ART
Advanced Realtime Tracking

DTRACK4 User's Guide

ARTTRACK, AT7-50, AT7-80, & DTRACK

Version 4.0.1
January 2026

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What's new in version 4.0.1?

The following new features are available in ***DTRACK4*** version v4.0.1:

- Minor bug fixes

What's new in version 4.0.0?

The following new features are available in ***DTRACK4*** version v4.0.0:

- Backend service running on Windows 10 and newer without dedicated Controller unit
- Support for ***AT7-50***
- 3D Monitor in Frontend

Contents

Terms and definitions

term	definition
3DOF	three degrees of freedom (i.e. only position)
6DOF	six degrees of freedom (i.e. position and orientation)
5DOF	five degrees of freedom (i.e. one degree less in orientation)
base	imaginary connecting line between two cameras
ARTTRACK6/M	infrared camera dedicated for compact environments or multi-sided projections
AT7-80	infrared camera dedicated for long range environments
AT7-50	infrared camera dedicated for standard range environments
body calibration	teach the system the geometry of a rigid body
body, rigid body	rigid arrangement of multiple markers intended for 6DOF tracking (see also "target")
calibration angle	belongs to the room calibration set and defines origin and orientation of the room coordinate system
ceiling suspension	equipment to mount an infrared camera to the ceiling
DTRACK4	
backend software	software service running on a customer's computer or dedicated PC doing all necessary calculations
frontend software	graphical user interface running on customer's computer to control the backend software
Field of View (FoV)	is the area of interest captured on the camera's image
finger thimble	a fixture for the finger tip to hold the active marker(s)
Fingertracking2	tracks the orientation of the hand and the position of the fingers
Fingertracking2 Tactile	tracks the orientation of the hand and the position of the fingers and provides Tactile Feedback
Flystick2/2+	wireless interaction device for virtual reality (VR) applications
Flystick feedback	vibrational or acoustic signal that can be triggered in a capable ***Flystick***
hand geometry	describes the dimensions of your hand and fingers
hybrid tracking	sensor fusion of optical and inertial data into one consolidated output
inertial sensor	an inertial measurement unit simultaneously measures 9 physical properties, i.e. angular rates, linear accelerations (unused) and magnetic field components (unused) along all 3 axes. This is achieved using solid state gyroscopes for measurement of roll, pitch and yaw and optical tracking for drift correction.
infrared optical tracking	position measurement of bodies (subjects or objects) based upon infrared light and optical measurement procedures
license code (license key)	software key to unlock certain capabilities of the tracking system
marker	object either made of retro reflective material or LED for position tracking (3DOF)
Measurement Tool	a pointing device which allows to measure the position of the tool's tip with high accuracy
measurement volume	defines the volume where optical tracking is possible
modulated flash	infrared signal which is used for wireless synchronization
motion capture	track movements of a human body
mutual blinding	at least one camera sees disturbing reflections caused by the infrared flashes of another camera
prediction	predicts output for the specified time in the future to compensate tracking and rendering latency
Radio Transceiver	exchange data with ***Flystick2/2+***

term	definition
RadioTransceiver2/3	uses USB port to exchange data with ***Flystick2/2+*** or ***Fingertracking2 Tactile***
room calibration	teach the system the position of each camera and define origin and orientation of the room coordinate system
room calibration set	consists of angle tool and wand
syncgroup	cameras being in one syncgroup receive the sync signal at the same time. Syncgroups are distinguished by a short time delay between their sync signals in order to avoid mutual blinding.
Tactile Feedback	system for finger-based interactions in immersive virtual reality applications (wires touch the inside of the finger tips and provide an impression when they are shortened)
target	rigid arrangement of multiple markers intended for 6DOF tracking (see also "rigid body")
tracking	position measurement of bodies that move in a defined space
virtual point cloud	used for calculating the relative position of cameras that cover the measurement volume
wand	precalibrated stick carrying two markers. The wand belongs to the room calibration set and is used to generate a virtual point cloud and to scale the measurement volume

1 Safety

1.1 Symbols and their meaning

You can find the following symbols and signs on the equipment or in the manual:

	Useful and important notes.
	Important notes, which may lead to system malfunction or to the loss of warranty by non-observance.
	Important safety warning to assure user's and operational safety. These warnings have to be observed, otherwise there is a potential risk for health and safety and damaging of the equipment resulting in loss of warranty and liability.
	Safety warning for infrared radiation. These warnings have to be observed, otherwise the user's eyes and sight are exposed to a potential hazard.

Table 1.1: Symbols and their meaning

1.2 Warnings

All warnings in this manual have to be observed for safe operation of the equipment.

Tous les avertissements dans ce manuel doivent être respectés pour garantir un fonctionnement sécurisé de l'équipement.

***ART* explicitly denies any warranty and liability if the product is not operated according to this manual or any other authorised documentation (e.g. quick-guides) or not according to the specifications of the equipment.**

1.2.1 Installation

The housings may NOT be damaged.

Do not install or use any equipment when it shows signs of damage (e.g. smoke, sparks, fire, smells, etc) or if parts of it show damaging.

Do not install or use any equipment when the power cord is damaged.

Insert batteries in the indicated polarity !

Insérer les piles dans le sens de polarité indiqué !

Some equipment employs connectors of proprietary design. Do not try to connect these to any other computer ports (e.g. COM port or LAN) !!!

Verify that voltage and frequency of your electrical grid comply with the appliance ratings of the equipment. The rating plates are found on the equipment's housing (typically on the rear side) or on the external power supplies.

Vérifiez que la tension et la fréquence de votre réseau électrique correspondent aux spécifications de l'appareil. Les plaques signalétiques se trouvent sur le boîtier de l'équipement (l'arrière du boîtier) ou sur l'alimentation externe.

The equipment may only be powered from power sockets connected to earth/ground. If the grounding wire is defective the requirement of the safety and the electromagnetic compatibility (EMC) cannot be guaranteed. To check the function of the grounding wire ask your local electrician.

L'équipement ne peut être alimenté que par des prises de courant reliées à la terre/au sol. Si le fil de mise à la terre est défectueux, les exigences de sécurité et de compatibilité électromagnétique (CEM) ne peuvent être garanties. Pour vérifier le fonctionnement du fil de mise à la terre, demandez à un électricien local.

The power switch on the equipment does not separate the device from mains. The equipment must be disconnected from mains.

1.2.2 Mounting

Do not touch the front pane of the cameras. The acrylic pane and the lens have highly sensitive surfaces. Be careful to avoid permanent damages (e.g. scratches).

Shock and severe vibrations can permanently damage the internal calibration of the cameras. De-calibrated cameras have to be sent in for maintenance.

The power cord and plug should be accessible freely. The power socket should be close to the equipment.

Install the cables that the line of sight of the cameras or *SMART-TRACK3+3/M* is not obstructed.

Grab the cameras only on the housing. Risk of Electrostatic Discharge (ESD) !

Tenez les caméras uniquement par le boîtier. Risque de décharge électrostatique (ESD) !

Do not drop the equipment.

Be sure that the cameras are firmly mounted using strong wall plugs / anchors and screws when mounting to walls or ceilings. Loosely mounted cameras may pose a serious hazard to health and safety.

Never unfasten screws that are not designed for mounting. All liability and warranty is void.

Use only accessories for mounting (screws, ceiling suspension) supplied by *ART* .

Ventilation holes on the equipment must not be covered. Ensure unblocked airflow at all times. The minimum distance between equipment and surrounding objects has to be larger than 3 cm.

Install a strain relief to all cables to avoid damage to the equipment.

Install the cables trip-proof (e.g. cable ducts or fixings). Inappropriate cabling may pose a serious hazard to health and safety.

Installez les câbles de manière à les protéger contre les risques (par exemple, en utilisant des canalisations ou des fixations pour câbles). Un câblage inapproprié peut représenter un grave danger pour la santé et la sécurité.

1.2.3 Operation

Unplug the equipment from mains immediately in any case of damage ! Please contact *ART* service

Removable batteries must be removed before shipping equipment.

Batteries should be removed when equipment is not used for a longer period of time - Risk of damage !

Do not use non-rechargable batteries in rechargable equipment (e.g. *Flystick2*) - Risk of explosion !

Ne pas utiliser de piles non rechargeables dans des équipements rechargeables (par exemple, *Flystick2*) - Risque d'explosion !

Do not crush or puncture batteries and avoid impact that might result in damage, leakage or short-circuiting.

Use only original components and accessories from *ART* or authorized by *ART* . Using unauthorized components or accessories may damage the equipment, may cause malfunctioning and may compromise operational safety.

Utilisez uniquement des composants et accessoires d'origine de *ART* ou autorisés par *ART* . L'utilisation de composants ou accessoires non autorisés peut endommager l'équipement, provoquer des dysfonctionnements et compromettre la sécurité opérationnelle.

In case connectivity is provided using third party equipment please ensure compliance to all applicable standards regarding connectivity and power supply (see chapter A on page 166). Non-compliance may result in loss of conformity ! All warranty and liability is void.

Only peripheral devices which meet the safety requirements of UL 60950-1 (U.S. only) and EN / UL / IEC 62368-1 (EU, U.S., etc.) for SELV may be attached on Ethernet-, BNC- and the DC-circuit of the equipment.

Do not change or modify the equipment in any way (e.g. mechanically, electrically). Non-compliance may result in loss of conformity ! All warranty and liability is void.

Do not spill fluids over the equipment!

Do not insert objects into the equipment (e.g. ventilation openings) !

Do not expose the equipment to high levels of humidity or condensing environments.

Ne pas exposer l'équipement à des niveaux élevés d'humidité ou à des environnements où la condensation est possible.

The equipment must not be operated in environments with intensive formation of dust.

L'équipement ne doit pas être utilisé dans des environnements avec une formation intense de poussière.

The equipment must not be operated in environments with elevated temperatures above 40° C (100° F).

L'équipement ne doit pas être utilisé dans des environnements avec des températures élevées supérieures à 40° C (100° F).

Do not use the equipment outdoors (i.e. outside of buildings or potentially moist / wet locations) !

Ne pas utiliser l'équipement à l'extérieur (c'est-à-dire en dehors des bâtiments ou dans des endroits potentiellement humides / mouillés) !

The cameras emit infrared light. Keep a distance of min. 20 cm when operating near cameras. All cameras are assigned to the Exempt Group according to IEC62471-1 and therefore pose no risk or hazard to the human eye or skin at this distance.

Les caméras émettent de la lumière infrarouge. Gardez une distance minimale de 20 cm lorsque vous travaillez à proximité des caméras. Toutes les caméras sont classés dans le Groupe Exempt selon la norme IEC62471-1 et ne présentent donc aucun risque ou danger pour les yeux ou la peau humaine à cette distance.

1.2.4 Maintenance

Only the housing of the cameras may be cleaned, do not touch lenses or other optical components. Before cleaning shut down the system and disconnect the power cords.

Do not use any solvents, water or chemicals to clean the cameras!

Do not try to repair anything by yourself!

All warranty and liability is void when the equipment is opened.

Danger High Voltage inside the equipment ! Do not open the equipment ! Risk of electric shock - even if the equipment is disconnected. Please contact *ART* service.

Danger Haute Tension à l'intérieur de l'équipement ! Ne pas ouvrir l'équipement ! Risque de choc électrique - même si l'équipement est déconnecté. Veuillez contacter service *ART* .

In order to replace mains fuses always unplug the power cord first. Risk of electric shock !

Pour remplacer les fusibles secteur, débrancher toujours d'abord le cordon d'alimentation. Risque de choc électrique !

Risk of explosion if removable batteries are replaced by an incorrect type!

Risque d'explosion si les batteries amovibles sont remplacées par un type incorrect!

1.2.5 Disposal & Recycling

Waste Electronic and Electrical Equipment (WEEE) should never be disposed of along with household waste.

Batteries should never be disposed of along with household waste.

Batteries or rechargeable batteries that are not permanently installed must be removed beforehand and disposed of separately.

To prevent fires due to short-circuits, tape battery terminals and/or place lithium-ion batteries in separate plastic bags.

Do not crush or puncture used batteries and avoid impact that might result in damage, leakage or short-circuiting.

2 General Information

2.1 Cleaning of the equipment

Use a dry, lint-free and antistatic cloth or tissue (e.g. lens-cleaning tissue for optical equipment).

Only the housing of the cameras may be cleaned, do not touch lenses or other optical components. Before cleaning shut down the system and disconnect the power cords.

Do not use any solvents, water or chemicals to clean the cameras!

2.2 Maintenance and service

Routine maintenance of the equipment is recommended every three years. If you experience any problems please do not hesitate to contact our support.

Do not try to repair anything by yourself!

Danger High Voltage inside the equipment (e.g. *ART Controller*) ! Do not open the equipment ! Risk of electric shock - even if the equipment is disconnected. Please contact *ART* service.

Danger Haute Tension à l'intérieur de l'équipement ! Ne pas ouvrir l'équipement ! Risque de choc électrique - même si l'équipement est déconnecté. Veuillez contacter service *ART* .

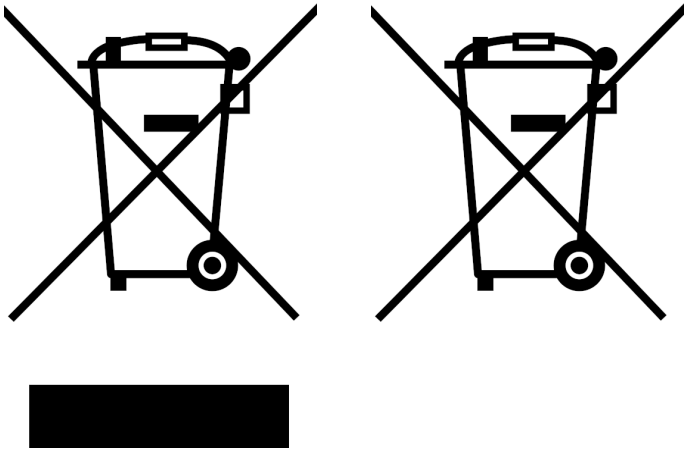
All warranty and liability is void when the equipment is opened.

2.3 Disposal and recycling of equipment

Waste Electronic and Electrical Equipment (WEEE) may contain a complex mixture of materials and hazardous substances. If not managed properly and thus exposed, these can cause serious damage to the environment, wildlife, and human health. In addition, modern electronics contain rare and expensive resources, which can be recycled and re-used to contribute to the circular economy. By ensuring that you dispose of WEEE properly, you are helping to improve sustainable production and consumption, to increase

resource efficiency and to preserve our natural resources and protect human health.

The symbol (crossed-out wheelie bin symbol according to Waste Electronic and Electrical Equipment (WEEE) Directive 2012/19/EU, see figure 2.1 (a) or (b) on page 15) indicates that the product should not be discarded as unsorted municipal waste but must be sent to separate collection facilities for recovery and recycling.



(a) equipment placed on the market prior to 2005

(b) equipment placed on the market after 2005

Figure 2.1: WEEE label

When your delivery address is outside of Germany, dispose of WEEE at your local waste facilities or recycling centers available by public waste management authorities only. Please consider that local regulations on the disposal of and recycling of electronic and electrical equipment may apply. Contact your local authority directly for more information.

For deliveries inside Germany only:

- End-users of WEEE are obliged to return the equipment or have it collected within the framework set up by ***ART*** .
- You are responsible for deleting personal or confidential data from the equipment to be disposed of. You can do this by resetting the device to its factory settings. Please refer to ***DTRACK4 User's Guide*** → *Connecting to the controller* → *Configuring your controller's network address without network access* for more details. ***ART*** is not liable for any data on your device. Before resetting your device, you should always back up any sensitive data.
- For further details regarding the WEEE directive, including how ***ART*** ensures the safe disposal of your electrical and electronic equipment, please refer to our website at https://ar-tracking.com/de/art-geraete-ruecknahmekonzept

Waste Electronic and Electrical Equipment (WEEE) should never be disposed of along with household waste.

2.4 Disposal and recycling of batteries

Batteries are made from important resources, including lead, cadmium, zinc, lithium and mercury. Many of the components of these batteries and rechargeable batteries could be recycled, avoiding the exposure of hazardous substances to the environment. In addition, by recycling your used batteries using the collection and recycling schemes available you are contributing to protecting Earth's natural resources by providing valuable materials to products and production processes.

The symbol (crossed-out wheeled bin symbol according to Battery Directive 2006/66/EC, see figure 2.1 (b) on page 15) indicates that you are legally obliged to dispose of batteries or rechargeable batteries separately from unsorted municipal waste, i.e. that they must be disposed of separately from household waste. If batteries or rechargeable batteries contain Mercury (Hg), Cadmium (Cd) or Lead (Pb), they are marked with the chemical symbols of the metals (Hg, Cd, Pb) for which the limit value is exceeded.

- Pb = battery contains more than 0.004 mass percent Lead
- Cd = battery contains more than 0.002 mass percent Cadmium
- Hg = battery contains more than 0.0005 mass percent Mercury

When your delivery address is outside of Germany, dispose of used batteries at dedicated battery collection points or recycling centers available by public waste management authorities only. Please consider that local regulations on the disposal of and recycling of batteries may apply. Contact your local authority directly for more information.

For deliveries inside Germany only:

- End-users of batteries are obliged to recycle used batteries via dedicated battery collection points or recycling centers set up by public waste management authorities or via retailers directly. Addresses of suitable collection points and recycling facilities in your area can be obtained from your city or by contacting your local authorities.
- For further details regarding the Battery Directive, please refer to our website at https://ar-tracking.com/de/art-geraete-ruecknahmekonzept

Batteries should never be disposed of along with household waste.

Batteries or rechargeable batteries that are not permanently installed must be removed beforehand and disposed of separately.

To prevent fires due to short-circuits, tape battery terminals and/or place lithium-ion batteries in separate plastic bags.

Do not crush or puncture used batteries and avoid impact that might result in damage, leakage or short-circuiting.

2.5 Warranty

General Please refer to the terms & conditions on our website at https://ar-tracking.com/en/terms-agb

Hardware ***ART*** warrants the hardware to be free from defects in material and workmanship, design and manufacturing for the warranty period set forth in our terms & conditions (see website) after the time of delivery. The time of delivery is defined as the day when the end-user takes possession of the equipment. If ***ART*** or any third party authorized by ***ART*** installs the system, the time of delivery is the time of the first installation.
If a defect arises during this warranty period, provided the instructions for returning the hardware are followed, ***ART*** will, to the extent permitted by law, initially either (i) repair or (ii) replace the hardware or any defective parts. All replaced parts and hardware shall become property of ***ART*** . This limited warranty applies only to hardware components that have been under ordinary and intended use and service being in their original, unmodified state and thus have not been subject to damage from external causes, alteration or unauthorized repair.

Software Software supplied is delivered on a tested "As Is" basis. ***ART*** explicitly does not warrant that the software is error (bug) free. If the user detects bugs and notifies ***ART*** , ***ART*** will provide a workaround or bug fix as soon as possible after successfully reproducing the error.

Warranty restrictions All warranty and liability is void, if the equipment

- is not operated according to this manual or any other authorized documentation (e.g. quick-guides),
- has not been used according to the specifications of the equipment,
- shows damages or signs of improper use,
- has been opened by the user or other non-authorized personnel (non-members of ***ART*** and third parties not authorized by ***ART***),
- has been modified or tampered with by the user or other non-authorized personnel (non-members of ***ART*** and third parties not authorized by ***ART***).

2.6 Liability

General Please refer to the terms & conditions on our website at https://ar-tracking.com/en/terms-agb

In no event shall ***ART*** be liable for any incidental, indirect or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business

interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use the software or hardware.

Measurement results *ART* products are not authorized for use under any circumstance where human life might be at risk due to malfunction, measurement errors or interrupted operation of the system without written approval of a managing director of *ART* .
It is the user's sole responsibility to check the results of the measurement data and to protect any downstream system against malfunction, measurement errors or interrupted operation of the system. Under no circumstances shall *ART* be held liable for any incidental, indirect or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of malfunction, measurement errors or interrupted operation of the system.

***ART* explicitly denies any warranty and liability if the product is not operated according to this manual or any other authorized documentation (e.g. quick-guides) or not according to the specifications of the equipment.**

Do not change or modify the equipment in any way (e.g. mechanically, electrically). Non-compliance may result in loss of conformity ! All warranty and liability is void.

3 Introduction to tracking

The ***ART*** tracking systems are infrared (IR) optical tracking systems. In this user manual we are going to perceive "tracking" as measurement of positional and rotational information (i.e. orientation) of objects or individuals that move in a defined space.

Concept of optical tracking The cameras send out synchronized IR flashes which are reflected back into the lens by retro-reflective material covering the markers of the target. The reflected IR light is detected by the tracking cameras which create a greyscale image based on the received IR radiation.
In the next step these images are preprocessed by the cameras to calculate the marker positions (2DOF) on the camera sensor with high accuracy using pattern recognition algorithms. Then this 2DOF data is sent to a control unit to calculate 3DOF or 6DOF information.

The simultaneous measurement of spatial position (X, Y, Z) and orientation (three independent angles) is called 'six degrees of freedom' (6DOF) tracking. If only the spatial position (X, Y, Z) is to be measured it is called 'three degrees of freedom' (3DOF) tracking.
Single markers are sufficient if only 3DOF coordinates are needed, but single markers cannot be distinguished in principle. An ID is assigned to a tracked 3DOF marker as long as it can be followed, but after loosing the tracking (e.g. due to occlusions) one would not be able to re-identify the marker and thus a new ID will be assigned. For 6DOF tracking, however, a unique target is mandatory. Targets are rigid arrangements of markers (=rigid bodies) and thus can be identified by their relative marker position. Figure 3.1 on page 20 shows the concept of infrared optical tracking with a two-camera system and a standard target.

The base for this calculation is that the cameras' field of views are overlapping. In a two-step teaching process, the position and orientation of the cameras is made known to the system (the 'room calibration'), after which the system is taught to identify the unique arrangements of markers as targets (the 'body calibration'). Then the paths of the optical rays from the cameras to the markers are calculated to deliver the ray intersections in three-dimensional coordinates. These intersections are the positions of the markers.
Based upon this, one is able to calculate 6DOF data and, finally, knows position and orientation of the target and therefore the object or individual to be tracked.

Note: In pure optical tracking systems tracking is only possible as long as

- objects or individuals to be tracked are equipped with single markers or targets

- the target is not occluded by any other objects in the cameras' line of sight, which could even be the object itself
- the target is positioned inside the tracking range of the cameras
- at least four markers of a target are visible to at least two cameras (this step enables tracking).

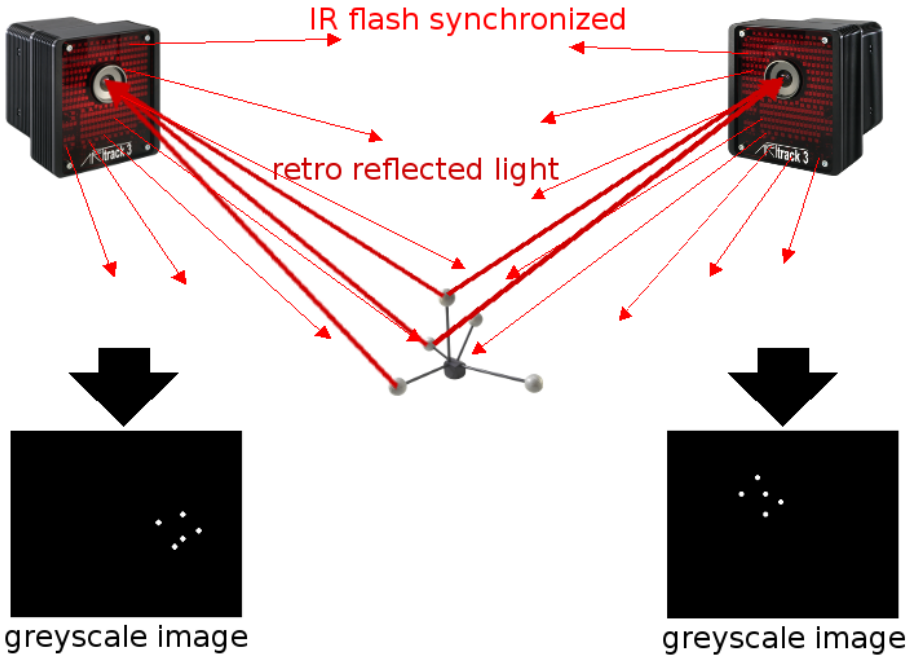


Figure 3.1: Concept of optical tracking (stereo vision)

Marker types Passive markers are covered with retro reflective material - they act as light reflectors. Active light emitters (i.e. based on infrared LEDs) are called active markers. Please refer to the ***ART Hardware Installation Guide*** for more information on markers & targets.

Hybrid tracking (via 3rd party software) In addition to tracking by a pure optical system it is possible to utilize data from inertial measurement units (IMU). These devices usually consist of several components such as gyroscopes, accelerometers and magnetometers. The underlying principle is the combination of solid-state microelectromechanical systems with integrated circuits and analog or digital outputs to achieve 6DOF rotational information.

Some of the most important advantages of hybrid tracking are:

- tracking data from IMUs offers low noise-levels while running at very high frequencies in combination with low latencies

- IMUs deliver tracking data (i.e. rotational information) even when the optical target is not inside the tracking volume or if the target cannot be tracked due to viewing limitations or occlusions
- drifting of IMUs (i.e. mostly from the 3-axis gyroscope) is compensated by fusing the inertial data with position measurements calculated from the optical tracking system

A hybrid target is basically an optical target additionally equipped with an IMU.
There the tracking data from both worlds (i.e. hybrid) is combined, which also leads to the term 'sensor fusion'. By nature the IMU contains an independent coordinate system which needs to be aligned to the optical tracking system axes. This additional teaching process is called hand-eye calibration.

Tracking with *DTRACK4* All new ***DTRACK4*** systems are based on a software service rather than a controller which operates cameras, interaction devices (optional) and targets respectively. The backend software runs as a service on a PC - all necessary calculations (3DOF, 6DOF data, etc.) are performed there. The data and control commands are interchanged between the service and the ***DTRACK4*** frontend software either locally or via ethernet (TCP/IP connection) with a remote PC. ***DTRACK4*** frontend offers a GUI for easy handling that enables the user to control the tracking system at a distance. The benefit is that the system becomes more flexible, i.e. different users can control the tracking system at any one time (but not simultaneously!) from different working places.
Data output to the application or graphics workstation is also done via ethernet (UDP/IP connection).

DTRACK4 also provides the possibility to control the functions in the backend via ethernet (i.e. without the ***DTRACK4*** frontend software). This is also done by establishing a TCP/IP connection with the service and exchanging short command strings (refer to the ***DTRACK4 Programmer's Guide***).

4 Installing *DTRACK4*

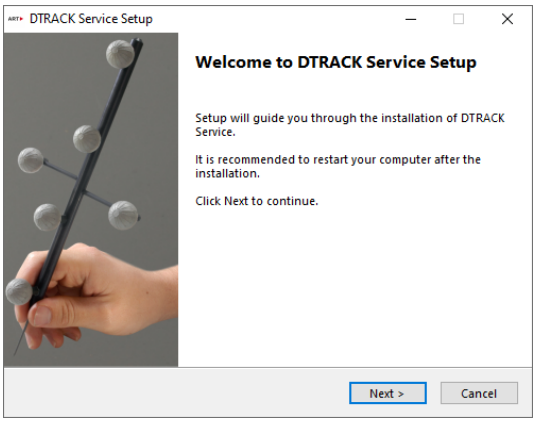
Installation of ***DTRACK4*** is a multi-step process of installing ***DTRACK Backend Service*** & ***DTRACK4 Frontend*** and configuring your network adapter to connect your PC to your tracking camera network.

The ***DTRACK Backend Service*** is intended to run on a PC (Windows) that connects to all cameras via ethernet while the ***DTRACK4 Frontend*** runs either on the same or on a remote PC (Windows). Both softwares are delivered via USB pen-drive or via the Download Center at
http://www.ar-tracking.com/downloads/

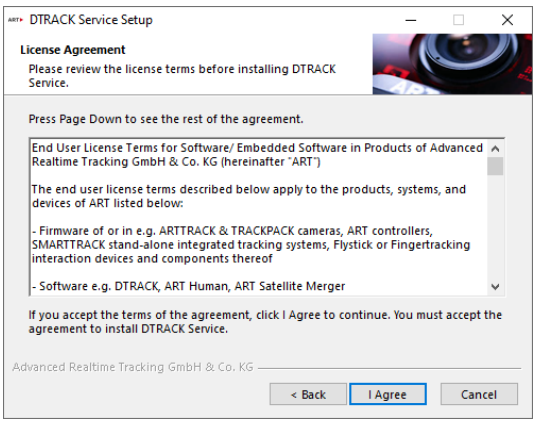
4.1 Installation of the backend service

☞ **Administrator privileges ARE necessary for the following steps. Please ensure you can provide the administrator password when prompted. Ask your system administrator or representative.**

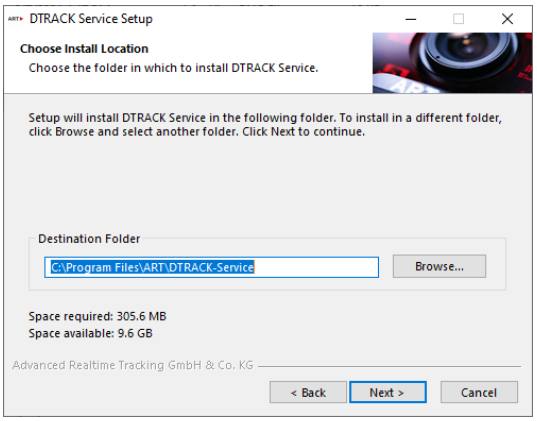
Please refer to chapter A.1 on page 166 for more information on supported operating systems (Windows 10 and later, 64-bit only).
Run the installation executable "*DTRACK4-4.X.Y-win64.exe*" (64-bit package available only) and the installation wizard of ***DTRACK Backend Service*** starts to unzip.



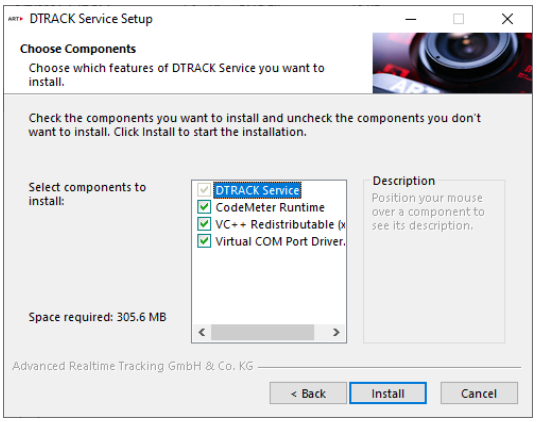
Click *Next* to continue and to start the installation process for ***DTRACK Backend Service*** .



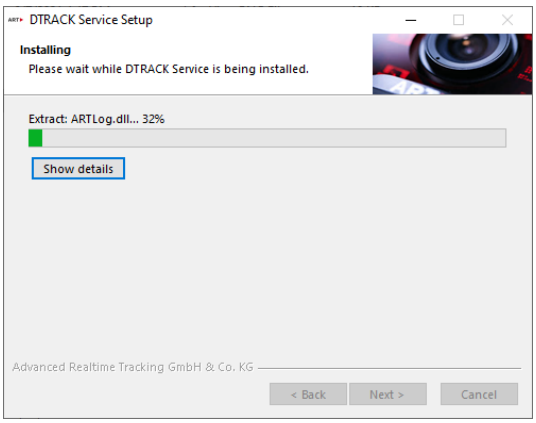
Please read the license terms carefully and press *I Agree* if you agree indeed.



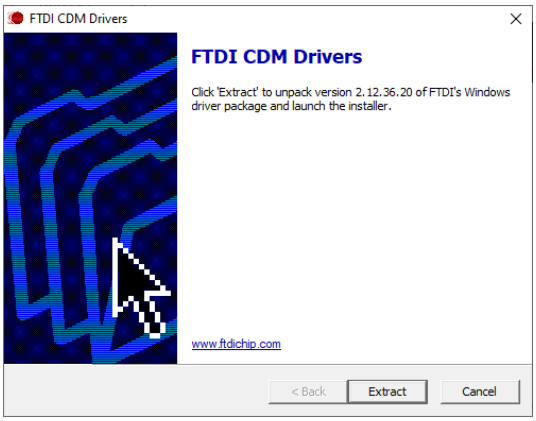
Now, please choose the destination folder in which you want to install ***DTRACK Backend Service*** .



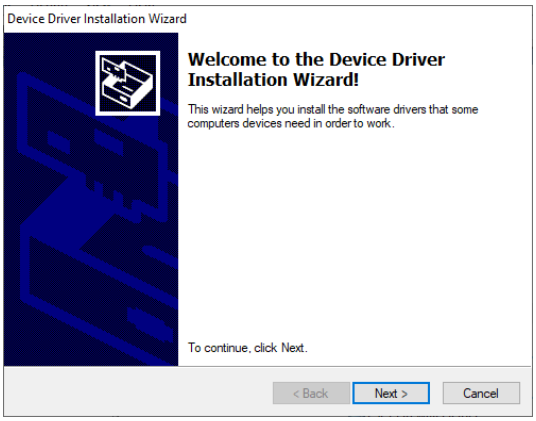
Next you may choose the components to be installed on the ***DTRACK Backend Service*** PC. Note: CodeMeter Runtime is obligatory to access the CmStick USB copy-protection dongle (WIBU-SYSTEMS). The Virtual COM Port Driver is optional but necessary for handling the ***Radio-Transceiver2/3*** device.



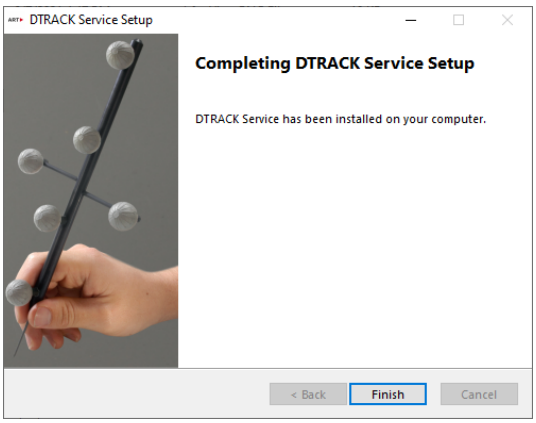
A new window shows the installation process of the ***DTRACK Backend Service*** using a progress bar.



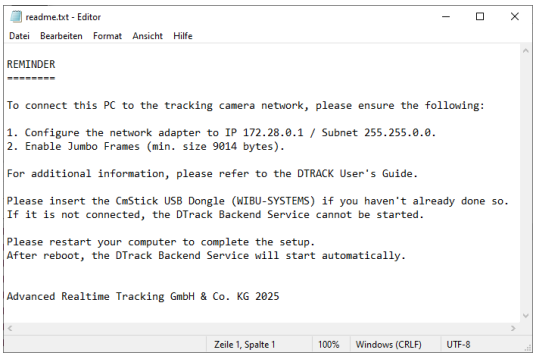
Optional: Installation of the Virtual COM Port Driver opens a separate dialog window. Click *Extract* to start the installation process.



Optional: Click *Next* to install the Virtual COM Port Driver. Accept the license terms by checking *I accept this agreement*, followed by clicking *Next*. After the installation has succeeded please close the dialog window by pressing *Finish*.



As soon as the ***DTRACK Backend Service*** has been installed press *Finish* to complete the ***DTRACK Backend Service*** setup wizard. A readme file will open afterwards to remind you to configure your network adapter.



Insert the CmStick USB copy-protection dongle (WIBU-SYSTEMS) in one of the USB slots and restart the PC. The backend service is started automatically after a restart.

Your *DTRACK Backend Service* PC should offer at least 2 physical network adapters.

Information regarding requirements to run *DTRACK Backend Service* (operating system, etc.) are opened automatically after the installation is complete. Please read the information carefully.

Please insert the CmStick USB copy-protection dongle (WIBU-SYSTEMS) in one of the USB slots and restart the PC after the installation of *DTRACK Backend Service* has been finished.

Please do not insert more than 1 CmStick USB copy-protection dongle (WIBU-SYSTEMS) in the *DTRACK Backend Service* PC.

After changing the CmStick USB copy-protection dongle (WIBU-SYSTEMS) the *DTRACK Backend Service* has to be restarted manually (e.g. using the *DTRACK4 Frontend*).

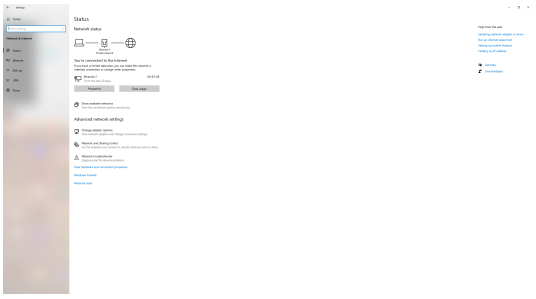
Newer versions of the *DTRACK Backend Service* may NOT be installed parallel to the last / current version. You will be asked to uninstall any previous installation.

Recommendation: Keep the installers of older backend service versions of *DTRACK Backend Service* so you can easily revert to the last version.

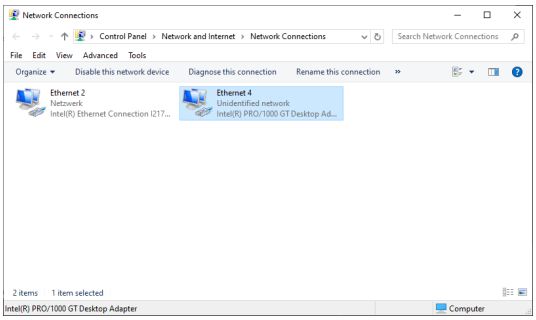
4.2 Configuration of the network adapter

Administrator privileges ARE necessary for the following steps. Please ensure you can provide the administrator password when prompted. Ask your system administrator or representative.

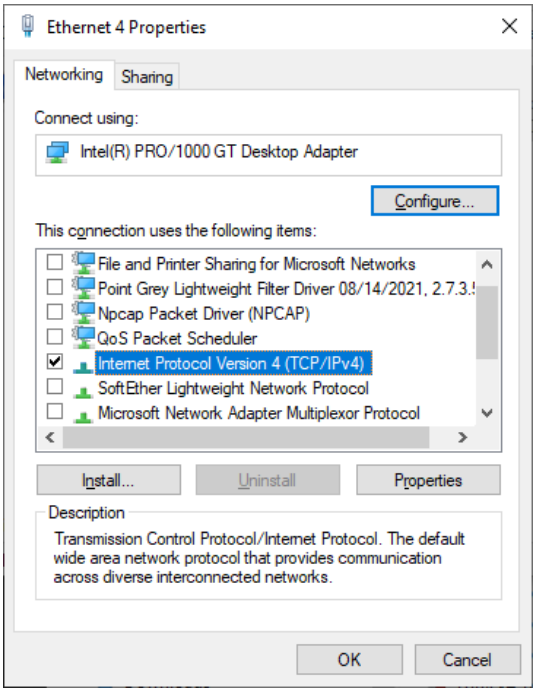
In order to connect to the tracking camera network you need to configure your secondary network adapter accordingly.



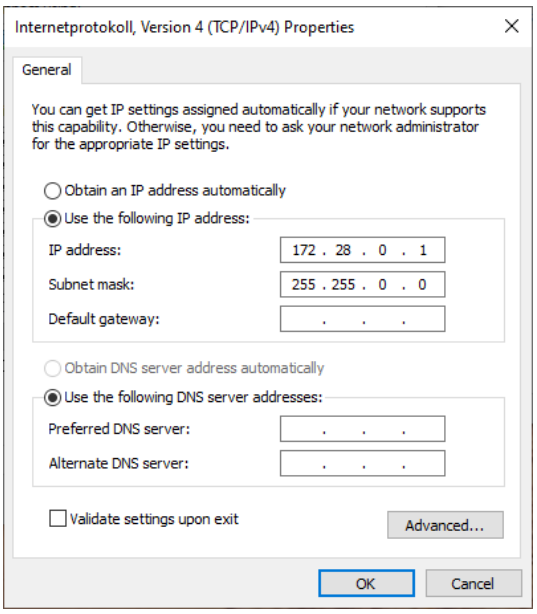
In Windows open the Start menu and go to *Settings*. In this dialog choose *Network & Internet* to open the dialog shown. Click *Change adapter options* under Advanced Network Settings.



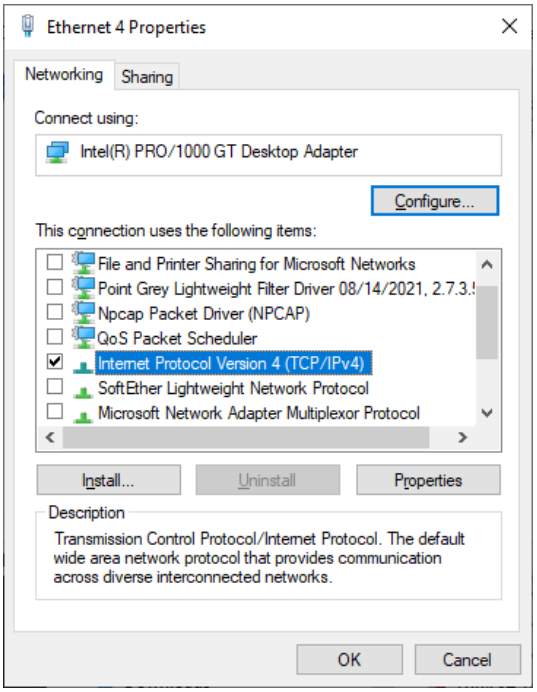
In the window *Network Connections*, please choose the network adapter that is showing *unidentified network* and open the context menu by right-clicking. Click on *Properties* and provide the administrator password.



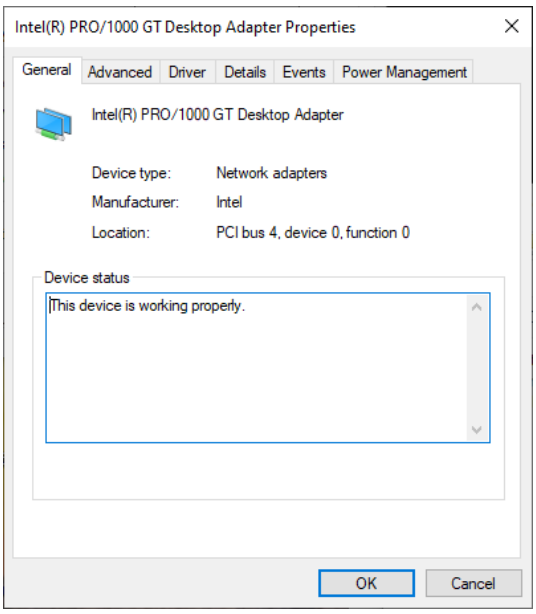
The *Ethernet Properties* dialog now shows several items. Untick all items other than *Internet protocol, Version 4 (TCP/IPv4)* to deactivate them. Next select the item *Internet protocol, Version 4 (TCP/IPv4)* and click on the button *Properties*.



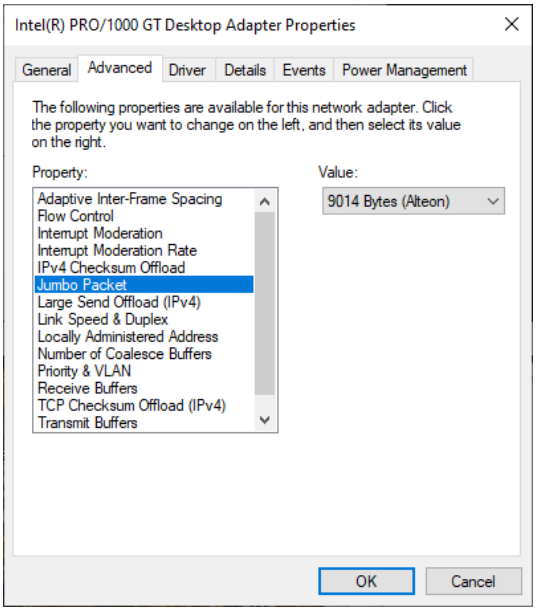
The subdialog *Internet protocol, Version 4 (TCP/IPv4) Properties* will open. Tick the option *Use the following IP address* and insert the following information: IP address: 172.28.0.1 / Subnet mask: 255.255.0.0. Close the subdialog by clicking *OK*.



After returning to the *Ethernet Properties* dialog click on the button *Configure*.



The dialog *Adapter Properties* opens showing the tab *General*.



Switch to the tab *Advanced* and select the property item *Jumbo Packet*. Increase the *Value* on the right to at least 9014 bytes. Accept the changes by clicking *OK*. All dialogs will close automatically up to *Network Connections*. Close that window as well.

The camera IP addresses are predefined - changes by the user are not possible:

- **IP address: 172.28.X.X**
- **subnet mask: 255.255.0.0**

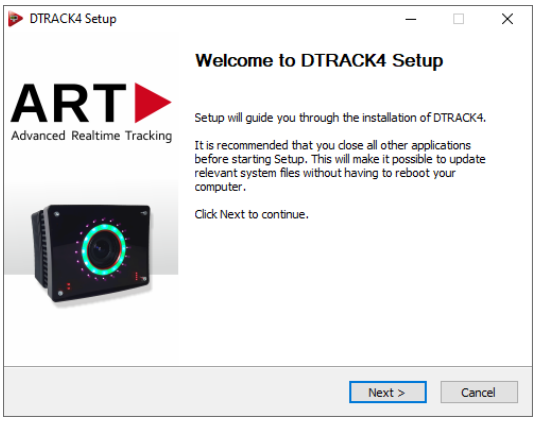
Please enable Jumbo Frames / Jumbo Packets (min. size 9014 bytes) on your network adapter connecting to the tracking camera network!

Please double-check that only the secondary network adapter settings are changed. Changes of the primary network adapter settings (i.e. IP address or Subnet mask) is not part of your personal configuration or Windows user account. It will affect all users of your *DTRACK Backend Service* PC! Your *DTRACK Backend Service* PC may become unreachable with wrong IP settings!

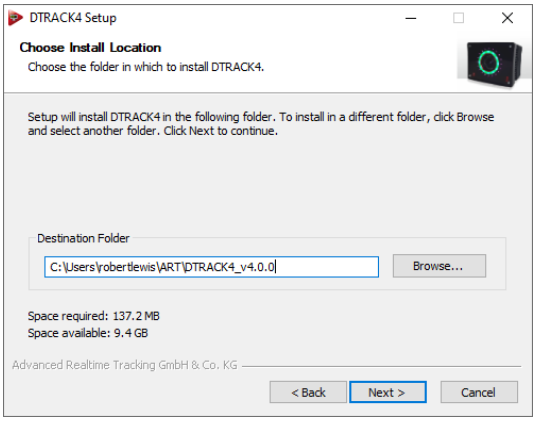
4.3 Installation of the frontend software

4.3.1 Installation under Microsoft Windows

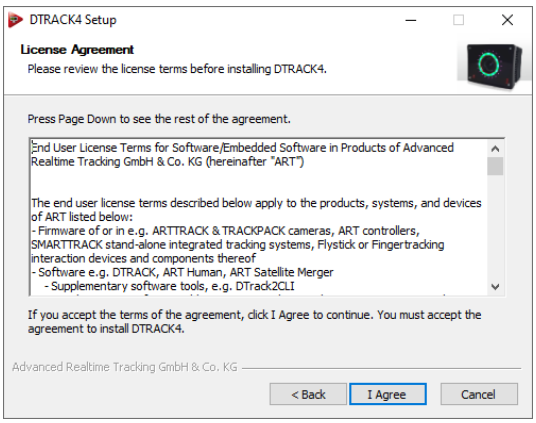
Please refer to chapter A.1 on page 166 for more information on supported operating systems (64-bit only).
Run the installation executable "*DTRACK4_v4.X.Y_win64_install.exe*" (64-bit package available only) and the installation wizard of ***DTRACK4 Frontend*** starts.



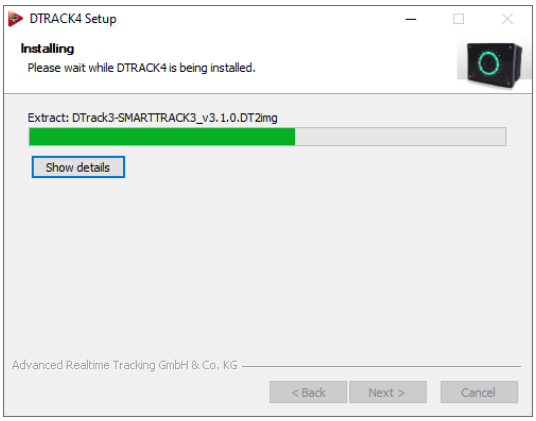
Click *Next* to continue and to start the installation process for ***DTRACK4 Frontend*** software. Administrator privileges are not necessary.



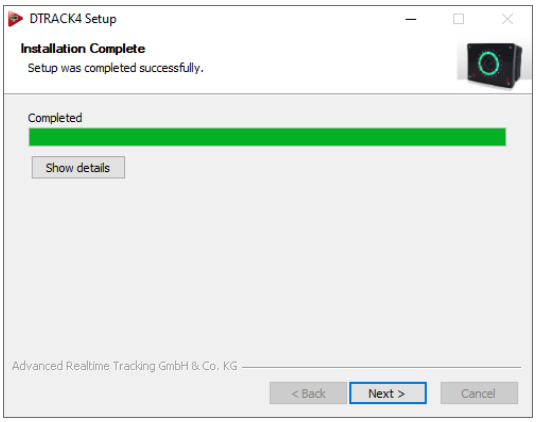
Now, please choose the destination folder in which you want to install ***DTRACK4 Frontend*** .



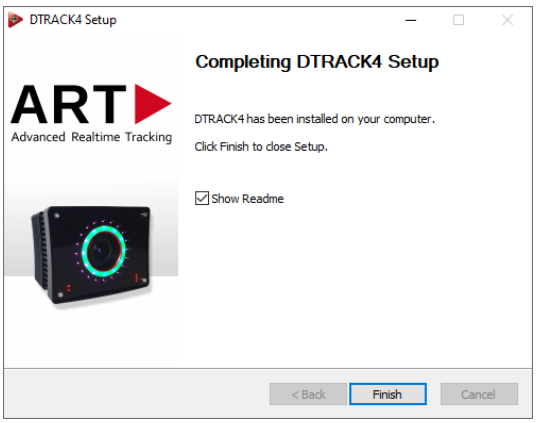
Please read the license terms carefully and press *I Agree* if you agree indeed. A new window shows the installation progress.



The installation of the ***DTRACK4 Frontend*** software is shown using a progress bar.



After ***DTRACK4 Frontend*** has been installed on your computer click *Next*.



Press *Finish* to complete the ***DTRACK4 Frontend*** setup wizard. Now, you can use ***DTRACK4 Frontend*** .

Information regarding requirements to run *DTRACK4 Frontend* (operating system, etc.) are opened automatically after the installation is complete. Please read the information carefully.

Newer versions of *DTRACK4 Frontend* may be installed parallel to the last / current version.

Recommendation: Do not overwrite previous installations of *DTRACK4 Frontend* so you can easily revert to the last version.

4.4 Software update

The latest ***DTRACK4*** software is always available from our Download Center at https://ar-tracking.com/en/downloadcenter
For installation of the backend service, please follow the chapter 4.1 on page 22. For installation of the frontend software, please proceed as mentioned before in chapter 4.3.1 on page 29.

All patch releases and updates (e.g. v4.0.0 → v4.0.1 → v4.0.2 →...) may be installed without restrictions.

It will be determined whether *DTRACK4* may be upgraded to the next minor version (e.g. v4.0.0 → v4.1.0) without purchasing a valid '*DTRACK4 Upgrade*' license. Please contact your *ART* representative for more information.

4.5 Automatic configuration backups

The current configurations and settings used by the backend service are saved automatically on the copy-protection dongle. In the event of a defective PC unit this backup can be transferred to any new replacement device. The license is transferred onto the replacement as well. Additionally all configurations are backuped upon starting the frontend software on the corresponding PC in the path `C:\Users\user\.ART\DTRACK4\v4.X.Y\backup\` with `user` being the name of the currently used account on Windows and

v4.X.Y being dependent on the version of ***DTRACK4*** . Please refer to 7.3.3 on page 65 how to restore a complete backup.

Only the 2 most current backups are stored, older versions are deleted periodically.

4.5.1 Deactivation of automatic backups

Automatic backups are active by default. In order to deactivate this feature (e.g. due to confidential data stored in the configurations) first close the ***DTRACK4 Frontend*** . Then open and edit the configuration file current-preferences.xml found in the following folder: C:\Users\user\.ART\DTRACK4\v4.X.Y\config\ with user being the name of the currently used account on Windows and v4.X.Y being dependent on the version of ***DTRACK4 Frontend*** .

Frontend configuration file Following, a description of the file (e.g. C:\Users\JohnDoe\.ART\DTRACK4\v4.0.0\config\current-preferences.xml) format:

```
<?xml version="1.0" encoding="UTF-8"?>
<DTRACK>
    <LAST_TRACKBOX MODEL="" IP="10.10.1.1" HOSTNAME="controller-hostname" MAC="AA:BB:CC:DD:EE:FF"/>
    <TRACKBOX_SELECTION>
        <FIX_HOSTNAME_OR_IP></FIX_HOSTNAME_OR_IP>
        <FIX_SUBNET>(all subnets)</FIX_SUBNET>
        <NET_RANGE>scan</NET_RANGE>
        <!-- possible values for NET_RANGE: scan, specific_atc -->
        <CASCADED_SYSTEM>false</CASCADED_SYSTEM>
    </TRACKBOX_SELECTION>
    <LAST_FRONTEND_UPDATE UPDATE_DATE="2023-09-29T18:28:50"/>
    <CAMERA_SETTINGS>
        <SHOW_DYNAMIC_REFLEX_SUPPRESSION>false</SHOW_DYNAMIC_REFLEX_SUPPRESSION>
    </CAMERA_SETTINGS>
    <MENUE>
        <SHOW_SERVICE>false</SHOW_SERVICE>
        <IS_DARK_THEME>true</IS_DARK_THEME>
    </MENUE>
    <MISC>
        <AUTO_BACKUP>true</AUTO_BACKUP>
    </MISC>
</DTRACK>
```

In order to deactivate the automatic backup feature change the corresponding entry and save the changes.

before:

```
    <MISC>
        <AUTO_BACKUP>true</AUTO_BACKUP>
    </MISC>
```

after:

```
<MISC>
    <AUTO_BACKUP>false</AUTO_BACKUP>
</MISC>
```

DTRACK4 Frontend has to be closed before editing the frontend configuration file.

Please note that these settings are only applicable for the user account currently used for log-in in Windows. Changes will not affect other user accounts on the remote PC.

The deactivation of automatic backups is applicable to all backend services accessed by the current user account in Windows.

5 Connecting to the controller

5.1 Start *DTRACK4 Frontend*

When you start up ***DTRACK4 Frontend*** on the remote PC you will see the following welcome splash screen (see figure 5.1 on page 34) . Using the mouse or shortkeys (2 = down, 4 = left, 6 = right, 8 = up) you can move around the splash screen window, e.g. to a secondary screen. The position of the window is then saved and will be used at the next start-up.

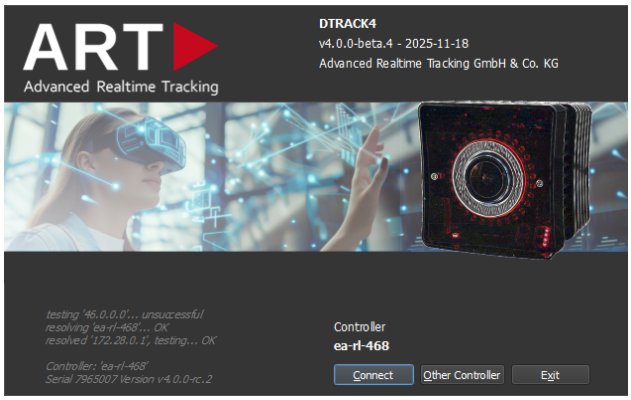


Figure 5.1: Welcome screen of ***DTRACK4 Frontend***

DTRACK4 Frontend will always try to connect to the last known ***DTRACK Backend Service*** . On the lower left hand corner of the splash screen the current status of connection is shown (refer to table 5.1 on page 35).

status message	Description
testing '*IP-address*'	***DTRACK4 Frontend*** is trying to access the last known ***DTRACK Backend Service*** using the IP address shown
testing '*IP-address*' ... OK	***DTRACK Backend Service*** is powered-up and is accessible by LAN
Controller: '*hostname*'	***DTRACK4 Frontend*** is able to connect to the last known ***DTRACK Backend Service***
no connection to controller '*hostname*', accessed by *IP address*	last known ***DTRACK Backend Service*** is being accessed by another client
testing '*IP-address*' ... unsuccessful	***DTRACK4 Frontend*** is unable to access the last known ***DTRACK Backend Service*** (e.g. not powered up / in standby, not accessible by LAN)
resolving '*hostname*' ... unsuccessful	
no connection to '*hostname*'	

Table 5.1: Splash Screen - Description of status messages

If ***DTRACK4 Frontend*** is run for the first time please open the window *Tracking System - Selection*. Please refer to chapter 5.1.2 on page 36. If the ***DTRACK Backend Service*** is powered up and you would like to connect to the ***DTRACK Backend Service*** shown at this point, just press *Connect*. The main window will open (refer to 6.1 on page 42).

In case you would like to choose a different ***DTRACK Backend Service*** , press *Other Controller*. Please refer to chapter 5.1.2 on page 36.

If the access to the *DTRACK Backend Service* has been restricted, you will be prompted to enter the password before the main window will open.

5.1.1 *DTRACK4* command line parameters

The following parameters (refer to table 5.2 on page 36) may be added to the command line (i.e. ***DTRACK4 Frontend*** icon → properties → shortcut → target) when starting the ***DTRACK4 Frontend*** .

Command line parameter	Description
-directstart	Connect with the last used ***DTRACK Backend Service*** (can be combined with -measure)
-help	Shows a window with these command line parameters and additional examples
-host <name or IP>	Connect with given ***DTRACK Backend Service*** (by hostname or IP number) (can be combined with -measure)
-measure	After connecting, start measurement
-wakeup	Wake up the last connected controller (can be combined with -directstart and -measure) (only for legacy products)
-wakeup <MAC>	Wake up controller with given MAC address (can be combined with -host and -measure) (only for legacy products)

Table 5.2: Command line parameters

If the access to the *DTRACK Backend Service* has been restricted, you will be prompted to enter the password before the main window will open.

5.1.2 Controller selection

Whenever you would like to select a different controller than the default one, press the button *Other Controller* on the welcome splash screen. A separate window *Controller Selection* will be opened to specify a ***DTRACK Backend Service*** , see figure 5.3 on page 38.

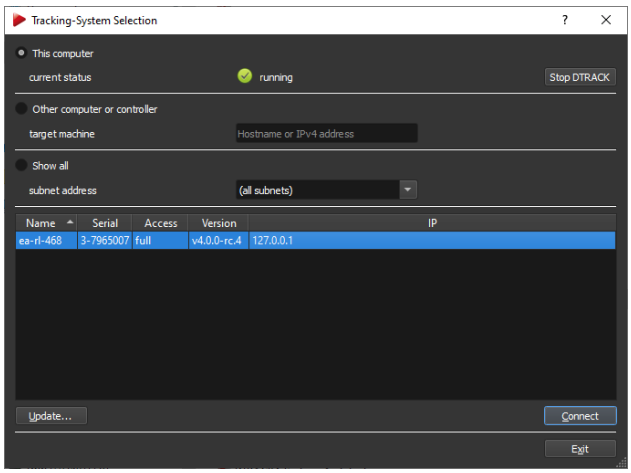
This is done automatically on the first run of ***DTRACK4*** .

5.1.2.1 This computer

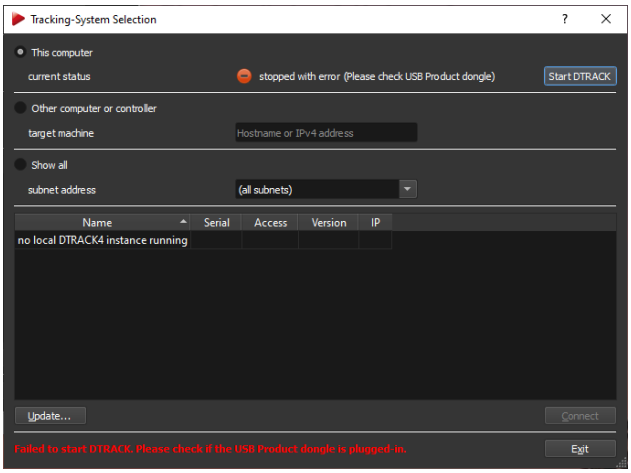
This computer This selection is to be used when both the ***DTRACK Backend Service*** and ***DTRACK4 Frontend*** are installed on the same PC. Tick the corresponding radio button (*This computer*) and then press *Connect*. This is should be the default (i.e. status *running* next to a green tick). In case the installation of the ***DTRACK Backend Service*** followed by a restart cannot automatically startup the ***DTRACK Backend Service*** (e.g. missing CMStick USB copy-protection dongle (WIBU-Systems)) a red mark will show the service in status *stopped with error* together with error messages next to it and at the bottom of the dialog. Please plug-in the copy-protection dongle and double-check that the device is also shown as an accessible drive in Windows Explorer. Press *Start DTRACK* to start up the ***DTRACK Backend Service*** . This is shown as the status *starting* with a 'breathing' tick. When the status *running* is shown, just press *Connect*.

5.1.2.2 Other computer or controller

Other computer or controller In case of LANs without a DHCP server or via direct connection to your remote PC (please refer to the ***ART Hardware Installation Guide***) tick



(a) This computer - status *running*



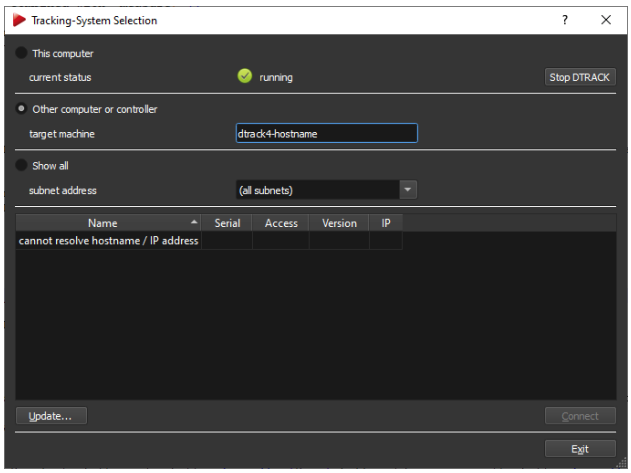
(b) This computer - status *stopped with error*

Figure 5.2: Other Controller Selection - This computer via local ***DTRACK Backend Service***

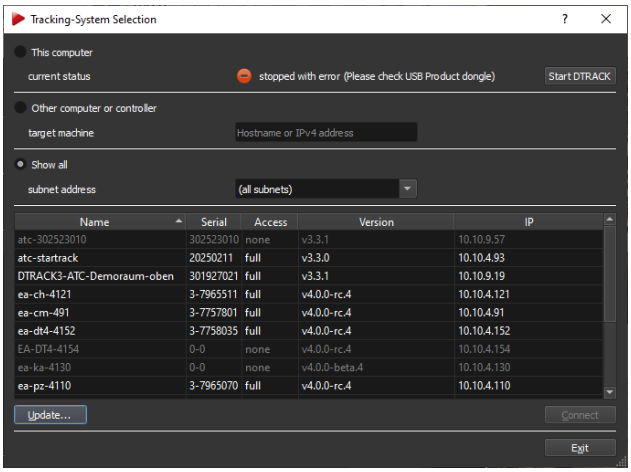
the corresponding radio button (*Other computer or controller*) and specify the IP-address or host-name of your ***DTRACK Backend Service*** directly by entering it in the field *target machine*. To connect press *Connect*.

Show all In case of LANs with DHCP-service you may scan your network for available ***DTRACK Backend Service*** PCs. Simply tick the radio button *Show all* followed by pressing the button *Update...*. You can also specify the subnet by using the adjacent drop-down menu *subnet address*.

All available ***DTRACK Backend Service*** PCs in your network will be listed in the table below. ***DTRACK Backend Service*** PCs set in grey are used by other remote PCs in your network ($\rightarrow$ accessed by IP address listed at welcome splash screen), whereas available ***DTRACK Backend Service*** PCs for connection are set in black.



(a) Other computer or controller



(b) Show all

Figure 5.3: Controller Selection

You can easily identify your ***DTRACK Backend Service*** PC by comparing the hostname (e.g. hostname-XYZ listed in column *Name*). You can also sort the list by serial number *Serial* or IP-addresses *IP*. Select the appropriate entry of your controller and press *Connect*.

If nothing is listed, please refer to chapter 13 on page 150.

If the access to the *DTRACK Backend Service* has been restricted, you will be prompted to enter the password before the main window will open.

Please make sure that the *DTRACK Backend Service* is connected to the local network and that it is powered up !

☞ **In case of LANs protected by firewalls all necessary ports for *DTRACK4 Frontend* network communication have to be unblocked. Please refer to section A.1 on page 166.**

6 Menu Overview

Please refer to the corresponding sections for each of the menus.

DTRACK4	*Shortcut*	page 58
Password		Set a password for access control via the ***DTRACK4*** frontend
Licenses		License overview → Adding licenses (e.g. higher amount of cameras, Measurement Tool or Cascaded Systems)
Configurations		Select, create new and save different configurations, lock the current configuration and backup & restore all settings
Start/Stop	M	Start/Stop measurement
Quit	Q	Quit ***DTRACK4***

Hardware	*Shortcut*	page 67
Search hardware	F2	Search for newly added hardware
Cascaded System		Configure a Cascaded System with available ***SMARTTRACK3+3/M***
Cameras	F7	Camera settings (e.g. flash intensities, sync group assignment)
Sync-source	Shift + F7	Sync-Source settings (e.g. tracking frequency)
Radio Transceiver		Settings for ***ART RadioTransceiver2/3*** and devices within your setup
Network		Check the IP settings of your ***DTRACK Backend Service***

Tracking	*Shortcut*	page 81
Room calibration	F5	Room calibration
Room adjustment	Shift + F5	Adjust / transform the room coordinate system
Single markers		Activate 3DOF calculation, adjust 5DOF central axis
Body administration	F8	Configure your bodies and start calibration process for all targets and interaction devices
Custom Body Calibration	F6	Custom body calibration
Body adjustment	Shift + F6	Adjust / transform the body coordinate system
Flystick		Configure your ***Flystick2/2+***
Fingertracking	F4	Configure your ***Fingertracking*** (incl. tactile feedback) device and start calibration process (i.e. hand geometry)
Measurement Tool		Configure your Measurement Tool
Measurement Tool tip calibration		Start tip calibration process for the Measurement Tool

Output	F9	Set output channels and configure the data to be transmitted

View	*Shortcut*	page 140
Set to default		Reset the shown displays to default
2D Monitor		Graphical display of markers recognized by the cameras
3D Monitor		Graphical representation of the tracking volume and data in 3D
Data	F10	Display measurement results (6DOF and / or 3DOF)
Flystick		Display ***Flystick2/2+*** measurement data
Fingertracking		Display Fingertracking measurement data
Measurement Tool		Display Measurement Tool data
Events		Display event messages generated by ***DTRACK4***

Tools	*Shortcut*	page 142
Measure points		Provides simple measurement acquisition for use with the Measurement Tool

Help	*Shortcut*	page 144
What's this?	Shift + F1	Help
What's new?		Overview of the new features
Controller and Camera Update		Start the assistant for updating cameras
Service and Guides		Service-ID, link to ***ART*** website and ***DTRACK4*** guides, export system configuration log
DTRACK4	F1	Software version of frontend & backend
About Qt		Qt toolkit version

Table 6.1: ***DTRACK4*** menu structure overview

6.1 GUI overview

The graphical user interface of ***DTRACK4*** can be divided into the following parts (see figure 6.1 on page 42):

- the *menu bar* with access to all settings (please refer to chapter 6 on page 40)
- the *toolbar* with graphical elements regarding the status of the tracking system (please refer to chapter 6.2 on page 43)
- the *docking displays* with graphical information, measurement results and event information (see chapter 6.3 on page 45).

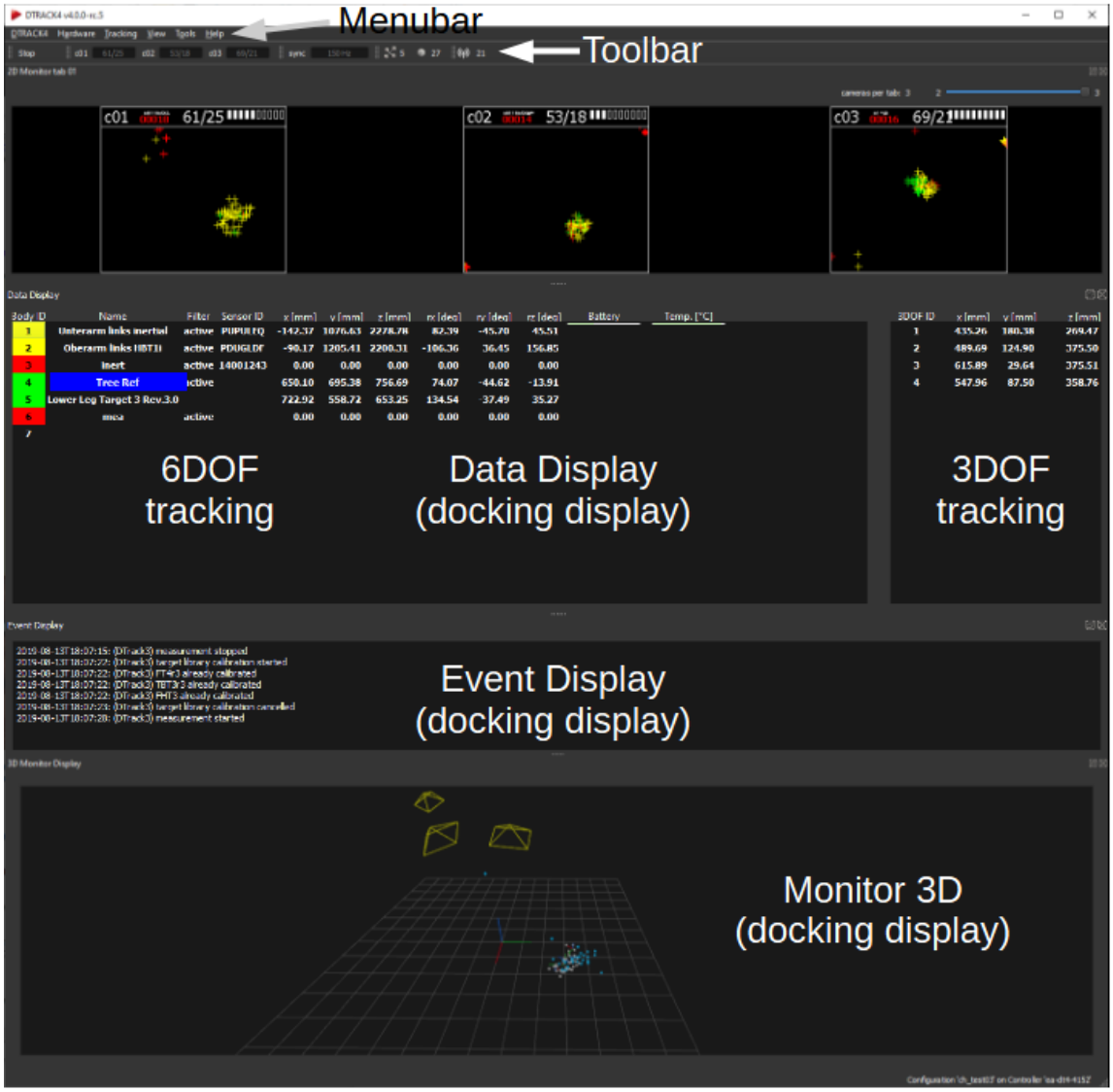


Figure 6.1: Graphical user interface of ***DTRACK4*** - default layout

6.2 Toolbar

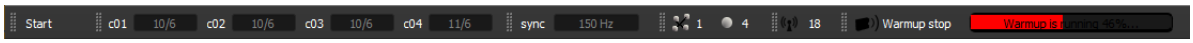


Figure 6.2: ***DTRACK4*** Toolbar

By default, the toolbar (see figure 6.2 on page 43) consists of the following elements (from left to right):

Toolbar element	Description
Start/Stop button	Starts and stops the measurement
Camera Status	Shows the number of markers seen (2DOF) / used for tracking targets (6DOF) by each camera
Sync Status	Displays the current tracking frequency
Tracking Status	Shows the number of tracked targets (6DOF) / single markers (3DOF)
Radio Transceiver Status	Displays the currently selected channel of the ***ART Radio-Transceiver2/3*** (greyed out, if not installed)

Table 6.2: Toolbar elements of ***DTRACK4***

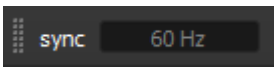
To change or activate elements right-click anywhere on the toolbar. Drag & drop the elements for re-arrangement by left-clicking.

Start / Stop button Press this button to start the measurement. To stop tracking press it once again.

Camera Status The *Camera Status* field shows two values for each camera (c01, c02, ...). The first one summarizes the amount of markers that are seen by each camera, wheras the second one only shows the subset which are used for 6DOF tracking.

In the case depicted (see figure 6.3 on page 44), one target equipped with 6 markers is tracked inside the measurement volume by all 4 cameras c01 to c04. As a result the second value equals 6 for all cameras.
At the same time cameras c01 to c04 track 4 single 3DOF markers, while camera c04 sees one more additional marker (presumably a reflection) leading to a total of 10 and 11 markers respectively. This additional marker cannot be tracked because it is not seen by at least one more camera.
One should note that this is a very simple example as multiple targets may be tracked by only a subset of cameras (min. 2) while additional 3DOF markers and reflections do not have to be seen by all cameras at the same time. Compare the *Tracking Status* for more information about tracked targets and single 3DOF markers (see figure 6.5 on page 44).

Figure 6.3: ***DTRACK4*** Camera Status (toolbar element)



(a) black / grey: max. 5 frames per minute lost

(b) yellow: 5 - 10 frames per minute lost

(c) orange: 10 - 15 frames per minute lost

(d) red: > 15 frames per minute lost

Figure 6.4: ***DTRACK4*** Sync Status (toolbar element) - Visualization of the decrease in effective synchronization frequency

Sync Status The *Sync status* field shows the current tracking frequency in Hz set in *Hardware* → *Sync-Source*. The background is changing its colour in case the effective frequency is decreasing due to processing overload (see figure 6.4 on page 44):

- black / grey: max. 5 frames per minute lost (i.e. 3600 frames per minute are transmitted, not shown)
- yellow: 5 - 10 frames per minute lost
- orange: 10 - 15 frames per minute lost
- red: > 15 frames per minute lost

Tracking Status In *Tracking status* the amount of tracked 6DOF targets and single 3DOF markers is shown (see figure 6.5 on page 44). The value on the left, next to the icon depicting a target, summarizes all activated and tracked targets (*Tracking* → *Body Administration* or *mtool*, *Flystick* etc.) inside the measurement volume, in this case only 1. All single 3DOF markers which are not used for 6DOF tracking are shown on the right next to the icon of a marker, in this case 4 markers.

Figure 6.5: ***DTRACK4*** Tracking status (toolbar element)

Radio Transceiver Status The *Radio Transceiver Status* shows the currently selected channel (see figure 6.6 on page 45) of the ***ART*** radio set in *Hardware* → *Radio Transceiver*, in this case '*Channel 18*'. The toolbar element is greyed out if no ***RadioTransceiver2/3*** are installed.

Figure 6.6: ***DTRACK4*** Radio transceiver status (toolbar element)

6.3 Docking Displays

The following docking displays are available (see table 6.3 on page 45):

Docking Display	Description
2D Monitor	Graphical display of all markers seen / tracked by the cameras. Colour and shape represent the circularity and size of the markers respectively.
3D Monitor	Graphical representation of the tracking volume including 3D and 6D tracking data of all markers and bodies seen / tracked by the cameras as well as camera data and coordinate system information.
Data Display	Displays measurement results (6DOF and / or 3DOF)
Event Display	Displays ***DTRACK4*** events (e.g. "no valid room calibration")
Flystick	Shows the measurement results (6DOF) of the ***Flystick2/2+*** and the operation of buttons and joystick
Fingertracking	Shows the measurement results of the hands
Measurement Tool	Shows the measurement results of the Measurement Tool and its reference body, if assigned

Table 6.3: Available docking displays in ***DTRACK4***

To change or activate the docking displays right-click anywhere on the *Toolbar* or use the menu *View* (refer to chapter 10 on page 140). Drag & drop the display windows for re-arrangement by left-clicking.

6.3.1 2D Monitor

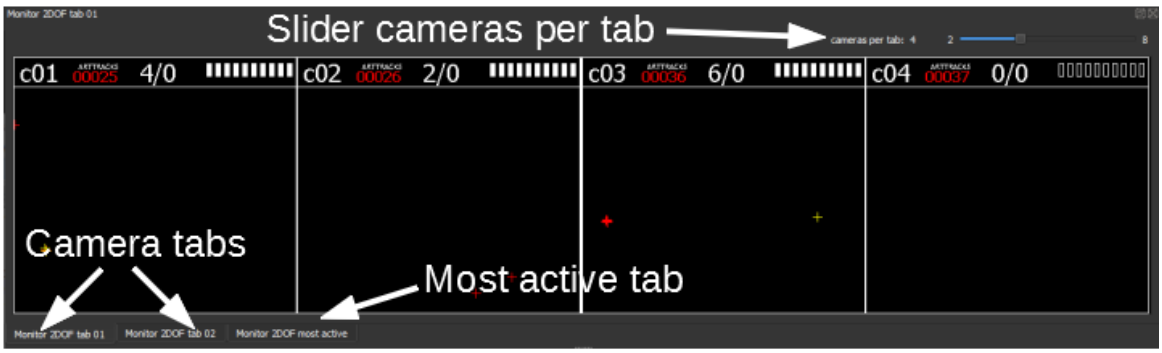


Figure 6.7: ***DTRACK4*** *2D Monitor* (docking display)

The *2D Monitor* is a 2-dimensional graphical display just like a monitor for each camera equivalent to its field of view (see figure 6.7 on page 45). Essentially the *2D Monitor* shows a black window with a schematic display of positions, sizes and shapes of all recognized markers / flashes or other IR sources that can be seen inside the field of view of the cameras. It is particularly useful for the adjustment (especially orientation) of the cameras (please refer to the ***ART Hardware Installation Guide***).

Additional *2D Monitor* functions In the *2D Monitor* additional functions are assigned to mouse interactions.

- left mouse button
  Drag & drop the camera monitors to move and arrange the position within the *Monitor 2DOF view*.
- middle mouse button
  Click to hide all camera monitors but the one you selected. Click again and all camera monitors will be displayed.
- right mouse button
  Click on a camera monitor to open a context menu for the corresponding camera; see figure 6.9 on page 48 and table 6.4 on page 49 for more details.

Cameras per tab In case several ***ARTTRACK*** cameras are being used in one system, it may prove helpful to adjust the number of cameras simultaneously shown in the *2D Monitor* in order to achieve a clear arrangement (see figure 6.7 on page 45).

Move the slider '*cameras per tab*' (in the upper right corner) to the left to decrease the amount of cameras. Tabs containing the remaining cameras will be added below the *2D Monitor*.

Monitor 2DOF most active tab The special tab '*Monitor 2DOF most active*' contains only those cameras in which the markers / targets are seen most of the time.

Example: Consider a four camera system with cameras c01 through c04 where you have set the number of '*cameras per tab*' to two. Now if you move a target in front of cameras c02 and c03 most of the time, only these two cameras will be shown in the '*most active cameras*' tab.

Adding/removing cameras It is possible to add or remove cameras without restarting the ***DTRACK Backend Service*** . Please refer to chapter 8.1 on page 67 how to dynamically analyse your system for changes in configuration.

When cameras are added to an already calibrated tracking system these cameras will not contribute for calculation and measurement until you perform a room (re-)calibration (see chapter 9.1.5 on page 85). Therefore as as reminder the *2D Monitor* of the corresponding cameras will show the message (re-)calibration required! in red color.

The *DTRACK Backend Service* will detect all cameras that have been removed from an already calibrated tracking system (e.g. due to a disconnected cable) and mark those as missing until a room (re-)calibration has been performed. The *2D Monitor* of the corresponding cameras will be disabled (crossed out) and in case of larger systems their corresponding displays will be moved to a new camera tab.

***DTRACK4* is able to operate when cameras have been added or removed; for best performance it is highly recommended to perform a recalibration**

6.3.1.1 2D Monitor display elements

Each marker is either displayed as a circle or as a cross. This indicates the projected size of the marker on the camera sensor and depends strongly on the distance to the camera, see figure 6.8 on page 47.

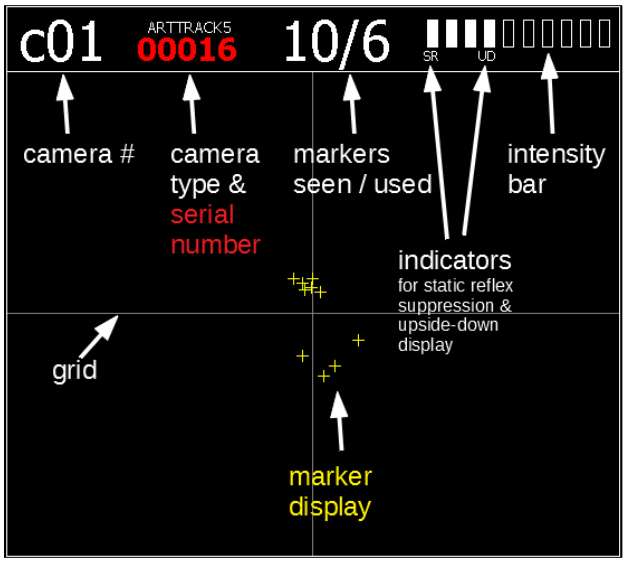


Figure 6.8: ***DTRACK4** 2D Monitor* elements

A simple color code represents the quality (i.e. circularity) of the markers:

green markers	...	very good tracking quality
yellow markers	...	good tracking quality
red markers	...	bad circularity, unreasonable size of marker and / or low intensities; may result in poor tracking quality
circles	...	big marker (e.g. close to camera)
cross	...	small marker

Recommendation Increase the flash intensity until all markers become yellow or green (*Hardware* → *Cameras* → '*flash intensity*'. Additionally pay attention to the intensity bar on the top right corner of each camera monitor, see figure 6.8 on page 47. This indicates the intensity of the brightest pixel in the field of view (refer to figure 6.1 on page 42), in this case 4 of 10.

As a rule of thumb: For measurement applications with high accuracy requirements the markers should be displayed in green with intensities of min. 4 bars; for VR applications yellow markers with intensities down to 2 bars are still sufficient.

6.3.1.2 *2D Monitor* context menu

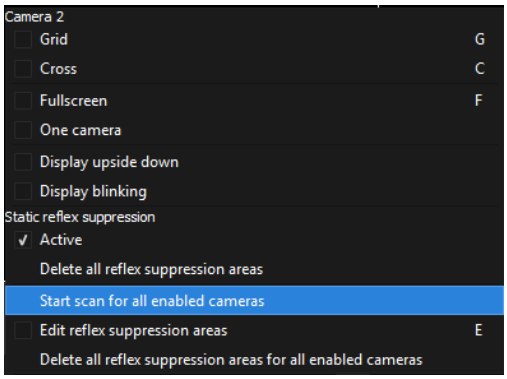


Figure 6.9: *2D Monitor* context menu (e.g. camera c02)

By right-clicking on the *2D Monitor* of the corresponding camera monitor the following context menu opens:

Function	*Shortcut*	
Grid	G	Shows a grid in the camera monitor.
Cross	C	Shows a cross in the camera monitor.
Fullscreen	F	Resizes *2D Monitor* to full screen and back.
One Camera		Only show the view of the selected camera.
Display upside down		Rotate the orientation of the camera monitor by 180°. '*UD*' is displayed in the camera monitor.
Display blinking		Activates / deactivates blinking of LED matrix display and status LEDs on the camera for easy identification.
Static Reflex Suppression Active		Enable static reflex suppression functionality for this camera. '*SR*' is displayed in the camera monitor.
Delete all reflex supression areas		Deletes the defined reflection areas for the selected camera only.
Start scan for all enabled cameras		Initiates a scan for static reflections. Enabled only if *Active* is ticked.
Edit reflex suppression areas	E	Enter the edit mode in order to manually select areas to suppress unwanted reflections.
Delete all reflex suppression areas for all enabled cameras		Deletes the defined reflection areas for all enabled cameras at once.

Table 6.4: Context menu of the *Monitor 2DOF view*

Display upside down The checkbox *display upside down* rotates the orientation of the corresponding camera monitor in the *2D Monitor* by 180°.

***Display upside down* proves to be useful when mounting the cameras upside down. Note: This setting is for display purposes only. It does not influence the tracking system nor the room calibration.**

6.3.2 Static reflex suppression

Automatic and manual reflection suppression First the feature has to be enabled either globally for all cameras or individually for each camera. Open *Hardware* → *Cameras* and mark the checkboxes for each camera you would like to activate the reflection suppression feature or select *global static reflex suppression* to activate the feature for all cameras at once. Please refer to chapter 8.3 on page 69 for details.
Alternatively right-click the *2D Monitor* on the respective camera monitor and enable the feature directly for each camera by selecting the option '*Active*', see figure 6.9 on page 48.

Hereafter there are two ways to carry out a reflection suppression:

1. run an automatic scan
   Open the context menu of the *2D Monitor* and start the scan by left-clicking *Start*

Scan for all enabled cameras (see figure 6.9 on page 48). A scan function will detect and suppress reflections automatically. Cancel the scan at any point by clicking *Cancel*, otherwise wait for completion and accept the detected areas by clicking *OK*. The areas will be stored in the ***DTRACK Backend Service*** and can be edited manually afterwards.

2. set the suppression areas manually
   You can define the areas manually where reflections need to be suppressed. Open the context menu of the *2D Monitor* and enter the edit mode by selecting '*Edit reflex suppression areas*', see below. You may also use the shortcut ('*E*') listed in table 6.4 on page 49).

☞ **Be sure to remove all targets from the measurement volume before starting the scan.**

☞ **Be aware that reflection suppression leads to decreased field of view / effective measurement volume by blocking the area in which the reflection originated.**

(a) Reflex suppression edit mode (b) Reflex suppression edit mode help

Figure 6.10: Reflex suppression Edit mode

Edit reflection suppression areas Within the edit mode (see figure 6.10(a) on page 50) you may:

- create new areas by left mouse button click, hold & drag a rectangle shaped box, then release mouse button,
- delete areas by right mouse button click inside an area followed by pressing the button *delete*,

- clear regions by shift + left mouse button click, hold & drag a rectangle shaped box to create a clearing area, then release the mouse button,
- move areas by left mouse button click, drag & drop an existing area,
- resize areas by left mouse button click on the edge or corner, hold & drag and then release mouse button.

Leave the edit mode by opening the context menu (right-click the *2D Monitor*) of the respective camera monitor, then de-select '*Edit reflex suppression areas*'. Reflection suppression areas are enabled as soon as you and accept the changes. The areas will be stored in the ***DTRACK Backend Service*** and can be edited each time you enter this mode.

Configuring reflection suppression If you want to disable the reflection suppression feature for one camera only, open the context menu of the respective camera monitor and deactivate the option '*Active*'.

To permanently delete the reflection suppression areas for one camera, right-click on the respective camera monitor and select '*Delete all reflex suppression areas*' and accept the changes.

You can also delete the reflection suppression areas for all cameras at once by selecting '*Delete all reflex suppression areas for all enabled cameras*'.

6.3.3 3D Monitor

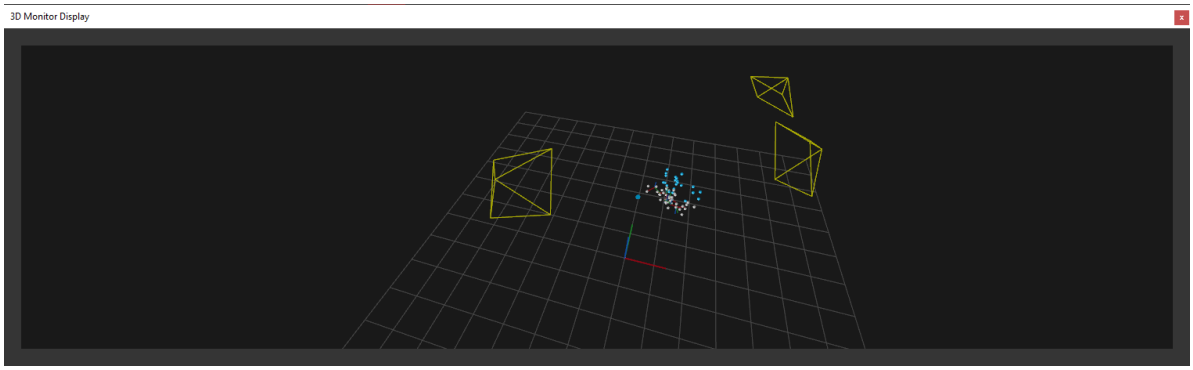


Figure 6.11: *Monitor 3D* (docking display)

If shown the *3D Monitor* displays the location and orientation of cameras (room calibration), the room coordinate system and the ground plane. While tracking is active the location of 3D markers, 6D poses of the tracked standard bodies and ***Flystick2/2+*** are shown in addition.

visualisation

- The camera frustums are depicted by yellow wire frames.
- A grey regular grid is representing the XY-ground plane.
- The origin and orientation of the coordinate system is visualized by a tripod in RGB colour, with the X-axis being red, the Y-axis being green and Z-axis being blue.
- 3D markers are depicted as spheres in light blue.
- 6D poses are displayed with tipod in RGB colour.
- Standard bodies are displayed with their body markers in grey.
- ***Flystick2/2+*** are displayed with their body markers in green.

6.3.3.1 Navigating the *3D Monitor*

Navigation to change position and viewing direction is possible with either mouse movement or with keyboard input.

navigating via mouse If the *3D Monitor* window is in focus keeping the left mouse button pressed while moving enables motion. Rotation is possible with keeping the right mouse button pressed. The mouse wheel enables zooming.

A right click opens a small context menu for toggling the display of 3D markers, standard bodies and ***Flystick2/2+*** via different check boxes. The context menu offers also the possibility to reset the scene.

navigating via keyboard The arrow keys enable motion according their directions by single press for stepwise motion or continous motion as long as they are being pressed. Pressing the key '*Alt*' in addition switches the arrow keys to rotation mode. The scene can be reset by pressing the key '*R*'.

6.3.4 Data Display

The *Data Display* is split into two parts, 6DOF and 3DOF measurement results respectively.

6.3.4.1 6DOF measurement results

On the left hand side (see figure 6.12 on page 53), the *Data Display* shows the following measurement results :

1. the *body ID*
2. the assigned *name*

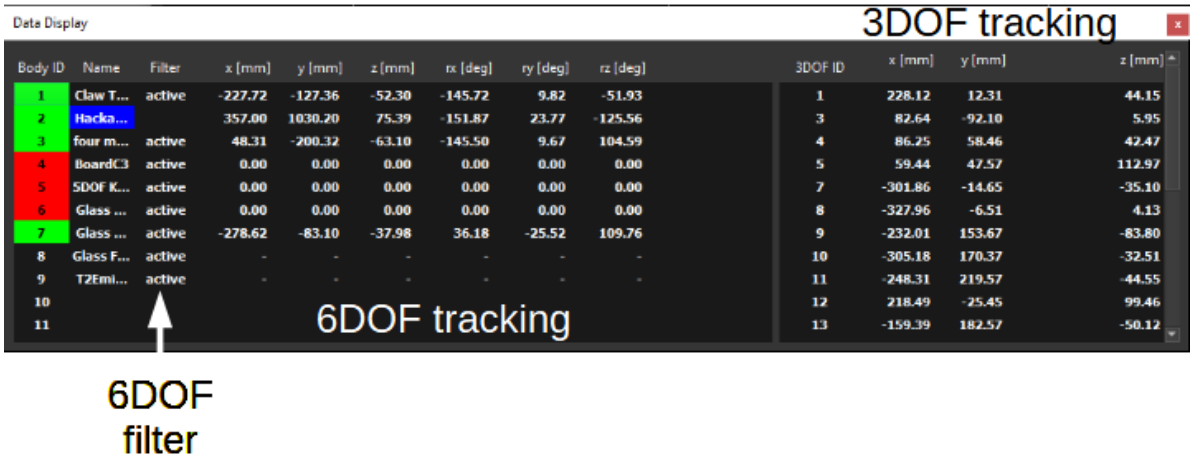


Figure 6.12: *Data Display* (docking display)

3. the status of an assigned *reference body*
4. filtering status of 6DOF measurement results (’*active*’ or ’ ’)
5. position (*X, Y, Z*) and orientation (*rx, ry, rz*) relative to the room coordinate system

Body ID The bodies are sorted by increasing *body ID*.
A simple colour code indicates the tracking status of the body:

green	...	body is being tracked; tracking data is displayed
red	...	body is not being tracked; instead of tracking data zeros are displayed
white / black	...	body is not activated; columns are filled with -
white / black	...	body is not calibrated; columns are left blank

Reference body The ’*name*’ of a standard 6DOF body assigned as reference will be highlighted.

reference	...	body is assigned as reference; ’reference’ is displayed when no specific name has been assigned

☞ **When a reference body has been assigned, all 6DOF bodies and 3DOF single markers can only be tracked when the reference body is being tracked as well.**

Filtering of 6DOF measurement results Next to the *body ID* the filtering status is shown (i.e. ’*active*’ or ’ ’). Right-click the field *active* in the column *filter* of the corresponding target and press the button *filter* to open the *filter settings* menu. For more information about filtering options please refer to chapter 9.4.6 on page 101.

Position and orientation The position (*X, Y, Z*) in mm and the orientation (*rx, ry, rz*) in deg °is given relative to the room coordinate system unless a reference body has been assigned. The rotation angles (rx, ry and rz) are rotations around the X, Y and Z axis respectively. The mathematical definition can be found in the ***DTRACK4 Programmer's Guide*** .

6.3.4.2 3DOF measurement results

On the right hand side, the *Data Display* shows the 3DOF measurement results. All tracked single 3DOF markers that have not been assigned to a calibrated 6DOF body (i.e. markers of targets not yet calibrated) are shown here.

Positional information of single 3DOF markers are shown in the data display only when activated in *Tracking* → *Single Markers* → *calculation of 3DOF markers*.

6.3.5 Flystick display

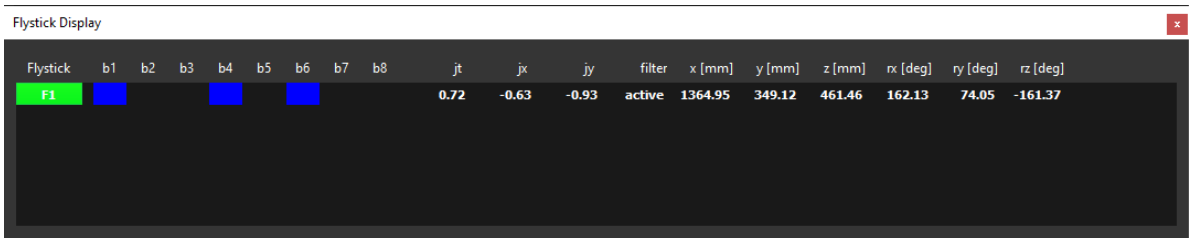


Figure 6.13: *Flystick Display* (docking display)

Flystick measurement results The *Flystick display* shows the following measurement results:

1. the *Flystick ID*
2. the status of buttons *b1...bx*, if applicable
3. the status of the trigger *jt* (***Flystick2+*** only)
4. the status of the joystick *jx, jy*
5. filtering status of 6DOF measurement results ('*active*' or ' ')
6. position (*X, Y, Z*) and orientation (*rx, ry, rz*) of the ***Flystick2/2+***

A simple colour code indicates the status of the *Flystick*:

green	...	***Flystick2/2+*** is being tracked; tracking data is displayed
red	...	***Flystick2/2+*** is not being tracked (e.g. Flystick has not been assigned to ART radio transceiver); instead of tracking data dashes are displayed
blue	...	button is being pressed
white / black	...	***Flystick2/2+*** is not calibrated; columns are left blank

6.3.6 Fingertracking display

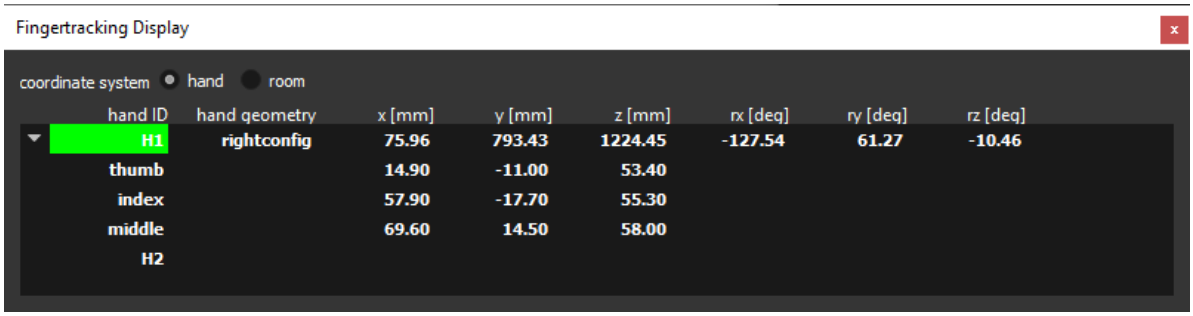


Figure 6.14: *Fingertracking Display* (docking display)

Fingertracking measurement results The *Fingertracking display* shows the following measurement results of all hands including each finger (i.e. thumb, index, middle, ...):

1. the *hand ID*
2. the assigned *name* of the hand geometry name (e.g. left or right)
3. position (*X, Y, Z*) and orientation (*rx, ry, rz*) of the hand and fingers relative to the selected coordinate system

The coordinate system of the measurement data may be switched by using the radio buttons *hand* and *room*. You can distinguish between the hands either by the *hand ID* or by the assigned *name* of the hand geometry.
A simple colour code indicates the status of the ***Fingertracking*** :

green	...	***Fingertracking*** device is being tracked; tracking data is displayed
yellow	...	Hand-target is being tracked (i.e. fingers are calibrated, but outside cameras field of view); last known tracking data is displayed
red	...	***Fingertracking*** device is not being tracked (e.g. only back of the hand is calibrated); last known tracking data is displayed
white / black	...	***Fingertracking*** device is not calibrated; columns are left blank

6.3.7 Measurement Tool display

The *Measurement Tool display* is split into two parts (see figure 6.15 on page 56):

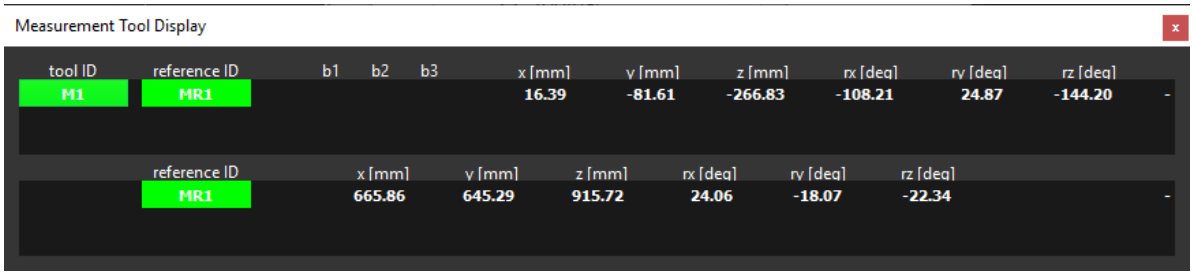


Figure 6.15: *Measurement Tool Display* (docking display)

Measurement Tool measurement results

1. the *Measurement Tool ID*
2. the assigned *reference ID* of the corresponding reference body
3. status of buttons *b1...b3*, if applicable
4. position (*X, Y, Z*) and orientation (*rx, ry, rz*) of the Measurement Tool 's tip

Measurement Tool reference measurement results

1. the *Measurement Tool reference body ID*
2. position (*X, Y, Z*) and orientation (*rx, ry, rz*) of the reference body

A simple colour code indicates the status of the Measurement Tool and the reference body, respectively:

green	...	tool is being tracked; tracking data is displayed
red	...	tool is not being tracked (e.g. tip calibration is missing); instead of tracking data dashes are displayed
blue	...	measurement is being performed and / or button is being pressed
white / black	...	tool is not calibrated; columns are left blank

A Measurement Tool with an assigned reference body can only be tracked when the reference body is tracked as well.

6.3.8 Event display

The *Event display* presents the status of the tracking system (see figure 6.16 on page 57). It offers feedback of the operational state regarding errors or warnings. Furthermore, it informs the user about successful room or body calibrations. Each entry is associated with a timestamp and date.

Figure 6.16: *Event Display* (docking display)

7 Menu *DTRACK4* - Basic Configuration

DTRACK4	*Shortcut*
Password	
Licenses	
Configurations	
Start/Stop	M
Quit	Q

Table 7.1: Menu *DTRACK4*

7.1 Password

In order to restrict the access to the currently connected ***DTRACK Backend Service*** you may enable password protection of the frontend.

Enable password protection Open the corresponding dialog via ***DTRACK4*** → *Password* and tick the checkbox *Enable password protection*. Please refer to figure 7.1 on page 59. Next enter your selected password in the entry fields '*New password*' and '*Repeat password*' respectively. If both entrys are matching the fields will turn green and a corresponding message will appear. Press *OK* and a warning message will appear next. If you are sure press *OK* to accept the password for protection. Otherwise press *Cancel* to return to the dialog.

Please note that these settings are not part of your personal configuration. Changes will affect all users of your *DTRACK Backend Service* ! Your *DTRACK Backend Service* may become unreachable when the password is lost!

The password protection only restricts the access via the *DTRACK4* frontend. Other control options such as the SDK or the CLI (command line interface tool) still provide full access to all functions and features !

Disable password protection In the dialog untick the checkbox *Enable password protection* and press *OK*. A warning message will appear next. If you are sure press *OK* to remove the password protection. In the last step you will be prompted to enter the current password. Enter the password and press *OK* once again. Please refer to figure 7.2 on

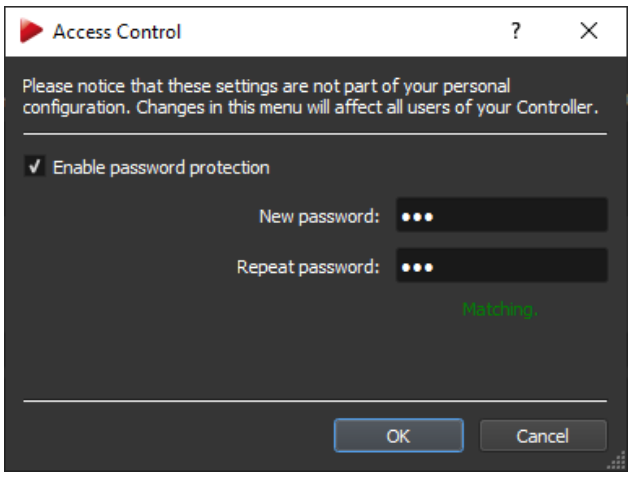


Figure 7.1: Enable Access control

page 59. The password protection feature is disabled and the previously set password is deleted.

If the entered password is incorrect a corresponding message will appear. You may then try again and enter the correct password.

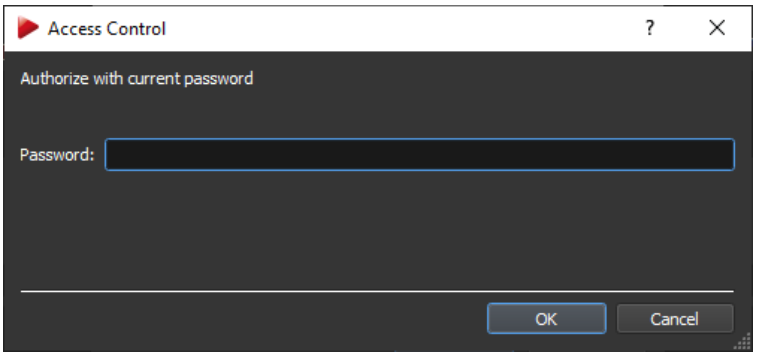


Figure 7.2: Authorize Access control

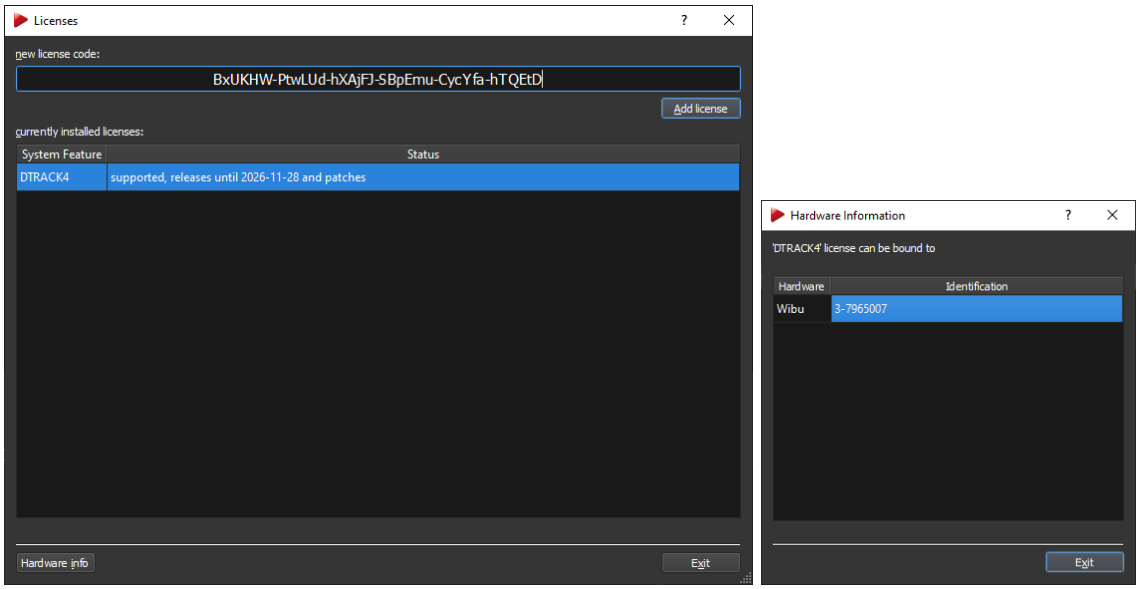
Change the currently set password In the dialog enter your new password in the entry fields '*New password*' and '*Repeat password*' respectively, then press *OK*. A warning message will appear next. If you are sure press *OK* to change the password. Otherwise press *Cancel* to return to the dialog. In the last step you will be prompted to enter the current password. Enter the password and press *OK* once again. Please refer to figure 7.2 on page 59. The password will be changed and the dialog is closed.

If the entered password is incorrect a corresponding message will appear. You may then try again and enter the correct password.

In case you have lost the password, please refer to other control options such as the SDK or the CLI (command line interface tool) which still provide full access to all functions and features to reset the password feature.

7.2 Licenses

The capability of the tracking system is defined by licenses which can be managed here, see figure 7.3 on page 60. You can upgrade to any functionality by simply entering a license code. Ask your *ART* representative for pricing.



(a) Licenses overview (b) Hardware information

Figure 7.3: Managing the licenses

7.2.1 Entering a license code

Example: If you would like to add a license, go ahead as follows:

- Select any feature by left-clicking.
- Click on *Hardware Info* to open the *Hardware Information* dialog.
- Contact your *ART* representative and communicate your version of *DTRACK4* together with the serial number of the CmStick USB copy-protection dongle (WIBU-SYSTEMS) (=*Identification*) in order to receive a valid license code.
- Exit the window *Hardware Information* and enter a valid license code in the field *new license code*.
- Click on *Add license*.

- Exit the window *Licenses*

7.2.2 License model

Starting with ***DTRACK4*** a new simplified license model has been established using a univeral license:

System Feature	Values	Status
DTRACK4		until releases *v4.X* and patches / until *date* and patches

Table 7.2: Licenses overview

All licenses may be issued with an expiration date, without expiration date they are shown as ('*supported*').

The total number of cameras cannot exceed 80 for any combination of cameras.

7.2.2.1 License Expiration

When issued each license may be acquired for a limited period of time ('*supported, expiry at*'). At that point the feature or functionality will stop working and the license status will change to ('*expired since*'). An additional warning message will appear 14 days in advance of expiration at every startup of the ***DTRACK4 Frontend*** (see figure 7.4 on page 61).

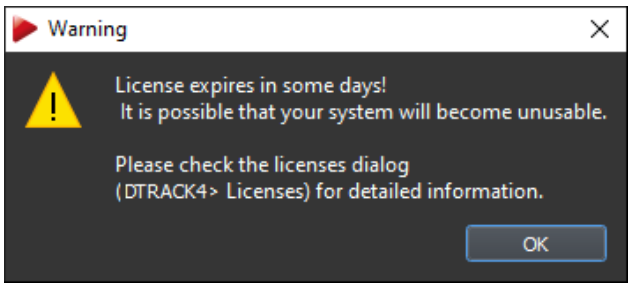


Figure 7.4: Expiry Warning for limited licenses

You may extend your licenses at any time. For further information please contact your ***ART*** representative.

When the license for your system expires you will not be able to start a measurement at all !

7.2.2.2 Update & Upgrade Licenses

License *DTRACK4 Upgrade* defines which updates of the ***DTRACK4*** software are possible. It corresponds either to a version number or the release date of a future release of ***DTRACK4*** . Updates of patch versions (increasing the third digit of a version number, e.g. v4.0.0 → v4.0.1 → v4.0.2 → ..., may be performed without restrictions at any time.

☞ **All patch releases and updates (e.g. v4.0.0 → v4.0.1 → v4.0.2 →...) may be installed without restrictions.**

☞ **It will be determined whether *DTRACK4* may be upgraded to the next minor version (e.g. v4.0.0 → v4.1.0) without purchasing a valid '*DTRACK4 Upgrade*' license. Please contact your *ART* representative for more information.**

7.3 Configurations

It is possible to create and manage personalised configurations, e.g. with different targets or flash intensity settings (see also figure 7.5 on page 62). Go to ***DTRACK4*** → *Configurations* to open the corresponding dialog.

7.3.1 Managing configurations

Any existing configuration may be activated and loaded by selecting the corresponding entry and clicking *Apply*.
All unlocked configurations except the '*standard*' one can be deleted. Select the entry to be deleted and click *Delete*. Quit the dialogue at any time by pressing *Exit*.

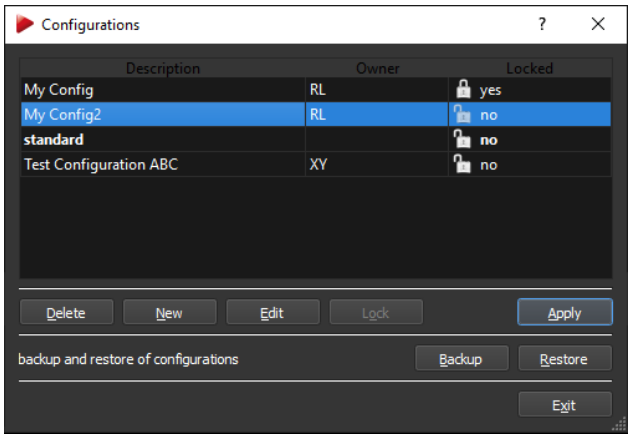


Figure 7.5: Manage configurations

☞ **A warning message will appear when the maximum storage space for configurations is running low. Please delete obsolete or unneccessary configurations at your earliest convenience.**

7.3.1.1 Editing configurations

Unless the configuration is locked, it may be changed using the button *Edit*. You can assign a meaningful description ('*description*') and enter your user name ('*owner*'), see also figure 7.6 on page 63. Accept the changes with *OK*.

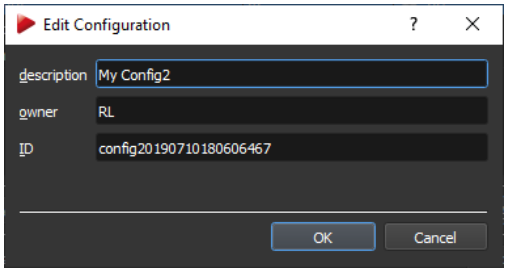


Figure 7.6: Edit configurations

7.3.1.2 Creating a new configuration

Press *New* to create a new configuration using the corresponding window (see figure 7.7 on page 63). You can assign a meaningful description ('*description*') and enter your user name ('*owner*').

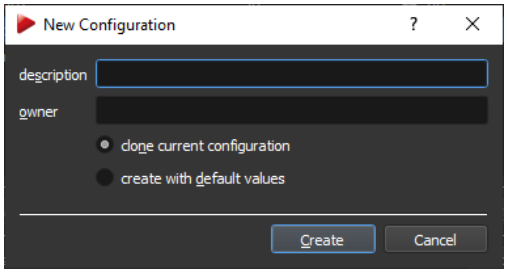


Figure 7.7: Creating a new configuration

Your personal configuration can be created in two ways:

1. '*clone current configuration*'
   all existing calibrations (room and body calibration), settings and values are inherited from the currently active configuration.

2. '*create with default values*'
   default values will be applied (i.e. the system will start from scratch as manufactured). The system will not have a valid room calibration or any body calibrations.

Just press *Create* and the configuration is saved on the CmStick USB copy-protection dongle (WIBU-SYSTEMS).

7.3.1.3 Locking configurations

It is possible to protect the settings of any configuration with a password by pressing the button *Lock*. You will be asked to enter and confirm a new password to lock your configuration (see figure 7.8 on page 64).

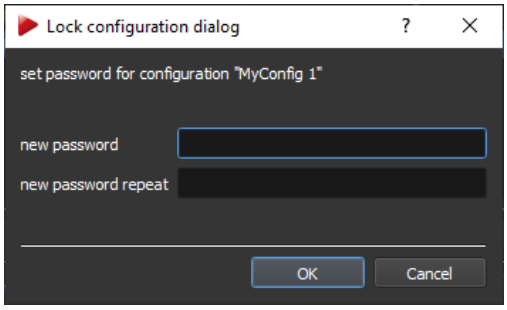


Figure 7.8: Locking a configuration

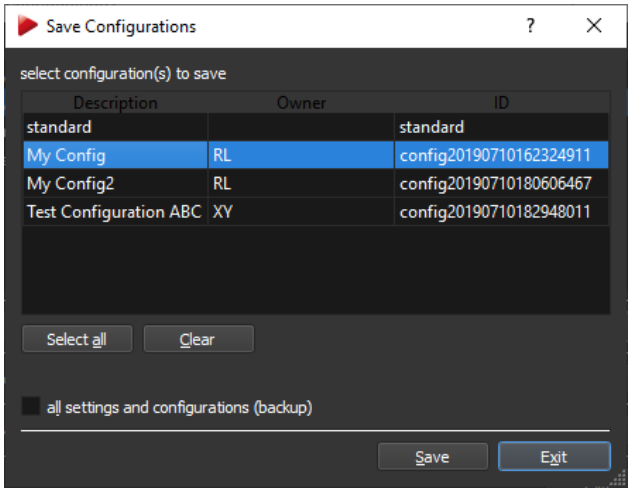
A locked configuration cannot be changed later on with *Edit*.

Locking the configuration does not provide access-control! Only changes in settings / calibrations are disabled.

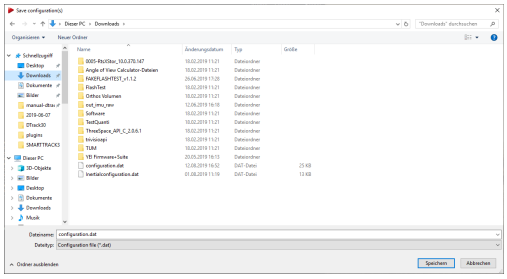
In case you forget the password please call *ART* for assistance

7.3.2 Backup Configurations

It is possible to export and re-import single configurations or to backup and restore all settings at once.



(a) Select the configurations to save



(b) Select the folder on remote PC

Figure 7.9: Backup configurations

Press the button *Backup* to open the corresponding *Save configurations* window for selecting the configuration(s) to export (see figure 7.9(a) on page 64). Either (de-)select

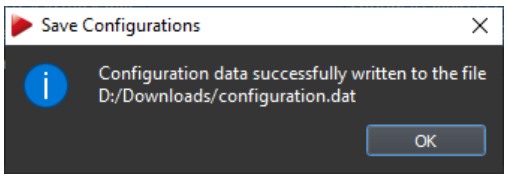
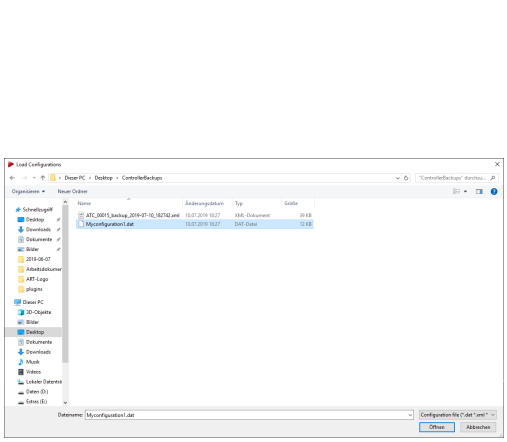


Figure 7.10: Backup configurations - Confirmation Window

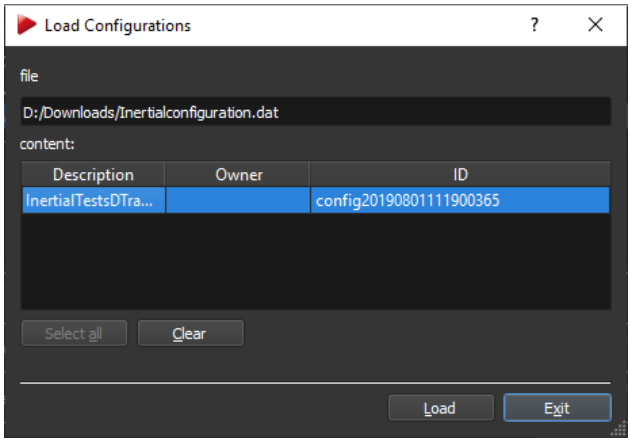
individual configurations by left-clicking or click *select all* and *clear* respectively. Tick the checkbox *all settings and configurations (backup)* to save a complete backup of your system's settings. Press '*Save*' to select a destination directory on a remote PC (see figure 7.9(b) on page 64). A confirmation window will inform you of the successful export (see figure 7.10 on page 65).

7.3.3 Restore Configurations

'*Restore*' loads previously exported configuration files or complete backups from a remote PC. First select the folder on the remote PC where you have stored the configuration files (see figure 7.11(a) on page 65), then select the configurations to import (see figure 7.11(b) on page 65). The imported configuration will be activated automatically. It is also possible to import multiple configurations at the same time. A confirmation window will inform you of the successful import (see figure 7.12 on page 66).



(a) Select folder on remote PC



(b) Select configurations to load

Figure 7.11: Restore configurations

Accidentally deleted configurations may be restored presuming an export had been carried out beforehand. In the unfortunate event of repairs this data can also be restored to a replacement PC. Note: A room (re-)calibration might be necessary especially in case the amount of cameras or the camera models should have changed.

Restoring configurations prior to *DTRACK4* is not possible !

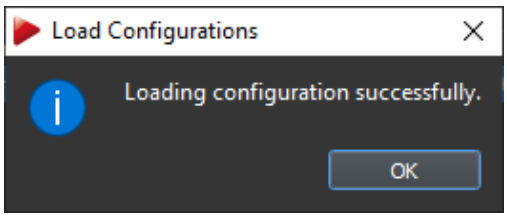


Figure 7.12: Restore configurations - Confirmation Window

☞ **Backup your data by exporting configurations on a regular basis !**

☞ **When exporting single or multiple configurations please assign meaningful filenames (e.g. exporting date 'Standard 07122012'). Configurations using the standard filename (e.g. "Standard") will be overwritten!**

7.4 Start/Stop

Start or stop the measurement by pressing the button *Start / Stop* or by using the keyboard shortcut 'M'.

7.5 Quit

Quit ***DTRACK4*** frontend software. In case the system is still in measurement mode, a confirmation window will show up (see figure 7.13 on page 66). You may leave the active measurement running or stop the measurement together with the frontend at this point.

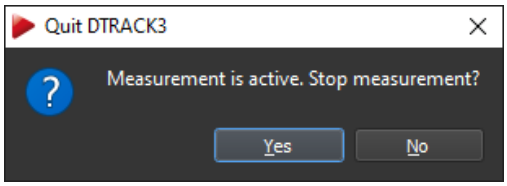


Figure 7.13: Quit ***DTRACK4*** - Confirmation Window

8 Menu Hardware - Hardware configuration

Settings	*Shortcut*
Search hardware	F2
Cascaded System	
Cameras	F7
Sync-Source	Shift+F7
Radio transceiver	
Network	
Time	

Table 8.1: Menu *Hardware*

8.1 Search hardware

Without the need for restarting the controller you can dynamically analyse your system for changes in configuration (e.g. added or removed cameras, ***ART RadioTransceiver2/3***). Therefore proceed as follows:

- connect a new camera to the controller
- wait until the camera has finished booting
- within ***DTRACK4*** press the button *Hardware* → *Search hardware* or use the shortcut '*F2*' to perform a search for new hardware
- check if the camera has been recognized successfully (e.g. by opening *Hardware* → *Camera* or use the shortcut '*F7*')
- start the measurement, the message (re-)calibration required! inside the *2D Monitor* of the corresponding camera (see chapter 6.3.1 on page 45 for details)
- perform a room re-calibration 9.1.5 on page 85, added cameras are automatically marked as '*moved*' in the room re-calibration dialog.

When cameras are added to an already calibrated tracking system these cameras will not contribute for calculation and measurement until you perform a room (re-)calibration (see chapter 9.1.5 on page 85). As a reminder the *2D Monitor* of the corresponding camera monitor(s) will show the message (re-)calibration required! .

The *DTRACK Backend Service* will detect all cameras that have been removed from an already calibrated tracking system (e.g. due to a disconnected cable) and mark those as missing until a room (re-)calibration has been performed. The *2D Monitor* of the corresponding cameras will be disabled (crossed out) and in case of larger systems their corresponding displays will be moved to a new camera tab.

DTRACK4 is able to operate when cameras have been added or removed; for best performance it is highly recommended to perform a recalibration.

8.2 Cascaded System Settings

We recommend creating a new configuration for all cascaded systems: *DTRACK4* → *Configurations* → *'New'*

Go to *Hardware* → *Cascaded System* to enter the configuration dialog for the cascaded systems (see figure 8.1 on page 68). There you may select ***SMARTTRACK3+3/M*** to build a cascade. On the right-hand side of the dialog all '*Available*' ***SMARTTRACK3+3/M*** are listed (i.e. which can become a slave in the cascaded system).

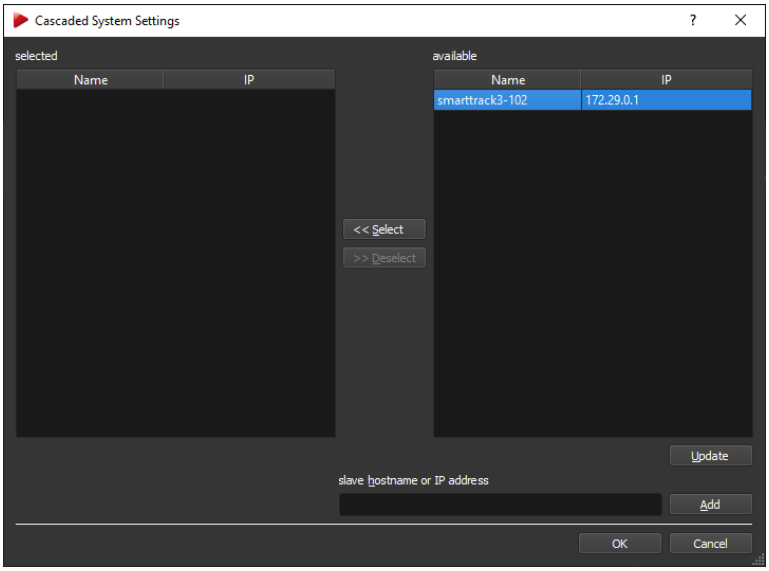


Figure 8.1: Cascaded System Settings

When you have set up your slave ***SMARTTRACK3+3/M*** properly by setting a static IP address the list will be filled automatically.

Mark the desired ***SMARTTRACK3+3/M*** by left-clicking and press '*Select*' to assign this device to the cascaded system. It will then appear on the left-hand side of the dialog in the list '*Selected*'. Repeat these steps if you want to add more slave ***SMARTTRACK3+3/M*** to the cascade.
To remove ***SMARTTRACK3+3/M*** from the cascaded system simply select the corre-

sponding device in the list '*Selected*' by left-clicking and press button '*Deselect*'.

You can also enter a '*slave hostname or IP address*' directly.

The changes will be accepted by the system by pressing '*OK*'. Settings (e.g. flash intensity, sync groups) of all cameras inside the cascade can now be edited through the *Hardware* → *Cameras* dialog. Proceed with configuration of your setup. The next time you start the measurement all cameras inside the cascade can be accessed through the *2D Monitor*.

If any slave *SMARTTRACK3+3/M* is not connected via an ethernet cable or no static IP address has been set prior to boot-up, it will use a fallback IP address (IP 192.168.0.1, subnet mask 255.255.255.0) and you will not able to connect to your slave devices !

The *DTRACK Backend Service* PC must be set to an additional specific static IP address 172.29.0.1 with subnet mask 255.255.0.0. In the subdialog *Internet protocol, Version 4 (TCP/IPv4) Properties* you need to add this IP range by clicking the button '*Advanced*'. Please refer to the 4.2 on 26.

Do not use the PoE injector nor the BNC synchronisation when connecting *SMARTTRACK3* & *SMARTTRACK3/M* slaves to PoE+ switches attached to *DTRACK Backend Service* .

8.3 Camera Settings

This dialog (see figure 8.2 on page 70) shows a comprehensive list of all cameras currently connected to the system as well as all cameras that have been removed since the last valid room calibration. It allows changes of all camera specific settings (e.g. flash intensity, static reflex suppression, syncgroup assignment, etc.) either for all cameras at once (globally) or for each camera separately by left-clicking and selecting the appropriate entry.
Here you can also toggle *modulated flash* in order to synchronize and trigger an active target.

8.3.1 All Cameras tab

By default the window opens up showing the tab *All Cameras*.
All detected cameras are shown in the table (8.2 on page 70) with their corresponding settings (from left to right):

8.3.1.1 Flash intensity

The flash intensity may be changed within an interval from

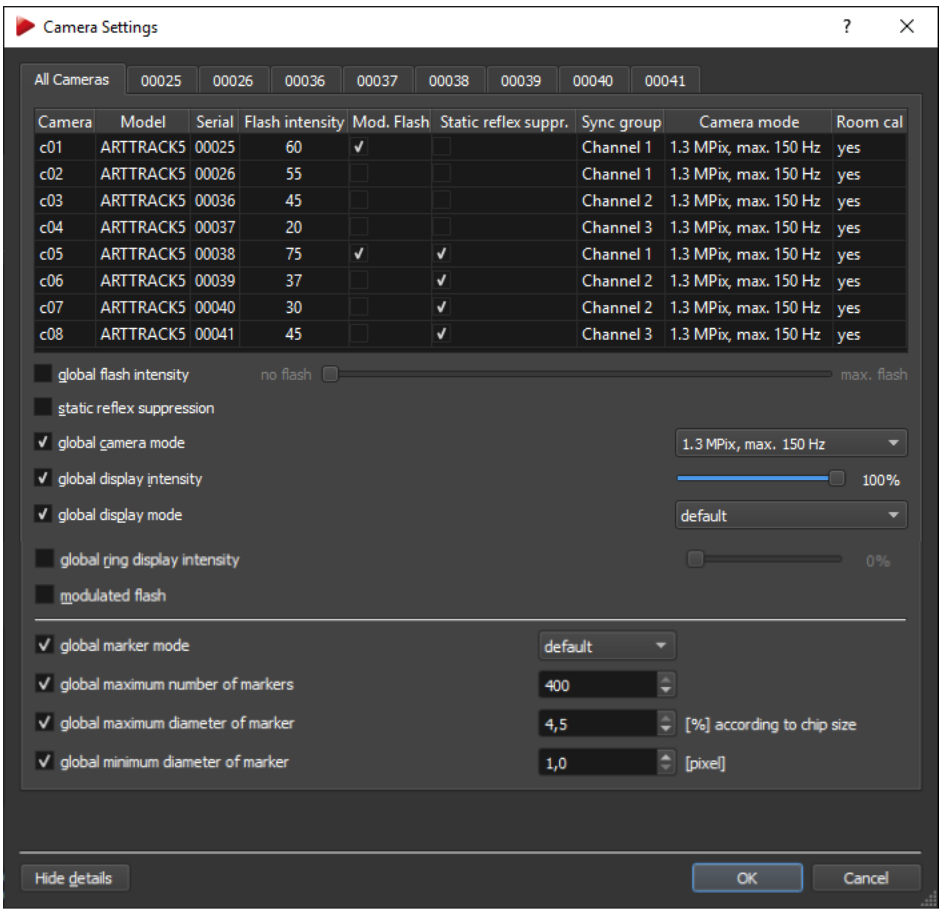


Figure 8.2: Camera Settings - All Cameras Tab

Column	Description
Camera	Shows the assigned camera ID c01 to ... (compare LED matrix display on ***AT7-80*** & ***AT7-50***)
Model	Shows the type of camera
Serial	Shows ***ART*** internal serial number of each camera
Flash intensity	Change the currently set flash intensity (individually)
Modulated flash	(De-)activates the synchronisation signal and trigger for active targets (individually)
Static reflex suppr.	(De-)activates the static reflex suppression for this camera (individually)
Sync group	Select the syncgroup (’*Channel 1*’ - ’*Channel 3*’ (individually)
Camera mode	Select the camera mode (available modes depend on model, individually)
Room cal	Shows the status of room calibration (i.e. ’*no*’ for newly added but not yet calibrated cameras)

Table 8.2: Menu *Camera Settings*

- 0 .. 100 for ***AT7-80*** , ***AT7-50*** and ***ARTTRACK6/M***

The flash setting strongly depends on the working area and range. Increase the flash intensity until all markers become yellow or green using the *2D Monitor*. Additionally pay attention to the intensity bar on the top right corner of each camera monitor. Please refer to chapter 6.3.1 on page 45 for instructions.

As a rule of thumb: For measurement applications with high accuracy requirements the markers should be displayed in green with intensities of min. 4 bars; for VR applications yellow markers with intensities down to 2 bars are still sufficient.

A warning message will appear if *AT7-80* or *AT7-50* are not connected to PoE+ rated switches or power supplying injectors indicating that the maximum available flash intensity is limited.

Keep a distance of min. 20 cm when operating the cameras ! All cameras are assigned to the Exempt Group according to IEC62471-1 and therefore pose no risk or hazard to the human eye or skin at this distance.

Modulated flash *ART* tracking systems can be used with active markers, i.e. markers consisting of infrared LEDs instead of retro reflective material (please refer to the ***ART Hardware Installation Guide*** → *Markers & Targets*). Tick the checkbox *modulated flash* in the table to activate the synchronisation signal (i.e. coded IR flash) that triggers active targets for individual cameras.

The effective flash intensity is reduced significantly when the modulation is used in combination with low flash intensities. The influence is negligible at higher flash intensity settings. Simply increase the flash intensity, if necessary.

The range of the modulated flash is significantly higher than the effective tracking distance of the cameras.

All cameras with activated modulated flash have to be assigned to syncgroup #1 (default).

8.3.1.2 Static reflex suppr.

Tick the corresponding checkbox to activate the support of static reflex suppression. Please refer to the 6.3.2 on page 49 for further information.

8.3.1.3 Sync group

In case of mutual blinding of cameras (see ***ART Hardware Installation Guide*** → *Setting up the cameras*) one can assign different syncgroups for opposing or adjacent cameras. You may change the assignment either on the *All Cameras* tab or on the *Individual tab* of the respective camera. Click on the appropriate field in the column '*Sync group*' to open a drop-down menu. Possible values are '*Channel 1*', '*Channel 2*' or '*Channel 3*'.
These channels correspond to the three syncgroup outputs (time delays #1: 0 μs, #2: 480 μs, #3: 960 μs). To change the predefined time delays please refer to 8.4 on page 77.

8.3.1.4 Camera mode

Depending on the model and on your application you can change the camera mode (i.e. the field of view) in order to achieve:

- higher max. frame-rates (refer to ***ART Hardware Installation Guide*** → *Technical Specifications* for each camera model)
- lower latencies (i.e. time delays for measurement data).

To switch the camera mode, click on the field in the column '*Camera mode*' to open a drop-down menu (e.g. *5.1 Mpix, max. 230 Hz*).

The max. frame-rate is limited by the camera with the largest field of view selected respectively the max. frame-rate of that individual camera. In mixed systems the max. frame-rate may be limited.

Note: Higher frame-rates come at the cost of the cameras' reduced field of view.

8.3.1.5 Room cal

This indicator shows whether the corresponding camera was present and running during the last valid room calibration. Hence, *yes* shows that the camera will be used for measurements and will contribute to the tracking. On the contrary *no* indicates that additional cameras have been added to an existing configuration without performing a room (re-)calibration. Thus a (re-)calibration is necessary for the corresponding camera to contribute to the tracking. Please refer to chapter 8.1 on page 67 on how to add new cameras dynamically.

The *DTRACK Backend Service* will detect all cameras that have been removed from an already calibrated tracking system (e.g. due to a disconnected cable) and mark those as missing until a room (re-)calibration has been performed. The corresponding entries are greyed out to show that the cameras have been disabled. The only data shown is model and serial number.

***DTRACK4* is able to operate when cameras have been added or removed; for best performance it is highly recommended to perform a re-calibration.**

8.3.1.6 Global settings

Tick the checkboxes to adjust the corresponding settings for all cameras at once.

global flash intensity Move the adjacent slider to adjust the flash intensities of all cameras globally.

static reflex suppression Tick the corresponding checkbox to activate the support of static reflex suppression for all cameras at once.

global camera mode Set the field of view for all cameras globally by using the adjacent dropdown-menu (e.g. *1.1 Mpix, max. 60 Hz*) on the right.

global display intensity Move the slider to adjust the brightness of the status LEDs on all camera models and the LED matrix display on the ***AT7-80*** and ***AT7-50*** . The brightness can be dimmed from 0...100% if necessary (e.g. in light-sensitive environments).

global display mode (*AT7-80* and *AT7-50*) Select *default* to activate the status LEDs and the LED matrix display to show the currently assigned camera ID. Alternatively select *number of markers / camera ID* to display the number of detected markers in the camera's field of view instead (only during measurements). The LED matrix display can also be deactivated by selecting *only status LEDs*.

global ring display intensity (*AT7-80* and *AT7-50*) Move the slider to adjust the brightness of the ring indicator LED on ***AT7-80*** and ***AT7-50*** models. The brightness can be dimmed from 0...100% if necessary (e.g. in light-sensitive environments).

modulated flash Tick the checkbox here to activate the modulated flash for all cameras at once.

8.3.1.7 Show Details

Here you can change the settings regarding low-level marker detection globally (see figure 8.2 on page 70):

Option	Description
global marker mode	configure the marker detection algorithm
global maximum number of markers	set maximum number of markers that a camera is allowed to detect simultaneously
global maximum diameter of markers	set maximum size of a marker that a camera is allowed to detect (in percentage of the camera's sensor size)
global minimum diameter of markers	set minimum size of a marker that a camera is allowed to detect (in pixel)

Table 8.3: *Camera Settings* - Show Details All Cameras Tab

marker mode The marker detection algorithm that is being used: '*fast*'.

maximum number of markers The maximum frame-rate for each camera type at any given FOV or camera mode respectively is limited by the amount of simultaneously de-

tected markers. The frame-rate is equivalent to the frequency set on the Synccard (see 8.4 on page 77). In scenarios with very high amounts of visible markers (e.g. 150 and beyond) the frame-rate may only be achieved by allowing a limited maximum number of markers.

maximum diameter of markers This parameter allows to exclude unreasonably sized markers from marker detection (e.g. reflections). The default values are derived from use of standard ***ART*** target dimensions and marker sizes in scenarios of typical measurement distances. Units are measured in percentage of observed marker sizes on the camera's sensor in relation to the sensor area. Should scenarios demand a deviation from the default values one may adjust this parameter (e.g. markers with high diameter in close proximity to the cameras requires an increase, while a strong decrease would exclude even the detection of standard sized markers at typical distances).

minimum diameter of markers Similar to the maximum observed marker size one can also exclude detections below a certain threshold. The minimum diameter is set to 1 pixel, by default. Should scenarios demand a deviation from this typical value one may adjust this parameter by increasing.

Depending on the camera type there may be only one marker detection algorithm available, which is automatically used as default.

The maximum tracking distance is limited when increasing the minimum diameter of markers.

8.3.2 Individual camera tabs

Each camera can also be accessed by its individual tab within this dialog (see figure 8.3 on page 75).
In the upper left corner of the tab you will find a depiction of the corresponding camera. To the right the following information is listed:

Info	Description
Model	Shows the type of camera
Serial	Shows ***ART*** internal serial number of the camera
Version	Shows ***ART*** internal firmware version of the camera
Focal length	Shows the focal length of the camera lens

Table 8.4: *Camera Settings* - Individual Tab Infos

Below you can change the following options (please refer to the former paragraphs for equivalent options):

8.3.2.1 Show Details

Here you can change the settings regarding low-level marker detection for individual cameras (see figure 8.3 on page 75):

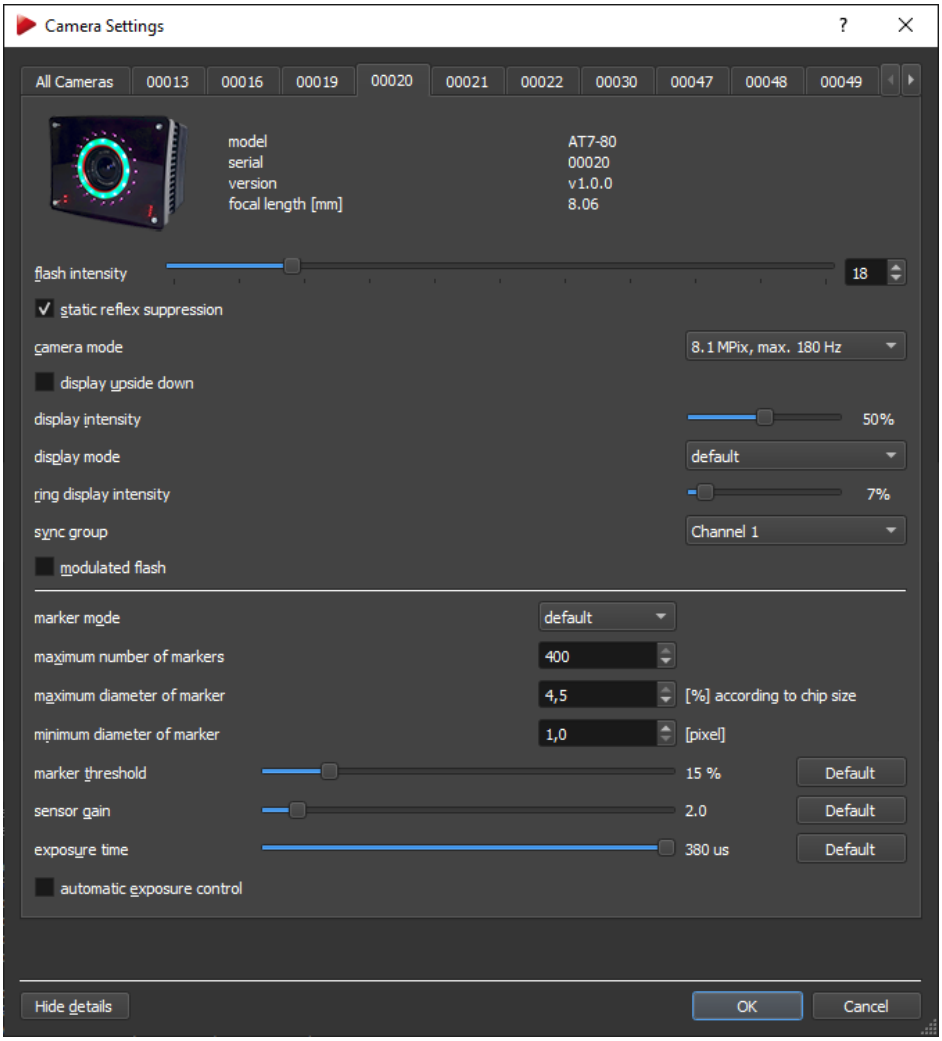


Figure 8.3: *Camera Settings* - Individual Tab

Option	Description
flash intensity	Change the currently set flash intensity
static reflex suppr.	(De-)activates the static reflex suppression for this camera
camera mode	Select the camera mode (available modes depend on model)
display upside down	Rotate the orientation of the camera monitor in the *2D Monitor* by 180°. '*UD*' is displayed in corresponding camera monitor.
display intensity	Adjust the brightness of the status LEDs (all camera models) and the LED matrix display (***AT7-80*** and ***AT7-50***)
display mode	(De-)activates the LED matrix display (***AT7-80*** and ***AT7-50***)
ring display intensity	Adjust the brightness of the ring indicator LED on (***AT7-80*** and ***AT7-50***) models.
sync group	Select the syncgroup '*Channel 1*' - '*Channel 3*' (***AT7-80*** , ***AT7-50*** and ***ARTTRACK6/M***)
modulated flash	(De-)activates the synchronisation signal and trigger for active targets

Table 8.5: *Camera Settings* - Individual Tab Options

Option	Description
marker mode	configure the marker detection algorithm
maximum number of markers	set maximum number of markers that a camera is allowed to detect simultaneously
maximum diameter of markers	set maximum size of a marker that a camera is allowed to detect (in percentage of the camera's sensor size)
minimum diameter of markers	set minimum size of a marker that a camera is allowed to detect (in pixel)
marker threshold	set the sensitivity of the marker detection algorithm (in percent)
sensor gain	set the gain level of the camera's sensor (as a factor) [1]
exposure time	set the exposure time of the camera manually (in microseconds)
automatic exposure control	set the exposure time of the camera based on the selected flash intensity
Default	return to default values
region of interest	selects a region of interest from within a camera mode (top, center, bottom)[2]

[1] not available for ***ARTTRACK6/M***
[2] only available for ***AT7-50***

Table 8.6: *Camera Settings* - Show Details Individual Camera Tab

marker threshold The *marker threshold* adjusts the minimum amount of brightness necessary for marker detection. In certain environments and scenarios (e.g. outdoors, sunlight, other factors that cause high intensities coming from stray light) you may improve marker detection and thus tracking quality by increasing the *marker threshold* and decreasing the *exposure time*. Try to adjust both parameters moderately until improvement is reached.

sensor gain The *sensor gain* adjusts the amplification factor on the cameras's sensor (not available for ***ARTTRACK6/M***). Decrease the value to factor 1 to turn off amplification in certain environments (e.g. outdoors, sunlight, other factors that cause high intensities coming from stray light). Move the slider up to the middle (i.e. towards factor 5) to increase for sensitivity in long-range measurement scenarios. Avoid very high sensor gain values (i.e. > factor 7) unless unwanted reflections are reduced to an absolute minimum beforehand.

exposure time The *exposure time* adjusts the maximum integration time of the camera's sensor in microseconds. Improve marker detection and reduce sensitivity to stray light by reducing the *exposure time*.

automatic exposure control Tick the checkbox to activate the *automatic exposure control*. This couples the maximum integration time of the camera's sensor to the flash intensity (i.e. the duration of the IR flash of the camera). Hereby the IR flash is used most effeciently (signal) while minimizing the time unwanted stray light (noise) is collected by

the sensor. This effect is seen best in scenarios where the flash intensitites are below 90%.

region of interest The *region of interest* selects the read out sensor part (top, center, bottom) from inside a camera mode when the sensor is not in full frame mode. This shifts the FoV so that the current camera orientation can remain unchanged.

Try to adjust *marker threshold*, *sensor gain* and *exposure time* moderately until improvement is reached.

When using passive markers only it is unnecessary to adjust the exposure time manually. Tick the checkbox *automatic exposure control* and decrease the *flash* until markers can still be tracked in good quality in the *2D Monitor*. Please refer to chapter 6.3.1 on page 45.

Active markers by *ART* need a minimum exposure time of at least 30 μs. Do not use *automatic exposure control* in combination with very low flash intensities (i.e. < 25).

In general do not adjust the *marker threshold*, the *sensor gain* or the *exposure time* to extreme values far from default. The tracking quality may become unreliable and the system may malfunction.

8.4 Sync-Source Settings

This dialog shows the model and the serial number of the camera that is being used as sync-source .

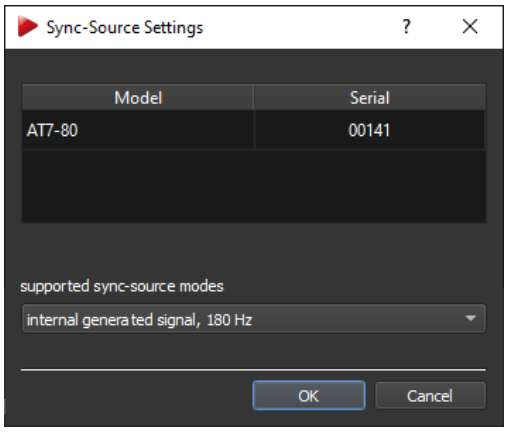


Figure 8.4: Sync-source Settings

The available modes for synchronisation are shown in table 8.7 on page 78.

supported Synccard modes	field of application
internal generated signal, ... Hz	run the controller without external synchronisation (available values dependent on camera model)
direct settings	advanced custom settings

Table 8.7: Overview of the supported sync-source modes

8.4.1 Direct Settings

If you select *direct settings* you may use advanced options for configuring the sync-source:

Option	Description
source	configure the type of synchronisation to be used (see details below)
frequency [Hz]	enter the tracking frequency manually (max. frequency dependent on camera model and selected camera mode)
divisor for external signal output	disabled (legacy)
Delay [us]	disabled (legacy)
	configure the delay between *Channel 1* and exposure syncgroups in *Channel 2* and *Channel 3*

Table 8.8: Sync-source direct settings

frequency [Hz] The tracking frequency can be set between 10 Hz and the max. frame-rate of the cameras in steps of 1 Hz. The max. frame-rate depends on the camera model and the selected camera mode. Please refer to the ***ART Hardware Installation Guide*** → *Technical Specifications* for more information.

Delay [us] When working with external synchronisation a time delay can be set between the external synchronisation signal and the exposure time of all camera syncgroups. The delay for syncgroups (*Channel 2* to *Channel 3*) is measured relative to *Channel 1*. If necessary these values can be changed individually.

Note: The max. delay is dependent on the camera model and camera mode. A difference of min. 300 μs between consecutive channels has to be maintained at all times.
Example: *Channel 1*: 1200 μs, *Channel 2*: 1500 μs, *Channel 3*: 1800 μs

The default values for the different channels (#1: 0 μs, #2 480 μs , #3: 960 μs) are preset for compatibility with active markers by *ART*. Do not increase the delays between the channels beyond 480 μs when using active markers.

8.5 Radio Transceiver

Here you can configure the settings of the ***ART RadioTransceiver2/3*** . Additionally you will get information about all attached interaction devices (e.g. ***Flystick2/2+***).

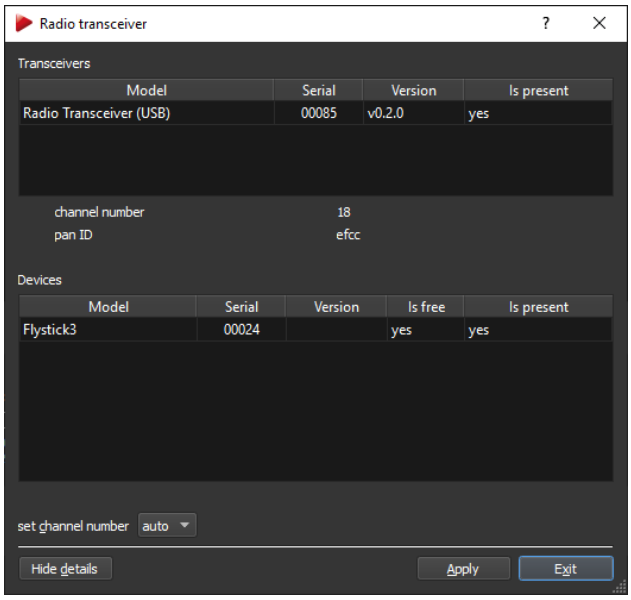


Figure 8.5: ART Radio Info Settings

The following information is offered:

Info	Description
Model	Shows the model of the transceiver or the device respectively
Serial	Shows the serial number of the transceiver or device respectively
Version	Shows the firmware version of the transceiver or device respectively
Is present	(’*yes*’): The transceiver is connected, the device is in range
Is free (only for Devices)	(’*yes*’): The device is available for communication and has not been assigned yet (’*no*’): The device is already assigned to a transceiver

Table 8.9: ***ART RadioTransceiver2/3*** info settings

Show details By clicking the button *Show details* the drop-down menu for selecting the radio channel of the ***RadioTransceiver2/3*** is shown.

Set channel number By default the ***RadioTransceiver2/3*** is automatically selecting a radio channel during boot-up, the drop-down menu is preset to (’*auto*’). You may also select a specific channel manually. The selected setting is saved persistently.

8.6 Network

On the *Network* window you may check the configuration of the primary network adapter settings that is used for connection ***DTRACK Backend Service*** to your clients.

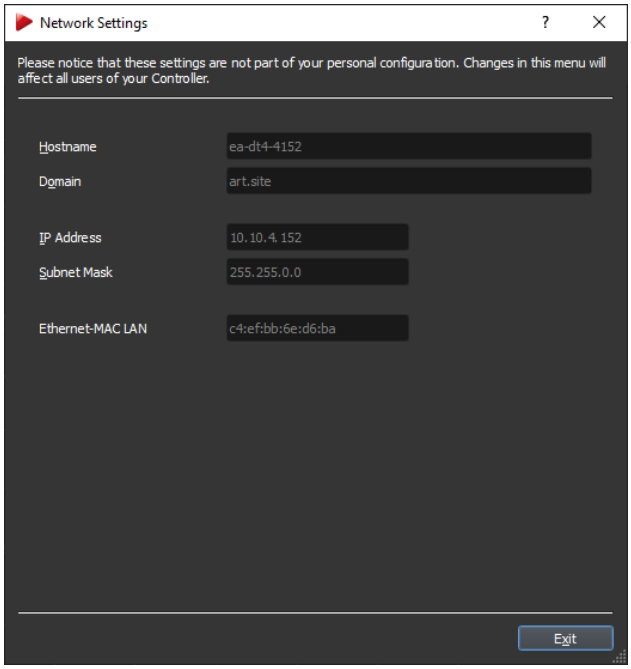


Figure 8.6: Network Settings

9 Menu Tracking - Tracking Configuration

Calibration	*Shortcut*
Room calibration	F5
Room adjustment	Shift + F5
Single markers	
Body administration	F8
Body calibration	F6
Body adjustment	Shift + F6
Flystick	
Fingertracking	
Measurement Tool	
Measurement Tool tip calibration	
Output	F9

Table 9.1: Menu *Tracking*

9.1 Room Calibration

Use the room calibration dialog (see figure 9.1 on page 82) to start the calibration process and set parameters therefore. After opening the dialog, the *Monitor 2DOF display* is automatically started in the background. It is possible to transfer a room calibration from one configuration to another (refer to section 9.1.7 on page 87).

It is recommended to perform a room (re-)calibration on a regular basis (e.g. after a certain operating time of the system) and especially if the system was subject to extreme vibrations or changing environmental conditions (.e.g. high or low temperatures).

9.1.1 Pre-defined room calibration sets

In the *Room calibration* dialog you can choose from a series of predefined calibrations sets (i.e. a pair of '*calibration angle*' and '*wand*' representing the common ***ART*** Room Calibration Sets, see table 9.2 on page 82).
Select the calibration set that has been delivered with your tracking system using the dropdown-menu *marker distances*. Verify the wand length or enter it manually in the corresponding field *wand length*, see figure 9.1 on page 82. The wand length is printed on the '*wand*' .

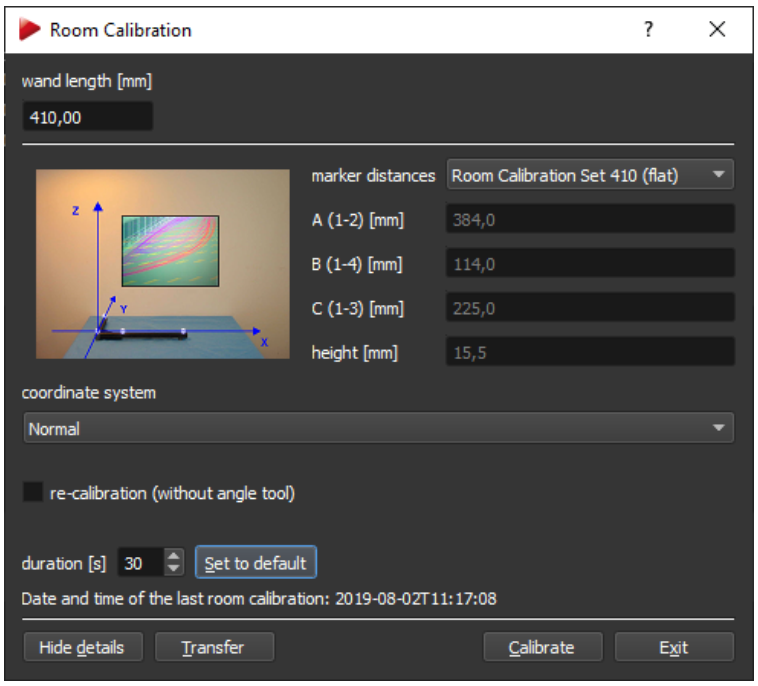


Figure 9.1: Room calibration - using calibration set RCS410

Calibration Set	wand length [mm]	marker dia. [mm]	height [mm] (see Fig. 9.2)
RCS TP (discontinued)	410.0	20	55
RCS 150 (special order)	184.0	16	15.6
RCS 150 active (special order)	204.63	N/A	15.5
RCS 410 flat	410.0	20	15.5
RCS 410 high (discontinued)	410.0	20	43
RCS 710	710.0	20	43
RCS 720 (special order)	720.0	30	48

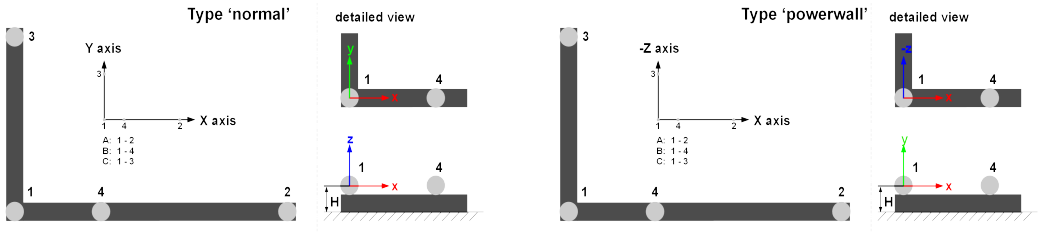
Table 9.2: Overview of the ***ART*** Room Calibration Sets (RCS)

Place the '*calibration angle*' inside the tracking volume of your cameras, double-check that all markers of the '*calibration angle*' are seen by the cameras. Start the calibration by pressing *Calibrate*. The room calibration is started with a five seconds delay.

9.1.1.1 Expert settings

Marker distances of the '*calibration angle*' can also be set manually using the setting *marker distances* → *expert*. The numbering of the markers is as seen in figure 9.2 on page 83.

Type	longer arm	shorter arm
'*normal*'	+X axis	+Y axis
'*powerwall*'	+X axis	-Z axis



(a) type 'normal' (b) type 'powerwall'

Figure 9.2: Marker distances (including numbering) on the '*calibration angle*' and definition of room coordinate system

The longer arm of the '*calibration angle*' defines the X axis (refer to figure 9.2 on page 83); the shorter one defines the Y axis. The Z axis is added in order to give a right-handed coordinate system. The center of marker #1 defines the origin of the room coordinate system (at a height of see table 9.2 on page 82).

Incorrect input data for this dialog will lead to a poor room calibration, to wrong system scaling, or to an abort of the whole room calibration process.

9.1.2 Coordinate System

With the drop-down menu inside the dialog *Room calibration* you may define how the coordinate system of the room is created relative to the '*calibration angle*' (refer to table 9.3 on page 83).
Select either '*normal*' or '*powerwall*', see figure 9.1 on page 82.

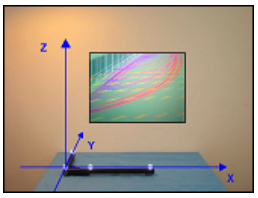
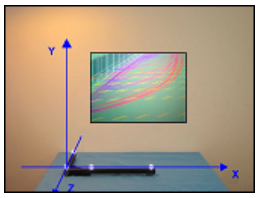
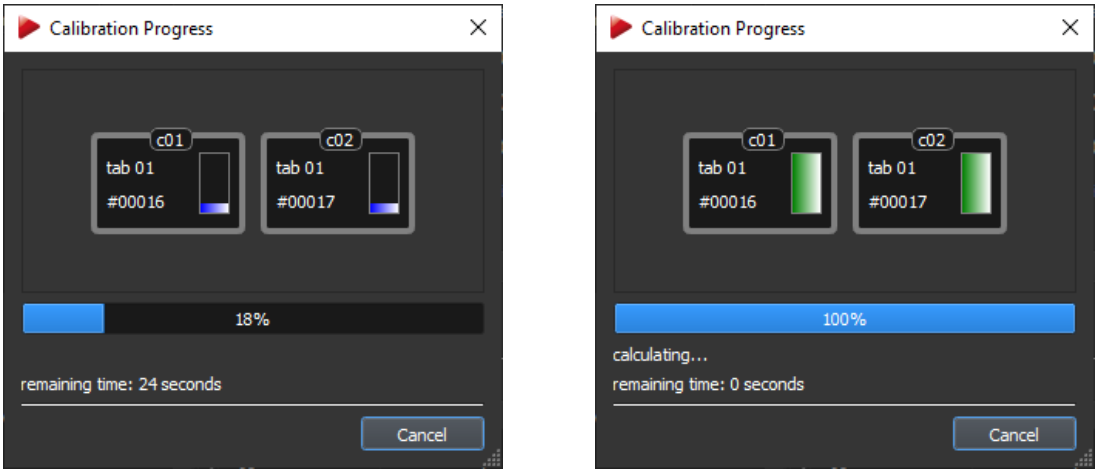
Normal	Powerwall
	
Normal: The angle defines the X/Y plane (X at the longer, Y at the shorter arm) and Z axis is added upwards.	*Powerwall*: The angle defines the X/Z plane, the Y axis is added upwards. The Z axis points out of the screen. This is the standard screen coordinate system for many VR systems (e.g. OpenGL, TrackD, etc.).

Table 9.3: Defining the coordinate system for the room calibration

9.1.3 Room Calibration Progress

When the room calibration process starts a window showing the progress appears (see figure 9.3(a) on page 84). The progress is shown individually for each camera which is especially helpful for big systems. As soon as enough data for calculation of the camera position has been collected for a specific camera the corresponding progress bar changes its colour to green (see 9.3(b) on 84).



(a) shortly after start (b) towards the finish

Figure 9.3: Room calibration progress

Note: The progress is also displayed individually on the LED matrix display and the ring indicator LED of each *AT7-80* or *AT7-50* camera. After collection of sufficient data the LED matrix display changes back to its defined setting. Please refer to chapter 8.3 on page 69 for detailed information.

The point cloud should fill at least two thirds of the measurement volume. Moving the '*wand*' in a restricted volume will results in reduced accuracy of calibration or failure.

9.1.4 Room Calibration Results

After a successful room calibration, the *Room Calibration Result* window is displayed. This window shows measures to estimate the quality of room calibration (refer to table 9.4 on page 85.

The room calibration is confirmed (i.e., the data are stored) by pressing the button *OK*.

Try to achieve a low '*wand residual*' up to 1 mm for VR installations while having high values for '*Used Frames*'.

The parameters '*Residual*' for each camera and the '*wand range*' depend on the system geometry and give additional information about the quality of calibration. Please call *ART* for further information.

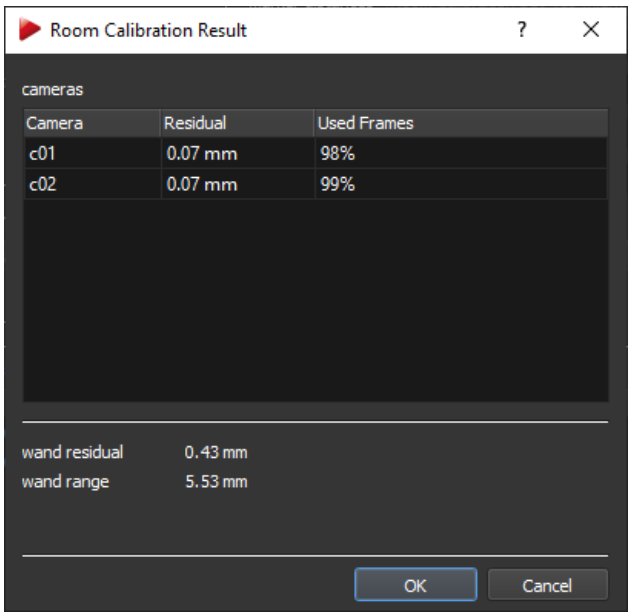


Figure 9.4: Room calibration result

indicator	Description
Residual	mean residual of single cameras (i.e. optical rays during marker detection)
Used Frames	represents the percentage of valid data for each camera (i.e. used for room calibration)
wand residual	mean deviation of '*wand length*'
wand range	max. deviation of '*wand length*'

Table 9.4: Room Calibration Result - Description of quality measures

☞ **The number of '*Used Frames*' should be greater than 70% for each camera. Values under 50% indicate poor room calibration quality.**

☞ **Please note that percentages of more than 70% may not be reached in large and complex measurement volumes.**

9.1.5 Room re-calibration

All camera setups may change after a certain operation time ; if e.g. movement of single cameras due to mechanical instabilities cannot be ruled out or thermal drifts occur it is necessary to perform room calibrations periodically.

DTRACK4 provides a simplified process to revise an existing room calibration without need of an '*calibration angle*', called Room re-calibration.
The '*calibration angle*' does not have to be present in the measurement volume; only the '*wand*' has to be moved the same way as for a standard room calibration. The main advantage of a *room re-calibration* is that ***DTRACK4*** preserves the origin and orientation of your coordinate system.

To re-calibrate your room tick the checkbox *re-calibration* in the bottom left corner of the room calibration dialog (see figure 9.5 on page 86). The settings *marker distances* and *coordinate system* are disabled / greyed out and thus are not allowed to be changed in comparison to the last valid standard room calibration. Settings regarding the '*wand*' may be modified, however.

In case camera positions have changed since the last valid room calibration you have to mark them as '*moved*' by unticking the corresponding checkboxes in *select static cameras* (see figure 9.5 on page 86). Start the calibration by pressing *Calibrate*. The room calibration is started with a five seconds delay.

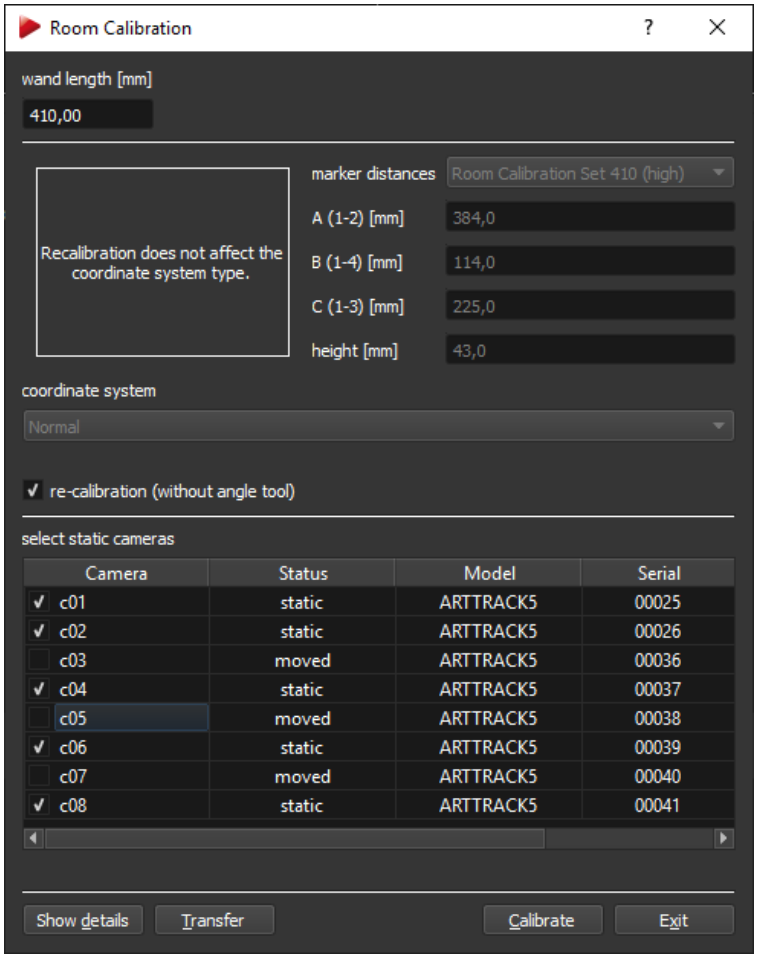


Figure 9.5: Room re-calibration dialog

Re-calibration is possible as long as camera movements are not too large. It will fail e.g. if the mounting of cameras has been changed completely.

The checkbox *re-calibration* is enabled only for *coordinate system* → '*normal*' or '*powerwall*'.

9.1.6 Show Details

The button *Show details* offers information about the date of the latest room calibration.

Duration You may adjust the '*duration*' of the room calibration (→ *Show details*) in a range of 10s - 120s. Reset the value to default by pressing the *Set to default* button (default = 30s).

Changing the duration of the room calibration towards shorter durations may lead to bad room calibration results! Please make sure that you are able to cover two thirds of the tracking volume within the set time.

9.1.7 Transfer of room calibration data

In case different configurations need to share the same room calibration data, one can transfer the parameters from the currently running configuration to selected others. Press the button *Transfer* to open the *Transfer room calibration* dialog (see figure 9.6 on page 87). Select the configuration(s) you would like to apply the current room calibration data and press *Apply*.

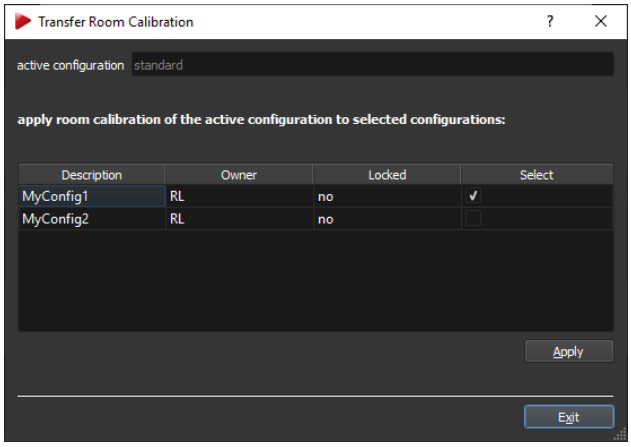


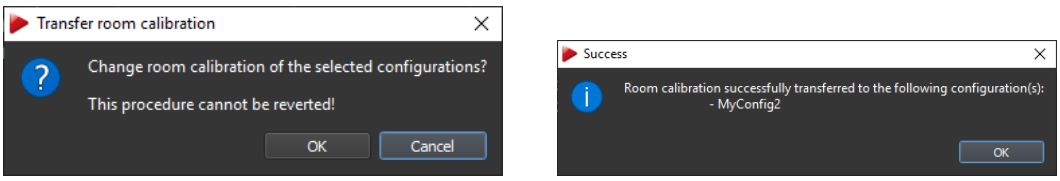
Figure 9.6: Transfer Room Calibration dialog

Accept the transfer by pressing *OK* or discard the changes by pressing *Cancel* (see figure 9.7(a) on page 88).

A status message will appear after the successful transfer (see figure 9.7(b) on page 88). Leave the *Transfer room calibration* dialog by pressing *Exit*.

Room calibration data can only be transferred to an unlocked configuration.

Any previously acquired room calibration stored in another configuration will be overwritten during transfer. This process cannot be reverted !



(a) Accept the Transfer (b) Transfer Successful

Figure 9.7: Transfer Room Calibration - sub-dialogs

9.2 Room adjustment

During a room calibration the marker located in the intersection of the two arms on the '*calibration angle*' defines the origin of the coordinate system (Marker #1), see figure 9.2 on page 83. Oftentimes it might be more suitable to set the origin in respect to a well-known point in space. Use the room adjustment functionality to alter the room coordinate system after calibration.

Possible scenarios for the application of the *Room adjustment* functionality are:

- adjust the origin to the center of a screen,
- align the coordinate system colinear / parallel to a screen (Note: even very small angular deviations might lead to substantial misalignment across the full width of the projection typically 0.1° on 5m length equals 8.7 mm deviation)
- shift and / or rotate the camera coordinate system to match a reference coordinate system, e.g. from CAD models
- maintaining a specific coordinate system / orientation when using mobile installations of cameras, i.e. frequently changing the camera setup locations (suitable reference points provided)

In all these cases the coordinate system must be altered after calibration.

9.2.1 Room adjustment - Coarse

Open the *Room adjustment* dialog where the *Coarse* tab offers a simple way to manipulate the orientation of the room coordinate system with just one click (see figure 9.8 on page 89. On the left hand side of the dialog the current camera coordinates calculated from the room calibration process are displayed. On the right hand side you can define the orientation of two axes using the drop-down menus *Assign axes to room directions* - the third one will be oriented automatically according to the right-hand rule.

Press *Enter* or click *OK* to confirm all changes (i.e. changes are sent to the controller) and the dialog closes. Press *Apply* to accept the current changes but the dialog is left open. Discard all changes by pressing *Cancel*. Press *Reset* to switch back to the unmodified state.

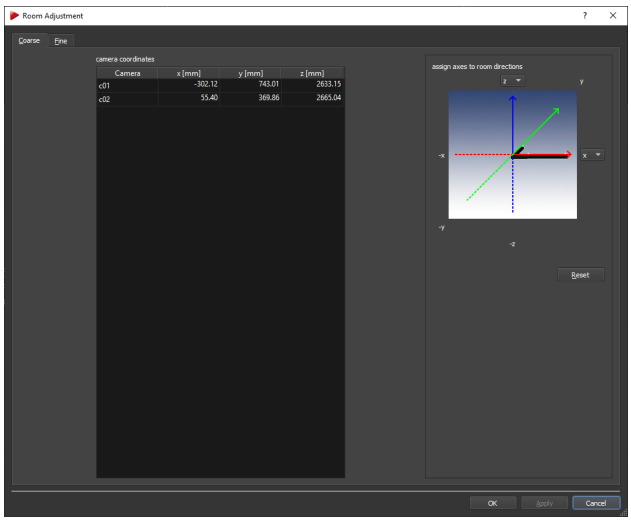


Figure 9.8: Room adjustment dialog (coarse)

9.2.2 Room adjustment - Fine

More detailed options to adjust the room coordinate system are given in the *Fine* tab (see figure 9.9(a) on page 90). By default a cartesian coordinate system is displayed on the left side of the window. On the right side of the window the room coordinate system may be customized freely, i.e. user-specific.

9.2.2.1 Graphical display

The room coordinate system is shown as a triplet of arrows with a defined color-coding (x-axis - red, y-axis - green, z-axis - blue), while the xy-plane is shown as a yellow grid. The current and the transformed room coordinate systems are marked with ('*O*') and ('*T*') respectively.

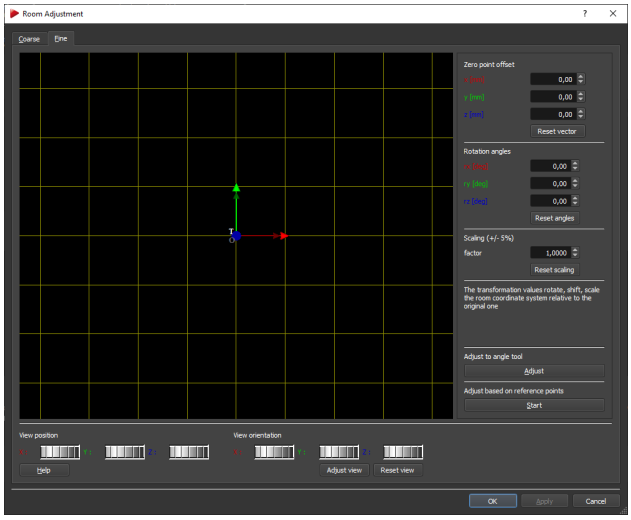
The viewing position and orientation may be changed in two different ways:

1. hold down the "Ctrl" key and the left / right mouse button to change the position / orientation inside the graphical display
2. use the six control dials *View position* and *View orientation* (below the graphical view) to adjust position and orientation along all axes

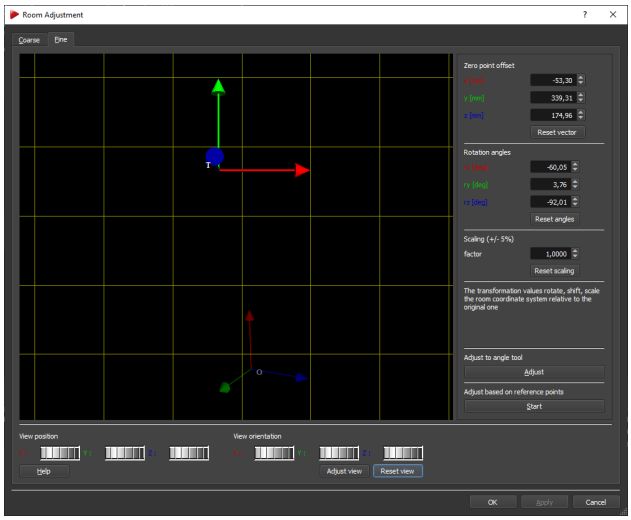
To center the current room coordinate system, press *Adjust view*. To restore the default view (shift and orientation), press *Reset view*. The visualisation itself can be changed by clicking the right mouse button to open a context menu with the following options (refer to table 9.5 on page 90). (De-)select the appropriate ones by (un-)ticking.

9.2.2.2 Manually transforming the coordinate system

Several options for transformation of the coordinate system can be selected (refer to table 9.6 on page 91).



(a) before Transformation



(b) after Transformation

Figure 9.9: Room adjustment dialog (fine)

Option	Description
'*Long axes*'	extends the coordinate axes of the body coordinate system by infinite dashed lines
'*Show XY plane*'	shows the XY plane (yellow grid)
'*Show YZ plane*'	shows the YZ plane (cyan grid)
'*Show XZ plane*'	shows the XZ plane (magenta grid)

Table 9.5: Room Adjustment (Fine) - Graphical display context menu

Example All entered transformation values are relative to the original room coordinate system, i.e. in a standard coordinate system (xy-plane on the ground, z-axis facing upwards) the origin is placed 42mm above the ground (due to the height of '*calibration angle*' + radius of spherical marker). If the new desired origin is to be placed 1 m above

Action	Description
Zero point offset [mm]	translate the room coordinate system along its axes in steps of 1mm
Reset vector	reset the zero point offset to the unmodified state (0.00 mm)
Rotation angles [deg]	rotate the room coordinate system around its axes (from -180 to +180 °)
Reset angles	reset the rotation angles to the unmodified state (0.00 °)
Scaling factor	enlarge / shrink the room coordinate system uniformly by a factor of +/-5 percent
Reset scaling	reset the scaling factor to the unmodified state (1.0000)
Start	start up a module for transforming & matching to a reference coordinate system (***DTRACK4*** licenses required)

Table 9.6: Room Adjustment (Fine) - Transform actions

the ground, then the *Zero point offset* for z is 958mm (1000 mm - 42 mm).

9.2.2.3 Adjust to angle tool

In some cases the room coordinate system needs to be transformed to a specific position and orientation using the *calibration angle* as reference. There is no need to use the *wand* in this process. Open the dialog *Adjust room coordinates to angle tool* (see figure 9.10 on page 92) and place the *calibration angle* inside your tracking volume to define the new origin and orientation. Please refer to figure 9.2 on page 83.

Double-check that all markers of the '*calibration angle*' are seen by the cameras and start the calibration process by pressing *Calibrate*.

A progress bar shows the current status (see figure 9.11(a) on page 92) after which a result window will be opened (see figure 9.11(b) on page 92).

Press *OK* to return to the dialog *Adjust room coordinates to angle tool*. Press *OK* to accept or *Cancel* to discard the changes.
Back in the *Fine* tab of the *Room adjustment* dialog (see figure 9.9(b) on page 90) press *Enter* or click *OK* to confirm the resulting transformation and to close the dialog. Pressing *Apply* accepts the current changes and leaves the dialog open. Discard all changes by pressing *Cancel*.

☞ **Incorrect selection of the *calibration angle* will result in failure of calibration.**

☞ **The calculated transformation is applied on both *zero point offset* as well as *rotation angles* in *Fine* tab.**

9.2.2.4 Adjust based on reference points

The purpose of the coordinate transformation is to convert the origin and orientation of the initial camera coordinate system (indicated with '*O*') into a reference coordinate system

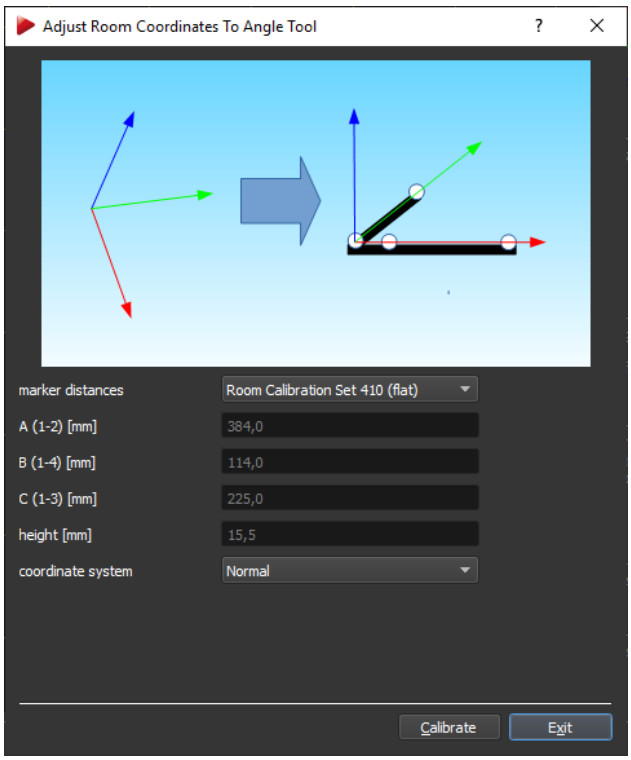
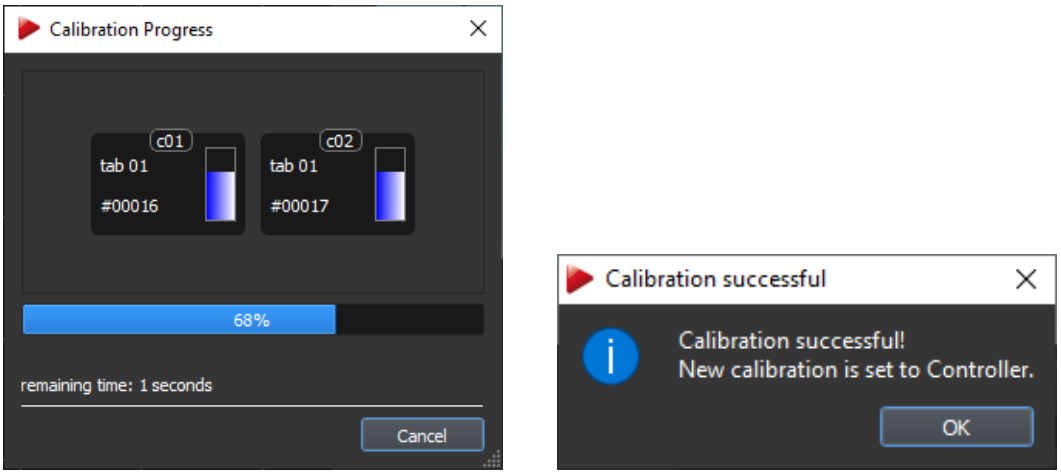


Figure 9.10: Room adjustment - Adjust room coordinates to angle tool



(a) Progress bar (b) Success Window

Figure 9.11: Adjust room coordinates to angle tool - sub-dialogs

(indicated with '*T*'), e.g. given by a certain object or CAD model. All measurement data will be transformed with respect to the reference coordinate system ('*T*'). Press *Start* in the *Fine* tab to open the room matching dialog (see figure 9.12 on page 93). This functionality depends on licenses (refer to chapter 7.2 on page 60).

If the Measurement Tool is not tracked (calibration required) matching cannot be performed. Use an authorised Measurement Tool by *ART* for best results.

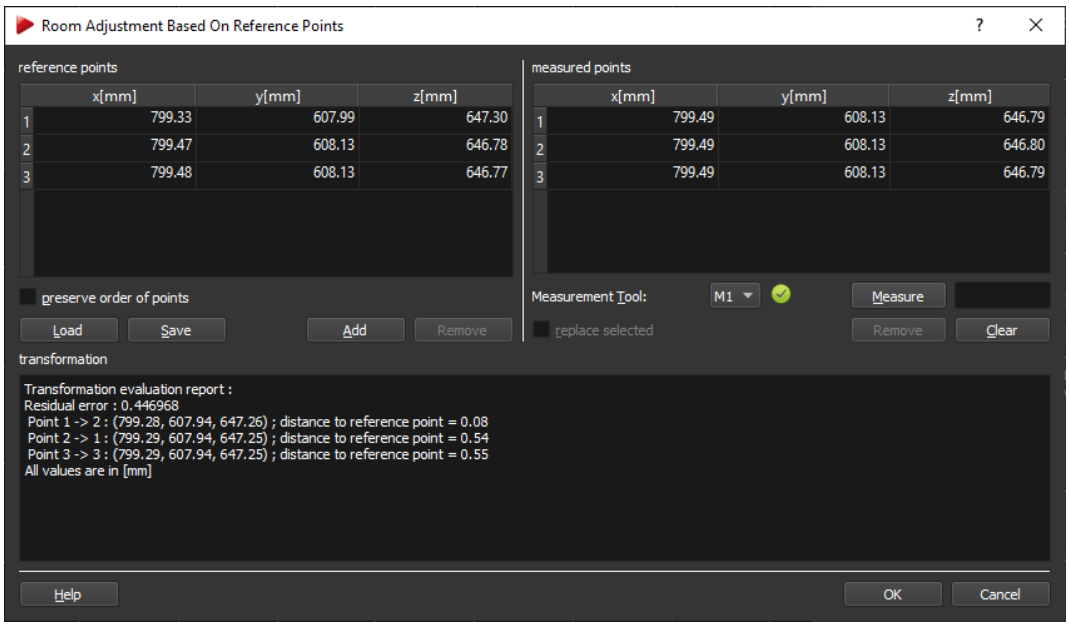


Figure 9.12: Room transform & matching dialog

Deselect any previously assigned Measurement Tool References prior to matching of the coordinate systems. Otherwise matching results will be erroneous.

Procedure A three-step process has to be performed:

1. Add measurement data from the reference coordinate system ('*T*') by manually entering the coordinates into the table *reference points* using the button *Add*. A minimum of three (3) data points is necessary for calculations.
   The current set of reference points can be saved by pressing *Save*.
   Delete single data points by selecting the corresponding row and press *Remove*.
   Alternatively load the coordinates from a text file (ASCII) using the button *Load*. The text file must comply to the following format:

   ```
   1 1.00 20.00 300.00 <CRLF>
   2 4.00 50.00 600.00 <CRLF>
   3 7.00 80.00 900.00 <CRLF>
   # x    y     z      <CRLF>
   ```

   The import strictly follows the sequence from the ASCII text file. Still in some cases the data might be ambigous regarding its 3-D orientation. Toggle the tickbox *preserve order of points* to lock the order in the table *reference points*.

2. Select a calibrated and tracked Measurement Tool from the drop-down menu and measure all points (e.g. on the corresponding object) which directly relate to the reference points (e.g. from a CAD model) defined in step 1.
   Each measurement can be started by:

- clicking the button *Measure*
- clicking the start button on the Measurement Tool (if applicable)
- using the start button simulation of the Measurement Tool (refer to 9.9 on page 133)
- clicking a button of an assigned ***Flystick2/2+***

3. After having measured all corresponding points the calculation is started automatically and the result of the transformation is displayed in the textbox *transformation*. Double-check that all measured data points correspond to the correct reference data points.
   Delete single data points by selecting the corresponding row and press *Remove* or delete all data points to start all over by pressing *Clear*.

   The residual error (standard deviation) is a measure of the transformation quality, i.e. how well the measured data fit the corresponding reference points. It may be influenced by the quality of data acquisition and by differences in scale of the camera and reference coordinate systems. Press *OK* to accept this transformation and to close the dialog box.

Back in the *Fine* tab of the *Room adjustment* dialog (see figure 9.9(b) on page 90) press *Enter* or click *OK* to confirm the resulting transformation and to close the dialog. Pressing *Apply* accepts the current changes and leaves the dialog open. Discard all changes by pressing *Cancel*.

☞ **If automatic matching between reference and measured points fails, acquire the data points in the exact sequence of the reference data and tick the checkbox *preserve order of points* .**

☞ **The calculated transformation is applied on both *zero point offset* as well as *rotation angles* in *Fine* tab.**

9.3 Single Markers

In this dialog you can enable / disable the calculation of 3DOF markers. Here you can also define the central axis for all 5DOF targets globally.

3DOF single markers By default the calculation of single markers is disabled. By enabling '*calculation of 3DOF markers*' the tracking data appears on the right hand side of the data display (refer to chapter 6.3 on page 45).

Axis 5DOF central Select the axis using the drop-down menu '*axis 5DOF central*'. Please refer to chapter 9.5.3 on page 108 for details.

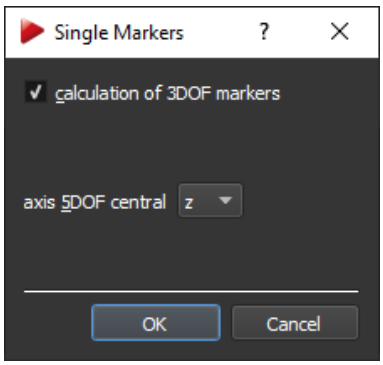


Figure 9.13: Single Marker Settings

9.4 Body administration

This dialog (see figure 9.14 on page 95) is the center for configuration and calibration of all bodies and interaction devices. The number and types of bodies to be tracked may be configured in here .
Furthermore you can assign names, delete or reset target calibrations, activate filtering of 6DOF tracking data or change the order in which the targets appear in the data display (see chapter 6.3 on page 45) and tracking output (see chapter 9.10 on page 137).

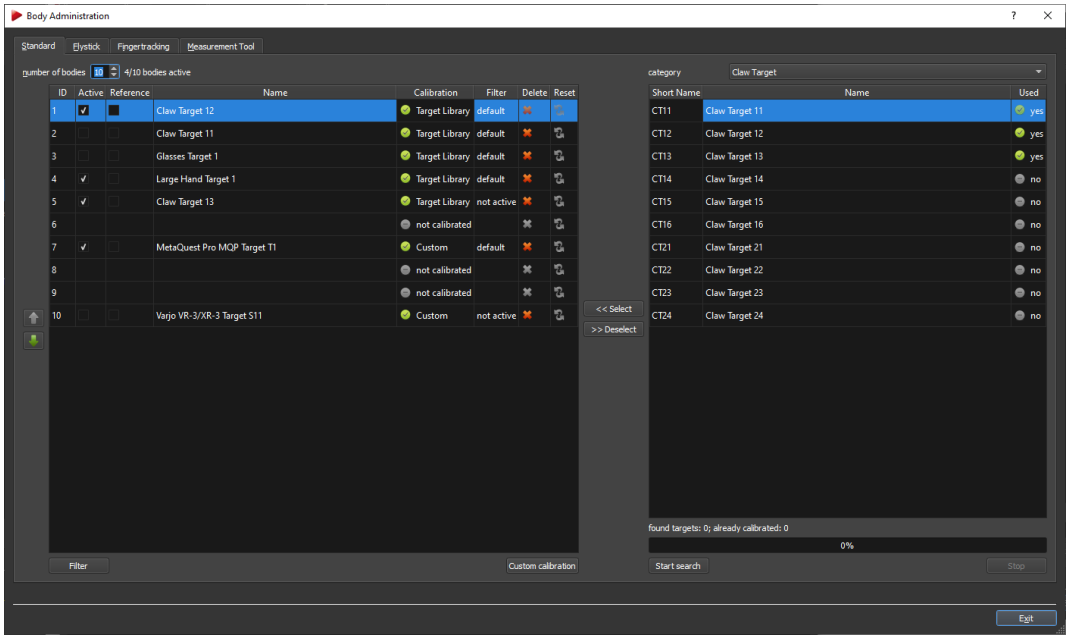


Figure 9.14: Body Administration

In the left table of the dialogue all configured bodies and their corresponding calibration status and filter are listed, while the table on the right shows the pre-calibrated bodyfiles (i.e. factory settings) from the *Target Library*.

Table 9.7 on page 96 shows a detailed description of all functions inside the dialogue.

Info / Action	Description
number of bodies	Increase / Decrease the number of accessible slots (i.e. body IDs, max. 70).
bodies active	Currently configured and activated slots (max. limit for activation depends on license key)
category	Filter the categories of the target library (e.g. Glasses targets, HMD targets, etc.)
Change order	Press the arrows on the left-hand side to re-arrange the target slot. The data output will change accordingly.
ID	All targets are sorted in ascending order (i.e. increasing body ID).
Active	Activate / Deactivate a target by ticking. Data of deactivated targets will not be transmitted in the data stream. The target sequence is unaffected.
Reference	Activate / Deactivate the assignment as reference body by ticking.
Name	Assign a description or name to the target.
Calibration	Provides information about the target calibration status.
Filter	Activate / Deactivate the filtering of tracking data for each target; filtering is activated by default. A detailed description of the filtering options can be found in chapter 9.4.6 on page 101.
Delete	Delete the calibration data of a target - effective immediately after confirming the query. The target sequence is unaffected.
Reset	Reset the calibration to predefined '*Target Library*' values (only available after the geometry has been re-calibrated by the user).
Short Name	Descriptor of authorized targets by ***ART*** stored in the target library.
Name	Name or label of authorized targets by ***ART*** stored in the target library.
Used	Indicator showing the status of assignment of a body calibration from the target library.

Table 9.7: Body Administration - Detailed description

The maximum amount of bodies that can be activated and tracked simultaneously is 70 .

The most comfortable way of calibration of a *Standard* body is making use of the built-in automatic recognition feature *Target Library* to identify the body geometry and to load the corresponding information. The target library contains calibration data for most ***ART*** targets (e.g. HMD clip-on targets, Motion Capture, 3D glasses, etc.). Interaction devices (e.g. ***Flystick2/2+*** or ***Fingertracking***) are configured and calibrated using the same procedure. Please refer to chapter 9.4.1 on page 97 for further information.

In certain cases, however, you may find the direct selection and assignment of calibration files faster and more helpful. Please refer to chapter 9.4.2 on page 99 for this method.

The third way of configuration and calibration of bodies is the custom body calibration (see 9.4.3 on page 100). Perform this procedure for custom-built targets and as fall-back solution when necessary.

9.4.1 Automatic Recognition via Target Library

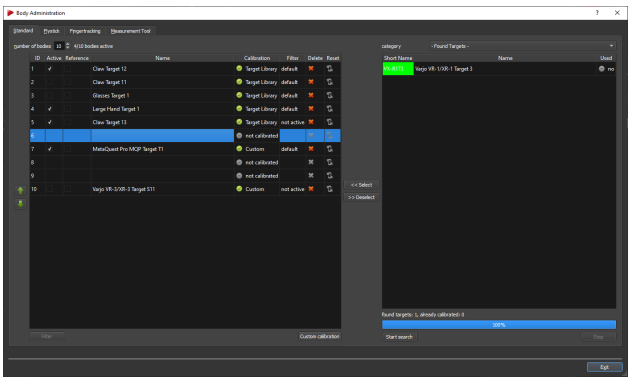
First choose the corresponding tab on the top to switch between *Standard* bodies, *Flystick*, *Fingertracking* and *Measurement Tool* respectively. Then select the amount of bodies to be configured by entering the *number of bodies* '*1...70* ' directly or use the numeric updown button. For each body an empty slot is added. The maximum amount of activated bodies is dependent on your license key. Please refer to chapter 7.2 on page 60 for further information.

Next perform the following the steps:

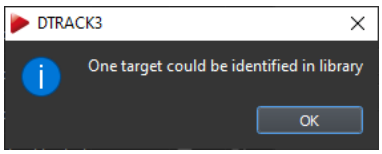
- turn on targets with active LEDs (e.g. ***Fingertracking*** devices)
- place all targets inside the tracking volume and make sure that all markers of the targets to be identified are visible to at least 2 cameras.
- run the target library identification by pressing *Start search*. The current status is shown by a progress bar while the amount of '*found new targets*' is listed (see bottom right in figure 9.15(a) on page 98).
- the targets may be moved during the search always considering that the cameras should see each marker of the body.
- the *Short Name* of the corresponding target will be marked green and a corresponding info dialog will appear (see 9.15(b) on page 98)
- mark the respective body *ID* from row '*1...70* ' under *number of bodies* by left-clicking
- mark the appropriate entry in the target library (e.g. '*Claw Target 13*') by left-clicking and
- press *Select*
- repeat the selection for each identified body in your system

The identified body calibration is assigned to the respective slot and activated by default (*Active* ticked) in order to transmit its data in the tracking output. The status for '*Name*', '*Calibration*' and '*Filter*' will be updated as well. The entry in the column *Calibration* will turn into a green tick followed by '*TargetLibrary*'. On the right side of the window the corresponding entry in column *Used* will turn into a green tick as well and change to '*yes*'.

All targets are sorted in ascending order (i.e. with increasing body *ID*). You can always delete the assignment by pressing the button *Deselect* or *Delete* in the left table. After confirmation to delete the body calibration the geometry will be available again for assignment to a different body *ID*. You may also re-assign a name, description or label of the target by double-clicking the field *Name* or deactivate or change the filtering of tracking data for each target by pressing *Filter*. A detailed description of the filtering options can be found in chapter 9.4.6 on page 101.



(a) Progress bar and labelling of identified targets



(b) Info dialog after Target Library recognition

Figure 9.15: Body Administration Target Library - automatic recognition

In some cases the system will inform you that a re-calibration of the body might be necessary, i.e. to compensate for manufacturing tolerances. Bending and twisting a clip-on target while mounting on a HMD casing or 3D glasses may also result in the geometries not matching perfectly to the data inside the target library (see warning figure 9.16 on page 98).

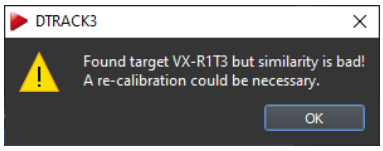


Figure 9.16: Body Administration Target Library - Specific Re-Calibration Warning

At the bottom of the window (see figure 9.14 on page 95) press *Custom Calibration* to switch to the *Custom Body Calibration* dialog and perform the re-calibration for the selected target (see chapter 9.5.7 on page 112). Simply repeat all steps for each body in your system where the information was displayed during identification.

The entire library is used for target recognition. Use the drop-down menu *category* to view specific subsets of the library by changing to a different category (e.g. Motion Capture).

Using the automatic recognition feature *DTRACK4* compares the geometry of the physical target with the calibration data of the target library. In some cases a re-calibration might be necessary to achieve optimal tracking accuracy.

The integrated target library contains most body geometries of *ART* hardware. In the unlikely case that a target is not identified automatically perform a custom body calibration.

9.4.1.1 Identification of Motion Capture targets

For this example it is assumed that a setup with at least eight cameras has been calibrated properly and that all necessary licenses are present.

First, fit the targets to the test person and make sure that the person is inside the tracking volume. Then, start the search (*Tracking* → *Body Administration* → *Start Search*) and allow the test person to move around. While this movement the targets must be visible for the tracking system. Next all targets should be recognized one after the other and will appear in the list of '*Found Targets*'. Select all found targets one by one and assign them to open slots. In case you need to adjust the sequence of the targets use the arrow keys on the left side. Finally, start the measurement in order for your application to receive tracking data.

9.4.2 Direct Selection via Target Library

In order to quickly add and configure well-known and unmodified targets to your system, you can directly select and assign the body calibrations from the *Target Library*. First choose the corresponding tab on the top to switch between *Standard* bodies, *Flystick*, *Fingertracking* and *Measurement Tool* respectively. Then select the amount of bodies to be configured by entering the *number of bodies* '*1...70* ' directly or use the numeric up-down button. For each body an empty slot is added. The maximum amount of activated bodies is dependent on your license key. Please refer to chapter 7.2 on page 60 for further information.

Next assign the corresponding body calibration to a selected body *ID*. All available body calibrations stored in the *Target Library* are shown in the table on the right.

Perform the following the steps for assignment:

- mark the respective body *ID* from row '*1...70* ' under *number of bodies* by left-clicking
- select the appropriate category (e.g. Glasses Target) from the drop-down menu *category* in the target library
- mark the appropriate entry in the target library (e.g. '*Glasses Target 2*') by left-clicking and
- press *Select*
- repeat the selection for each body in your system

The loaded body geometry is assigned to the respective slot and activated by default (*Active* ticked) in order to transmit its data in the tracking output. The status for '*Name*', '*Calibration*' and '*Filter*' will be updated as well. The entry in the column *Calibration* will turn into a green tick followed by '*TargetLibrary*'. On the right side of the window the cor-

responding entry in column *Used* will turn into a green tick as well and change to '*yes*'.

All targets are sorted in ascending order (i.e. with increasing body *ID*). You can always delete the assignment by pressing the button *Deselect* or *Delete* in the left table. After confirmation to delete the body calibration the geometry will be available again for assignment to a different body *ID*. You may also re-assign a name, description or label of the target by double-clicking the field *Name* or deactivate or change the filtering of tracking data for each target by pressing *Filter*. A detailed description of the filtering options can be found in chapter 9.4.6 on page 101.

With this method the system will not inform you when a re-calibration of the body might be necessary, i.e. to compensate for manufacturing tolerances resulting in the geometries not matching perfectly to the data inside the target library. A generic warning, however, is shown for targets that may be compromised from bending or twisting such as clip-on targets mounted on a HMD casing or 3D glasses (see figure 9.17 on page 100.

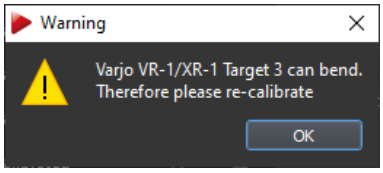


Figure 9.17: Body Administration Target Library - Generic Re-Calibration Warning

In order to achieve optimal tracking accuracy or in case of tracking problems please perform a body re-calibration. To this end press *Custom Calibration* at the bottom of the window (see figure 9.14 on page 95) to switch to the *Body Calibration* dialog and perform the re-calibration for the selected target (see chapter 9.5.7 on page 112). Simply repeat all steps for each body where a generic warning was displayed during assignment.

☞ **Using the direct selection and assignment *DTRACK4* DOES NOT compare the geometry of the physical target with the calibration data of the target library. Only generic warnings are shown for targets where the geometry may be compromised from bending or twisting. Please perform a re-calibration to achieve optimal tracking accuracy.**

9.4.3 Custom Body Calibration

For custom-made or modified targets you can perform a *Custom calibration*. First choose the corresponding tab on the top to switch between *Standard* bodies, *Flystick*, *Fingertracking* and *Measurement Tool* respectively. Then select the amount of bodies to be configured by entering the *number of bodies* '*1...70* ' directly or use the numeric updown button. For each body an empty slot is added. The maximum amount of activated bodies is dependent on your license key. Please refer to chapter 7.2 on page 60 for further information.
Next select an available slot in the left table and start the *Custom Calibration* at the bottom of the window (see figure 9.14 on page 95) to switch to the *Custom Body Calibration*

dialog. Please refer to the corresponding chapter 9.5 on page 104 for further details.

After successful calibration and closing the *Custom Body Calibration* dialog the custom body calibration is assigned to the respective slot and activated by default (*Active*) in order to transmit its data in the tracking output. The status for '*Calibration*' and *Filter* will be updated as well. The entry in the column *Calibration* will turn into a green tick followed by '*Custom*'.

All targets are sorted in ascending order (i.e. with increasing body *ID*). You can always delete the body by pressing the button *Delete* in the left table. You may also assign a name, description or label of the target by double-clicking the field *Name* or deactivate or change the filtering of tracking data for each target by pressing *Filter*. A detailed description of the filtering options can be found in chapter 9.4.6 on page 101.

Simply repeat all steps for each body in your system.

Do not calibrate the body geometry for HMD clip-on targets manually ! Always use the built-in target library and re-calibrate afterwards to compensate for mechanical bending or twisting due to mounting. Otherwise the tracking pivot point cannot be determined resulting in poor immersive experience.

9.4.4 Reference body

Any standard 6DOF body may be assigned as reference upon which all 6DOF and 3DOF tracking data is calculated relative to this body coordinate system instead of the room coordinate system. Only one reference can be assigned at a time by ticking the checkbox in the column *Reference* of the respective body.

When a reference body has been assigned, all 6DOF bodies and 3DOF single markers can only be tracked when the reference body is being tracked as well.

9.4.5 Calibration status

The column *Calibration* (see table 9.8 on page 102) provides information about the target calibration status:

9.4.6 Filtering options for 6DOF tracking data

DTRACK4 incorporates advanced filtering options for enhanced 6DOF tracking performance. One can choose between recommended presets or customize filtering options in order to optimize tracking behaviour individually for each target. For example in applications where reference targets are used to calculate the position of a seating buck it is possible to apply a strong filter for these targets which results in practically noise-free

Calibration Status	Description
not calibrated	a customized target has not been calibrated yet
Target Library	the predefined calibration file from the system is being used
Target Library, re-calibrated	the predefined calibration file has been used, but the geometry has been re-calibrated
Custom	a custom body calibration has been performed

Table 9.8: Body Administration - Description of calibration status

tracking data.
On the contrary tracking (e.g. of HMD units) oftentimes calls for a compensation of system intrinsic latencies. Here ***DTRACK4*** is able to deliver tracking data that incorporates probabilistic prediction up to tens of milliseconds ahead in time.

Access the filtering options for each target either via the menu *Body Administration* or directly through the main GUI docking window *Data Display*. Please refer to table 9.7 on page 96 and 6.3.4 on page 52 to open the menu *Filter Settings*.

☞ **When using third-party hybrid tracking solutions (e.g. LP Research's LPVR-CAD) turn off filtering for the respective HMD target altogether in order to achieve the best performance and immersive experience.**

9.4.6.1 Filter Settings

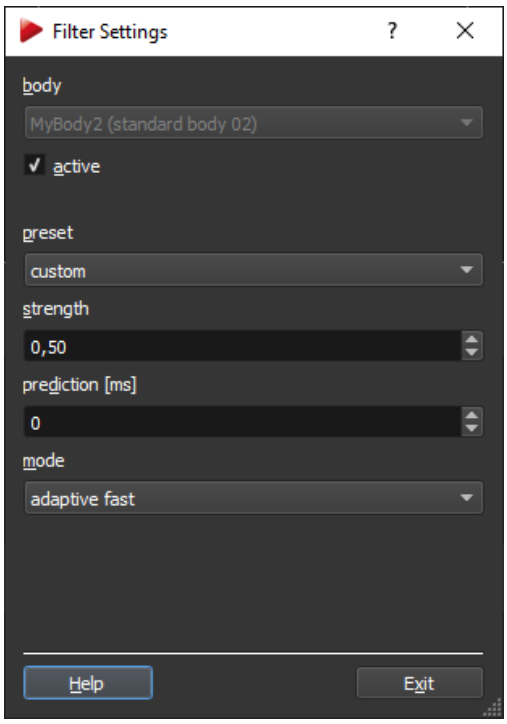


Figure 9.18: Filter Settings

Filtering of 6DOF tracking data is activated by default. Untick the checkbox '*active*' to deactivate filtering for the respective target or choose from several recommended presets shown in the following table:

Presets optical tracking	Description
custom	Customizable preset. A detailed description of the parameters can be found in table 9.10 on page 104.
default	Standard filtering without prediction or smoothing.
Flystick	Recommended setting for use with ***Flystick2/2+*** (responsive filtering, designed for fast to slow motions).
HMD-1	Recommended setting for tracking of a HMD without hybrid tracking (down-tuned filtering with prediction, designed for fast motions).
medium prediction	Filter with prediction of tracking data (less responsive filtering, designed for slow to medium motion).
reference target	Filter with smoothing for tracking of stable reference positions (strong non-responsive filter, designed for occasionally moving objects).
smoothing (delayed)	Filter with strong smoothing and high averaging (responsive filtering with high latencies, designed for recording of tracking data).

Table 9.9: Filtering of 6DOF tracking data - Detailed description of the presets

It is also possible to customize the tracking behaviour to the requirements of the application using the following tunable settings:

Settings	Description	Usage
Strength	Sets the strength of the filter. Low values lead to faster reaction but higher jitter. High values result in smoother output but slower reaction. Note: Not available for hybrid tracking.	A higher strength may be ideal for tracking seating bucks
Prediction	Predicts output for the specified time into the future (ms) in order to compensate tracking and rendering latency. Note: Too high positive values can increase jitter and reduce precision. Negative values can be used for smoothing the output at the cost of higher latency.	A negative prediction may be ideal for recording data and offline analysis.
Mode optical tracking	Specifies the elementary behavior of the filter. Several options are available:	for optical tracking only
'*Adaptive fast*'	Automatically adapts to the observed motion.	Moving targets that change between fast and slow motions, such as ***Flystick2/2+*** .

'*Adaptive slow*'	Automatically adapts to the observed motion, with stronger filtering of fast motions.	Moving targets with slow and medium motions
'*Fast*'	Optimized for fast motions without special filtering of slower motions.	Targets where quick reaction is important, such as HMDs.
'*Slow*'	Optimized for medium motions without special filtering of slow motions.	Targets where quick reaction is important, but motions are slow.
'*Static*'	Optimized for targets that are known not to move at all.	Reference targets attached to non-moving objects
'*Reference target*'	Optimized for generally static objects, with automatic detection of occasional motions.	Reference targets attached to occasionally moving objects.

Table 9.10: Customizable preset 6DOF filtering - Detailed description of the parameters

9.5 Custom Body Calibration

The process of teaching a target's geometry to the tracking system is called body calibration. For a body calibration, the target (= rigid body) to be calibrated has to be in the field of view of the IR cameras.

The body may be moved during body calibration always considering that the cameras should see each marker of the body.

If the body is not moved during body calibration it should be considered that each marker of the target has to be seen by at least two cameras and generally should be seen by as many cameras as possible.

The target orientation can be checked using ***DTRACK4*** 's *2D Monitor*, which is opened automatically in the background after starting the body calibration. The following figure 9.19 on page 105 shows a rigid body with five markers that are all correctly seen by the IR camera.

☞ **Do not calibrate the body geometry for a HMD clip-on targets manually ! Always use the built-in target library and re-calibrate afterwards to compensate for mechanical bending or twisting due to mounting. Otherwise the tracking pivot point cannot be determined resulting in poor immersive experience.**

☞ **If two markers, seen from one camera's point of view, are merging to one reflection, body calibration may be affected. These "merging marker situations" should be avoided during body calibration, i.e. the target should be oriented in a way that reduces merging markers to a minimum.**

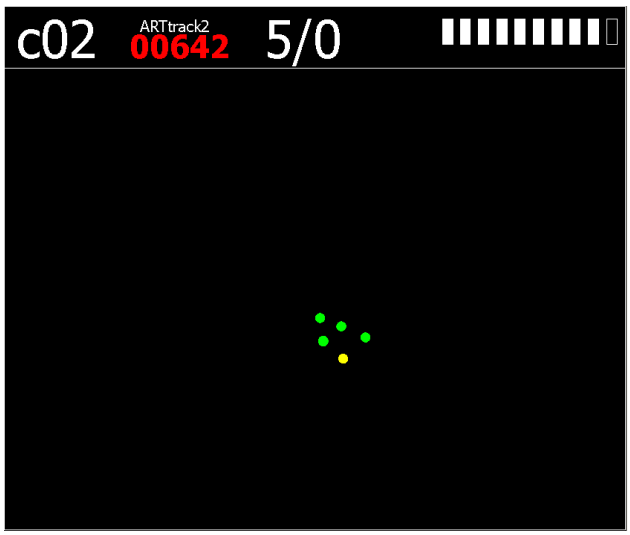


Figure 9.19: Recognized target in ***DTRACK4*** *2D Monitor*

☞ **Ensure the absence of any additional markers in the measurement volume during body calibration. If additional markers that are not part of the target are in the field of view of the IR cameras during body calibration these markers will be assigned to the target. Hence the target will not be correctly calibrated and therefore tracking problems may occur.**

9.5.1 Selecting the body type

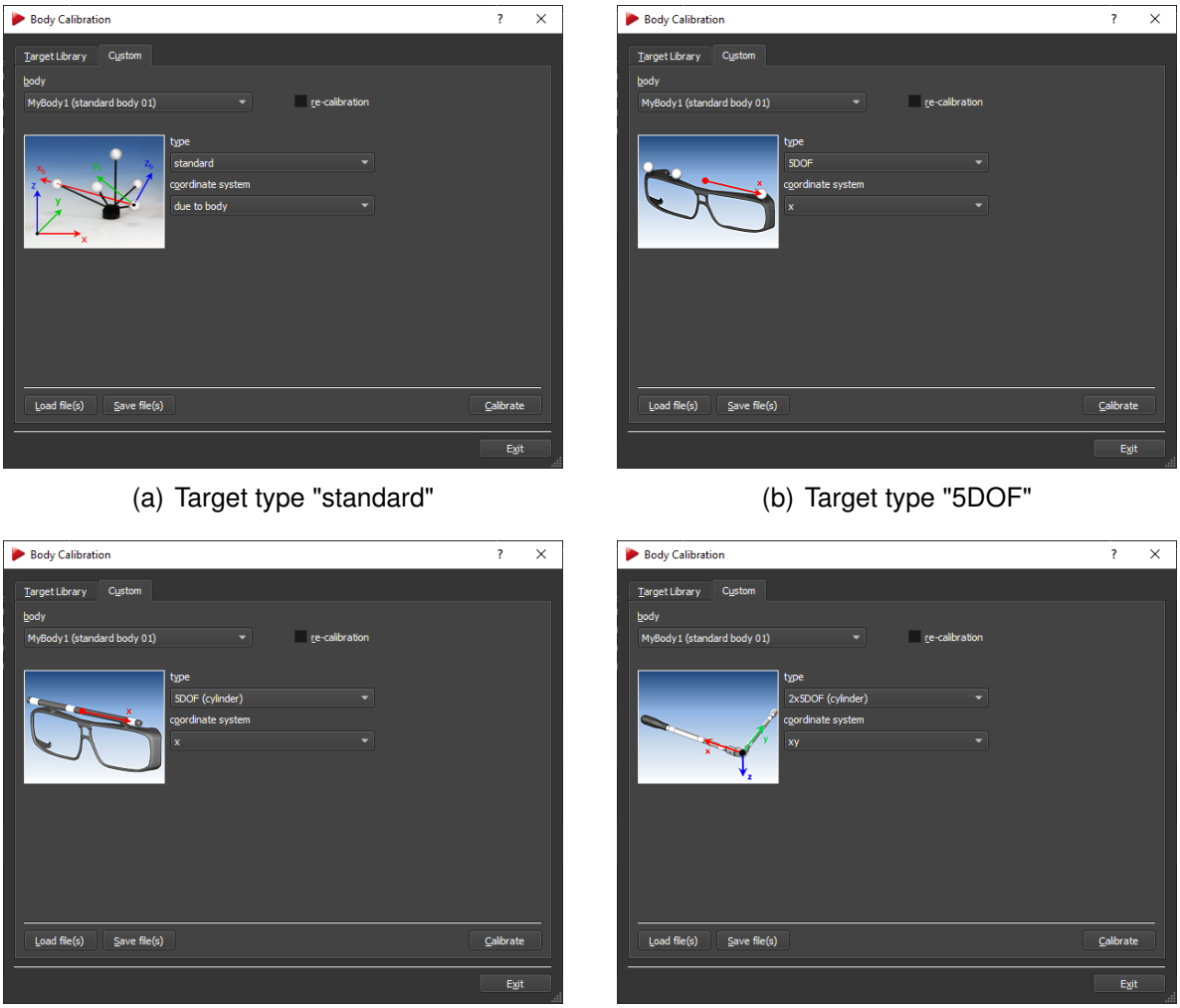
Open the dialog *Tracking* → *Body Calibration* → *Custom Tab* to start a body calibration .

First select the target that should be calibrated in the select list *Body*. By default the *type* is set to '*standard*' which allows for calibrating a 6DOF target with spherical, flat or active markers. When you are using a 5DOF target or a target made of ring markers you would select the '*type*' according to the geometry of the target:

- '*5DOF*' .. a target made of spherical markers which are aligned along one main axis. The rotation around that axis cannot be detected by the system - you loose one dimension of freedom. Therefore only 5 dimensions.
- '*5DOF (cylinder)*' .. a target made of ring markers which are aligned along one main axis.
- '*2x 5DOF (cylinder)*' .. an L-shaped target made of ring markers which delivers complete 6DOF data.

Next select the type of body calibration (refer to section 9.5.2 on page 106 then press *Calibrate* to start the body calibration with a delay of five seconds.

To re-calibrate a body tick the checkbox *re-calibration* next to the drop-down menu. For more information about body re-calibration please refer to chapter 9.5.7 on page 112.



(a) Target type "standard"

(b) Target type "5DOF"

(c) Target type "5DOF (cylinder)"

(d) Target type "2x 5DOF (cylinder)"

Figure 9.20: Body calibration dialog

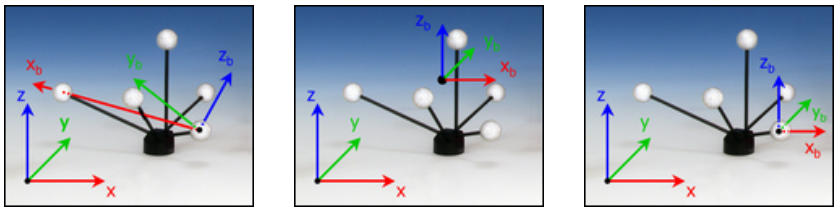
After a new room calibration or room re-calibration it is not necessary to perform a new body calibration. Only if the body itself has been changed you have to calibrate the body again.

The previous body calibration will be lost if you carry out a new body calibration. If you want to save the previous body calibration please use the '*Save file(s)*' option in the *Body calibration* dialog.

9.5.2 Selecting the coordinate system for 6DOF targets

During body calibration, ***DTRACK4*** defines a local coordinate system (body coordinate system) for each target .

The type of body calibration can be set as '*due to body*', '*due to room*' or '*due to room (zero in marker)*' (see figure 9.21 on page 107. The difference between these types is to be found in the orientation of the body coordinate system relative to the body itself.



(a) Body calibration "due to body"

(b) Body calibration "due to room"

(c) Body calibration "due to room (zero in marker)"

Figure 9.21: Defining the target coordinate system

9.5.2.1 Body calibration setting due to body

The body coordinate system is fixed by the markers of the rigid body according to a set of rules (refer to 9.21 a) on page 107):

1. Search for the largest distance between two markers of the rigid body. These two markers (# 1 and # 2) will define the x-axis.
2. Search for a third marker (# 3) with the shortest distance to one of the two markers # 1 and # 2. The marker that is closest to marker # 3 becomes marker # 1. It will define the coordinate origin. The other marker will become # 2. The positive X axis is directed from marker # 1 to marker # 2.
3. Marker # 3 defines the x/y-plane, together with markers # 1 and # 2. Marker # 3 has a positive Y coordinate.
4. The z-axis is added resulting in a right-handed coordinate system.

9.5.2.2 Body calibration setting due to room

The origin of the body coordinate system is set to the center (center of gravity) of all markers building the rigid body (refer to 9.21 b) on page 107). The axes of the body coordinate system are parallel to the axes of the room coordinate system in the beginning of the body calibration. The result of this type of body calibration will depend on the angular rotation of the target during calibration.

Without moving the body a 6DOF measurement right after the calibration will give the angular coordinates 0°/ 0°/ 0°.
If the target was moved during calibration instead ***DTRACK4*** will use the direction of the target at the beginning of the calibration.

9.5.2.3 Body calibration setting due to room (zero in marker)

This is a combination of the methods '*due to body*' and '*due to room*' (refer to 9.21 c) on page 107). The direction of the axes of the body coordinate system will be set parallel to the room coordinate system in the moment of body calibration - analog to the setting

'*due to room*'. The origin of the body coordinate system is set to a marker of the body according to the rules for '*due to body*'.

9.5.3 Selecting the coordinate system for 5DOF targets

In contrast to 6DOF bodies all markers are aligned along one main axis (body axis).

9.5.3.1 Coordinate system setting for type '*5DOF*' and '*5DOF (cylinder)*'

The origin of the body coordinate system is in the middle of the body axis, i.e. between the two markers with the largest distance to each other (refer to 9.20 b) and c) on page 106). The orientation is defined by the marker with the shortest distance to the origin. Its position has a negative sign. The other two directions are undetermined due to the missing degree of freedom. Therefore the rotation around this axis cannot be measured by the tracking system.

This is where the '*5DOF central axis*' comes into play. The '*5DOF central axis*' defines the missing degree of freedom if you intend to use the tracking data for 6DOF scenarios nonetheless. Effectively the body axis (X, Y or Z) is aligned towards the corresponding room axis (X, Y or Z), thereby minimizing the angle in between. If a '*5DOF central axis*' is chosen with a negative sign, the body axis (X, Y or Z) is aligned to the opposite room axis (-X, -Y or -Z) respectively.
Please refer to chapter 9.3 on page 94 to set the central axis in the menu *Tracking* → *Single Markers*.

Setting the 5DOF central axis in a VR setup with head tracking It general it is recommended to choose the '*5DOF central axis*' by using a direction in your setup which is perpendicular to the tracked body axis most of the time. For example when using a target for shutter glasses do not set the '*5DOF central axis*' parallel to the floor or ceiling but rather use the vertical axis instead.

Note: For orientations of the '*5DOF central axis*' close to the body axis (i.e. the two axes are driven into a parallel configuration) the rotation angle for the '*5DOF central axis*' will show strange behaviour, e.g. large odd-looking changes.

9.5.3.2 Coordinate system setting for type '*2x 5DOF (cylinder)*'

The body is expected to consist of two connected 5DOF targets with a roughly perpendicular and constant angle in between (refer to 9.20 d) on page 106). These are placed on the two axes. The origin is placed at the intersection of the two 5DOF targets. The first axis is assigned to the 5DOF target which includes the marker with the largest distance to the origin. The other 5DOF target is placed in the plane created by the two axes.

A click-type torque wrench is one the most prominent members of this class of bodies. Due to the engineering backlash and other high mechanical tolerances in these devices often times the resulting body calibrations are error-prone.

Due to the L-shaped geometry in the case of 2x5DOF tracking the data provided consists of complete 6DOF information. Therefore the data is not affected by the 5DOF central axis chosen.

9.5.4 Body calibration progress

During the body calibration the current status is shown using a progress bar (see figure 9.22 on 109). Verify that all markers of the target are recognised properly.

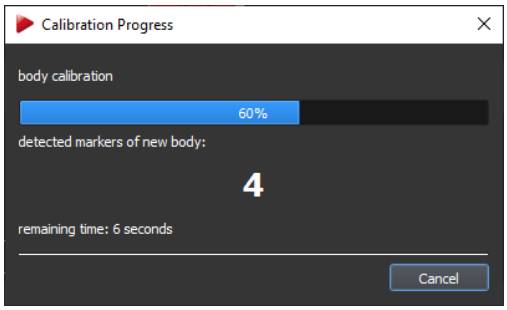


Figure 9.22: Body Calibration Process - Progress bar

9.5.5 Body calibration result

After successfully calibrating a body the result window is displayed (see figure 9.23 on 110).

All markers of the rigid body that have been recognized during calibration are listed. Confirm the result with *OK* or discard the calibration with *Cancel*. The information (i.e. geometry data) of the calibrated target will be stored inside the controller in your personal configuration (see also section 7.3 on 62).

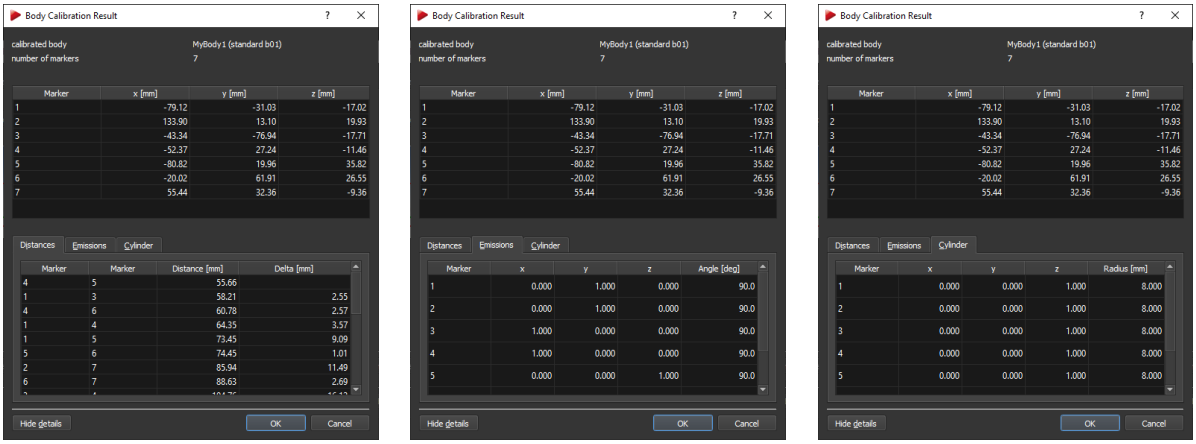
Please double-check the number of markers and compare to the rigid body that all markers have been recognized properly.

9.5.5.1 Show Details

By clicking *Show details* additional information can be displayed (see figure 9.24 on page 110:

- '*Distances*' shows all possible combinations of distances for all markers (min. distances are important for customer-specific geometries, call ***ART*** for further information)

Figure 9.23: Body Calibration Process - Result Window



(a) Distances between markers

(b) Emission vector & aperture information

(c) Cylinder Information

Figure 9.24: Body calibration Result

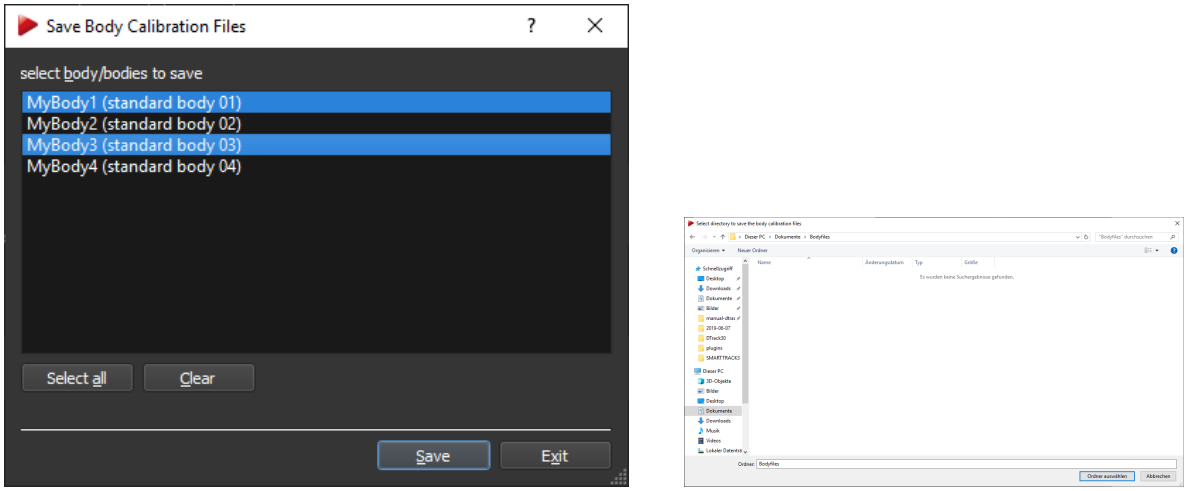
- '*Emissions*' shows normalised emission vectors x, y, z and emission aperture for bodies with restrictions of visibility (only for calibration files available on request by ***ART***)
- '*Cylinder*' shows coordinates and radii for bodies with (cylindrical) ring markers

9.5.6 Calibration files

To easily create backups of calibrated bodies, calibration files can be saved and restored from files. These files contain the dimensions of the target and the distances between all markers. Each file is specific for just one type of target.
Just click *Load file(s)* and select the appropriate calibration file(s) or click on *Save file(s)*

respectively.

9.5.6.1 Save a body calibration file



(a) Selecting the body file(s) to save (b) Select the folder on the remote PC

Figure 9.25: Saving calibration files

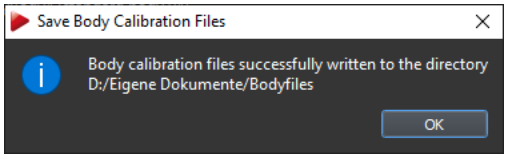


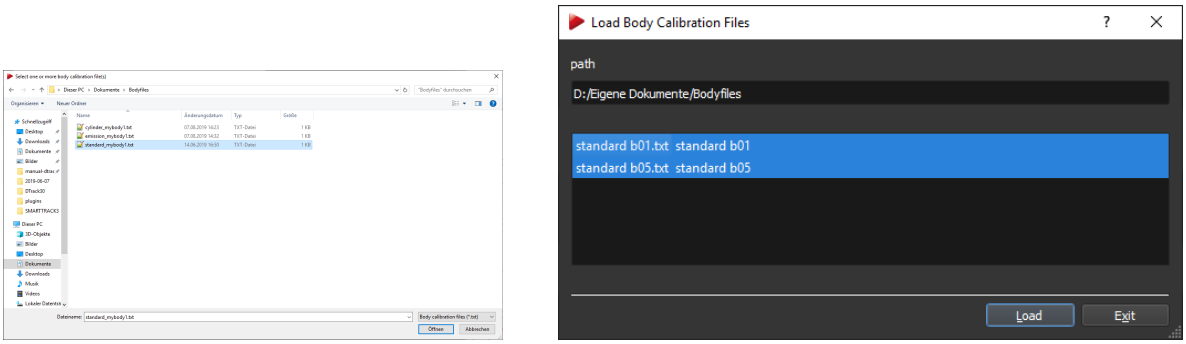
Figure 9.26: Saving calibration files - Confirmation Message

Press '*Save file(s)*' option in the *Body calibration* dialog to store the calibration file(s) of the currently used bodies.
Select the individual bodies by left-clicking or all ot once by pressing *select all* (see figure 9.25(a) on page 111). Press *Save* and in the upcoming window select a folder on your remote PC for storage (see figure 9.25(b) on page 111). After successful saving a confirmation window will show up (see figure 9.26 on page 111). Press *OK* then exit the dialog.

The format of the file name will be according to "*standard b01.txt*" with "*b01*" being the identifier which refers to the ID of the target.

9.5.6.2 Load a body calibration file

You can load calibration file(s) by pressing *Load file(s)* and choose the calibration file(s) for your targets. Select the corresponding body *body ID* and load single calibration files one after the other by pressing *Load* (see figure 9.27(a) on page 112).
Alternatively you can load multiple files simultaneously when the corresponding body cal-



(a) Select the body file(s) to load

(b) Confirmation window for multiple files

Figure 9.27: Loading calibration files

ibration files comply to the ***DTRACK4*** file name convention (i.e. "*standard b01.txt*" with "*b01*" being the identifier which refers to the ID of the target). ***DTRACK4*** automatically assigns the calibration file to the respective *body ID* by using the identifier in the file name. Select multiple files and press *Load*.

A confirmation window will open, press '*Load*' again to import of the body calibration files (see figure 9.27(b) on page 112).

In the upcoming window the coordinates of all identified markers are listed together with the body's label as well as the number of markers. It is analog to the body calibration result window (see figure 9.23 on page 110).

Any previous body calibrations will be overwritten when you load calibration files.

Invalid or corrupt files are not loaded by *DTRACK4* . This is indicated by an error message in the confirmation dialog.

9.5.6.3 Restricted Visibility / Emission Cones

Optionally a restricted visibility can be defined for each marker of a body. This is performed setting up so called 'emission cones'; in essence, a 2DOF observation from a camera has to be inside this cone so that tracking data can be used later for pose estimation. Currently the only way to equip markers with emission cones is to import an appropriate calibration file which are available on request. These files are created at ***ART*** on site performing a body calibration in a defined environment or measurement volume respectively.

9.5.7 Body re-calibration

DTRACK4 provides a possibility to re-calibrate a rigid body without losing the body's coordinate system. This function may be used in case the body geometry is affected due to e.g. mechanical impact. Tick the checkbox *re-calibation* and perform a routine body

calibration as described in 9.5 on page 104.

Only during a body re-calibration the origin and orientation of the initial coordinate system as well as specific information (tracking pivot point, predefined emission vectors, cylindrical marker info) are preserved.

Re-calibration is possible as long as changes in the body geometry are not too large (e.g. replacement of markers). It will fail e.g. if the body has been modified completely.

9.6 Body adjustment

The *Body adjustment* function is a tool to visualise and manipulate calibration data of rigid bodies , i.e. the body coordinate system may be changed relative to the markers of the body.

Body adjustment is not available for 5DOF targets or measurement tools.

The main features of *Body adjustment* are:

- adjusting the body position and orientation of each target manually,
- use predefined body coordinate systems,
- move and set the origin of the body coordinate system (e.g. into a selected marker or the center of gravity),
- aligning the axes of body and room coordinate system without changing the origin,
- delete selected markers from the target geometry,
- "live" mode (i.e. the 3D-representation of the target in the '*Graphic view*' is depicting movements / rotation of the target in "real time"),
- (optionally) visualise predefined emission cones due to restrictions of visibility (directional and angular dependence) for all markers

9.6.1 Body Adjustment - Graphic View

Open the menu *Tracking* → *Body Adjustment* and select the desired body from the drop-down list *Body* at the top of the window (see figure 9.28 on page 114).

By default a cartesian coordinate system is displayed on the left side of the window depicting the selected rigid body's geometry ('*Graphic view*'). On the right hand side the body's coordinate system can be manipulated.

The body coordinate system is shown as a triplet of arrows with a defined color-coding (x-axis: red, y-axis: green, z-axis: blue), while the xy-plane is shown as a yellow grid. All markers are visualised by sequentially colored spheres (RGB) for better identification.

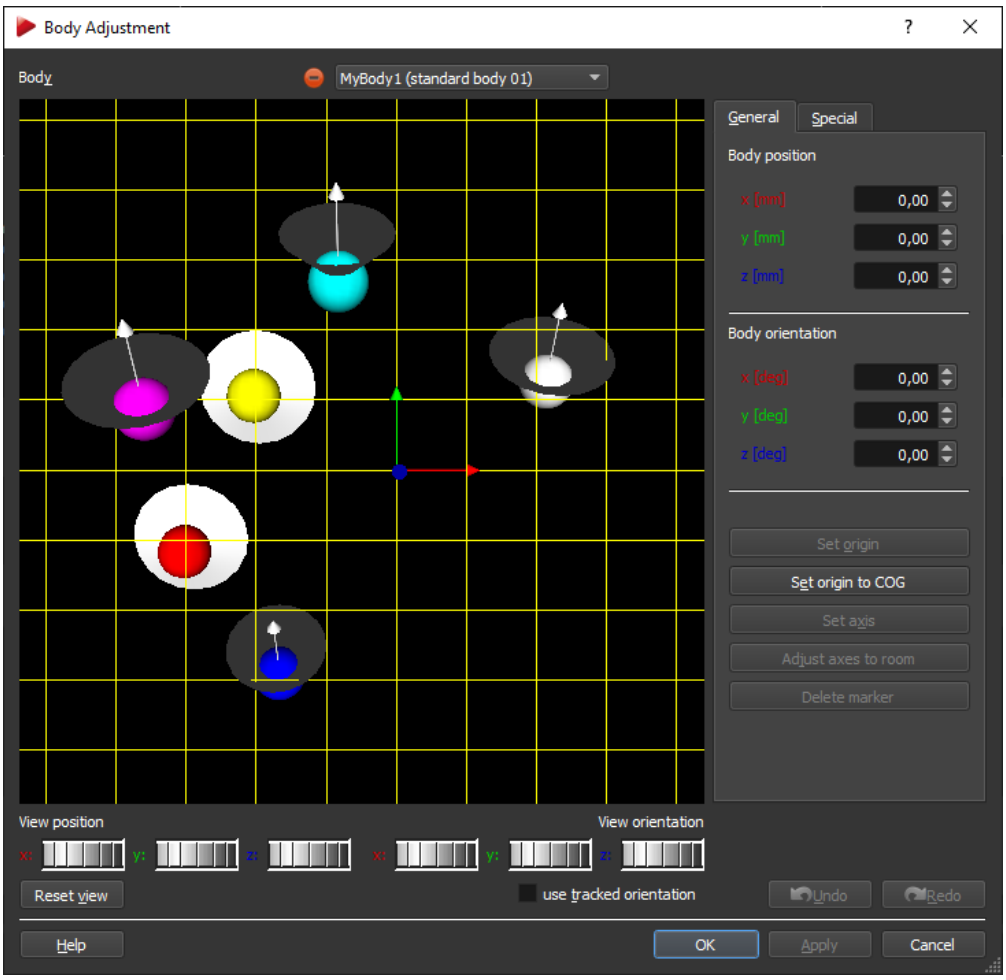


Figure 9.28: Body Adjustment

In case the selected rigid body features visibility restrictions (optional), emission cones may have been predefined. Direction of visibility (emission vector) is depicted as an arrow (white) for each marker, while the angular restriction (emission aperture) is shown as a cone (grey).

The viewing position and orientation may be changed in two different ways:

1. hold down the "Ctrl" key and the left / right mouse button to change the position / orientation inside the graphical display

2. use the six control dials *View position* and *View orientation* (below the graphical view) to adjust position and orientation along all axes

To restore the default view press *Reset view*.
Press *Enter* or click *OK* to accept all changes for all bodies (i.e after confirmation the changes are sent to the controller) and to close the dialog. Press *Apply* instead to change the currently selected body only - the body will be redrawn and the dialog will be left open.

Option	Description
'*Small markers*'	reduces the size of the marker spheres
'*Colored markers*'	shows the markers in RGB colors (untick: greyish)
'*Emissions*'	shows emission vectors (arrows) and emission aperture (cones) (if applicable)
'*Long axes*'	extends the coordinate axes of the body coordinate system by infinite dashed lines
'*Show COG*'	shows the body's center of gravity (white square)
'*Show XY plane*'	shows the XY plane (yellow grid)
'*Show YZ plane*'	shows the YZ plane (cyan grid)
'*Show XZ plane*'	shows the XZ plane (magenta grid)
'*Show room orientation*'	shows the room coordinate system (only available when checkbox '*use tracked orientation*' is ticked)
'*Add line between markers*'	adds a line between two selected markers (option greyed out until two markers are selected)
'*Delete line between markers*'	removes a line between two selected markers (option greyed out until line is selected)
'*Data view*'	switches to the data view

Table 9.11: Body Adjustment Graphic View - Context Menu

Press *Undo* to switch back to the unmodified state or *Redo* to repeat the last action. Discard all changes by pressing *Cancel*.

Context Menu The visualisation can be changed by clicking the right mouse button to open a context menu with the following options. (De-)select the appropriate ones by (un-)ticking.

Live View Tick the *use tracked orientation* checkbox to switch to live mode. The 3D-representation of the target in the '*Graphic view*' will depict movements / rotation of the target in the "real time"). This also enables the function *Adjust axes to room* (see table 9.12 on page 116 in order to align the body coordinate system collinear to the room coordinate system.

9.6.2 Changing the body geometry

For manipulating the body geometry you have the choice between *General* or *Special* options:

General The body coordinate system may be customized user-specific (see table 9.12 on page 116):

Special Choose from the following predefined transformations (see table 9.13 on page 116):

Action	Description
Body position [mm]	translate the body coordinate system along its axes in steps of 1mm
Body orientation [deg]	rotate the body coordinate system around its axes
Set origin	activate and highlight a marker in the '*Graphic view*' by left-clicking the mouse. the button *Set origin* is activated. press the button to translate the origin of the body coordinate system into the center of the selected marker.
Set origin to COG	translate the origin of the body coordinate system into the target's center of gravity
Set axis	activate and highlight two markers sequentially in the '*Graphic view*' by left-clicking the mouse. the first marker is highlighted in white, the second one in grey. the button *Set axis* is activated. press the button to open a dialog to configure the transformation.
Adjust axes to room	press this button to align the body coordinate system collinear to the room coordinate system
Delete marker	activate and highlight a marker in the '*Graphic view*' by left-clicking the mouse. the button *Delete marker* is activated. press the button to remove the selected marker from the target geometry.

Table 9.12: Body Adjustment (General) - Transform actions

Action	Description
due to body	the body coordinate system is defined by the target geometry (see section 9.5.2.1 on page 107)
due to room (origin in COG)	the body coordinate system is rotated and aligned collinear to the room coordinate system with the origin set in the center of gravity (COG) (see section 9.5.2.2 on page 107). tick the checkbox *use tracked orientation* to use this function.
due to room (origin in marker)	the body coordinate system is rotated and aligned collinear to the room coordinate system with the origin set in one specific marker (see section 9.5.2.3 on page 107). tick the checkbox *use tracked orientation* to use this function.

Table 9.13: Body Adjustment (Special) - Transform actions

Predefined visibility restrictions (emission vectors and emission apertures) are retained along all body transformations.

If the MultiUser function for *Flystick2/2+* is enabled the *Body Adjustment* module will load standard bodies only - a label *'MultiUser function should be disabled!'* will appear at the bottom of the dialog. To adjust the body calibration data of your *Flystick2/2+* , make sure that the *MultiUser* function is disabled (*Tracking* → *Flystick*).

9.7 Flystick

Open the *Tracking* → *Flystick* dialog to manage the *number of Flysticks* (max. 20) and to configure the corresponding settings to be used, see figure 9.29 on page 117.

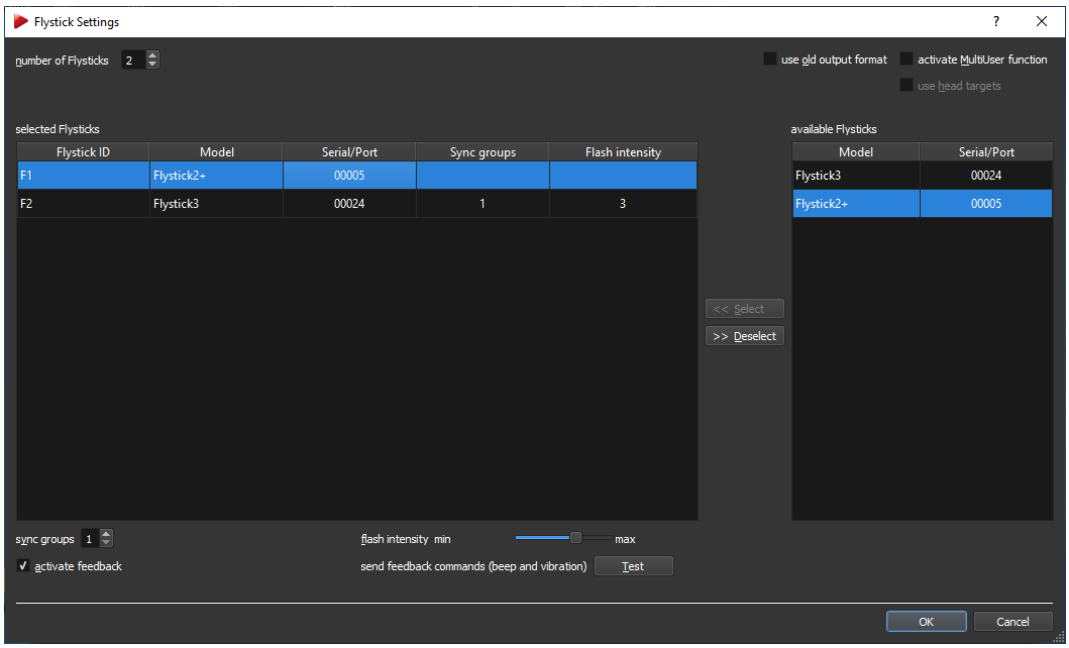


Figure 9.29: Flystick Settings

Checkbox	**Description**
use old output format	use the legacy output format of the Flystick1 (refer to the ***DTRACK4 Programmer's Guide***)
activate MultiUser function	activate the use of multiple ***Flystick2/2+*** (refer to section 9.7 on page 118)
use head targets	the data pair (***Flystick2/2+*** and head target) of one user is made available as output data (MultiUser enabled only)
active *Flystick3* (discontinued)	**Description**
sync groups	configure your active ***Flystick3*** (discontinued) for use with syncgroups (syncgroup #1, syncgroups #1 and #2, . . . ; default = syncgroup #1)
flash intensity	change the flash intensity of the active target of the ***Flystick3*** (discontinued) by moving the slider (default = 3)
***Flystick2+* only**	**Description**
activate feedback	activate feedback functionality of ***Flystick2+***
Test	start feedback vibration test run

Table 9.14: Flystick settings - Description of the checkboxes and options

MultiUser option The MultiUser option is an enhancement especially for VR/AR applications when working with more than one ***Flystick2/2+*** . Tick the checkbox '*activate MultiUser function*' to activate the function. Please refer to the ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet* for more details.

Use head targets In order to use a ***Flystick2/2+*** and a head target as data pair tick the checkbox '*use head targets*' as well. Up to ten users can be equipped with a ***Flystick2/2+*** and a head target (usually mounted on glasses). ***DTRACK4*** is able to track them all but only the data pair (***Flystick2/2+*** and one designated head target) of one user is available as output data. Switching between the single users can be done by pressing one of the ***Flystick2/2+*** buttons.

9.7.1 Flystick Configuration

Enter the *number of Flysticks* '*0...20*' directly or use the numeric updown button. The corresponding entries in the list of *selected Flysticks* will show up. The fields *Model*, *Serial / Port*, *Sync Groups* and *Flash Intensity* are empty by default.

Make sure that your ***Flystick2/2+*** are listed under *available Flysticks* - compare the serial number listed here to the one printed on the battery compartment of the ***Flystick2*** or on the back cover of the ***Flystick3*** . Detach the upper marker compartment of the ***Flystick2+*** to gain access to the serial number.

Now assign your ***Flystick2/2+*** to a *Flystick ID*:

Therefore,

- mark the respective *Flystick ID*, e.g. '*F1*', by left-clicking the corresponding entry from the list of *selected Flysticks*
- mark the desired ***Flystick2/2+*** from the list of *available Flysticks* by left-clicking
- press *Select* to finalize the assignment.

Repeat these steps if you want to use another ***Flystick2/2+*** .

If the list of *available Flysticks* does not contain your *Flystick2/2+* press any button of the *Flystick2/2+* to register it at the *RadioTransceiver2/3*

9.7.2 Flystick2+ Feedback

This function is only available after assignment of at least one ***Flystick2+*** device to a corresponding *Flystick ID*.

Tick the checkbox *activate feedback* in the lower left corner of the dialog to activate the feature globally on all ***Flystick*** devices providing feedback functionality. Mark the respective *Flystick ID* (e.g. '*F1*') under *selected Flysticks* by left-clicking and press the button *Test* to send a series of feedback commands to test beep and vibration of the ***Flystick2+*** . The corresponding status LEDs will light up to indicate radio communication. Please refer to the ***ART Hardware Installation Guide*** → *Interaction devices* → *Flystick2+* → *Control Elements*.

9.7.3 Flystick Calibration

After assigning the ***Flystick2/2+*** to the ***ART RadioTransceiver2/3*** , close the *Flystick Settings* dialog and open *Tracking* → *Body calibration*. There select the body *Flystick body 01* for calibration. Define the orientation of the body coordinate system relative to the body (default: *due to body*). Make sure that all markers of the ***Flystick2/2+*** are seen by the cameras using the *2D Monitor* which appears in the background. Press *Calibrate* and the calibration will start within 5 seconds. Please refer to chapter 9.5.1 on page 105 for more information concerning the body calibration procedure.

9.7.4 Flystick Output settings

The last step is to define where the ***Flystick2/2+*** data has to be sent to. Open *Tracking* → *Output*. There either select *this computer* (= remote PC) or enter an IP address of another client you want to send data to. Tick the checkbox '*6df2*' to transmit the ***Flystick2/2+*** data. Please refer to chapter 9.10 on page 137 for more details.

9.7.5 Flystick Display

Press *Start* to start the measurement. In order to view the tracking data enable the *Flystick display* by clicking *View* → *Flystick*. Please refer to chapter 6.3 on page 45 for details.

Note that output of *Flystick* tracking data is just possible after the *Flystick* has been activated (at least once after booting the *DTRACK Backend Service*). So if no data is appearing in *Flystick display*, simply press an arbitrary button on the *Flystick2/2+* .

9.8 Fingertracking

This dialog is the center for configuration and calibration of ***Fingertracking*** hardware (optional with tactile feedback).

The following steps describe a full calibration of one hand using non-customized ***ART Fingertracking*** hardware:

1. Select the number of hands you want to use with your tracking system (up to 4).
2. Assign body calibrations for all hand targets (using the target library). When using customized hand targets please refer to the corresponding chapter 9.8.3 on page 126 for further details.
3. Calibrate the complete hand geometry (i.e. the position and orientation of the finger tips in respect to the hand target).
4. (optionally) Install an ***ART RadioTransceiver2/3*** when using ***Fingertracking2 Tactile*** devices (refer to the ***ART Hardware Installation Guide*** → *Other equipment* → *Radio Transceiver* and section 8.5 on page 79 for details).

5. (optionally) Assign tactile devices for all hand targets, if applicable

Simply repeat all steps for each tracked hand in your system.

9.8.1 Fingertracking Settings

First, open the dialog *Tracking* → *Fingertracking* and configure the *number of hands* you are using. Enter the *number of hands* '*0...4*' directly or use the numeric updown button.

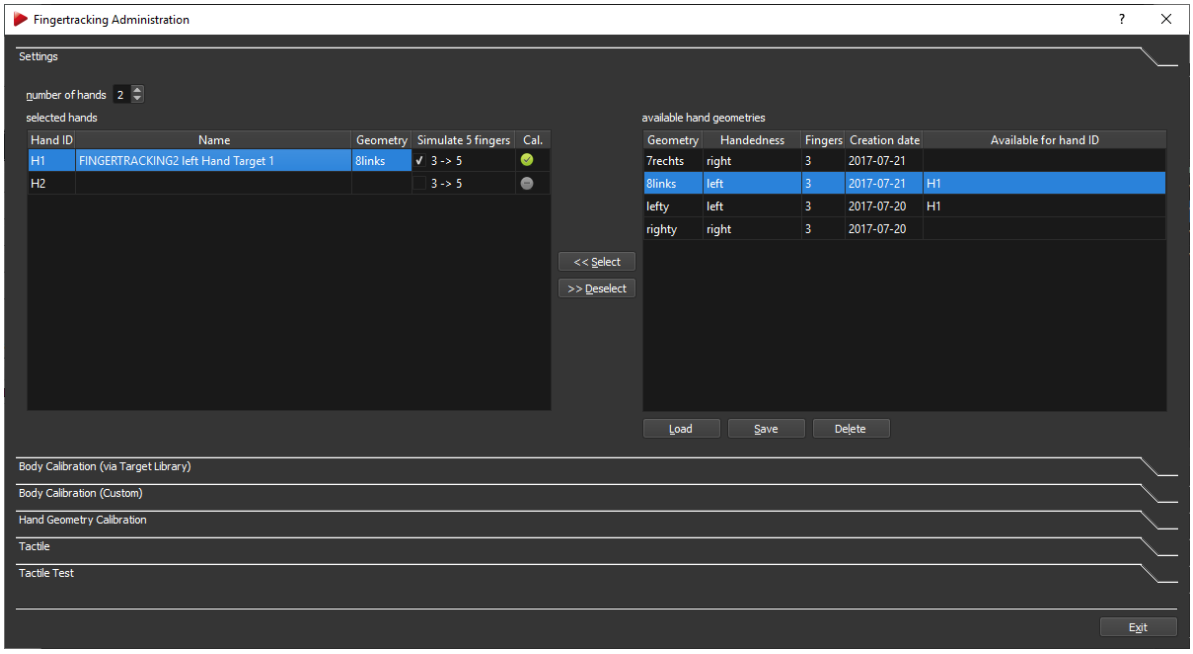


Figure 9.30: Fingertracking Administration - Settings

For each *Hand ID* a row from '*H1...H4*' will show up correspondingly on the left side of the window under *selected hands*. The '*Name*' and '*Geometry*' entries will be empty, while the column *Cal.* will show a grey *No Entry* sign.
Next a body calibration for the hand target has to be assigned using the target library (refer to chapter 9.8.2 on page 123).

Hand target calibrations without corresponding hand geometries are marked with a yellow tick on the corresponding *Hand ID* row under *selected hands*. A fully calibrated *Hand ID* is marked with a green tick.

9.8.1.1 Available hand geometries

It is also possible to (re-)assign previously calibrated hand geometries (i.e. position and orientation of the finger tips) to existing hand target calibrations . This way one set of ***Fingertracking*** hand targets can be used by several different users and, most importantly, one needs to calibrate the hand geometry only once for each person during first installa-

tion.

A hand geometry listed on the right side of the window under *available hand geometries* can be assigned to a selected *Hand ID* the following way:

- mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking
- mark the appropriate entry '*Available for hand ID*' → '*H1...H4*' under *available hand geometries* by left-clicking and
- press *Select*
- (optionally) confirm to overwrite the assignment by pressing *OK*. This confirmation will only show up when the assignment to a specific *Hand ID* is to be changed.

If the hand geometry is already in use (multiple assignment) a warning message will be shown instead. You can always delete a previously assigned hand geometry by pressing the button *Deselect*. The geometry will be available again for assignment.

In order to identify different hand geometries under *available hand geometries* and to assign it to the corresponding hand target please use meaningful names for the '*geometry*' and double-check the column '*Available for hand ID*'.

In case of multiple assignments (i.e. one hand geometry is to be assigned to more than one hand target calibration) a warning message will pop up. Delete the current assignment prior to re-assigning.

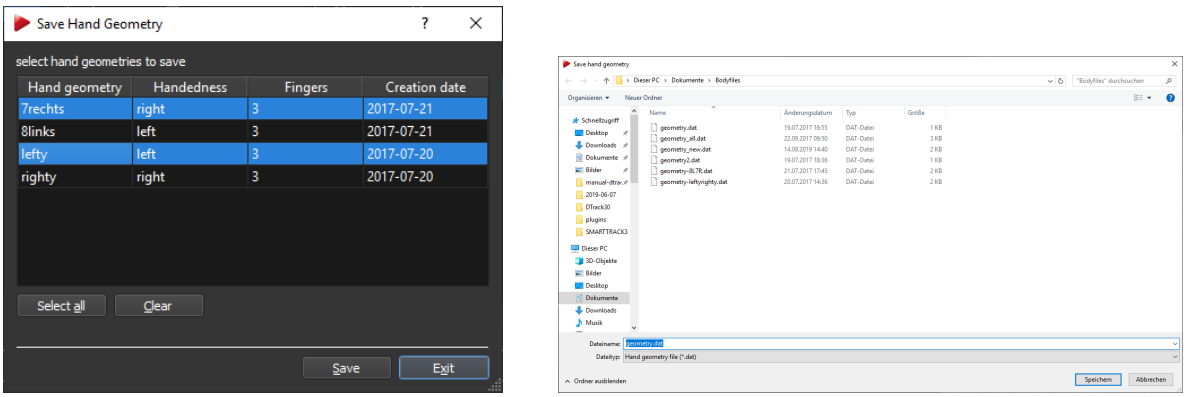
9.8.1.2 Managing hand geometries

Exporting hand geometries In order to export hand geometries just press '*Save*' and select the hand geometries you would like to export in the upcoming window (see figure 9.31(a) on page 122). Press '*Save*' again, select the location of the respective folder and choose an appropriate file name (see figure 9.31(b) on page 122).

A confirmation window will show the successful import (see figure 9.32 on page 122).

Importing hand geometries You can also import previously saved hand geometries by pressing the button '*Load*'. A window will open to select the respective folder (see figure 9.33(a) on page 122). Choose the appropriate file and press '*OK*'. Then select the individual geometries to import by left-clicking or select all geometries at once by clicking *select all* (see figure 9.33(b) on page 122). Press *Load* to import.

A confirmation window will show the successful import (see figure 9.34 on page 122).



(a) Select the hand geometry file(s) to save

(b) Select the folder on the remote PC

Figure 9.31: Fingertracking Administration - Saving hand geometry files

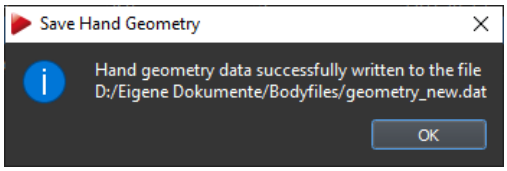
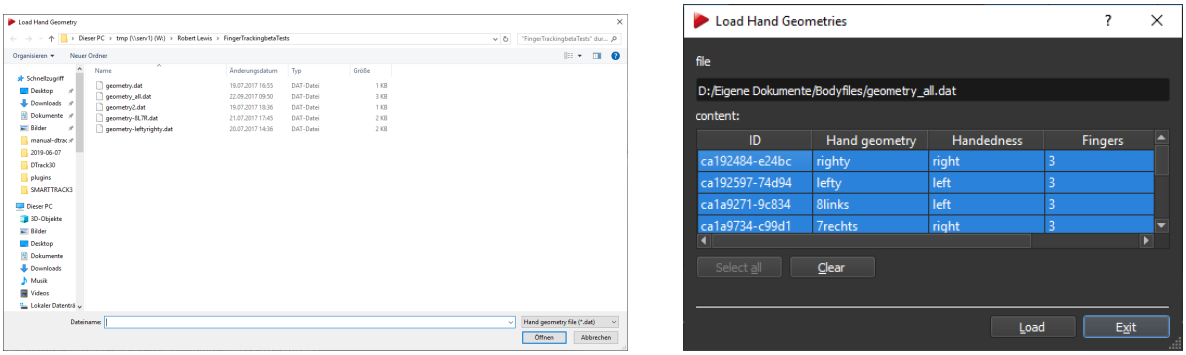


Figure 9.32: Fingertracking Administration - Saving hand geometry files - Confirmation window



(a) Select the folder on the remote PC

(b) Select the hand geometry file(s) to load

Figure 9.33: Fingertracking Administration - Loading hand geometry files

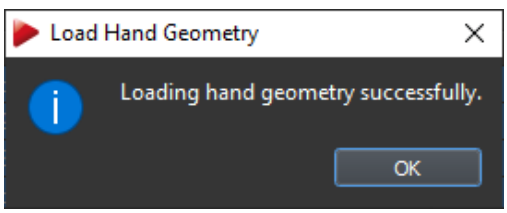
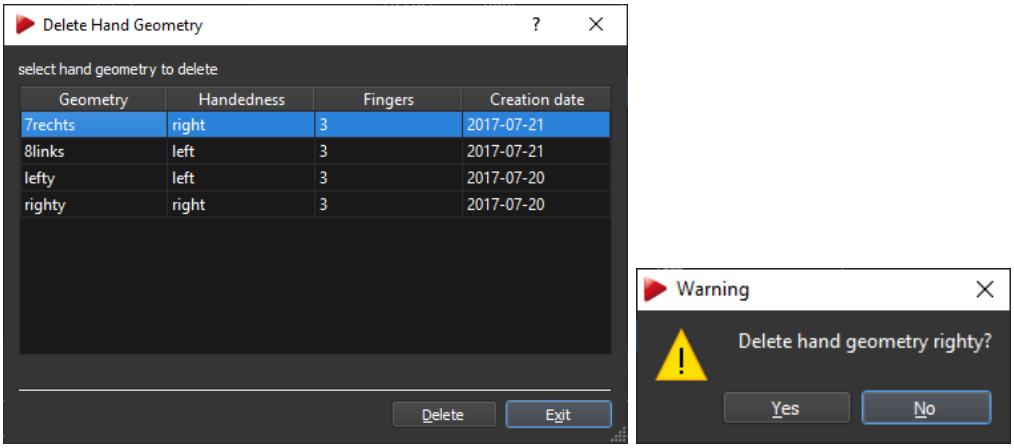


Figure 9.34: Fingertracking Administration - Loading hand geometry files - Confirmation window

Deleting hand geometries You can also remove entries from *available hand geometries* by left-clicking and pressing '*Delete*'. Select the hand geometries you would like to delete in the upcoming window (see figure 9.35(a) on page 123). Press '*Delete*' again to remove the corresponding entry.

A confirmation window will show up to confirm the removal (see figure 9.35(b) on page 123).



(a) Select the hand geometry file(s) to delete (b) Confirm the removal

Figure 9.35: Fingertracking Administration - Deleting hand geometry files

9.8.2 Fingertracking Body calibration via Target Library

Open the sub-dialog *Fingertracking* → *Body Calibration via Target Library* to either make use of the automatic recognition feature or directly assign the corresponding body calibration of each hand target to a selected *Hand ID*. All hand target body calibrations stored in the target library are shown on the right side of the window.

The integrated target library contains most hand target calibrations of *ART* Fingertracking hardware. Perform a custom body calibration only when the hand target cannot be identified automatically.

Automatic recognition via Target Library For automatic identification follow these steps:

- turn on all ***Fingertracking*** devices
- place them inside the tracking volume and make sure that all hand targets to be identified are visible to at least 2 cameras.
- run the target library identification by pressing *Calibrate*. The current status is shown by a progress bar while the amount of '*found new targets*' is listed (see bottom right in figure 9.36 on page 124).

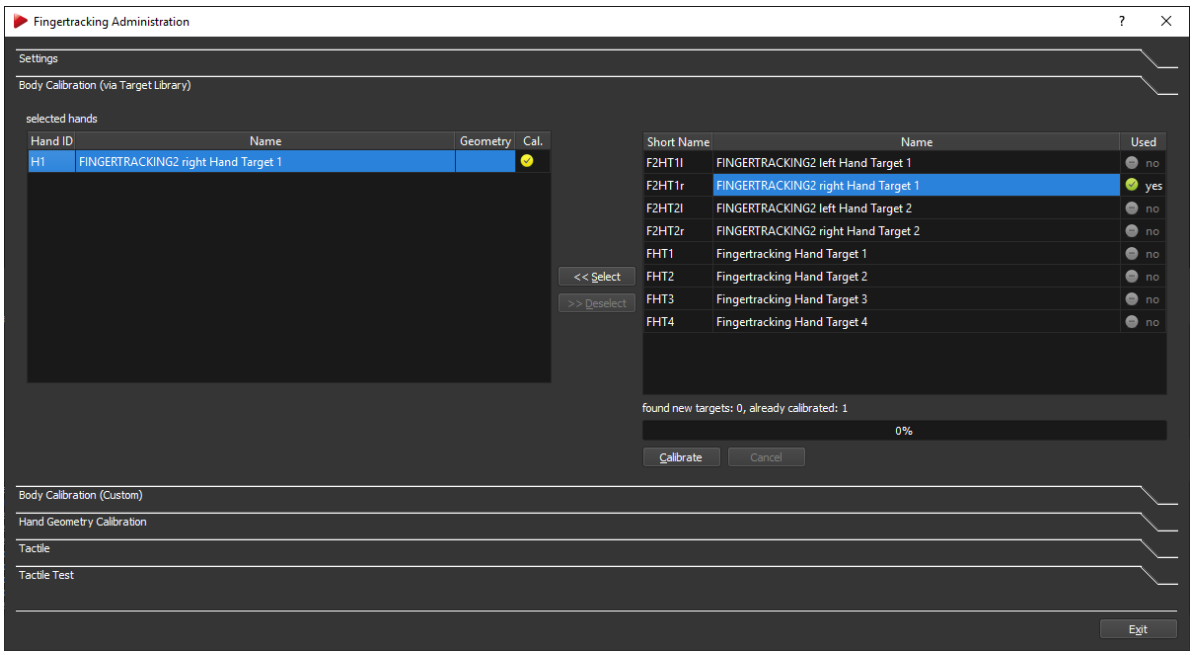


Figure 9.36: Fingertracking Administration - Body Calibration Target library

- the *Short Name* of the corresponding hand target will be marked green
- mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking
- mark the appropriate entry in the target library (e.g. '*FINGERTRACKING2 left Hand Target 1*') by left-clicking and
- press *Select*
- repeat the selection for each identified hand target in your system

In some cases the system will inform you that a re-calibration of the hand target might be necessary, i.e. to compensate for manufacturing tolerances resulting in the geometries not matching perfectly to the data inside the target library (see warning figure 9.16 on page 98). Please refer to the section for Custom Fingertracking Body Calibration (see 9.8.3 on page 126.
After selection and assignment the '*Name*' and '*Geometry*' entries will be updated. The entry in the column *Cal.* will turn into a yellow tick. On the right side of the window the corresponding entry in column *Used* will turn into a green tick and will change to '*yes*'.

All hand targets are sorted in ascending order (i.e. with increasing *Hand ID*). You can always delete the assignment by pressing the button *Deselect*. After confirmation to delete the body calibration the bodyfile will be available again for assignment to a different *Hand ID*.

You may also rename a description or label of the hand by double-clicking the field *Name*.

Direct selection via Target Library You can also directly select the body calibration and assign it to a *Hand ID* the following way:

- mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking
- mark the appropriate entry in the target library (e.g. '*FINGERTRACKING2 left Hand Target 1*') by left-clicking and
- press *Select*
- repeat the selection for each hand target in your system

With this method the system will not inform you that a re-calibration of the body might be necessary, i.e. to compensate for manufacturing tolerances resulting in the geometries not matching perfectly to the data inside the target library. In order to achieve optimal tracking accuracy or in case of tracking problems please perform a re-calibration. Please refer to the section for Custom Fingertracking Body Calibration (see 9.8.3 on page 126. After selection and assignment the '*Name*' and '*Geometry*' entries will be updated. The entry in the column *Cal.* will turn into a yellow tick. On the right side of the window the corresponding entry in column *Used* will turn into a green tick and will change to '*yes*'.

All hand targets are sorted in ascending order (i.e. with increasing *Hand ID*). You can always delete the assignment by pressing the button *Deselect*. After confirmation to delete the body calibration the bodyfile will be available again for assignment to a different *Hand ID*.

You may also rename a description or label of the hand by double-clicking the field *Name*.

Using the automatic recognition feature *DTRACK4* compares the geometry of the physical target with the calibration data of the target library. In some cases a re-calibration might be necessary to achieve optimal tracking accuracy.

Using the direct selection and assignment *DTRACK4* DOES NOT compare the geometry of the physical target with the calibration data of the target library. Please perform a re-calibration to achieve optimal tracking accuracy.

The integrated target library contains most body calibrations of *ART* hardware. In the unlikely event that a target is not identified automatically perform a custom body calibration.

The next step is to calibrate the handedness as well as the position and orientation of the finger tips (refer to chapter 9.8.4 on page 126).

The *Fingertracking* (discontinued) is delivered with different hand target geometries when using two pair of sets, whereas *Fingertracking2* devices have to be set up properly. Refer to the *ART Hardware Installation Guide* → *Interaction devices* → *Fingertracking2 and Fingertracking2 Tactile Hand Targets* how to switch the configuration.

Select the Set *1* or *2* configuration of the *Fingertracking2* handtargets during first-time installation only. Do not change the setting during routine operation or tracking will fail !

9.8.3 Fingertracking Body calibration Custom

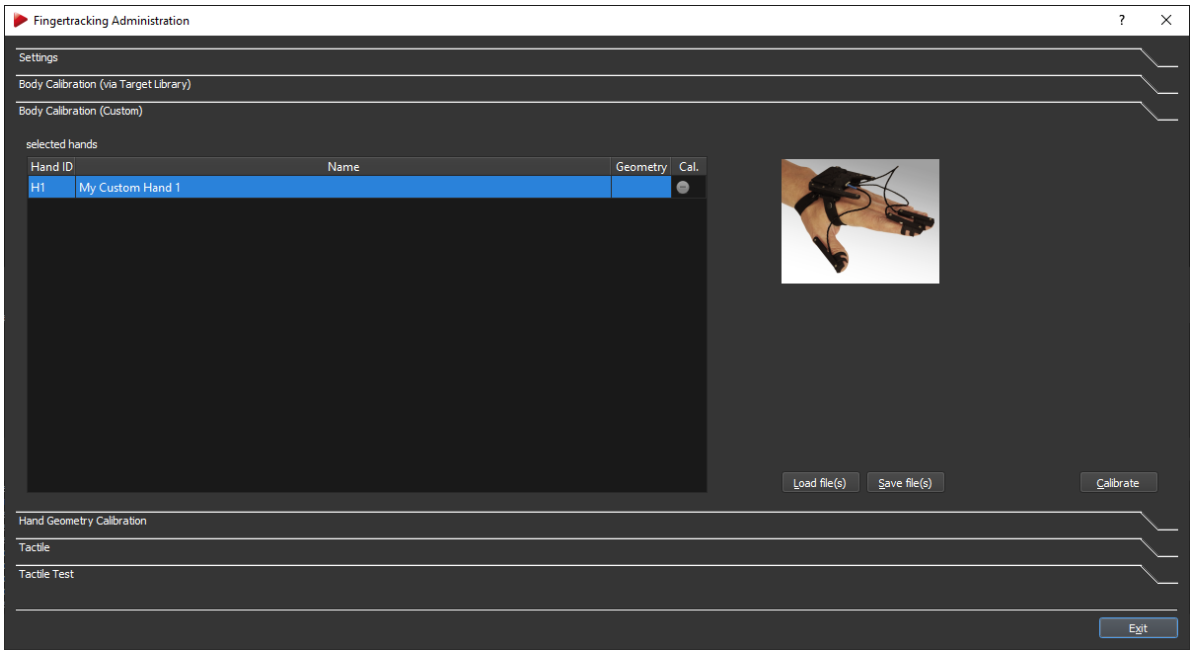


Figure 9.37: Fingertracking Administration - Body Calibration Custom

When using hand targets not found inside the target library (e.g. customized) a standard body calibration has to be carried out. The process of calibrating a 6DOF body is described in chapter 9.5.1 on page 105.

Mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking and start the calibration by pressing the button *Calibrate*.

You can also load a calibration from a calibration file instead by pressing '*Load*' after marking the corresponding *Hand ID*. Please refer to chapter 9.5.6 on page 110 for details.

9.8.4 Fingertracking Hand geometry calibration

Open the sub-dialog *Fingertracking* → *Hand Geometry calibration* to calibrate the handedness as well as the position and orientation of the finger tips . The respective *Hand ID* is selected automatically during the calibration process.

The hand geometry calibration is performed the following way:

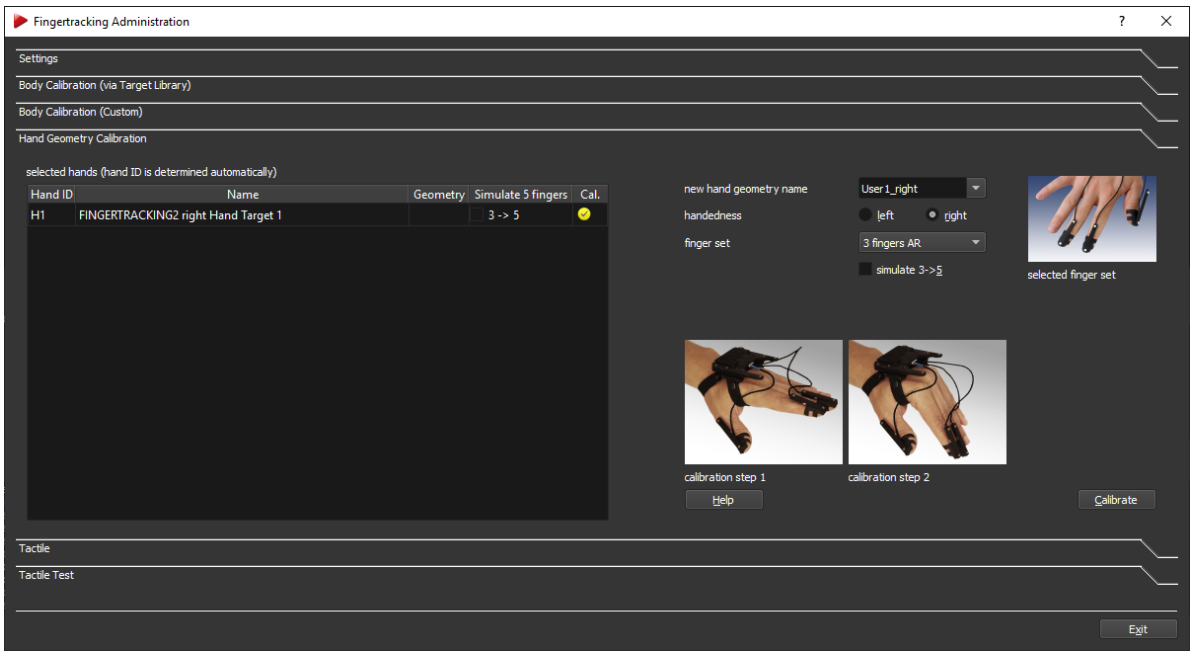


Figure 9.38: Fingertracking Administration - Hand Geometry Calibration

- enter a meaningful name for the geometry (e.g. username-left) in the field *new hand geometry name*
- select the handedness by ticking the corresponding radio button for *left* or *right* hand
- select the appropriate thimble set from the dropdown-menu *fingerset*
- (optionally) activate the 5 finger simulation (only available for 3-finger thimble sets) by ticking the checkbox *3 -> 5*
- press *Calibrate* to start the two-step calibration process

For easy identification and assignment of the correct hand geometry for different users please use meaningful names for the '*geometry*'.

Click on the button *Help* to open a window where the calibration process is additionally explained and visualized.

Calibrate one hand geometry after the other. Make sure to switch off all hand targets but the one that is currently used for calibration.

9.8.4.1 Hand geometry calibration process

After pressing *Calibrate* a countdown for the first step of the calibration process begins.

In the first phase (calibration step 1)

- all fingers have to be stretched out (see left picture in dialog, refer to figure 9.38 on page 127)

- the thumb has to be spread away from the hand
- do not spread the other fingers, keep them together. Take care, that there is no space between them
- do not move any finger nor the thumb during the first calibration phase
- you may move the entire hand slightly

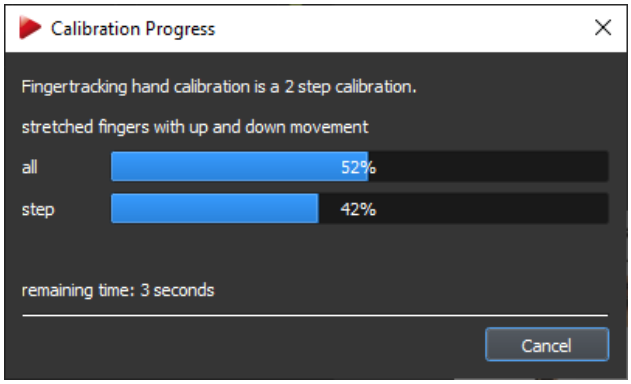


Figure 9.39: Fingertracking Administration - Hand Geometry Calibration progress bar

A progress bar shows the status of the calibration (see figure 9.39 on page 128).

☞ **If calibration step 1 fails, please check if modulated flash is activated for at least one camera and if the correct handedness and thimble set are selected.**

☞ **It is important that the hand is held inside the tracking volume and all markers are visible to at least two cameras when starting the calibration process.**

After the first step has been completed a new countdown for step 2 is started.

During the second phase (calibration step 2)

- keep the fingers stretched out (see right picture in dialog, refer to figure 9.38 on page 127)
- keep the thumb spread away from the hand
- keep the other fingers close together
- gently move all of your fingers up and down at the same time until the calibration process is finished. The thumb is still spread away from the hand and should not be moved during this phase.
- do not bend or cross your fingers

Try to achieve an angle of approximately 60°between up and down position of the fingers.

If the calibration terminates with an error message, double-check the calibration procedure by clicking the button *Help*.

If calibration step 2 fails, please take care not to bend your fingers, and not to move the thumb too much

After data collection a process is started which calculates the finger sizes from the movement of the finger tips (see figure 9.40 on page 129. The length of the thumb is derived by the finger lengths.

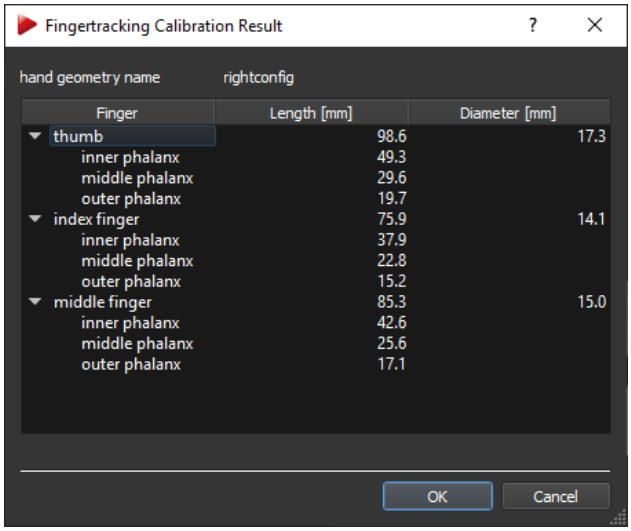


Figure 9.40: Fingertracking Administration - Hand Geometry Calibration result window

After successful calibration the '*geometry*' entry under *selected hands* will be updated. The entry in the column *Cal.* will turn into a green tick.

When using ***Fingertracking*** without tactile support, the next step is to activate the data output. Please refer to chapter 9.8.7 on page 131. When using ***Fingertracking2 Tactile*** you need to assign the tactile devices, see to chapter 9.8.5 on page 130 for details.

9.8.4.2 5 Finger Simulation

If you are using a three finger thimble set but would like to get data for five fingers, tick the checkbox *simulate 3 -> 5*. ***DTRACK4*** will simulate the data of the two missing fingers by putting them parallel to the middle finger. By default, the checkbox *simulate 3 -> 5* is unticked until you have carried out a hand geometry calibration.

9.8.4.3 Resetting finger tip sequence

When the ***Fingertracking*** device has been removed from the hand and afterwards is put on again by the same user, the system needs to reset the correct order of the finger tips.

To regain the correct sequence, the hand must be kept still with all fingers stretched out and the thumb spread to the side (see first phase of calibration process). When using two hands, both hands have to be separated by at least 50 cm during this procedure.

Fingertracking devices will compensate short synchronization losses internally.

In the rare case when the _Fingertracking_ devices have lost synchronization use the reset procedure to regain synchronisation. Refer to the _ART Hardware Installation Guide_ → _Interaction devices_ → _Fingertracking_ → _Description of the hand targets_.

9.8.5 Fingertracking Tactile Assignment

Open the sub-dialog *Fingertracking* → *Tactile Assignment* to assign a tactile device to the corresponding *Hand ID*. All *available tactile devices* will show up on the right side of the window. This function is only available with ***Fingertracking2 Tactile*** devices.

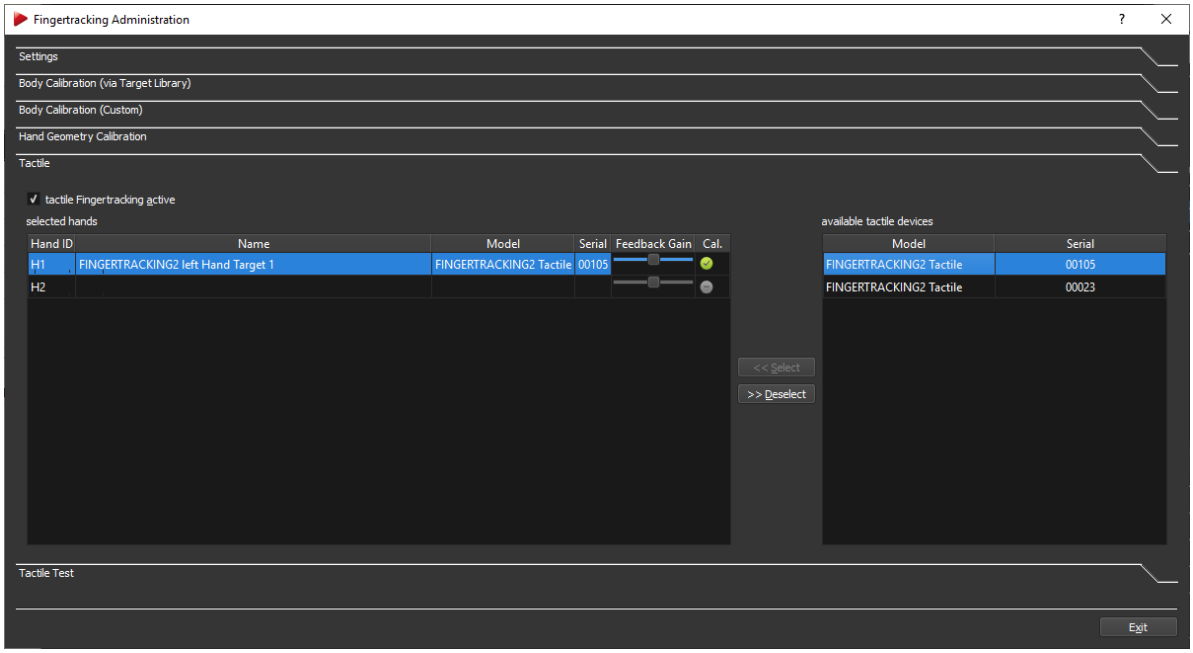


Figure 9.41: Fingertracking Administration - Tactile Device Assignment

Tactile devices are assigned the following way:

- activate the support for tactile devices by ticking the corresponding checkbox *tactile Fingertracking active*
- mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking
- mark the appropriate entry under *available tactile devices* (e.g. '*FINGERTRACKING2 Tactile*' with '*serial number*' XY) by left-clicking and

- press *Select*

The '*Model*' and '*Serial Number*' entries will be updated accordingly.

You can always delete the assignment by pressing the button *Deselect*. The tactile device will be available again for assignment to a different *Hand ID*.

Feedback Gain The feedback strength can be adjusted using a global gain setting, i.e. the feedback used inside the application is multiplied by this value. By default, this feedback gain is set to average. Activate the slider *Feedback Gain* by double-clicking, then move it to the right to increase the gain setting, move the slider to left to decrease it respectively.

Please refer to the ***DTRACK4 Programmer's Guide*** → *Input of Control Data via Ethernet* for more information about setting the feedback strength.

You can also test the feedback strength (refer to the next chapter 9.8.6 on page 131).

The serial number of the tactile device can be found on the bottom of the hand target, e.g. 8L means tactile device #8. Refer to the *ART Hardware Installation Guide* → *Interaction devices* → *Fingertracking* → *Description of the hand targets*

Please install an *ART RadioTransceiver2/3* when using *Fingertracking2 Tactile* devices (refer to the *ART Hardware Installation Guide* → *Other equipment* → *Radio Transceiver* and section 8.5 on page 79 for details).

9.8.6 Fingertracking Tactile Test

Open the sub-dialog *Fingertracking* → *Tactile Test* to test the feedback on the thimbles. This function is only available after assignment of a ***Fingertracking2 Tactile*** device to a corresponding *Hand ID*.

Mark the respective *Hand ID* from row '*H1...H4*' under *selected hands* by left-clicking. Then press the button *Test hand*. The tactile thimbles will be activated sequentially from thumb over index finger to middle finger.

You can also test one finger after the other by pressing the corresponding buttons *Test thumb*, *Test index* or *Test middle*. The corresponding status LED will light up to indicate radio communication. Refer to the ***ART Hardware Installation Guide*** → *Interaction devices* → *Fingertracking* → *Description of the hand targets*.

9.8.7 Fingertracking Output settings

The last step is to define where the ***Fingertracking*** data has to be sent to. Open *Tracking* → *Output*. There either select *this computer* (= remote PC) or enter an IP address

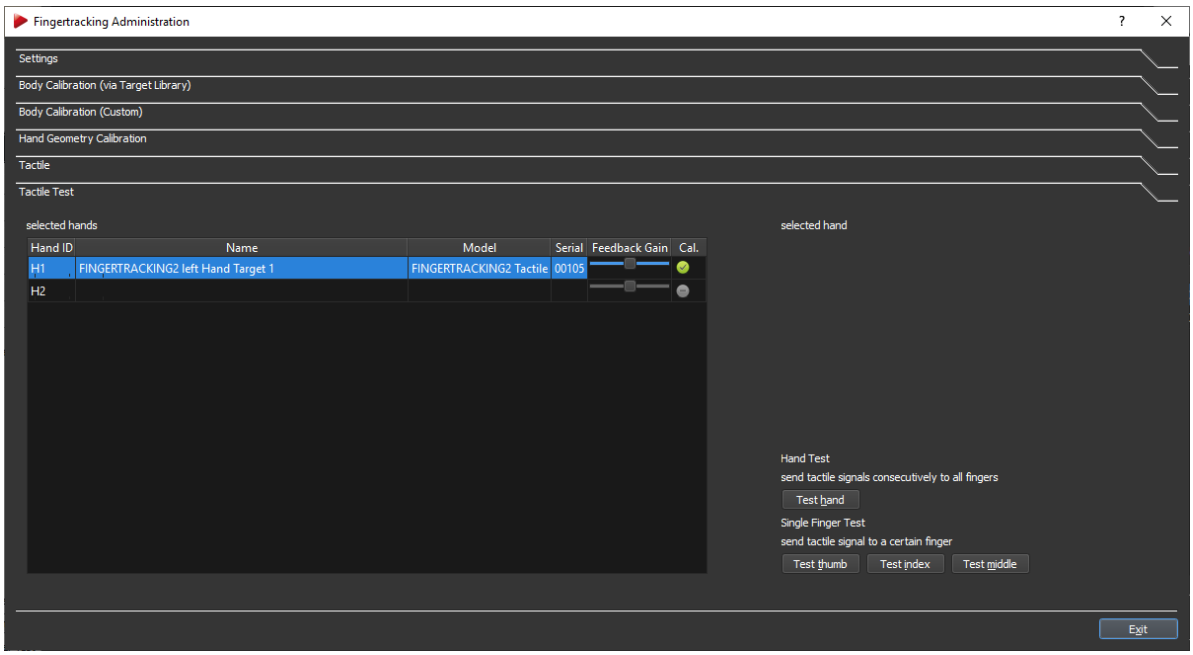


Figure 9.42: Fingertracking Administration - Tactile Device Test

of another client you want to send data to. Tick the checkboxes '*gl*' and '*glcal*' to transmit the ***Fingertracking*** data.
Please refer to chapter 9.10 on page 137 for more details.

9.8.8 Fingertracking Display

Press *Start* to start the measurement. In order to view the tracking data enable the *Fingertracking display* by clicking *View* → *Fingertracking*. Please refer to chapter 6.3 on page 45 for details.

9.8.9 External Add-On - Fingertracking Viewer

The Fingertracking Viewer is a tool for visualisation of the hand and finger positions. It is available free of charge for demonstration and testing purposes to be installed on the PC that receives ***DTRACK4*** data.

After starting the viewer, proceed the following way:

- specify ***DTRACK Backend Service*** to connect to by defining the host name or IP address
- specify the UDP data port the viewer has to listen to
- press the *Go Online* button

- press *OK* to connect the viewer to ***DTRACK4***
- choose the *Hand ID* you want to display

The indicator adjacent to the *Hand ID* setting shows whether this hand is tracked or not (green=tracked, red=not tracked). Finally click on one of the buttons featuring a hand to see your tracked hand and fingers.

You can also start a small demo showing the handling of a virtual object by opening the *Demos* menu. There is a limited number of demos available, e.g. you can handle a virtual sphere or cube. To insert the virtual object into the tracking volume, place the tracked hand at a convenient position and press the *Grab object* button.

9.9 Measurement Tool

Within this dialog you can manage the *number of Measurement Tools* and the *number of references* (max. 4 each) and configure the corresponding settings to be used (see figure 9.43 on page 133).

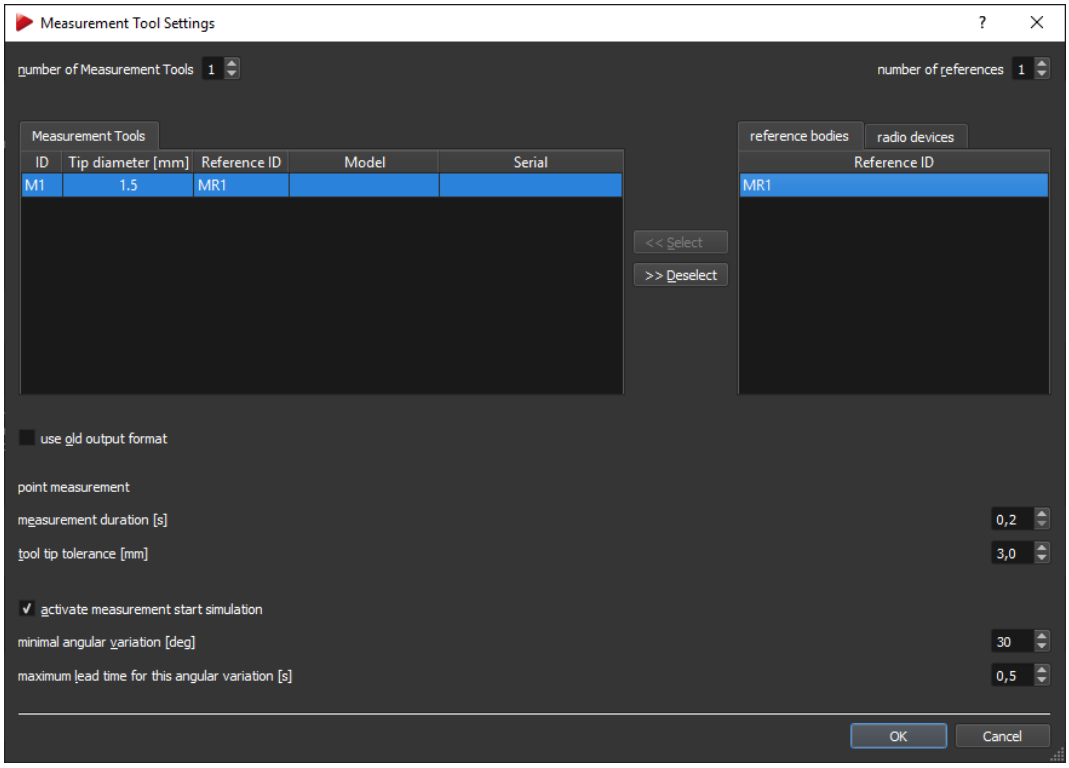


Figure 9.43: Measurement Tool

Additionally several other parameters can be changed to suit your application:
Enter the *number of Measurement Tools* '*0...4*' directly or use the numeric updown button. The corresponding entries in the list of *Measurement Tools* will show up. The fields *Model*,

Control	Description
number of Measurement Tools	configure the number of devices to be used
number of references	configure the number of reference bodies to be used
Tip diameter [mm]	define the diameter of the tip (ball-shaped)
use old output format	use the legacy output format (refer to the ***DTRACK4 Programmer's Guide***)
measurement duration [s]	configure how long a measurement with the Measurement Tool (valid range: 0.2 - 10.0 sec) should take
tool tip tolerance [mm]	specify the range within the tip is assumed to be static (valid range: 0.1 - 5.0 mm)
activate measurement start simulation	activate the gesture detection and enable the respective controls
minimal angular variation [deg]	specify the minimum angle that the Measurement Tool has to be tilted over to start a measurement (valid range: 10°- 120°)
maximum lead time for this angular variation [s]	waiting time before the measurement start after gesture detection

Table 9.15: Measurement Tool settings

Serial are empty by default. Double-click the corresponding entry *Tip diameter [mm]* and enter a value (in mm) when using ball-shaped tips. The diameter will be included in the data output (refer to the ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet*).

Measurement Duration It is possible to define the duration of a point measurement. A compromise has to be found between the amount of data collected and the convenience of holding the Measurement Tool . Enter the value in seconds in the field *measurement duration [s]*.

Tool Tip Tolerance The tracking system will take measurements up to a defined jitter in millimeter around the tool tip. Configure this tolerance to suit your needs for accuracy. Enter the value in millimeters in *tool tip tolerance [mm]*.

Start Simulation In certain applications and use cases it might be more convenient to start the measurement by a gesture rather than pressing a button on your PC. Tick the checkbox *activate measurement start simulation* to enable the gesture detection.

The gesture is simply tilting the Measurement Tool along the tip axis similar to waving. You can configure the minimum angle of tilt that is necessary to detect the gesture. Enter the value in °[deg] in the field *minimal angular variation [deg]*. Additionally you can specify a waiting time until the measurement starts after detection of the gesture. Specify the time in seconds in the field *maximum lead time for this angular variation [s]*.

9.9.0.1 Reference bodies

If you are working with a reference body you may assign it to a specific Measurement Tool :

- mark the respective *Measurement Tool ID* by left-clicking,
- mark the reference body *Reference ID* and
- press *Select*.

The '*Reference ID*' entry will be updated accordingly. Repeat these steps if you want to assign references to other Measurement Tools .

If you are working with reference bodies you will need to calibrate them as well. This is done using a standard body calibration of e.g. *Measurement Tool reference body 01*. Please refer to chapter 9.5.1 on page 105 for more information concerning the body calibration procedure.

A Measurement Tool with an assigned reference body can only be tracked when the reference body is tracked as well.

9.9.1 Measurement Tool Calibration

The calibration of the Measurement Tool is separated into two steps:

1. body calibration of the Measurement Tool and
2. calibration of the tip (refer to section 9.9.2 on page 135.

9.9.1.1 Measurement Tool Body Calibration

First, calibrate the Measurement Tool using a standard body calibration. Close the *Measurement Tool Settings* dialog and open *Tracking* → *Body calibration*. There select the body *Measurement Tool body 01* for calibration. Define the orientation of the body coordinate system relative to the body (default: *due to body*). Make sure that all markers of the Measurement Tool are seen by the cameras using the *2D Monitor* which appears in the background. Press *Calibrate* and the calibration will start within 5 seconds. Please refer to chapter 9.5.1 on page 105 for more information concerning the body calibration procedure.

9.9.2 Measurement Tool Tip Calibration

After a successful body calibration, you have to calibrate the tip of the Measurement Tool by opening *Tracking* → *Measurement Tool Tip calibration* (see figure 9.44 on page 136) .

Place the Measurement Tool in front of the cameras with the tip fixed at exactly one position

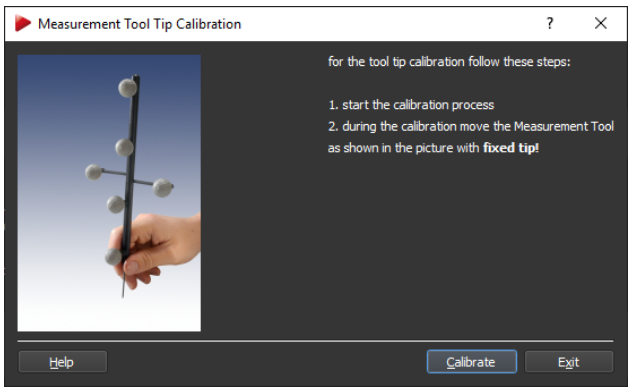
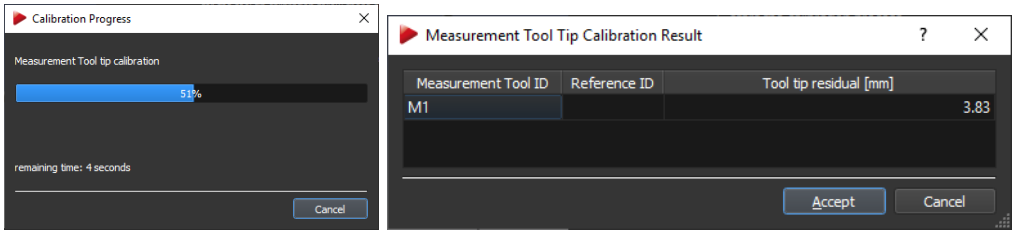


Figure 9.44: Measurement Tool Tip Calibration

(e.g. on a hard surface). Press *Calibrate* to start the calibration process.

Gently move the Measurement Tool while tilting it around its tip in all axes. A progress bar will show the current status (see figure 9.45(a) on page 136. ***DTRACK4*** will calculate the position of the tip relative to the markers of the Measurement Tool , i.e. the origin of the body coordinate system is transformed into the Measurement Tool 's tip.



(a) Progress bar (b) Calibration Result

Figure 9.45: Measurement Tool Tip Calibration Process

After successful tip calibration the result is presented in the dialog *Measurement Tool Tip Calibration Result* (see figure 9.45(b) on page 136. Please check the information and either '*Accept*' or '*Cancel*' the tip calibration.

A tool tip calibration result below 0.2 mm is recommended for measurements with high accuracy.

Keep the Measurement Tool positioned at exactly one point, i.e. do not lift it from the surface.

The progress bar will stop if the Measurement Tool is not moved sufficiently.

9.9.3 Measurement Tool Output settings

The last step is to define where the Measurement Tool data has to be sent to. Open *Tracking* → *Output*. There either select *this computer* (= remote PC) or enter an IP address of another client you want to send data to. Tick the checkboxes '*6dmt2*' and

'*6dmtr*' to transmit the Measurement Tool data.
Please refer to chapter 9.10 on pag 137 for more details.

9.9.4 Measurement Tool Display

Press *Start* to start the measurement. In order to view the tracking data enable the *Measurement Tool display* by clicking *View* → *Measurement Tool*. Please refer to chapter 6.3 on page 45 for details.

9.10 Output Settings

In this dialog you can manage the settings for data output via ethernet (see figure 9.46 on page 137). You can send data to any computer within your local network with a total of up to 10 individual channels for UDP data.

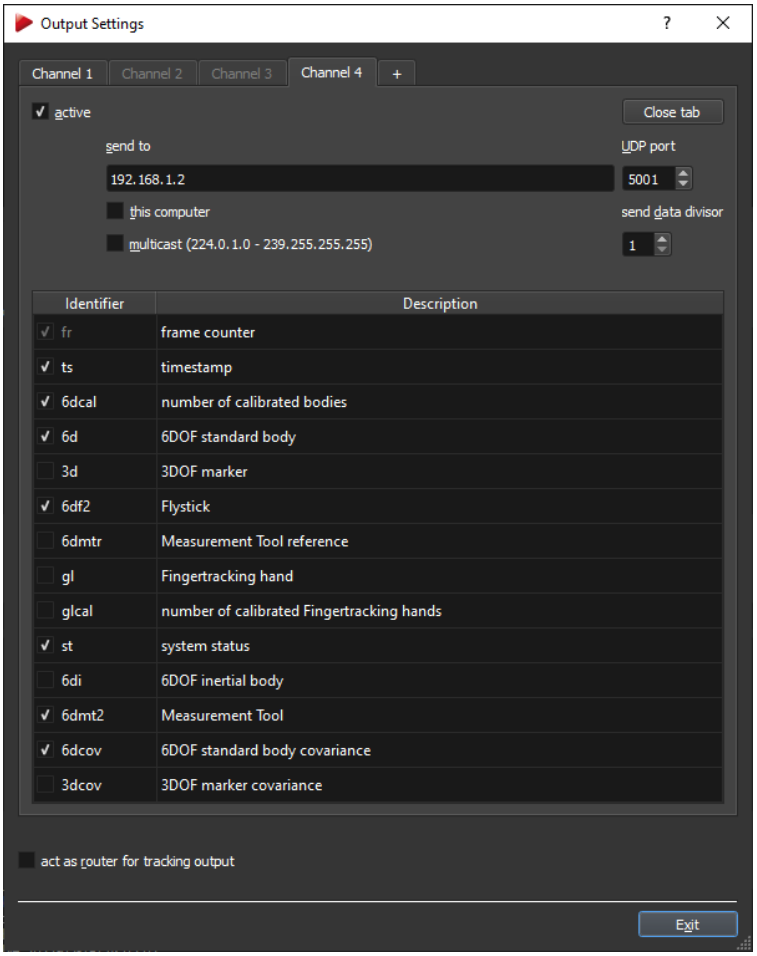


Figure 9.46: Output settings

First tick the checkbox *active* on the corresponding tab to enable data output for each channel. Next enter the IP address of the receiving client in the box *send to* and choose

a UDP port number in *UDP Port*.
Alternatively tick the checkbox *this computer* instead to send the data to the PC from where you started the ***DTRACK4 Frontend*** (which may be the same you are running ***DTRACK Backend Service*** on).

You can also send the data to a multicast IP address by ticking the checkbox *multicast* (IP address range: 224.0.1.0 to 239.255.255.255).

By clicking on the tab *+* you can add one channel at a time up to 10 channels. Set-up each channel on the corresponding tab as described above. Scroll horizontally using the *left / right arrow button* or simply resize the dialog window using the mouse. Click the button *Close tab* to remove the selected output channel configuration. A warning message will appear to confirm the action. Press *Exit* to close the *Output Settings* dialog.

send data divisor In order to reduce the amount of data from the data stream you can define a divisor starting with 1. The divisor works the following way:

- 1 .. every frame is transmitted,
- 2 .. every second frame is transmitted,
- 10 .. every tenth frame is transmitted.
- ...

Selection of UDP output data

Identifier	Description
fr	frame counter
ts	timestamp
ts2	timestamp (extended format)
6dcal	number of calibrated bodies
6d	6DOF standard body
3d	3DOF marker
6df	Flystick (old format) [1]
6df2	Flystick
6dmtr	Measurement Tool reference
gl	Fingertracking hand
glcal	number of calibrated Fingertracking hands
st	system status
6dmt	Measurement Tool (old format) [2]
6dmt2	Measurement Tool (also for ball probes)
6dcov	6DOF standard body covariance
3dcov	3DOF marker covariance

[1] only available if activated in Tracking → Flystick → checkbox '*use old output format*'
[2] only available if activated in Tracking → Measurement Tool → checkbox '*use old output format*'

Table 9.16: Description of UDP output data

Please refer to the ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet* for the format of the data output.

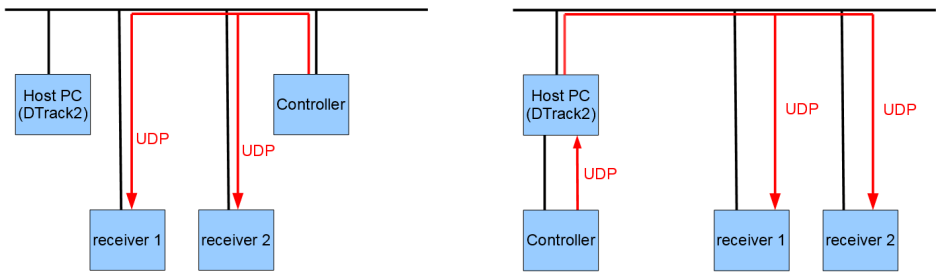
☞ **When using the identifier '*timestamp*' please refer to the *DTRACK4 Programmer's Guide* → *Output of Measurement Data via Ethernet* regarding the accuracy of timestamps.**

☞ **Please double-check that output channels are activated only for connected clients ready to receive data. De-activate all output channels when clients have been disconnected or IP addresses have become invalid.**

9.10.1 Act as router for tracking output

This functionality may be used when it is not allowed to connect the ***DTRACK Backend Service*** PC to your local network due to IP security reasons. The UDP output data can then be routed to your local network via ***DTRACK4 Frontend*** . The mandatory requirement for this function is that the PC running the ***DTRACK4 Frontend*** is equipped with two ethernet LAN ports. One is necessary for connecting the ***DTRACK Backend Service*** and the other for connection to your local network (see figure 9.47 on page 139).

Tick the checkbox *act as router for tracking output* to activate the function.



(a) *act as router* disabled (default) (b) *act as router* enabled

Figure 9.47: Depiction 'act as router' functionality

Using *DTRACK4 Frontend* to forward the UDP data output will add a short delay / latency (approx. 0.1 ... 0.5 ms, dependent on the calculation power of the Host PC)

☞ **Do not use this function if the application PC and the *DTRACK Backend Service* are in the same network or on the same PC!**

10 Menu View - Frontend configuration

Display	*Shortcut*
Set to default	
2D Monitor	
3D Monitor	
Data	F10
Flystick	
Fingertracking	
Measurement Tool	
Events	

Table 10.1: Menu *View*

Set to default This function resets the appearance of the ***DTRACK4*** frontend, i.e. all views and the size of the windows are reverted to default values. Only the *Monitor 2DOF* and the displays *Data* and *Events* are shown.

2D Monitor The *2D Monitor* is a graphical display of the field of view of the cameras to visualise all markers that are seen by the cameras. It is activated by default. A more detailed description can be found in chapter 6.3.1 on page 45.

3D Monitor The *3D Monitor* is a graphical representation of the tracking volume including 3D and 6D tracking data of all markers and bodies seen / tracked by the cameras as well as camera data and coordinate system information. A more detailed description can be found in chapter 6.3.3 on page 51.

Data On the left hand side the *Data Display* shows the 6DOF measurement results (i.e. position and orientation of the body relative to the room coordinate system). Additional information for inertial sensors are also shown, if applicable. On the right hand side the results for 3DOF calculation of single markers (e.g. from not-calibrated targets) are shown, if activated.

Measurement Tool The *Measurement Tool* display shows the measurement results of the position and orientation of the Measurement Tool .

Events The *Event Display* shows the status of the tracking system. All messages and entries shown here are also stored in event logs on the remote PC. These files are necessary for tech support by ***ART*** (please refer to chapter 7.3 on page 62).

Fingertracking The *Fingertracking* display shows the measurement results for the hands - i.e. of back of the hand + each finger (thumb, index, middle, ...).

Flystick The *Flystick* display shows the measurement results of the position and orientation of the Flystick.

11 Menu Tools

Tools	*Shortcut*
Measure points	

Table 11.1: Menu *Tools*

11.1 Measure Points

This tool (see figure 11.1 on page 142) provides a simple acquisition method for measurements with the Measurement Tool .

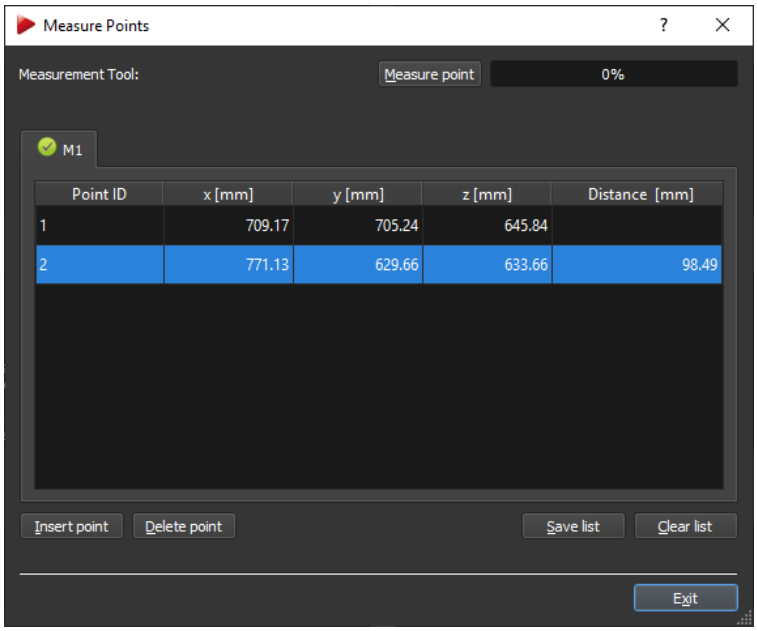


Figure 11.1: Measure Points

The dialog shows the following informations:

The measurement of a point is started either by pressing the button *Measure point*, by performing a gesture with the Measurement Tool or by pressing a button of an assigned ***Flystick*** . Tilt over the Measurement Tool as defined in 9.9 on page 133. The distances between adjacent points are computed automatically. You may insert or delete points from the list and you may save the list to a file.

Control	Description
Measure point	Place the Measurement Tool at the position you want to measure and press this button.
Insert point	Add an additional measurement to the list (above the selected point).
Delete point	Remove the selected measurement from the list.
Save list	Export the list of measurements to a file (e.g. for import in a spreadsheet program).
Clear list	Delete all entries of the list.

Table 11.2: Measure Points - Description

If the Measurement Tool is not tracked a measurement cannot be performed!

12 Menu Help

About	*Shortcut*
What's this?	Shift + F1
What's new?	
Camera Update	
Service and Guides	
DTRACK4	F1
About Qt	

Table 12.1: Menu *Help*

12.1 What's this?

By clicking *What's this*, you may use the context-sensitive help function within the ***DTRACK4*** frontend software. Just point the mouse cursor over any feature of the ***DTRACK4*** GUI, then left-click to receive additional information.

12.2 What's new?

The upcoming window provides information about the new features that have been released with the current version. By clicking on '*Show more*' you can access the history of introduced features in previous versions (see figure 12.1 on page 145).

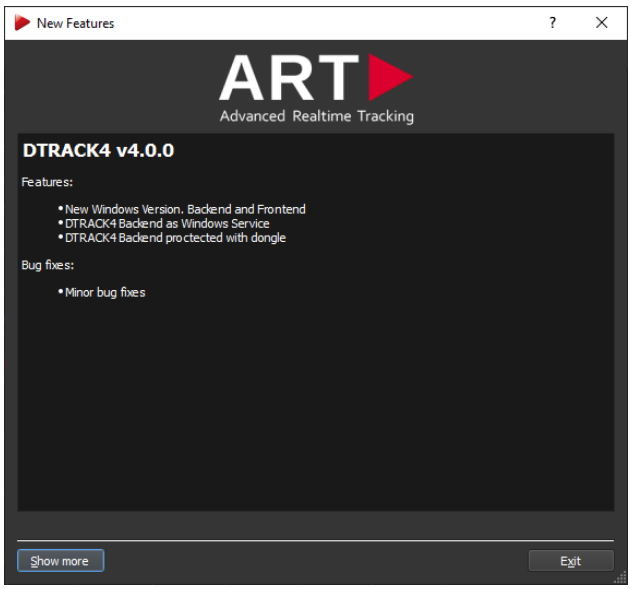
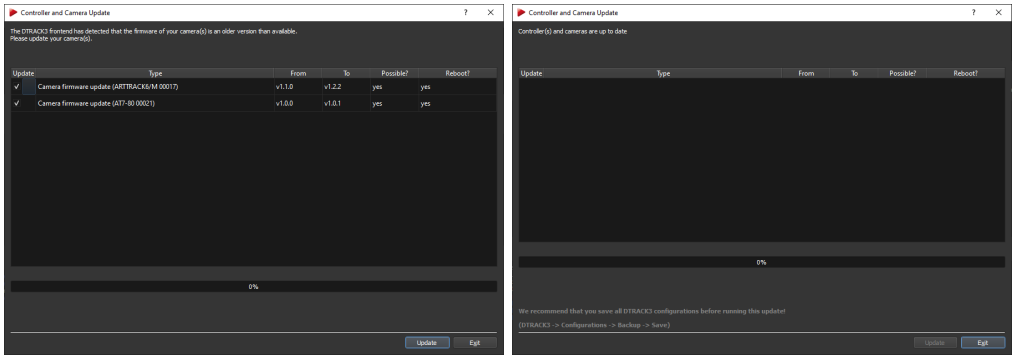


Figure 12.1: What's new Information

12.3 Camera Update

After updating the ***DTRACK4 Frontend*** software an automatic update of the cameras is started, if necessary. In case you have aborted this process during first run you can re-open the update dialog here (see figures 12.2(a) on page 145).

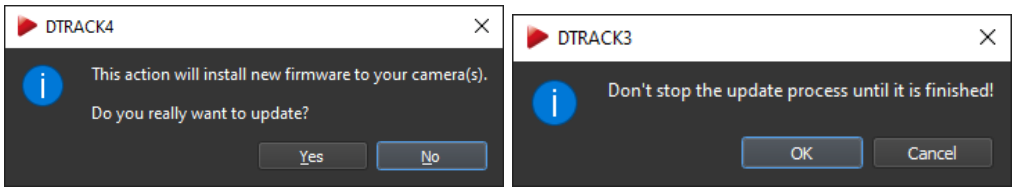


(a) Dialog for camera update (b) Update completed

Figure 12.2: Update Assistant

Click *Update* to start the update process, when applicable. Confirm by clicking *Yes* in the upcoming dialog (see figure 12.3(a) on page 146). After a final warning the update is started (see figure 12.3(b) on page 146). Do not stop the process afterwards.

The update dialog will show no further update option when your cameras are up-to-date (refer to figure 12.2(b) on page 145). Click *Exit* to close the update dialog.



(a) Confirmation window (b) Confirmation warning

Figure 12.3: Confirming the update

The update dialog will then show the current status using a progress bar (refer to figure 12.4 page 146). Depending on the update this may take several minutes.

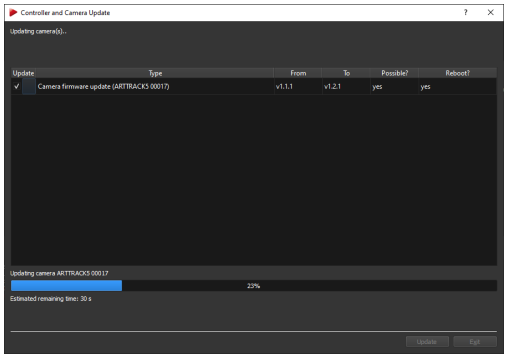


Figure 12.4: Progress bar for camera update - Running the update

After the update has been completed the controller and / or cameras are automatically restarted to finalize the update process.
You may then continue with your measurement.

Personal settings and configurations (e.g. room and body calibration, output settings, etc.) will be preserved during update!

Don't stop the update process e.g. by turning off or unplugging the cameras.

The cameras will be restarted automatically to finish the update process.

12.4 Service and Guides

The service dialog shows important information when contacting ***ART*** technical support (see figure 12.5 on page 147).

The *Service-ID* is a unique identifier of your controller. Next the current software version on your controller (i.e. backend) is shown next to *DTRACK*. You can select both entries to copy & paste.

You can also access the ***ART*** website directly using the link below. The *Service-ID* is

attached automatically at the end of the link.

At the bottom of the dialog the export system information window can be opened (please refer to section 12.4.1 on page 147).

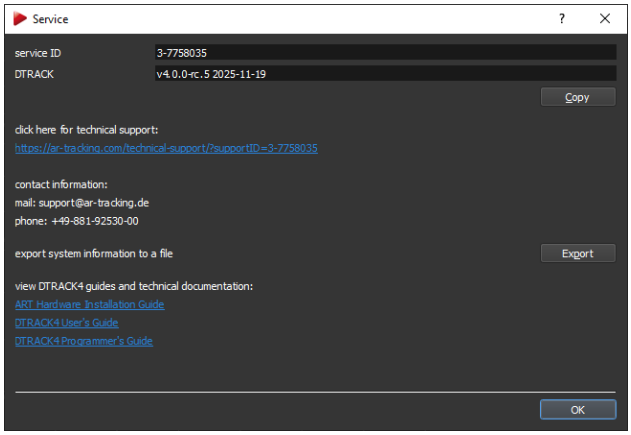


Figure 12.5: Service Information

Please have your Service-ID and current software version ready when you contact the *ART* technical support.

12.4.1 Export system information

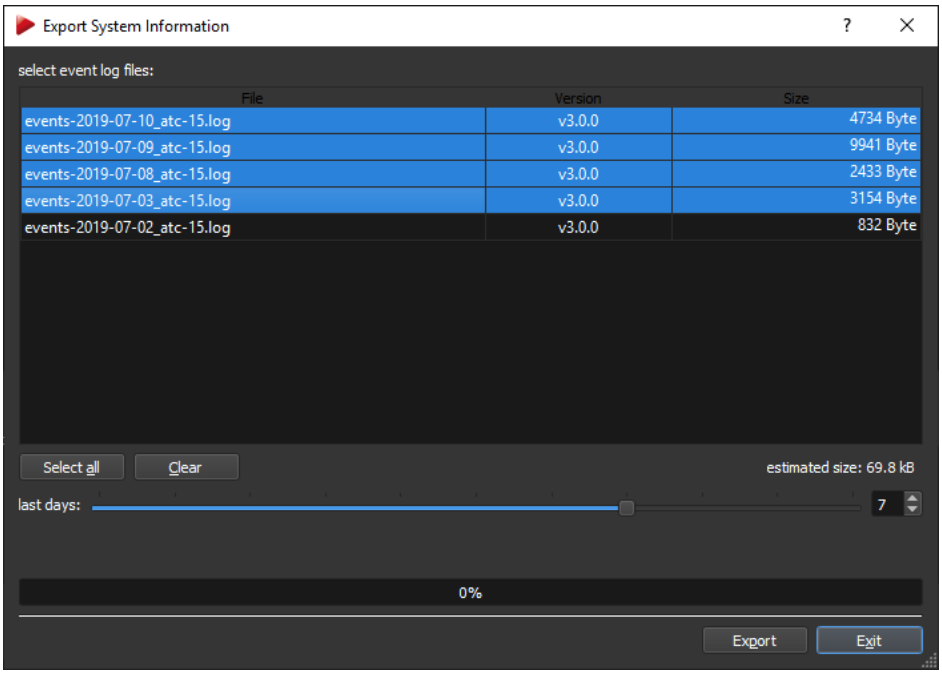


Figure 12.6: Export System Information

This dialog is intended for saving a current system information file as well as recent event logs in case you need to contact tech support at *ART* (see figure 12.6 on page 147). In-

formation is included such as number and types of cameras, validity of room calibration, number and types of targets, current settings, warnings and error messages etc.

Select the appropriate *Event log files* by left-clicking the entries or by moving the slider below the table to the left or right respectively. You can also enter the number of *last days* manually (max. 30 days). Press *Export* to save the selected event logs together with the system information file in (ASCII-)TXT format on any remote PC in your local network.

12.4.2 View *DTRACK4* guides and technical documentation

All ***DTRACK4*** manuals (including this one) can be easily displayed by clicking the corresponding links (if a suitable PDF viewer is installed at your PC). If this doesn't work you can find them also in the ***DTRACK4 Frontend*** installation directory under `.\DTRACK4_v4.X.Y\doc\`

12.5 DTRACK4

This dialog offers information about the software version and release date of the ***DTRACK4 Frontend*** and ***DTRACK Backend Service*** running (see figure 12.7 on page 148). Additionally hostname of the ***DTRACK Backend Service*** PC shown. By clicking on the button *Show details* a list of all included software modules is shown together with their respective software versions. Information regarding licensing of ***DTRACK4*** can be found under *Open-Source software*.

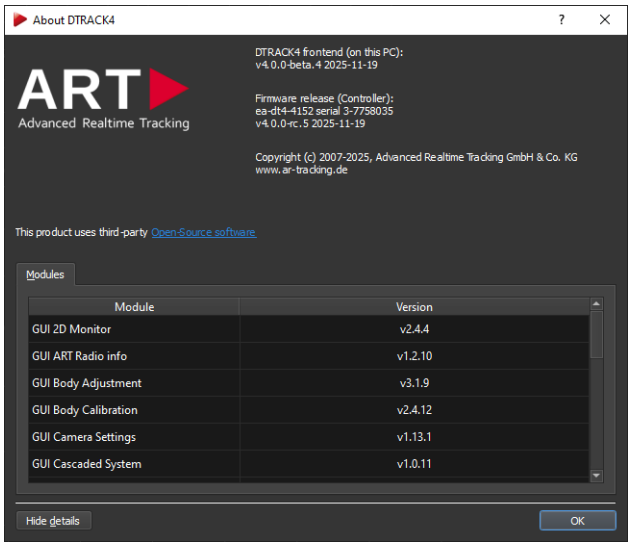


Figure 12.7: About ***DTRACK4*** Information

12.6 About Qt

This offers information about the Qt software toolkit used within ***DTRACK4*** .

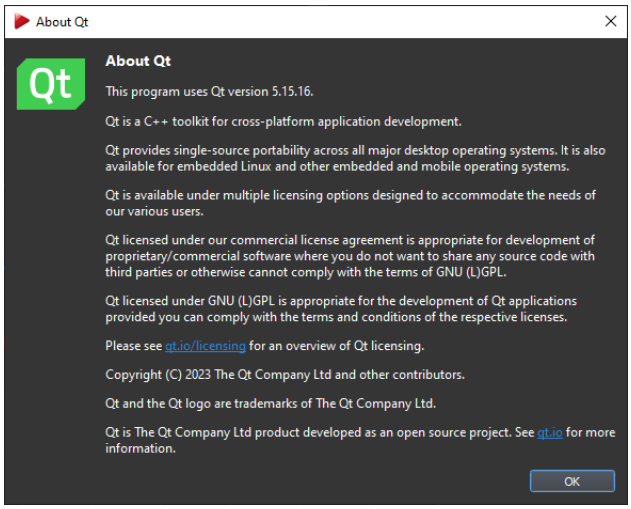


Figure 12.8: About Qt Information

13 Frequently asked questions (FAQ)

Within this FAQ chapter we are offering solutions for easy-to-solve questions that our support encounters from time to time. The questions are grouped into specific topics to make it more convenient for you to find a solution.

In case you do not find a proper solution for your specific problem, please do not hesitate to contact us.
Our goal is to offer the best support possible. Therefore, we ask you to have the system running and that you have internet access when you call us. Additionally we will need details about your system. Please refer to the ***DTRACK4 User's Guide*** → *Menu Help* → *Service* → *Export System Information File* for details how to export a system information file. Please include it in your mail when you contact tech support.

13.1 Backup

➪ How do I create a backup of important configurations?

All your configurations are stored on the CmStick USB copy-protection dongle (WIBU-SYSTEMS). Yet it is possible to export and import configurations. Please refer to chapter 7.3.2 on page 64 for details how to export and backup your configurations. In case of an accidental deleting of a configuration it will be possible to restore it presuming that an export had been carried out before. In the unfortunate event of repairs this data could also be restored to a replacement ***DTRACK Backend Service*** PC.

Please note that a room (re-)calibration might be necessary especially in case the amount of cameras or the camera models have changed.

☞ **Do not tamper with the data / folder structure on the CmStick USB copy-protection dongle (WIBU-SYSTEMS). It might become invalid to run *DTRACK Backend Service* .**

13.2 Cameras

➪ How many cameras may be connected to the tracking system?

Starting with ***DTRACK4*** a new license model has been established.

You may use up to 80 cameras in any combination with up to 70 simultaneously activated targets using the universal license.
Please refer to table 7.2 on page 61 for a complete license overview.

13.3 *DTRACK Backend Service* PC

⇨ What is the IP address of my *DTRACK Backend Service* PC?

- Please go the Windows Network Adapter configuration or ask your system administrator.
- It is possible that your ***DTRACK Backend Service*** PC has become unreachable due to wrong IP settings (wrong IP address or IP address area, etc.).
- In case you are using a firewall, please do not block ***DTRACK4*** communication. Please refer to chapter A.1 on page 166.

⇨ How can I assign a specific IP address to the *DTRACK Backend Service* PC?

You may configure a static IP address the following ways:

- Please go the Windows Network Adapter configuration or ask your system administrator.

13.4 *DTRACK4* and shutter glasses

⇨ What types of shutter glasses can be used with the *ART* tracking system

DTRACK4 does not offer external trigger synchronisation.

13.5 *DTRACK4* and interfaces

⇨ I'm using VRPN. Which output identifiers have to be activated?

It is absolutely mandatory that you activate at least the '*6d*' and '*6dcal*' output identifiers (refer to table 9.16 on page 138). Activate other output identifiers depending on your application (e.g. if you're using ***Flystick2/2+*** you have to activate '*6df2*').

⇨ I'm using VRPN and TrackD but I only succeed in receiving data via just one of them.

Please make sure that you are using two separate output channels with different port numbers. Please refer to chapter 9.10 on page 137.

⇨ I'm having problems with the *Flystick2/2+* data transmission via TrackD.

Please make sure that you are using the latest version of the TrackD module - ***ART*** will provide information upon request. Versions of trackd 5.5 which are older than February 2007 do not support data transmission for ***Flystick2/2+*** .

If you don't want to change the module you may also use the '*old output format*' for legacy Flystick1. Please refer to chapter 9.7 on page 116 for more details.

13.6 Software *DTRACK4*

➪ Where do I get the software *DTRACK4* from?

The software ***DTRACK4*** is downloadable, Furthermore, you may register for the ***ART*** Download Center
(`http://www.ar-tracking.com/support/`) in order to always have access to the latest patch release of ***DTRACK4*** .
Please refer to chapter 7.2 on page 60 for more information about ***DTRACK4*** release policy.

You will need a CmStick USB copy-protection dongle (WIBU-SYSTEMS) to run *DTRACK Backend Service* .

➪ Why is my frontend not starting up?

- Please refer to chapter A.1 on page 166 for a list of supported operating systems.
- Please update to Windows 10 or newer. Windows XP, Windows 7 or 8.1 are not supported.
- Windows 32-bit is not supported in any version. Please upgrade to a compatible 64-bit Windows distribution.

➪ Some of my menu items are missing. What can I do?

- Please check if the latest updates for your operating system are installed.
- Please refer to chapter A.1 on page 166 for a list of supported operating systems.

➪ Some of my menu items are greyed out / disabled. What can I do?

- Please check if your configuration is locked. In case unlock your configuration.
- Please refer to chapter 7.3 on page 62 how to manage your configurations.

➪ Where is the *2D Monitor*?

- Please check if the latest updates for your operating system are installed.
- Please make sure that your firewall is not blocking ***DTRACK4*** , even partly.
- Please refer to chapter A.1 on page 166 for a list of supported operating systems and communication ports.

⇨ Why is the *2D Monitor* crossed out for some cameras?

- Please check if all the cameras used during room calibration are connected.
- Please refer to the ***ART Hardware Installation Guide*** → *FAQ* for the common reasons of disconnected cameras.
- Please refer to section 6.3.1 on page 45 for more information about Adding / removing cameras.

⇨ Why does the "(re-)calibration required" message appear in Monitor 2DOF?

- Please make sure you have performed a correct room calibration using all connected cameras.
- Please refer to section 6.3.1 on page 45 for more information about Adding / removing cameras.

⇨ My target is not visualized within the *2D Monitor*.

- Please make sure that the target is inside the tracking volume and within tracking range of the cameras.
- Double-check the settings for the flash intensities of the cameras (refer to chapter 8.3 on page 69).
- In case you are using active targets, please make sure that you have activated the modulated flash. Please refer to chapter 8.3 on page 69 for further details.

⇨ There are greyish areas in my *2D Monitor*. What do they indicate?

The static reflex suppression is currently active. This is indicated with these greyish areas. Markers in these areas will not contribute to tracking.

Please refer to chapter 6.3.2 on page 49 for more information.

⇨ What do the abbreviations "SR", "DR" and "UD" mean?

SR ... static reflex suppression active
UD ... display orientation is upside down

Please refer to chapter 6.3.1 on page 45 for more information on the additional *2D Monitor* settings.

⇨ The display bar in the *2D Monitor* is indicating very high intensities although no markers are illustrated. Where's the light coming from?

Please check that the cameras are not in the field of view of each other to avoid mutual blinding. Furthermore, remove other strong IR radiation sources from the tracking volume or, at least, prevent them from interfering with the tracking system. Please refer to the ***ART Hardware Installation Guide*** → *Setting up the cameras* for more information.

⇨ Monitor 2DOF and/or Data Display are 'freezing' after some time, although tracking didn't stop.

This can be caused by a firewall that is running on the ***DTRACK4*** PC and blocking (UDP) output data.
Check your firewall settings and ensure that it is not blocking ***DTRACK4*** application, even partly. Please refer to chapter A.1 on page 166.

⇨ How do I define the number of targets to be tracked?

Go to *Tracking* → *Body Administration* and change the number of activated target slots by ticking '*Active*' next to the corresponding body *ID*. Please refer to chapter 9.4 on page 95.

⇨ What is the maximum number of targets?

The maximum number of targets (not including ***Flystick2/2+*** , ***Fingertracking*** and Measurement Tool devices) is 70.
Starting with ***DTRACK4*** a new license model has been established.
You may simultaneously activate and track up to 70 activated targets using the universal license.

Please refer to table 7.2 on page 61 for a complete license overview.

⇨ Where do I get a license code from?

You may purchase additional licenses for your system. Please contact your ***ART*** representative in case you need consultation.

Please refer to chapter 7.2 on page 60 for further details.

⇨ Where do I enter a new license code?

Go to *DTRACK4* → *Licenses* and enter the code in line '*new license code*'.

Please refer to chapter 7.2 on page 60 for further details.

⇨ Where do I get a software update from?

The latest patch release of ***DTRACK4*** is always available at the ***ART*** Download Center (`http://www.ar-tracking.com/support/`).
Please refer to chapter 7.2 on page 60 for more information about ***DTRACK4*** release policy.

⇨ I want to run a software update. How do I preserve my data and my configurations?

Your data and your configurations are automatically preserved when running a software update. But it is recommended to regularly create backups of your configuration(s). Please refer to chapter 7.3.2 on page 64 for further details.

⇨ How do I run a software update?

Please contact ***ART*** to receive the latest patch release and follow the instructions in chapter 4.4 on page 31 and chapter 12.3 on page 145.

⇨ Do I have to update the *DTRACK4* frontend software and the software of the *DTRACK Backend Service* at the same time?

Yes, this is mandatory.

⇨ My specific settings have been lost.

Please check if the correct configuration is selected:
go to *DTRACK4* → *Configurations* and select the correct configuration.
Please refer to chapter 7.3 on page 62 for further details.

⇨ Is it possible to automatically start the measurement after booting the *DTRACK Backend Service* PC?

No, this feature is not available as customer surveys have provided negative feedback.

⇨ May I close the *DTRACK4* frontend software window after starting the measurement?

Yes, the measurement continues even if the ***DTRACK4*** frontend software is not active.

⇨ What's the version of my *DTRACK4* software?

Go to *Help* → *DTRACK4* to find out the version of your ***DTRACK4 Frontend*** and ***DTRACK Backend Service*** . Please refer to chapter 12 on page 144 for further details.

13.7 Calibration

⇨ How can I find out when the room has been calibrated last time?

Please go to *Tracking* → *Room calibration* and click *Show details*. The date of the last room calibration is shown.

⇨ How do I define position and orientation of the room coordinate system?

The calibration angle defines position and orientation of the room coordinate system depending on how you place it within the tracking volume. Please refer to table 9.3 on page 83.

DTRACK4 offers the possibility to adjust the room coordinate system after the room calibration. Please refer to chapter 9.2 on page 88 for more information.

⇨ How do I have to move the wand?

Move the wand gently within the measurement volume, in order to generate a virtual point cloud. This point cloud should fill at least about two thirds of the measurement volume. Please refer to the ***ART Hardware Installation Guide*** → *Setting up the cameras* → *Room Calibration - Overview* for more information.

⇨ I do not succeed in performing a room calibration.

- Please make sure that the calibration angle is placed within the measurement volume such that it is seen completely by at least two cameras (→ verify with *2D Monitor* display). If not all cameras see the angle be sure that a sufficient volume connects each camera to the others. No other marker except for the ones belonging to the calibration angle should be visible.
- Please make sure that the correct calibration set is selected in the settings for room calibration. Please refer to chapter 9.1 on page 81 for details.
- Please make sure that no reflections are seen by the cameras. If it is not possible to eliminate the reflections you may use static suppression of reflections to remove them. Please refer to the ***ART Hardware Installation Guide*** → *Setting up the cameras* for more information.
- Please make sure that the markers positioned on the calibration angle are not damaged or misarranged.
- Increase the flash intensities of the cameras until all markers are of good quality (i.e. at least yellow). Please refer to chapter 8.3 on page 69.
- Restart the room calibration. Move the wand gently within the measurement volume, in order to generate a virtual point cloud. This point cloud should fill at least about two thirds of the measurement volume.

Please refer to the ***ART Hardware Installation Guide*** → *Setting up the cameras* → *Room Calibration - Overview* for more information.

⇨ I cannot cover two thirds of the measurement volume within the set time for the room calibration. How do I extend the time for the calibration process?

Please open the dialogue *Tracking* → *Room calibration* and click *Show details*. There you can extend the duration for the calibration process. Please refer to chapter 9.1 on page 81 for more information.

⇨ How shall I evaluate the room calibration results?

Please refer to chapter 9.1.4 on page 84 for a detailed explanation.

⇨ *DTRACK4* reports the error message "*no angle tool detected*". What went wrong?

First of all, please double-check if all markers are visible and that there are no disturbing reflections. Sometimes, it might help to move the calibration angle a little bit.
Please always verify the settings for the room calibration before repeating:

- wand length is printed on a label on the wand;
- select the correct calibration set.

⇨ The progress bar of the room calibration stopped.

Please double-check in the *2D Monitor* display whether the calibration wand is recognized by the cameras during its movement.

⇨ What is a "re-calibration" and when do I have to perform one?

DTRACK4 provides simplified room and body calibrations, called room and body re-calibration. The main advantage of a re-calibration is that ***DTRACK4*** preserves the origin and the orientation of your coordinate system as well as specific information (predefined emission vectors, cylindrical marker).

You may perform a room re-calibration from time to time or if a camera moved slightly (e.g. due to mechanical instabilities).Please refer to chapter 9.1.5 on page 85.

If your body fell down or if the structure is bent you should carry out a body re-calibration. Please refer to chapter 9.5.7 on page 112 for more information.

⇨ What does '*scaling factor*' mean?

Performing a room calibration results in a certain scaling error. This might be a problem when applications do have very high accuracy requirements (e.g. when performing measurements with the Measurement Tool).
The scaling error can be determined, for instance, by measuring points on a defined scale (e.g. tape measure). The determined scaling error can thus be adjusted with the ***DTRACK4*** '*scaling factor*' (refer to chapter 9.2 on page 88).

Please contact ***ART*** if you require further information.

⇨ I cannot calibrate my target.

- Please check if the markers of the target are seen by the cameras in good quality (i.e. at least yellow) - a slight change of the target position might help. If necessary increase the flash intensities of the cameras. Therefore, go to *Hardware* → *Cameras*.
- Make sure that when starting the body calibration every marker of the target is visible to the cameras.
- A body calibration can be carried out only if a valid room calibration has been carried out before. Check in the *Event Display* if there is a warning saying 'no valid room calibration', additionally the button *Calibrate* is greyed out and cannot be clicked.
  In that case, please carry out a new room calibration.
- Please make sure using the *2D Monitor* display that no marker is overlapped (i.e. merged) by another one. If necessary rearrange the target and restart the body calibration.
- Try to carry out the body calibration with a moving target. Therefore, shift the starting position of the target for calibration (often a shift of 10 or 20cm is enough to enable calibration again).
- Make sure that no other markers or targets are inside the tracking volume other than the one you want to calibrate.
- Please carry out a new room calibration.

⇨ I'd like to save all my body files for backup reasons but I receive less files than configured bodies.

DTRACK4 only creates body files for calibrated bodies. For example: if you have configured 15 targets for tracking but only 4 of them are calibrated, you will only receive 4 calibration files.

⇨ I'd like to calibrate a body but the body calibration dialogue is greyed out.

Please ensure that you have performed and accepted a valid room calibration prior to body calibration. Check in the *Event Display* if there is a warning saying 'no valid room calibration'.

⇨ What is the difference between '*due to body*' and '*due to room*'?

When selecting '*due to body*', the body coordinate system is determined by the arrangement of the rigid body itself. When '*due to room*' is used the origin of the body coordinate system is set to the center of gravity of all markers building the rigid body.

Please refer to chapter 9.5.2 on page 106 for more information.

⇨ Do I have to move the target while performing a body calibration?

If possible we recommend to perform moderate movements because accuracy can be improved doing so. However, the body has to be visible to the cameras all the time.

⇨ May I change the position and the orientation of the body coordinate system later on?

Yes, you may use the dialogue *Body adjustment* to alter position and orientation of the body coordinate system. Please refer to chapter 9.6 on page 113 for more information.

⇨ How do I define a name for a target?

Go to *Tracking* → *Body Administration (F8)*. Double-click into the name field and enter a name for the respective body. Please refer to chapter 9.4 on page 95 for more information.

⇨ I cannot increase the number of targets anymore.

The maximum number of target slot to be configured and calibrated is 70 (not including ***Flystick2/2+*** , ***Fingertracking*** and Measurement Tool devices).
Starting with ***DTRACK4*** a new license model has been established.
You may simultaneously activate and track up to 70 activated targets using the universal license.

Please refer to table 7.2 on page 61 for a complete license overview.

⇨ How shall I evaluate the body calibration results?

Verify that all markers of the target have been recognized during the ***DTRACK4*** body calibration. Further, you may check if the single distances between the markers are correct (refer to chapter 9.5.5 on page 109).

As a special service you may send us the calibration file and we are going to check it.

13.8 Tracking

⇨ My target (active or passive) is not recognized sporadically or only partly or even not at all.

- Go to *Hardware* → *Cameras* and tick the checkbox '*modulated flash*'. Alternatively select the ones that have unobstructed view of the whole tracking area. Furthermore all cameras with activated *modulated flash* have to be assigned to syncgroup #1 ! ***AT7-80*** , ***AT7-50*** , & ***ARTTRACK6/M*** systems may be configured via software.
- Also, take into account that the distance between active target and cameras should not the tracking range of the camera model.
- Active targets cannot be used near or in front of plasma screens. The IR emission of the plasma screen overdrives the IR receiver in the active target. See also the FAQ section: Operation near plasma screen.
- Please perform a new room calibration.
- Double-check if the marker surface is not dirty or dusty and that it doesn't appear to be worn out.

⇨ Tracking does not work.

- Please make sure that the measurement has been started and that the target is within tracking range of the cameras.
- If marker recognition is poor then increase the flash intensity.
- Check the number of markers that are used for calculation. If all markers of the target are seen by the cameras, but some are not used for calculation, then execute a new room and body calibration.
- Go to *Tracking* → *Output*. Define a receiver for the tracking data and configure the type of data to be transmitted.
- Activate the tracking functionality within your graphics application.

⇨ I'm having too many heavy reflections.

- Please double-check that the flash intensities of the cameras are not too high. In general, a flash intensity of approx. 50 % might be sufficient.
- Make sure that no other strong infrared radiation sources (e.g. sunrays or halogen lamps) are present in the tracking volume. If they cannot be removed you may use the reflex suppression feature of ***DTRACK4*** .

- If mutual blinding is possible please either try to adjust the cameras differently or try to arrange them in different syncgroups.

⇨ Does *DTRACK4* send data if no target is being tracked?

No tracking data is sent except for the frame number ('*fr*').

⇨ The application PC does not receive tracking data.

- Go to *Tracking* → *Output*. Define a receiver for the tracking data and configure the type of data to be transmitted.
- Check the network connection physically and try to address the ***DTRACK Backend Service*** PC with a 'Ping'.
- Double-check whether a firewall is blocking communication.
- Activate the tracking functionality within your graphics application.

⇨ May I use passive and active targets at the same time?

Yes, of course, there are no restrictions on using passive and active targets simultaneously.

⇨ I am moving my target upwards but within the *2D Monitor* it moves downwards.

The camera is set to display data upside down. In the *2D Monitor*, right-click on the respective camera window and disable *Display upside down*.

13.9 Flystick

⇨ The *ART* radio transceiver cannot be found.

Please make sure that the ***ART*** radio transceiver is plugged in. Then, simply press '*F2*' in order to perform a search for new hardware. The radio transceiver should be detected now.

⇨ My *Flystick2/2+* is not listed under the available Flysticks list.

- Make sure that the battery is charged. Press any button of the ***Flystick2/2+*** and the orange status LED should be switched on.
- Go to *Hardware* → *ART Radio Info* to see if the ***ART*** radio transceiver has been recognized.
- Go to *Hardware* → *ART Radio Info* → *Show details* and set the channel number manually.

⇨ Why is the pressing of the *Flystick2/2+* buttons not recognized (within *DTRACK4*)?

- Make sure that the battery is charged. Press any button of the ***Flystick2/2+*** and the orange status LED should be switched on.
- Double-check whether the button pressed events are recognized by ***DTRACK4*** . Therefore:
  - enable the Flystick Display (*View* → *Flystick*)
  - blue rectangles should light up on each button pressed event in the Flystick Display.
- Go to *Hardware* → *ART Radio Info* to see if the ***ART*** radio transceiver has been recognized.
- Go to *Hardware* → *ART Radio Info* → *Show details* and set the channel number manually.
- Go to *Tracking* → *Flystick* and assign your Flystick (to be found in the available Flysticks list) to any '*Flystick ID*'.

⇨ Why is the pressing of the *Flystick2/2+* buttons not recognized (within the graphics application)?

- Make sure that the battery is charged. Press any button of the ***Flystick2/2+*** and the orange status LED should be switched on.
- Go to *Tracking* → *Flystick* and assign your Flystick (to be found in the available Flysticks list) to any '*Flystick ID*'.
- Go to *Tracking* → *Output* and check if the data output is configured correctly:
  - data receiver defined ('*send to*'),
  - identifier '*6df2*' selected,
  - if you are using the legacy *old output format*: identifier '*6df*' selected.

⇨ What is the maximum number of *Flystick2/2+* to be used simultaneously?

type	max. number
Flystick2	5
Flystick2+	5

Please double-check that the targets of the ***Flystick2/2+*** , that are used simultaneously, are not identical. If in doubt please contact ***ART*** .

⇨ What is the MultiUser option for *Flystick2/2+* ?

The MultiUser option is an enhancement especially for VR/AR applications when working with more than one ***Flystick2/2+*** .

Please refer to chapter 9.7 on page 118 for more information.

⇨ The Flystick output data is not transmitted.

- Make sure that the ***Flystick*** is activated by pressing an arbitrary button.
- Go to *Tracking* → *Output* and check if the data output is configured correctly:
  - data receiver defined ('*send to*'),
  - identifier '*6df2*' selected,
  - if you are using the legacy *old output format*: identifier '*6df*' selected.

13.10 Fingertracking

⇨ The *Fingertracking* hand target is not recognized sporadically or even not at all.

- Make sure that the battery is charged and the hand target is switched on.
- Go to *Hardware* → *Cameras* and tick the checkbox '*modulated flash*'. Alternatively select the ones that have unobstructed view of the whole tracking area. Furthermore all cameras with activated *modulated flash* have to be assigned to syncgroup #1 ! ***AT7-80*** , ***AT7-50*** , & ***ARTTRACK6/M*** systems may be configured via software.
- Increase the brightness of the LEDs on ***Fingertracking2*** devices. Please refer to the ***ART Hardware Installation Guide*** → *System setup* → *Interaction devices*..

⇨ When using Fingertracking, there are always some markers that are flashing alternately in the *2D Monitor*.

This is not bug, but rather it is due to the sequential activation of the finger thimble markers in order to achieve a separation of the fingers.

⇨ What's the meaning of the status LEDs on the Fingertracking hand target?

Please refer to the ***ART Hardware Installation Guide*** → *System setup* → *Interaction devices* for more information.

⇨ What's the maximum number of hands to be used?

You may use two ***Fingertracking*** sets (i.e. four hands) in your tracking system at the same time. However, the targets of the hand devices must be different.

⇨ How do I assign a hand geometry to a hand ID?

Go to *Tracking* → *Fingertracking*. Please refer to chapter 9.8 on page 119 for further details.

⇨ The finger calibration fails. What do I do wrong?

- The configuration dial has to be turned to the proper position. Please refer to the ***ART Hardware Installation Guide*** → *System setup* → *Interaction devices* for more information.
- Go to *Hardware* → *Cameras* and tick the checkbox '*modulated flash*'. Alternatively select the ones that have unobstructed view of the whole tracking area. Furthermore all cameras with activated *modulated flash* have to be assigned to syncgroup #1 ! ***AT7-80*** , ***AT7-50*** , & ***ARTTRACK6/M*** systems may be configured via software.
- Please observe the calibration procedure defined in chapter 9.8.4 on page 126.
- Make sure that you selected the correct handedness and type of fingerset in *Tracking* → *Fingertracking* → *Hand geometry calibration*.
- Double-check that the diffusor spheres (not applicable for ***Fingertracking2***) are not broken or missing.

⇨ The *Fingertracking* output data is not transmitted.

Go to *Tracking* → *Output* and check if the data output is configured correctly:

- data receiver defined ('*send to*'),
- identifiers '*gl*' and '*glcal*' selected.

⇨ Is it possible to upgrade to the 3-finger or the 5-finger version?

Yes, if you are currently using the non-tactile 3-finger version you may also use 5-finger thimble sets and vice versa. Tactile thimbles are available for 3 fingers only. Please contact ***ART*** to receive more information.

13.11 Measurement Tool

⇨ I'm using the *Measure Points* tool but I cannot measure any points.

Please check whether both, the Measurement Tool and the Measurement Tool reference body (if assigned), are tracked.

⇨ It is not possible to perform a tip calibration.

Please check whether both, the Measurement Tool and the Measurement Tool reference body (if assigned), are tracked.
Then, try to keep the tip in the same position while doing the tip calibration. Therefore, tilt the Measurement Tool in both room directions, not only in one direction (i.e. left and right, as well as back and forth). When rotating around one axis only, a tip position cannot be defined.

13.12 Active Targets

⇨ Operation near plasma screen

A plasma screen is a very strong IR source which overdrives the IR receiver in the active target (e.g. ***Fingertracking***). Thus, active targets may not work properly near plasma screens. If possible use passive targets as alternative.

⇨ Shutter glasses

Due to the Windows based service architecture, external trigger units, e.g. projectors or graphics cards as well as shutter glasses that need synchronisation are not supported.

13.13 Radio transceivers used in *ART* products

⇨ Can *ART* radio transceivers pose any security issue ?

Radio transceivers for ***Flystick2/2+*** , Measurement Tool or ***Fingertracking2 Tactile*** use a protocol based on IEEE 802.15.4 which was developed in-house at ***ART*** specifically for these devices. The protocol is proprietary, no other devices should work with this protocol. The design of all interaction devices by ***ART*** ensures that use of this protocol is limited to transfering measurement data (like button-pressed events) and configuring devices.

A Technical specifications

☞ **The specifications are subject to change without notice.**

A.1 Overall system

System parameters	
number of cameras	2 - 80
max. number of targets	70
max. number of hands	4
max. number of Flysticks	
- Flystick2	5
- Flystick2+	5
- Flystick3	2
Scalability	***ARTTRACK*** system: fully scalable (2 - 80 cameras)
Accuracy	
- of the timestamp	based on ***DTRACK4*** backend: $\Delta t_{err} \sim \pm 1ms$

Compatible shutter glasses
none for ***DTRACK4***

DTRACK Backend Service	
System requirements	
- Free disk space	$\geq$ 200MB
- Processor	Intel: $\geq$ Core i3-13100T AMD: $\geq$ Ryzen 5600X
- RAM	$\geq$ 16GB
Operating systems	Windows 11 Pro 64 Bit Windows 10 Pro 64 Bit

DTRACK4 Frontend	
System requirements	
- Free disk space	$\geq$ 200MB
- Processor	min. requirements for Windows 10 / 11 compatibility
- RAM	min. requirements for Windows 10 / 11 compatibility
Operating systems	Windows 11 64 Bit Windows 10 64 Bit

Used IP ports in *DTRACK4*

backend		frontend	purpose
TCP 50105	$\leftrightarrow$	TCP dynamic	general communication

UDP 50105	↔	UDP dynamic	general communication
UDP 50107	→	UDP dynamic	measurement data (6DOF, timestamps, etc.)
backend		user's application (e.g. DTrackSDK)	purpose
TCP 50105	↔	TCP variable	remote commands (optional)
UDP 50107	→	UDP user-defined (default: 5000)	measurement data (6DOF, timestamps, etc.)
UDP 50110	←	UDP variable	control commands (optional; for ***Fingertracking2*** ***Tactile*** or ***Flystick*** feedback devices)

'dynamic' port	defined by the OS; can be among all local ports within the accessible range of the OS (i.e. from the pool of 'registered ports' in Microsoft WINDOWS)
'variable' port	arbitrary, by design of the user's application
'user-defined' port	defined from within the frontend (Menu *Tracking* → *Output*)

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