MagVenture TMS Atlas™
- Neuro Navigation System

Quick guide

MagVenture
Research. Treatment. Results.

At the time of printing, this manual correctly described the device and its functions. However, as modifications may have been carried out since the production of this manual, the system package may contain one or more addenda to the manual. This manual including any such addenda must be thoroughly read, before using the device.

The following situations void any guarantee and obligations for Tonica Elektronik A/S:
- The device is not used according to the enclosed manuals and other accompanying documentation
- The device is installed or modified by persons other than Tonica Elektronik A/S or other authorized service technicians.

Version 3.7

Contents

Safety Information

Safety requirements

The following precautions need to be followed to guarantee safe and consistent use of the MagVenture TMS Atlas Neuro Navigation System and its components.

The MagVenture TMS Atlas Neuro Navigation System is designed to be used as an accessory for the MagVenture TMS Therapy system. Please refer to the instructions for use for the other devices for a description of safety requirements.

Warnings

- First inspect the BrainTRAK electronics unit and cables/connectors for visible damage, and in case of damage abort the session.
- Use of accessories, transducers and cables other than those specified or provided by the manufacturer of this equipment could result in increased electromagnetic emissions or decreased electromagnetic immunity of this equipment and result in improper operation.
- When using automatic marker placement, always carefully check that the markers were placed in the correct position. Automatic marker placement is only approximate.
- The popular targets available in the MagVenture TMS Atlas Neuro Navigation software are based on the available literature. You should always consider which target to stimulate for which purpose.
- Always make sure that the imported fMRI activation map is already co-registered with the anatomical scan that you have selected. The fMRI activation maps are not automatically registered.
- Reproducible coil placement is purely intended to reproduce a previously recorded coil position and orientation, and is not considered an accurate method to navigate to a brain area. For that purpose, an MRI scan is needed.
- No unauthorized modification of this equipment is allowed. Especially modifications of the position tracker (BrainTRAK) can result in hazards for the user and the patient.
- The MagVenture TMS Atlas Neuro Navigation System should not be used on or used by persons with a pacemakers or other active implanted cardiac devices.
- When power is applied or the tracker is running, do not open the cover and touch exposed electronic components. Contact with exposed components could cause injury.
- Make sure to proceed cautiously when the tip of the pointer is close to the skin, otherwise you could injure the patient.
- When moving the pointer close to the eyes one should be really cautious to avoid damage to the cornea of the patient's eye caused by the tip. Ask the patient to close the eyes at that point.
- Use of this equipment adjacent to or stacked with other equipment should be avoided because it could result in improper operation. If such use is necessary, this equipment and the other equipment should be observed to verify that they are operating normally.
- Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm (12 inches) to any part of the system, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result.

Cautions

- Sensors and cables are fragile, always handle them with care and avoid cable stress.
- Always clean the pointer and sensor headband after use.
- Always visually inspect the skin of the patient. Do not use the pointer on damaged skin.
- The electronics unit, associated cables and connectors, sensor headband and the pointer should be inspected for damage before each use and cannot be used in case of damage.
- Ensure the coil is placed with the coil surface tangent to the scalp.
- Ensure that the head sensors do not move after having taking measurements on the patient e.g., when placing the vacuum pillow.
- Low quality readings imply there is a source of distortion nearby (such as pure iron, an electromotor, or the like), or that the sensor has been damaged.
- Do not stimulate in close proximity to one of the sensors in the sensor headband. It is possible to disconnect one sensor and only

use the other sensor for head movement compensation.

- Do not add your own extension cables or connectors, you will compromise performance and void both regulatory approvals and your warranty.
- To prevent infection due to contaminating substances originating from previous patients, make sure to clean the pointer properly before re-use.
- The intensity, duration, frequency and moment of TMS administration is the sole responsibility of the operator. Always consult the instructions for use of the TMS device before operating it.
- To avoid the risk of electric shock, this equipment must only be connected to a power supply main with protective earth.
- Do not use power extension cords to connect the electronics unit, but always a wall mounted power outlet with protective earth.
- Keep the transmitter, sensors, and cables away from sources of heat.
- Patients and operators should not be closer than 10 cm to the center of the transmitter during operation.
- Always provide adequate ventilation if mounting the transmitter inside an enclosure.
- Never power up the system or place the transmitter in an explosive atmosphere.
- Never look away from the patient while measuring facial landmarks.
- The MagVenture TMS Atlas Neuro Navigation System is not recommended to be used in environments of high EM disturbance such as near HF equipment or in the RF shielded room of a system for MR imaging. Please see additional details regarding the appropriate EM environment to use at the end of this document.
- When essential performance due to EM interference is lost, the consequence will be inaccurate navigation.
- Federal (United States) law restricts this device to sale by or on the order of a licensed practitioner.

Intended use

- The MagVenture TMS Atlas Neuro Navigation System is a neuronavigation system indicated for accurate positioning of the treatment coil of the MagVenture TMS Therapy system with respect to target brain regions based on data obtained from MRI measurements.
  Specifically, the MagVenture TMS Atlas Neuro Navigation System is indicated for use with the following MagVenture treatment coils manufactured by Tonica Elektronik A/S: C-B60, Cool-B65, Cool-B70, Cool D-B80, MCF-B65, MCF-B70, and C-B70.

Waste management

- The European Union has issued a directive, known as the WEEE (Waste Electrical and Electronic Equipment) Directive, to protect the quality of our environment by reducing the amount of electrical equipment waste buried in landfills. WEEE focuses on the recycling and reuse of “equipment that depends on an electronic current or an electromagnetic field to operate and as equipment for the generation, transfer and measurement of such currents and fields.” Although none of the MagVenture TMS Atlas Neuro Navigation System's components are hazardous materials, proper disposal is important, especially, in the European Union where these components cannot be consigned to a landfill. Wherever available, tracker components should be brought to centralized recycling and collection points. Please contact the manufacturer for further instructions on the correct disposal procedures in your country.

Introduction to the Atlas system

The Atlas system is a tool for navigating structural MRI images with overlaid functional MRI maps after they are registered to the physical space of a patient's head.

The Atlas system enables an operator to spatially match a patient's MRI data with the physical head shape and position.

The Atlas system supports head-tracking and compensation for head movements during neuronavigation. This way, the patient's head can move during navigation, and the software will take this into account, show it on the screen and alert the operator that the coil must be moved to keep accurate neuronavigation.

Your navigation system should be assembled and installed by a qualified service engineer from MagVenture or an authorized partner.

Components of the MagVenture TMS Atlas Neuro Navigation System

The complete Atlas system package consist of:

MagVenture TMS Atlas Neuro Navigation System components

1. BrainTRAK
2. Navigation trolley
3. Medical grade PC all in one
4. Transmitter
5. Keyboard and mouse
6. Remote
7. Pointer and sensor
8. Head sensor band and sensors
9. Navigation clamp and sensor

MagVenture TMS Therapy system components

- A Stimulator
- B Patient Management System 360
- C Flow Arm (or Super Flex Arm)
- D Treatment chair
- E Trolley
- F Vacuum pillow
- G Cap
- H Coil
- I Vacuum pump
- J Isolation transformer
- K Coil Cooler

The complete Atlas Navigation System must be powered from MagVenture Isolation Transformer 230V~ outlet.

How to use the Atlas system

Preparation

In this section, the configuration of the Atlas system is described.

Start by switching on your BrainTRAK unit.

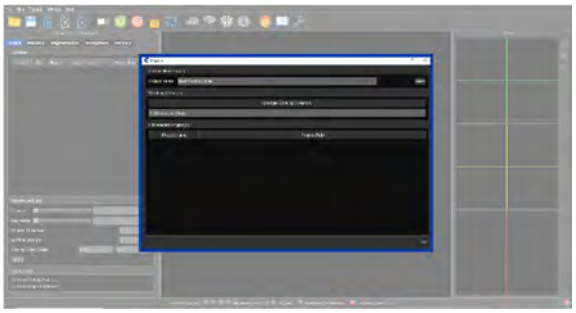
Accompaning the system is a printout of the account Atlas User and password. This account should be used to log into the PC and run the Atlas application.

The Atlas Admin account is exslusivly for MagVenture service personell.

Create project

When you start the Atlas system, a dialog box named Projects will open.

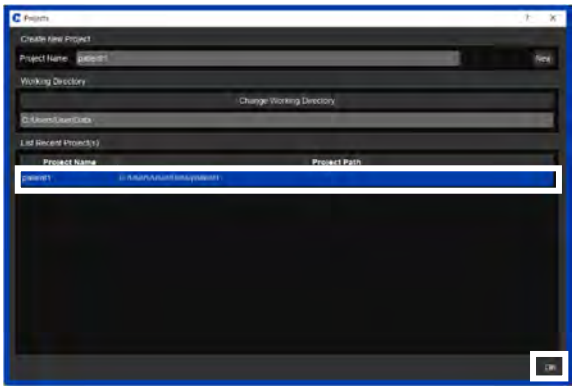
Here you can add a new project.



Name the new project and select the working directory; this is the directory on your PC where all project files will be saved.
Note: To maintain patient confidentiality when using the software; do not enter Protected Health Information in any text fields, including in the project names. Always use project names that are anonymized.

Then press OK.

The next time you open the Atlas system, you can select the project in the list, and press OK. The project file will open again.

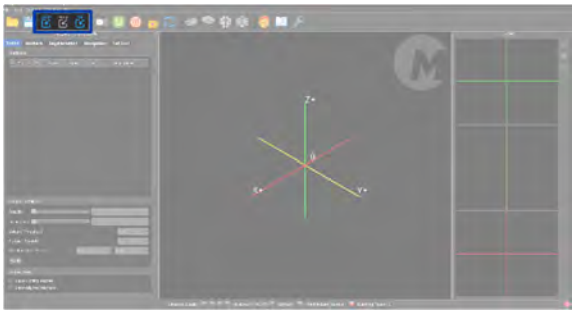


Insert USB stick

Insert the USB stick in the USB port on the left side of the Atlas screen. For more information on using encrypted USB sticks, see page 79.

Load image volumes

Open your project as described above and load image volumes by selecting one of the icons in the taskbar.

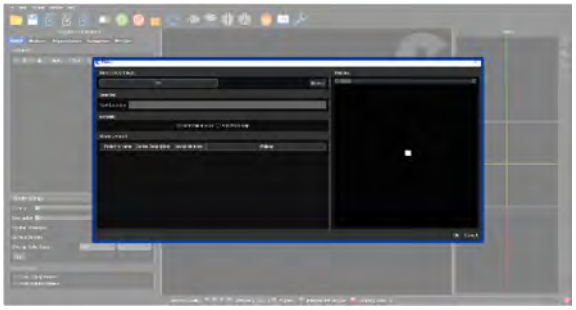


Alternatively, image volumes can be loaded by selecting File in the main window and selecting a data format, see File Menu on page 30.

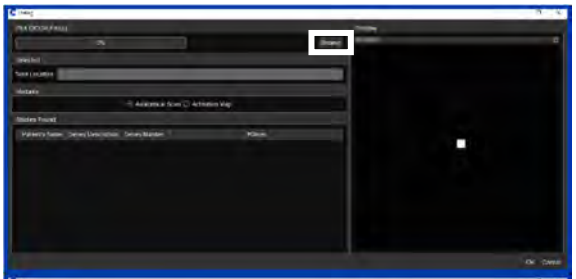
In the following the DICOM (DCM) workflow is demonstrated. For Nifti (NII) workflow, see page 48.

More details regarding the data type and format you need to provide for neuronavigation can be found in Required (f)MRI data on page 83.

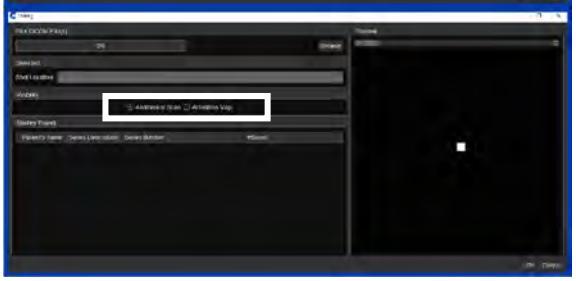
When an icon is clicked or when a selection is made from the file menu, a dialog box pops up.



Click Browse and select your DICOM folder. The import starts automatically.
Note: The files will not be visible within the folder; therefore, you should select the location of the data, not the individual files.



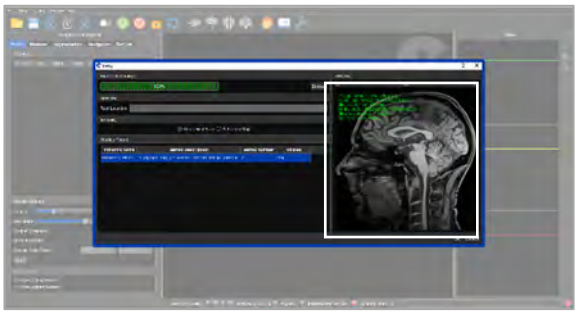
After the importer has scanned all your DICOM files, select Anatomical Scan, and click OK.

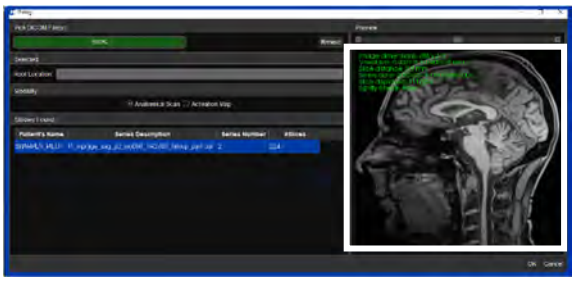


Once the data is loaded, it is automatically converted to a surface representation. The resulting surfaces will be visible in the main window when the slices are selected.

Select the images and press OK to continue.

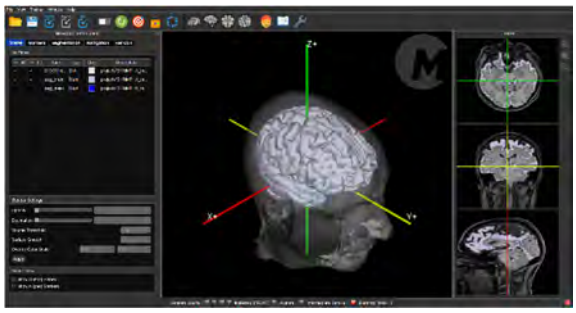
The system will, as a default, automatically perform brain segmentation. For more information, see page 50.





Set facial markers

To spatially register a patient's real head to the MRI dataset, the Atlas system relies on the correct setting of markers on the skin rendering representing certain facial features. Good facial features should be recognizable on the MRI skin rendering as well as on the real skin of the patient.



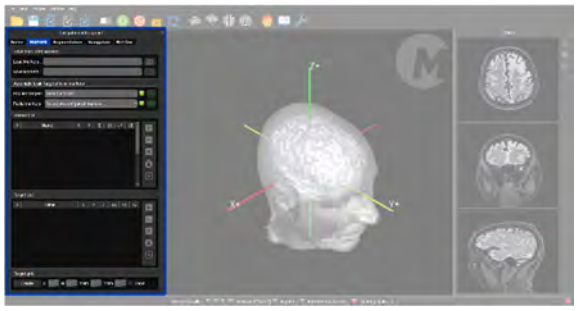
Start by setting the preferred skin opacity, see page 62.

There are two possible ways of setting the markers. This section describes how to set the markers automatically.

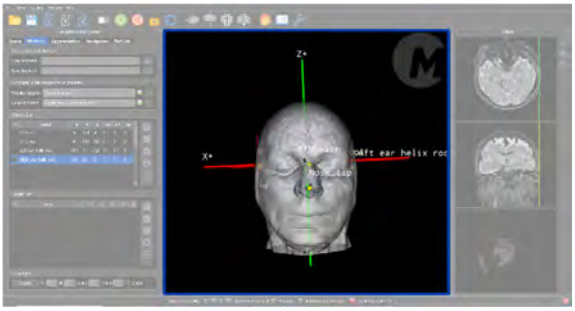
For manual marker placement, see Create manual markers on page 66. For more information on how to create and move markers, see Software user interface on page 27.

Choose a marker set in the 'Facial Markers' drop-down menu inside the 'Automatic brain targets/facial markers' in the Markers tab.

After choosing the marker set, press the green arrow. The markers will then automatically be placed in the correct location.
WARNING When using automatic marker placement, always carefully check that the markers were placed in the correct position. Automatic marker placement is only approximate.



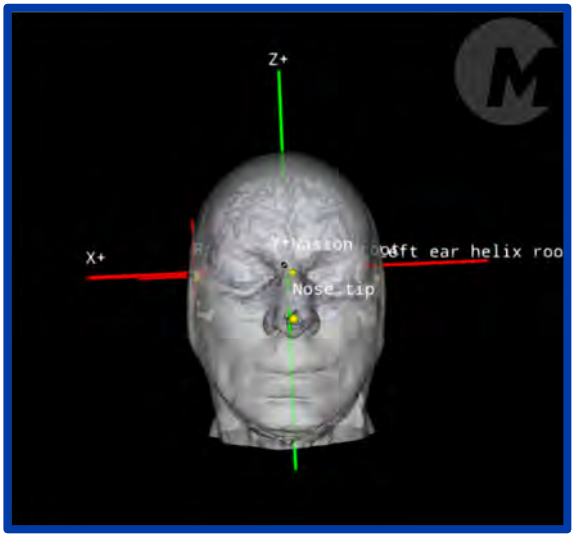
The markers are shown with yellow spheres representing the exact marker placement as well as with a text describing the marker placement.



If the markers are not placed correctly, you can grab them by clicking them with your mouse and dragging them to the correct position.

When placing the markers, the head can be rotated by clicking on it with the mouse and dragging it in the desired direction while pressing (and holding) the left mouse button.

Moving the mouse while pressing the right mouse button or using the mouse wheel will zoom in or out. To set the image in a certain way you can also use the four icons in the taskbar: Oblique. Sagittal, Axial or Coronal view of the 3D image, see page 29.



When marker placement is finalized, the markers are locked using the padlock symbol. See more on page 29.

Setting target for TMS therapy

Setting a target for the TMS therapy session works identically to setting markers as described above.

A target can be automatically placed by choosing the target in the 'Popular targets' dropdown menu in the Markers tab.

After choosing the target, press the green arrow. The target will then automatically be placed.

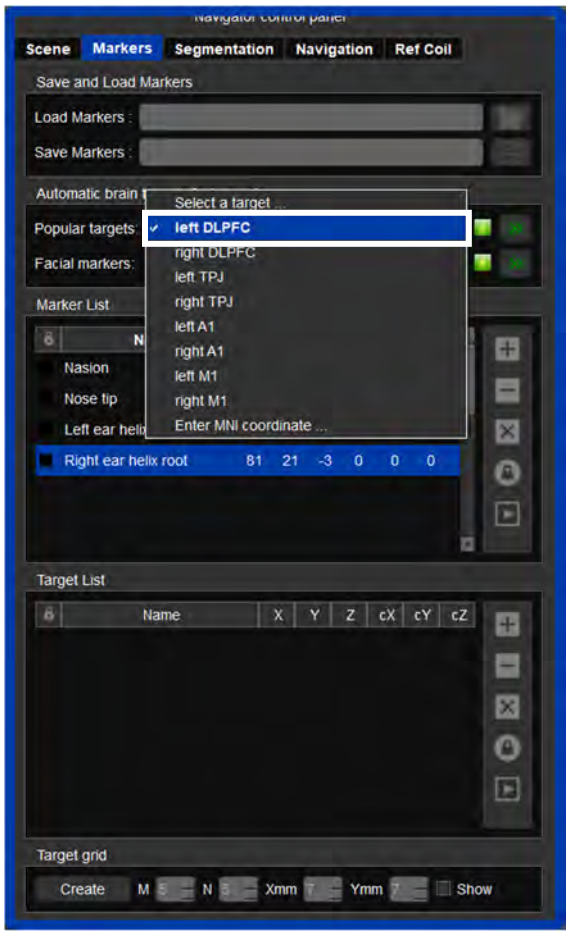
Before proceeding, lock the target using the padlock symbol. See more on page 29.

WARNING The popular targets available in the MagVenture TMS Atlas Neuro Navigation software are based on the available literature. You should always consider which target to stimulate for which purpose.

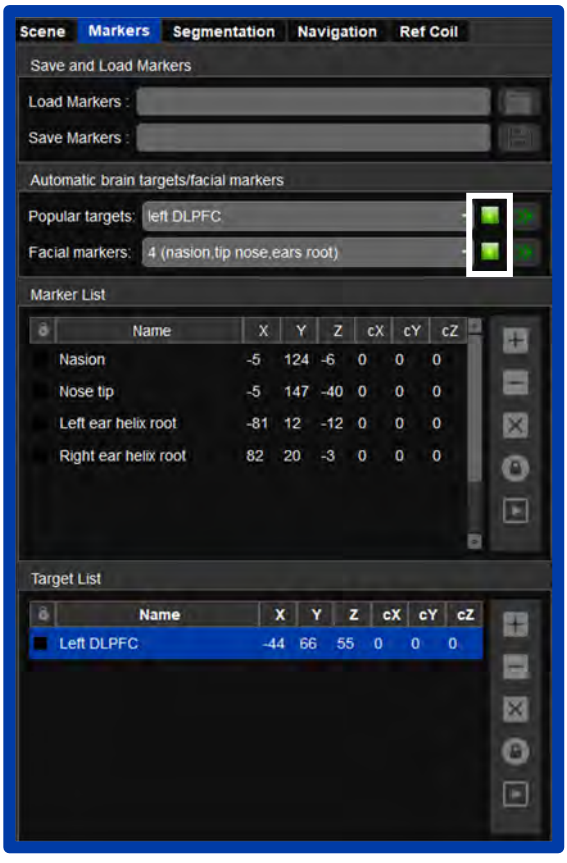
WARNING When using automatic marker placement, always carefully check that the markers were placed in the correct position. Automatic marker placement is only approximate.

The size of the targets can be changed by opening the application settings graphics tab. See more on page 35.

Please note that the target coordinates are not used to determine the spatial registration transformation. Targets only serve as visible landmarks to guide your coil during navigation.

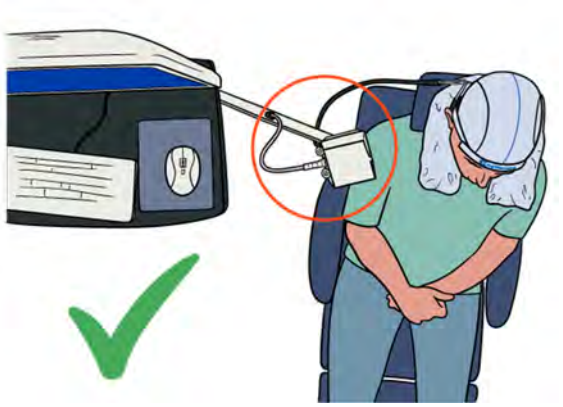


Please ensure that the boxes next to the dropdown menus for both markers and targets are green before commencing, indicating that MNI (Montreal Neurological Institute) co-registration has been completed successfully.



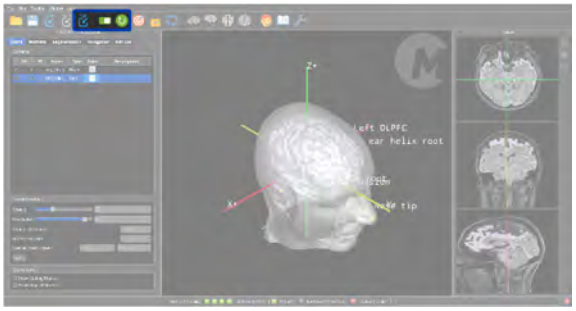
Patient arrival

Before beginning the TMS session, it is important to ensure that the patient is comfortable and properly prepared. Once the patient has arrived, you can continue the workflow.



The transmitter should be placed to the side in front of the chair.
Note: The Atlas system is earth protected; however, the patient should avoid touching the system.

Initialize the 'Tracker' by pressing the symbol in the top bar.

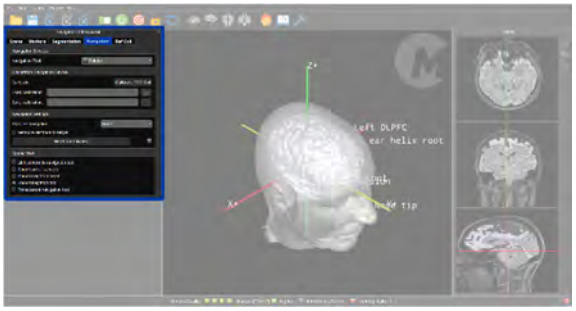


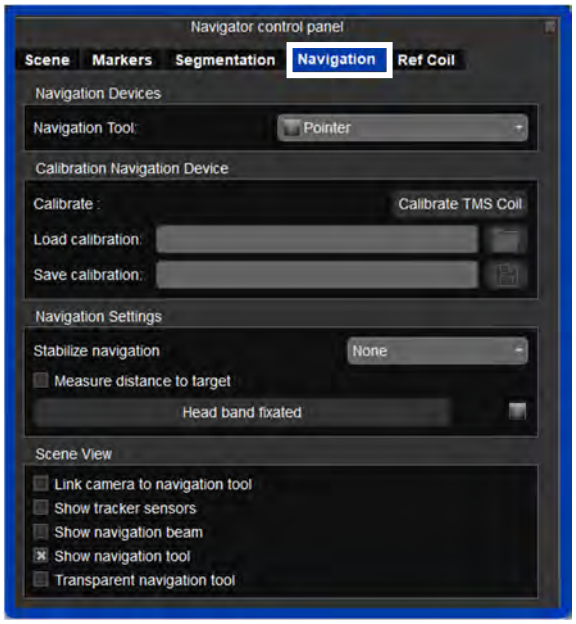
It is also possible to initialize the tracker from the Tracker menu, see more on page 41.

Wait for the initialized indicator in the status bar at the bottom of the screen to stay green. For more information see page 46.

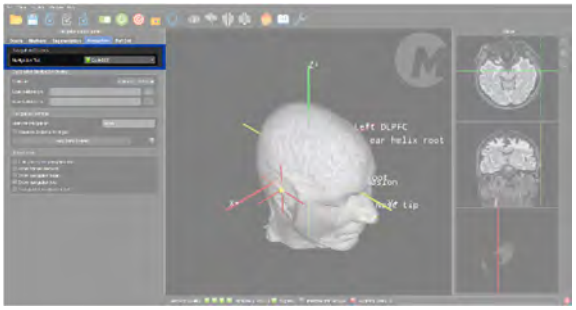
In case of unforeseen issues during initialization, check the event log to determine if the tracker was initialized correctly. For more information, see page 46.

In the control panel, go to the Navigation tab.





Select your coil from the Navigation Tool drop-down menu.



Before you can use the coil for navigation, you must let the software know where the tracking sensor is with respect to the coil isocenter (maximum magnetic field location) that you wish to aim at a predefined brain area. You need to calibrate your coil from the coil surface to do this.

The system is compatible with different coils. An overview of the supported coils can be found on page 87.

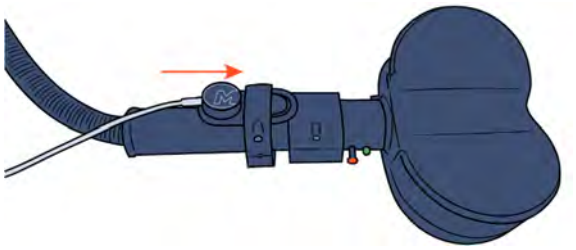
Make sure the coil is not connected to your stimulator during calibration, or that the stimulator is not powered up.

Calibrate the coil

To use head tracking, the system needs four sensors attached:

- no. 1 for the pointer
- no. 2 for the navigation clamp, and
- no. 3 and no. 4 for the sensor headband.

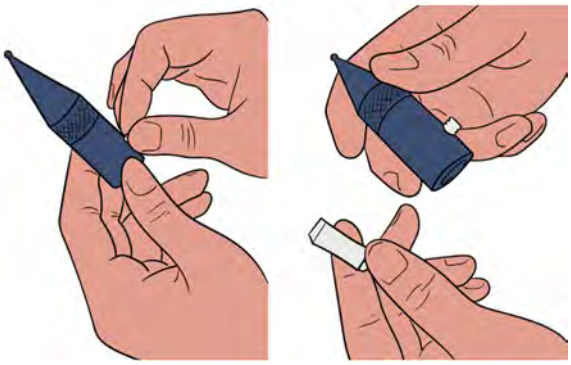
First, insert sensor no. 2 into the navigation clamp.



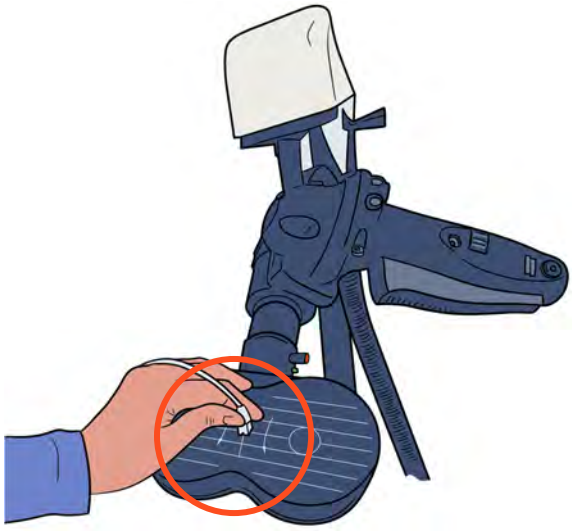
Next, stabilize and fixate your coil for example by using the Flow Arm.

Check that both sensors are green to ensure a good-quality reading. See more on sensor quality on page 64.

Then remove sensor no. 1 from the pointer.



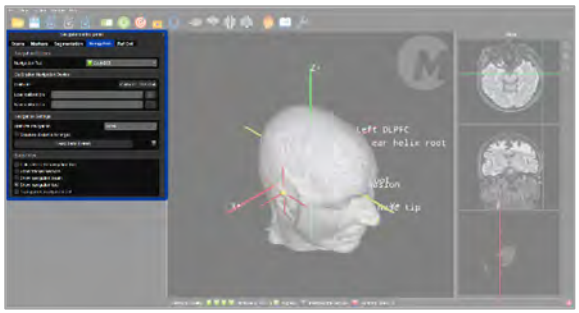
Sensor no. 1 is then placed on the top of and right at the center of the coil.

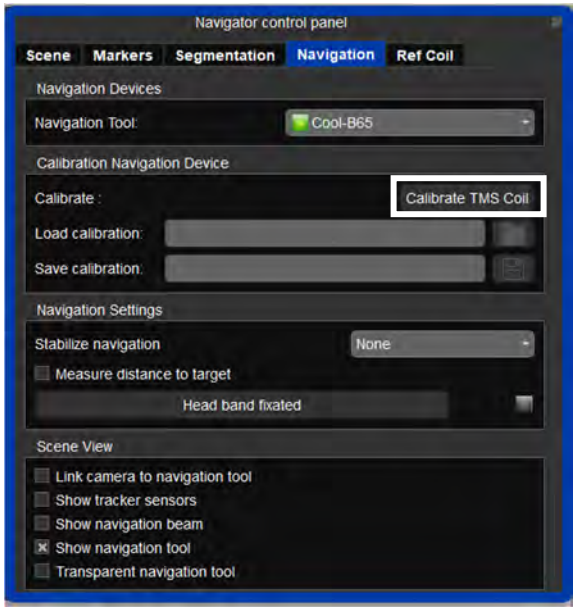


Make sure the small slit on the sensor surface points forwards. That is, away from the coil handle, as in the picture.

Keep the sensor on the coil, open the Navigation tab, go to Calibration Navigation Device, and press the 'Calibrate TMS Coil' button.

Now the coil is calibrated.

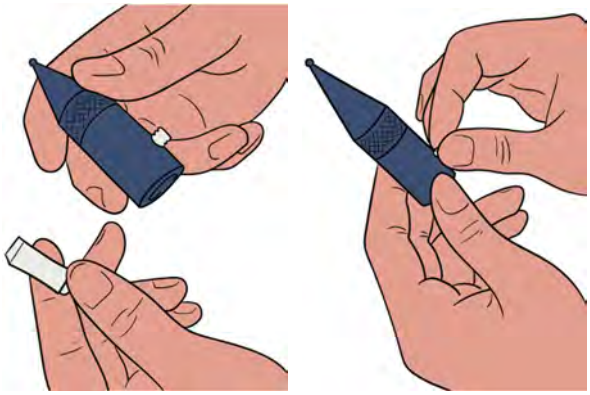


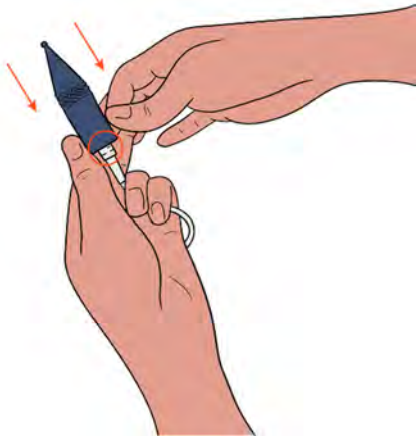


The software will automatically remember the coil calibration parameters when it is reopened.

If you reposition or remove and reattach the navigation clamp attached to the coil handle, you will need to repeat this procedure. The system remembers which coil calibration file you used last and will automatically reuse it.

Reattach sensor no. 1 to the pointer.





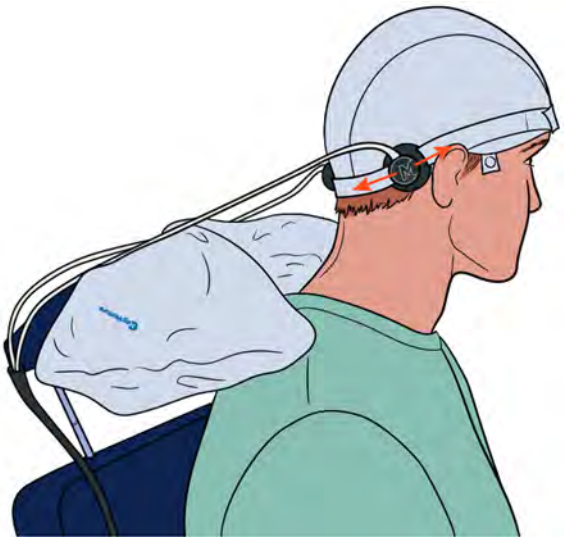
Patient preparation

Start by putting on the patient cap.

Attach the sensor headband.

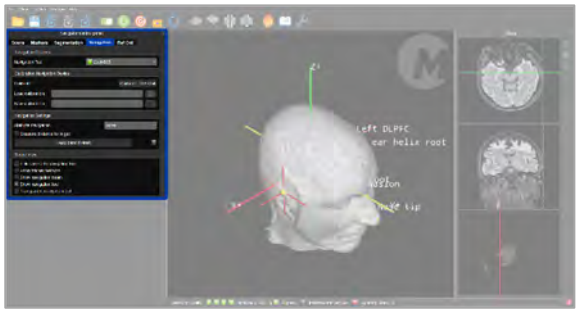
Place the sensors behind the patient's ears, resting on the skull bone away from the stimulation target.

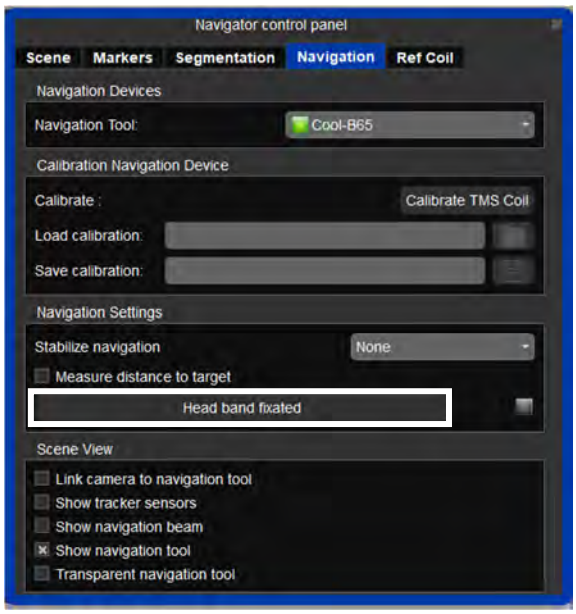
CAUTION Do not stimulate in close proximity to one of the sensors in the sensor headband. It is possible to disconnect one sensor and only use the other sensor for head movement compensation.



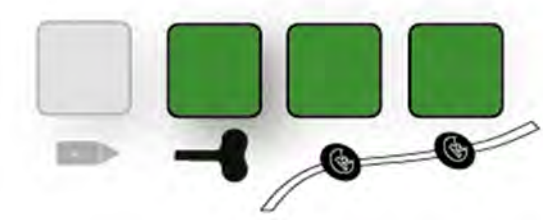
Make the patient comfortable and mold the pillow to not interfere with the sensors or coil.

When the patient is comfortable, and you are ready to continue, go to the Navigation tab and press *Head band fixated*.
Note: Make sure head movement compensation is enabled before proceeding.





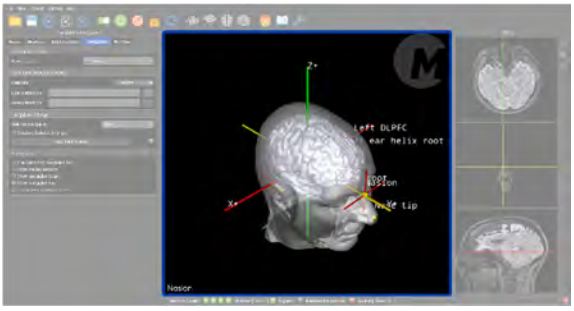
Ensure that coil and headband sensors are green.

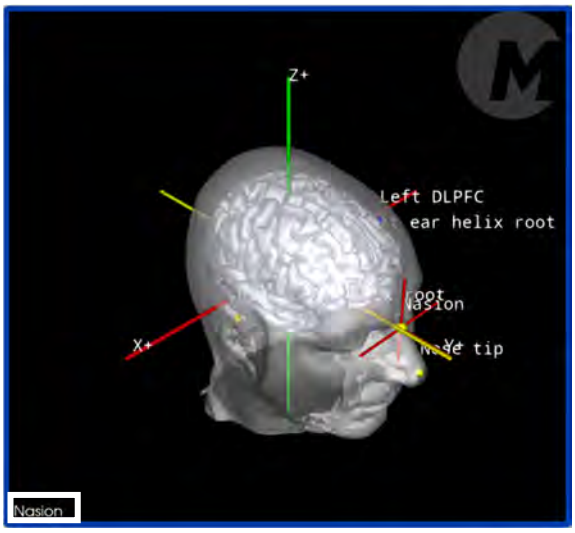


Capturing markers

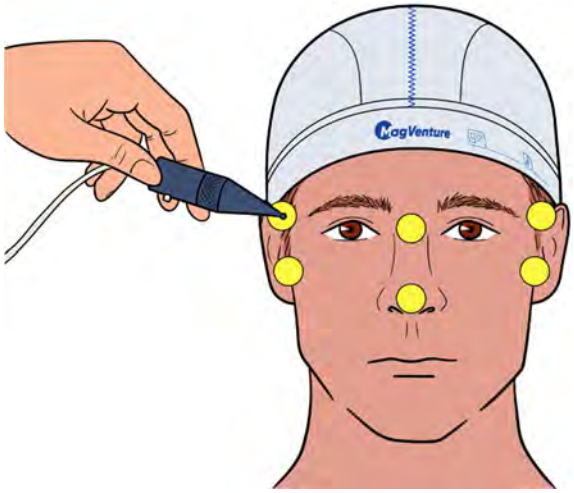
Now proceed to capture markers by pushing the blue button on the remote.

The first marker is now visible in the lower left corner.





Now move the pointer to the selected marker of the patient's head, and hold the small, rounded tip as close as possible to the skin.



WARNING Make sure to proceed cautiously when the tip of the pointer is close to the skin, otherwise you could injure the patient.

When the tip is held at one of the markers (for example the nasion), the coordinates of the tip of the pointer can be 'captured'. The coordinates will appear in the marker list, on the far-right side (you might have to enlarge the marker panel to see it).

WARNING When moving the pointer close to the eyes one should be really cautious to avoid damage to the cornea of the patient's eye caused by the tip. Ask the patient to close the eyes at that point.

To capture, press the remote's right arrow button in your non-dominant hand (the pointer should be in your preferred hand). You will hear a beep from the speakers when capturing is successful, there is no need to look at the screen, and you can focus on your patient.

CAUTION Always visually inspect the skin of the patient. Do not use the pointer on damaged skin.

CAUTION Never look away from the patient while measuring facial landmarks.

The system will automatically move to the next marker in the list. Also capture that marker with the right arrow button. Repeat until all landmarks are captured.

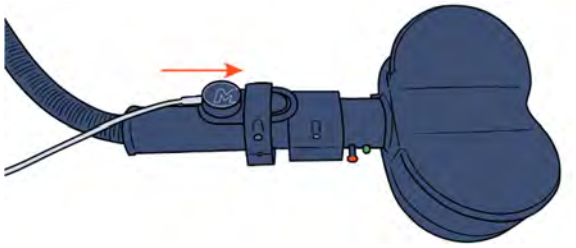
You can go back to the previous marker with the left arrow button.

When all markers are captured, "Alignment SUCCESS with a quality metric of: [xx]" will appear on the bottom left of the screen.

If alignment in unsuccessful, go to Alignment on page 70 for information on how to resolve the problem.

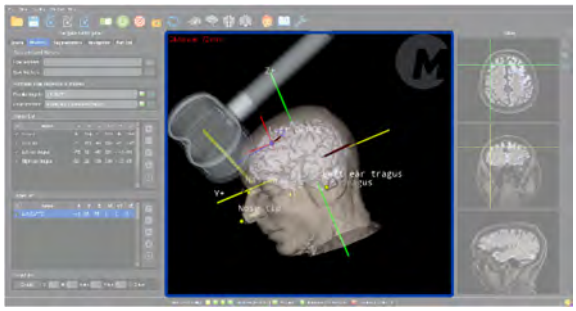
Navigate the coil to the target

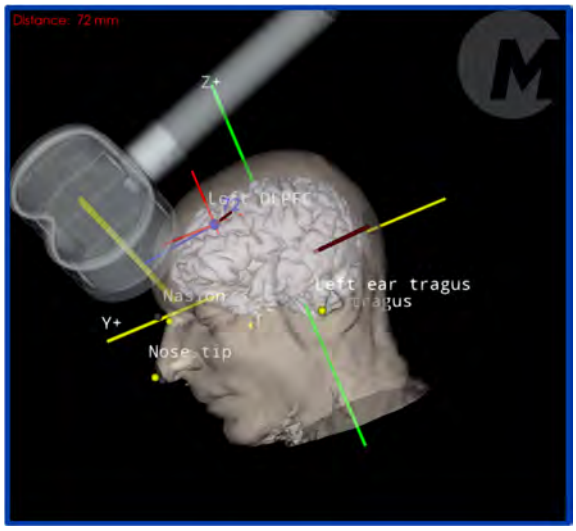
Make sure that sensor no. 2 is inserted correctly in the navigation clamp attached to the coil and that the correct coil is selected in the Navigation Tool dropdown menu.



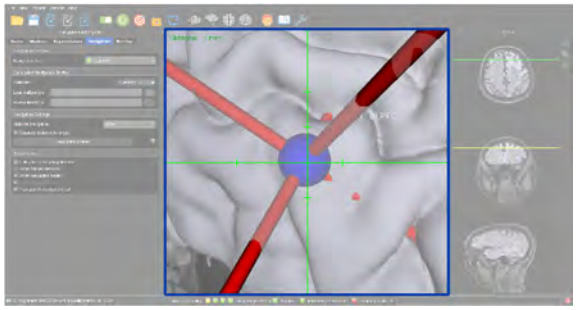
When selecting the coil as your navigation tool, you will see a replica of the coil moving on the screen where you hold the real coil in relation to the patient's head.

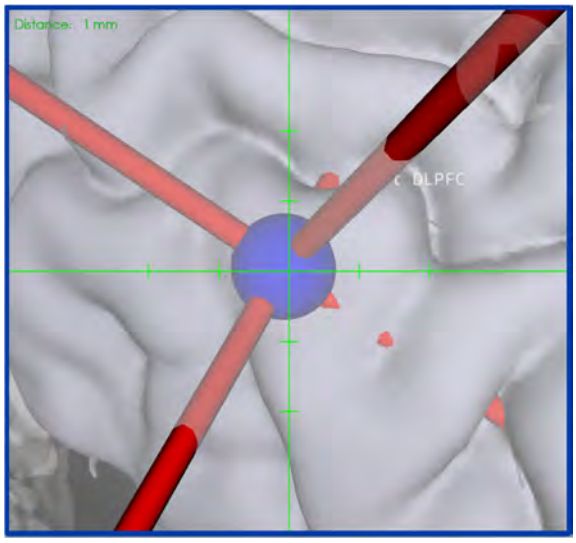
Note that you can either render the coil transparent or opaque through the lower option in the navigation tab. For actual navigation, transparent coils or even hidden coils are most convenient as one can see the area of the brain under the coil.
Note: The location of the yellow rod indicates the location of the TMS pulse.





You can also get a crosshair view head by checking 'Link Camera to Navigation tool' box in the navigation panel's 'scene view' section.

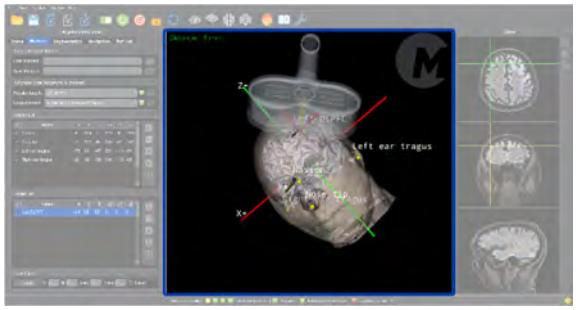


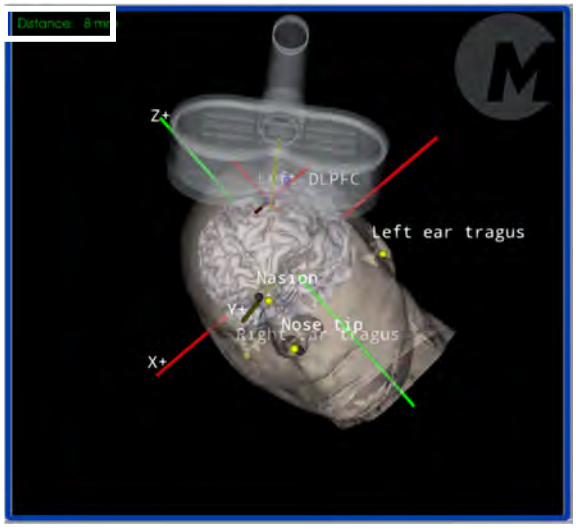


A distance measure can be seen in the upper left corner of the center picture.

If the distance between the target and coil is more than 10 mm, a beep will sound to warn the operator that navigation is now off target.

Before starting treatment, make sure that the coil is placed tangential to the skull.

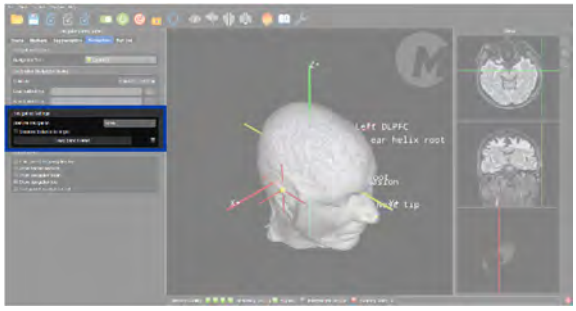


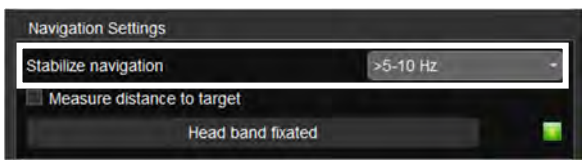


The electromagnetic disturbance by the TMS pulses should be filtered out before starting treatment.

Go to the Navigation tab, navigation settings and select stabilize navigation. Here select the filter settings covering the stimulation frequency.

When the selection has been made, you are ready to start the treatment.



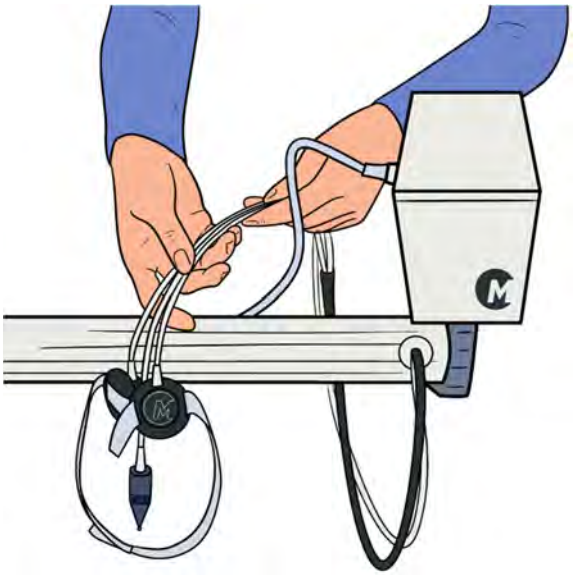


After treatment

When treatment is finished, remove the coil and headband from the patient.

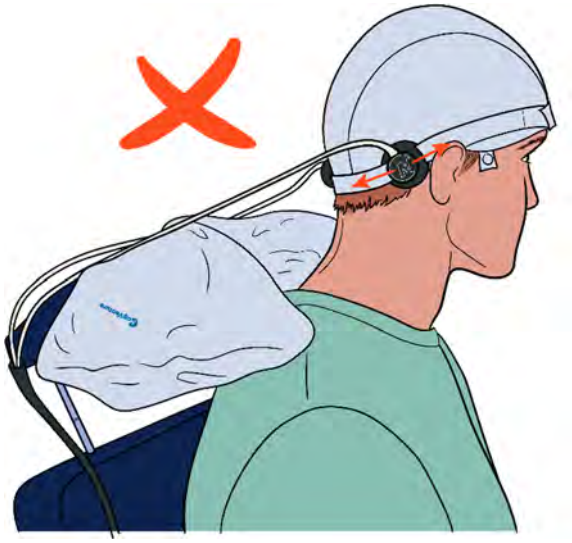
Store the headband on the trolley.

CAUTION To prevent infection due to contaminating substances originating from previous patients, make sure to clean the pointer properly before re-use.

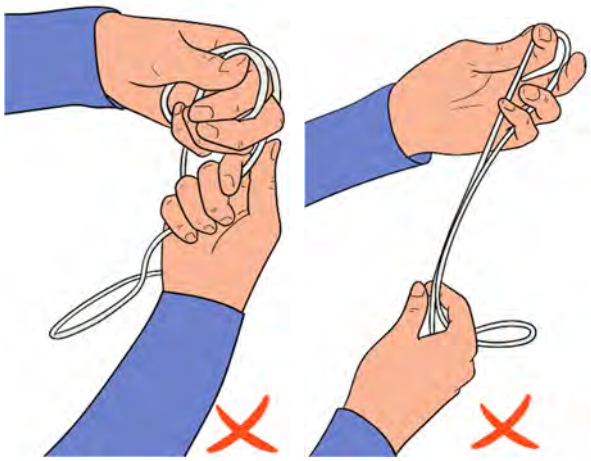


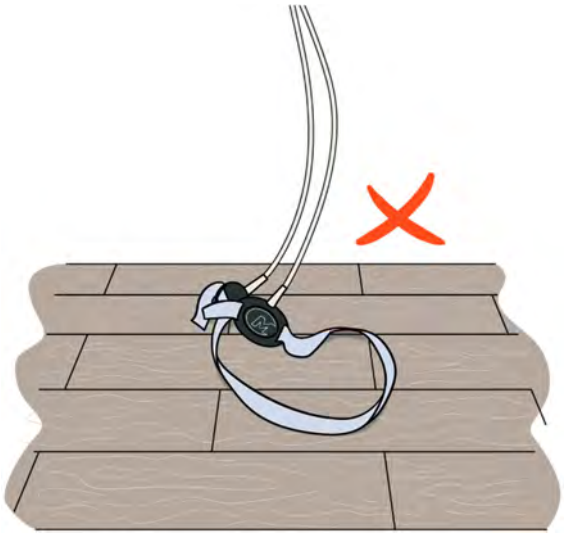
Take care when the patient is leaving the treatment chair. Remove sensors first.

Patients wearing the sensors should not rise unexpectedly or quickly. Avoid placing any weight or pressure on the cables to maximize the life of the sensors.



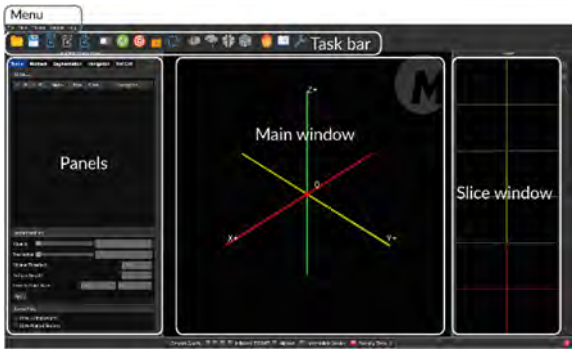
CAUTION Sensors and cables are fragile, always handle them with care and avoid cable stress.





Software user interface

When starting the Atlas system, you will see a main window with coordinate axes, a slices window, a panels section, a menu and a task bar.

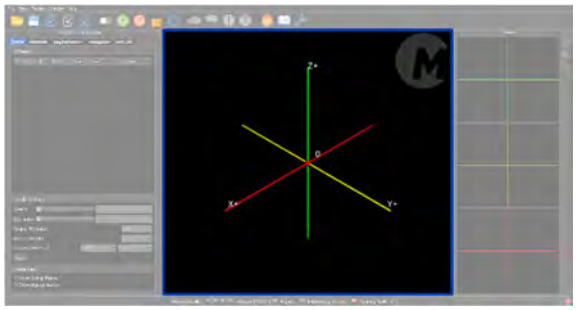


Below, the interface components and their functions are described.

Windows

Main window

This window displays the surfaces of skin, brain, and brain activation based on (f)MRI data.

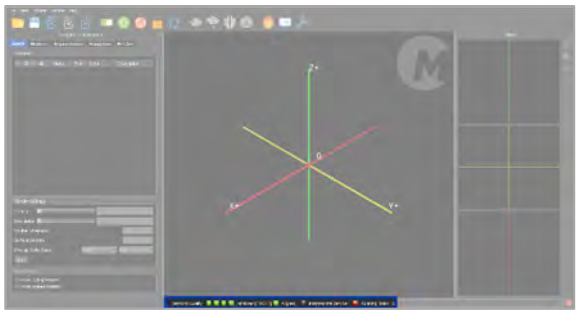


Only the main coordinate axes (red = X-ax, yellow = Y-ax, green = Z-ax) will be visible. The data in the coordinate system can be viewed from different angles.

The view angle can be changed using the mouse:

- Rotate the camera around the origin by clicking the left mouse button and dragging the coordinate axes.
- Zoom in and out by dragging with the right mouse button or operating the mouse wheel.

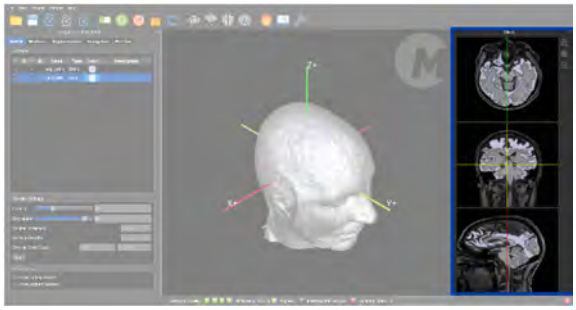
Note that at the bottom of the screen, you can see 'status buttons', indicating the state of the position tracker and navigation system.



It can indicate whether the tracker is initialized and to which tracking hemisphere the transmitter is set, whether the markers are aligned, and it shows the quality of the sensors.

Slices window

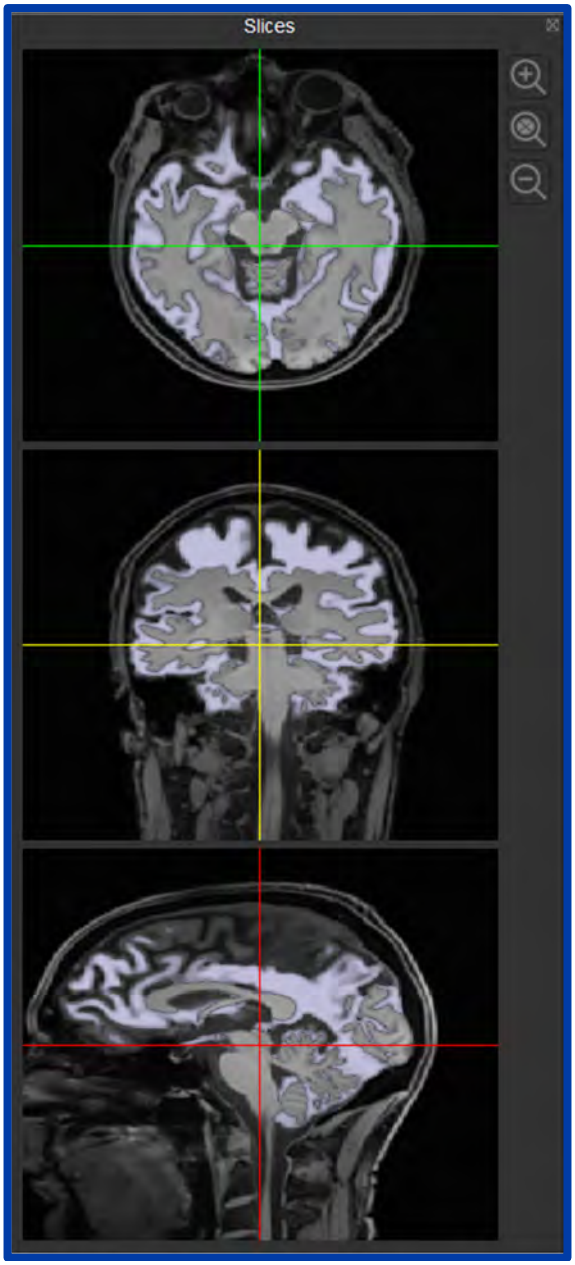
A T1 weighted scan is visible as three 2D slices in the Slices window on the right side when loaded. The 2D slices can be useful when placing craniotopic markers or checking the MRI data.



When you click in the slices, they will change to sections corresponding to the location in the head.

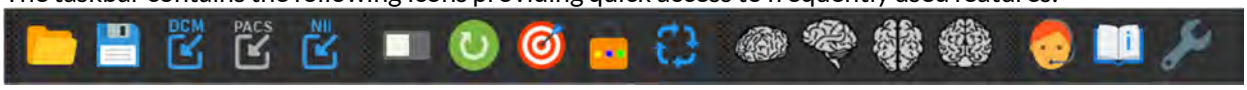
You can zoom in and out using the + and – button and reset the zoom settings by pressing the X in the middle. If you don't want the slices' view to be visible click on the 'x' in the upper right corner.

You can also turn the 2D- slices on and off in the windows menu.



Taskbar

The taskbar contains the following icons providing quick access to frequently used features:



Tracker operations:


Open the project file


Save the project file

Import a DICOM file

Query PACS-DICOM server

Import a Nifti file


Start the tracker


Restart the tracker


Initiate auto capturing procedure


Lock and unlock the location of markers and targets


Fits an MNI space head model to the patient (for reproducibility purposes)

3D view actions:

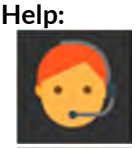

Turns the 3D image to an oblique view.


Turns the 3D image to a sagittal view.


Turns the 3D image to an axial view


Turns the 3D image to a coronal view.

Help:



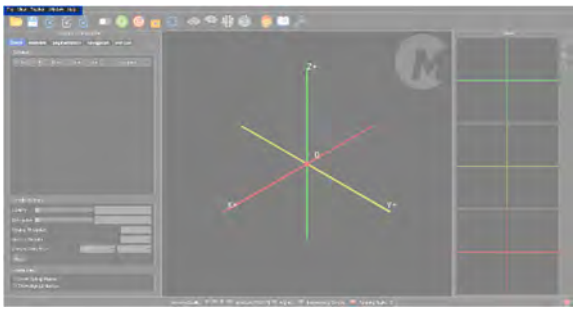
Request support at our customer support site

Open the user manual

Open the application settings

Menus

Over the main window the menus ‘File’, 'View', ‘Tracker’, 'Window' and ‘Help’ are found. They will be discussed one by one.



File Menu

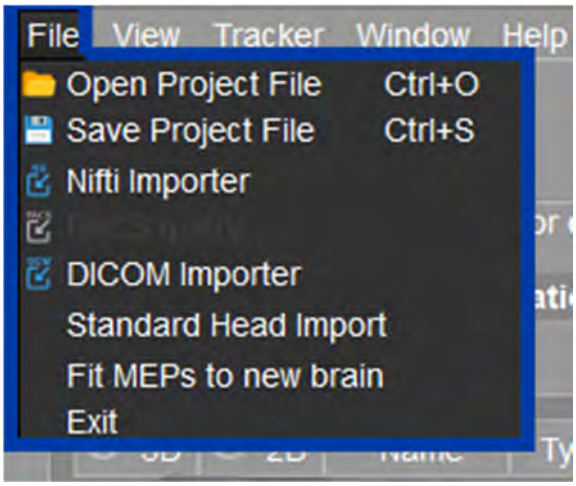
The File Menu contains the following items:

- **Open Project File**
  Gives the option to either create a new project file or load a saved project file.

- **Save Project File**
  Saves the settings as a 'project' file, which contains the skin, brain and markers, render settings and coil calibration files.

- **Nifti Importer**
  Allows the import of a segmented brain, an (T1 weighted) anatomical scan, or an activation map for your project file.

- **PACS query**
  This function is currently not available
  Allows the import of a series of MRI scans located on a PACS server. Scans can be found by searching for the name of a patient, a birthday, a description of the study, a description of the series, and a range of the date.

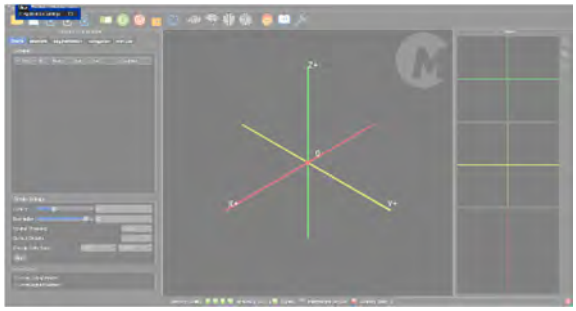


- **DICOM Importer**
  Allows the import of a full DICOM exam containing many scans and allows one to select the (T1-weighted) anatomical MRI scan of the patient in a selection window.

- **Standard Head Import**
  Loads MNI standard head without markers.

- **Fit MEPs to new brain**
  This function is currently not available

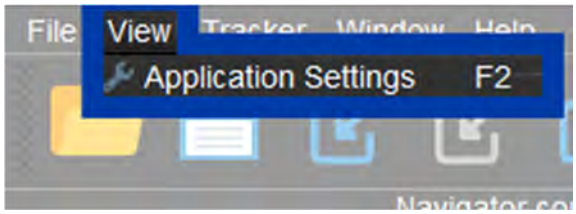
View menu



Through this menu, you can change the general viewing settings of the Atlas system. In the application settings, you'll find the following settings:

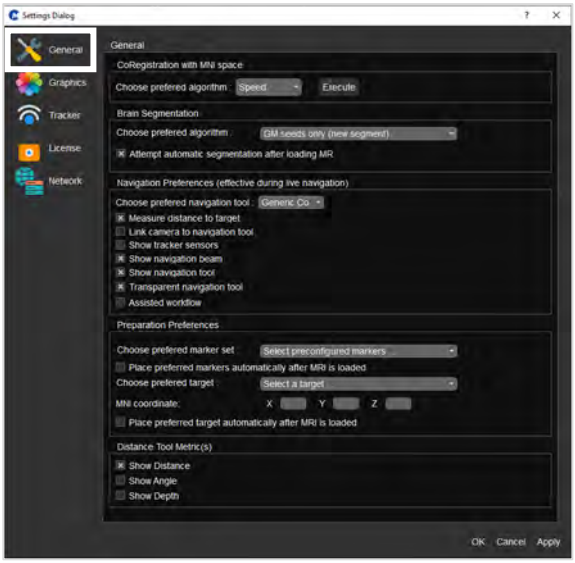
- General settings,
- Graphics,
- Tracker and
- License

First, go to View and select Application Settings.



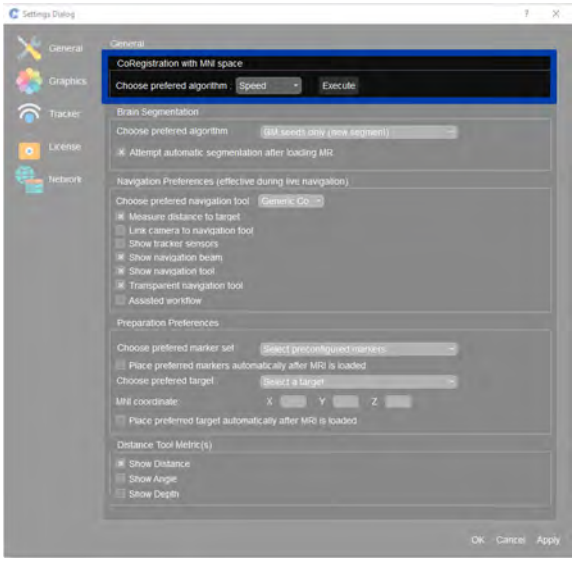
General settings

In General settings, you can set the items described below.



CoRegistration with MNI space

You can choose whether you want the co-registration algorithm used for registration of an MNI space average brain to your patient's MRI scan to run as fast as possible or as accurately as possible. This process starts automatically if you load a new anatomical scan and works behind the scenes.

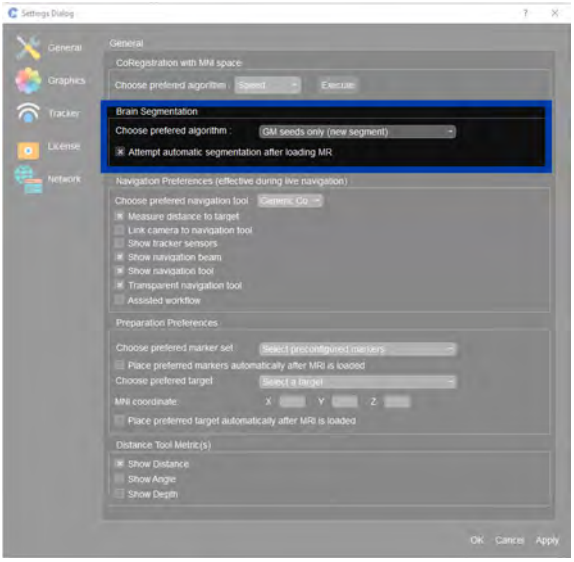


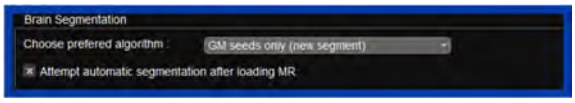
Brain Segmentation

Used for segmentation of different anatomical structures in the head such as brain meningeal structures and skull based on gradient detection.

- *Choose preferred algorithm*
  Choose between GM (Gray Matter) and WM (White Matter) seeds for segmentation. Default setting is GM for automatic brain segmentation.

- *Attempt automatic segmentation after loading MRI*
  When checked, automatic segmentation occurs after loading MRI. When unchecked, no automatic segmentation occurs.

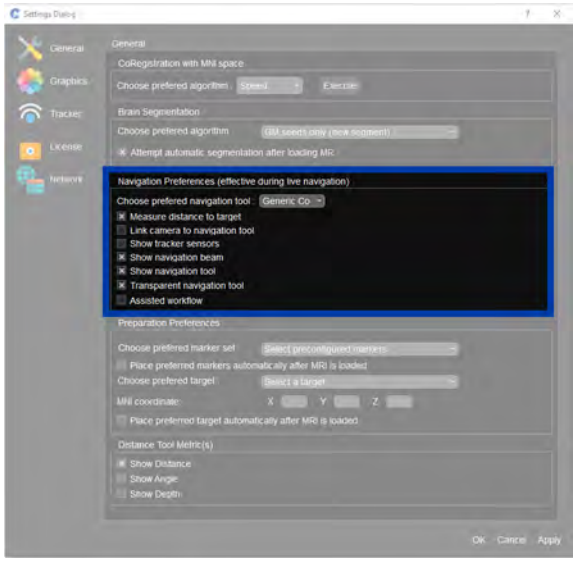


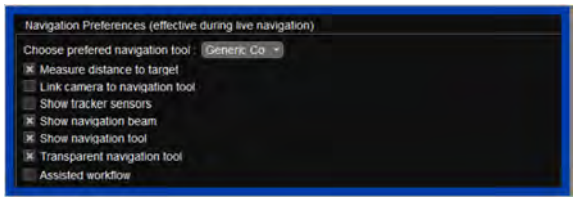


Navigation Preferences

Choose preferred navigation tool

Here you can select your preferred navigation tool (e.g., choose a coil that you will use for stimulation) and choose desired display settings.





- *Measure distance to target:*
  When checked, this displays the distance between the center of the coil surface in relation to the selected target.

- *Link camera to navigation tool:*
  This shows a cross hair intersection viewed from the coil center. It is advised only to be used in close proximity to the target.

- *Show tracker sensors:*
  Turn on and off the visibility of the tracking sensors.

- *Show navigation beam:*
  Turn on and off the visibility of the navigation beam.

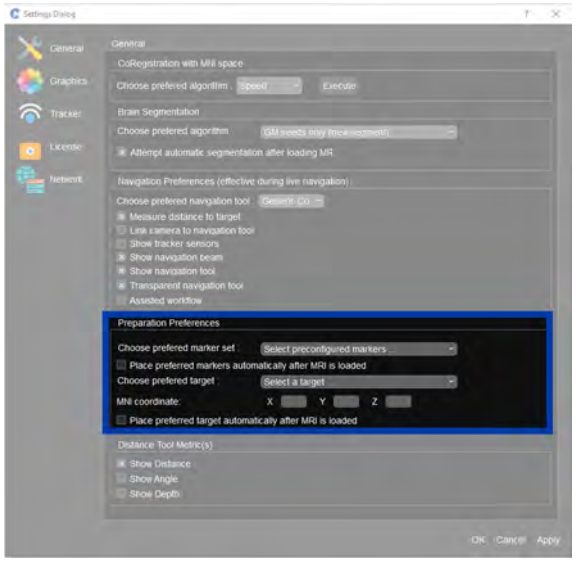
- *Show navigation tool:*
  Turn on and off the visibility of the navigation tool.

- *Transparent navigation tool:*
  Turned on, the navigation tool transparent. Turned off, the navigation tool is opaque.

- *Assisted workflow:*
  When checked, the system will automatically follow a suggested workflow. Not a default option.

Preparation preferences

Here you can choose a default set of facial markers and a default target in the brain and indicate whether you want them placed in the scene automatically after loading an MRI.



- *Choose preferred marker set:*
  Here you can choose a preconfigured marker set as default as well as choose if these should be placed automatically after MRI is loaded.

- *Choose preferred target:*
  A selection of targets is available from a drop-down menu. This is primarily relevant if you always use the same target.

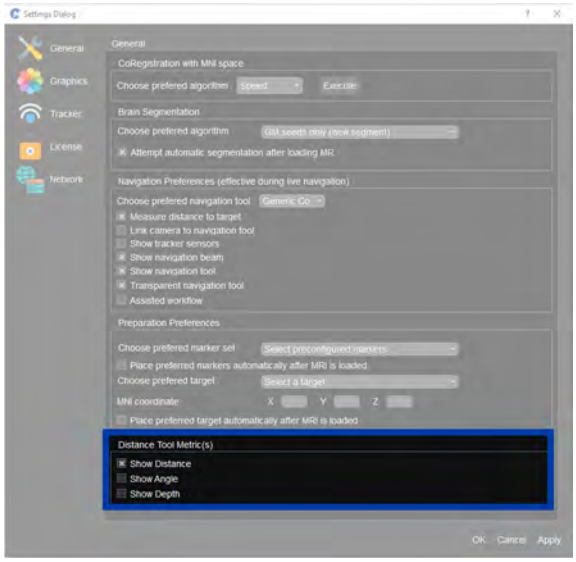
- *MNI coordinate:*
  When checked, the system places a target based on an MNI coordinate. This is primarily relevant if you always use the same target.

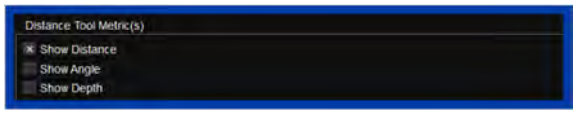
Distance tool metric
Here you can choose your preferred settings for TMS application.

- *Show distance:*
  Shows the distance between the coil isocenter and the selected target. This feature can be turned on and off.

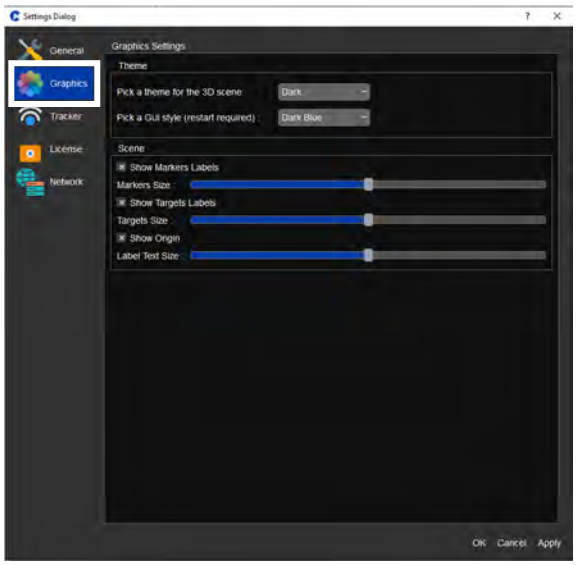
- *Show angle of coil:*
  Shows the angle of the coil. This feature can be turned on and off.

- *Show depth:*
  Shows the depth of the coil. This feature can be turned on and off.





Graphic settings
In Graphic settings, you can set the items described below.



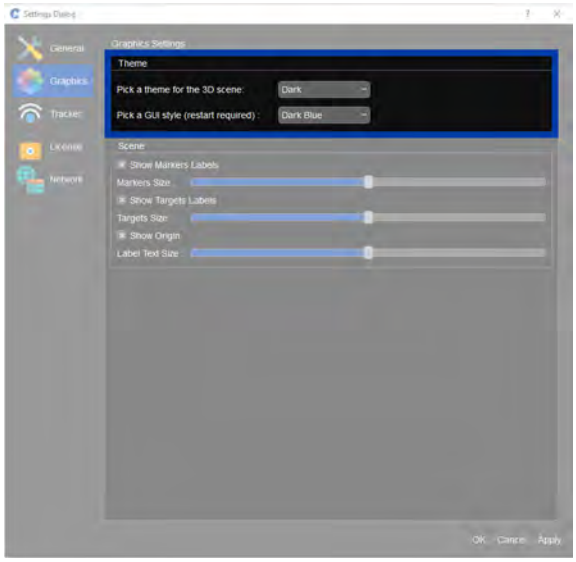
Theme

Pick a theme for the 3D scene

You can choose between a dark or a light theme.

Pick a GUI style (restart required)

You can choose your preferred text color and background color.



Scene

Show Markers Labels

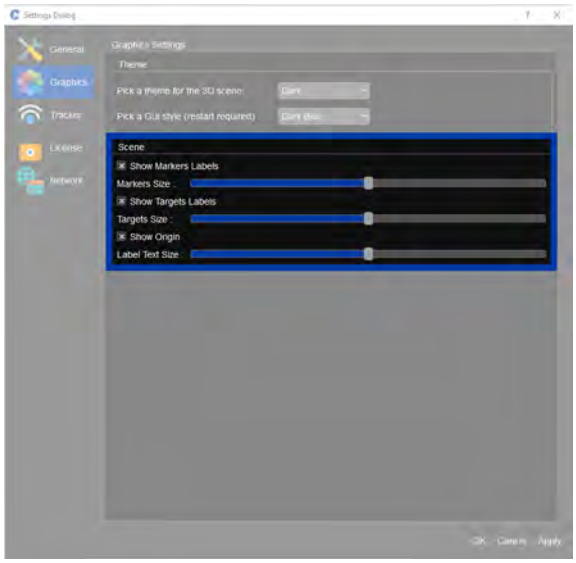
Turn marker labels on and off. The size of the marker can also be set here.

Show Targets Labels

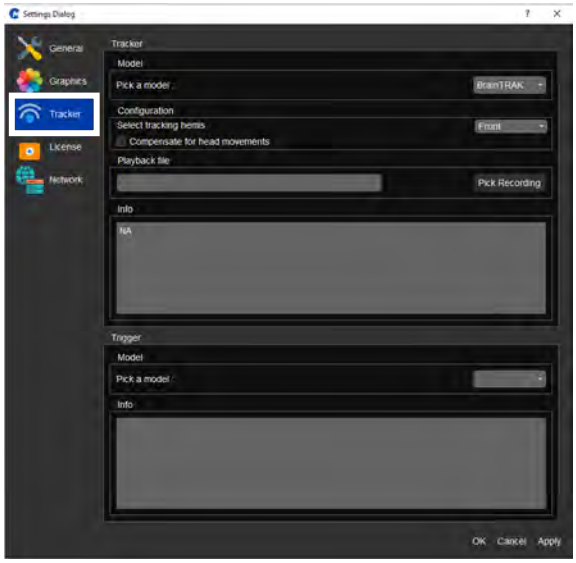
Turn target labels on and off. The size of the target can also be set here.

Show Origin

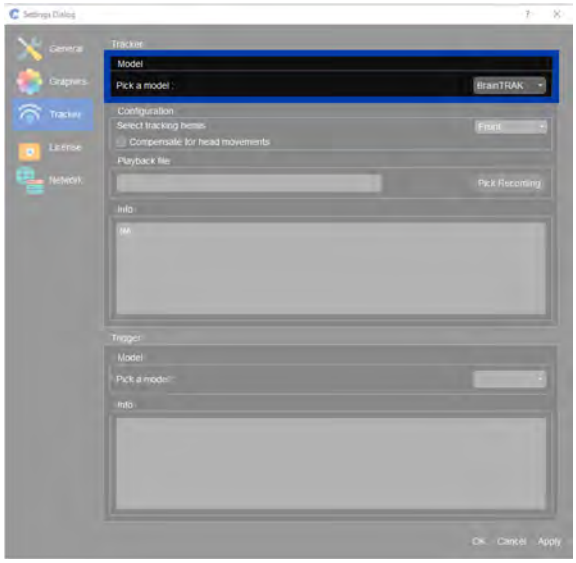
You can also turn on or turn off the axes in the 3D view. The size of the text can also be set here.



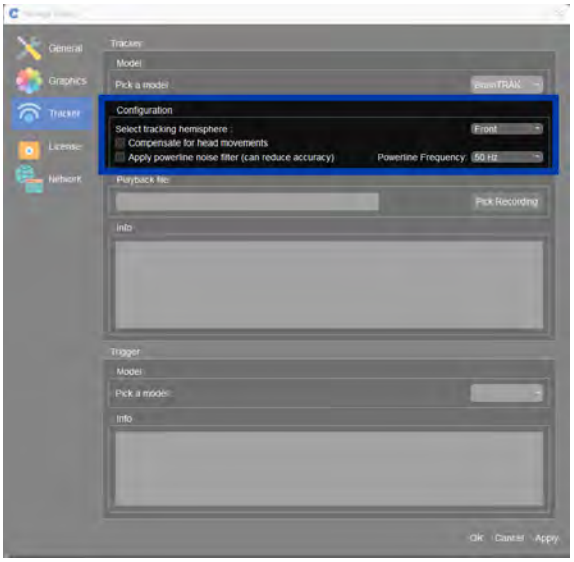
Tracker settings
In Tracker, you can set the items described below.



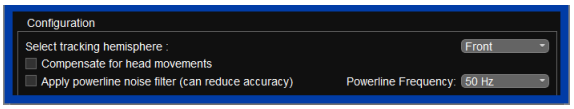
Tracker
Model
Here you can choose your tracker model; the setting must always be BrainTRAK. PlayTRAK is a non-functional tracker for demo purpose.



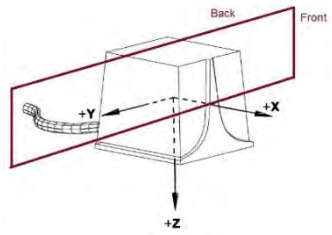
Configuration
Here you can select your tracking hemisphere, compensate for head movement and apply powerline noise filter.

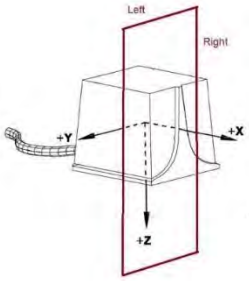


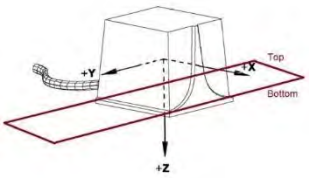
The tracker can only operate correctly in 1 half of space, i.e., the 'hemisphere'. Select the hemisphere appropriate for your situation.



See available hemispheres on the right.

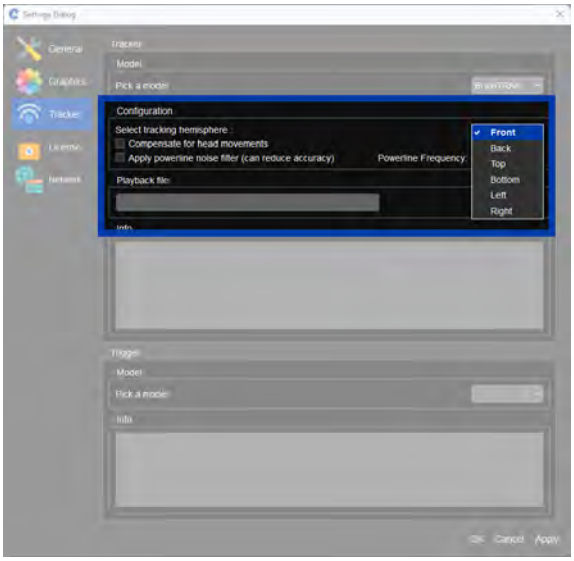


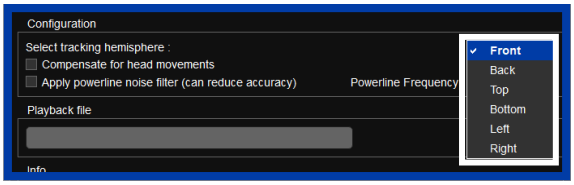




Go to Select tracking hemisphere and choose the appropriate hemisphere from the drop-down menu.

When the hemisphere has been selected, press Apply and OK.

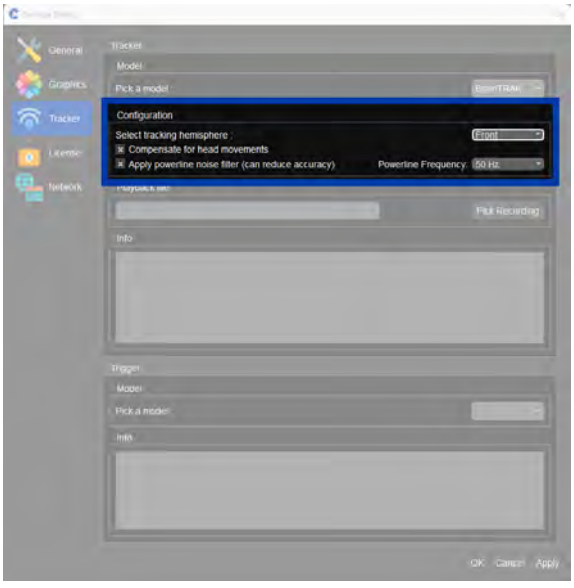


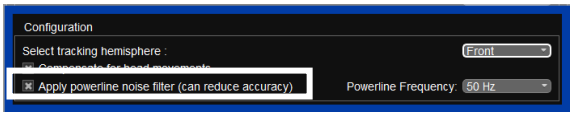


Compensate for head movements
Here compensate for head movements can be turned on and off.

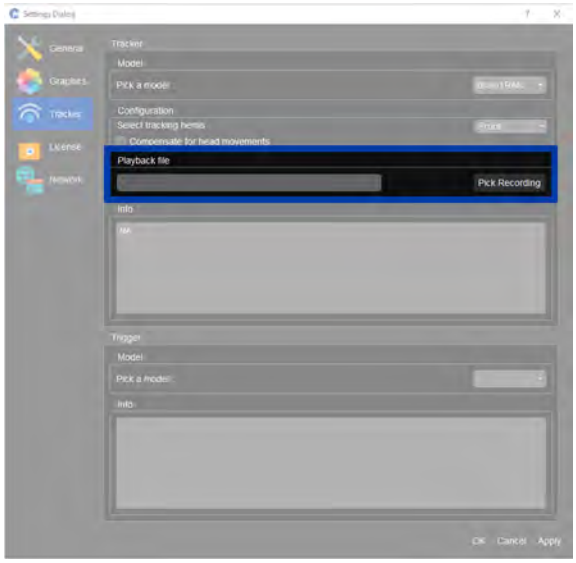
Apply powerline noise filter
If you're experiencing too much noise from powerlines in your tracking environment, you can use this option to filter it out. This feature is built into the tracker's electronics. Make sure to choose the correct powerline frequency for your country – usually 50Hz in the EU and 60Hz in the USA.

This filter should only be used as a last resort, as it might affect the performance of real-time TMS filters, which are essential for navigating during rTMS protocols. The first step to tackle excessive powerline noise is to find and remove its source. This could be large equipment nearby, like generators or heavy-duty air conditioners in server rooms. Ideally, clinical treatment rooms should be free from excessive powerline noise.

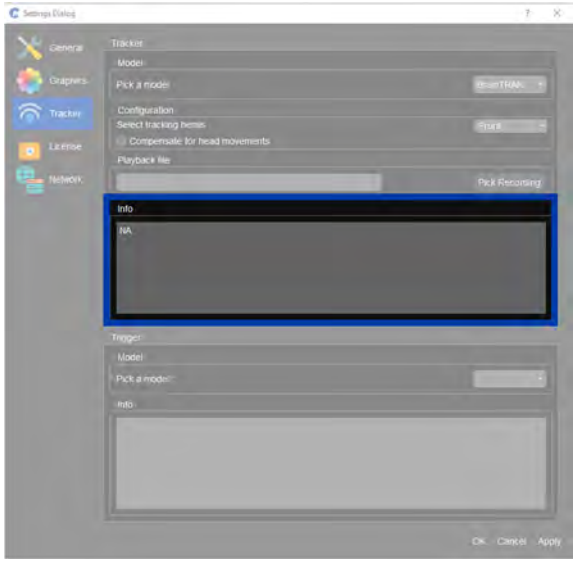


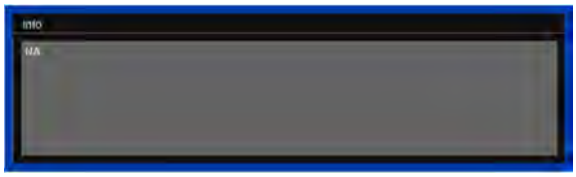


Playback file
This function is currently not available

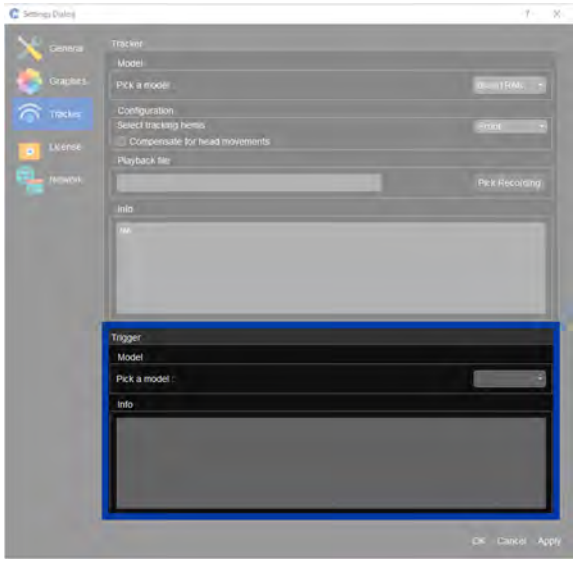


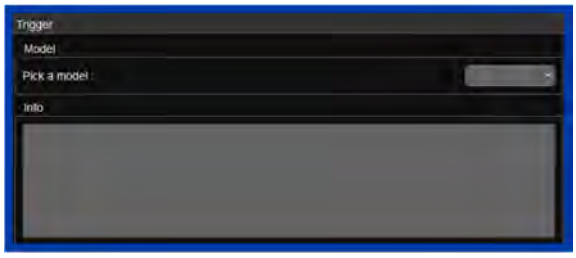
Info
Shows information on different aspects of your Tracker setup e.g., number of attached sensors and other variables.





Trigger
This function is currently not available.

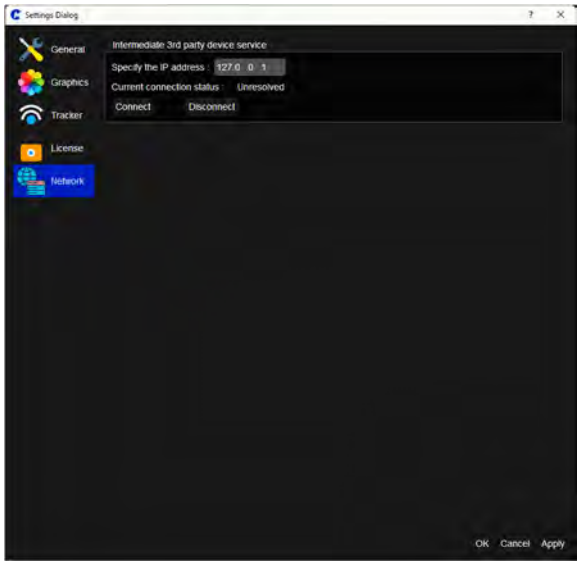




License settings
License File
Here you can browse for your license file.

License Details
Here you can see your license file details e.g., license ID, issue date, expiry date etc.

Network
This function is currently not available
For data IO with third party devices.



Tracker menu

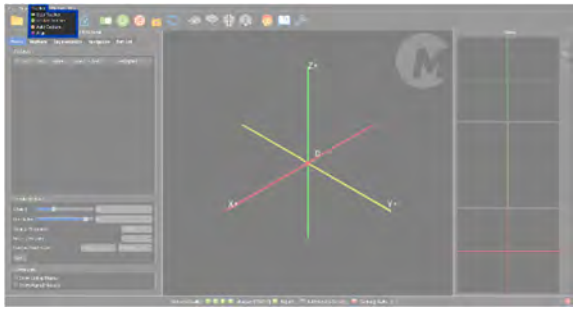
In the Tracker menu, you can set the items described below.

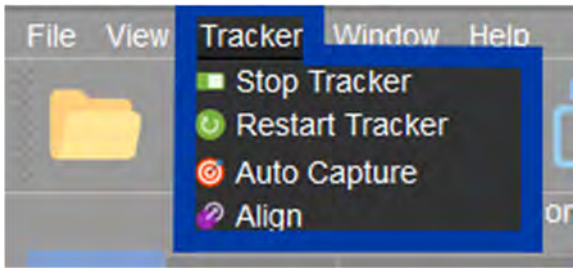
Start / Stop Tracker
Starts and stops tracking.

Restart Tracker
Initializes the BrainTRAK and starts tracking.

Auto capture
Initiates capture of markers in sequence.

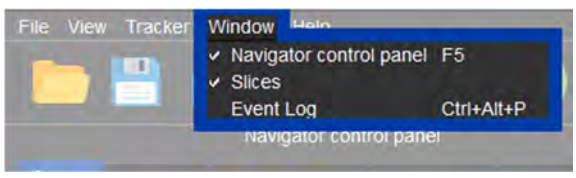
Align
Computes alignment from the current marker list and shows BrainTRAK sensor in main window, aligned with the brain.





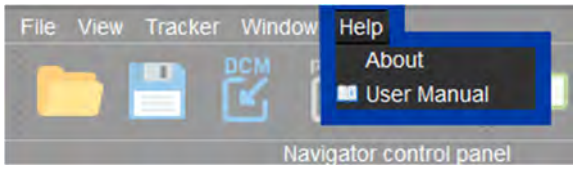
Window Menu

Through this menu, you can enable or disable the Atlas system interface components, and you can open the event log.



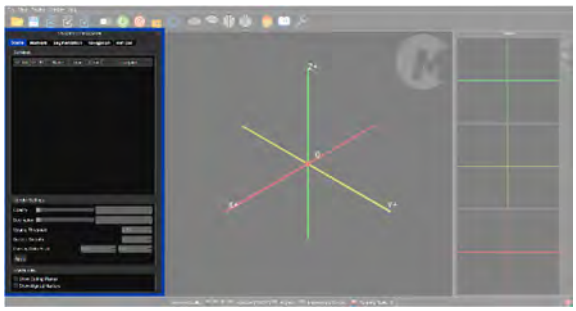
Help Menu

Gives access to About and instructions for use.



Panels

At the left top of the main window, you will find 5 panels:



- Scene,
- Markers,
- Segmentation,
- Navigation, and
- Ref Coil

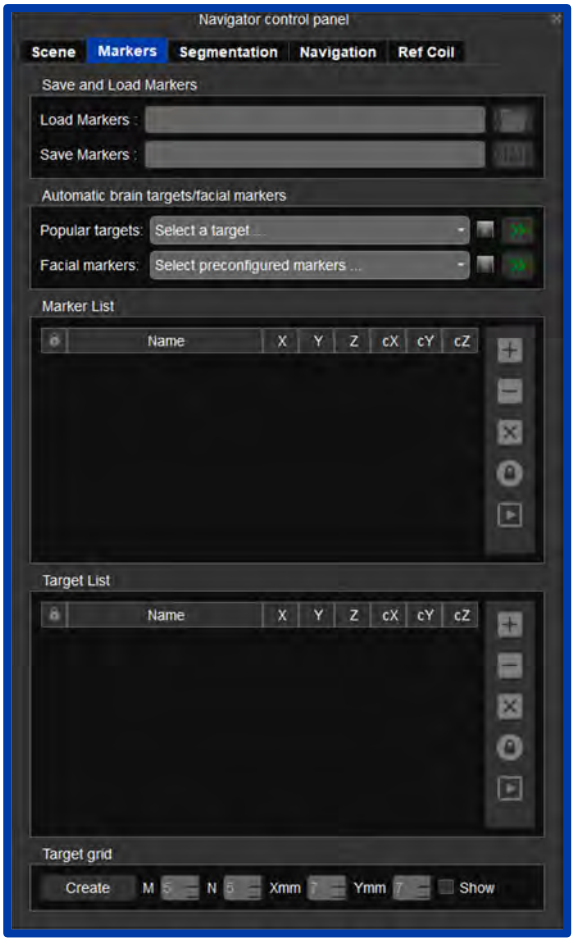
By clicking on the label, the full panel will be displayed. Below, the function of the panels is described. In Using the Atlas system: alternative steps in navigation the actual use is explained in a step- by-step example.

Scene panel

The scene panel allows you to control how the surfaces of skin, brain and activation maps are calculated and their visual appearance in the main window. Most notably, a list of the loaded surfaces is visible at the top, and by selecting a surface the rendering threshold, opacity, smoothness and decimation can be controlled from the 'Render Settings'.

Furthermore, in the 'Scene View' some general properties of the 3D scene in the main window can be controlled, such as setting the cutting plane for the sliced view and showing aligned markers. The last option is only enabled at the appropriate phase of the treatment, e.g., after pressing 'align'. In the surface list, loaded maps can be deleted by selecting them and pressing the delete key on your keyboard. Skin and brain cannot be deleted; they are simply replaced by loading them again from the ‘File’ menu.

Markers panel
The markers panel allows you to create, manipulate, save and load craniotopic markers to place on the skin rendering. These markers are the actual reference points used for aligning the Tracker space with the MRI space.



Segmentation panel
In the brain segmentation panel, you can create a 3D brain segmentation from the MRI scan you loaded previously using Generate Full Automatic Segmentation. It contains the panel where gray matter and white matter seeds can be created, and 2 edit boxes where you can enter parameters that influence segmentation (white matter smoothing factor and the gray matter growth factor), and buttons to start generating the segmentation (this can take a few minutes). See Using built-in brain segmentation on page 50 for details on how to perform brain segmentation.

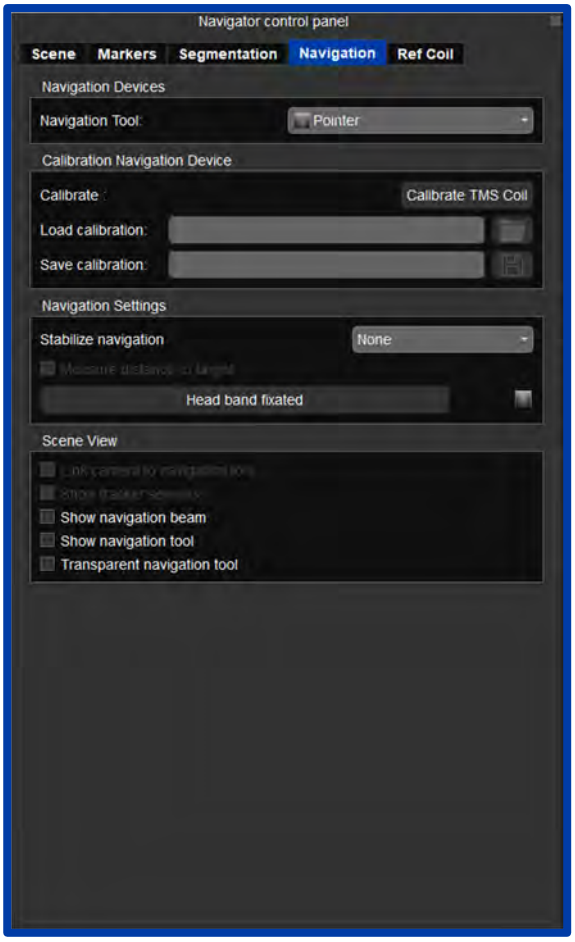
Navigation panel
In the navigation panel you can control navigation settings. You choose whether you want to navigate with the pointer or with one of the available coil models directly in the 'Navigation devices' section.

For the latter, you need to attach the navigation clamp to the coil handle (see Calibrate the coil on page 16), and calibrate it using the tools in the 'Calibrate Navigation Device' section. Results of calibrations are automatically saved for later use.

In the 'Navigation settings' panel you can switch on 'stabilize navigation' for navigation during rTMS (either <5Hz, 5- 10Hz, or TBS), and 'compensate head movements' for head movement correction during navigation. The distance tool can also be turned on to aid precise navigation to a target with a millimeter distance indication and auditory warning for imprecision, see Using the Atlas system: alternative steps in navigation for more details on these special features.

Also, in the navigation tab, you can choose to enable or disable settings such as showing the tracker sensors, showing the navigation beam, showing the navigation tool, or making the navigation tool transparent.

After alignment you'll also be able to link the camera to the navigation tool.



Ref coil
Save and load reference coil
Loads and saves a file containing a list of reference coils.

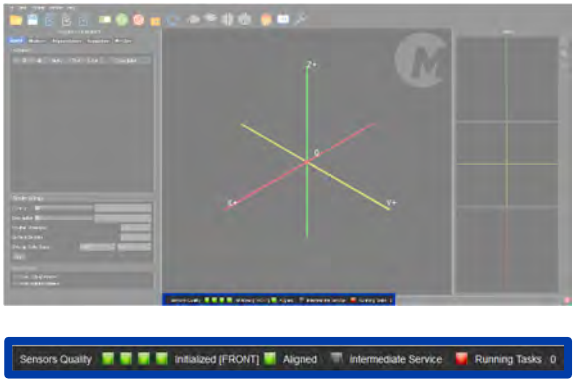
Reference coil
Allows you to save a position using your navigation coil as a reference.

When the desired position is found, press the '+' button and a position and time stamp will appear in the Reference coil section of the Ref Coil window.

Press the '-' button to remove positions individually or the 'x' button to remove all positions.

The "play" button saves reference coil position when pressing the right arrow button on the remote.

Status bar
In addition to the abovementioned areas, there is also a status bar at the bottom of the screen.



The status bar has 3 indicators:

- The four sensor quality indicators. For more on these readings, see Sensor quality indicators on page 64.
- The ‘tracker initialized’ indicator that is black (tracker off) or green (tracker initialized)
- The ‘aligned’ indicator that is black (not aligned) or green (aligned)

In addition to the indicators there is a bar that shows whether a task is running and a shortcut to the event log window.

Using the Atlas system: alternative steps in navigation

Overview

When you plan a typical (f)MRI guided TMS therapy session using the Atlas system, you need to complete a couple of steps to be able to navigate the pointer to a position on the scalp overlying a certain brain region or fMRI activation. In this section, all the steps you need to take to start navigating in the Atlas system are outlined in detail.

Prior to these steps, the data obtained from the MRI operator should be saved to an appropriate location on your hard drive first.

Please note that the Atlas system supports 2 workflows. This is not a strict division, and workflows can be combined, but it is advised to make a choice when you start using the system. The DICOM workflow is defined as users working with DICOM format MRI data throughout and intend to do all processing inside the Atlas system. The DICOM workflow is described on page 9. The Nifti workflow is defined as users with a Nifti format workflow, as it is often used in MRI processing software such as SPM or FSL. For information regarding data format see Required (f)MRI data on page 83.

When the MRI data has been loaded and segmented, the workflow is the same for both DICOM workflow and Nifti workflow.

DICOM workflow: The workflow works directly from DICOM data as generated on scanners, and exported directly from the MRI scanner to DVD or USB flash drive, and includes the brain segmentation functionality built in to the Atlas system to generate the 3D brain surface. DICOM data can be read from the file system (a location on your hard drive or a USB flash drive), in which case you have to copy your data from the MRI scanner to your navigation yourself, for example by reading a DVD provided to you by the MRI technicians, or using a portable USB drive.

Nifti workflow: The workflow works with Nifti (*.nii) data and assumes image processing such as brain segmentation and functional MRI processing is done outside the Atlas system, for example in SPM or FSL. Please note that brain segmentation within the Atlas system is still possible for this workflow.

In summary, the workflows include the following steps:

1. Loading the MRI data (skin is visible immediately)
2. Segmenting brain in the Atlas system (DIOM workflow) or load segmented brain (Nifti workflow) if not using automatic segmentation
3. Adjusting rendering settings
4. Setting markers to facial landmarks
5. Setting targets for TMS
6. Saving the project before patient arrival
7. Capture real facial landmarks with the pointer
8. Navigating the coil to the selected target

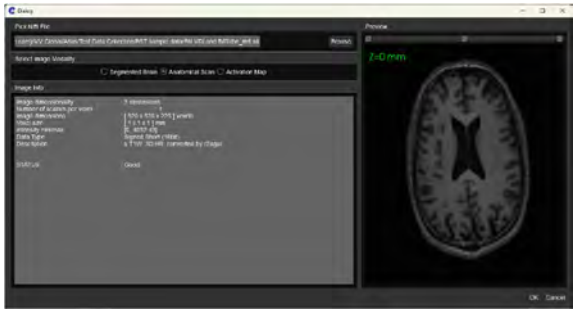
Steps 1-6 are typically done well in advance of the actual treatment. Ideally, when a patient arrives all the data and marker steps have been completed. Below the alternative steps are detailed with screenshots from the Atlas system software.
Note: Most of the preparation steps can be combined into a single fully automatic workflow, including image loading, brain segmentation and automatic markers and targets placement. See section Automating your preferred workflow on page 77 for more details.

Previously in this document, the DICOM workflow was presented, outlining the process of import and segmentation in the DICOM format, see page 9. In the following section, the Nifti workflow will be presented, outlining the corresponding process in the Nifti format.

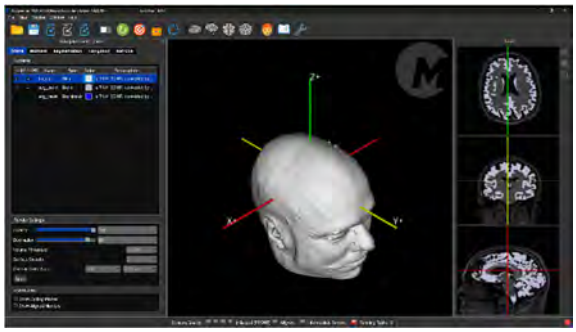
Nifti format import (Nifti workflow)
Press the Nifti icon and select Anatomical Scan.

Click on 'Browse' and choose the data you want to load. Wait until the skin has been extracted (check the progress bar). The Atlas system software has a special procedure to estimate the right skin render threshold from many types of structural MRI data (it is set to "100%").

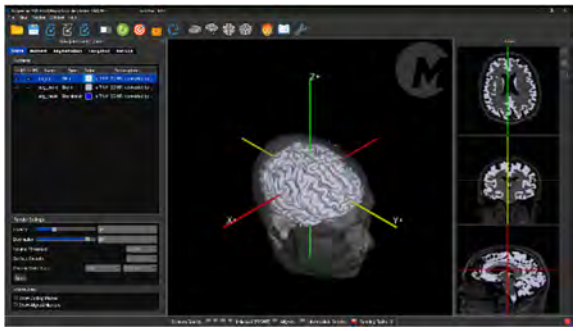
If the skin looks garbled or contains holes, slightly increase or decrease the render threshold using the slider in the scene panel and press Apply until a clear and detailed skin surface can be seen. Decimation is most likely set correctly; slightly decrease it when the skin has rough edges and large flat surfaces. Opacity is set to 30% by default resulting in transparent skin.



When setting opacity to 100%, the skin will look like the picture on the right.



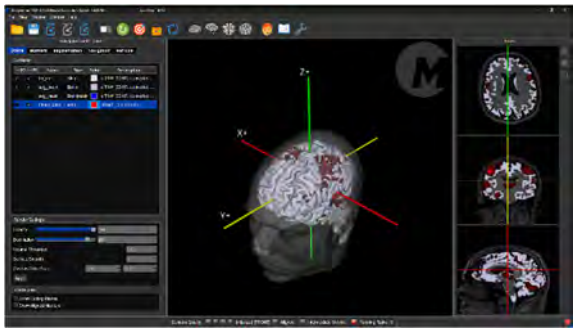
To import a segmented brain in Nifti format, press 'File' > Nifti import again or use the Nifti importer icon. Choose the Segmented Brain option as your image modality and then press 'Browse' to select your Gray Matter image created in an appropriate MRI processing software package. Wait until the brain is visible using the standard rendering settings (100% opaque), and you should see a brain looking similar to the picture on the right.



To vary the depth of the sulci and other details, change the render threshold. By default, it is set to 0.3 (representing a 30% gray matter probability), which is usually adequate. If you prefer to segment the brain from the anatomical scan using the Atlas system segmentation process, see Using built-in brain segmentation on page 50. If you choose this option, you do not need to load the segmented brain here.

Optionally you can also import a co-registered activation map to go with your anatomical scan and brain segmentation. To do this, choose the 'Activation Map' option as your image modality when importing the Nifti file. After you have imported an (f)MRI activation map, an activation field will appear in both the 3D view and the 2D slices. You will also see the loaded fMRI map appear in the list of surfaces. By altering the Render Settings, you can manipulate how the fMRI activation maps are shown. For instance, if you increase the volume threshold, only those spots on the brain in which the 'activation' surpasses the chosen value is shown on the brain. It is also possible to change the overlay color scale, so the activation maps give an overview of the parts where 'most activation' was measured in the brain. This is best visible after turning off the fMRI activation map in the 3D view.

Note: It is important to ensure that the imported fMRI activation map is already co-registered with the anatomical scan you selected. The fMRI activation maps are not automatically registered whenever you import them; therefore, you need to ensure that the activation maps fit the anatomical scan.



Using built-in brain segmentation

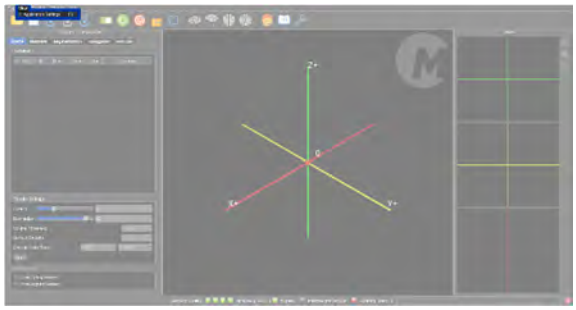
This section describes how to create a brain surface directly from an unprocessed anatomical scan (DICOM workflow). This requires MRI scans obtained directly from the MRI scanner.

Brain segmentation from an imported file can be either fully automatic or semi-automatic. Automatic segmentation is turned on as default.

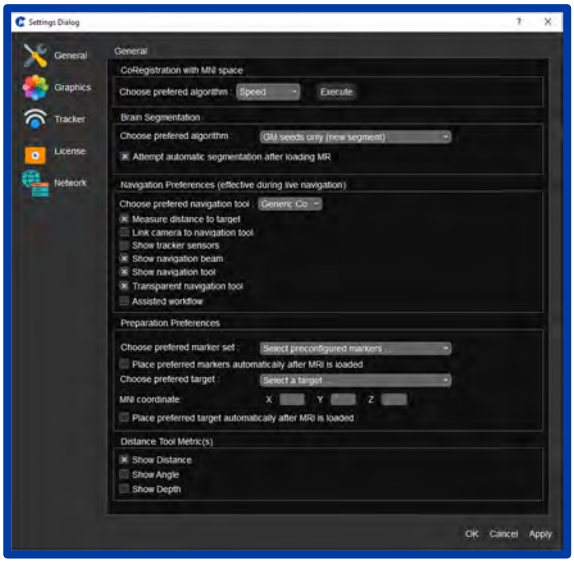
This section describes how to use the fully automatic brain segmentation feature. For information on how to use the semi-automatic brain segmentation feature see page 53.

Using fully automatic brain segmentation

First go to the View menu and select Application Settings.



Next, go to General.

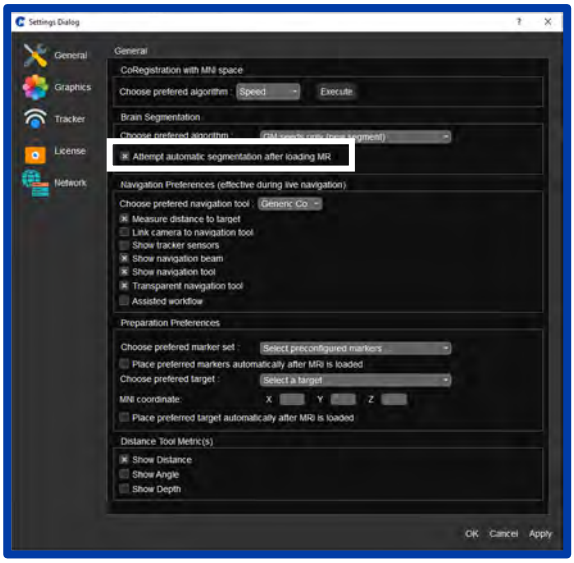


Select *Attempt automatic segmentation after loading MRI* and press Apply.

Now fully automatic brain segmentation will occur immediately after MRI import.

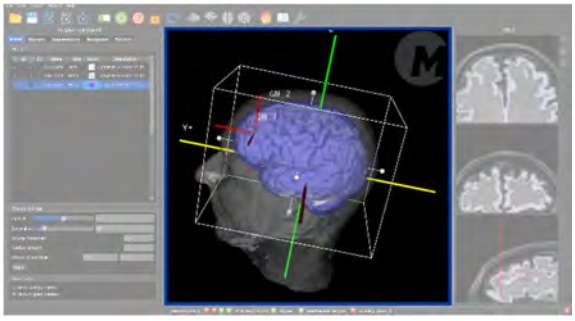
Press OK to continue.

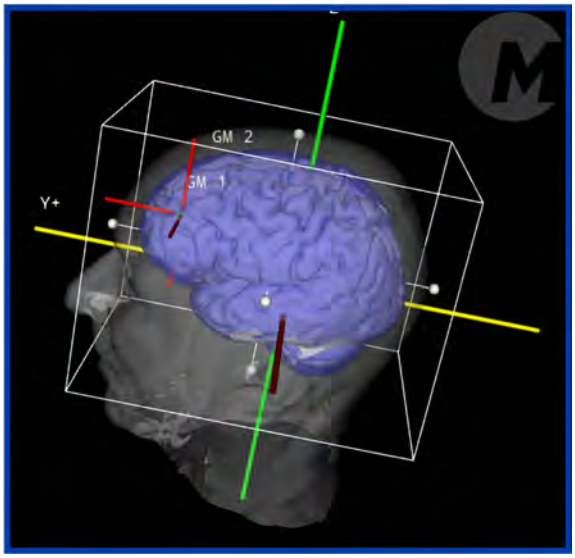
Alternatively, automatic brain segmentation can be accomplished after MRI import.



Go to Brain segmentation in the control panel and press *Generate Full Automatic Segmentation.*

When the segmentation has been generated, go to Scene and enable 3D mask. Now a 3D brain, a transparent blue brain mask, and a box to resize the mask will appear.





To remove non-brain tissue that has been misclassified, such as the dura mater, one can shrink the brain mask by manipulating the white spherical handles (click and drag with the left mouse button).

When the mask size has been altered, return to Segmentation and click 'Apply Mask'.
Note: Rather than changing masking, you might also have to alter the brain render threshold in the scene tab. For example, when there are holes in the cortex, you need to decrease it (e.g. to 0.2) or when sulci are not visible, you might have to increase the threshold (e.g. to 0.5).

A step-by-step guide to semi-automatic brain segmentation

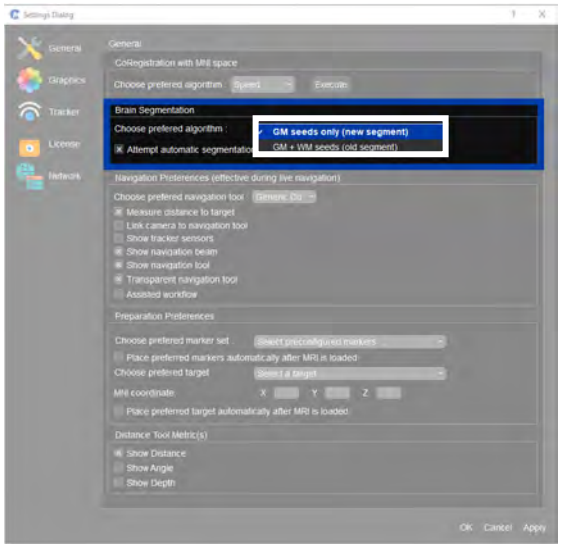
When opting not to use fully automatic segmentation, as described on page 50, an alternative approach is to implement a semi-automatic segmentation method outlined below.

The semi-automatic brain segmentation requires the manual placement of a few seed points (a minimum of 2 points in total) in the gray matter of the anatomical scan.

Below, is a step-by-step tutorial with screenshots for performing brain segmentation. In this example, a DICOM dataset is used. See Load image volumes on page 9 for more information on how to import MRI.

Note that the first method outlined below is referred to as the 'GM seeds only', which is the advised semi-automatic segmentation algorithm in the Atlas system.

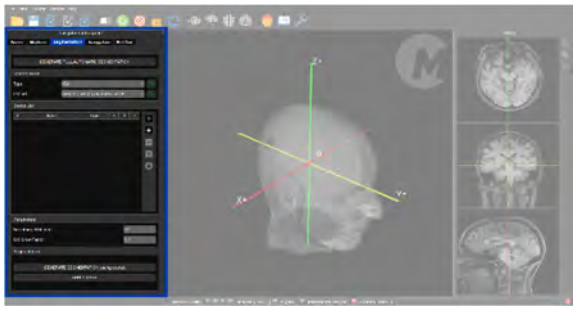
The second method described is an alternative approach available where one must set more seed points, also in the white matter, named the 'GM + WM seeds' method. This method is less automated, and not the default for semi-automatic brain segmentation. There still could be cases such as deformed or lesioned brains where this method is the better option. The preferred method can be selected in the Settings Dialog.



Step 1: Place gray matter seed points in the brain

First, go to the 'Segmentation' tab. To achieve a high-quality surface of the brain, at least 2 gray matter (GM) seeds should be placed, one in each hemisphere.

You can either place all seeds manually in the gray matter, or use our automatic seed placement tool, available through the dropdown menu in the segmentation tab's 'Create Seed' section.



When using the automatic seed placement, a prepopulated seed set is created at locations in the gray matter optimal for segmentation, and warps them to the patient's MRI, using the diffeomorphic nonlinear registration algorithm built into the Atlas system. See Automatic registration with MNI space on page 85 for details.

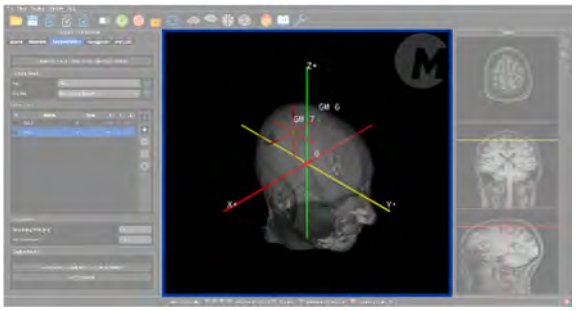
The automatic seed placement tool has the following prefabricated sets of seeds available for you:

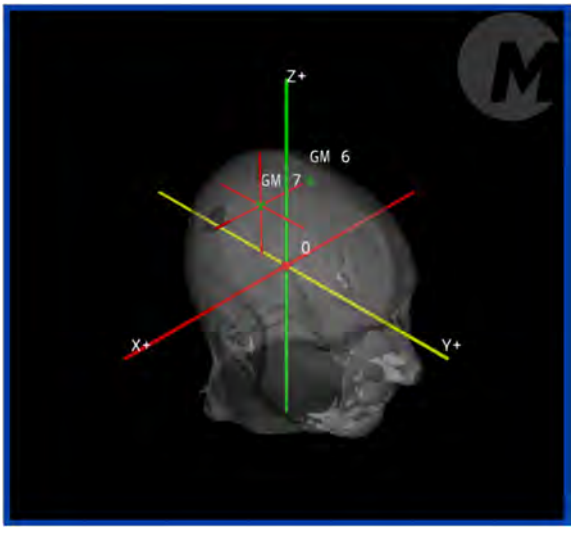
- 2x cortical superior,
- 4x cortical superior,
- 8x cortical superior,
- 4x cortical distributed and
- 8x cortical distributed.

In the example here, we will use '2x cortical superior', which is sufficient in most cases. The 4x and 8x cortical superior sets create more seeds in the cortex at the superior portion of the brain, which can help if certain parts of the cortex have not been segmented well enough.

After selecting the GM set, press the green arrow.

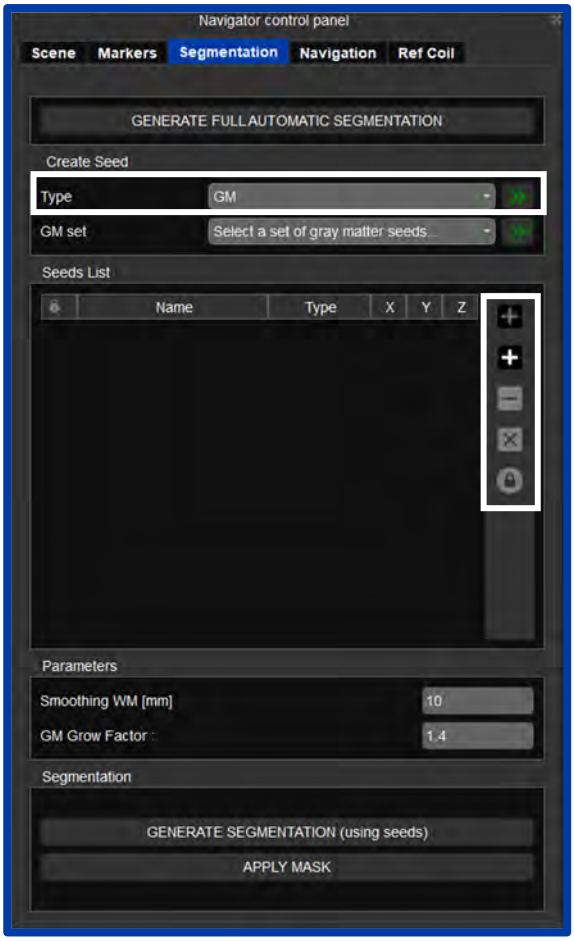
The seeds will then automatically be placed.





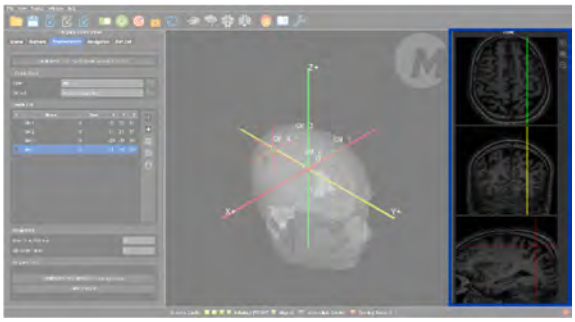
Alternatively, the gray matter seeds can be created by, select 'GM' in the dropdown menu and click on the "+".

A green cubic gray matter seed appears in the 3D space. Drag the marker roughly to the location you want. Continue until you have created all the seed points necessary.



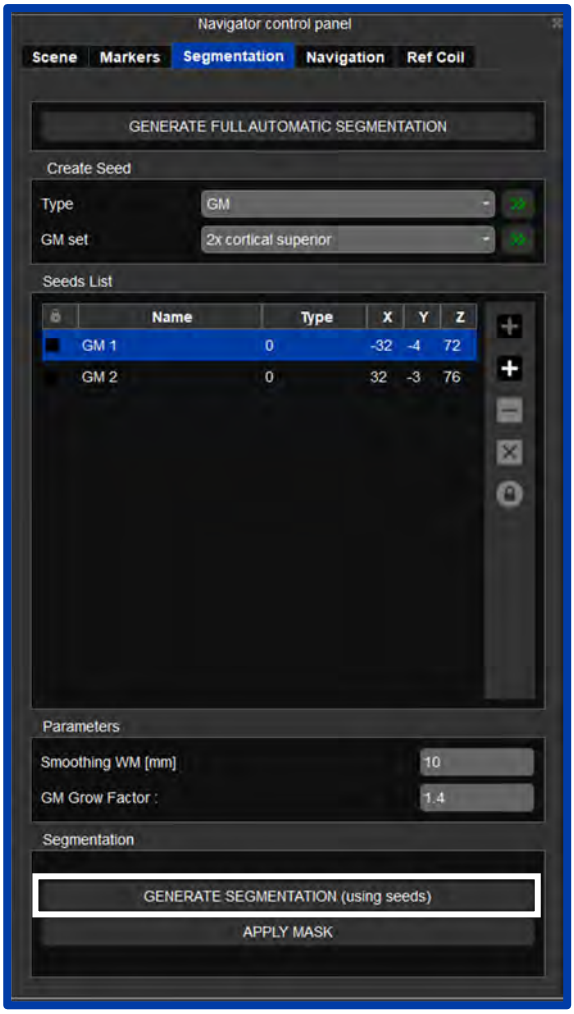
Regardless of the seed placement method you used, now continue to accurately place the GM seed in the gray matter sheet: click on the appropriate location in the slices panel and use the scroll button of your mouse to zoom in on the brain.

Inspect the coronal, axial and sagittal views to verify you placed the seed in the gray matter correctly. It does not matter in which part of the brain you placed the GM seed, as long as it is in gray matter and not in other tissue.

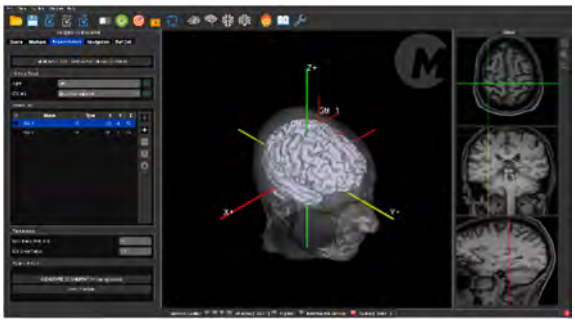


When at least 2 gray matter seeds are correctly placed inside the brain, click the 'Generate segmentation (using seeds)' button to create a brain surface.

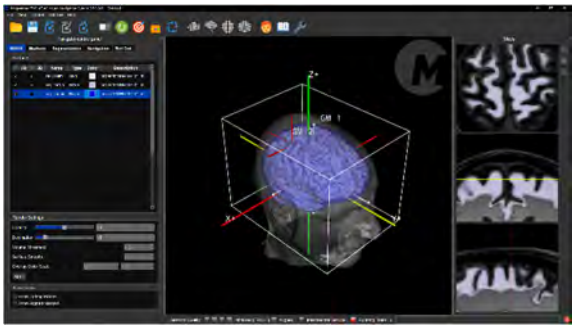
This can take a couple of minutes to complete.



If the seed points are set correctly and your anatomical scan has sufficient quality and contrast, the 3D brain surface appears. If turned on in the Scene panel, a transparent blue brain mask and a resize box will also appear after segmentation.



Step 2 (optional): Adjust brain mask
To remove non-brain tissue that has been misclassified, such as the dura mater, one can shrink the brain mask by manipulating the white spherical handles in the 3D scene (click and drag with the left mouse button).



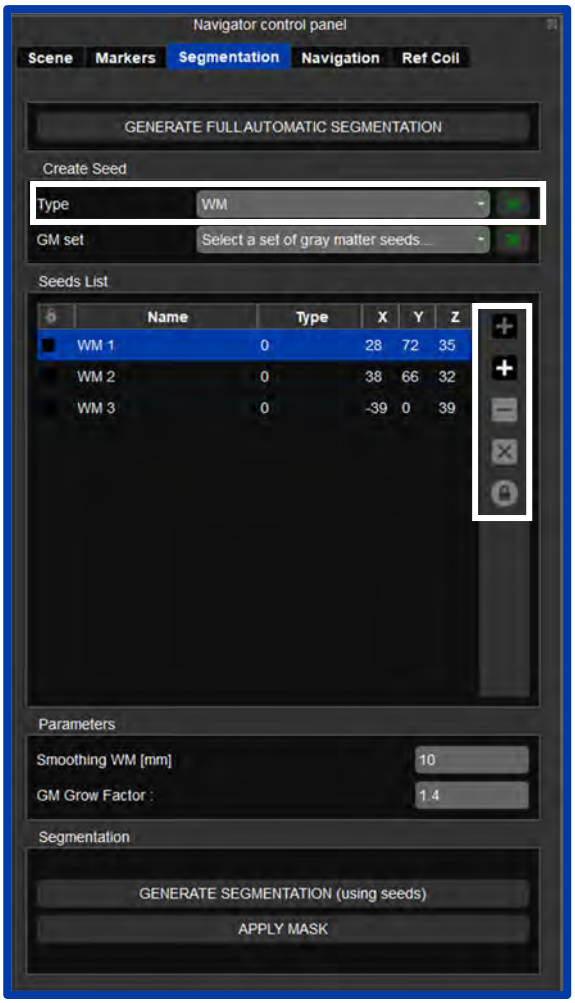
When the mask size has been altered, there are 2 options:

- Click 'Generate segmentation (using seeds)' again. The entire segmentation is calculated again from scratch, and the mask is resized according to your changes. This is likely to provide the cleanest results and works for enlarged as well as shrunk masks.
- Click 'Apply mask' to just cut away tissue outside the mask, to clean the segmentation. This is not optimal for semi-automatic segmentation but might

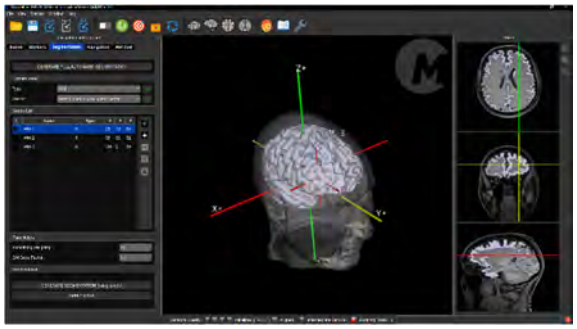
sometimes be needed if the above method does not give the desired result. Also note this does not work when enlarging the mask, no new tissue will be 'created'.

Step 1: Place white matter seed points in the brain
You can also use the brain segmentation algorithm including the placement of white matter (WM) seeds.

To create the white matter seeds, select 'WM' in the dropdown menu and click on the "+".



Use the slice view to place the seed in the white matter tissue of the brain, for example, in the right hemisphere.



While gray matter seed placement needs to be quite precise as the gray matter sheet is quite thin, placing white matter seeds is much easier. As a rule of thumb, it is advisable to place WM seeds at the general level of the ventricles.

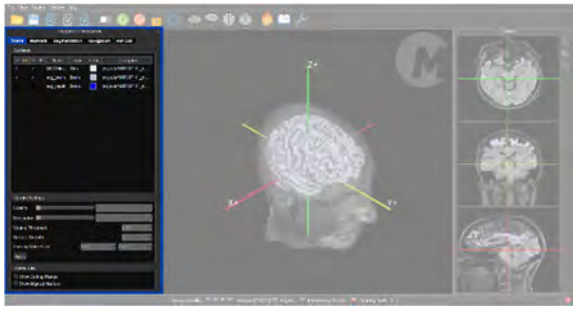
Verify WM seed placement through inspection of the coronal, axial and sagittal slices. Repeat this procedure to create more white matter seeds.

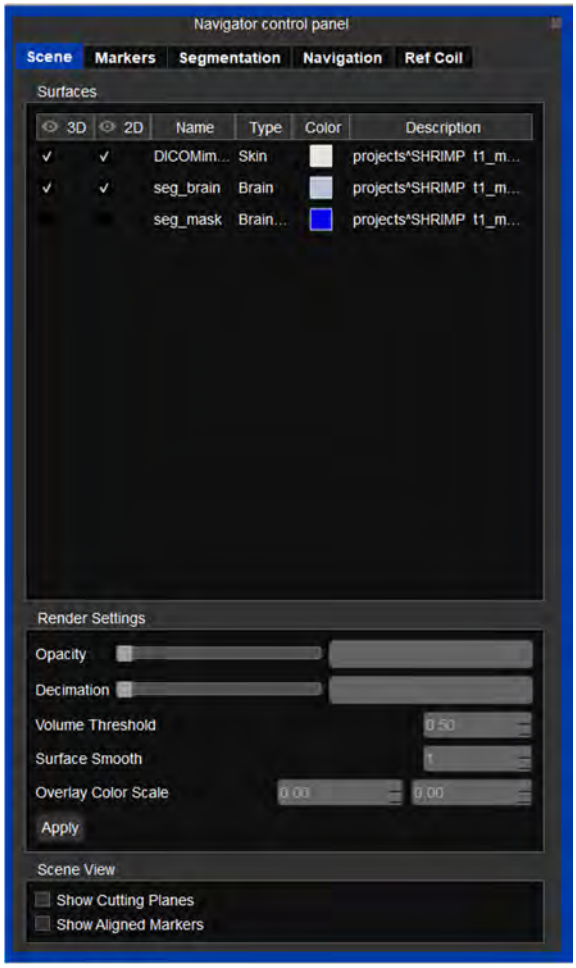
Now select 'generate segmentation (using seeds)' to obtain the result. You may need to adjust the brain mask (see step 2 above).

Otherwise, this method works as the semi-automatic procedure with only GM seeds described above.

Adjusting rendering settings in the Scene panel

In the Scene panel, there is a list with surfaces once loaded. By selecting a particular surface in this list, you get access (in the "render settings" section) to some of the parameter values controlling the generation and appearance of the surface. Other rendering parameters can be adjusted directly in the surface list itself. The relevant parameters and how to adjust them are discussed below.

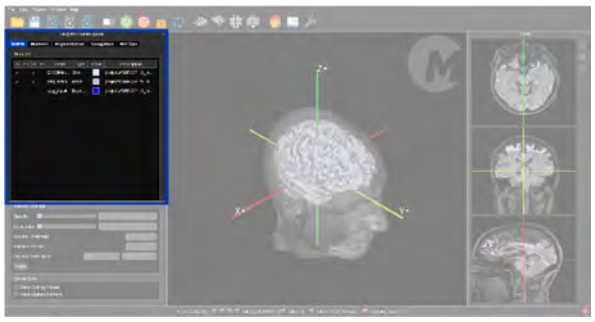


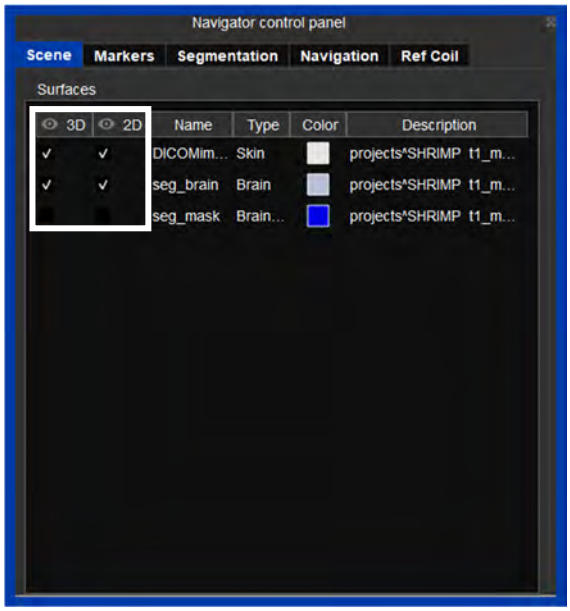


Surfaces

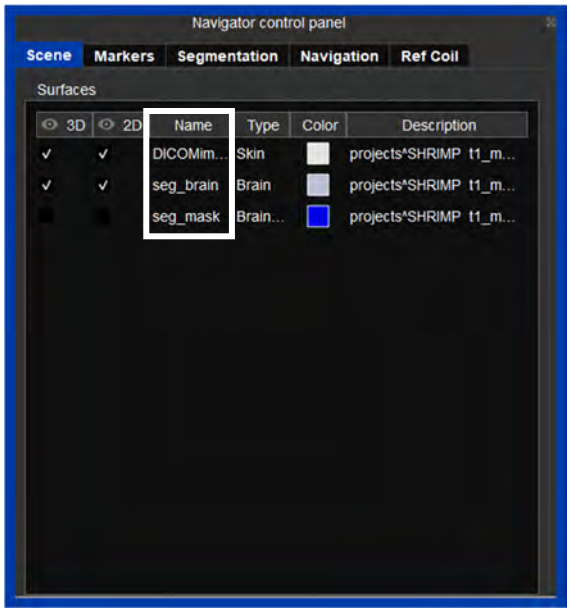
3D and 2D

Rendered surfaces can be hidden in both the 3D image as well as in the 2D slices by checking the box in the column under the eye symbol directly in the surface listing.

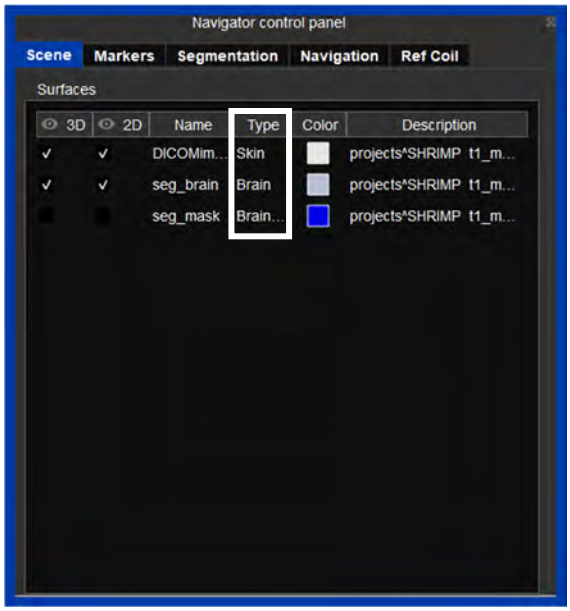




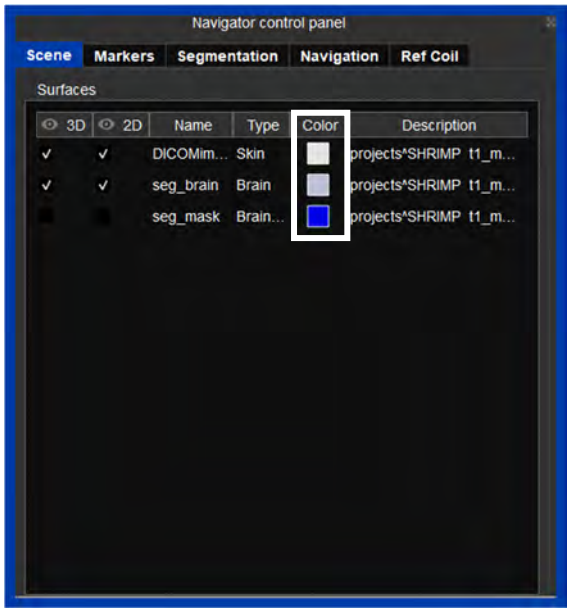
Name
Lists the name of the loaded structures either skin, brain or mask.



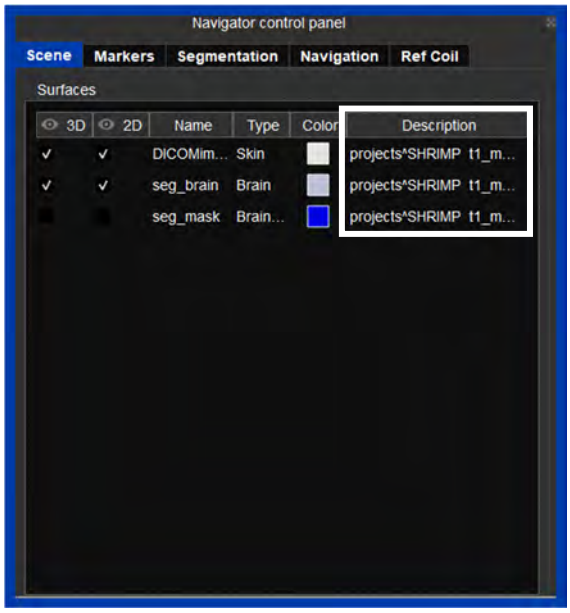
Type
Lists the type of loaded structures either skin, brain or mask.



Color
The color of the selected surface can be changed directly by double clicking on the colored square.

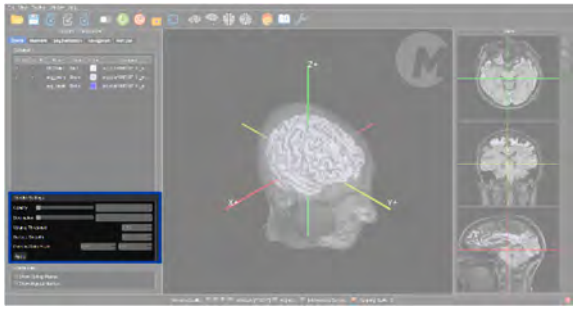


Description
Lists the imported file name.



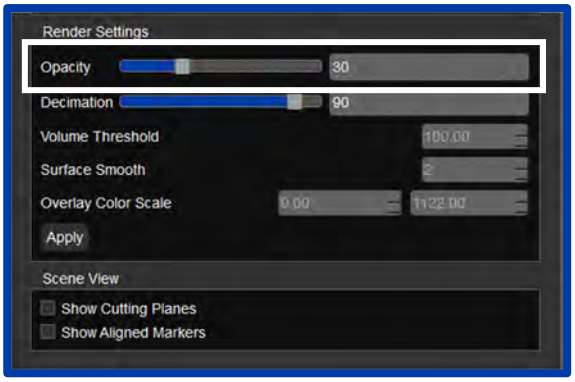
Render settings
First select the surface you wish to adjust in the surfaces list.

Press Apply when adjustments are complete.



Opacity
The opacity scrollbar determines the opacity or transparency of the loaded surfaces.

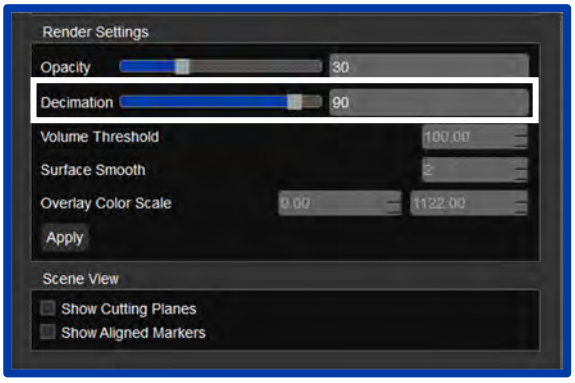
A value of 0 means the object is completely transparent and a value of 100 means the object is completely solid.



Decimation
The decimation scrollbar determines how much the surface is decimated.

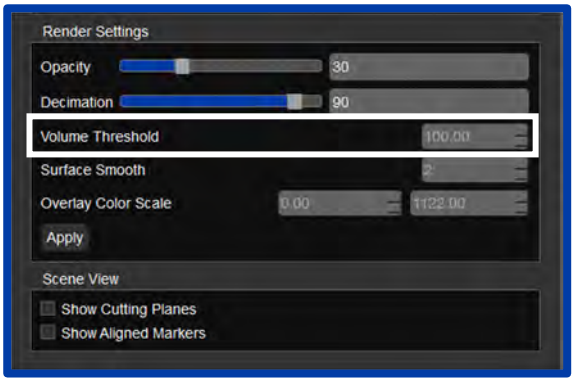
A higher value will make the rendering of the surface faster. This leads to larger triangles for relatively flat surfaces, and small triangles only where needed, usually where there is more curvature.

A lower decimation value leads to a slower rendering, but a more precise visualization of the data.

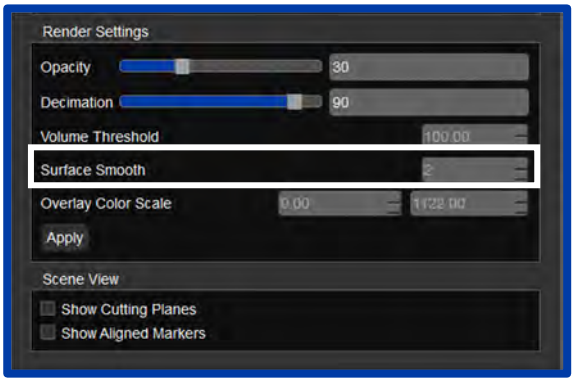


Volume threshold
For skin rendering, the system tries to find the optimal air-to- skin threshold automatically i.e., 100%.

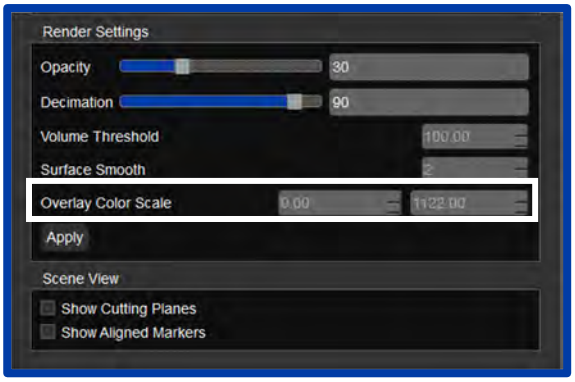
For other surfaces as brain and mask, it is recommended to keep the default threshold.



Surface smooth
Changes the smoothness of the surface (to remove rendering artifacts due to imperfections like noise in the MRI image.



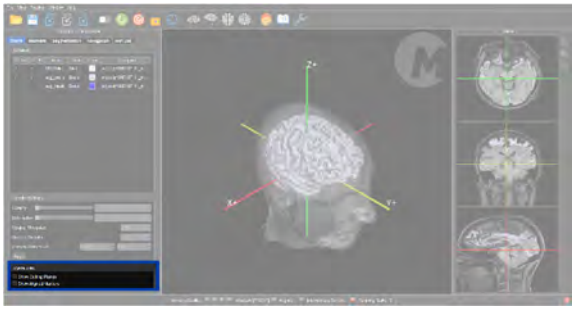
Overlay color scale
Used to visualize fMRI data. The value can be increased or decreased to show areas of higher and lower functional brain activity.



Scene view

- *Show cutting planes*
  Show axial, coronal and sagittal cutting planes through current markers used to create 2D slice panels.

- *Show aligned markers*
  Show captured markers after alignment. Use this to inspect the alignment accuracy.

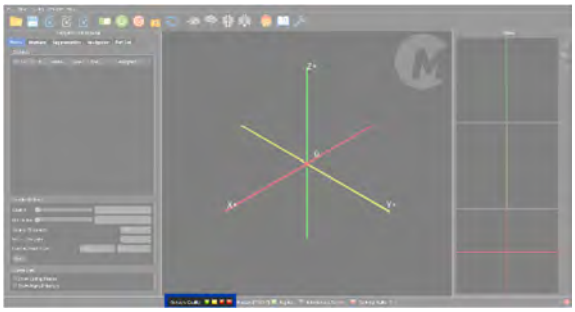


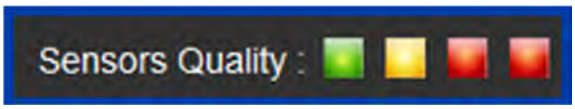
Sensor quality indicators

The position measurements for each of the 4 sensors contain a quality assessment.

The navigation software has 4 indicators (one for each sensor) in the status bar at the bottom that reflect the quality of the sensor readings with a color code, as follows:

- green (good quality reading)
- yellow (moderate quality reading)
- red (bad quality reading).



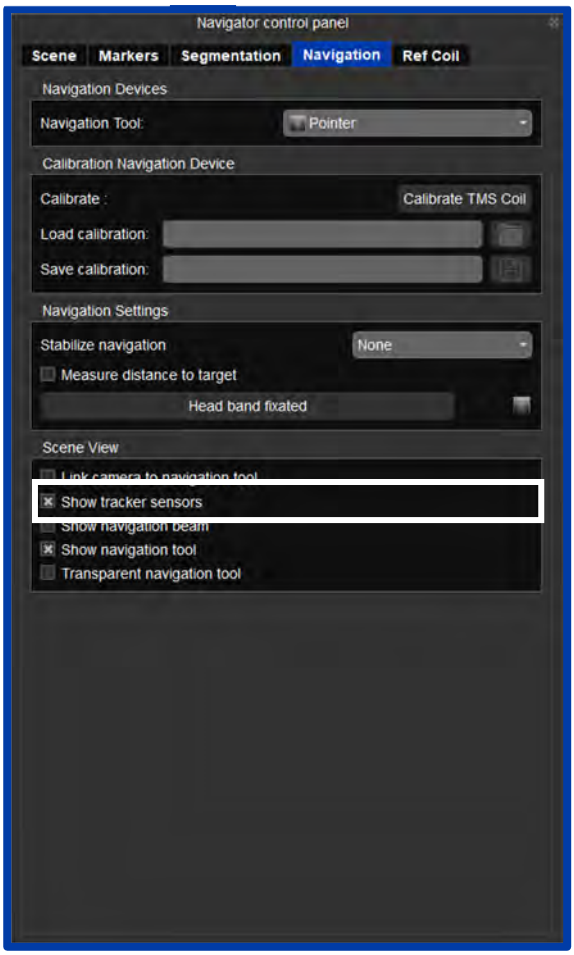


- Sensor no. 1 is for the pointer,
- Sensor no. 2 is for the navigation clamp, and
- Sensor no. 3 and no. 4 for the sensor headband.

Low quality readings imply there is a source of distortion nearby (such as pure iron, an electromotor, or the like), or that the sensor has been damaged.

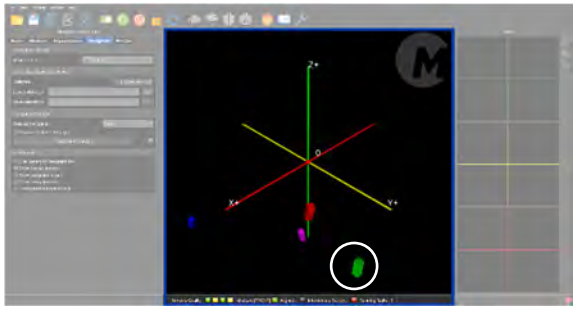
During setup, please verify the sensor quality indication in the workspace where the head of the patient will be located, to prevent any bad readings during navigation.

Go to the Navigation tab and switch on “show tracker sensors”.

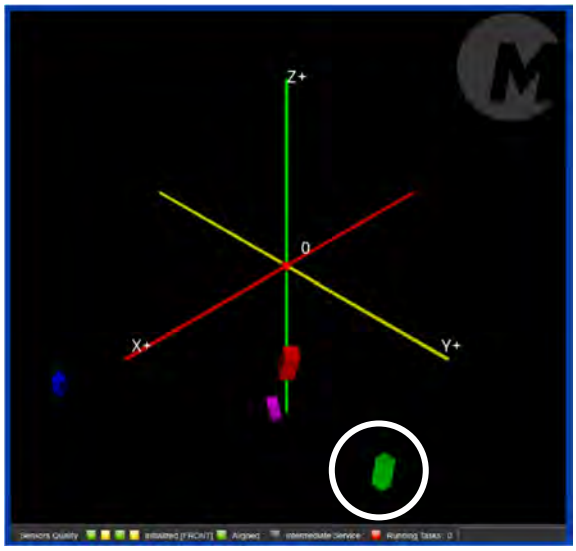


When “show tracker sensors” is switched on 4 colored boxes that represent the sensors, each in its own color, can be seen on the 3D screen.

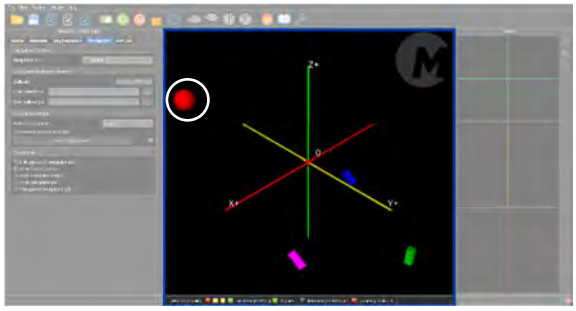
As default, sensor 1 is shown as the pointer. This can be disabled in the Navigation tab’s Show navigation tool, see page 33.

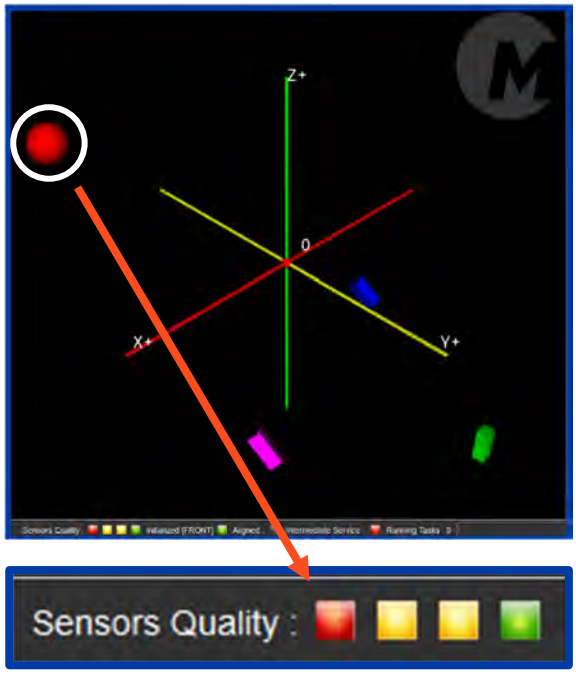


Sensors with a good quality reading (green or yellow in the status bar), are shown as colored boxes.



If sensor reading quality deteriorates, a small sphere will start to emerge at the center of the colored box. The bigger the sphere, the worse the quality of the sensor readings. For poor quality, large spheres will completely contain the colored boxes.





Create and set markers and targets manually

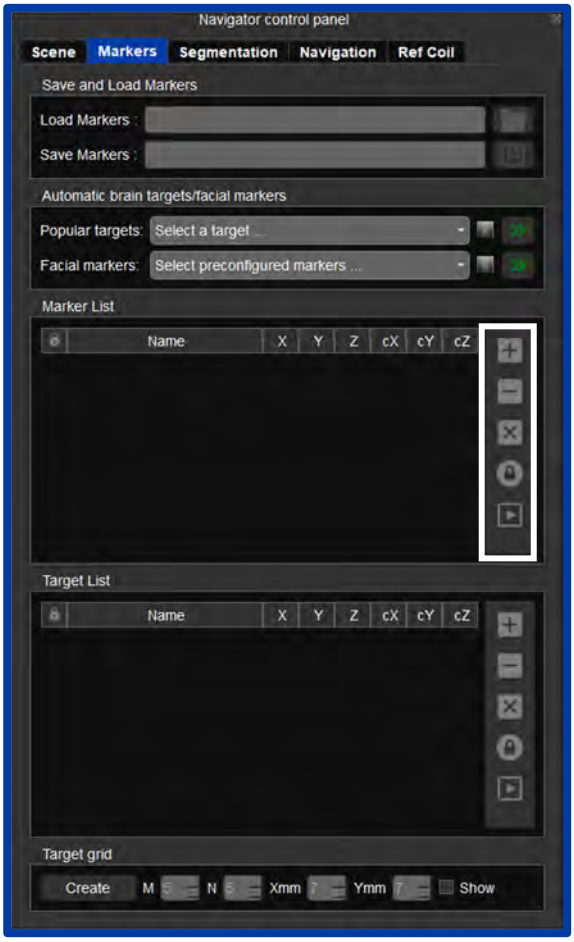
Create manual markers

To create and place markers manually, go to “Marker list” and press the ‘+’ button.

To move the marker, grab it with the mouse, or use the 2D slices overview, whichever is most convenient. Drag the markers in the 3D overview to move the markers large distances or use the X, Y, and Z position in the ‘Marker List’ display for small steps. “Grab” the marker in the main window by clicking on it while keeping the left mouse button depressed; it can then be moved in the x-y plane (e.g., left-right and backward-forward). When you grab it with the right mouse button, you can drag the marker in the x-z plane (e.g., left-right and up-down).

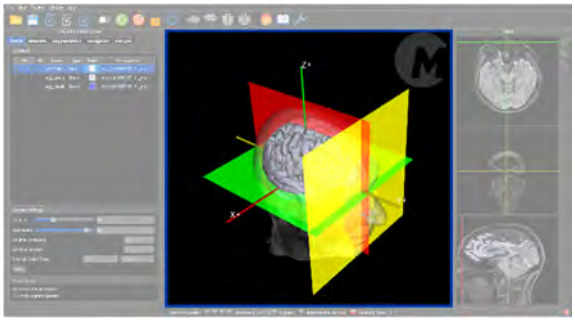
Double-click to rename the marker.
Note: The names of the markers can be displayed next to the marker spheres in the 3D screen. This option can be selected from the application settings, see page 35.

Press the ‘-‘ button to remove markers individually or the ‘x’ button to remove all markers.



Setting markers using the ‘sliced view’

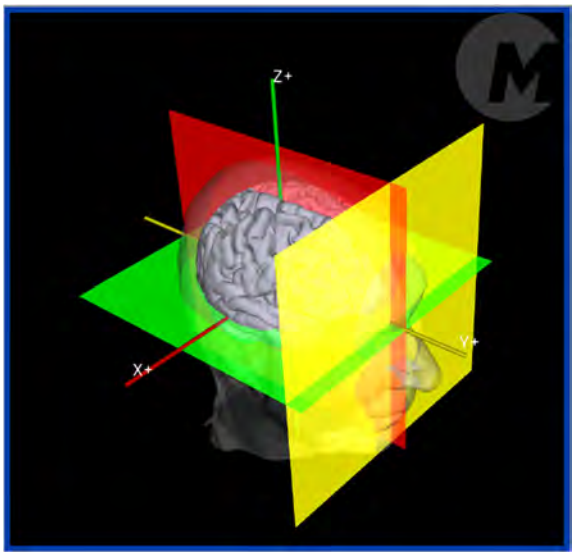
When setting markers, it is sometimes not sufficient to simply use the skin surface rendering in the 3D view of the main window. Therefore, the Atlas system also allows one to display gray-level coded slices through the brain behind the cursor, similar to how scans look on the console of most MR scanners. You can then use the MR gray level information in the slices directly to place your markers, when appropriate.



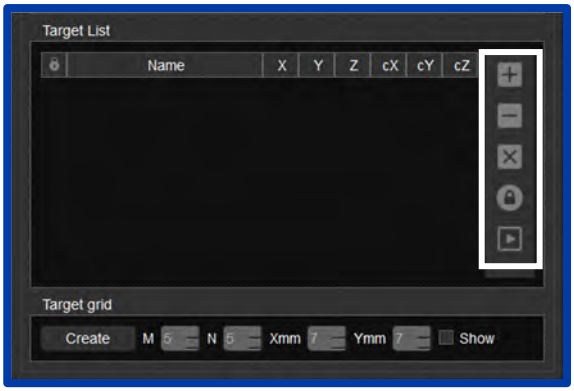
To aid sliced positioning of markers, one can also turn on the so-called 'cutting planes' in transparent surfaces, see page 63.

The slices views provide sagittal, coronal and axial views through the scan, obtained from 3 planes through the location of the currently selected marker or target.

You can click in the slices to rearrange your markers. With the right mouse button, you can zoom in or out of the slices.



Create targets manually



To create and place markers manually, go to “Target list”, and create a new target by pressing the ‘+’ button. A new target will populate as a blue sphere above the head in the 3D image and appear in the target list.

You can move the target into the desired position by either clicking and dragging on it in the 3D image or by left clicking in the 2D slice images.

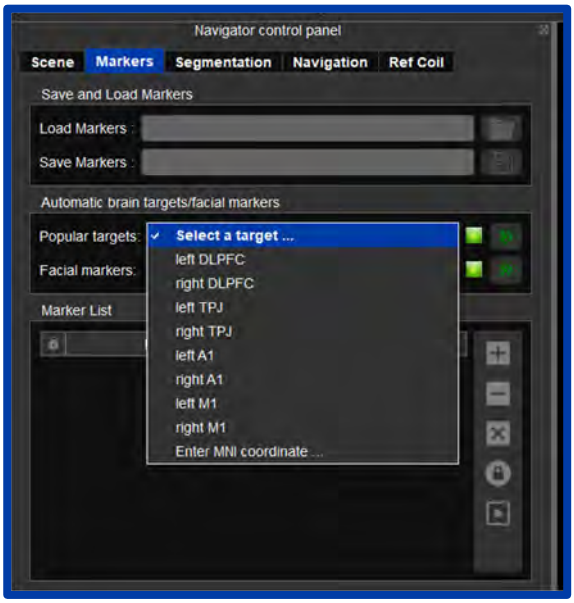
- Left click and drag the marker in the 3D image to move it along the x and y axis.
- Right click and drag the marker in the 3D image to move it along the z axis.
- Tip: use the predefined image orientation icons in the top panel to help.

Manually created targets can be renamed by double clicking on its name in the ‘Target List.’

Press the ‘-‘ button to remove targets individually or the ‘x’ button to remove all targets.

The “play” button snaps the target marker to the location of the navigation tool. This can be useful when using the beamF3 method of targeting, for example. To use this feature, load a new custom target, ensure the pointer is your navigation tool, put the pointer on your target location, and then press the “play button.” The target marker will snap to the location of the pointer.

Create markers with MNI coordinates



You can also enter MNI coordinates to place a target. To do this, select ‘Enter MNI coordinate…’ from the Popular targets dropdown menu, then click the green arrow. Enter your target marker's x, y, and z coordinates, then click OK. The new target marker will populate on the 3D image at the desired coordinates and appear in the Target list.

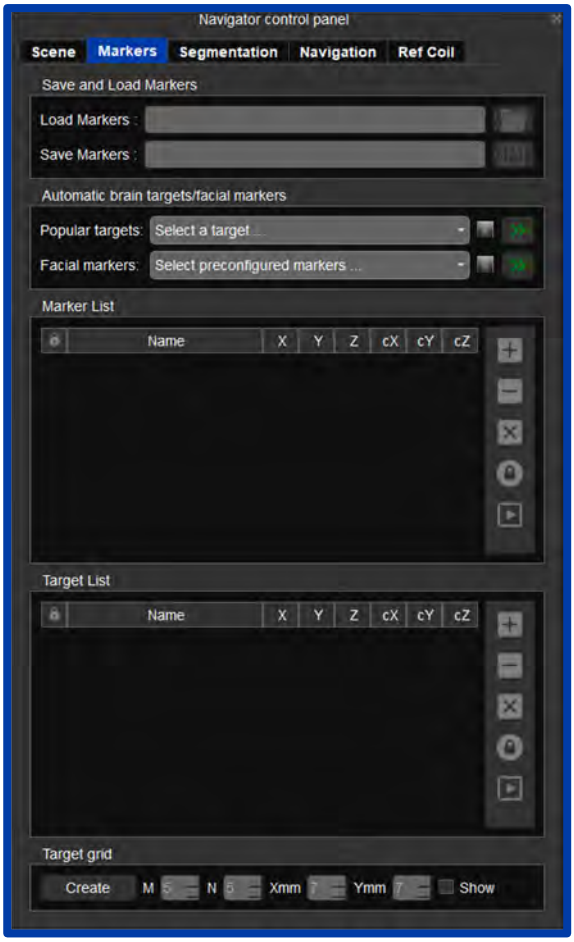
You can edit a target marker’s MNI coordinates after placing it by double-clicking on the specific x, y, or z coordinate you want to change.

Create target using pointer

To create and place markers using the pointer, go to "Target list", and create a target by pressing the '+' button. Now place the pointer on the desired location while holding the pointer perpendicular to the surface of the head, as this is how the coil will be placed.

The position is based on head surface position which can correspond to an entrance point above the real brain target. When the location has been found, press the 'play' button.

These targets are marked with red spheres.

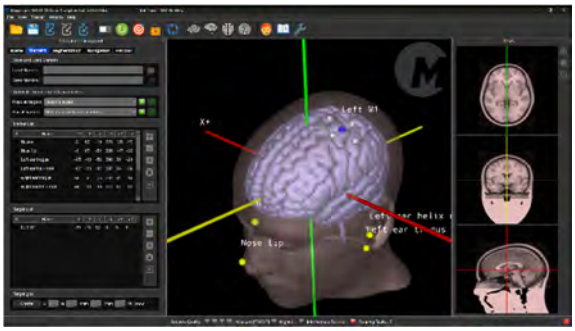


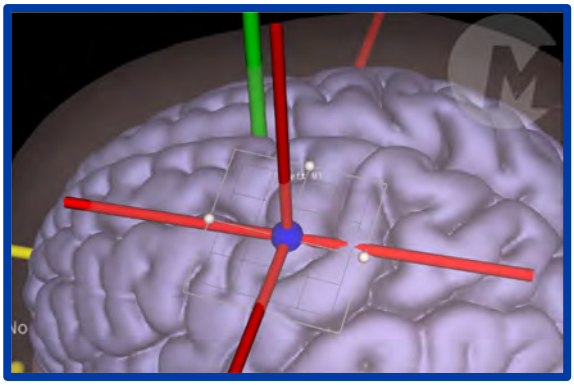
Create a target grid

By creating a 'Target Grid' you can structurally work your way through single pulse stimulation. You can make a grid of targets with the number of rows and columns of your preference and the size of the squares in the grid, which can be helpful for MT determination.

Open the markers panel to begin creating a target grid. Click on the checkbox next to 'Show' under 'Target grid.' An empty grid will appear above the head in the 3D image.

Click and drag on the grid in the 3D image while holding the shift key to move the grid to the location of interest. Release the shift key and click & drag to rotate the grid.



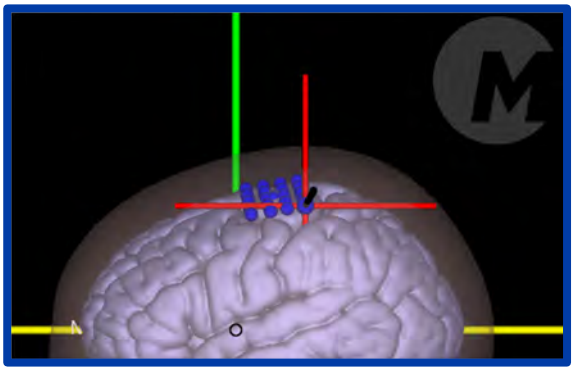


When the grid is in your desired position, click 'Create' to load target markers onto the grid. The new target markers will populate in the 3D image and be listed in the 'Target List.'

Tip: change the size of the markers and marker labels in the graphics settings to help your view.

You can select individual target markers by clicking on them in the list or in the 3D image. Move the target marker to the desired location by clicking & dragging it into place on the 3D image or by left clicking on the desired location in the 2D image.

- Left click & drag the marker in the 3D image to move it along the x and y axis.
- Right click & drag the marker in the 3D image to move it along the z axis.



Tip: use the predefined image orientation icons in the top panel to help.

Alignment

In most cases, alignment is successful. However, if the remaining error in the match is too large, and the software cannot compute the match, the alignment fails. This can occur if the wrong marker is captured, or the pointer wasn't held close enough to the facial landmark, among other reasons. If the alignment fails, navigation cannot be performed accurately.

Check 'Show Aligned Markers' in the Scene tab to show the captured markers in the main window after they are projected into MRI space, to see whether the alignment is sufficiently accurate. The aligned markers are shown as black spheres, whereas the markers set in Create and set markers and targets manually on page 66 are shown as yellow spheres.

The black and yellow spheres should be close together for alignment to be successful.

If necessary, either adjust the markers set or recapture the facial markers. When alignment is successful, the "Aligned" indicator at the bottom status bar will turn green, see page 46.

Use a distance measurement while navigating to your target

The next step in the process is to directly navigate to your markers.

The Atlas system has several tools that makes it easier to accurately aim for your predefined target, and optimize coil placement:

- a distance measure in millimeters
- the depth of the target below the coil in millimeters, and
- the angle with respect to the midsagittal plane of the brain in degrees.

Below, these measures are explained in detail.

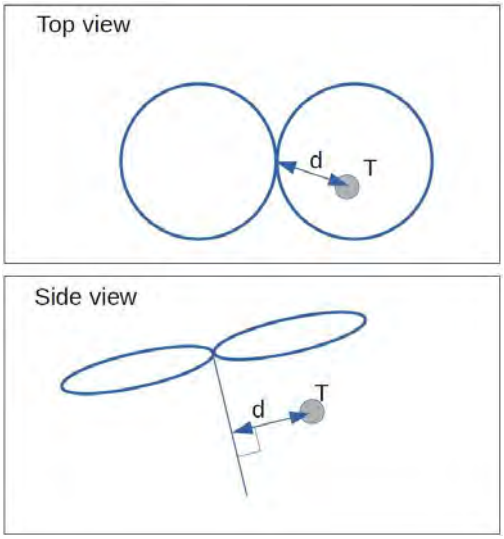
Distance measure

The distance measure is defined as the orthogonal distance between the center line (yellow beam) of the coil and the blue target sphere in the brain.

That is the length of the line shown in the 3D scene, that extends from the blue target sphere to the yellow beam along the shortest path. This allows you to see how far in millimeters the TMS pulse is away from the predefined target.

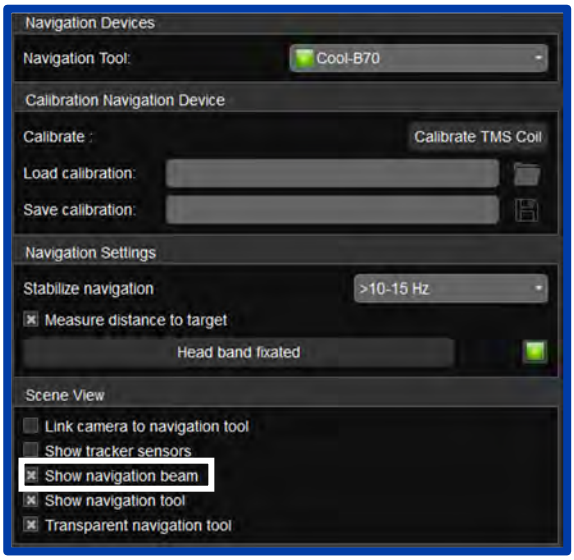
This can be useful, as the system will warn you when the navigation is no longer accurate. You can then correct the coil position immediately until you are again at your desired target.

See the figure on the right for a geometrical clarification of this distance d with respect to target T, with the coil and center line (beam) shown.



Simply turn on this setting in the 'Navigations Settings' window in the Navigation tab.

The distance between the location of the target and the location of the coil will appear at the bottom left section of the screen.
Note: You must select the target sphere you wish to aim for in the Markers menu for this tool to be activated.



If the distance is less than 10mm, the distance measure is colored green, and you are within acceptable accuracy.

If the distance is between 10 and 20mm, the distance measure turns yellow, and a beep sounds every few seconds, to warn the operator that navigation is now inaccurate.

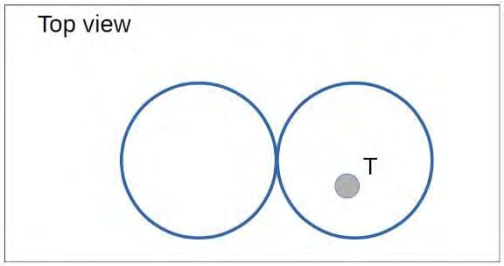
If the distance is larger than 20mm, the distance measure turns red, and a more alarming tone sounds at shorter intervals.

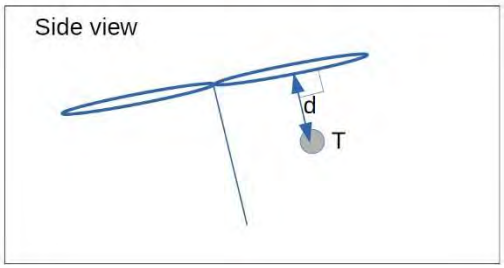
Depth below the coil

The depth below the coil is computed as the perpendicular distance between the bottom surface of the coil and the blue target sphere previously placed in the brain, in millimeters.

Importantly, this is equal to the shortest distance between the target and the bottom coil surface, and could hence also be to a non-central spot on the coil, for example in a coil wing for a figure-8 coil.

See the drawing on the right for a geometrical explanation of this depth measure, **d** with respect to target **T**, with the coil and center line (beam) shown.
Note: The accuracy of the depth estimate depends on the quality of your alignment and your MRI scan, it might not be 100% correct if either quality is compromised.



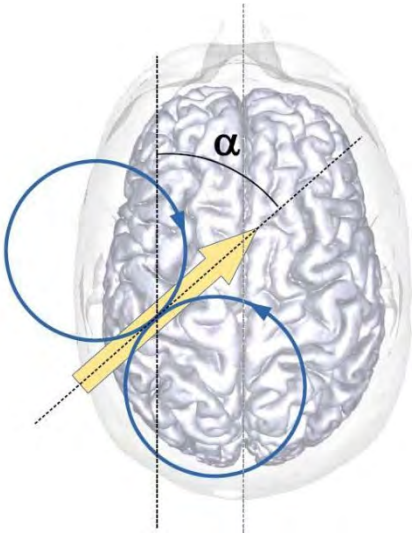


Coil angle

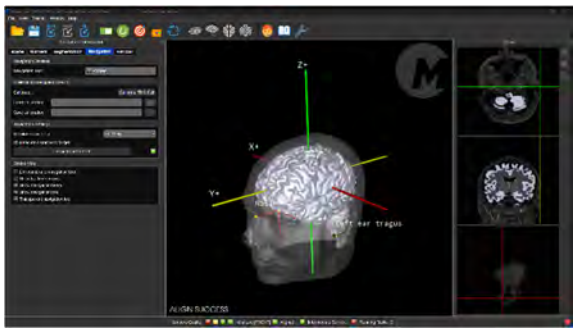
The real time angle measure reflects the angle between the direction of incident currents evoked by the coil in an underlying medium, and the midsagittal plane of the patient's head.

See the figure with a coil on the motor cortex with an angle of about 45 degrees with respect to the midsagittal plane. The current orientation in the coil wires is shown, and the incident current in the brain of the patient is shown as a yellow arrow.

Note that the current evoked by the coil is assumed here to be directed away from the coil handle and that the incident current direction is projected to the ground plane (x,y) before this measure is computed.



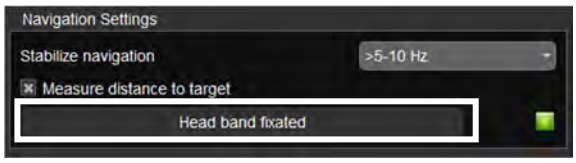
Head movement compensation



The Atlas system can track head movements and compensate navigation for head movements.

The head movement compensation tool guarantees correct navigation on the screen as the 3D scene changes with the patient's head movements. Head movement compensation does not mean the coil is automatically displaced.

Switch on head movement compensation by selecting 'compensate head movements' in the 'Tracker' tab of the General Settings.



When using head movement compensation during marker capturing, please click "Head band fixated" before capturing to allow the patient to move the head during that phase.

If this button is not clicked, head movement compensation will not take place. In this case, the patient's head should not move during marker capturing and alignment and should preferably be fixed (either by asking the patient to hold the head very still or by fixing the head with the vacuum pillow.

After capturing and immediately at successful alignment, head movement compensation will automatically start and it is assumed the headband is appropriately fixated.

Note: The above only applies when the 'compensate for head movements' checkbox in the tracker settings (see page 38) is enabled. If not, head movement is never applied, and the patient should not move the head at all during capturing, alignment and treatment.

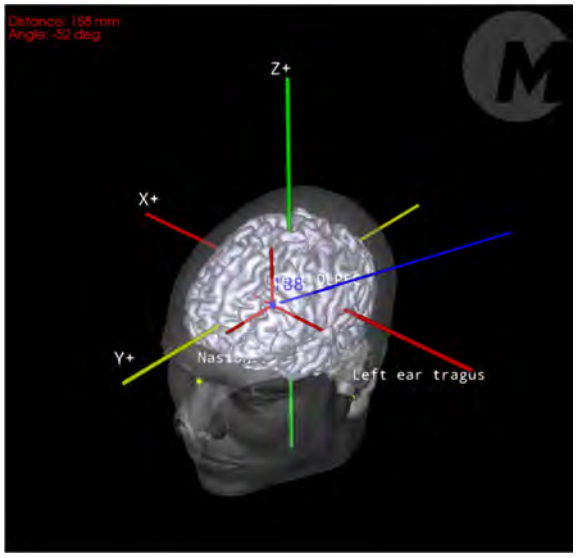
If you enabled head movement compensation, the patient can move his/her head gently and is not required to keep the head immobile all the time, starting either just before capturing or at the moment of alignment at the latest.

The software can indicate that the target was missed due to too much head movement, and you can see this happen on the screen. The navigation tools (pointer or coil) will move opposite to the head movement; the head on the screen will stay still (for normal navigation, not 'linked to navigation tool').

Relative to the head, the navigation tools are shown in the correct position. This is most convenient during navigation, as an immobile head on the screen will allow you to keep your preferred view on the previously chosen brain.

Note that once the head has moved, you will have to correct the coil position and move it to the new position on the scalp overlying your brain region of interest.

It is highly advised to use head movement compensation together with the distance tools, see page 34. When Measure distance to target is switched on and the target selected, a tone will sound to indicate incorrect navigation due to head movement, which will trigger you to correct the position of the real coil until the tone stops. This will allow you to focus the patient and the real coil the whole time.



It is possible to slide the patient sensors along the patient headband when stimulating near the recommended sensor placement area.

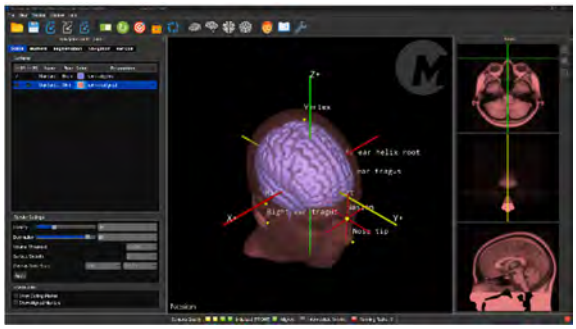
CAUTION Do not stimulate in close proximity to one of the sensors in the sensor headband. It is possible to disconnect one sensor and only use the other sensor for head movement compensation.

Reproducible coil placement using MNI

Note that for this feature, you **do not need an MRI** scan of the patient.
WARNING Reproducible coil placement is purely intended to reproduce a previously recorded coil position and orientation, and is not considered an accurate method to navigate to a brain area. For that purpose, an MRI scan is needed.

The method is performed in 3 main steps, described below.

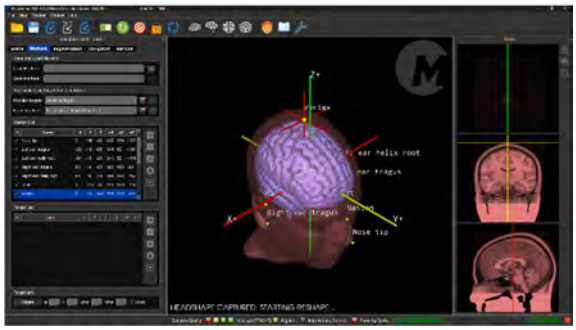
Step 1. Start the MNI Workflow



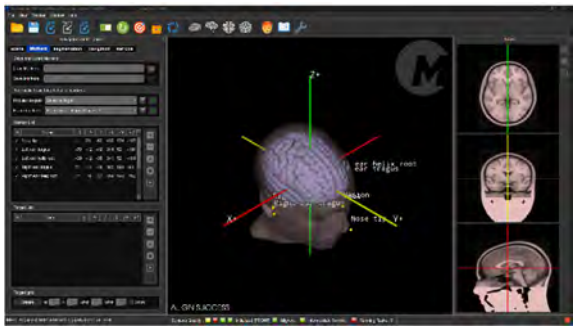
To start, click the MNI icon in the top taskbar and accept the warning message to continue.

An MNI space head and brain model will load, including a marker set containing six facial markers and two additional markers for the vertex and inion that will only be used during the patient's first registration.

The tracker initializes, and the auto-capturing process begins. Use the pointer and remote to capture each facial marker as indicated in the 3D screen one by one using, very much like normal capturing described in the preceding sections.



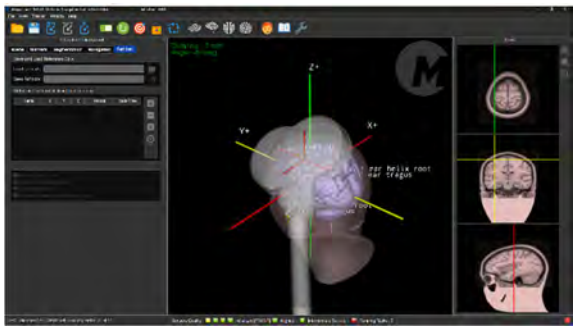
After this capturing procedure is completed, the software will perform a linear affine transformation in which the template MNI scan is roughly and linearly (full affine) transformed to the actual size of the head of the person you are navigating on and will indicate that '*headshape is captured, starting reshape*'. The Inion and Vertex markers are removed; they only were present to allow a coarse estimate of the patient's head shape. See the picture on the right for an overview of the screen you now should see.



Note that the remaining facial markers are also displaced a bit with respect to this reshaped head, even to the extent that they no longer fit the head features. This is the case as the captured markers positions captured on the patient are mapped rigidly onto the reshaped MNI space head, which is not 100% exact. This allows precise reproduction of alignment in future sessions, as the markers in the 3D scene are now shaped exactly as the actual patient head shape. Do NOT reposition the markers yourself to the corresponding facial landmarks; the mismatch is intentional. Note that the refitted model head is the part that could be a little mismatched, as an MNI space head model can never be exactly matched to a patient head shape. Furthermore, it is important you wait until this entire process has finished. Watch the progress bar at the bottom of the application for this.

You can save the project by clicking the Save icon, storing the reshaped MNI space head and markers and targets to disk, allowing you to resume during a future session.

Step 2. Saving Coil Position.



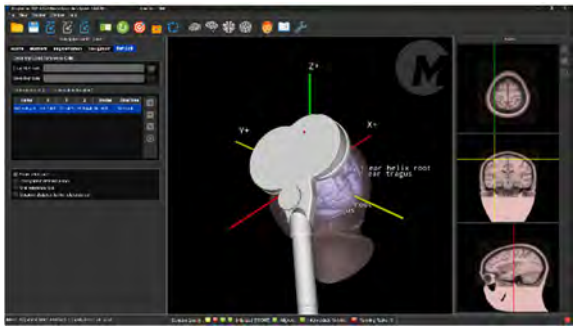
Open the 'Ref Coil' tab in the Navigation control panel and place your coil on the desired scalp location, for example, saving an MT hotspot or a 5.5 cm placement rule that allows you to visit a stimulation spot not based on an MRI scan.

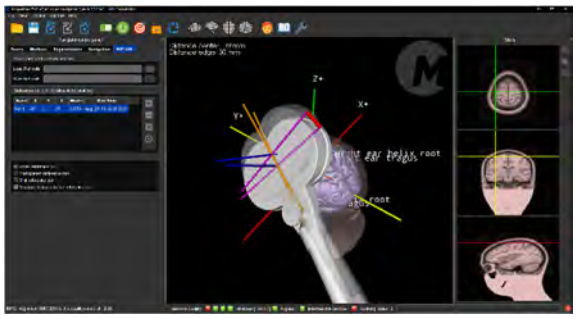
Press the '+' button in the Ref Coil panel to capture the position of the coil. A new reference coil will appear in the list 'Reference coil (coil at stimulation location).'

Tip: Double-click on the name of the reference coil to rename it.

Save your project.

Step 3. Repositioning the coil for a future visit.





Load the previously stored Project for this patient and open the 'Ref Coil' tab. Click on the reference coil you want to recall, then check 'Show reference coil.' You can also select the 'transparent reference tool' and 'mini reference tool' options to help with your view.

To reposition the coil, open the 'Navigation' tab and select your previously used coil as the navigation tool, which will become visible in the 3D scene. Open the 'Ref Coil' tab, and then select 'Show reference coil' and 'Measure distance to the reference coil.'

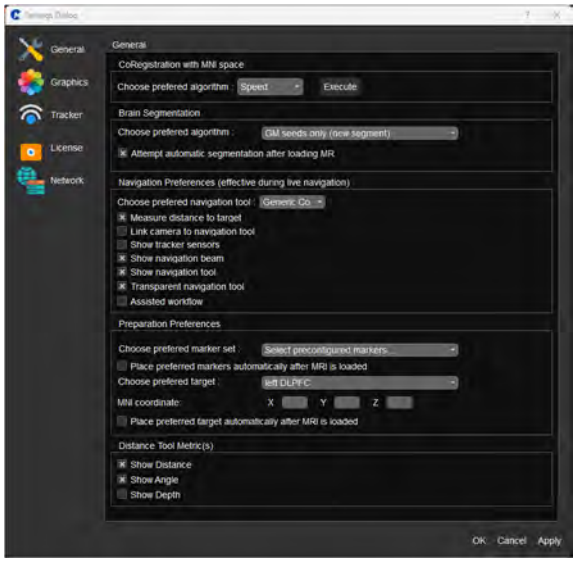
The distance and angle of the coil you navigate relative to the reference coil will be displayed in the top left corner. When the distance and angle measurements are equal to zero, the coil is in the same position as when you created the reference coil.

Automating your preferred workflow

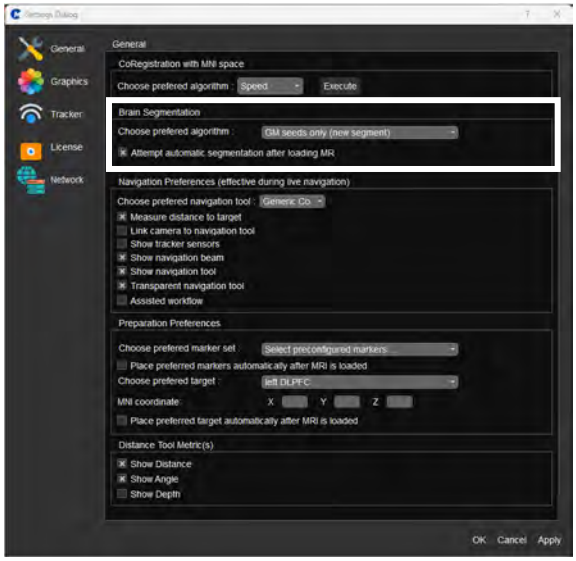
Most preparation steps can be combined into a single fully automatic workflow, including image loading, brain segmentation and automatic markers and target placement.

In practice, when you import an MRI, brain segmentation begins automatically, registration with MNI space is performed, and your preferred marker set and stimulation target in the brain are placed. You could begin with navigation on your patient almost immediately after, pending a final check and some slight adjustments if needed.

To configure your automatic workflow, go to the Settings page, then the “General” Tab.

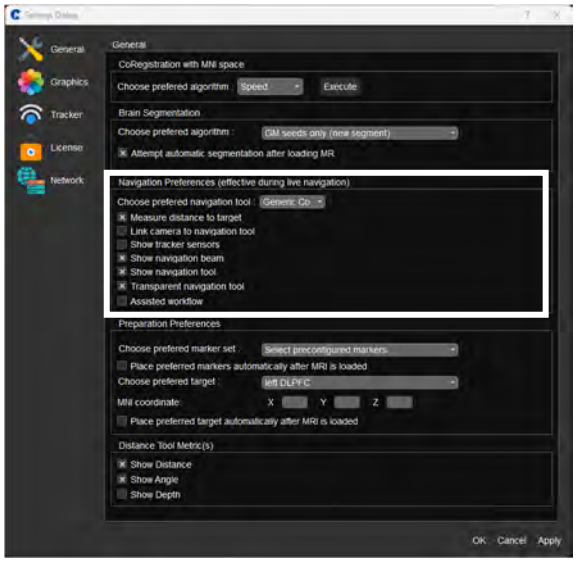


Check the corresponding box in the “Brain Segmentation” tab to automatically initiate brain segmentation after importing an MRI image. In the ‘Preparation preferences’ section, you can select the preferred set of facial markers to position on your patient’s MRI, and the preferred stimulation target on the brain surface.



Note that after automatic preparation, you do need to inspect the final result of segmentation, and the markers and target’s locations.

Finally, you can select the coil you wish to use in the “Navigation Preferences”, as well as other preferences related to live navigation, such as transparency of your coil, whether you want to see the distance measurements, and so on.
These preferences will be taken into account right after alignment succeeds, so you can start to navigate immediately.

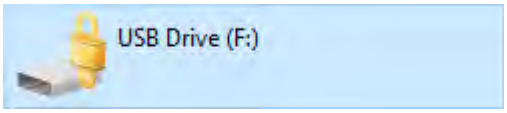


Using these automation features, going from a raw MRI to actual navigation becomes very easy, and you can start MRI guided treatments quickly.

Encrypted USB stick

Using encrypted USB stick

Insert the included, BitLocker encrypted USB stick on Windows computer.



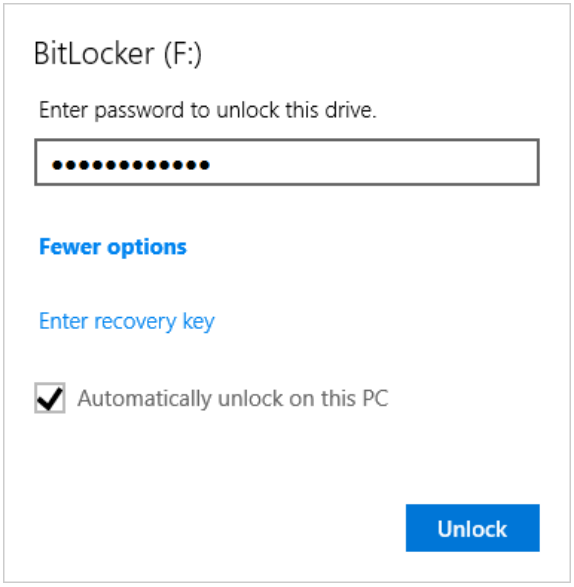
Open: Windows File Explorer
Click: Encrypted USB Drive

Find USB stick password on Atlas password sheet.

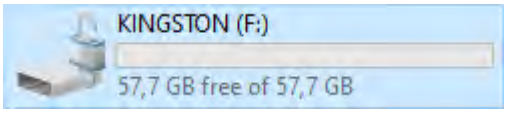
Type password.

For convenience, select: Automatically unlock on this PC.

Click: Unlock



Notice that USB drive gets unlocked.

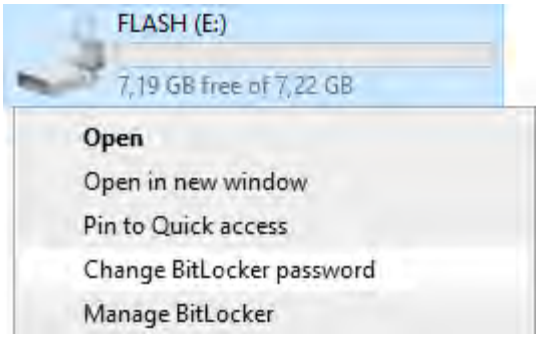


At this point USB stick can be used like any other between work PC and Atlas system, while data is protected and inaccessible on any other system.

Store original password in a safe and secure location or change the password like described below.

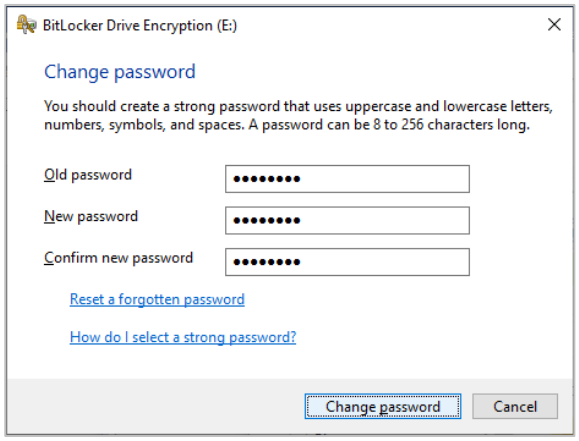
Change BitLocker password

You can change the BitLocker password like this:
Open: Windows File Explorer
Right-click & click: Change BitLocker password



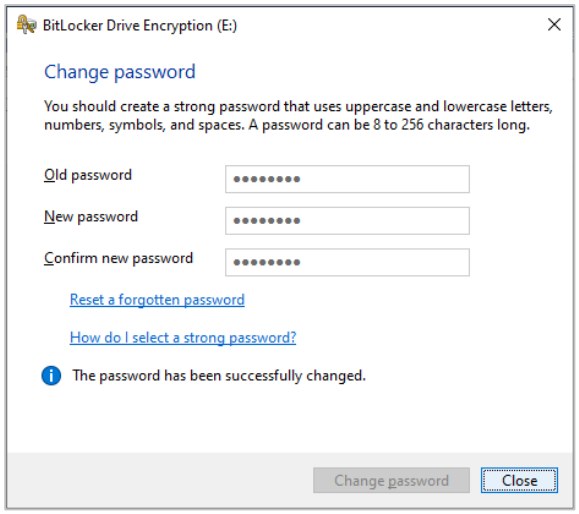
Type old password, new password and confirm new password.

Click: Change password



Notice message: The password has been successfully changed.

Click: Close

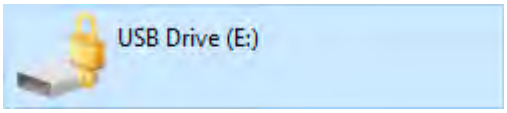


Using recovery key

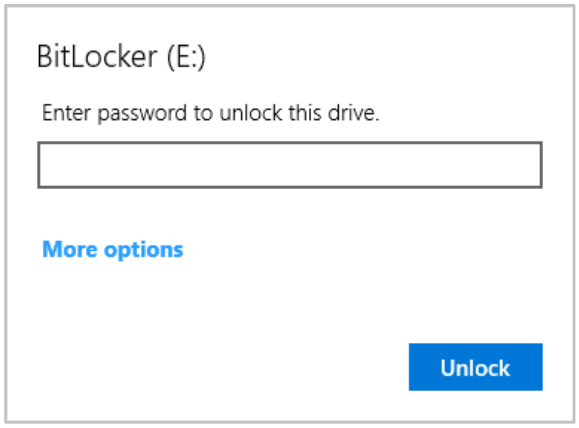
If password is lost or drive otherwise becomes inaccessible using recovery key is the final option.

Find included recovery key for USB stick.

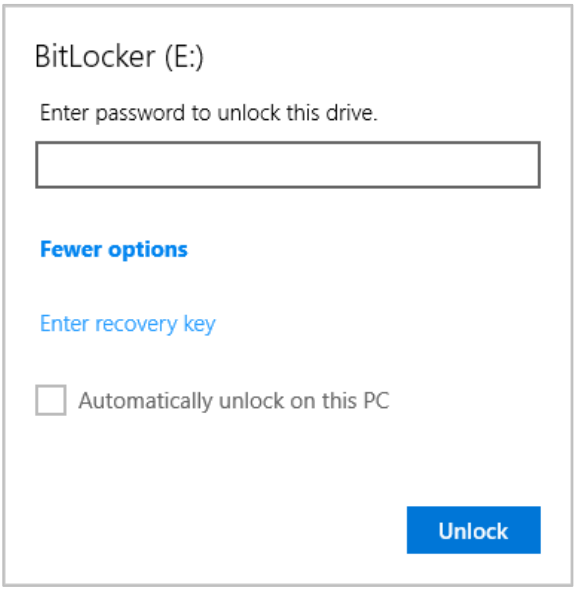
Open: Windows File Explorer
Click: Encrypted USB Drive



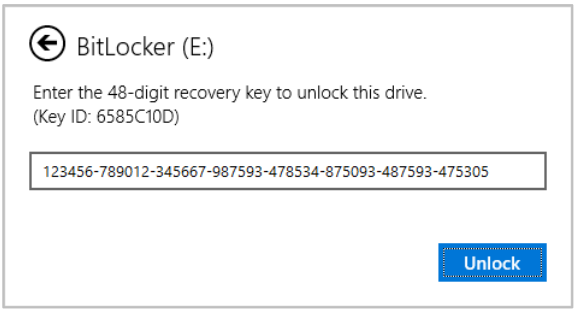
Click: More options.



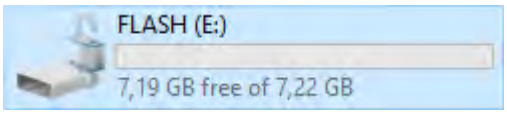
Click: Enter recovery key.



Type: recovery key exactly
Check: recovery key
Click: Unlock

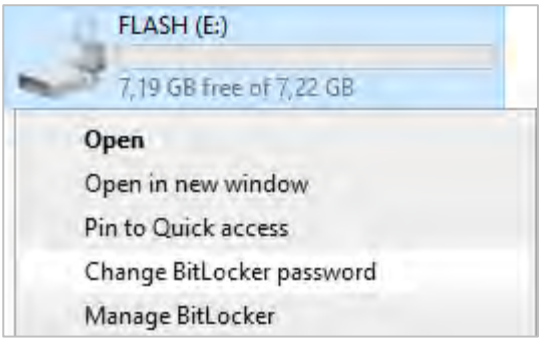


Notice that USB drive gets unlocked.

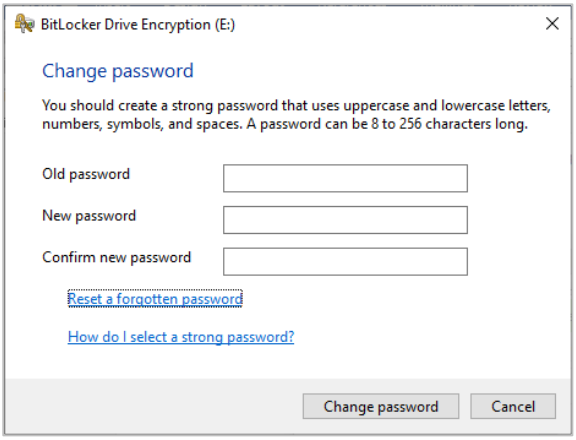


It will be very inconvenient to use the recovery key each time the USB stick is inserted so a new password should be set.

Right-click & click: Change BitLocker password

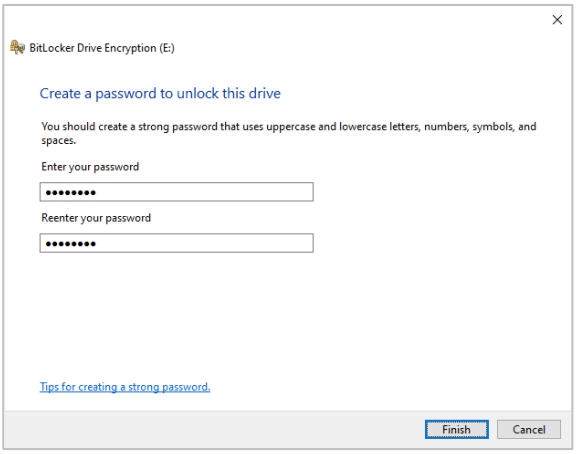


Click: Reset a forgotten password



Type new password twice.

Click: Finish



Required (f)MRI data

You yourself are fully responsible for providing the proper MRI data to the Atlas system. It is very important to verify beforehand that the MRI data quality is sufficient. When the quality of MRI data is poor, neuronavigation will be poor or unsuccessful. If you do not have a proper background in MRI data acquisition and image inspection, be sure to consult your local MR physicist or radiologist for support.

Also, ensure that proper spatial registration of the three image types that can be loaded into the Atlas system is assured. When for example the T-map is not properly registered with the anatomical scan, there is no way for the Atlas system to determine where the activation pattern is located in the patient's head, and navigation will most likely be inaccurate. Usually, segmentations based on the anatomical scan will be co-registered automatically, since they are derived from the anatomical scan.

Supported data format specification

The Atlas system is a tool to navigate a patient's brain and mark regions on his or her scalp directly overlying a brain region or activity pattern of interest. It is the user's responsibility that the proper data is provided for use with the Atlas system. The MR data should be stored in a digital 3D image volume containing intensity values for each voxel. The Neural Navigator currently reads 3D image volumes stored according to the Nifti 1.0 specification as introduced by NIH, and data in the DICOM standard common to many medical applications.

The Nifti data format is nowadays the format of choice for many MRI analysis and display packages. It usually has the .nii extension (header and data in 1 file), but is also allowed to have 2 separate files with the header and image (.hdr, *.img). On the CD you can find proper sample data to practice the use of Atlas system.

The Atlas system also allows you to import a DICOM dataset of an MRI exam, which is often available directly at the MRI scanner from a DVD. You can import DICOM using our powerful DICOM import wizard, which searchers through the many scans that can be in your DICOM folder, and displays all types of scans made in a clear interface. You can then select the T1 weighted MRI scan from that list. This will automatically compute and visualize a 3D surface representing the skin. To see a 3D brain rendering, you need to segment the brain from this anatomical scan, which you can do in our brain segmentation tab in a few simple steps.

Image volumes required for the Atlas system

Surface representations of skin, cortex and activation areas will be extracted from the image volumes needed. Below are the data types that are required to navigate a patient's brain stereotactically described in more detail.

Required

Volume A. An unprocessed T1 weighted anatomical MRI image (in the following referred to as anatomical scan), with sufficient spatial resolution (1x1x1 mm is recommended) and anatomical contrast. The format should be either a Nifti (*.nii) file, or a DICOM dataset directly produced by your MRI scanner. Ensure that a sufficiently large area of the head is scanned; the Atlas system uses facial landmarks such as the eyes, nasal features, ears, etc. It is recommended to scan at least the entire area between the lips and the vertex when recording your anatomical scan. This image volume is used by the Atlas system to extract the skin surface, which is necessary to place the 3D markers on facial landmarks. Loading this anatomical image also allows you to set targets for TMS stimulation directly in the sliced view of the brain, so when you only want to stimulate a brain region you can identify on anatomical slices, you do not necessarily need the data described below in 2) and 3).

Optional

Volume B (brain segmented in other software package). An image volume of the same size and dimensions as the anatomical scan containing segmented gray matter voxels. This map should represent a probability map with values between 0 and1 indicating low or high probabilities for gray matter. Most MRI analysis packages produce decent segmentations directly from the high-resolution anatomical scan for neuronavigation purposes. Segmentation typically creates gray matter, white matter and cerebral spinal

fluid (CSF) probability maps from a high-resolution anatomical scan. Ensure the segmentation scan is properly registered with the anatomical scan before loading it. Please note that you can also produce a brain segmentation in the Atlas system, using the brain segmentation tab. This is most useful when you use a workflow starting with DICOM. In this case, you do not need Volume B.

Optional

Volume C. An image volume containing a statistical map of fMRI activation patterns, such as T maps generally provided by MRI data analysis packages. Again, make sure it is registered with the anatomical scan.

Additional considerations regarding your data

- One can either target an anatomical brain feature such as a sulcus when using the Atlas system, an activity pattern, or both. You could load one of the volumes B (brain) or C (activation), although using both is perfectly fine. When you can identify your region of interest on the slices in the slice window, you do not even need the brain or activation data but can start navigating with only volume A.
- When navigating the 3D image, it is rotated around the so-called 'origin' as specified by the data file's header information. The loaded surfaces of skin and brain and maps will be rendered around this origin, and the coordinate axes in the Atlas system main window are drawn through the origin. An origin at the anterior commissure is recommended.
- Upon request, MagVenture. can provide assistance and advice in MR image processing and MRI data quality inspection.

MNI

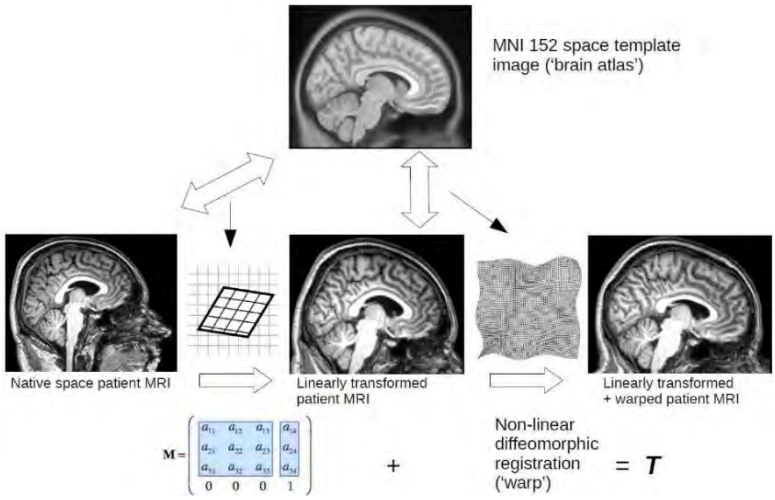
Automatic registration with MNI space

The Atlas system v3.3 and higher can register a stereotactic template MRI image (in Montreal Neurological Institute (MNI) space), i.e., a 'brain atlas', to an MRI image of the individual patient MRI. This will establish a well-defined spatial relationship between the brain atlas and the individual brain of the patient, and thus allow the user of the Atlas system to automatically mark of locations on the head and in the brain for neuronavigation purposes. This section provides some background on this process.

Stereotactic templates of head and brain have been around for decades. They consist of matched averages of usually 100s of individual MRI scans.

The process we refer to as 'registration' here is more specifically referred to as 'normalization', and serves to match objects of different shape and size to each other.

The spatial operations needed for such a process hence consist of an approximate linear part (incorporating rotation, translation, zoom and sheer operations), and a more precise non-linear part that locally shifts tissues to perfect the match between the MNI space template and the individual patient's brain. The total transformation T (first linear and then nonlinear warping) can be used to map points from patient native space to the brain atlas space and vice versa.



When you load an MRI image, the transformation T is computed, which can take several seconds to several minutes, depending on the registration profile you have chosen. The speed profile only performs the linear registration process displayed above, which takes approximately 5 to 10 seconds on a modern PC, and is only moderately accurate. The 'accuracy' profile computes the non-linear warping process after the initial linear registration, which together can take minutes to complete but results in a closer match between the locations preselected in the MNI space template (such as stimulation targets and facial markers) for you and the patient MRI that you loaded. Nonetheless, it is always needed to inspect automatically labeled locations and adjust manually where needed.

This transformation T is used for automatic facial marker and brain target placement, as it takes the known MNI space locations for these positions and warps them to the space your patient MRI is in.
As an MNI template, we use the T1 weighted MNI image derived from 152 individually matched MRI scans of human heads, in the symmetric variant (we will refer to it as the MNI152 template in the following). This template preserves ample brain morphology and at the same time is representative for a wide range of the human adult population.
Note that you need a good quality anatomical MRI scan to create a reliable co-registration of your MRI with MNI space. With low quality MRI scans, your automatic placement of markers and targets is likely to be unreliable.

Technical Data

Mechanical Data

Dimensions

BrainTrak:	(HxWxD)	292 x 185 x 64mm

Weight

Atlas system incl trolley:	39 kg / 86 lbs

Environmental data

Operating temperature:	5 – 40°C (41-104°F)
Storage Temperature:	0 – 60°C (32-140°F)
Operating Humidity:	10 – 90% non-condensing humidity
Storage Humidity:	5 – 95% RH
Operating Pressure:	max. 79.4 kPa
Operating Altitude:	max. 2.000m
Storage/transport Pressure:	24-106kPa
Storage/transport Altitude:	-400m to 10,000m

Pollution degree 2: Micro-environment with non-conductive pollution, except occasional conductivity caused by condensation.

System Power

The complete Atlas Neuro Navigation System is powered from MagVenture Isolation Transformer 230V~ outlet.

BrainTRAK Electrical ratings and specifications

Electrical rating:	100 - 240 V ~ 50/60 Hz
Input power:	50 VA
Type:	Class I Device with Type B Applied Part (sensors), EN 60601-1 Compliant. RoHS and WEEE compliant.
Installation class:	2
Safety class:	1
IP class:	IP20
Type of applied part	B
Fuse Type:	T1AL250V: 1 0 A; 250V; T (Time Lag /SLO-BLO)

Medical grade PC Electrical ratings and specifications

Electrical rating:	100 - 240 V ~ 50/60 Hz
Input power:	90W
UL approved:	E211696

Part numbers

MagVenture TMS Atlas Neuro Navigation System	9018M0011

Supported coils

Cool coils	MCF-coils	Standard coils
Cool-B65	MCF-B65	C-B60
Cool-B70	MCF-B70	C-B70
Cool D-B80		

Literature reference

Location	Abbrev.	MNI space coordinate		Source
		Left x,y,z (mm)	*Right x,y,z (mm)*	
Dorsolateral prefrontal cortex	DLPFC	-39.6,43.5,36.7	39.6, 43.5, 36.7	Fitzgerald et al 2009 (PMID 19145228)
Temporo parietal junction	TPJ	-69.0,-41.0,11.0	69.0,-38.0, 13.0	Hoffmann et al 2013 (PMID 23485015)
Primary auditory cortex (Heschl's gyrus)	A1	-67.0,-12.4,2.5	68.0,-7.0,2.5	Abdul Kareem et al 2008 (PMID 18666141)
Primary motor cortex thumb knob	M1	-38.0,-17.0,70.0	38.0,-17.0,70.0	Manually determined hand knob in MNI152 img (Yousry et al 1997, PMID 9055804)
Nasion	-	0.0,85.0,-44.0		Manually determined in MNI152 img
Tip of the nose	-	0.0, 100.0,-86.0		Manually determined in MNI152 img
Tragus of ear	-	-82.6,-18.0,-5.0	82.6,-18.0,-65.0	Manually determined in MNI152 img

Symbols

Device symbols

Attention, see Instructions for use. Specific warning notification in manual.

SN Serial number

Lot number

Catalogue number

Risk of electrical shock

Applied part B (can be applied to patient)

Individuals with pacemakers or other medical electronic implants are not allowedto be treated with or operate this device.

Do not use if package is damaged

Consult instructions for use

Manufacturer

Date of Manufacture

Medical Device

Indicates that item is not for general waste. Equipment must dispose in compliance with the WEEE (Waste Electrical and Electronic Equipment) Directive of the European union.

Transport and storage symbols

Storage temperature range

Humidity limitation

Atmospheric pressure limitation

This side up

Keep dry

Fragile

Maintenance

Prior to use

Prior to use, go through the following steps:

- Check the transmitter and sensor cables for damages to the insulation.
- Inspect both the component connectors and receptacles for bent or damaged pins.
- Inspect the transmitter for cracks and exterior damage. If transmitter is cracked or interior of the transmitter is exposed in some way, the component should be replaced after proper disposal.

Periodic maintenance

Periodic maintenance includes the following:

- Check that transmitter, sensor, and electronics unit mounting provisions are secure.
- Maintenance of the internal parts of the BrainTRAK electronics unit may not be performed by the user, but only by the manufacturer, nor may the housing of the unit be opened by the user, otherwise regulatory approvals and your warranty will be void. If the electronics unit is defective or malfunctioning, it needs to be returned to the manufacturer for repairs.

Sensors and cables

Sensors and cables are subject to frequent and continuous stress. To minimize problems, pay attention to the following:

- Do not flex or twist the sensor cable.
- Prevent any part of the sensor from being crushed. The connectors can become warped if stepped on; the internal wires in the sensor cable may break or become weakened if pinched; and the sensor head may be damaged if trapped under something heavy.
- Do not drop or hit the sensor against a hard surface. This will cause accuracy errors.

Cleaning

The Atlas system components which come in contact with the patient must be cleaned after each use, mainly the pointer and headband. They also need to be inspected for cracks and sharp edges due to daily use or wear.

- To clean sensor headband, sensors, transmitter and the navigation clamp, wipe them with a cloth dampened with a general-purpose cleaning solution such as soap and water, isopropyl alcohol, etc.
- Do not immerse the transmitter's sensors, or cables in liquid.
- Clean the pointer with hot water (temperature below 60° Celsius) and soap. Rinse well. Navigation cannot be performed without prior cleaning of the pointer.

Technical Description

WARNING Do not modify this equipment without authorization of the manufacturer.

CAUTION Do not remove cover; Electric shock hazard. Any maintenance inside the device must be performed by qualified service personnel.

Service must only be referred to Tonica or other authorized service personnel, except for such works described in this manual as being performed by the operator. The device must be disconnected from all voltage sources before being opened for any adjustment, replacement, maintenance or repair.

CAUTION Replace fuse with same type and rating.

The BrainTRAK device has two primary fuses: F1, F2: T1AL250V: 1.0 A; 250V; T (Time Lag /SLO-BLO), ø5x20mm, Bussmann type.

External power adapter for Medical grade PC device: 19VDC, 90W. FSP Group Inc. model: FSP090-RBBM1.

Mechanical spare parts

Atlas Navigation Coil clamp kit, ø38 - 1pc	9017B0011
Atlas Navigation Coil clamp kit, ø29 - 1pc	9017B0021
Atlas Navigation Coil clamp kit, ø25 - 1pc	9017B0031
Atlas flex-headband kit - 5pcs	9017B0041

Electromagnetic compatibility

Electromagnetic emissions

The Atlas system is intended for use in the electromagnetic environment specified below.
The customer or the user of the Atlas system should assure that it is used in such an environment.

Emissions test	Compliance	Electromagnetic environment – guidance
RF emissions CISPR 11	Group 1	The Atlas system uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The Atlas system is suitable for use in all establishments, including domestic establishments and those directly connected to the public low voltage powersupply network that supplies buildings used for domesticpurposes.
Harmonic emissionsIEC 61000-3-2	Not applicable	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Not applicable	

Electromagnetic Immunity

The Atlas system is intended for use in the electromagnetic environment specified below.
The customer or the user of the Atlas system should assure that it is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
Electrostatic discharge (ESD) IEC 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete orceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30 %.
Electrical fast transient/burst IEC 61000-4-4	± 2 kV for power supply lines ± 1 kV for input/output lines	± 2 kV for power supply lines ± 1 kV for input/output lines	Mains power quality should be thatof a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV line(s) to line(s) ± 2 kV line(s) to earth	± 1 kV line(s) to line(s) ± 2 kV line(s) to earth	Mains power quality should be thatof a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	<5 % *UT* (>95 % dip in *UT*) for 0,5 cycle 40 % *UT* (60 % dip in *UT*) for 5 cycles 70 % *UT* (30 % dip in *UT*) for 25 cycles <5 % *UT* (>95 % dip in *UT*) for 5 s	<5 % *UT* (>95 % dip in *UT*) for 0,5 cycle 40 % *UT* (60 % dip in *UT*) for 5 cycles 70 % *UT* (30 % dip in *UT*) for 25 cycles <5 % *UT* (>95 % dip in *UT*) for 5 s	Mains power quality should be thatof a typical commercial or hospital environment. If the user of the Atlas system requires continued operation during power mains interruptions, it is recommended that the Atlas system be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic ofa typical location in a typical commercial or hospital environment.

NOTE *UT* is the a.c. mains voltage prior to application of the test level.

Emissions test	IEC 60601 test level	Compliance level	Electromagnetic environment – guidance
			Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm to any part of the MagPro, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result. **Recommended separation distance** $d = 1.2\sqrt{P}$
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	$d = 1.2\sqrt{P}$ 80 Mhz to 800 Mhz
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2,5 GHz	3 V/m	$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey [a] should be less than the compliance level in eachfrequency range [b]. Interference may occur in the vicinity of equipment marked with the following symbol: 

NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the Atlas system is used exceeds the applicable RF compliance level above, the Atlas system should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the Atlas system.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [V1] V/m.

Recommended separation distances between portable and mobile RF communications equipment and the Atlas system

The Atlas system is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Atlas system can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Atlas system as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter W	Separation distance according to frequency of transmitter Meter (m)		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	>0.3	>0.3	>0.3
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1: At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Who is MagVenture?

MagVenture is a Danish medical device company specializing in non-invasive magnetic stimulation systems for clinical treatments and neuroscience research.

Through collaborations with leading neuroscientists around the world, MagVenture has – for well over two decades – helped researchers push the technology forward in fields such as neurophysiology, neurology, cognitive neuroscience, rehabilitation, and psychiatry, thus shaping the future path of TMS.

Our coils and magnetic stimulators are ranked among the most powerful, advanced and durable on the market and sold globally through direct sales subsidiaries in the USA, Germany, the UK and Brazil, and through a network of distributors in Europe, Asia, Middle East and the Americas.

Get the latest news on Magnetic Stimulation
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