BRAINLAB

TRAJECTORY PLANNING

BRAINLAB ELEMENTS TRAJECTORY PLANNING
Version 2.5

Software User Guide
Revision 1.0

TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Contact Data

Support

If you cannot find information you need in this guide, or if you have questions or problems, contact Brainlab support:

Region	Telephone and Fax	Email
United States, Canada, Central and South America	Tel: +1 800 597 5911 Fax: +1 708 409 1619	us.support@brainlab.com
Brazil	Tel: (0800) 892 1217	brazil.support@brainlab.com
UK	Tel: +44 1223 755 333	support@brainlab.com
Spain	Tel: +34 900 649 115	
France and French-speaking regions	Tel: +33 800 676 030	
Africa, Asia, Australia, Europe	Tel: +49 89 991568 1044 Fax: +49 89 991568 811	
Japan	Tel: +81 3 3769 6900 Fax: +81 3 3769 6901	

Expected Service Life

Brainlab provides five years of service for software. During this period of time, software updates as well as field support are offered.

Feedback

Despite careful review, this user guide may contain errors. Please contact us at user.guides@brainlab.com if you have improvement suggestions.

Manufacturer

Brainlab AG
Olof-Palme-Str. 9
81829 Munich
Germany

1.2 Legal Information

Copyright

Brainlab Trademarks

- Brainlab® is a trademark of Brainlab AG.
- Brainlab® Elements is a trademark of Brainlab AG.
- **iHelp**® is a trademark of Brainlab AG.
- **SmartBrush**® is a trademark of Brainlab AG.

Non-Brainlab Trademarks

Elekta®, Leksell® and Leksell® Vantage™ are registered and unregistered trademarks of Elekta AB (publ) in Sweden and other countries.

inomed® is a registered trademark of inomed Medizintechnik GmbH.

Luminant®, Precision®, Radionics® and CRW® are trademarks of Integra Burlington MA, Inc. in the US and other countries.

Microsoft® and Windows® are registered trademarks of Microsoft Corporation in the US and other countries.

Patent Information

This product may be covered by one or more patents or pending patent applications. For details, see: www.brainlab.com/patent.

Integrated Third-Party Software

This software is based in part on the following work. The full license and copyright notice can be found at the links below:

- Independent JPEG Group (https://github.com/uclouvain/openjpeg/blob/master/LICENSE)
- OpenJPEG (https://github.com/uclouvain/openjpeg/blob/master/LICENSE)
- libjpeg-turbo (https://github.com/libjpeg-turbo/libjpeg-turbo/blob/master/LICENSE.md)
- libtiff 4.0.4 beta, copyright© 1988-1997 Sam Leffler and copyright© 1991-1997 Silicon Graphics, Inc. (http://www.simplesystems.org/libtiff)
- Xerces-C++, developed by the Apache Software Foundation (https://xerces.apache.org)
- This product includes software developed by the Apache Software Foundation Copyright © 1999-2004 (www.apache.org/)
- Portions of this software are based on the work of Sun Microsystems, Inc.
- The Brainlab PDF-Viewer implementation is based on the PDF Direct/PDF Quick View library, soft Xpansion GmbH & Co. KG, Copyright © 2003-2011
- This product includes software developed by Telerik, Inc., Copyright © 2002 - 2016

CE Label

CE 0123

The CE label indicates that the Brainlab product complies with the essential requirements of Council Directive 93/42/EEC (the “MDD”).

Brainlab Elements **Trajectory Planning** is a Class IIb product according to the rules established by the MDD.

Report Incidents Related to This Product

You are required to report any serious incident that may have occurred related to this product to Brainlab, and if within Europe, to your corresponding national competent authority for medical devices.

Sales in US

US federal law restricts this device to sale by or on the order of a physician.

1.3 Symbols

Warnings

Warning

Warnings are indicated by triangular warning symbols. They contain safety-critical information regarding possible injury, death or other serious consequences associated with device use or misuse.

Cautions

Cautions are indicated by circular caution symbols. They contain important information regarding potential device malfunctions, device failure, damage to device or damage to property.

Notes

NOTE: Notes are formatted in italic type and indicate additional useful hints.

1.4 Using the System

Intended Use

Trajectory Planning's indications for use are the viewing, presentation and documentation of medical imaging, including different modules for image processing, image fusion, atlas assisted visualization and segmentation, intraoperative functional planning where the output can be used e.g., with stereotactic image guided surgery or other devices for further processing and visualization.

Example procedures include but are not limited to:

- Planning and simulation of cranial surgical procedures such as shunt placement, minimal invasive stereotactic interventions, biopsy, planning and simulation of trajectories for stimulation and electrode recording.

Typical users of **Trajectory Planning** are medical professionals, including but not limited to surgeons and radiologists.

Intended Use Environment

Trajectory Planning is a medical device configuration based on a combination of the component Brainlab **Trajectory** (Element) and the following (compatible) components that are installed in the environment of intended use:

- **Patient Data Manager** (Elements Environment)
- **Image Fusion** (Element)
- **SmartBrush** (Element)
- **Fibertracking** (Element)

Trajectory Planning is designed to be used on Brainlab platforms inside and outside the OR or on regular computers.

Plausibility Review

Warning

Before patient treatment, review the plausibility of all information input to and output from the system.

1.5 Compatibility with Medical Devices and Software

Compatible Medical Devices

Manufacturer	Medical Device	Description
Elekta AB (Publ) Box 7593 SE-103 93 Stockholm Sweden	Stereotactic localizer	• Vantage CT Indicator • Vantage MR Indicator • Open CT Indicator • Open MR Indicator • CT Indicator • MR Indicator
	Arc system	• Vantage Multi Purpose Arc • Multi Purpose Arc
	Head frames	• Coordinate Frame G • Vantage Coordinate Frame
inomed Medizintechnik GmbH im Hausgrün 29 79312 Emmendingen Germany	Stereotactic localizer	• Rev. R • Rev. U
	Arc system	• ZD Arc
	Head rings	• Open Ceramic Head Ring • Titanium Ring
Integra Burlington MA, Inc. 22 Terry Avenue Burlington, MA 01803	Stereotactic localizer	• UCLF-0 • LL01 MR/CT • BRW-LF Luminant
	Arc system	• CRW-ASL • Precision CRW
	Head ring	• UCHR-AP • HRA-IM

Non-Brainlab Devices

Warning

Using medical device combinations that have not been authorized by Brainlab may adversely affect safety and/or effectiveness of the devices and endanger the safety of the patient, user and/or environment.

Instrument Use

Only use instruments and spare parts specified by Brainlab with **Trajectory**. Using unauthorized instruments/spare parts may adversely affect safety and/or effectiveness of the medical device and endanger safety of patient, user and/or environment.

Instrument Assembly

If any instrumentation is used with this product, ensure that all instruments are correctly assembled according to the instructions within the corresponding **Instrument User Guide**.

Compatible Brainlab Medical Software

Only Brainlab medical software specified by Brainlab may be installed and used with the system. Contact Brainlab support for clarification regarding compatibility with Brainlab medical software.

Non-Brainlab Software

Only authorized Brainlab employees may install software on the Brainlab system. Do not install or remove any software applications.

Updates

Warning

Updates to the operating system (hotfixes) or third-party software should be performed outside clinical hours and in a test environment to verify correct operation of the Brainlab system. Brainlab monitors the released Windows hotfixes and will know, for some updates, if problems can be expected. Contact Brainlab support if any problems to operating system hotfixes are encountered.

Virus Scanning and Malware

Brainlab recommends protecting the system with state-of-the-art anti-virus software.

Be aware that some malware protection software (e.g., virus scanner) settings can negatively affect system performance. For example, if real-time scans are performed and each file access is monitored, then loading and saving patient data may be slow. Brainlab recommends disabling real-time scans and performing virus scans during non-clinical hours.

Warning

Ensure that your anti-virus software does not modify any Brainlab directories, specifically:

- **C:\Brainlab, D:\Brainlab, F:\Brainlab, etc.**
- **C:\PatientData, D:\PatientData, F:\PatientData, etc.**

Warning

Do not download or install updates during treatment planning.

Contact Brainlab support for further information regarding any of these issues.

Microsoft Security Updates for Windows and Driver Updates

Brainlab allows the installation of security patches only. Do not install service packs and optional updates. Verify your settings to ensure updates are downloaded and installed correctly and at a suitable time. Do not update drivers on Brainlab platforms.

See the Brainlab website for more information about settings and a list of Microsoft Security Updates blocked by Brainlab support.

Address: www.brainlab.com/updates

Password: WindowsUpdates!89

Medical Electrical Systems

For information regarding the configuration of medical electrical systems, see the relevant System User Guide and Technical User Guide.

Related Links

6.1 Supported Elekta (Leksell) Stereotactic Systems on page 75
6.2 Supported inomed Arc Systems on page 80
6.3 Supported Integra (Radionics) Arc Systems on page 83

1.6 Training and Documentation

Brainlab Training

Before using the system, all users must participate in a mandatory training program held by a Brainlab authorized representative to ensure safe and appropriate use.

Supervised Support

Before using the system for surgical procedures where computer-aided navigation is considered critical, perform a sufficient number of complete procedures together with a Brainlab representative.

Responsibility

Warning

This system solely provides assistance to the physician and does not substitute or replace the clinical user's experience and/or responsibility during its use.

Extended OR Time

Brainlab Navigation Systems are sensitive technical equipment. Depending upon OR setup, patient positioning, calculation durations and complexity, surgery duration using navigation may vary. It is up to the user to decide whether a potential prolongation is acceptable for the respective patient and treatment.

Reading User Guides

This guide describes complex medical software or medical devices that must be used with care.

It is therefore important that all users of the system, instrument or software:

- Read this guide carefully before handling the equipment
- Have access to this guide at all times

Available User Guides

NOTE: Available user guides vary depending upon the Brainlab product. If you have questions regarding the user guides you received, please contact Brainlab support.

User Guide	Contents
Software User Guides	• Overview of treatment planning and image-guided navigation • Description of OR system setup • Detailed software instructions
Hardware User Guides	Detailed information on radiotherapy and surgical hardware, typically defined as large complex instruments
Instrument User Guides	Detailed instructions on instrument handling
Cleaning, Disinfection and Sterilization Guide	Details on cleaning, disinfecting and sterilizing instruments
System User Guide	Detailed information on system setup
Technical User Guide	Detailed technical information on the system, including specifications and compliances

User Guide	Contents
System and Technical User Guide	Combines the contents of the System User Guide and the Technical User Guide.

Abbreviations

This user guide contains the following abbreviations:

Abbreviation	Definition
AC/PC	Anterior Commissure/Posterior Commissure
ADC Trace Map	DTI Apparent Diffusion Coefficient
B0	DTI Image acquired at b=0 sec/mm^2
BOLD	Blood Oxygen Level Dependent
CT	Computer Tomography
DICOM	Digital Imaging and Communications in Medicine
DTI	Diffusion Tensor Imaging
MER/S	Microelectrode Recording and Stimulation
MRI	Magnetic Resonance Imaging
PACS	Picture Archiving and Communication System
PET	Positron Emission Tomography

2 SOFTWARE OVERVIEW

2.1 Getting Started

Getting Started with Trajectory Planning

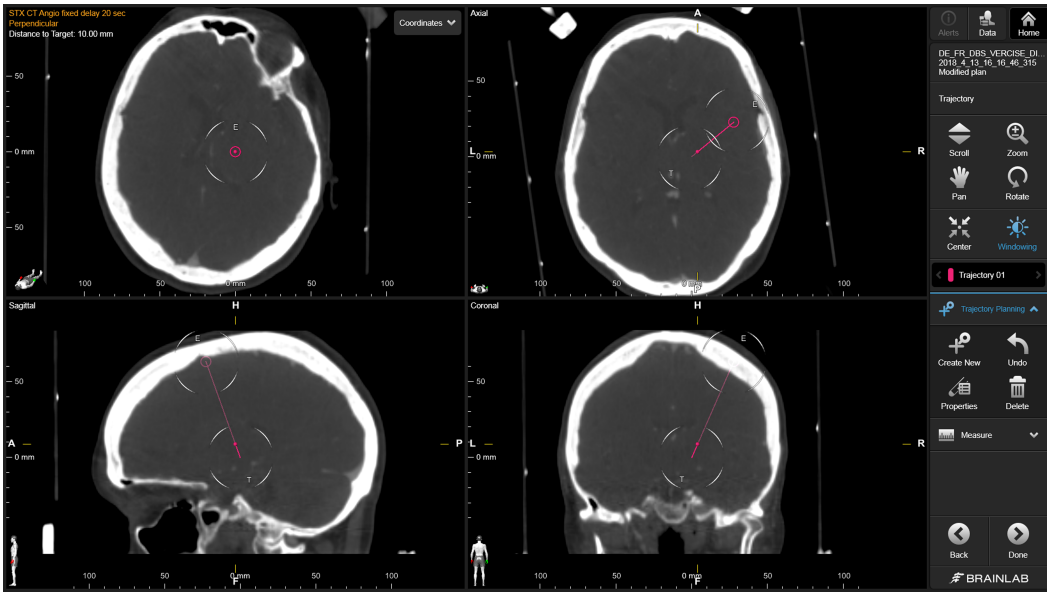


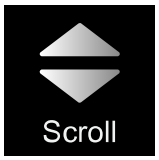
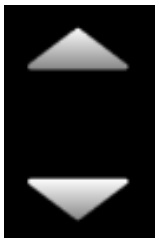
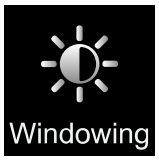
Figure 1

Trajectory Planning is a medical device configuration based on the **Trajectory** software that delivers necessary key functions dedicated to trajectory planning.

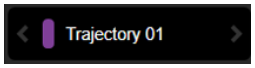
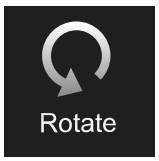
You can plan possible pathways for the surgical instruments on the scanned images with **Trajectory** software.

2.2 Image Viewing Functions

Viewing Options

Button	Function
	**Zoom**: Activates the zoom function to the region of interest. You can also use Ctrl + mouse wheel to zoom.
 	**Scroll**: Activates scroll functions in the displayed reconstruction (plane). For each view and interaction option, there is a dedicated scroll increment: • Use the in-view buttons to scroll up/down 0.5 mm. • Drag the mouse pointer within the main view to scroll up/down (zoom level dependent). • Turn the mouse wheel with the mouse pointer over the side of the **Inline** view to scroll up/down 0.5 mm in the trajectory direction. *NOTE: Some scroll functions are available independently of **Scroll** being activated.*
	**Pan**: Pans vertical and horizontal planes. You can also use Ctrl + left mouse button to pan.
	**Windowing**: Adjust the brightness and contrast of a slice. • Drag down/up to increase/decrease the brightness. • Drag right/left to increase/decrease the contrast level.

Additional Options

Button	Function
	• Shows the active trajectory • Use arrow buttons to toggle between trajectories
	**Center**: Automatically scrolls and pans the reconstruction to display the target/entry (at the center of the view).
	**Rotate**: Rotates the current view. • Rotates the 2D reconstruction in relation to other views. • Rotates the 3D reconstruction plane/3D rendering. • Adjusts the scrolling plane (in specific views).

Button	Function
	**Undo**: Undoes the last change made or multiple consecutive steps.

2.3 Data Menu

Using the Data Menu

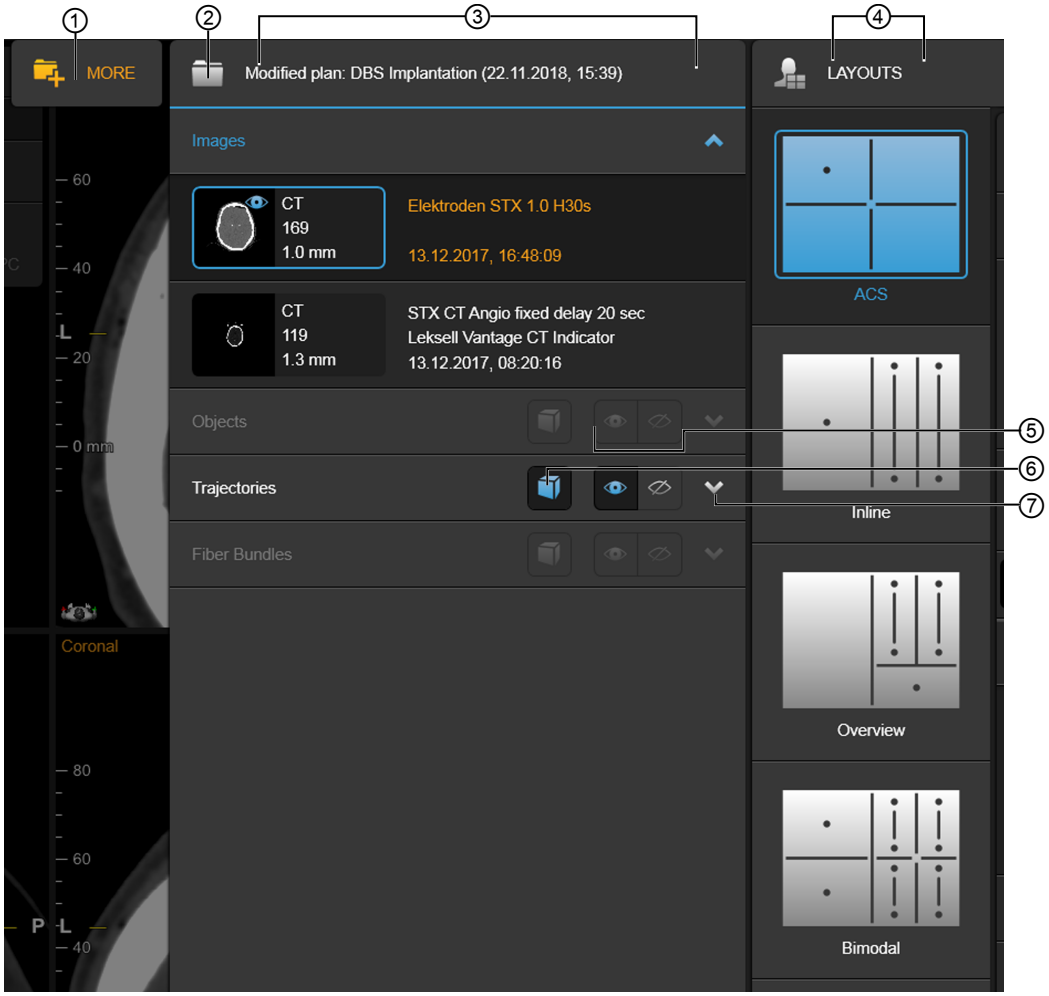


Figure 2

Select **Data** to open the **Data** menu. View available patient data and other content (e.g., **Trajectories**) or change layouts.

No.	Description
①	Select **MORE** to view additional content.
②	The active plan is displayed within the **Data** menu, with status.
③	View available patient data. By default, all content in the **Images** drop-down menu is shown while content in other drop-down menus is hidden.
④	Switch between available layouts.
⑤	Select/deselect to show/hide all content in the menu.
⑥	Select/deselect to show/hide 3D shapes.
⑦	Select the arrow to open/close a content menu.

Warning

Segmented objects or fiber tracts may be wrong or too inaccurate for the localization of an anatomical or functional structure. For this reason, only use segmented objects and fiber

tracts for trajectory planning as supplemental information in addition to patient image reconstructions.

Trajectories

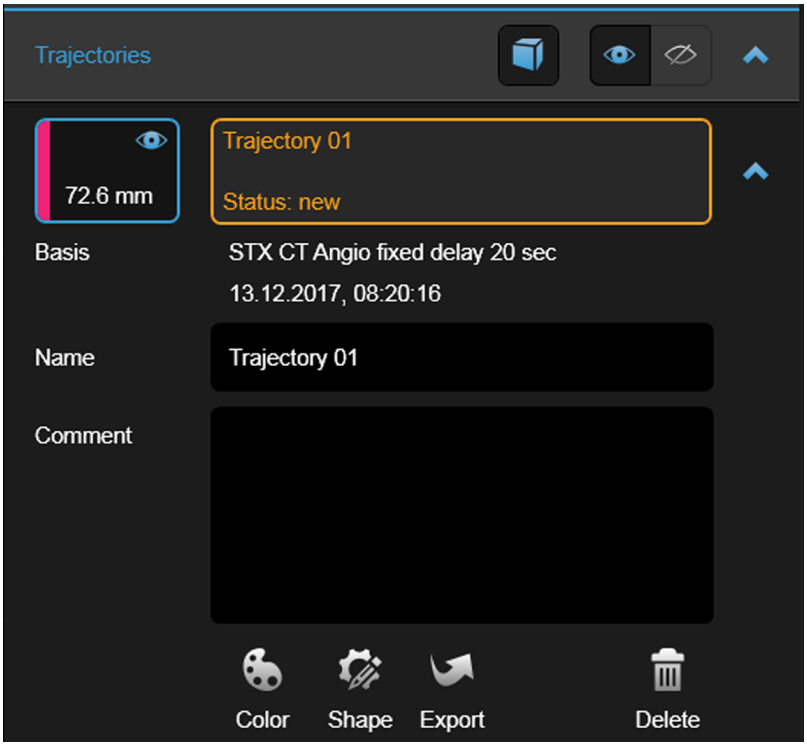


Figure 3

Within the **Data** menu, the following information is provided about each trajectory:

- The image set in which the trajectory is registered
- The length (target to entry distance)
- The name and its properties

Use the **Trajectories** menu to view, define and edit the following trajectory properties:

- **Name**: Enter a name in the space provided
- **Comment**: Add a comment as required
- **Color**: Select a color from the color palette
- **Shape**: Select and edit a shape from the **Custom 3D Shape** menu

You can also export the trajectory via **Export**.

2.4 Layouts

ACS Layout

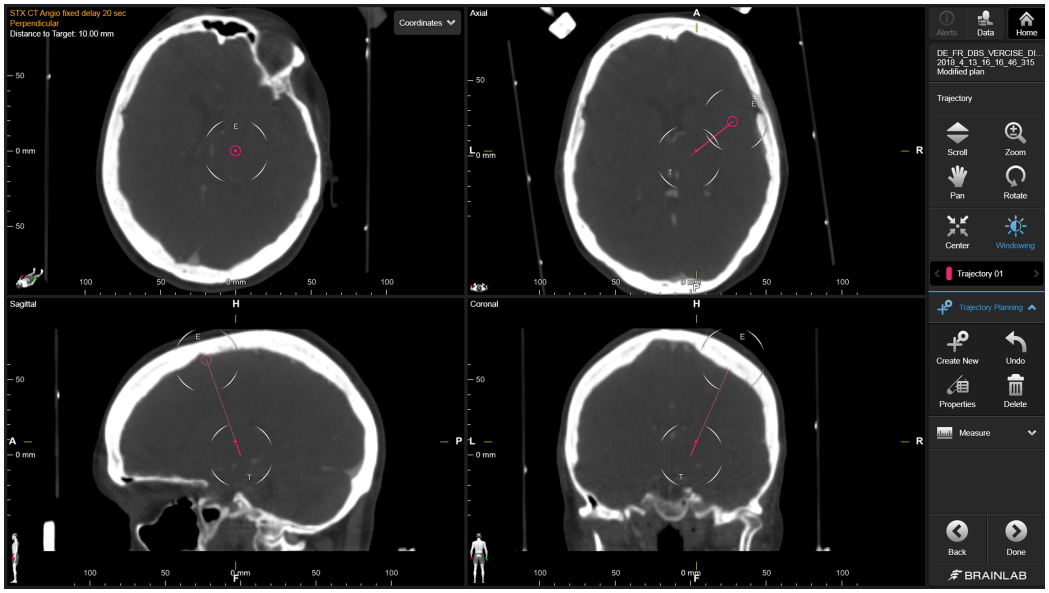


Figure 4

ACS layout displays corresponding axial, coronal, sagittal and perpendicular reconstructions of the active image set in a 2 x 2 view layout. With regards to scrolling through the imaged volume, it is the most flexible layout of the four. The triplanar arrangement of the three orthogonal reconstructions (i.e., axial, coronal and sagittal), provides a good spatial overview of the viewed anatomy.

- If you click on the trajectory in the view in the upper left corner, **Distance to target** is displayed. If you are not on the trajectory, **Perpendicular** is shown.
- If you have scrolled the views to a point not being on the trajectory axis, no distance to target is shown, and the four views will display a "cursor cross" in all four views, indicating the position of the point in space being viewed.
- If you make any changes to the trajectory, all views update.

Use this classical **ACS** layout for initial positioning of the trajectory, precise corrections as well as the final plan review.

Inline Layout

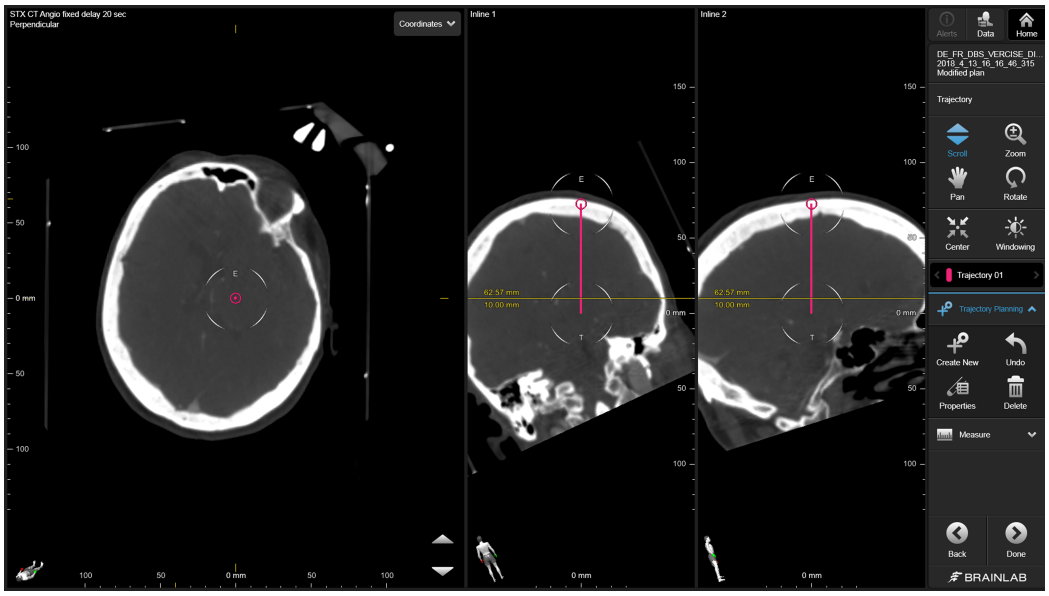


Figure 5

In **Inline** layout, the image on the left shows a perpendicular reconstruction through that point on the trajectory axis that is being defined by the yellow line as well as the values labeled in the view. The two inline views on the right show reconstructions that are in plane with the trajectory axis. **Inline 1**, **Inline 2** and **Perpendicular** reconstructions are orthogonal to each other.

Use **Inline** layout to review and refine the trajectory paths (e.g., to avoid vessel penetration or optimize targeting approach).

Overview Layout

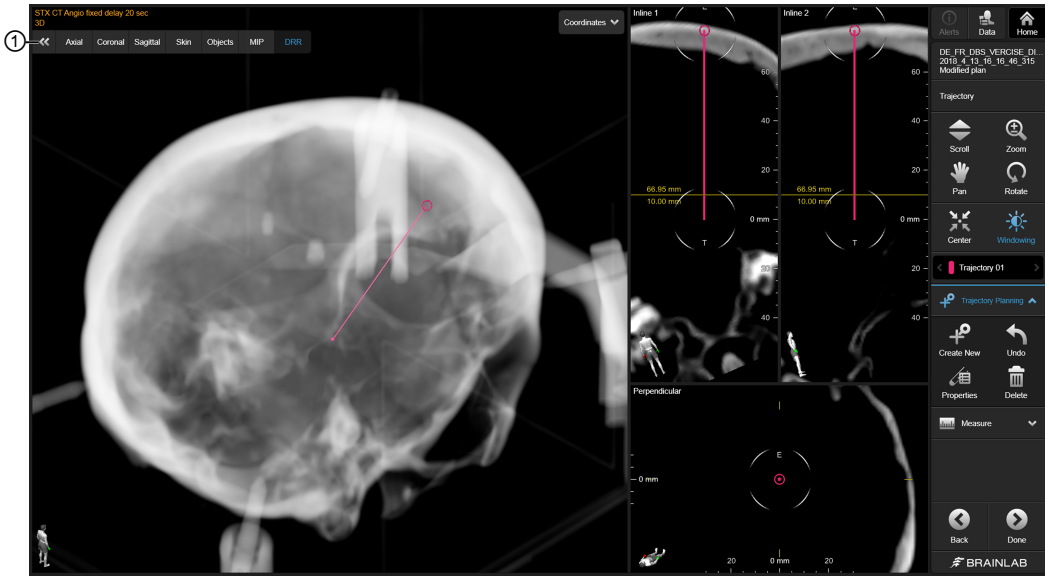


Figure 6

Overview layout is similar to **Inline** layout, but adds a 3D view for displaying 3D plane reconstructions (**Axial**, **Coronal**, **Sagittal**) or 3D renderings (**Cortex**, **Bone**, **Skin**, **Objects**, **MIP**, **DRR**).

Select ① to view the 3D viewing options (e.g., 3D axial plane or 3D rendering options). Which options are available is based on the type of image selected in the **Data** menu. In this instance, **DRR** is displayed:

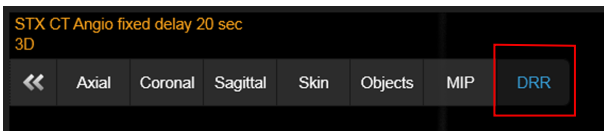


Figure 7

Use **Overview** layout as an alternative to the **ACS** and **Inline** layouts. You can also use it to view 3D renderings for anatomical overview.

Warning

Depending on image resolution, contrast and individual patient anatomy, critical anatomical conditions may not appear, or appear masked, in the 3D renderings. 3D-rendered structures must always be verified in 2D reconstructions or original slices.

Bimodal Layout

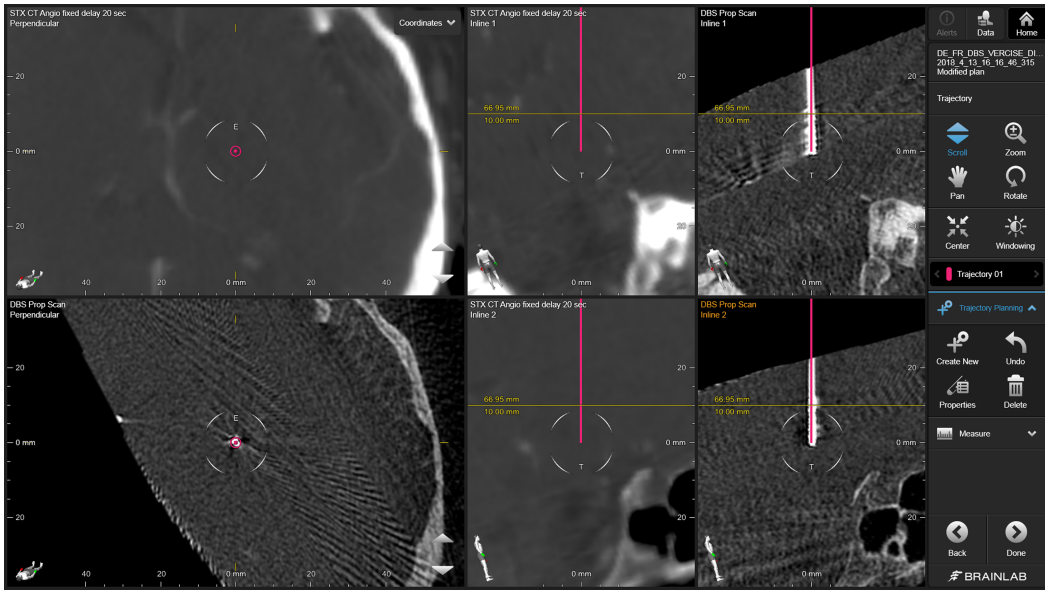


Figure 8

With **Bimodal** layout, you can review a trajectory in side-by-side reconstructions of two different image sets (e.g., CT and MR) that are coregistered over one or more image fusions.

Use **Bimodal** layout to ensure that the overall accumulated error/inaccuracy of the coregistrations (image fusion) is acceptable. You can also use it to confirm that the trajectory is safe and effective in an overall plan review (e.g., on the day of surgery).

2.5 Trajectory Planning Menu

About the Trajectory Planning Menu

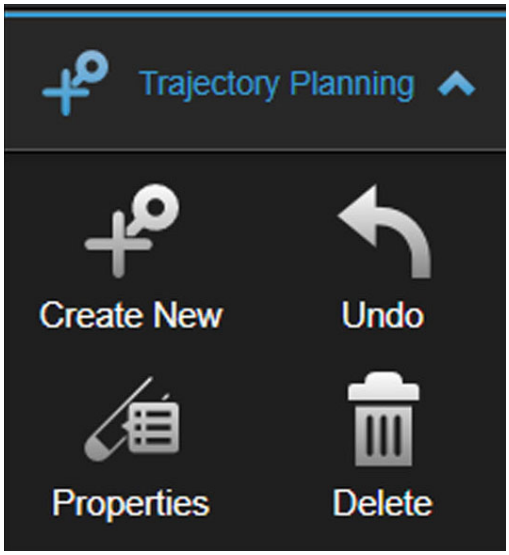


Figure 9

The **Trajectory Planning** menu allows you to create new trajectories, edit trajectory or lead properties, undo changes, or delete trajectories.

Open the menu by selecting the arrow.

Button	Description
Create New	Creates a new trajectory (or lead). Drag the target and entry points to align the trajectory (or lead).
Properties	Select to open the **PROPERTIES** dialog.
Undo	Undoes consecutive changes made to the position of target or entry points.
Delete	Enables adjustment of target and entry points.

Editing Trajectory and Lead Properties

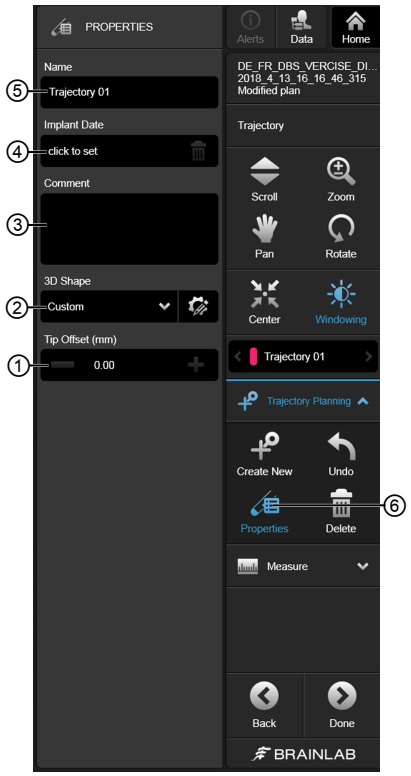


Figure 10

Specific lead models can be defined by assigning the model type and various additional parameters. Based on these parameters, a corresponding lead model is created, and can then be utilized in other applications that interpret this information.

To open the **PROPERTIES** dialog, select **Properties** ⑥ from the toolbar.

No.	Description
①	**Tip Offset**: Enter the length of tip offset (in mm) or click on the + or - symbols to automatically set the tip offset to a value that corresponds with the marked sections of the 3D shape.
②	**3D Shape**: Select a 3D shape.
③	**Comment**: Enter a comment if desired.
④	**Implant Date**: Date of implantation (saved as additional information).
⑤	**Name**: Edit the assigned trajectory name.

2.6 Measure Menu

About the Measure Menu

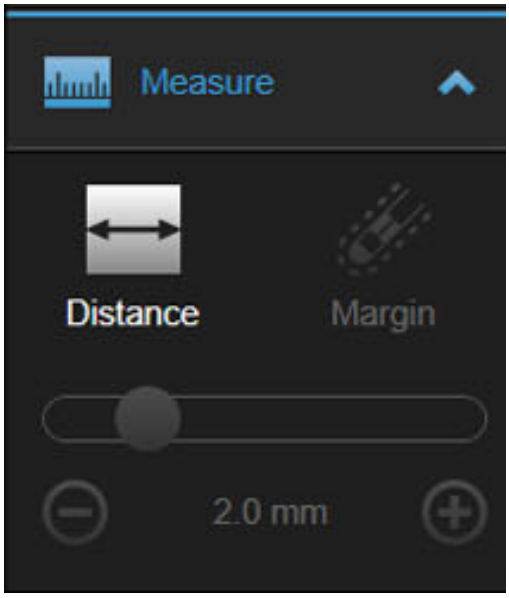


Figure 11

The **Measure** menu allows you to calculate trajectory distance or add a margin around a trajectory.

Open the menu by selecting the arrow.

Button	Description
Distance	Calculate trajectory distance.
Margin	Display a margin around the 3D shape of the trajectory.
Margin slider	Change the dimension of the margin around the 3D shape (in mm).

Measuring Distance

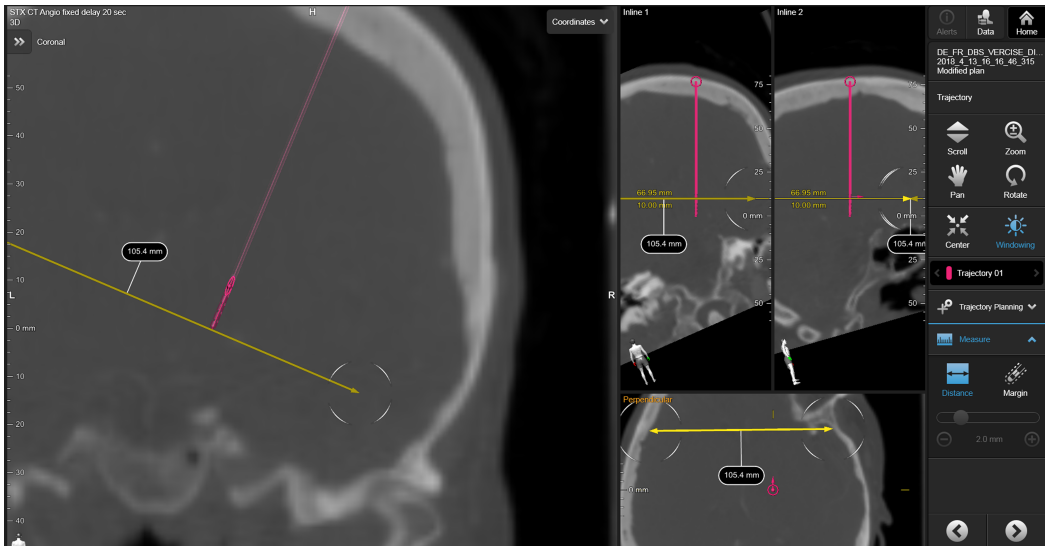


Figure 12

Select **Distance** from the **Measure** menu to measure anatomical distances in all views.

Adding Margins

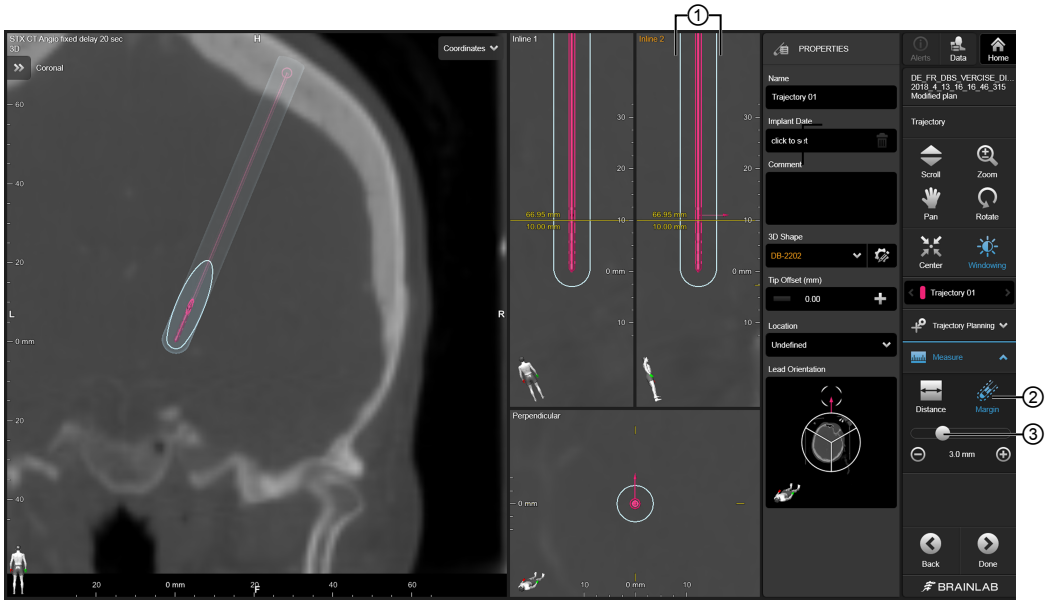


Figure 13

Select **Margin** ② in the **Measure** menu to display a margin value around a 3D shape that is assigned to a trajectory ①. The surrounding margin is shown in all views.

You can change the dimension of the margin by moving the slider ③ or pressing the ⊕ and ⊖ symbols.

2.7 Frame Planning Menu

About the Frame Planning Menu (Stereotaxy only)

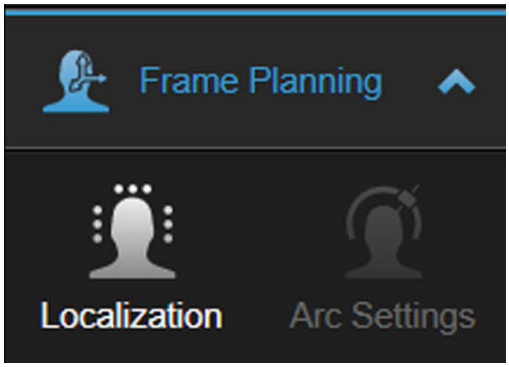


Figure 14

Use the **Frame Planning** menu to switch to the localization software or select arc settings related to the current data set. Open the menu by selecting the arrow.

Button	Description
Localization	Opens the graphical user interface and features dedicated to stereotactic localization.
Arc Settings	Opens a panel to show/edit stereotactic arc settings (calculated from stereotactic localization) for the active trajectory.

About Localization

You can access the features dedicated to stereotactic localization by selecting **Localization**. Once you select your localizer from the drop-down menu on the toolbar, localization begins automatically.

Warning

You must select the correct localizer for localization from the options provided. If an incorrect localizer option is selected, all slices might be successfully localized; however, the subsequent coordinate system, based on a combination of localizer, head ring and arc system, will be incorrect.

About Arc Settings

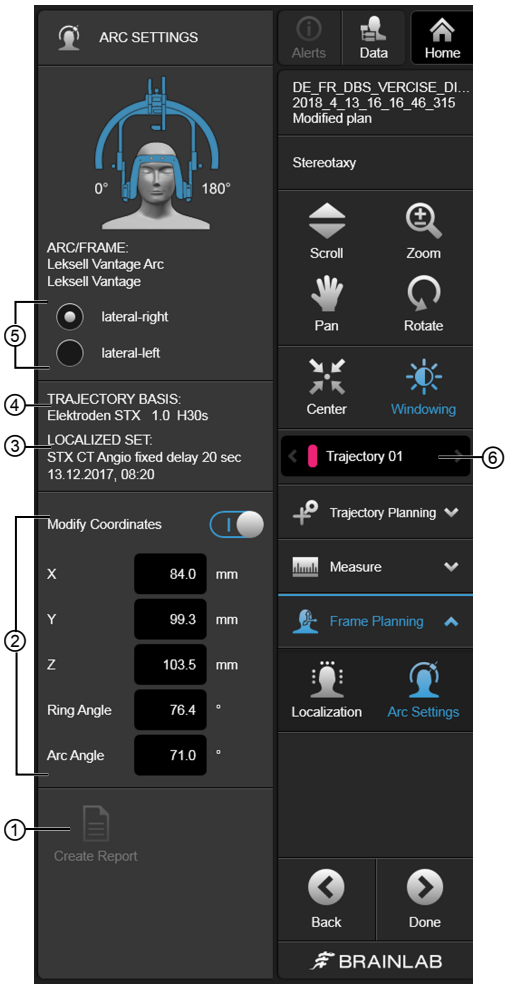


Figure 15

After finishing the stereotactic localization, select **Arc Settings** to open the **ARC SETTINGS** menu.

No.	Description
①	Select to create report (disabled as long as arc settings are in edit mode).
②	Modify arc coordinates.
③	Localized set, including date and time. *NOTE: Always verify the correct image set is being used for localization and arc setting calculation.*
④	Basis for active trajectory. *NOTE: This could be different than the localized set.*
⑤	Change arc direction (if available for your localizer).
⑥	Active trajectory.

Related Links

2.7 Frame Planning Menu on page 27

5.2.1 How to Localize the Image Set on page 64

How to Adjust Arc Settings

Modify the mounting orientation of the arc system.

Step	
1.	To adjust arc settings, toggle on **Modify Coordinates** in the **ARC SETTINGS** menu.
2.	To modify the mounting orientation of the arc system, select an option from the drop-down list (**lateral-left**, **lateral-right**, **sagittal-anterior** or **sagittal-posterior**).
3.	To adjust values for the target coordinates (in millimeters), enter the values in the field provided (e.g., **X**, **Y**, **Z**).
4.	To adjust the values (in degrees) for the angle parameter, enter the value in the fields provided (e.g., **Ring Angle**, **Arc Angle**). *NOTE: Always specify the values in the given format. Otherwise the software may not accept your arc settings.*

2.8 Coordinates Menu

About the Coordinates Menu

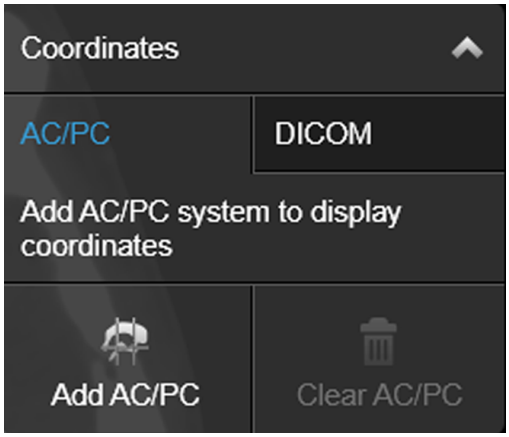


Figure 16

The **Coordinates** menu is located within the view area.

If there is no trajectory or the active trajectory is not coregistered to the active image set, then no AC/PC or DICOM coordinates are displayed. DICOM coordinates are always related to the active image set.

Related Links

4.8 AC/PC Localization on page 54

4.8.2 How to Add AC/PC Coordinates on page 54

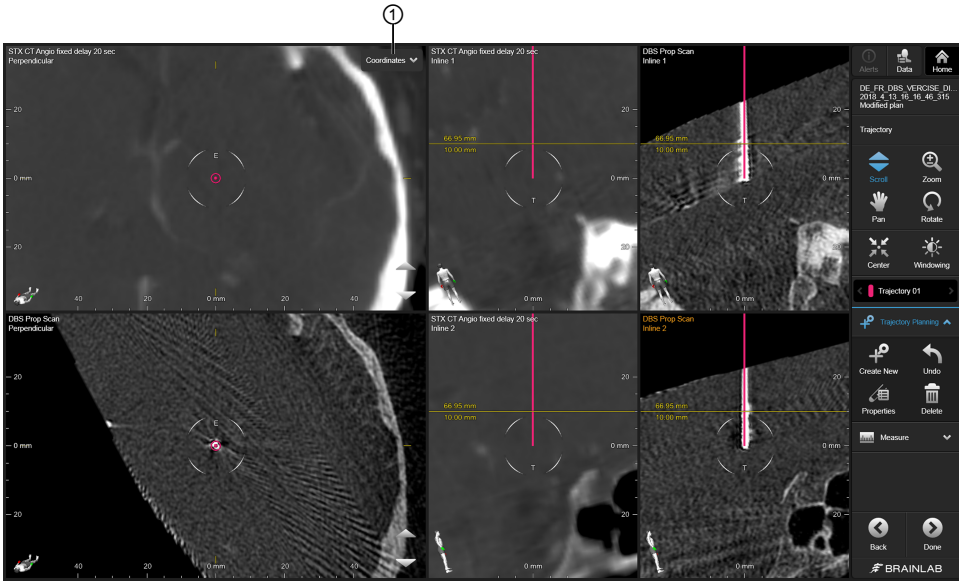
About AC/PC Coordinates

The AC/PC coordinates are only enabled if:

- AC/PC localization has been performed in the selected image set
- The selected image set has been fused to an image set that is AC/PC localized

NOTE: Modifying the AC/PC localization does not change the trajectories defined within the AC/PC function. Trajectories always retain their position relative to the image data in which they were created.

How to Show and Hide the Coordinates Menu

Step	
1.	 To open the **Coordinates** menu, select the arrow ①. The menu opens.
2.	To hide the **Coordinates** menu, select the arrow. The menu closes.

3 WORKFLOWS

3.1 About Typical Workflows

Available Workflows in Trajectory Planning

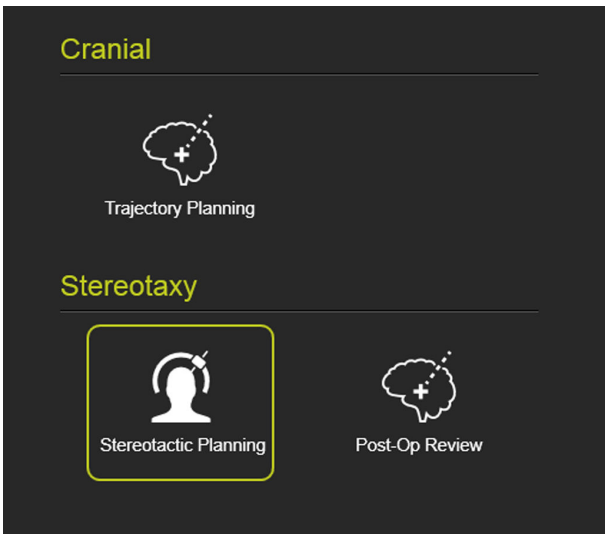


Figure 17

Depending on your requirements, use **Trajectory Planning** for preoperative planning, stereotactic registration on the day of surgery, or postoperative review (e.g., including lead localization and detecting orientation).

To begin, select a specialty workflow:

- **Cranial** > **Trajectory Planning**
- **Stereotaxy** > **Stereotactic Planning**
- **Stereotaxy** > **Post-Op Review**

Trajectory Planning Workflow

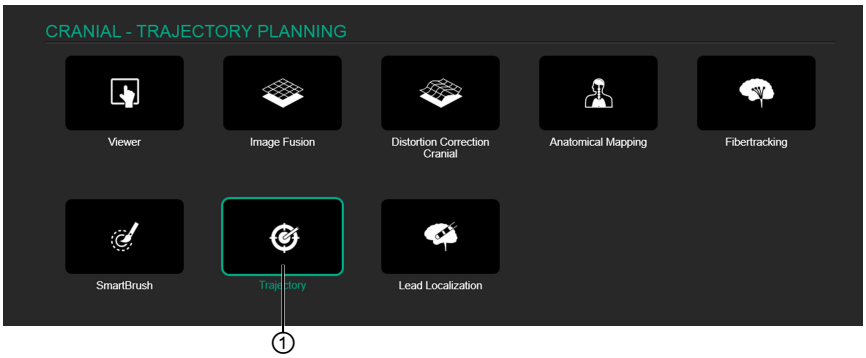


Figure 18

Use the trajectory planning workflow at any stage for the creation of image-based anatomical planning of trajectories. This workflow offers only **Trajectory** features, and no features for stereotactic localization or arc settings calculation.

Step	
1.	Select a workflow (e.g., **Cranial** > **Trajectory Planning**). **Patient Selection** opens.
2.	Select a patient. Select images, objects, fiber bundles, trajectories, or plans, and then select **OK**. *NOTE: If you select a plan, all data referenced in that plan will be selected.*
3.	Create, modify and remove co-registrations using **Image Fusion**. Select **Done** to continue.
4.	Create, modify and remove objects using **SmartBrush** or **Anatomical Mapping**. Select **Done** to continue.
5.	Create, modify and remove fiber bundles using **Fibertracking**. Select **Done** to continue.
6.	Create, modify and remove trajectories using **Trajectory** ①.
7.	Save as a plan with a unique, user-defined name.
8.	Identify the plan name and status (e.g., unmodified) and review/approve the plan using **Trajectory**. *NOTE: If the plan cannot be approved for surgery after review, the plan needs to be modified (e.g., corrected). Repeat steps 3 through 8 as required.*
9.	End the session. *NOTE: For more information, see the corresponding Software User Guides.*

Stereotactic Planning Workflow

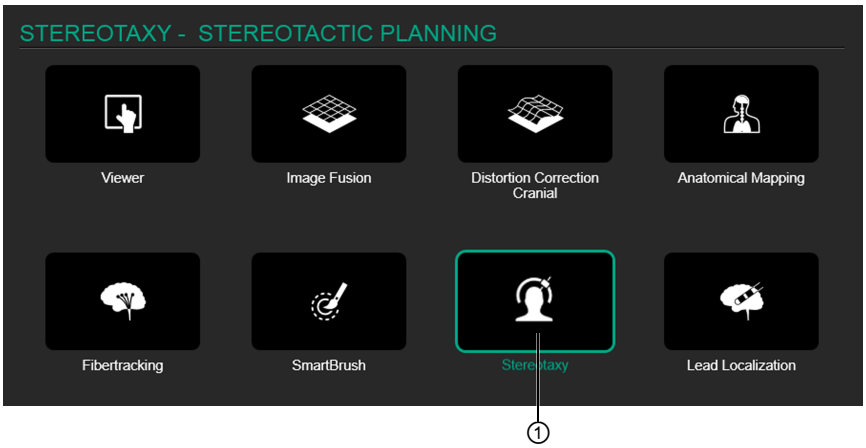


Figure 19

By starting with the reviewed and approved plan you created in the trajectory planning workflow, the stereotactic planning workflow allows you to generate arc settings for the planned trajectories so that a stereotactic surgery can be performed.

Step	
1.	Select a workflow (e.g., **Stereotaxy** > **Stereotactic Planning**). **Patient Selection** opens.
2.	Select the reviewed and approved preoperative plan that shall be used for surgery. *NOTE: You can also start a new plan.*
3.	Select the image set that shall be stereotactically localized and coregistered to the preoperative plan.
4.	Select **Image Fusion** and coregister the localizable image set to one image set of the preoperative plan.
5.	Select **Stereotaxy** ①.
6.	Identify the plan name and status (e.g., unmodified) and then review/approve the plan (e.g., arc settings, mounting position) using **Trajectory**. *NOTE: If the plan cannot be approved for surgery after review, the plan needs to be modified (e.g., corrected). Repeat steps 4 through 6 as required.*
7.	Save as a plan with a unique, user-defined name.
8.	Stereotactically localize the localizable image set. The software generates arc settings for the active trajectory.
9.	Create a PDF report containing arc settings.

Postoperative Review Workflow

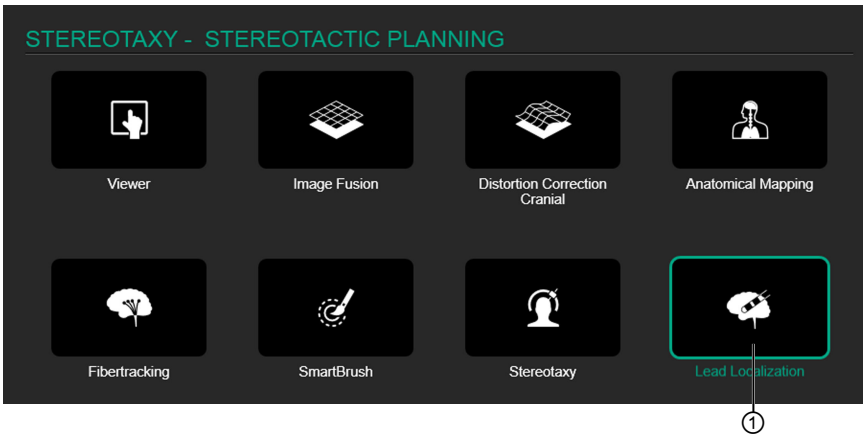


Figure 20

Use the postoperative workflow to add postoperative image sets, and compare actual implant positions with planned positions.

Step	
1.	Select a workflow (e.g., **Stereotaxy** > **Post-Op Review**). **Patient Selection** opens.
2.	Select a patient. Select all images, objects, fiber bundles, trajectories, or plans, and then select **OK**. *NOTE: If you select a plan, all data referenced in that plan will be selected.*
3.	Select **Lead Localization** ①.
4.	Select **Detect** from the toolbar.
5.	Review each lead with regards to lead detection definition.
6.	Assign 3D shapes to each trajectory (e.g., custom 3D shape or lead).
7.	End the session. *NOTE: For more information, see the corresponding Software User Guides.*

4 TRAJECTORY PLANNING AND POSTOPERATIVE REVIEW

4.1 Introduction

About Trajectory Planning

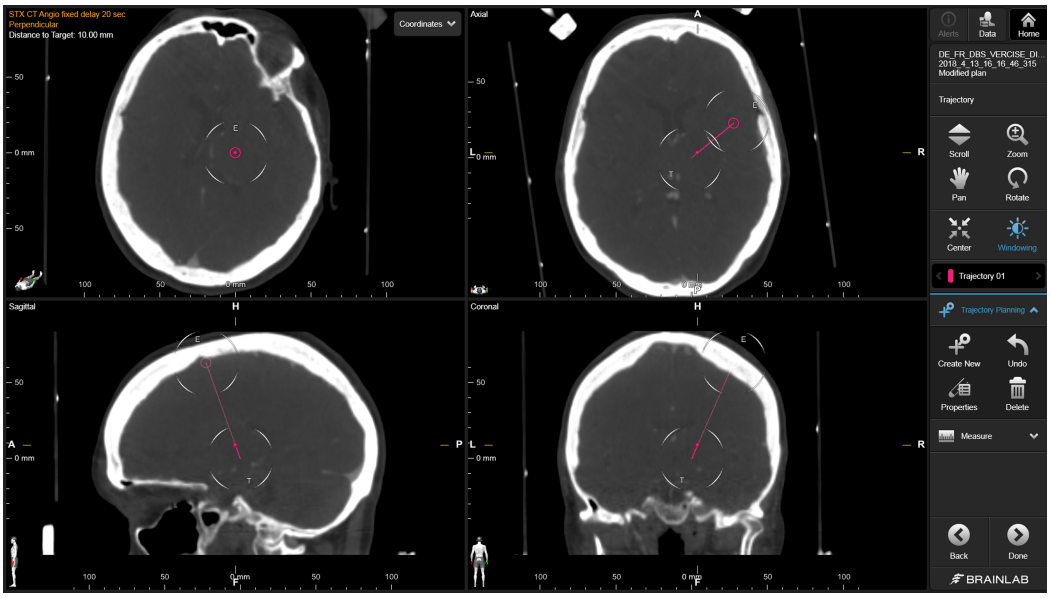
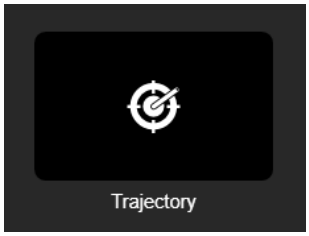


Figure 21

The aim of **Trajectory Planning** is to create a minimally invasive trajectory path using **Trajectory**.

How to Start Trajectory Software

Step
 Select **Trajectory** from your specialty workflow (e.g., **CRANIAL > TRAJECTORY PLANNING**).

4.2 Understanding Trajectories

About Trajectories

An intersection point is the point in 3D space where the trajectory axis intersects the displayed reconstruction plane.

An intersection point is displayed:

- Beyond entry
- Between target and entry
- Beyond target

When the depth position is placed on the target point, after selecting **Center**, the intersection point indicates the exact position of the target.

Warning

Do not confuse the intersection indicator with the target or entry position. If in doubt, use Center to auto-scroll to the target or entry in all views and/or inspect the depth-line, including distances to target and entry.

Example: Trajectory Intersection Point and Target Point

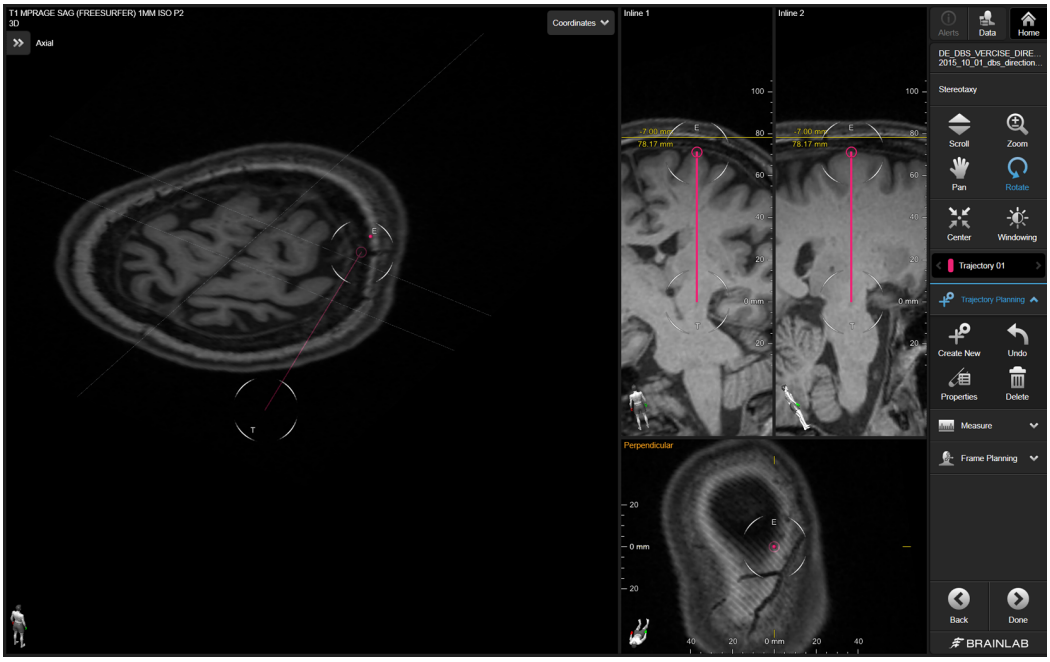


Figure 22

The intersection point (yellow line) is 7 mm above entry (pink circle).

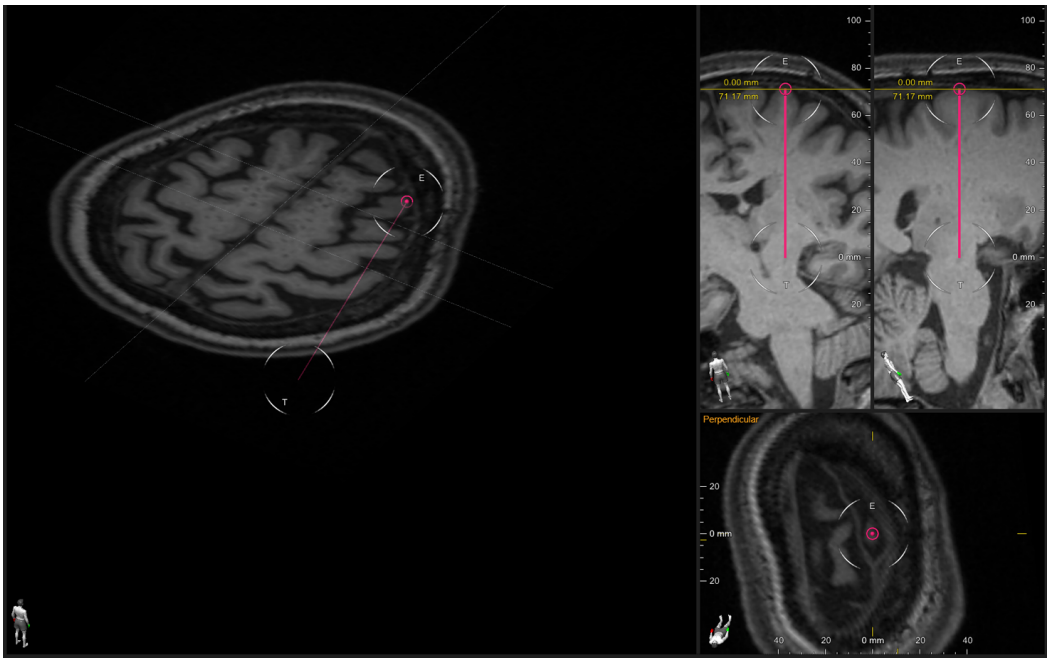


Figure 23

The intersection point is exactly on entry (yellow line and pink circle meet).

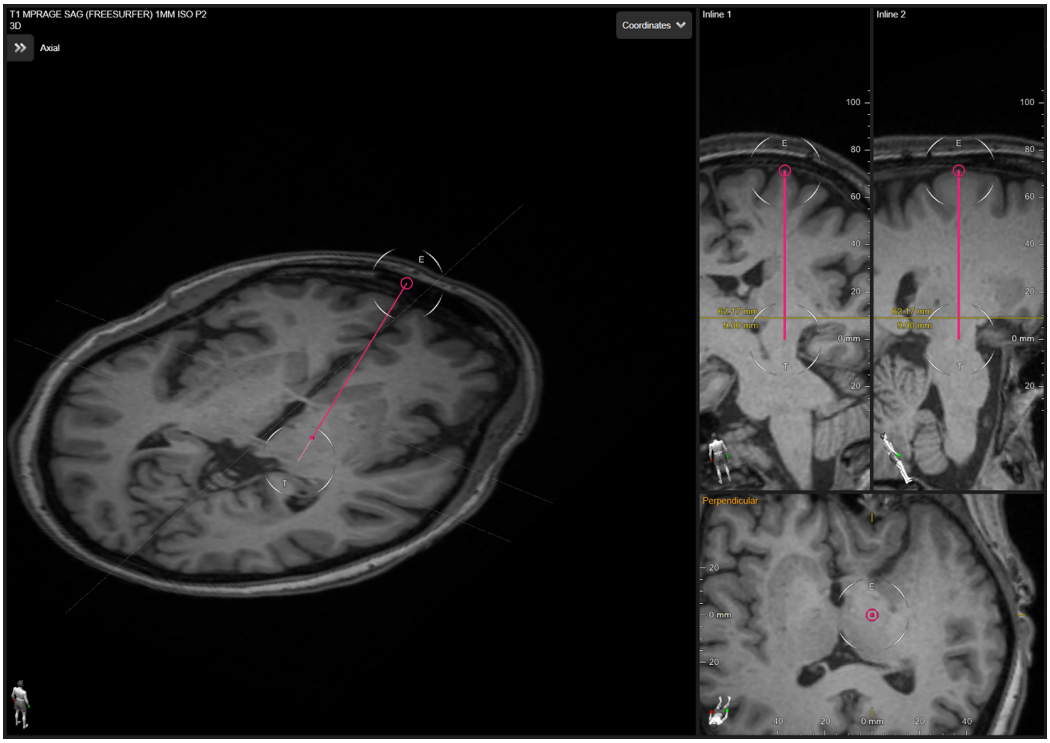


Figure 24

The intersection point (yellow line) is 9 mm above target (pink trajectory).

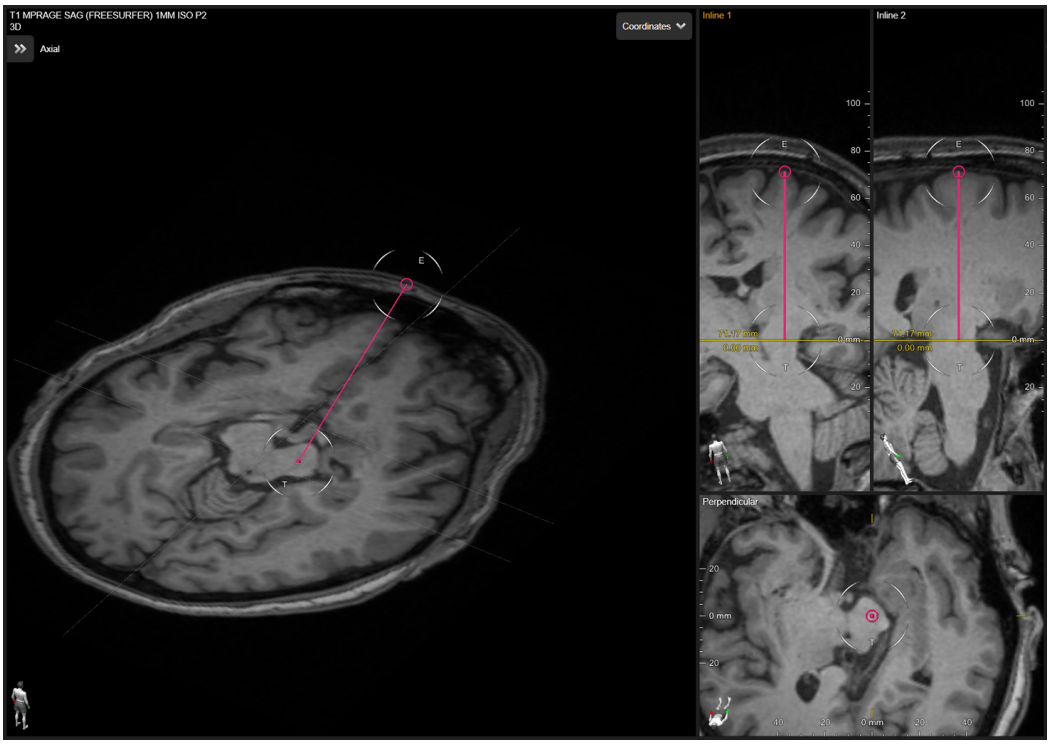


Figure 25

The intersection point is exactly on target (yellow line and pink trajectory meet).

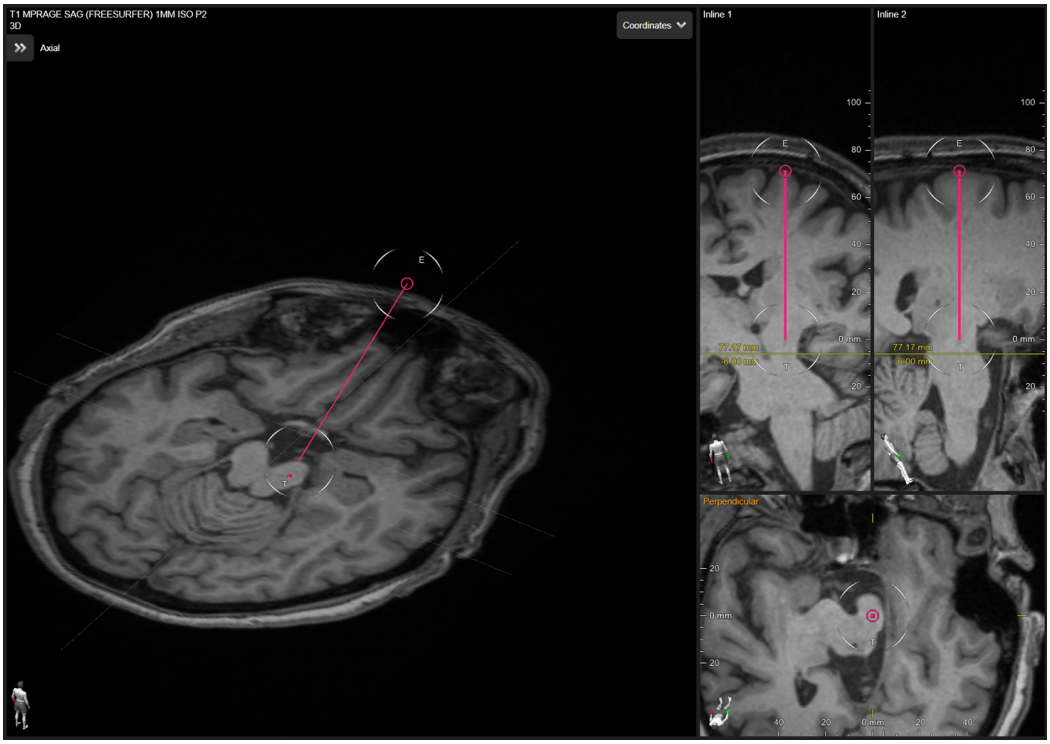


Figure 26

The intersection point (shown by yellow line) is 6 mm below target (pink trajectory).

4.3 Creating, Modifying and Removing Trajectories Using Trajectory Software

About Creating Trajectories

You can create new trajectories and remove existing ones at any time using the toolbar options in **Trajectory**.

NOTE: Brainlab recommends assigning unique names and colors to distinguish between different trajectories, objects, fiber bundles, etc.

Trajectory Positioning Controls

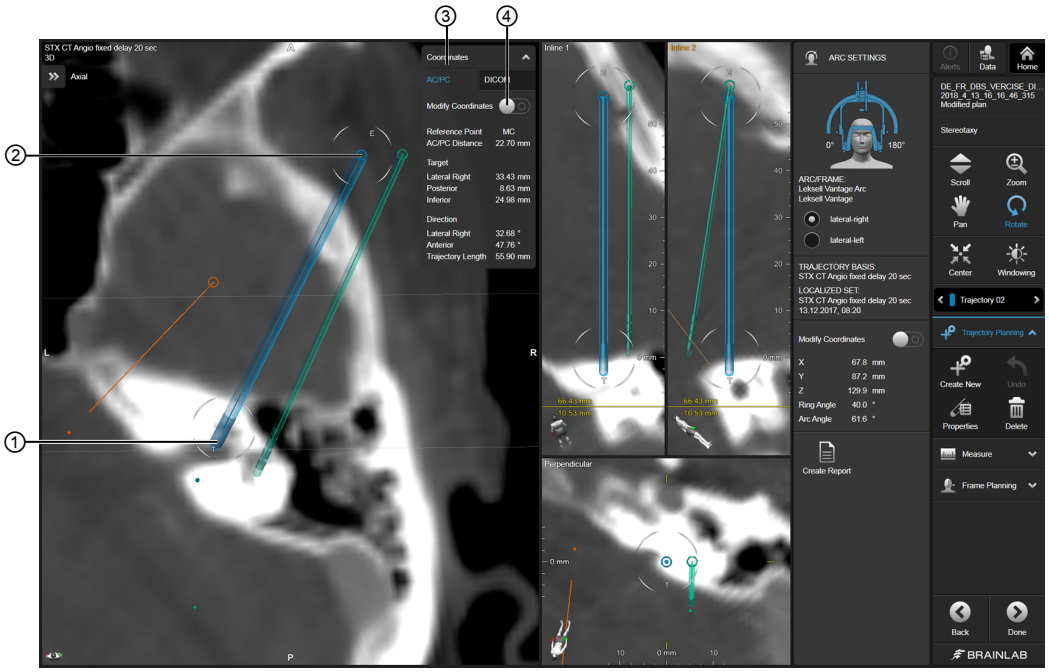
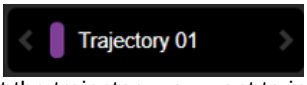


Figure 27

No.	Description
①	**Target** positioning selection area and catch handles.
②	**Entry** positioning selection area and catch handles.
③	**DICOM** and **AC/PC** coordinate tabs.
④	Toggle to modify coordinates.

How to Select an Active Trajectory

There are two ways to select a trajectory to interact with it:

Step	
1.	 Use the arrow buttons to select the trajectory you want to interact with.
2.	Alternatively, use the **Data** menu.

Step
NOTE: You can only interact with the active trajectory.

How to Create a New Trajectory

Step	
1.	Position the mouse anywhere in the view.
2.	Select **Create New**. A new trajectory is created.  **Warning** **Assign each trajectory a unique and meaningful name so it can be clearly identified.** *NOTE: Optionally, you can add new trajectories using **Lead Localization** at the postoperative stage.*

Related Links

4.5 Getting Started with Lead Localization Software on page 50

How to Replicate a Trajectory

Step	
1.	Select **Center** after you position the original trajectory so the target is centered in the views.
2.	Select **Create New** to replicate the original trajectory (and all 3D shape definitions).
3.	With this newly created trajectory, you can now: a. Change the entry point to plan an alternative entrance direction b. Change the target point to plan an alternative target area from the same entry point c. Use AC/PC relative coordinates to mirror the second trajectory to the lateral side

How to Edit Trajectory Properties

You can edit a trajectory's properties at any time.

Step	
1.	Use the arrow buttons on the toolbar to find the trajectory you wish to edit.
2.	Select **Properties** from the toolbar. The **Properties** menu opens.
3.	Edit the properties as necessary. The following properties can be edited or selected: • **Name** • **Implant Date** • **Comment** • **Type** • **Tip Offset** (in mm)

Assign each trajectory a unique name so that it can be clearly identified.

Repositioning Target and Entry Points

You can reposition the target and entry points for the trajectory within the views or by editing the DICOM and/or AC/PC relative coordinates of the trajectory. There are two options for this:

- Drag the trajectory's target and entry points using the mouse pointer (or finger)
- Amend coordinates directly in the menu

How to Drag Target and Entry Points

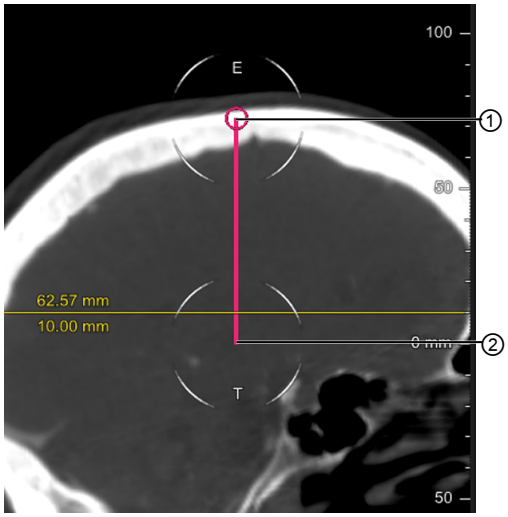


Figure 28

Step	
1.	Drag the target point ② using the mouse pointer (or finger on touchscreens) to reposition it on screen.
2.	Drag the entry point ① to reposition it on screen.

How to Modify AC/PC Coordinates

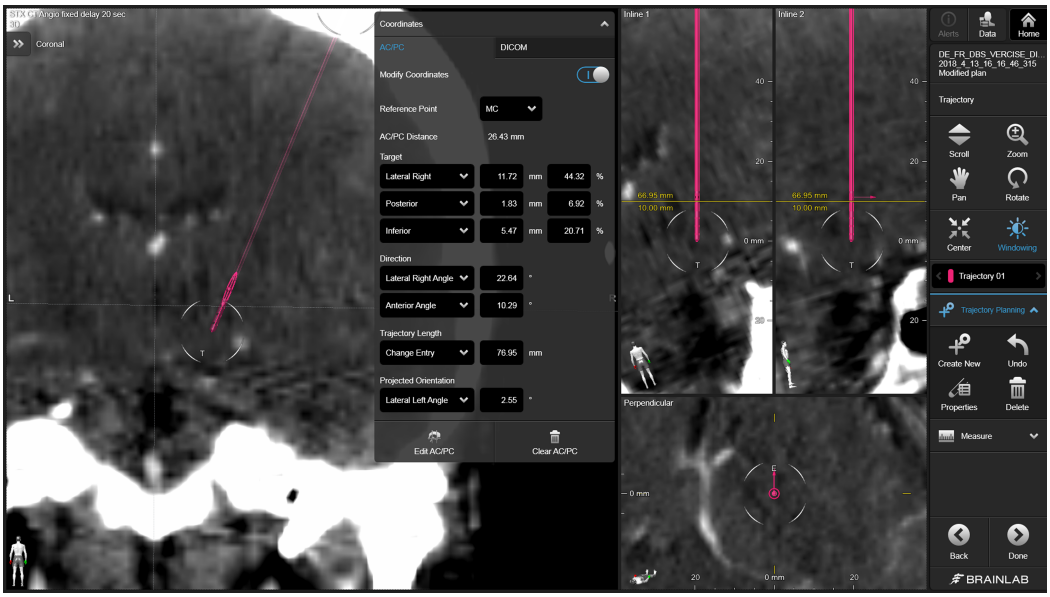
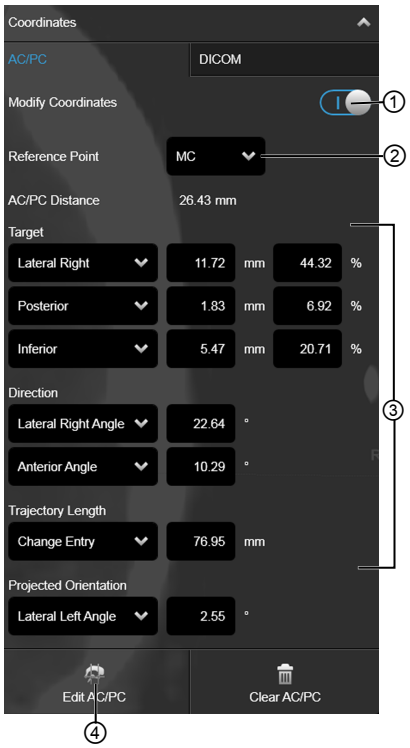
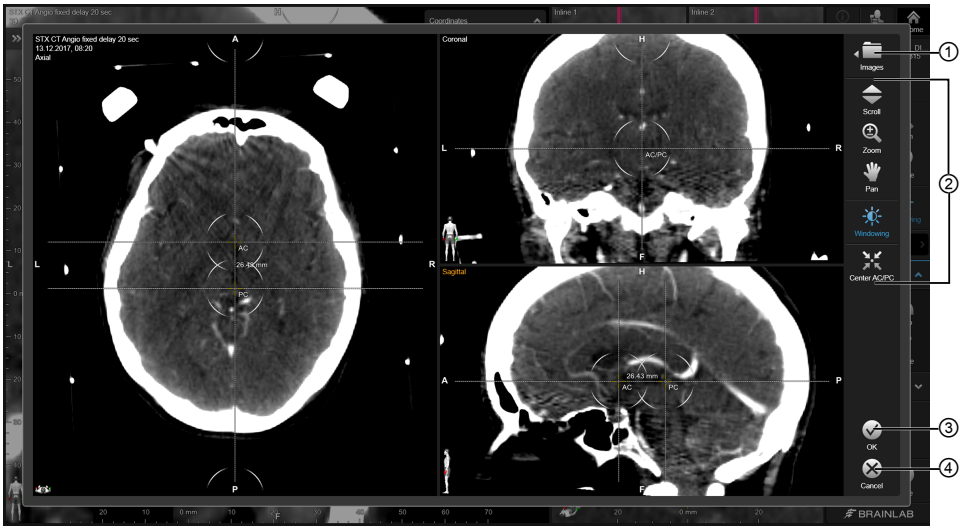


Figure 29

You can use the **Coordinates** menu to manually modify AC/PC coordinates in your image set.

Step	
1.	Select the **AC/PC** tab from the coordinates menu.
2.	 Toggle on **Modify Coordinates** ①.
3.	Select the reference point ② (e.g., **AC**, **MC** or **PC**) for the coordinate system. *NOTE: Depending on your settings, a default reference point is set.*

Step	
4.	Edit the criteria fields ③. You can edit: • **Target** • **Direction** • **Trajectory Length**
5.	If the coordinates are satisfactory, toggle off **Modify Coordinates**.
6.	If the coordinates are not satisfactory, select **Edit AC/PC** ④ to view manual editing options. The manual coordinate modification screen opens.
7.	
8.	Review or modify planned trajectories using the following viewing options ②: • **Scroll** • **Pan** • **Windowing** • **Center AC/PC** You can also review other image sets with **Images** ①.
9.	When you are done, select **OK** ③ or **Cancel** ④ to undo any changes.

Projected Orientation

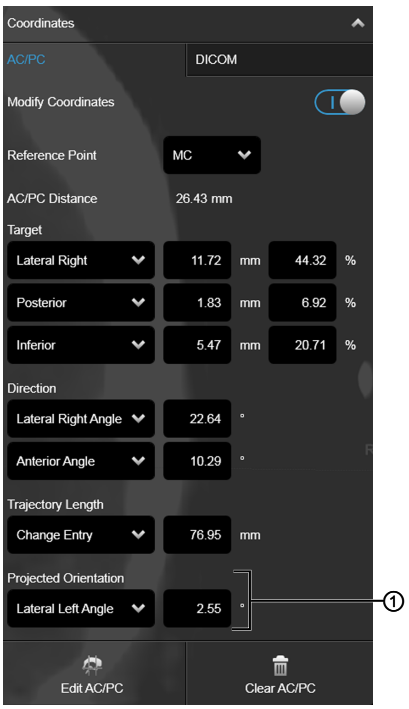
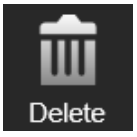


Figure 30

For directional leads, the software also displays **Projected Orientation** ①. Select a direction and a value to indicate an angle projected to a plane (e.g., to later create X-ray angio scans in all angles).

The default setting is 0° (anterior).

How to Remove Trajectories

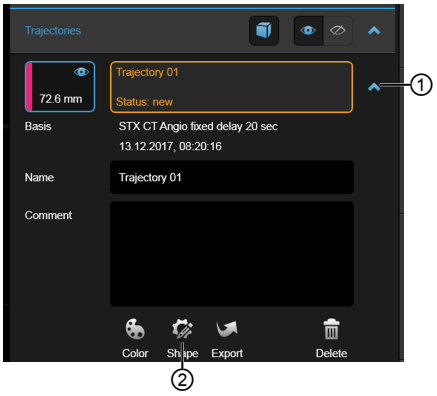
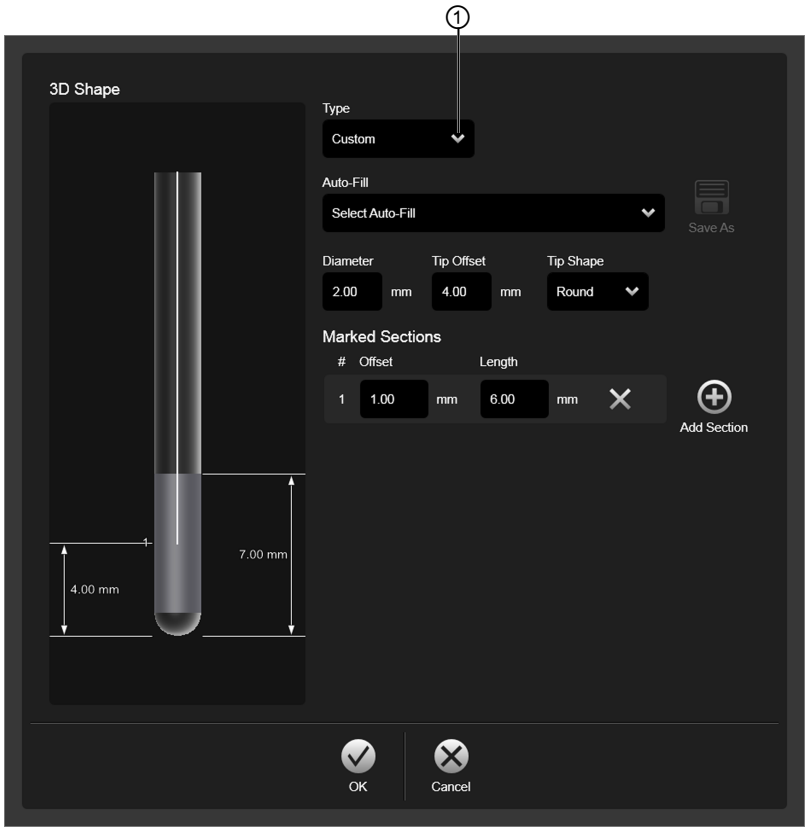
Step	
1.	Select the trajectory in the toolbar.
2.	 Select **Delete**. The trajectory is removed from your planning result (but is not permanently deleted). *NOTE: It is recommended that you always remove any unsafe, ineffective or unnecessary trajectory options before saving the planning result as a plan.*

4.4 Creating 3D Shapes

Background

You can assign a custom shape to a trajectory. A 3D shape can either be custom defined by entering parameters (e.g., via custom type) or by choosing a predefined Boston Lead type.

How to Create 3D Shapes

Step
1. Open the **Data** menu.
2.  Select the down arrow ① by the trajectory you want to edit.
3. Select **Shape** ②. The **3D Shape** dialog opens.
4.  Select a **3D Shape** type from the drop-down menu ①.

NOTE: 3D shapes can be used as a visual aid for placing the target/entry of a trajectory.

How to Adjust Shape Parameters

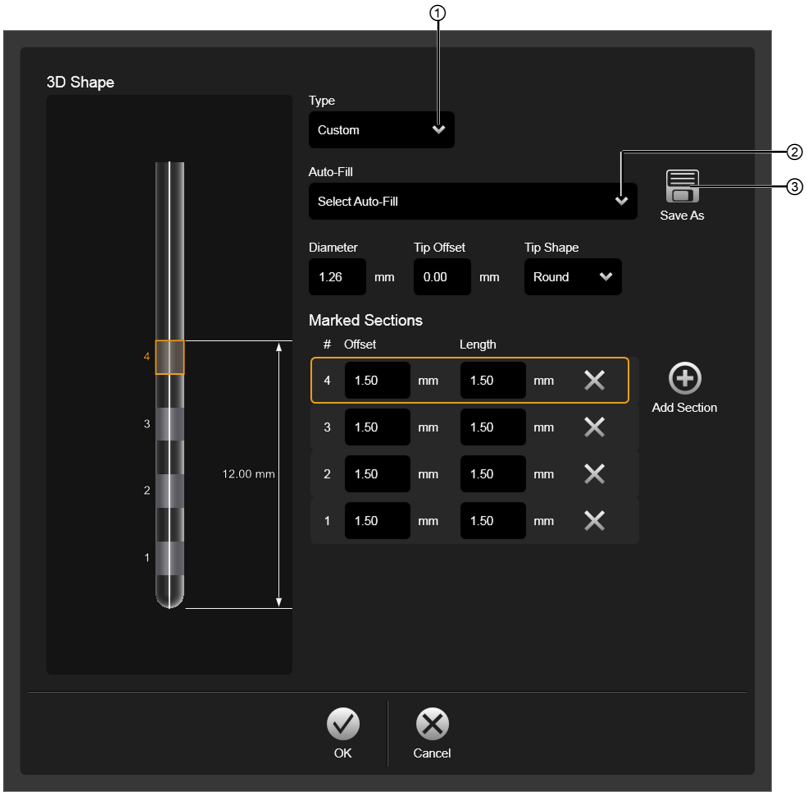


Figure 31

You can adjust the parameters of each **3D Shape**.

Step	
1.	Select a **3D Shape** type from the drop-down menu ①.
2.	 Use **Add Section** to add a new marked section to the **3D Shape**.
3.	Amend the parameters as appropriate to your surgical application. For instance: • **Diameter** • **Tip Offset** • **Tip Shape** • **Offset** • **Length**
4.	Select **OK**.
5.	If desired, use auto-fill options ② to automatically fill all parameter fields. Save custom auto-fill options by selecting **Save As** ③ after you created your own custom 3D shape.
6.	Select **OK**.

Step	
	NOTE: Always verify that the parameters for any auto-fill option is acceptable with the implant's technical specifications. *NOTE: Both abstract shape visualization and 3D shape visualization is intended to be used as a visual aid for positioning the target and entry points of the trajectory.*

How to Export Leads

Figure 32

To export leads, follow these steps.

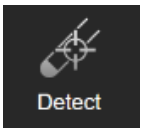
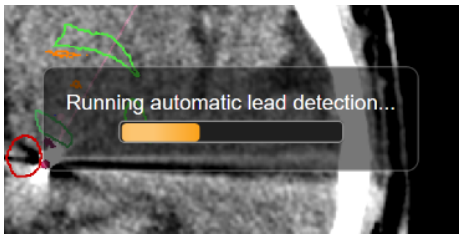
Step	
1.	Open the **Data** menu.
2.	From the **Trajectories** menu, select the lead you want to export.
3.	Select **Export**. The export segments menu opens. You can select either: • **Separate Segments**, if you would like to export the lead's marked sections separately • **Combined Segments**, if you would like to export all of the lead's marked sections
4.	The software exports the lead information.

4.5 Getting Started with Lead Localization Software

Getting Started

Before you can adjust lead or trajectory position or create 3D shapes, you must first detect leads and define orientation.

How to Detect Leads

Step	
1.	 Select **Detect** in the main menu.
2.	 A progress bar fills. Leads are detected and assigned names and colors.

4.6 About Auto Align

About Auto Align

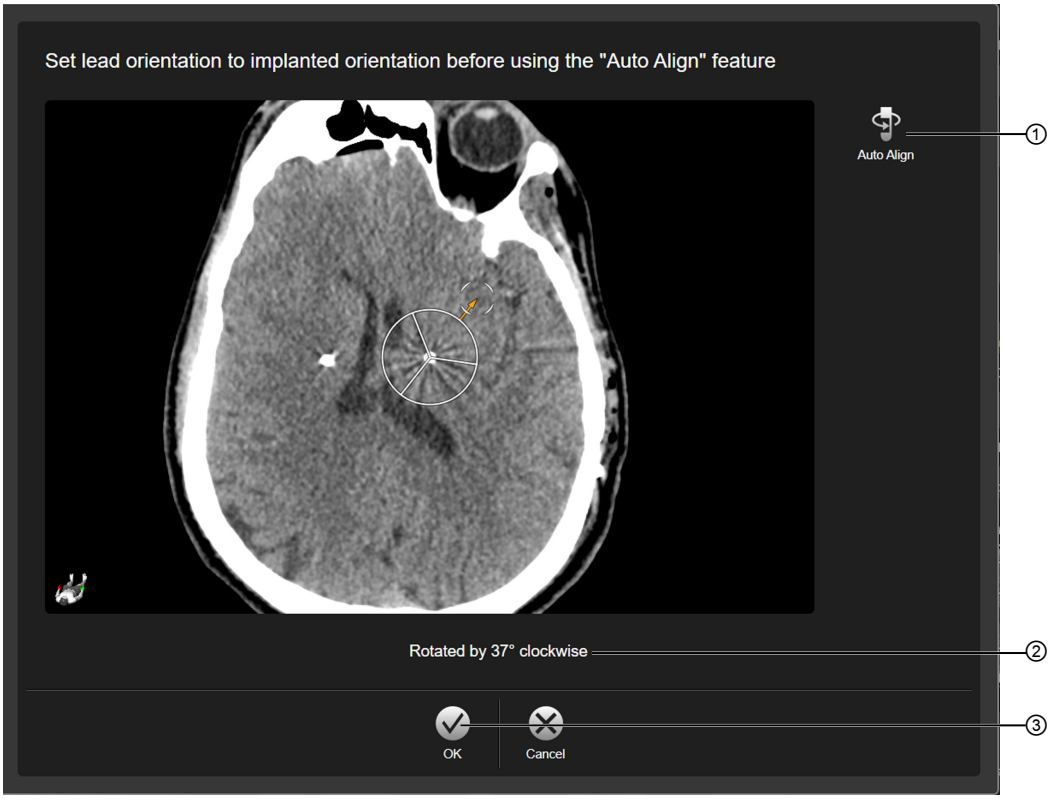


Figure 33

You can automatically detect lead orientation in CT scans. To do so, first set lead orientation for each lead to the implanted orientation, then select **Auto Align** ①. The software will display the rotation below the image ②.

Select **OK** ③ to return to the main screen.

4.7 About Automatic Lead Detection

About Automatic Lead Detection

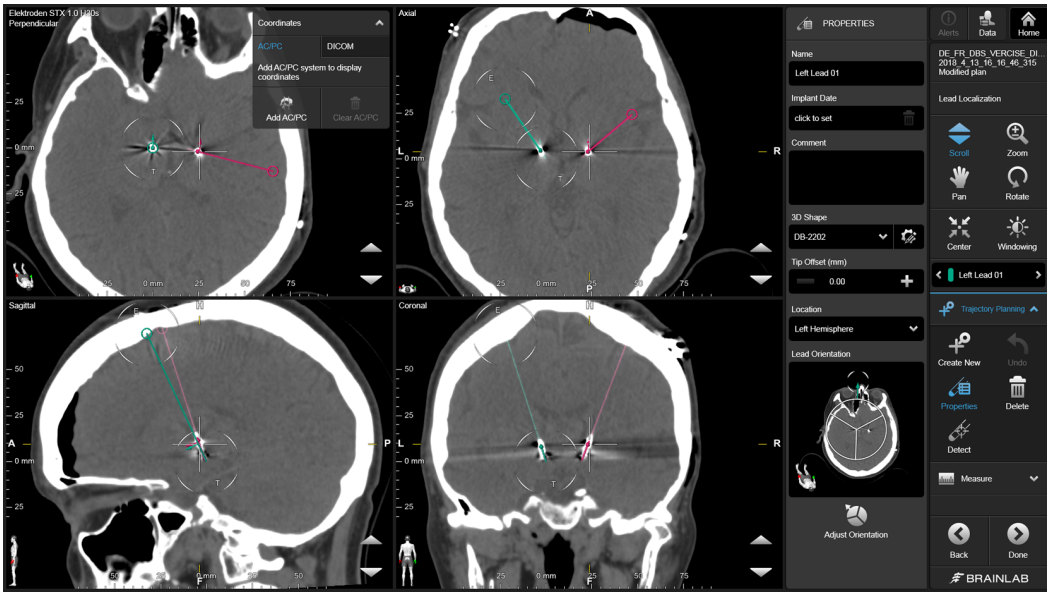


Figure 34

You can automatically detect trajectories and leads with **Lead Localization**. Additionally, you can manually adjust orientation of leads within the software, and, for CTs, automatically detect lead orientation.

How to Automatically Detect Leads

Step	
1.	Open **Stereotaxy**. Your patient data opens in the software.
2.	Open the **Trajectory Planning** menu.
3.	Select **Detect**. The software automatically detects any leads or trajectories in the image set.
4.	To manually adjust lead orientation, select **Properties**. The **PROPERTIES** menu opens.
5.	Adjust the lead orientation at the bottom of the menu.

How to Define the Lead Orientation

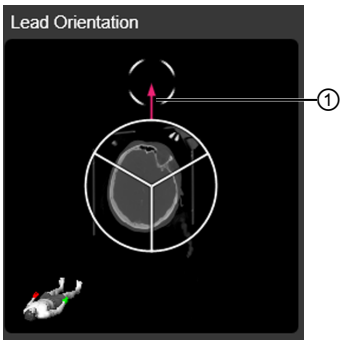


Figure 35

If you have defined a directional lead, the **Define Orientation** view is active.

Step
Drag the orientation marker ① to mirror the directional lead's orientation. Use the orientation guide in the lower left corner to determine direction.

4.8 AC/PC Localization

Background

You can define the AC/PC localization by:

- The mid-sagittal plane
- The positions at which the anterior commissure (AC) and the posterior commissure (PC) intersect the mid-sagittal plane

When is AC/PC Localization Required?

AC/PC localization is required for:

- Patient orientation, which is used for the alignment of reconstructed views (e.g., axial, coronal and sagittal) in planning tasks
- Trajectory planning based on definable AC/PC coordinates

Related Links

4.3 Creating, Modifying and Removing Trajectories Using Trajectory Software on page 41

How to Add AC/PC Coordinates

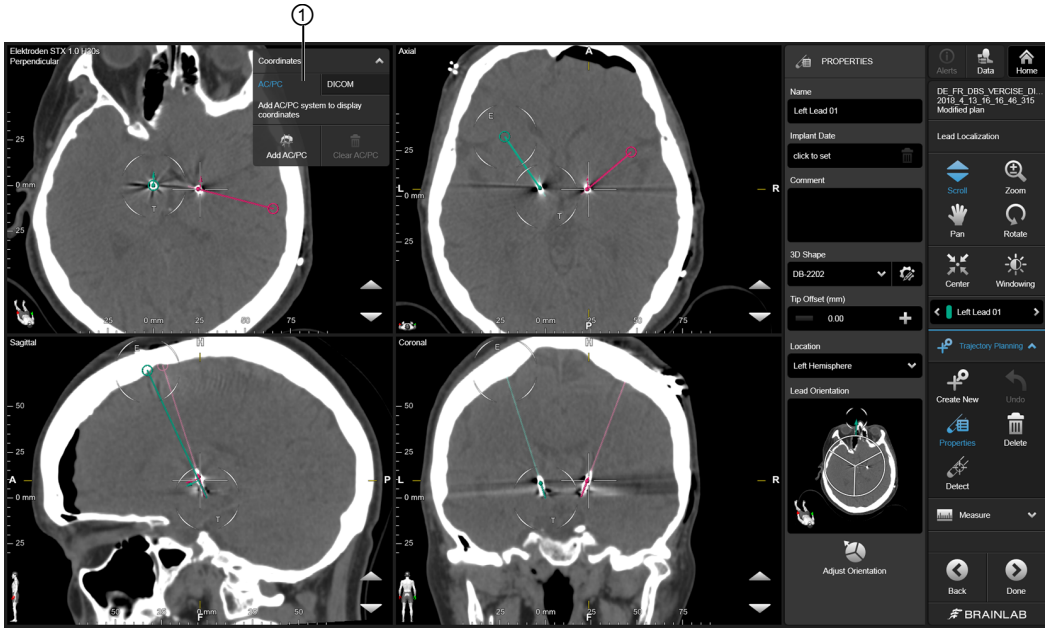
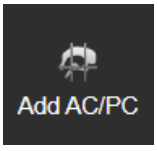
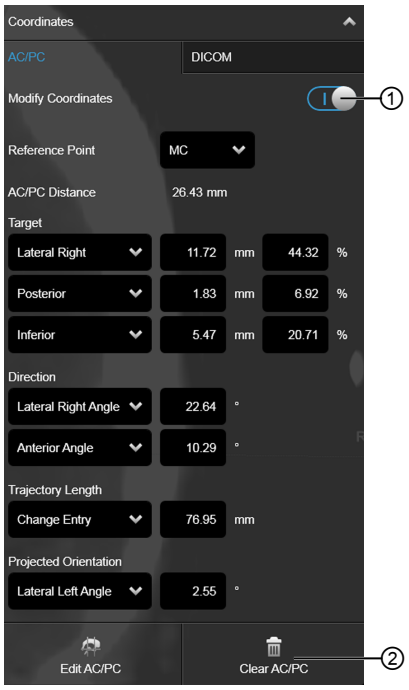


Figure 36

If no localization is defined, or you want to add coordinates, add them via the **Coordinates** menu.

Step	
1.	 Select **Add AC/PC** ① on the **Coordinates** menu. The default AC/PC coordinates are displayed in the image views.
2.	If required, you can now modify the localization.

How to Remove AC/PC Localization

Step	
1.	 Toggle on **Modify Coordinates** ①.
2.	Select **Clear AC/PC** ② to remove the AC/PC localization.

Inaccurate AC/PC Information

Warning

The information provided by the AC/PC coordinates may be incorrect, inconsistent or inaccurate due to improper localization of the AC/PC system, or due to inherent insufficiencies of the planning methods based on the AC/PC system. To prevent patient injury, make sure to review all trajectory positions in the patient image views (e.g., the DICOM and AC/PC tabs).

AC/PC Localization Example

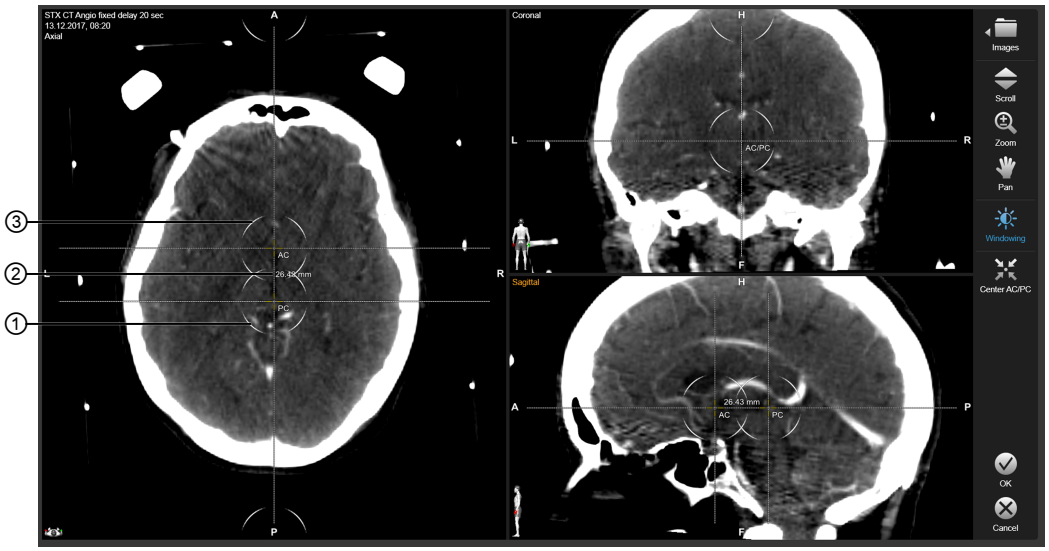


Figure 37

No.	Explanation
①	PC positioning selection area
②	Distance between AC and PC points
③	AC positioning selection area

NOTE: AC and PC points are visible in all views.

4.9 Reviewing Trajectories

Background

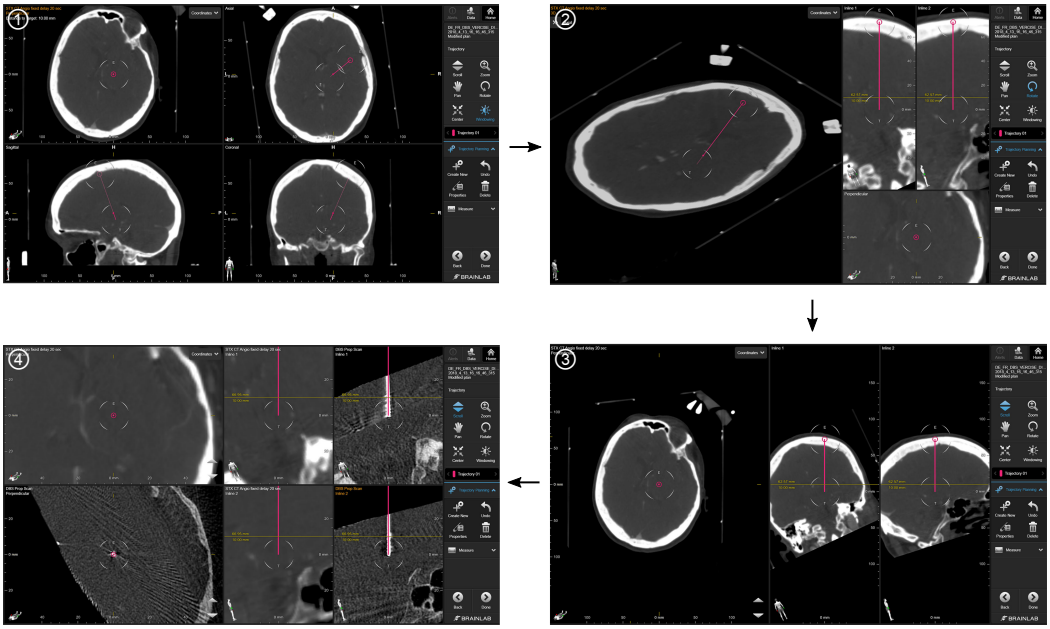


Figure 38

Select **Data** to view and manage preexisting assets (e.g., trajectories, objects and data types for your trajectory).

For best results:

- Review the entire pathway of each planned trajectory in the **ACS** ①, **Overview** ②, and **Inline** ③ layouts to verify that no critical structures are penetrated and that the target is adequately placed.
- Rule out any possible questions about safety and effectiveness by reviewing every image set coregistered to the trajectory.
- Use **Bimodal** layout ④ to review each trajectory and ensure there are no accumulation of co-registration errors (e.g., fusion chains between the stereotactically localized set and the image set in which the trajectory is registered).

Warning

All trajectories currently loaded must be reviewed regarding their safety and effectiveness. To identify potential planning inconsistencies, safety and effectiveness issues, the following essential requirements must be fulfilled:

- **Ensure all available information is utilized: Always review all available coregistered multi-modal image sets for each trajectory.**
- **Confirm acceptable risk: Always verify whether the sum of all propagated errors within a fusion net is acceptable for the trajectory/registration method to be used.**
- **Verify plan conditions are controlled: Only perform a trajectory review with a loaded, unmodified plan. If the planning result is a modified plan or a data selection, it must first be saved by the user with a user-defined name, so that it can be reviewed under controlled plan conditions.**

Warning

Always remove any unsafe or ineffective trajectory options after review.

The finalized, saved (preoperative) plan (to be loaded at the day of surgery) must not contain any unsafe/ineffective trajectories. Remove all unsafe/ineffective trajectory planning found during review in order to prevent the risk of accidental usage and save the

planning result as a new plan with a unique, user-defined name. Via review, always ensure that only safe/effective trajectories are contained in the plan to be used for the surgery.

NOTE: Deselect all data before loading another plan to ensure that you do not merge the plan data with any currently loaded data.

How to Review Trajectories

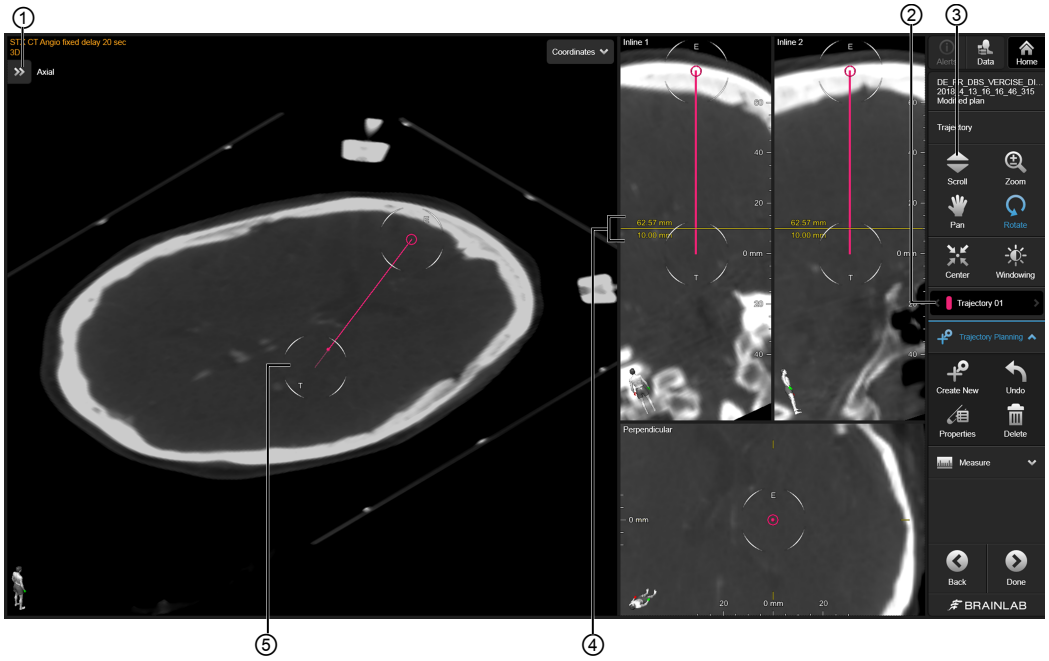


Figure 39

Before starting review, ensure that the planning result has been saved as a plan and has not been modified. If the plan for review has been modified or comes directly from data selection, be sure to first resave the planning result as a plan with a user-defined, dedicated name.

Step	
1.	Select a plan for review.
2.	Select a trajectory on the toolbar ②.
3.	Select a view in the upper left corner ① (e.g., Axial).
4.	Move to the region of interest using the **Pan** and **Zoom** functions.
5.	Select **Scroll** ③ and scroll through the scan reconstructions using the buttons in the **Overview** layout. The scan depth is indicated by a yellow line ④ in the **Inline** view.
6.	Repeat steps 2 through 5 as required in the different layouts.
7.	Continue with all trajectories in this unmodified plan.
8.	If you are satisfied with your overall trajectory planning review result, select **Done**. You can also leave via **Home** and save the planning result as a plan with a user-defined name.
9.	If the trajectory is not satisfactory, continue to adjust the trajectory entry and target points (e.g., by dragging the handles ⑤ or adjusting the values in the **Coordinates** menu).

*NOTE: You can also use **Pan** and **Center** to assist with reviewing your plan.*

4.10 About Plans and the Plan Status

Background

Always assign your planning results a unique plan name so it can be clearly identified later. This can then be reviewed using **Trajectory** software. If after review your plan cannot be approved for surgery, make any required changes, save the plan with a new dedicated name, and then start the review process again.

See the **Patient Data Manager Software User Guide** for more information.

Warning

- **Save intermediate planning results as plans with unique names so that each of the plans can be clearly identified, reviewed and/or (un-)approved.**
- **Do not use automatically saved plans for review and/or treatment.**
- **Do not load automatically saved plans with the intention of continuing your planning session where you left off, since an unintended planning result (e.g., an accidental modification) might be saved automatically.**

Identifying the Plan Status

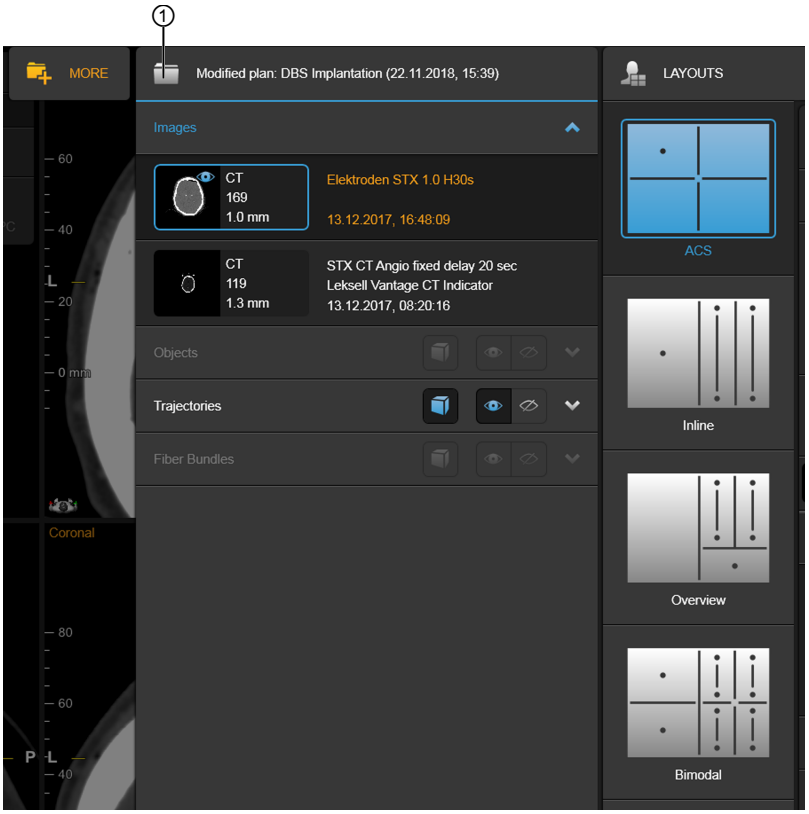


Figure 40

The plan status ① is displayed in the **Data** menu. A plan may be modified or unmodified. In this example, the plan has been modified.

Warning

Do not (load and) use auto-saved plans for patient treatment. Only use the (unmodified) plan for patient treatment! A plan dedicated to patient treatment must meet all of the following conditions: The plan must be:

- **Saved by the user with a unique user-defined name**

- **Reviewed to be safe and effective in its unmodified state**
- **Approved for patient treatment**
- **Loaded to the treatment system as being reviewed (without modification)**

Warning

Always perform an overall plan review after making modifications. Adding, changing or removing content such as images, objects, windowing, fusions or trajectories may change what you originally planned. Always verify the following:

- **The planning result is reviewed and the loaded plan is an unmodified plan (e.g., after performing modifications but before starting the review of the overall planning result, it was saved as a plan with a user-defined name).**
- **After modification, the sum of all propagated errors within a fusion net is still acceptable for the trajectory/registration method to be used.**
- **All planning contents that depend on other planning contents are still valid after modification of planning contents. For example, the consistency of multi-modally segmented objects is no longer given after the modification of co-registration net, because a new multi-modal segmentation based on the new co-registration net would deliver different objects.**

How to Save a Plan

Always assign your planning results a unique plan name so it can be clearly identified later. Follow these steps to save a planning result before reviewing it prior to surgery.

Step	
1.	To save a plan, leave the software via the **Home** button at the top of the toolbar.
2.	Select **Save As** from the top of the **Content Manager** screen.
3.	In the box that opens, enter a unique name for your plan, and then select **Save As** to return to **Content Manager**.

5 STEREOTACTIC PLANNING

5.1 Stereotactic Planning and Localization

About Stereotactic Planning and Localization

With the localization planning task, you can assign the localizer to the selected image set and perform stereotactic localization. Stereotactic localization provides a head ring-specific coordinate system in which it is possible to calculate the arc settings for a planned trajectory.

Warning

The software cannot identify all potential collisions of stereotactic arc/head ring components. Thus, there is the potential that a trajectory cannot be adjusted on the arc system as planned. In such cases, you must plan alternative trajectories.

NOTE: Stereotactic localization should be performed prior to planning trajectories or objects in the image set, as well as prior to performing image fusion, to ensure consistent visualization of planning content in all views.

Hardware

Carefully check the accuracy of your localization hardware on a regular basis.

Warning

To ensure a safe and effective Stereotactic Localization, the stereotactic hardware must be fully functional and (scanned) in proper condition:

- **No hardware defects or damage**
- **Rods sufficiently filled with contrast agent (e.g., not dried out, no air bubbles, etc.)**
- **Front localizer plate is not bent away (e.g., by a body part)**
- **Patient positioning does not cause localizer to be mechanically distorted**
- **Localizer is not scanned with a highly distorted MR sequence**
- **Full localizable range of localizer is scanned (e.g., not only few slices)**
- **Scan slices are not highly tilted against localizer geometry**

Supported Images

Imaging modalities that cause image distortions (e.g., MR EPI data sets) or improper rod marker representation (due to poor contrast) cannot be properly localized.

Warning

The system provides functionality for image-based measurement and/or calculation of distances, volumes, diameters, angles, point locations (in Cartesian coordinates), etc. is provided. To avoid patient injury due to such measurements and calculations, the user must verify the used image data to ensure that it is suitable for these purposes.

The suitability of image data must be established, maintained and regularly verified by both the user of the image data and the image provider (e.g., the hospital's radiologist) according to the following guidelines:

- **The user of the image data (e.g., the software user), as well as the image provider must be aware that the provided image data is to be used by Trajectory Planning for geometrical measurements and calculations.**
- **The user of the image data is responsible for specifying image data requirements that are relevant for the specific use case (e.g., spatial accuracy) to the image provider.**
- **The image provider is responsible for providing image data that fulfills the requirements (e.g., spatial accuracy) specified by the user of the image data.**
- **The image provider is responsible for verifying that the provided image data fulfills the requirements (e.g., by calibrating the scanner and performing phantom tests using Trajectory Planning functionality for measuring on a regular basis).**
- **The user of the image data and the image provider must be aware that neither Brainlab nor the software itself can validate or verify patient specific image data that is used in combination with Trajectory Planning for specific use cases.**

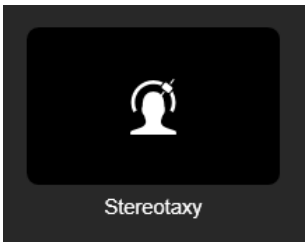
Warning

Image data acquired for accurate stereotactic localization should never be a compromise between tissue distinction, spatial accuracy and localizer rod representation. This could lead to incorrect treatment planning results and harm the patient.

Warning

Do not use distorted images for stereotactic localization. MR distortion may be intrinsic to the scanner and to the susceptibility of materials within the image volume. In the context, the use of MR for stereotaxy by itself can be critical. Only perform stereotaxy using images that are distortion-free and highly accurate.

How to Start Stereotaxy Software

Step
 Select **Stereotaxy** from your specialty workflow (e.g., **STEREOTAXY > STEREOTACTIC PLANNING**).

General Workflow

Step	
1.	Select the image set scanned with the localizer.
2.	Select your chosen localizer from the toolbar. Localization starts automatically.

How to Review and Correct Stereotactic Localization Results

Step	
1.	Review each slice with regards to rod detection definition.

Step	
	This applies to all slices (e.g., green, yellow, red). If a rod is not detected correctly, manually correct its position. If a rod is not detected at all, use **Add Rod** to position it manually.
2.	Use **Ignore Slice** for slices outside the localizable range (i.e., for slices outside the localizer geometry, showing none or insufficient number of rods).
3.	Select **Localize** after performing the adjustments in order to get a new localization result based on reviewed and corrected rod detections.
4.	Continue using **Ignore Slice** to exclude single slices (e.g., those containing air bubbles). Do not use **Ignore Slice** to correct image distortions, artifacts or defective localizer hardware (e.g., with loose or bent plates).

NOTE: If too many slices have been ignored (e.g., due to defective hardware or scanning artifacts), localization cannot be calculated. In this case, the localizer needs to be repaired and/or a new scan must be acquired.

Failed Localization

If no slices could be localized:

Step	
1.	Check the assigned localizer.
2.	If the wrong localizer has been selected, assign the correct localizer and repeat localization.
3.	Start the steps according to the general workflow described above.

5.2 Localizing the Image Set

About Localizer Assignment

The first step in performing localization is localizer assignment. This provides a frame of reference for the slice set.

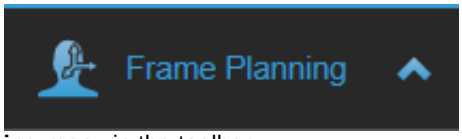
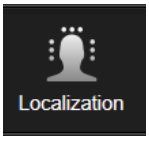
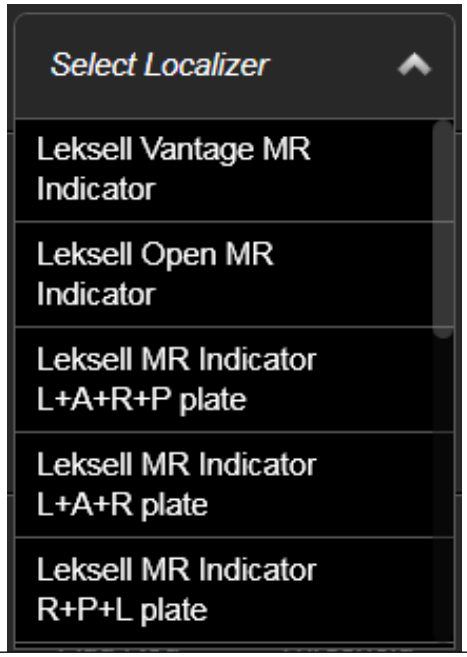
Localizer Hardware

Warning

To ensure a safe and effective Stereotactic Localization, only use compatible stereotactic hardware. Stereotactic hardware must be scanned and used in a compatible way.

- **The correct localizer plate must be mounted in the correct position (e.g., with the inomed system, ensure that the right localizer plate is not mounted on the patient's left side)**
- **Only use localizer revisions that Brainlab has declared are compatible**
- **Only select head rings and/or localizer mounting options that Brainlab had declared are compatible**

How to Localize the Image Set

Step	
1.	While in **Stereotaxy**, open **Data** and select the image set to be localized.
2.	 Open the **Frame Planning** menu in the toolbar.
3.	 Select **Localization**. The screen changes to localization mode.
4.	

Step	
	Select your localizer from the drop-down menu. Make sure you choose the same combination that was used during scanning.
5.	Localization starts automatically.

Warning

You must select the correct localizer option for localization. If an incorrect localizer option is selected, all slices might be successfully localized; however, the subsequent coordinate system, based on a combination of localizer, head ring and arc system, will be incorrect.

Localization Example

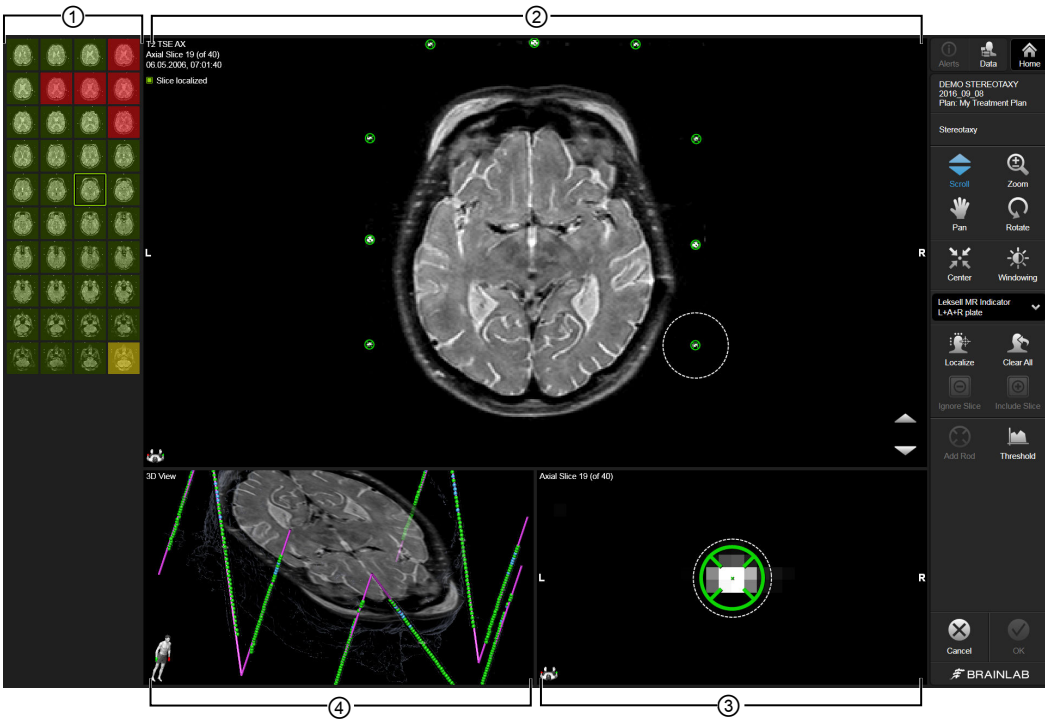


Figure 41

No.	View	Explanation
①	Catalog	Depending on the localization result, the slices are shown with the following colors: • Green: Slice successfully localized • Yellow: Slice has been localized, but precision is low due to one or more misplaced rod markers, poor image quality or an inaccurate localizer geometry • Red: Slice could not be localized. Several reasons are possible (e.g., not enough rods detected)
②	Main	Shows the slice currently selected in the catalog view and whether the image slice could be localized (upper left corner). Rod marker colors: • Green: Localized rod markers • Yellow: Rod markers with poorest localization result • Blue: Indicates that some, but not all rod markers could be localized

No.	View	Explanation
③	Magnified axial view	Shows a magnified view of the area indicated by the white dotted circle in the main view. Use this view to better examine the position of a particular rod marker. To magnify another area, click on a different rod marker.
④	3D	3D view of all detected rod markers together with the expected localizer geometry. Use this view to verify the localizer rod geometry and identify slices with misplaced rod markers. Rod markers should reconstruct in a straight line.

Reviewing Localization

Visually review the contents of each view carefully to ensure that localization has been successful.

Warning

Verify each individual slice about correctness and accuracy of the detected localizer rods. Even if the software indicates, that a slice has been localized successfully (e.g., displayed in green in the catalog view), each slice must be explicitly verified to determine potential need for manual correction of the localizer rod detection. Visually verify the contents of each view carefully in order to ensure that localization has been successful.

How to Adjust the Threshold

If rod markers are not clearly detected, use **Threshold**.

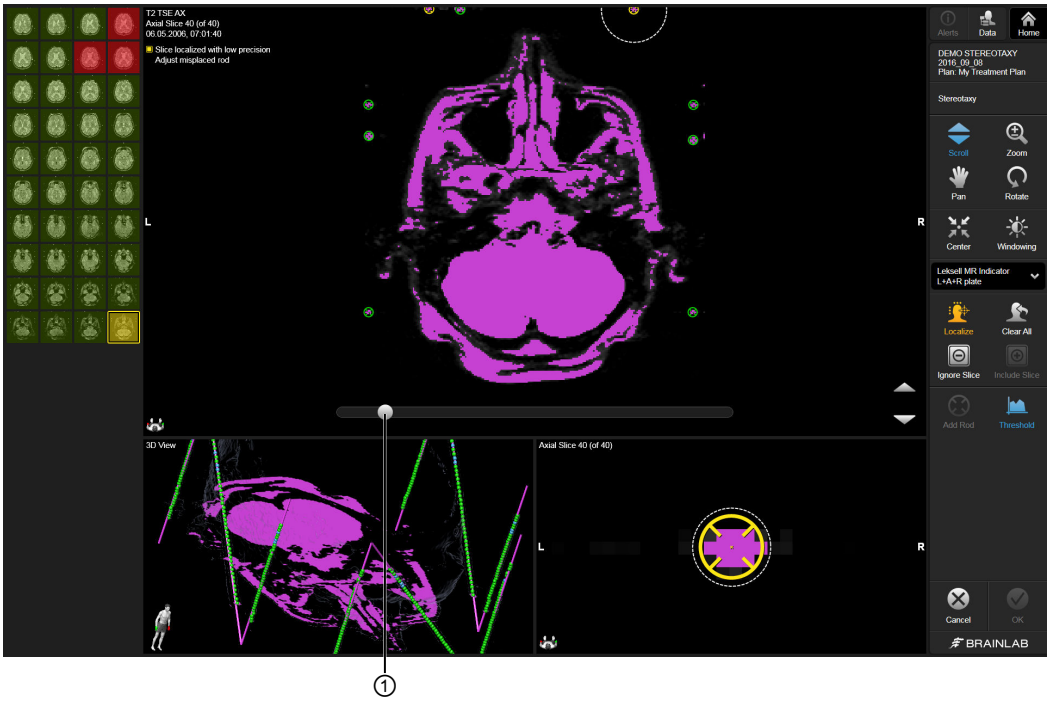


Figure 42

Step
Adjust the **Threshold** by using the slider ①. If necessary, adjust the threshold value used to detect rod markers.

Localization Status Report

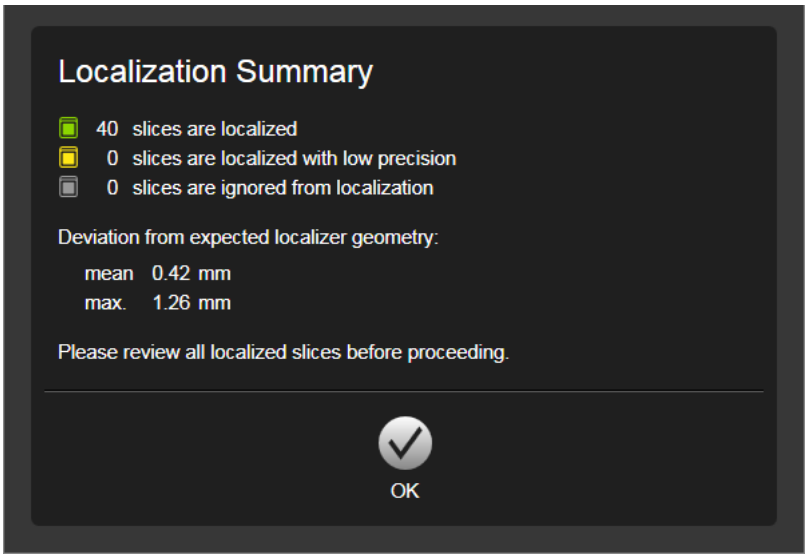


Figure 43

The software localizes the available slices and displays a status report of the localization.

5.3 Ignoring Slices

When to Ignore Slices

The **Ignore Slice** function allows you to exclude slices with insufficient rod marker definition from the localization calculation. This might be used for slices where it is not possible to manually position rod markers.

When you ignore such slices, the slices are no longer considered for localization calculation; however, they keep their relative position within the image set.

The **Ignore Slice** function does not delete slices from the localization.

*NOTE: The **Ignore Slice** function is contraindicated if:*

- *The patient moved during scanning*
- *Image sets show distortions*
- *You are trying to correct defective localizer hardware that contains impurities (e.g., many air bubbles)*

Warning

Ignored slices of a data set may lead to an inaccurate localization as a result of not using all available rod marker information for localization. The user must make sure to localize as many slices as possible (e.g., by manually correcting the localizer rod detection in all affected slices) so that the overall localization precision is as high as possible. Only ignore slices that still cannot be localized after all rod marker detections have been manually corrected accurately.

How to Ignore Single Slices

Step	
1.	Select the slice in the catalog overview.
2.	Select **Ignore Slice**. The localization result is updated and the slice color in the catalog overview changes from red/yellow to gray.

How to Ignore Multiple Consecutive (Intermediate) Slices

Step	
1.	Press Shift on the keyboard and select the first slice to be ignored. Keeping Shift pressed, select another slice to be ignored or double click on a slice to select all neighboring slices showing the same color.
2.	Select **Ignore Slice**. The selected slices and all those in between are ignored from the localization. The localization result is updated and the slice color in the catalog overview changes from red/yellow to gray.

5.4 Adding and Positioning Rod Markers

When to Add or Position Rod Markers

You can manually add rod markers to the slice if the software is not able to localize a slice because an insufficient number of rod markers have been detected (e.g., due to bubbles in the rods, unfavorable scan parameters, or T1/T2 weighting).

If a slice cannot be localized because marker rods were incorrectly or inaccurately positioned, you can reposition rod markers in that image slice.

Rod Marker Positions

If a gantry tilt is used (e.g., for CT), or if a scan is oblique (e.g., MR), the image slices must still intersect the rods of the localizer at a perpendicular angle. Refer to the scanning instructions for acceptable gantry tilt or oblique angles.

How to Add Rod Markers

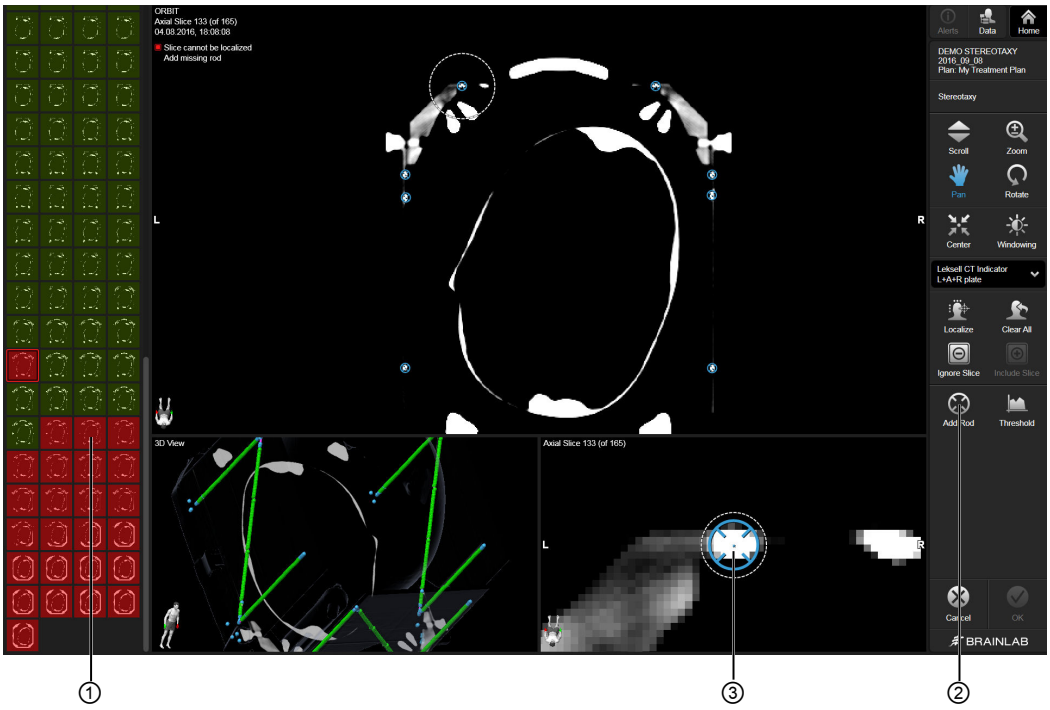


Figure 44

Step	
1.	Select the desired slice in the catalog overview ① and select **Add Rod** ②.
2.	Select in the magnified view ③ to finely adjust the marker position as needed.
3.	Continue in this way until the required amount of rod markers have been added. *NOTE: The **Add Rod** function is deactivated when a sufficient number of markers has been added.*

How to Repeat Image Slice Localization

Step
After you have manually modified rod markers, select **Localize**.

5.5 Stereotactic Report

Background

Before you can generate a report, you must first:

- Create a trajectory
- Localize your image set

Report Content

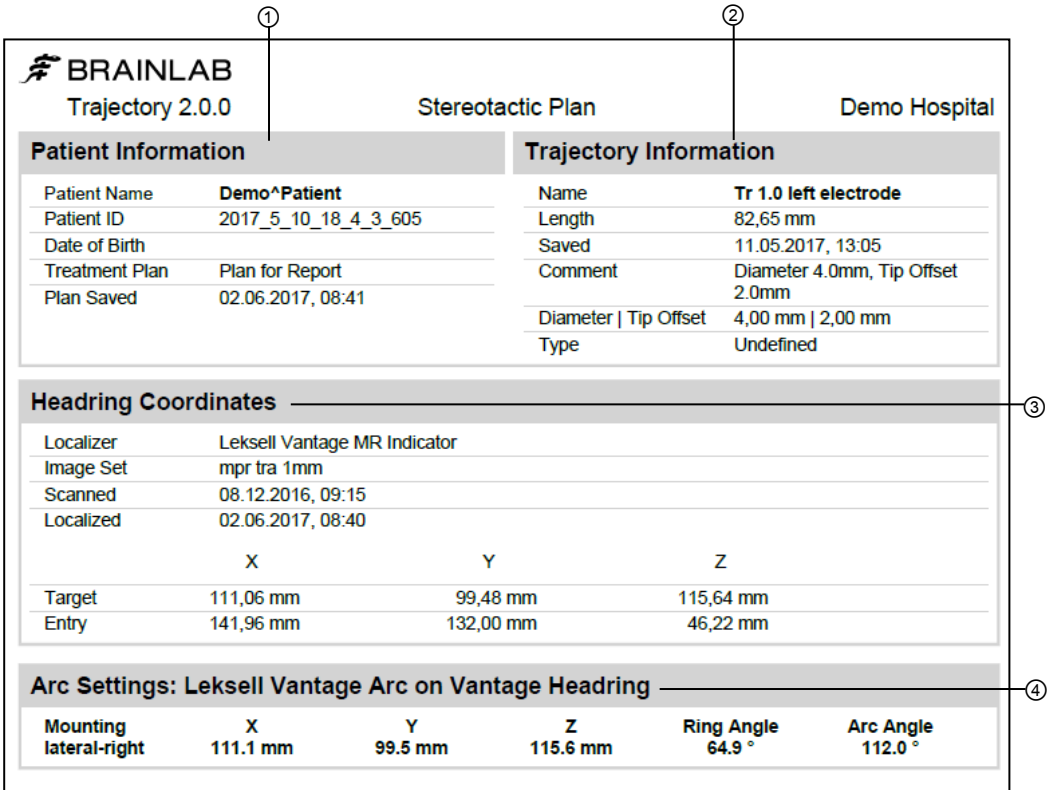
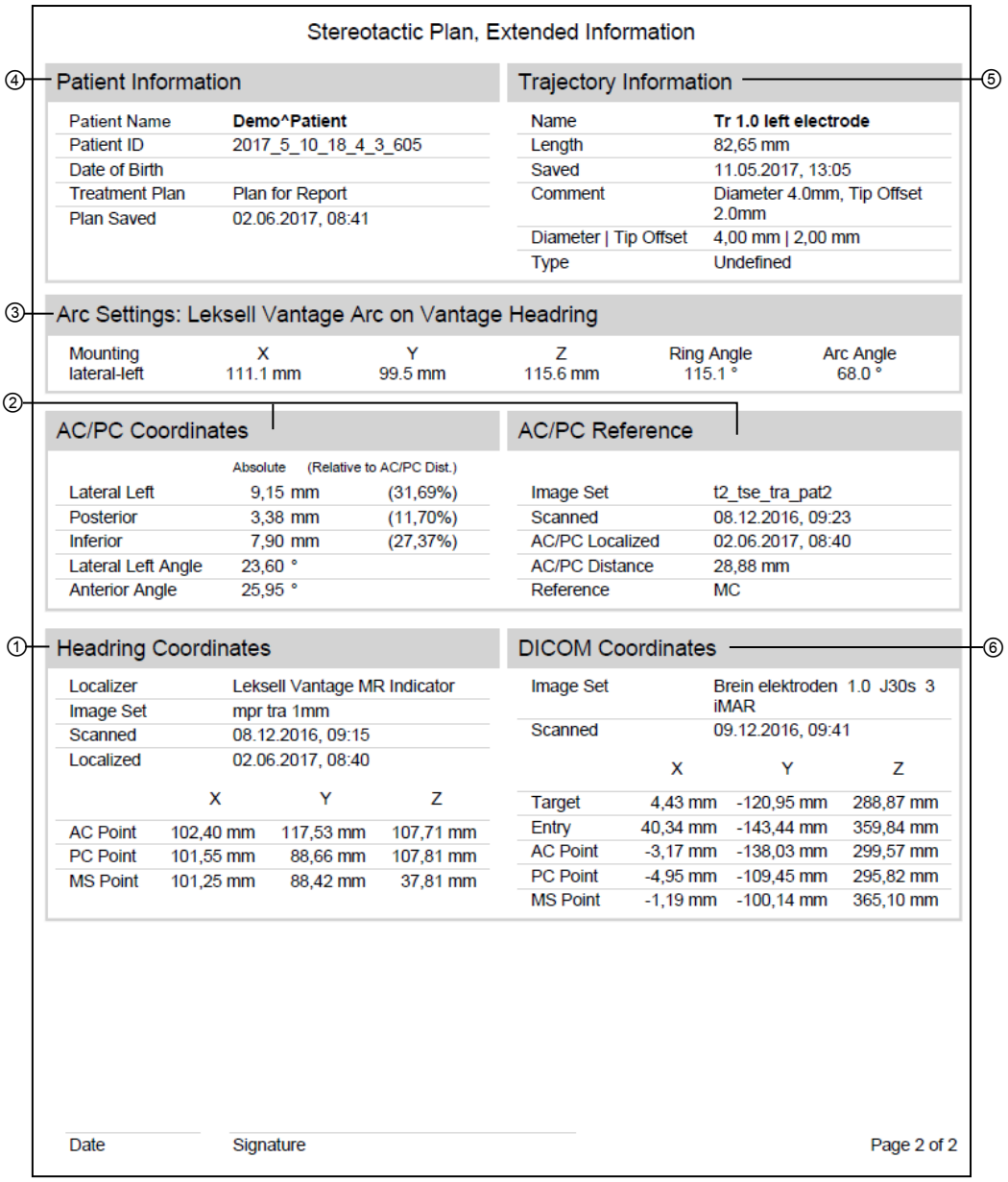


Figure 45

The first page of the stereotactic report contains mandatory information about the selected trajectory and subsequent arc settings as selected in the application.

No.	
①	Patient information
②	Trajectory information
③	Head ring coordinates of selected trajectory
④	Arc settings for selected mounting orientation



Stereotactic Plan, Extended Information

④ Patient Information

Patient Name	**Demo^Patient**
Patient ID	2017_5_10_18_4_3_605
Date of Birth	
Treatment Plan	Plan for Report
Plan Saved	02.06.2017, 08:41

⑤ Trajectory Information

Name	**Tr 1.0 left electrode**
Length	82,65 mm
Saved	11.05.2017, 13:05
Comment	Diameter 4.0mm, Tip Offset 2.0mm
Diameter | Tip Offset	4,00 mm | 2,00 mm
Type	Undefined

③ Arc Settings: Leksell Vantage Arc on Vantage Headring

Mounting	X	Y	Z	Ring Angle	Arc Angle
lateral-left	111.1 mm	99.5 mm	115.6 mm	115.1 °	68.0 °

② AC/PC Coordinates

	Absolute	(Relative to AC/PC Dist.)
Lateral Left	9,15 mm	(31,69%)
Posterior	3,38 mm	(11,70%)
Inferior	7,90 mm	(27,37%)
Lateral Left Angle	23,60 °	
Anterior Angle	25,95 °	

AC/PC Reference

Image Set	t2_tse_tra_pat2
Scanned	08.12.2016, 09:23
AC/PC Localized	02.06.2017, 08:40
AC/PC Distance	28,88 mm
Reference	MC

① Headring Coordinates

Localizer	Leksell Vantage MR Indicator
Image Set	mpr tra 1mm
Scanned	08.12.2016, 09:15
Localized	02.06.2017, 08:40

	X	Y	Z
AC Point	102,40 mm	117,53 mm	107,71 mm
PC Point	101,55 mm	88,66 mm	107,81 mm
MS Point	101,25 mm	88,42 mm	37,81 mm

⑥ DICOM Coordinates

Image Set	Brein elektroden 1.0 J30s 3 iMAR
Scanned	09.12.2016, 09:41

	X	Y	Z
Target	4,43 mm	-120,95 mm	288,87 mm
Entry	40,34 mm	-143,44 mm	359,84 mm
AC Point	-3,17 mm	-138,03 mm	299,57 mm
PC Point	-4,95 mm	-109,45 mm	295,82 mm
MS Point	-1,19 mm	-100,14 mm	365,10 mm

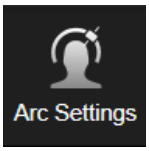
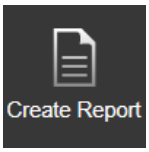
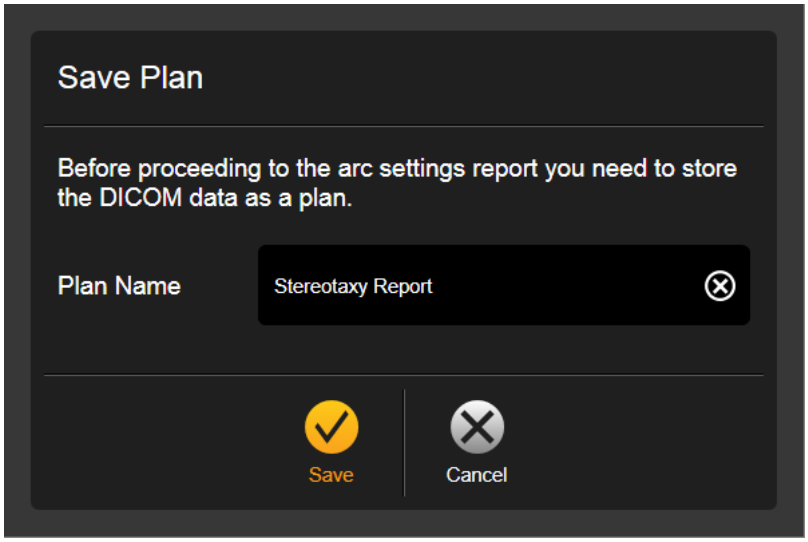
Date Signature Page 2 of 2

Figure 46

The second page of the stereotactic report contains extended information about the selected trajectory.

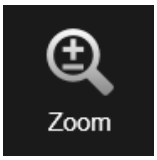
No.	Description
①	Patient information
②	Trajectory information
③	Alternative mounting positions with respective arc settings
④	AC/PC coordinates of target point
⑤	Head ring coordinates of AC/PC system
⑥	DICOM coordinates of target and entry points

How to Generate a Report

Step	
1.	 Select **Arc Settings**.
2.	 Select **Create Report**.
3.	 Assign a unique name for your plan and choose **Save**. *NOTE: Saving a plan is always required. It allows you to restore the information used to create a report.*

5.6 Report Functions

Report Functions

Button	Description
	Pan around the report.
	Zoom to an area of the report.
	Fits the report to the width of the screen.
	Closes the report.
	Saves the report to a specified location.
	Prints the report to a specified printer.

6 SUPPORTED ARC SYSTEMS

6.1 Supported Elekta (Leksell) Stereotactic Systems

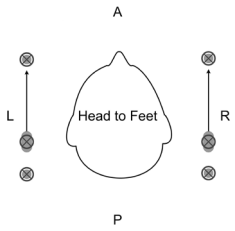
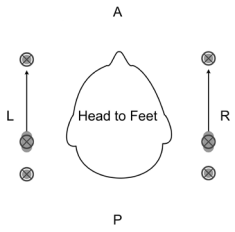
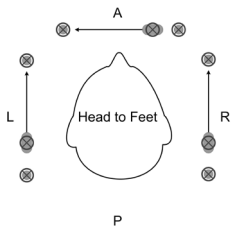
About Stereotactic Localizers

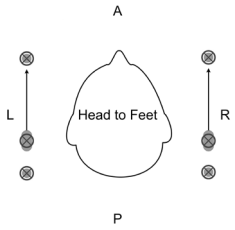
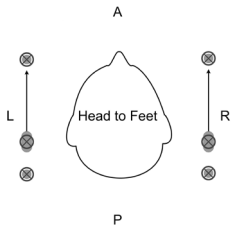
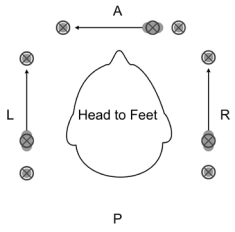
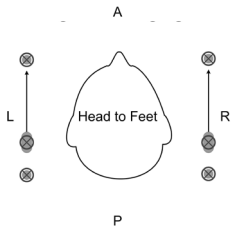
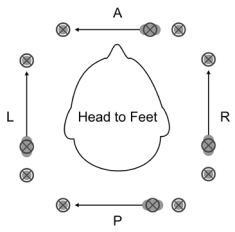
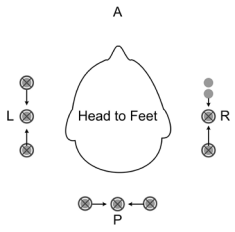
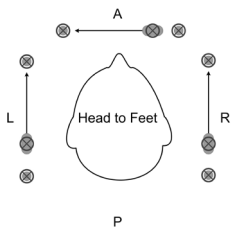
Depending on the type of stereotactic localizer that you select, the scan modality and orientation, the number of rod markers and their geometry may vary.

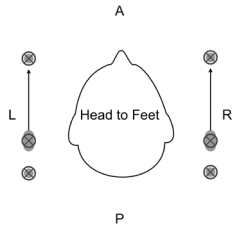
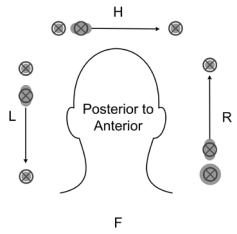
The tables in this section provide information on the rod marker geometry for your localizer.

Supported Elekta (Leksell) Systems

Trajectory supports:

Localizer	Head Ring	Arc System	Supported Configuration/Localizer Plates	Rod Marker Geometry
Vantage MR Indicator	Vantage Coordinate Frame	Vantage Multi Purpose Arc	L+R (Axial: 6 rods)	
Vantage CT Indicator	Vantage Coordinate Frame	Vantage Multi Purpose Arc	L+R (Axial: 6 rods)	
Open CT Indicator	Coordinate Frame G	Multi Purpose Arc	L+A+R (Axial: 9 rods)	

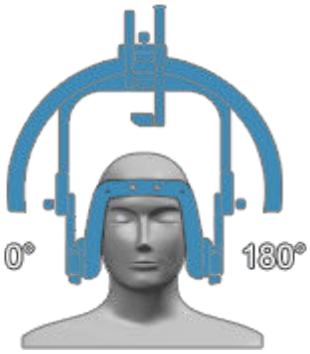
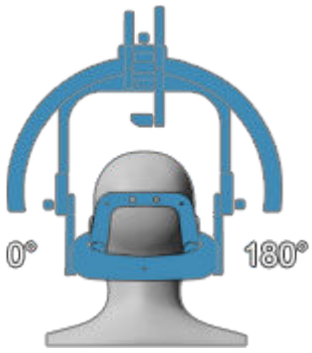
Localizer	Head Ring	Arc System	Supported Configuration/Localizer Plates	Rod Marker Geometry
			L+R (Axial: 6 rods)	
CT Indicator	Coordinate Frame G	Multi Purpose Arc	L+R (Axial: 6 rods)	
			L+A+R (Axial: 9 rods)	
			L+R (Axial: 6 rods)	
			L+A+R+P (Axial: 12 rods)	
MR Indicator	Coordinate Frame G	Multi Purpose Arc	R+P+L (Axial: 9 rods)	
			L+A+R (Axial: 9 rods)	

Localizer	Head Ring	Arc System	Supported Configuration/Localizer Plates	Rod Marker Geometry
			L+R (Axial: 6 rods)	
			L+H+R (Axial: 9 rods)	

NOTE: The Coordinate Frame G head frame must be oriented on the patient's head with the removable front piece (anterior part of the frame) pointing towards the anterior portion of the patient's head.

*Other orientations are not supported by **Trajectory**.*

Leksell Vantage Arc Mounting Options

Option	Illustration
Lateral right	
Lateral left	

Leksell Multi Purpose Stereotactic Arc

The mounting position of the Leksell Multi Purpose Stereotactic Arc is the side of the arc where the X- and Y-scale can be read.

For example, in the lateral right position, the scales point to the right side of the frame and the patient's head, respectively (see table).

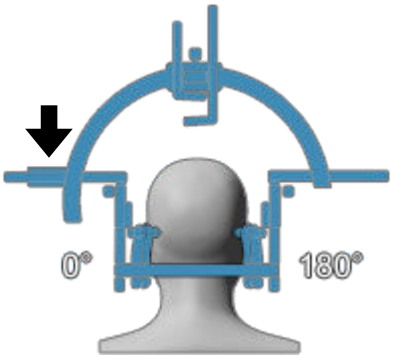
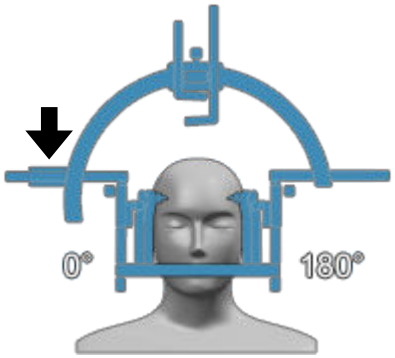
Consult the arc manufacturer's manual for further information.

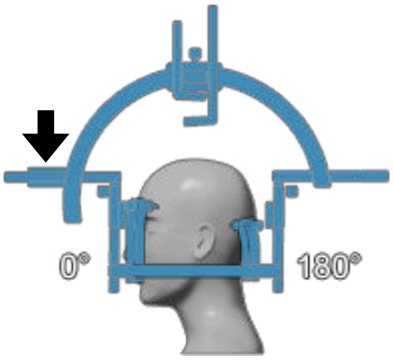
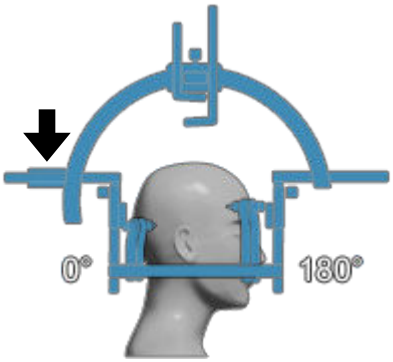
Position	Comment
Sagittal anterior	The arc's Y-scale matches with the frame's Y-scale. Read the Y-value for sagittal anterior and sagittal posterior mountings.
Sagittal posterior	
Lateral left	The arc's X-scale matches with the frame's X-scale. Read the X-value for lateral left and lateral right mountings.
Lateral right	

Recommended Ranges

Scale	Range
X	40 to 160 mm
Y	25 to 175 mm
Z	65 to 160 mm
Arc angle	60 to 167°
Ring angle	0 to 360°

Leksell Multi Purpose Stereotactic Arc Mounting Options

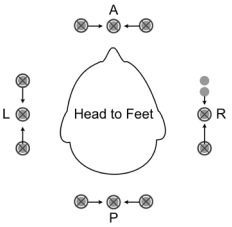
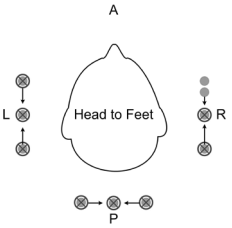
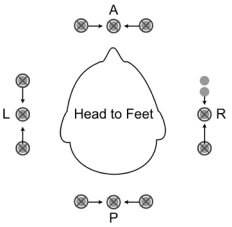
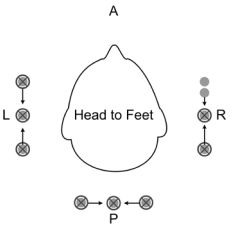
Option	Illustration
Lateral left (X/Y-scale, see arrow)	
Lateral right (X/Y-scale, see arrow)	

Option	Illustration
Sagittal anterior (X/Y-scale, see arrow)	
Sagittal posterior (X/Y-scale, see arrow)	

6.2 Supported inomed Arc Systems

Compatible inomed ZD Arc Systems

Trajectory supports:

Localizer	Head Ring	Arc System	Supported Configuration/Localizer Plates	Rod Marker Geometry
Rev. R	Titanium Ring	ZD Arc	L+A+R+P (CT/MR Axial Upmount)	
			L+R+P (CT/MR Axial Upmount)	
Rev. U	Open Ceramic Head Ring	ZD Arc	L+A+R+P (CT/MR Axial Upmount)	
			L+R+P (CT/MR Axial Upmount)	

About the inomed Arc System

Trajectory allows for mechanical restrictions and ensures the overall stability of the inomed ZD Arc System by limiting the adjustable range of scales.

The supported range of settings is therefore restricted compared to the arc system. **Trajectory** supports the ranges indicated in the table.

Should you need a wider range, contact Brainlab.

Recommended Ranges

Scale	Location	Range
A1	Right-angled drum axle	0 to 65 mm
A2	Right-angled drum axle	20 to 0 mm
B1	Fixation rail	0 to 75 mm

Scale	Location	Range
B2	Fixation rail	75 to 0 mm
C	Right-angled drum	0 to 105 mm
D1	Drum axle	0 to 360°
E	Arc	20 to 110°

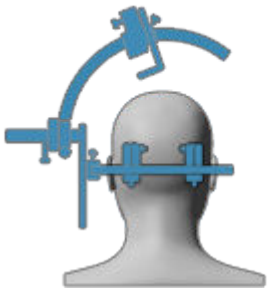
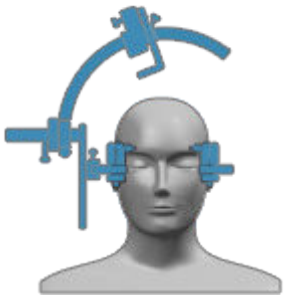
Arc Setting Module Scale

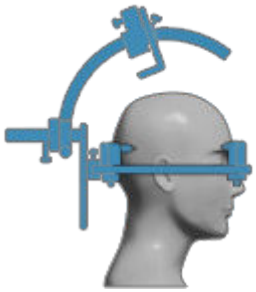
The following table shows the relation between the stereotactic coordinate axes and the arc setting modules (scales) for the upmount orientation:

Position of the ZD Arc on the Head Ring	Stereotactic Coordinate Axes	Corresponding Scale of the ZD Arc Setting Module
0°, anterior	+X (-X) +Y (-Y)	B2 (B1) A1 (A2)
90°, lateral right	+X (-X) +Y (-Y)	A1 (A2) B2 (B1)
180°, posterior	+X (-X) +Y (-Y)	B2 (B1) A2 (A1)
270°, lateral left	+X (-X) +Y (-Y)	A2 (A1) B2 (B1)

inomed ZD Arc System Mounting Options

The following table shows the options for the upmount orientation:

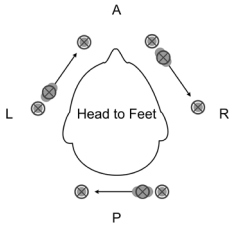
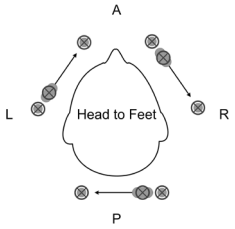
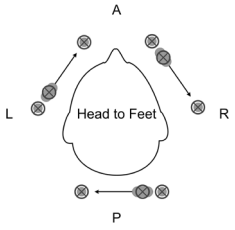
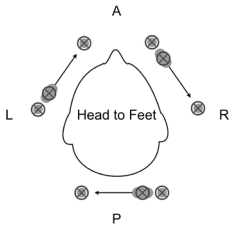
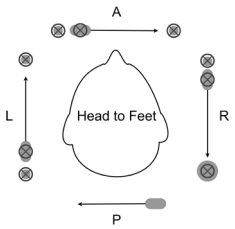
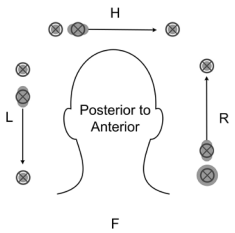
Option	Illustration
270°, lateral left	
90°, lateral right	

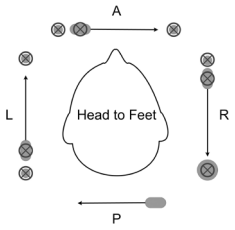
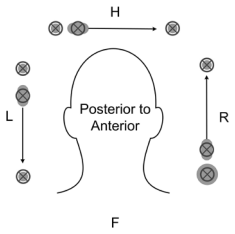
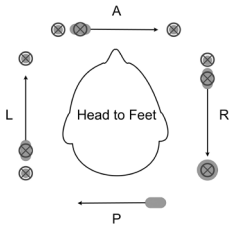
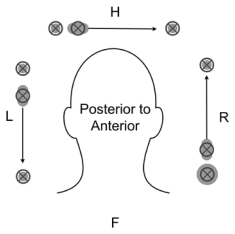
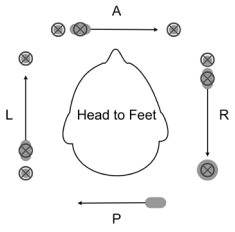
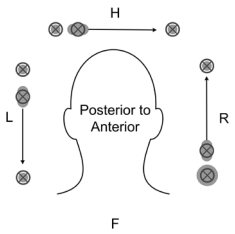
Option	Illustration
0°, anterior	
180°, posterior	

6.3 Supported Integra (Radionics) Arc Systems

Compatible Integra (Radionics) Systems

Trajectory supports:

Localizer	Head Ring	Arc System	Supported Configuration/ Localizer Plates	Rod Marker Geometry
BRW-LF	HRA-IM	CRW-ASL	(CT Axial: 9 rods)	
		Precision CRW	(CT Axial: 9 rods)	
	UCHR-AP	CRW-ASL	(CT Axial: 9 rods)	
		Precision CRW	(CT Axial: 9 rods)	
ULCF-0	UCHR-AP	CRW-ASL	L+A+R+P (CT/MR Axial: 10 rods)	
			L+H+R (MR Coronal: 9 rods)	

Localizer	Head Ring	Arc System	Supported Configuration/ Localizer Plates	Rod Marker Geometry
		Precision CRW	L+A+R+P (CT/MR Axial: 10 rods)	
			L+H+R (MR Coronal: 9 rods)	
LL01	UCHR-AP	CRW-ASL	L+A+R+P (CT/MR Axial: 10 rods)	
			L+H+R (MR Coronal: 9 rods)	
		Precision CRW	L+A+R+P (CT/MR Axial: 10 rods)	
			L+H+R (MR Coronal: 9 rods)	

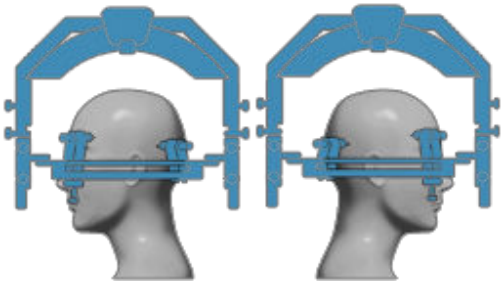
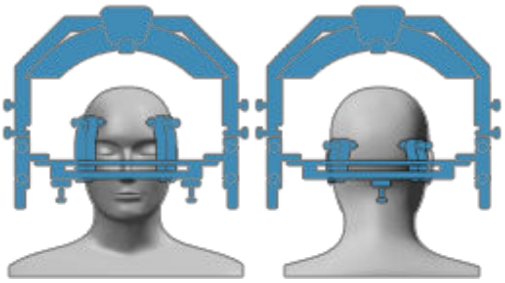
NOTE: Integra (Radionics) uses the following abbreviations.

- *BRW-LF = Brown Roberts Wells - Localizer Frame*
- *HRA-IM = Intubation Head Ring Assembly*
- *CRW-ASL = Cosman Robert Wells - Lightweight Arc System*
- *UCLF-0 = Universal Compact Localizer Frame*
- *UCHR-AP = Universal Compact Head Ring - Adapter Plate*
- *LL01 = Luminant Localizer*

Recommended Arc Ranges

Scale	Range
A-P	-100 to 100 mm
Lateral	-100 to 100 mm
Vertical	-67 to 65 mm
Arc angle	60 to 0 to 60°
Ring angle	-30 to 90 to -30°

Radionics Mounting Options

Option	Illustration
Probe carrier anterior or posterior (trunnion rings are in the left-to-right position)	
Probe carrier lateral left or lateral right (trunnion rings are in the front-to-back position)	

7 SCANNING INFORMATION

7.1 Stereotactic Localization Scan Requirements

Best Practice

Using scans with insufficient data for localizing a patient could cause injury. To ensure best results, Brainlab recommends the following patient setup, scanning and localizer settings.

NOTE: For more information, see the Brainlab Stereotactic Localization scan protocols.

Scan Properties

Sequential Scans	Recommendation
Scan direction	Axial only
Slice thickness	≤ 1 mm, do not scan with gap

Spiral/Helical Scans	Recommendation
Scan direction	Axial only
Slice thickness	≤ 1 mm
Pitch	≤ 1.5
Slice distance	May be changed during the scan

NOTE: For Airo, use helical scans.

Localization Accuracy and CTs

Issues affecting CT accuracy:

- Avoid scanning with artifacts. Do not use CT scans for localization if artifacts are visible.

Localization Accuracy and MRs

Stereotactic localization based on MR images could be affected by possible distortion. Scan with T1-weighting for low distortion over the entire scanned area. Issues affecting MR accuracy:

- Image distortions.
- Bias field artifacts (i.e., caused by changing gray values).
- Ignoring limitations of MR localization equipment (e.g., resulting in poorly visible localizer rods).
- Using non-rigid MR-compatible materials (e.g., plastic plates).

Mounting the Frame and Localizers

- Mount frame and localizer according to manufacturer specifications to prevent misdetecting rods.
- Mount the frame with a neutral rotation and tilt.
- With Fischer or inomed localizers, always use a scanning ring to ensure accuracy. For inomed localizers, Brainlab Elements supports only the upmount modality.

Patient Setup

Setting	Recommendation
Position	Supine
Patient orientation	Head first
Scan orientation	Cranial to caudal
Table height	Do not change during the scan

Localizer Instructions

- The obliqueness of the localizer geometry relative to the scanned slice must not exceed ± 10°.
- The localizer should not be rotated by more than ± 20°.
- For CTs, there is no limit on gantry tilt, provided obliqueness and rotation requirements are met.

Field of View

Keep the field of view (FOV) as small as possible. Always:

- Include region of interest and localizer.
- Scan the full localizable range (e.g., complete rod marker geometry).
- Ensure localizer rods do not touch edge of scan area.
- Exclude table (CT only).

7.2 Lead Localization Scan Requirements

Best Practice

To ensure best results, Brainlab recommends the following patient setup, scanning and localizer settings.

NOTE: For more information, see the Brainlab DBS Lead Localization scan protocols.

Special Settings

- Disable any metal artifact reduction algorithms to automatically detect lead orientation for Boston Scientific leads.
- Select a soft reconstruction kernel for automatic lead detection and/or automatic lead orientation detection.

Scan Instructions

Keep slices as orthogonal to the leads as possible.

Do not change table height during scan.

Sequential Scans	**Recommendation**
Scan direction	Axial only
Slice thickness	≤ 1 mm, do not scan with gap

Spiral/Helical Scans	**Recommendation**
Scan direction	Axial only
Slice thickness	≤ 1 mm
Pitch	≤ 1.5
Slice distance	May be changed during the scan
Reconstructed images	Allowed, but for orientation detection, use non-reconstructed slices.

NOTE: For Airo, use helical scans.

Field of View

- Scan should include complete lead(s) within the patient’s skull.
- Keep FOV as small as possible.
- Do not cut off lead tip(s).

INDEX

Numerics

A

C

D

E

F

H

I

L

M

N

O

P

R

S

T

U

V

W

Z

BRAINLAB

brainlab.com

Art-No. 60919-34EN