



Technical Note

Leksell GammaPlan® version 8.0/8.2/8.3

Leksell SurgiPlan® version 8.2/8.3

Product information for users of Leksell GammaPlan® version 8.0, 8.2 & 8.3 and
Leksell SurgiPlan® version 8.2 & 8.3

October 23rd, 2008

IMPORTANT NOTICE

Error in ImageMerge™

Description

ImageMerge™ add-on provides functionality for registering image studies as well as for verifying the accuracy of the resulting co-registration. A study that has been co-registered to a stereotactic study can be used like any other study in the treatment planning application.

The result of the co-registration is a geometrical relation, a transformation, between the target study and the reference study. This result must be visually verified in the co-registration dialog.

Problem:

Although the co-registration looks good during the verification step in the co-registration dialog, the obtained transformation may include an error that depends on the voxel sizes and acquisition parameters of the co-registered image studies.

The larger the discrepancy between the target and reference voxel sizes, the bigger the error.

The larger the rotation between the target and reference studies, the bigger the error.

This error can be estimated using the mathematical equation (see next pages) and displayed using an anatomical landmark or reference point visible in both co-registered studies (see description on page 2).

Versions affected

ImageMerge™ used in Leksell GammaPlan® and Leksell SurgiPlan® version 8.0 to 8.3 is affected by this problem. ImageMerge™ can be used in combination with a treatment plan, a pre-plan, a follow-up or a re-treatment. Pre-Plan™, Re-Treatment™, ColorPET™ add-ons rely on ImageMerge™.

Recommendations

You must not use ImageMerge™ except if you judge that the transformation error has no clinical significance. Information on next pages can guide you to make such decision.

Elekta will shortly release new versions of Leksell GammaPlan® and Leksell SurgiPlan® to solve this issue.

For further information, do not hesitate to contact your Elekta support representative.

Error visualization:

Once a target study has been co-registered, it is possible to display the transformation error by visualizing the target and reference studies simultaneously in a workspace (e.g. 2 axial, 2 coronal and 2 sagittal views).

Moving the point of exploration on an anatomical landmark in the reference study shall show you the amplitude of the error in the target study. This means that QA of the co-registration procedure needs to be done also outside the co-registration dialog.

Error estimation:

The reference study A is characterized by a voxel size $(V_{Ax}; V_{Ay}; V_{Az})$.

The target study B is characterized by a voxel size $(V_{Bx}; V_{By}; V_{Bz})$

The rotation between the target and reference study is defined by the matrix R

The components of the error vector \vec{E} are
$$\begin{bmatrix} E_x \\ E_y \\ E_z \end{bmatrix} = \begin{bmatrix} V_{Bx} \\ V_{By} \\ V_{Bz} \end{bmatrix} - R \cdot \begin{bmatrix} V_{Ax} \\ V_{Ay} \\ V_{Az} \end{bmatrix}$$

Examples:

If we suppose that there is only a rotation α around the axis x between the reference and target studies and no rotation around the other axes, the components of the error vector \vec{E} are:

$$E_x = V_{Bx} - V_{Ax} ; E_y = V_{By} - V_{Ay} \cdot \cos \alpha - V_{Az} \cdot \sin \alpha ; E_z = V_{Bz} + V_{Ay} \cdot \sin \alpha - V_{Az} \cdot \cos \alpha$$

The length of the error vector \vec{E} can be calculated using the following formula

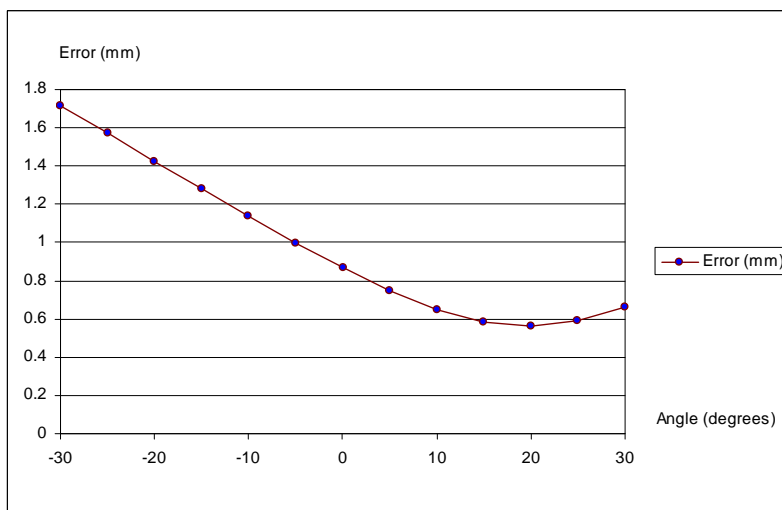
$$\|\vec{E}\| = \sqrt{(V_{Bx} - V_{Ax})^2 + (V_{By} - V_{Ay} \cdot \cos \alpha - V_{Az} \cdot \sin \alpha)^2 + (V_{Bz} + V_{Ay} \cdot \sin \alpha - V_{Az} \cdot \cos \alpha)^2}$$

1. MR-CT co-registration:

The target MR study has a FoV of ca. 25 cm, an acquisition matrix of 256x256 and 1.5mm slice distance. $V_{Bx} = 1.0$ mm; $V_{By} = 1.0$ mm; $V_{Bz} = 1.5$ mm.

The reference CT study has a FoV of ca. 25 cm, an acquisition matrix of 512x512 and 2.0 mm slice distance $V_{Ax} = 0.5$ mm; $V_{Ay} = 0.5$ mm; $V_{Az} = 2.0$ mm.

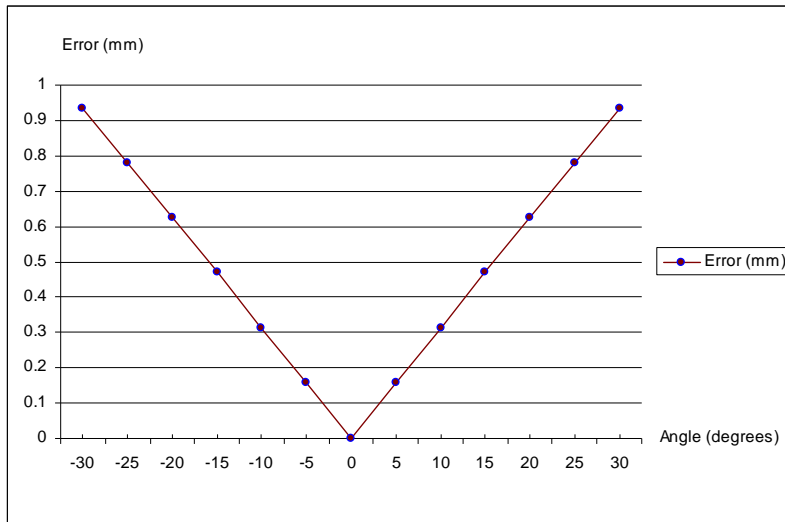
The graphic below shows the error as a function of the angle α



2. MR-MR co-registration:

The target MR study has a FoV of ca. 25 cm, an acquisition matrix of 256x256 and 1.5 mm slice distance. $V_{Bx} = 1.0$ mm; $V_{By} = 1.0$ mm; $V_{Bz} = 1.5$ mm.

The reference MR study has a FoV of ca. 25 cm, an acquisition matrix of 256x256 and 1.5 mm slice distance $V_{Ax} = 1.0$ mm; $V_{Ay} = 1.0$ mm; $V_{Az} = 1.5$ mm



3. PET-MR co-registration:

The target PET study has a FoV of ca. 25 cm, an acquisition matrix of 128x128 and 2.0 mm slice distance. $V_{Bx} = 2.0$ mm; $V_{By} = 2.0$ mm; $V_{Bz} = 2.0$ mm.

The reference MR study has a FoV of ca. 25 cm, an acquisition matrix of 256x256 and 1.5 mm slice distance $V_{Ax} = 1.0$ mm; $V_{Ay} = 1.0$ mm; $V_{Az} = 1.5$ mm

The graphic below shows the error as a function of the angle α

