Position Visualisation Methods for the Eight-degrees of Freedom, High Capacity Kappa Goniometer

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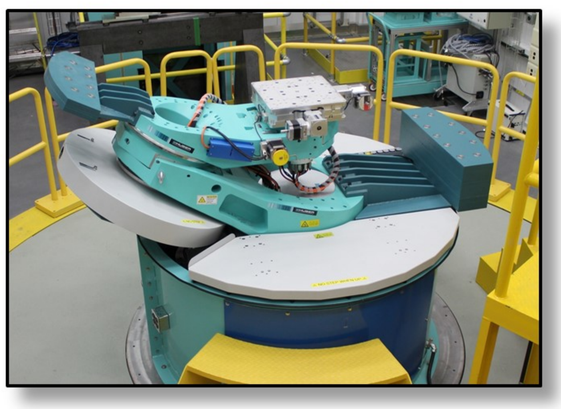
Introduction



- MRT: Microbeam Radiation Therapy
- 30° kappa-goniometer
- 120 kg load capacity
- 8 degrees of freedom:
  - 3 rotational (ϕ1, ϕ2, ϕ3)
  - 5 linear

The Biomedical Imaging and Therapy (BMIT) beamline at the Canadian Light Source uses the MRT lift to position samples for x-ray imaging.

Motivation

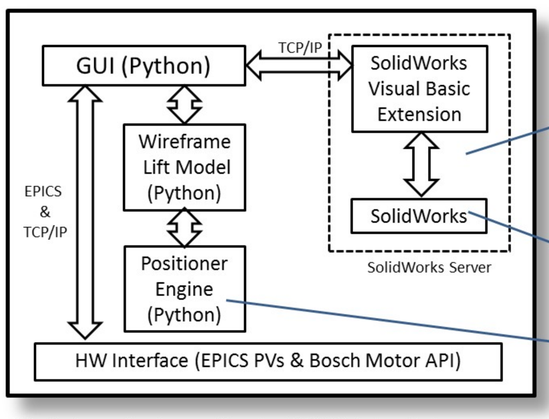
Accurately positioning the MRT Lift is difficult and time consuming!

BMIT supports a large variety users who generally do not have a background in robotics. The high complexity of the MRT lift poses operating challenges even for experienced operators.

Additionally, positioning the MRT Lift is one of the most time consuming portions of setting up an experiment, using up precious beamtime!

The Solution – a dynamic visualization of the MRT Lift using SolidWorks

Implementation

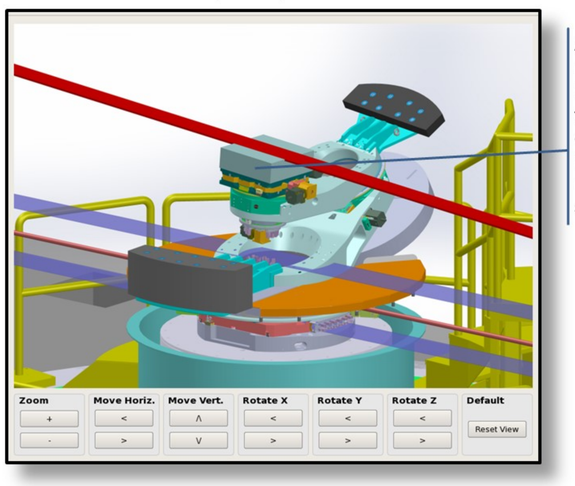


A VB.net extension for SolidWorks running on the host machine allows clients to connect via TCP/IP, creating a server.

Only one computer with SolidWorks is required.

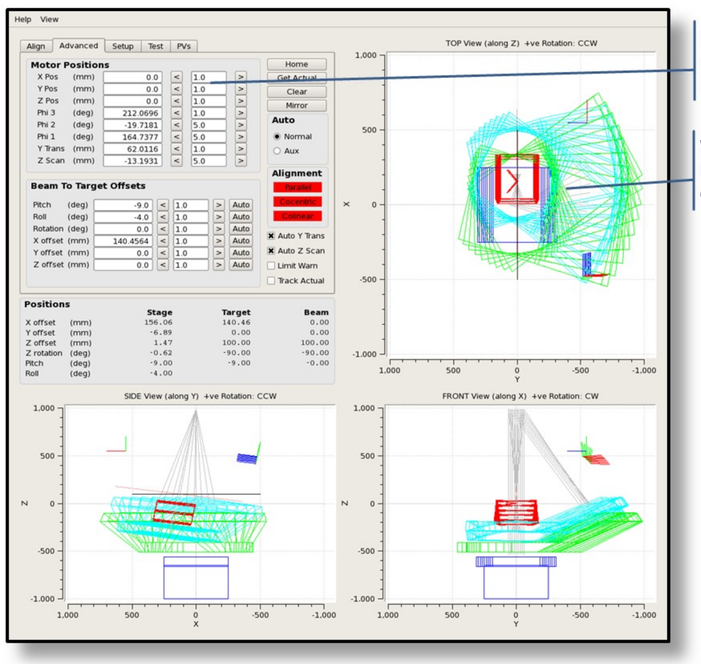
Client program handles control logic and user input.

The logic required to position the MRT Lift is handled externally by a client Python program. The Python program sends positions to the SolidWorks server which returns images of the requested position.



A variable sized rectangular prism can be used to simulate the spatial constrains of samples. The client has the ability to remotely control the size of the prism.

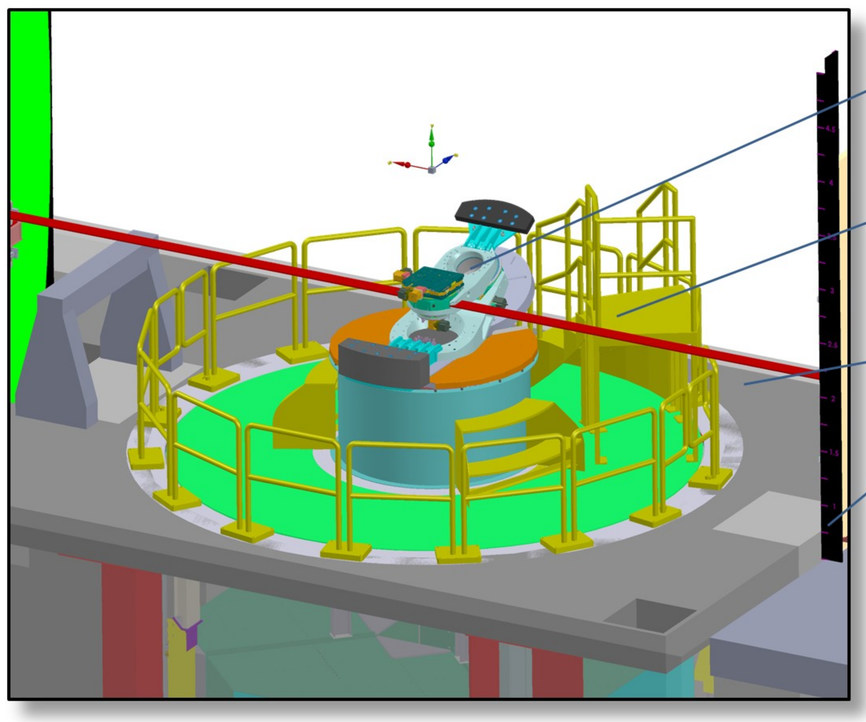
This Python interface displays returned images from the server. Buttons at the bottom can be used to move the view around inside the model.



Position data to be sent to the SolidWorks Model

Wireframe view of MRT lift built in to client program.

This Python program acts as the client portion of the connection. It calculates MRT Lift positions from user inputs and then sends the parameters to the remote server.



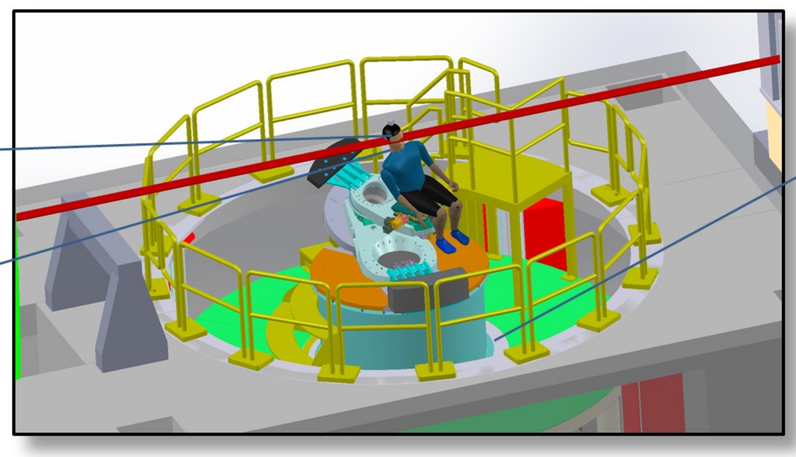
High resolution images of the MRT Lift and surroundings can be returned in real time

Geometrically accurate model allows for evaluation of potential collisions

Virtual beam allows users to visually compare the position of the MRT Lift to the beam

Rulers allow for quick height comparisons

Overview of Virtual MRT Lift model. The beam can be seen in red.

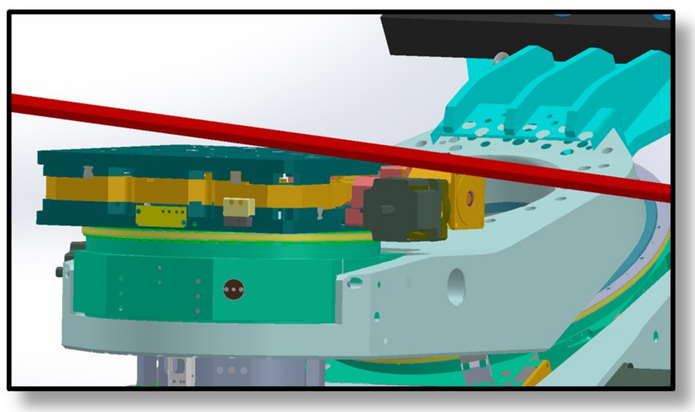


Experimental setups can be tested and verified without even entering the hutch.

Positioning time is much faster when the beam is visible.

Notice the lack of stairs in this picture. The stairs did not exist when the picture was taken. Beamline modifications can be quickly updated in the model.

Mock-ups of samples can be easily added to the model. Doing so makes it much easier to place the beam in the correct position on the sample. BMIT is a highly variable beamline and changes inside the hutch can be quickly updated inside the model.



The stage of the MRT Lift can be zoomed in on to see lots of detail. Notice that the beam hits the yellow motor mounting bracket before it reaches the stage. Problems such as this can be time consuming to solve without a visualization.

Additional Possibilities

1. **Interactive Website/Remote user access**
   - TCP/IP server can be connected to from anywhere in the world
   - Possibility of users testing setups remotely
2. **Automatic Collision Detection**
   - Currently collisions identified visually by user
   - SolidWorks API allows for collision detection

Features

1. **Real Time MRT Lift Visualizations**
   - Can track current position or preview desired position depending on client request.
   - Images are returned quickly.
2. **Alternate Views**
   - Translate/Rotate/Zoom View commands supported
   - View from any angle/zoom
3. **Support for different beam modes**
   - 05ID-2 Beamline has multiple beam positions and sizes, each of which can be simulated
4. **Unlimited Client Connections**
   - Can return separate images to multiple clients
   - Only requires one SolidWorks copy on host computer
5. **Highly Modifiable**
   - Modifications to the lift or surroundings can be easily added in SolidWorks
   - Models of samples can be added for experiments

Benefits

1. **Intuitive Use**
   - Images from this model do not require special training to interpret
   - BMIT has a large variety of users not experienced with robotics
2. **Faster Alignment Times**
   - Maximizes useful beam time for users
3. **Easy Location of Beam**
   - Beam location can be visually compared to samples and the MRT Lift Stage
4. **Collision Assessment**
   - Potential collisions can be visually identified and avoided

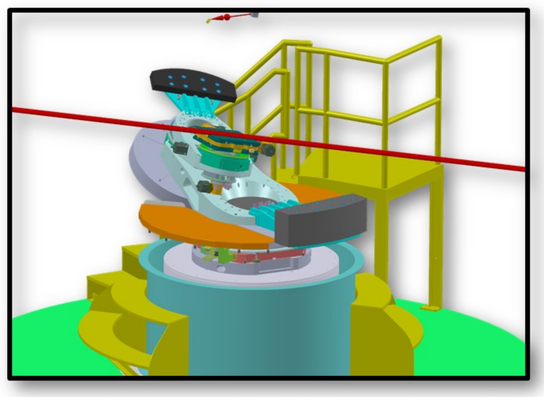


Image returned from the MRT Lift model in an aligned configuration. This position requires 3 rotations and 2 translations, becoming difficult to predict without the SolidWorks model.