LCLS CXI Sample Chambers and Engineering Solutions

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Introduction

In the CXI instrument, the X-ray beam is apertured using two sets of germanium blades. However, the current holder for these blades do not allow the germanium blades to be laterally translated once the X-ray beam has damaged the Ge blades. This translation significantly extends the lifetime of the apertures. A new holder was designed to fix this problem.

Also, in the serial sample chamber of the CXI hutch, it is currently difficult to overlap a visible pump laser and the X-ray beam onto the sample. The laser is meant to trigger chemical reactions within the sample, which would then be recorded with X-ray diffraction. A mirror-lens breadboard system was designed to assist with the laser and X-ray interaction.

Keywords: CXI, X-ray, germanium blades, holder, laser, breadboard

Research

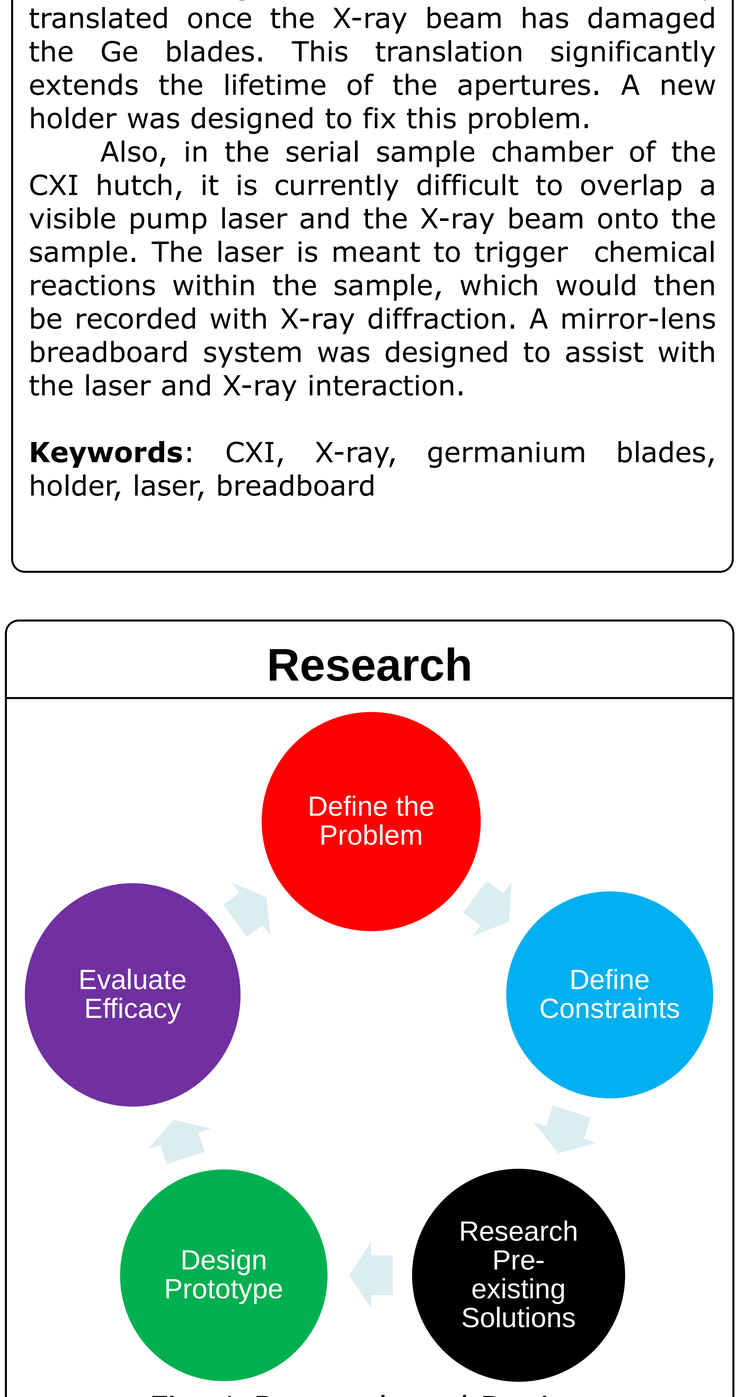

Fig. 1-Research and Design Flow Chart

Ge Blades Holder

- Background
  - Laser Gaussian profile
  - "Tails" must be truncated to clean the beam for better images
  - Ge attenuation length allows for truncation of "tails" but transmission of beam center
- Constraints
  - Spring interface
  - Column support
  - Ge blade intersection with beam

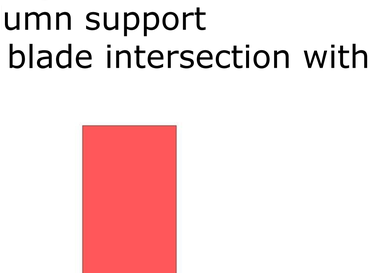

Figure 2-Ge Blade Intersection

- Material Selection
  - Vacuum compatibility
  - Aluminum 6061-T651
    - Holder
  - Nylon
    - Low modulus reduces Ge damage
    - Washers

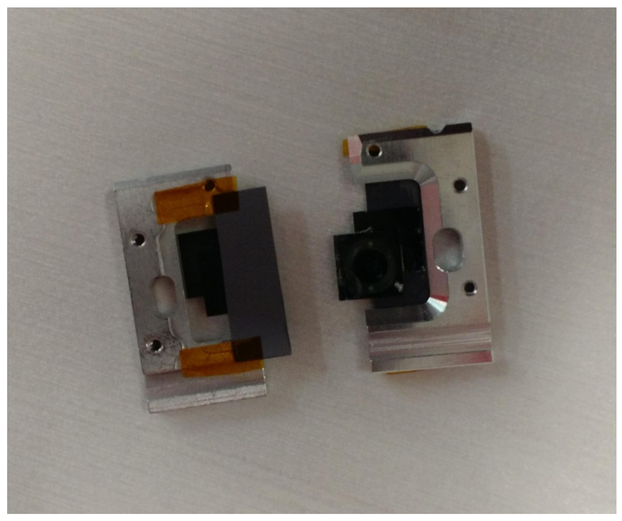

Fig. 3-Current Ge Blades Holder

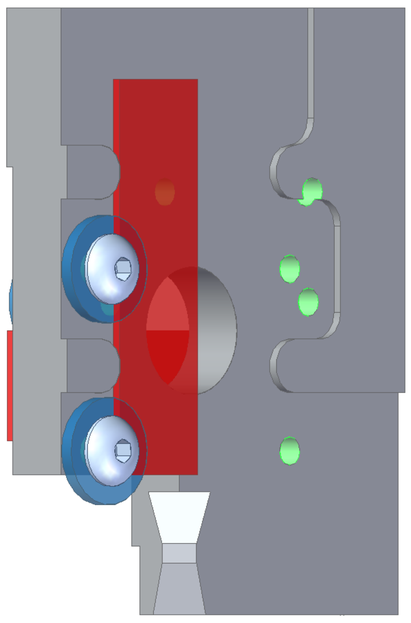

Figure 4-Final Ge Blades Holder

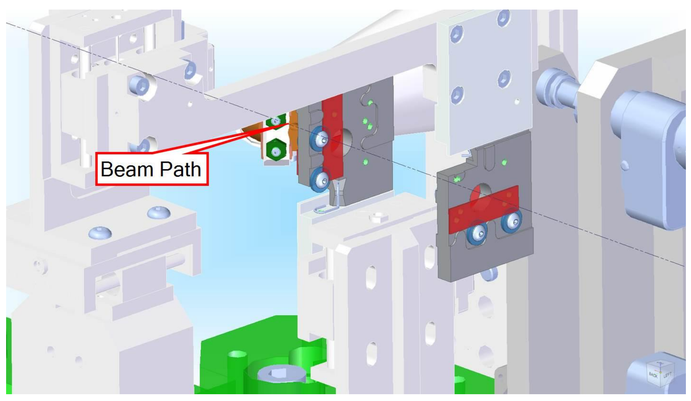

Figure 5-Dual Ge Blade Holder Assembly

Laser Path Breadboard

- Background
  - Laser triggers a reaction within the sample
  - X-ray acts as the probe to obtain images of sample undergoing the reaction
  - Rayleigh Criterion: Smaller wavelengths results in an increase in image focus
    - X-ray<Laser

- Constraints
  - Dual port entry for laser
  - 50mm linear travel for lens
  - Interaction with existing devices on the breadboard: illumination and no free space in the beam path.
  - Minimal amount of mirrors
- Components on board
  - Manually adjustable mirror stand
  - Mirror in tip-tilt motorized stage
  - Lens on 50mm linear travel motorized stage
  - Clamps for manual adjustment of mirror and lens posts
  - Countersink constraints for improved board placement accuracy

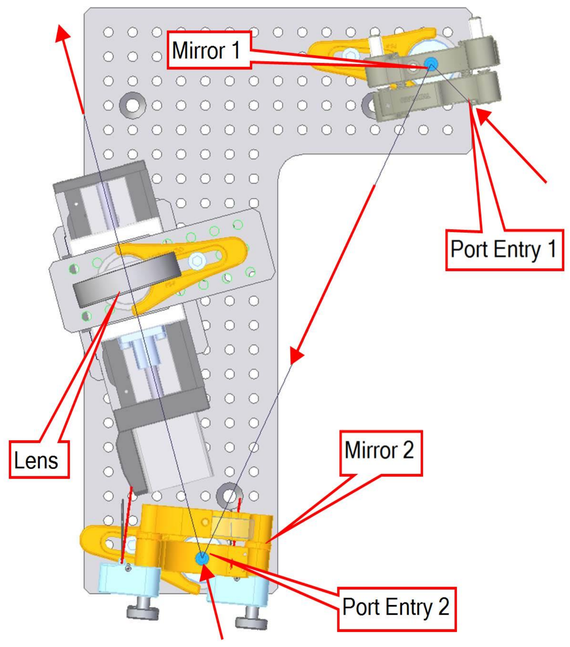

Figure 6-Final Breadboard Assembly

Conclusions

Over the course of this internship I learned about engineering design, especially within the fields of vacuum compatibility. Looking back on my experience, I wish that I was able to design a more cost effective Ge blades holder; one that was less difficult to machine but still able to accomplish its task. In the future it might serve useful to look at how to design a laser path that is able to reduce intensity loss by optimizing reflection angles and mirror material, but still able to pass a series of functional constraints.

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