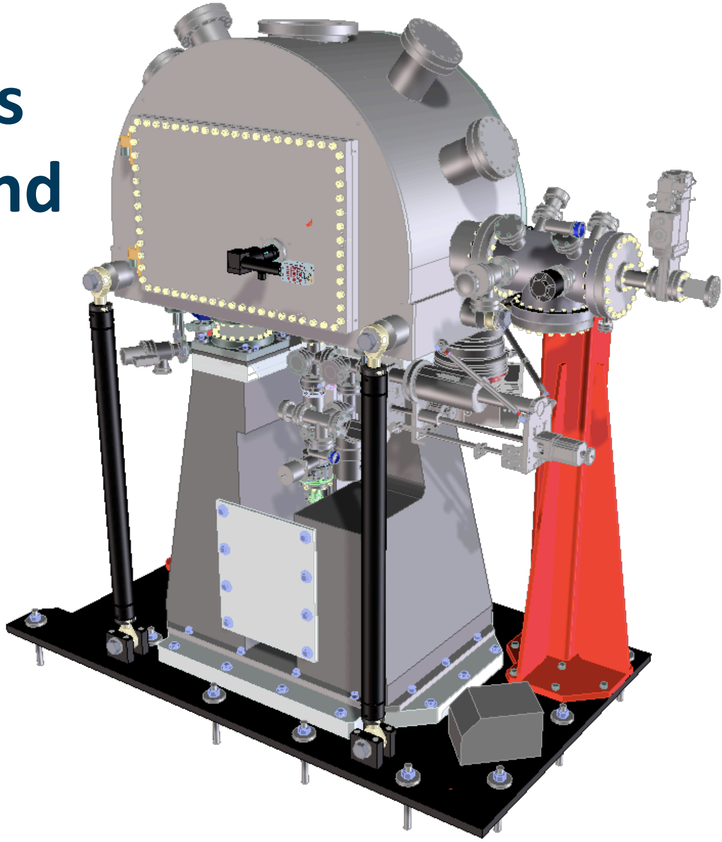
ALS
ADVANCED LIGHT SOURCE

An Endstation with Cryogenic Coils Contributing to a 0.5 Tesla Field and 30-400K Sample Thermal Control



Presented by Gregory Scharfstein

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Outline

- Introduction to the Endstation
- Magnetic System
  - Mechanical Design
  - Magnet Design and Analysis
  - Current Status
- Sample Thermal Control
  - Mechanical and Thermal Design
  - Current Status

Acknowledgements

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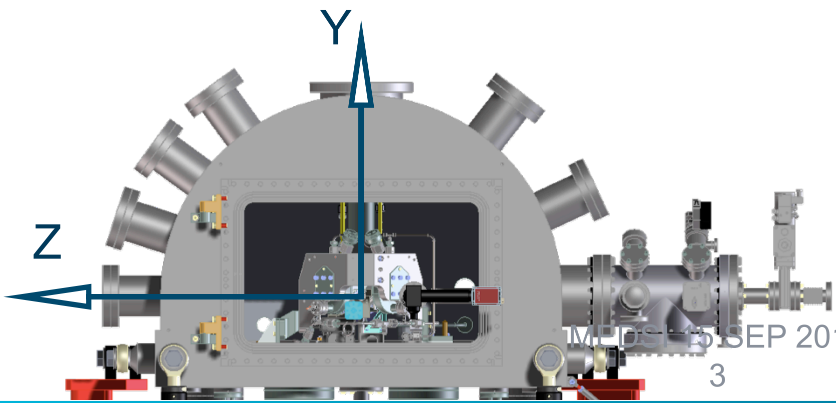
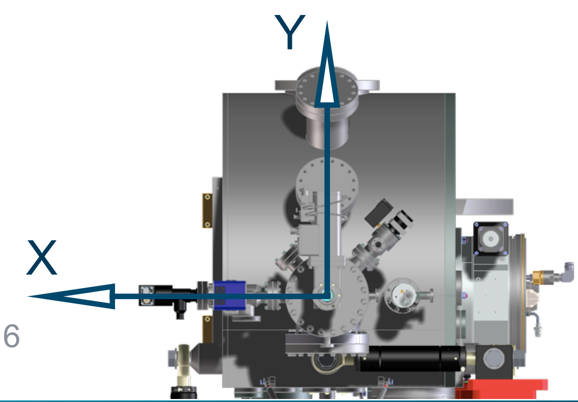
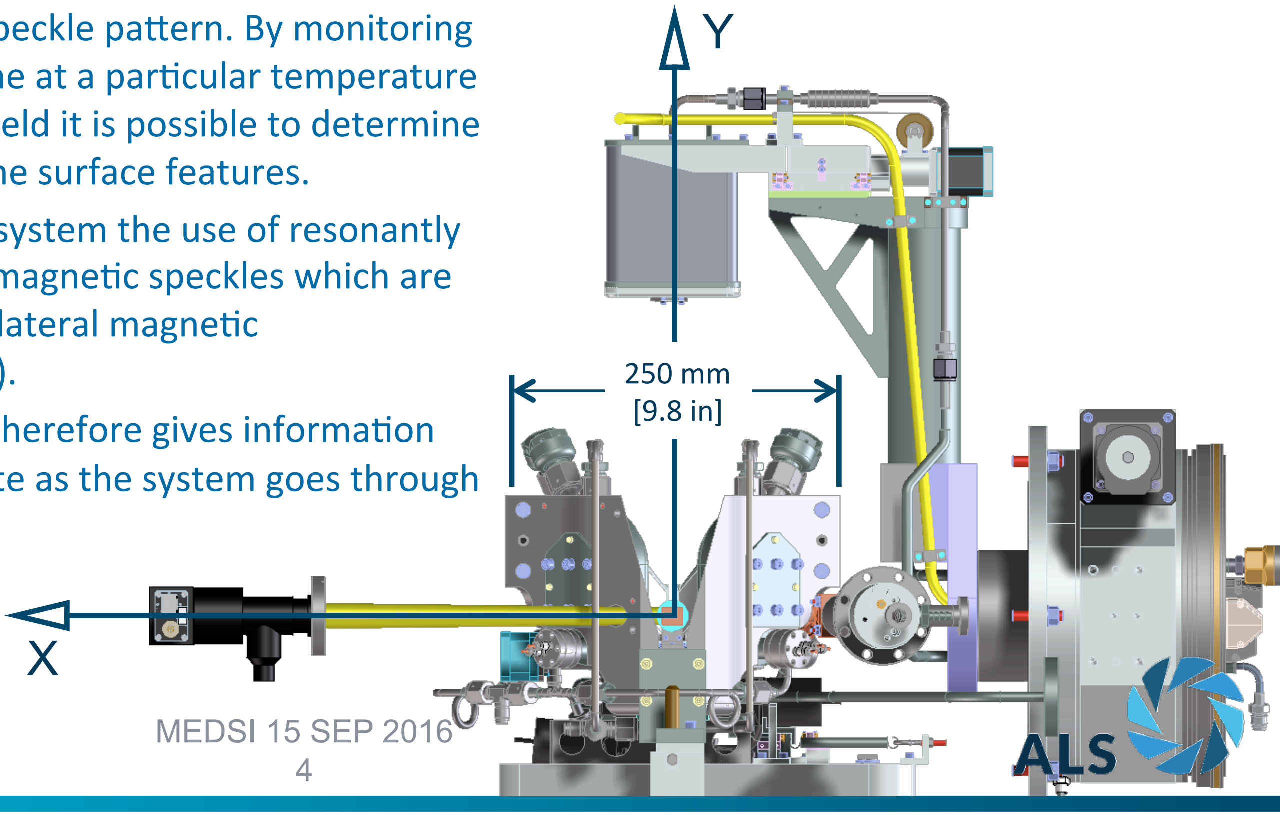
- Engineering Division at LBNL
- All Staff that support the ALS
- The COSMIC Scattering Endstation Team





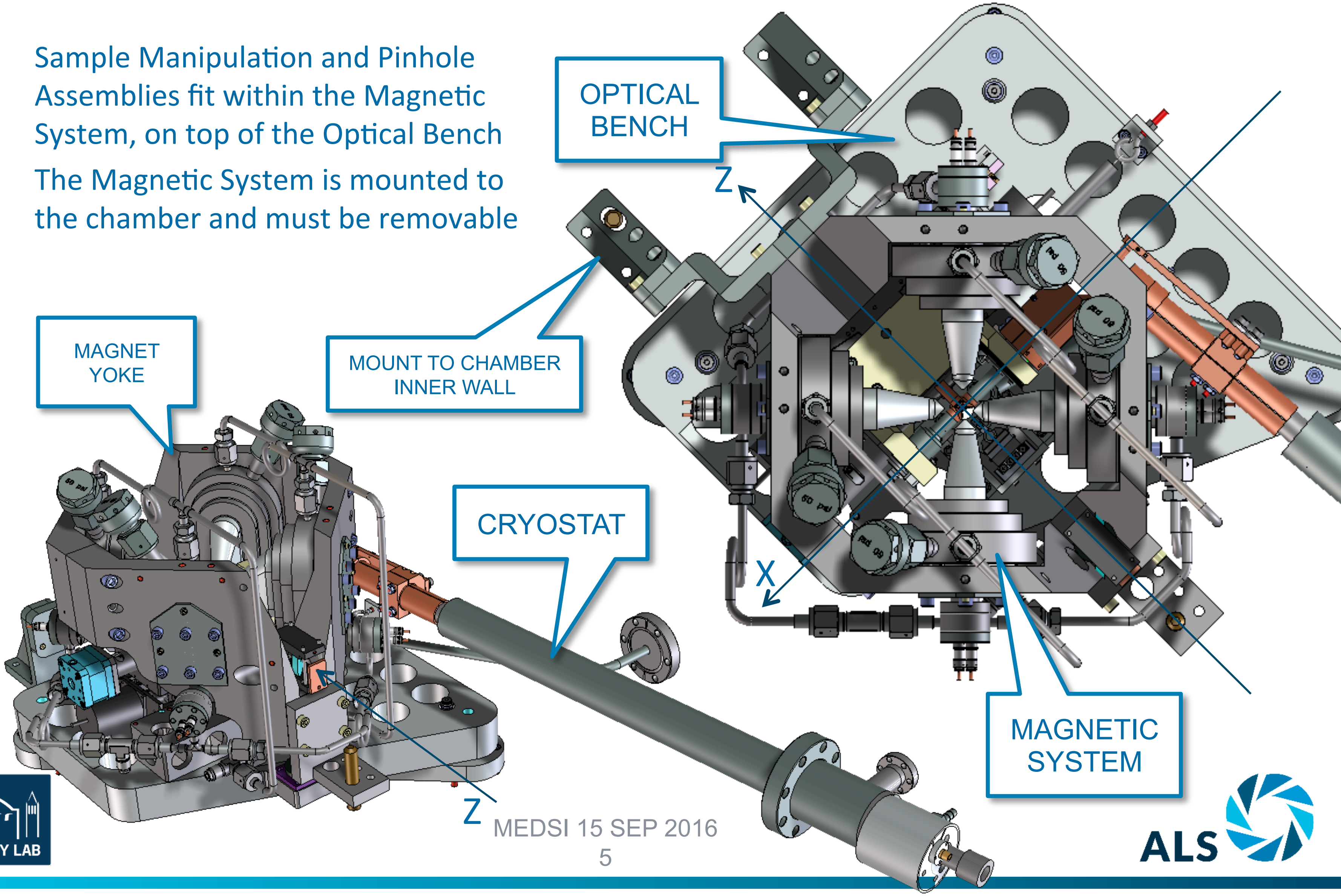
COSMIC Scattering Endstation

- COherent Scattering and MICroscopy: 260 – 1600 ev [4.7686 – 0.7749 nm]
- X-ray Photon Correlation Spectroscopy (XPCS), which is a method to study temperature fluctuation in hard and soft condensed matter systems.
- Diffuse scattering due to coherent x-rays give rise to speckles due to the interference of scattered wave fronts that are randomly phase shifted by the morphology of the sample.
- Any change in the surface morphology causes a subsequent change in the speckle pattern. By monitoring the speckle pattern over time at a particular temperature and/or magnetic (electric) field it is possible to determine the temporal evolution of the surface features.
- For example, in a magnetic system the use of resonantly tuned coherent x-ray gives magnetic speckles which are representative of the exact lateral magnetic heterogeneity (i.e. domains).
- XPCS in a magnetic system therefore gives information about how domains fluctuate as the system goes through a phase transition.



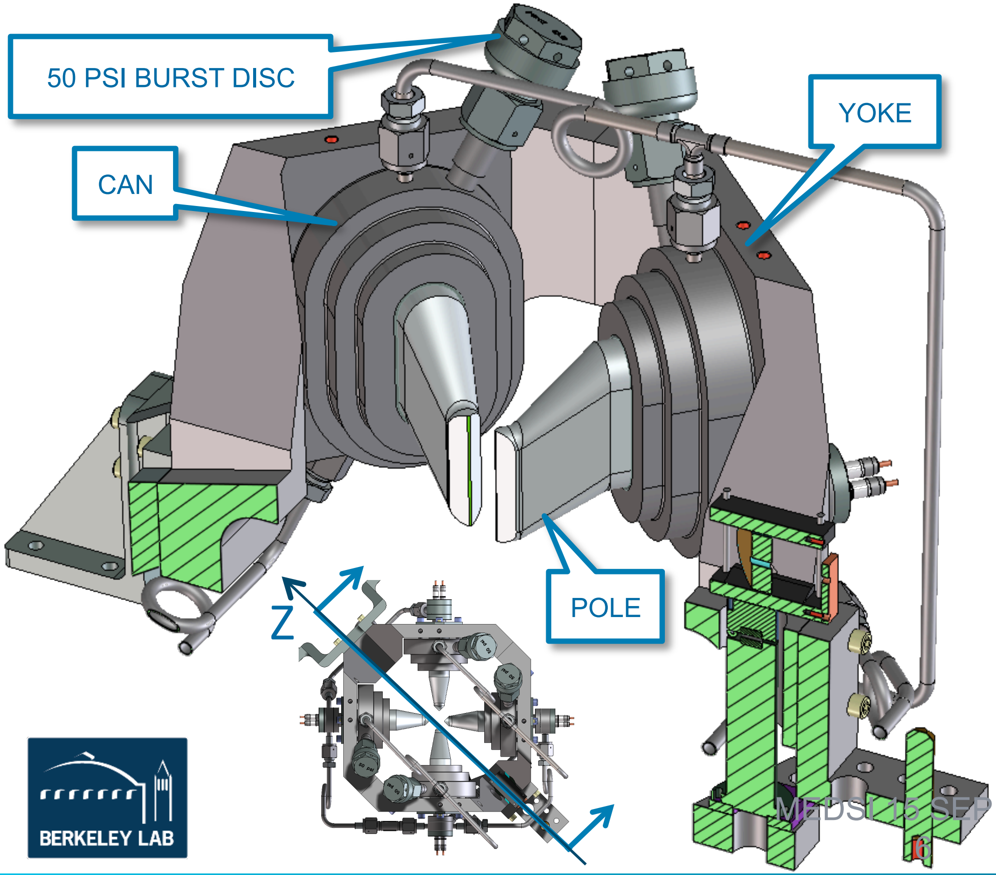
Experimental Assembly

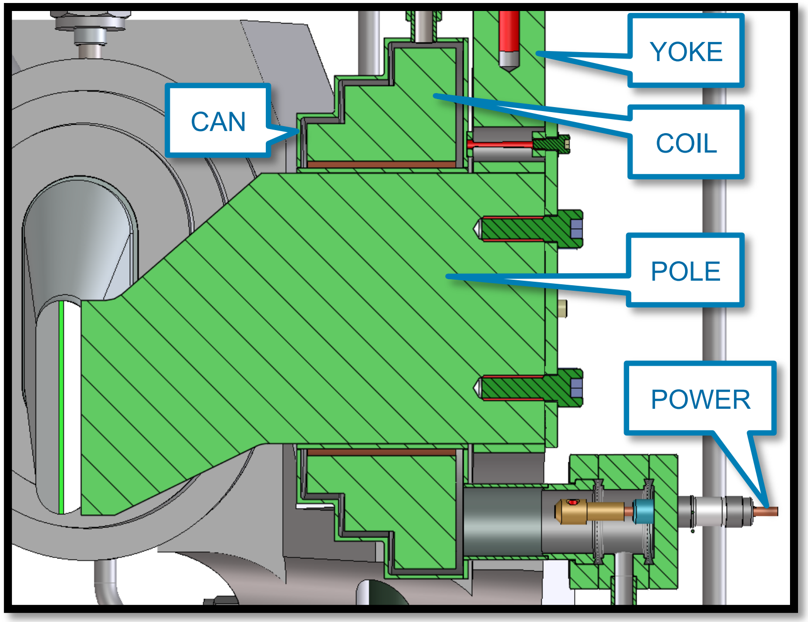
- Sample Manipulation and Pinhole Assemblies fit within the Magnetic System, on top of the Optical Bench
- The Magnetic System is mounted to the chamber and must be removable



Magnetic System Mechanical Design

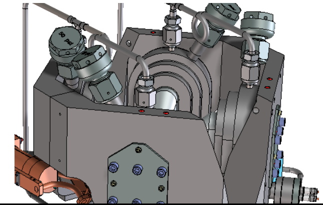
- Iron Dominated Magnet, LN2-cooled Coils
- Vanadium permendur poles (4 poles) are used to maximize field
- Pole geometry is optimized to reduce saturation (taper) within geometric constraint envelope



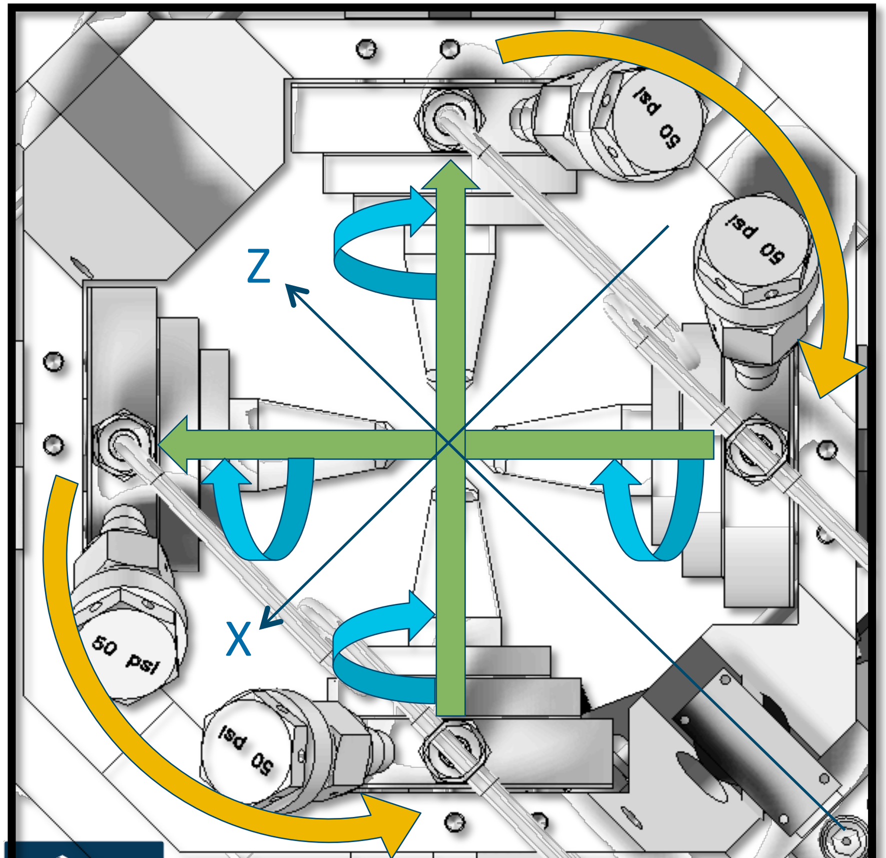


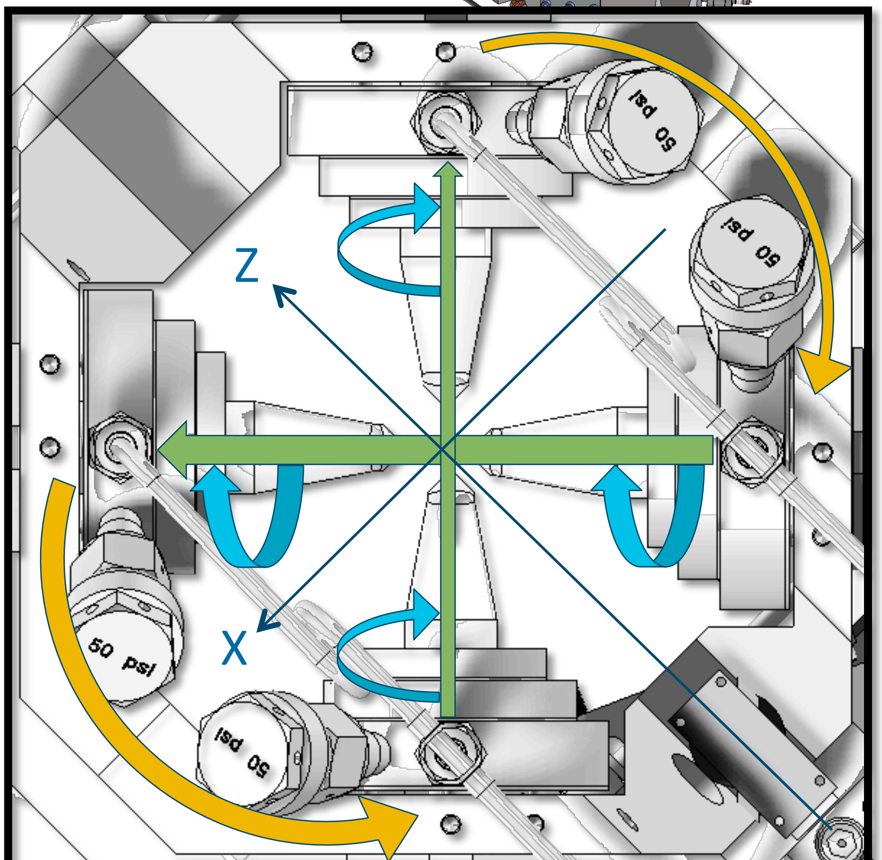
A cross section of the pole-coil assembly is shown above. The 5000 ampere-turn coil is enclosed within a 304 SS welded can designed to hold liquid nitrogen. This cooling enables the field strength at the sample with 18A at 2.85 V running through each coil.

Magnetic System: Power Configuration



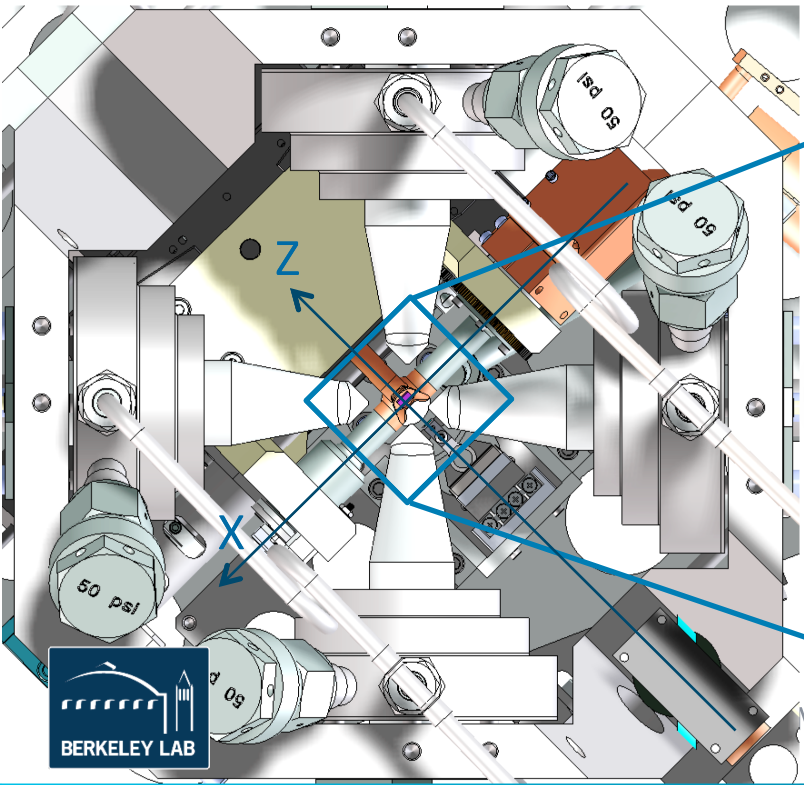
- Using two power supplies (with opposing coils powered in series) the field orientation can be rotated in the X-Z plane

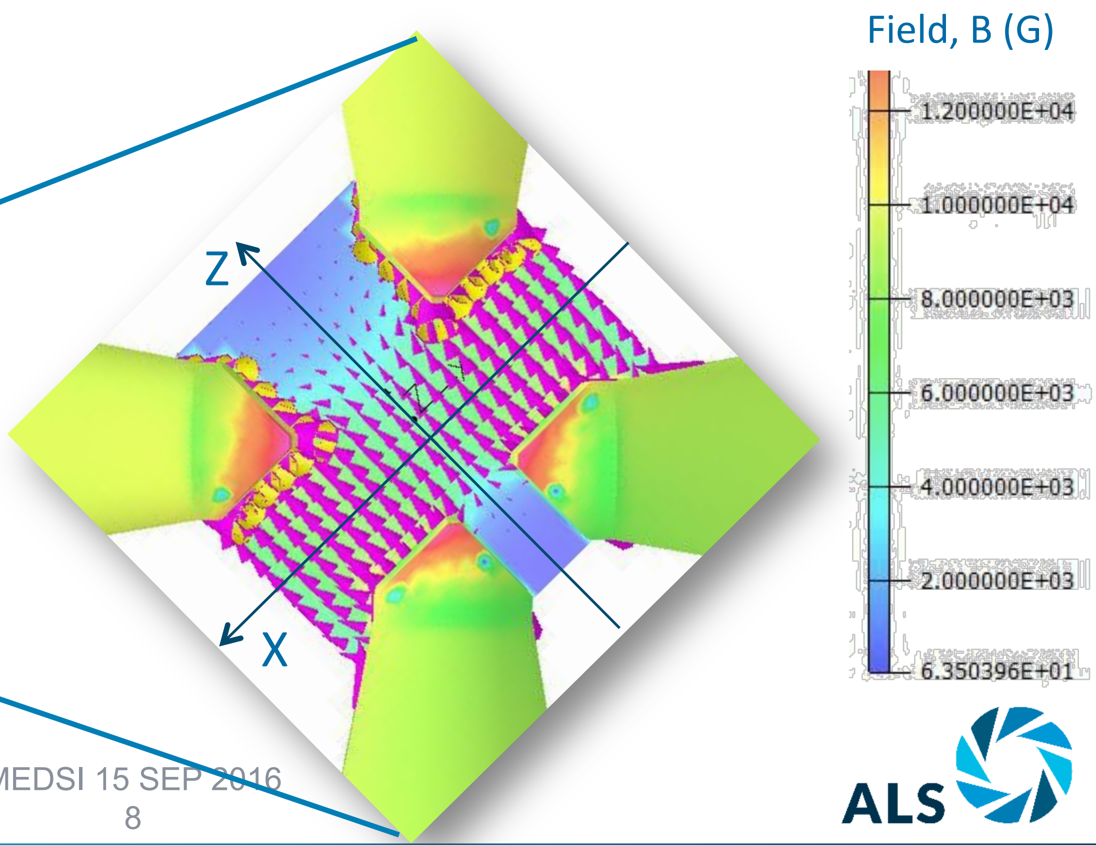




Analysis of Flux at the Sample

- Optimized for maximum magnetic field within the constrained space that allows for sample manipulation and cooling and line of sight to the rotating detector
- Using two power supplies (with opposing coils powered in series) the field orientation can be rotated in a plane





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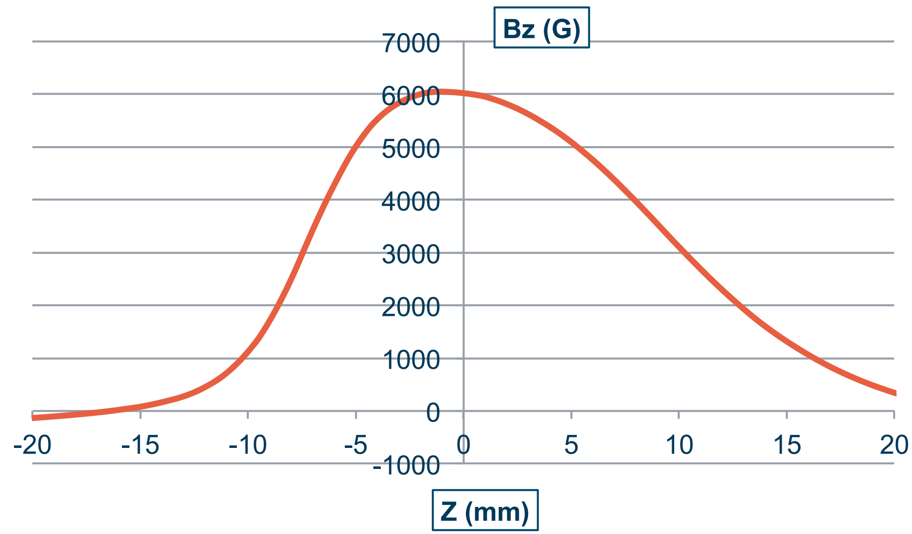
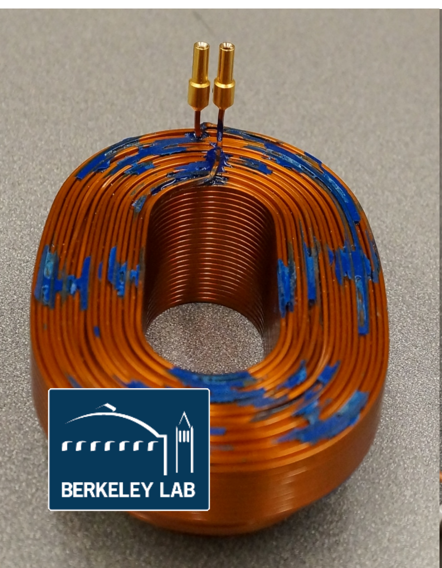
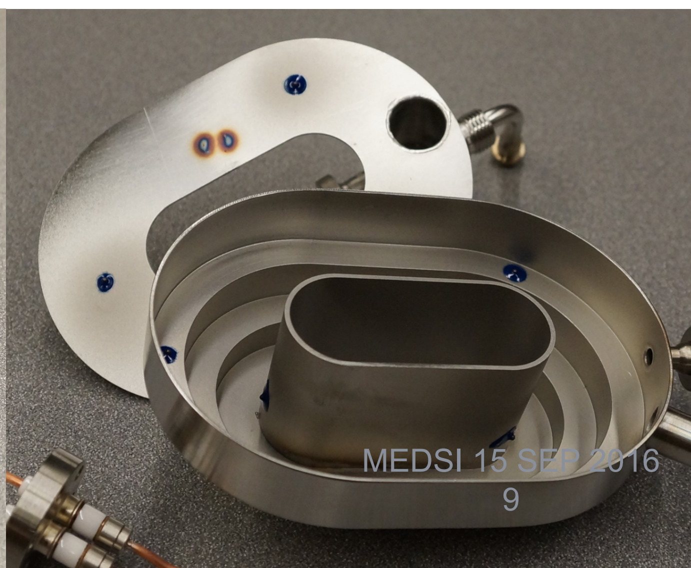
Magnet System Status

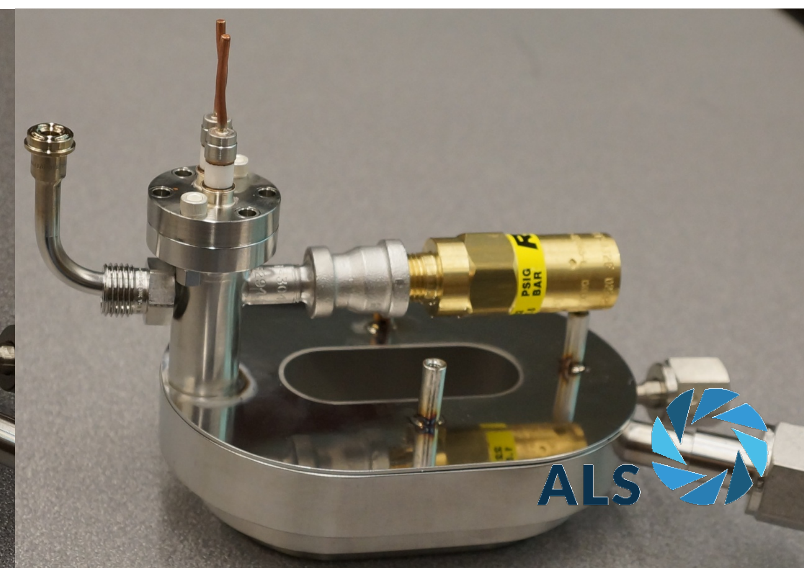
- Analysis is complete
- Proof of Concept Test is complete
- Production assembly by end of December 2016
- Production test by end of February 2017

Magnetic Field Along the Beam (z-axis)



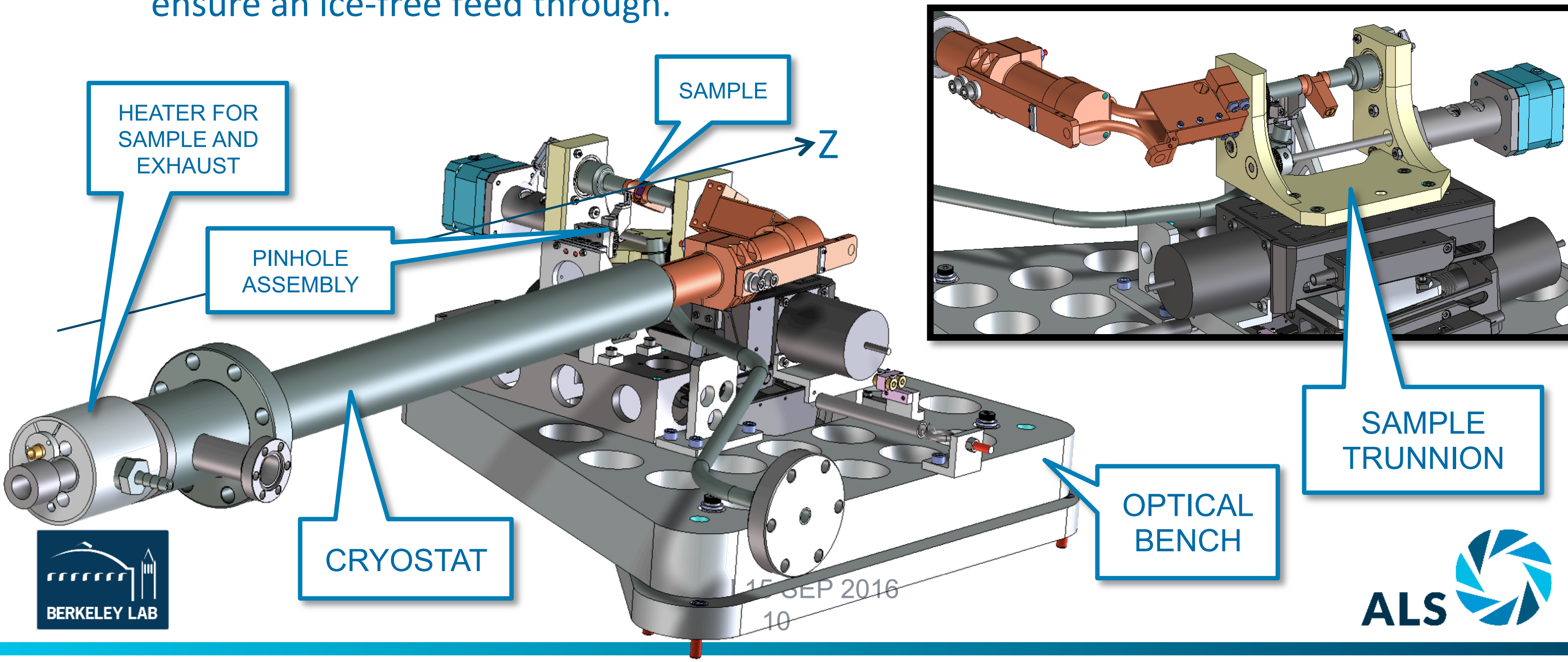






Sample Thermal Control: 30K – 400K

- Cooling is enabled by a coaxial flow cryostat that is attached to a trunnion that rotates the sample.
- Requirements call for a short cryostat design which is accomplished with a serpentine path for the exhaust.
- The unique helium exhaust transition employs automatic thermal control to ensure an ice-free feed through.



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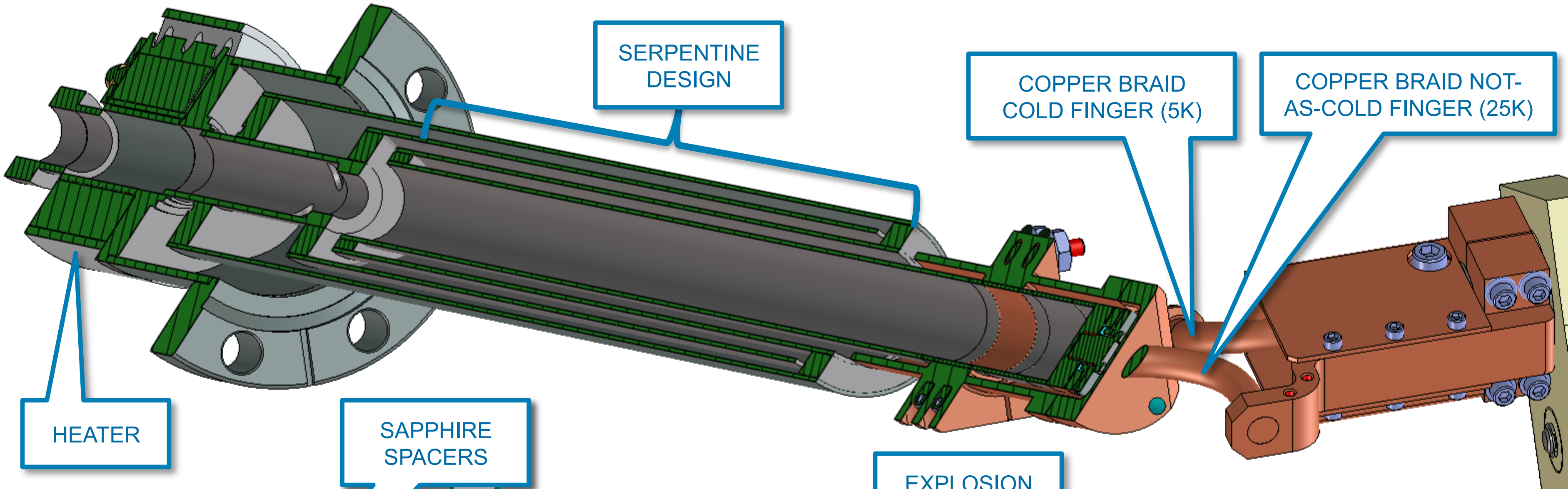
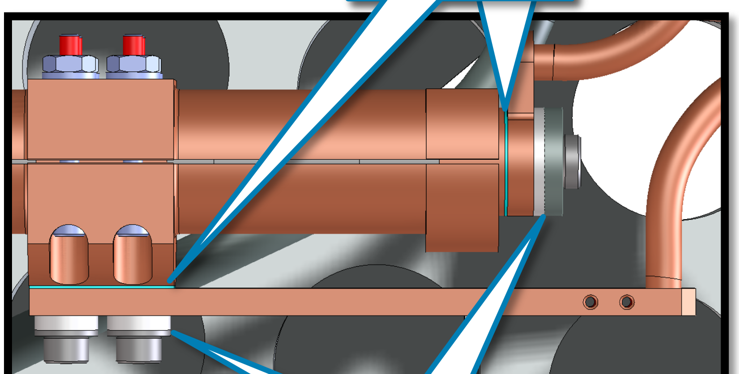
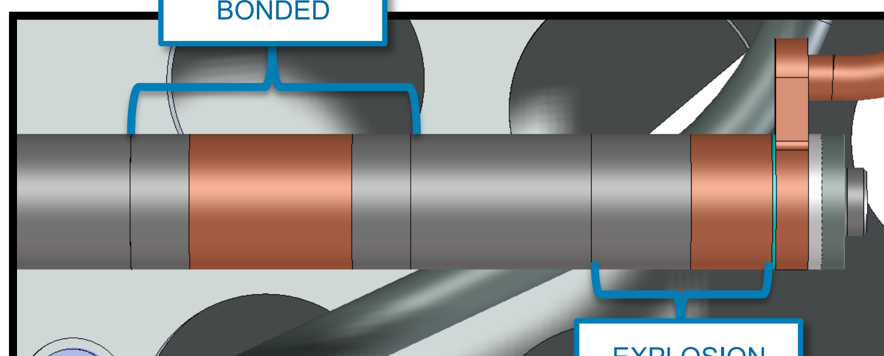
Cryostat Design

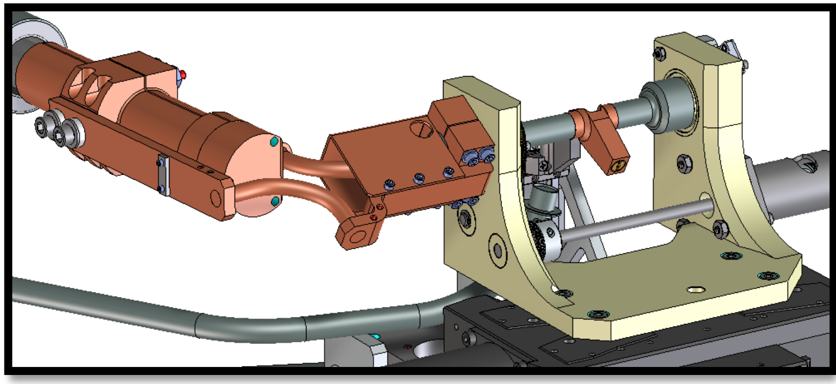


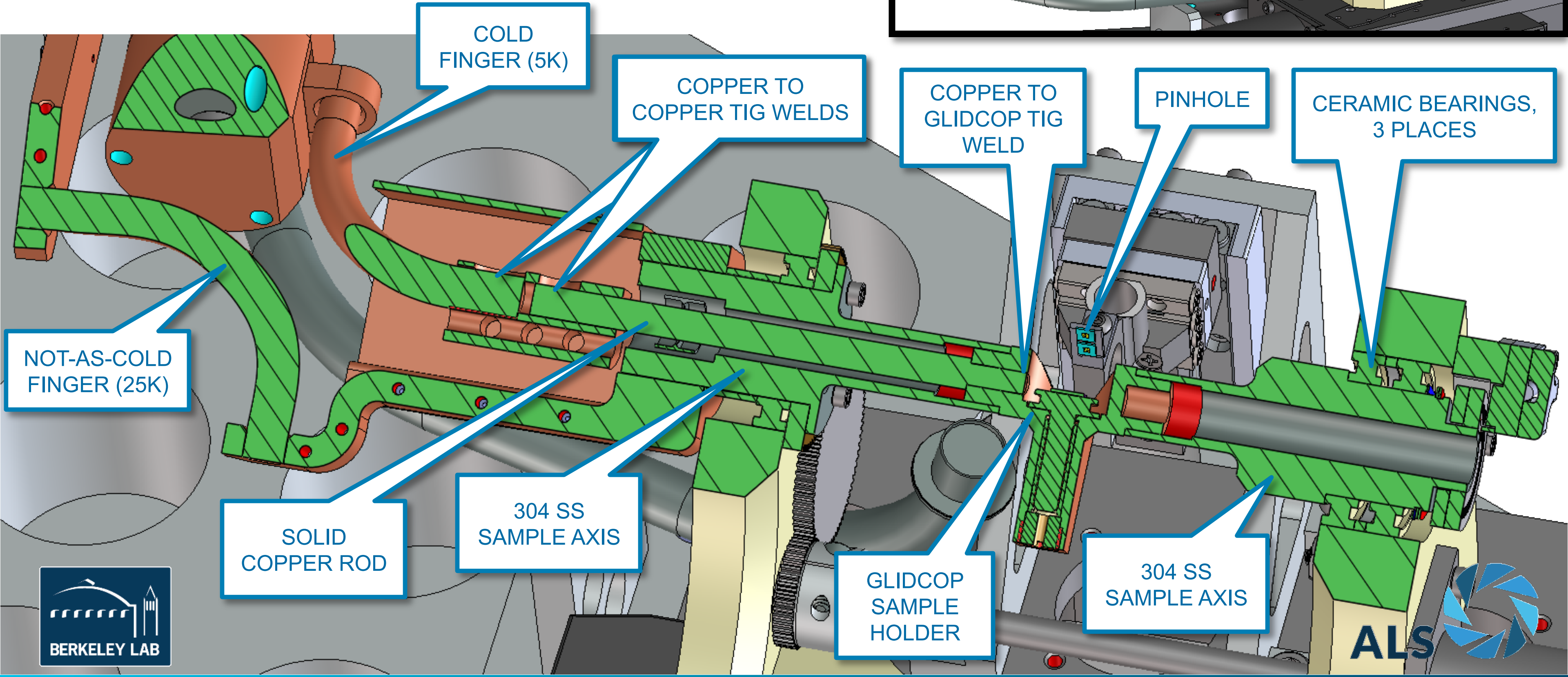




Cryostat-Sample Cross Section

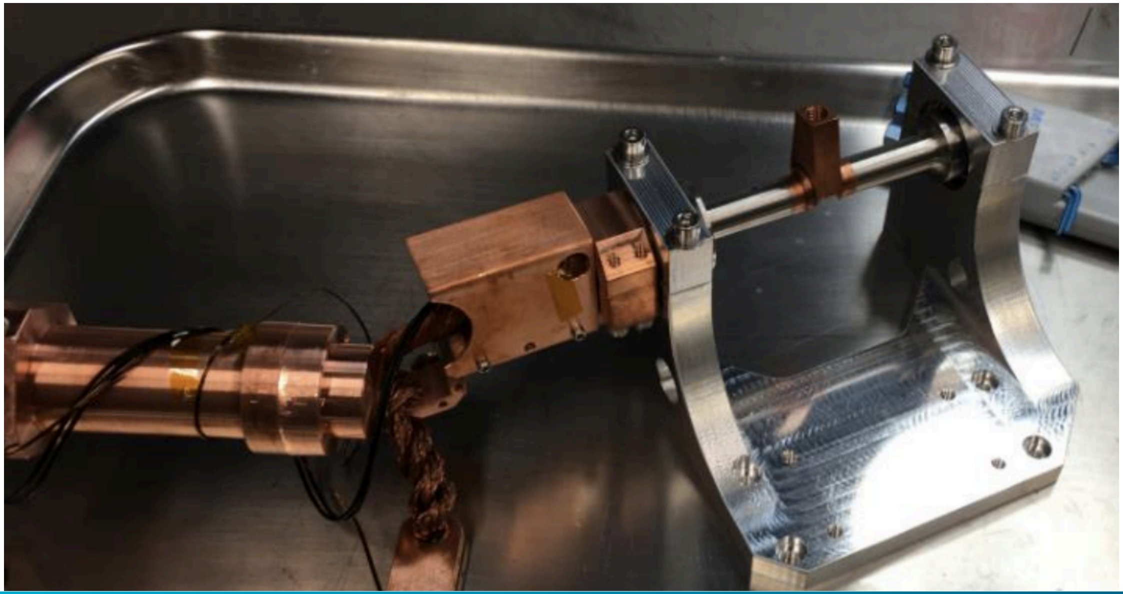
- Copper braids used to allow sample motion
- Copper to copper/glidcop interfaces are TIG welded
- Stainless steel to glidcop interfaces are silver soldered





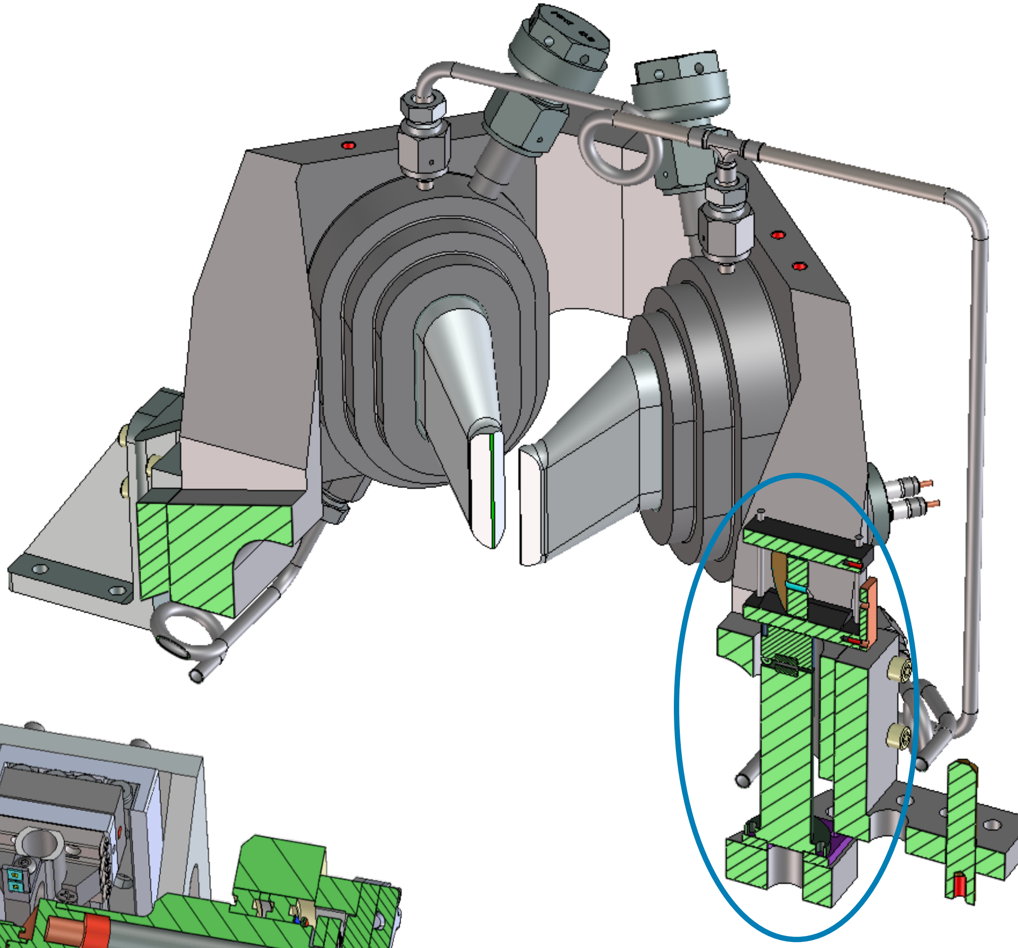
Sample Thermal Control Status

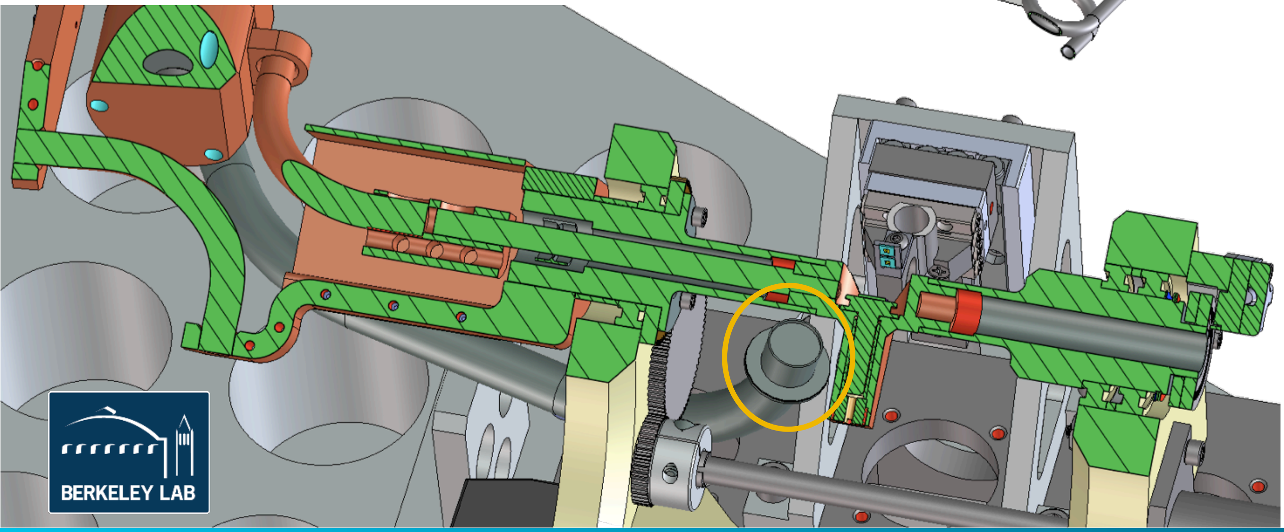
- Cryostat is complete
- Cold Tests
  - Cold Finger at 5K; Sample at 13.9K
  - Closed-cycle Cryocooler, cold finger at 7K
- Complete design of trunnion by end of September 2016
- Production assembly by end of December 2016
- Production test by end of February 2017



Clever Diagnostics

- Alignment Microscope to see pinhole and sample
- Borescope to witness automatic sample transfer





Thank you!

Questions / Comments

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