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AMI American Magnetics

A 4 Tesla Superconducting Magnet for the *XMaS* Beam line

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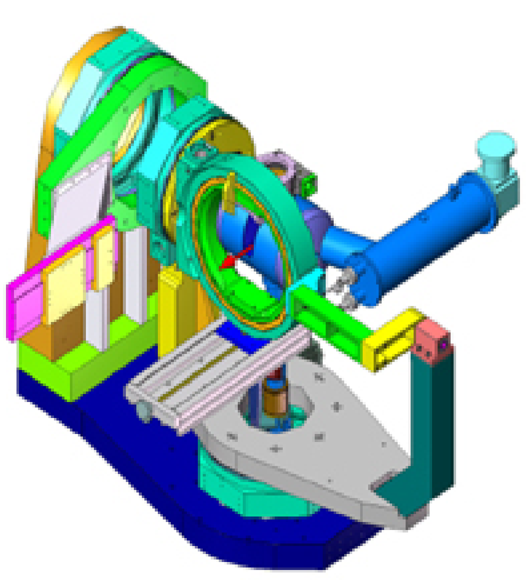
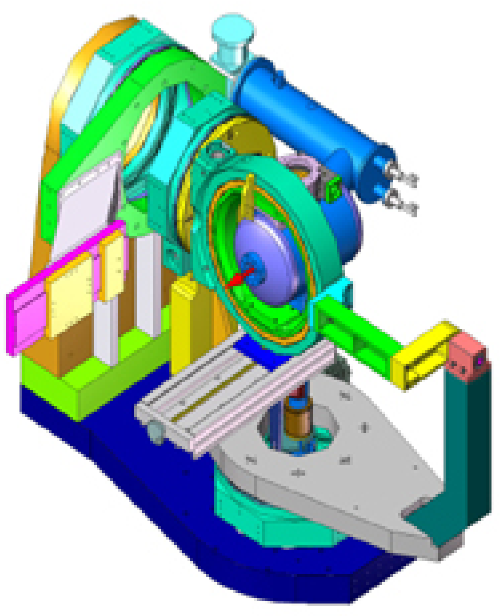


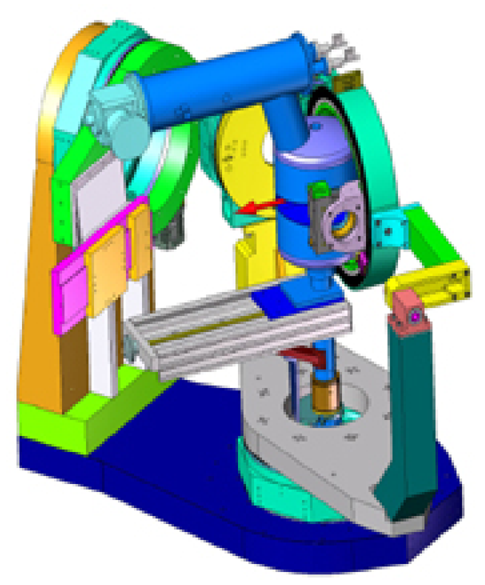
Vertical Scattering

90 ° Horizontal Scattering (± 5 °)



Vertical Scattering (± 5 °)

90 ° Horizontal Scattering (± 5 °)



Vertical Field

Horizontal Scattering

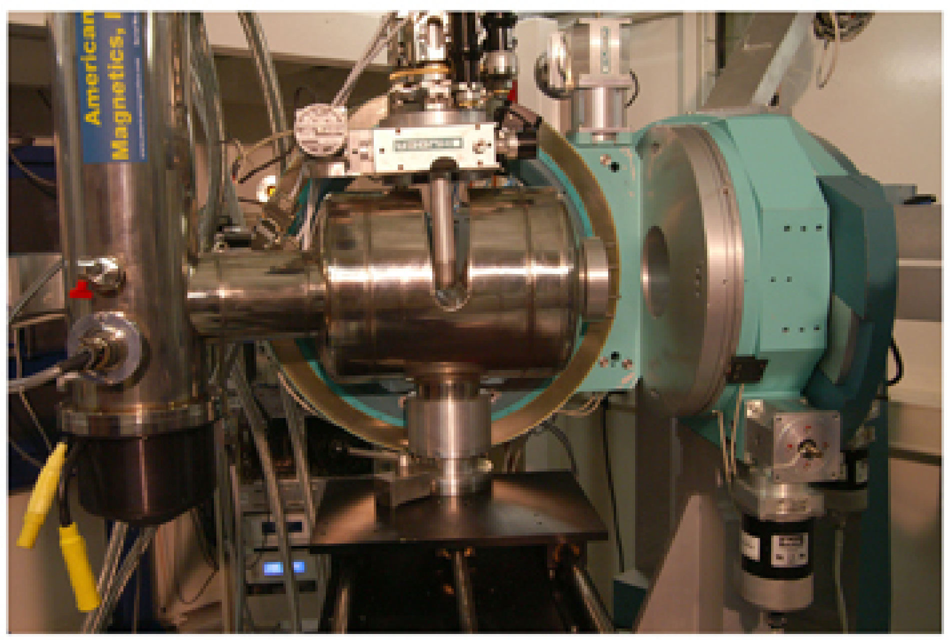
KEY FEATURES:

- 4 Tesla field
- 180 degree slot allowing a large access to reciprocal space
- Cryogen free design, enabling operation in a variety of geometries
- Sub 2 K sample environment

Specifications

- The magnet system must operate without the use of liquid helium (i.e., cryogen-free).
- The system must be capable of operation in any angular orientation.
- The system must fit within the Euler cradle of the Huber diffractometer at the *XMaS* beam line, located at the E.S.R.F.
- The magnetic central field must be 4.0 Tesla.
- The magnetic central field homogeneity must be at least +/-1.0% over a 1 cm diameter spherical volume.
- The magnet system must provide 180° of clear room temperature radial access to the central magnetic field
- The magnet system must provide a room temperature radial gap of 38 mm with +/- 5° access in the axial direction.
- The magnet system must provide a room temperature axial bore with at least +/-5° optical access from the magnet center position.

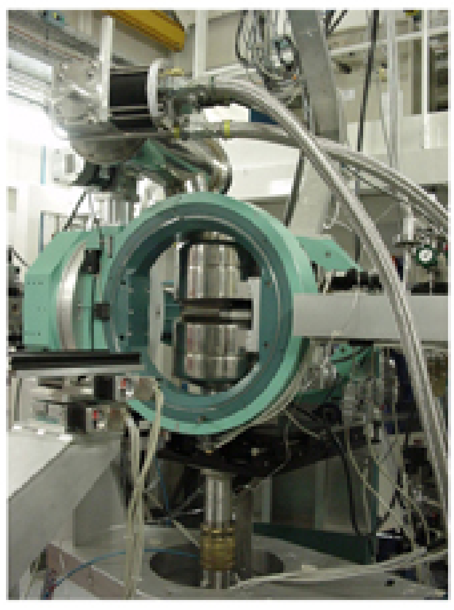
- Rated field ---------------------------------- 4.0 Tesla
- Homogeneity ------------------------------ +/-1.0% in a 1 cm diameter spherical volume (DSV)
- Rated operating current ----------------- 81.5 A
- System cool down time ------------------ 29 hours
- Ramp time from 0T to 4T -------------- 11 minutes



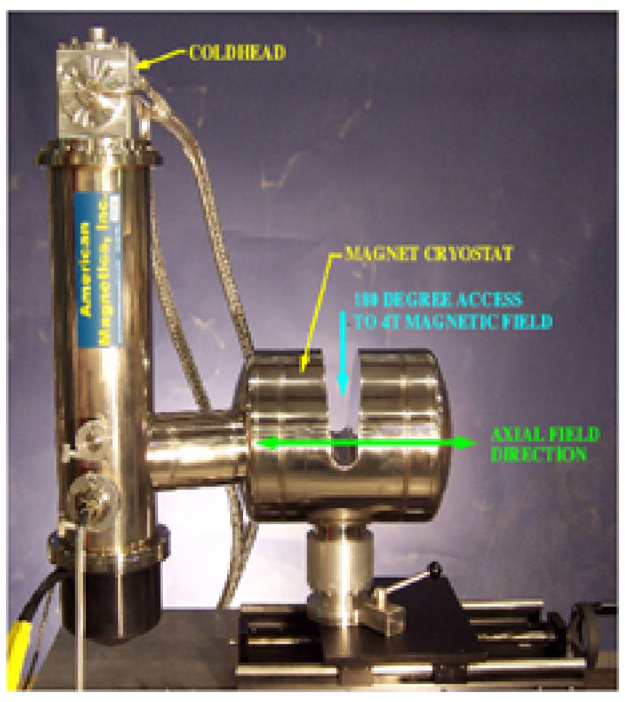
AMI Magnet mounted within the cradle of the Huber diffractometer on the *XMaS* beam line

Description

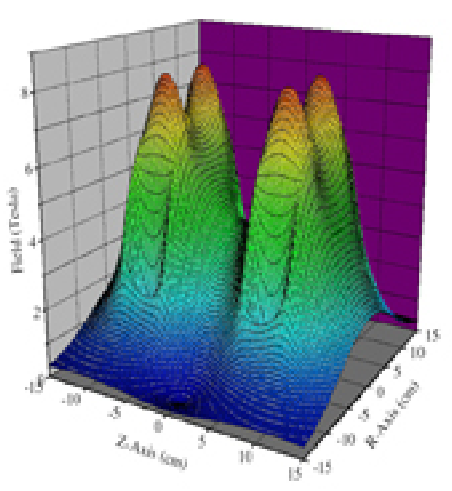
- The superconducting magnet is wound of twisted multifilamentary Niobium-Titanium (NbTi) superconductor embedded in a copper matrix. Twisted filaments maximize magnetic stability and minimize magnetic hysteresis.
- The former for the magnet coil is constructed of non-magnetic titanium alloy, At 4 Tesla, the split coil produces 68,000 N of force, which acts to collapse the 180° open radial access. This ensures stiffness to prevent coil movement, thus avoiding pre-quenching. Quench protection diodes are mounted with the magnet.
- The magnet system has been optimized to allow for a maximum number of ampere-turns within the geometrical constraints of the diffractometer. At some points there is only 4mm between 3K and room temperature.
- A 4 Tesla field in the centre of the magnet produces ~ 8.5 Tesla within the coil winding, close to the critical field limit of Nb-Ti
- A commercial Sumitomo closed cycle refrigerator is used to cool the magnet. High temperature superconducting leads are used to energize the system.



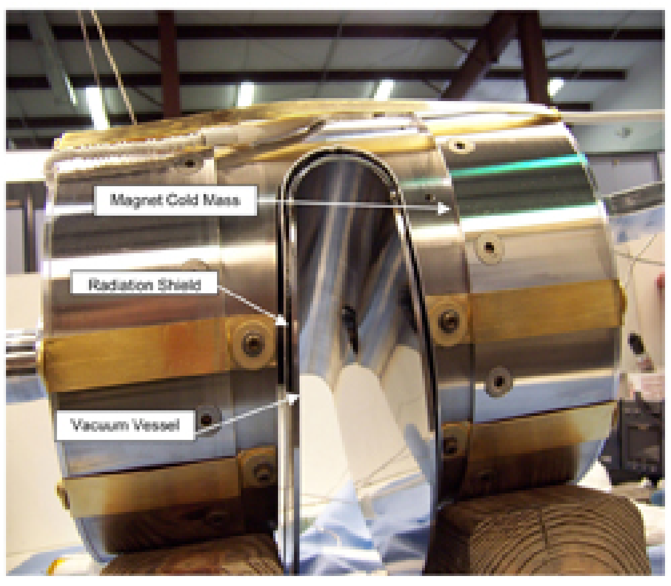
A view of the magnet system installed onto the Huber diffractometer in a vertical field, horizontal scattering geometry. The Be vacuum shroud of the variable temperature insert can be clearly seen.



A view of the completed magnet is shown, showing cryocooler and open room temperature access to the magnetic field.



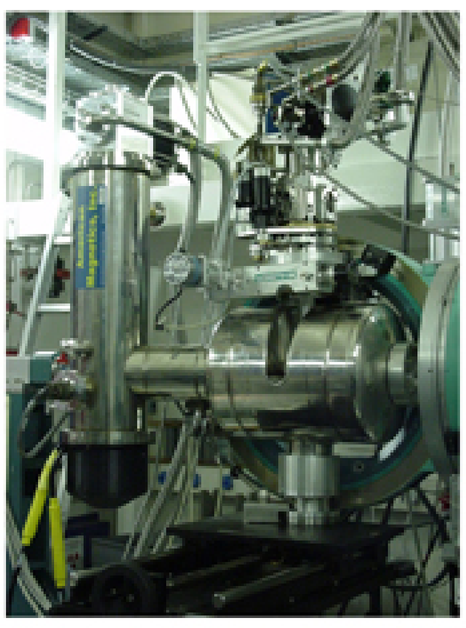
3D-Magnetic field profile when the system is energized to 4.0 Tesla. Peak fields of 8.5 Tesla can be seen within the windings centered at ~ 7.5 cm.



Magnet cold mass illustrating minimal spacing between magnet, thermal radiation shield and vacuum vessel components.

Variable Temperature Insert

The variable temperature insert is based around a RICOR 2/9 two-stage displex, capable of reaching 10K. However, a third stage has been developed by the cryogenics group at the I.L.L. in Grenoble. This novel device, shown below is capable of operating down to 1.7 K using ^4He gas to within a few mK stability. It may also be operated over a wide range of angles without degradation of the base temperature.



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