



## Multi-Axis Superconducting Magnet Systems

Multi-axis magnets of numerous configurations have been manufactured for both end-users and OEM integrators alike over the years. Recently, the popularity of multi-axis magnet systems has risen dramatically. Researchers benefit from the ease and precision of rotating magnetic field instead of physically rotating the sample. Higher fields are now possible with larger vector sum angles that ever before.



### Cryogen-FREE 3-Axis Magnet System

Typical 3-Axis Magnet System with 5T Central Field and 1T Spherical Vector Rotation

Most multi-axis magnets consist of a central Z-axis solenoid which is surrounded by either a single split pair of coils (X-axis) or two split pairs (X-axis and Y-axis). Split pair only configurations are also available. This arrangement allows for independent operation of any axis up to full rated field or 360 degree planer vector in 2-axis designs or spherical vector operation in 3-axis designs. Vector fields typically are rated at 1 Tesla with higher fields available.

Systems such as pictured at left are cryogen free. This particular system contained a 3-axis superconducting magnet assembly:

- 5T in the Z-axis
- 1T in the X-axis
- 1T in the Y-axis

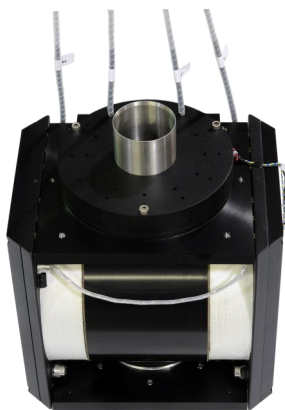
In addition to manufacturing multi-axis systems in room temperature bores, we can also provide integrated VTI systems in both cryogen-free and traditional bucket dewar systems. Further configurations are available which allow for operation in either vertical or horizontal orientation.

Ideal for emerging research areas such as 2D materials and quantum devices, precise application of magnetic vector forces allow the researcher to explore new boundaries with relative ease.

As the world leading manufacturer of superconducting magnets for gyrotron applications (gyrotron magnet systems typically have five superconducting magnets included for shaping field – a true challenge for multiple axis coils), Cryomagnetics has multiples of these successful installations worldwide.

Most gyrotron magnet systems have been cryogen-free since 2000, making Cryomagnetics the most experienced manufacturer of cryogen-free multi-axis magnet systems.

Cryomagnetics Navigator™ Software Control System  
Navigator™ is a dedicated software package that allows complete automation of the superconducting magnet system control electronics.



Typical 2-Axis Magnet Design, Note the central vertical solenoid flanked by split pair (*white*) windings.

2-Axis	3-Axis
7T/2T (7 Tesla Z-Axis;2 Tesla X-axis)	1T/1T/1T (1 Tesla Z-Axis;1 Tesla X-Axis;1 Tesla Y-Axis)
8T/2T (8 Tesla Z-Axis;2 Tesla X-Axis)	5T/1T/1T (5 Tesla Z-Axis;1 Tesla X-Axis;1 Tesla Y-Axis)
9T/1T (9 Tesla Z-Axis;1 Tesla X-Axis)	7T/1T/1T (7 Tesla Z-Axis;1 Tesla X-Axis;1 Tesla Y-Axis)
9T/4T (9 Tesla Z-Axis;4 Tesla X-Axis)	9T/1T/1T (9 Tesla Z-Axis;1 Tesla X-Axis;1 Tesla Y-Axis)

# Superconducting Magnets and Systems

## C-Mag Cryogen-FREE

### Integrated VTI Systems

- Single Cryocooler for both the magnet and sample
- Low Vibration Options
- Large 49mm sample space
- Solenoids up to 14 Tesla
- Split Pairs up to 7 Tesla
- Multi-axis Configurations
- Upgradeable with dilution and He3

inserts

### Superconducting Magnets

- Solenoids, split pairs, multi-axis
- Solenoids up to 21 Tesla
- Split Pairs up to 11 Tesla
- 2 and 3 axis Magnet Configurations
- Cryogen-FREE
- High homogeneity
- Ultra-low current
- Compensated

- Actively Shielded
- Custom Configurations

### Turn-Key Systems

- Accelerator beamline magnets
- Gyrotron
- Nuclear Demagnetization
- Optical access magnets, microscopy
- OEM
- NMR/EPR
- Magnetic separation

## *Magnet System Cooling Options*

### Cryogen FREE:

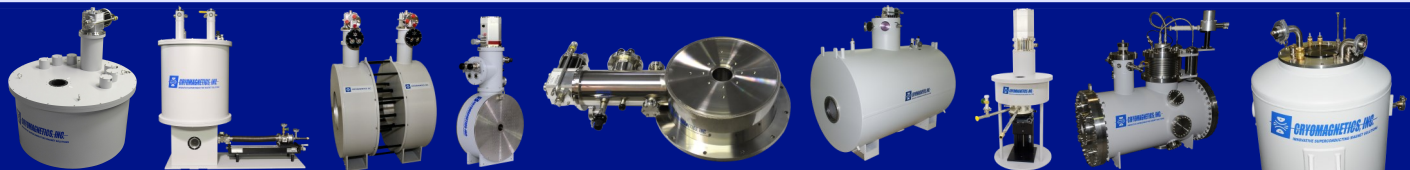
In response to liquid helium becoming increasingly difficult to obtain and afford, most research magnet configurations are now available Cryogen-FREE. Using two stage closed cycle cryocoolers, temperatures of <1.8K are obtainable. Vertical or horizontal bores in either room temperature or with integrated inserts are available. Efficient magnet and cryostat designs allow for the use of smaller cryocoolers. This saves both on initial investment and cost of long term operation. Mechanically decoupled sample stages are available as options for low vibration applications.

### Recondensing systems:

Integration of a closed cycle cryocooler into a traditional liquid helium vessel allows for the recovery of helium traditionally lost through boiloff. The presence of a helium reservoir allows for operation with ultra low vibration as the cryocooler can be turned off during sensitive measurements (Helium will be lost while operating in this manner). Similarly, in the event of power failure the magnet can be discharged safely using the automatic rampdown feature of the Model 4G Power Supply.

### Liquid Helium Cooled:

The lowest initial investment option continues to be liquid helium cooled systems. To help offset the high cost of helium, our efficient magnet designs allow for lower charging currents which result in the lowest boiloff in the industry. Superinsulated or liquid nitrogen shielded dewars are available. Liquid options are still traditionally used for high heat load applications such as rapid



***Contact us today to order your configuration!***

### Additional cryogenic components available:

Model LM-510 Liquid Level Monitor and Sensors  
Helium Reliquifier Control System  
Model 612/614 Temperature Monitor and Sensors  
Model 4G Bipolar Superconducting Magnet Power Supply  
Current Leads (Vapor cooled, HTS and Duty Cycle Optimized)

Cryogenic Dewars, Vapor shielded, LN2 and Recondensing  
Cryogenic Transfer Lines  
HTS Magnets  
Custom design and manufacture of magnets and cryostats



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