SPECIFICATIONS

12 TESLA CRYOGEN-FREE SUPERCONDUCTING MAGNET

NRL has a requirement for a 12 Tesla Cryogen-Free Superconducting Magnet. This cryogen-free superconducting magnet is intended to be used with gyrotrons operating at frequencies up to 330 GHz at the fundamental harmonic and frequencies up to 1 THz at higher cyclotron harmonics.

1. Superconducting Magnet

a. Must have a solenoidal configuration
b. Must be able to reliably produce a 12.2 Tesla central field at a current of less than 100 amperes
c. The total inductance should be approximately 125 henries
d. The central field can vary by no more than 0.2 percent over a 20 mm length on axis
e. The axial magnetic field shall be symmetric with respect to the center of the magnet and, at distances up to 0.5 m along the axis of the magnet, shall differ by no more than 1 percent from the values given in the attached table in both directions.
f. Must be fully protected from damage due to a quench
g. A persistent switch is not required

2. **Cryosta**t

a. Must have a vertical room temperature bore configuration
b. Must be of aluminum construction
c. Must include an evacuation valve and safety positive pressure relief devices
d. Must have a 3.00 inch (76.2 mm) clear bore diameter
e. The distance from the top flange to the bottom flange must be 24.0 inches (609.6 mm) to allow for accommodation of the gyrotron.
f. The main cryostat body should be at least 30 inches (762 mm) in diameter
g. Must include high-temperature superconducting current leads
h. Must include an electrical feedthrough for system diagnostics and an instrumentation cable at least 5 meters long
i. Must include at least 4 ruthenium-oxide sensors for temperature diagnostics
j. Must include lifting lugs
k. Must be equipped with removable legs, length to be determined by NRL.
l. Must be cooled by a cryorefrigerator/cryocooler. The cyrorefrigerator (cryocooler) must include the below requirements.

3. 4K Cryocooler

a. Must be based on a Gifford McMahon two-stage refrigeration cycle.
b. First stage cooling capacity must be at least 45 W at 50K.
c. Second stage cooling capacity must be at least 1.5 W at 4.2K.
d. Cold head service interval must be at least 10,000 hours and must be capable of being performed in the laboratory.
e. Compressor must be air-cooled.
f. Input power requirement for compressor must not exceed a maximum power of 8.3 kW, or a steady state power 7.5 kW. Compressor must be operable using a 200Vac, 3-phase, 60 Hz, 30 Ampere circuit.
g. Service interval of compressor must be at least 20,000 hours and compressor must be serviceable in the laboratory.
h. Must include flexible helium gas lines at least 10 m in length.
i. One ruthenium oxide temperature sensor must be installed on the first stage of the cold head to monitor temperature during operation.
j. One ruthenium oxide temperature sensor must be installed on the second stage of the cold head to monitor temperature during operation.
k. To ensure compatibility with the cryostat the coldhead must be mountable on an o-ring equipped flange with an o-ring approximately 148 mm in diameter and a bolt circle 170 mm in diameter. The length of the coldhead extention into the cryostat should not exceed 400 mm. The overall length of the coldhead should not exceed 600 mm and the overall width including the power unit and helium gas supply lines should not exceed 300 mm.

4. Magnet Power Supply

a. A low noise, bipolar power supply is required.
b. Must be able to produce plus/minus 100 amperes at plus/minus 10 VDC
c. Output current stability must be plus/minus 0.005 percent at a temperature of 25 plus/minus 1 degree C
d. Ripple/noise must be less than 10 mV RMS at full rated current
e. Must have a built-in energy absorber and automatic quench detection and protection
f. Must have persistent switch heater power supply
g. Must be programmable
h. Must have a RS-232 computer interface and drivers for use with LabView software
i. Must include output cables at least 15 feet in length

5. **Temperature Monitors**
    a. Used to monitor temperature of the superconducting magnet system as indicated by the (4) ruthenium oxide sensors
    b. Must have an RS 232 Computer Interface and drivers for use with LabView software

6. **Electronics Cabinet**
    a. A 19-inch inside width, industry-standard rack mount cabinet capable of housing all system electronics shall be included.
    b. Must be pre-wired with a 20 inch length input power cable

7. **Documentation**
    a. The contractor shall provide complete and detailed system drawings for approval, no later than two (2) weeks after contract award and prior to fabrication of the system.
    b. All other system documentation, including operation and maintenance manuals.

8. **Warranty**
    The contractor shall provide a standard one (1) year commercial warranty.

Notes:

- The Contractor shall perform final engineering of the system during the first month following award of the contract and in accordance with specifications provided by NRL. This shall include the flanges or bolt circles needed for attaching the gyrotron tube to the magnet and orienting it relative to the magnet bore. Also the height of the magnet support legs

TABLE I

On-axis Axial Magnetic Field Profile

Z (cm)	B[axial] (G)
0.0000	122000
1.0000	121777
2.0000	121101
3.0000	119949
4.0000	118282
5.0000	116047
6.0000	113186
7.0000	109639
8.0000	105366
9.0000	100373
10.000	94731
11.000	88583
12.000	82119
13.000	75533
14.000	68990
15.000	62614
16.000	56499
17.000	50718
18.000	45329
19.000	40373
20.000	35870
21.000	31825
22.000	28222
23.000	25035
24.000	22232
25.000	19775
26.000	17624
27.000	15743
28.000	14099
29.000	12660
30.000	11398
31.000	10290
32.000	9316
33.000	8456
34.000	7695
35.000	7020
36.000	6421
37.000	5886
38.000	5409

TABLE I (con't)

39.000	4981
40.000	4596
41.000	4250
42.000	3937
43.000	3654
44.000	3398
45.000	3165
46.000	2953
47.000	2759
48.000	2582
49.000	2419
50.000	2270