

Cost and Schedule for MICE Magnets, Magnet Power Supplies, and Cryogenic Refrigeration

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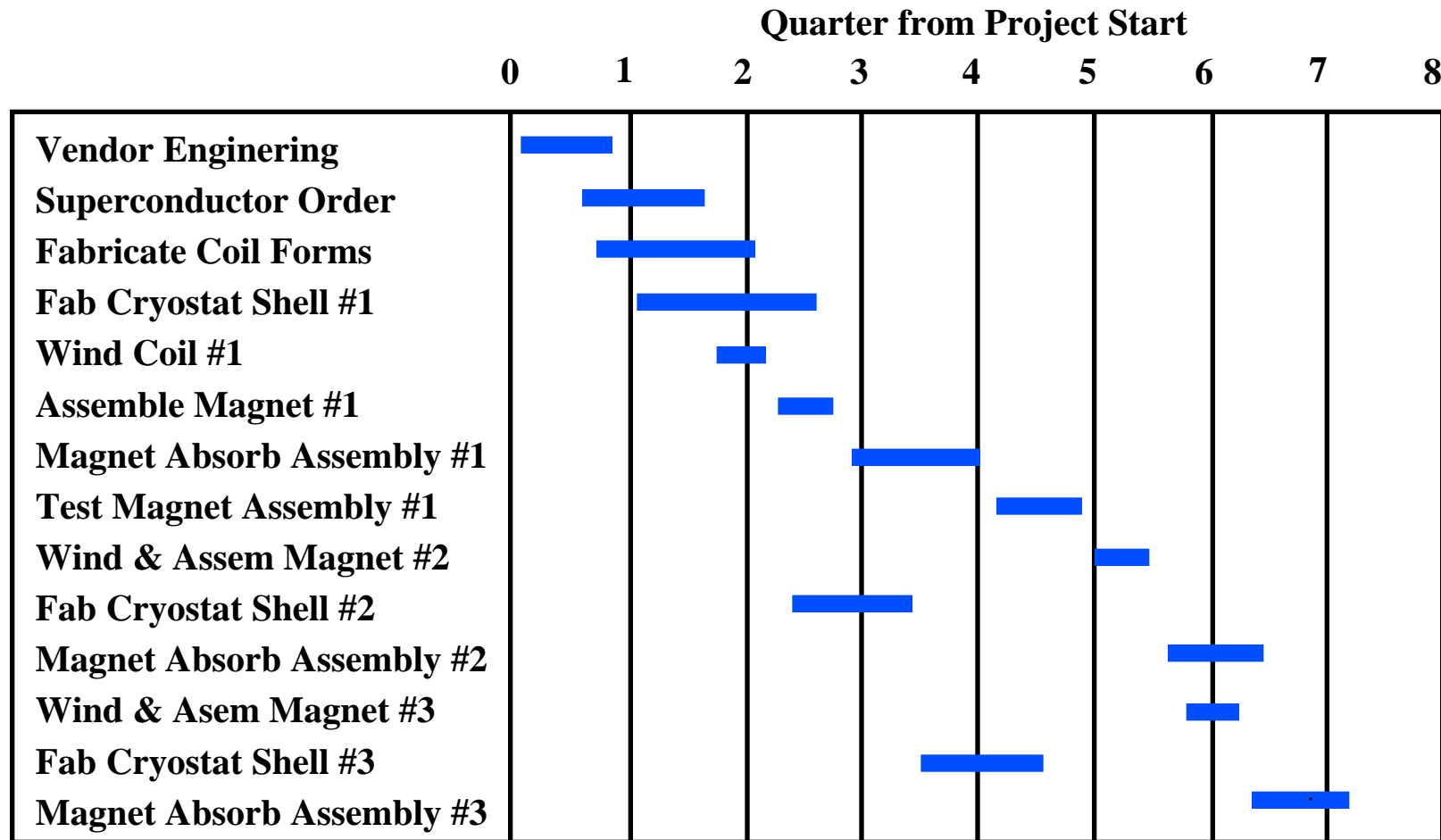
Cost and Schedule Information

- **For the MICE cooling channel coupling solenoids**
- **For the MICE cooling channel focusing solenoids**
- **For the MICE cooling channel detector and matching solenoids**
- **For the cryogenic refrigeration system for cooling the superconducting solenoids and absorbers (either liquid hydrogen or liquid helium absorbers)**
- **For the power supplies and the power supply cables needed to supply the various MICE superconducting solenoids with current**

MICE Magnet Cost

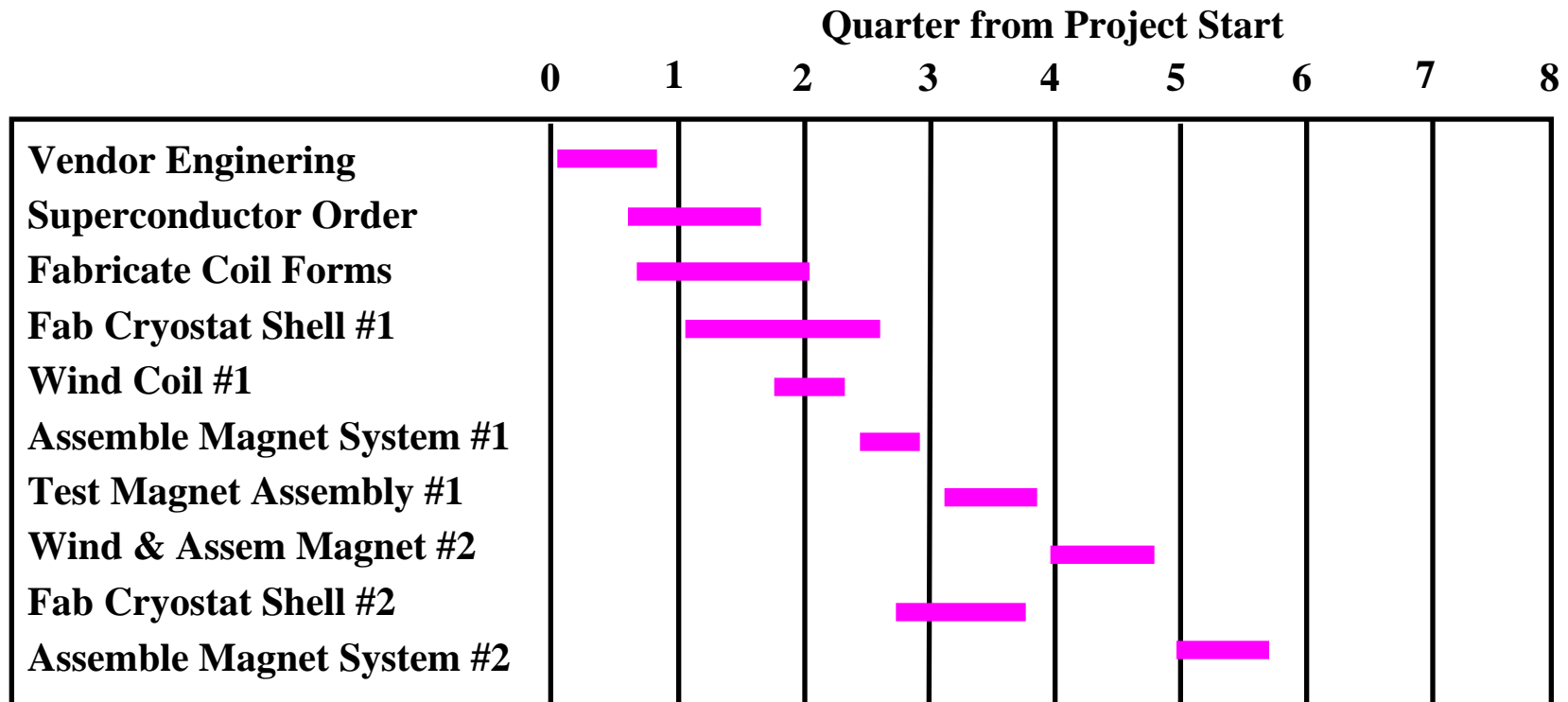
| | Coupling Cost (k\$) | Focusing Cost (k\$) | Detector Cost (k\$) |
|-------------------------------|------------------------|------------------------|------------------------|
| Number of Units | 2 | 3 | 2 |
| Superconductor | 124 | 90 | 162 |
| Bobbin Sub-assembly | 20 | 30 | 30 |
| Cryostat Sub-assembly | 24 | 21 | 20 |
| Other Purchases | 28 | 54 | 60 |
| Vendor Engineering & Tooling | 200 | 250 | 200 |
| Vendor Fabrication & overhead | 1901 | 1415 | 1899 |
| Integration with Absorber | --- | 150 | --- |
| Total Vendor Cost | 2297 | 2010 | 2371 |
| Purchase Overhead | 43 | 40 | 44 |
| Laboratory Engineering | 220 | 440 | 330 |
| Sub Total w/o Contingency | 2560 | 2491 | 2745 |
| Contingency (30 %) | 768 | 747 | 824 |
| Total with Contingency | 3328 | 3228 | 3569 |

Focusing Solenoid Fabrication Schedule



The schedule assumes that one uses a commercially available MRI conductor. The schedule assumes that only one coil is tested and that testing does not take longer than 11 weeks. The schedule assumes that the absorber is tested and fully ready for integration with the magnet. The schedule above is optimistic. 4

Coupling Solenoid Fabrication Schedule

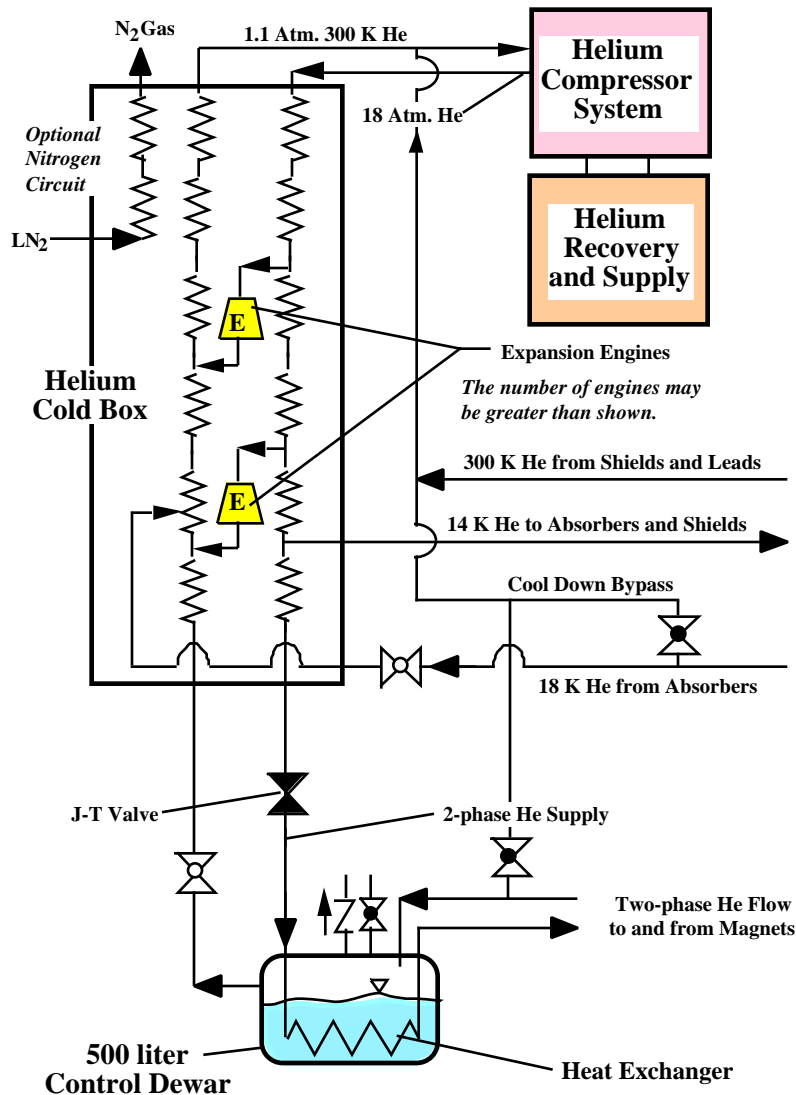


The schedule assumes that one uses a commercially available MRI conductor. The schedule assumes that only one coil is tested and that testing does not take longer than 11 weeks. The schedule is success oriented and may be a little optimistic. The coupling solenoids are the easiest solenoids to build.

Detector Solenoid Schedule

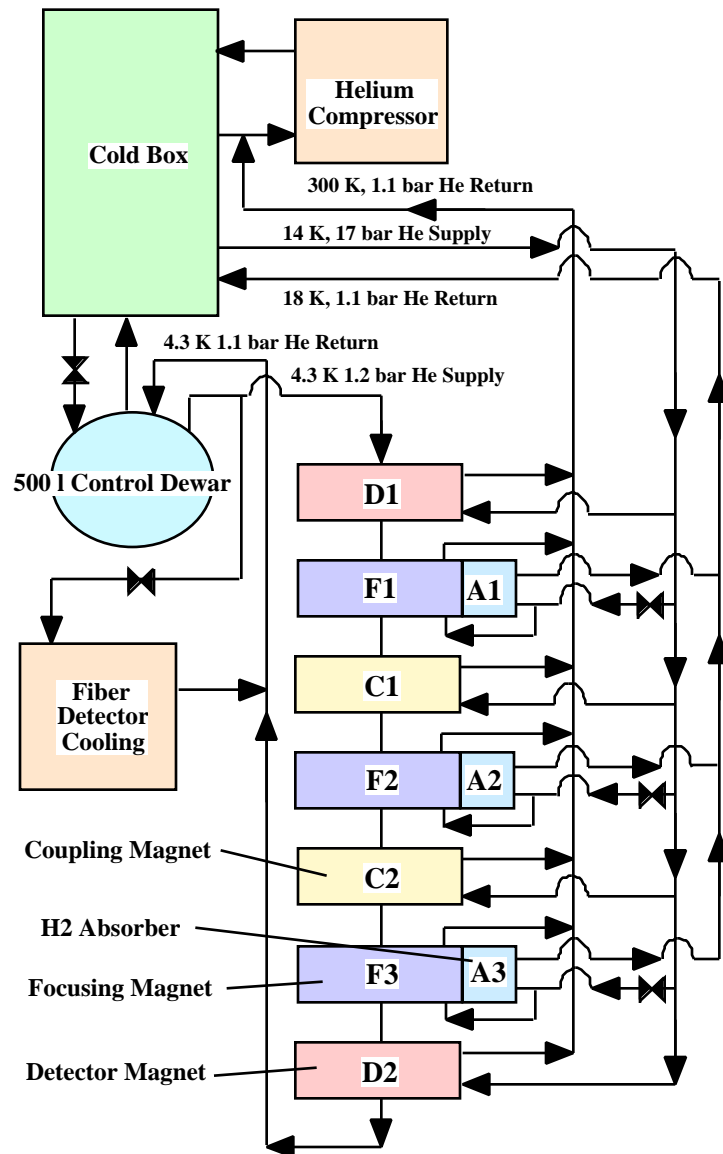
- **Stefania Farinon announced that the detector and matching solenoids would take about 30 months to fabricate. There is not much difference in delivery time between one and two magnets.**
- **The solenoid delivery time can be shortened to 25 to 26 months with an increase in cost of about 5 percent.**

Helium Refrigerator Cold Box



- 80 W of cooling to the magnets as two-phase helium (up 8 g/s)
- 300 W of cooling to three liquid hydrogen absorbers at 14 K
- 100 to 150 W of cooling to the scintillating fiber detectors at 5 K

Cold Helium Distribution System

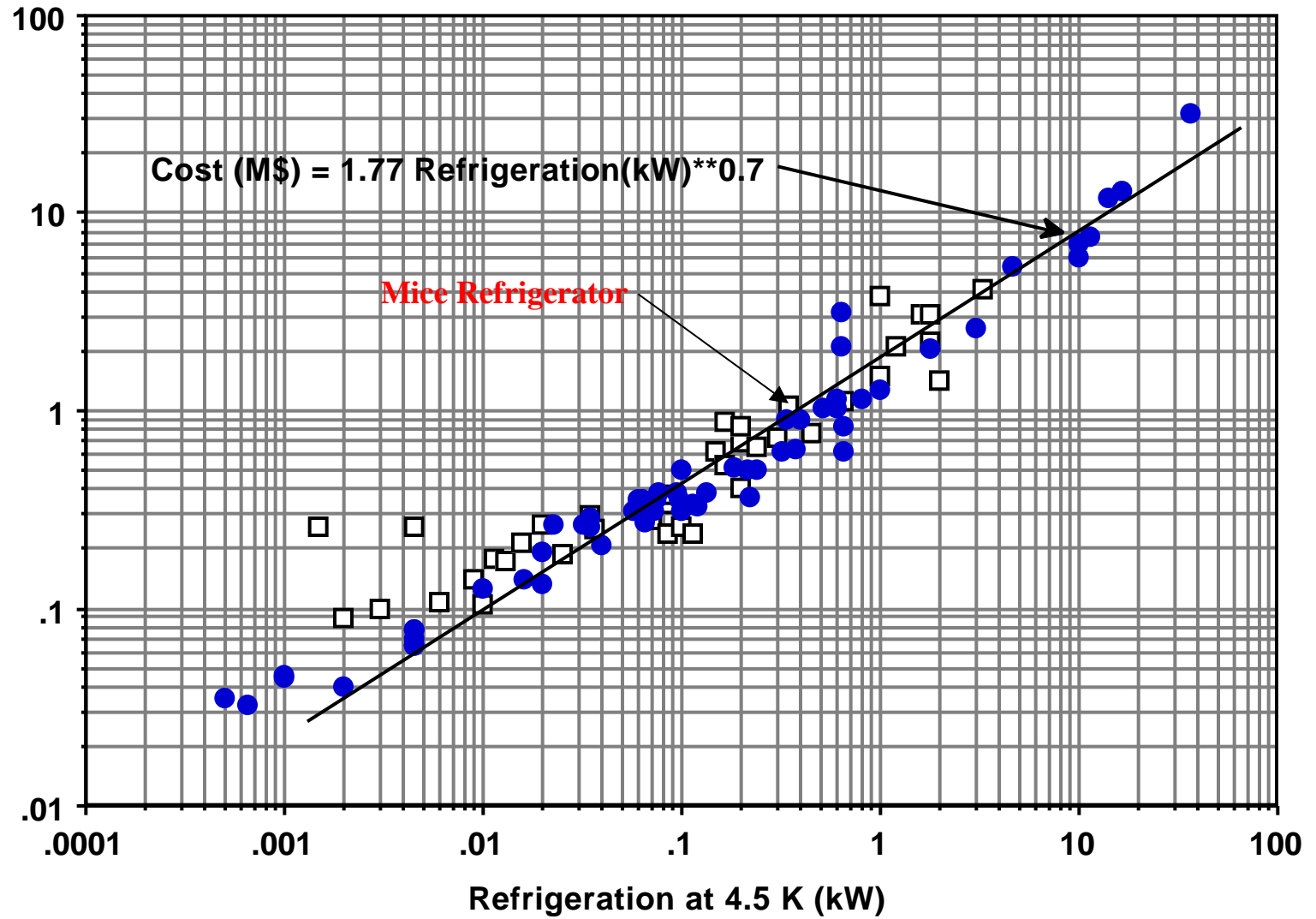


- The solenoids are cooled in series from the 4.4 K two-phase helium cooling circuit.
- The cryogenic absorbers are cooled using three parallel 14 K cooling circuits
- The fiber detector cooling comes from the 4.4 K two-phase cooling circuit

MICE Helium Cooling Requirements

| | |
|--|-------------|
| 4.4 K Cooling for Magnets (W) | 30 |
| 14 K for Absorbers & Shields (W) | 300 |
| 5 K Cooling for Detectors (W) | 150 |
| 77 K Cooling for Detectors (W) | 1000 |
| Equivalent Cooling at 4.4 K (W) | 300 |
| 4.4 K Refrigerator Size (W) | 440 |
| Detector Liquid Nitrogen Usage (l/hr) | 22.7 |
| Installed Refrigerator Input Power (kW) | 250 |

The Cost of Various Refrigerators as a Function of Refrigeration at 4.5 K



MICE Cryogenic System Cost

| | Cost (k\$) |
|---------------------------|------------|
| Helium Cold Box Cost | 1130 |
| Transfer Line Cost | 120 |
| Control Dewar System Cost | 60 |
| Cryosystem Sub Total | 1310 |
| Purchasing Overhead | 35 |
| Engineering (0.7 man yr) | 155 |
| Cryo Cost w/o Contingency | 1500 |
| Contingency (30%) | 450 |
| Total Cryosystem Cost | 1950 |

Allow 16 months Delivery for the Cold Box

Allow 12 months Delivery for other Components

Power Supply Cost Assumptions

- Each focusing coil has its own leads so that the focusing coil can be operated in the gradient mode or the solenoid mode. All of the focusing coils are hooked together in series with a single 300 A, 10 V power supply.
- The coupling coils are hooked up in series to a single 300 A, 10 V power supply.
- Each detector solenoid has four 300 A 10 V power supplies for uniform field generation and tuning.
- There is one spare 300 A, 10 V power supply.
- Three 100 A, 5 V tuning supplies are purchased.

MICE Solenoid Power Supply Cost

| | |
|---|----------------|
| Number of Power Supplies | 11 |
| Power Supply Maximum Current | 300 A |
| Power Supply Voltage | 10 V |
| Power Supply Regulation | 0.01 % |
| Cost for Eleven 300 A Power Supplies | 385 k\$ |
| Cost for Three 100 A Power Supplies | 30 k\$ |
| Cable and Cable Tray Cost | 35 k\$ |
| Purchase Sub Total Cost | 450 k\$ |
| Purchase Overhead | 22 k\$ |
| Engineering (0.25 man yr) | 50 k\$ |
| Sub Total w/o Contingency | 523 k\$ |
| Contingency (30 %) | 157 k\$ |
| Total Magnet Power System Cost | 680 k\$ |

Allow 6 months for delivery of the first power supply.

Allow 12 months delivery for all eleven supplies.

Concluding Comments

- **The costs given are based on fabrication by vendors that is supervised by LBNL. The costs include engineering, purchasing overhead and contingency.**
- **The refrigeration plant used for the cost estimate allows for hydrogen absorbers, liquid helium absorbers, and a large number of fiber channels.**
- **The number of power supplies allows for a wide range of operation conditions for MICE.**