RHIC-19

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Status of Magnet System for RHIC

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STATUS OF MAGNET SYSTEM FOR RHIC*

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Introduction

A Relativistic Heavy Ion Colliding beam accelerator[1] (RHIC) has been proposed at Brookhaven National Laboratory. The machine would generate colliding beams of energies up to 100 GeV/amu of ions as heavy as ^{197}Au. The facilities neccessary to accelerate these ions up to 11 GeV/amu are either already operational or under construction at BNL. This paper will discuss the magnet system for the actual collider ring itself, which will further accelerate the particles to beam energies of between 7 and 100 GeV/amu, store them, and provide interaction regions. This magnet system will consist of two rings of superconducting magnets placed in an existing 3.8 km tunnel.

Because of the much larger charge, the emittance of heavy ion beams is greatly increased by intra-beam scattering[2]. This requires a larger aperture than an equivalent proton machine. Much of the interesting physics requires the collision of ions of differing masses, with protons striking gold being the extreme case. To accomplish this, the two rings must run at magnetic fields differing by a factor of 2.5. This is a comparatively small machine and must maximize the use of available technology to minimize R&D.

RHIC MAGNET INVENTORY

Magnet Type	Length (m)	Bore (mm)	Field (T)	Number	Status
Regular Arc					
Dipoles	9.5	80	3.5	288	4 full size prototypes under construction 5 successful tests
Quadrupoles	1.2	80	67/m	276	Engineering Design
Sextupoles	0.75	80	1300/mxm	276	Engineering Design
Correctors	0.5	80	..	276	Magnetic Design
Insertions					
Dipoles	3.5/5.5	80	3.5	24	Same as Regular Arc
	4.4	100	4.4	24	Magnetic Design
	3.3	200	3.3	12	Conceptual Design
Quads	1.1/1.7	80	67/m	144	Same as Regular Arc
	1.1/2.2	130	57/m	72	Conceptual Design
Sextupoles	0.75	80	1300/mxm	12	Conceptual Design
Correctors	0.5	80	..	144	Conceptual Design
	0.5	130	..	96	Conceptual Design

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Magnet Design

These constraints produce a design which is significantly different from the superconducting proton machines built or under construction: large bore -- 80 mm, modest dipole field -- 3.5 Tesla, short, strong focussing cell structure -- 1 dipole/half cell, independence of the two rings -- both magnetic and cryogenic. The lattice consists of 6 arcs of 12 cells each plus six interaction regions.

The design of the quadrupole, which uses the same concepts as the dipole is shown in Fig. 1. The conductor is a 30 strand Rutherford cable (Cu-63%, NbTi-37%) which is partially keystoned. The molded coil fits into the precision molded insulator which is forced against alignment steps in the iron lamination. The iron laminations are compressed and welded to establish the 10 kpsi prestress. The helium is contained with a stainless steel jacket welded around the yoke.

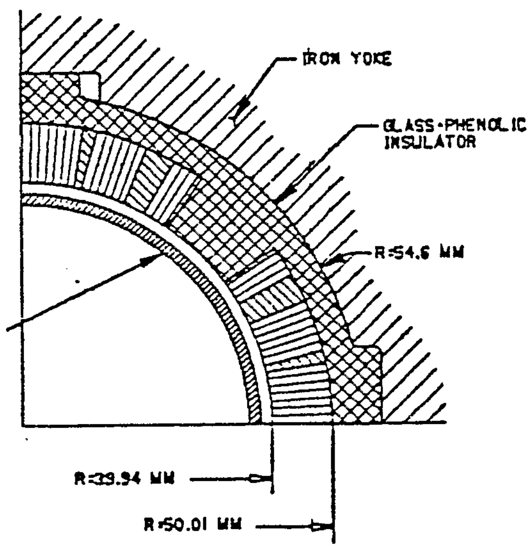


Fig. 1 Quadrupole Cross Section

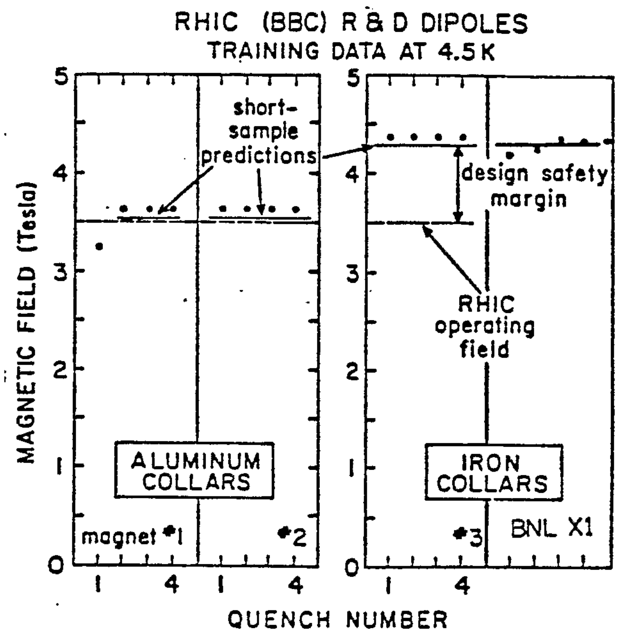
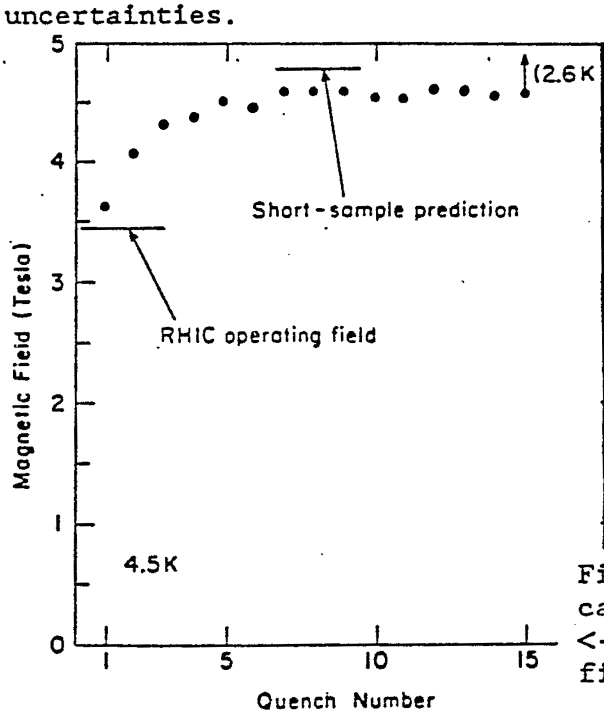


Fig. 2 Quench History Experimental Magnets.

Prototypes

Three classes of prototypes are complete or under construction. The first class consists of five experimental magnets to test the basic properties of the one layer iron clamped design. The second consists of 4.5 meter long field quality magnets(only one built to date). The last consists of full length (9.5 meter) pre-production prototypes. (Four of these are under construction). The experimental magnets were intended to investigate construction techniques and quench performance. These were built with coils wound and molded by FNAL. BNL constructed one magnet using these coils and a modified CBA yoke. No difficulties were experienced in the construction and the test results are shown in Fig. 2. In addition to the complete absence of training apparent in this figure, quench velocity measurements indicated that for a full scale magnet the maximum temperature would be 700 K, comfortably below the measured 1050 K damage threshold. The test results for three additional magnets assembled by Brown Boveri et Cie are also shown. These magnets demonstrated that the technology could be transfered successfully to private industry. The variations of collar materials verified that the iron collared magnets performed exactly as predicted. The performance shown in this figure is unprecedented for a new magnet design.

The field quality magnets are being constructed to verify the calculations and to check the details of the final design geometry. The first of these was constructed of the same cable as intended for the final design. This cable was fully keystoned. This resulted in excessive compression of the inner edge of the cable which is believed to be the cause of the quench performance shown in Fig. 3. Because of this training, the coil was redesigned as shown in Fig. 1 to use partially keystoned cable. The field measurements are shown in Fig. 4; the agreement with calculations is within the uncertainties.



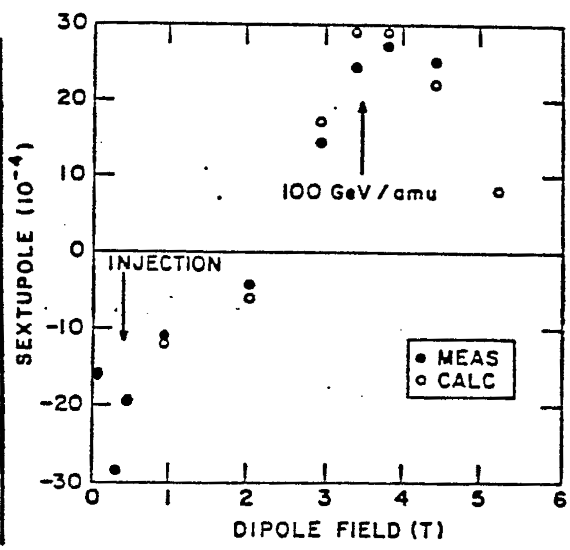


Fig. 4 Comparison of measured and calculated sextupole

<--Fig. 5. Quench history for first field quality magnet.

Presently full length magnets with the revised cable are under construction (one at BNL and three at BBC). These are intended to be full scale production models and will be connected together for a string test, as well as individual quench and field quality testing.

References

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