Magnet Studies for High Energy Muon Colliders * – DRAFT of 4 December, 2000

HEMC Magnet Working Group

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Abstract

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1 Introduction

Editor's Note to Authors: This report is intended to be relatively brief and to reference and summarize all of the more detailed individual writeups for the study in each of the relevant areas. The layout of this report is subject to change depending on technical input throughout the study and the relative emphasis the study participants give on each of the topics. Unpolished precursors to actual text are given either as a bulleted list or enclosed in square brackets: [...].

- Diverse magnets needed (list them)
- Long-term extrapolation in magnet technologies so all discussions are very preliminary and speculative.
- etc.

2 Superconducting Dipole, Higher Multipole and Combined Function Magnets

2.1 Dipoles and/or Combined Function Magnets for Acceleration and the Collider Ring

[Since these are a major (if not dominant cost driver) they need to be as affordable as possible ($\simeq$simple?). They also need to be able to deal with the

*studies performed as part of the 6-Month Feasibility Study on High Energy Muon Colliders; Oct'00–Apr'01,
Study web page: http://pubweb.bnl.gov/people/bking/mucoll .

Figure(s) for dipole/other design...

Figure 1: Figure(s) needed ...

heat deposited from muon decay products (e.g. a warm tungsten liner or open mid-plane) and ideally should be strong enough to satisfy the average bending fields for the straw-man collider parameter sets. Note that combined function magnets eliminate the need for quadrupoles without bending fields, which may sometimes be undesirable due to the neutrino radiation hotspot from aligned decays along the length of the quadrupole.]

2.2 Specialty High Field Multipoles for the Chromatic Correction and Final Focus Sections of the Collider Ring

[High performance is more important than cost since there will only be a few of these and higher gradients will translate rather directly into a higher luminosity. Very approximate maximum aperture sizes and desirable gradients are included in the table of straw-man collider parameters.]

2.3 FFAG Specialty Magnets

[Magnets for FFAG lattice designs will usually need a very large horizontal aperture and “scaling” FFAG lattice designs in particular may also include a superposition of several different large multipole components.]

[...]

Figure for quad. design ...

Figure 2: Figure needed ...

Figure for FFAG magnet ...

Figure 3: Figure needed ...

Figure for capture solenoid ...

Figure 4: Figure needed ...

3 Solenoidal Magnets

3.1 Capture Solenoid for Pion Production

Pion production studies for muon colliders and neutrino factories have indicated that, for optimal pion yield, the production target be enclosed in a solenoidal magnet with a field-times-bore radius (corresponding to a transverse momentum cut-off) of approximately 150 Tesla-cm over a length of approximately 30 cm. Within these constraints and the requirement for substantial radiation shielding, the field should be as high as possible because (it turns out from the optics of an adiabatically tapered solenoidal magnetic field that) the effective initial transverse emittance of the pion-plus-muon cloud is reduced in inverse proportion to the magnetic field for a fixed field-times-bore.

[Most nuon collider studies to date have assumed a hybrid solenoid – a SC outsert from niobium-titanium and niobium-tin plus a copper magnet insert of either a hollow-conductor or bitter magnet – with a field and bore radius of around 20 Tesla and 7.5 cm. Given the rapid progress in high-Tc cable, perhaps we should also look into the option of an all-SC solenoid using a high-Tc SC insert.]

3.2 Solenoidal Magnets for the Cooling Channel

3.3 Detector Solenoid (Optional Topic)

4 Fast-Ramping and Specialty Magnets

4.1 Magnets for Fast-Ramping Synchrotron Option (Optional Topic)

4.2 Kicker Magnets for the Cooling and Acceleration Channels

4.3 Lambertsons or Other Extraction Magnets (Optional Topic

5 Magnet Inventory and Cost Drivers for Muon Colliders

6 Summary

7 Summary

References

[1] The Neutrino Factory and Muon Collider Collaboration, `http://pubweb.bnl.gov/people/bking/mucoll` .

[2] The Muon Collider Collaboration, *Status of Muon Collider Research and Development and Future Plans*, Phys. Rev. ST Accel. Beams, 3 August, 1999.

[3] The Muon Collider Collaboration, $\mu^+\mu^-$ *Collider: A Feasibility Study*, BNL-52503, Fermilab-Conf-96/092, LBNL-38946, July 1996.