Target System Concept for a Muon Collider/Neutrino Factory

(5th High Power Target Workshop, Fermilab, May 20, 2014)

K.T. McDonald,[5] X. Ding[2], V.B. Graves,[3] H.G Kirk,[1] H. K. Sayed,[1] N. Souchlas,[4] D. Stratakis,[1] R.J. Weggel[4]

[1]Brookhaven National Laboratory, Upton, NY 11953, [2]UCLA, Los Angeles, CA 90095

[3]ORNL, Oak Ridge, TN 38731, [4]Particle Beam Lasers, Inc., Northridge, CA 91324

[5]Princeton University, Princeton, NJ 08544

Specifications from the Muon Accelerator Staging Scenario

6.75 GeV (kinetic energy) proton beam with 3 ns (rms) pulse.

1 MW initial beam power, upgradable to 2 MW (perhaps even to 4 MW).

50 Hz initial rep rate for Neutrino Factory;
15 Hz rep rate for later Muon Collider.

The goal is to deliver a maximum number of soft muons,
~40 < KE < ~ 180 MeV.

Target System Concept

Graphite target ($\rho \sim 1.8$ g/cm^3), radiation cooled (with option for convection cooling); liquid metal jet as option for 2-4 MW beam power.

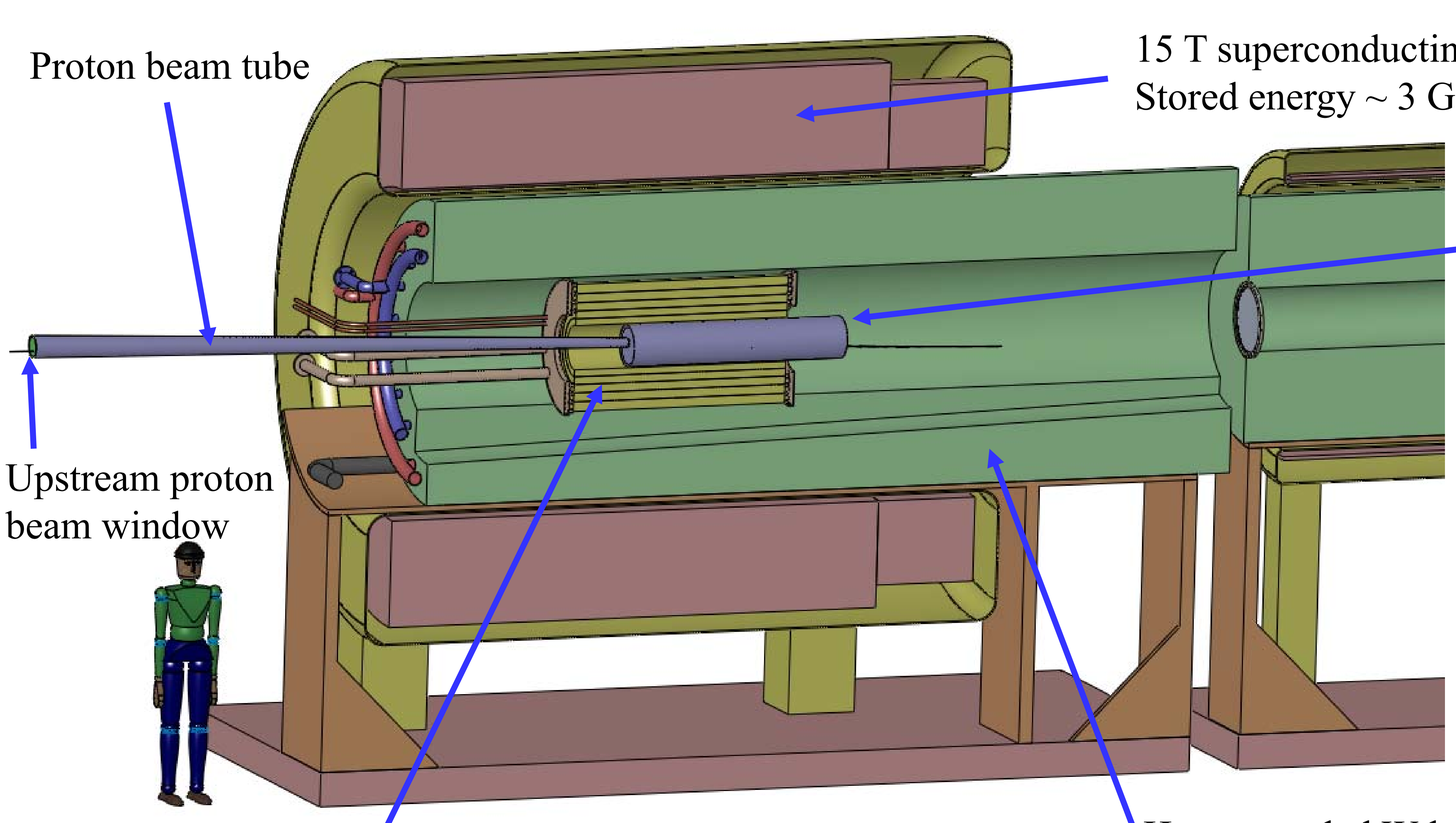
Target inside high-field solenoid magnet (20 T) that collects both $\mu^\pm$.

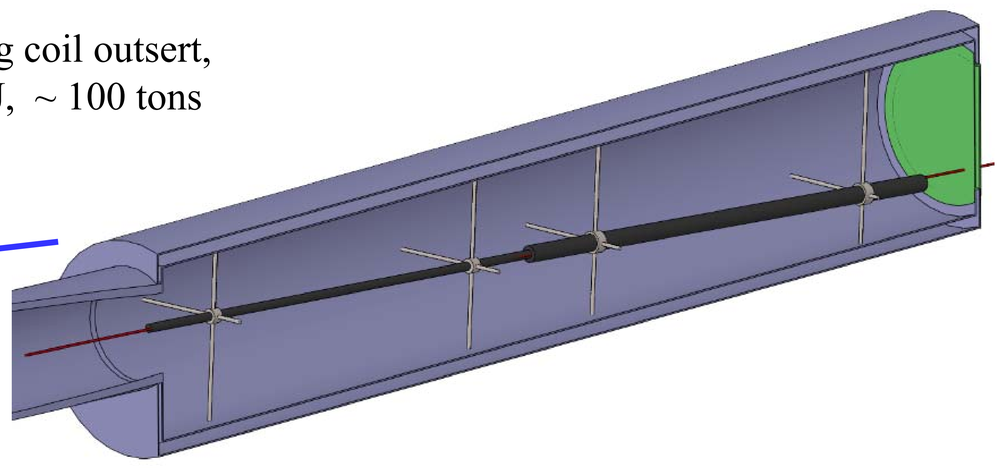
Target and proton beam tilted with respect to magnetic axis.

Superconducting magnet coils shielded by He-gas-cooled W beads.

Proton beam dump via a graphite rod just downstream of the target.

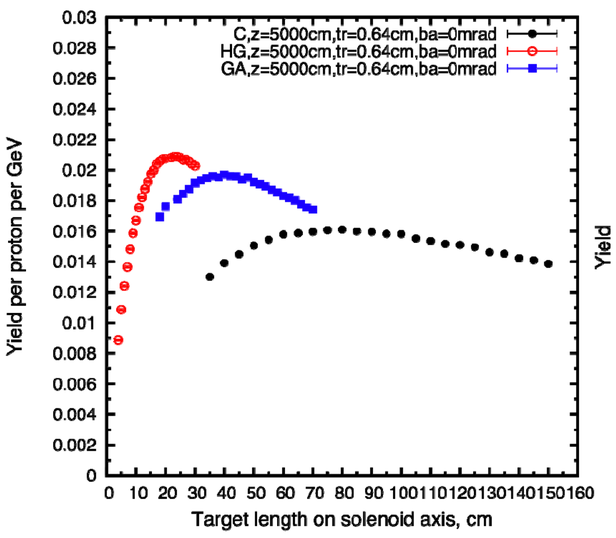
Some of the proton and π/μ transport near the target is in air.

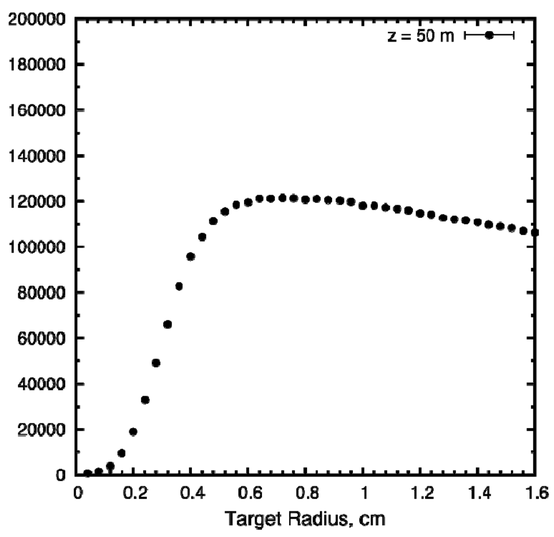


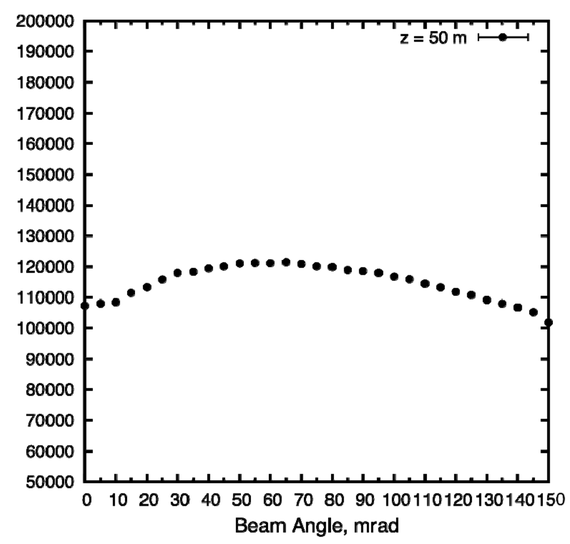


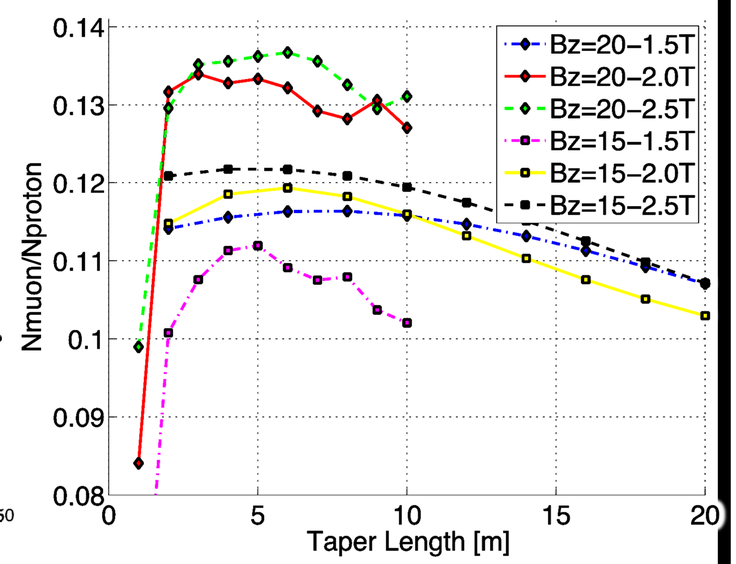
Stainless-steel target vessel (double-walled with intramural He-gas flow for cooling) with graphite target and beam dump, and downstream Be window.

This vessel would be replaced every few weeks at 1 MW beam power.









Target System Optimizations

High-Z favored.

Optima for graphite target: length = 80 cm,
radius ~ 8 mm (with 2mm (rms) beam radius),
tilt angle = 65 mrad.

Graphite proton beam dump, 120 cm long, 24 mm radius to intercept most of the (diverging) unscattered proton beam.

The 20 T field on target should drop to the ~ 2 T field in the rest of the Front End over ~ 5 m.

Issues for Further Study

Thermal "shock" of the short proton pulse on the graphite target.
Probably OK for 2 MW and 50 Hz operation; 15-Hz option needs study.

Cooling of target, and the W beads.

Lifetime of target against radiation damage.

Beam windows.

β^* and beam emittance at the target.

To preserve liquid-metal-jet upgrade option, need related infrastructure installed at t = 0.