Target System Concept for a Muon Collider/Neutrino Factory

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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).

60 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.

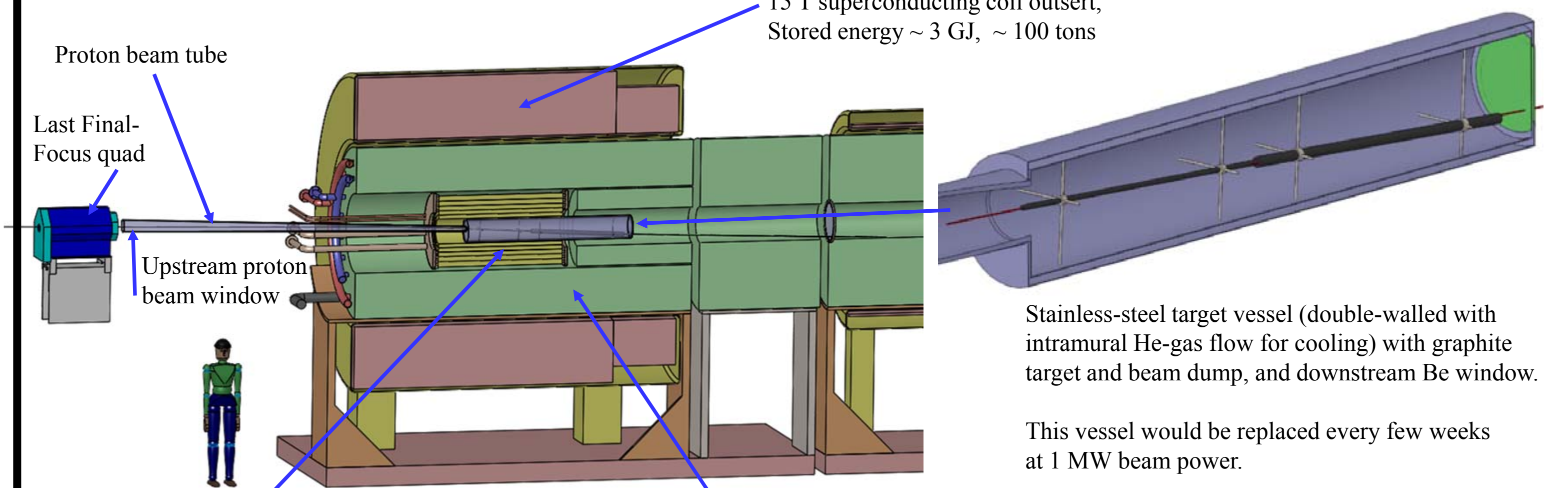
Target inside high-field solenoid magnet (20 T) that collects both $\mu^{\pm}$.

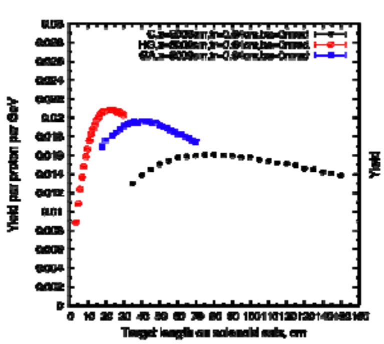
Target and proton beam tilted with respect to magnetic axis.

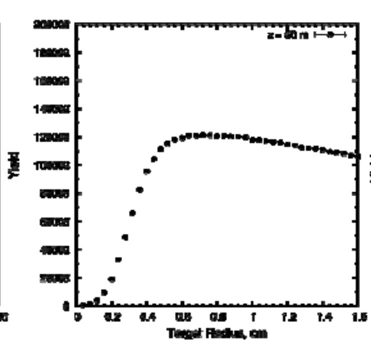
Superconducting magnet coils shielded by He-gas-cooled W beads.

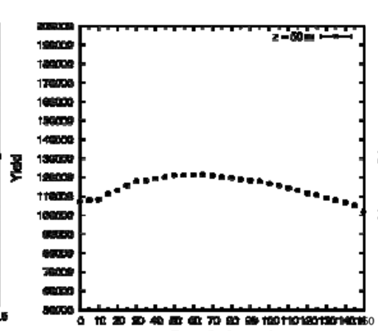
Proton beam dump via a graphite rod just downstream of the target.

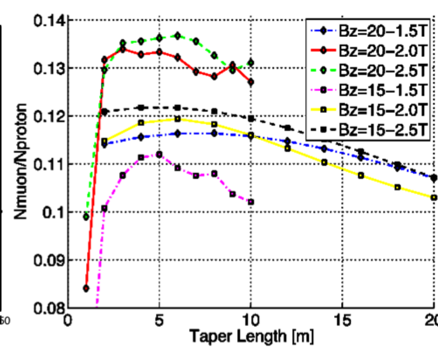
Some of the proton and π/μ transport near the target is in air.











Target System Optimizations

High-*Z* favored.

Optima for graphite target: length = 80 cm (for $\rho = 1.8$ g/cm^3),
radius ~ 8 mm (with 2mm (rms) beam radius),
tilt angle = 65 mrad.
nominal geometric rms emittance $\epsilon_\perp = 5$ µm.
$\beta^* = \sigma_r^2 / \epsilon_\perp = 0.8$ m.

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 60 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.