Preparing MCenter Secondary to   
Transport 120 GeV Primary Beam to MC7  
V0.1

Kobilarcik

06 September 2020

**ABSTRACT**

The ECA “Precision Neutrino Fluxes for LBNF/DUNE” requires 120 GeV primary beam in MC7. We specify the work and measurements necessary to demonstrate that Accelerator Division is capable of achieving this goal. At present, experimental requirements, such as rate, spot size, or target scans, are unknown. Therefore, we also specify the measurements needed to characterize existing capabilities. We note that 120 GeV primary beam had been transported to MC7 in support of the MIPP experiment.

**Shielding Considerations**

At present, MC7 is limited to 3.00E6 particles per four second spill (Memorandum, Wayne Schmitt, November 20, 2018). The secondary intensity assumes 64 GeV particles. Assuming the dose scales as (E/1000)^(0.8), the limit for 120 GeV particle is 1.81E6 particles per four second spill.

**Primary Beam Attenuation**

Presently, primary beam to MCenter is limited to 1.70E10 protons per four second spill. Rates as low as 1.0E10 protons per spill are achievable. Based on the shielding considerations, an attenuation factor of approximately 2E-4 is required.

The pinhole collimator located in MC2, MC2PIN, will be used to attenuate the primary beam. The resulting beam intensity will be measured using the ion chamber MC6IC, located immediately upstream of the primary target. In conjunction with measuring the intensity at the ion chamber MC1IC, located upstream of the pinhole collimator, one can calculate the attenuation factor.

**Primary Beam Measurements**

In addition to measuring the primary beam intensity, the profiles at MC4WC, MC5WC, and MC6WC will be measured. This will allow one to calculate the emittance and divergence of the beam as it leaves the MC2 pinhole collimator.

**Secondary Beamline Power Supplies**

The dipole string, MC6D, which selects the secondary energy, will be set to 120 GeV. This is a ramped magnet. Measurements will be made to determine if the current is stable during extraction. Note that this measurement can proceed without beam; only an interlocked enclosure and timeline events are required.

**Primary Beam Transport to MC7**

Ideally, the proof-of-principle will consist of transporting primary beam to MC7. The successful transport of primary beam will be verified by recording a profile on MC7WC.

In the event that the MC2 pinhole collimator does not achieve adequate attenuation, profile measurements will allow one to characterize the beam and develop a plan for primary beam transport.

**Required Work**

* Verify that MC2PIN motion control and readback is functioning. Controls.
* Verify that MC6D is capable of steady running at 718 Amps during extraction. EE Support
* Develop a plan to remove MC6TGT. (If it is not moved, beam will hit it …) Radiation Safety
* Verify the allowed primary beam rate. Radiation Safety.
* Operating note allowing the transport of 120 GeV primary beam to MC7. Radiation Safety
* Verify the MC7WC is in place and may be read (and logged) through ACNET. Instrumentation.
* Work of a lower priority includes verifying that the MC3 vertical and horizontal collimators are functioning (setting and reading). These devices may be useful in cutting tails or further reducing intensity. Controls and MSD.

**Supporting Calculations**

*Initial calculation of MC2PIN attenuation and of spot size in MC7*

Using data from S210, MOOWC, MC1WC, and MC2WC, determine size and divergence of the beam at MC2PIN. The aperture of the pinhole collimator is approximately 1/16” square (Koizumi/Monningh measurement).

Knowing the spot size and aperture, the attenuation can be calculated.

After cutting on phase space with the collimator, the spot size at MC7 can be estimated. Intervening apertures, such as the scrapers in the secondary beamline, should be accounted for.

*120 Gev Setting for MC6D*

MC6D consists of four EPB dipoles. This dipole string selects the secondary momentum and “levels off” the secondary beam. The primary beam, level through Meson, was previously pitched upward by the MC5U dipole string. The MC5U dipole string consists of three EPB dipoles.

During the FY2020 run, MC5U was run at 957 Amps. Scaling this value, MC6D should run at 718 Amps.

*Beam Movement at Target*

(This task is lower priority.) There are two trim magnets per plane in the secondary beamline. Knowing the transfer functions of the magnets, and rigidity of the beam, one may calculate the parallel movement of the beam.