Preparing MCenter Secondary to Transport 120 GeV Primary Beam to MC7

V0.3

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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 3.00×10^{6} particles per four second spill (Memorandum, Wayne Schmitt, November 20, 2018). The secondary intensity assumes 64 GeV particles. Assuming the dose scales as $(E_2/E_1)^{0.8}$, the limit for 120 GeV particle is 1.81×10^{6} particles per four second spill.

Primary Beam Attenuation

Presently, primary beam to MCenter is limited to 1.70×10^{10} protons per four second spill. Rates as low as 1.0×10^{9} protons per four second spill are achievable. Based on the shielding considerations, an attenuation factor of approximately ($1.81\times10^{6}/1.0\times10^{9}$ =) 1.8×10^{-3} 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.

Measurements from the 2004 run, which operated MCSecondary at 120 GeV, show an attenuation factor of ranging from 2×10^{-6} to 5×10^{-6} – several orders of magnitude greater than that required to operate safely. Refer to Beams-doc-8615 "MC2 pinhole collimator attenuation for 120 GeV beam with intensities measured by MC1SEM and MC6SC".

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.

A recent test confirmed the ability to operate MC6D at 900 amps (in excess of the 120 GeV value) and achieve a stable current during the expected extraction time. Refer to Beams-doc-8615 "Successful MC6D power test results to operate this dipole string at 120 GeV currents".

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 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. Completed Oct. 6, 2020.
- Develop a plan to remove MC6TGT. 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

This should not be considered an exhaustive list. As the beamline systems are checked, additional issues may arise which would need to be addressed.

Initial Calculation of MC2PIN Attenuation and of Spot Size in MC7

Using data from upstream SWICs, along with knowledge of the size of the pinhole, calculate the attenuation of the primary beam and the spot size at MC7.

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

Using knowledge of the secondary beamline, calculate possible beam motion in MC7.

Determine Adequacy of MC2PIN Controls

Determine reproducibility of MC2PIN position; minimum step size; accuracy of readback.