**MI BEAM POWER FOR DIFFERENT BEAM ENERGIES**

**Ioanis Kourbanis**

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**Introduction**

For NOvA MI will provide 4.9E13p at 120 GeV beam momentum every 1.33 sec for a beam power of 708KW. In order to achieve this beam power the Recycler is used as a proton Ring for Slip Stacking. There has been some interest to know the MI beam power at different momenta than 120 GeV. The following note attempts to answer this question in a consistent manner.

**Assumptions**

In order to calculate the MI beam power at different momenta the following assumptions were made: The RR cycle time was assumed to be 13 Booster ticks long or 0.866 sec. The max pdot is 240 GeV/sec and no extra PS supplies are added. The MI cycle time in each energy considered, was rounded off to represent an integer number of Booster ticks. The MI cycle time cannot be smaller than the RR cycle time.

**Results**

The MI cycle time for different momenta from 30-120GeV is plotted in Fig. 1. As mentioned before the MI cycle time was rounded off to the closest integer number of 15 Hz Booster ticks. From this plot we can see that for MI momenta smaller than 70 GeV the MI cycle time is smaller than the RR cycle time required for slip stacking. For the MI power calculations the MI cycle time for momenta smaller than 70 GeV will be considered constant and equal to RR cycle time. The MI power vs. beam momentum is shown in Fig. 2.

**Fig. 1: MI time required to ramp to different momenta.**

**Fig. 2: MI Beam Power vs. Beam Momentum**

**Booster Beam Requirements**

For the NOvA 700KW operation we assume 4.3E12 per batch from Booster at 9Hz. The Booster repetition rate required for the different MI beam momenta is shown in Fig. 3. The protons per hour required from Booster as a function of MI beam momentum is shown in Fig. 4.

**Fig. 3: Booster Rep. Rate vs. MI Beam Momentum.**

**Fig. 4: Booster proton per hour vs. MI beam Momentum.**