Potential Benefits of a Tevatron Run Extension for MINERvA

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This note describes the impacts to the MINERvA experiment from a Tevatron run extension. Because MINERvA and NOvA share the same beamline, the impact on MINERvA's is coupled to the details of NOvA's run plans. However, the qualitative impacts on MINERvA and NOvA of a Tevatron extension are not necessarily similar.

In particular, MINERvA's physics reach for each part of its program depends on the incoming neutrino energy distribution. NOvA, by contrast, sees a spectrum mostly unaffected by the on-axis NuMI tune with a small reduction in rate if NuMI runs in a lower energy tune than NOvA's preferred "medium energy" configuration. The more Low Energy neutrino beam that MINERvA can collect due to a Tevatron run extension, the more beneficial that extension is to the MINERvA program.

MINERvA's physics goals fall into two basic categories: exclusive final states and inclusive scattering.

Measurements of exclusive final states are those most relevant for upcoming neutrino oscillation experiments, and are generally best done in the low energy beam. MINERvA's statistics in this beam are limited because of the relatively low rates. The original MINERvA proposal envisaged a four year run in this low energy beam, and MINERvA would benefit increased beam in a low energy configuration up to at least a factor of two over the 4.4E20 now planned to be delivered before the March 2012 shutdown.

By contrast, inclusive scattering measurements, used for example to extract parton distributions from nuclei, are best done in the higher energy neutrino beams preferred by NOvA. This physics also needs a significant anti-neutrino exposure. Because of the high event rates expected in the medium energy beam, MINERvA is less affected by a lack of statistics in medium energy than in the low energy running.

The effect on MINERvA's program depends on the details of how the Accelerator Upgrade for NOvA (ANU) accommodates the extended Tevatron Run. NOvA described a change to the original single shutdown plan by splitting the work into two distinct shutdowns. If more Low Energy neutrino data can be accumulated by MINERvA, either during the first shutdown or between the two shutdowns when NOvA projects a total of 7E20 protons on target might be accumulated, then this new shutdown plan could have substantial benefit to MINERvA's exclusive state physics program with only a minor delay to its inclusive scattering program. If this additional Low Energy data were taken well before most of NOvA's far detector was operational then it would have reduced impact on NOvA's physics reach.

So overall, while delaying the ANU upgrades as a consequence of the Tevatron run extension would have the effect of delaying the 12E20 protons on target requested by MINERvA in the medium energy configuration by approximately 18 months, similar to the delay to NOvA, added running which might be possible in the low energy configuration would be an opportunity for MINERvA. A larger data set in a low energy beam gives MINERvA more precision in measurements that most directly impact oscillation experiments, and since MINERvA does not have any competition for these medium energy measurements the delayed results would still be timely.