The High-Power Targetry Experiment

H.G. Kirk, K.T. McDonald, 4/28/04

The goal of this experiment is to provide a proof-of-principle demonstration of the targetry concept of a free mercury jet + high-field solenoid magnet + intense, pulsed proton beam, with parameters close to those of the Neutrino Factory Study 2**.**

Baseline parameters for targetry in Neutrino Factory Study 2:

1. 1 MW, 24-GeV proton beam, 15 Hz, in groups of 6 pulses of 20-msec separation.
2. Each pulse is 3 ns (rms), containing 16 TP $=16\times10^{12}$ protons, in a spot size of $\sigma_r = 2.5$ mm.
3. The proton beam is tilted at 67 mrad to the axis of the 20-T capture solenoid.
4. The mercury jet target has 1-cm diameter, and is tilted at 100 mrad to magnetic axis. This leads to an interaction region with the proton beam that is 60 cm long.
5. For the jet to move over the 60-cm interaction length during the 20 msec bunch spacing will require a velocity of 30 m/s.

Parameters of the proposed CERN proof-of-principle experiment:

1. 24 GeV proton pulses, in a bunch train consisting of any subset of the 8 PS bunches, whose spacing is 250 ns, with individual pulse width of about 40 ns (rms).
2. 5 TP per bunch. Thus, extraction of all 8 bunches implies 40 TP in 2 μs.
3. The proton beam spot size is to have $\sigma_r = 2.5$ mm.
4. The proton beam will be tilted by 67 mrad with respect to the 15-T pulsed solenoid
5. The mercury jet will have a 1-cm diameter, will be tilted by 100 mrad with respect to the magnet axis, and will have a velocity of 20 m/s. This velocity is sufficient to insure that the jet is straight enough against gravitational bending over the 60-cm interaction region.

Comments:

1. 3 extracted bunches of 5 TP each are equal in number of protons in the single bunch of 16 TP of the Study 2 design. However, these 3 bunches will extend over 500 nsec in the CERN experiment. Hence, we wish to include studies of the beam-jet interaction as a function of the total time spread of the proton bunches, to verify that a 500 nsec spread is a good simulation of a 3 ns bunch, insofar as jet dispersal is concerned.
2. It is important to observe the length *L* along the mercury jet that is dispersed by the interaction with the proton beam. The jet velocity must be $v = L/0.02$ for a fresh segment of mercury to be available for the subsequent pulse of Study 2.
3. Studies of the stability of the jet interaction with the magnetic field are to be made with the 15-T magnet prior to use of the proton beam. Our baseline is to perform these tests at CERN in Q1 of 2006, but with sufficient cash flow it may be possible to perform these tests at MIT (where the magnet will be first commissioned) during Q3-4 of 2005.