Executive Summary of AGS Experiment E951

An R&D Program for Targetry and Capture at a Muon Collider/Neutrino Factory Source

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Future accelerator complexes such as a muon collider and a neutrino factory based on a muon storage ring need a copious source of muons. These particles derive from the decay of π mesons that are produced in the collisions of an 8-24 GeV proton beam impinging on a nuclear target. Proton beams of power up to 4 MW ($> 10^{15} p$/sec) are contemplated. Pion production is more efficient with a high-Z target that resides inside a 20-T solenoid magnet capture system. A "disposable" target consisting of a jet of mercury may be an excellent option. Furthermore, formation of the pions into a bunch for later accelerator should begin with a low-frequency, high-gradient rf cavity located as close to the target as possible.

This targetry scenario is aggressive, with two broad classes of issues:

1. Viability of targetry and capture for a single pulse.

2. Long-term viability of the system in a high radiation area.

AGS experiment E951 has been proposed by members of the Neutrino Factory and Muon Collider Collaboration as an R&D program to explore the first class of issues. Its overall goal is to test key components of the front-end of a neutrino factory/muon collider in realistic single-pulse beam conditions. The BNL AGS was chosen as the site of these tests as it has the highest-intensity short-pulse proton beam in the world, which intensity is well matched to that needed for a muon collider/neutrino factory.

The targetry R&D program will expand with time to include long-term issues as well.

The E951 program is comprised of 8 steps:

1. Simple tests of liquid (Ga-Sn, Hg) and solid (C, Ni) targets with AGS Fast Extracted Beam (FEB) of 1.5×10^{13} $p$pp.

2. Tests of a liquid jet entering a 20-T, 20-MW, cw Bitter magnet at the National High Magnetic Field Laboratory).

3. Tests of liquid jet and other targets with 10^{14} $p$pp via extraction of 6 AGS bunches.

4. Add a 20-T pulsed magnet (5-MW peak power) to the target tests with the AGS FEB.

5. Add a 70-MHz rf cavity downstream of target; test in the AGS FEB.

6. Surround the rf cavity with a 1.25-T magnet; test in the AGS FEB. At this step we have all essential features of the source.

7. Characterize the pion yield from the target + magnet system with AGS slow extracted beam (SEB).

8. Ongoing simulation of the thermal hydraulics of liquid-metal and other target systems.

Steps 1 and 3-7 involve use of an AGS proton beam, in a parasitic "pulse-on-demand" mode. The schedule of E951 is as follows:

- FY99:
  Prepare the A3 beam area at the AGS (Step 1);
  Begin work on liquid jets, magnet systems, and rf systems (Steps 2, 4-6).

- FY00:
  Complete the A3 line (Step 1);
  Continue work on liquid jet, magnet and rf systems (Steps 2, 4-6);
  Begin work on AGS extraction upgrade (Step 3).

- FY01:
  First test of targets in the A3 beamline (parasitic to $g-2$ operation; Step 1);
  Liquid jet tests in 20-T magnet at NHMFL (Step 2);
  Continue work on extraction, magnet and rf systems (Steps 3-6).

- FY02:
  Complete extraction upgrade, magnet and rf systems (Steps 3-6);
  Test targets with 10^{14} ppp (Steps 3);
  Begin work on pion yield diagnostics (Step 7);
  Option to study a mercury beam dump in a vertically pitched beam (Step 3.5).

- FY03:
  Beams tests of target + 20-T pulsed magnet + rf cavity (Steps 4-6);
  Complete pion detectors; test yield with low intensity SEB (Step 7).

The full E951 facility is shown in the figure below: