Draft
January 2, 2008

PREx January 2008 Beamtest Run Plan

1. Introduction

The PREx beamtest is currently scheduled to start Jan 26, 2008 and last for ~ 6 days (~ 18 shifts). There are 5 main categories of studies we would like to perform during this time: Lead target tests, PREx detector tests, instrumentation tests, lumi tests, and Compton tests. The goals and strategy for each category are outlined in this document.

2. ^{208}Pb Target Tests (from Bob Michaels)

2.1. Initial Target Tests before E06007: Alignment and Establish proposal goals (50 μA).

- Prefer high energy (3-pass)
- VDCs and scintillators on. Maintain rates $\ll 1$ MHz throughout.
- Use R-HRS only, initially at $\sim 20°$. The L-HRS is parked at some "big" angle with the magnets off to protect NaI, etc.
- Things to monitor: 1. Raster X-Y, 2. VDC tracks extrapolated to target 3. Rates in scintillators and Lumi (if Lumi available). 4. Target temperatures, vacuum pressure, radiation monitors.
- Note about the raster X-Y: the best snapshot of the target is the raster current – triggering off the scintillators the raster X,Y plot is a "photograph" of the target density, and we can see if the frame is hit, as well as if a hole develops in the target.
- Alignment Check with "holey" target. The "holey" target is a $100\frac{\text{mg}}{\text{cm}^2}$ carbon target with a 3 mm diameter hole in it, located below the lead targets. We will check with beam scans and by monitoring scattering rates how well the beam hits the middle of the hole. The R-HRS is at $\sim 20°$ and the beam current $\sim 10\mu$A. With a big raster, can use VDC tracks and the raster X-Y picture target to verify the hole.
- Alignment check using thin tilted lead target at 2 μA, first with 2×2 mm raster, and later with bigger raster. This is useful because the tilted targets

have a tighter constraint to the beam. Adjust raster size and steering in X and Y to find if we hit the target edge. Check rates, raster X-Y, and target variables.

- Put in the thick PREX target. Ramp the beam current slowly to 60μA in steps of 5 μA, pausing 10 min per step. Leave the target at 60μA for 1 hour. It's somewhat negotiable how high we go, but the idea here is to *firmly establish* the PREX proposal conditions of 50μA. This also establishes an operational range for E06007, although they might want to go higher themselves on the tilted target, but we won't until later (see below).

2.2. High Current Target Tests: Find failure point (max 100μ*A).*

- See previous section for things to monitor (raster X-Y, scintillator rates, etc).
- High energy (3-pass) preferred. The angle should be "big" to avoid huge rates.
- VDCs will be turned off if the rates exceed 100 kHz.
- The test must not exceed 1 MHz rate in the scintillators.
- First, re-establish good alignment (see steps above).
- Using the thick PREX lead target, start at 1 μA and slowly ramp up to 100μA in 10 steps, pausing 20 minutes per step.
- Leave the target at 100μA for $\sim$8 hours.

3. PREx Detector Tests

Shift 1, 3-Pass. Primary Goal: Measure pulse height spectrum of SD (stack detector) at 2.7 GeV

- Set up Carbon target with HRS at 12.5 degrees
- Determine beam current to establish 100 Hz-1kHz in drift chambers
- Establish the S0 trigger
- Find pulses in SD and time in ADC
- Scan momentum to place elastic peak in center of stack detector
- measure blinded tube background

- Take data run to measure SD pulse height distribution. If time permits: Remove S0, time in TD2 and measure pulse height distribution

Shift 2, 1-Pass. Primary Goal: measure pulse height distribution of TD1 (1 cm thin quartz) and TD0.5 (0.5 cm thin quartz).

- Set up Tantalum target at 19 degrees HRS
- Redo steps to measure SD pulse height distribution at 0.9 GeV
- Install TD1, observe pulses, time in ADC
- measure blinded tube background
- measure pulse height distribution
- Repeat with TD0.5. If time permits: remove slits, crank up current and try integration on TD0.5

Shift 3, 1-Pass. Primary Goal: measure pulse-pair width for all 3 detectors.

- Setup carbon target at 12.5 degrees HRS and determine effective cross-section to within 10-20%
- scan momentum and put elastic peak in center of detector
- Change PMT gains to be able to integrate signals and measure pulse-pair widths at several currents
- Repeat with Ta target
- Swap in second TD and repeat

4. Lumi Tests

- Optimize light input and PMT current output: Set ND filters to give 10nA lightlevel, look at some PMT responses in counting room, set appropriate PMT HV settings to limit anode current to 50 μA.
- Ensure PMT responses are dominated by high energy scatters from the target: Blinded tube tests, examine dithering coefficients vs. PMT number.
- Study noise properties: Minimize pedestal noise, examine widths vs. flip rate, different oversampling, different beam currents (10 and 50 microAmps), and different targets.

- Perform dithering run at low and high current
- Redo HV settings for 1 pass beam.
- Measuring transverse asymmetry. Will want 1 pass beam for this.

5. Instrumentation Tests

5.1. Low-Current Tests of Cavity Monitors (from Bob Michaels)

- The ATLis test plan (John Musson) must be performed first. If it was not done before our beam time, we should do this first.
- Beam energy is irrelevant. Empty target. Beam current initially $\geq 10\mu$A.
- Outputs from cavity BPMs and BCMS: There is a "fast" (100 kHz) output appropriate for higher currents, and a "slow" (5 kHz) output for low (50 nA) current. The fast output goes to the HAPPEX and HRS DAQs. The slow output goes to the HRS DAQ only.
- Measure cavity BPMs and currents with HAPPEX DAQ and HRS DAQ.
- Scan in X and Y using steering coils to measure the slope $\frac{\partial x}{\partial I}$ where x is position and I is the value of the steering coil.
- Repeat the scan in X and Y for progressively lower current: 2μA ,1μA, 0.2μA, 100 nA, 50 nA, and 10 nA. Although the striplines and other standard monitors will lose the beam below $\sim 1\mu$A, the coil slopes should allow us to know where the beam is. We can make brief excursions to higher current to check if position has not wandered.
- HARP scans may be attempted, but I'm not sure how low a current they'll work at.
- Online analysis: Deduce the absolute accuracy and resolution at each current.

5.2. Other Specific Instrumentation ?

.

-

6. Compton Tests

An early shift will do the tuning with old array to get decent background and establish baseline performance. Much of the rest is parasitic, except for access to install new detector.

- Old array commissioning. Beam tuned through chicane, laser on.
- Check background rates.
- Install new test detector/12 stage PMT.
- Check phase advance for dithering.
- Restore previous standards: Check that FADC sees pulses and Compton edge; get good signal/background ratio.
- Measure noise at 15Hz.
- Other noise sources?
- Measure the asymmetry and check that it flips sign with laser polorization and HWP. (We might need to disable dithering unless the veto flag is very reliable.)