PREx Status Update

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PREx Status Update

Outline

- Review: PREx Measurement and Challenges
- Results from Recent Beamtests
- New Septum Design and FOM Changes
- Summary and Outlook

PREx Measurement

- $A_{PV} \sim 0.6$ ppm, $Q^2 \sim 0.01$ GeV
- $E_{beam} = 1$ GeV, 5° scattering, ~ 2 GHz Rate
- Statistical error goal ~ 15 ppb
- Systematic Error $\lesssim 2$ %

Physics Extracted

- Weak charge density
- Neutron density
- Neutron radius (~ 1 % level)

$\rightarrow$With broad-based fundamental nuclear physics applications: Neutron stars, atomic PNC, heavy ion beams.

$*$ PREx Workshop Aug 17 - 19, 2008 at JLab

Experiment Challenges

- Precision Measurement of Q^2
  - $\rightarrow$Requires beam monitoring at 0.05 μA using new BCMs
  - $\rightarrow \pm 0.02^\circ$ accuracy in spectrometer angles
- Precision beam polarimetry at 1-pass beam energies
  - $\rightarrow$Upgrade Compton polarimeter: new cavity, e^- and γ detectors
- Unprecedented control over helicity correlated beam asymmetries
  - $\rightarrow Q_{asym} \lesssim 100 \pm 10$ ppb
  - $\rightarrow$Maintain beam position differences $\lesssim 1 \pm 0.1$ nm
  - $\rightarrow$High precision beam trajectory corrections: cavity BPMs and new dithering system
- Require sub-100 ppm pulse-to-pulse electronics noise
  - $\rightarrow$Employ new 18-bit ADCs (in development)
  - $\rightarrow$Improve Luminosity Monitor performance
- Keep all sources of systematics in check...for example
  - $\rightarrow$Septum collimator alignments/acceptances
  - $\rightarrow$Spect. optics tuning and prex detector size and positioning

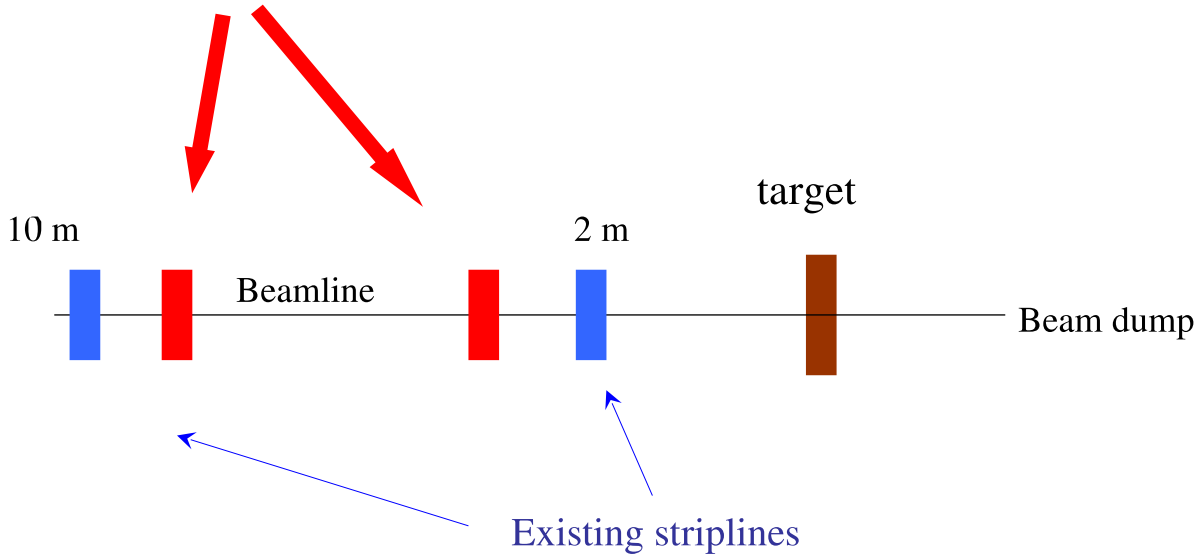
Recent Beamtest Results

- Beam Cavity Monitors: Initial checkout, low current tests
- Compton Polarimeter: Integrating Compton DAQ test using FADC and Accumulator
- Lead Target: 50, 80, and 100 μA stress tests
- Luminosity Monitor: Signal, bkgd, and noise level tests for diff. targets, I_{beam}, pmt light filters, Pb-brick shielding, ...
- PREx Detectors: Design tests–detector size, resolution, efficiency, and more

Beam Cavity Monitors

Low - current Cavity Monitors

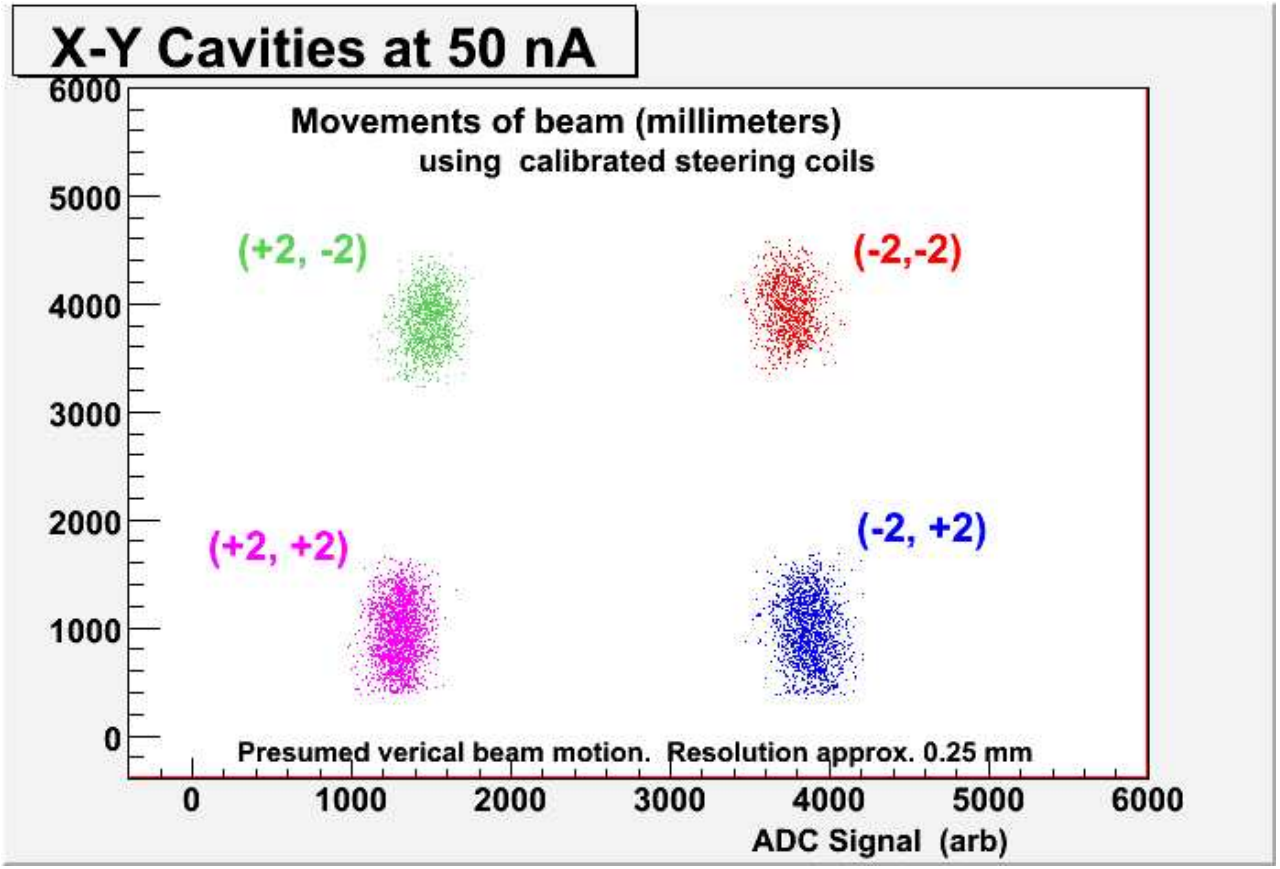
2 triplets of (X, Y, Q)



J. Musson, *et.al.*

BCM low current tests

- Observed $\sim$ 250 μm resolution at 50 nA (online analysis)
- Offline analysis ongoing to unfold any beam motion

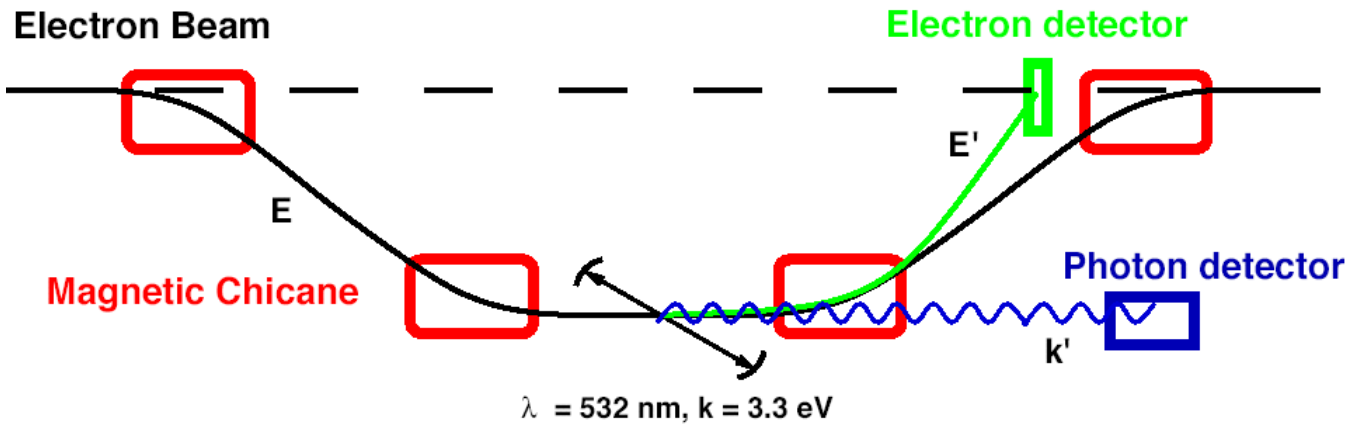


Compton Polarimetry

- Upgrades to laser cavity and γ-detector are requirements for PREx

Compton Polarimetry

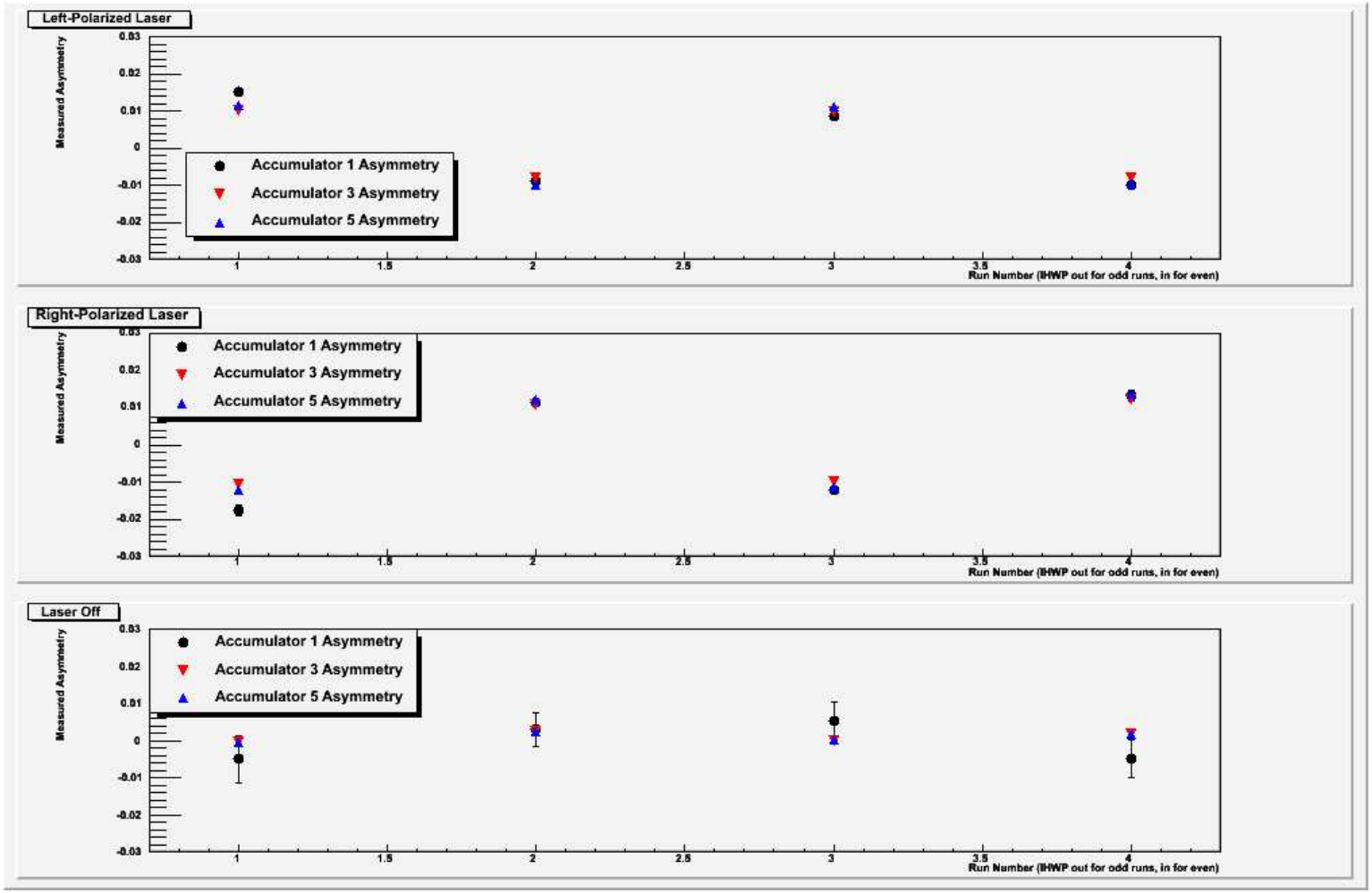
Goal : < 1% error



Sirish Nanda, *et.al.*

Compton Integrating DAQ Test

- Purpose: To prove that we have the tools in place to measure the polarization: Electronics noise, signal size, linearity



Test Period Target Design

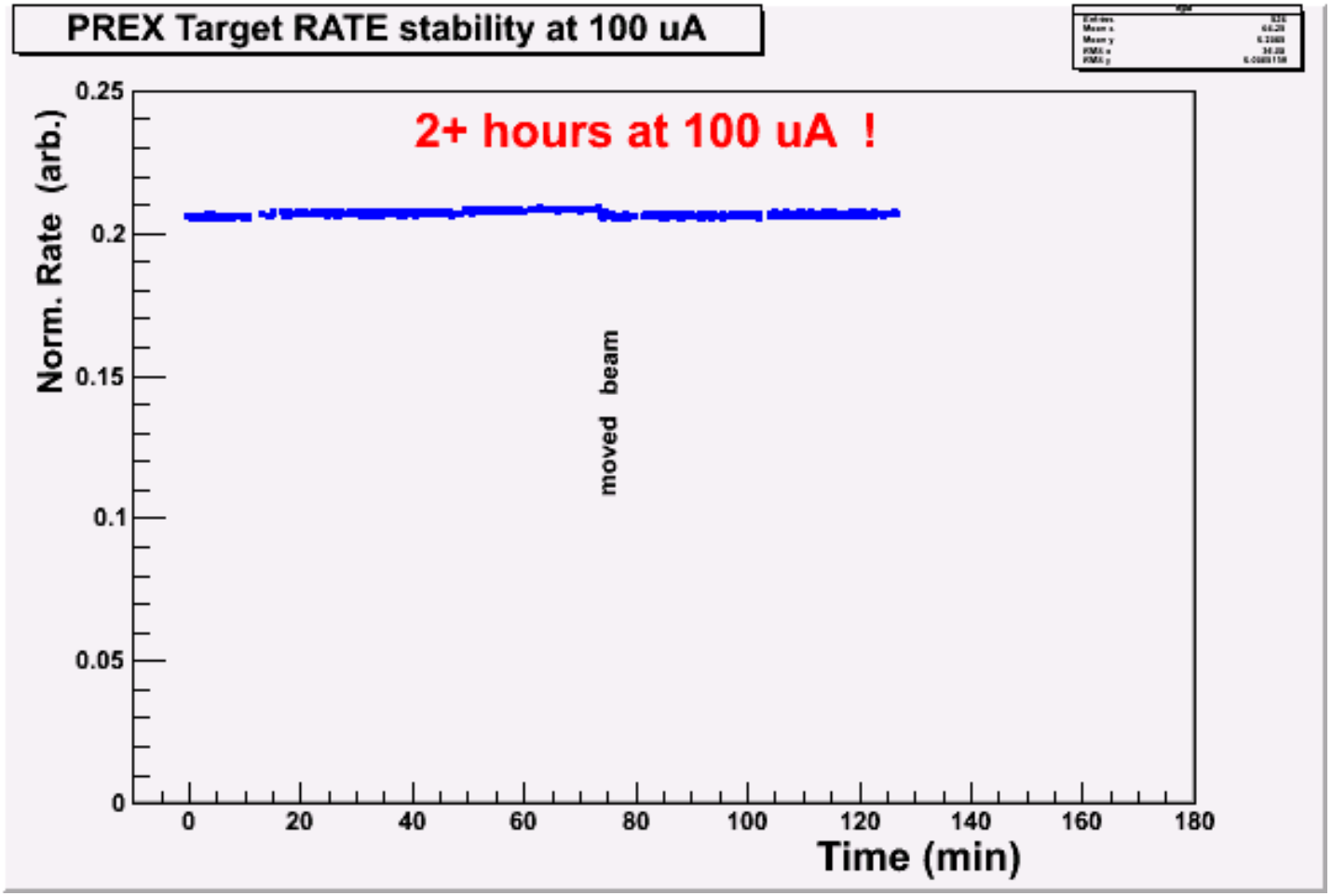
PREX target

(0.5mm)

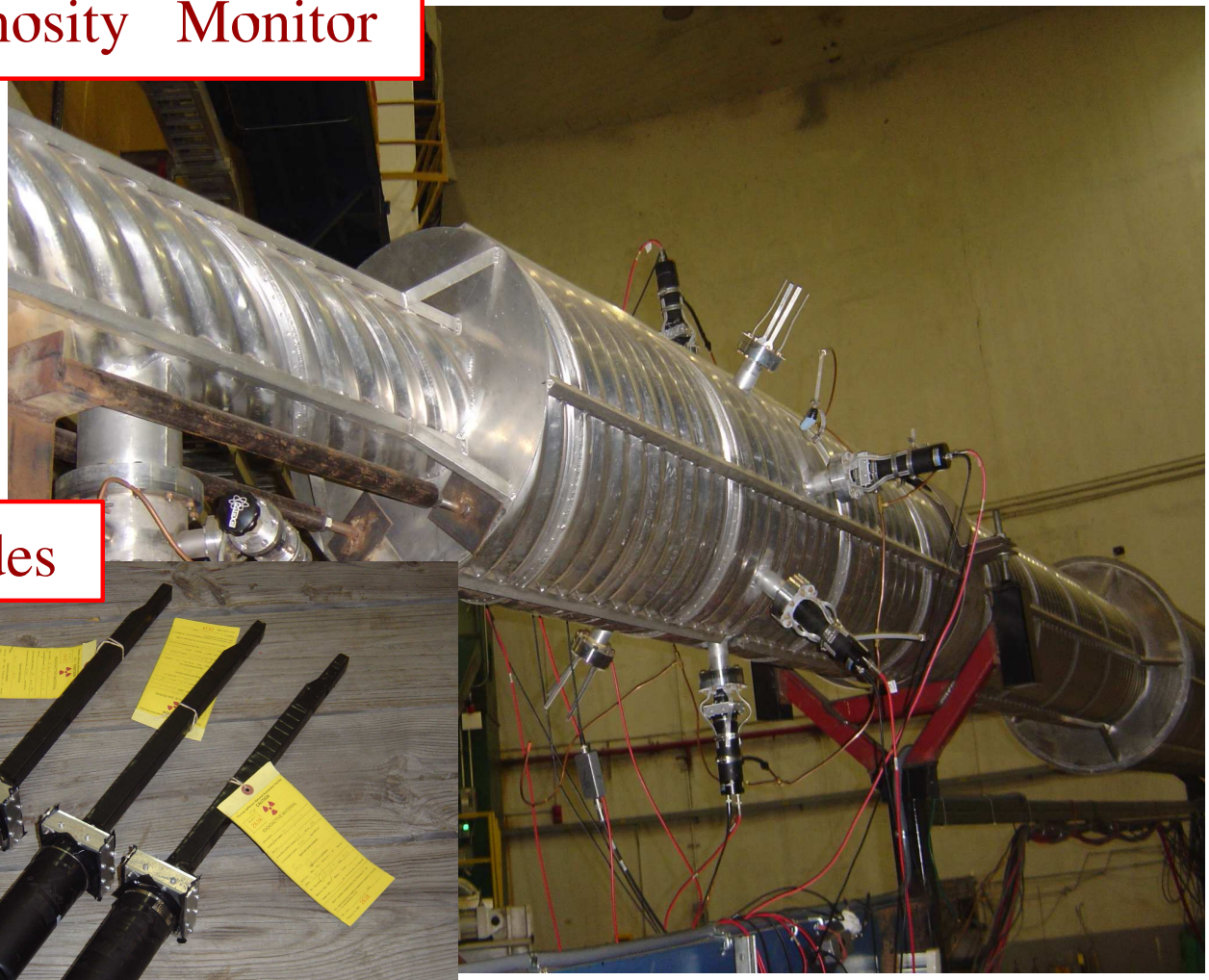
e06007 targets

(tilted by 30deg)

PREx ^{208}Pb Target Stress Tests



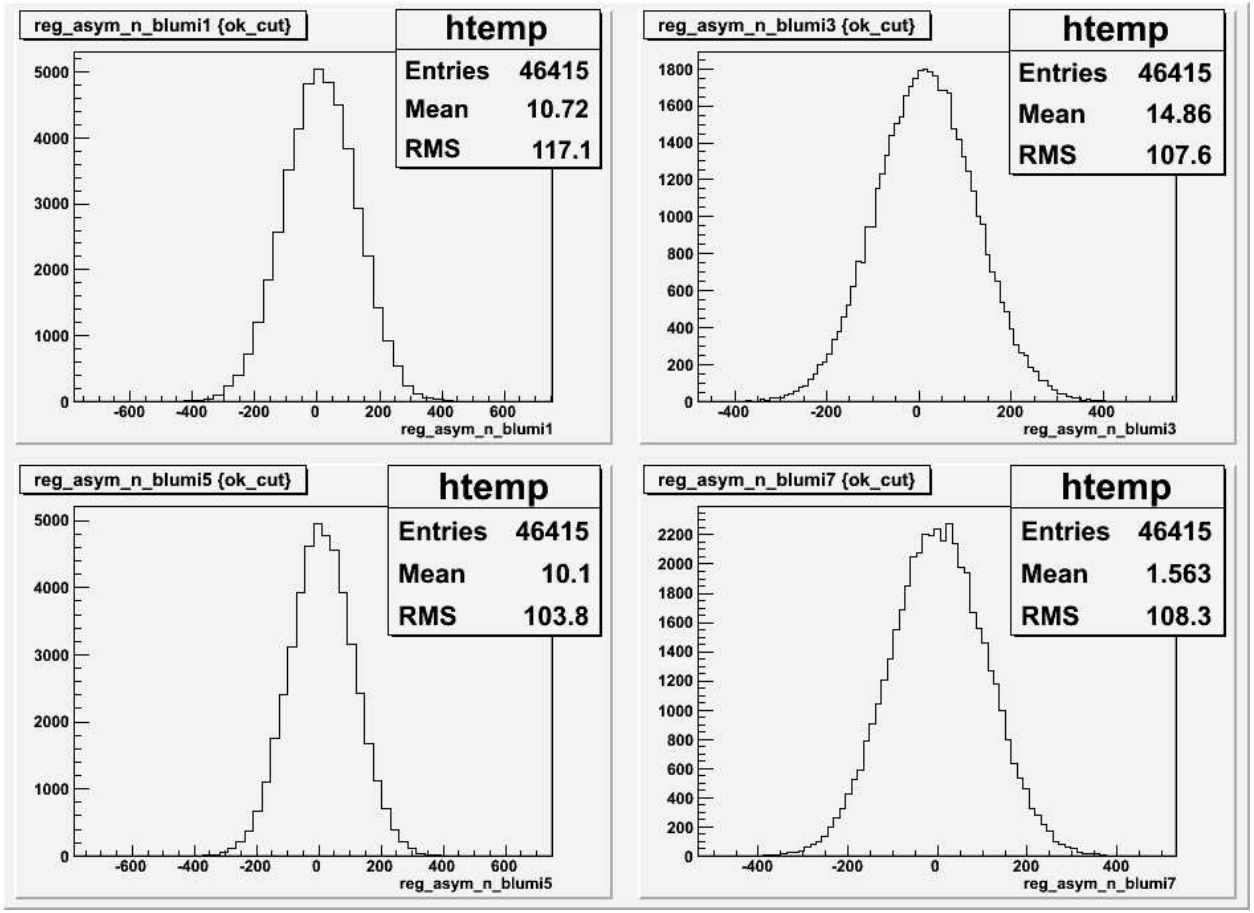
Luminosity Monitor



Upgrades

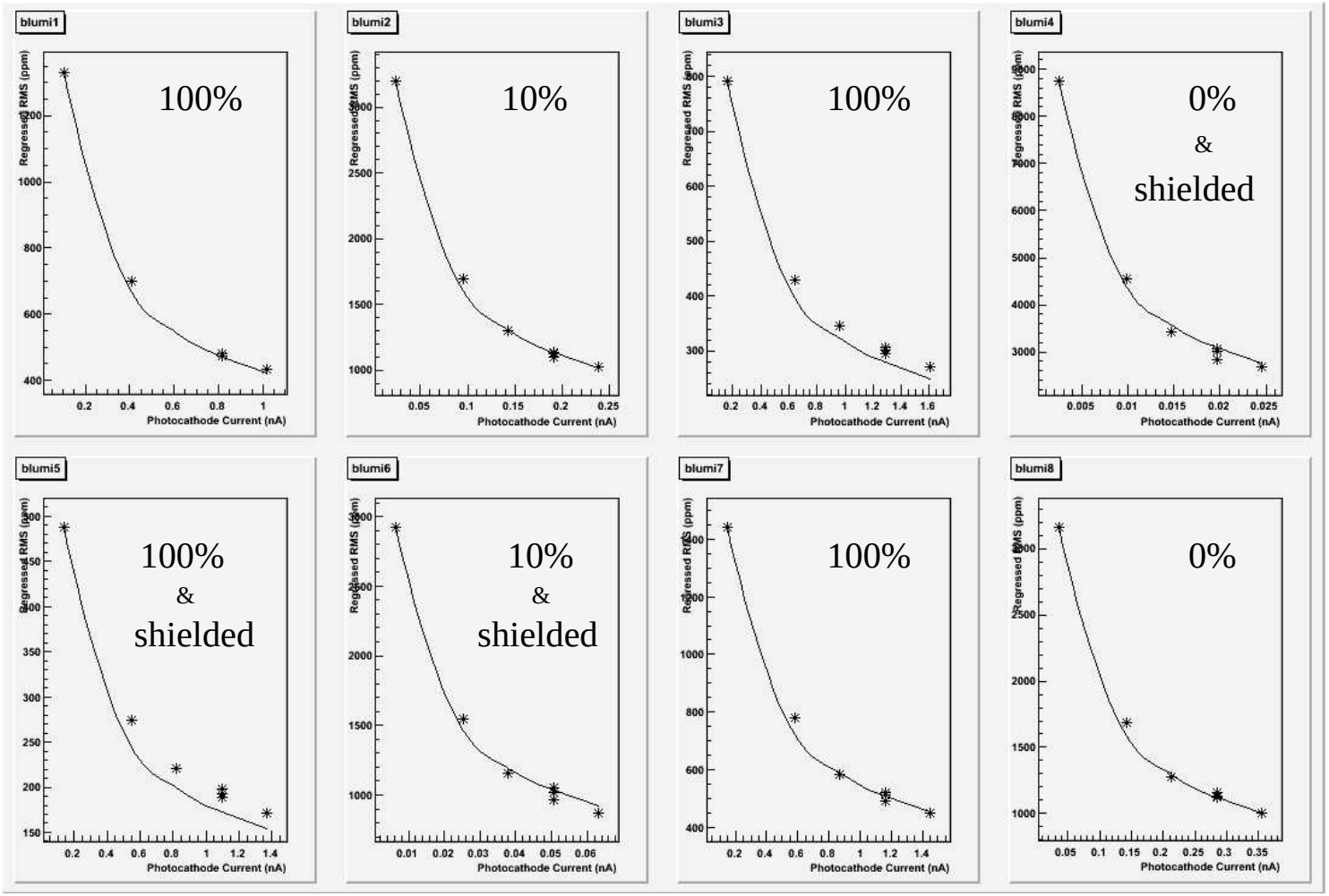
Lumi Performance: Normalized Regressed Asymmetries

- 60 μA on thin ^{208}Pb target
- Individual Lumi asymmetry widths at $\sim$ 100 ppm



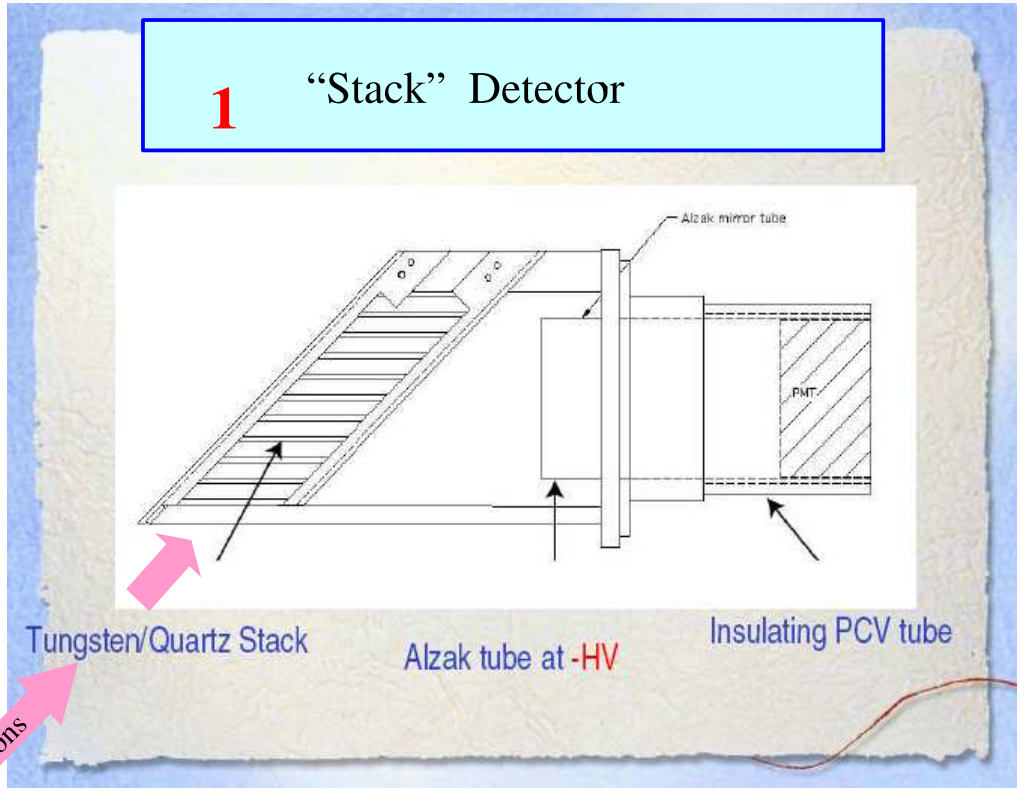
Regressed Lumi Signal RMS vs. PMT Cathode Current

- Noise levels follow 1/sqrt(I)
- Demonstrates great progress toward optimizing Lumi setup

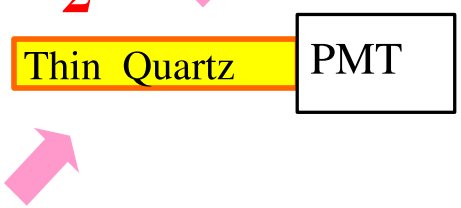


PREX Detector Tests

1 "Stack" Detector



2

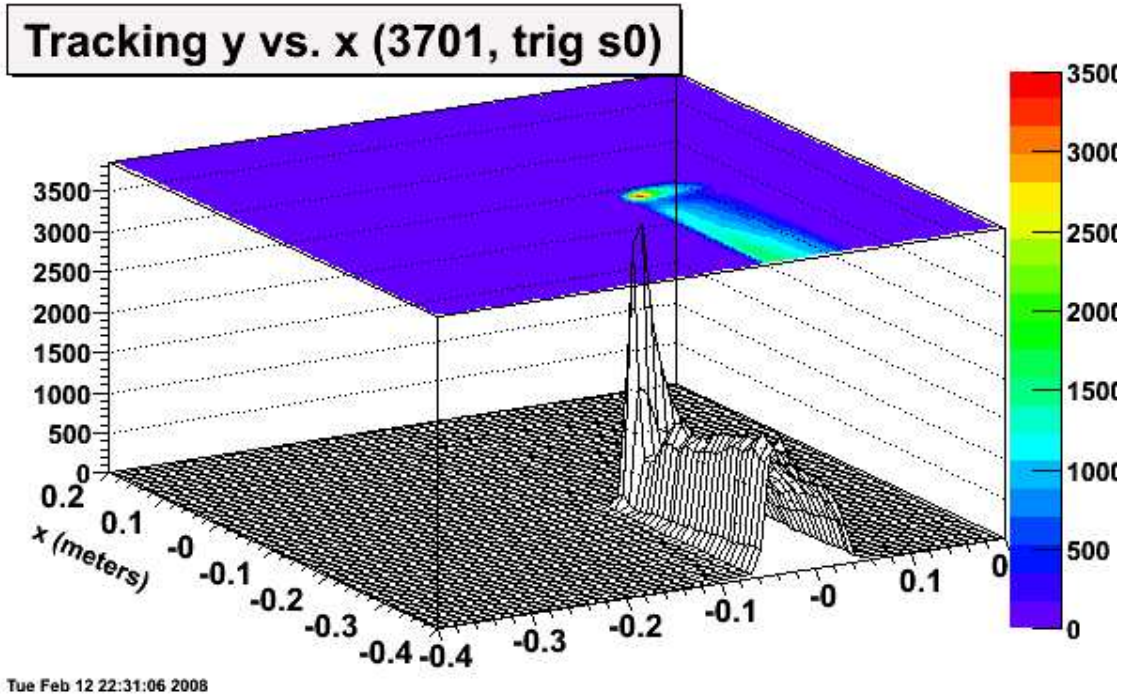


Two detectors tested: 1 , 2

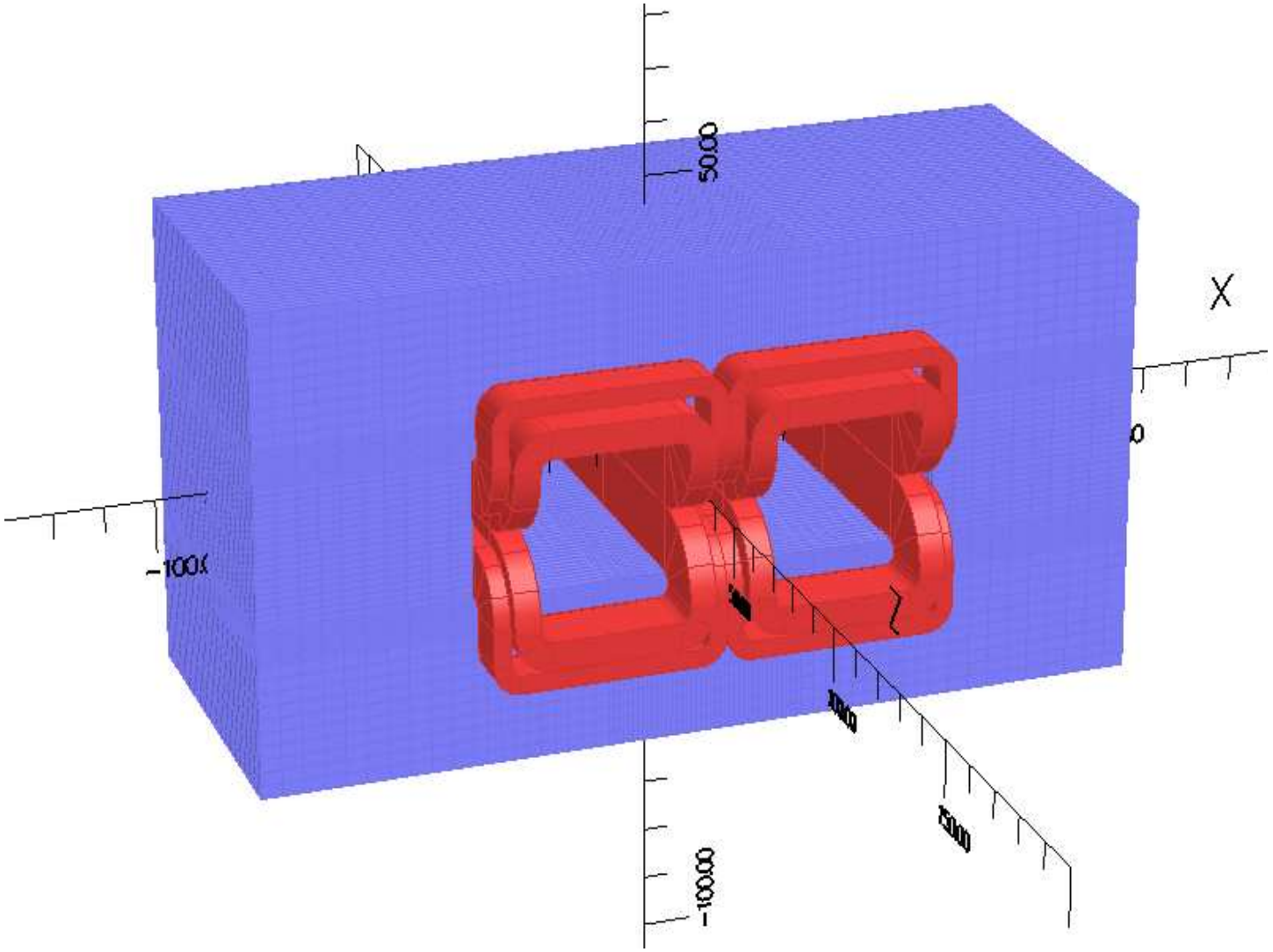
UMass / Smith College

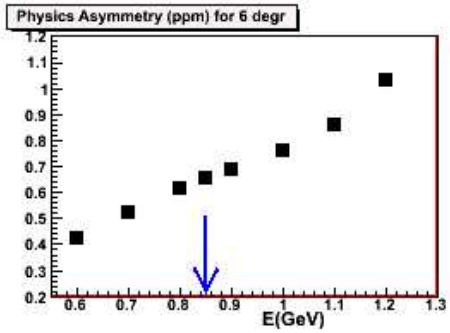
Examined Tantalum Spectrum (in rHRS) at 12.5°

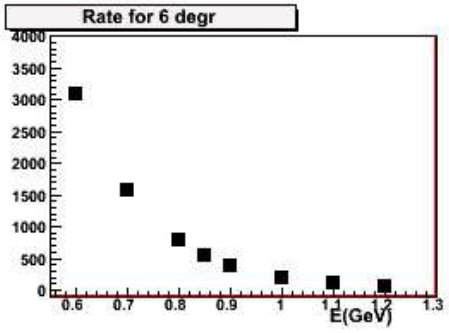
- Position 4×4 cm^2 detectors in elastic Ta peak:
  $\rightarrow$ Tune HRS dipole for x-positioning
  $\rightarrow$ Physically move detectors for y-positioning
- Examine effect of Q3 tweaking (focusing in y)
- Determine detector rates, resolution, and efficiencies
- Perform integrating DAQ runs; compare results

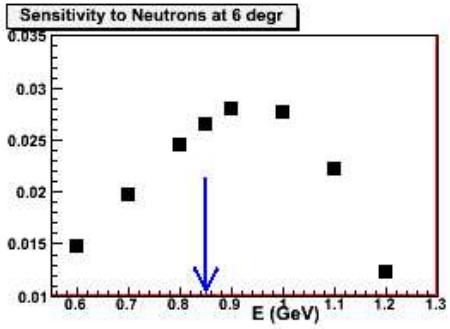


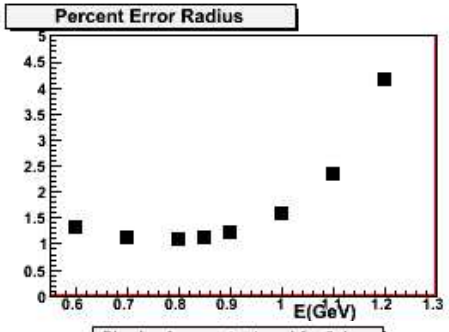
Warm Septum Design (Changed from 6° to 5°)

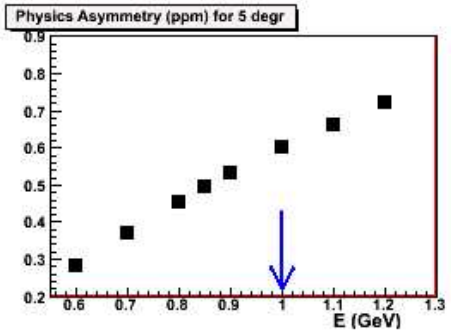


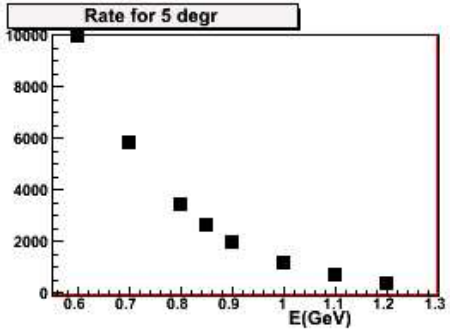

Physics Asymmetry (ppm) for 6 degr
E(GeV)

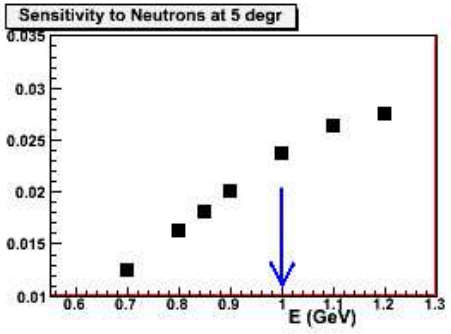

Rate for 6 degr
E(GeV)

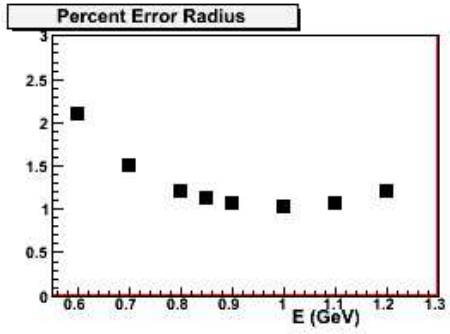

Sensitivity to Neutrons at 6 degr
E (GeV)


Percent Error Radius
E(GeV)


Physics Asymmetry (ppm) for 5 degr
E (GeV)


Rate for 5 degr
E(GeV)


Sensitivity to Neutrons at 5 degr
E (GeV)


Percent Error Radius
E (GeV)

Summary and Outlook

- Steady progress is ongoing to meet the experimental challenges
- Changes in septum design ($6^\circ \rightarrow 5^\circ$) give optimized FOM at $E_{beam} = 1.05$ GeV
- Target design passed stress tests even without full cooling
- Other specific ongoing projects:
  - $\rightarrow$ Design, fabrication and testing of optimized quartz detectors
  - $\rightarrow$ Bench testing and finalizing design of 18bit ADCs
  - $\rightarrow$ Pinpointing and minimizing sources of signal noise, electronic and otherwise
  - $\rightarrow$ Compton activities
  - $\rightarrow$ Polarized source studies
  - $\rightarrow$ Helicity-correlated beam-asymmetry studies
  - $\rightarrow$ Transverse-asymmetry sensitivity studies
  - $\rightarrow$ Beam Modulation system redesign

Lead Radius Experiment (PREx) Workshop and Neutron Rich Matter in the Heavens and on Earth

August 17 - 19, 2008 at JLab

Must register to attend

Registration is free

http://conferences.jlab.org/PREx/index.html