PREx status report
Hall A Collaboration Meeting

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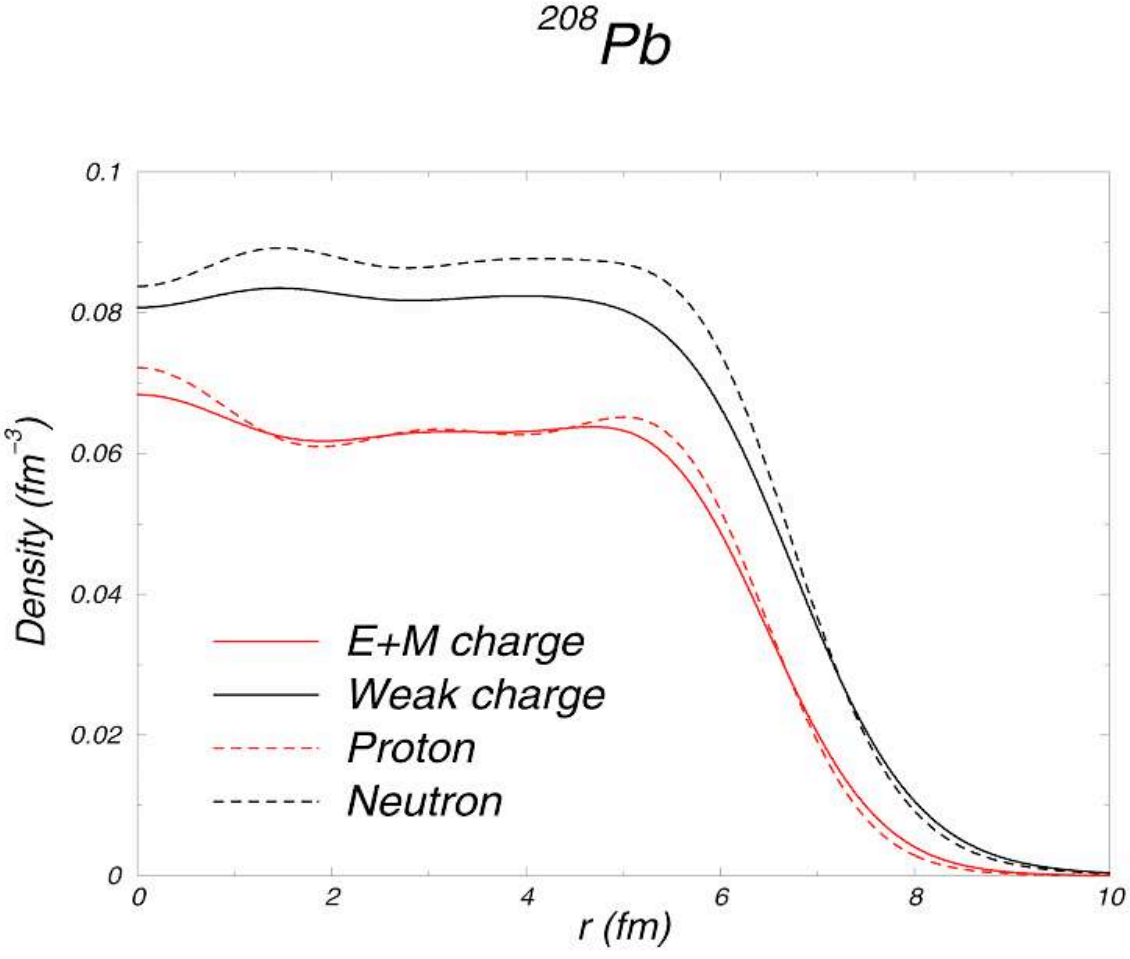
For the PREX Collaboration

Introduction

- Interesting to a broad range of communities: neutron star structure, heavy ion collisions, and atomic parity violation...
- Will measure weak charge density, neutron density and gives neutron radius to 1%.
- Difficult experiment: very small asymmetry, very sensitive to helicity correlated beam effects.



Parameters

forward angle with new septum magnets

1.05 GeV, 5 degrees, $Q^2 \sim 0.01$ GeV^2

$A_{PV} \sim 500$ ppb

0.5-1 GHz per spectrometer

50-100 μA

~100 ppm precision at 15 Hz

$\delta A_{PV} \sim 15$ ppb (3%)

Experimental Requirements

- Control of helicity correlated systematic errors
- Precision polarimetry (Moller and Compton polarimeter upgrades)
- Control of transverse asymmetry
- New beam modulation system
- Low current calibration (Q2 measurement)
- Hall A beamline optics
- High power lead target
- Low noise levels (statistically dominated width)

Significant New Hardware

- Green Compton polarimeter
- High field, high current Moller polarimeter
- Double Wein rotation
- Septum magnets
- Beam modulation system
- PREX detector

HC beam requirements

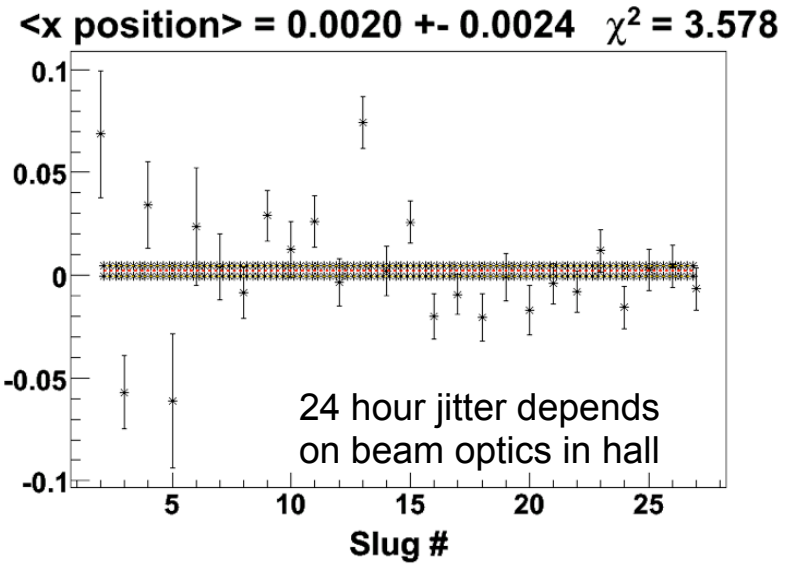
Beam Property	Nominal Value	Maximum Run-averaged Helicity-correlation	HC One-day ("slug") Average	Maximum Jitter at 30 Hz
Average Current $\langle Q \rangle$	50-100 μA[1]	200 ppb	1 ppm	1000ppm
Energy	1.05 GeV	$\langle \frac{\Delta E}{E} \rangle \leq 1$ ppb	5 ppb	5 ppm
Energy spread σ_E/E	10^-3	-	-	-
Position x at target	0	< 2 nm	10 nm	10 μm
Angle $y\prime$ at target	0	0.3 nrad	1.5 nrad	1.5 μrad
Position y at target	0	4 nm	< 20 nm	20 μm
Angle $y\prime$ at target	0	1 nrad	5 nrad	5 μrad
Spot Size [2] at target	$100 - 300\ \mu$m (r.m.s., unrastered) 4mm x 4mm (box, rastered)	$\delta\sigma/\sigma < 10^{-4}$	10^{-3}	-

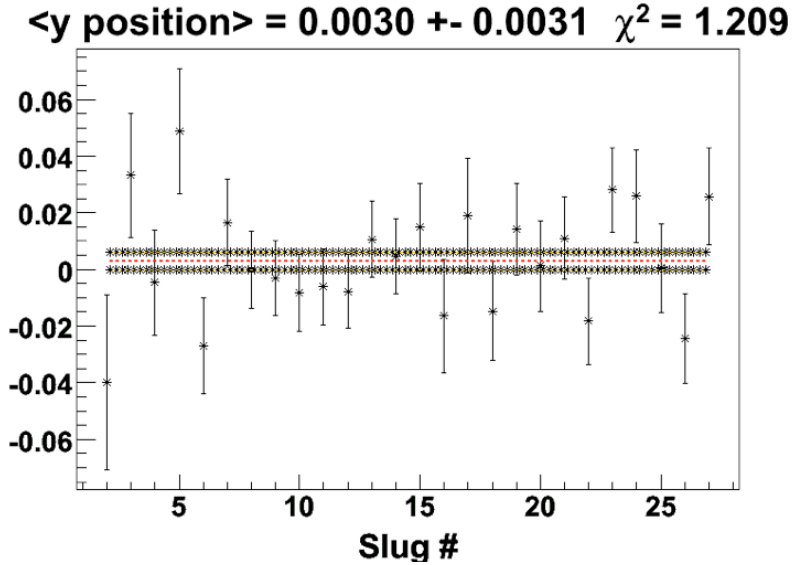
Previously Achieved

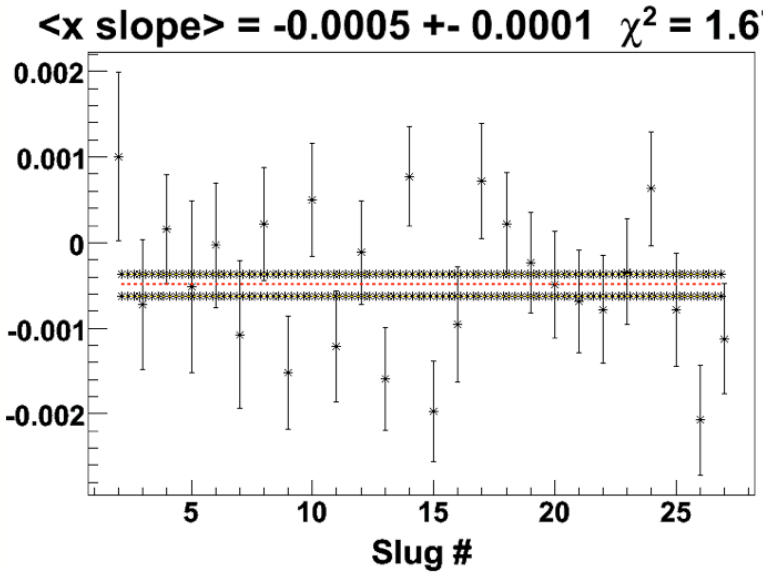
Requires slow reversal

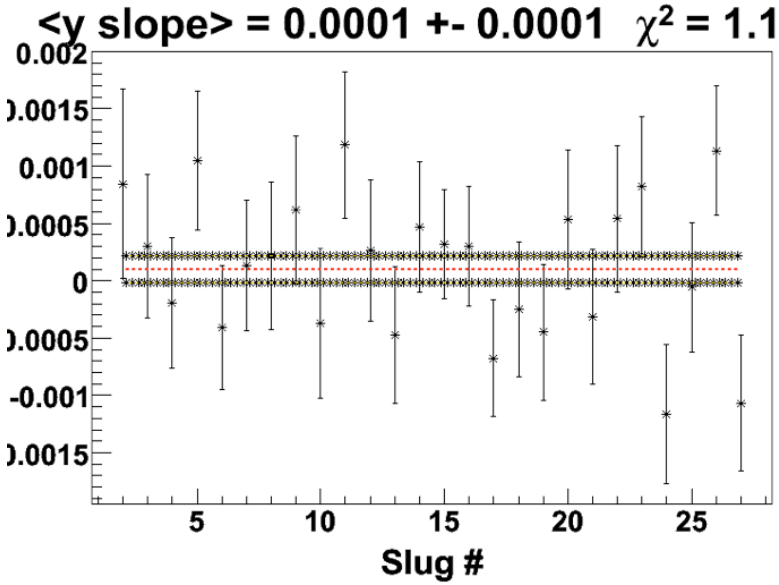
- **Nominal Value:** This is the usual desired central value of the beam property.

HCBA during HAPPEX-III

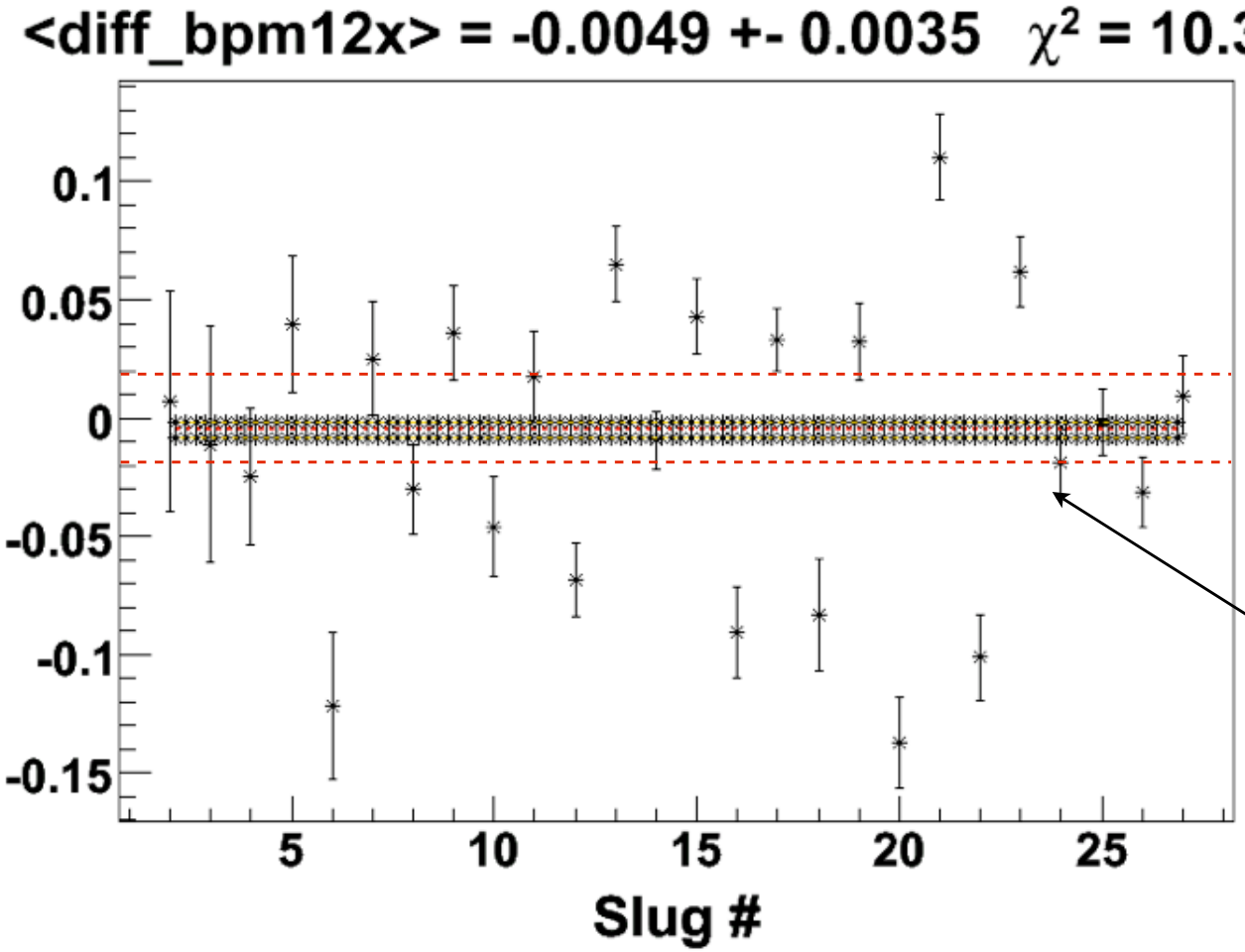








HCBA during HAPPEX-III



Dispersion ~4 :
4x larger than dE/E

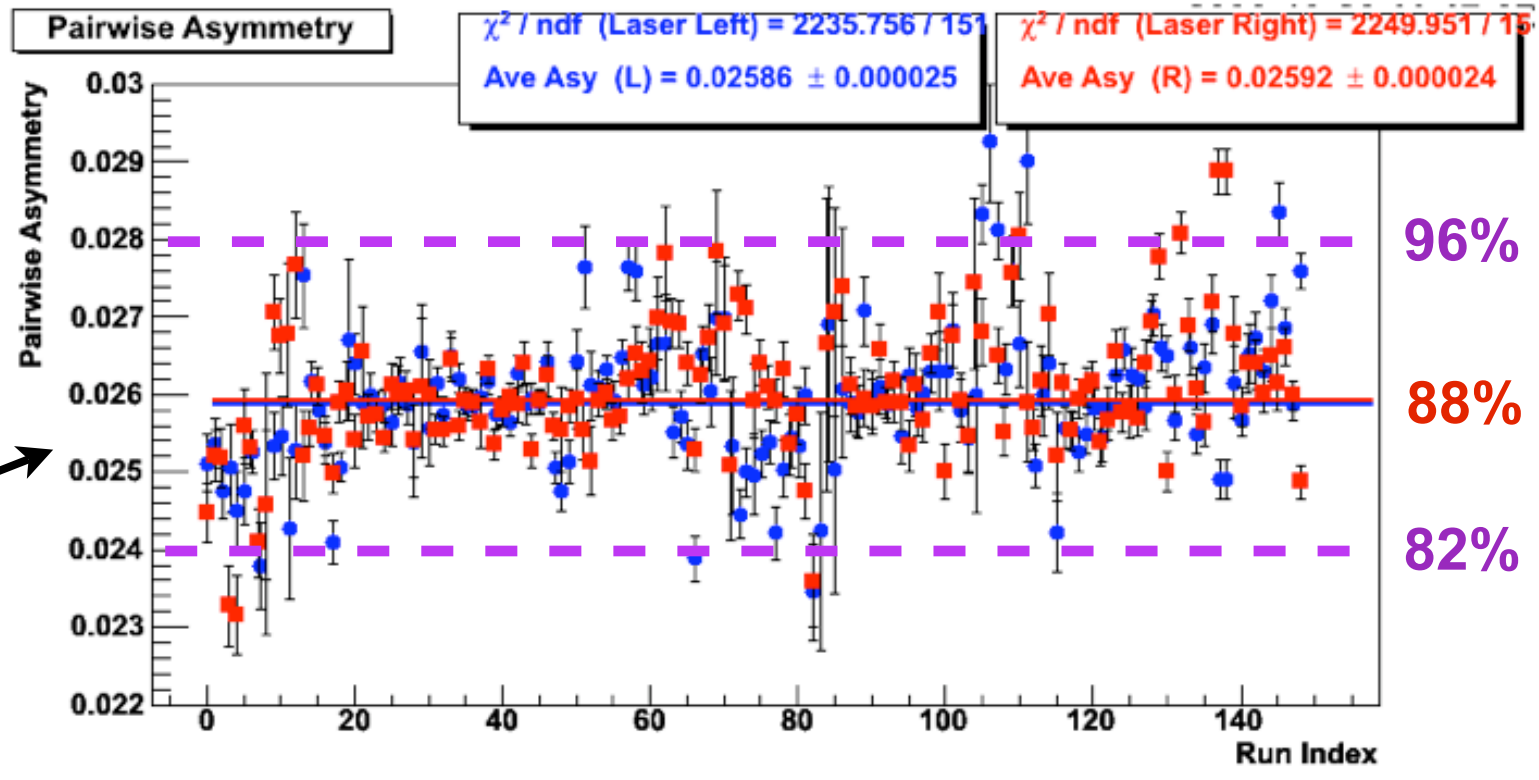
PREX jitter requirement

injector configuration fixed to reduce MS interception

PREX required levels achieved during HAPPEx II

Polarimetry

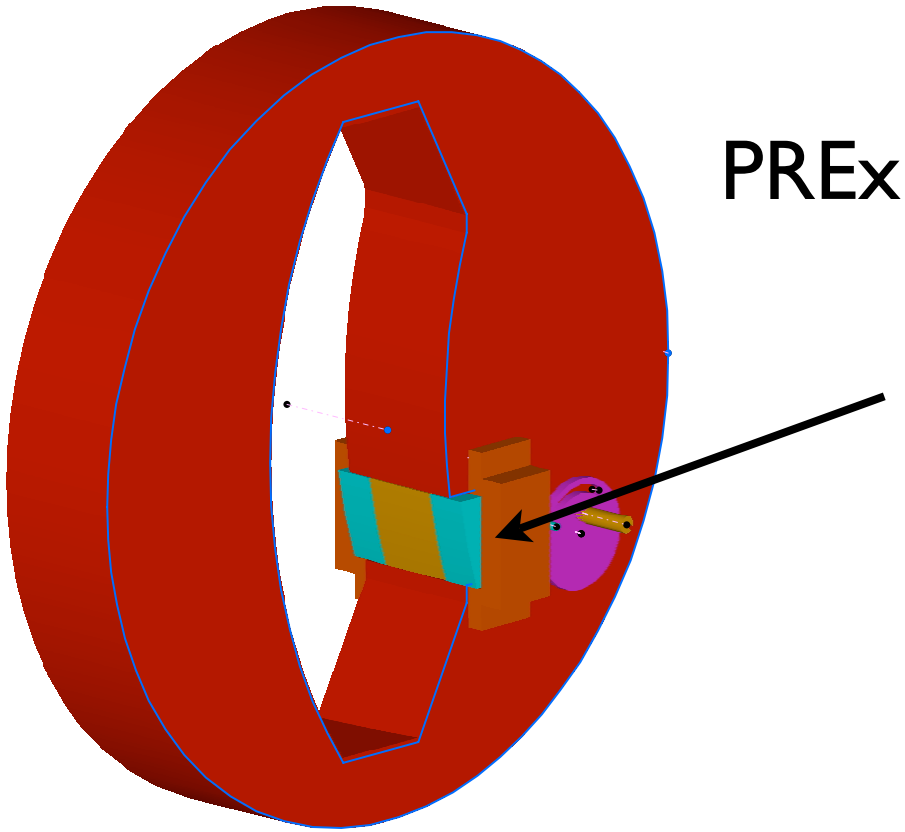
- Extensively discussed yesterday.
- Upgrades to Moller and Compton polarimeters required.
- Integrating Compton photon analysis likely to be the analysis used (minimises calibration uncertainty.) Requires linearity and integrated detector response function (can be obtained by simulation.)



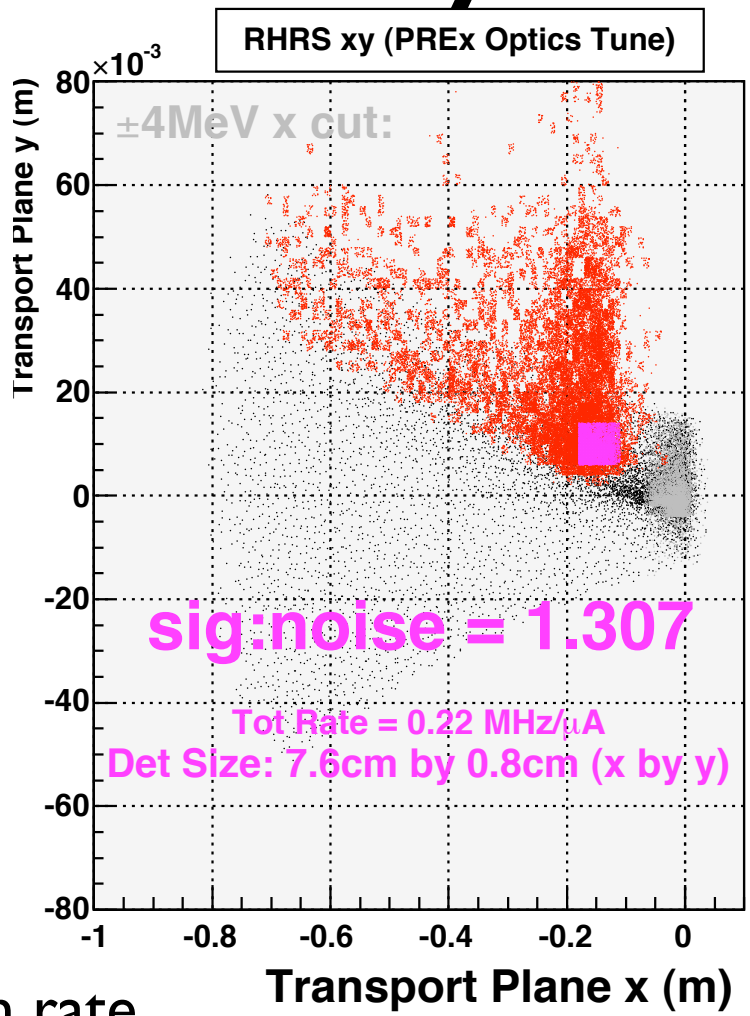
HAPPEx III data: With careful analysis, expect robust results significantly better than 2%

Transverse Asymmetry

- Huge, possibly as much as 50 ppm
- Zero vertical polarisation in injector with Mott, measure with spectrometer difference.
- A_T hole measure horizontal
- Feed back on measured transverse asymmetry



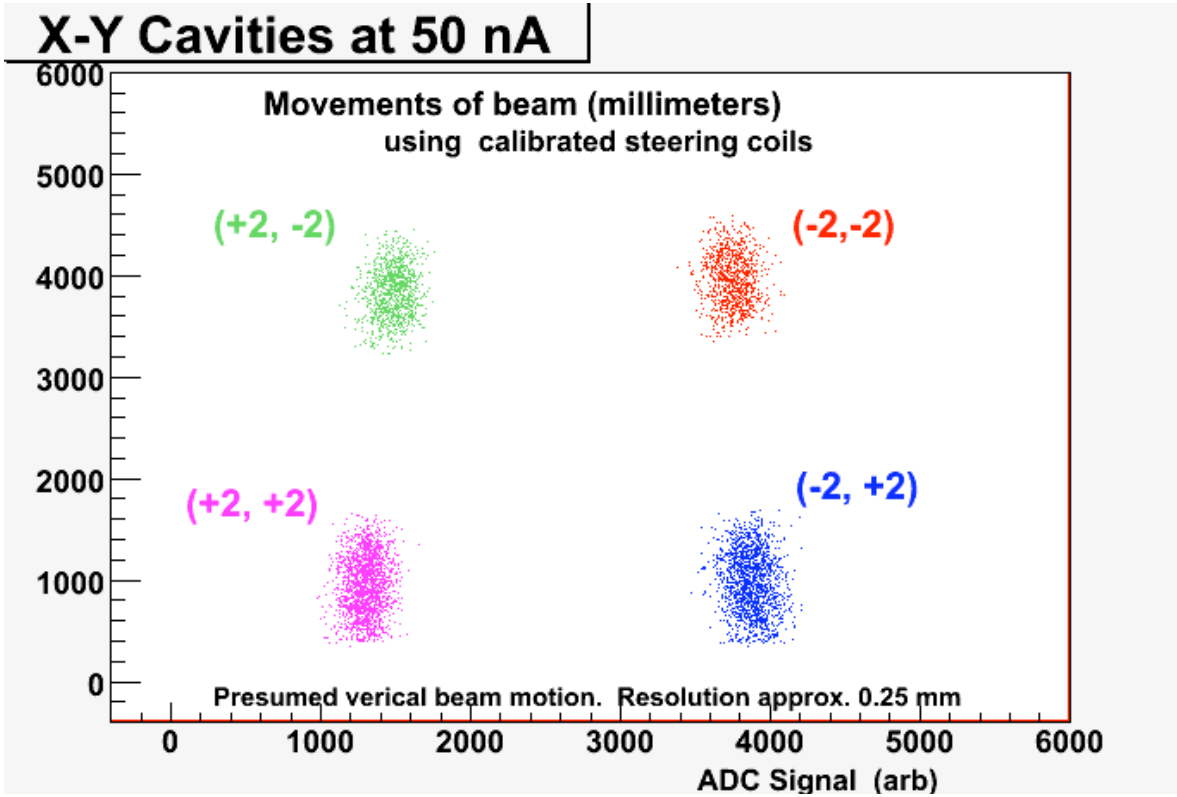
PREx collimator



A_T hole
Low angle - high rate
Out of plane angle gives sensitivity to A_T
Be in the "hole" degrades energy
Detected with separate integrating detector in focal plane

Q^2 Measurement

- ~ 0.7 % uncertainty required
- operation at 50 nA yields ~1 MHz rate (requires high rate tracking eg GEMs.) Calibrate with standard spectrometer tracking on optics targets.
- Cavity BPMs appear to give enough resolution at low current.



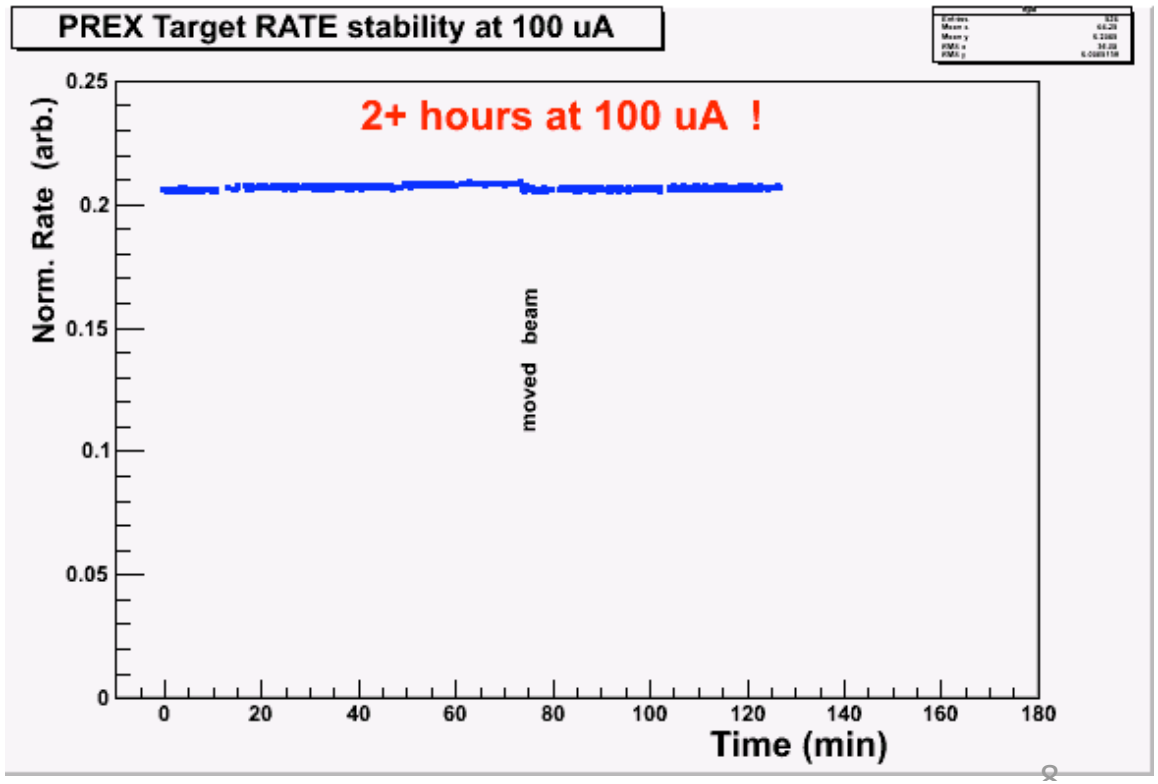
Beam Optics in Hall A

- Multiple (competing?) parameters
  - Low Compton backgrounds
  - HC effect minimization (matching)
  - Horizontal jitter
  - phase advance
  - small intrinsic spot (30 μm < σ < 50 μm)
  - raster (at least 4x4 mm)

Target

0.5mm, 10% X_0 isotopically pure (99.1%) ^{208}Pb foil, sandwiched between 0.2 mm thick diamond sheets. Successfully tested up to 100 μA

5 days at 60 uA
1 shift at 80 uA
3 hrs at 100 uA



PREx target

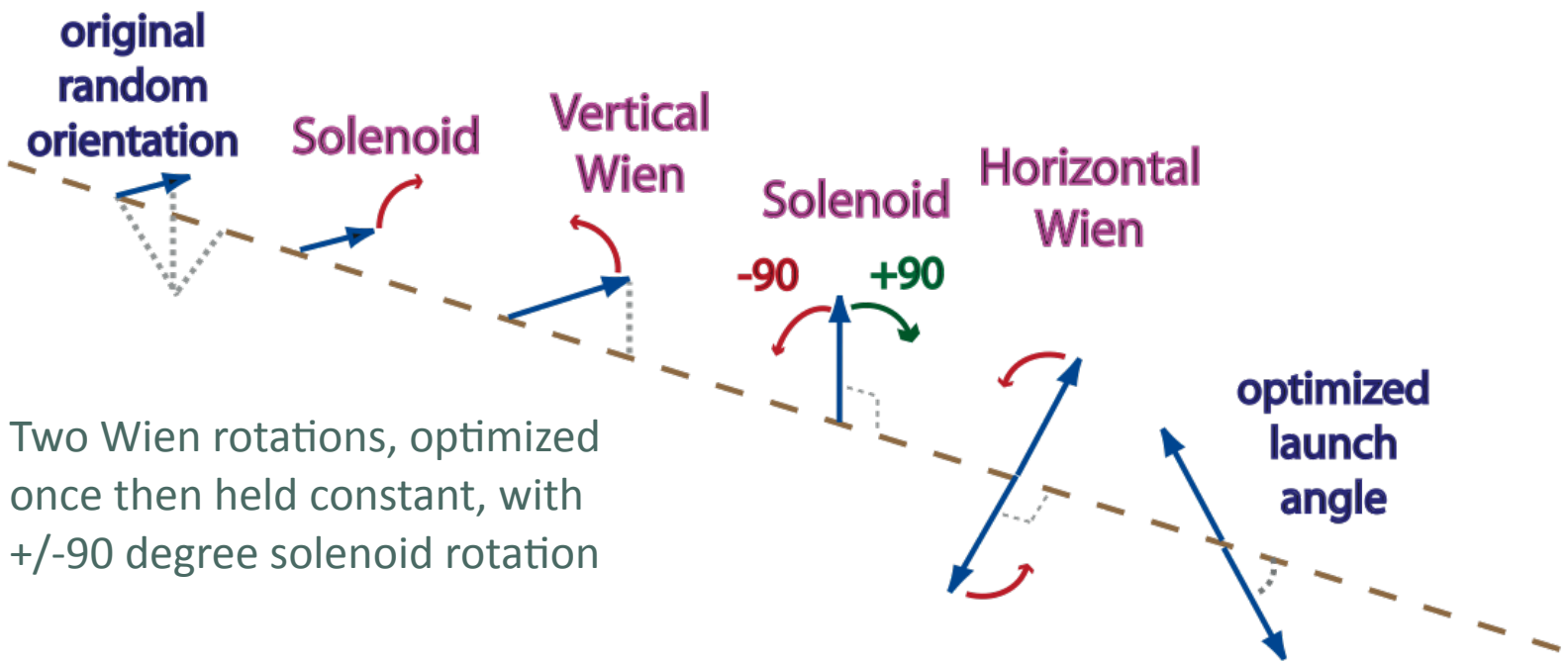
Noise

- High flip rate (240 Hz), new helicity board and multiplet structure. May also run at 120 or 30 Hz, depending on rate, noise etc.
- 140 ppm statistical width per arm at 30 Hz.
- 20 ppm electronic width (18 bit ADCs)
- Beam current will depend on observed noise floor

Double Wein

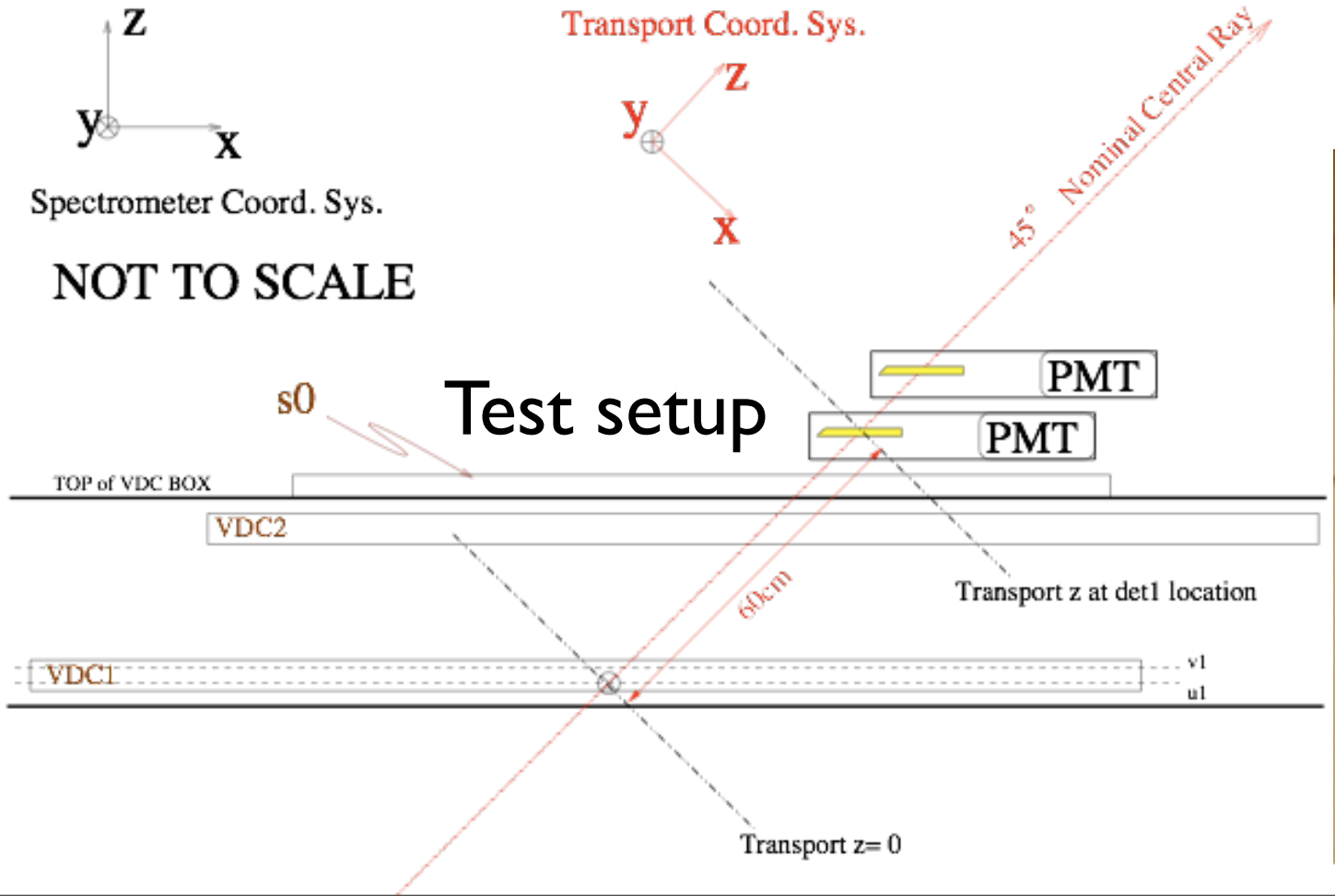
Injector group will install a second Wein filter with a pair of intermediate solenoids during down.

Solenoid rotates spin +/-90 degrees (spin rotation as B but focus as B^2).
No optics perturbation under reversal!

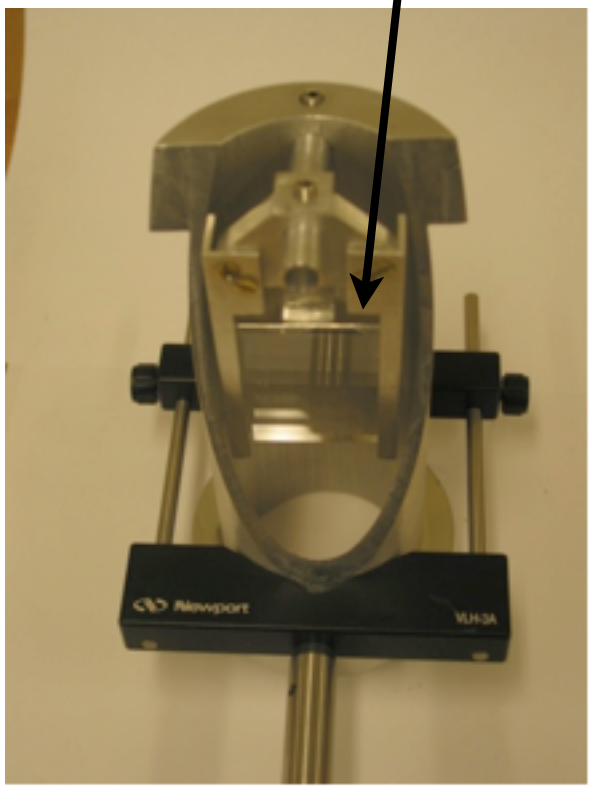


PREX detector studies

Data taken to measure light output and calibrate full simulation of detector response.

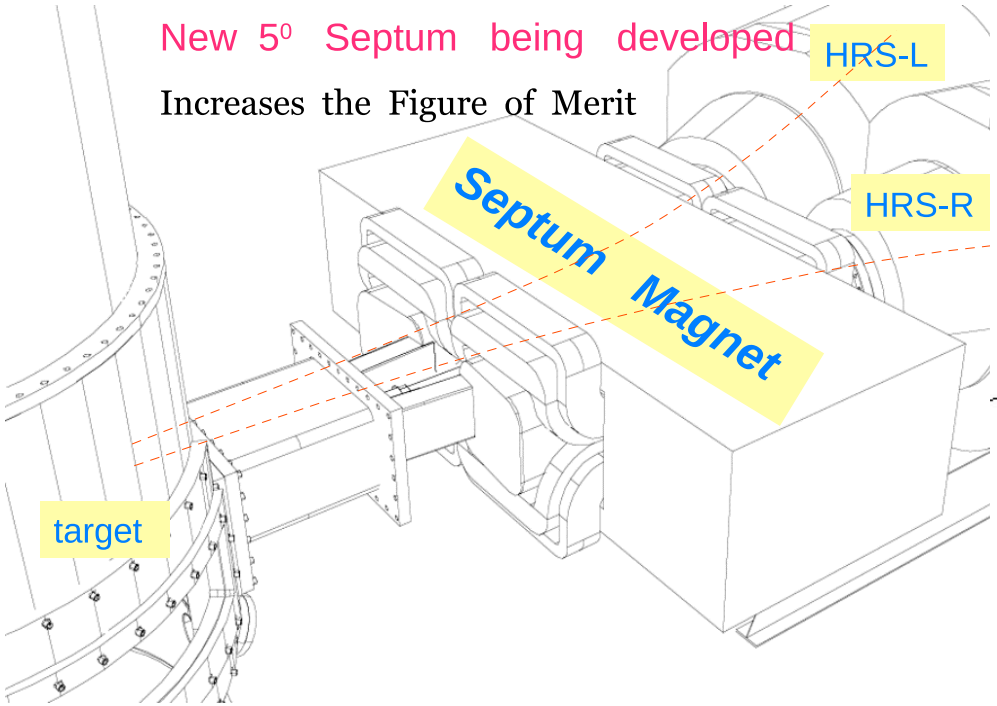


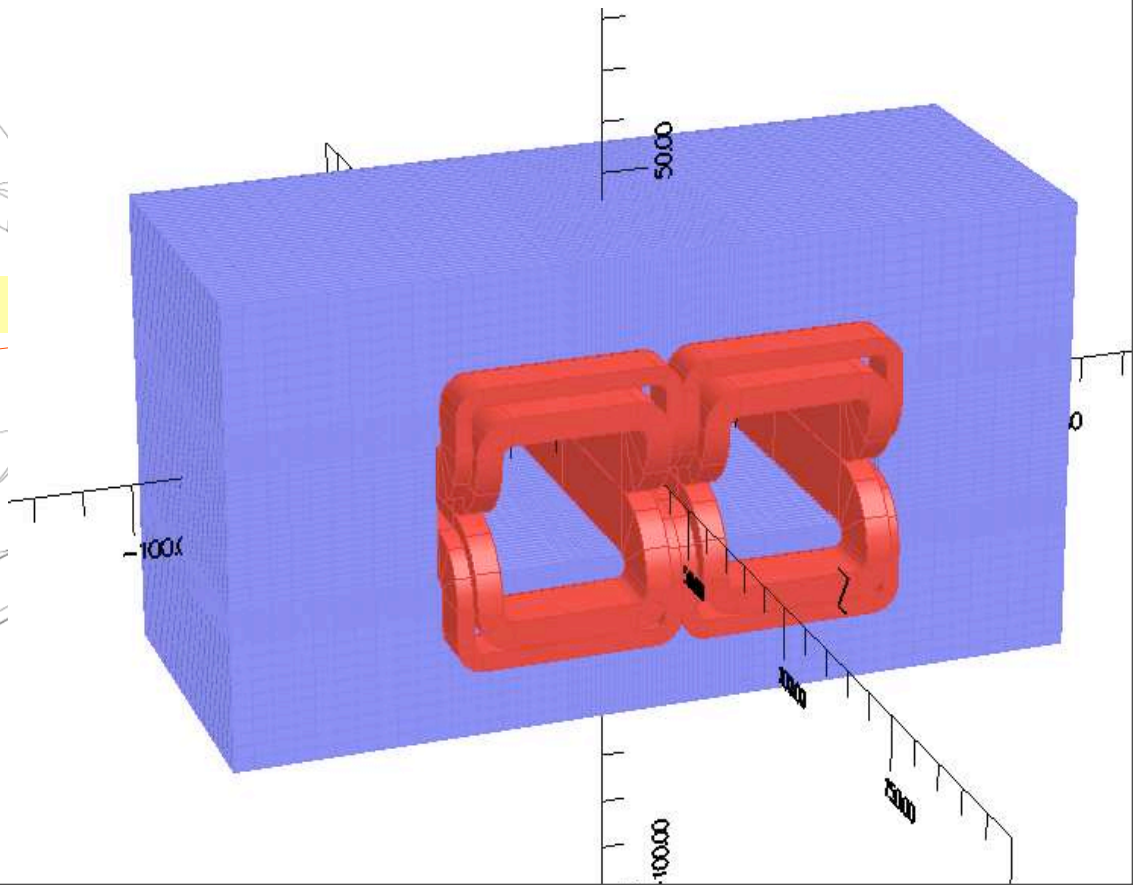
Thin detector



Septum Magnets

Magnets are here and will be field mapped next week





Beam Modulation

- Sine wave modulation of variable frequency (~10 - 250 Hz) and amplitude (comparable to present.)
- Two magnets simultaneously (frequency and phase.)
- Compatible with or pause FFB.
- Will require new control and readout
- Qweak developing similar system

Summary

- PREx is the next experiment in Hall A
- Preparations are on track - we have a busy few months ahead.