E99-115 & E00-114
HAPPEX Status Report

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UMASS

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Theory

HAPPEX-H

$$A^{PV} = \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} \qquad \left\{ A_0 = \frac{-G_F Q^2}{\sqrt{2}\pi\alpha} \right\}$$

$$= A_0 \frac{\epsilon G_E^{p\gamma} G_E^{pZ} + \tau G_M^{p\gamma} G_M^{pZ} - \frac{1}{2}\left(1 - 4\sin^2\theta_W\right)\epsilon' G_M^{p\gamma} G_A^{pZ}}{\epsilon (G_E^{p\gamma})^2 + \tau (G_M^{p\gamma})^2}$$

$$G_{E,M}^{pZ} = \frac{1}{4}\left(G_{E,M}^{p\gamma} - G_{E,M}^{n\gamma}\right) - \sin^2\theta_W G_{E,M}^{p\gamma} - \frac{1}{4} G_{E,M}^{s}$$

HAPPEX-He

$$A^{PV} = -\frac{A_0}{2}\left(2\sin^2\theta_W + \frac{G_E^s}{G_E^{p\gamma} + G_E^{n\gamma}}\right)$$

Theory cont'd

Leading nonzero moments of $G^s_{E,M}$:

$$\mu_s \equiv G^s_M(0) \qquad \rho_s \equiv \left[\frac{G^s_E}{d\tau}\right]_{\tau=0}$$

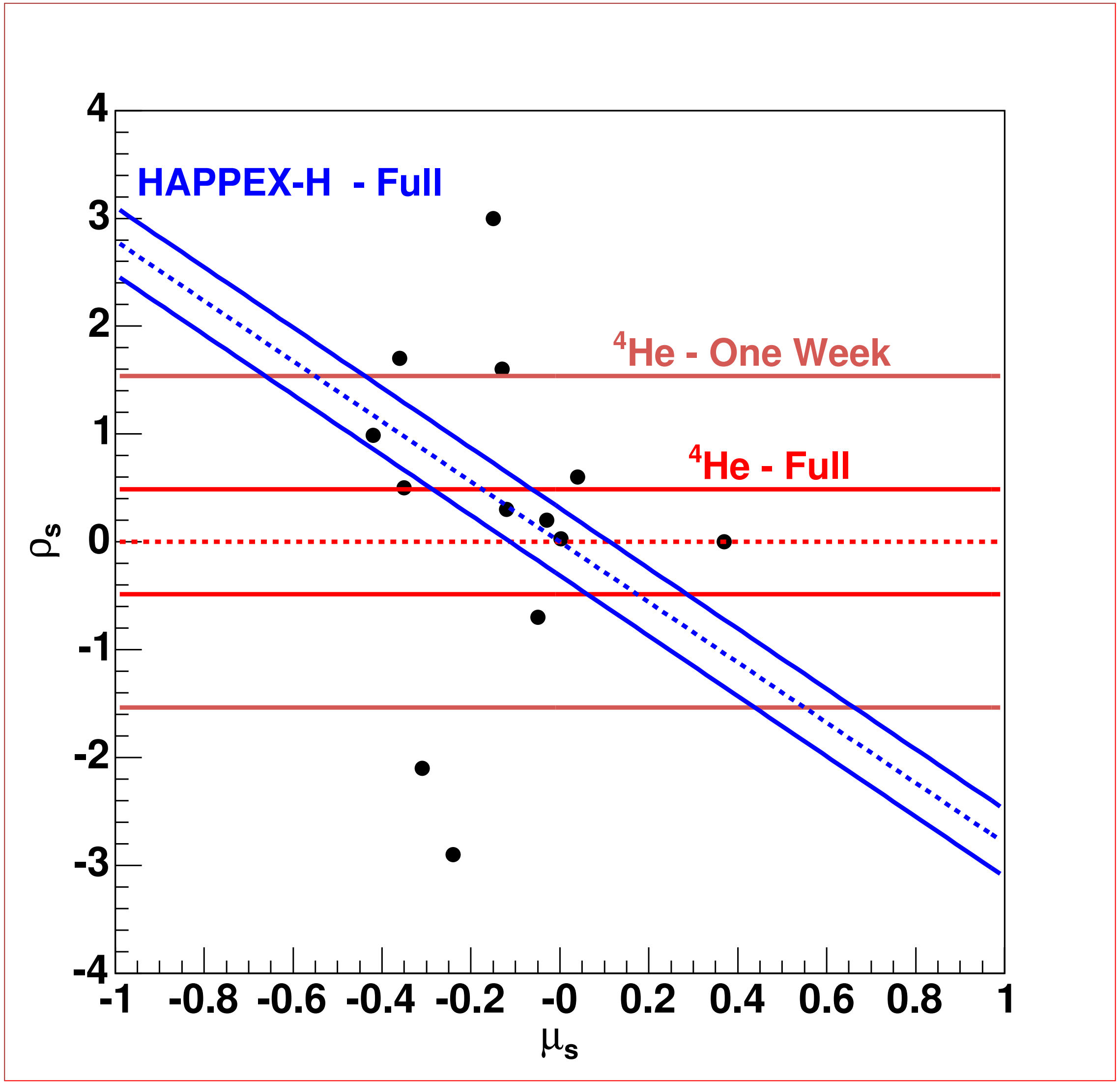
HAPPEX-H

$$A^{PV} \simeq \frac{A_0}{4}\left[\left(1 - 4\sin^2\theta_W\right) + \tau\left(\mu_n - \rho_s - \mu_p(\mu_n + \mu_s)\right)\right]$$

HAPPEX-He

$$A^{PV} \simeq -\frac{A_0}{2}\left(2\sin^2\theta_W + \rho_s\tau\right)$$

Experimental Impact

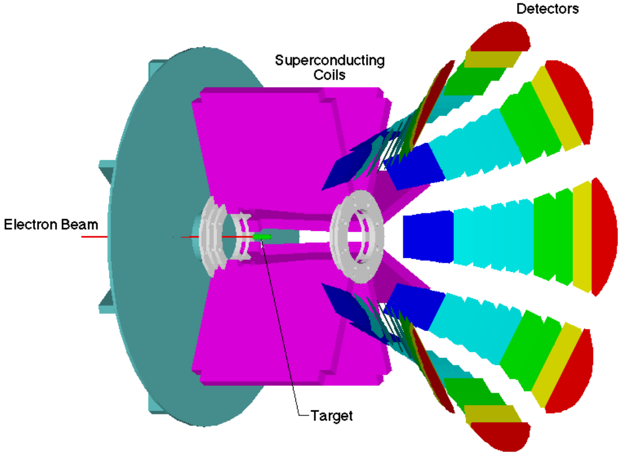


Competition

JLab G^0

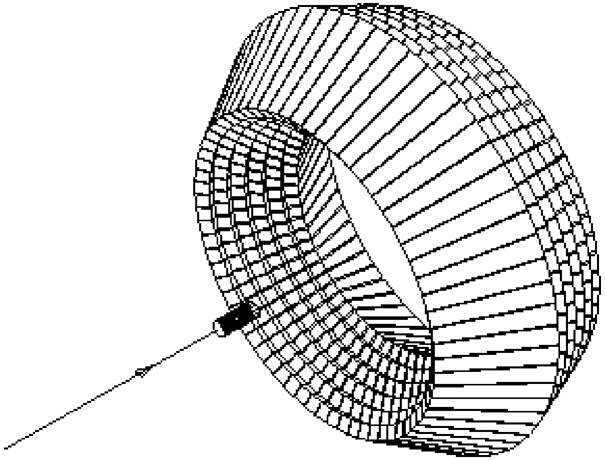
- $5^\circ < \theta < 15^\circ$, $E_0 = 3$ GeV
  $0.16 < Q^2 < 0.95\ (\mathrm{GeV/c})^2$

G0 Experiment


Detectors
Superconducting Coils
Electron Beam
Target

Mainz A4

- $\theta = 35^\circ$, $E_0 = 855$ MeV
  $Q^2 = 0.1\ \&\ 0.225\ (\mathrm{GeV/c})^2$



HAPPEX Run Schedule

Anticipated Run Schedule	
May 17-20	Source Installation
May22-June 1	Beam Commissioning (parasitic to E04-012)
June 2-6	Installation (target, detectors, sieve)
June 7	Optics Commissioning (sieve slit)
June 8-9	Configuration change (sieve slit removal)
June 10-16	HAPPEX-^{4}He
June 17-18	Configuration change (detector change)
June 19-July 2	HAPPEX-H
July 3-7	Down (Lab holiday and maintenance)
July 8	Restore
July 9- 25	HAPPEX-H

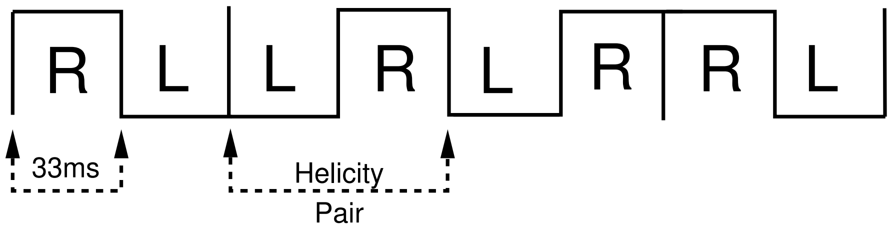
HAPPEX Precision

	A^{PV}	Relative Error	Precision
HAPPEX-H	1.2 ppm	5%	60 ppb
HAPPEX-He	8 ppm	3%	240 ppb

- Use HRS with septum magnets $\longrightarrow \theta = 6^\circ$
- $Q^2 = 0.1\ (\mathrm{GeV/c})^2$, $E_0 = 3.0$ GeV
- 100μA, 80% polarization
- Polarimetry: Hall A Møller & Compton (2%)

Measurement and Corrections

Beam Helicity


R
L
L
R
L
R
R
L
33ms
Helicity Pair

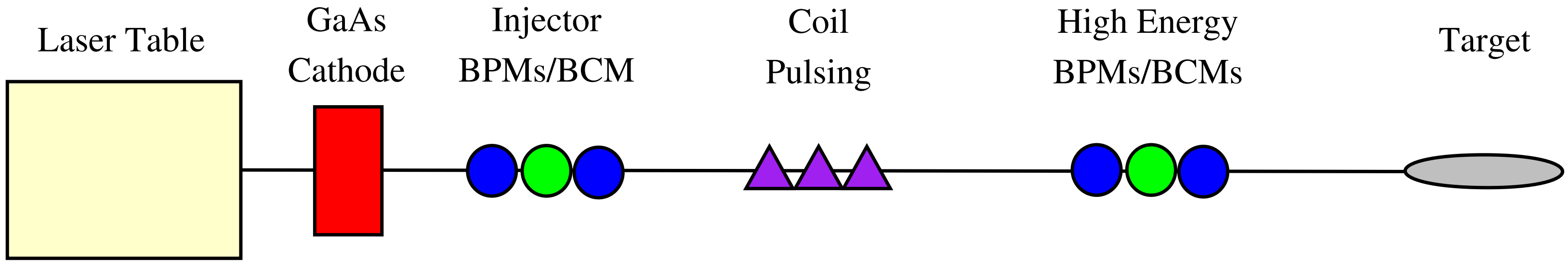
Integrated Detected Flux D

$$A_{det} = \frac{D_R - D_L}{D_R + D_L}$$

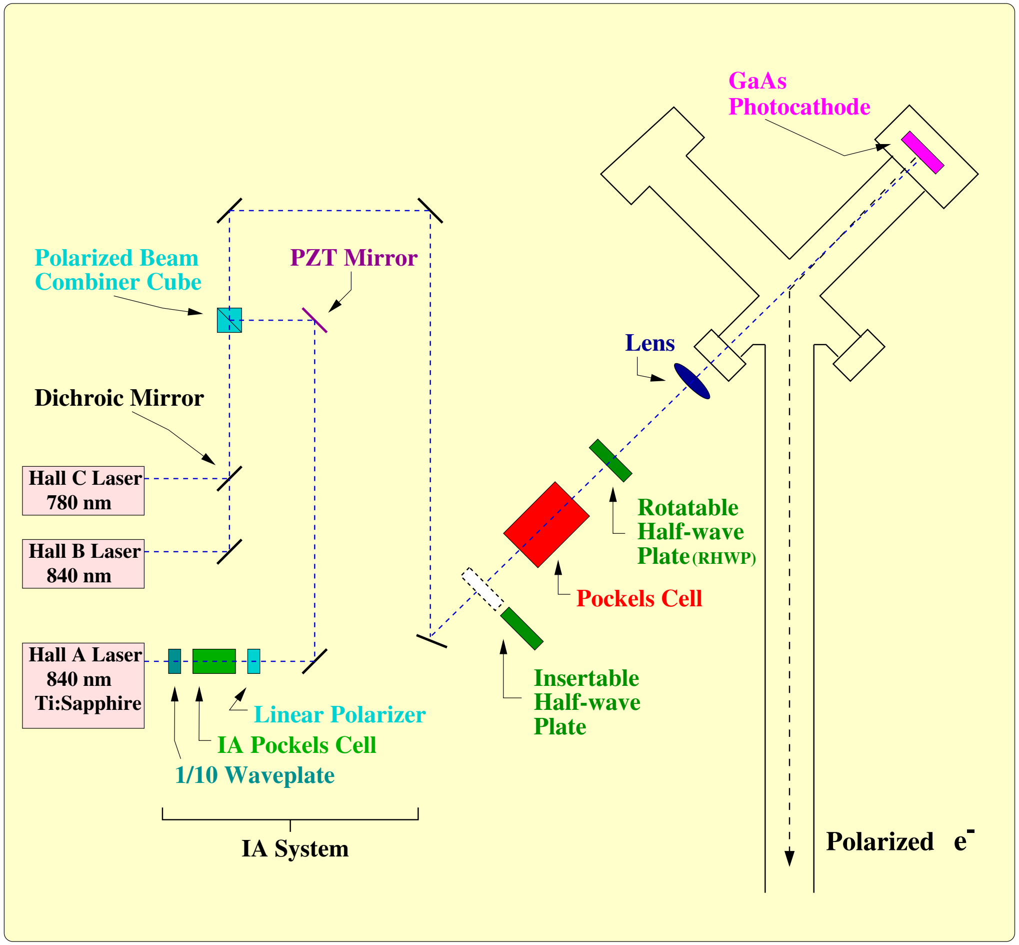
Corrected Asymmetry

$$A_{physics} \simeq A_{det} - A_Q + \alpha A_E + \sum_i \beta_i \Delta x_i$$

Goal (Run avg): $A_Q \leq 0.6$ ppm & $\Delta x \leq 2$ nm @ target


Laser Table
GaAs Cathode
Injector BPMs/BCM
Coil Pulsing
High Energy BPMs/BCMs
Target

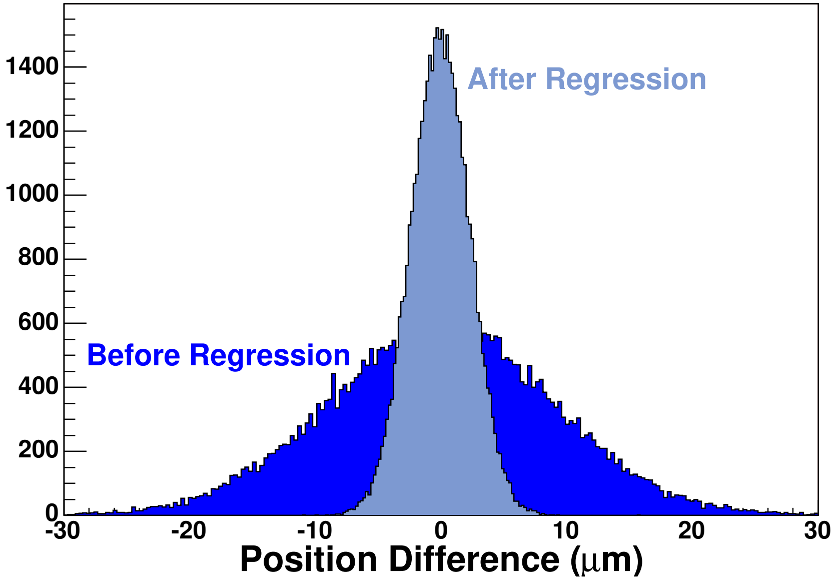
Polarized Source


GaAs
Photocathode
Polarized Beam
Combiner Cube
PZT Mirror
Lens
Dichroic Mirror
Hall C Laser
780 nm
Hall B Laser
840 nm
Rotatable
Half-wave
Plate (RHWP)
Pockels Cell
Hall A Laser
840 nm
Ti:Sapphire
Linear Polarizer
IA Pockels Cell
1/10 Waveplate
Insertable
Half-wave
Plate
IA System
Polarized e-

- Installation this week!
- Align Pockels cells to minimize position differences
- Injector beam studies
- Feedback for A_Q and possibly for Δx
- Commision parity quality beam during pentaquark

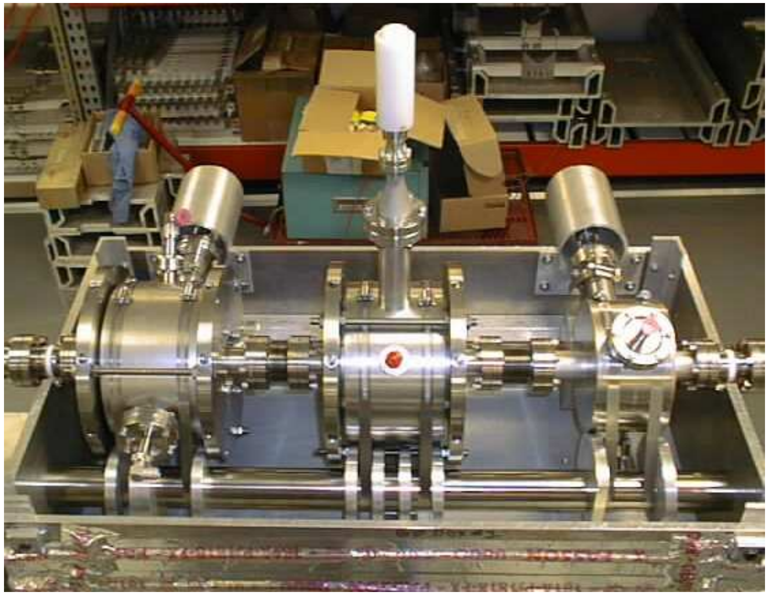
Position Resolution

Goal (30Hz): $\sigma_{\Delta x} \leq 1.2\mu$m in each BPM



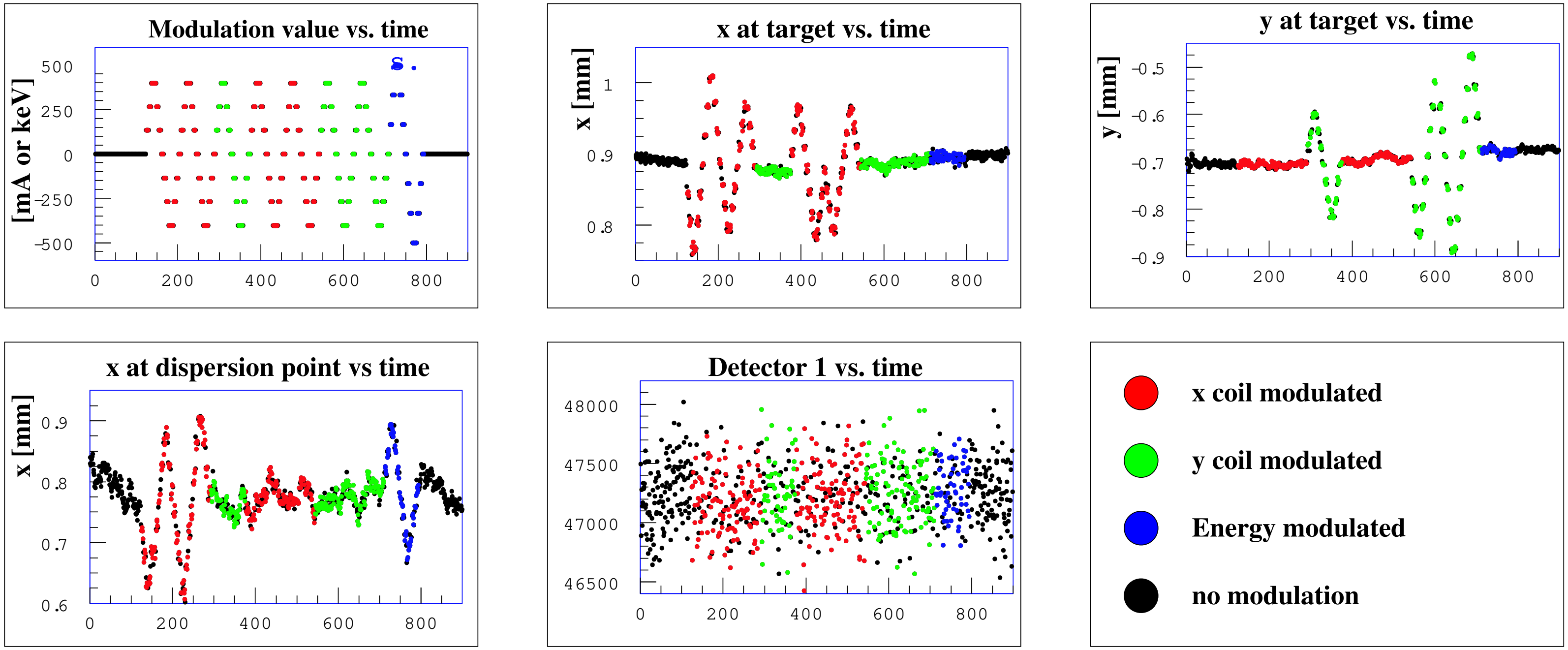
Stripline Position Monitor
Resolution ~ 1.8μm

Cavity Position Monitors

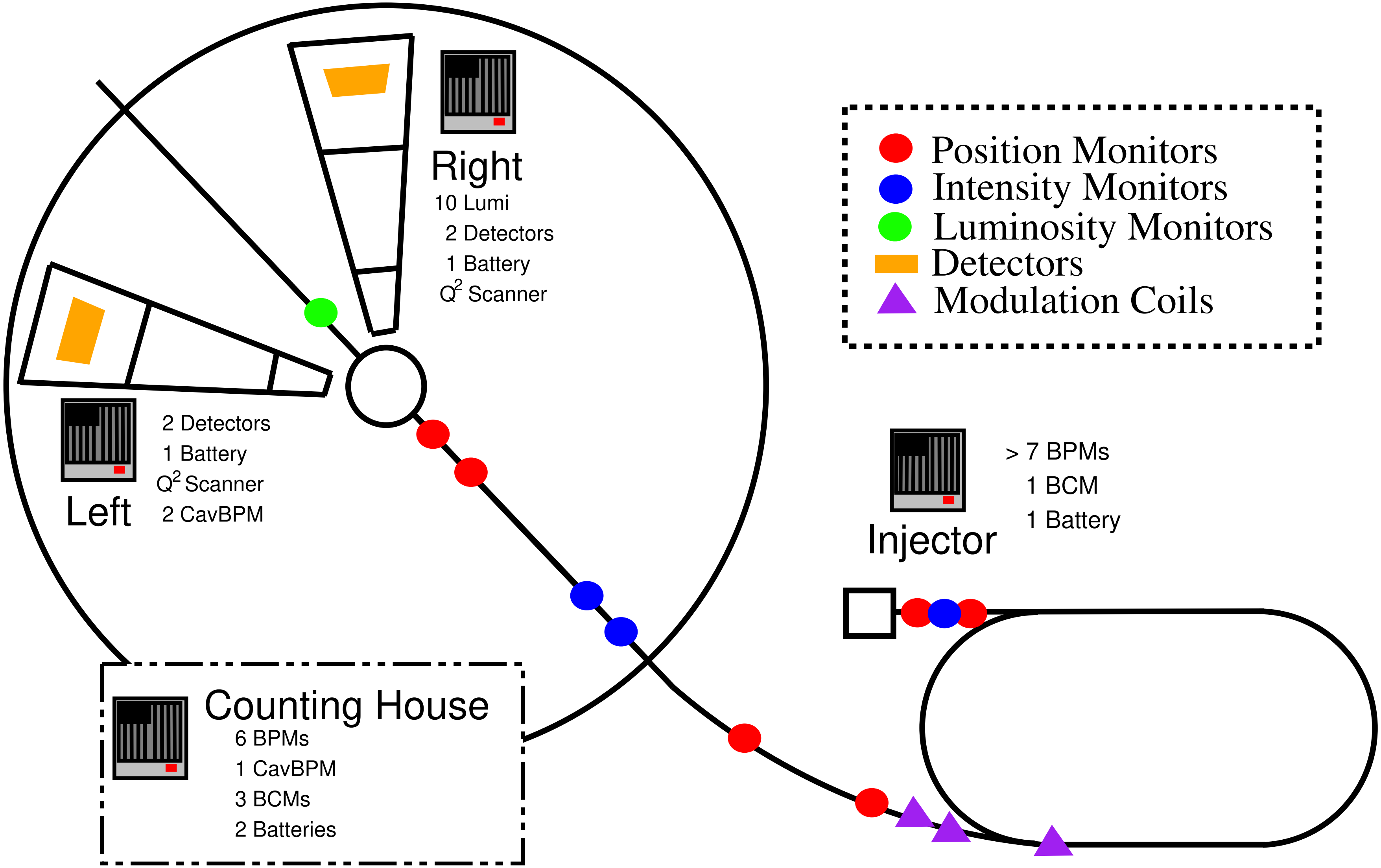


Beam Modulation (Dithering)

$$A_{physics} \simeq A_{det} - A_Q + \alpha A_E + \sum_i \beta_i \Delta x_i \qquad \beta_i = \frac{\partial D}{\partial x_i}$$



HAPPEX DAQ



Right

10 Lumi
2 Detectors
1 Battery
Q^2 Scanner

Left

2 Detectors
1 Battery
Q^2 Scanner
2 CavBPM

Counting House

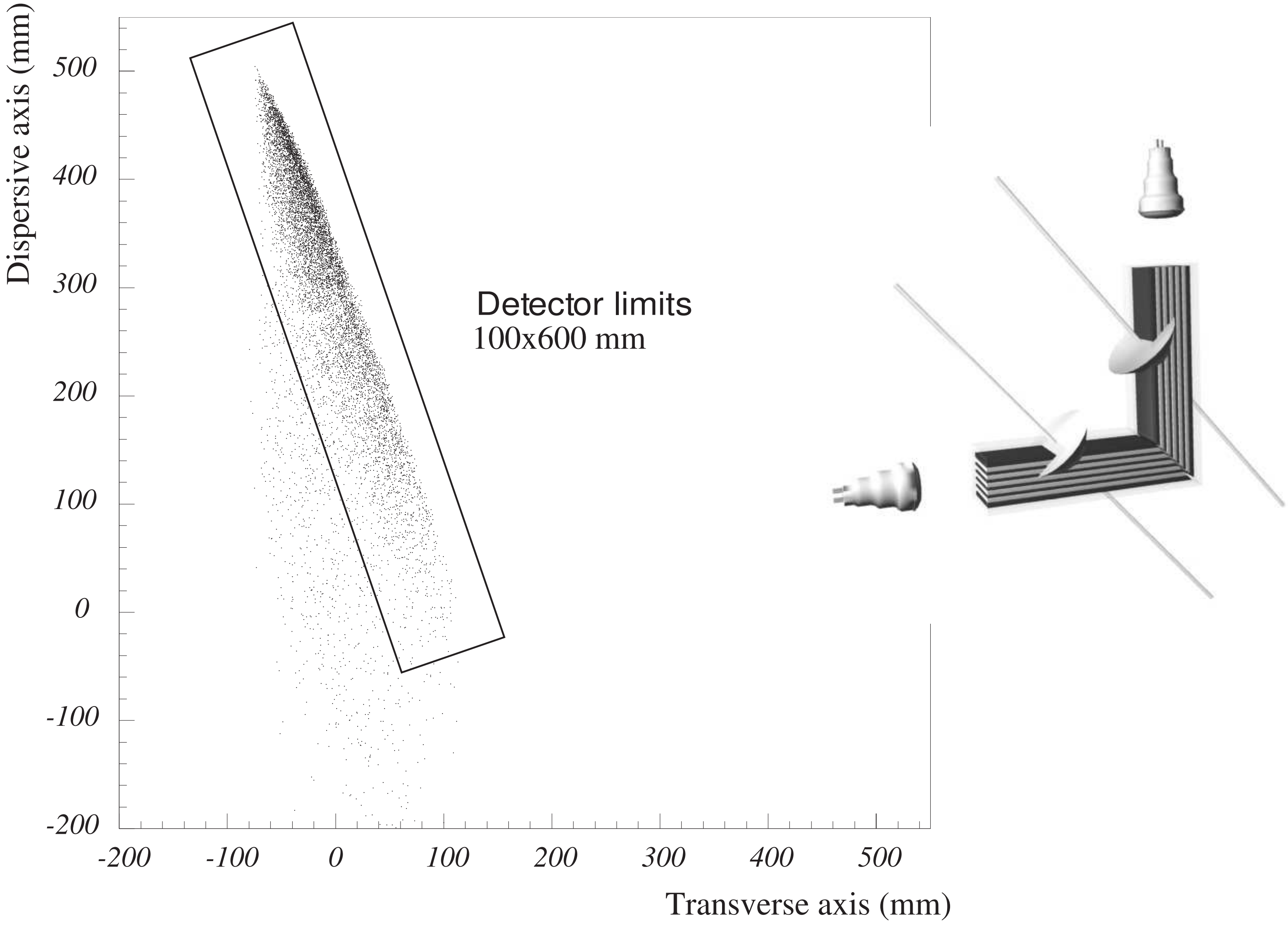
6 BPMs
1 CavBPM
3 BCMs
2 Batteries

- 🔴 Position Monitors
- 🔵 Intensity Monitors
- 🟢 Luminosity Monitors
- 🟧 Detectors
- ▲ Modulation Coils

Injector

> 7 BPMs
1 BCM
1 Battery

HAPPEX Detector



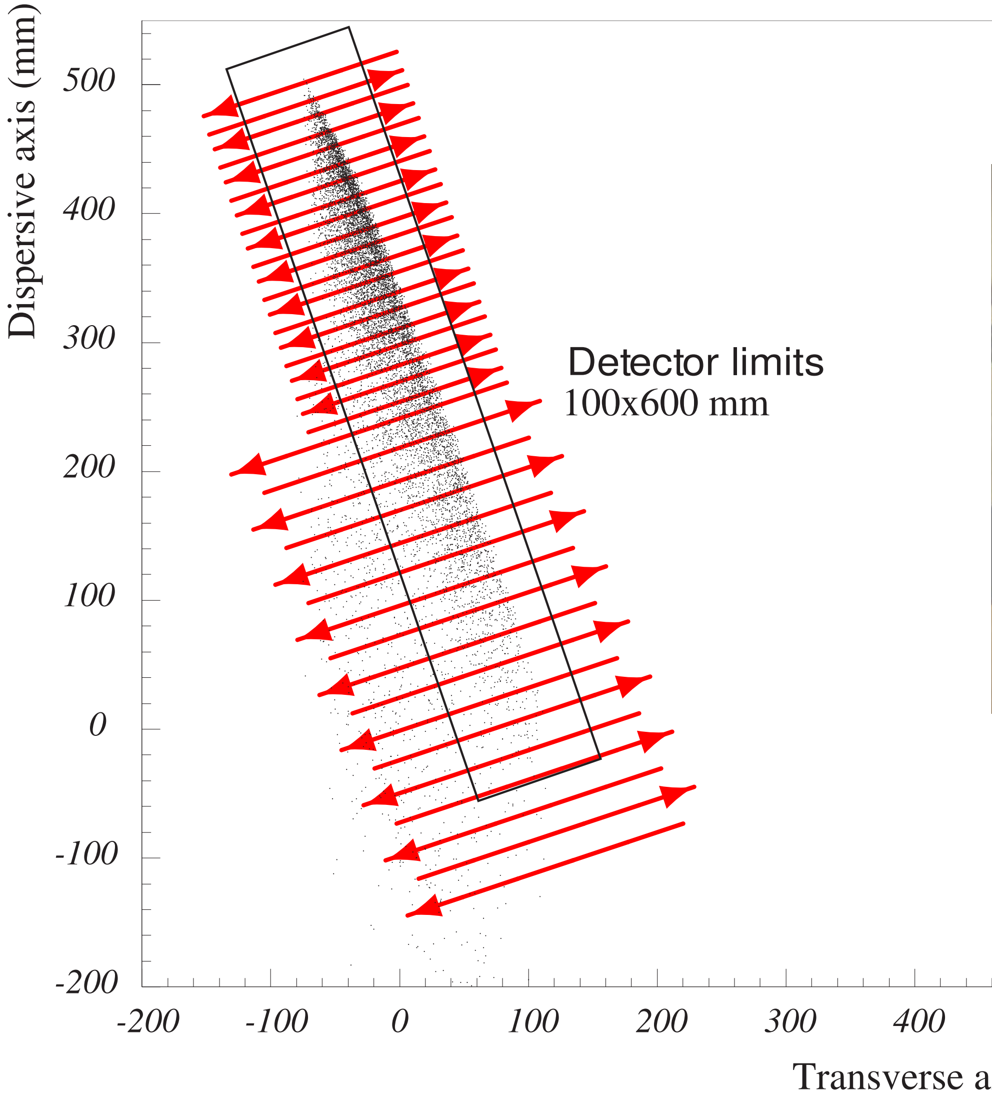
Detector limits
100x600 mm

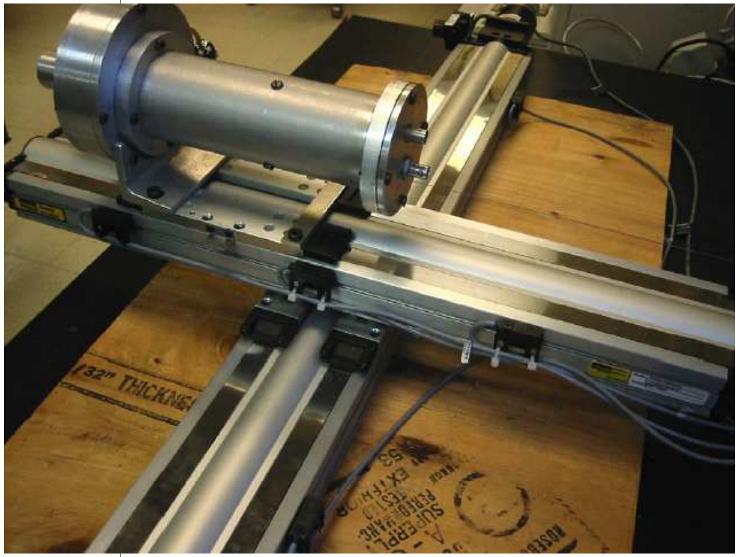
Q^2 Measurement and Optics

$$Q^2 = 2EE'(1 - \cos\theta)$$

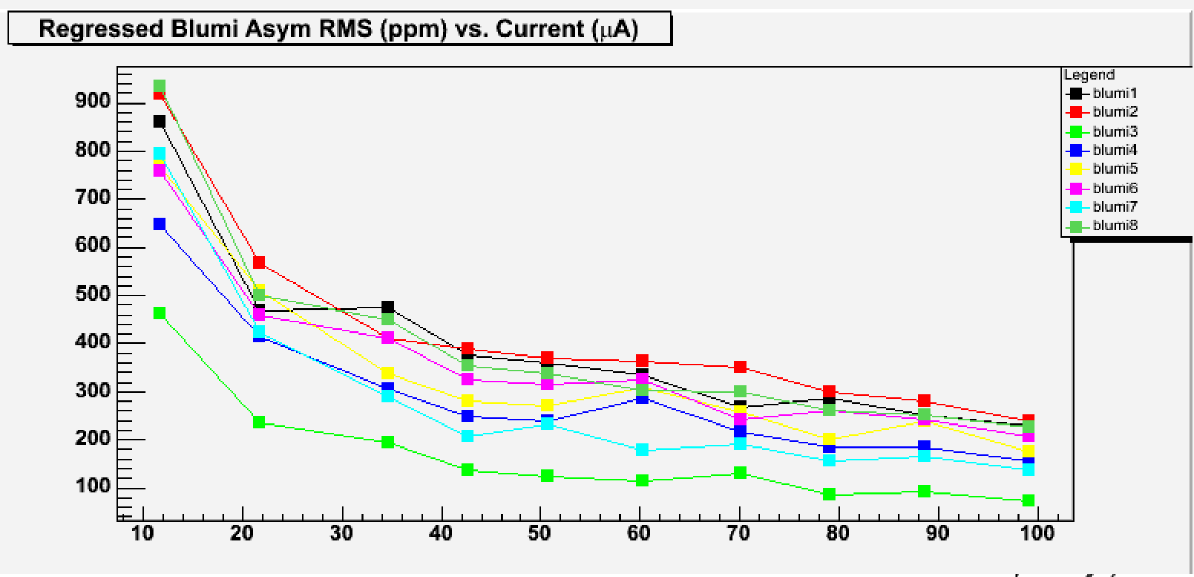
- Determine central pointing angle of spectrometer with a precision of 0.5 mrad in order to know Q^2 to 1%
- Measure momentum difference of elastic scattering from two different nuclei - H and ^{12}C - in order to measure scattering angle precisely
- Low current (100 nA) is necessary for the measurement of the Q^2 distribution for uniform efficiency of event reconstruction
- Q^2 profile scanner will map out spatial distribution of Q^2 at high current to check low current measurement

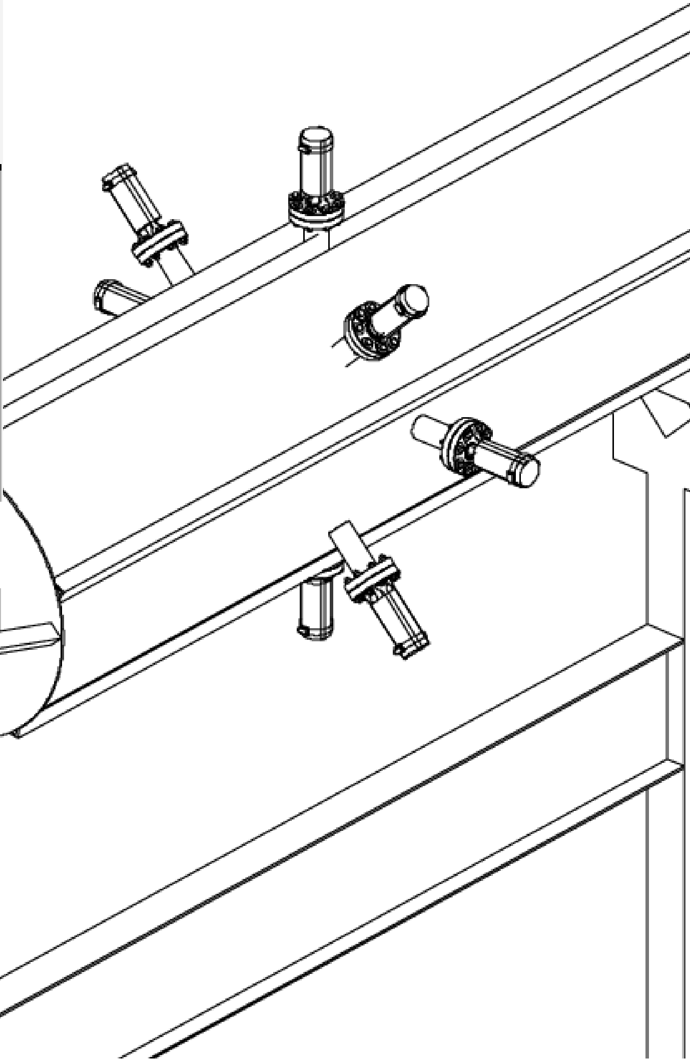
Profile Scanner





Luminosity Monitor





- 8 working detectors!
- Detector widths at the level we expect from the HAPPEX detector

Compton Polarimeter

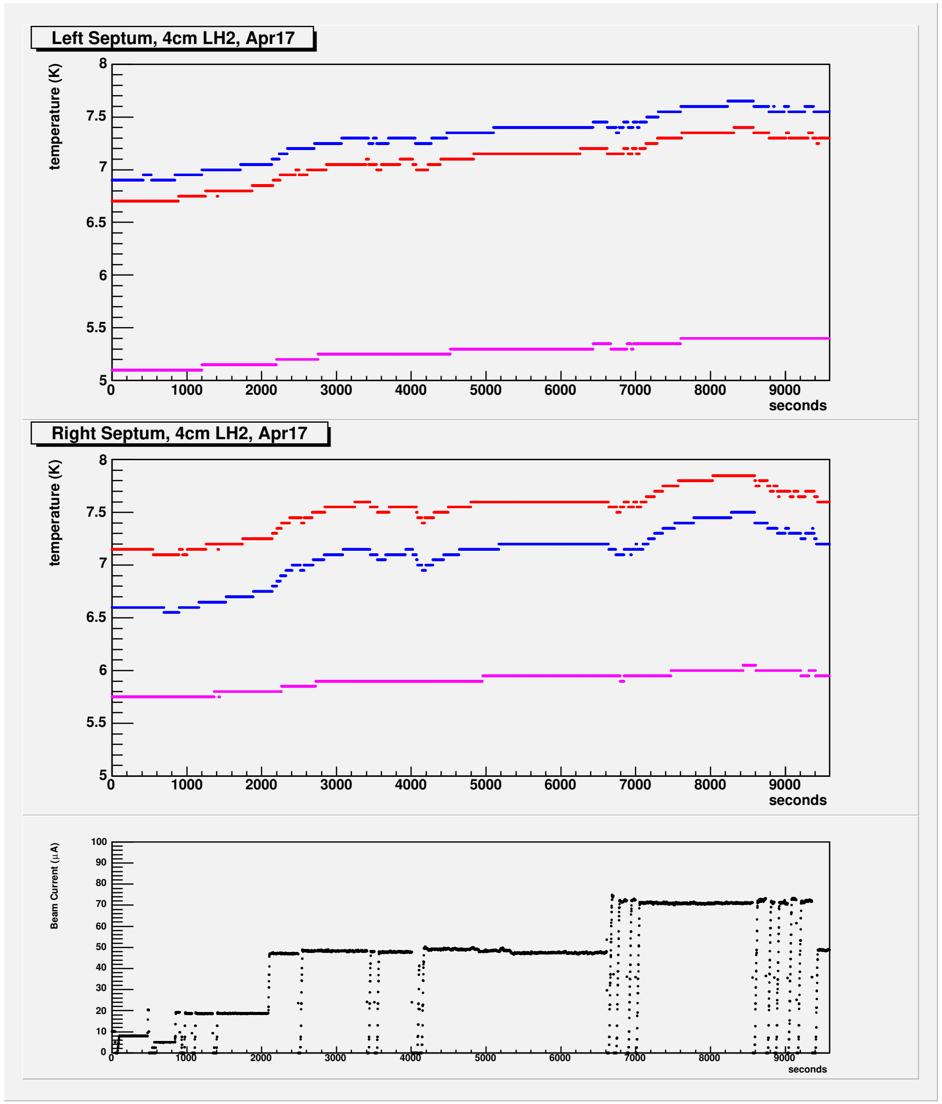
- Run Compton polarimeter during entire running of HAPPEX
- Beam halo needs to be well controlled < 100 Hz/μA @ 3 mm
- Beam will go through Compton chicane during pentaquark for commissioning of the polarimeter
- Need Compton operators for shifts

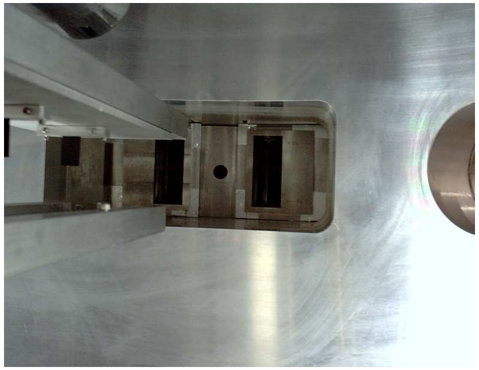
Targets

- 20 cm racetrack cell for ^{4}He
- 20 cm racetrack cell for H
- 15 cm “beercan”
- Solid targets for optics

- More ^{4}He to Hall A, connected to CHL ⇒ retraining for target operators
- Target boiling is a concern - previous “beercans” suitable, racetrack cells not yet measured

Septum Heating





- 2500 cm^2 of 18X_0 shielding →still too much heating
- Pb wall to shield entire cold mass will be installed
- Difficult to predict heating for HAPPEX → more realistic test during pentaquark

HAPPEX Shifts

- Where can I sign up?

  http://hallaweb.jlab.org/experiment/HAPPEX/

- 3 Shifters:
  1. Shift leader
  2. Target operator - Current operators will need to be retrained
  3. Compton operator & “prompt” analysis