E99-115 & E00-114 Status Report

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The College of WILLIAM & MARY

- Overview: Theory and Measurement

- Update: Progress and Readiness

Hall-A Collaboration Meeting

July 10^{th}, 2003

Strange Quarks in the Nucleon?

- μ-P Scattering:
  - "Nucleon Spin-Crisis"
- Deep Inelastic ν Scattering:
  - Contribution to Nucleon's Longitudinal Momentum
- π-N Scattering:
  - Contribution to Nucleon's Mass from $\langle N|s\overline{s}|N\rangle$

e-N Scattering $\rightarrow$ Vector strange matrix elements $\langle N|s\gamma^{\mu}\overline{s}|N\rangle$

Strange Form Factors $G^{s}_{E,M}(Q^2)$

Theory

HAPPEX-II

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

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

Assuming Isospin Symmetry

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

HAPPEX-He

$$A^{PV} = -A_0 \tau \left(4sin^2\theta_W + \frac{2G_E^s}{G_E^{p\gamma} + G_E^{n\gamma}} \right)$$

$\therefore$ Measuring A^{PV}, with knowledge of $G_{E,M}^{p\gamma}$ and $G_{E,M}^{n\gamma}$, determines $G_{E,M}^{s}$

Theory cont'd

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

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

Expand A^{PV} to first order in τ:

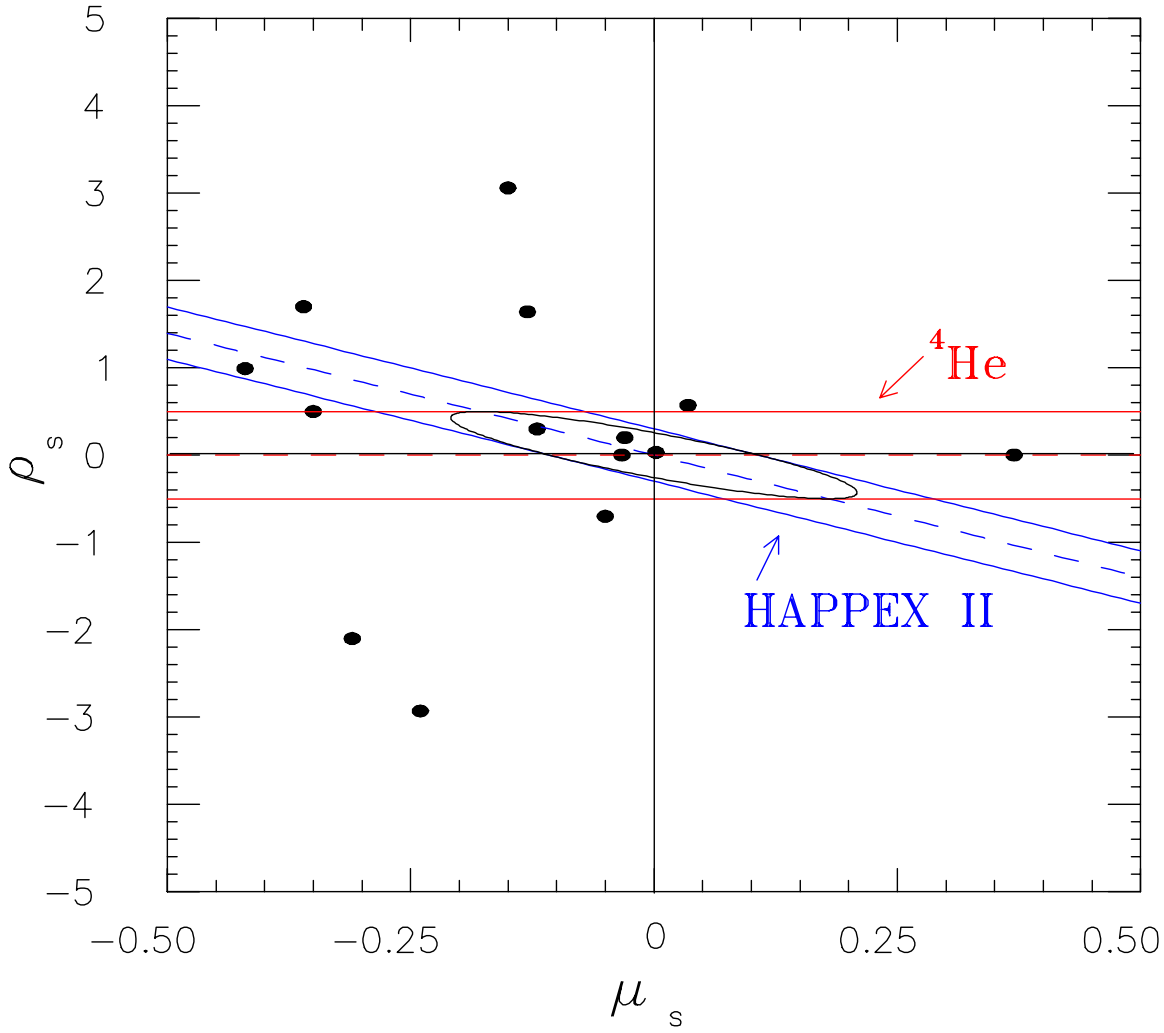
HAPPEX-II

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

HAPPEX-He

$$A^{PV} \simeq A_0\tau\left(4sin^2\theta_W+2\rho_s\tau\right)$$

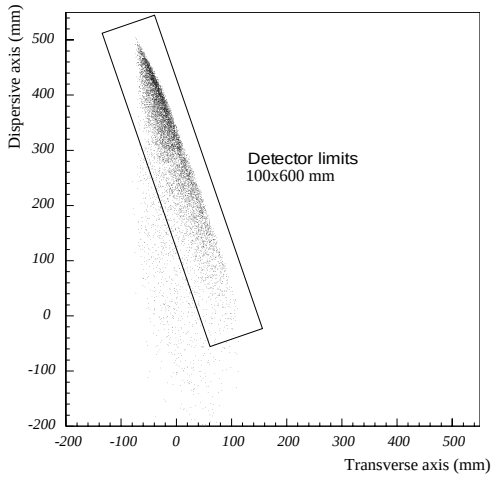
Theoretical Predictions

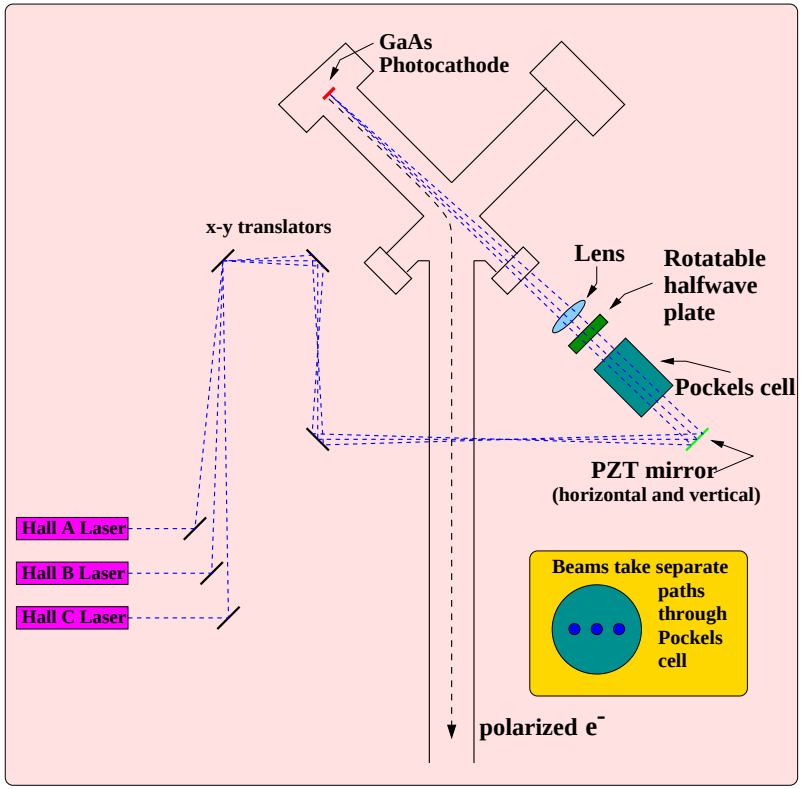


Upcoming Hall-A Parity Experiments

	A^{PV}	Relative Error	Precision
HAPPEX II	1.6 ppm	5%	80 ppb
HAPPEX He	8 ppm	3%	240 ppb

- Use HRS with septum magnets $\rightarrow \theta$ = 6°
- $Q^2 = 0.1$ (GeV/c)^2, $E_0 = 3.2$ GeV
- 100 μA, 80% polarization
- Polarimetry: Hall A M$\varnothing$ller & Compton (2%)
- Integrating; total absorption Detector





Measure detected flux D

for each window

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

Corrected Measured Asymmetry

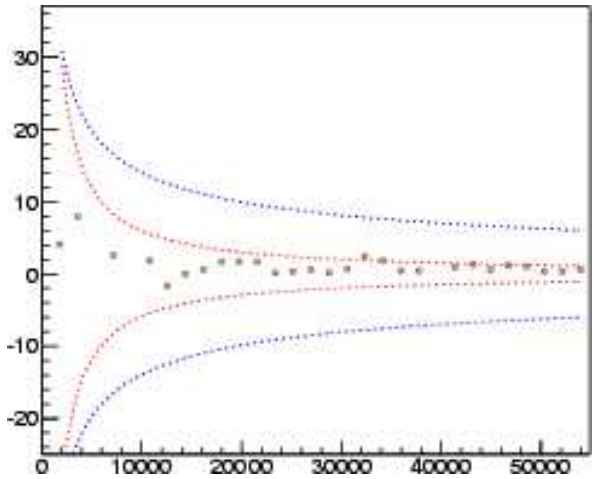
$$A_{physics} \simeq A_{det} - A_Q + \alpha A_E + \sum_i \beta_i \Delta x_i$$

Charge Asymmetry

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

Intensity Attenuator (IA):

Pockels Cell and $\lambda/4$-plate, between two linear polarizers. Voltage control is helicity correlated to provide control of charge asymmetry.



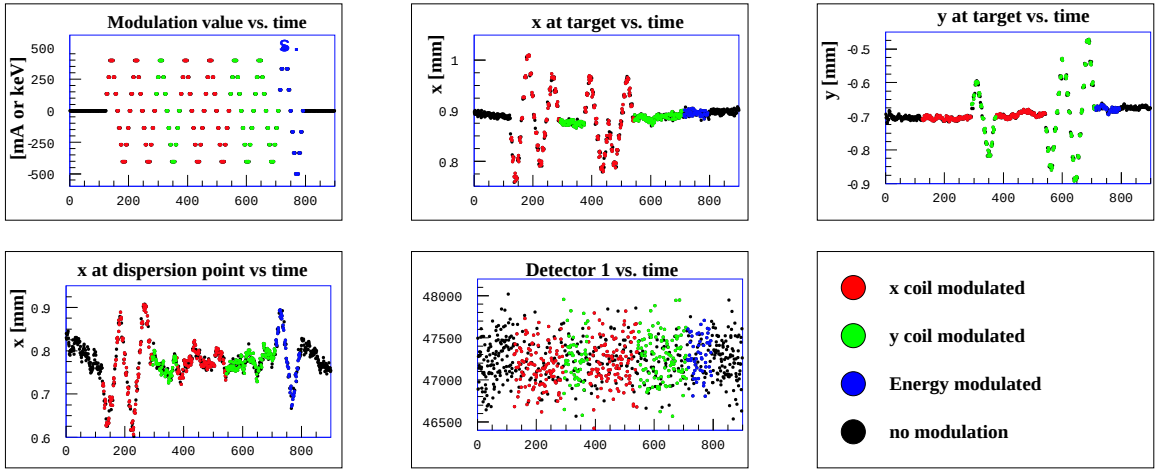
- Used to provide A_Q feedback for Spin-Duality and GDH.
- For HAPPEX-II/He:

  Small Corrections - IA Cell

  Large Corrections - Pockels Cell

Beam Modulation

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



- 7 deflector magnets, 1 energy-modulation cavity
- System must be completely revived
- Tests to be completed soon

Position Differences

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

Goal: $\Delta x \leq 2$ nm at the target

- Adiabatic Damping

  - Full Benefit: x100 suppression

  - Weekly “Parity Quality Beam” Meetings - Chao

- ITS Laser Room Test Stand

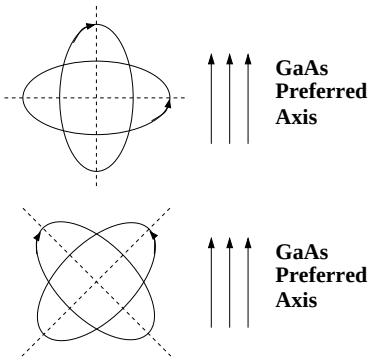
  - Pockels Cell Characterization

  - Birefringence Gradients and Steering

- Injector Beam Studies

  - Other sources of Δx (Cathode Gradients)

  - Source Tuning Procedure Developed

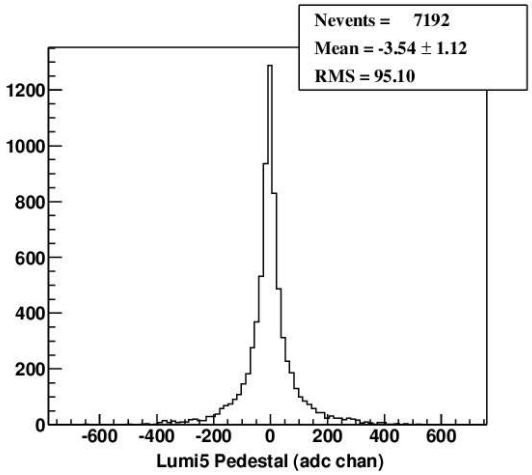


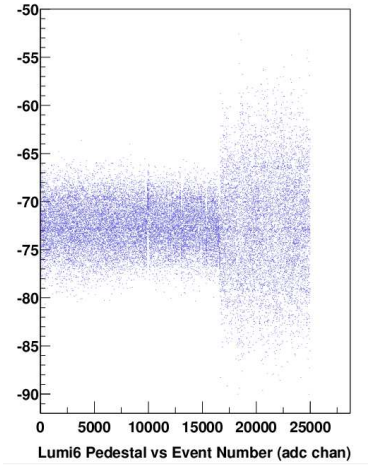
Pedestal Noise

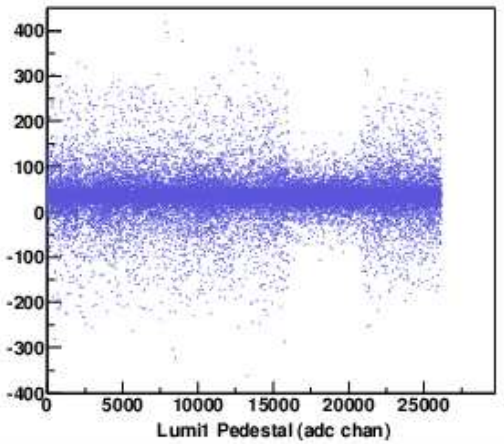
- HAPPEX-II Counting Rate $\rightarrow \sigma_A \simeq$ 500 ppm

  Electronics Noise (Pedestal Width) must be $\ll$ 24 ADC Channels

- Luminosity Detector - Large Pedestal Width with HV (Ground Loop ??)

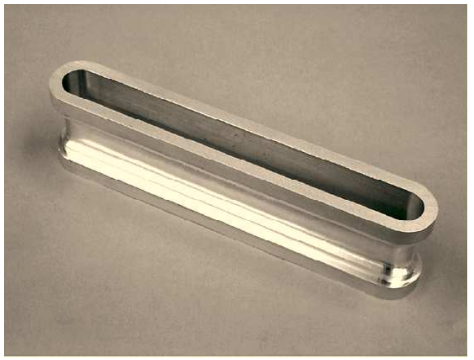


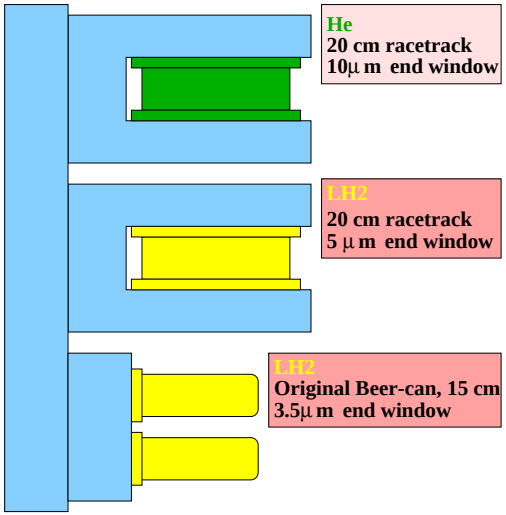


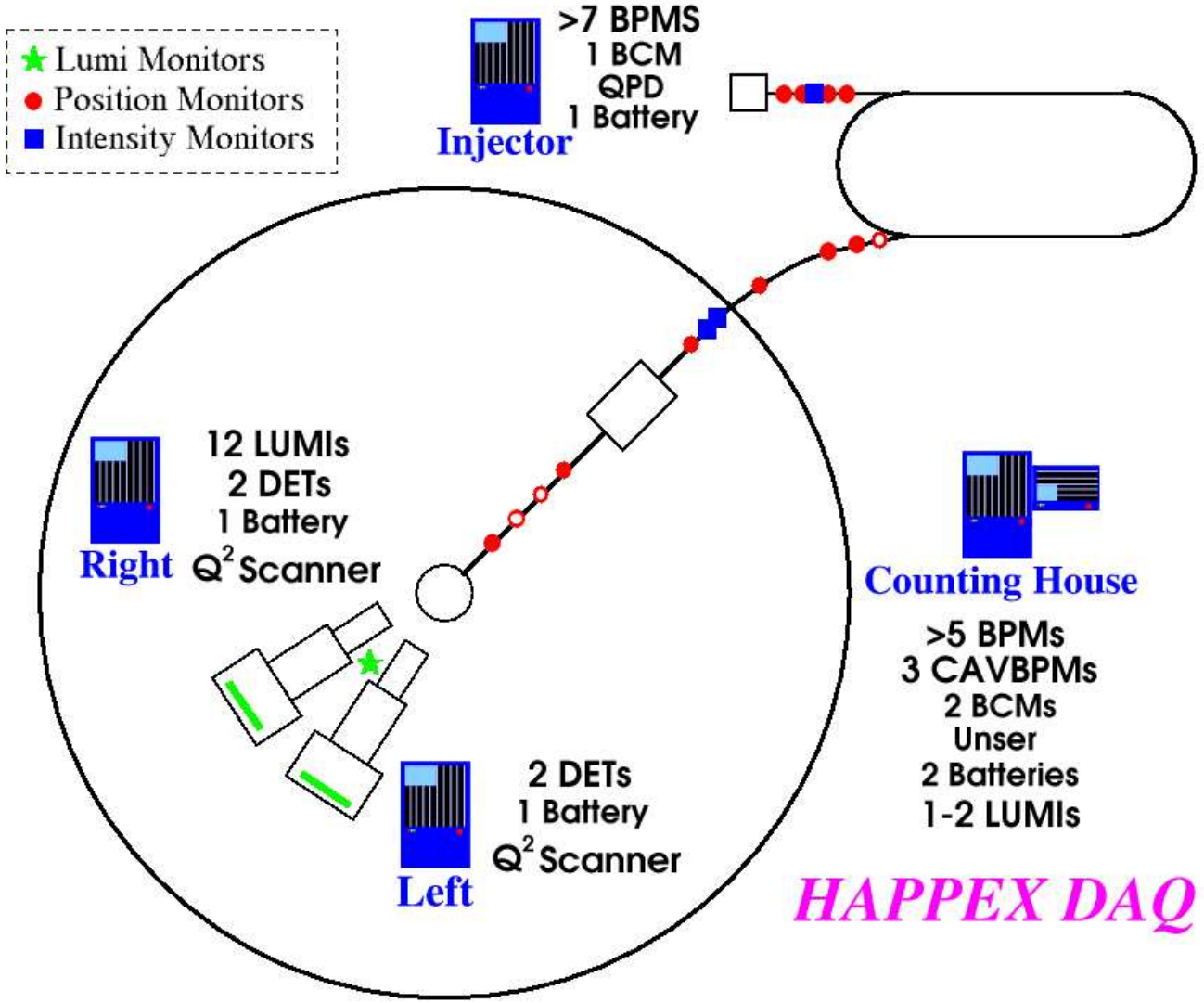


Cryo-Target

- Boiling Studies in Nov. ’02 show unacceptable fluctuations ($\sim$10000 ppm) for Standard Cells (TN-03-017)
- 20cm “Racetrack” Cells - Transverse Flow
  15cm “Beer Can” Cells - Backup
- New Cells Mounted to Cell Block
  No “Racetrack” Spares yet






Lumi Monitors
Position Monitors
Intensity Monitors
Injector
>7 BPMS
1 BCM
QPD
1 Battery
Right
12 LUMIs
2 DETs
1 Battery
Q² Scanner
Left
2 DETs
1 Battery
Q² Scanner
Counting House
>5 BPMs
3 CAVBPMs
2 BCMs
Unser
2 Batteries
1-2 LUMIs
HAPPEX DAQ

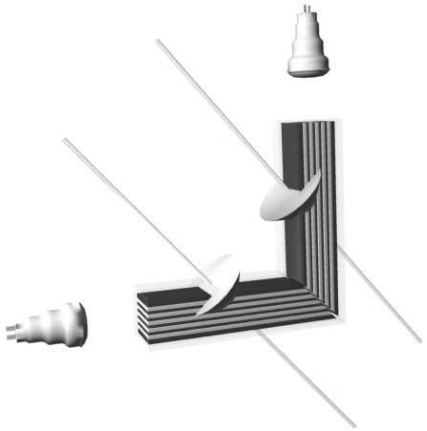
Other Progress...

- Two more Luminosity Monitors commissioned

  Six more to be installed
- HAPPEX Detector Test Install completed

  Pedestal and Cosmics runs
- Q^2 Scanner being assembled and tested
- Cavity Position Monitors installed

  Readout Electronics to be installed



Other Concerns/Issues

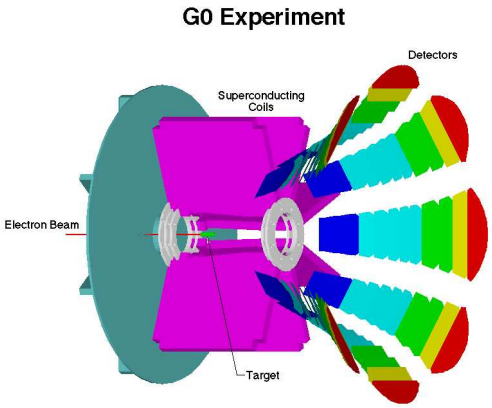
- Simultaneous Position and Charge Feedback
- Tentative Schedule: Fall 2004? (Essentially Ready Now)
- Competition...

Competition

JLab G^0

- $5^\circ < \theta < 15^\circ$, $E_0 = 3$ GeV

  $0.16 < Q^2 < 0.95$ (GeV/c)^2



Mainz A4

- $\theta = 35^\circ$, $E_0 = 855$ MeV

  $Q^2 = 0.1 \ \& \ 0.225$ (GeV/c)^2