

# *E99-115 & E00-114*

## *HAPPEX Status Report*

*Overview: Theory and Measurement*

*Update: Progress and Readiness*

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**WILLIAM & MARY**

# Strange Quarks in the Nucleon?

- Hints:
  - ★ EMC - “Nucleon Spin-Crisis”
- Evidence:
  - ★ Contribution to Nucleon’s Long. Momentum
  - ★ Contribution to Nucleon’s Mass from  $\langle N | s\bar{s} | N \rangle$
- Theoretical Motivation  $\langle N | s\gamma^\mu \bar{s} | N \rangle$ :
  - ★ Isolation of  $G_{E,M}^s$  through  $N(\vec{e}, e')$  scattering

## HAPPEX-H

$$\begin{aligned}
 A^{PV} &= \frac{\sigma_R - \sigma_L}{\sigma_R + \sigma_L} \quad \left\{ A_0 = \frac{-G_F Q^2}{\sqrt{2}\pi\alpha} \right\} \\
 &= A_0 \frac{\epsilon G_E^{p\gamma} G_E^{pZ} + \tau G_M^{p\gamma} G_M^{pZ} - \frac{1}{2} (1 - 4 \sin^2 \theta_W) \epsilon' G_M^{p\gamma} G_A^{pZ}}{\epsilon (G_E^{p\gamma})^2 + \tau (G_M^{p\gamma})^2}
 \end{aligned}$$

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

## HAPPEX-He

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

Leading nonzero moments of  $G_{E,M}^s$ :

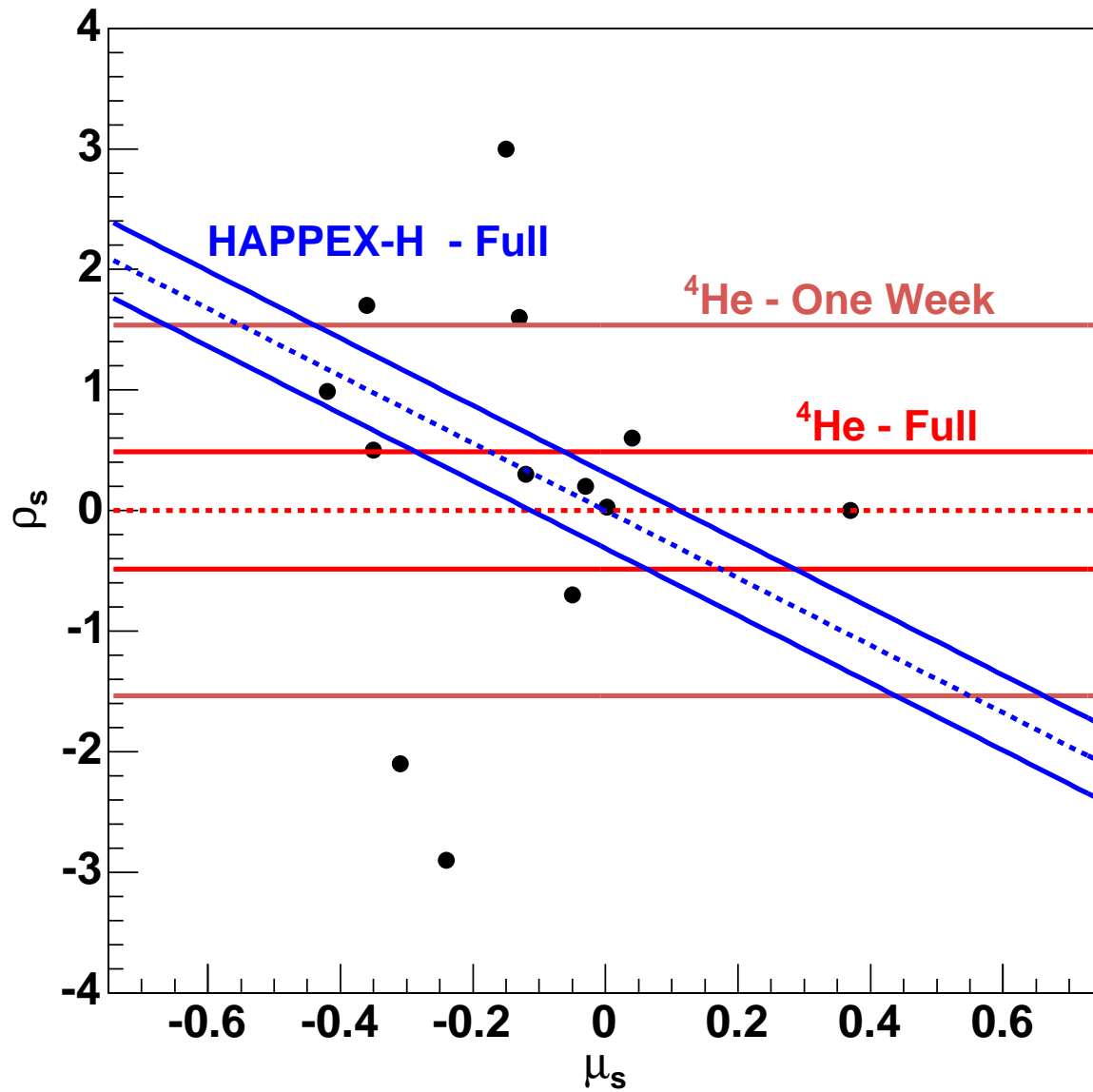
$$\mu_s \equiv G_M^s(0) \quad \rho_s \equiv \left[ \frac{G_E^s}{d\tau} \right]_{\tau=0}$$

## HAPPEX-H

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

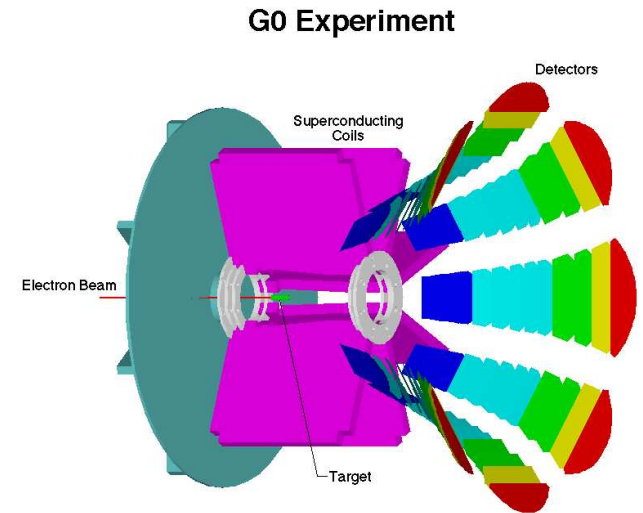
## HAPPEX-He

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



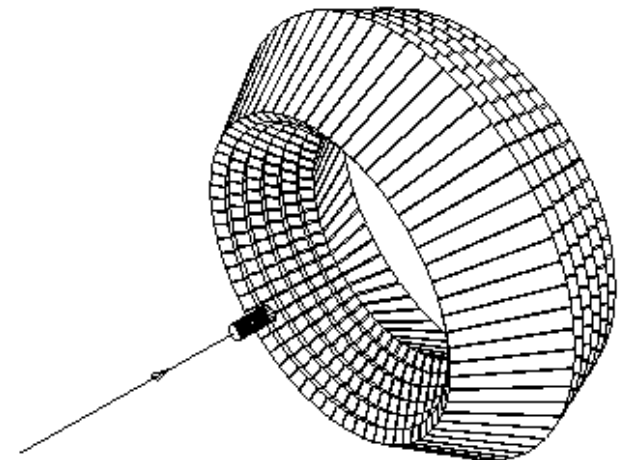
## JLab G<sup>0</sup>

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



## Mainz A4

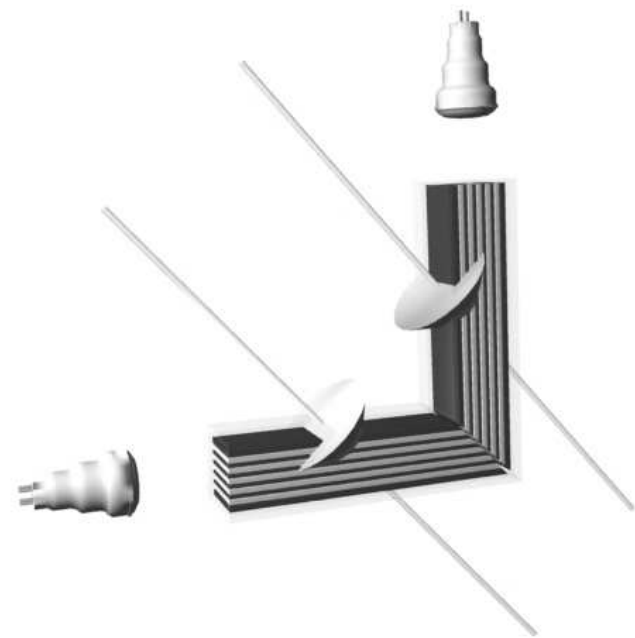
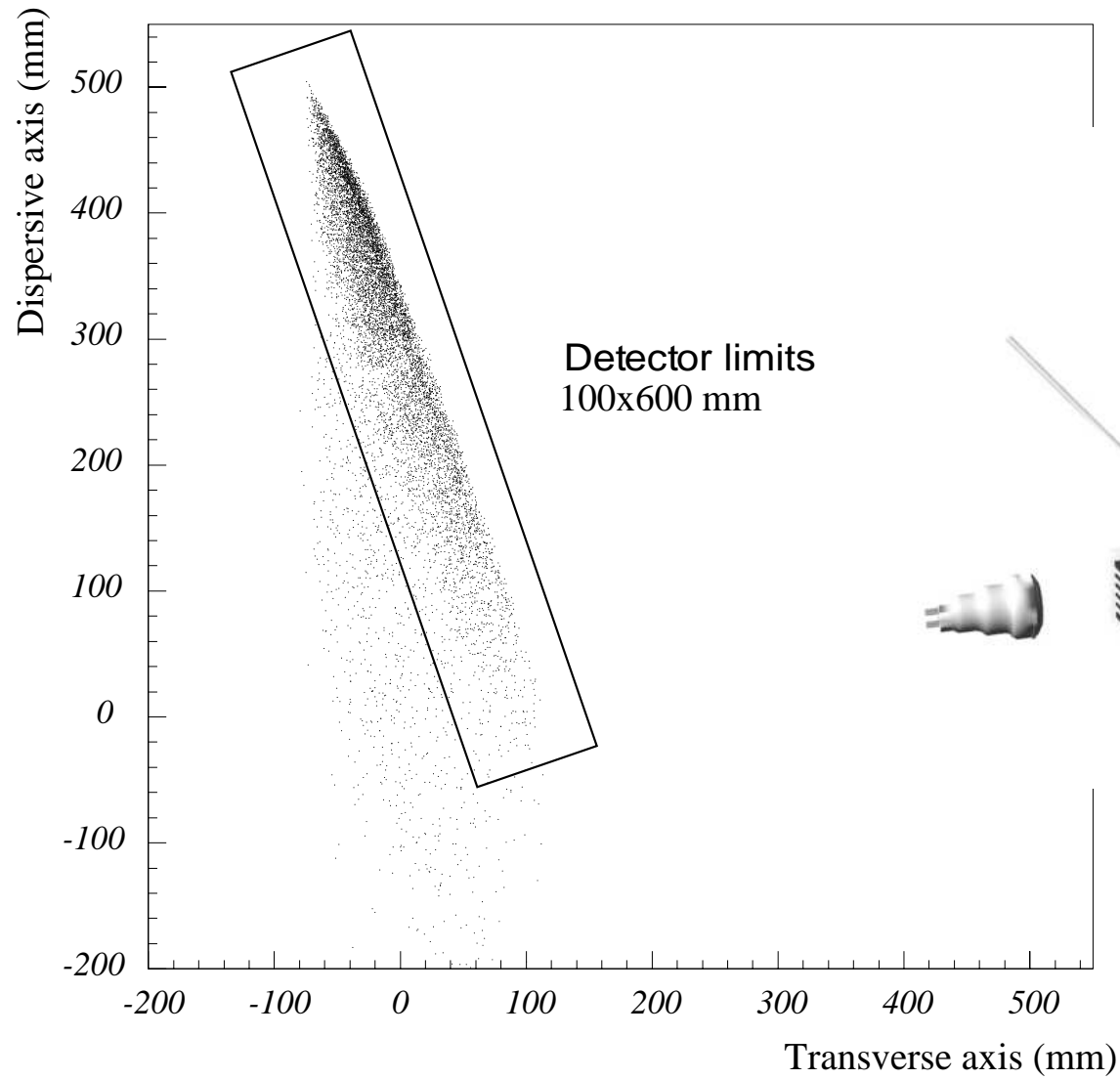
- $\theta = 35^\circ$ ,  $E_0 = 855 \text{ MeV}$   
 $Q^2 = 0.1 \text{ \& } 0.225 \text{ (GeV/c)}^2$



## Upcoming HAPPEX Experiments

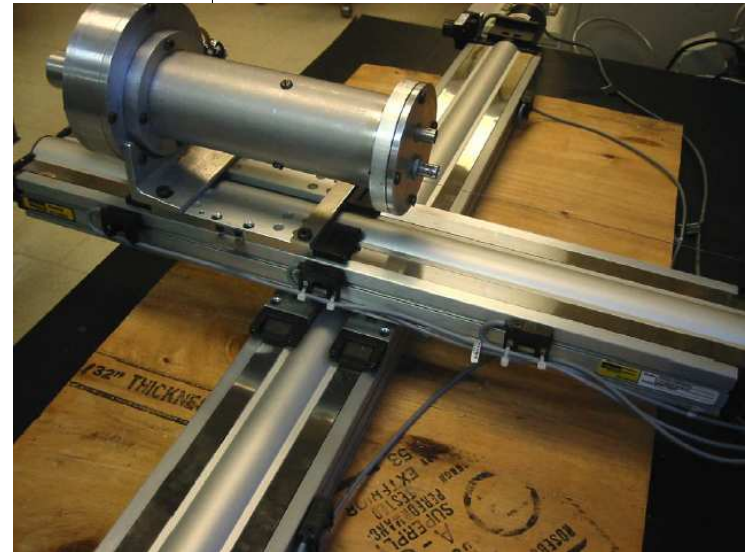
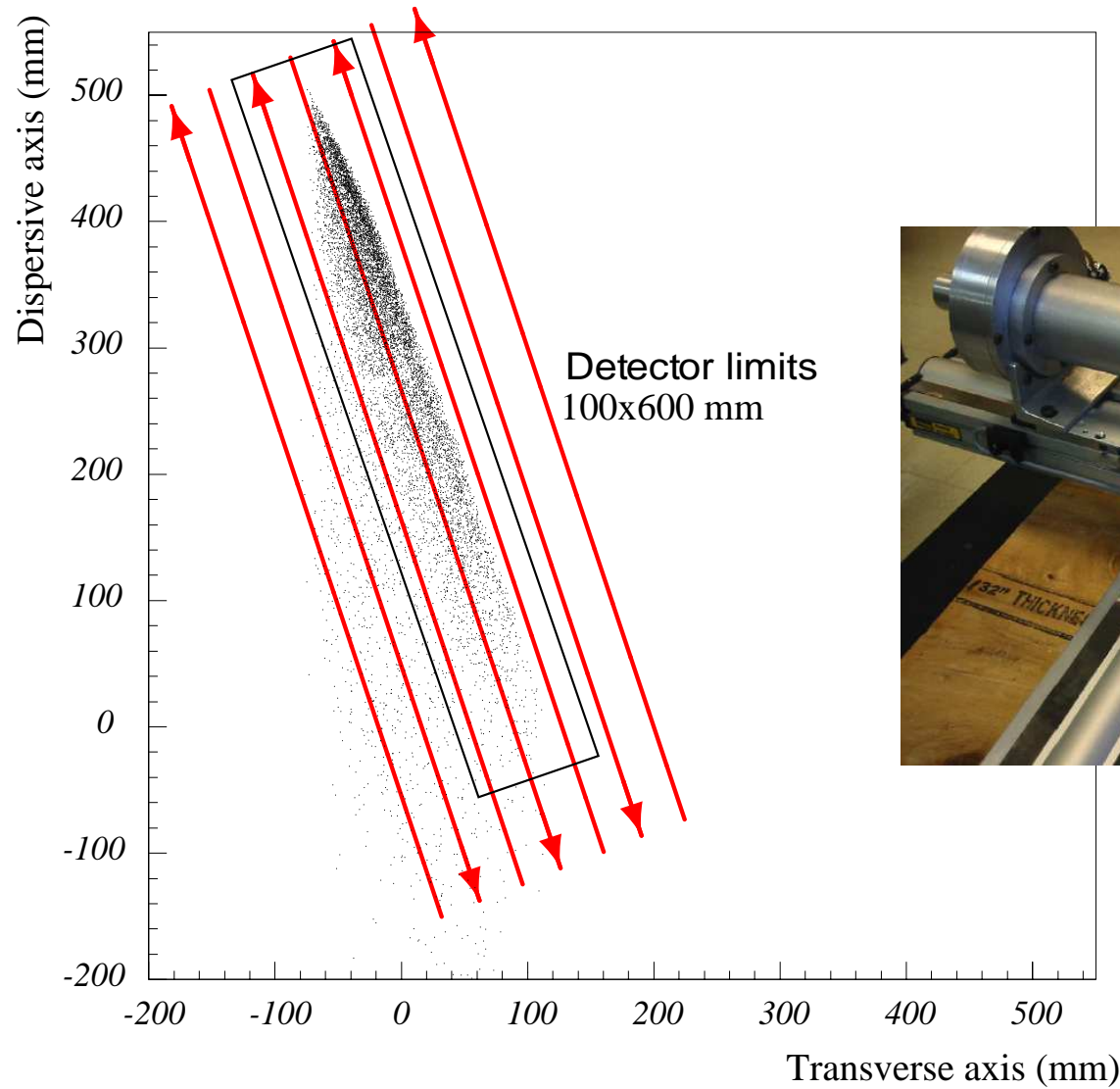
	$A^{PV}$	Relative Error	Precision
HAPPEX-H	1.2 ppm	5%	60 ppb
HAPPEX-He	8 ppm	3%	240 ppb

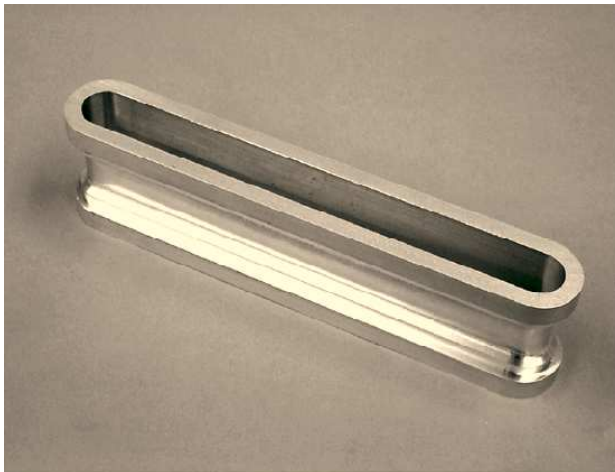
- Use HRS with septum magnets  $\rightarrow \theta = 6^\circ$
- $Q^2 = 0.1 \text{ (GeV/c)}^2$ ,  $E_0 = 3.0 \text{ GeV}$
- $100\mu\text{A}$ , 80% polarization
- Polarimetry: Hall A Møller & Compton (2%)



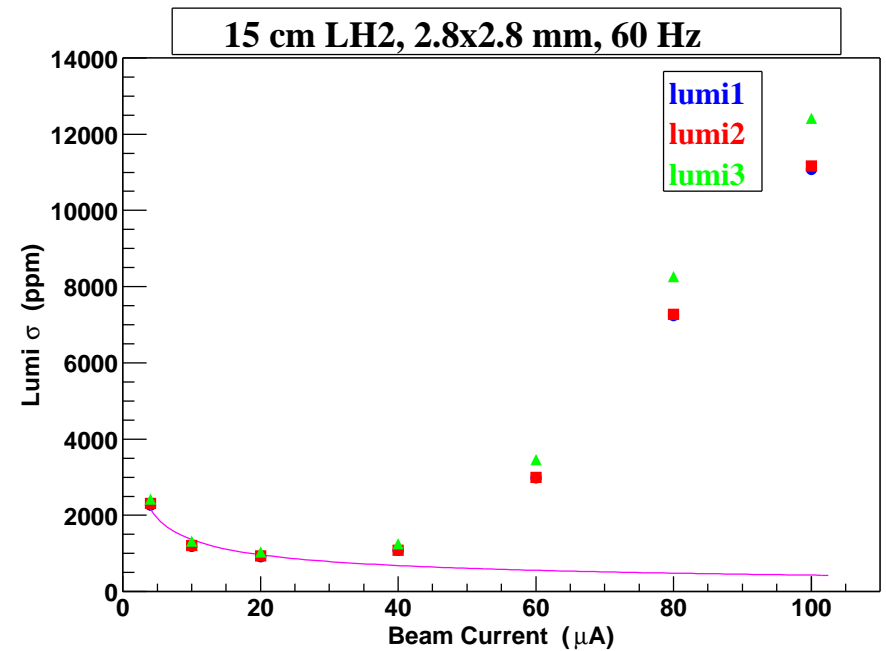


# Profile Scanner

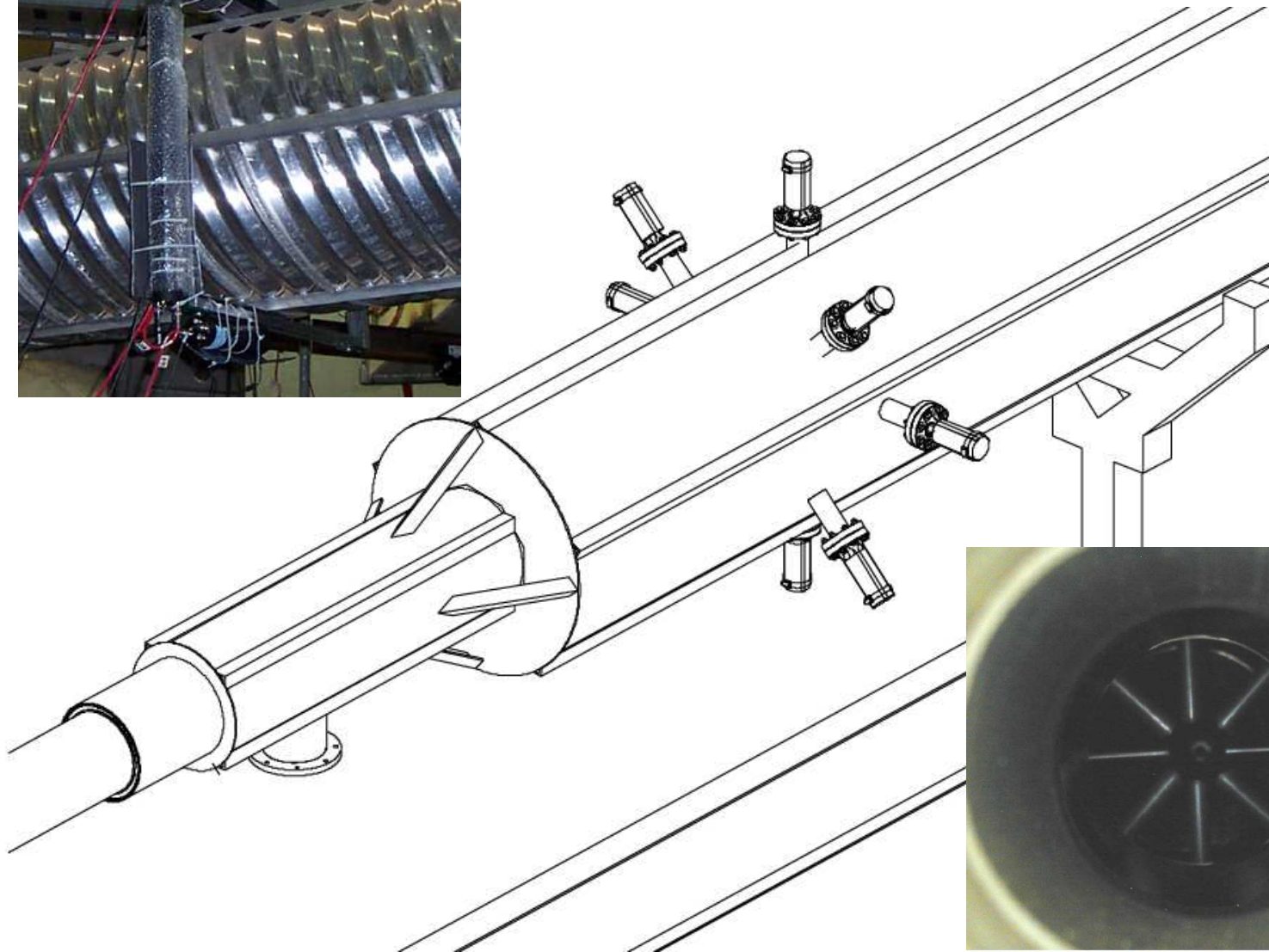
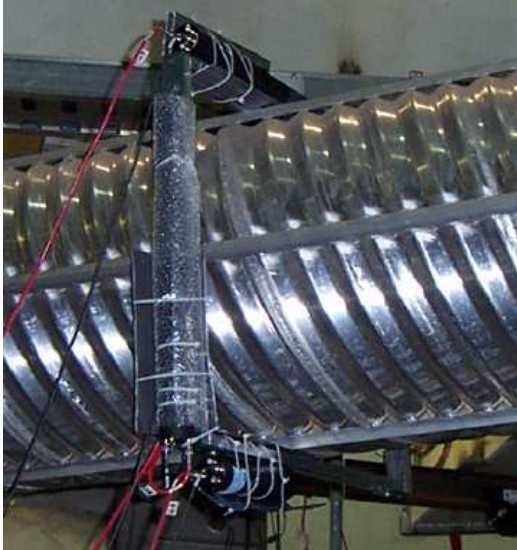


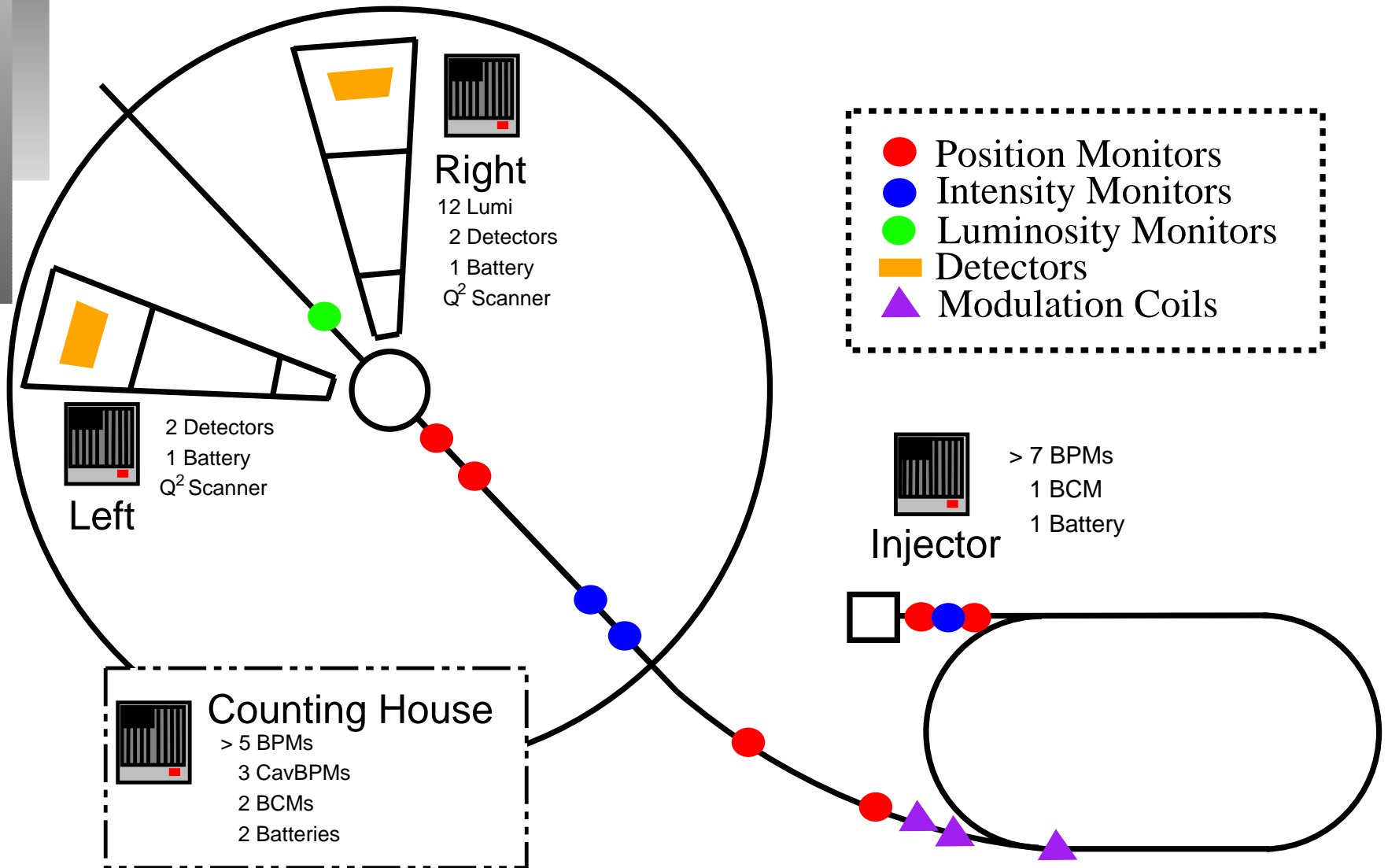


## 2002 Boiling Studies (TN-03-014)

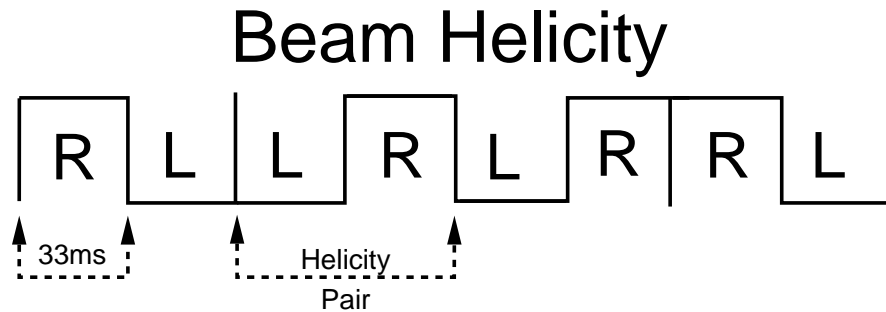


# Luminosity Monitor





# Measurement & Corrections

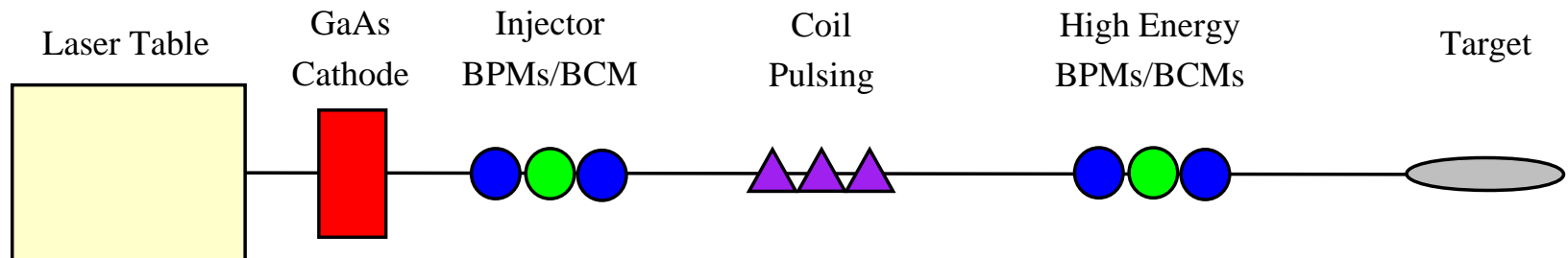


Integrated Detected Flux D

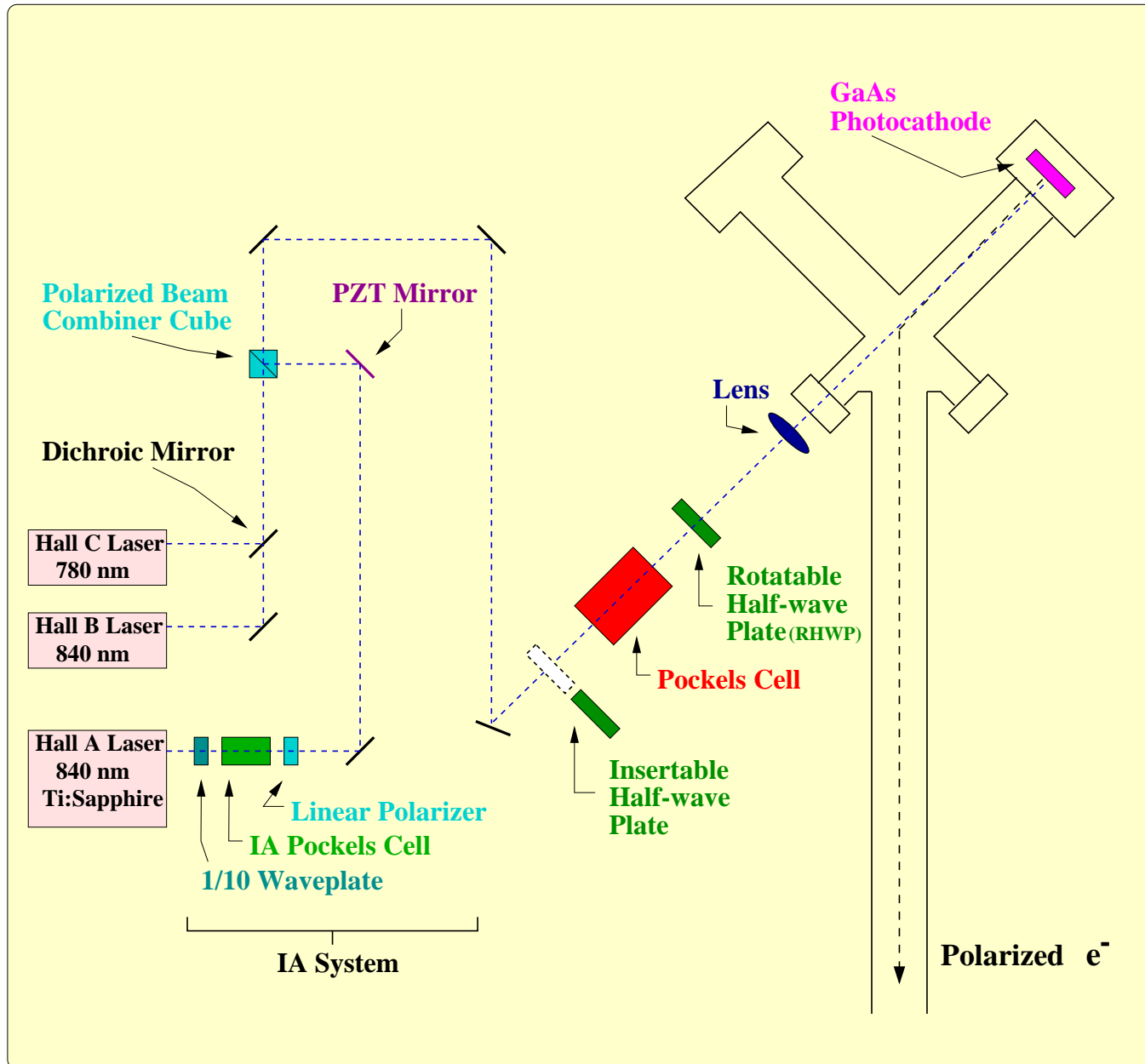
$$A_{det} = \frac{D_R - D_L}{D_R + D_L}$$

## Corrected Asymmetry

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



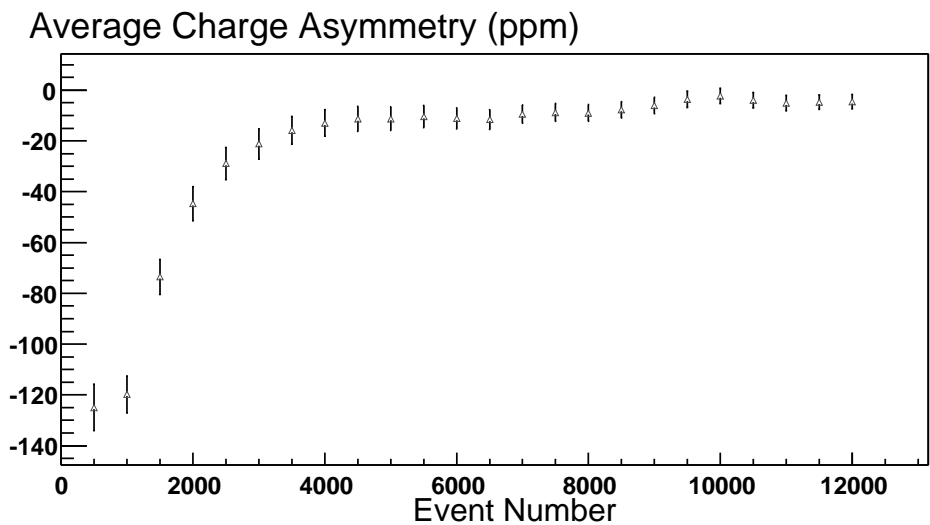
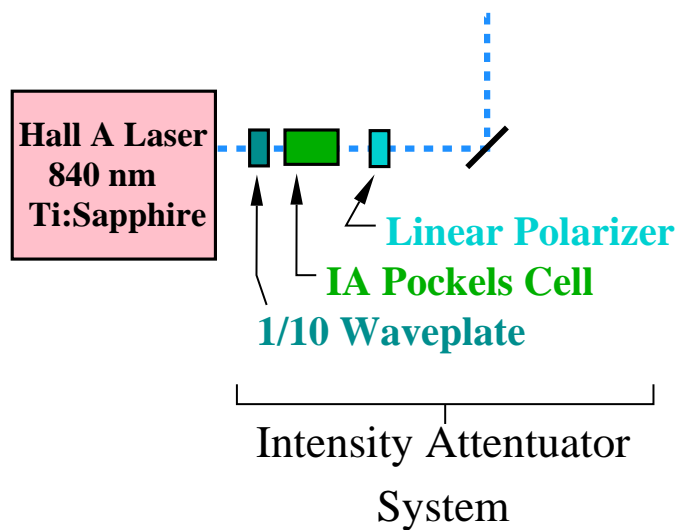
# Laser Table



# Charge 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



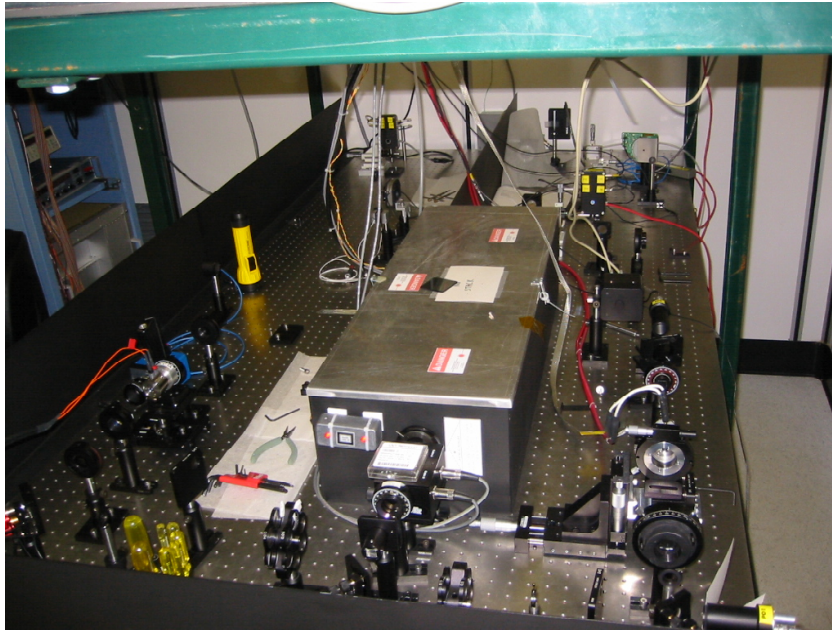
Spin-Duality (E01-012) @  $12\mu A$

$A_Q \sim 0.2$  ppm

## Position Differences

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

Goal (Run Avg.):  $\Delta x \leq 2 \text{ nm @ target}$



### ITS Laser Room

- Pockels Cells
- Ti-Sapphire Laser
- $\lambda$ -plates
- HV Switches

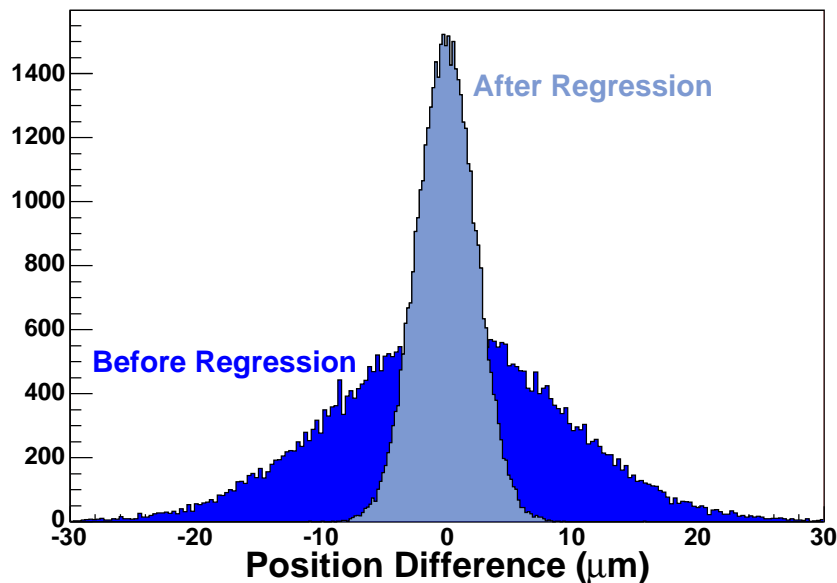
Injector Beam Studies

Adiabatic Damping

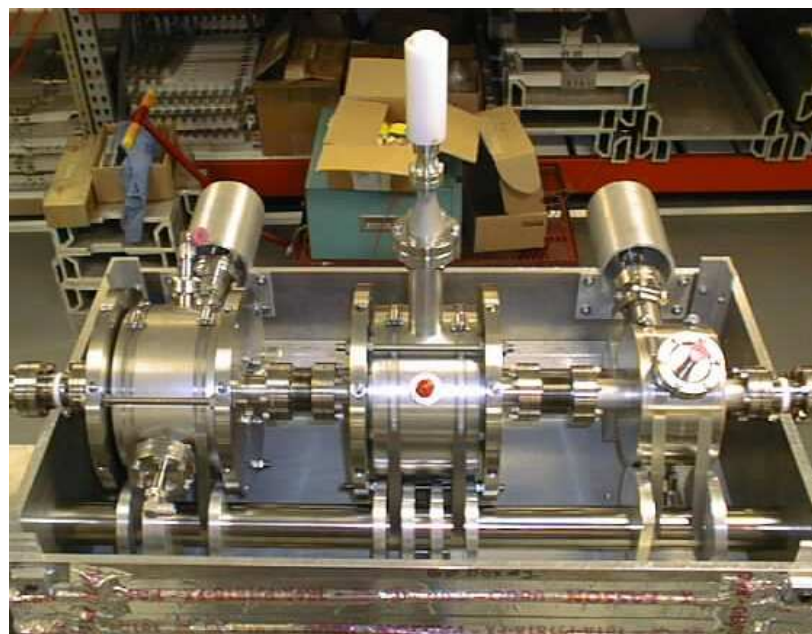


## Position Resolution

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



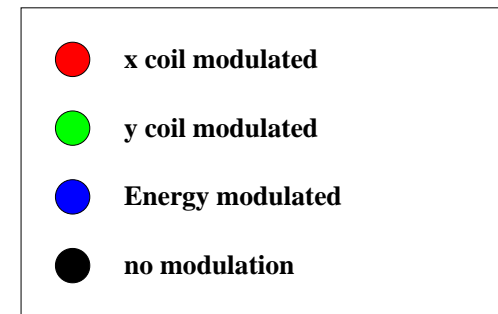
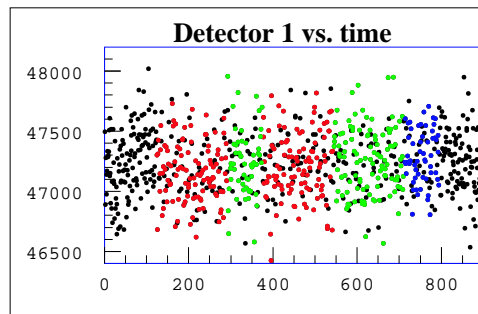
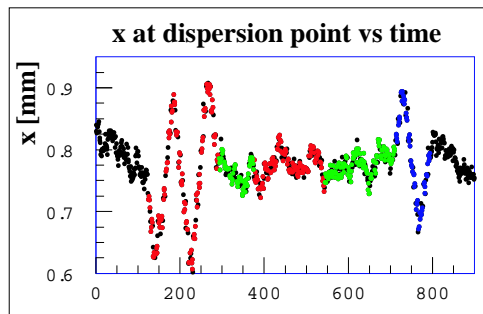
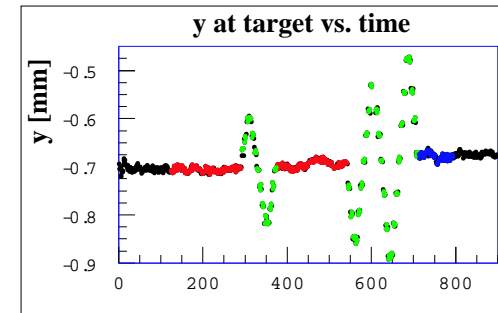
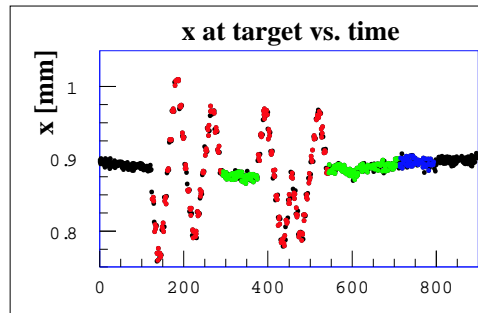
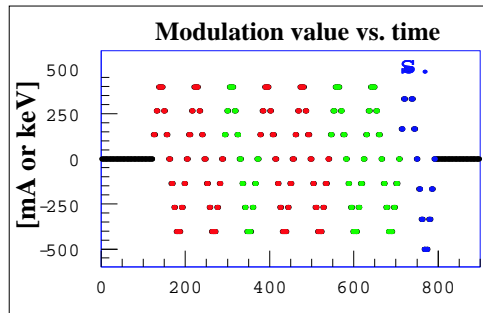
Stripline Position Monitor  
Resolution  $\sim 1.8\mu\text{m}$



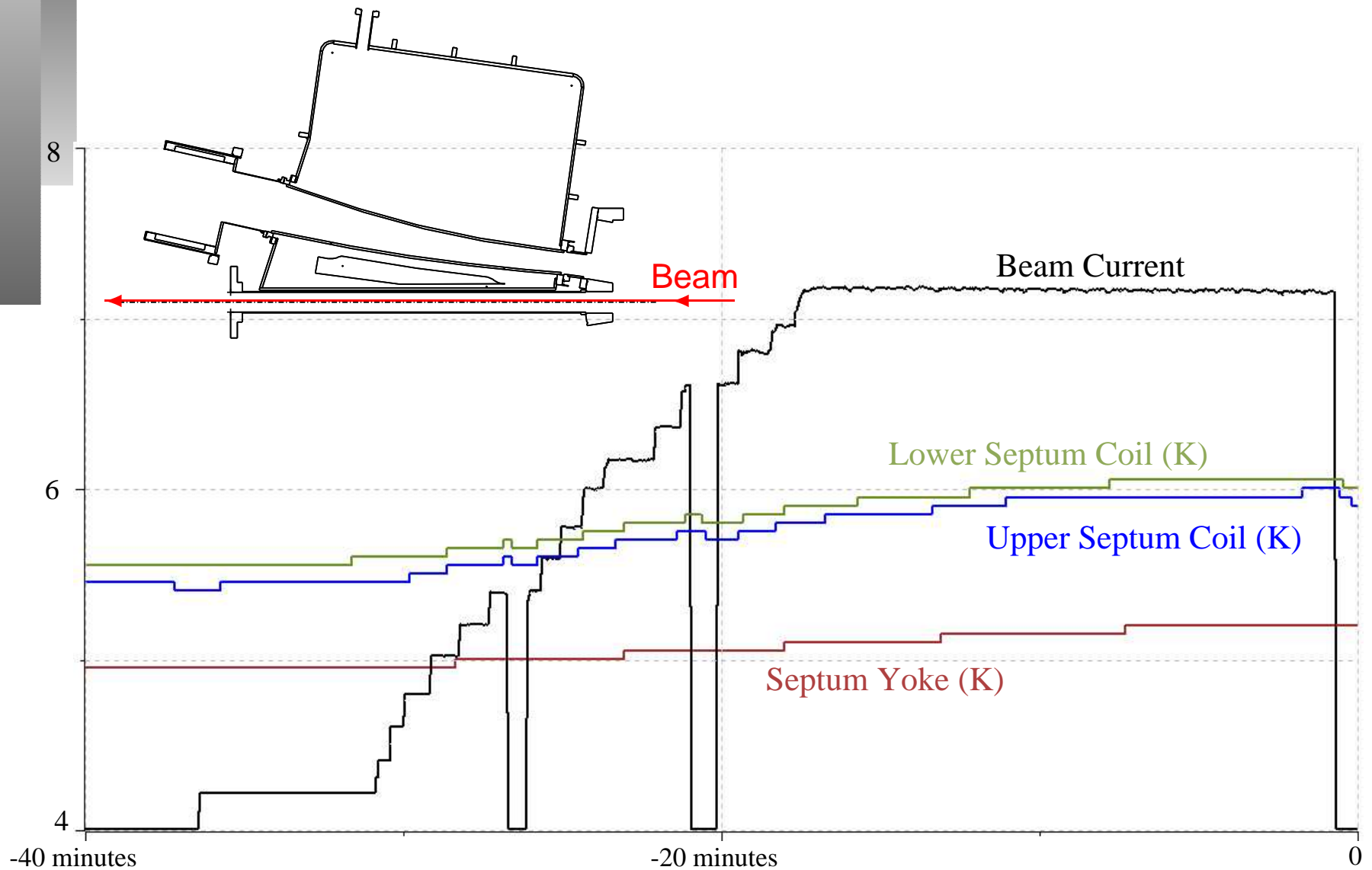
Cavity Position Monitors

# Beam Modulation

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

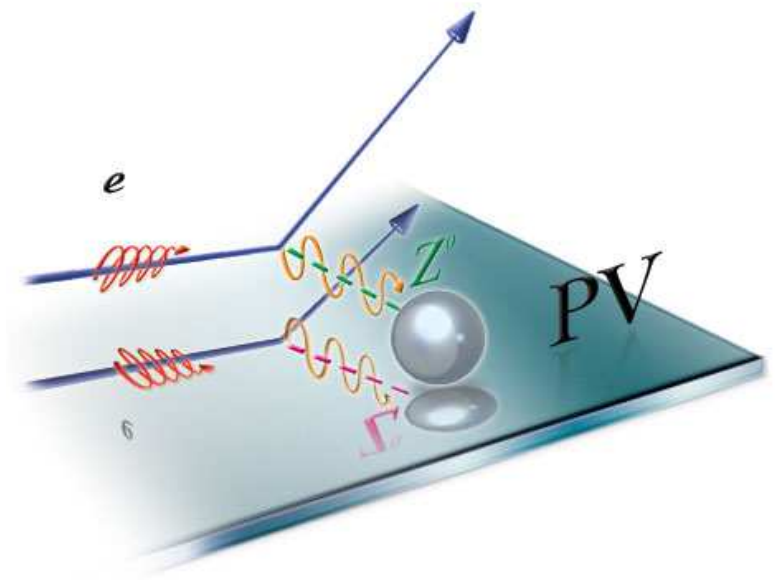


# Septum Heating



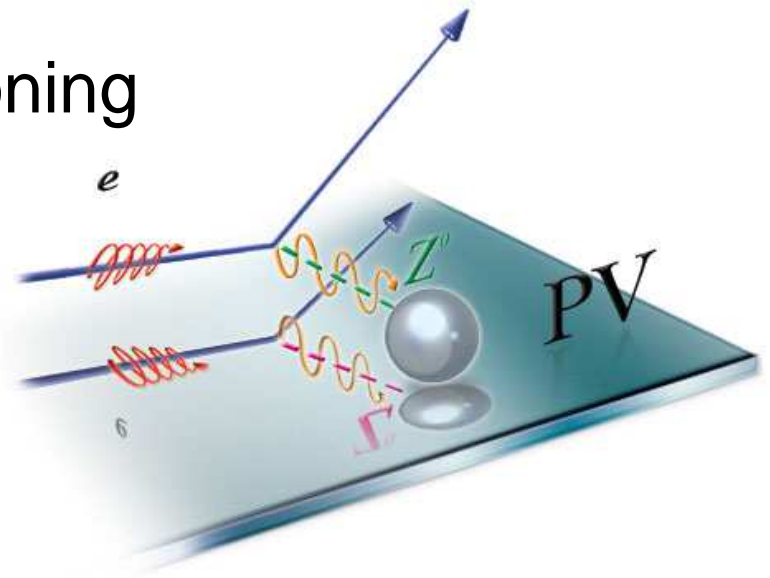
# Summary & Conclusion

- Continuing Progress
  - ★ Minimizing Position Differences at the Source



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- Continuing Progress
  - ★ Minimizing Position Differences at the Source
- Planned Tests/Commissioning
  - ★ Septum Heating
  - ★ Beam Modulation
  - ★ Luminosity Monitors
  - ★ Cavity Monitors



# Summary & Conclusion

- Continuing Progress
  - ★ Minimizing Position Differences at the Source
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  - ★ Beam Modulation
  - ★ Luminosity Monitors
  - ★ Cavity Monitors
- Ready for Beam (April 2004)

