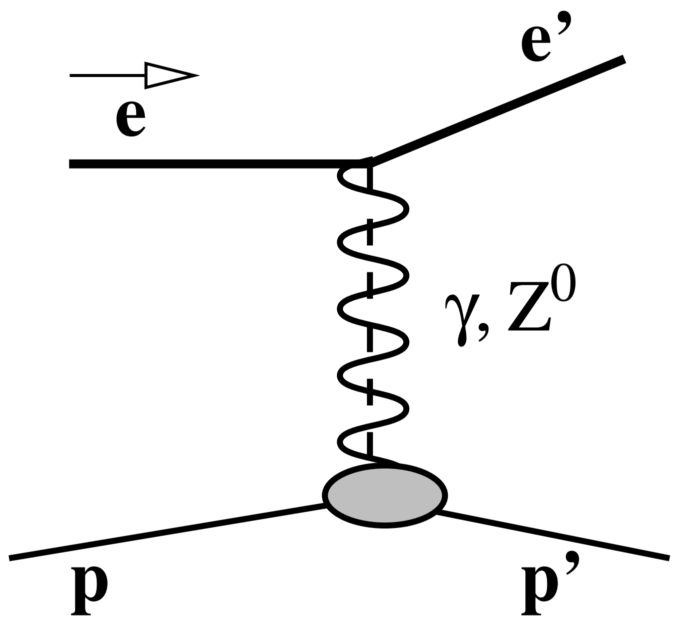
MEASUREMENT OF THE STRANGENESS CONTENT OF THE PROTON THROUGH PARITY VIOLATING ELECTRON SCATTERING AT JLAB

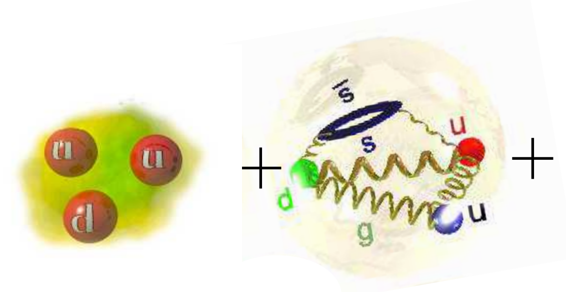


HAPPEX collaboration

OUTLINE

- Physics motivation
- Experimental design
- Systematics
- Preliminary results from 99' run
- Summary, outlook

Strangeness in the nucleon

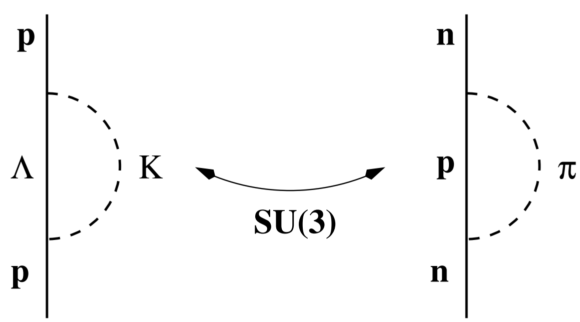
Nucleon =  **+ •••**

Valence + quark-gluon sea

Does strangeness play a role in the ground state of the nucleon?

No valence contribution

→ **Unique and pure probe of the sea**

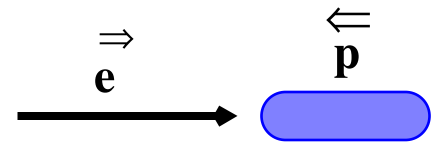


SU(3) image of the π-loop contribution in G_E^n , decorrelated from the quarks contribution.

Strange Matrix Elements

- **Lepton deep inelastic scattering:**

  $\langle N|\bar{s}\gamma_\mu\gamma_5 s|N\rangle$ **Axial vector matrix element.**

  Sea contributes to the spin, $\Delta s \sim -10\%$ [SU(3)]

  $$A = \frac{\sigma_{\uparrow\uparrow} - \sigma_{\uparrow\downarrow}}{\sigma_{\uparrow\uparrow} + \sigma_{\uparrow\downarrow}}$$

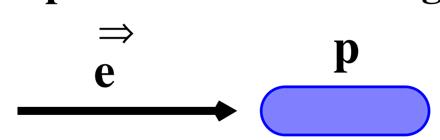
- **π-N scattering:**

  $\langle N|\bar{s}s|N\rangle$ **Scalar matrix element**

  s quarks = 15 % of the mass [Many assumptions]

- **Vector matrix element?** $\langle N|\bar{s}\gamma_\mu s|N\rangle$

  Lepton elastic scattering

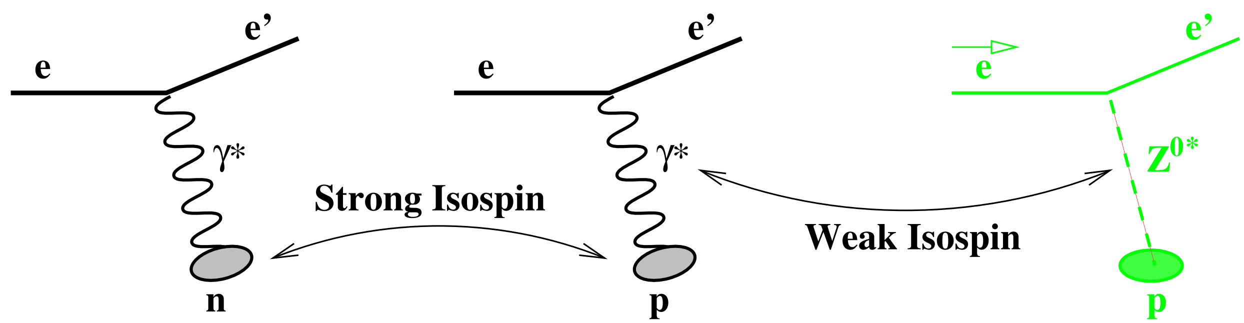
  Contribution to charge and current distributions

  Clean observables of the strangeness of the nucleon

  [Assumes only isospin and Standard Model]

  $$A = \frac{\sigma_{\uparrow} - \sigma_{\downarrow}}{\sigma_{\uparrow} + \sigma_{\downarrow}}$$

Parity Violating Electron Scattering



Assuming three flavor degrees of freedom:

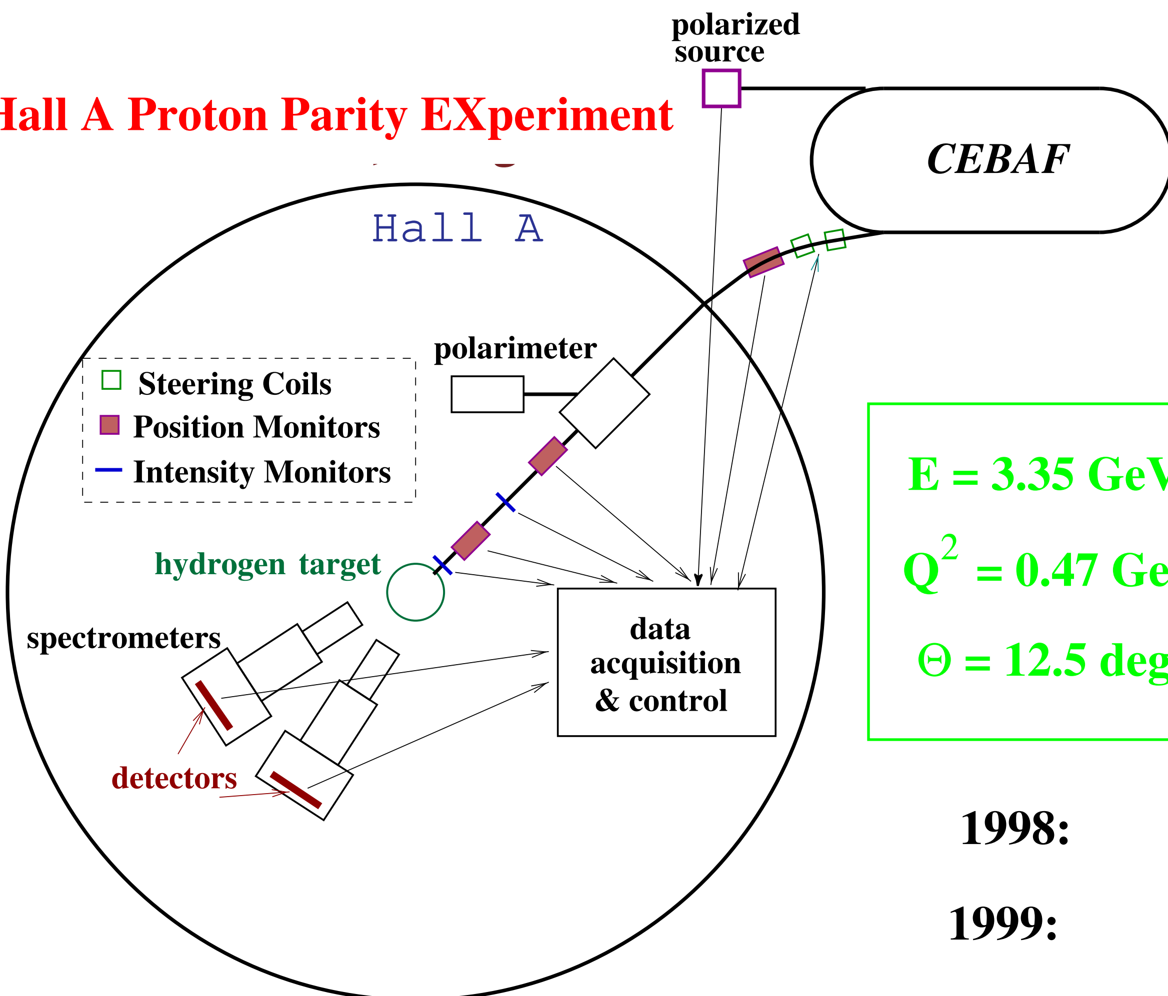
$$G_p^Z = \frac{1}{4}(1 - 4\sin\Theta_W)G_p^{\gamma} - G_n^{\gamma} - \boxed{G^s}$$

$$\sigma = \left|M_{\gamma} + M_Z\right|^2 \qquad A = \frac{\sigma_{\uparrow} - \sigma_{\downarrow}}{\sigma_{\uparrow} + \sigma_{\downarrow}} \sim \frac{M_Z}{M_{\gamma}} \sim 10^{-6} \;\; (\mathrm{Q}^2 = 0.1\ \mathrm{GeV}^2)$$

$$A^{PV} = -\frac{G_F Q^2}{4\pi\alpha\sqrt{2}} \times \left\{(1 - 4\sin\Theta_W{}^2) - \frac{\varepsilon G_E^p\,(G_E^n + G_E^s) + \tau G_M^p\,(G_M^n + G_M^s) - \cancel{(1 - 4\sin\Theta)\varepsilon' G_M^p\,G_A^p}}{\varepsilon G_E^{p\,2} + \tau G_M^{p\,2}}\right\}$$

HAPPEX: An Overview

Hall A Proton Parity EXperiment



Jefferson Lab
Princeton
Saclay
Syracuse
William &Mary
Hall A collaboration

$E = 3.35$ GeV

$Q^2 = 0.47$ GeV

$\Theta = 12.5$ deg.

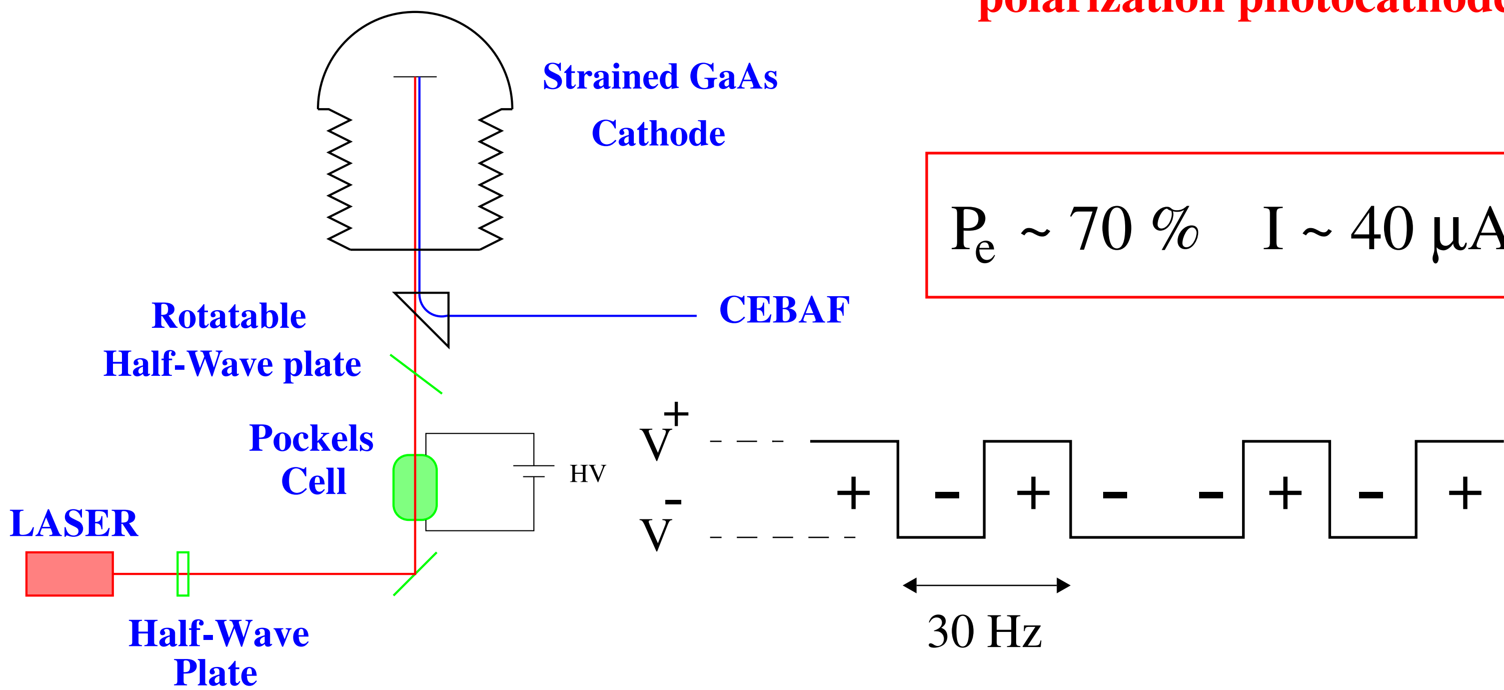
A ~ 15 ppm

Rate = 2 MHz

1998:	37%	100µA	80C
1999:	70%	35µA	75C
1999(II):	75%	45µA	~10C

Polarized Source

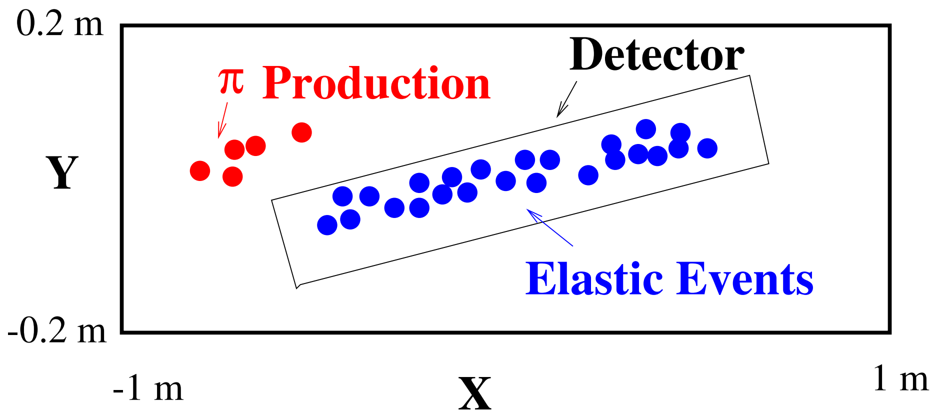
1999 run:
First parity violation measurement with high polarization photocathode.



$P_e \sim 70\ \%$ $\quad I \sim 40\ \mu A$

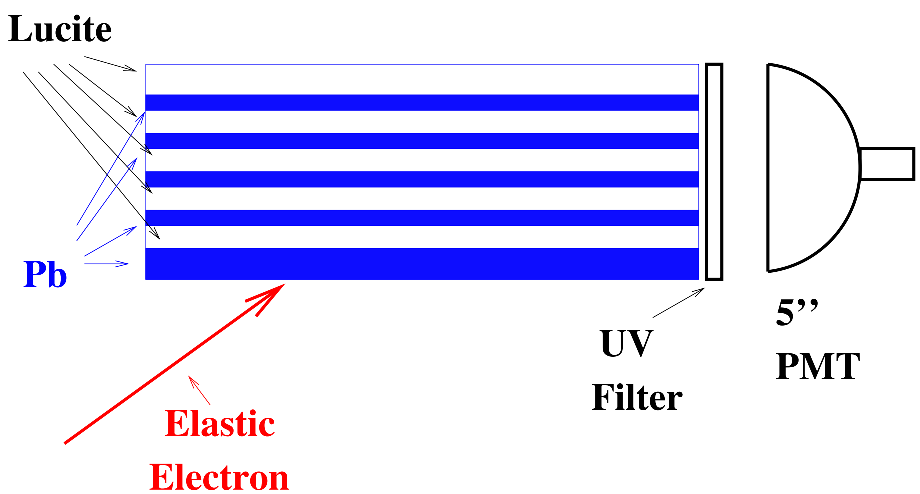
- Rapid and Random Helicity Flips
- Sign Reversal using a Half-Wave plate

Detection



Inelastic discrimination

in the focal plane of the HRS



Electron Calorimeter:

- **Lead-lucite sandwich**
- **Signal integrated over helicity pulse**
- **No dead time**
- **No background rejection**

Normalization

- **Polarimetry**

  Moller already at 3%.

  Monitoring with Compton.

  Better syst. in 1999.

- **Q^2 determination**

  $$\frac{\delta Q^2}{Q^2} \sim 2 \times \frac{\delta\Theta}{\Theta}$$

  Main error: determination of scattering angle

  Syst. = 1.2%

- **Background**

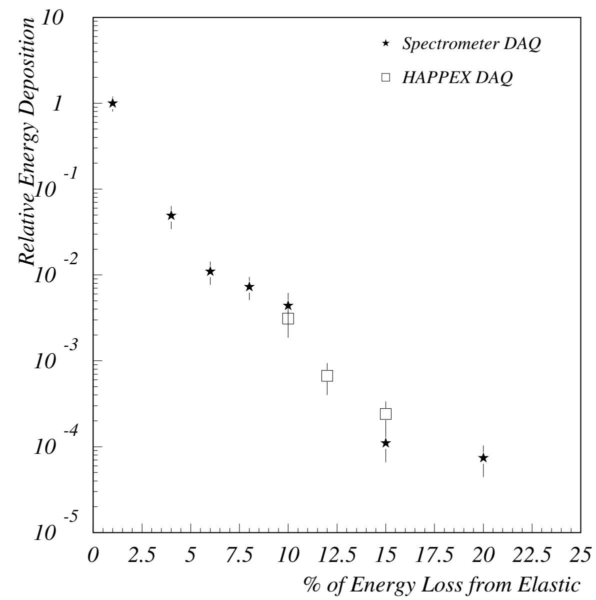
  *** Quasi-elastic in end-caps**

  *** Pole-tip scattering**

  *** Rescattering of inelastic events**

  Syst. ~ 2%

Dipole scan: HAPPEX data at 12 deg.



Conclusions and Outlook

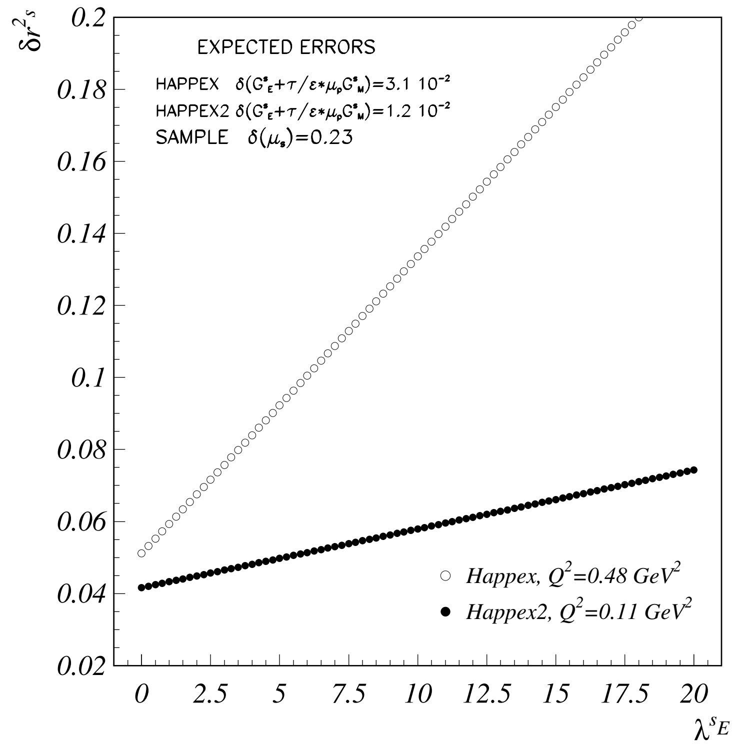
Successfull HAPPEX runs:

Fisrt point, at $Q^2 = 0.47 GeV^2$

Anticipated stat. error of 6.5%

Very good control of the systematics

$\rightarrow$ **Cebaf meets all the requirements for accurate measurements of the weak form factors**



Measurements at low Q^2**:**

HAPPEX2 accepted in hall A at Jlab.

SAMPLE+HAPPEX2 should give powerfull constraint on the nucleon strangeness radius.

1998 Results

Source of error	**ΔA/A (%)**
Statistics	13.4
Beam polarization	7.0
Q^2 Determination	1.0
Background	2.0
Radiative Corrections	1.4
G_E^n	9.6
Nucleon form factors	4.0

$$A_{Exp} = -14.7 \pm 2.0(stat) \pm 1.1(syst)\, ppm$$

$$G_E^s + 0.39 G_M^s = 0.023 \pm 0.034(stat) \pm 0.022(syst) \pm 0.026(\delta G_E^n)$$