Measurement of G_E^n from $\vec{d}(\vec{e}, e'n)p$ at Jefferson Lab

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Outline

- Motivation and background
- Double polarization experiments
- Experimental setup
- Data analysis
- Results and discussion

G_E^n is IMPORTANT because:

- is related to charge distribution in neutrons
- provides a test for models of nucleon structure
- essential in electronuclear calculations

G_E^n is POORLY KNOWN because:

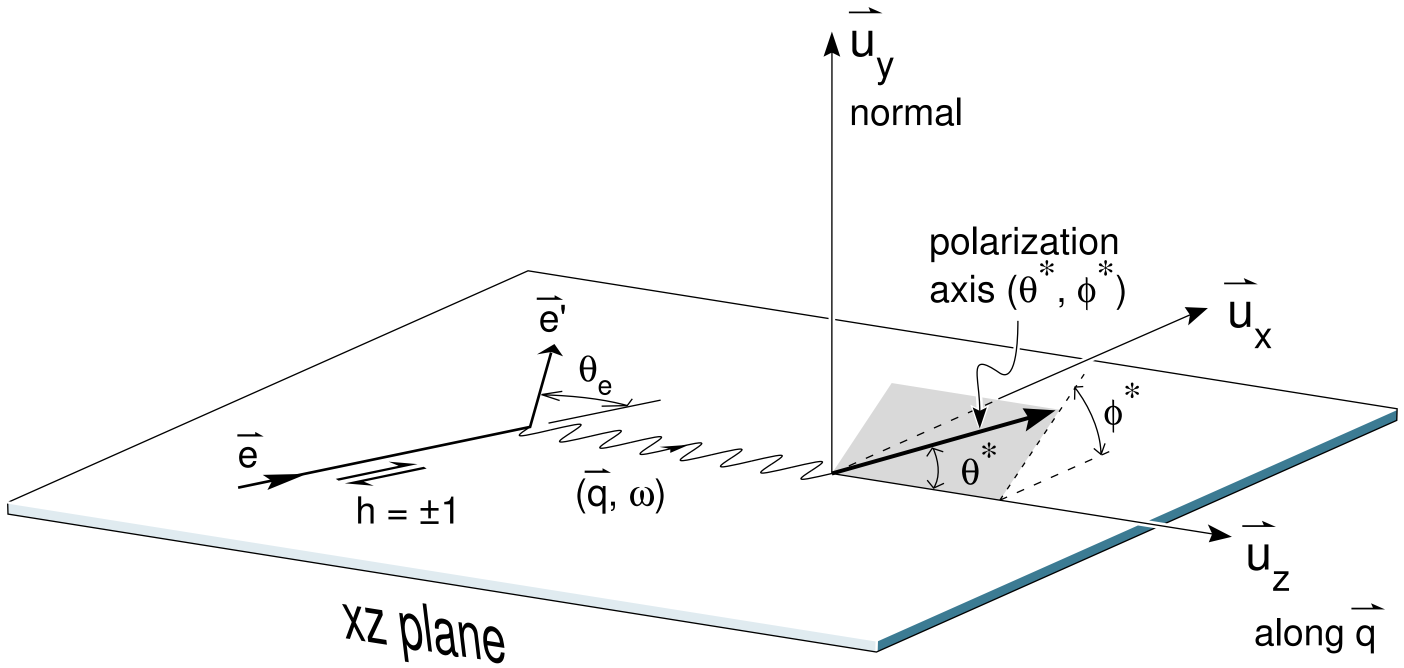
- no free neutron targets (nuclear effects)
- neutrons don't have net charge (G_E^n is small)

$$(\frac{d\sigma}{d\Omega})^{pol} = (\frac{d\sigma}{d\Omega})_{Mott} f_{rec}^{-1} \left[\Sigma + hP_t\Delta\right]$$

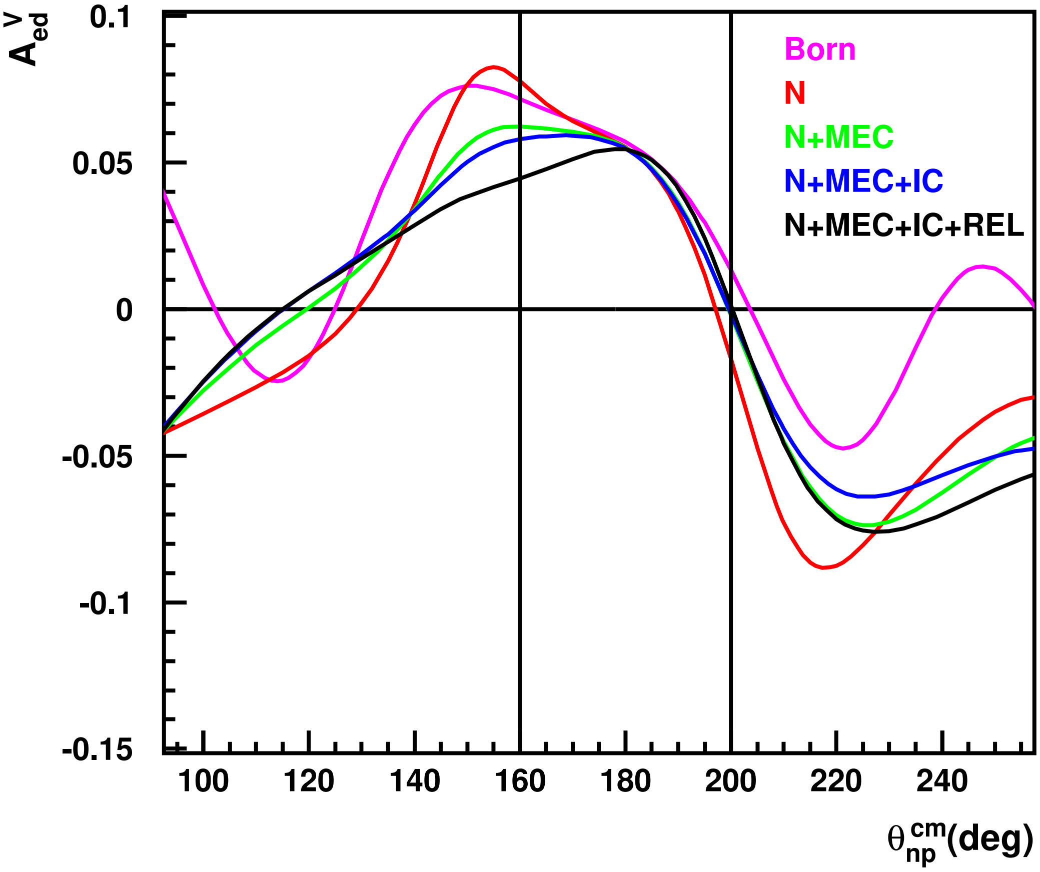
$$\Sigma = \frac{(G_E^n)^2 + \tau(G_M^n)^2}{1+\tau} + 2\tau(G_E^n)^2 \tan^2(\theta_e/2)$$

$$A_{en}^V = \frac{\Delta}{\Sigma} = \frac{-2\sqrt{\tau(1+\tau)}\tan(\theta_e/2) G_E^n G_M^n}{(G_E^n)^2 + \tau\left[+2(1+\tau)\tan^2(\theta_e/2)\right](G_M^n)^2}$$

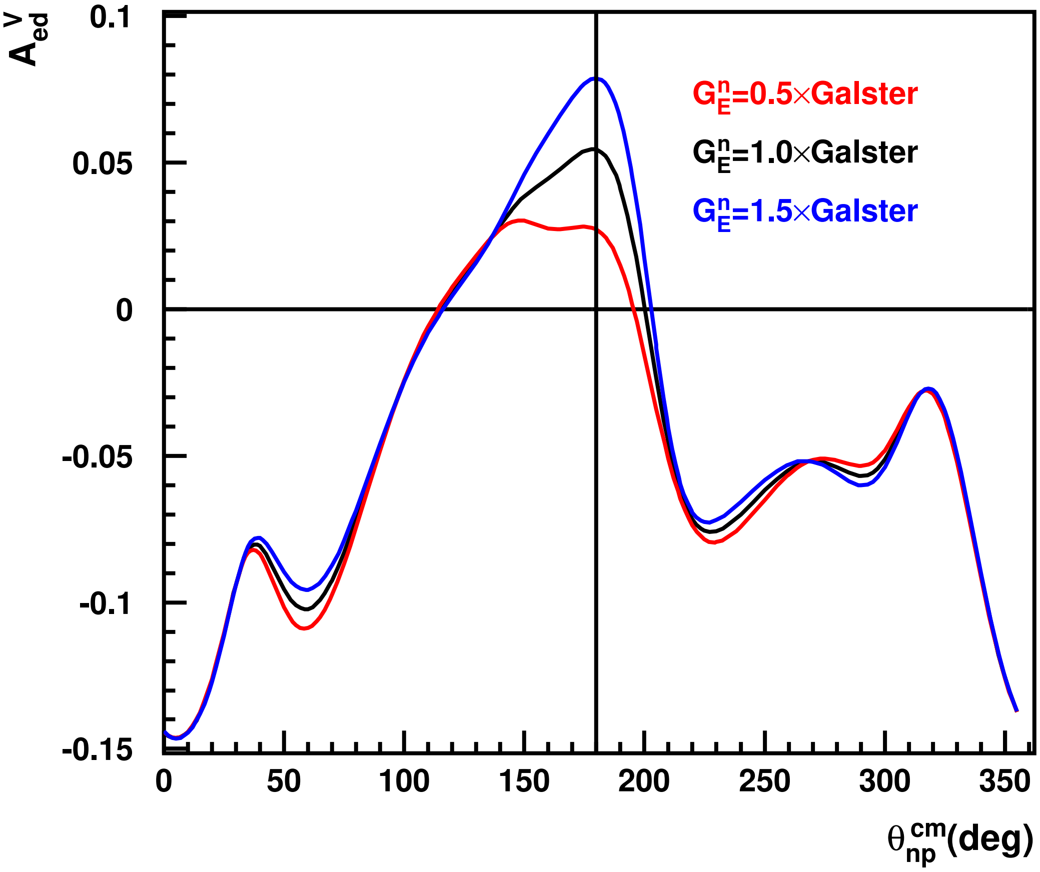
(for $\phi^* = 0$ or 180° and $\theta^* = \pi/2$)



Minimize model dependence



Maximize sensitivity to G_E^n.



JLab E-93026:

- data taken: Aug-Oct 1998 and July-Dec 2001
- kinematics measured: $Q^2 = 0.5$ and $Q^2 = 1.0$
- $Q^2 = 0.5$ kinematics:
  $E_{beam} = 2.332$ GeV
  $\theta_e = 18.5^\circ$
- 5×10^6 neutrons at $Q^2 = 0.5$
  1×10^6 neutrons at $Q^2 = 1.0$
- analysis still in progress

Gen01 Collaboration

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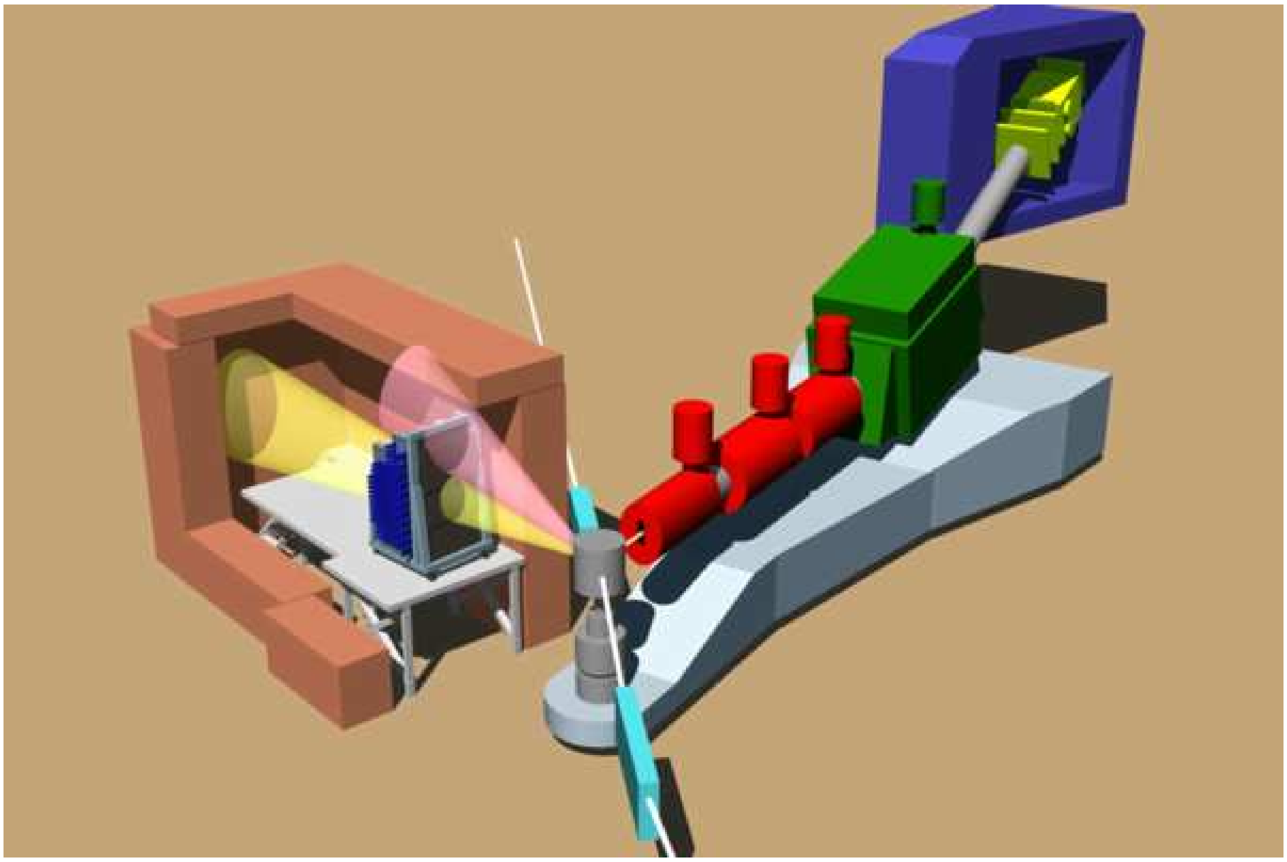
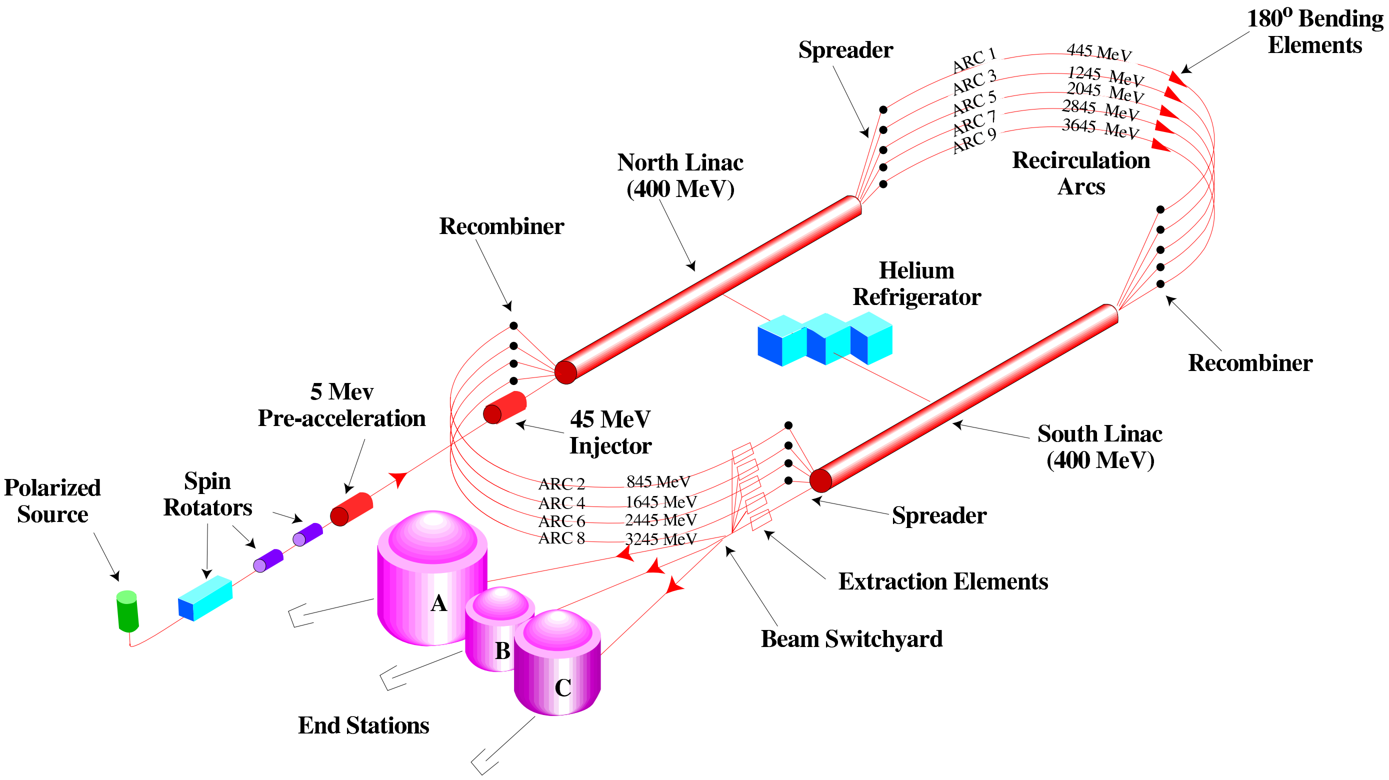
Duke University, Florida International University, Hampton University, Jefferson Lab, Louisiana Tech University, Mississippi State University, Norfolk State University, North Carolina A&T State University, Old Dominion University, Ohio University, Southern University at New Orleans, Tel Aviv University, University of Basel, University of Maryland at College Park, University of Virginia, Virginia Polytechnic Institute & State University, Vrije Universiteit of Amsterdam, Yerevan Physics Institute

Experimental setup



- polarized $^{15}ND_3$ target
- Hall C HMS
- neutron detector

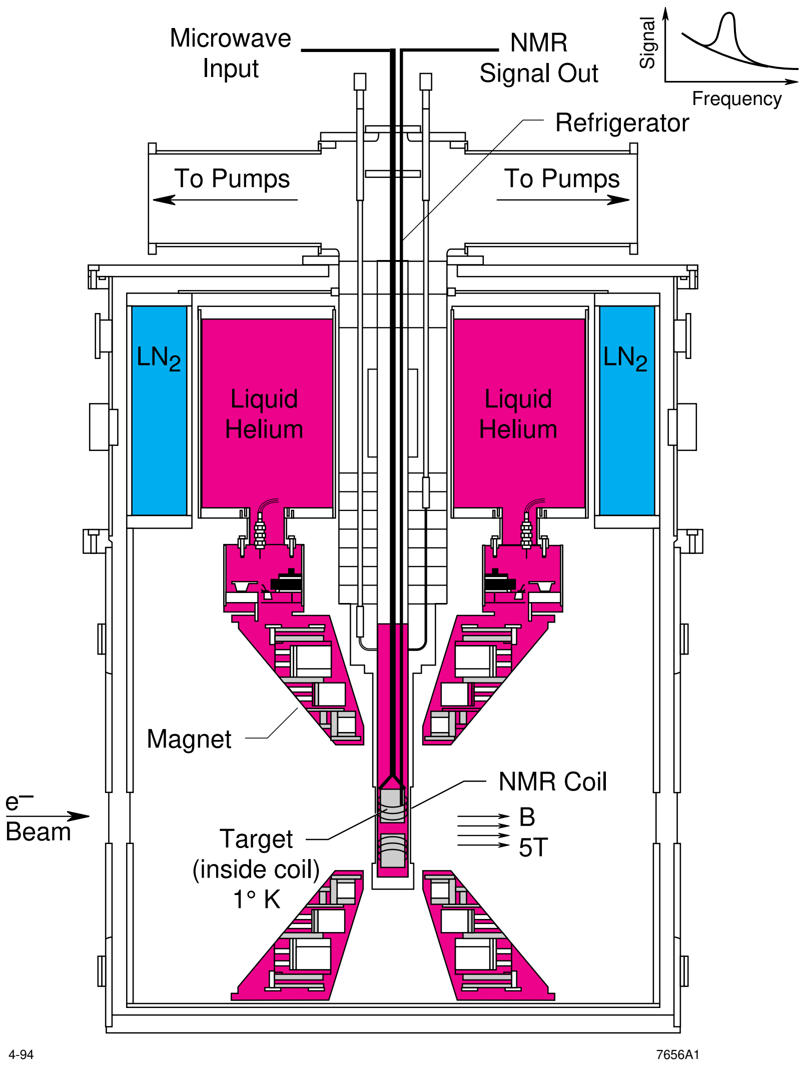


- 5.8 GeV machine (currently being upgraded to 12 GeV)

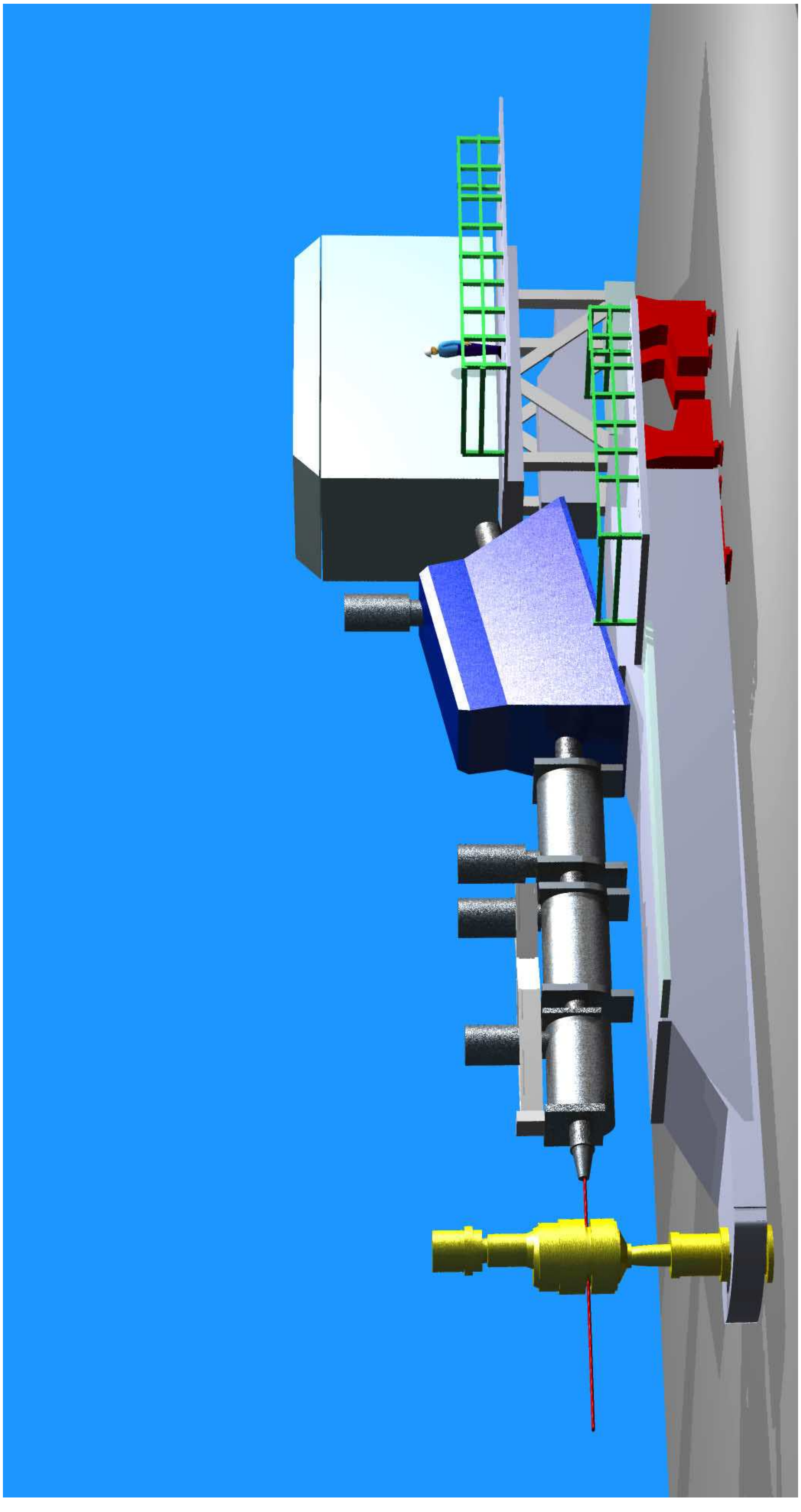
- electron polarization up to 80%

- capable of delivering beam to 3 independent experimental halls

- beam rastered over the face of the target



- frozen $^{15}ND_3$ in 1K He bath
- polarization continuosly measured by NMR circuit
- average polarization = 22%



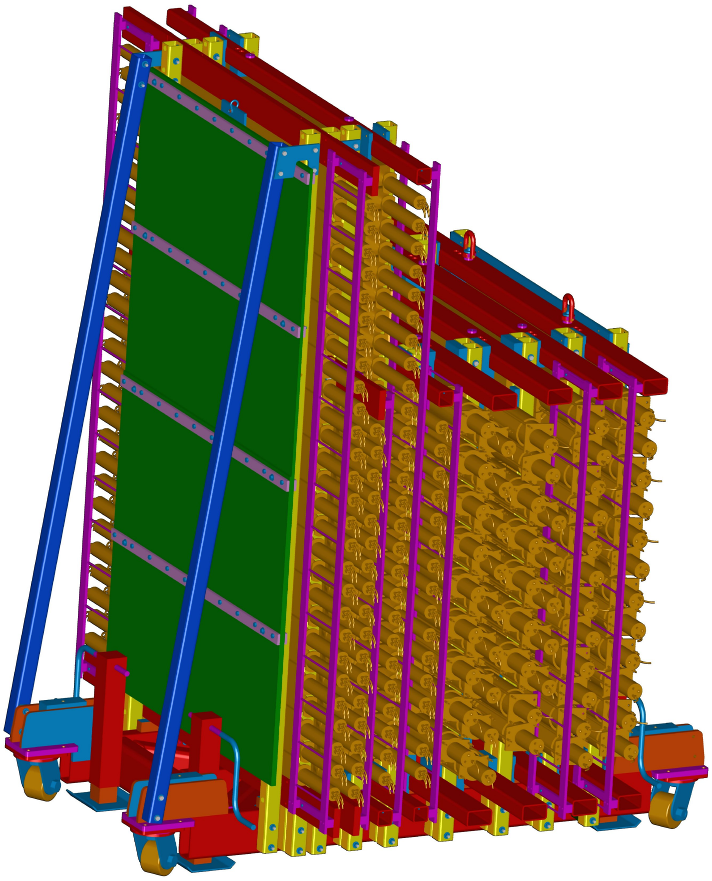
- collimator system

- three quandrupoles and one dipole

- detector hut:
  - two drift chambers
  - two hodoscopes
  - gas Čerenkov counter
  - lead-glass shower counter

- $d\Omega \sim 6\ msrad$
  $\frac{\Delta P}{P} \sim 20\%$
  $\delta p = 0.1\%$
  $\delta\theta(\phi) \sim 1\ mrad$

Front angle view of the neutron detector



- 2 paddle planes for particle ID

- 6 bar plane for neutron detection
  - spatial resolution $\sim 10\ cm$
  - time resolution $\sim 400\ ps$

Event selection

- $\theta_e > 0.26$
- $|W - 0.939| \leq 0.05$ GeV/c^2
- $E' > 2.002$ GeV
- -3 ns $< \Delta t <$ 5 ns
- $|y_{pos}| <$ 40 cm
- $\theta_{pq} < 0.11$

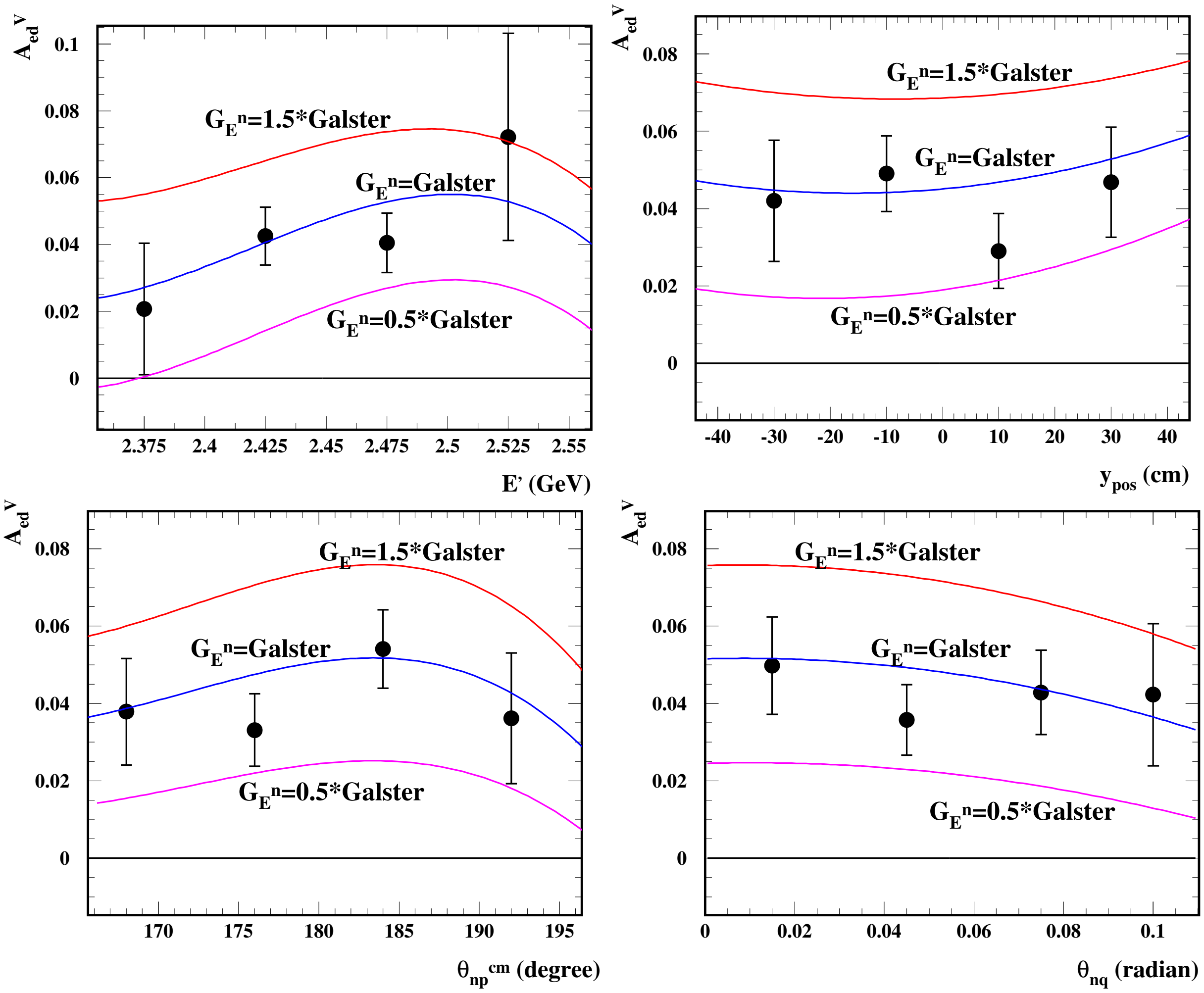
From ϵ to A_{ed}^V

$$\epsilon = \frac{\frac{N^+}{Q^+(1-dt^+)} - \frac{N^-}{Q^-(1-dt^-)}}{\frac{N^+}{Q^+(1-dt^+)} + \frac{N^-}{Q^-(1-dt^-)}} = P_B P_T f A_{ed}^V$$

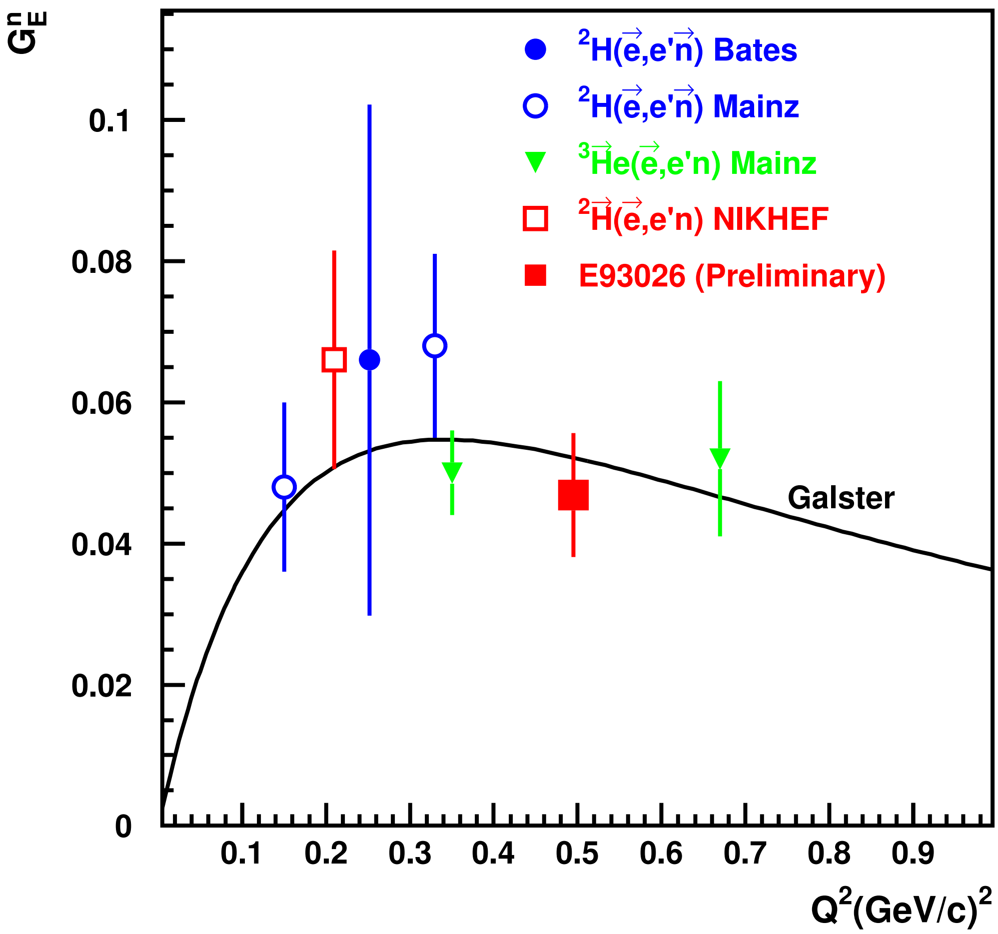
Corrections:

- Dilution factor
- Proton contamination
- Accidental background
- Radiative corrections

From A_{ed}^V to G_E^n



PRELIMINARY results



$$G_E^n = 0.87 \times Galster$$

$$\left(\frac{\delta G_E^n}{G_E^n}\right)_{stat} = 7.4\%$$

Systematic uncertainties

Target polarization	3-5%
Beam polarization	1%
Dilution factor	3%
Cut dependence	2%
Kinematic uncertainties	2%
Uncertainty in G_M^n	1.7%
Other	1%
Total	$6-8\%$