The Polarized ^{3}He Target for the Measurement of G_E^n at high Q^2 in Hall A

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for the G_E^n/Hall A Collaboration

University of Kentucky

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Outline

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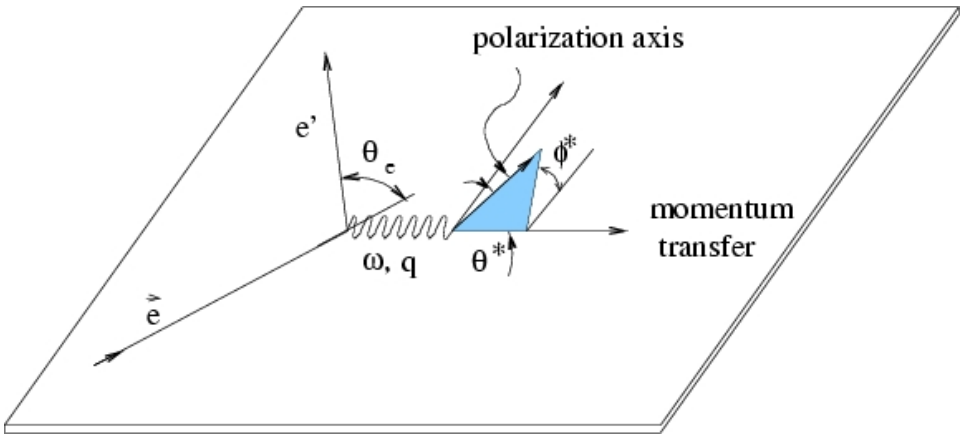
The Basics of G_E^n

$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_{Mott} \frac{E'}{E}\left(\frac{G_E{}^2 + \tau G_M{}^2}{1+\tau}\cos^2\frac{\theta}{2} + 2\tau G_M{}^2 \sin^2\frac{\theta}{2}\right) \Longrightarrow \text{Dominated by } G_M$$

Asymmetry

$$A_T = -\frac{2\sqrt{\tau(\tau+1)}\tan\frac{\theta}{2}\frac{G_E}{G_M}}{\left(\frac{G_E}{G_M}\right)^2 + (\tau + 2\tau(\tau+1))\tan^2\frac{\theta}{2}}$$

$\tau = Q^2/2M$



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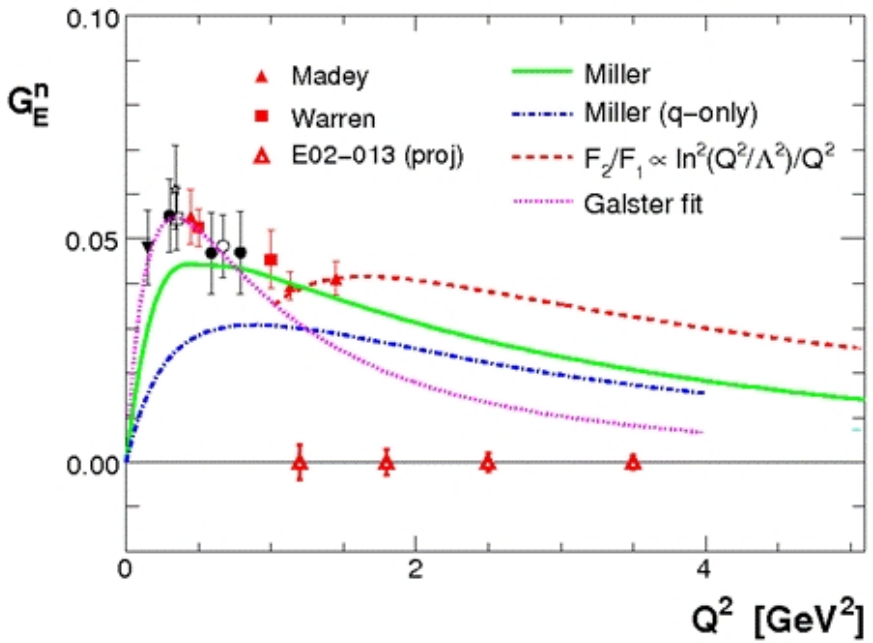

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Polarized ^{3}He as a Polarized Neutron Target

- Free neutrons have a lifetime of about 15 minutes.
- For ^{3}He, 90% of the spin comes from neutrons
- Luminosity $\sim 10^{37}$ neutrons/cm^2/s or density?
- Is easy to polarize and maintain polarization

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$$n \rightarrow p + e^- + \overline{\nu_e}$$

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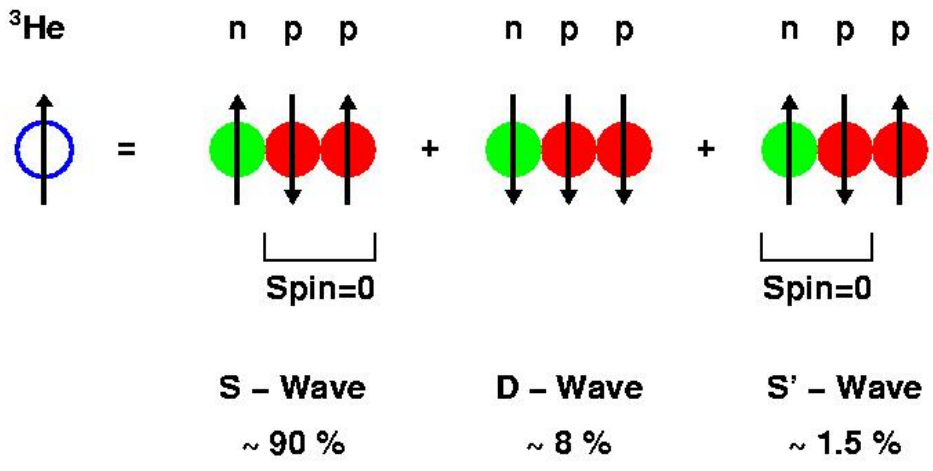

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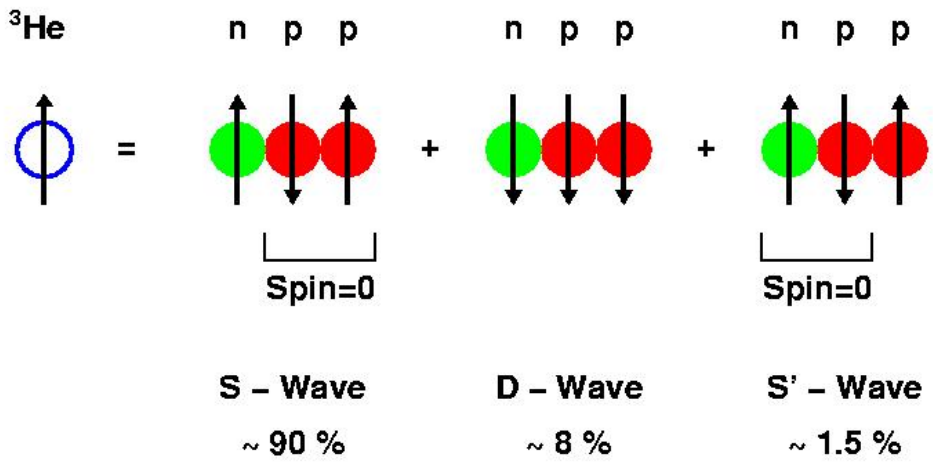

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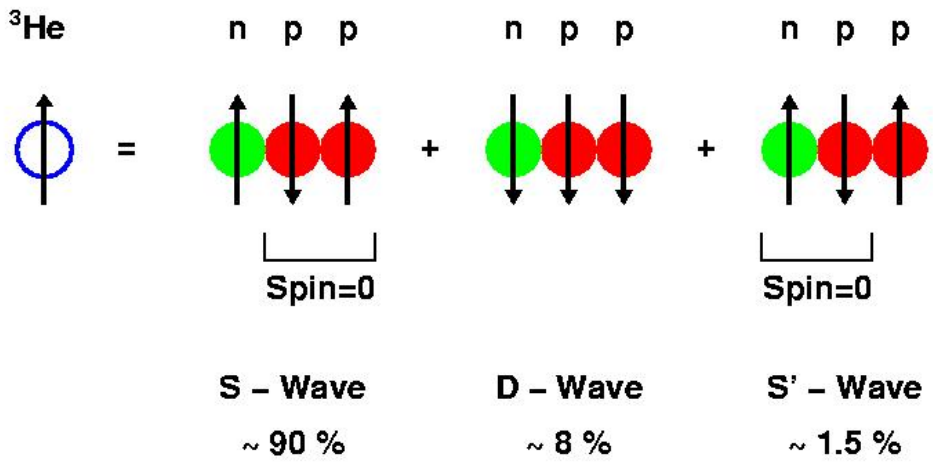
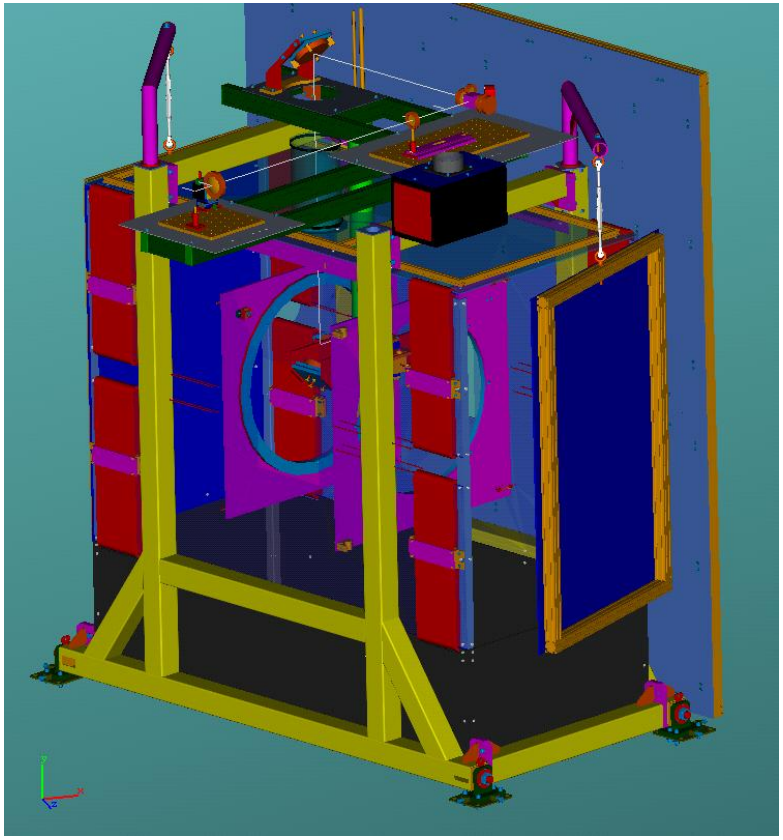
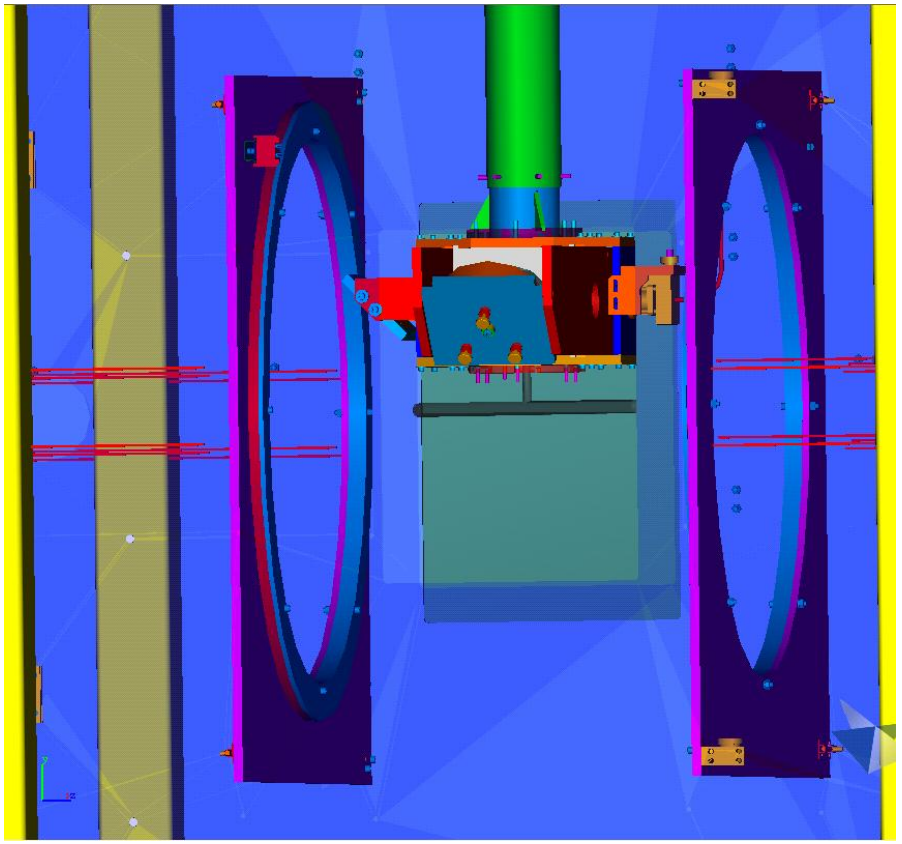


The G_E^n Target Setup





The Concept of Hybrid Cells ??

1. A mixture of ^{3}He, Rb, K and N_2
2. Polarized using optical pumping and spin-exchange (??)
3. Higher polarization and faster spin-up compared to the earlier only Rb cells
4. Lower polarization losses in-beam and during polarimetry

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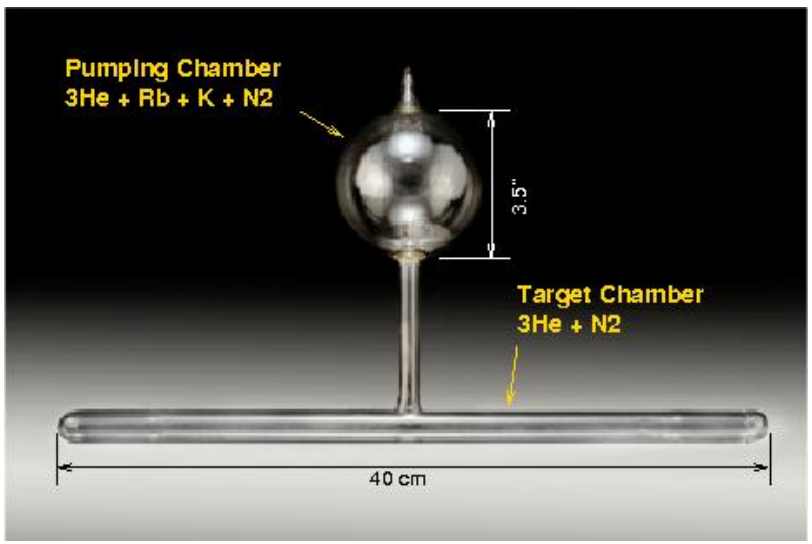

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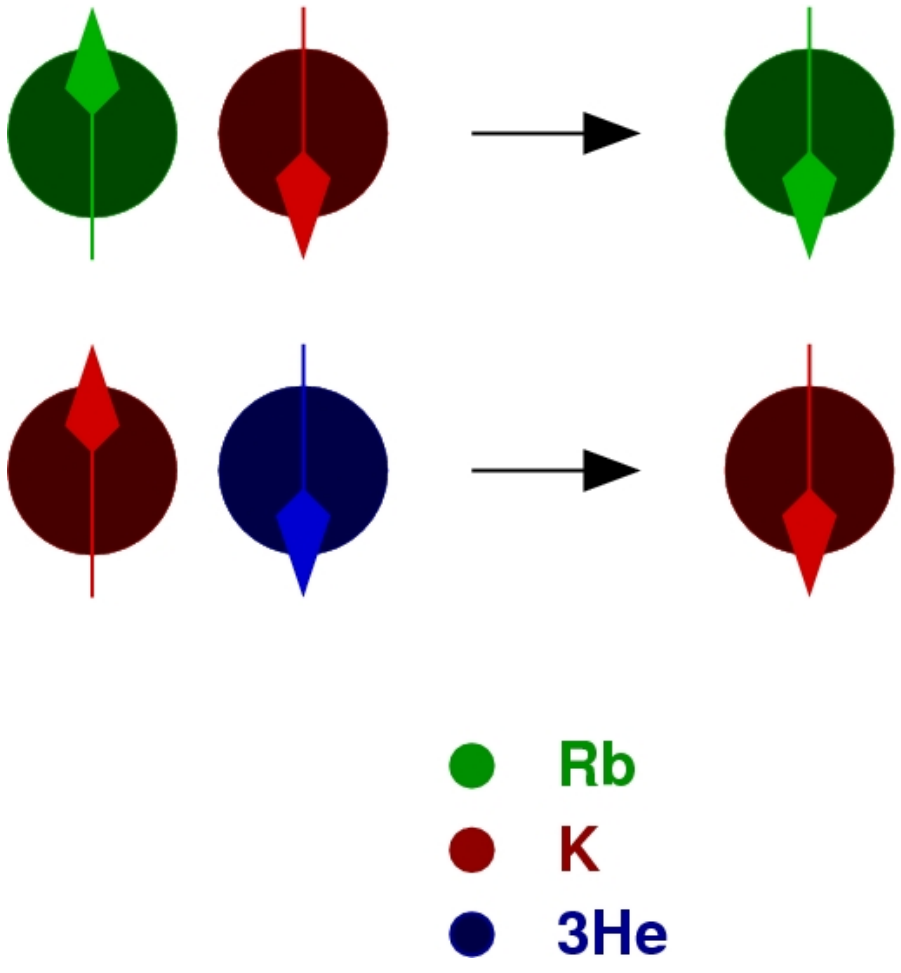

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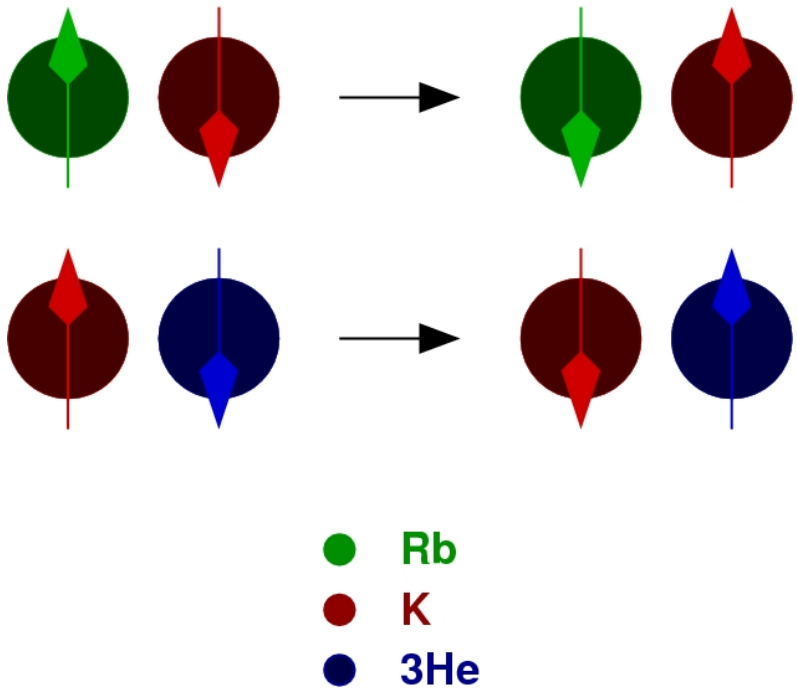

Target During Experiment

1. About 120W of circularly polarized infra-red laser light incident on target pumping chamber.
2. Target polarization measured regularly with NMR calibrated with EPR
3. Polarizations over 50% - up from 40% during previous experiments
4. Magnetic field direction measured to within 1mrad with new *air-floated* compass
5. Steel target magnet box provided uniform magnetic field and kept fringe fields from BigBite out

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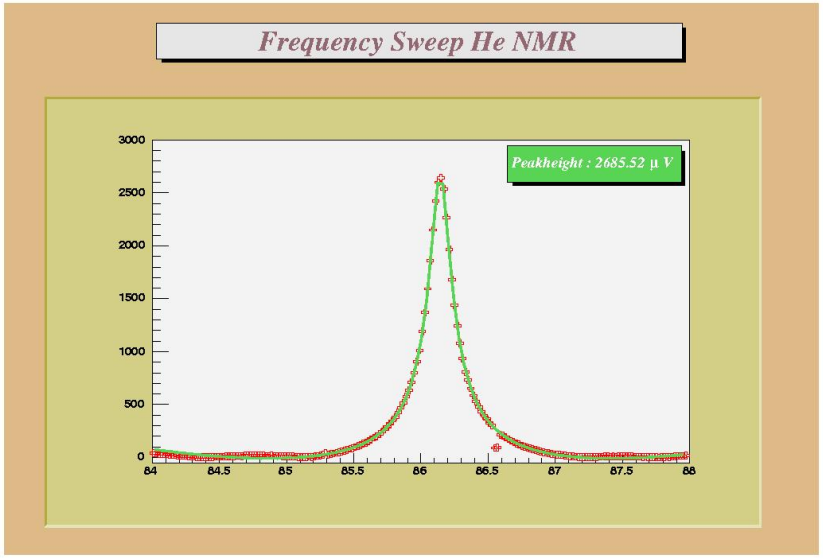

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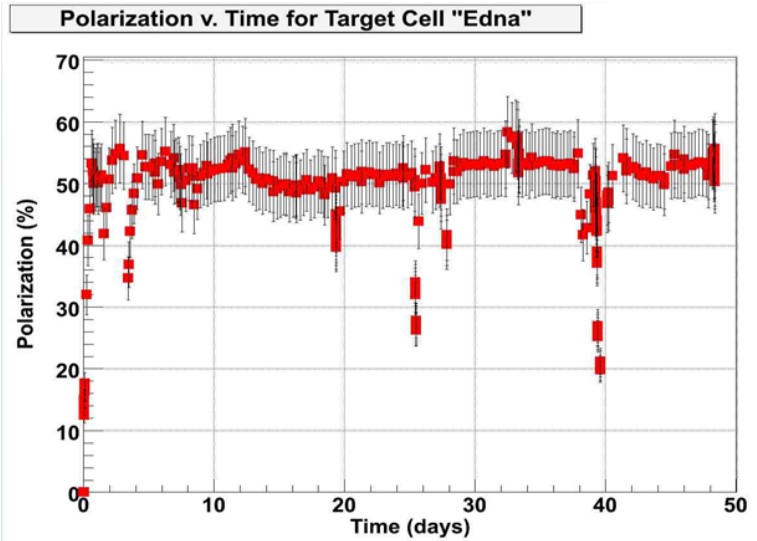

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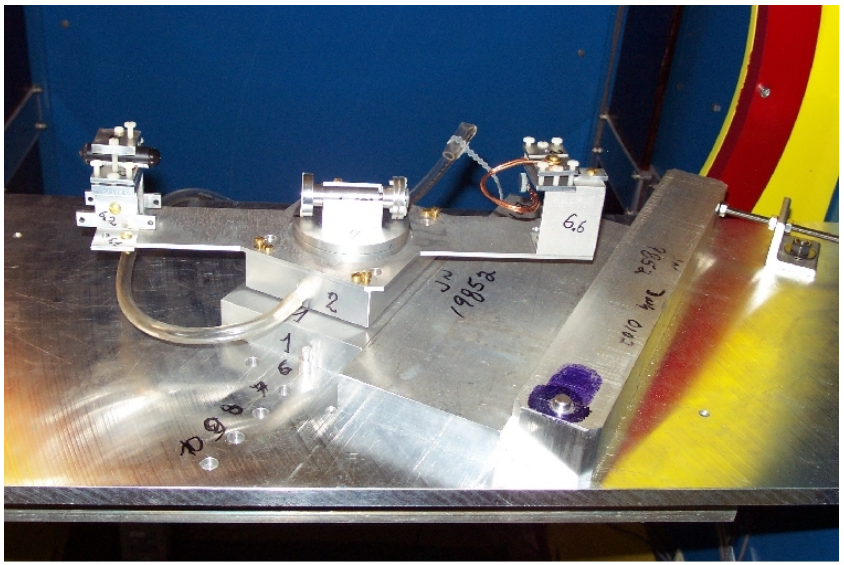

The Magnetic Compass

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Summary

G_E^n Target Status

1. The Magnet Box worked well as a shield from the powerful BigBite magnet and provided uniform magnetic field for the target.
2. New hybrid cells used successfully and to be deployed for future experiments.
3. New fiber optics technology used sccessfully.
4. Both polarimetries (NMR and EPR) performed. Polarizations in excess of 50%.
5. Compass measured the field direction precisely to within 1mrad.
6. The target performed very well during the experiment!