First Use of Novel Techniques for Polarized ^{3}He Target

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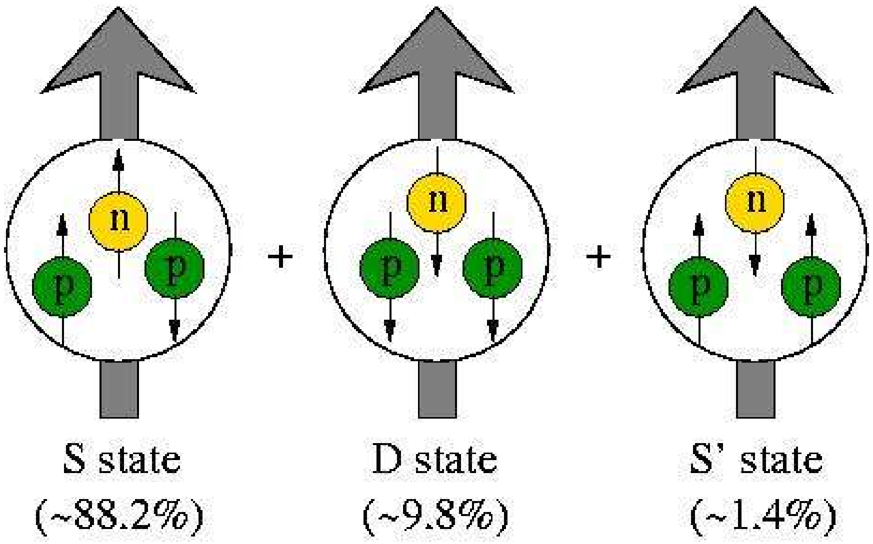
Outline

- Introduction to polarized ^{3}He targets
- Magnetic Field
- Compass
- Hybrid Optically Pumped Cells
- Polarimetry Improvements

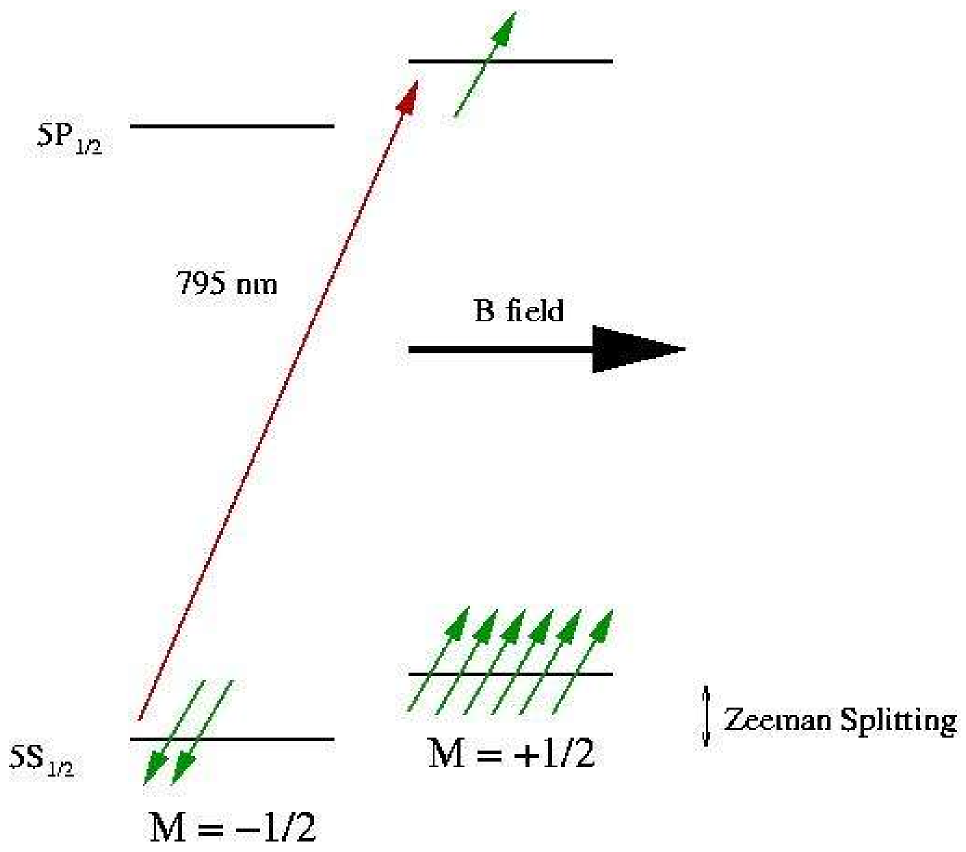
Introduction to Pol. ^{3}He



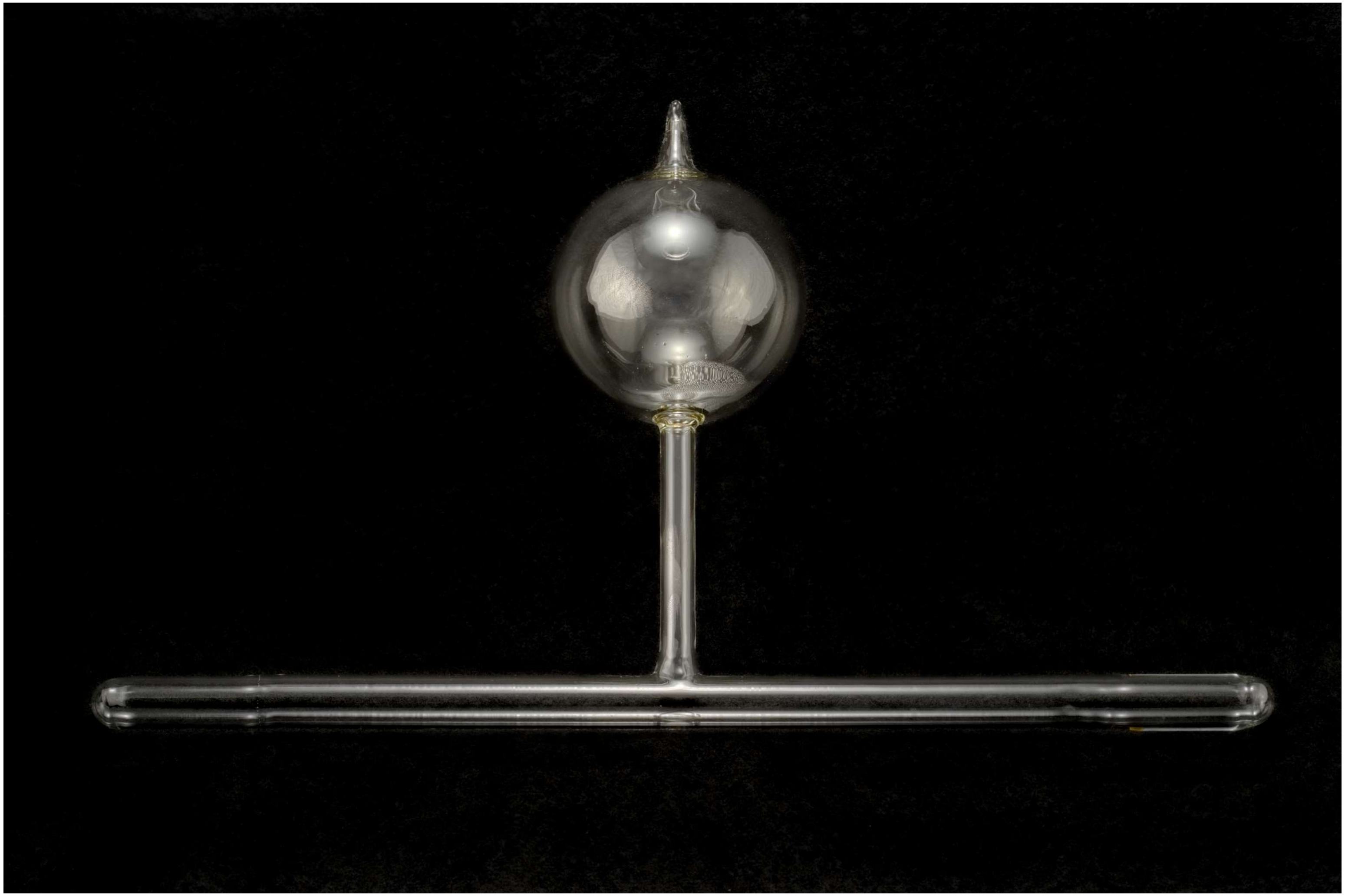
- No free polarized neutron targets
- ^{3}He acts as polarized neutron target
- Luminosity of 5×10^{35} neutrons/cm^2/s

Spin-Exchange Optical Pumping

- Alkali metal pumped to excited state
- Decays to polarized state
- Spin-Exchanges with ^3He (hyper-fine like)

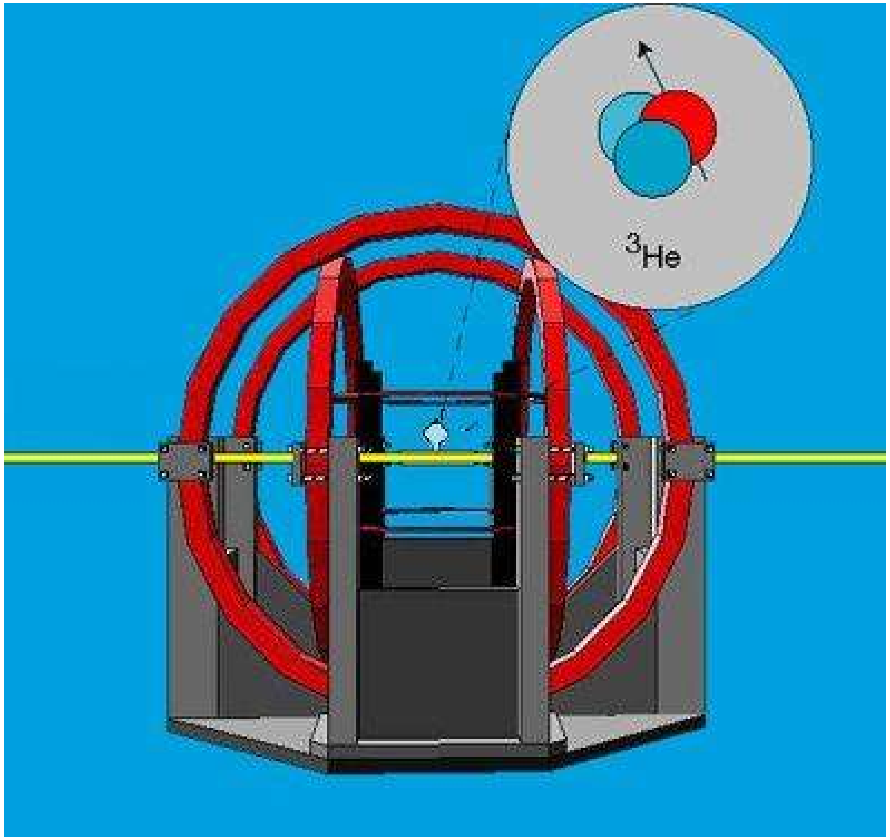


Target Heart (of Glass)

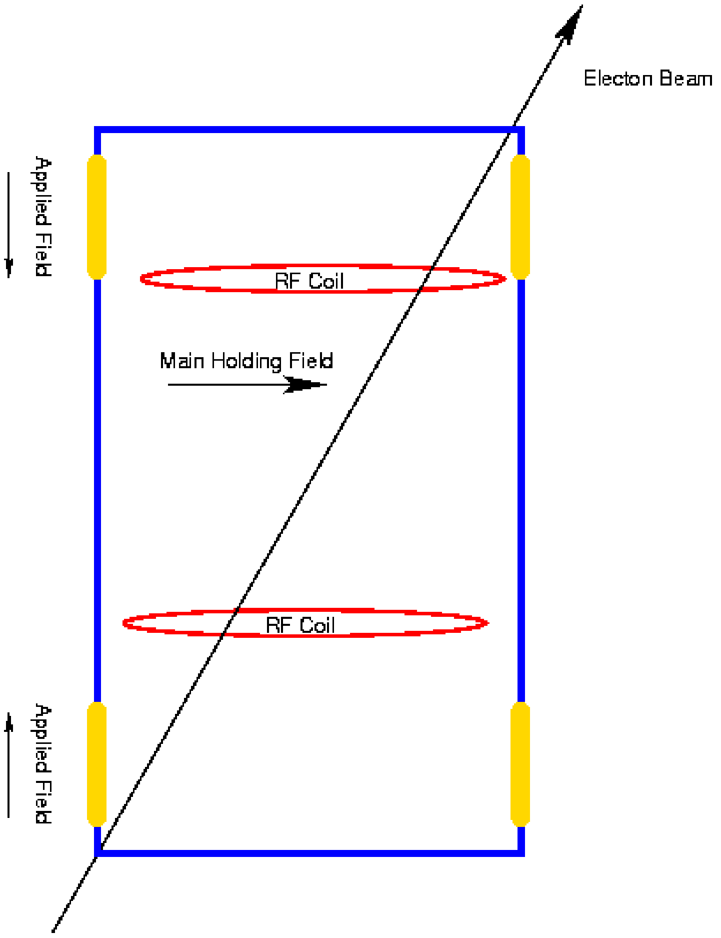


Magnetic Field

- Previous Design: Open Helmholtz
- Experiment uses large open magnet
- Polarized Target requires uniform field



Magnetic Field

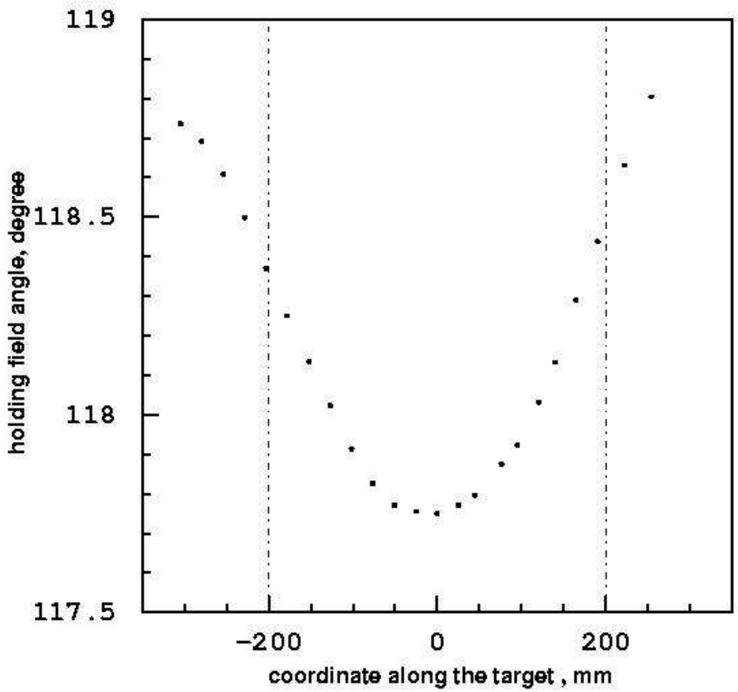


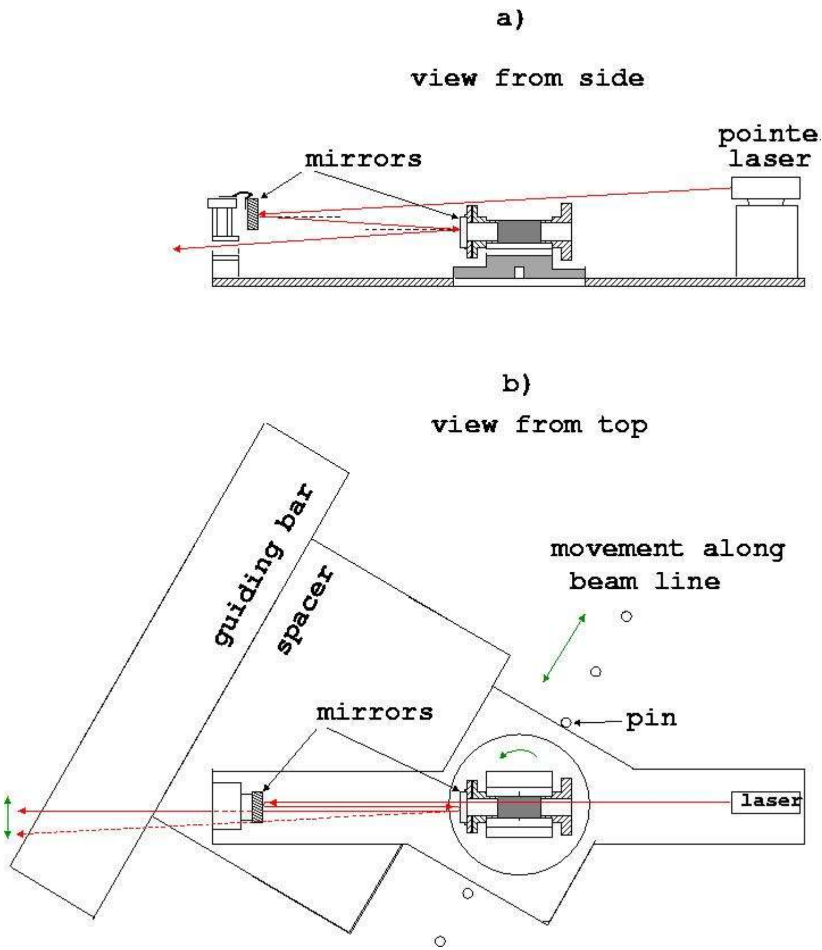
Coil Orientation (Top View)

- Magnetic field in Iron Box
- Creates uniform field in region of interest
- No hysterisis effects at our low field

Compass

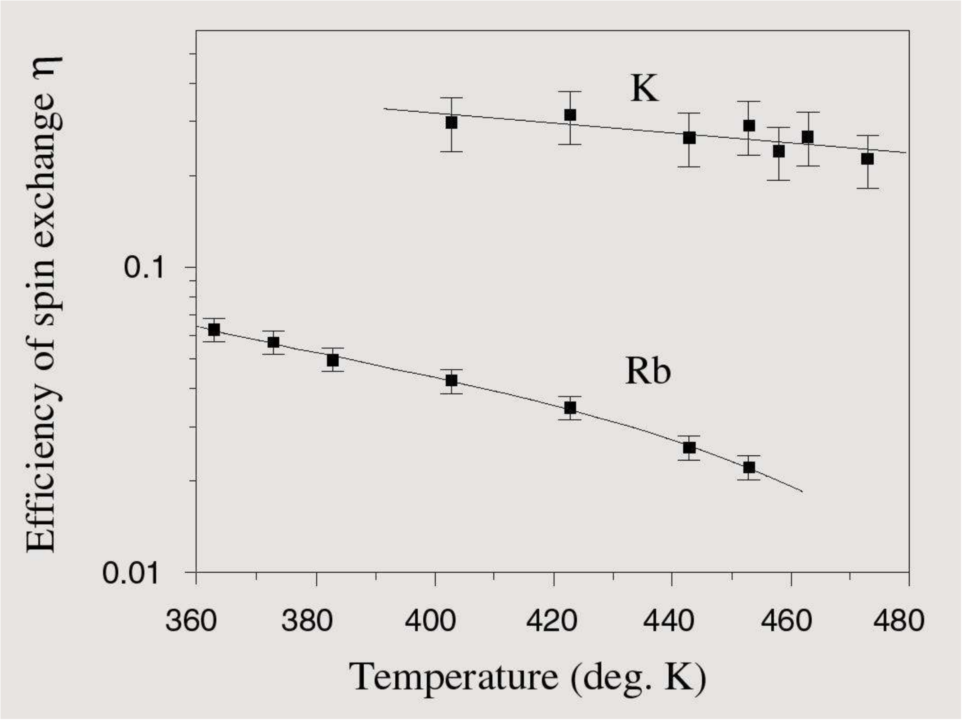
- **Air-float, frictionless design**
- **Resolution < 2mrad**





Hybrid Cells

- **Spin-Exchange between Rb and 3He ”slow”**
- **Spin-Exchange between Rb and K almost instant**
- **Spin-Exchange between K and 3He very efficient**



A. B-A Baranga, *et al.* Phys. Rev. Lett. **80** 2801 (1998)

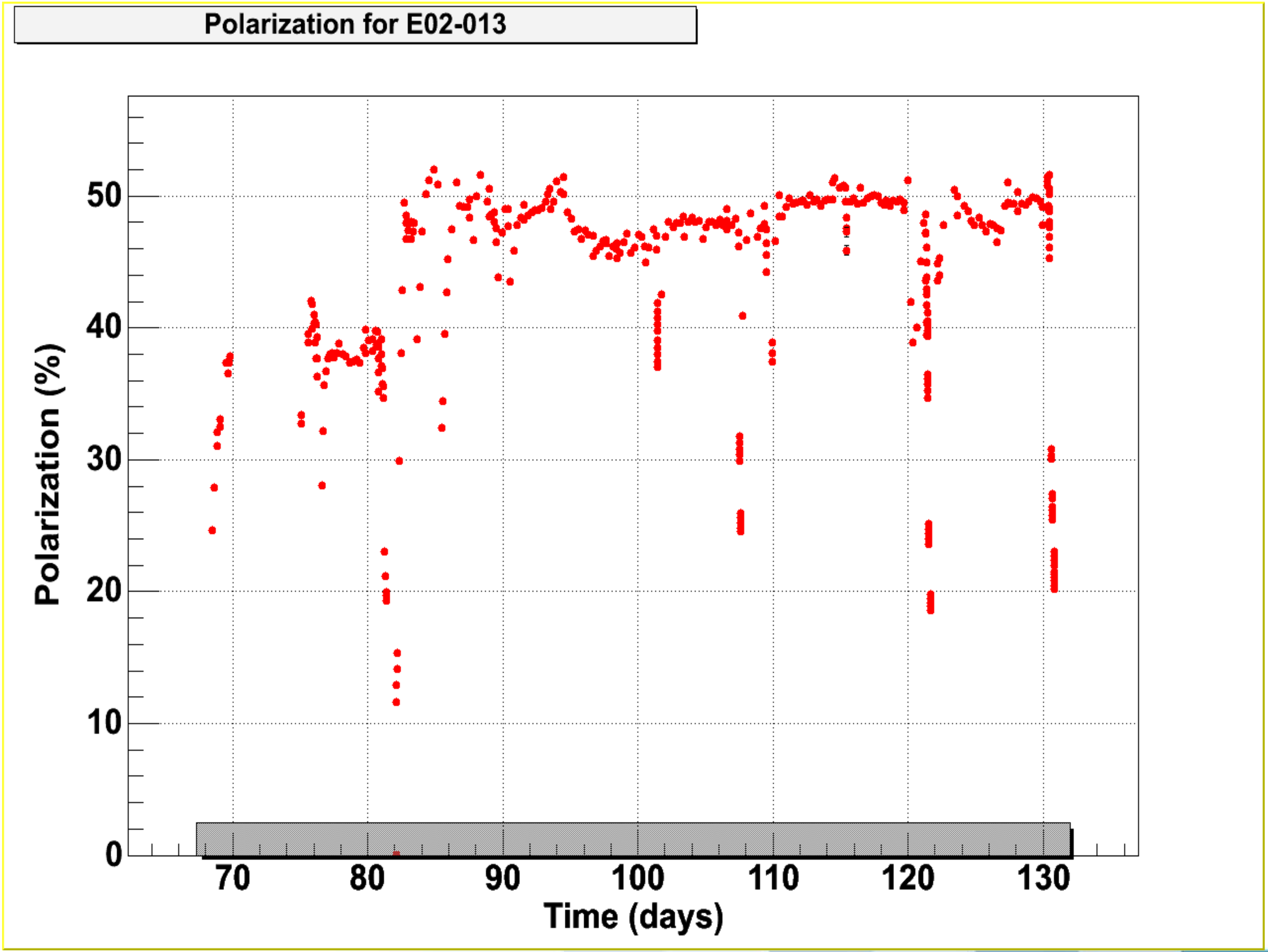
Polarimetry

- Use a combination of NMR and EPR
  - Nuclear Magnetic Resonance
    - Relative Measurement
    - ”Easy” Data to take
    - Sensitive to noise and density
  - Electron Paramagnetic Resonance
    - Absolute Measurement
    - Requires expert
    - Sensitive to temperature and density

Polarimetry Improvements

- Passive Noise Cancellation, using a simple coil
- Relative Density Measurements, using additional pickup coil
- EPR using K resonance
- Non-conducting tungsten collimators

Overall Performance



Performance

- Overall systematic errors small
- Dominated by constant in EPR measurement
- Cell ”Edna” lasted almost 6 weeks

Source	Relative Error
κ_0	4.11%
EPR Measurement	1.32%
Flux and Density	1.00%
NMR Fit	$\approx$ 0.6%
Other density	0.25%
Overall	**4.47%**

Results

- Uniform Magnetic Field in prescence of large open spectrometer
- Highly precise compass
- Faster polarization
- Higher polarization
- 25% increase in polarization = 56% increase in statistics

Thanks!

Thanks to:

- Todd Averett, Gordon Cates, Bogdan Wojtsekhowski
- Ameya Kolarkar, Jaideep Singh, Vladimir Nelyubin, Al Tobias
- Rest of E02-013 Collaboration

The G_E^n Compass

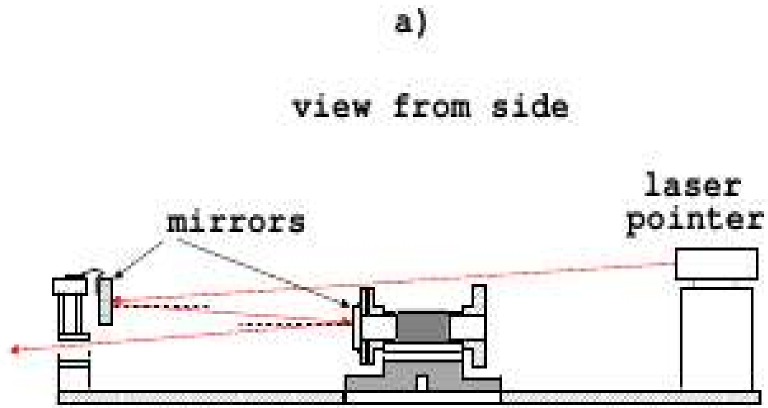
- Finite detector acceptances and small deviation of the target spins from being exactly transverse introduces a longitudinal contribution to the asymmetry.

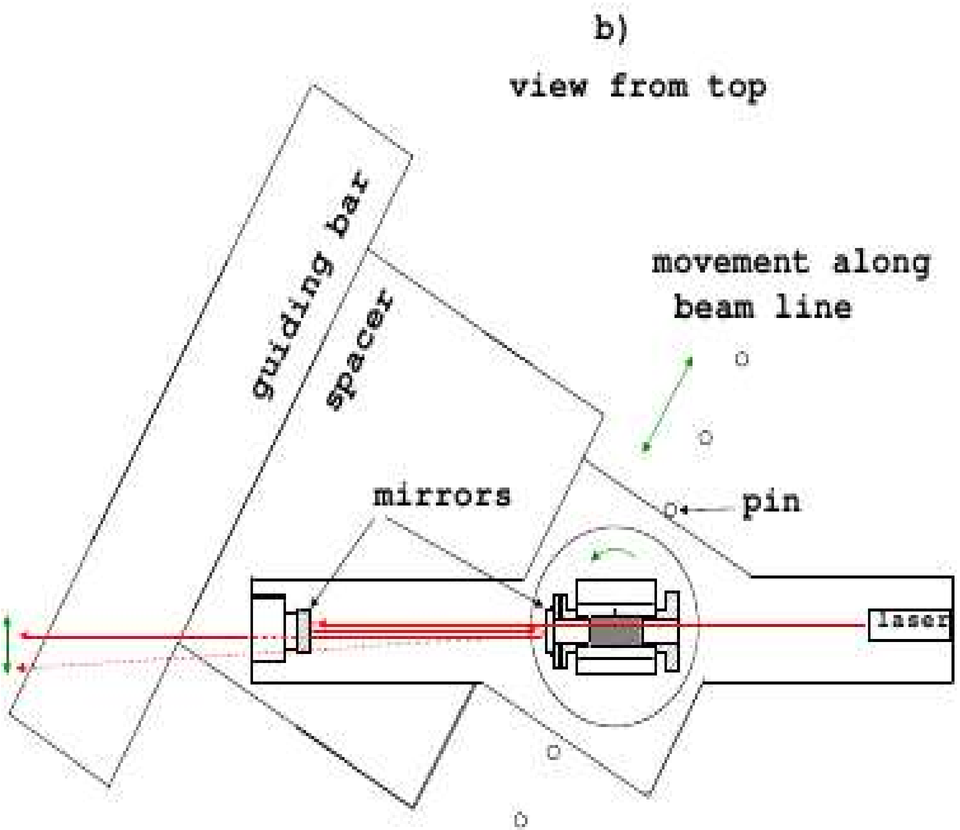
  See here

- The knowledge of this angle is essential to calculate this contribution.

Magnetic Compass

- Conceived at Kentucky (Wolfgang Korsch); modified at JLab
- Air-floated, frictionless design
- Capable of absolute and relative measurements ...
- ... and continuous monitoring of the field direction.





Compass Results

- The entire region around the target was scanned.
- Results from only one horizontal plane are shown.
- A resolution of better than 2 mrad was achieved.