The Polarized $^3$He Target at Jefferson Lab Hall A

Why Polarized $^3$He?

- Effective nucleon polarizations: $P_x = 86\%$, $P_y = -2.8\%$

$^3\text{He} \approx \hat{n}$

Principle of Operation

- Optical pumping of Rb
- Spin exchange between Rb atom and $^3\text{He}$ nuclei

Target Setup

Cell Characteristics

- High pressurized glass cells:
  - cell length: 40 cm
  - $^3\text{He}$ density: $\approx 10$ atm
  - $P \approx 40\%$ with 12 $\mu$A beam
- Polarimetries: NMR $\odot$ EPR
- Highest Polarized luminosity of the world: $1 \times 10^{37}$ cm$^{-2}$sr$^{-1}$

Physics Program

- Neutron Spin Structure
  - GDH (1995), $A_1$, $g_1$ (2001)
  - low $Q^2$ GDH, $g_1$ duality
- Neutron Form Factors
  - $G_M$ (1998)
  - $G_E$
- Key program @ 12 GeV Upgrade

Medical Application

- Traditional method
- Radioactive $^{133}$Xe + gamma camera
- Resolution: 1~2 cm
- Noble-gas imaging
- Polariized $^3\text{He}$ gas + MRI
- Resolution: a few mm

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