Polarized ^3He neutron polarization analyzer

1. desired precision
2. operation scenario
3. hardware requirements

unpolarized neutron transmission through unpolarized analyzer

$$T_0 = \exp(-\sigma N d)$$

transmission of spin up/down neutrons through polarized analyzer

$$t_+ = \exp(-\sigma N d (1 - P_A))$$

$$t_- = \exp(-\sigma N d (1 + P_A))$$

analyzing power of filter ≡ polarization of transmitted beam

$$A = \tanh(\sigma N d P_A) = \frac{t_+ - t_-}{t_+ + t_-}$$

$$\equiv P_n$$

flipping ratios of counting rates...

where beam & analyzer parallel, flipper off

$$R_1 = \frac{N_+}{N_-} = \frac{1 + p_n A}{1 - f\, p_n A}$$

$f \equiv$ flip efficiency

after AFP, beam & analyzer antiparallel, flip off

$$R_2 = \frac{N_+ f}{N_-} = \frac{a(1 + f\, p_n A)}{a(1 - p_n A)}$$

$a \equiv$ AFP efficiency

$$f = \frac{N_+ f/a - N_- f}{N_+ - N_-/a}$$

R_3 = AFP again, determines a

beam analysis with opaque spin filters ...

$$A = \tanh x \qquad x \equiv \sigma N d P_A$$

$$R = \frac{N_+}{N_-} = \frac{1 + p_n A}{1 - f p_n A}$$

uncertainty

$$\frac{\delta p_n}{p_n} \geq \frac{\delta A}{A} = \frac{2x}{\sinh 2x} \frac{\delta x}{x} + \text{counting statistics}$$

$x = 2$ multiplier $= 10$
$x = 3$ multiplier $= 60$

for $P_A \sim 0.33$

$x = 2 \rightarrow \sigma N d = 6$
$x = 3 \rightarrow \sigma N d = 9$

(for optimal neutron velocity)

$$x = \frac{0.72\, N d\, P_A}{\sqrt{E}}$$

$Nd \sim$ amagat·cm
$E \sim$ meV

for $x = 3$ $Nd = 15$ a·cm $E \sim 1$

incl. counting statistics ?

determination of $P_A \equiv P_{^3He}$ analyzer?

unpolarized neutrons....

$$T_0 = \exp(-\sigma N d)$$

$$T_n = T_0 \cosh(\sigma N d P_A)$$

no. no unpolarized neutrons

AFP?

magnetometer?

reproducibility $\longrightarrow$ flat windows

Fabrication : new vs. old

assessment Oct 14. at Los Alamos

1. polarizing station
2. polarization measurement
3. transport case
4. Cells
5. beamline fixture
6. beamline aperture