Statistical and systematic uncertainties in a and A

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Statistical errors in a and A

$$\sigma_a = \frac{2.33}{\sqrt{N}}$$ from proton TOF

$$s_a = \frac{15.3}{\sqrt{N}}$$ from e - p correlations without TOF

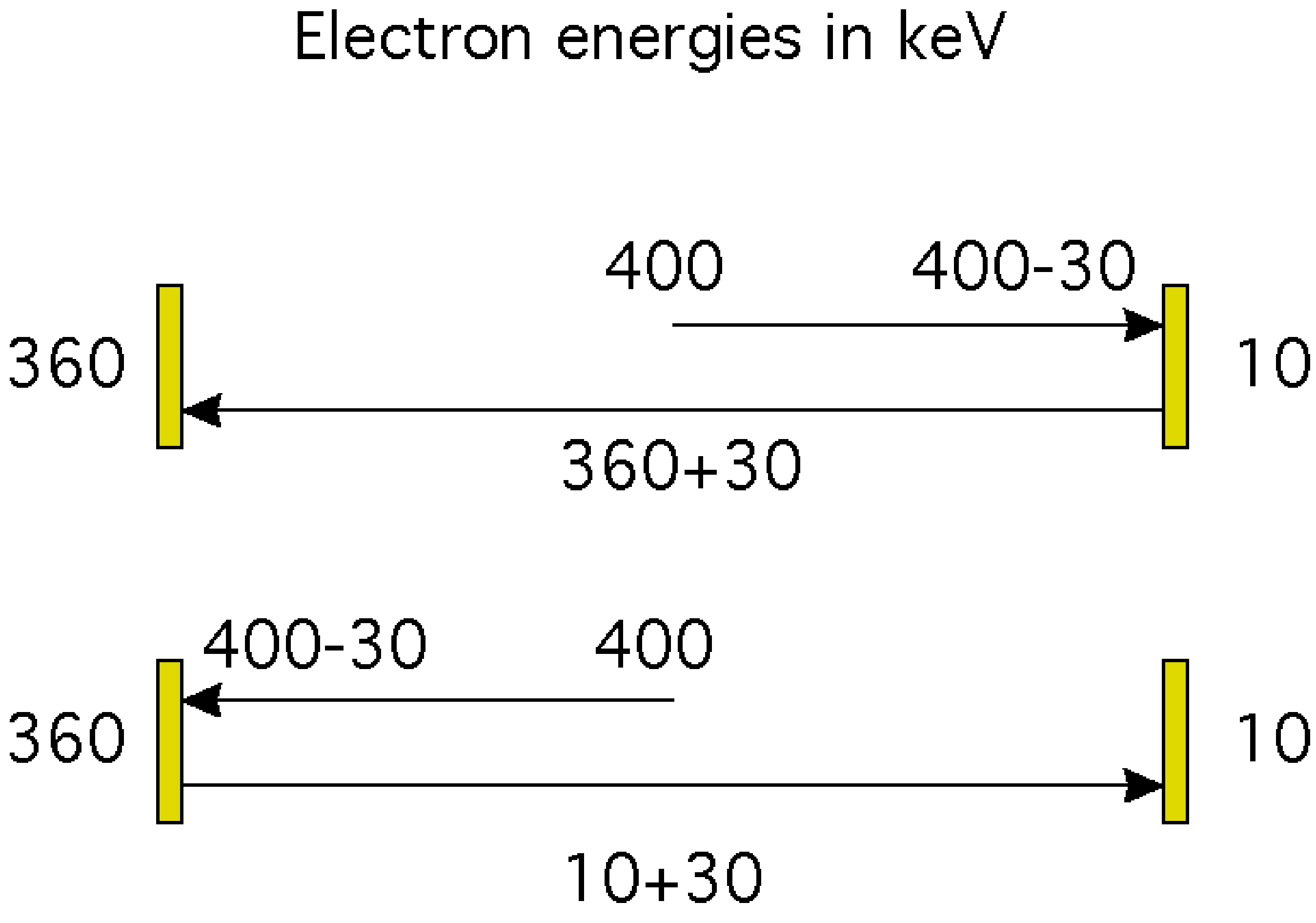
$$\frac{dN}{dt} \sim 30 \text{ Hz/cc}$$

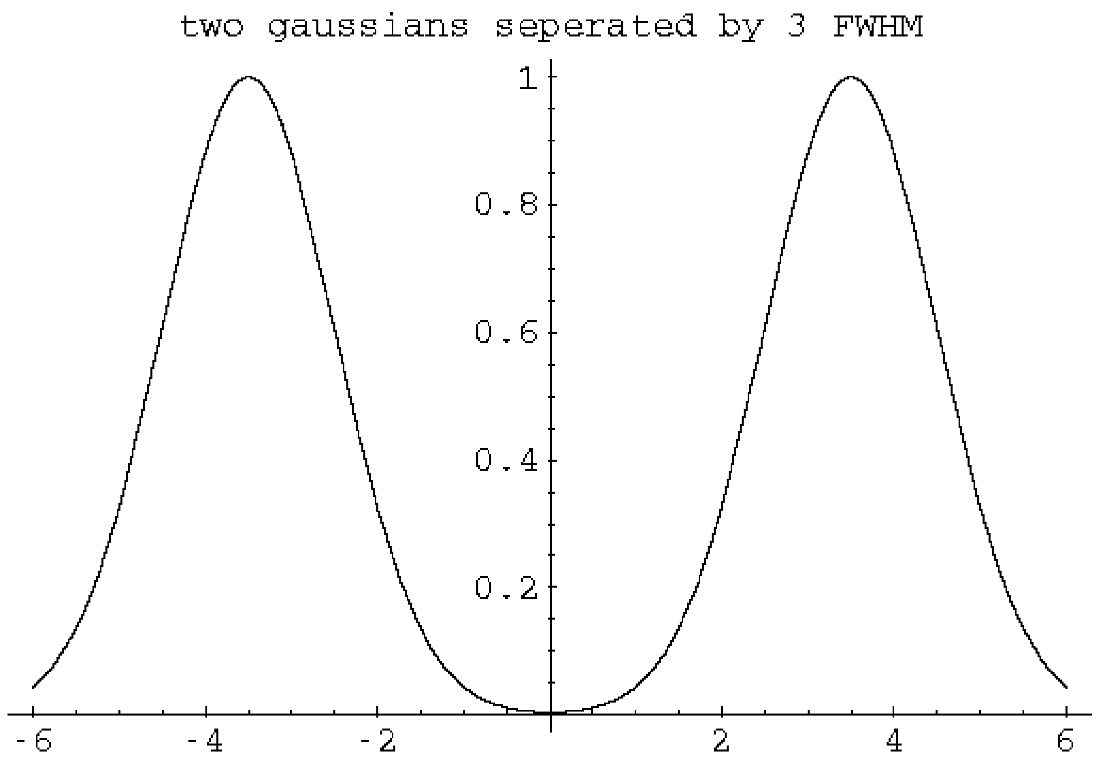
$$s_A = \frac{2.69}{\langle Pol \rangle \sqrt{N}}$$ (from spin - electron correlation)

$$\frac{dN}{dt} \sim 4 \text{ Hz/cc,}$$

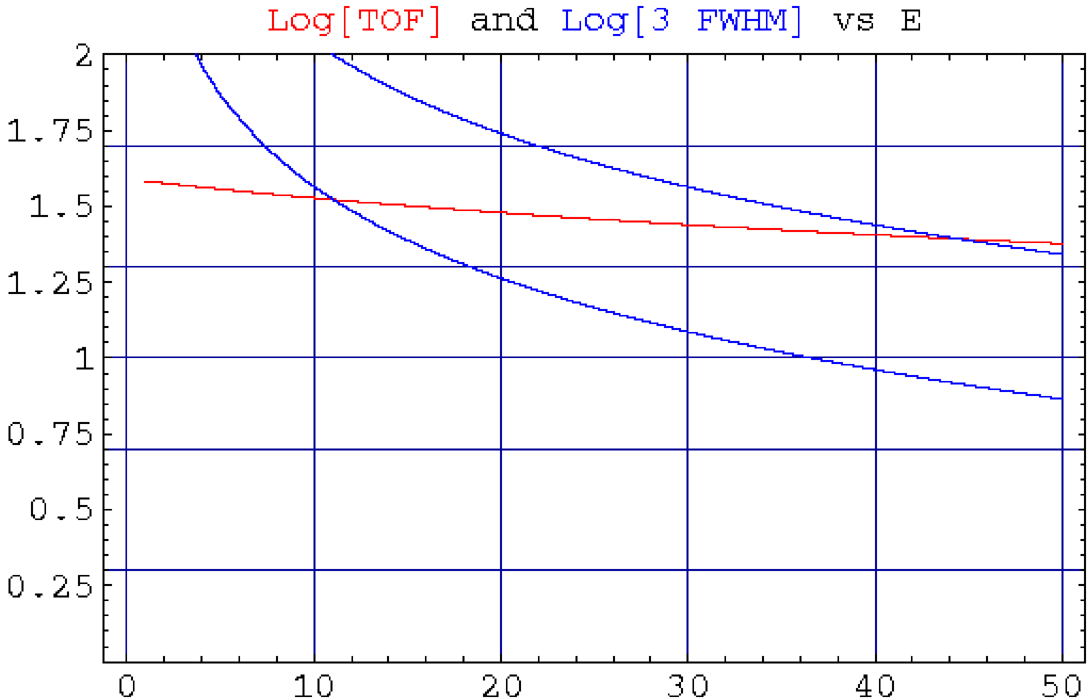
(~ 4 loss from polarizer and 2 loss from frame selection)

Electron scattering from Si detectors




two gaussians seperated by 3 FWHM
1
0.8
0.6
0.4
0.2
-6
-4
-2
2
4
6

ΔTOF and 3 FWHM vs ΔE



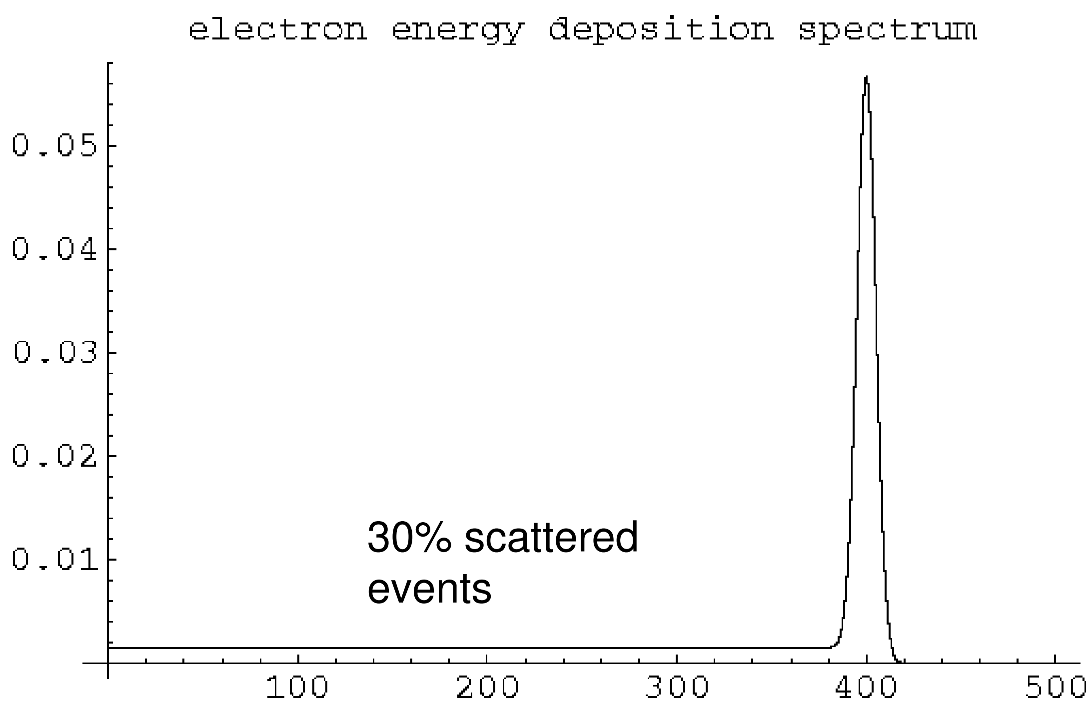
ΔT=1.4 ns

ΔT=0.5 ns

ΔE=11 keV

ΔE=45 keV

430 keV electron



Estimate correction to A

$$A_{measured} = A\left(1 - f\frac{DE}{E}\right)$$

$DE =$ Energy threshold, assume 11 keV.

Assume an electron energy $E = 400$ keV.

$f \sim .3$ for normal incidents, but larger for oblique incidence.

f is correlated with Cos[J].

For $f = .5,\ DE = 11,\ f\dfrac{DE}{E - 30} = 1.5\%$.

The correction is large compared to .1% and must be accurately modeled and measured. We need to determine the correction to 2%!

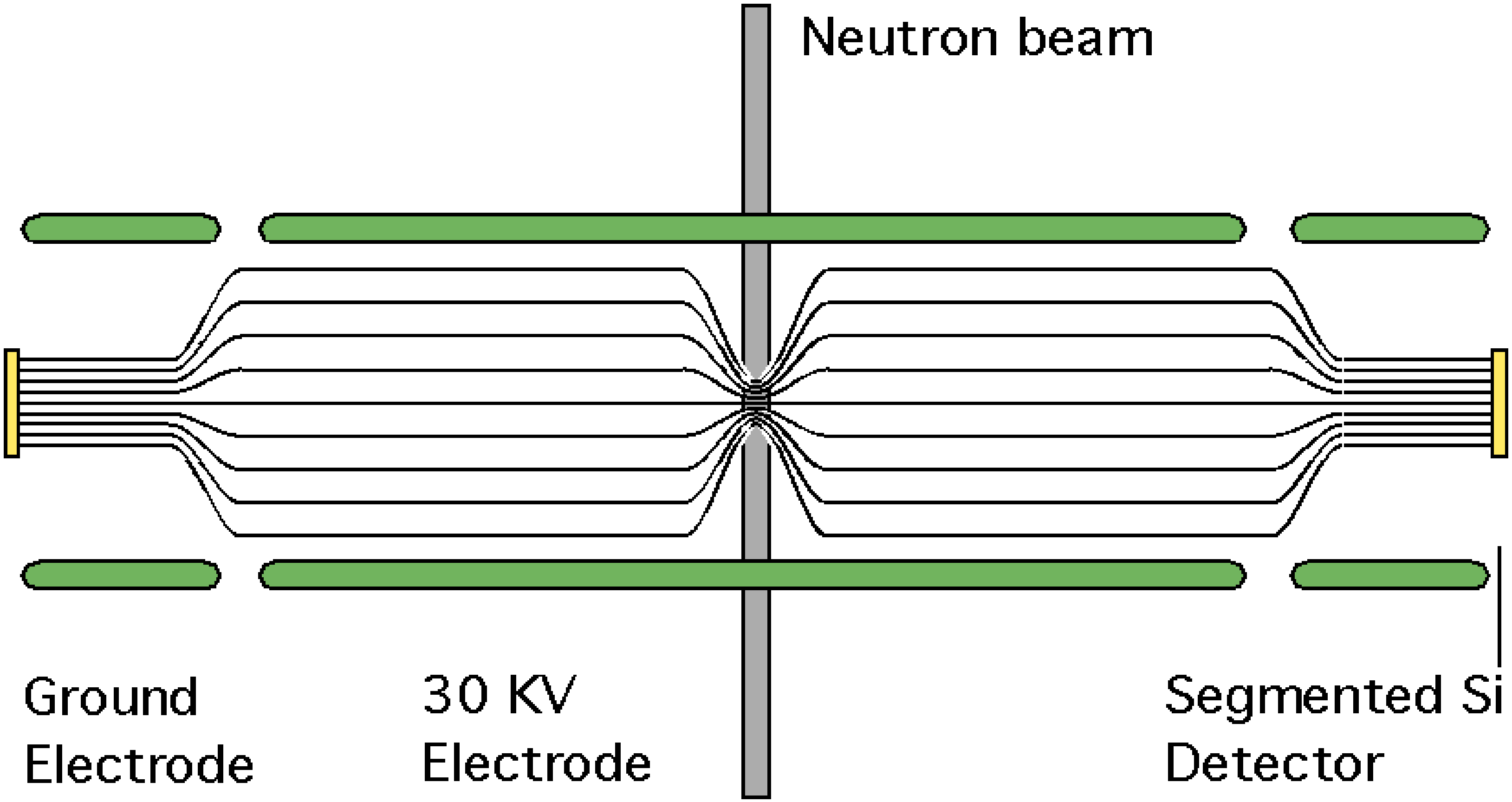
The spectrometer must be optimized to reduce the correction.

1. Increase the field expansion (but reduces the rate)
2. Decrease the accelerating potential
3. Reduce the detector noise
4. Reduce the detector time resolution
5. Increase the spectrometer length

The correction to a is smaller, because the proton does not back scatter and the electron TOF~10^{-3} proton TOF

The systematic uncertainty in a must be evaluated. The most important systematic uncertainty in a is from the field map in the decay and expansion regions

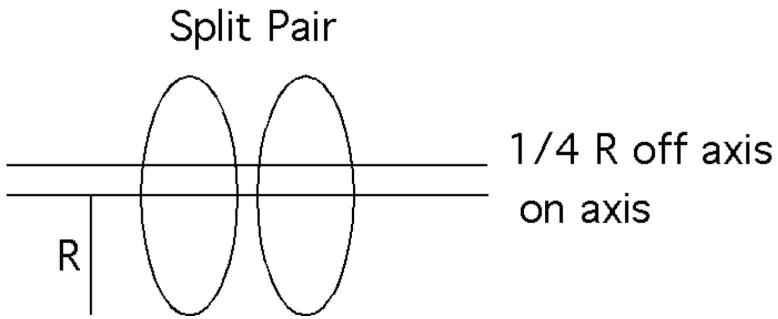
A/a spectrometer

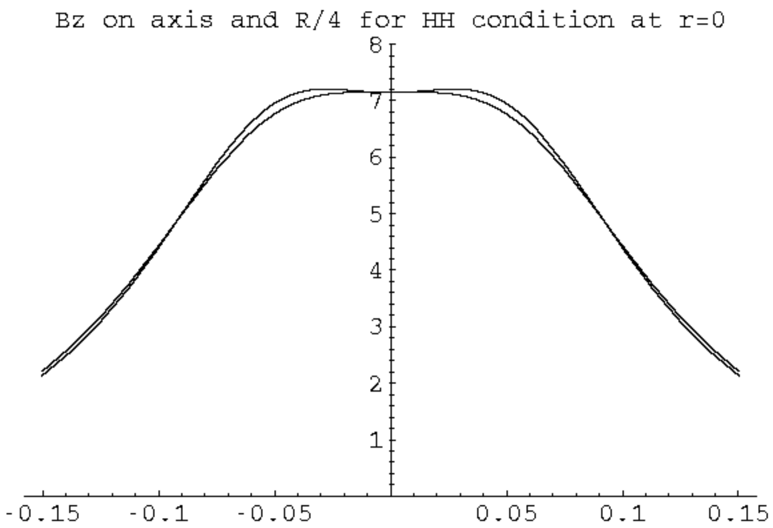


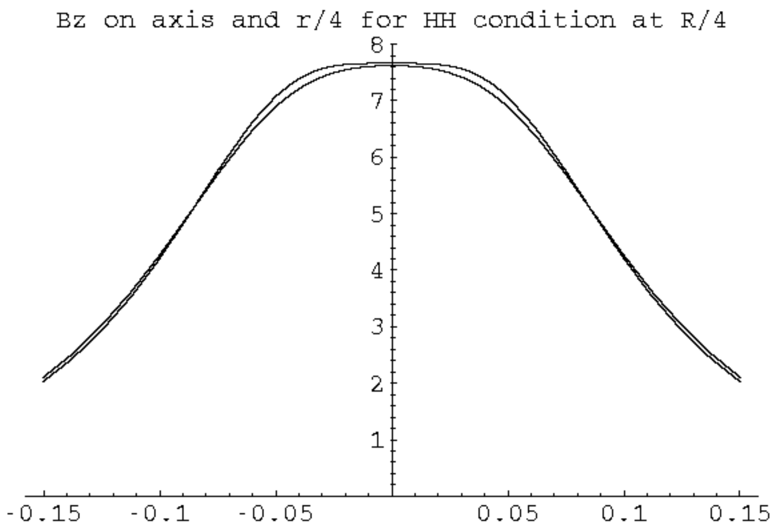
The a and A spectrometers are compatible

- ~ $\times$4 field expansion
- The large field expansion required by a (~20) makes the proton TOF spread smaller for A and reduces the width of the time distribution.
- The A experiment is more sensitive to reflection in the decay region and requires a higher field homogeneity than the a experiment.
- The a experiment requires a rapid field expansion to achieve a good separation between TOF=dL/Pz in the decay region and TOF=DL/P in the drift region

Split pair can produce an electron trap







electron/proton reflections

$$B = B_0\left(1 - g\frac{z^2}{z_0^2}\right)$$

Assume $g = .01$

Reflection probability $= \frac{\sqrt{g}}{2} = .05$

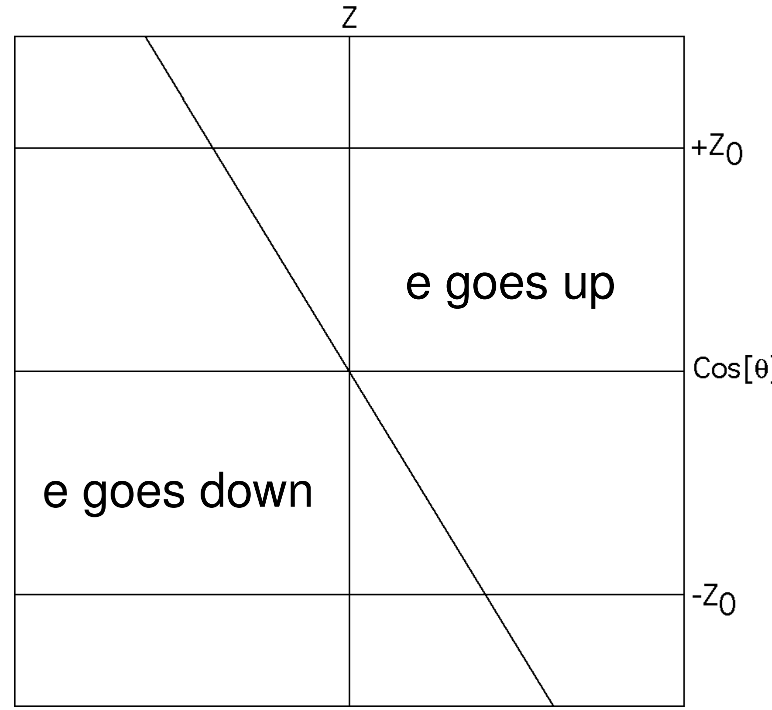
$A_{measured} = A\left(1 - \frac{g}{3}\right)$ $3\ 10^{-3}$ correction

If the field is not symmetric, $B = B_0\left(1 - g\frac{z^2}{z_0^2} + d\frac{z^3}{z_0^3}\right)$

$A_{measured} = A\left(1 - \frac{g}{3} - \frac{d}{6\sqrt{g}}\right)$ For $g = .01$ and $d = .001$,

the second term is $1.6\ 10^{-3}$

We must map the field!



$$Cos[J] = \sqrt{g}\frac{z}{z_0}$$

Precision polarimitry

(discussed in Pentilla and Bowman, NIST workshop)

- For a ^{3}He polarizer, $B(t)=B\,\mathrm{Tanh}(-t/\tau)$. Determine both B and τ from a fit to TOF spectrum
- Neutron pulse width, ^{3}He cell thickness variations, drifts, depolarization by magnetic impurities in cell walls, … all $<10^{-4}$.
- Largest uncertainty is from β-delayed neutrons in spallation source. Measure in SNS commissioning run.

Neutron depolarization in the RF spin flipper and in the zero in the spectrometer field

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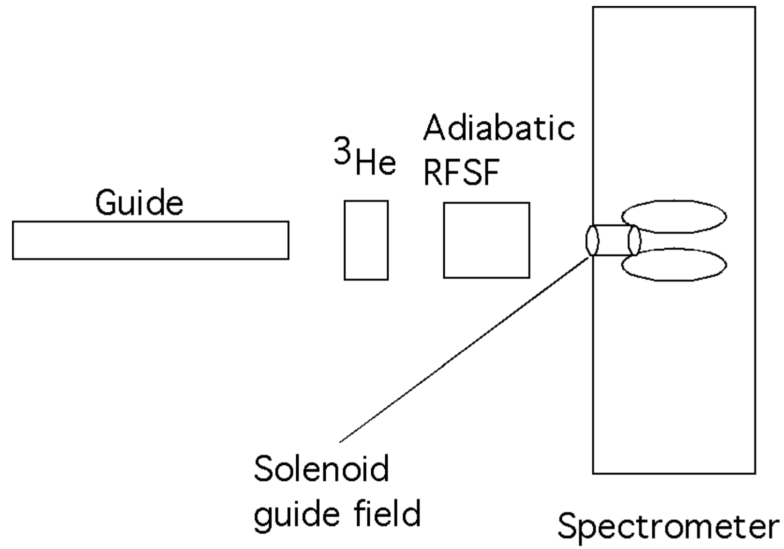

$$Pol = 1 - \frac{2p}{3} Exp\left(-\frac{pl}{2} + \frac{4}{3}\right) + \ldots$$

$$l = \frac{gB_{\wedge}^{2}}{GV} = \frac{w_L}{\frac{dJ_B}{dt}}$$

For 10^{-5} depolarization we want $l > 6$.The minimum field in the solenoid guide field, spectrometer + solenoid, along the neutron direction must be .05 Tesla for G = 24 Tesla/meter. $l = 6$ is easy to get for the RFSF