Spectrometer Magnetic Field for Neutron Beta Decay

at the SNS

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Introduction

- **The abBA Experiment**: "Precise Measurement of Neutron Decay Parameters", J.D. Bowman (LANL) and W.S. Wilburn (LANL), spokespersons.
- **The Nab Experiment**: "Precise Measurement of the Neutron Beta Decay Parameters *a* and *b*", J.D. Bowman (LANL) and D. Pocanic (Virginia), spokespersons.
- **The PANDA Experiment**: "The Proton Asymmetry in Neutron Decay Experiment", T. Chupp (Michigan), spokesperson.
- A Proposal Review and Advisory Committee (PRAC) reviewed these proposals on September 8-9, 2005. The PRAC key recommendation reads, "... We strongly encourage the three efforts to investigate the option of a common magnet which could be tuned to provide the different field profiles needed for the three experiments..."

Design Considerations

1. Magnetic Field Strength:

B (T)	Decay	Drift	Detector
abBA	~ 4.0	~ 1.0	~ 1.0
Nab	2.0 - 4.0	0.1-0.4	0.5 –1.0
PANDA	~ 2.0	~ 2.0	~ 2.0

2. A magnetic field homogeneity $dB/B < 10^{-2}$ is required in the decay region.

- 3. The length of the magnet should be at least 2 m on each side of the decay region.
- 4. The magnet diameter should be at least 25 cm in the drift and detector regions.

5. The spectrometer must permit an approximate *10 cm gap* for transmission of the neutron beam.

6. The magnetic field must allow the *transmission of a polarized neutron beam* in and out of the decay region without a significant loss of polarization. This requirement is that the loss of polarization should be < 0.15%.

The Baseline Design



The abBA Configuration





The Decay Region





Particle Trajectories



The Nab Configuration



The Decay Region





Particle Trajectories



The PANDA Configuration



Polarized Neutrons Transmission



Polarized Neutrons Transmission



Design Outlook

- Electric Field
- Magnetic Shielding (w/wo Iron)
- Simulations Field Profiles
- First cost estimate
- First pass at mechanical design (forces,)
- Design Report