Title: Precision Measurement of Neutron Decay Correlations

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Project Goals

- Develop new experiments to measure neutron decay parameters with 10^{-4} precision
- Analyze and understand important systematic effects
- Develop precision neutron polarimetry techniques required for these experiments
- Develop a new detector technology based on large-area ion-implanted silicon detectors

Background & Significance

- The neutron is an ideal laboratory to search for physics beyond the Standard Model
- Neutron decay can be calculated very accurately in the SM
- Precision measurements of neutron decay parameters are possible
- Sensitive to undiscovered particles and couplings
- New facilities provide intense sources of neutrons
- New techniques are needed to reduce systematics to match the expected statistics
- Previous experiments limited by key systematic uncertainties
- Knowledge of neutron polarization
- Backgrounds in detectors
- Limitations of available detector technologies
- This project aims to improve these limiting systematics
- Develop a new method for precision neutron polarimetry
- Develop new detectors
- Develop techniques to detect decay particles in coincidence

Results & Discussion

- Prototype detector testing
  - Basic operation of detector has been verified using alpha and beta sources
  - Preliminary measurement of entrance window Picosness is consistent with specifications
  - Cryogenics for cryogenic operation has been designed and is being procured
- Precision neutron polarimetry method demonstration
  - First measurement with LANSE beam yielded 0.7% precision, limited by statistics and systematics
  - Second measurement with improved apparatus completed in June
- Data analysis in progress
- Third measurement planned for next FY
- Analysis of systematic uncertainties
  - 20 systematic uncertainties identified and estimated
  - Three results in correlation > 10^{-1}, require careful control
  - Neutron pulse width (2x10^{-1})
  - Magnetic field inhomogeneity (3x10^{-3})
  - Neutron polarization (4x10^{-1})
  - Four identified as requiring further simulation for accurate estimate
  - Misalignment effects
  - Electron backscatter from detectors
  - Proton time-of-flight effects
  - Detector timing resolution
  - Proton scattering from residual gas
- Results presented in proposal to Spallation Neutron Source (SNS) Fundamental Neutron Beam (FnPB)

Conclusion & Future Plans

- Finish characterization of prototype detector properties
- Complete third precision neutron polarimetry experiment
- Complete analysis of systematic effects
- Propose full experiment (the abBAe experiment) for SNS FnPB