Theoretical motivations

- Theories beyond the Standard Model predict new light scalar bosons
  - Axions and Axion-like particles
  - WISP: candidate to Dark Matter
  - New short range monopole-dipole interaction potential $V$ which occurs as a pseudo-magnetic field

$$ V = g_s g_p \frac{\hbar}{8\pi M_N c} \frac{\phi_A}{\lambda} \left( \frac{1}{\lambda r} + \frac{1}{r^2} \right) \exp \left( -\frac{r}{\lambda} \right) $$

Principle of the measurement

- Measure a polarized Helium 3 cell longitudinal relaxation rate $\Gamma_1$ dependence with the holding magnetic field $B_0$
- Search for an exotic contribution due to pseudo-magnetic field

$$ \Gamma_1 = \Gamma_{1w} + \Gamma_{1dd} + \Gamma_{me} + \Gamma_{mi} + \Gamma_{NF} $$

- Behaviour of contributions:
  - Constant with $B_0$: $\Gamma_{1w}, \Gamma_{1dd}, \Gamma_{me}$
  - Behave as $B_0^{-2}$: $\Gamma_{mi}$
  - $\Gamma_{NF}$ behaviour is very different from the other contributions:

$$ \Gamma_{NF} = \frac{\hbar^2 N^2}{8 m_n D N_C} \frac{\lambda^3 (\gamma_B \phi) \left( 1 - e^{-\gamma_B^2} \right)}{(1 + \phi^2)^2} \left( \frac{1}{\phi^2} (1 - \phi_0 (2 - \phi)) + (\phi^2 - 3) \right) $$

Expected constraints

- Improved constraints
  - Magnetic shield: gradients decreased by factor 30
  - Solenoid: a more homogeneous $B_0$ magnetic field