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NoMoS: BSM Physics in Neutron Decay

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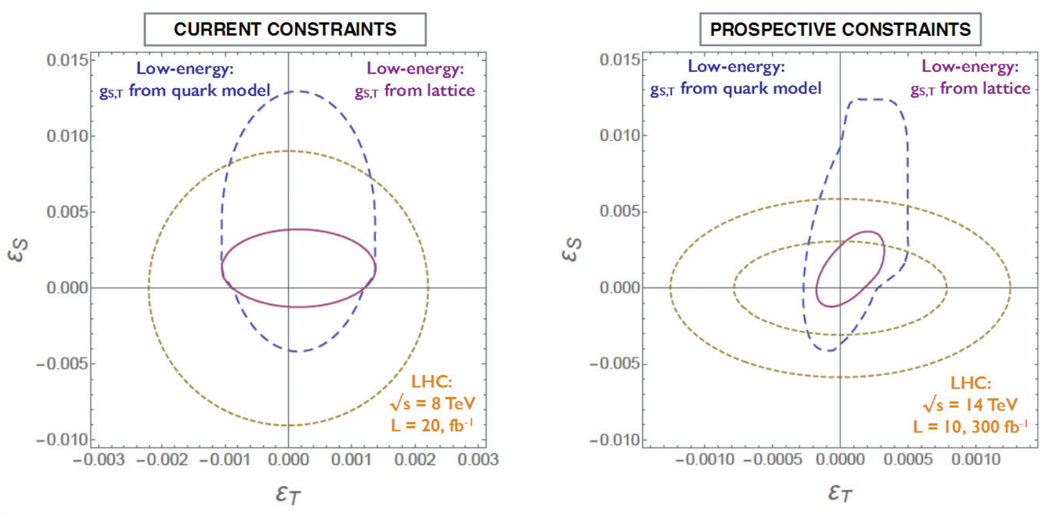
Abstract

The New Frontiers Group `NoMoS´ (neutron decay products momentum spectrometer) aims to search for traces of new physics in neutron beta decay with novel experimental techniques[7]. Precision measurements in neutron decay allow searching for physics beyond the Standard Model[4]. An accuracy of 10^{-4} in the observables corresponds to energy scales of 1 to 100 TeV for new particles and interactions[3]. To achieve this accuracy, a new technique is developed: RxB spectroscopy[9]. For measurements at ultimate statistics, NoMoS will be installed at PERC[1,6].

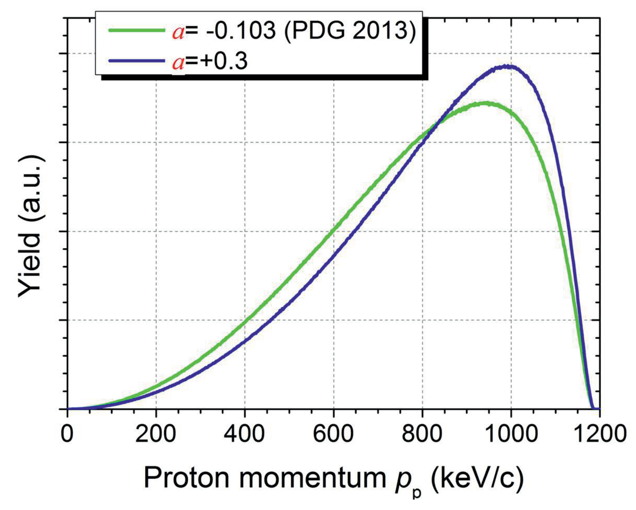
BSM Physics in LHC era

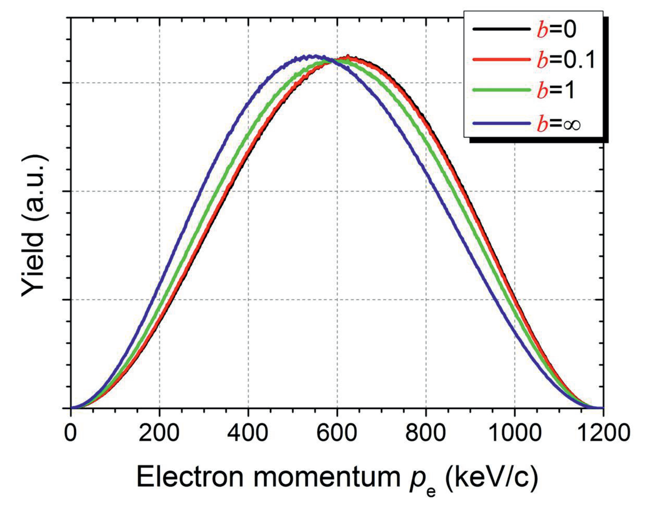


If future low-energy experiments (b, B, $b_{^6He}$ at 10^{-3} level; plus $\pi \to e\nu\gamma$, $0^+ \to 0^+$) find non-zero signal, scale of new particles can be predicted, and probed at LHC or future colliders[2].

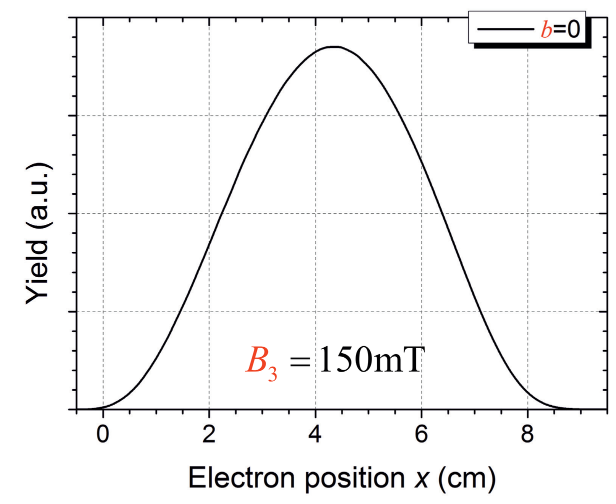
Observables

$$d\Gamma_b = \left(1 + b\frac{m_e}{E_e}\right) d\Gamma_{SM}$$

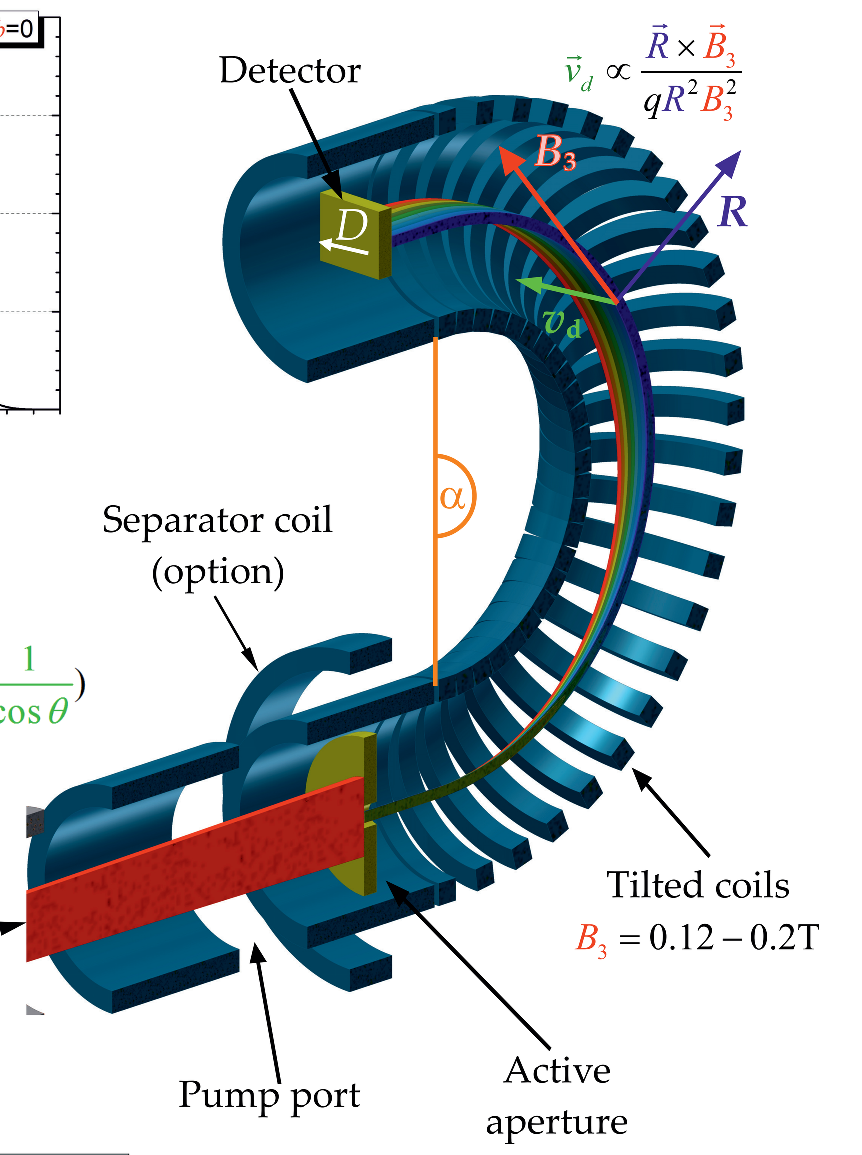




RxB Spectrometer

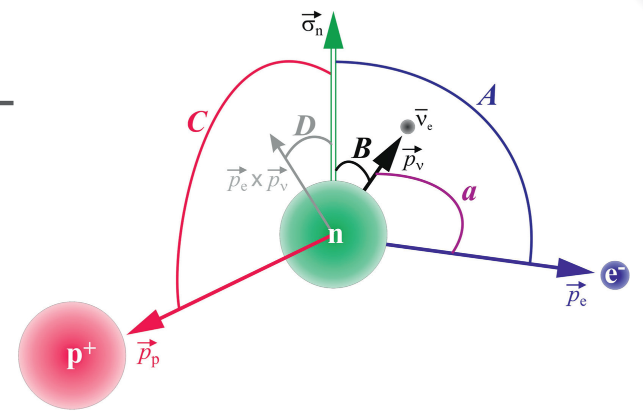


$$D(p,\theta) = \int_T v_d \, dt = \frac{p}{qB_3} \cdot \alpha \cdot \frac{1}{2}\left(\cos\theta + \frac{1}{\cos\theta}\right)$$



Field line curvature R	100 cm		
Analyzing field B_3	120 mT - 200 mT	Max. incident angle θ	8.1° - 10.5°
Bending angle α	180°	Max. gyration radius r_g	4.7 mm - 3.6 mm
Aperture size HxW	1 x 1 cm²	Max. RxB drift D	10.4 cm - 6.2 cm

Physics programme



The following measurements are planned:

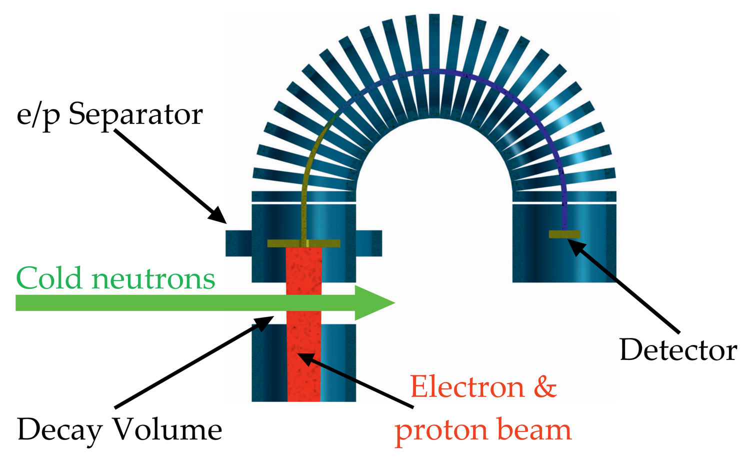
- Weak magnetism form factor f_2,
- Fierz interference term b,
- Neutrino-electron correlation coefficient a,
- Beta asymmetry parameter A,
- Oscillatory, sidereal effects in the case of LIV.

The goal is electron / proton spectroscopy on the 10^{-4}- / 10^{-3}-level. This needs adequate input from theory. The following analyses are planned by M. Pitschmann *et al.*:

- Analysis of correlation coefficients a, A, B, C, and D to order 10^{-5} within SM[5],
- Analysis of non-standard correlations N, G, R, Q, and L to order 10^{-3} within SM,
- Most precise possible evaluation if g_S and g_T, within SM and interactions beyond[8].

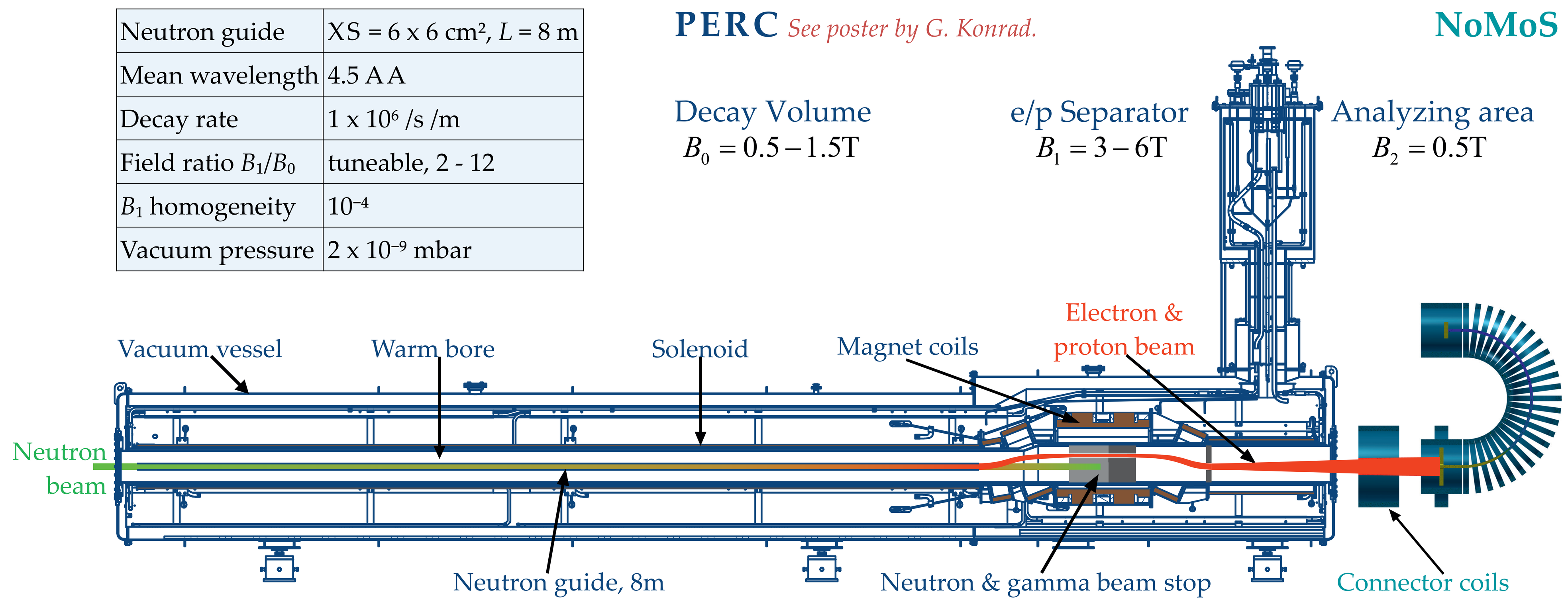
First measurements at ILL

PF1B	Unpolarized	Polarized
Beam XS	6 x 20 cm²	up to 6 x 8 cm²
Mean wavelength	4.0 - 4.5 AA	
Capture flux	2.2 x 10¹⁰ n/cm²/s	3.0 x 10⁹ n/cm²/s



Measurements at ultimate statistics at FRM II

Neutron guide	XS = 6 x 6 cm², L = 8 m
Mean wavelength	4.5 AA
Decay rate	1 x 10⁶ /s /m
Field ratio B_1/B_0	tuneable, 2 - 12
B_1 homogeneity	10^{-4}
Vacuum pressure	2 x 10^{-9} mbar



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NoMoS Collaboration

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