Estimation of the νGeN experiment sensitivity to the anti-neutrino magnetic moment.

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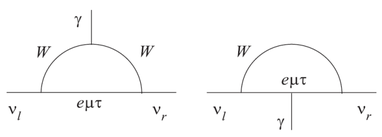
Neutrino magnetic moment

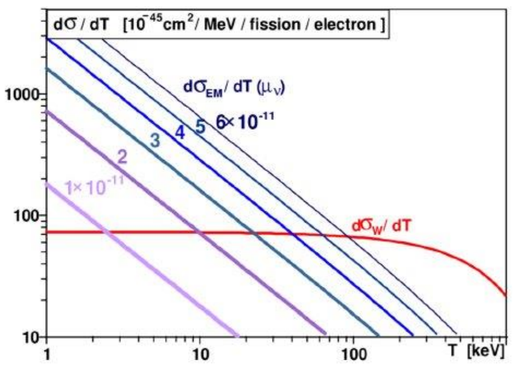


Standard Model predicts neutrinos to have a non-zero magnetic moment which is responsible for the change of chirality, yet it is extremely low and impossible to observe with modern detectors. However, there are various extensions to Standard Model which allow neutrino magnetic moment to be several orders of magnitude bigger and possible to observe.

The studied process is neutrino scattering on electron via electro-magnetic interaction and in the region of interest it prevails over other possible processes: scattering on electron via weak interaction; Coherent Elastic Neutrino-Nucleus Scattering.

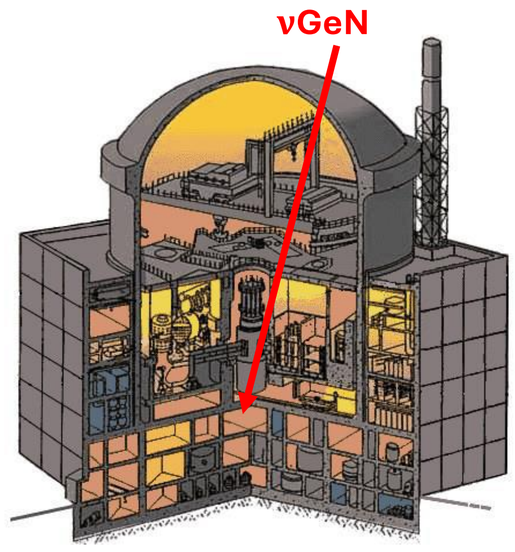
SM magnetic moment: $<10^{-19}\ \mu_B$.

BSM magnetic moment: $<10^{-11}$ .. $10^{-12}\ \mu_B$.



*A. Beda et al., Physics of Particles and Nuclei Letters, 2013, 10, 2, 139-143.

Experimental setup

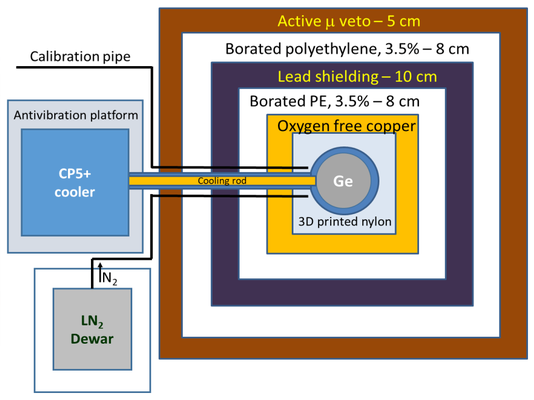


- νGeN experimental setup is located at Kalinin Nuclear Power Plant near reactor unit #3.
- The anti-neutrino flux is about $4*10^{13}$ $s^{-1}*cm^{-2}$ and the detector is located at the distance 11 m from the reactor core.

Shielding and detector

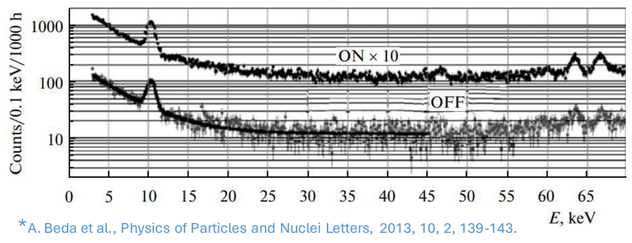
P-type contact HPGe detector

Scheme of νGeN shielding



- A multi-lawyer shielding scheme is used to suppress various sources of background. In addition, a spectrometer is installed on a lifting mechanism to change the neutrino flux. Also, reactor unit building provides good shielding (≈50 m water equivalent) from cosmic rays.
- 1.4 kg germanium detector is used to achieve low-threshold, low background and high-resolution measurements. Detector is cooled by electric cooling to -185°C.

GEMMA experiment



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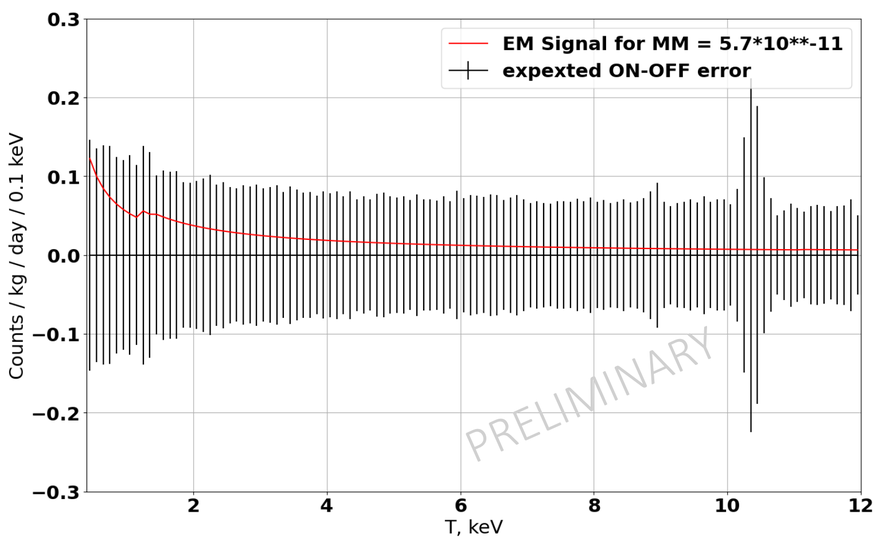
- The predecessor of νGeN – GEMMA experiment carried out similar research and set the best at a time limit on a neutrino magnetic moment.

	Flux, $s^{-1} * cm^{-2}$	ON exposition	OFF exposition	Region of interest	NMM limit (GEMMA); Sensitivity (νGeN)
νGeN	$4.4 * 10^{13}$	140.2 days	69.2 days	0.4 keV ... 12 keV	$5.7 * 10^{-11}\ \mu_B$
GEMMA	$2.7 * 10^{13}$	755.6 days	187.0 days	2.8 keV ... 55 keV	$2.9 * 10^{-11}\ \mu_B$

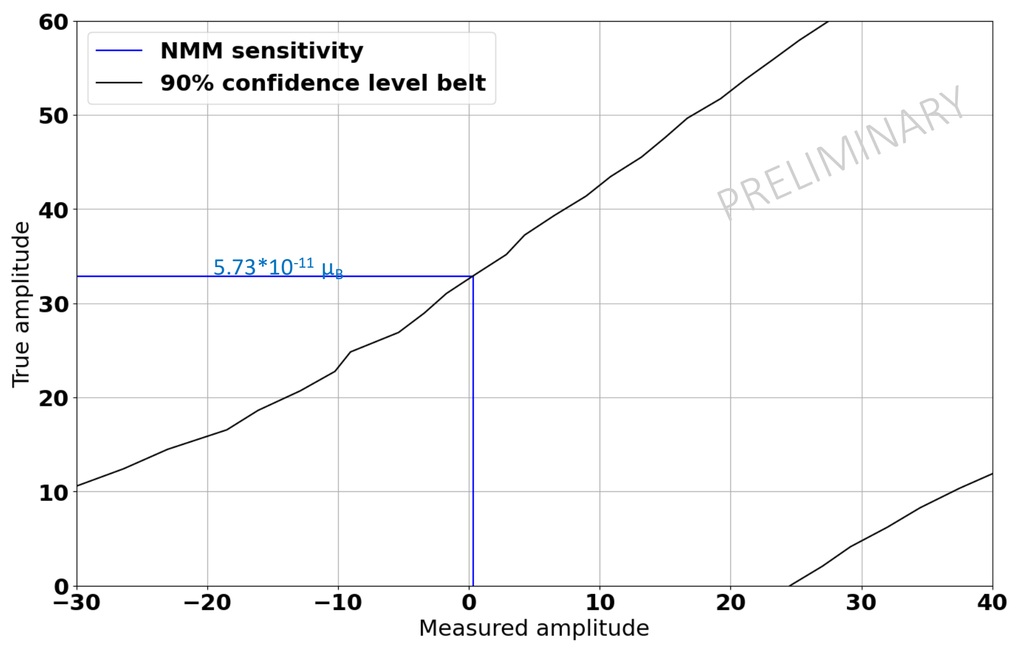
Sensitivity estimation

"Azimov" data set



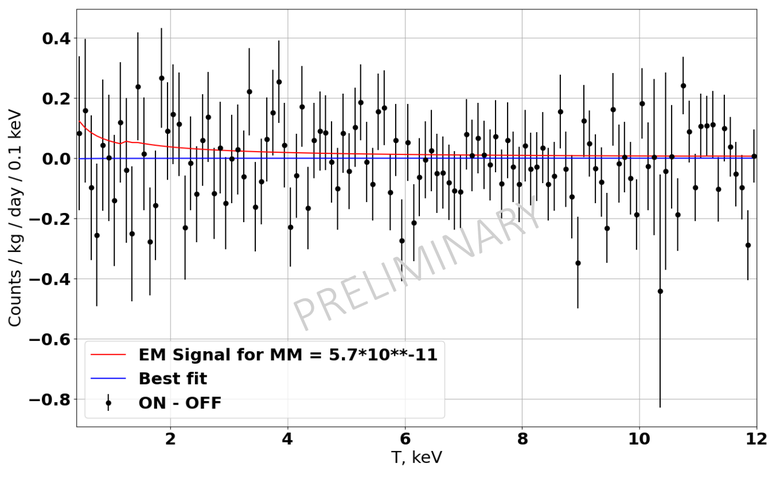
- Sensitivity of the νGeN experiment to the magnetic moment of reactor anti-neutrinos was estimated with Feldman-Cousins method and the result is $5.73*10^{-11}\ \mu_B$.
- Fitting OFF spectrum may significantly improve NMM sensitivity (about 1.4 times).
- Square root of amplitude is magnetic moment*$10^{-11}\ \mu_B$.

EM interaction amplitude confidence belt



ON data and NMM limit

ON – OFF experimental data

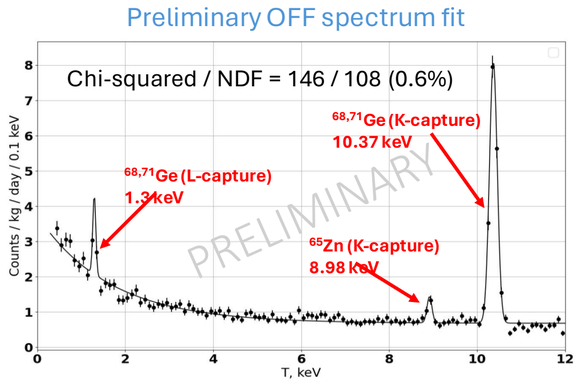


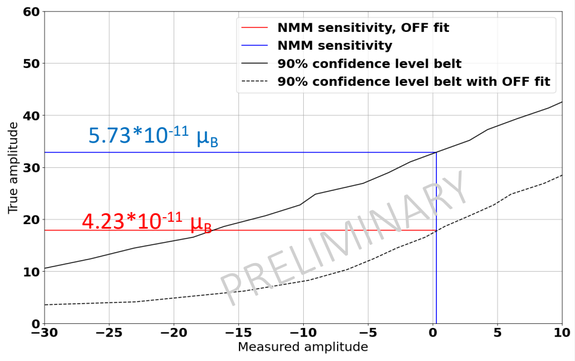
- 140 days ON and 69 days OFF.
- The region of interest is from 0.4 keV to 12 keV.
- Chi-square (best) / NDF = 100.7/115 (82.7 %).
- First analysis of the ON data shows that limit on the MM is slightly better than estimated sensitivity: $5.66*10^{-11}\ \mu_B$.

Plans

- Make reasonable background fit in this energy range.

Preliminary OFF spectrum fit





EM interaction amplitude confidence belt comparison

- Extend region of interest (include low-energy 0.3 keV bin and high energies up to 55 keV).
- Use all the available statistics (the correction for Rn-related background is needed).