Sterile neutrino in keV region in Tritium decay by Trotsk nu-vass

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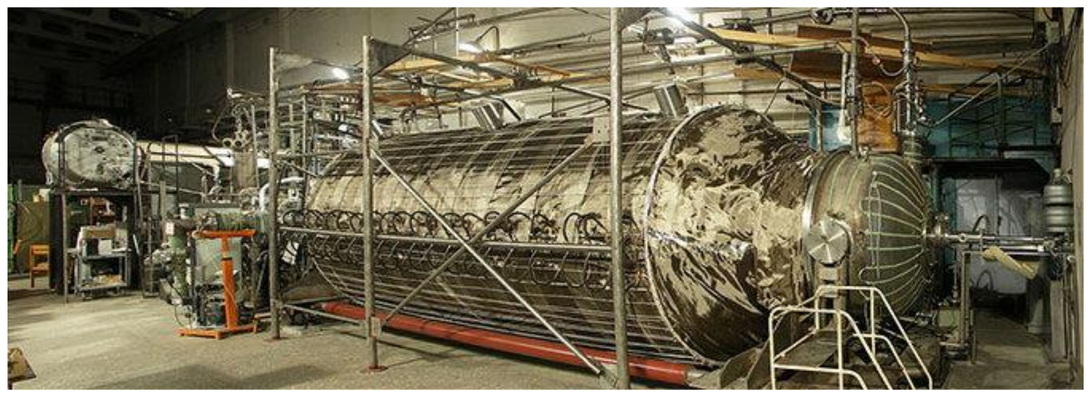
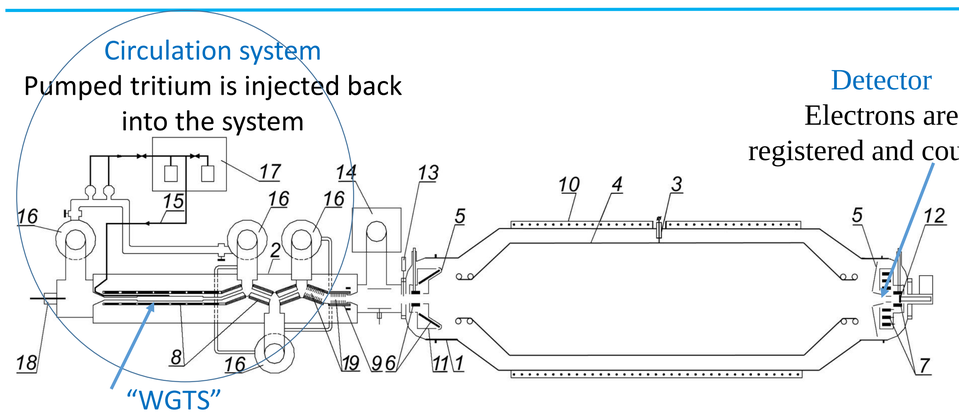
We present status, first results and upcoming updates of precision measurements of tritium beta-decay spectrum by the “Troitsk nu-mass” experiment. The goal is to find distortion in the spectrum which may be caused by the existence of a heavy sterile neutrinos. A signature would correspond to a kink in the spectrum with characteristic shape and end point shifted by the value of a heavy neutrino mass. We set a new upper limits to the neutrino mixing matrix element U^2_{e4} which improve existing limits by a factor from 2 to 5 in the mass range 0.1-2 keV. More results on the collected statistics are underway. New collaboration TRISTAN-Troitsk with new Si multi pixel detector will open the road to higher and better quality data.

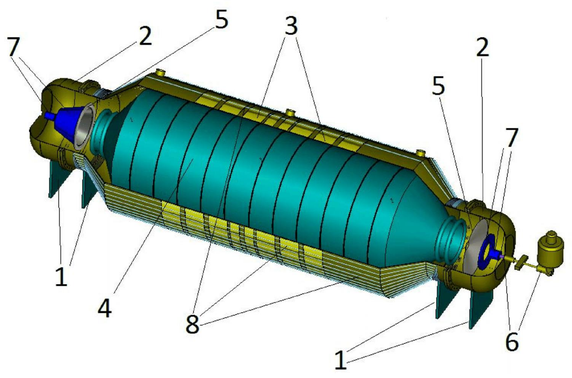


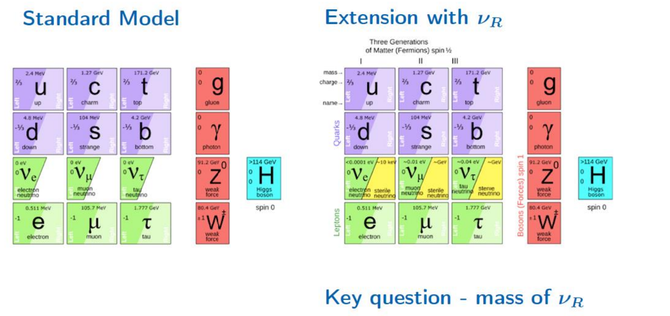
Circulation system
Pumped tritium is injected back into the system

Detector
Electrons are registered and counted

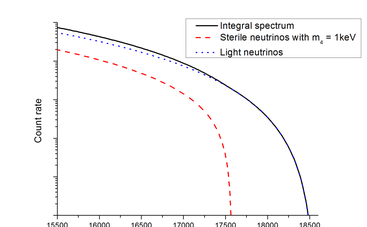


Electrostatic magnito-adiabatic spectrometer

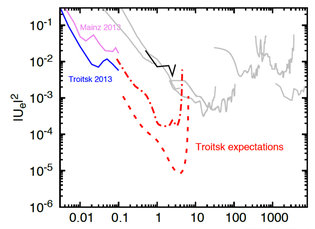




See also *Lett. of Intent*, arxiv:1504.00544 JINST 10 (2015) no.10, T10005



$$S(E) = U^2_{e4} S(E, m^2_4) + (1 - U^2_{e4}) S(E, m_1)$$

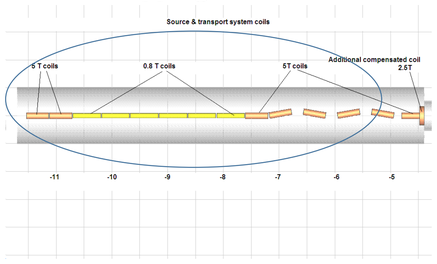


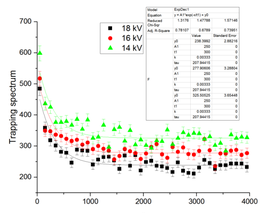
Estimated upper limits with old electronics

Devil is in details - systematics

- Insufficient accuracy of electron energy loss in gaseous source
- Electron trapping in “magnetic bottle” in the source
- Distortion of spectrometer transmission function
- Detector efficiency and electron scattering at different energy
- Electronics dead time and pile up
- Gas column density fluctuation
- High voltage stability

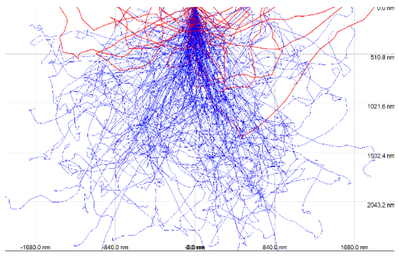
Trapping in WGTS





Differential spectrum of trapped electrons

Up to 20% of electrons suffer back scattering from surface of the Si detector.
Simulation of electron tracks in Si.



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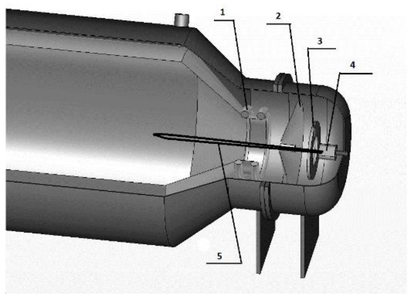
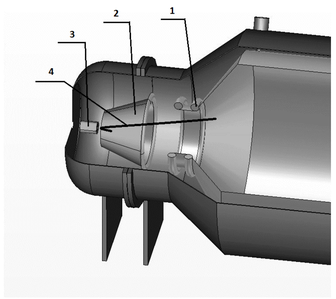
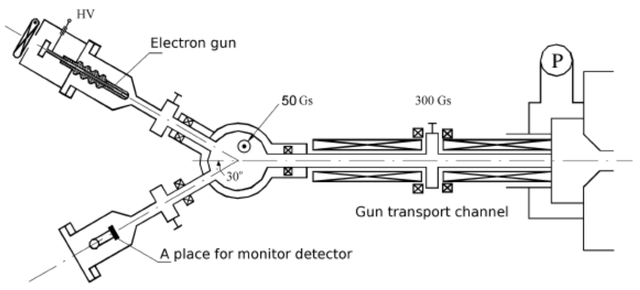
Back scattered electrons can be reflected by electrostatic or magnetic mirrors or event exit through the spectrometer entrance back to WGTS and be lost



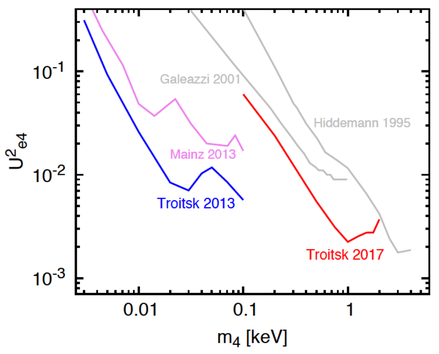


Electrostatic mirror at the detector side. Magnetic mirror at the entrance

Electron Gun up to 30 keV at rear section



Recent published data



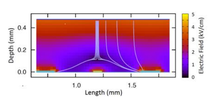
JETP Lett. 105 (2017), 753, arXive:1703:10779

Upgrade: TRISTAN in Troitsk

KATRIN – Max Plank Institute for Physics, Munich – Institute for Nuclear Research, Moscow- Troitsk

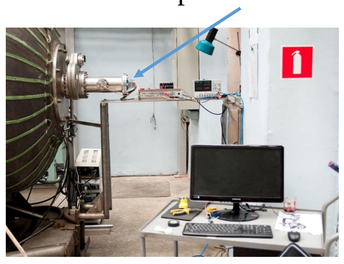
Very low noise multi-pixel Si drift detector.
Prototype – 7 pixels by 2 mm each.

Final detector– 166 ch.
Will allow to measure m_s up to 10-12 keV

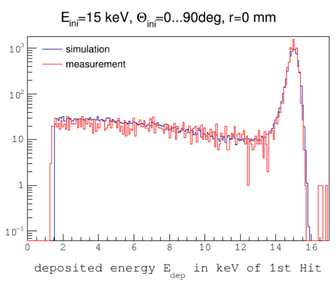


Si drift cell

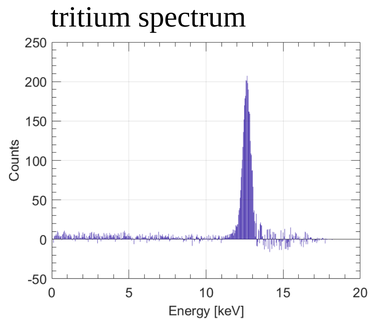
First test setup in Troitsk



Spectrum from e-gun



Differential analysis of tritium spectrum



Raw tritium spectrum measured by one of the pixels in April 2018 Run. Data are been analyzed.