Search for light sterile neutrinos with the KATRIN experiment

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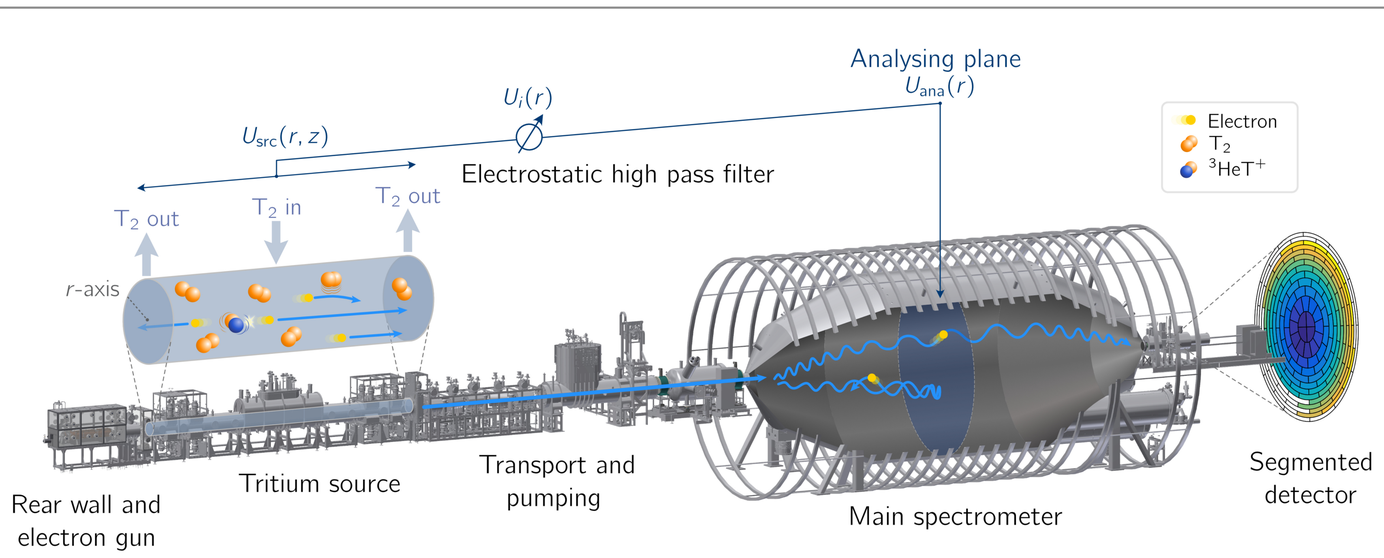
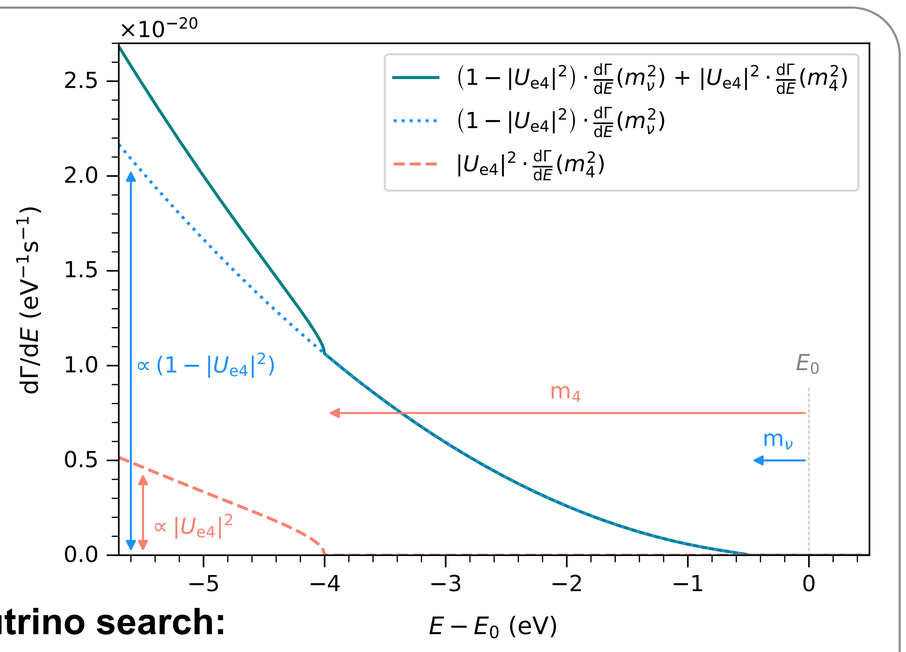




- **Goal:** Measurement of the effective electron anti-neutrino mass, m_ν, with 0.2 eV sensitivity at 90 % CL
  - Measurements with T_2 since 2018
  - Nine successful measurement campaigns to date

⇒ **Combined neutrino mass analysis of first and second campaigns:**

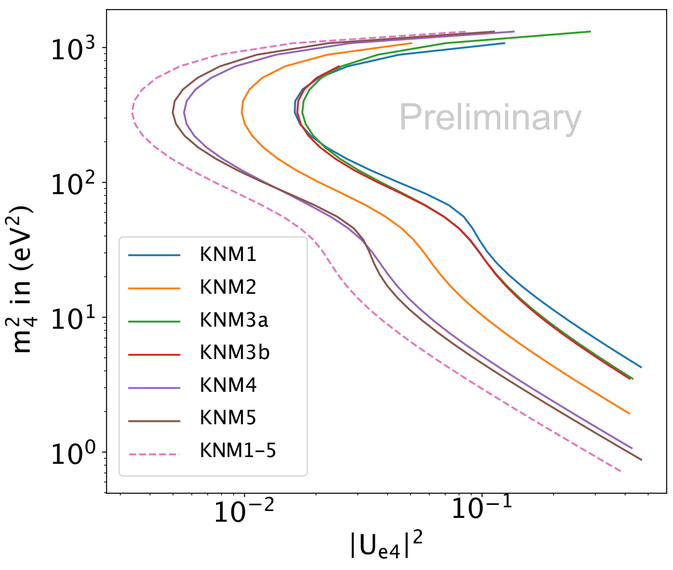
$\Rightarrow m_\nu \leq 0.8\,\text{eV}\ (90\,\%\ \text{CL})$ [Nat. Phys. 18, 160-166 (2022)]

eV-scale sterile neutrino search:

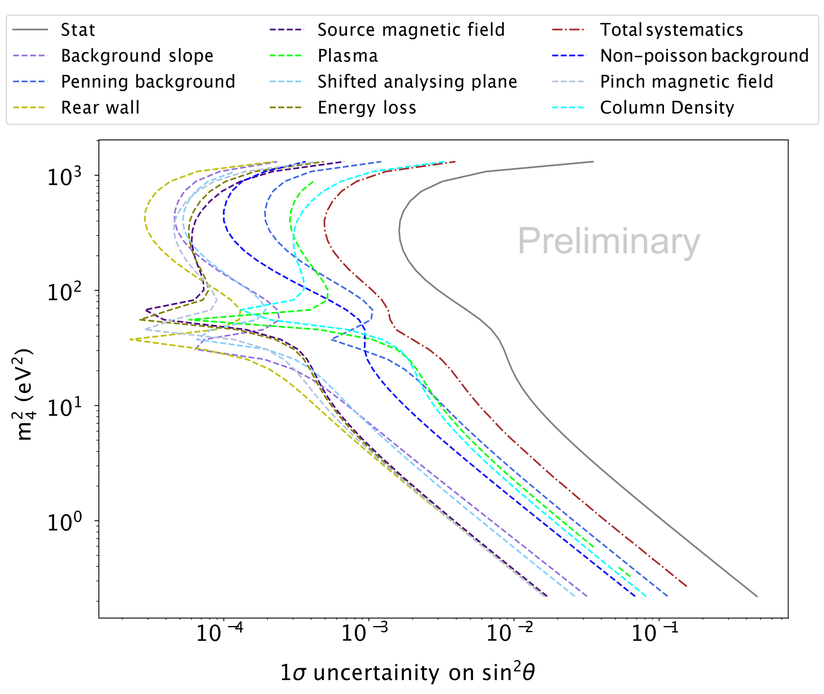
- Fourth mass eigenstate contribute to the spectrum via an extended PMNS matrix

$$R_\beta = (1-|U_{e4}|^2)\cdot R_\beta(m_\nu^2) + |U_{e4}|^2 \cdot R_\beta(m_4^2)$$

- First branch corresponds to active neutrinos: $m_\nu^2 = \sum_{i=1}^{3} |U_{ei}|^2 \cdot m_i^2$
- Kink-like signature of sterile neutrinos at m_4^2



- Sensitivity comparison of individual campaigns at 95 % CL



Treatment of systematics with the Pull Term approach:

- Systematics are included by adding penalty terms to the χ^2

$$\chi^2 = \chi^2_{\text{stat.}}(m_\nu^2, E_0, \text{Sig}, \text{Bg}, \theta_1, ...) + \frac{(\theta_1 - \hat{\theta}_1)^2}{\sigma^2_{\theta_1}} + ...$$

- Investigate impact of individual systematics
- Addition of systematics one-by-one
- Calculate 68 % CL uncertainty on $|U_{e4}|^2$:

$$\sigma_{\text{syst.}}(|U_{e4}|^2) = \sqrt{\sigma^2_{\text{stat.+syst.}} - \sigma^2_{\text{stat.}}}$$

⇒ **Sensitivity is statistics dominated for all m_4^2**

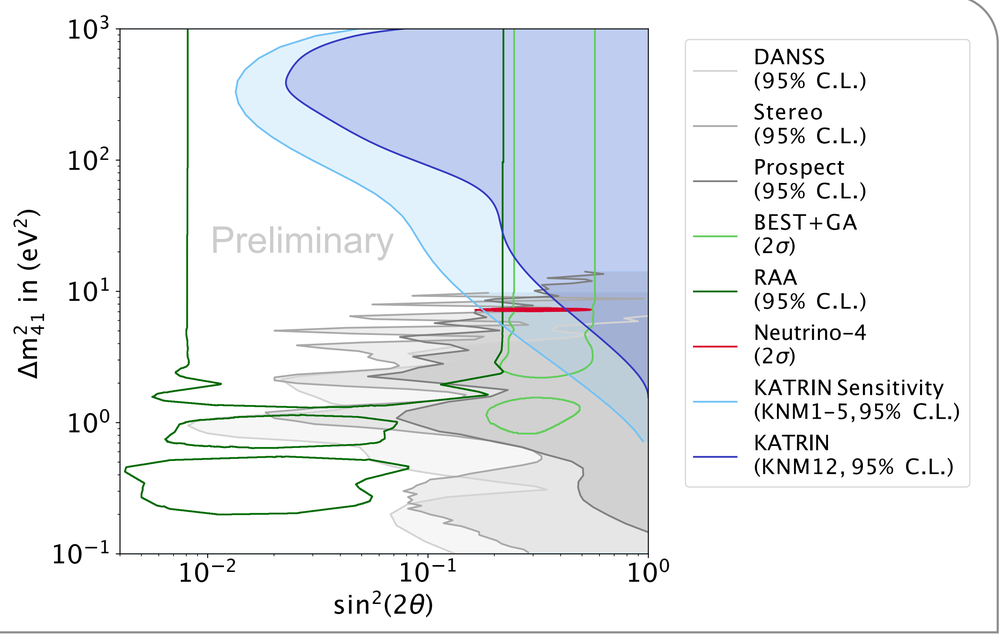
10.1103/PhysRevD.105.072004

Comparison to published results and other experiments

- Expected KNM1-5 sensitivity yields more stringent constraints in the sterile parameter space
- Probes parameter space for light sterile neutrino anomalies

⇒ KATRIN can probe interesting regions in the sterile parameter space and is able to exclude regions of the reactor and gallium anomalies

⇒ Analysis of data of the first five science runs ongoing



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