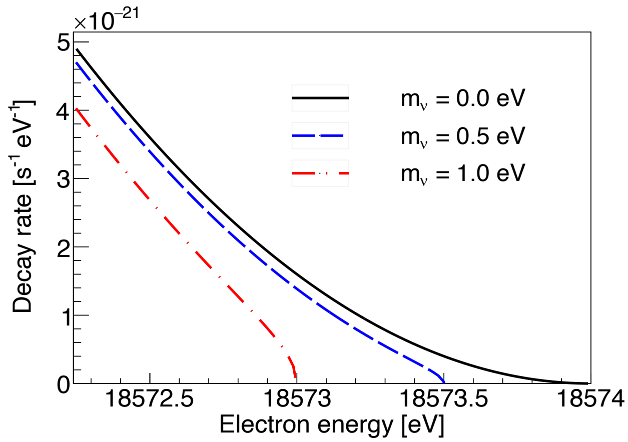
The KATRIN spectrum

The differential spectrum of tritium β-decay can be described by Fermi's theory:

$$R_\beta(E_e) \propto F(E_e, Z) \cdot E_e \cdot E_\nu \cdot p_e \cdot p_\nu \,,$$

with $F(E_e, Z)$ being the Fermi function, followed by the phase space terms. Neutrino mass shows up in $p_\nu = \sqrt{(E_0 - E)^2 - m_\nu^2}$, as can be seen below:



Due to rotational and vibrational final state distribution of molecular tritium, the KATRIN differential spectrum is modified as

$$R'_\beta(E_e) = \sum_f P_f \cdot R_\beta\big(E_e - V_f\big)\,,$$

where P_f is the probability of falling into the final state f with energy V_f.

The KATRIN measured spectrum from tritium β-decay is an integration over the differential spectrum, convolved with the response function:

$$R_{\mathrm{int},\beta}(qU_i) = \int_{qU_i}^{\infty} R_\beta(E_e) \cdot f(E_e, qU_i)\, dE_e\,,$$

in which $f(E_e, qU_i)$ is the response for electron with energy E_e at a high voltage of U_i.

To account for possible statistical fluctuations, a negative m_ν^2 is allowed in the spectrum calculation. This results in an asymmetric profile log likelihood curve for m_ν^2.