Methods for an unbiased m_ν analysis with KATRIN

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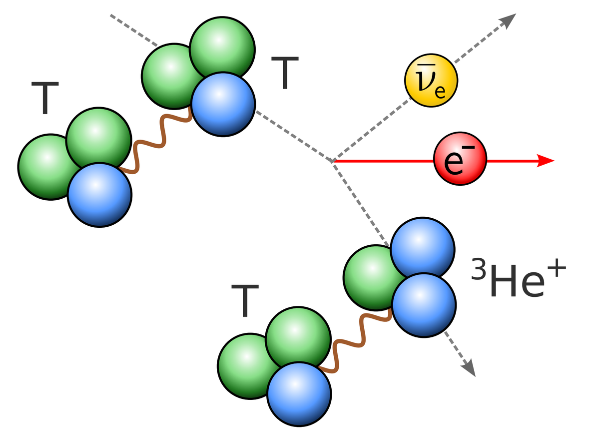
for the KATRIN collaboration

Detect electrons from molecular tritium β-decay

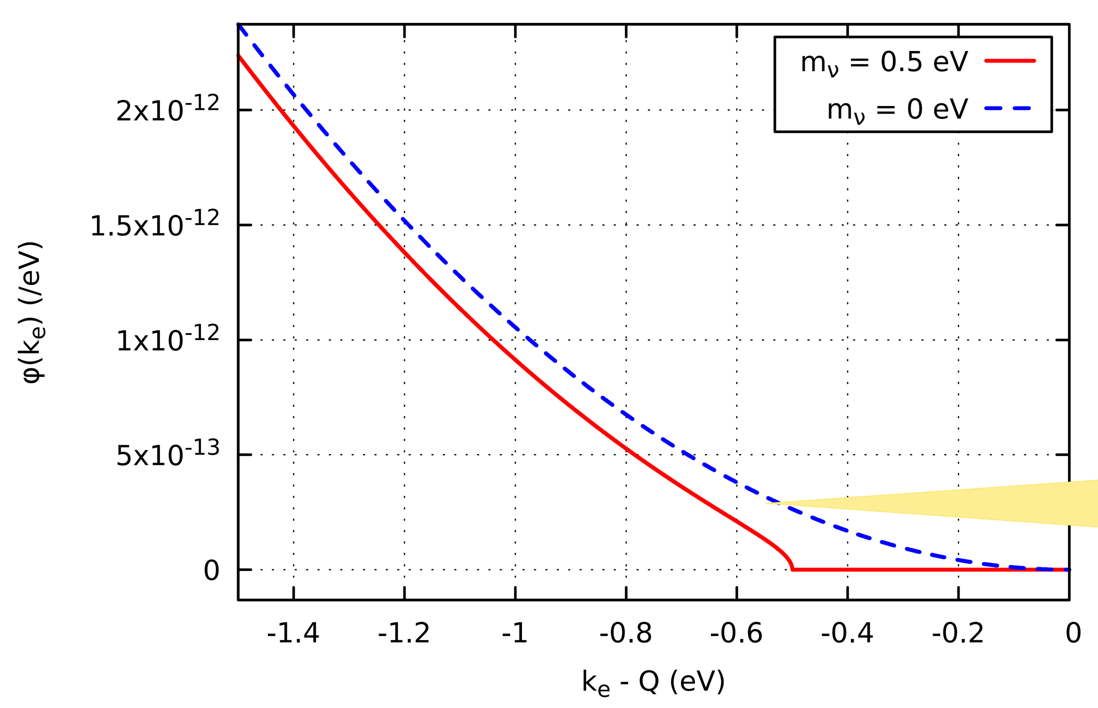
May be excited

$T_2 \rightarrow {}^3HeT^+ + e^- + \bar{\nu}_e$

May scatter with T_2



Near-endpoint m_ν measurement



Fit $m_\nu{}^2, Q$, signal amplitude and background

Blind analysis

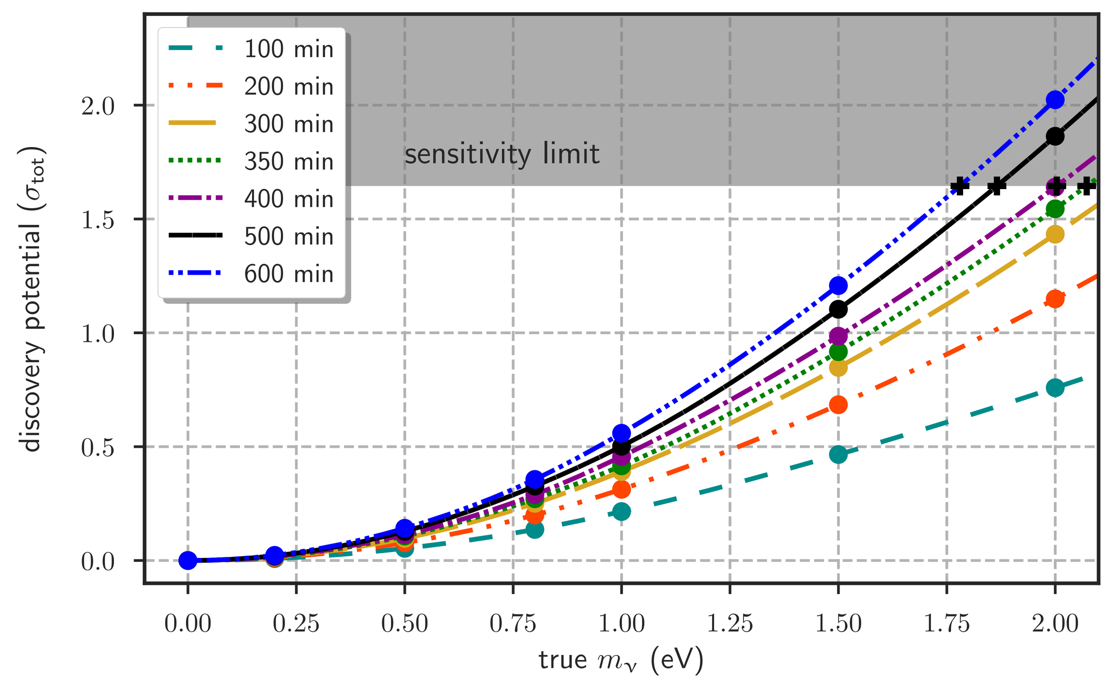
- Prevent observer's bias
- Limit blind sensitivity (Troitsk and Mainz legacy)

$$m_\nu < 2\,\text{eV} \quad (95\%\,\text{C.L.})$$

- Allow monitoring and systematic investigations
- Data blinding or model blinding

Reduced statistics

- Sensitivity depends on true m_ν and measuring time
- Reduce simulated statistics until fit yields $m_\nu^2 < 1.645\,\sigma_{tot}(m_\nu^2)$

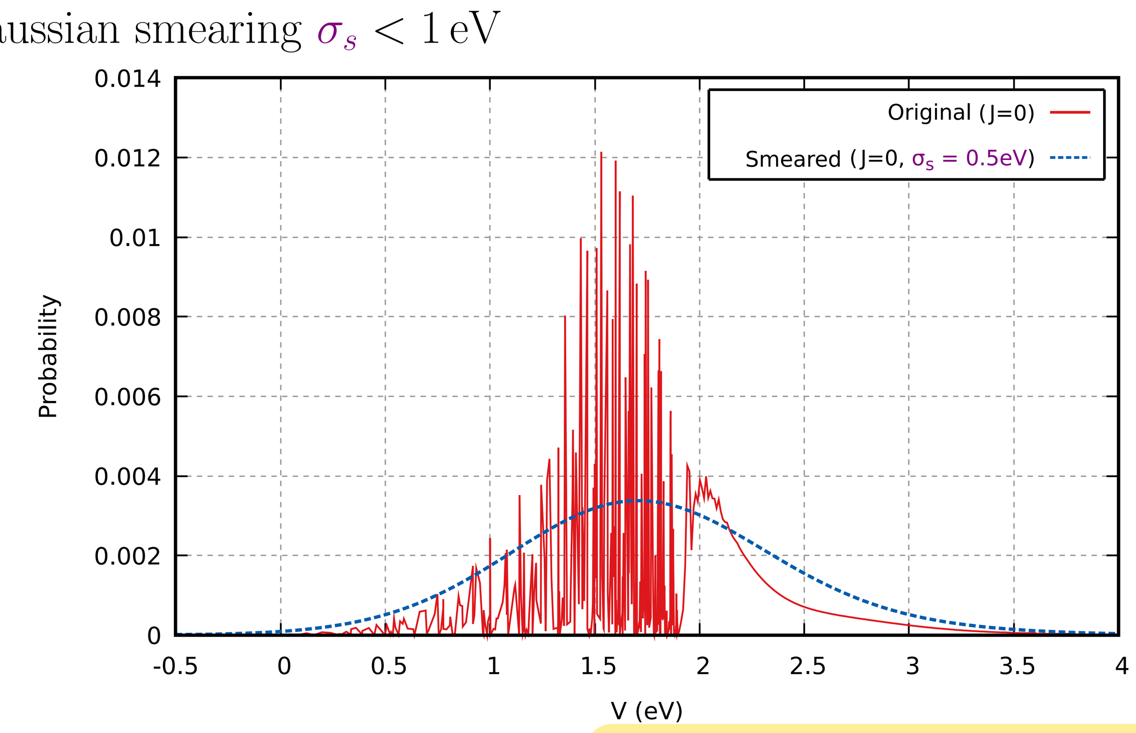


- Full energy range accessible
- Re-blinding easy

- Low precision on other fit parameters
- Parameter stability difficult to monitor

Final states smearing

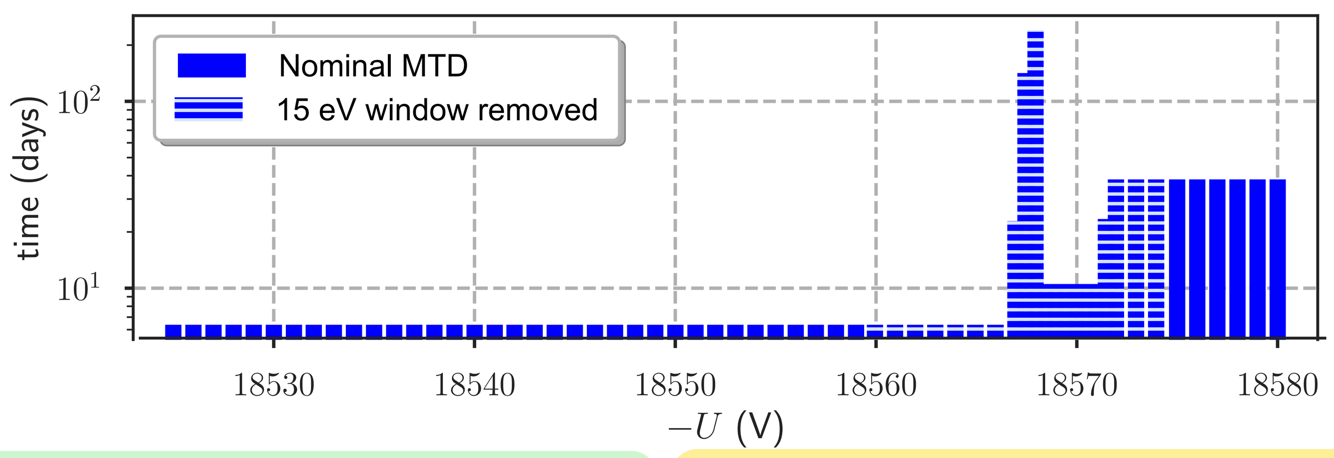
- Convolve Gaussian with final states spectrum f_V
- Random Gaussian smearing $\sigma_s < 1\,\text{eV}$



- Cf. Energy smearing
- No need to re-process the data

- χ^2 values harder to interpret
- Older unsmeared distributions available
- Positive mass bias

Window blinding

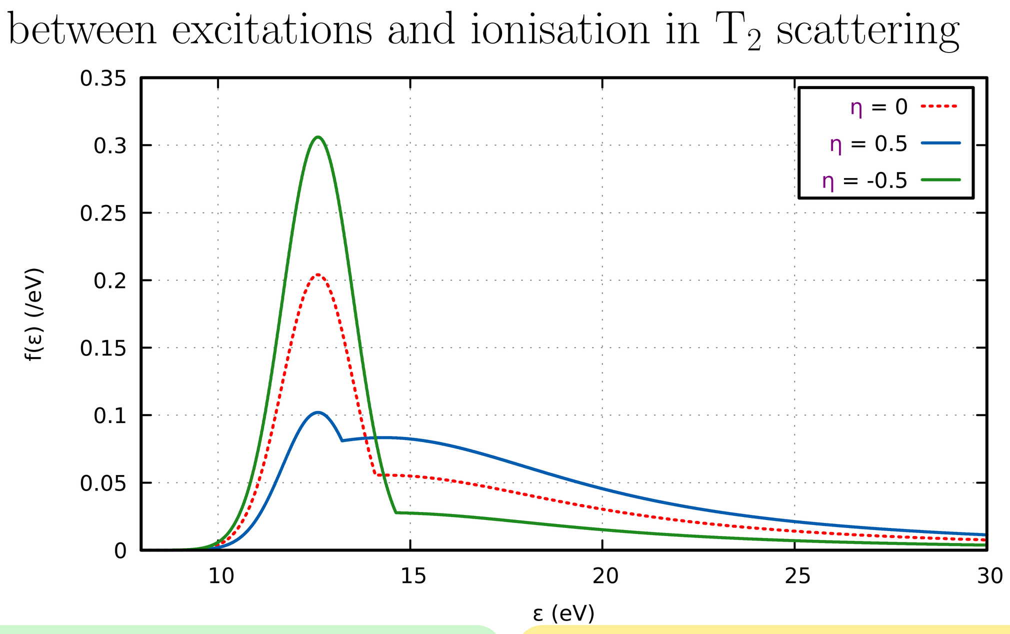


- More than 80% of the total counts

- Systematics near Q harder to investigate

Imperfect energy loss

- Modify share η between excitations and ionisation in T_2 scattering

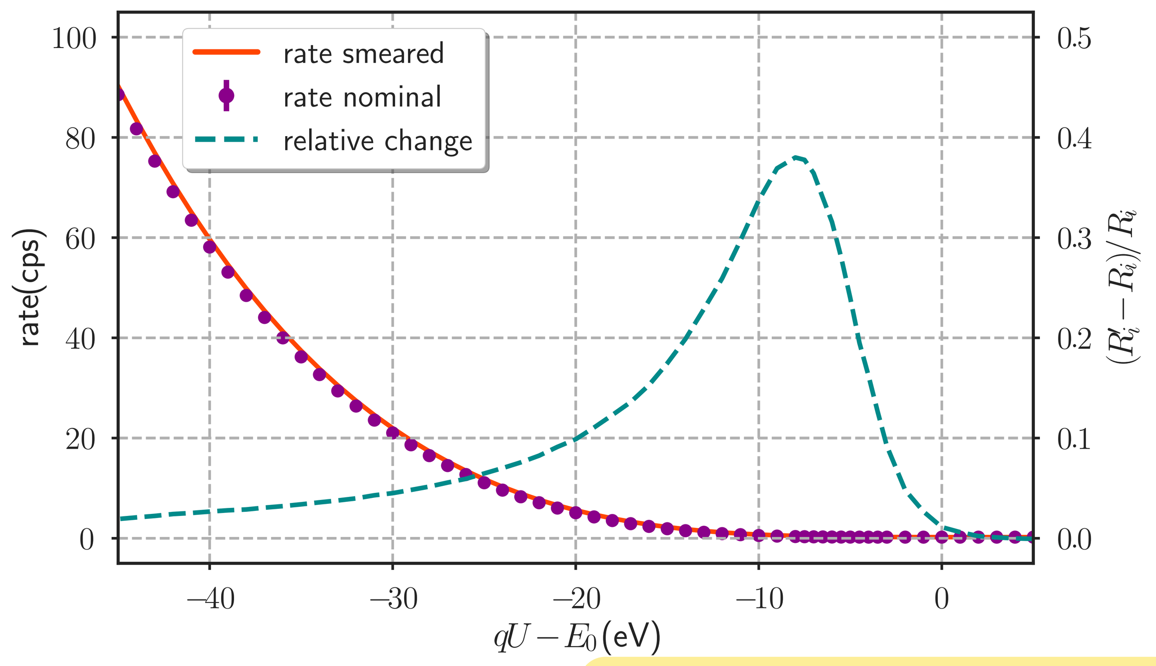


- Full energy range & statistics
- Can choose mass bias sign

- Sizeable shift of other fit parameters
- Other energy loss available

Energy smearing

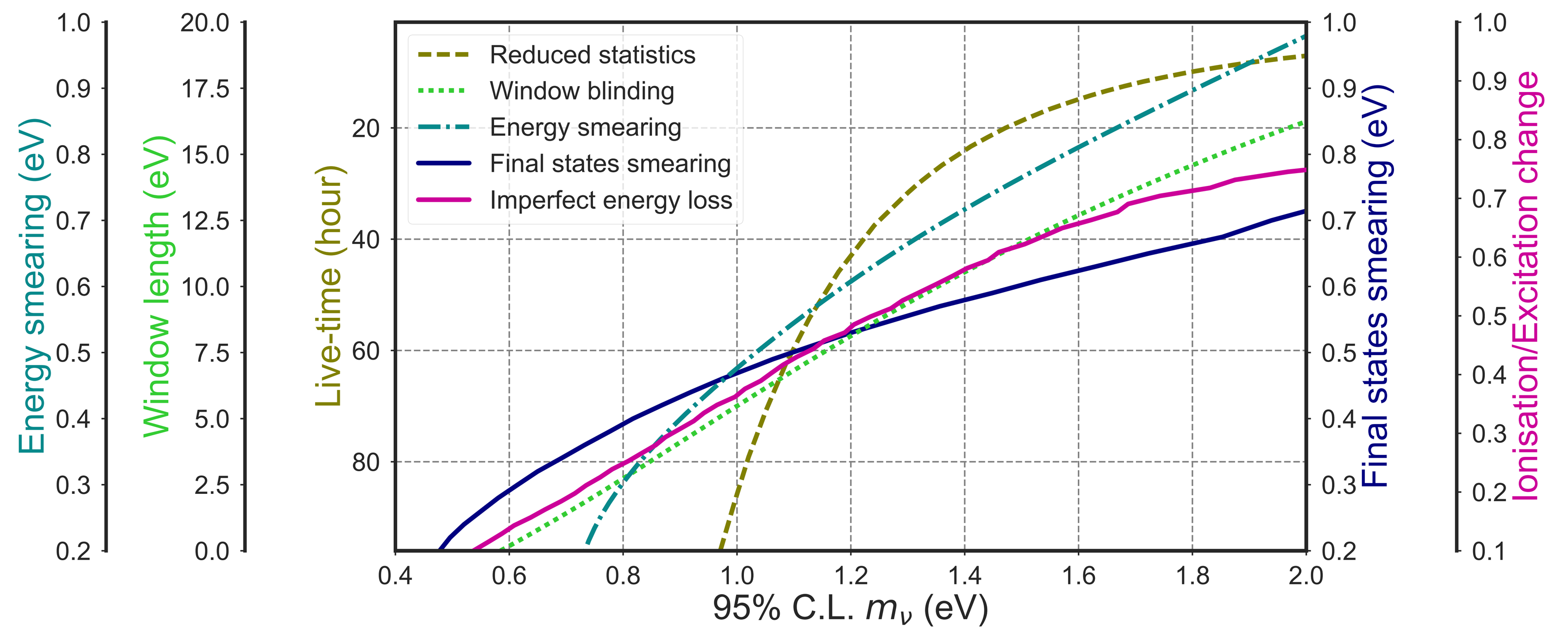
- Convolve Gaussian with differential β-spectrum



- Full energy range & statistics
- Systematic studies feasible

- χ^2 values harder to interpret
- Data re-processing required
- Can be accounted for in the fit
- Negative mass bias

Conclusion & Prospects



- All methods reach $m_\nu = 2\,\text{eV}$
- Test techniques against first T_2 data

- Propose method for longer 30 d period
- Release biased and unbiased m_ν

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