Raman spectroscopy for the Windowless Gaseous Tritium Source of the KATRIN experiment

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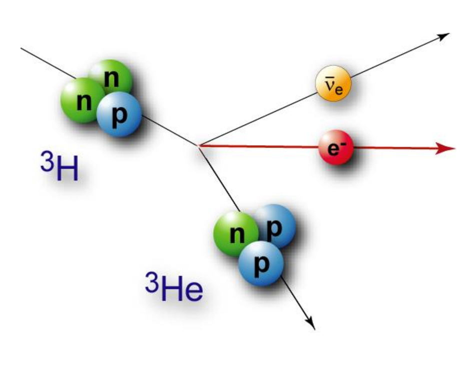
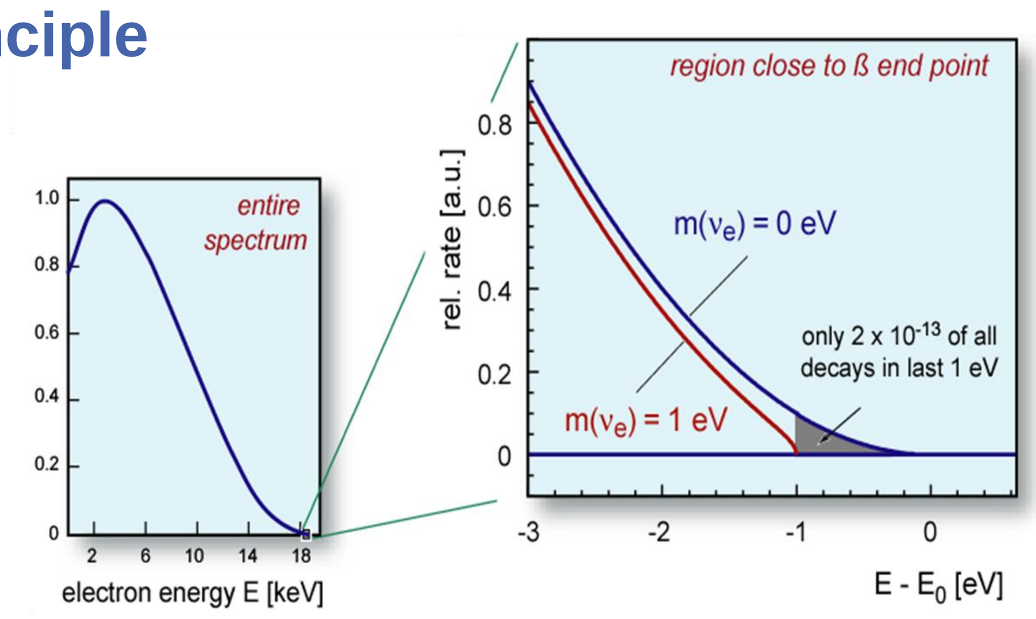
The KATRIN experiment

Measurement principle



$^3H \rightarrow {}^3He + e^- + \bar{\nu}_e$



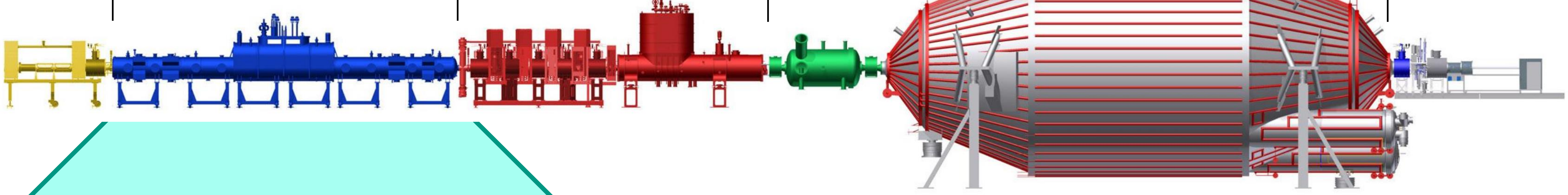
$$\frac{dN}{dE} \propto \sqrt{(E_0 - E)^2 - m_\nu^2} \qquad m_\nu^2 = \sum_{i=1}^{3} |U_{ei}|^2 m_i^2$$

More about KATRIN:
Talk by T.Thümmler
Thursday, 18:58,
Working Group 2

- **Model-independent measurement of the neutrino mass, based on kinematics of β-decay**
- **200 meV sensitivity (90% C.L.) on neutrino mass**

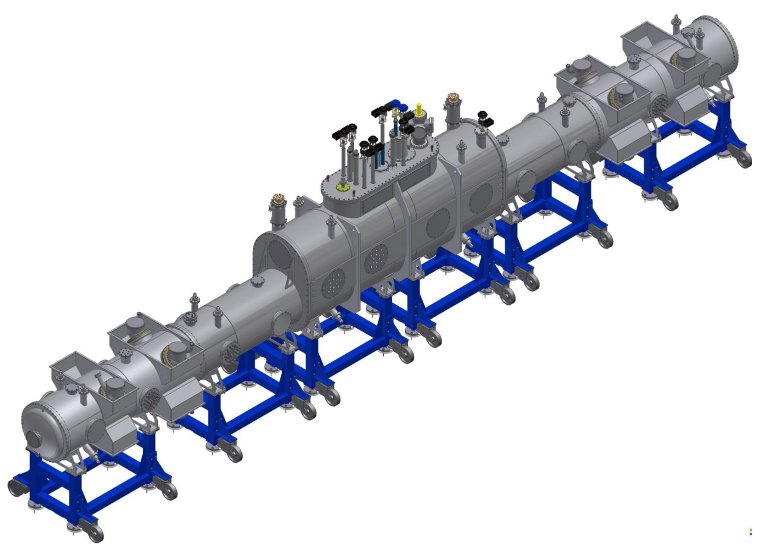
KATRIN Setup

CMS | **Tritium source (WGTS)** | **Transport section** | **Spectrometers** | **Detector**



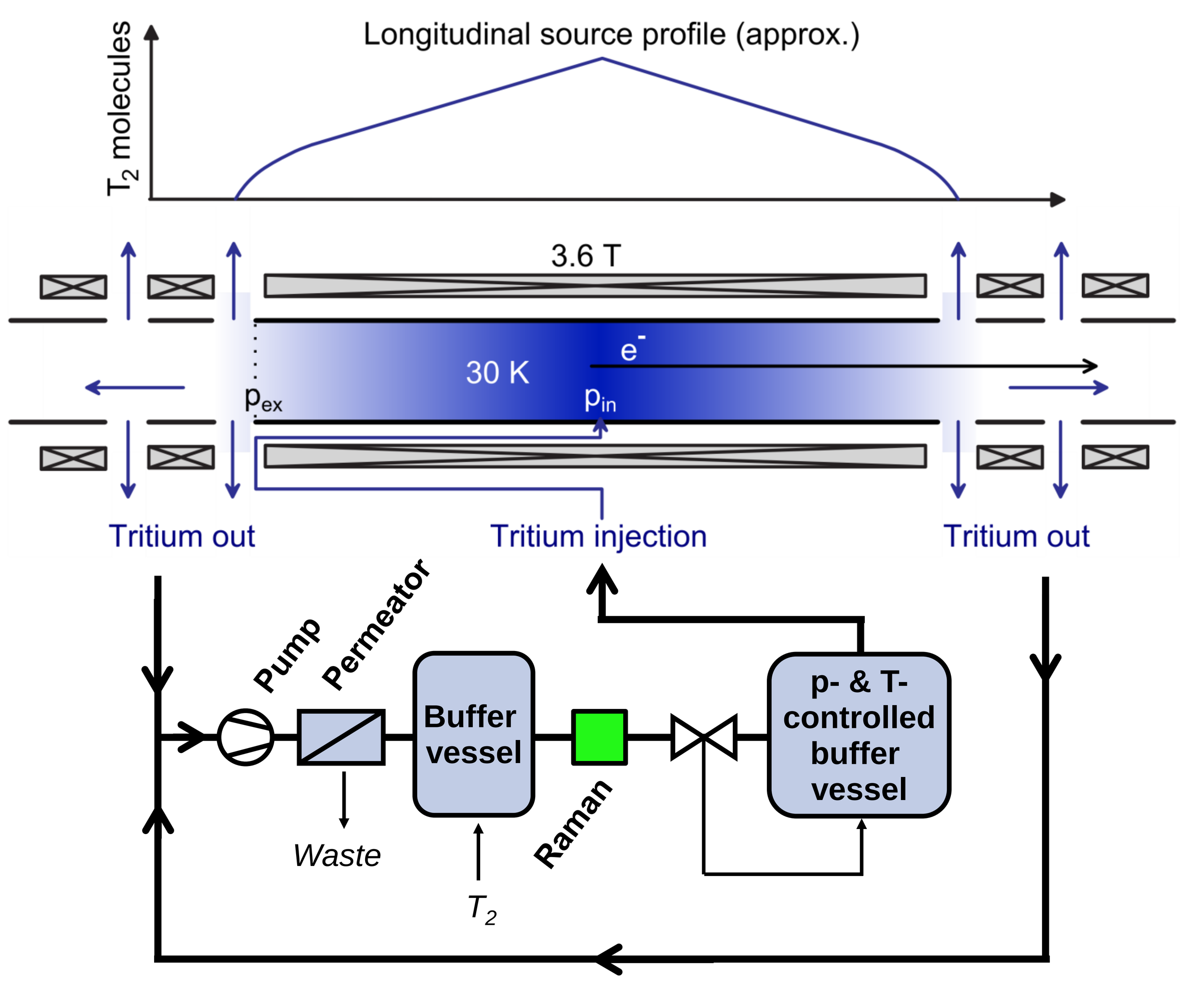
The Windowless Gaseous Tritium Source (WGTS)

The WGTS cryostat



- **Source activity:** 10^{11} e^- / s
- **Throughput:** 10 kg tritium/year in closed tritium cycle
- **Requirements:** 0.1% stability for small systematic uncertainties

Principle of the WGTS



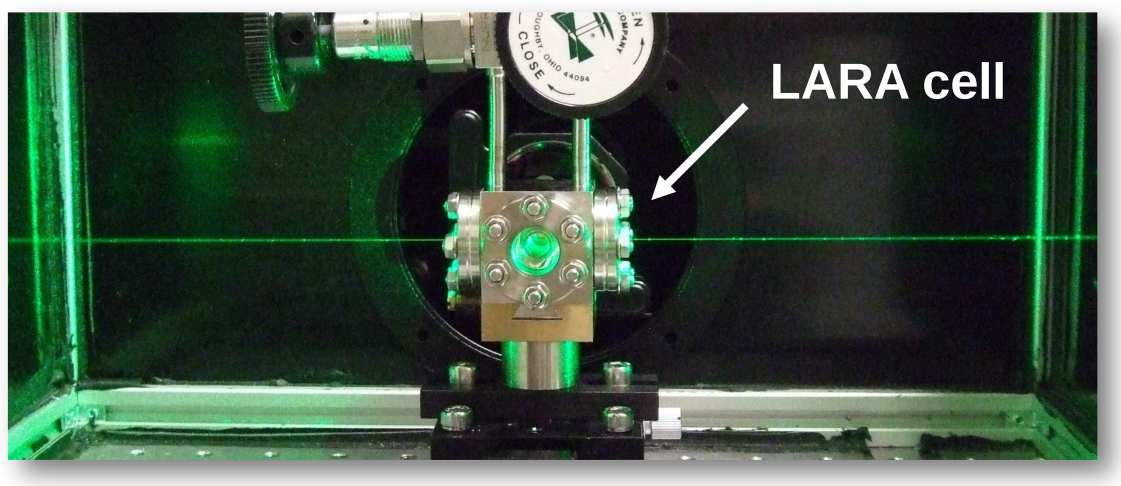
Control and monitoring

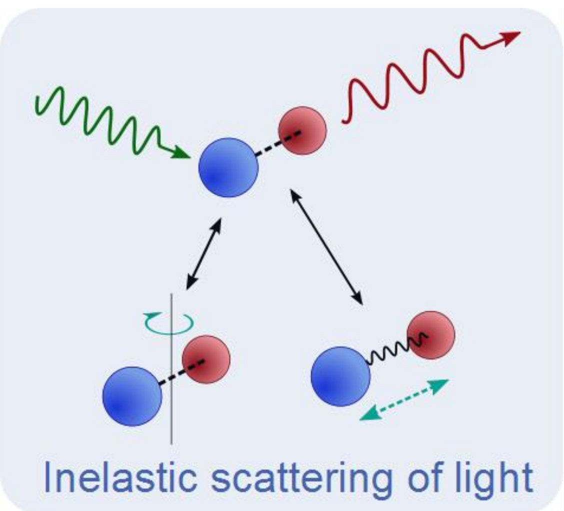
- **Column density stability**
  Achievements:
  - Pressure: 0.02% stability
  - Temperature: 0.005% stability
- **Gas composition monitoring**
  Achievements:
  - Precision < 0.1% in 60 s
  - Calibration uncertainty < 3%

Essential for KATRIN sensitivity: Control and monitoring of source parameters on 0.1% level

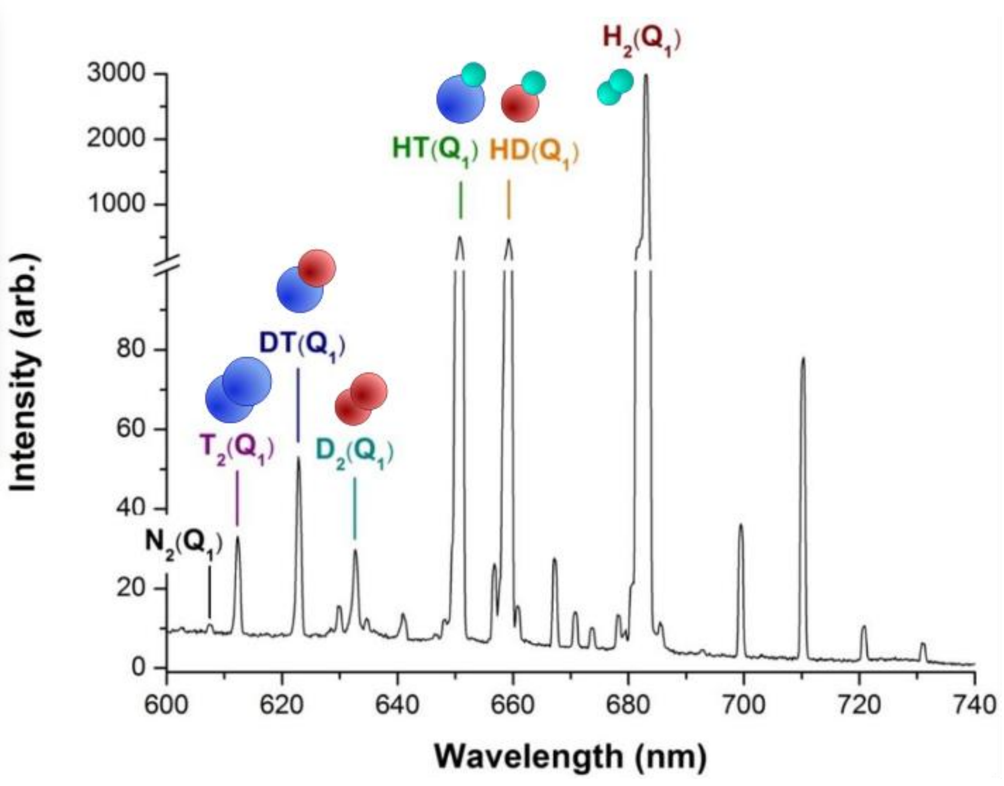
M. Babutzka et al., New J. Phys. 14 (2012) 103046

Raman spectroscopy – a high precision composition monitoring tool for KATRIN



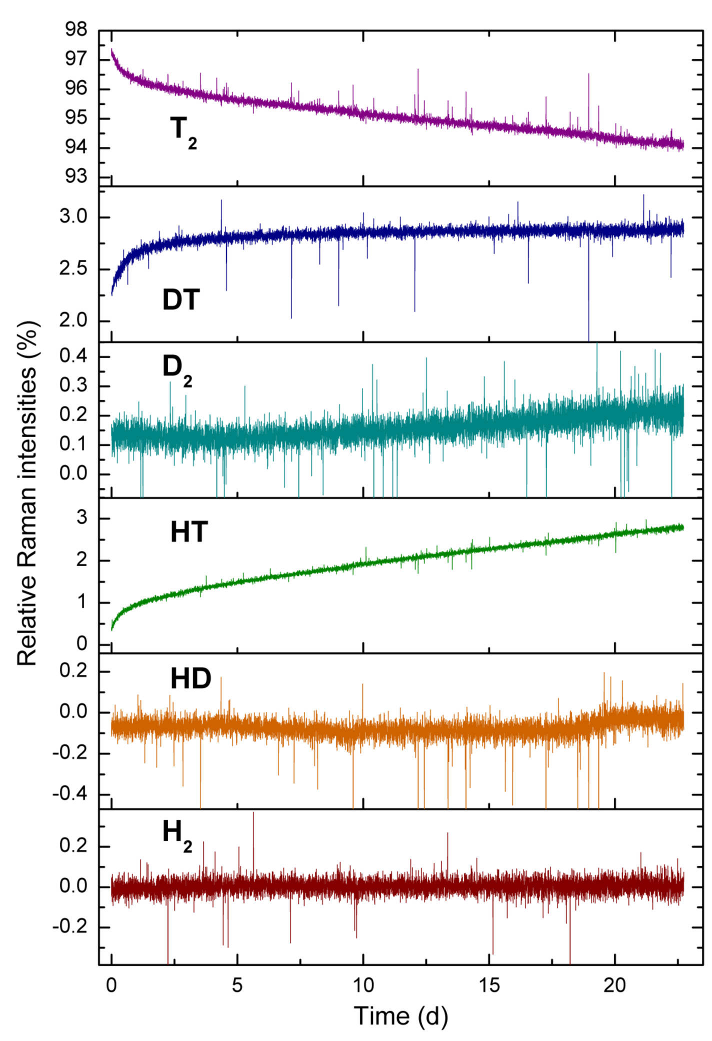


- Characteristic wavelength shift for each molecule → **simultaneous detection**
- **Contact-free, in-line** gas analysis



Quantitative analysis of gas sample composition based on Raman line intensities

Long term measurement



Observation of
- Exchange reactions
- Surface reactions
- Impurities

0.1% precision verified under realistic conditions

S. Fischer et al., Fusion Sci. Technol., 60 3 925 (2011)