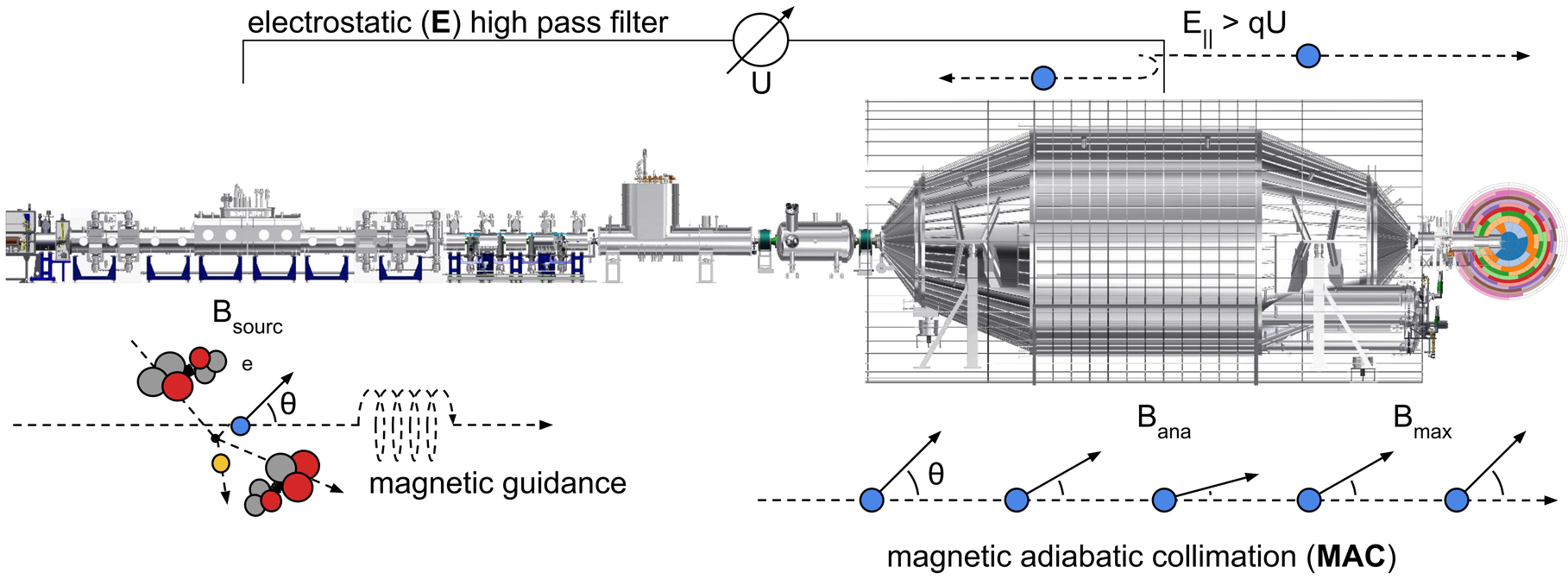
KATRIN neutrino mass analysis - Insights into the neural network approach

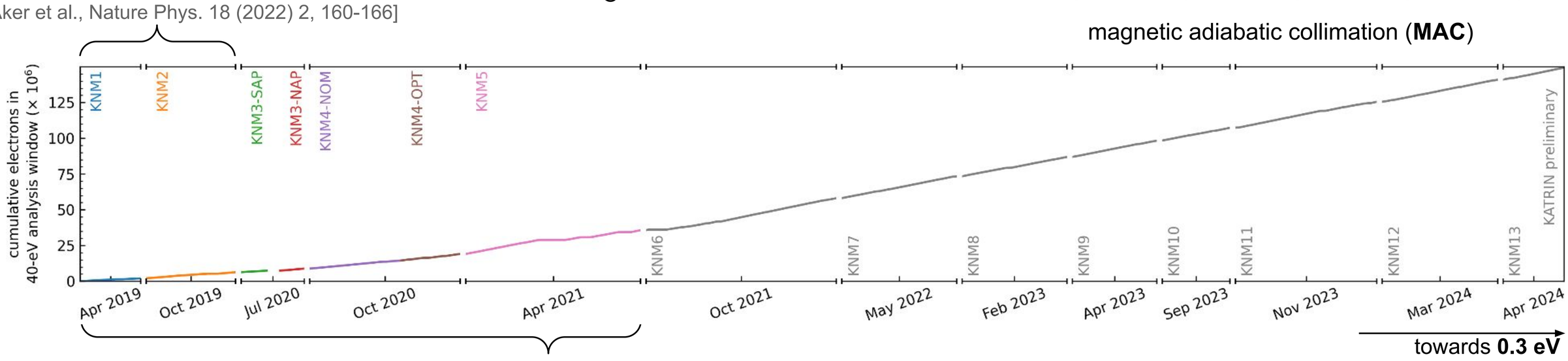
*Susanne Mertens, **Alessandro Schwemmer** alessandro.schwemmer@tum.de and Christoph Wiesinger (TUM) for the KATRIN collaboration*

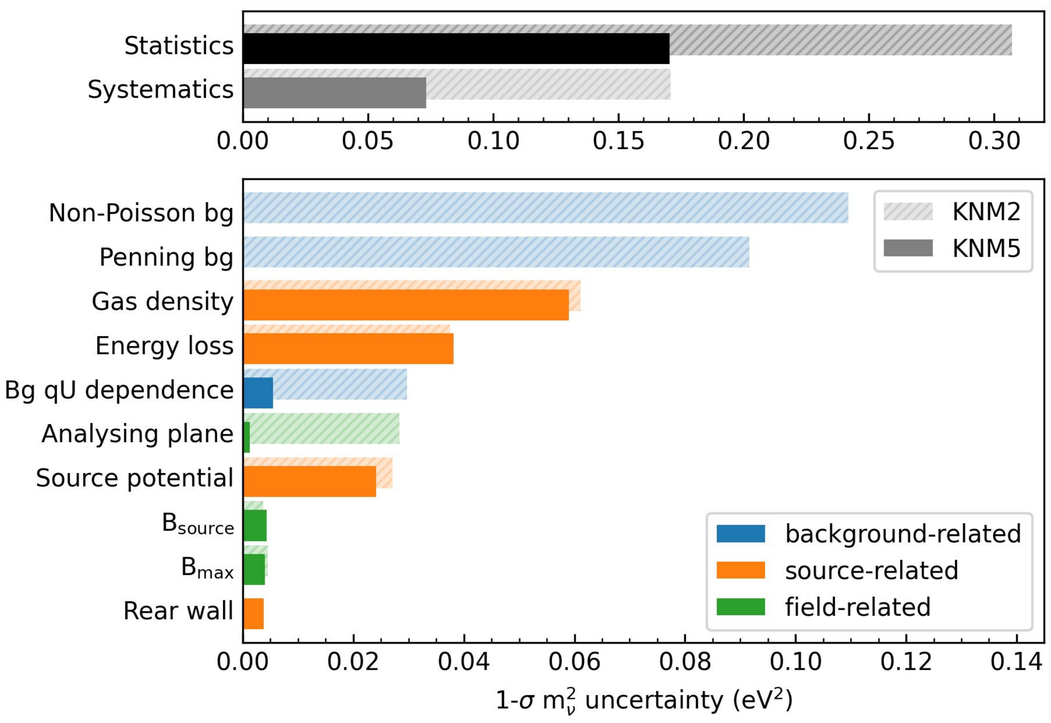
Karlsruhe **Tri**tium **N**eutrino Experiment

- Kinematic measurement of **effective electron-antineutrino** mass m_ν
- High-activity **windowless** gaseous **tritium source**
- Probe region close to **β-decay** endpoint
- High-precision **electron-spectroscopy** with **MAC-E filter**



m_ν < 0.8 eV (90% CL)
[M. Aker et al., Nature Phys. 18 (2022) 2, 160-166]



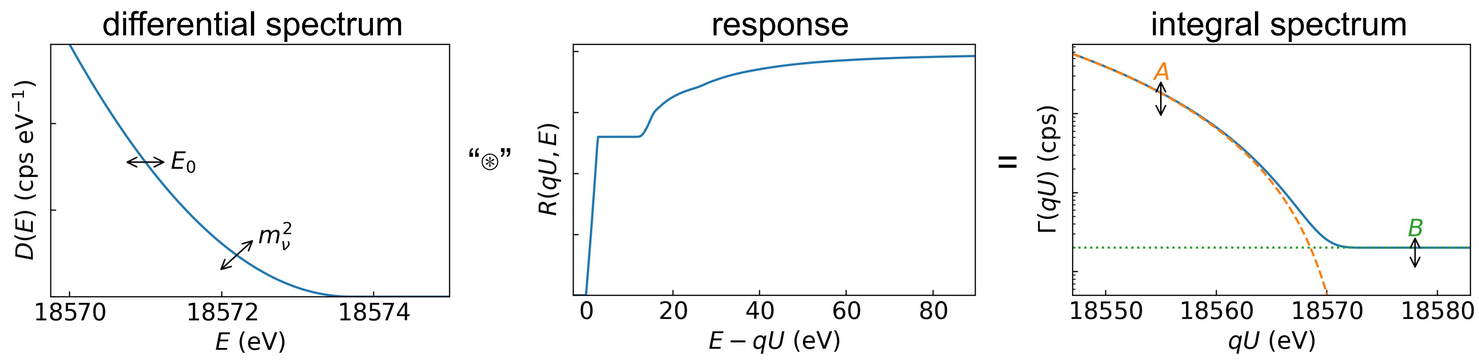


Improvements since last publication

- Six-fold **increase in statistics**
- **Improved signal-to-background** ratio (new spectrometer settings)
  [Lokhov et al., Eur.Phys.J.C 82 (2022) 3, 258]
- **3-fold reduction** of systematic uncertainties
- **Data taking ongoing** towards final sensitivity goal

Analysis challenges

- **High granularity,** simultaneous fit of 59 datasets (>1600 data points)
- **High dimensionality:** Over 350 fit parameters, parameter correlations across data sets
- **Complex model**, differential spectrum integrated over response

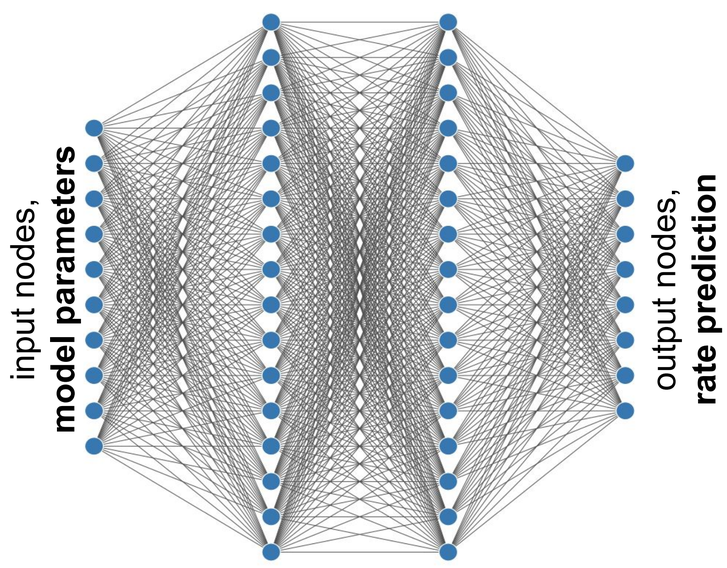


Neural network approach

Karl et al., EPJ C 82 (2022) 5, 439

- Generate **sample spectra** using integral spectrum model
- Train a **dense feed-forward** neural network with two hidden layers (128 hidden nodes each)

➔ **Fast and precise** prediction of integral spectrum shape

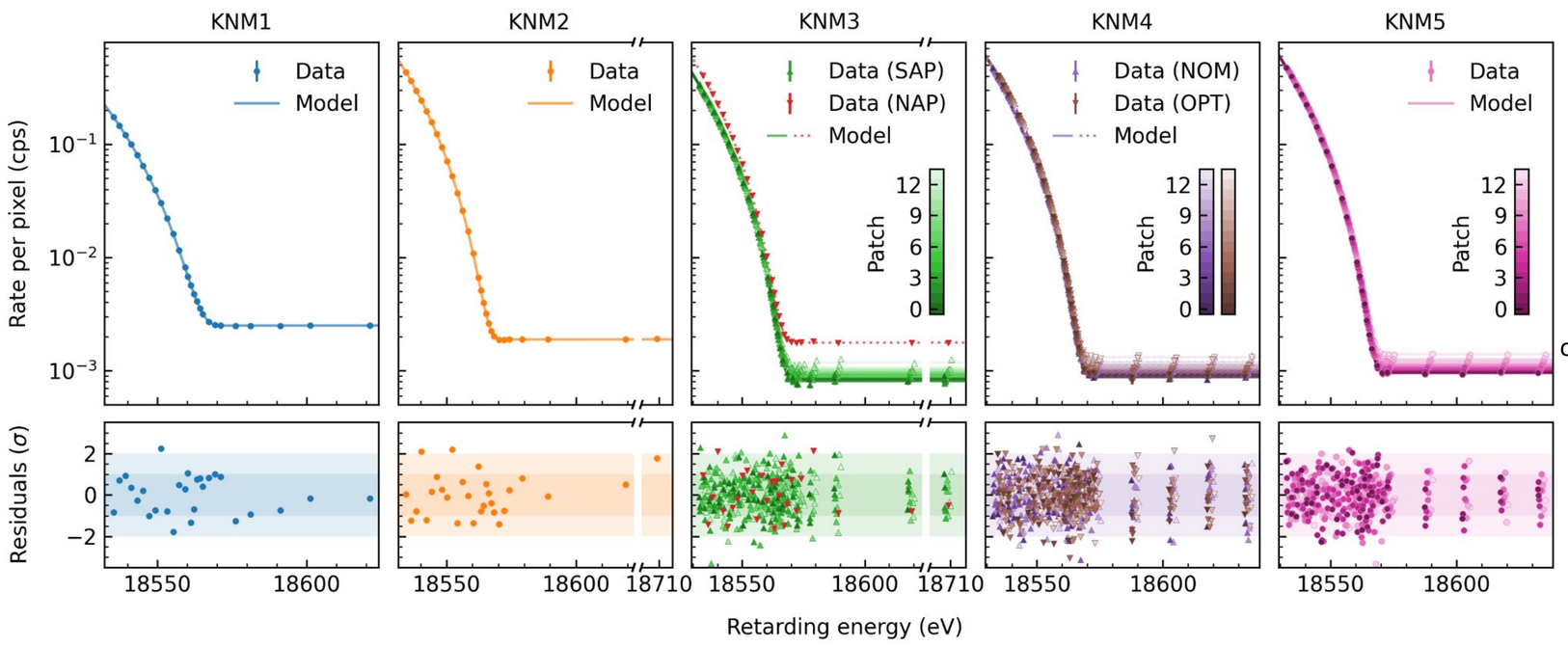


Results and Outlook

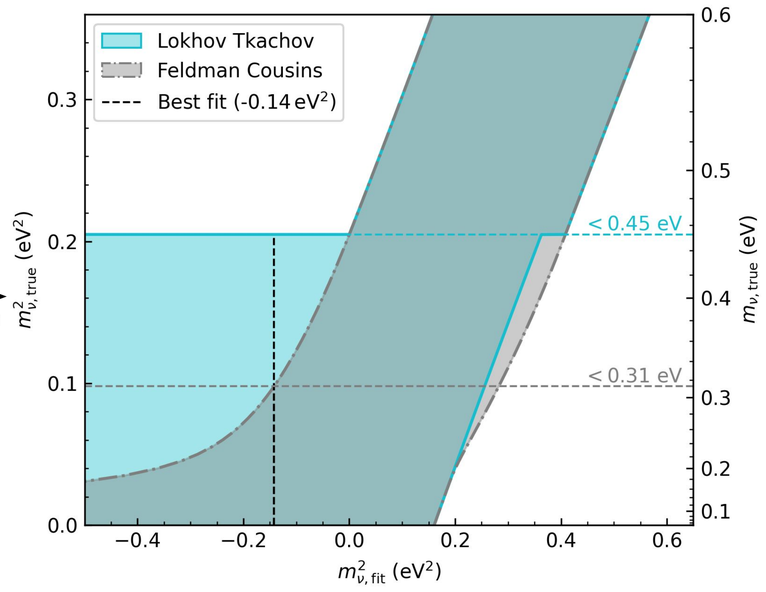
- **Successful analysis** of **first five** measurement campaigns

➔ New world-leading upper limit **m_ν≤ 0.45 eV** (90% CL) using the Lokhov Tkachov method

- **Bayesian analysis** work in progress



belt construction



We acknowledge the support of Helmholtz Association (HGF), Ministry for Education and Research BMBF, the doctoral school KSETA at KIT, Helmholtz Initiative and Networking Fund, Max Planck Research Group, and DFG in Germany; Ministry of Education, Youth and Sport in the Czech Republic; INFN in Italy; the National Science, Research and Innovation Fund via the Program Management Unit for Human Resources & Institutional Development, Research and Innovation in Thailand; and the DOE Office of Science, Nuclear Physics in the United States. This project has received funding from the ERC under the European Union Horizon 2020 research and innovation programme. We thank the computing cluster support at the Institute for Astroparticle Physics at KIT, Max Planck Computing and Data Facility (MPCDF), and the National Energy Research Scientific Computing Center (NERSC) at LBNL.