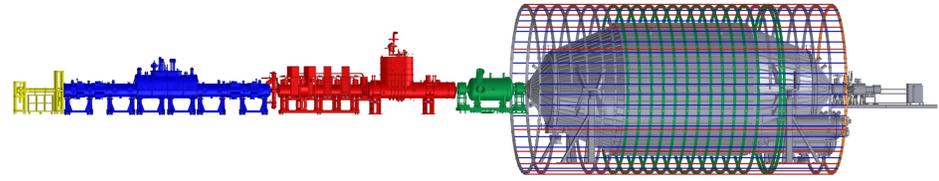


Neutrino Properties

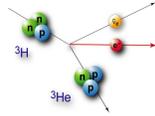
Marco Haag (KIT), Juan Pablo Yanez (DESY)

Neutrino Masses and KATRIN

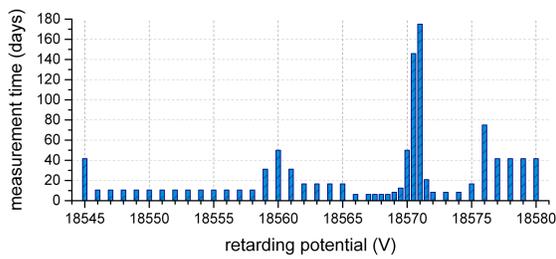
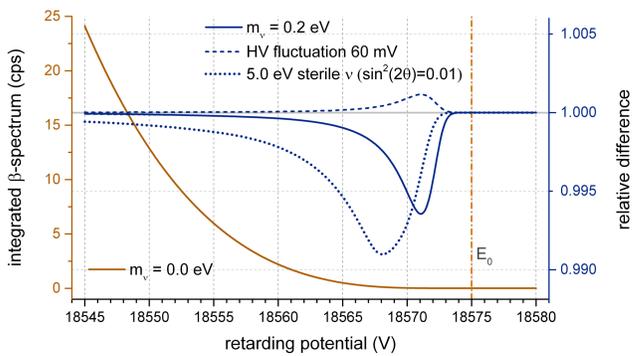
- Massive neutrinos lead to a slope modification of the spectral slope of β decay
- Sensitivity on m_ν after 3 years of measurement time: 200 meV (90% C.L.)



$$m_{\nu_e}^2 = \sum_{i=1}^3 |U_{ei}|^2 m_i^2$$

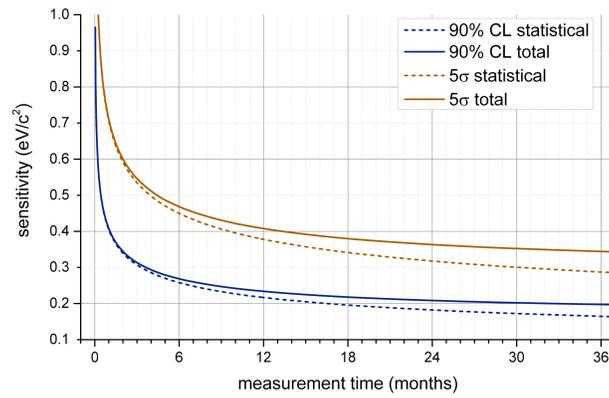


- Mass extraction by spectral shape analysis (at least 1+3 parameter fit)

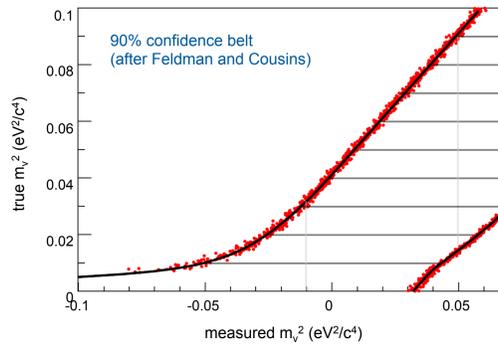


- Monte Carlo optimized measurement schedule

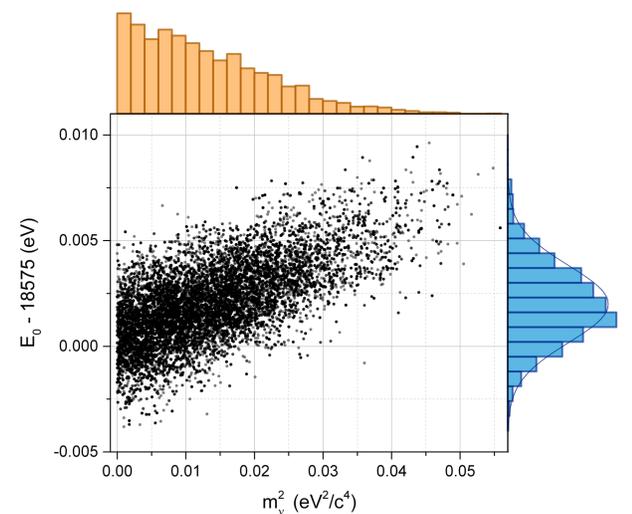
- KATRIN will exceed existing limits on the absolute neutrino mass scale after a few weeks



- Frequentist statistical methods for confidence belt construction and goodness-of-fit tests



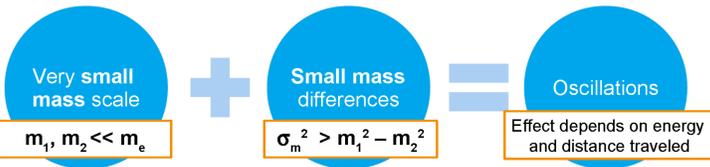
- Bayesian methods for calculation of probability density functions
- Markov Chain Monte Carlo sampling allows high-dimensional studies (e.g. sterile neutrino search)
- Robust marginalization of correlated nuisance parameters (tritium endpoint, signal amplitude, background level)



Probability distribution of the tritium endpoint energy E_0 vs. m_ν^2 . Sampled from a simulated measurement with $m_\nu = 0.0$ eV/c². Flat priors, excluding non-physical negative m_ν^2 .

Neutrino Oscillations and IceCube DeepCore

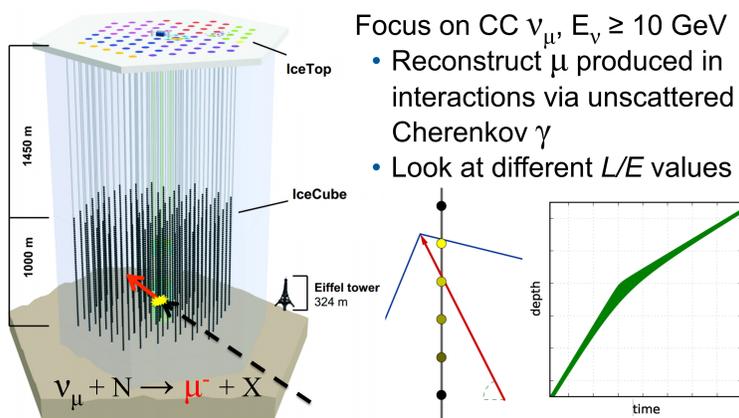
V
unique
properties



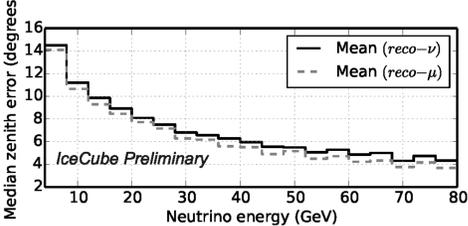
$$P(\nu_\alpha \rightarrow \nu_\beta) = \sin^2(2\theta) \sin^2(1.27 \Delta m^2 L/E)$$

- Oscillation parameters θ_{23} and Δm_{23}^2 (in eV²)
- Variables L_ν (distance traveled in km) and E_ν (energy in GeV) measurable in atmospheric neutrinos using very large detectors

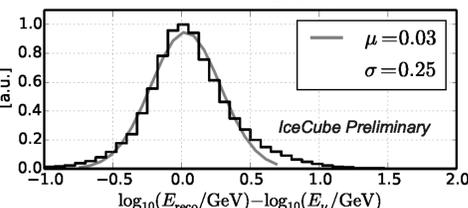
Method



Resolutions in final sample



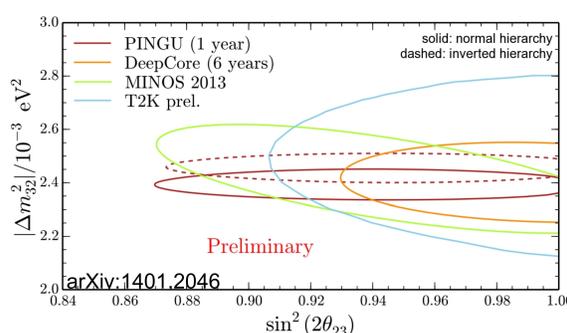
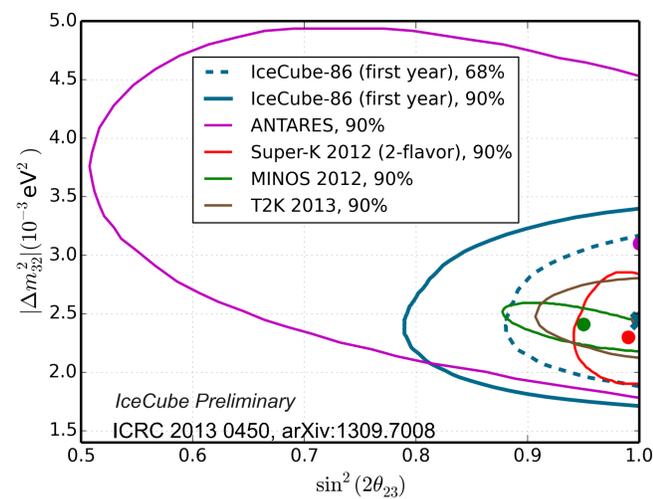
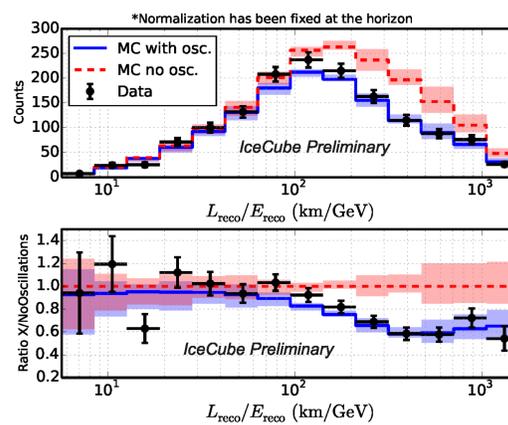
- Direction (zenith angle)
 - Unscattered light from the muon
 - Fitting hyperbolae
 - 6 degree resolution



- Neutrino energy
 - Sum of two fits:
 - Shower brightness
 - Muon range
 - About 40% resolution

Results

- 1487 events found in first year (~500 disappeared due to osc.)
- Best fit: $|\Delta m_{32}^2| = 2.4 \pm 0.4 \cdot 10^{-3}$ eV², $\sin^2(2\theta_{23}) = 1$ (> 0.93)



The Future: PINGU

Denser array inside DeepCore

- Factor 10 increase in neutrinos detected
 - About 20,000 useful events per year
- More light per interaction
- Improved energy estimation