



The SuperNEMO - $\beta\beta$ detector



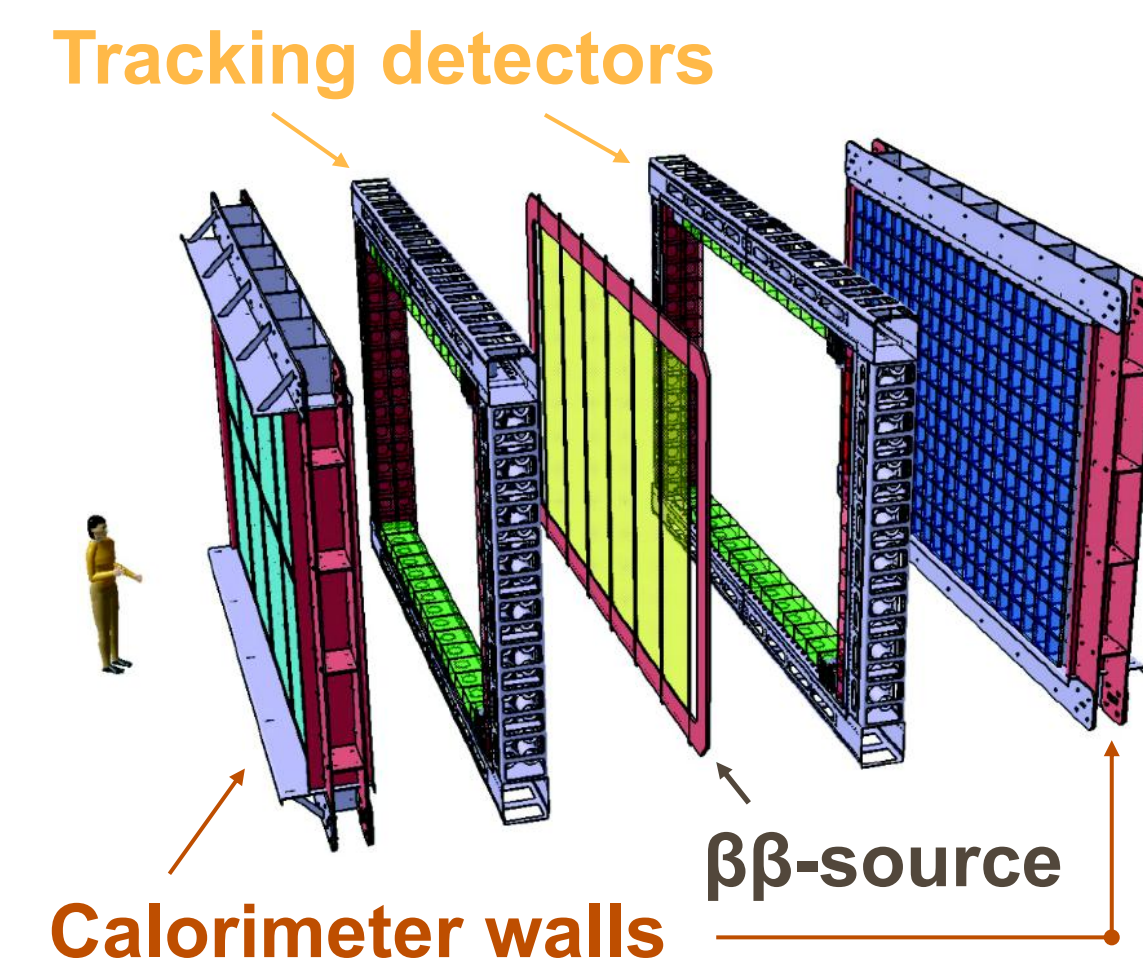
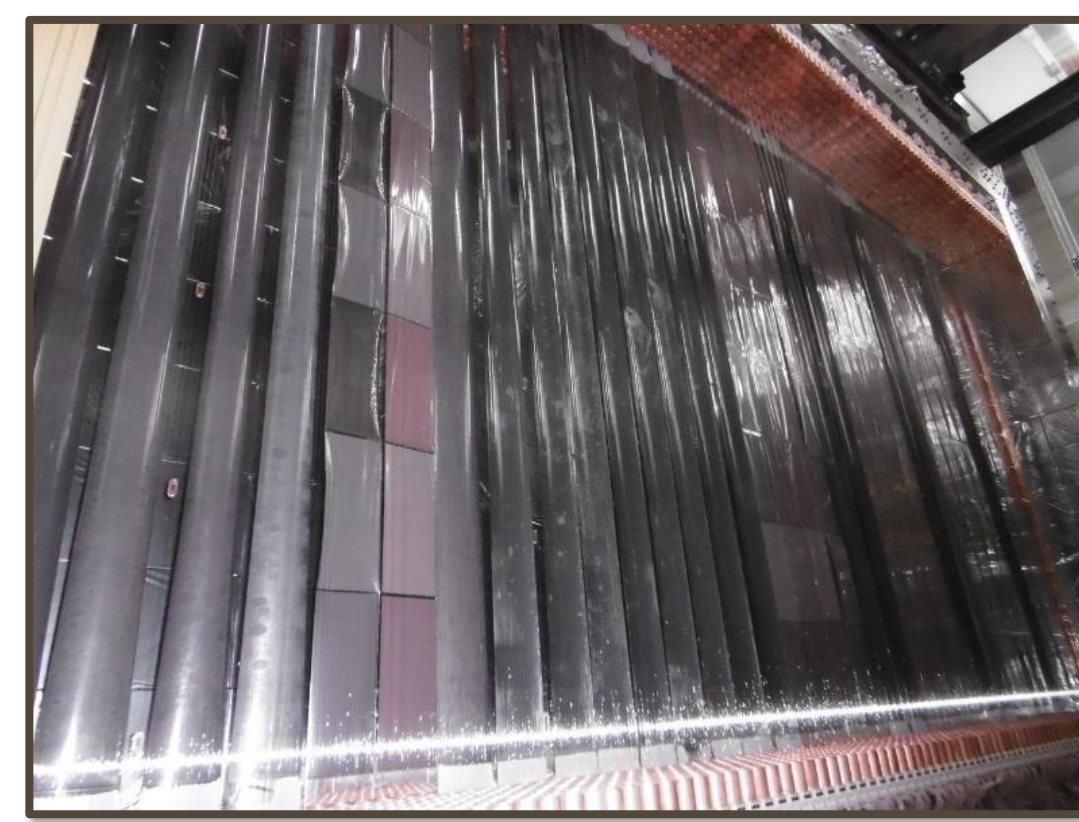
The SuperNEMO Demonstrator - basic facts

- **Source:** ^{82}Se (6.11 kg), $Q_{\beta\beta} = 2.99$ MeV
- **Tracker:** 2034 drift cells working in Geiger mode
- **Calorimeter:** 712 plastic scintillators + PMTs
- **Energy calibration system:** 42 deployable ^{207}Bi sources

Watch our video about $\beta\beta$ -source:



Watch our video about tracking detectors:



Background suppression strategy

1. The shielding is used to suppress:

- **radon:** anti-radon tent (ART, inside)
- **gammas:** iron shielding (around ART)
- **neutrons:** polyethylene (outside)



ART with radon-free air

Iron

Polyethylene

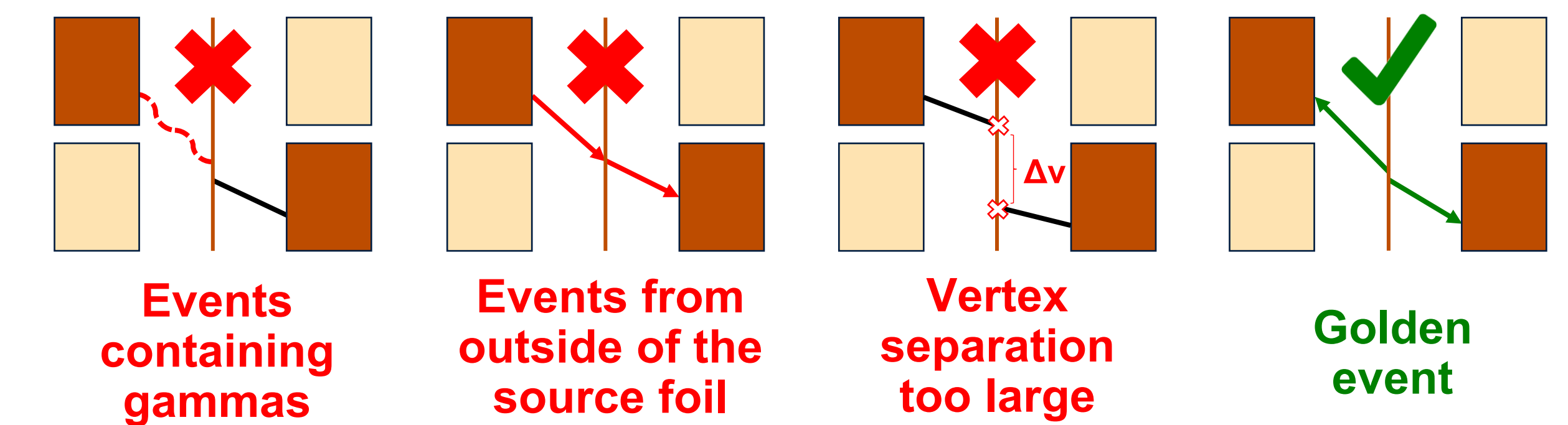
2. Placement underground:

- Modane Underground Laboratory
- muon suppression factor 10^6
- depth: 4800 m.w.e.



3. Data postprocessing cuts:

- particle identification
- time of flight
- vertex separation cut
- and more



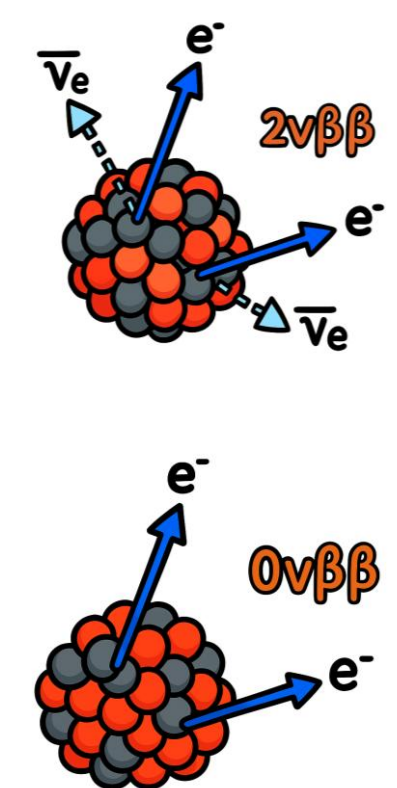
Our physics program

The SuperNEMO measures:

- single electron energies (E_1, E_2)
- angles between the electrons (ϕ)

Using E_1, E_2 and ϕ allows

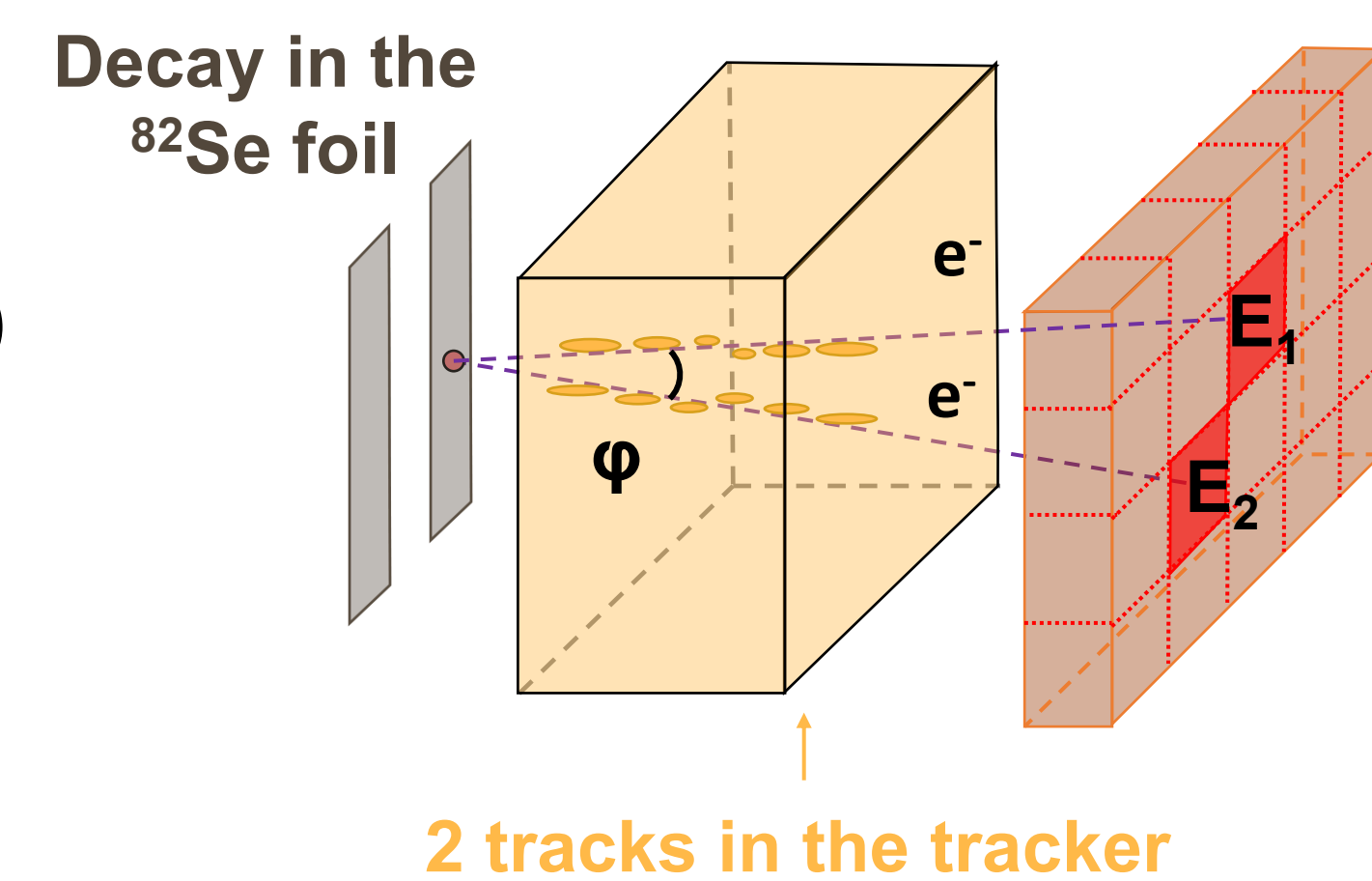
- better background suppression
- multidimensional analysis
- easier study of variety of modes:



$2\nu\beta\beta / 0\nu\beta\beta$ with right-handed currents

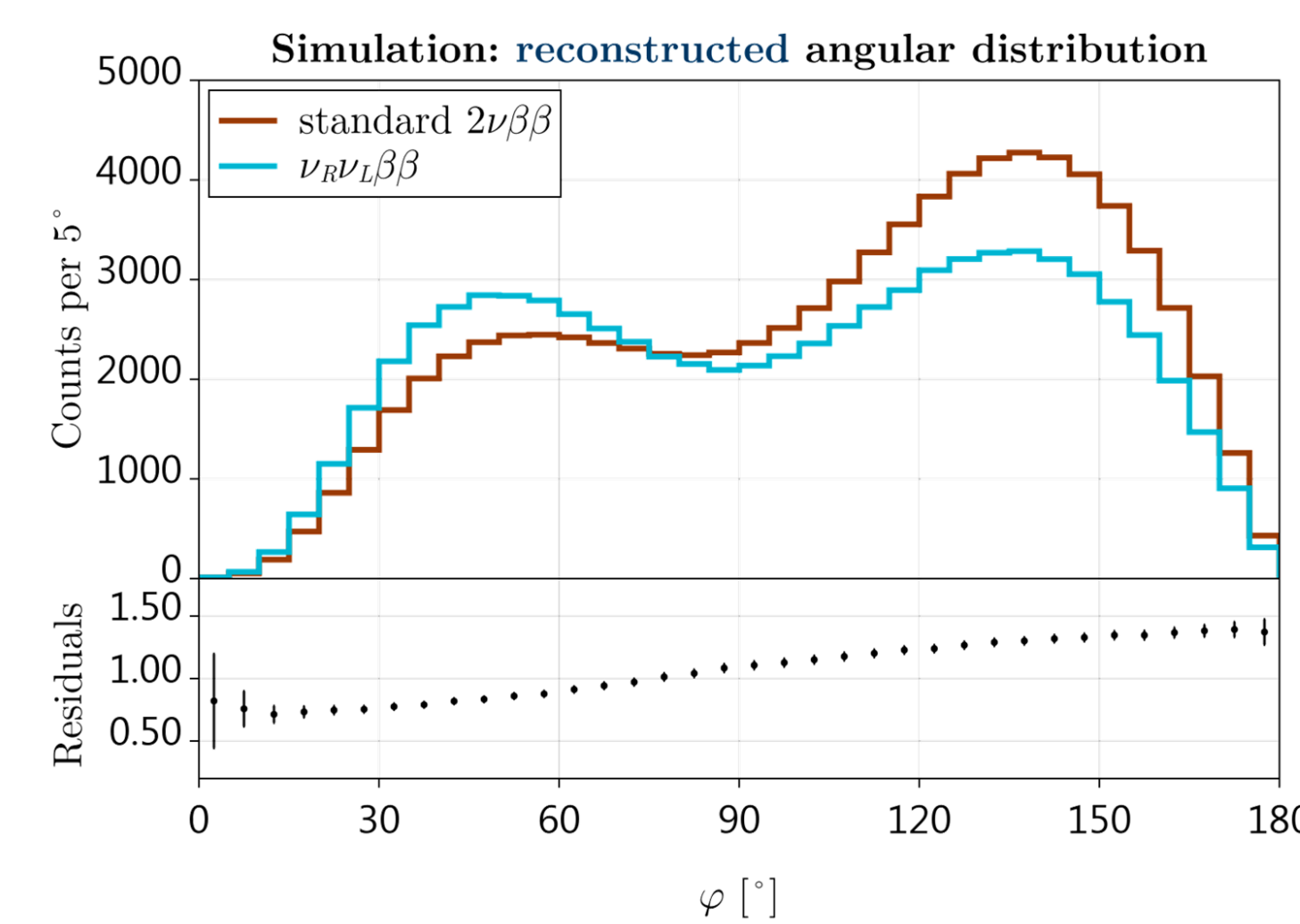
sterile Majoron neutrinos

For more information see [1, 2]



Energy and time measurement in segmented calorimeter

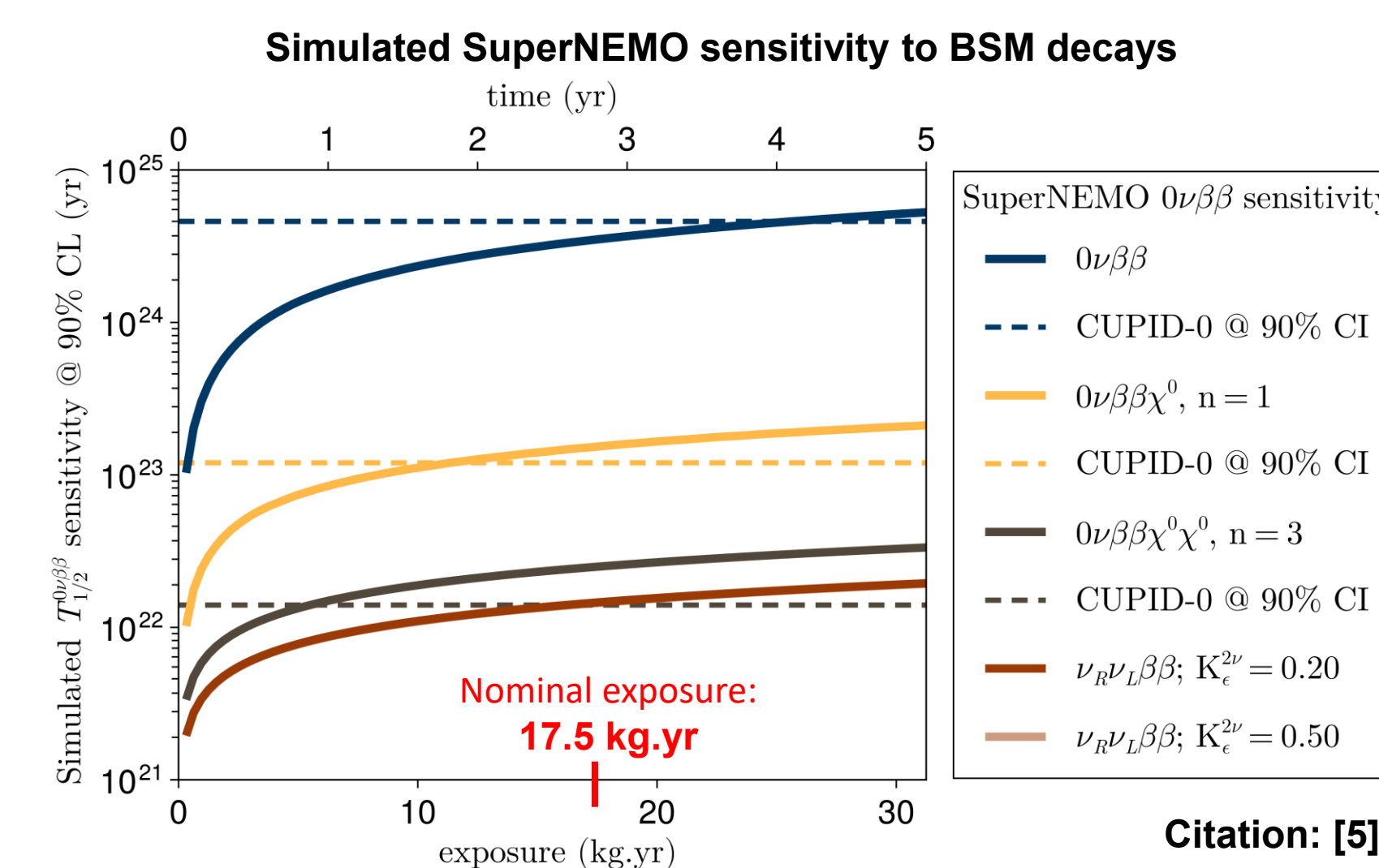
Example: $2\nu\beta\beta$ and $\nu_{RH}\beta\beta$ have almost identical energy spectra, but they differ in the angular distributions [4]!



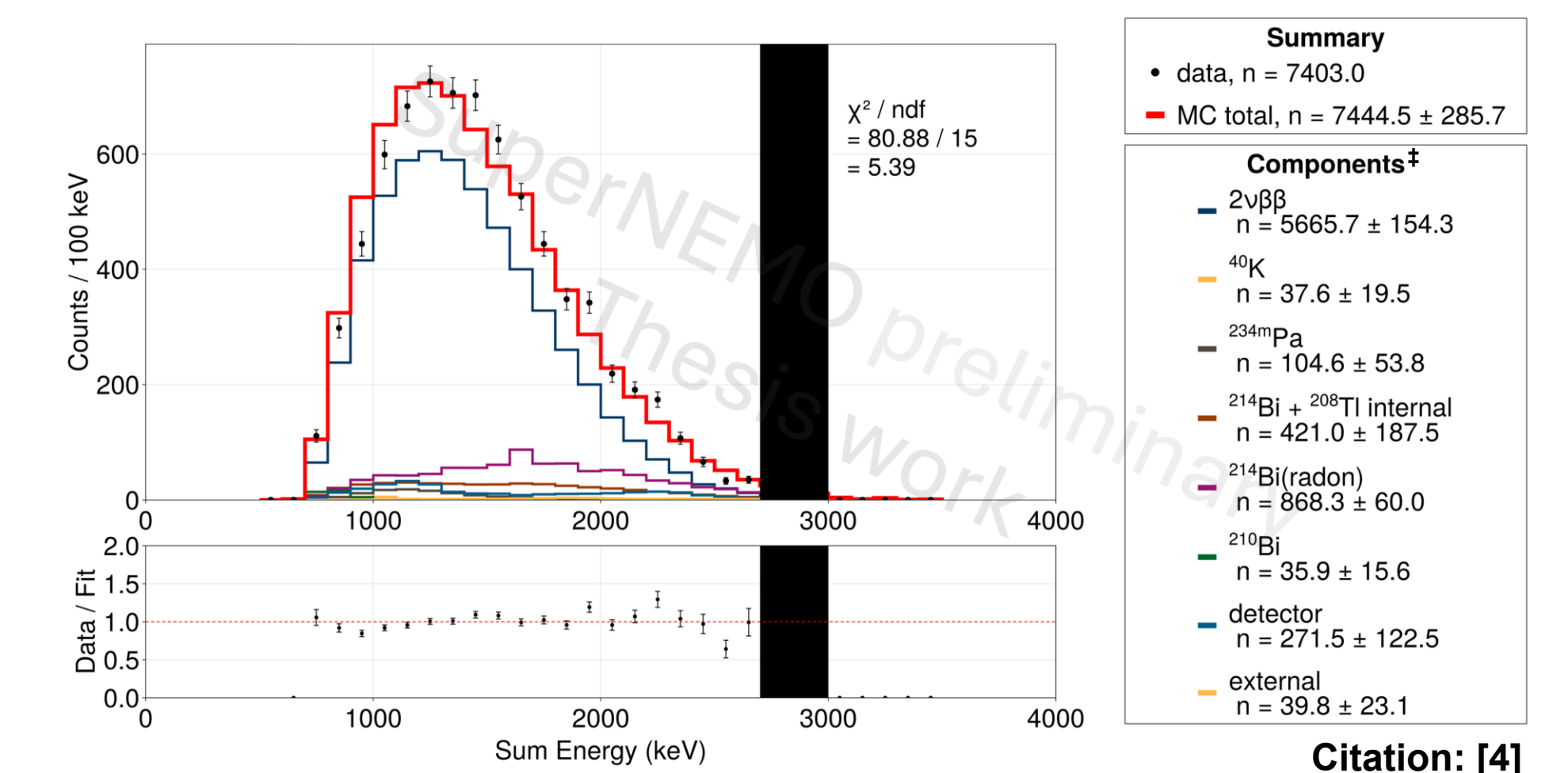
Status and first results

The SuperNEMO Demonstrator is continuously taking data since 10 April 2025!

- Preliminary analysis: exposure of **2.86 kg.yr.**
- Measured $2\nu\beta\beta$ $T_{1/2}$ (^{82}Se): **$(8.7 \pm 0.2) \times 10^{19}$ yr.**
- Good match between MC and data already.
- More improvements to come soon!



Summed electron energy spectra: simulation and data from the detector



The background components consist of decays of isotope present inside of the foil, "detector" background represents contamination of the detector materials and "external" is all other backgrounds outside of the foil and the detector materials.

- We expect to break several world's best limits!
- The goal is achievable
 - with Rn suppression at the level of **0.15 mBq/m³**
 - with nominal exposure of **17.5 kg.yr**

References:

- [1] F. F. Deppisch, L. Graf, and F. Šimkovic, Physical Review Letters 125 (2020) 171801.
- [2] P. D. Bolton, F. F. Deppisch, L. Graf, and F. Šimkovic, Physical Review D 103 (2021) 055019.

[3] Figure produced by Cimrman software: T. Křížák, master thesis, CTU in Prague, 2025.

[4] M. Petro, PhD. thesis, Comenius University in Bratislava, 2026.

[5] M. Petro, talk at MEDEX'25 conference in Prague, 23-27 Jun 2025.