New multi-detector coincidence devices at STUK

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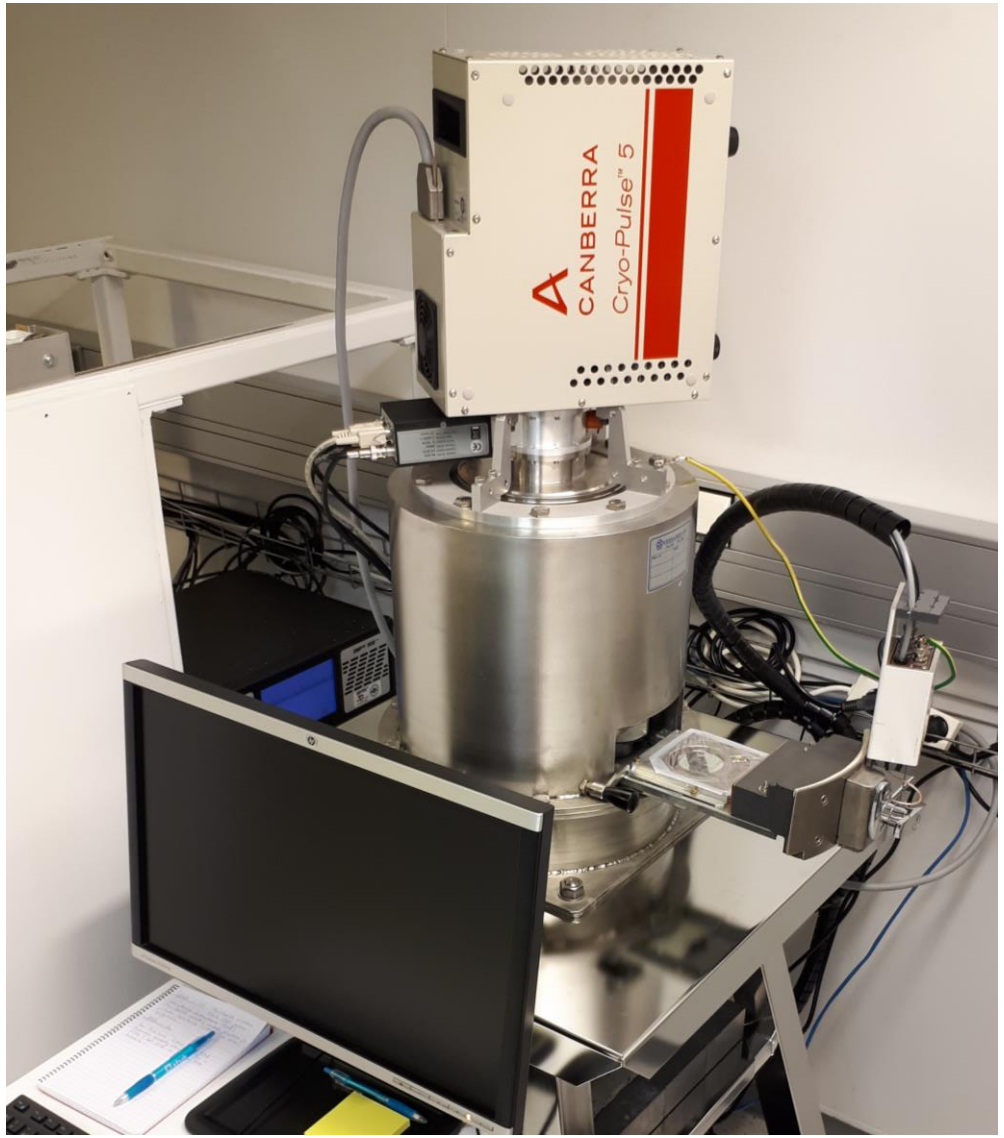
Timo Hildén

MiniPANDA

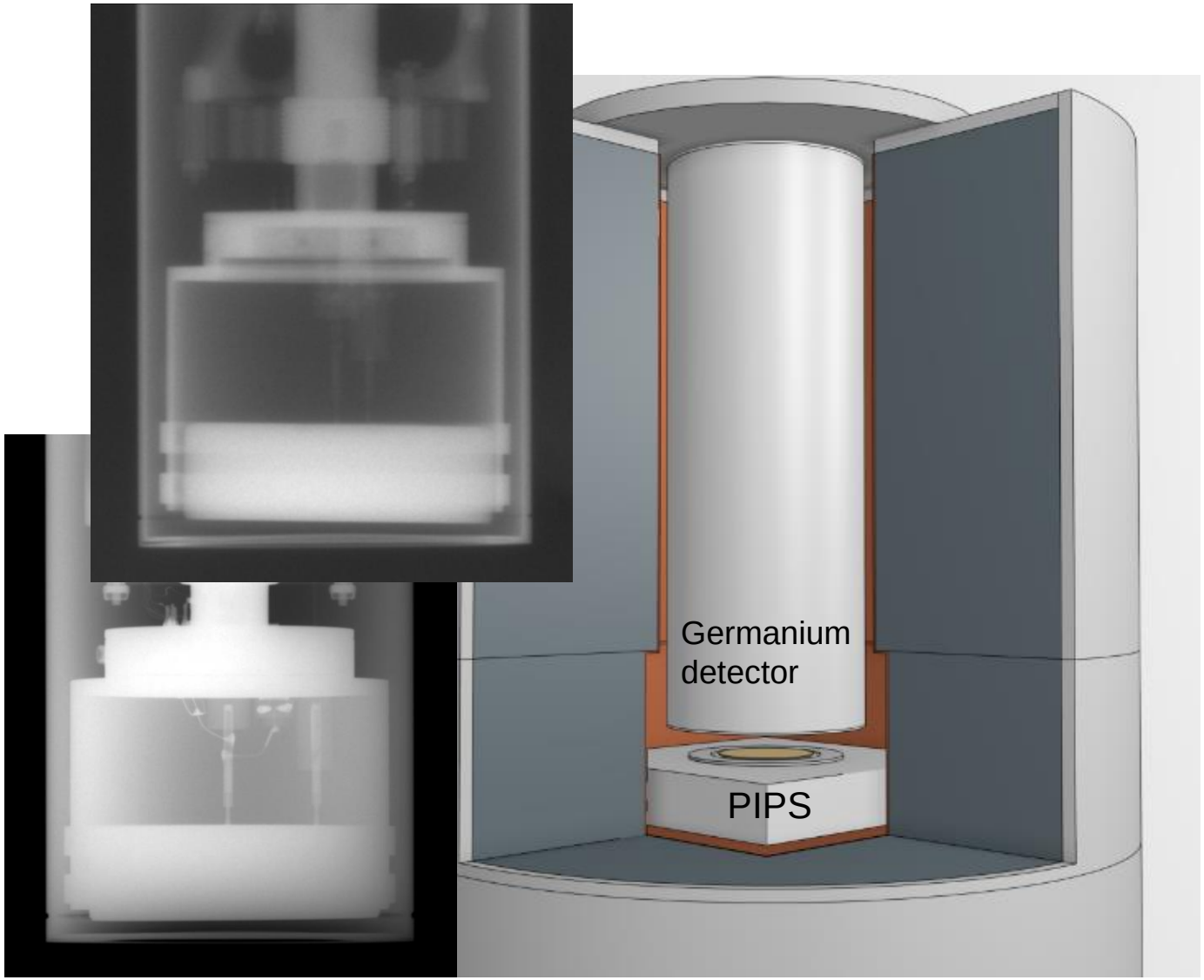
MiniPANDA

- The purpose of MiniPANDA is to provide α – γ coincidence measurements just like the PANDA device described earlier
- Not a vacuum system
- Detector is built inside a compact lead shield
  - Can be used for traditional gamma spectrometry
- Designed for thin samples, such as air filters and swipe samples
  - Is also used in hybrid measurements with full stack of air filters with alpha detection for the bottom filter
- Integration into the NAMIT laboratory information system in 2021
- Scientific article submitted to NIM A



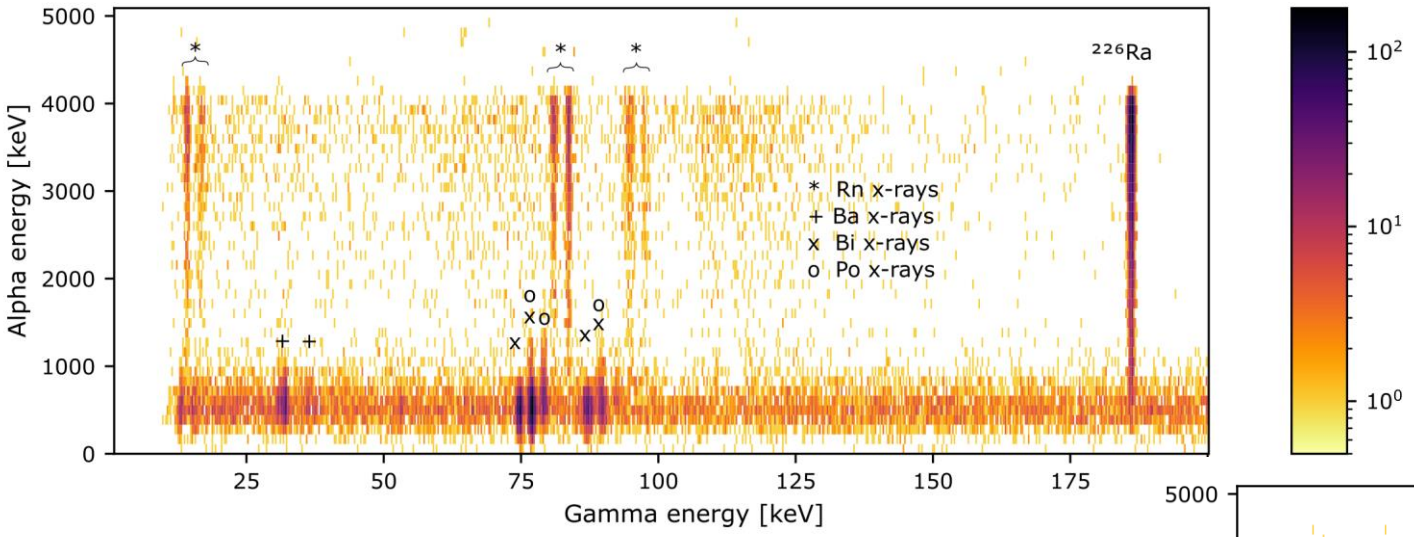
MiniPANDA setup

- Passivated Implanted Planar Silicon (PIPS) detector as the alpha detector
  - Diameter of 50 mm
  - Thickness of 0.3 mm
- High purity germanium detector (BEGe)
  - Diameter of 70 mm
  - Thickness of 20 mm
- Close geometry
  - Sample placed on top of the alpha detector
  - 14 mm gap to gamma detector

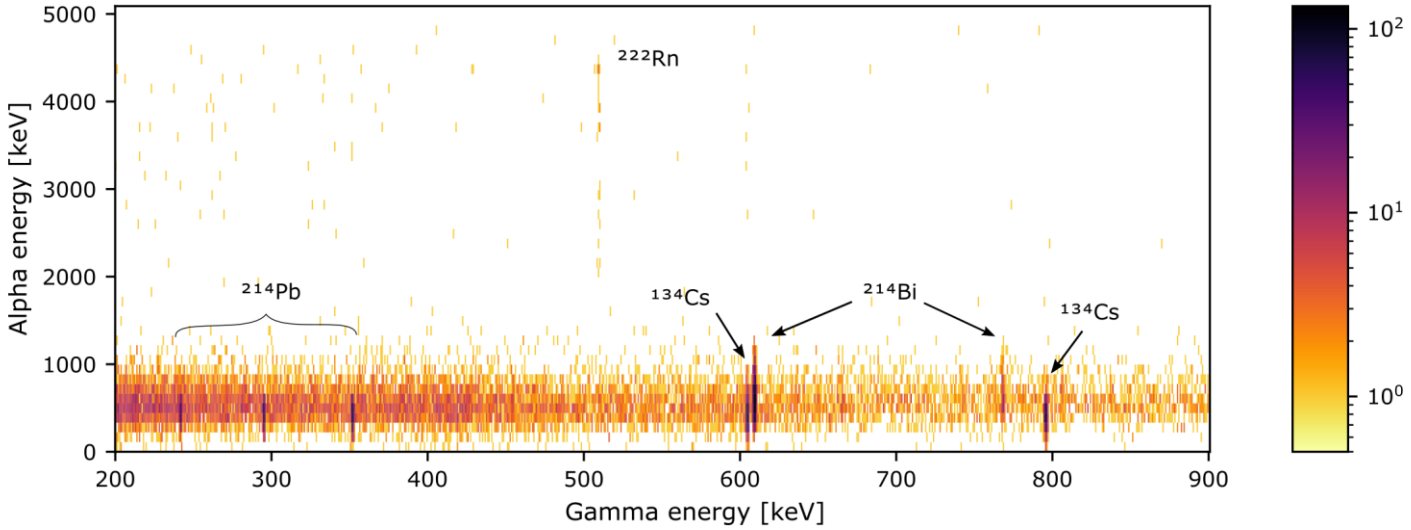


Geant4 simulation geometry of MiniPANDA

MiniPANDA results (Ra-226 and Cs-134)



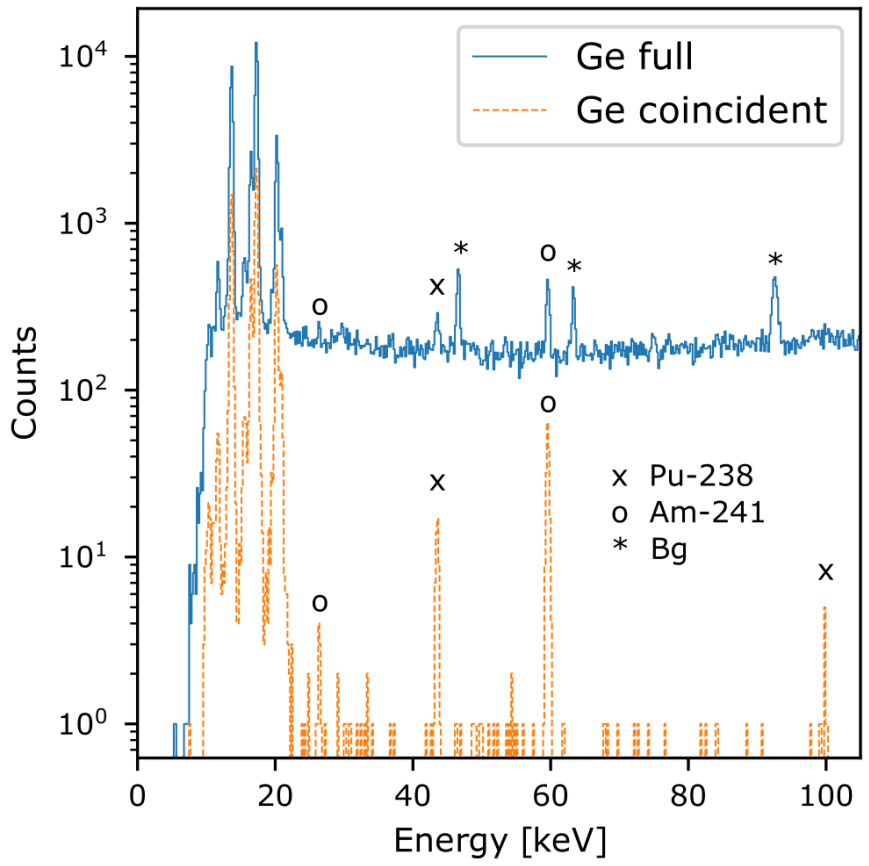
- Nearly zero background for alphas in coincidence measurement
- Detection from 27 counts of Rn-222 (510 keV line intensity 0.076 %)

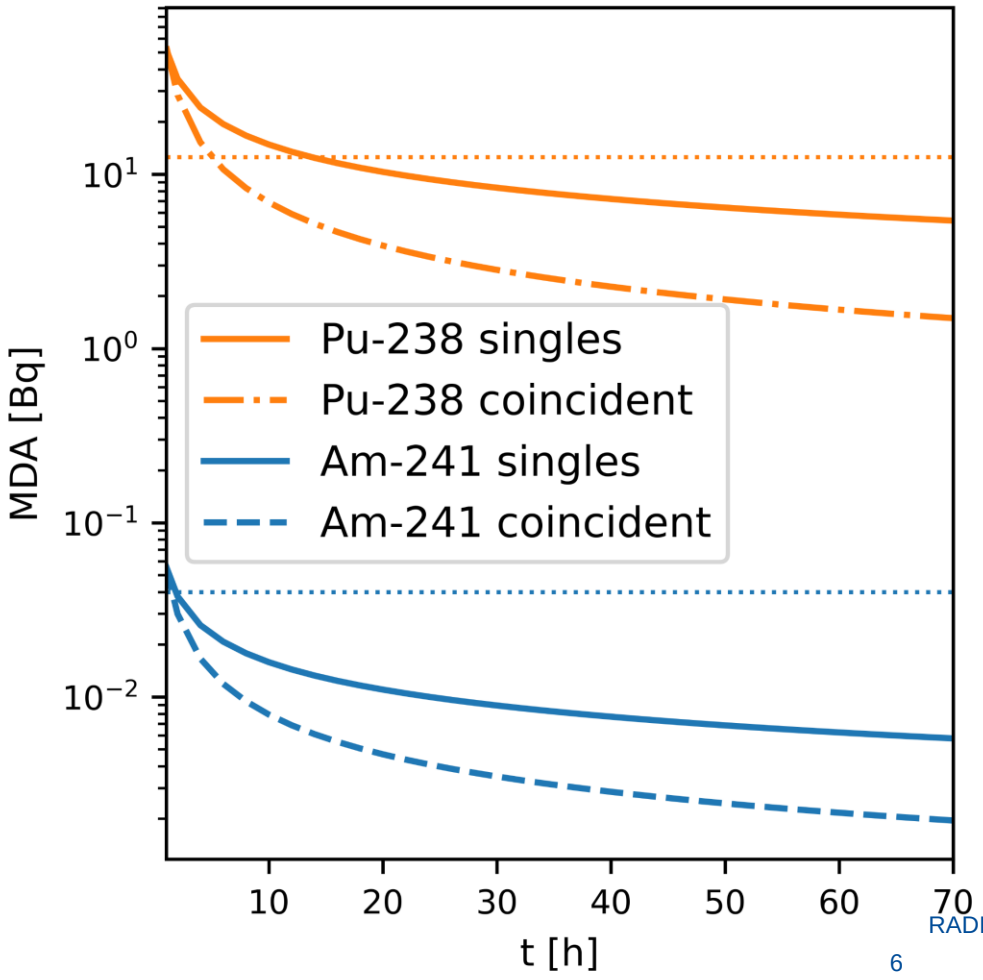


- Beta sensitivity for mean energy > 200 keV
- Separation of high energy beta particles by energy deposition

MiniPANDA results (particle with Pu-238 and Am-241)

For 70 h measurement the improvement in MDA is by a factor of 3 - 4





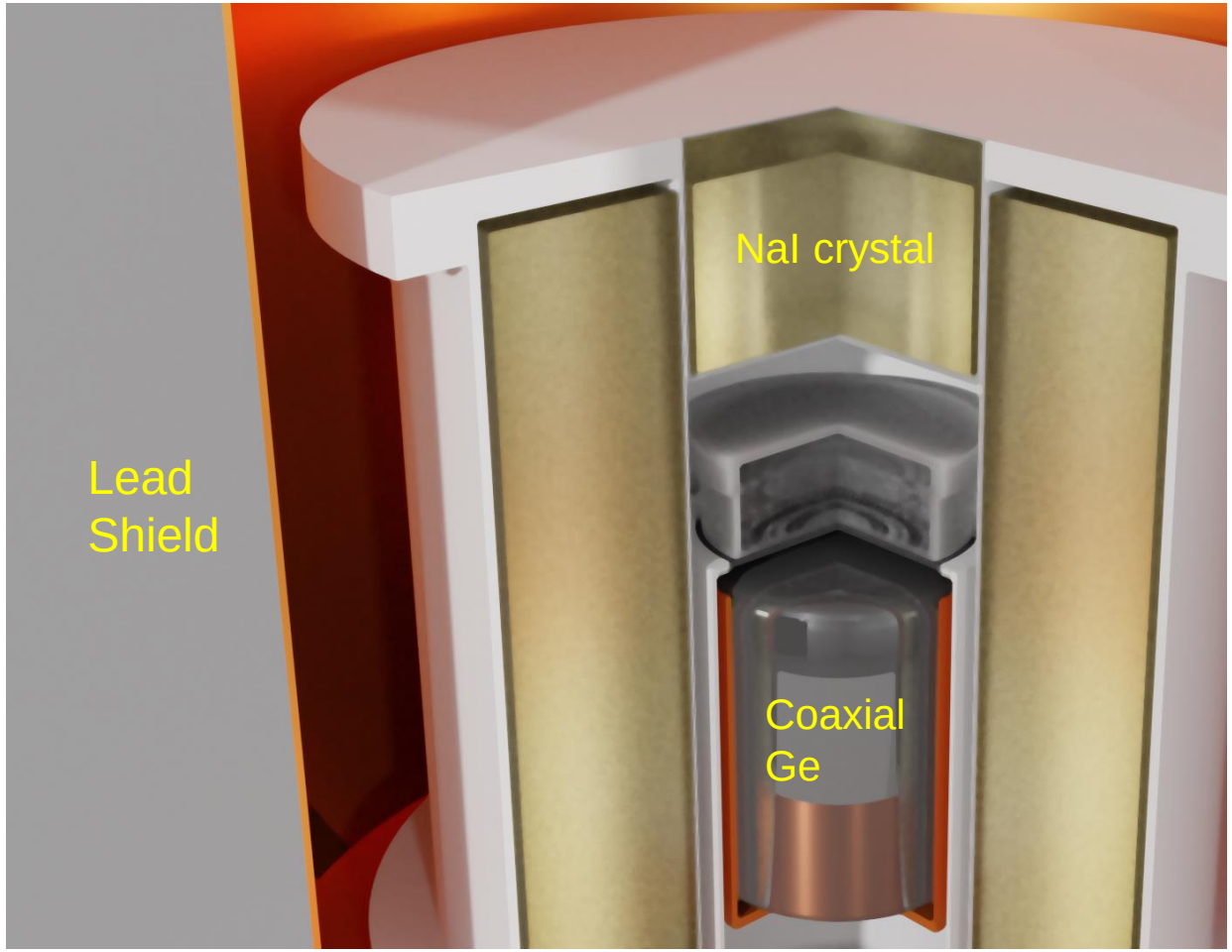
cossu

COmpton Suppression Shield for the removal of Unwanted background (a.k.a. COSSU)

- An active shield for removing background from Compton scattering
- A germanium spectrometer with two-piece scintillation detector surrounding
- Used as a normal gamma spectrometer with improved sensitivity
- Integration into the NAMIT laboratory information system in 2021
- Scientific article on its way

COSSU

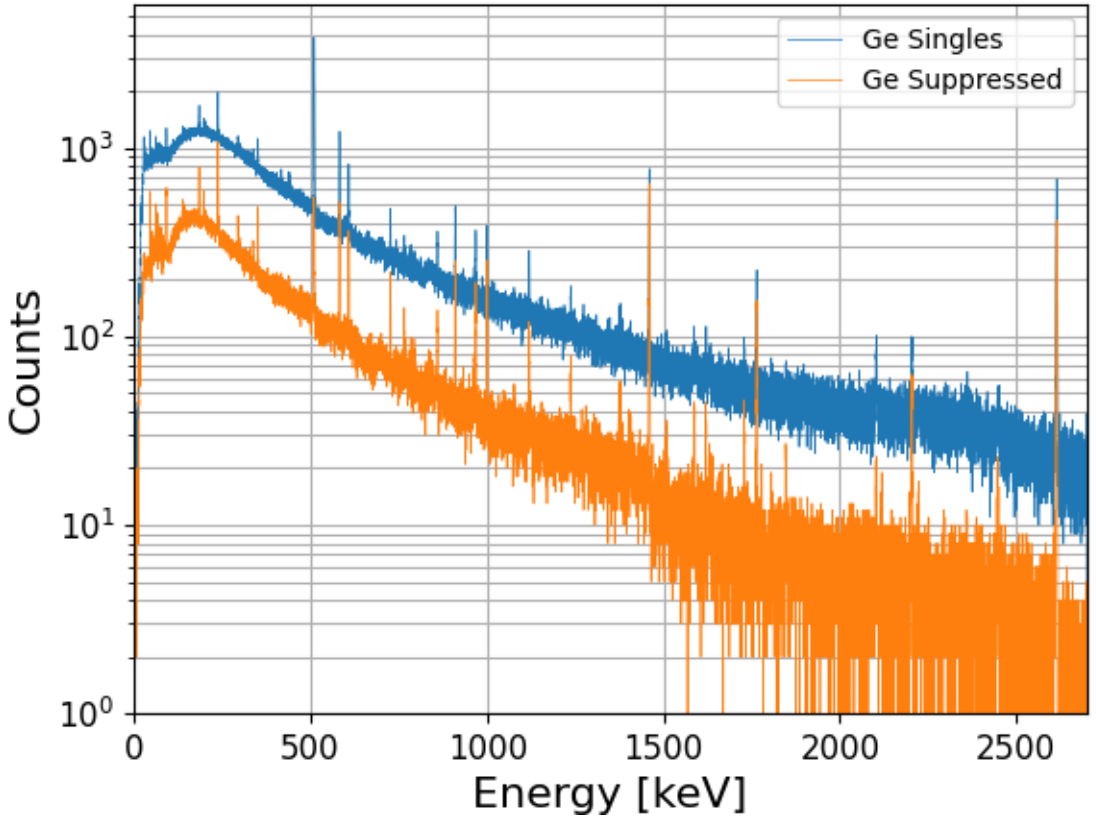
- A heavy-duty lead castle to shield from normal background
- Large coaxial germanium detector as the spectrometer (81.6 mm by 98.9 mm)
- Two scintillator detectors acting as veto detectors
  - A cylinder completely enclosing the germanium detector (240 mm by 255 mm)
  - A plug detector that is removed while loading the sample (102 mm by 51 mm)

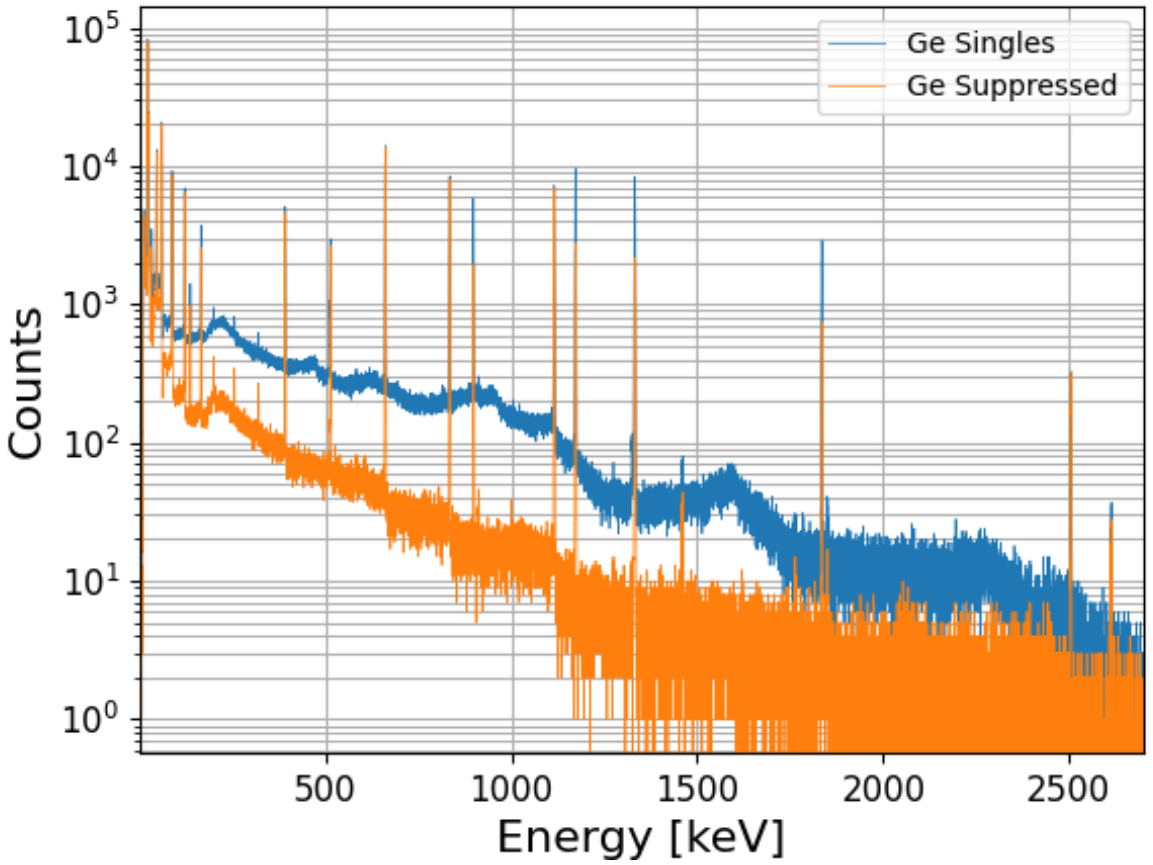


Geant4 simulation geometry of COSSU

COSSU results

- Long background measurement (16 d)

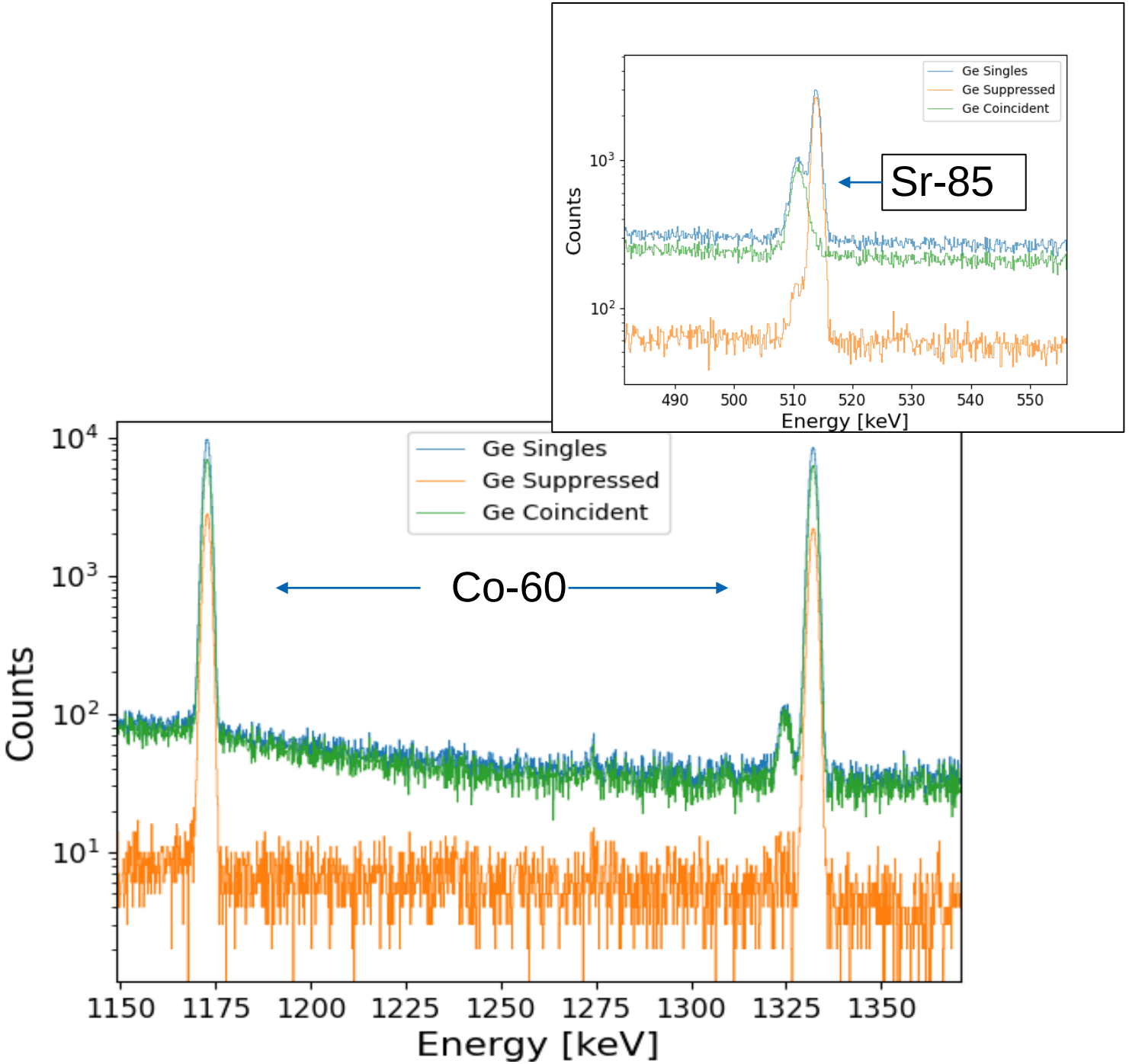




- Measurement of mixed nuclide calibration source

COSSU results

- Nuclides with multiple gamma emission will get suppressed by the veto
- Complicates analysis
- Digital readout and list mode data simplify the situation
- Access to the coincidence spectrum in addition to the suppressed spectrum



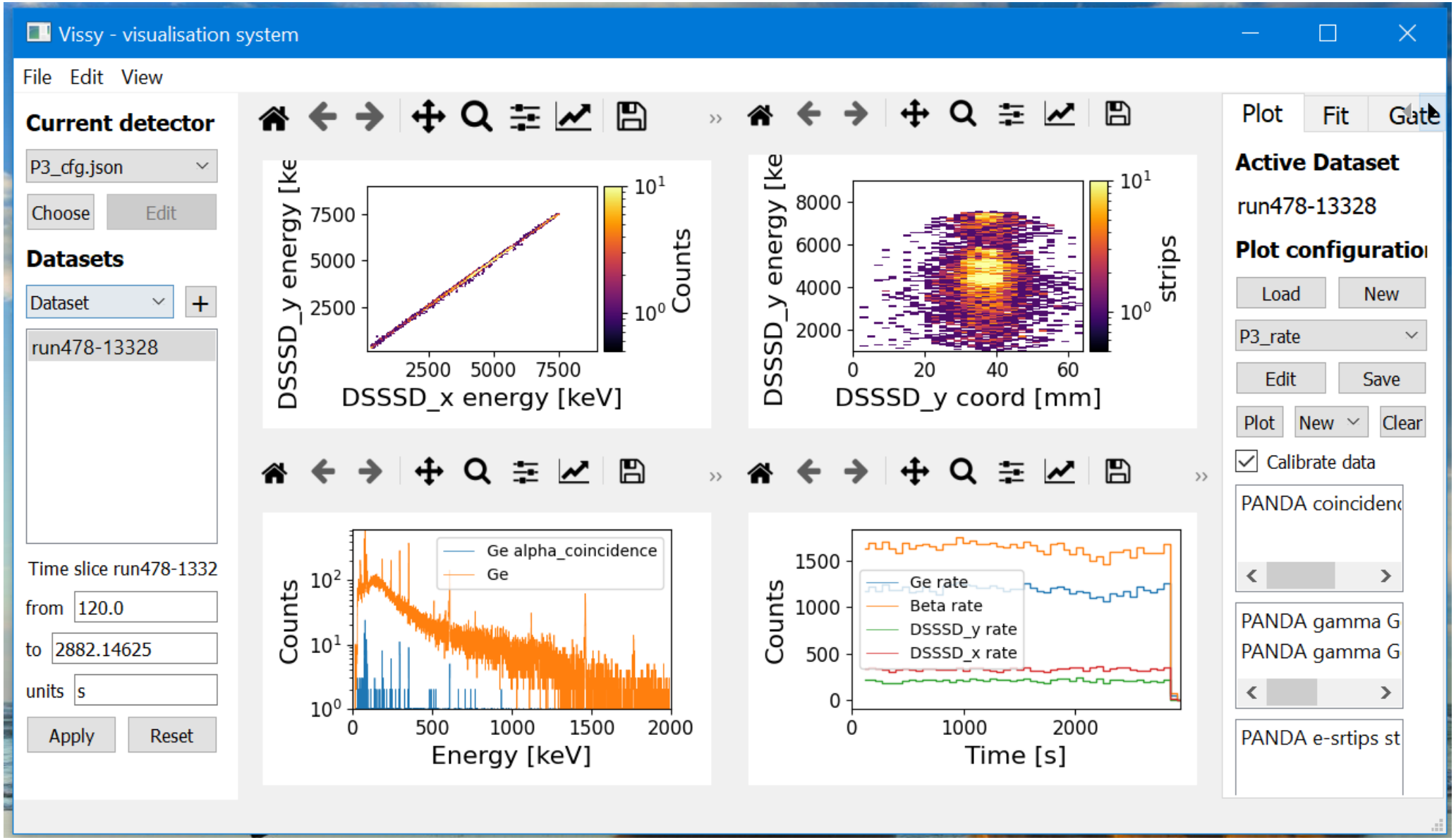
Data sorting and simulation tools

- VISSY
- Geant4

VIsualisation and data Sorting SYstem (a.k.a. VISSY)

- Visualization, manipulation and analysing of listmode data produced by the new multi-detector setups was a challenge
- ListMode-library, implemented using Python, was developed for the task
- Basis for command line tools and scripts used in the RADICAL project
- A graphical user interface VISSY was developed during summers -20 and -21 with the help of summer interns
  - Flexible handling of detectors and datasets
  - Interactive multichannel gating
  - Time slicing
  - Easy time slice selection
  - Histogram exporting (csv, phd)
  - Simple peak fitting capability

VISSY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Geant4 tools

- A toolchain was developed to
- Geometry, detectors and source definitions definable via configuration files
- Python tools to create and run batches, with parameterization of almost any part of the simulation possible
- Energy deposition in the detectors can be saved in the data format of the ListMode library
  - Easy to visualize and compare with measurements
  - Straightforward to combine simulation and measurement
- Visualization with Blender 3D graphics suite.