

Array of Cryogenic Calorimeters to Evaluate Spectral Shape of β decays

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Why study forbidden β decays?

Understanding the nature of neutrinos is one of the key open challenges in modern physics.
 The observation of **neutrinoless double beta decay ($0\nu\beta\beta$)** would reveal that neutrinos are Majorana particles and provide access to their absolute mass scale.
 However, the interpretation of $0\nu\beta\beta$ results is currently limited by **nuclear physics uncertainties**, in particular:

- Nuclear Matrix Elements (NME)
- The effective axial coupling constant g_a

Why forbidden β decays are special?

In **forbidden non-unique β decays**, the shape of the emitted electron spectrum is:

- highly sensitive to nuclear structure
- strongly dependent on g_a

Small changes in nuclear parameters lead to **large distortions of the spectral shape**, making these decays ideal probes of nuclear models relevant for $0\nu\beta\beta$.

The ACCESS project

ACCESS (Array of Cryogenic Calorimeters to Evaluate Spectral Shapes) uses **cryogenic calorimeters** to perform high-precision measurements of **β -decay spectra**.
 For some isotopes (e.g. **Indium**), the detector crystal itself contains the **β -emitting isotopes** and acts as both source and detector, while for others the **β source** is deposited on **high-performance cryogenic detectors**.

Cryogenic calorimetry in a nutshell

- ❖ detector operated a ~ 10 mK
- ❖ energy deposition produces a tiny temperature rise
- ❖ thermal sensors (**Ge-NTD/TES**) converts it into an electrical signal

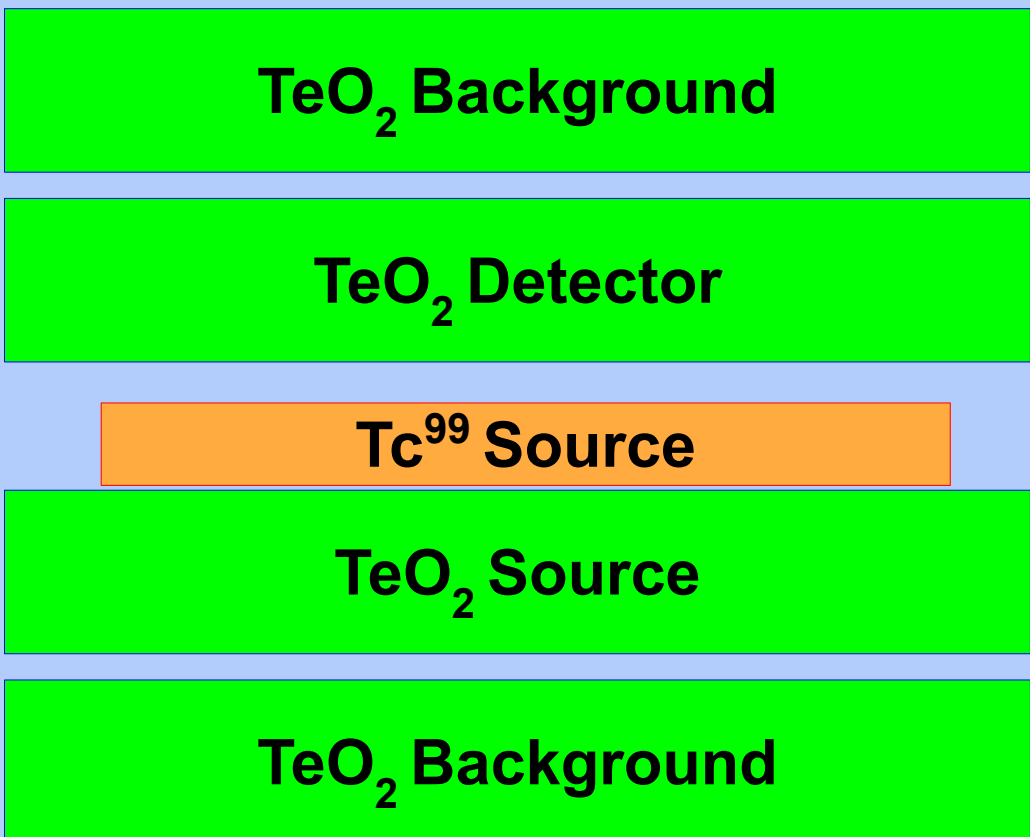
Key advantages

- ❖ excellent energy resolution ($< 1\%$)
- ❖ low energy threshold (few keV)
- ❖ direct measurement of the full decay energy

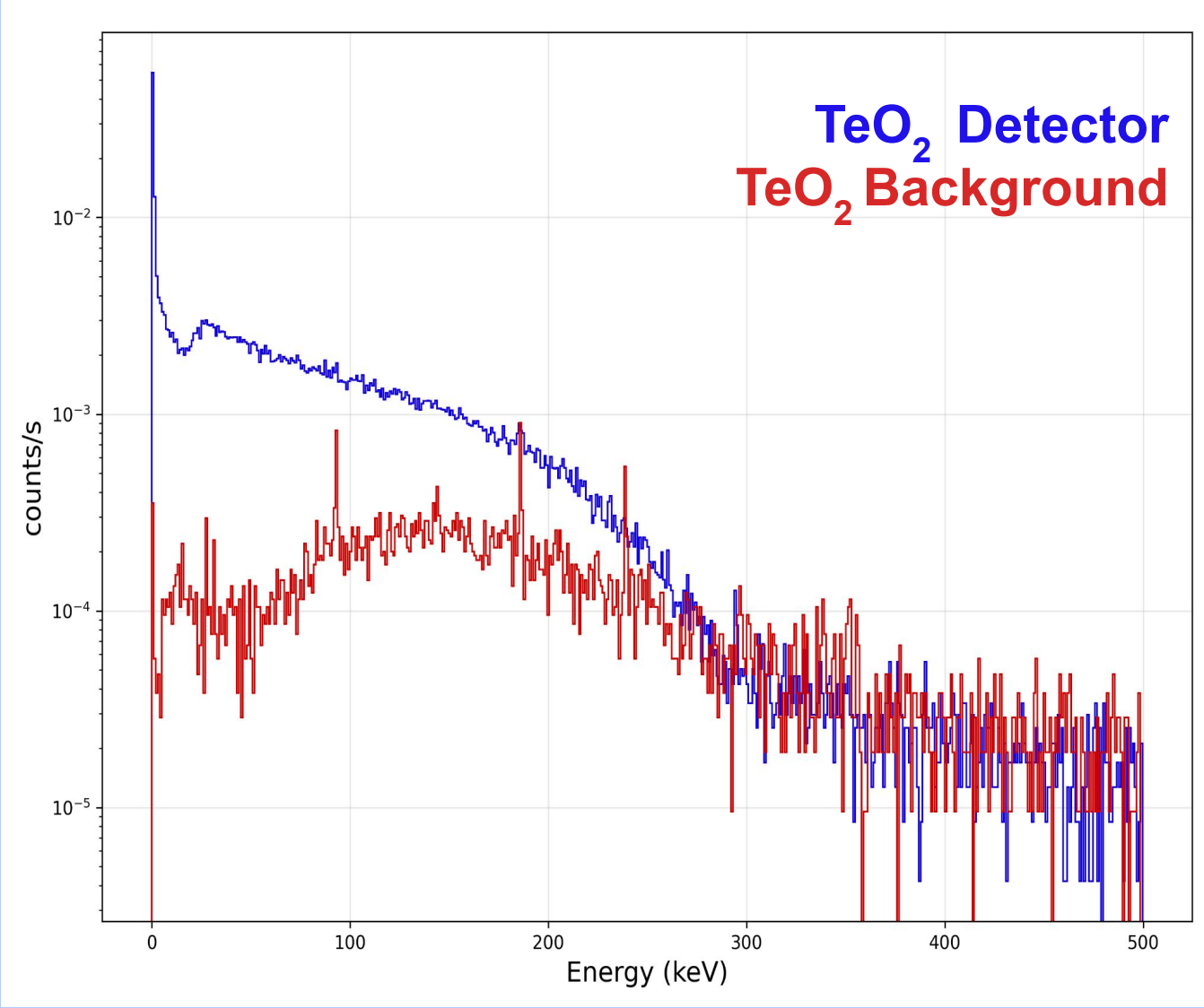
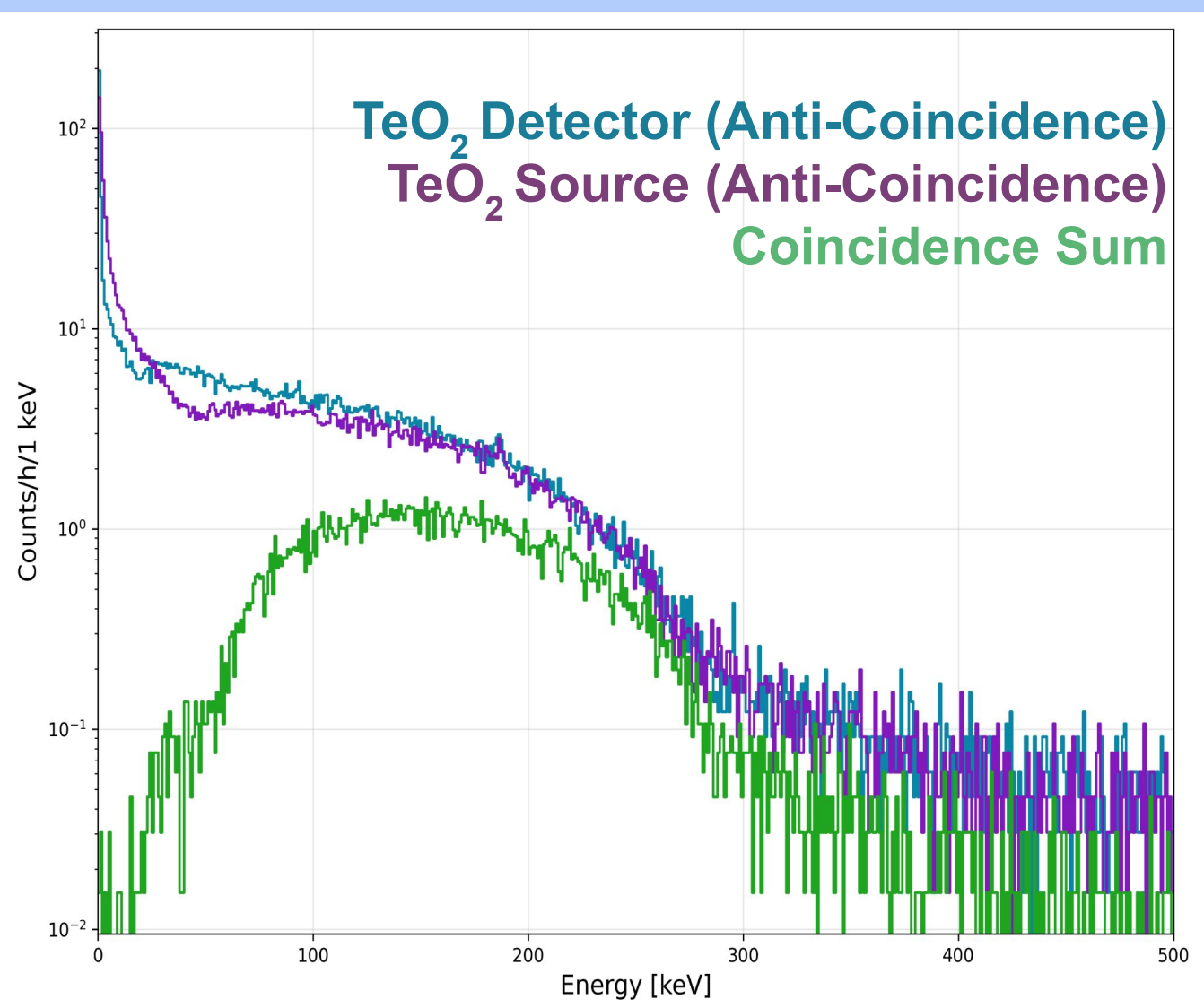


Preliminary measurements of forbidden β decays

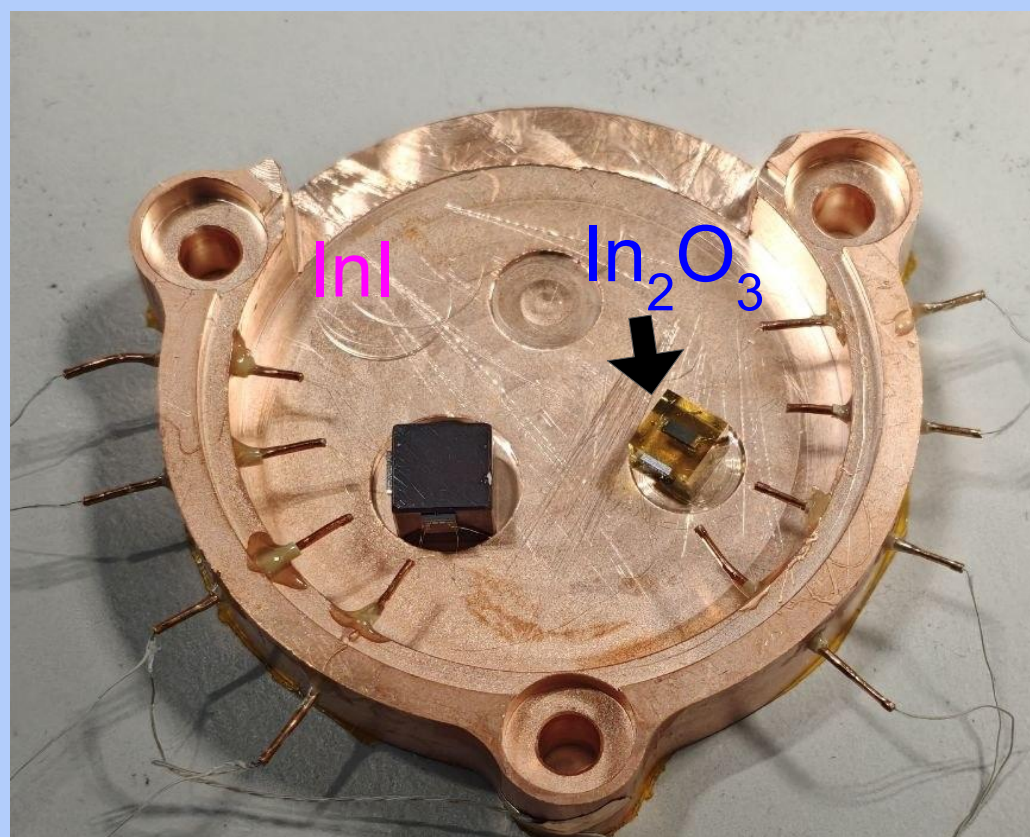
^{99}Tc source + TeO_2 absorber



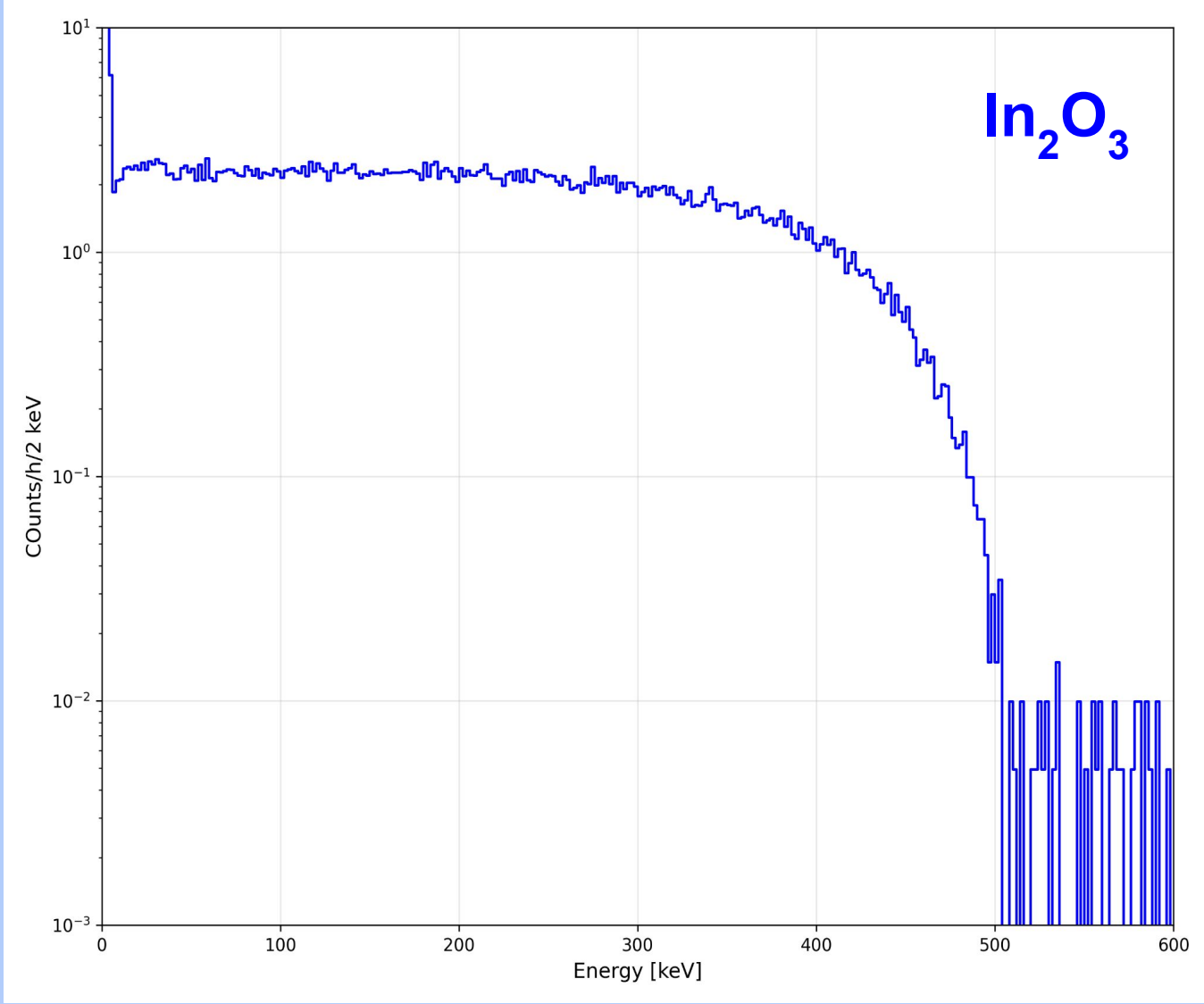
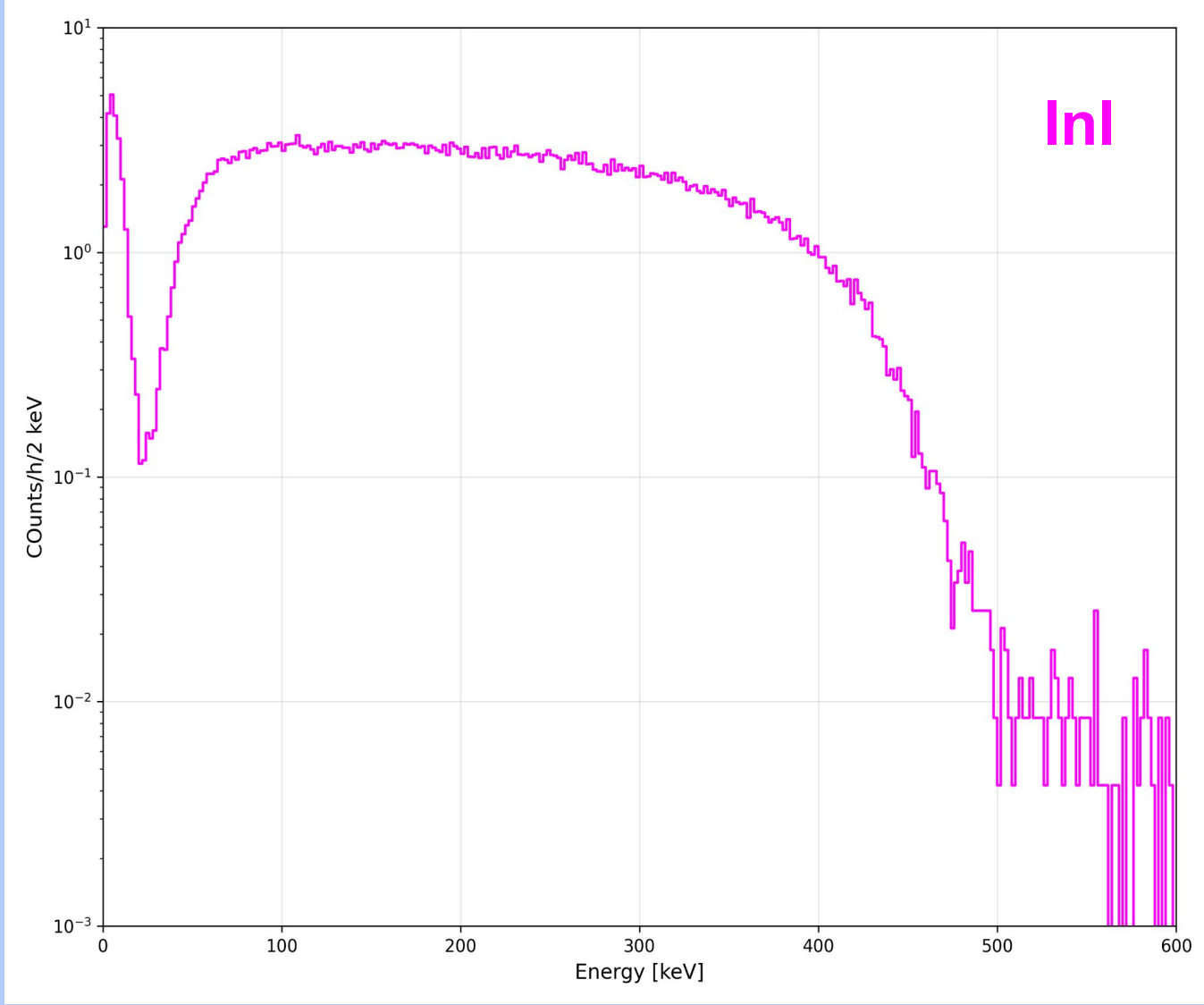
^{99}Tc β decay measured with an **external source** and TeO_2 cryogenic calorimeters. Coincidence techniques allow **signal** and **background** contributions to be characterized.



In crystals



In-containing crystals provide a *source = detector* configuration, enabling a **low-systematic measurement** of the ^{115}In β spectrum.



	TeO_2 Detector	TeO_2 Source	TeO_2 Background	InI	In_2O_3
THRESHOLD	2 keV	4.5 keV	0.7/0.4 keV	15 keV	1.5 keV

Next steps

- ❖ Replacement of part of the lead shield with **Roman lead shield**.
- ❖ New copper thick pot to **reduce external background**.
- ❖ New dedicated run for In crystals and TeO_2 with ^{99}Tc source.
- ❖ ^{36}Cl with **NaCl** irradiated with thermal neutron at reactor

