ARGON RECOIL IONIZATION AND SCINTILLATION FROM ELECTRON RECOILS
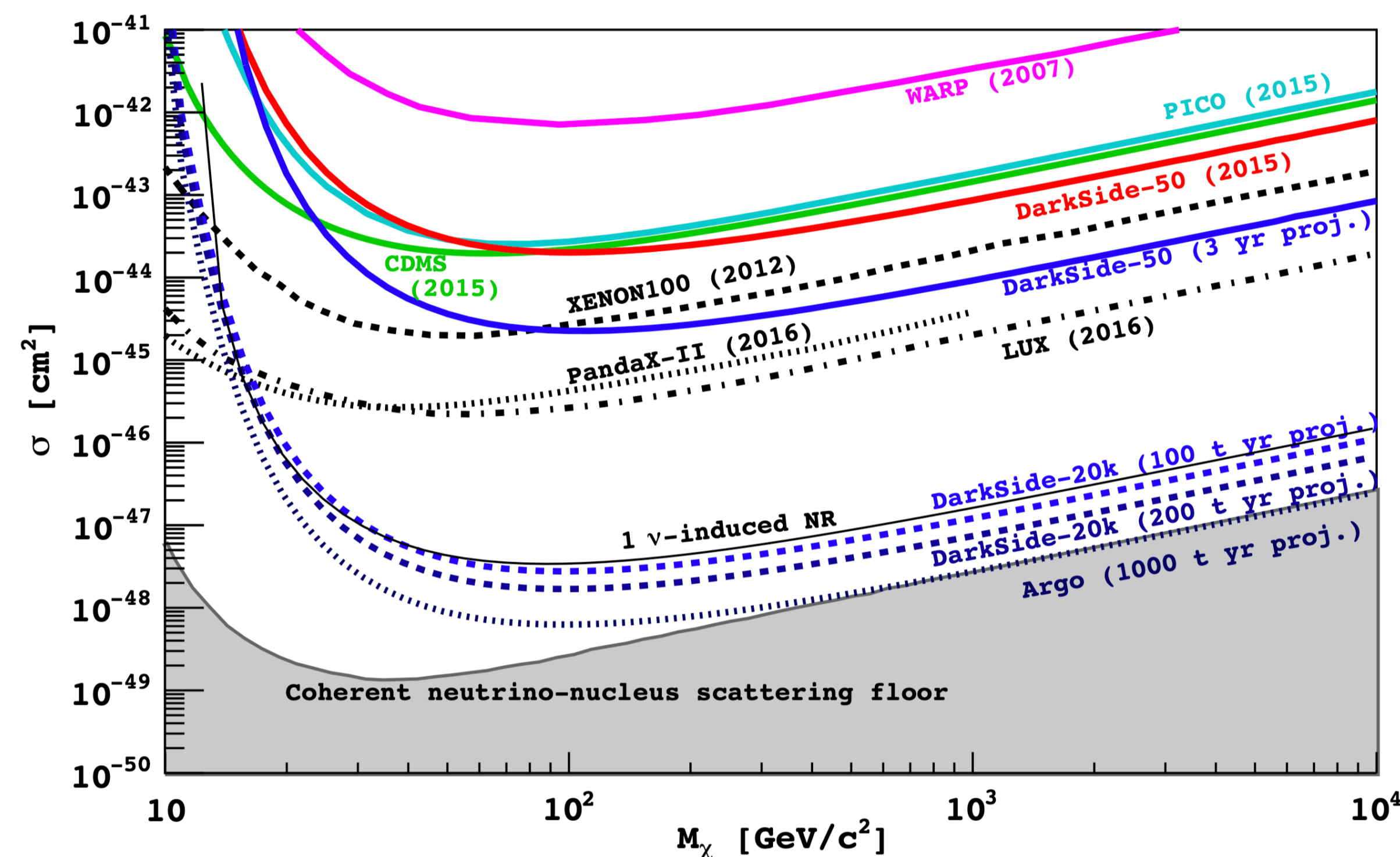
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DarkSide-20k

The DarkSide-20k experiment will use a two-phase LAr time projection chamber (TPC) to search for nuclear recoils induced by an interaction with dark matter [2].

DarkSide-20k aims at a significant improvement upon recent limits set on the WIMP cross-section (σ).

A considerable analysis challenge faced by DarkSide-20k is the **accurate modeling of the detector's response to different classes of dark matter interactions and backgrounds**.

ARIS Results (2017)
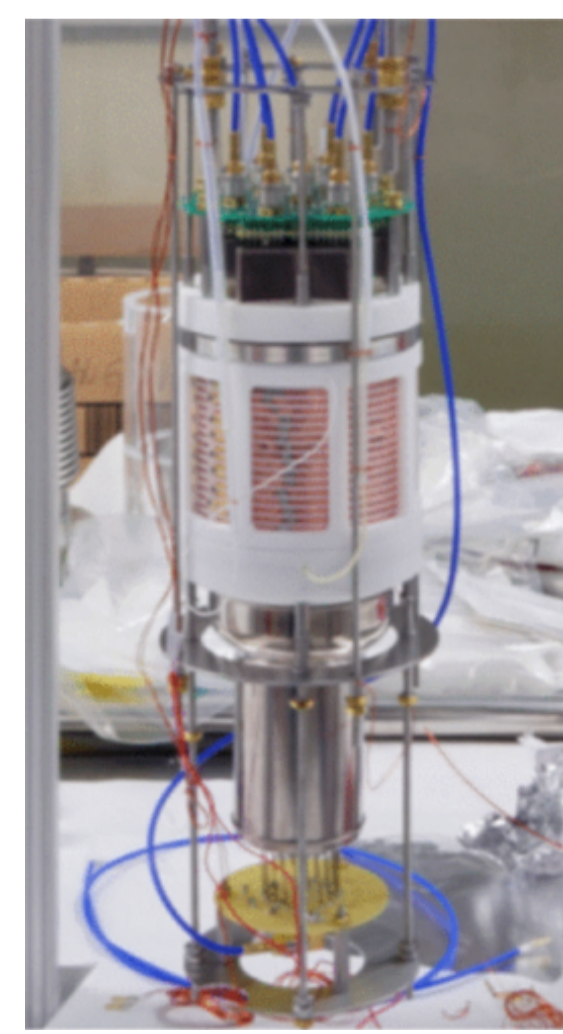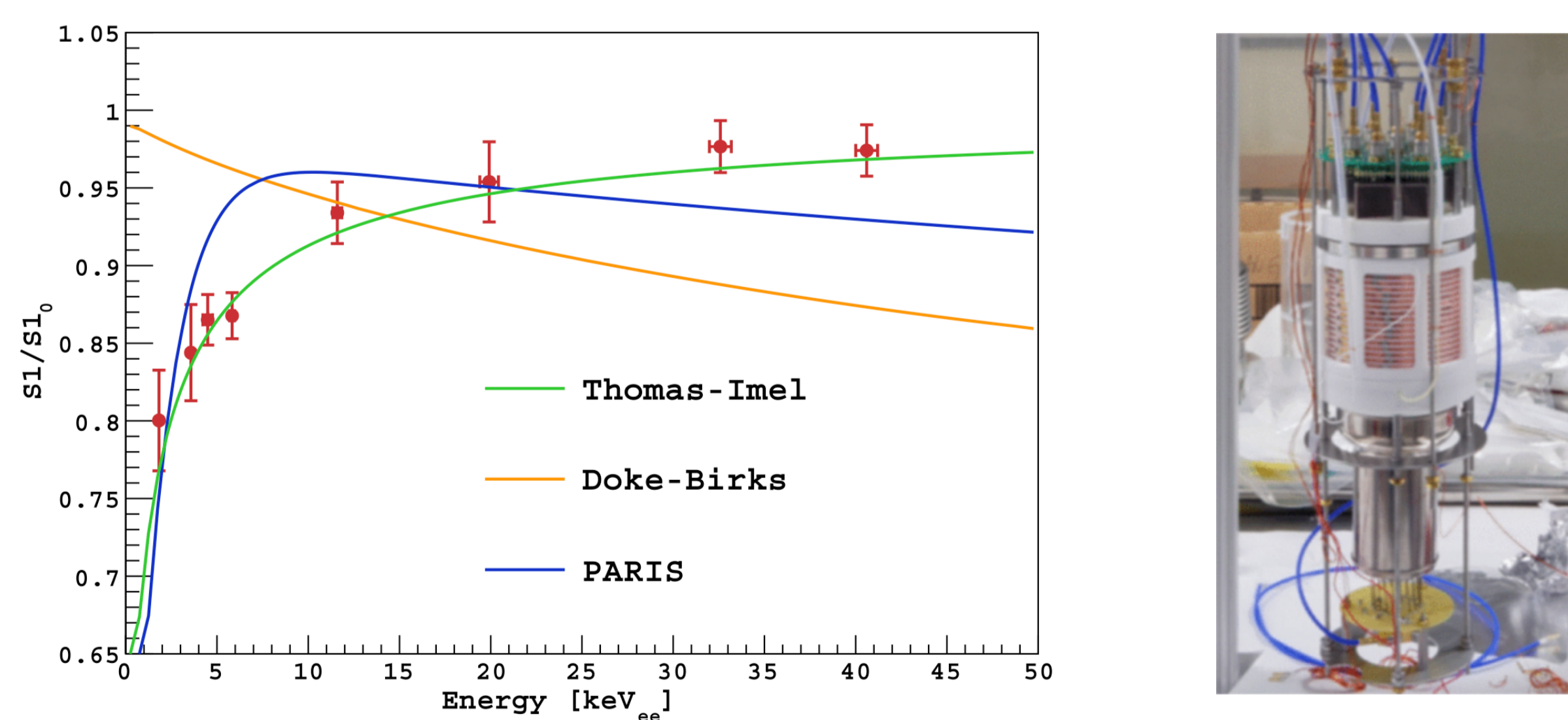
The ARIS experiment measured the scintillation and ionization response of LAr to neutrons of known energy [3].

A comprehensive model of the **LAr response to dark matter-argon nuclear recoils** was defined.

Abstract

The response of liquid argon (LAr) to low energy dark matter-electron recoils is poorly understood, mainly due to a lack of measurements. It is currently modeled using measurements at higher energies [1].

The **Argon Recoil Ionization and Scintillation from Electron Recoils (ARIS-ER)** experiment will measure the **response of liquid argon to electron recoils** with two main goals:

1. *To characterize the LAr response to electron recoils down to a keV*
2. *To refine a GEANT4-model describing the fundamental principles governing the ionization and scintillation processes of LAr*

ARIS-ER Proposal

ARIS-ER will use gammas produced by a ^{22}Na source to induce electronic recoils in LAr.

Procedure:

- 511 keV gamma Compton scatters in the TPC
- Energy of the scattered gamma is measured by a high resolution Broad Energy Germanium (BEGe) detector
- Two BaF_2 scintillation detectors tag the 1273 keV gamma and back-to-back 511 keV gamma from ^{22}Na decay
  - ⇒ Allows for separation of desired events from the environmental background

This knowledge is vital to LAr-based dark matter searches like DarkSide-20k for the identification of sub-GeV dark matter-electron scattering events and the modeling of backgrounds for dark matter-nucleon scattering [4].
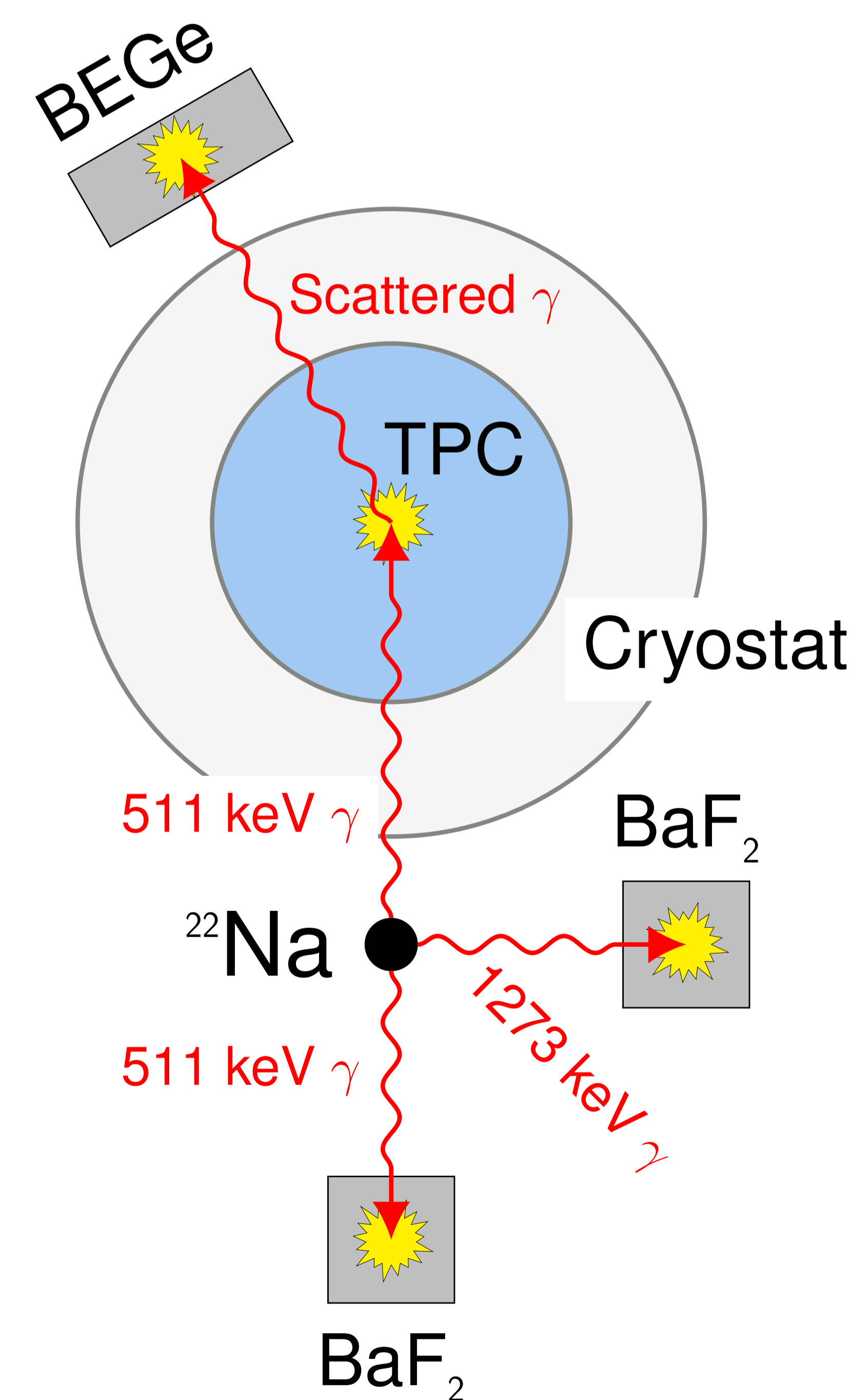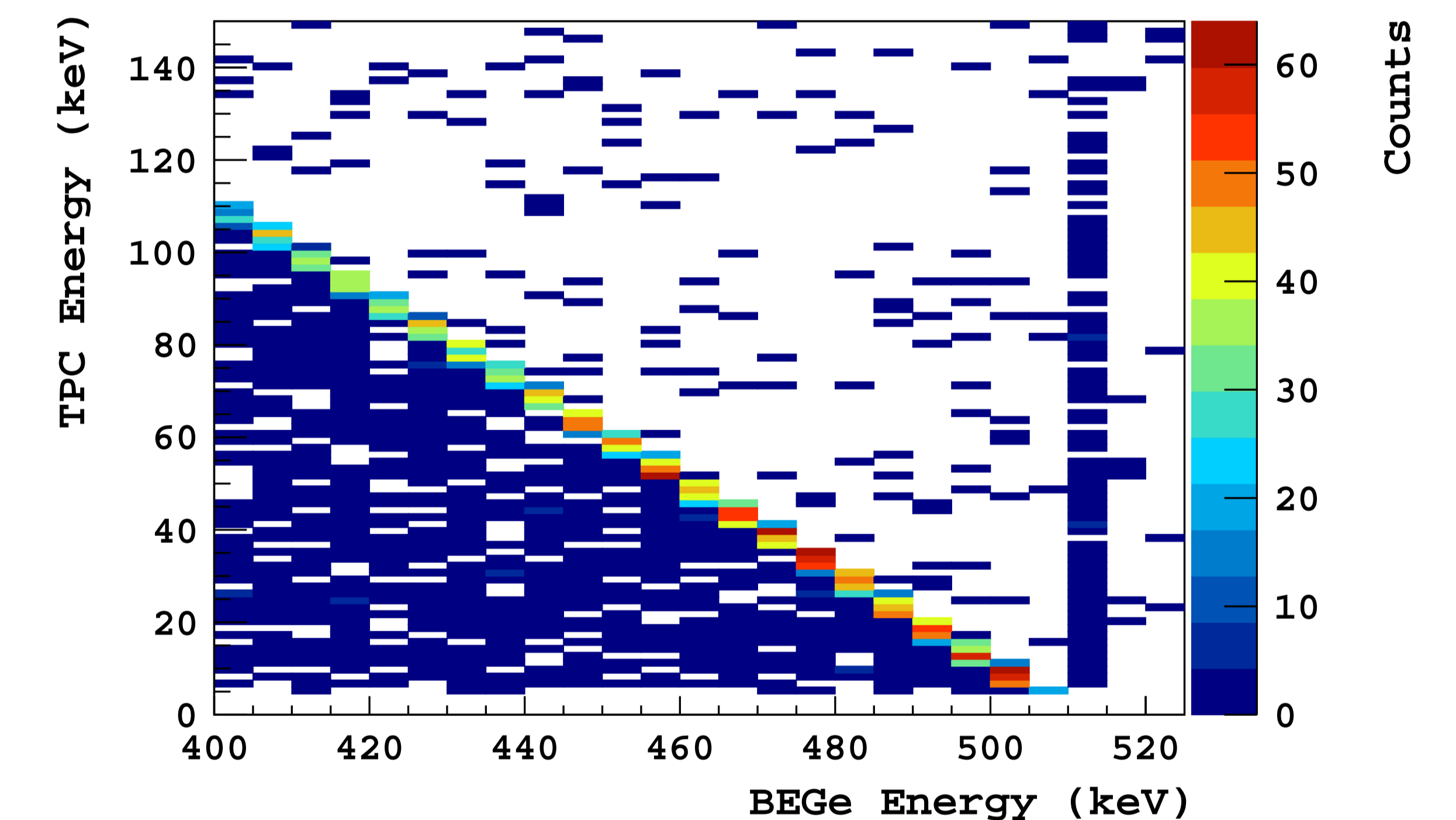

ARIS-ER Status

To demonstrate the feasibility of ARIS-ER, the GEANT4-based Monte Carlo package G4DS [1] was used to run simulations of the proposed geometry.
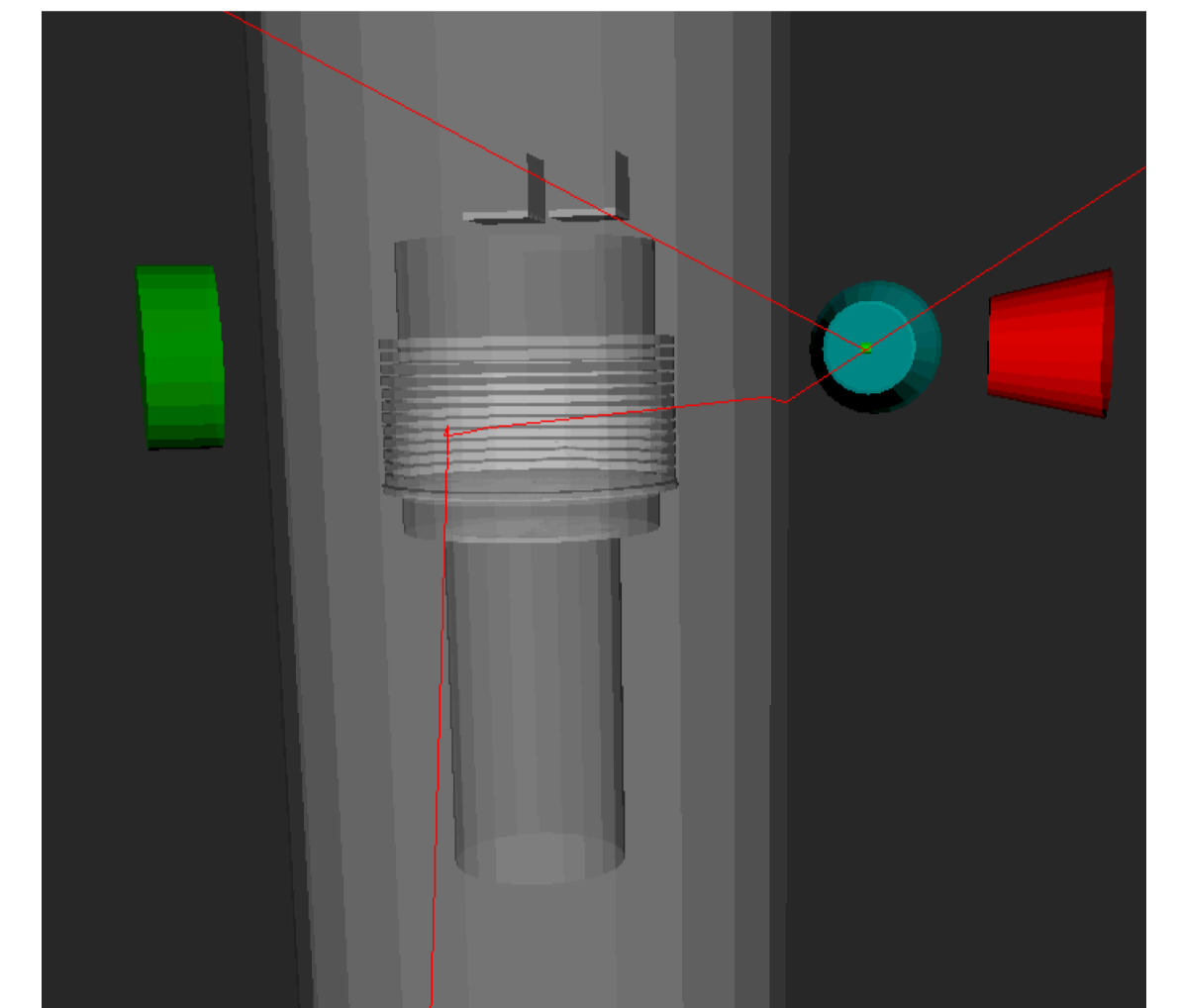
Only the back-to-back gamma was tagged in this Monte Carlo study due to the number of available statistics.

Clear TPC energy peaks occur for each BEGe energy bin.

Gaussian fits of the TPC energy for each BEGe energy bin show that the desired events required for calibration can be resolved from backgrounds.

Consequently, **calibration over a large energy range can be done** without altering the experimental setup. This notably improves the predicted systematic error.

The ARIS-ER experiment will begin taking data in 2020.

References

[1] P. Agnes et al., Journal of Instrumentation **12**, P10015 (2017).
[2] C. E. Aalseth et al., The European Physical Journal Plus **133**, 131 (2018).
[3] P. Agnes et al., Physical Review D **97**, 112005 (2018).
[4] P. Agnes et al., Phys. Rev. Lett. **121**, 111303–111304 (2018).

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