

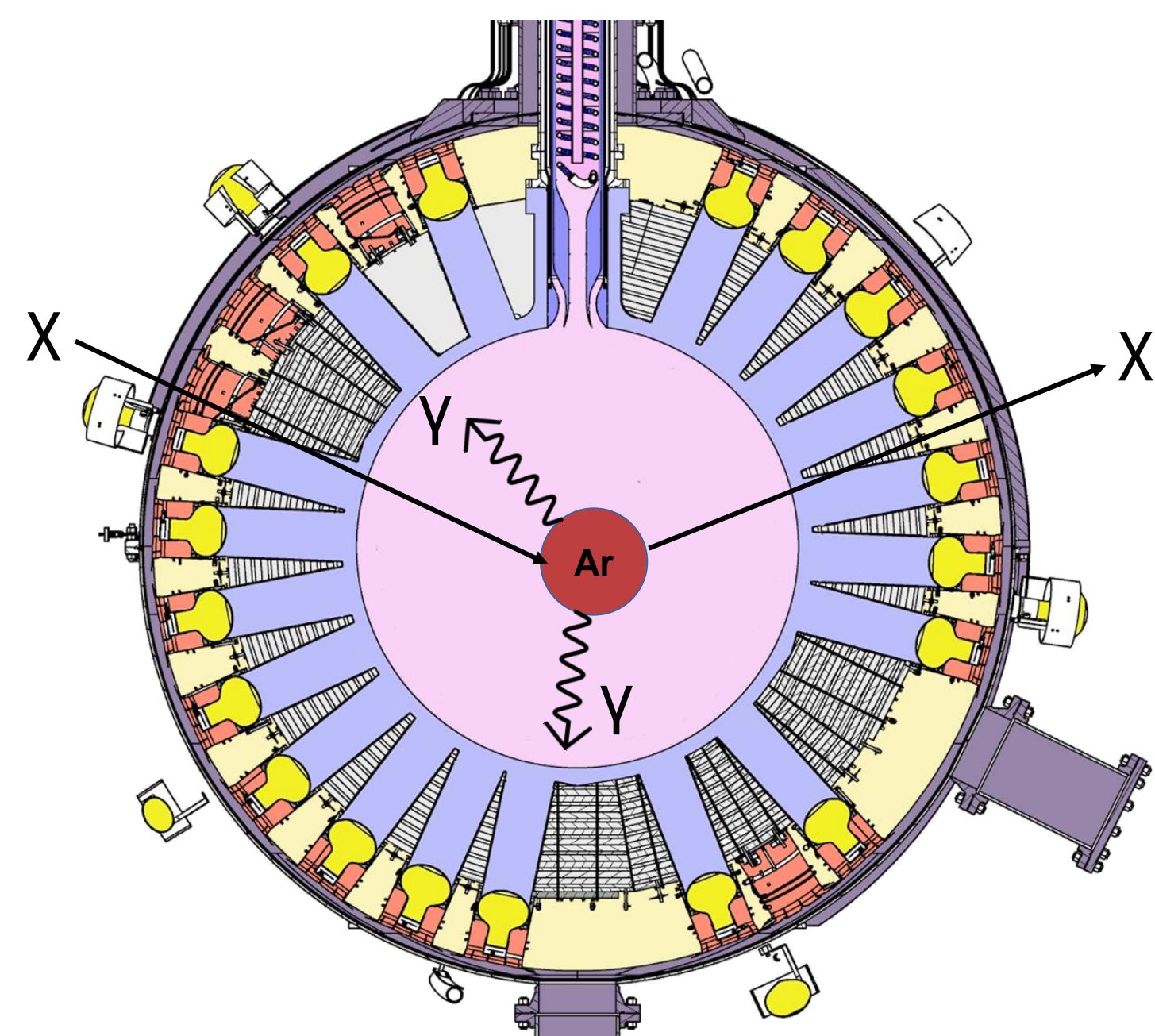
DEAP-3600 Detector

Dark matter Experiment using Argon Pulse-shape discrimination, containing 3300 kg of liquid argon

Single phase, liquid argon scintillation light detector

Particle interactions in the argon induce scintillation light

Photomultiplier tubes (PMTs) detect light from interactions inside the detector¹



Ar-39 Spectrum Investigation

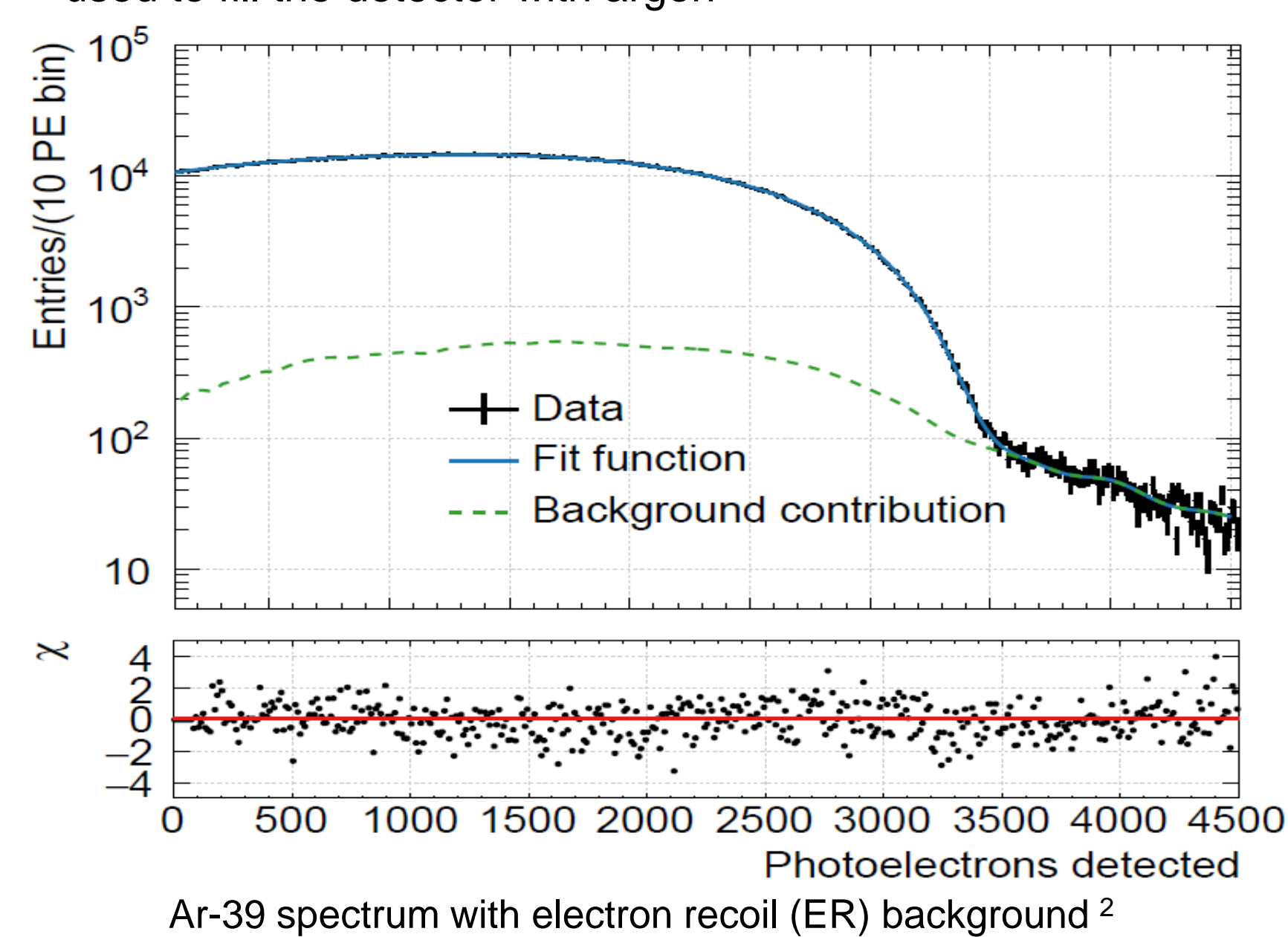
Deviations from the Ar-39 spectral shape can lead to implications for searches related to
 Radiative neutrinoless double electron capture of Ar-36
 Weak magnetism in Ar-39
 Sterile neutrino searches

This work also directly informs on the energy response of the detector

Several efforts are underway to study the Ar-39 spectrum in DEAP-3600, including Ar-39 activity, half-life, and spectral shape

All of these studies require an extensive understanding of backgrounds to the Ar-39 spectrum

One possible background is Kr-85, which is a radioactive isotope that can potentially bypass the purification methods used to fill the detector with argon



Constraining background from Kr-85 on Ar-39 activity and spectral shape measurements

Possible contribution from Kr-85 in the Ar-39 spectrum

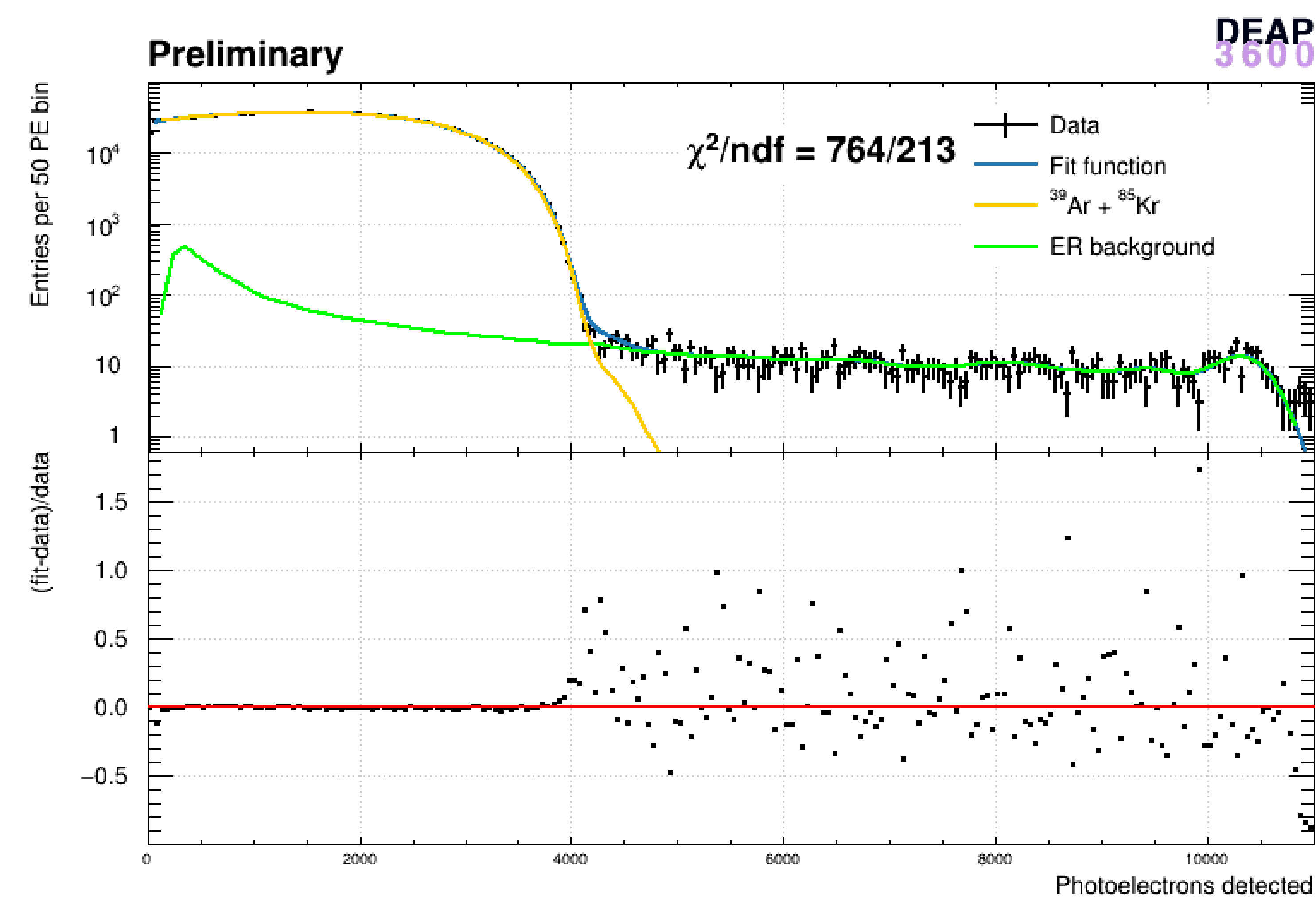
Kr-85 Q-value above Ar-39, $Q_{Kr-85} = 687$ keV while $Q_{Ar-39} = 565$ keV

Full fit to Ar-39 data was completed, including electron recoil (ER) background

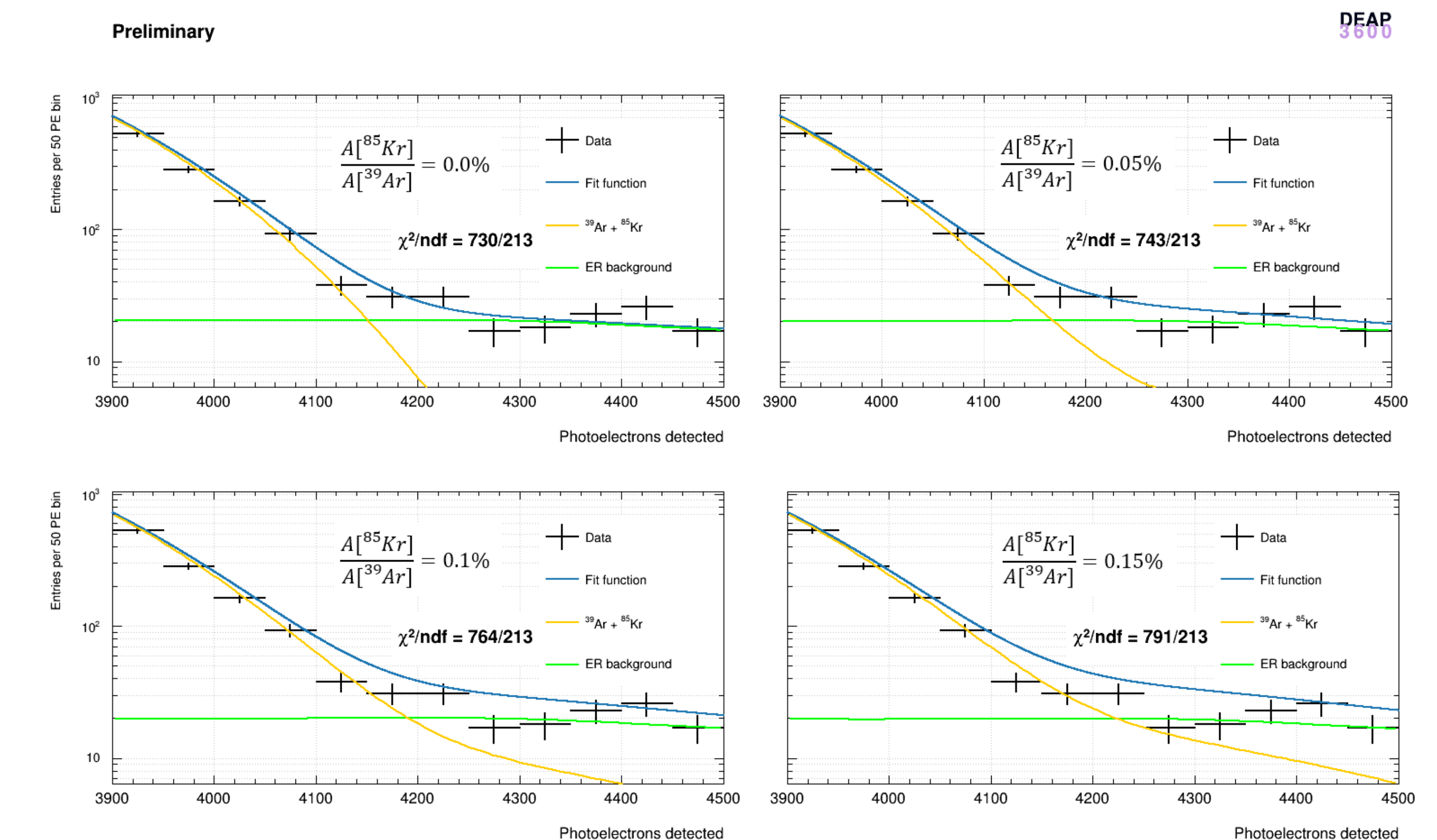
Kr-85 spectrum³ is added to the Ar-39 spectrum in small, varied amounts

Region above the endpoint of Ar-39 is the best place to search for signs of Kr-85 activity in DEAP-3600

By varying the amount of Kr-85 included in the fit, we can observe the effect on the shape of the spectrum and compare it to data



Ar-39 fit to data including electromagnetic recoil background spectrum. This fit includes 0.1% Kr-85 counts relative to the Ar-39 counts.



Four fits with varying amounts of Kr-85 relative to Ar-39. The fit is completed on the full spectrum, with a small region shown here. These plots focus on the endpoint of the Ar-39 beta spectrum, which is fixed at 565 keV here. The endpoint of the Kr-85 beta spectrum is slightly higher, at 687 keV.

Any contribution from Kr-85 must be small

Preliminary best fit shown here is at 0% additional krypton

Still possible that there is some contribution from krypton given the uncertainties in this measurement

Systematics including Ar-39 endpoint uncertainty and updated theoretical model are being evaluated

Results from this study will have potential impacts on measurements of the Ar-39 specific activity, spectral shape, and half-life in DEAP-3600

References

1. Design and construction of the DEAP-3600 dark matter detector, DEAP Collaboration, <https://doi.org/10.1016/j.astropartphys.2018.09.006>
2. Search for dark matter with a 231-day exposure of liquid argon using DEAP-3600 at SNOLAB, DEAP Collaboration, <https://journals.aps.org/prd/abstract/10.1103/PhysRevD.100.022004>
3. Improved calculations of β decay backgrounds to new physics in liquid xenon detectors, S. J. Haselschwardt, J. Kostensalo, X. Mougéot, and J. Suhonen, <https://journals.aps.org/prc/abstract/10.1103/PhysRevC.102.065501>

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