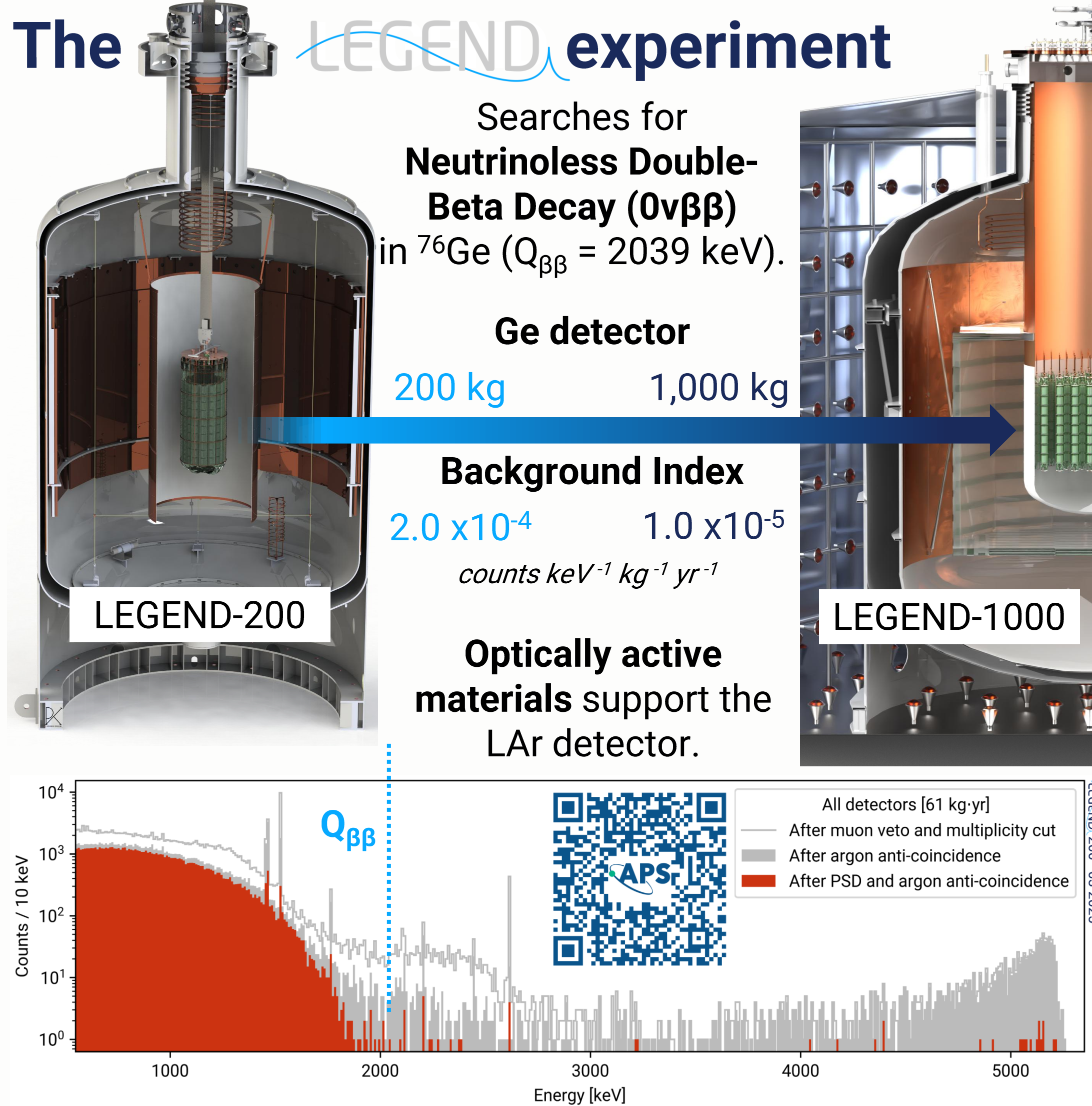


Optically Active Poly(ethylene naphthalate) Components for Liquid Noble Gas Detectors

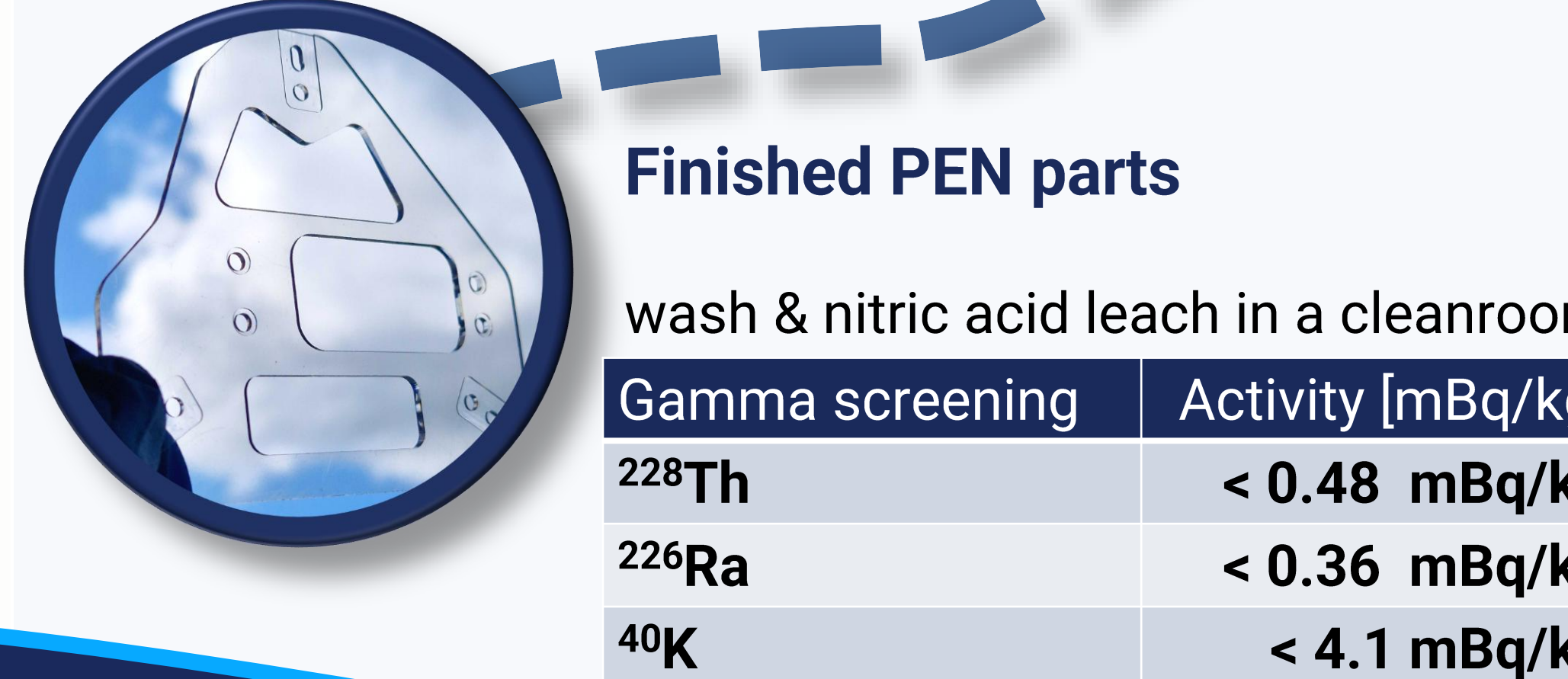
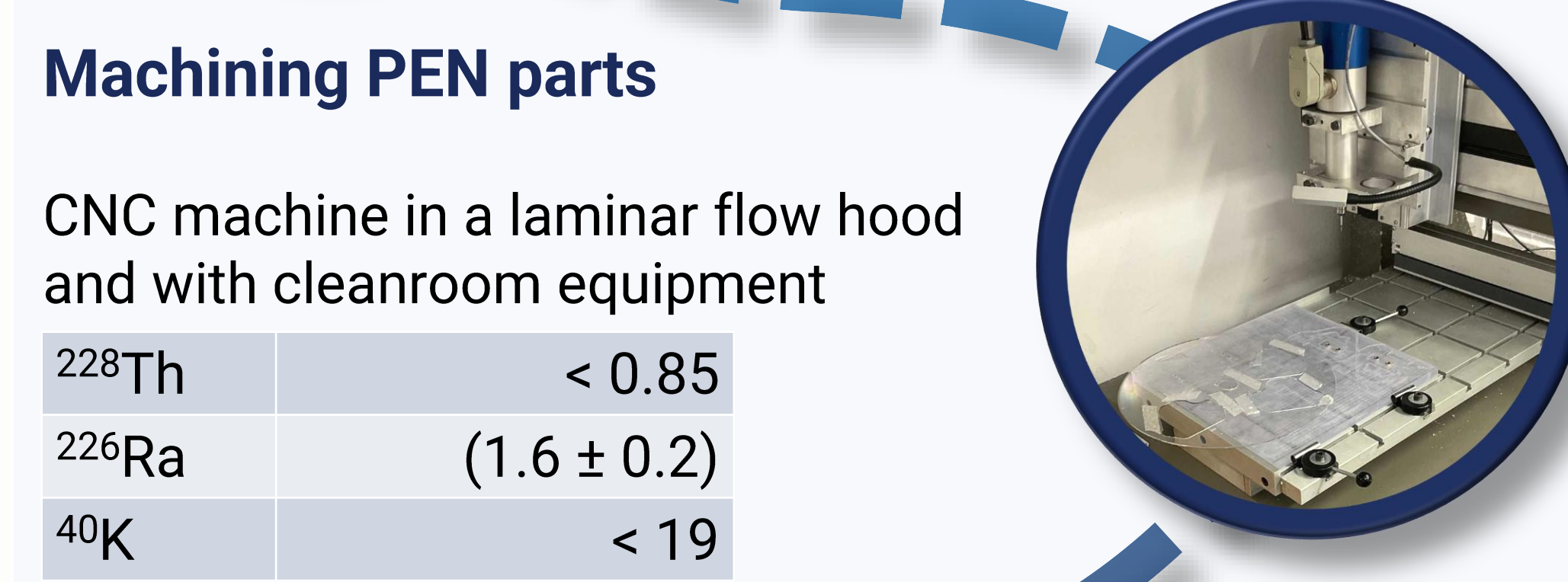
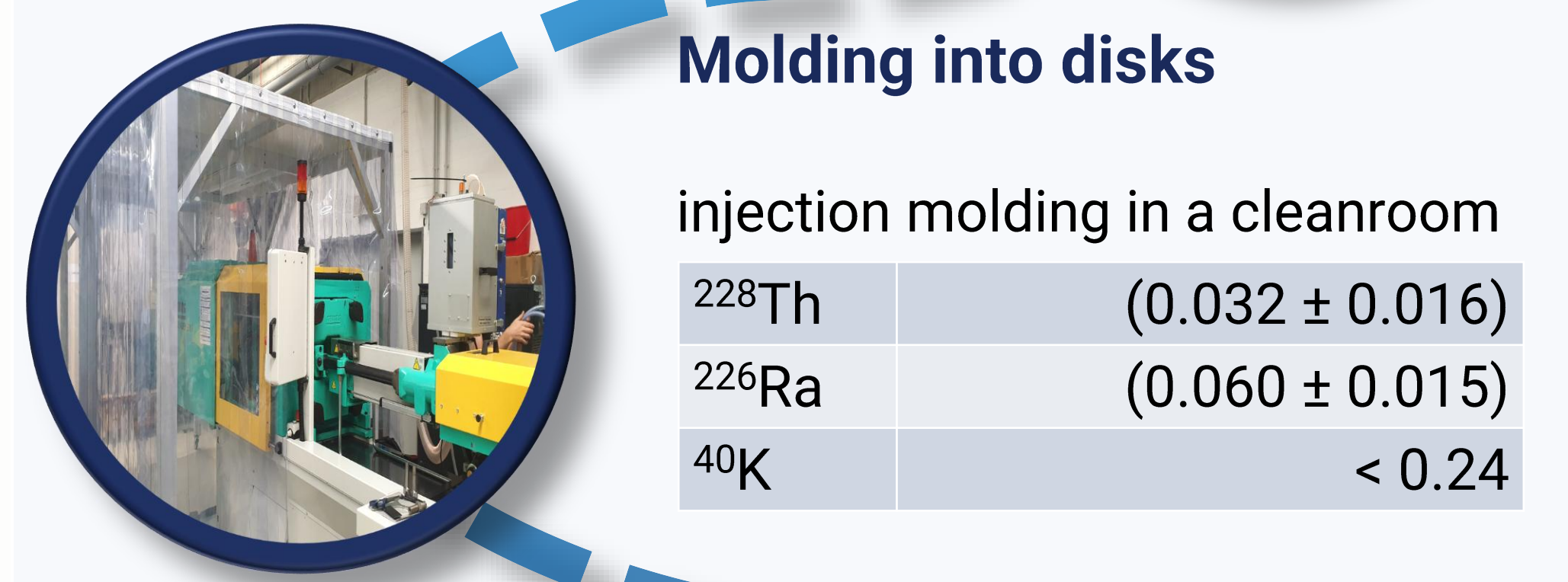
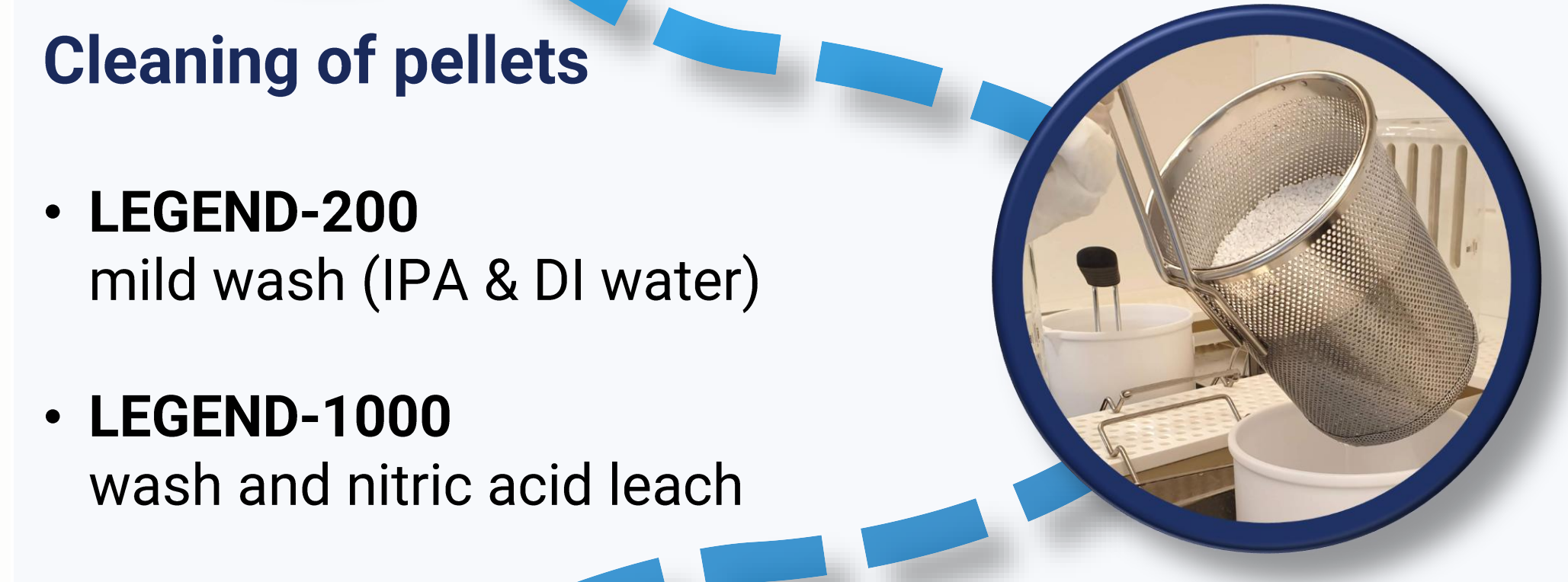
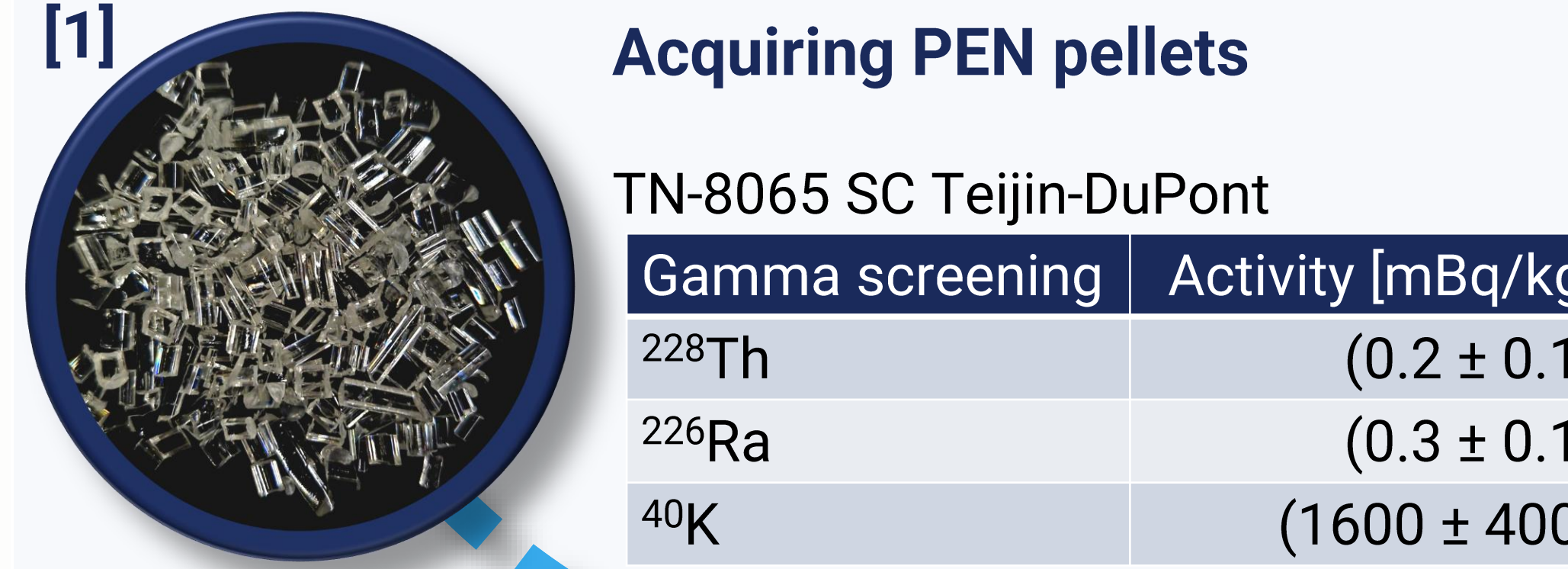
Andreas Leonhardt¹, on behalf of the LEGEND Collaboration and Peter Bauer², Ines Kühnert³, Andreas Leuteritz³, Florian Puch², Markus Stommel³

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³Division Polymer Materials Engineering, Leibniz Institute of Polymer Research Dresden, 01069 Dresden, Germany

Contact: andreas.Leonhardt@tum.de



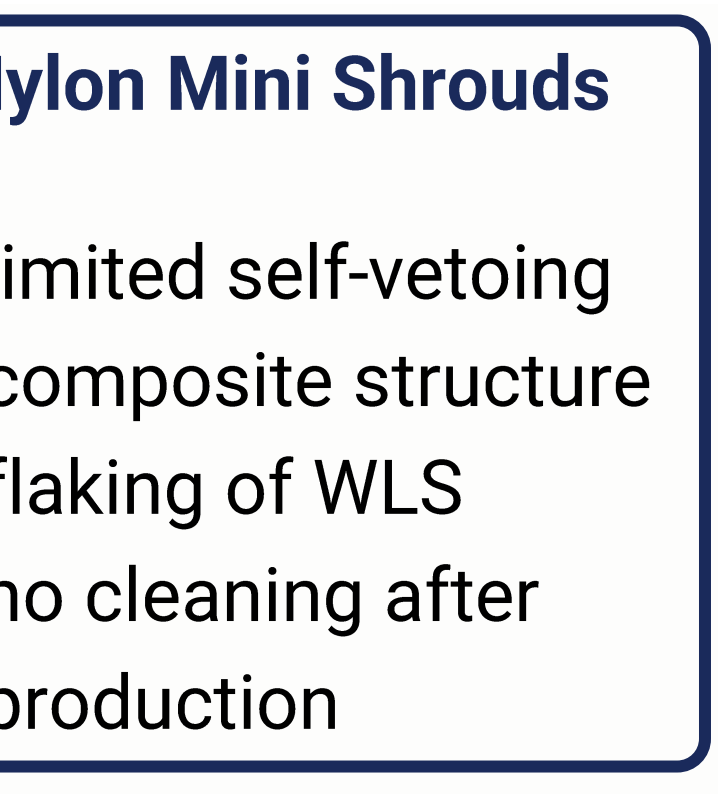
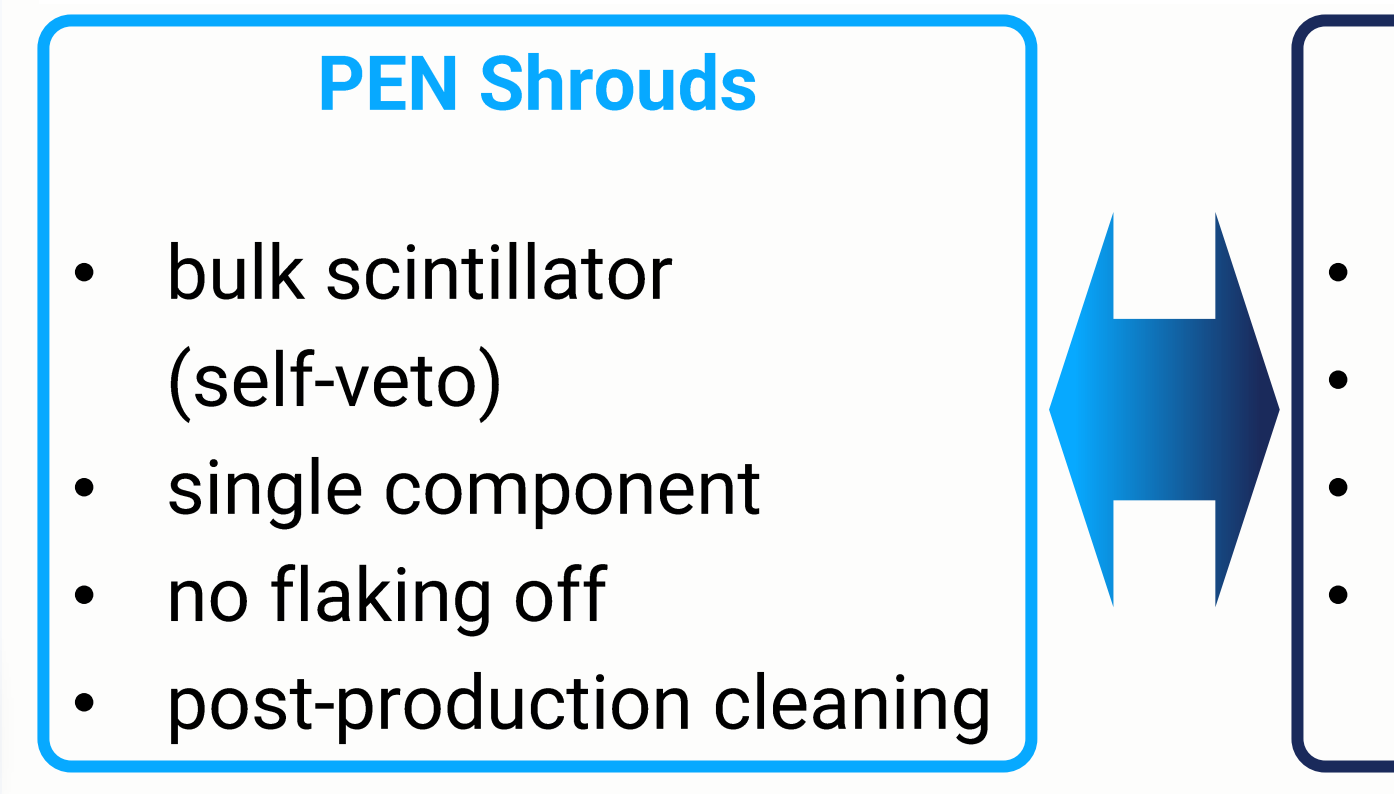
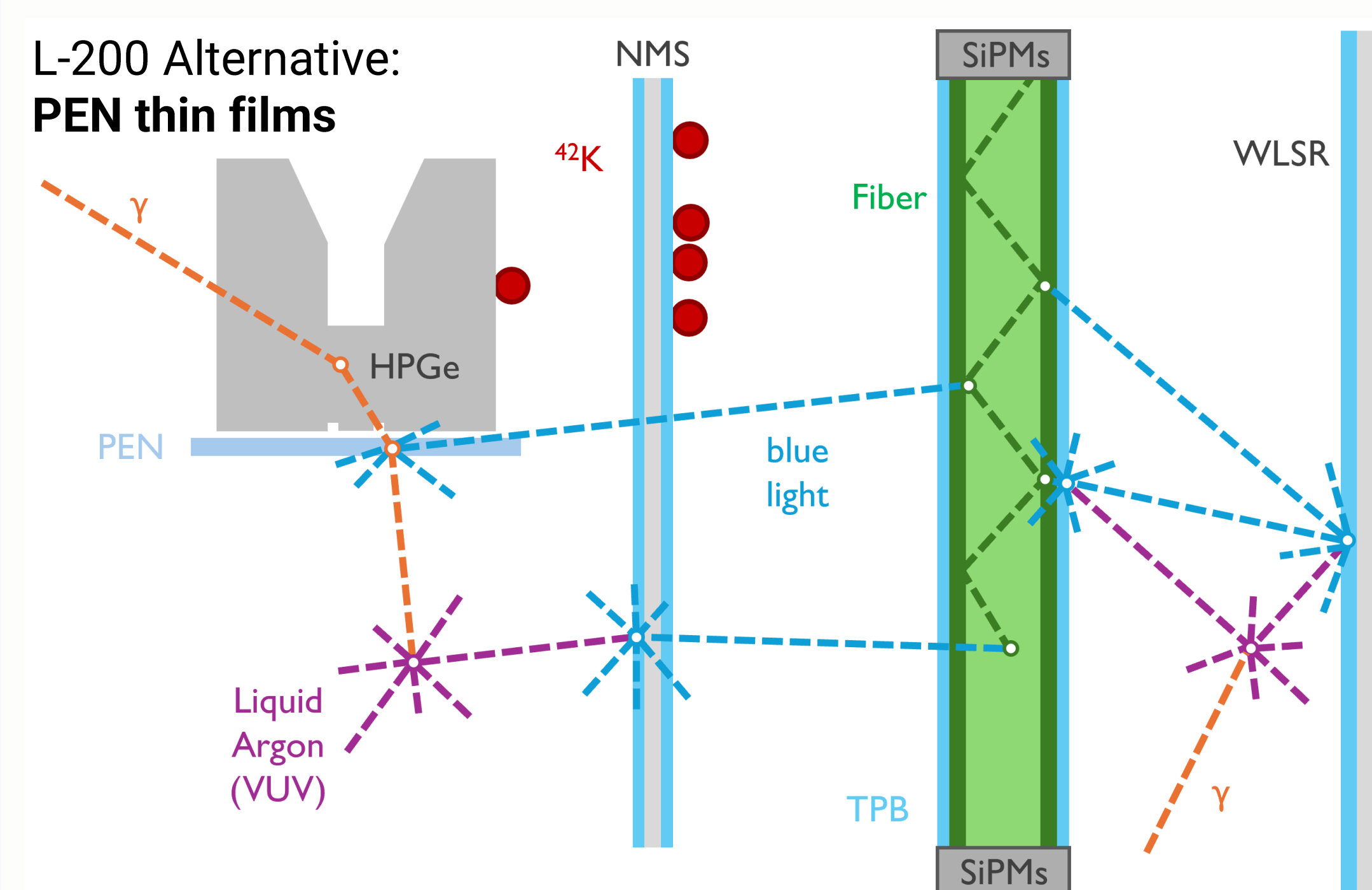
From pellet to LEGEND component [1]



^{42}K mitigation with PEN

Beta decay of ^{42}K ($Q_{\beta} = 3525$ keV) is background in ROI if not mitigated.

In L-200, **Nylon Mini Shrouds (NMS)**, coated with a wavelength shifter (TPB), block 42K drift in HPGGe detectors.

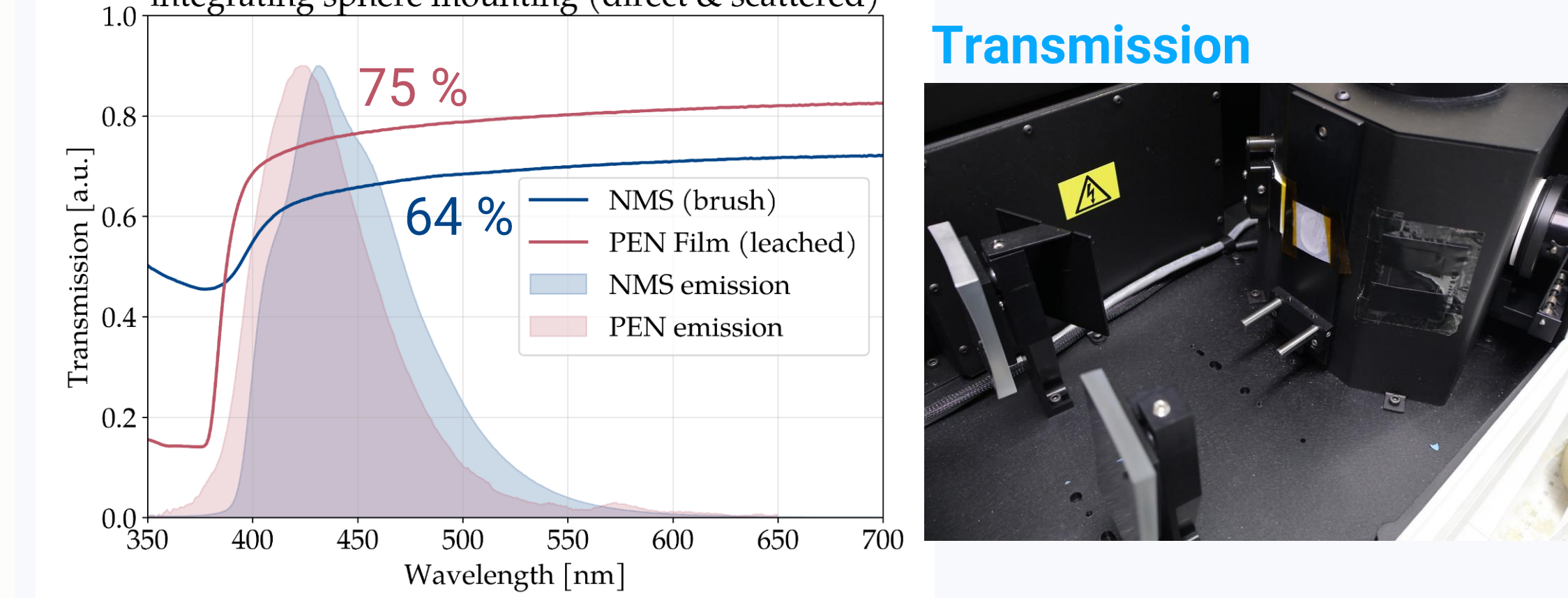
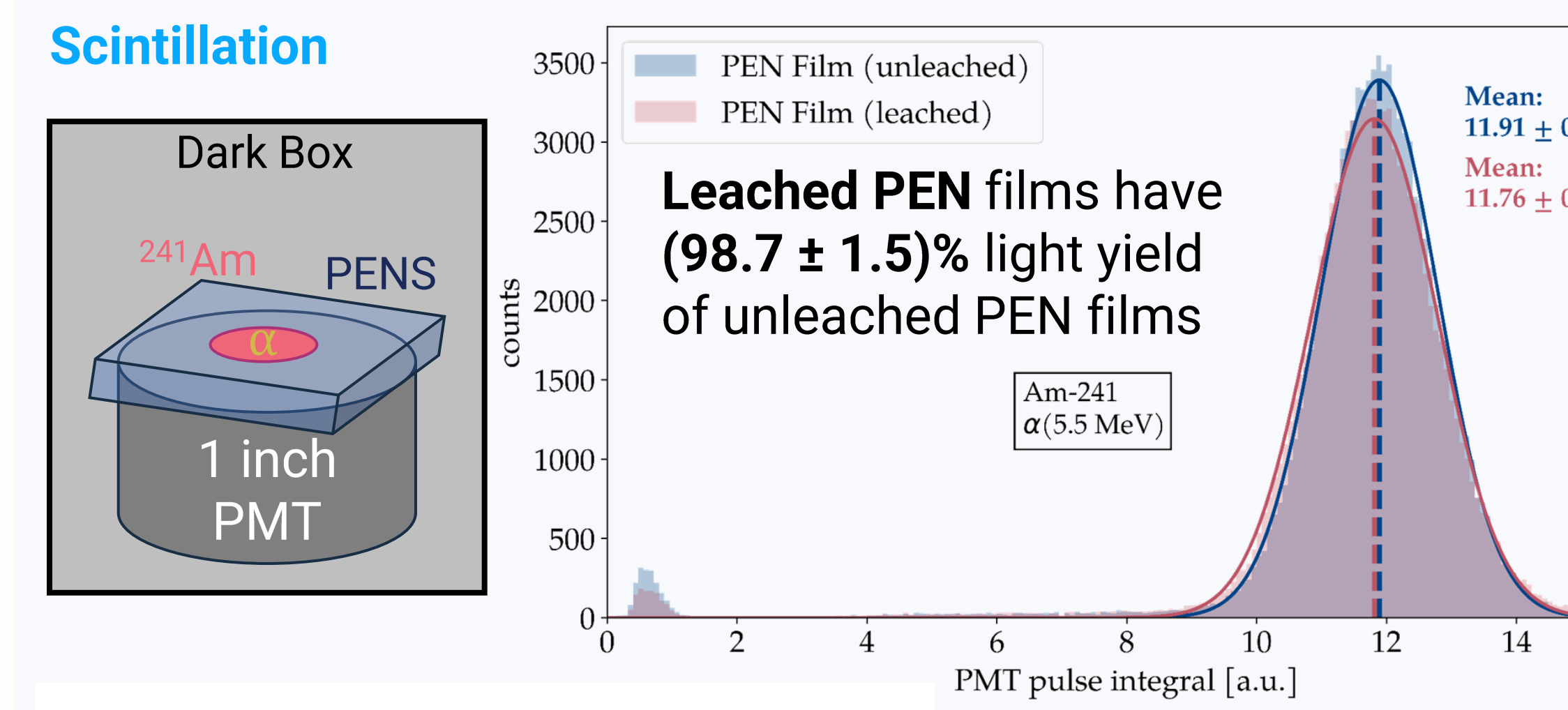


Cleaning & Assay of PEN Films

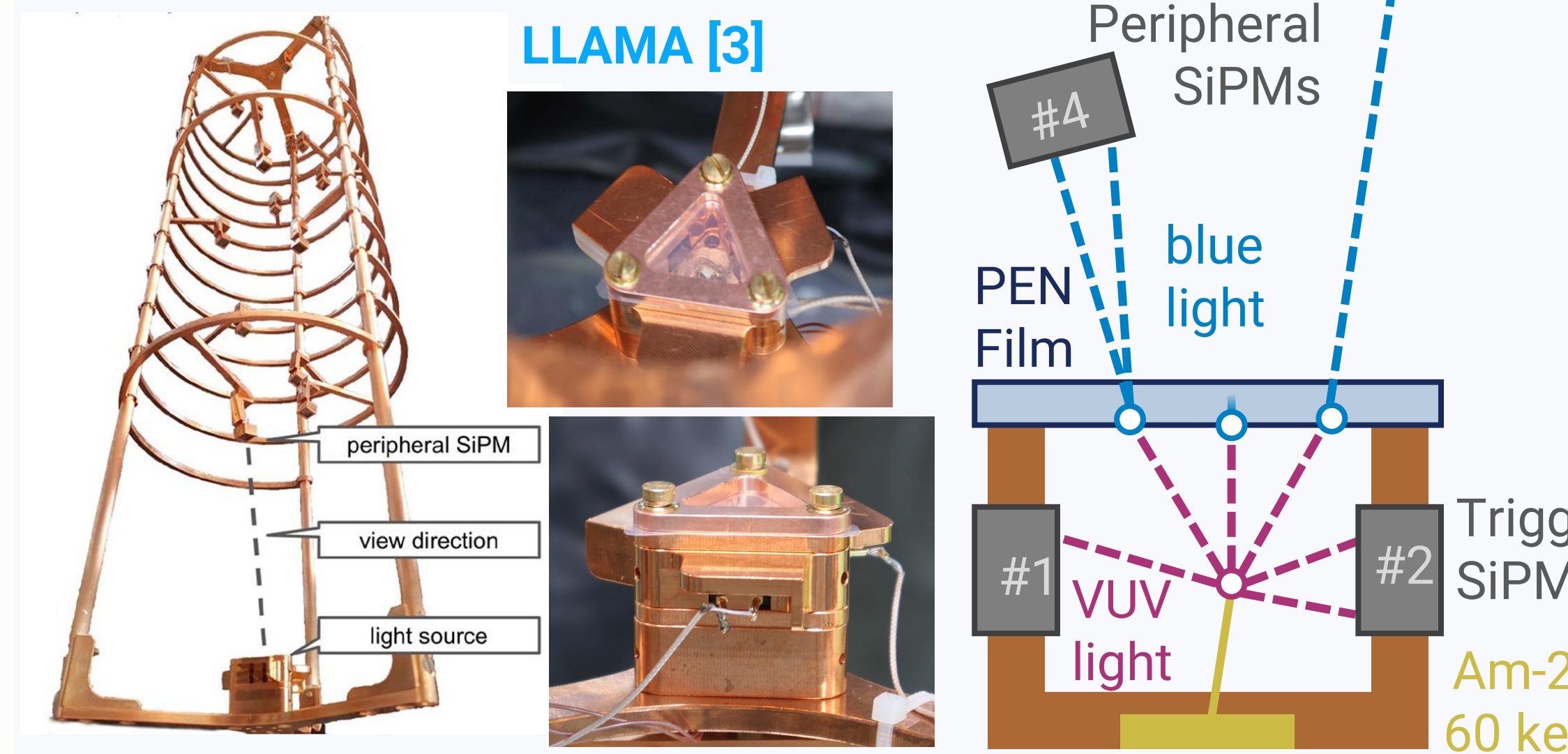
- Goodfellow PEN Film 75 μm**
- Wash in 1% micro90 solution
 - Leach in 20% nitric acid for 24 hours
 - Soak in DI water for 24 hours
 - Dry in nitrogen purge

ICP-MS	^{nat}K [ppb]	^{232}Th [ppt]	^{238}U [ppt]
Dirty film	172 ± 15	28 ± 2	11.8 ± 0.7
Leached film	94 ± 15	1.8 ± 0.4	1.9 ± 0.5
L-200 NMS	94 ± 28	75 ± 23	

Optical Performance of PEN Shrouds



In-situ testing of PEN Shrouds



Light Source Cover	Pulses per Trigger in SiPM #4
no film	0.198 ± 0.002
PEN Shroud	0.192 ± 0.002
L-200 NMS	0.326 ± 0.003

PRELIMINARY

Next steps

Fully integrated test with HPGGe detectors & LAr light readout in the SCARF test stand at TUM ($^{42}\text{Ar}/^{42}\text{K}$ -spiked [4])

Poly(ethylene naphthalate)

PEN is a commercially available polyester that can be acquired as a **granulate, filament, or a pre-extruded thin film.**

It intrinsically **scintillates** and **shifts UV light** to the visible blue (380 – 550 nm). Its **structural properties excel at cryogenic temperatures** [1].

R&D on PEN components



- #### LEGEND Institutions
- Centre for Energy, Environmental and Technological Research
 - Cornelius Univ.
 - Czech Technical Univ. in Prague and IEAP
 - Daresbury Laboratory
 - Duke Univ. and Triangle Universities Nuclear Laboratory
 - Gran Sasso Science Institute
 - Hochschule RheinMain
 - Indiana Univ. Bloomington
 - INFN - Sezione di Napoli
 - Institute for Nuclear Research Russian Academy of Sciences
 - Jagiellonian Univ.
 - Joint Institute for Nuclear Research
 - Joint Research Centre Geel
 - Laboratori Nazionali del Gran Sasso
 - Laboratori Nazionali di Frascati

- Lancaster Univ.
- Leibniz Institute for Crystal Growth
- Leibniz Institute for Polymer Research
- Los Alamos National Laboratory
- MPI for Nuclear Physics
- MPI for Physics
- National Research Centre "Kurchatov Institute"
- National Research Nuclear Univ. MEPhI
- National Taiwan University (NTU)
- North Carolina State Univ.
- Oak Ridge National Laboratory
- Polytechnical Univ. of Milan
- Princeton Univ.
- Roma Tre Univ. and INFN

- South Dakota School of Mines and Technology
- Technical Univ. of Dresden
- Technical Univ. of Munich
- Tennessee Technological Univ.
- Univ. of California and Lawrence Berkeley National Laboratory
- Univ. College London
- Univ. of L'Aquila and INFN
- Univ. of Cagliari and INFN
- Univ. of California San Diego
- Univ. of Houston
- Univ. of Liverpool
- Univ. of Milan and INFN
- Univ. of Milano Bicocca and INFN

- Univ. of New Mexico
- North Carolina at Chapel Hill
- Univ. of Padova and INFN
- Univ. of South Carolina
- Univ. of South Dakota
- Univ. of Tennessee, Knoxville
- National Laboratory
- Univ. of Texas at Austin
- Univ. of Tuebingen
- Univ. of Warwick
- Univ. of Washington and Center for Experimental Nuclear Physics and Astrophysics
- Univ. of Zurich
- Williams College

- Slovak Research and Development Agency
- MSMT

- Swiss National Science Foundation
- Sanford Underground Research Facility
- Ministerstwo Nauki i Szkolnictwa Wyzszego
- DFG
- Ministry of Education and Youth and Sports
- UKRI
- INFN

- FLXR Engineering Biocompatible Grade Filament PEN-Natural, URL: <https://www.flxr.engineering/pennatural>
- Liquid Argon Instrumentation and Monitoring in LEGEND-200, M. Schwarz et al 2021 EPJ Web of Conferences 253 11014
- ^{42}Ar production and injection to a liquid argon environment for background mitigation studies, M. Schwarz et al 2026 NIM A 1087 171434

- Production and validation of scintillating structural components from low-background Poly(ethylene naphthalate), Y. Efremenko et al 2022 JINST 17 P01010

- FLXR Engineering Biocompatible Grade Filament PEN-Natural, URL: <https://www.flxr.engineering/pennatural>
- Liquid Argon Instrumentation and Monitoring in LEGEND-200, M. Schwarz et al 2021 EPJ Web of Conferences 253 11014
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