

Motivation

- PSD plastic scintillators can identify between gammas and neutrons based on scintillation pulse shape.
- Radiation portal monitors (RPMs) commonly use ^3He tubes to detect neutrons [1]
- Worldwide ^3He shortage – other neutron detectors desired
- PSD plastic potential alternative but previous iterations have shown limited lifespans – EJ-276D reported to be more robust [2]

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Pulse Shape Discrimination

- Interactions of different particle species produces different light pulse shapes allow for radiation type identification
- Charge integration method uses ratio of areas between a long and short gate applied to the pulse to calculate PSD parameter
- Discrimination ability can be quantified using figure of merit (FOM) [2]:

$$FoM = \frac{PSD(n) - PSD(\gamma)}{FWHM(n) + FWHM(\gamma)}$$

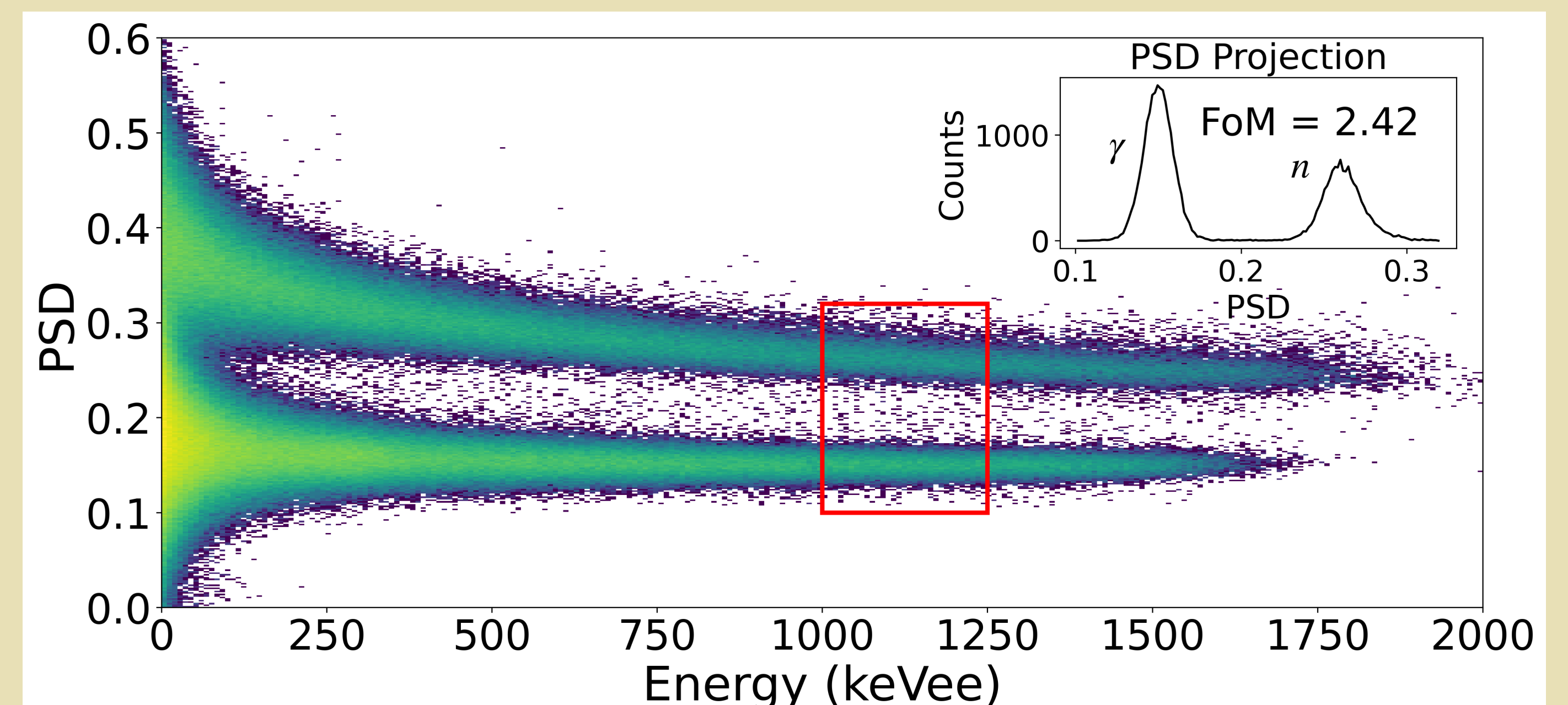


Fig 1: Example 2D PSD histogram produced using EJ276-D with an AmBe source. Inset shows the y axis projection within highlighted region

Scintillator Wrapping and Uniformity

- To optimise the light collected by photodetector, scintillators are wrapped with PTFE tape
- 3 layers of 0.2mm thick tape point of diminishing returns
- Scintillators compared using position of Cs137 Compton edge

Scintillator Number	1	2	3	4	5	6
Compton edge location (a.u.)	560(4)	564(3)	560(3)	552(5)	556(4)	551(5)

Accelerated Ageing

- Thermal cycling was used to accelerate the rate at which the scintillators degrade following the cycle shown in Fig 2. Throughout the cycle the humidity remained at 95% RH
- Other plastic scintillators have experienced fogging when raised to high temperatures and humidities and then cooled with as few as 1 cycles [3]
- So far 10 cycles have been completed
- There have been no visible change to the EJ-276D samples so far

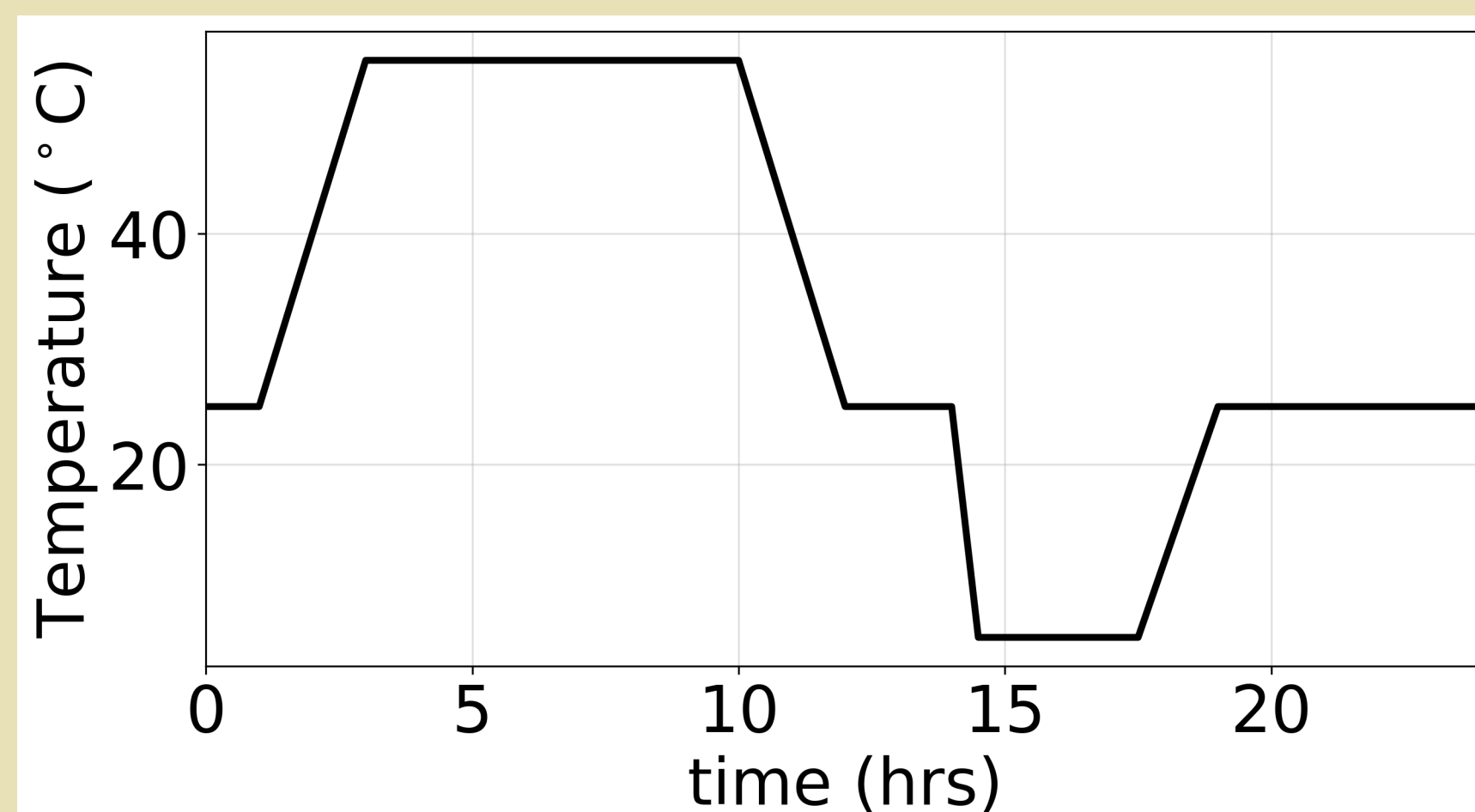


Fig 2: The temperature profile followed for 1 cycle in the environmental chamber

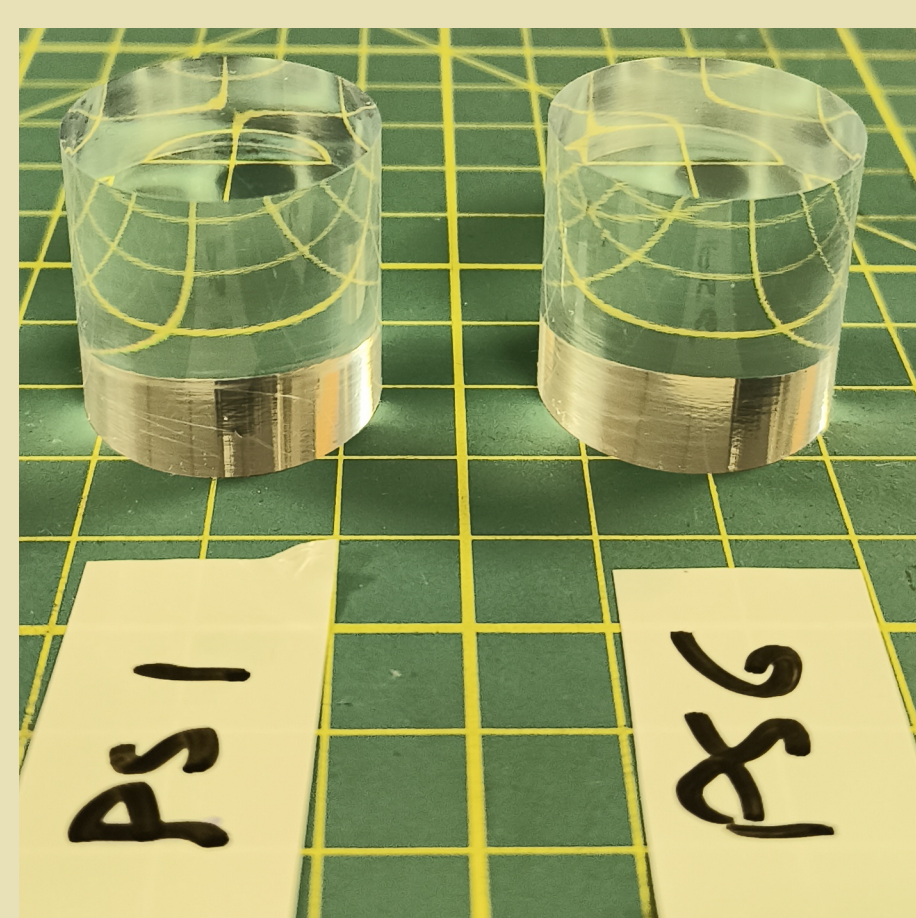


Fig 3: The aged scintillator sample after 10 cycles (left in each image) next to an unaged sample for comparison. The right image features the scintillators illuminated with UV light

Preliminary results

- A sample of EJ-276D underwent 10 cycles in environmental chamber with light output and figure of merit measured between various cycles

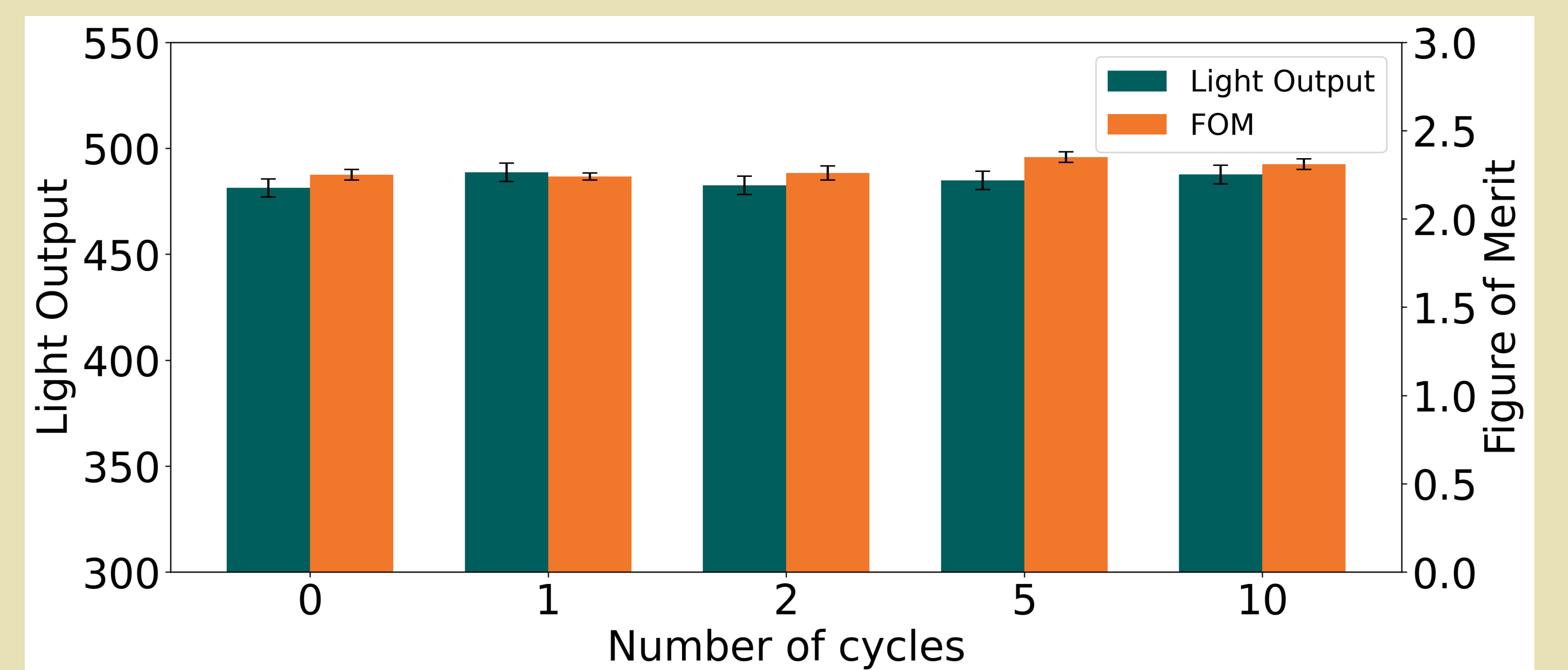


Fig 4: The light output and figure of merit of a sample of EJ-276D measured after various numbers of cycles in an environmental chamber

- A total of ten cycles have been completed so far
- No significant change in the light output or the figure of merit
- Lack of degradation so far indicates improved performance compared to previous PSD plastic scintillators

Future Work

- Continue ageing of first sample of EJ-276D
- Repeat ageing with more samples.
- Alter humidities and temperatures used in thermal cycling to identify the cause of any degradation that does occur

References

- [1] – A. Tomanin. On the optimisation of the use of ^3He in radiation portal monitors. Nucl. Instrum. Methods Phys. Res. A. 2013
- [2] – N. Zaitseva. Performance stability of plastics for neutron-gamma pulse shape discrimination. Nucl. Instrum. Methods Phys. Res. A. 2024
- [3] – R.Cameron. Fogging in Polyvinyl Toluene Scintillators, IEEE Trans. Nucl. Sci. 2015

Acknowledgements

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