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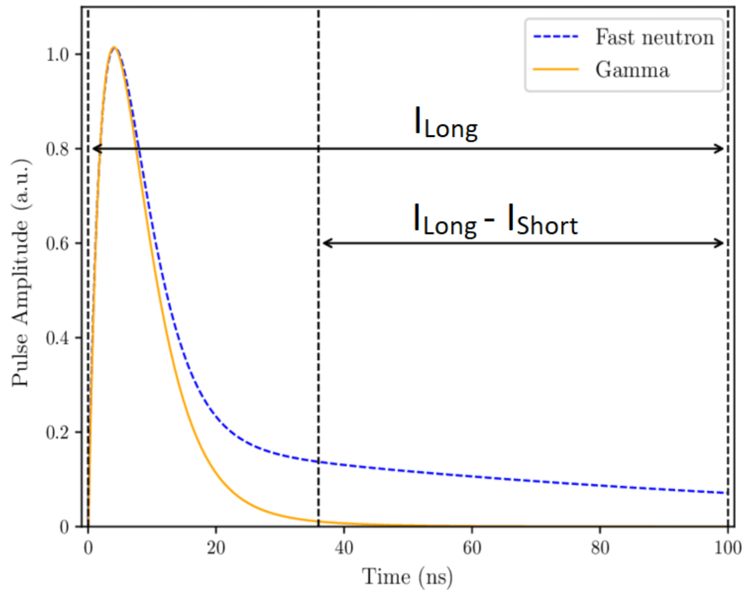
# Neutron Pulse Shape Discrimination:

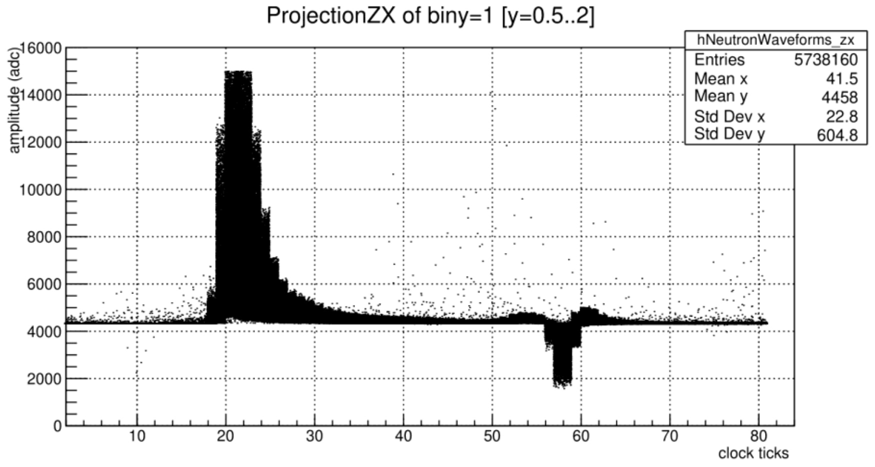
## Impact of the short integration window

Michael Heines

# Recap - waveforms

- Neutrons are heavier → longer pulse tails
- Compare main peak region and tail region
- Average baseline in first 10 clock ticks
- Integrals start from 10 clock ticks
- Still not using pile-up and overflow events



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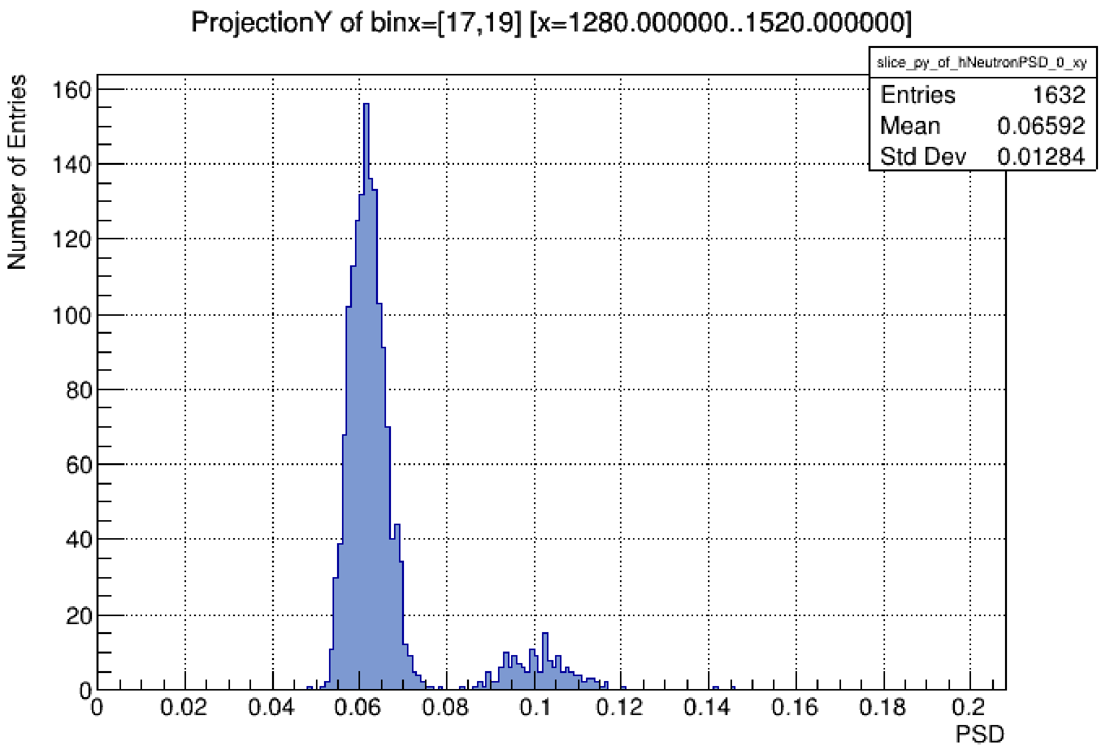
# Recap – PSD and FOM

- $PSD = \frac{Long\ integral - Short\ integral}{Long\ integral}$
- $0 < PSD < 1$

- Fit 1D-projection with a double gaussian
- $FOM = \frac{\mu_2 - \mu_1}{2.355\ (|\sigma_1| + |\sigma_2|)}$





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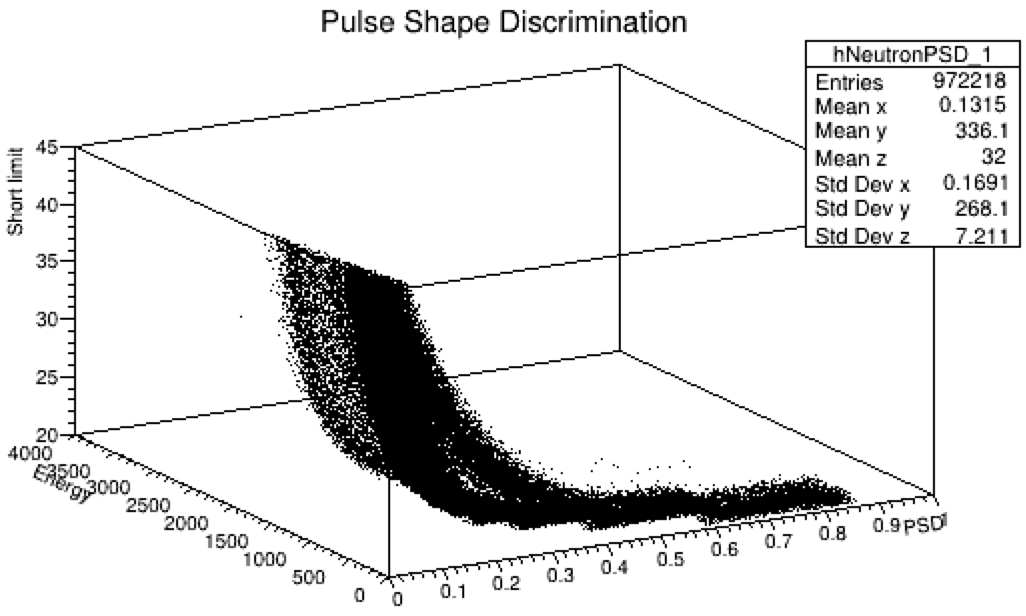
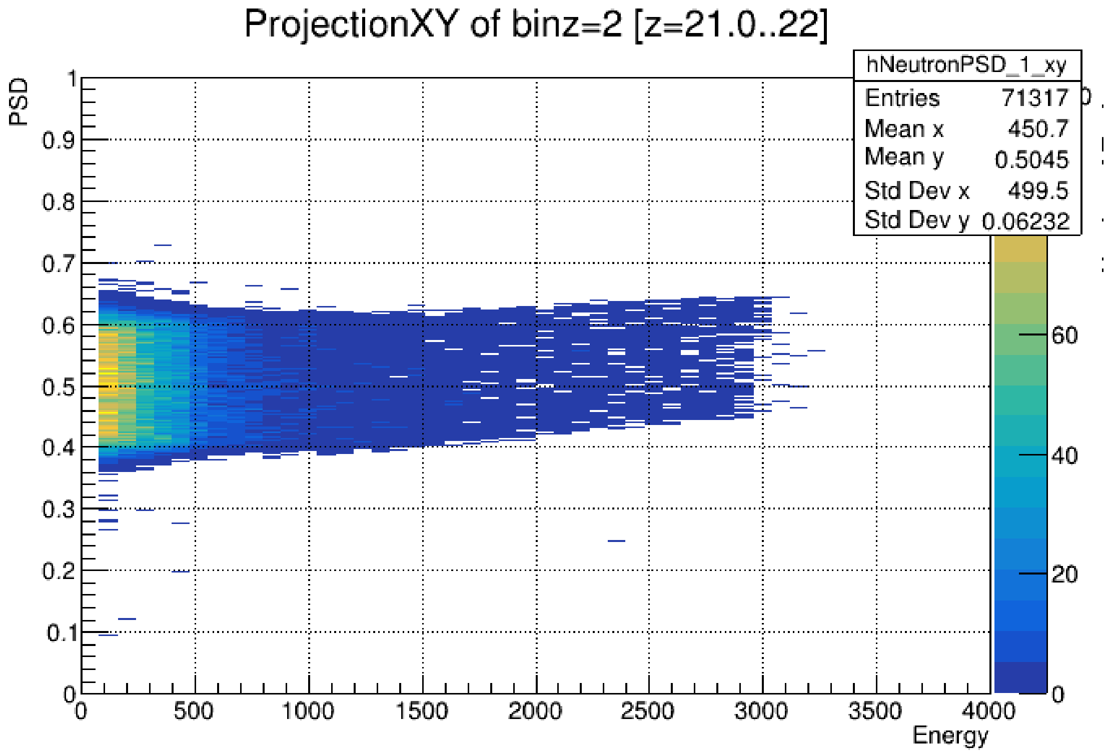
# 2D PSD Projection



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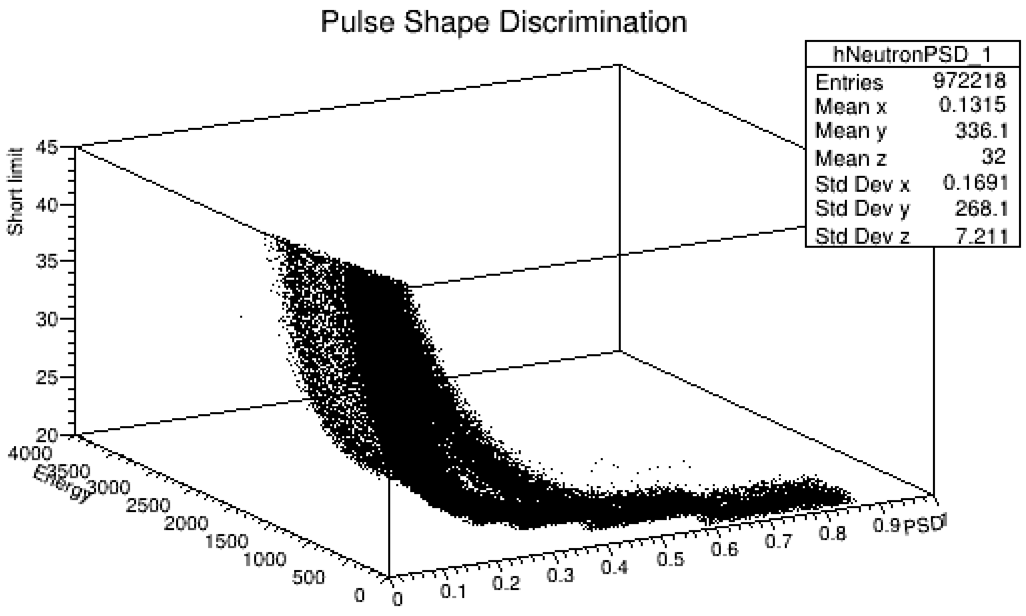


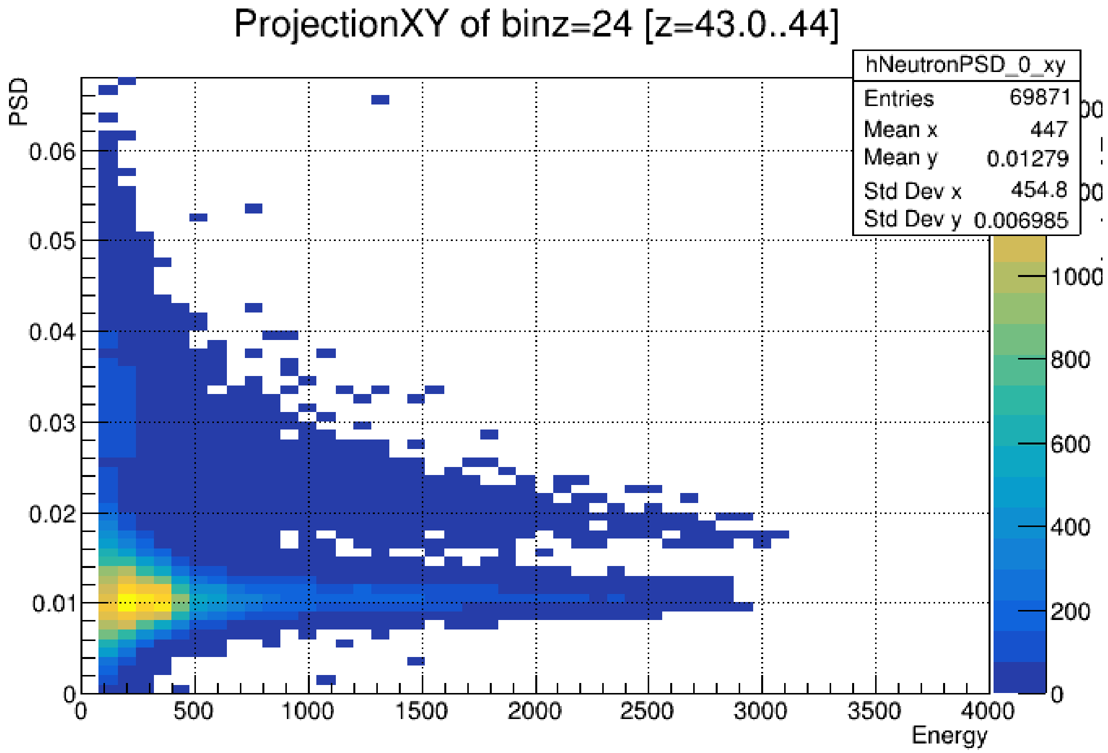




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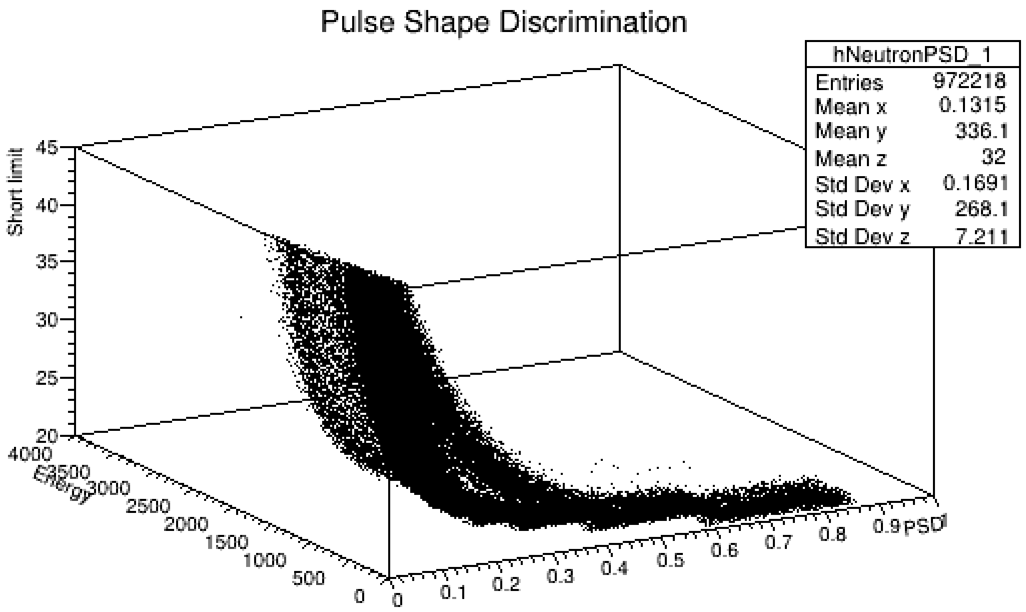


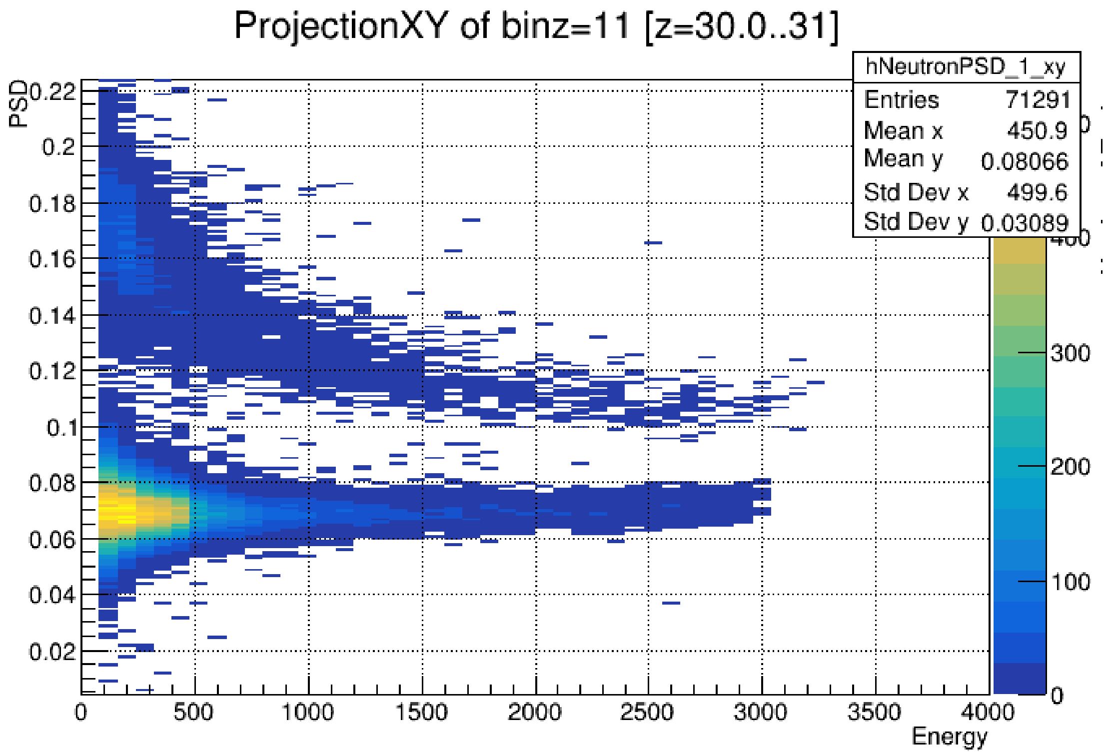




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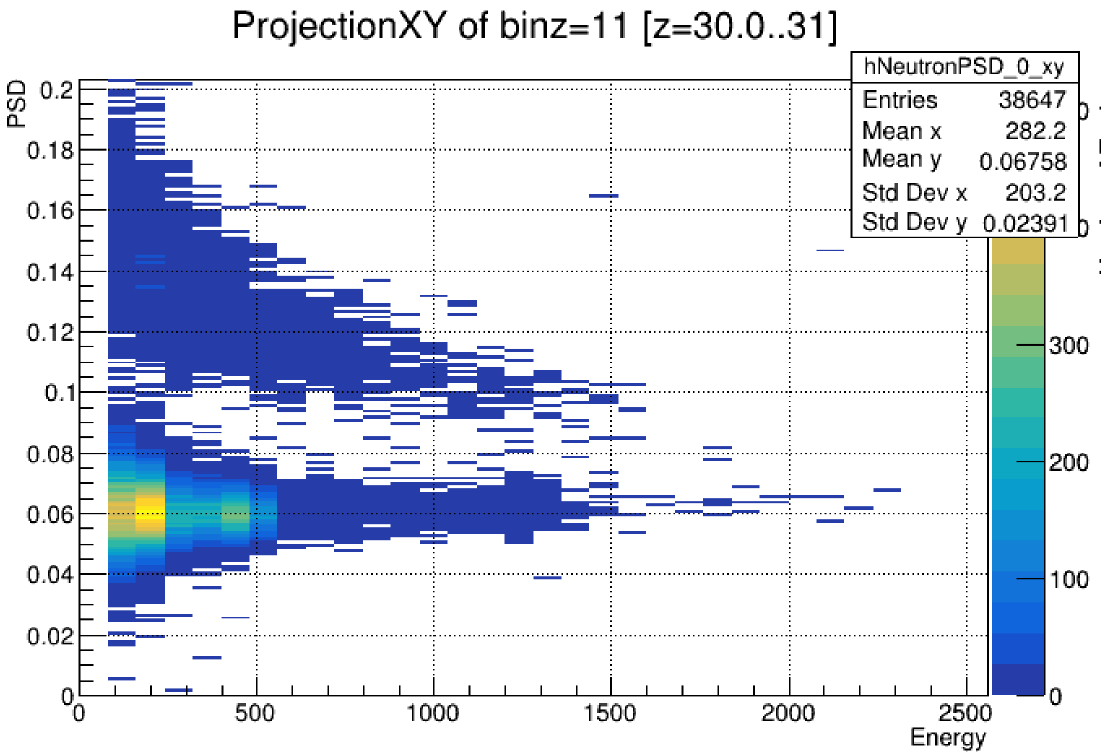
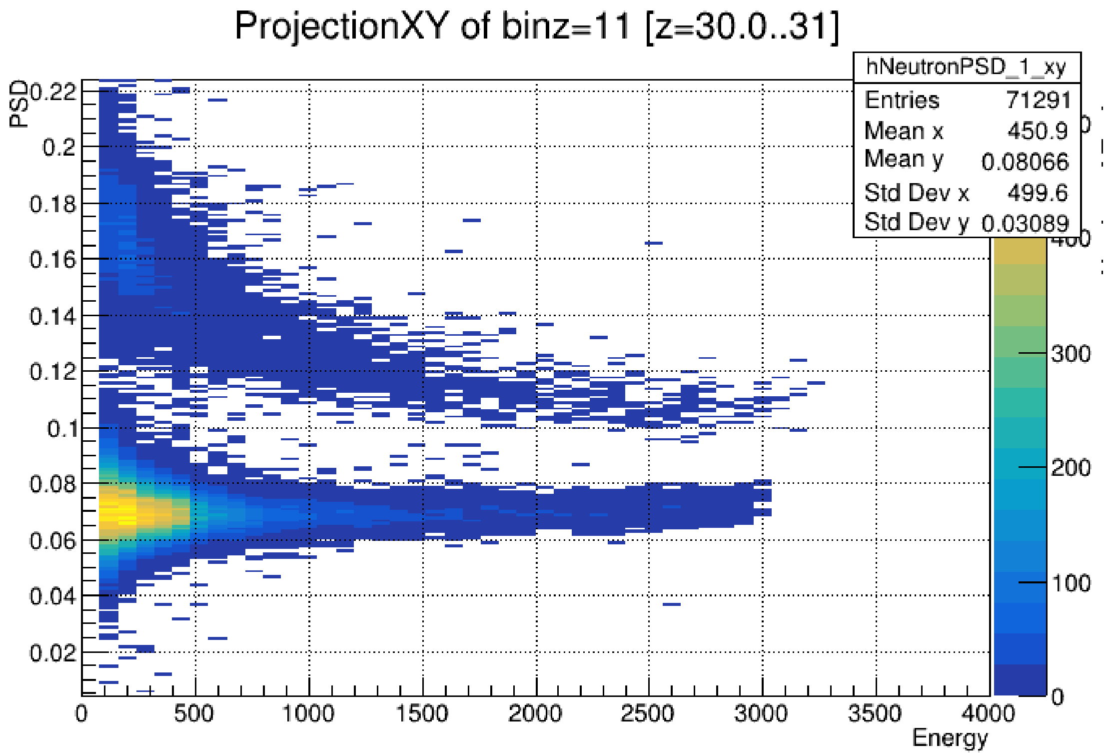
# Different runs




Calibration run




Beam on run



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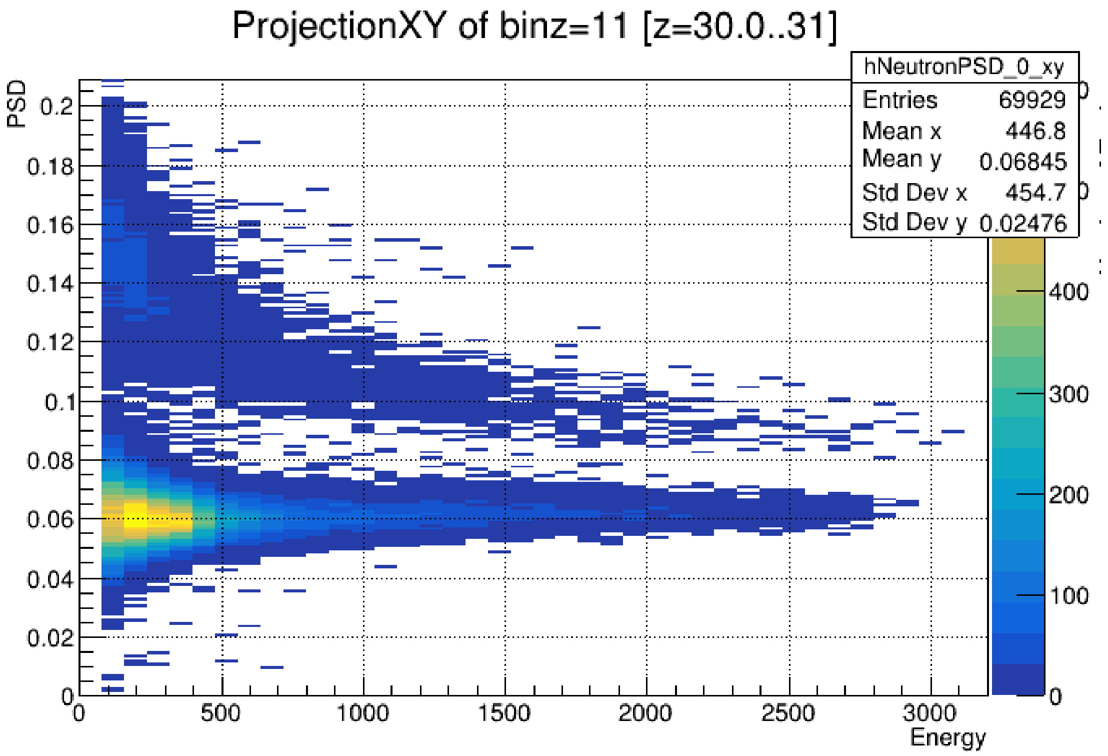
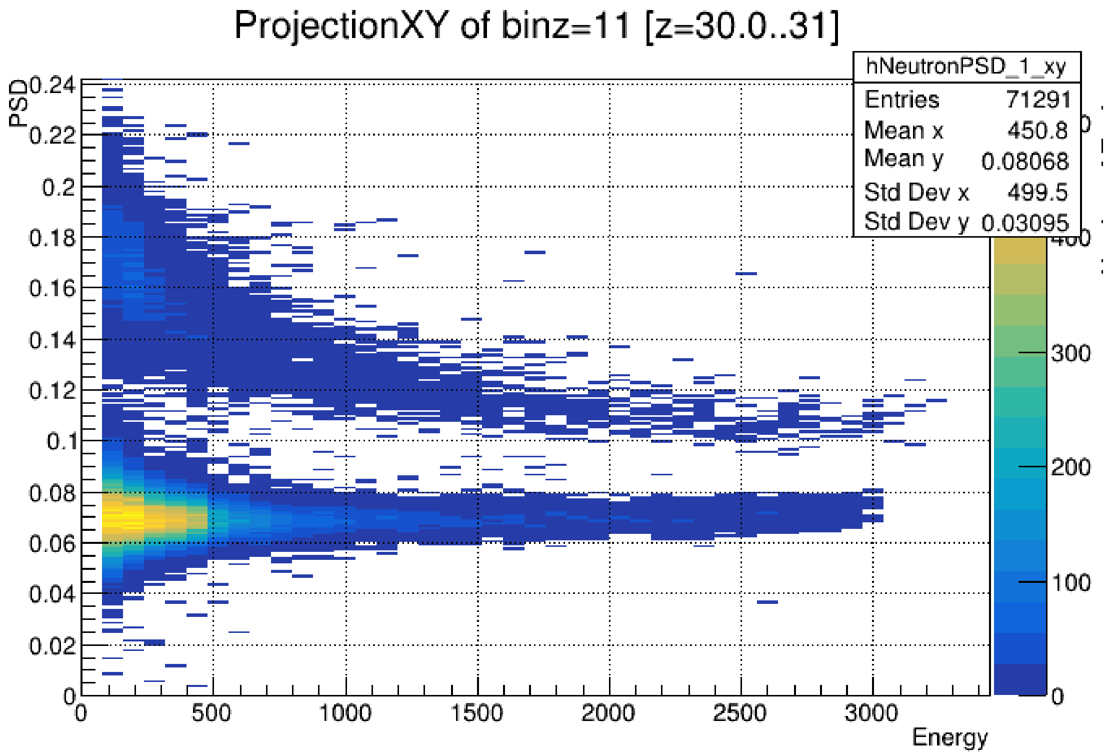
# Different detectors




Detector 0




Detector 1



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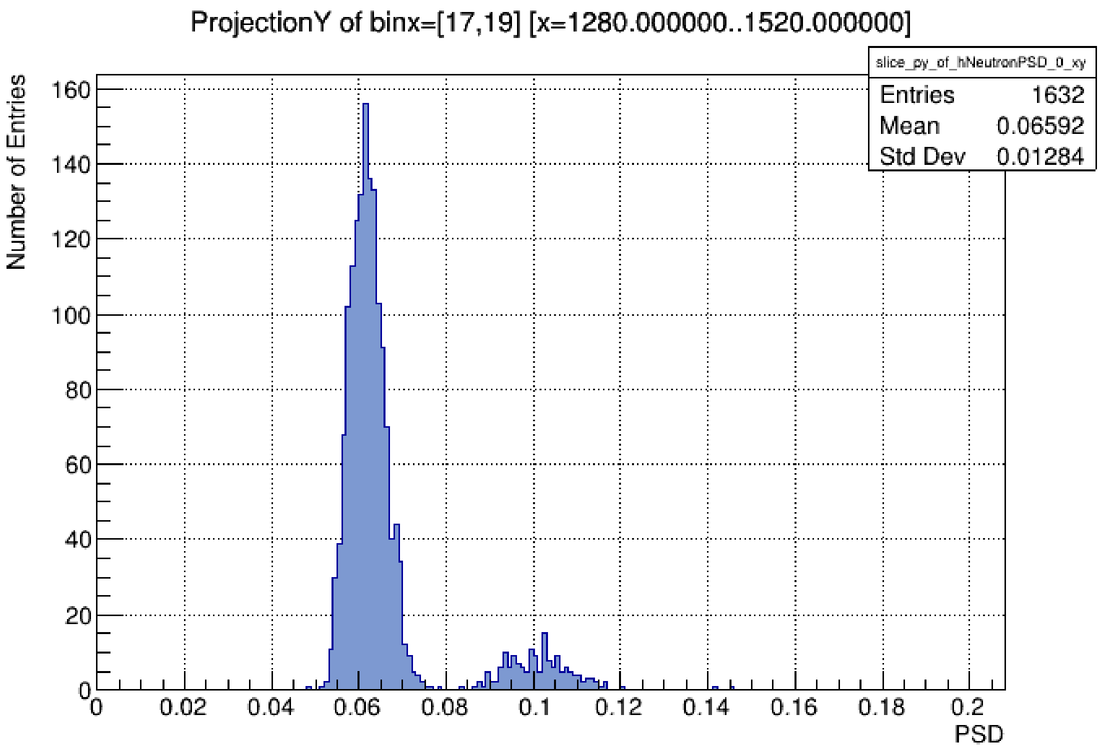
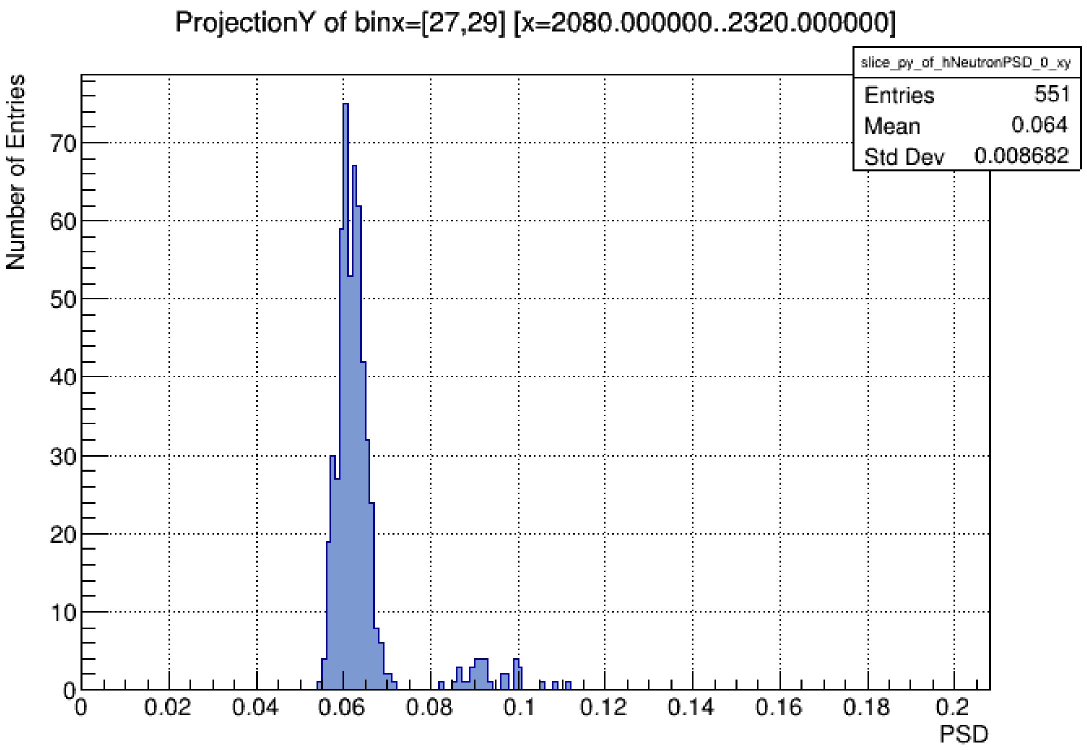
# 1D PSD Projection



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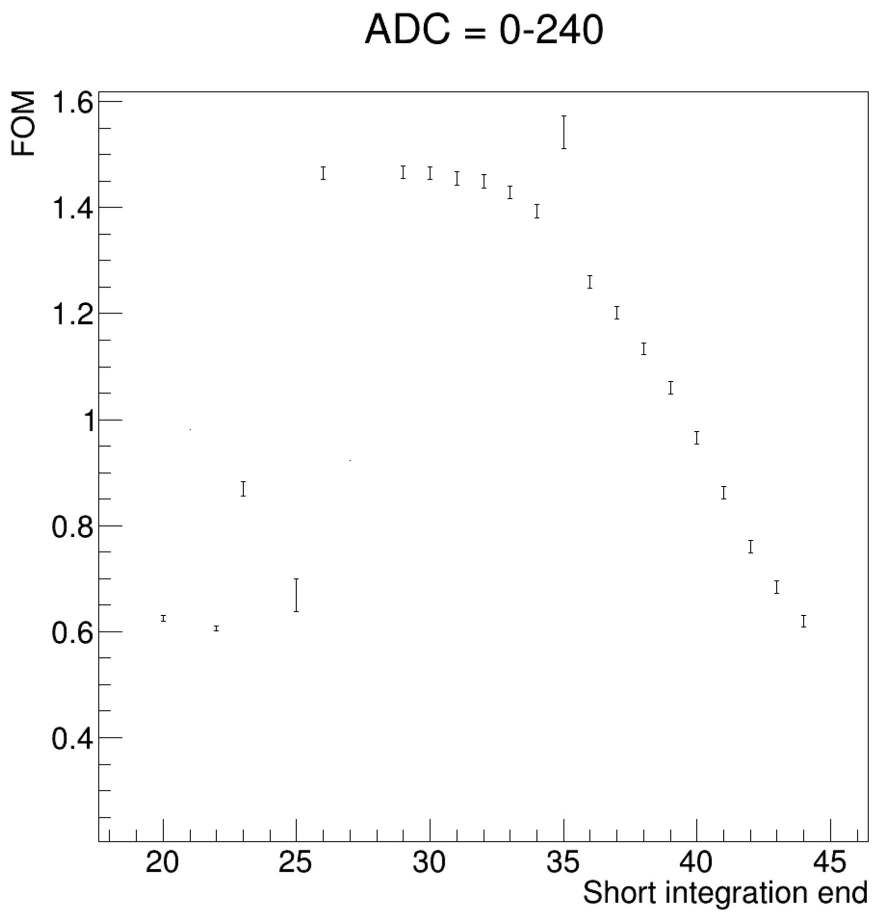
# Figure of Merit

- Short integration end: Ideal value shifts upwards as a function of energy
- As a function of energy: Generally higher optimal FOM at higher energy
- Fit is not always stable (low statistics, skewed/double peaks)





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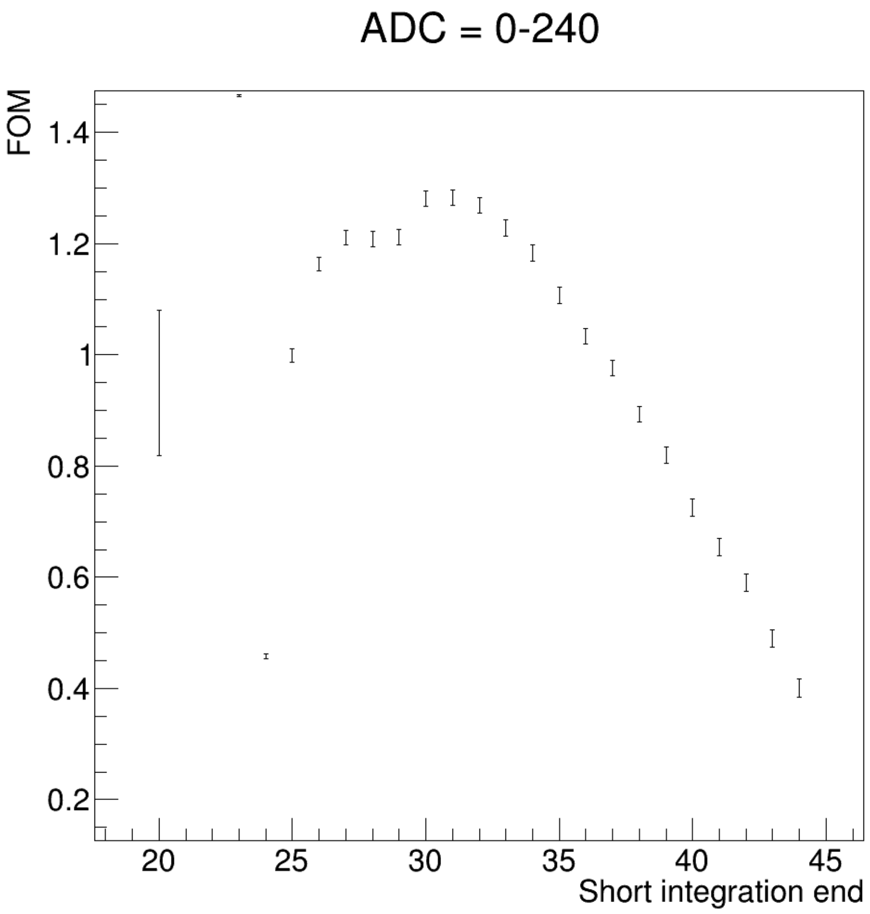
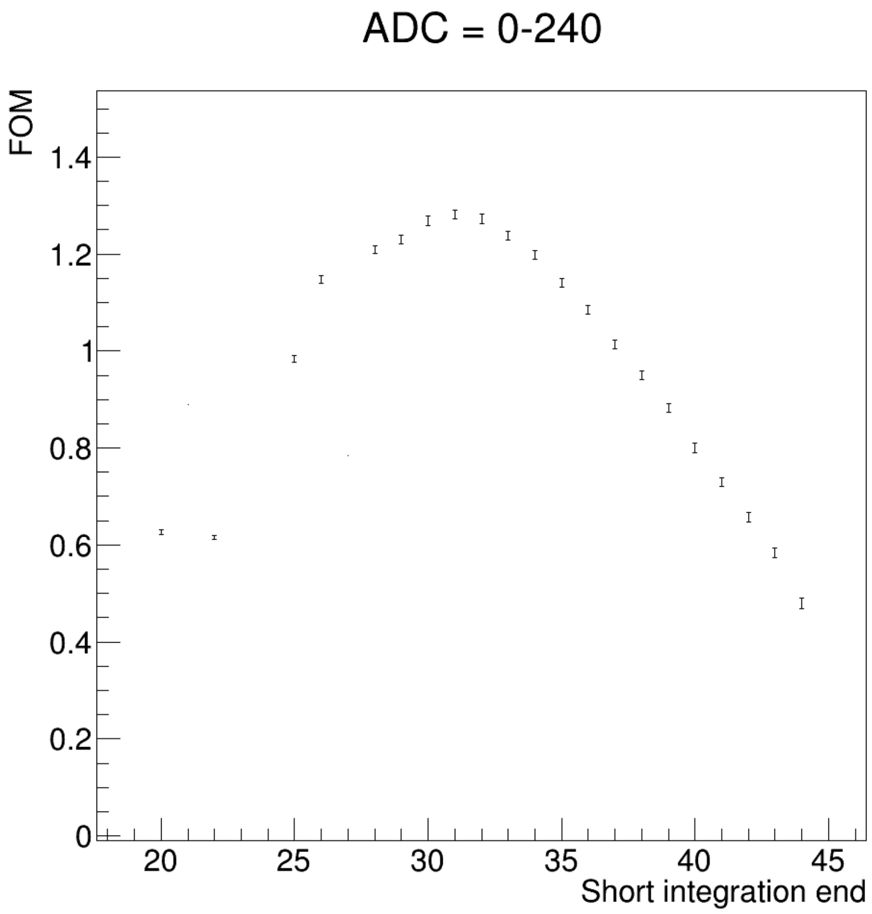
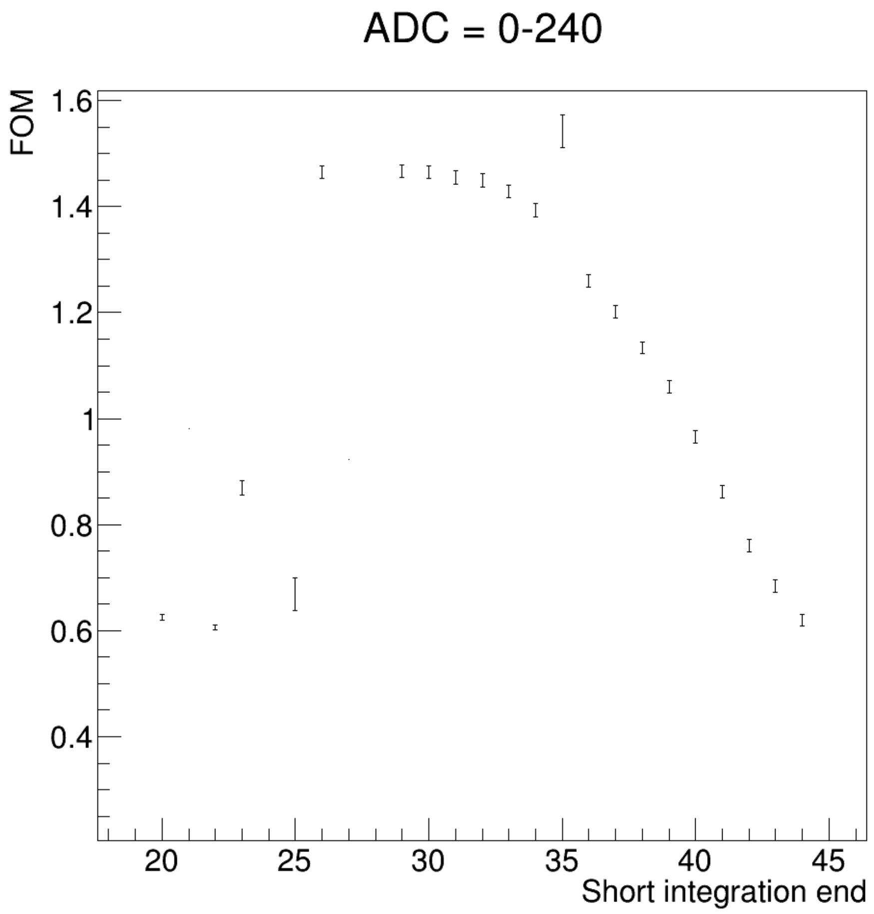
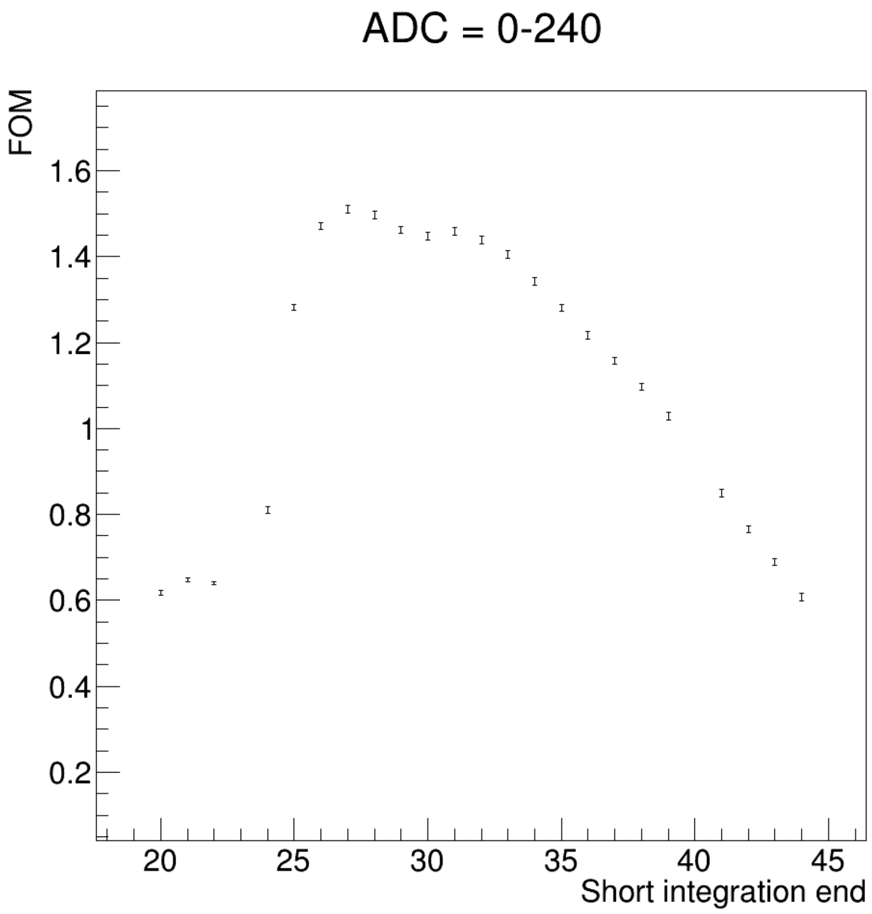
# FOM for detector 0



# FOM for detector 1



# Bayesian probabilities

- $N =$ being a neutron
- $\overline{N} =$ not being a neutron (roughly the same as being a photon)
- $\gamma =$ being a photon
- $f =$ being a flag

- $P(N|f) \approx \frac{P(f|N)}{P(f|\gamma)}\left(\frac{P(f|\gamma)}{P(f)} - 1\right)\left(1 + \frac{P(f|N)}{P(f|\gamma)}\right)^{-1}$
- $P(f|\gamma)$ from run with only photons
- $P(f|N)$ from run with only neutrons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# What's next?

- Choose best integration window: fixed or varying?
- Set Energy box (or several)
- Make NeutronCandidate Flag
- Perform calibration based on Compton edges



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