VD Coldbox data
(04.2024)

Vitaliy Popov, Aviv Ben Porat, Erez O. Cohen, Adi Ashkenazi
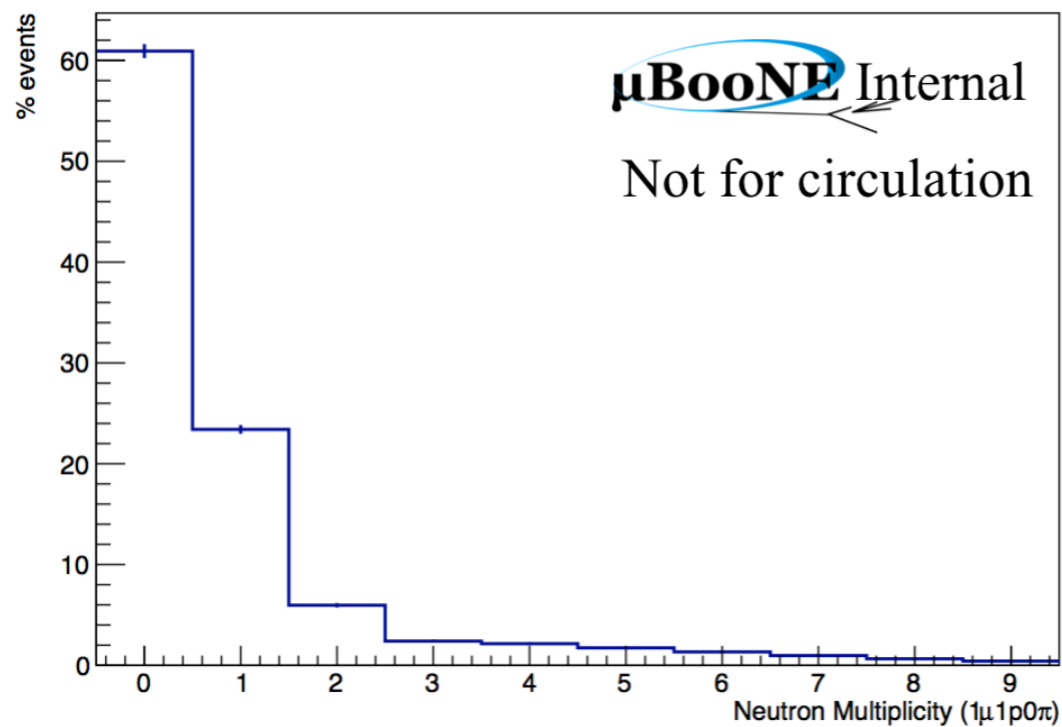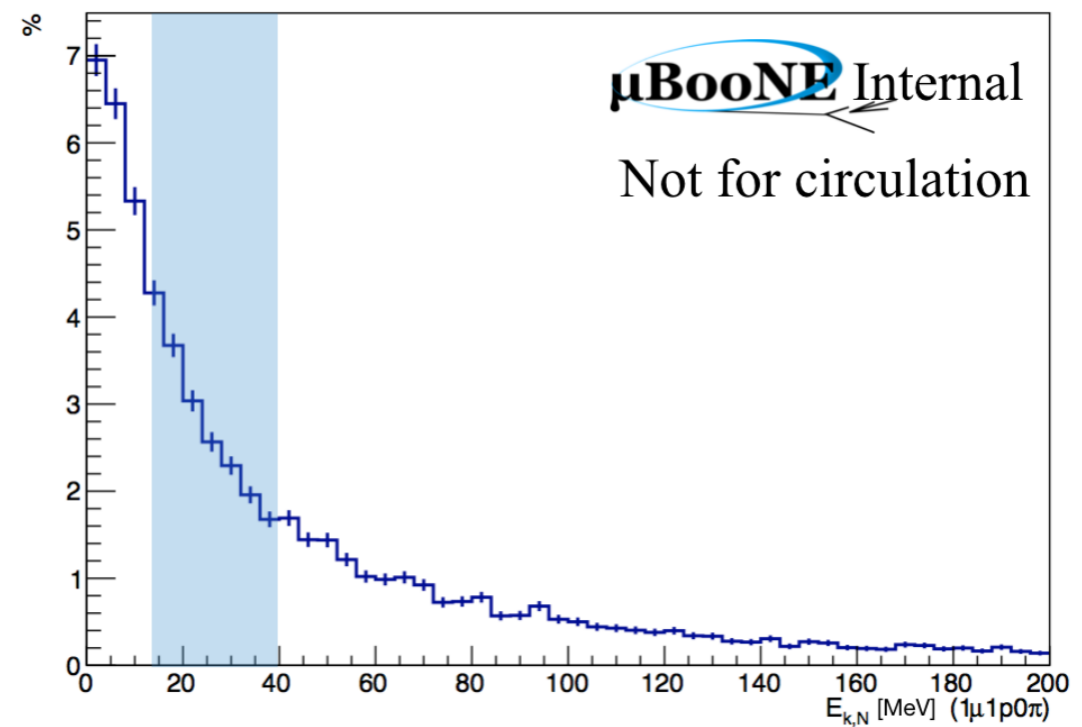
vitaliy.w.popov@gmail.com

Motivation

Insufficient knowledge of the energy carried by <u>undetected particles</u> emerging from these interactions, such as neutrons, can skew the reconstructed neutrino energy spectrum and bias the extraction of oscillation parameters, and searches for new physics.

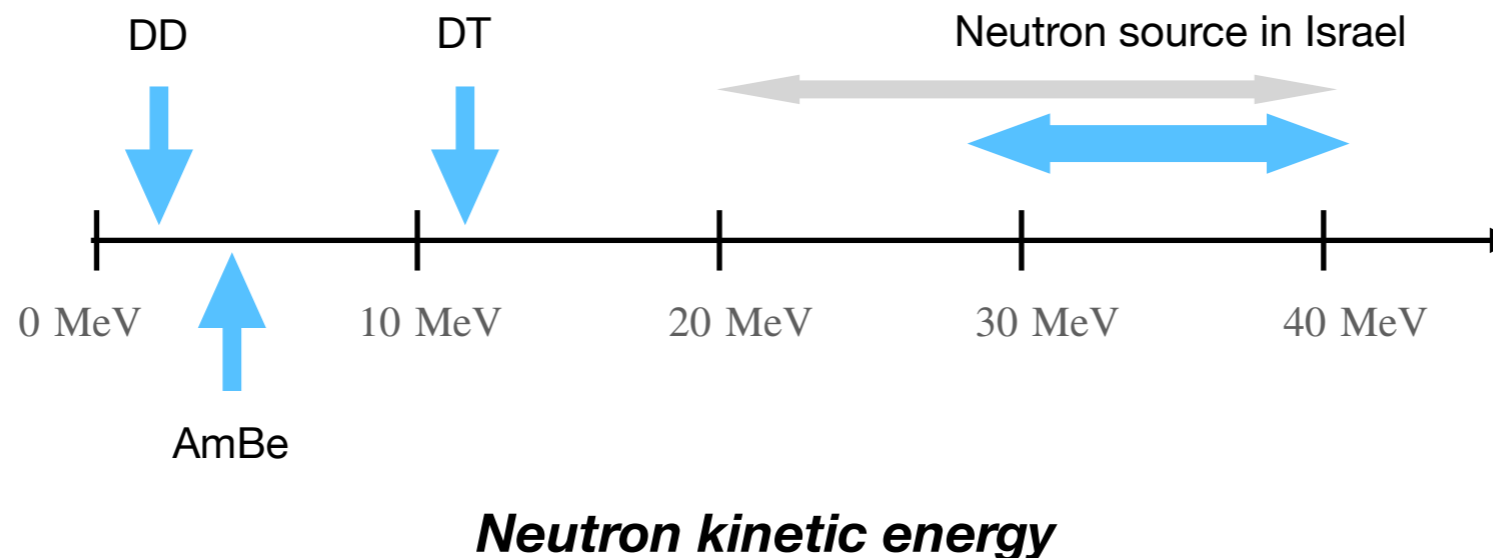Neutron multiplicity   Neutron kinetic energy

Studies show that ~40% of QE events have at least one neutron.

Potential measurements

Our group targeting neutron reconstruction for various energies:
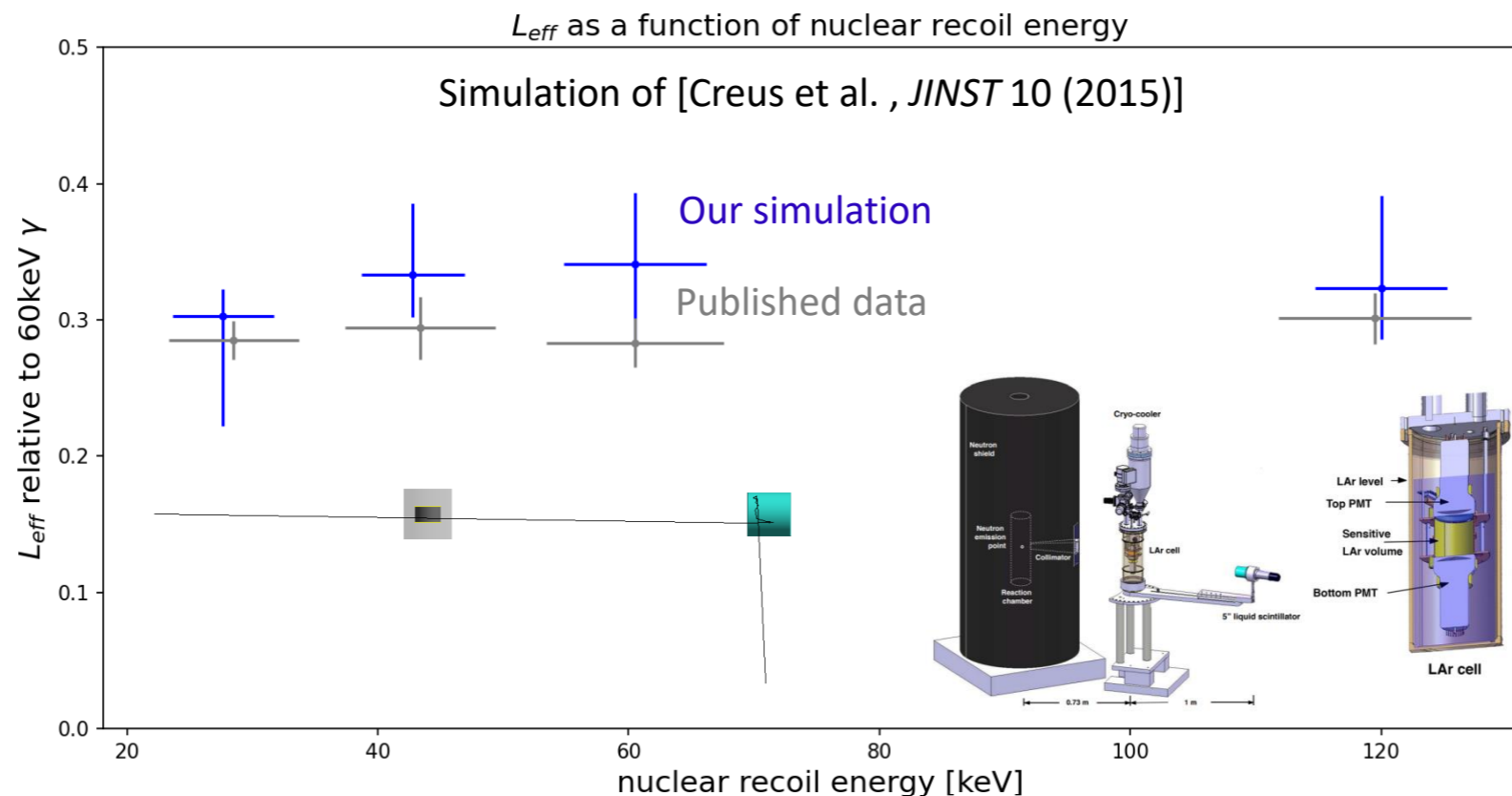

Neutron kinetic energy

- Runs with DD generator (2.5 MeV) done in LAr cells (see for example *JINST 10 (2015) 08, P08002*). Also some data available for protoDUNE;

- There is DT (~14 MeV) generator operating in Israel;

- Future neutron source in Israel will be able to deliver monochromatic beam of neutrons with energies ~30..40 MeV. Also wider energies will be available in mixed-energies beams.

Simulation

Aviv Ben Porat, Erez Cohen

GEANT4 based simulation to better understand n-Ar interaction for variety of possible energies.

L_{eff} as a function of nuclear recoil energy

Simulation of [Creus et al. , *JINST* 10 (2015)]

Our simulation

Published data

L_{eff} relative to 60keV γ

nuclear recoil energy [keV]

And another important task for the simulation is estimation of the required light coverage.

Simple estimation:

Ar takes 1/40 from the energy of the *n*, hence 2.2 MeV neutron will give 50 KeV *Ar* recoil; nuclear quenching argon recoil will give 10 times less, which gives 5 KeV;

Would be nice light coverage of at least 10 photoelectron /5 KeV meaning: 2000 photoelectron/ MeV
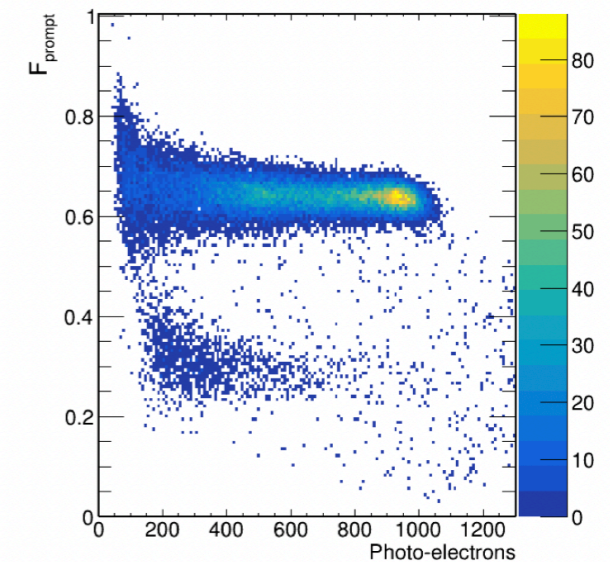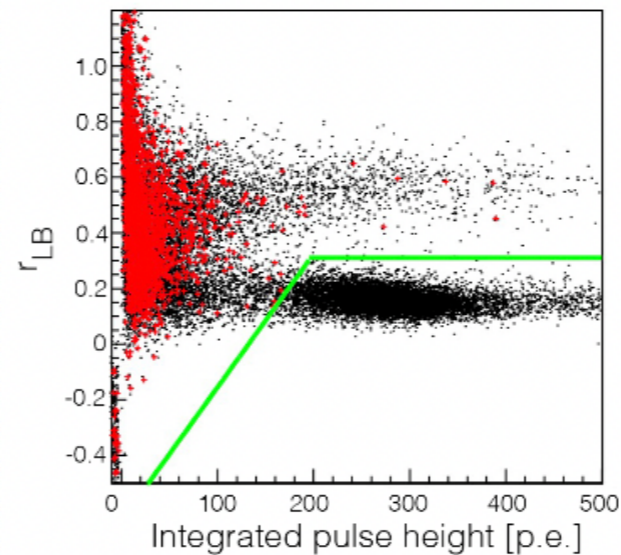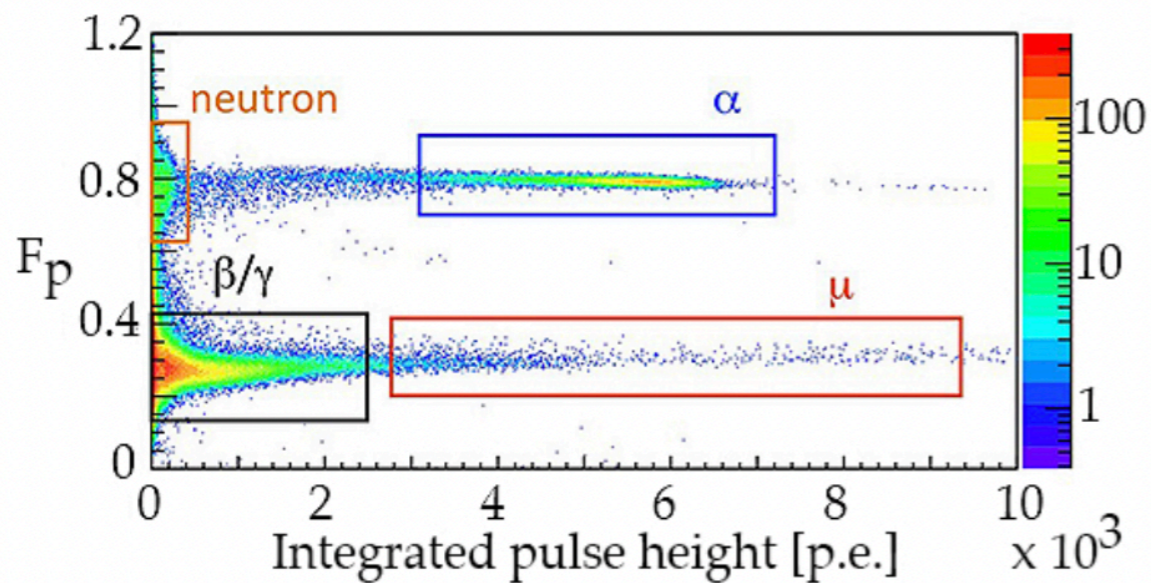
Data analysis

Main goal: Neutrons identification in DUNE with light Pulse Shape Discrimination (PSD) technique.

[*JINST 10 (2015) 08, P08002*]
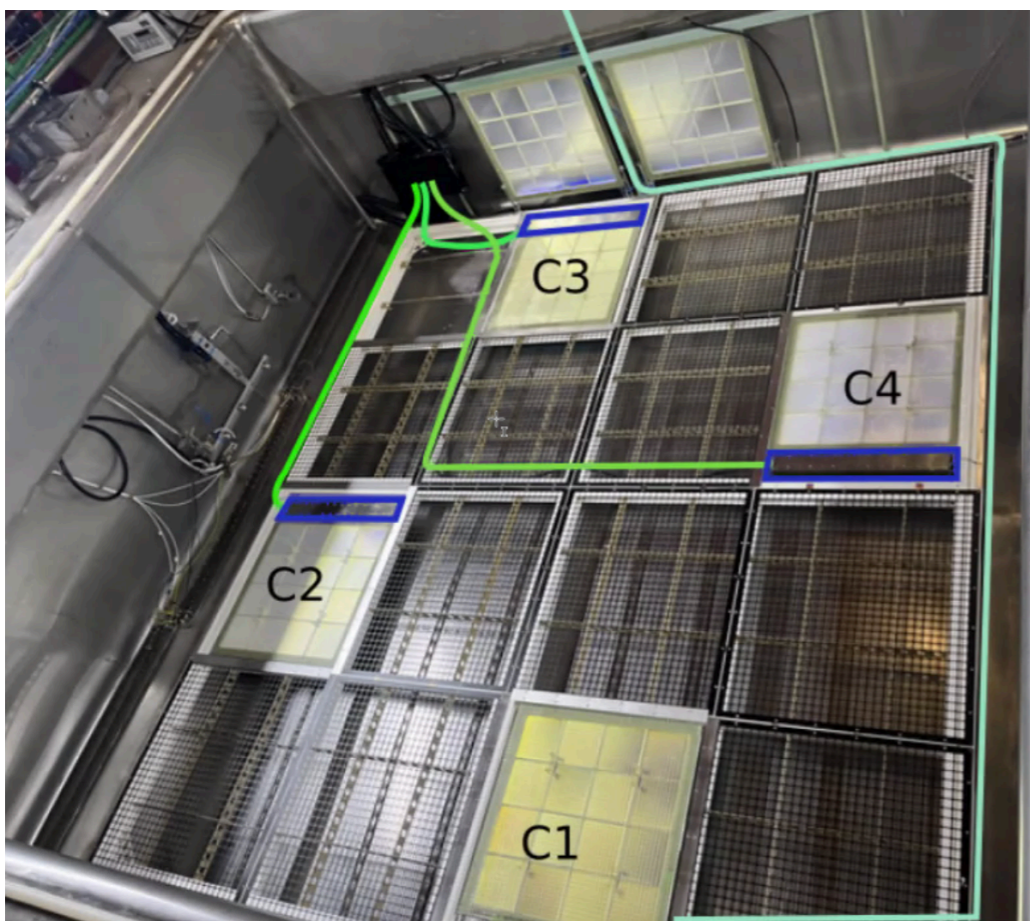[Phys. Rev. B **27**, 5279]
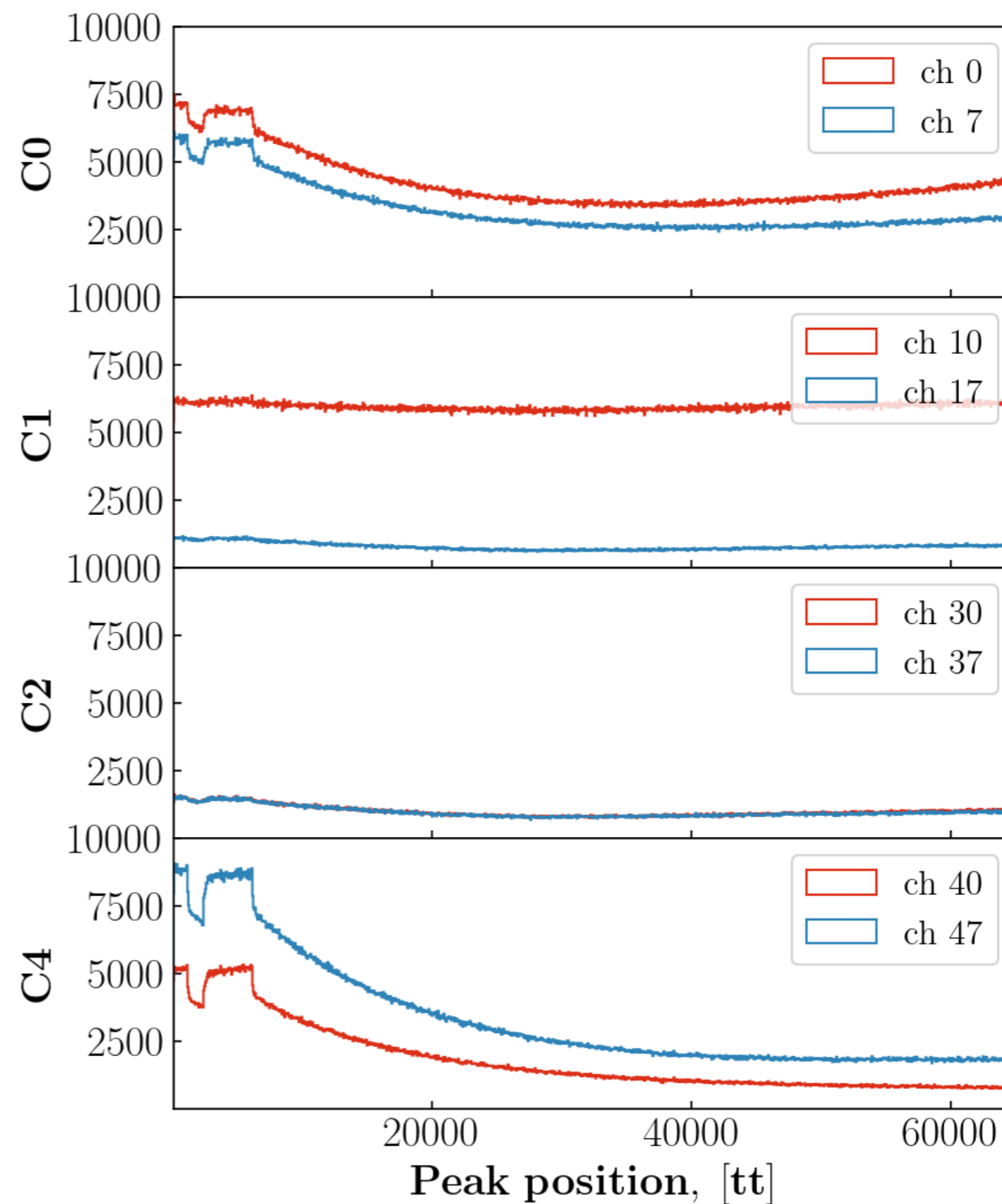[*JINST* 16 (2021) 09, P09027]

While neutrons are our main goal we are interested in studying PDS response to various particles in protoDUNE environment.
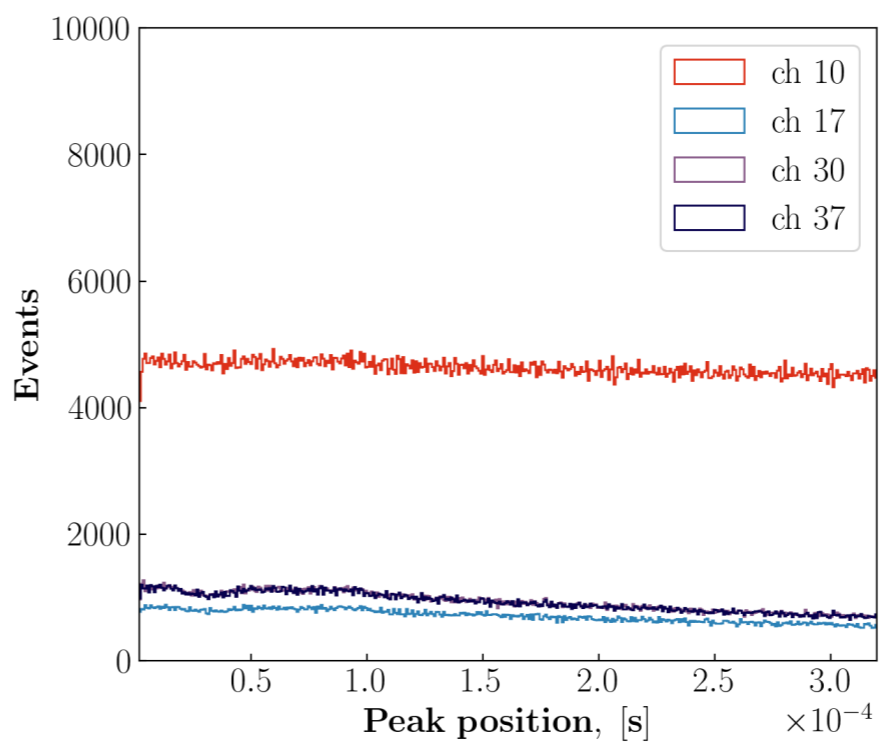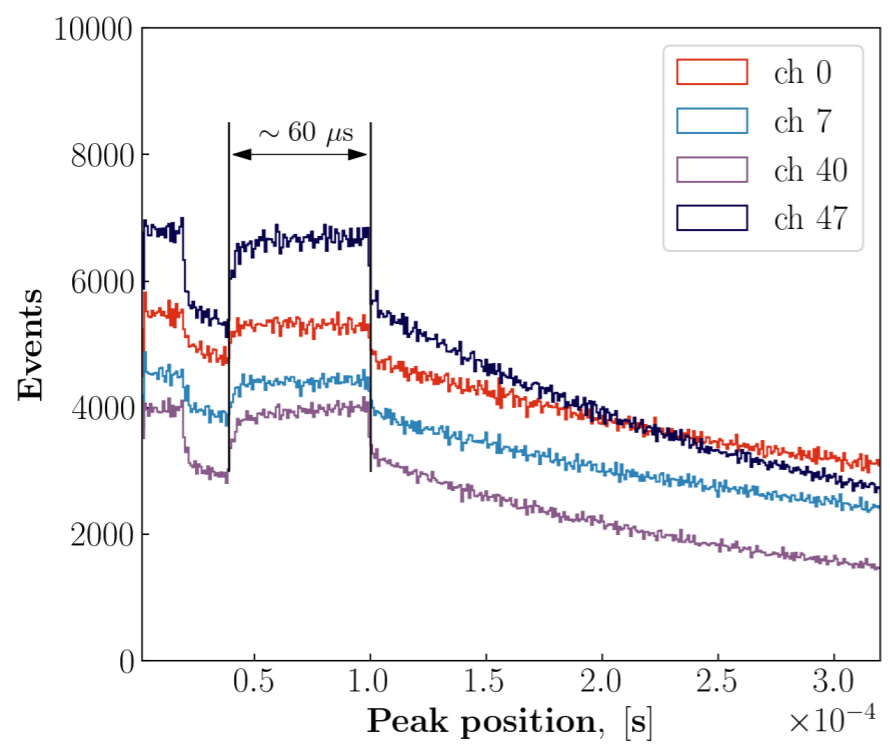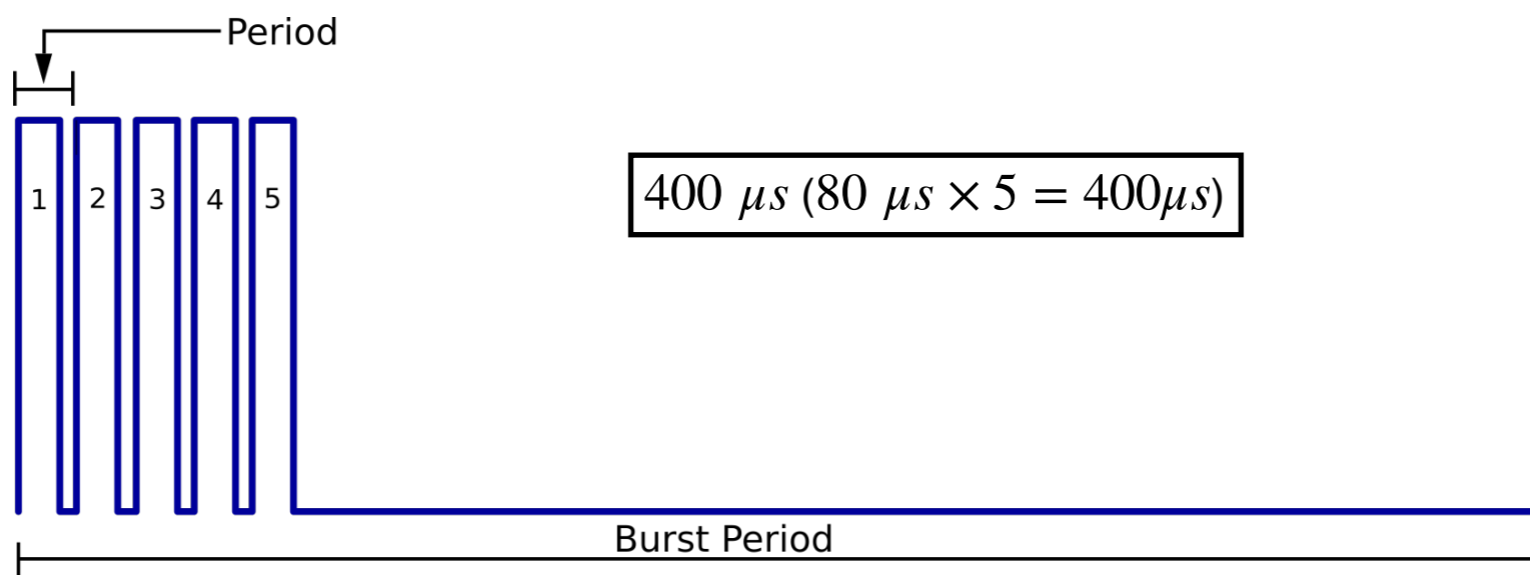
Data analysis

Run 25080

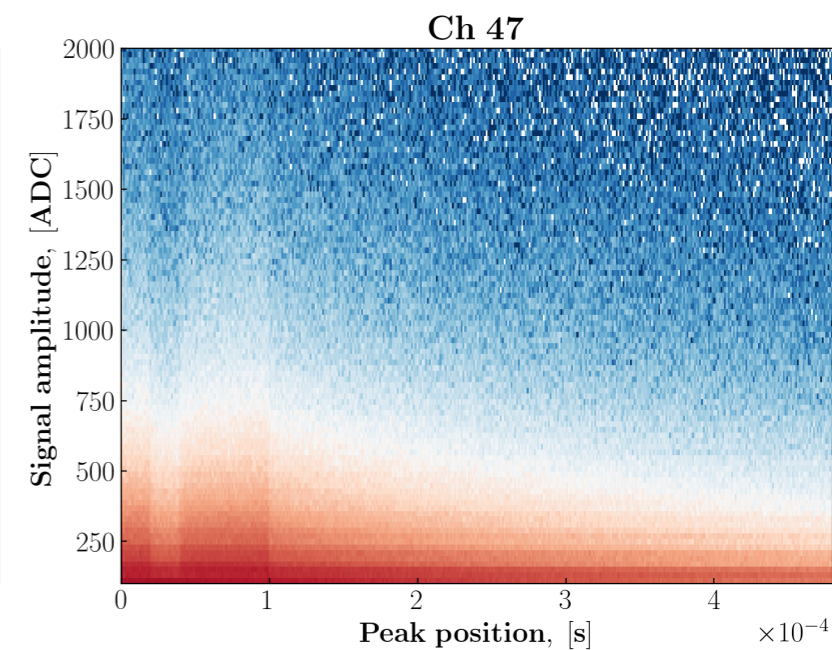# Neutron source pulse shape

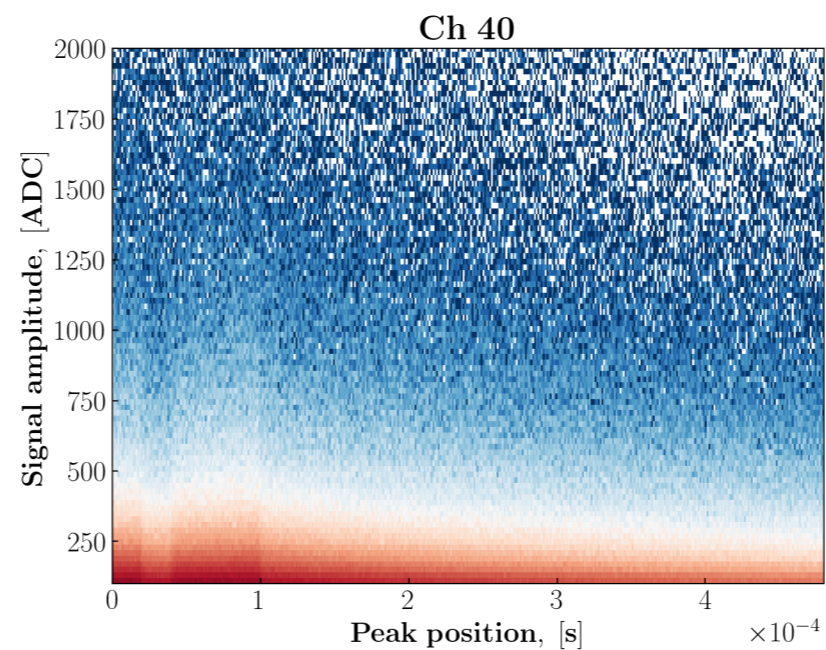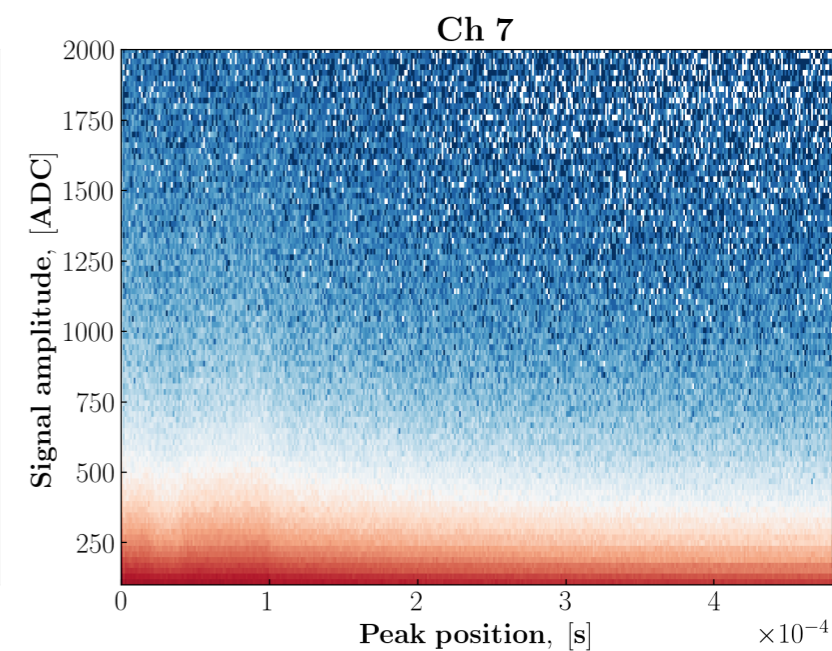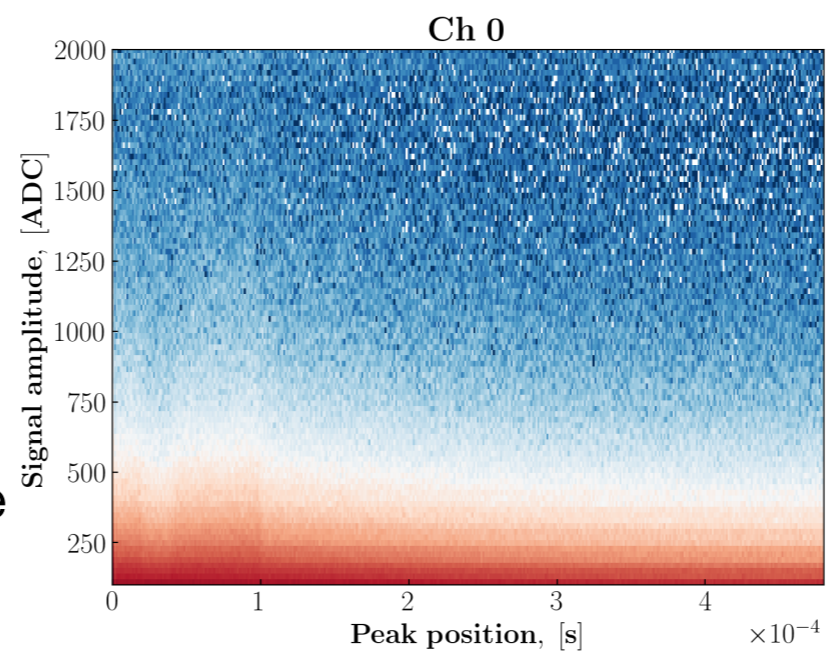$400\ \mu s\ (80\ \mu s \times 5 = 400 \mu s)$

$(60 + 20)\mu s$ observed

Data analysis

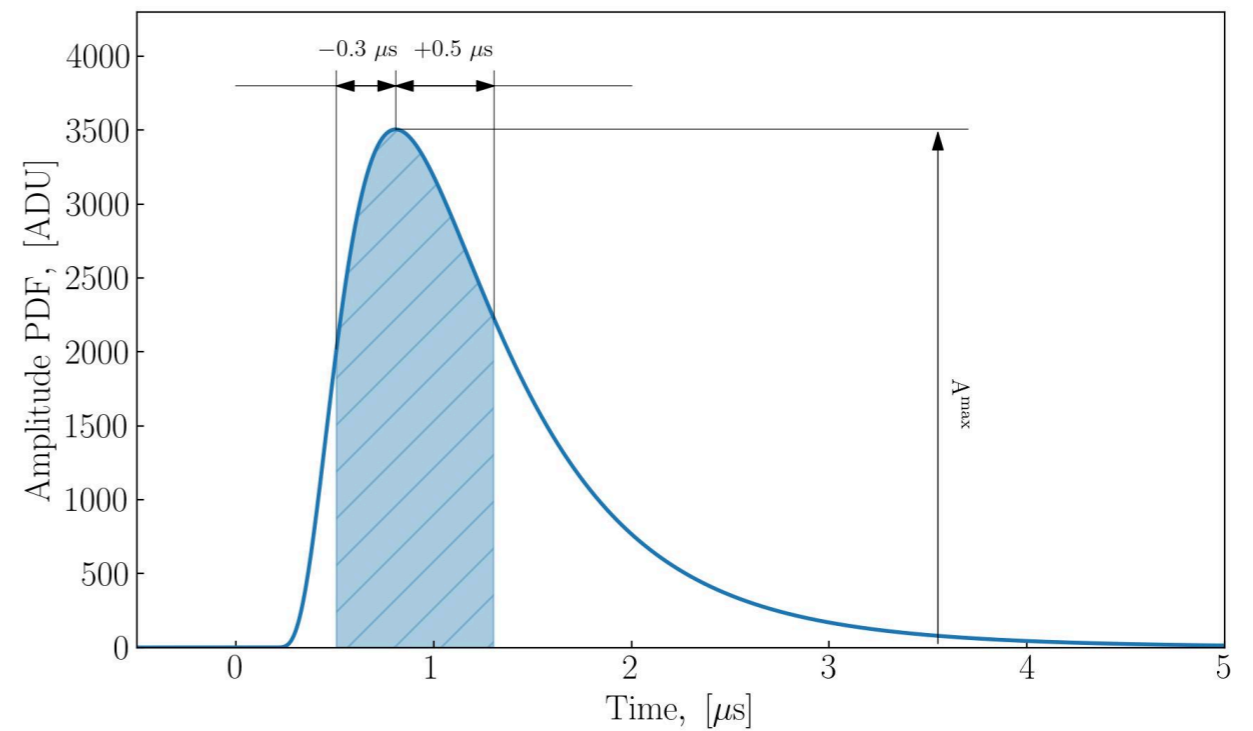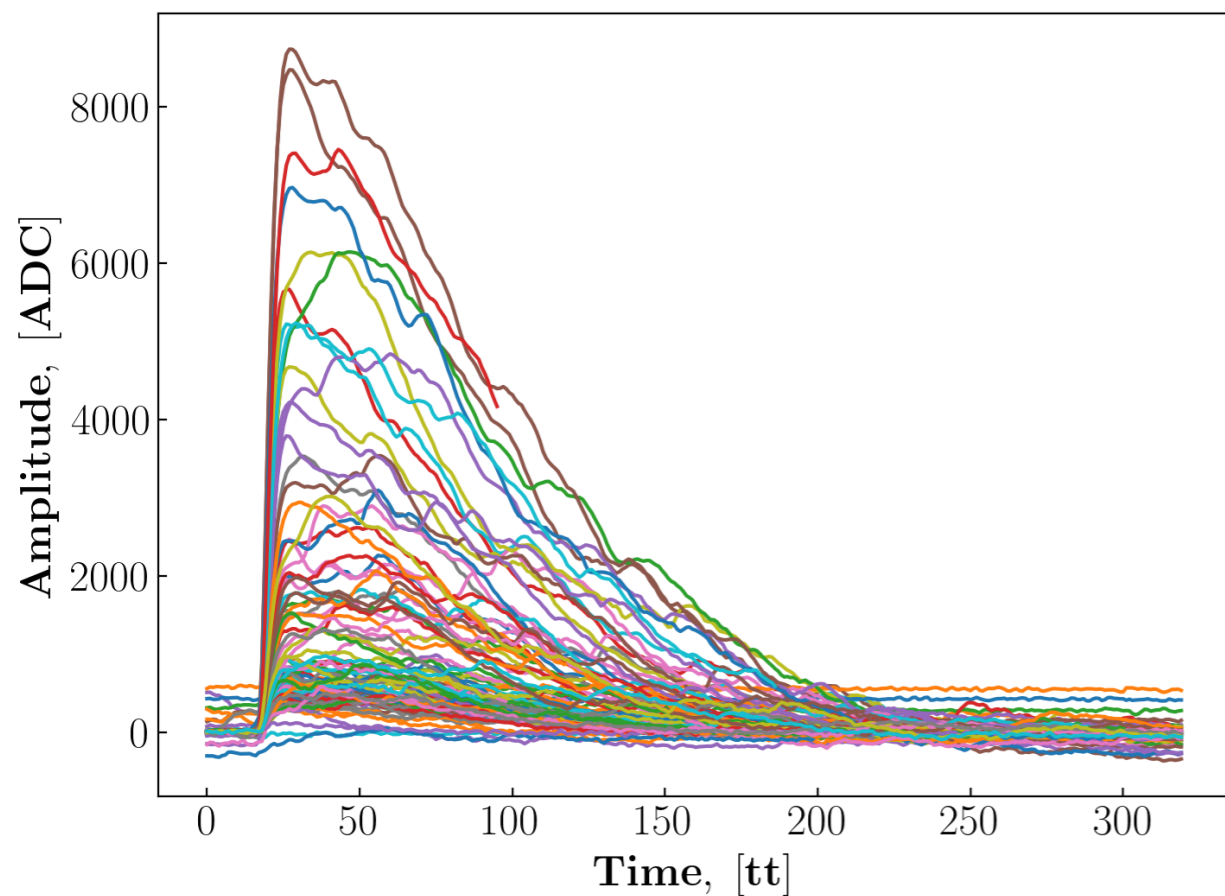At the peak position VS peak amplitude plot DD pulse also could clearly be seen;

PNS data:pulse shape discrimination

Prompt light fraction $- F'_p = \dfrac{\int_{t_{\max}-0.3}^{t_{\max}+0.5} A(t)dt}{\int_{t_0}^{t} A(t)dt};$

Full run 25036. Waveforms are pedestal subtracted and aligned by the rising edge.

Data analysis

For the selected time window one could expect the vast of the waveforms would be of neutron-Ar origin.

However with the current setup at the VD Coldbox no pulse shape difference to cosmic signal observed.