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COHERENT experiment: CsI detector

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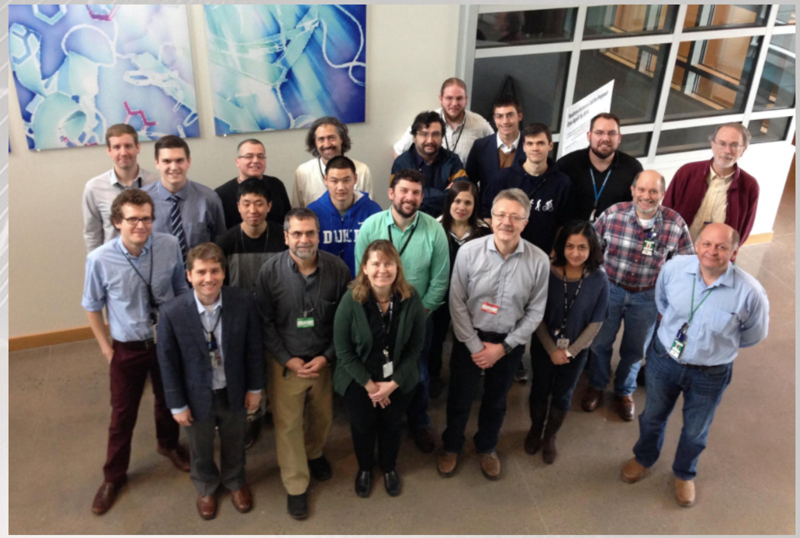
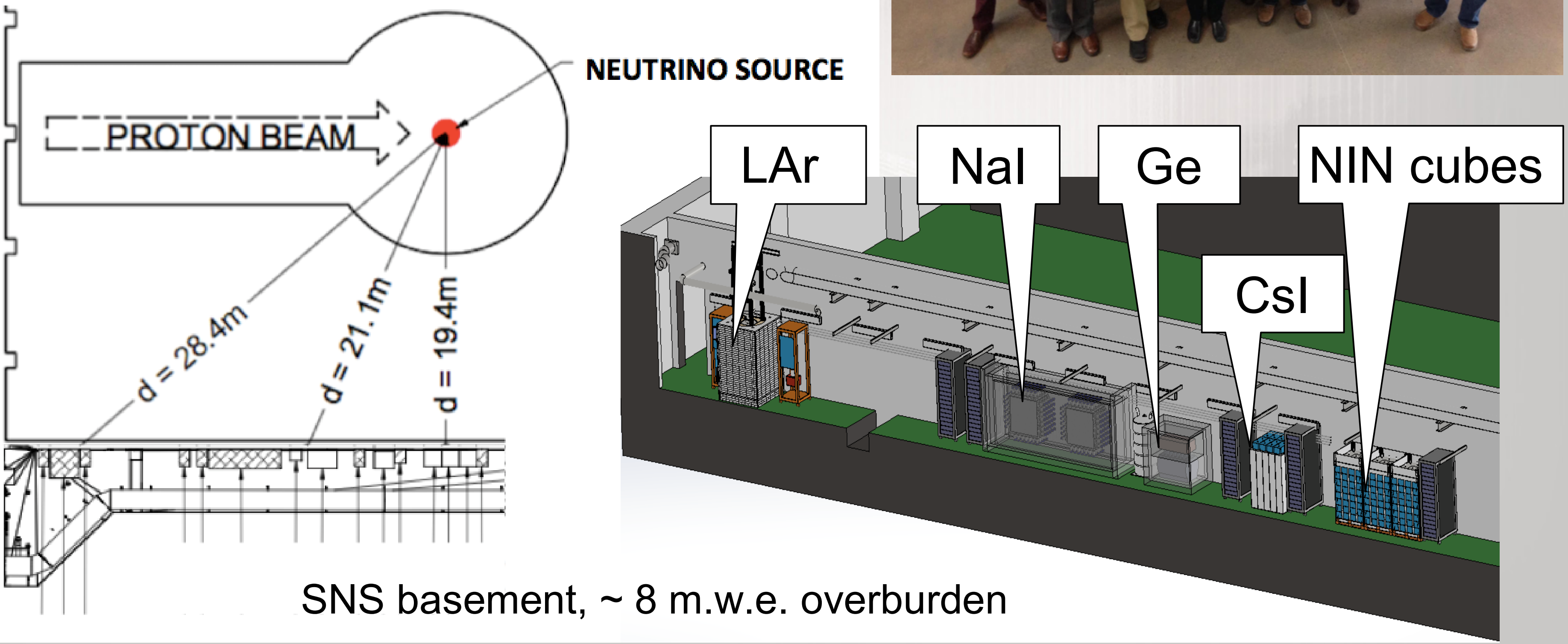
on behalf of

Outline

1. COHERENT detectors: location at SNS
2. CsI detector shielding and veto
3. Data taking and analysis strategy
4. Signal/background
5. Calibration and QF measurements

CsI [Na] detector location





SNS basement, ~ 8 m.w.e. overburden

Looking for CEvNS – coherent elastic neutrino-nucleus scattering

Crystal parameters and shield design

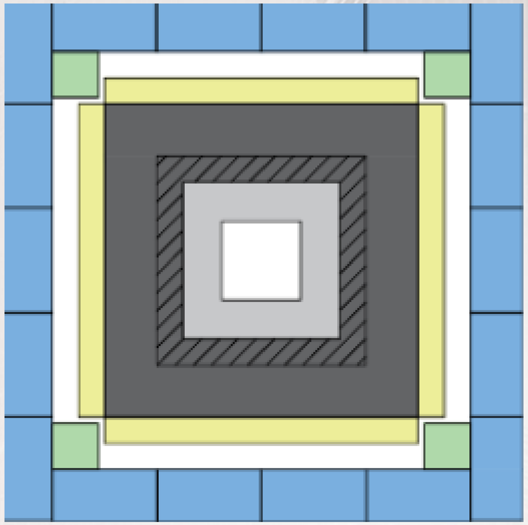
The set up was developed at the University of Chicago

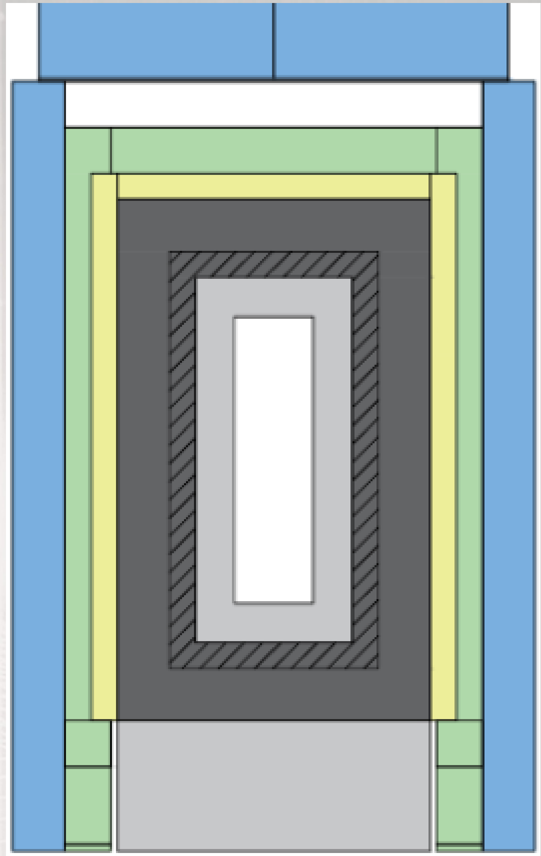
CsI[Na] cylindrical crystal manufactured by Amcrys-H, Ukraine:

- diameter: 11 cm,
- length: 34 cm,
- weight: 14.5 kg

  +

- R877-100 PMT





Shielding design

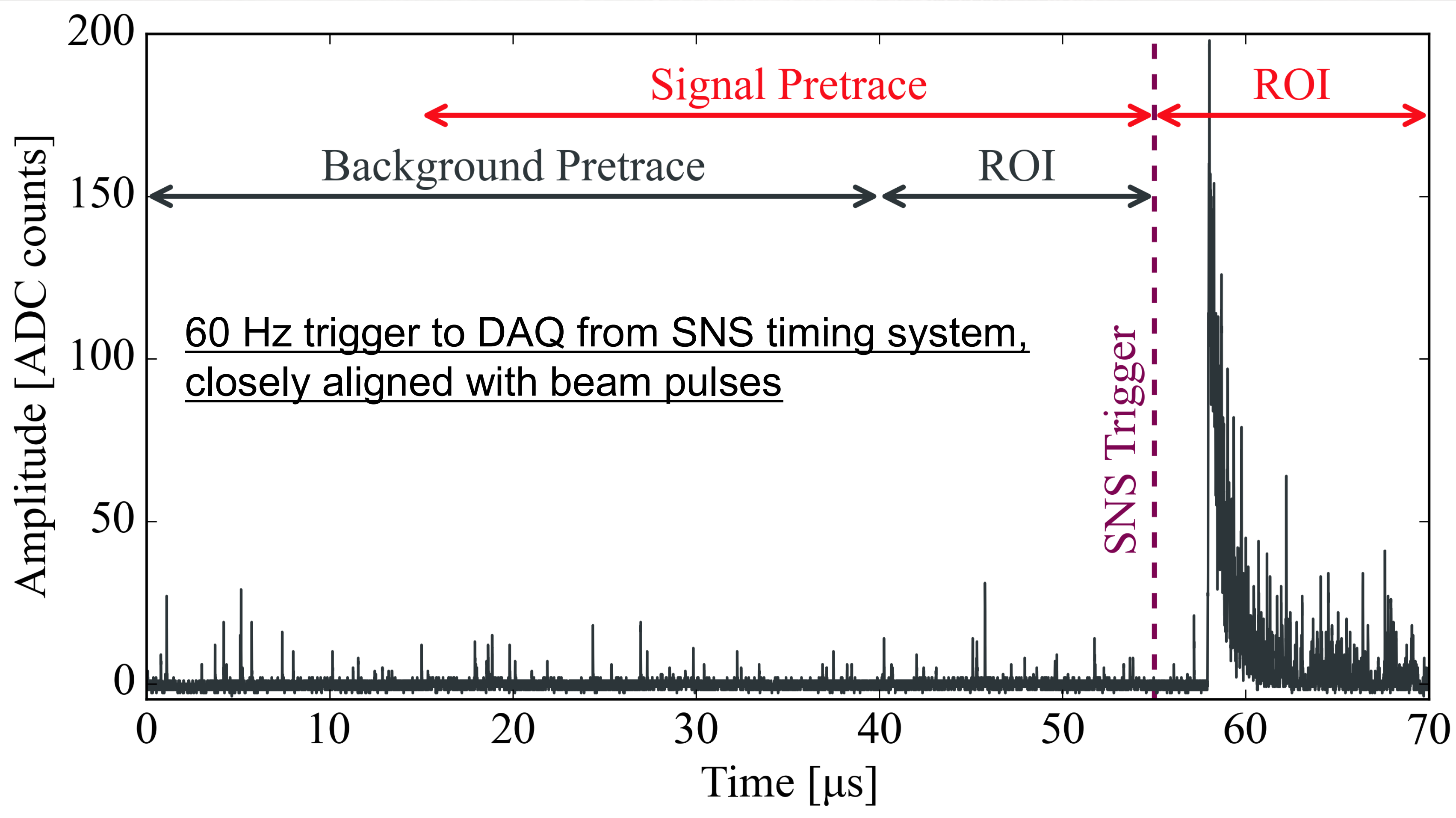
Layer	HDPE*	Low backg. lead	Lead	Muon veto	Water
Thickness	3''	2''	4''	2''	4''
Colour					

* - high density polyethylene

Shield assembling

Data taking and analysis strategy

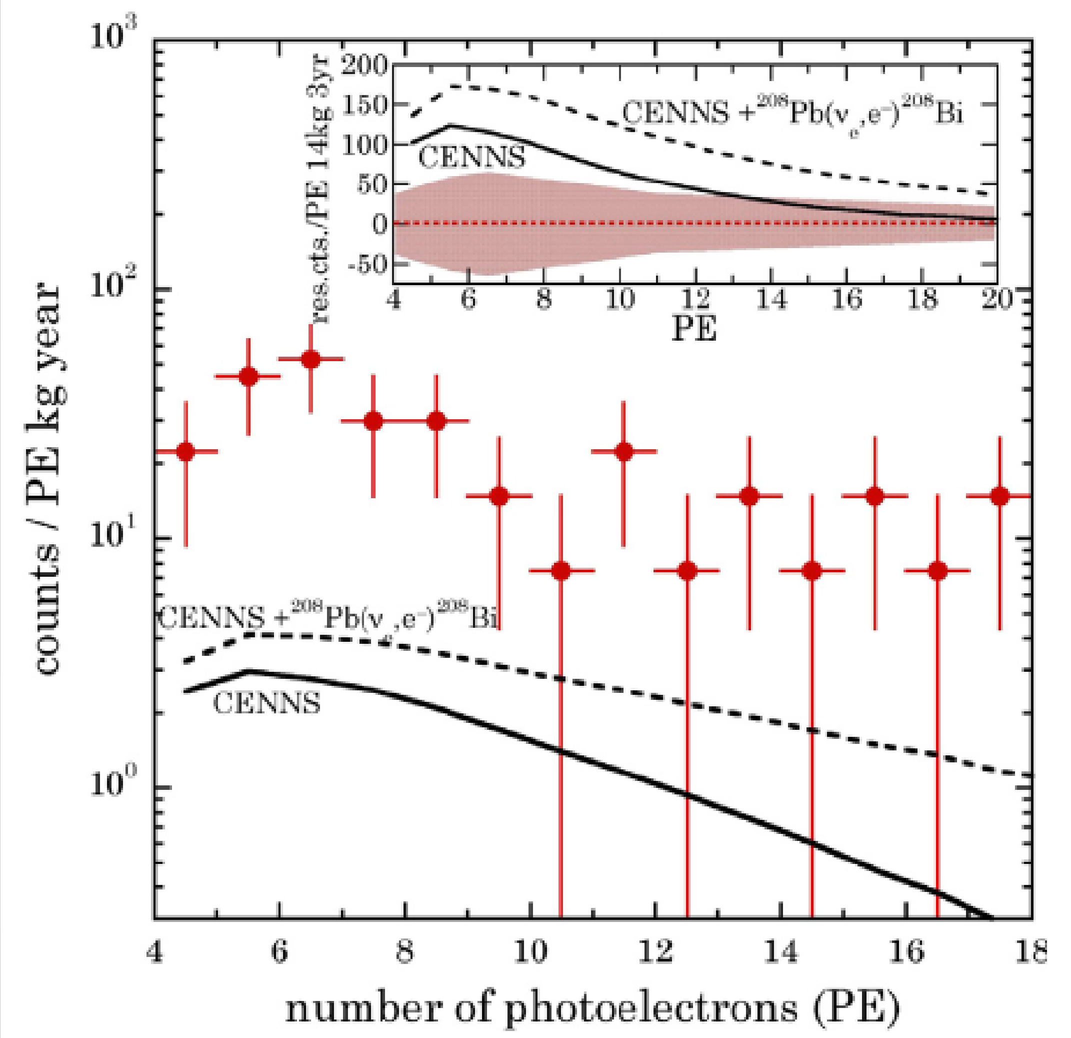
Recording of 70 µs waveforms with 500 MHz sampling of CsI and veto channels



ROI (After trigger) – ROI (Before trigger) =

CEvNS + Beam correlated background + Fluctuations of the steady background

Signal/background



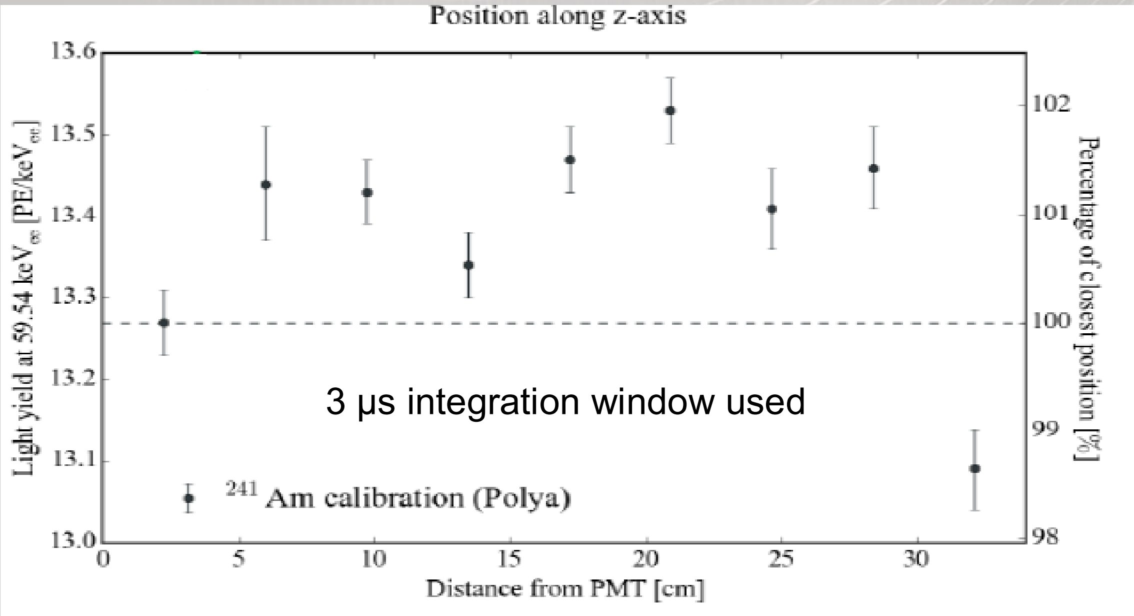
• the steady state background at the SNS is by a factor of 5-10 smaller than the measurement performed at the University of Chicago laboratory (~6 m.w.e. overburden, almost similar shielding)

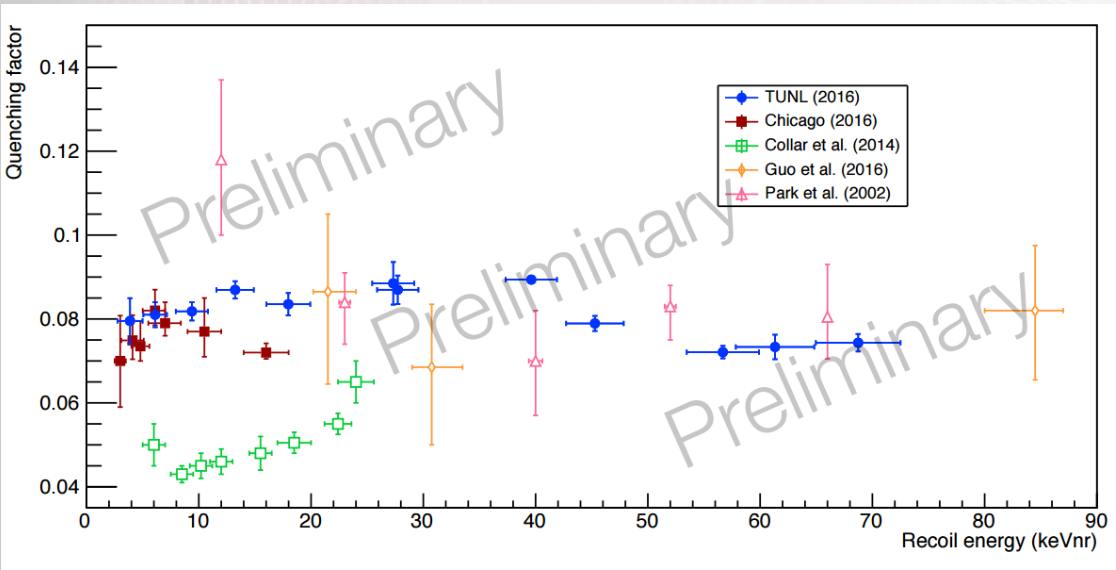
• the quenching factor has been remeasured indicating non-trivial increase in expected signal yield (TUNL and University of Chicago measurements)

• expected neutrino induced neutron background rate is ~4% of the CEvNS signal due to HDPE

J.I. Collar et al., "Coherent neutrino-nucleus scattering detection with a CsI[Na] scintillator at the SNS spallation source", NIM, 2015

^{241}Am calibration and QF





^{241}Am calibration, 59.54 keV

- photoelectrons → keVee
- the light yield shows <~2% deviation along the length of a crystal

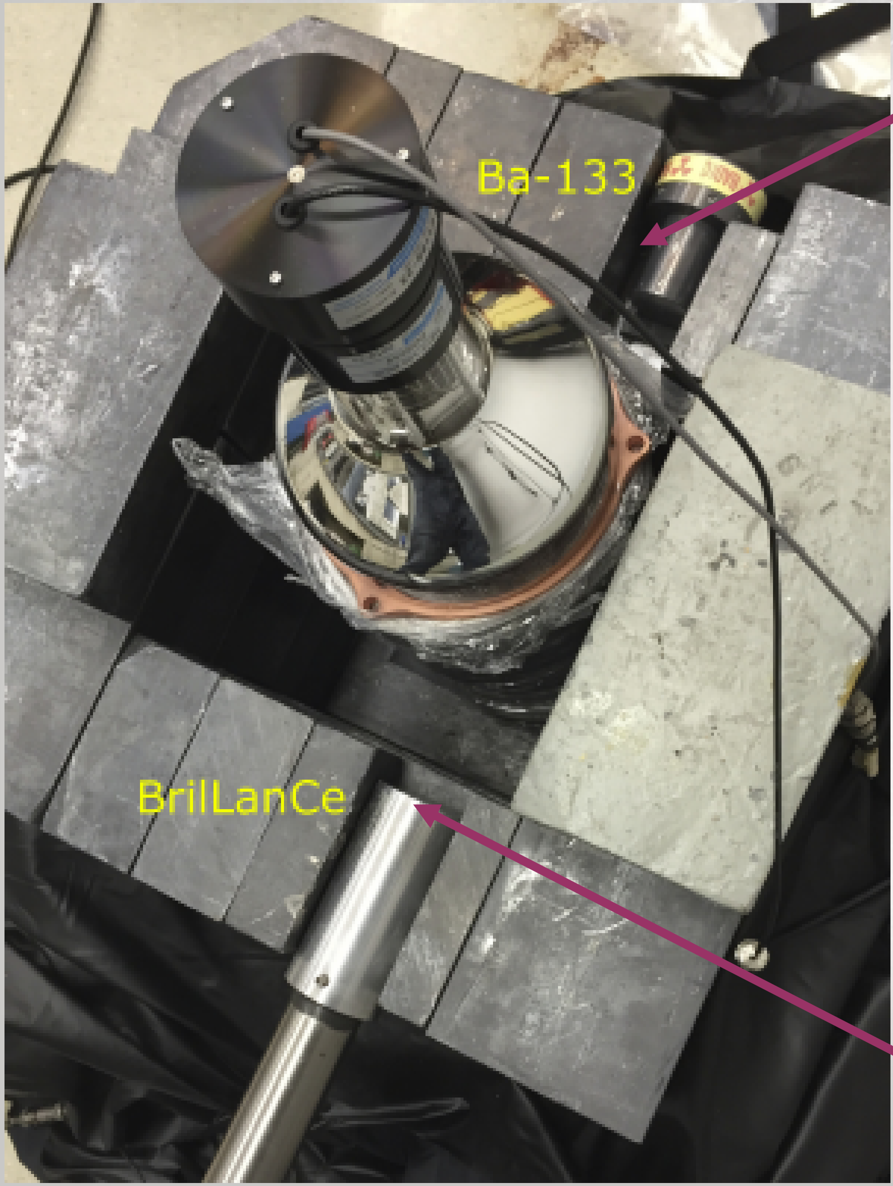
QF measurement at TUNL

D(D,n) neutron production, 12 backing detectors and the “zero-degree” beam monitor

- keVee → keVnr

two different datasets taken and two separate analyses performed by Chicago and Duke at TUNL

^{133}Ba calibration



collimated pencil beam of ^{133}Ba gammas

The maximum single scattering angle for a coincidence signal is $\theta \sim 12°$

Corresponding energy – up to 6.2 keV

Goal:

to have a dataset with few to few tens phe events to “train” cuts on

BrilLanCe crystal to trigger on forward scattered gammas

Summary

Data and operation:

- ^{241}Am and ^{133}Ba calibrations of CsI[Na] detector were done
- QF measurements of CsI[Na] were performed
- CsI[Na] detector has been taking data for ~ 1 year at SNS (~ 400 CEvNS)

Analysis:

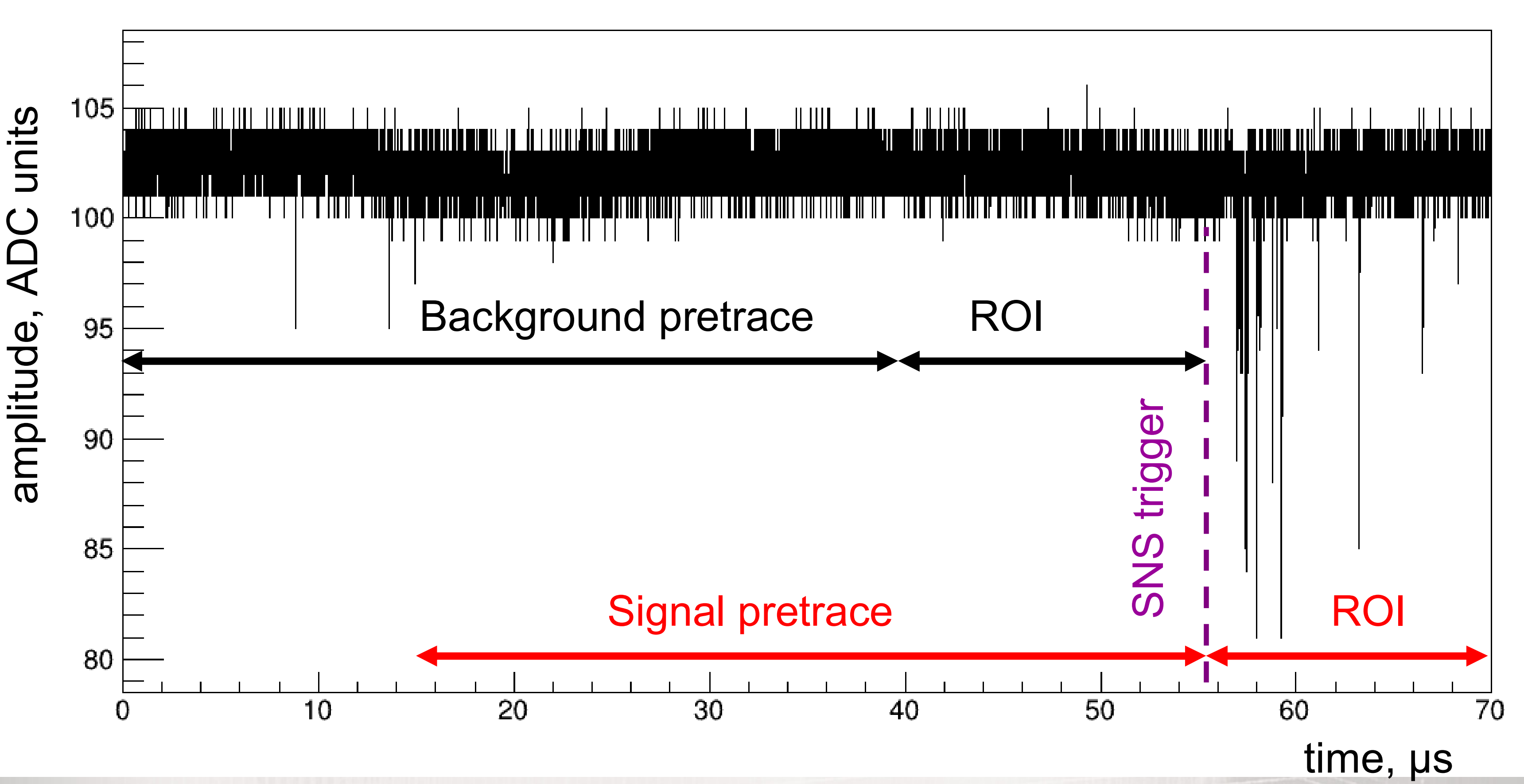
- ^{241}Am analysis is mostly finished
- ^{133}Ba is in process
- QF analysis is coming to its end

We are starting to look at ROI!

Plans:

- continue data taking at SNS
- perform in-situ neutron calibration with ^{252}Cf

Backup: low energy event at SNS



Backup: QF measurements at TUNL

TUNL shielded source area (SSA)

- D(D,n) generator (3.8 MeV)
- shield to attenuate off-axis neutrons
- scatterer under investigation (not shown)
- twelve backing detectors
- zero-degree beam monitor