A short summary of neutron beam test in 2020

Guang Yang

Introduction

A large amount of neutron beam data has been taken in 2019.

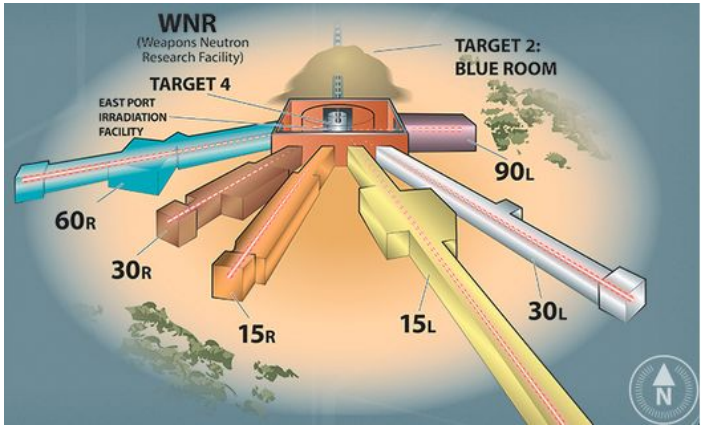
A new beam test has been done in Dec 2020 with an additional US-Japan prototype with more configurations.

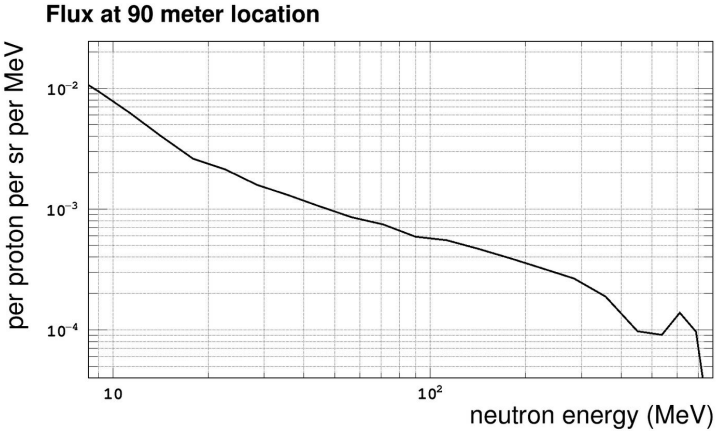
The main goal of the beam test is to characterize the neutron detection capability for superFGD and 3DST => a number of measurements can be done including neutron cross section, detection efficiency, threshold, double scattering signature etc.

Neutron beam test facility

LANL provides neutron beam ranged from 0 - 800 MeV

We have two weeks of run time in 2020 at 15L 90 m location





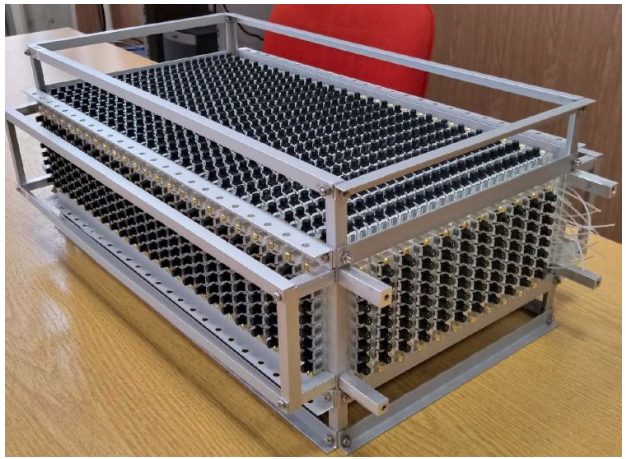
Detectors

SuperFGD prototype being used for the charged particle beam test in CERN (24x8x48) and 2019 neutron beam test

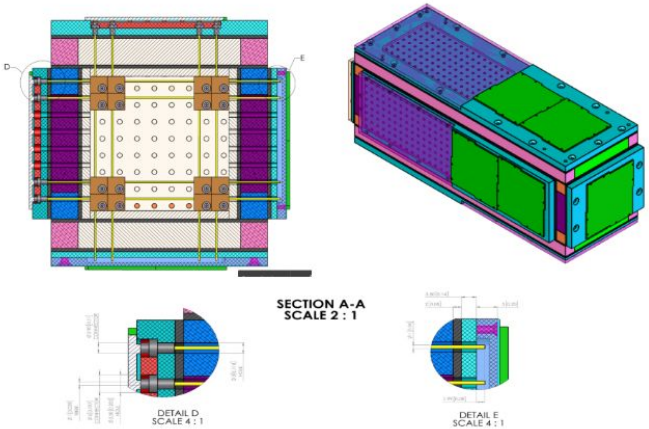
US-Japan prototype uses some new designs that will be used in the T2K upgrade, probably 3DST (8x8x32)

They can be combined in a number of ways

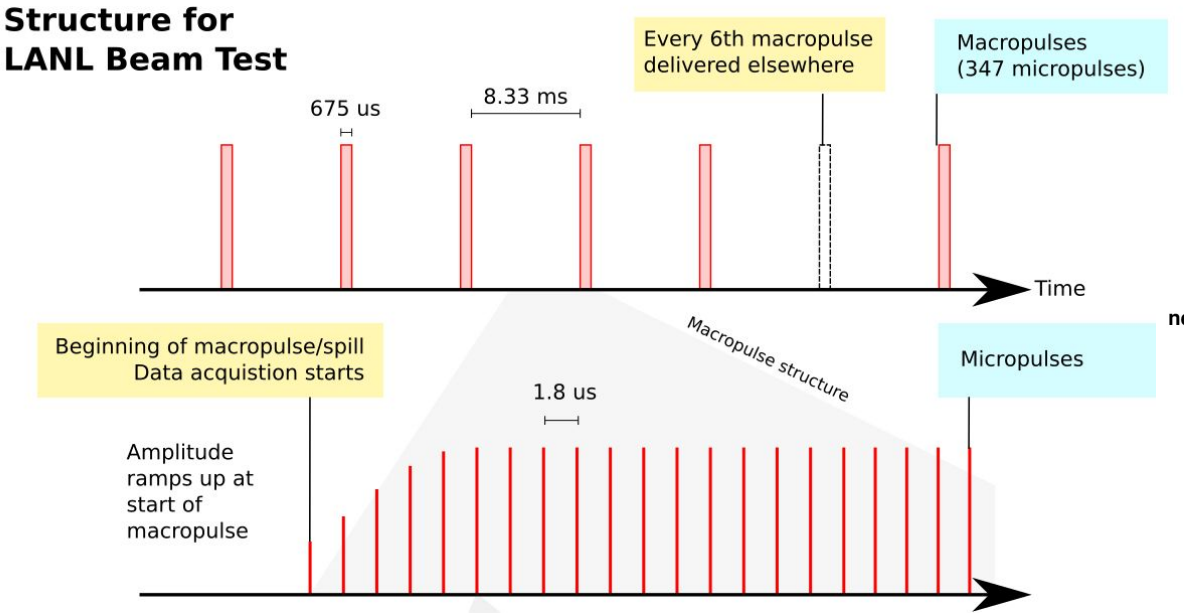
superFGD



US-Japan

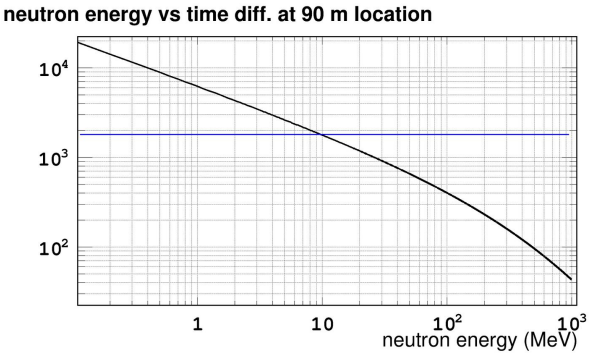


Neutron beam time structure



We have 675 us trigger window to cover each macropulse

Gamma flash and t0 are available for micropulses



Very short summary

- Collected a good amount of neutron data for each desired configuration
- Collected a good amount of cosmics data
- Unique things comparing to last year:
  - 3.6 us spacing data were collected successfully for various configurations
  - High angle scattering data were collected
  - Detector alignment is still rough even with the laser system
  - 1 mm collimator may help with low energy neutrons, but not for high energy ones
  - Upstream materials did not change throughout the beam run, so we don’t expect any spectrum change
  - 21 remote shifters from about 10 (I need to confirm) institutions => this is a team work

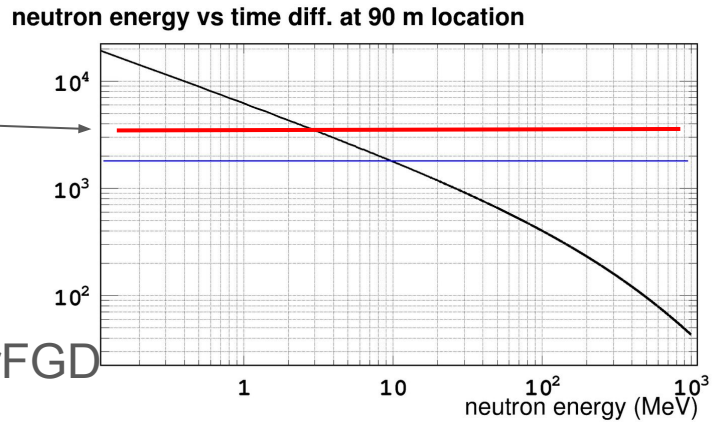
Outstanding new configurations this year

1 mm collimator while last year only 7 mm collimator

- May not work as expected because the length of the 1 mm collimator is not enough

3.6 us spacing

- It pushed two a lower wrap-around threshold, i.e. low energy and high energy neutrons can be understood better

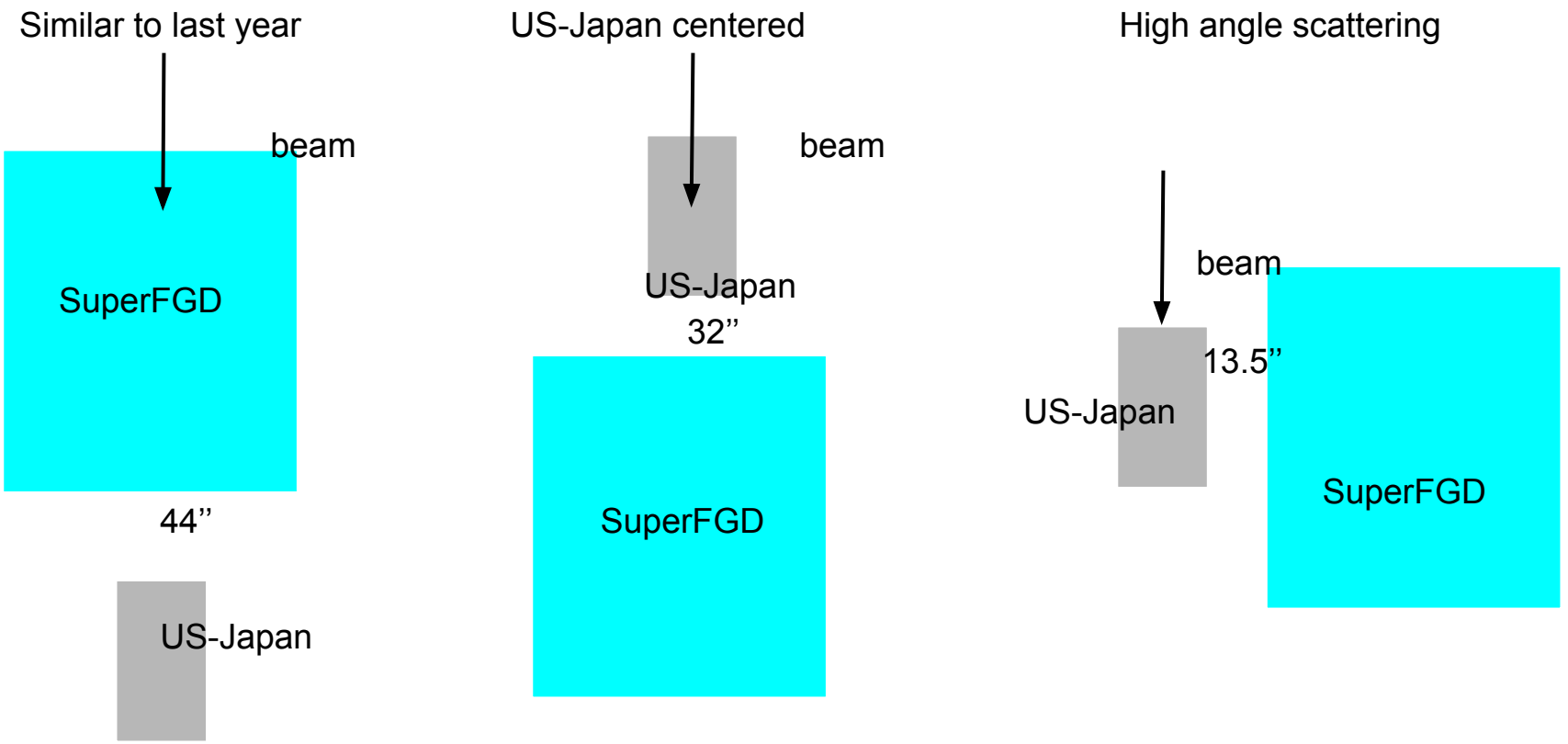


US-Japan prototype in combination with superFGD

- An large extension on for all angles

All in top view

Detector configurations



Data Summary Table

Potential good data rate only, some data with bad alignment, bad t0 or a lot of missing channels etc. do not count.

Mins(>2e5* int. n per min)	1 cm + 1.8 us	1 cm + 3.6 us	1 mm + 1.8 us	1 mm + 3.6 us
Same to last year	1055	1260	930	515
USJ centered	1310	NA	3355	NA
High angle sct.	1095	325	NA	NA

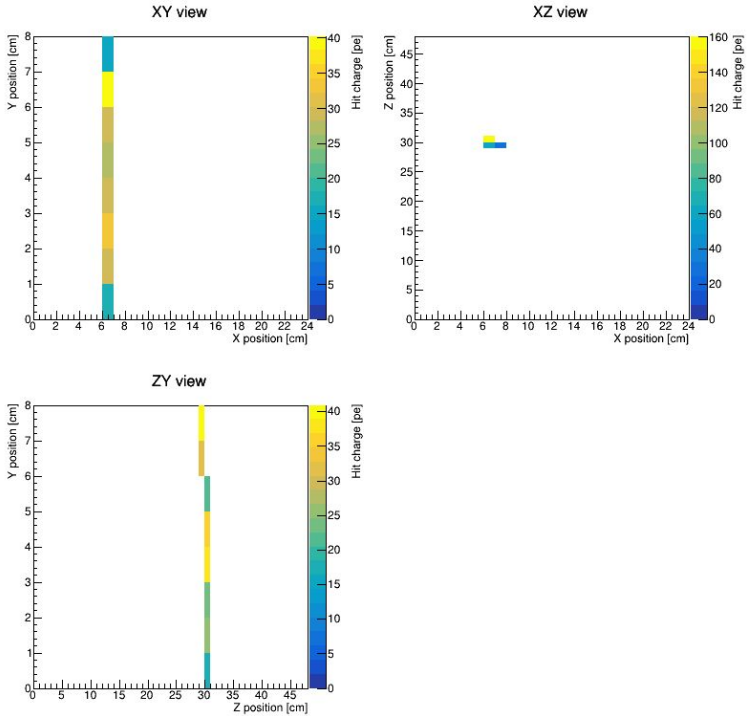
*>1e5 for 3.6 us spacing

USJ centered 1mm + 1.8 us breakdown

USJ centered 1mm+1.8us	1 1 mm collimator	2 1 mm collimator	4 1 mm collimator	5 1 mm collimator
3355	1960	770	240	385

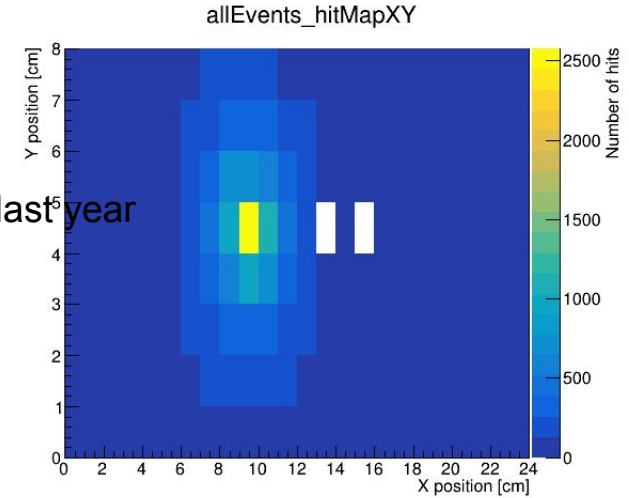
Some plots from the new run

cosmics



Similar to last year

SFGD



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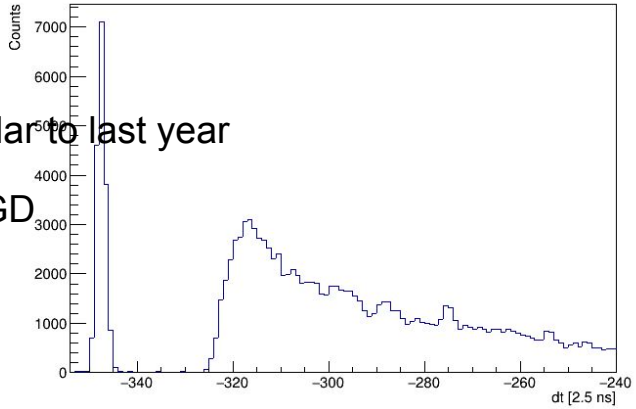

Plans

- Continue finishing the total cross section measurement with the help of 3.6us for wrap-around
- Exclusive channel selection
- Double/triple.. Scattering selection
- Exclusive neutron detection efficiency evaluation