Introduction to 3DST

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BIWG meeting

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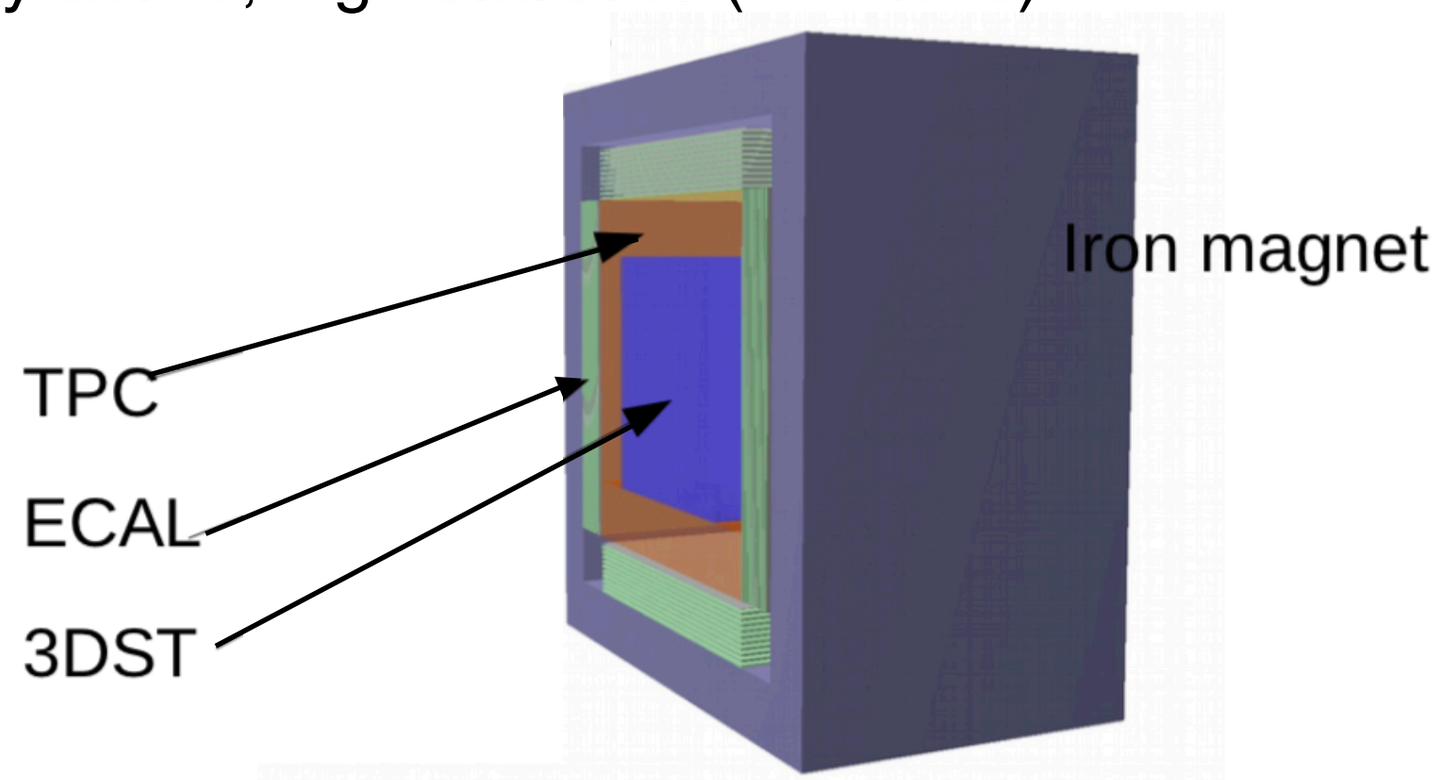
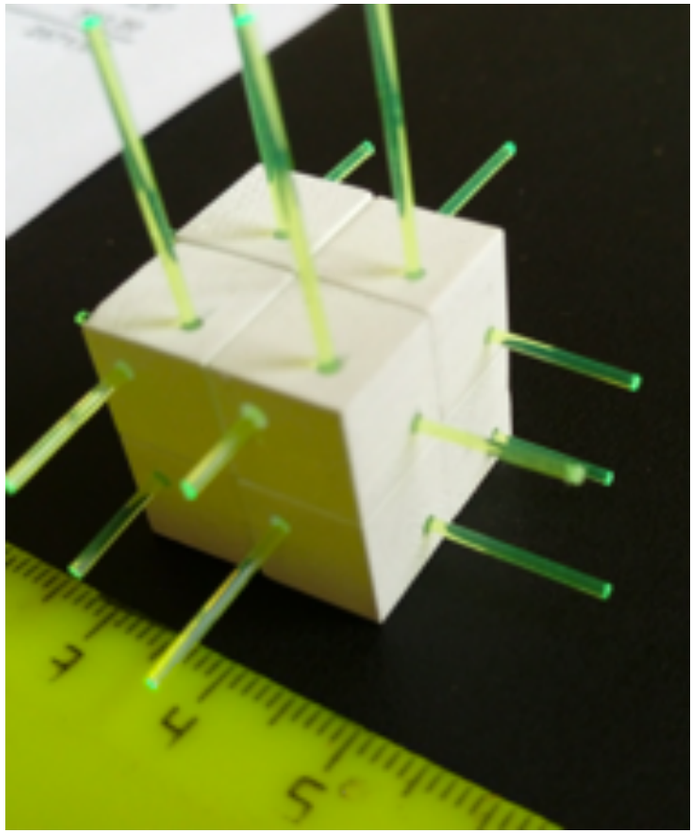
DUNE-ND

- There is a proposal for the DUNE ND composed by three main systems
- ArCube: segmented LAr TPC
    - ✦ similar detection technique as far detector, same nucleus
    - ✦ High statistics
    - ✦ Not magnetized
- MultiPurpose detector (MPD) based on HpGasTPC + ECAL + magnet:
    - ✦ Same nucleus as far detector
    - ✦ sensitivity to very low-momentum particles (protons and pions)
    - ✦ Very precise XSec measurements needed to better understand nuclear effects, but not optimized for neutron detection
    - ✦ Spectrometer for muons escaping ArCube
- 3DST: 3D granular plastic scintillator detector (see next slides)

The 3DST detector

- New detector concept for active targets in neutrino experiments
  - ✦ T2K is going to install this detector in the upgraded ND280 (SuperFGD)
  - ✦ Same detector (but much bigger) proposed for the DUNE ND (3DST)
- Whole size is 3x5x5 m^3. 3DST size is 2.4x2.4x2 m^3
- Fully active, high statistics (~12 tons)





Concept described in 2018 *JINST* **13** P02006

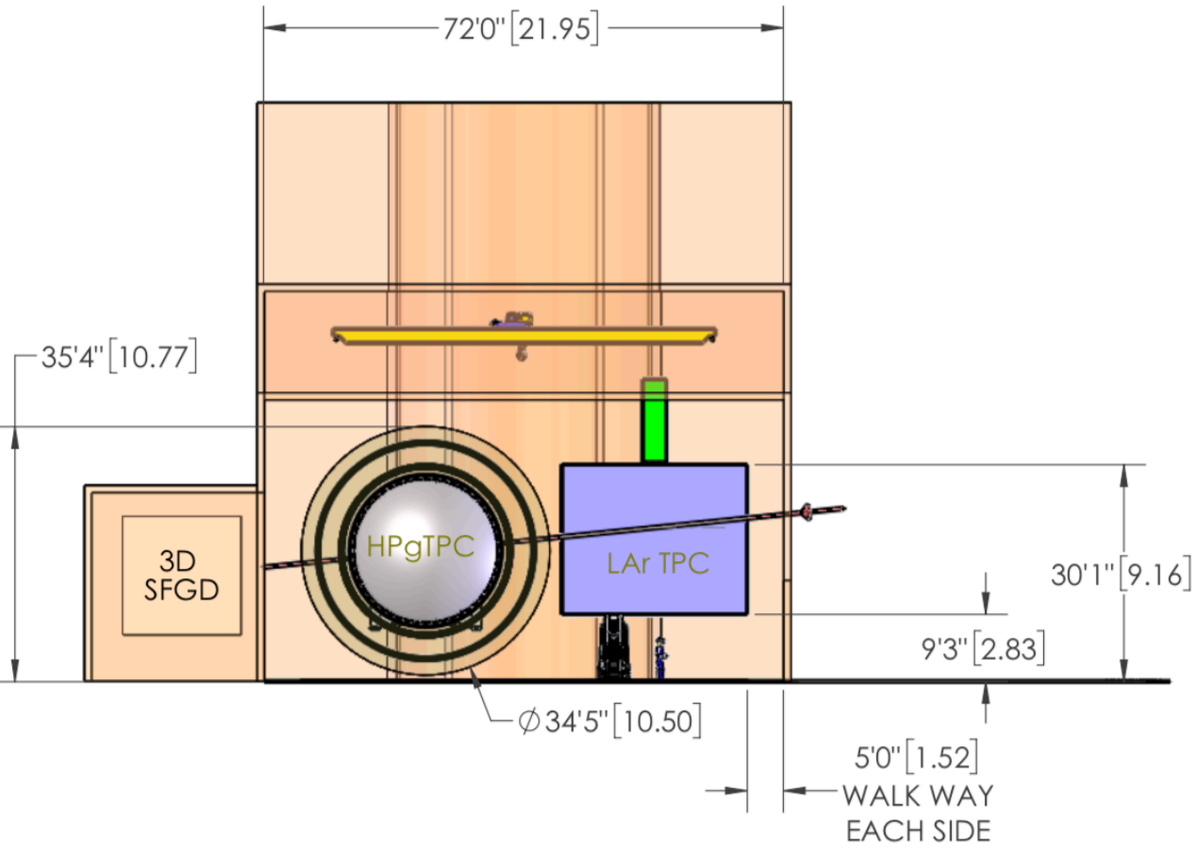
Plastic scint. 1x1x1 cm^3 cube
Chemical etching as reflector (~50-100 mum thick)
3 WLS fibers (Kuraray Y11, 2-clad, 1mm) along XYZ

- 4pi detector and low-momentum threshold for protons (~300 MeV/c)

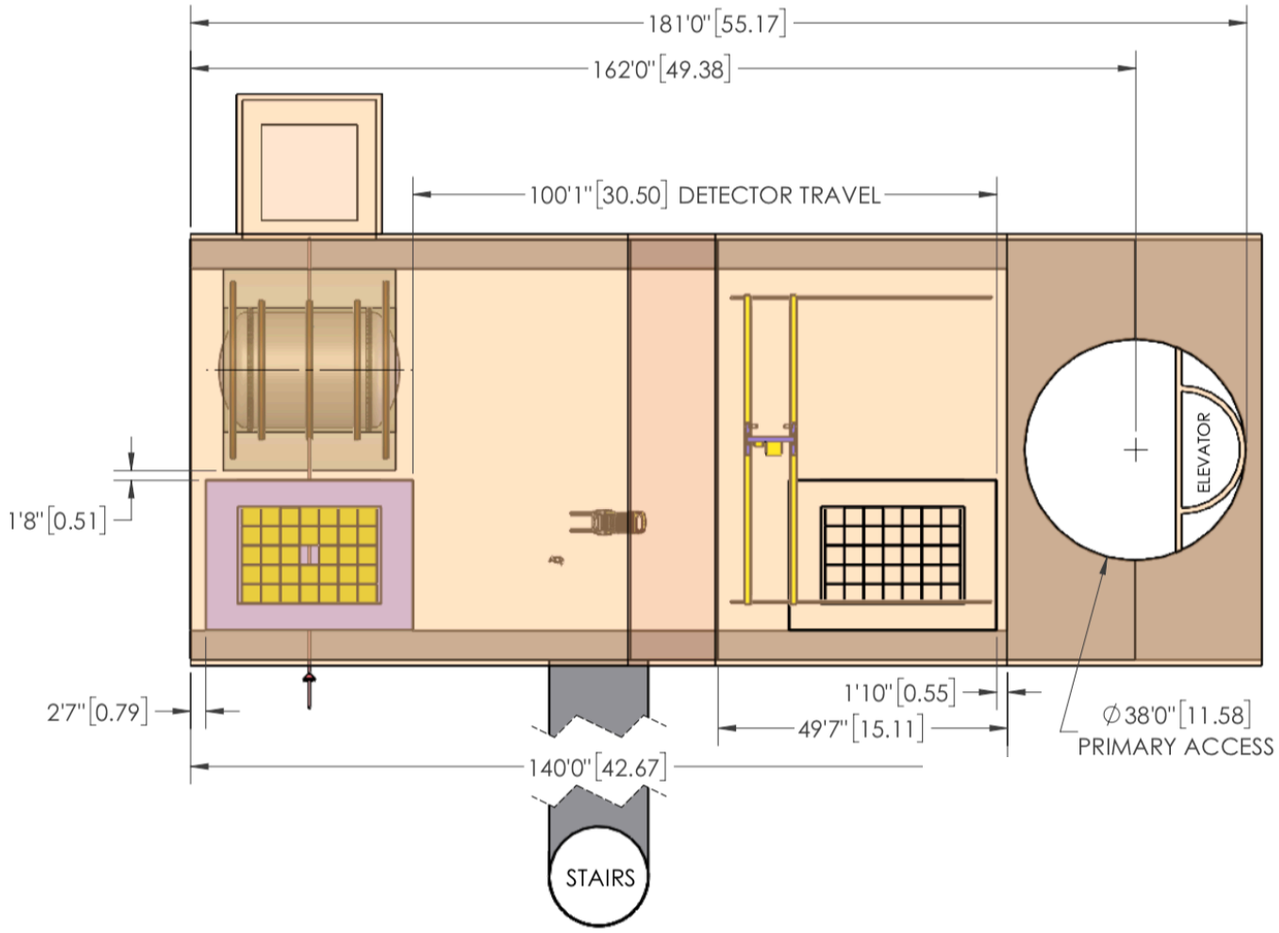
DUNE-ND configuration

- Preliminary drawing of the cavern including all the three systems

Front view



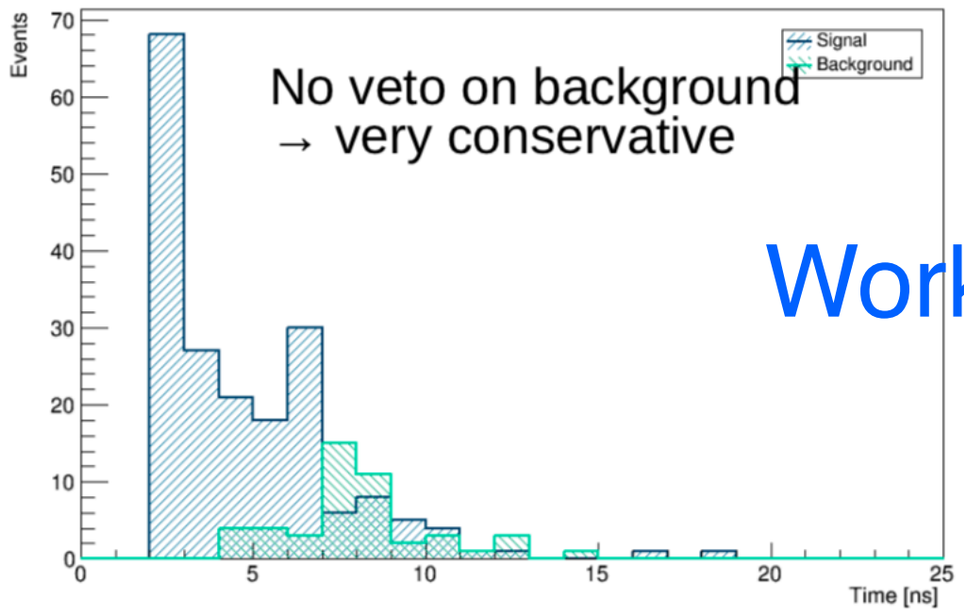
Top view



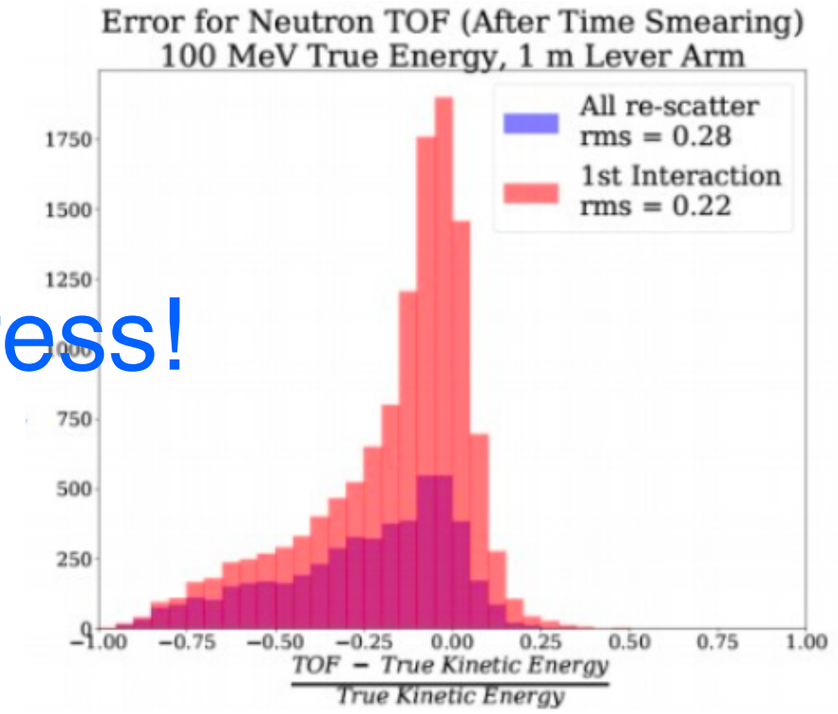
- DUNE-PRISM:
  - ✦ ArCube and MPD moving off-axis
  - ✦ 3DST will be the only detector always on axis

Goals of 3DST

- (Anti)Neutrino beam monitor as only on-axis detector (see Jairo's talk)
- Potential to detect neutrons with high purity and measure energy by ToF

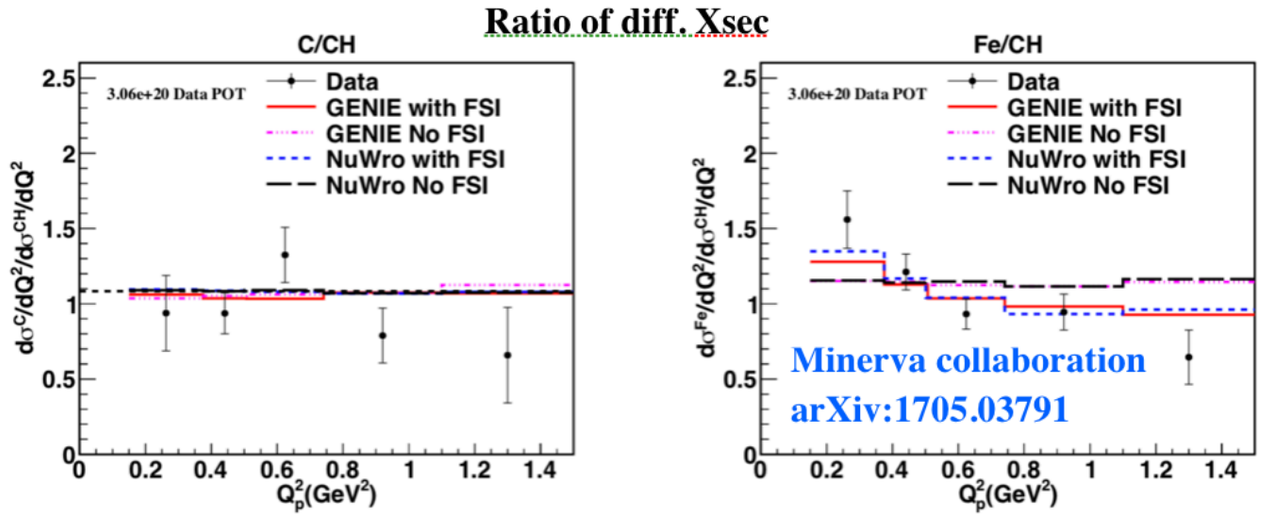


Work in progress!



- Precise XSec measurements in plastic
  - ✦ strong link with other experiements (T2K-ND in 2nd osc. max. Energy range)
  - ✦ Important to understand nuclear effects and final state interactions in Ar —> strong A-dependence !

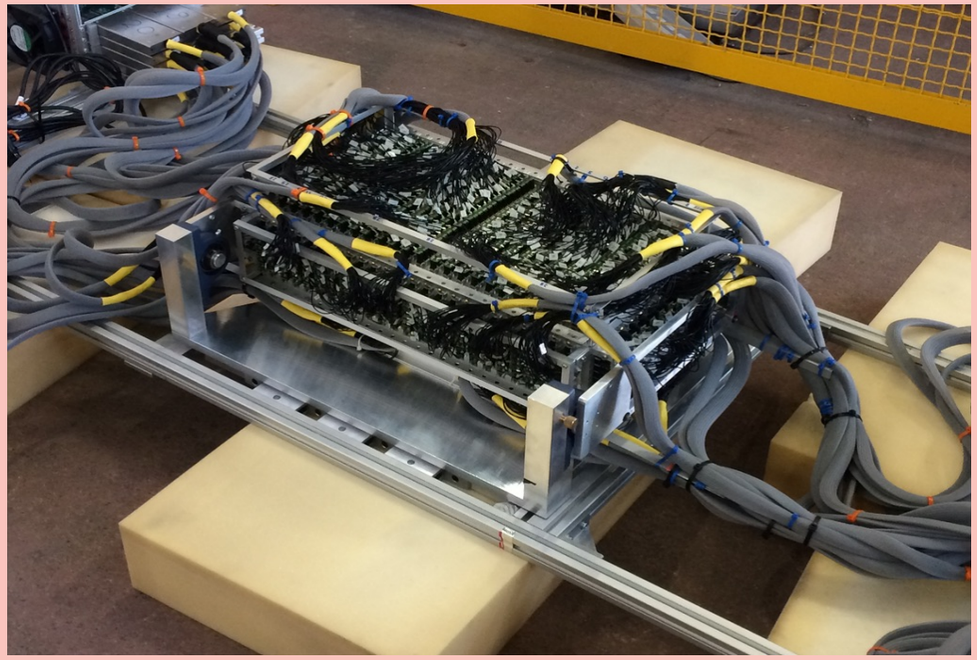
- Potential to improve the AntiNeutrino energy reconstruction thanks to unprecedented neutron detection capabilities



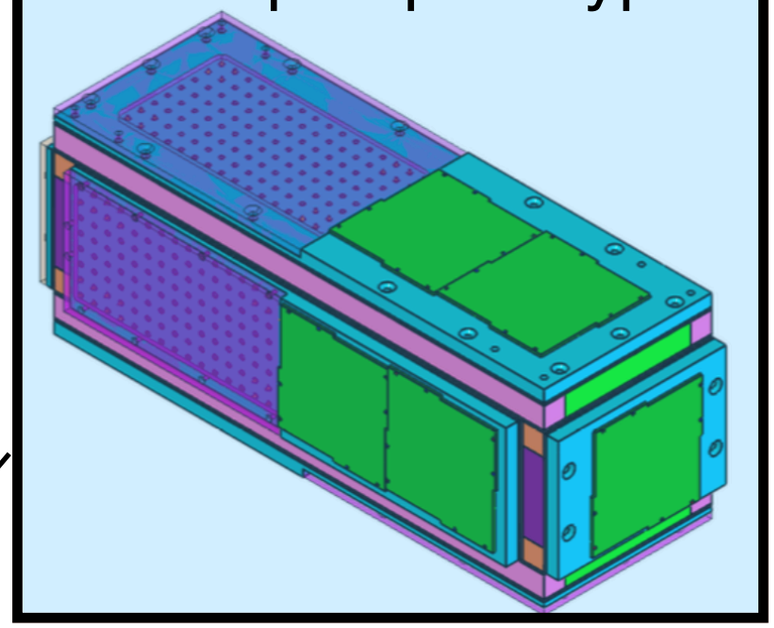
Neutron test beams

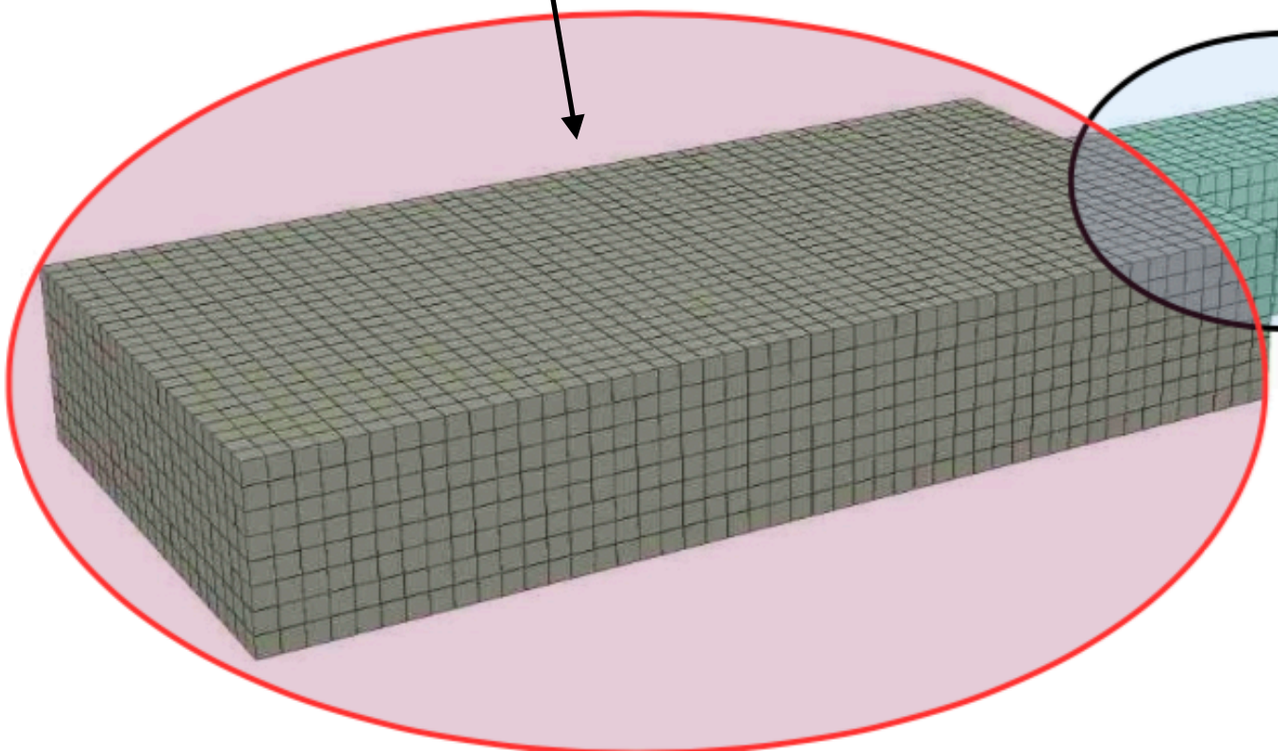
- We had test beams at CERN and plan for neutron test beam in Los Alamos

CERN prototype



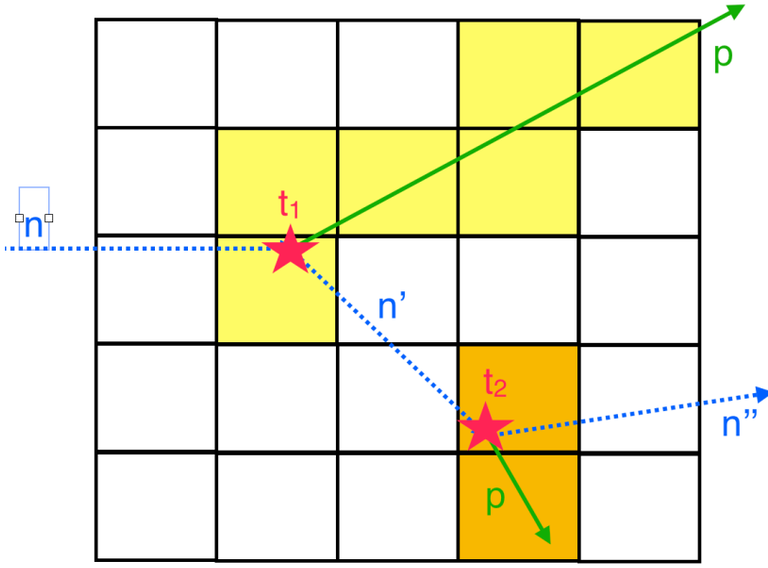
US-Japan prototype





n beam

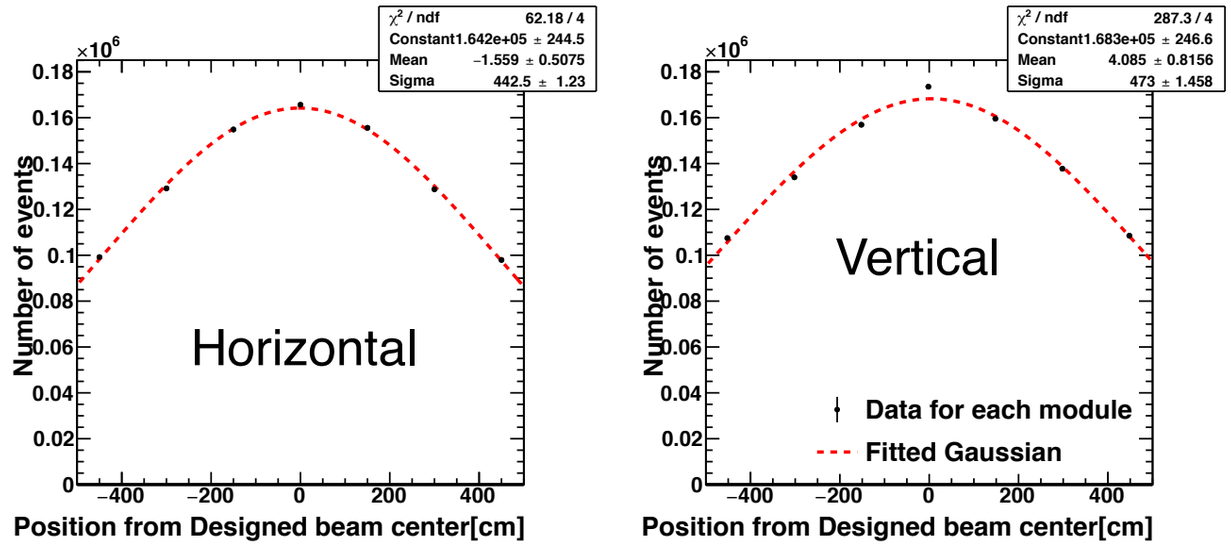
The CERN prototype can be also rotated by 90 degrees



The example of the T2K-ND On-Axis detector: INGRID

- 16 modules iron/scintillator tracking detectors (0-0.9° degrees off-axis)
  - ✦ Accuracy better than 0.4 mrad
  - ✦ 4% uncertainty on the rate

- Beam direction stable within 1 mrad
  - ~2% shift to peak in off-axis ν energy

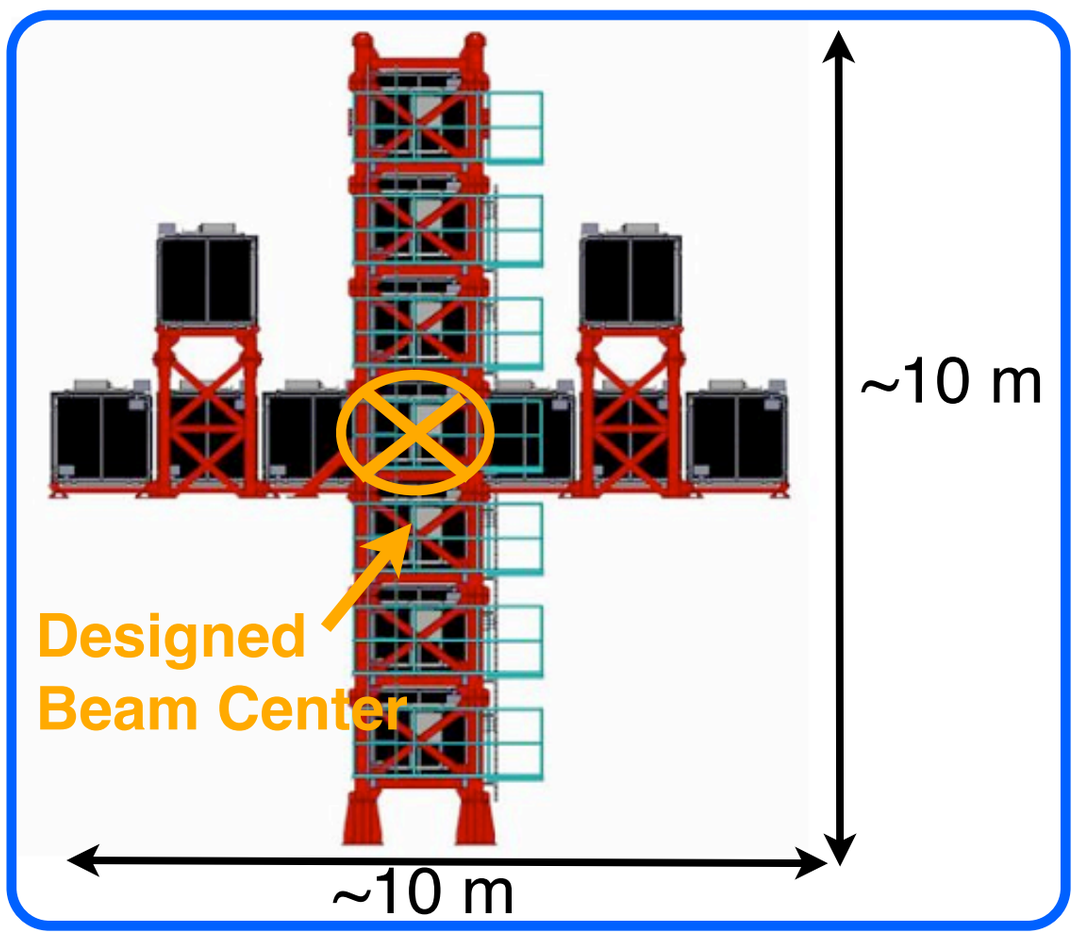


- Protons On Target (POT) normalized event rate stable better than 1%

- INGRID data used to constrain the flux systematic uncertainties

- 3DST can do an analogous job in DUNE

- Moreover one of the goals could be to monitor the neutrino energy spectrum



BACKUP