The Short Baseline Near Detector

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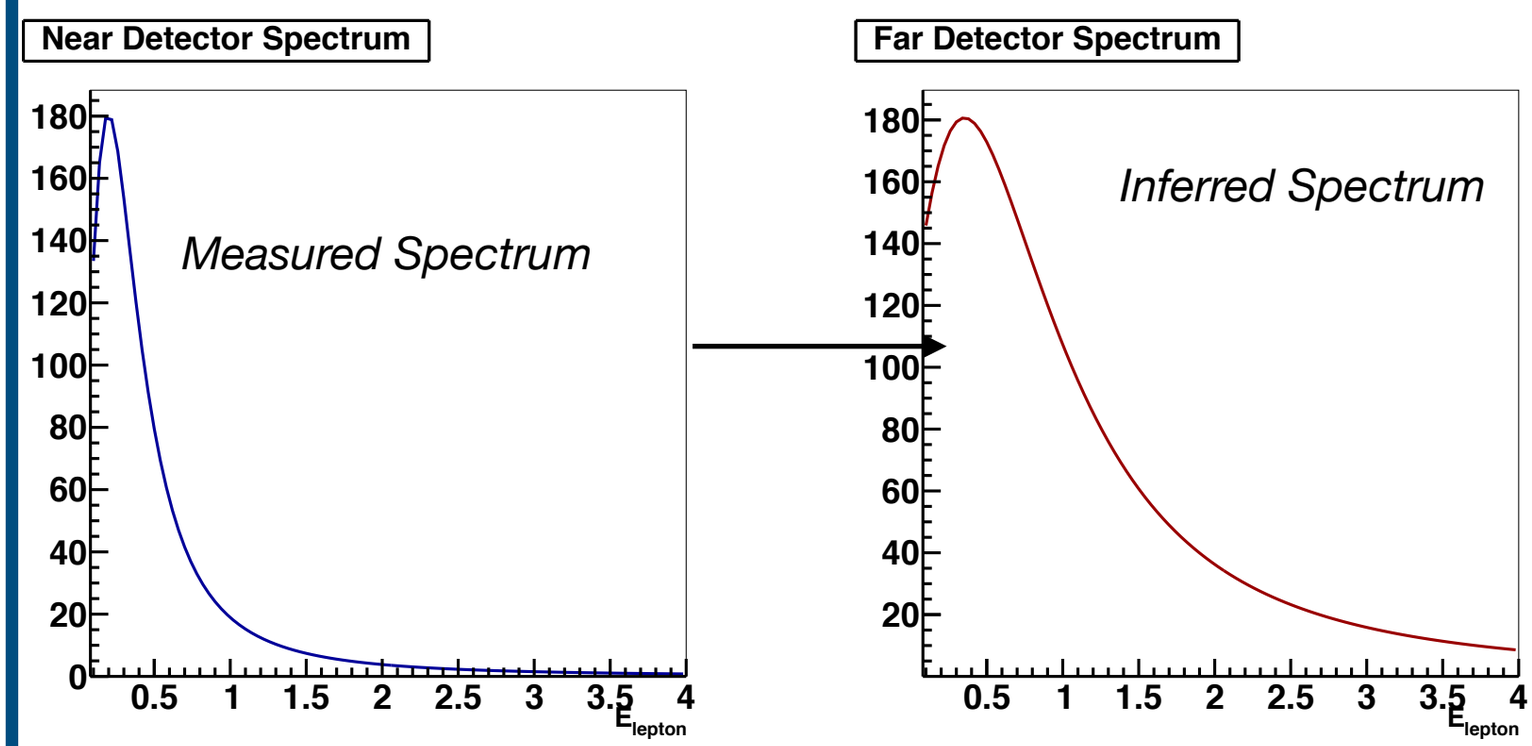
Why Build A Near Detector?

- Detectors do not measure neutrinos, they measure (primarily) leptons from neutrino + nucleus interactions.

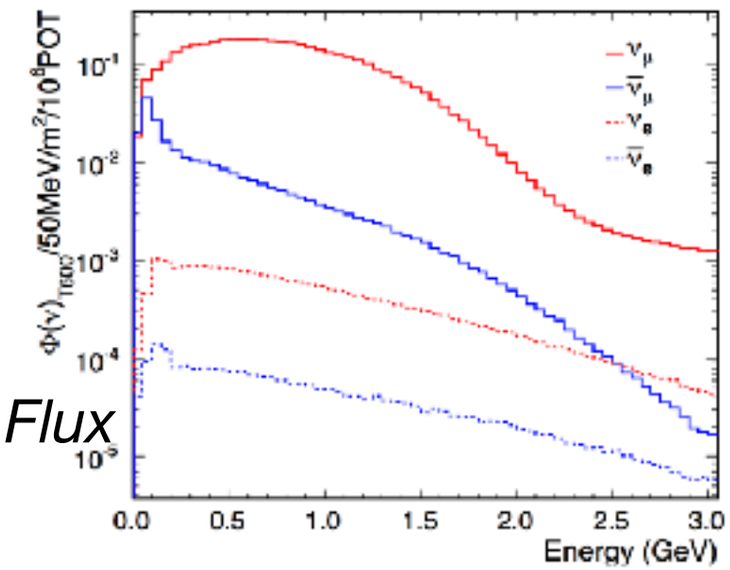
- *Measure* cross-section, acceptance, FSI in a near detector to *predict* an un-oscillated spectrum in your far detector.

- Reality is a bit more complex, typically use a model to *extrapolate* a near detector spectrum to a far detector.

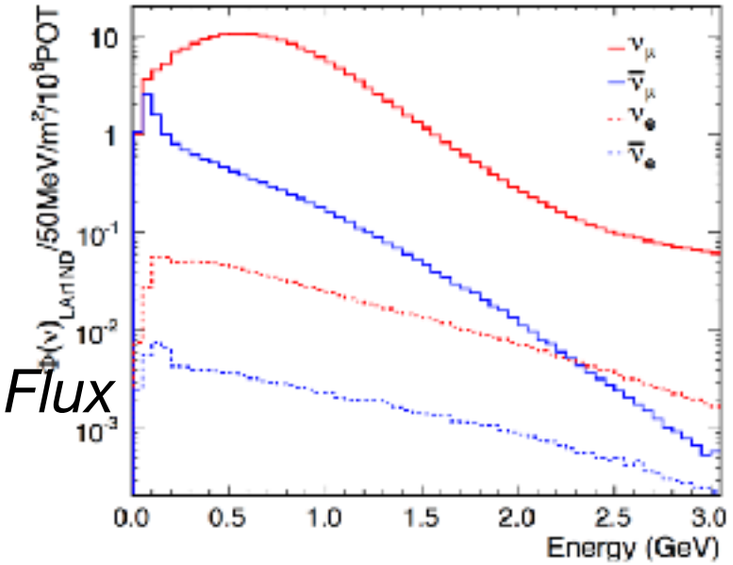


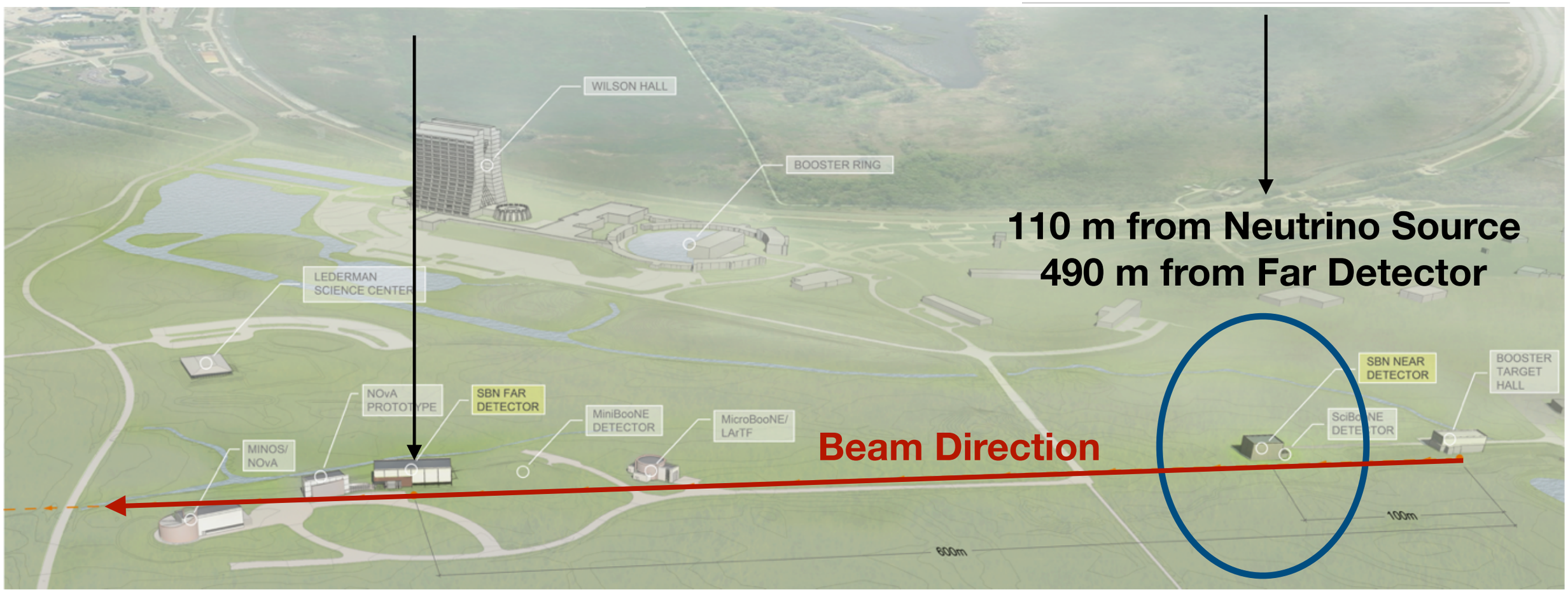
Location in SBN

Far Det. Flux



SBND Flux

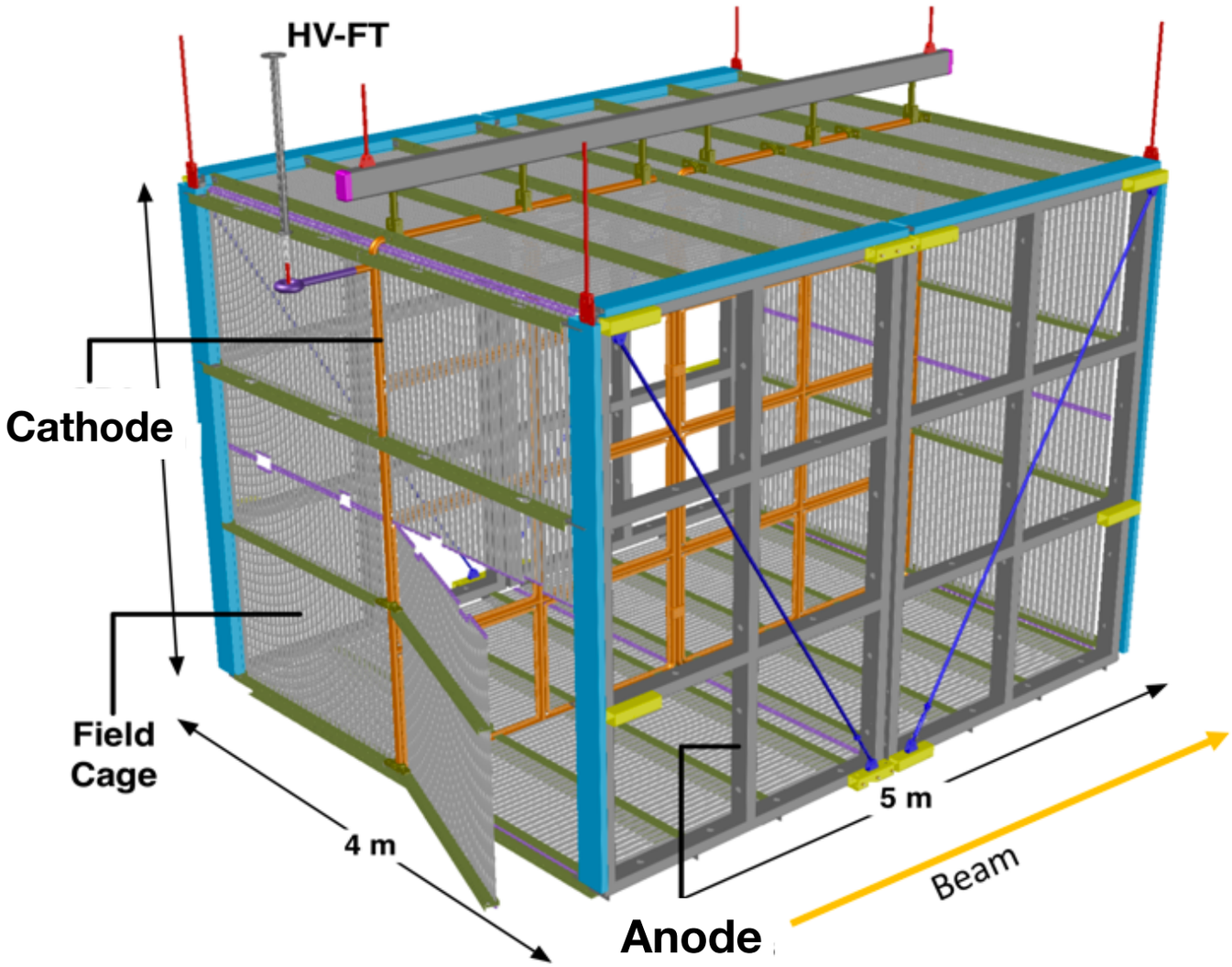




110 m from Neutrino Source
490 m from Far Detector

Building a Better Near Detector

e^- drift away from the Cathode.
Wires pick up charge from passing e^-.

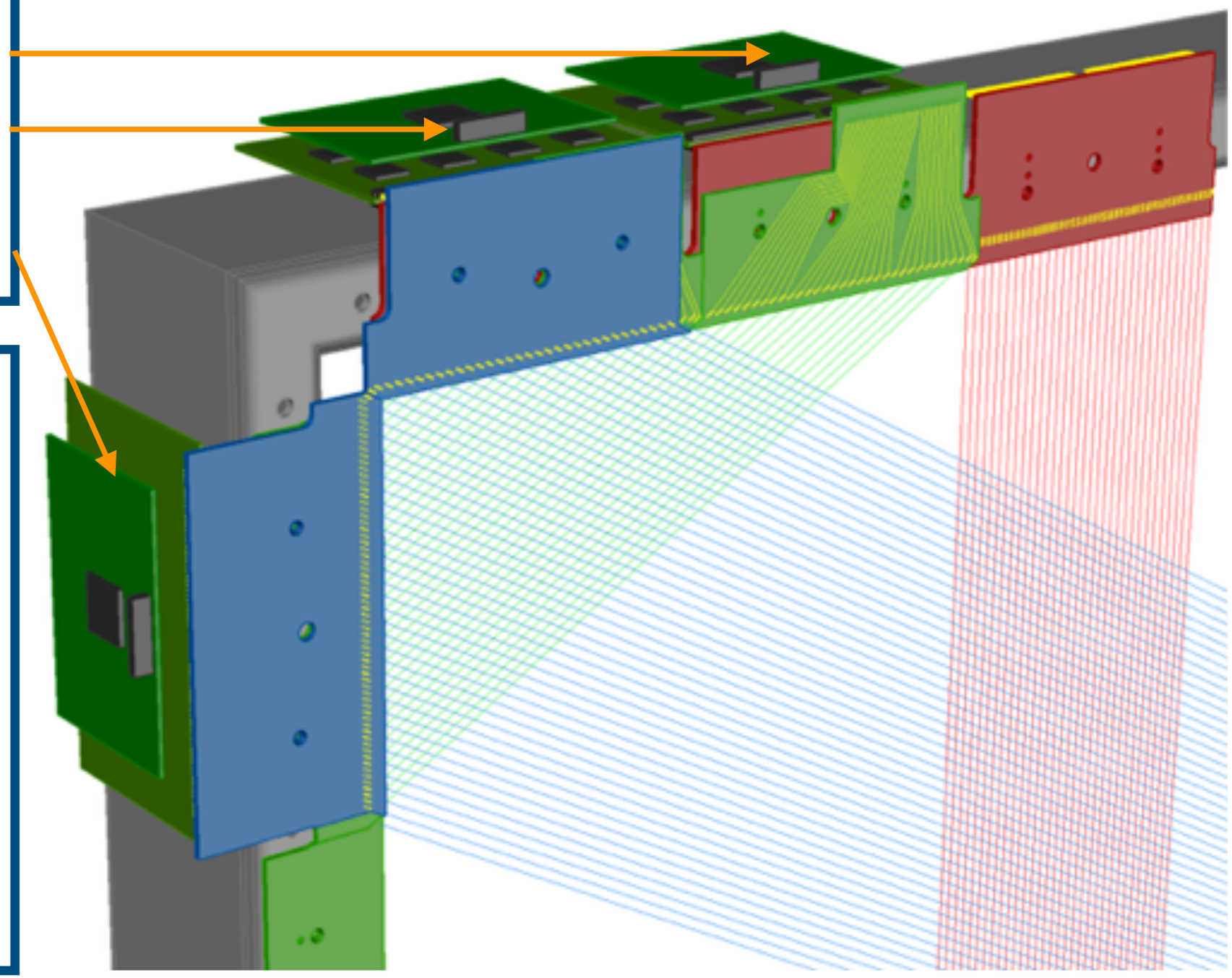


- Ideal case for a near detector: same target nucleus (Ar) and detection technology (TPC) as far detector.
- SBND employs two different drift chambers, shorter drift distance for same volume.
- 4π coverage cosmic tagger (not pictured), reduces largest background

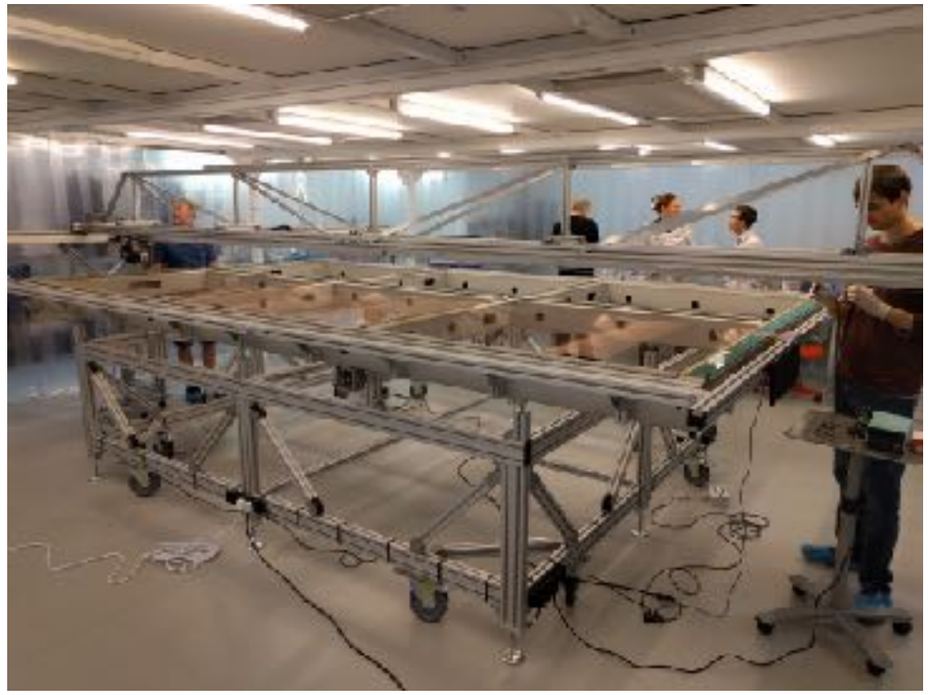
Wire Plane Details

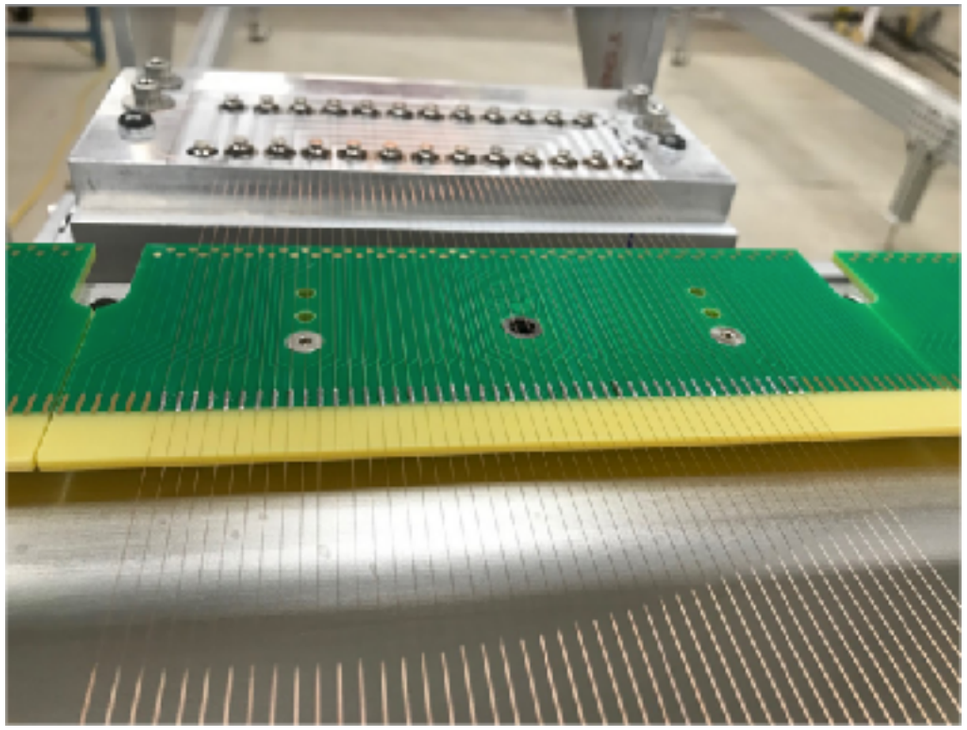
- Cold Electronics boards:
  - Pre-Amp
  - ADCs

- Each anode composed of 12 frames.
- 3 Wire directions per frame.
- 3 mm wire pitch.



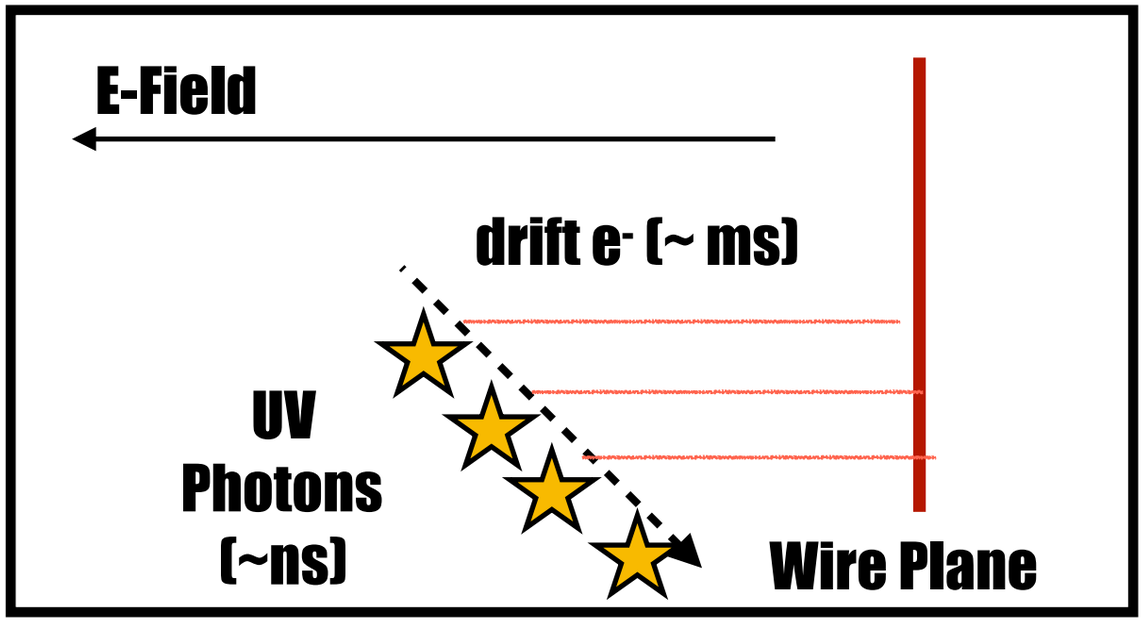
Anode Plane Construction



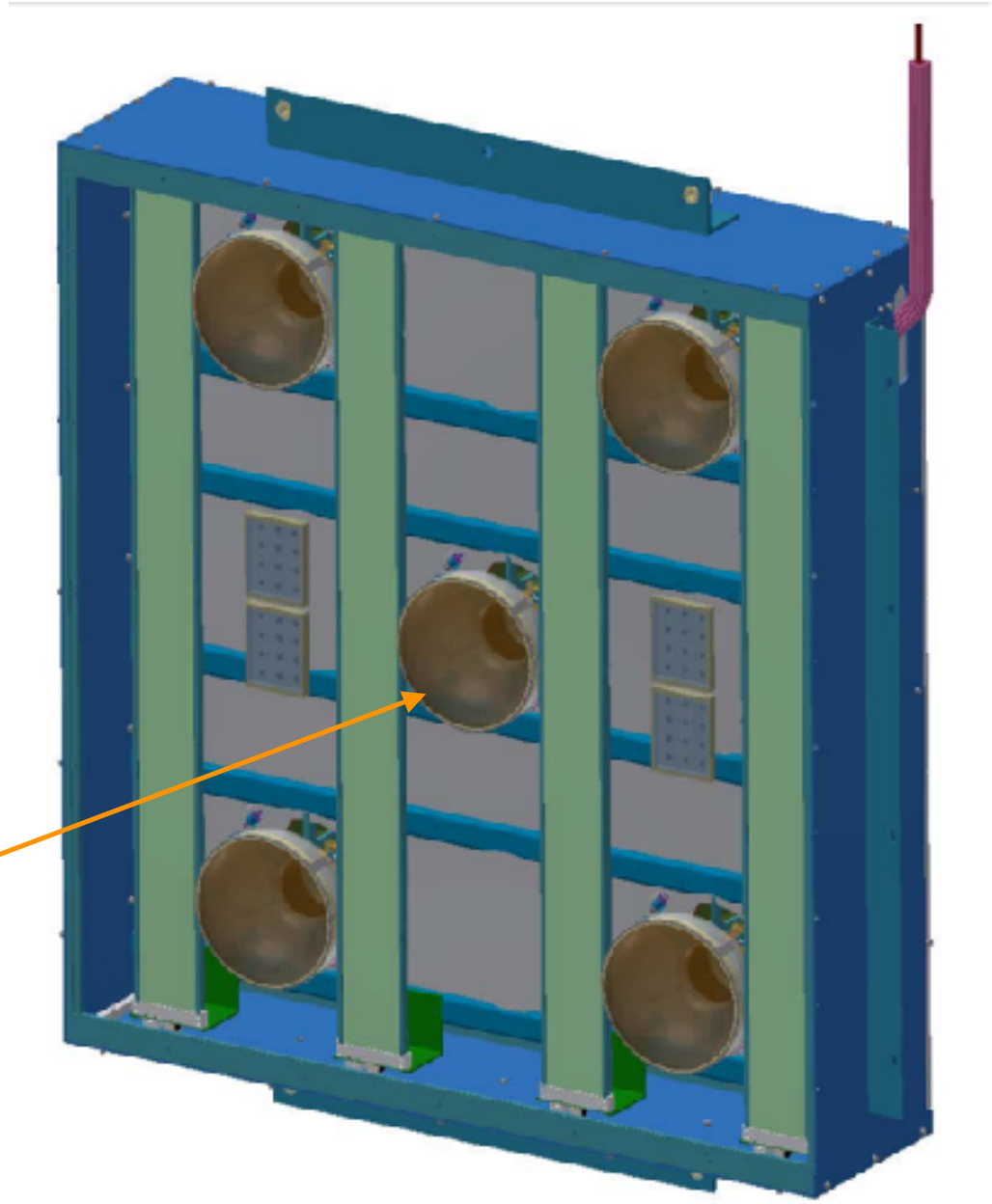


- Wire-Winding currently taking place in US (Yale) and UK (Daresbury).
- First planes from UK expected end of the summer, first from US shortly after.

Scintillation Light Detection



- Light detection used to measure t_0 of an event relative to the readout window.
- UV detected with TPB coated PMTs, sit within the wire frame.

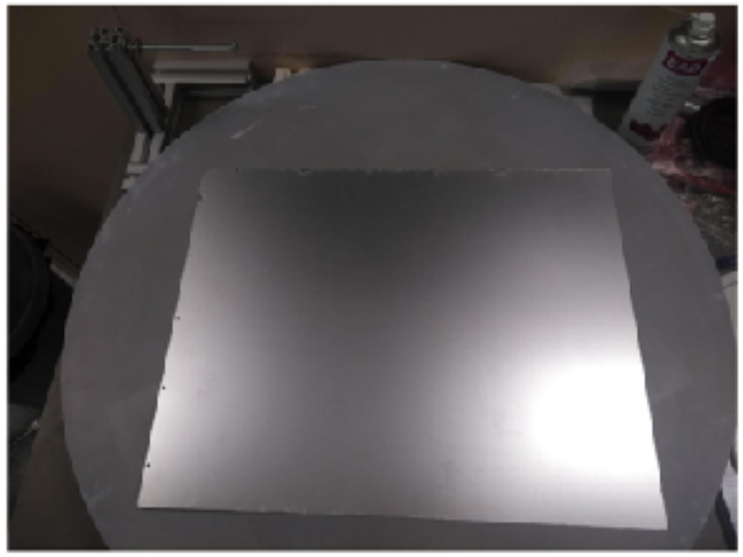


Detector Research and Development

- Numerous research and development projects in photon detection approved for SBND:

Reflective Foils

- Evaporative coating of TPB on highly reflective (R= 0.99) foils.

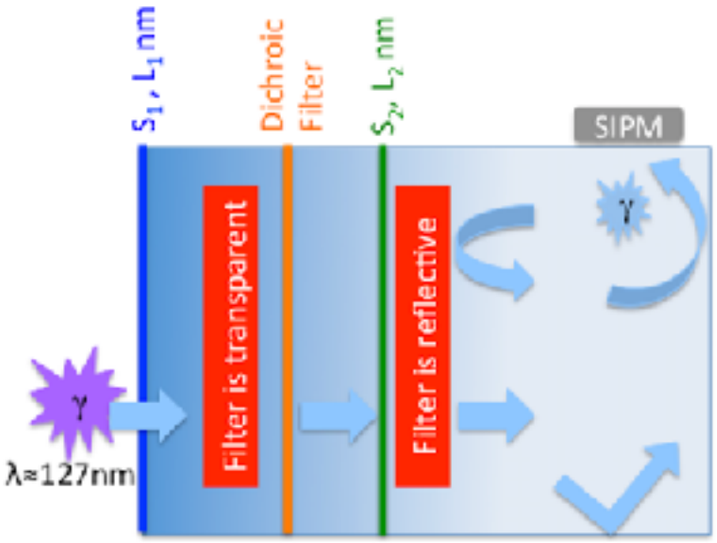


Light Bars

- TPB Coated acrylic bars.
- Visible light observed by SiPM arrays on bar ends

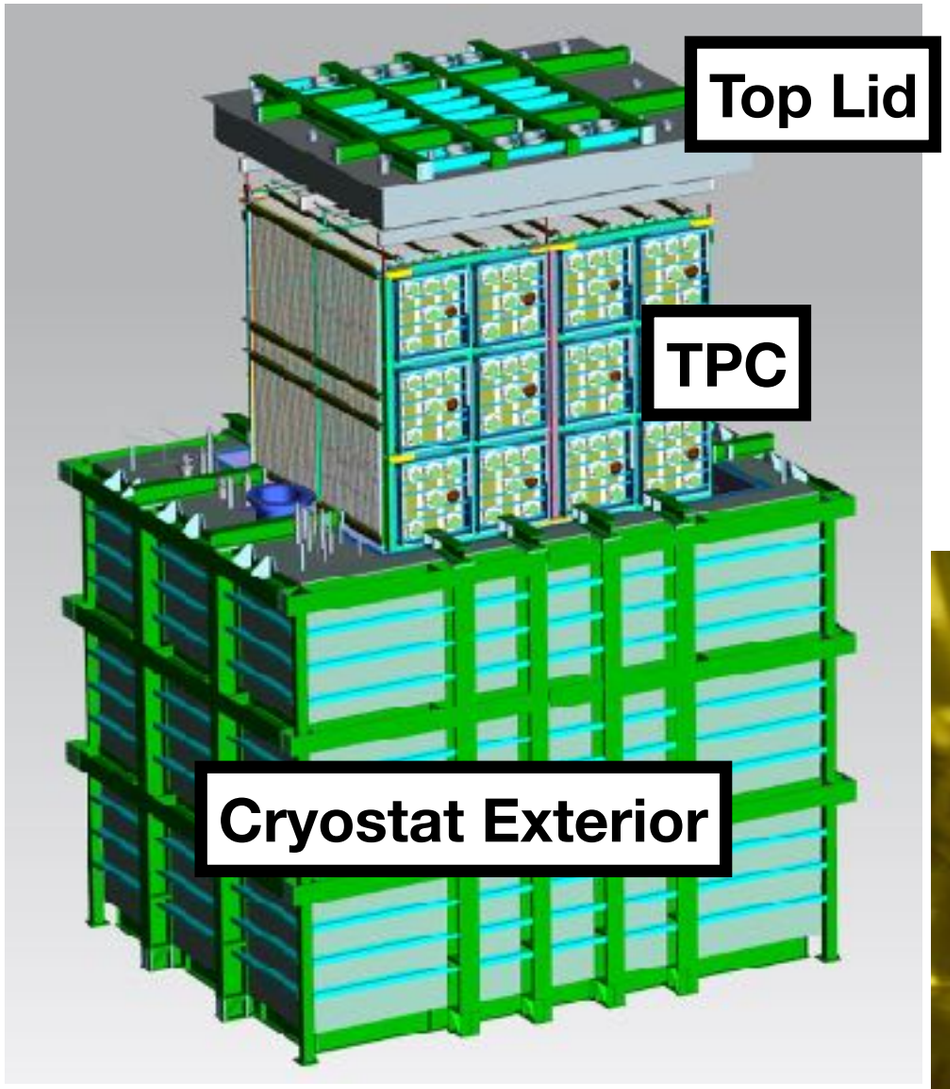
Arapucas

- Trap light via filter + shifter planes.



A. A Machado and E. Segreto, JINST 11 2016

Building a Better Cryostat



- Stainless steel membrane cryostat.
- TPC supported by Cryostat lid.

- Same design as DUNE / ProtoDUNE (right).

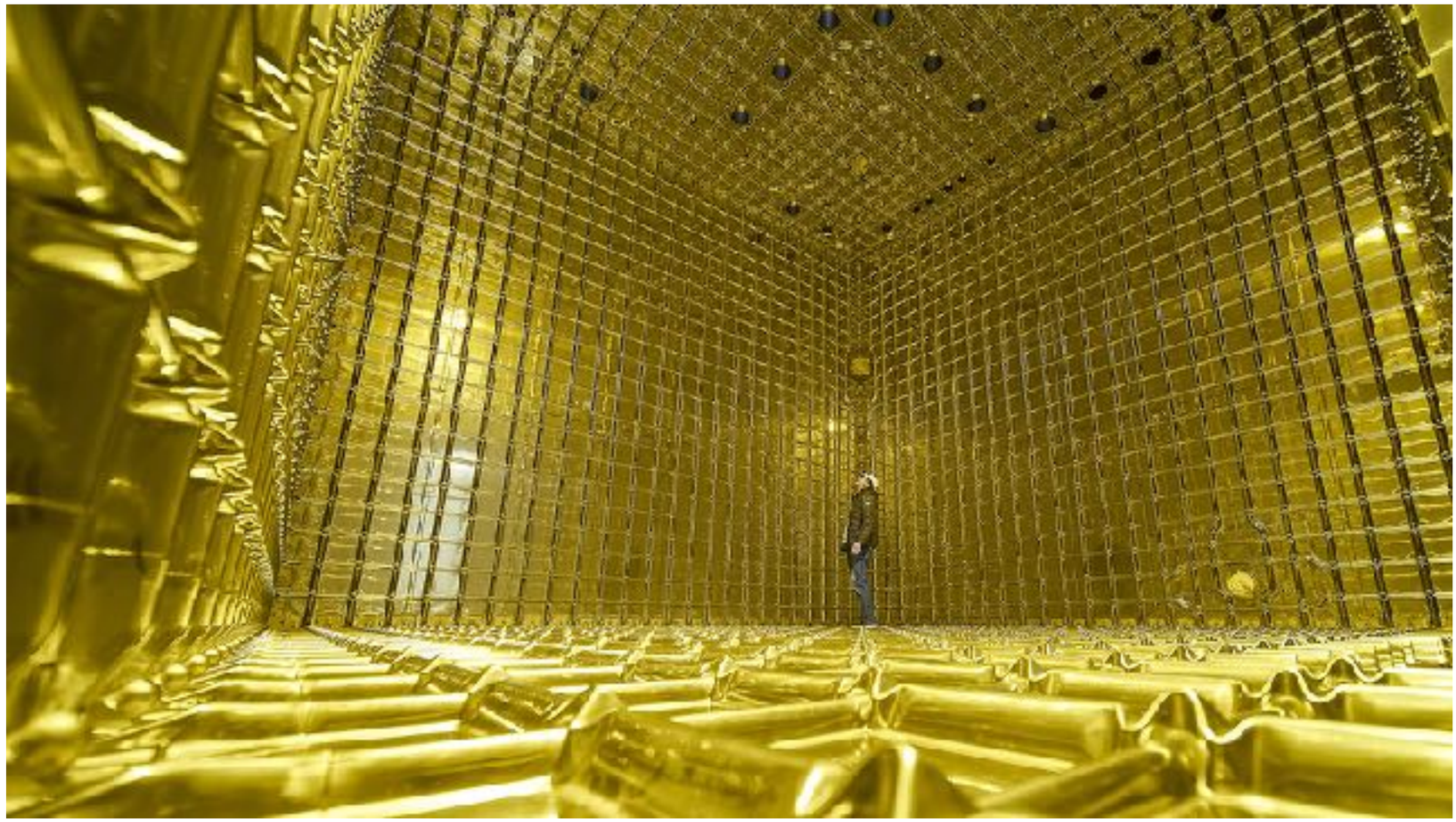
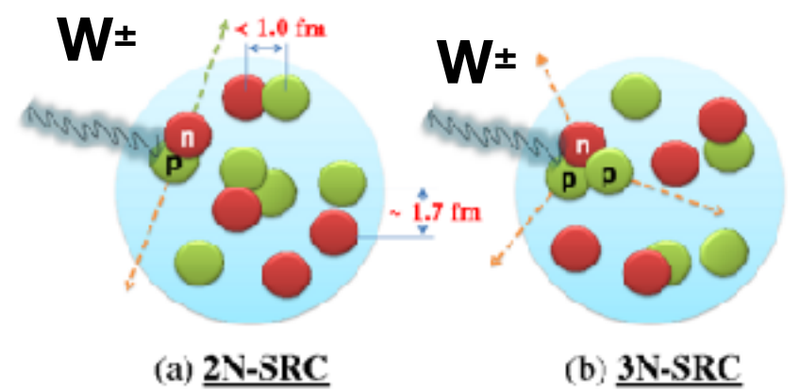
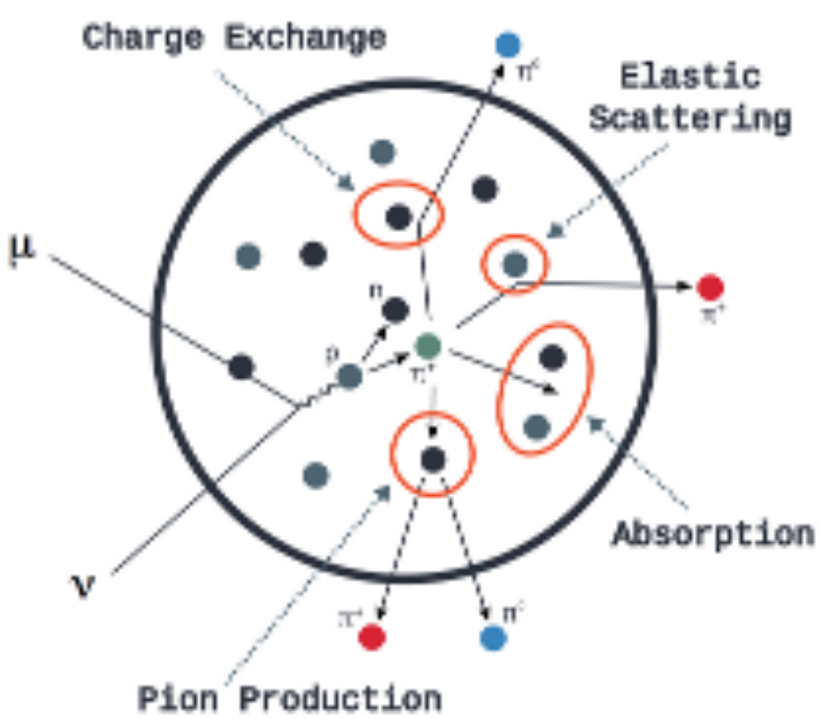


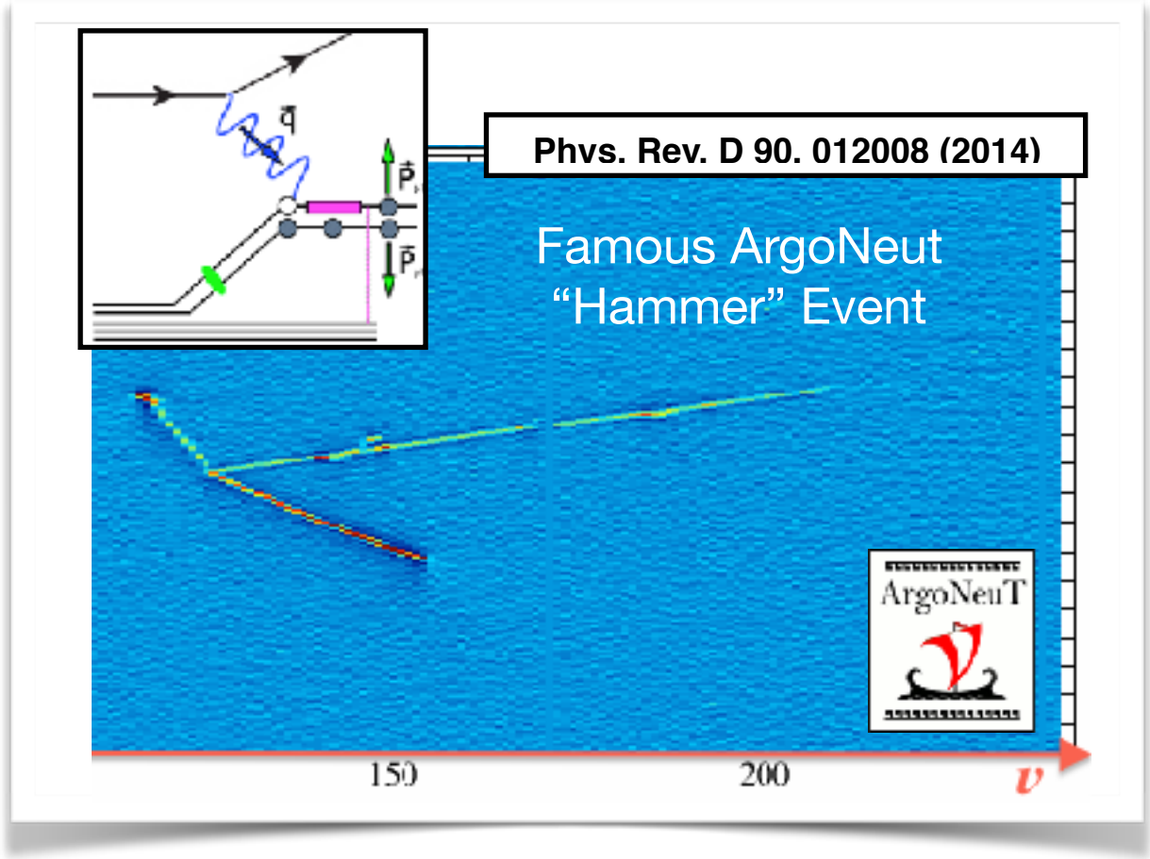
Photo courteous of Maximilien Brice, CERN

More than a Near Detector!

- As a heavy nucleus (A=40), argon is an ideal laboratory for studying A dependent effects of neutrino scattering:







Unprecedented ν-Ar Interaction Statistics

- SBND sits close (100 m) to the neutrino source, provides an immensely intense beam.
- Number of events over 3 years exposure:

$Inclusive : \nu_\mu + Ar \rightarrow \mu^- + X$	**5M Events**
$Single\ p^+ : \nu_\mu + Ar \rightarrow \mu^- + 1p$	**2M Events**
$\pi^\pm : \nu_\mu + Ar \rightarrow \mu^- + N\pi^\pm + nucleons$	**1M Events**
$Inclusive : \nu_e + Ar \rightarrow e^- + X$	**37k Events**
$Inclusive : \nu_\mu + Ar \rightarrow \nu_\mu + N$	**2M Events**

Numbers from GENIE Event Generator

Conclusions

- Short baseline near detector provides a data-driven constraint of multiple models necessary for an oscillation result.
- Multiple uses of SBND:
  - Test bed of new optical detection technology
  - Designing future cryostats.
  - Ambitious cross-section program due to intense beam.
- On pace to begin taking data in 2020.

From all of SBND…

Thank You for your Attention!

The SBND Collaboration

Updated June 2018

Including both scientific and technical personnel

*Spokespeople

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Yale University: B.T. Fleming, D. Franco, E. Gramellini, X. Luo, B. Russell, G. Scanavini, S. Tufanli

The SBND Collaboration

196 Total Collaborators

167 Scientific Collaborators **(faculty/scientists, postdocs, students)**

36 Institutions

23 US Institutions

- 5 DOE national laboratories
- 18 US universities
- University of Puerto Rico

13 International Institutions

- CERN
- 6 UK universities
- 1 Swiss university
- 5 Brazilian universities

Detector Construction Status

Today

Fall 2018

Late 2018

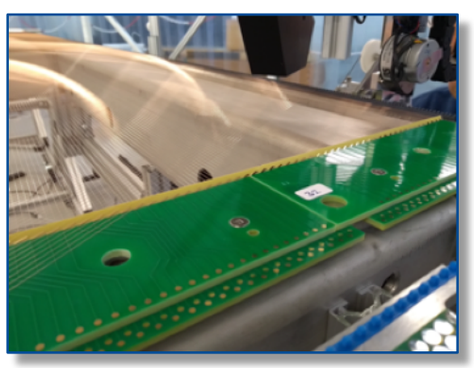
Mid 2019

Late 2019

Mid 2020

Late 2020

1st Wire Planes Finish



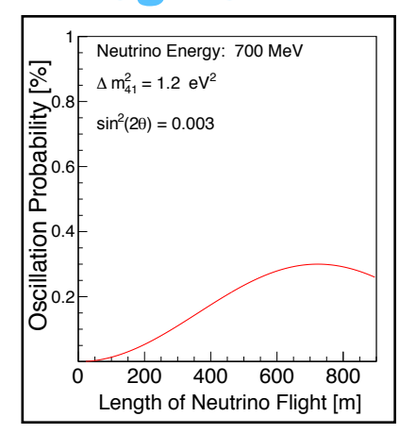
All Wire Planes Finished

Detector Assembled

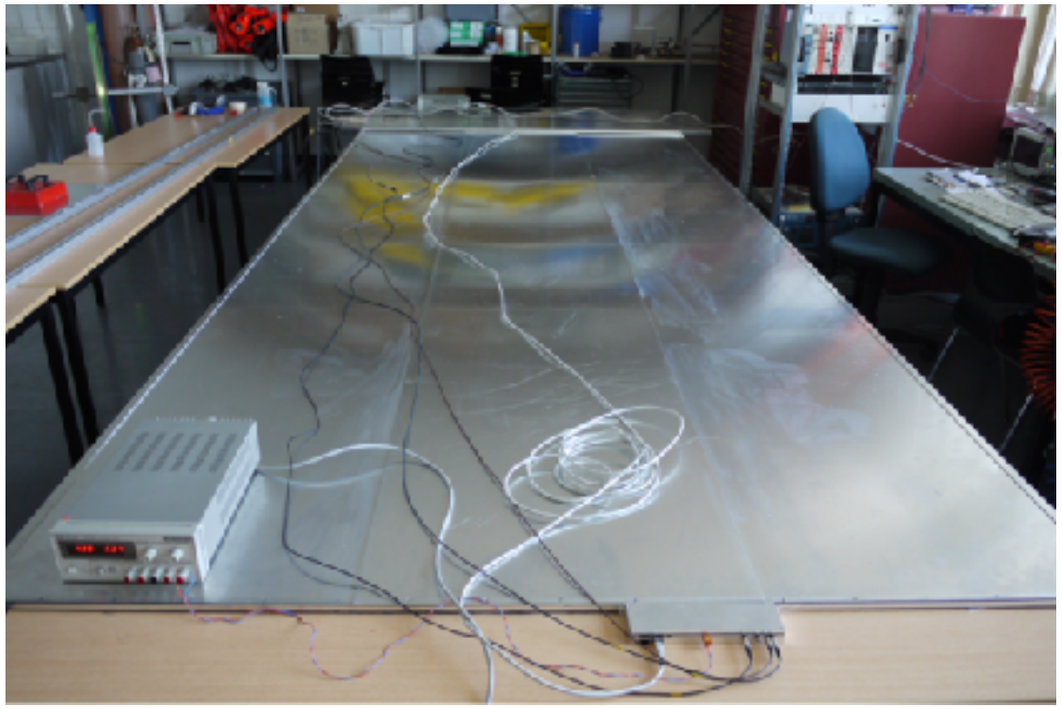
Cryostat Installed

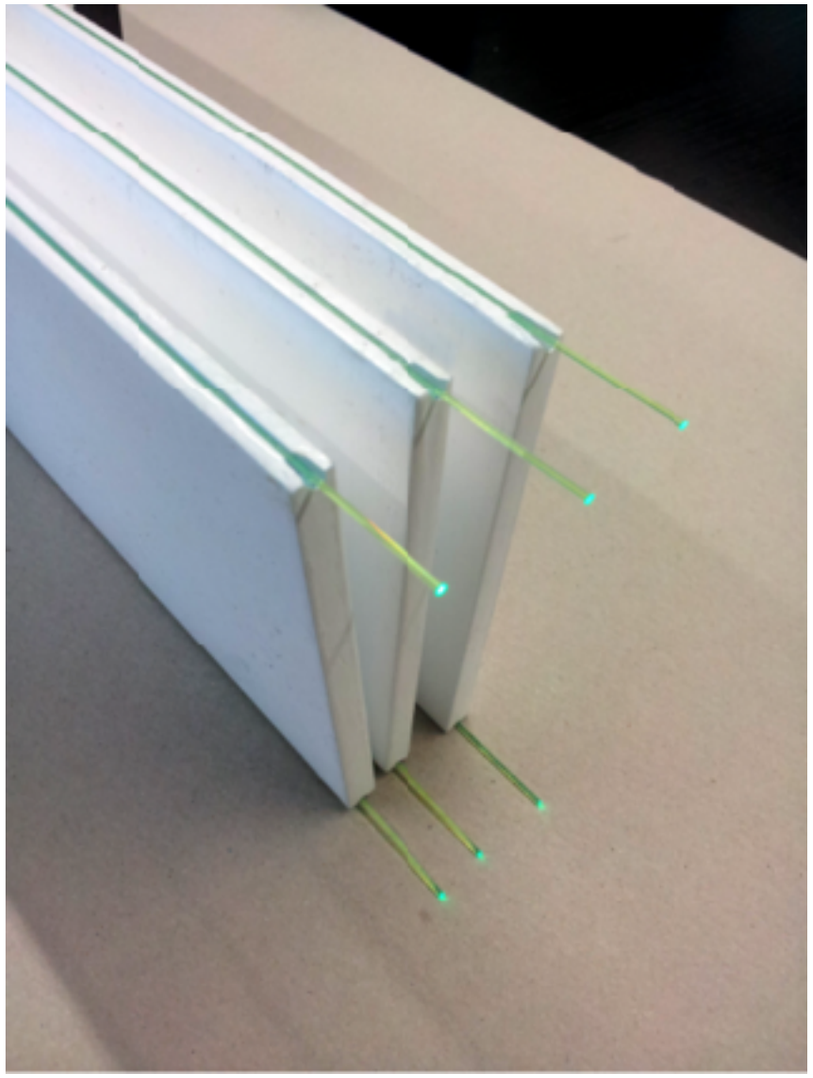
Detector Moved to Cryostat

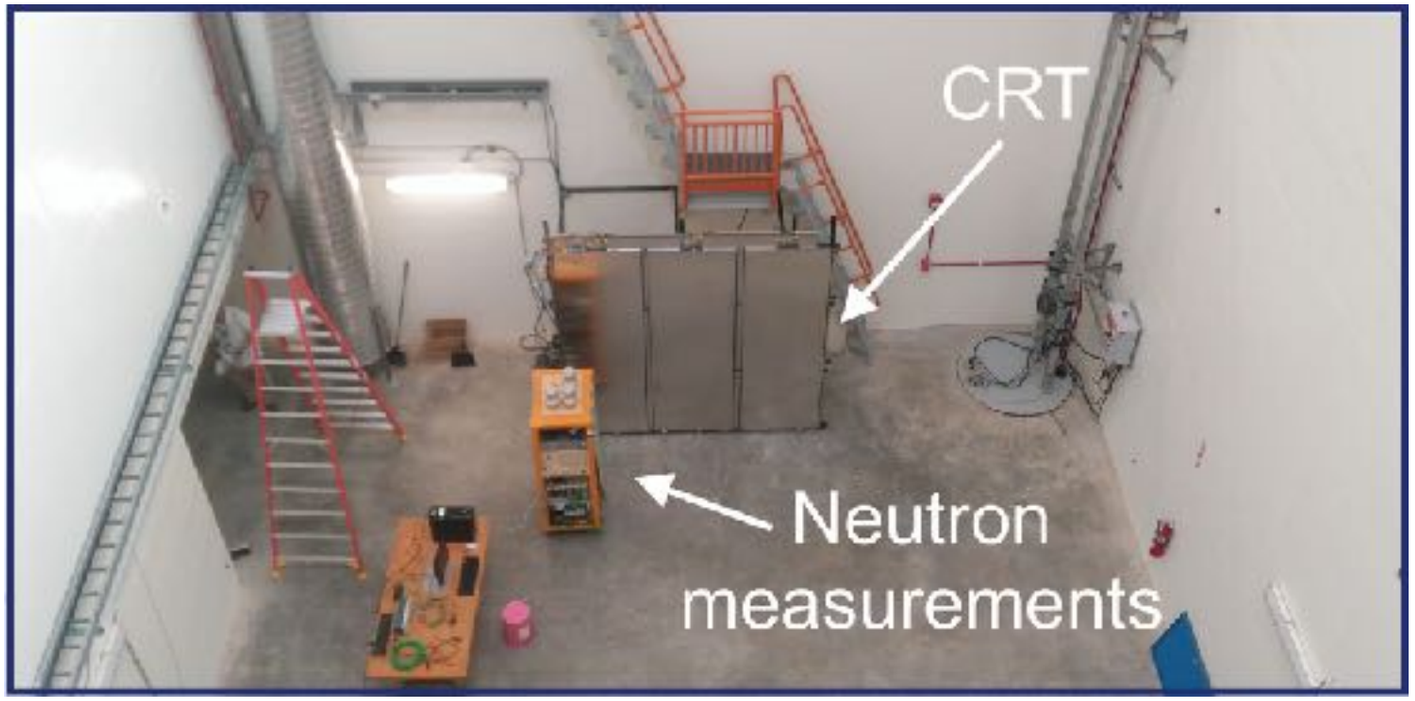
Data Taking Begins!



Cosmic Ray Tagger







- Cosmic Ray modules (top left) taking data in near detector pit, measuring beam induced neutrons.