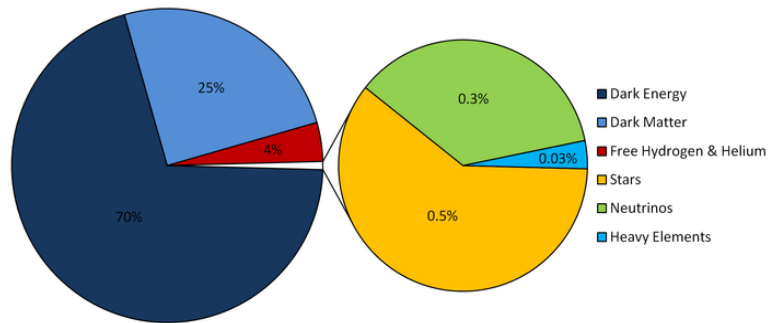


A visualization of particle tracks on a dark blue background. The tracks are composed of small dots in red, yellow, and green, forming a complex, branching structure that resembles a particle detector's output. The tracks start from a dense cluster at the bottom left and extend upwards and to the right, with some tracks branching out. There are also some isolated tracks and clusters of dots scattered across the background.

Bonnie Fleming
Physics Department
Yale Day of Instrumentation
November 16th, 2018

Mega-scale Instrumentation in Particle Physics

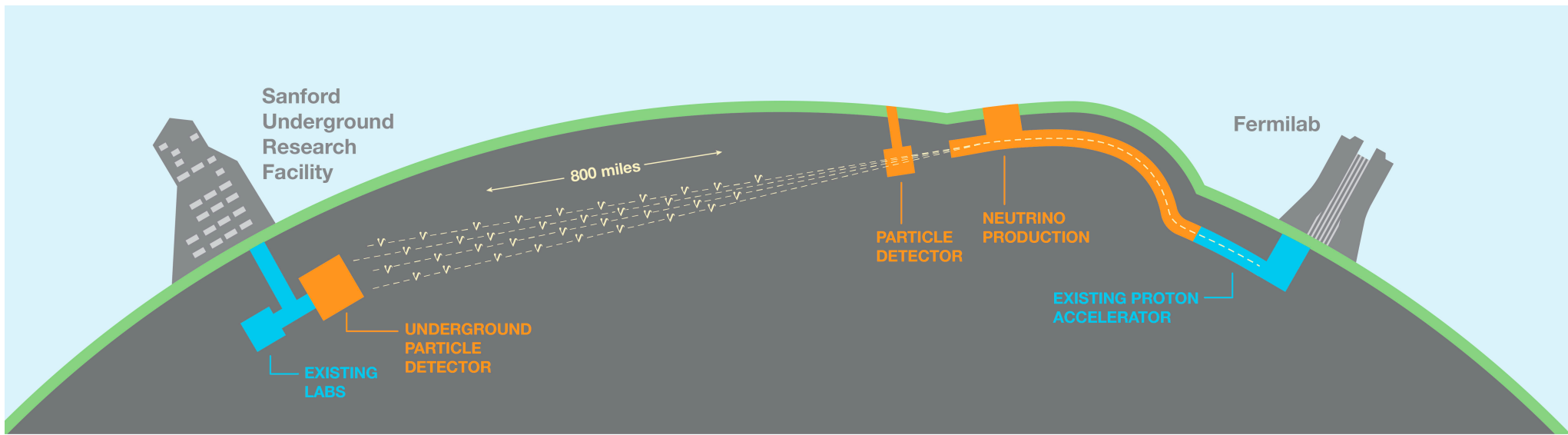
To understand the tiniest particles that make up the universe we often need some of the biggest experiments!

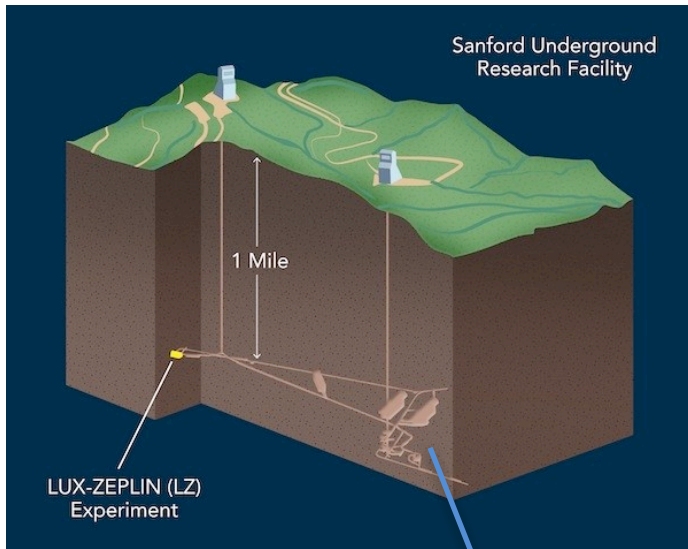


Neutrinos permeate the universe!

The Deep Underground Neutrino Experiment:

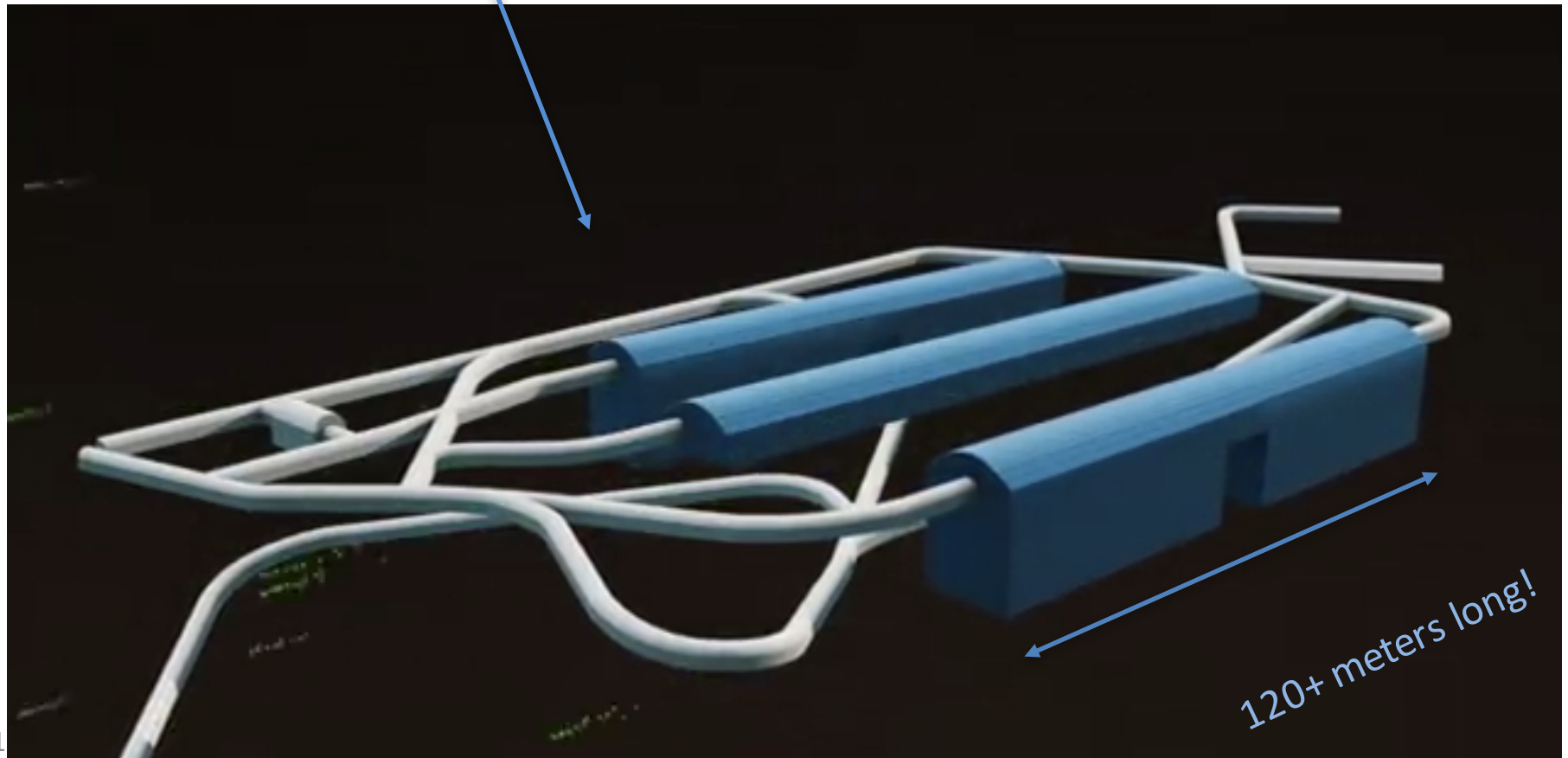
- Send neutrinos from Chicago to South Dakota
- Measure their properties in massive detectors a mile deep underground
- Look for differences between neutrinos and anti-neutrinos.....

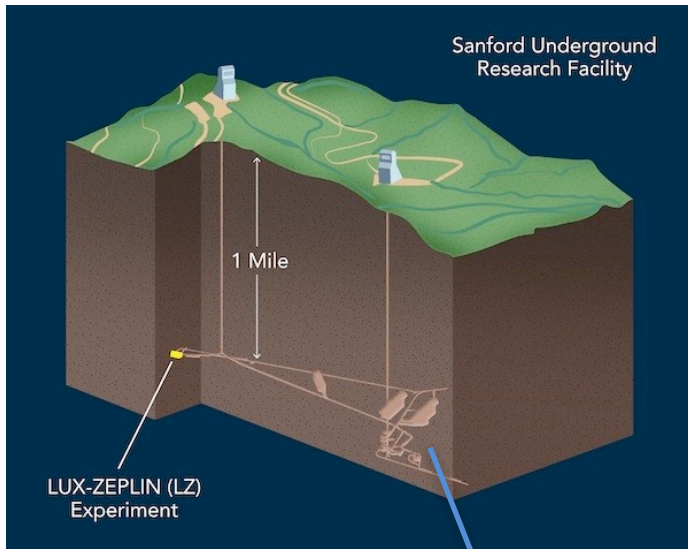




DUNE in South Dakota SURF Laboratory

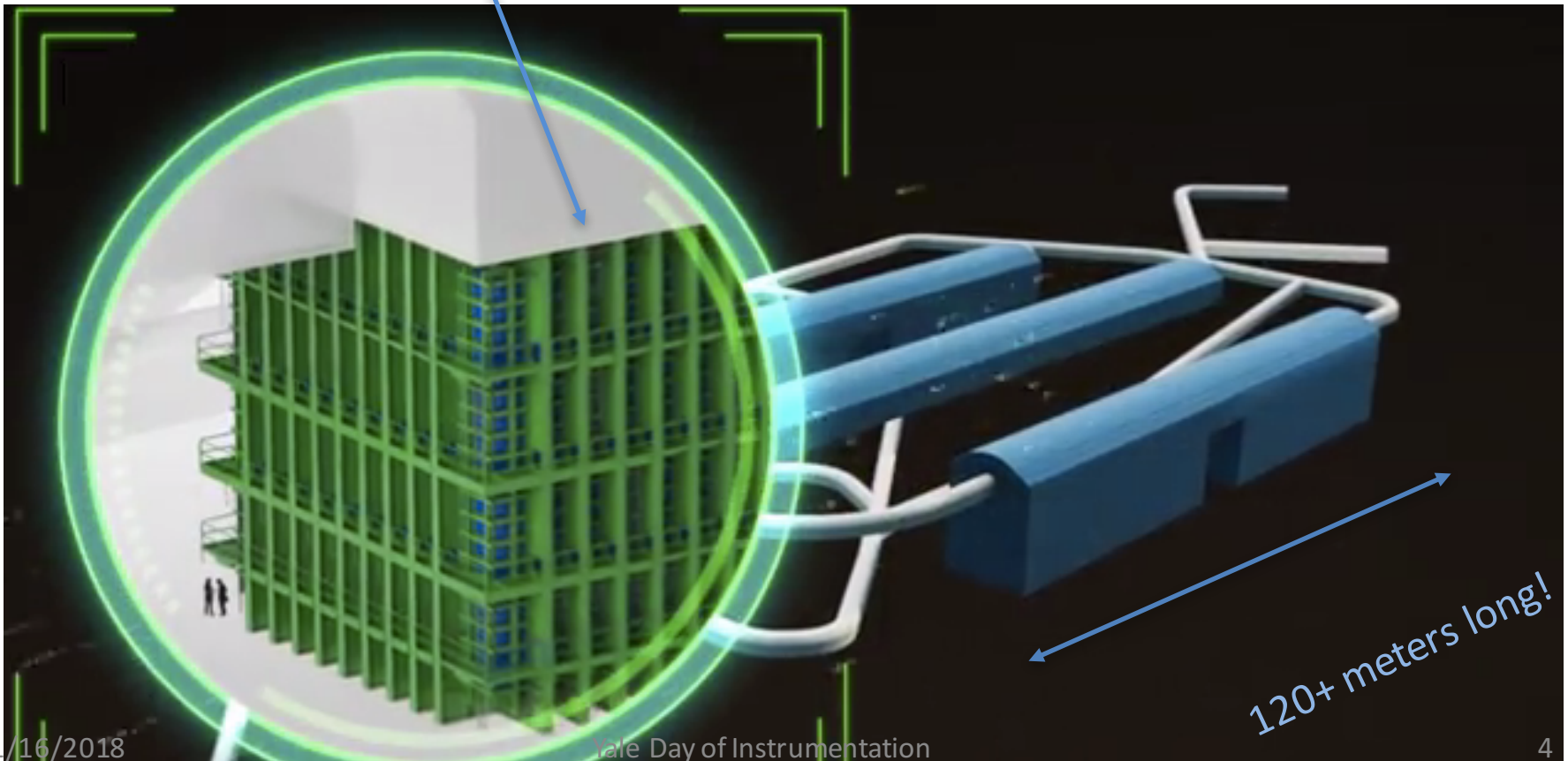
Precision Liquid Argon Time
Projection Chamber built in parts
above ground and assembled 1
mile underground

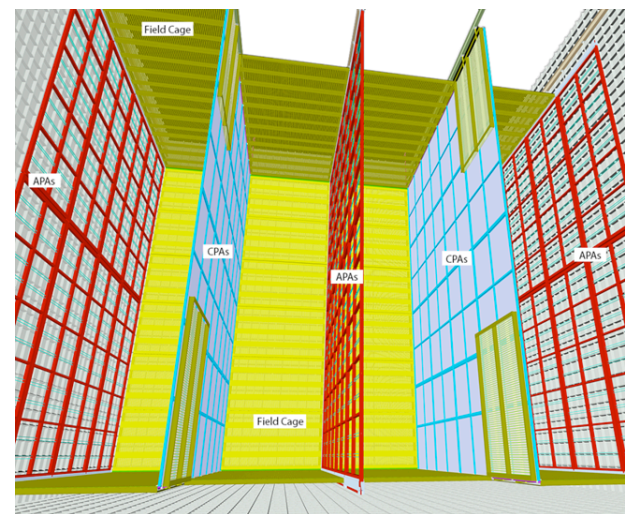
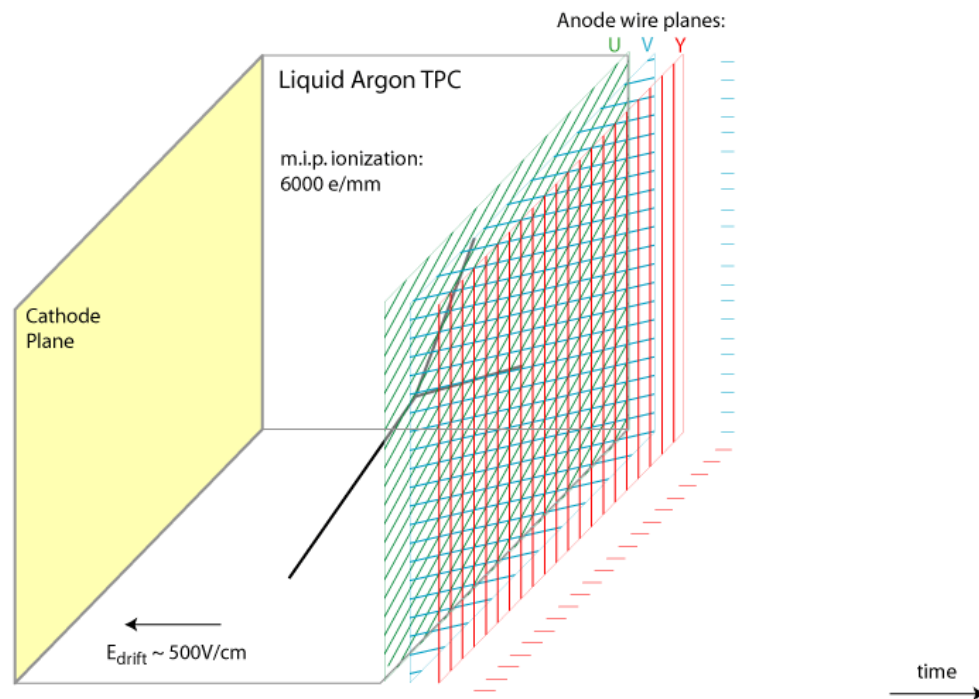




DUNE in South Dakota SURF Laboratory

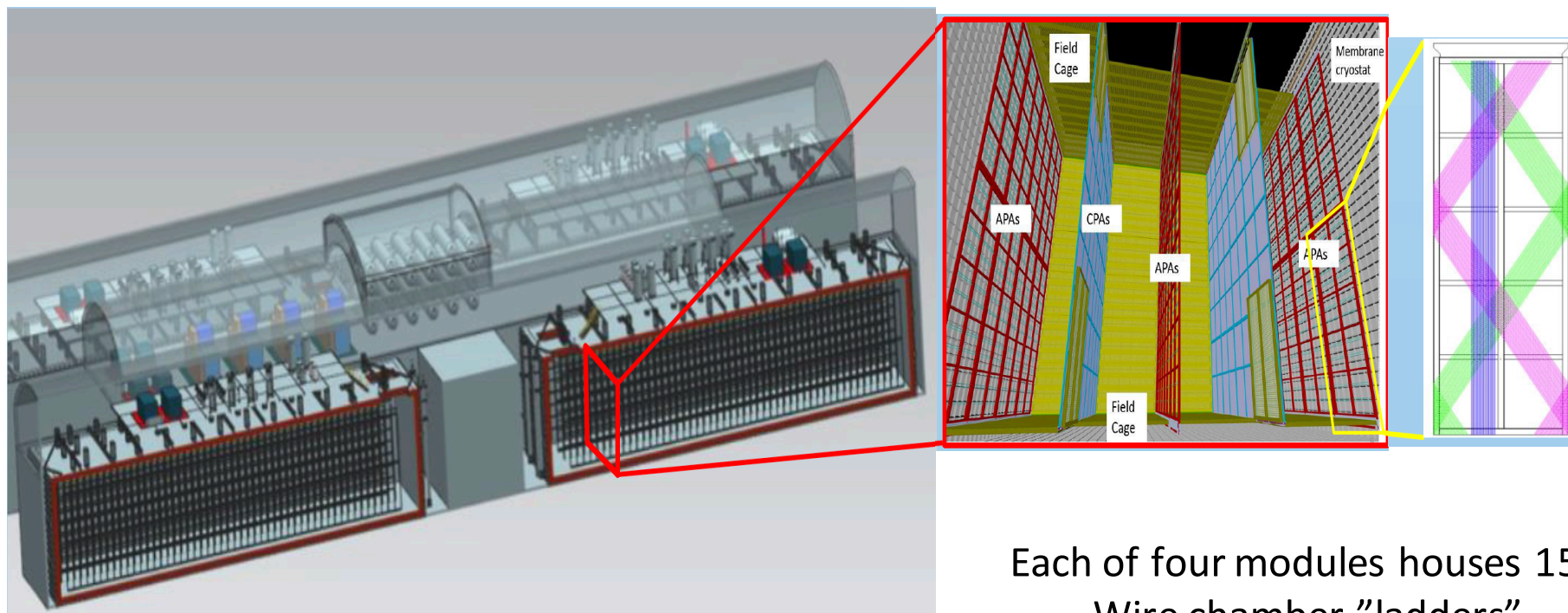
Precision Liquid Argon Time
Projection Chamber built in parts
above ground and assembled 1
mile underground





DUNE Liquid Argon Time projection Chamber

- Operate in Ultra pure Liquid Argon (~ 10 s of parts per trillion impurities)
- Drift charge over 5m to wire chamber planes with $\sim 150\text{kV}$ E fields
- 3 planes in xyz are strung with $150\mu\text{m}$ wire at 3mm pitch
- Signals amplified and multiplexed in detector
- Light collection devices housed between adjacent planes
- Components must be constructed with requirement of no broken wires
- Assemble in components sized to lower down mine shafts



Each of four modules houses 150
Wire chamber "ladders"

Yale will be one of four worldwide sites to
develop and construct these chambers

Requires:

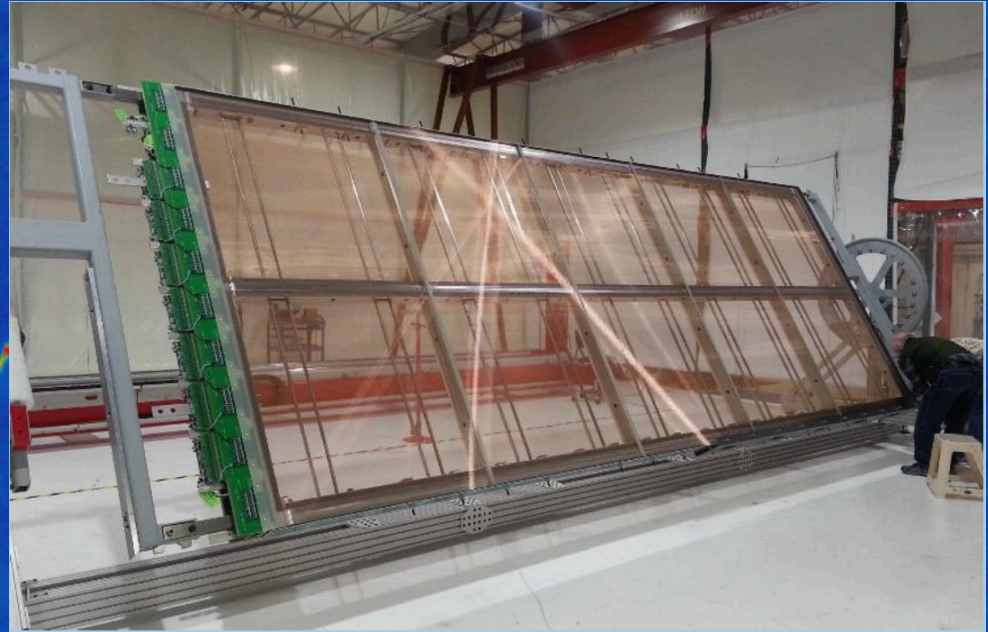
- Mechanical and Cryogenic engineering expertise
- Technical expertise
- Project execution planning
- Teams of Students and PDs to participate in construction and assembly

11/16/2018

Yale Day of Instrumentation

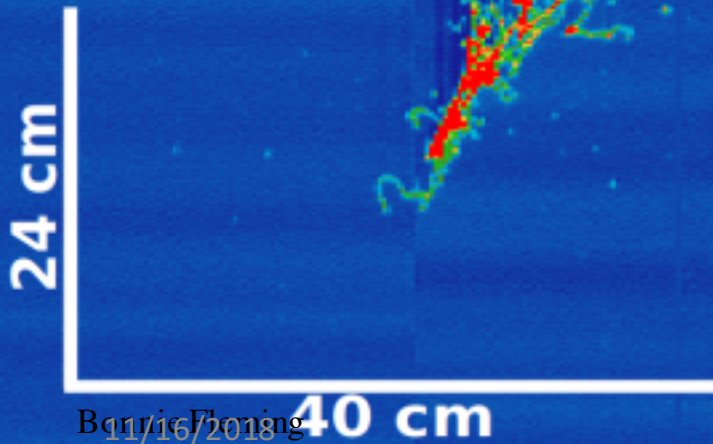


Neutrino Physics with Precision Instrumentation at Yale



millimeter scale resolution for
building sized detectors

Yale to host facility to design,
develop and construct wire winders
and wire chamber instrumentation



Bonnie Fleming
11/16/2018

Yale Day of Instrumentation

Run 1153 Event 40. Au