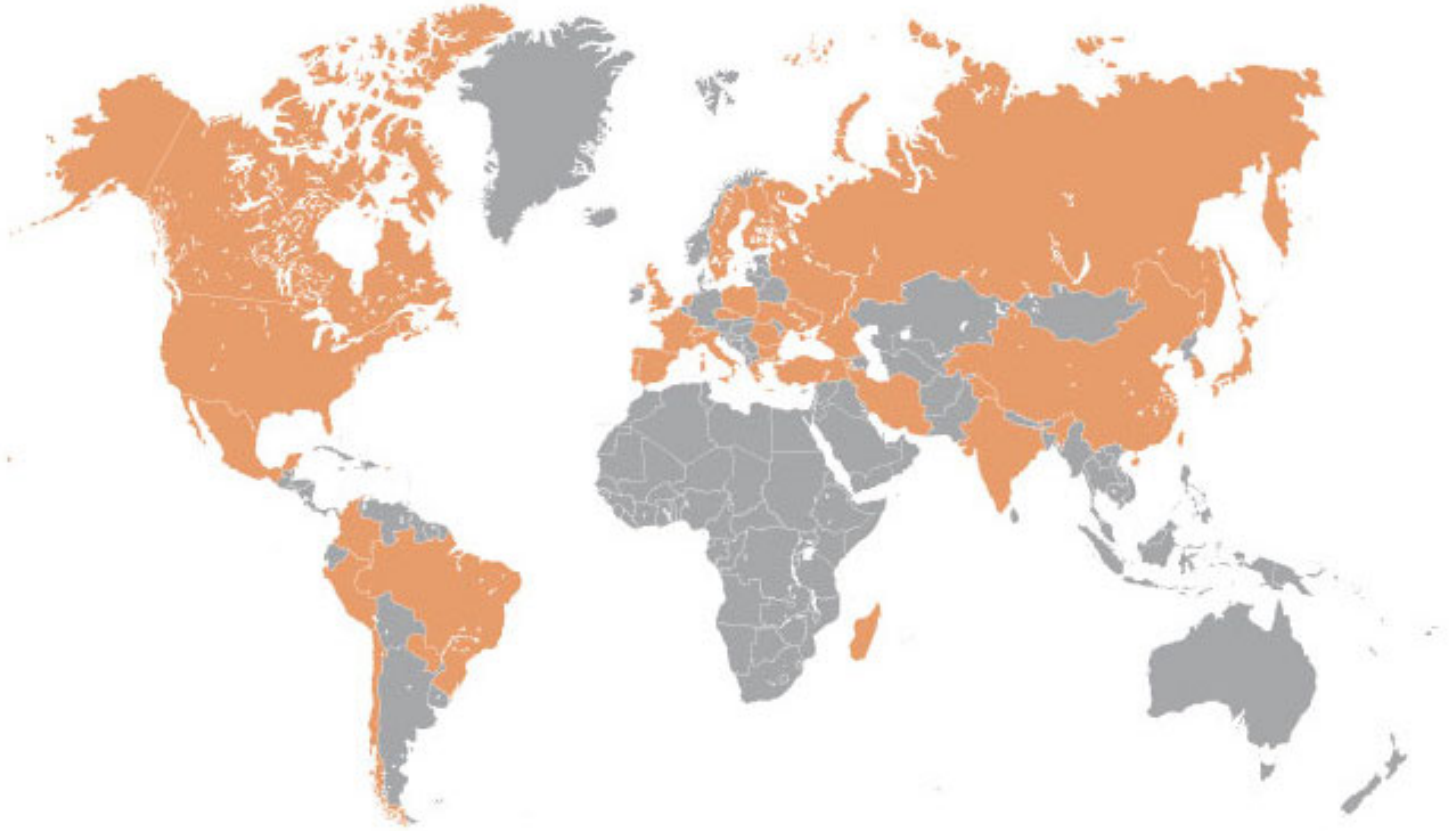


DUNE COMPUTING AND GLOBALIZATION

Heidi Schellman, Oregon State University
For the computing teams

10/6/18

Outline

- Why we are doing this
- What we are doing
- The plan

2 different views of the same neutrinos

ν_e

ν_μ

ν_τ

Flavor Basis
(Interactions)

ν_1

ν_2

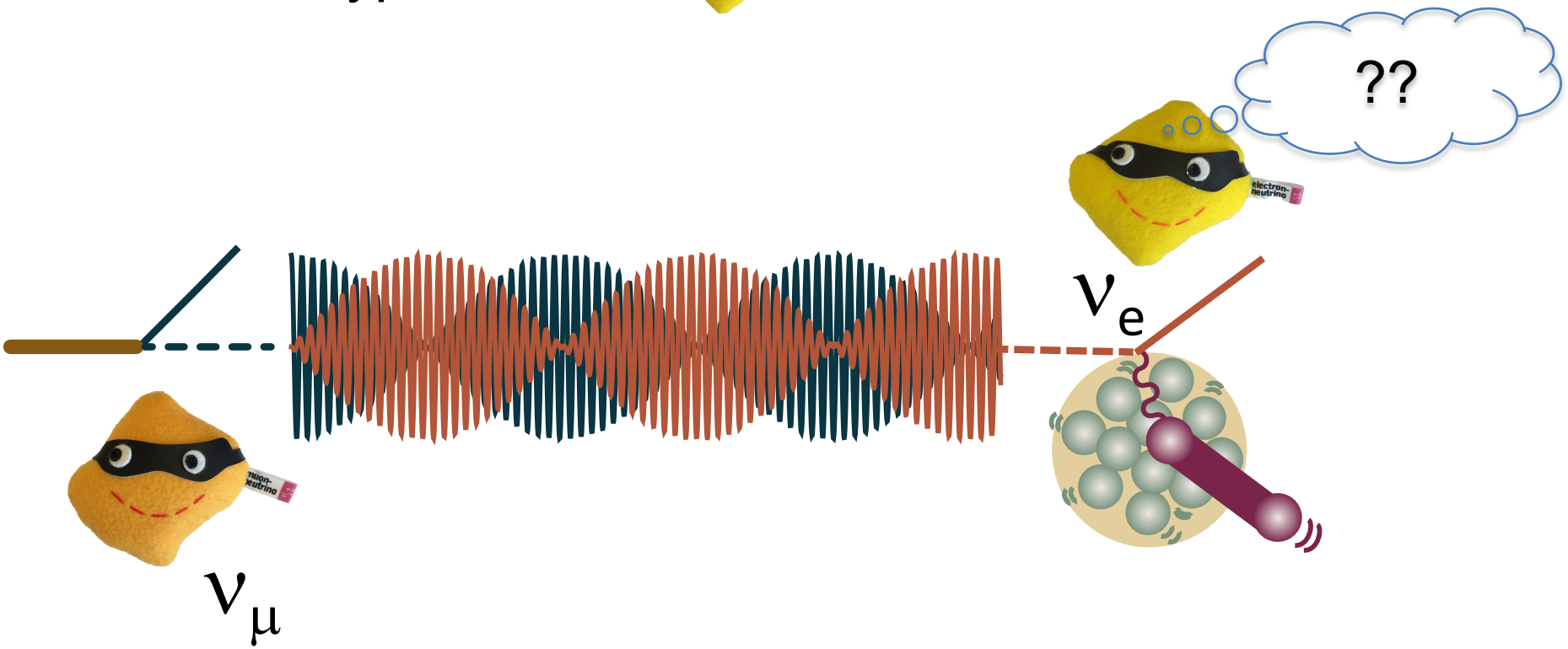
ν_3

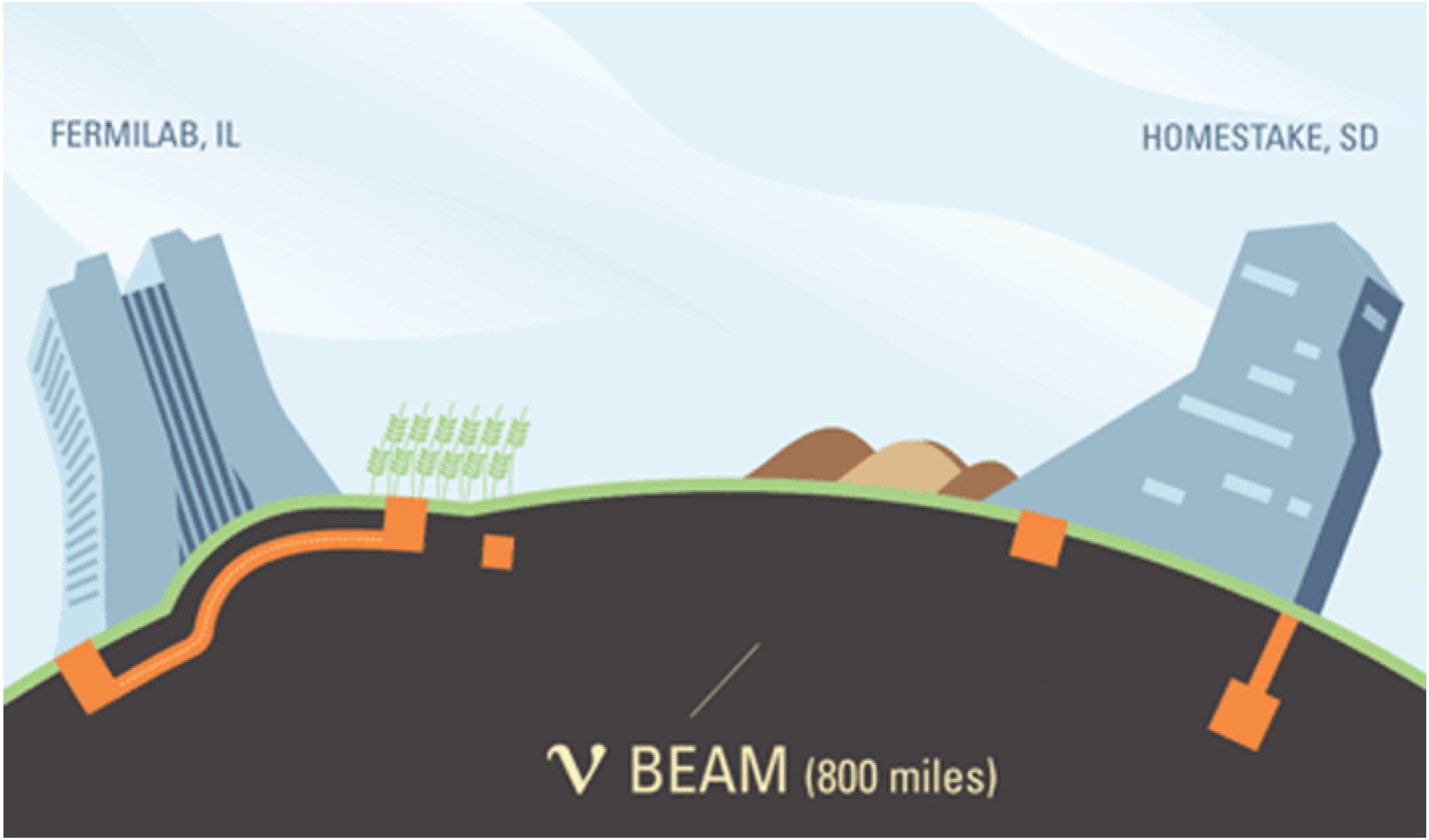
Mass Basis
(Motion)

Particlezoo.net

The quantum wavelength of a 2 GeV muon neutrino is ~ 10^{-10} m
But it is actually a superposition of the 3 mass types of neutrinos which have slightly different wavelengths – the beat wavelength between the types is about 2000 km.

Bottom line – propagation can change a muon type neutrino into an electron type neutrino





Plan is to put a future huge LAr detector “DUNE” in the Homestake Gold Mine

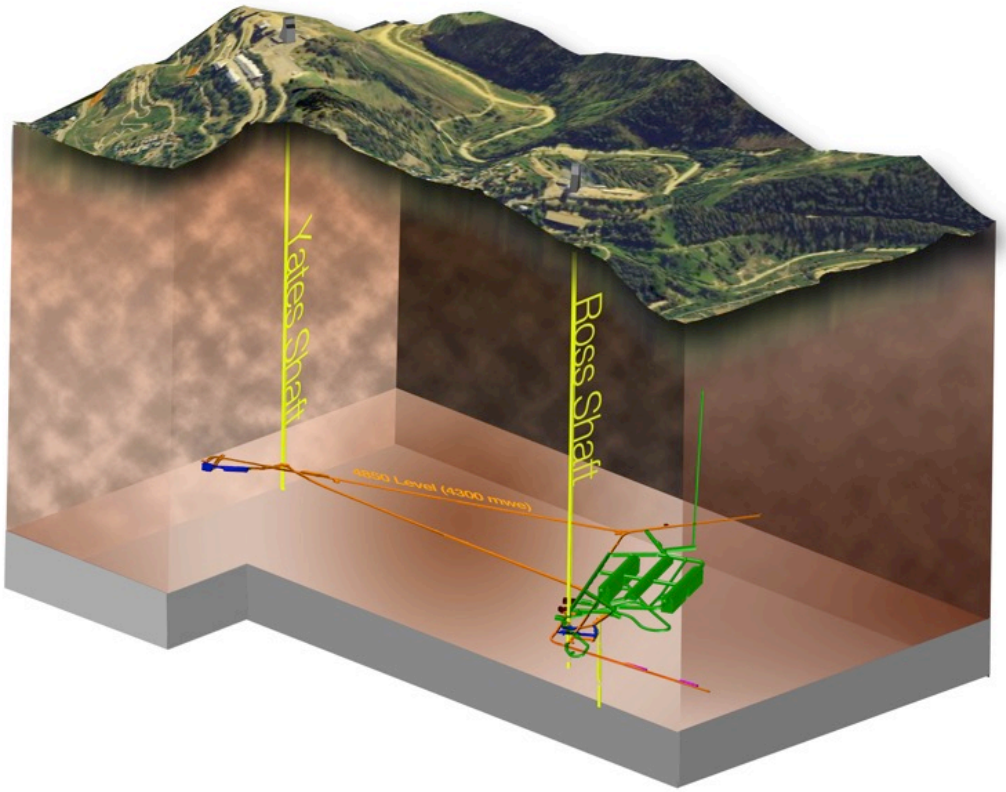
Actual route

This is on the route for the Southwest PDX/MDW flight

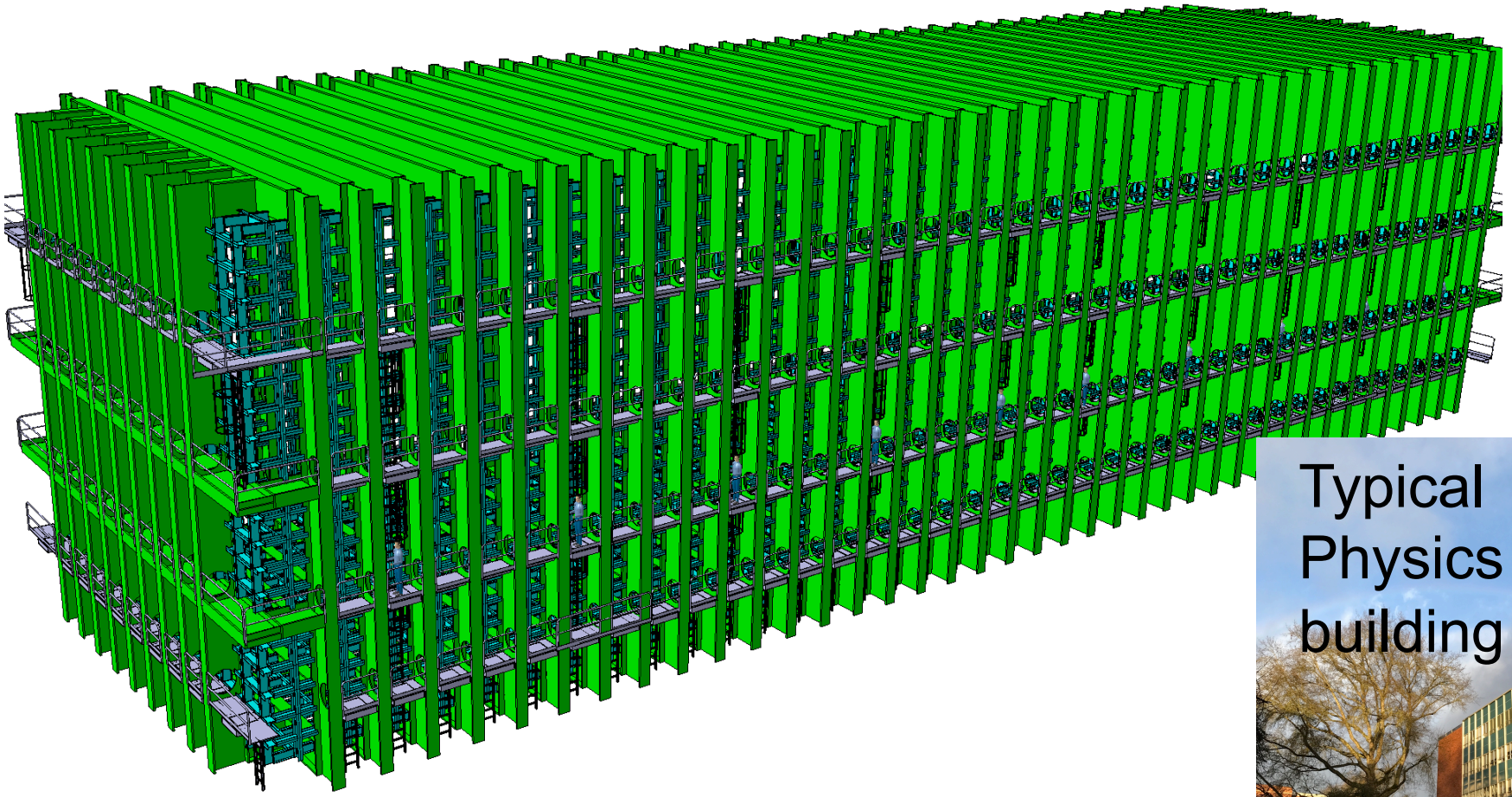
Underground Laboratory

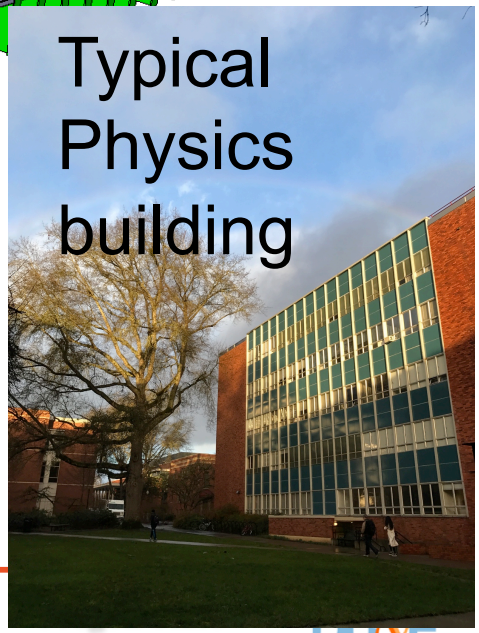
DUNE Far Detector site

- Sanford Underground Research Facility (SURF), South Dakota
- Four caverns on 4850 level (~ 1 mile underground)



4 of these – filled with liquid Argon



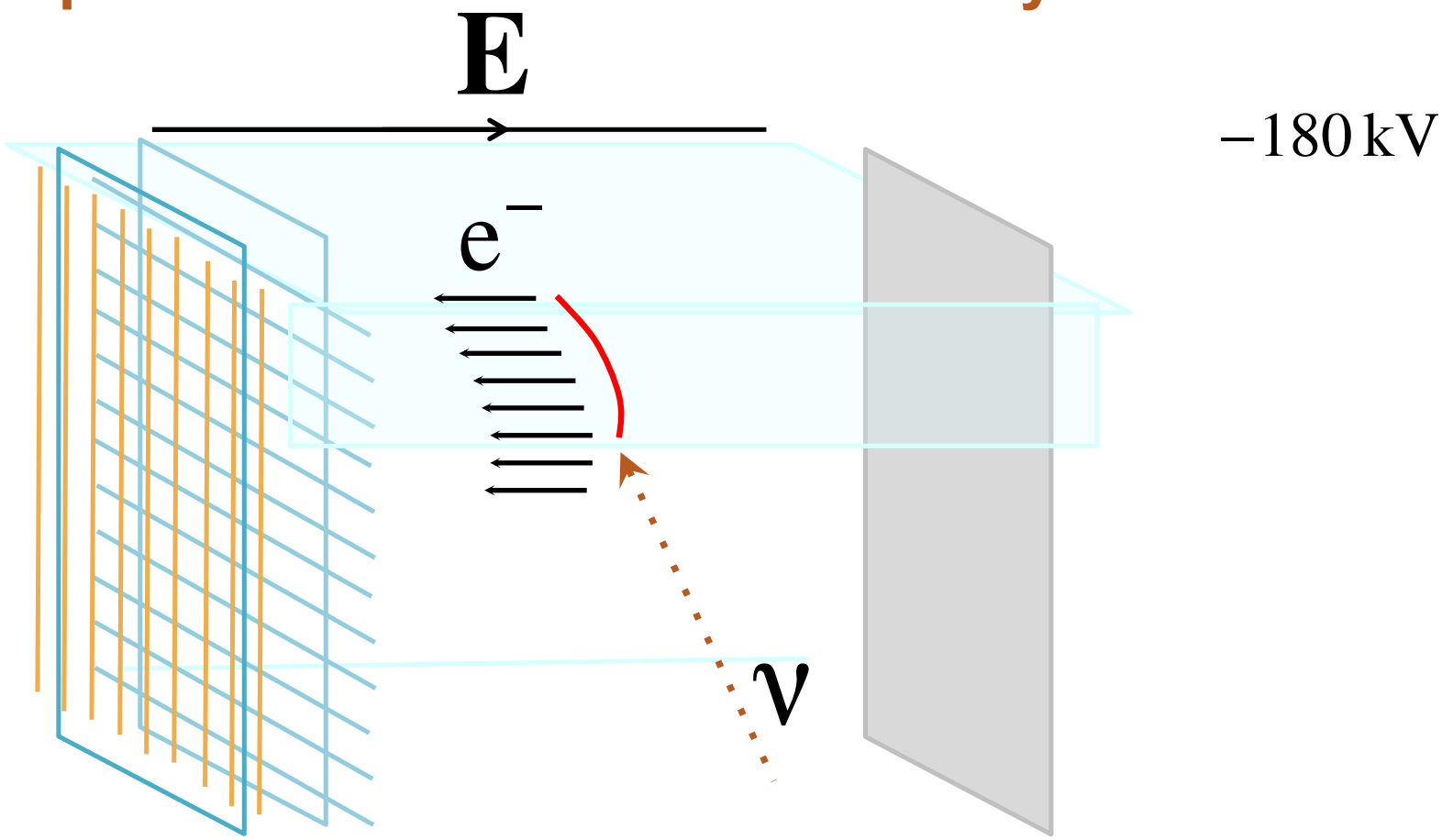


External Dimensions: 19.1m x 18.0m x 66.0m

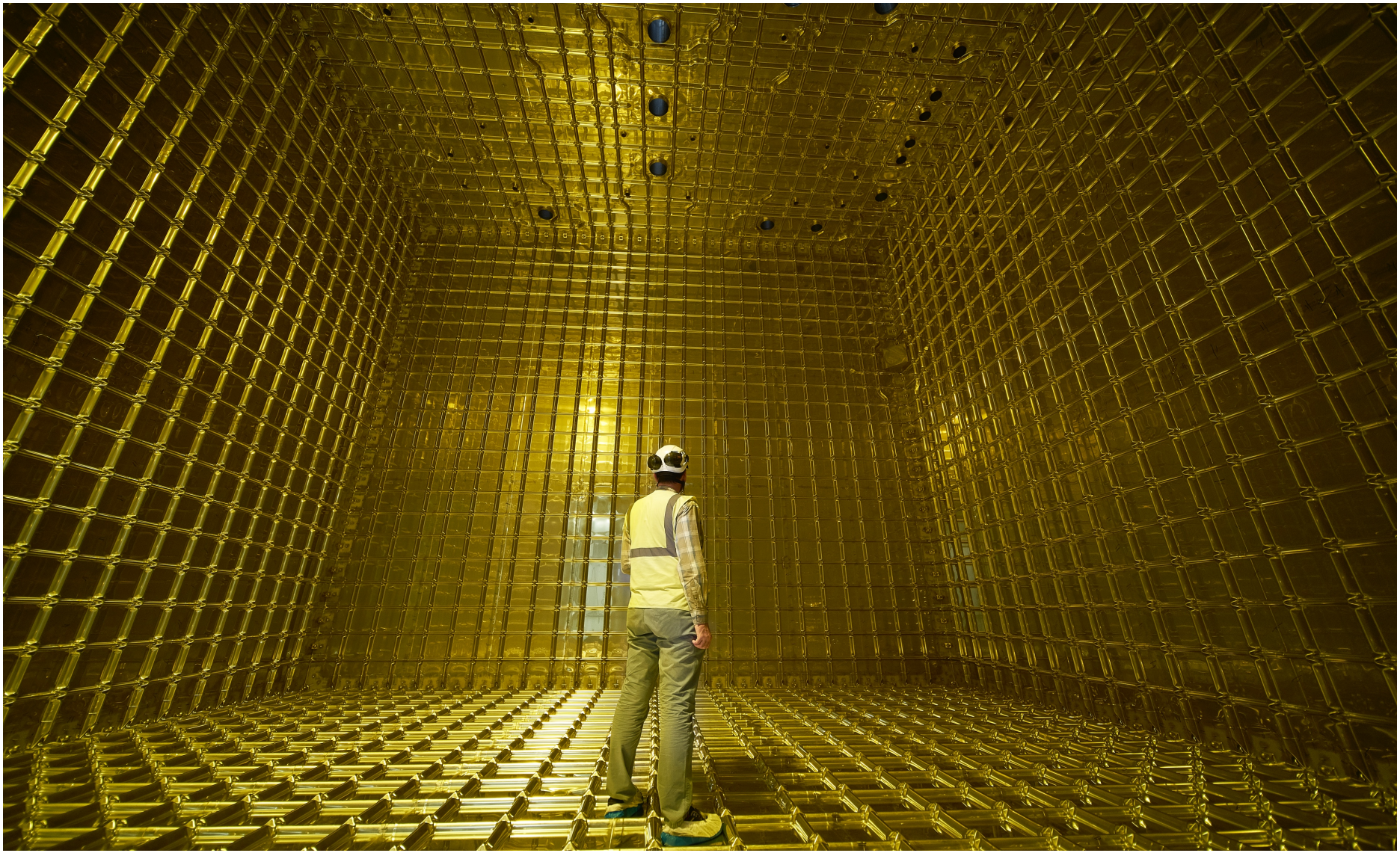
University

Liquid Argon TPC Basics

- **Large tank of Liquid Argon**
- **Apply electric field**
- **Charged particles leave ionization which you then collect.**

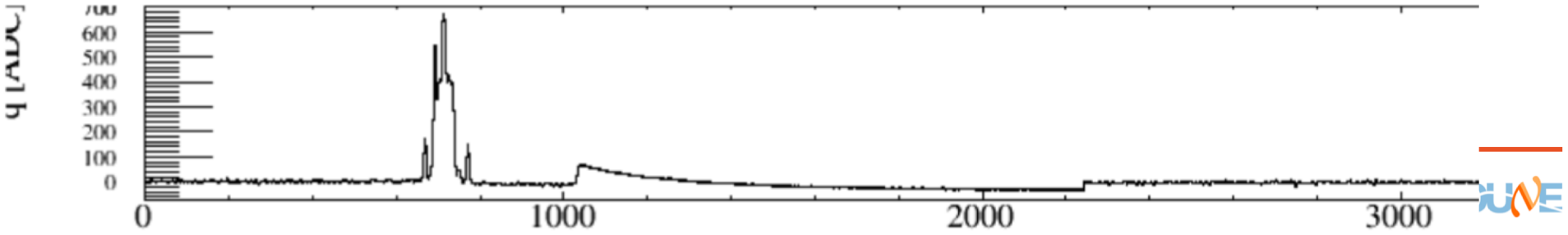


Build a “small” prototype @CERN

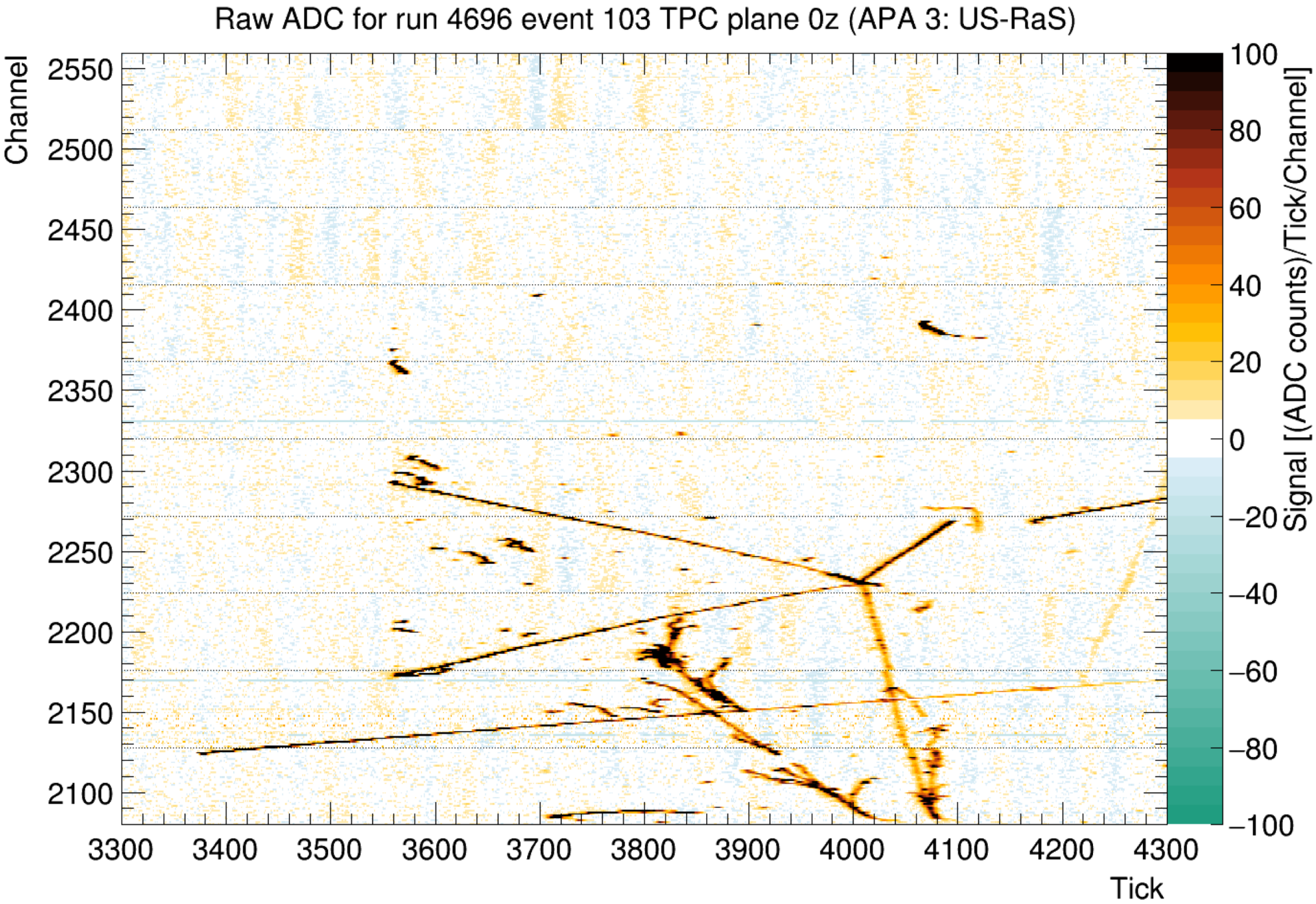


ProtoDUNE is running @CERN

- Two walls of the cryostat are covered with 3 planes of wires spaced 0.5 cm apart. Total of **15,360** wires
- The electrons take ~ 3msec to drift across and you need to detect and time them for the full time
- Each wire is read out by 12-bit ADC's every 0.5 microsecond for 3-5 msec. Total of around **10,000** samples/wire/readout.
- Around **230 MB/readout.**
- ProtoDUNE is running now and reading out at **10-25 Hz**
- The issue – this is a **1%** prototype of the real beast!
- The big one won't read out as often….

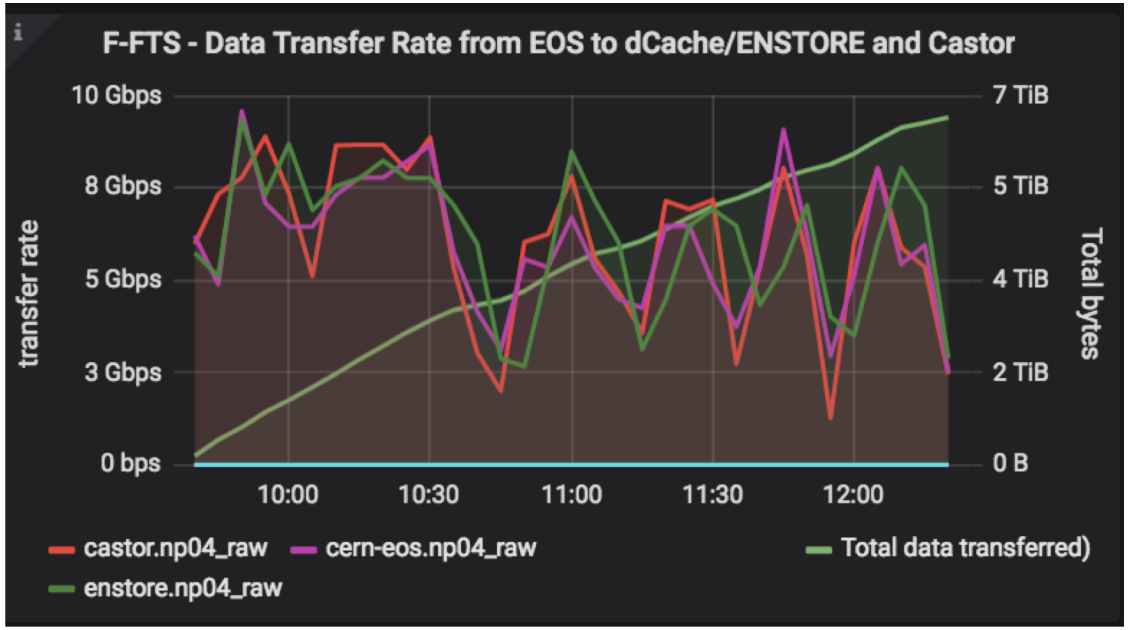


Raw data


Raw ADC for run 4696 event 103 TPC plane 0z (APA 3: US-RaS)
Channel
2550
2500
2450
2400
2350
2300
2250
2200
2150
2100
3300
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
Tick
100
80
60
40
20
0
−20
−40
−60
−80
−100
Signal [(ADC counts)/Tick/Channel]

The computing problem

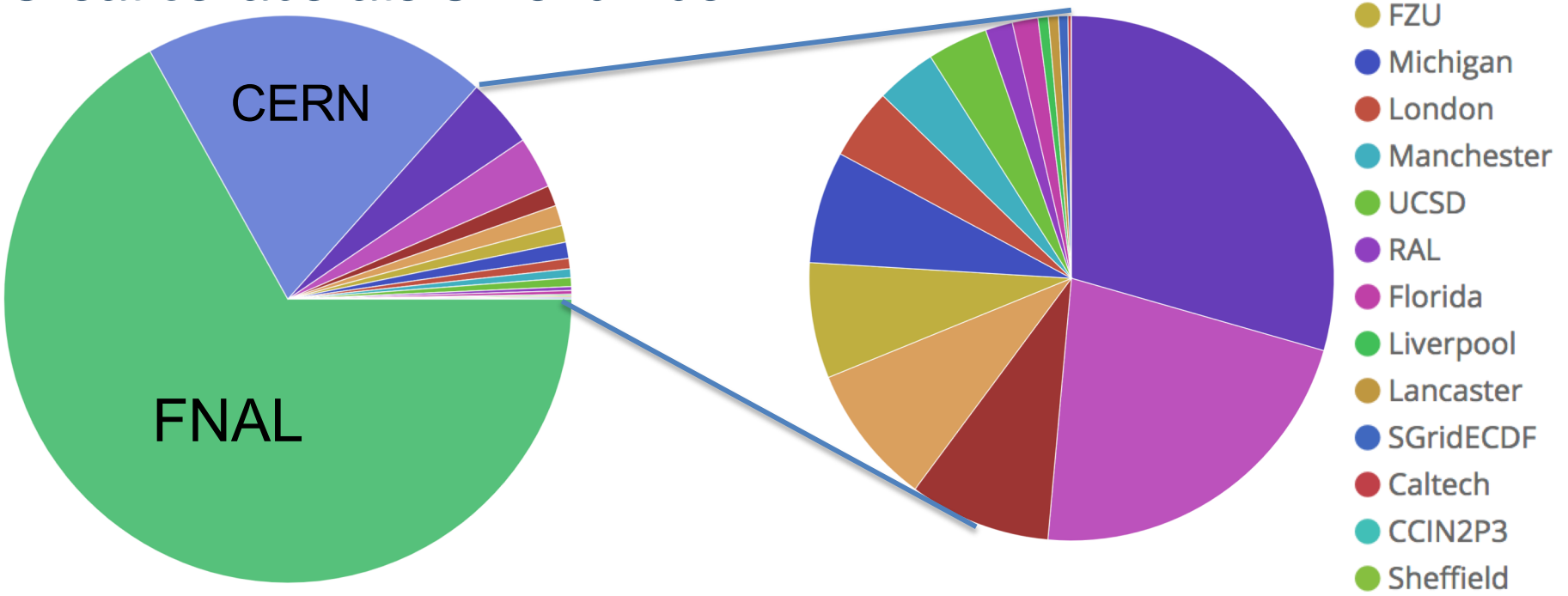
3 hrs of raw data transfers from CERN->FNAL on Friday



- ProtoDUNE can write up to 2-3 GB/sec of data when running at 25 Hz beam.
- Expect 2-5 PB of raw data from the 6 weeks of running this fall + more from additional cosmic running + ProtoDUNE-DP
- Big DUNE will write 10-30 PB/year from the far detectors and probably more than that from the near detector.
- Instantaneous rates are already >= CMS/ATLAS.
- Integrated rates in 2026 will be where ATLAS/CMS are now

Good news

- We’re smaller than LHC– but not tiny.
- A lot of infrastructure for worldwide computing already exists and we are already using it.
- Great collaborators worldwide!



Not so good news

- Much of the LHC infrastructure is experiment specific and reflects N years of desperate work by dozens of people to keep up!
- We're just starting.. And we're already running at high rate!

The LHC solution the WLCG

- LHC computing structure
  - Common infrastructure
  - Technical decision process
  - Allocation of resources
  - Central operation teams funded by collaboration resources (security/networks …)
- Works well but the LHC is the 500 pound gorilla!

The plan

- Forming a DUNE consortium of interested parties to work on DUNE strategy, assemble resources and make technical decisions
- Where it works, collaborate with the broader HEP and Astrophysics communities on common tools and infrastructure
  - Grid jobs
  - Data management (Rucio!)
  - Authentication!
  - New coding methodologies

The Goal(s)

- Record, reconstruct and analyze the ProtoDUNE data ASAP
- Prepare a CDR for full DUNE (x100 in size) which starts taking data in 2026
- Work with other experiments SKA/LHC/HyperK/LSST/SBND to have robust, global shared strategies
- Get the 400 lb gorilla into the club so we're ready for beam and supernovae

Current status of Consortium

- Many institutions are already contributing resources!!!!
- Setting up a directory of institutional contacts and resources
- Setting up a formal structure for technical decision-making
- Setting up a formal structure for resource contributions
  - Hardware (cores/GB)
  - Operations (people to keep it all running)

Three-fold way

Facilities	Technical	Operations
National infrastructure	DUNE standards	Lab support
Funding agencies	Common tools	Common costs
	New architectures	Collaborators

This workshop

- Explore use cases for data storage and processing
- Integration of computing facilities for DUNE
  - Find and stomp on all the administrative bugs that make it hard
  - And then it generally works at speed!
- Identification of future common projects
  - Rucio/Sam integration
  - Resource management for jobs
  - Less annoying authentication methods
  - Models for multi-core processing
  - HPC's?