VD FC Module-Assembly Workshop
FC Overview and DUNE Timeline

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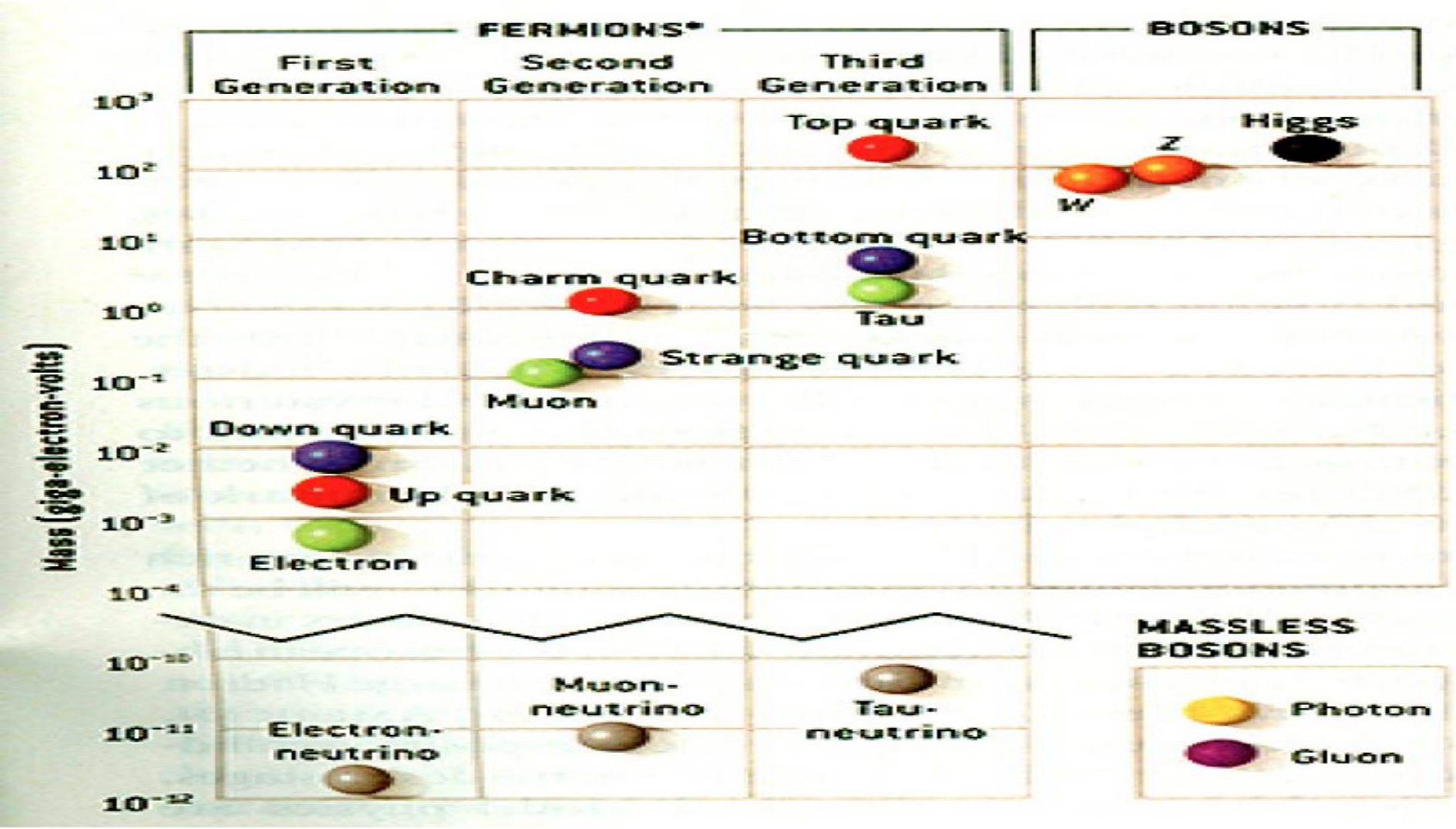
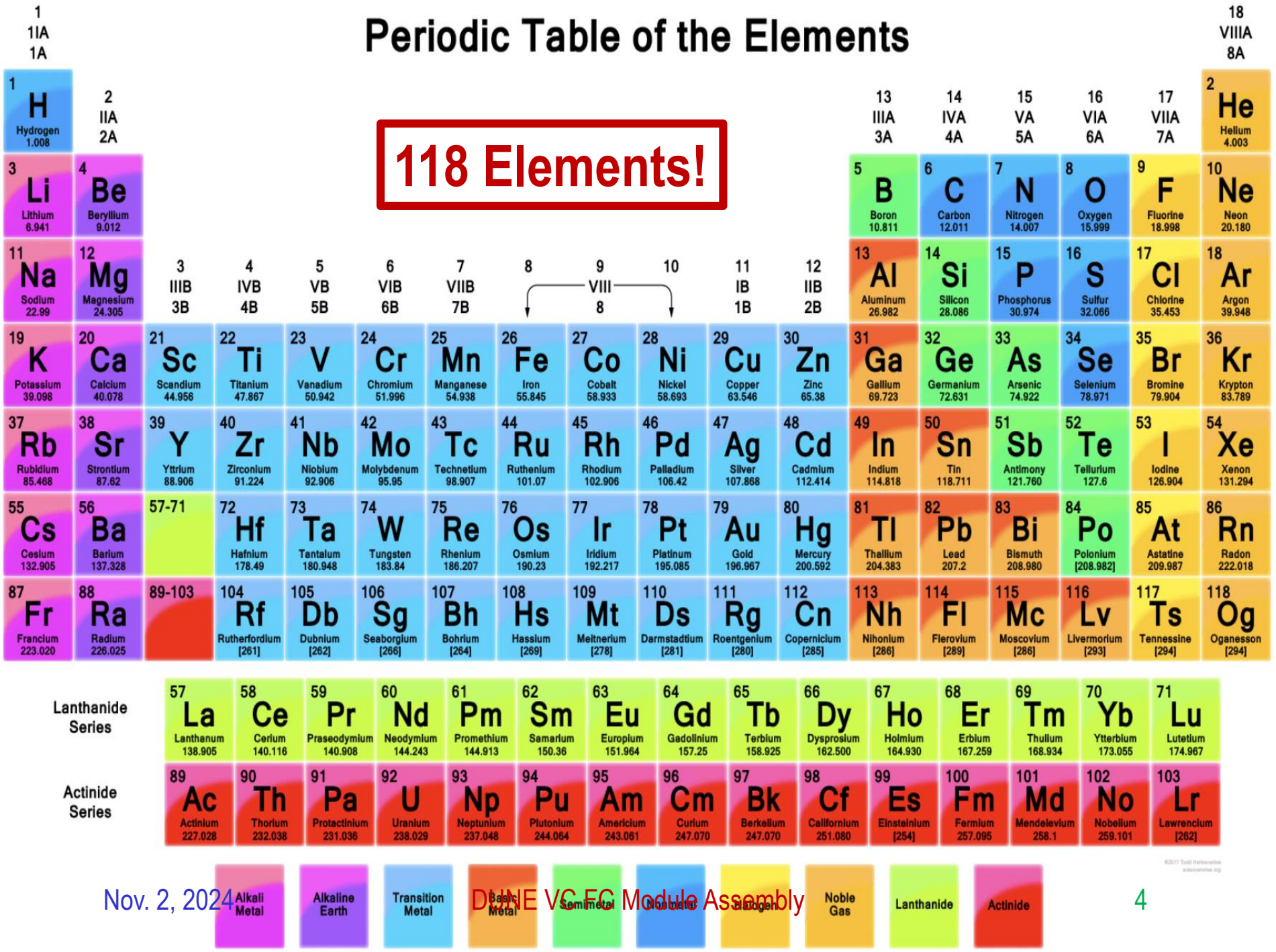
Workshop Fundamentals

- Goals : To learn the VD FC module assembly and QC procedure and to decide on the assembly table height
- Tasks to complete in the workshop
  1. Understand the scope and the tasks involved in FC assembly and the module QC
  2. Hands-on training of the module assembly procedure and complete the procedure documentation
  3. Exercise the module QC procedure, exercise recording them into the QC iPADs and complete the QC procedure documentation

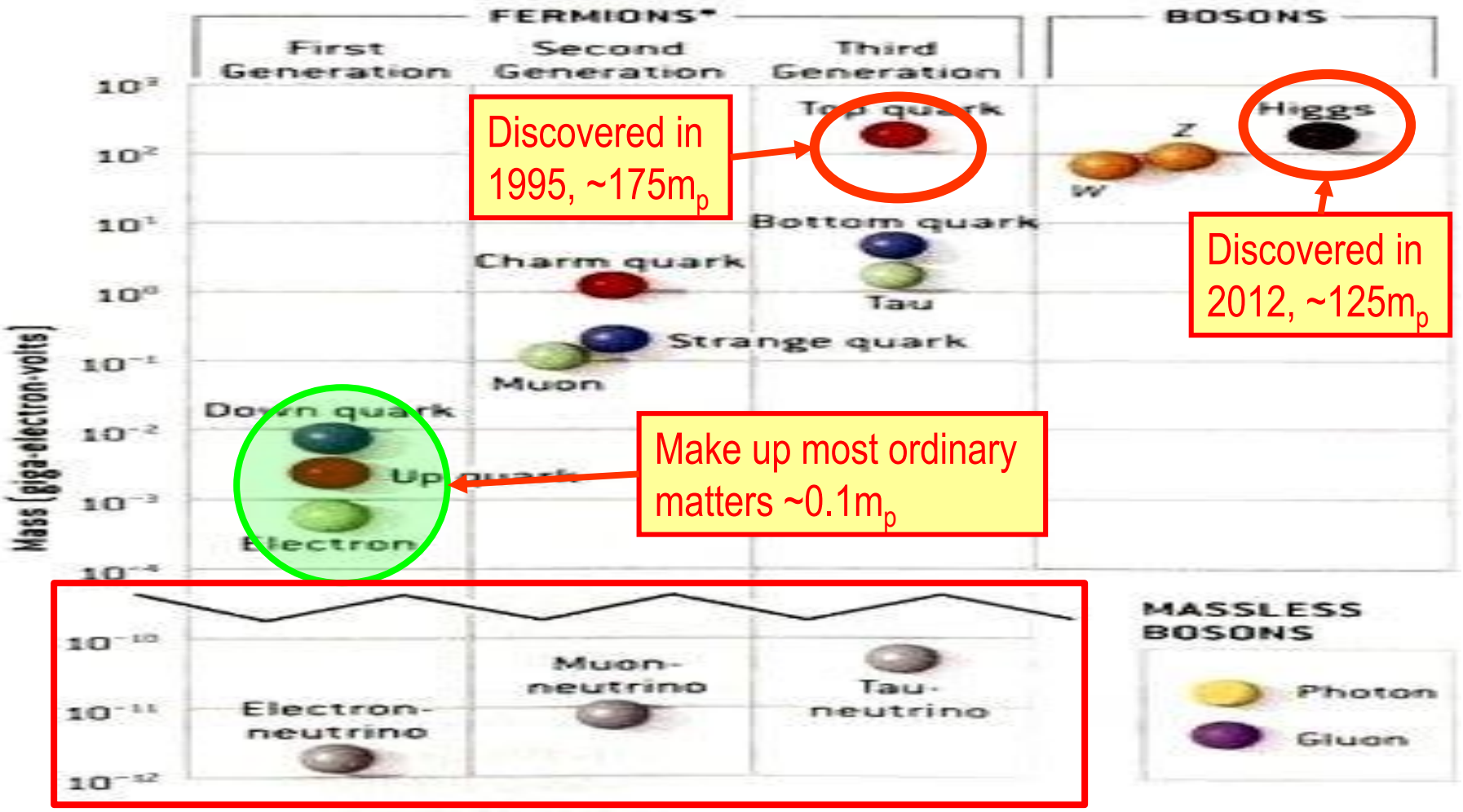
The SM Fundamental Particle Table



- Total of 12 particles, 4 types of force mediators and the Higgs make up all the **visible** matter in the universe! → Simple and elegant!!!


Periodic Table of the Elements
118 Elements!
Lanthanide Series
Actinide Series
Alkali Metal
Alkaline Earth
Transition Metal
Basic Metal
Semimetal
Nonmetal
Halogen
Noble Gas
Lanthanide
Actinide

HEP and the Standard Model



- Total of 12 particles, 4 types of force mediators and the Higgs make up all the visible matter in the universe! ➔ Simple and elegant!!!
- Tested to a precision better than 1 part per million!

Neutrino fundamentals – 1

- Postulated in 1930 to explain the nuclear β-decay and detected experimentally in 1956 (**1995 Nobel**)
- Fundamental particles of matter in the current Standard Model of Particle Physics
  - Makes up a quarter of the whole particle table in TSM as **massless particles**
  - Have three flavors – electron (ν_e – **2002 Nobel**), muon (ν_μ – **1988 Nobel**) , and tau (ν_τ) types
  - Charge neutral and only interact via the weak force ➔ do not interact often in matter

Neutrino fundamentals – 2

- Large numbers of low E neutrinos (ν_e) produced in the Sun (**2002 Nobel**) and in reactors
  - ➔ 65×10^9 ν_e /s/cm^2 (FFT: how many passes throughout your body/sec?)
- Neutrino flavor oscillation (change their flavors in flight!) discovered & confirmed throughout late 1990 and early 2000 (**2015 Nobel**)
  - Happens because flavor and mass eigenstates differ (oscillation probability dependent on L/E_ν)

$$P\left(\nu_\mu \rightarrow \nu_e\right) = \sin^2 2\theta \sin^2\left(\frac{1.27\Delta m^2 L}{E_\nu}\right)$$

  - Neutrinos have mass! ➔ SM in BIG trouble!

The Next Big Thing - DUNE Experiment

- Stands for Deep Under Ground Neutrino Experiment
- $3.5B US flagship long baseline (1300km) { experiment
  - 1500m underground in an old South Dakota gold mine

completed on Jan. 25, 2024

- Experiment infra work ongoing

Recent Photos from SURF

Early 2023

Jan. 2024

Cryostat parts are arriving and being delivered to SURF

Total weight > 2500 tons/cryostat

Total number of components > 150,000/ cryostat

The Next Big Thing - DUNE Experiment

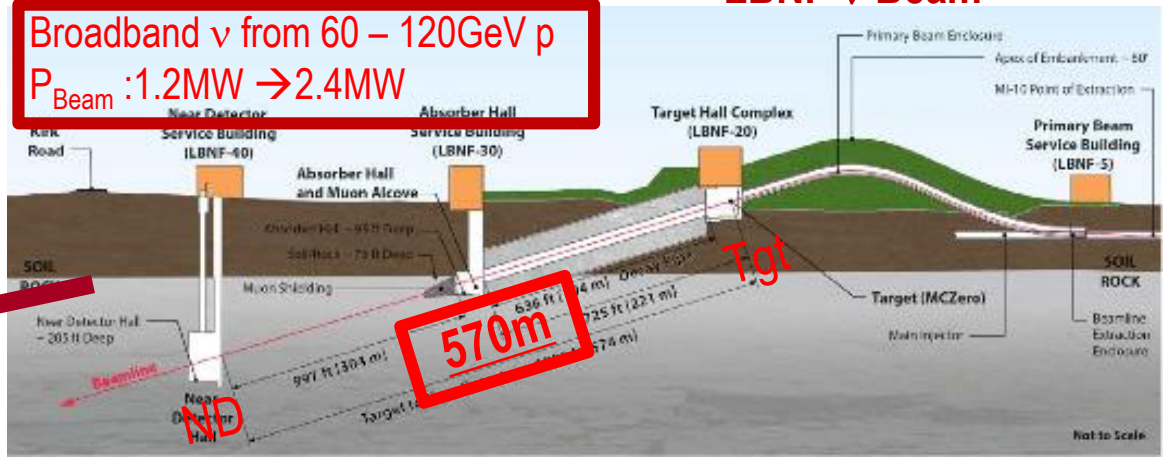
- Stands for Deep Underground Neutrino Experiment
- $3.5B US flagship long baseline (1300km) experiment
  - 1500m underground in an old South Dakota gold mine
- Needs a very high intensity proton beams (1.2MW → 2.4MW!)
  - Result in a large number of ν for precision measurements
  - Great potential for Dark Matter search and other BSM phys.
- Large mass (~70kt! total) **LArTPC** Far Detectors at SURF
- Powerful near detector complex to control systematics
- Was born March 2015!
  - Combination of LBNE (US) and LBNO (EU)
- >1500 collaborators from >209 institutes in >36 countries + CERN

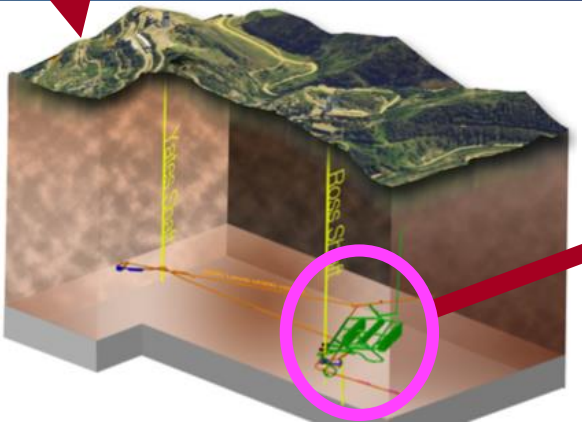
Anatomy of DUNE

LBNF ν Beam

Broadband ν from 60 – 120GeV p

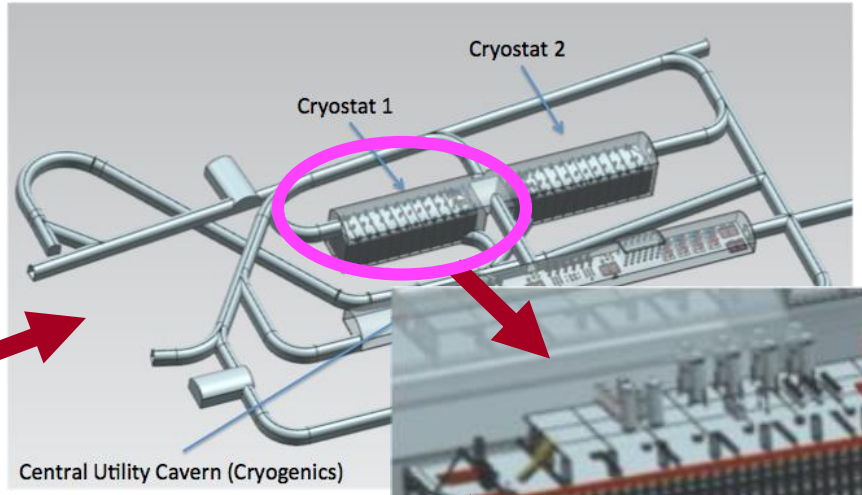
P_{Beam} :1.2MW →2.4MW





LBNF Far Detector Site, SURF

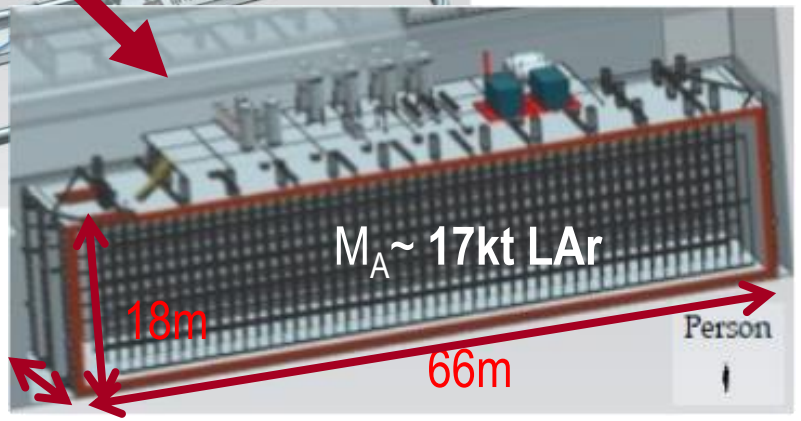
1500m underground



4 caverns for

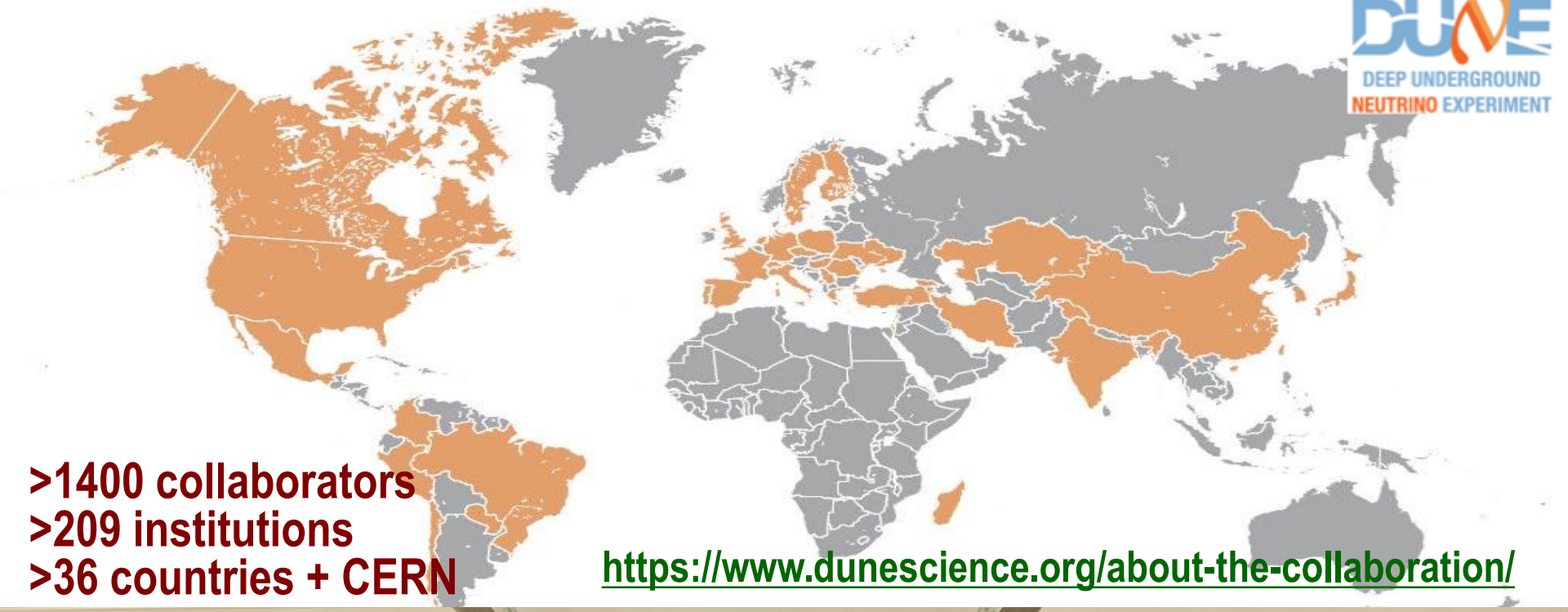
M_t~ **70kt LAr**

(>85% complete)



18m

The Map of the DUNE Experiment



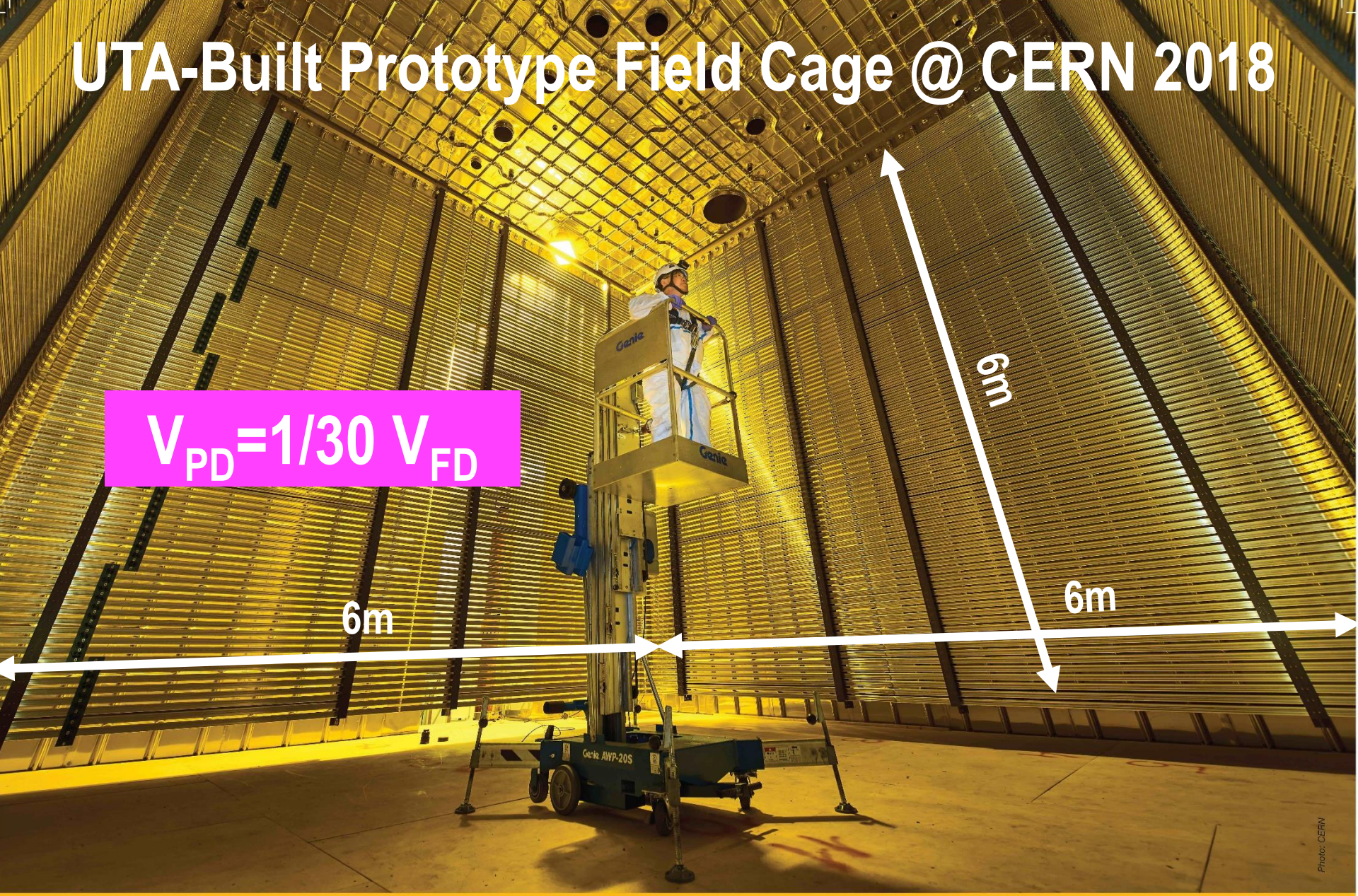
DUNE
DEEP UNDERGROUND NEUTRINO EXPERIMENT

>1400 collaborators
>209 institutions
>36 countries + CERN

https://www.dunescience.org/about-the-collaboration/

CM@CERN, CH/Jan. 2024

UTA-Built Prototype Field Cage @ CERN 2018



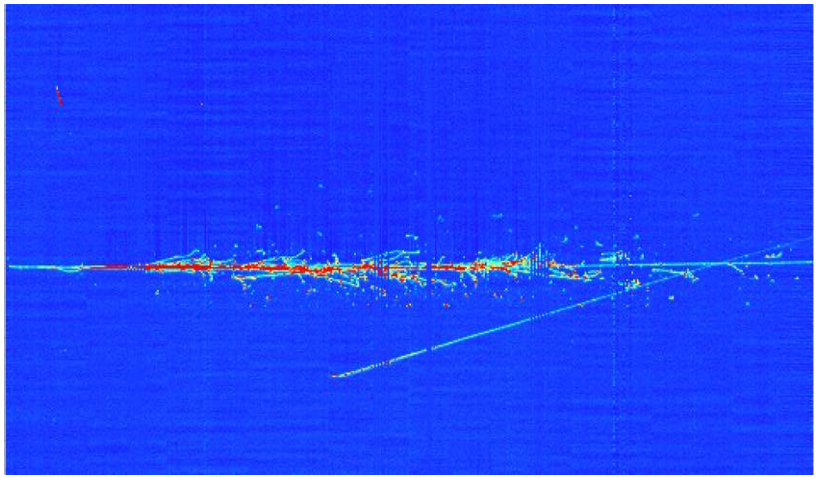
Eric Garcia, Gajendra Gurung & Atharva Dange @ CERN, March 2023

ia @ CERN, June 2022

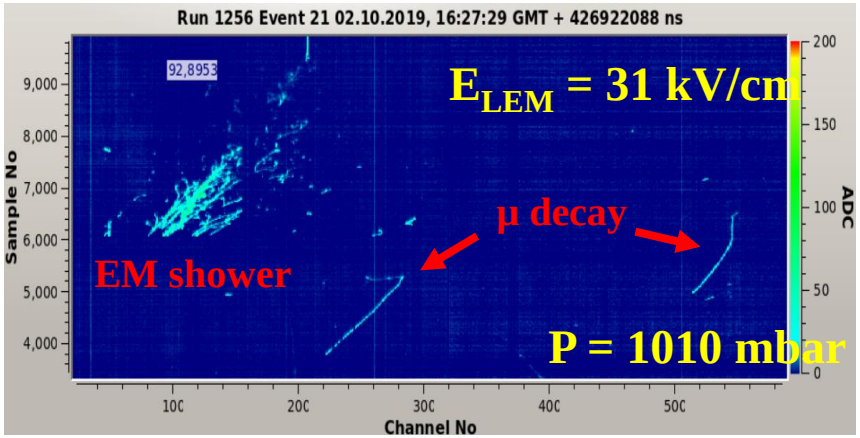
Akash Behanan, Sam Blanchard, Brad Brown, Gajendra Gurung & Rohit Raut @ CERN, Summer 2024

Images in DUNE LAr-TPC Prototypes

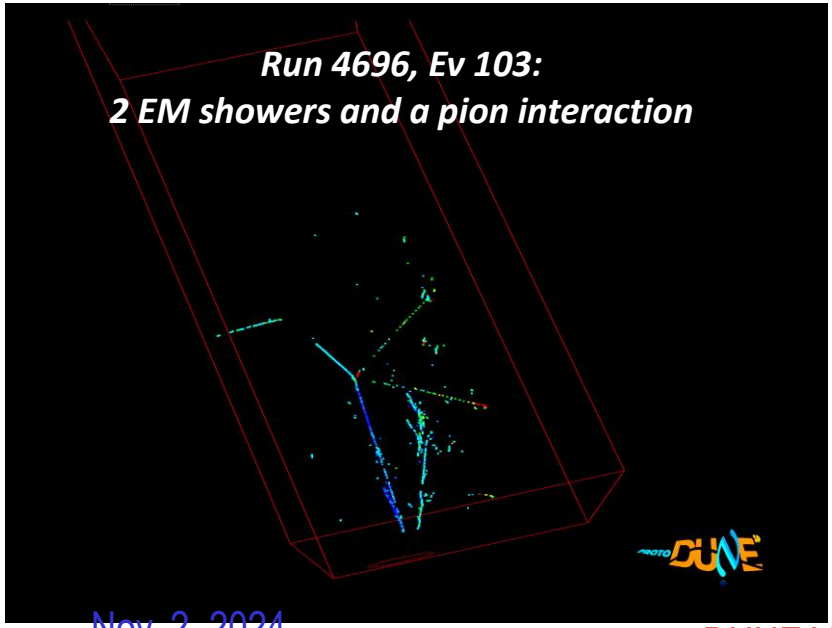
Throughgoing μ



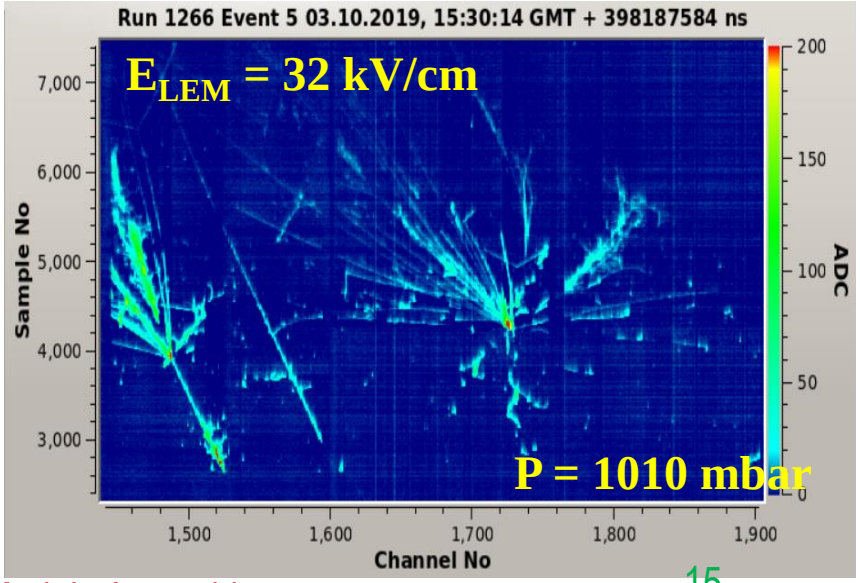
Electromagnetic shower + two muon decays



Run 4696, Ev 103:
2 EM showers and a pion interaction



Multiple hadronic interactions in a shower

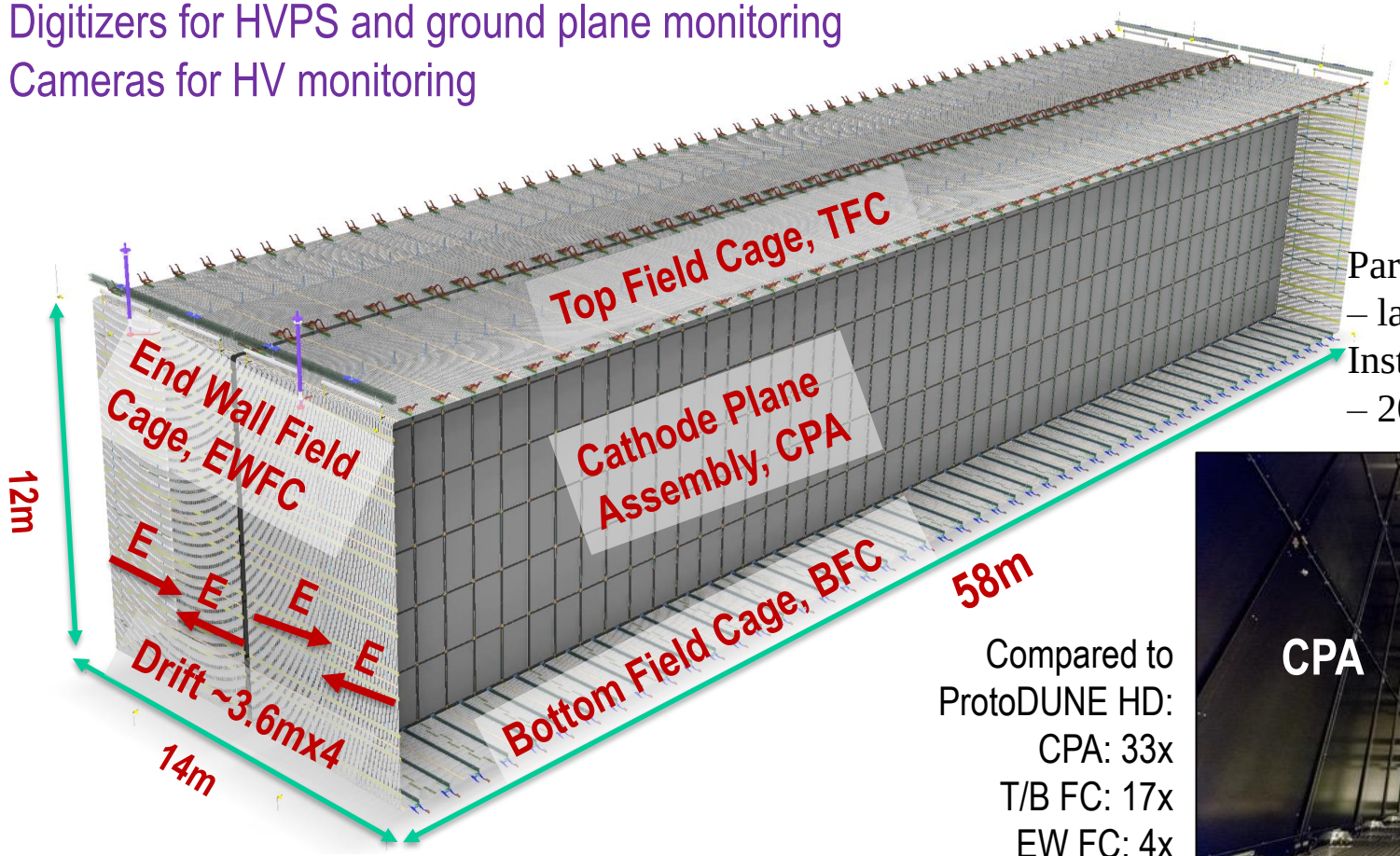


Latest news on DUNE

- DUNE far detector cavern excavation completed Jan. 25 and the steel parts for FD cryostat getting delivered to SURF
- ProtoDUNE HD beam data taking completed yesterday
- LAr to be transferred from HD to VD along with some additional LAr for ProtoDUNE beam run spring 2025
- FD site infrastructure construction on going!
- FD2 VD installation to go first in 2026 before the HD
- Expect significant overlap in VD and HD parts production and a few months on installation work

HVS Consortium Scope - FD1-HD TPC

- Design, fabricate, test and assemble:
  - **100 CPA** resistive panels forming two cathode arrays (1400m^2)
  - **100 top** + **100 bottom** field cage modules, **48 End Wall** field cage modules (1728m^2)
  - 2 sets of HV power supplies, cables, ripple filters, and feedthroughs
  - Digitizers for HVPS and ground plane monitoring
  - Cameras for HV monitoring

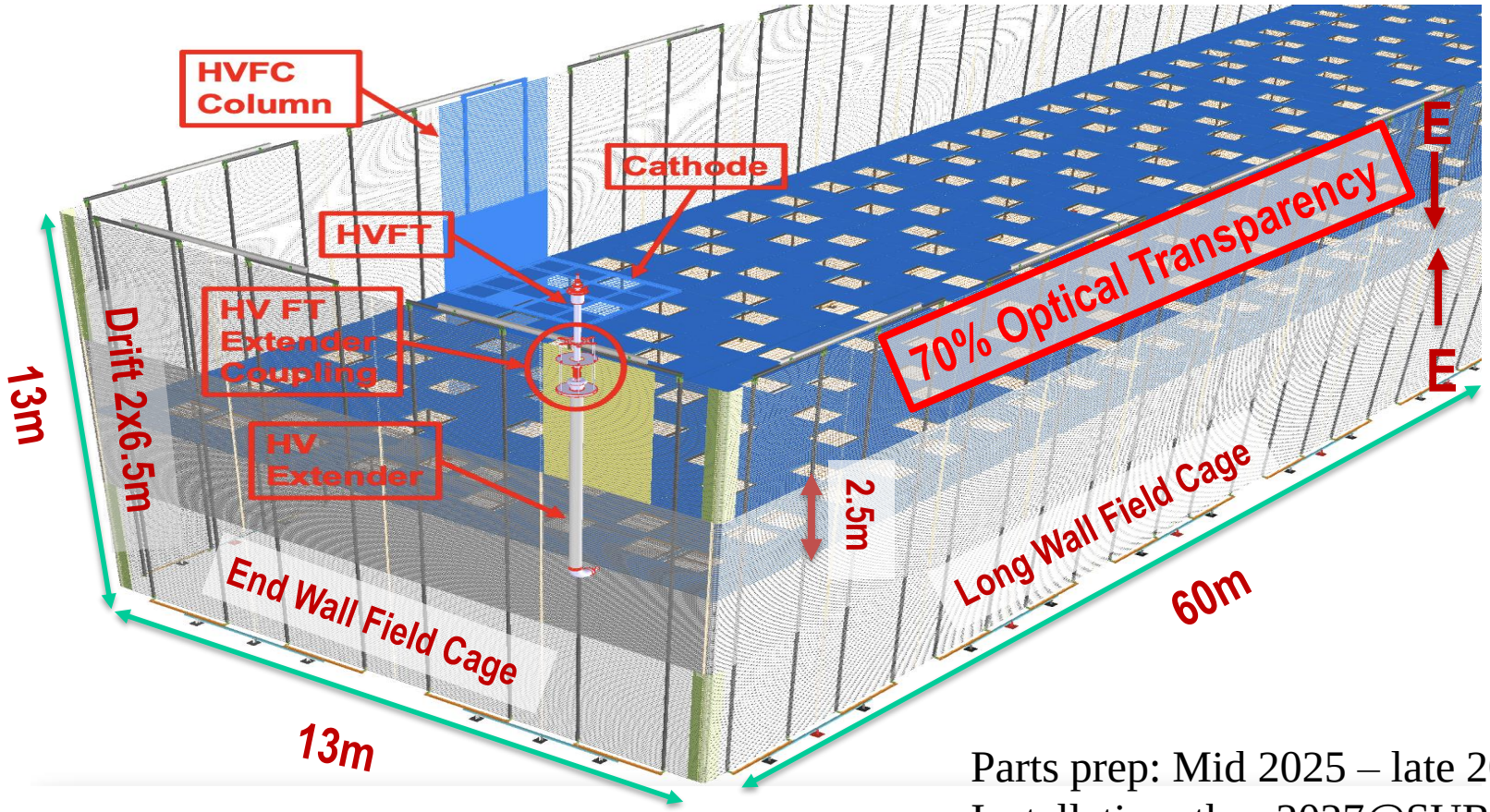


Parts prep: 2026 – late 2027
Installation: 2028 – 2029 @SURF

Compared to ProtoDUNE HD:
CPA: 33x
T/B FC: 17x
EW FC: 4x

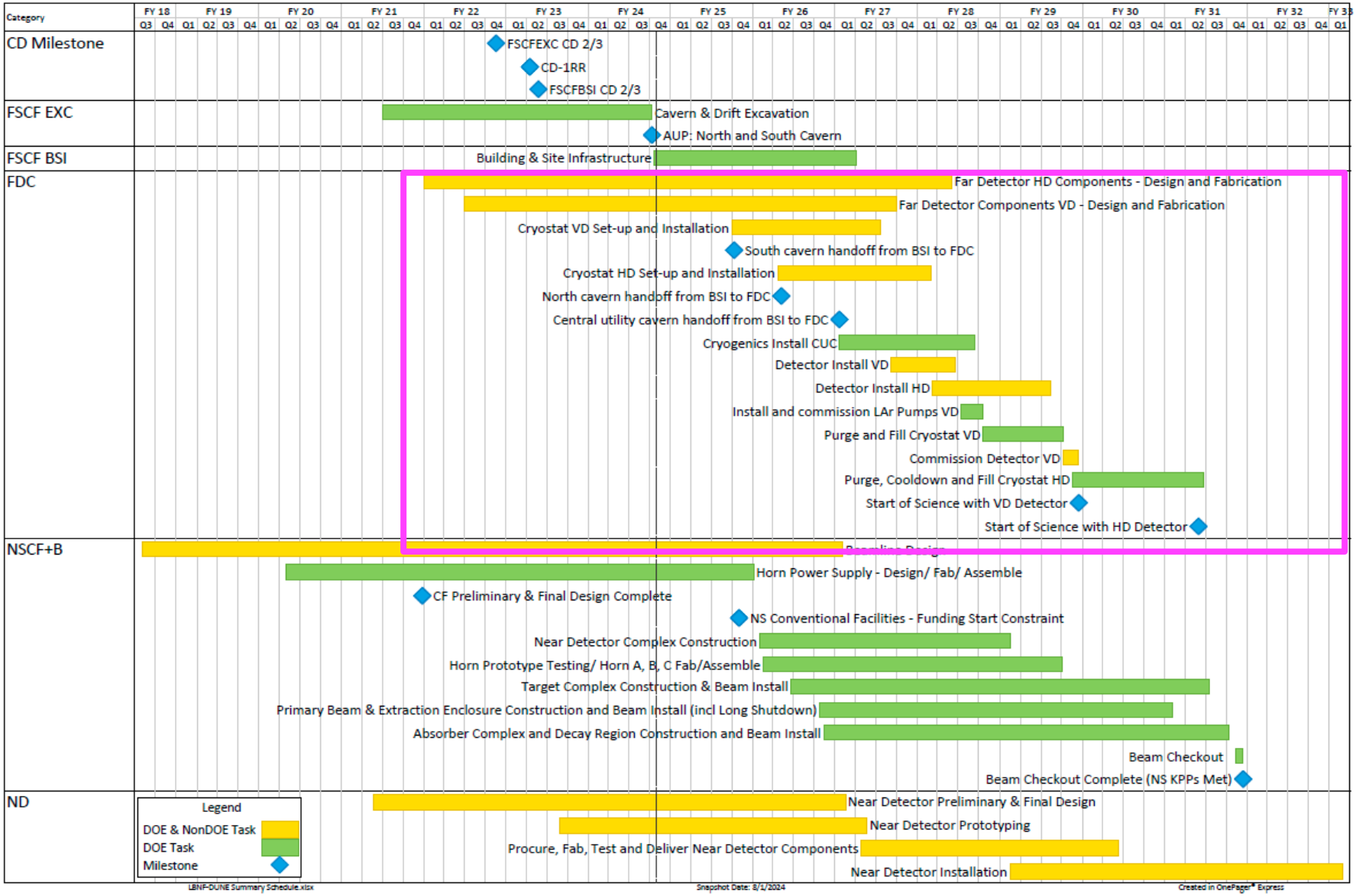
HVS Consortium Scope - FD2-VD TPC

- Design, fabricate, test and assemble:
  - **80 Full** Unit Cathode Planes (780m^2) with embedded PD
  - **192 field cage modules – 160 Long Wall and 32 End Wall modules (~1781m^2)**
  - One set of HV power supply, cable, ripple filter, and feedthrough
  - Digitizers for HVPS and current monitoring
  - Cameras for HV monitoring



Parts prep: Mid 2025 – late 2026
Installation: thru 2027@SURF

DUNE Detector and Facility Timeline



DUNE Far Detector Timeline

- VD Installation goes first
- VD Timeline
  - Q4/26: VD Cryostat Installation Complete
  - **Now – Q2/26 : VD Detector component production**
  - Q4/26 – Q2/27 : VD Detector installation
  - Q3/27 : VD LAr pump and other cryo-infra installation
  - Q1/28 – Q4/28 : VD LAr purge, cooldown and fill
  - Q1/29: VD Commissioning
  - Q2/29 : VD Start of science
- HD Timeline
  - Q3/27 : HD Cryostat Installation Complete
  - **Now – Q4/27: HD Detector component production**
  - Q2/27 – Q1/29 : HD Detector installation
  - Q2/29 : HD LAr pump and other cryo-infra installation
  - Q3/29 – Q4/30 : HD LAr purge, cooldown and fill
  - Q1/31: HD Commissioning
  - Q2/31 : HD Start of science

What do we need to do today?

- Exercise, learn and familiarize the VD FC module assembly and QC procedure
- Complete the documentation for the assembly procedure
- Train and familiarize yourself to the different types of parts, including all hardware and tools
- Exercise both laying down on the creeper and sitting on a chair for the assembly and clearly understand the advantages and disadvantages of the two heights of the assembly tables
- Prepare for production readiness review (PRR) for both HD and VD parts production ➔ late 2024 for HD (led by UMN) and early 2025 for VD (UTA only)

Group's 3E Motto

Demand Yourself Excellence!

Demand Each Other Excellence!

Help Each Other Become Excellent!