

IFAE Neutrino Group

-

“LBNO Experiments in Japan”

Thorsten Lux

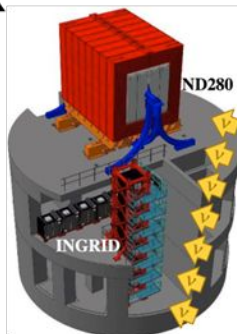
LBNO Experiment Concept

Far detector

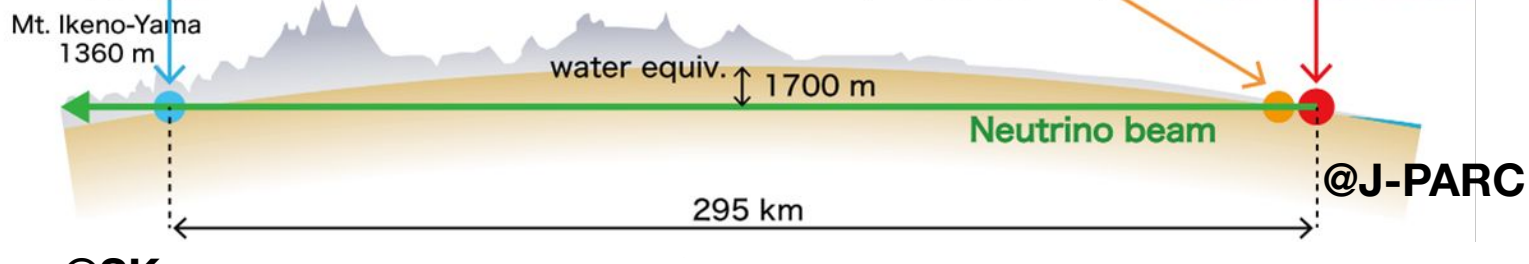


Near detector complex

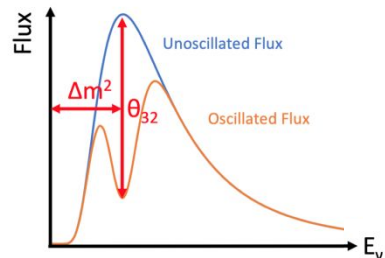
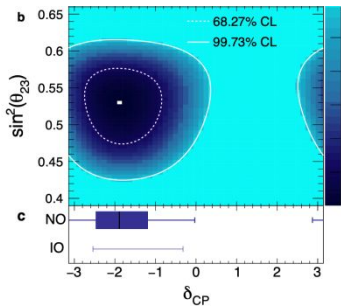
complex



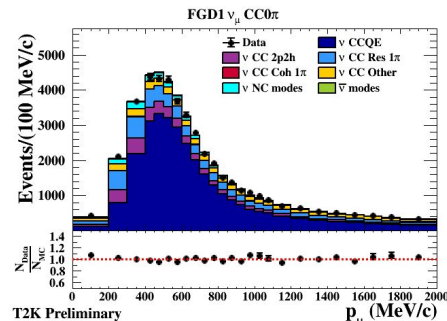
Neutrino Beam



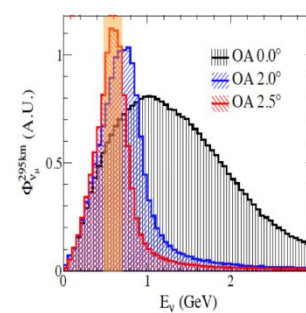
Measure oscillated beam



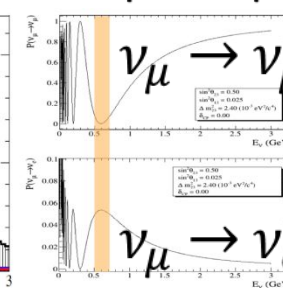
Characterize beam and ν interactions



Create Neutrino's off-axis beam

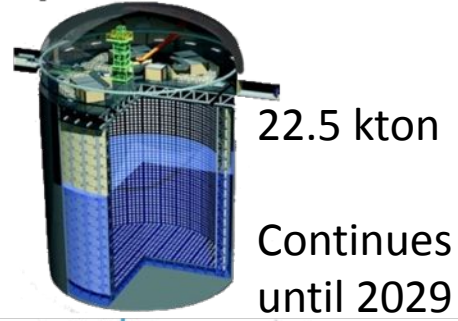


ν_μ or $\bar{\nu}_\mu$

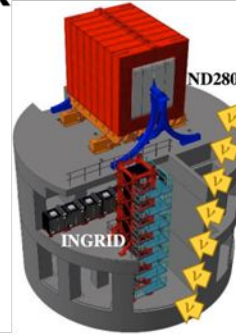




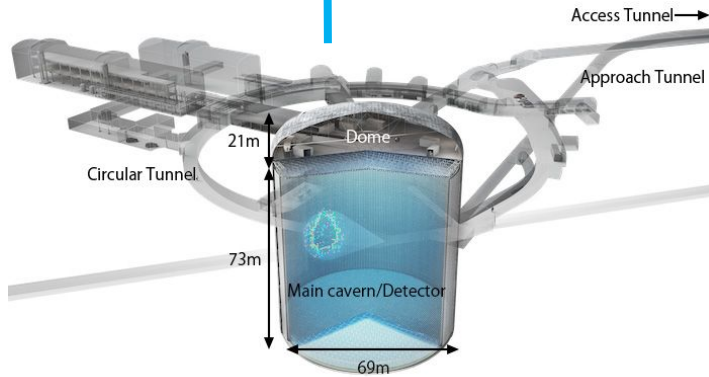
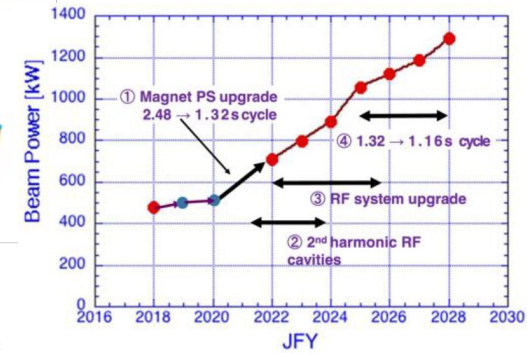
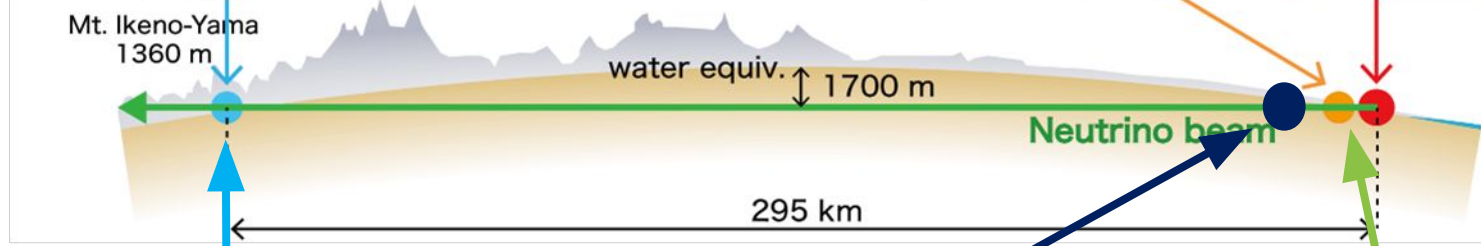
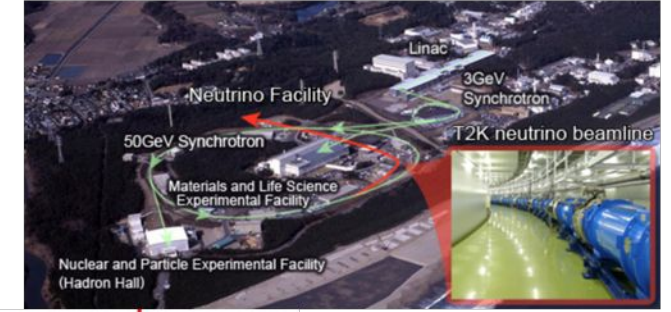
**Far detector
Super Kamiokande**



Near detector complex

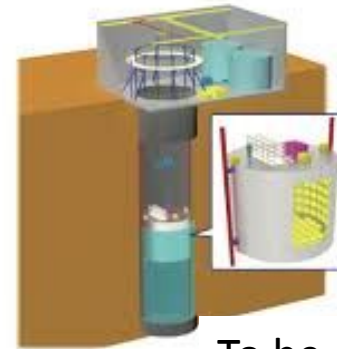


**J-Parc
Neutrino Beam**



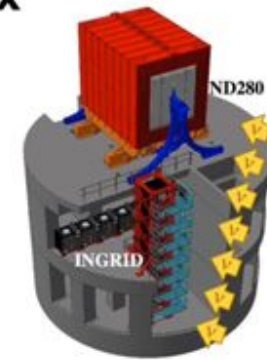
190 kton
(fiducial mass)

Off-axis spanning intermediate water Cherenkov detector (IWCD)



To be constructed

Near detector complex



T2K-HK ND280 MOU being finalized soon

INGRID/ND280 crucial for HK

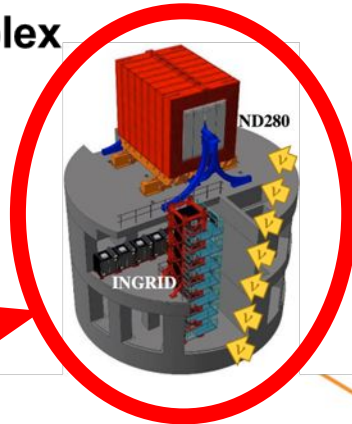
T2K

**Far detector
Super Kamiokande**

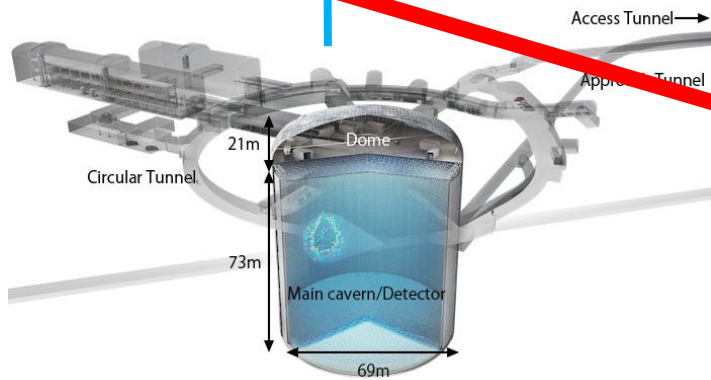
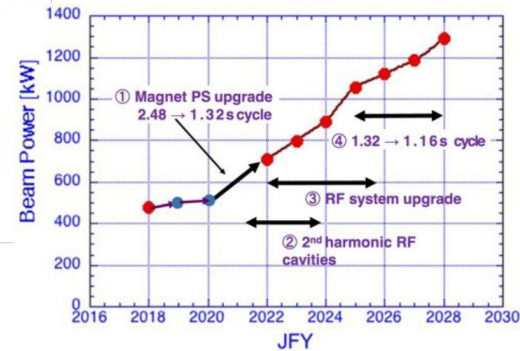
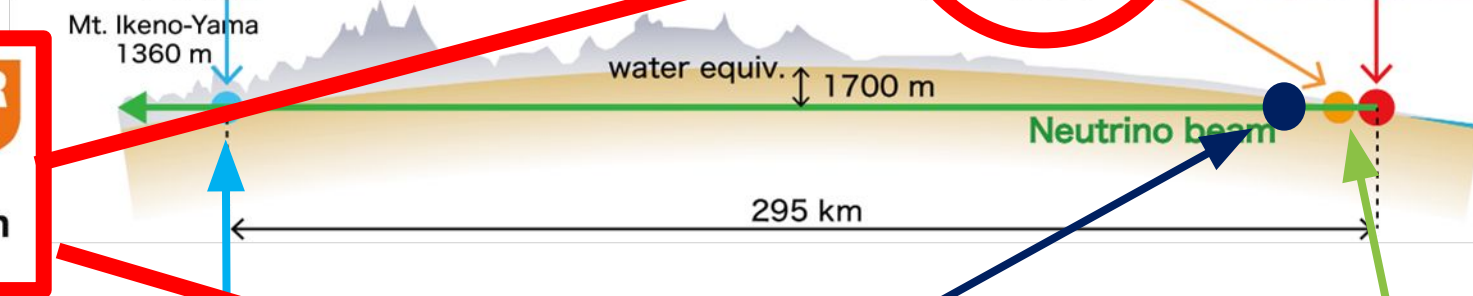
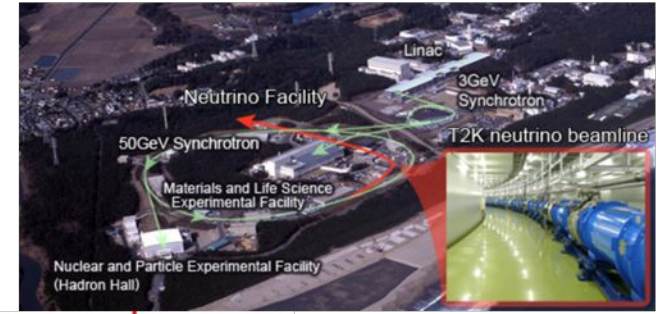


22.5 kton
Continues until 2029

Near detector complex

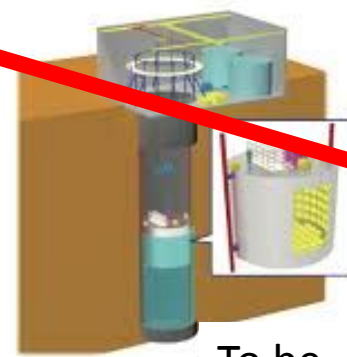


**J-Parc
Neutrino Beam**



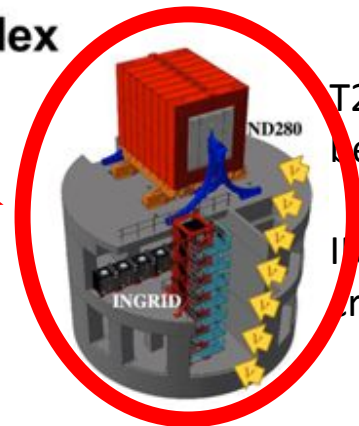
190 kton (fiducial mass)

Off-axis spanning intermediate water Cherenkov detector (IWCD)



To be constructed

Near detector complex

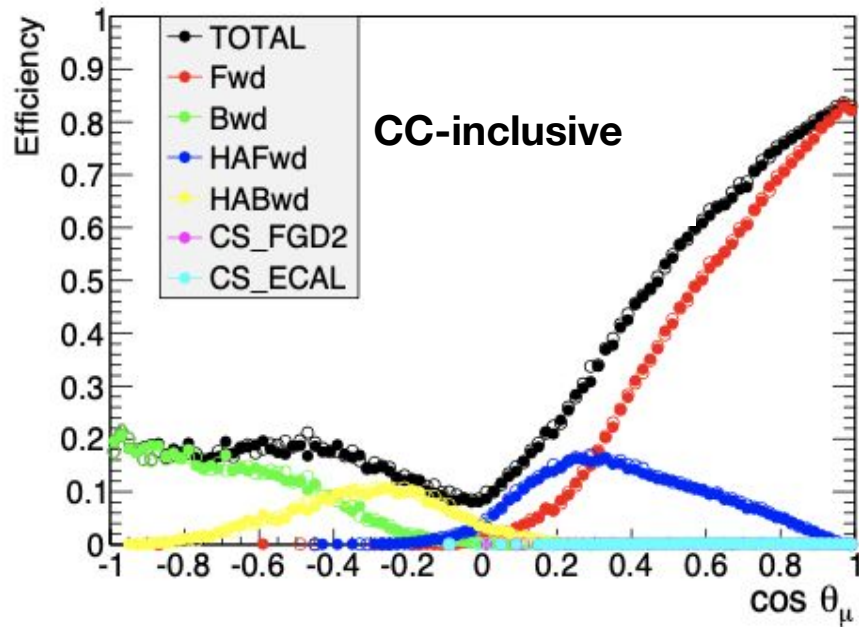
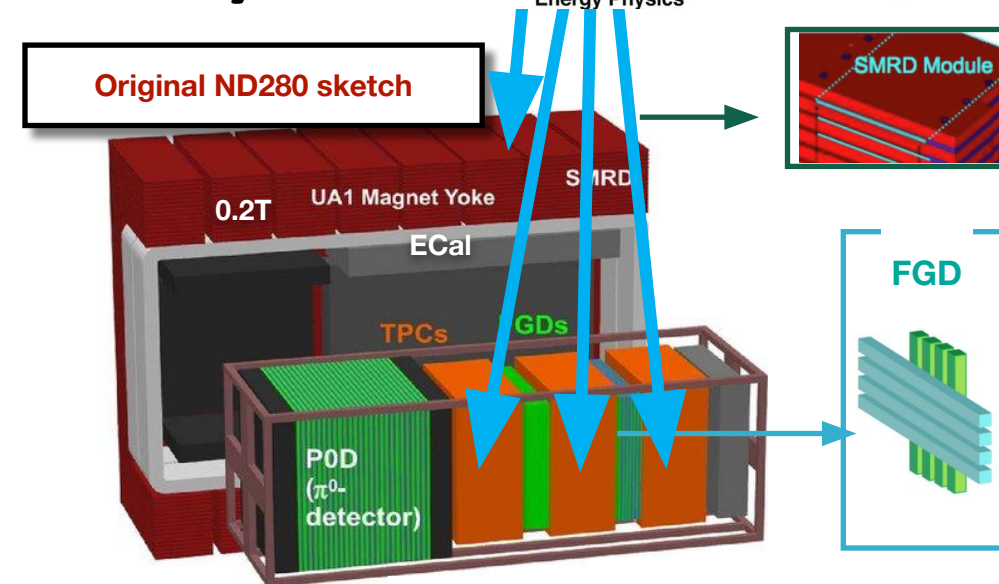


T2K-HK ND280 MOU being finalized soon

INGRID/ND280 crucial for HK

T2K: Original ND280 (2009-2022)

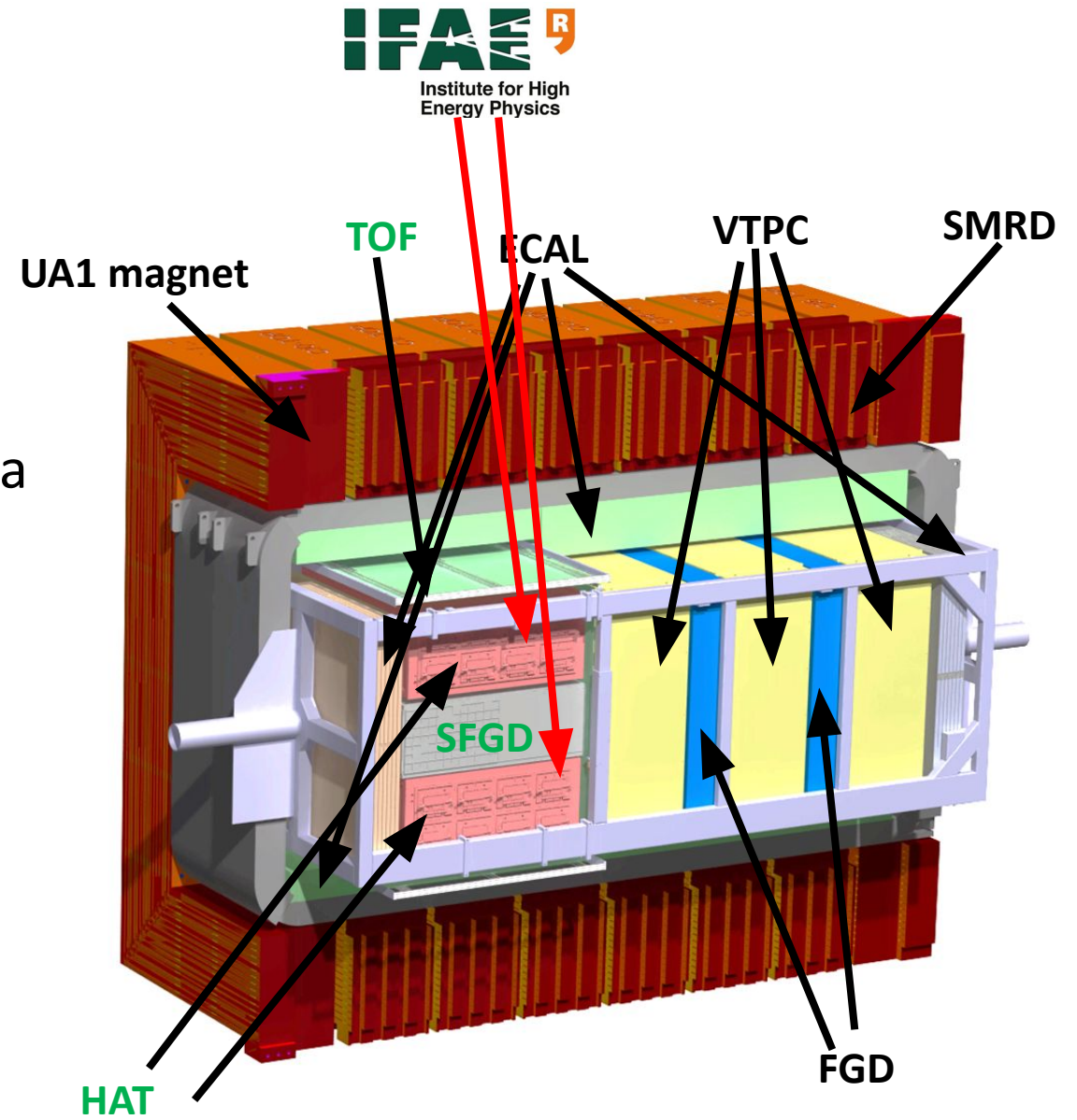
- ND280 great success story
- Crucial for T2K key measurements eg:
 - First ν_e appearance measurement (Phys. Rev. Lett. **112**, 061802)
 - First δ CP measurement (Nature volume 580, pages 339–344)
- **But not perfect ...**



- Some limitations**
- ◆ Tracks w/o TPCs (high angle).
 - ◆ Tracks w/o TPCs (low momentum).
 - ◆ Limited timing information => no direction information
 - ◆ No neutron info
 - ◆ Poor electron/photon separation
 - ◆ High detection threshold

T2K: Upgraded ND280

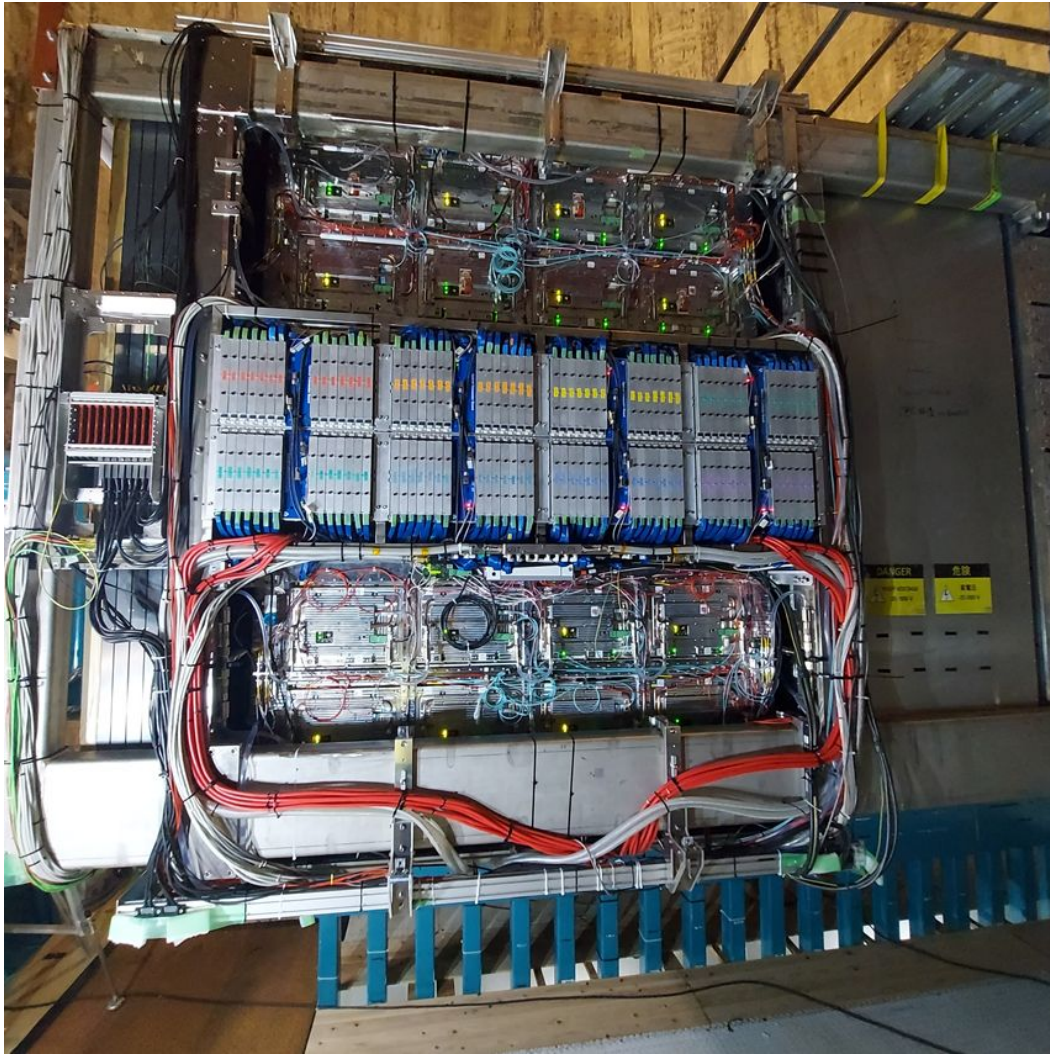
- Complex detector with several subdetectors:
 - FGD: scintillator tracker, target
 - VTPC/**HAT: TPCs, PID**
 - ECAL: electromagnetic calorimeters, gamma and pion/muon separation
 - SMRD: side muon range detector
 - **TOF: measures direction of particles**
 - **SFGD: 3D scintillator tracker, target**
 - UA1 magnet: 0.2 T
- In addition, a lot of support infrastructure (magnet chiller, gas system, DAQ, slow control, electronics cooling, ...)



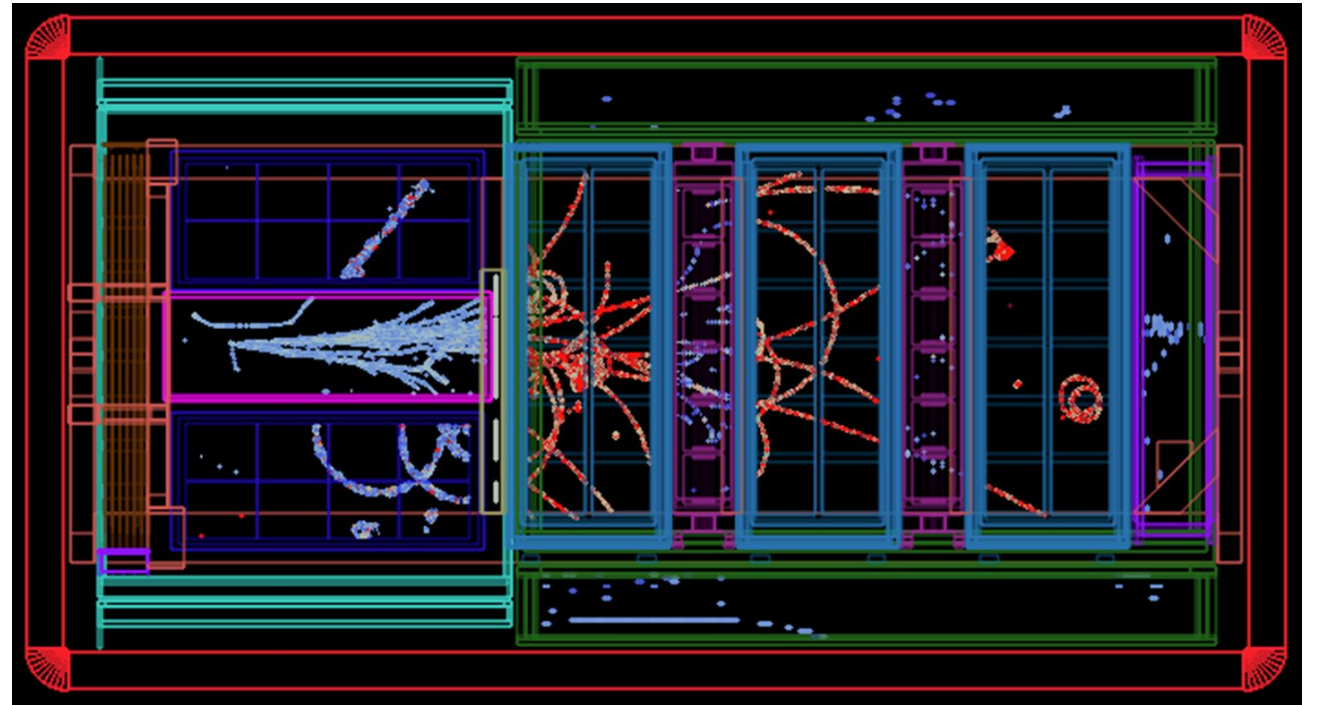
IFAE Contributions to T2K ND280 Upgrade

- Management:
 - Co-project leader / CERN [NP07](#) co-spokesperson
 - Technical coordinator (incl. stays at CERN (assembly) + J-PARC (installation))
- Hardware-related:
 - HAT: Cathodes and HV power supplies
 - HAT: MIDAS slow control interface of gas system (+ support for other HAT systems)
 - SFGD: Fraction of electronics crates
- Software-related:
 - All subdetectors: Testbeam data analysis
 - HAT: data analysis of commissioning data
 - HAT: Electronics noise implementation

T2K: Upgraded ND280: Operation

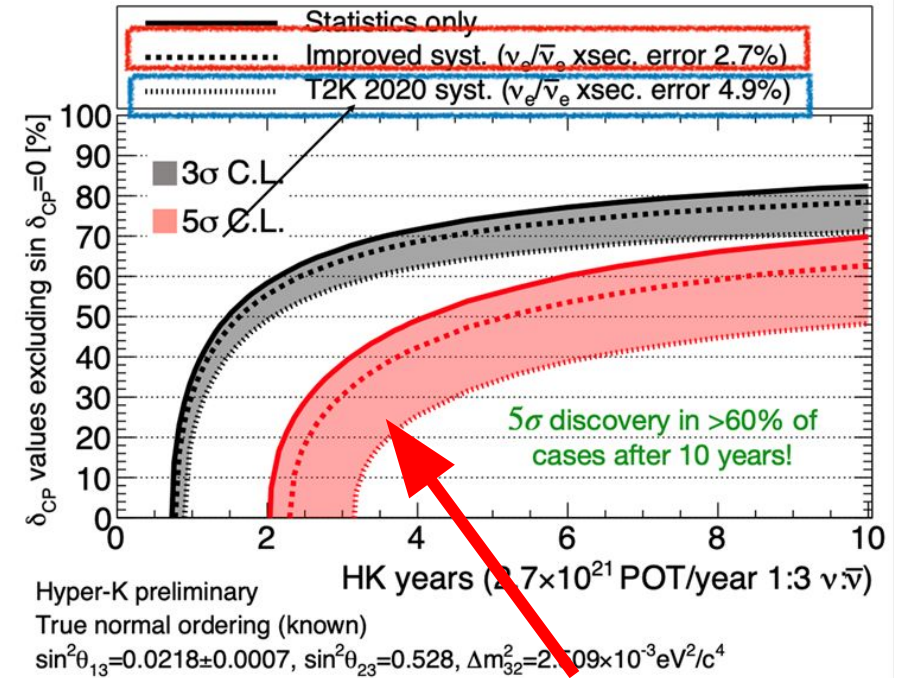


- Installation completed in May 2024
- Old and new parts are working well together
- Will continue data taking until start of HK

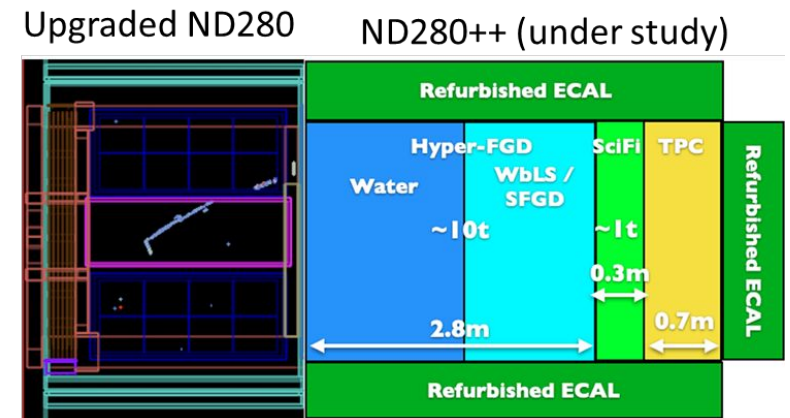


HK ND280

- Now focussed on transfer from T2K to HK, non-trivial
- HK is not a continuation of T2K and many colleagues leave towards DUNE
- But ND280/INGRID will be crucial to achieve deltaCP physics goal
- We must be ready to start data taking in November 2028
- Plans to have another ND280 upgrade, ND280++, in 2030+

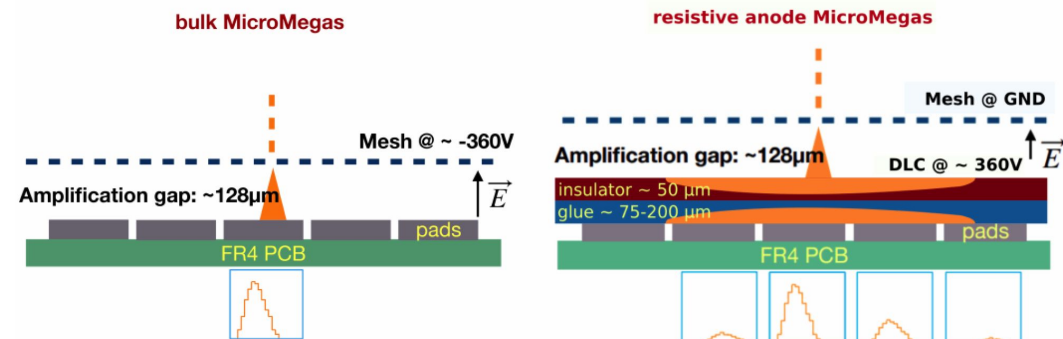


With upgraded ND280 operational we will be somewhere here



Hardware Projects: TPC

- Since many years involved in TPC projects
- Original TPCs, first TPCs with MPGD readout (bulk MicroMegas)
- HAT (ND280 Upgrade TPCs) first full-size TPC with composite material field cage
- Field cages was produced by local company
- Readout with resistive MM
- Working closely with international experts on this, especially INFN and Saclay



Hardware Projects: Scintillator Tracker

- Involved in R&D for ND280++
- Idea is to have 8-10 ton scintillator tracker
- Simulation study to use opaque scintillator (LiquidO) almost completed
- Preparing to have a small prototype with 192 channels (SO)
- Ideal would be opaque WbLS with 90% H₂O
- Collaborating with LPHNE, ETH, Univ. Mainz, ...

