Fermilab U.S. DEPARTMENT OF ENERGY | Office of Science

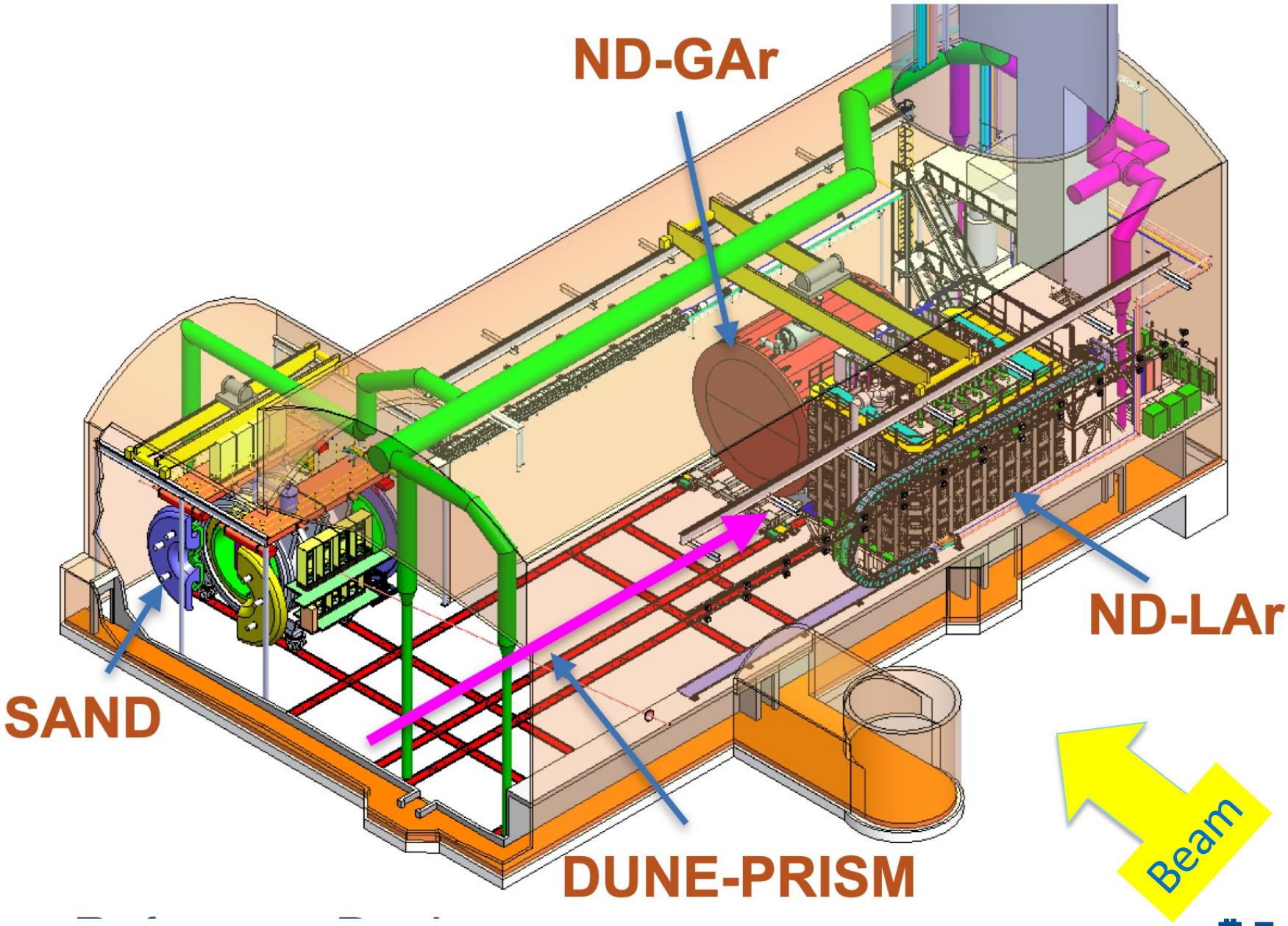
DUNE ND-LAr 2x2 Demonstrator Neutrino Beam Test Program

Ting Miao – Fermilab

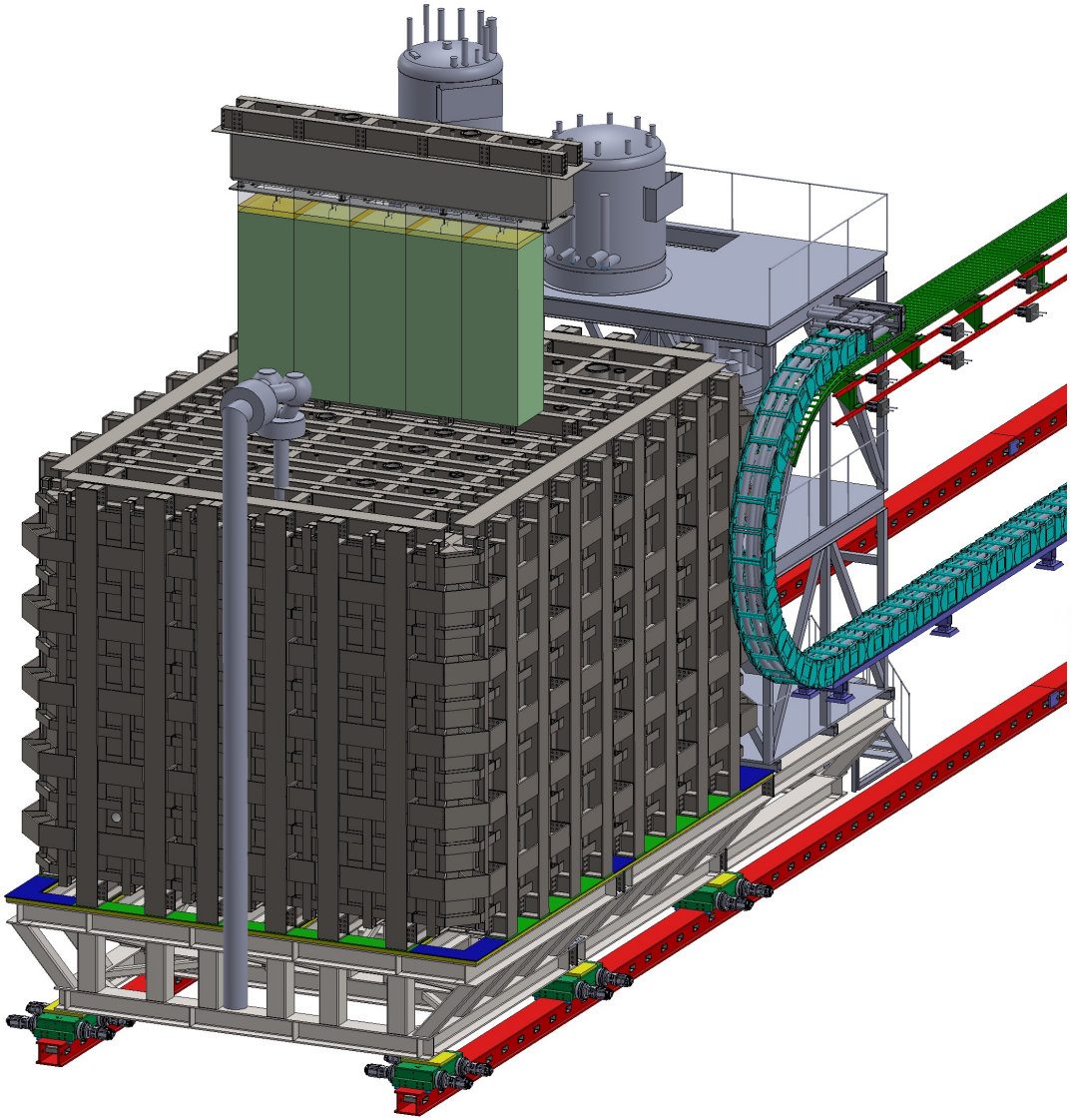
August 2, 2021

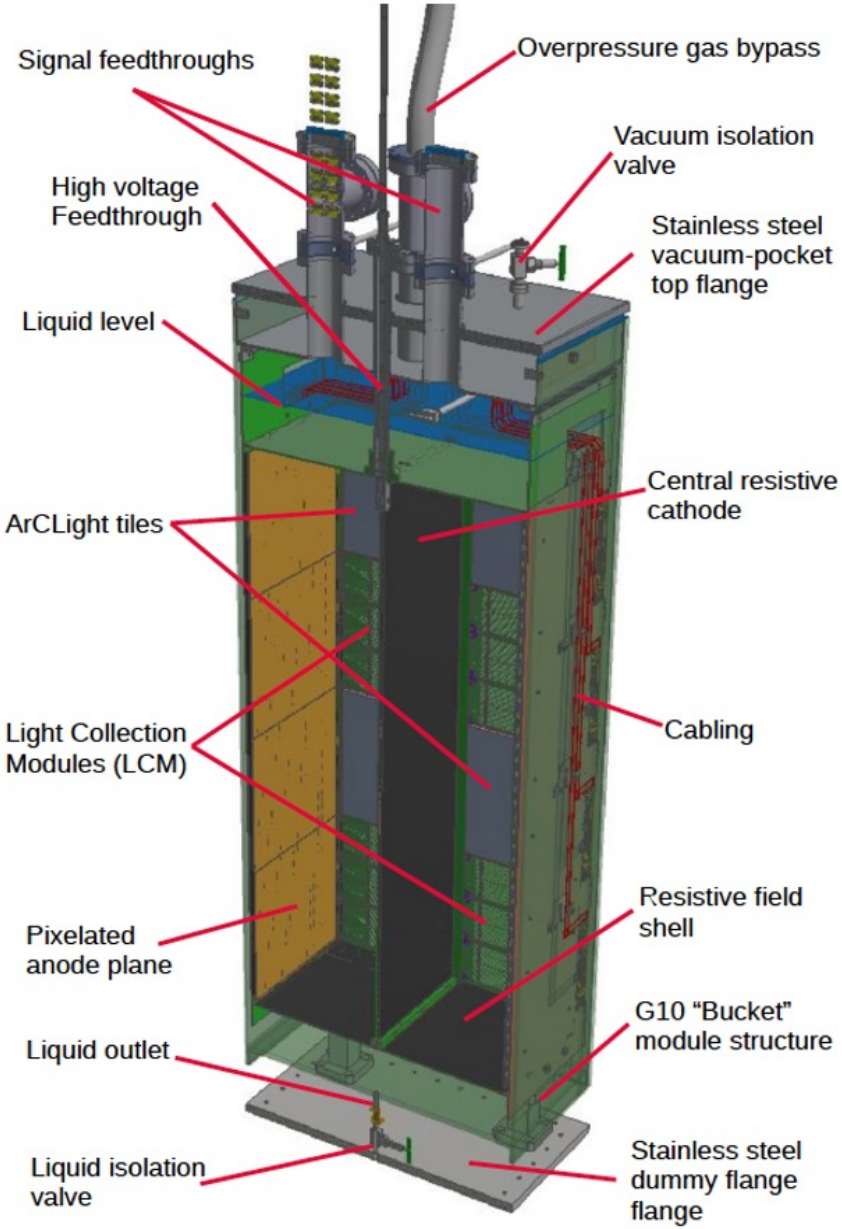
DUNE Near Detector

ArgonCube



DUNE ND-LAr TPCs

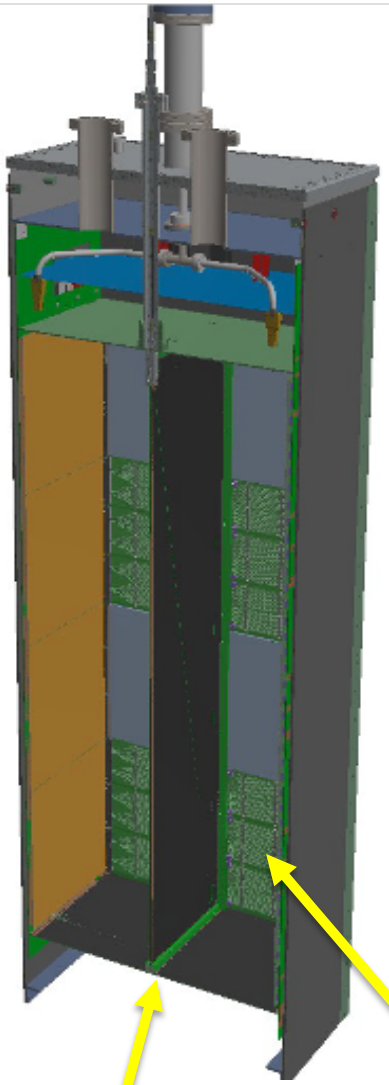


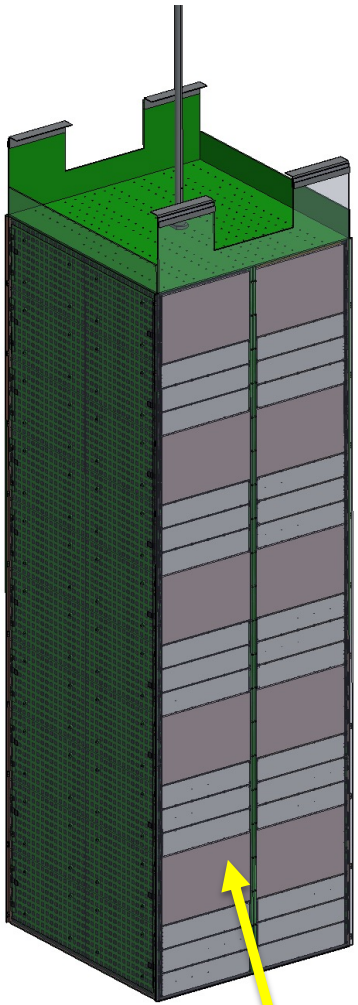


5 x 7 = 35 TPC modules

ND module size – 1m x1m x 3m

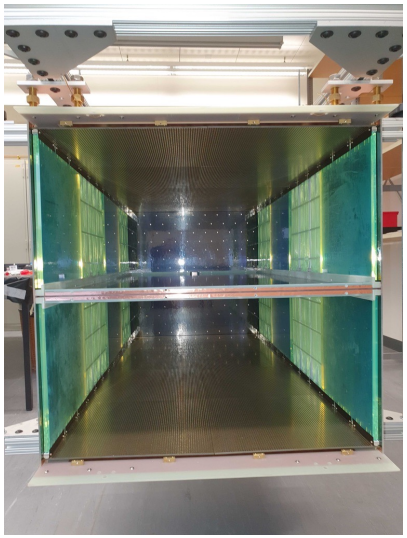
2x2 TPC – 0.75m x 0.75m x 1.6m





Cathode and Field Cage with 10GΩ Resistive DuPont Films

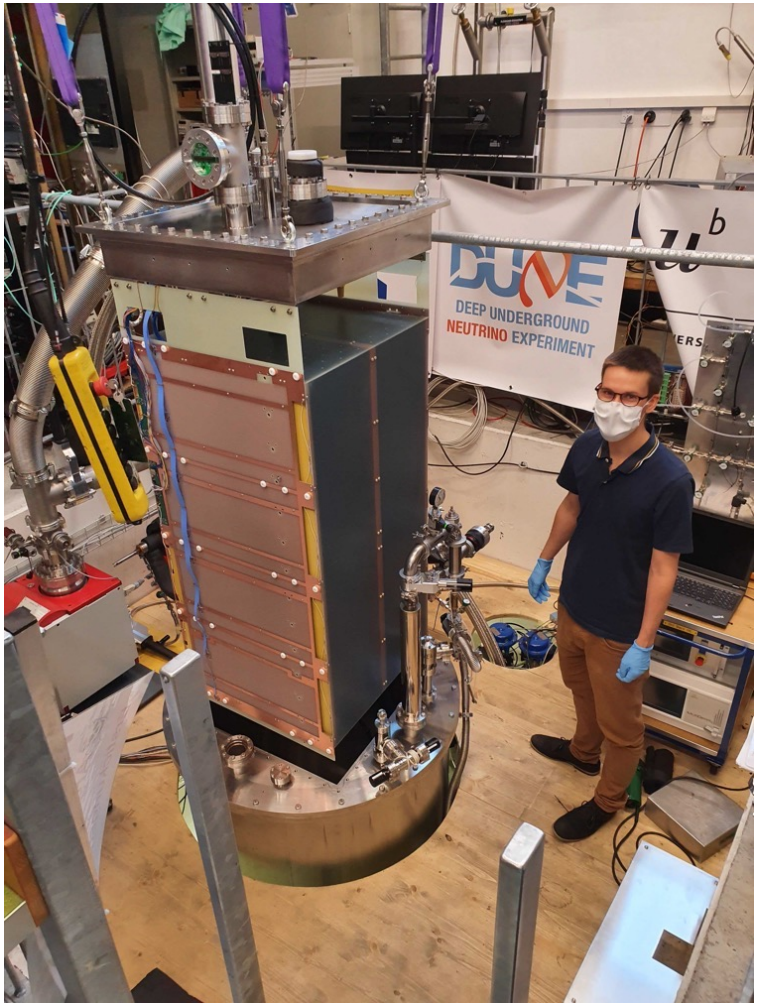
Light Readout and LArPix Charge Readout



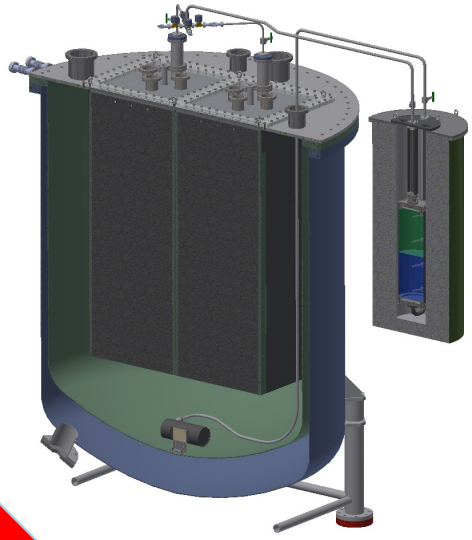
Module Assembly at University of Bern

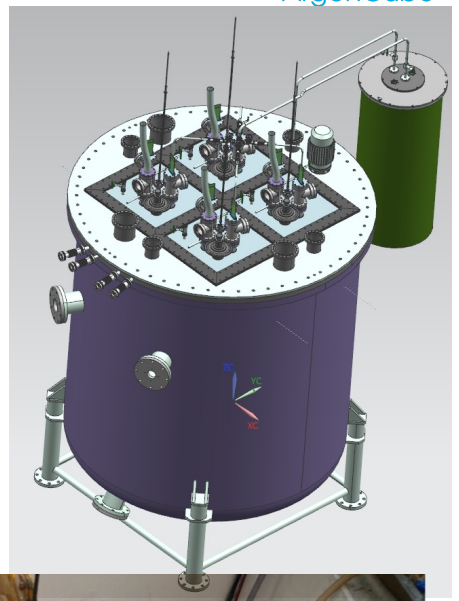
2x2 TPCs and Cryostat

ArgonCube

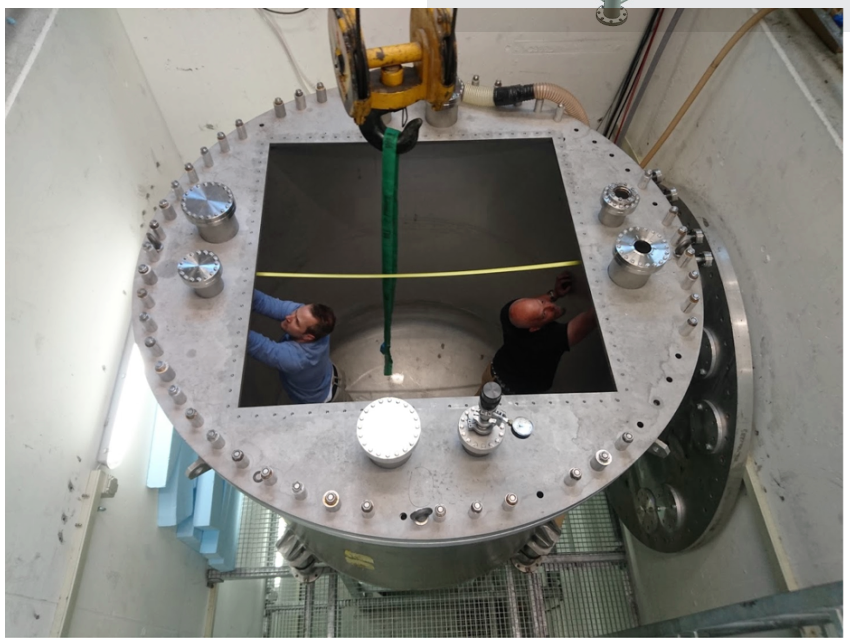


Module-0 test at U. of Bern in April





2x2@FNAL
(4 modules)



Multiple TPC operation at FNAL

Detector Configuration in MINOS Hall

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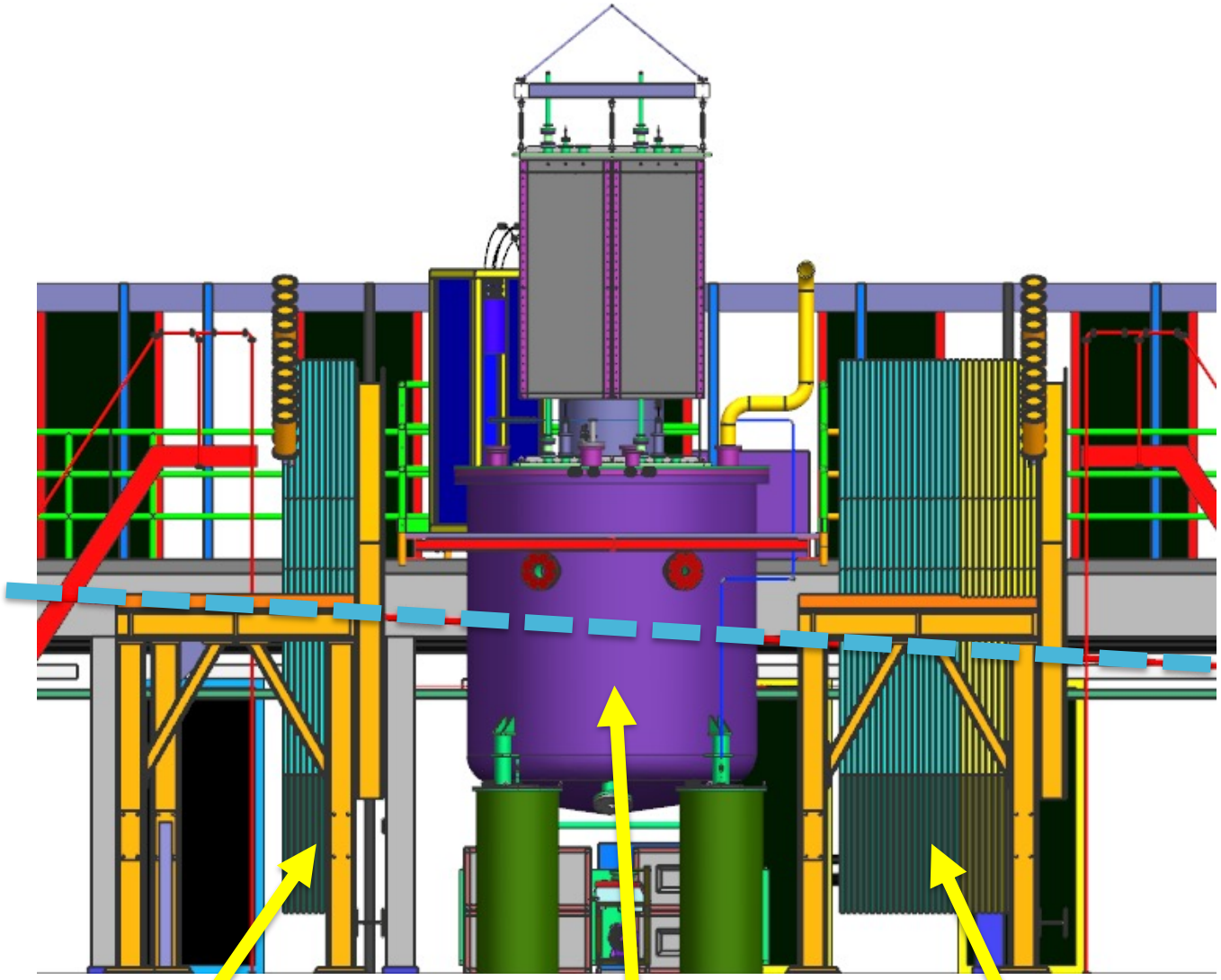


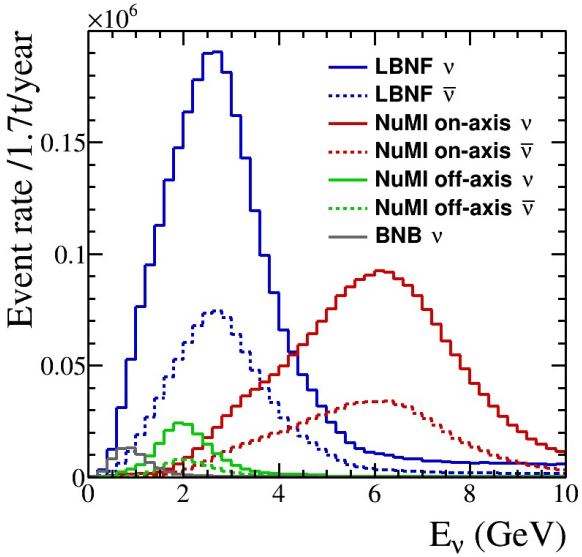
12 MINERvA Modules

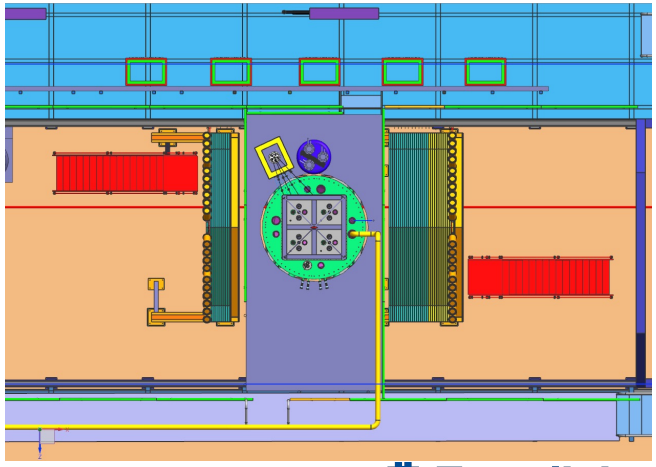
2x2 Cryostat and 4 TPCs

32 MINERvA Modules

NuMI Beamline

Expected event rates for 2x2





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Scope of Works for 2x2 Test at Fermilab

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- Underground detector hall preparation
  - MINERvA and MINOS decommissioning – completed in June
- New infrastructures to support ArgonCube TPC operation
  - Cryogenics, cooling, venting and ODH mitigation
  - Low noise AC power for TPC electronics
  - TPC installation support and cryostat access platform
- Electronics integration and DAQ
  - System engineering and safety reviews of front-end electronics and controls
  - DAQ for multiple TPC readout and integration with MINERvA
- Coordination with consortium on TPC and electronics delivery
- 2x2 test in Fermilab starts in LArTF building

2x2@LArTF Test

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- DUNE prototyping plan includes operation of 4 TPCs together before production for 35 ND-LAr TPCs
  - Original plan: 2x2 starts with cosmic ray at Bern ➔ new: individual module tests
  - It will be in LArTF that we have the first opportunity to test TPCs side-by-side
- 2x2@LArTF to test full cryogenics system before underground in MINOS hall
  - Gaining valuable experience with large cryocooler system
- 2x2@LArTF to give us a head start on integration and help us
  - to work out details of TPC module QA/QC
  - to start integration on electronics, DAQ and beam timing
  - to get students and postdocs involved earlier

2x2 Team and Speakers for the Session

- Integration and installation support
  - ND and PPD Mechanical Engineering Groups
  - Lead Engineer: **Min Jeong Kim**
- Cryogenics
  - ND Cryo Engineering Group and University of Bern
  - Lead Engineer: **Mike Zuckerbrot**
- Electronics and DAQ integration
  - ND Electrical Engineering Group and Operation Support Group
  - Lead Engineer: **Linda Bagby**
- TPC modules and readout electronics deliverables
  - ND-LAr TPC component subsystems
  - **Michele Weber** of University of Bern

2x2 Plan and Schedule Considerations

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- Goal is to collect NuMI data for at least 3 months in FY2023
- 3 months commissioning time before NuMI runs
- 6 months installation in MINOS hall starting summer 2022
- *Final TPC modules delivery expected early summer 2022*
- Integration test with 1-2 TPCs in LArTF March-April 2022
- Cryogenics and TPC installations in LArTF Sept 2021-Jan 2022
- Cryostat and TPC module-0 delivery July – Sept 2021

Timeline for 2x2 Test

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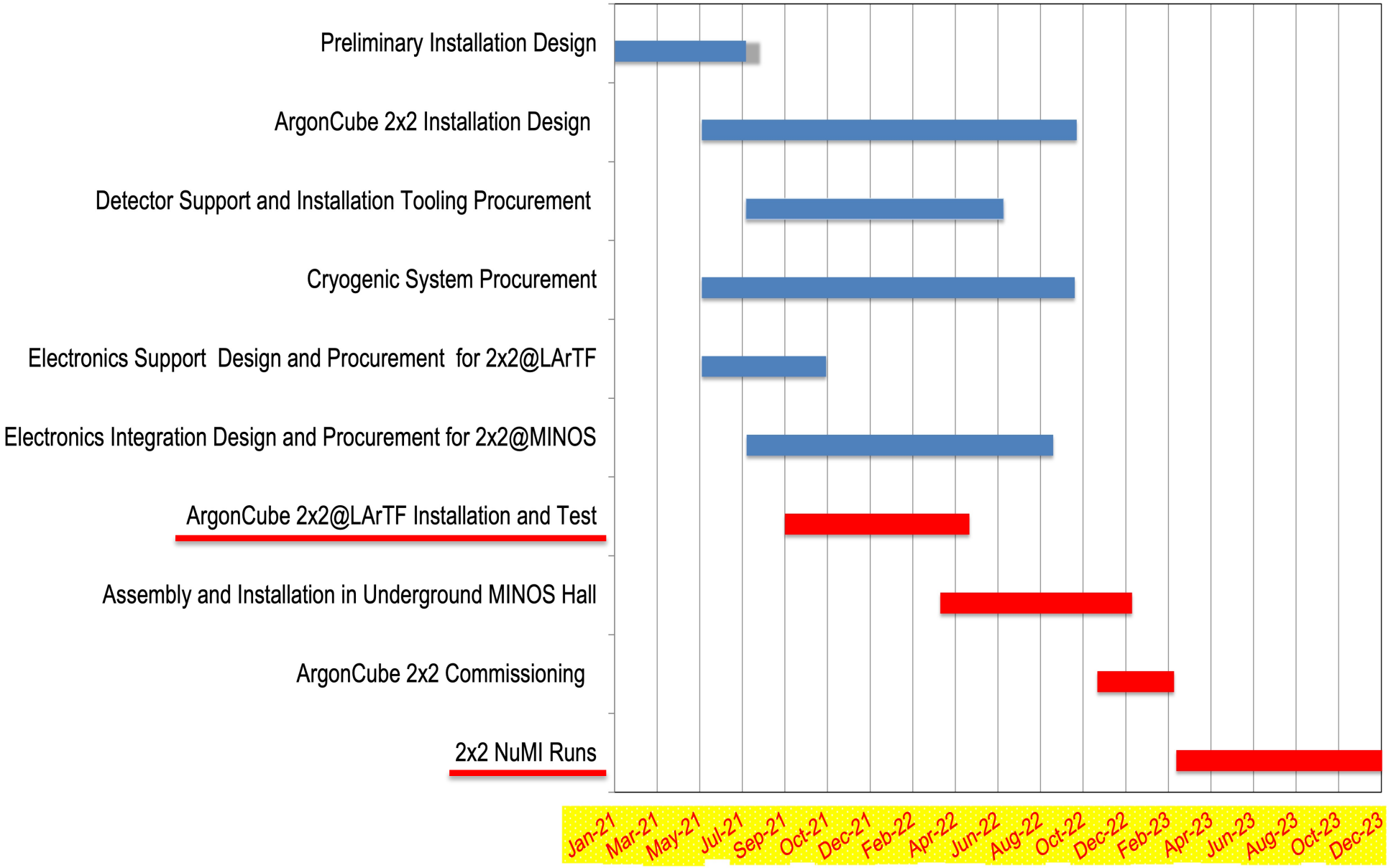
- Cryostat and first TPC module to be delivered this summer
  - Cryostat certification, TPC QA/QC, electronics integration to start soon after
- Cryogenics system will be put together this winter
  - Procurement for long lead time equipment already started
- 2x2 test in LArTF to start in Spring and complete in May 2022
- Installation in MINOS to start next summer after 2x2@LArTF
  - *Final two TPC modules are to be delivered in early summer 2022*
- Commissioning for cryogenics and DAQ to start in late 2022
- To collect NuMI data for 3 months before July 2023
  - 2nd run after summer NuMI shutdown

2x2 Schedule

ArgonCube2x2@FNAL Schedule



Overall Schedule 2x2 Test at Fermilab

WBS Tasks	Start Date	Finish Date
Preliminary Installation Design	10/25/18	7/8/21
ArgonCube 2x2 Installation Design	05/07/21	10/17/22
Detector Support and Installation Tooling Procurement	7/8/21	7/6/22
Cryogenic System Procurement	5/7/21	10/14/22
Electronics Support Design and Procurement for 2x2@LArTF	5/7/21	10/29/21
Electronics Integration Design and Procurement for 2x2@MINOS	7/9/21	9/14/22
ArgonCube 2x2@LArTF Installation and Test	9/1/21	5/19/22
Assembly and Installation in Underground MINOS Hall	4/8/22	1/3/23
ArgonCube 2x2 Commissioning	11/15/22	3/3/23
2x2 NuMI Runs	3/6/23	12/29/23

- Cryogenics equipment delivery is driving 2x2@LArTF schedule
- TPC module/electronics delivery and integration will drive 2x2@MINOS schedule

Summary

- 2x2 is a physics prototyping program with NuMI beam. It is the only test with multiple TPC modules before ND-LAr production
- The program will test ND-LAr design and provide valuable experience of detector installation and operation
- We are aiming to take neutrino beam data in early 2023
  - First to operate ArgonCube TPCs on the surface in LArTF
  - Then to install and commission the system underground in MINOS hall
- Schedule planning and cost estimate are based on experiences with LAr TPCs and underground installation
- Funding and engineering supports are critical to realize the plan