AIDA innova

Advancement and Innovation for Detectors at Accelerators

# WP9: Cryogenic Neutrino Detectors

## (3rd Annual Meeting )

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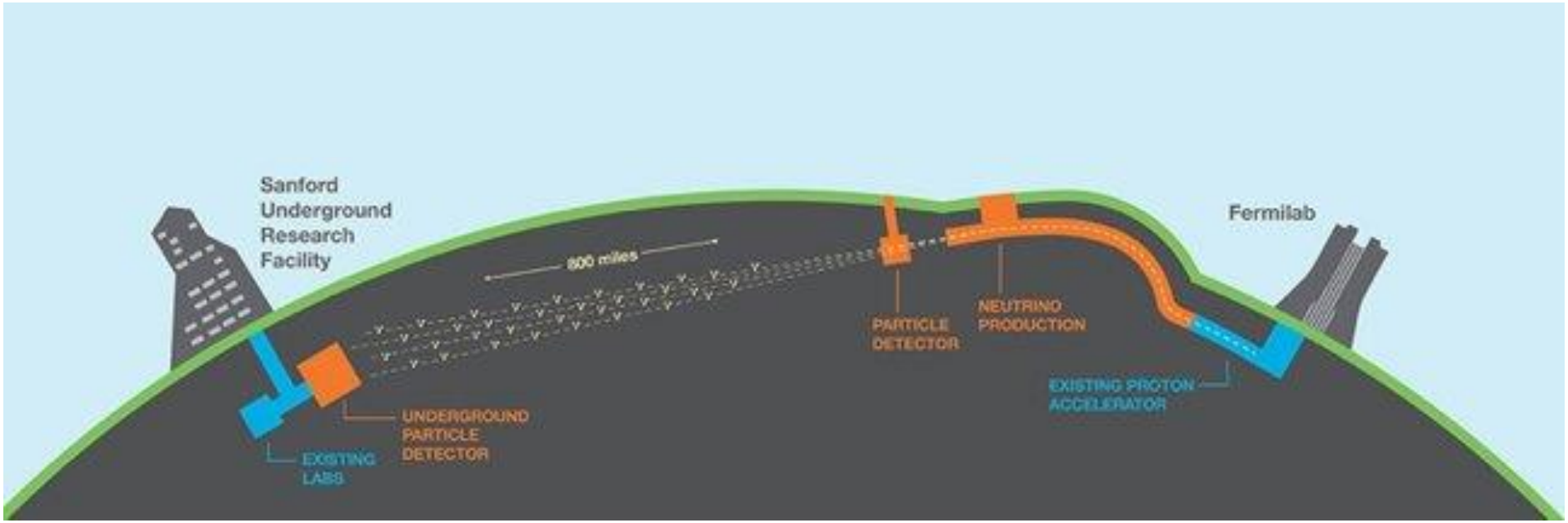
# WP9: Cryogenic Detectors

## 3rd Annual meeting in Catania

# WP9: Cryogenic Detectors

- **WP9: Cryogenic neutrino detectors**
- Focus on innovative developments in large cryogenic detector readout:
  - Charge readout with pixels
  - Charge readout with vertical-drift detectors
  - Readout of scintillation light.
- Applications geared towards DUNE and large-scale DM detectors.



# Work Packages and objectives

- Task 9.1: Coordination and Communication (CNRS-IP2I, Edinburgh)

- Task 9.2: Pixel Charge Readout (Manchester, Bern)
  - Optimized pixel tile pattern for the DUNE LAr far detector
  - Design and prototype for large scale tile-based anode plane

- Task 9.3: Vertical Drift Charge Readout (CNRS-IP2I, CNRS-IJCLab, CNRS-LAPP)
  - Novel Vertical Drift perforated anodes charge readout design evolving from the dual-phase charge readout stack
  - Development and tests of novel design of the Charge Readout Plane (CRP) integration surface of the Vertical Drift perforated anodes
  - Developments and tests of integrated cold electronics, new feedthrough chimneys design
  - Developments in associated digitization hardware and online data treatment

- Task 9.4: Light Readout (CIEMAT, INFN-MIB, Edinburgh)
  - Characterization of new photon detection methods, calibration devices and readout electronics
  - Implementation and characterization of a more efficient light collection system in NP02/ProtoDUNE phase II (Xe doping and Wave-Length Shifting (WLS) combined with reflective foils)
  - Dissemination of R&D results and NP02/ProtoDUNE II light-collection performance (web site)

# WP9: Cryogenic Detectors

## DUNE entering in a new phase ! :

- FD MOUs signed in November 2023
- Caverns excavation completed in January 2024:

https://news.fnal.gov/2024/02/excavation-of-colossal-caverns-for-fermilabs-dune-experiment-completed/

- Entered in 2024 in the construction phase for the DUNE far detectors (productions starting of many components covered by WP9 in tasks 9.3 and 9.4)
- LAr availability now for operating NP04 and NP02 at CERN with beam in 2024-2025
- SBND also filled (some aspects relevant to task 9.4)

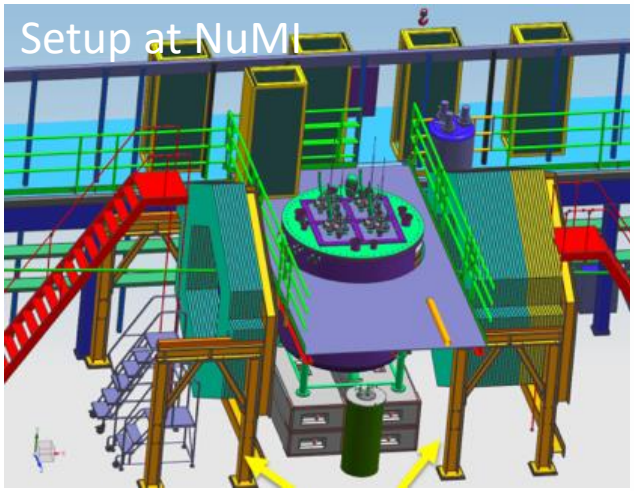
# Pixels charge readout [T:9.2] (UNIMAN, UBERN)

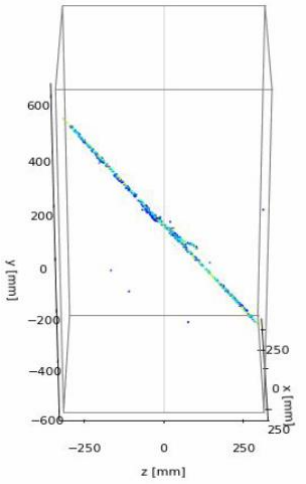
## Pixel prototypes:

- "2x2" @ NuMI/FNAL
  - Test 4 modules (2x2) in the NuMI neutrino beam
- Solar prototype V2 anode PCB

with LarPix and 64 VUV SiPMs tested

In Bern with cosmic rays in July 2023




The cube TPC assembled and hanging on the top flange


The laboratory at University of Bern with the LAr cryostat

# Vertical Drift charge readout [T: 9.3] (CNRS-IP2I, CNRS-IJCLab, LAPP)

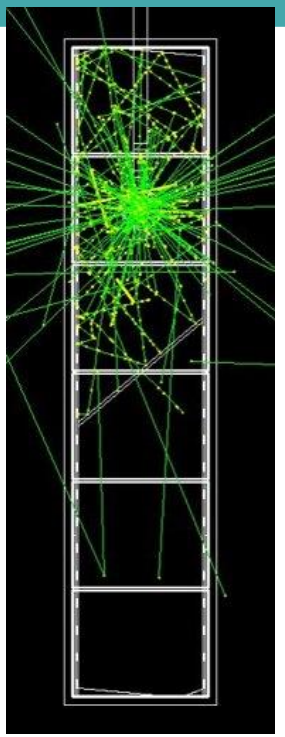
- Vertical Drift Charge Readout Planes (CRPs) with perforated anodes and the readout electronics were successfully tested at the CERN Neutrino Platform in 2021-2022 in the cold-box (full LAr TPC). VD HV tests with 6m drift also completed in 2022 in NP02
- Technology fully validated, starting FD2 detector construction in 2024

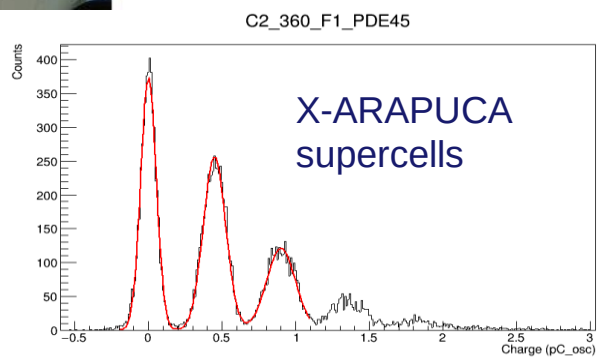
- All VD elements were successfully integrated in 2023 in NP02 (it will be possible to fill NP02 this fall and take beam data in 2025)

- Additional dedicated tests for some elements (not possible within NP02) for chimneys and FD2 installation ongoing at the CERN neutrino platform

# Light Readout [T:9.4] (CIEMAT, INFN-MIB, UEDIN)

- Cryo-tests of X-ARAPUCA VD detectors (new dedicated facilities)
- Precise measurements of X-A QE
- Detectors instaled in ProtoDUNE-VD
- New WLS geometry
- Measurements of dichroic filter performance
- Developing large scale wavelength-shifter + reflectors surfaces





# Milestones and Deliverables

**Milestones**

| MS # | Milestone Name | Lead beneficiary | Due Date (in months) | Means of verification |
|---|---|---|---|---|
| MS36 | Pixel optimisation | 40 - UNIMAN | 23 | Report (Task 9.2) |
| MS37 | Status report on chimneys | 8 - CNRS | 22 | Report (Task 9.3) |
| MS38 | Status report on CRPs | 8 - CNRS | 23 | Report (Task 9.3) |
| MS39 | Status report on digitisation | 8 - CNRS | 33 | Report (Task 9.3) |
| MS40 | Large-scale WLS surfaces and SiPMs Tested | 21 - INFN | 22 | Report (Task 9.4) |

Milestones set

**Deliverables**

| D # | Deliverable Name | Lead beneficiary | Type | Due Date (in months) |
|---|---|---|---|---|
| D9.1 | Large-scale Pixel Anode | 40 - UNIMAN | Report | 44 |
| D9.2 | Vertical Drift chimneys, digitisation, CRPs | 8 - CNRS | Report | 46 |
| D9.3 | R&D in LAr optical readout | 29 - CIEMAT | Report | 45 |

→ looking forward to close deliverables

# WP9 Progress

Advertisement: Industry workshop on cryogenics in big science Paris 16-17/4/24 supported by AIDAInnova
https://indico.cern.ch/event/1376314/ WP9 related talk:
*Cryogenics developments for large size noble liquid detectors*

| | | | |
|---|---|---|---|
| 10:00 | **WP9 Introduction** | *Andrzej Michal Szelc et al.* | |
| | *Remote only* | 10:00 - 10:10 | |
| | **Light Collection R&D at CIEMAT** | *Clara Cuesta Soria* | |
| | *Remote only* | 10:10 - 10:35 | |
| | **Light Collection R&D at Milano Biccocca** | | |
| | *Remote only* | 10:35 - 11:00 | |
| 11:00 | **Coffee Break** | | |
| | *Remote only* | 11:00 - 11:20 | |
| | **Large-scale WLS Development** | *Andrzej Michal Szelc* | |
| | *Remote only* | 11:20 - 11:35 | |
| | **Update on SoLAr and Pixel R&D** | *Dr Anyssa Navrer-Agasson* | |
| | *Remote only* | 11:35 - 11:55 | |
| 12:00 | **Update on Vertical Drift development** | *Dario Autiero* | |
| | *Remote only* | 11:55 - 12:15 | |

- Details on WP9 tasks progresses will be presented in the parallel session today
- Summary tomorrow at the plenary talk

Have a nice meeting !