SENSE - Search for new physics and technological advancements from neutrino experiments at the high intensity frontier. A cooperative Europe – United States – Brazil effort

Simone Donati

HORIZON-MSCA-2021-SE-01
GA 101081478

A cooperative Europe – United States – Brazil effort (I)

SENSE BENEFICIARIES	
UNIPI	IT
INFN	IT
CERN	CH
Clever Operation	FR
CIEMAT	ES
UGR	ES
CSIC	ES
NIKHEF	NL
PRISMA	EL

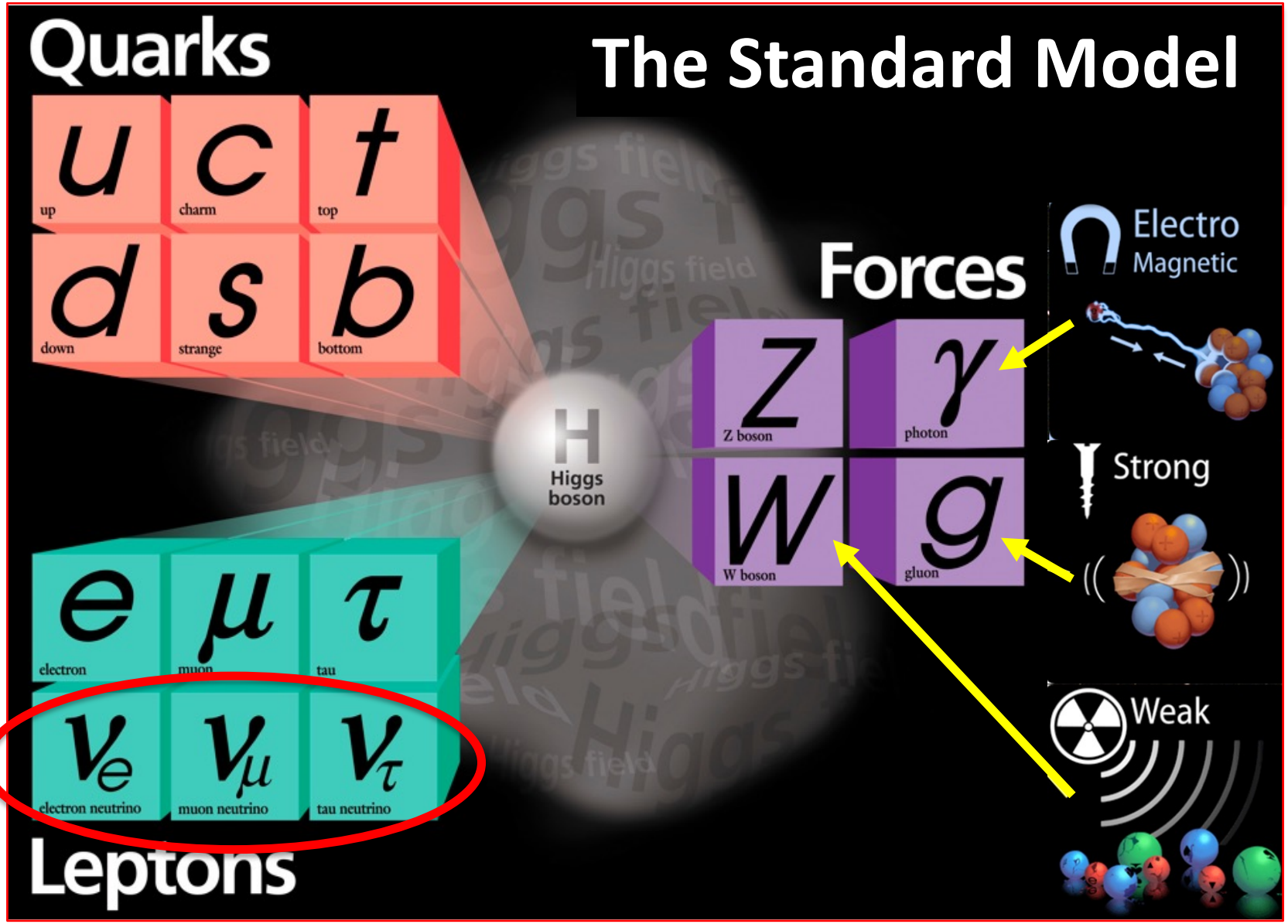
SENSE PARTNERS	
University of Bern	CH
University of Cambridge	UK
University of Liverpool	UK
Universitat de Valencia	ES

A cooperative Europe – United States – Brazil effort (II)

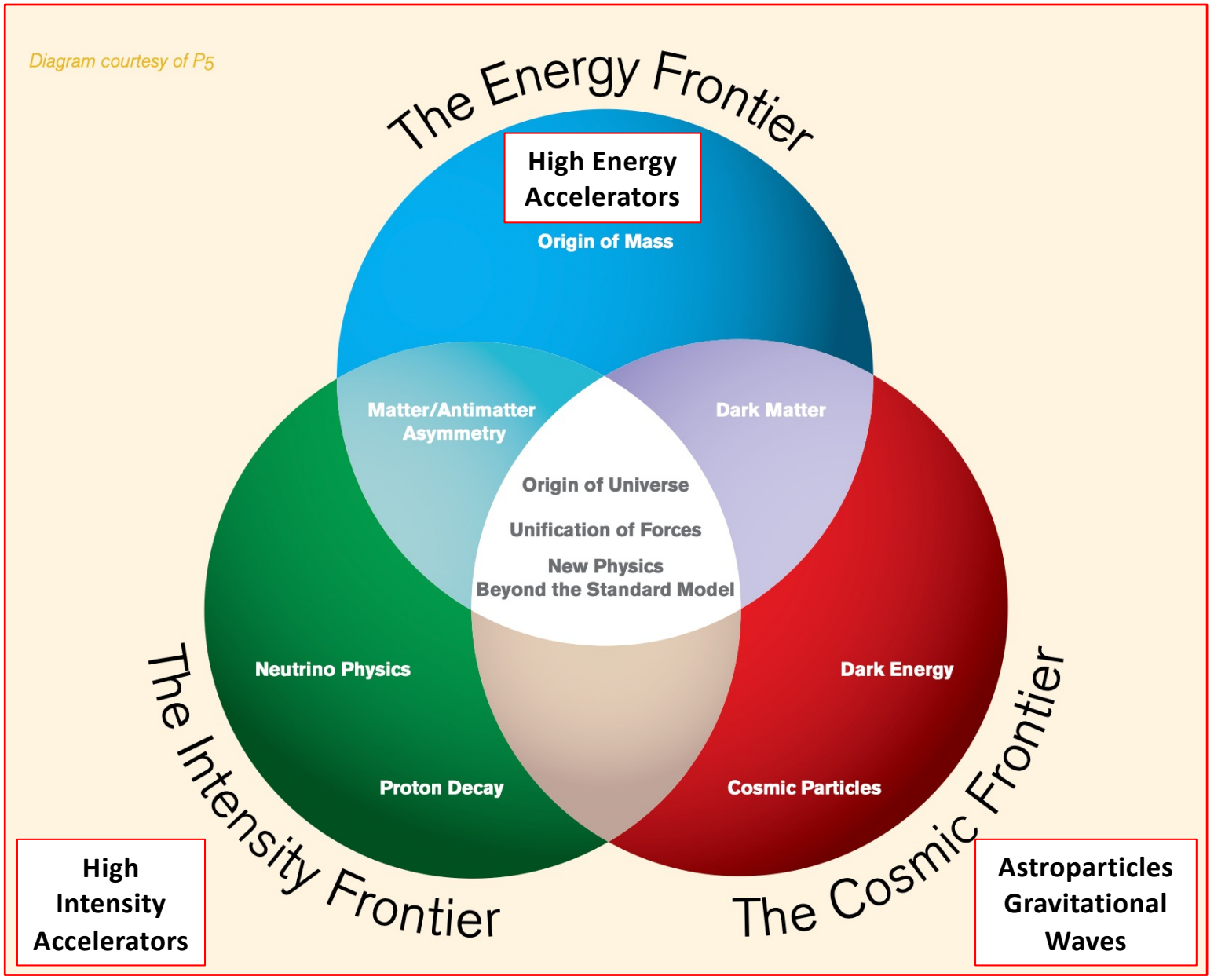
SENSE PARTNERS	
Fermi National Accelerator Laboratory	US
Universidade Estadual de Campinas	BR
Universidade Technologica F. do Parana	BR

Simone Donati, SENSE MidTerm Review Meeting, Pisa (Italy)

Elementary particles & fundamental interactions

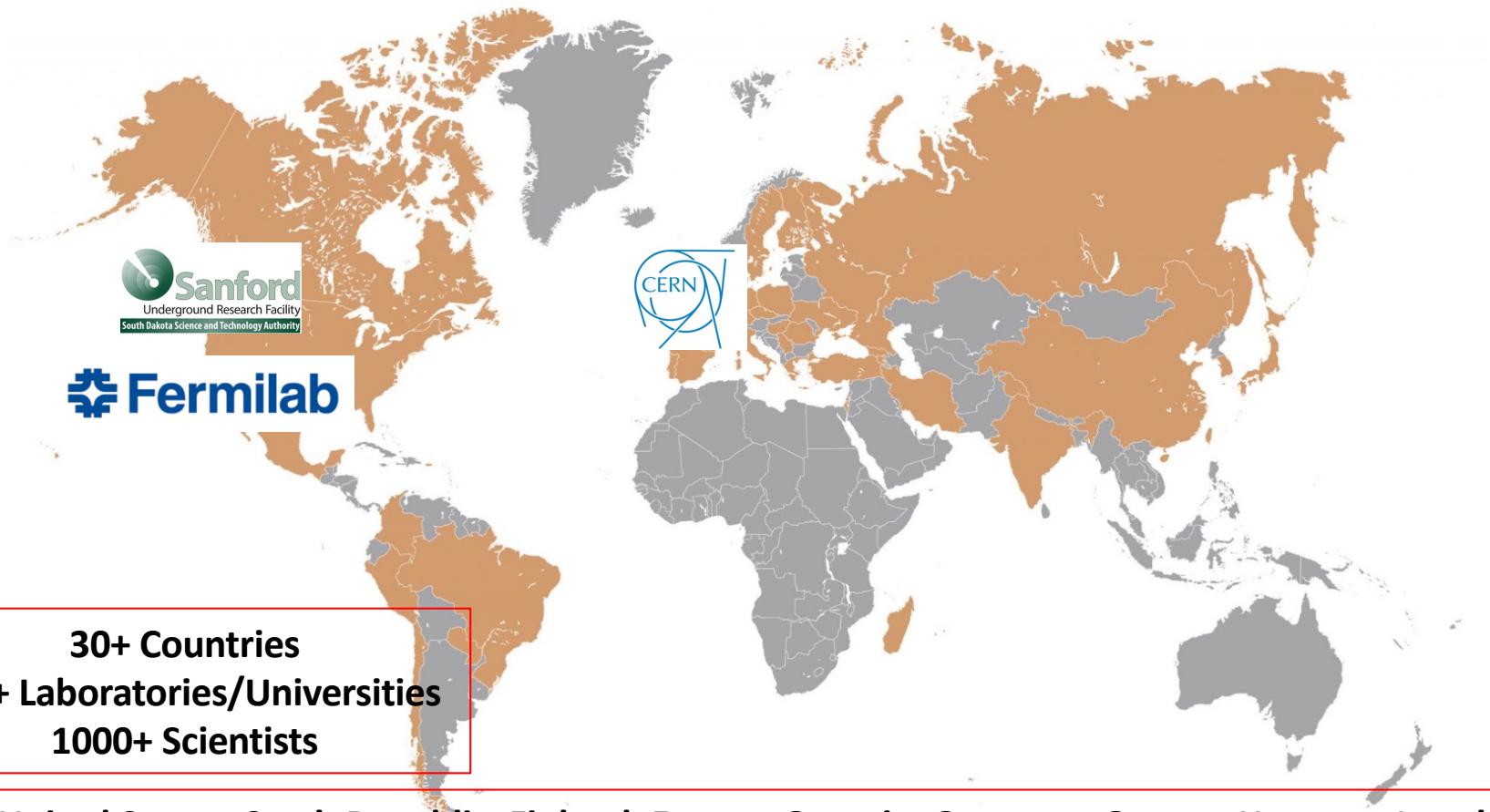


SENSE: Exploring the Intensity Frontier



Simone Donati, SENSE MidTerm Review Meeting, Pisa (Italy)

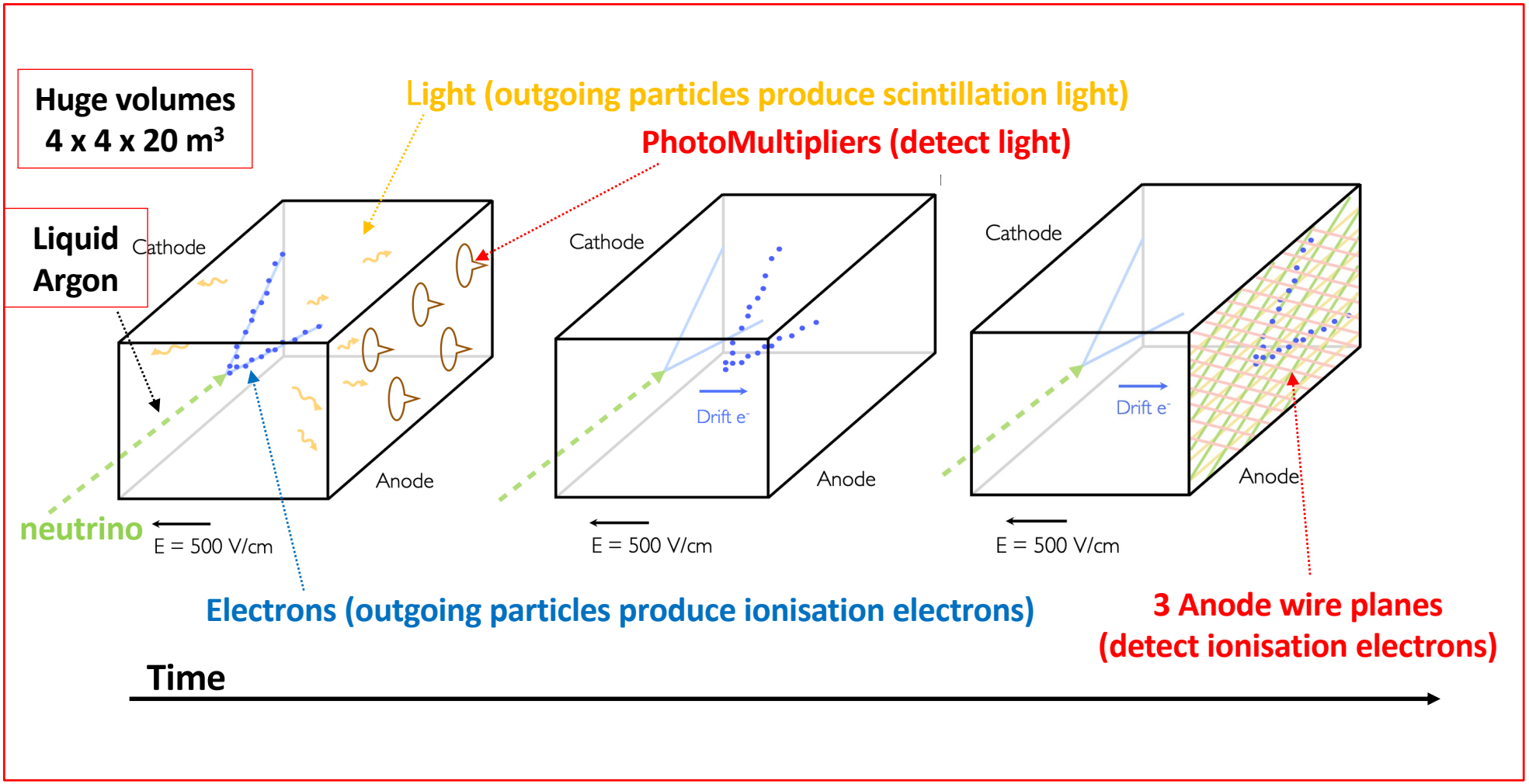
Short Baseline Neutrino Program (SBN)
and Deep Underground Neutrino Experiment (DUNE)



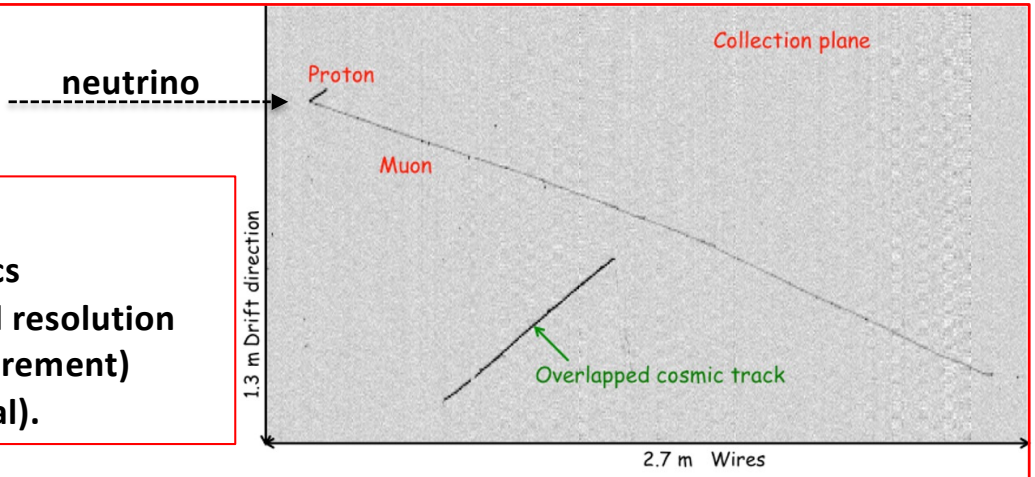
30+ Countries
200+ Laboratories/Universities
1000+ Scientists

United States, Czech Republic, Finland, France, Georgia, Germany, Greece, Hungary, Israel, Italy, Netherlands, Poland, Portugal, Romania, Russia, Serbia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom

Exploiting a European (Lar-TPC) Technology at Fermilab
To solve neutrino mysteries - I



Exploiting a European (Lar-TPC) Technology at Fermilab
To solve neutrino mysteries - II

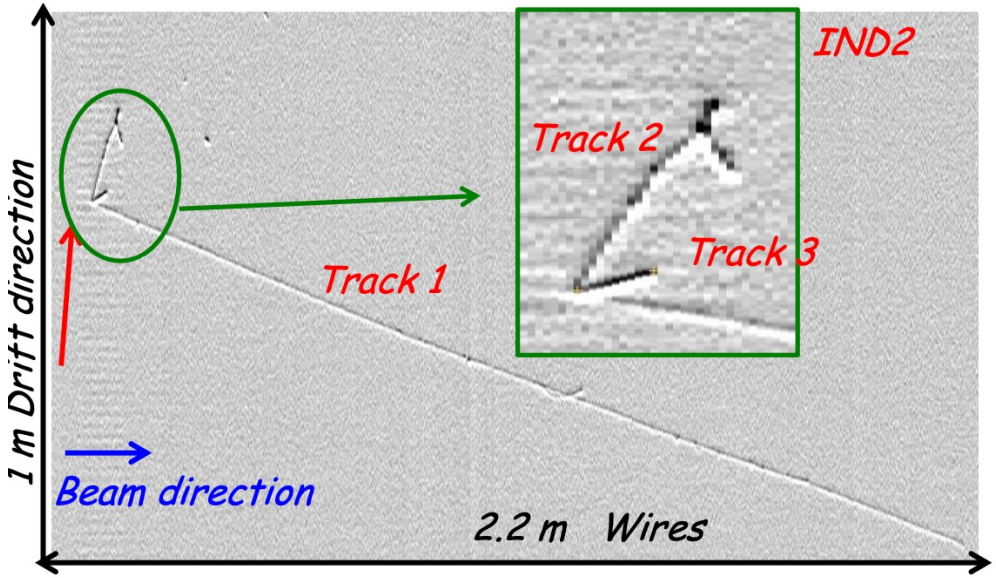


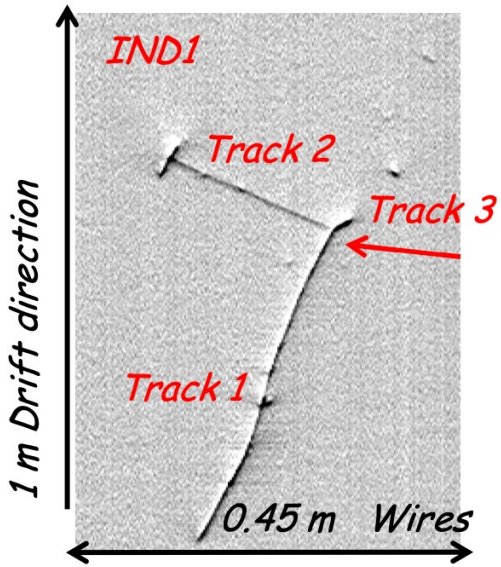
Liquid Argon -TPC

Ideal technology for neutrino physics

- **3D reconstruction with mm spatial resolution**
- **Precise calorimetry (energy measurement)**
- **Fast scintillation light (trigger signal).**

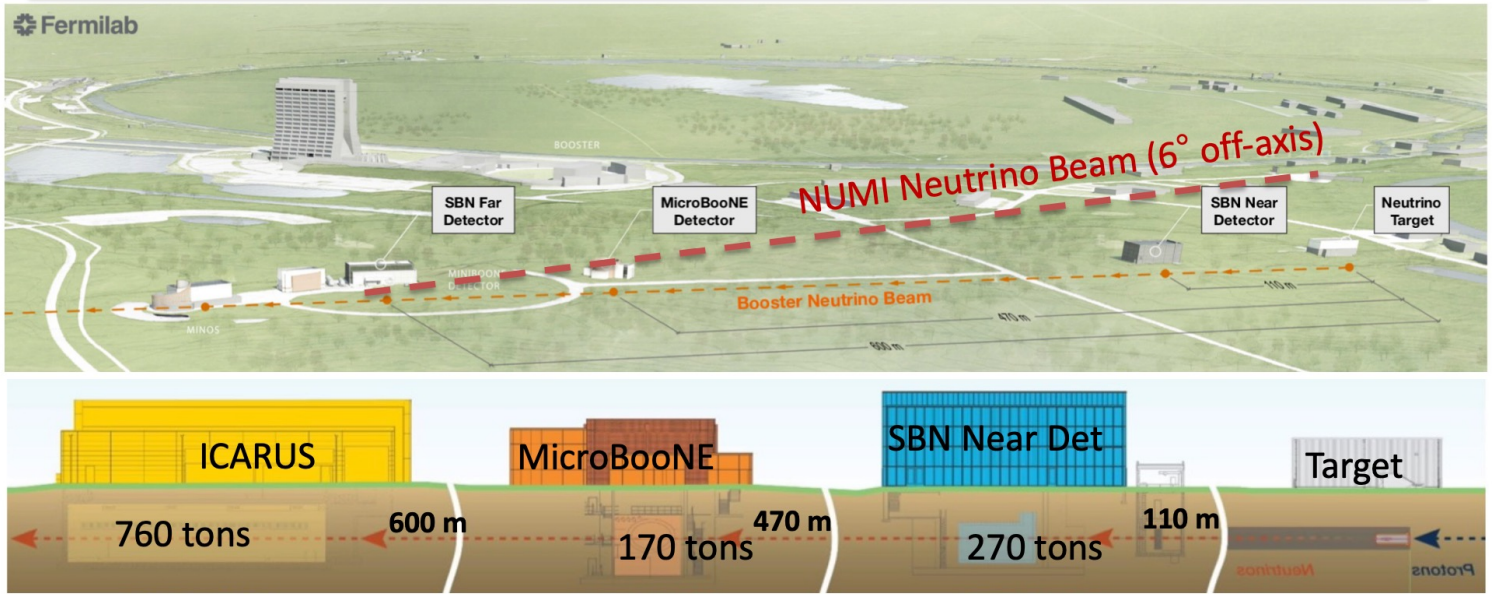
And more complex topologies





Short-Baseline Neutrino Program (SBN)

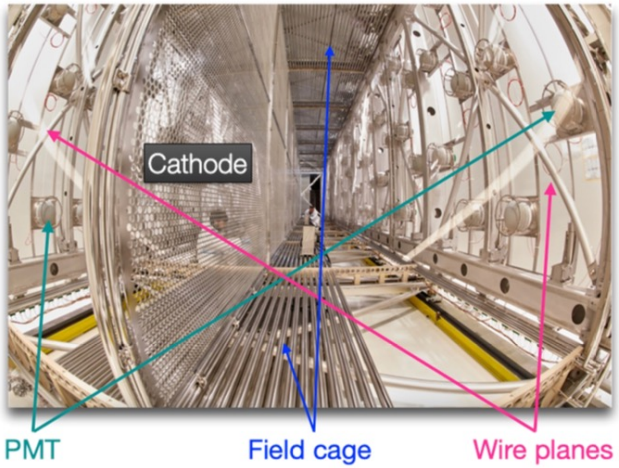
SBN Physics goal: solve sterile neutrino puzzle, measure oscillations and ν-Ar cross sections, understand nuclear effects/final states, develop technology for DUNE.



- **Two LArTPC detectors**:
  - SBND: near detector for flux and v-Ar cross section constraint
  - ICARUS: far detector to measure oscillated neutrino spectrum
- **Two beams**: Booster Neutrino Beam and NUMI (only for ICARUS)

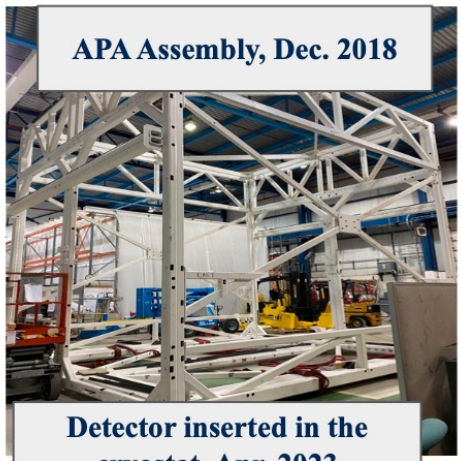
ICARUS Experiment at SBN

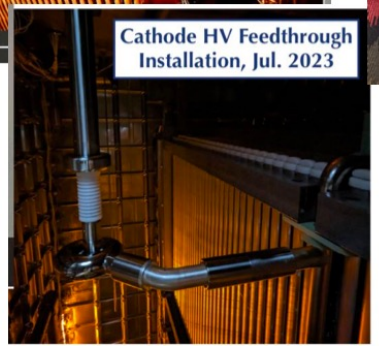
- ICARUS T600 is the first large scale LAr-TPC:
  - 2 identical cryostats (3.6 x 3.9 x 19.6 m^3)
  - active mass: 470 tons
- **4 Time Projection Chambers:**
  - 3 wire planes per anode (0°,±60° w.r.t horizontal)
  - 500 V/cm E field (1.5 m drift)
  - Warm front-end electronics
- **Photon Detection System:**
  - 360 PMTs coated with TPB behind anode wire planes (90 per anode) for event triggering/timing with light
- **Cosmic Ray Tagger :**
  - top/side cosmic ray tagger panels (scintillator + SiPM readout)
- **3 m concrete overburden** for cosmic γ/n suppression



Physics run started in June 2022 and progressing smoothly
ICARUS is collecting a lot of interesting data (see Alice Campani's Talk)

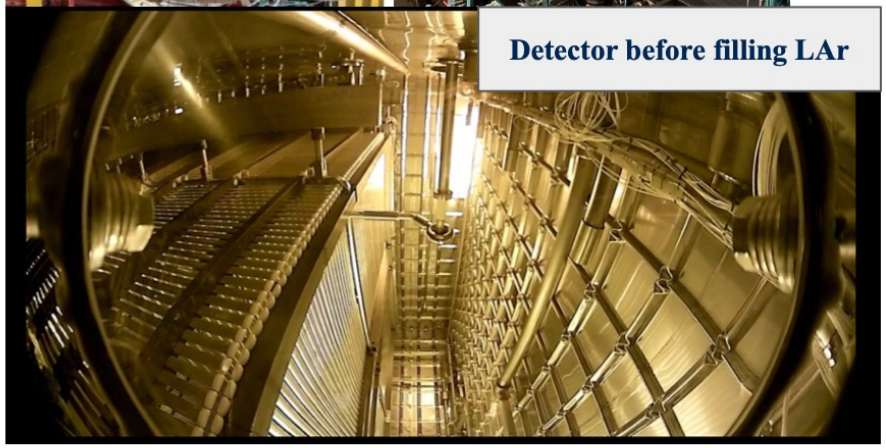
The Short-Baseline Near Detector Experiment (SBND) - I



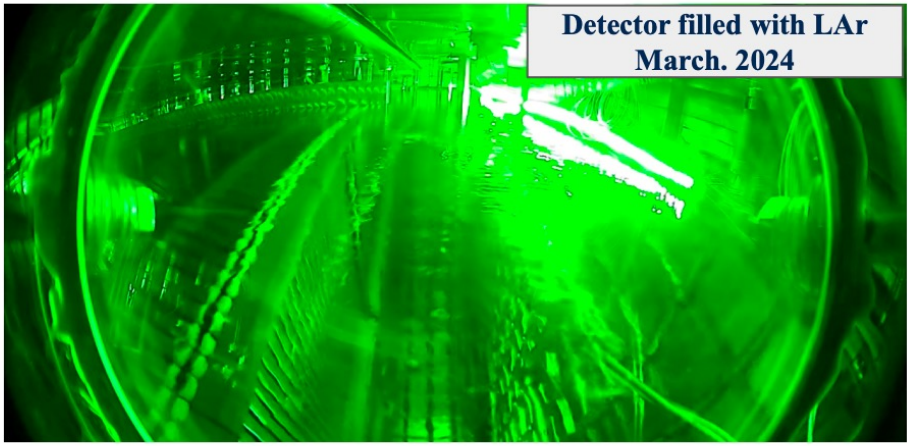


see Diego Garcia-Gamez's Talk

The Short-Baseline Near Detector Experiment (SBND) - II

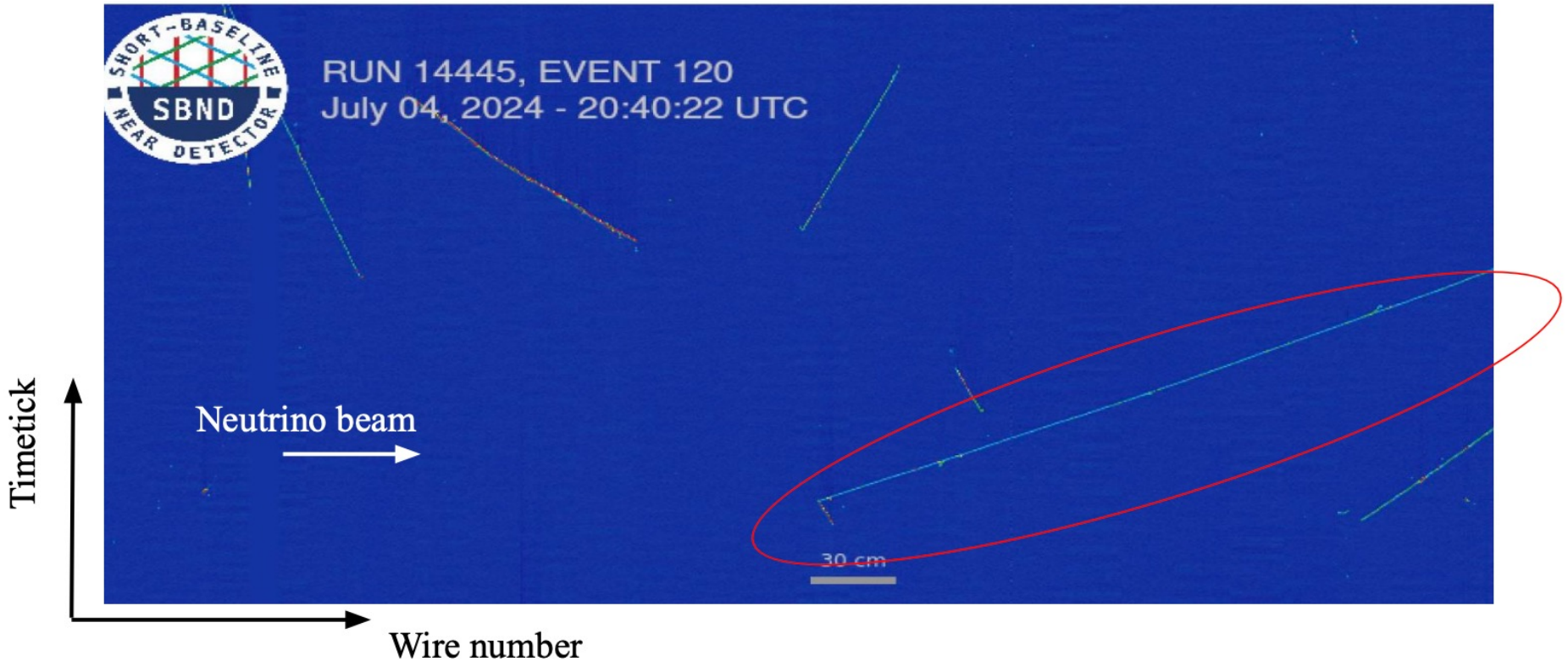


All the detector subsystems were powered ON in March 2024!



see Diego Garcia-Gamez's Talk

The Short-Baseline Near Detector Experiment (SBND) - III



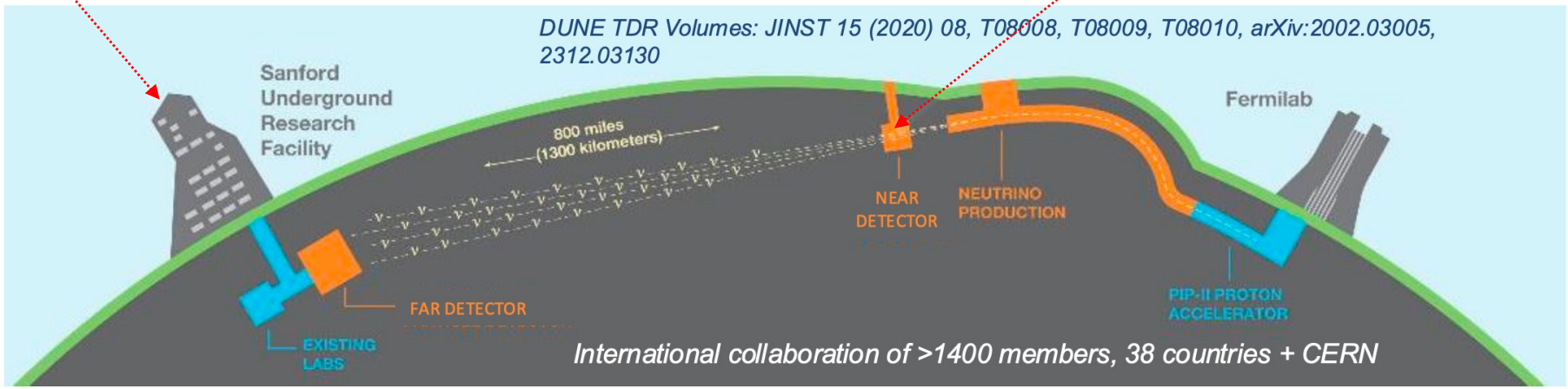
SBND started collecting beam data on July 3, 2024
Cathode HV at the design target of 100 kV

see Diego Garcia-Gamez's Talk

Deep Underground Neutrino Experiment (DUNE)

see Jan Kunzmann's Talk on the Far Detector

see Anselmo Cervera's Talk on the Near Detector



- The **most powerful neutrino beam in the world** (>2 MW) will be sent from Fermilab (Chicago) to SURF (South Dakota) along 1300 km distance to be detected by four liquid argon **far detector** modules (70 kton LAr) at 1.5 km deep underground and a **near detector** complex at 560 m from the neutrino source
  - The **long baseline** enables an unambiguous measurement of the neutrino mass ordering
  - The **wide-band energy spectrum** of neutrinos enables detailed fitting of the oscillation parameters
  - **LArTPC technology** enables precise reconstruction of the neutrino interactions
  - The FD **underground location** enables astrophysical measurements
  - The **ND complex** enables unprecedented control of systematic uncertainties

see Inés Gil Botella's Talk on the DUNE Physics Program

SENSE Network Organization: Management Board/Scientific Board

MANAGEMENT BOARD	
Simone Donati	UNIPI
Elena Pedreschi	INFN
Francesco Lanni	CERN
Radia Sia	CLEVER
Inés Gil Botella	CIEMAT
Antonio Bueno Vilar	UGR
Michel Sorel	CSIC
Paul De Jong	NIKHEF
Christos Spandonidis	PRISMA
Chair: Simone Donati	

	WORK PACKAGE	LEAD BENEFICIARY	SCIENTIFIC BOARD
WP1	SBN Program	CIEMAT	A.Campani (INFN), D.Garcia-Gámez (UGR), A.Fava (FNAL)
WP2	DUNE Far Detector	CERN	A.Cervera (CSIC), F.Pietropaolo (CERN)
WP3	DUNE Near Detector	UNIPI	M.Weber (UBERN), J.Kunzmann (UBERN), S.Donati (UNIPI)
WP4	DUNE Phsyics Program	INFN	I.Gil-Botella (CIEMAT), D.Gibin (INFN), M.Sorel (CSIC)
WP5	Dissemination and Outreach	UGR	C.Farnese (INFN), A.Bueno Vilar (UGR), D.Turrioni (FNAL)
WP6	Transfer of Knowledge	CSIC	F.Varanini (INFN), R.Sia (CLEVER), C.Spandonidis (PRISMA)
WP7	Management	UNIPI	S.Donati (INFN)
			Chair: Simone Donati

SENSE MidTerm Review Meeting - Agenda

	Welcome - Introduction	
	Introduction	Simone Donati
WP1	The SBN Program and the Icarus experiment at FNAL	Alice Campani
WP1	The SBND experiment at the FNAL SBN	Diego Garcia-Gamez
WP2	The DUNE Far Detectors	Anselmo Cervera
WP3	The DUNE Near Detectors	Jan Kunzmann
WP4	The DUNE Physics Program	Inés Gil Botella
WP5	Dissemination and Outreach	Christian Farnese
WP6	Transfer of Knowledge	Filippo Varanini
WP7	Management	Simone Donati
	Talks from Seconded Researchers	Maria Artero Pons
	Talks from Seconded Researchers	Namitha Chithirasreemadam
	Recommendations from Project Officer	
	Conclusions	

SENSE Deliverables

Deliverable Number	Work Package	Title	Due Date	Due Date in Months	Status in System	Comment on progress and planning deviations
D1.1	WP1	SBND liquid argon cryostat installed	31/05/2024	10	Submitted	Completed
D1.2	WP1	SBND Detectors, Cosmic Ray Tagger and Photon Detection System installed	31/12/2024	24	Submitted	Completed
D2.1	WP2	Design of the second DUNE Far Detector validated	31/12/2024	24	Submitted	Completed
D2.2	WP2	First DUNE Far Detector cryostat installed	31/05/2026	42	Pending	On-track
D2.3	WP2	Second DUNE Far Detector cryostat installed	31/12/2026	48	Pending	On-track
D3.1	WP3	2x2 Near Detector demonstrator assembled, commissioned and operational at FNAL	31/12/2024	24	Submitted	Completed
D3.2	WP3	Full-size pre-production Module of ND-LAr assembled and tested	31/12/2026	48	Pending	On-track
D4.1	WP4	DUNE Far Detector simulation and reconstruction tools developed and testes	31/12/2024	24	Submitted	Completed
D4.2	WP4	Report on DUNE physics prospects	31/12/2026	48	Pending	On-track
D5.1	WP5	Workshop day at General Meetings	31/08/2023	9	Pending	Postponed
D5.2	WP5	Summer Students at US Laboratories	31/07/2023	8	Submitted	Completed
D5.3	WP5	Communication, Dissemination and Exploitation Plan	31/05/2023	6	Submitted	Completed
D5.4	WP5	Data Management Plan	31/05/2023	6	Submitted	Completed
D6.1	WP6	Trainings at General Meetings	31/08/2023	9	Pending	Postponed
D7.1	WP7	Progress Report No. 1	31/01/2023	13	In Writing	Completed
D7.2	WP7	MidTerm Meeting	31/05/2024	18		

Backup