The CERN Neutrino Platform

M.Nessi, 27-4-2015

CERN ν Platform Mandate (2014)

- Assist the various groups in their R&D phase (detectors and components) in the short and medium term and give coherence to a fragmented European Neutrino Community
- Provide to the ν community a test beam infrastructure (charged particles)
- Bring R&D at the level of technology demonstrators in view of major technical decisions
- Continue R&D on ν beam, as a possible base for further collaborations
- Support the short baseline activities (infrastructure & detectors)
- Support the long baseline activities (infrastructure & detectors)

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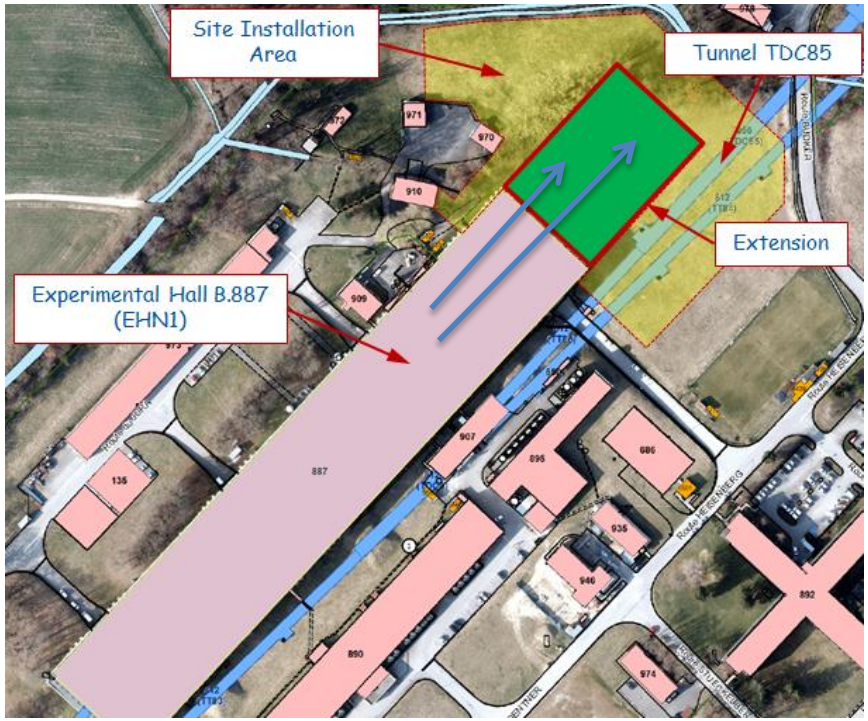
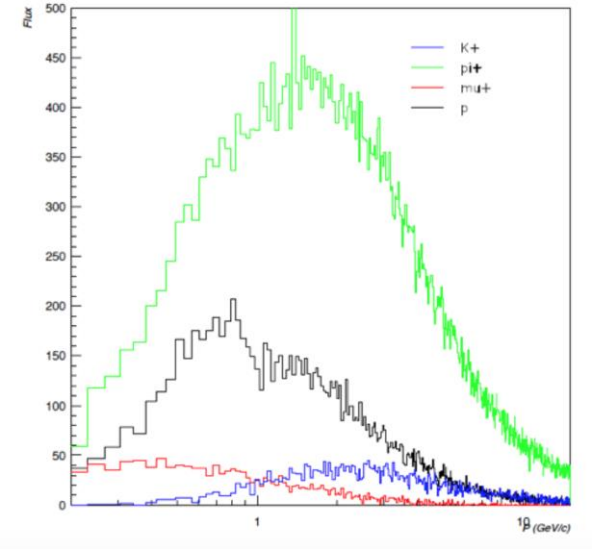
EHN1 extension

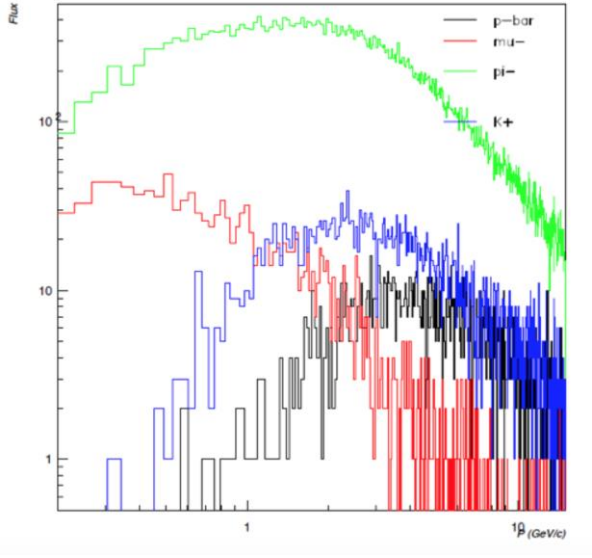
- ✓ Civil Engineering contract signed in January
- ✓ Dismantling of the infrastructure, barracks, end wall ongoing
- ✓ Weekly integration meetings on going (EN/MEF-LE)
- ✓ Civil Engineering work ongoing
- ✓ Beam optimization studies ongoing (see I.E.)

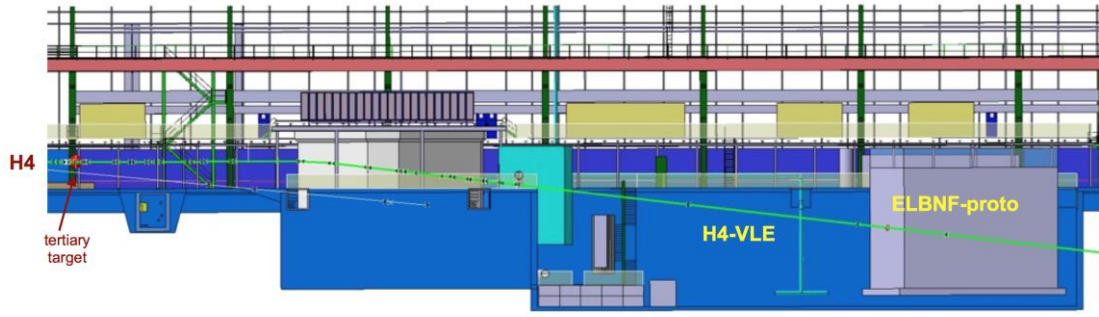


EHN1 extension

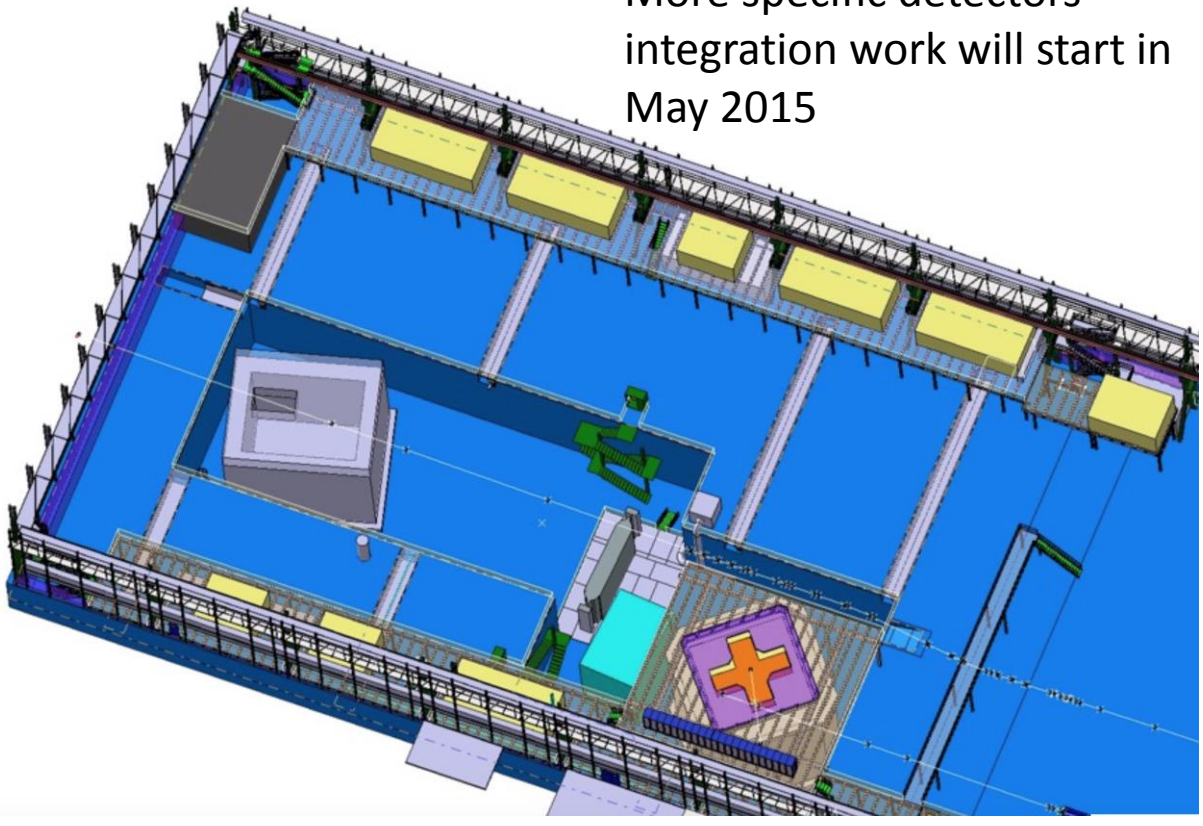
EHN1 integration and beams







More specific detectors integration work will start in May 2015



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The LAr TPCs story

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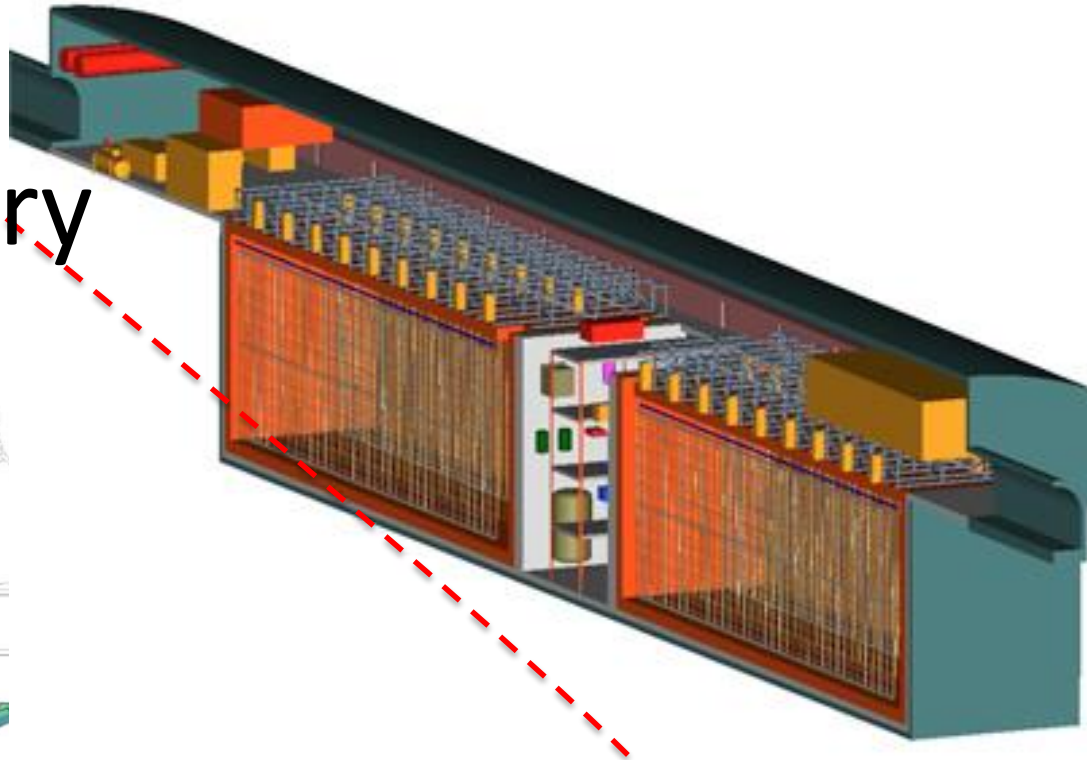

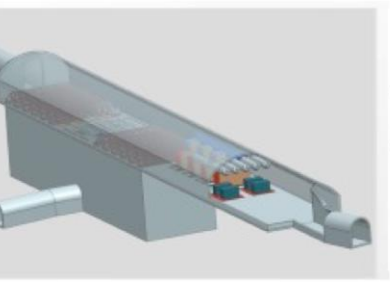

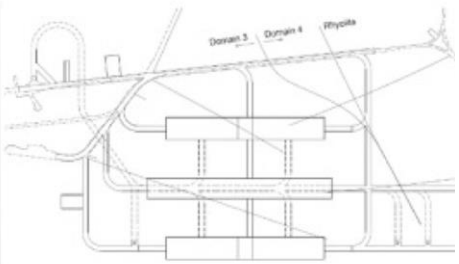

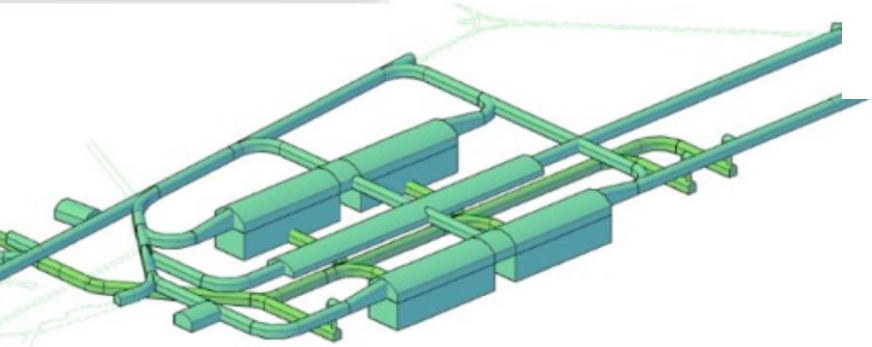

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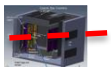

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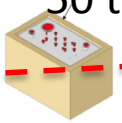

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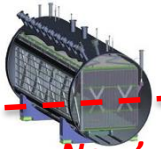

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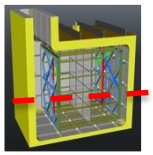

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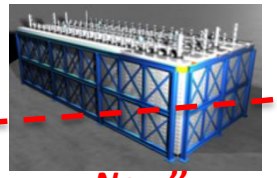

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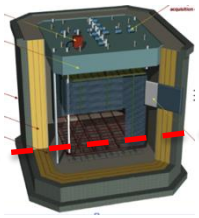

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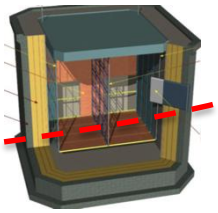

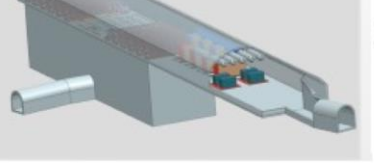

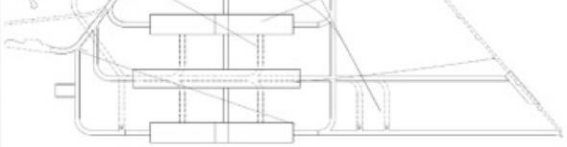

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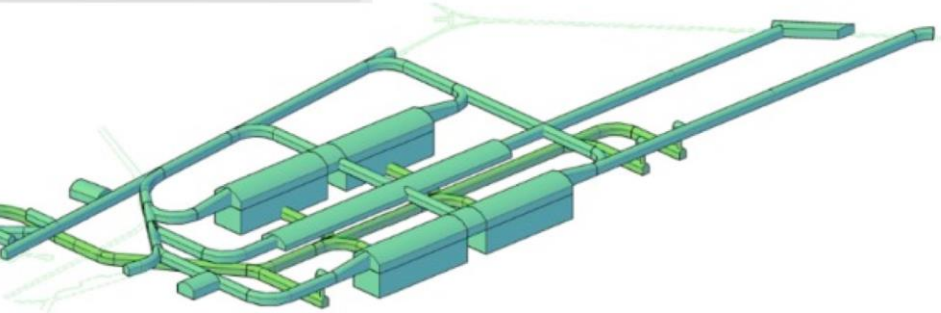

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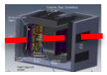
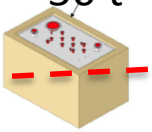
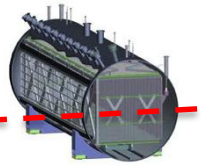
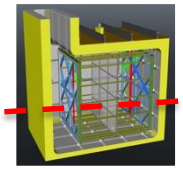
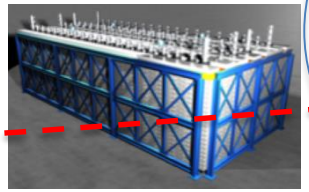
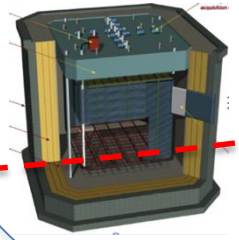


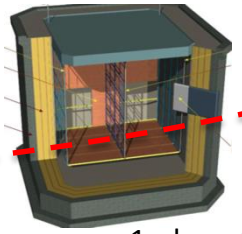












1-ph LAr TPC

2-ph LAr TPC

1-ph

1-ph

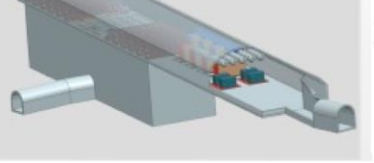
1-ph

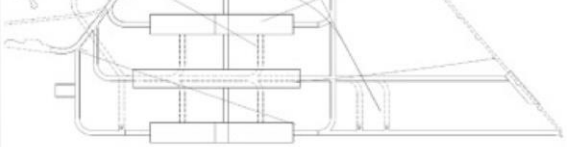
2-ph

1-ph

R&D — Short Baseline — NA61 Minerva …. — CERN ν Platform →

To succeed we need to proceed in steps





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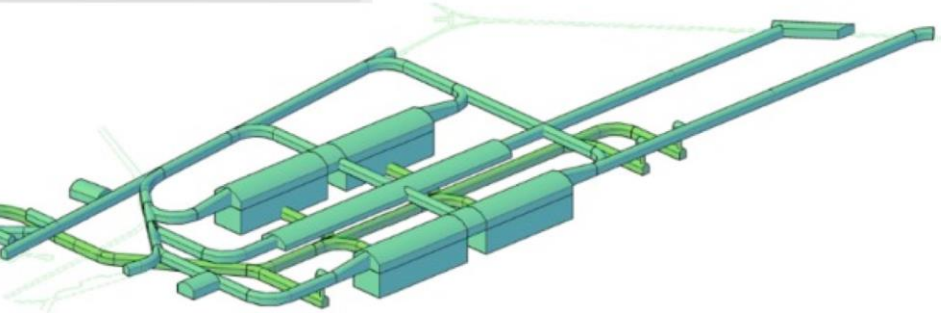

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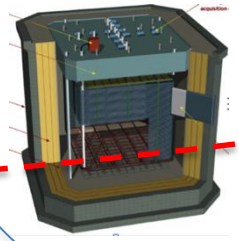

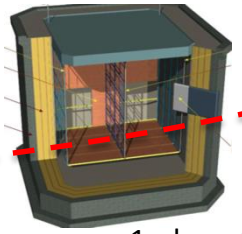

1-ph

2-ph

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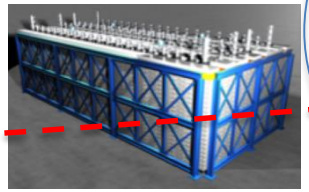

1-ph

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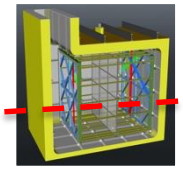

1-ph

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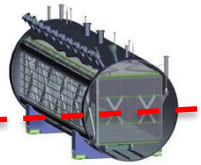

1-ph

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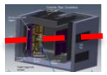
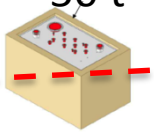


1-ph
LAr
TPC

50 t

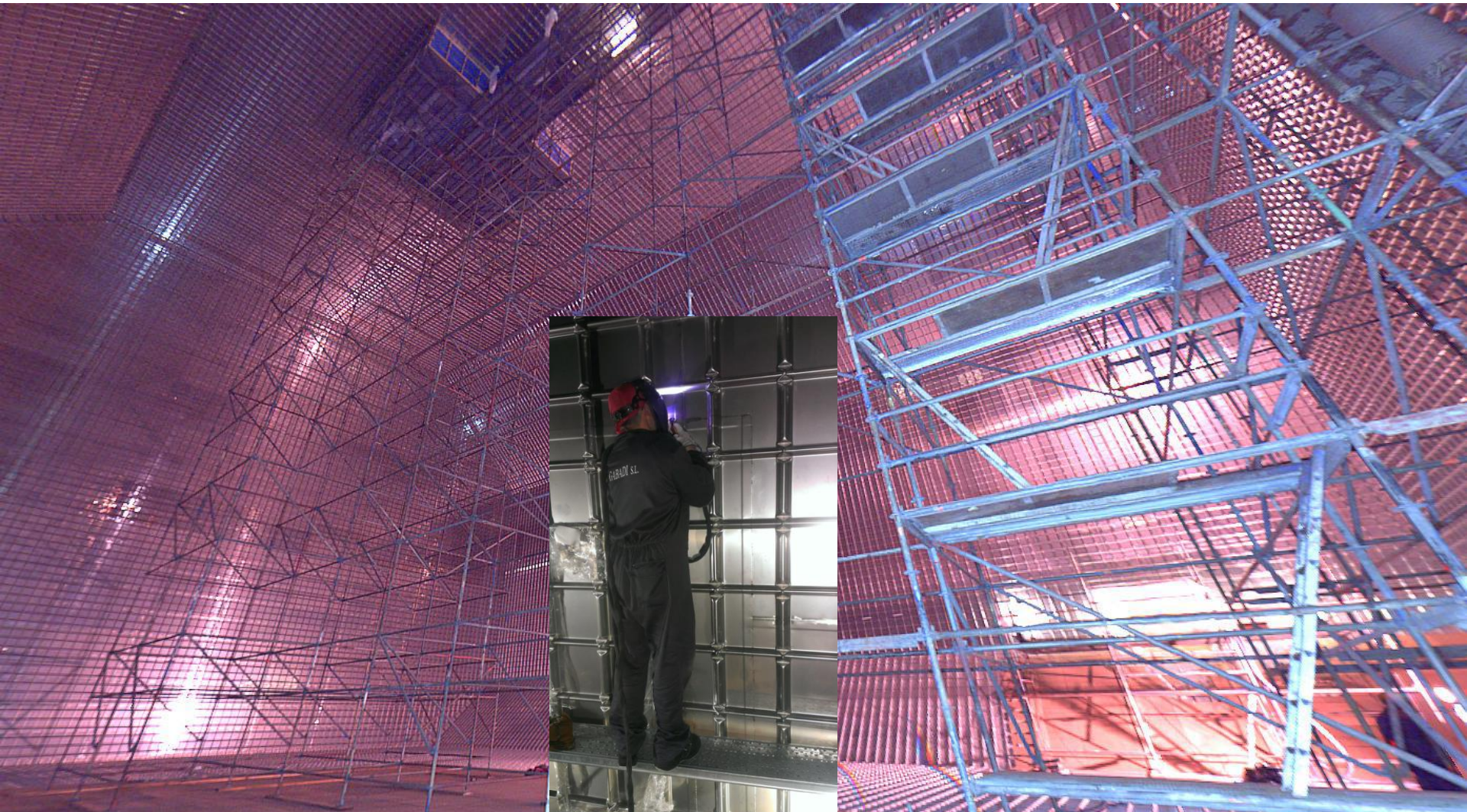


2-ph
LAr
TPC

Several problems to solve:

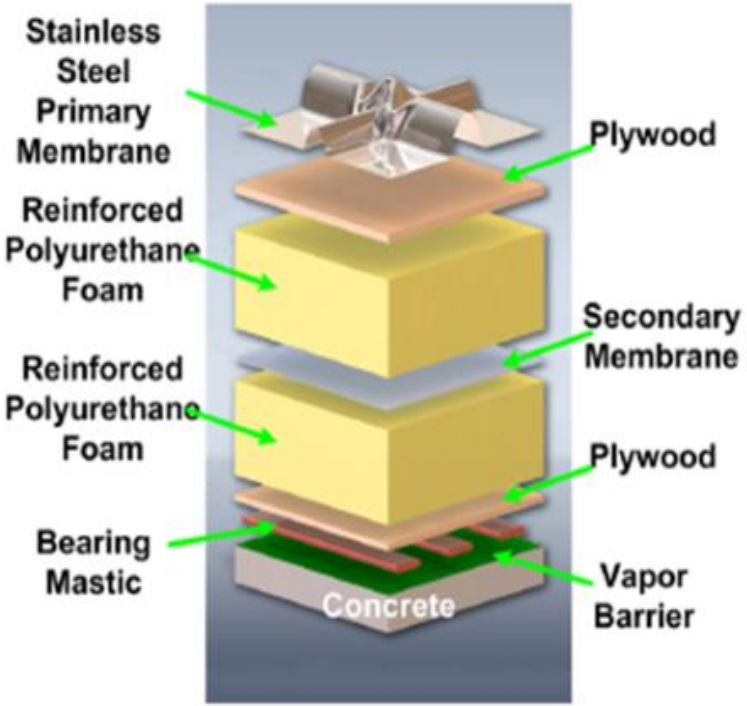
- large LAr mass : cryostats and cryogenics
- Underground infrastructure and access (~1500 m underground)
- TPC technology (single or double phase)
- Large data handling and automatic event pattern recognition

Main problem: how to get and handle multi ktons cryostats and cryogenics



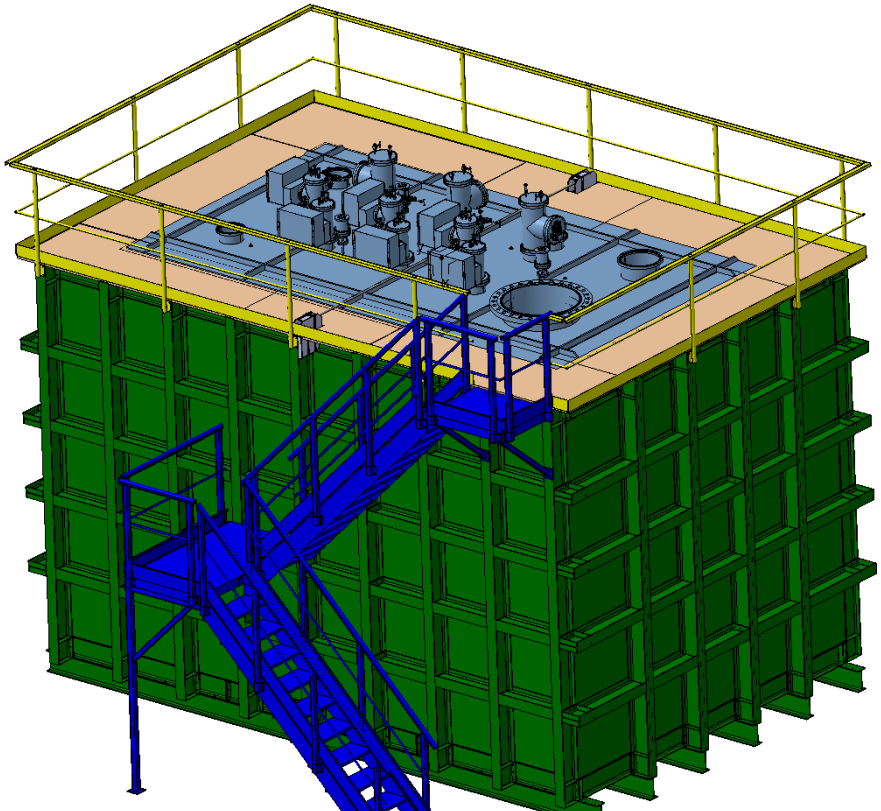
Cryostats & Cryogenics activities

- We are re-creating a LAr cryogenics group at CERN which should serve the needs of the community at large (in cooperation with FNAL)
- Existing Cryolab @ CERN, augmented by 5 FTEs
- 5 large cryostats and related cryogenics under scrutiny and construction !
- A frame contract with GTT under negotiation



First learning phase : WA105 cryostat in 182

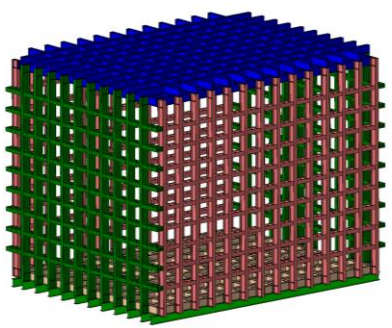
- Warm vessel ready
- Membrane ordered
- Expect installation in the next 2 months
- Detailed engineering of top cap ongoing

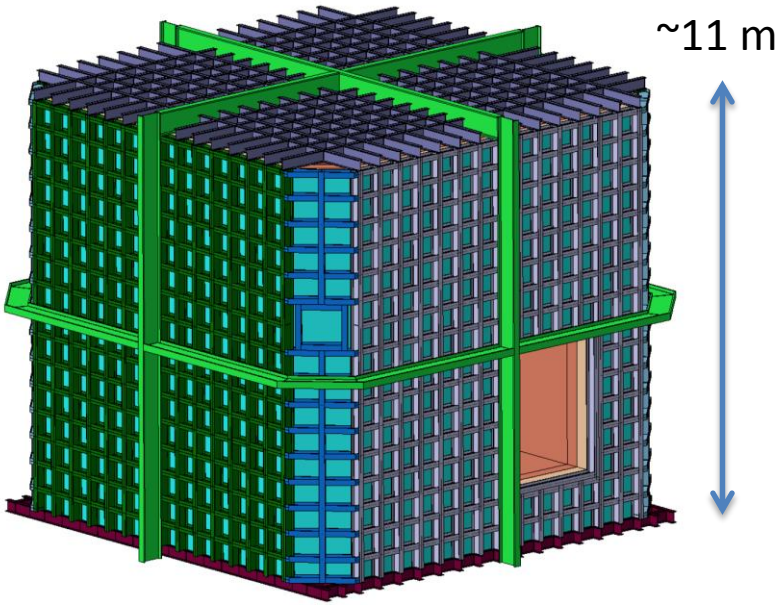


next: 3 large cryostats for EHN1 prototypes and SBN

- 3 large cryostats in the engineering phase
- FE warm vessel + GTT membrane
- At the same time we are designing and engineering the associated cryogenic plants

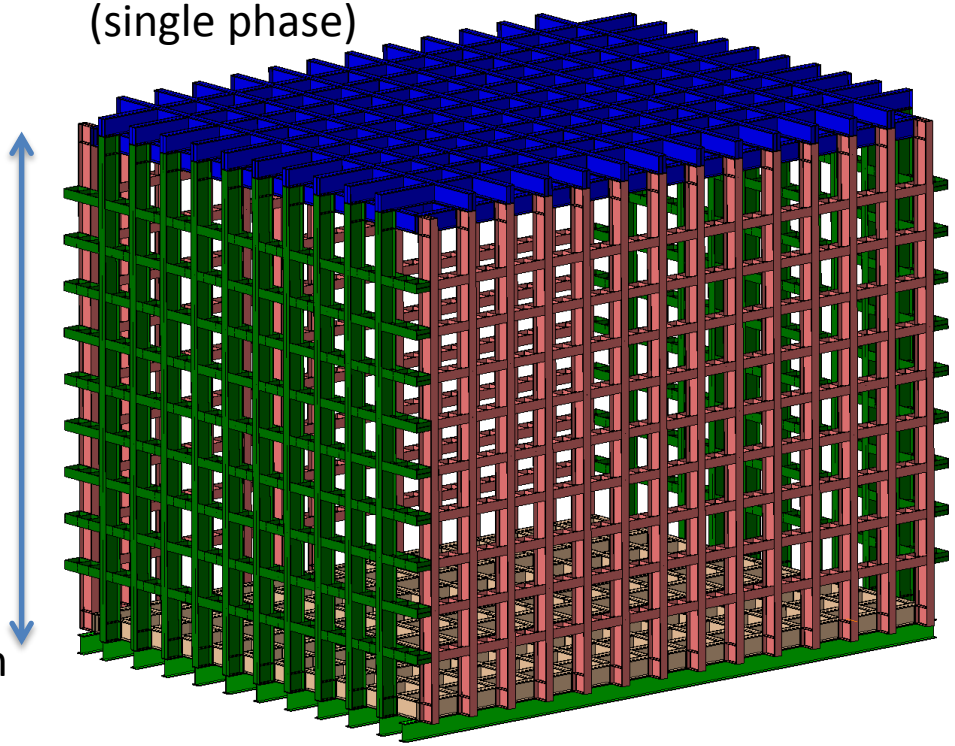
SBN -ND





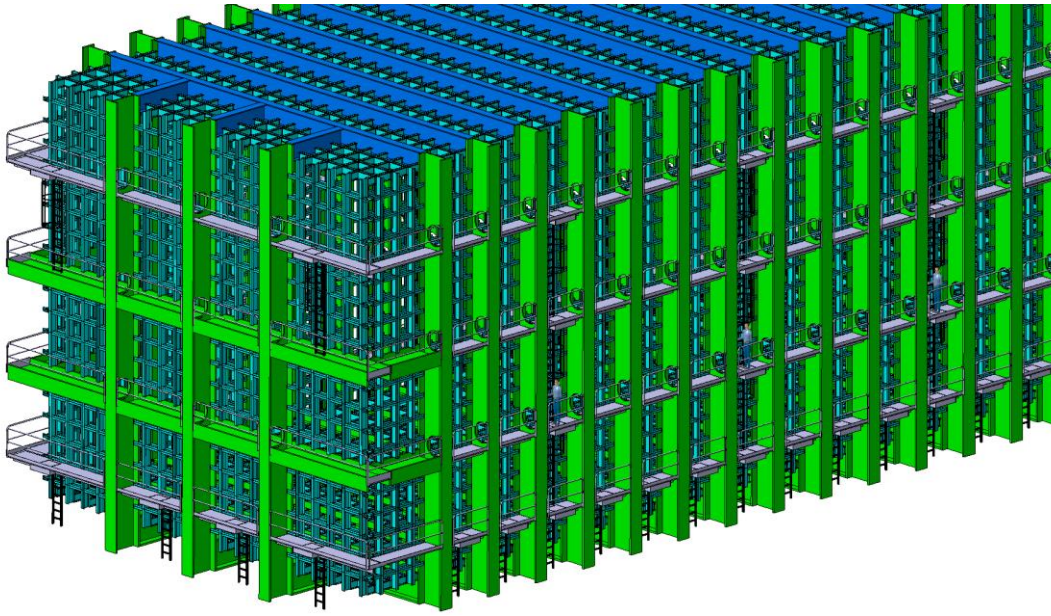
WA105 EHN1 prototype
(double phase)

Dune EHN1 prototype
(single phase)

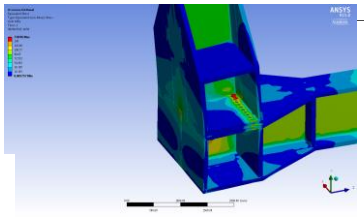


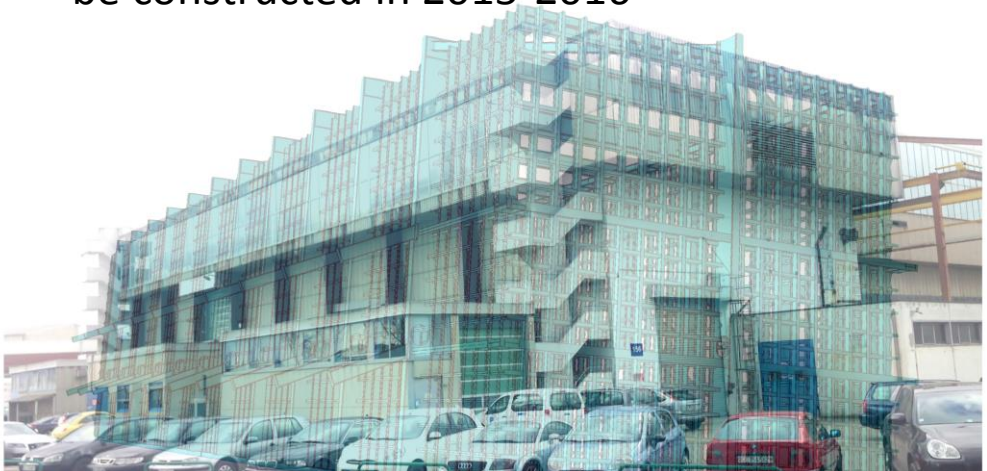
LBNF cryostats

- 4 large cryostats, all the same
- FE warm vessel + GTT membrane
- ~20’000 tons of LAr in each one
- CERN : large engineering
- Explore in-kind contribution possibilities

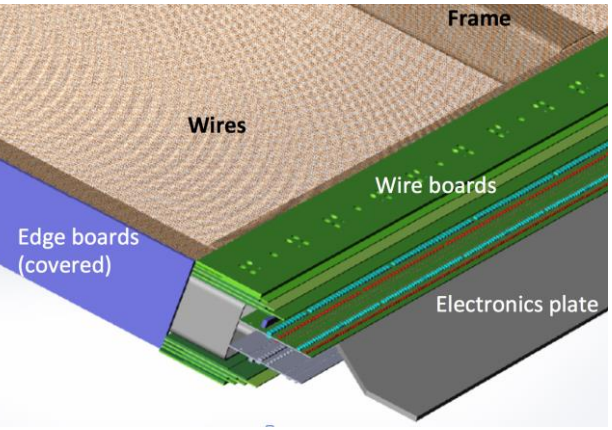


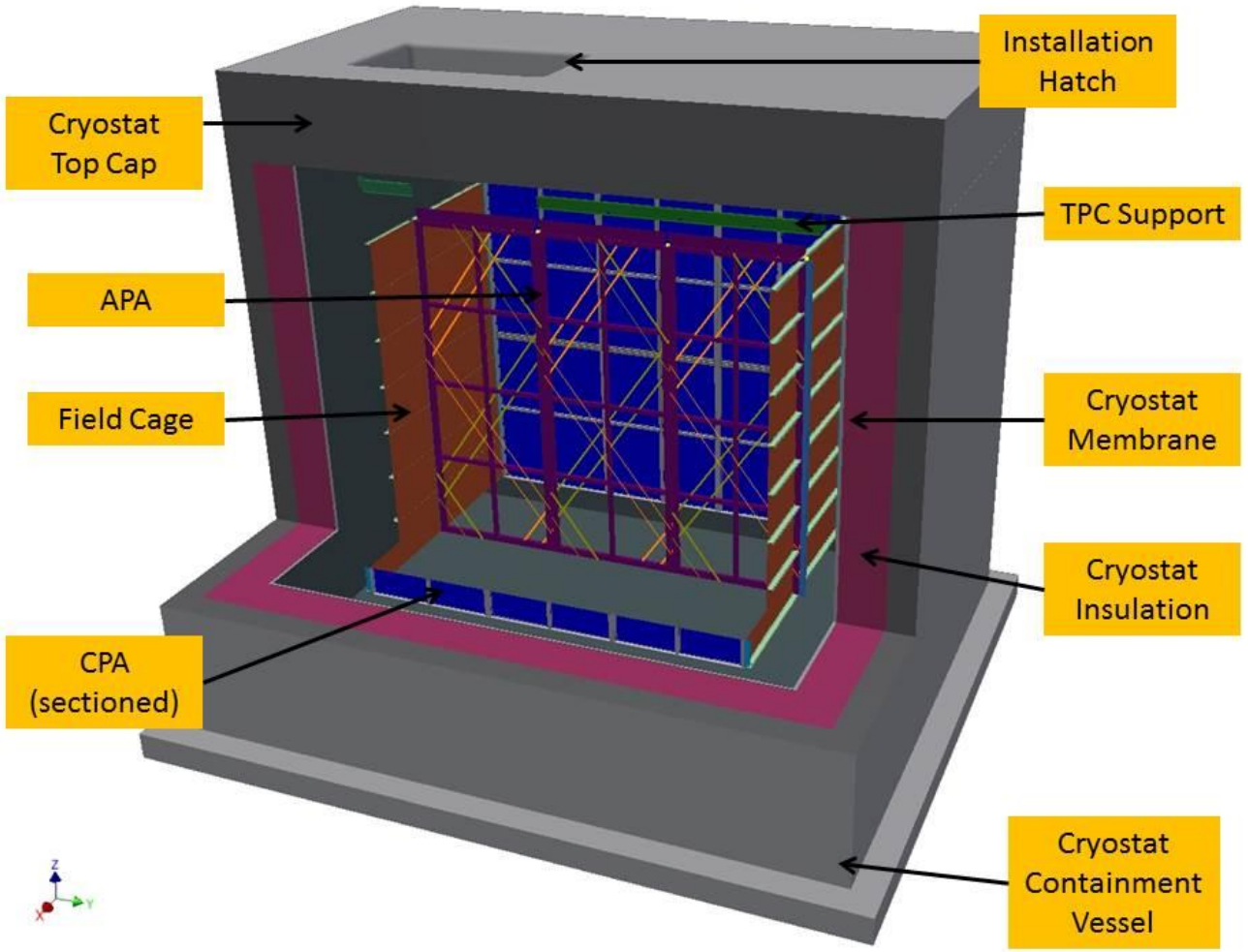
- First design review in June
- US main review in November
- All what we learn in between will be applied to the CERN prototypes to be constructed in 2015-2016

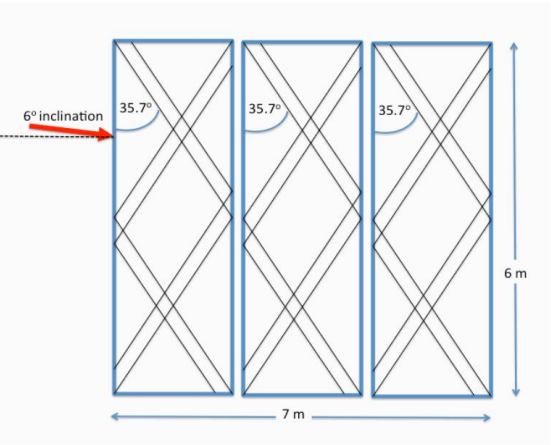




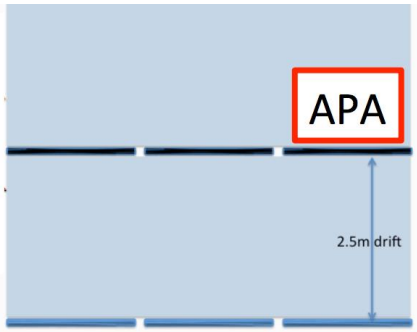
DUNE single phase LAr TPC demonstrator







Side view

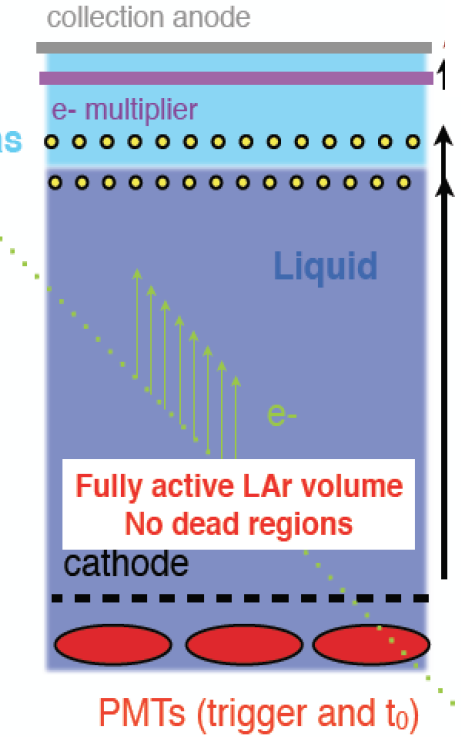


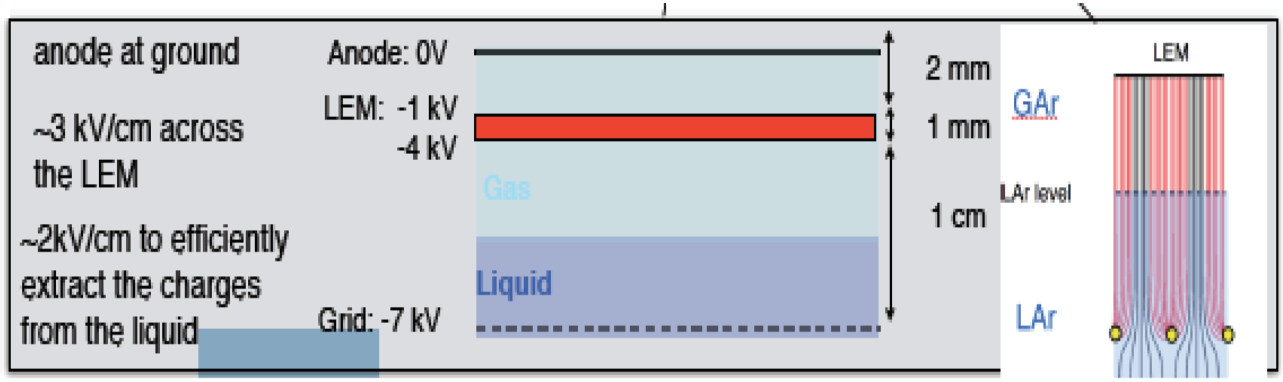
Top view

- ✓ ***Engineering optimization***
- ✓ ***Calibration with beams***

Two phases LAr TPC

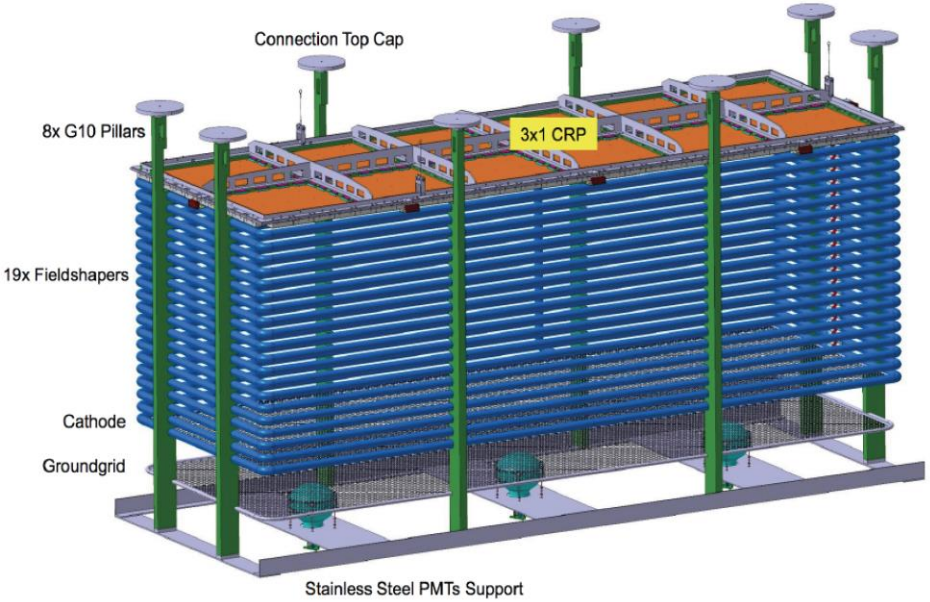
- WA105 (previous LAGUNA) Collaboration
- Long drifts possible because signal amplification in the gas phase (LEM technique)
- Optimal use of the LAr mass (effective mass)

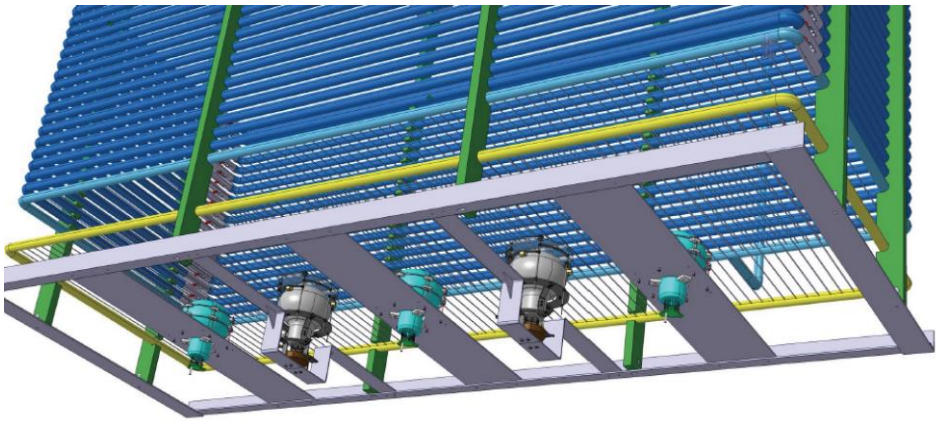


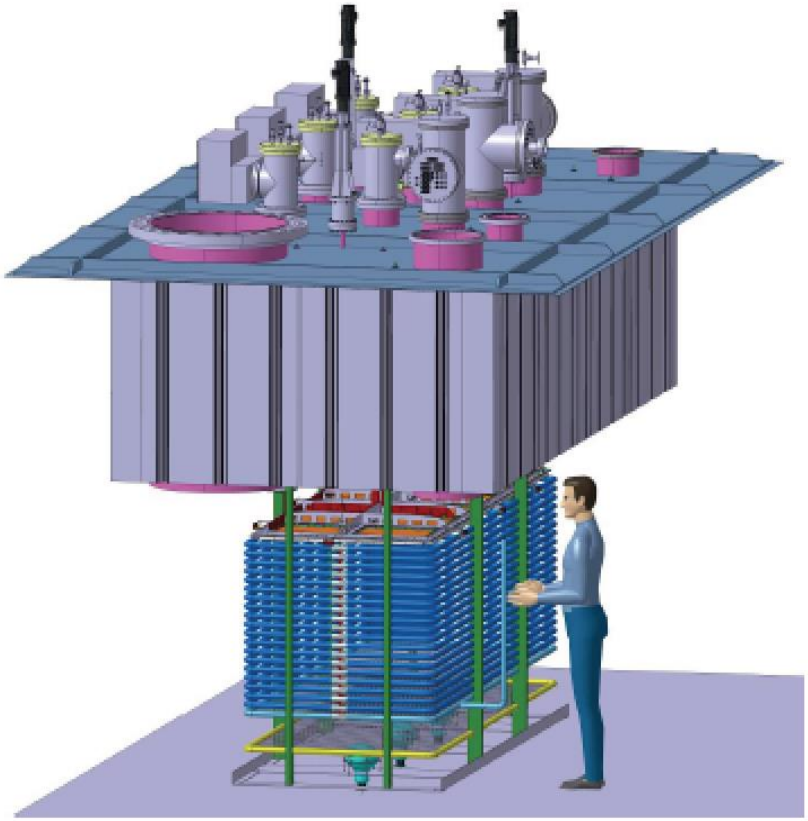


→ **Need large demonstrators before implementation in LBNF**

First double phase prototype under construction ready in Fall 2015, 17 m^3 LAr



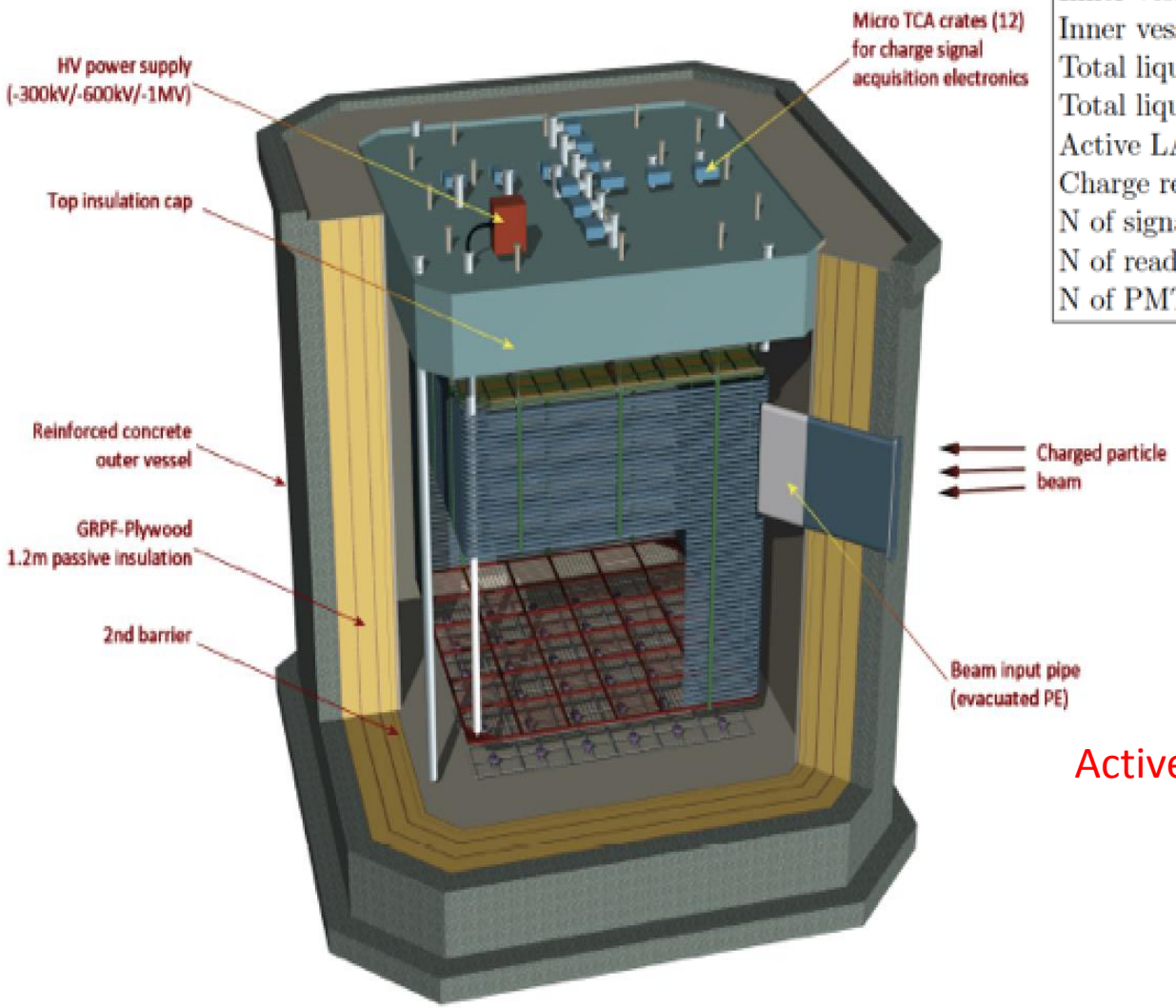




WA105 large demonstrator (2 phases LAr TPC)

Timescale : 2016-2018

Liquid argon density	T/m^3	1.38
Liquid argon volume height	m	7.6
Active liquid argon height	m	5.99
Hydrostatic pressure at the bottom	bar	1.03
Inner vessel size (WxLxH)	m^3	8.3 × 8.3 × 8.1
Inner vessel base surface	m^2	67.6
Total liquid argon volume	m^3	509.6
Total liquid argon mass	t	705
Active LAr area	m^2	36
Charge readout module (0.5 x0.5 m^2)		36
N of signal feedthrough		12
N of readout channels		7680
N of PMT		36



External dimensions:

12.5(w) * ~12.5(l) *~11.2(h) m^3

Active Volume:

6(w) * **6**(l) ***6**(h) m^3

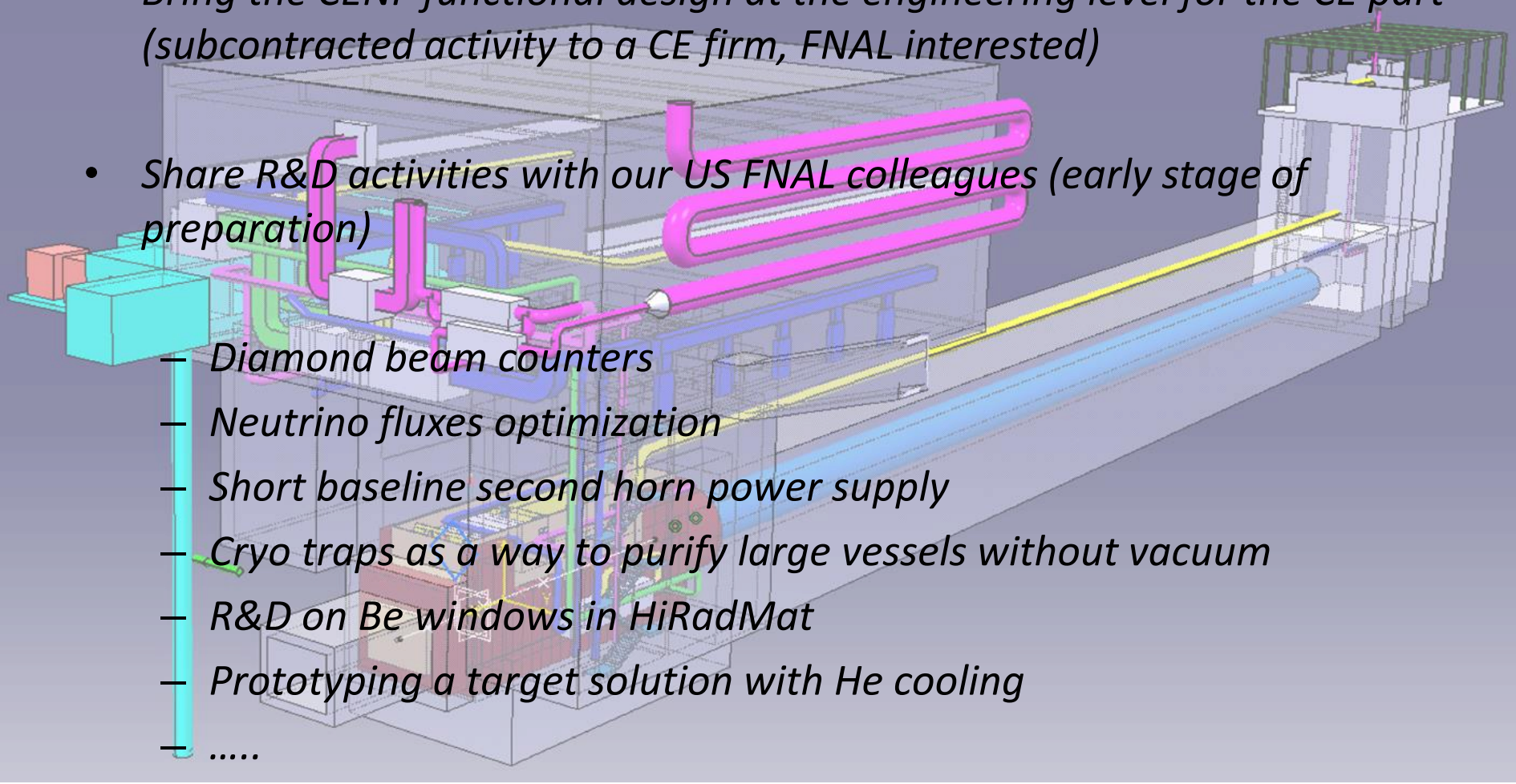
300 tons LAr

CERN ν Platform Mandate (2014)

- Assist the various groups in their R&D phase (detectors and components) in the short and medium term and give coherence to a fragmented European Neutrino Community
- Provide to the ν community a test beam infrastructure (charged particles)
- Bring R&D at the level of technology demonstrators in view of major technical decisions (DUNE experiment)
- **Continue R&D on ν beam, as a possible base for further collaborations**
- Support the short baseline activities (infrastructure & detectors)
- Support the long baseline activities (infrastructure & detectors)

Neutrino Beam lines activities (CERN ν beam line, now frozen!)

- *Bring the CENF functional design at the engineering level for the CE part (subcontracted activity to a CE firm, FNAL interested)*
- *Share R&D activities with our US FNAL colleagues (early stage of preparation)*
  - *Diamond beam counters*
  - *Neutrino fluxes optimization*
  - *Short baseline second horn power supply*
  - *Cryo traps as a way to purify large vessels without vacuum*
  - *R&D on Be windows in HiRadMat*
  - *Prototyping a target solution with He cooling*
  - *…..*



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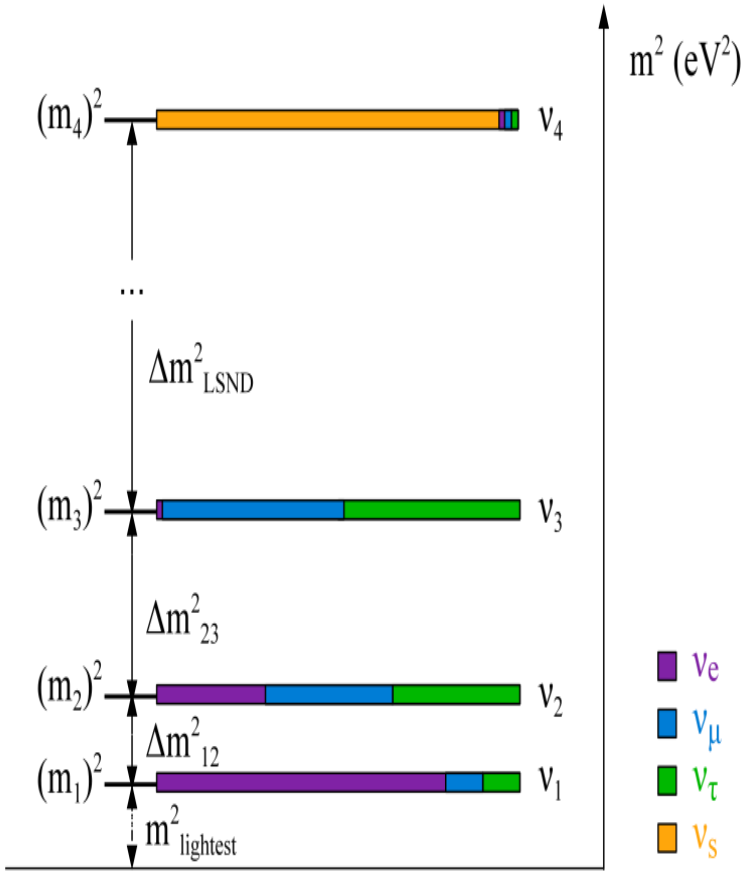
- Support the long baseline activities (infrastructure & detectors)

SBN Physics Program : The Three Neutrino Paradigm

- A Multi-detector program will address the unexplained anomalies which together could be hinting at new physics (steriles?)
  - *MicroBooNE will address MiniBooNE low energy excess but is not designed to explore the complete sterile neutrino oscillation parameter space on its own*
  - *Plans to have all 3 detectors in operation in 2018 (Approved experiment by FNAL PAC in Feb 2015)*



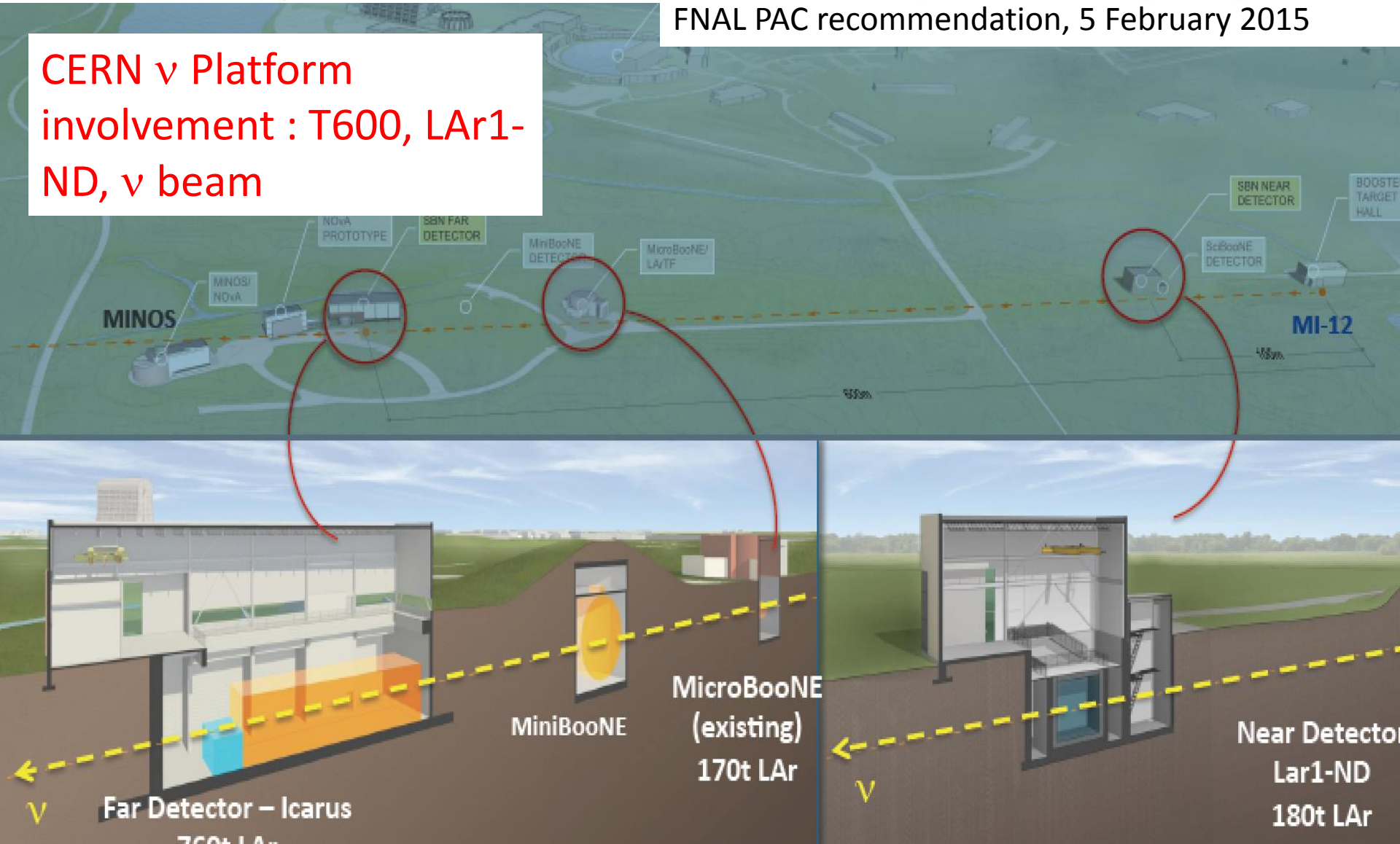
Experiment	Type	Channel	Significance
LSND	DAR	$\bar{\nu}_\mu \to \bar{\nu}_e$ CC	3.8σ
MiniBooNE	SBL accelerator	$\nu_\mu \to \nu_e$ CC	3.4σ
MiniBooNE	SBL accelerator	$\bar{\nu}_\mu \to \bar{\nu}_e$ CC	2.8σ
GALLEX/SAGE	Source - e capture	ν_e disappearance	2.8σ
Reactors	Beta-decay	$\bar{\nu}_e$ disappearance	3.0σ

K. N. Abazajian et al. "Light Sterile Neutrinos: A Whitepaper", arXiv:1204.5379 [hep-ph], (2012)

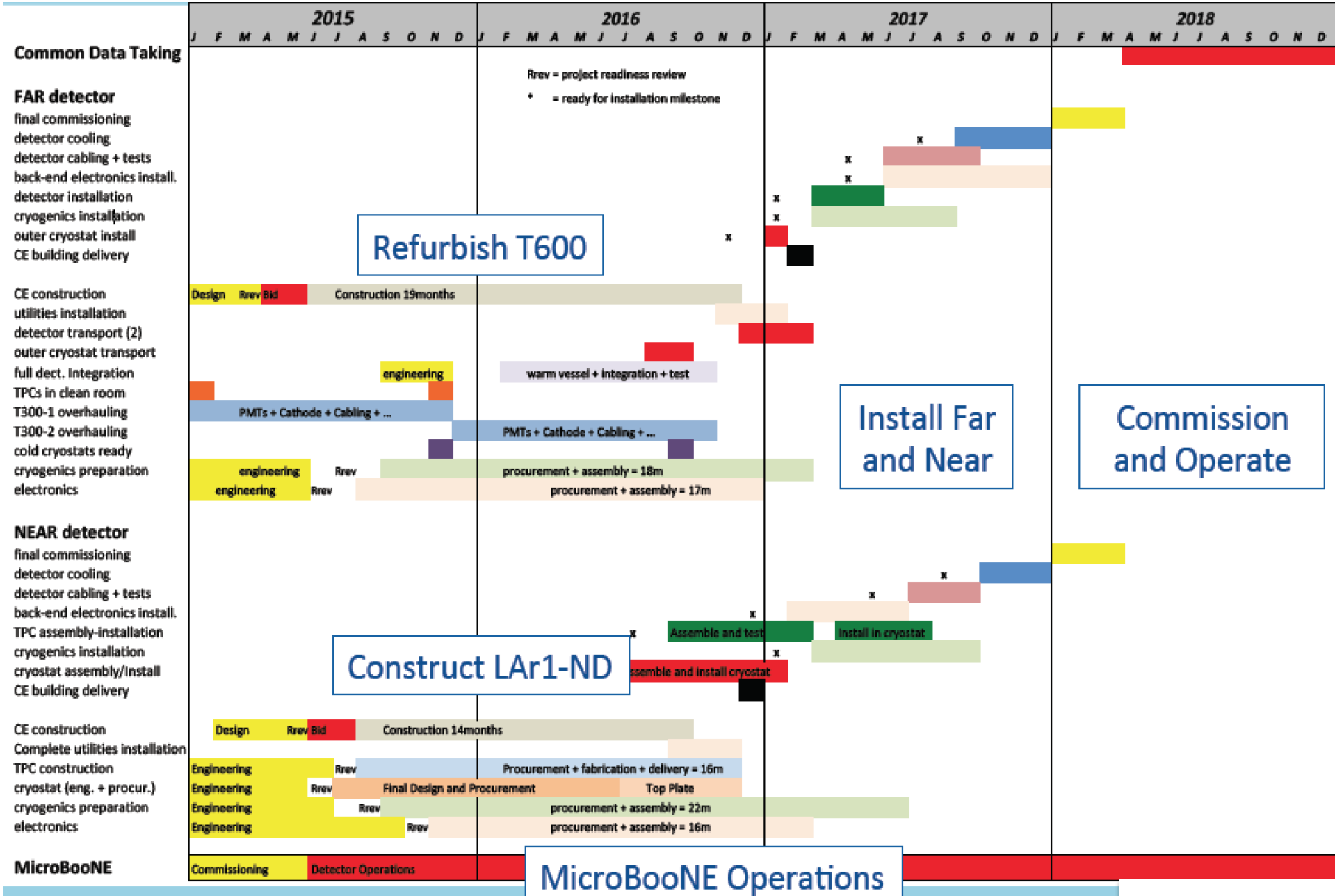
The Committee *"recommends Stage 1 approval for the SBN program, which incorporates LAr1ND and ICARUS with MicroBooNE towards a coherent SBN program. We recommend that the laboratory provide the necessary engineering and technical resources to allow the program to move forward expeditiously, and to understand the scope of the Booster Neutrino Beamline modifications and improvements."*

FNAL PAC recommendation, 5 February 2015

CERN ν Platform involvement : T600, LAr1-ND, ν beam



Short Baseline @FNAL (Prel. Schedule)



WA104 : ICARUS detector overhauling

ICARUS Collaboration with INFN

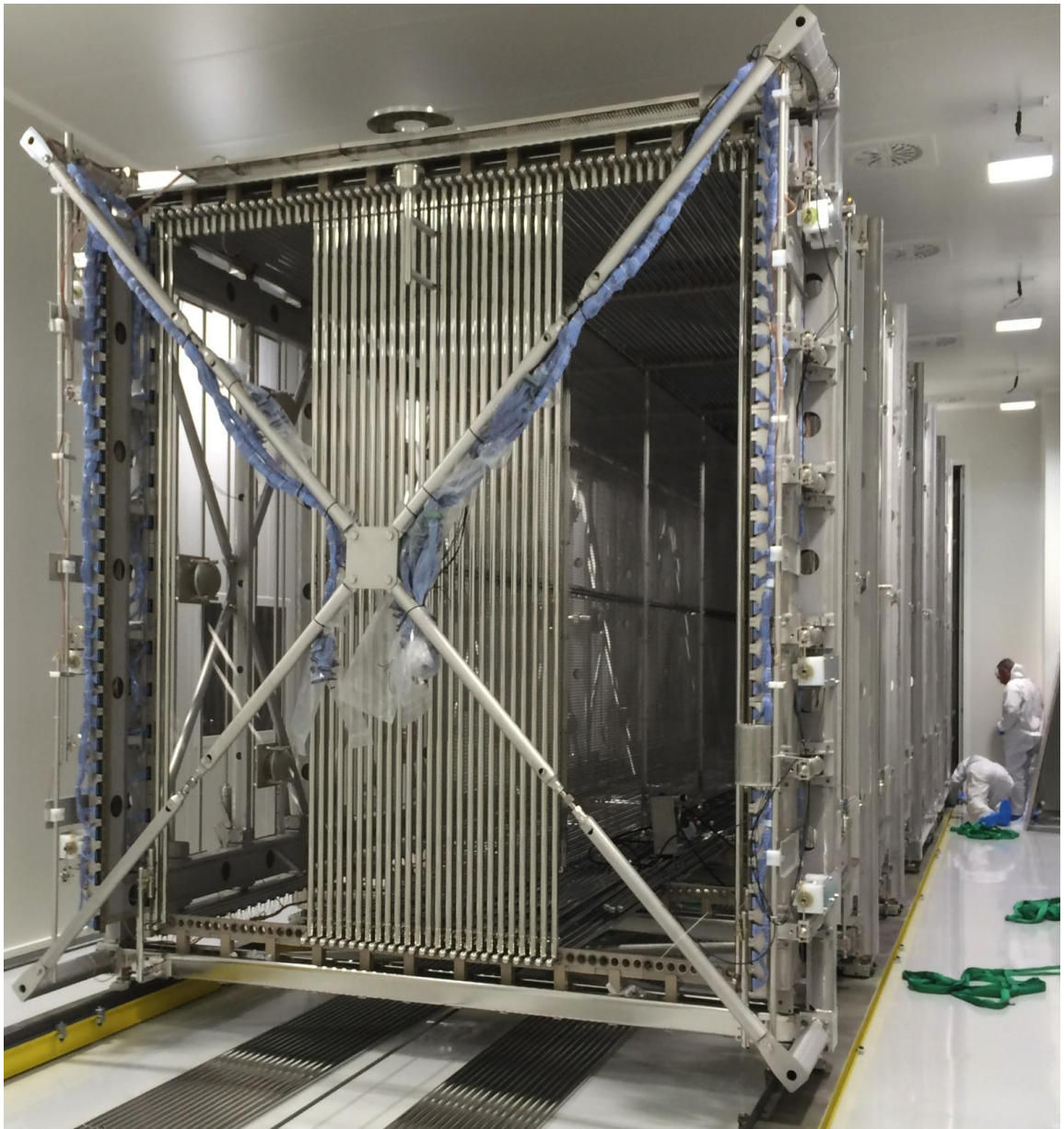
and CERN help

- *Detector moved (2014) from the GS Laboratory to CERN*
- *Prepare at CERN all the necessary infrastructure (clean rooms, cryogenics, …)*
- *Reshape the detector with new components (more PMTs, fix cathode, new inner cabling, new electronics, ..)*
- *Construct a new generation of cold cryostats*
- *Reshape, maintain and modernize the cryogenics plant*
- *Reassemble the 2x T300 detectors inside their cryostats*
- *Construct a new outer vessel*
- *Make it ready for shipment to FNAL*

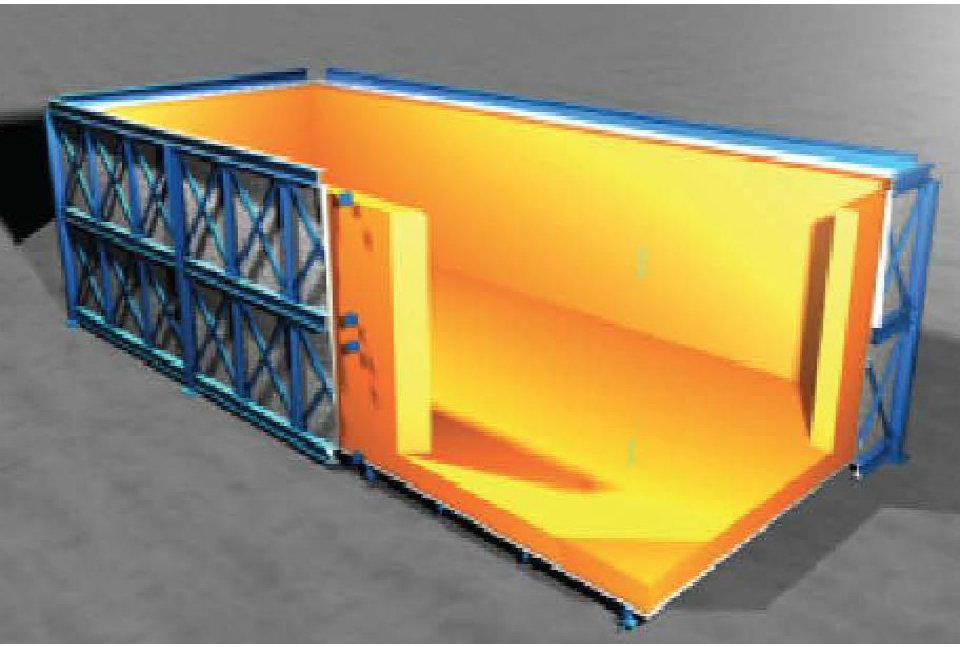
ICARUS Detector at Gran Sasso being dismantled

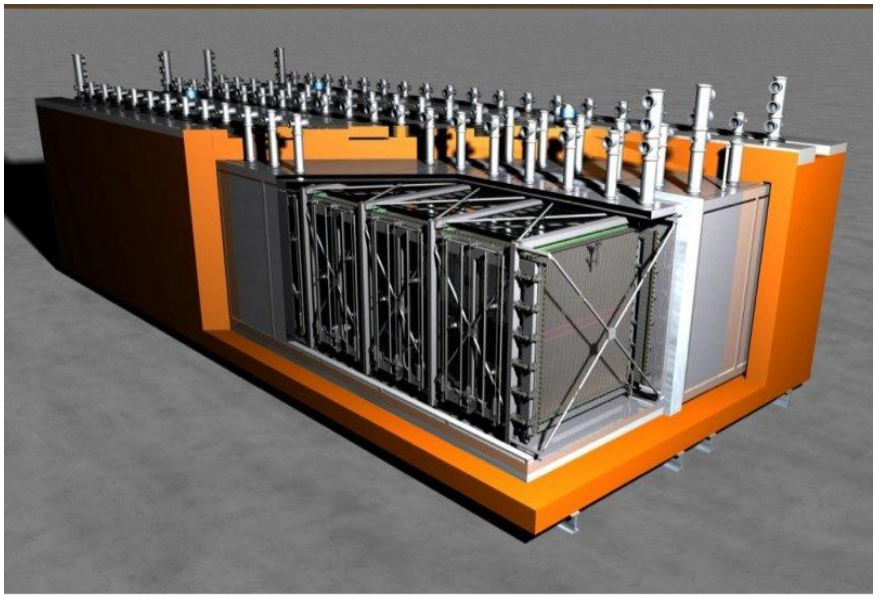
and moved to CERN (10 days trip)

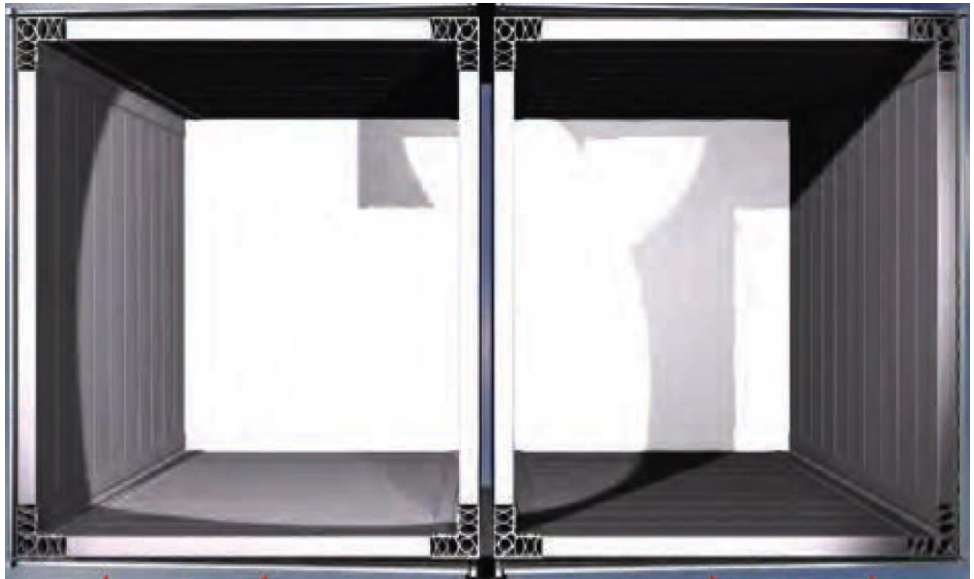
ICARUS Detector arrived at CERN (first T300) and is now in the CERN dedicated clean room

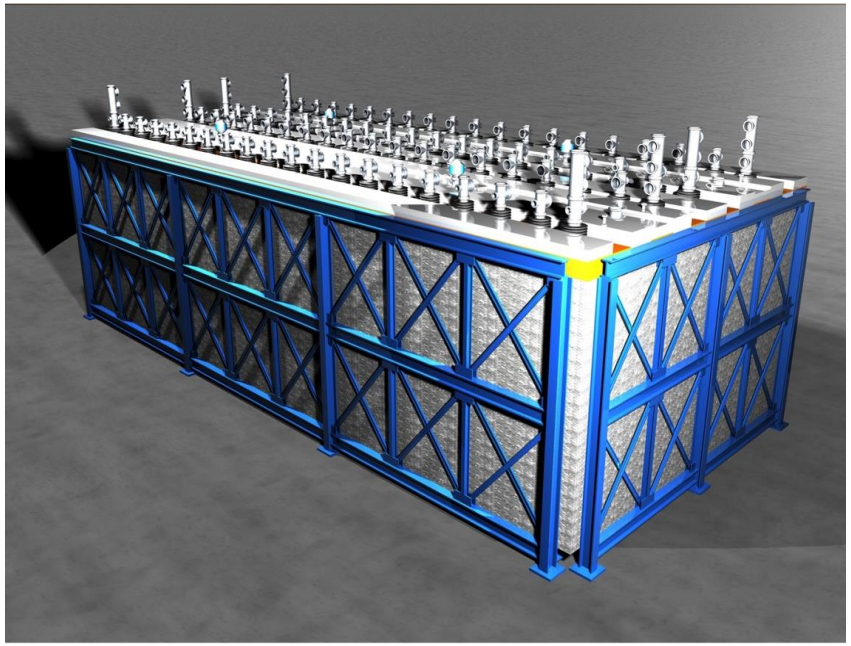


ICARUS Cryostat





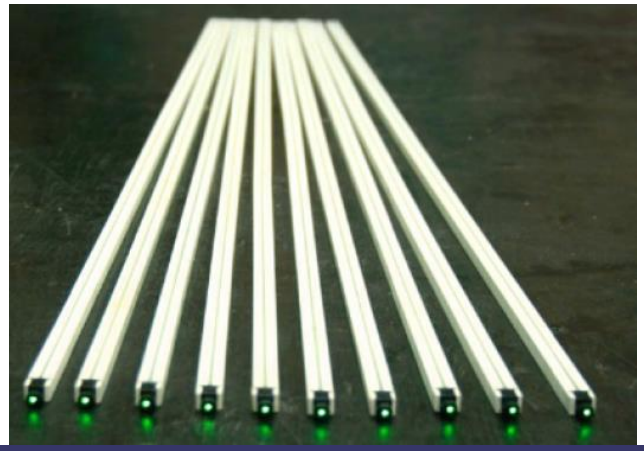




Projects

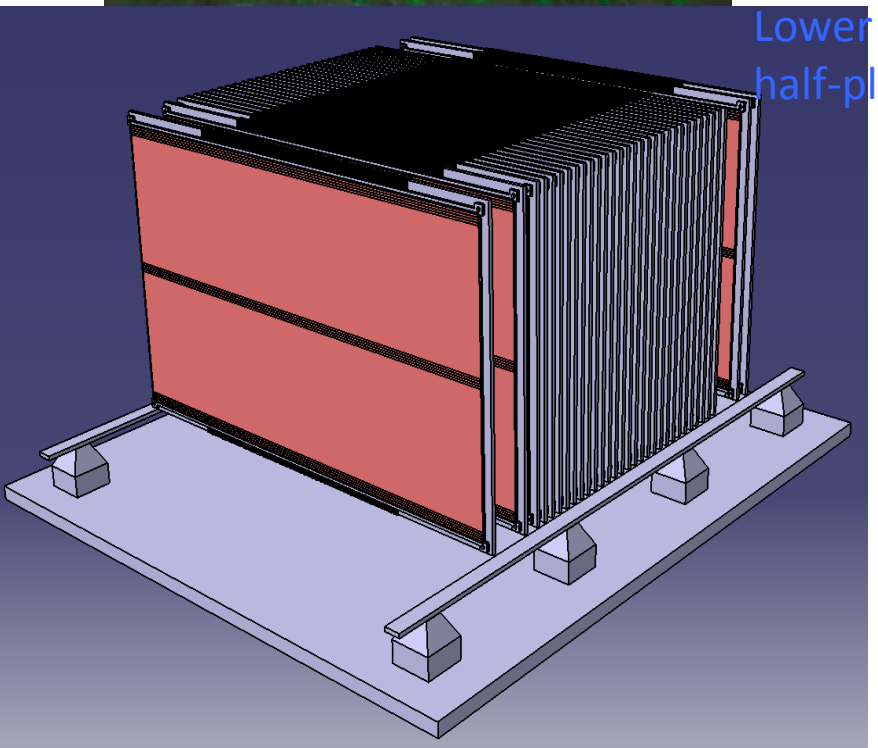
- Projects discussed in the SPSC and RB
  - *WA104 (ICARUS), WA104(NESSiE), WA105, Baby-MIND, PLAFOND*
  - *For all these we have signed MOUs or MOUs in preparation*
- Projects being discussed in the SPSC
  - *DUNE PROTOTYPE, ARGONCUBE*
  - *For all these we work with the teams on preparing the project and the engineering*
- Projects not yet discussed with SPSC
  - *Near detector (HKK) components*
  - *LAr magnetize DUNE near detector*
  - *…….*

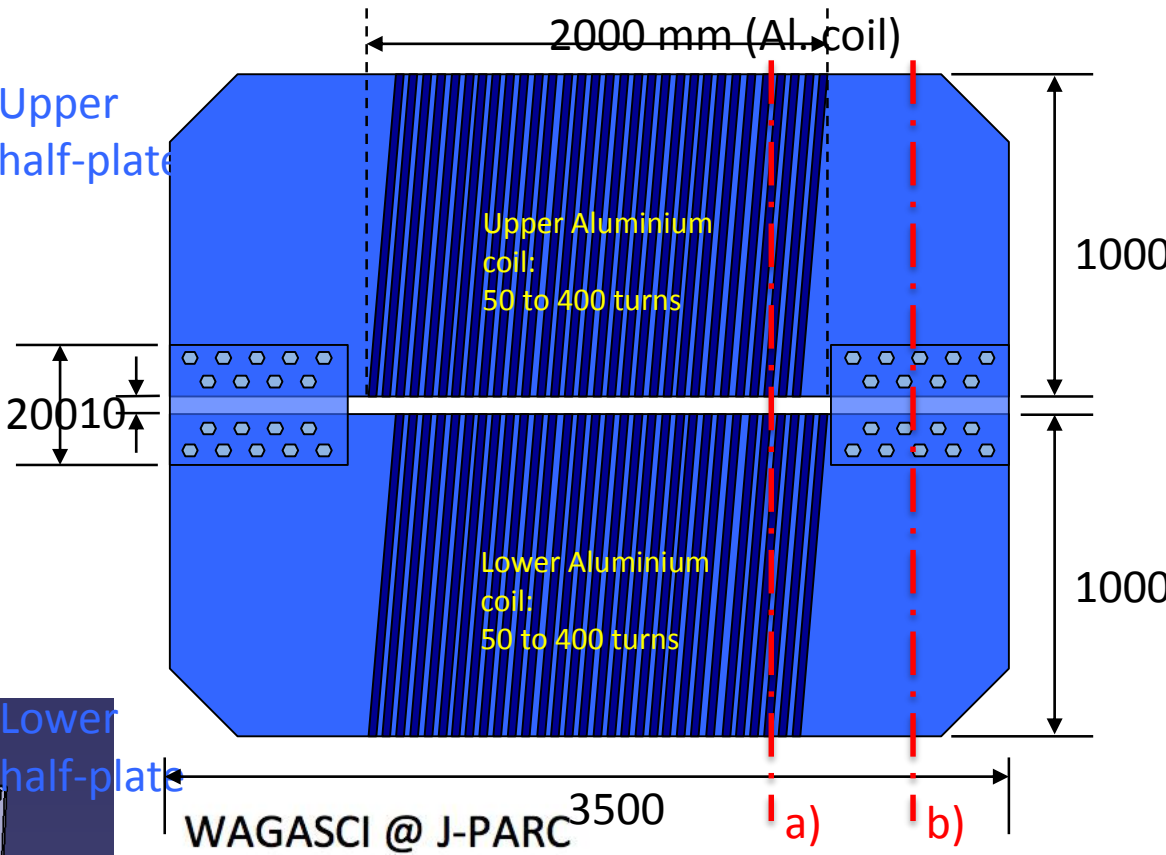
Baby MIND



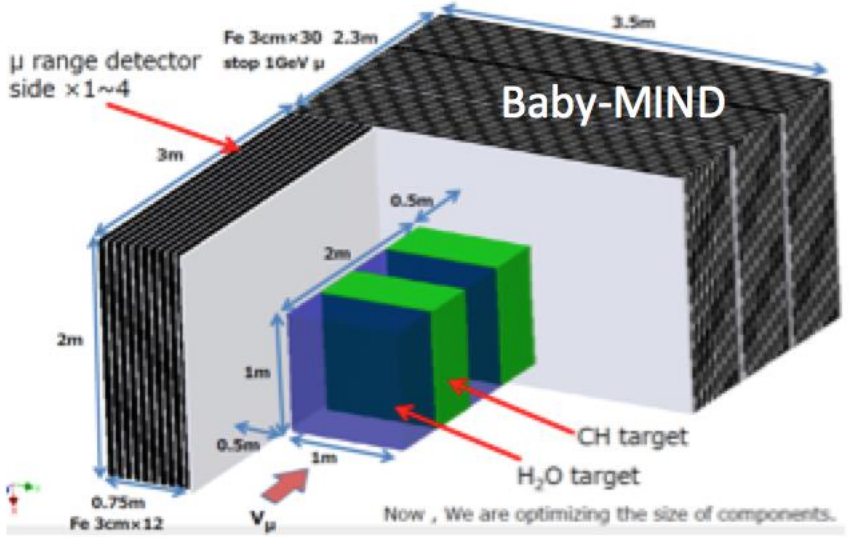
Upper half-plate

Lower half-plate

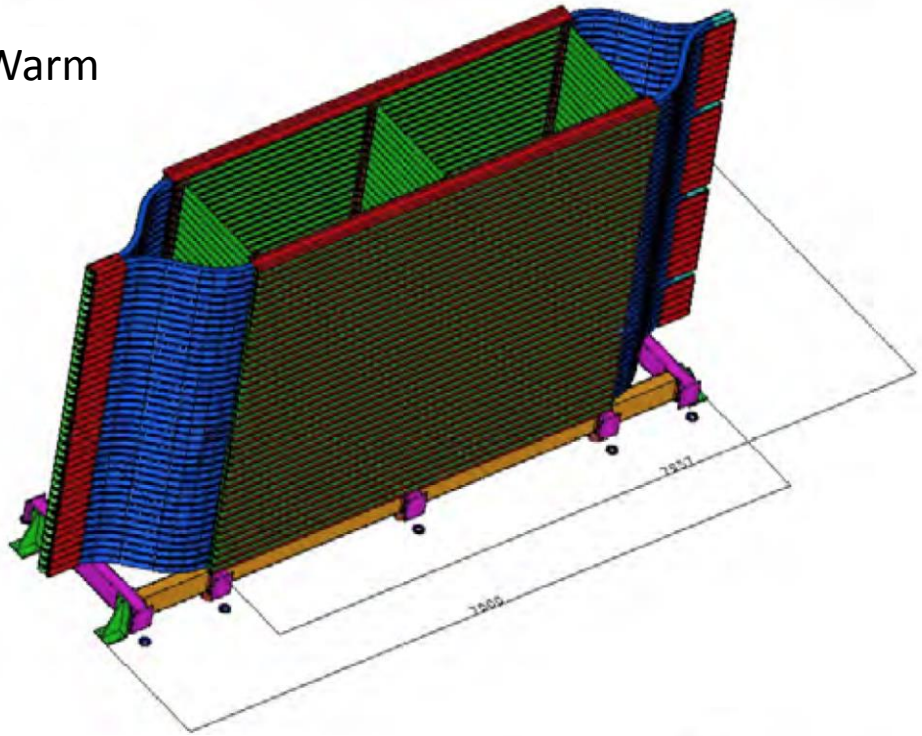




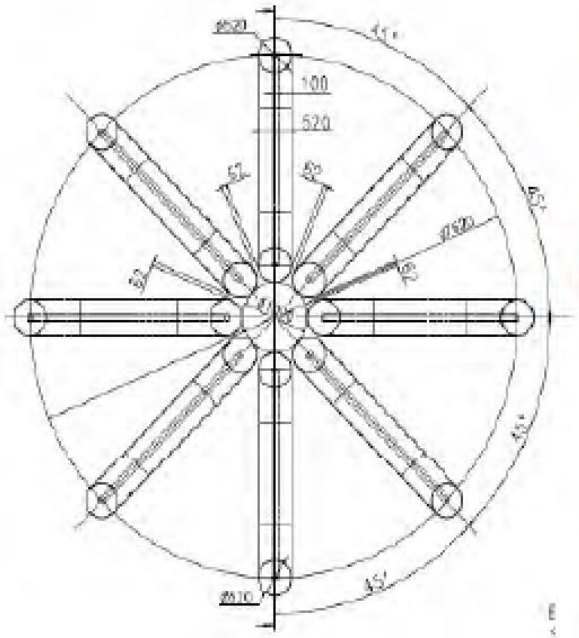
WAGASCI @ J-PARC



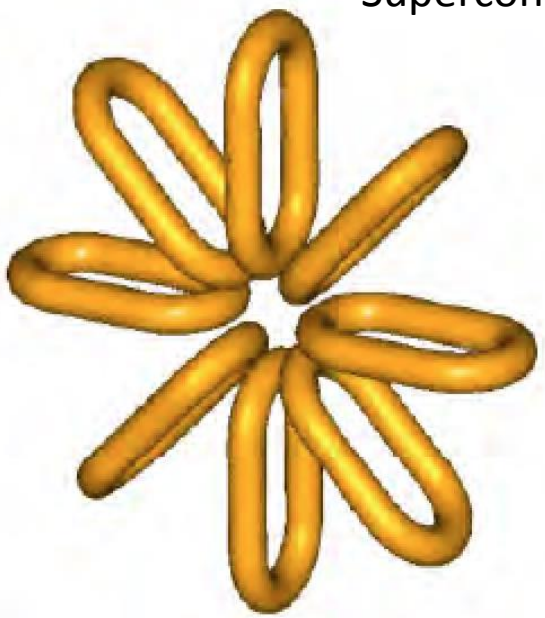
Warm

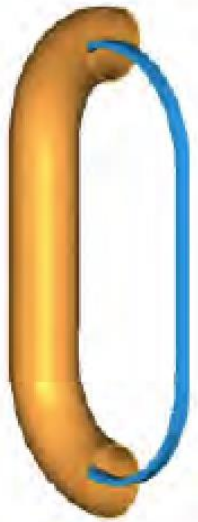


Air core magnets
R&D
NESSiE
Collaboration

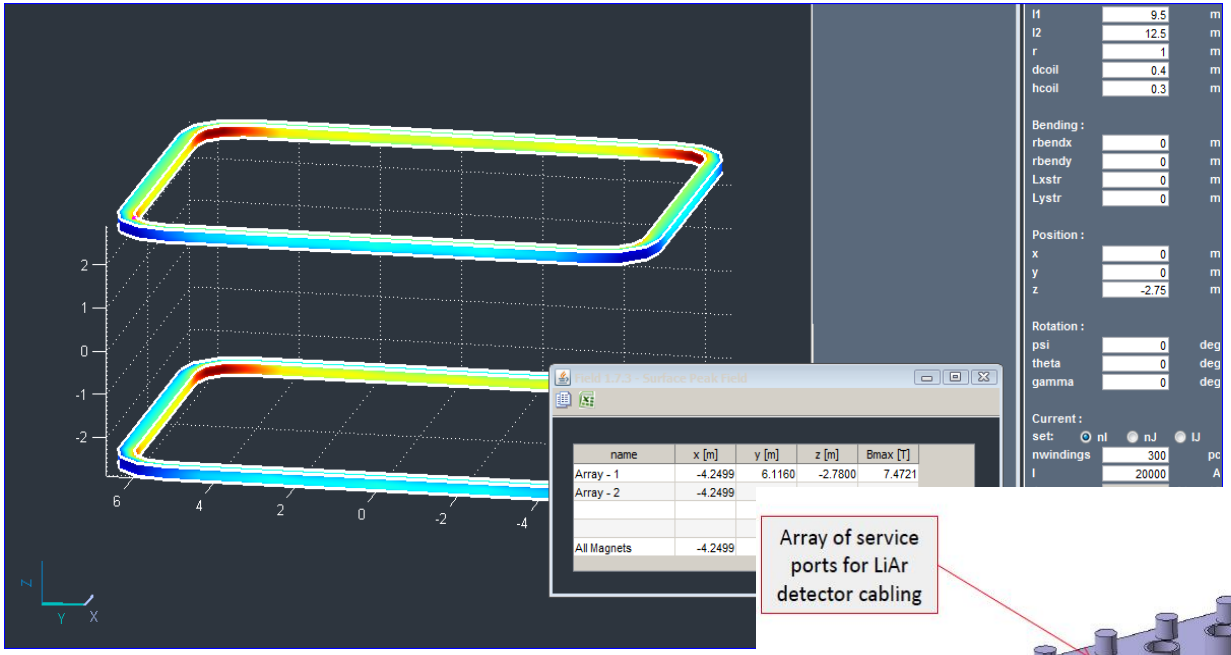


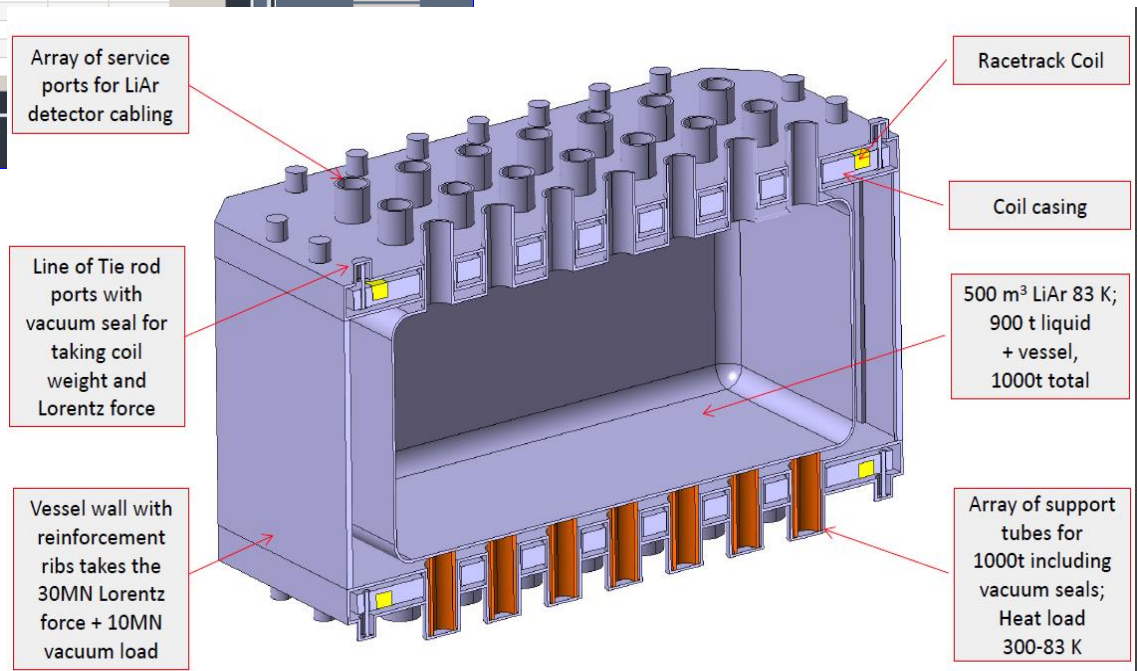
Superconducting



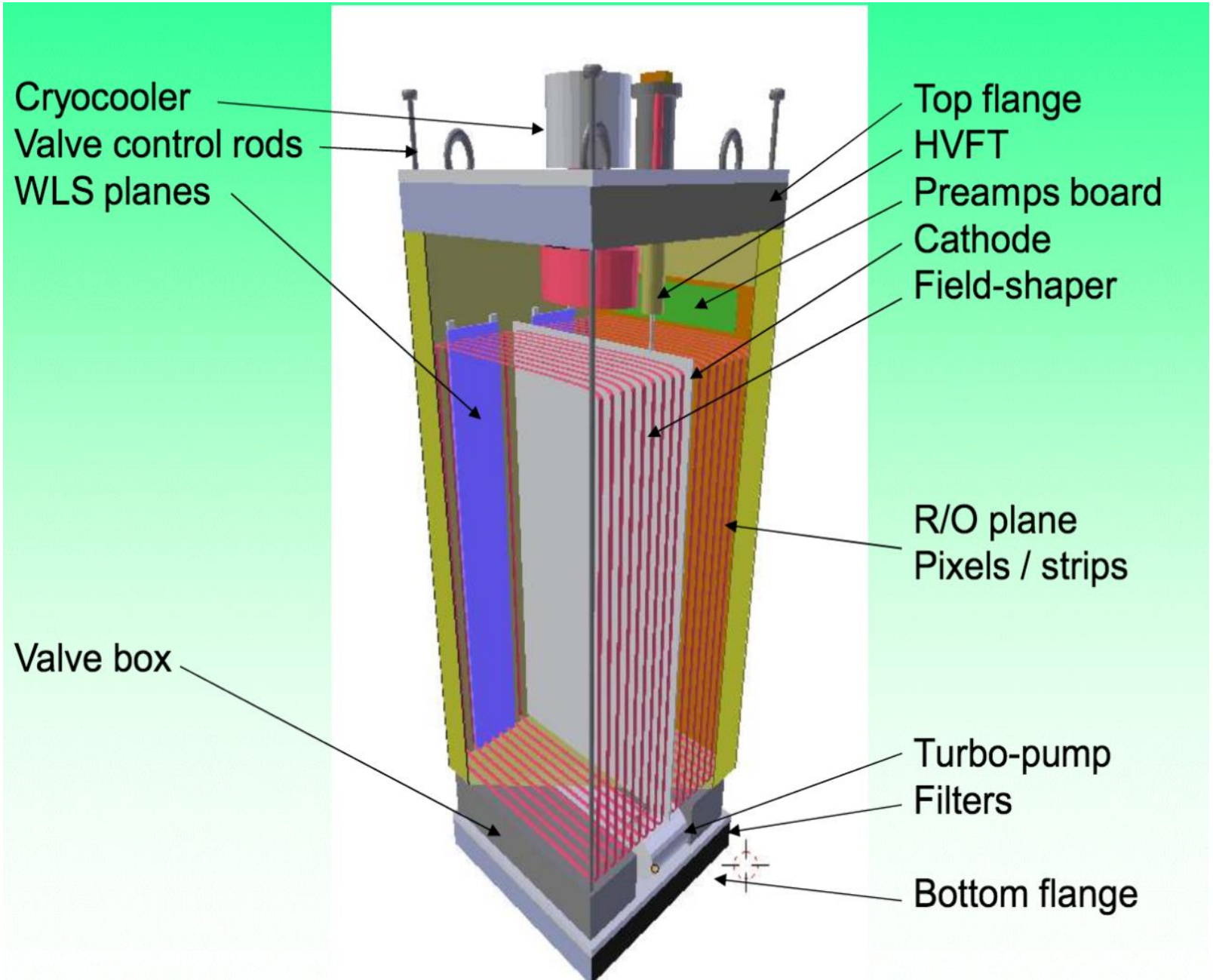


A fully magnetized TPC ?

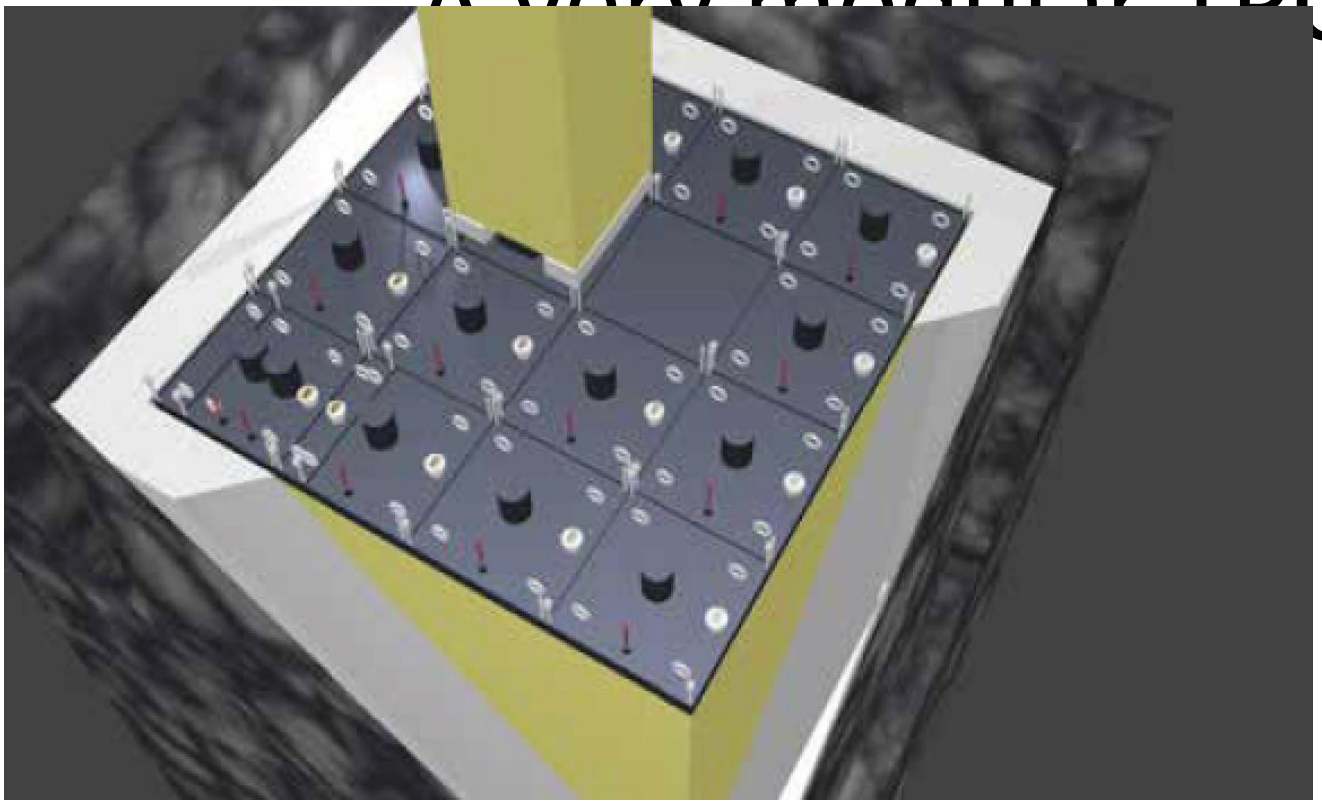




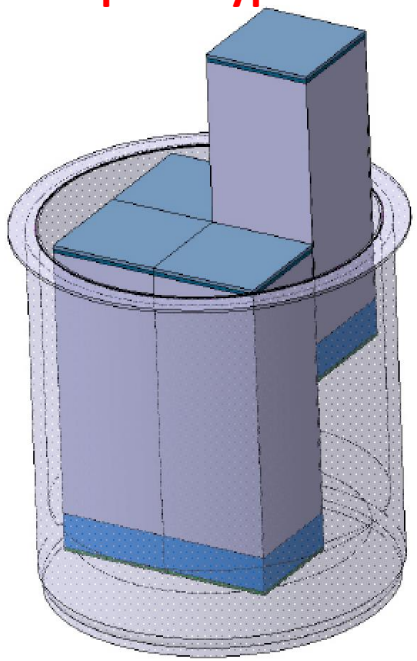
A very modular TPC ? (ArgonCube)

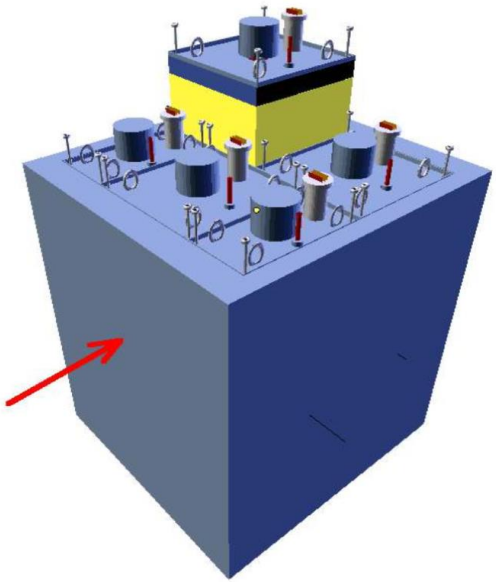


A very modular TPC



First prototypes 2015 !





MOU frame, How to get in?

Memorandum of Understanding

for providing a framework for developing a Neutrino Program at CERN

between

The EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH, an Intergovernmental Organization having its seat at Geneva, Switzerland, ('CERN,'), as the Host Laboratory,

on the one hand,

and

The FUNDING AGENCIES/INSTITUTIONS PARTICIPATING IN THE NEUTRINO PHYSICS RESEARCH PROJECTS AT CERN ('the Neutrino Institutions'),

on the other hand,

(collectively "the Parties")

Preamble

(a) As endorsed by the CERN Research Board at its meeting of August 28th, 2013 and detailed in Annex 1, CERN has decided to develop a Neutrino Program at CERN ('the Neutrino Program') to pave the way for a substantial European role in future Long-Baseline Experiments and explore the possibility of major participation of Europe in leading Long-baseline Neutrino Projects in the United States and Japan;

(b) The Neutrino Institutions, including possibly CERN, wish to collaborate in the research and development (R&D) and construction of prototypes, equipment and related infrastructure for the Neutrino Program and have obtained the support of their Funding Agencies to enable them to participate in the Neutrino Program;

How to get in?

- Present to the CERN SPSC a LOI or an expression of interest
- When approved we prepare together an MOU (addendum) which defines all responsibilities and resources needed
- Then a CERN experiment is created (WA104, WA105, …), with all priviledges and requirements

https://edms.cern.ch/document/1353815

Summary

- Platform active
- Several activities in progress (construction, design, engineering, …)
- Within the allocated CERN MTP budgets
- Community build up
- It is looking in particular to the US short and long baseline (for the moment)
- Discussions have started on the platform direct involvement in the US baselines (15 years long projects) neutrino facilities
- Activities on the neutrino beams R&D are still ongoing