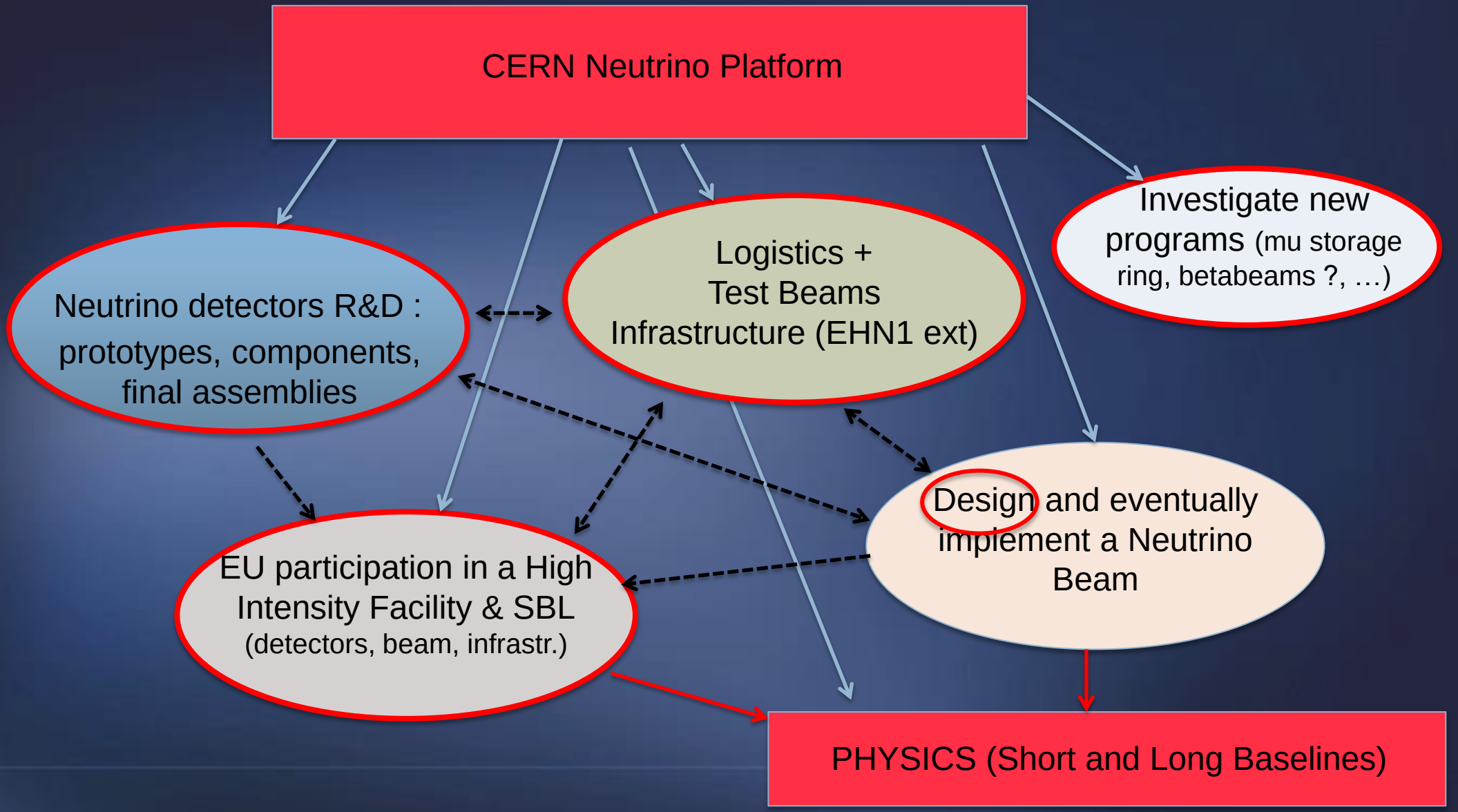
The CERN Neutrino Platform

20th October2014

Marzio Nessi, CERN & University of Geneva

CERN Neutrino Platform



Projects presently under consideration

- *WA104 ICARUS detector overhauling*
- *WA105 construction and test of 2 large prototypes/demonstrators*
- *WA104 NESSiE R&D and test of a new generation of muon spectrometers*
- *Baby MIND : demonstrator and test of a new muon tracking detector (LBNO, ND-HKK?)*
- *LBNF test of a TPC module*
- *ArgonCube : prototypes of a new generation of highly modular TPCs*
- *HKK : R&D and test of detector components (EU)*
- *Construction and test of a new magnetized TPC (future ND ?)*
- *Generic cryogenics support to various detectors (new cryo group at CERN)*
- *Participation in the design and construction of LAR1-ND cryostat and cryo plant*

A few examples !!

WA104 : ICARUS detector overhauling

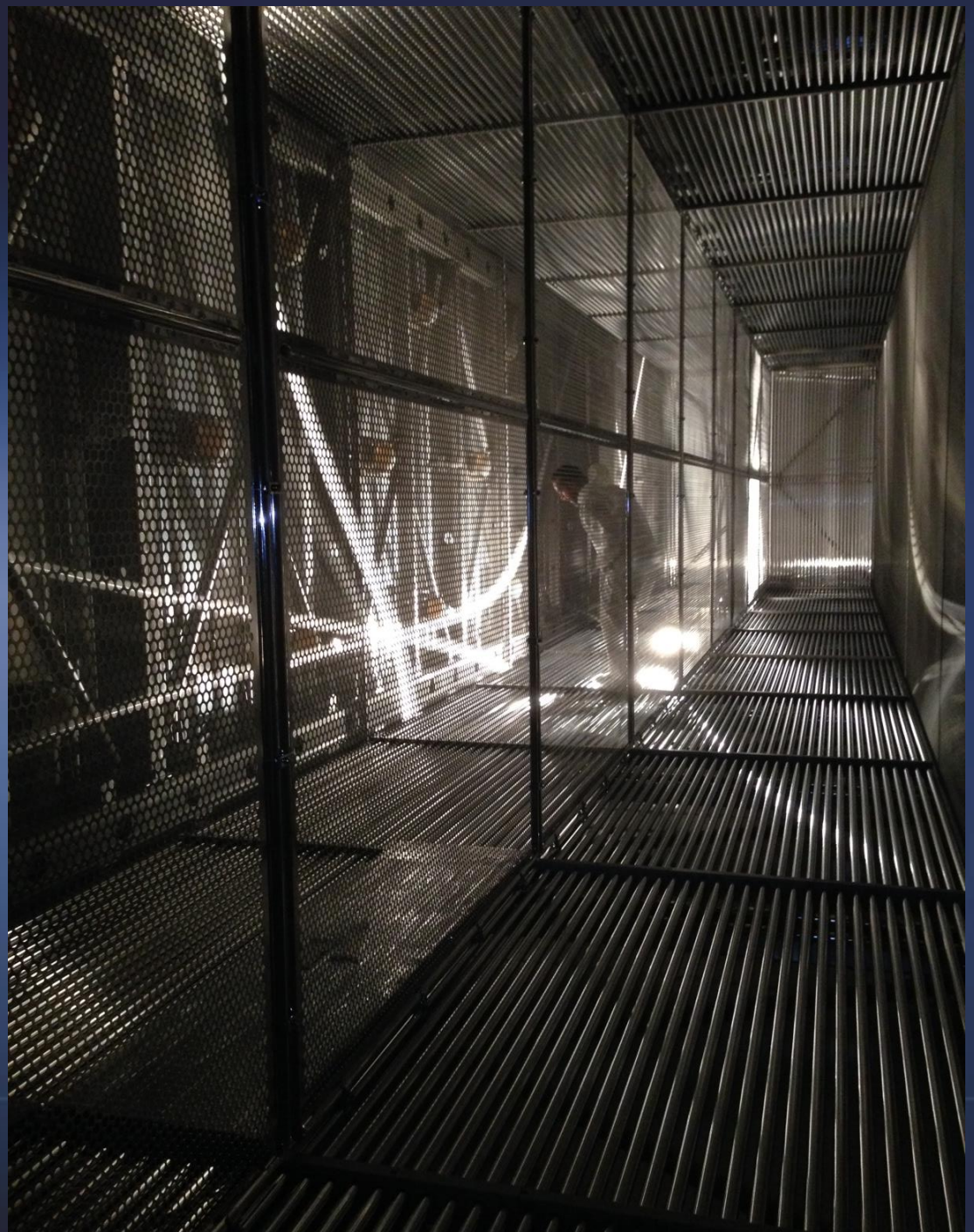
ICARUS Collaboration with INFN and CERN help

- *Move the detector from the GS Laboratory to CERN (2014)*
- *Prepare at CERN all the necessary infrastructure (clean rooms, cryogenics, …)*
- *Reshape the detector with new components*
- *Construct a new generation of cryostats*
- *Reshape, maintain and modernize the cryo plant*
- *Reassemble the 2 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

From 19 September

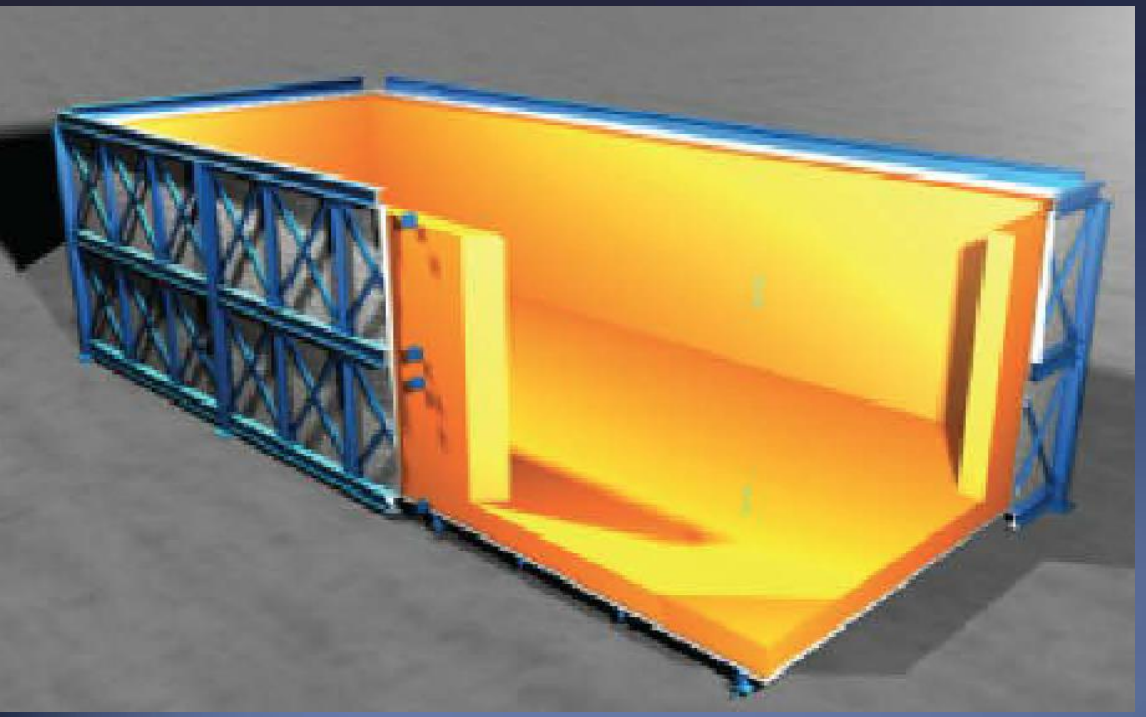
ICARUS Detector at Gran Sasso being dismantled and moved to CERN

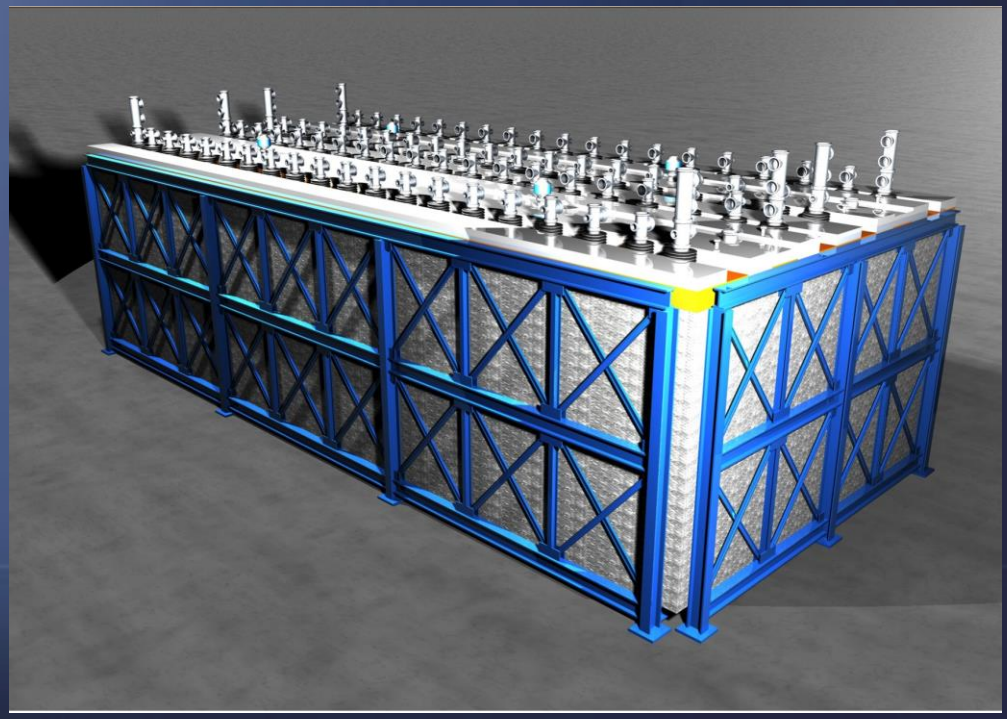


Ready to start

02/10/2014

ICARUS detector overhauling





To be constructed : *two cold vessels with these dimensions*

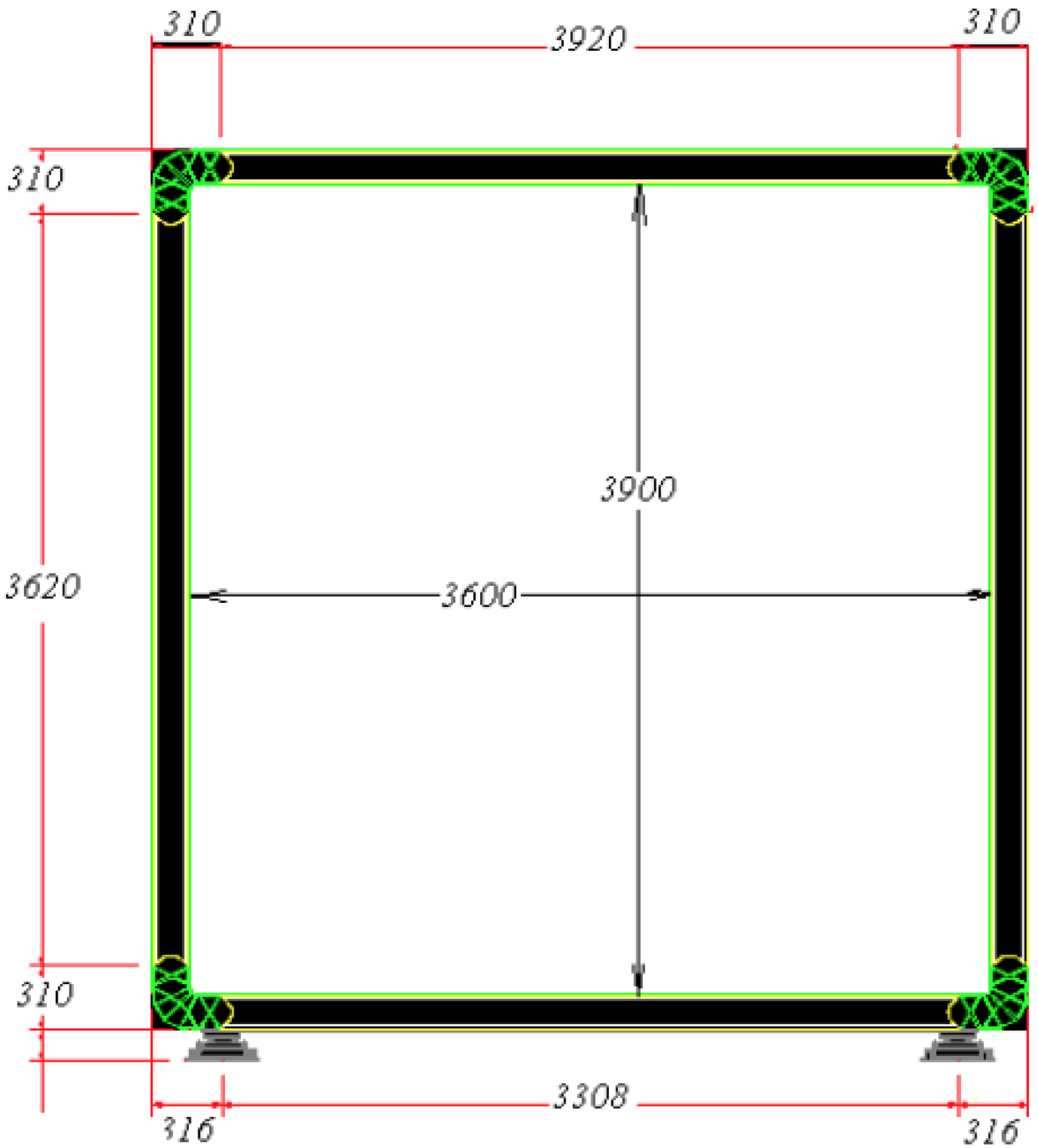
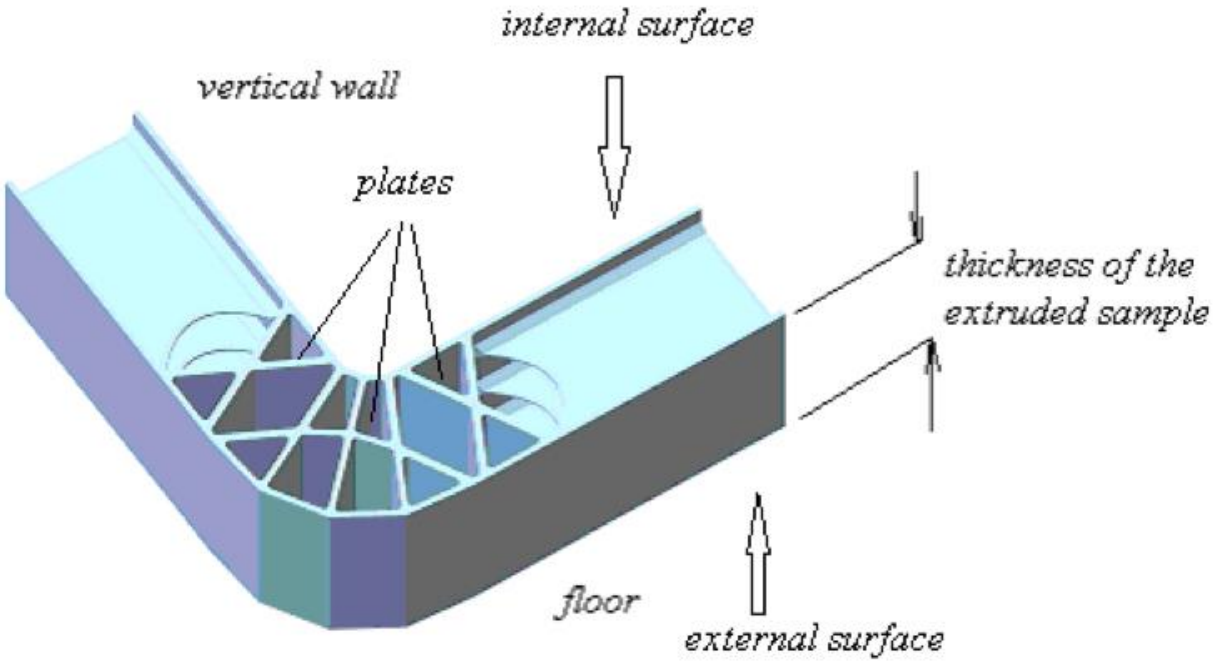
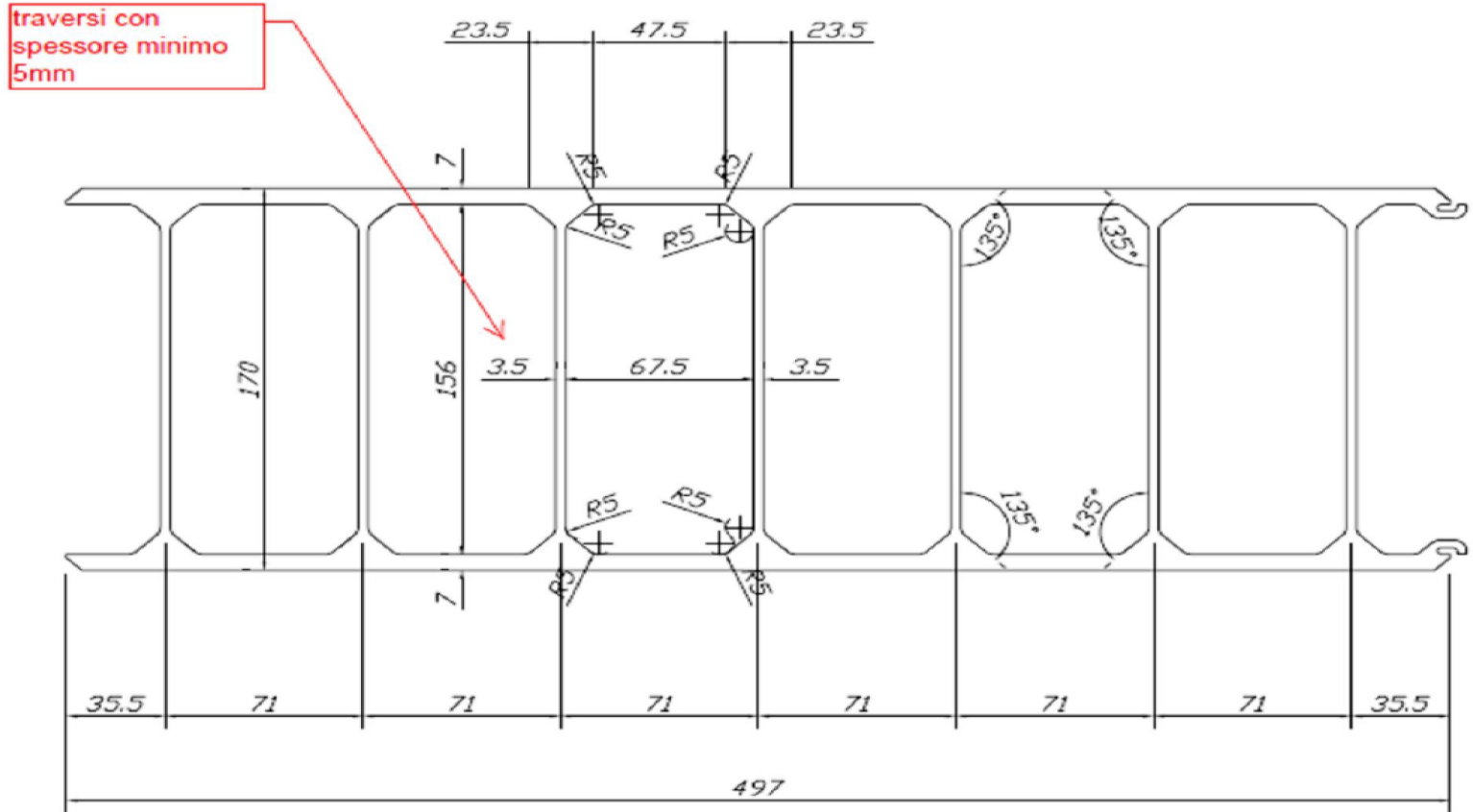
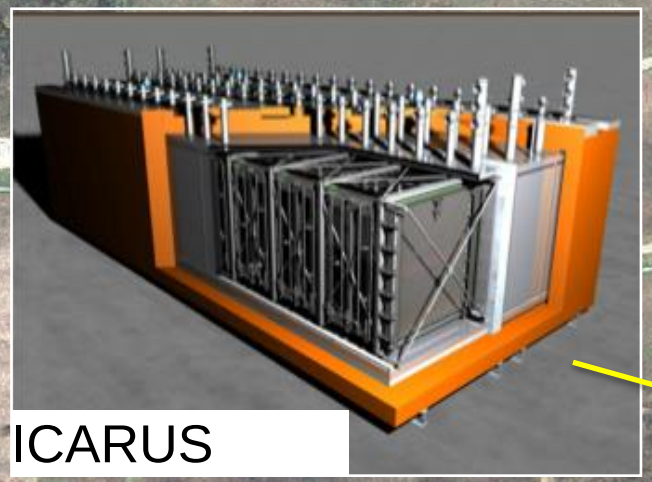


Fig. 1 : Vertical cross section, in a transversal plane. Internal and external dimensions.

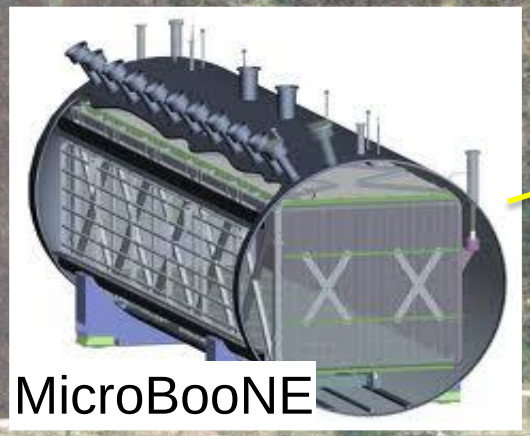

internal surface
vertical wall
plates
thickness of the
extruded sample
floor
external surface


traversi con
spessore minimo
5mm
23.5
47.5
23.5
7
R5
R5
R5
135°
135°
170
156
3.5
67.5
3.5
R5
R5
135°
135°
7
R5
R5
35.5
71
71
71
71
71
71
35.5
497

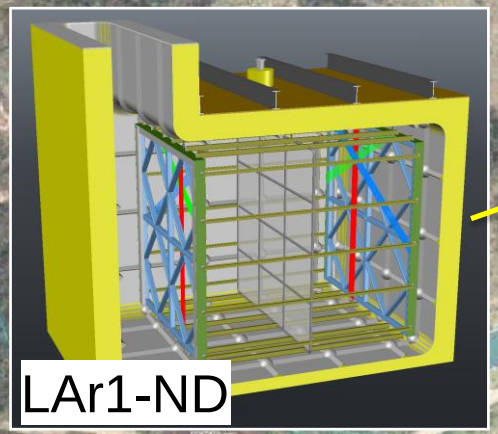
SBL at the FNAL ~ 0.8 GeV ν Booster Beam



ICARUS T600



MicroBooNE



LAr1-ND

	LAr Mass	
	Total	Active
LAr1-ND	180t	82t
MicroBooNE	170t	89t
T600	760t	476t

MINOS

NOvA

600m – Far Detector
ICARUS/T600

MiniBooNE

MicroBooNE

NuMi Line

110m - Near Detector
LAr1-ND

SciBooNE

BNB Target

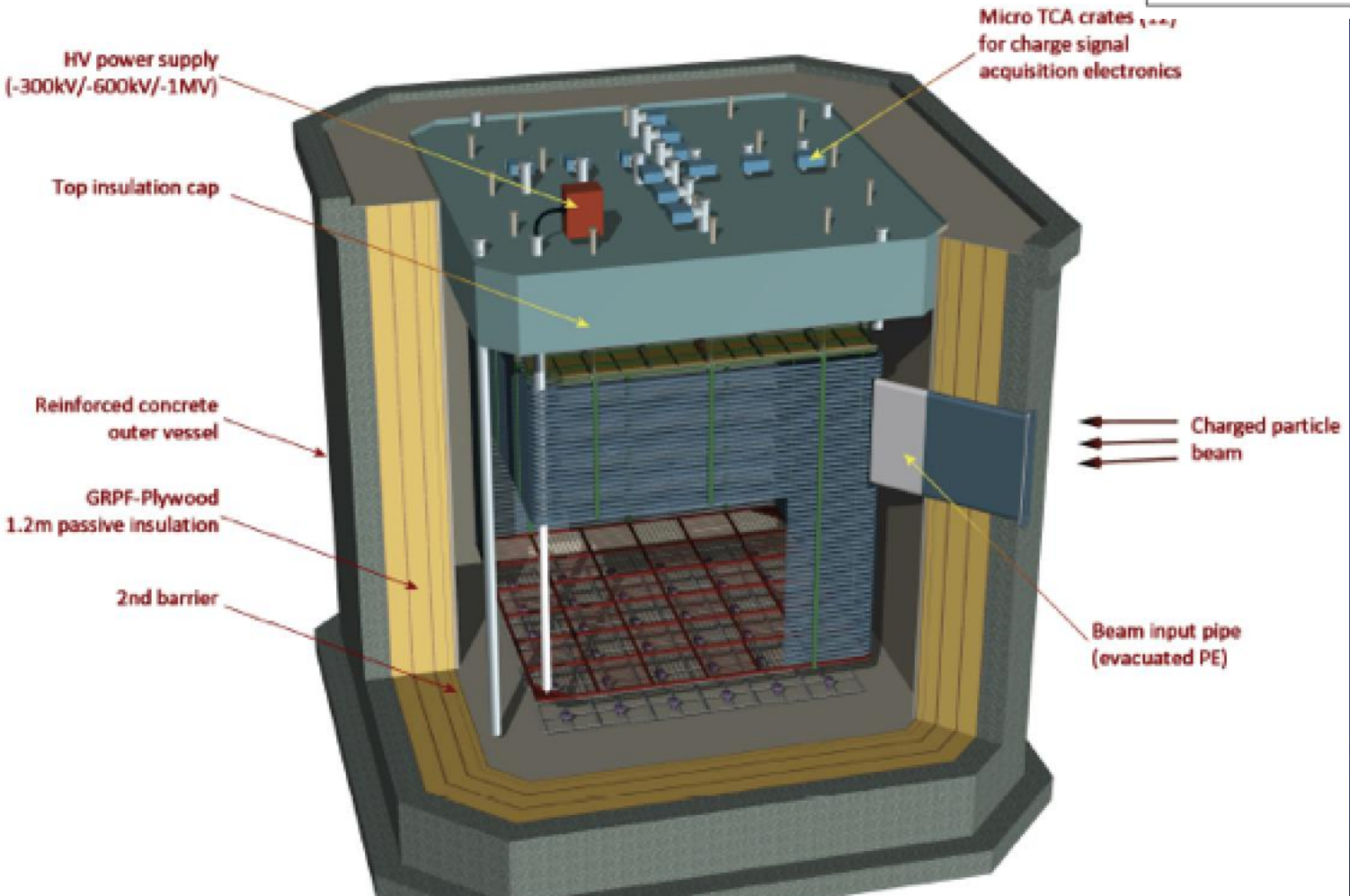
WA105 : LAGUNA detector Demonstrator

LAGUNA Collaboration with CERN help

- *Prepare at CERN all the necessary infrastructure (clean rooms, cryogenics, …)*
- *Construct a new generation of cryostats based on membrane technology*
- *Provide all the necessary cryogenics*
- *Construct and test 2 prototypes of a 2-phases LAr TPC*
  - *3 x1 x 1 m^3*
  - *6 x 6 x 6 m^3*
- *Charged beam tests at the SPS with full readout capabilities*

The WA105 - LBNO-Demo Detector

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)Å~12.5(l)Å~11.2(h) m

The WA105 - LBNO-Demo Detector

Courtesy :WA105 collab. CERN-SPSC-2014-

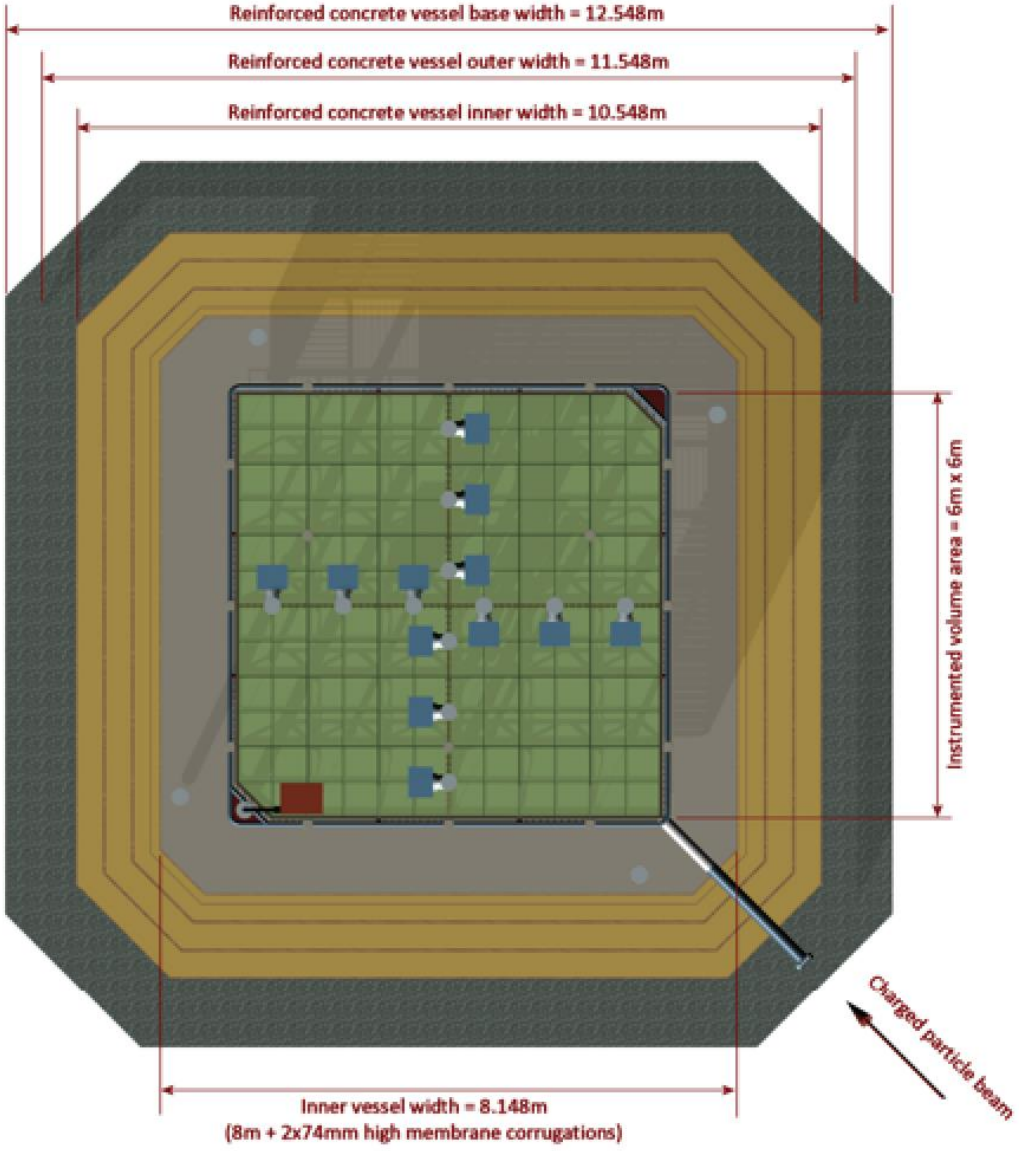


FIG. 13: Plan view section of the $6 \times 6 \times 6\text{m}^3$.

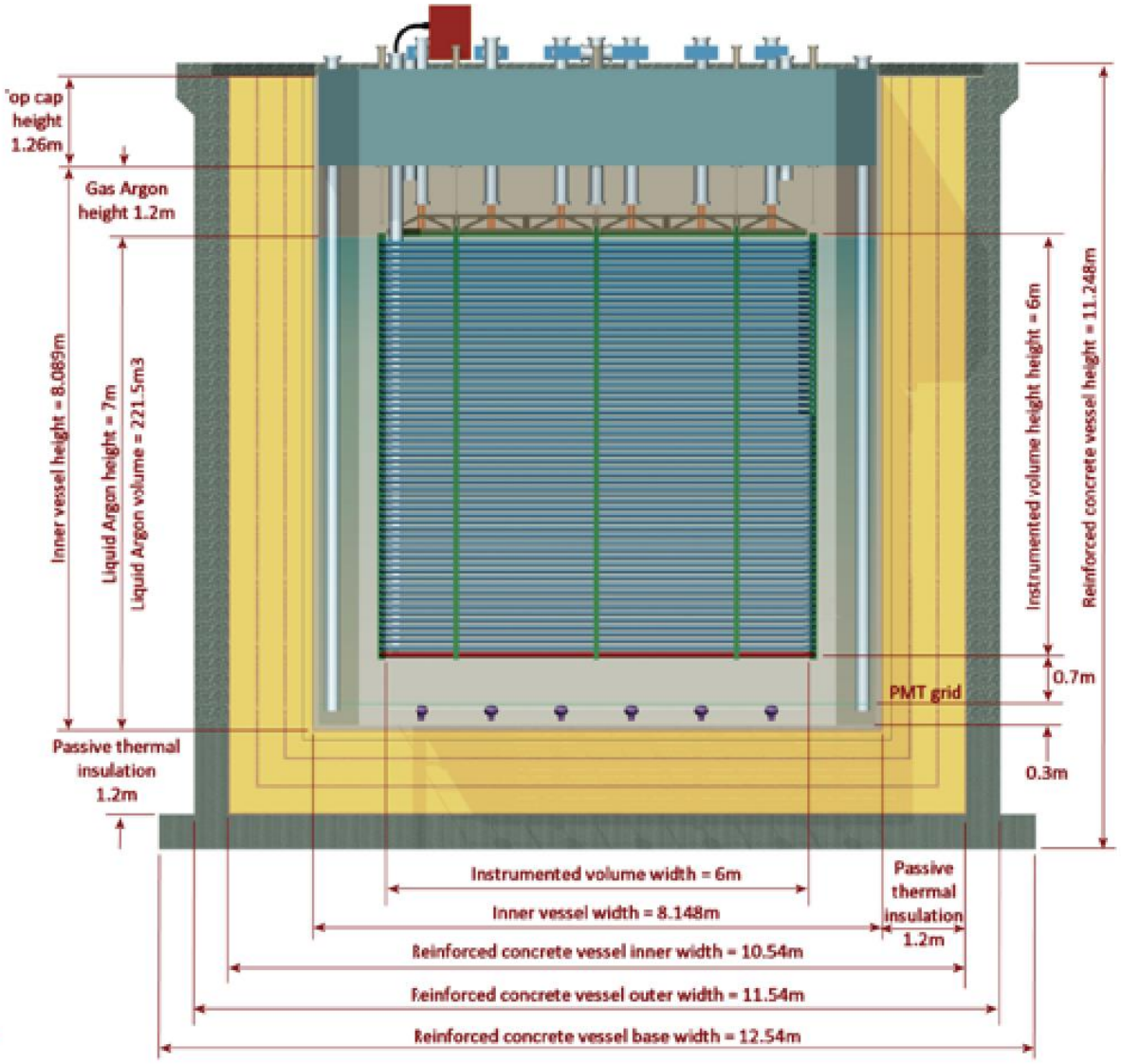
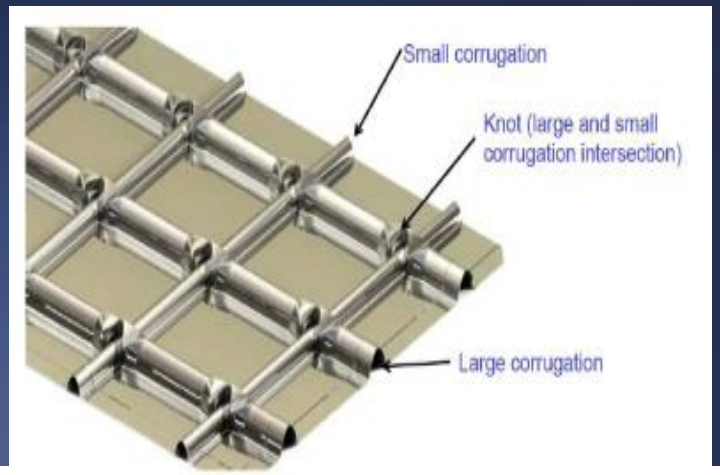
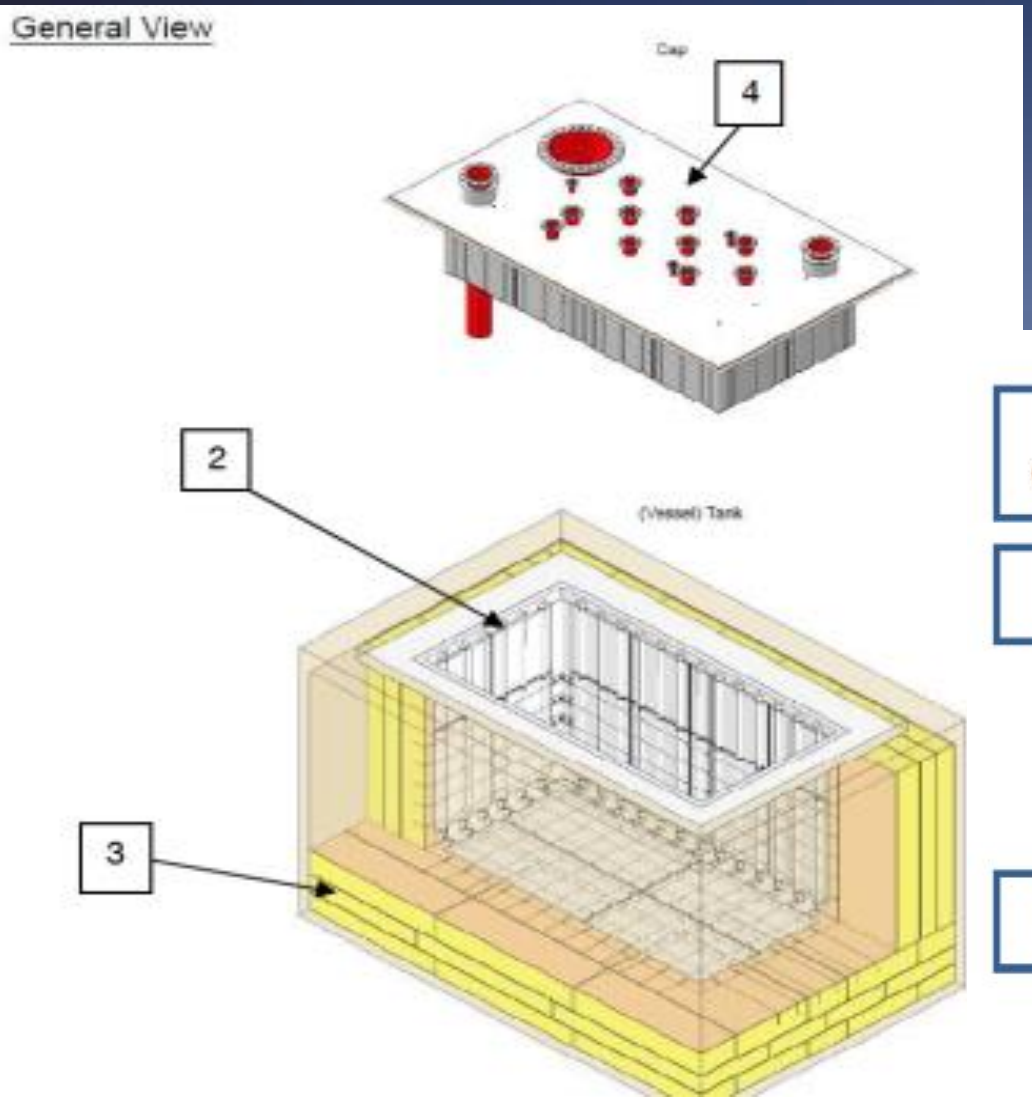
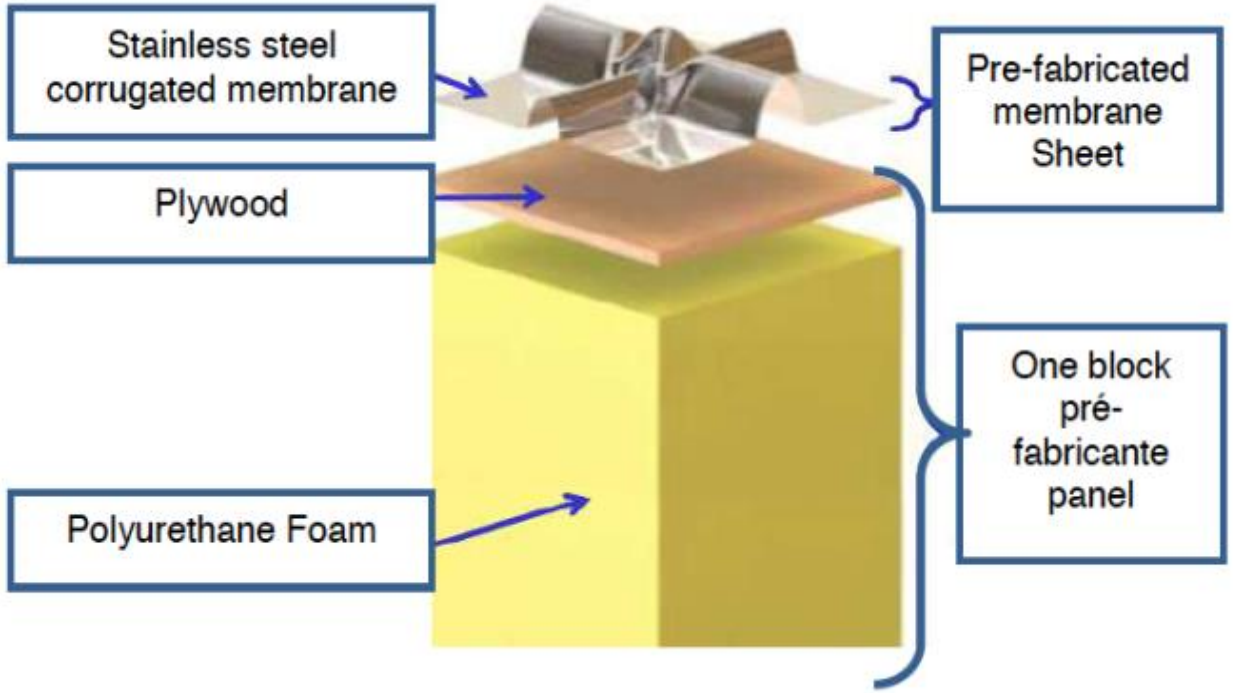


FIG. 14: Vertical cross section of the $6 \times 6 \times 6\text{m}^3$.

First membrane cryostat under construction (ready in spring 2015, 17 m^3 LAr)







The outer structure

Overview

Steel profiles (IPE240)

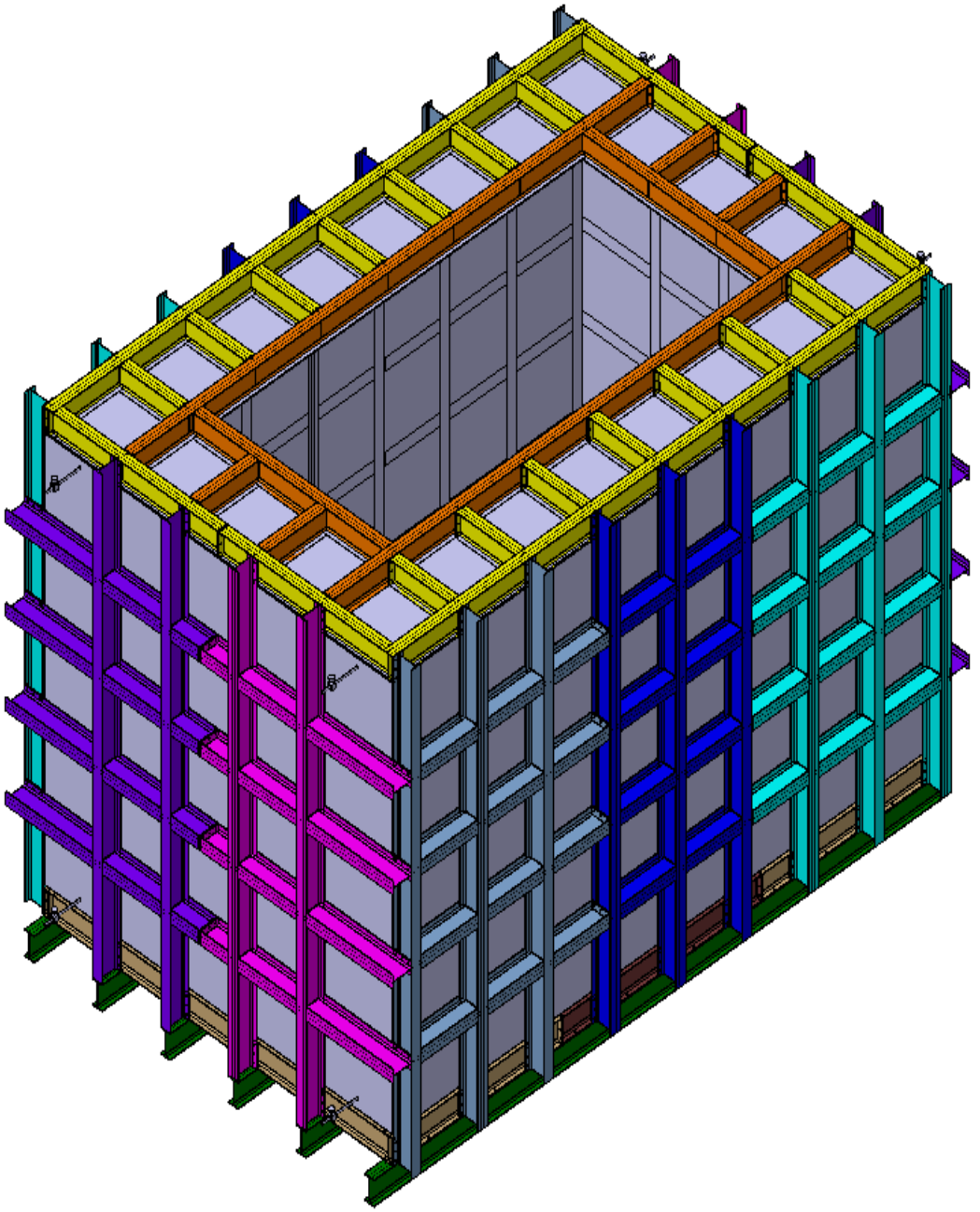
bolted and welded together

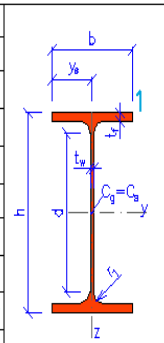
Internal dimensions (now confirmed):

6’812mm x 4’412mm x 4’002mm (L x W x H)

Weight:

12T (confirmed)



IPE240			
Geometry			
h = 240 mm		Section properties	
b = 120 mm		Axis y	Axis z
t_f = 9.8 mm		I_y = 3.89E+7 mm^4	I_z = 2.83E+6 mm^4
t_w = 6.2 mm		W_{y1} = 3.24E+5 mm^3	W_{z1} = 4.72E+4 mm^3
r_1 = 15 mm		$W_{y,pl}$ = 3.66E+5 mm^3	$W_{z,pl}$ = 7.39E+4 mm^3
y_s = 60 mm		i_y = 99.7 mm	i_z = 26.9 mm
d = 190.4 mm		S_y = 1.83E+5 mm^3	S_z = 3.70E+4 mm^3
A = 3910 mm^2		Warping and buckling	
A_L = 0.92 $m^2.m^{-1}$		I_w = 3.74E+10 mm^6	I_t = 1.31E+5 mm^4
G = 30.7 $kg.m^{-1}$		i_w = 29.9 mm	i_{pc} = 103 mm

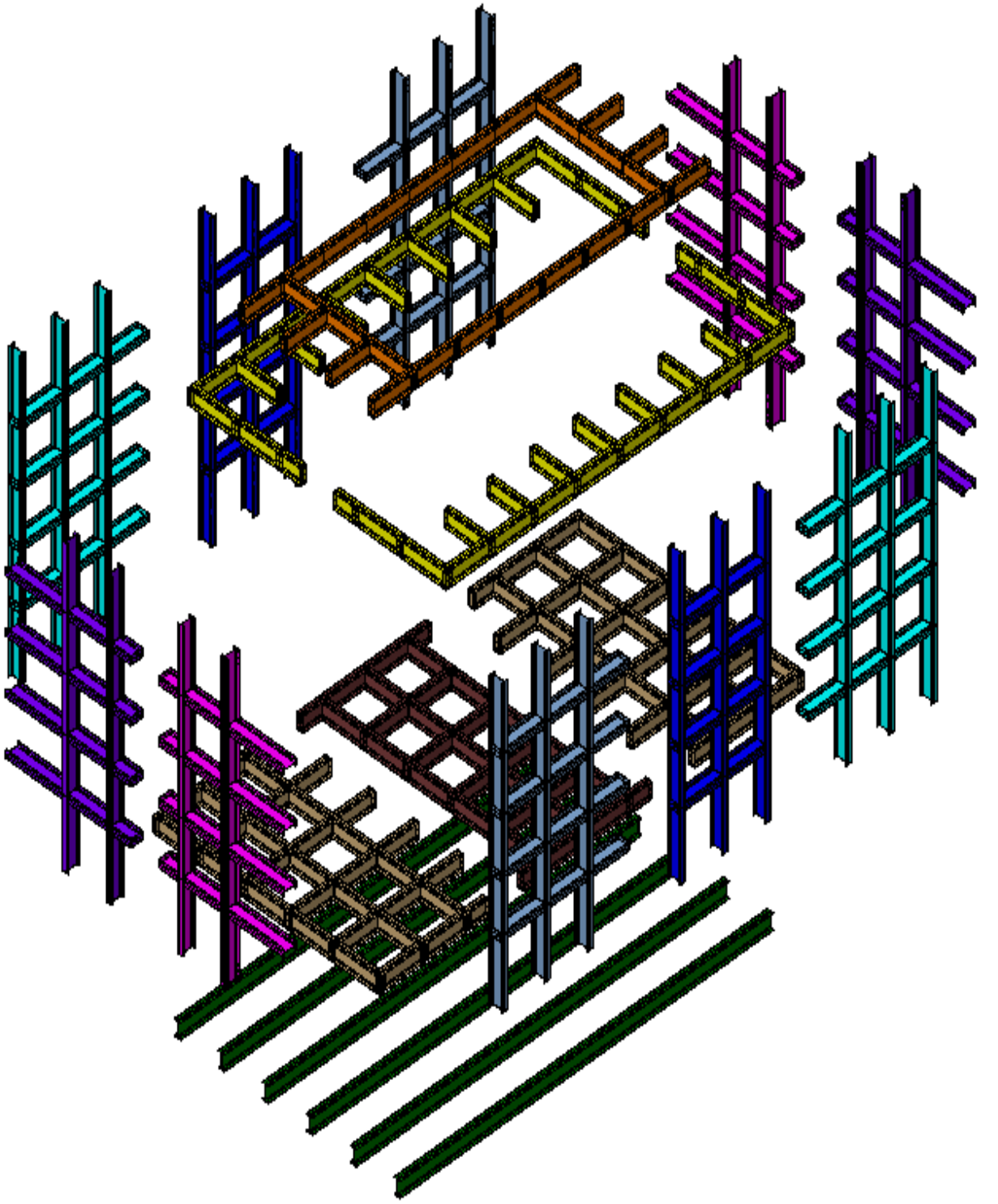
Transportation

Divided in 18 pieces:

- Weight: 1 – 1.5 T each
- Sizes: 4.5m x 2.5m

Standard trucks:

- Probably two
- 10T each
- 2m height each



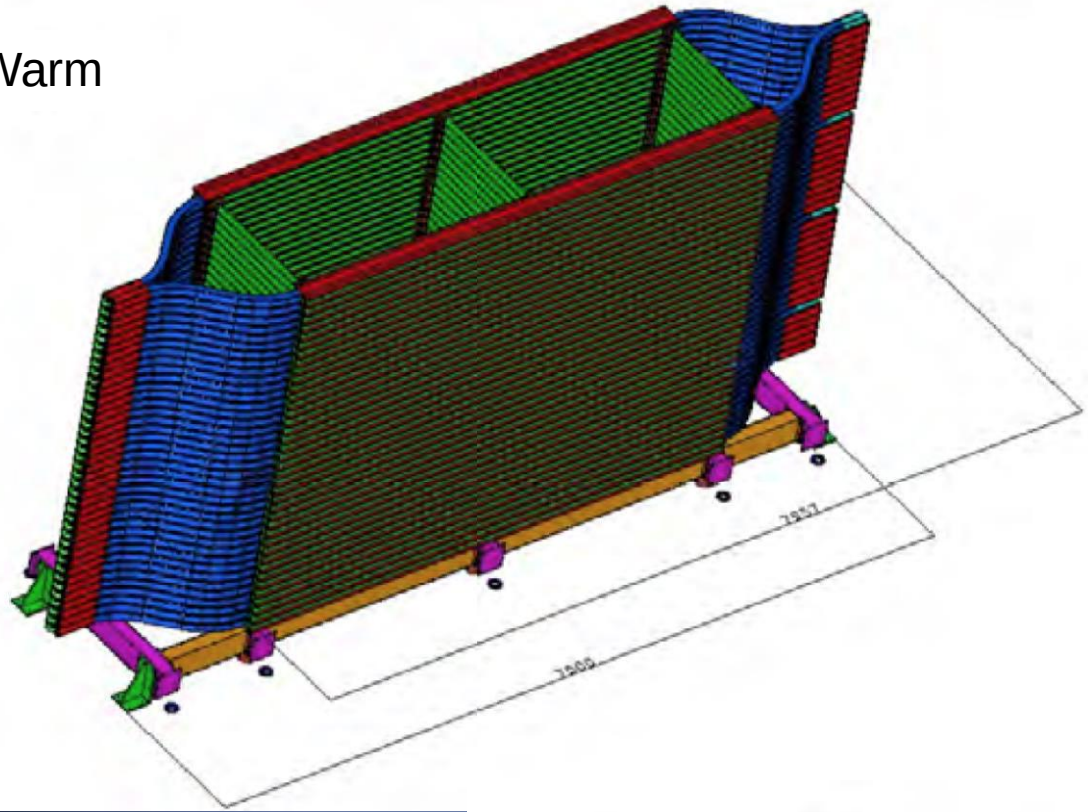
WA104 : Magnetized Muon Spectrometer

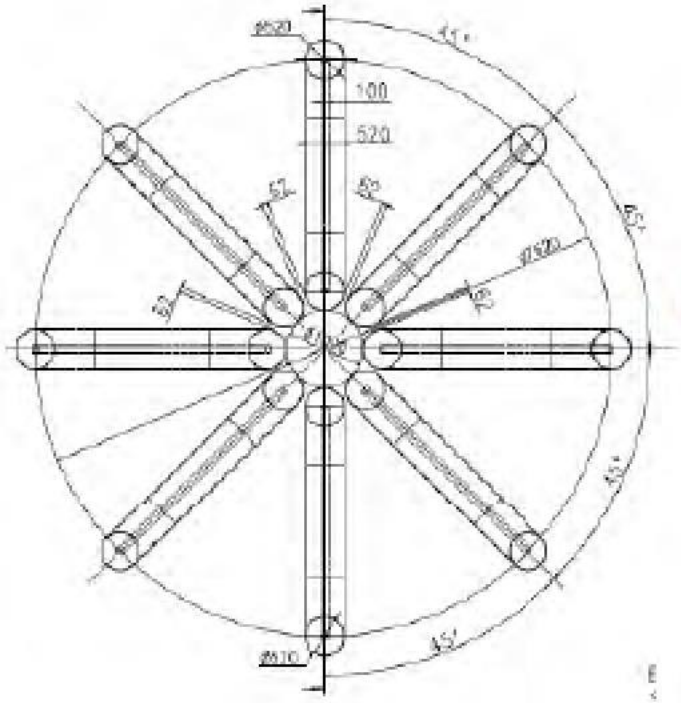
NESSiE Collaboration with CERN help

- *Prepare at CERN all the necessary infrastructure (space, logistics)*
- *R&D on a warm air core magnet*
- *R&D on a cold air core magnet*
- *Construct and test prototypes of a possible muon spectrometer*
- *Charged beam tests at the SPS with full readout capabilities*

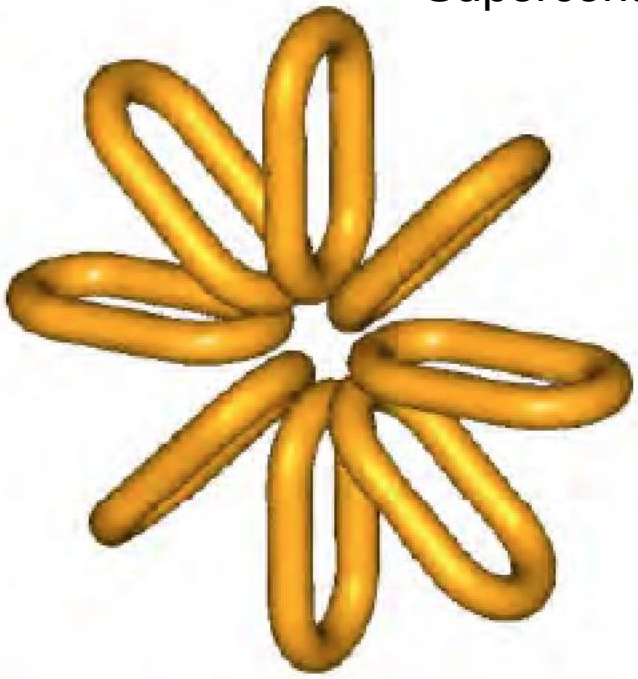
Air core magnets R&D

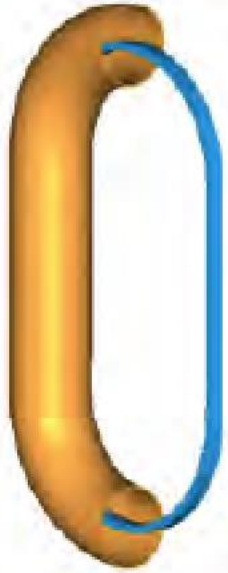
Warm





Superconducting

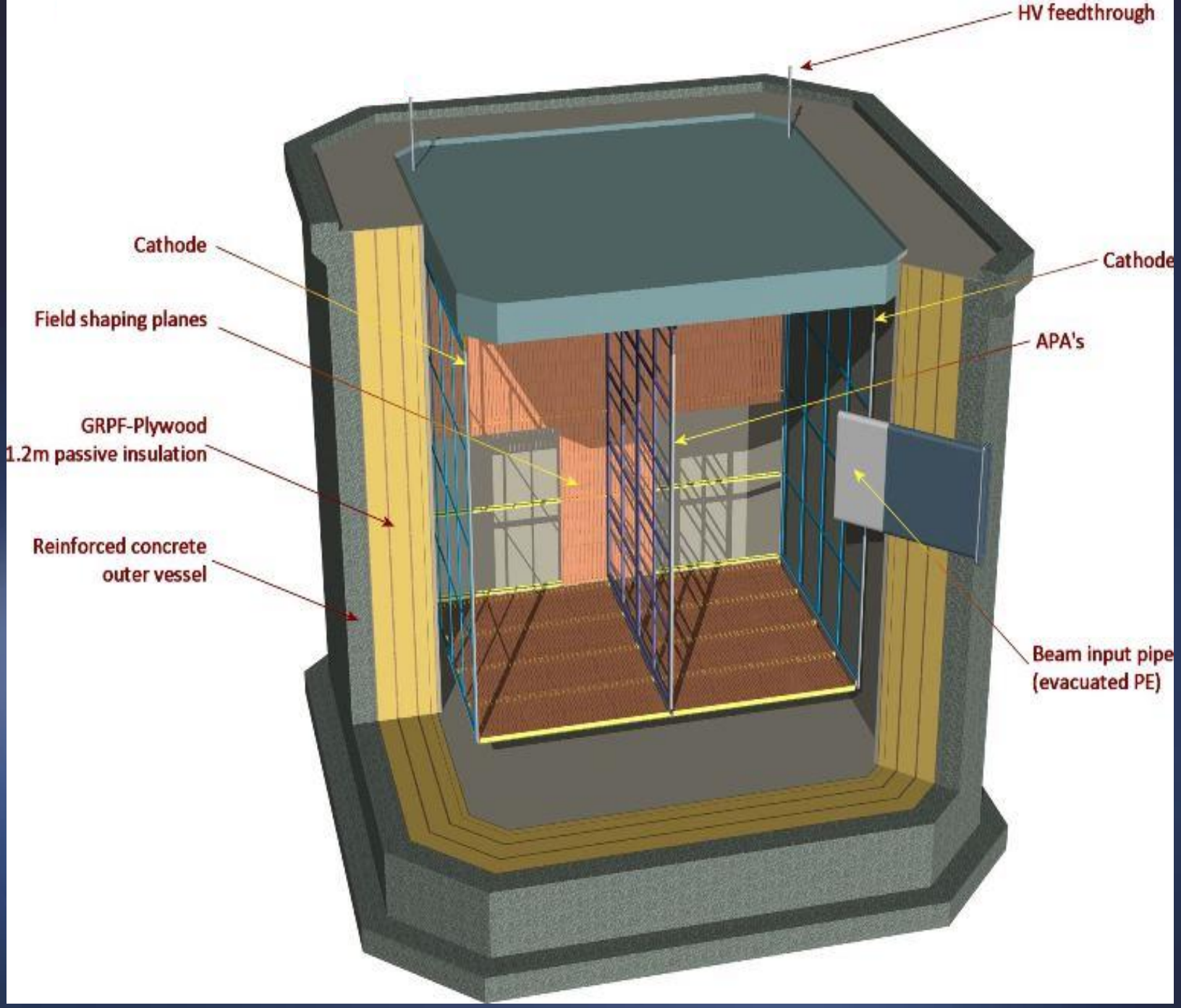




LBNF : Test of a large TPC module

LBNF Collaboration with CERN help

- *Prepare at CERN all the necessary infrastructure (space, logistics)*
- *Prepare a large cryostat for receiving this detector (new cap)*
- *Bring to CERN components assembled in the UK and USA*
- *Prepare/adapt the necessary cryogenics*
- *Charged beam tests at the SPS with full readout capabilities*

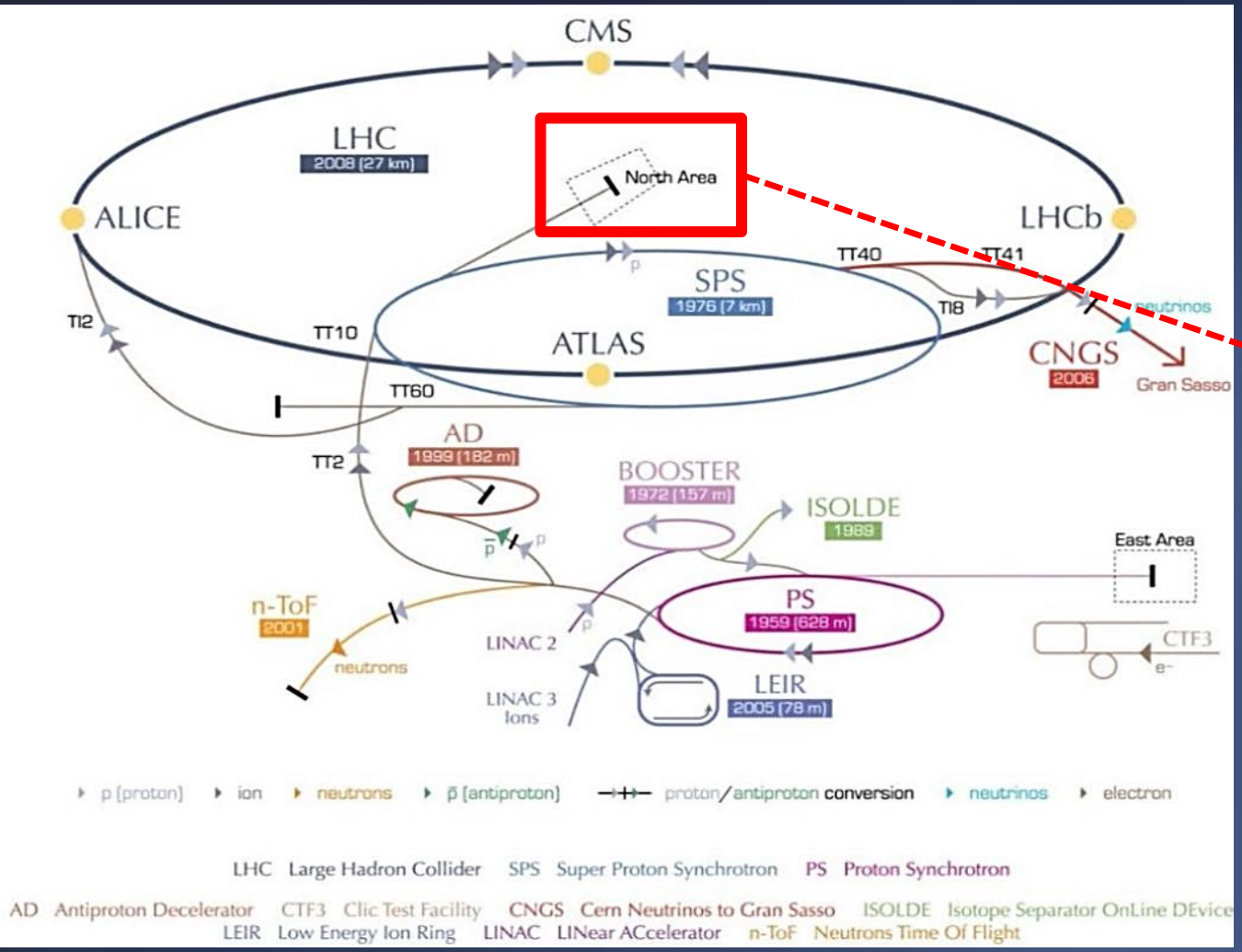

HV feedthrough
Cathode
Cathode
Field shaping planes
APA's
GRPF-Plywood
1.2m passive insulation
Reinforced concrete
outer vessel
Beam input pipe
(evacuated PE)

CERN support groups

- ✓ a detector mechanical engineering team (3 eng. already involved)
- ✓ a new Lar cryo group : 3 staff engineers + 3 Project associates eng. in rotation. The support of the CERN cryolab infrastructure (cryo tecs and frames contracts)
- ✓ a team of technicians
- ✓ an electrical engineer
- ✓ a controls group
- ✓ a (Si)PM characterization lab
- ✓ a simulation group for beam issues
- ✓ safety and environment experts
- ✓ secondary beam experts (from CNGS + new people)
- ✓ access to many CERN technology groups (EL, power, CV, material, ….)
- ✓ a new physics team

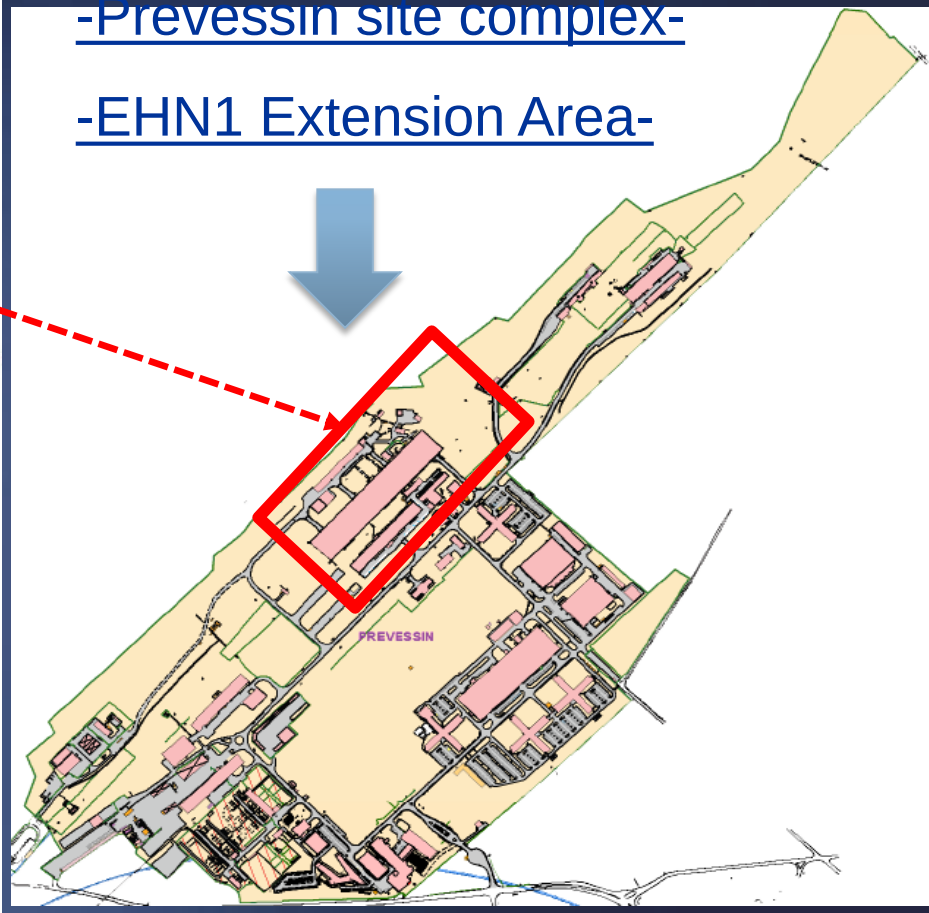
EHN1 extension as a new test area

CENF – Civil Engineering Extension B887

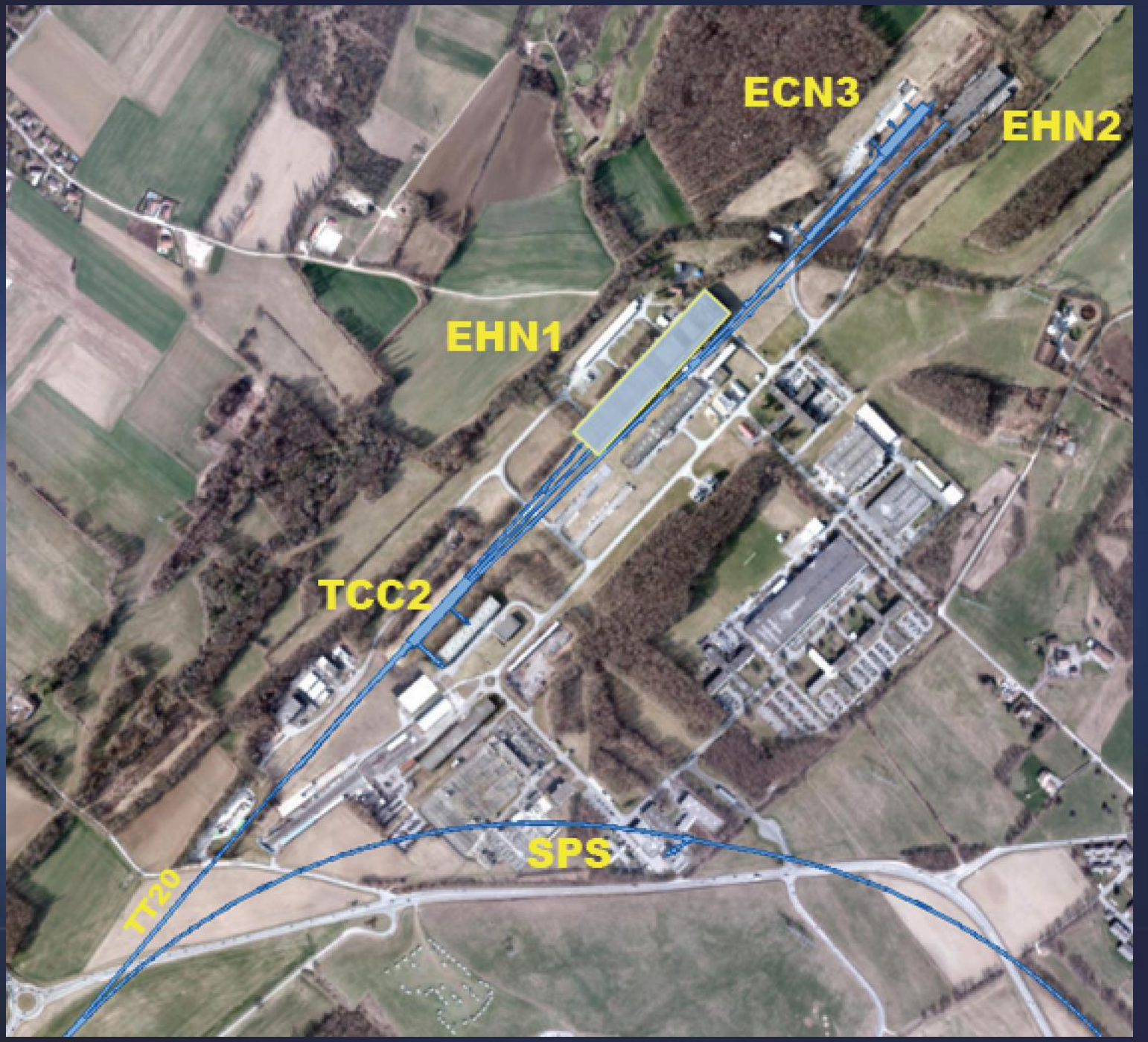


-Prevessin site complex-

-EHN1 Extension Area-

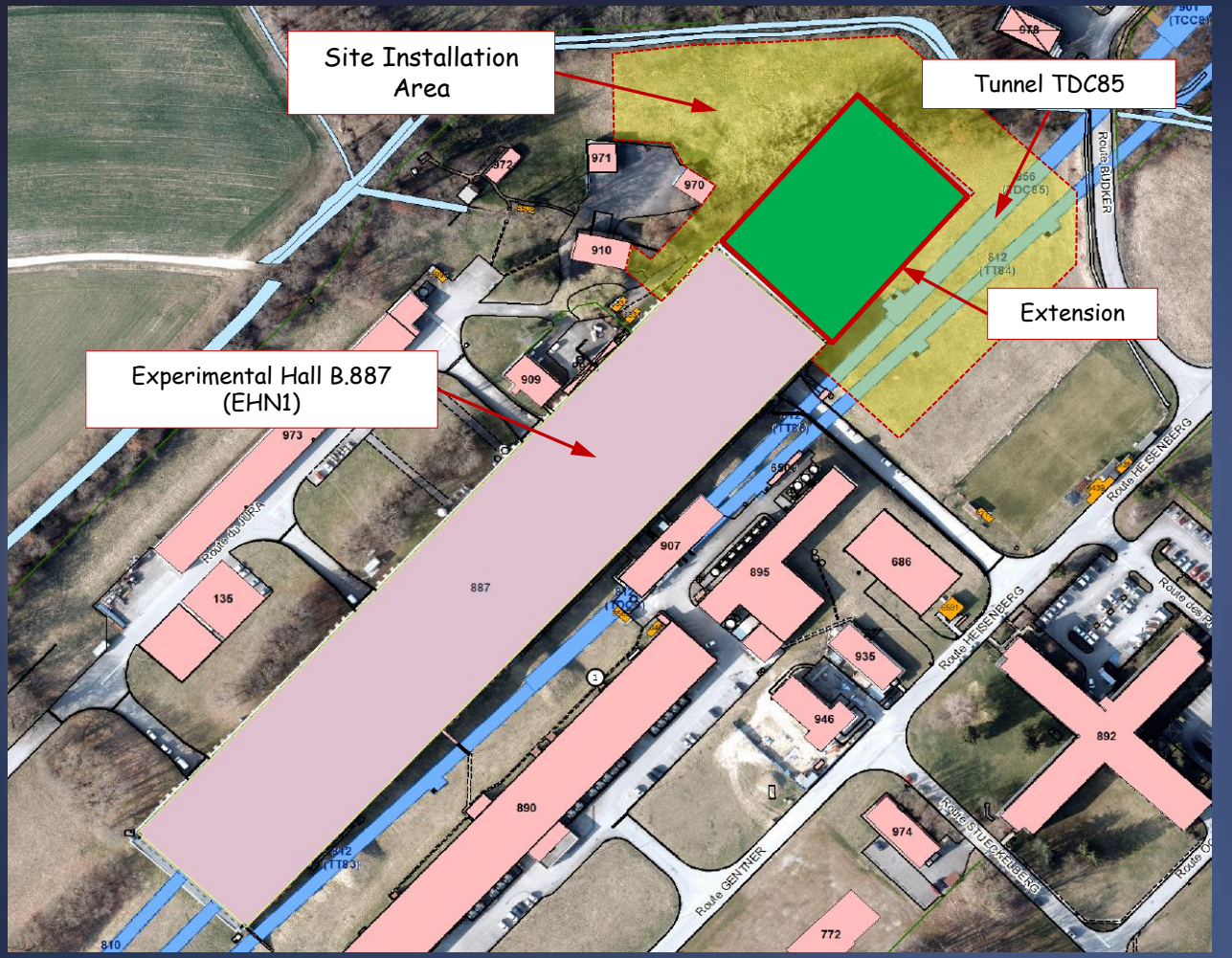


The Experimental Hall North 1 - EHN1



CENF – Civil Engineering Extension B887

Technical Aspect: Location

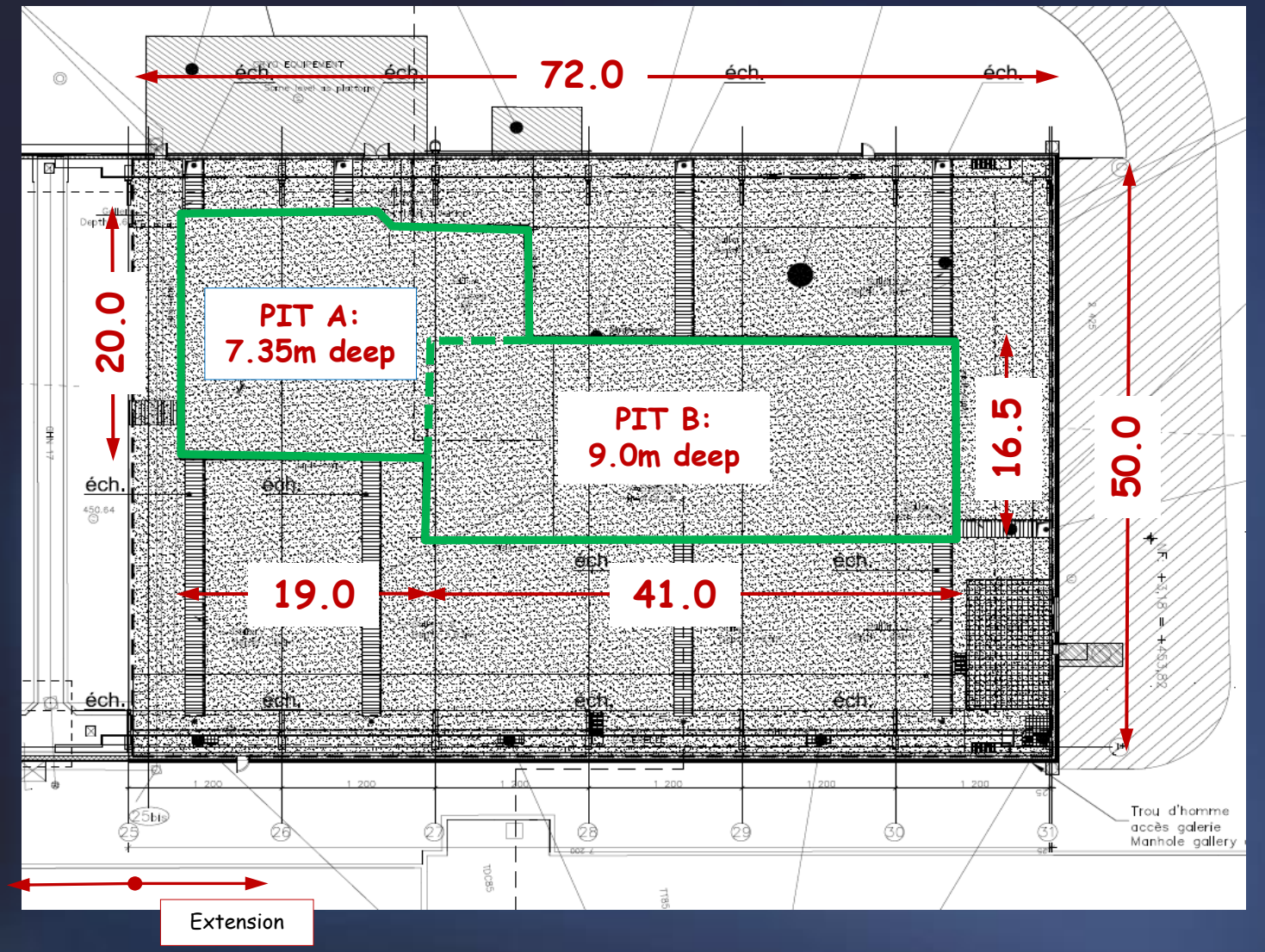


The EHN1 is a large industrial building situated on french territory, in Prévessin. The building has to be extended for the new generation of experiments on the neutrinos.

The Extension will extend northwards from the building for about 70 m in the direction of the beams.

CENF – Civil Engineering Extension B887

Technical Aspect: General info



The Extension's dimensions are 72 m long by 50 m wide and 20 m high.

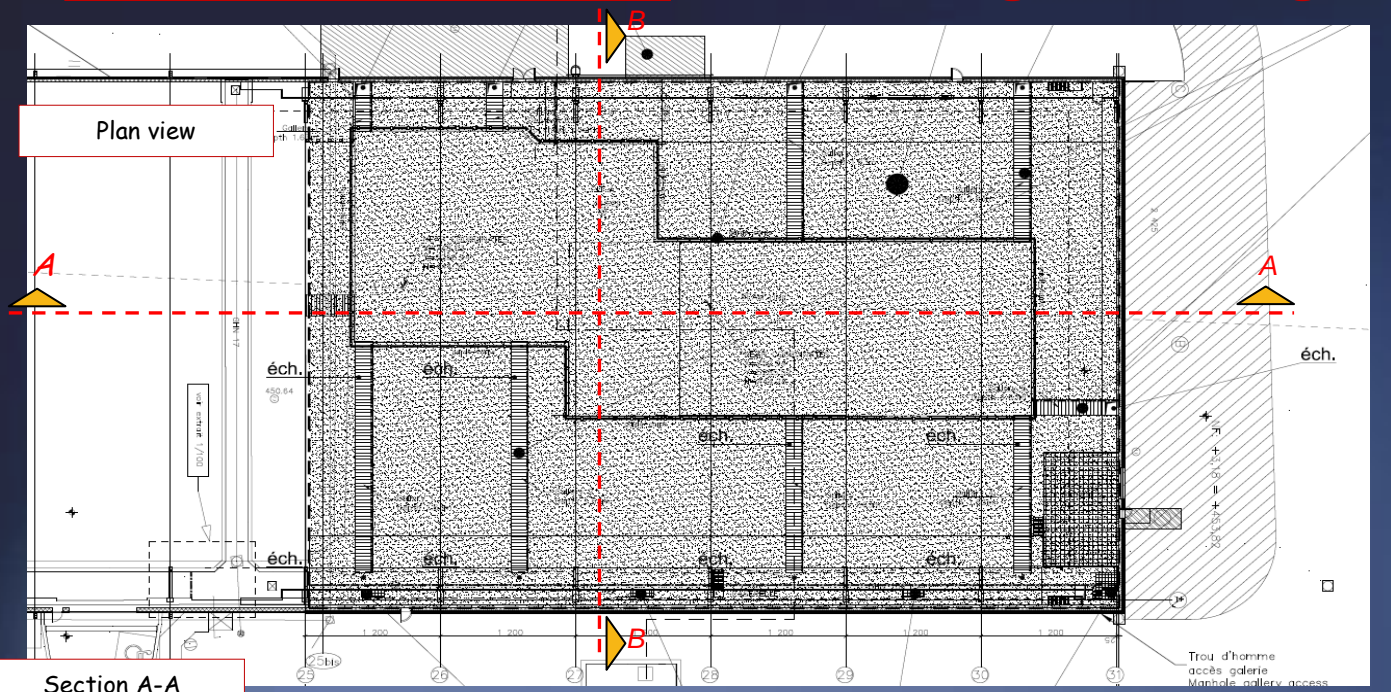
The extension includes two large pits of 7.35m and 9.0m deep.

The top metallic structure is similar to the existing building, allowing for an easy continuation of the overhead crane and services.

The technical gallery will be prolonged. Swallow service trenches will provide the access from the sidewalls to the pits.

CENF – Civil Engineering Extension B887

Technical Aspect: Civil Engineering main activities (1/2)



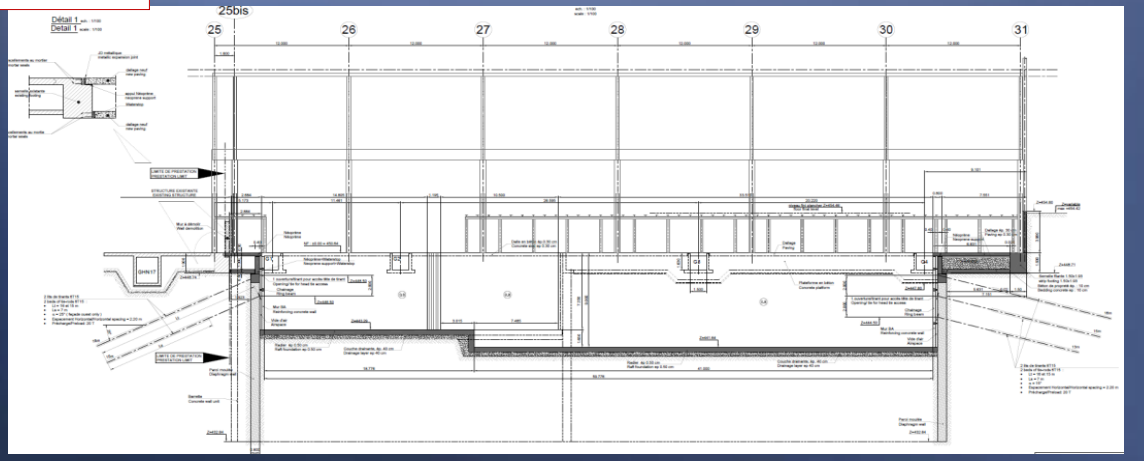
-Construction sheet piles (or Reduce Cost Alternative Option)

-Construction diaphragm wall and final tie beams

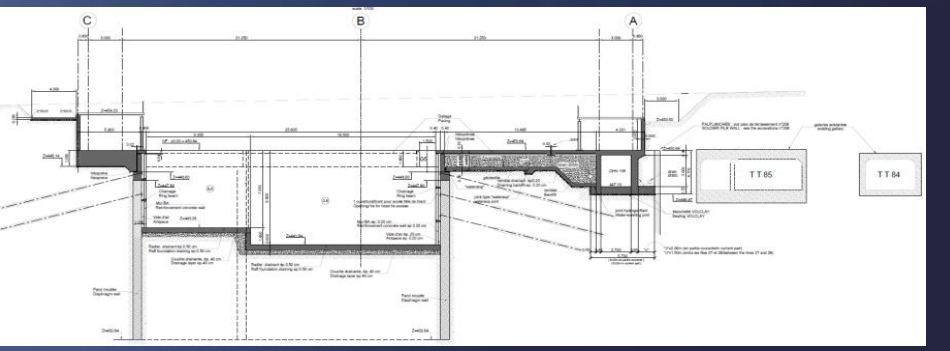
-Construction of reinforced concrete structure (raft foundations, slabs, walls, etc.)

-Demolition of the existing gable retaining wall

Section A-A



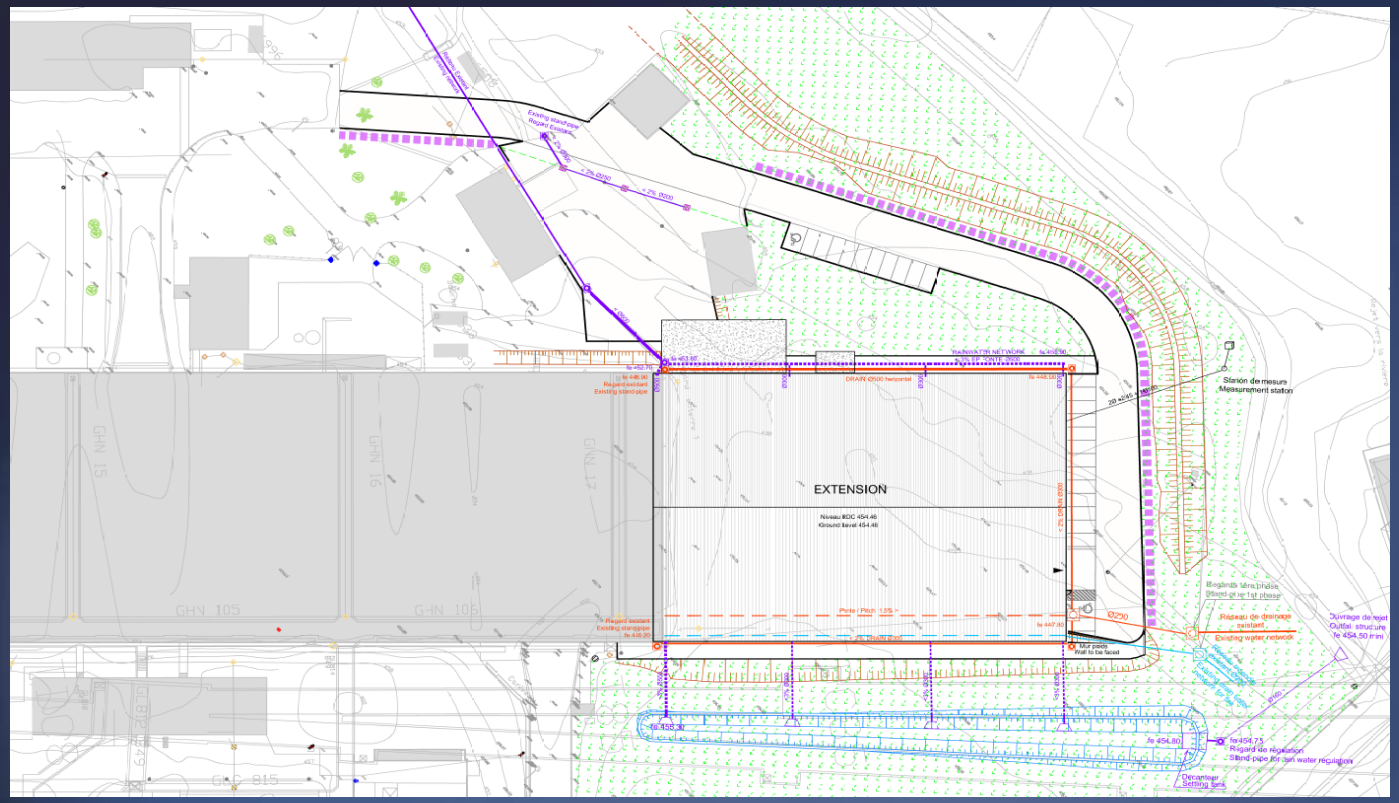
Section B-B



CERN Prototype Meeting – M.Nessi
N.Lopez, M.Manfredi (GS-SE)

CENF – Civil Engineering Extension B887

Technical Aspect: Civil Engineering main activities (2/2)



The works to be carried out will include:

-General worksite installation

-Rerouting and cutting existing underground networks

-Mass and ditch earthworks

-Drawdown of the water table

-Road works, car parks and landscaping.

-Rainwater treatment structures (worksite and definitive)

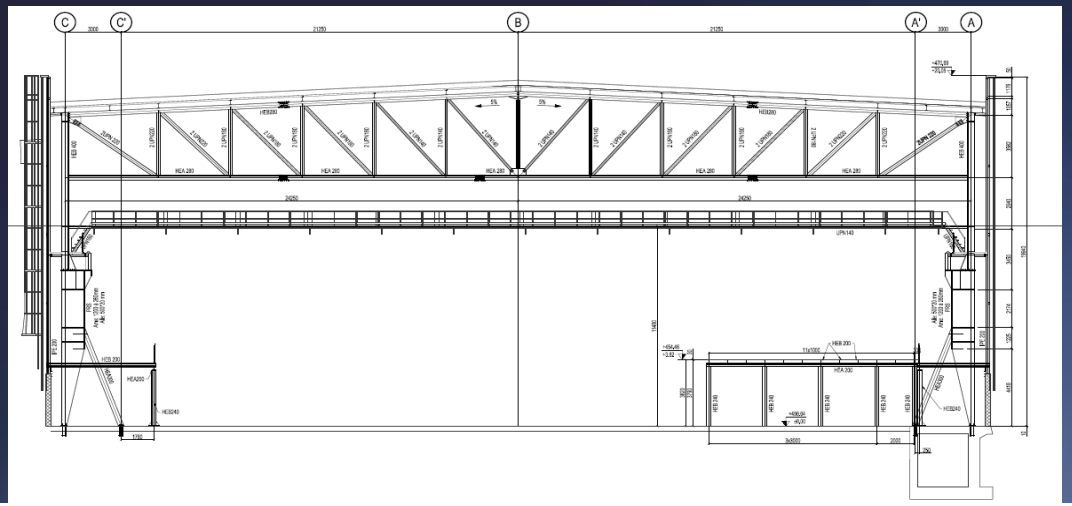
Notes:

Particular attention should be kept to the extracted cut material within 5.50m of distance from the TDC85

Radiological Protection: People allow to enter the technical gallery or inside the existing building 887 should equipped (passive/operational dosimeter) and accredited by CERN. No special measure need to be planned to work outside

CENF – Civil Engineering Extension B887

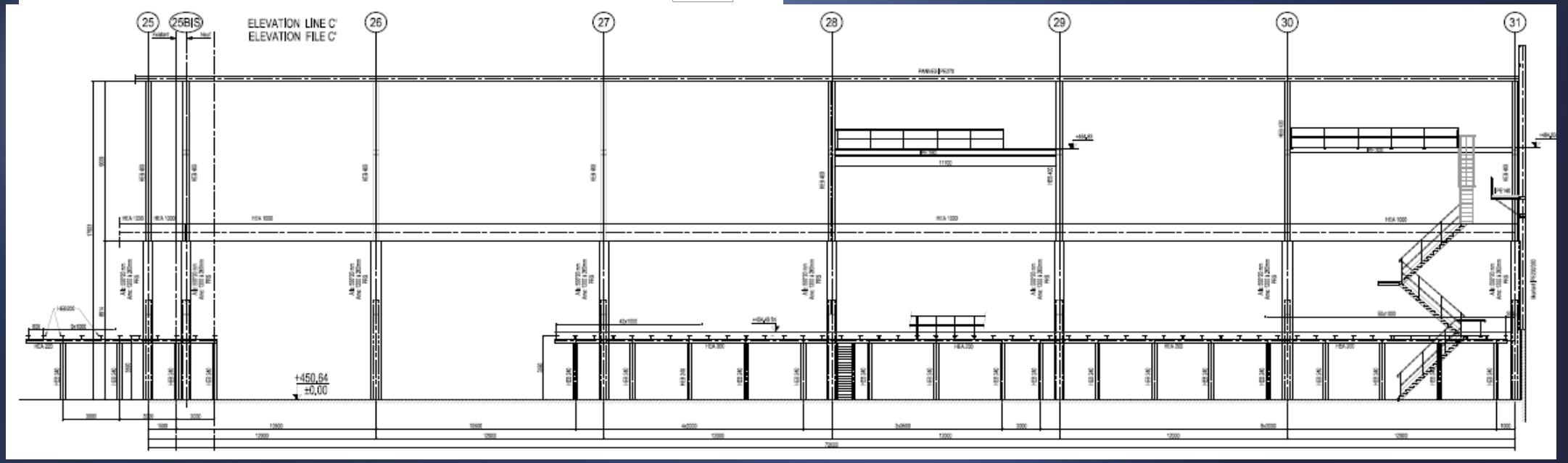
Technical Aspect: Structural steel main activities (1/2)



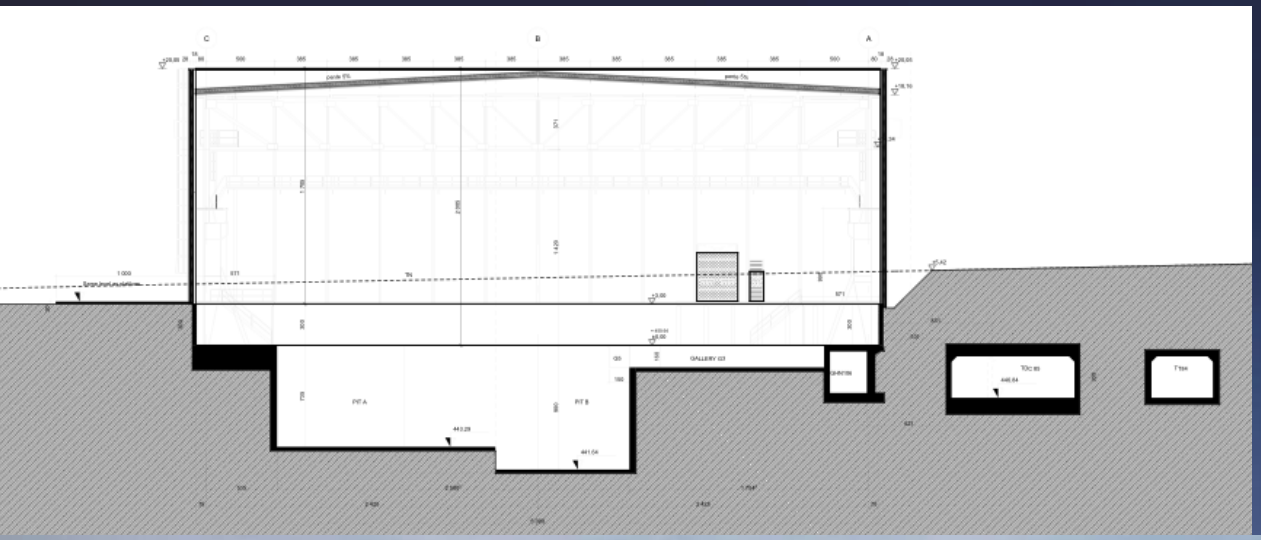
-Structural steelwork and associated components (Main and Secondary structures, Internal structures, Travelling crane structures)

-Metalwork: guardrails, stairs, ladders, doors

-Removal of the north gable of the existing building (not before the extension is water-tight and air-tight)



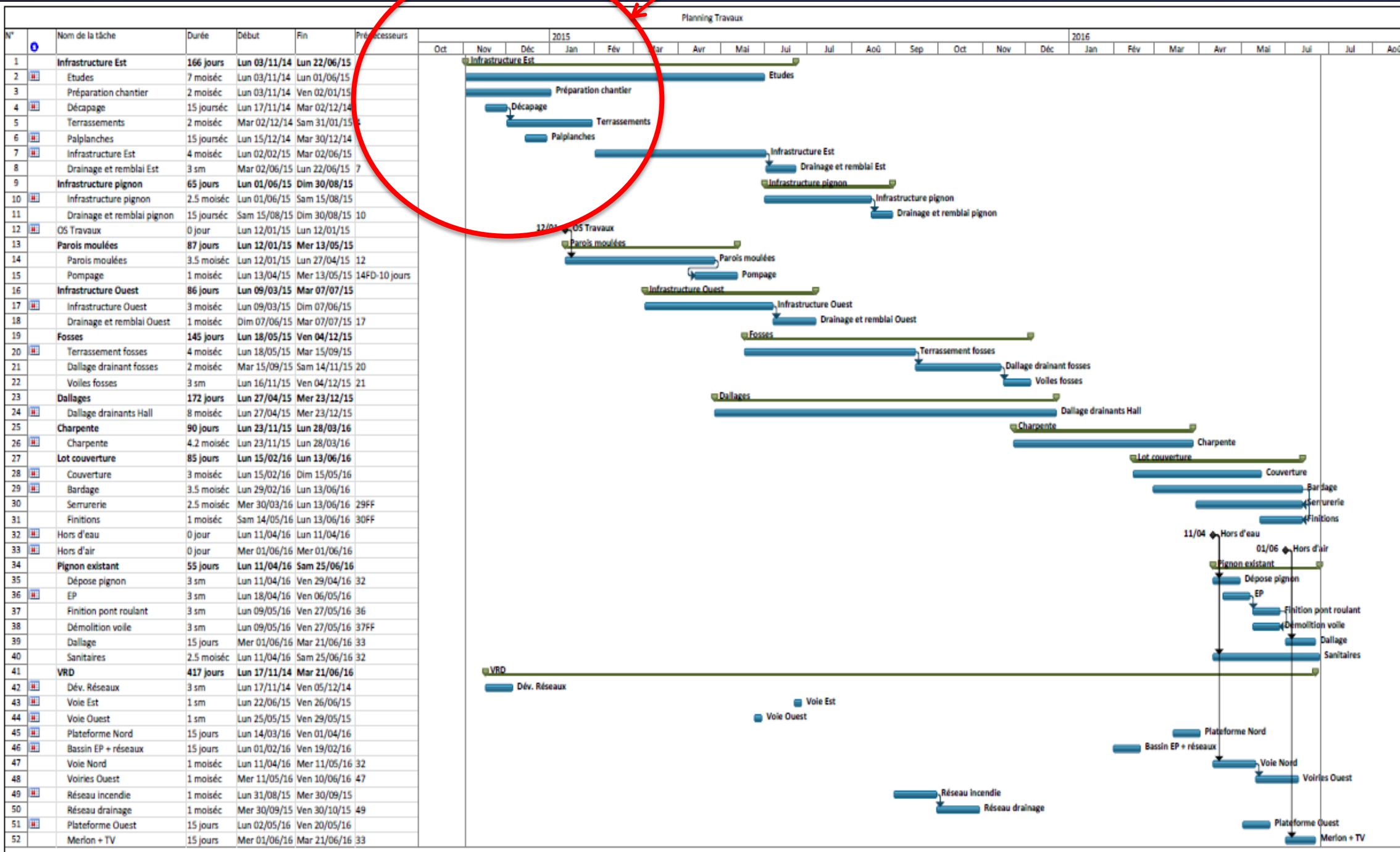
Nord Area EHN1 extension



Ready for beams in 2017

Schedule

Anticipated start of the works (if possible) + 18 months



N°	Nom de la tâche	Durée	Début	Fin	Prédécesseurs
1	**Infrastructure Est**	**166 jours**	**Lun 03/11/14**	**Lun 22/06/15**	
2	Etudes	7 moiséc	Lun 03/11/14	Lun 01/06/15	
3	Préparation chantier	2 moiséc	Lun 03/11/14	Ven 02/01/15	
4	Décapage	15 jourséc	Lun 17/11/14	Mar 02/12/14	
5	Terrassements	2 moiséc	Mar 02/12/14	Sam 31/01/15	4
6	Palplanches	15 jourséc	Lun 15/12/14	Mar 30/12/14	
7	Infrastructure Est	4 moiséc	Lun 02/02/15	Mar 02/06/15	
8	Drainage et remblai Est	3 sm	Mar 02/06/15	Lun 22/06/15	7
9	**Infrastructure pignon**	**65 jours**	**Lun 01/06/15**	**Dim 30/08/15**	
10	Infrastructure pignon	2.5 moiséc	Lun 01/06/15	Sam 15/08/15	
11	Drainage et remblai pignon	15 jourséc	Sam 15/08/15	Dim 30/08/15	10
12	OS Travaux	0 jour	Lun 12/01/15	Lun 12/01/15	
13	**Parois moulées**	**87 jours**	**Lun 12/01/15**	**Mer 13/05/15**	
14	Parois moulées	3.5 moiséc	Lun 12/01/15	Lun 27/04/15	12
15	Pompage	1 moiséc	Lun 13/04/15	Mer 13/05/15	14FD-10 jours
16	**Infrastructure Ouest**	**86 jours**	**Lun 09/03/15**	**Mar 07/07/15**	
17	Infrastructure Ouest	3 moiséc	Lun 09/03/15	Dim 07/06/15	
18	Drainage et remblai Ouest	1 moiséc	Dim 07/06/15	Mar 07/07/15	17
19	**Fosses**	**145 jours**	**Lun 18/05/15**	**Ven 04/12/15**	
20	Terrassement fosses	4 moiséc	Lun 18/05/15	Mar 15/09/15	
21	Dallage drainant fosses	2 moiséc	Mar 15/09/15	Sam 14/11/15	20
22	Voiles fosses	3 sm	Lun 16/11/15	Ven 04/12/15	21
23	**Dallages**	**172 jours**	**Lun 27/04/15**	**Mer 23/12/15**	
24	Dallage drainants Hall	8 moiséc	Lun 27/04/15	Mer 23/12/15	
25	**Charpente**	**90 jours**	**Lun 23/11/15**	**Lun 28/03/16**	
26	Charpente	4.2 moiséc	Lun 23/11/15	Lun 28/03/16	
27	**Lot couverture**	**85 jours**	**Lun 15/02/16**	**Lun 13/06/16**	
28	Couverture	3 moiséc	Lun 15/02/16	Dim 15/05/16	
29	Bardage	3.5 moiséc	Lun 29/02/16	Lun 13/06/16	
30	Serrurerie	2.5 moiséc	Mer 30/03/16	Lun 13/06/16	29FF
31	Finitions	1 moiséc	Sam 14/05/16	Lun 13/06/16	30FF
32	Hors d'eau	0 jour	Lun 11/04/16	Lun 11/04/16	
33	Hors d'air	0 jour	Mer 01/06/16	Mer 01/06/16	
34	**Pignon existant**	**55 jours**	**Lun 11/04/16**	**Sam 25/06/16**	
35	Dépose pignon	3 sm	Lun 11/04/16	Ven 29/04/16	32
36	EP	3 sm	Lun 18/04/16	Ven 06/05/16	
37	Finition pont roulant	3 sm	Lun 09/05/16	Ven 27/05/16	36
38	Démolition voile	3 sm	Lun 09/05/16	Ven 27/05/16	37FF
39	Dallage	15 jours	Mer 01/06/16	Mar 21/06/16	33
40	Sanitaires	2.5 moiséc	Lun 11/04/16	Sam 25/06/16	32
41	**VRD**	**417 jours**	**Lun 17/11/14**	**Mar 21/06/16**	
42	Dév. Réseaux	3 sm	Lun 17/11/14	Ven 05/12/14	
43	Voie Est	1 sm	Lun 22/06/15	Ven 26/06/15	
44	Voie Ouest	1 sm	Lun 25/05/15	Ven 29/05/15	
45	Plateforme Nord	15 jours	Lun 14/03/16	Ven 01/04/16	
46	Bassin EP + réseaux	15 jours	Lun 01/02/16	Ven 19/02/16	
47	Voie Nord	1 moiséc	Lun 11/04/16	Mer 11/05/16	32
48	Voiries Ouest	1 moiséc	Mer 11/05/16	Ven 10/06/16	47
49	Réseau incendie	1 moiséc	Lun 31/08/15	Mer 30/09/15	
50	Réseau drainage	1 moiséc	Mer 30/09/15	Ven 30/10/15	49
51	Plateforme Ouest	15 jours	Lun 02/05/16	Ven 20/05/16	
52	Merlon + TV	15 jours	Mer 01/06/16	Mar 21/06/16	33

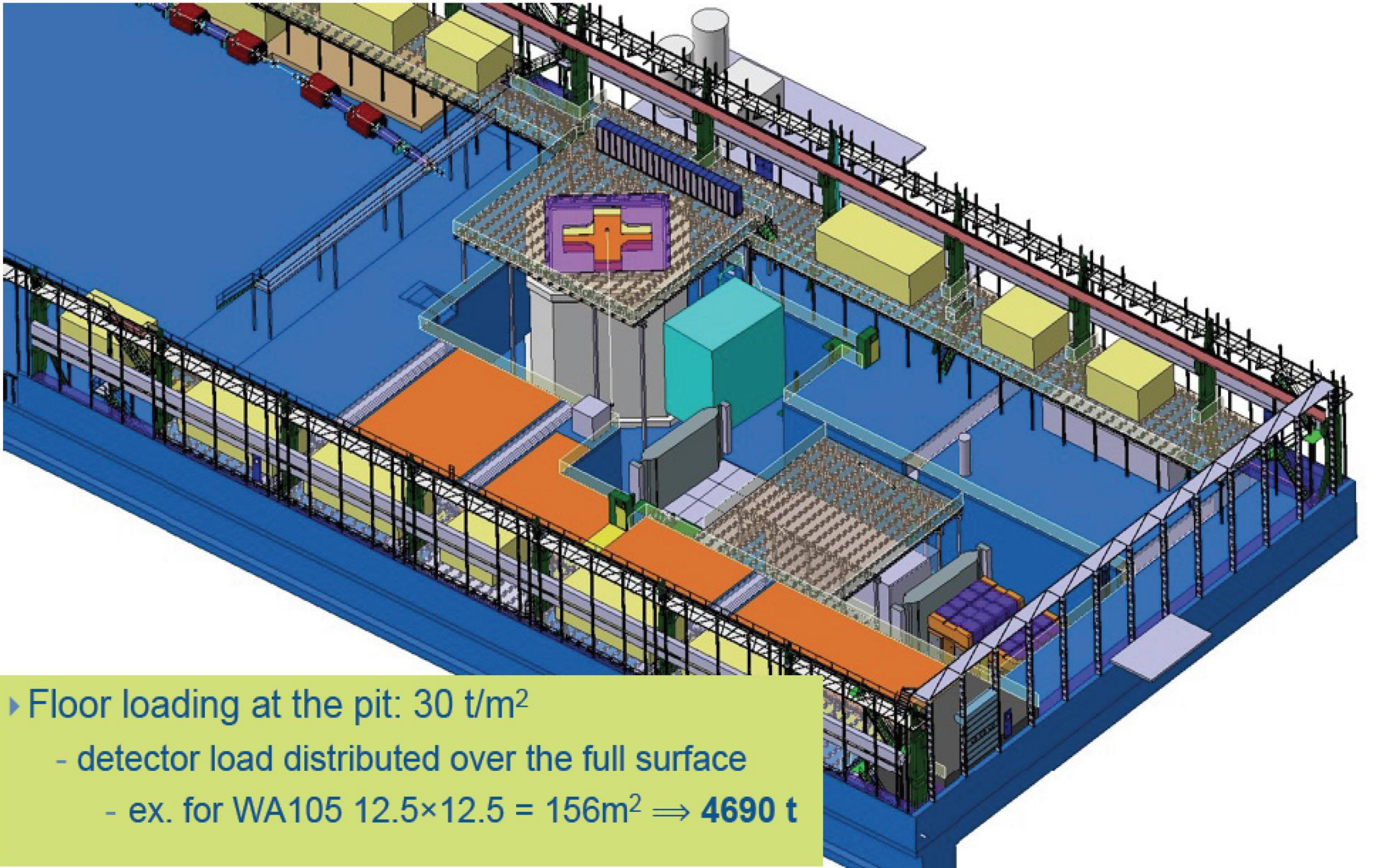
Source : ARCADIS → to be updated after tendering procedures

Civil engineering CERN team

- ✓ Luigi Scibile (group leader)
- ✓ Matasha Lopez (project leader)
- ✓ Martin Manfredi (CE engineer)
- ✓ new CERN CE engineer to follow the construction on side to be appointed
- ✓ firm ARCADIS as responsible for design and construction follow up (contract running)

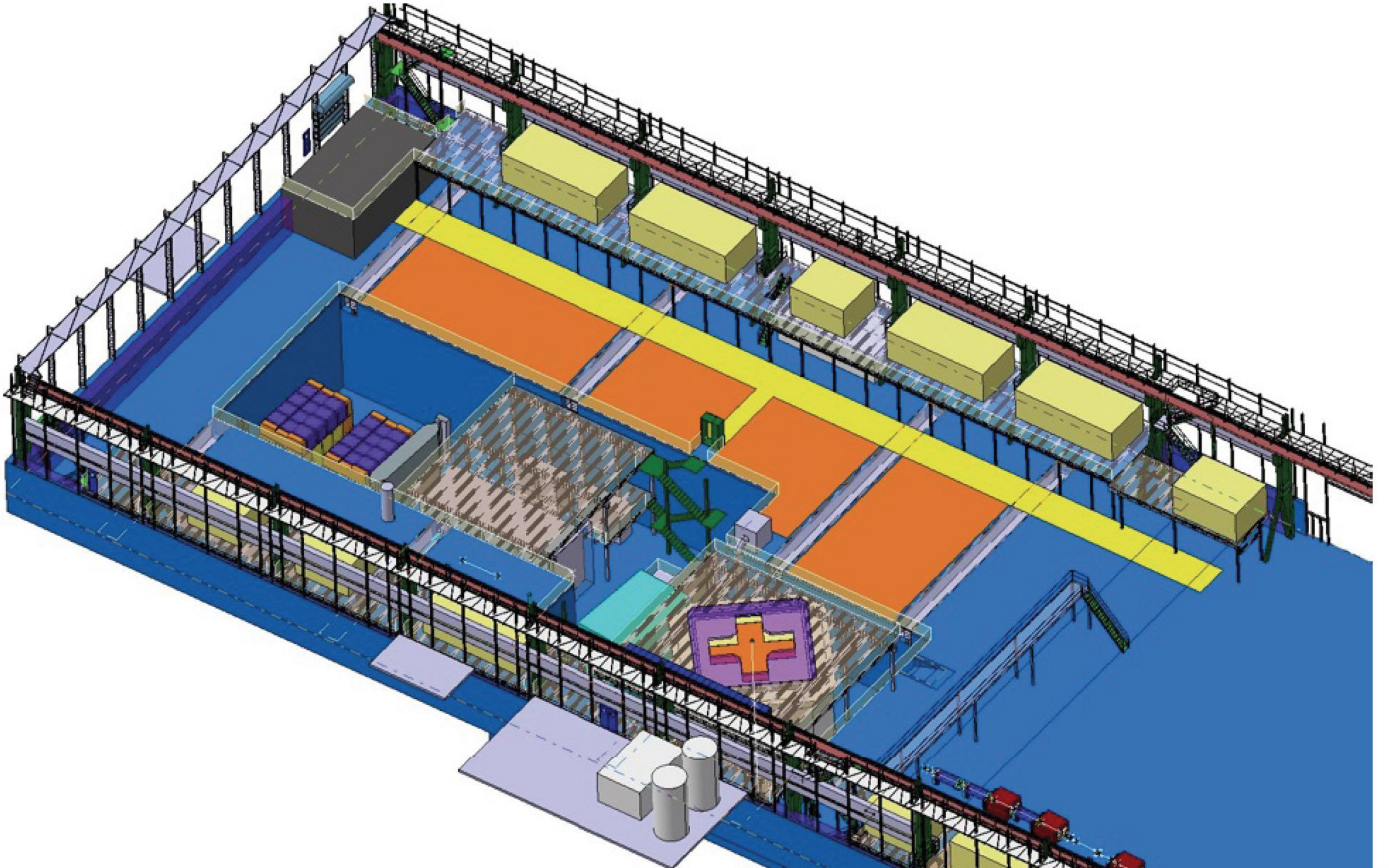
Consortium of firms selected for the construction, Contract still in 2014 after CERN Finance Committee approval

The EHN1 Extension - Detector Integration

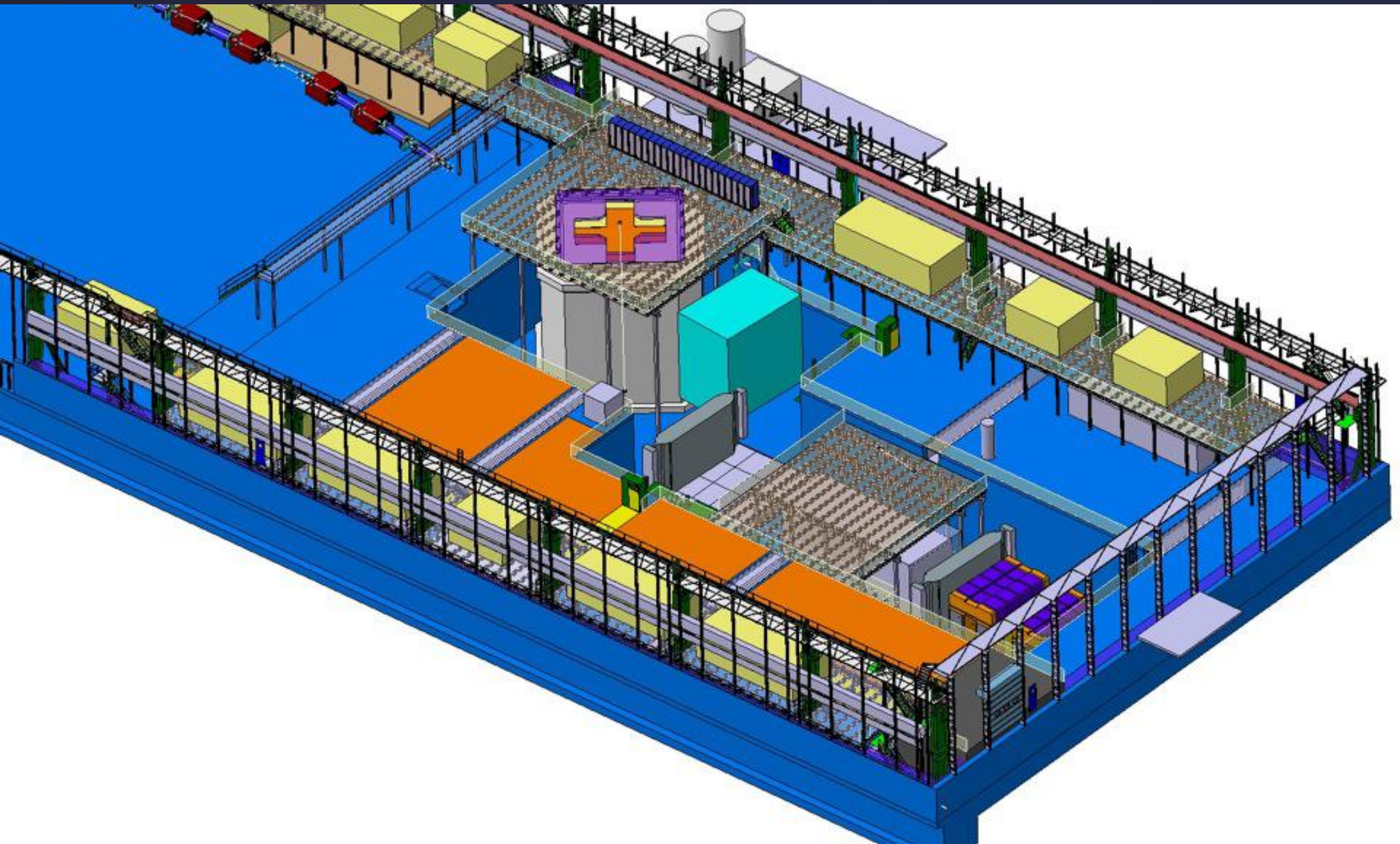


- Floor loading at the pit: 30 t/m^2
  - detector load distributed over the full surface
    - ex. for WA105 12.5×12.5 = 156m^2 $\Longrightarrow$ **4690 t**

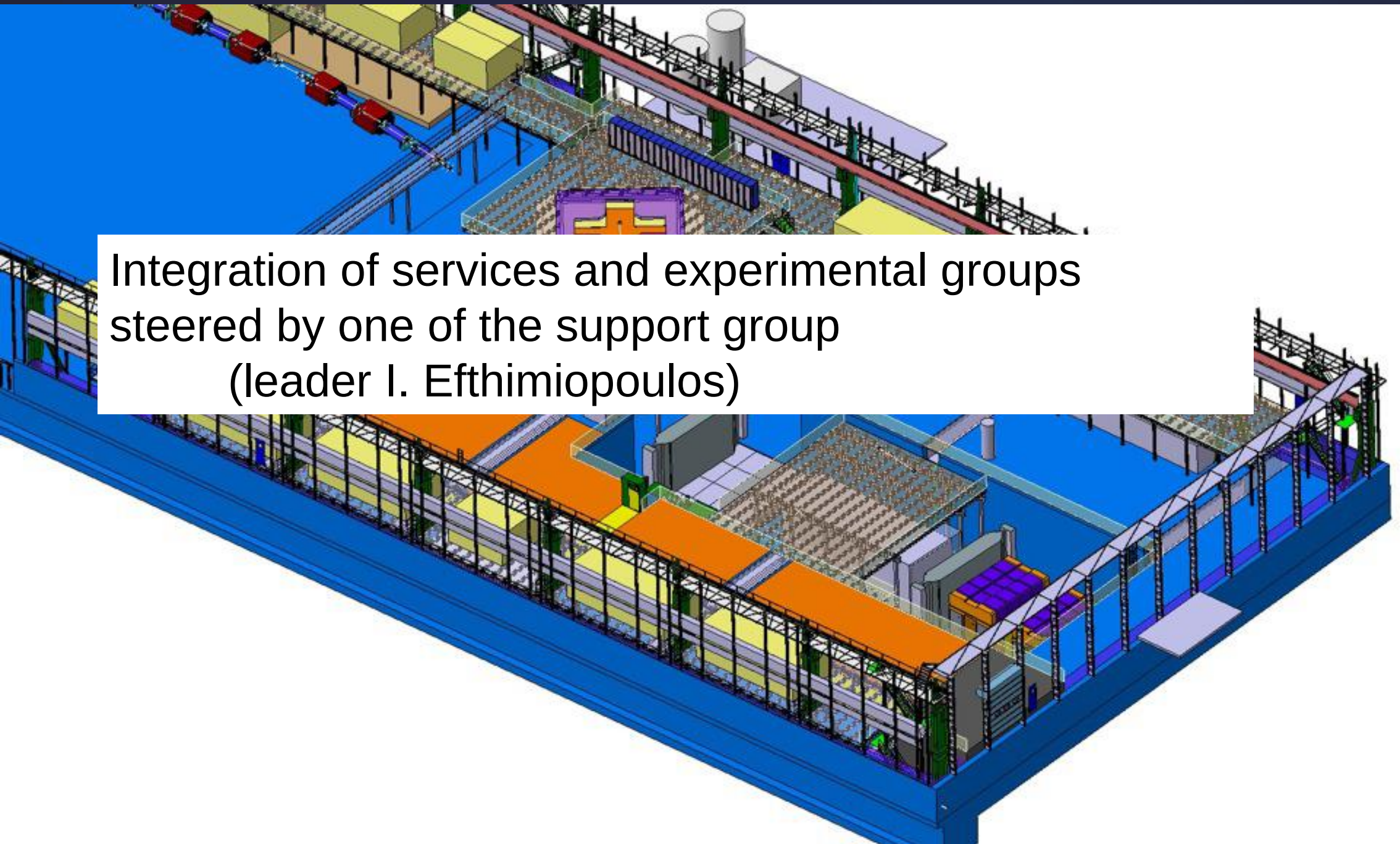
The EHN1 Extension - Detector Integration



Neutrino extension



Neutrino extension



Integration of services and experimental groups steered by one of the support group

(leader I. Efthimiopoulos)

EHN1 Extension Integration - Control Rooms for Experiments

- Follow (if possible) the same design as in the existing building
- Counting rooms in ground and 1st floor
- Fully metallic structures, not connected to the building
  - modular design, allows reconfiguring upon needs
  - separate ventilation units per room (or groups of rooms)

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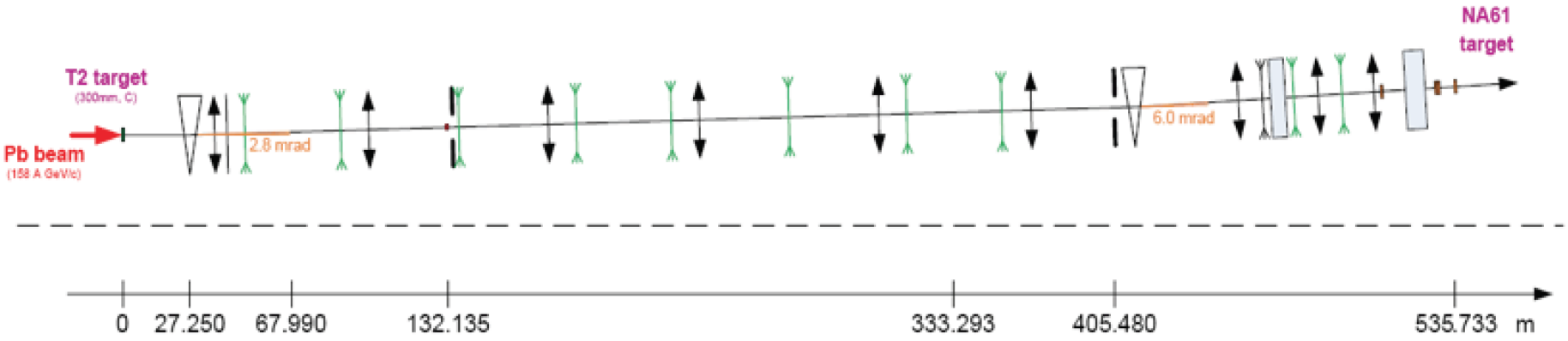
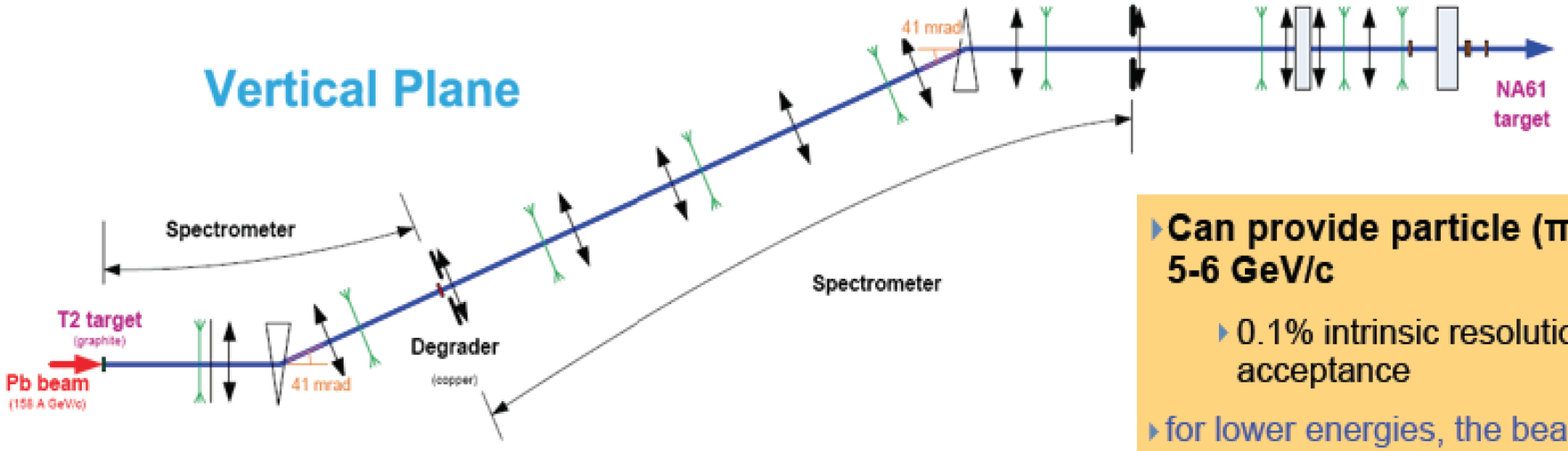
EHN1 Secondary Beams

H2 Beam Line – SPS North Area

Horizontal Plane



Vertical Plane

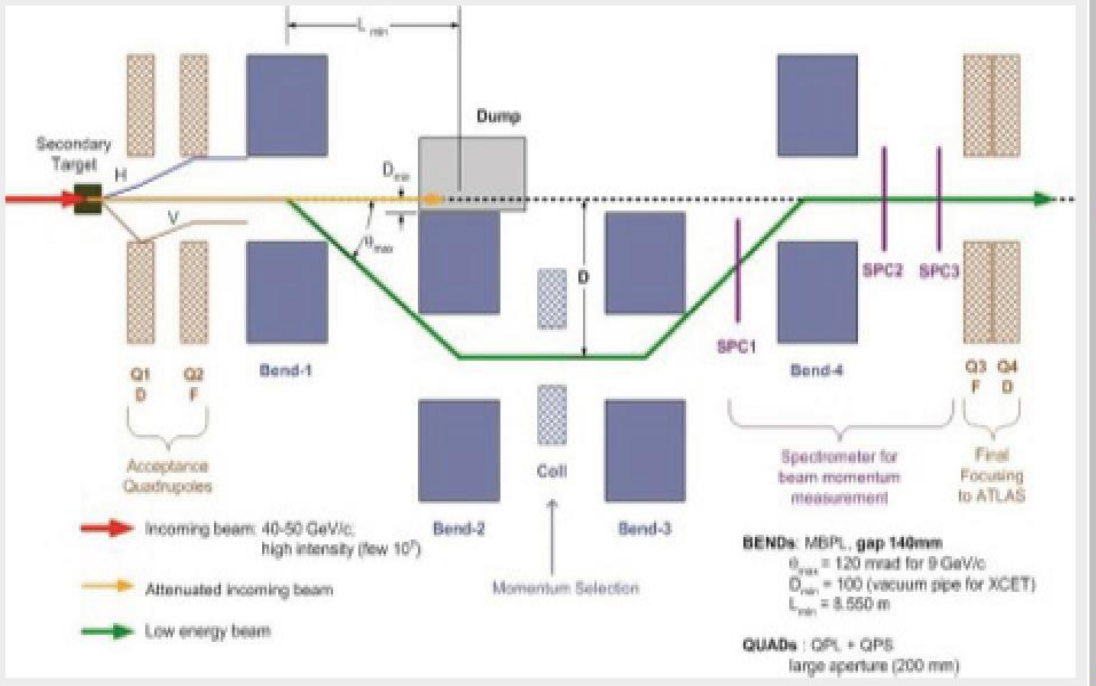


- **Can provide particle (π,μ,p,e) beams down to 5-6 GeV/c**
  - 0.1% intrinsic resolution, 1.5%max momentum acceptance
- for lower energies, the beam momentum definition is very challenging, and with large error,
  - and rate loss due to decays for π beams
- use **tertiary beams** from a secondary target

Design of the Low-Energy Tertiary Beams

Four-bends layout

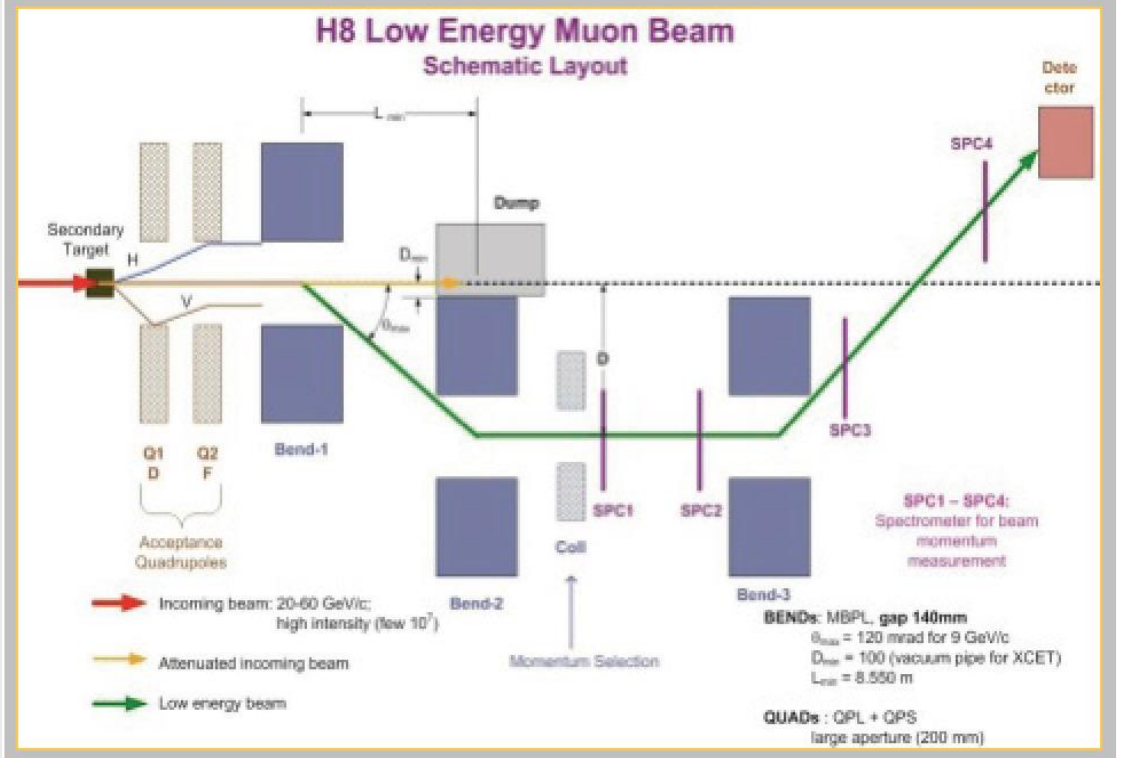
- Available magnets: **MBPL 120mrad for 1-9 GeV beams**



- design used for the ATLAS(H8) &CMS(H2) calorimeters in the past
- suffers from large background from the direct secondary beam

Three bends layout (EHN1-Ext)

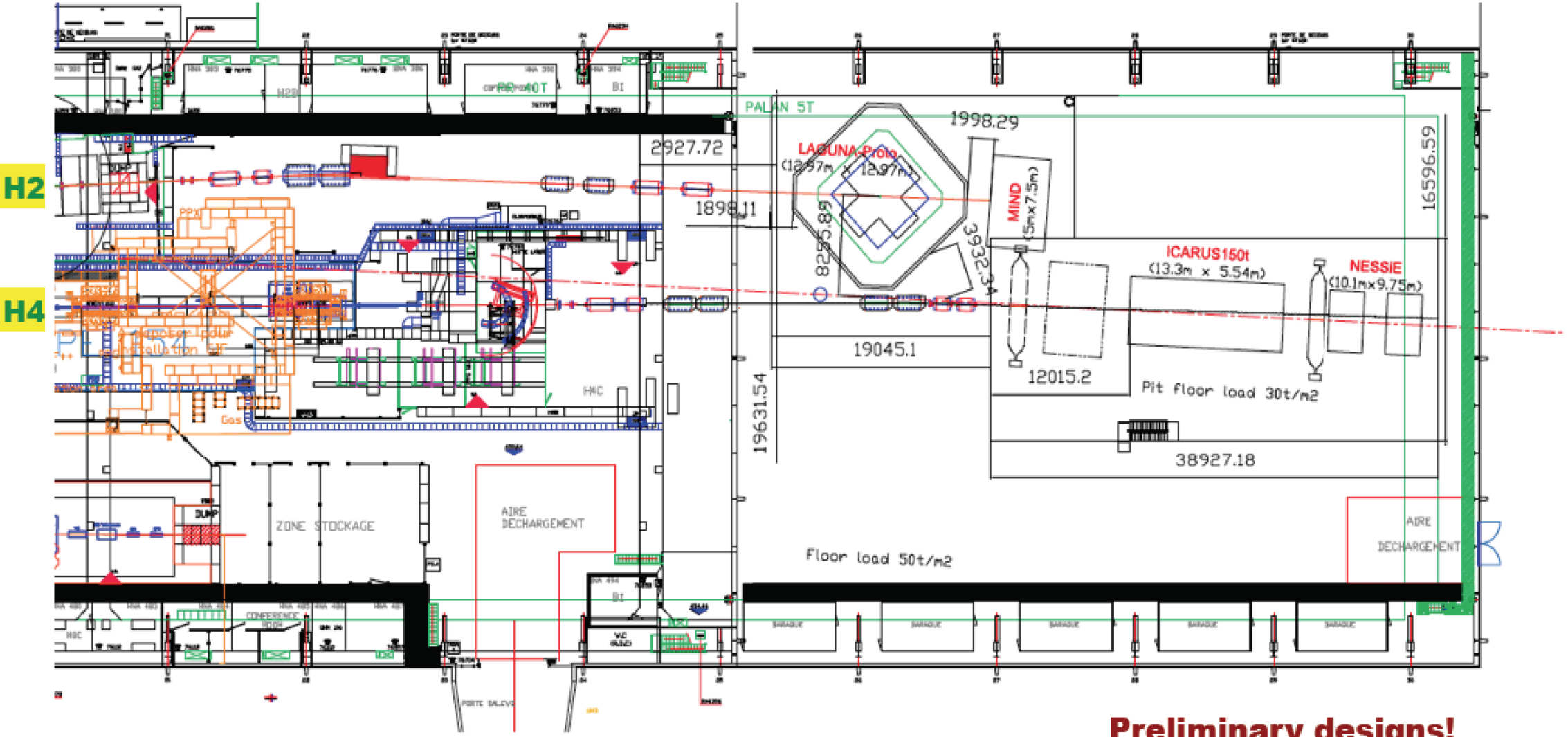
- detector off-axis wrt incoming secondary beam



- reduces background to the experiment, critical for detectors with large drift volumes

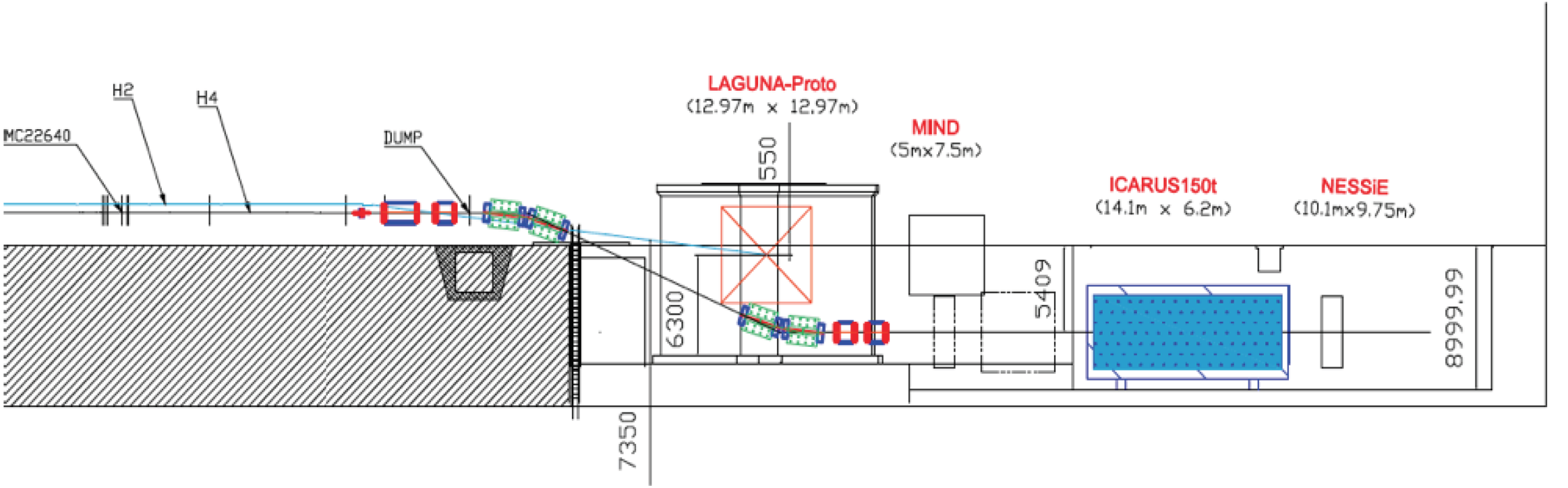
The EHN1 Extension - Charged beams

- VLE tertiary beams for the ν detectors
  - H2 extension: **1-20 GeV/c**, hadrons ($\pi^{\pm}$, $\mu^{\pm}$, p - mixed beam), electrons($e^{\pm}$)
  - H4 extension: **1-5(7) GeV/c**, hadrons ($\pi^{\pm}$, $\mu^{\pm}$, p - mixed beam), electrons($e^{\pm}$)



Preliminary designs!

The EHN1 Extension - Charged beams

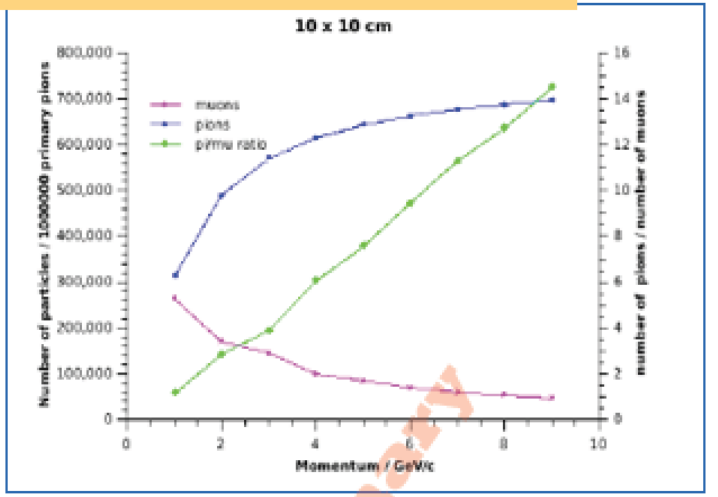


- Preliminary layout seems to work ok.
- Detailed designs ongoing, including all performance aspects for the beam
  - hardware installation {magnets, beam instrumentation, handling, …}
  - safety {radiation protection, access, …}
  - beam performance & background to the experiments !
    - **key issue and motivation to have the detectors in the pits !!!**

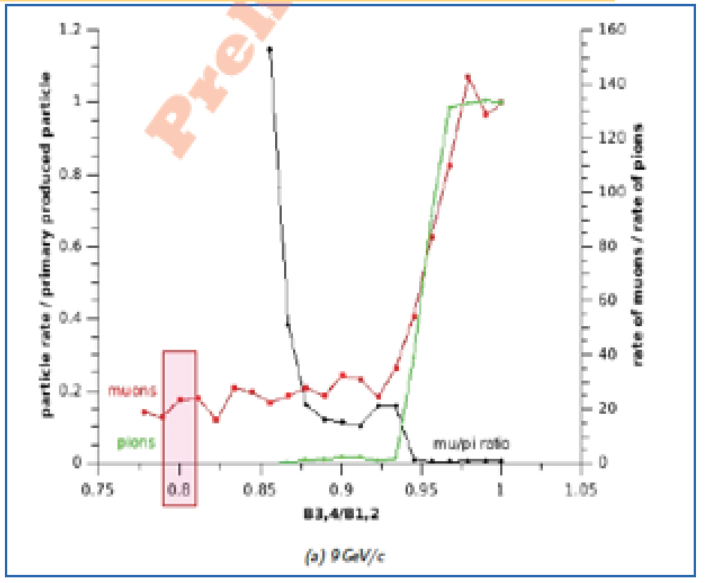
The EHN1 Extension - Charged beams

- Issues to address/resolve for the beams:
  - **particle momentum :** beam acceptance ±5% in Δp
    - if not sufficient, must design and build a low-Z spectrometer (chambers) around the last magnet
  - **particle content:**
    - we can make pure electron beams and muon beams with high (>80%) purity
    - hadron (π, p) beams will always be mixed beams from e/μ content
    - particle tagging is possible with threshold Cherenkov counters (but also add material to the beam!)
  - **background to experiment:**
    - from secondary high-intensity beam (~ 10^4 higher rate!)
      - efficient trigger system would be required
    - LArgon part inside the cryostat upstream the active volume
      - possible to introduce an extruder, possibly covering part of acceptance to do tests with/without it?

- π/μ ratio on axis for a π VLE beam



- μ/π ratio on axis for a μ VLE beam



Integration team

… and to all colleagues for their work so far:

B.Bannister, J. Devine, J. Pierlot, M. Obrecht, M. Battistin, C. Bertone, I. Ruehl, A. Fabich, A.L. Perrot, S. Girod, M. Manfredi, L.A.Lopez-Hernandez, J. Gascon, A. Henriques, J. Bremer, S. Hutchins, C. Theis, H. Vincke

How to get in ?

MOU frame

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

Several MOUs are being prepared for signature

Addendum No. 01

to the
Memorandum of Understanding
for Collaboration in the Neutrino Program

WA104

Overhauling of the ICARUS T600 and R&D on Liquid Argon Time Projection Chamber (LAr TPC)

ANNEXES

Annex 1:	List of the Sub-units (systems) and/or deliverables provided by participating institutes
Annex 2:	Organization and Management structure of the Collaboration and persons currently holding management positions
Annex 3:	List of Institutes, Funding Agencies and Representatives
Annex 4:	Value of deliverables, grouped by Funding Agency and/or sub-units (systems) and payment profile
Annex 5:	Project Milestones

The European Organization for Nuclear Research (CERN)

and

The INFN, on behalf of the WA104 Collaboration

declare that they agree on the Present Addendum to the Memorandum of Understanding for the overhauling of ICARUS T600 and R&D on Liquid Argon Time Projection Chamber (LAr TPC)

Done in Geneva

.....

for CERN

Sergio Bertolucci
Director of Research and
Scientific Computing .....

For the participating institutes

Institute / Funding Agency	Signatory
.....	.....
Place and Date	Signature
.....	.....

Summary

- CERN is providing the community with a Neutrino Platform to develop detectors, beams and components
- A new test area is under preparation
- CERN provides the community with technical support, logistics and expertise
- Any type of application is welcome
- Platform organized via an MOU system