JUNO

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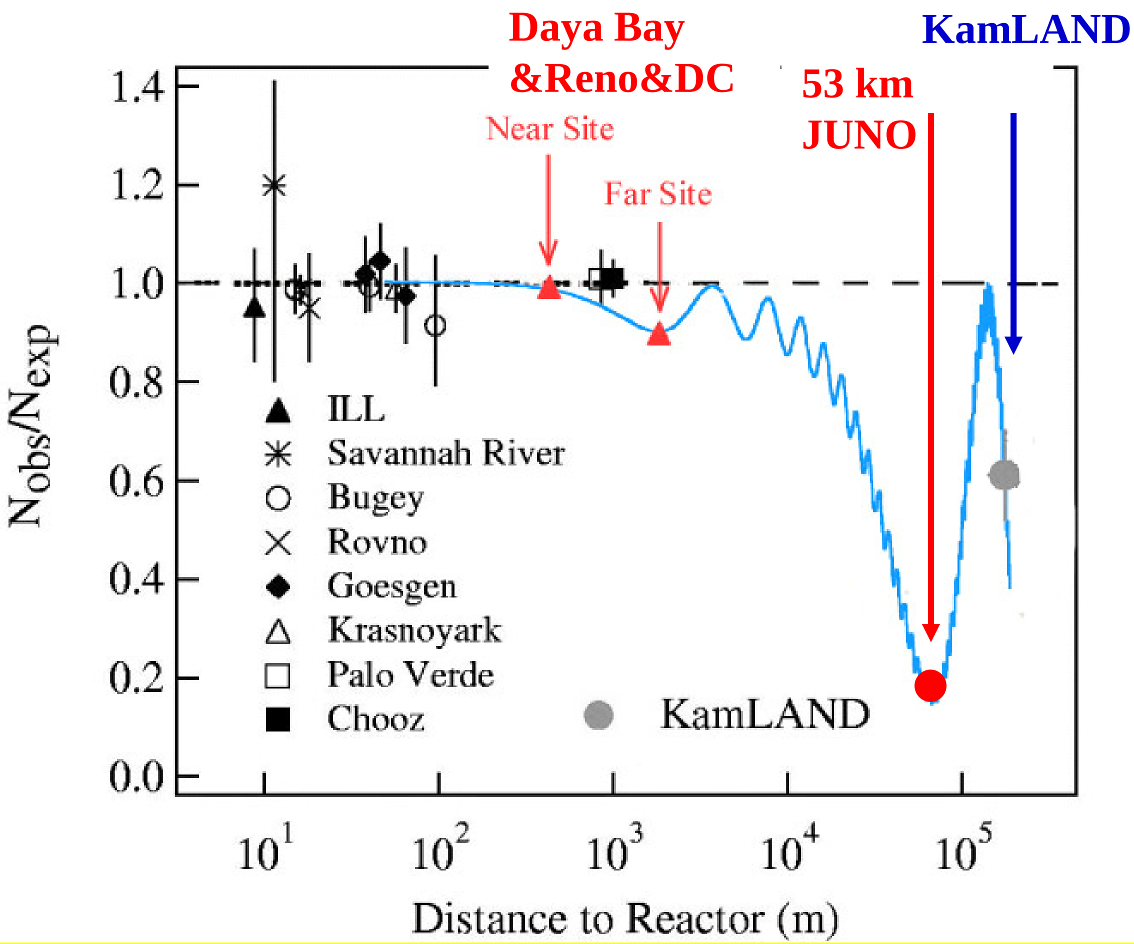
Consiglio di sezione INFN

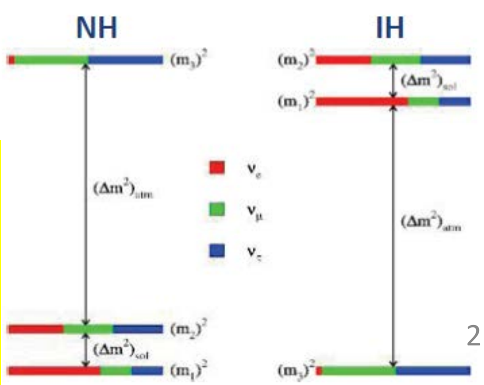
Milano, July 10 - 2018

- Determination of the neutrino mass hierarchy with a large mass liquid scintillation detector located at medium distance – 53 km – from a set of high power nuclear reactors
- Precise measurements of oscillation parameters
- Additional astroparticle program
- Requirements, technical features and status of the experiment

JUNO physics summary



- **20 kton LS detector**
- **~3 % energy resolution-the greatest challenge**
- Rich physics possibilities
  - ⇨ **Mass hierarchy**
  - ⇨ **Precision measurement of 3 mixing parameters**
  - ⇨ **Supernovae neutrino**
  - ⇨ **Geoneutrino**
  - ⇨ **Sterile neutrino**
  - ⇨ **Atmospheric neutrinos**
  - ⇨ **Nucleon Decay**
  - ⇨ **Exotic searches**



Neutrino Physics with JUNO, J. Phys. G 43, 030401 (2016)

The tension between the solar and KamLAND Δm^2 has further boosted the importance of the precision Δm^2_{21} measurement

A large LS spherical detector

– LS large volume: ➔ for statistics

– High Light(PE) ➔ for energy resolution 1200 pe/MeV

Steel Truss

Holding PMTs

~20000 x 20”

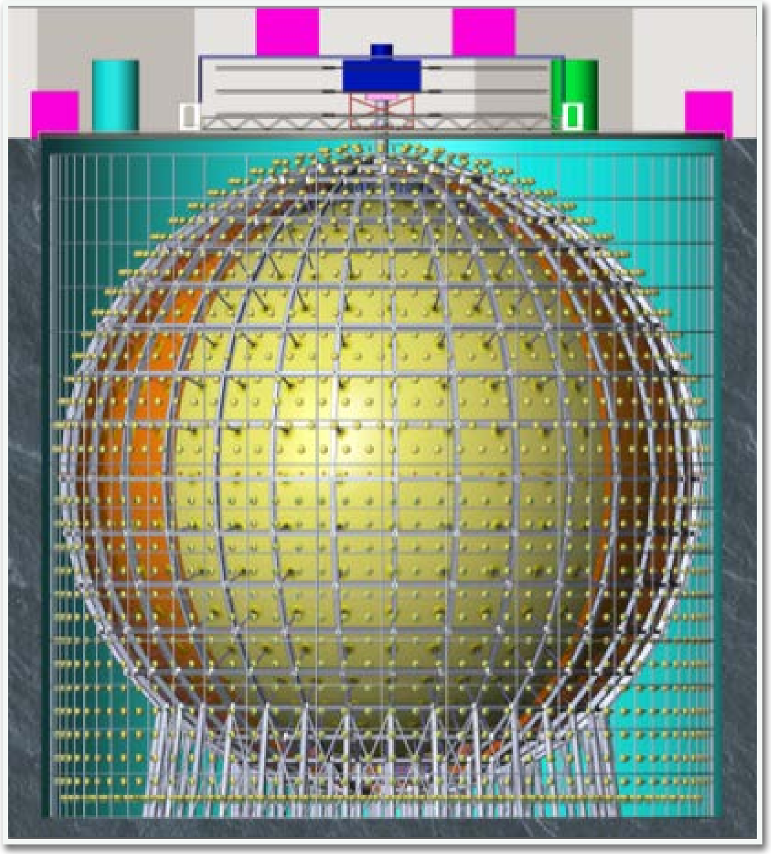
18000 Inner

2000 veto

~25000 x 3”

Acrylic Sphere

filled with 20 kt LS



JUNO has been approved in China in Feb. 2013

Prospective and approved funding from several other countries:

- **Belgium**
- **Czechia**
- **Finland**
- **France**
- **Germany**
- **Italy**
- **Russia**
- **Taiwan**
- **Chile**
- **Brasil**
- **Thailandia**
- **Pakistan**

Updated list of JUNO members

Country	Institute	Country	Institute	Country	Institute
Armenia	Yerevan Physics Institute	China	IMP-CAS	Germany	U. Mainz
Belgium	Université libre de Bruxelles	China	SYSU	Germany	U. Tuebingen
Brazil	PUC	China	Tsinghua U.	Italy	INFN Catania
Brazil	UEL	China	UCAS	Italy	INFN di Frascati
Chile	PCUC	China	USTC	Italy	INFN-Ferrara
Chile	UTFSM	China	U. of South China	Italy	INFN-Milano
China	BISEE	China	Wu Yi U.	Italy	INFN-Milano Bicocca
China	Beijing Normal U.	China	Wuhan U.	Italy	INFN-Padova
China	CAGS	China	Xi'an JT U.	Italy	INFN-Perugia
China	ChongQing University	China	Xiamen University	Italy	INFN-Roma 3
China	CIAE	China	NUDT	Latvia	IECS
China	DGUT	China	Zhengzhou University	Pakistan	PINSTECH (PAEC)
China	ECUST	Czech Rep.	Charles U.	Russia	INR Moscow
China	Guangxi U.	Finland	University of Jyvaskyla	Russia	JINR
China	Harbin Institute of Technology	France	APC Paris	Russia	MSU
China	IHEP	France	CENBG	Slovakia	FMPICU
China	Jilin U.	France	CPPM Marseille	Taiwan	National Chiao-Tung U.
China	Jinan U.	France	IPHC Strasbourg	Taiwan	National Taiwan U.
China	Nanjing U.	France	Subatech Nantes	Taiwan	National United U.
China	Nankai U.	Germany	Forschungszentrum Julich ZEA2	Thailand	NARIT
China	NCEPU	Germany	RWTH Aachen U.	Thailand	PPRLCU
China	Pekin U.	Germany	TUM	Thailand	SUT
China	Shandong U.	Germany	U. Hamburg	USA	UMD1
China	Shanghai JT U.	Germany	IKP FZJ	USA	UMD2

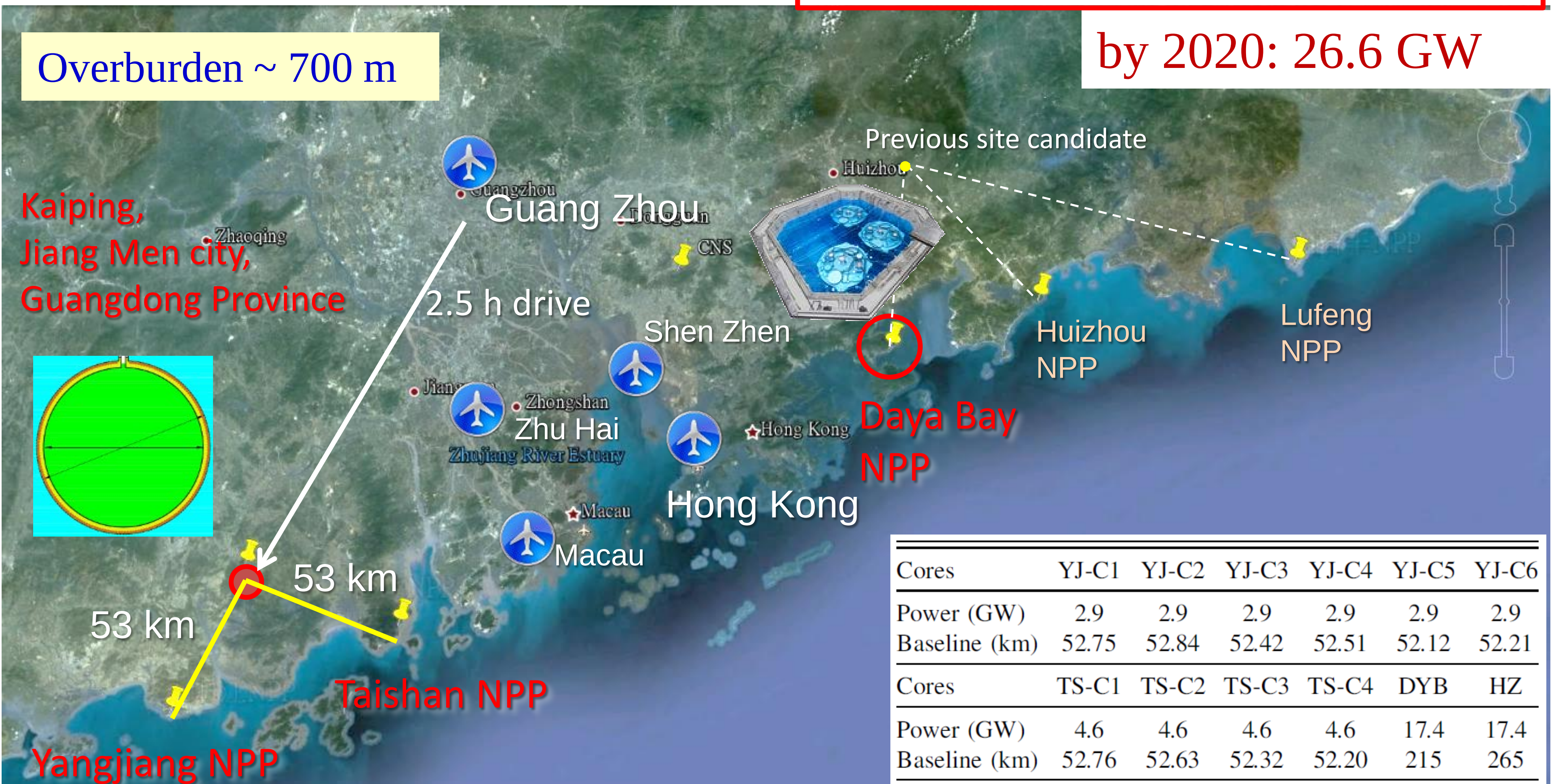
= 72 member Institutions

5 Observers

Location of JUNO

NPP	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operational	Planned	Planned	Under construction	Under construction
Power	17.4 GW	17.4 GW	17.4 GW	17.4 GW	18.4 GW

by 2020: 26.6 GW



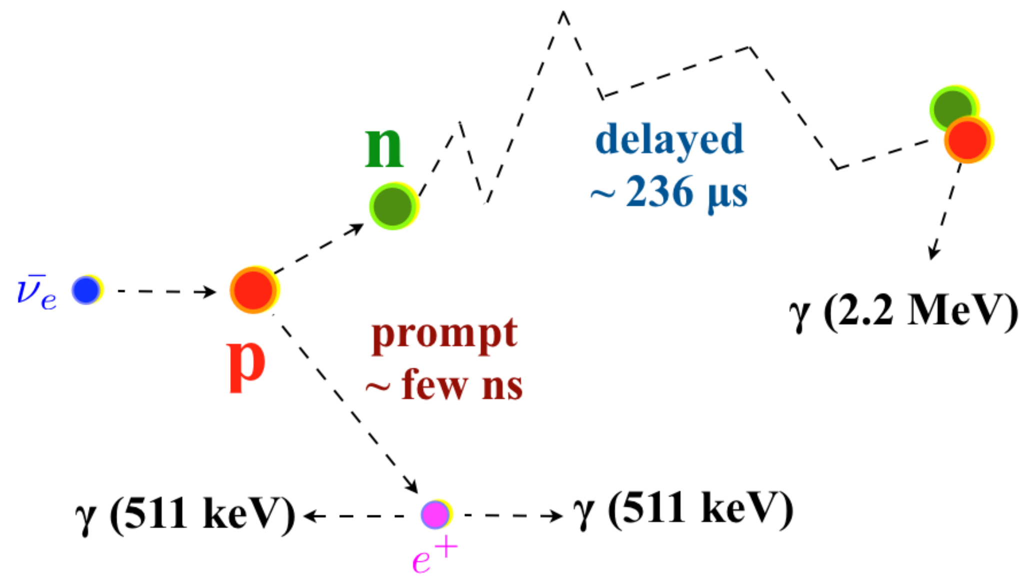
Cores	YJ-C1	YJ-C2	YJ-C3	YJ-C4	YJ-C5	YJ-C6
Power (GW)	2.9	2.9	2.9	2.9	2.9	2.9
Baseline (km)	52.75	52.84	52.42	52.51	52.12	52.21
Cores	TS-C1	TS-C2	TS-C3	TS-C4	DYB	HZ
Power (GW)	4.6	4.6	4.6	4.6	17.4	17.4
Baseline (km)	52.76	52.63	52.32	52.20	215	265

Approach to infer the Mass Hierarchy

The determination of the mass hierarchy relies on the identification on the positron spectrum of the "imprinting" of the anti-ν_e survival probability

Detection through the classical inverse beta decay reaction

$$\overline{\nu} + p \rightarrow n + e^{+}$$ E_ν>1.8 MeV



The time coincidence between the positron and the γ from the capture rejects the uncorrelated background

The "observable" for the mass hierarchy determination is the positron spectrum
It results that $E_{vis}(e^+)=E(\nu)-0.8$ MeV

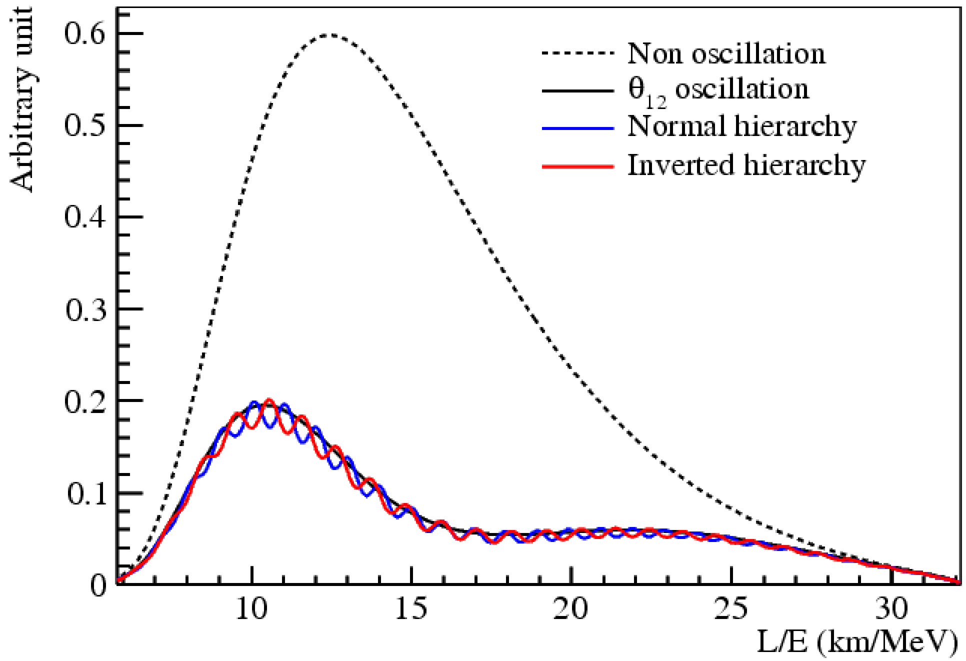
Method from Petcov and Piai, Physics Letters B 553, 94-106 (2002)

MH and Survival probability

arXiv 1210.8141

$$P_{ee} = \left| \sum_{i=1}^{3} U_{ei} \exp\left(-i\frac{m_i^2}{2E_i}\right) U_{ei}^* \right|^2$$
$$= 1 - \cos^4\theta_{13}\sin^2 2\theta_{12}\sin^2(\Delta_{21})$$
$$- \cos^2\theta_{12}\sin^2 2\theta_{13}\sin^2(\Delta_{31})$$
$$- \sin^2\theta_{12}\sin^2 2\theta_{13}\sin^2(\Delta_{32})$$

$$\Delta_{ij} \equiv \frac{\Delta m_{ij}^2 L}{4E_\nu}, \quad (\Delta m_{ij}^2 \equiv m_i^2 - m_j^2)$$



Or to make the effect of the mass hierarchy explicit, exploiting the approximation $\Delta m^2_{32} \approx \Delta m^2_{31}$:

$$P_{ee} = 1 - \cos^4\theta_{13}\sin^2 2\theta_{12}\sin^2(\Delta_{21})$$
$$- \sin^2 2\theta_{13}\sin^2(|\Delta_{31}|)$$
$$- \sin^2\theta_{12}\sin^2 2\theta_{13}\sin^2(\Delta_{21})\cos(2|\Delta_{31}|)$$
$$\pm \frac{\sin^2\theta_{12}}{2}\sin^2 2\theta_{13}\sin(2\Delta_{21})\sin(2|\Delta_{31}|),$$

+ NH
- IH

The big suppression is the "solar" oscillation → Δm^2_{21} , $\sin^2\theta_{12}$
The ripple is the "atmospheric" oscillation → Δm^2_{31} from frequency
MH encoded in the phase
"high" value of θ_{13} crucial

Key elements of the INFN participation in JUNO

Solid scientific and technical expertise

Scientific continuity $\rightarrow$ Neutrino oscillation studies and astroparticle investigations in JUNO natural evolution of the INFN activities in both fields and will be strategic to maintain at top level the INFN participation to these areas of particle research

Technological continuity $\rightarrow$ broad expertise acquired in the course of several previous scientific programs in many areas, e.g. scintillator optical properties and purification, electronics, low background techniques, analysis and MC methods, geoneutrino detection; all are profitably reused within the JUNO project

Specific assets from Gran Sasso to Jiangmen $\rightarrow$ capitalization and transfer to JUNO of the scintillator purification experience and competence acquired with Borexino and reuse of the OPERA plastic scintillator tracker for the JUNO top muon tracker

Strong partnership with the Chinese group

Effective intra-European links

History and INFN group composition

2 years of participation to the proto-collaboration since 2012
Italian component formally established in June 2014
Group now well consolidated
Approval by INFN Committee II on September 2014
Approval by CTS (Scientific and Technical Council) on December 2015
MoU Approved by INFN Council on February 2017 and signed by the President

Eight INFN sections	Previous experiences
Catania	Auger
Ferrara	Borexino
Frascati	Opera
Milano	Borexino, DarkSide
Milano Bicocca	Cuore
Padova	Gerda, Opera, Icarus
Perugia	Borexino, DarkSide
Roma3	Argo, DarkSide

Several groups are deeply connected with Gran Sasso, Roma3 with previous vast experience in China for Argo and well established cooperation of Catania with IHEP on computing projects

Areas of activity of the individual INFN sections

Each group has defined its own commitments

Eight INFN sections	Areas of activity within JUNO
Catania	Computing, PMT testing
Ferrara	Physics&software, geoneutrino , scint. purification
Frascati	Electronics for the top tracker
Milano	Scintillator purification and optical properties, physics&software
Milano Bicocca	Low background techniques for material assay, reactor studies
Padova	Electronics of the CD, also for the small PMTs, physics&software
Perugia	Scintillator optical properties and lab. scale purification tests
Roma3	physics&software, computing, trigger

New option : interest to the possible near detector realized with scintillator and SiPM

Participation to the management structure: L2 – L3 managers

L2
GR Liquid scintillator

Alberto Garfagnini – Electronics GCU

L3
Alessandro Paoloni Veto - TT electronics (including DAQ software?) and slow control

Paolo Lombardi – Liquid scintillator Distillation and stripping units

Michele Montuschi - Liquid scintillator DCS

Monica Sisti – Background coordinator

Giuseppe Salamanna – Data production and validation

1 member in the EB GR
1 member in the publication committee Alberto Garfagnini
1 member in the technical board Paolo Lombardi

GR deputy spokesperson/deputy project manager

The European framework

All our commitments are characterized by a strong cooperative link with the Chinese groups and the European groups

In particular in the European context:

- ✓ Scintillator studies done in cooperation with Munich, Mainz, Jyvaskyla and Russian groups (Dubna, INR Moscow)
- ✓ Electronics for Central detector in cooperation with Brussels and Dubna
- ✓ Top tracker in cooperation with Paris, Strasbourg and Dubna
- ✓ Radioactivity test carried out in coordination with French groups
- ✓ Active a European physics&software group
- ✓ INFN Coordination of the available European Computing infrastructures - CNAF prominent role in Europe

The concept underlying all our efforts: fully integrated activities at Collaboration level since the beginning of the design phase

Frequent working groups meetings at European level together with the Chinese collaborators, as well as group meetings in China - **scintillator working group in Baikal in September, and electronics working group in Brussels in May – European meetings as well -> next in Finland in October**

Purification program of the liquid scintillator
Main effort of the Milano group

Timeline

a) From the general concepts put forwards in 2013/2014

b) Through a concrete plan of a pilot system to be tested at Daya Bay formulated in 2015

c) Through the installation of the Daya Bay pilot plants in 2016

d) To the execution of the first full test in February/March 2017

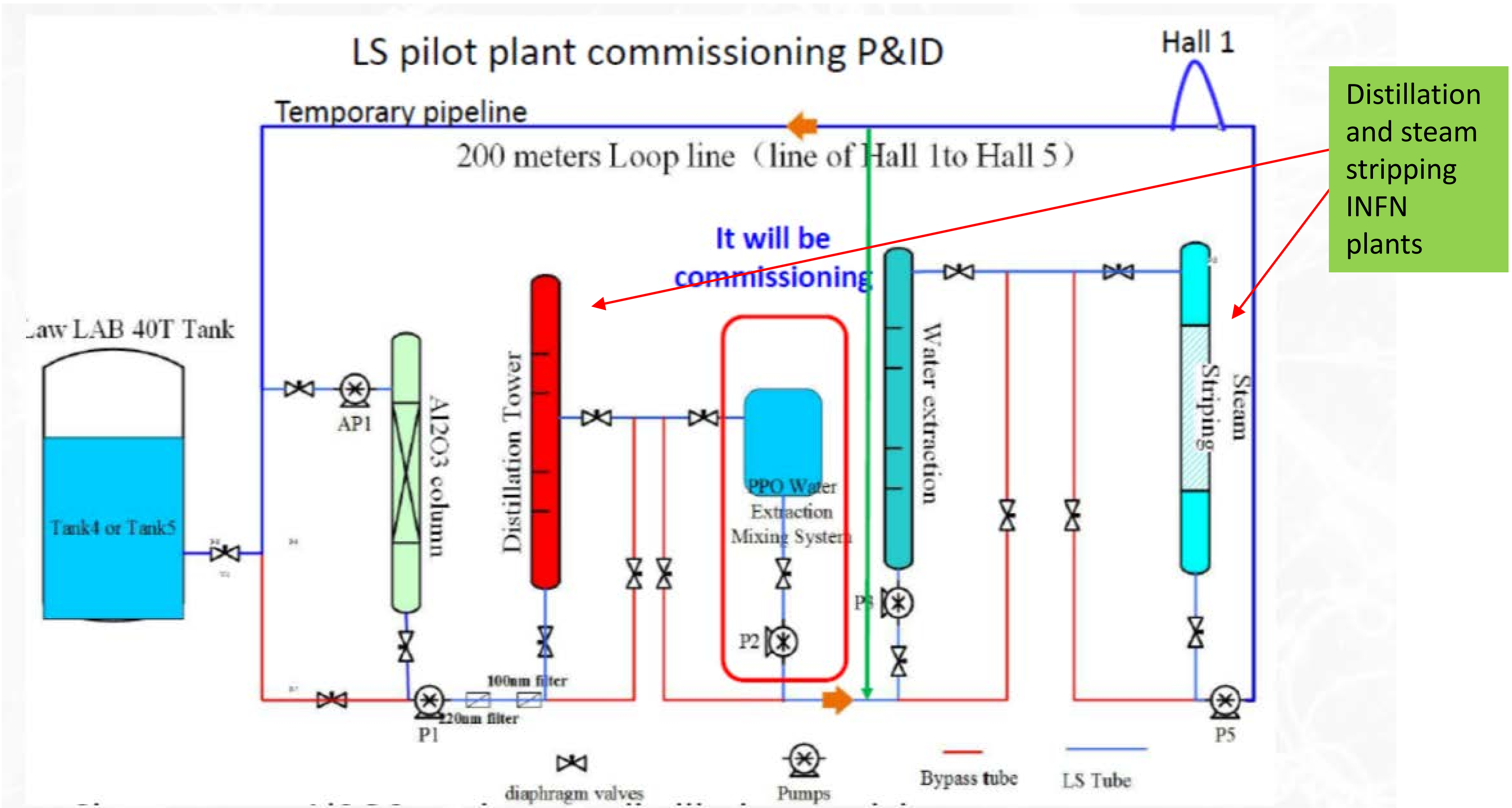
e) And execution of the stripping radon removal test in November 2017

Very good results on attenuation length (order 25÷30 m), on radon removal efficiency, and preliminary indications for bulk radioactivity

This effort and its output is guiding the design of the JUNO large scale plants – **INFN tender for distillation and stripping units done**

Italian Producer who won the tender for the pilot plants and for the final JUNO distillation and stripping units

Design in progress with continuous feedback from our side
Planned beginning of the construction at the Company site in the Fall


LS pilot plant commissioning P&ID
Hall 1
Temporary pipeline
200 meters Loop line (line of Hall 1to Hall 5)
It will be commissioning
Distillation and steam stripping INFN plants
Law LAB 40T Tank
Tank4 or Tank5
AP1
Al2O3 column
Distillation Tower
PPO Water Extraction Mixing System
Water extraction
Steam Striping
P1
P2
P5
100nm filter
220nm filter
diaphragm valves
Pumps
Bypass tube
LS Tube

Operations @ Day Bay site – Installation and commissioning 2016

- Distillation plant arrived at Daya Bay at the end of March 2016 while the Steam Stripping plant was installed on April 22nd. 2016
- in the past year we commissioned both plant distilling and stripping with more than 4000 l
- resolution of critical issues found on commissioning and loop test with all the plants

Attenuation Length in the range of 25-30 m @ 430 nm

Operations @ Day Bay site – Fill of one detector Feb/March 2017

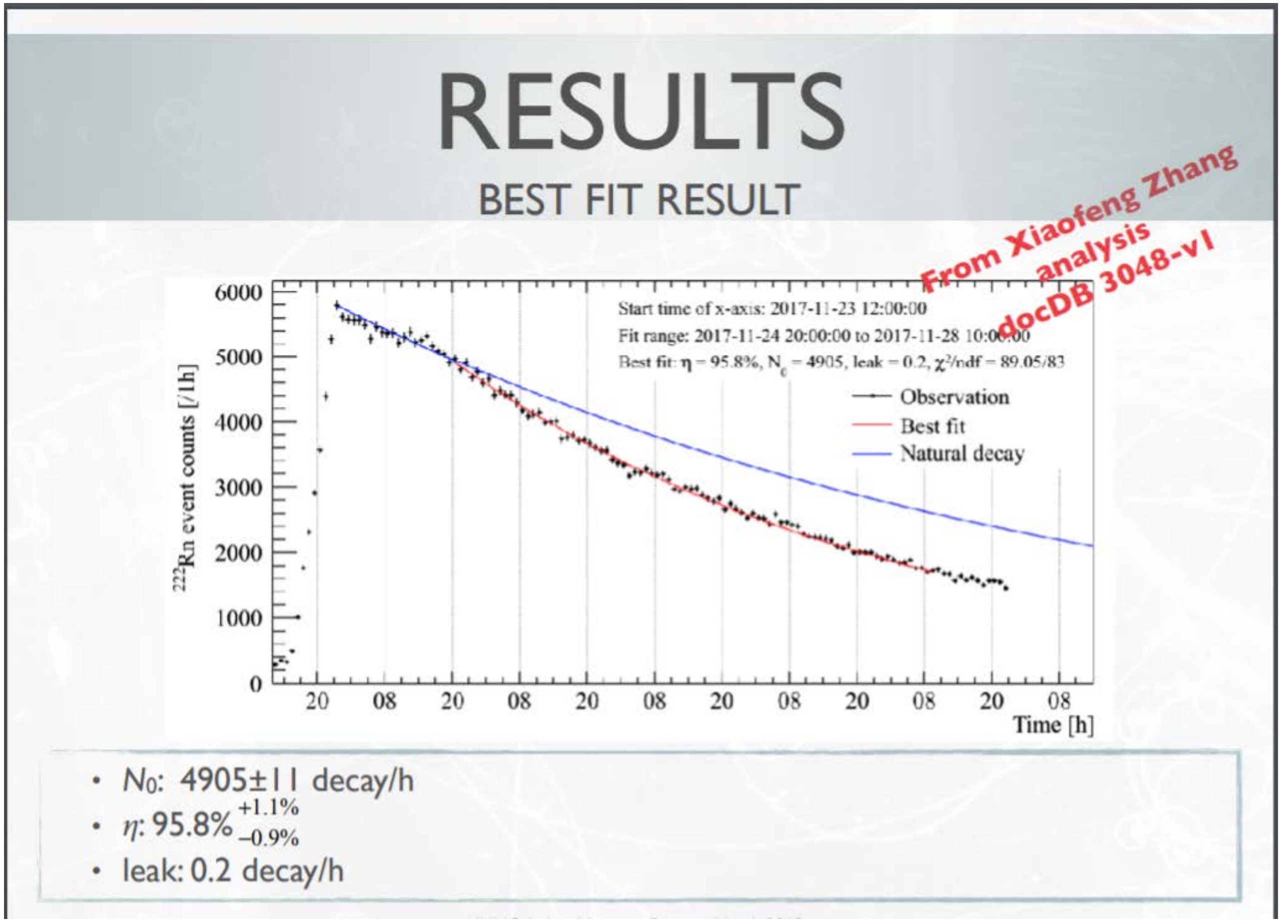
- from 18/02 to 21/02: start up of the plants and training of new operators
- 22/02
  - start 24-hours shifts in loop mode
  - Analysis of the Absorption spectra to check the quality of the LAB exiting from each subsystems
- 23/02: beginning of the filling at a flow rate of 95 l/h
- 24/02: stop the filling for a couple of hours to check the light yield of the LAB with a calibration source in the A.D.
- 26/02
  - new Quality check measuring the Absorption Spectra of the LAB exiting each subsystems
  - Stop filling for 3 hours to collect some distilled LAB for the Master Solution Preparation
- 27/02
  - Start the Water Extraction of the Master Solution
  - Added 300 l more distilled LAB to the Master Solution
- 28/02: Start adding Master Solution in the LAB input stream of the Water Extraction Water Plant. the desired concentration of PPO is 0.5 g/l
- 04/03: Burned a pump in the Water extraction plant, to be substituted.
- 06/03:
  - 8:00 am end of the filling.
  - Data taking started.
  - Calibration with the source (LY=105 pe/Mev)
- 07/03
  - pump substitution (in output of steam stripping plant)
  - scintillator mixing

European participation to this effort
Jyvaskyla
Munich
Mainz
In addition to
Ferrara
Milano

Fundamental cooperation with the Chinese group

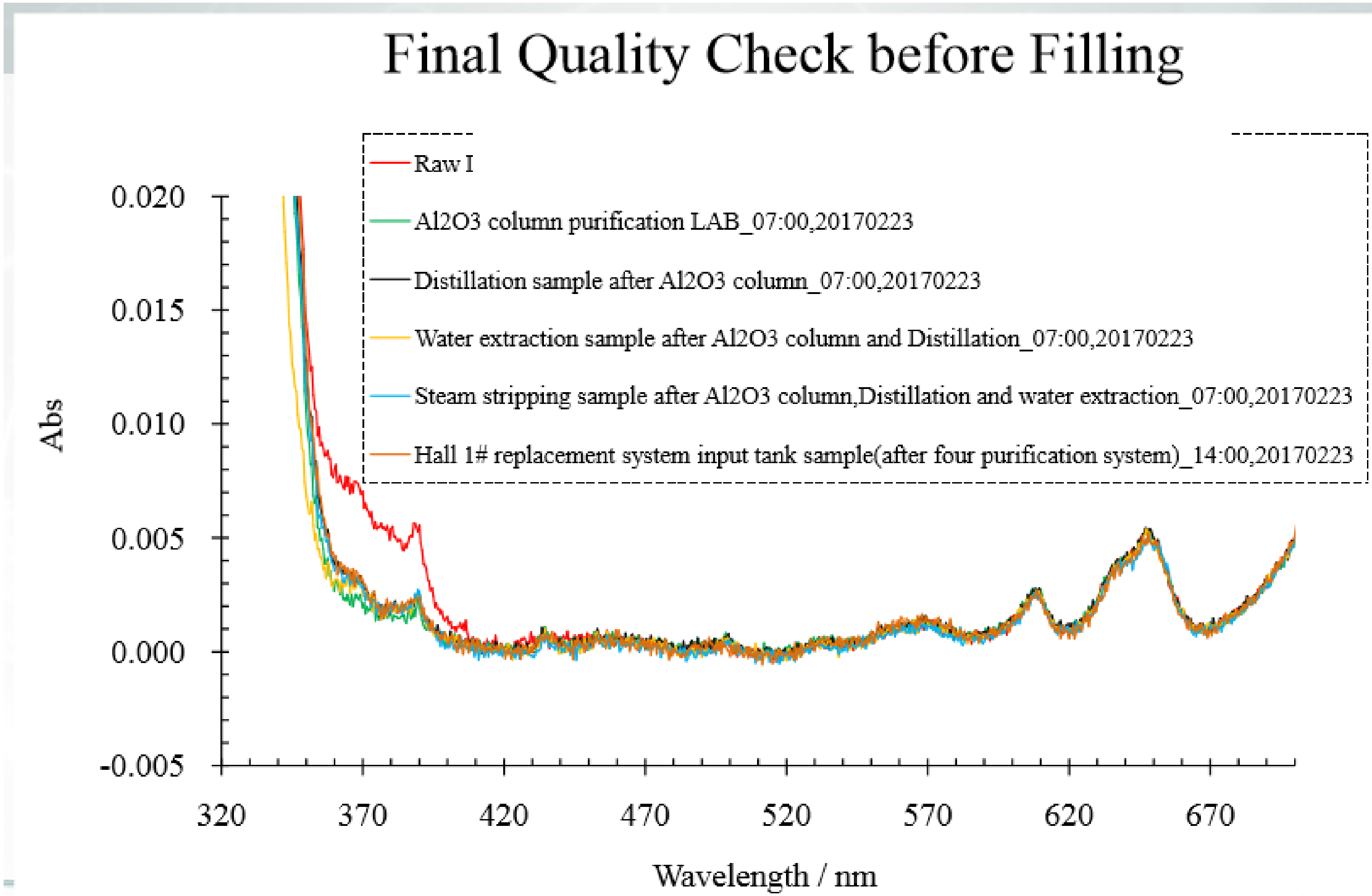
Stripping test for Radon removal efficiency – November 2017

1. **Blank test** (without stripping) to check the amount of ^{222}Rn added during the recirculation
2. **Tested** if the Stripping Pilot Plant **introduce** ^{222}**Rn** in the liquid scintillator during the operations
3. **Added ^{222}Rn in the Liquid Scintillator** using water with an high content of ^{222}Rn in the water extraction plant
4. Processed 10498 l of the Liquid Scintillator at a flow rate of 113 l/h on average with the **Stripping Pilot Plant** using a 1,5 Nm^3/h N_2 flow



Efficiency of Radon removal determined to be about 96%
Very promising indication from the pilot plant

Absorbance



Good global effectiveness of the adopted methods

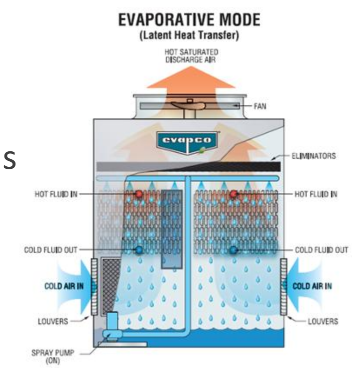
Attenuation length ok

Re-commissioning of the plants in the Fall
Further distillation test next year

Distillation Plant

Distillation plant:

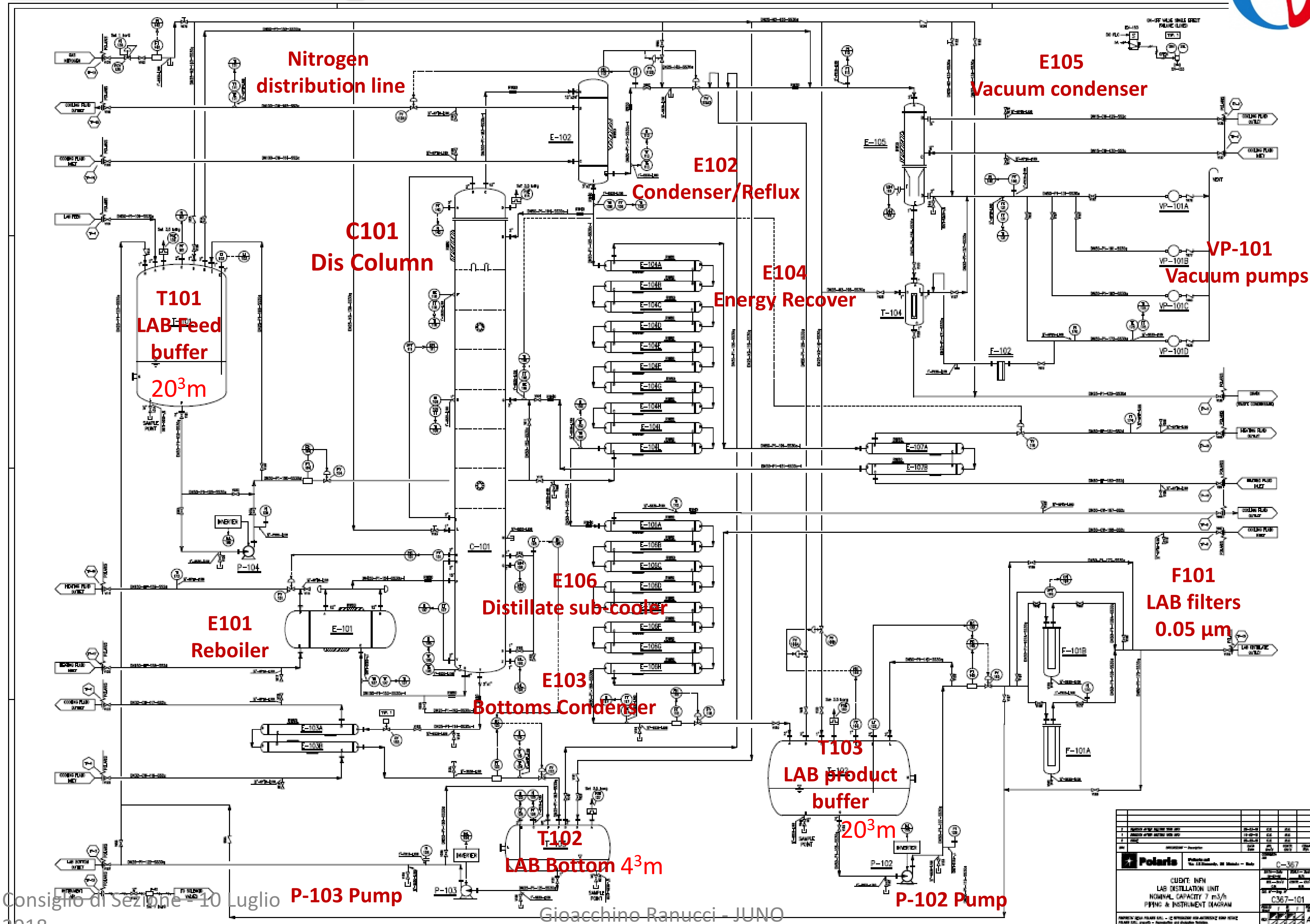
1. Flow rate 7000 l/h
2. Distillation under vacuum with sieve trays without downcomers
3. 6 physical trays (with 8 as an option)
4. 1-2% bottom column discharge (sent back to Alumina column?)
5. High adjustable reflux rate (up to 40%)
6. Filtration up to 0.05 microns
7. Parallelization and spare parts on shelf to minimize filling dead time
8. Heat exchanger energy recovery
9. Nominal Electrical Power ~ 1000 kW (plants + heating) [1250 Kw available]
10. Cooling water ~ 1000 kW (thermal power) ~ 350 kW electrical power or less if evaporative cooling tower)
11. Hot Oil system (electrical)
12. All the plant is kept under continues nitrogen blanket either to avoid oxidation/contamination but also for safety reason (LAB temperature > flash point only inside the distillation column)
13. Vapor condenser before nitrogen exhaust for safety (avoid LAB vapor exhausting)
14. Rupture disks for pressure safety (plant certified up to 3.5 bar PED an SELO Norm.)
15. Single leak rate < 10^{-6} mbar L / s
16. Integral leak rate < 10^{-8} mbar L / s



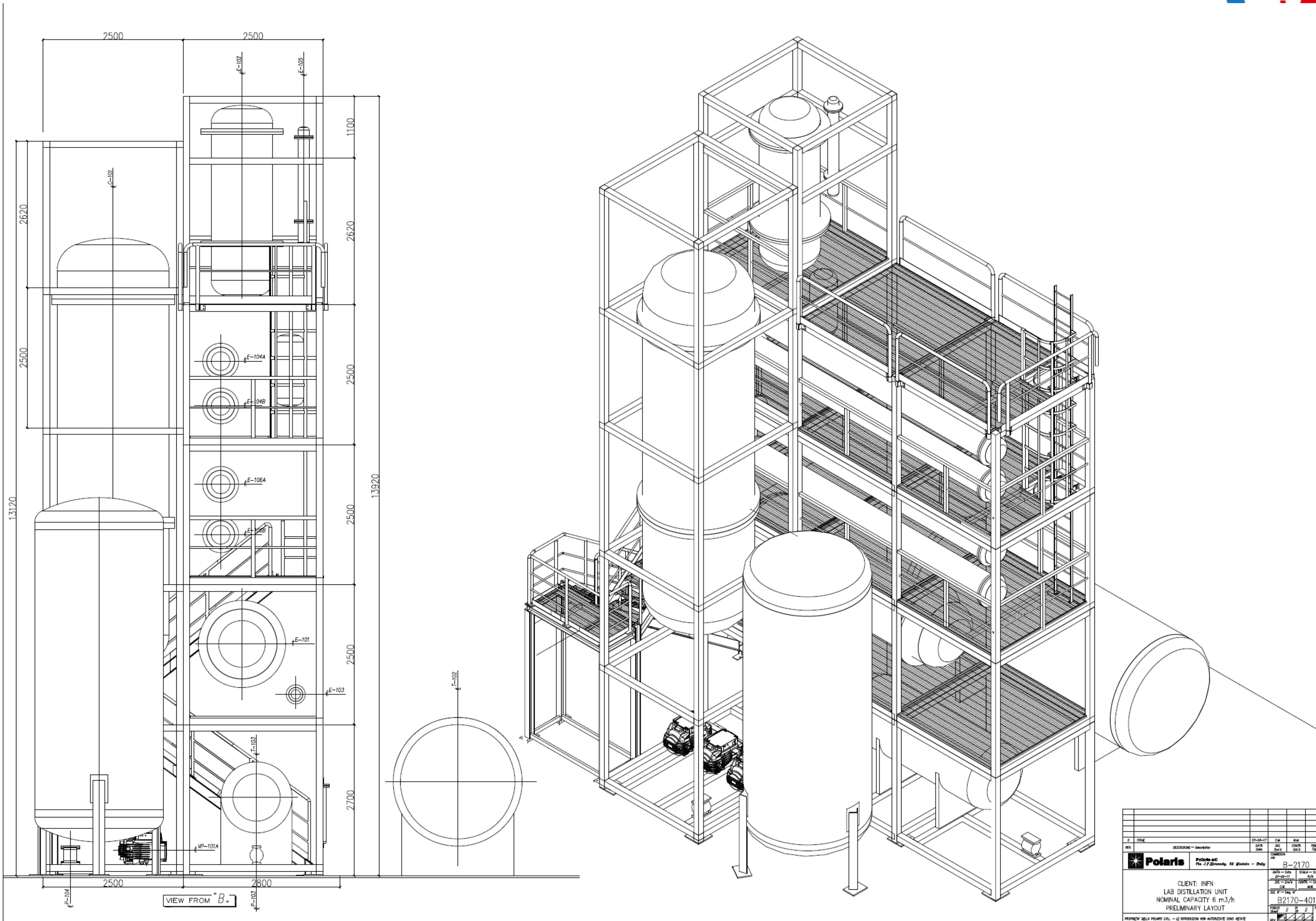
Process parameters

	High [m]	*Diameter [mm]*	*N° Trays*	*Pressure [mbar]*	*Temperature [°C]*	*Scint. Flux [l/h]*	*Scint. Reflux [l/h]*	*Max Gas flow [kg/h]*
Distillation	***4.0***	***2000***	***6***	***10***	***200***	***7000***	***2000***	***50***

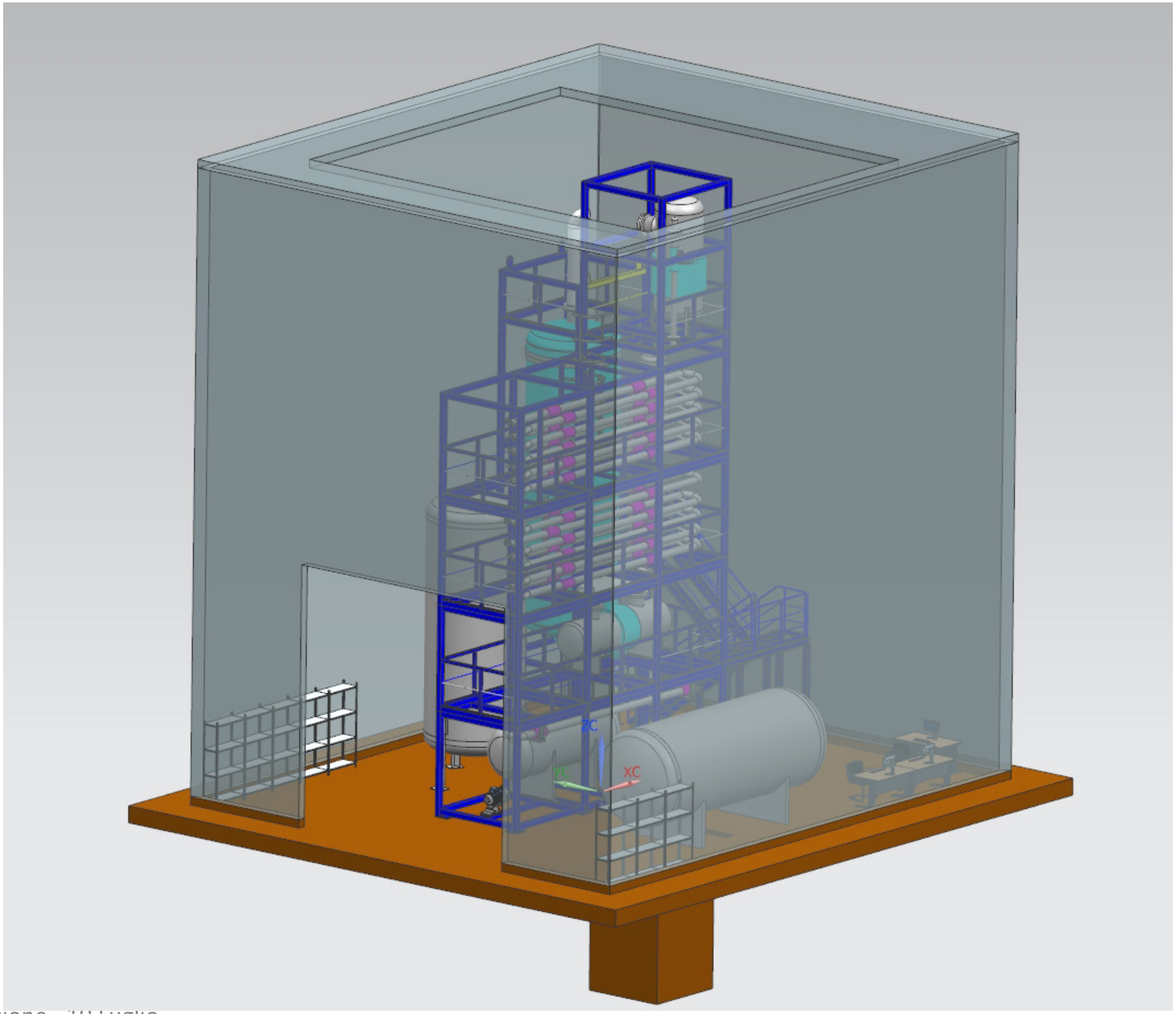
Distillation plant P&Ids:



Skids dist. layout:



Distillation skids layout:



Steam Stripping Plant

Steam Stripping plant:

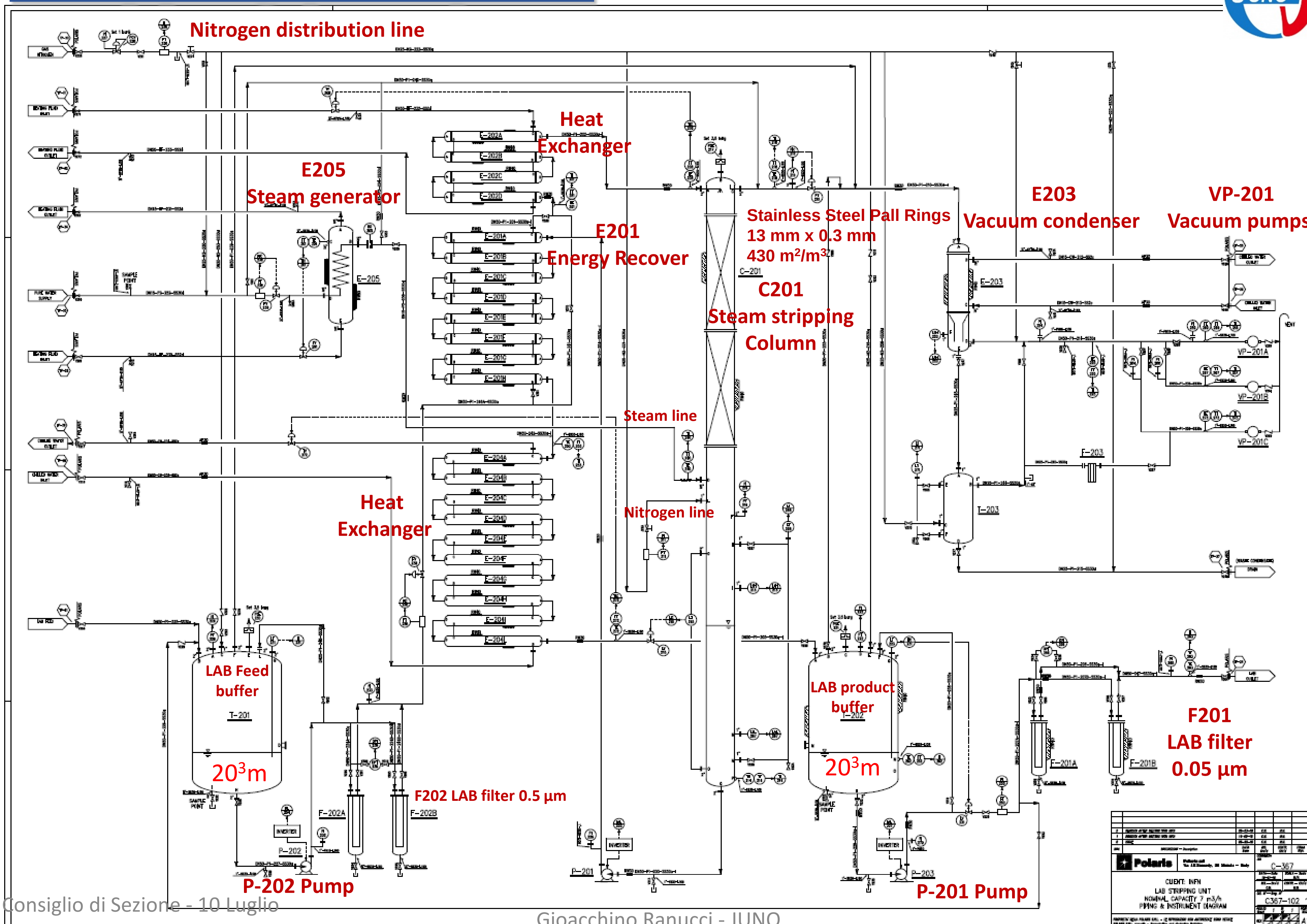
Stripping plant will be based on the “steam stripping” technique to remove the impurities that are more volatile than LAB: Ar, Kr and Rn. Water steam to avoid to use huge quantity of nitrogen in underground (safety). Stripping is carried out with counter-current flow of the liquid LAB and water super heated steam and/or nitrogen with unstructured packing.

1. Flow rate 7000 l/h
2. High temperature (90 °C) for higher column efficiency
3. Partial vacuum (around 300 mbar)
4. Both steam and nitrogen stripping could be tested in the plant
5. Filtration up to 0.05 microns
6. Parallelization and spare parts on shelf to minimize filling dead time
7. Nominal Electrical Power~ 200 kW (plants + Hot Oil)
8. Cooling Power~ 200 kW (thermal power ~ 100 kW electrical power)
9. Pure water from water plant (approx. 25 l/h)
10. Hot Oil system (electrical)
11. All the plant is kept under continues nitrogen blanket either to avoid oxidation/contamination
12. Vapor condenser before water vapor/nitrogen exhaust for safety
13. Rupture disks for pressure safety (plant certified up to 3.5 bar PED an SELO Norm.)
14. Single leak rate < 10^{-6} mbar L / s
15. Integral leak rate < 10^{-8} mbar L / s

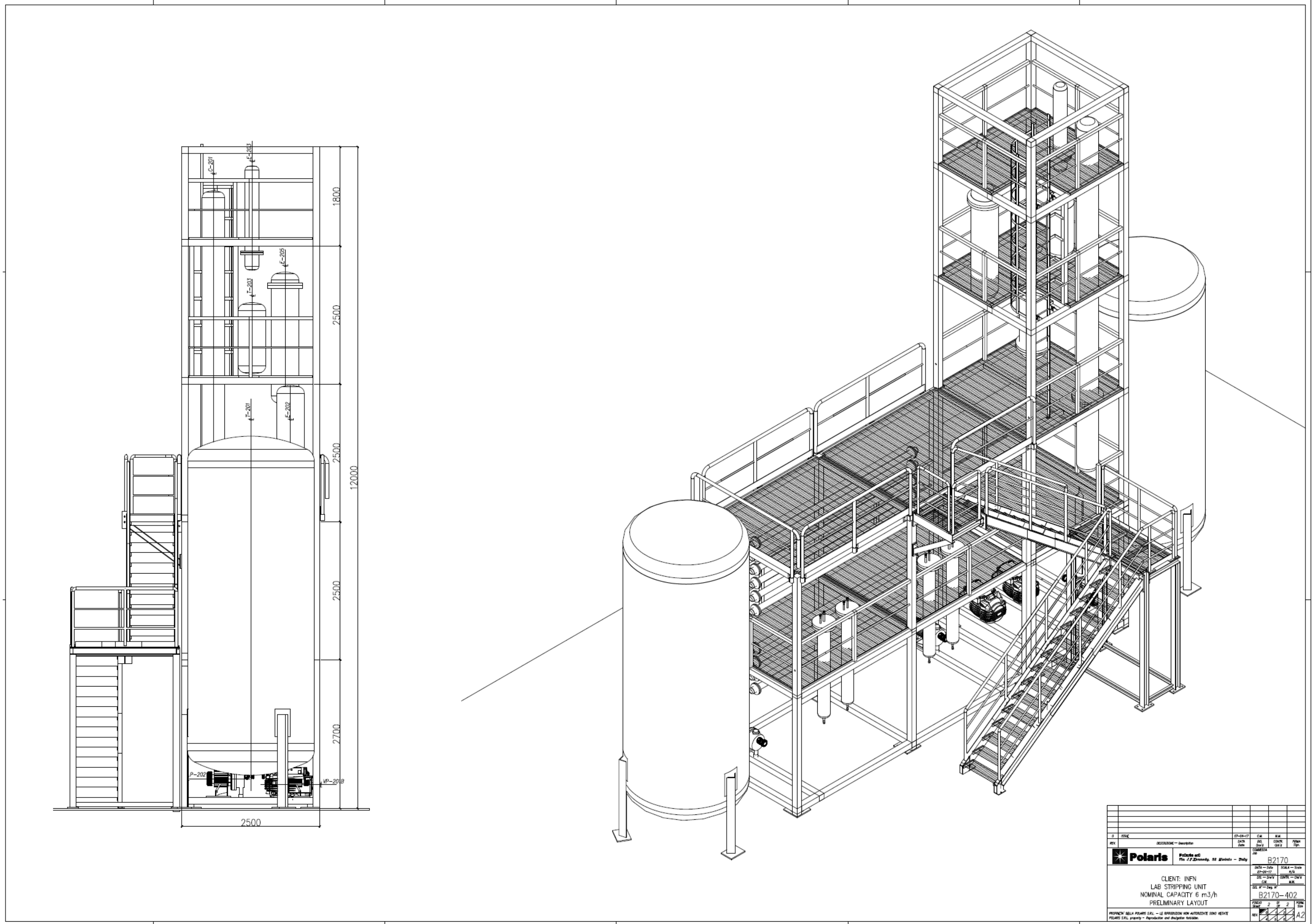
Process parameters

	High [m]	Diameter [mm]	N° Trays	Pressure [mbar]	Temperature [°C]	Scint. Flux [l/h]	Steam Flux [kg/h]	Gas flow [kg/h]
Stripping	6.0	450	Unstructured packing	300	90	7000	25	60

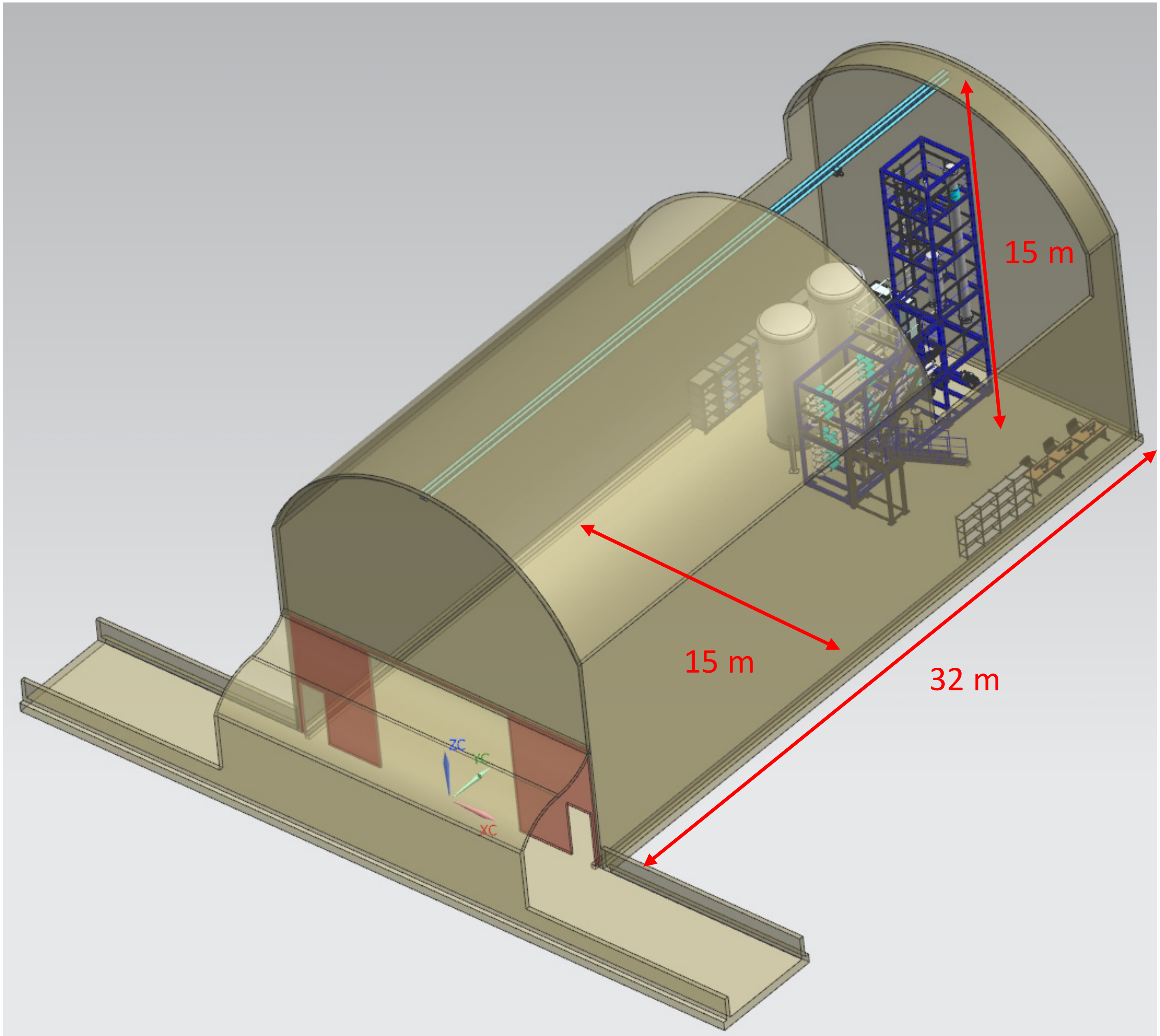
Stripping pilot plant:



Skids strip. layout:



Skids strip. Layout:



Plants: skids size and weight

DISTILLATION SKID			
Skid	Dimensions [mm]	Weight empty [kg]	Weight full (water) [kg]
1	2400x2500x7500	5000	11000
2	2400x2500x7500	9500	11500
3	2400x2500x7500	8500	9500
4	2400x2500x7500	7200	8000
5	2400x2500x4000	4600	6900
6	2400x2500x11500	11500	45600
Tank T-101	2400x2800x7000	5000	26000
Tank T-102	2400x2500x8000	5000	26000
Ladder	5000x3000x5000	2500	2500
TOT		**58800**	**147000**
STRIPPING SKID			
Skid	Dimensions [mm]	Weight empty [kg]	Weight full (water) [kg]
1	2500x2400x8500	6000	7000
2	2500x2400x6000	7000	7500
3	2500x2400x9000	5000	7500
Tank T-201	2400x2500x8000	5000	26000
Tank T-202	2400x2500x8000	5000	26000
Ladder	5000x2000x5000	2500	2500
TOT		**30500**	**76500**

Schedule: Milestones

Nov 2017:

Start of the final design with Polaris company

August 2018:

Design frozen and beginning of plants construction

Jan – Apr 2020:

Plants shipping to Jiangmen & installation of plants at site (distillation first)

Sep 2020:

Long term plants commissioning (8 month)

May 2021:

Plants ready for operations

Man Power:

Big manpower requirement during commissioningng and fill of the detector

To face the manpower issue, we will ask the plants company to perform all the installation and Factory Acceptance Tests (FAT) directly onsite.

The company will also provide manpower during the commissioning phase.

During the operational phase the manpower estimation is:

- 8 Task Managers (6 + 2 for a day shift rest)
- 8 Operators (6 + 2 for a day shift rest)
- 2 Chinese mechanical technician on call (external utilities maintenance)

16 people every 3 wks

HAZOP: HAZard and OPerability analysis

Distillation and Stripping Plants HAZOP was done on two days meeting at Polaris company from June 26th to 27th. The Hazop International Team was compose by:

- 4 Polaris Engineers (Chemical, Mechanical, Electronic)
- 2 INFN Engineers (Paolo and Michele)
- 2 SNOLAB Engineers (Paul Larochelle Operations Eng. and Allan Barr Chemical Eng.)

Plants and auxiliary systems have been divided in several process nodes and for each one a careful discussion on process parameters and deviation was discussed, analyzed and finally reported in a HAZOP table.

Laboratory tests @ Mi

In Milano we have a general purpose laboratory for scintillator and PMTs characterization.

Measurements capability:

1. PMT: S.e.r, TTS, After Pulses, linearity…
2. Scintillator:
   - Photon decay time profile apparatus (Single photoelectron technique)
   - Charge measurement apparatus (relative light yield, linearity, spectroscopy, etc…)
   - **Set-up to determine the Scintillator non linearity**
   - **SALA: (Scintillator Attenuation Length Apparatus)**
   - **Spectrophotometer**

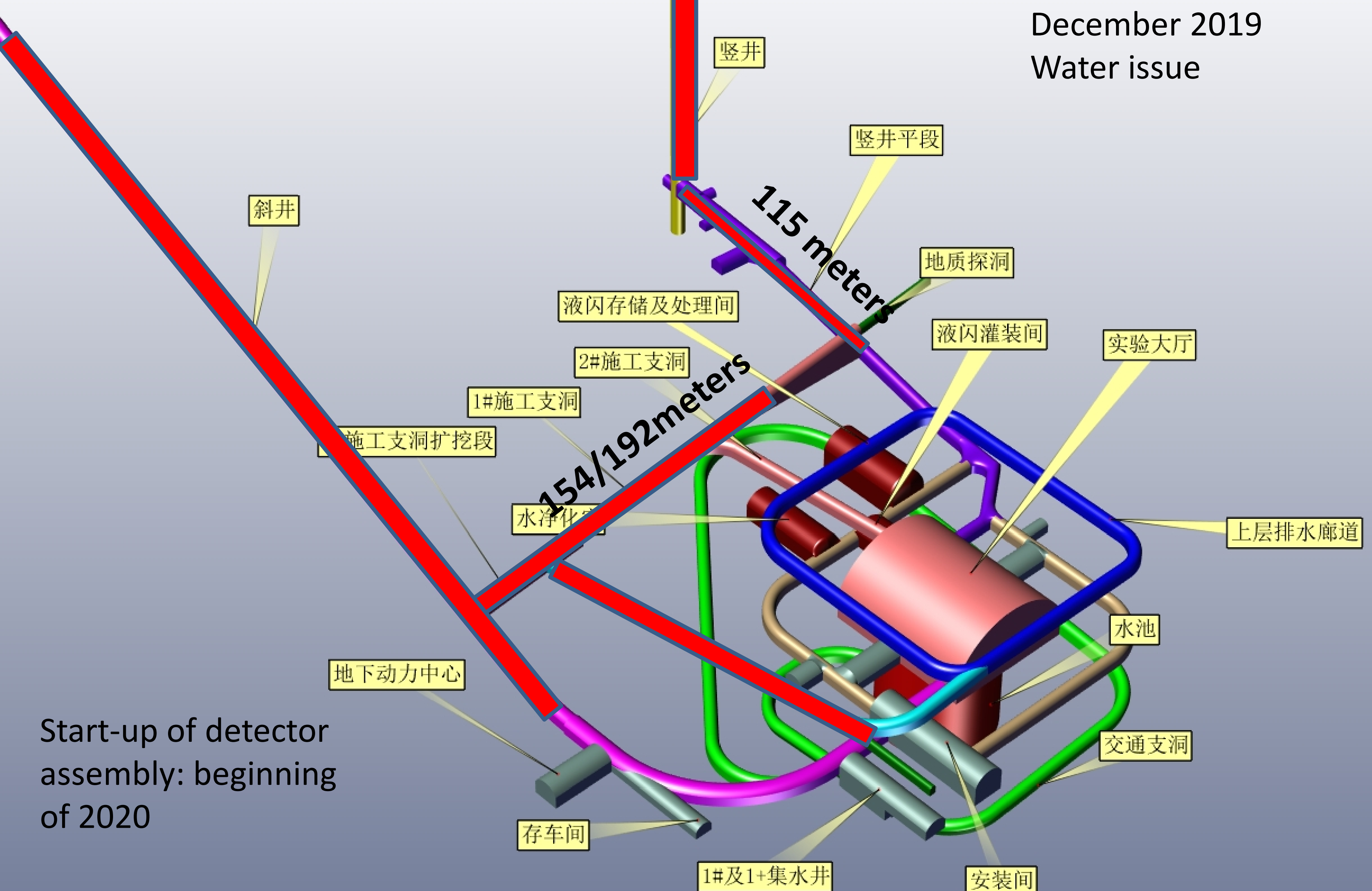
Systems realized/purchased for JUNO

Software&MC &other studies@ Mi

Solar Neutrino studies, MH determination, High energy atmospheric neutrinos and signal of Lorentz invariance violation

Civil status

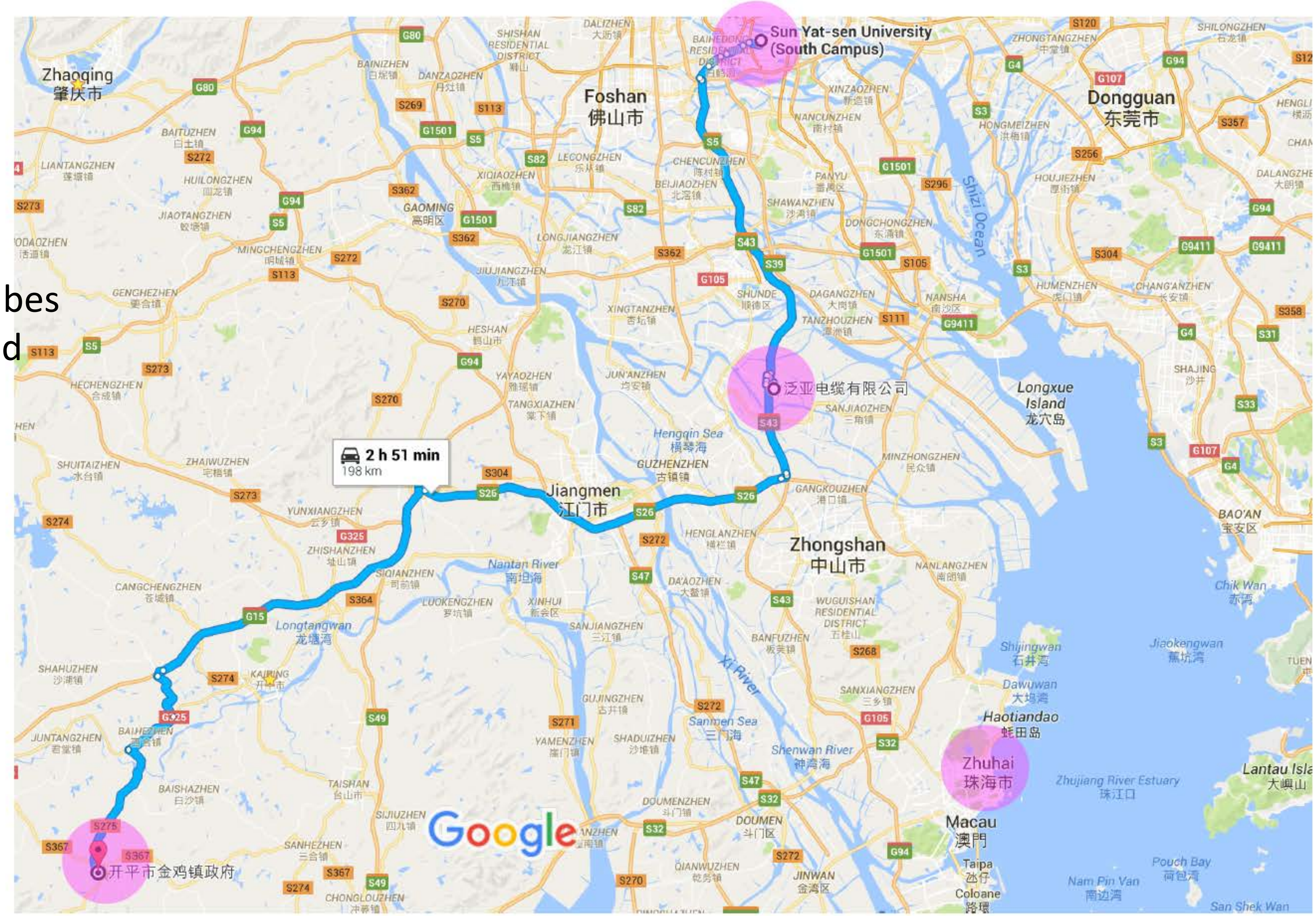
Completion planned for
December 2019
Water issue



Start-up of detector assembly: beginning of 2020

Storage/Testing Places: Pan-Asia in Zhongshan

40% of phototubes delivered



Map data ©2016 Google 10 mi

Toward the construction of the core infrastructure

- Detector structure design completed with a number of reviews
  - Earthquake fully understood
  - Interface to civil defined
  - Other technical details
- Assembly & Installation process defined after a lot of discussions with manufacturing & installation companies
- Identified 5 different construction packages
  - Acrylic Vessel
  - Supporting platform & lifting structure for Acrylic tank construction
  - Stainless steel structure manufacturing and assembly
  - VETO structure including the earth magnetic field compensation coil
  - PMT module manufacturing and installation
- Contracts signed for each of them - Acrylic Vessel already under construction

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Preventivo per l'anno 2019

Struttura
Milano

CODICE	SIGLA	CC
	JUNO	
Resp. Loc.: Gioacchino Ranucci		

PREVENTIVO LOCALE DI SPESA (In K€)

L'inserimento delle richieste è a carico dei responsabili locali delle CSN1,2,3,5 P.S. e C.C.R.
Per la CSN4, l'inserimento è a carico dei responsabili NAZIONALI e/o dei coordinatori.
L'accesso ai responsabili locali di CSN4 è garantito in SOLA LETTURA

Capitolo	*Descrizione*	Parziali		Tot
		Richiesta	SJ	Richieste
MISSIONI	1. 1. Test distillazione LAB a Daya Bay (3 mesi x 4 persone)	70.00		
	2. 2. Meeting in Cina (4 persone x 2 meeting)	16.00		
	3. 3. Meeting in Europa (4 persone x 2 meeting)	8.00		
	4. 4. Meeting in Italia (4 persone x 4 meeting)	8.00		
	5. 5. Viaggi x il deputy Spokeperson e rappresentante naz.	10.00		
	6. 6. Conferenze	5.00		
	7. 7. Turni per collaudo PMT (2 turni da 2 settimane)	5.00		122.00
MISSIONI				
CONSUMO	1. 1. N. 10 Portadisco DN65 Donadon	3.50		
	2. 2. N. 10 Disco di rottura DN65 Donadon	3.50		
	3. 3. N. 4 Portadisco DN50 Donadon	1.50		
	4. 4. N. 4 Disco di rottura DN50 Donadon	1.50		
	5. 5. N. 16 Filtri FLHF050E-10M3F-PW 300 [0.05 μ]	10.50		
	6. 6. N. 8 Filtri FLHF450-10M3F-PW 300 [0.45 μ]	6.00		
	7. 7. N. 14 Pressure Safety Valves PSV-202	11.00		
	8. 8. Dispositivo IWAKI contro la marcia a secco DRN-01	0.50		
	9. 9. Cellette quarzo per Spettrometro UV/VIS	1.50		
	10. 10. Vetreria per test invecchiamento accelerato OR in LAB	1.50		41.00
ALTRI_CONS	1. 1. Utensileria meccanica di metabolismo	4.00		4.00
INVENTARIO	1. 1. Pompa IWAKI MDM32-1501PKKF040I-D2	13.00		
	2. 2. Notebook	1.50		
	3. 3. Bilancia analitica Kern ABT 120-5DNM	3.00		17.50

Anagrafica

JUNO

Preventivi 2019 > CSN II > JUNO > Milano > Modulo EC/EN 7

Modulo EC/EN 7

A cura di: Gioacchino Ranucci

Ricercatori

	Nome	Età	Contratto	Qualifica	Aff.	%
1	Antonelli Vito		Associato	Docente	CSN IV	70
2	Ding Xuefeng		Associato	Dottorando	CSN II	50
3	Ford Richard James		Associato	Ricercatore straniero	CSN II	100
4	Formozov Andrey		Associato	Dottorando		100
5	Grassi Marco		Associato	Ricercatore straniero	CSN II	100
6	Meroni Emanuela		Associato	Prof. Ordinario	CSN II	0
7	Re Alessandra Carlotta		Dipendente	Assegno di Ricerca	CSN II	20
				Numero Totale Ricercatori	7	FTE: 4.4

Tecnologi

	Nome	Età	Contratto	Qualifica	Aff.	%
1	Lombardi Paolo		Dipendente	Primo Tecnologo	CSN II	60
2	Pompilio Ruben		Associato	Assegnista	CSN II	100
3	Ranucci Gioacchino		Dipendente	Dirigente Tecnologo	CSN II	60
				Numero Totale Tecnologi	3	FTE: 2.2

Tecnici

	Nome	Età	Contratto	Qualifica	Aff.	%
1	Brigatti Augusto Andrea		Dipendente	Collaboratore Tecnico E.R.	CSN II	50
2	Parmeggiano Sergio		Dipendente	Collaboratore Tecnico E.R.	CSN II	50
3	Saggese Paolo		Dipendente	Collaboratore Tecnico E.R.	CSN II	20
				Numero Totale Tecnici	3	FTE: 1.2

Summary

- The collaboration has reached a remarkable dimension with distinctive contributions from Italy and Europe
- A lot of progresses on many hardware fronts
- The line of activity of the scintillator purification - Milano is in very good shape
- Very well articulated Italian INFN group with several visible commitments
- The civil excavation despite the difficulty of the underground water progresses at reasonable speed
- The design of components and subsystems is well advanced with some already in construction phase (PMTs, acrylic)