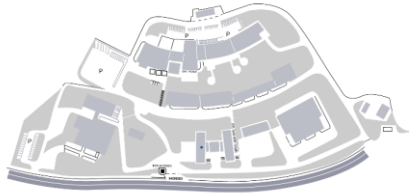
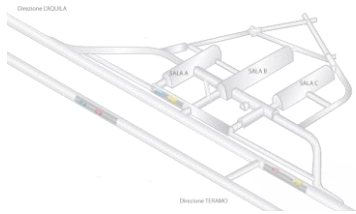


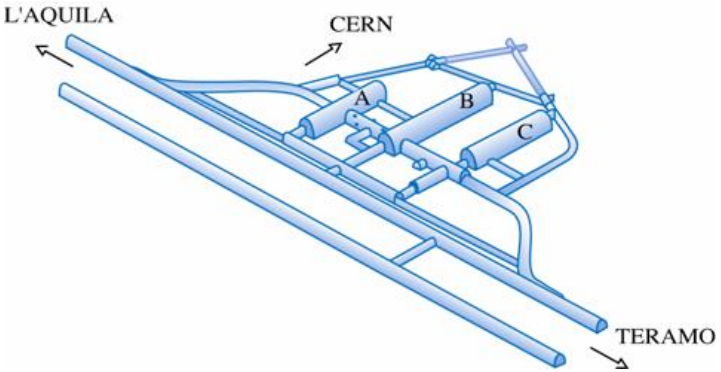


Ventilation Plant of Gran Sasso National Laboratories

Valentino Di Marcello - LNGS

History of Gran Sasso National Laboratory

- 1979 → Submission proposal to the Italian Parliament about the realization of the Underground Laboratory
- 1982 → Approval of the Parliament
- 1987 → The Underground Laboratory is completed
- 1989 → The first experimental apparatus begins the data taking.

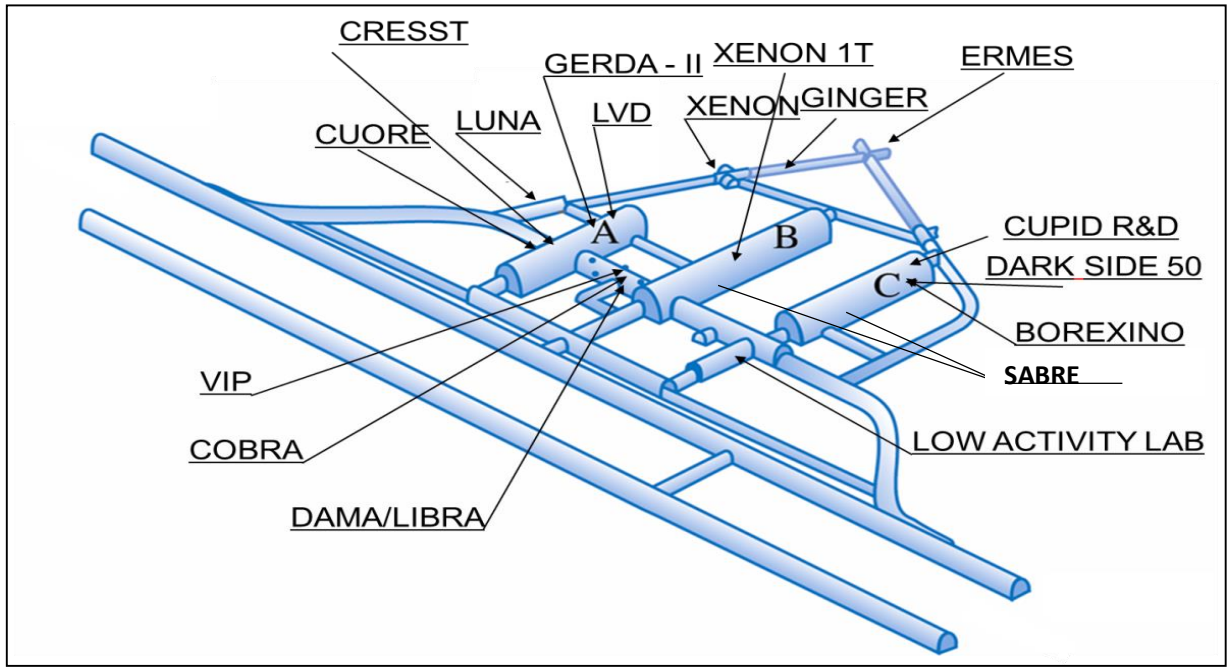


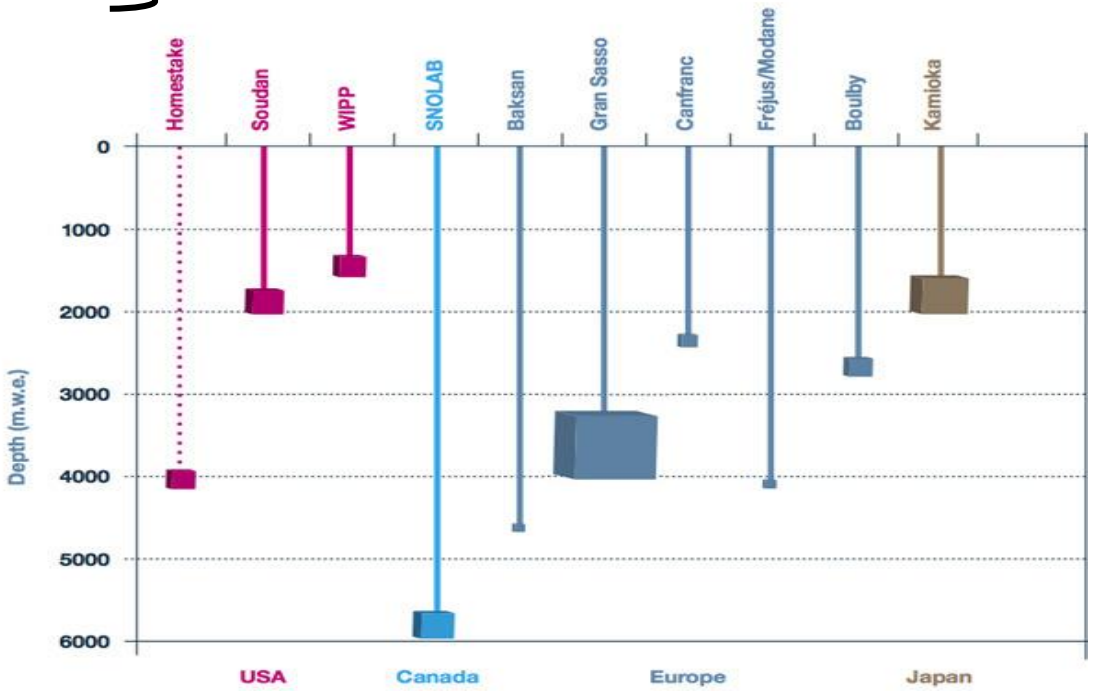
Underground laboratory and experiments

Main research activities:

- Neutrino physics (BOREXINO, LVD, GERDA, CUORE, COBRA)
- Dark matter (DAMA/LIBRA, DARKSIDE-50, XENON, CRESST, SABRE)
- Nuclear reactions of astrophysics interest (LUNA)
- Fundamental Physics (VIP)
- Multidisciplinary activities (GINGER, Cosmic Silence, ERMES-W)

15 experiments
1000 researchers
25 different countries





Why underground

Underground laboratories are shielded by layers of rock and offer the unique possibility of studying rare physics phenomena in an environment which is almost free from cosmic ray background.

The earth is subjected to an intensive cosmic rays radiation that leads to muon generation in contact with the atmosphere (at sea level 100 muons / m^2 s)

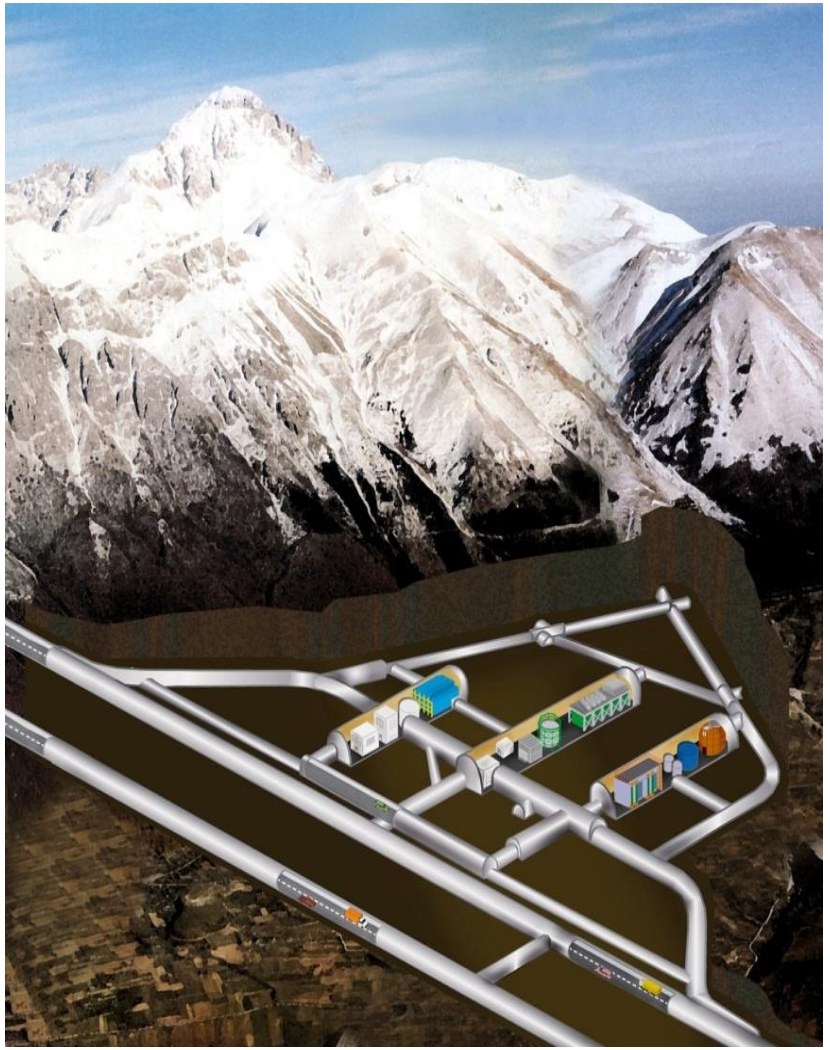
Some features of the Laboratory:

1400 m of rock thickness

Underground Volume: 180000 m^3

Underground Surface: 17800 m^3

Factor of muon flux reduction : 10^6 (~ 1 muon / m^2 h)



Overview of LNGS ventilation plant

The ventilation system provides air change inside the underground laboratories keeping the overpressure of the laboratory as regards the motorway tunnel. As a consequence the ventilation reduces the radon gas concentration.

Air is supplied to the underground laboratories by two ventilation stations:

- Teramo Station: duct characteristics length: 4,3 km, material: steel, diameter: 1,5 m.
- L'Aquila Station: duct characteristics length: 6,5 km, material: stainless steel, diameter: 1,5 m.

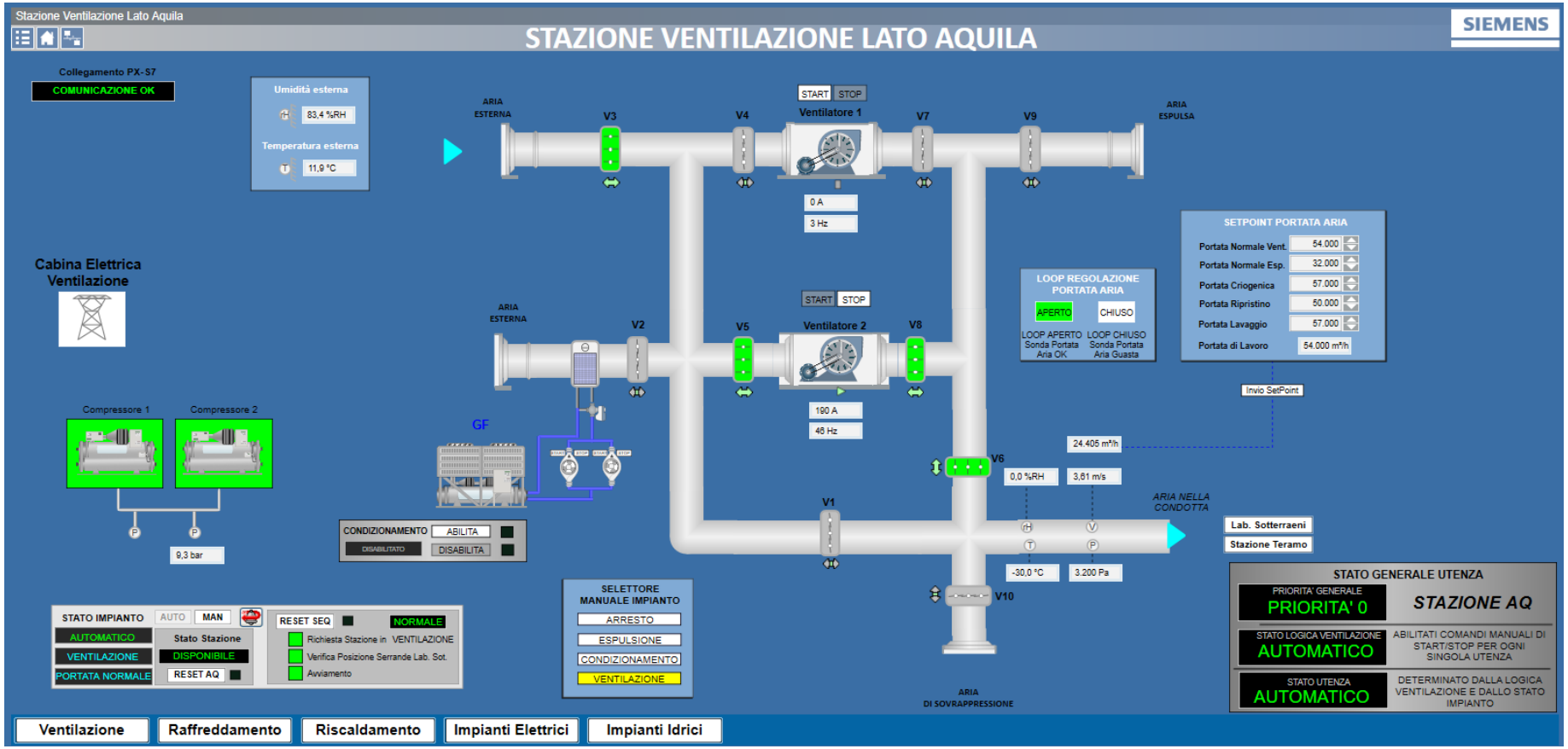
The two stations can operate combined or separately in case of failure of one of them.

L’Aquila Ventilation Cabin

Maximum flow: 60.000 m^3/h

Two electric fans (one backup)

Two diesel generators for electrical backup one redundant

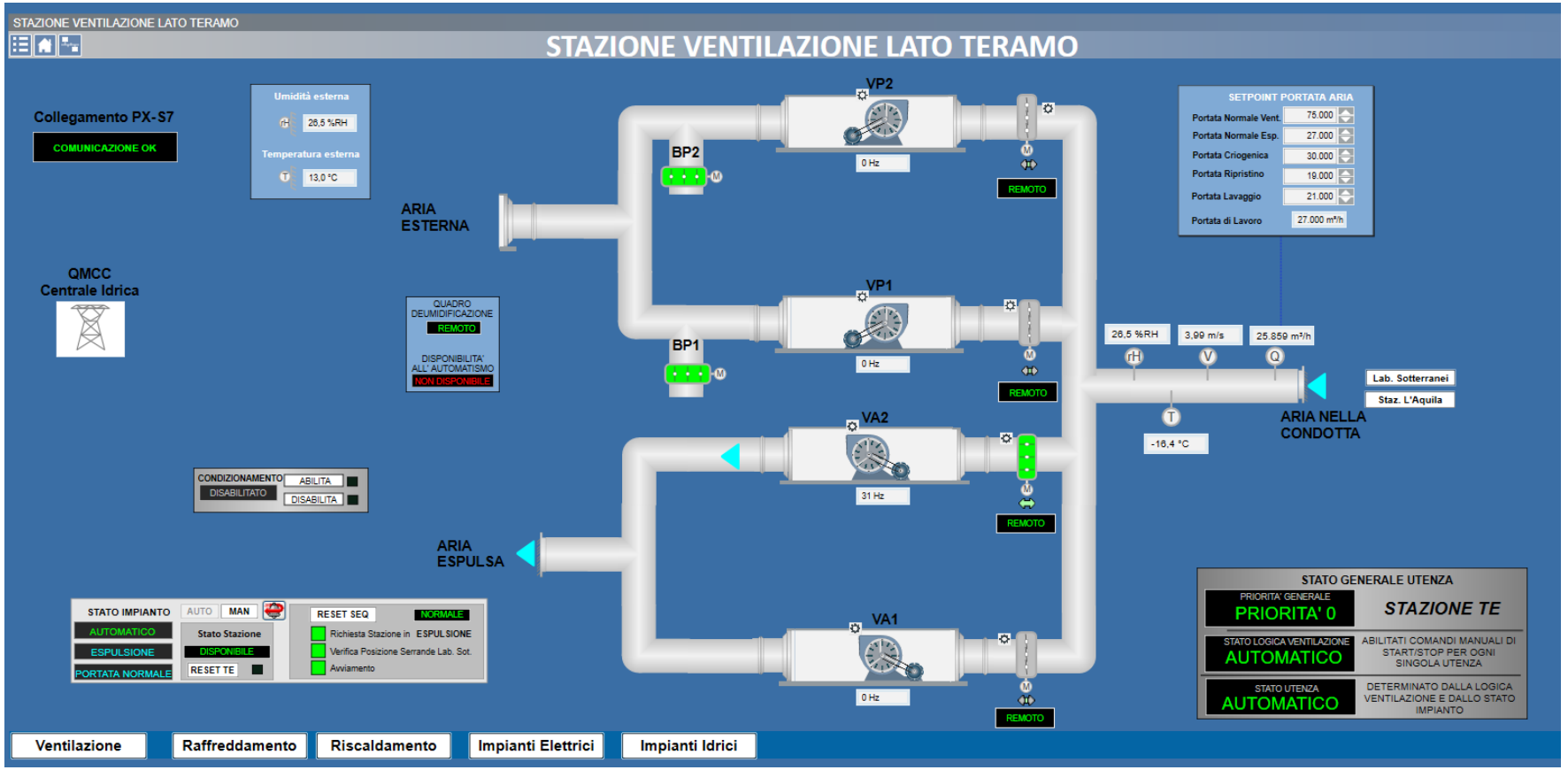


Teramo Ventilation Cabin

Maximum flow: 50.000 m3/h;

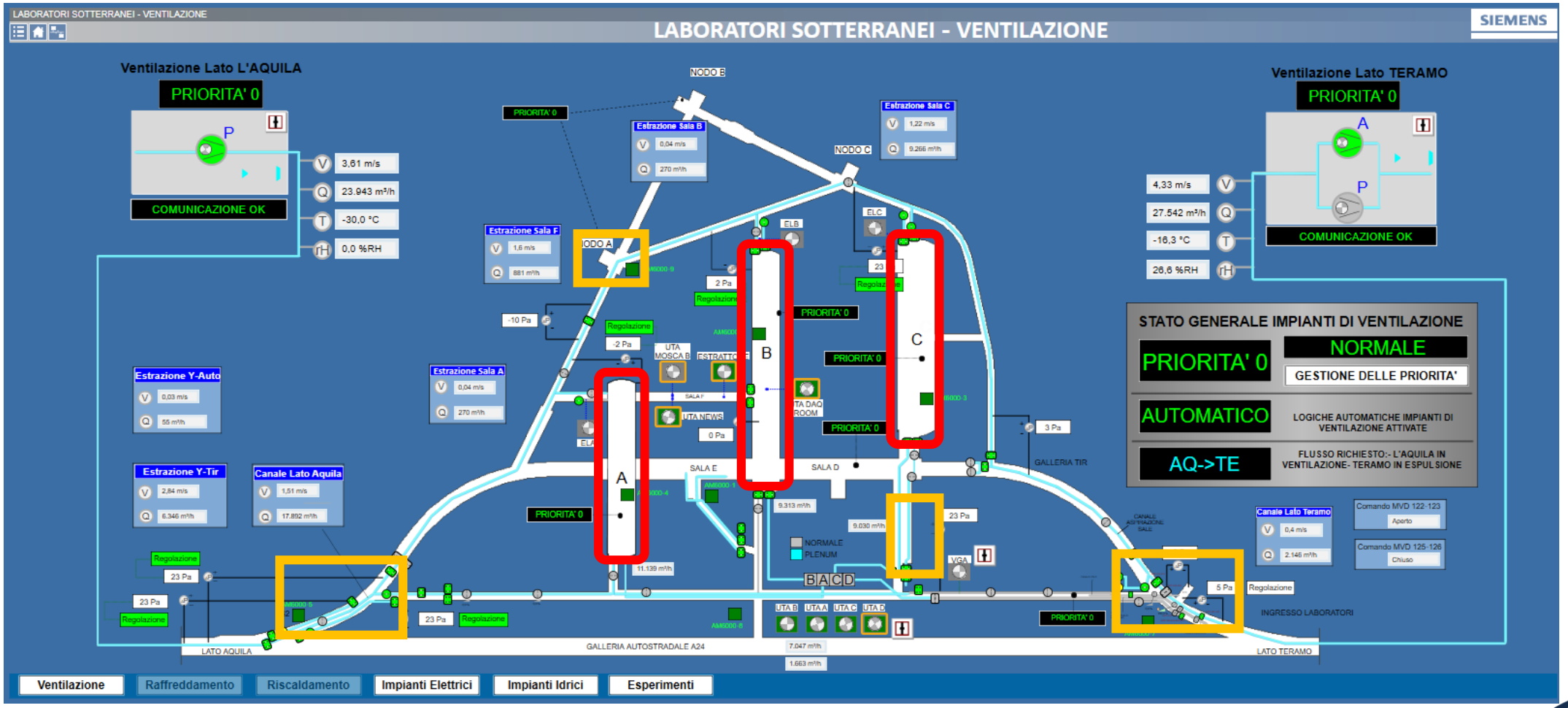
Two electric fans (one backup) for air inlet;

Two electric fans (one backup) for air extraction



Underground ventilation plant

The air drawn into the gallery ensures the ventilation of three experimental halls (red circles) and some technical rooms (orange rectangles) by 4 AHU (air handling unit).



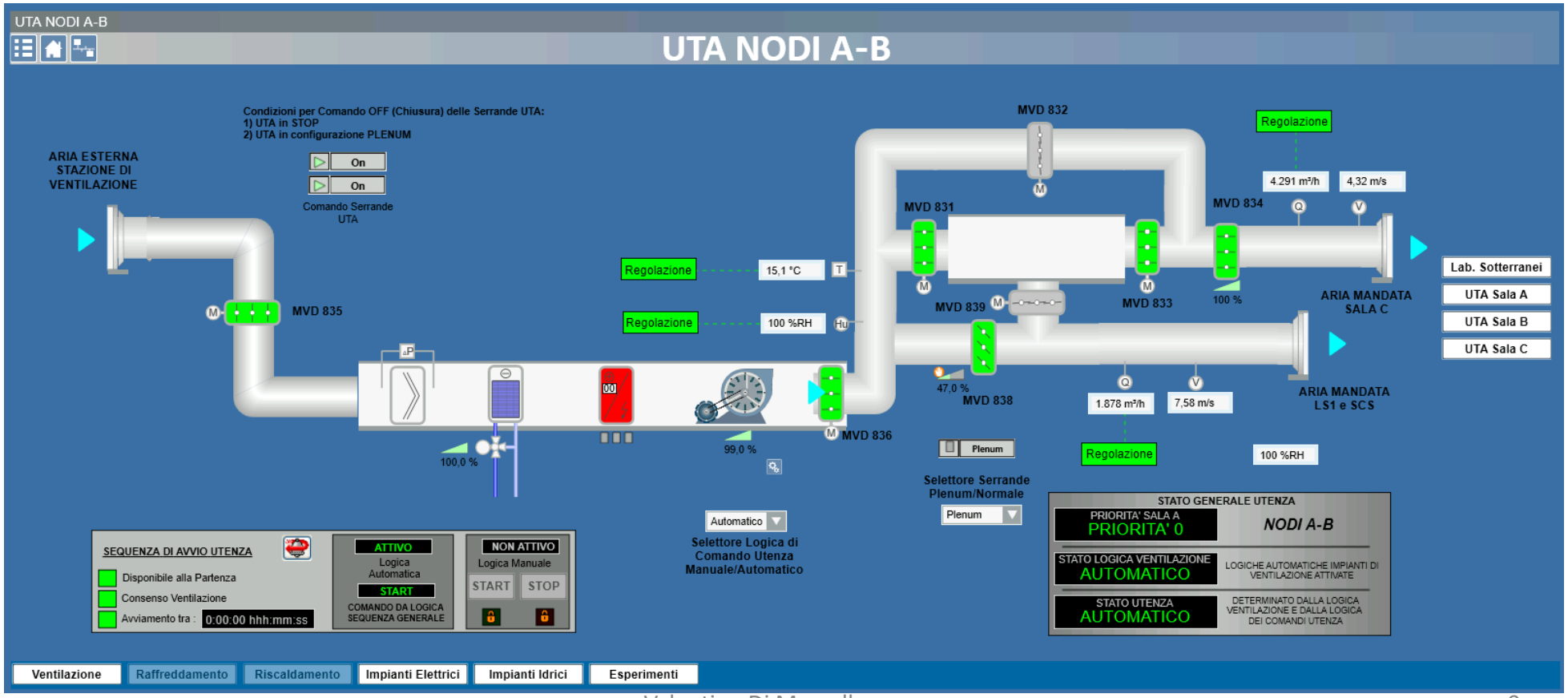
AHU Characteristics

Maximum flow: 12.000 m3/h;

Dehumidification section;

Post heating;

In case of fault of one of 4 AHU it is possible to send air in a plenum.



Flownex Modelling

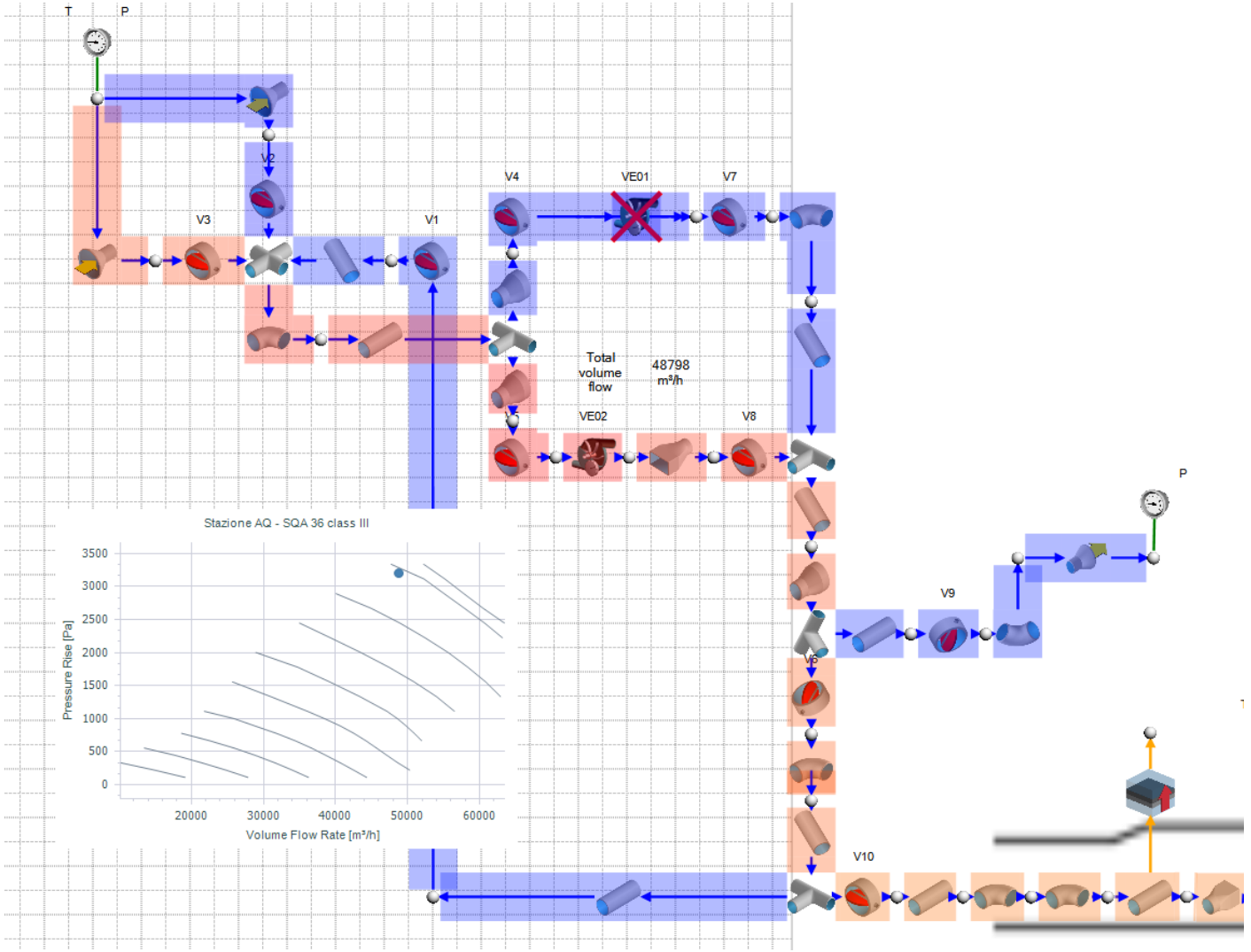
Objectives:

- Analysis and optimization of the ventilation plant:
  - Flow rate balancing
  - Emergency air removal from Halls
  - Over-pressurization control of the different halls

- Design activities:
  - Installation of a new ventilation system for Hall D
  - Upgrade of the ventilation cabins, both AQ and TE side

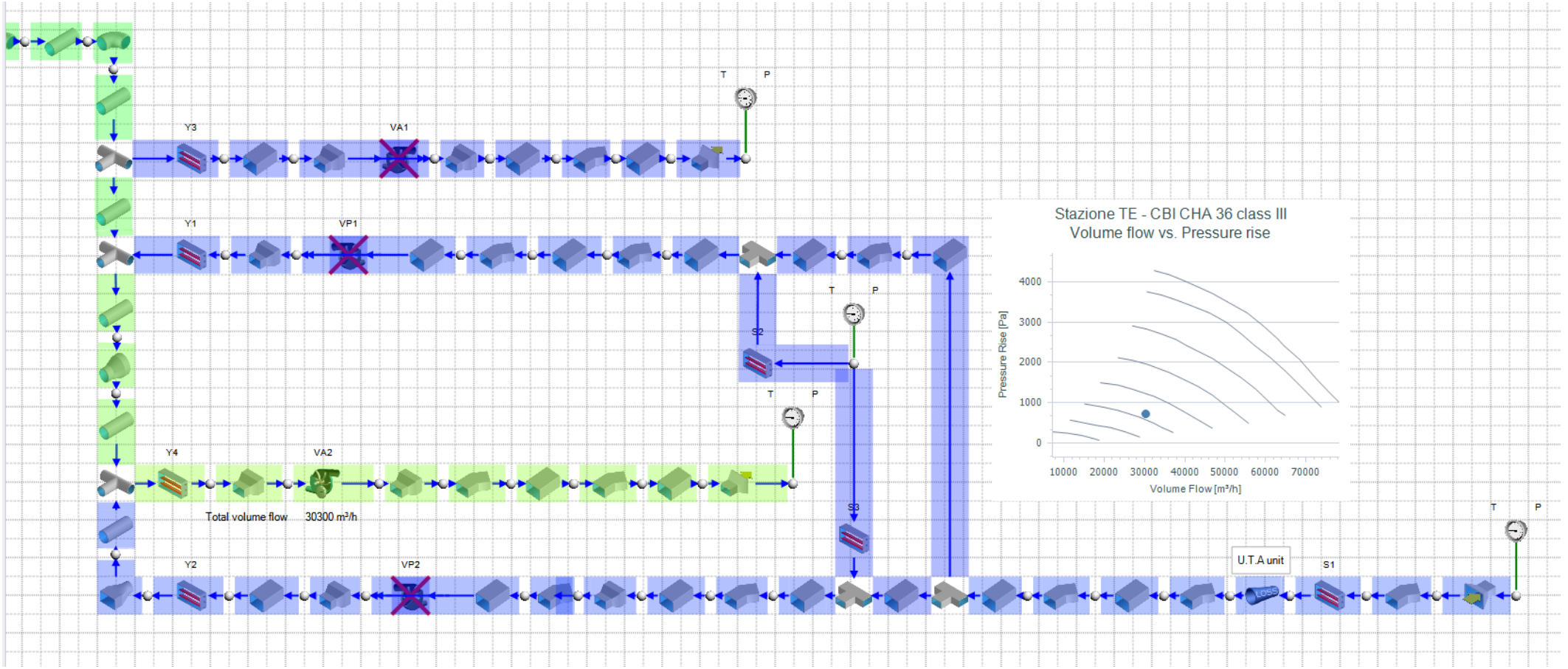
Ventilation cabins modelling

L’aquila Side

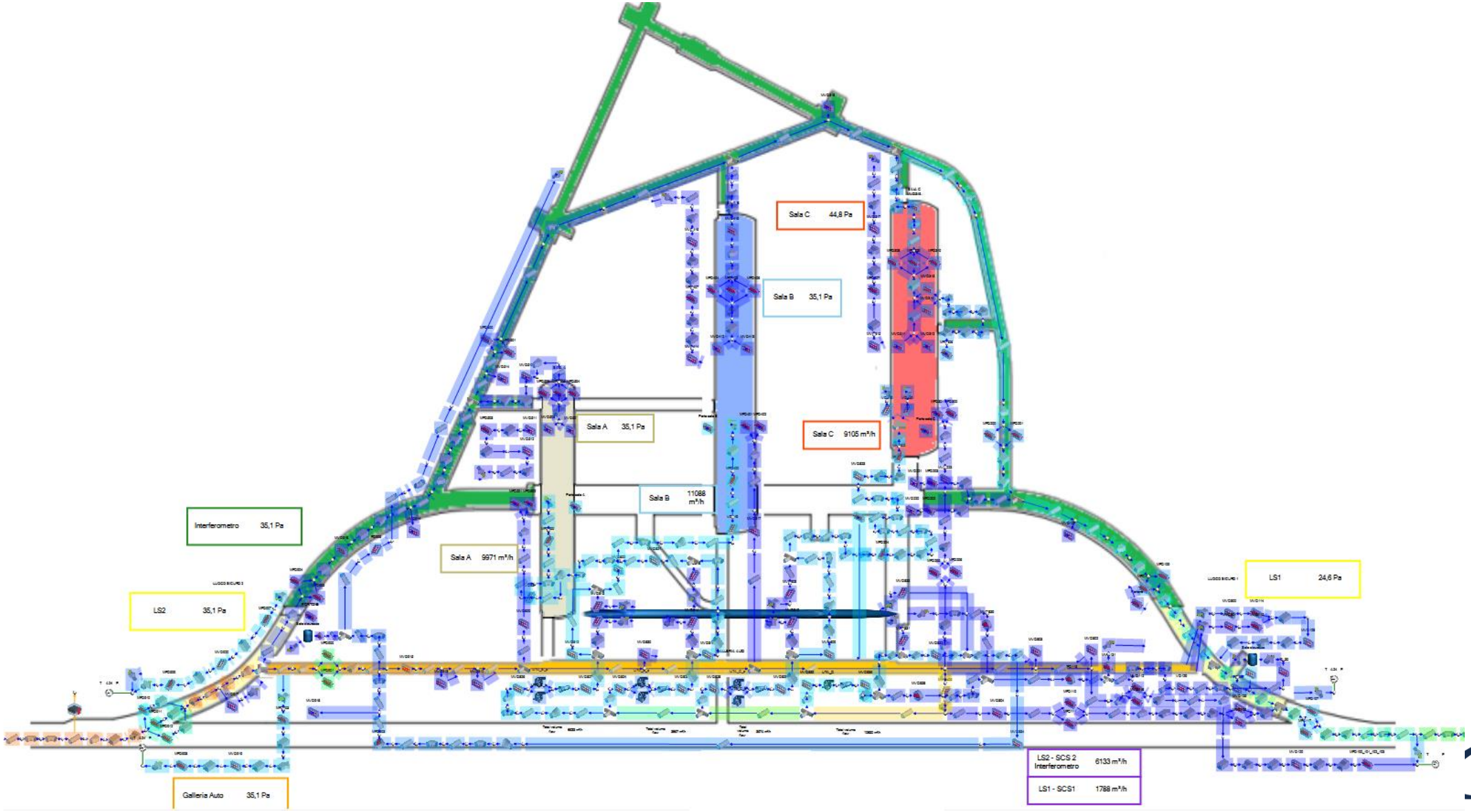


Ventilation cabins modelling

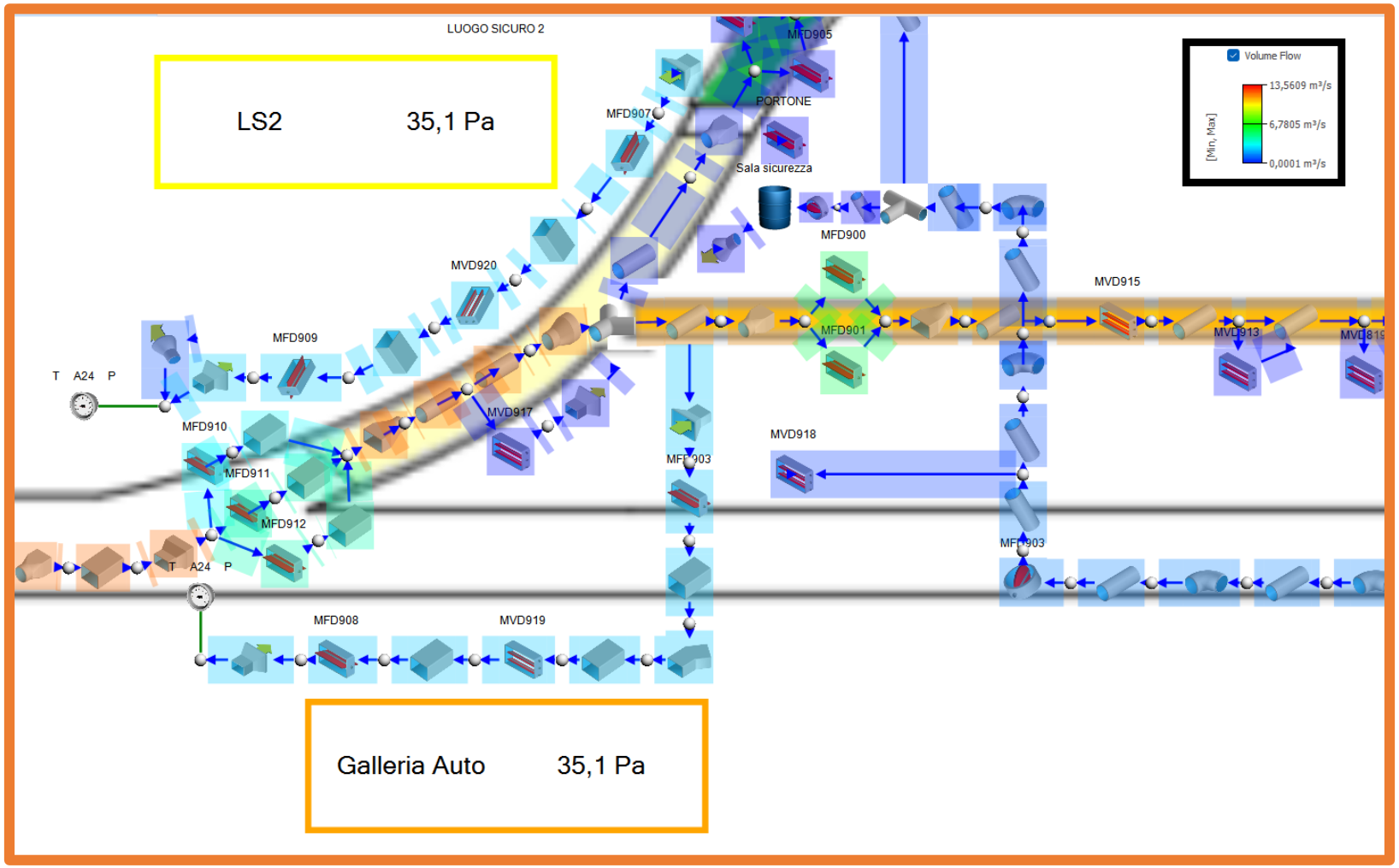
Teramo Side

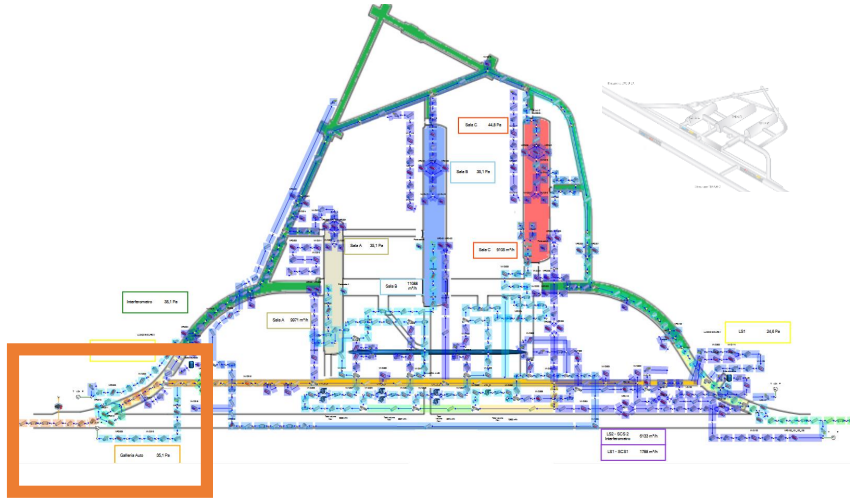


Underground plants modelling



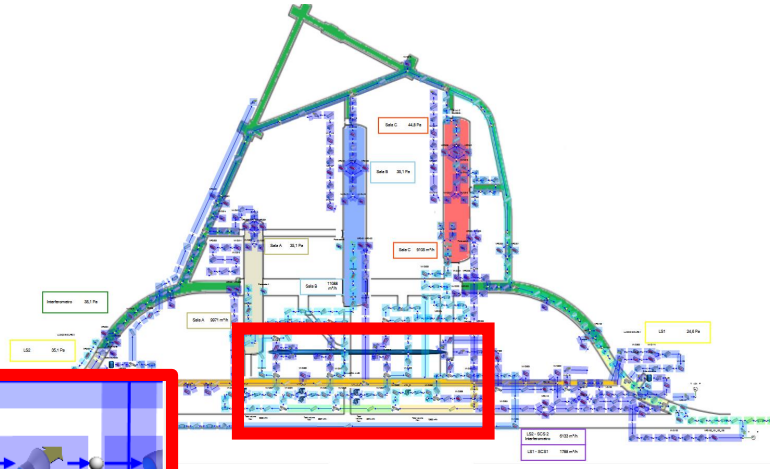
Underground plants modelling

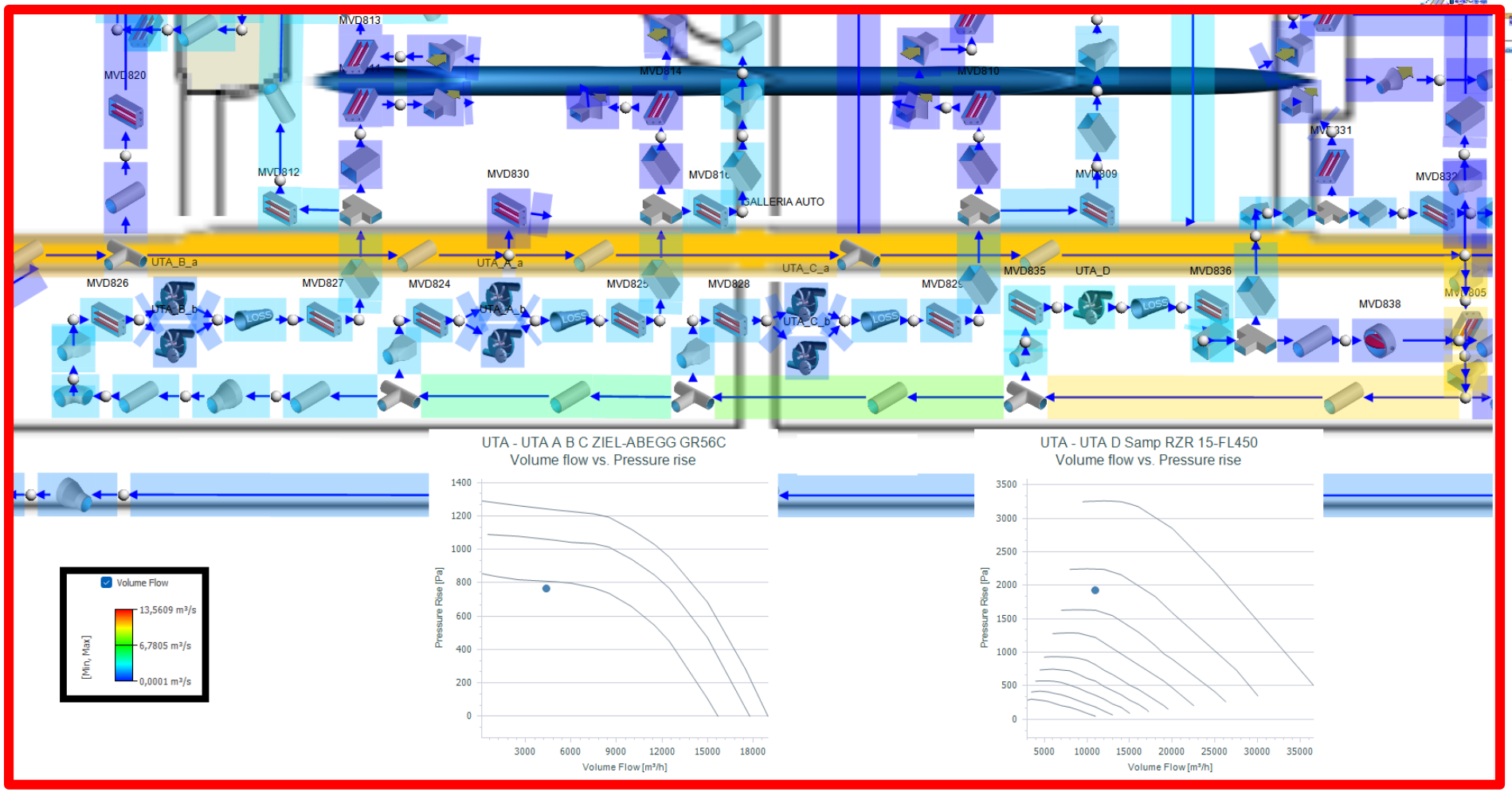




Underground plants modelling

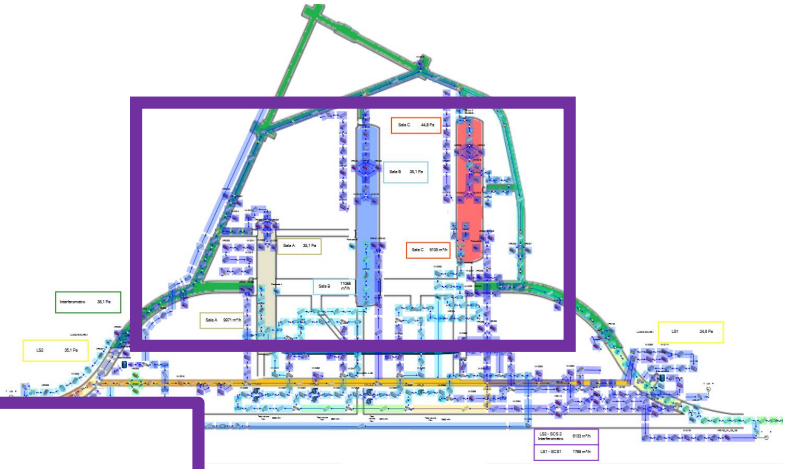
AHU

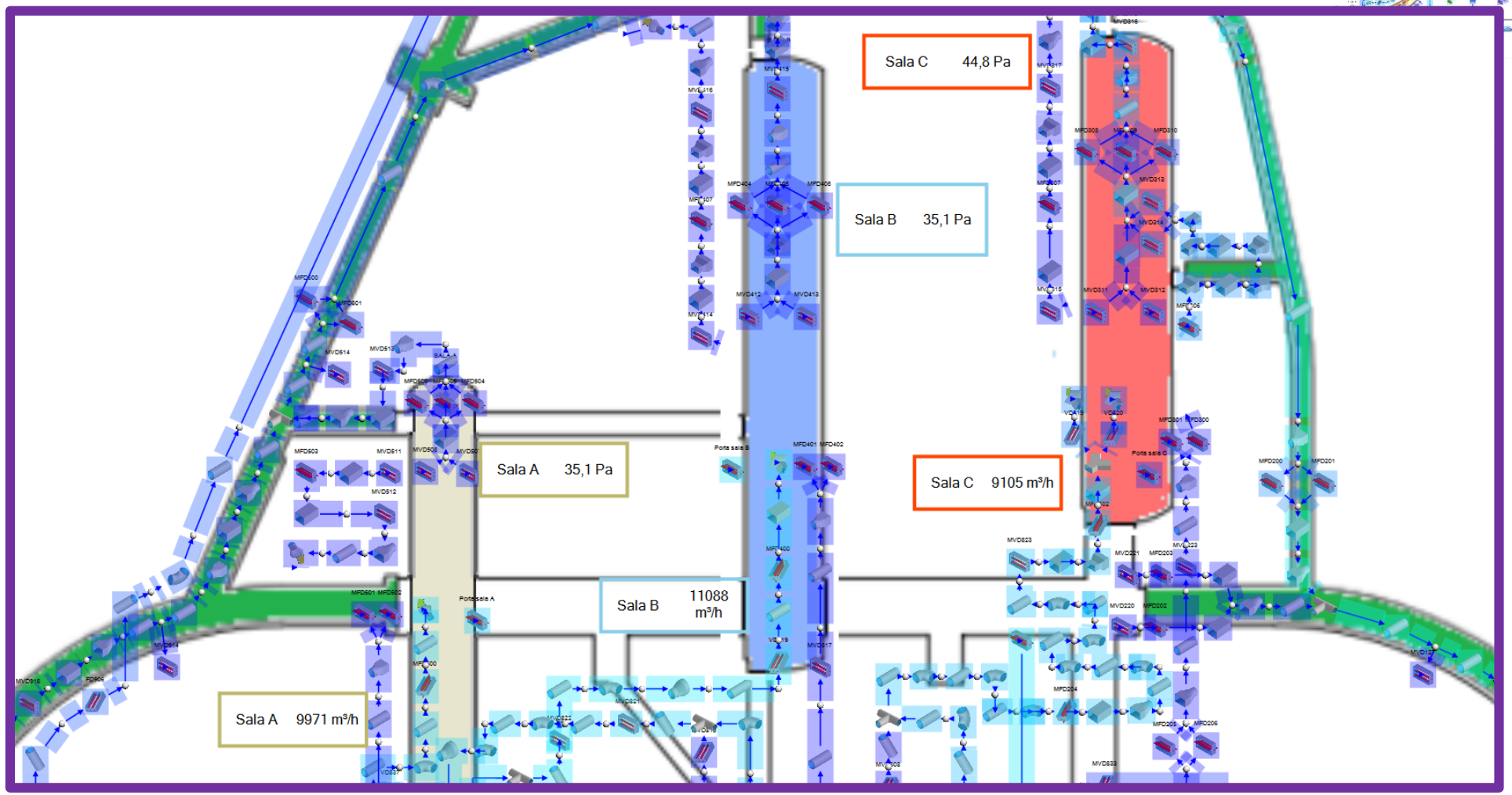




Underground plants modelling

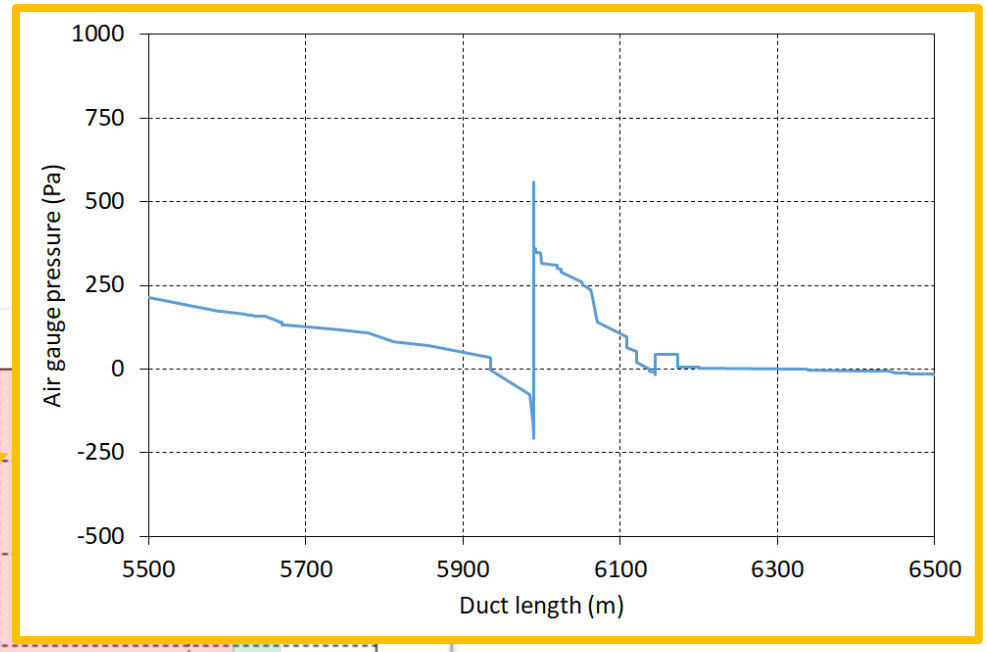
Main Halls



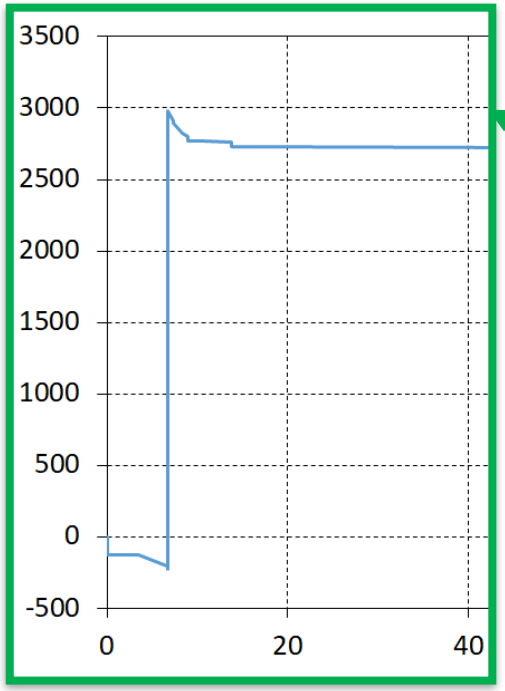


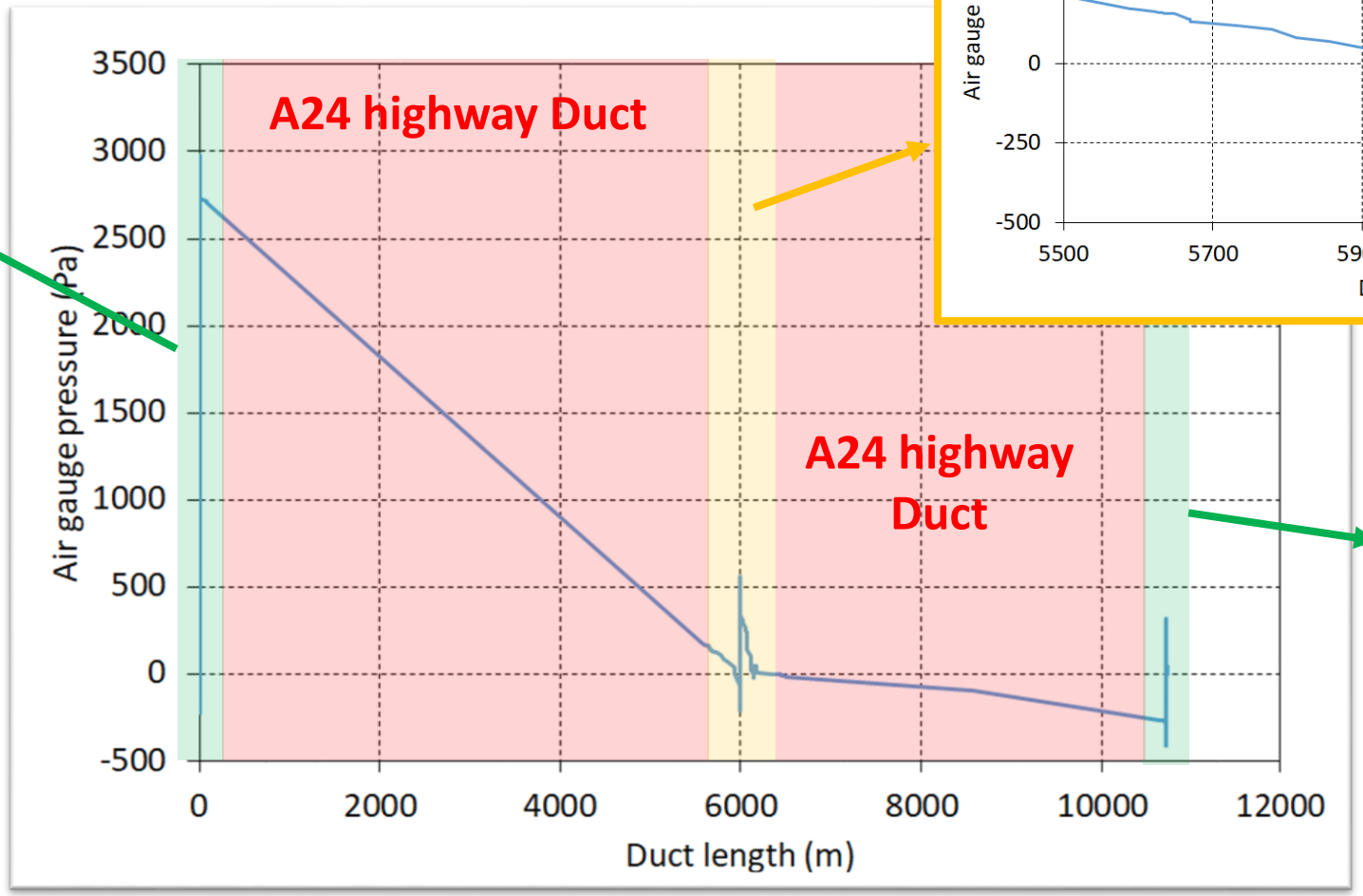
Results – Pressure drops

Undergound lab



AQ Cabin





TE Cabin

Results – Preliminary comparison with measured data

Analysed scenario:

- Priority 0 mode (normal operation)
- Hall A and Hall B doors open
- Door between Interferometro and Galleria Auto open
- Damper position in Flownex imposed according to the ventilation control system

	Measured	Calculated
Teramo cabin flow rate (m^3/h)	25859	30300
Interferometro outflow (m^3/h)	9500	10199
Flow rate to Hall A (m^3/h)	11139	9971
Flow rate to Hall B (m^3/h)	9313	11088
Flow rate to Hall C (m^3/h)	9030	9105
Flow rate to LS1 - SC1 (m^3/h)	1663	1788
Flow rate to LS2 - SC2 – Interferometro (m^3/h)	7047	6133
Interferometro overpressure (Pa)	25-45	35.1
Galleria Auto overpressure (Pa)	25-45	35.1
Hall A overpressure (Pa)	0	0
Hall B overpressure (Pa)	0	0
Hall C overpressure (Pa)	10	9.7

Conclusions

- Ventilation plant of Gran Sasso Nations Laboratories has been modelled by means of Flownex software
- Given the complexity of the system, accurate representation in the software of some ducting sections and components is still under development
- Preliminary results shows good agreement between measured and calculated quantities

Future work

- Complete model validation with the analysis of a wider range of scenarios
- Design of ventilation plant upgrade (AQ and TE cabin and AHU C)
- Safety analysis in case of halls contamination and improvement of the ventilation plant capabilities for emergency conditions

Thank you for the attention