1st Cost & Schedule Review Meeting Frascati 11 Dicembre 2023

EUROPEAN PLASMA RESEARCH ACCELERATOR WITH EXCELLENCE IN APPLICATIONS

EuPRAXIA

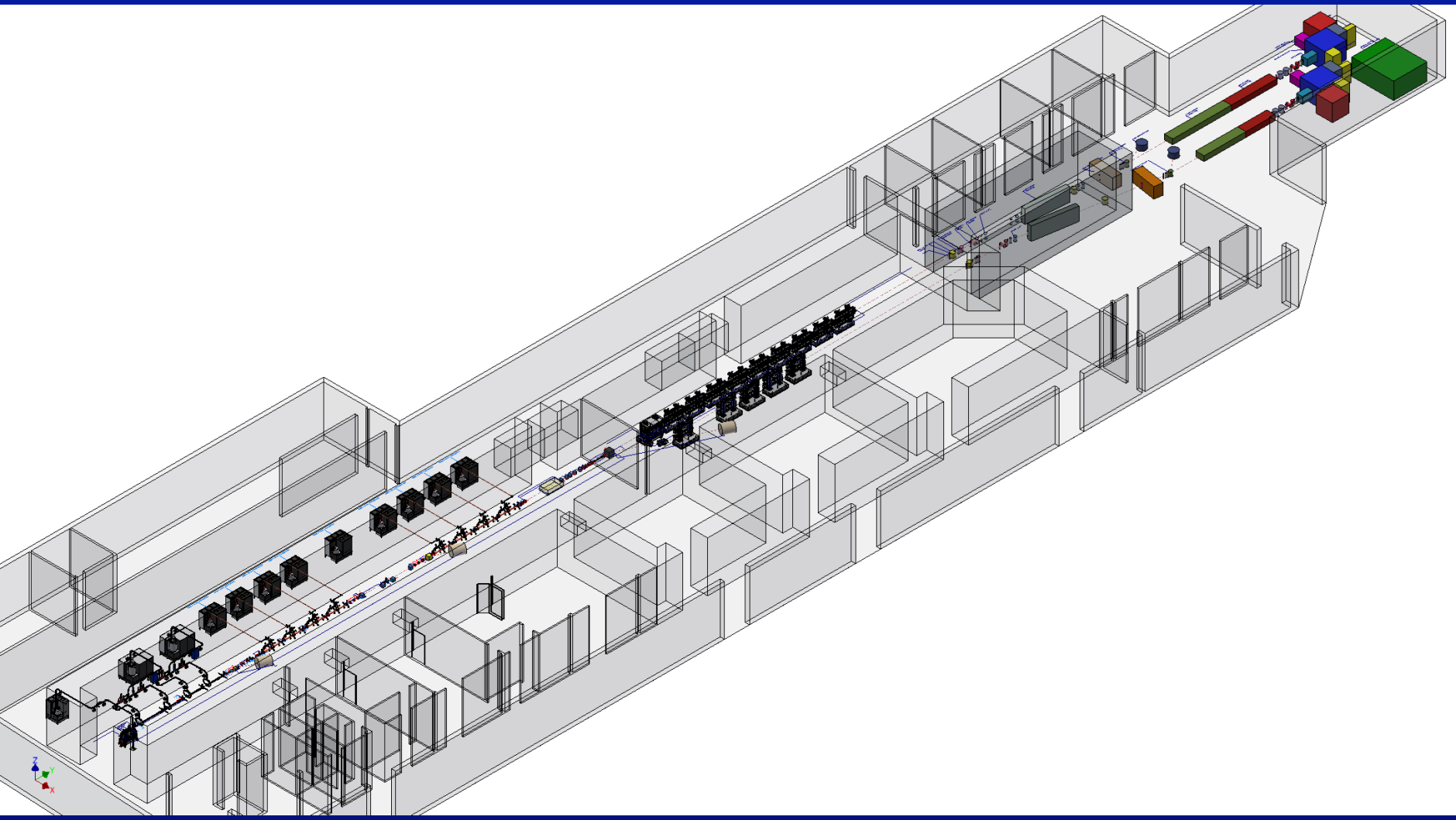
Status EuPRAXIA@Sparc_LAB Technical Design Report

Andrea Ghigo on behalf of EuPRAXIA@SPARC-LAB Collaboration

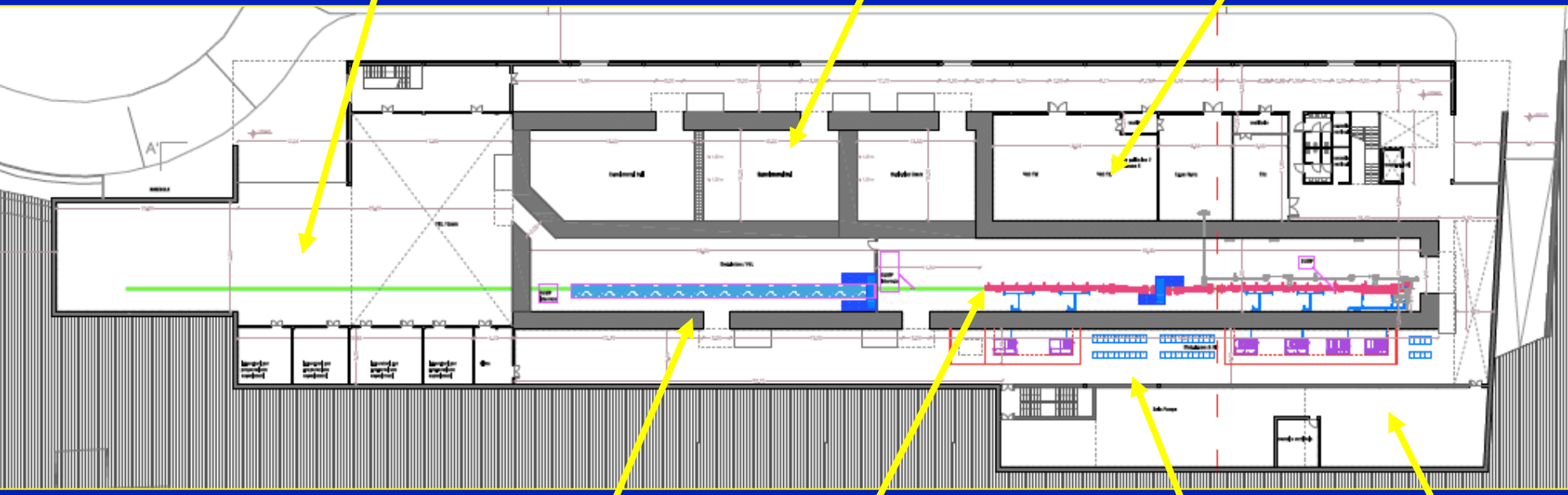
INFN Istituto Nazionale di Fisica Nucleare

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101079773

EuPRAXIA@SPARC-LAB: Machine and Building Layout



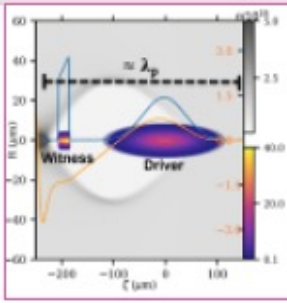
Functional description of the areas



Starting from Beam Dynamics

REFERENCE WORKING POINT BEAM DYNAMICS

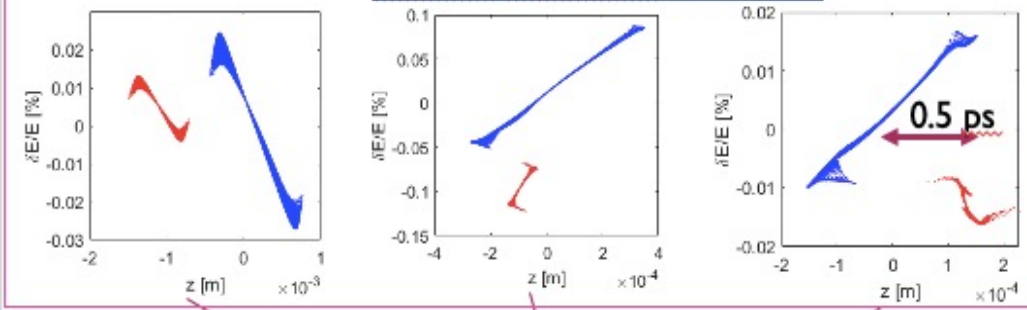
A. Giribono



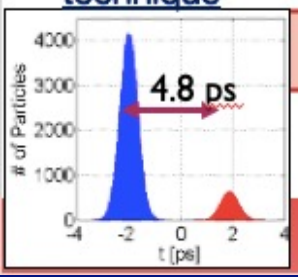
- Beside the FEL specifications, the **reference working point** has been determined by the plasma module
  - At least 500 MeV energy gain (in less than 1 m)
  - Weakly non-linear regime (bubble with resonant behaviour)

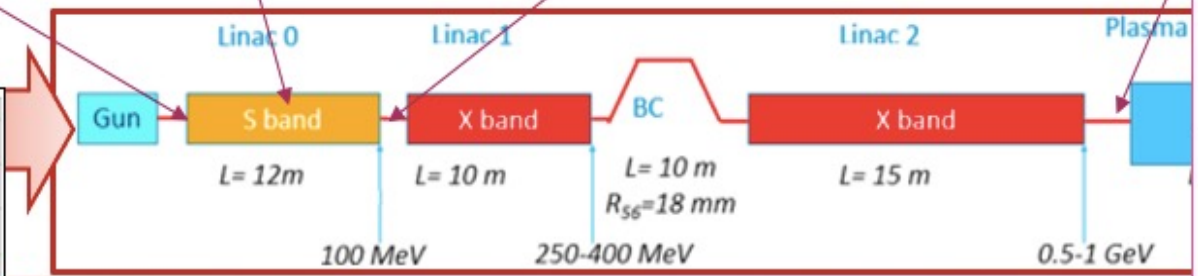
1. 200 pC driver + 30 pC witness
2. plasma density of the order of $10^{16} cm^{-3}$ (λ_p = 334 μm)
3. Driver-witness separation of around 0.5 ps (i.e. λ_p /2)
4. Driver and witness bunches of 200 fs and 10 fs rms
5. Driver and witness spot size of 4 and 1 μm with α=1

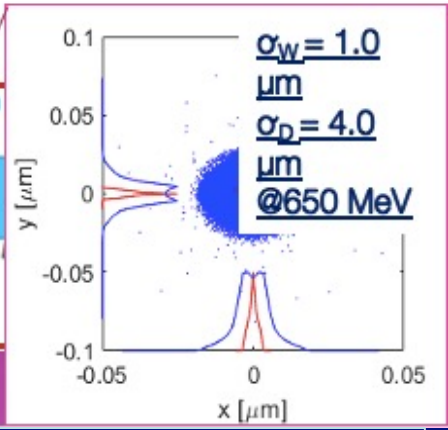
Velocity bunching technique



Laser comb technique

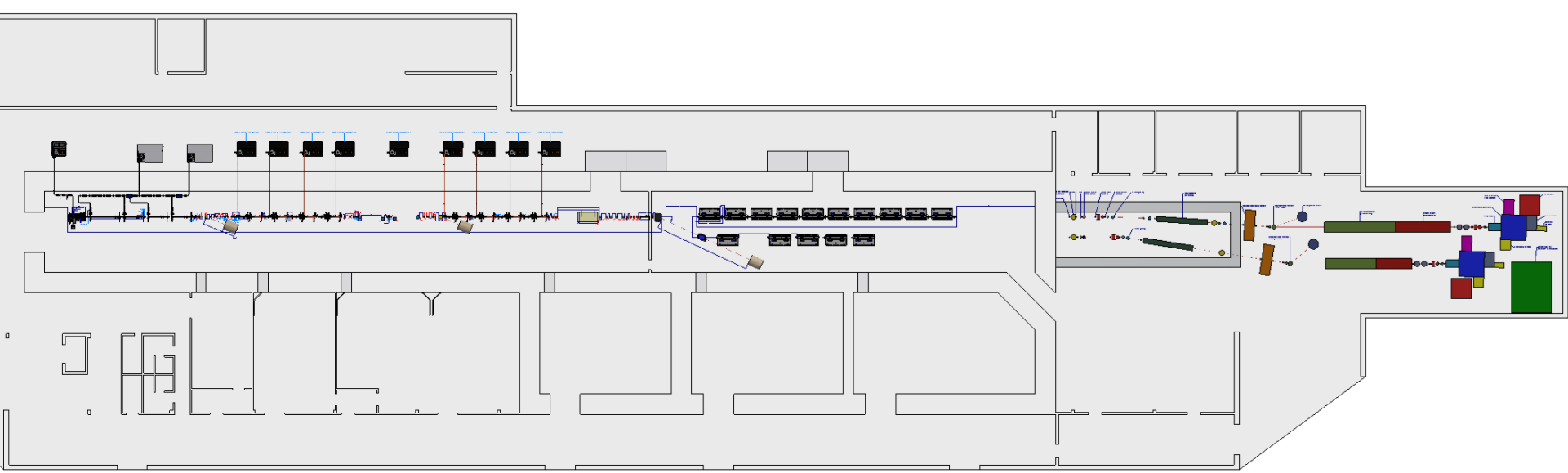






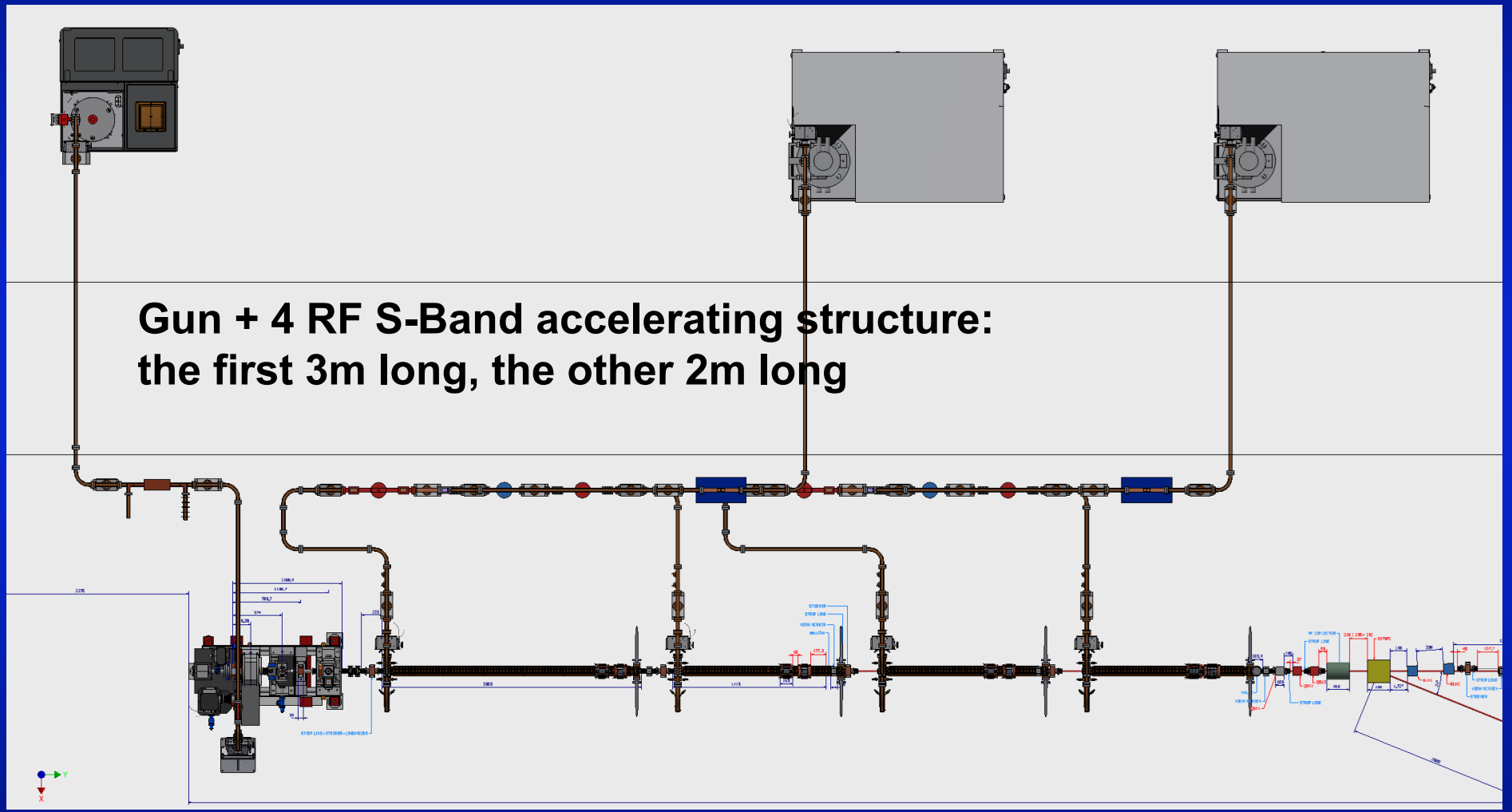
Courtesy of C.Vaccarezza

Linac, undulators and user area layout

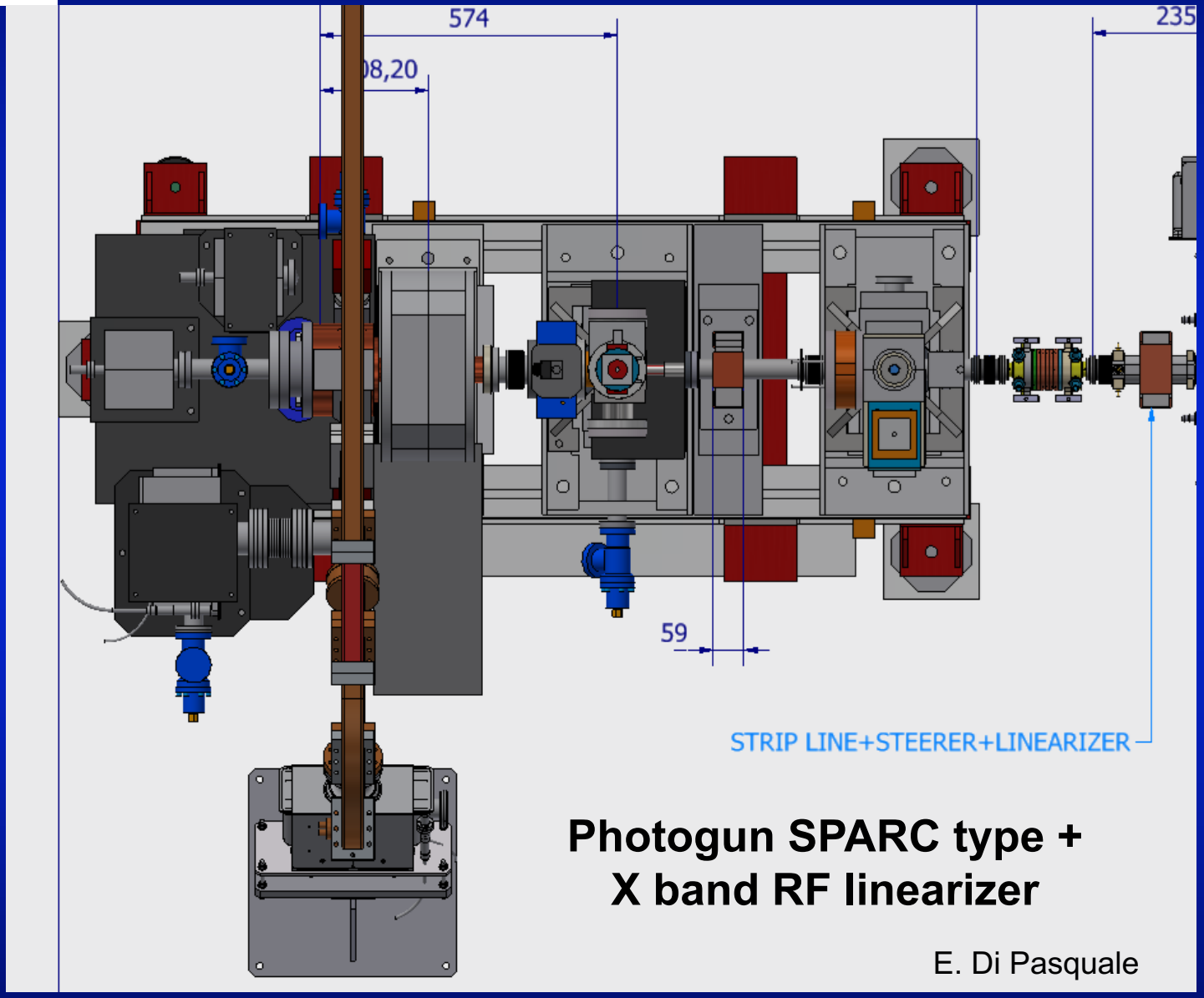


The components studied so far for the EuPRAXIA complex are:
the injector, the RF linac, the plasma acceleration module,
two undulator lines, two optical lines and two experimental stations

Injector 2D layout



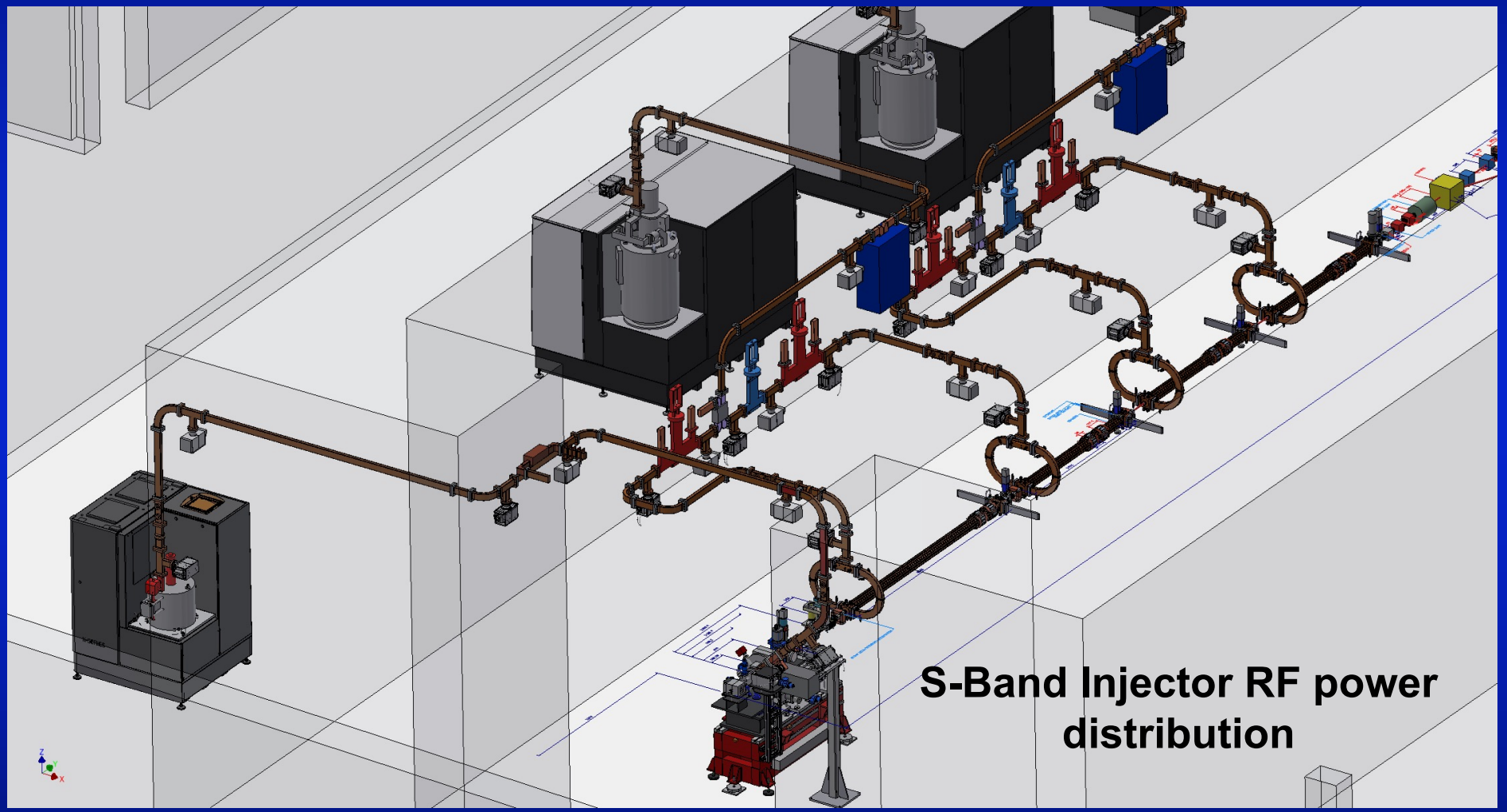
RF Photogun



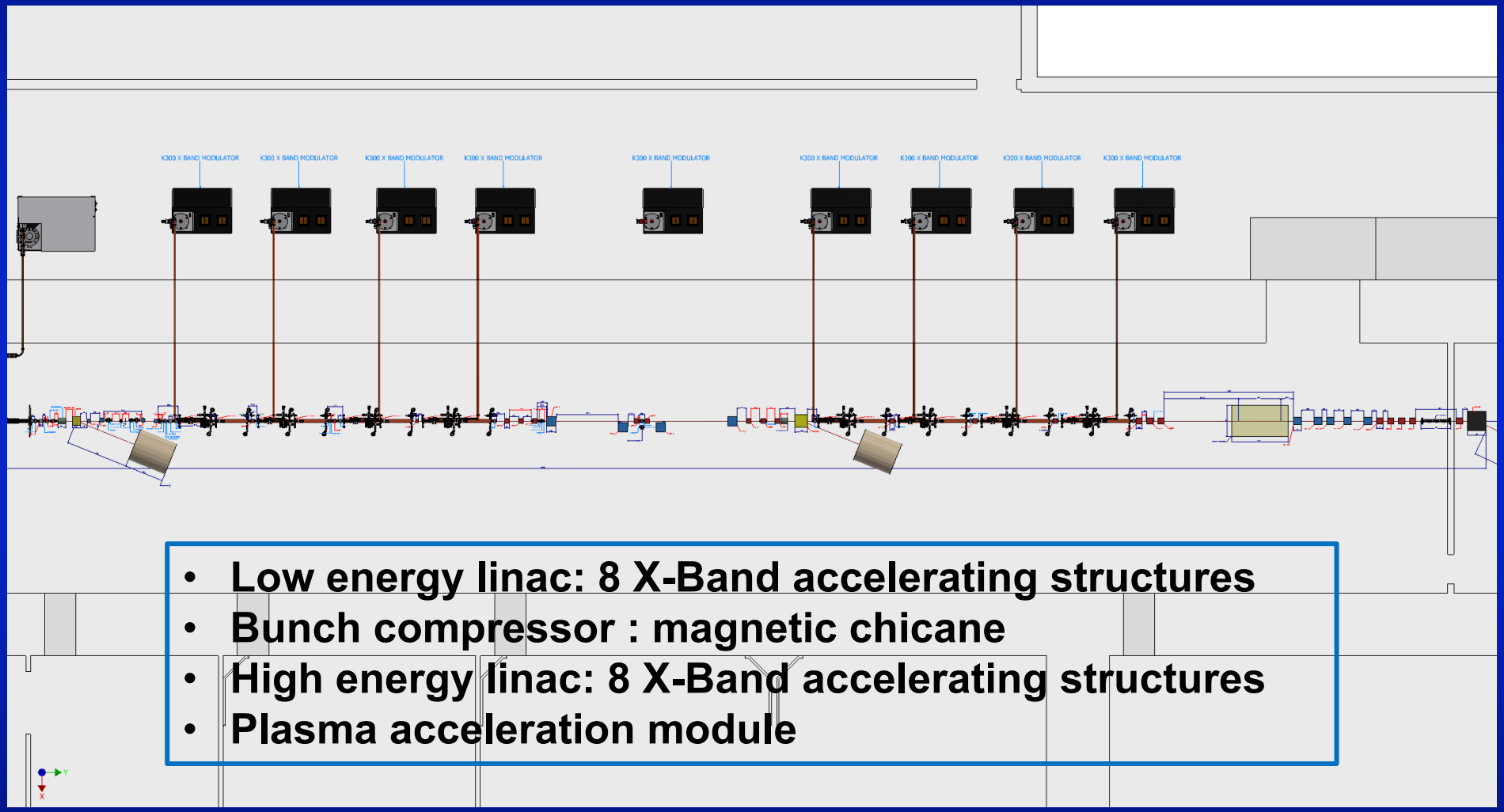
Photogun SPARC type +
X band RF linearizer

E. Di Pasquale

Injector & RF distribution

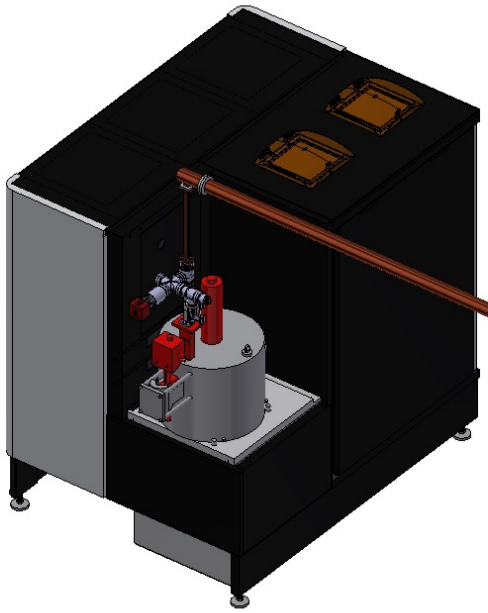


X-Band Linac 2D layout

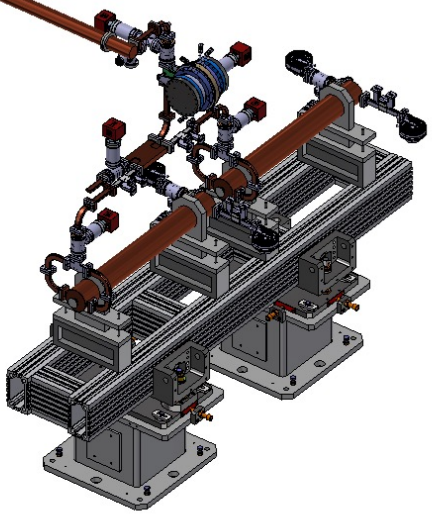


- Low energy linac: 8 X-Band accelerating structures
- Bunch compressor : magnetic chicane
- High energy linac: 8 X-Band accelerating structures
- Plasma acceleration module

X-Band RF module



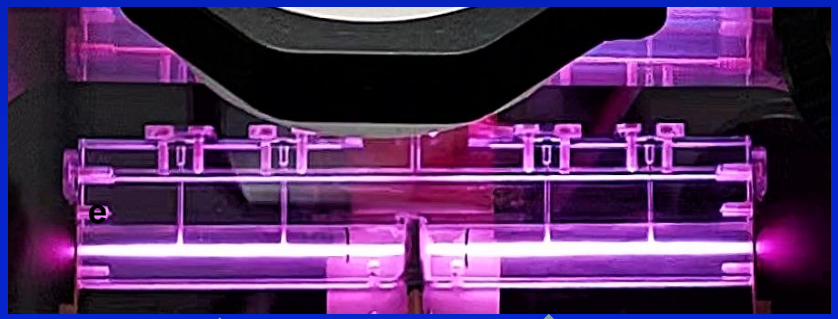
CANON 25 MW Klystron
SCANDINOVA K300 Modulator

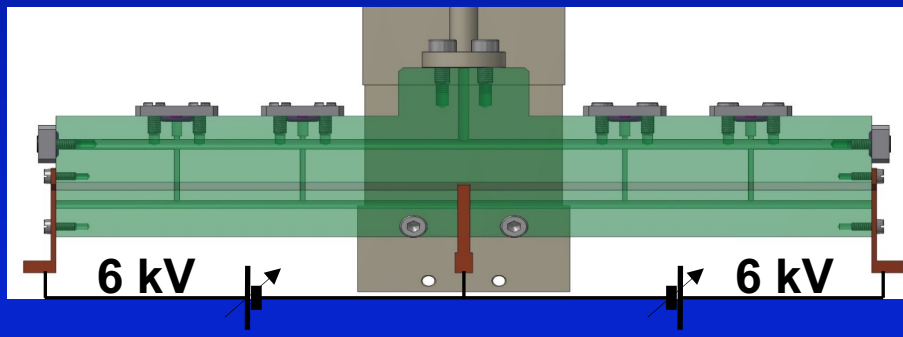


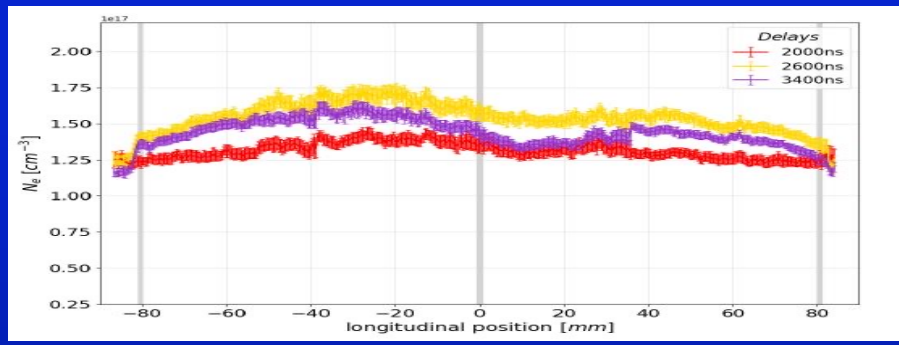
BOC Pulse Compressor +
2 x 90cm X-band Accelerating Sections

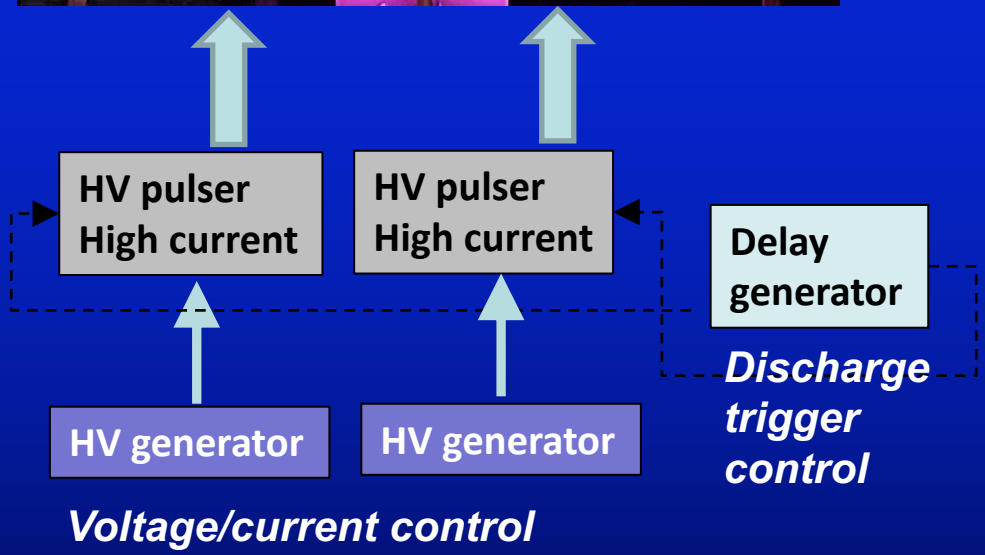
Plasma section - Plasma sources for EuPRAXIA

- Plasma sources larger than 40 cm (m-scale) with HV pulses less tahn 10 kV
- Longitudinal density modulation
- 1.5 GV/m m-scale capillary - density 10^{16} cm-3

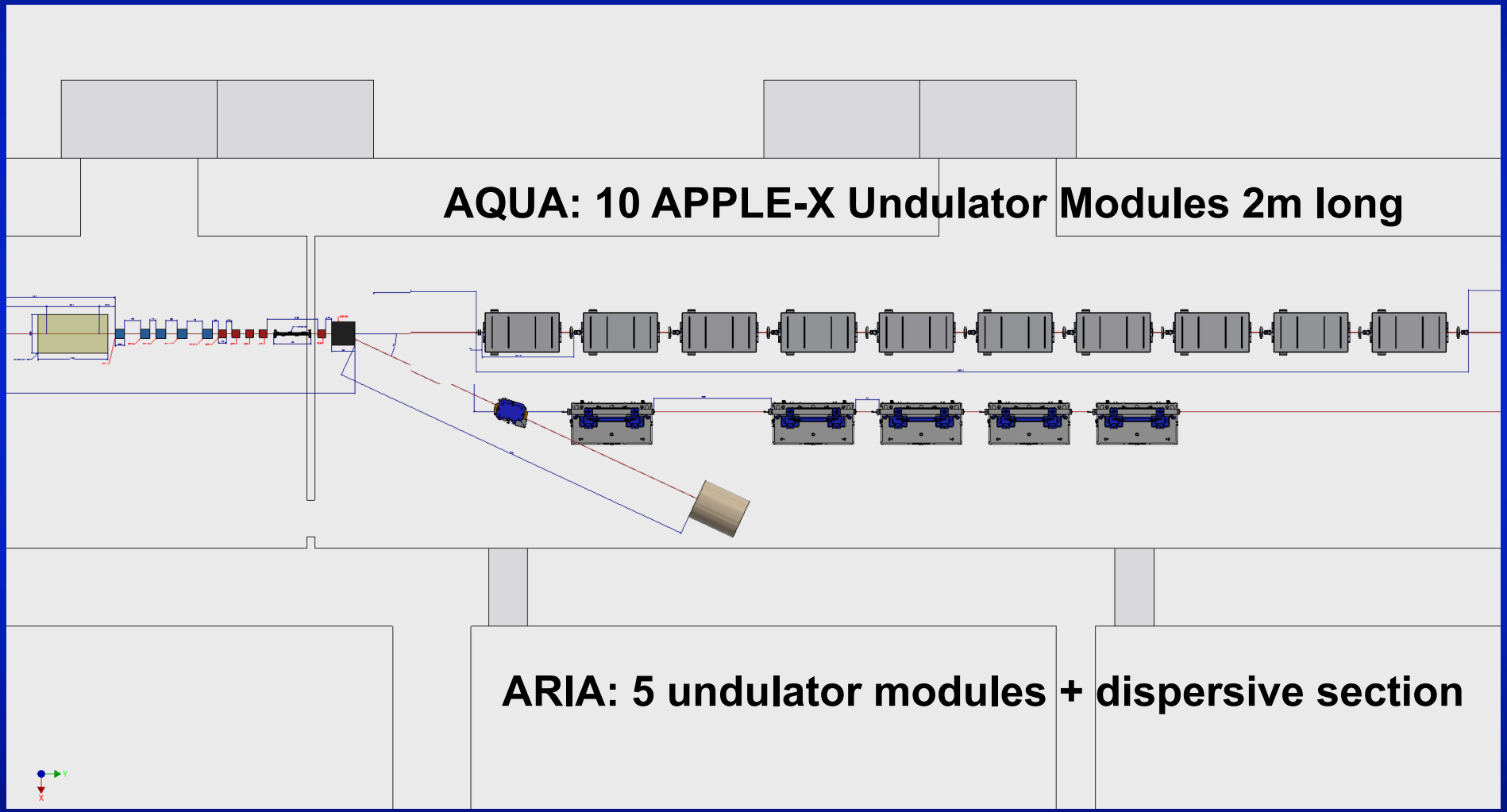






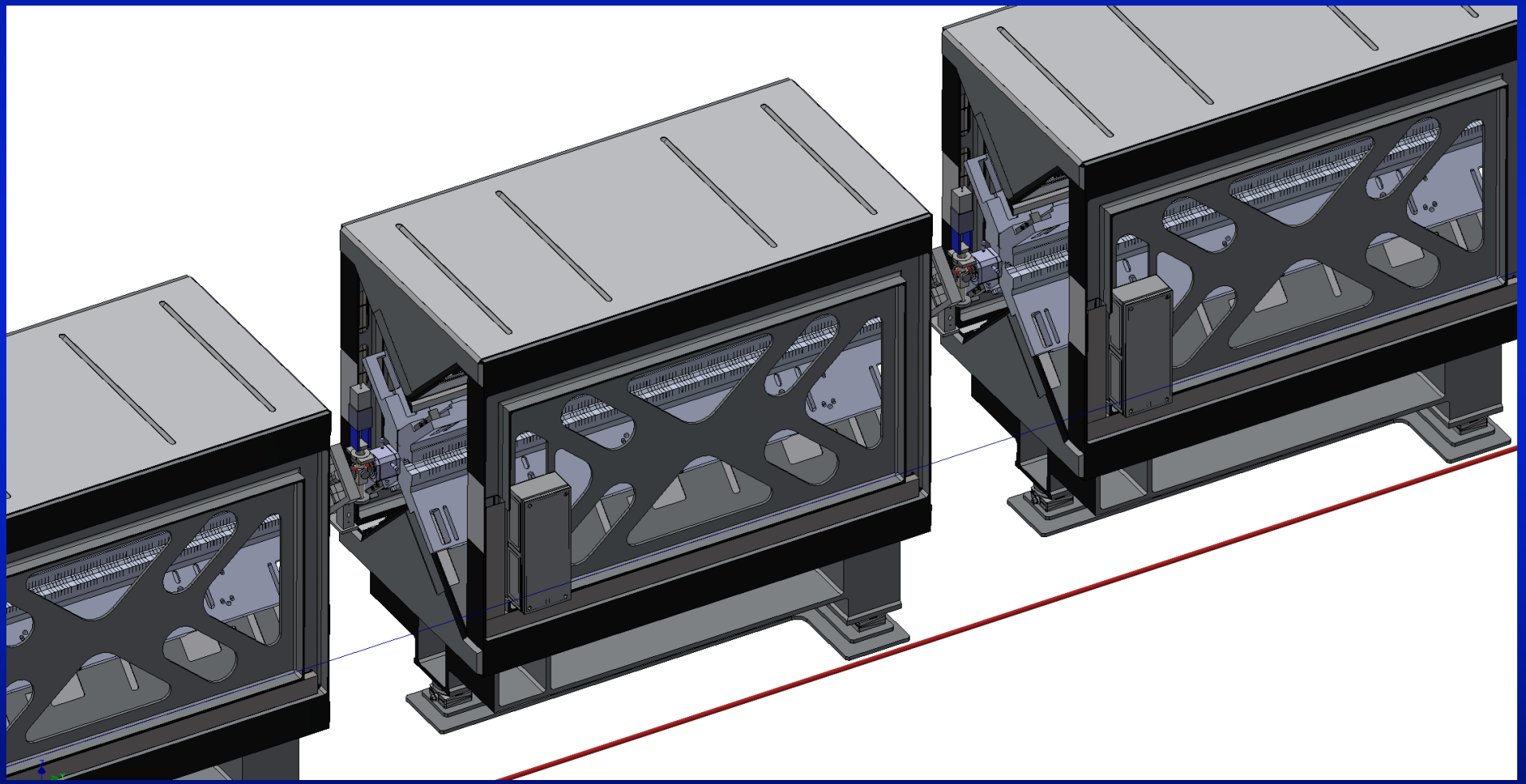


AQUA and ARIA undulators lines

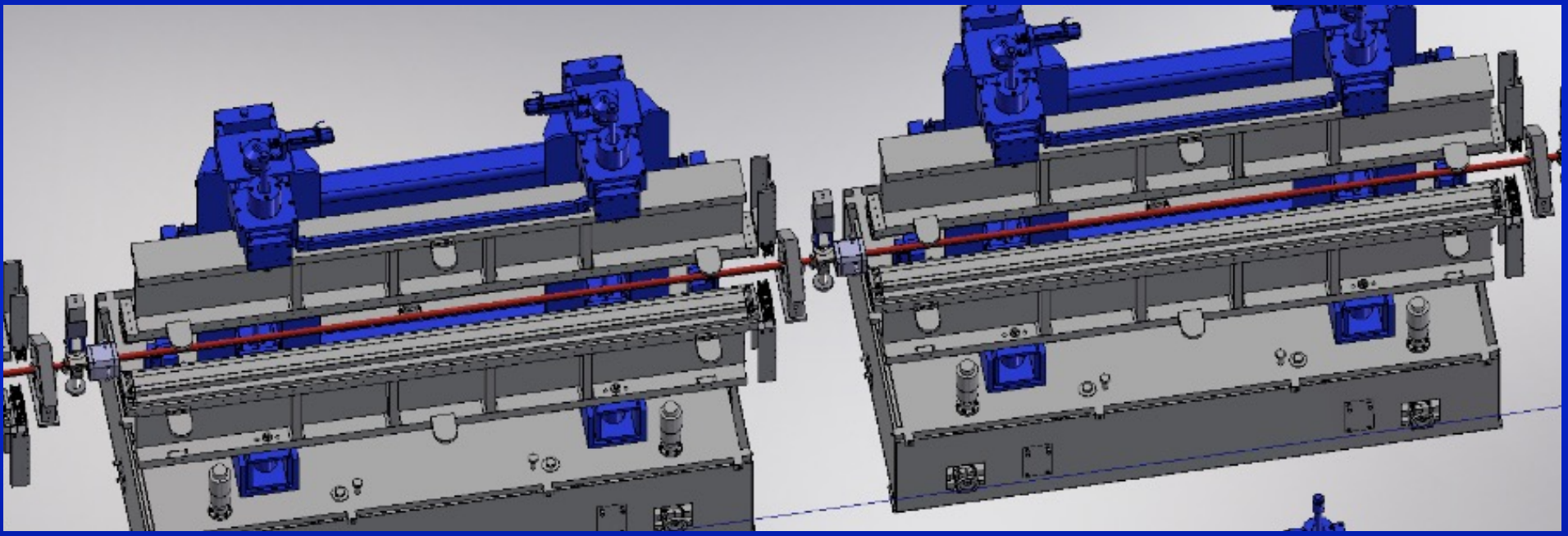


AQUA APPLE-X Undulators

Quadrupole-corrector magnet; Cavity Beam Position Monitor; view screen and pumping unit have been inserted between each module

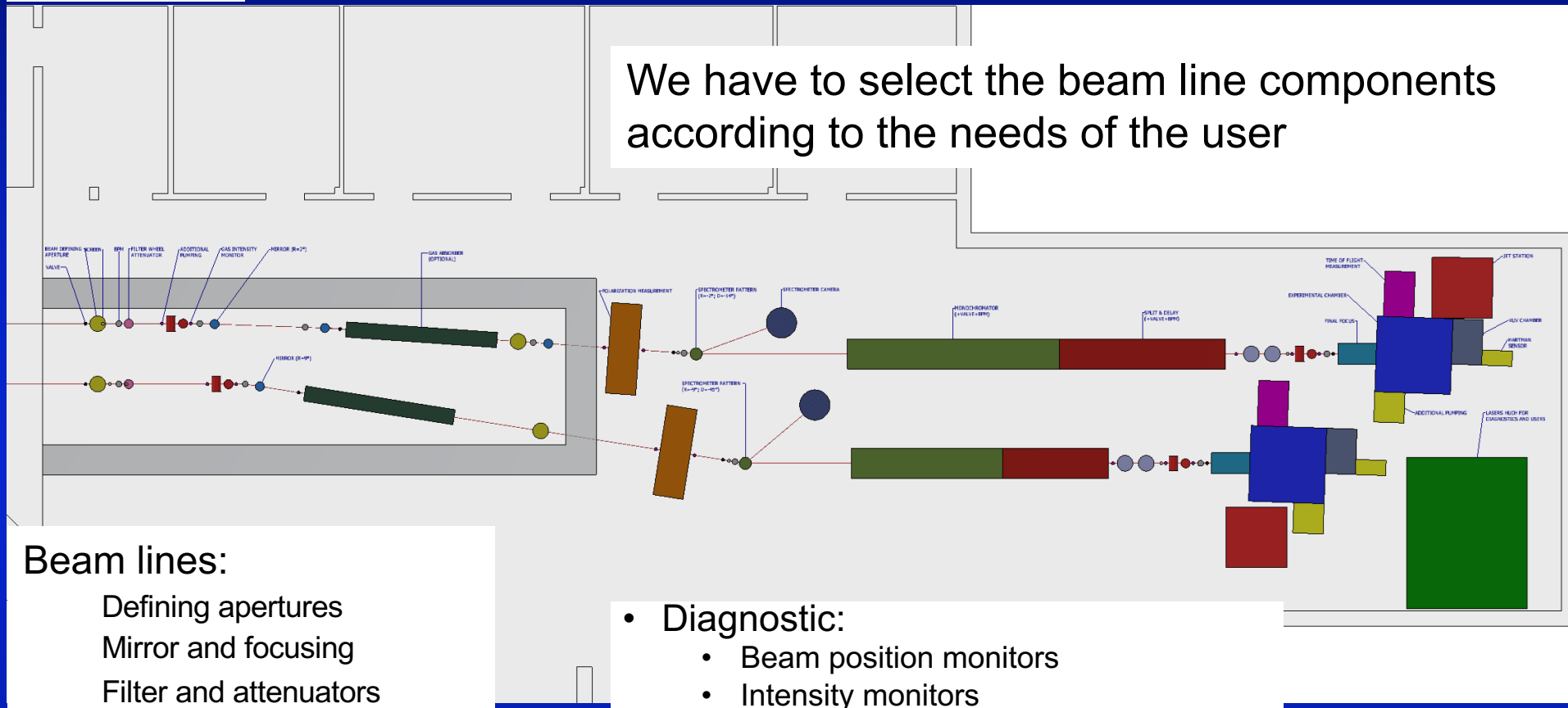


ARIA Planar Undulator Module with quads & diagnostics



FEL Users area

We have to select the beam line components according to the needs of the user



Beam lines:

- Defining apertures
- Mirror and focusing
- Filter and attenuators
- Monochromator
- Split & delay

- Diagnostic:
  - Beam position monitors
  - Intensity monitors
  - Spectrometer
  - Transverse dimension
  - Longitudinal dimension & time arrival
  - Wavefront measurement
  - Polarization measurement
  - Coherence measurement

TDR Structure

	Chapter	Reference person/people
1	executive summary	ferrario
2	eupraxia in the european context	assmann/ferrario
3	eupraxia@sparc_lab	ferrario/ghigo
4	scientific case	stellato
5	experience with the LNF test facilities	pompili/cardelli/biagioni
6	beam physics	vaccarezza/giannessi
7	machine layout	ghigo
8	photoinjector	chiadroni
9	X-band linac	alesini/gallo
10	plasma accelerating module	pompili/biagioni
11	Free Electron Laser	giannessi/petralia
12	photon beam lines	villa
13	experimental endstations	stellato/villa
14	electron and photon diagnostics	cianchi/villa
15	laser systems	anania
16	timing and synchronisation	bellaveglia
17	control system	pioli
18	vacuum system	liedl
19	magnets and power supply	sabbatini
20	machine protection system	pioli
21	civil infrastructures	rotundo
22	radiation safety and beam dump	esposito
23	integration, implementation and commissioning strategy	del franco
24	system engeneering	cioeta
25	project costs , timeline and management structure	falone

Building rendering

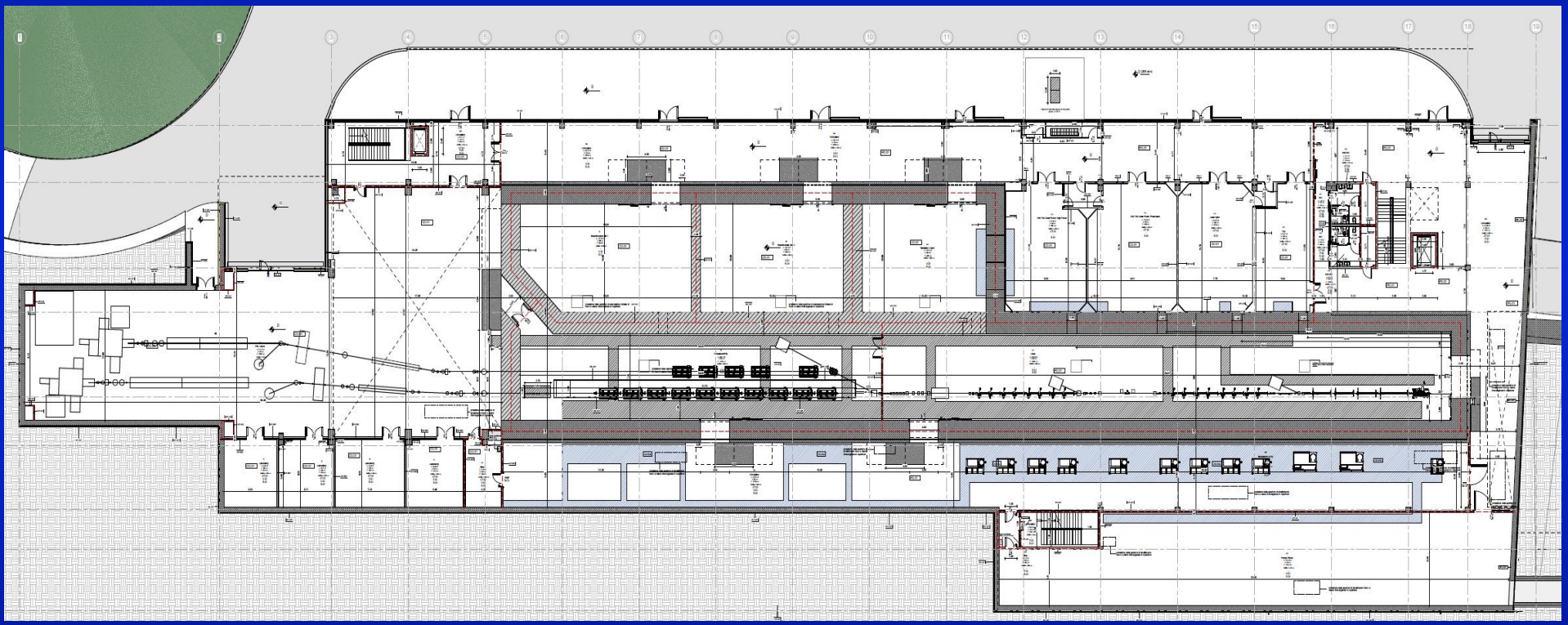
Infrastructure Status

Progress in the design finalization and authorization process:

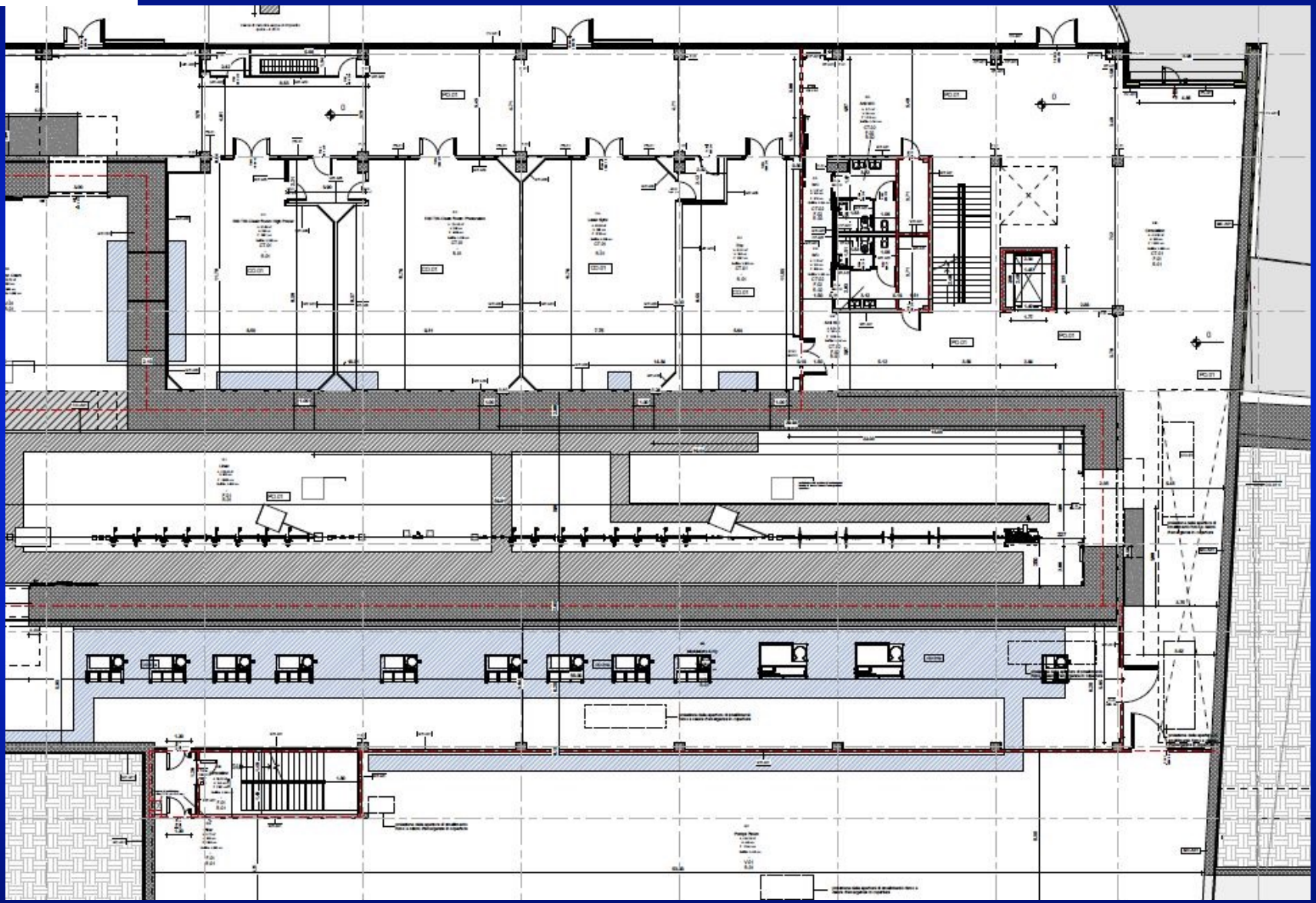
- Final Draft has been validate
- **The «Conferenza dei Servizi»** (Permitting authority committee) has given construction permission.
- Mythos Consortium, the external designer, started the executive design, final step to start the tender for the construction
- The bid for the executive project review from an external firm started
- Cost updated has been presented at INFN management level (GE).

Courtesy S.Incremona, U.Rotundo

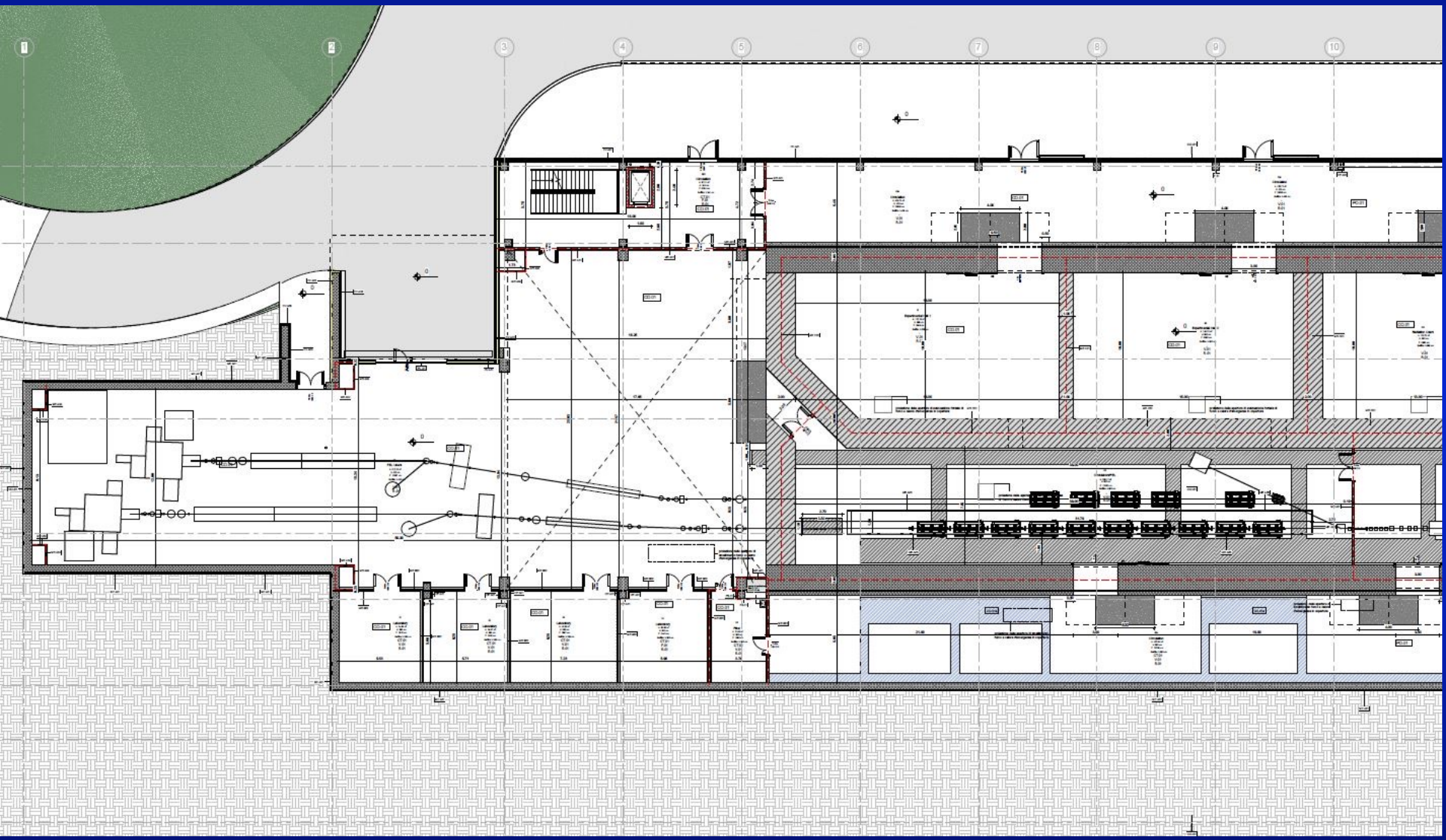
Equipments & Building CAD integration



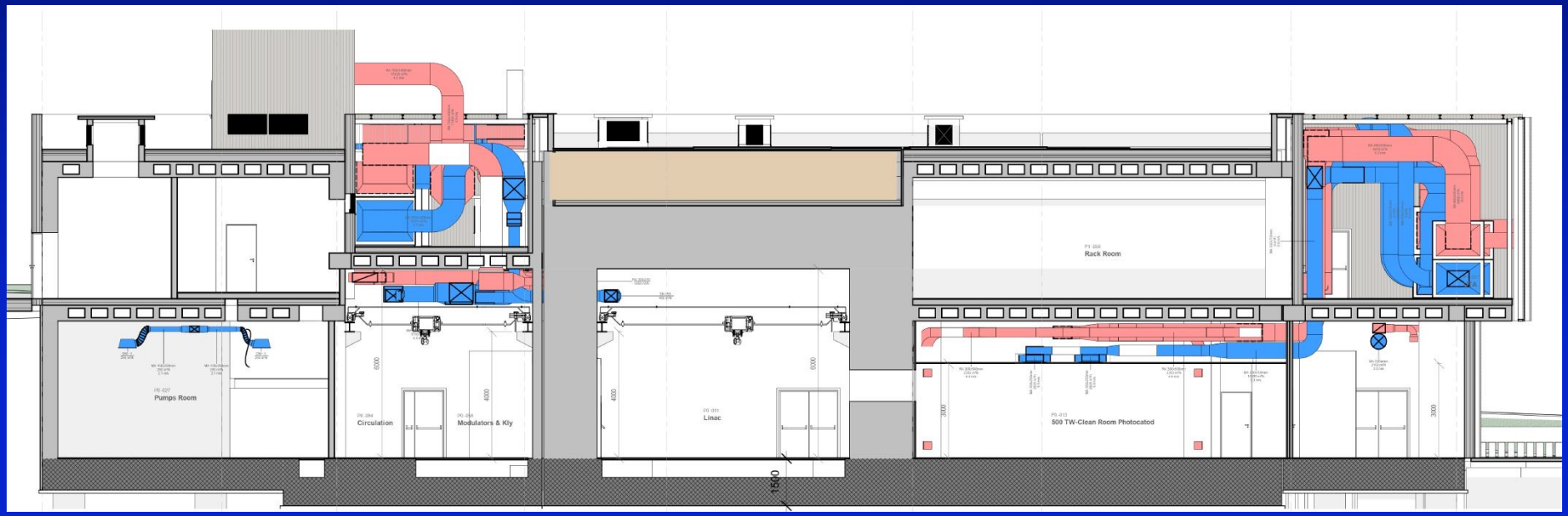
Accelerator & lasers Area



Undulators & users Area

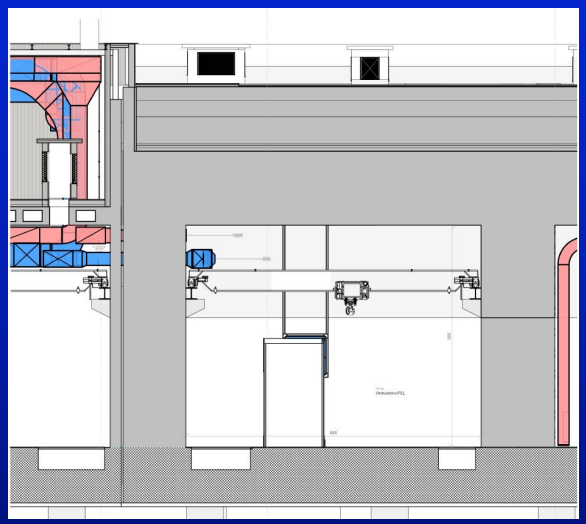


Drawing of the linac tunnel section



The final version of the definitive project took place after several iterations with the consortium of designers and revisions by our technical division

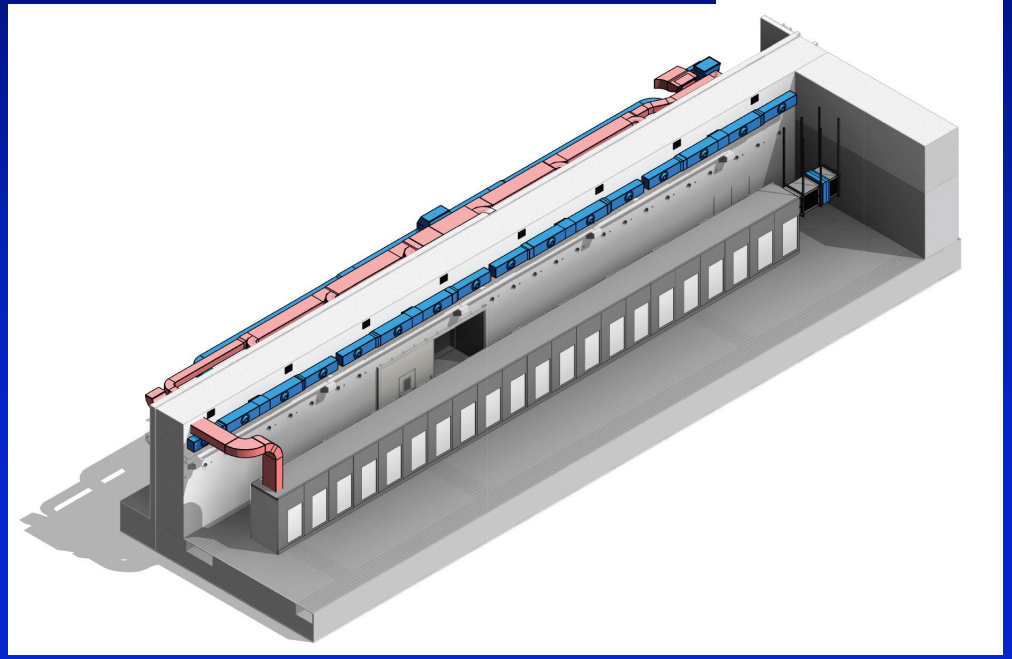
Courtesy S.Incremona, U.Rotundo and MYTHOS company



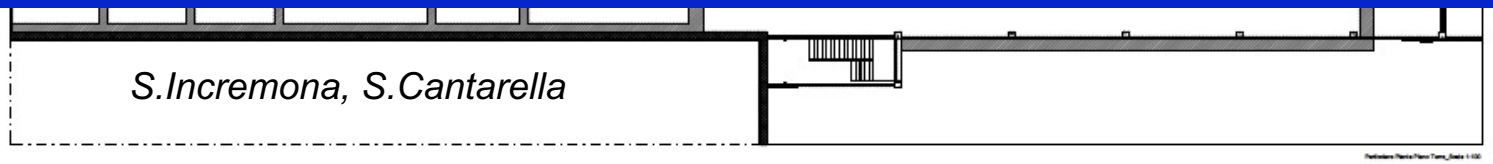
The building: Linac & undulator areas

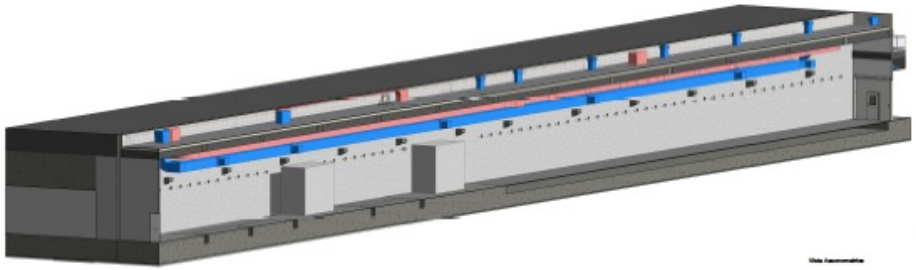
Undulator area

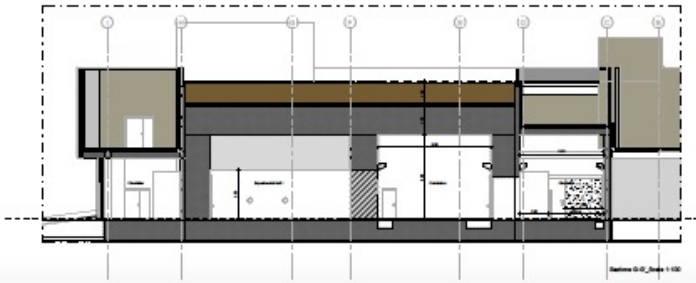
Building drawing of final draft with air cooling distribution



Linac area







EuPRAXIA@SPARC_LAB Functional Layout – V2.3

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EuPRAXIA

Areas	
LNT	Linac Tunnel
FTN	Fel Tunnel
USR	User Room
MHS	Modulator Hall S-Band
MHX	Modulator Hall X-Band
PWS	Power Supply Area

Module	
LA	Accelerating Module
LM	Magnetic Module

System Zones	
INJ	Injector
LEL	Low Energy Line
CMP	Bunch Compressor
HEL	High Energy Line
PLS	Plasma Section
FEL	Undulator Line

Component Legend

- BPM
- Corrector Magnet
- BPM with Corrector Magnet
- FAST Current Transformer (FCT)
- YAG/OTR Beam Screen
- Vacuum Valve
- S-Band Accelerating Structure
- X-Band Accelerating Structure
- Transverse Deflecting Cavity
- Linearizer
- Quadrupole Magnet
- Sextupole Magnet
- Special Dipole
- Dipole Magnet
- Vacuum Chamber
- Radiation Stop
- Beam Dump

F.Cioeta

1 of 1

Thanks for the attention