EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS

EuPRAXIA Project Management

Antonio Falone (INFN - LNF)

TDR review committee, 21/11/2023

INFN
LNF
Istituto Nazionale di Fisica Nucleare

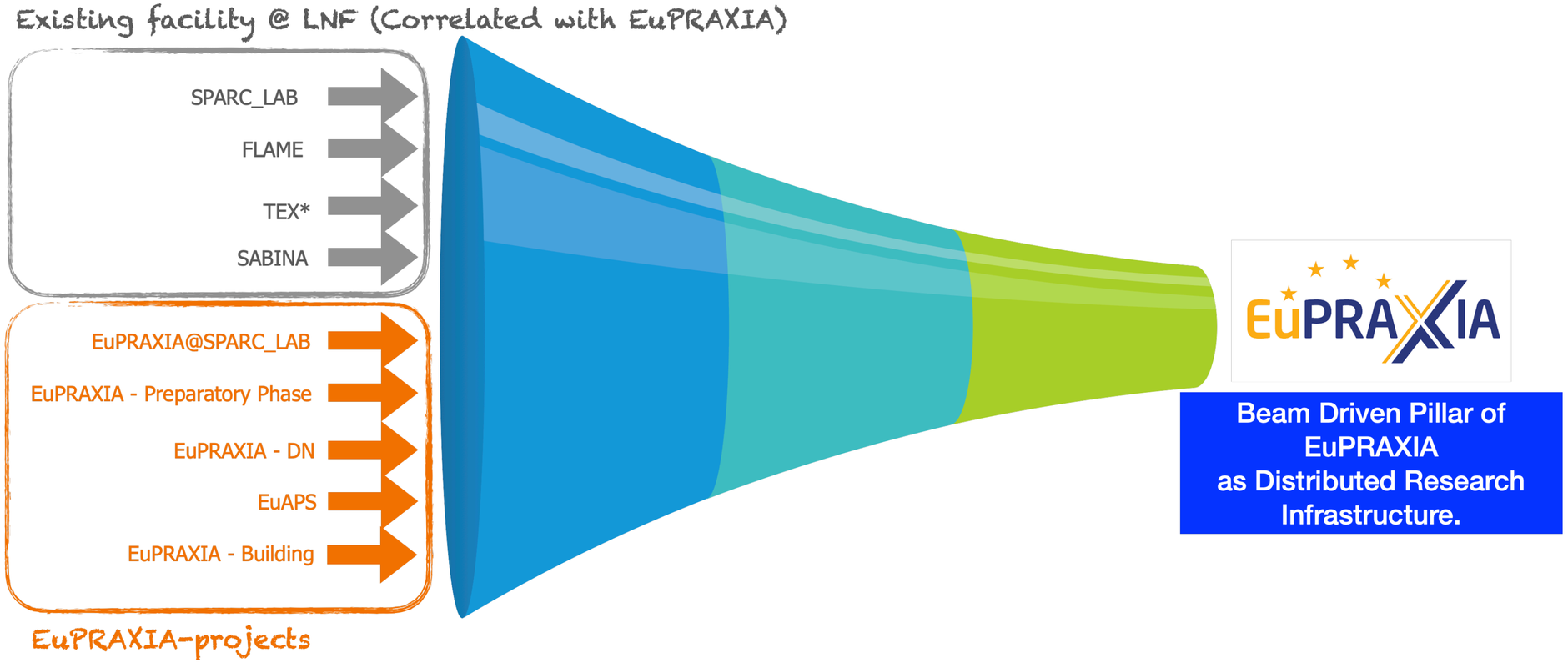
Outline

- EuPRAXIA Program : general overview
- Relevant news
- Status
- Risk assessment and mitigation actions
- Transition to the implementation phase

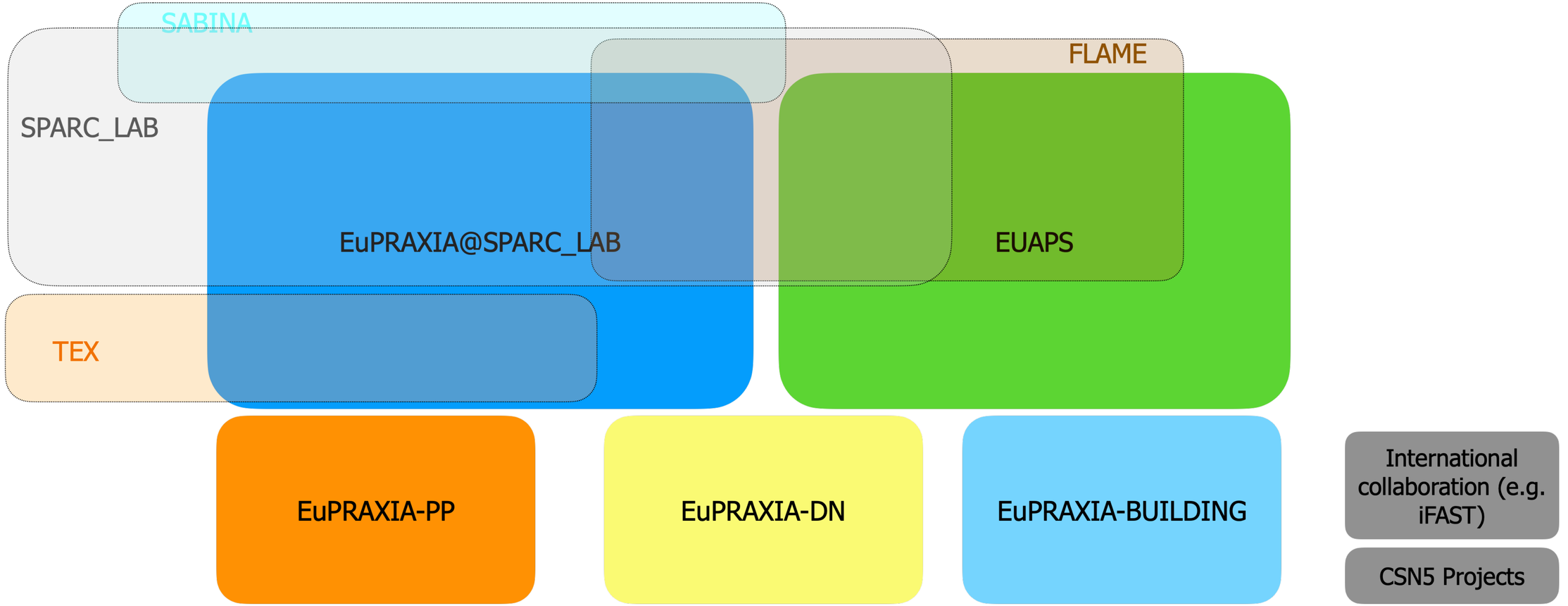
EuPRAXIA Projects and LNF facilities

Existing facilities at LNF serve all EuPRAXIA projects

Some of those facilities are undergoing an extensive upgrading.



EuPRAXIA Projects



All of them rely on the same resource pool (basically Accelerator Division and Technical Division).

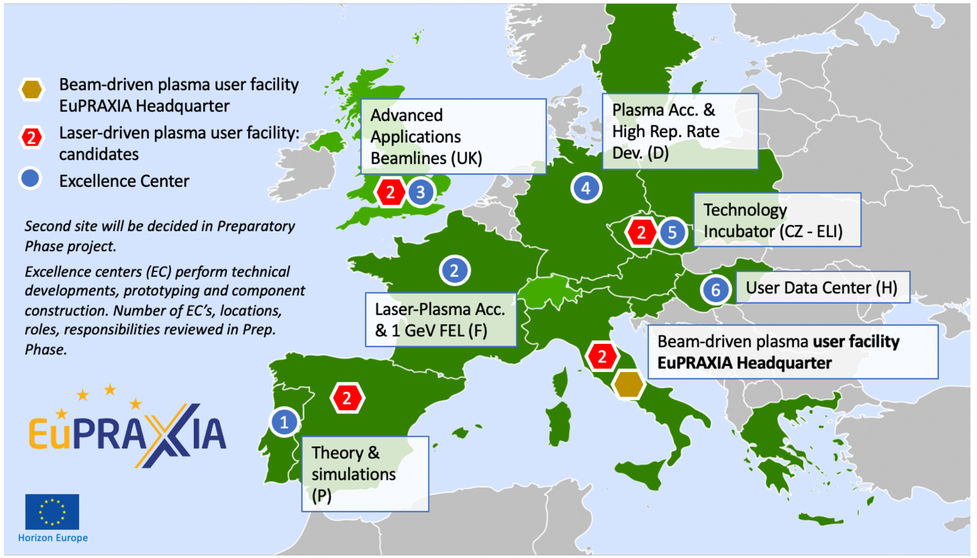
This is just a partial view of the activity of the LAB many other activities are ongoing (i.e. DAFNE Run) that still use the same resources

EuPRAXIA Projects

	EuPRAXIA@SPARC_LAB	EuPRAXIA Building	EuAPS	EuPRAXIA-Preparatory Phase	EuPRAXIA - Doctoral network
Scope	Redaction of the TDR of the Beam Driven Pillar	Design and construction of the building that will house the facility	Betatrone Source High Power Laser High Repetition Rate Laser	Definition and design of EuPRAXIA as distributed RI (legal, governance, financial model)	10 PhD programs across Europe on plasma accelerator science
Duration	TDR is expected at the end of 2025	End of 2027 (approx)	30months (+6) Not later than 31/12/2025	48 months 30/10/2026	48 months 31/12/2026
Budget	9 M€	O(40M€)	22,3 M€	2,7 M€ (+ In kind contribution)	2,5 M€ (+ In kind contribution)
Funding source	Internal funding through GE	Internal funding through GE	PNRR / next generation EU program	Horizon Europe	Horizon Europe
R&D required	Yes	NO	Some	NO	NO
Partner	Mainly internal LNF with some partnership with Elettra, ENEA UniTOV, Uniroma1, INFN-MI	Internal LNF	LNF, LNS, INFN-MI (INFN) CNR UniTOV	25 Partner + 9 Associated	23 Partner + 15 Associated

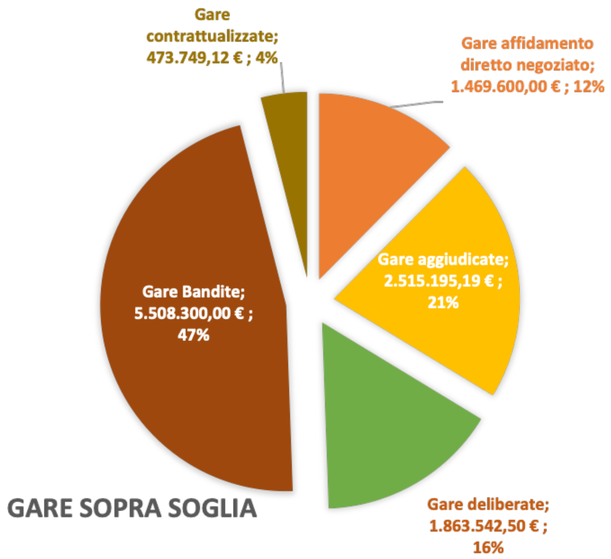
Relevant news EuPRAXIA - Preparatory Phase

- ✓ First year is over —> Technical & Financial Reporting is ongoing
- ✓ First batch of M12 deliverables produced on time and uploaded in the portal
- ✓ A number of dedicated workshops and meeting took place during the year, mostly to discuss the future architecture of the EuPRAXIA European Facility.



- ✓ Survey on possible in-kind contributions has been done.
- ✓ Discussions on 2nd site decision are ongoing.
- ✓ Overall architecture of the distributed RI is taking shape

Relevant news Status EuAPS



- ✓ First critical milestone - All the tender must be adjudicated by 31/12/23
  It has been essentially accomplished.
- ✓ Big effort in the last months to finalize the design and tender procedures
- ✓ Resource leveling for 2024 is in progress to mitigate resource conflicts on different projects and produce a realistic installation baseline.
- ✓ Hiring complete on all the Work Packages: 1 infrastructure manager + 7 technologists + 1 to be hired soon.

Courtesy C.Bortolin, L.Roscioli

Relevant news EuPRAXIA - Building

- Final design finalized
- Formal authorization from permitting authorities received
- Tender for the verification of the executive design issued
- Executive design kick-off meeting on the 18th October 2023.

DONE

- Executive design in progress

On Going

Courtesy S.Incremona, U.Rotundo

Relevant news

EuPRAXIA - Building

694

APPROVED

MINISTERO DELLE INFRASTRUTTURE E DEI TRASPORTI

PROVVEDITORATO INTERREGIONALE PER LE OO.PP. PER IL LAZIO, L'ABRUZZO, LA SARDEGNA

* * * * *

VIA MONZAMBANO, 10 – ROMA

AVVISO

ai sensi dell'art. 29 del D.Lgs. 18 aprile 2016, n. 50

OGGETTO: C.[illegible] n. [illegible]4 - Realizzazione di un nuovo complesso edilizio EuSPARC per ospitare la facility EuPRAXIA presso i Laboratori Nazionali di Frascati INFN.

Amministrazione Proponente: [illegible] Istituto Nazionale di Fisica Nucleare

Si comunica che ai sensi dell'art. 14-bis comma 5 della L. 241/90 e ss.mm. e ii., è da considerarsi acquisito l'assenso sul progetto in argomento da parte delle Amministrazioni invitate alla Conferenza. Si **DICHIARA**, pertanto, sulla scorta degli atti acquisiti, perfezionata l'intesa per la localizzazione e realizzazione dell'opera indicata in oggetto e, di conseguenza, **AUTORIZZATO** il relativo progetto definitivo.

Gli atti del procedimento sono in visione presso la Segreteria dell'Ufficio Conferenze di Servizi di questo Provveditorato

IL DIRIGENTE
Dott. Ing. Carlo Guglielmi

Firmato digitalmente da
CARLO GUGLIELMI
O = MMS
C = IT

IL RESPONSABILE DEL PROCEDIMENTO
Dott. Arch. Alessia Costa

Alessia Costa
MMS
19.05.2023 13:22:39
GMT+00:00

IL PROVVEDITORE
Dott. Ing. Vittorio Rapisarda Federico

VITTORIO
RAPISARDA
FEDERICO
Ministero delle
Infrastrutture
e dei Trasporti
23.05.2023
11:37:37
GMT+01:00

Roma, li _____

PUBBLICATO _____

RITIRATO _____

Courtesy S.Incremona, U.Rotundo

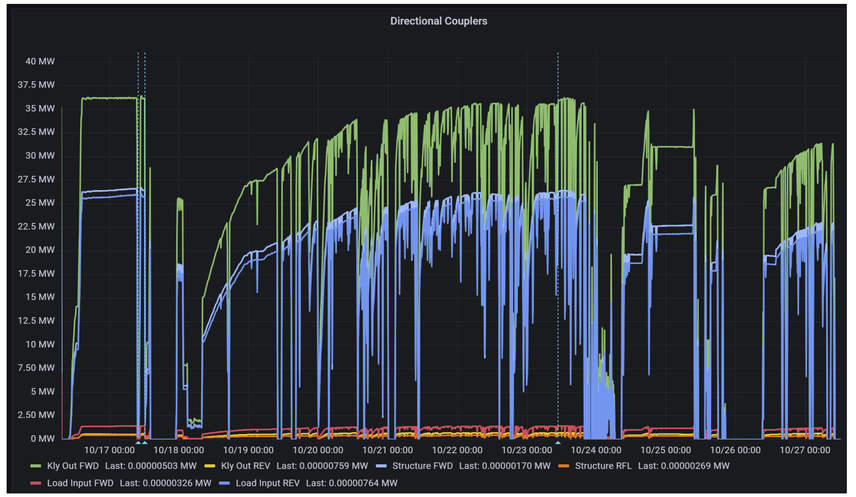
EuPRAXIA@SPARC_LAB

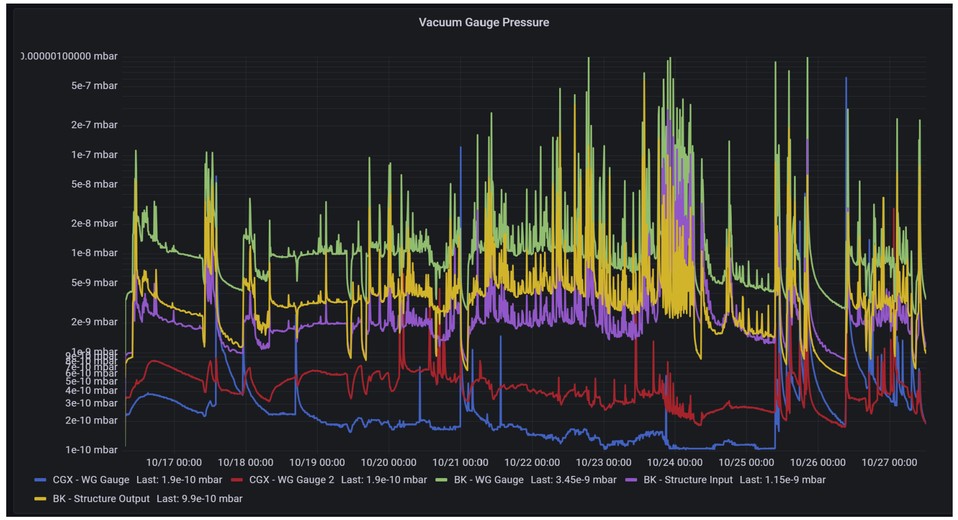
Relevant news RF test stand TEX

- ✓ RF design of X-Band waveguide components is completed (e.g. mode converter and pumping port)
- ✓ Procurement High Efficiency High Power CPI Klystron (50MW) – Concluded. Preliminary design review completed (09/23), final design review scheduled on the12th of December - ON TIME
- ✓ Procurement High Repetition Rate Canon Klystron through Scandinova is almost finished - FAT@ Canon premises done on the 14th November 2023. Installation scheduled next spring
- ✓ TEX Facility – Operating. Test on CERN/ PSI X-Band section. Test on Circular Waveguide & Waveguide Mode converters done.
- ✓ Optimization of the RF Distribution on going (Choice on RF system for linearizer and deflector - dedicated RF station or distributed waveguide system)

Courtesy F.Cardelli / S.Pioli

Relevant news RF test stand TEX

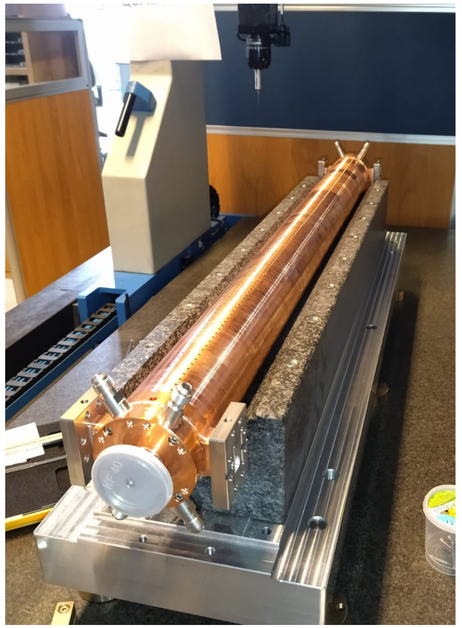


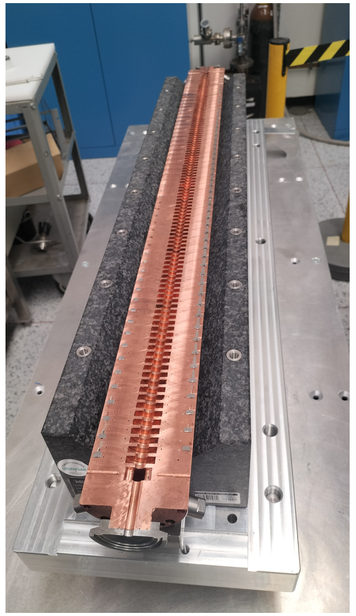


Courtesy F.Cardelli / S.Pioli

Relevant news Linac

- ✓ Mechanical Prototype X-Band section successfully validated. No significant deformation after brazing and vacuum tightness.
- ✓ RF prototype produced - Brazing is expected at the end of November / beginning of December
- ✓ RF test on the prototype will be likely postponed to mid 2024 due to the upgrading works foreseen@TEX for the new RF stations that will be installed in spring.





Courtesy D.Alesini

Relevant news

Technical Design Report - Framework

Chapter	
1	executive summary
2	eupraxia in the european context
3	eupraxia@sparc_lab
4	scientific case
5	experience with the LNF test facilities
6	beam physics
7	machine layout
8	photoinjector
9	X-band linac
10	plasma accelerating module
11	Free Electron Laser
12	photon beam lines
13	experimental endstations
14	electron and photon diagnostics
15	laser systems
16	timing and synchronisation
17	control system
18	vacuum system
19	magnets and power supply
20	machine protection system
21	civil infrastructures
22	radiation safety and beam dump
23	integration, implementation and commissioning strategy
24	system engeneering
25	project costs , timeline and management structure

This will be complemented by:

- Scientific Case Report
- Project Management Plan

Overleaf structure is already in place and the population of each single chapter has just started.

System engineering

In view of the completion of the TDR and the consequent upcoming implementation phase,
There are some progress on the system engineering issues.

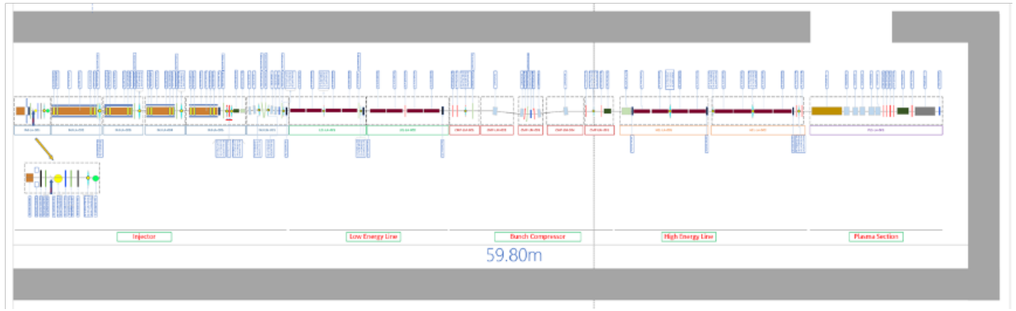
Definition of an integrated framework for:

- Machine configuration management and naming convention;
- Components database management Machine
- Components management related to ancillary elements (power supplies, cabling, controller, DAQ, etc…)
- Budget management

Courtesy F.Cioeta

System engineering

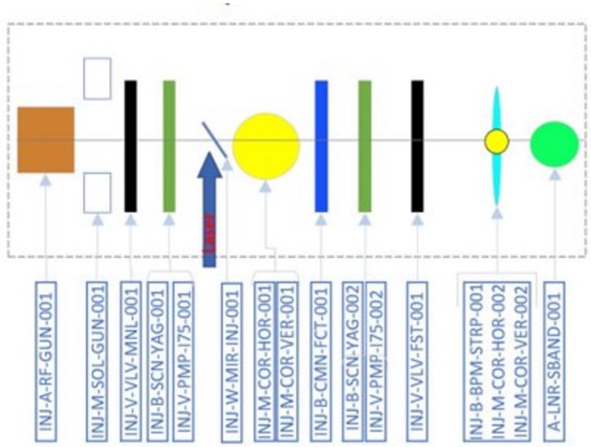
The schematic layout was developed using Viso Professional of Microsoft Office 365 as the project software. The purpose of the schematic layout is to give an immediate overview of machine elements in order to help to plan and to implement machine components that will be after listed in a specifics database.



The name of a system is the set of two codes

.....and Naming Convention

The need for a hierarchical and arborescent organization of objects for the purpose of efficient and traceable management of configuration machine occurs through the use of a specific ***nomenclature.***

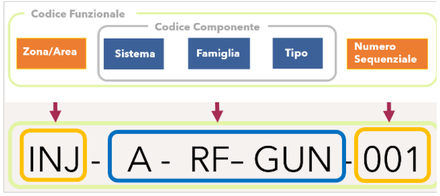


Component Code:

It identifies the system as such. Identical components may have the same code.

Functional Code:

Additional fields that determine the uniqueness of the component by identifying the zone or area of the machine where it is installed and where the component acquires its functionality.



Courtesy F.Cioeta

System engineering

Using specific software as a database (e.g. Hexagon INFOR-EAM), it is possible to create relationships between the various tables that collect requirements and components related to machine elements, so as to identify for each individual element the auxiliary components necessary at the proper operation and control as well as visualize all the components in the machine through the CAD interface. For each component therefore is possible to identified a specifics codes and attributes such as:

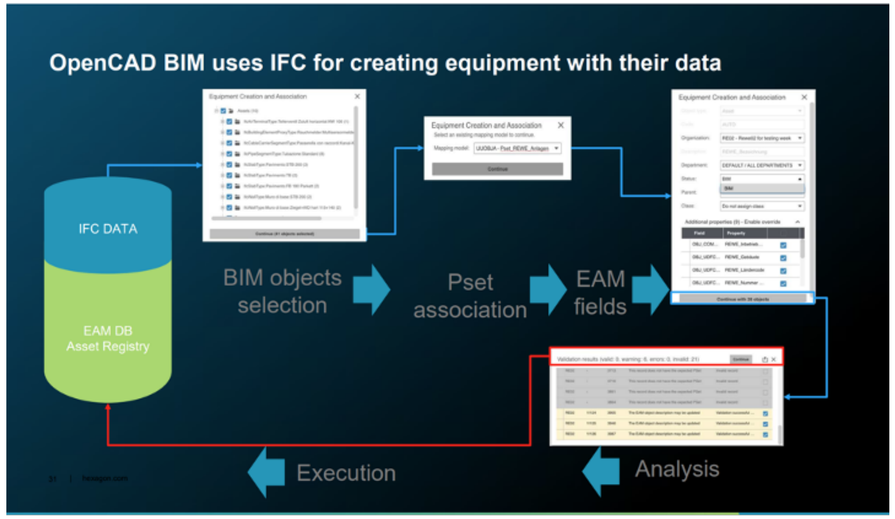
- UUID Code
- PBS Code
- WBS Code
- Moduls
- Longitudinal coordinate
- Type of connectors
- Facility requirements (water flow, electrical power)
- Costs
- Status
- Suppliers

➢ Moreover is possible to link other document such as:

1. Specifications
2. Approved construction drawings
3. Commercial documents (orders, specifications, etc.)
4. Quality documents (calibration certificates, certificates of conformity, etc.)
5. Warranty
6. Manuals

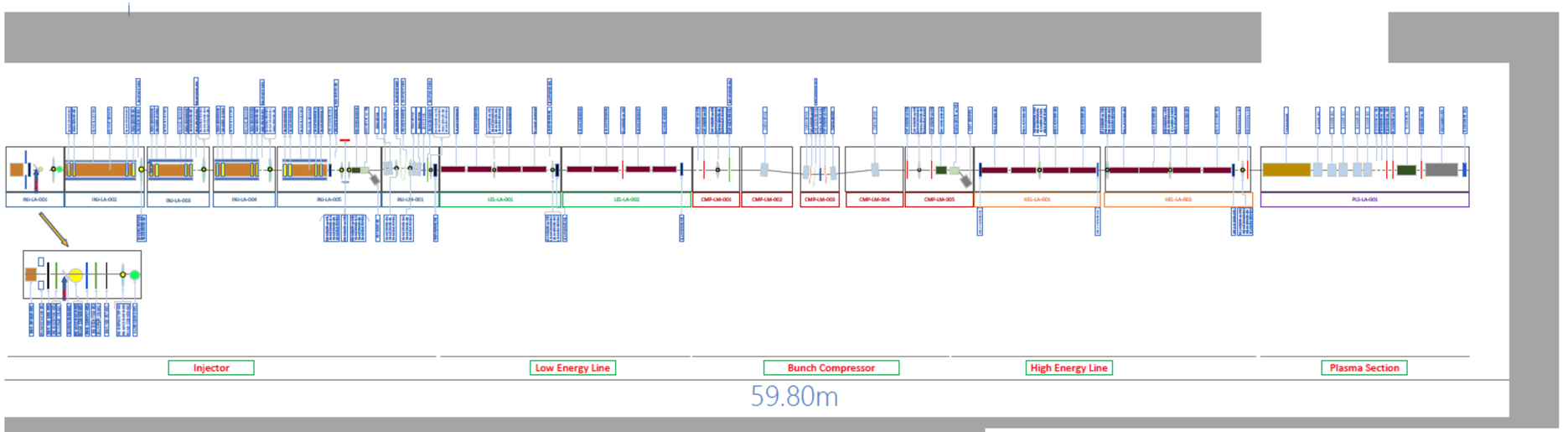
Riquadro di spostamento

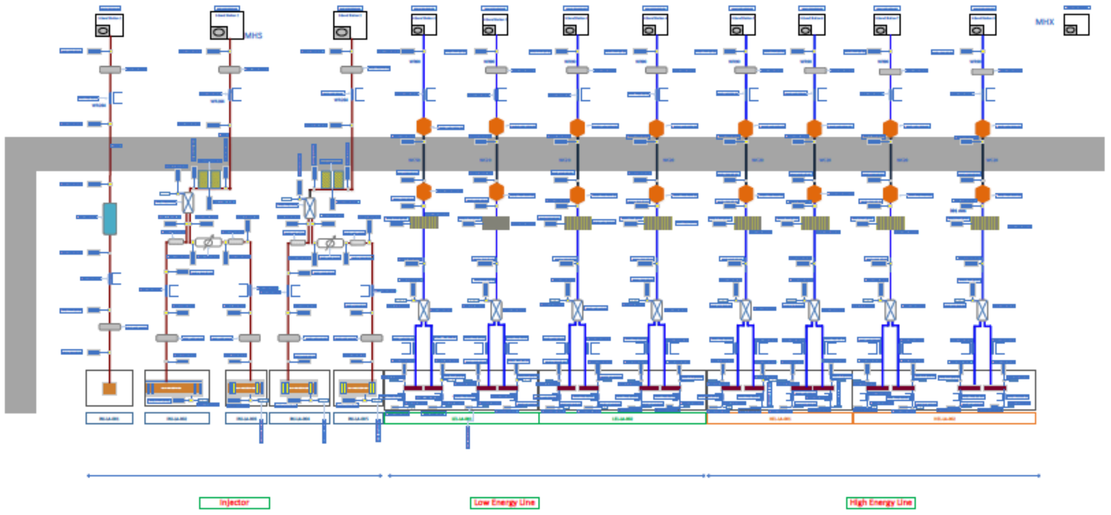
ID	ID_COM	WA C	WE	AREA	SYS	FAM	TYPE	SEQUE	PBS-CODE	DESCRIPTION	Z-C	MODULS
1	RFG	WA2	WP08	INJ	A	RF	GUN	001	INJ-A-RF-GUN-001	RF GUN	0	INJ-LA-001
2	I20			INJ	V	PMP	I20	001	INJ-V-PMP-I20-001	ION PUMP GUN	0	INJ-LA-001
3	I20			INJ	V	PMP	I20	002	INJ-V-PMP-I20-001	ION PUMP GUN	0	INJ-LA-001
4	NEG			INJ	V	PMP	NEG	001	INJ-V-PMP-NEG-001	NEXTOR Z100 GUN	0	INJ-LA-001
5	NEG			INJ	V	PMP	NEG	002	INJ-V-PMP-NEG-002	NEXTOR Z 100 GUN	0	INJ-LA-001
6	SLG			INJ	M	SOL	GUN	001	INJ-M-SOL-GUN-001	SOLENOID GUN	0	INJ-LA-001
7	VMN			INJ	V	VLV	MNL	001	INJ-V-VLV-MNL-001	MANUAL VALVE GUN	0	INJ-LA-001
8	SYA			INJ	B	SCN	YAG	001	INJ-B-SCN-YAG-001	SCREEN GUN	0	INJ-LA-001
9	I75			INJ	V	PMP	I75	001	INJ-V-PMP-I20-001	IONIC PUMP GUN	0	INJ-LA-001
10	MIR			INJ	W	MIR	INJ	001	INJ-W-MIR-INJ-001	MIRROR GUN	0	INJ-LA-001
11	CHO			INJ	M	COR	HOR	001	INJ-M-COR-HOR-001	HORIZONTAL CORRECTOR GUN	0	INJ-LA-001
12	CVE			INJ	M	COR	VER	001	INJ-M-COR-VER-001	VERTICAL CORRECTOR GUN	0	INJ-LA-001
13	CMN			INJ	B	CMN	FCT	001	INJ-B-CMN-FCT-001	CURRENT MONITOR GUN	0	INJ-LA-001
14	SYA			INJ	B	SCN	YAG	002	INJ-B-SCN-YAG-002	SCREEN GUN	0	INJ-LA-001
15	I75			INJ	V	PMP	I75	002	INJ-V-PMP-I75-002	IONIC PUMP GUN	0	INJ-LA-001
16	VFS			INJ	V	VLV	FST	001	INJ-V-VLV-FST-001	FAST VALVE GUN	0	INJ-LA-001
17	LNR			INJ	A	LNR	SBD	001	INJ-A-LNR-SBD-001	LINEARIZER	0	INJ-LA-001
18	BPM			INJ	B	BPM	STP	001	INJ-B-BPM-STP-001	STRIPLINE GUN	0	INJ-LA-001
19	CHO			INJ	M	COR	HOR	002	INJ-M-COR-HOR-002	HORIZONTAL CORRECTOR GUN	0	INJ-LA-001
20	CVE			INJ	M	COR	VER	002	INJ-M-COR-VER-002	VERTICAL CORRECTOR GUN	0	INJ-LA-001
21	XBG			INJ	A	ACC	XBD	001	INJ-A-ACC-XBD-001	XBAND GUN	0	INJ-LA-001
22	CHO			INJ	M	COR	HOR	003	INJ-M-COR-HOR-003	HORIZONTAL CORRECTOR LA002	0	INJ-LA-002
23	CVE			INJ	M	COR	VER	003	INJ-M-COR-VER-003	VERTICAL CORRECTOR LA002	0	INJ-LA-002
24	SOL			INJ	M	SOL	SEC	001	INJ-M-SOL-SEC-001	SOLENOID SBAND	0	INJ-LA-002
25	SBD			INJ	A	ACC	SB3	001	INJ-A-ACC-SB3-001	SBAND 3M LA002	0	INJ-LA-002
26	CHO			INJ	M	COR	HOR	004	INJ-M-COR-HOR-004	HORIZONTAL CORRECTOR SB1	0	INJ-LA-002
27	CVE			INJ	M	COR	VER	004	INJ-M-COR-VER-004	VERTICAL CORRECTOR SB1	0	INJ-LA-002
28	SYA			INJ	B	SCN	YAG	003	INJ-B-SCN-YAG-003	FIRST SCREEN LA002	0	INJ-LA-002
29	I75			INJ	V	PMP	I75	003	INJ-V-PMP-I75-003	ION PUMP SBND1	0	INJ-LA-002
30	BPM			INJ	B	BPM	STP	002	INJ-B-BPM-STP-002	STRIPLINE LA002	0	INJ-LA-002
31	CHO			INJ	M	COR	HOR	005	INJ-M-COR-HOR-005	HORIZONTAL CORRECTOR LA002	0	INJ-LA-002
32	CVE			INJ	M	COR	VER	005	INJ-M-COR-VER-005	VERTICAL CORRECTOR LA002	0	INJ-LA-002
33	CHO			INJ	M	COR	HOR	006	INJ-M-COR-HOR-006	HORIZONTAL CORRECTOR LA003	0	INJ-LA-003
34	CVE			INJ	M	COR	VER	006	INJ-M-COR-VER-006	VERTICAL CORRECTOR LA003	0	INJ-LA-003



Courtesy F.Cioeta

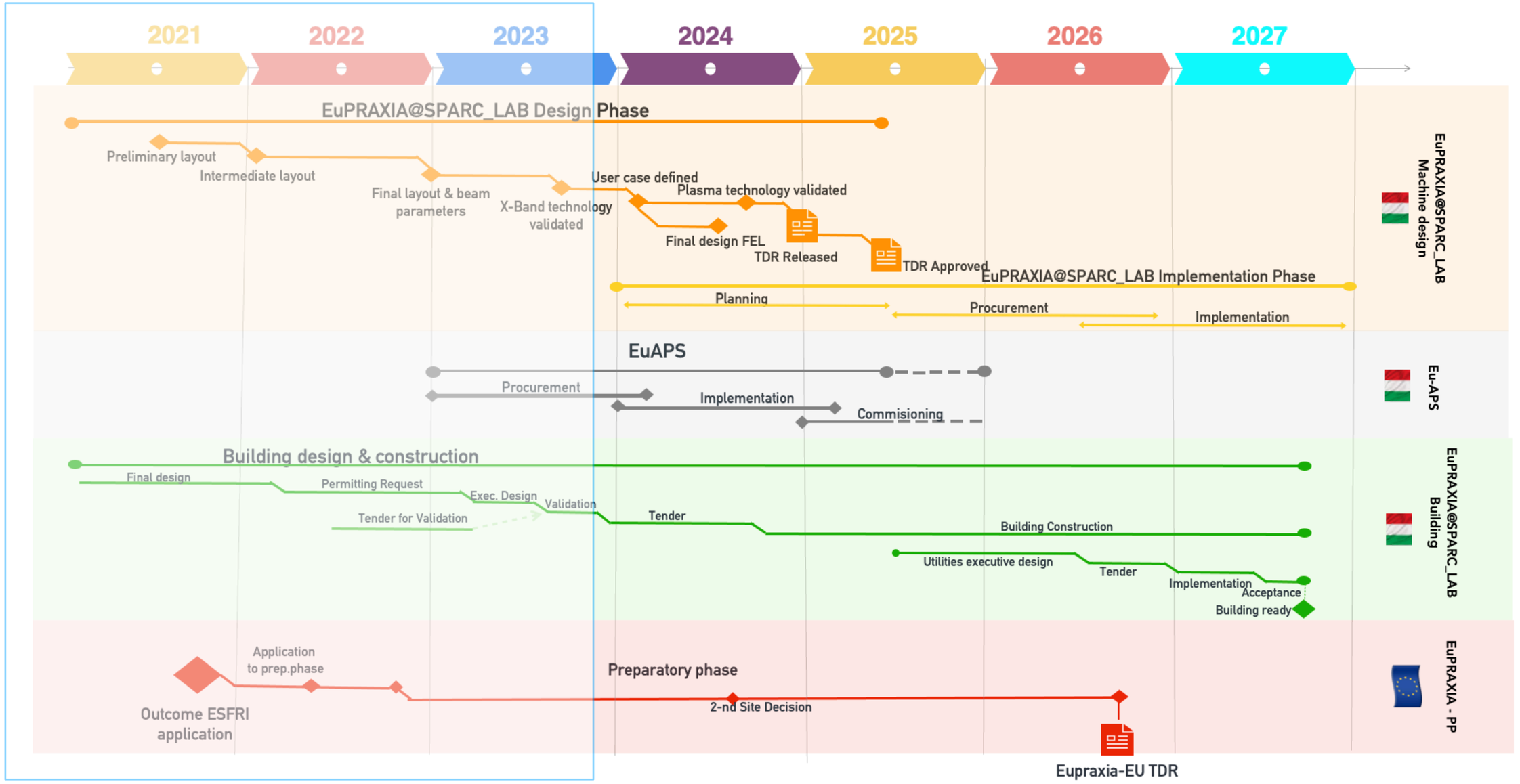
System engineering





Courtesy F.Cioeta

EuPRAXIA Master Schedule



EuPRAXIA Milestones status

WA ID	Intermediated deliverable expected	Expected Date	Updated Status	Comment	NOTE
WA1 BEAM PHYSICS					
M1.1	S2E new layout completed	08/01/22		Consolidated	
M1.2	Photon Number optimization	12/01/22		Consolidated	
M1.3	Machine intermediate layout	01/06/23		Done	On time
M1.4	RF specifications	01/06/23		Done	On time
M1.5	Magnets specifications	01/06/23		Consolidated	
M1.6	Stability& Jitter studies	23/06/23		Preliminar	
M1.7	Laser heater parameters	07/03/23		Preliminar	
M1.8	Machine final layout	24/05/24		To be done	

EuPRAXIA Milestones status

WA ID	Intermediated deliverable expected	Expected Date	Updated Status	Comment	NOTE
WA2	**Injector**				
M2.1	Injector preliminary layout	18/06/21		Done	On time
M2.2	Injector Layout	10/03/22		Done	On time
M2.3	Injector components design	11/06/23		Done	On time
M2.4	Injector RF Distribution	23/01/23		Done	On time
M2.5	Photocathode laser design	23/03/23		Marginal delay	Not critical
WA3	**Linac**				
M3.1	Linac Design	28/04/23		Minor details to be completed	
M3.2	Vacuum Design	28/04/23		Minor details to be completed	
M3.3	Linac RF Distribution	07/04/24		Done	On time
M3.4	HP Waveguide Validated	06/01/23		Done	On time
M3.5	X-Band section validated	01/01/24		Marginal delay	Brazing next week. Not critical delay

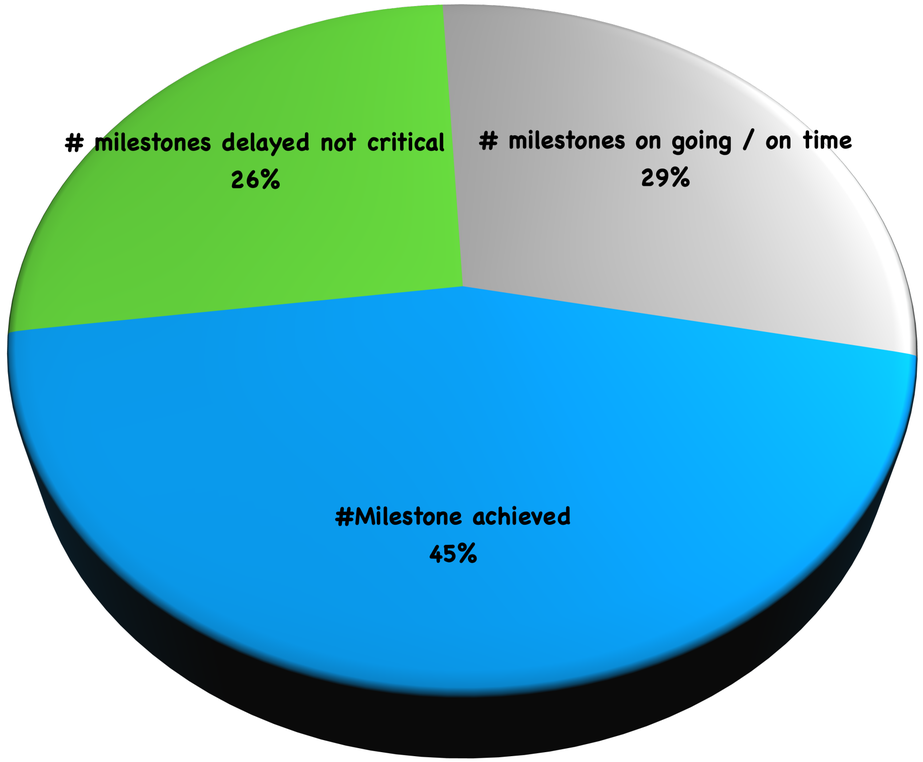
EuPRAXIA Milestones status

WA ID	Intermediated deliverable expected	Expected Date	Updated Status	Comment	NOTE
WA4	**RF & Power Supplies**				
M4.1	S-Band Waveguide design	03/08/22		Done	On time
M4.2	X-Band Waveguide design	03/08/22		Done	On time
M4.3	Power supply design validated.	28/04/23		Premilinar	Delay Not critical
M4.4	X-Band RF power system validation	23/08/24		Consolidated	Will be on time
M4.5	Timing & Synchronization system designed	19/07/24		Consolidated	On time
WA5	**Plasma**				
M5.1	Capillary plasma characterization	25/10/23		Consolidated	Delay to be assessed
M5.2	Plasma section final design	17/01/24		On time	Expected at the final of the TDR
WA6	**FEL**				
M6.1	FEL Configuration Strategy	05/03/22		Done	On time
M6.2	Final Design Phase 0	11/08/24		Preliminar	On time
M6.3	AQUA Final Design	29/03/24		Preliminar	On time

EuPRAXIA Milestones status

WA ID	Intermediated deliverable expected	Expected Date	Updated Status	Comment	NOTE
WA9 User					
WA8.M1	Design optical elements	11/03/23		Draft	Lack of manpower to be addressed
WA8.M2	Final design user end station	19/04/24		Draft	Lack of manpower to be addressed
WA8.M3	TDR Users	10/04/24		To be done	Possible delays (not critical for the implementation phase)
WA10 Diagnostics					
M10.1	BPM prototype validation	28/09/22		Done	On time
M10.2	BLM prototype validation	30/01/23		Draft	Delay not critical
M10.3	Compact Diag Chamber validation	02/07/23		Done	On time
M10.4	High Precision Charge measurement validation	20/05/22		Preliminar	Delay not critical
M10.5	Diagnostic prototyping validation	02/07/23		Preliminar	Delay not critical
M10.5	Final e-beam diagnostic design	02/07/23		Preliminar	Possible delays

EuPRAXIA Milestones status



WA ID	Intermediated deliverable expected	Expected Date	Updated Status
WA 1	**Beam Physics**		
M1.1	S2E new layout completed	08/01/22	
M1.2	Photon Number optimization	12/01/22	
M1.3	Machine intermediate layout	01/06/23	
M1.4	RF specifications	01/06/23	
M1.5	Magnets specifications	01/06/23	
M1.6	Stability& Jitter studies	23/06/23	
M1.7	Laser heater parameters	07/03/23	
M1.8	Machine final layout	24/05/24	
WA 2	**Injector**		
M2.1	Injector preliminary layout	18/06/21	
M2.2	Injector Layout	10/03/22	
M2.3	Injector components design	11/06/23	
M2.4	Injector RF Distribution	23/01/23	
M2.5	Photocathode laser design	23/03/23	
WA 3	**LINAC**		
M3.1	Linac Design	28/04/23	
M3.2	Vacuum Design	28/04/23	
M3.3	Linac RF Distribution	07/04/24	
M3.4	HP Waveguide Validated	06/01/23	
M3.5	X-Band section validated	01/01/24	
WA 4	**RF & Power Supplies**		
M4.1	S-Band Waveguide design	03/08/22	
M4.2	X-Band Waveguide design	03/08/22	
M4.3	Power supply design validated.	28/04/23	
M4.4	X-Band RF power system validation	23/08/24	
M4.5	Timing & Synchronization system designed	19/07/24	
WA 5	**PLASMA**		
M5.1	Capillary plasma characterization	25/10/23	
M5.2	Plasma section final design	17/01/24	
WA 6	**FEL**		
M6.1	FEL Configuration Strategy	05/03/22	
M6.2	Final Design Phase 0	11/08/24	
M6.3	AQUA Final Design	29/03/24	
WA 8	**USERS**		
WA8.M1	Design optical elements	11/03/23	
WA8.M2	Final design user end station	19/04/24	
WA8.M3	TDR Users	10/04/24	
WA 10	**Diagnostics**		
M10.1	BPM prototype validation	28/09/22	
M10.2	BLM prototype validation	30/01/23	
M10.3	Compact Diag Chamber validation	02/07/23	
M10.4	High Precision Charge measurement validation	20/05/22	
M10.5	Diagnostic prototyping validation	02/07/23	
M10.5	Final e-beam diagnostic design	02/07/23	

EuPRAXIA Milestones status | Mitigation actions

Some delays accumulated in the last months.

Final assessment on the impact of the overall delay will be done after the executive design of the building (Super critical milestone).

In the meantime some mitigation actions are being implemented in order to proceed with the program activities:

- Start to prepare the TDR in order to assess the real TRL
- Integrated resource allocation for all the EuPRAXIA projects - effort optimization
- Assessment of the baseline by mid 2024 (after building executive design completion) in order to have a more solid information on the upcoming years.

Transition to Implementation Phase

✓ Starting the planning of the implementation phase

1 additional Working Area - INTEGRATION to help in the definition of the implementation phase:

- Installation and commissioning strategy
- Procurement strategy and planning
- Ancillary systems to be organized (pre-assembly area, alignment, logistics etc…).

✓ TDR Structure is in place (proto-WBS for the implementation phase)

Transition to Implementation Phase

- ✓ A cost Estimation based on the existing layout has been produced and it is now in the phase of a refinement.
- ✓ Cost Estimation based on the existing layout and grouped in three families.
- ✓ First Cost&Schedule Review Meeting is scheduled on the 11th December 2023.

Machine

- Linac
- Ondulators
- Photon Beamline
- User End Station
- RF & Power Supplies
- Laser system
- Ancillary System (DAQ, Controls)

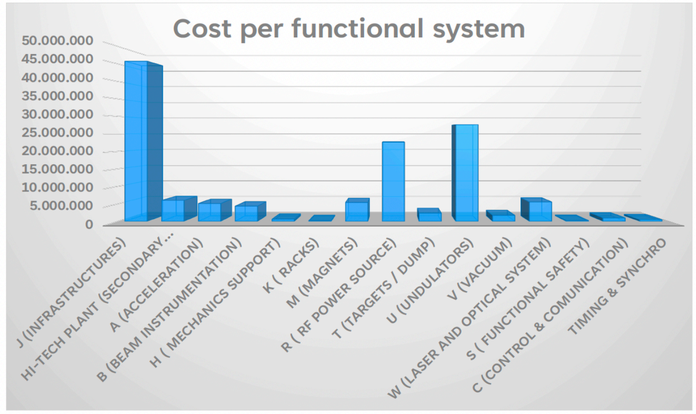
Utilities

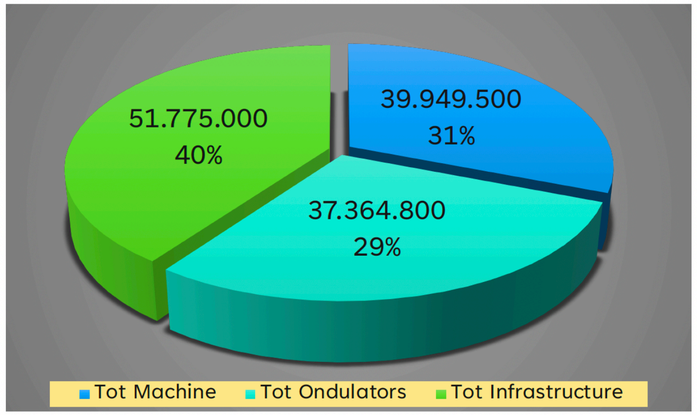
- Cabling
- Secondary cooling system

Civil Engineer

- Building
- HVAC
- Electrical Distribution

Cost estimation analysis





Functional Area	Expected Cost [€] VAT Included
Injector	4.897.100
Low Energy Line	1.918.900
Bunch Compressor	969.500
High Energy Line	2.211.300
Plasma Module	2.137.000
RF Power Station	22.631.000
Control (W/Timing & Synchro)	1.500.000
Photocathode Laser	1.100.000
Tot Machine	37.364.800
ARIA	13.986.800
ARIA BeamLine	5.985.700
AQUA	15.000.000
AQUA BeamLine	4.977.000
Tot Ondulators	39.949.500
Building	45.775.000
Hi-Tech Utilities	6.000.000
Tot Infrastructure	51.775.000
TOTAL	129.089.300

Transition to the implementation phase

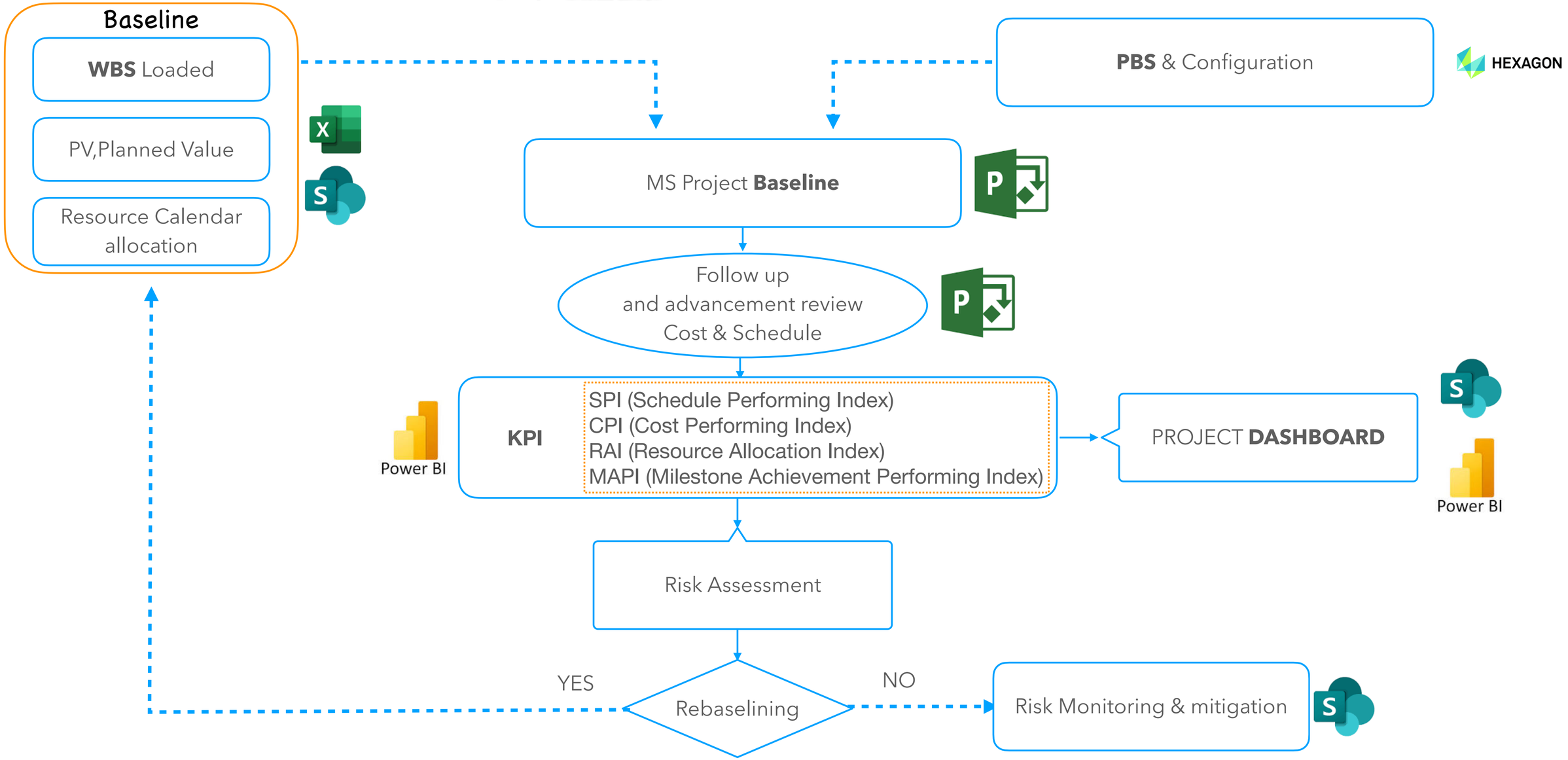
The transition to the implementation phase concerns not only the cost-assessment but also a comprehensive review of the Project Management Tool to be implemented considering that:

- PMO has now sufficient (and outstanding) resources available
- EuAPS experience on PM framework is a valuable asset that will be used in the implementation phase
- The implementation phase is intrinsically complex, risky and expensive project.

EVM Framework to be implemented.
Still some issues cannot be done easily, and it is mandatory to involve the central administration (a.k.a. AC).
For example there is no automated process to extract the Actual Cost for each work package

We are actively working to increase the Project Management Maturity in the organization, the EuAPS project is a very useful tool to implement more advanced PM process and monitoring & control technique.

Earned Value Management framework



Conclusions

- EuPRAXIA is a set of correlated projects. EuPRAXIA@Sparc_Lab and the EuPRAXIA building are the most complex, expensive and resource consuming.

- Some important milestones achieved: Building authorization and executive design started. Progress on the RF X_band activities

- The TDR redaction has just started. This will help to assess the real impact of some delays accumulated.

- Preparation of the implementation phase has started and it is gaining momentum (1st cost&schedule review on the 11th December 2023).

- EVM methdologies is being developed for EuAPS and it will be used for the implementation phase