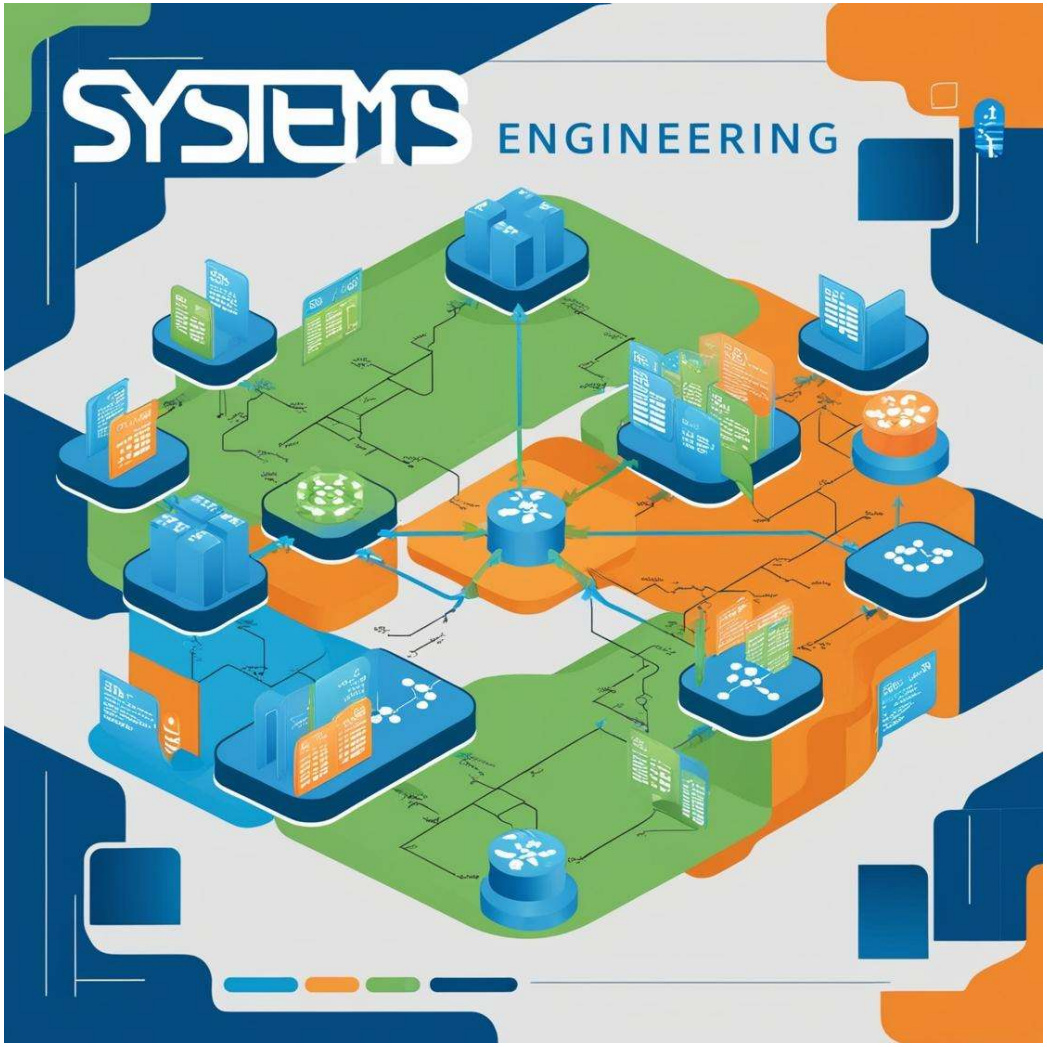
SYSTEM ENGINEERING

EuPraxia@SPARC_Lab
PROJECT

2nd Cost&Schedule Review
LNF 22/11/2024



Ing. Fara Cioeta, PhD

Configuration Manager of EuPraxia@SPARC_Lab Project

System Engineering

The main phases of systems engineering are generally divided into several key stages, each with specific objectives. Here is an overview of the main phases:

1.Requirements Definition: In this phase, stakeholder requirements are gathered and analyzed to understand the needs and expectations of the system. This includes defining the system's functionalities, performance, and constraints.

2. System Design: Based on the requirements, a system architecture is developed that describes how the different components will interact with each other. This phase includes modeling and simulation to verify that the design meets the requirements.

3.Implementation: In this phase, the system components are developed and integrated. This can include writing code, building hardware, and integrating software and hardware.

4. Verification and Validation: Once implemented, the system is tested to ensure it works as expected and meets all requirements. This can include unit testing, integration testing, and system testing.

5. Deployment: After the system has been verified and validated, it is deployed to the end users. This phase includes installation, configuration, and user training.

6. Maintenance and Support: After deployment, the system requires maintenance to fix any issues, update functionalities, and ensure it continues to meet user needs.

These phases *are iterative and can overlap*, with continuous feedback between the different phases to *improve the system*.

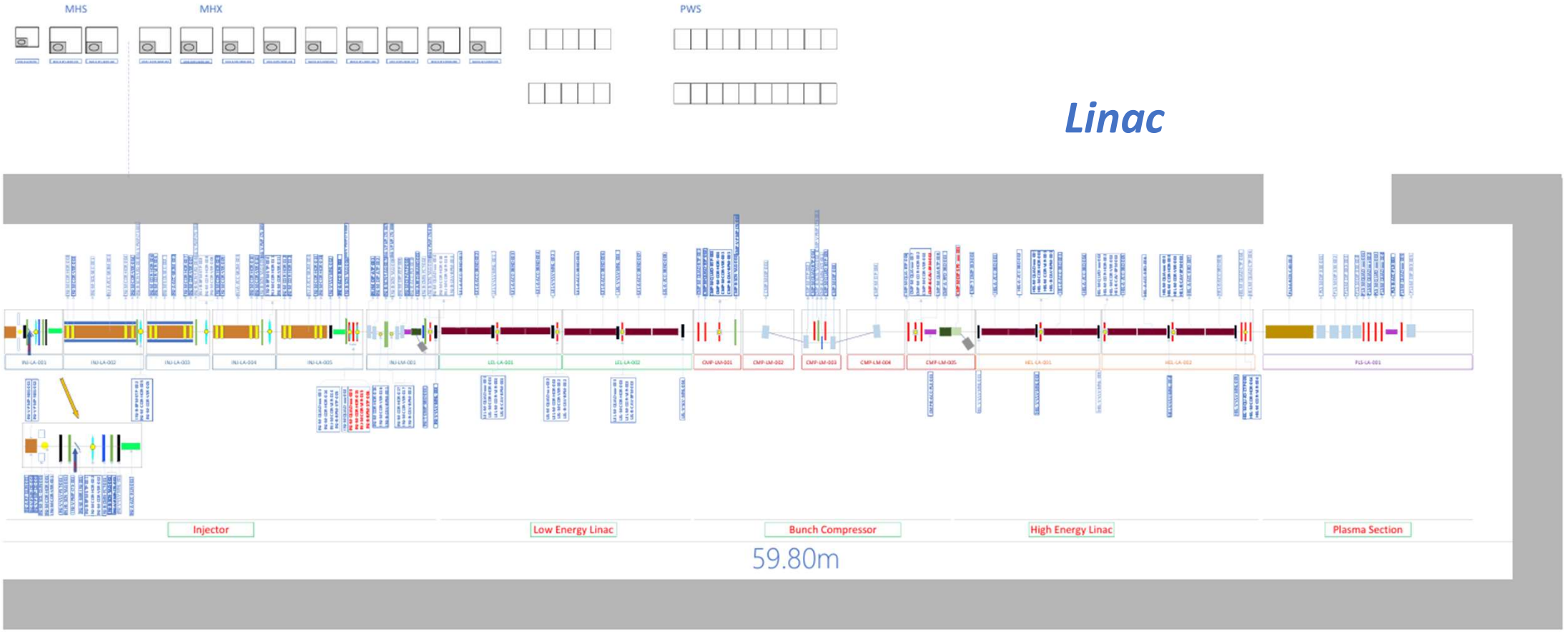
EuPRAXIA@SPARC_LAB PROJECT MANAGEMENT

The project is being implemented through SE phasing approach, the TDR Phase is the phase dedicated to the full design of the machine. In order to develop the TDR phase, a group of technologists is responsible for coordinating the management of activities related to the project. Within this framework, the project strategy put in place covers the following points:

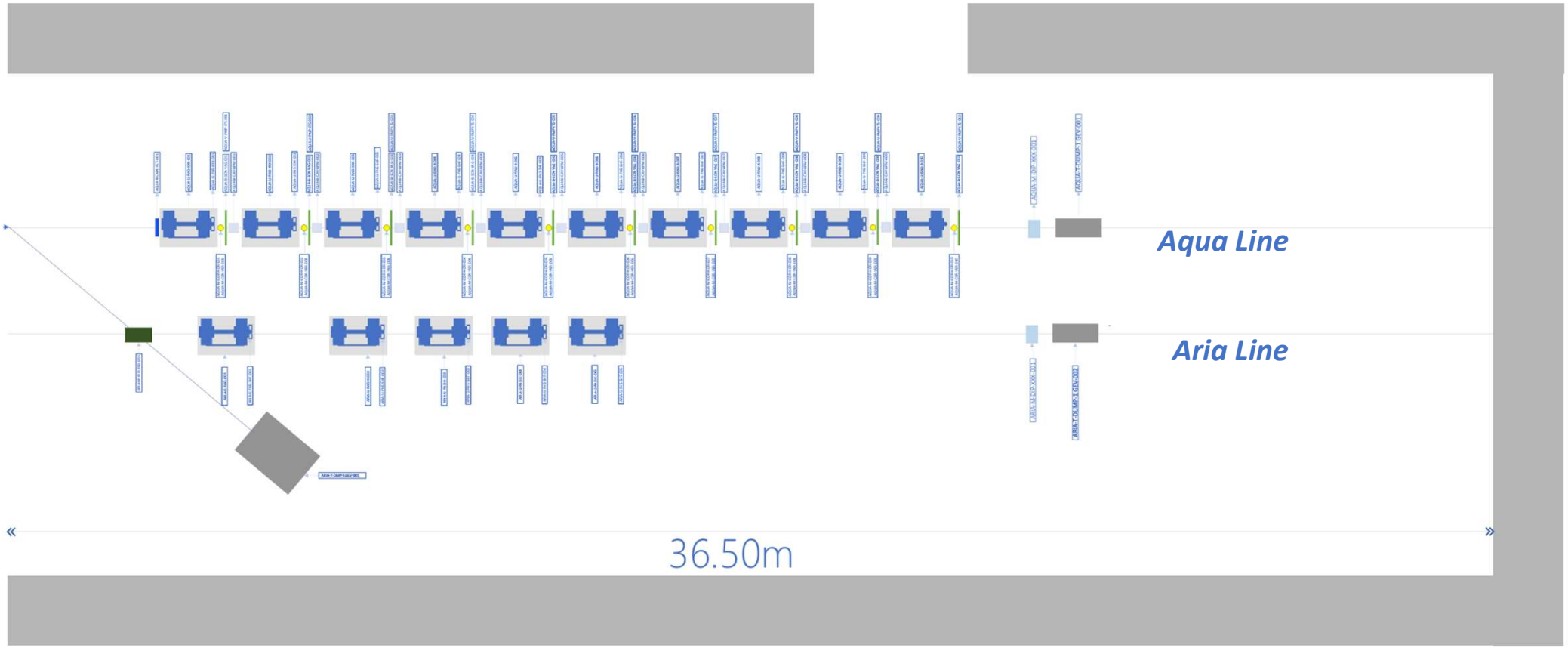
- Functional Layout and naming convention;
- PBS database
- Budget management

EuPRAXIA @ SPARC_LAB – Configuration Machine

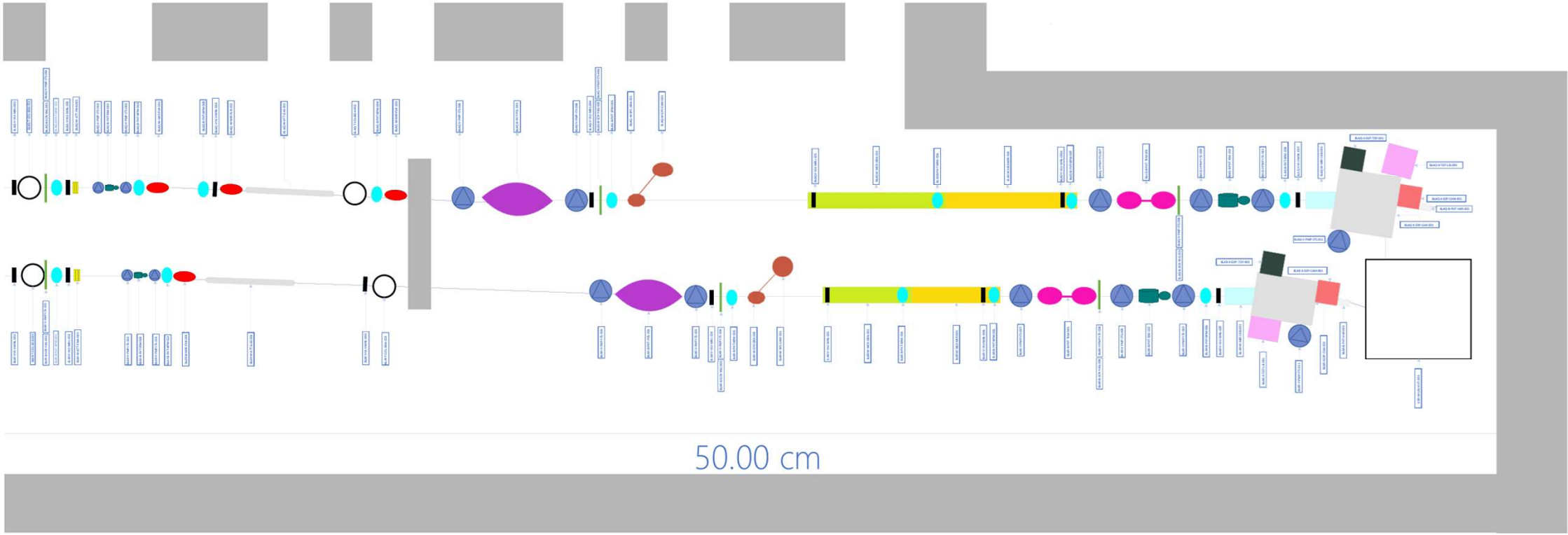
The *schematic layout* was developed using Visio Professional from Microsoft Office 365 as the project software. The purpose of the schematic layout is to provide an immediate overview of the machine elements to help plan and implement the machine components, which will later be listed in a specific database



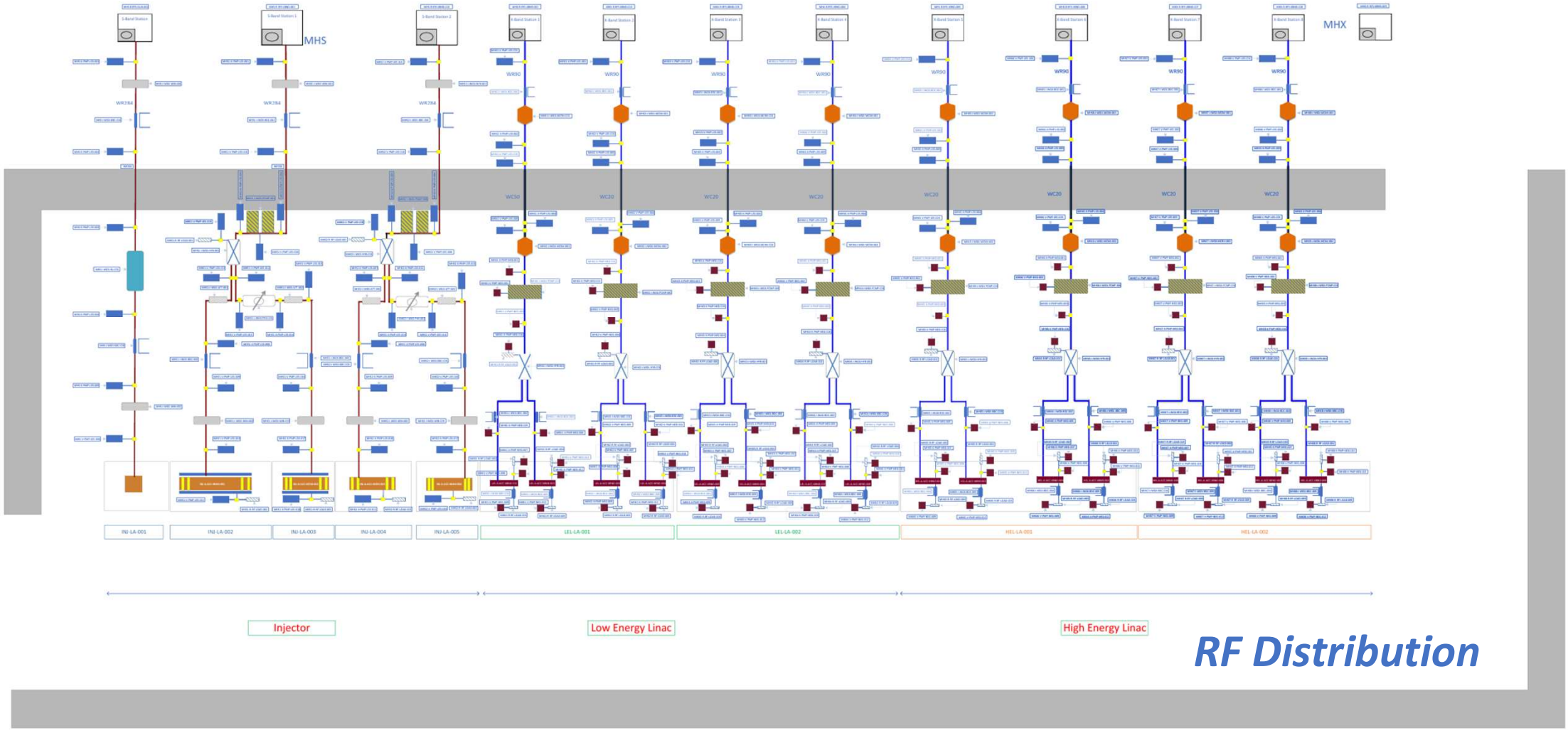
Undulators



Aqua & Aria Users Beamlines



EuPRAXIA @ SPARC_LAB - Configuration Machine



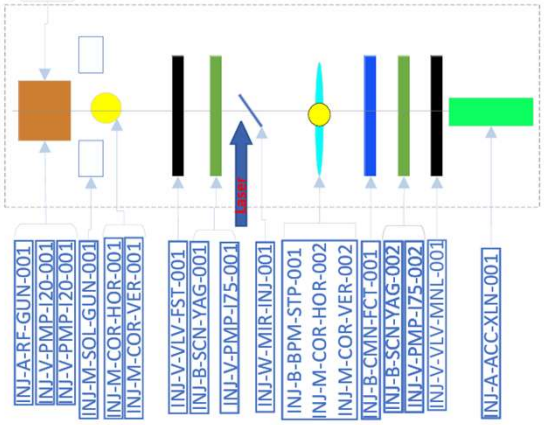
RF Distribution

EuPRAXIA @ SPARC_LAB – Naming Convention

INJ-V-PMP-NEG-001
INJ-V-PMP-NEG-002

In systems engineering, the hierarchical and tree-like organization of objects is crucial for efficient and traceable configuration management. This approach helps in systematically organizing and managing the various components and their relationships within a system.

Using a specific nomenclature ensures consistency and clarity, making it easier to track changes, manage configurations, and maintain the integrity of the system throughout its lifecycle. This structured method allows to quickly identify and address issues, ensuring that all parts of the system are correctly configured and functioning as intended.



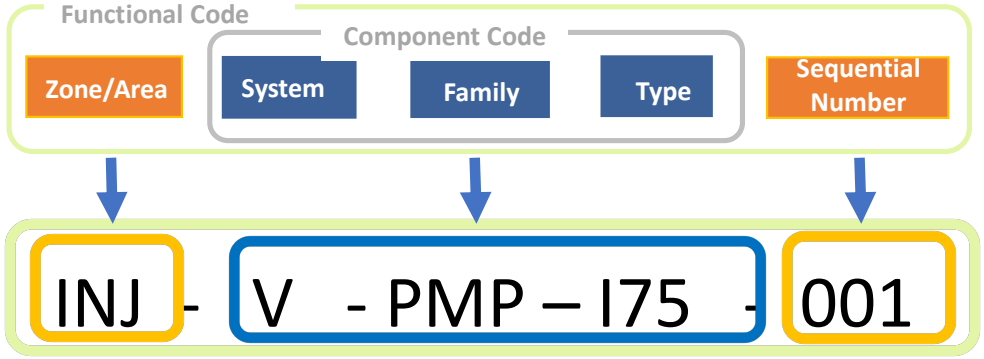
The identifier component machine is defined as the union of two codes

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.



EuPRAXIA @ SPARC_LAB – PBS Database

An Excell File has been produced that acts as database for all the components of the machine.

ID	ID_COMPONEN	WA CODE	WBS CODE	AREA/ZONE	SYSTEM	FAMILY	TYPE	EQUENTIAL NUM	PBS-CODE	DESCRIPTION	NOR	MODULS	STATUS	UNIT COST (k€	SPARE	NOTE	SPARE COST (k€)	CAD REFERENC	SERIAL NUMBE	MO
3	CMN	WA-10	WP-14	INJ	B	CMN	FCT	001	INJ-B-CMN-FCT-001	CURRENT MONITOR GUN	0	INJ-LA-001	A	20,00				X	X	
4	FCT	WA-10	WP-14	INJ	B	CMN	FCT	001	INJ-B-CMN-FCT-002	CURRENT MONITOR LM001	0	INJ-LM-001	A	26,00				X	X	
5	RFG	WA-02	WP-08	INJ	A	RF	GUN	001	INJ-A-RF-GUN-001	RF GUN	0	INJ-LA-001	D	120,00	10	Note 123	120	X	X	
6	I20	WA-02	WP10	INJ	V	PMP	I20	001	INJ-V-PMP-I20-001	ION PUMP L20 GUN	0	INJ-LA-001	D	4,20				X	X	
7	I20	WA-02	WP10	INJ	V	PMP	I20	002	INJ-V-PMP-I20-002	ION PUMP L20 GUN	0	INJ-LA-001	D	4,20				X	X	
8	NEG	WA-02	WP10	INJ	V	PMP	NEG	001	INJ-V-PMP-NEG-001	NEXTOR Z100 GUN	0	INJ-LA-001	D	18,20		IL COSTO COMPRENDE ATTIVATORE 4 CANALI PER LE NEG (8700 Euro)		X	X	
9	NEG	WA-02	WP10	INJ	V	PMP	NEG	002	INJ-V-PMP-NEG-002	NEXTOR Z100 GUN	0	INJ-LA-001	D	9,50				X	X	
10	VUG	WA-02	WP-10	INJ	V	VUG	CCT	001	INJ-V-VUG-CCT-001	VACUUM GAUGE SU NEG 02 IN INJ-LA-001	0	INJ-LA-001	D	3,80				X	X	
11	SLG	WA-02	WP-17	INJ	M	SOL	GUN	001	INJ-M-SOL-GUN-001	SOLENOID GUN	0	INJ-LA-001	D	95,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
12	CHO	WA-02	WP-17	INJ	M	COR	HOR	001	INJ-M-COR-HOR-001_A TYPE	HORIZONTAL CORRECTOR GUN	0	INJ-LA-001	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
13	CVE	WA-02	WP-17	INJ	M	COR	VER	001	INJ-M-COR-VER-001_A TYPE	VERTICAL CORRECTOR GUN	0	INJ-LA-001	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
14	VMN	WA-02	WP10	INJ	V	VLV	MNL	001	INJ-V-VLV-FST-001	MANUAL VALVE GUN	0	INJ-LA-001	D	9,10				X	X	
15	SYA	WA-10	WP-14	INJ	B	SCN	YAG	001	INJ-B-SCN-YAG-001	SCREEN GUN	0	INJ-LA-001	A	15,00				X	X	
16	I75	WA-02	WP10	INJ	V	PMP	I75	001	INJ-V-PMP-I75-001	IONIC PUMP GUN	0	INJ-LA-001	D	10,20				X	X	
17	MIR	WA-02	WP-11	INJ	W	MIR	INJ	001	INJ-W-MIR-INJ-001	MIRROR GUN	0	INJ-LA-001	D	0,05				X	X	
18	LFC	WA-02	WP-11	INJ	W	LAS	PHO	001	INJ-W-LAS-PHO-001	LASER FOTOCATODO	0	INJ-LA-001	D	1.400,00						
19	BPM	WA-10	WP-14	INJ	B	BPM	STP	001	INJ-B-BPM-STP-001	STRIPLINE GUN	0	INJ-LA-001	A	16,00		VALORE CON PS		X	X	
20	CHO	WA-02	WP-17	INJ	M	COR	HOR	002	INJ-M-COR-HOR-002_A TYPE	HORIZONTAL CORRECTOR GUN	0	INJ-LA-001	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
21	CVE	WA-02	WP-17	INJ	M	COR	VER	002	INJ-M-COR-VER-002_A TYPE	VERTICAL CORRECTOR GUN	0	INJ-LA-001	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
22	SYA	WA-10	WP-14	INJ	B	SCN	YAG	002	INJ-B-SCN-YAG-002	SCREEN GUN	0	INJ-LA-001	A	15,00				X	X	
23	I75	WA-02	WP10	INJ	V	PMP	I75	002	INJ-V-PMP-I75-002	IONIC PUMP GUN	0	INJ-LA-001	D	10,20				X	X	
24	VUG	WA-02	WP-10	INJ	V	VUG	CCT	002	INJ-V-VUG-CCT-002	VACUUM GAUCE SU L75-002 IN INJ-LA-001	0	INJ-LA-001	D	3,80				X	X	
25	VFS	WA-02	WP10	INJ	V	VLV	FST	001	INJ-V-VLV-MNL-001	FAST VALVE GUN	0	INJ-LA-001	D	25,00				X	X	
26	XBG	WA-03	WP-08	INJ	A	ACC	XBD	001	INJ-A-ACC-XLN-001	XBAND LINEARIZER GUN	0	INJ-LA-001	S	50,00				X	X	
27	CHO	WA-02	WP-17	INJ	M	COR	HOR	003	INJ-M-COR-HOR-003_B TYPE	HORIZONTAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
28	CVE	WA-02	WP-17	INJ	M	COR	VER	003	INJ-M-COR-VER-003_B TYPE	VERTICAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
29	SOL	WA-02	WP-17	INJ	M	SOL	SEC	001	INJ-M-SOL-SEC-001	SOLENOID SBAND	0	INJ-LA-002	D	280,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
30	SBD	WA-03	WP-08	INJ	A	ACC	SB3	001	INJ-A-ACC-SB3-001	SBAND 3M LA002	0	INJ-LA-002	D	150,00				X	X	
31	CHO	WA-02	WP-17	INJ	M	COR	HOR	004	INJ-M-COR-HOR-004_B TYPE	HORIZONTAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
32	CVE	WA-02	WP-17	INJ	M	COR	VER	004	INJ-M-COR-VER-004_B TYPE	VERTICAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
33	SYA	WA-10	WP-14	INJ	B	SCN	YAG	003	INJ-B-SCN-YAG-003	FIRST SCREEN LA002	0	INJ-LA-002	A	15,00				X	X	
34	I75	WA-02	WP10	INJ	V	PMP	I75	003	INJ-V-PMP-I75-003	ION PUMP SBND1	0	INJ-LA-002	D	10,20				X	X	
35	VUG	WA-02	WP-10	INJ	V	VUG	CCT	003	INJ-V-VUG-CCT-003	VACUUM GAUGE SU L75-003 IN INJ-LA-002	0	INJ-LA-002	D	3,80				X	X	
36	BPM	WA-10	WP-14	INJ	B	BPM	STP	002	INJ-B-BPM-STP-002	STRIPLINE LA002	0	INJ-LA-002	A	16,00		VALORE CON PS		X	X	
37	CHO	WA-02	WP-17	INJ	M	COR	HOR	005	INJ-M-COR-HOR-005_B TYPE	HORIZONTAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
38	CVE	WA-02	WP-17	INJ	M	COR	VER	005	INJ-M-COR-VER-005_B TYPE	VERTICAL CORRECTOR SB1	0	INJ-LA-002	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
39	CHO	WA-02	WP-17	INJ	M	COR	HOR	006	INJ-M-COR-HOR-006_B TYPE	HORIZONTAL CORRECTOR LA003	0	INJ-LA-003	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
40	CVE	WA-02	WP-17	INJ	M	COR	VER	006	INJ-M-COR-VER-006_B TYPE	VERTICAL CORRECTOR LA003	0	INJ-LA-003	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
41	SOL	WA-02	WP-17	INJ	M	SOL	SEC	002	INJ-M-SOL-SEC-002	SOLENOID SBAND	0	INJ-LA-003	D	280,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	
42	SB2	WA-03	WP-08	INJ	A	ACC	SB2	002	INJ-A-ACC-SB2-002	SBAND 2M LA003	0	INJ-LA-003	D	150,00				X	X	
43	CHO	WA-02	WP-17	INJ	M	COR	HOR	007	INJ-M-COR-HOR-007_B TYPE	HORIZONTAL CORRECTOR LA003	0	INJ-LA-003	D	20,00		MAGNETI COSTOCOMPRESO DI POWER SUPPLY E CAVI		X	X	

PBS – Project Breakdown Structure

Breakdown of the components of the machine and associated equipments.

Together with the associated documentation this will be the CONFIGURATION of the machine.

This database will provide in one shot the whole configuration of the machine.

This database will identify each component of the machine together with most relevant information:

- Name
- Position
- Connection
- Cost
- Status
- Utilities Requirements
- Drawings.

EuPRAXIA @ SPARC_LAB – Hexagon EAM Database

The ExGN EAM is an Industry-leading asset management software to extend asset lifecycles and improve productivity.

HxGN EAM core modules

1. Asset management - Record, maintain, structure and standardize asset information;
2. Asset performance management (APM) : Utilize a framework that enables to make use of physical assets to realize specific goals;
3. Work management - Manage, plan and monitor work, as well as the necessary resources to complete that work;
4. Materials management - Determine the correct stocking levels to provide an acceptable service level of parts and supplies to meet anticipated demand for maintenance;
5. Procurement management - Manage every aspect of the purchasing cycle — from requisition creation, approvals, supplier selection, purchase order placement and goods receipt through invoice matching.;
6. Project management - Automate the administration of the complete project process — from initial budget and timescale planning to completion of the final work. Facilitate comparison of actual status and progress of work, resource usage and costs against a project plan.

Advanced add-on modules

- OpenCAD — Access and mark-up drawings within HxGN EAM. Calculate floor space using predefined industry standards. Save time by building your asset registry and creating assets in HxGN EAM directly from drawings;
- OpenCAD BIM — Create and manage project data with an intelligent, 3D-model-based, process building information modeling (BIM) tool. BIM gives architecture, engineering and construction professionals data access and tools that can help them more efficiently plan, design, construct and manage buildings and infrastructure.

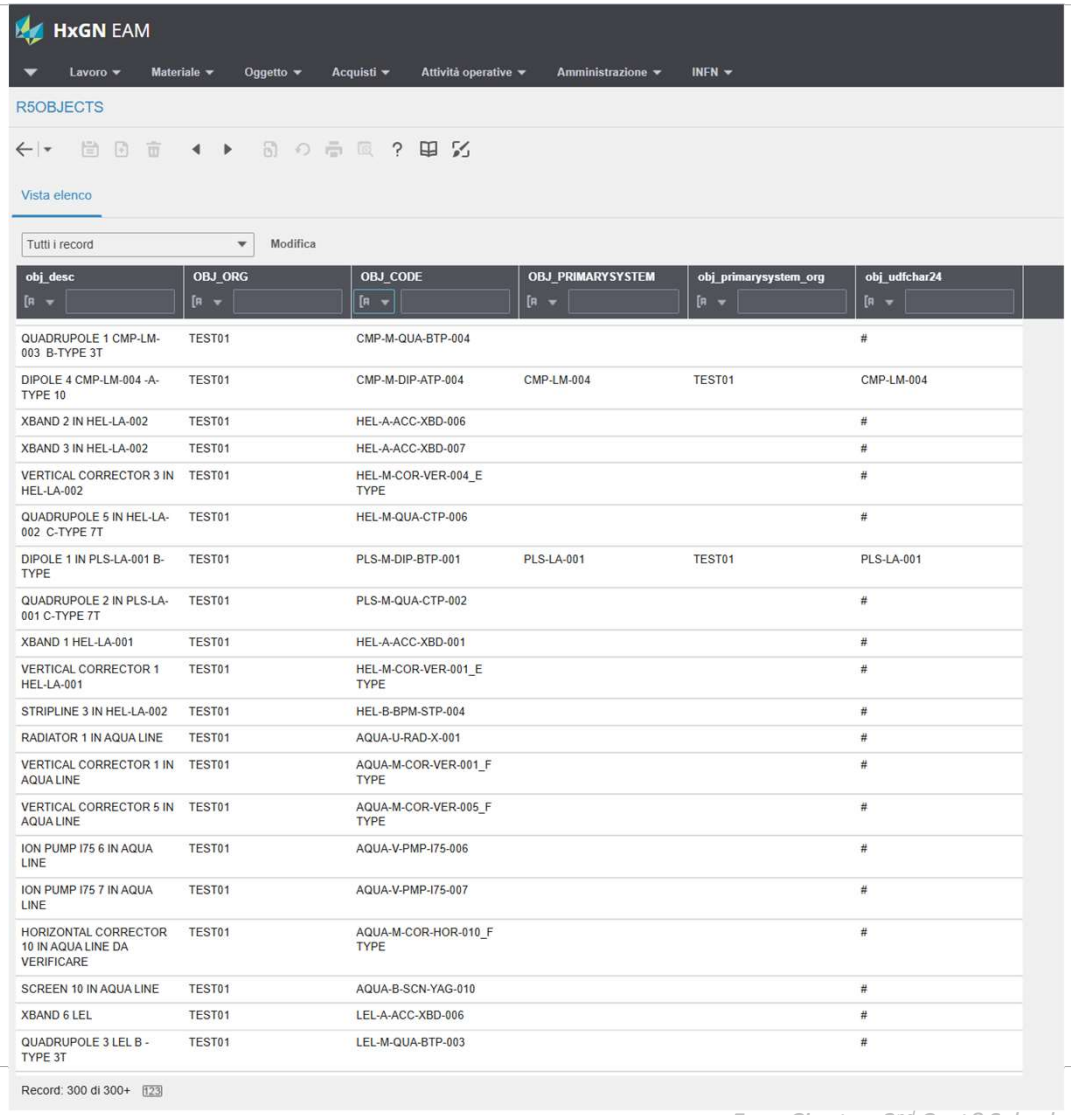
EuPRAXIA @ SPARC_LAB – Hexagon Database

In Hexagon, it is possible to manage a significant number of assets for which so-called user fields are defined. Each user field is linked to a class, which in our project is represented by systems:

SYSTEM
A - Acceleration
B - Beam Instrumentation
I - Circuits
M - Magnets
R -RF Power Source
T - Target
U - Undulators
V - Vacuum
W - Laser & Optical System
X - Experimental Users

User Fileds

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



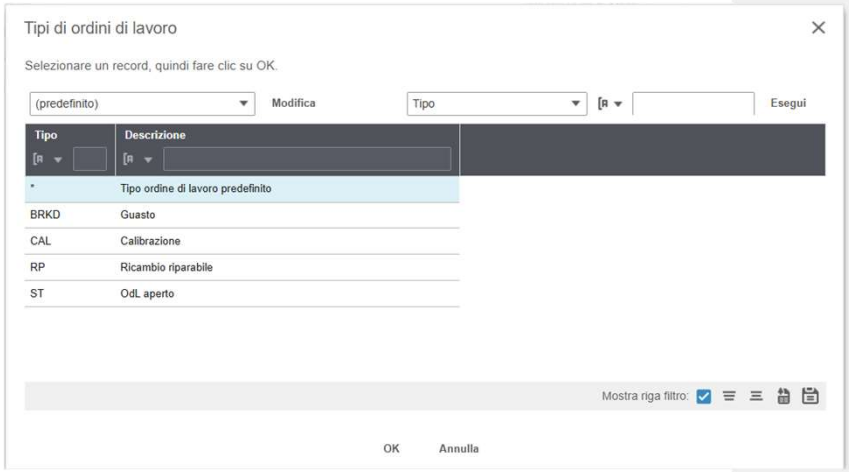
obj_desc	OBJ_ORG	OBJ_CODE	OBJ_PRIMARYSYSTEM	obj_primarysystem_org	obj_udfchar24
QUADRUPOLE 1 CMP-LM-003 B-TYPE 3T	TEST01	CMP-M-QUA-BTP-004			#
DIPOLE 4 CMP-LM-004 -A-TYPE 10	TEST01	CMP-M-DIP-ATP-004	CMP-LM-004	TEST01	CMP-LM-004
XBAND 2 IN HEL-LA-002	TEST01	HEL-A-ACC-XBD-006			#
XBAND 3 IN HEL-LA-002	TEST01	HEL-A-ACC-XBD-007			#
VERTICAL CORRECTOR 3 IN HEL-LA-002	TEST01	HEL-M-COR-VER-004_E TYPE			#
QUADRUPOLE 5 IN HEL-LA-002 C-TYPE 7T	TEST01	HEL-M-QUA-CTP-006			#
DIPOLE 1 IN PLS-LA-001 B-TYPE	TEST01	PLS-M-DIP-BTP-001	PLS-LA-001	TEST01	PLS-LA-001
QUADRUPOLE 2 IN PLS-LA-001 C-TYPE 7T	TEST01	PLS-M-QUA-CTP-002			#
XBAND 1 HEL-LA-001	TEST01	HEL-A-ACC-XBD-001			#
VERTICAL CORRECTOR 1 HEL-LA-001	TEST01	HEL-M-COR-VER-001_E TYPE			#
STRIPLINE 3 IN HEL-LA-002	TEST01	HEL-B-BPM-STP-004			#
RADIATOR 1 IN AQUA LINE	TEST01	AQUA-U-RAD-X-001			#
VERTICAL CORRECTOR 1 IN AQUA LINE	TEST01	AQUA-M-COR-VER-001_F TYPE			#
VERTICAL CORRECTOR 5 IN AQUA LINE	TEST01	AQUA-M-COR-VER-005_F TYPE			#
ION PUMP I75 6 IN AQUA LINE	TEST01	AQUA-V-PMP-I75-006			#
ION PUMP I75 7 IN AQUA LINE	TEST01	AQUA-V-PMP-I75-007			#
HORIZONTAL CORRECTOR 10 IN AQUA LINE DA VERIFICARE	TEST01	AQUA-M-COR-HOR-010_F TYPE			#
SCREEN 10 IN AQUA LINE	TEST01	AQUA-B-SCN-YAG-010			#
XBAND 6 LEL	TEST01	LEL-A-ACC-XBD-006			#
QUADRUPOLE 3 LEL B - TYPE 3T	TEST01	LEL-M-QUA-BTP-003			#

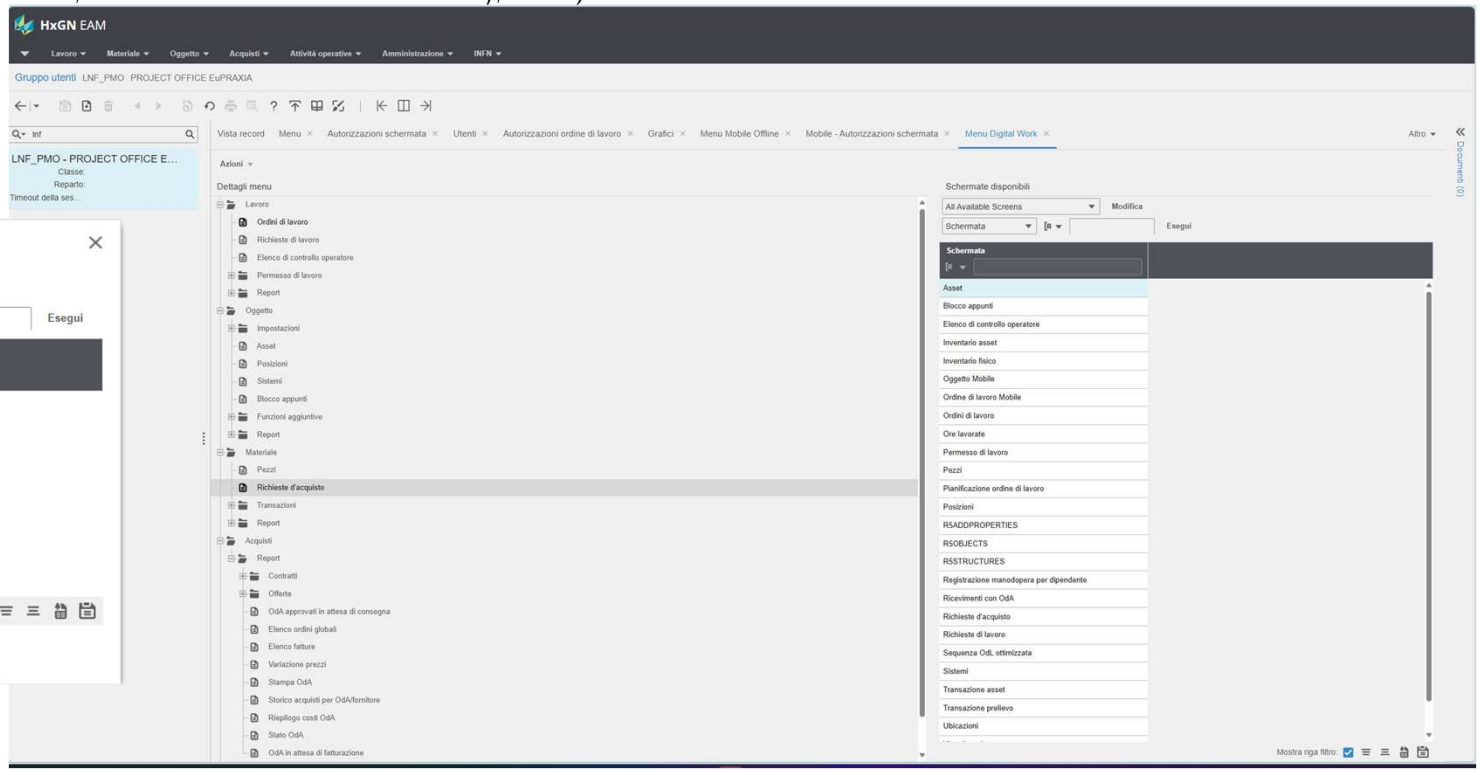
Record: 300 di 300+

EuPRAXIA @ SPARC_LAB – Hexagon Database

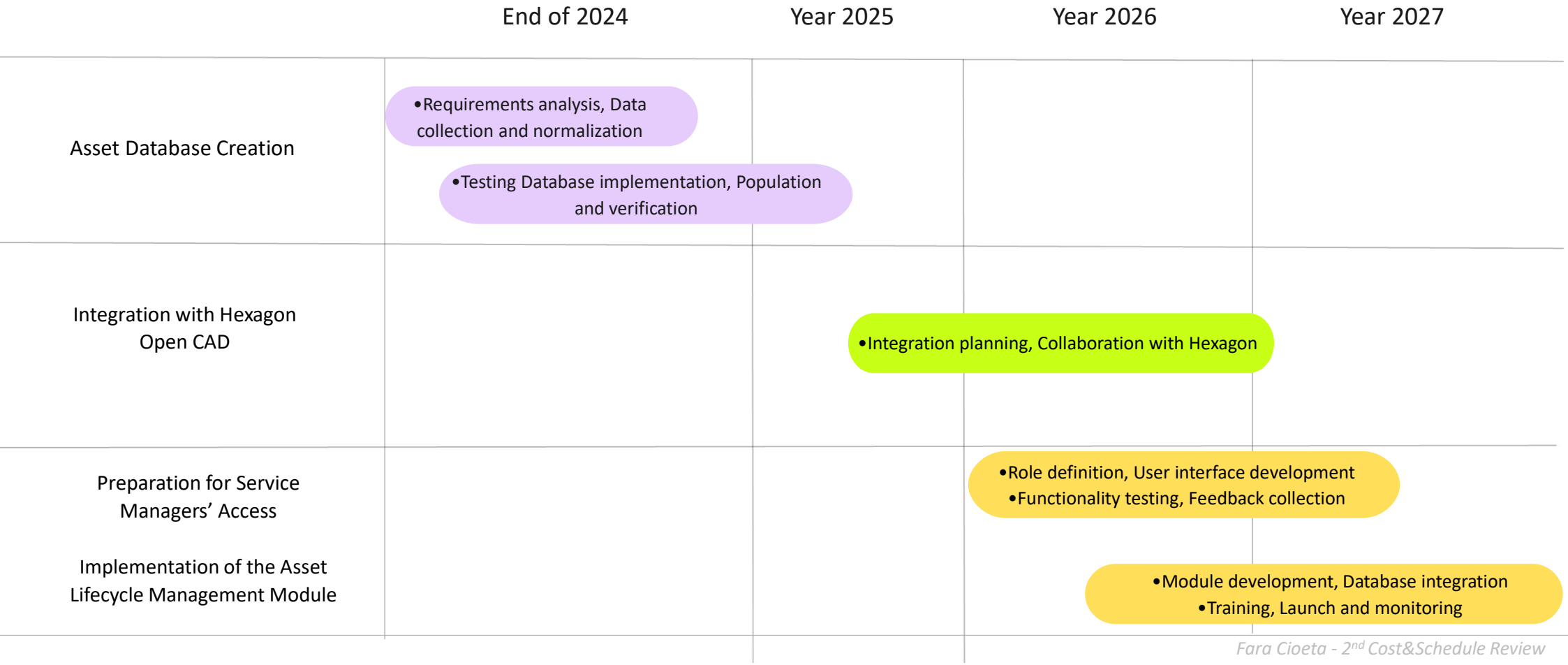
- Moreover is possible to link other document such as:

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
7. Maintenance





Roadmap- EuPRAXIA @ SPARC_LAB Hexagon Database



thankyou

For you Attention