

EUROPEAN  
PLASMA RESEARCH  
ACCELERATOR WITH  
EXCELLENCE IN  
APPLICATIONS



# Introduction

WP9 – RF, Magnets & Beamline Components

WP leaders: S. Antipov, F. Nguyen

1<sup>st</sup> Meeting on March 15<sup>th</sup> 2023



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

European Plasma  
Research Accelerator  
with eXcellence In  
Applications

## EuPRAXIA

**2020 Publication of  
Conceptual Design  
Report**  
600+ page CDR, 240  
scientists contributed



## ESFRI Landmarks Roadmap 2021 (Physical Sciences & Engineering)

Two new entries in 2021: **Einstein Telescope (ET)** and **EuPRAXIA**  
EuPRAXIA is the only accelerator facility selected in the last 6 years  
EuPRAXIA is the first plasma accelerator facility ever included

## A European Strategy for Accelerator Innovation

### PRESENT EXPERIMENTS

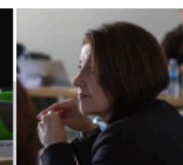
Demonstrating  
**100 GV/m** routinely  
Demonstrating **GeV**  
electron beams  
Demonstrating basic  
quality

### EuPRAXIA INFRASTRUCTURE

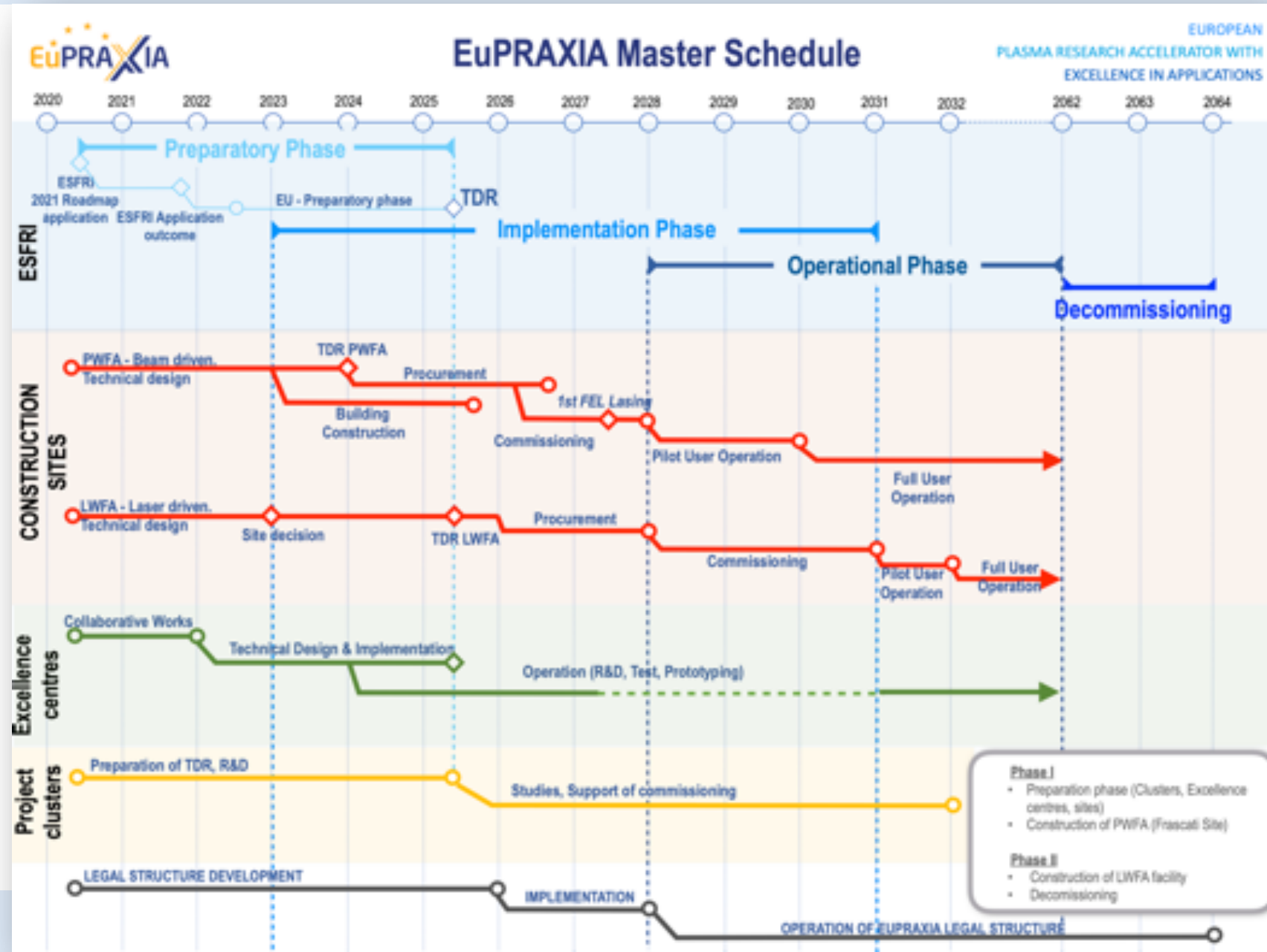
Engineering a high  
quality, compact  
plasma accelerator  
**5 GeV electron beam**  
for the **2020's**  
Demonstrating user  
readiness  
**Pilot users from FEL,  
HEP, medicine, ...**

### PRODUCTION FACILITIES

Plasma-based **linear  
collider** in **2040's**  
Plasma-based **FEL** in  
**2030's**  
**Medical, industrial**  
applications soon



- Technical WP's  
(correspond to Project Clusters):
  - **Update of CDR** concepts and parameters, towards technical design (full technical design requires more funding)
  - Specify in detail **Excellence Centers and their required funding**: TDR related R&D, prototyping, contributions to construction
  - Help in defining funding applications for various agencies
- Output defined in **milestones & deliverables** with dates



- Compact magnets (both electromagnets and permanent magnets) for beam capture and transport
- Radiofrequency high power sources and structures for conventional acceleration
- Magnetic undulators for free-electron laser production

High quality, high stability  
electron and photon beams  
in compact physical layout

**WP7 - E-Needs and Data Policy**

R. Fonseca, IST  
S. Pioli, INFN

**WP8 - Theory & Simulation**

J. Viera, IST  
H. Vincenti, CEA

**WP9 - RF, Magnets & Beamline Components**

S. Antipov, DESY  
F. Nguyen, ENEA

**WP10 - Plasma Components & Systems**

K. Cassou, CNRS  
J. Osterhoff, DESY

**WP11 - Applications**

G. Sarri, U Belfast  
E. Chiadroni, U Sapienza

**WP12 - Laser Technology, Liaison to Industry**

L. Gizzi, CNR  
P. Crump, FBH

**WP13 - Diagnostics**

A. Cianchi, U Tor Vergata  
R. Ischebeck, EPFL

**WP14 - Transformative Innovation Paths**

B. Hidding, U Strathclyde  
S. Karsch, LMU

**WP15 - TDR EuPRAXIA @SPARC-lab**

C. Vaccarezza, INFN  
R. Pompili, INFN

**WP16 - TDR EuPRAXIA Site 2**

A. Molodtsov, ELI-Beamlines  
R. Pattahil, STFC

**Not into Plasma (WP10), Laser (WP12) or Diagnostics (WP13) components**

→ **It does not mean to prevent synergies between different WPs!**

**Important feedback: constraints from the 2<sup>nd</sup> site choice (WP16 outcomes)**

Project: 101079773 — EuPRAXIA — HORIZON-INFRA-2021-DEV-02

 Associated with document Ref. Ares(2022)5382240 - 28/07/2022

<b>Work Package Name</b>	RF, Magnets and Beamline Components		
<b>Start Month</b>	1	<b>End Month</b>	48

Objectives
<p>The primary objective of this WP is to steer the technical progress on the development and design of accelerator components, in particular:</p> <ol style="list-style-type: none"> <li>1. Radiofrequency high power sources and structures for conventional acceleration</li> <li>2. Design of compact magnets (both electromagnets and permanent magnets)</li> <li>3. Design of magnetic undulators for free-electron laser production</li> </ol> <p>For each item a TRL must be properly defined and assessed and if possible, a report on the progress in order check the final technology readiness level will be produced.</p>

Description
<p>This WP brings together experts from several partner institutes to assess and develop conventional accelerator components and systems for implementation in the EuPRAXIA accelerator and beamlines, namely radiofrequency (RF) sources and structures for beam acceleration and phase space manipulation, compact beam optics magnets for electron beam capture and transport between laser plasma accelerator (LPA) stages, and innovative magnetic undulators for free-electron laser (FEL) applications. These components will aim to support high quality, high stability electron and photon beams produced in compact physical layout.</p> <p>The components and systems evaluated in this WP are:</p> <ul style="list-style-type: none"> <li>- Bright and compact RF injectors, with the related components for RF-laser synchronization;</li> <li>- High gradient X-band RF structures: feasibility of an active energy correction scheme;</li> <li>- Compact high gradient and highly tunable magnets for LPA beam transport;</li> <li>- Short period high field undulator magnets for Hard X-ray FELs.</li> </ul> <p>Potential prototype R&amp;D will be reviewed for the various components in collaboration with all involved partners. The WP will organize scientific and technical workshops to identify the most relevant concepts and prototypes for the TDR phase. This status overview will allow the elaboration of coordinated funding requests to solve the technical and scientific challenges in a coordinated way at the national and European levels.</p>

- Review potential R&D prototypes, identify the most relevant concepts and prototypes for the TDR phase
- Coordinate funding requests at national and European level (see D9.1 Deliverable later on)
- Assess technical readiness level of RF, magnet, undulator technology
- Update concepts and parameters (e.g. previously addressed in the CDR) towards TDR

- D9.1 Report on structures to be funded from national/bilateral/european level for RF, Magnets and beamlines components (M12)
- D9.2 Report on technical results achieved in the field of RF, Magnets and beamlines components (M24)
- **M.20 Update of concepts for EuPRAXIA, systems status report (M24)**
- D9.3 TRL Report and maturity assessment on the development of RF, Magnets and beamlines components (M42)

**Staff effort per participant**  
*Grant Preparation (Work packages - Effort screen) — Enter the info.*

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9
1 - INFN	108.00	6.00	10.00	54.00			6.00	6.00	6.00
2 - CNR		2.00						4.00	
3 - ELETTRA	4.00				30.00				
4 - ENEA									4.00
5 - UNI SAPIENZA						30.00			6.00
6 - UNITOV					48.00				
7 - CEA								37.00	
8 - CNRS			6.00			22.00		22.00	
9 - THALES									
10 - DESY			6.00					6.00	18.00
19 - IP-ASCR								24.00	6.00
20 - CERN				2.00					2.00
21 - IASA		8.00	8.00	8.00					8.00
22 - CLPU								2.00	2.00
23 - HUJ									
24 - Fraunhofer	2.00								
25 - ALBA-CELLS									4.00
31 - UKRI									10.00
32 - ULIV		46.00							
33 - USTRATH									
34 - UOXF									
<b>Total Person-Months</b>	123.00	68.00	30.00	64.00	102.00	52.00	60.00	179.00	66.00

Lead beneficiary

66 person-months  
over 4 years

## **Deliverable D9.1 – Report on structures to be funded from national/bilateral/european level for RF, Magnets and beamlines components**

Project: 101079773 — EuPRAXIA — HORIZON-INFRA-2021-DEV-02

 Associated with document Ref. Ares(2022)5382240 - 26/07/2022

<b>Type</b>	R — Document, report	<b>Dissemination Level</b>	PU - Public
<b>Due Date (month)</b>	12	<b>Work Package No</b>	WP9

Description
Work plans for RF, magnets and beamlines components are reviewed and updated for on-schedule implementation of the full EuPRAXIA RI. A detailed collaborative EuPRAXIA work plan in this area is defined, connecting to work at existing research infrastructures. Required funding is analysed and described, to be used for EuPRAXIA discussions with funding bodies at national/bilateral/European levels.

**Our understanding: after a short highlight of RF, magnet & beamline technologies, with references to the published EuPRAXIA CDR, we have to focus on present and possible funding schemes needed to fulfill the WP9 work plan → “structures”**

- We asked the management for confirmation
- Deliverable template already circulated

- Wide open “get to know each other”, to assess interests, expectations and areas where to contribute
  - To start synchronizing towards each Deliverable/Milestone
  - For discussion: identify common interests, form topical teams – better right after all contributions
  - To schedule next meetings, next actions
  - Please, do not forget to send me or Sergey Today's presentations of yours!
- Very many thanks!
- Do not hesitate to pile us up with questions, doubts, comments!