EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS



EuPRAXIA-PP (General and WP1)

R. Assmann, INFN & DESY

M. Ferrario, INFN

EuPRAXIA-PP Kickoff Meeting, LNF Frascati, 24 – 25 Nov 2022







ESFRI Roadmap Update December 2021



E uropean

S trategy

F orum on

R esearch

I nfrastructures

https://roadmap2021.esfri.eu

Roadmap projects selected after thorough review by ESFRI committee and approved by **EU governments** every few years

2006 - 2008 - 2012 - 2016 -

2018 **- 2021**





ESFRI Landmarks Roadmap 2021



(Physical Sciences & Engineering)

ESFRI LANDMARKS

NAME	FULL NAME	TYPE	LEGAL Status (y)	ROADMAP Entry (y)	OPERATION Start (y)	INVESTMENT COST (M€)	OPERATION COST (M€/Y)
СТА	Cherenkov Telescope Array	single-sited	gGmbH, 2014	2008	2024*	400.0	20.0
ELI ERIC	Extreme Light Infrastructure	single-sited	ERIC, 2021	2006	2018	850.0	80.0
ELT	Extremely Large Telescope	single-sited	ESO#	2006	2027*	1,309.0	48.0
EMFL	European Magnetic Field Laboratory	distributed	AISBL, 2015	2008	2014	170.0	20.0
ESRF EBS	European Synchrotron Radiation Facility Extremely Brilliant Source	single-sited	ESRF#	2016	2020	128.0	82.0
European Spallation Source ERIC	European Spallation Source	single-sited	ERIC, 2015	2006	2026*	3,009.0	140.0
European XFEL	European X-Ray Free-Electron Laser Facility	single-sited	European XFEL#	2006	2017	1,540.0	137.0
FAIR	Facility for Antiproton and Ion Research	single-sited	GmbH, 2010	2006	2025*	NA	NA
HL-LHC	High-Luminosity Large Hadron Collider	single-sited	CERN#	2016	2027*	1,408.0	136.0
ILL	Institut Max von Laue - Paul Langevin	single-sited	ILL#	2006	2012	188.0	100.0
SKAO	Square Kilometre Array Observatory	single-sited	SKAO, 2011	2006	2027*	1,986.0	77.0
SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	single-sited	GANIL	2006	2019	307.3	5.2

https://roadmap2021.esfri.eu



ESFRI Projects Roadmap 2021



https://roadmap2021.esfri.eu

▶ ESFRI PRO	JECTS					
NAME	FULL NAME	TYPE LEGAL STATUS (Y)	ROADMAP Entry (y)	OPERATION Start (Y)	INVESTMENT Cost (M€) C	OPERATION OST (M€/Y)
EST	European Solar Telescope	single-sited	2016	2029*	200.0	12.0
ET	Einstein Telescope	single-sited	2021	2035*	1,912.0	37.0
ET EuPRAXIA KM3NeT 2.0	European Plasma Research Accelerator with Excellence in Applications	distributed	2021	2028*	569.0	30.0
KM3NeT 2.0	KM3 Neutrino Telescope 2.0Two new entri	es in 2021: Einstein Telescope (2016 ET) and	2020	196.0 AXIA	3.0
		ne only accelerator facility select ne first plasma accelerator facilit			•	

PHYSICAL SCIENCES & ENGINEERING



What is EuPRAXIA About?



Building a facility with very high field plasma accelerators, driven by lasers or beams 1 – 100 GV/m accelerating field

Shrink down the facility size



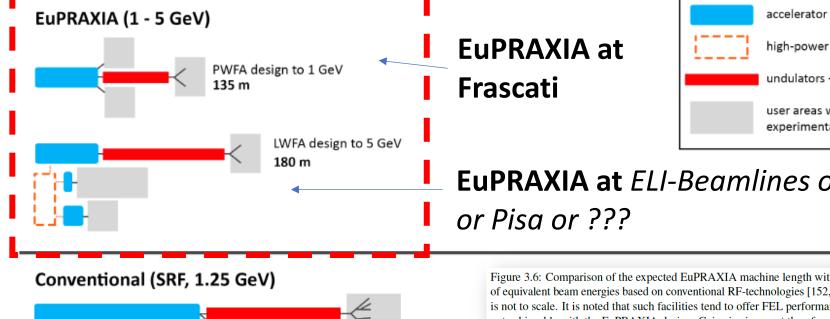
2020 Publication of Conceptual Design Report 600+ page CDR, 240 scientists contributed





EuPRAXIA Facility Size: COMPACT





315 m

- accelerator (plasma or RF) high-power laser undulators + photon beamline user areas with possibly multiple experimental stations
- **EuPRAXIA at** *ELI-Beamlines or EPAC*
 - Figure 3.6: Comparison of the expected EuPRAXIA machine length with parameters for facilities of equivalent beam energies based on conventional RF-technologies [152, 153]. The transverse size is not to scale. It is noted that such facilities tend to offer FEL performance parameters which are not achievable with the EuPRAXIA design. Gains in size must therefore be put into the context of performance limitations with the EuPRAXIA approach.
- Conventional (C-band, 5.8 GeV) 740 m 0 m 250 m 500 m 750 m

- Distributed
- 2 Construction Sites
- Several Excellence Centers

IMPORTANT:

EuPRAXIA design includes innovative concepts & solutions

but also lab space, RF injectors, transfer lines, undulator lines, shielding, ... (the **real space** needed)

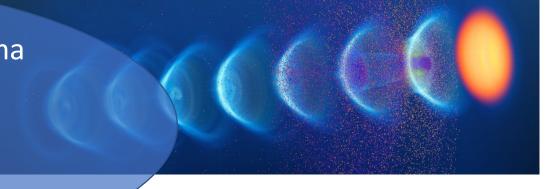




What is **EuPRAXIA** About?



Building a facility with very high field plasma accelerators, driven by lasers or beams 1 – 100 GV/m accelerating field



Shrink down the facility size



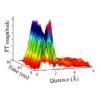
Coherent imaging



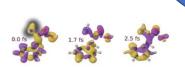
X-ray absorption spectroscopy

Raman spectroscopy









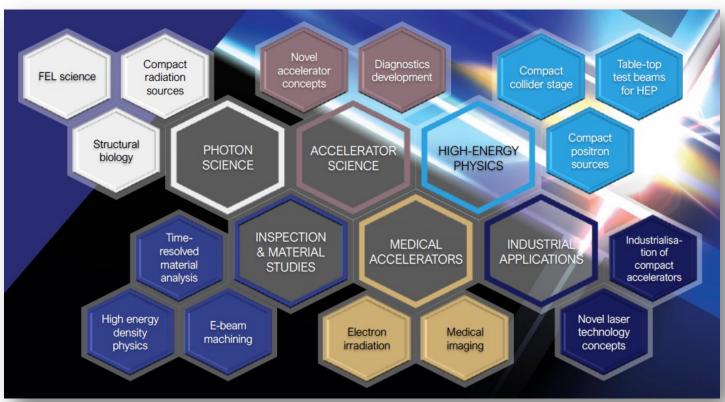
support several urgent and timely science

Enable frontier science in new regions and parameter regimes

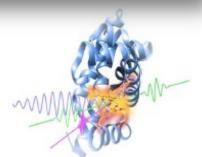
Producing particle and photon pulses to

cases

Versatile – Designed for Users in Multiple Science Fields



Topics of research: proteins, viruses, bacteria, cells, metals, semiconductors, superconductors, magnetic materials, organic molecules



Delivers 10-100 Hz **ultrashort** pulses

- Electrons (0.1-5 GeV, 30 pC)
- **Positrons** (0.5-10 MeV, 10⁶)
- **Positrons** (GeV source)
- Lasers
 (100 J, 50 fs, 10-100 Hz)
- Betatron X rays (1-110 keV, 10¹⁰)
- FEL light

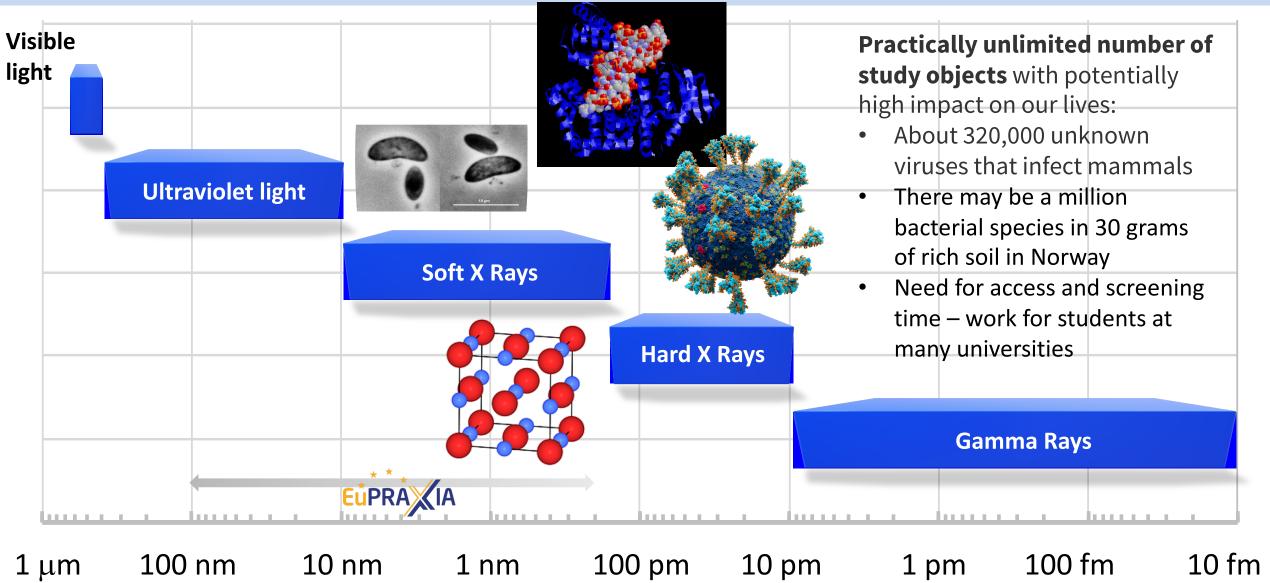
 (0.2-36 nm, 10⁹-10¹³)





Why Additional Compact (Less Powerful) FEL's?







EuPRAXIA-PP (Preparatory Phase) Key Facts

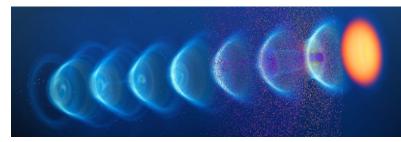


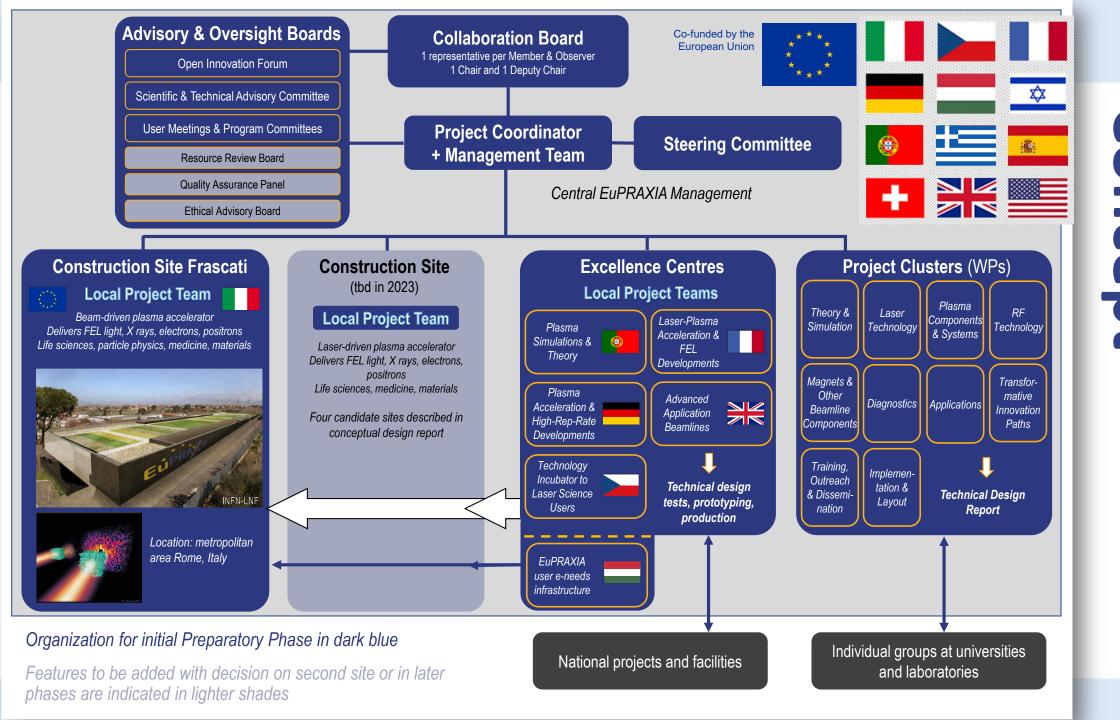
Prepares the implementation of the full RI in Europe

- Total project volume (including in-kind): 8.3 M€
 - EU funding: **2.49 M€** (EU without in-kind)
 - Outside EU: **0.69 M€** (Switzerland)
 - **0.51 M**€ (UK)
- Work organized in 16 Work Packages
- Project dates: 1 Nov 2022 31 Oct 2026
- Coordinator and location of headquarters: INFN
- **34** participating organizations from 12 countries
- Will establish a "Board of Financial Sponsors" with representatives of funding agencies.
- So far ~ 25% of total M&P funding (569 M€)
 secured. Site 1 is essentially financed → Massimo.









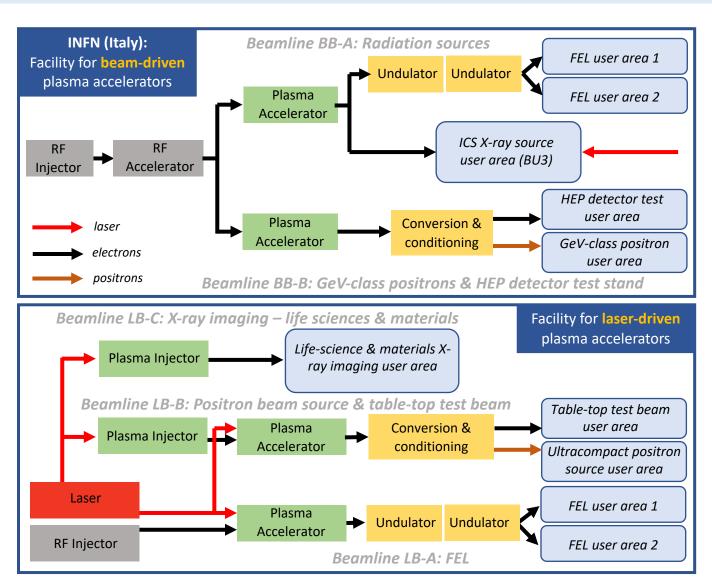




Phased Implementation of Construction Sites

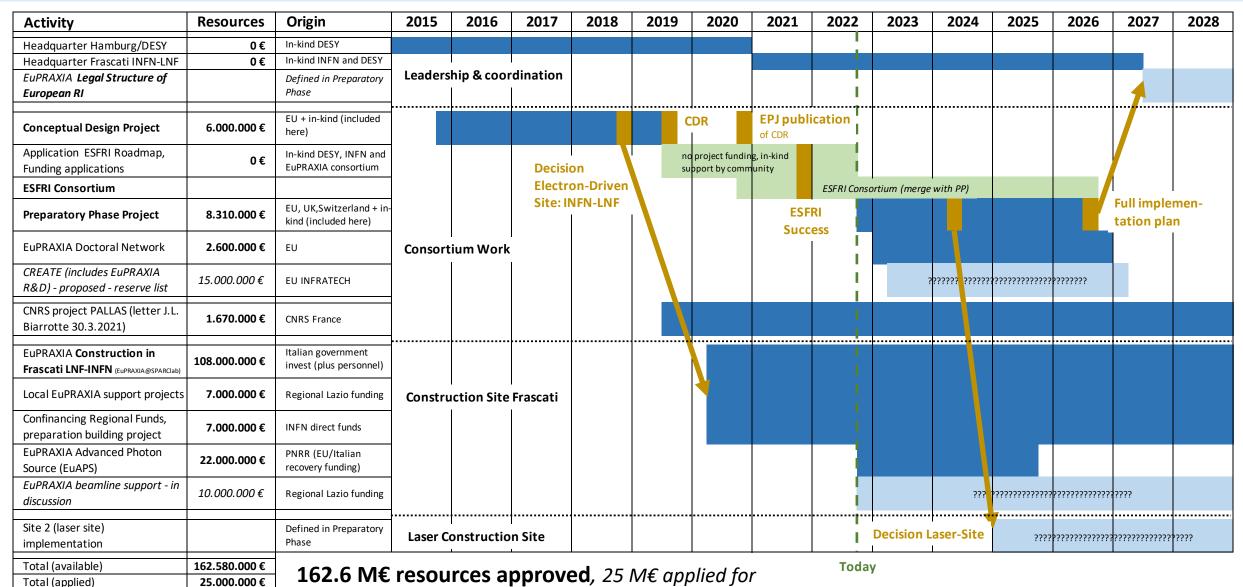


	Laser-driven	Beam-driven
Phase 1	✓ FEL beamline to 1 GeV+ user area 1	✓ FEL beamline to 1 GeV + user area 1
	✓ <u>Ultracompact positron</u> <u>source beamline</u> + positron user area	✓ <u>GeV-class positrons</u> <u>beamline</u> + positron user area
Phase 2	√ X-ray imaging beamline + user area	✓ <u>ICS source</u> beamline + user area
	✓ Table-top test beams user area	✓ HEP detector tests user area
	✓ FEL user area 2	✓ FEL user area 2
	✓ FEL to 5 GeV	✓ FEL to 5 GeV
Phase 3	✓ High-field physics beamline / user area	✓ Medical imaging beamline / user area
	✓ Other future developments	✓ Other future developments





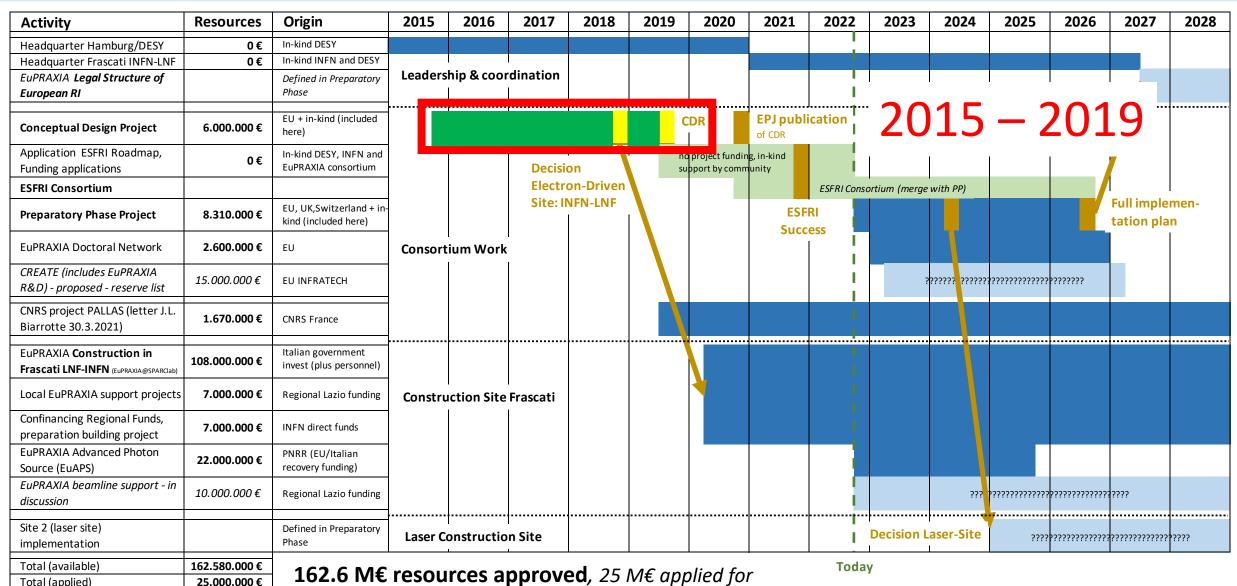






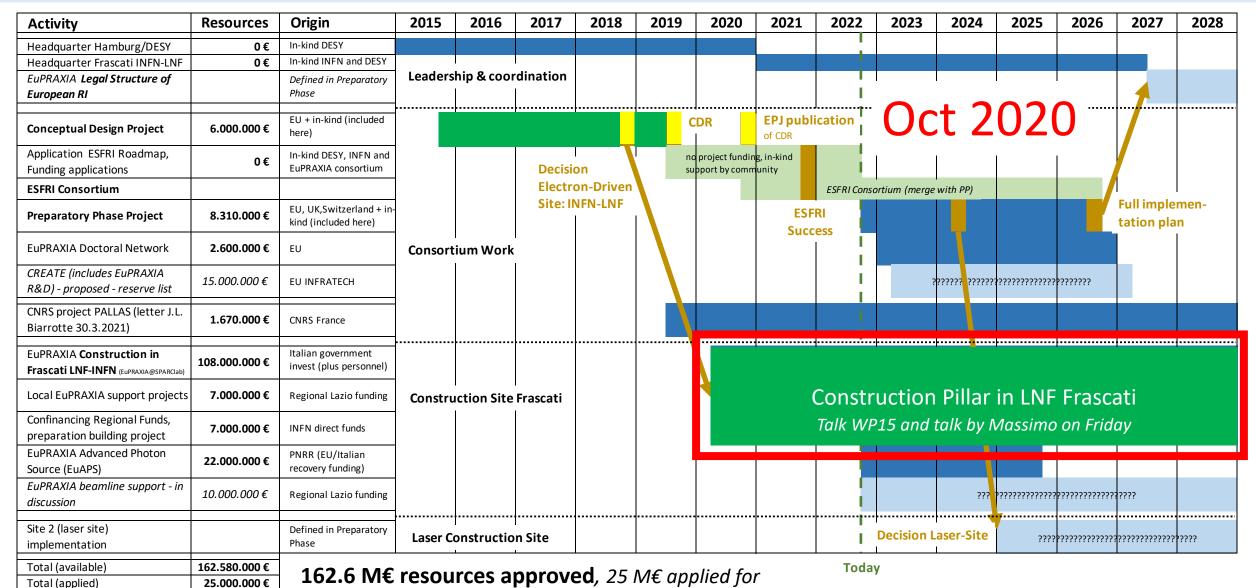
Total (applied)





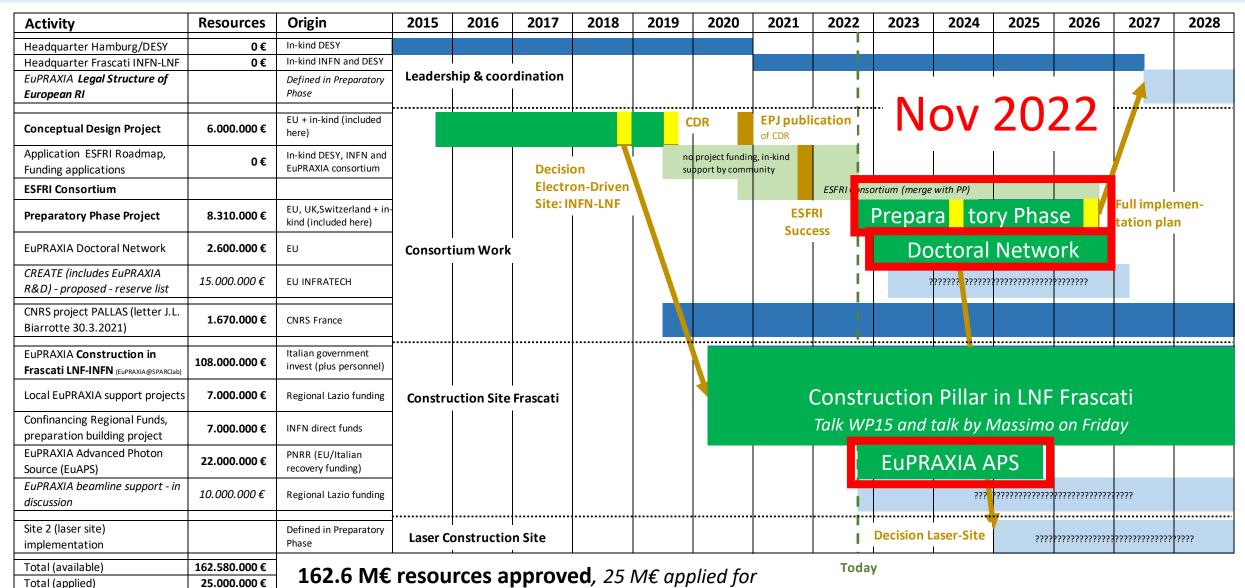






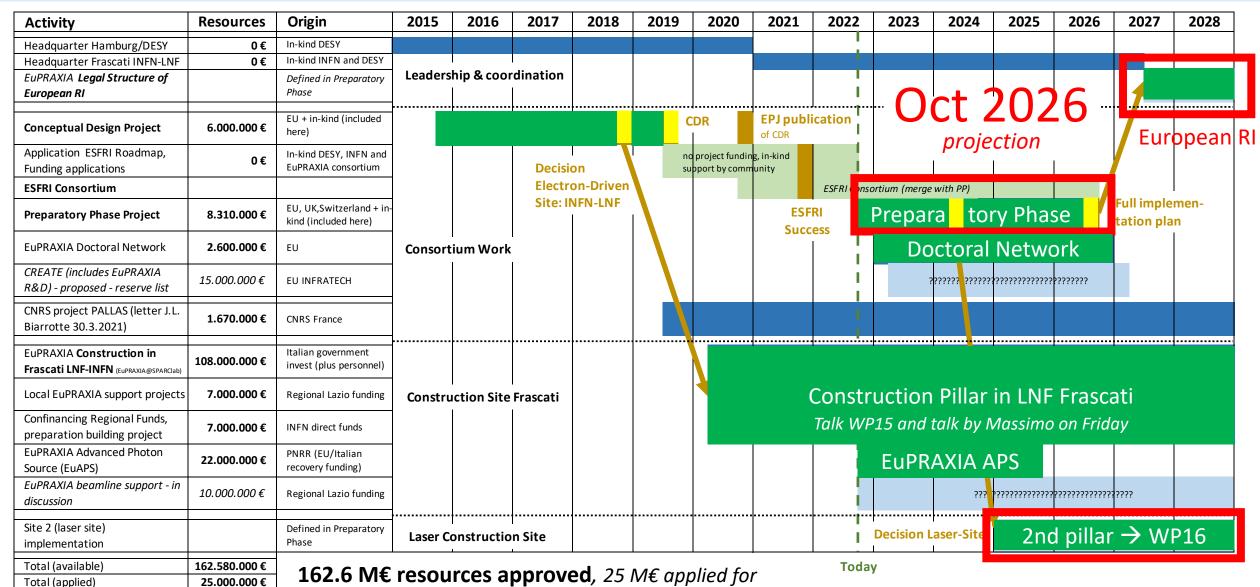














Relevant Questions for Preparatory Phase

hub, connections)

shop in first year

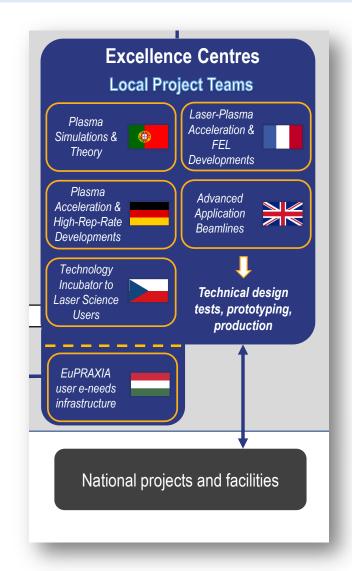
enter

rables (baseline or



- Updates to CDR concepts towards a TDR
- Second site on LWFA: Location and definition
- Excellence centres (add excellence centre lines to project overview and funding lines):
 - Define final number and conce
 - Can be cross-WP or single WP.
 - Specify R&D, prototyping, test upgrades) to construction site.
 - Determine required budget and uncess implementation possibilities
- User services and access mo
- E infrastructure requirement gration
- Legal and financial models, open science and open innovation
- Rules and organization, extension of membership

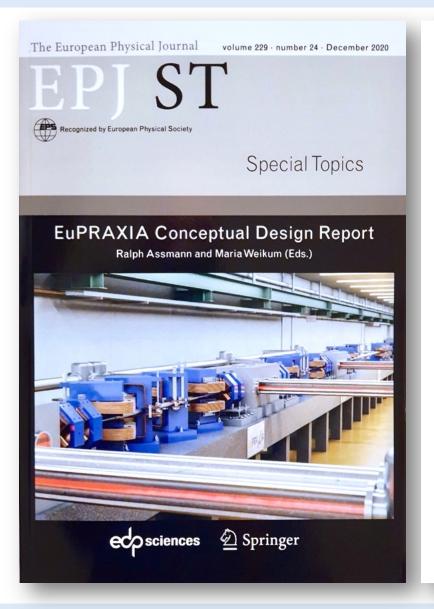
• ...





Reference Documents EuPRAXIA-PP





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

Associated with document Aler: Ares (2022) \$382240 - 126/07/2022



EUROPEAN RESEARCH EXECUTIVE AGENCY (REA)

REA.C – Future Society
C.4 – Reforming European R&I and Research Infrastructures

GRANT AGREEMENT

Project 101079773 — EuPRAXIA

PREAMBLE

This Agreement ('the Agreement') is between the following parties:

on the one part,

the European Research Executive Agency (REA) ('EU executive agency' or 'granting authority'), under the powers delegated by the European Commission ('European Commission'),

and

on the other part,

1. 'the coordinator':

ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN), PIC 999992789, established in Via Enrico Fermi 54, FRASCATI 00044, Italy,

and the following other beneficiaries, if they sign their 'accession form' (see Annex 3 and Article 40):

- CONSIGLIO NAZIONALE DELLE RICERCHE (CNR), PIC 999979500, established in PIAZZALE ALDO MORO 7, ROMA 00185, Italy.
- ELETTRA SINCROTRONE TRIESTE SCPA (ELETTRA), PIC 999589851, established in SS 14 KM 163.5 AREA SCIENCE PARK, BASOVIZZA TRIESTE 34149, Italy,
- 4. AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE (ENEA), PIC 999988521, established in LUNGOTEVERE GRANDE AMMIRAGLIO THAON DI REVEL 76, ROMA 00196, Italy,
- UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA (UNI SAPIENZA), PIC 999987745, established in Piazzale Aldo Moro 5, ROMA 00185, Italy,
- UNIVERSITA DEGLI STUDI DI ROMA TOR VERGATA (UNITOV), PIC 999844864, established in VIA CRACOVIA 50, ROMA 00133, Italy,
- COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA), PIC 999992401, established in RUE LEBLANC 25, PARIS 15 75015, France,
- CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS (CNRS), PIC 999997930. established in RUE MICHEL ANGE 3. PARIS 75794. France.

EuPRAXIA Consortium Agreement, final version date 15.11.2022

Consortium Agreement



HORIZON EUROPE GRANT AGREEMENT N. 101079773

Final Version - Date 15/11/2022

Based on DESCA – Model Consortium Agreement for Horizon Europe

AP Version 1

July 2022

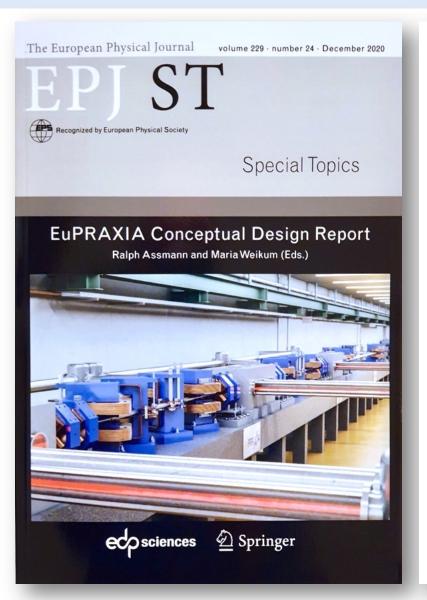
© DESCA - Model Consortium Agreement for Horizon Europe, www.desca-agreement.eu
DESCA AP Version 1

1/89



Reference Documents EuPRAXIA-ESFRI





Consortium Agreement

between research institutions and organisations

for the Preparatory Phase of the EuPRAXIA infrastructure

Preamble:

Istituto Nazionale di Fisica Nucleare (INFN), Via Enrico Fermi 40, Frascati 00044, Italy,

Commissariat à l'Énergie Atomique et aux Énergies Alternatives (CEA), rue Leblanc 25, Paris 15, 75015, France.

European Organization for Nuclear Research (CERN), an Intergovernmental Organization having its seat at Geneva, Switzerland and its address at Esplanade de Particules 1, 1217 Meyrin, Switzerland,

Consiglio Nazionale delle Ricerche (CNR), Via Moruzzi, 1, 56124 Pisa, Italy,

Centre National de la Recherche Scientifique (CNRS), Rue Michel-Ange 3, 75794 Paris, France,

Deutsches Elektronen-Synchrotron DESY (DESY), Notkestraße 85, Hamburg 22607, Germany,

Elettra - Sincrotrone Trieste S.C.p.A., Strada Statale 14 - km 163,5 in AREA Science Park, 34149 Basovizza,

Institute of Physics of the Czech Academy of Sciences, a public research institution, Na Slovance 2, Prague 8, post code 182 21, Czech Republic (Extreme Light Infrastructure – Beamlines Facility),

Swiss Federal Laboratories for Materials Science and Technology (EMPA), Überlandstr. 129, 8600 Dübendorf, Switzerland,

Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenible (ENEA), Via Enrico Fermi, 45, Frascati 00044, Italy.

Ecole Polytechnique Fédérale de Lausanne (EPFL), Bâtiment CE- 3.316, Station 1, CH-1015 Lausanne,

Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik within the Forschungsverbund Berlin e.V. (FBH). Gustav-Kirchhoff-Straße 4. 12489 Berlin. Germany.

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V., Hansastr. 27c, 80686 München acting as legal entity for and on behalf of its Fraunhofer Institute for Laser Technology, Steinbachstraße 15, 52074 Aachen, Germany,

Forschungszentrum Jülich GmbH (FZJ), Wilhelm-Johnen-Straße, 52425 Jülich, Germany,

Hebrew University of Jerusalem, Jerusalem, Israel,

Helmholtz-Zentrum Dresden-Rossendorf e.V. (HZDR), Bautzner Landstr. 400, 01328 Dresden, Germany,

Institute of Applied Physics of the Russian Academy of Sciences, 46 Ul'yanov Street, Nizhny Novgorod, 603950 Russia

Imperial College of Science, Technology and Medicine, South Kensington Campus, London SW7 2AZ, United Kingdom,

Institute of Plasma Physics and Laser Microfusion (IFPiLM), ul. Hery 23, 01-497 Warszawa, Poland,

23 June 2020 Page 1 of 88



EuPRAXIA-Preparatory Phase Consortium



34 Institutes from 12 Countries → to be merged with ESFRI Consortium



Complemented by institutes in **EuPRAXIA ESFRI consortium: additional 17 institutes** from France, Germany, Poland, Sweden, United Kingdom, China, Japan, United States. Russian institutes presently suspended.



PP Steering Committee: Leaders Behind EuPRAXIA



Governing Board (Decision-making body)

Steering Committee

Scientific Advisory Board

Technical & Industrial Advisory Board

Board of Financial Sponsors

WP1 - Coordination & Project Management

R. Assmann, INFN & DESY M. Ferrario, INFN

WP2 - Dissemination and Public Relations

C. Welsch, U Liverpool

S. Bertellii, INFN

WP3 - Organization and Rules

A. Specka, CNRS

A. Ghigo, INFN

WP4 - Financial & Legal Model. Economic Impact

A. Falone, INFN

WP5 - User Strategy and Services

F. Stellato, U Tor Vergata

E. Principi, ELETTRA

WP6 - Membership Extension Strategy

B. Cros, CNRS

A. Mostacci, U Sapienza

WP7 - E-Needs and Data Policy

R. Fonseca, IST

S. Pioli, INFN

WP8 - Theory & Simulation

J. Vieria, 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. Molodozhentsev, ELI-Beamlines

R. Pattahil, STFC

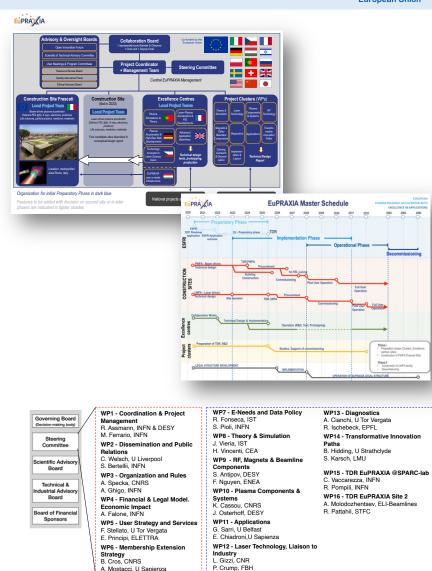
WP's on coordination & implementation as ESFRI RI (organization, legal model, financing, users) WPs on technical implementation and sites



Preparatory Phase Main Goals



- Managerial WP's
 - Outreach to public, users, EU decision makers and industry
 - Define legal model (how is EuPRAXIA governed?), financial model, rules, user services and membership extension for full implementation
 - Works with project bodies and funding agencies → Board of Financial Sponsors
- 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





Reporting Periods – M12, M30, M48



			Payments			
	Reporting periods		Туре	Deadline	Туре	Deadline (time to pay)
RP No	Month from	Month to				
					Initial prefinancing	30 days from entry into force/10 days before starting date – whichever is the latest
1	1	12	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
2	13	30	Periodic report	60 days after end of reporting period	Interim payment	90 days from receiving periodic report
3	31	48	Periodic report	60 days after end of reporting period	Final payment	90 days from receiving periodic report



Project Reviews – M14, M32



PROJECT REVIEWS

-			_		
Pro	17	act.	к	ev	ews

Grant Preparation (Reviews screen) - Enter the info.

Review No	Timing (month)	Location	Comments
RV1	14	tbd	
RV2	32	tbd	



Deliverables & Milestones WP1



Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Туре	Dissemination Level	Due Date (month)
D1.1	Data Management Plan (WP1)	WP1	1 - INFN	R — Document, report	PU - Public	6
D1.2	Description of updated implementation scheme after site decision	WP1	1 - INFN	R — Document, report	PU - Public	24
D1.3	EuPRAXIA-RI Implementation Plan	WP1	1 - INFN	R — Document, report	PU - Public	48

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
1	Kick off Meeting	WP1	1-INFN	Meeting website	1
2	Formation of project boards	WP1	1-INFN	Report	6
3	Decision on ranking of legal models for RI	WP1	1-INFN	Report	24
4	Agreement on legal and financial packages	WP1	1-INFN	Report	48



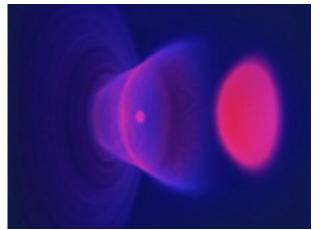
Conclusion



- Happy that we have reached the next level. Game not yet over but on contrary – future looks really exciting.
- So far **highly attractive** for funding: high tech and urgent science!
- All of you are needed to define best possible, very convincing proposals for **full implementation** in the European research area.
- **Steering committee** every 2 3 months: will discuss and steer together the progress.
- Form WP teams:
 - First discussions at kick-off meeting
 - Via email through our contact lists
- Dedicated workshop to be organized: "EuPRAXIA WP`s and Excellence Centers" – making the cross connections – needs to be in first year









Thank You





Backup Slides





Staff Effort



Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person-Months
1 - INFN	108.00	6.00	10.00	54.00			6.00	6.00	6.00	6.00	340.00
2 - CNR		2.00						4.00		2.00	63.00
3 - ELETTRA	4.00				30.00						34.00
4 - ENEA									4.00		4.00
5 - UNI SAPIENZA						30.00			6.00		54.00
6 - UNITOV					48.00						78.00
7 - CEA								37.00			37.00
8 - CNRS			6.00			22.00		22.00		21.00	95.00
9 - THALES											4.00
10 - DESY			6.00					6.00	18.00	12.00	54.00
11 - FBH											8.00
12 - FZJ											38.00
13 - HZDR											7.00
14 - LMU MUENCHEN											7.00
15 - Wigner RCP	3.00	6.00									9.00
16 - USZ											12.00
17 - UP											6.00
18 - IST ID							30.00	72.00			102.00
19 - IP-ASCR								24.00	6.00	24.00	102.00



Staff Effort



Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person-Months
20 - CERN				2.00					2.00		6.00
21 - IASA		8.00	8.00	8.00					8.00		56.00
22 - CLPU								2.00	2.00		8.00
23 - HUJ										2.00	4.00
24 - Fraunhofer	2.00									1.00	5.00
25 - ALBA-CELLS									4.00		8.00
26 - UCLA								6.00			18.00
27 - EPFL											53.00
28 - EMPA					18.00		24.00				154.00
29 - Imperial											6.00
30 - QUB	6.00				6.00					6.00	54.00
31 - UKRI									10.00		46.00
32 - ULIV		46.00									46.00
33 - USTRATH											18.00
34 - UOXF											6.00
Total Person-Months	123.00	68.00	30.00	64.00	102.00	52.00	60.00	179.00	66.00	74.00	1542.00



Staff Effort



Staff effort per participant

Grant Preparation (Work packages - Effort screen) — Enter the info.

Participant	WP11	WP12	WP13	WP14	WP15	WP16	Total Person-Months
1 - INFN		12.00		6.00	120.00		340.00
2 - CNR	2.00	48.00	2.00			3.00	63.00
3 - ELETTRA							34.00
4 - ENEA							4.00
5 - UNI SAPIENZA	18.00						54.00
6 - UNITOV			24.00	6.00			78.00
7 - CEA							37.00
8 - CNRS	4.00		14.00	6.00			95.00
9 - THALES		4.00					4.00
10 - DESY		12.00					54.00
11 - FBH		8.00					8.00
12 - FZJ				38.00			38.00
13 - HZDR				7.00			7.00
14 - LMU MUENCHEN				7.00			7.00
15 - Wigner RCP							9.00
16 - USZ	6.00	6.00					12.00
17 - UP				6.00			6.00
18 - IST ID							102.00
19 - IP-ASCR	6.00	24.00	6.00			12.00	102.00
20 - CERN			2.00				6.00
21 - IASA	8.00				8.00	8.00	56.00
22 - CLPU		2.00	2.00				8.00
	•						

Staff effort per participant

Grant Preparation (Work packages - Effort screen) - Enter the info.

	Participant	WP11	WP12	WP13	WP14	WP15	WP16	Total Person-Months
	23 - HUJ			2.00				4.00
Ī	24 - Fraunhofer		1.00				1.00	5.00
1	25 - ALBA-CELLS			4.00				8.00
1	26 - UCLA			6.00	6.00			18.00
1	27 - EPFL			53.00				53.00
	28 - EMPA		56.00	56.00				154.00
	29 - Imperial				6.00			6.00
	30 - QUB	36.00						54.00
	31 - UKRI	6.00	12.00	12.00			6.00	46.00
	32 - ULIV							46.00
	33 - USTRATH				18.00			18.00
	34 - UOXF				6.00			6.00
$\frac{1}{1}$	Total Person-Months	86.00	185.00	183.00	112.00	128.00	30.00	1542.00