EUROPEAN PLASMA RESEARCH ACCELERATOR WITH EXCELLENCE IN APPLICATIONS

EuPRAXIA

Horizon2020

DESY

Science & Technology Facilities Council

cnrs

Consiglio Nazionale delle Ricerche

University of Oxford

SOLEIL Synchrotron

Manchester 1824 The University of Manchester

Imperial College London

IST-ID Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento

INFN

University of Liverpool

ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development

cea

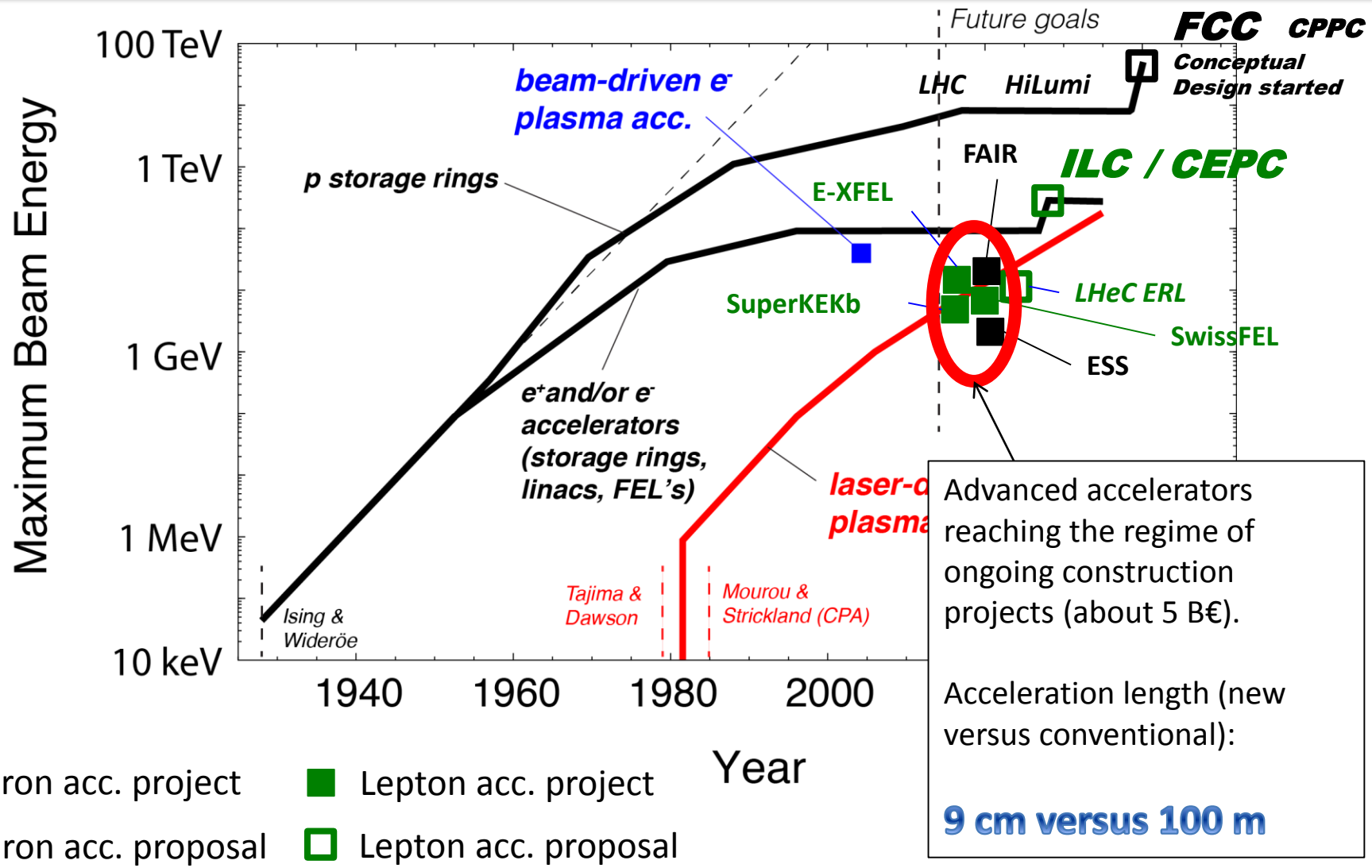
Universität Hamburg

University of Strathclyde Glasgow

Sapienza Università di Roma

R. Assmann
DESY
EuCARD2 Yearly Meeting 2016
Malta, 26.4.2016

Livingston and Future Accelerators (here e^+/e^- and p)



Advanced accelerators reaching the regime of ongoing construction projects (about 5 B€).

Acceleration length (new versus conventional):

9 cm versus 100 m

Plasma Accelerators: The Future?

- **Believers:** Believing that we can build GeV/TeV/PeV particle accelerators for a lower price tag and can open many new applications and scientific discoveries.
- **Non-believers:** Believing that the many short-comings of the plasma accelerator technology (efficiency, positrons, stability, energy spread, ...) cannot be solved in reasonable time.
- **The EuPRAXIA approach:**
  - Focus on facts and physics. Take short-coming serious.
  - However, if not proven impossible we assume solutions can be found and we work on these solutions.
  - Use the plasma accelerator technology to design a full blown particle accelerator and estimate the achievable performance.

Reminder: A Particle Accelerator is More than the Accelerating System

- In a circular accelerator facility:
  Accelerating systems < 10% of total investment
- In a linear accelerator facility:
  Accelerating systems < 30% of total investment

- Highly developed (and expensive) systems for generation/bending/focusing/diagnostics/correction/collimation/control of particle beams:
  - Accelerator facilities would not provide interesting performance without these systems.
  - **For plasma accelerators not at addressed yet, due to focus on acceleration highlights and lack of budget → EuPRAXIA**

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EuPRAXIA

http://eupraxia-project.eu

NOVEL FUNDAMENTAL RESEARCH

COMPACT EUROPEAN PLASMA ACCELERATOR WITH SUPERIOR BEAM QUALITY

Find Out More

OUR TECHNOLOGY

EuPRAXIA brings together novel acceleration schemes, modern lasers, the latest correction technologies and large-scale user areas.

LEARN MORE

PARTICIPANTS

A consortium of 16 laboratories and universities from 5 EU member states has formed to produce a conceptual design report.

LEARN MORE

WORK PACKAGES

The project is structured into 14 work packages of which 8 are included into the EU design study.

LEARN MORE

MANAGEMENT

The management bodies will organise, lead and control the project's activities and make sure that objectives are met

LEARN MORE

OPENING NEW HORIZONS

EUPRAXIA IS A LARGE RESEARCH INFRASTRUCTURE BEYOND THE CAPABILITIES OF A SINGLE LAB

DESY | cnrs | cea | Consiglio Nazionale delle Ricerche | SOLEIL SYNCHROTRON | IST-ID Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento | MANCHESTER 1824 The University of Manchester | INFN | UNIVERSITY OF LIVERPOOL | ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development | UNIVERSITY OF OXFORD | SAPIENZA UNIVERSITÀ DI ROMA | University of Strathclyde Glasgow | Imperial College London | UHH Universität Hamburg | Science & Technology Facilities Council

plus 18 associated partner institutes

EuPRAXIA – Connected Labs and Institutes

Horizon2020

List of participants:

Participant no.	Participant organisation name	Short name	Country
1 (Coordinator)	Stiftung Deutsches Elektronen Synchrotron	DESY	Germany
2	Istituto Nazionale di Fisica Nucleare	INFN	Italy
3	Consiglio Nazionale delle Ricerche	CNR	Italy
4	Centre National de la Recherche Scientifique	CNRS	France
5	University of Strathclyde	USTRAH	UK
6	Instituto Superior Técnico	IST	Portugal
7	Science & Technology Facilities Council	STFC	UK
8	Synchrotron SOLEIL – French National Synchrotron	SOLEIL	France
9	University of Manchester	UMAN	UK
10	University of Liverpool	ULIV	UK
11	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenible	ENEA	Italy
12	Commissariat à l'Énergie Atomique et aux énergies alternatives	CEA	France
13	Sapienza Universita di Roma	UROM	Italy
14	Universität Hansestadt Hamburg	UHH	Germany
15	University of Oxford	UOXF	UK
16	Imperial College London	ICL	UK

16 beneficiaries from 5 EU member states

plus 18 associated partners

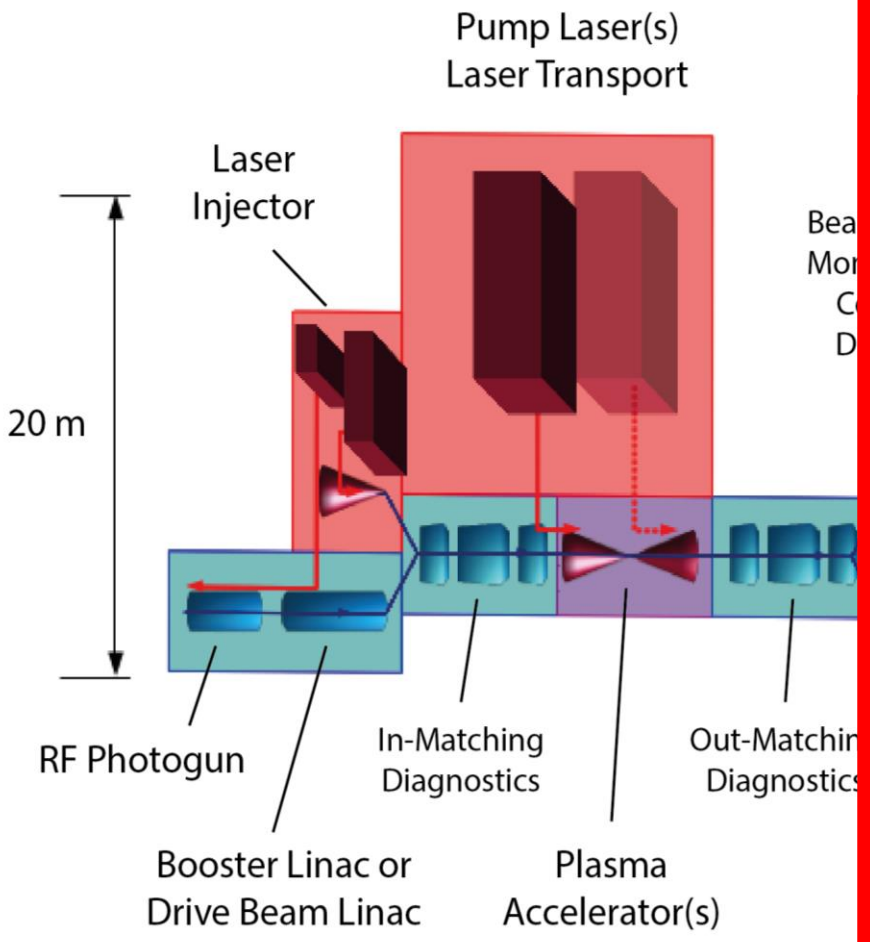
Associated partner organisation name	Short name	Country
Jiaotong-Universität Shanghai	JUS	China
Tsingua University Beijing	TUB	China
Extreme Light Infrastructures - Beams	ELI-B	Czech Repu
Lille University	PHLAM	France
Helmholtz Institute Jena	HIJ	Germany
Helmholtz-Zentrum Dresden-Rossendorf	HZDR	Germany
Ludwig-Maximillians-Universität München	LMU	Germany
Wigner Research Center of the Hungarian Academy of Science	WIGNER	Hungary
European Organization for Nuclear Research	CERN	IEIO[1]
High Energy Accelerator Research Organization	KEK	Japan
Kansai Photon Science Institute, Japan Atomic Energy Agency	KPSI-JAEA	Japan
Osaka University	OU	Japan
RIKEN SPring-8 Center	RSC	Japan
Lund University	LU	Sweden
Center for Accelerator Science and Education at Stony Brook U & BNL	CASE	USA
Lawrence Berkeley National Laboratory	LBNL	USA
SLAC National Accelerator Laboratory	SLAC	USA
University of California, Los Angeles	UCLA	USA

EuPRAXIA Research Infrastructure for the 2020's

5 GeV electron beam

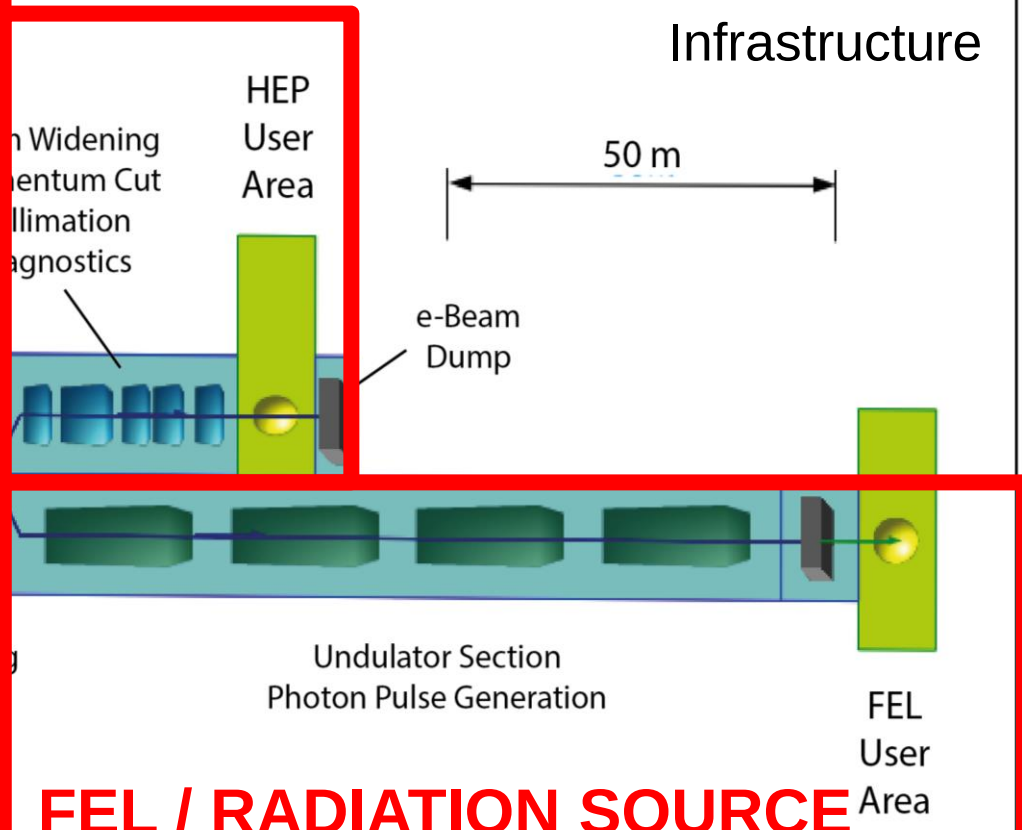
Horizon2020

PLASMA ACCELERATOR



HEP & OTHER USER AREA

EuPRAXIA
Research
Infrastructure



FEL / RADIATION SOURCE USER AREA

EuPRAXIA

A Child of EuCARD and EuCARD2

Many thanks to > 5 years of support from J.P. Koutchouk, M. Vretenar and many others!

Project Organization

Detailed list of names, email addresses and WP memberships collected (64 names).

Work Package	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	WP11	WP12	WP13	WP14
No. Members	14	24	19	9	15	11	6	4	4	4	6	3	8	7
	Management	Physics & Simulations	LPA structure	Laser	Electron beam	FEL	HEP & other apps	Outreach	Beam-driven plasmas	Other techs	FEL prototyping	Test facilities	Other radiation	Hybrid

EU Work Packages *In-Kind Work Packages*

Available manpower over 4 years (from proposal):

42 man-years (new hires – paid by EU budget)

+ 81 man-years (in-kind)

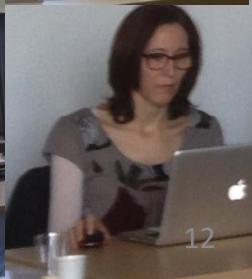
Final deliverable:

Conceptual Design Report published

Kick-off meeting at DESY on Nov 26th – 27th

EuPRAXIA

Ecole polytechnique
2016 02 19



Intranet

Horizon2020

Home

Wikipraxia

EuPRAXIA News Blog

Site Actions

View All Site Content

Lists
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Sites
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- EuPRAXIA News Blog

Discussions
- Team Discussion

People and Groups

Create a Blog / Wiki

Recycle Bin

File sharing site for the H2020 Design Study EuPRAXIA

Announcements

1st Steering Committee Meeting 03/02/2016 12:08
by Welsch, Alexandra

Dear Steering Committee Members,

The first EuPRAXIA Steering Committee Meeting will take place on 19th February 2016 at Laboratoire Leprince-Ringuet, Ecole Polytechnique, Palaiseau, France.

You will have the possibility to attend in person or remotely.

...

Welcome to the EuPRAXIA Intranet! 25/01/2016 13:42
by Welsch, Alexandra

Dear participants,

We would like to welcome you to the new EuPRAXIA Intranet. This file repository has been created in order to help the coordination between different workpackages, facilitate the exchange of information, and keep a record of theprogress...

Add new announcement

EuPRAXIA

Calendar

19/02/2016 10:15 EuPRAXIA Management (Support) Team Meeting

Management Team:
-Ralph Aßmann -Arnd Specka -Carsten Welsch

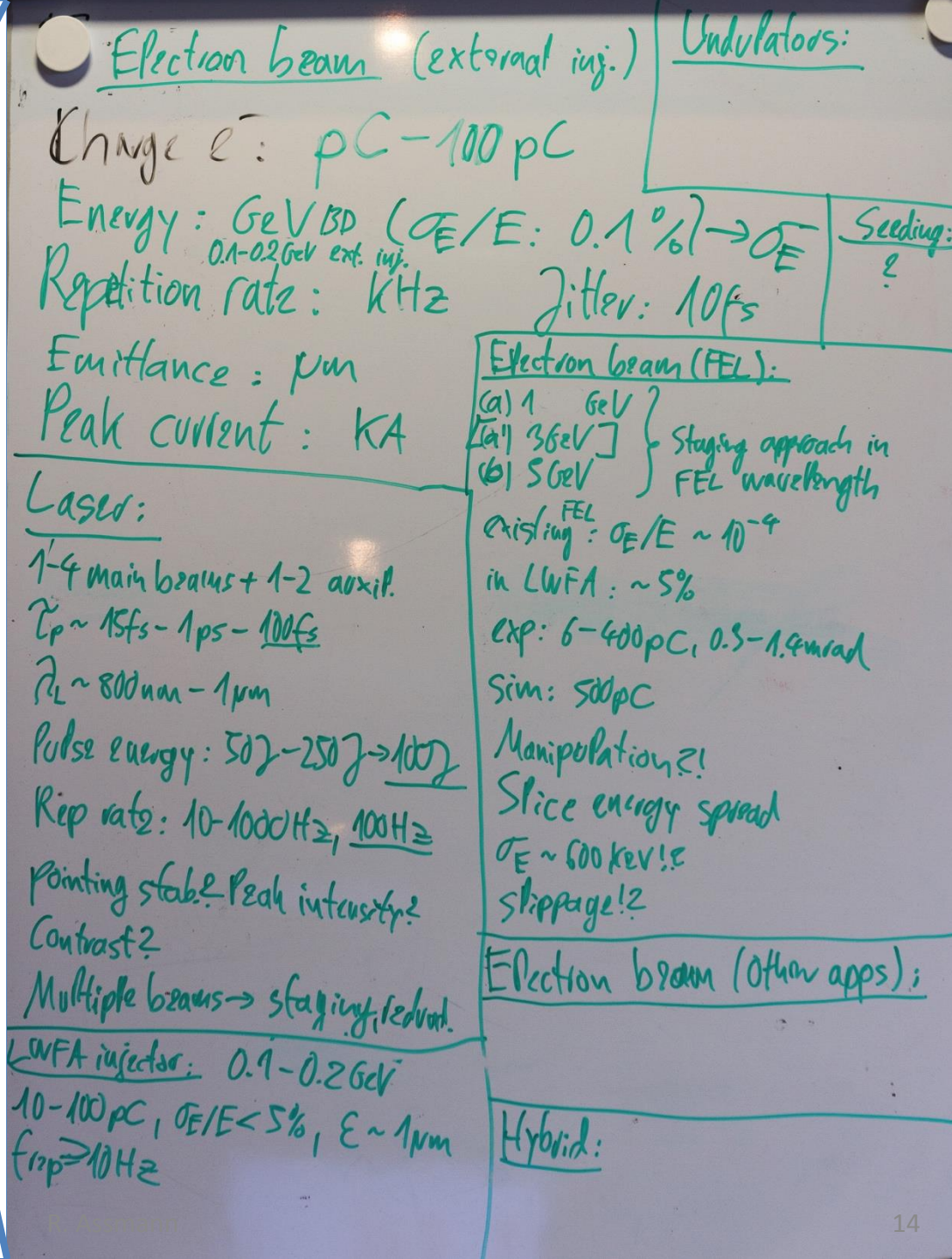
Management Support Team:
-Tom Förster -Ruth Mundt - Ricardo Torres - Andreas

Links

- Beneficiarys
- Associated Partners
- http://www.eupraxia-project.eu/
- VOCAL UserGuide pdf
- VOCAL Support: intranet@eupraxia-project.eu

Add new link

Beam Parameter	Unit	Value
Particle type	-	Electrons
Energy	GeV	1 – 5
Charge per bunch	pC	1 – 50
Repetition rate	Hz	10
Bunch duration	fs	0.01 - 10
Peak current	kA	1 – 100
Energy spread	%	0.1 – 5
Norm. emittance	mm	0.01 – 1



Repetition rate: kHz

Emittance: μm

Peak current: kA

Jitter: 10 fs

Laser:

1-4 main beams + 1-2 auxil.

τ_p ~ 15 fs - 1 ps - 100 fs

λ_L ~ 800 nm - 1 μm

Pulse energy: 50 J - 250 J → 100 J

Rep rate: 10 - 1000 Hz, 100 Hz

Pointing stab.? Peak intensity?

Contrast?

Multiple beams ...

Electron beam (FEL):

(a) 1 GeV
[a') 3 GeV]
(b) 5 GeV
} Staging approach in FEL wavelength

existing FEL: $\sigma_E/E \sim 10^{-4}$

in LWFA: ~ 5%

exp: 6 - 400 pC, 0.3 - 1.4 mrad

Sim: 500 pC

Manipulation?!

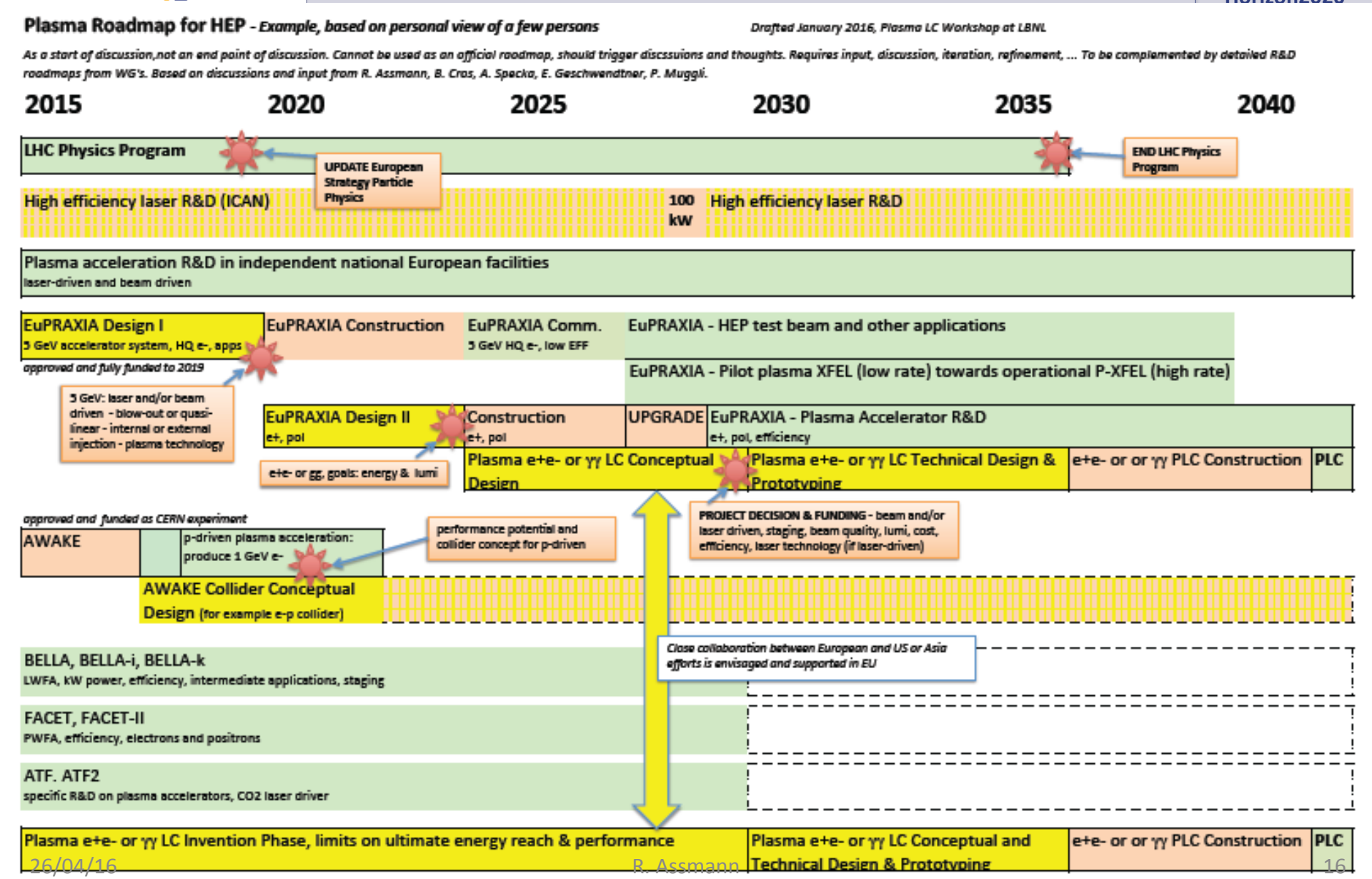
Slice energy spread

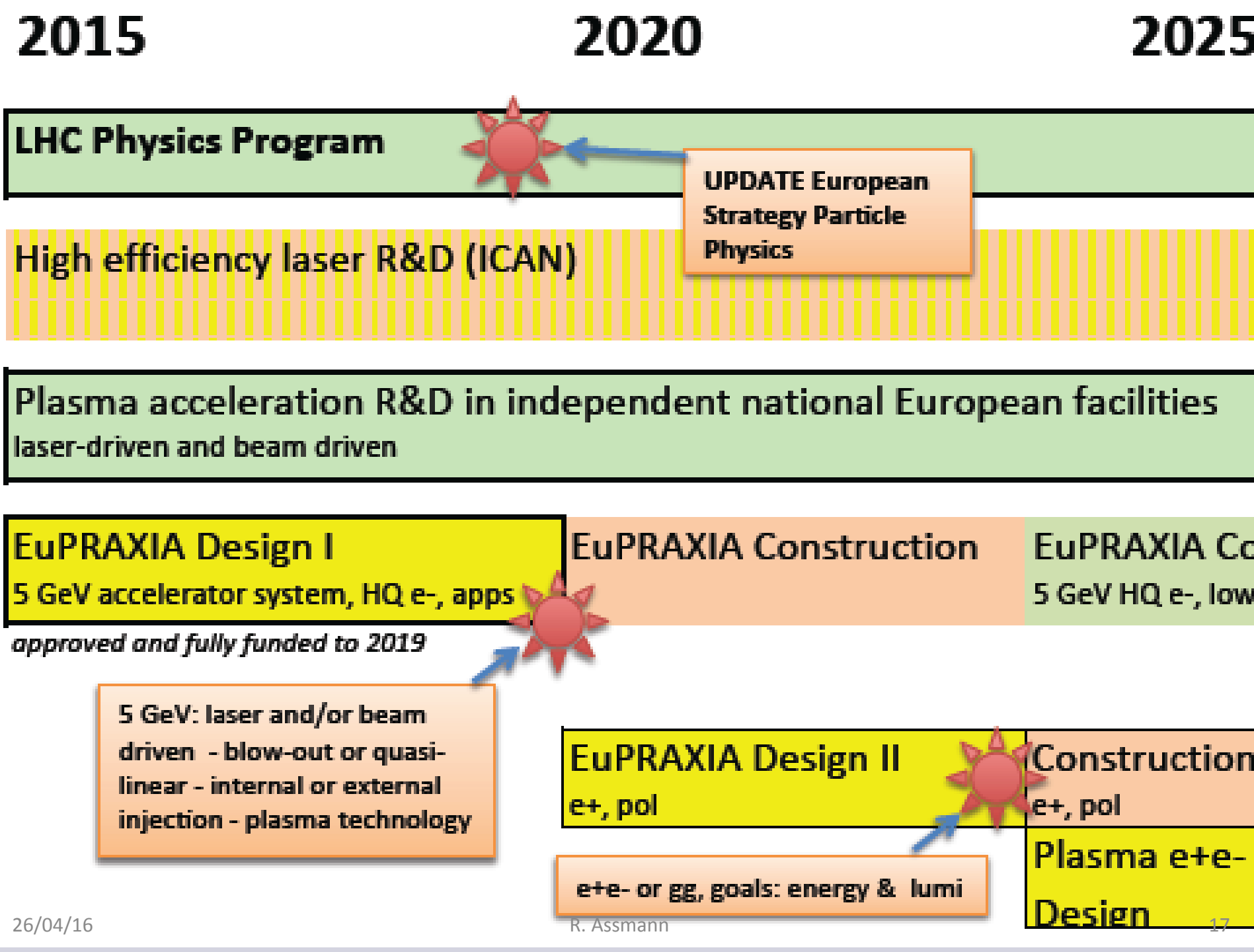
σ_E ~ 600 keV!?

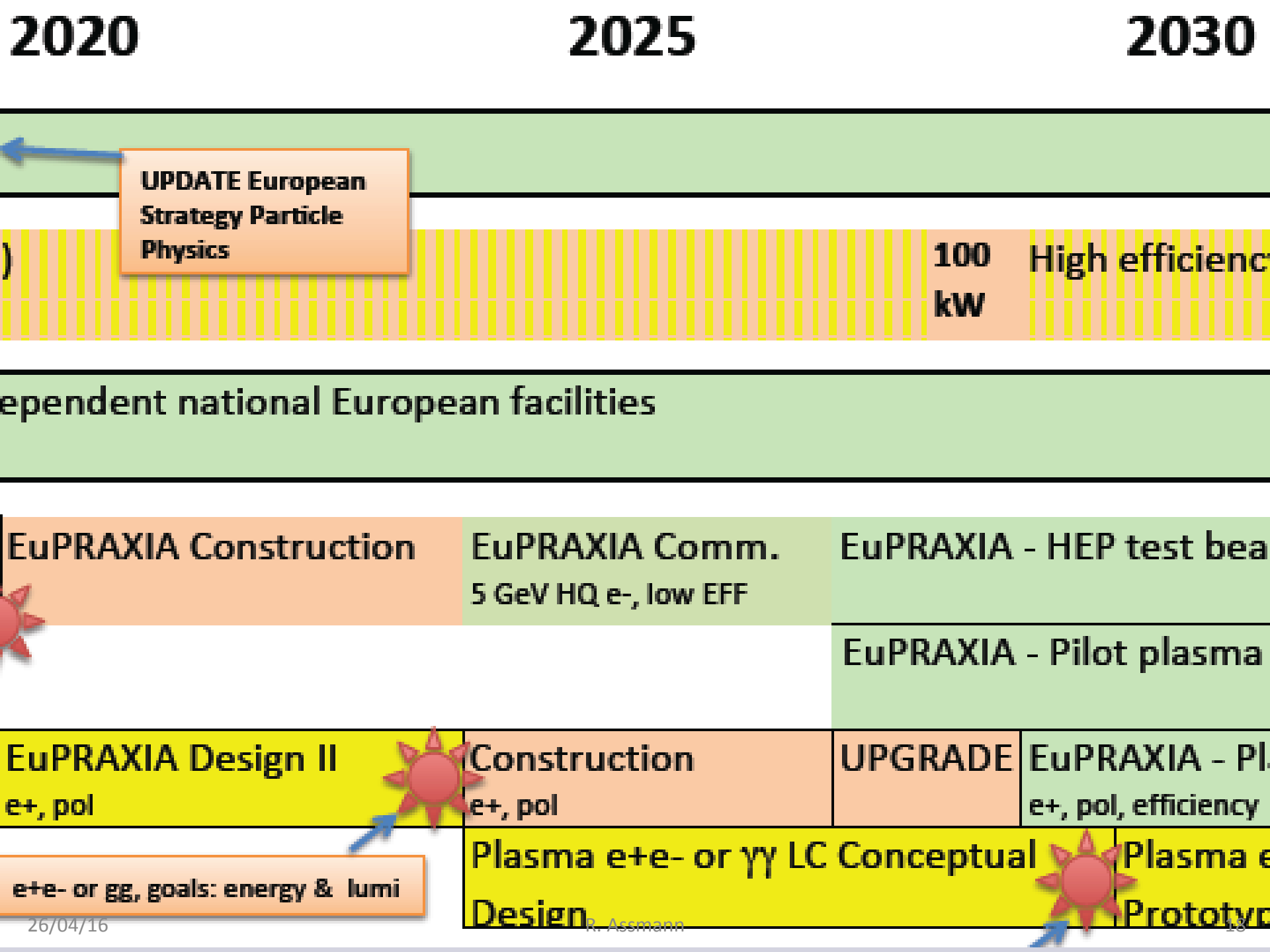
slippage!?

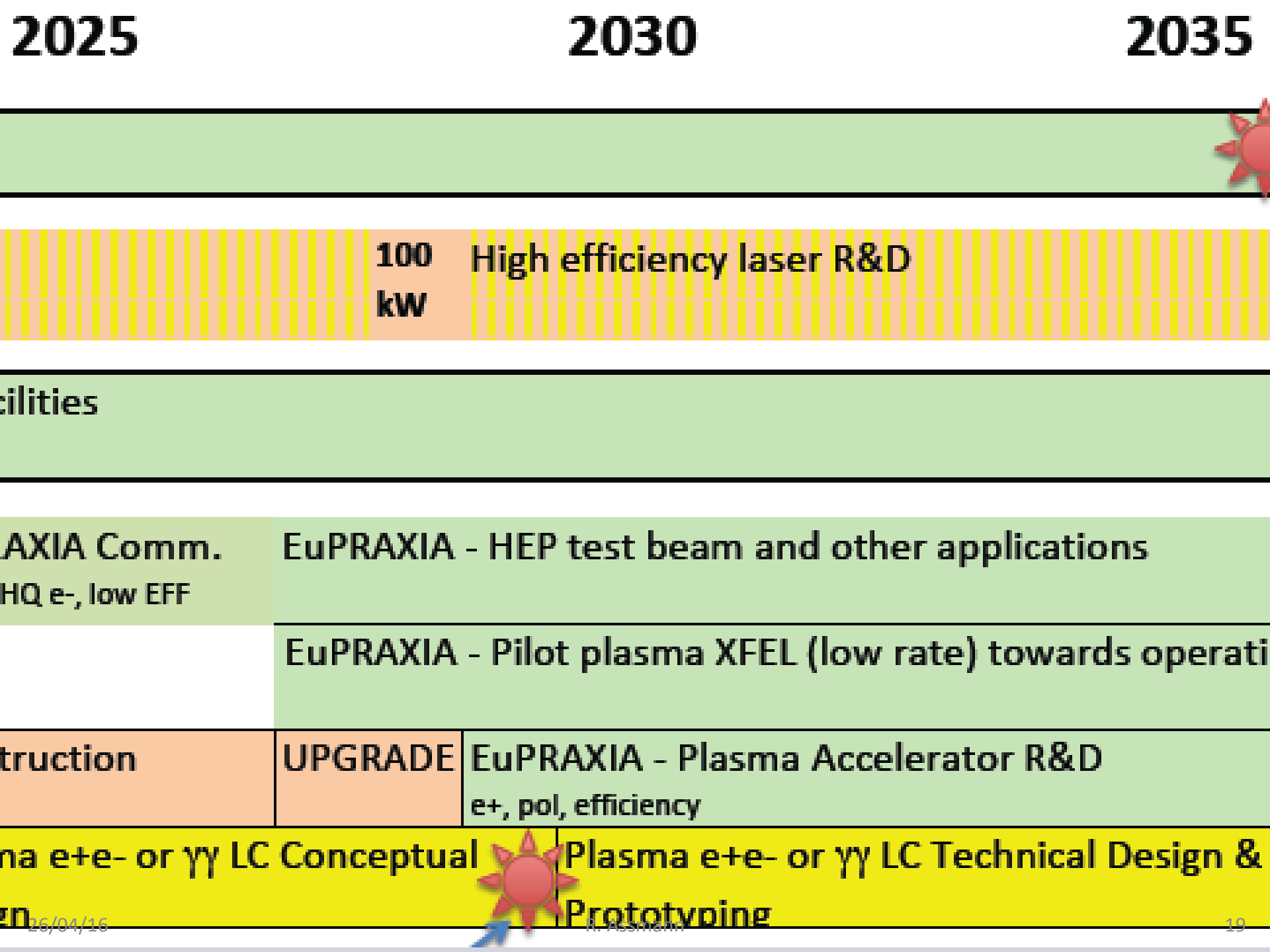
Electron beam (other apps):

Roadmap with Interfaces to International R&D

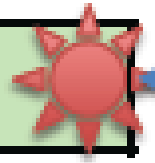



2015
2020
2025
LHC Physics Program
UPDATE European Strategy Particle Physics
High efficiency laser R&D (ICAN)
Plasma acceleration R&D in independent national European facilities
laser-driven and beam driven
EuPRAXIA Design I
5 GeV accelerator system, HQ e-, apps
approved and fully funded to 2019
EuPRAXIA Construction
EuPRAXIA Co
5 GeV HQ e-, low
5 GeV: laser and/or beam driven - blow-out or quasi-linear - internal or external injection - plasma technology
EuPRAXIA Design II
e+, pol
Construction
e+, pol
Plasma e+e-
Design
e+e- or gg, goals: energy & lumi


2020
2025
2030
UPDATE European Strategy Particle Physics
100 kW
High efficienc
ependent national European facilities
EuPRAXIA Construction
EuPRAXIA Comm.
5 GeV HQ e-, low EFF
EuPRAXIA - HEP test bea
EuPRAXIA - Pilot plasma
EuPRAXIA Design II
e+, pol
Construction
e+, pol
UPGRADE
EuPRAXIA - Pl
e+, pol, efficiency
e+e- or gg, goals: energy & lumi
Plasma e+e- or γγ LC Conceptual Design
Plasma e
Prototyp


2025
2030
2035
100 kW
High efficiency laser R&D
cilities
AXIA Comm.
HQ e-, low EFF
EuPRAXIA - HEP test beam and other applications
EuPRAXIA - Pilot plasma XFEL (low rate) towards operati
truction
UPGRADE
EuPRAXIA - Plasma Accelerator R&D
e+, pol, efficiency
na e+e- or γγ LC Conceptual
gn
Plasma e+e- or γγ LC Technical Design &
Prototyping

2030 2035 2040



END LHC Physics Program

efficiency laser R&D

test beam and other applications

t plasma XFEL (low rate) towards operational P-XFEL (high rate)

AXIA - Plasma Accelerator R&D

, efficiency

Plasma e+e- or γγ LC Technical Design & Prototyping

e+e- or or γγ PLC Construction

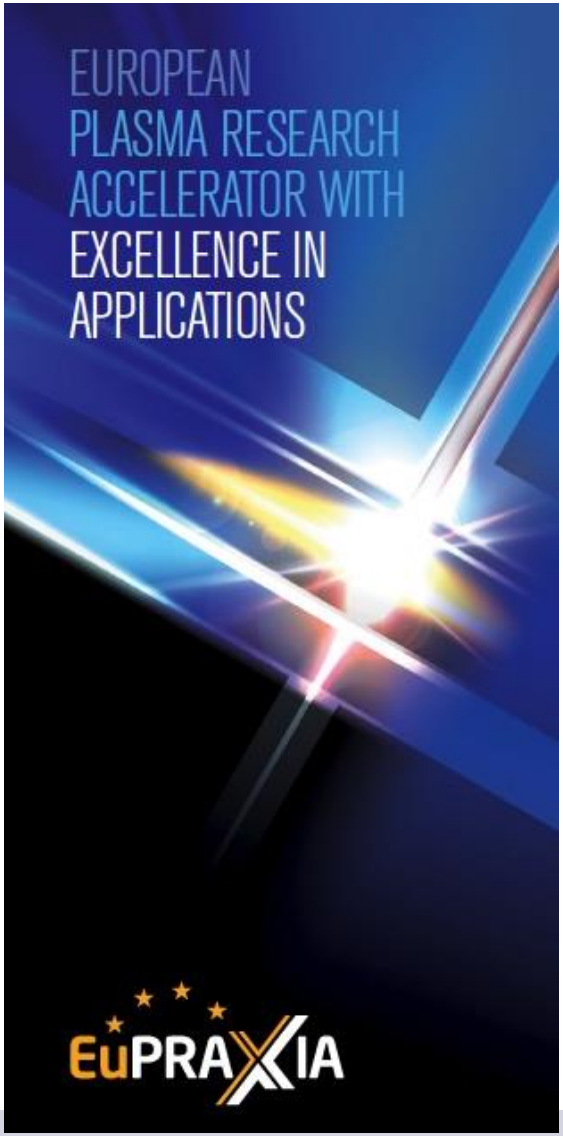
Key Message

The accelerator field, HEP and photon science must invest now for allowing the possibility for a novel technology, compact accelerator facility at the frontier of science in the 2040's.

→ EuPRAXIA or similar

If this investment will not be done, plasma accelerators will come too late for filling a possible gap in accelerator-based HEP collider physics after the completion of the LHC physics program.

EuPRAXIA Leaflet



Evolution and change is important also for our particle accelerators. However, it can also be uncomfortable and skepticism is to be expected.

We need to explain and discuss our view of strategic developments.

We need to interest science and the public in our approach.

→ "Accelerating News" and "LaserLab Newsletter"

A **EuPRAXIA leaflet** has been designed to reach out to the communities involved and to bring our messages across. Many thanks to University Liverpool, Cockcroft Institute team (R. Torres, A. Welsch et al).

Will be distributed at IPAC16. We will also send a copy to EuCARD2 WP leaders.

PARTICIPANTS

DESY, Germany

INFN, Italy

CNR, Italy

CNRS, France

University of Strathclyde, UK

IST-ID, Portugal

STFC, UK

SOLEIL, France

University of Manchester, UK

University of Liverpool, UK

ENEA, Italy

CEA, France

Sapienza Universita di Roma, Italy

Universität Hansestadt Hamburg, Germany

Imperial College London, UK

University of Oxford, UK

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www.eupraxia-project.eu

EUROPEAN PLASMA RESEARCH ACCELERATOR WITH EXCELLENCE IN APPLICATIONS

ACCELERATOR INNOVATION FOR NEW HORIZONS IN SCIENCE

SMALLER SIZE AND IMPROVED COST-EFFICIENCY

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant No 653782. The information herein reflects only the views of its authors and the Research Executive Agency is not responsible for any use that may be made of the information contained.

EuPRAXIA

DESIGNING THE FUTURE

The EuPRAXIA Consortium is preparing a conceptual design for the world's first multi-GeV plasma-based accelerator with industrial beam quality and dedicated user areas.

© DESY, Heiner Müller-Elsner

ADVANCED TECHNOLOGIES

The project is structured into 14 working groups dealing with simulations of high gradient laser plasma accelerator structures, design and optimization of lasers and electron beams, research into alternative and hybrid techniques, Free Electron Lasers (FEL), high-energy physics, and radiation source applications.

EuPRAXIA joins novel acceleration schemes with modern lasers, the latest correction technologies and large-scale user areas. The consortium offers unique training opportunities for researchers in a multidisciplinary field.

Image of a plasma cell.
© DESY, Heiner Müller-Elsner

Particle accelerators have become powerful and widely used tools for industry, medicine and science. Today there are some 30,000 particle accelerators worldwide, all of them relying on well-established technologies.

The achievable energy of particles is often limited by practical boundaries on size and cost, for example, in hospitals and university laboratories, or available funding for very large scientific instruments at the energy frontier.

A new type of accelerator that uses plasma wakefields promises accelerating gradients as much as 1,000 times higher than conventional accelerators! This would allow much smaller machines for fundamental and applied research.

The goal of this project is to produce a conceptual design for the world's first multi-GeV plasma-based accelerator that can provide industrial beam quality into dedicated user areas.

INTERNATIONAL COLLABORATION

EuPRAXIA brings together a consortium of 16 laboratories and universities from 5 EU member states. The project, coordinated by DESY, is funded by the EU's Horizon 2020 programme. The consortium has been joined by 18 associated partners to make additional in-kind contributions.

The consortium holds open international events to strengthen collaborations, to connect to interested users from FEL's, high-energy physics, medicine and industry, and to assess the development of the project.

Computer simulation of a laser wakefield
© Dr Jorge Vieira, Instituto Superior Tecnico, Lisbon

OPENING NEW HORIZONS

The project will bridge the gap between successful proof-of-principle experiments and ground-breaking, ultra-compact accelerators.

With a smaller size and improved efficiency, plasma-based technologies have the potential to revolutionize the world of particle accelerators multiplying their applications to medicine, industry and fundamental science.

Participants in the EuPRAXIA Steering Committee Meeting. Paris, February 2016
© Sylvaine Pieyre, LLR

Supported by EU Horizon 2020

EuPRAXIA

European Network for Novel Accelerators

EuroNNAc 2

supported by EU via EuCARD2

EuroNNAc and EuPRAXIA Workshop on a European Plasma Accelerator

We are organizing a workshop in Pisa inviting the communities of conventional facilities, lasers and novel accelerators, discussing the unique opportunities for our fields from such a design study. We will bring together the initial EuPRAXIA project team, EuroNNAc network participants and interested scientists to collect input from all parties and to base this effort deeply into the interests of our communities.

The EuroNNAc and EuPRAXIA Workshop on a European Plasma Accelerator will take place June 29 to July, 1, 2016 at INO-CNR/INFN, Pisa, Italy.

Conclusion

- EuPRAXIA is an idea and project coming out of EuCARD and EuCARD2. **Many thanks for support and guidance!**
- After approval a lot of effort spent on implementation. Quite some hectic months...
- EuPRAXIA work has started. If you are interested: **Come to our Pisa workshop June 29 to July 1**
- A roadmap for novel accelerators has been developed, showing that **EuPRAXIA is a very timely project if we want to include these novel technologies** in the medium term future of our fields.
- Start of a **PR campaign** at IPAC16, to reach out to accelerator field, HEP, photon science and other fields.

Thank you for your attention

WP 1 – 3

WP1	**Management (M)**			
	1.1	Management	**Ralph Assmann**	
	1.2	Parameter, Layout and Cost Committee	**Arnd Specka**	
	1.3	Quality Assurance Plan		
	1.4	Governance Model and Site Study		
	1.5	Radiological Impact		
WP2	**Physics and Simulation (PS)**			
	2.1	Machine Model	**Alban Mosnier**	
	2.2	Start to End Simulations	**Luis Silva**	
	2.3	Tolerance Budget	**Jorge Vieira**	
	2.4	Performance		
WP3	**High Gradient Laser Plasma Accelerator Structure (HGLPAS)**			
	3.1	plasma device = target : Laser-Driven Option		
	3.2	Plasma chamber design issues		
	3.3	staging	**Brigitte Cros**	
	3.4	plasma diagnostics	**Zulfikar Najmudin**	
	3.5	module coupling: plasma mirror		
	3.6	Engineering Issues for Stability		

WP 4 – 6

WP4	**Laser Design and Optimization (LDO)**			
	4.1	Overview Industrially Available Lasers	**Leo Gizzi**	
	4.2	Error and Stability Analysis for Lasers	**Francois Mathieu**	
	4.3	Feedbacks and Correction Methods	**Luca New Labate**	
	4.4	Prototype Laser Feedbacks and Tests		
	4.5	Two plasma-module laser acceleration		
WP5	**Electron Beam Design and Optimization (EBDO)**			
	5.1	Beam for Injection (external RF injector)	**Enrica Chiadroni**	
	5.2	Beam extracted from plasma	**Antoine Chance**	
	5.3	Correction and Optimization of Plasma-Accelerated Beam		
	5.4	e beam diagnostic		
WP6	**FEL Pilot Application (FPA)**			
	6.1	FEL Parameters and Performance		
	6.2	Undulators	**Marie-Emmanuelle Couprie**	
	6.3	Experimental Area 1	**Giuseppe Dattoli**	
	6.4	Science Reach	**Jim Clarke**	
	6.5	Operational Model (towards 24/7?)		

WP 7 – 9

WP7	**HEP and Other Pilot Applications (HOPA)**			
	7.1	applications for particle beams	**Arnd Specka**	
	7.2	Experimental Area 2	**Roman Walczak**	
	7.3	Science Reach		
	7.4	Operational Model (towards 24/7?)		
WP8	**Outreach and Liaison (OL)**		**Carsten Welsch**	
	8.1	Liaison with FEL and HEP Science	**Bernhard Hidding**	
	8.2	Dissemination of Information and Industry outreach		
	8.3	Training of required experts		
WP9	**Alternative e-Beam Driven Plasma Structure (AEBDPS)**			
	9.1	Plasma device = target: e-beam driver option		
	9.2	Plasma chamber and vacuum issue		
	9.3	Staging		
	9.4	Plasma Diagnostics	**Jens Osterhoff**	
	9.5	Beam Tailoring and Preparation	**Massimo Ferrario**	
	9.6	Engineering Issues and Stability		

WP 10 – 11

WP10	**Use of Other Novel Technologies**	**Ulrich Dorda**	
	10.1 Novel cold injectors	**Guoxing Xia**	
	10.2 Dielectric structures	**Barbara Marchetti**	
	10.3 Fibre laser		
WP11	**FEL Application Prototyping**		
	11.1 ERC grant activities France	**(Victor Malka)**	
	11.2 LUX and ELI activities Germany	**Agustin Liftshitz**	
	11.3 FEL Parameter Design	**Andreas Maier**	
	11.4 LWFA requirements for FEL's	**Florian Grüner**	

WP12

WP12	Accelerator Prototyping and Experiments at Test Facilities	
	12.1	SCAPA (UK)
	12.2	STFC (UK)
	12.3	LLC (Sweden)
	12.4	LAOLA (Germany)
	12.5	CILEX (France)
	12.6	LOA (France)
	12.7	ELBE (Germany)
	12.8	CALA (Germany)
	12.9	ILPP (Germany)
	12.10	ELI (International)
	12.11	SPARC (Italy)
	12.12	ILIL (Italy)
	12.13	AWAKE (CERN)

Rajeev Pattahil

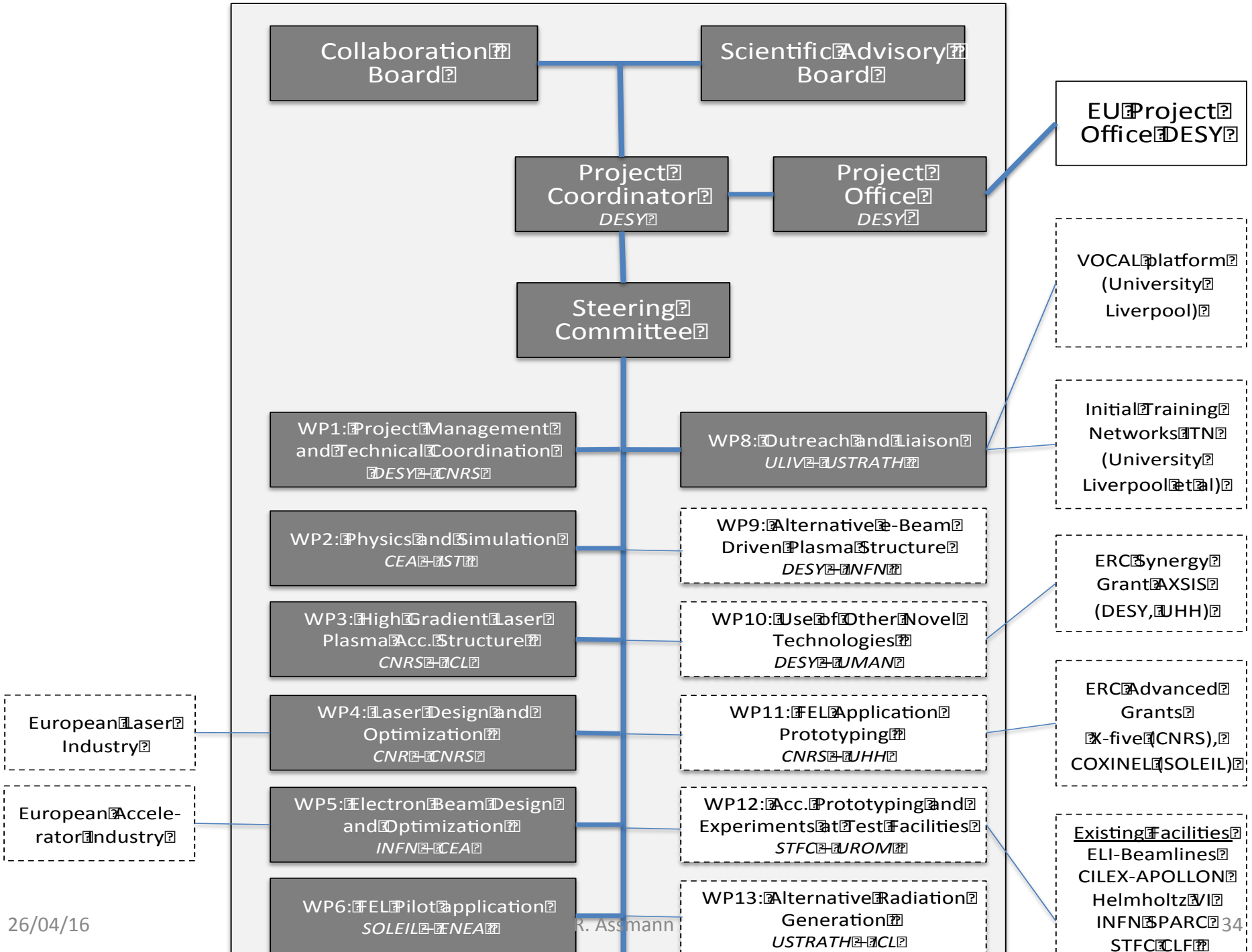
Andrea Mostacci

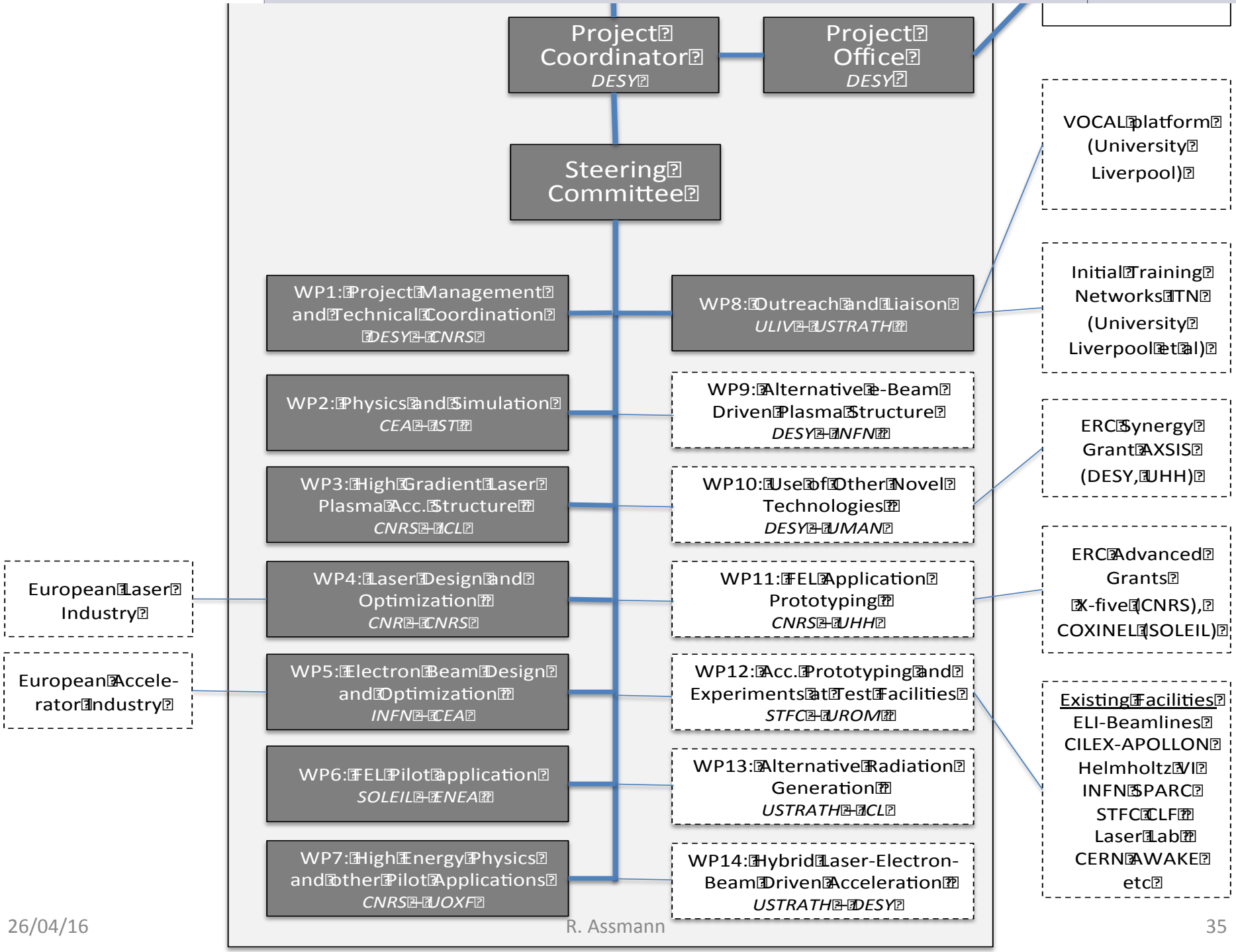
WP 13 – 14

WP13	**Alternative Radiation Generation**	
	13.1	Experimental and theoretical investigations of plasma media for plasma-based radiation sources
	13.2	Experimental and theoretical investigations of injection schemes for plasma-based radiation sources
	13.3	Experimental and theoretical investigations of cohere development in plasma-based radiation sources
	13.4	Extension of spectral range of plasma-based radiation sources to gamma-rays and far infra-red.
	13.5	Development of diagnostic systems for investigating plasma-based radiation sources
WP14	**Hybrid Laser-Electron-Beam Driven Acceleration**	
	14.1	Selective preionization of plasma components
	14.2	Trojan Horse underdense photocathode witness bunch generation
	14.3	Wakefield-induced ionization injection
	14.4	Exploiting LWFA-generated electron bunches as drivers for PWFA

Dino Jaroszinsky
Zheng-Ming Sheng
Mark Wiggins

Bernhard Hidding
Alberto de la Ossa


Collaboration Board
Scientific Advisory Board
EU Project Office DESY
Project Coordinator
DESY
Project Office
DESY
Steering Committee
VOCAL platform (University Liverpool)
Initial Training Networks ITN (University Liverpool et al)
WP1: Project Management and Technical Coordination
DESY - CNRS
WP8: Outreach and Liaison
ULIV - USTRATH
WP2: Physics and Simulation
CEA - IST
WP9: Alternative e-Beam Driven Plasma Structure
DESY - INFN
ERC Synergy Grant AXSIS (DESY, UHH)
WP3: High Gradient Laser Plasma Acc. Structure
CNRS - ICL
WP10: Use of Other Novel Technologies
DESY - UMAN
European Laser Industry
WP4: Laser Design and Optimization
CNR - CNRS
WP11: FEL Application Prototyping
CNRS - UHH
ERC Advanced Grants
X-five (CNRS), COXINEL (SOLEIL)
European Accelerator Industry
WP5: Electron Beam Design and Optimization
INFN - CEA
WP12: Acc. Prototyping and Experiments at Test Facilities
STFC - UROM
Existing Facilities
ELI-Beamlines
CILEX-APOLLON
Helmholtz VI
INFN SPARC
STFC CLF
WP6: FEL Pilot application
SOLEIL - ENEA
WP13: Alternative Radiation Generation
USTRATH - ICL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CEA-IST
WP3: High Gradient Laser Plasma Acc. Structure
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WP4: Laser Design and Optimization
CNR-CNRS
WP5: Electron Beam Design and Optimization
INFN-CEA
WP6: FEL Pilot application
SOLEIL-ENEA
WP7: High Energy Physics and other Pilot Applications
CNRS-UOXF
WP8: Outreach and Liaison
ULIV-USTRATH
WP9: Alternative e-Beam Driven Plasma Structure
DESY-INFN
WP10: Use of Other Novel Technologies
DESY-UMAN
WP11: FEL Application Prototyping
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STFC-UROM
WP13: Alternative Radiation Generation
USTRATH-ICL
WP14: Hybrid Laser-Electron-Beam Driven Acceleration
USTRATH-DESY
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STFC CLF
Laser Lab
CERN AWAKE
etc