EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS

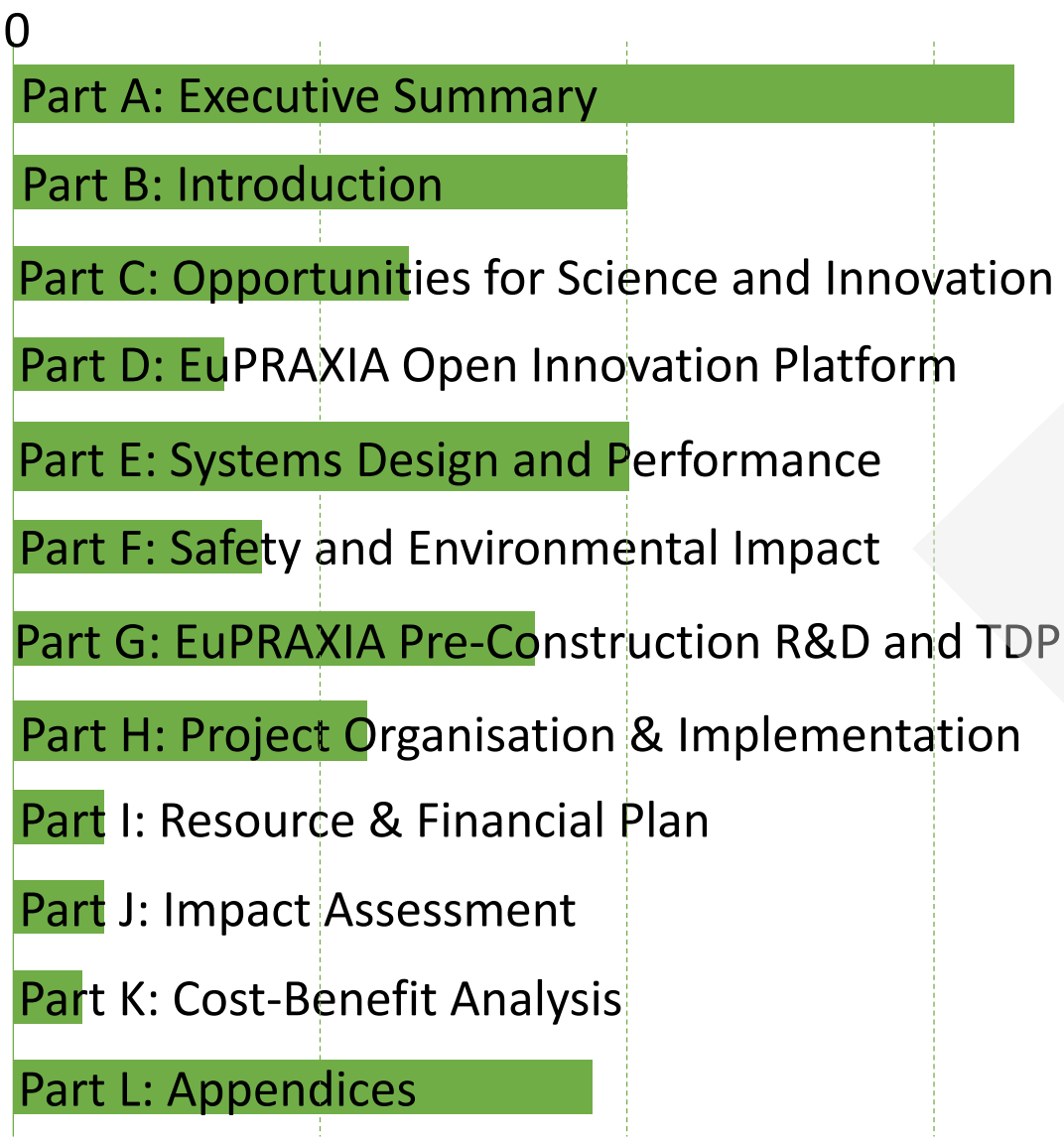
EuPRAXIA

# Status of the CDR

Maria Weikum

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 653782.

# Status of the CDR Chapters




| |
|---|
| 22. Background |
| 23. Overall Facility Layout and its Building Blocks |
| 24. Beam Distribution Concept |
| 25. Start-to-End Simulations |
| 26. RF System as an Enabling Technology (integrated in Ch. 28/30.1) |
| 27. Laser Systems as Innovative Power Drivers |
| 28. RF Accelerator to 500 MeV as Beam Driver |
| 29. LWFA Plasma Stage as Novel Hybrid Beam Driver |
| 30.1 RF Injector |
| 30.2 Plasma Injector |
| 30.3 Hybrid Plasma Photocathode |
| 31.1 Laser-Driven Plasma Accelerator to 1 / 5 GeV |
| 31.2 Beam-Driven Plasma Accelerator to 1 / 5 GeV |
| 32.1 Beam Transport for the Low-Energy Beam |
| 32.2 Beam Transport for the High-Energy Beam |
| 33. Plasma Diagnostics |
| 34. Electron Beam Diagnostics |
| 35. Electron Beam Dump |
| 36.1 Free-Electron Laser User Area |
| 36.2 Compton Source User Area |
| 36.3 Betatron X-Ray User Area |
| 37.1 High Energy Physics User Area |
| 37.2 Secondary Particles User Areas |
| 38.1 Plasma Injection Mechanisms |
| 38.2 Compact Radiation Generation |
| 38.3 Dielectric Technology for Diagnostics & Beam Control |
| *38.4 Additional application beamlines* |
| 39. Command Control System |
| 40. Summary Tables of Parameters and Technical Data |

*Received draft*
*Received some content, but not full draft*
*Received no content yet*

# Timeline for CDR Completion

| | |
|---|---|
| July 2019 | ❑ **<u>Need all CDR contributions!</u>** |
| August 2019 | ❑ Final content revisions<br>❑ Complete highlight plots / layout drawings (by INFN technical designer team / external company)<br>❑ Complete CDR page design (partially by external company) |
| September 2019 | ❑ Complete proof-reading (by external company)<br>❑ **<u>Final complete CDR version</u>**<br>❑ Printing |
| October 2019 | ❑ Have printed CDRs ready for Final EuPRAXIA Event<br>❑ Submit final CDR to EU |

# Work Clusters

| Cluster descriptions | |
|---|---|
| 1. Theory & Simulation | ✓ |
| 2. Laser Technology | |
| 3. Plasma Components & Systems | ✓ |
| 4. RF & Accelerator Technology | |
| 5. Diagnostics | ✓ |
| 6. Additional Innovation Paths | |
| 7. Control & Operation | (✓) |
| 8. Infrastructure | ✓ |
| 9. Training, Outreach & Dissemination | |
| 10. Safety | (✓) |

# Work Clusters - Overview

| Clusters | | | Applications | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| No. | Name | Institutes | FEL from PWFA - 1GeV | FEL from LWFA - 1GeV | FEL from LWFA - 5GeV | Low-energy positron source | High-energy positron beams | HEP detector test beams | ICS Source | Medical imaging betatron source |
| | | | *add coordinator* | *add coordinator* | *add coordinator* | QUB | QUB | *add coordinator* | *add coordinator* | *add coordinator* |
| 1 | Theory & Simulation | DESY, INFN, CNRS, USTRATH, IST-ID, UMAN, ENEA, URLS, UHH, ICL, UOXF, ELI, HIJ, HZDR, LMU, URTV, WIGNER | x | x | x | x | x | x | x | x |
| 2 | Laser Technology | DESY, INFN, CNR, CNRS, STFC, UHH, ICL, UOXF, HIJ, HZDR, LMU, IAP RAS, FBH | | x | x | x | | x | x | x |
| 3 | Plasma Components & Systems | DESY, INFN, CNRS, USTRATH, STFC, ICL, UOXF, HZDR, LMU, HUJI, QUB, YORK | x | x | x | x | x | x | x | x |
| 4 | RF & Accelerator Technology | DESY, INFN, USTRATH, STFC, SOLEIL, UMAN, ULIV, ENEA, CEA, URLS, UHH, ICL, UOXF, HIJ, URTV, LMU, KIT, QUB | x | x | x | x | x | x | x | x |
| 5 | Diagnostics | DESY, INFN, CNRS, CEA, UMAN, HIJ, LMU, WIGNER, KIT, URTV, QUB | x | x | x | x | x | x | x | x |
| 6 | Additional Innovation Paths | DESY, USTRATH, HZDR, LMU, QUB | | | | | | | | |
| 7 | Control & operation | DESY, INFN, USTRATH, ULIV, WIGNER | x | x | x | x | x | x | x | x |
| 8 | Infrastructure | DESY, INFN, URLS, KIT | x | x | x | x | x | x | x | x |
| 9 | Training, outreach & dissemination | DESY, INFN, USTRATH, ULIV, URLS, WIGNER | | | | | | | | |
| 10 | Safety | DESY, INFN, USTRATH, UMAN, WIGNER | x | x | x | x | x | x | x | x |

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| 2 | Laser Technology | DESY, INFN, CNR, CNRS, STFC, UHH, ICL, UOXF, HIJ, HZDR, LMU, IAP RAS, FBH | | x | x | x | | x | x | x |
| 3 | Plasma Components & Systems | DESY, INFN, CNRS, USTRATH, STFC, ICL, UOXF, HZDR, LMU, HUJI, QUB, YORK | x | x | x | x | x | x | x | x |
| 4 | RF & Accelerator Technology | DESY, INFN, USTRATH, STFC, SOLEIL, UMAN, ULIV, ENEA, CEA, URLS, UHH, ICL, UOXF, HIJ, URTV, LMU, KIT, QUB | x | x | x | x | x | x | x | x |
| 5 | Diagnostics | DESY, INFN, CNRS, CEA, UMAN, HIJ, LMU, WIGNER, KIT, URTV, QUB | x | x | x | x | x | x | x | x |
| 6 | Additional Innovation Paths | DESY, USTRATH, HZDR, LMU, QUB | | | | | | | | |
| 7 | Control & operation | DESY, INFN, USTRATH, ULIV, WIGNER | x | x | x | x | x | x | x | x |
| 8 | Infrastructure | DESY, INFN, URLS, KIT | x | x | x | x | x | x | x | x |
| 9 | Training, outreach & dissemination | DESY, INFN, USTRATH, ULIV, URLS, WIGNER | | | | | | | | |
| 10 | Safety | DESY, INFN, USTRATH, UMAN, WIGNER | | | | | | | x | x |

- *More general applications / deliverables?*
- *Need coordinators for applications*
- *Confirm cluster involvement of institutes*

# Work Clusters - Example

## EuPRAXIA Cluster – 3. Plasma Components & Systems

Lead Partner: CNRS  All Partners: DESY, INFN, CNRS, USTRATH, STFC, ICL, UOXF, HZDR, LMU, HUJI, QUB, YORK, IST

This cluster brings together experts from partner institutes to develop plasma components and systems requested for the implementation of the EuPRAXIA accelerator and beamlines, in particular: laser driven plasma injectors (LPIs), laser and beam driven plasma accelerators (LPAs & BPAs), interface components such as plasma mirrors and passive or active plasma lenses. Particular efforts will be oriented towards the development of components providing high quality, stable electron beams at high repetition rate. The contribution of identified partners is planned as follows:

**Development of LPIs**

1/ Development of optimized electron injection schemes in tailored density profiles for the EuPRAXIA accelerator baseline : modelling through fluid, PIC and Monte Carlo simulations, design and construction of relevant gas cells, and experimental testing of stable injection schemes (CNRS, York, LMU, QUB, HZDR, USTRATH); Numerical and experimental investigation of optical injection with spatio-temporally controlled laser pulses (UOXF).
2/ Investigation of physics implications for operation at higher repetition rate, >10 Hz, (York, QUB); development of high repetition rate LWFA targets (IST, ICL); investigation of strategies for post-acceleration removal and recovery of unused wake energy (UOXF).
3/ Development of LWFA integrated targets optimised for betatron radiation and imaging applications (aiming hard x-ray high-quality imaging (> 50 keV) and high magnification (> 20 x or sub-micron resolution) with low noise and low dose) (IST).

**Development of LPA**

1/ Optimization of plasma parameters and the development of gas-filled discharge capillaries to reach long plasma channel lengths, typically several tens of centimeters (INFN SPARC lab, DESY).
1/ Development of novel long, low-density plasma channels suitable for multi-GeV accelerator stages operating at high repetition rates (UOXF, CNRS, IST, DESY).
3/ Guiding of high intensity laser beams in curved plasma channels: Multi-staged capillaries will be built and tested in guiding experiments (HUJI). Numerical and experimental investigation of curved hydrodynamic optical-field-ionized (HOFI) plasma channels (UOXF).

**Development of plasma components for laser or electron beam transport and shaping**

Development of active plasma lenses and passive plasma lenses for electron beam shaping (LMU, DESY, QUB); plasma lenses for laser focusing (HUJI); theoretical modeling of plasma channel lenses using a short capillary discharge (2-3 mm) to create a plasma lens, used to increase the intensity of the impinging beam in order to increase the laser intensity; investigation of energy dechirping concepts including multiple plasma stages (DESY, HZDR, USTRATH); plasma mirrors, adaptive mirrors, feedback loops (STFC).

**System integration or prototypes development**

Multistage design and experiments (LPI and LPA components driven by separate laser beams) (CNRS, DESY, QUB); full start-to-end analysis to optimize the choice of injection energy, and laser and plasma channel parameters in curved plasma channels (HUJI).

# To Do's

**1. Complete your CDR chapters (if not done yet)**

2. Some more input requests for WP leaders regarding WP-related aspects of EuPRAXIA design:

- Main technical risks
- Main required prototyping / R&D activities
- Main technical milestones to achieve

→ *Bulletpoint lists are completely sufficient*

3. Send EuPRAXIA authors / contributors