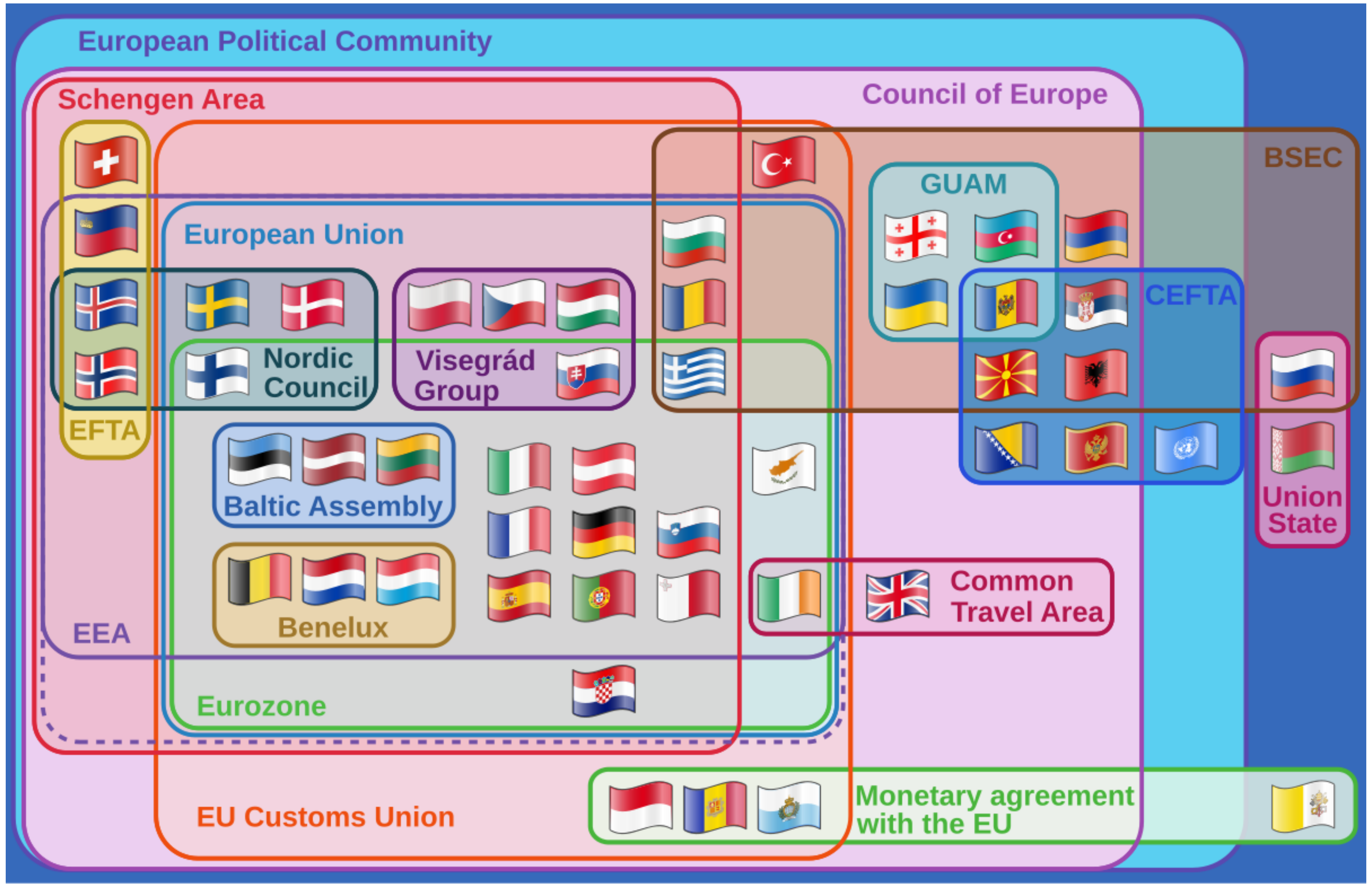
Status and Outlook of Advanced Accelerator Concepts Research in Europe

Simon Hooker

Department of Physics, University of Oxford
United Kingdom

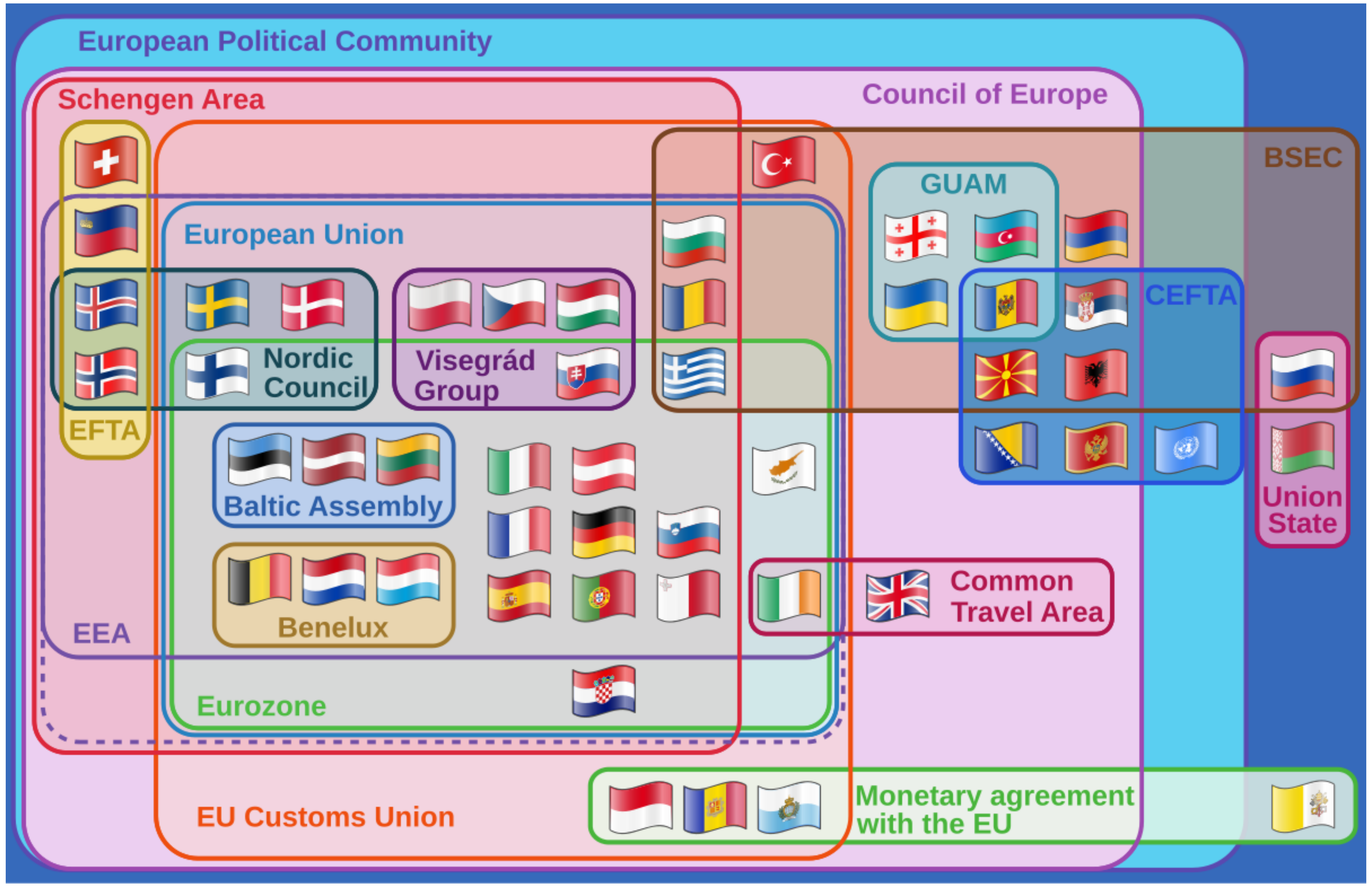
Scope of talk



Euler diagram showing relationships between different European organizations & agreements
Image: Wikimedia Commons

Scope of talk

- Only time to discuss large projects
- Will not discuss
  - Ion acceleration
  - THz / DLA



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Outline of talk

- EuPRAXIA
- LWFA research
- PWFA research
- Other topics
- Coordination
- Summary

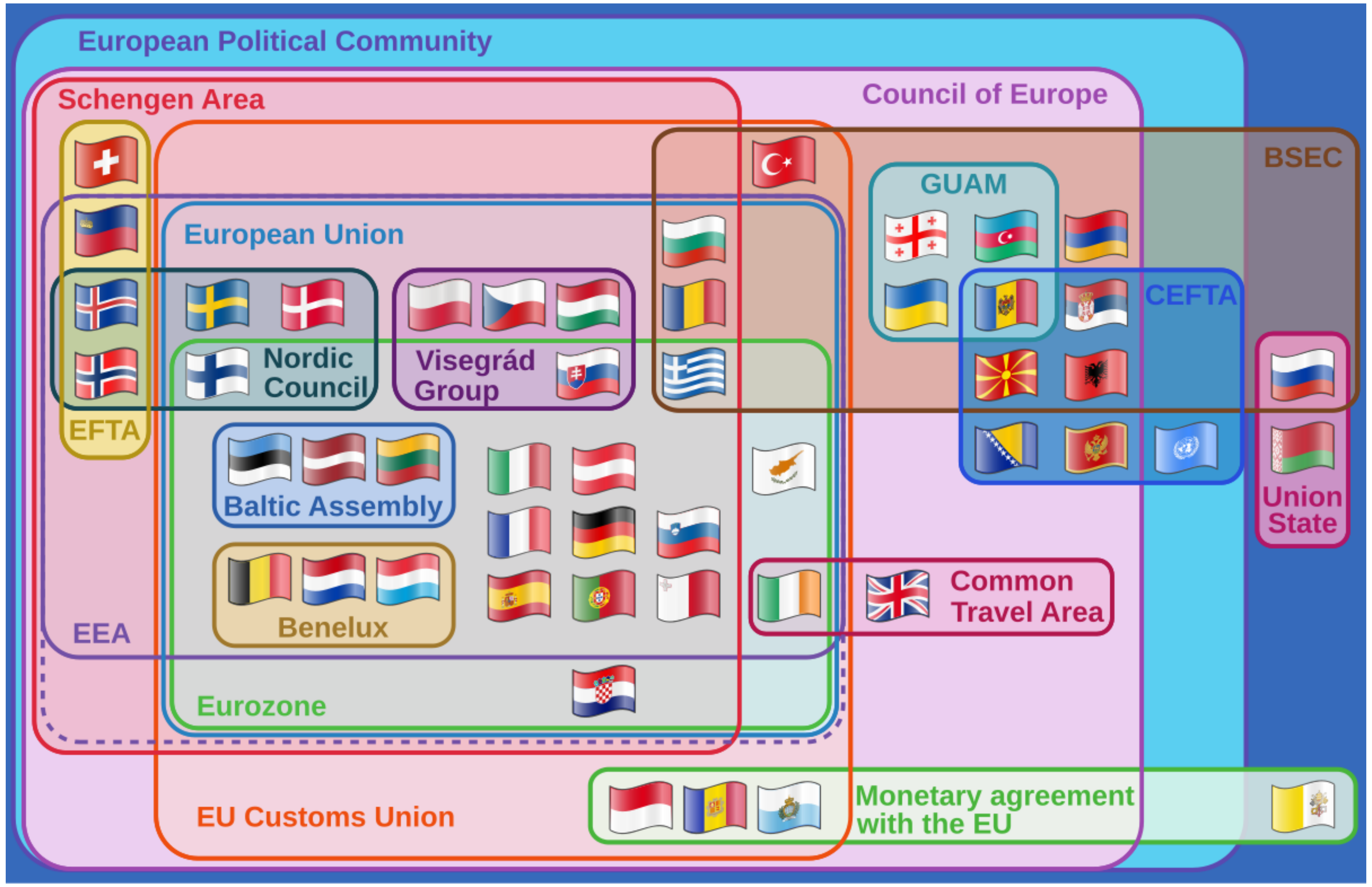

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Image: Wikimedia Commons

EuPRAXIA:
European Plasma Research Accelerator with eXcellence in Applications

EuPRAXIA

Funded by the European Union

Contact

Lead: Pierluigi Campana (INFN)
Web: https://www.eupraxia-facility.org/

Concept

- EuPRAXIA is a HEP-style collaboration to set-up & manage a Large European Network on:
  - Advanced acceleration technologies
  - Laser drivers
  - Industrial & societal applications

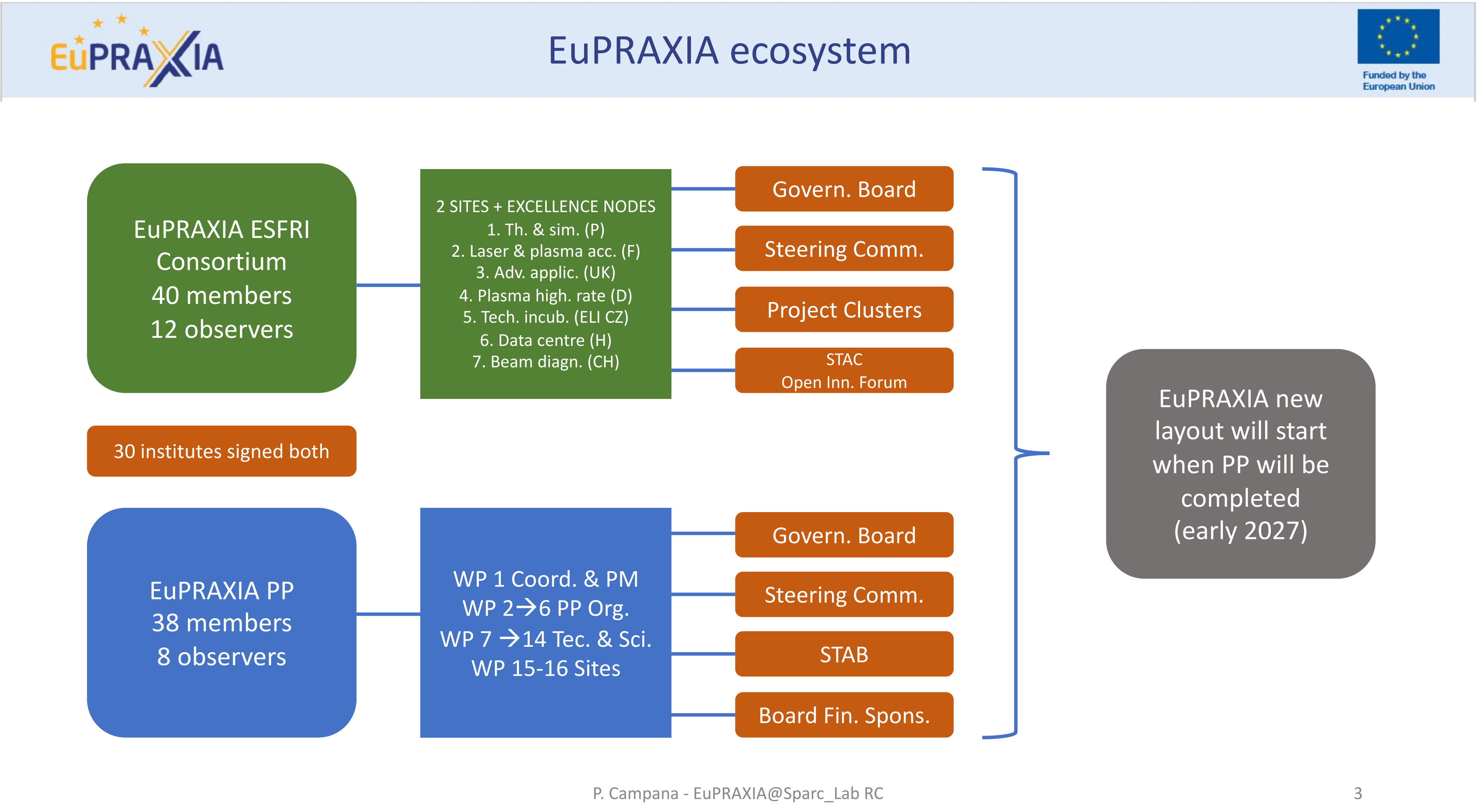
References
Assmann *et al.*, *Eur. Phys. J. Spec. Top.* **229** 3675 (2020)

Thanks to: Pierluigi Campana & Massimo Ferrario

EuPRAXIA

EuPRAXIA ESFRI Consortium

- 2 sites: LWFA-driven & PWFA-driven
- Excellence nodes
  1. Theory & simulation (Portugal)
  2. Laser & plasma accel. (France)
  3. Advanced applications (UK)
  4. Plasma acc. & high rep-rate dev. (Germany)
  5. Technology Incubator (Czech Republic)
  6. User data centre (Hungary)
  7. Beam diagnostics (Switzerland)



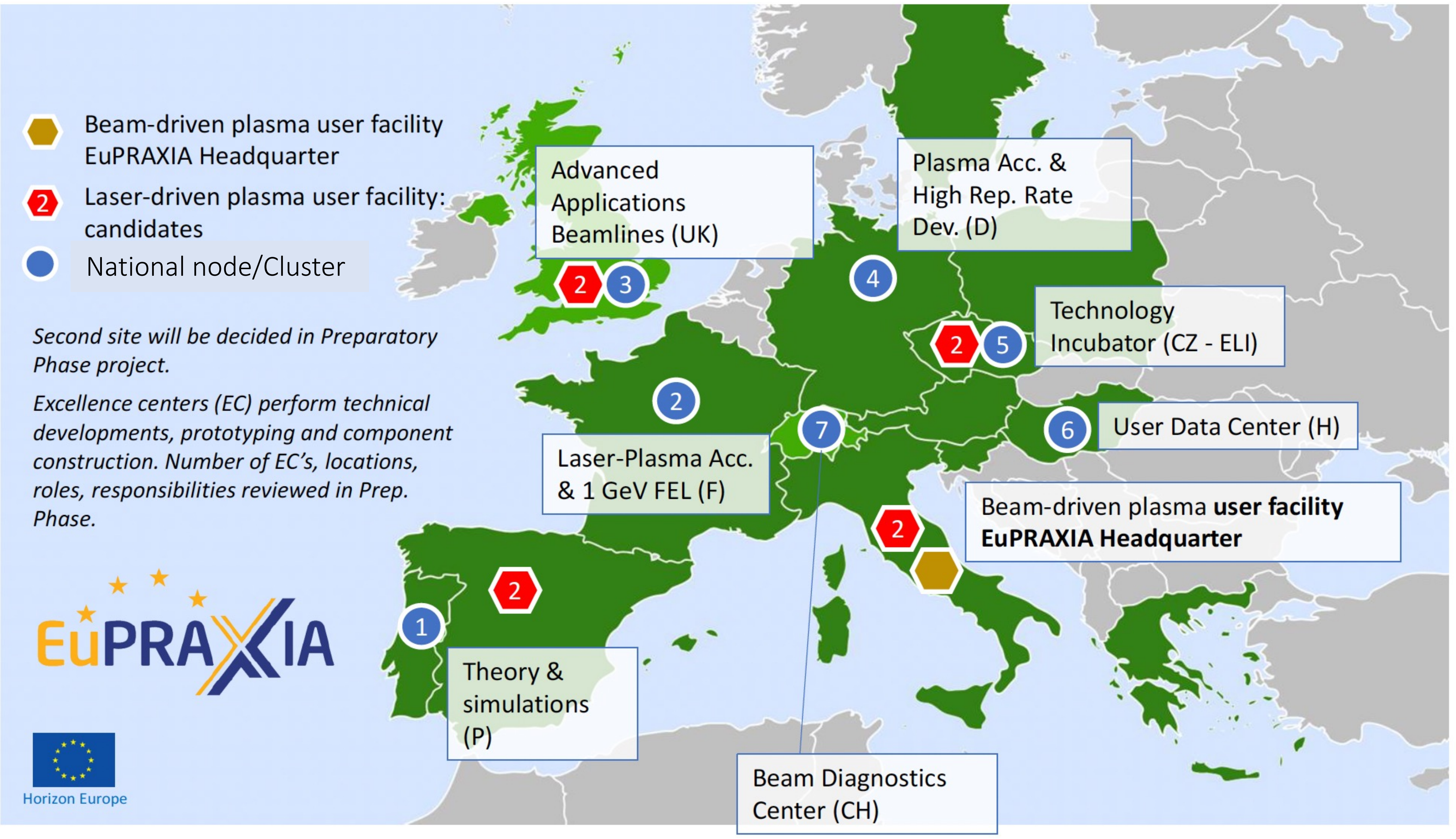
EuPRAXIA-PP: Preparatory phase

- Objective: bring project to a level of organizational, legal, financial, & technological maturity that it can be implemented at the end of the preparatory phase
- 4 types of work package:
  - Coordination
  - Organizational
  - Technical (mirror Clusters)
  - TDR (link to two construction sites)

References
Assmann *et al.*, *Eur. Phys. J. Spec. Top.* **229** 3675 (2020)

Thanks to: Pierluigi Campana & Massimo Ferrario

EuPRAXIA Consortium Networking



A large collection of the best European know-hows in accelerators, lasers and plasma technologies

Network organization
- Sites (PWFA/LWFA)
- National nodes
- Technology clusters

4 candidates for LWFA
- CLPU, Salamanca
- CNR-INO, Pisa
- ELI ERIC, Prague
- EPAC-RAL, UK

P. Campana - EuPRAXIA@Sparc_Lab RC 5

EuPRAXIA-PP Consortium

Coordinator

17

EuPRAXIA

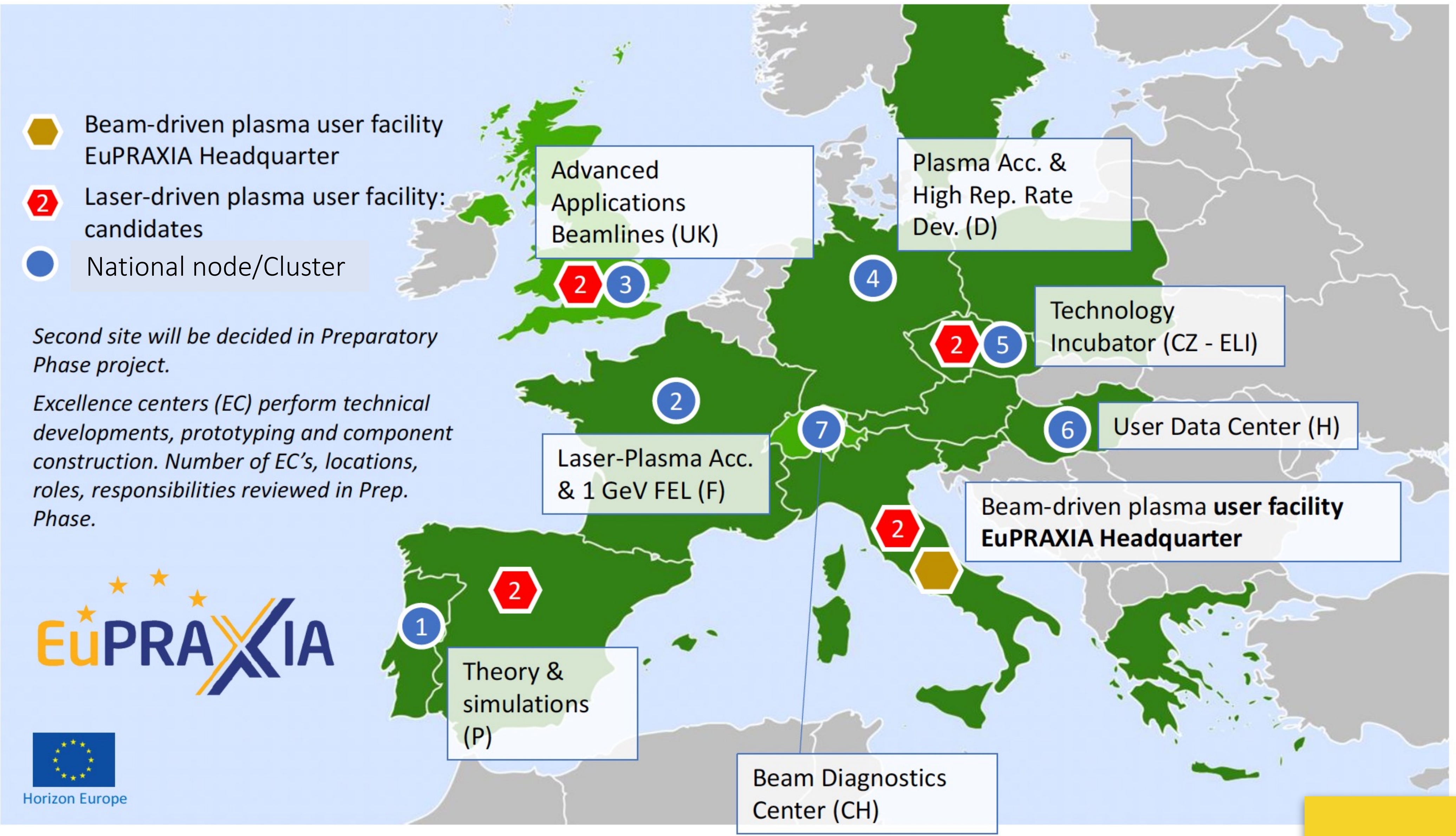
Funding expectations

- Total cost ~ €569M (2021)
  - 80% of Site 1 cost (Frascati) secured
- Sources of funding
  - In-kind + regional + EU calls
  - Operational costs primarily from host institutions / nations

EuPRAXIA

EuPRAXIA Consortium Networking

Funded by the European Union



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P. Campana - EuPRAXIA@Sparc_Lab RC

EuPRAXIA-PP Consortium

Coordinator

17

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  - Operational costs primarily from host

Breaking news

- Agreement in principle to fund PACRI project
- Budget: ~ €10M
- Objectives (abbreviated):
  - Dev. of high-rep-rate plasma modules for EuPRAXIA
  - Improving X-band technology, paving way to kHz operation
  - Dev. laser components required for high-power, high-rep-rate operation required by EuPRAXIA and ELI ESFRI

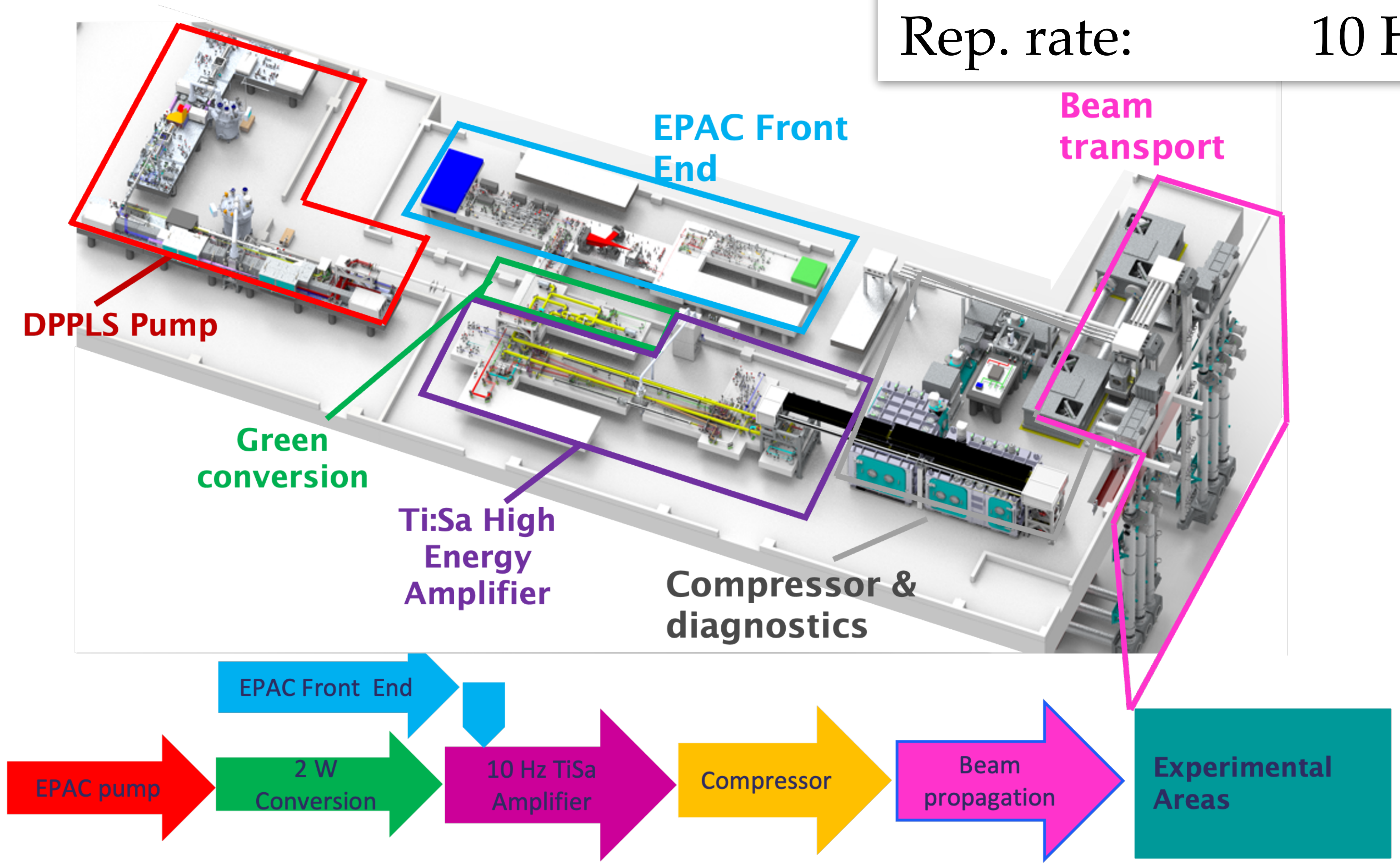
Laser-driven plasma wakefield accelerators (LWFA)

EPAC: Extreme Photonics Application Centre

- Scope:
  - £102M investment
  - Building complete
  - Laser being installed
  - Operational 2026 / 27
- Objectives:
  - Acceleration of electrons, protons, ions
  - Generation of secondary radiation
  - Exploitation of plasma accelerators for applications in industry, medicine, & security
  - Fundamental science
- EPAC laser
  - 1 PW, 10 Hz
  - Ti:Sa pumped by 100 J DiPOLE pump laser

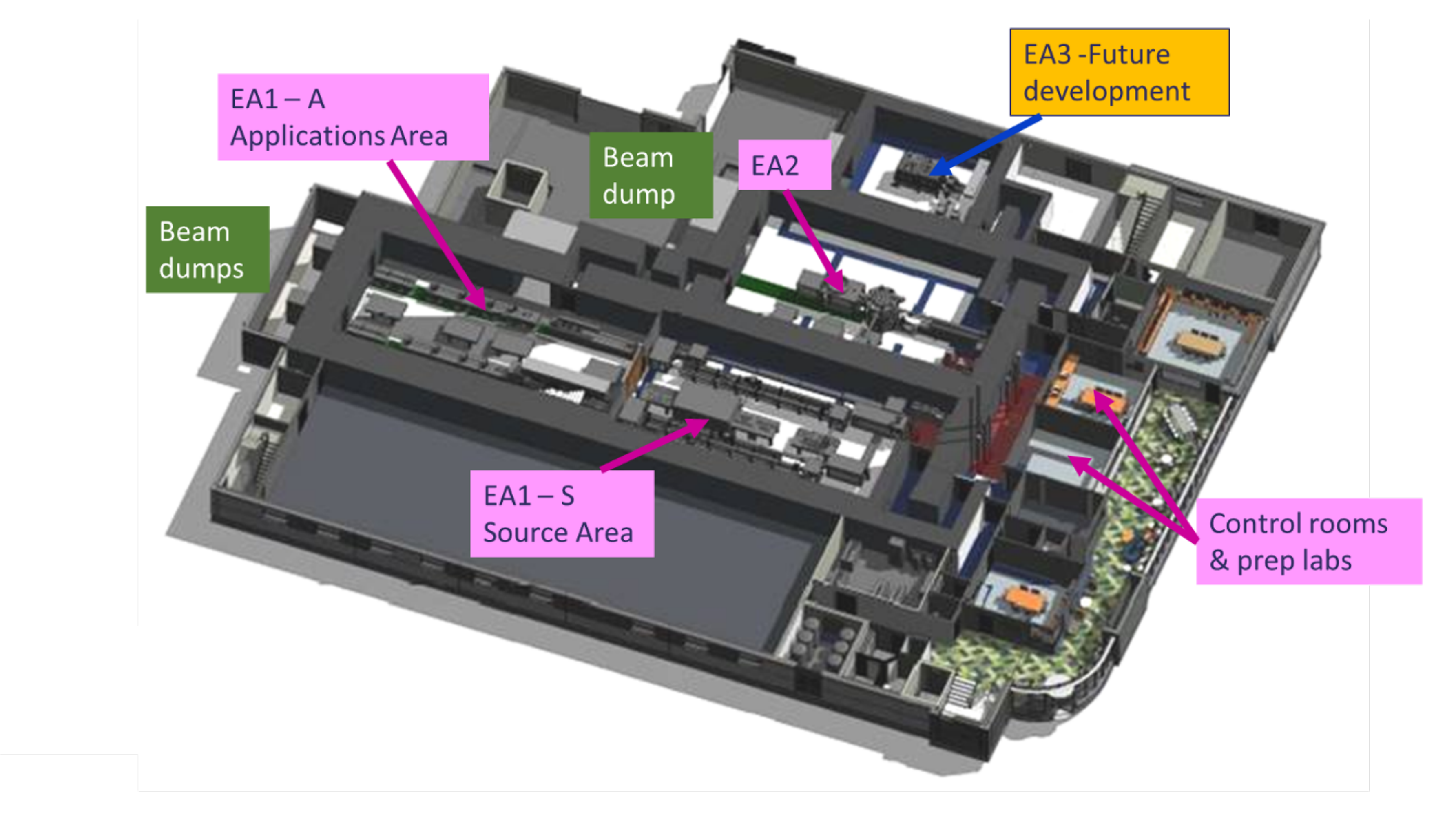
EPAC specification

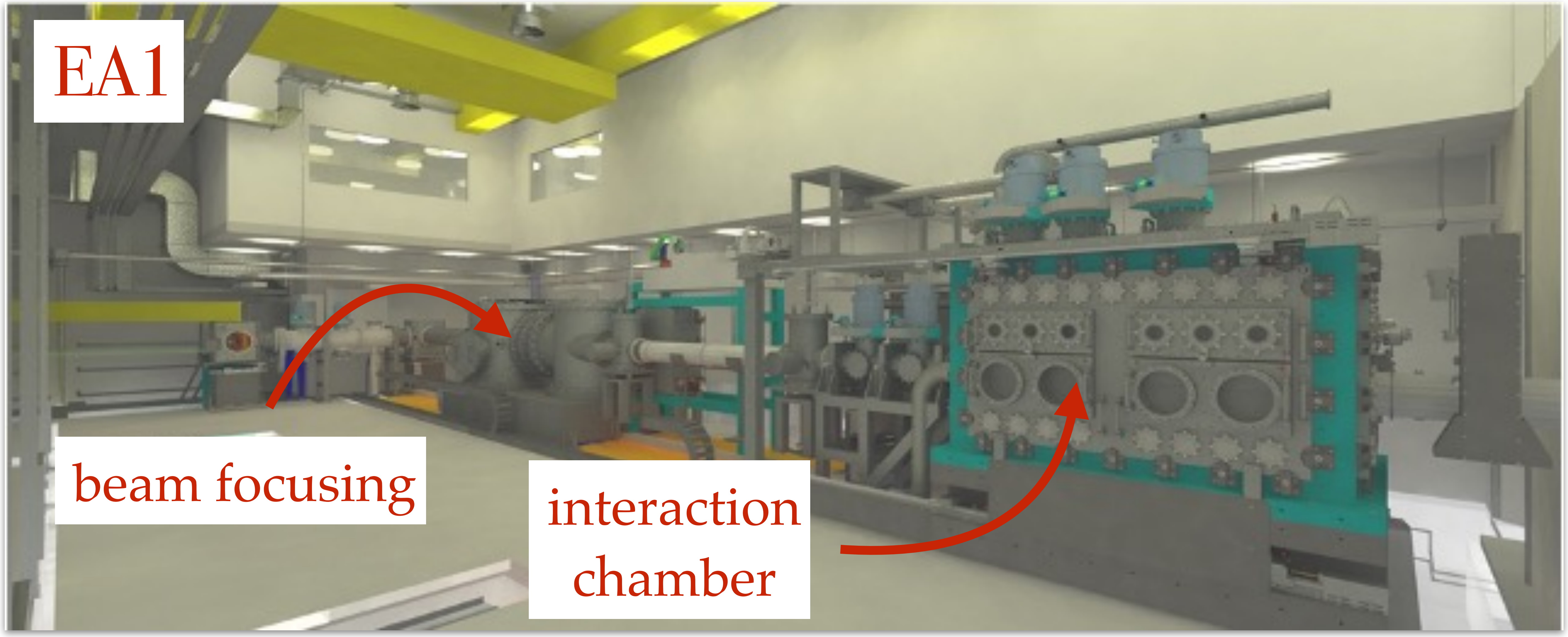
Pulse energy:	30 J
Pulse duration:	< 30 fs
Rep. rate:	10 Hz



Thanks to: Rajeev Pattathil

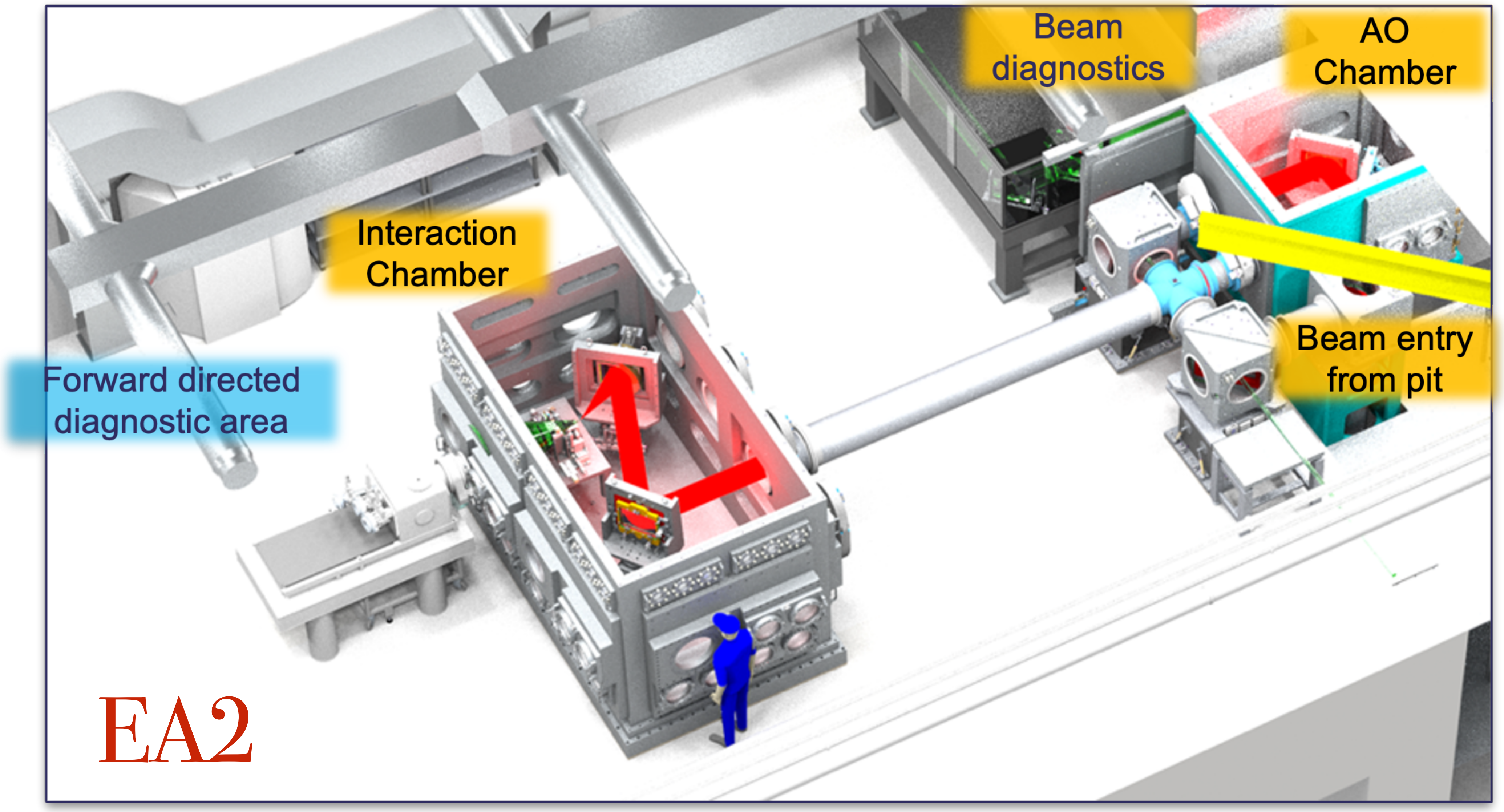
EPAC: Extreme Photonics Application Centre





EPAC will have 3 shielded target areas:

- EA1 (38 × 10 m):
  - Electron acceleration & applications
  - X-ray generation & applications
- EA2 (18 × 10 m):
  - Ion acceleration & HED science
- EA3: TBC



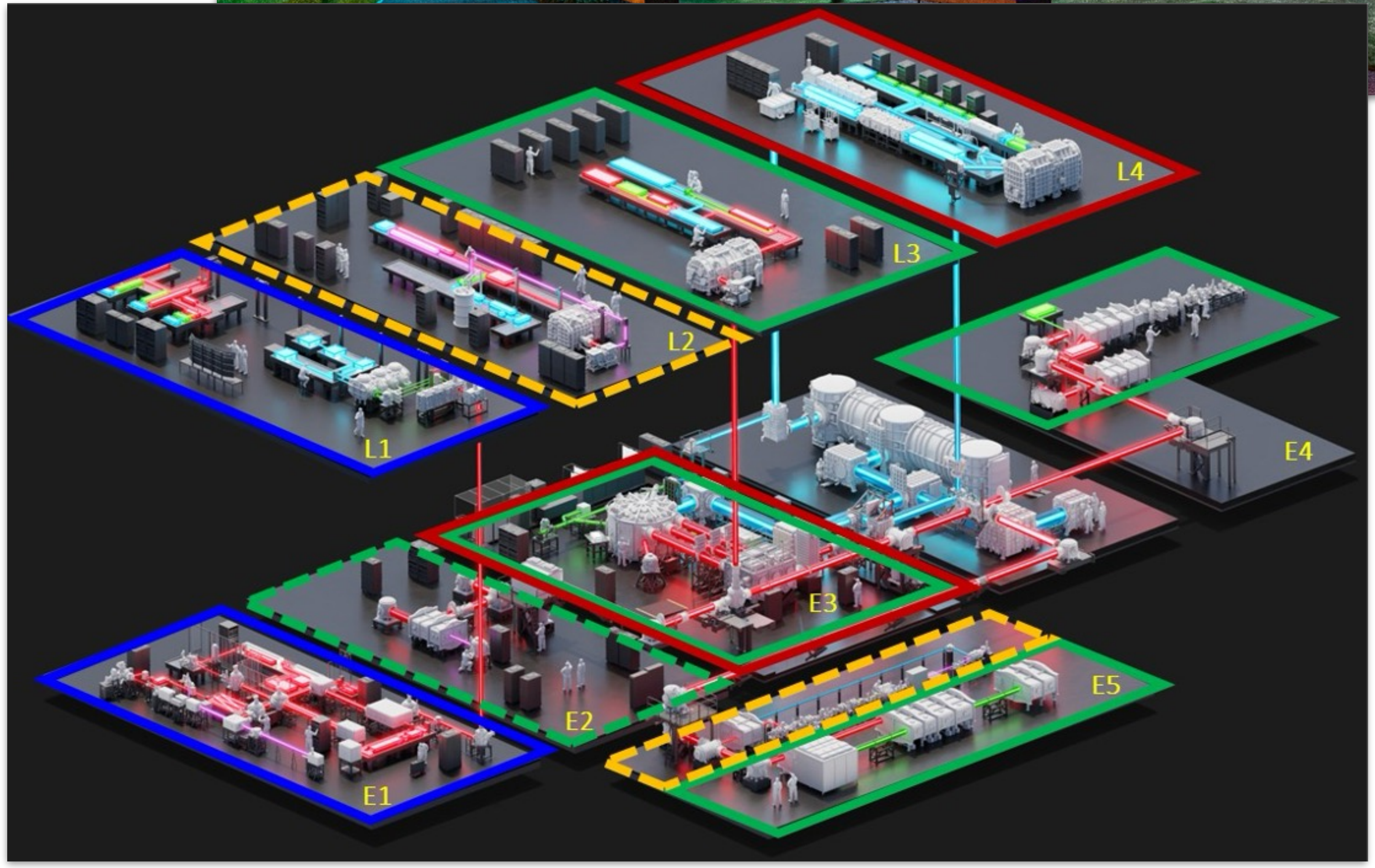
Thanks to: Rajeev Pattathil

ELI-Beamlines

Extreme Light Infrastructure (ELI)

- Three sites:
  - ELI - Beamlines (Czech Republic)
  - ELI - ALPS (Hungary)
  - ELI - NP (Romania)
- Apply for user access to ELI ERIC facilities at: https://up.eli-laser.eu

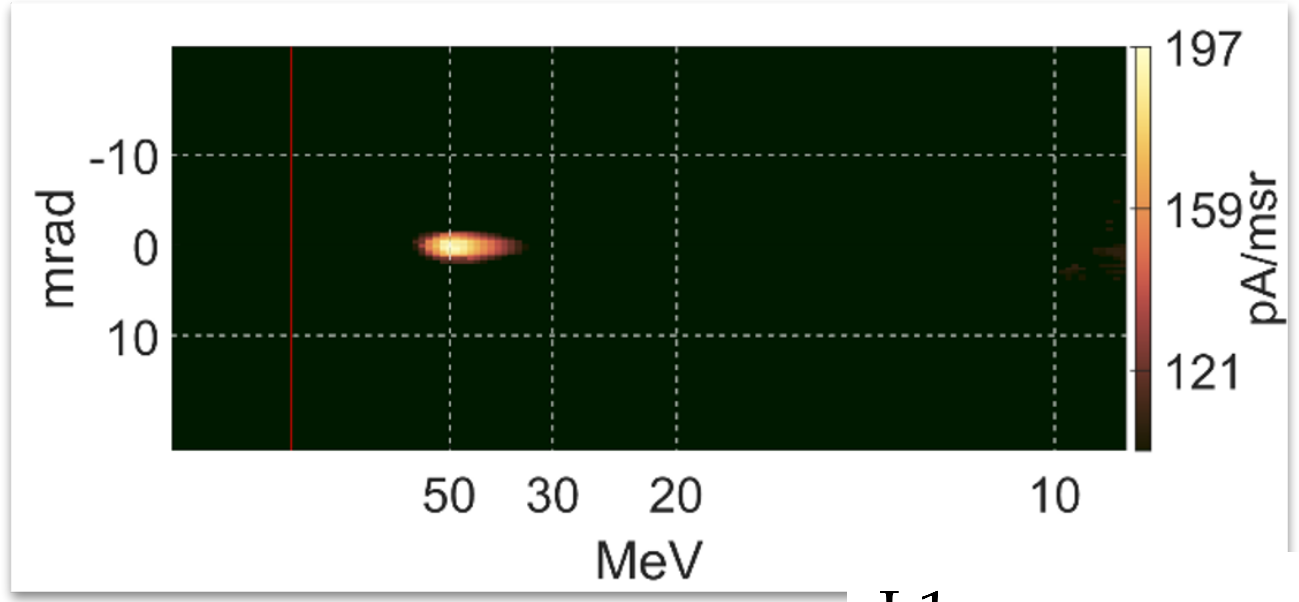
Primary source	Performance on target
L1-ALLEGRA	~50mJ, 15fs, 3TW, 1kHz, 800nm
L3-HAPLS	12J, 27fs, 0.4PW, up to 3.3Hz, 850nm
L4n-ATON	1.2kJ (0.3kJ@2w), 2-10ns, 1shot/2min, 1055nm
L4f-ATON (10PW)	under commissioning
L2-DUHA (100 TW)	under construction



Thanks to: Daniele Margarone (ELI BL)

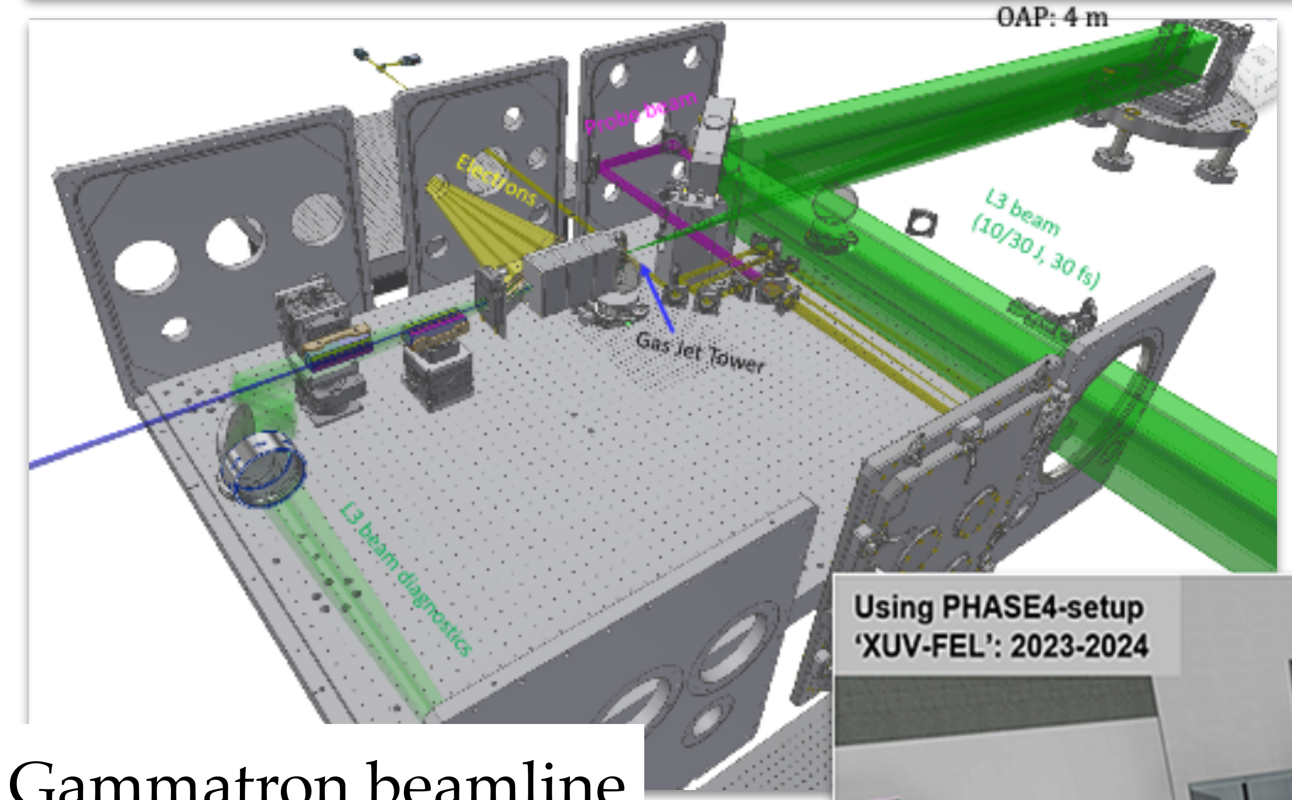
ELI-Beamlines

- L1 Hall: ALFA kHz LPA
  - kHz electron bunch $E \lesssim 30$ MeV
  - In-air end station for user experiments
- E5: ELBA Electron Accelerator & Collider
  - Multi-GeV + PW laser electron-photon collider
  - QUB + ELI commissioning expts achieved 20 k shots in ~ 2 hours
- E2: Gammatron beamline
  - betatron / Compton source
  - ~ 10 fs, micron source size
  - 10^{11} photons shot^{-1}
  - Available Q4 2024
- E5: LUIS FEL beamline
  - High quality bunches for FEL
  - L2 - DUHA: 3 J, 25 fs @ 50 Hz OPCPA



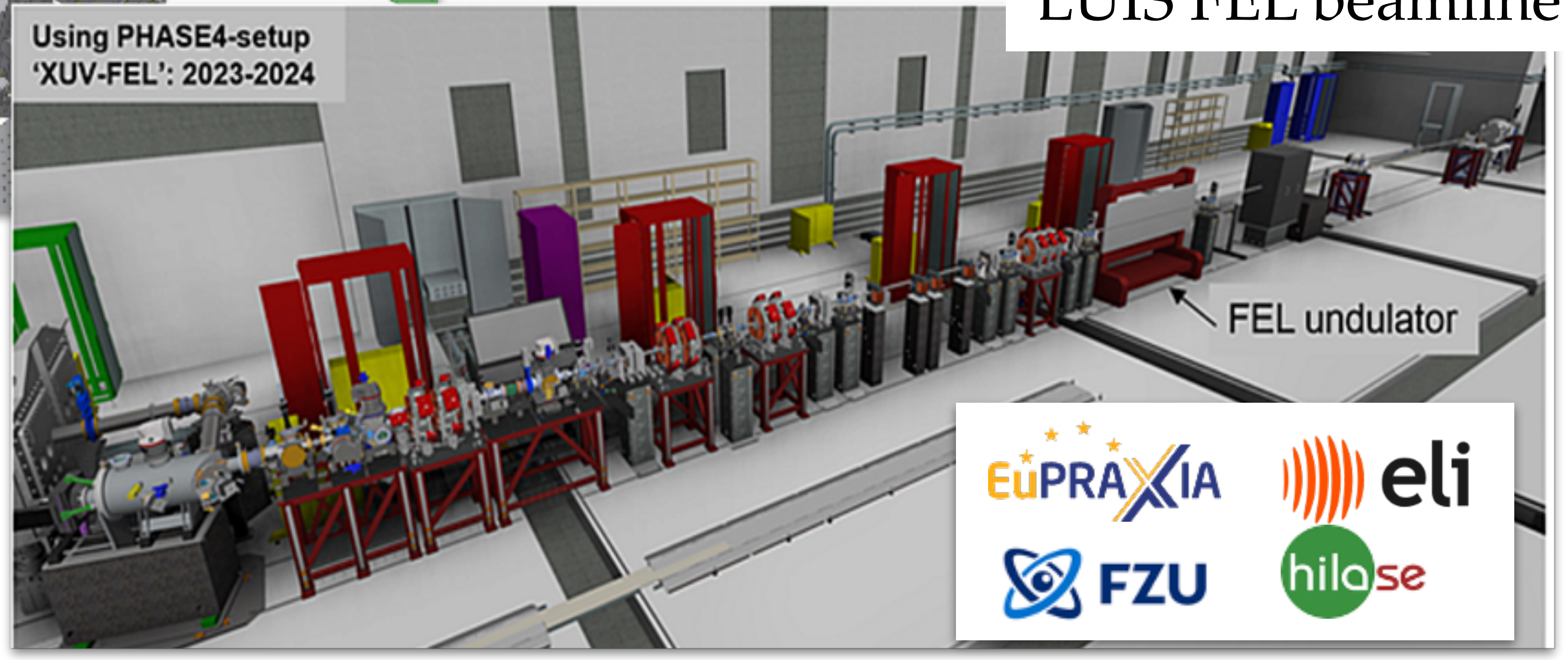
L1 energy spectrum
Lazzarini *et al.* *Phys. Plasm.* **31** 030703 (2024)

ELBA commissioning



Gammatron beamline

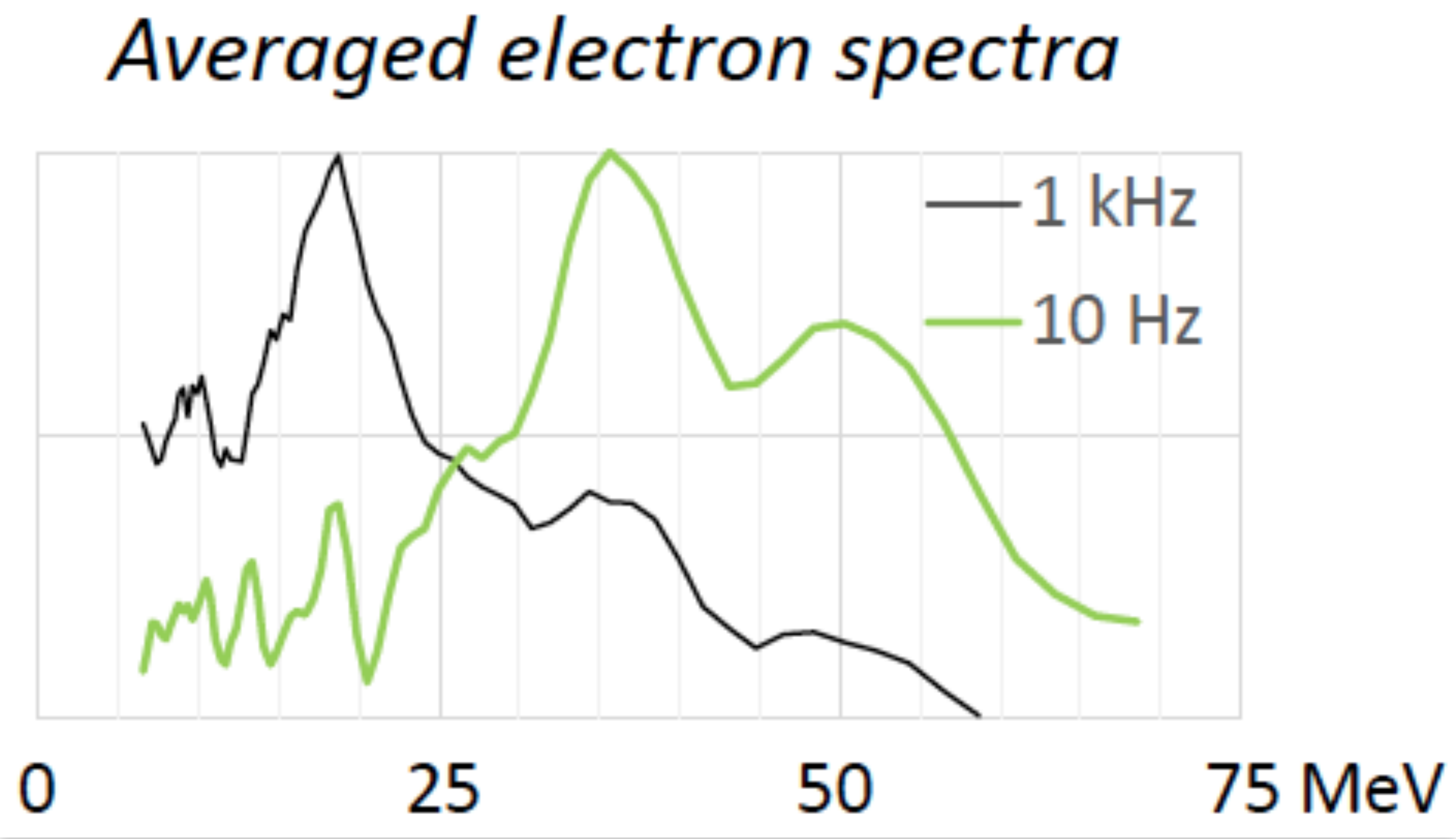
LUIS FEL beamline



Thanks to: Daniele Margarone (ELI BL)

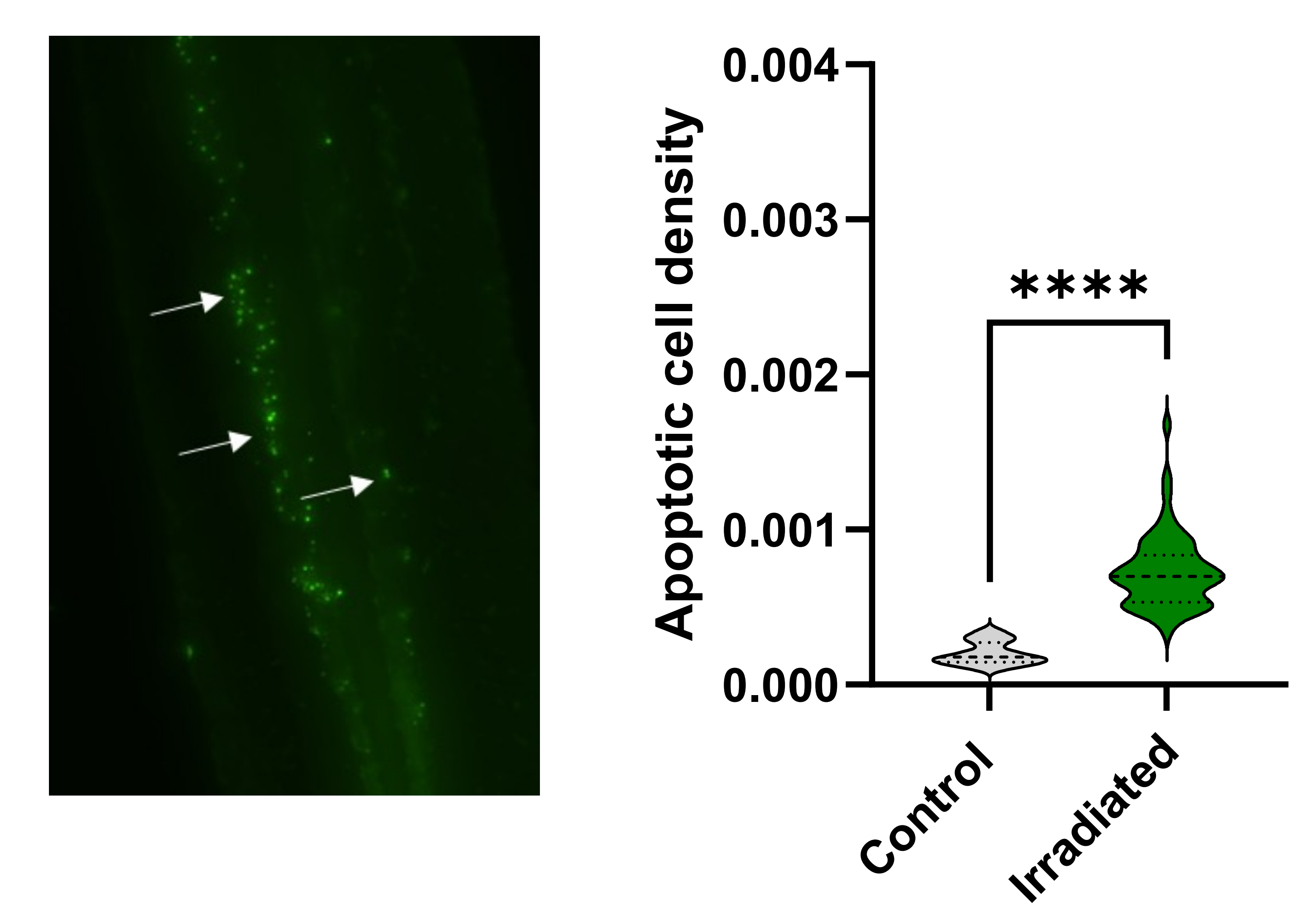
ELI - ALPS

- ELI - Attosecond Light Pulse Source (ALPS)
  - Szeged, Hungary
- SYLOS 3 laser
  - 120 mJ, 9 fs, 1 kHz, CEP stable
- Electron acceleration results
  - Stable beams at 50 mJ, 10 Hz
  - Continuous operation at 1 kHz (15 min)
  - Biologically-relevant irradiation doses (5 Gray) delivered on Zebrafish embryos
- Open for user access



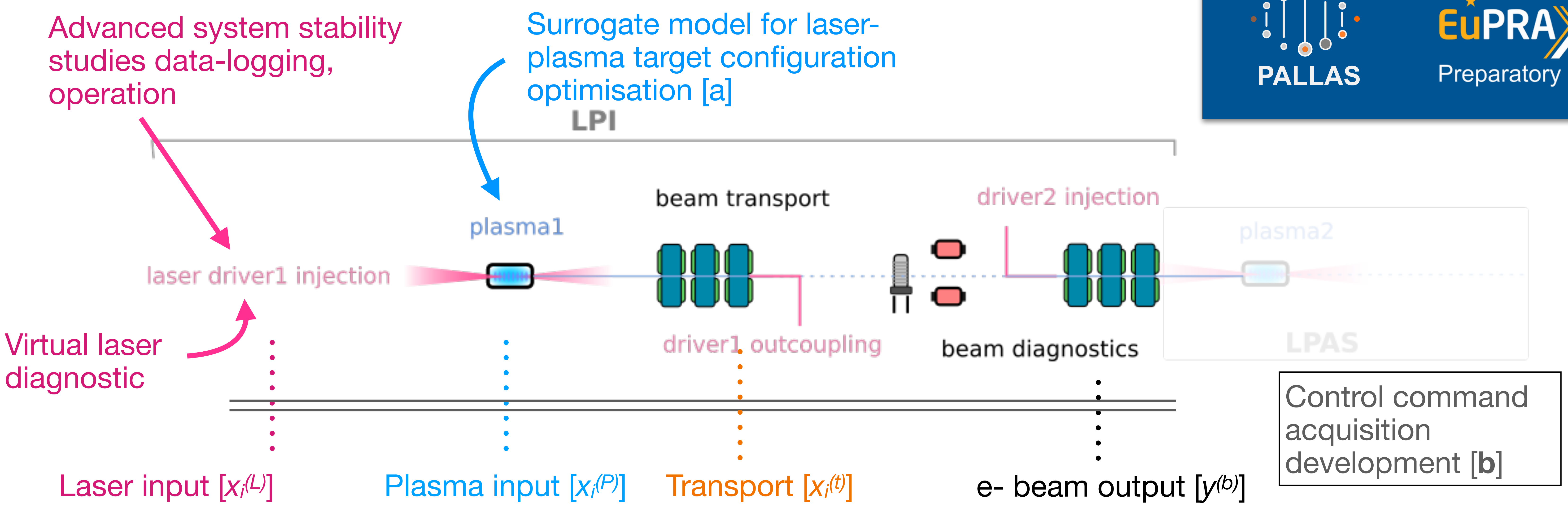
eli attosecond

Imperial College London



Thanks to: Christos Kamperides (ELI-ALPS), Zulfikar Najmudin (Imperial College London)

PALLAS project



[a] Large PIC simulation Data set
Low fidelity random scan using fast PIC simulations
Design optimisation of LPI source parameters
Surrogate model (DNN, XGboost, stacking, GP, BO)
Open data

[b] Data acquisition development
Timestamped data in archived in HDB++ timeScaledB
Distributed control command (Tango Controls) ease deployment
Development of device server specific for LPA/LPI [9]
Open data

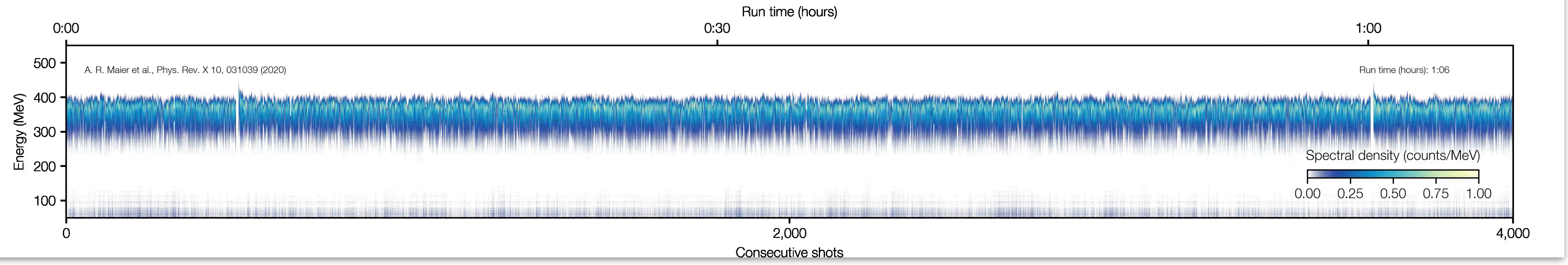
PIA3-ANR, CNRS-IN2P3, Université Paris Saclay, EuPRAXIA-PP and CPER

PALLAS — EuPRAXIA Preparatory Phase

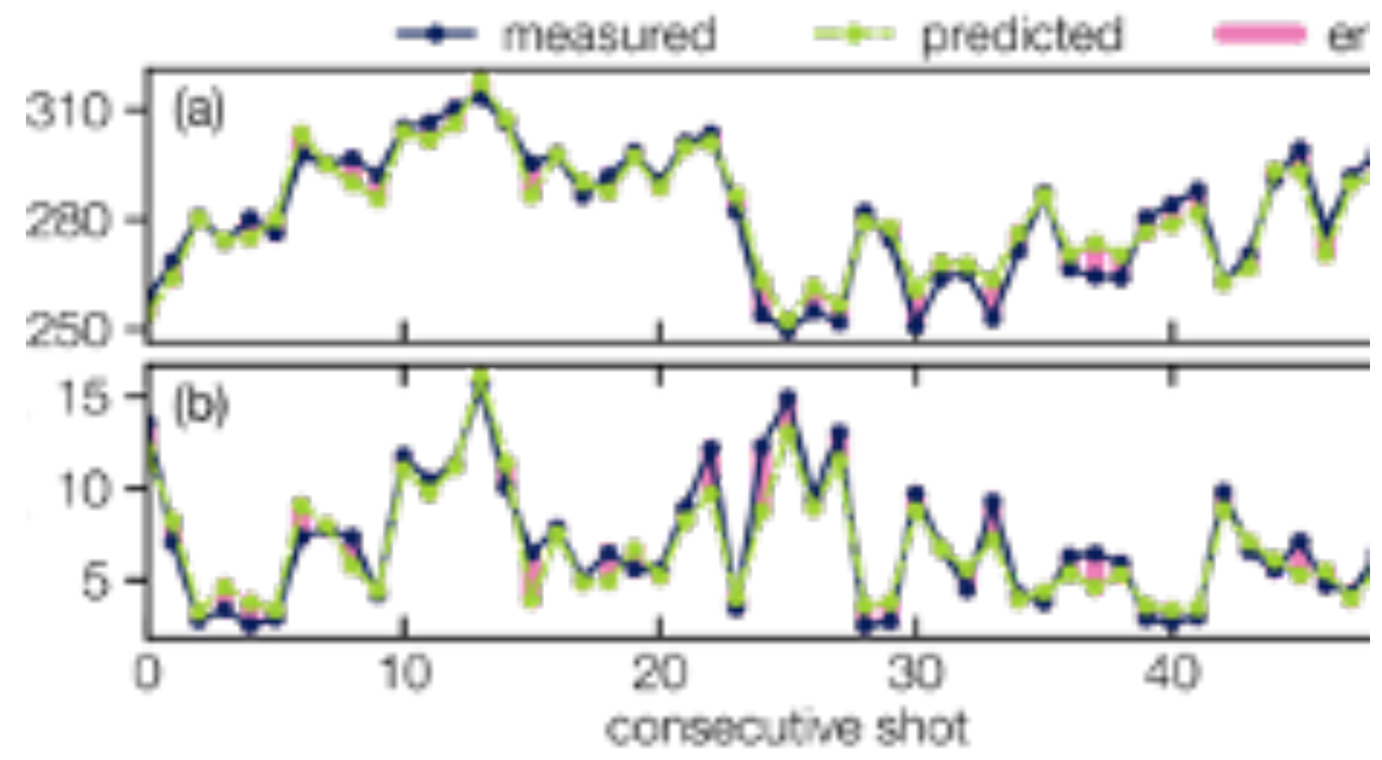
- Concept
  - Test facility for LPA injector optimization
  - High quality beam, control & reliability
  - Target: 10 Hz, 150 - 250 MeV, 10 - 100 pC, dE < 5%
- Budget ~ €2.3M
- Timeline:
  - 2024: commissioning @ 1 Hz
  - 2026: Fully controlled & optimized LPI @ 10 Hz

Thanks to: Kevin Cassou

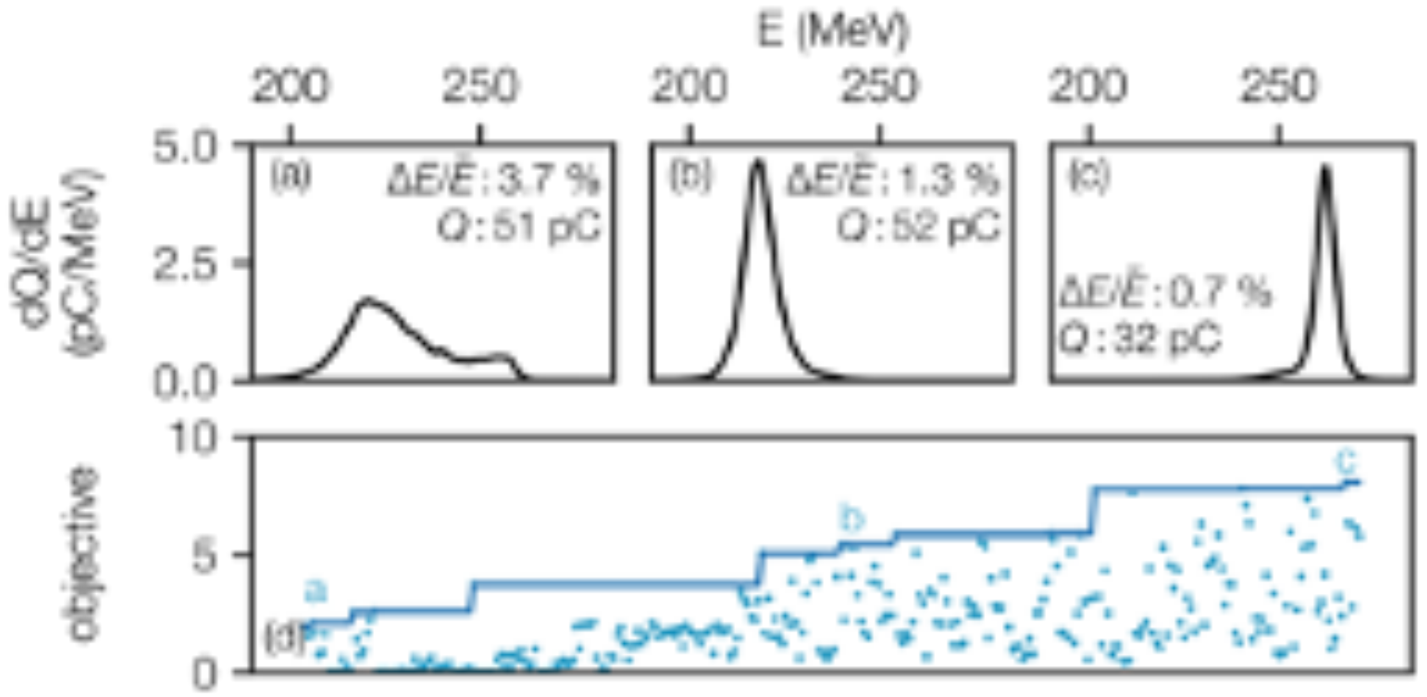
LWFA @ DESY



Active stabilization



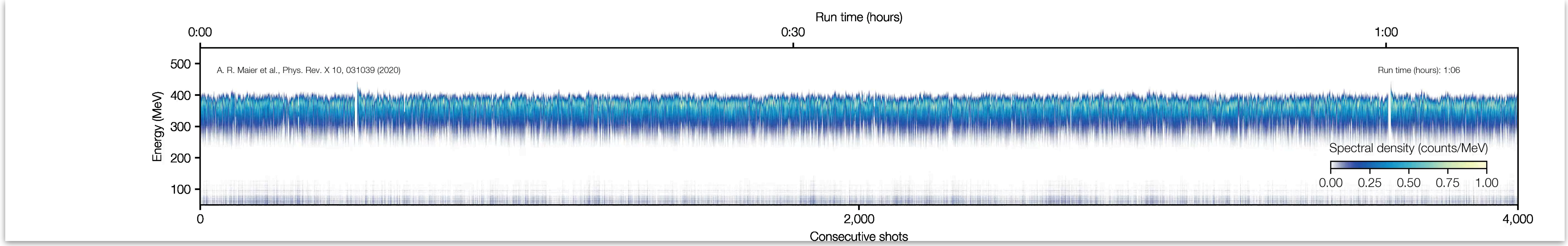
Autonomous tuning



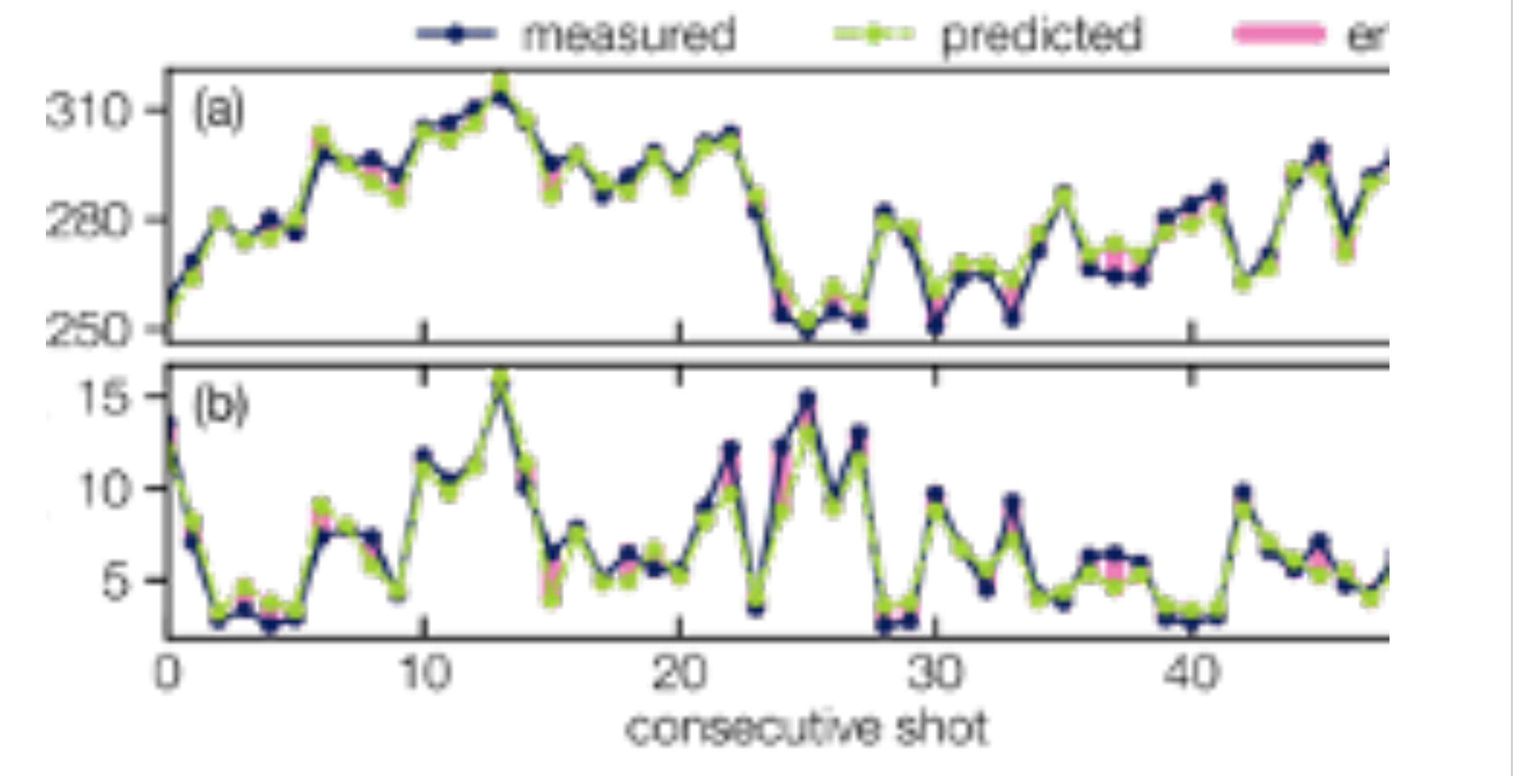
- LUX beamline has demonstrated
  - Stable operation @ 1 Hz over > 24 hours
  - ML-assisted active stabilization
  - Automatic, ML-assisted tuning

References
Maier *et al.*, *Phys. Rev. X* **10** 031039 (2020)
Kirchen *et al. Phys. Rev. Lett.* **126** 174801 (2021)
Jalas *et al. Phys. Rev. Lett.* **126** 104801 (2021)

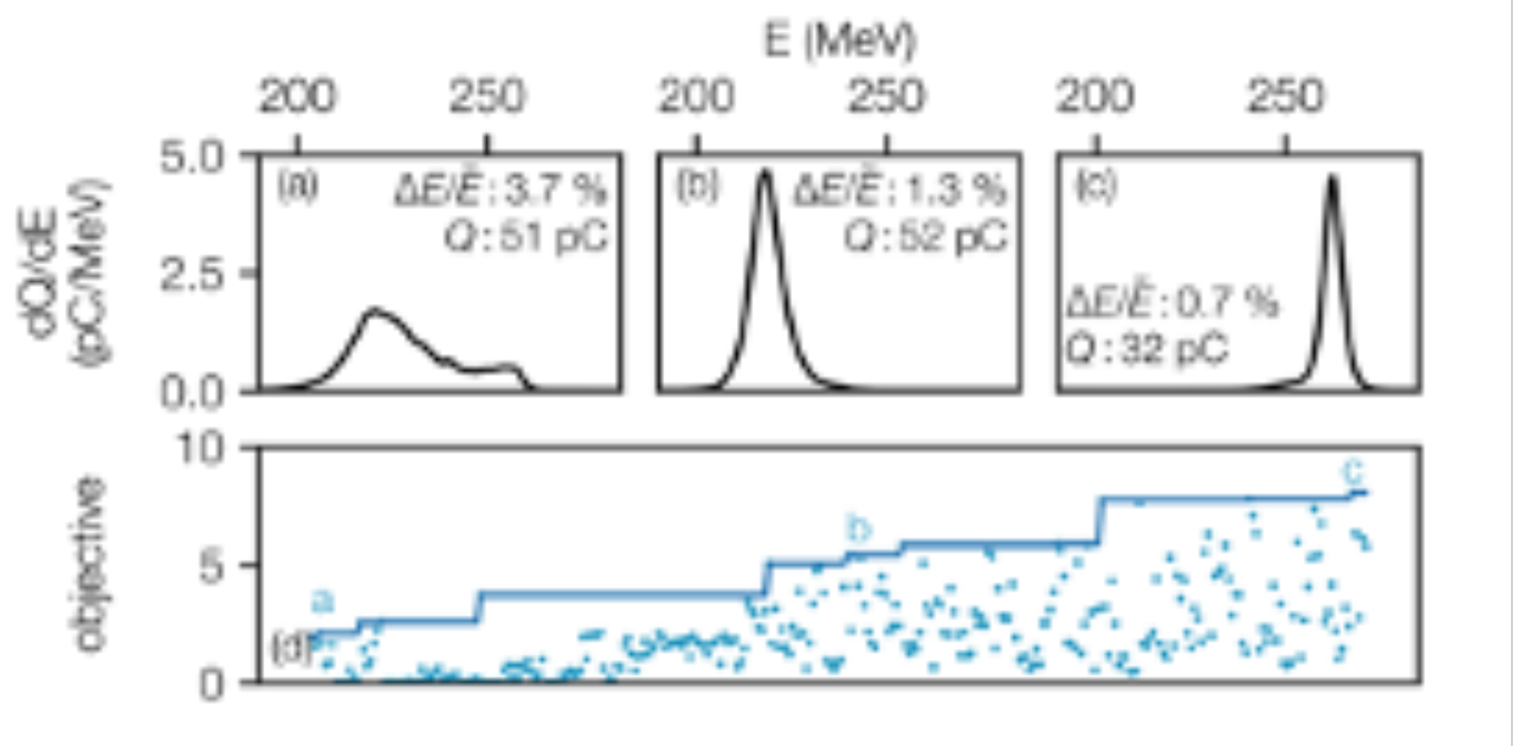
LWFA @ DESY



Active stabilization



Autonomous tuning



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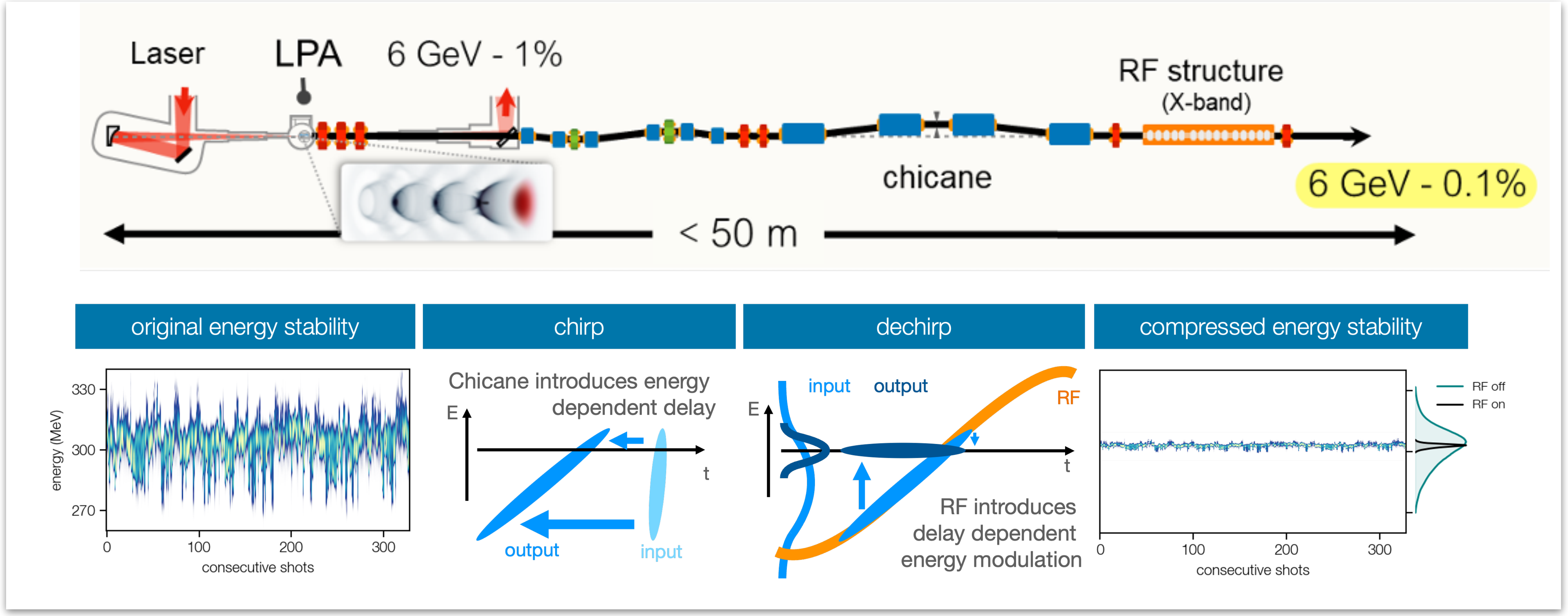
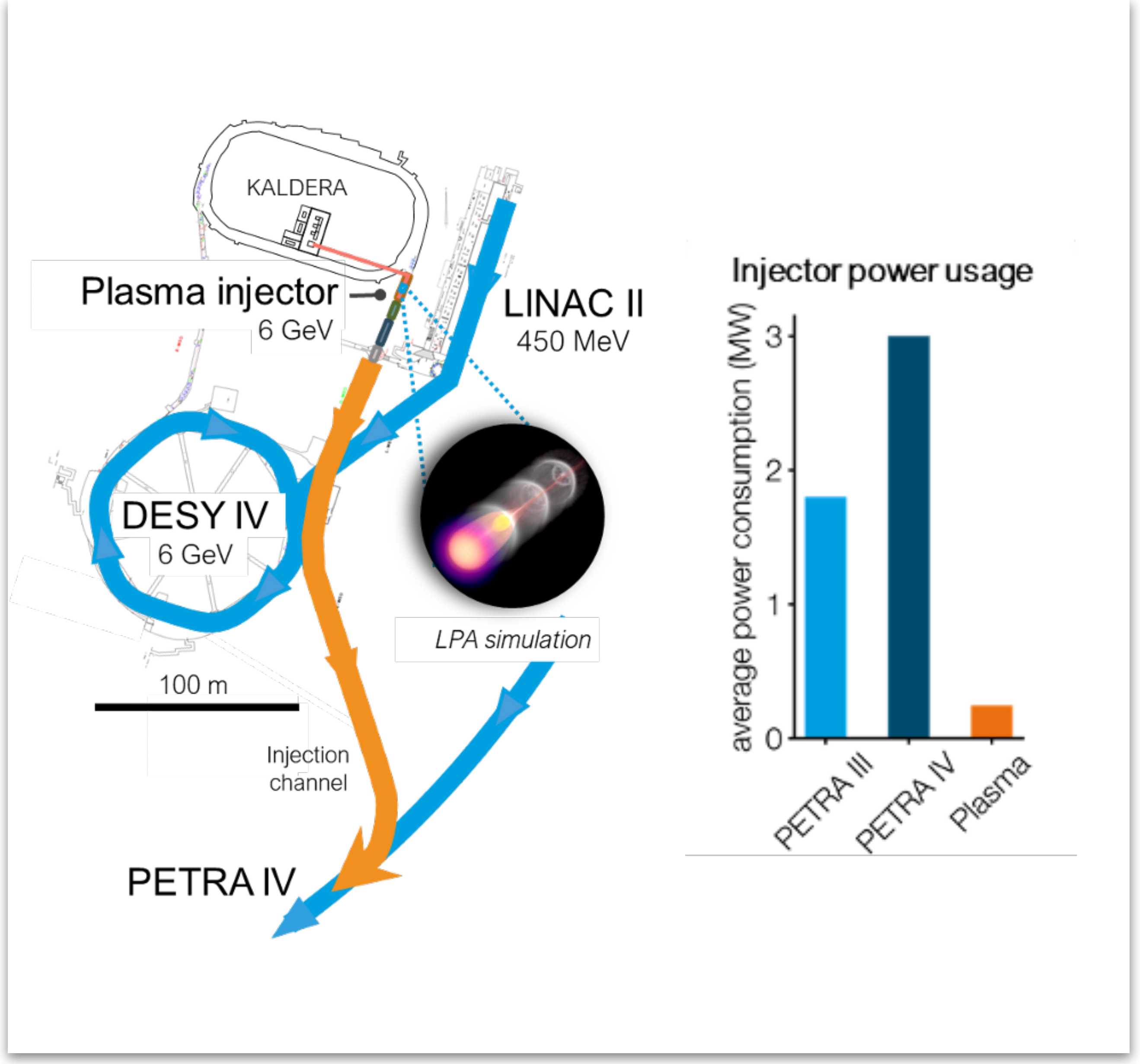
Jalas *et al. Phys. Rev. Lett.* **126** 104801 (2021)

DESY “Moonshot”: Plasma injector for PETRA IV



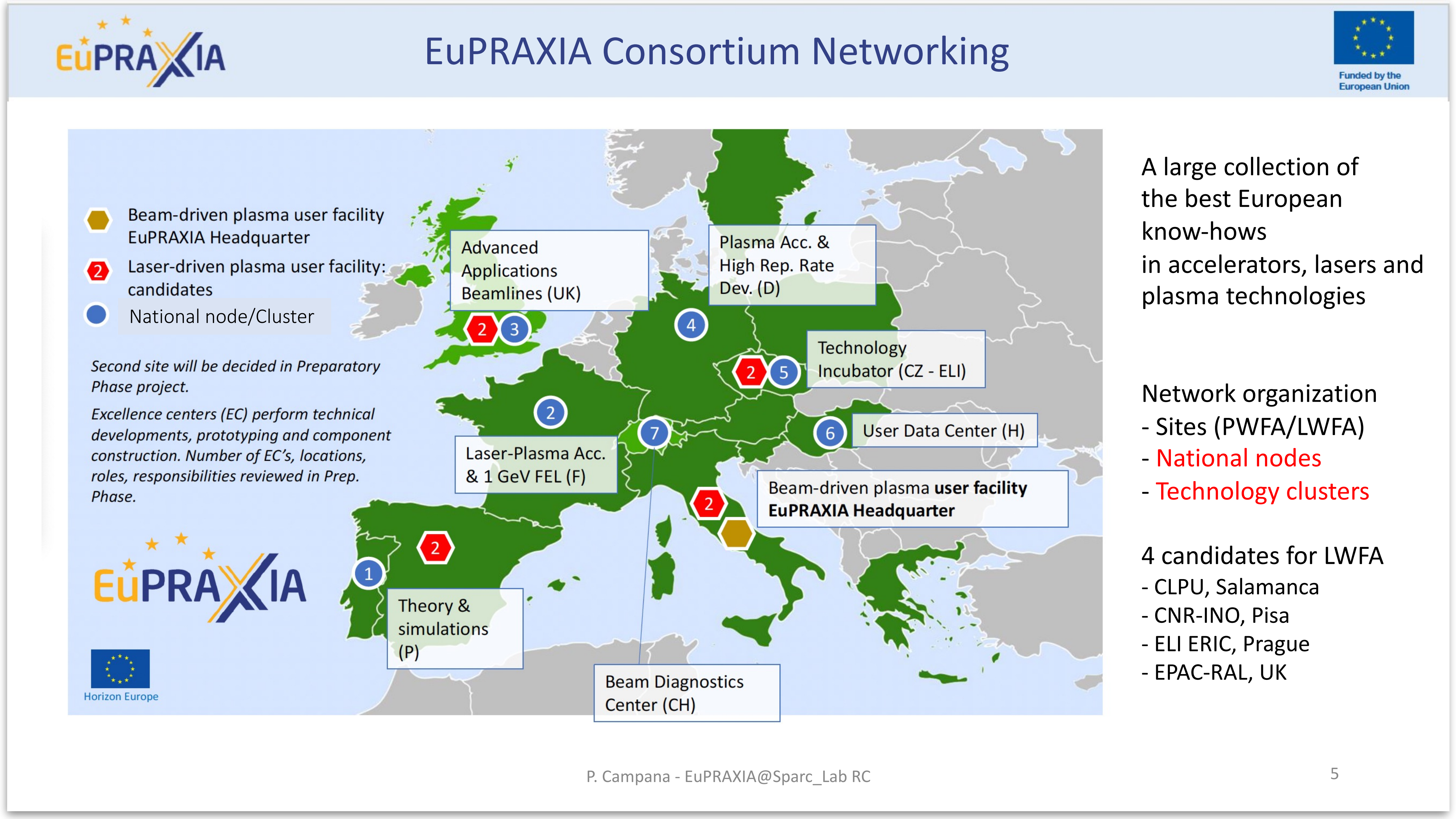


- Concept
  - Chicane + X-band RF dechirper stabilizes bunch energy
  - S2E sims show energy spread & jitter can be reduced by factor 10
- Next steps, PETRA IV pre-project:
  - Demonstrate laser tech capable of 24/7 operation at 99% availability
  - Demonstrate plasma injector at 450 MeV for PETRA III (with 6 GeV upgrade path)

References
Antipov *et al. Phys. Rev. Accel. Beams* **24** 111301 (2021)
Ferran Pousa *et al. Phys. Rev. Lett.* **129** 094801 (2022)

Thanks to: Wim Leemans

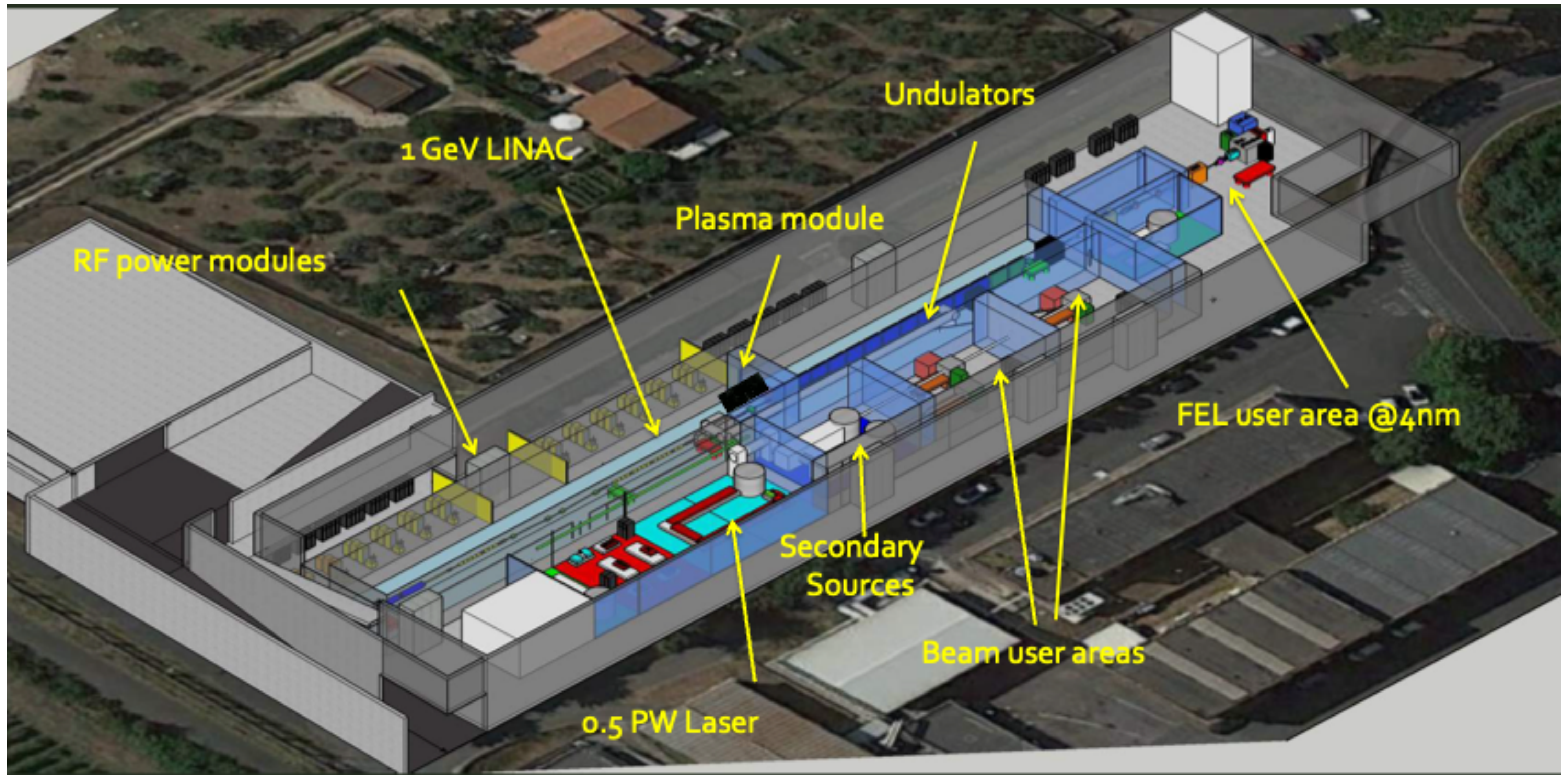
EuPRAXIA : second site



- 4 possible sites for EuPRAXIA LWFA-driven FEL:
  - CNR, Pisa, Italy
  - ELI-ERIC, Prague, Czech Republic
  - CLPU, Salamanca, Spain
  - EPAC, Harwell, UK
- Decision process:
  - Formal site visits completed
  - Decision by Collaboration Board due Feb/Mar 2025

Beam-driven plasma wakefield accelerators (PWFA)

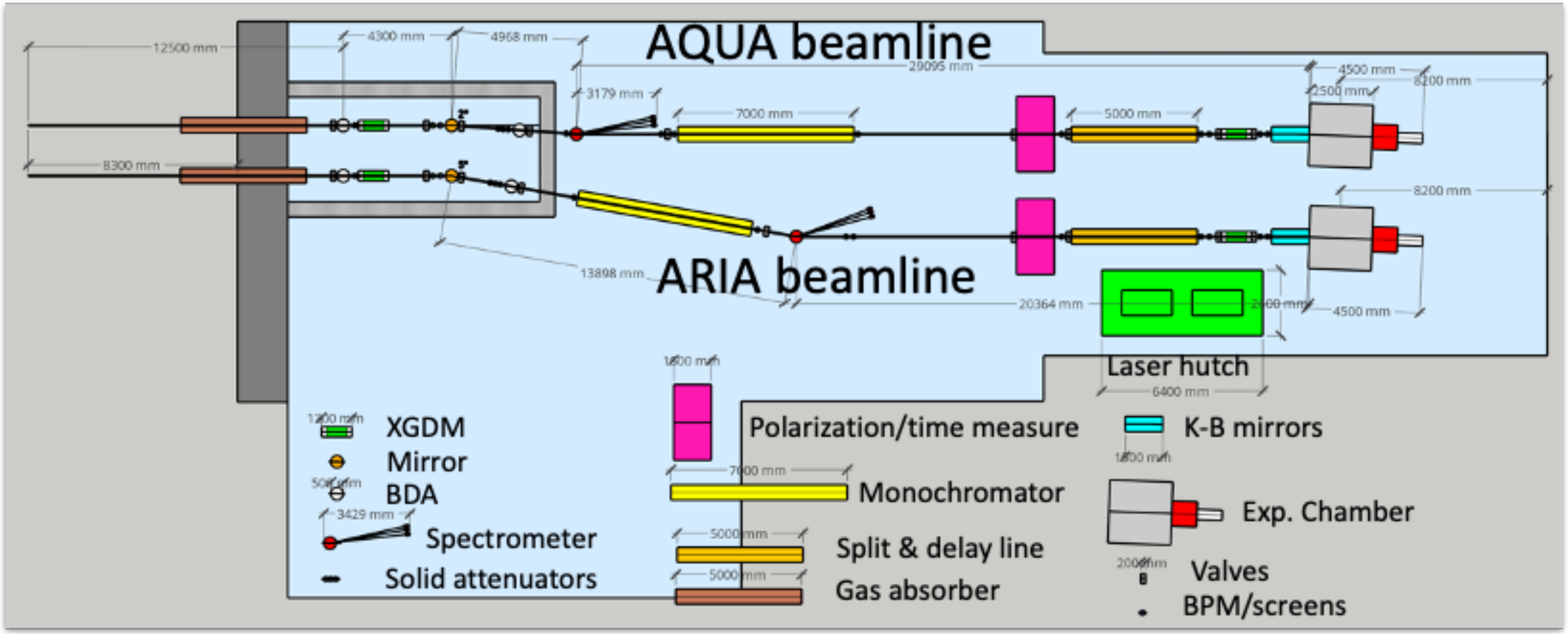
EuPRAXIA headquarters & site 1



- Headquarters of EuPRAXIA at SPARC_LAB, Frascati
- €130M investment
- New, dedicated building
- First FEL operation expected 2029

Thanks to: Pierluigi Campana & Massimo Ferrario

EuPRAXIA site 1: radiation sources

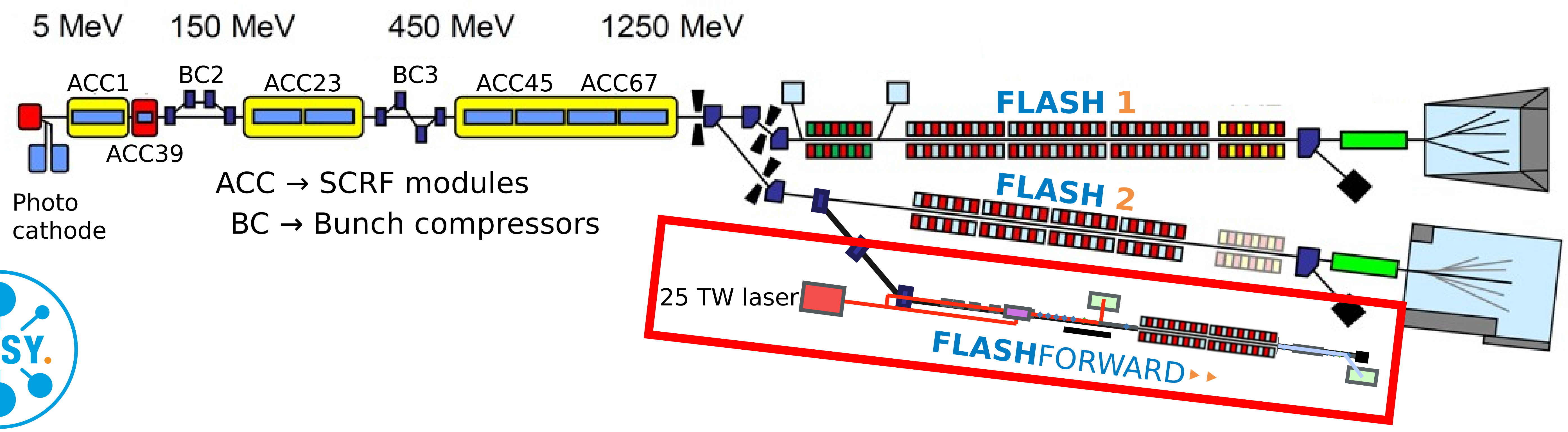


- 2 FEL lines:
  - AQUA: soft X-ray SASE FEL, optimized for 4 nm
  - ARIA: VUV-seeded HGHG FEL beamline
- Betatron source:
  - E_{crit}: 1 - 10 keV

Parameter	
Freq. (GHz)	11.9942
No. cells	112
Peak input power / structure (MHz)	70
P_{out} / P_{in}	25%
Rep. rate (Hz)	10
Driver / Witness energy before plasma (MeV)	530
Witness energy after plasma (GeV)	1.1
Driver charge (pC)	200 - 500
Witness charge (pC)	30 - 50

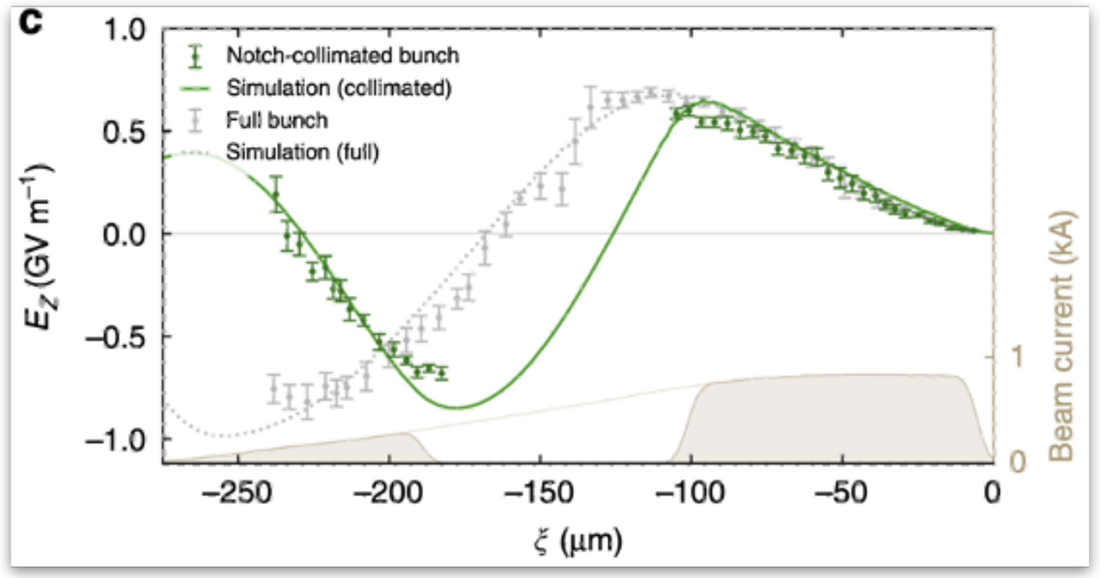
Thanks to: Pierluigi Campana & Massimo Ferrario

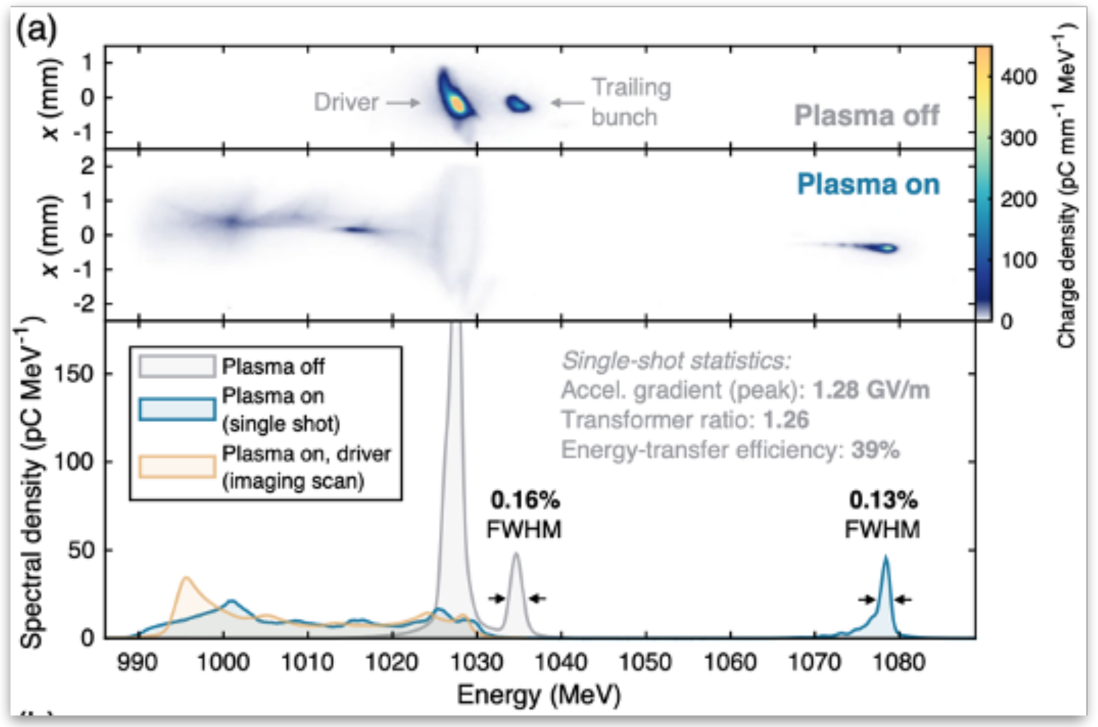
PWFA @ DESY

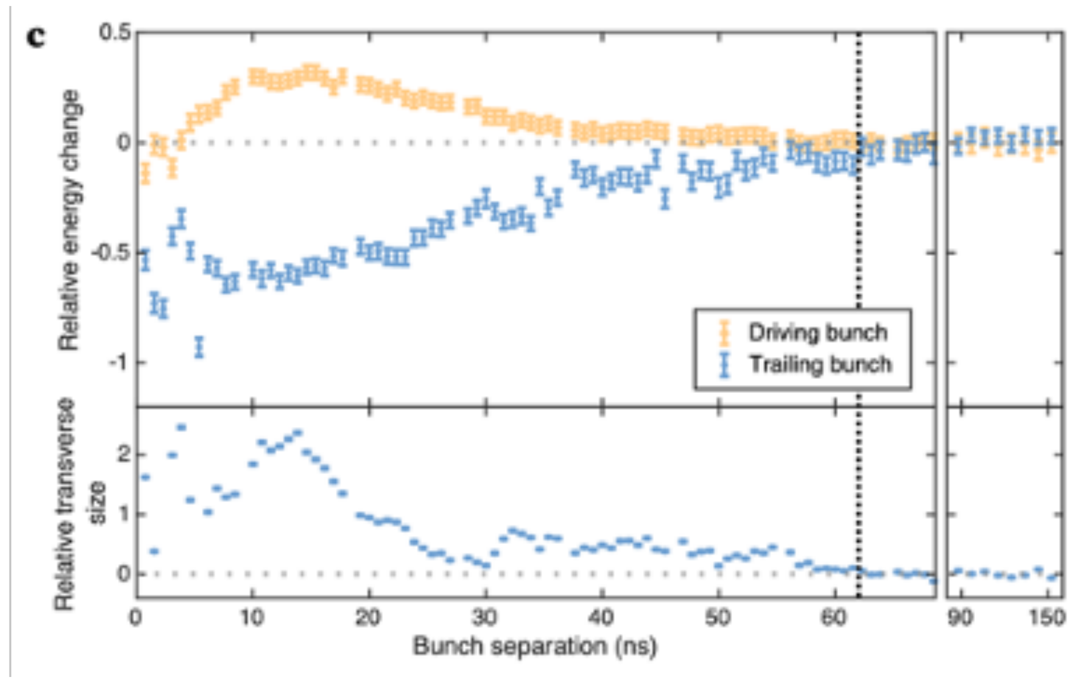


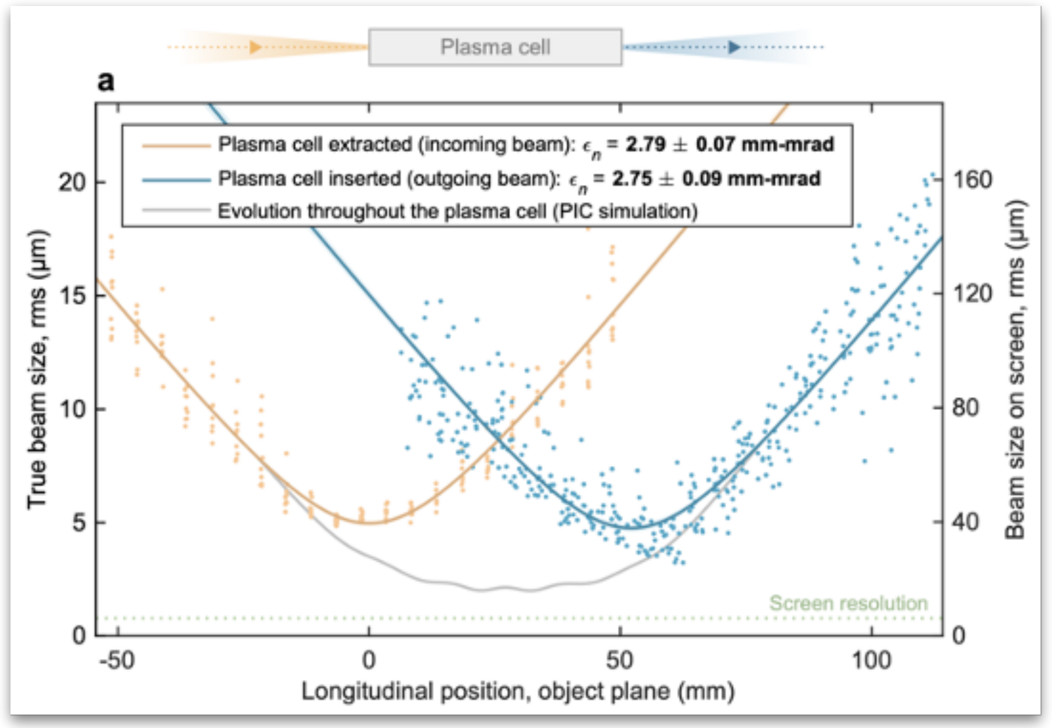
References
D'Arcy *et al. Phil. Trans. R. Soc. A.* **377** (2018)
Schröder *et al. Nat. Comm.* **11** 5984 (2020)
Lindstrøm et al., *Phys. Rev. Lett.* **126** 014801 (2021)
D'Arcy *et al. Nature* **603** 58 (2022)
Lindstrøm *et al. Nat. Comm. accepted* (2024)

- FLASHForward is a beamline for PWFA research
  - ~10 kW average beam power @ MHz repetition rate in 10 Hz bursts
- Recent results
  - First direct wakefield sampling
  - First energy spread preservation at 0.1% & record efficiency
  - First demonstration of emittance preservation
  - Plasma recovery time shown to be compatible with MHz operation







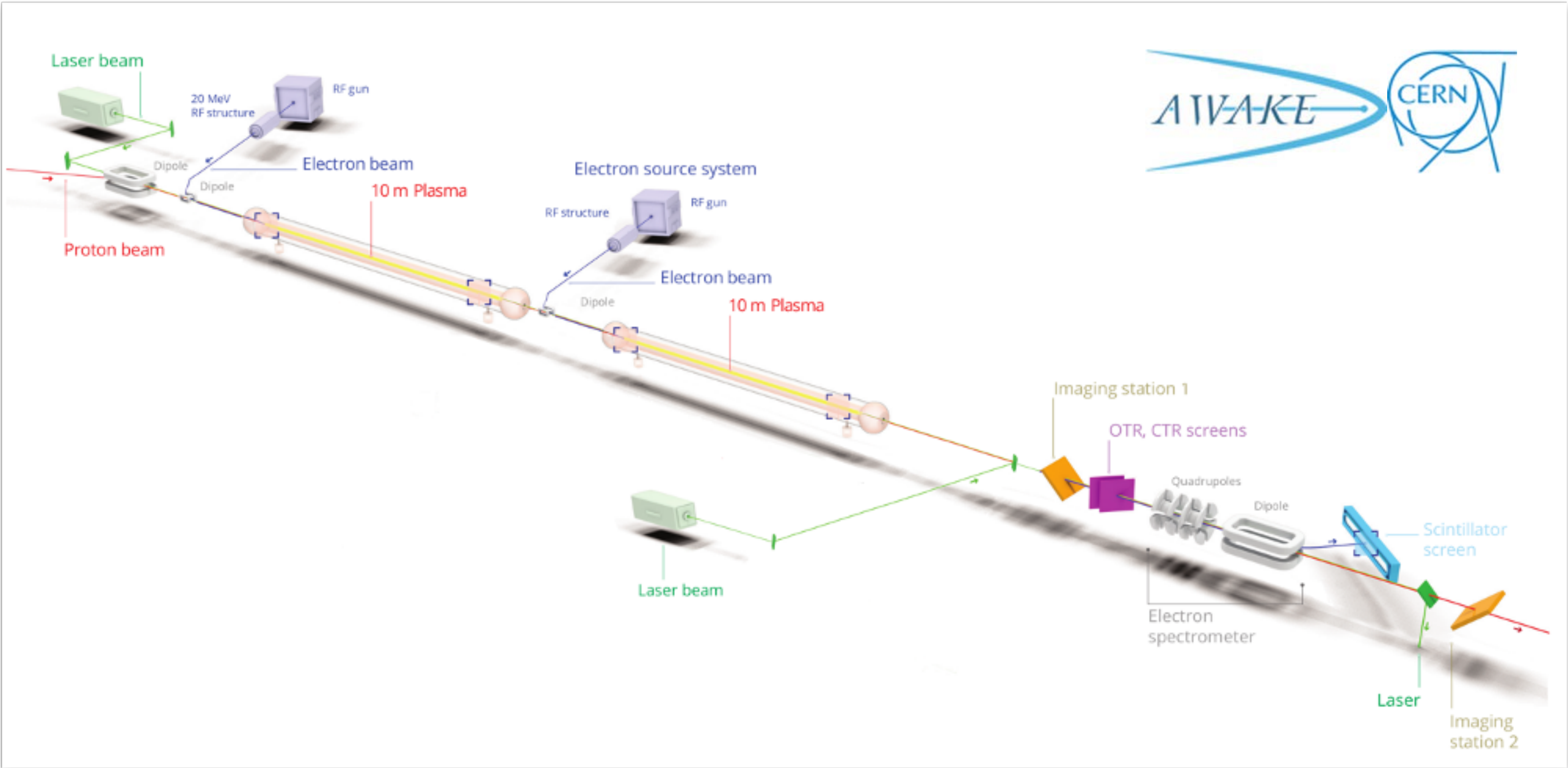


Thanks to: Wim Leemans

AWAKE

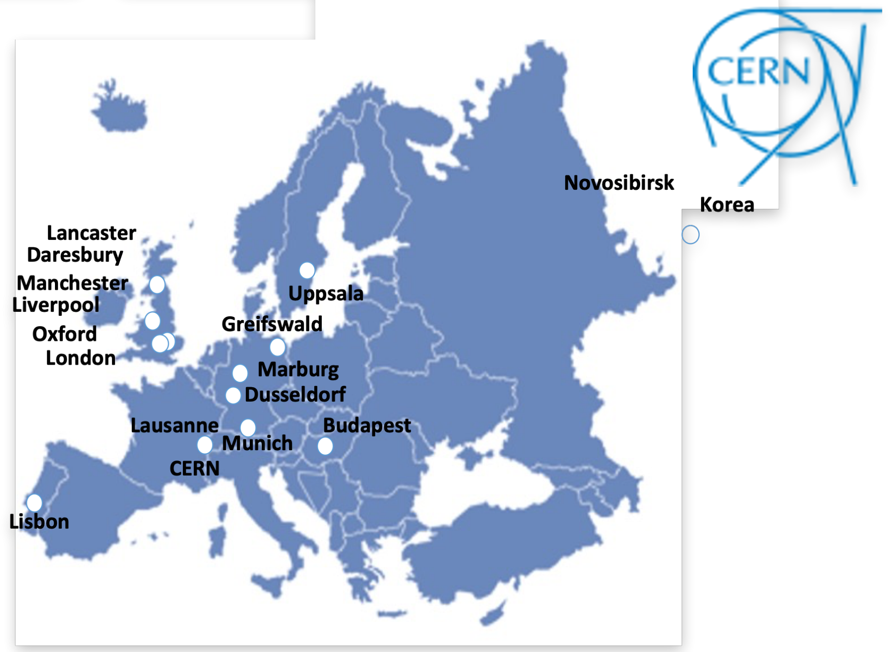
Concept:

- Drive plasma accelerator with 400 GeV SPS proton beam
- Allows acceleration to high energies in a single stage
- Proton beam too long (~ 200 ps), so must be (self)-modulated



Scope:

- International collaboration of 22 institutes



Contact

Lead: Edda Gschwendtner (CERN)

Web: https://home.cern/science/accelerators/awake

AWAKE: scientific roadmap

- Run 2a (2021 - 2022): **Control** — demonstrate seeding of the self-modulation of the entire proton bunch with an electron bunch
- Run 2b (2023 - 2024): **Stabilization** — maintain large wakefield amplitudes over long plasma distances by introducing a step in the plasma density

Approved in June 2024!

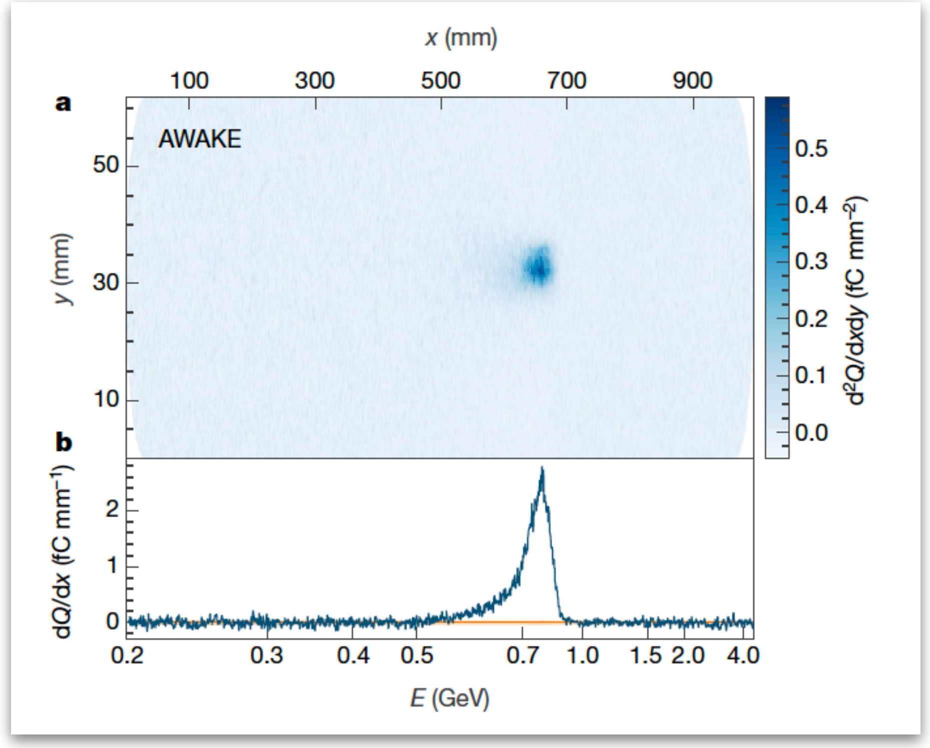
- Run 2c (2028 - 2031): **Quality** — demonstrate acceleration and emittance preservation of externally injected electrons
- Run 2d (2032 - LS4): **Scalability** — development of scalable plasma sources to 100s m length with sub-% density variation

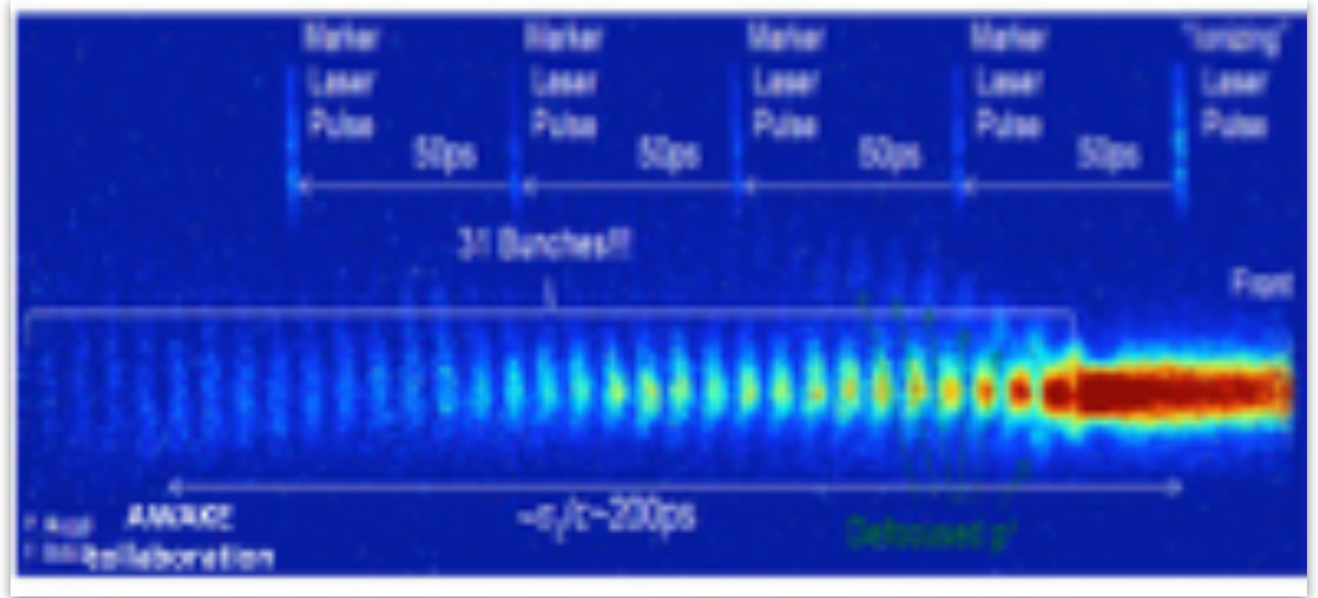
Parameter	Value
Norm. emittance ()	2 - 30 mm mrad
Q (pC)	100 pC
$\Delta E \ / \ E$	5 - 8 %
Energy gain: Run 2c	4 - 10 GeV
Energy gain: Run 2d	> 10 GeV

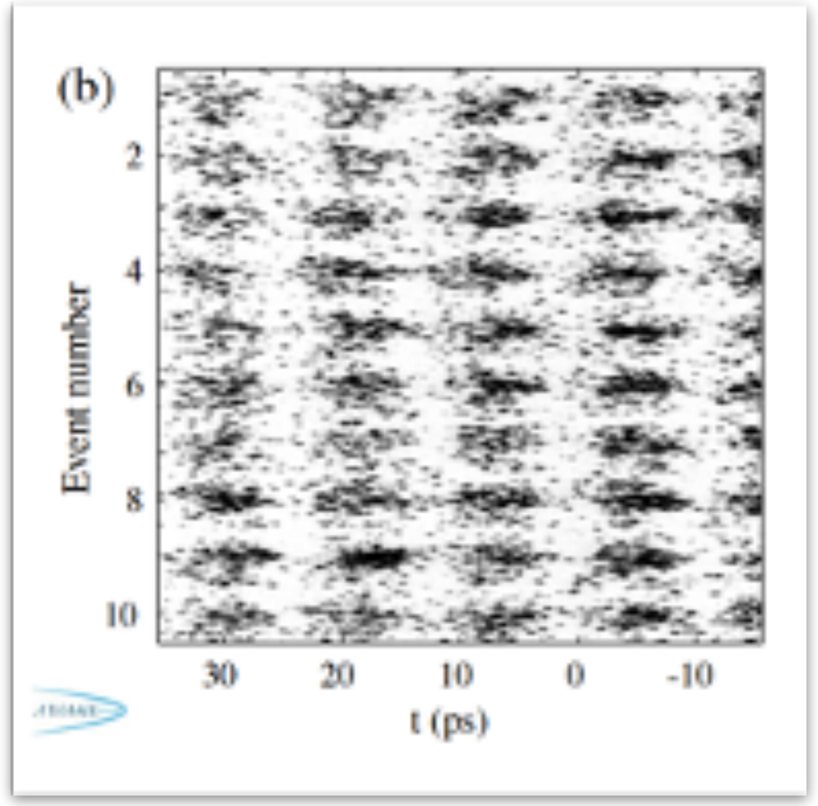
Thanks to: Edda Gschwendtner

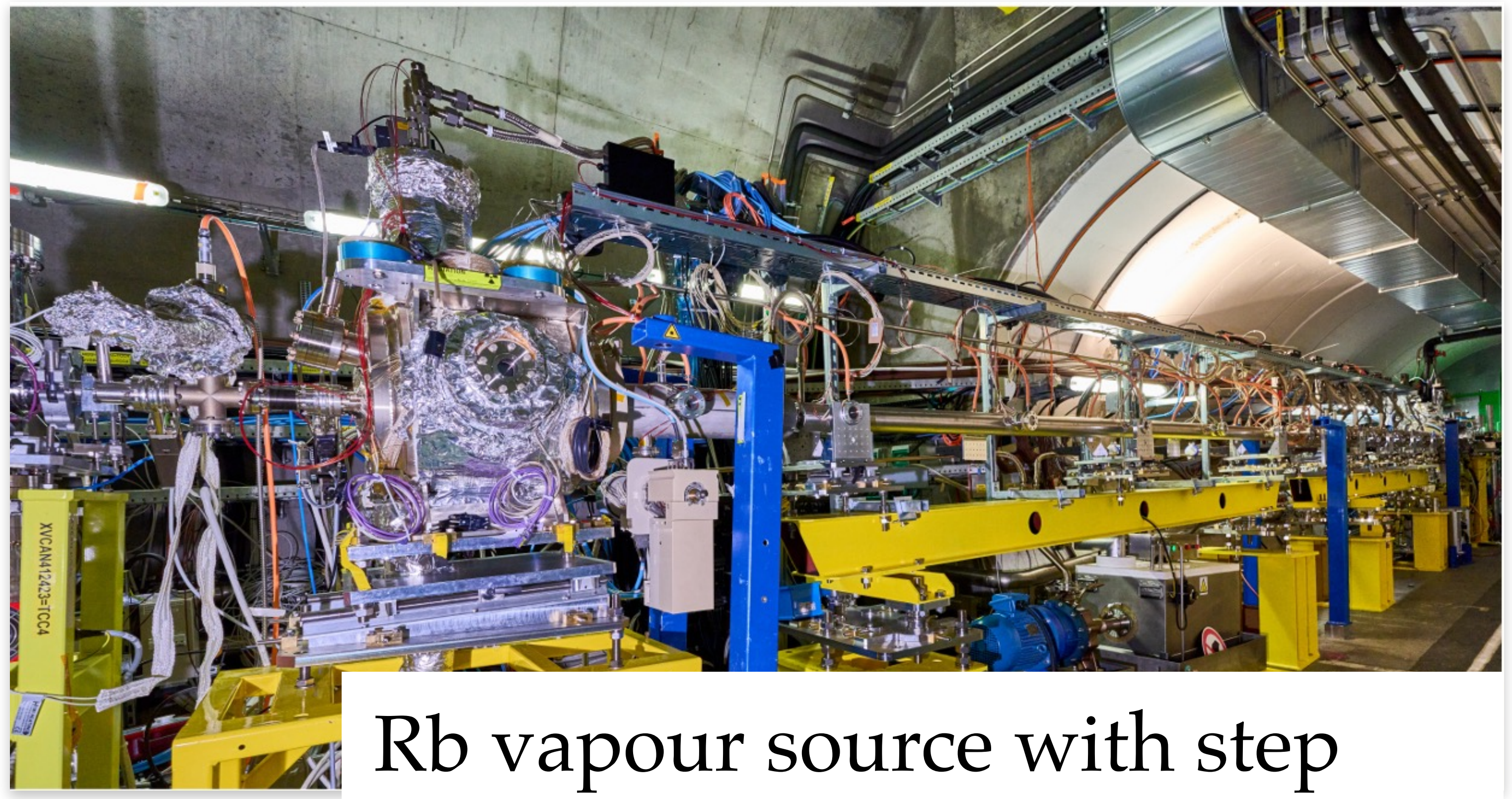
AWAKE: Some highlights

- Many scientific achievements
  - Electron acceleration demonstrated
  - Wakefield growth due to SM observed
  - Proton bunch self-modulation demonstrated
  - Seeding with ionization front & electron bunch demonstrated
  - Beam hosing instability investigated
- Many technological achievements
  - S-band gun with X-band accelerator
  - Rb vapour source with density step
  - 10m long discharge plasma source
  - BPMs with 10 um resolution

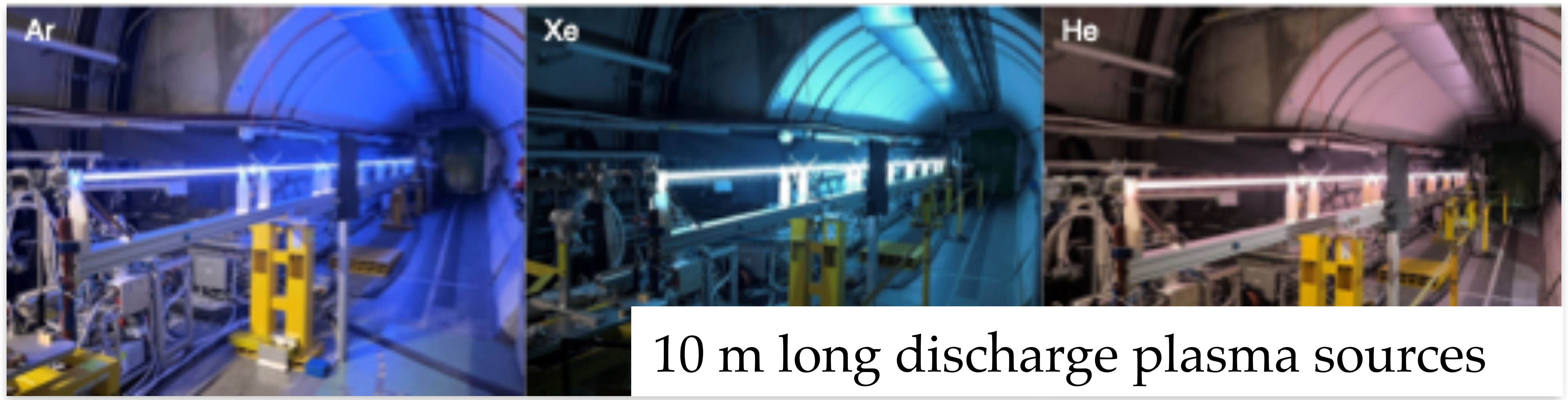








Rb vapour source with step



10 m long discharge plasma sources

References

Adli *et al.*, *Nature* **561** 363 (2018)

Turner *et al.*, *Phys. Rev. Lett.* **122** 054801 (2019)

Adli *et al.*, *Phys. Rev. Lett.* **122** 054802 (2019)

Batsch *et al.*, *Phys. Rev. Lett.* **126** 164802 (2021)

Verra *et al.*, *Phys. Rev. Lett.* **129** 024802 (2022)

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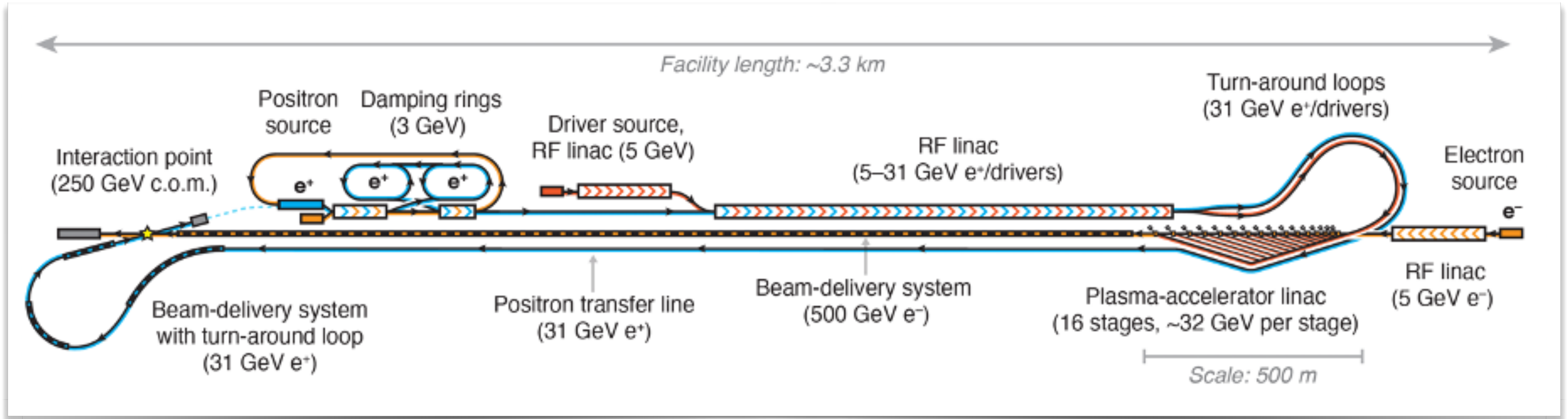
AWAKE CERN

Thanks to: Edda Gschwendtner

HALHF: Hybrid Asymmetric Linear Higgs Factory



Concept:

- Exploit high gradient of e- acceleration in PWFA & avoid difficulty of e+ acceleration by using RF linac
- Reduces costs since:
  - Low e+ energy (31 GeV) -> high e- energy (500 GeV). E_{CM} ~ 250 GeV
  - Increased I(e+) and decreased I(e-); this and asymmetric emittance (larger for e-) eases PWFA requirements
- Facility length ~ 3.3 km; cost ~ 25% of ILC/CLIC (~ $1.9B @ 2022)

Thanks to: Brian Foster, Carl Lindstrøm, Richard D'Arcy

HALHF

- HALHF programme is led by Carl Lindstrøm (Oslo); and Brian Foster (Oxford & DESY), and Richard D'Arcy (Oxford)
  - Aim is to design a self-consistent plasma-based electron–positron collider at the sub-TeV scale (for Higgs production)
- Current activities
  - Write "pre-CDR" (i.e. a self-consistent parameter set with a full-detail start-to-end simulation and realistic RF accelerators, with a credible cost estimate) for the ESPP update in March 2025.
  - Monthly online expert meetings since October 2023
  - Two in-person collaboration meetings (Hamburg in Oct 2023, Oslo in April 2024), and will have another in Erice, Sicily in October 2024
  - Working on a detailed cost model to which we can apply Bayesian Optimization to produce an updated baseline

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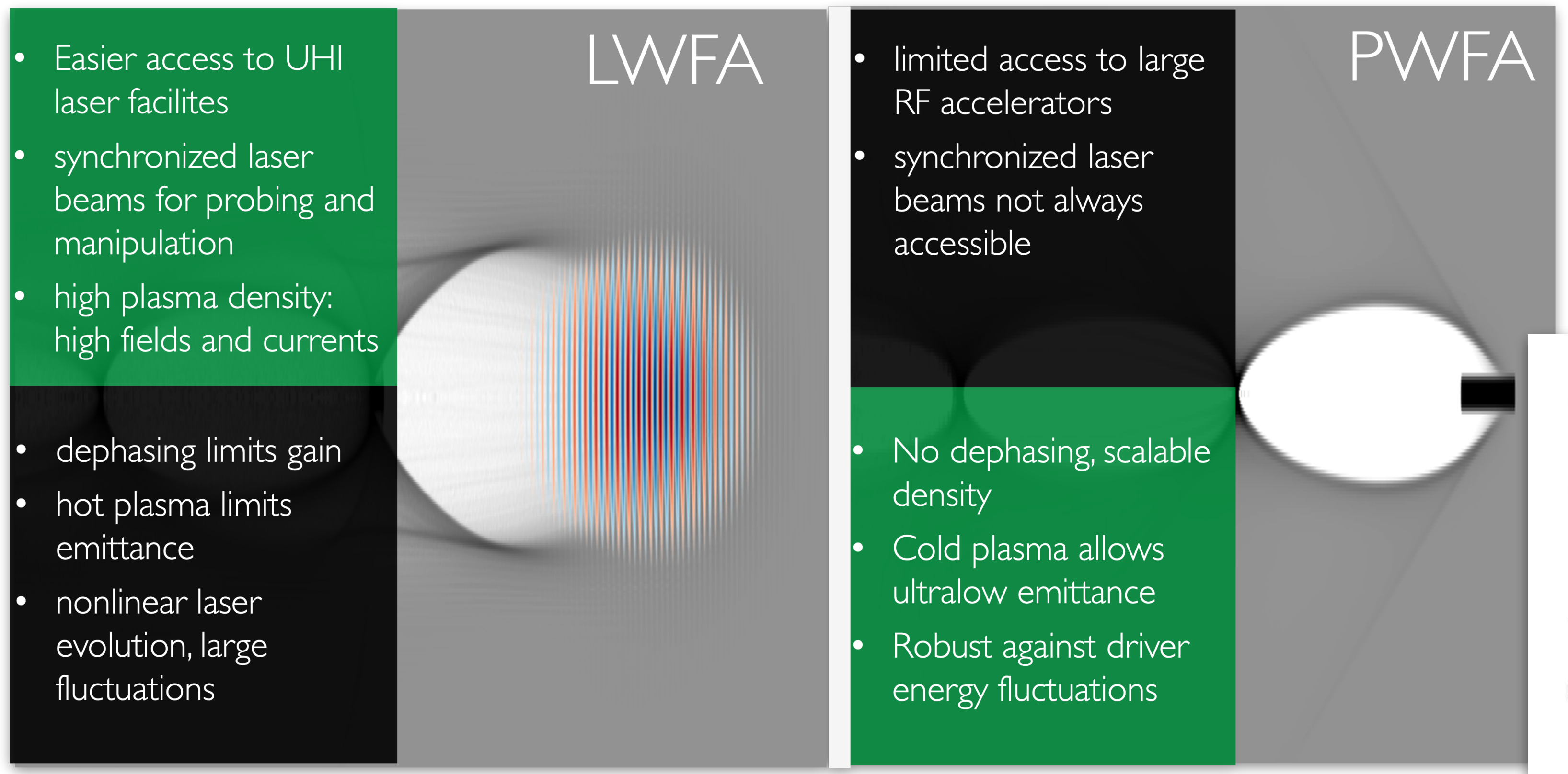
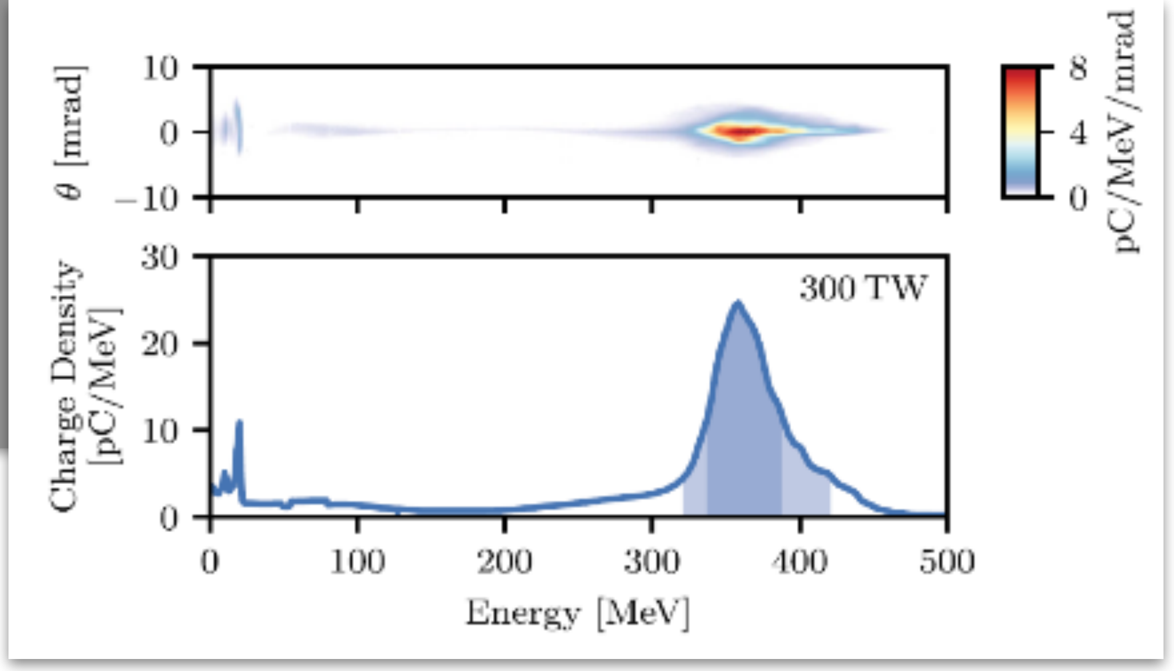
Foster *et al.*, *New J. Phys.* **25** 093037 (2023)
Lindstrøm *et al.* arXiv:2312.04975 (2023)
Diederichs *et al.* arXiv:2403.05871 (2024)

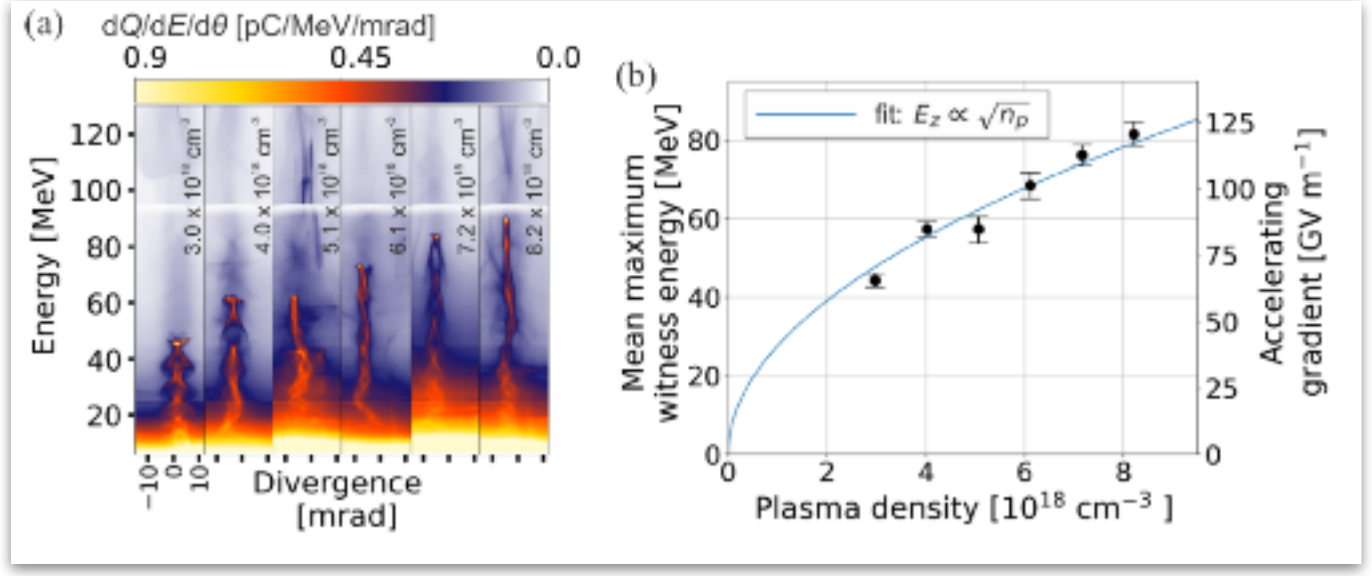
Other topics

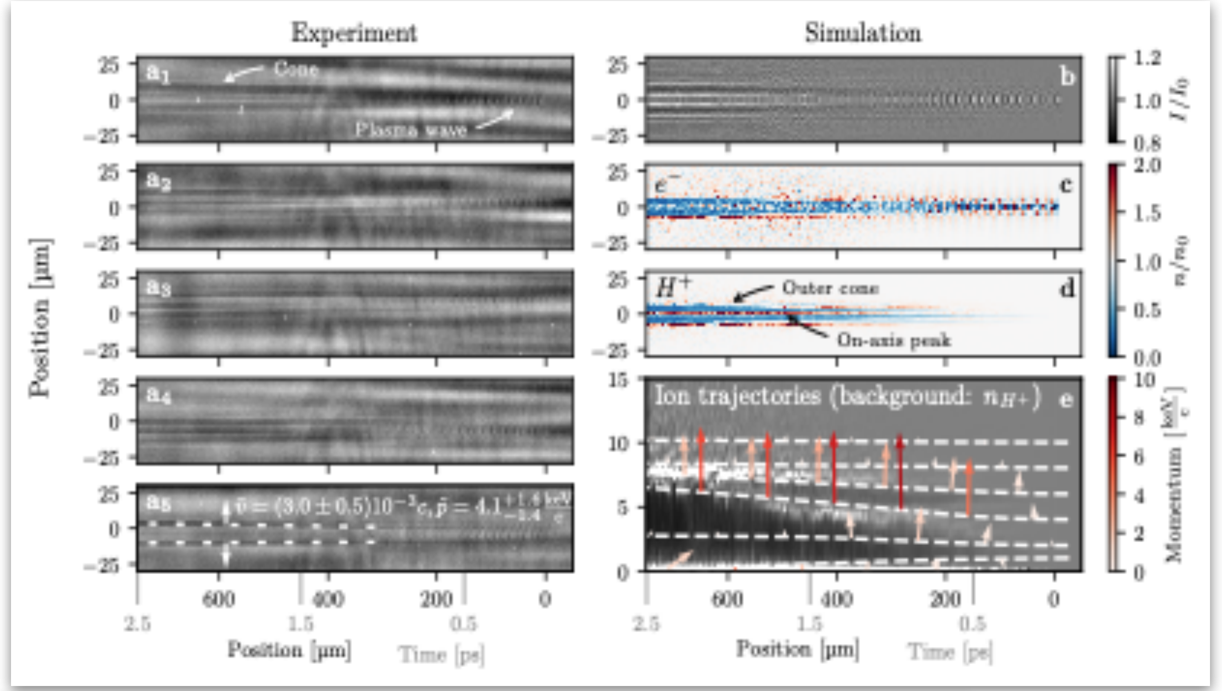
Hybrid acceleration

- Concept
  - Drive a PWFA with e- from a LWFA
  - Combines best features of LWFA & PWFA
- Progress
  - nC driver beams generated
  - Observation of plasma waves driven by laser-accelerated e-
  - Internal (shock) injection of witness beam in PWFA stage
  - Generation of stable, high-quality beams by LPWFA





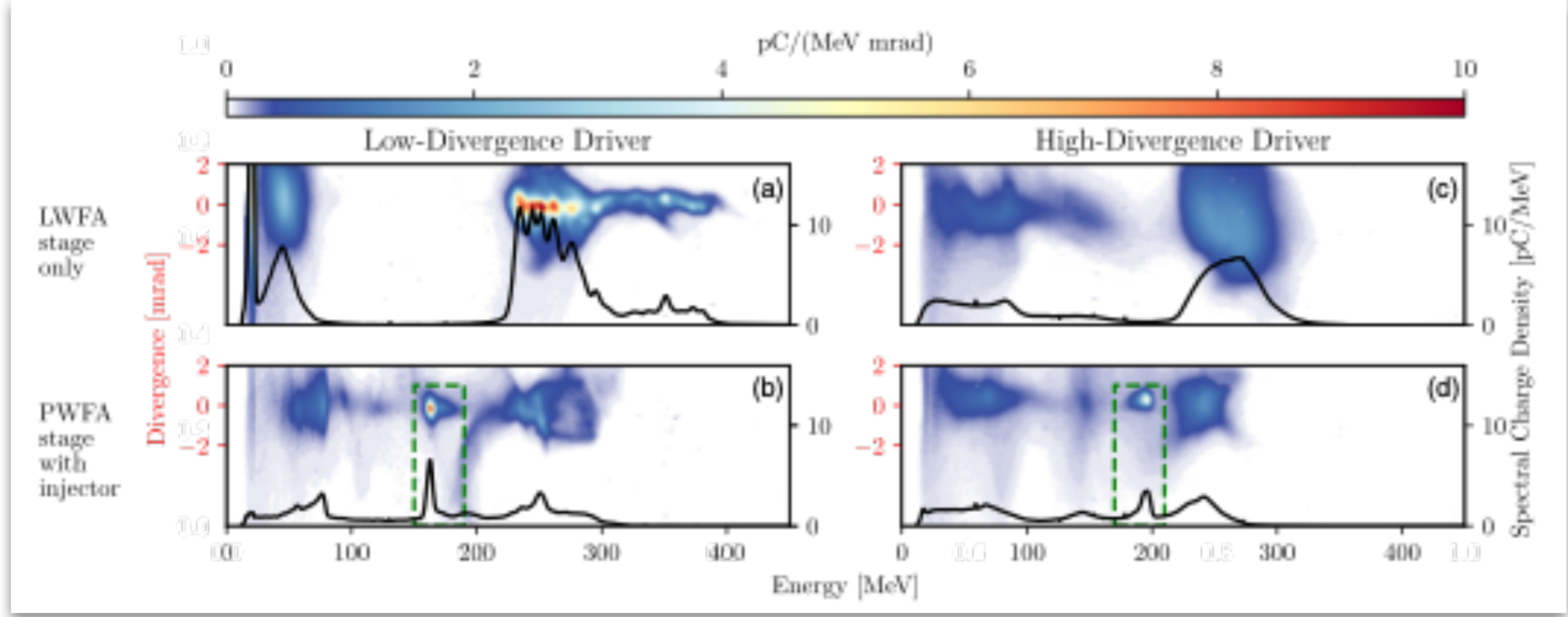




Hybrid collaboration

University of Strathclyde Glasgow

Heinrich Heine Universität Düsseldorf



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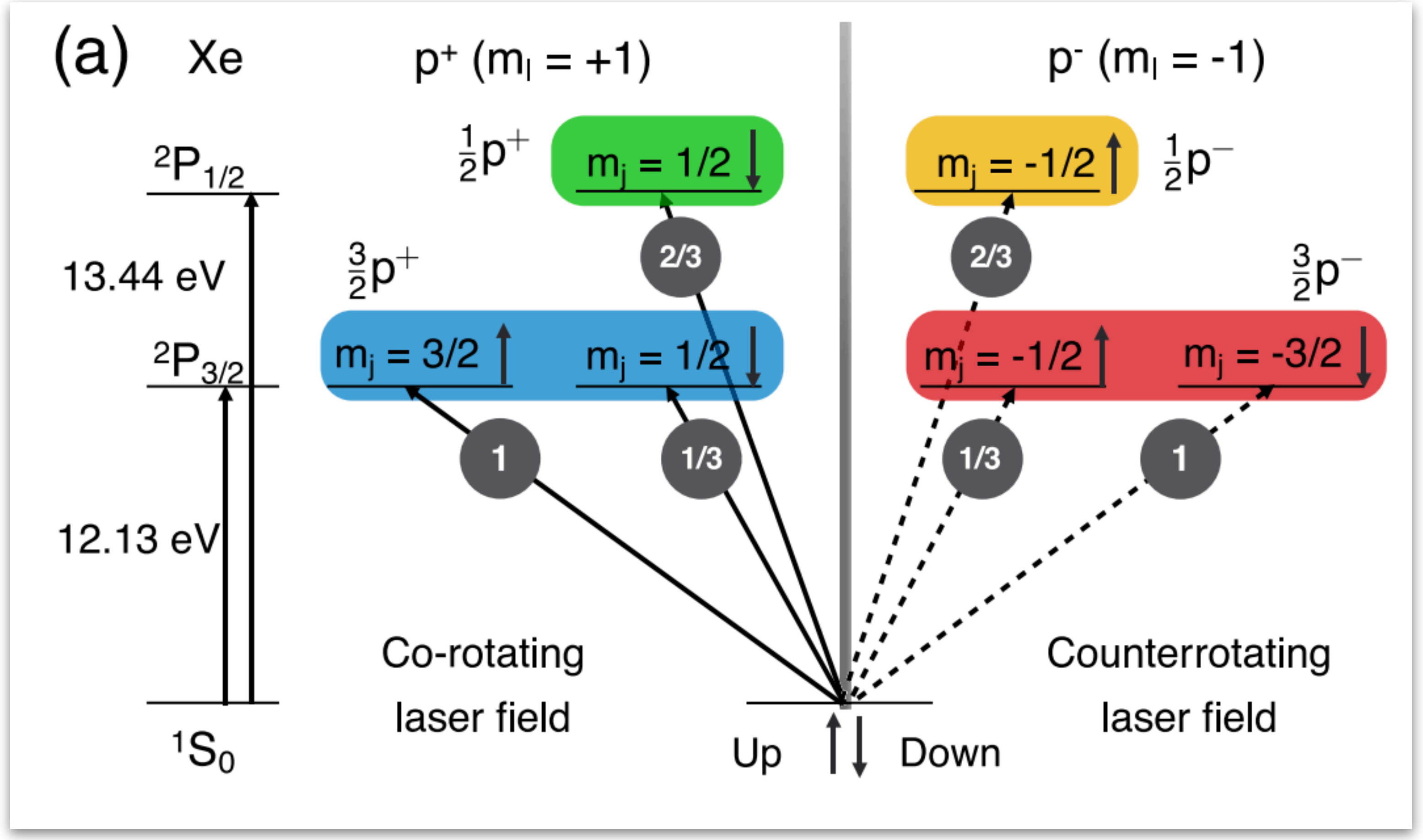
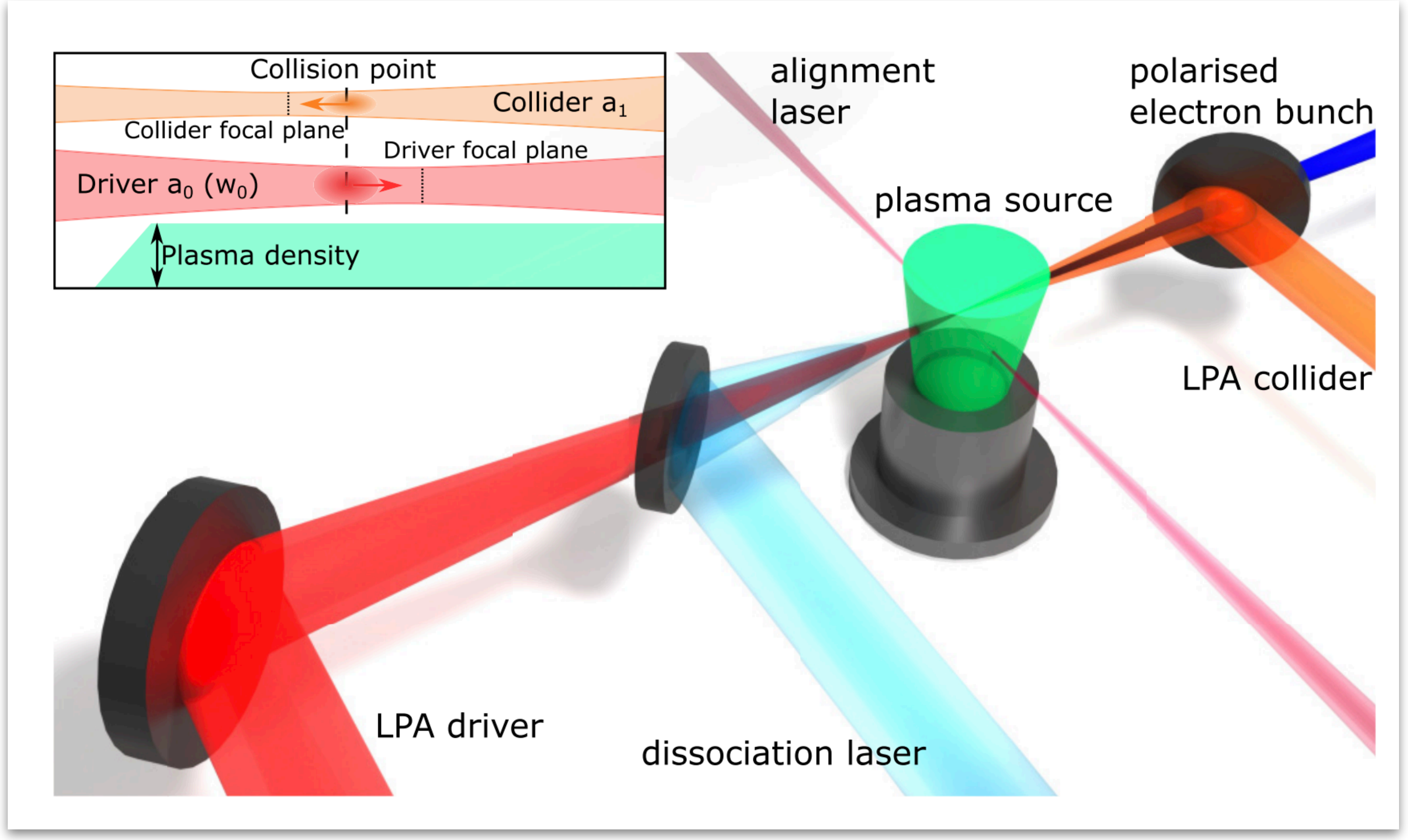
Foerster *et al.* *Phys. Rev. X* **12** 041016 (2022)

Thanks to: Bernhard Hidding & Stefan Karsch

Spin polarization

- Vital for plasma-based collider
- LEAP project at DESY
  - Demonstrate generation & accelation of spin-polarized electrons in a LPA
  - Source: UV ionization of Xe
- Progress
  - Spin tracking added to FBPIC & HIPACE++
  - Sims show colliding-pulse injection yields high-quality polarized beams
- Next:
  - UV source upscale
  - Pre-polarized source demo
  - Polarized LPA demo





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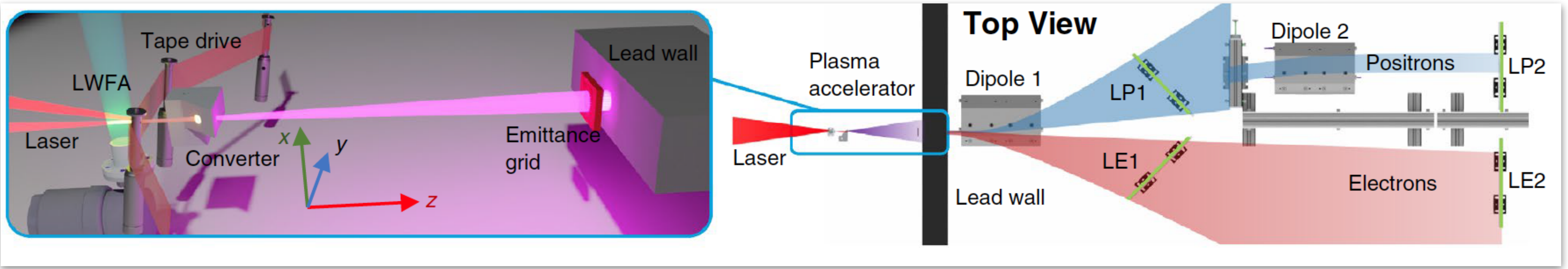
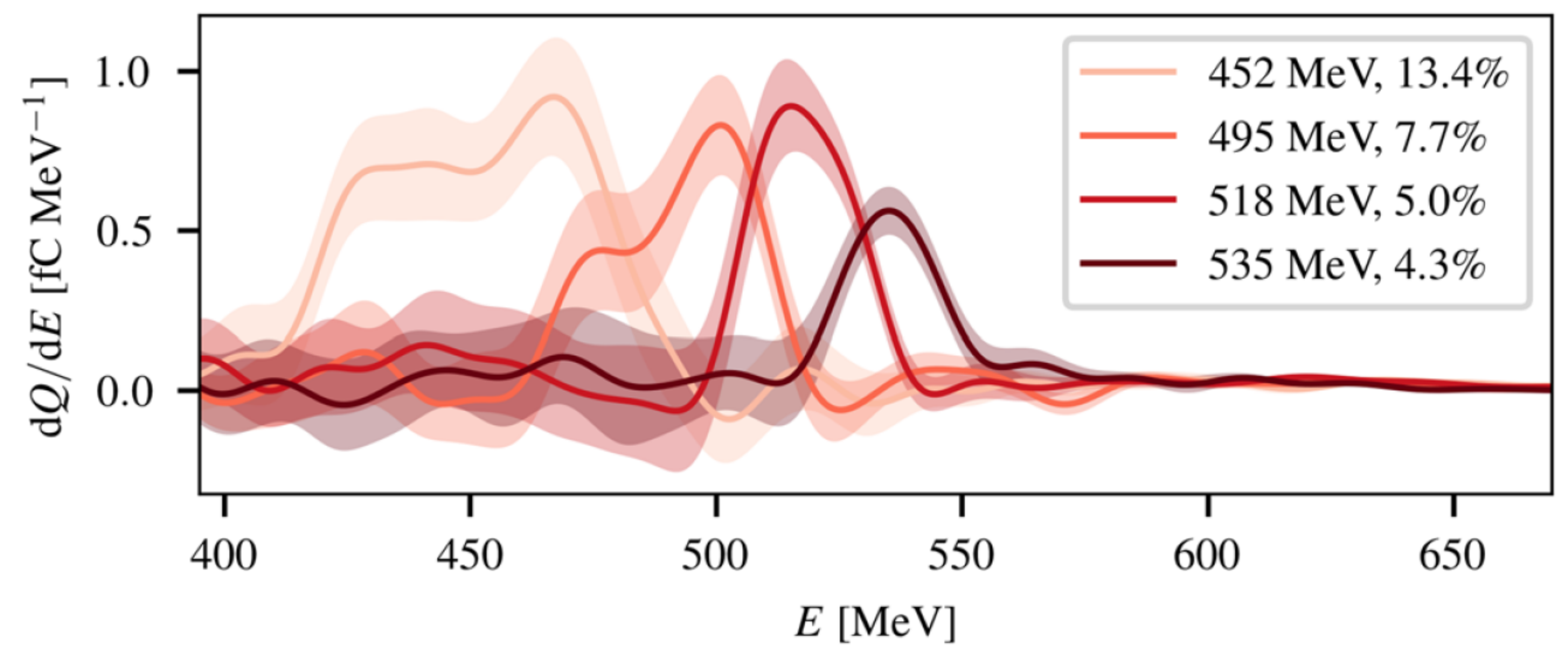
Acceleration of positrons





- Addresses a major challenge for future advanced colliders
- Proof-of-principle experiments at 150 TW:
  - Positrons (Bethe-Heitler process): E ~ 500 MeV; $\Delta E/E \sim 5\,\%$; $Q = 0.2\,\text{pC}$; $\epsilon_n = 18\,\mu\text{m}$
  - Sufficient quality for injection into RF or plasma-based accelerator
- Simulations: could generate e+ bunches with 10 - 20 pC, 5% BW around 1 GeV, 30 fs, from nC electron bunches produced by PW-scale lasers
- Positron beamlines:
  - Being designed for Frascati (EuPRAXIA) and EPAC
  - Being investigated for plasma-based future upgrades to HALHF concept

Imperial College London | Central Laser Facility | University of Michigan | Queen's University Belfast

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Streeter *et al. Sci. Rep.* **14** 6001 (2024)

Thanks to: Gianluca Sarri

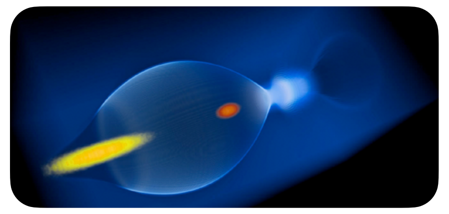
There is a significant effort to improve simulation tools

- Significant effort to ensure compatibility with new exascale HPC architectures.
- Some recent development highlights include:

EPOCH https://epochpic.github.io/

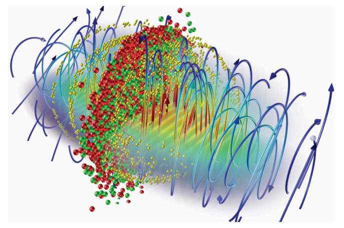
- Developing ionisation models (collisional); brems. & NCS radiation
- Cylindrical mode w/ azimuthal decomposition now available
- EPOCH++: porting from FORTRAN to C++; adding GPU support via Kokkos — first release expected October 2025

Smilei) https://smileipic.github.io/Smilei/



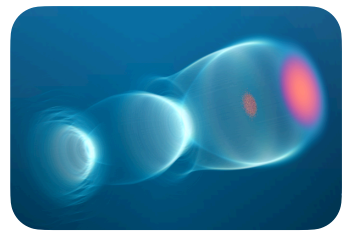
- Strong-field QED; atomic physics processes; advanced laser field injectors
- Laser envelope model (w/ ionisation) in all geometries w/ PML
- Smilei v5.0: NVIDIA & AMD GPU support available (2D & 3D cartesian)
- Continuing to port additional physics modules and advanced solvers to GPU

Osiris 4.0 https://osiris-code.github.io/



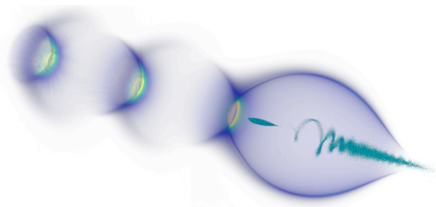
- Coherent/incoherent radiation modelling; final-focus collisions
- Single socket version for all exascale architectures available; CPU/GPU/FPGA
- MPI implementation for all architectures expected operational by Q1 2025

WakeT https://wake-t.readthedocs.io/



- Rapid axisymmetric simulations; laser- or beam-driven
- Recently added adaptive grid and ion motion
- Python implementation — seconds/minutes on a laptop
- Multi-physics models coming soon.

HiPACE++ https://hipace.readthedocs.io/



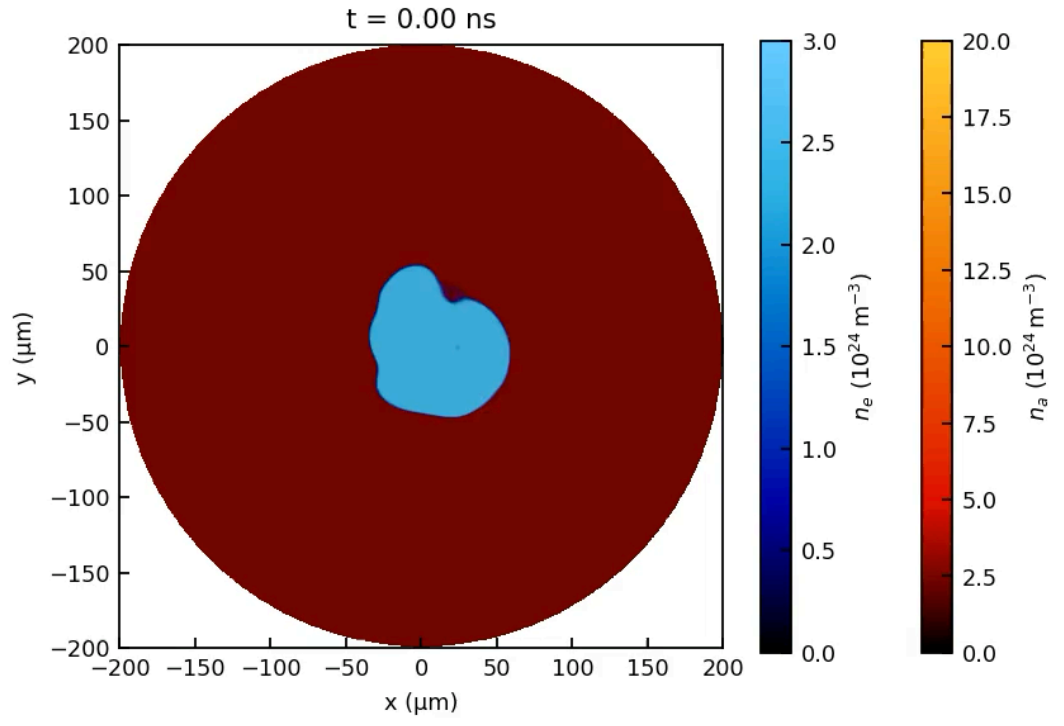
- 3D quasi-static PIC code
- Recently added mesh refinement; laser envelope solver; multi-physics including radiation reaction, spin tracking and binary collisions
- Written in C++ w/ NVIDIA & AMD GPU support
- Ongoing optimisation work, adding new physics processes soon

Thanks to: Tony Arber, Arnaud Beck, James Chappell, Luis Silva, Maxence Thevenet

There is a significant effort to improve simulation tools

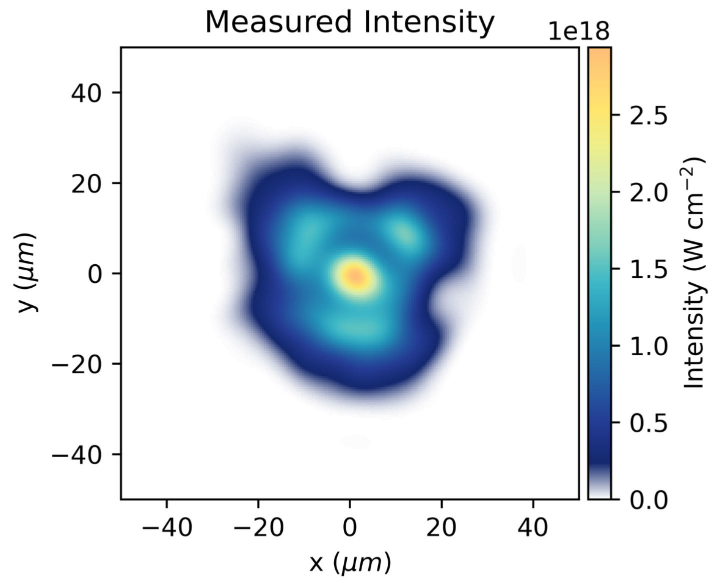
COMSOL

Developing plasma hydrodynamics module
- *Plasma expulsion within discharge capillary*
- *2D simulation of HOFI channel formation*



LASY

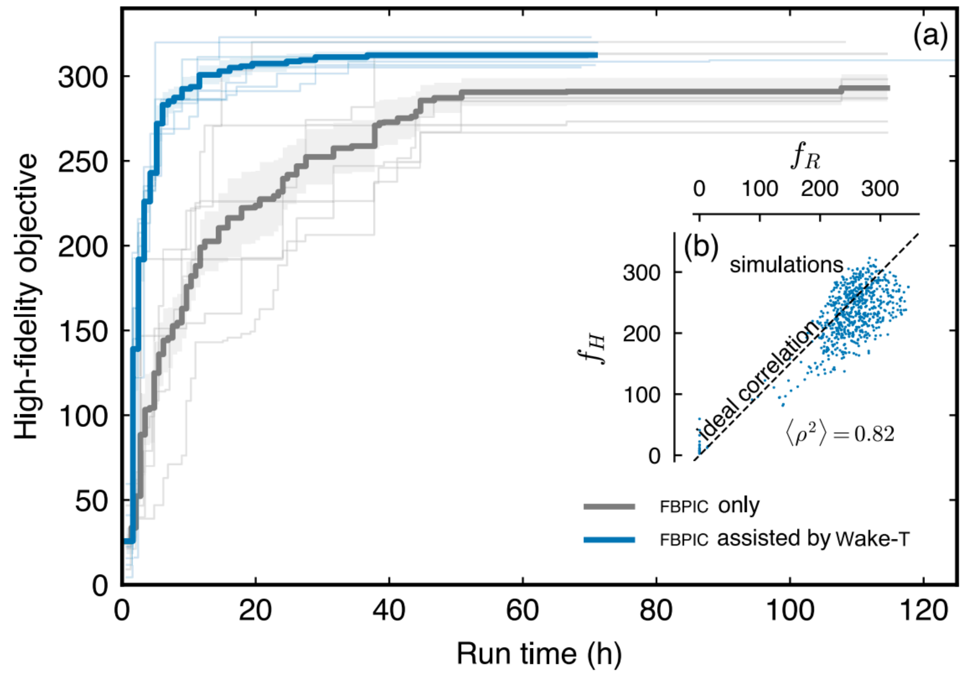
- Simplifies inclusion of realistic laser profiles in simulations
- Combine electromagnetic and quasistatic PIC for faster simulations



https://lasydoc.readthedocs.io/

optimas

- Bayesian optimisation — experiments and simulations
- Highly scalable parallel optimisation

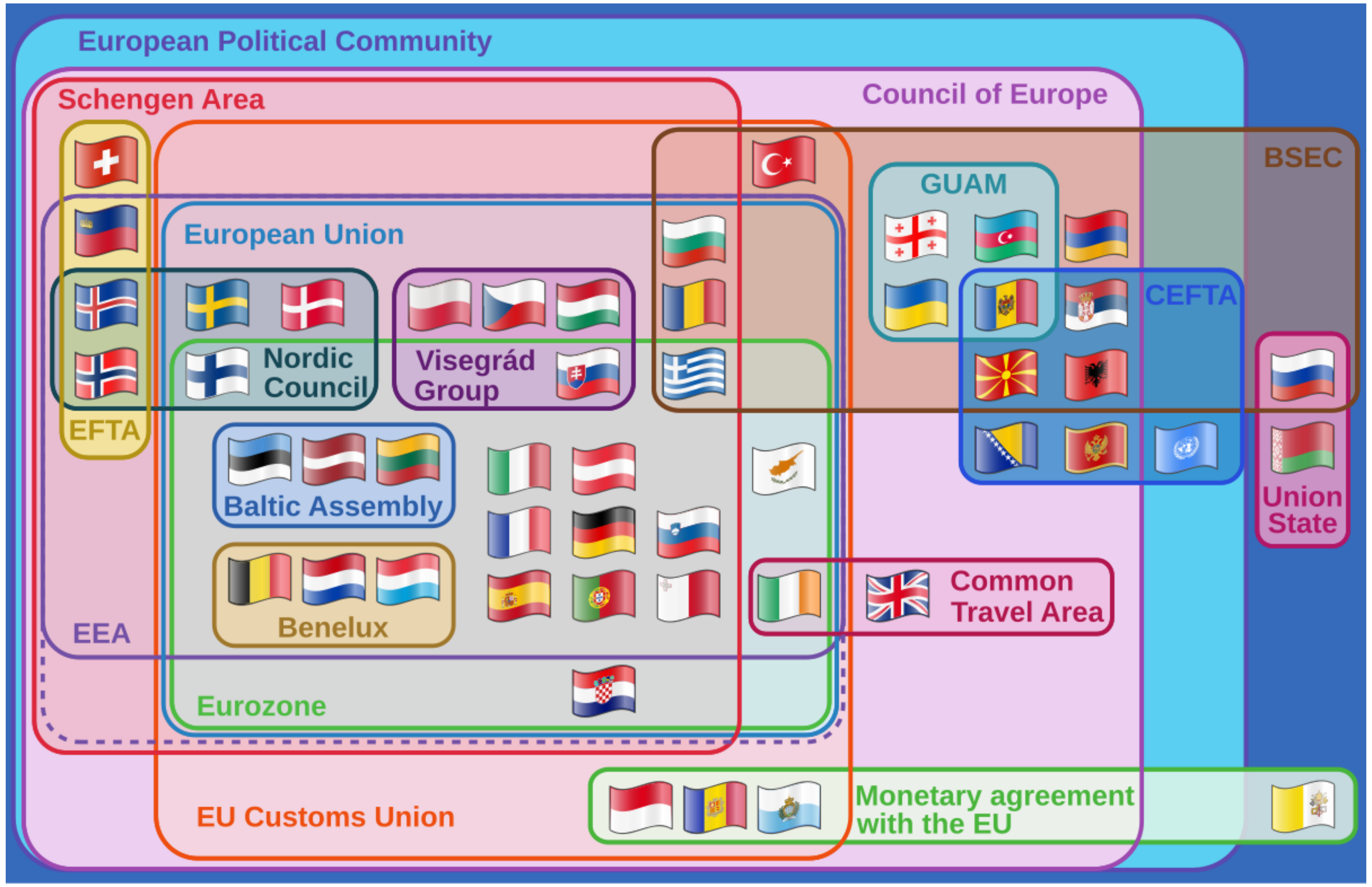


https://optimas.readthedocs.io/

- Developing a suite of tools for **multi-physics** start-to-end studies, including:
  - Simulations beyond wakefield interaction (beam transport, plasma source design….)
  - Development of tools to allow more representative inputs
  - Consistent input/output format (e.g. OpenPMD) enables "handshaking" between codes
  - Scalable ensembles and optimisation studies

Thanks to: Tony Arber, Arnaud Beck, James Chappell, Luis Silva, Maxence Thevenet

Coordination



Euler diagram showing relationships between different European organizations & agreements
Image: Wikimedia Commons

EuPRAXIA project

- Key player in coordinating ANA research with applications to compact light sources

Advanced LinEar collider study GRoup

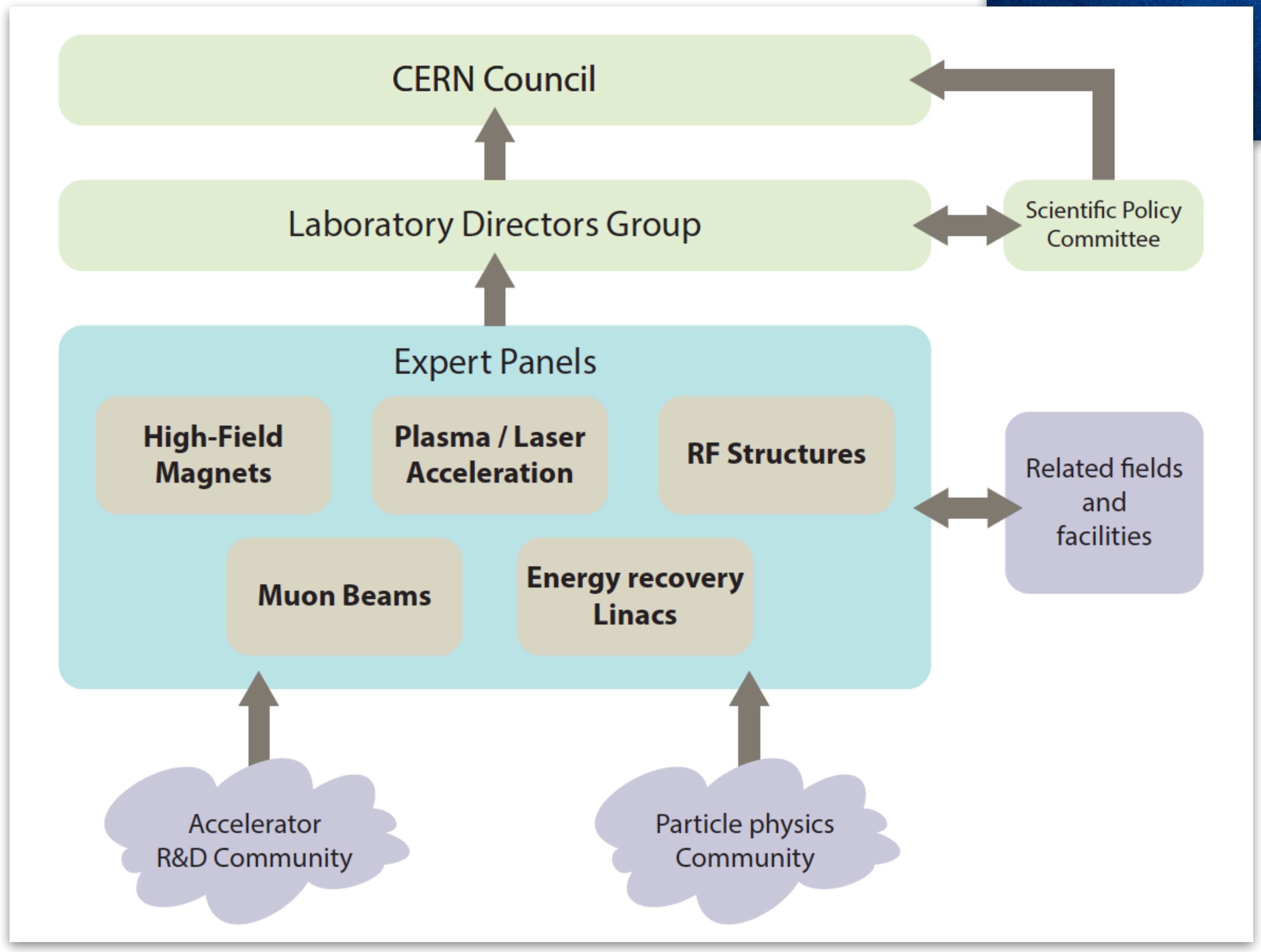
- Open to scientists worldwide
- Reports to ICFA ANA
- 8 working groups
- Meets ~ annually

Laboratory Directors' Group

- Directors of labs with national role in accel., PP or detector research
- Currently: LNF, LNGS, CEA), IJCLab, DESY, PSI, NIKHEF, CIEMAT, STFC, CERN (DG + observers)
- LDG chair (Dave Newbold) is ex-officio member of Strategy Secretariat & invited to strategy discussions at CERN Council

Timeline

- 2020: Update of European Strategy for Particle Physics (ESPP)
  - “**The European particle physics community must intensify accelerator R&D and sustain it with adequate resources.**”
  - “The technologies under consideration include … **plasma wakefield acceleration and other high-gradient accelerating structures**”
- 2021: Laboratory Directors’ Group (LDG) mandated by CERN Council to oversee development of roadmaps in 5 areas incl. “**High-gradient plasma and laser accelerators**”
- 2021: Meetings of expert panels (Jan - July)



Timeline

- 2022: Roadmaps published. "High gradient" roadmap:
  - 7 Work Packages
  - 9 Deliverables

Deliverable	Date
Report: Electron high energy case study (175 - 190 GeV)	June 2024
Report: Physics case of an advanced collider	June 2024
Report: Positron high energy case study	June 2025
Report: Low energy study case for electrons & positrons (15 - 50 GeV)	June 2025
Report: Pre-CDR and collider feasibility report	Dec. 2025
Expt: High-repetition-rate (laser) plasma accelerator module (kHz)	Dec. 2025
Expt: High-efficiency electron/proton-driven plasma accelerator with high beam quality	Dec 2025
Report / prototyping: Scaling of DLA/THz accelerators	Dec. 2025
Report: spin-polarized beams in plasma accelerators	Dec. 2025

Timeline

- 2022: Roadmaps published. "High gradient" roadmap:
  - 7 Work Packages
  - 9 Deliverables
- 2023 & 2024: Additional community meetings
  - ALEGRO workshops
  - Frascati, July 2023
  - Deliverables refined
  - "Aspirational" timeline developed
  - "Indicative" funding developed
  - HALHF concept adopted as strawperson design for Pre-CDR

Deliverable	Date
Report: Electron high energy case study (175 - 190 GeV)	June 2024
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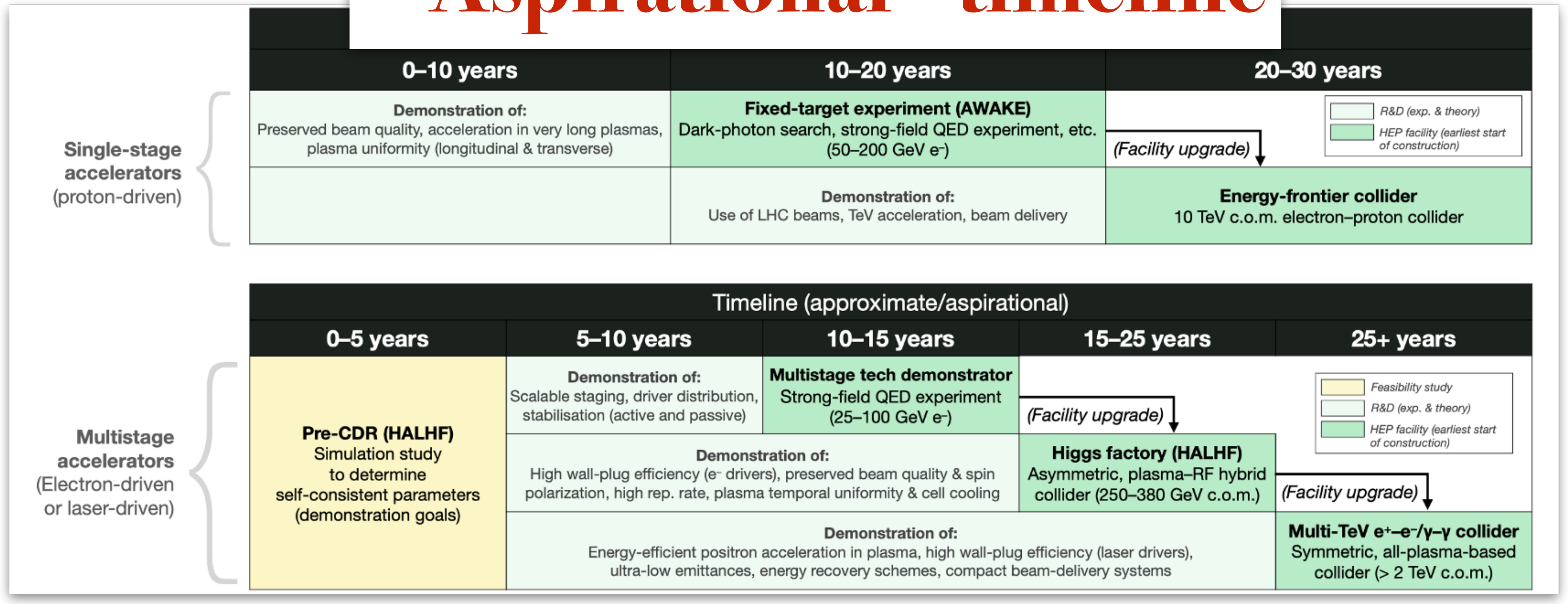
Expt: High-efficiency electron/proton-driven plasma accelerator with high beam quality	Dec 2025
~~Report / prototyping: Scaling of DLA/THz accelerators~~	~~Dec. 2025~~
Report: spin-polarized beams in plasma accelerators	Dec. 2025

Resource	Cost (€k)
Post-docs (62.5 FTE)	6,250
Consumables	200
Meetings &	100
Computing resources	100
Access to facilities	50
TOTAL	**6,700**

These resources remain aspirational !

"Aspirational" timeline



Summary

- There is a very wide range of research activities in Europe on advanced accelerator concepts
- New facilities are coming on-stream, with internationally competitive capabilities
  - ELI ERIC
  - EPAC
  - EuPRAXIA beamlines
- Applications of advanced accelerators being explored intensively
  - EPAC
  - Plasma injector for synchrotrons (DESY)
- Research is coordinated through formal & informal structures
  - EuPRAXIA
  - ESPP
  - ALEGRO

Thanks to the following for their input & advice

- Tony Arber (Warwick, UK)
- Arnaud Beck (INPNPP & LLR, FR)
- Pierluigi Campana (INFN, IT)
- Kevin Cassou (Paris-Saclay, FR)
- James Chappell (Oxford, UK)
- Richard D'Arcy (Oxford, UK)
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- Wim Leemans (DESY, DE)
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- Daniele Margarone (ELI-Beamlines, CZ)
- Stuart Morris (Warwick, UK)
- Zulfikar Najmudin (Imperial College London, UK)
- Rajeev Pattathil (RAL, UK)
- Kristjan Põder (DESY, DE)
- Gianluca Sarri (QUB, UK)
- Luis Silva (IST, PT)
- Maxence Thévenet (DESY, DE)