

Fundamental cross-cutting idea: use LWFA to generate high-current e-beams which can power PWFA (LWFA2PWFA)

2010 Monoenergetic energy doubling in a hybrid laser-plasma wakefield accelerator, PRL 104, 195002, 2010

2012 ERC proposal: *“The bunch quality transformer is enabled by the following steps: laser-plasma-produced electron bunches are used to excite a beam-driven plasma wake”*, B. Hidding, ERC Starting Grant proposal (NOT GRANTED)

2013 US DOE SBIR project by RadiaBeam: “Plasma Photocathode Beam Brightness Transformer for Laser-Plasma-Wakefield Accelerators” (GRANTED, supported the FACET E210 experiment)

2014 ERC proposal: “Ultrabright Light Sources Based on Hybrid Plasma Wakefield Acceleration”, B. Hidding, ERC Starting Grant proposal (NOT GRANTED)

2015 EuPRAXIA project WP14: “Hybrid Laser-Electron-Beam Driven Acceleration“, B. Hidding, A. De la Ossa et al. GRANTED

Task 14.4. Exploiting LWFA-generated electron bunches as drivers for PWFA

2016 ERC proposal: *“In the M-PAC project, I propose to power plasma accelerators with laser-accelerated electron beams based on 100-TW-class laser systems, so as to miniaturize the so-called “beam-driven plasma accelerators”. The project crosses the boundary of the fields of research of laser acceleration and of beam-driven plasma acceleration”*, S. Corde, LOA, ERC starting grant proposal GRANTED

Other groups such as Jena, Belfast, Manchester, Munich, Dresden, LOA now also engaging (also outside of EuPRAXIA). Plans for HZDR Dresden experiment presented by A. de la Ossa at Paris workshop.

Scheme picking up steam.

Allows ultracompact design of EuPRAXIA, is relevant to many WPs and groups

Additional EuPRAXIA funding request (260k€) submitted:

Please describe what the additional funding would be used for in 1 paragraph/5 sentences.

Hybrid LWFA2PWFA is picking up momentum, also in other groups which are not direct beneficiaries (e.g. HZDR Dresden and LMU Munich, S. Chou, S. Karsch, Phys. Rev. Lett. 117, 144801 (2016), Helmholtz Jena, S. Kusche, Zepf, Phys. Rev. Accel. Beams 19, 071301). Also, SCAPA is ready for engaging in these research direction, which not only links the LWFA and PWFA world, but also promises to produce e-bunches with ultralow emittance and ultrahigh brightness and hence supports both the HEP and the light source /FEL arm of EuPRAXIA across the board. Joint experiments with participants from a wide range of EuPRAXIA beneficiaries, joining the LWFA and PWFA fractions, should be carried through, for example at above mentioned facilities (Glasgow, Dresden, Jena etc.) and beyond. This could include further partners which are so far not direct beneficiaries or not even associated members, thus further broadening the supporter base for EuPRAXIA.

WP14 Hybrid Laser-Electron-Beam Driven Acceleration



Further part of WP14: Generate SUPERIOR BEAM QUALITY

Task 14.1. Selective ionization of plasma components

Task 14.2. Trojan Horse underdense photocathode witness bunch generation

Task 14.3. Wakefield-Induced ionisation injection

Task 14.4. Exploiting LWFA-generated electron bunches as drivers for PWFA

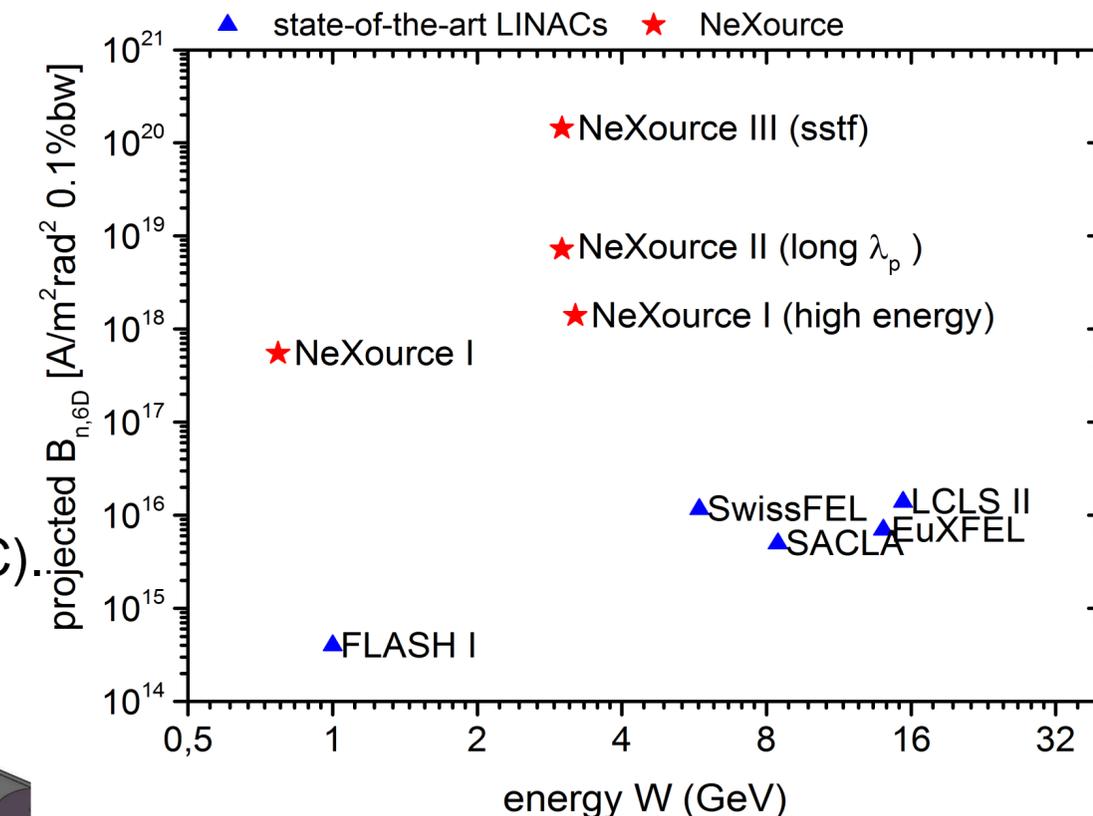
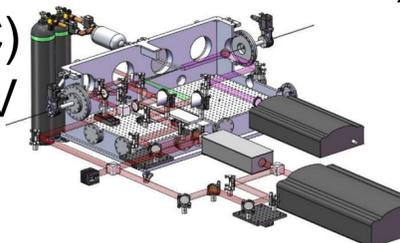
These methods are exactly what can provide SUPERIOR BEAM QUALITY. Furthermore, in combination with LWFA2PWFA they can make EuPRAXIA especially COMPACT.

BEAM QUALITY: emittance at nm-level, tens of kA current, tunability. Leads to ultrahigh 5d-brightness.

- Emittance is a key for HEP as it limits luminosity (that's why damping rings are needed in conventional collider setups). Trojan Horse plasma photocathode is the only known (plasma) method to produce beams with nm (10^{-9} mrad) normalized emittance. Photocathode linacs or LWFA reach 10^{-6} to 10^{-7} m rad levels, at best.
- Emittance and brightness is also a key for FEL. 5D-brightness of Trojan Horse is many orders of magnitude *higher* than even at LCLS
- Energy spread is also key issue. Novel dechirping approach, highly synergistic with Trojan Horse, promises to be able to remove energy chirp completely within the same plasma stage. Energy spread reduced by 2 orders of magnitude.

□ ⇒ Can fulfil Pellegrini criterion, Pierce parameter criterion at the same time even for hard x-ray FELs, single plasma stage. Ultracompact version possible due to LWFA2PWFA.

- Hybrid plasma photocathode also part of ELBA proposal (M. Ferrario et al., submitted to ERC).
- NeXource ERC consolidator proposal to ERC (B. Hidding, submitted to ERC)
- Collaboration with RadiaBeam Technologies on designing a drop-in box THV (Trojan Horse Vessel). Highly useful as component for EuPRAXIA



WP unifies LWFA and PWFA. Unique approach to reach superior beam quality which could be a unique selling point for EuPRAXIA