EUROPEAN PLASMA RESEARCH ACCELERATOR WITH EXCELLENCE IN APPLICATIONS

EuPRAXIA

WP6 : FEL Pilot Application

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Tasks, Milestones, Deliverables

Tasks

WP6.1 : Coordination and Communication (SOLEIL, ENEA)
WP6.2 : FEL baseline cases (SOLEIL, ENEA, CNRS-LOA, UHH, Lille Univ.)
WP6.3 : Undulator and technological development of equipments (SOLEIL, UHH, INFN, DESY, STFC)
WP6.4 : Towards scientific applications (SOLEIL, ENEA, STFC, DESY)
WP6.5 : Operational model (SOLEIL, DESY, INFN)

Milestones

MS4 : Electron beam baseline parameter for FEL application (SOLEIL) M6, published on intranet, DONE
MS5 : State-of-the-art of short period undulator (SOLEIL) M7, Activity report, DONE
MS17 : Models and scaling laws for plasma FEL dynamics (SOLEIL) M 20, Activity report, DONE

Deliverables

D6.1 : Report on state-of-the-art of short period undulators, Report, Public, M12
D6.2 : Models, scaling laws plasma FEL dynamics, Report, Public, M24
D6.3 : Diagnostic requirements and technical approaches, Report, Public, M24
D6.4 : Specific magnetic elements, Report, Public, M32
D6.5 : FEL Scientific user workshop, Report, Public, M48

FEL pilot user meeting

Roma, June 17-18, 2019

https://indico.desy.de/indico/event/23123/overview

FEL simulations

Beam name	saturation length [m]	line width [%]	pulse duration $[fs]$	photons per pulse $[10^{10}]$	brightness $\times 10^{30}$ $[s^{-1}(mm \times mrad)^{-2}(0.1\%\, bw)^{-1}]$
Maynard–5	126	0.18	0.4	0.19	3.7
Rossi–5	38	0.23	2	3.2	40
Marocchino–1	16	0.59	2	1.3	0.08
Rossi–1	28	0.25	2.4	2.3	0.5

λ_R [nm]	λ_u [mm]	K	B_0 [T]
0.22	20	1.5	0.81
5.5	20	1.5	0.81

Beam name	saturation length [m]	line width [%]	pulse duration $[fs]$	photons per pulse $[10^{10}]$	brightness $\times 10^{30}$ $[s^{-1}(mm \times mrad)^{-2}(0.1\%\, bw)^{-1}]$
Maynard–5	26	0.3	0.71	4.2	27.6
Rossi–5	20	0.3	2.2	72	475
Marocchino–1	23	3.6	15	16	0.02
Rossi–1	16	0.54	7.8	31	0.86

λ_R [nm]	λ_u [mm]	K	B_0 [T]
1.65	30	4.36	1.56
41	30	4.36	1.56

Results obtained with the full beam longitudinal dynamics: current, energy & energy spread proper longitudinal profiles, not only slice values, no Gaussian assumption!!!

FEL results

Horizon 2020

instruments

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Special Issue "Status of The Eupraxia Design Study – Towards The Next Generation of Particle Accelerators"

- **Print Special Issue Flyer**

Article

Free electron laser performance within the EuPRAXIA facility

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Some WP6 thoughts

WP6 remarks:

-FEL calculations at the end of the calculation chain:
=>data arrived when the post-docs already left.
The schedule was more dictated by the Deliverable and Milestone Reports

-Scaling law analysis (PA + FEL) for the different schemes not completed (see G. Dattoli):
It could have been interesting for deep understanding and enlightening the main trends

-Still not so easy to get nice FEL characteristics :
There has been a huge progress in the design of Plasma based beam getting close to the e beam requirements, however, only a few schemes can be selected.

=> For the FEL application, reaching even better e-beam quality than the targeted one in EuPRAXIA could be useful for enabling advanced FEL schemes: stability has to be guaranteed, to attract users!

Also, control of plasma electron beam quality is required.

Some WP6 thoughts

- Still a huge « gap » between what has been presently achieved experimentally (so far no experimental demonstration of FEL effect with plasma acceleration) and test user facility at a European level

=> Intermediate experimental milestones should be achieved :

For example :

- test the different LPA configurations such as REMPI, Angel Pousa's one,
- get FEL results with steps in electron beam energy and photon wavelength
- Develop intermediate test facilities

- Keep also in mind that FEL users will go where the best photons are, whatever the facility is compact or not

- Besides « compactness », advantages of Plasma driven FEL has to be further investigated, such as the attosecond pulses with respect to what is already successfully achieved with conventional accelerators