

EUROPEAN
PLASMA RESEARCH
ACCELERATOR WITH
EXCELLENCE IN
APPLICATIONS



Facility Access Plenary discussion

Coordinators

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1st Collaboration Week, 19-23 June, 2017



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

- WP12 updates
- Inputs required from WP's- discussion points
- Forward plans - Access

Objectives

- Facilitate tests for concepts and prototypes developed in other work packages in various facilities
- Survey of the experimental results of the proof-of-principle tests and accelerator prototyping studies

Key Tasks

- Gather information regarding potential experimental facilities where tests can be conducted (nearly done)
- Describe capabilities of these facilities and access mechanisms (nearly done)
- Gather information regarding concepts that need testing/prototyping in consultation with other WP's (discussion today/tomorrow)
- Approaching facilities on behalf of EuPRAXIA regarding the best method for access (discussion today/tomorrow)



Germany

DESY/Hamburg Uni

50 TW, 200 TW (LUX)
 Hybrid Laser-beam-driven PWFA,
 Electron bunch injection into LWFA
 Plasma target design, Laser-driven light sources
 Access: collaboration?

MPQ/LMU

ATLAS-3000 3PW, PFS few-cycle PW
 CALA centre – main focus is on medical applications
 Access: collaboration?

**Helmholtz
 Institute Jena**

POLARIS 17J, 100fs (diode-pumped)
 JETI 40 1.5J, 25fs, 10Hz, JETI 200 4J, 17fs Commercial systems
 Electron acceleration with few-fs probing
 Access: collaboration?

**Helmholtz-Zentrum
 Dresden-Rossendorf**

DRACO Commercial PW system
 Main focus is on medical applications
 Access: collaboration?

France

Cilex, Centre Interdisciplinaire Lumière Extrême

- LOA: Access – collaboration? Laserlab
 - Salle Jaune (3J, 10Hz): gas targets of various kinds
 - LUIRE PW?
- LIDyL-Saclay: Access-collaboration?, Laserlab?
 - UHI100 - 100TW, 25 fs, 10 Hz
- Apollon, LULI (ELFIE): Access – Calls? Collaboration? Laserlab?
 - ELFIE-20J, 350fs, 1 shot in 20 mins
 - 10PW, 150 J in 15fs at 1 shot per minute (later this year?)
- CELIA

Italy

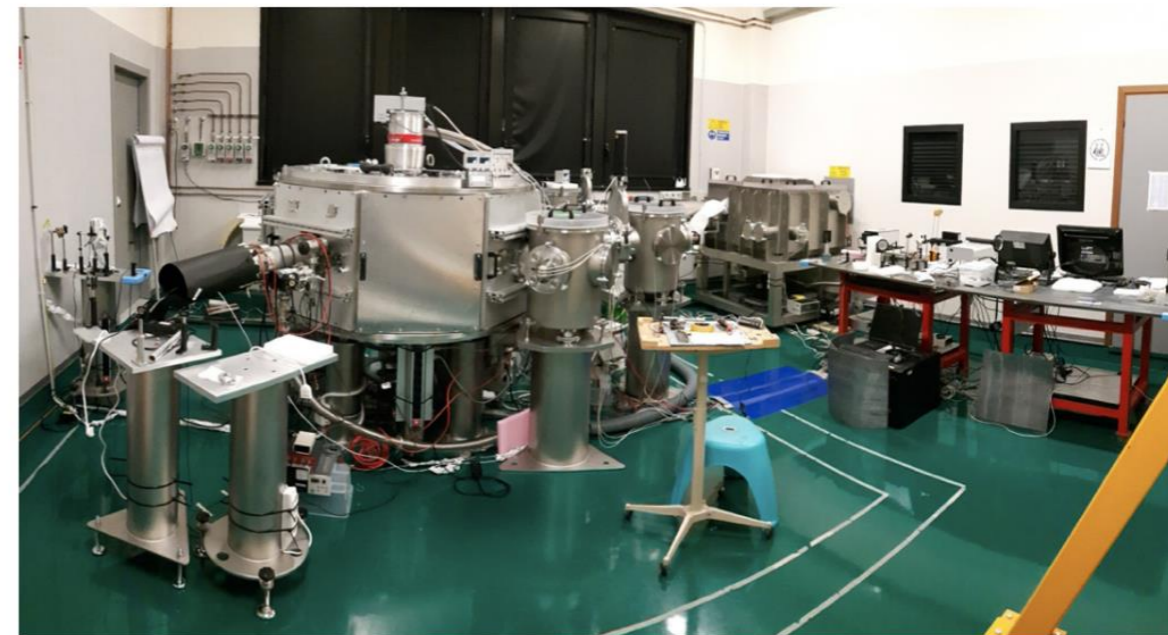
ILIL LAB@CNR-INO, Pisa: 100TW @2Hz, 10TW @ 10Hz, F/3 & F/10 focusing, Access – collaboration

INFN, Frascati (FLAME): 280TW, 10Hz electron acceleration configurations

The **ILIL-PW** interaction area is equipped with a 140 cm diameter octagonal vacuum chamber connected to the compressor chamber by a two-mirror chicane. Energy on target up to **4 J in <30 fs** pulse duration is focused with an f/10 off-axis parabolic mirror, with a spot radius down to 10 μm and an intensity exceeding **$3 \times 10^{19} \text{ W/cm}^2$** . Alternatively, the beam can be focused with an f/3 off-axis parabolic mirror, delivering a spot radius of 3 μm and an intensity exceeding **$2 \times 10^{20} \text{ W/cm}^2$** .

The **ILIL-TW** interaction area is equipped with two 80 cm diameter interaction vacuum chambers. One of the interaction chamber is configured with an f/10 off-axis parabolic mirror, with an energy on target of **400mJ in a 35 fs pulse** duration and a focal spot radius of 10 μm , for an intensity of **$3 \times 10^{18} \text{ W/cm}^2$** . The set up is optimized for repetitive operation (1Hz) of **LWFA in the multi tens of MeV electron energy for applications, gamma-ray generation and detector tests and development**. The other chamber is configured with an f/3 off-axis parabolic mirror, with an energy on target of 400mJ in a 35 fs pulse duration and a focal spot radius of 3 μm , for an intensity of **$2 \times 10^{19} \text{ W/cm}^2$** .

Intense laser Irradiation Laboratory (ILIL)
Istituto Nazionale di Ottica
CNR
Pisa, Italy



UK

STFC-RAL: Access - Calls & FAP, Laserlab, programmatic slots to be defined

Gemini: 2 x 0.5 PW beams at 1 pulse in 20 seconds, gas targets of various kinds, F/40 focusing, capability of staging, betatron imaging,

Astra: 20 TW, 5Hz, 10fs probe, **off-harmonic probe, tested feedback control at 5Hz,** gas targets of various kinds, f/15 focusing

SCAPA: Access – collaboration, Laserlab -TBD

350TW (8.75 J, 25 fs, 5Hz) laser commissioned, experimental areas under commissioning, 40 TW (1.4 J, 35 fs, 10 Hz

Electron beam transport, imaging, ...

Smaller-scale, TW-class systems: Imperial, Oxford, Daresbury...

Sweden

Lund Laser Centre: Access – collaboration?, Laserlab,

10 Hz 35 fs, 40 TW laser

- **ELI-Beamlines (Prague)**
1PW, 10Hz beamlines
10 PW beamline



- **ELI – Romania**
10PW beamlines



- **CILEX**

Will they be online in time?



High Brightness Electron Photo-injector

research facility with high brightness electron beams
(particle driven particle acceleration, FEL, Compton Source, THz source, advanced diagnostics ...)

Energy	30-180 MeV
Energy Spread	< ~ 0.1%
charge	10 pC - 1nC
bunch length	10 fs -10 ps
Rep rate	10 Hz

plasma interaction chamber installed on the beam line

FEL undulators aligned with the plasma chamber

Compton interaction point

External injection text stand in construction

Ongoing activities

PWFA, active plasma lens, THz source, advanced diagnostics

300 TW class laser

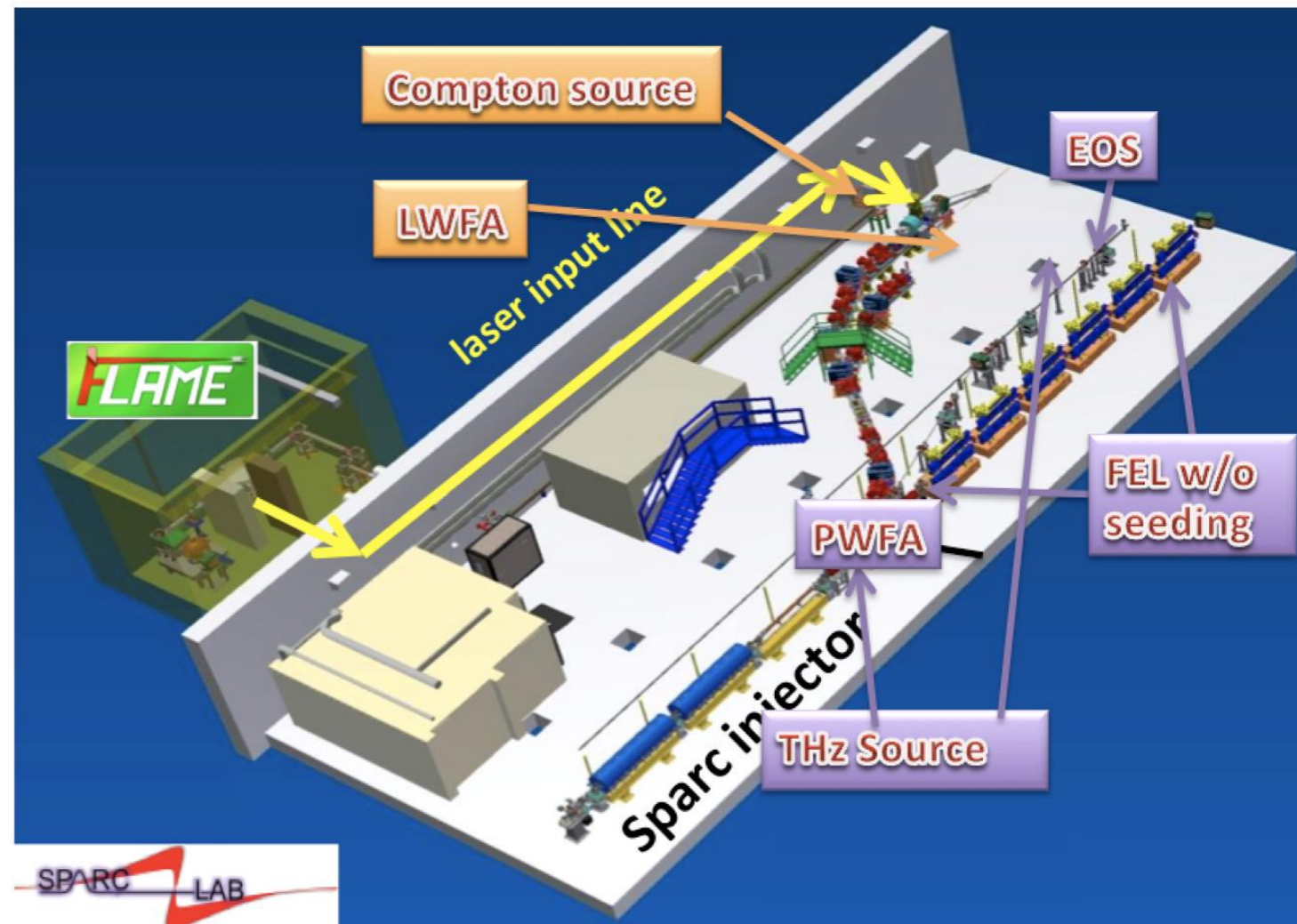
self injection electron beam, betatron radiation

Rep rate	10 Hz
Wavelength	800 nm
Energy (after compression)	7J
Pulse duration	~25fs
Synchronisation with Linac	~50 fs
Beam quality	M2<1.5
Energy stability	<1.5%

Ongoing activities

LWFA, TNSA, advanced diagnostics

Access: collaboration



LAOLA, the **L**aboratory for **L**aser- and beam-driven plasma **A**cceleration is a collaboration between groups from Desy and University of Hamburg

SINBAD (Short INnovative Bunches and Accelerators at DESY)

2019 first beam available for future experiments

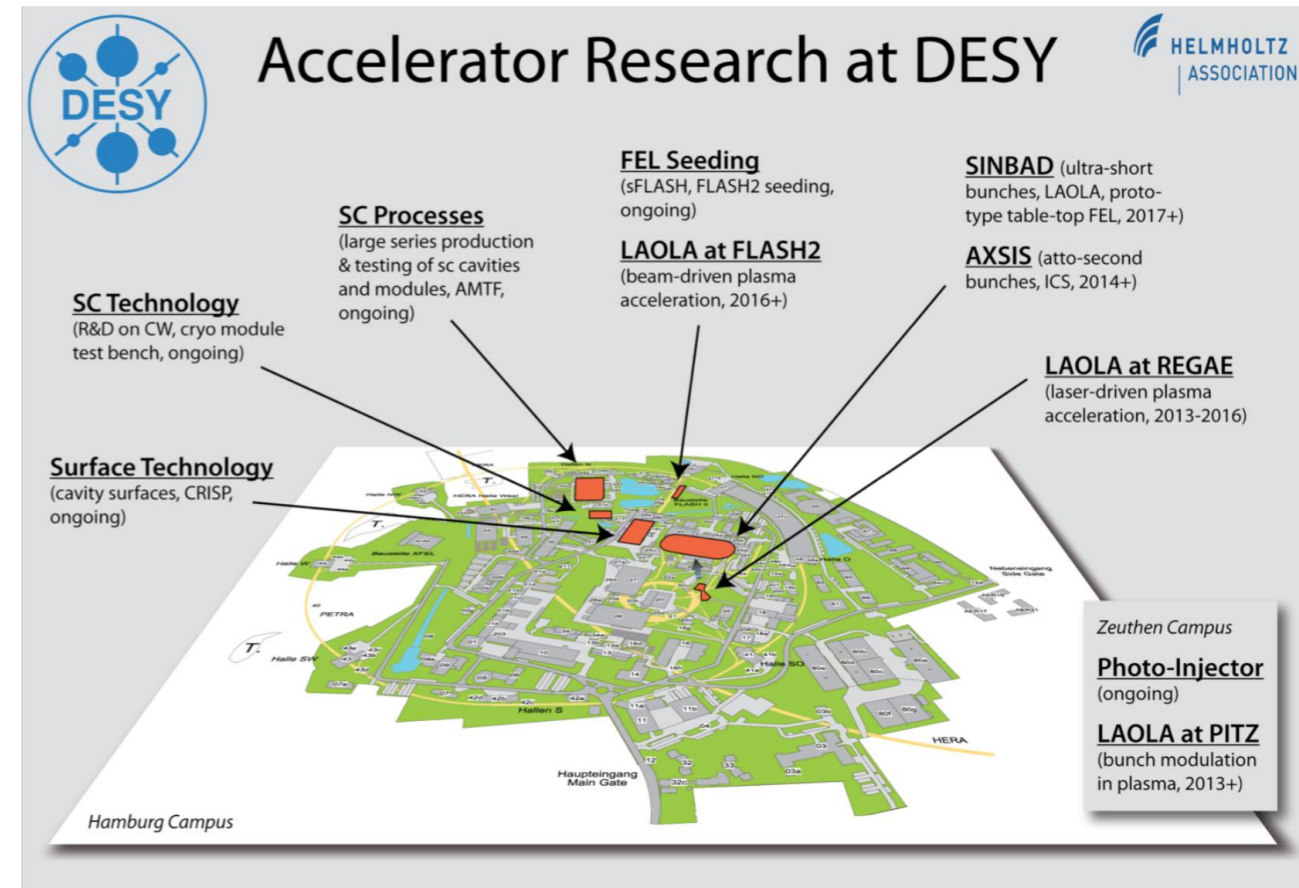
design parameters

Energy	100 MeV
Charge	0.5 - 20 pC
Bunch length	sub-fs to few fs
Electron Time arrival jitter	< 10fs rms
Rep rate	10-50 Hz

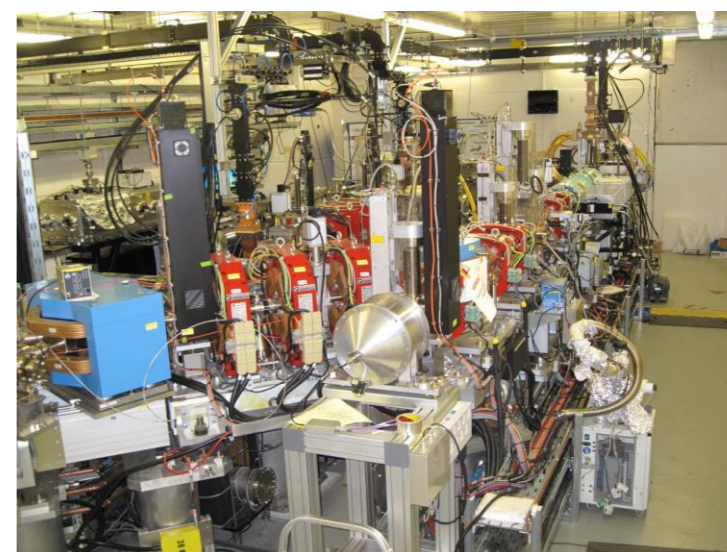
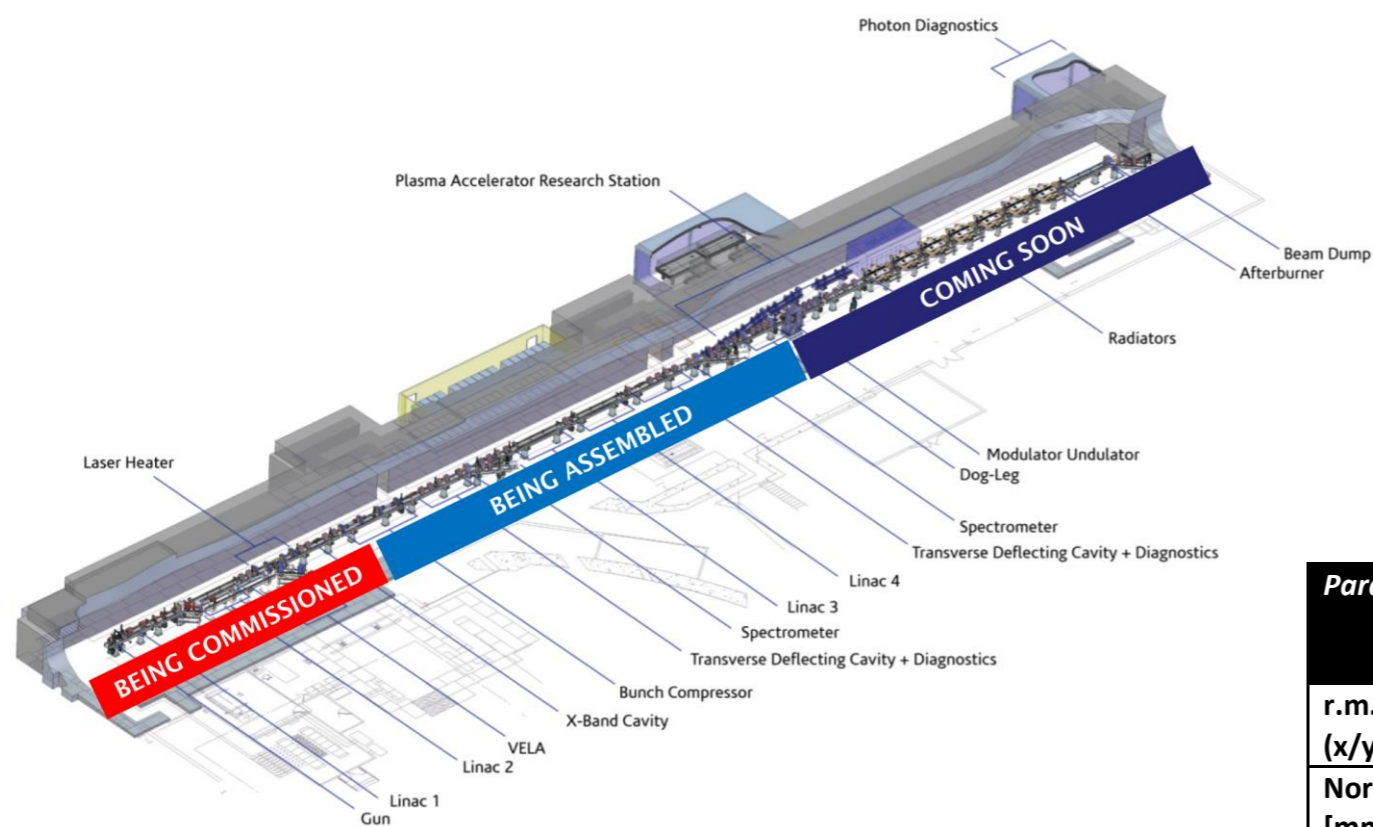
Flash-Forward

Goal parameters

Energy	1.25 GeV
Energy Spread	~0.1%
Emittance	2 μm
Bunch length	10-500fs
Rep rate	10 Hz
Laser-to-beam synchronisation	~30 fs rms



- CLARA is a purpose built dedicated flexible FEL Test Facility
- A scaled down version of an X-ray FEL containing all of the key technical components, where all lessons learnt can be directly applied to any future UK XFEL.



<i>Parameter</i>	100pC VELA 4.8MeV	250pC VELA 4.8MeV	100pC F.E. 55MeV	250pC F.E. 55MeV	100pC VB 16MeV	250pC VB 16MeV
r.m.s. Beam Size (x/y/area) [μm]	200/300/ 60,000	800/250/ 200,000	50/200/ 10,000	100/100/ 10,000	200/50/ 10,000	300/300/ 90,000
Norm. Emittance (x/y) [mm-mrad]	2/2.75	6/7	4.5/4.5	15/6	1.5/1.5	5/5
Bunch Length (r.m.s.) [ps]	9	11	0.15	0.9	0.1	0.15
Energy Spread (r.m.s.) [%]	1.3	1.5	1.4	1	0.6	4.5
Beam Volume [$\mu\text{m} \times \mu\text{m} \times \text{ps}$]	540,000	2,200,000	1,500	9,000	1,000	13,500

WP12-Laser facilities for tests and prototyping

Laser facilities for testing and Prototyping

(1) Direct Application

These facilities can be accessed through open access application process for beam-time. The access is free at the point of contact and some facilities (those at RAL) cover T&S costs as well, for scheduled experiments.

Facility	Energy (J)	Pulse width (fs)	Rep rate (Hz)	Peak power (PW)
RAL (Gemini)	15	30	0.05	0.5
LULI (Elfie)LI (Elfie)	20	350	1/ 20 min	0.06
CILEX (APOLLON*)	75	Phase 1: 15	1/min	Phase 1: 5PW
		Phase 2: 150		Phase 2: 10PW
ELI-BEAMS* ⁻	15	15	10	PW
ELI-AS*	0.5	12	100	0.04

* Under construction - expected to be operational 2018

(2) Application through Laserlab
<https://laserlab.mbi-berlin.de/access/>

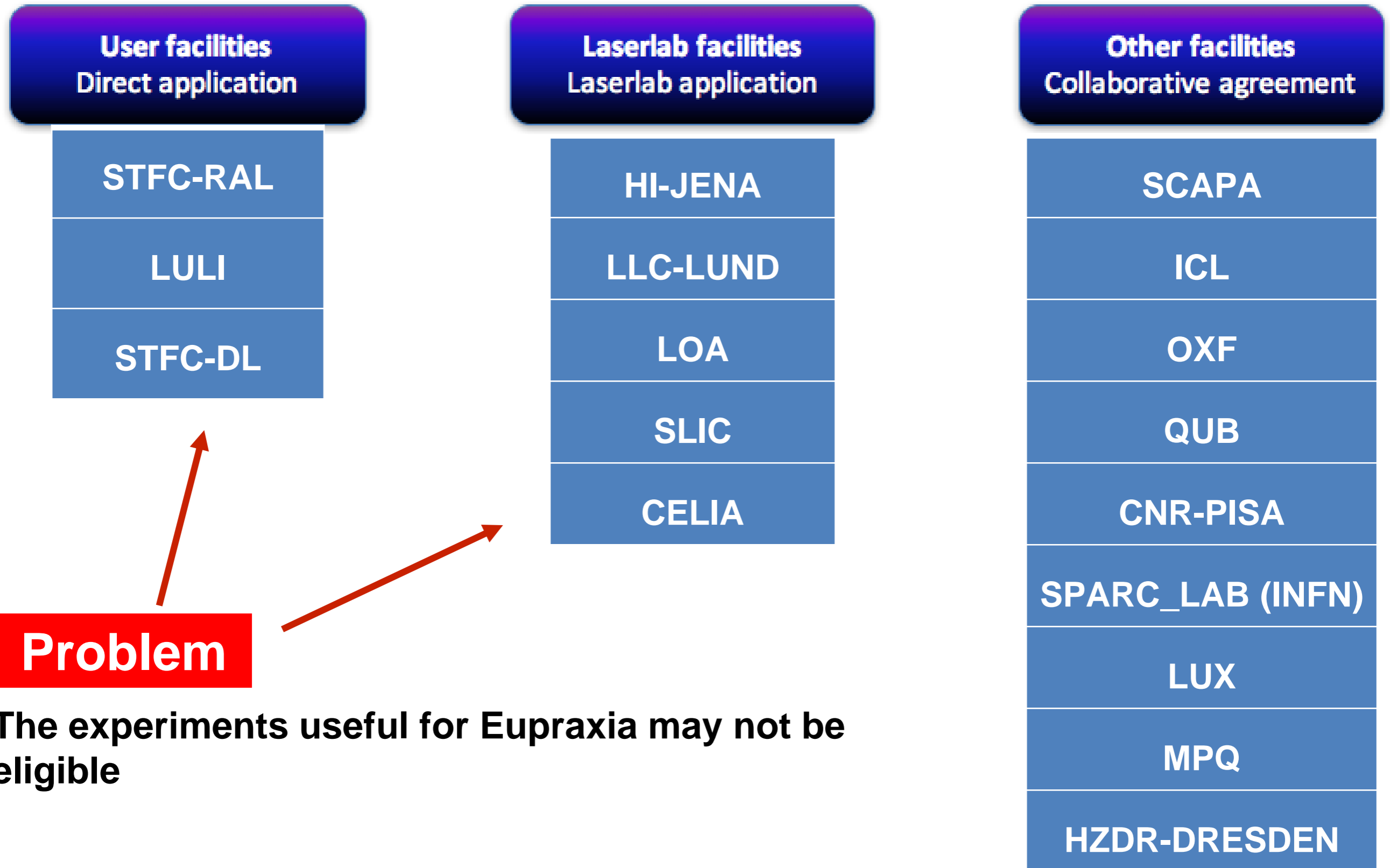
Laserlab is a consortium of European Laser laboratories that set aside ring-fenced slots for access. Details are provided in the website above.

Facility	Energy	Pulse	Rep	Peak
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vocal-external.liv.ac.uk/sites/eupraxia

	Contact name	Contact email
STFC-RAL (Gemini)	Dan Symes	dan.symes@stfc.ac.uk
LULI (Elfie)	Arnd Specka	specka@llr.in2p3.fr
HI-JENA (JETI)	Matt Zepf	m.zepf@uni-jena.de
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Clara - Vela	Jim Clarke	jim.clarke@stfc.ac.uk

- **Please send us requirements**
 - Slice energy spread of plasma accelerated beam (~3fs slice for 1nm radiation)
 - Schemes for selected issues (e.g. driver removal, resonant multiple laser pulses)
 - Plasma based beam dump
 - Switching options for driver and witness at low energy, preserving beam qualities.
 - Compact advanced diagnostics
 - Stability of different schemes for plasma injectors (pointing stability of laser, plasma oscillations)
 - High charge (higher than few tens of pC) in Plasma Injectors
 - Synchronization for external injections
 - Advanced devices (e.g. de-chirper)
 - Feedback control (pointing, temporal, phase..)



- Brainstorming on concepts need testing
- How to approach facilities?
- Proposals – will they get through panel?
- How to have ring-fenced slots?
- Access fee? Consumables? T&S?