Laserlab V
JRA1

PRImary and SEcondary Sources
bottlenecks, metrology, diagnostics tools and advanced application workstations
(PRISES)

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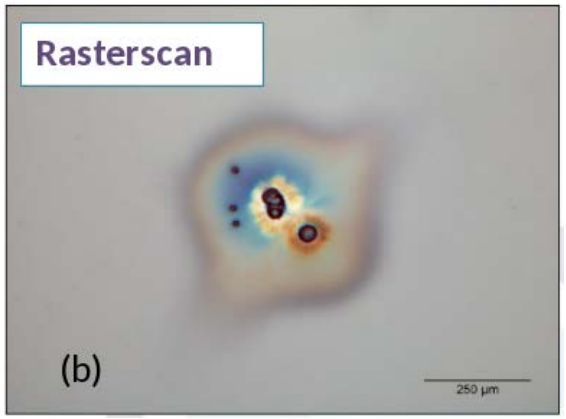
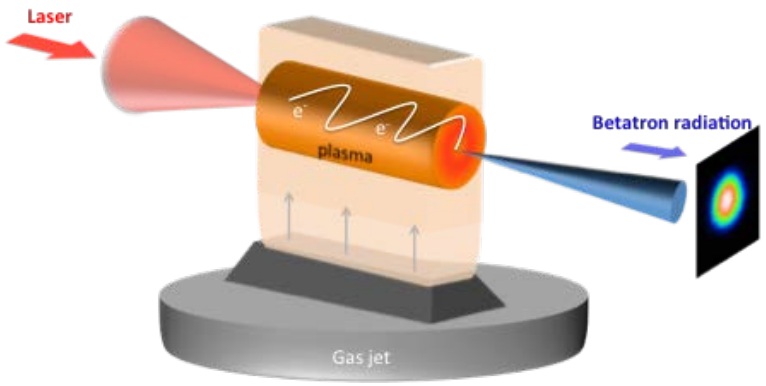
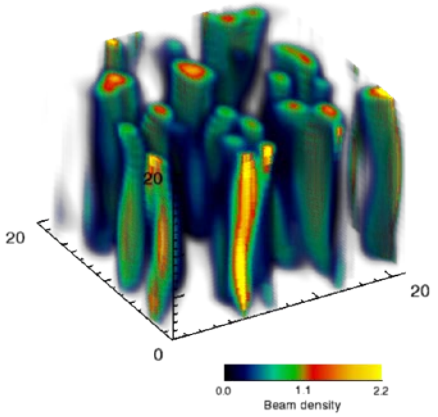
PRISES

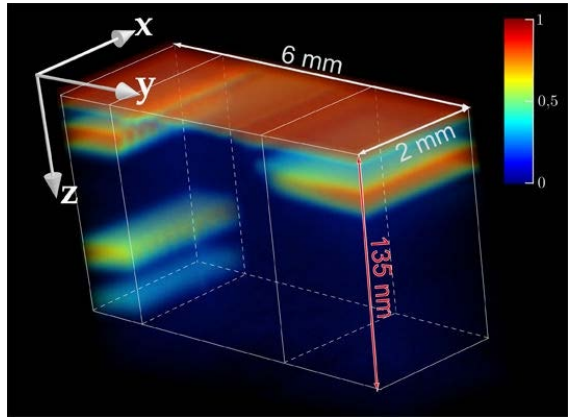
PRImary and Secondary Sources

- Development of frontier laser technology and laser science, applications
- Strategic advances for short-pulse and high-power lasers
- Applications to generate secondary sources of particles and radiation
- Advanced application workstations
- 28 partners in 14 focused tasks of 3 interconnected objectives.









PRISES - OBJECTIVES

1

Primary laser source development and metrology

- High power, few-cycle … single-cycle puls laser development
- Novel laser types, Mid-IR (up to 10µm), OPCPA
- Mitigating spatio-temporal coupling effects
- Development advanced spatio-temporal metrology equipment

2

Advanced secondary beam sources

- Diffraction-limited XUV pulses
- Relativistic electrons
- X-rays
- Ion sources
- Improvement thgrough extended simulation (PIC codes)

3

Workstations for advanced applications

- X-rays and particle bams, novel collaborative facilities
- Selected applications, that benefit from metrology advances and source control
- Radio-biology with laser plasma accelerators
- Phase contrast X-ray imaging
- XAFS spectroscopy

THE PARTNERS AND TASKS

1

Primary laser source development and metrology

***Task 1.1: CESTA**, CNRS-LULI, CNRS-LP3, HiLASE, VULRC, STFC-CLF, GSI*
Laser-induced damage threshold measurements and aging effects of optical components in high repetition rate lasers

Task 1.2: *MBI, LIDYL, FERMI, CNRS-CELIA, CNRS-LOA*
Strategies for pulse post-compression

Task 1.3: *IST, ULF-FORTH, HIJ, HiLASE, ICFO, LENS, MBI, STFC, VULRC*
Mid-IR laser development: through Tm-, Ho- and Yb-sources to OP(CP)A sources and their applications

***Task 1.4: LIDYL**, MBI, HZDR, LLC, CNRS-LULI, CLPU*
Spatio-temporal metrology of advanced laser sources

***Task 1.5: GSI**, CNRS-LULI, HZDR, USZ, MBI*
High temporal contrast sources and their characterization

2

Advanced secondary beam sources

***Task 2.1: CNRS-LOA**, ULF-FORTH, CNRS-CELIA, LLAMS, IST, PALS*
Diffraction-limited, ultrafast X-UV sources for scientific and societal applications

***Task 2.2: CLPU**, CNRS-LOA, STRATH, PALS*
Future electron sources and secondary radiation for user applications

***Task 2.3: IST**, CRNS-LOA, PALS, STRATH*
High brightness betatron X-rays for low dose and ultra-fast probing and imaging

***Task 2.4: CLPU**, CNRS-CELIA, HZDR, STRATH, GSI*
High repetition rate energy selected ion sources for applications

***Task 2.5: HZDR**, LIDYL, IST, PALS, GSI*
Development of common input/output standards of Particle-In-Cell (PIC) codes and associated in-situ and post-processing tools

***Task 2.6: GSI**, CLPU, HIJ, CNRS-CELIA*
Standardization and automatization of ion spectrum measurements

3

Workstations for advanced applications

***Task 3.1: HZDR**, LYDIL, CNRS-LOA, MUT-IOE, PALS, STRATH, USZ*
Facility development of laser-plasma radiation sources for high pulse rate radiobiology/radiation chemistry applications

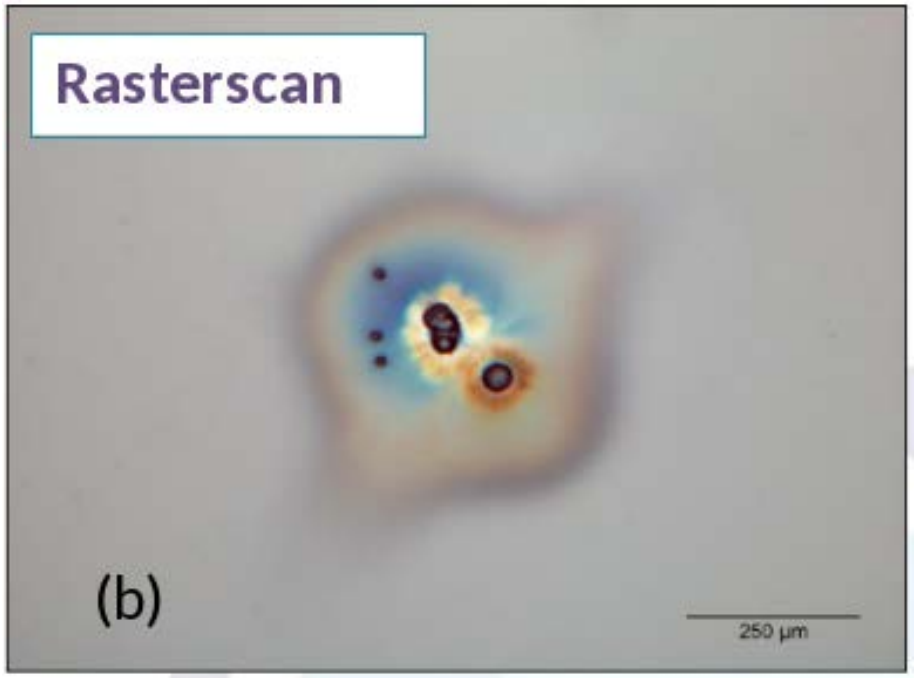
***Task 3.2: CNRS-CELIA**, LLC, CLPU, CNRS-LULI, CNRS-LP3, INFLPR, STFC-CLF*
Development of phase contrast imaging based on high-repetition rate laser-driven X-ray sources
enabling time-resolved measurements of materials, biological samples and WDM/HED plasmas

***Task 3.3: MUT-IOE**, CNRS-LP3, ICFO, LACUS, MBI, MPQ, STRATH*
X-ray absorption fine structure (XAFS) spectroscopy using laser-driven sources of X-ray radiation

Task 1.1: **CESTA**, *CNRS-LULI, CNRS-LP3, HiLASE, VULRC, STFC-CLF, GSI*

Laser-induced damage threshold measurements and aging effects of optical components in high repetition rate lasers

- increase the robustness, the reliability, the ease of operation of ultra-short and high-peak-power (high-average-power) installations,
- Increase the beam time availability for users,
- reduce the cost of maintenance mainly linked to laser induced damage of their optical components.



LID Test made by VULRC

Task 1.2: **MBI**, LIDYL, FERMI, CNRS-CELIA, CNRS-LOA

Strategies for pulse post-compression

- develop common strategies and know-how interchange for pulse compression of new generations of advanced light sources, and benchmark the performance of different techniques for a wide range of systems.

SME Collaborations

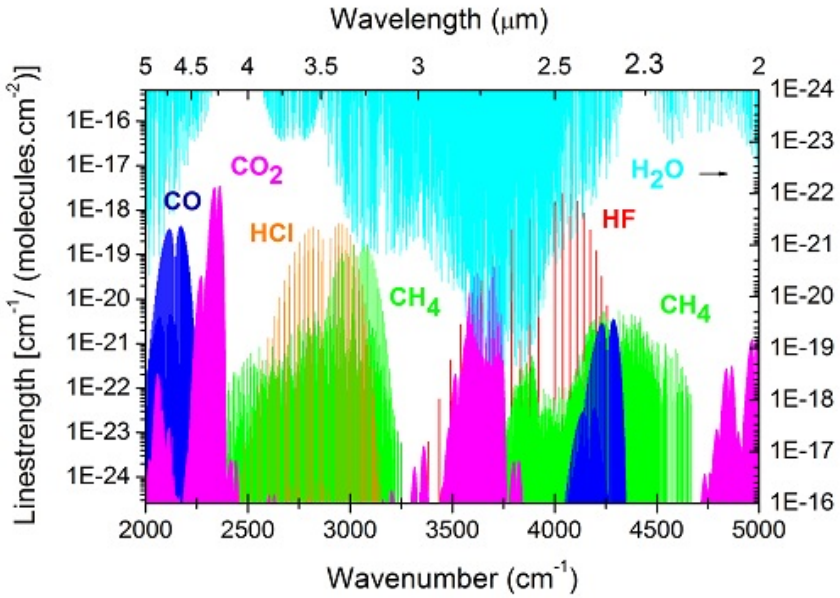
Lidaris (www.lidaris.com) to perform LIDT tests,
Amplitude Group (www.amplitude-laser.com) within the joint research laboratory (Impulse),
Trumpf Scientific Lasers (www.trumpf-scientific-lasers.com) will loan a laser and provide technical assistance for operation.

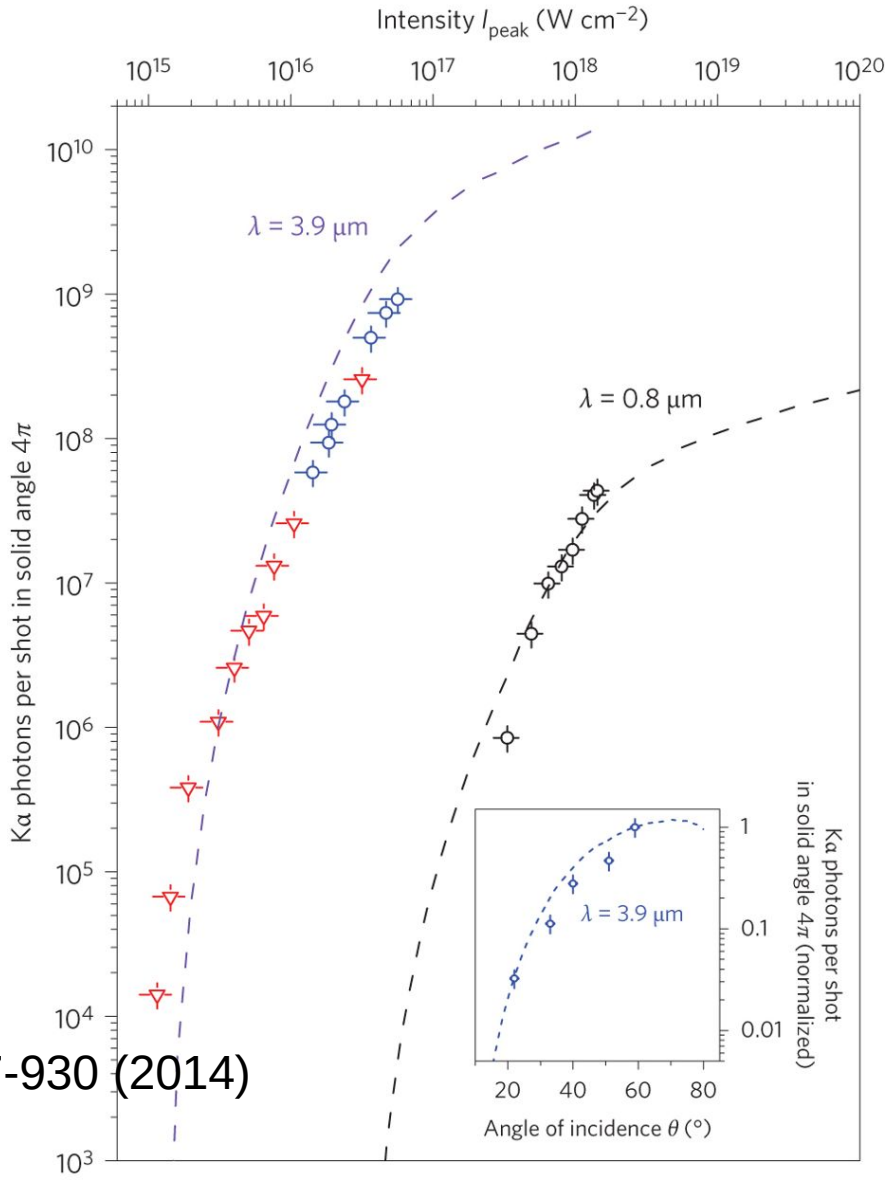
Task 1.3: ***IST****, ULF-FORTH, HIJ, HiLASE, ICFO, LENS, MBI, STFC, VULRC*

Mid-IR laser development: through Tm-, Ho- and Yb- sources to OP(CP)A sources and their applications

1

- Reaching high mid-IR pulse energies will significantly improve the sources available to LASERLAB-EUROPE users,
- expanding the scope of experiments
- sharing know-how about e.g. emerging non-linear materials, amplification and compression techniques
- new OPCPA sources pumped by available high energy sources





J. Weisshaupt et.al.,
Nature Photonics **8**, 927-930 (2014)

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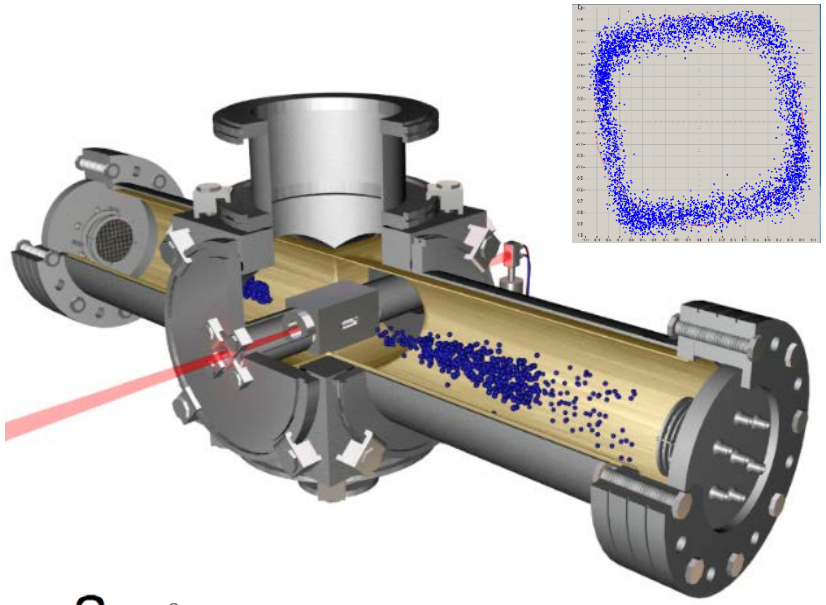
Task 1.4: ***LIDYL****, MBI, HZDR, LLC, CNRS-LULI, CLPU*

Spatio-temporal metrology of advanced laser sources

- preserve the transverse spatial coherence of the laser beam,
- improve STC measurement technology and to organize multiple measurement campaigns on different advanced laser systems within LASERLAB

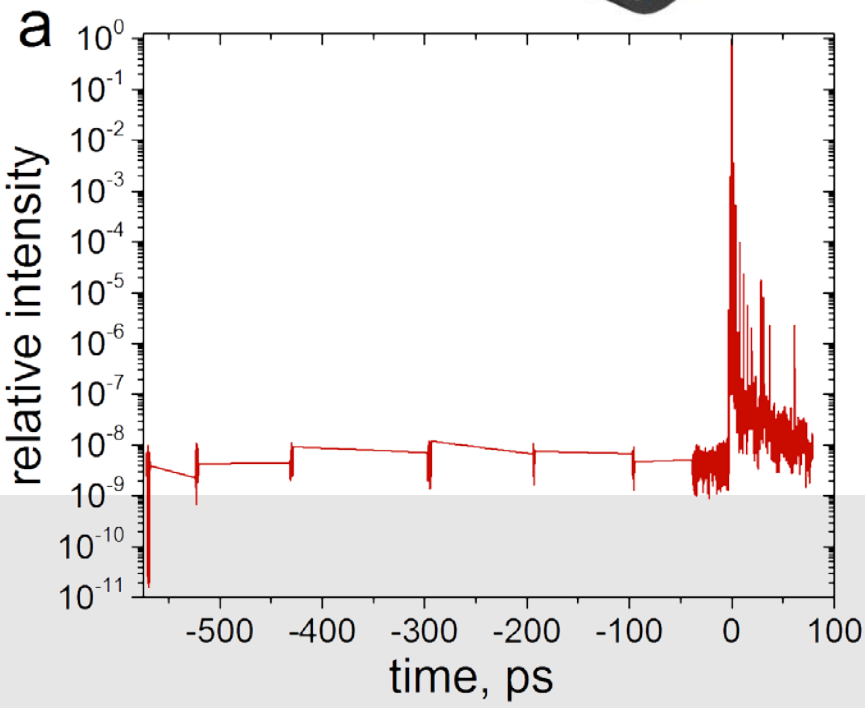


Task 1.5: ***GSI****, CNRS-LULI, HZDR, USZ, MBI*

High temporal contrast sources and their characterization

- need for low-noise seed pulses for experiments (secondary sources)
- pump laser development for parametric amplifiers

Subcontractor: ORION will support the activities performed at MBI.



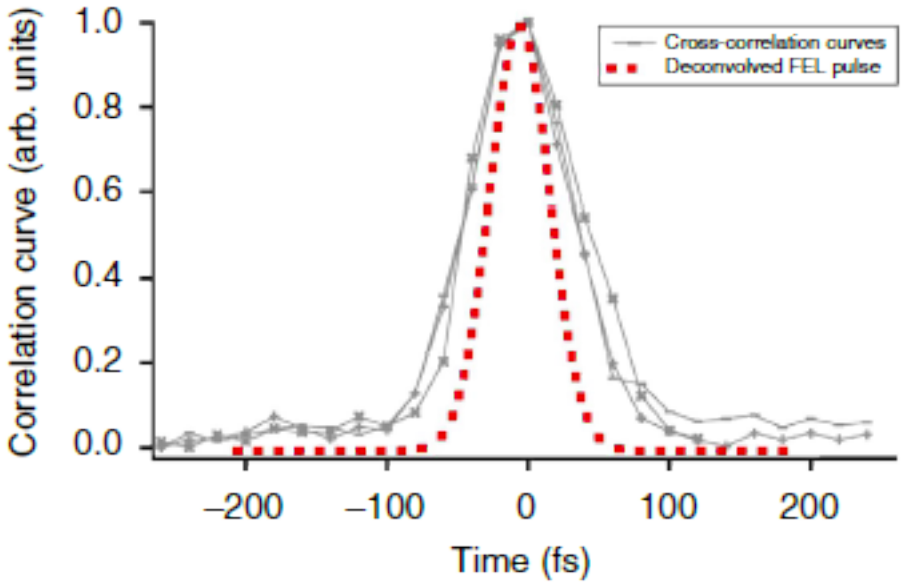
SME Collaborations

SOURCELAB (www.sourcelab-plasma.com) in partnership with LIDYL,
ITEOX (www.iteox.com) in partnership with CNRS-LULI and HZDR
IMAGINE OPTIC (www.imagine-optic.com) in partnership with CNRS-LULI.

Task 2.1: ***CNRS-LOA****, ULF-FORTH, CNRS-CELIA, LLAMS, IST, PALS*

Diffraction-limited, ultrafast X-UV sources for scientific and societal applications

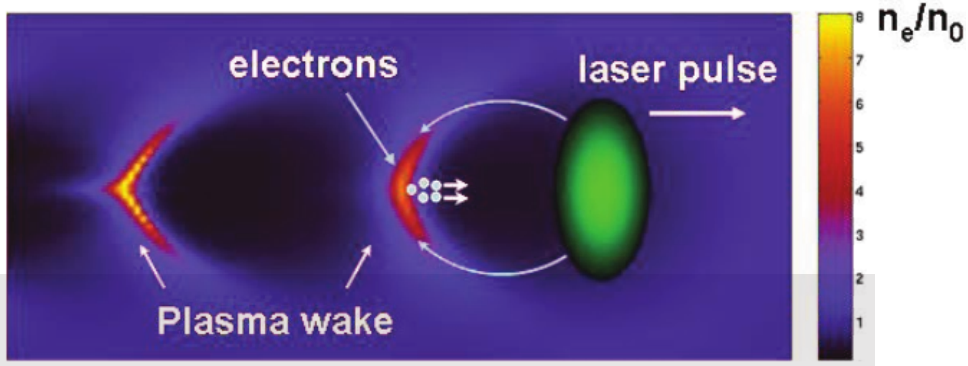
- Increase offer on coherent, ultrafast, diffraction limited XUV and soft X-ray
- X-UV and soft X-ray sources for applications like:
  - warm dense matter creation
  - coherent imaging
  - femtochemistry



Task 2.2: ***CLPU****, CNRS-LOA, STRATH, PALS*

Future electron sources and secondary radiation for user applications

- This requires developing new and challenging ways of characterization and optimization of the sources,
- demanding diverse methods and collaboration
  - Electron bunch injection
  - Stabilization of high-repetition rate electron sources



SME Collaborations

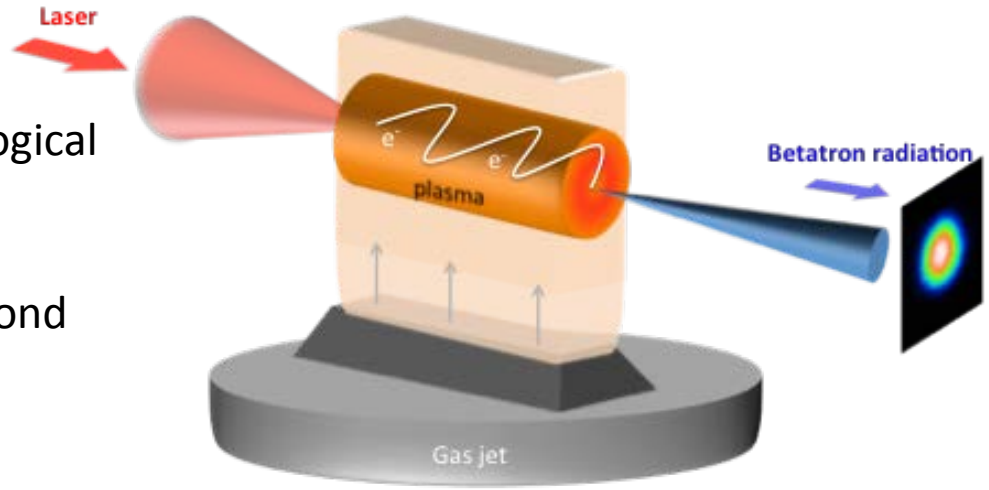
Bergoz Instrumentation (www.bergoz.com) diagnostics for particle accelerators

AIR institute (www.air-institute.org) artificial intelligence and machine-learning

Vacuumschmelze GmbH & Co. KG (www.vacuumschmelze.de) permanent magnet optics

Task 2.3: ***IST****, CRNS-LOA, PALS, STRATH*

High brightness betatron X-rays for low dose and ultra-fast probing and imaging



- Improving further the betatron source parameters and beamline experimental modules to address new challenges in low-dose biological imaging, industrial imaging, and ultra-fast probing of WDM
- collaborate to develop and compare new injection schemes
- new betatron applications such as femtosecond and sub-femtosecond XAS

Task 2.4: ***CLPU****, CNRS-CELIA, HZDR, STRATH, GSI*

High repetition rate energy selected ion sources for applications

- source enhancement and stabilization, and on ion beam transport
- operation at high-repetition-rate (HRR) will enable improvement in both the total delivered dose and measurement
- deliver ions to distant samples athigh energy-density flux. Energy selection and focusing

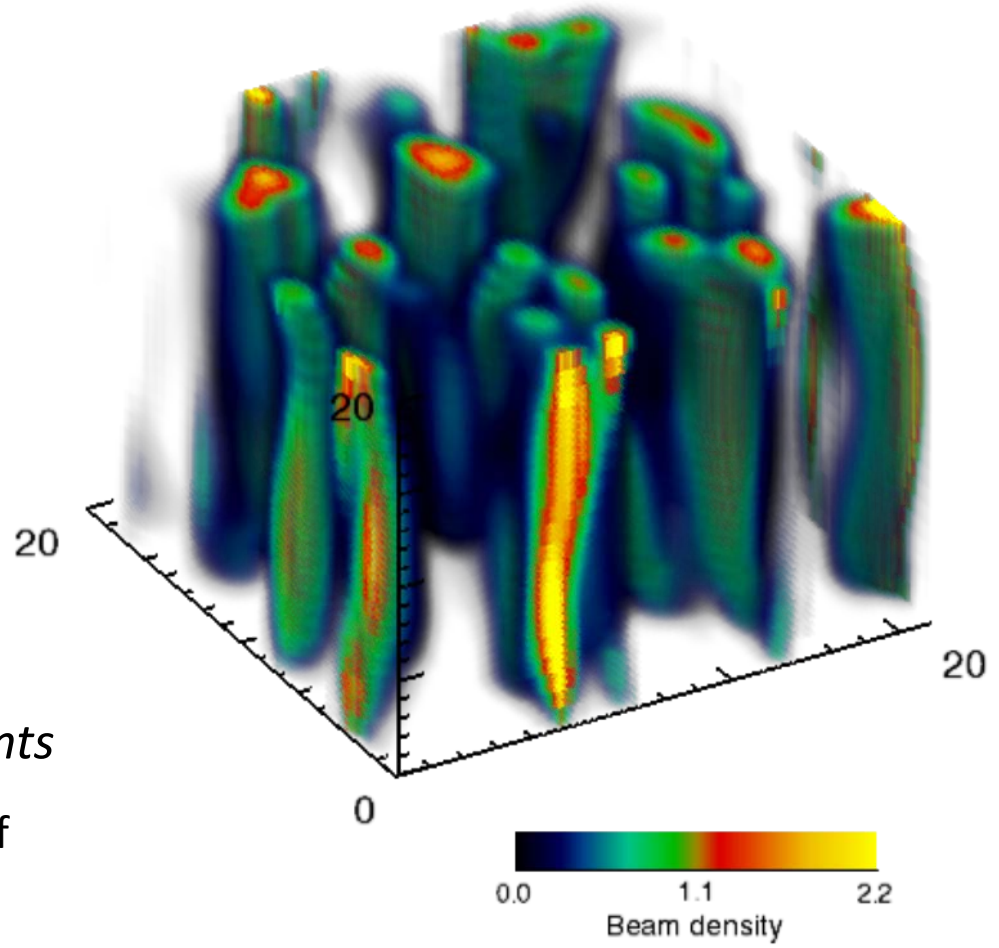
SME Collaborations

SOURCELAB (www.sourcelab-plasma.com),
Advanced Microfluidic Systems GmbH (www.amf.ch). Both are target providers to CNRS-CELIA and CLPU

Task 2.5: ***HZDR****, LIDYL, IST, PALS, GSI*

Development of common input/output standards of Particle-In-Cell (PIC) codes and associated in-situ and post-processing tools

- Numerical simulations with Particle-In-Cell (PIC) codes are key to the characterization and optimization of these laser-produced sources.
- implement important features that are still missing in the standard,
  - diagnostics,
  - multi-physics modules,
  - ionization or collisions,
  - laser geometries and higher-order modes
  - external fields



Task 2.6: ***GSI****, CLPU, HIJ, CNRS-CELIA*

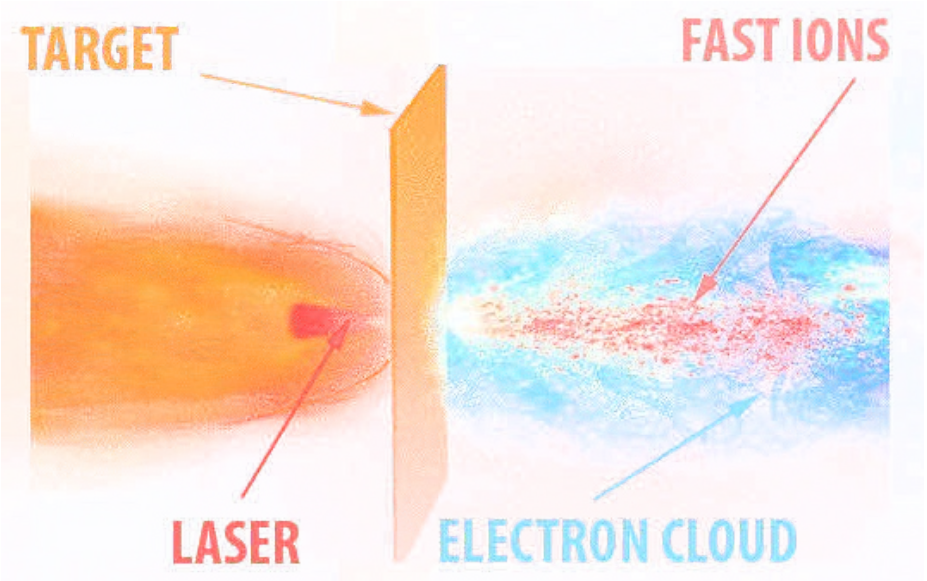
Standardization and automatization of ion spectrum measurements

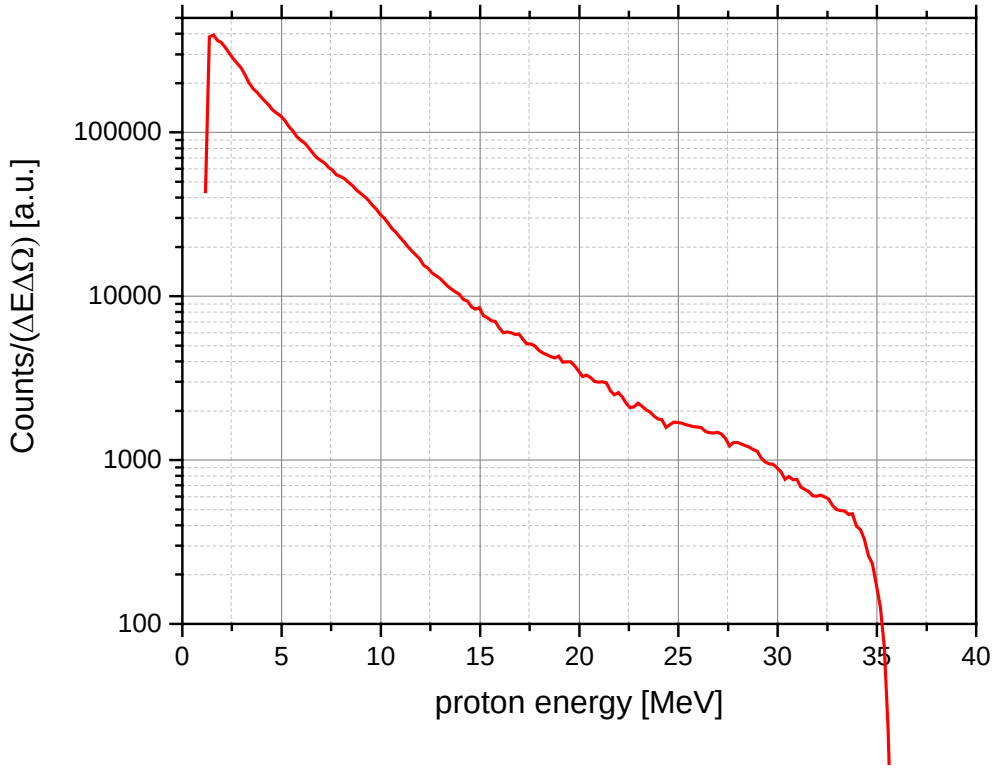
- Users are interested in having access to well-characterized sources of particles and radiation.
  - ion beam energy spectrum,
  - spatial- distribution and
  - charge distribution.
- develop standard detectors and diagnostic systems

Task 3.1: ***HZDR****, LYDIL, CNRS-LOA, MUT-IOE, PALS, STRATH, USZ*

Facility development of laser-plasma radiation sources for high pulse rate radiobiology/radiation chemistry applications

- a collaborative multi-facility LPA platform to make these unique (ultra-short,high dose rate particle/radiation) pulses available for the investigation of novel dose-rate and time-structure related effects in
  - radiobiology
  - radiation chemistry.
- development and optimization of setups, methods and techniques at the LPA facilities will be guided by benchmark experiments

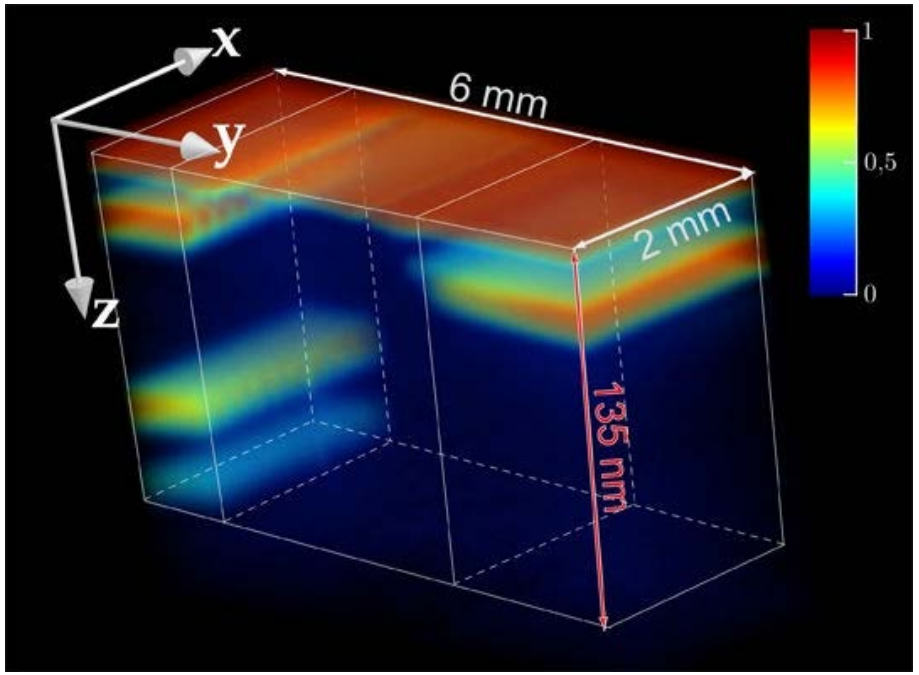




Task 3.2: ***CNRS-CELIA****, LLC, CLPU, CNRS-LULI, CNRS-LP3, INFLPR, STFC-CLF*

Development of phase contrast imaging based on high-repetition rate laser-driven X-ray sources enabling time-resolved measurements of materials, biological samples and WDM/HED plasmas

- deliver superior performance than available today
- demonstrating phase enhanced time-resolved radiographic imaging with 1-micron resolution (eventually in 3D)
- using betatron sources that can be operated at high repetition rates
- optimization of the Talbot setup and of the imaging algorithms for the betatron geometry and spectrum.



SME Collaborations

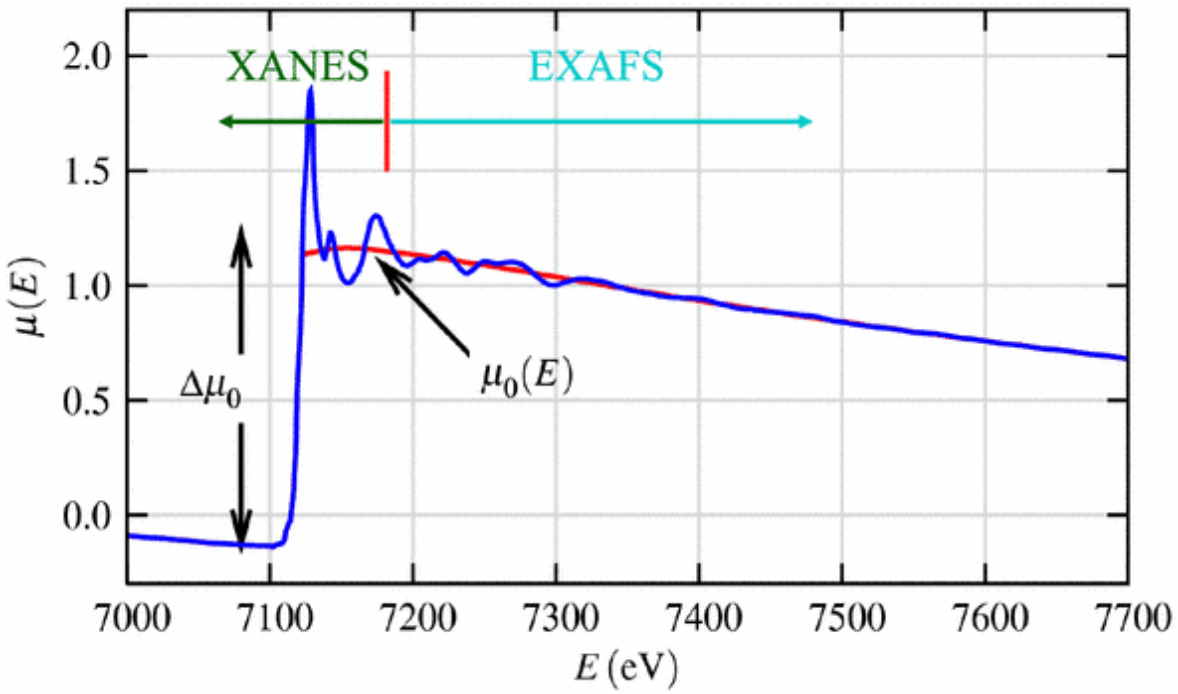
Scitech Precision (www.scitechprecision.com), provider of micro targets for laser facilities

Microworks Gmbh (www.micro-works.de), provider of X-ray gratings.

Task 3.3: ***MUT-IOE****, CNRS-LP3, ICFO, LACUS, MBI, MPQ, STRATH*

X-ray absorption fine structure (XAFS) spectroscopy using laser-driven sources of X-ray radiation

- workstations for XAFS based on laser-driven laboratory sources of X-ray radiation.
- NEXAFS and EXAFS spectra,
- pump probe arrangements
- additionally using synchrotrons and XFELs



SME Collaborations

OptiXfab (www.optixfab.com)

Nano Optics Berlin (www.nanooptics-berlin.com)

Xenocs (www.xenocs.com)

Rigaku (www.rigakuoptics.com), provider of X-ray optical elements and components

Greateyes (www.greateyes.de/en), provider of X-ray CCD cameras

THE PARTNERS

1	LLC	Lund Laser Centre	Sweden
2a	CESTA	Centre d'Etudes Scientifiques et Techniques d'Aquitaine	France
2b	LIDYL	Laboratoire Interactions, Dynamiques et Lasers	France
3	CLPU	Centro de Lasers Pulsados	Spain
4a	CNRS-CELIA	Centre Lasers Intenses et Applications	France
4b	CNRS-LOA	Laboratoire d'Optique Appliquée	France
4c	CNRS-LULI	Laboratoire pour l'Utilisation des Lasers Intenses	France
4d	CNRS-LP3	Laboratoire Lasers, Plasmas et Procédés Photoniques	France
5	FEERMI	FERMI lightsource, Elettra-Sincrotrone Trieste	Italy
6	LACUS	Lausanne Centre for Ultrafast Science	Switzerland
7	ULF-FORTH	Ultraviolet Laser Facility, FORTH	Greece
8	MBI	Max-Born-Institute	Germany
9a	GSI	Helmholtz-Center for Heavy Ion Research	Germany
9b	HIJ	Helmholtz-Institute Jena	Germany
10	HZDR	Helmholtz-Center Dresden Rossendorf	Germany
11	ICFO	The Institute of Photonic Sciences	Spain
14	INFLPR	National Institute for Laser, Plasma & Radiation Physics	Romania
15	HiLASE	HiLASE	Czech Rep
16	PALS	Prague Asterix Laser System	Czech Rep
17	IST	Instituto Superior Técnico	Portugal
18	LENS	Laboratorio Europeo di Spettroscopie Non Lineari	Italy
19	MPQ	Max Planck Institute of Quantum Optics	Germany
20	MUT-IOE	Military University of Tech, Inst. of Optoelectronics	Poland
23	STRATH	University of Strathclyde	Great Britain
25	STFC-CLF	Central Laser Facility	Great Britain
27	USZ	University of Szeged	Hungary
28	LLAMS	Laserlab Amsterdam	Netherlands
29	VULRC	Vilnius University Laser Research Center	Lithuania