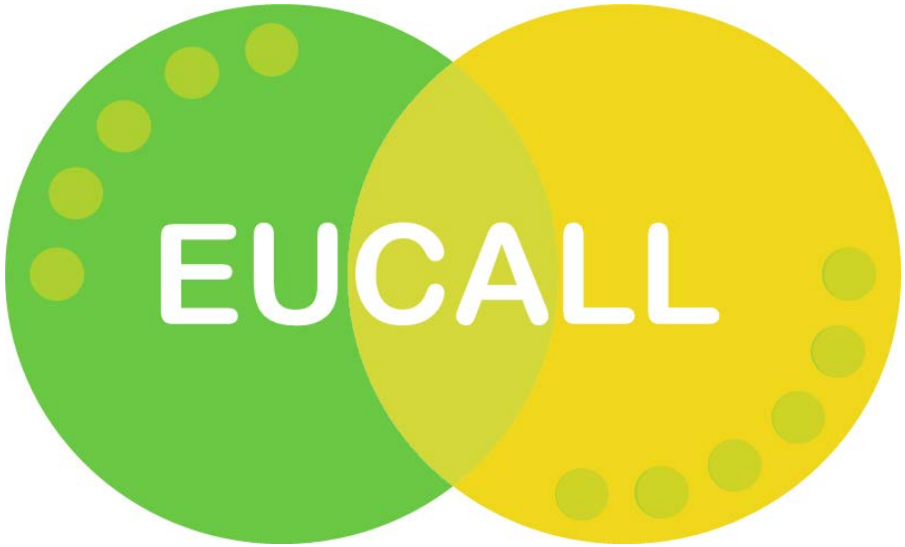

The European Cluster of Advanced Laser Light Sources

Graham Appleby – Project Coordinator

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 654220

Light Sources in Europe

- Accelerator-based RIs (SR, FEL)
  - Successful and large user program
  - Increasing complexity (OLs, FELs, …)
  - X-rays reach diffraction limit & non-linear regime
  - Optical laser methods applied
- Optical-laser based RIs (ELI, LLE faci.)
  - High power laser (HPL)
  - New and ramping up
  - HPLs as sources of UV and x-ray beams
  - UV/x-ray methods provided to users

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European Cluster of Advanced Laser Light Sources

EUCALL is a network between large-scale user facilities for:

- free-electron laser (FEL) radiation
- synchrotron radiation (SR)
- optical laser radiation

Under EUCALL, they work together on:

- common technologies and research opportunities
- tools to sustain this interaction in the future

Facts and figures:

- 7M€ from Horizon 2020 for project period Oct 2015 - Oct 2018
- 11 partners from nine countries, and two further clusters

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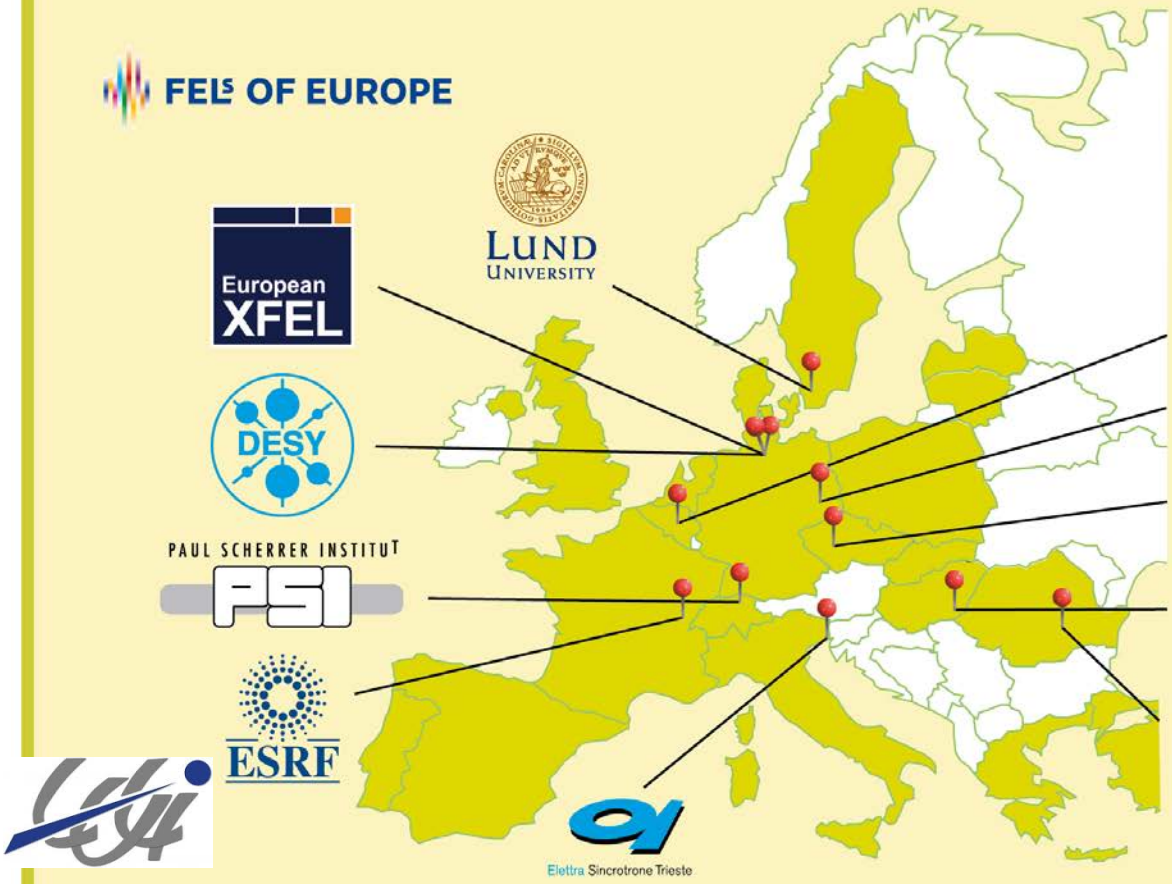
European Cluster of Advanced Laser Light Sources



EUCALL's six FEL and synchrotron sources and five optical light facilities (red pins). Countries involved in the European clusters FELs of Europe and Laserlab-Europe are coloured.

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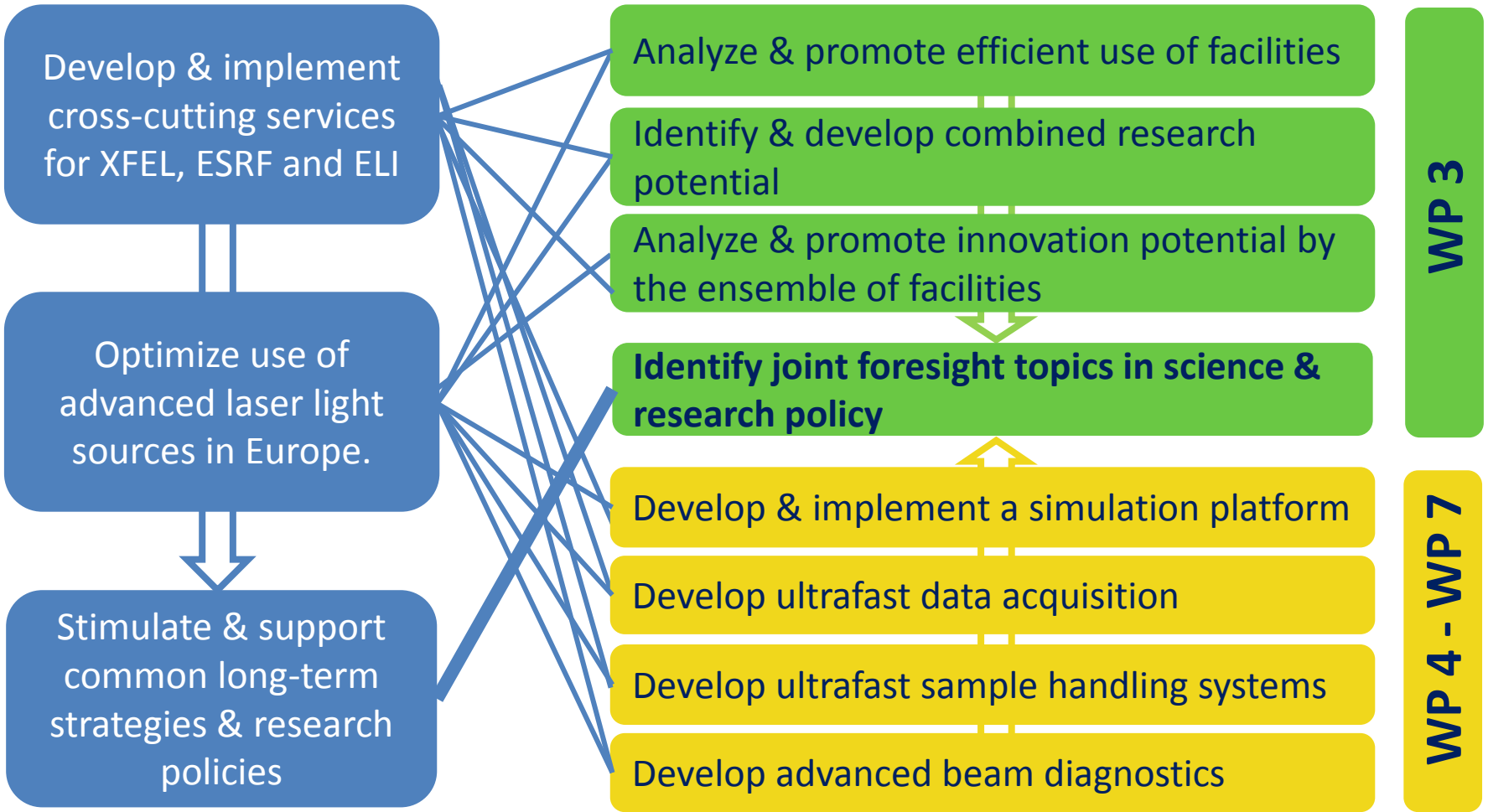
EUCALL's Strategic Goals and Objectives



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WP4 - SIMEX: Simulation of Experiments

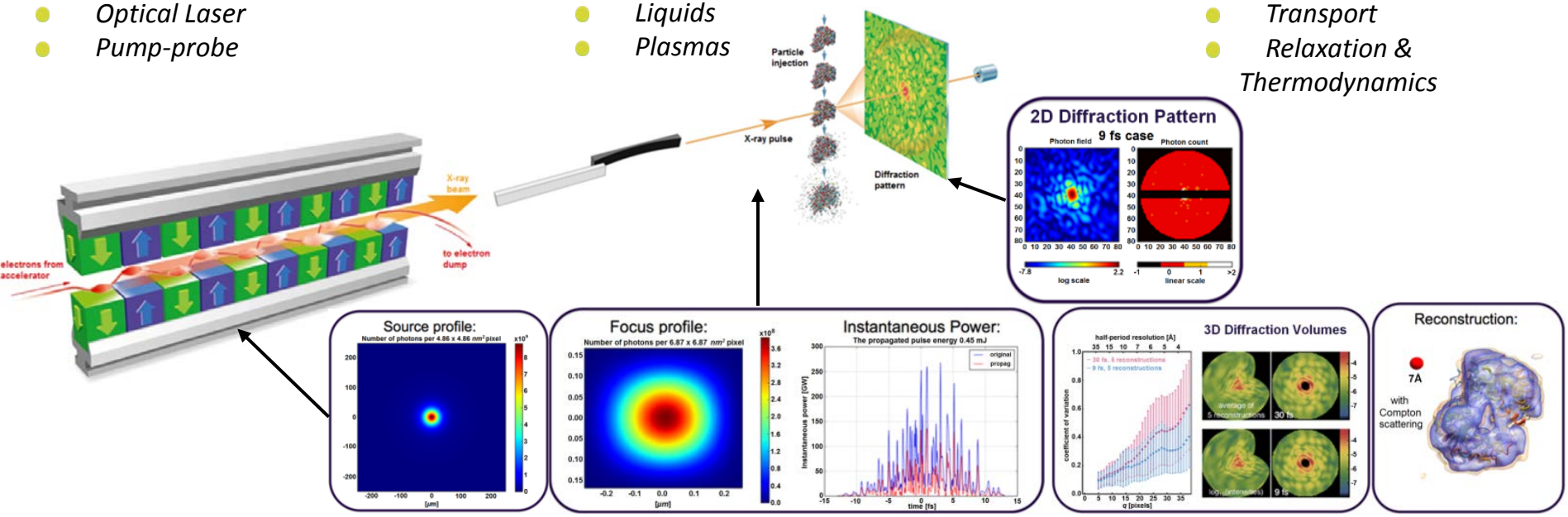
Photon Source
- *XFEL*
- *Synchrotron*
- *Optical Laser*
- *Pump-probe*

Photon Waveguide
- *Lenses*
- *Mirrors*

Target/Sample
- *Single particles*
- *Solids, surfaces*
- *Liquids*
- *Plasmas*

Detection
- *Spectroscopy*
- *Imaging*

Photon Data Analysis
- *Structure determination*
- *Electronic structure*
- *Transport*
- *Relaxation & Thermodynamics*



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WP4 - SIMEX: Simulation of Experiments

SIMEX is an open source software platform which simulates:

- single-particle imaging
- x-ray scattering
- x-ray spectroscopy
- x-ray probing of shock compressed warm dense matter
- x-ray probing of short pulse laser excited matter
- laser-plasma acceleration based x-ray sources

The SIMEX platform is open source and can be downloaded at:

www.github.com/eucall-software/simex_platform

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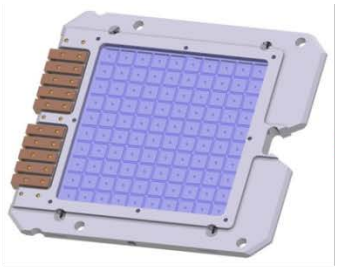
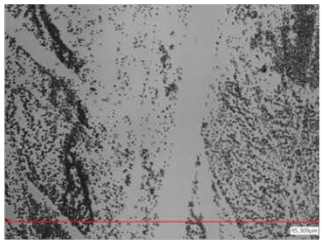
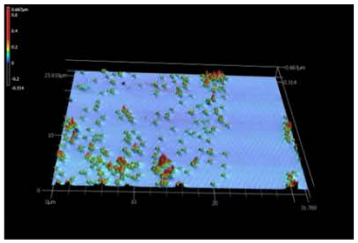
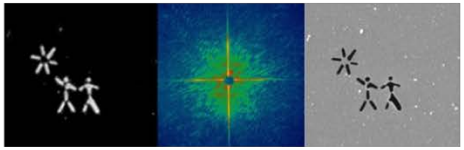
WP6 – HIREP: High Repetition Rate Sample Delivery

Sample Pre-Investigation Workflow



Sample automatically screened via microscope and points of interest identified and logged.




From the generated coordinates, sample is raster scanned at 10 Hz at beamline for analysis.

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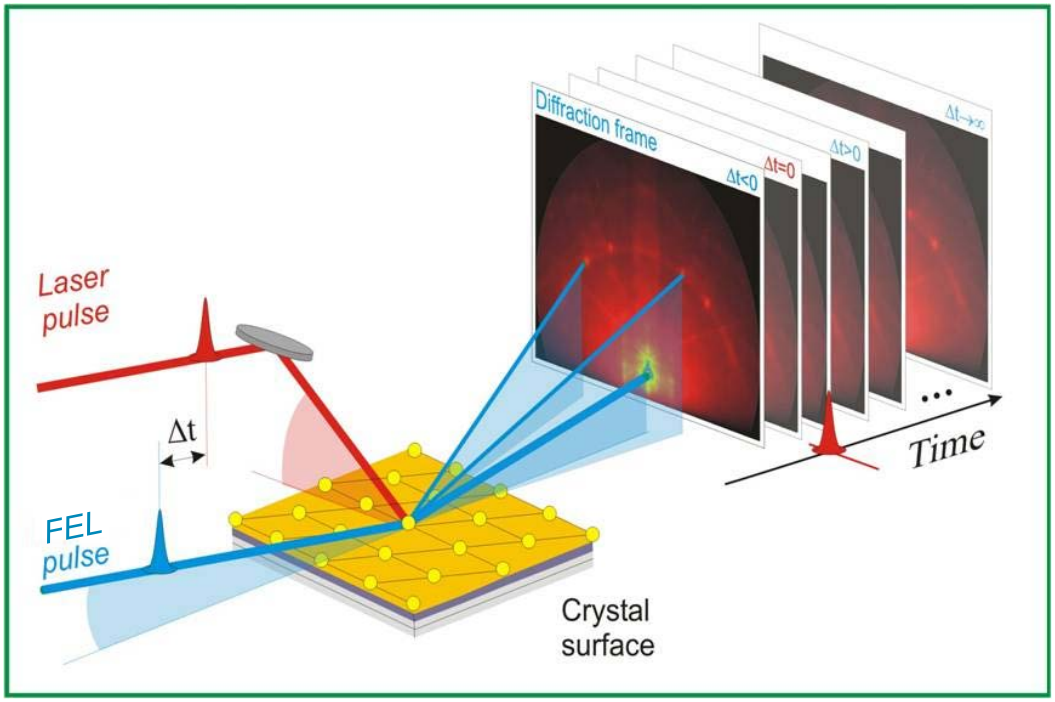
Tasks of each partner

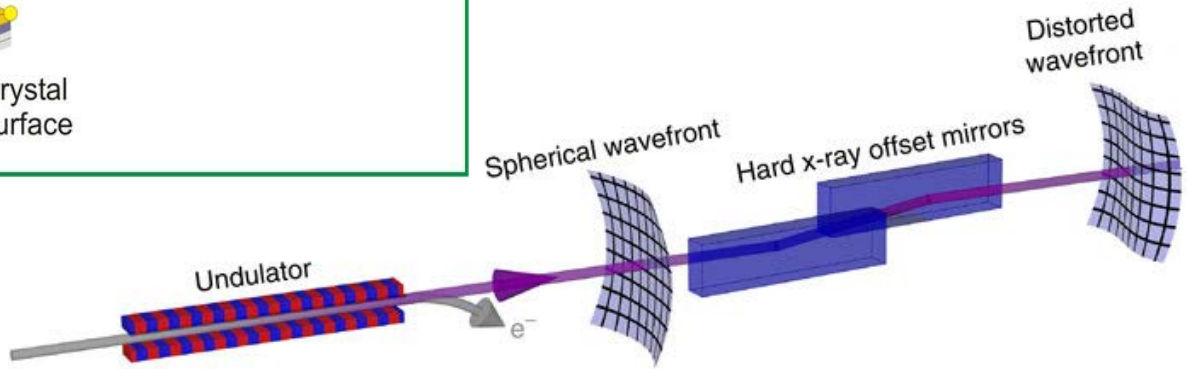
Participant	Deliverable	Milestone
XFEL	**Standard frame (D6.1)**, **beta-software for pre-investigation, scanning (D6.3)**, High precision scanning stages **(D6.2)**	Specification of cooling and heating **(M6.4)**
ELI-BL	**Beta-software for alignment, scanning (D6.3)**, EMP tests, High precision scanning stages **(D6.2)**	
ELI-NP	**Beta software for pre-alignment (D6.3)**, EMP tests, High precision scanning stages **(D6.2)**	Specification of cooling and heating **(M6.4)**
DESY	High precision scanning stages **(D6.2)**	**Specification of cooling and heating (M6.4)**
MAX	**High precision scanning stages (D6.2)**	
HZDR	**EMP tests of stages (D6.4)**, High precision scanning stages **(D6.2)**	

WP7 - PUCCA: Pulse Characterisation and Control



From F. Vigliotti (2004), Adapted with permission)

Rutishauser et al, J Synchrotron Rad **20** (2013)



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Flat Sheet Liquid Jet Timing Tool

← pressure regulators for the nozzles

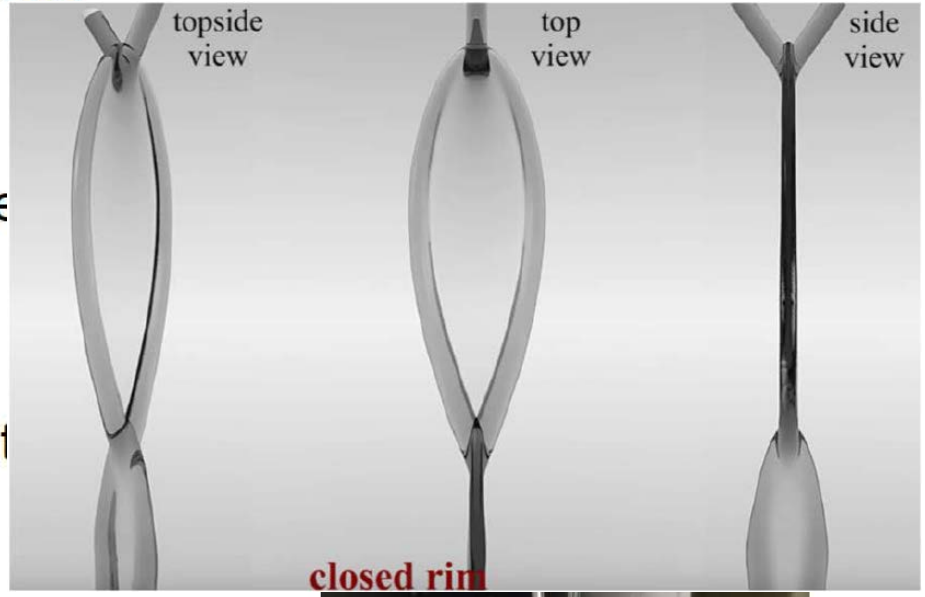
← XYZ manipulator (je

← temperature regulat

← XY+Z adjustable nozzles

← XYZ manipulator (catcher)

Courtesy of Sebastian Schulz



X. Chen and V. Yang: entry 84217 for 2012 Gallery of Fluid Motion Competition of 65th Annual DFD Meeting

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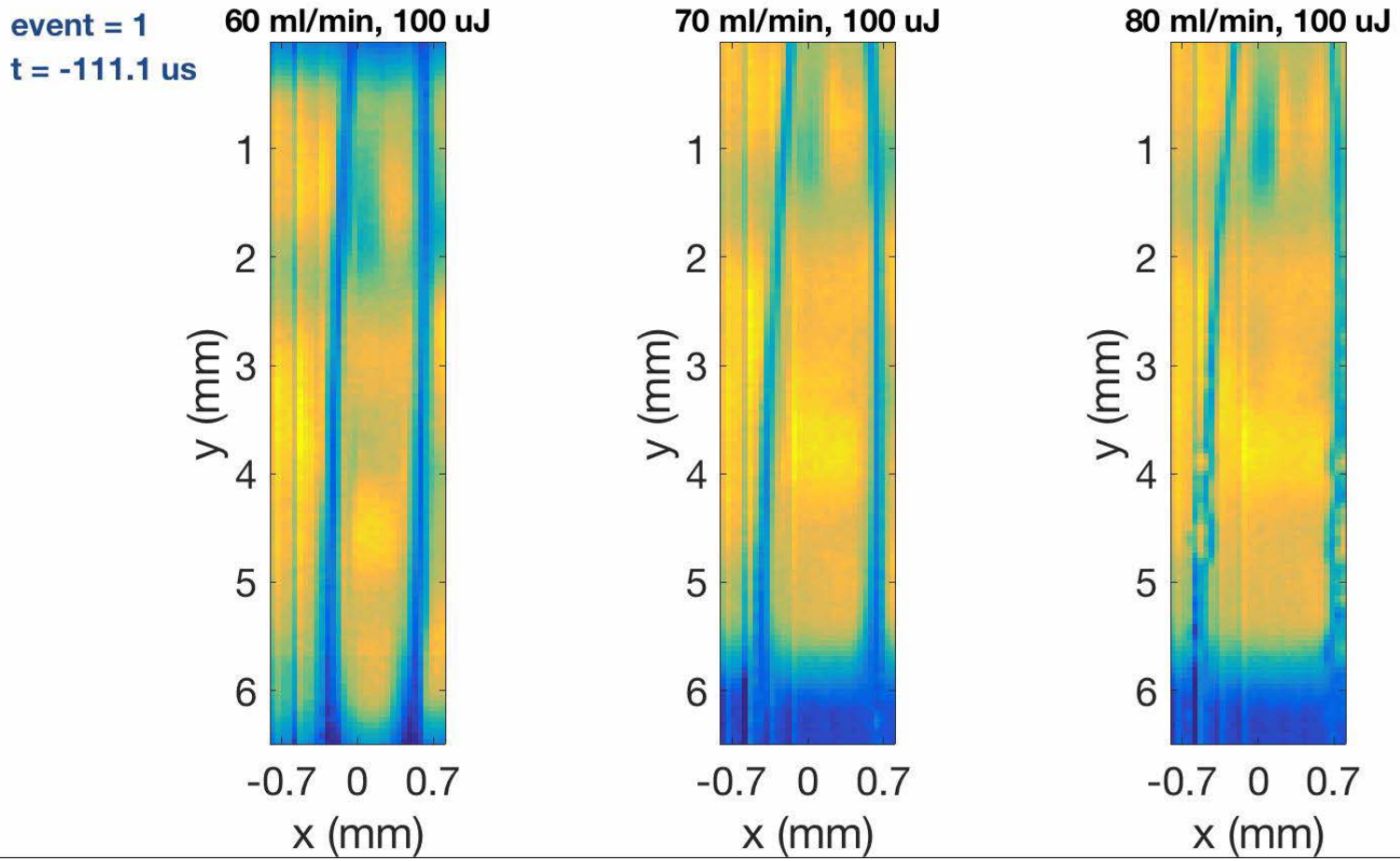
Flat Sheet Liquid Jet Timing Tool

Courtesy of Sebastian Schulz



- 128 µm nozzles
- laser
  - f_{rep} = 3 kHz
  - 100 µJ
- camera
  - 360000 fps
  - track travel of distortion

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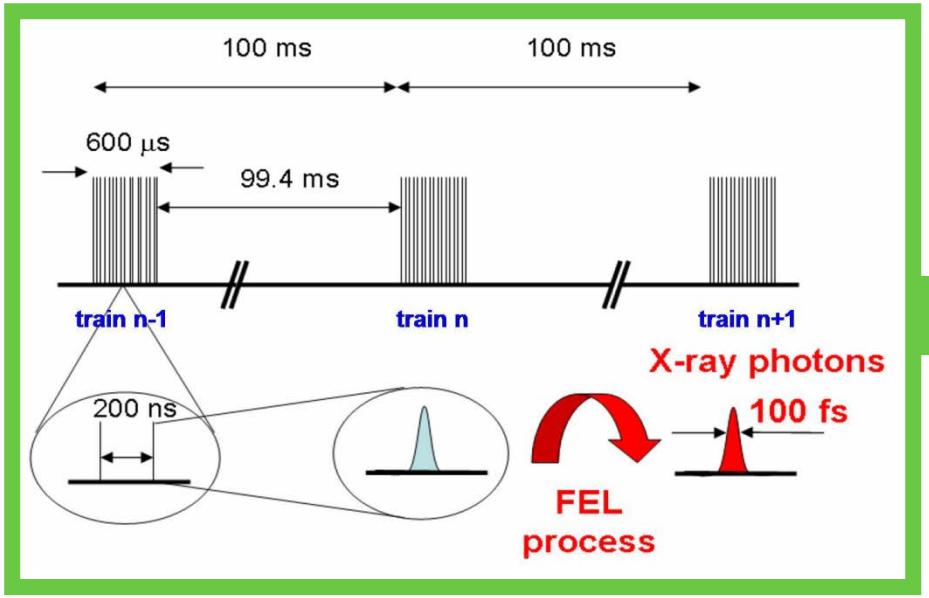
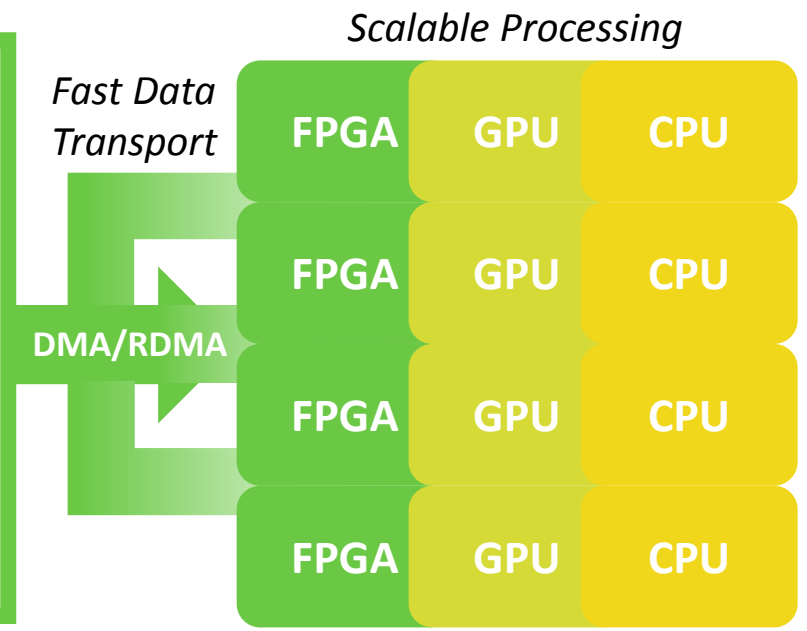
WP5 - UFDAC: Ultrafast Data Acquisition

European XFEL pulse train





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WP3 – Synergy of Advanced Light Sources

- Analyze & promote efficient use of facilities
- Identify & develop combined research potential
- Analyze & promote innovation potential by ensemble of facilities
  - Collect information from RIs about: science applications, techniques/methods, available instrumentation, operational matters (beamtime allocation and scheduling, procedures)
  - Cross-community activities; experience exchange; joint (user) training
  - Analyze & develop suggestions for future collaboration

- Identify joint foresight topics in science & research policy
  - New science & technology applications using laser and x-ray background and expertise

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EUCALL Young Researcher Travel Bursaries

- EUCALL provides 500€ for PhDs/Post-Docs for Travel, Accommodation costs at various workshops/summer schools

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ELI Summer School 2017

Deadline 14.07.2017 - http://www.eli-np.ro/eliss2017

- Astrophysics and cosmology with high-power lasers
- Attoscience
- Fundamental nuclear science and spectroscopy
- Generation of attosecond pulses
- Generation of bright coherent and incoherent x-ray pulses using short pulse lasers
- High-power laser based particle acceleration and applications
- High-peak and -average power ultrafast lasers
- Laser-driven nuclear physics
- Materials under extreme conditions
- Novel medical imaging and therapeutic applications
- Nuclear materials imaging, transmutation and management
- Photo-production of rare isotopes
- Physics of dense plasmas and warm dense matter, laboratory astrophysics
- Strong-field QED and dark-matter physics with high-power lasers
- Tabletop Free Electron Lasers (FEL) based on laser wakefield plasma accelerators

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Summary

- EUCALL addresses technological overlap between SR, FEL and HPL RIs
- EUCALL develops standardised software and hardware tools for
  - Simulation of Experiments
  - Ultrafast Data Acquisition
  - High Repetition Rate Sample Delivery
  - Pulse Characterisation and Control

- Synergy WP will foster new collaboration between RIs
  - Workshops planned for 2017/2018

- Collaboration highly successful after 18/36 months

- Young Researcher Travel Bursaries for Conferences and Summer Schools

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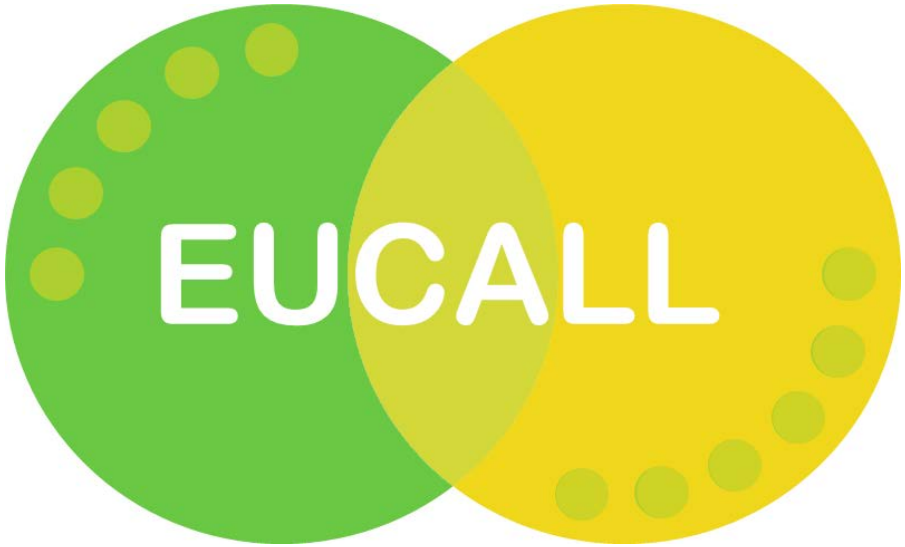

EUCALL foresight activity: a target network for advanced laser facilities

Irene Prencipe

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 654220

A target network for advanced laser facilities

- Response to emerging demands for high repetition rate target delivery

- Target supply
  - Variety of target configurations
  - Controllable/reproducible fabrication processes
  - Metrology
- High repetition rate experiments
  - 1 Hz = 3600 targets/hour
  - Mitigation of technical issues

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EUCALL Satellite Workshop, HZDR, August 2016

90 users, target experts, user facility representatives to discuss

- Target needs
  - Dynamic compression physics – S. Pascarelli
  - Isochoric heating and electron transport – R. Stephens
  - Laser-driven radiation and particle sources – J. Fuchs
- Enabling technologies for high repetition rate experiments – D. Schumacher

Summary report paper to be published in High Power Laser Sci. Eng. (2017)

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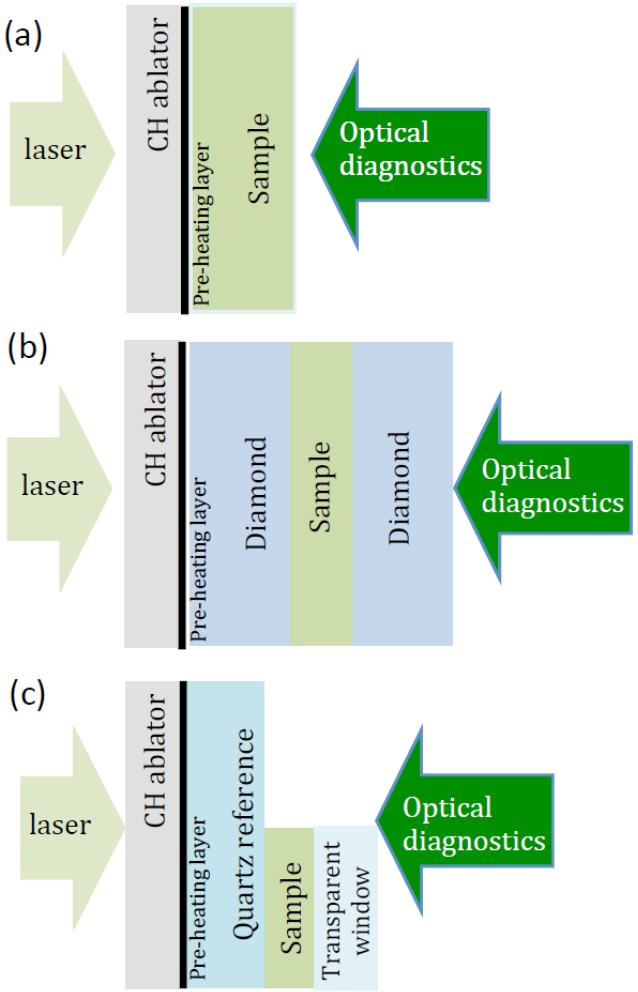
Target needs for dynamic compression physics

Multilayer targets

- Production
  - Coating techniques
  - Glued layers
  - Window with AR coating
  - Laser cut/micromachining
- Characterization
  - Reproducibility check
  - Initial properties of each layer (density, thickness, crystalline phase, orientation, grain size, composition, reflectivity…)
- High repetition rate (1 shot/min)
  - Better statistics/more data
  - Low signal phenomena



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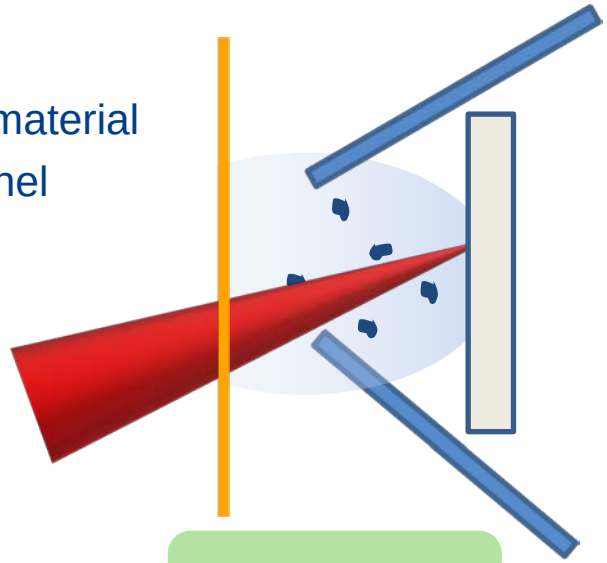
High repetition rate challenges

DEBRIS
study case

Vaporized material
Shrapnel



- **PARTIAL SOLUTIONS AVAILABLE BUT STRESSED AT HRR**
- **STRONG DEPENDENCE ON THE EXPERIMENTAL CONFIGURATION**

TOOL KIT
better than single solution

Membrane

Reduced mass targets

Renewable mirrors (liquid Hg/Ga)

E-field guiding

Renewable plasma mirrors (liquid crystals)

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High repetition rate challenges

DEBRIS

ELECTROMAGNETIC PULSES

DAMAGE OF NEARBY TARGETS

PLASMA DAMAGE, HEATING and ACTIVATION OF THE HOLDER FRAME

PRECISE POSITIONING

TARGET BACKREFLECTONS AND SCATTER

- PARTIAL SOLUTIONS AVAILABLE BUT STRESSED AT HRR
- STRONG DEPENDENCE ON THE EXPERIMENTAL CONFIGURATION

TOOL KIT
better than single solution

ONLINE CHARACTERIZATION

X-RAY + OPTICAL LASER ADDITIONAL ISSUES?

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What's next?

Meeting of facility directors and representatives (April 10th, Frankfurt)

- Common needs and possible synergies
- Scope of a common initiative
  - Enhancement of the existing target supply infrastructure
  - Enabling technologies for high repetition rate experiments
  - Long term sustainability of supply chain for high rep rate facilities
- Network structure and access model
- Funding tools
  - Infrastructural funding (Transnational Access, Supporting Technological Infrastructures, Cluster of ESFRI)
  - Innovative Training Network
  - Research and Innovation Staff Exchange

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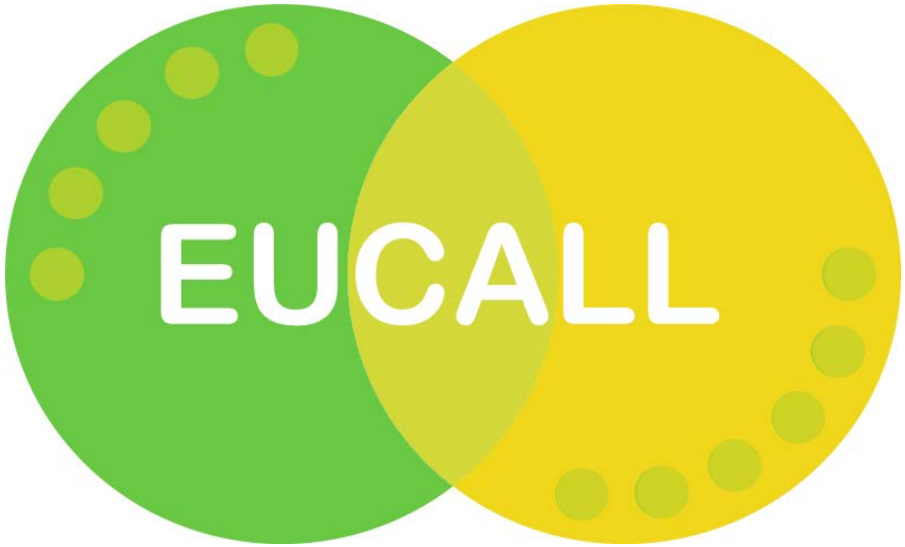

Thank you for your attention

www.eucall.eu / contact@eucall.eu

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