I. Prencipe, M. Cernaianu, T. Cowan, G. Fiquet, J. Fuchs, Z. Konopkova, P. Lutoslawski, D. Margarone, S. Pascarelli, D. Schumacher, B. Schramm, R. Stephens, M. Tolley, T. Tschentscher

Consideration of a Target Network for Advanced Laser Light Sources

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

EUCALL

3rd ELIMED Workshop

Catania, September 9th 2016

Partner von DRESDEN concept exzellenz-dresden.de

HZDR

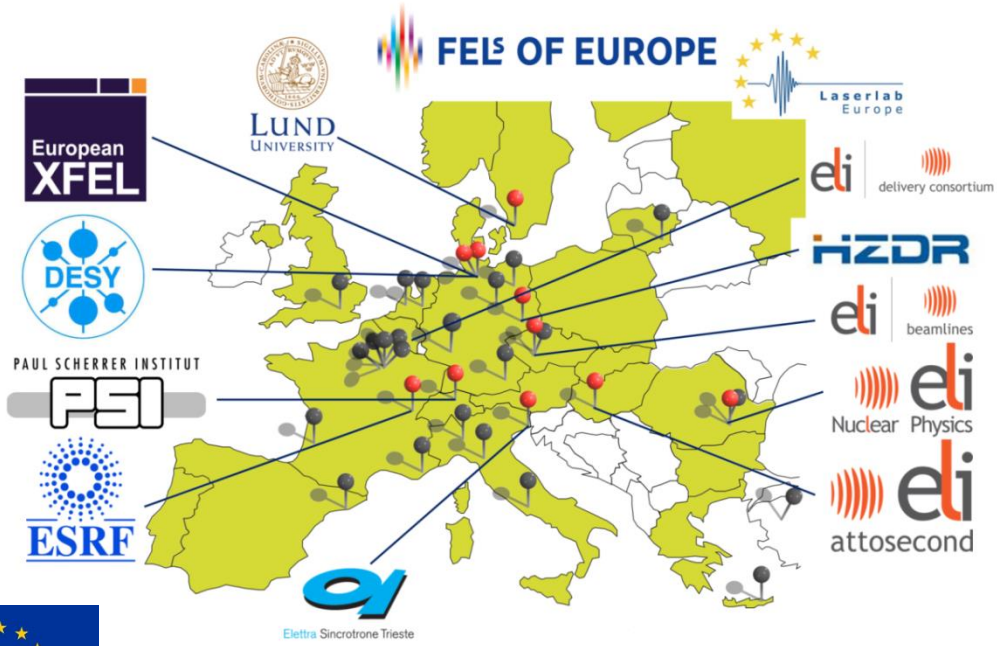
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

The European Cluster of Advanced Laser-Light Sources

EUCALL

Network of user facilities for short-wavelength radiation & lasers

- Exploit synergies of lasers at x-ray sources, and x-ray sources at lasers
- Use joint expertise for developments
- Identify connections and exchange ‘lessons-learned’ of different facilities
- Develop concept for sustained collaboration



Partners

- ESFRI facilities
- Key national facilities
- Networks of FEL and Laser facilities

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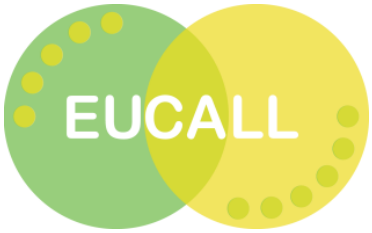
DRESDEN concept HZDR

EUCALL Activities



Synergy work package

- Analyze & promote efficient use of facilities
- Identify & develop combined research potential
- Analyze & promote innovation potential by the ensemble of facilities
- Identify joint foresight topics in science & research policy

Scientific/technology developments

- **SIMEX** – Simulation of experiments: Develop and implement simulation platform for users and facility operators to fully simulate experiments at the various light sources.
- **UFDAC** – Ultrafast data acquisition: Ultrafast online image processing, data transfer and injection, and processing of digitizer data for fs & as pulsed photon sources.
- **HIREP** – High repetition rate sample delivery: Integrated concept for decentralized sample characterization and fast sample positioning to give external user groups unhampered access to EUCALL's facilities
- **PUCCA** – X-ray pulse characterization & control: Arrival time monitors with fs time resolution, wavefront sensor & analysis software, and transparent intensity monitor

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Upcoming European Advanced Laser Facilities

eli beamlines

2 X 1 PW
15 fs / 30 fs
15 J / 30 J
10 Hz

10 PW
150 fs – 1.5 ns
150 J – 1.5 kJ
1 shot/min

eli Nuclear Physics

2 x 1 PW
25 fs
30 J
λ=800 nm
1 Hz

2 x 10 PW
15-30 fs
200 J
λ=800 nm
1 shot/min

eli attosecond

ALPS-HF
17 fs
34 J
λ=700-900 nm
10 Hz

European XFEL

HED Instrument

- DiPOLE

2-20 ns, 100 J, λ=500 nm, 1-10 Hz

- 100 TW-class CPA Ti:Sapphire

30-50 fs, 3-5 J, λ=500 nm, 10 Hz

ESRF

ID 24
4-10 ns, 100-200 J
λ=1064 nm, 1 shot/min

CileX Apollon

10 PW 15 fs,
150 J, 1 shot/min

DRESDEN concept HZDR

Targets for Advanced Laser Facilities

TARGET = CONSUMABLE

UPCOMING FACILITIES

- Increased availability/accessibility
- high repetition rates
  (1 Hz = 3600 targets/hour)

demand for

a large number of targets

+

Issues related to repetitive irradiation

Targets for Advanced Laser Facilities

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TARGET DESIGN

on the basis of

- physical phenomenon under investigation
- experimental configuration
  (laser properties, diagnostics)

huge **variety**
of possible target configurations
(often **complex**)

Targets for Advanced Laser Facilities

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→ huge **variety**
of possible target configurations
(often **complex**)

TARGET PROPERTIES

affect strongly the laser-matter interaction process

→ **production**

- controllable and reproducible

characterization

- density, thickness, crystalline structure, surface quality

Targets for Advanced Laser Facilities

TARGET SUPPLY

- Users and facilities lack **know-how and infrastructure** for target fabrication and characterization
- **Target purchase** accessible only to expert users: limited access to advanced facilities!
- **Target suppliers network**

HIGH REPETITION RATE ISSUES

- **Operation at 0.1-10 Hz**
  - Target positioning and alignment
- **Collateral effects**
  - Exacerbation of existing issues
  - New challenges

Challenge: how do we deal with targetry?

STEP 1

- Assessment of the **current situation**

STEP 2

- Discussion of a **coordinated strategy**

Consideration of a Target Network for Advanced Laser Light Sources

Workshop

29-31 August 2016
Helmholtz-Zentrum Dresden-Rossendorf

Organizing Committee
M Cernaianu, T Cowan, G Fiquet, Z Konopkova, D Margarone, S Pascarelli, I Prencipe, M Tolley

i.prencipe@hzdr.de

Credits Anna Ferrari

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Targetry identified
as foresight activity
by the EUCALL synergy board

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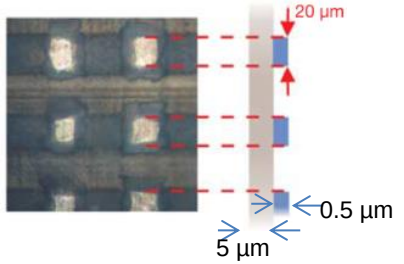
Step 1:

Assessment of target needs and target-related issues

Assessing target needs and target-related issues

Laser-driven particle and radiation sources

Julien Fuchs

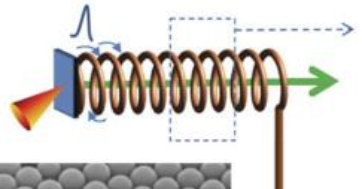


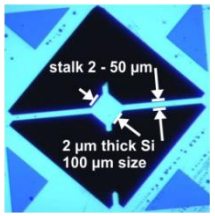
High repetition rates required for

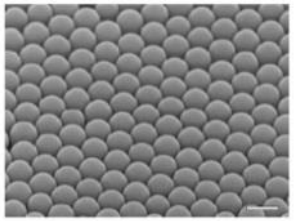
- Production of particle/radiation beams

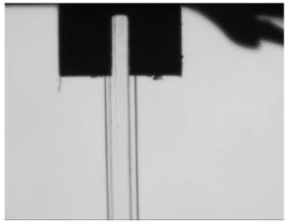
Target needs: not only solid targets

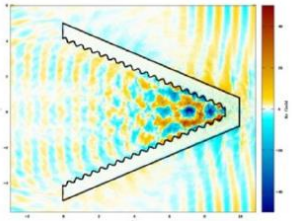
- Solid targets: multi-layer, structured, controlled/near critical density, surface patterns, 3D shapes...
- Gas jets and cells (need modeling)
- Droplets (need stabilization)
- Liquid crystals (no high Z)
- Cryogenic (thickness, shape)
- Multiple targets

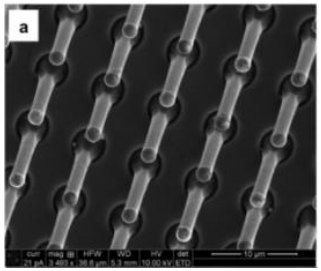


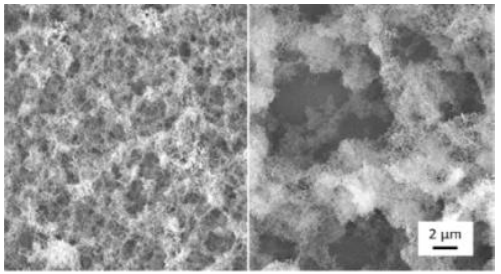



SEM image (microsphere ∅ 530 nm)









D. Margarone et al.; S. Kar et al.; H. Schwoerer et al., J. H. Bin *et al*, I. Prencipe *et al.*, S. Jiang *et al.,* J. P. Perin et al

Assessing target needs and target-related issues

Electron transport and isochoric heating

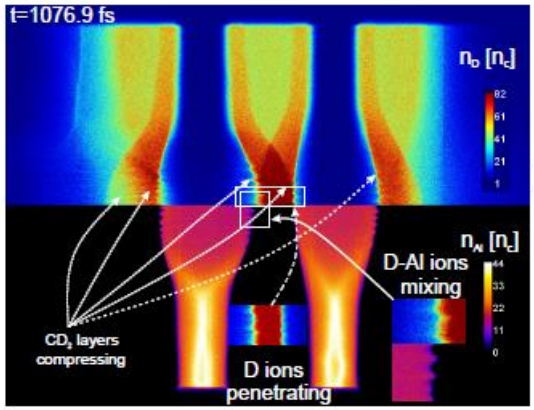
Richard Stephens

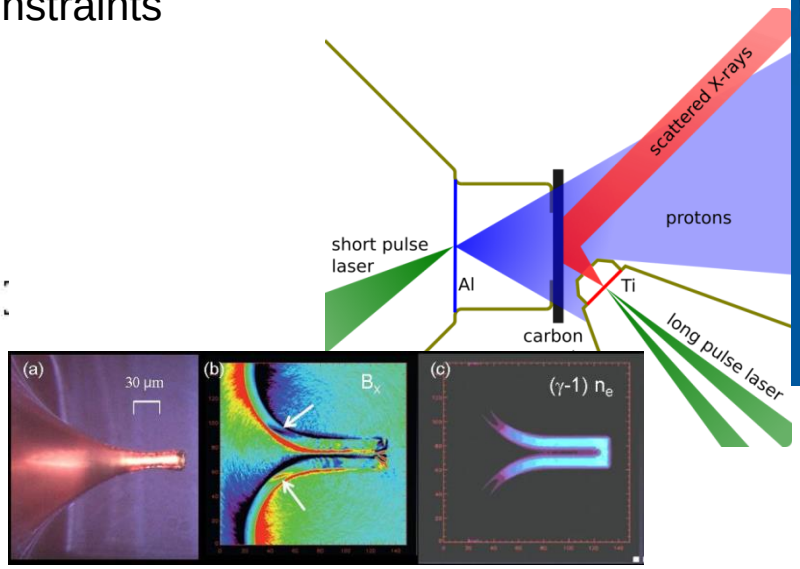
High repetition rates required for

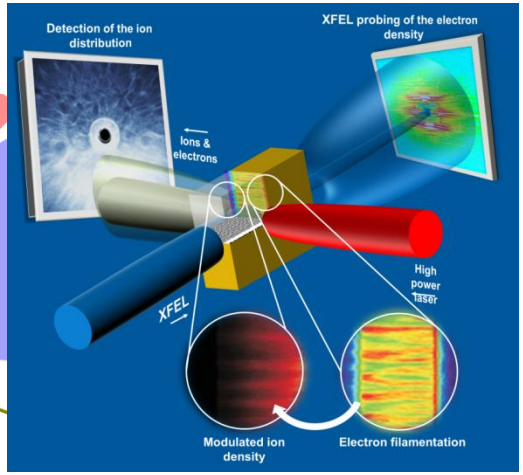
- Statistics: study of small effects, instabilities: shot to shot variations
- Parameter scan: need for characterization to allow sorting of shot results

Target needs

- 2D: multilayer, buried structures and wafer based (RMT, gratings...)
- 3D: cones, spheres, multi-target configurations
- Precise geometry constraints







T. Kluge et al.;L. Huang et al.; K. Zeil et al.

Assessing target needs and target-related issues

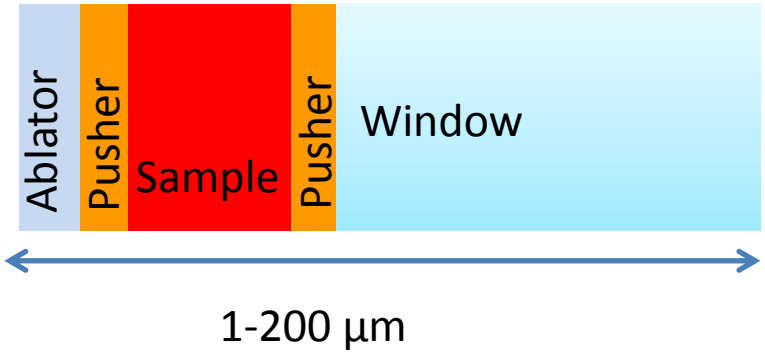
Shock-compression phyisics

Sakura Pascarelli

Repetition rate

- 1 shot/min to 1 shot/10 min BUT 0.1 Hz to open new perspectives

Target needs: multilayer targets



- Reproducibility
- Characterization

Experiment and target design: hidrodynamic codes

- Needs for progress in modeling (input of equations of state, phase transition, 2D)
- Need for broadly available for user-friendly codes with good documentation

Assessing target needs and target-related issues

High repetition rate challenges

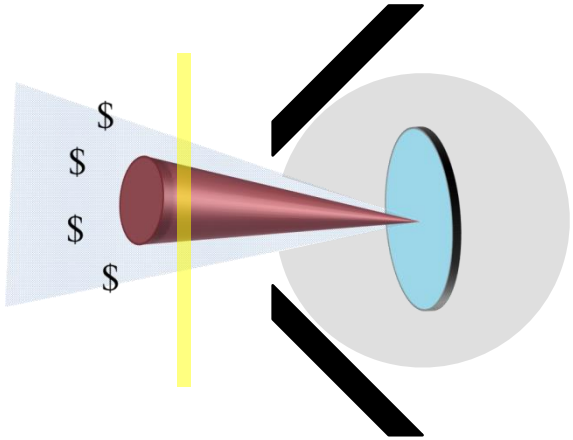
Douglass Schumacher

Target delivery

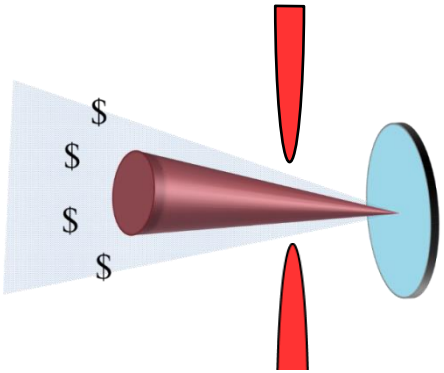
- Alignment and positioning

Collateral effects

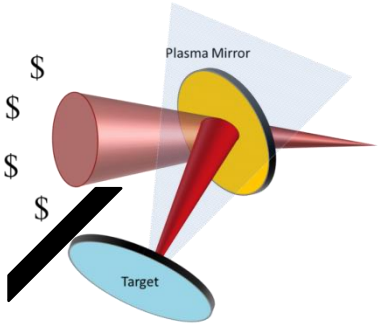
- EMP, Activation, Thermal loads
- Damage of nearby targets
- Debris (vaporization + shrapnel)
- Plasma damage of holder frame
- Target back-reflections and scatter



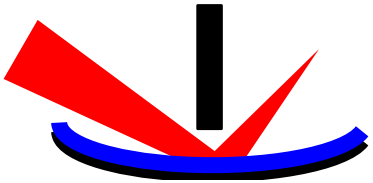
Membrane (vaporization)



E-field guiding



Reformable plasma mirrors



Reformable mirrors

The EUCALL-HIREP working package

High Repetition Rate Sample Delivery

Integrated software:

- automatic and semi-automatic sample identification and localization (coordinates of the points of interest to be stored in the common database)
- stage control for fast positioning

Integrated setup:

- sample holder – with fiducial marks; cooling/heating capacities, low activation
- high precision stages – EMP/UHV compatible
- UHV microscope.

WP Leader: D. Margarone, ELI Beams (CZ)

WP Coordinator: J. Schulz, European XFEL (DE)

Assessing target needs and target-related issues

High repetition rate challenges

Douglass Schumacher

- Issues depend strongly on the experimental configuration (laser, target, rep rate): need for extensive parametric investigations
- Available partial solutions
  - Need for information sharing!
  - Tool kit of solutions rather then a single solution!
- Existing solutions for low rep rates stressed at high rep rates
- Need for on-line characterization (position + target surface damage)
- X-ray + optical laser : additional issues?

Assessing target needs and target-related issues

Commonalities and transversal issues

Production

2 schemes:

- **mass production** for „beamline approach“
- **fast prototyping** for explorative campaigns

Currently

- available extensive know-how and capabilities
- but R&D needed for most kinds of target

Characterization

Needs depend on production reliability

- random variations: each target must be characterized (?)
- systematic variations: calibration of process parameters

Assembly and delivery of large number of targets

- robotic assembly
- wafer based techniques/planar geometries
- need for automation

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Workshop

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Step 2:

A coordinated strategy

for targetry

A coordinated strategy for targetry

Input from the discussion

Planning

- targetry must be taken into account in the experiment planning/budget
- target development considered in the proposal writing and evaluation
- early involvement of target scientists and better communications

Networking

- Joint Research Activities to address common issues
- Training of the next generation of target experts
- User facilities: dedicated experts to assist users in target design

Access models

- user facilities
- in-house facilities

A coordinated strategy for targetry

Possible synergy levels

Bilateral collaborations

In-kind contributions, co-authorship, know-how sharing

- Workshops
- Bilateral funding schemes
- Target catalogue/database
- Innovative Training Network

User Facilities: User Consortium Contributions

Target supply = service to the users community in exchange for beamtime

- ESRF: LTP (Long Term Proposals)
- HIBEF UC Contribution?

An integrated network for targetry

- Extablish a sustainable target supply chain
- Joint Reasearch Activities to address common issues
- Partners: target fab, user facilities, users

A coordinated strategy for targetry

A target network for advanced laser light sources

Trans-national/Virtual Access (INFRA-IA)

- Pool of research infrastructures: target fab labs(instrumentation/manpower/know-how)
- Joint research activities to improve the service to users
- Networking activities (workshops/trainings...)

Future and Emerging Technologies

- multi-disciplinary collaborations on future and emerging technologies
- kick-starting new European research and innovation

Factories of the Future

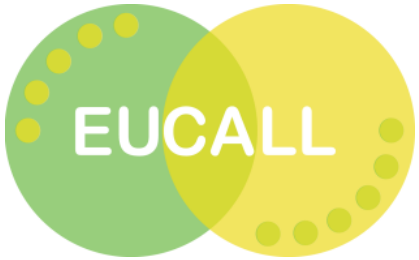
high added value manufacturing technologies for the factories of the future, which will be clean, highly performing, environmental friendly and socially sustainable.

Lobbying for an appropriate call:

2018-2019 – EUROPEAN RESEARCH INFRASTRUCTURES

A coordinated strategy for targetry

Next steps



Formation of an **expert panel** to define

- network concept
- funding scheme
- access models

A **white book** document to

- raise awareness in the scientific community about target related issues
- prepare lobbying activities at the EU commission level
- support partners in their grant writing.

Organization of a **workshop** to propose, discuss and refine.

Lobbying activities at the EU level for an appropriate call

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Acknowledgements

ORGANIZING COMMITTEE

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PANEL LEADERS

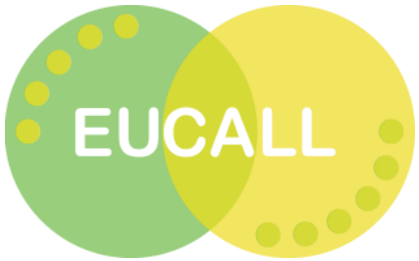
J. Fuchs, S. Pascarelli, D. Schumacher, R. Stephens, T. Tschentscher

HZDR

B. Schramm, J. Fassbender, U. Schramm, J von Borany, J. Grenzer, A. Erbe, B. Gross

EUCALL WP 6

D. Margarone, J. Schultz, R. Appio, M. Cernaianu, C. Deiter, J. Dreyer, M. Gugiu, A. Meents, A. Pelka, T. Ursby, T. Wiste



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DRESDEN concept

HZDR

Thank you