WG2 Summary

Ion beams from plasmas

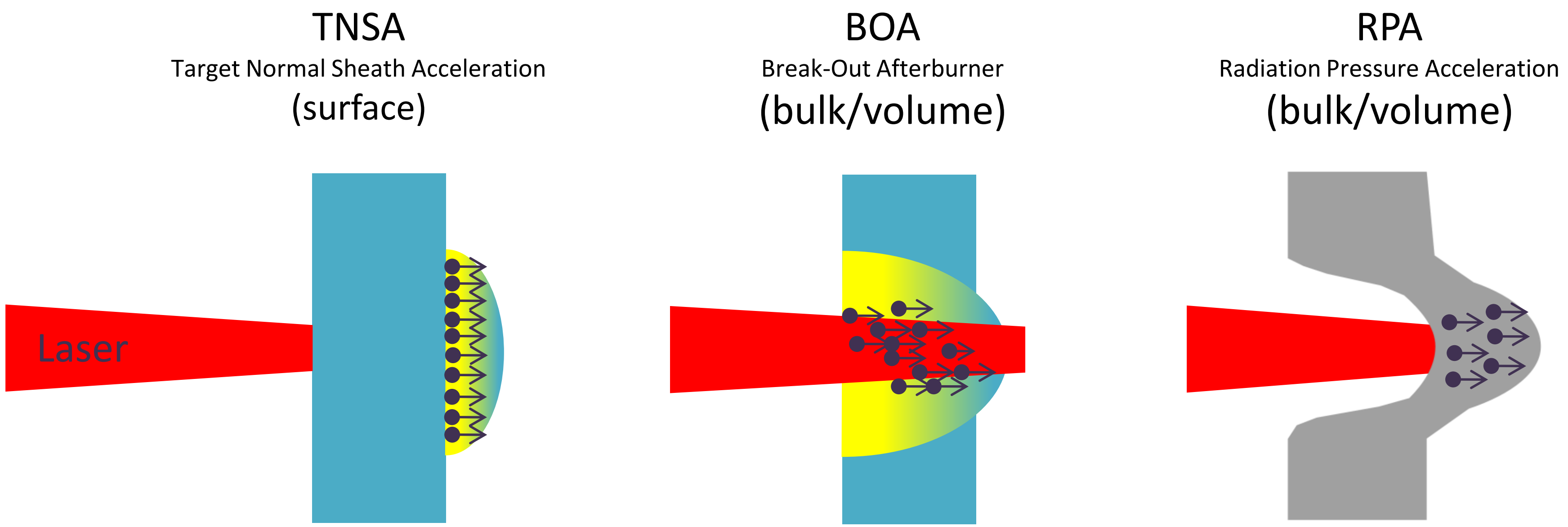
Julien Fuchs
Ecole Polytechnique, CNRS - France

Highlights

- ❑Mechanisms
- ❑Ion beam handling
- ❑Applications

New insights on ion acceleration mechanisms

The enhanced capability of ultra-intense lasers allow transiting from standard TNSA (surface) acceleration to volumetric acceleration, leading to higher ion energies

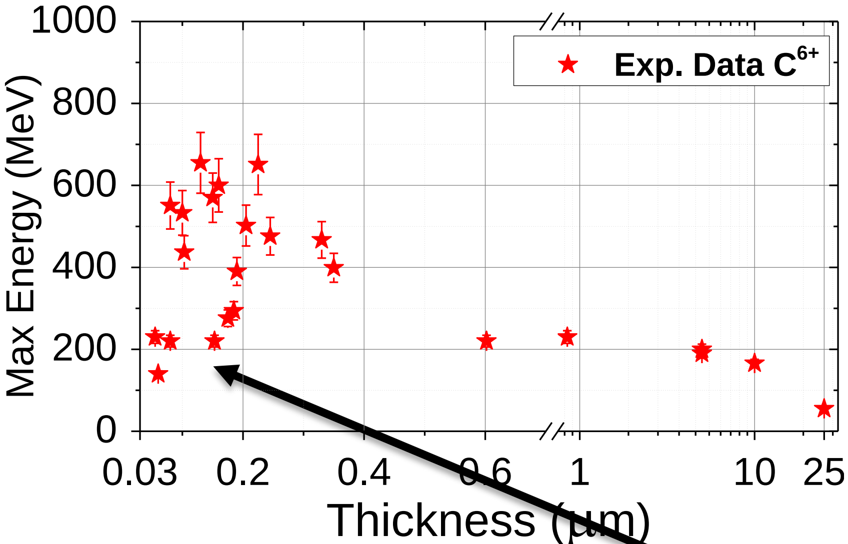


Daniel Jung

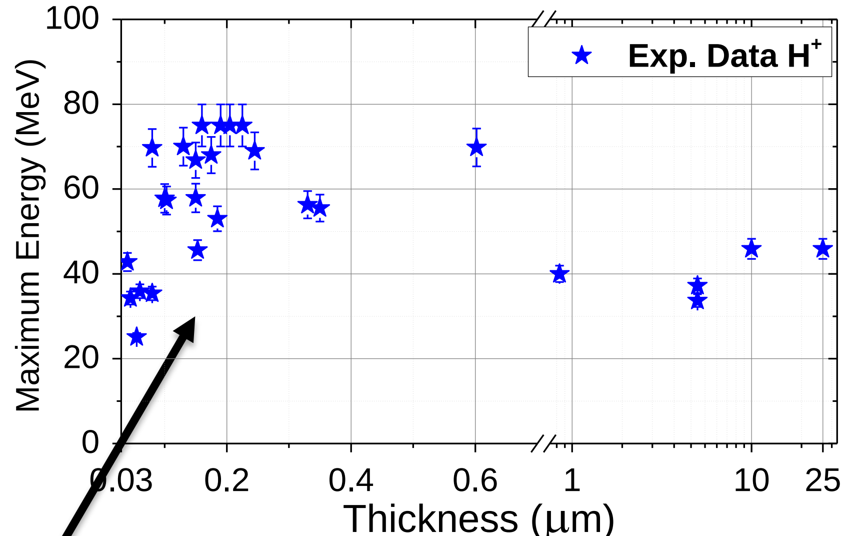
Los Alamos NATIONAL LABORATORY
LMU
MPQ

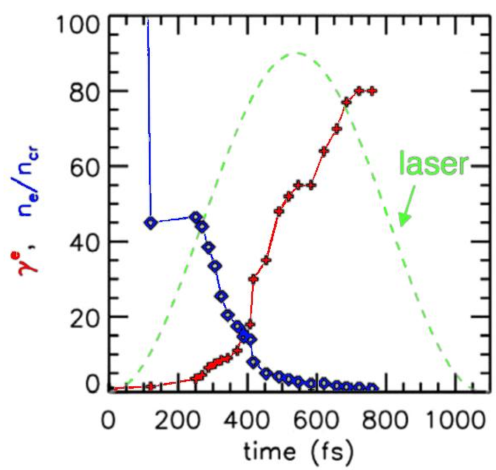
Break-Out Afterburner (BOA): Experimental realization and maximum ion energies with diamond targets

Thickness scan carbon C^{6+}



Thickness scan carbon H^{+}



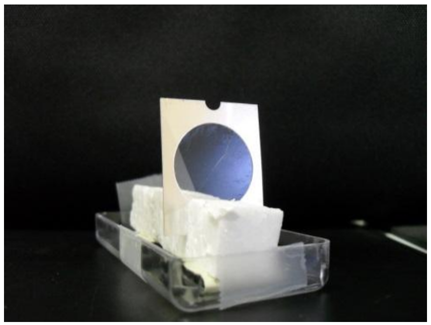


- Optimum diamond thickness for Trident at ~200nm
- will change with intensity & contrast level

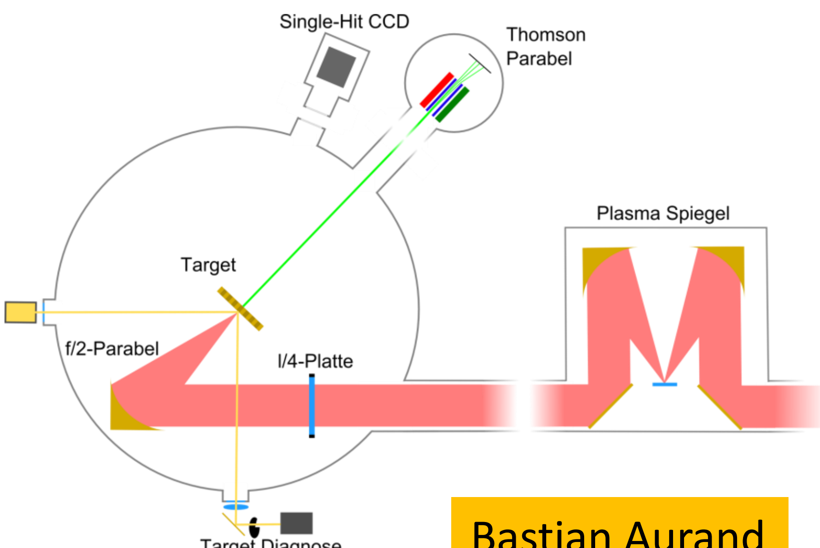
Daniel Jung

B. Hegelich, *et al.*, Nucl. Fusion 51, 083011 (2011)

But these processes induce strong constraints on lasers and targets



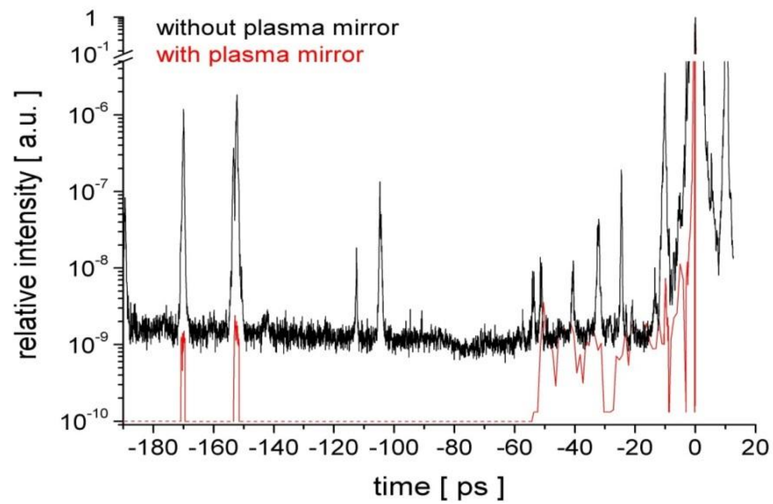
- Polymer Foils (Parynene dixF; $[C_8H_6F_2]_n$):
  - *„Ein Verfahren zur Herstellung ultradünner Polymerfolien“*
    (engl.:“A process for preparing ultra-thin polymer films”)
    Deutsches Patent- und Markenamt Az.: DE 10 2012 100 476.5



- Single plasma-mirror:

  Contrast: - Peaks < 10^{-9}
  - ASE < 10^{-11}

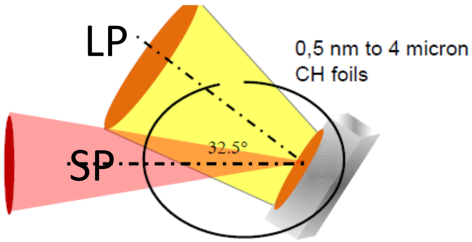
C. Rödel *et al.* Apl. Phys. B. **103** 4329 (2010)

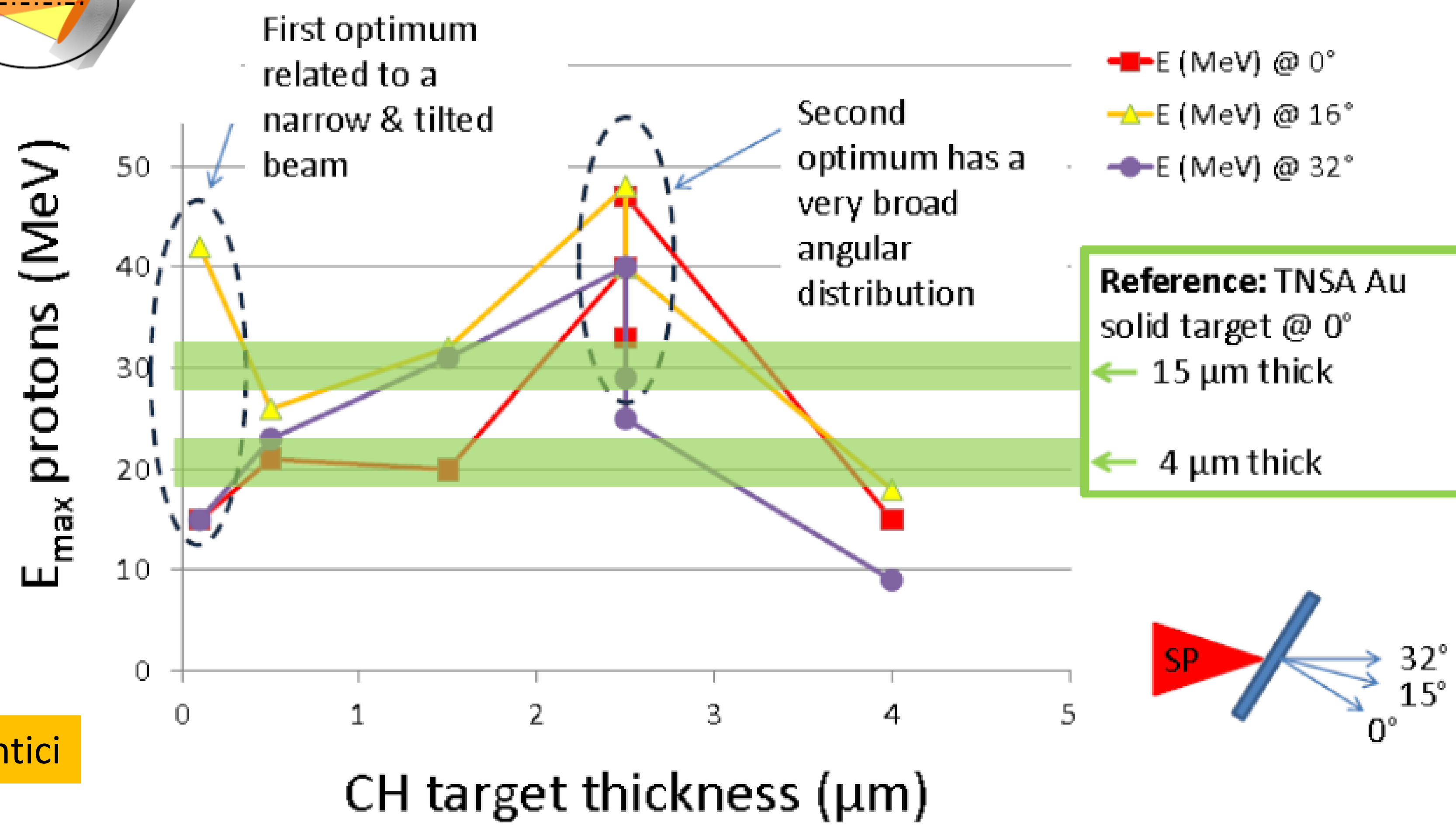


Bastian Aurand

LUND UNIVERSITY
HELMHOLTZ GEMEINSCHAFT Helmholtz-Institut Jena
GSI
JÜLICH FORSCHUNGSZENTRUM
IOQ Jena

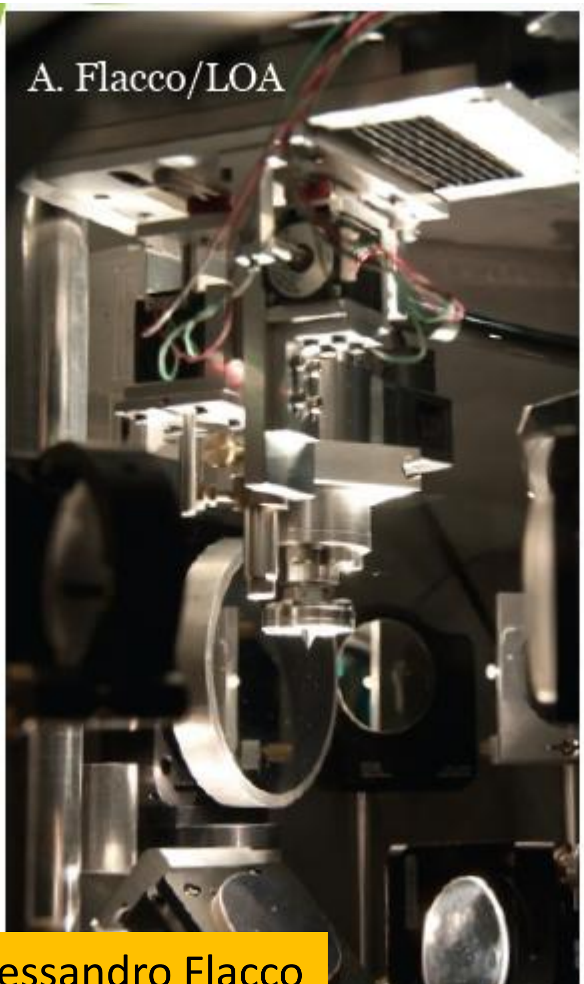
Alternative: use lower-than solid targets (reduced constraints) example: shock acceleration





Patrizio Antici

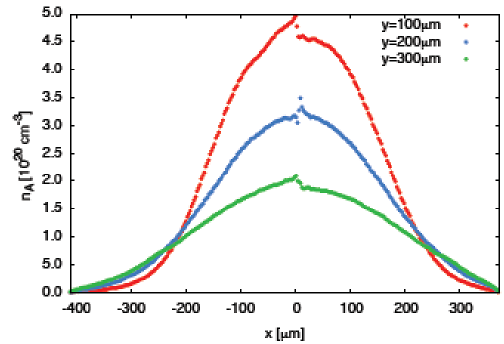
High-density gas targets to allow high-repetition rate operation

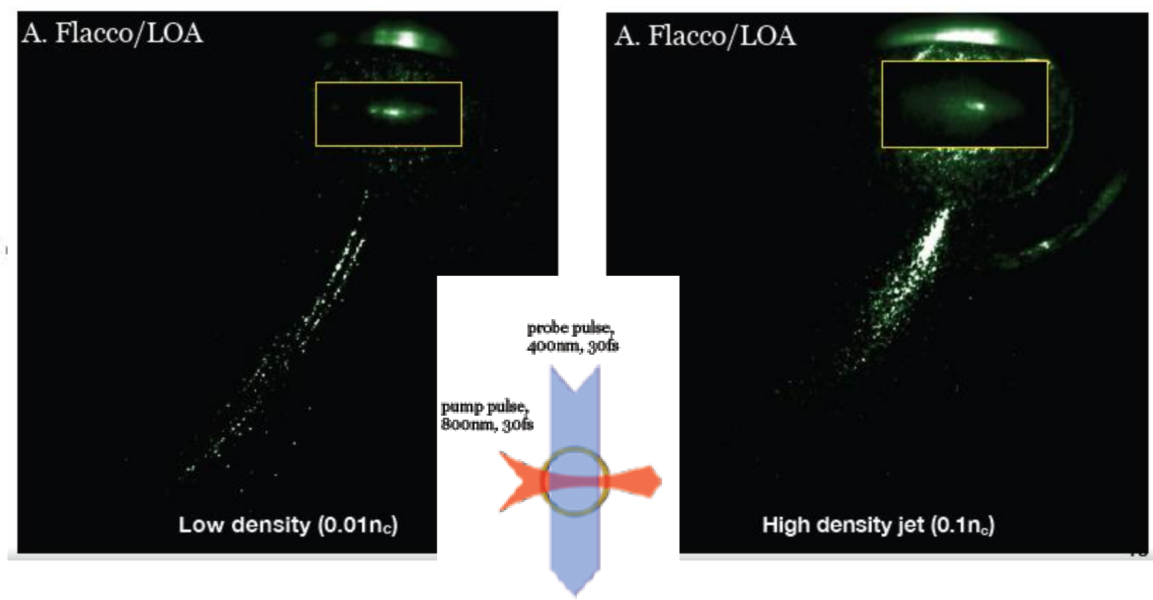


Key features

- single ion type
- intrinsically high repetition
- possibly less contrast demanding

Experimental observations:





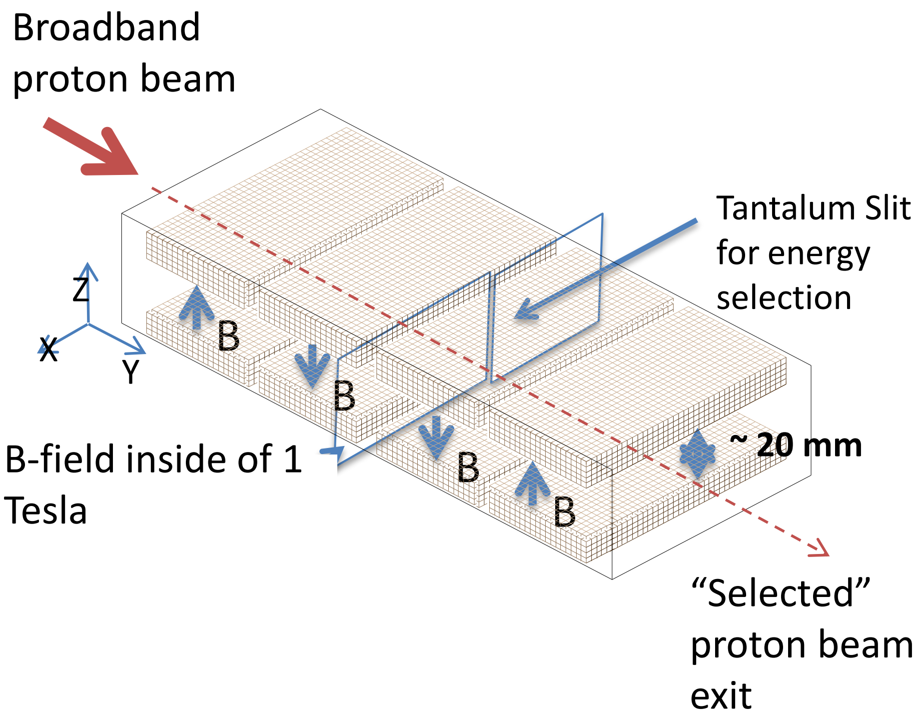
Alessandro Flacco

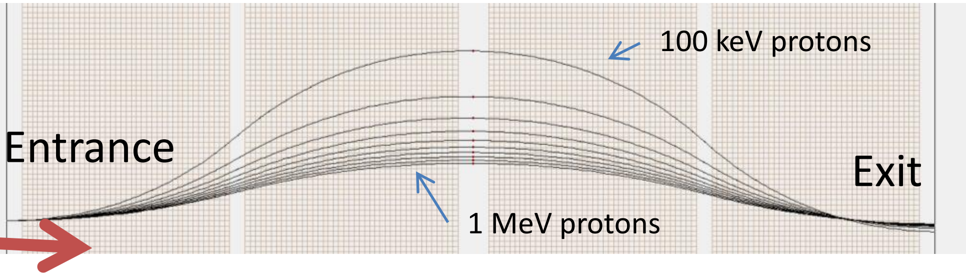
New insights on ion beam handling

Updates on solutions to present drawbacks of laser-accelerated ions:

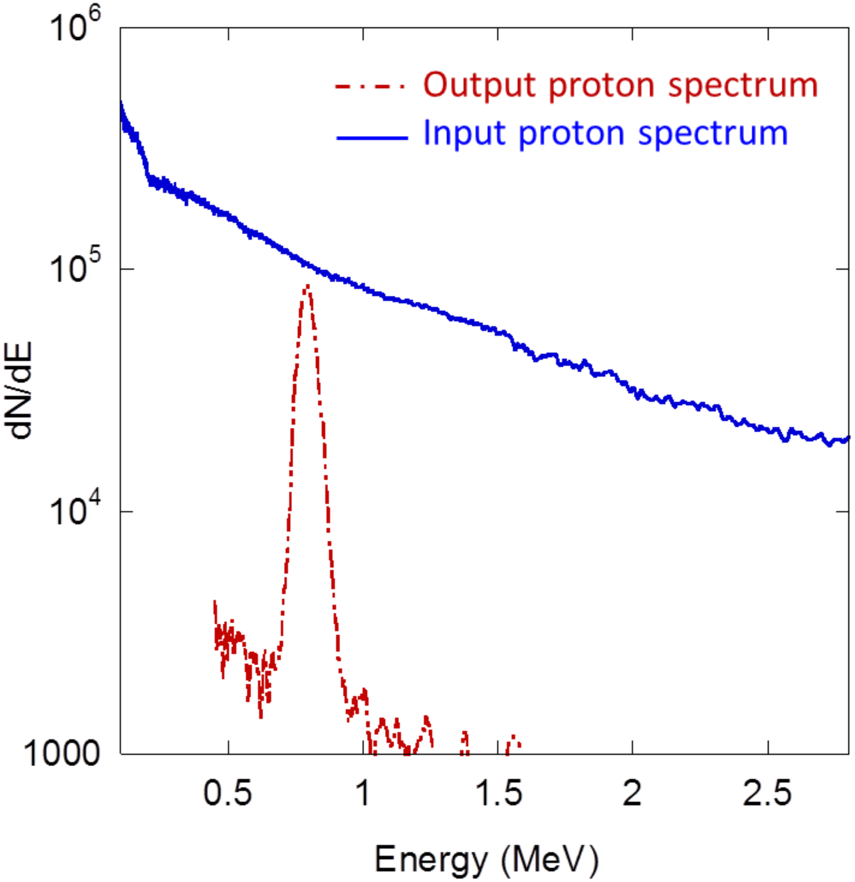
- Large divergence
- Broadband spectrum

Use of conventional chicane to reduce beam bandwidth



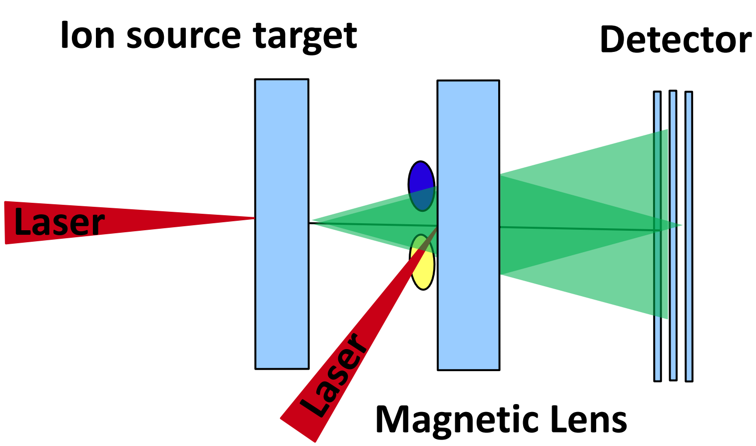


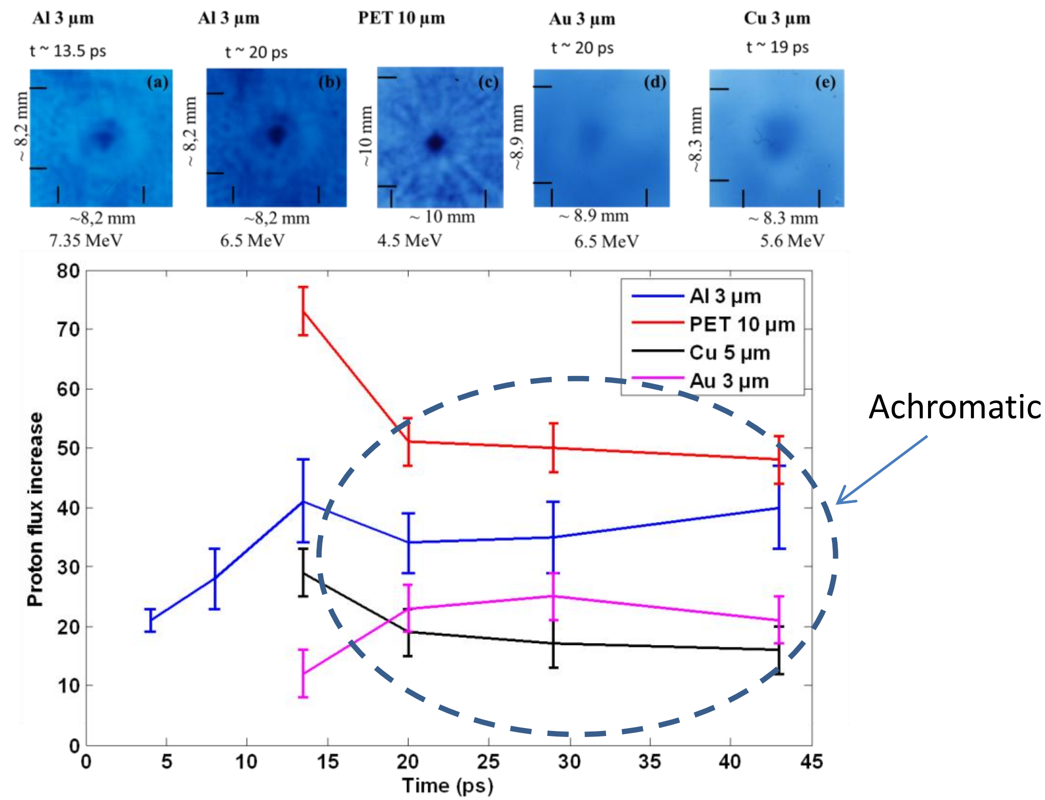
Beam centered at 750 keV
bandwidth of 75 keV



Sophia Chen

Use of 10s of MG B-fields *in plasmas* to achromatically focus kA laser generated ions beams





LIGHT – the project

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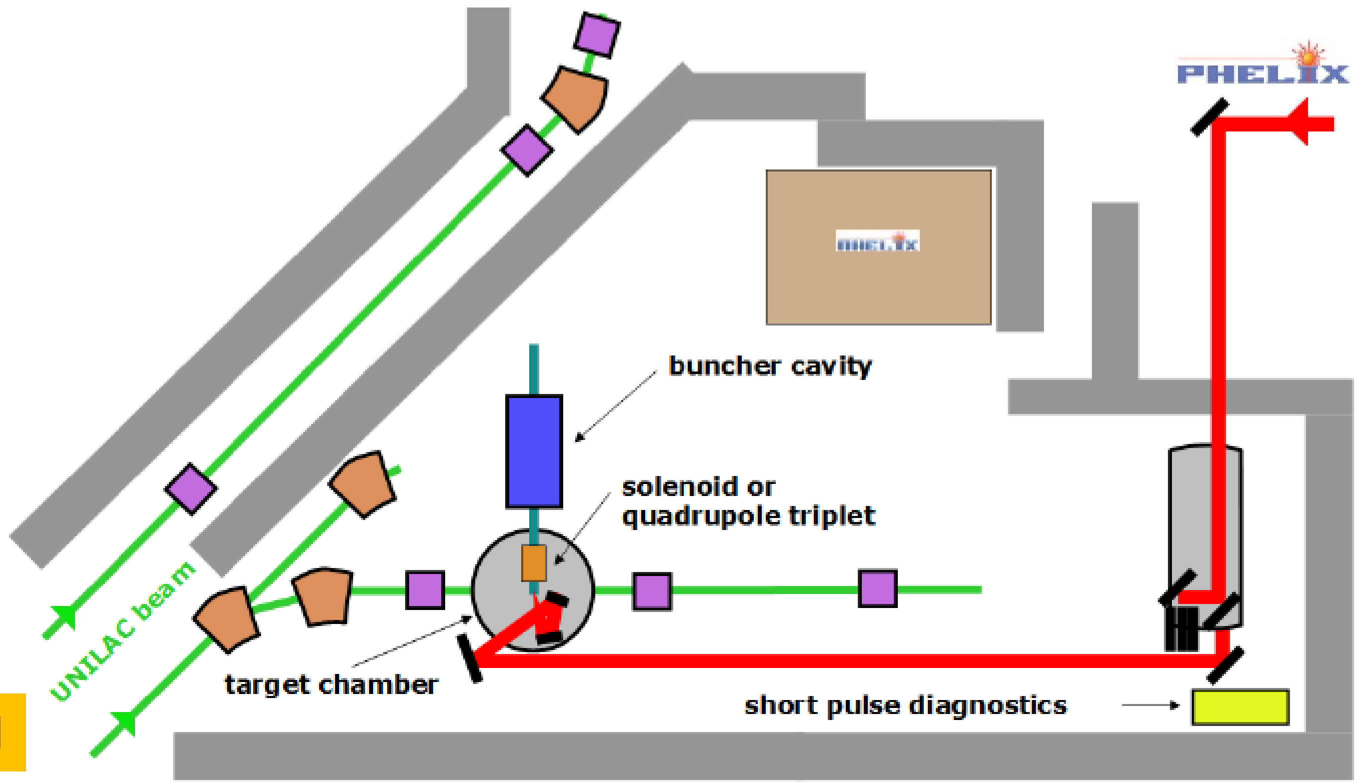
Laser Ion Generation, Handling and Transport

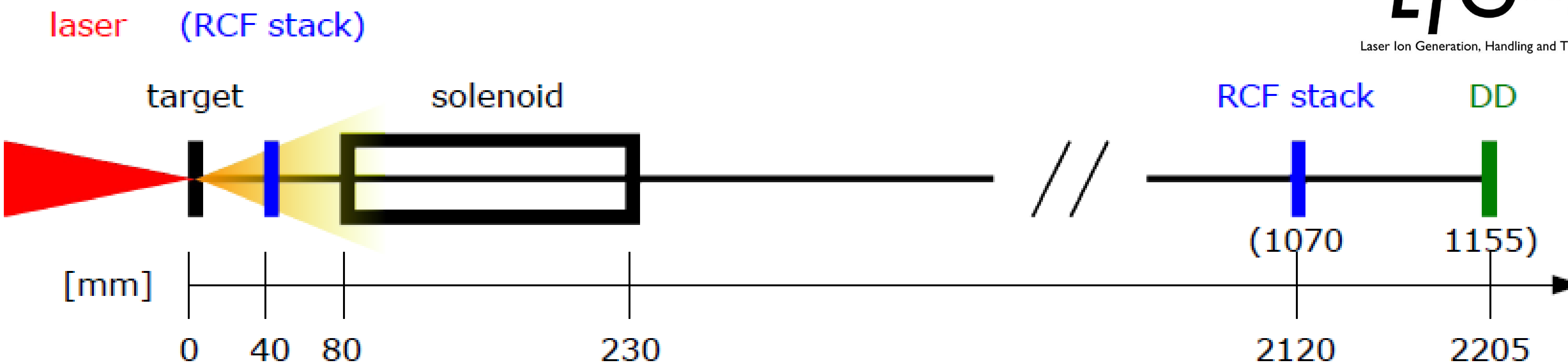


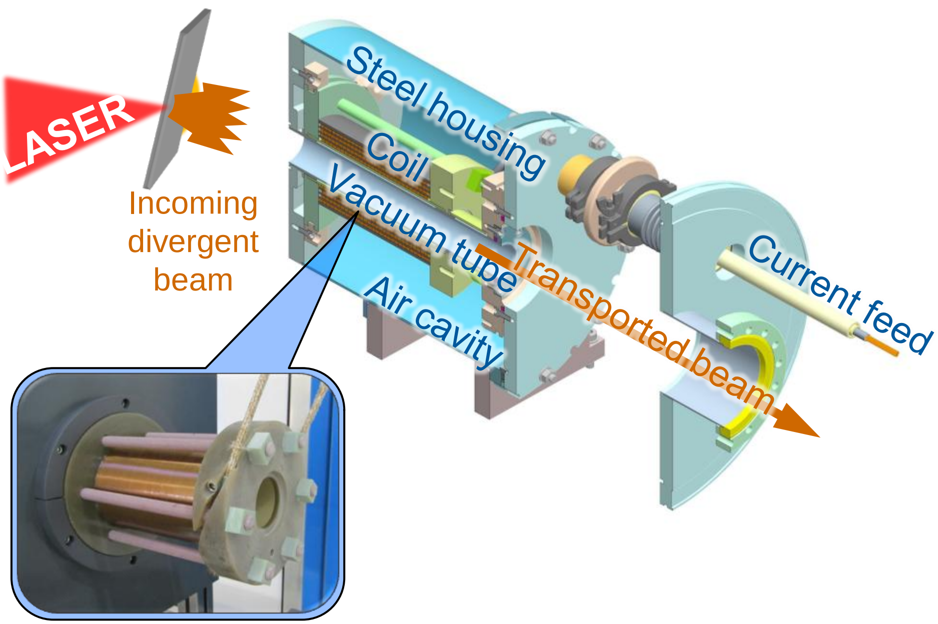
Simon Busold

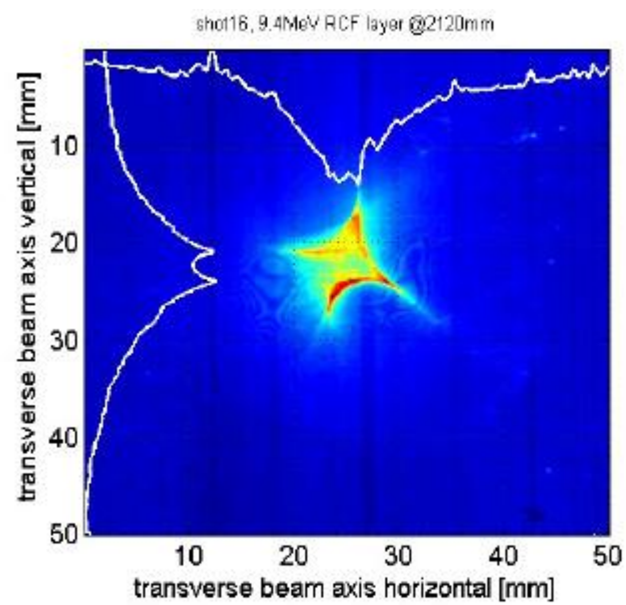
Focusing of 10 MeV at 2 m distance with > 10^9 particles

LIGHT – the project

Laser Ion Generation, Handling and Transport



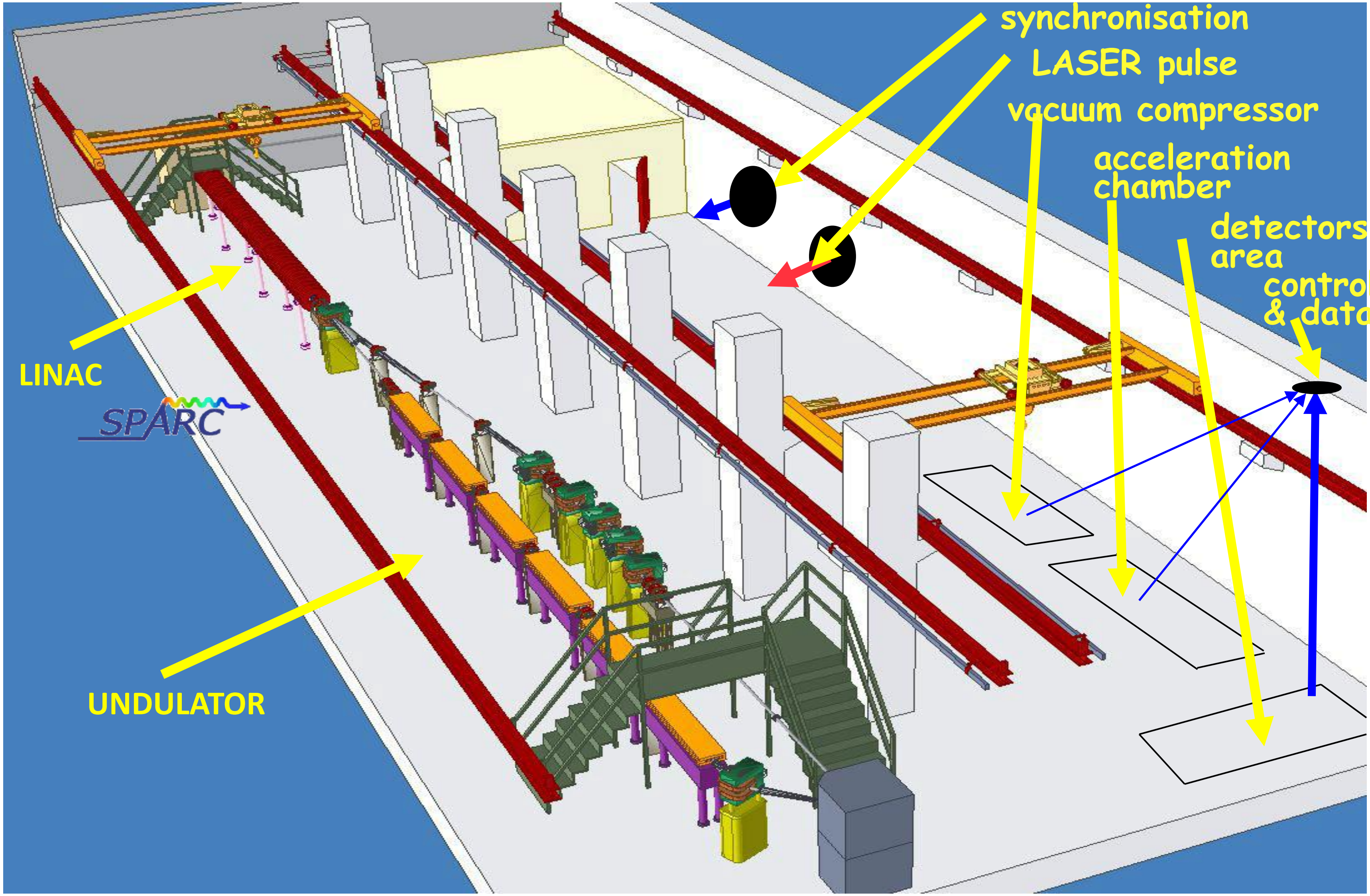




Simon Busold/Florian Kroll

→ Explore phase rotationto narrow the bandwidth

LILIA INFN-experiment is also seeking to transport laser-produced protons & post-accelerate them

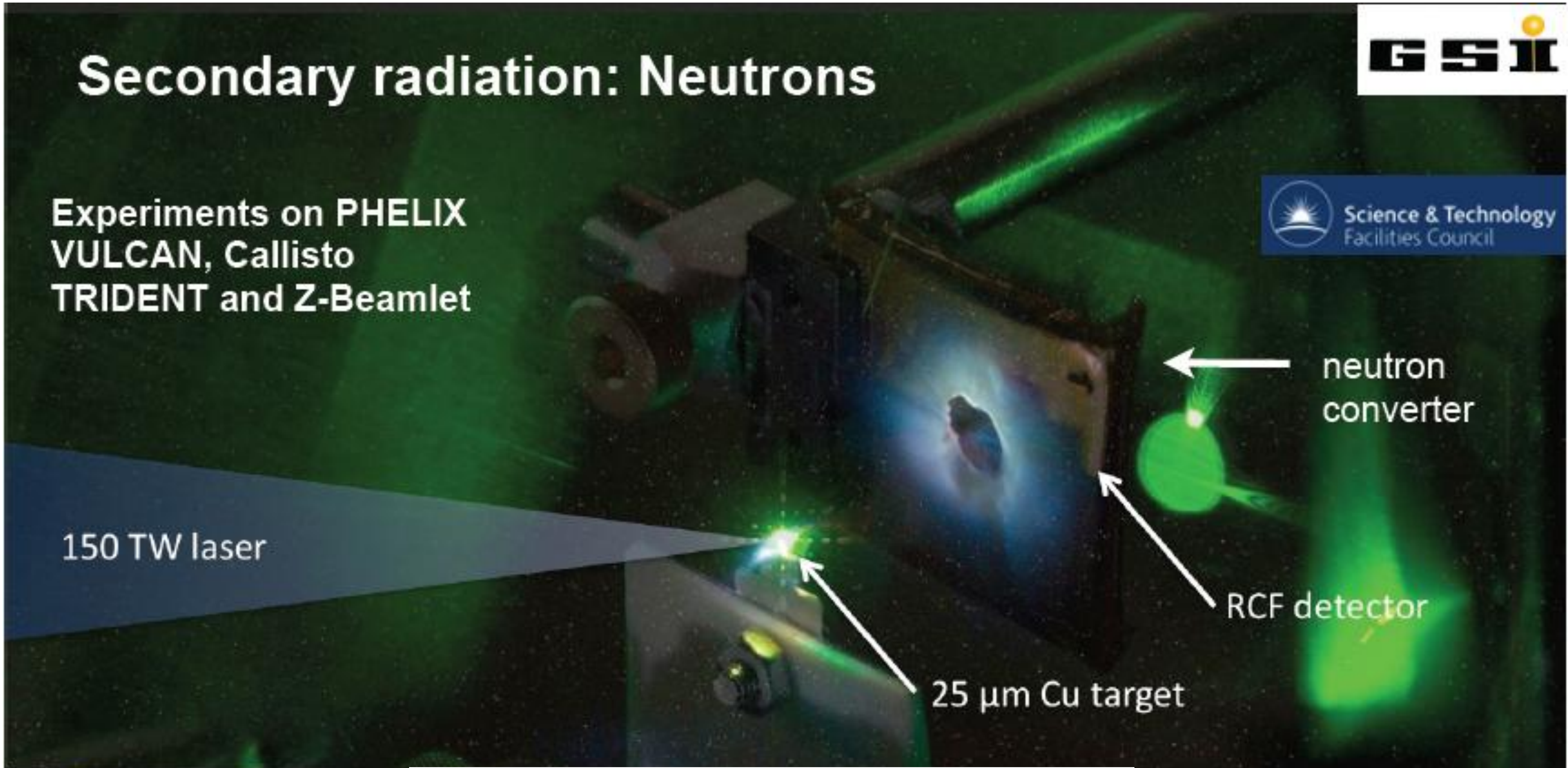


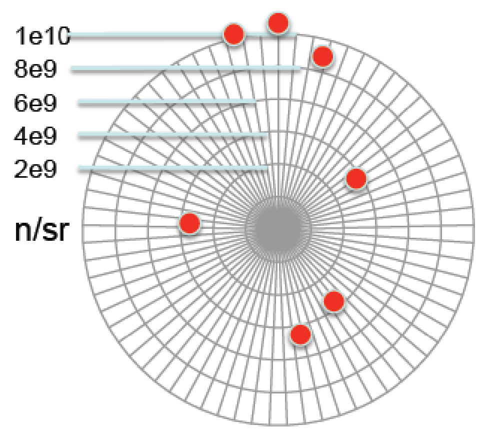
Danilo Guilietti

New insights on (laser-driven) ion beam applications

Secondary radiation: Neutrons

Experiments on PHELIX
VULCAN, Callisto
TRIDENT and Z-Beamlet





Neutrons:
$>10^{10}$/sr
>200 MeV
Peak @ 70 MeV

60 J of Laser energy
1×10^{21} W/cm^2

Markus Roth

First short pulse laser driven fast neutron radiography

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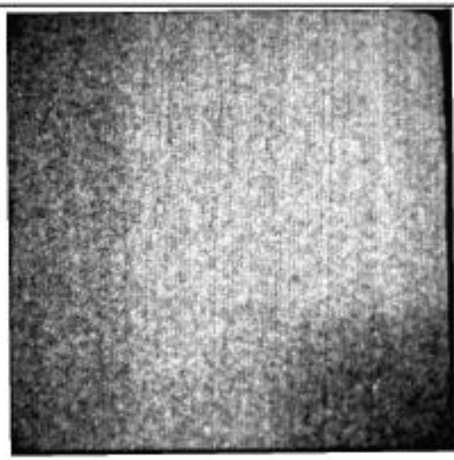
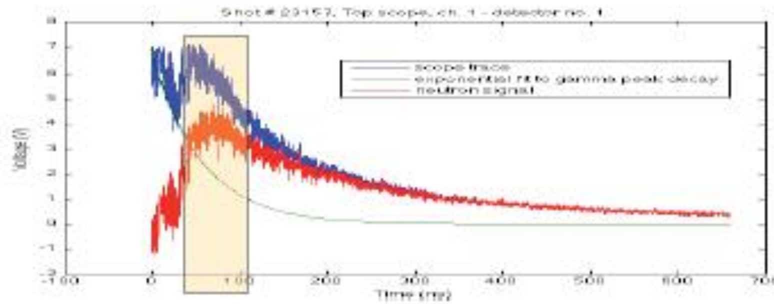
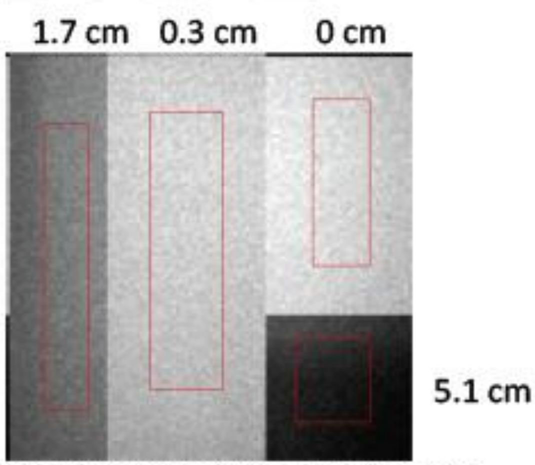
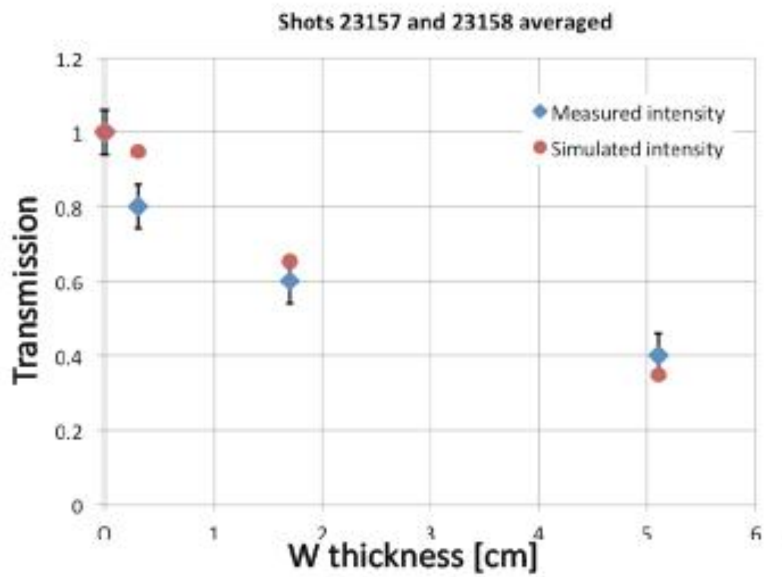






W thickness and simulated image



Markus Roth

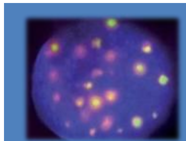
Translational research in Radiobiology

Discovery → Translational research → Clinical practice

FaDu & SKX

Establish dosimetric protocols & cell lines

p^+ & e^-



In vitro cell irradiations

e^-

In vivo irradiation of animals

Clinical trials

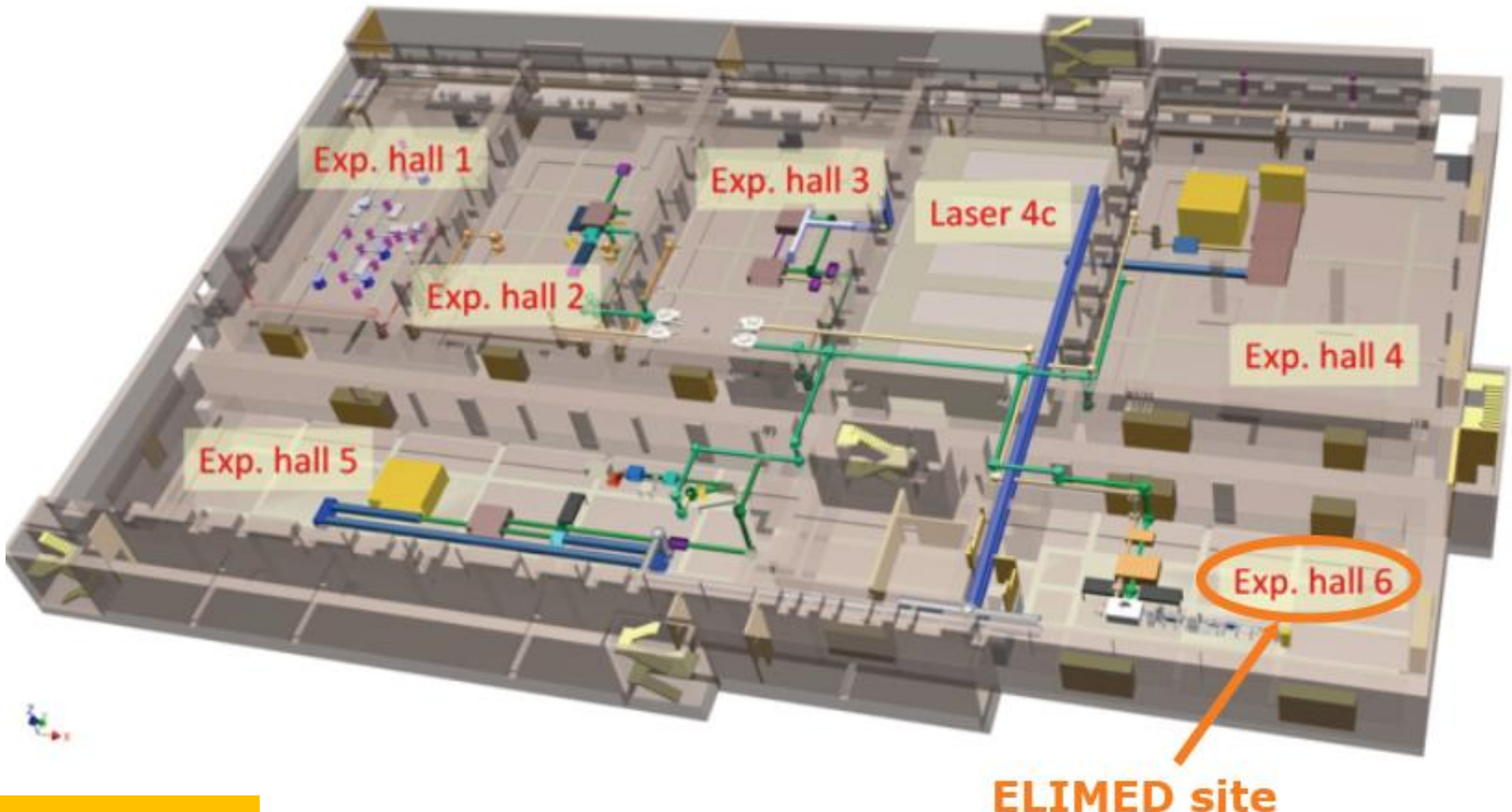
Clinical practice

Laser accelerator progress

Florian Kroll

ELIMED
ELI-Beamlines MEDical and multidisciplinary applications

ELIMED area at ELI-Beamlines



Valentina Scuderi

Summary:

- new, more efficient, volumetric laser acceleration mechanisms emerge
- beam transport lines based on a mix of conventional & plasma optics
- new applications (nuclear physics, neutron probing) + push toward tests of feasibility of therapy

Thanks to all WG2 participants!

Workshop on ion beams diagnostics: forum for both laser-driven & conventional accelerators

Last one: June 2012 at ÉCOLE POLYTECHNIQUE ParisTech

Next one in 2014 at GSI

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