EUROPEAN UNION

Structural Instruments 2014-2020

Project co-financed by the European Regional Development Fund through the Competitiveness Operational Programme "Investing in Sustainable Development"

eli nuclear physics

Extreme Light Infrastructure-Nuclear Physics (ELI-NP) - Phase II

IFIN-HH

GeV Compton photons generated by self-aligned collisions with a plasma mirror

Petru Ghenuche on behalf of the ELI-NP team and collaborators

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EAAC2025 7th European Advanced Accelerator Conference

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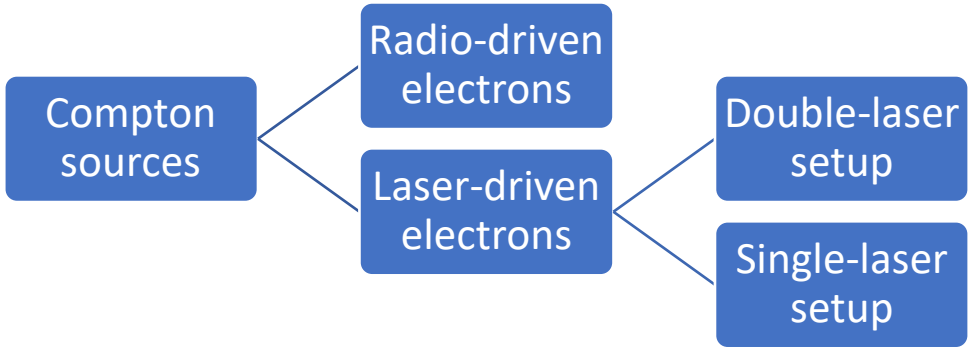
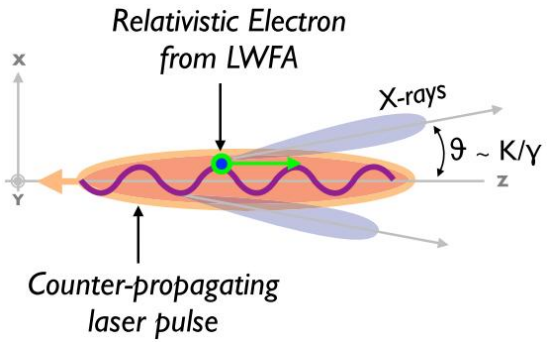
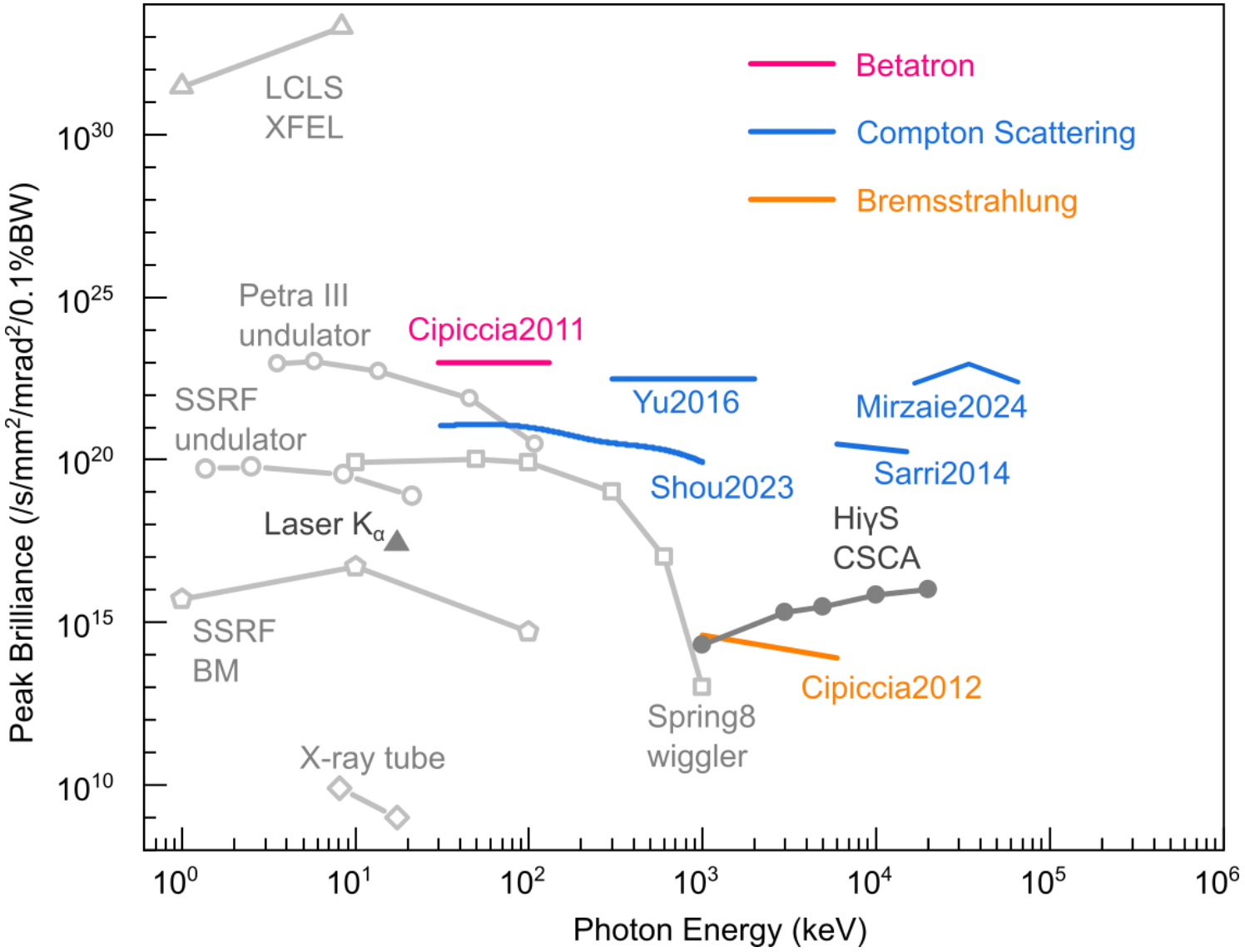
P. S. M. Claveria

Background: Compton light sources





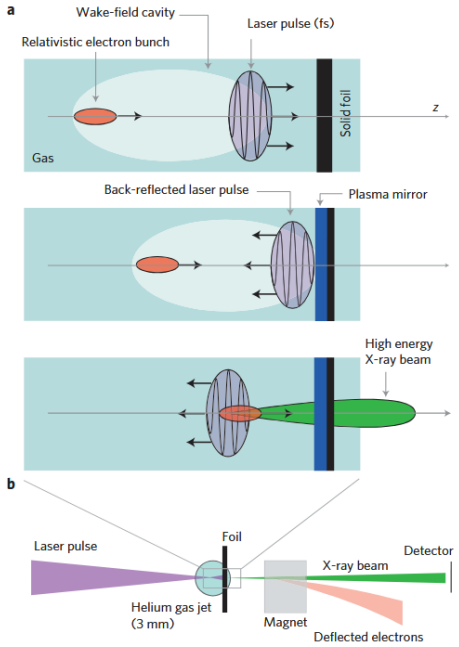


S. Corde et al. Rev. Mod. Phys. 85, 1, 2013

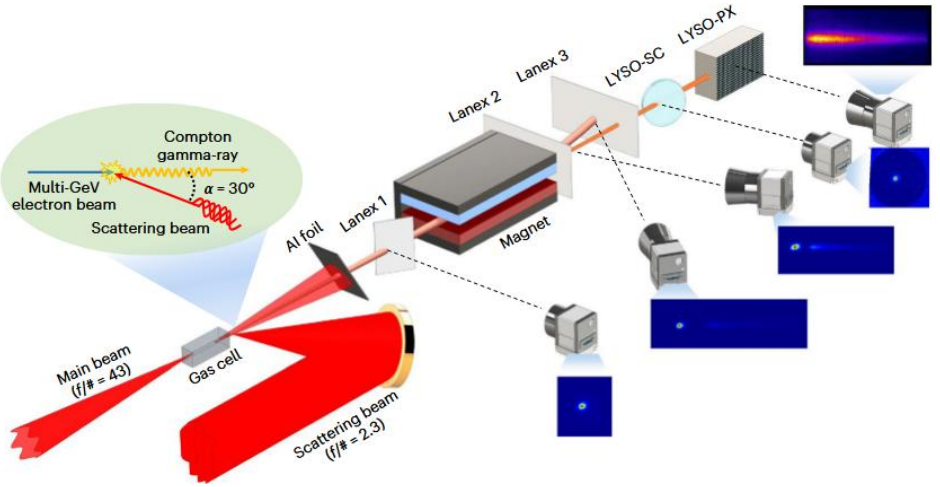
P. Tomassini et al., Appl. Phys. B 80, 419–436 (2005)

Y. Shou et al., Nature Photonics 2023

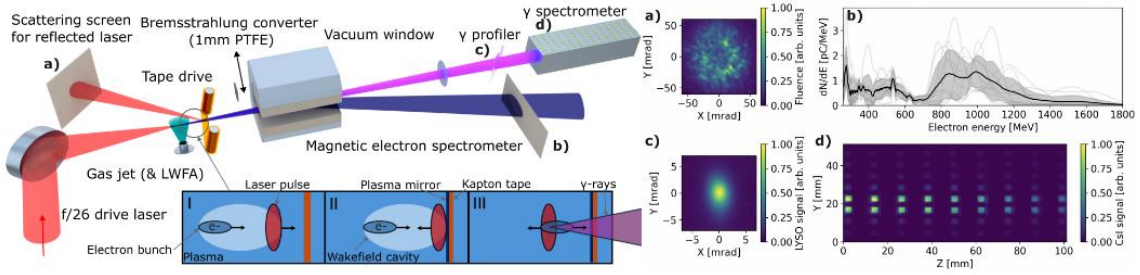
All Optical Schemes (Selection)



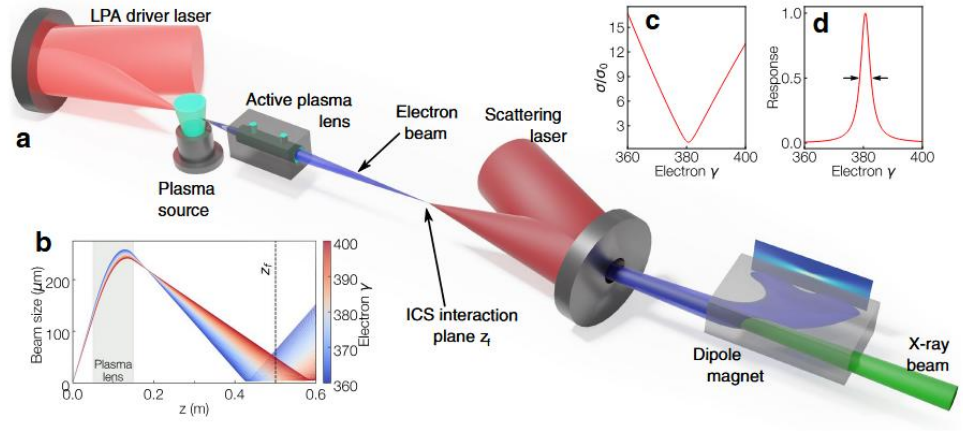
K. Ta Phuoc et al., Nat. Photon. 2012



Mirzaie et al. Nat. Photon. 2024

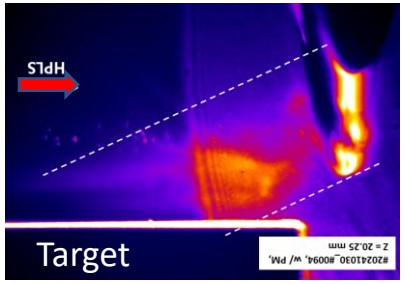


E. Gerstmayr et al., arXiv 2025



T. Brümmer et al., Sci. Rep. 2022

ELI-NP laser: experimental setup



Shadow

Phasics

Specular

Probe

Plasma mirror
5° angle

Window

Magnet
~ 1 T

e-spectra

Slit jet

42°

Entry
Lanex

ICT

57°

67°

Lanex1

Lanex2

Lanex3

LYSO

CsI

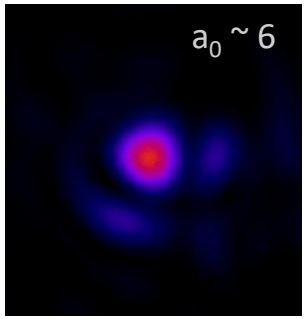
Laser Dump

Probe

FROG

Topview
Far field
Near field

Focal spot



Spherical mirror: 30 m focal length (F#60)

Spot size diameter: 58.0 ± 2 µm at FWHM

Laser max. energy: 185 J on target

Encircled energy: ~ 50% @ $1/e^2$

Pulse duration : 24±2 fs on target

Laser energy stability at full power: ±2%

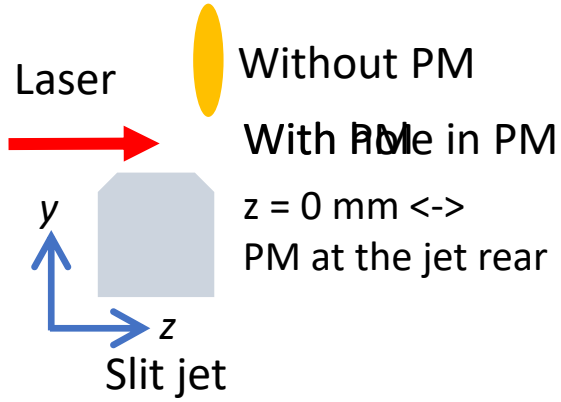
Laser pointing stability on target: < 1 µrad

Laser strength a_0: ~ 6

Gas target: He + 2%N_2

V. Lelasseux

Y. Shou

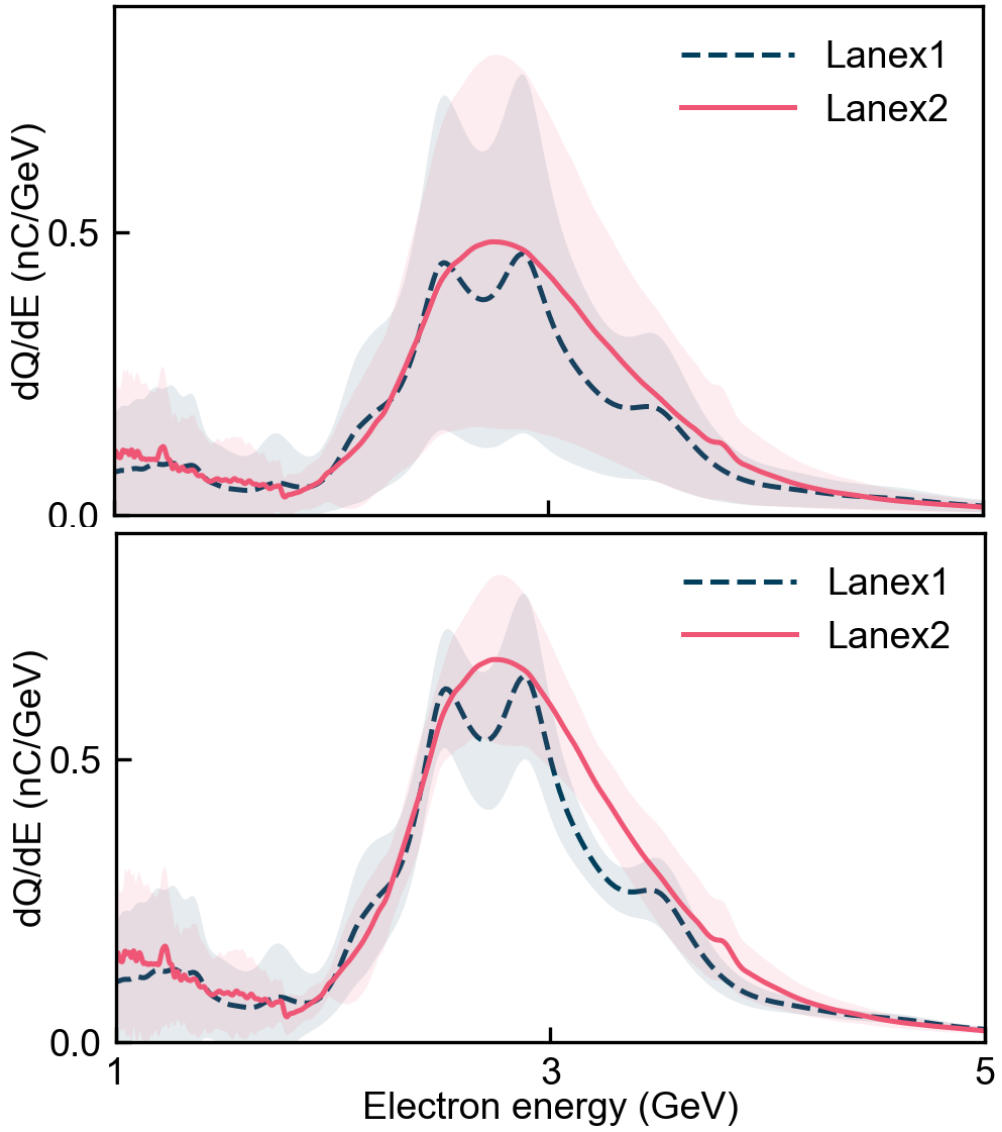


ELI-NP laser: Cross-check of electron spectra and charges

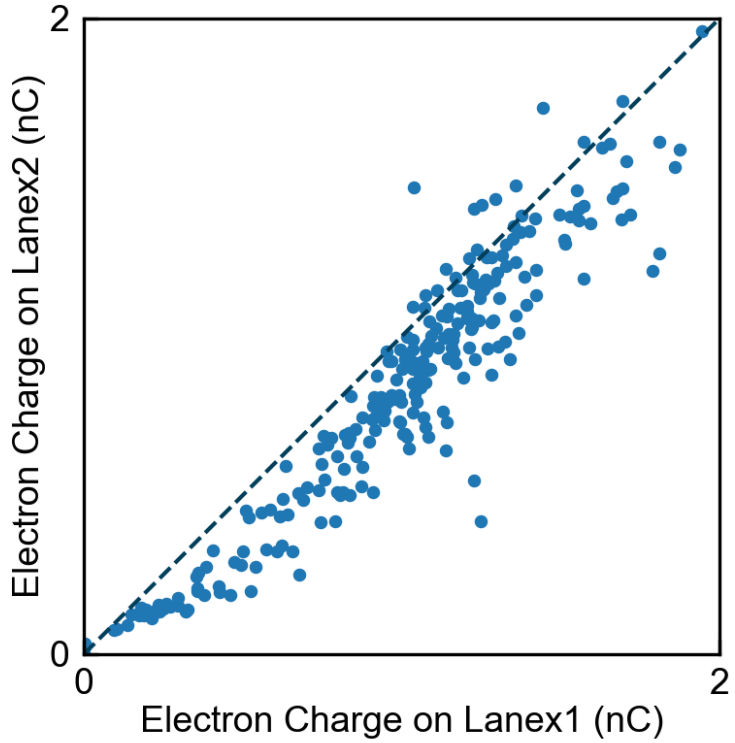
Y. Shou

Electron spectra without PM

Electron spectra with hole in PM

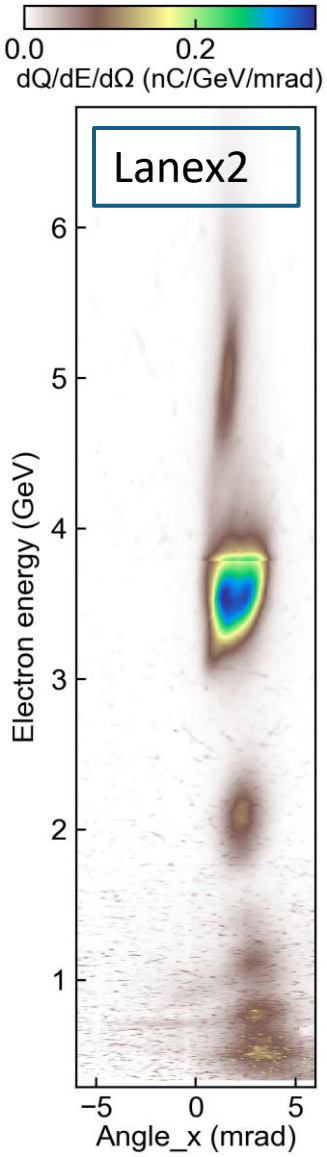


Electron charge measured by Lanex1 and Lanex2

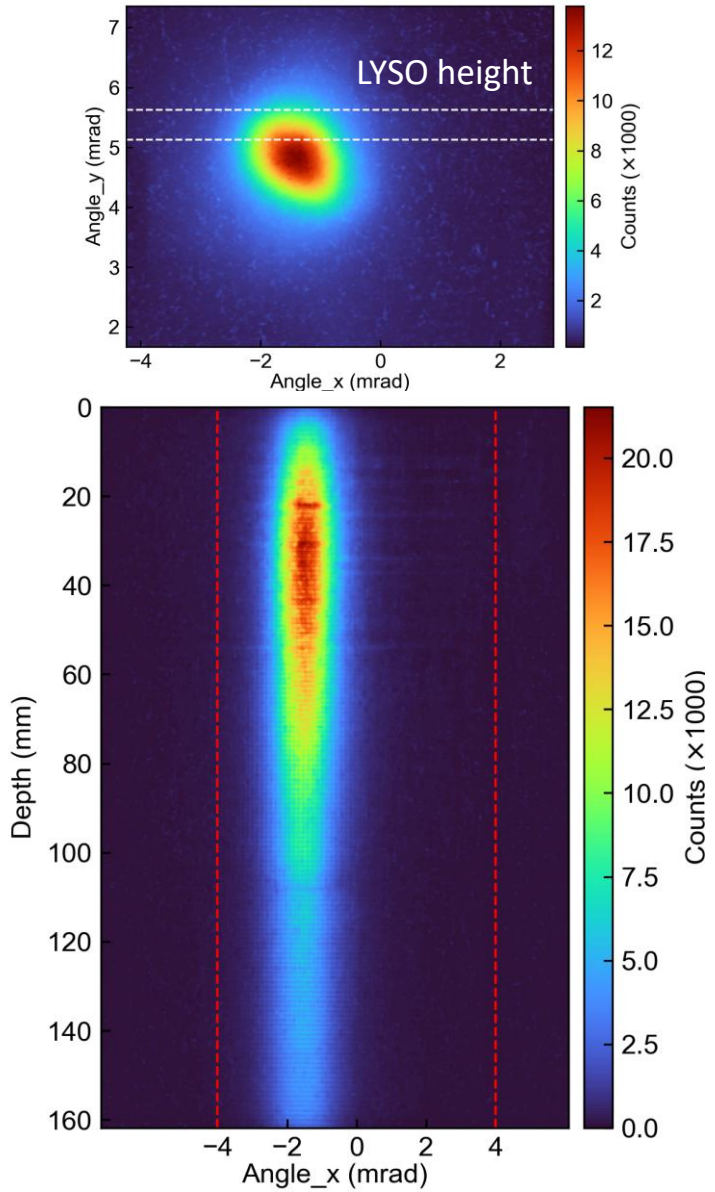


ELI-NP laser: Experimental results for References

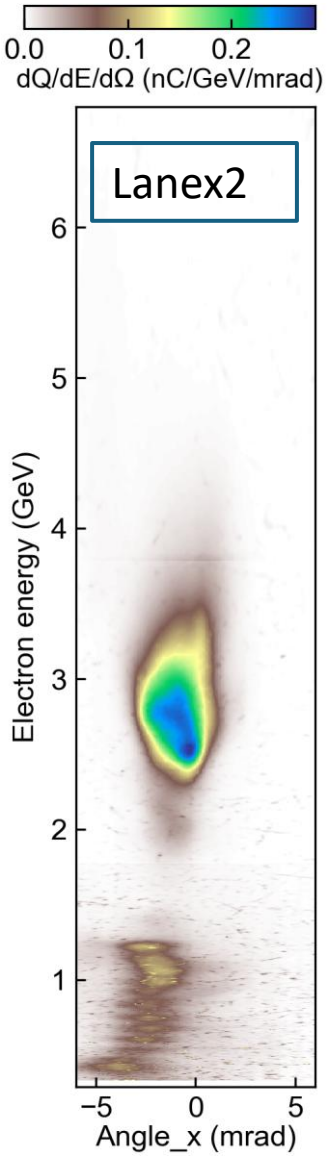
No PM



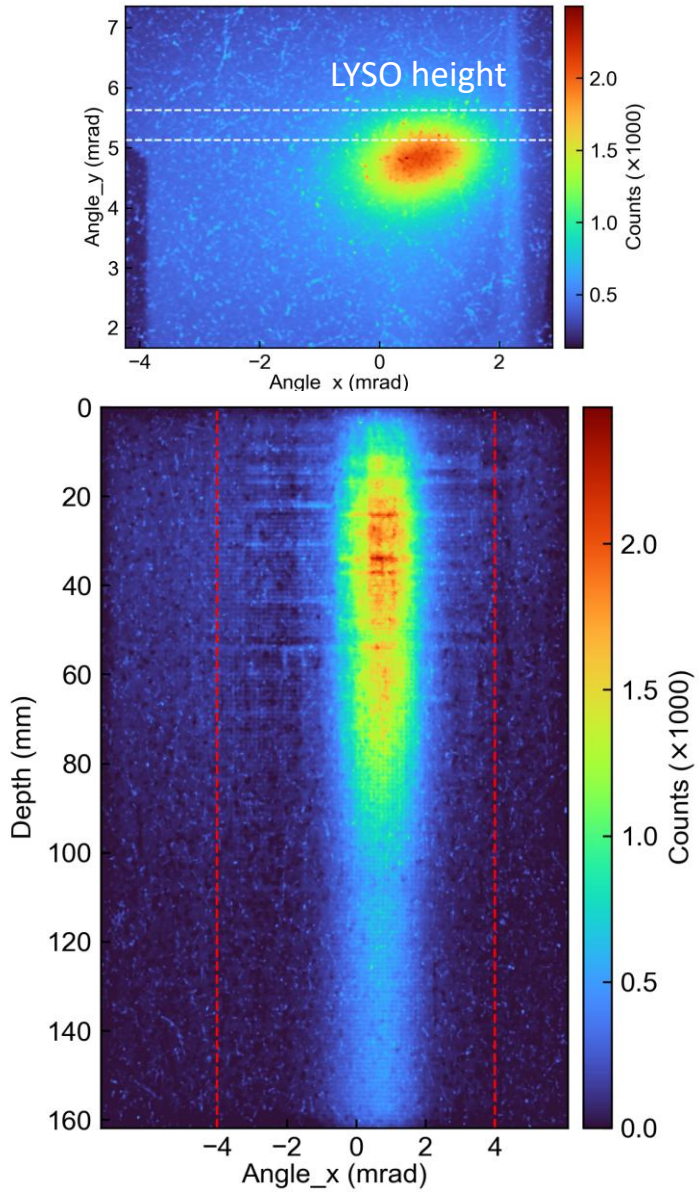
Bremsstrahlung



Hole



Bremsstrahlung

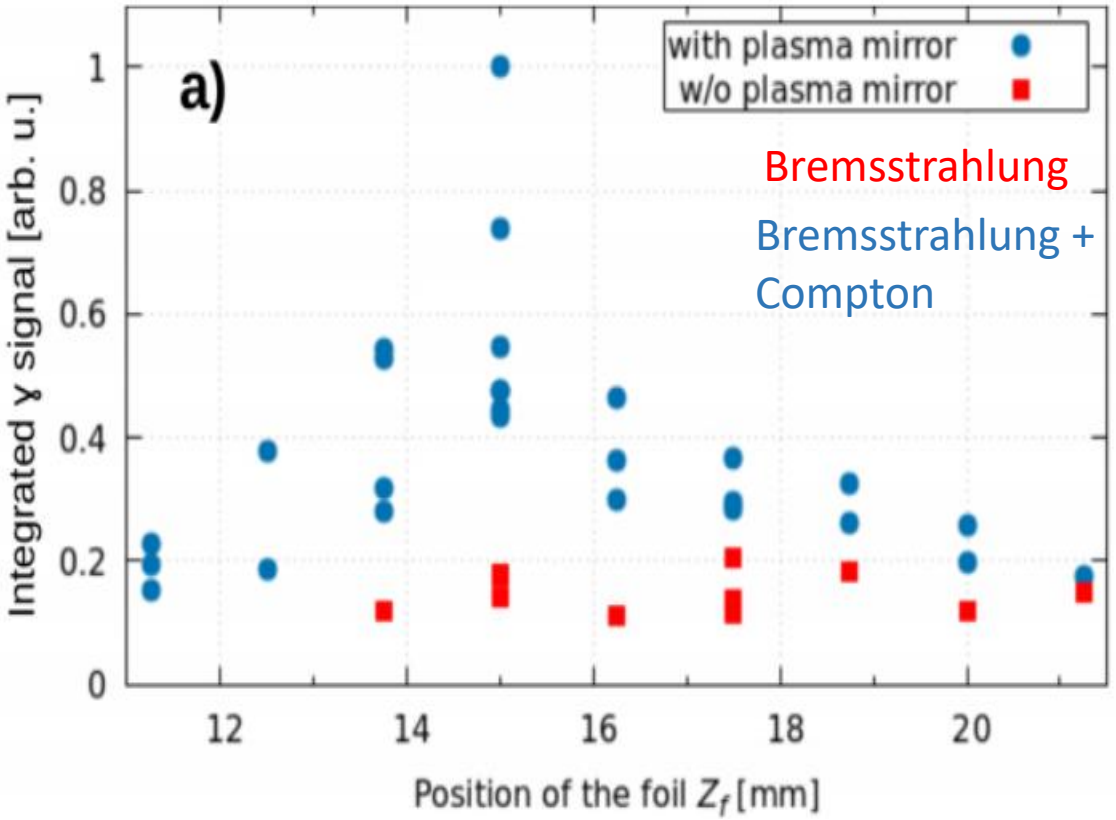


Photon profile

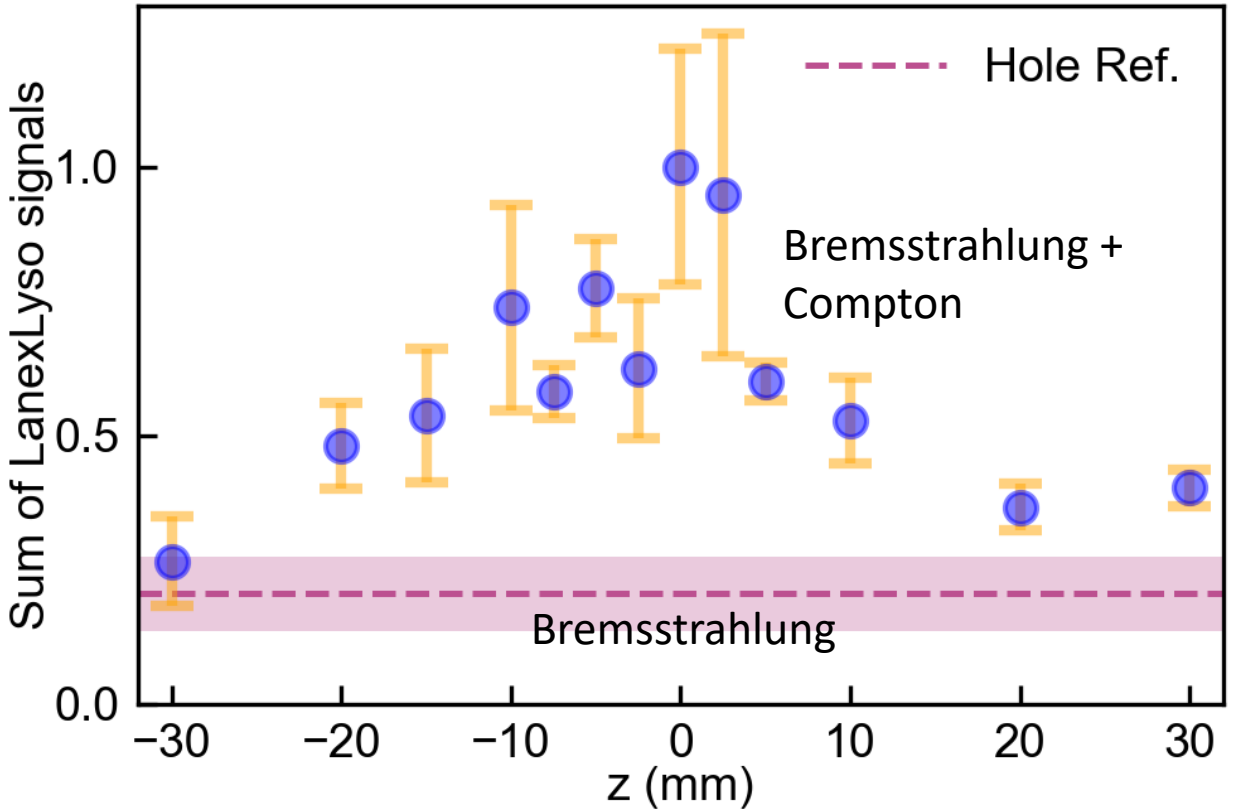
Photon spectra

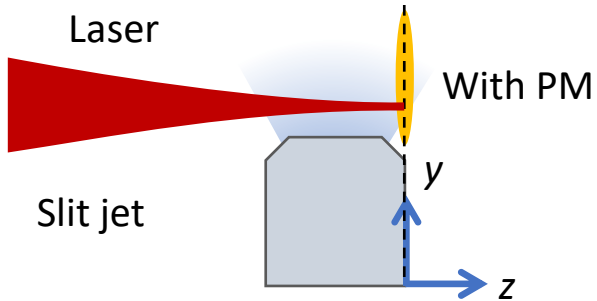
Scan of PM position and Integrated gamma signals

Results at Apollon



Results at ELI-NP





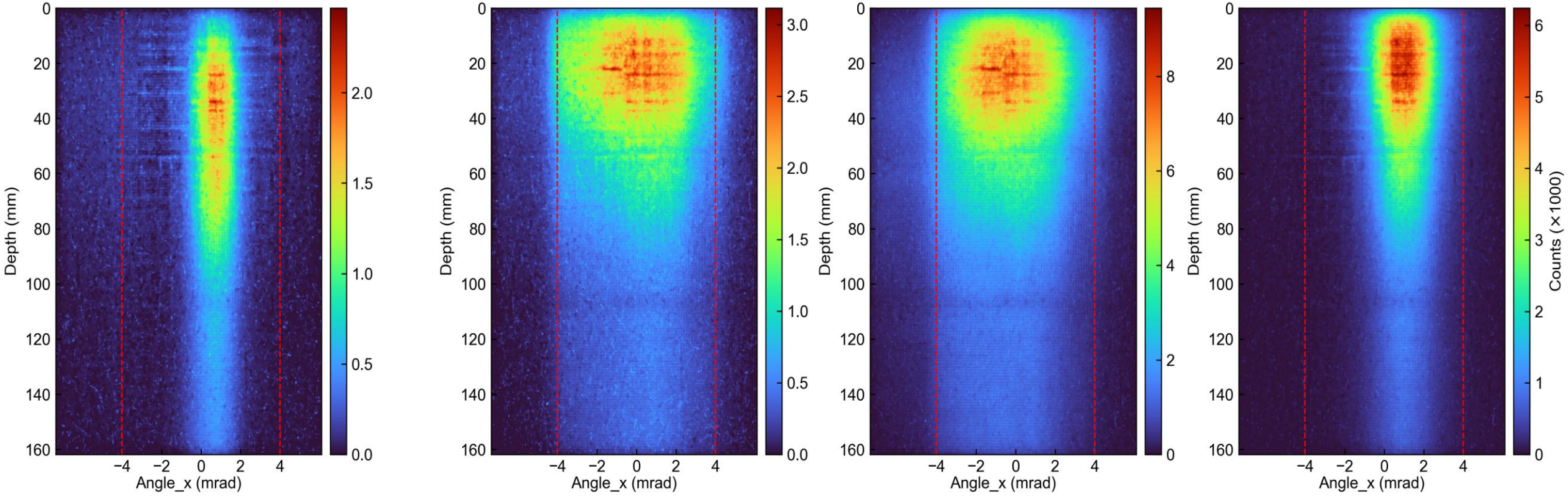
A. Matheron et al., submitted

ELI-NP laser: PM position scan

LYSO signals: Gamma-ray

Towards the gas-jet ← → Away from the gas-jet

Ref: Hole | z@-7.5 mm | z@0 mm | z@10 mm

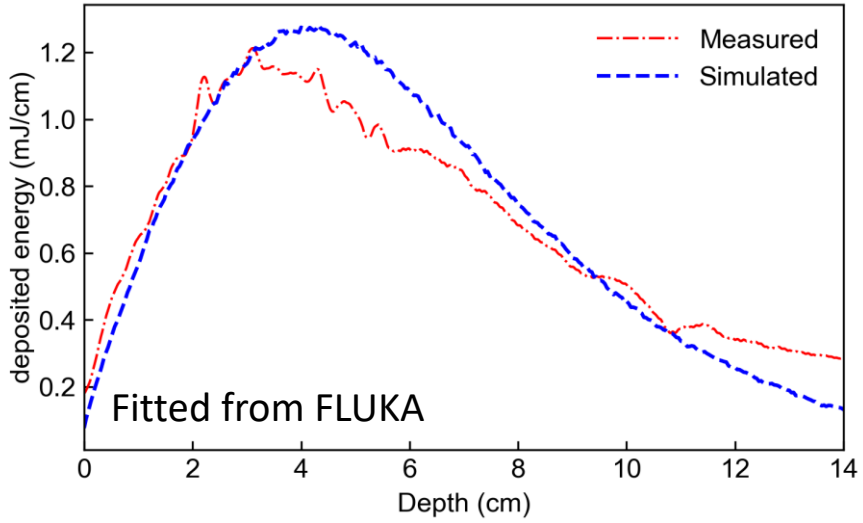


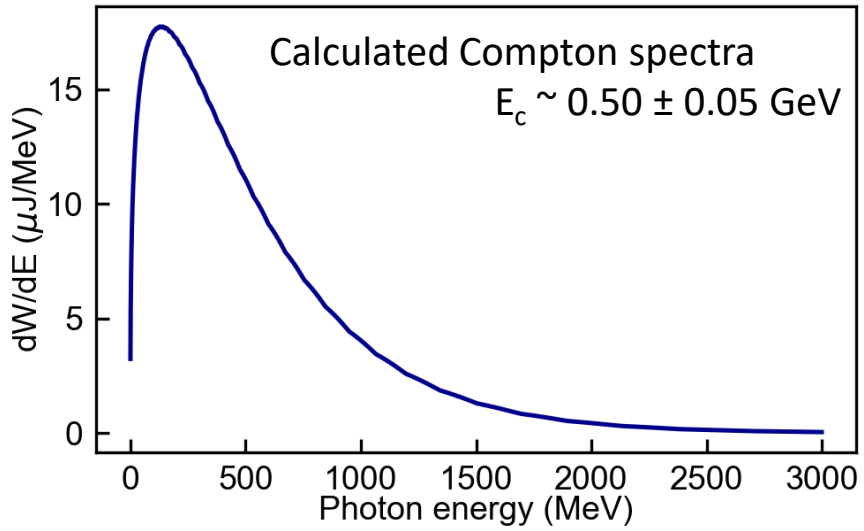
Bremsstrahlung

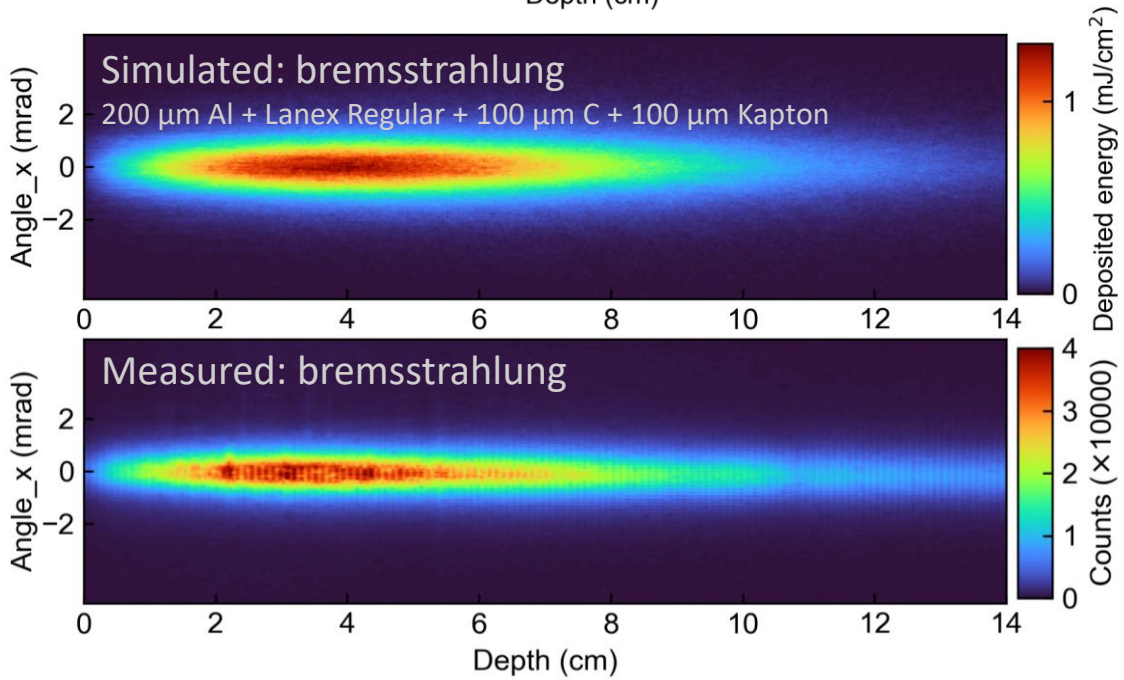
Bremsstrahlung + Compton

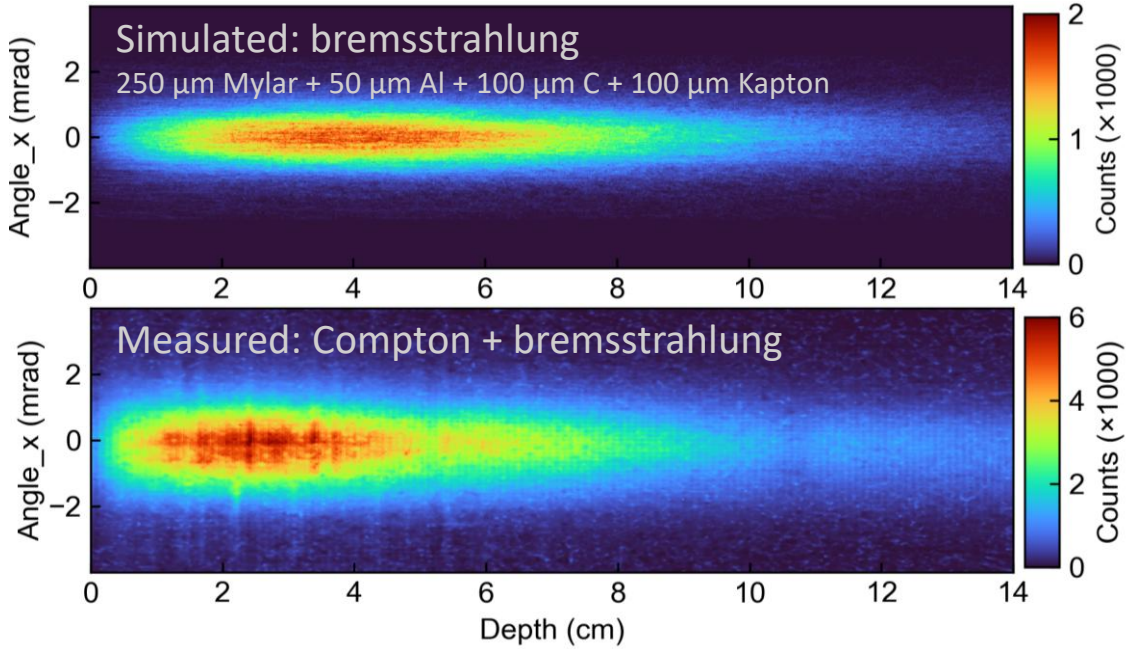
ELI-NP laser: Spectra calibrated with bremsstrahlung and Compton results

Gamma ray spectra









ELI-NP and Apollon laser results

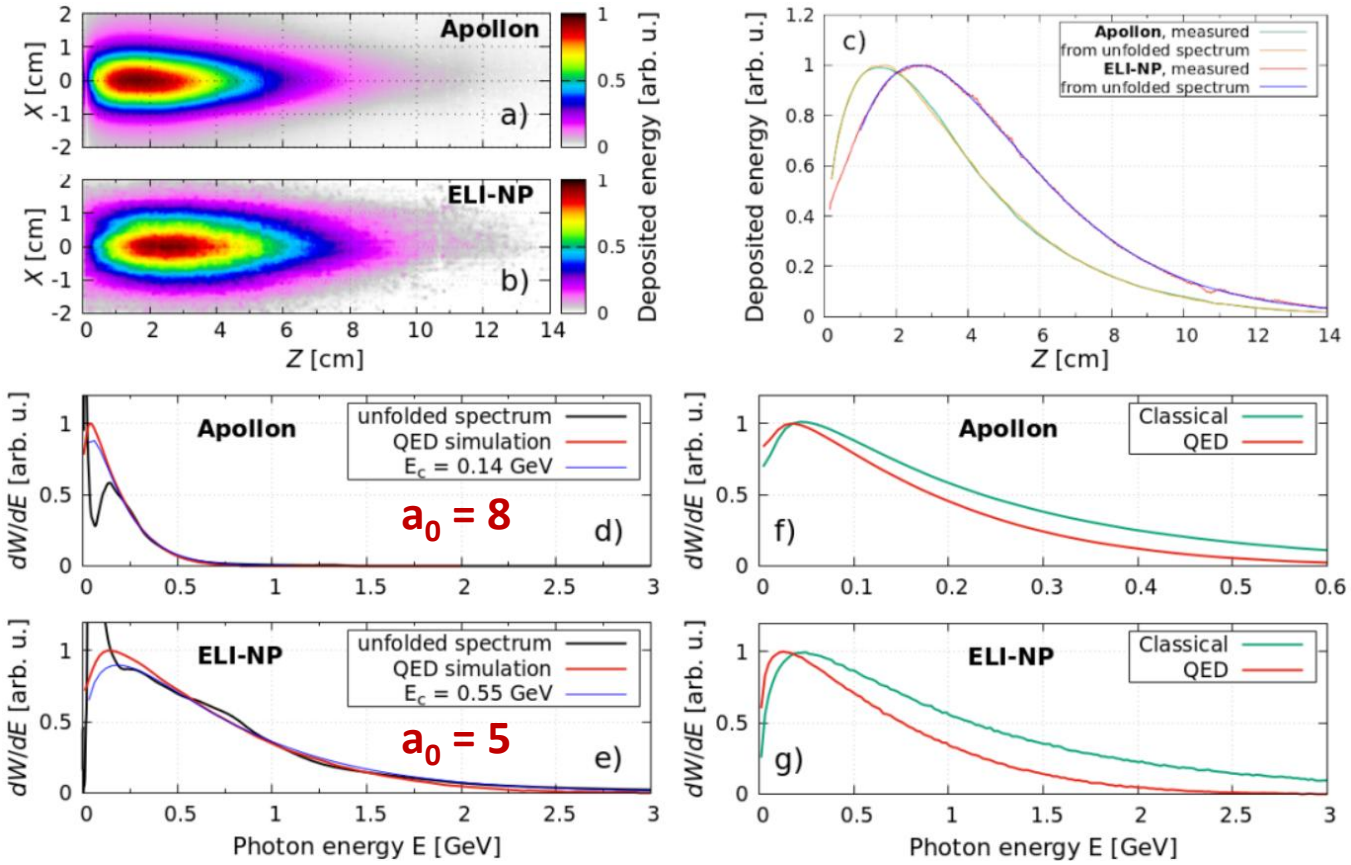
A. Matheron

J-R Marquès

I. Andriyash

Spherical mirror: 6 m focal length (F#40)
Spot size diameter: 40 µm at FWHM
Laser max. energy: 15 J on target
Pulse duration: 25 fs on target
Laser strength a_0: ~ 3
Gas target: He + 1%N_2

Spherical mirror: 30 m focal length (F#60)
Spot size diameter: 58.0 ± 2 µm at FWHM
Laser max. energy: 185 J on target
Pulse duration : 24±2 fs on target
Laser strength a_0: ~ 6
Gas target: He + 2%N_2

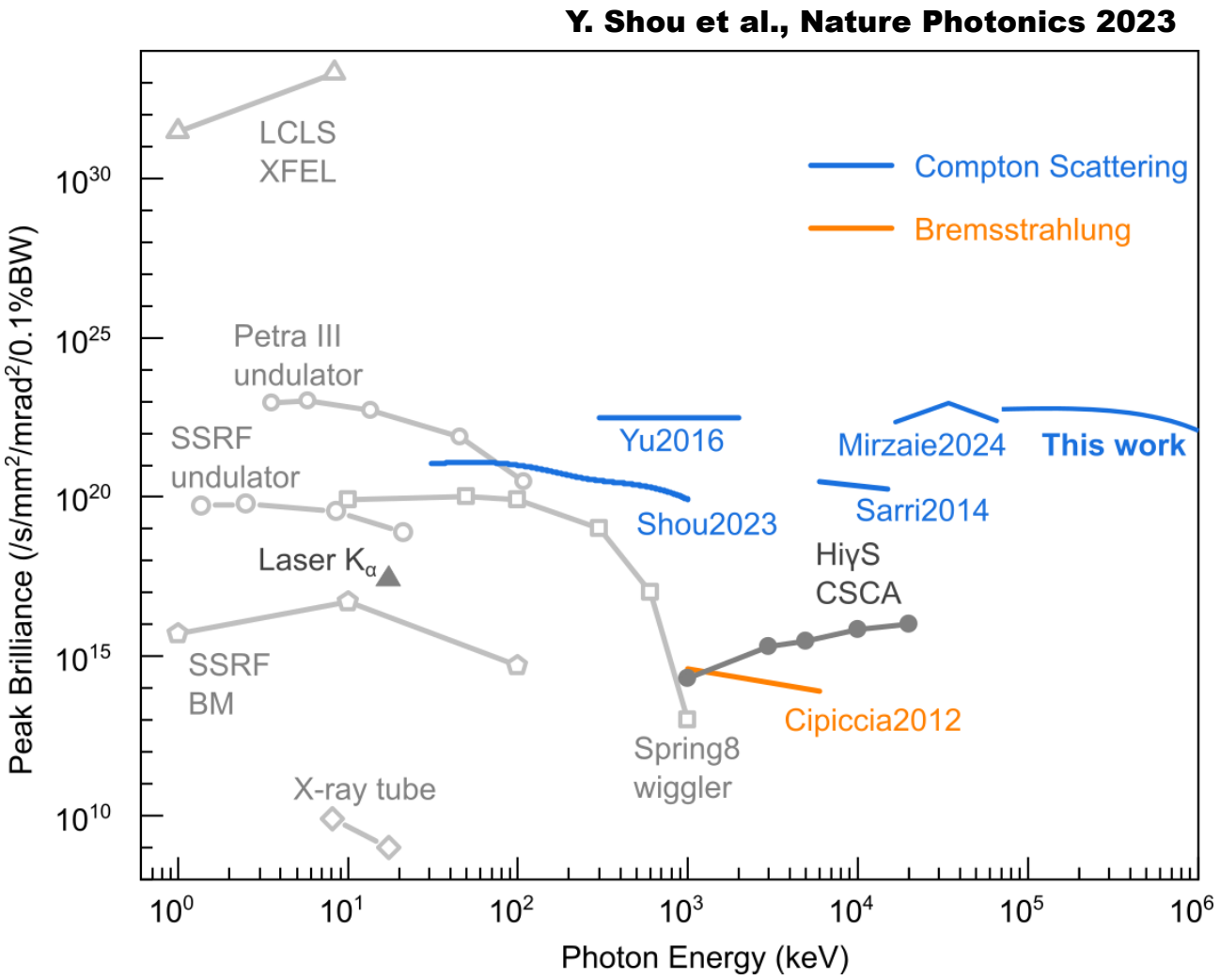


Electron Spectra + Compton Spectra > Scattering Laser Intensity

Ptarmigan code

A. Matheron et al., submitted

Results: Brightness of the GeV gamma-rays



- **We experimentally demonstrate GeV photons generated in a self-aligned single-laser Compton scattering setup, combining a laser-plasma accelerator and a plasma mirror.**
- **Collisions guaranteed by automatic laser-electron overlap provide a stable approach for precise investigations of strong-field QED processes.**
- **The Gamma-rays, with a number of photons > 10 MeV of 4×10^{8}, have a peak brightness of around 10^{23} phs/s/mm²/mrad²/0.1%BW at hundreds of MeV, with a conversion efficiency from laser to Gamma-rays as 10^{-5} ~ 10^{-4}.**

Next Steps: Analyze the CSI stack and the data with lower Brem

Thanks to the ELI-NP all staff, and special thanks go to

All Laser Driven Experiments Department (**LDED**) team and in particular
M. O. Cernaianu, F. Rotaru, P. Tomassini, B. Diaconescu, V. Nastasa, L. Tudor

I. Dancus, D. Ursescu, O. Chalus, C. Derycke and the whole Laser System Department (**LSD**) and **Thales** team, and **MARVEL** fusion

B. Diaconescu, M. Gugiu, D. Ghita, M. Kiss, D. Nistor, M. Masruri, A. Lazar, L. Vasescu, V. Iancu, A. Toma, A. B. Naziru,
A-M. Talposi, D. Matei for the **technical support**

Thanks to the **Technical Department**

Management: V. Malka, K. A. Tanaka, C.A. Ur

Thanks to our collaborators

**QUB (UK), University of Strathclyde (UK), CLF-RAL (UK), Osaka University (JP), KPSI (JP), UCSD (US),
LLE (US), HZDR (DE), ELI-BL (CZ), Weizmann Institute of Science (IL), EP,CNRS, LOA,LULI (France)**

ELI - RO

NUCLEU and IOSIN programs

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Thank you!

Plasma Physics, Optics, Nuclear Physics, Material Science

1PW and 10PW laser beams available for the community

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eli-np.ro

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