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Manuel Sanchez del Rio

European Synchrotron Radiation Facility ESRF Grenoble (France)

Simone Manti

INFN-Laboratori Naziolali di Frascati (Italy)

COST ACTION CA24131
European Network for radiation-detection based Research and Innovation addressing increasing societal CHallenges (ENRICH)

ENRICH

WG3 in 2025-2026 (Software Advancements)

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the European Union

COST-ENRICH Annual Meeting 2026

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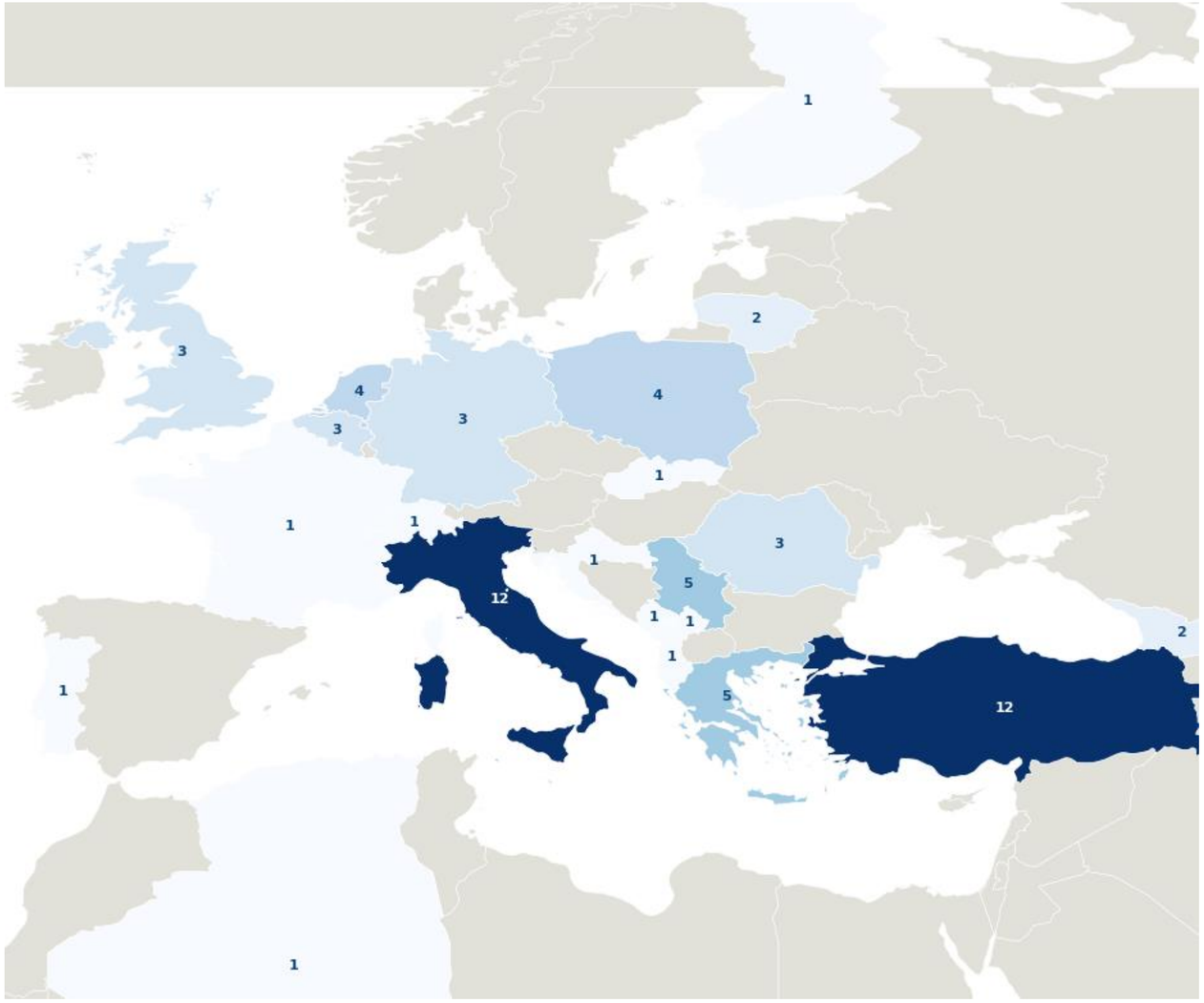
69 Members- 22 countries

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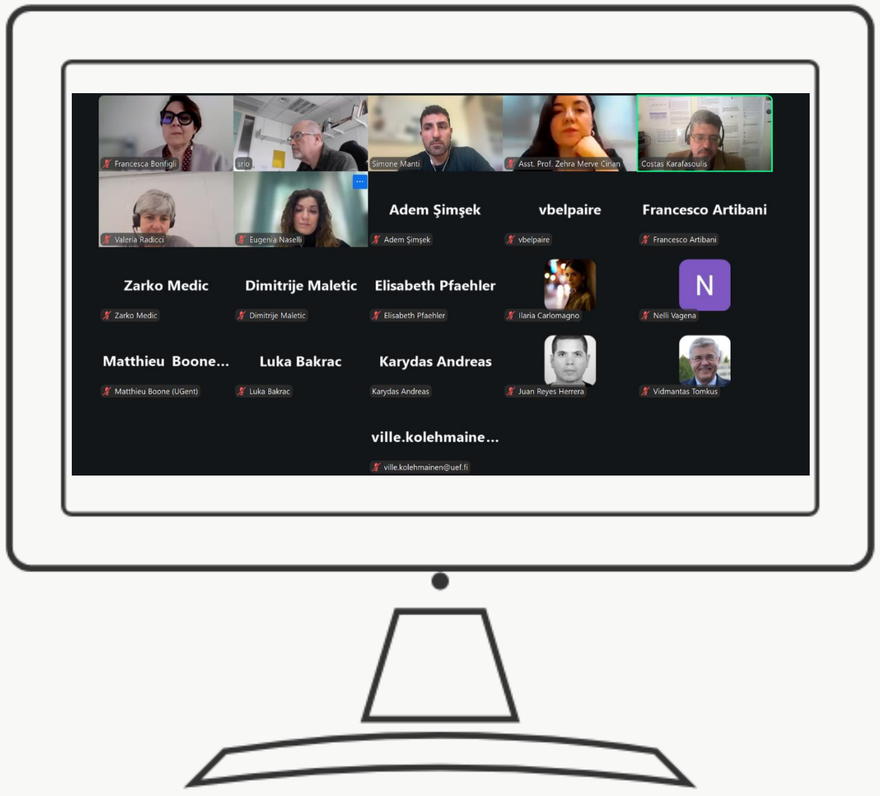
WG3 Meetings: https://pandora.infn.it/public/8d7620

- 6 February 2026
  - Simone Manti
  - Manuel Sanchez del Rio
- 16 March 2026
  - Francesco Artibani
  - Vincent Belpaire
  - Costas Karafasoulis
  - Eugenia Naselli
- 12 June 2026
  - Juan Reyes Herrera
  - Zarko Medic
  - Kalliopi Tsampa



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Activities

1.1.2 Description of the challenge (main aim)

Data Analysis, Software, and Ray Tracing Simulations: The ENRICH Action will integrate the raytracing/wave optics simulations community, which currently focuses on beamline applications, into the broader radiation detection field. The aim is to develop high-quality ray propagation simulation codes for general applications and assist research groups in applying these codes. ENRICH will also seek to enhance collaboration between the raytracing/wave optics community and other MC simulation frameworks like GEANT and FLUKA, promoting multidisciplinary experiments. The Action will leverage Machine Learning to standardize analysis techniques for photon detection applications, addressing challenges like handling large data volumes and improving experimental reliability.

1.2.1 Technological Efforts (TE)

- TE5: Integrate advanced raytracing and wave optics simulations with MC simulation software to enhance multidisciplinary experiments.
- TE6: Discuss innovations in data acquisition and pre-processing hardware and software, including AI-powered solutions.
- TE7: Standardize new Machine Learning data analysis techniques for broader understanding and use.
- TE8: Develop Machine Learning-based self-alignment tools for optical components adaptable to various applications and measurements.

1.2.2.1 Research Coordination Objectives

- RCO4: Promote knowledge exchange among Monte Carlo simulation communities, integrating ray-tracing software with other physics simulations (e.g., GEANT4, FLUKA).
- RCO5: Support the comparison and exchange of advanced data fitting and simulation techniques, focusing on novel Machine Learning algorithms. This includes targeted training and expert exchanges to standardize effective data analysis techniques.
- RCO6: Compare and exchange the latest techniques

4.1.1 Implementation in WPs

- WG3: Software Advancement: this WG focuses on all the necessary activities involving the development of new software and standards for the community.
- T3.1: Foster collaboration among Monte Carlo simulation communities to integrate ray-tracing software with other simulation tools and validate integrated simulation models for various photon detection applications (RCO4, TE5).
- T3.2: Realize a compilation of the various data analysis techniques used by the various research teams of the Action, aiming at a more generalized standardization and wider comprehension of the experimental outcomes in different fields and applications (TE7, TE8).
- T3.3: Collaborate with software developers to promote the realization of open-source packages with a multidisciplinary approach, allowing for easy modifications and customizations by the research teams to be adapted to many possible applications (RCO5, TE6).
- T3.4 Enhance AI-powered solutions for data processing and analysis to implement next-generation data processing systems (TE8).

Keywords

Ray tracing simulations, Wave optics, Radiation detection, Data analysis, Monte Carlo simulation, Machine learning, Photon detection, Beamline applications

Actions

- Integrate raytracing and wave optics simulations with MC simulation
- Discuss data acquisition and pre-processing, including solutions.
- Standardize data analysis
- Develop ML tools

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Funding

Funding provided by COST supports **networking activities**, namely:

- Meetings (Action MC, WG or other meetings),
- Training Schools,
- Mobility of researchers and innovators,
- Presentation at conferences organised by third parties for:
  - Capacity building (limited to young researchers and innovators from ITC or NNC),
  - Dissemination of COST Actions' work and results.

Other expenses specifically supporting the Action shall include:

- Dissemination and communication products,
- Expenses incurred for the benefit of the network.

The level C Rules shall describe the scope of the funding schemes as well as their working and financial modalities.

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Training School 20-22 May in Grenoble

41 participants from 19 countries — including 8 expert instructors

COST-ENRICH: Press release
https://web.infn.it/enrich/esrf-enrich-oasys-school-eos26-concluded-in-grenoble/
Course material (slides, examples, documentation, material)
https://github.com/oasys-kit/oasys_school_eos26

Lectures and Practicals

- fundamentals and advanced aspects of optical system design for X-rays
  - Theory
  - Instrumentation
  - multi-technique coupling
  - data processing
  - Components – mirrors, crystals, lenses, gratings and other key optical elements
- Practical training using SHADOW4 in the OASYS2 ecosystem

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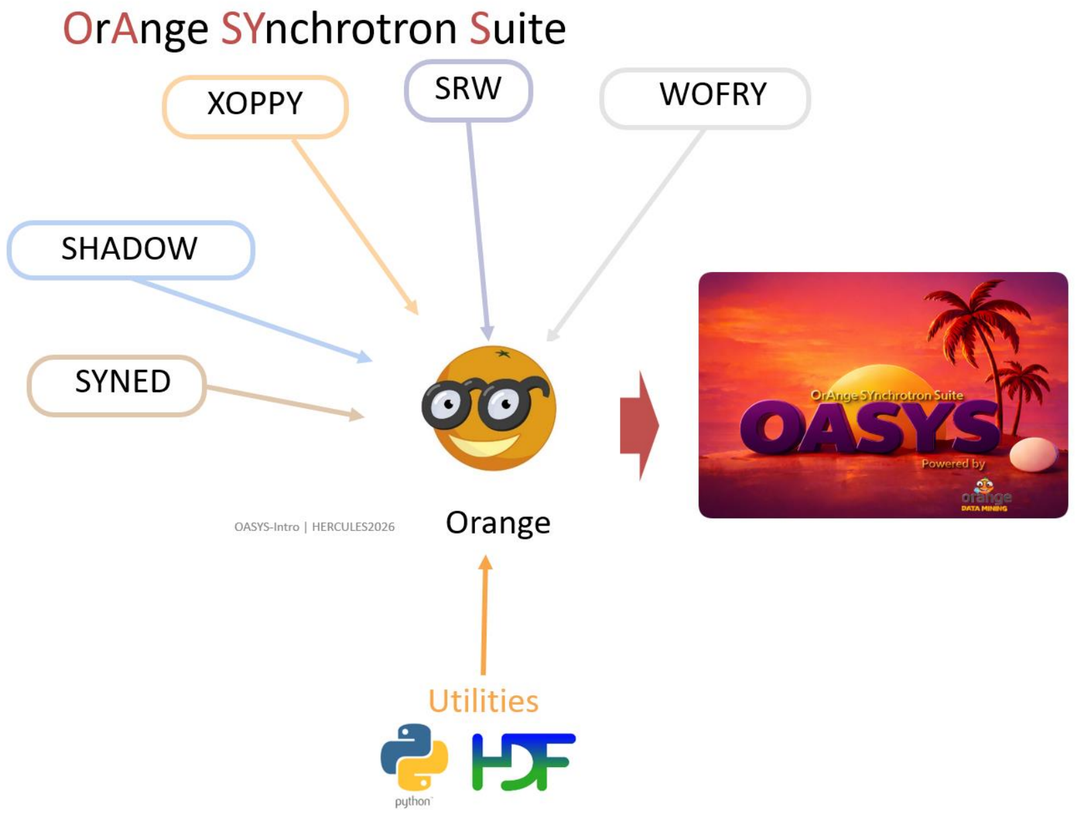
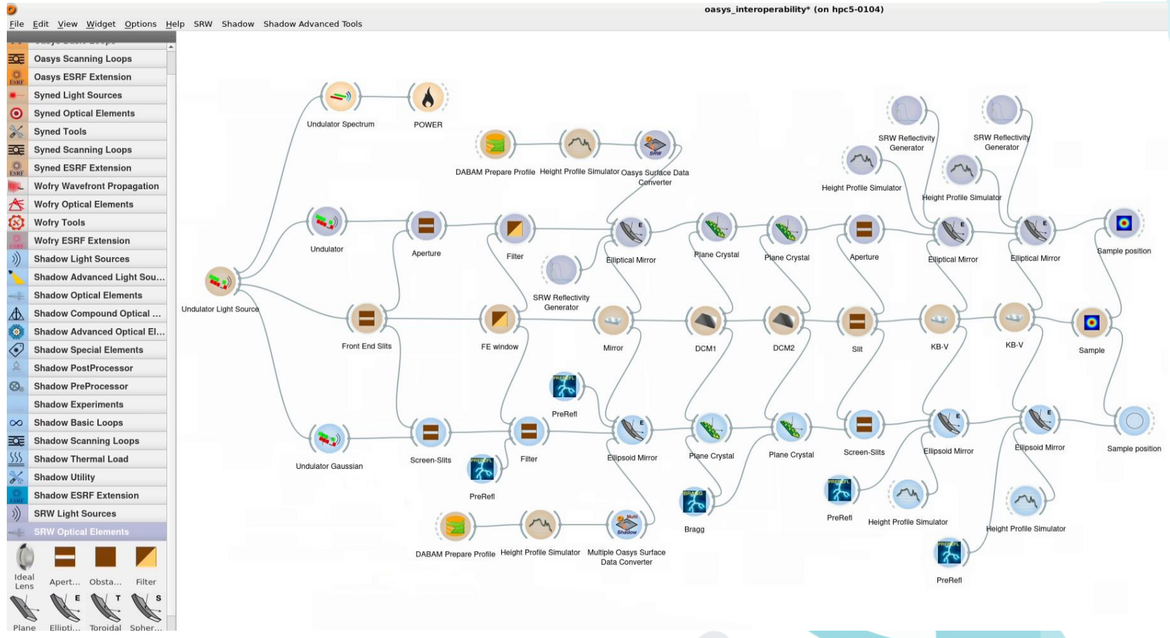
Training School





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ENRICH

Training School

41 participants from 19 countries — including 8 expert instructors

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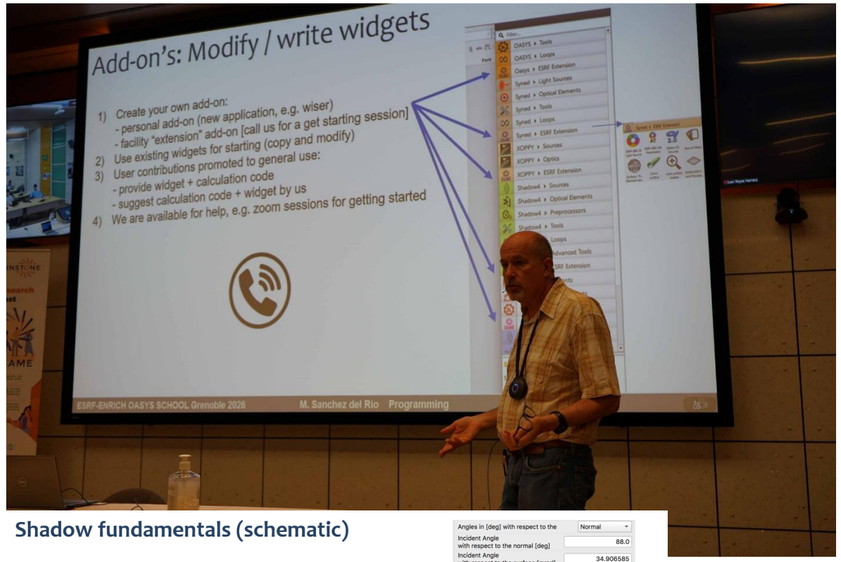
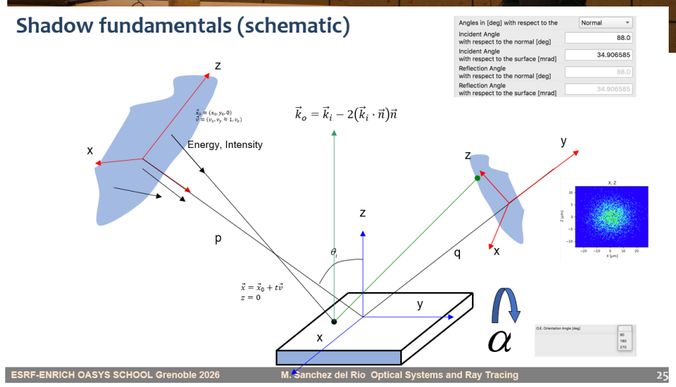
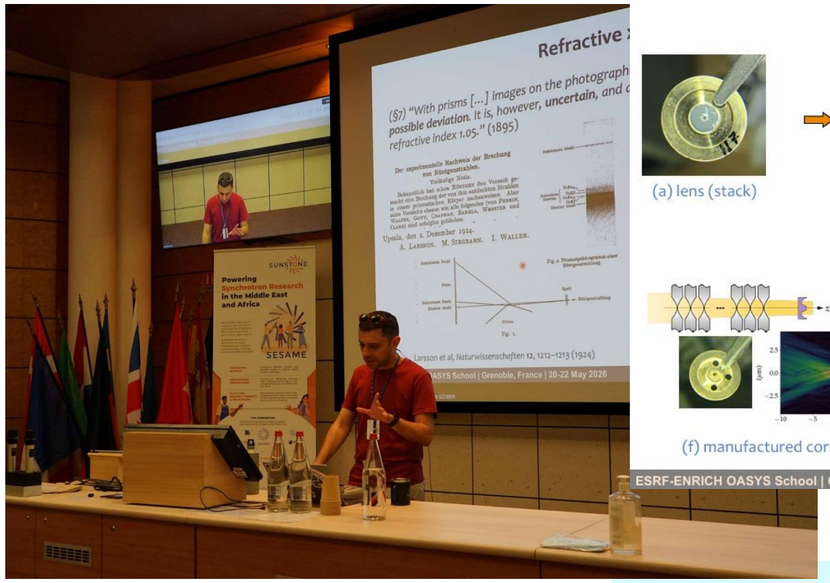
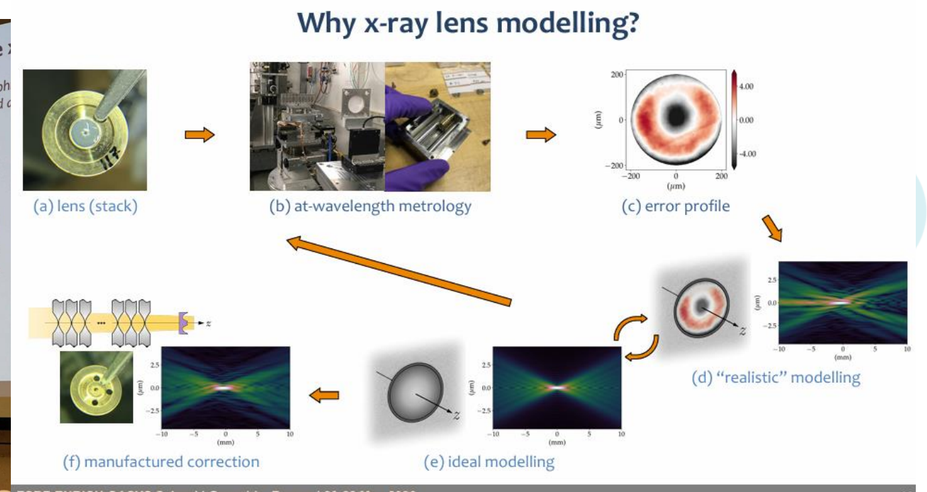
Training School

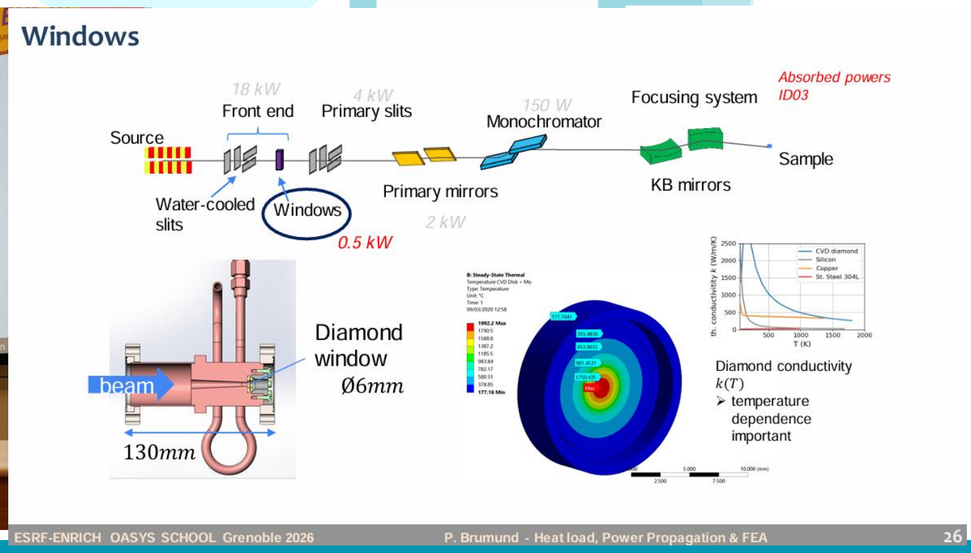
ESRF speakers:
Manuel Sanchez del Rio
Rafael Celestre
Philipp Brumund











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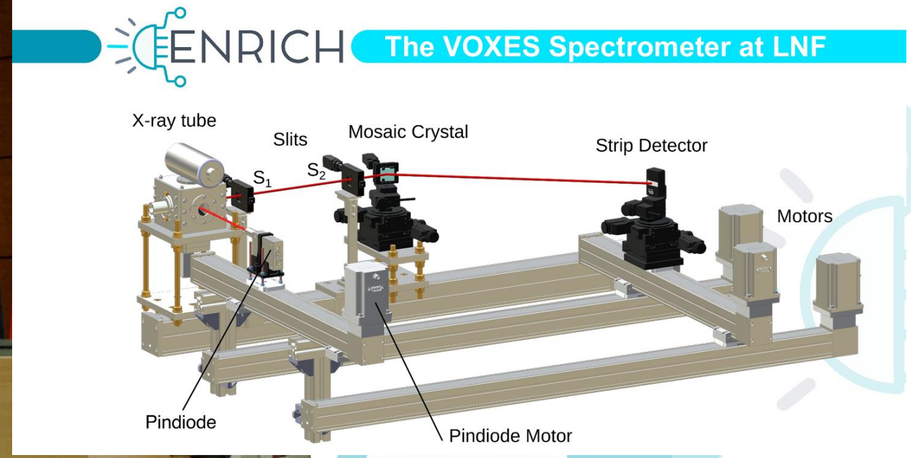
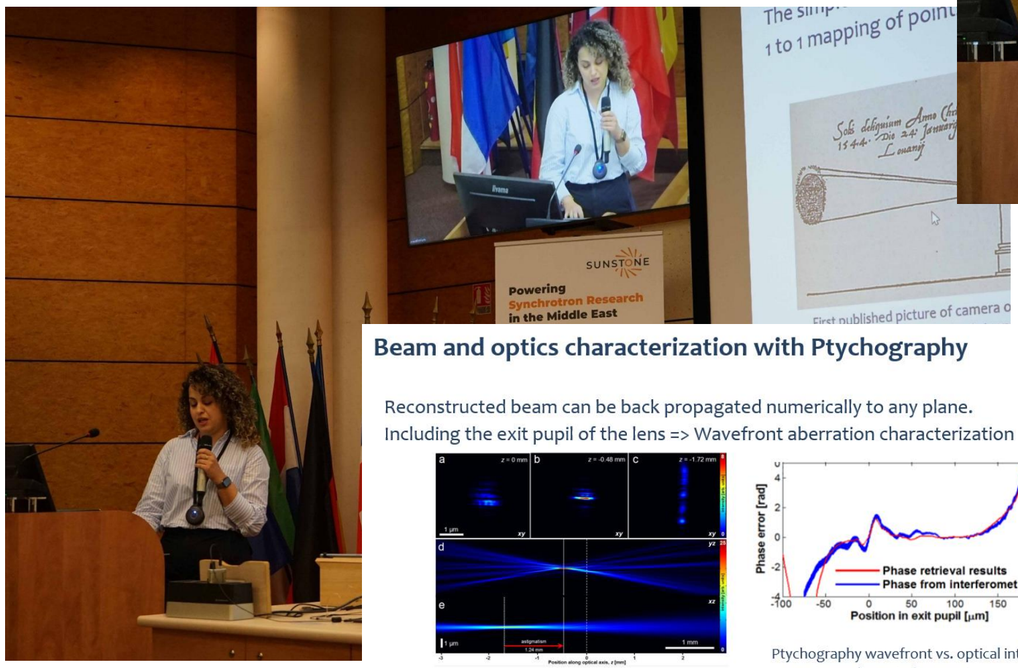
Guest speakers:
Nazanin Samadi (DESY, Hamburg)
Simone Manti (INFN Frascati)
Juan Reyes-Herrera (Elettra, Trieste)





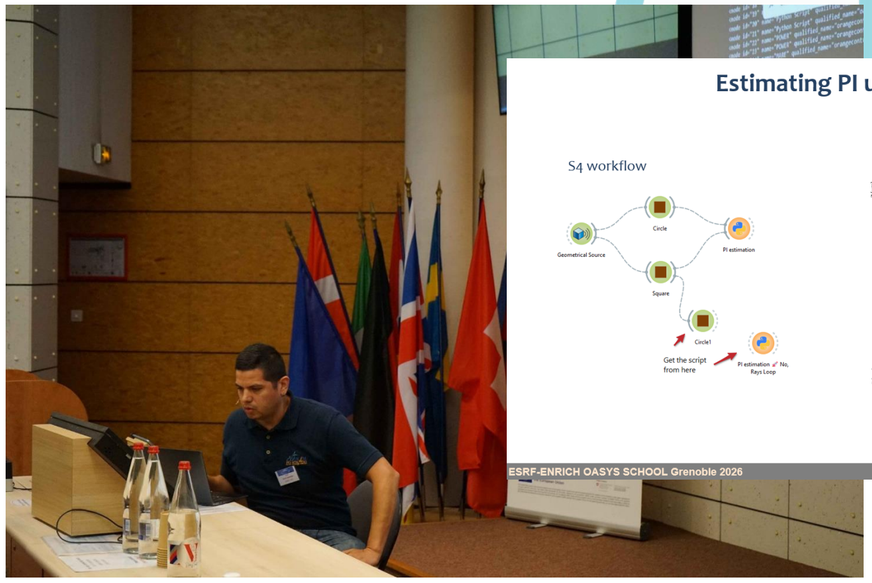
Beam and optics characterization with Ptychography

Reconstructed beam can be back propagated numerically to any plane.
Including the exit pupil of the lens => Wavefront aberration characterization

Ptychography wavefront vs. optical interferometry
+ 40 microradian misalignment

M. Guizar-Sicairos et al., "Measurement of hard x-ray lens wavefront aberrations using phase retrieval," Appl. Phys. Lett. 14, 111108 (2011)
C. Kewish et al., "Reconstruction of an astigmatic hard X-ray beam and alignment of K-B mirrors from ptychographic coherent diffraction data," Opt. Express 18, 23420-23427 (2010).

ESRF-ENRICH OASYS SCHOOL Grenoble 2026 Nazanin Samadi - Beam Diagnostics 37

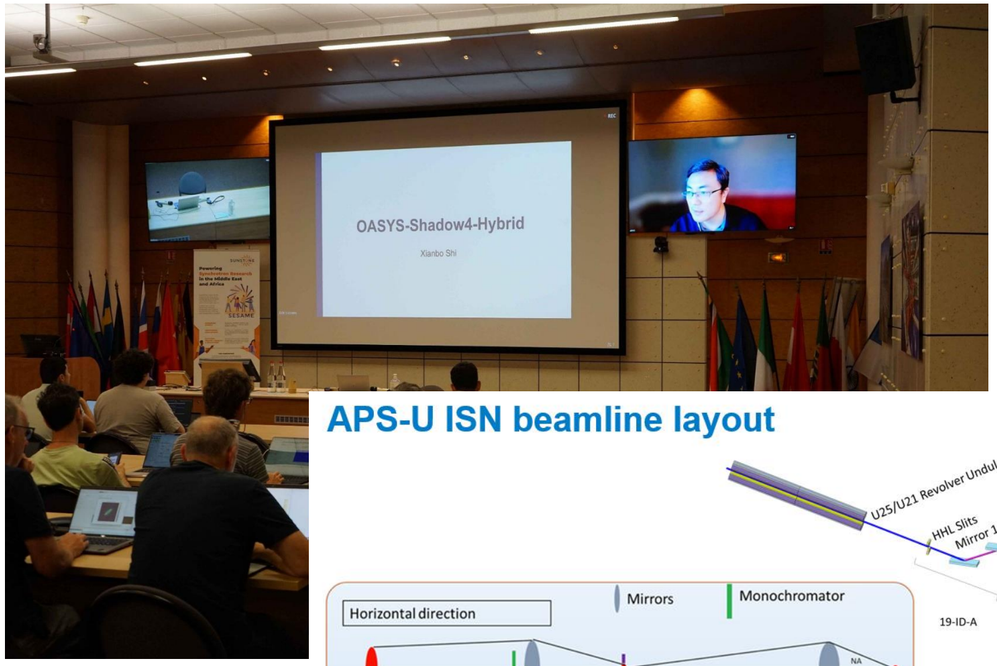


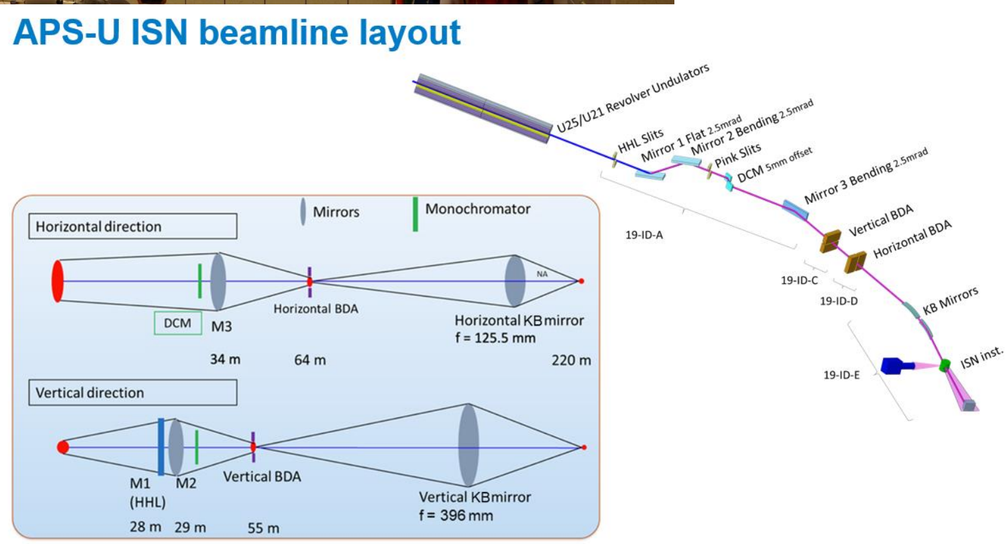
Estimating PI using SHADOW4

ESRF-ENRICH OASYS SCHOOL Grenoble 2026 Juan Reyes Herrera – SHADOW4 Scripts

Remote speakers (USA):

Xianbo Shi





Luca Rebuffi

Visit ESRF:

•Experimental Hall tour

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Official cocktail

Unofficial drinks

Highlights: Wave effects in MC

Giuseppe Mazzola et al (CERN): **X-ray reflection: A FLUKA model: https://doi.org/10.1103/lr4z-r8ph**

X-ray reflection at boundaries

- Feature added in view of radiation studies for design of FCC-ee
- Supports reflection on multilayer-mirrors and provides polarization-dependent reflection:

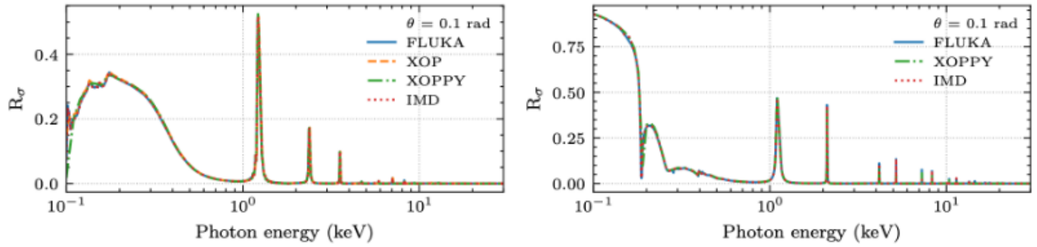


FIG. 9. Reflectivity as a function of photon energy for a Si-W (left column) and Mo-B_4C (right column) multilayer mirror (see text) evaluated with FLUKA (solid curves), XOP (dashed curves), XOPPY (dot-dashed curves), and IMD (dotted curves) for σ-polarised photons at the indicated incidence angles.

- June 2026: paper accepted for publication in Physical Review Accelerators and Beams
  In collaboration: CERN +ALBA + Argonne Natl. Labs + ESRF Grenoble + IMD + Universitat de Barcelona

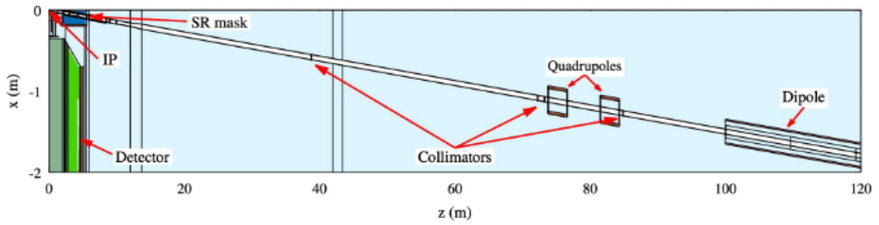
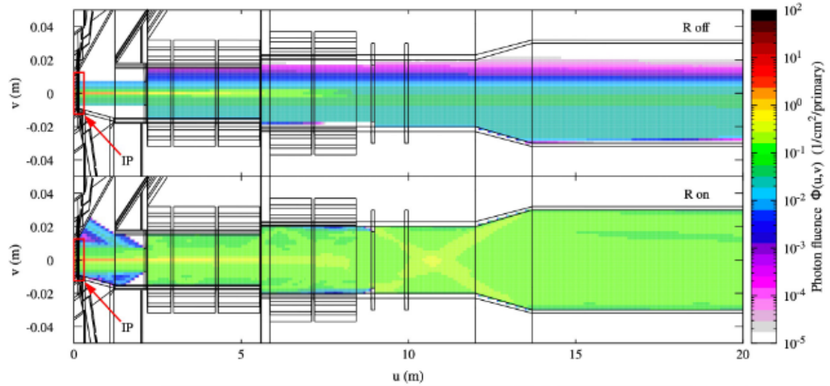


FIG. 13. FLUKA geometry model of the last 120 m of the FCC-ee MDI region.



ACCEPTED PAPER

X-ray reflection: A FLUKA model and its application in the design of synchrotron light beamlines and CERN's Future Circular Collider

G. Mazzola, S. Chitra, A. Devienne, A. Frasca, M. J. García-Fusté, D. Heinis, A. Lechner, G. Lerner, L. Rebuffi, M. Sanchez del Rio, D. L. Windt, E. Graugés, and F. Salvat Pujol

Phys. Rev. Accel. Beams - **Accepted** 16 June, 2026 Export Citation

https://doi.org/10.1103/lr4z-r8ph

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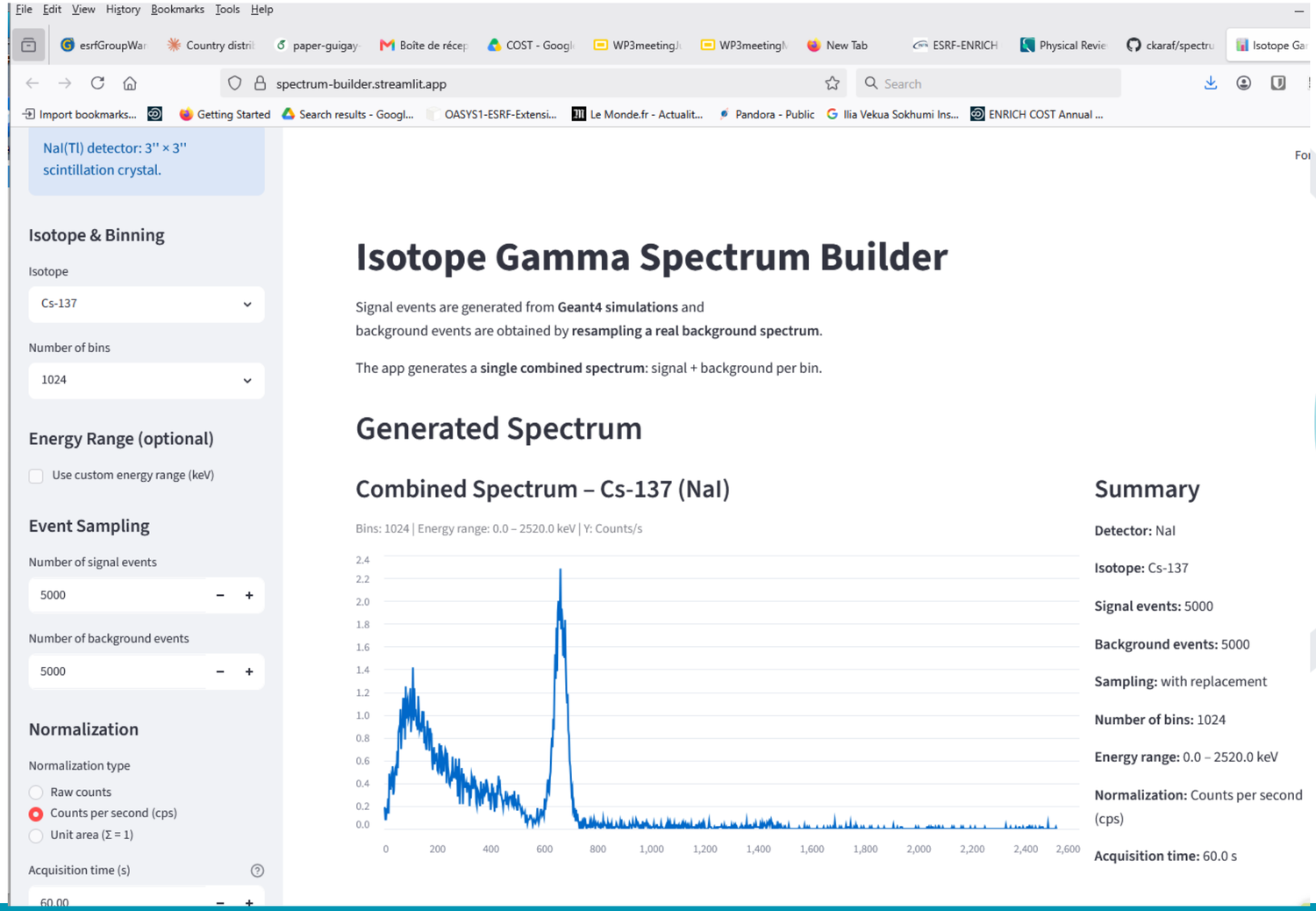
Highlights: Isotope Gamma emission spectra

https://github.com/ckaraf/spectrum-builder/ Costas Karafasoulis

Tool designed for the interactive generation and exploration of gamma-ray spectra.

The app allows users to build synthetic spectra, adjust relevant parameters, and visualize the resulting spectral response intuitively.



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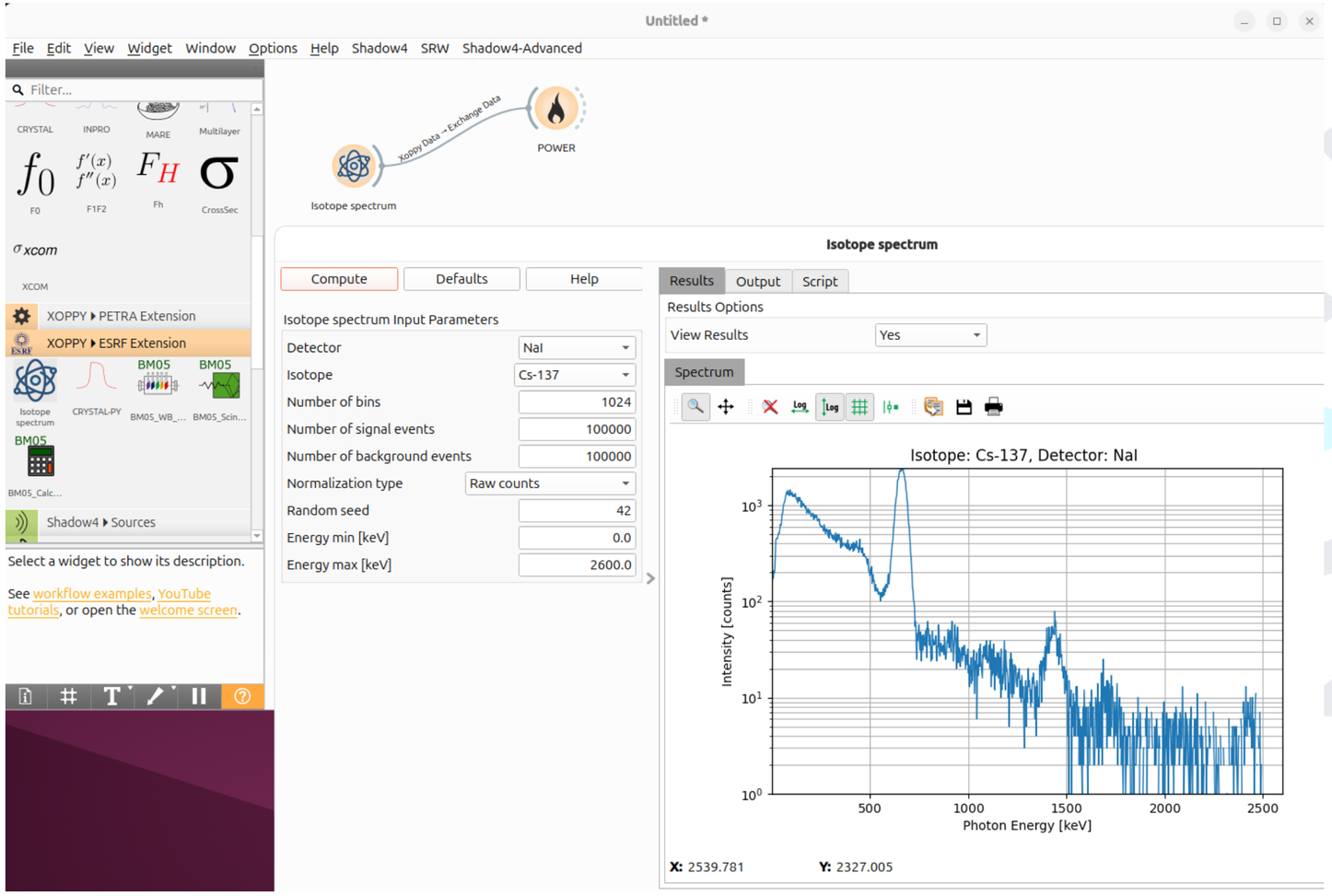
Highlights

https://github.com/ckaraf/spectrum-builder/ Costas Karafasoulis

Soon in OASYS!



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Next year!

Acknowledgements

This presentation is based upon work from COST Action ENRICH - CA24131, supported by COST (European Cooperation in Science and Technology).

COST (European Cooperation in Science and Technology) is a funding agency for research and innovation networks. Our Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

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