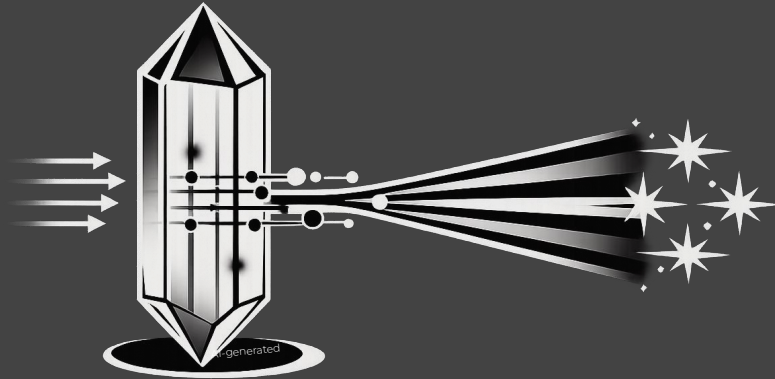


Crystal Radiators for Strong-Field QED and other Application



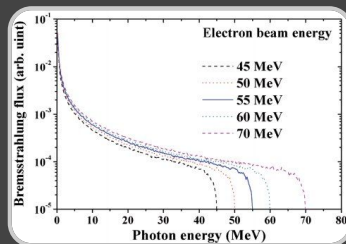
Ivo Schulthess, Institute for Particle Physics and Astrophysics, ETH Zurich
LUXE SAS Meeting, 12. January 2026

Crystal Radiators

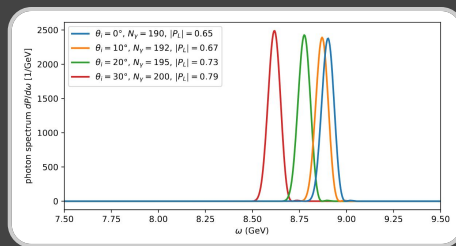
LUXE Gamma Source

gamma source parameters

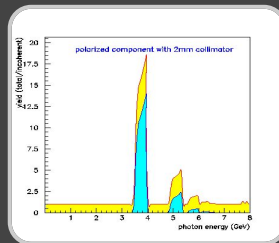
- L_{bsl} 7.5 m
- σ 5 μm
- θ 8.6 μrad
- ε_n 1.4 mm mrad
- Q 100 pC
- δE 2 MeV



H. Naik et al. (2014)



LUXE Collaboration (2021)



Crystal Radiators

Radiation Mechanisms

channeling radiation (CR)

- charged particles trapped in planar/axial potential
- bound oscillatory motion
- fixed-energy lines defined by
 - lattice potential
 - particle energy
- limited by dechanneling

coherent bremsstrahlung (CB)

- unbound charged particles traverse crystal lattice
- coherent interference of bremsstrahlung amplitudes
- energy peaks tunable by angle
- contrast limited by multiple scattering

Crystal Radiators

Free Parameters

discrete parameters

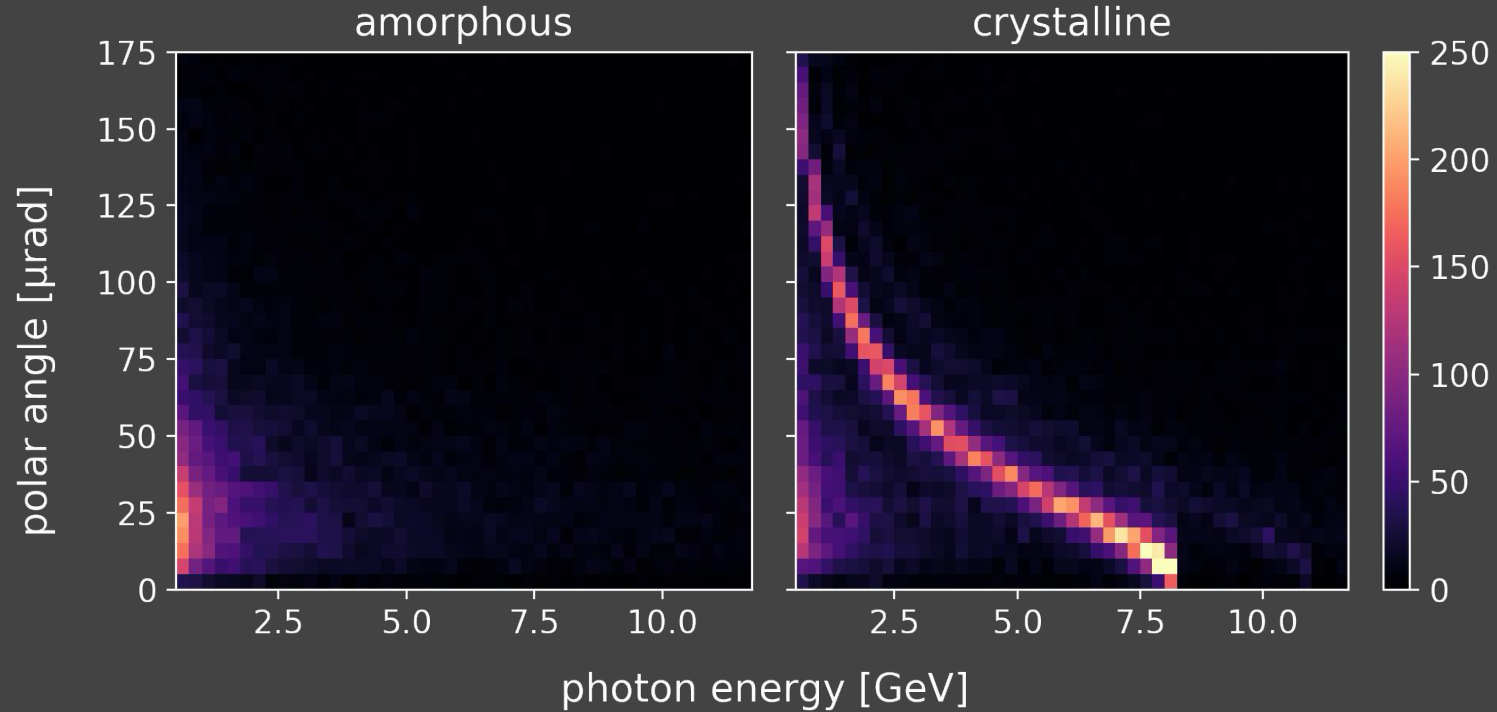
- lattice orientation
 - planar, e.g. **(110)**, (111), or (100)
 - axial, e.g. <110>, <111>, or <100>
- material
 - **Dia**
 - **Si**
 - Ge
 - W

continuous parameters

- thickness t
 - $N_{\text{inc}} \propto t / X_0$
 - $N_{\text{coh}} \propto t / X_0 \cdot \exp(-C t / X_0)$
- yaw angle ψ
 - $E_{\text{cb}} \propto \gamma^2 / \psi_{\text{cb}}$
 - $|\psi_{\text{cr}}| \lesssim \vartheta_{\text{L}}$
 - $E_{\text{cr}} \propto \gamma^{3/2} U_0^{1/2} / d$

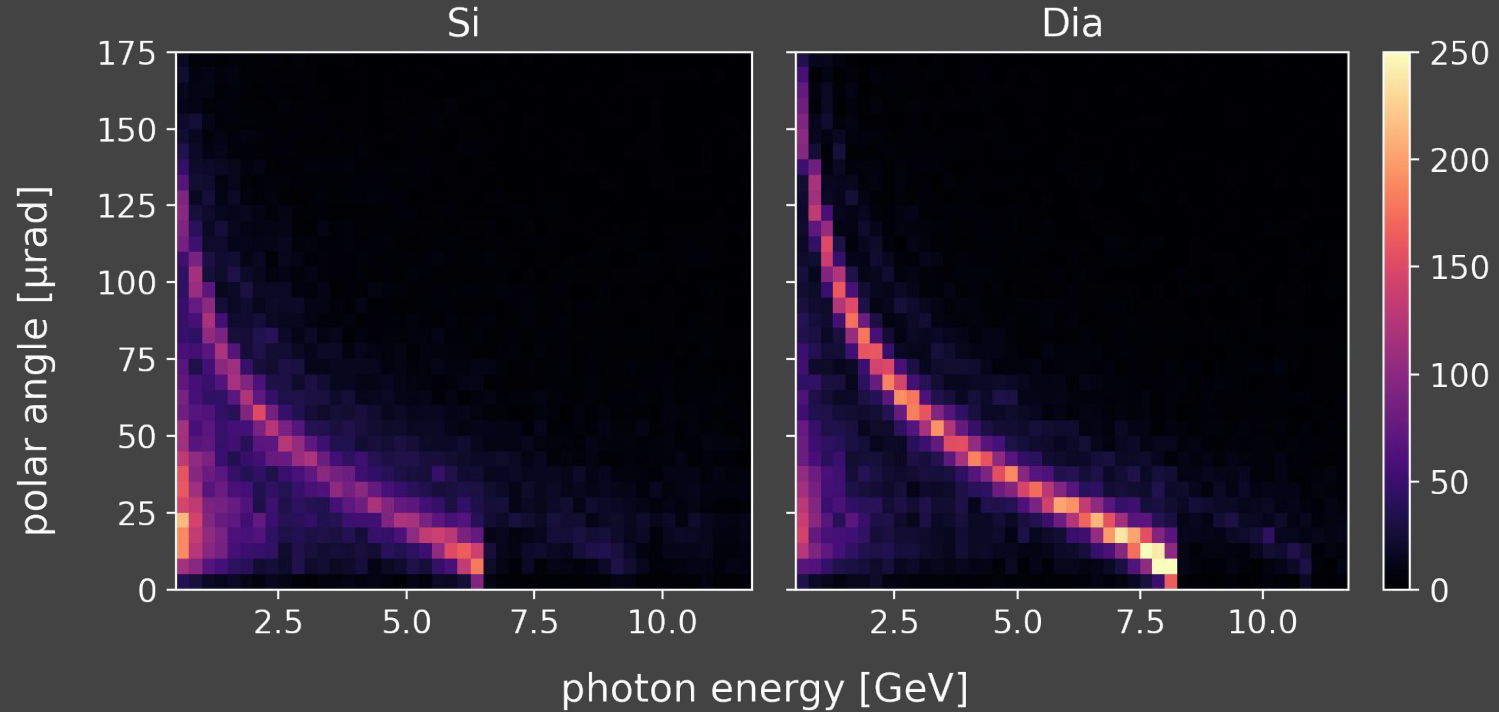
Crystal Radiators

Structure



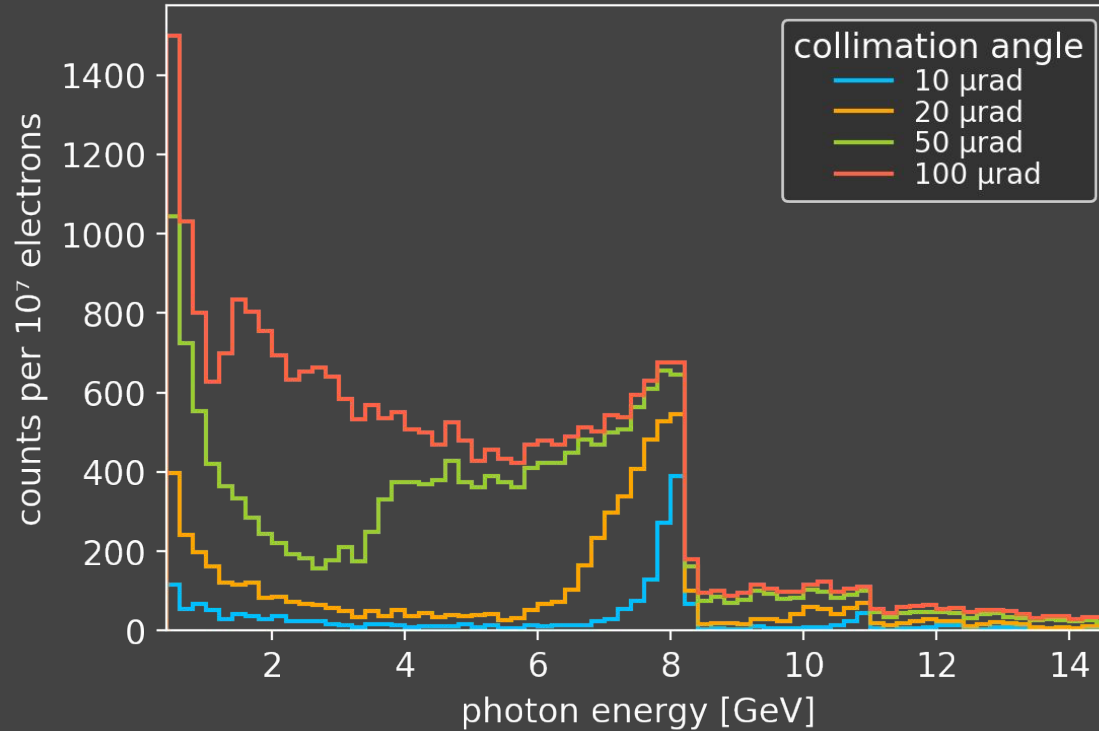
Crystal Radiators

Material



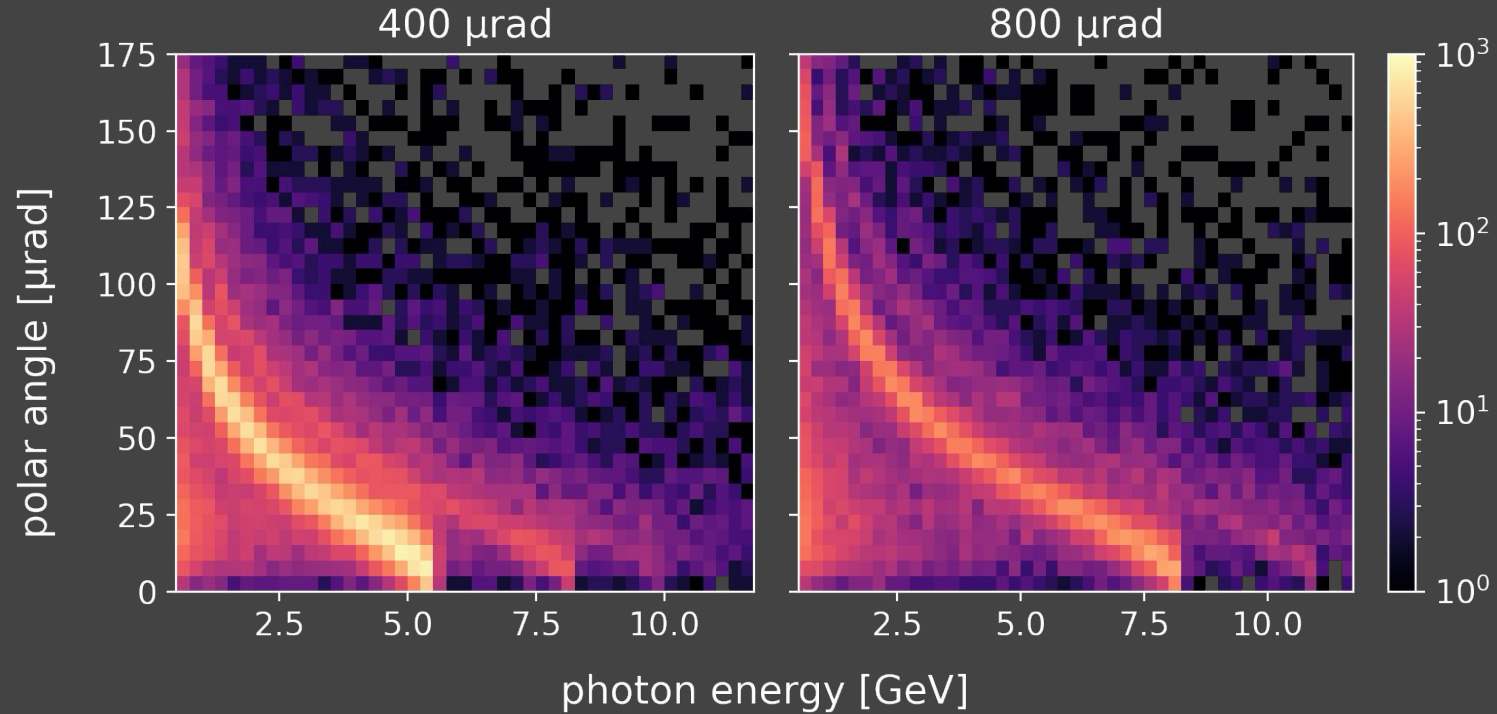
Crystal Radiators

Collimation



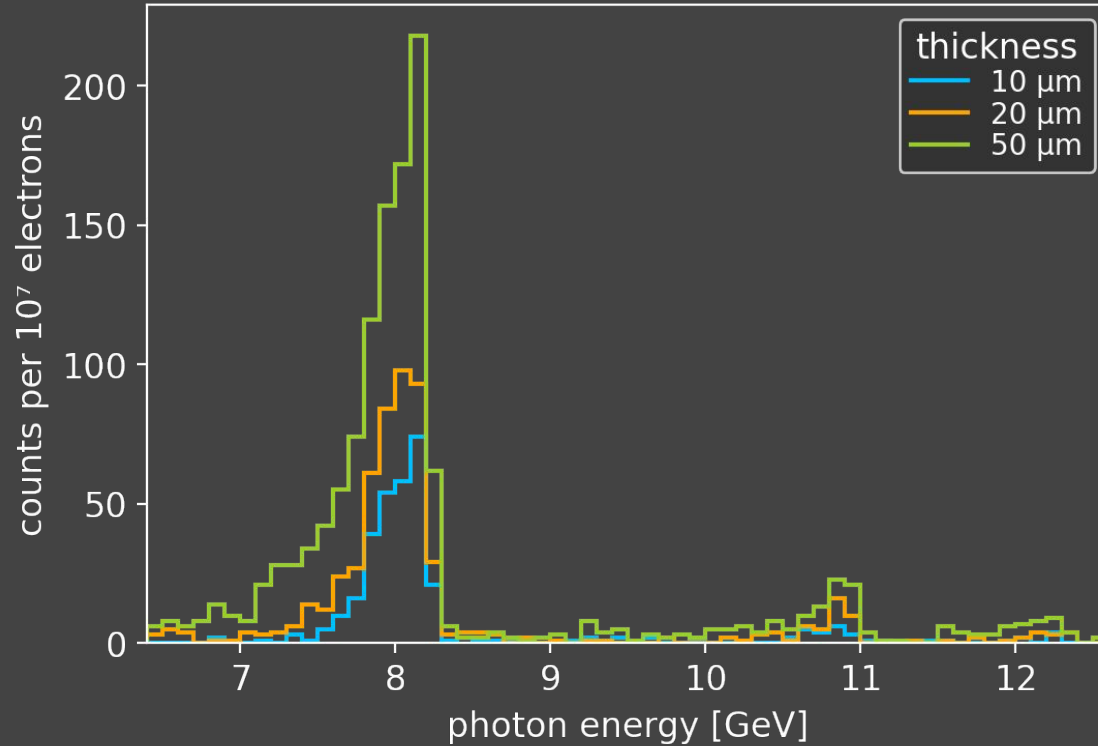
Crystal Radiators

Yaw Angle



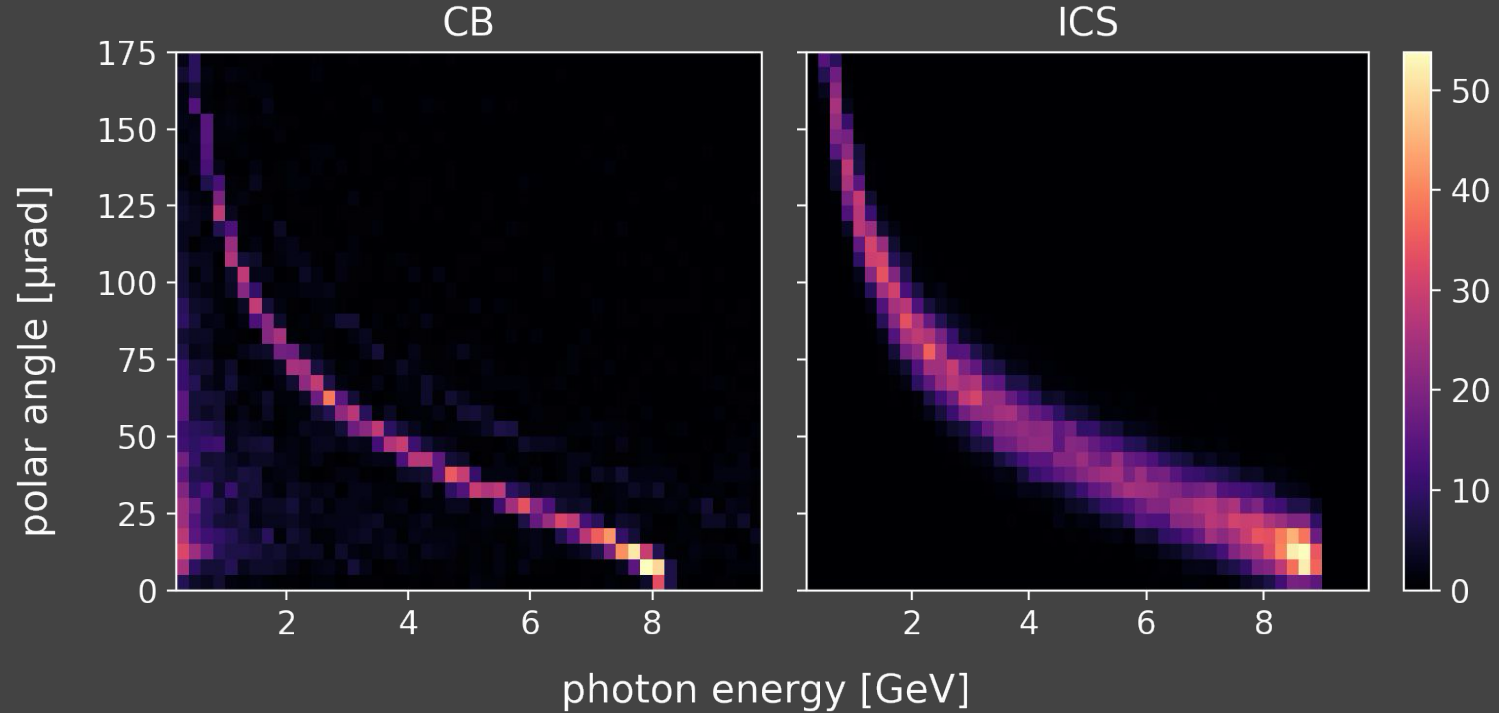
Crystal Radiators

Thickness



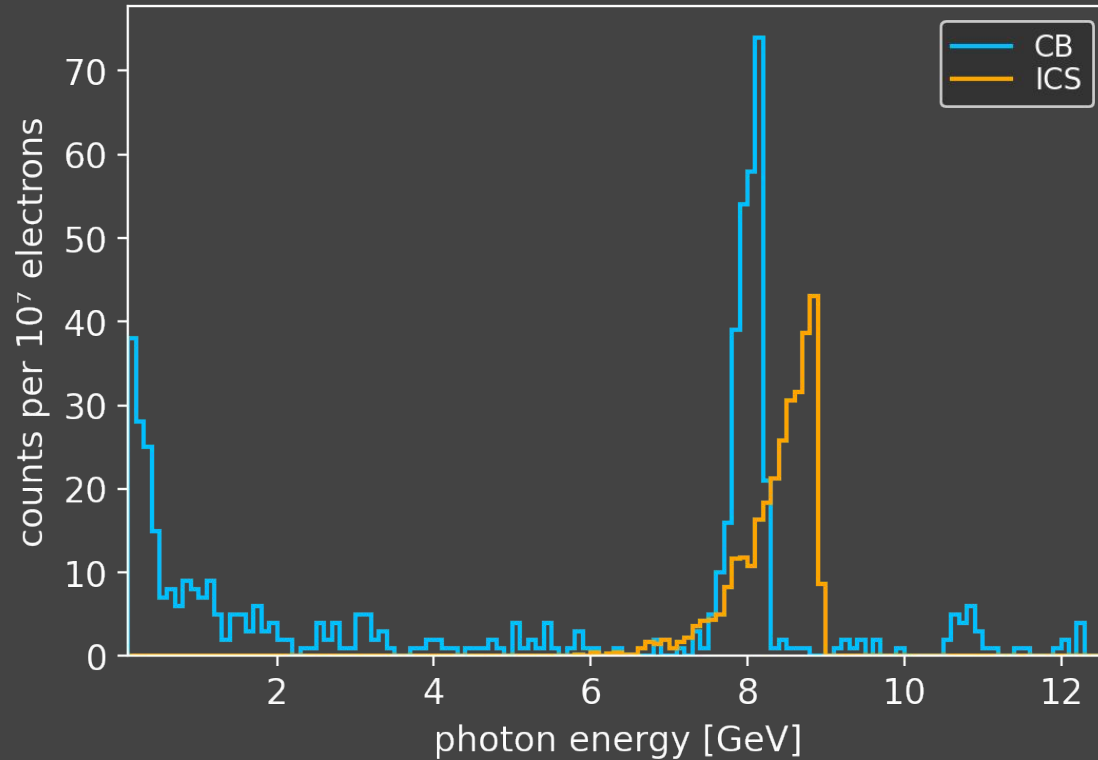
Crystal Radiators

Compton Source Comparison



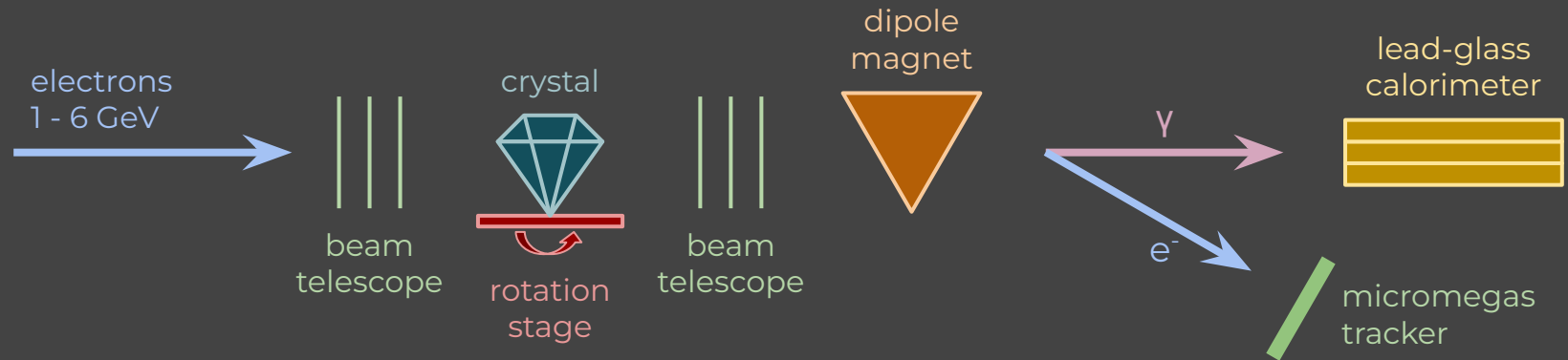
Crystal Radiators

Compton Source Comparison



Crystal Radiators

DESY 2 Testbeam



Crystal Radiators

Summary

- CB is appealing for the LUXE gamma mode
- does not require a "complicated" laser setup
- intrinsically synchronized
- very tunable energy
- unavoidable low-energy background