Exploring New Physics with the Optical Dump at LUXE

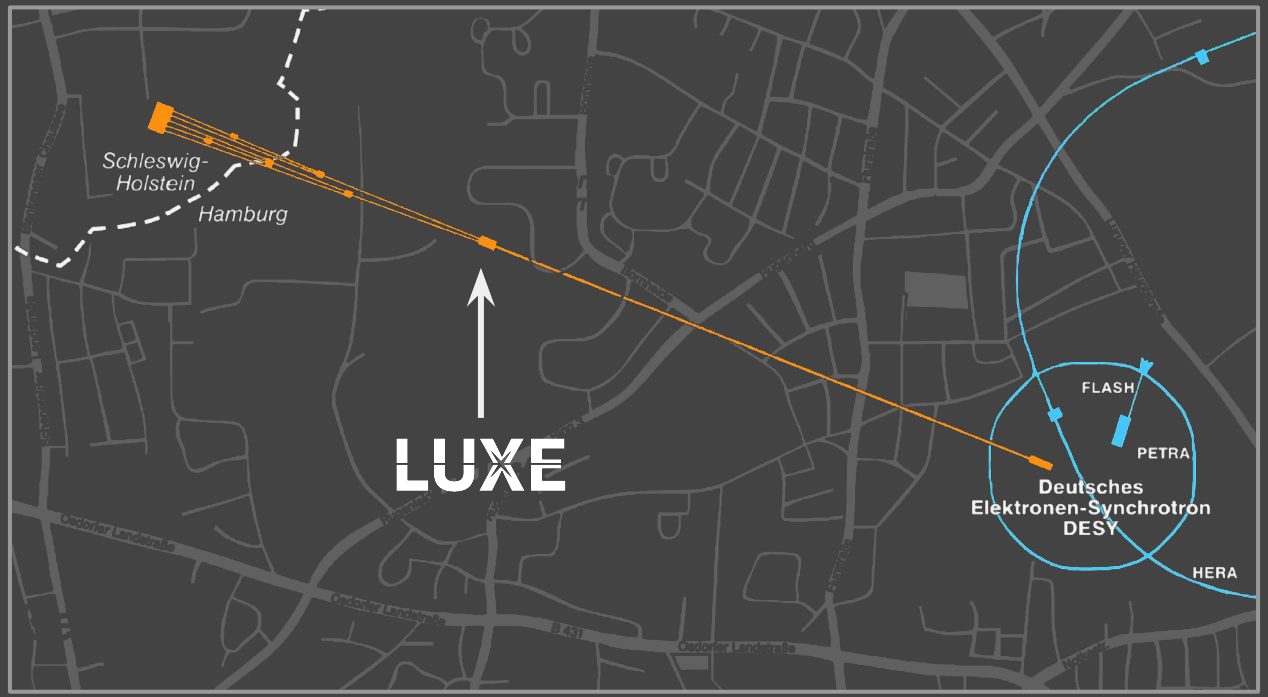
Ivo Schulthess, on behalf of the LUXE collaboration

7th of August 2024 - The Axion Quest 2024

Deutsches Elektronen-Synchrotron DESY

Laser Und XFEL Experiment LUXE

DESY and European XFEL Site



Laser Und XFEL Experiment LUXE

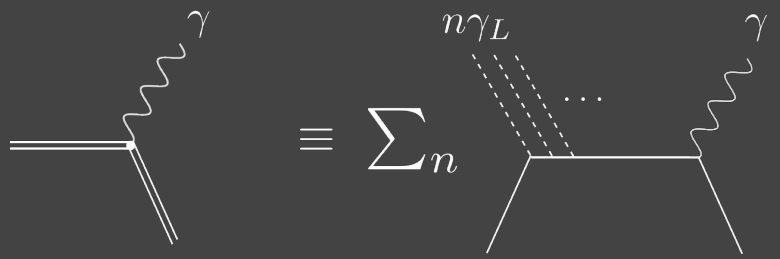
The Collaboration

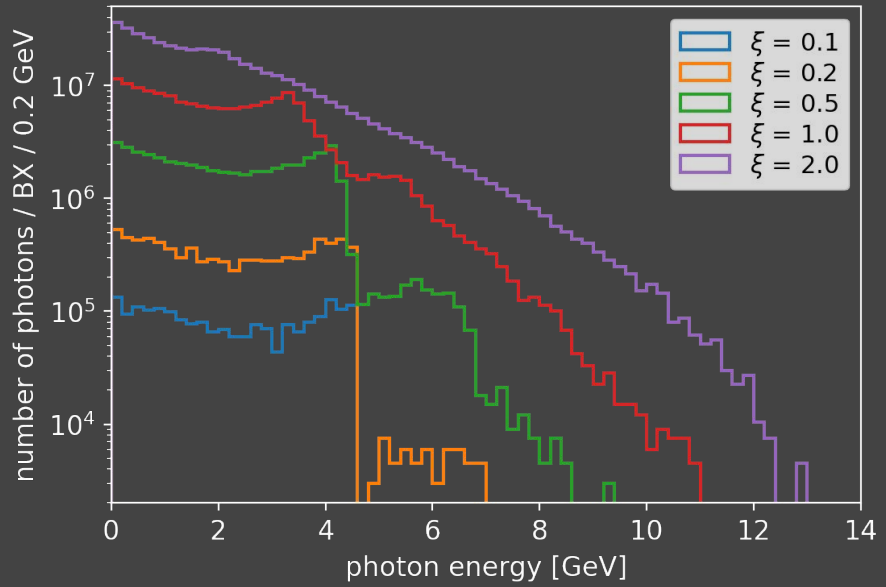
Laser Und XFEL Experiment LUXE

Strong-Field QED Processes

non-linear Compton

$e^{\pm} \rightarrow e^{\pm} + \gamma$



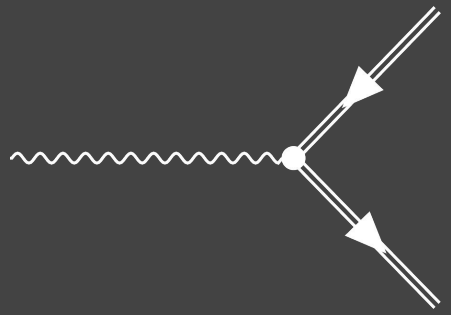


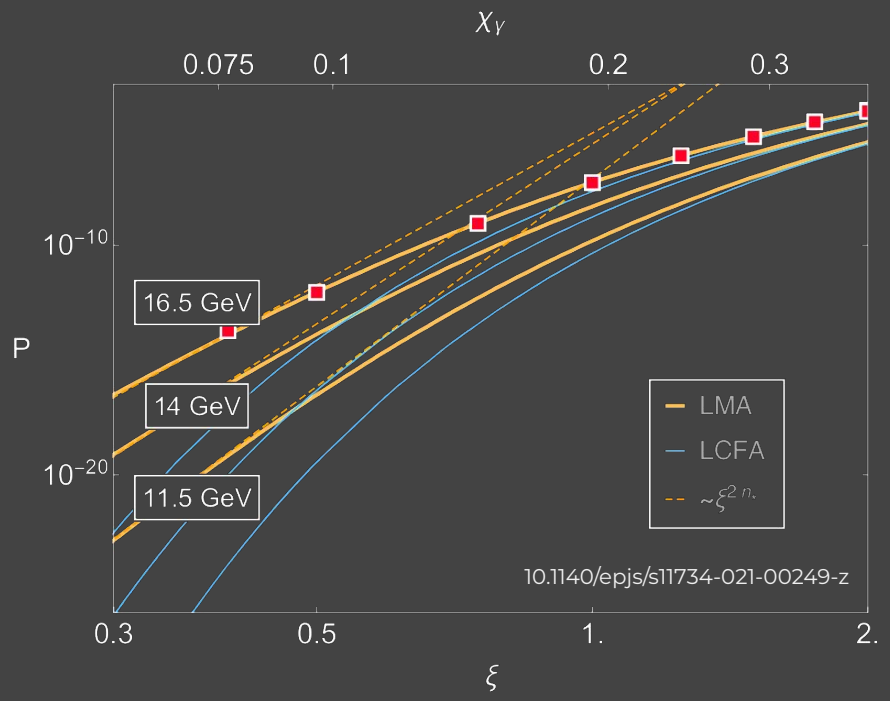
Laser Und XFEL Experiment LUXE

Strong-Field QED Processes

non-linear Breit-Wheeler

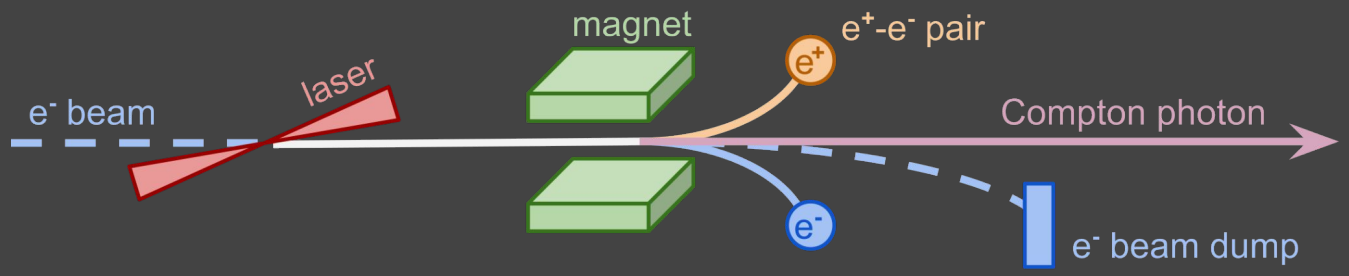
$\gamma \rightarrow e^+e^-$





Laser Und XFEL Experiment LUXE

Experimental Schematic: Electron-Laser Mode



electrons
- 10 Hz bunches
- up to 17.5 GeV
- 10^9 e^-/bunch

laser
- 1 Hz
- 40 TW (phase-0)
- 350 TW (phase-1)

photons
- 3.5 γ/e^-
- 1.7 γ/e^- (>1 GeV)

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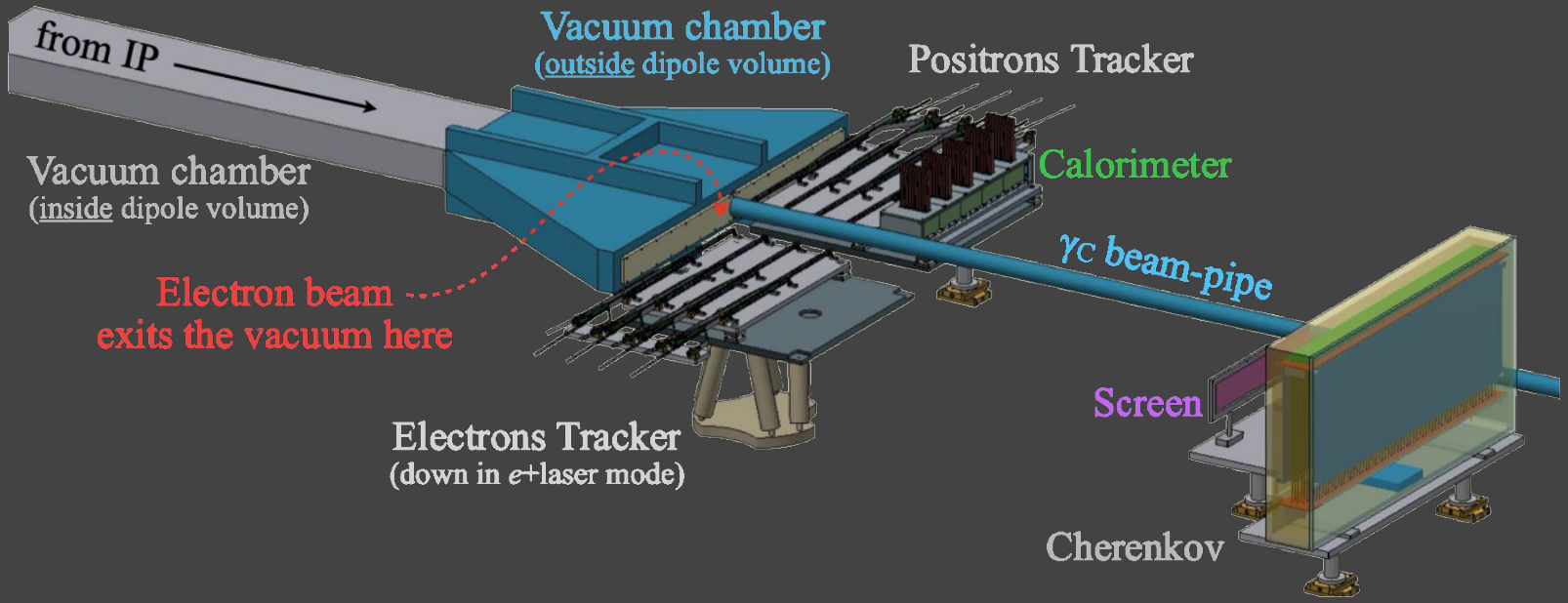
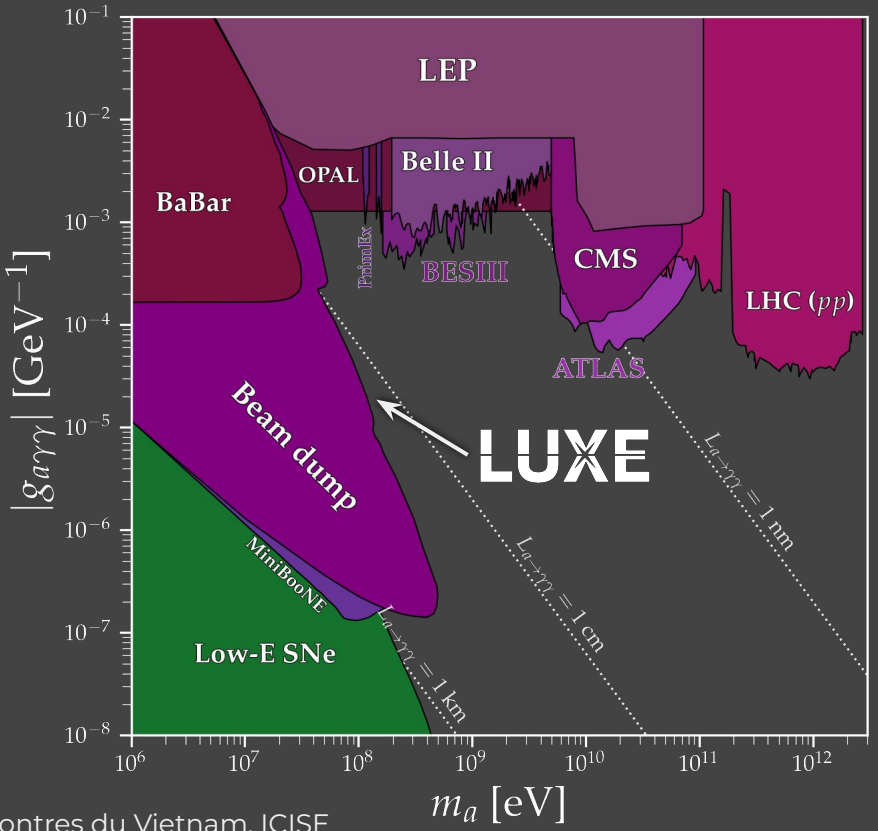
Electron and Positron Detection System



courtesy: N. Tal Hod (WIS)

New Physics at Optical Dump NPOD

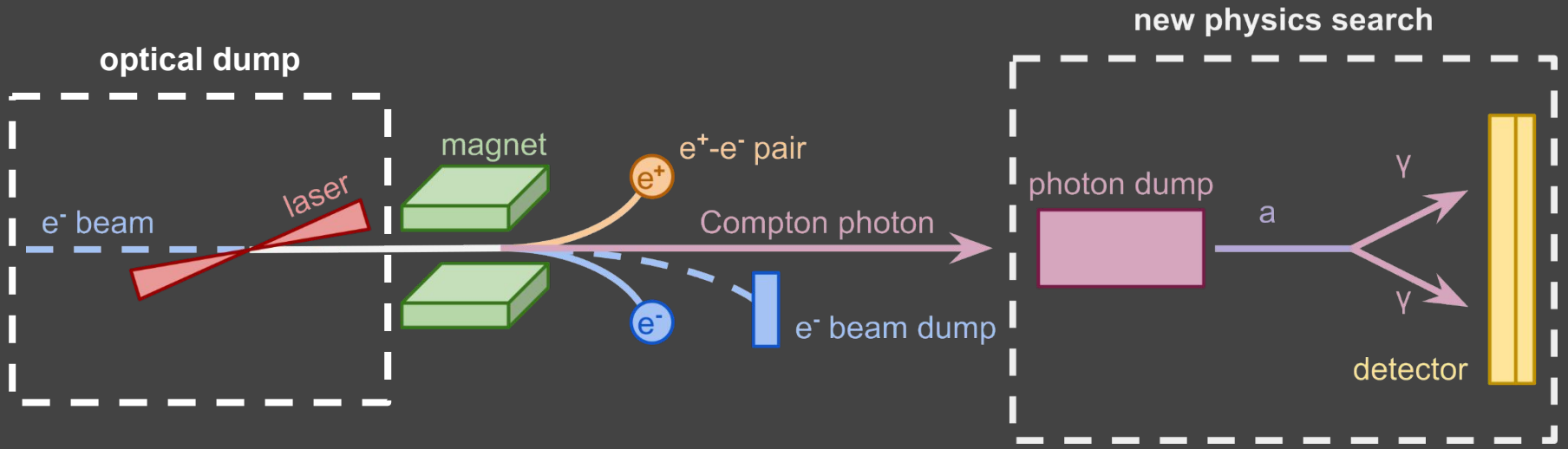
Beam Dump and Collider Constraints



courtesy:
C. O'Hare, *AxionLimits*, 10.5281/zenodo.3932430

New Physics at Optical Dump NPOD

New Physics at Optical Dump NPOD



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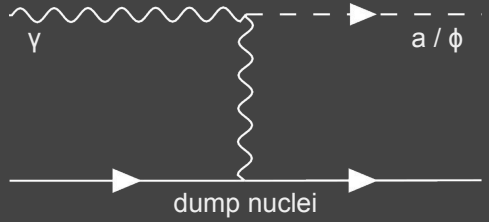
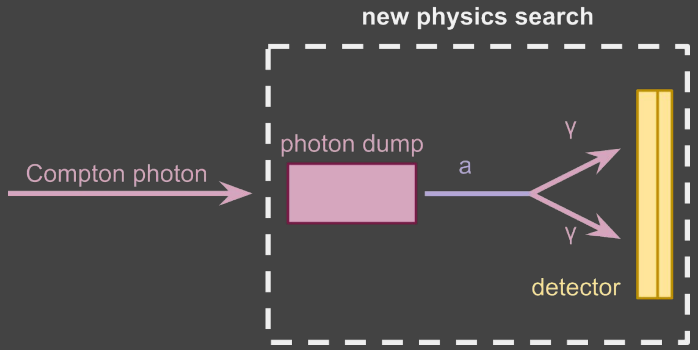
Production and Decay Mechanisms

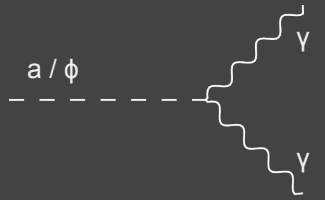
Primakoff production



$$\mathcal{L}_a = \frac{a}{4\Lambda_a} F_{\mu\nu}\widetilde{F}^{\mu\nu}$$



photon decay channel



$$\Gamma_{a\to 2\gamma} = \frac{m_a^3}{64\pi\Lambda_a^2}$$

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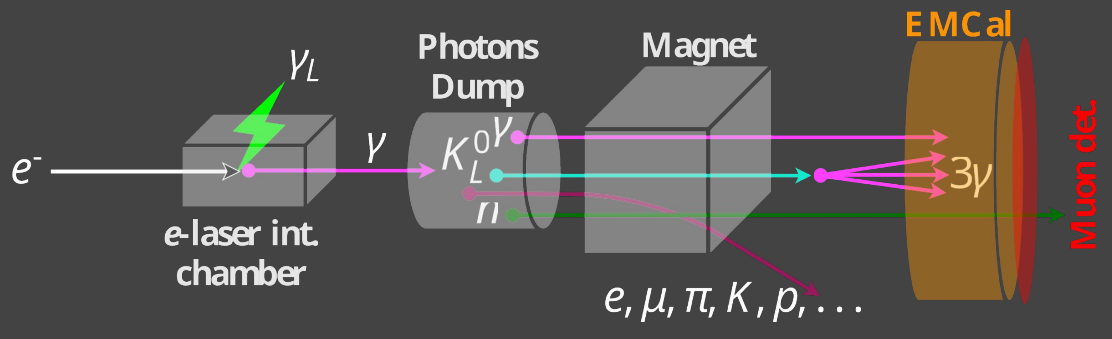
Background Estimation



10.1103/PhysRevD.106.115034

	LUXE NPOD	LUXE e^- on dump
N_a	4	16.5
N_{BG}	0.8	156.1
SNR	5	0.1

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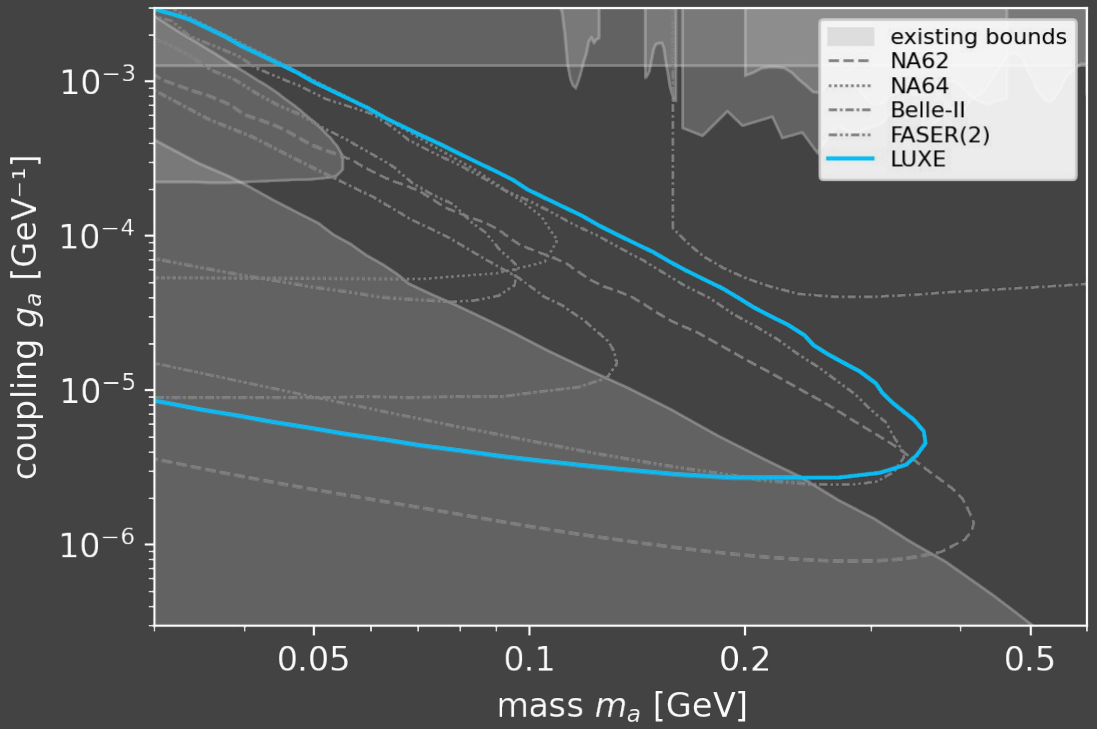
Expected Phase-Space Coverage



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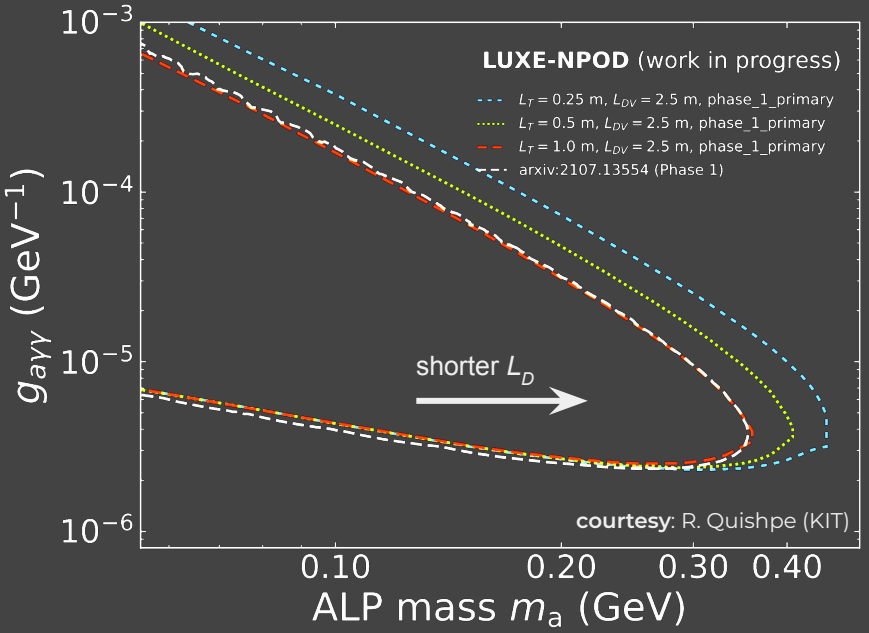
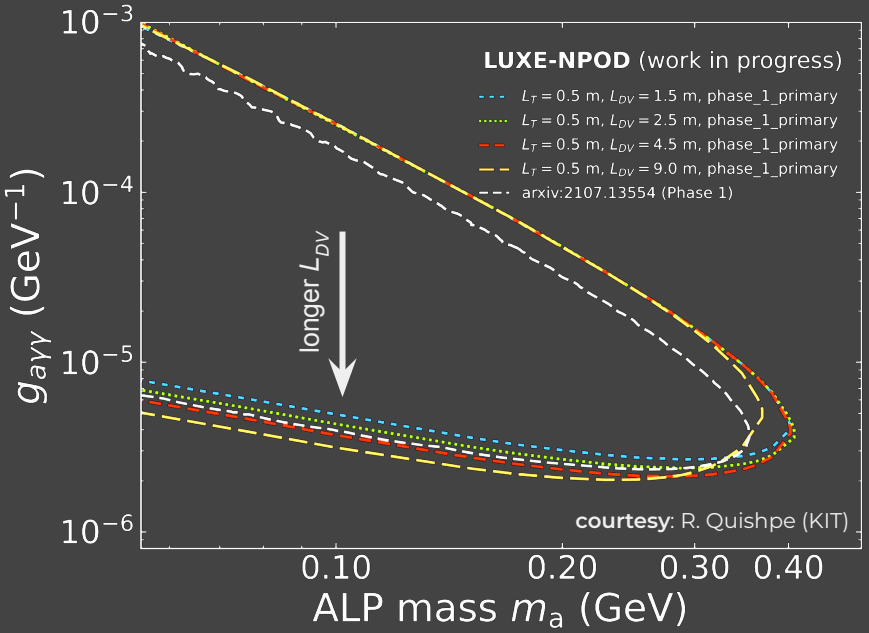
Photon Dump and Decay Volume Optimizations





New Physics at Optical Dump NPOD

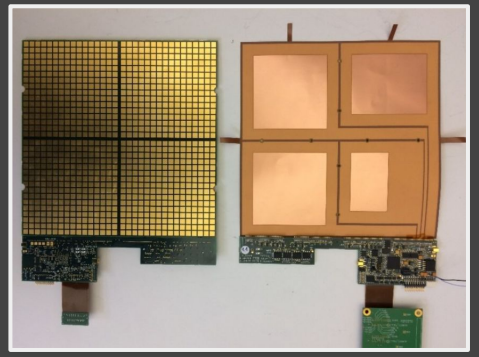
NPOD Detector Option: LUXE ECAL-E

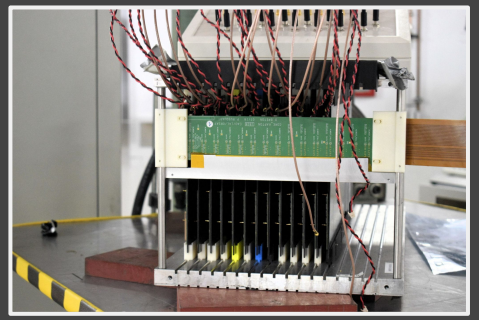
technology:

- high-granularity SiW calorimeter

configuration:

- three modules, each 18 x 18 cm^2
- 15 sandwich layers
- 0.5 mm thick silicon with a 5.5 x 5.5 mm^2 readout structure
- tungsten absorbers of 7 x 2.8 mm and 8 x 4.2 mm thickness





10.48550/arXiv.2004.12792
10.1016/j.nima.2019.162969

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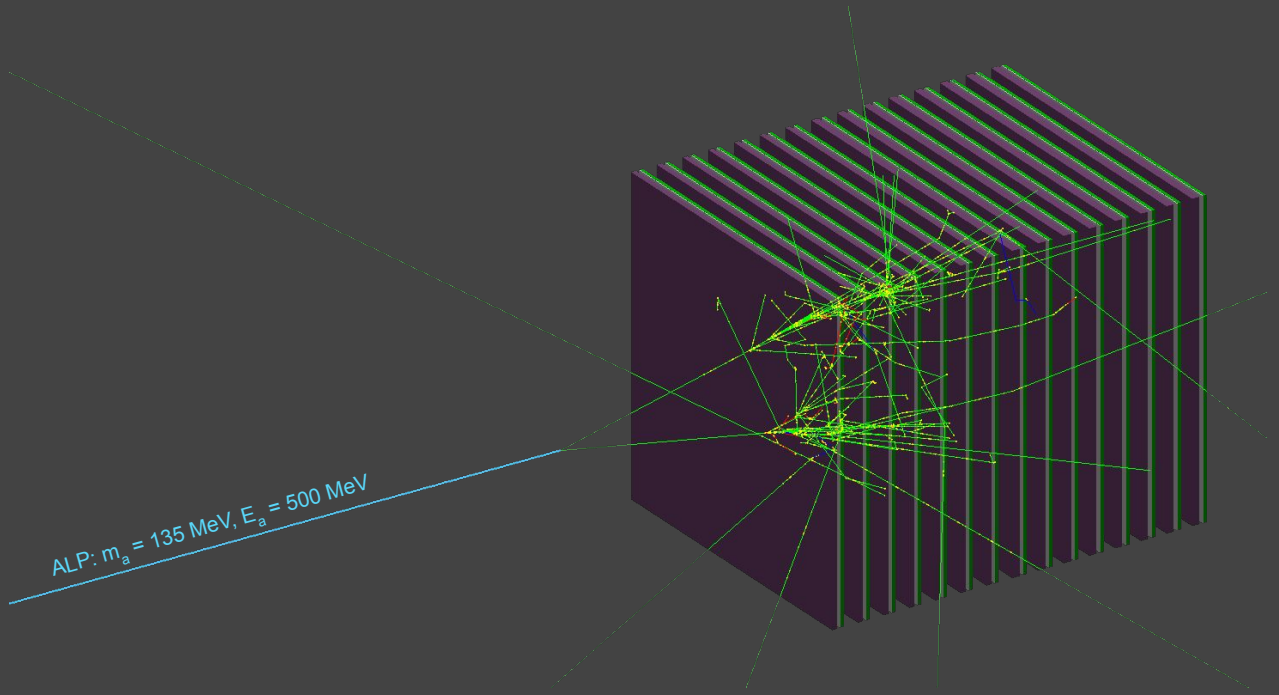
NPOD Detector in DD4HEP Framework



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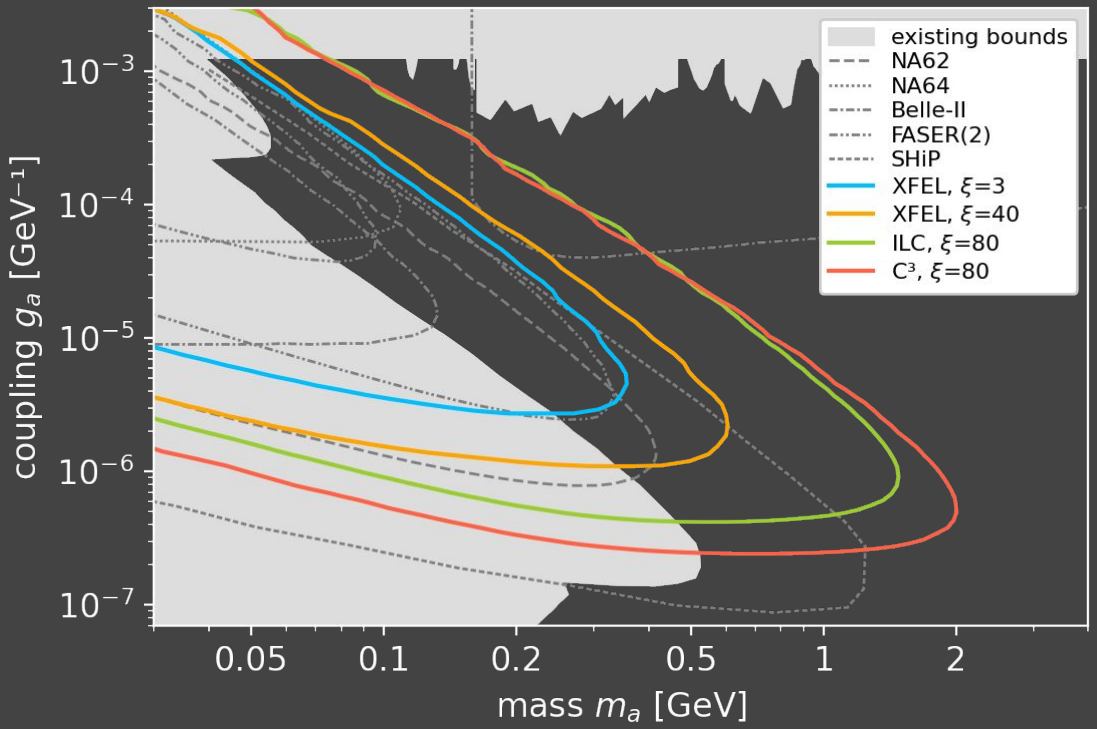
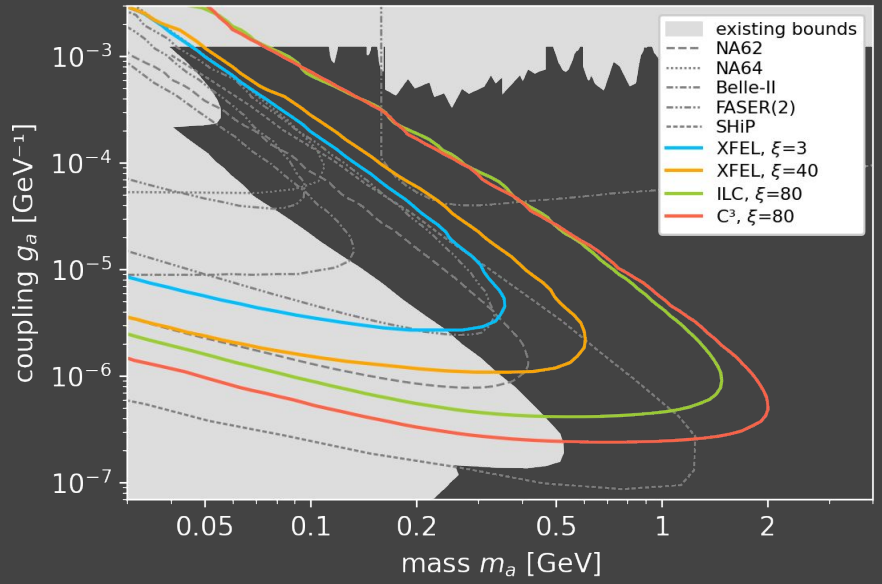
Prospects for Future Facilities



New Physics at Optical Dump NPOD

Conclusion



- LUXE will allow a precise investigation of strong-field QED
- it allows to search for new physics with the optical dump concept
- the concept may be applicable to future facilities