Inputs & requirements for the e^+e^- detector system.

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HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

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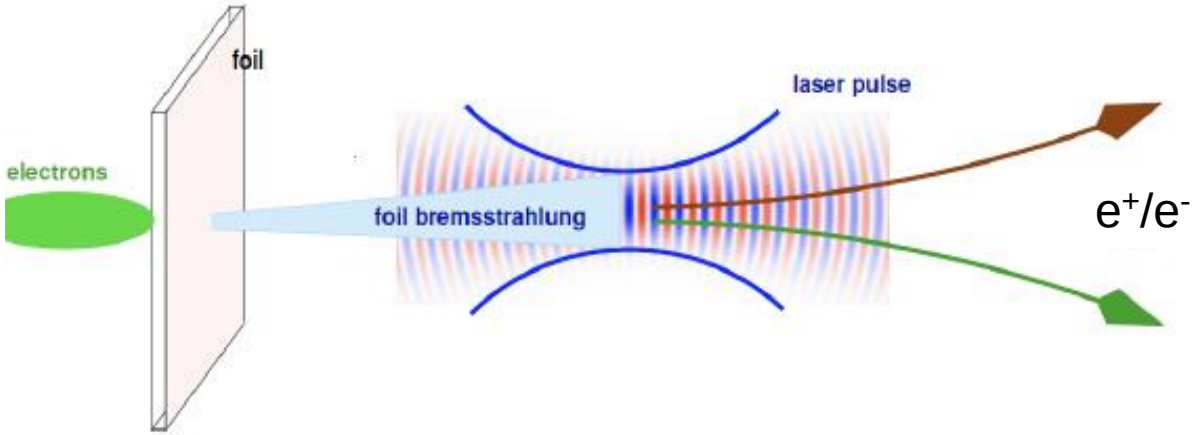
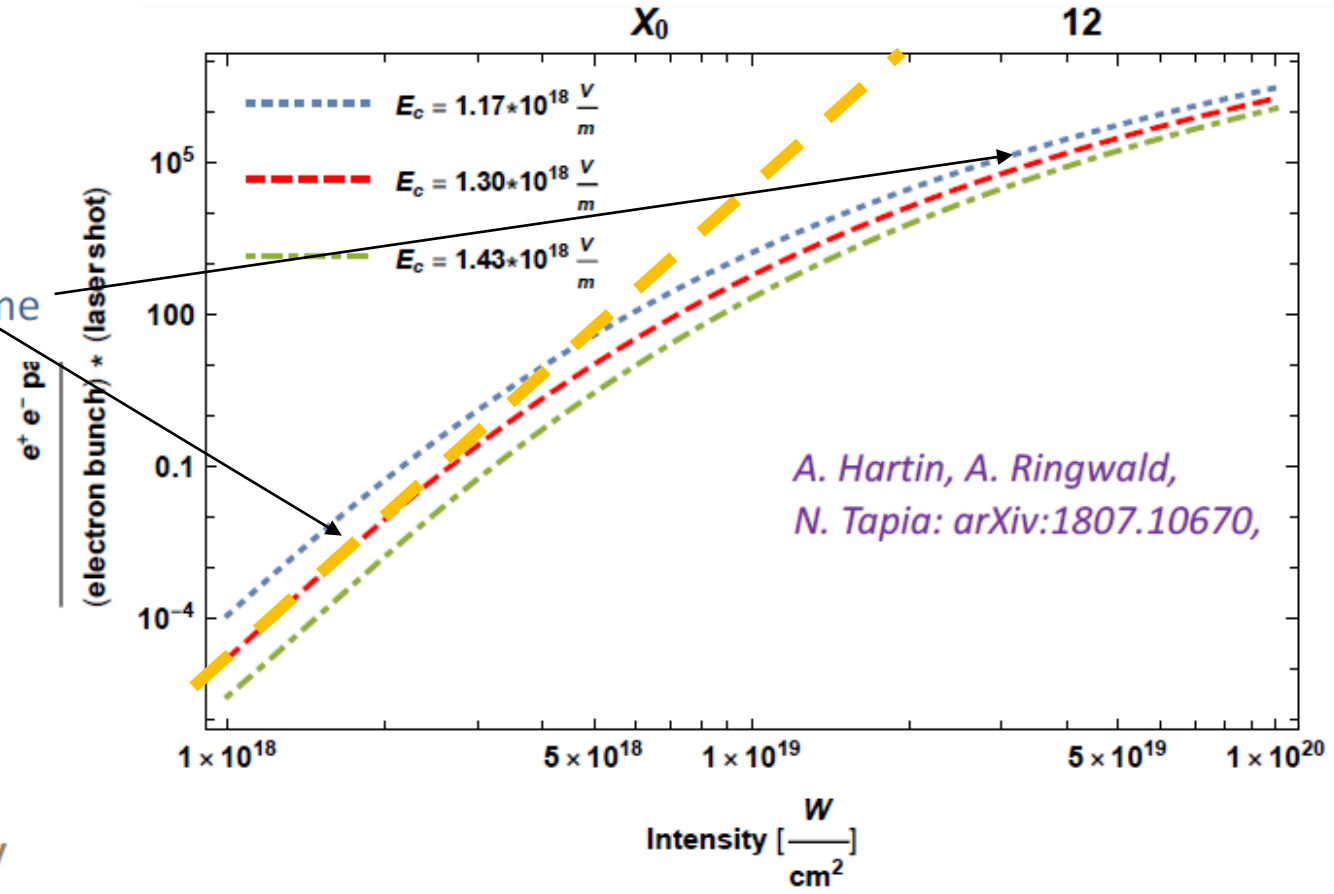
Introduction and Motivation

Measuring the exponential behavior of the non-perturbative regime



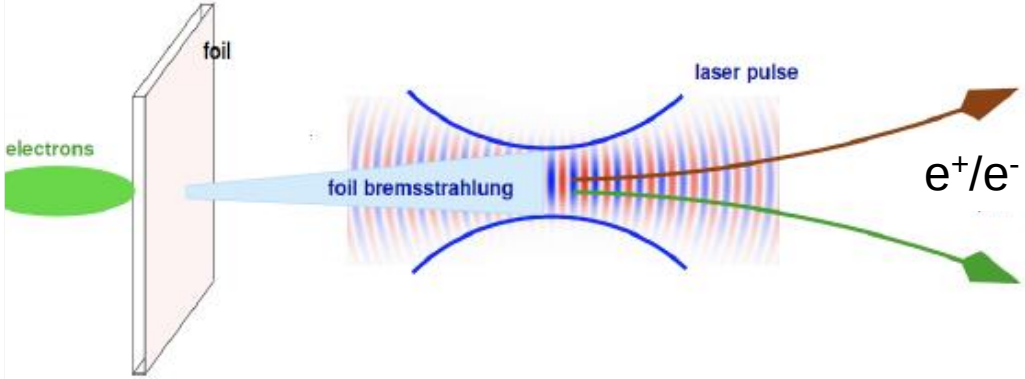
$$\xi \ll 1: \; R_{e^+} \propto \xi^{2n} \propto I^n$$ ☚ Strong rise

$$\xi \gg 1: \; R_{e^+} \propto \boxed{\exp\left(-\frac{8}{3\chi}\right)} \propto \gamma\sqrt{E_L}$$ ☚ Non-perturbative regime



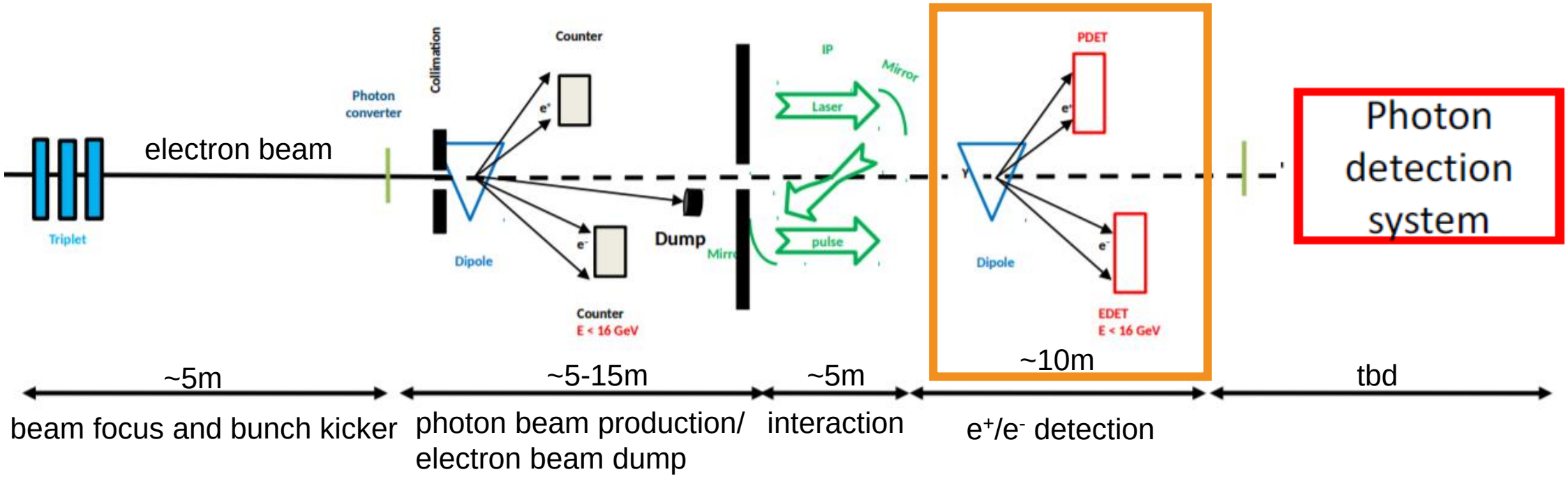
LUXE Setup and Parameters

Design of the experiment



Design Laser Parameters	
Energy[J]	7.0
Power[TW]	200
Intensity[W/cm^2]	2×10^{20}
ξ	6,8
χ	1,4

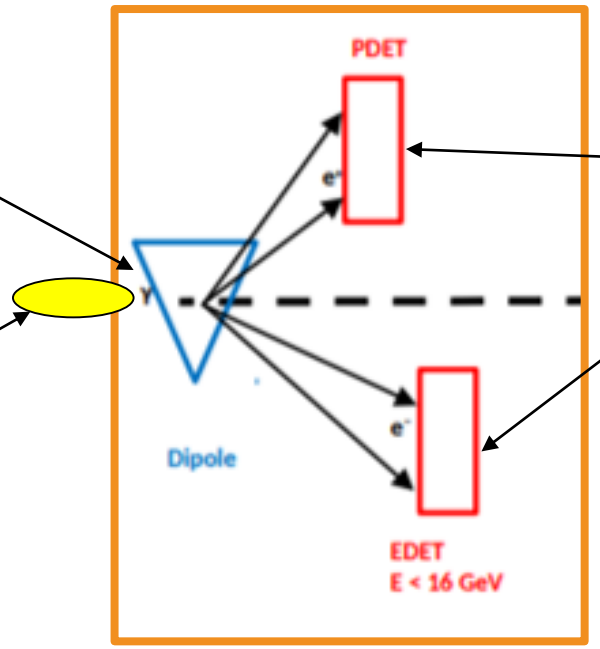
Electron/Positron Spectrometer



Input parameters to consider

Magnet
- Aperture
- Field strength
- size

Incoming particles
- Energy Distribution
- Number
- Spatial distribution



Detector system?
- Pixel Silicon Trackers
- Multiple Layers?
- Calorimeters

Spacial constraints
- Tunnel

XSDU1 tunnel ~2m diameter, European XFEL

Proposed Magnet

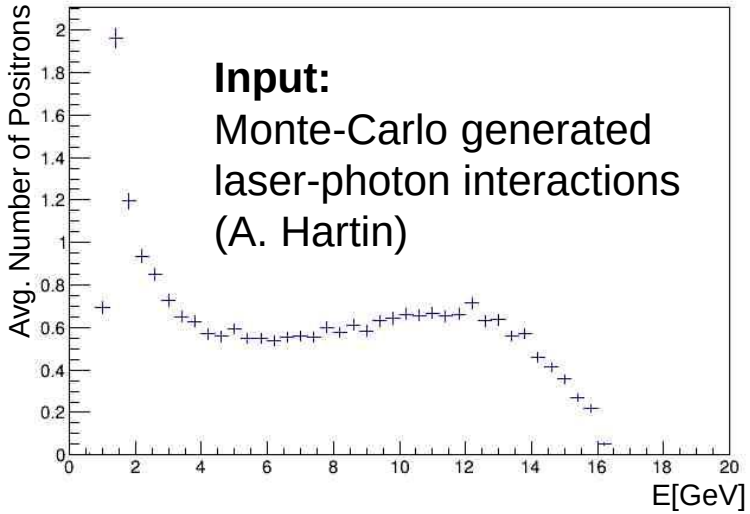
Taken from the DESY storage

suitable magnet from old DORIS accelerator

Doris Dipole	
Length	1.029m
Aperture horizontal	0.6m
Aperture vertical	0.3m
Max. Field strength	2.24T

e^+e^- from interaction

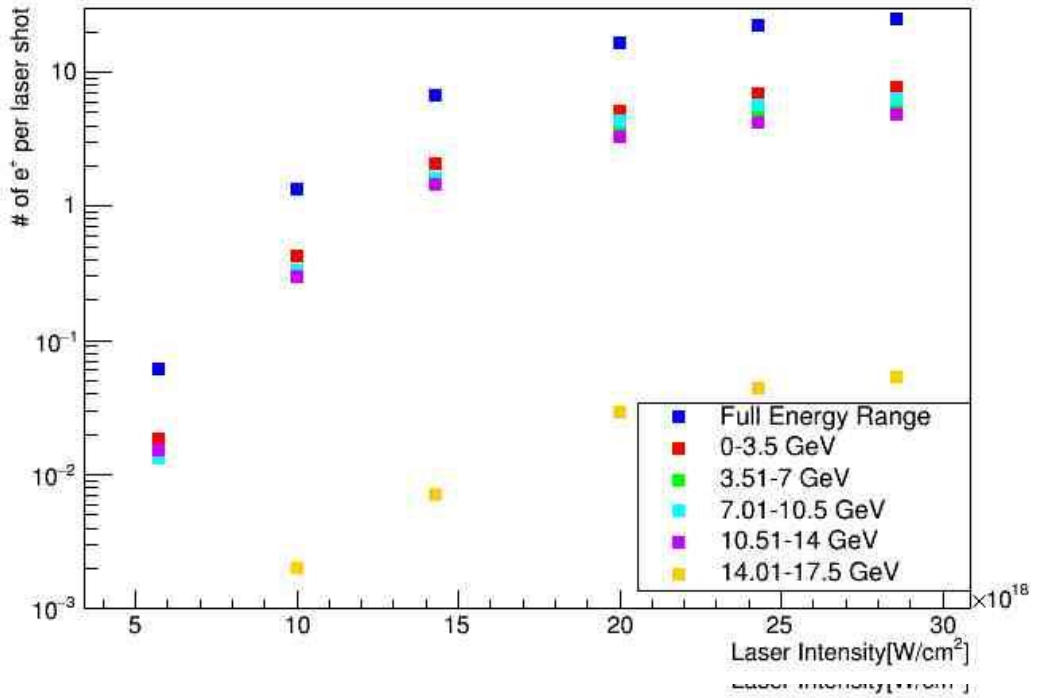
Energy spectrum of incoming positrons

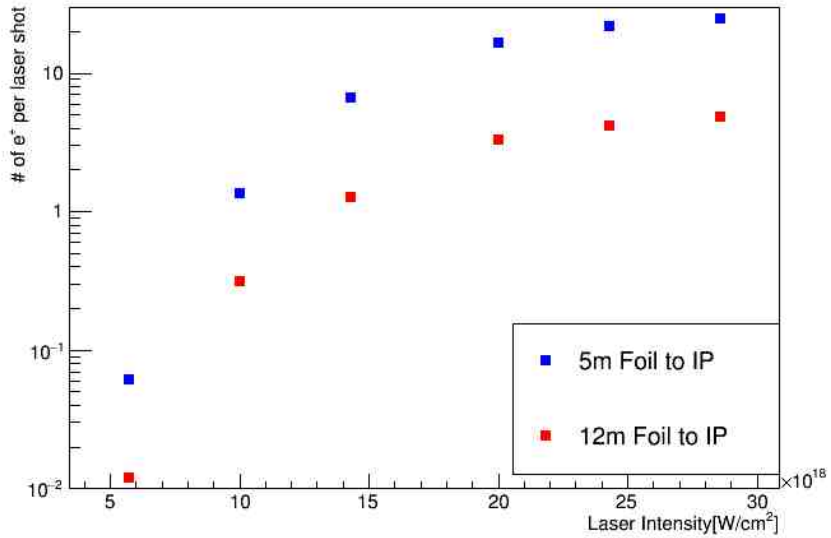


Input:
Monte-Carlo generated laser-photon interactions (A. Hartin)

Slope is independent of Energy range

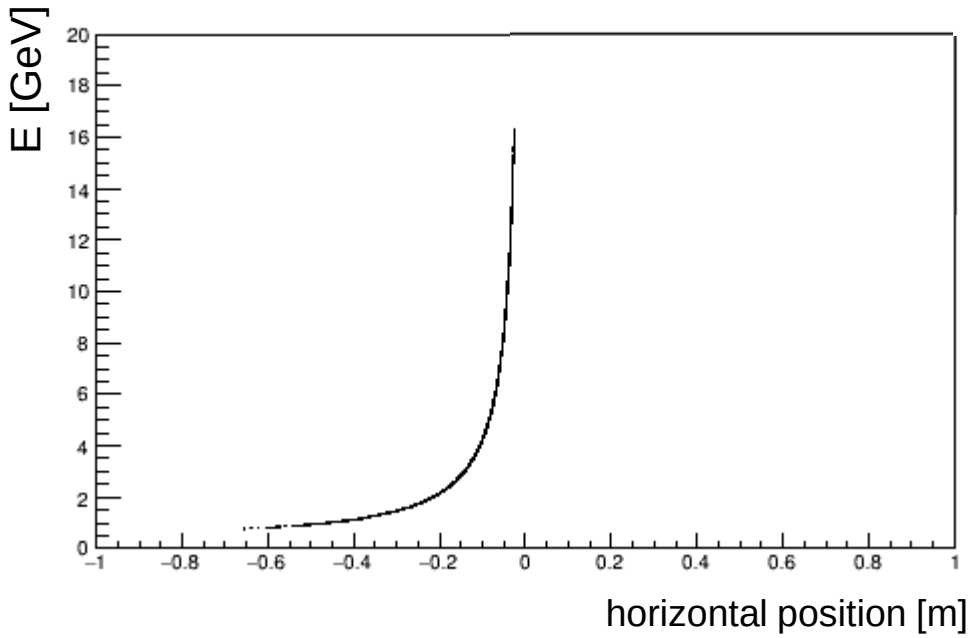
Number of positrons produced for Foil-IP 5m





O(30) positrons for 1 J of laser energy
(Design Laser Energy = 7J)

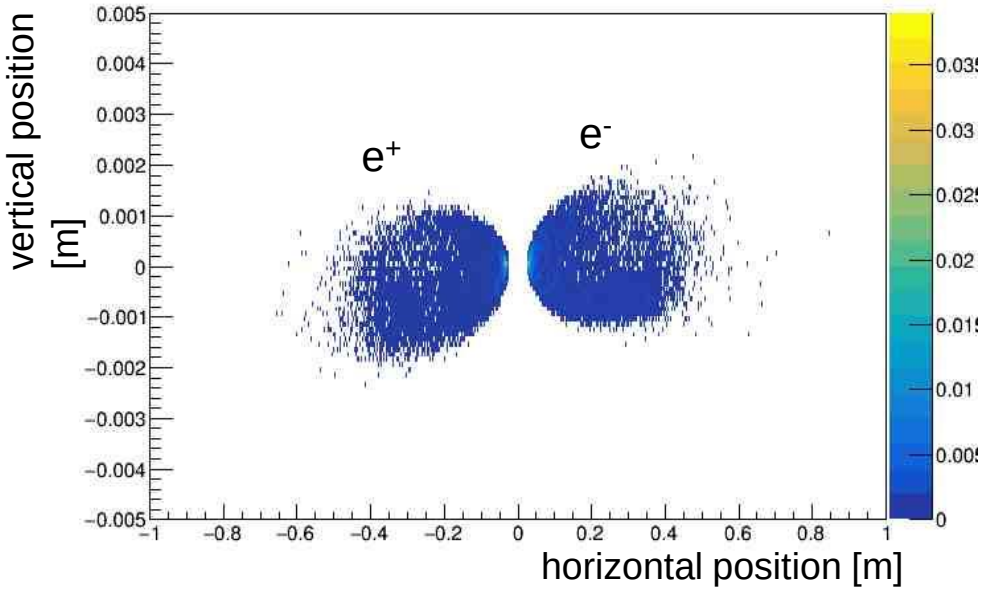
Simulation of Magnetic Spectrometer



3 steps to evaluate particle losses

A: Particles from Simulation → B: Spacial losses → C: Not hitting the detector → D: multiple particles in single pixel

E>1 GeV		x_det < 1 m
x_magnet < 0.3 m	Aperture	y_det < 0.15m
y_magnet < 0.15m		



Max occ. /pixel = 1
pitch: 50 µm × 50 µm
100 µm × 100 µm
50 µm × 500 µm
50 µm × 50 µm
50 µm × 15000 µm (strip)
1000 µm × 1000 µm
10000 µm × 10000 µm
1M µm × 150k µm

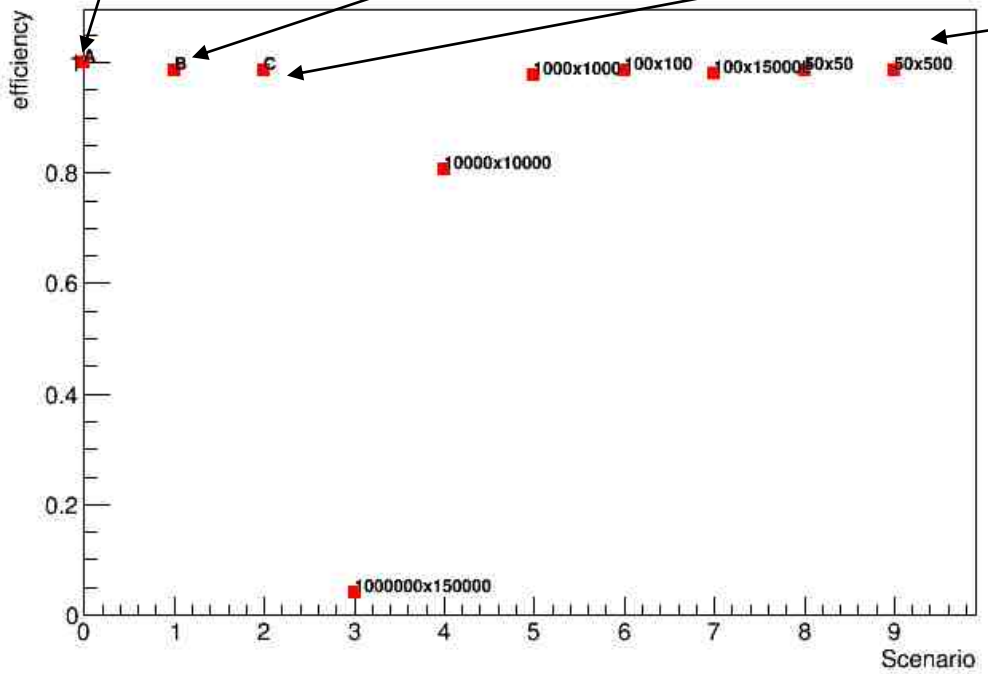
3 steps to evaluate particle losses

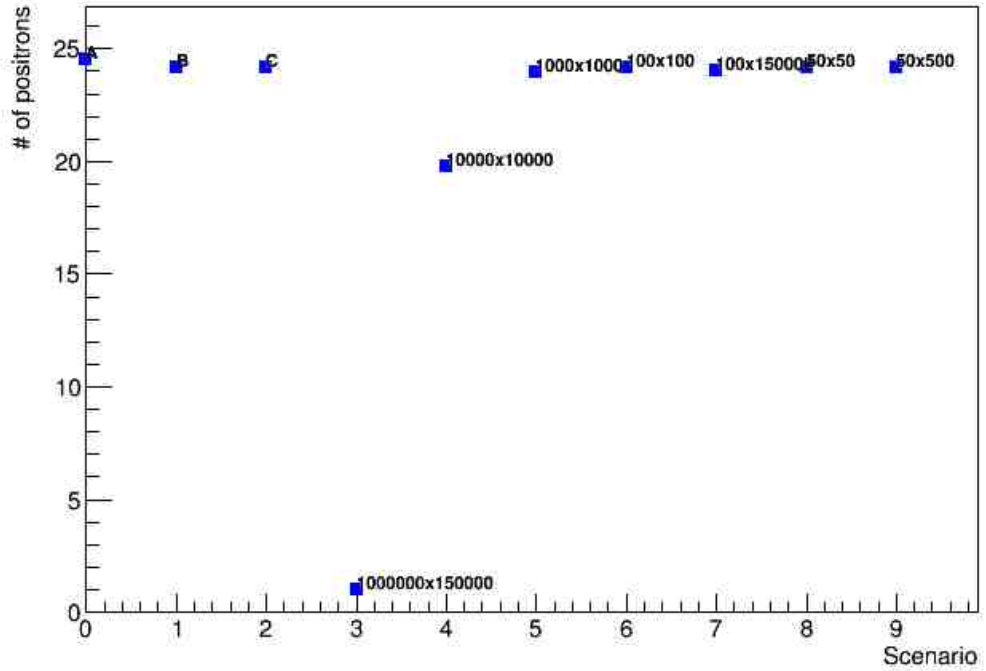
A: Particles from Simulation

B: Spacial losses

C: Not hitting the detector

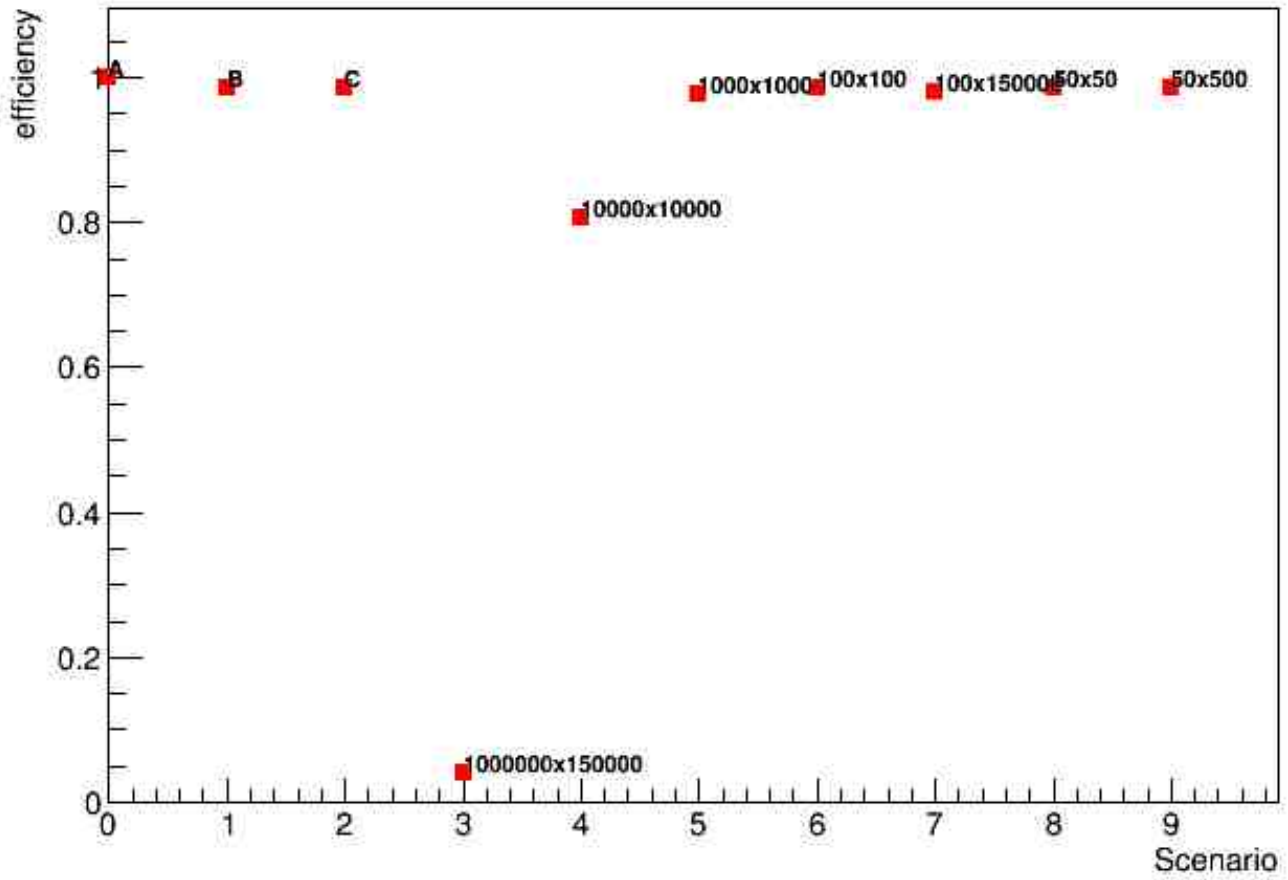
D: multiple particles in single pixel





Pixel size / comparison

Experiment	Pitch
ATLAS IBL	50 µm × 250 µm
CMS Pixel Upgrade	25 µm × 100 µm
LHCb	55 µm × 55 µm
CMS HGCAL	0.5 cm^2 hexagons



Pixel Technology readily available

Moving to Full Calorimeter readout?

Outlook

1. Finalize design simulation studies

- derive final design for the photon Laser interaction scenario
- Monte Carlo up to design Laser Intensity

2. Design studies for direct electron-photon interaction

3. Implement final design Full simulation in GEANT4

4. DESY test beam runs for validation of photon production models

Thank you for your Attention

Contact

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