

LUXE-NPOD

Torben Ferber, Alexander Heidelbach, Markus Klute, Nicolò Trevisani

KIT - Karlsruhe Institute of Technology

21/07/2022

Outlook

- Details of the primary photons energy spectrum estimation
- First look at background distributions
- Progress on the tracking calorimeter design and simulation

Primary Photons Spectrum

We want to check the energy spectrum of photons hitting the physical dump:

- Needed to reweight the Madgraph signal samples
- For now, just considering primary photons
 - Secondary photons have lower energy spectrum and should play a smaller role
 - Noam shared histograms with primary and secondary photons spectra for phase 1 and phase 2
 - What are the laser configurations used to produce the distributions?
 - Is the primary-to-secondary ratio only dependent on the phase (e.g., can we use it independently of the laser configuration, inside a given phase?)
 - \circ $\,$ Also had a look using the same samples we use for primary photon spectrum estimation
- Code <u>here</u>

Few Technical Details

Files used (references: <u>signal+MC</u> and <u>electron-laser</u> mode):

- Phase-0, xi $3.0 \rightarrow e0ppw_{3.0}g4\{0-4\}$ (BX = 4)
- Phase-0, xi 7.0 \rightarrow e0ppw_7.0_g4{0-4} (BX = 4)

Events election:

- Primary photons at physical dump position:
- "detid == 88000 && abs(pdg) == 22 && trackid == 1"
 Recent fix
 Weight:
 Event weight divided by "electrons per BX times **BX per sample**"
 "weight/(4 x 1.5e9)"

Primary Photons: Results

Primary photons spectra for the two laser configurations we are using (both phase 0)



Torben will show more about how we use the spectrum and the results we obtain

Secondary Photons

We looked at secondary photons, by inverting the 'trackid' requirement on the same samples:



"detid == 88000 && abs(pdg) == 22 && trackid != 1" \rightarrow is it the correct approach?

The plots is suffering from low statistics:

- We can try looking at the 'e0gpc_*.0_g4_22_01' samples, with ~100 BX to have more populated bins
- But we need to validate the samples first
- Is the average event weight the only expected difference between 'ppw' and 'gpc' samples?
 - What is their meaning?

First Look at Background Distributions

Again, we use the same samples, focusing on what we get at the BSM detector position

- We select events that can mimic our signal signature:
 - Events with either two photons, two neutrons, or one neutron and one photon
- We plot some relevant kinematical distributions
 - Particles distance from the center of the detector
 - Particles distance from each other at the detector surface
 - Angular distributions
 - o ...
- Very preliminary results, work in progress
- Starting with one file from the Phase-0, xi 3.0 sample (1 BX)

Background Distributions: Delta-Phi

Delta phi between the two particles

• Currently looking at nn and γγ events only



Background Distributions: Distance at Detector Surface

Distance at detector surface between the two particles

• Currently looking at nn and γγ events only





Background Distributions: Invariant mass

Invariant mass of the two-particles system

• Currently looking at nn and γγ events only





Next Steps

We have an estimation of the primary photons spectrum hitting the physical dump

- Promising results in Torben's talk
- Quick look at secondary photons spectrum: statistics seem low
- Using the same samples, we looked at the expected background events and few kinematic distributions
 - Very preliminary results, just setting up the code
 - Have to compare with expected signal yield and consider neutron mis-id probabilities
- Currently, only looking at phase 0 samples. But we plan to look at phase 1

We are working on a *standalone* simulation of a sampling calorimeter in Geant4:

- Easy to test different configurations and optimize detection efficiency
- Keeping in mind we want to eventually include its implementation in the LUXE framework

Physics goals:

- Precise reconstruction of ALP invariant mass (vertex and timing information)
 → Good resolution of photons direction and energy
- Background suppression
 - \rightarrow Shower shape determination

Alexander Heidelbach

Current Design

- Sampling calorimeter of alternating absorber and pixel detector plates
 - Absorber: let photons showering
 - Pixels: track charged particles in the shower
- Possibility to replace the absorber with scintillation material
- Energy measured by additional calorimeter placed after the absorber and tracking materials
- Covering the ~1m x 1m NPOD surface with ~5cm x 5cm cells



Nicolò Trevisani - LUXE-NPOD at KIT

Status & Outlook

Current Status

- First detector simulation is completed
- Output: energy depositions of every component
- Each component size, material and distance are free parameters in the simulation

Outlook

- Implementation of HepMC3 as input format
- Begin of first order studies with different ALP model parameters
- Long term: Implementation of reconstruction algorithms with MVA-based structures



Alexander Heidelbach