Karlsruhe Institute of Technology

ALP sensitivity for LUXE-NPOD

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LUXE-NPOD Meeting

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LUXE

ETP
Institut für Experimentelle Teilchenphysik

Signal studies setting

- Photon spectra from Nicolo (Phase0)
- MadGraph samples from Arka
- Assume that all photons produce ALPs in the first mm of the target
- Random boosted ctau (calculations cross-checked with Arka)
- Four vector selection:
  - ALP decay after target and before detector
  - $E_\gamma > 0.5$ GeV
  - $r_{det} < 1.0$ m
  - no photon separation requirement yet

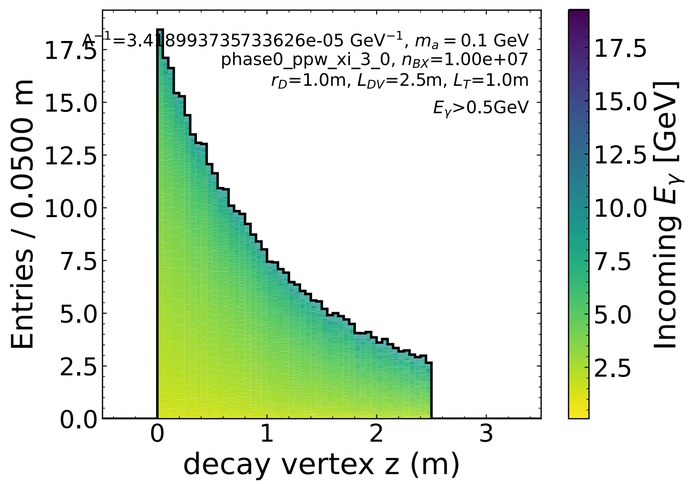
```
# see LUXE-NPOD paper eq. 13
N_e = 1.5e9 #electrons per bunch
N_bx = 1e7 #bunch crossings

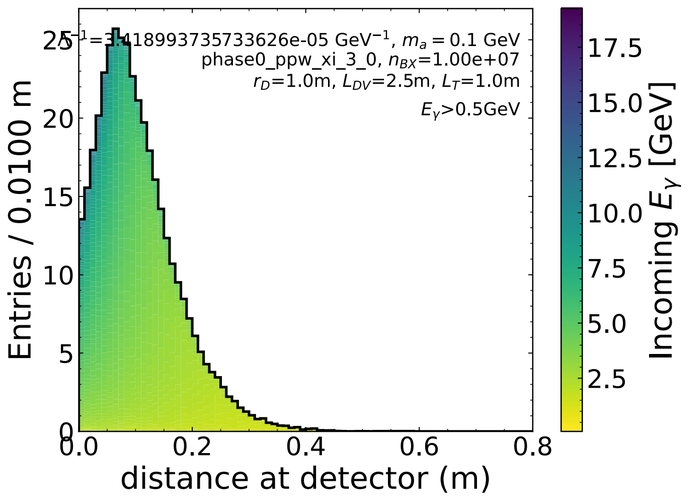
rho_W = 19.3 # tungsten
X_0 = 0.35 # tungsten radiation length
A_W = 184 # tungsten atomic number
m0 = 1.661*pow(10,-24) #nucleus mass

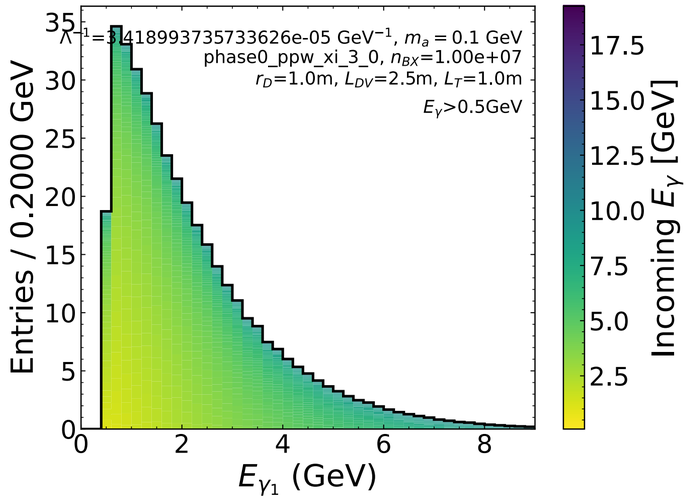
L_eff = N_e * N_bx * 9.0 * rho_W * X_0 / (7.0 * A_W * m0)
L_eff_pb = L_eff / 1e36 #luminosity in picobarn
```

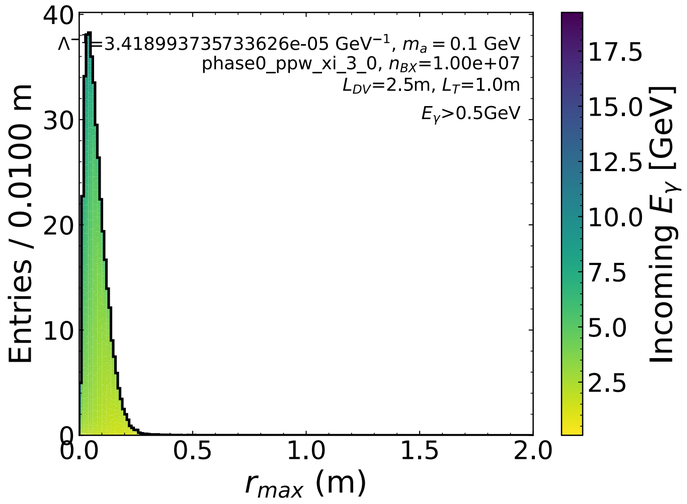
L_eff = 426.26 pb

Distributions for incoming photon energy spectra

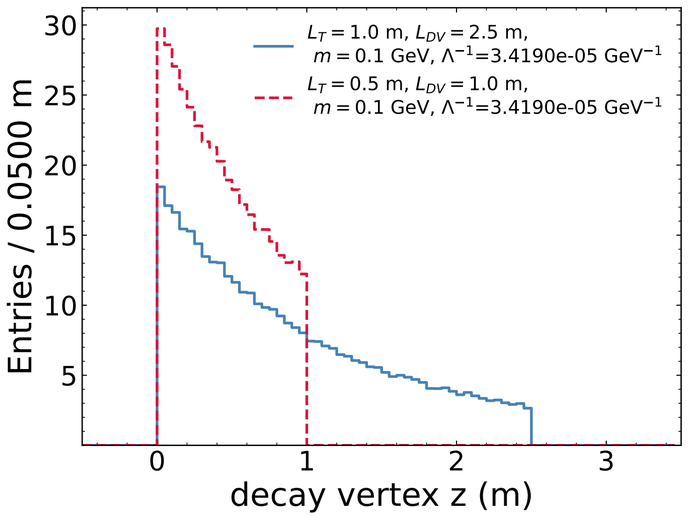


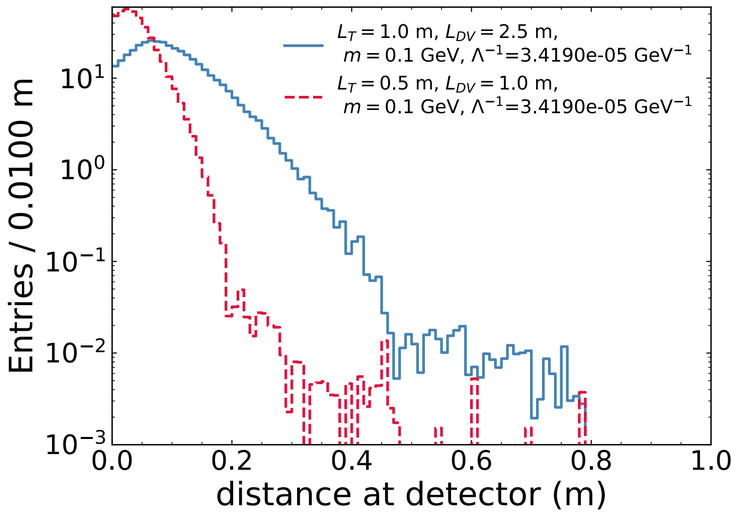


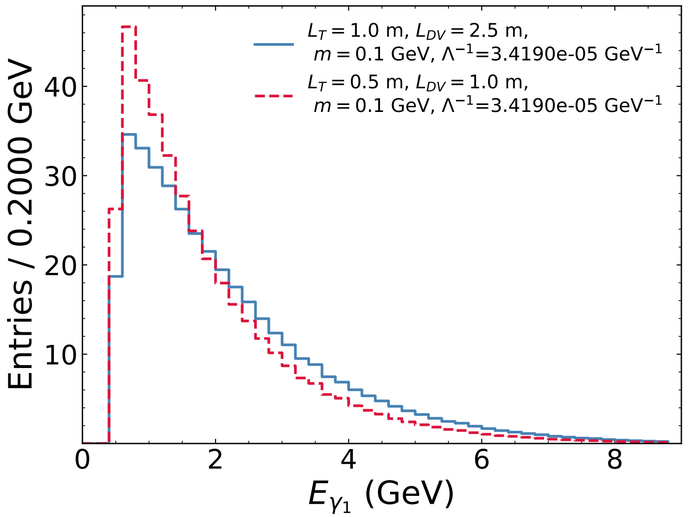


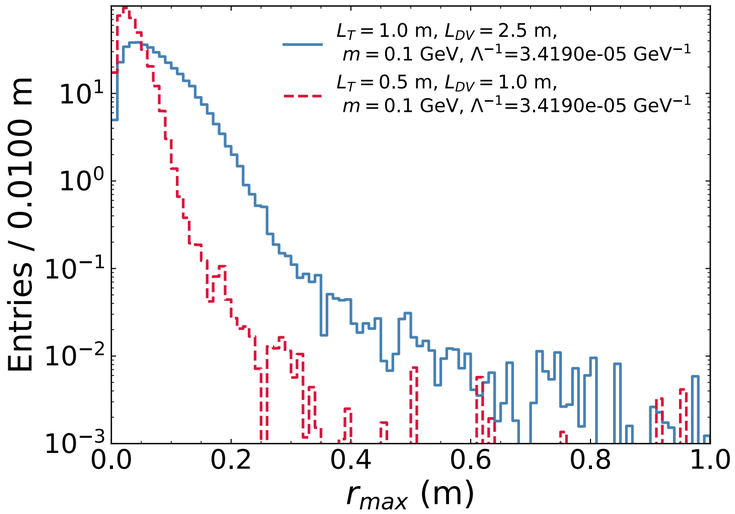


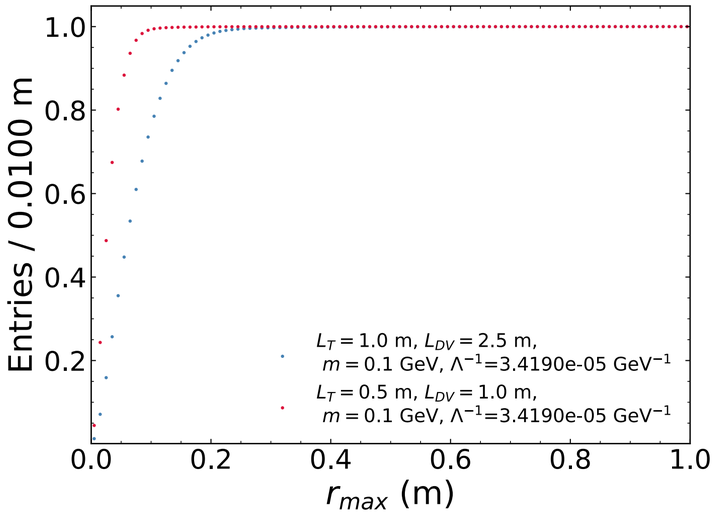
Distributions for different target and DV configurations



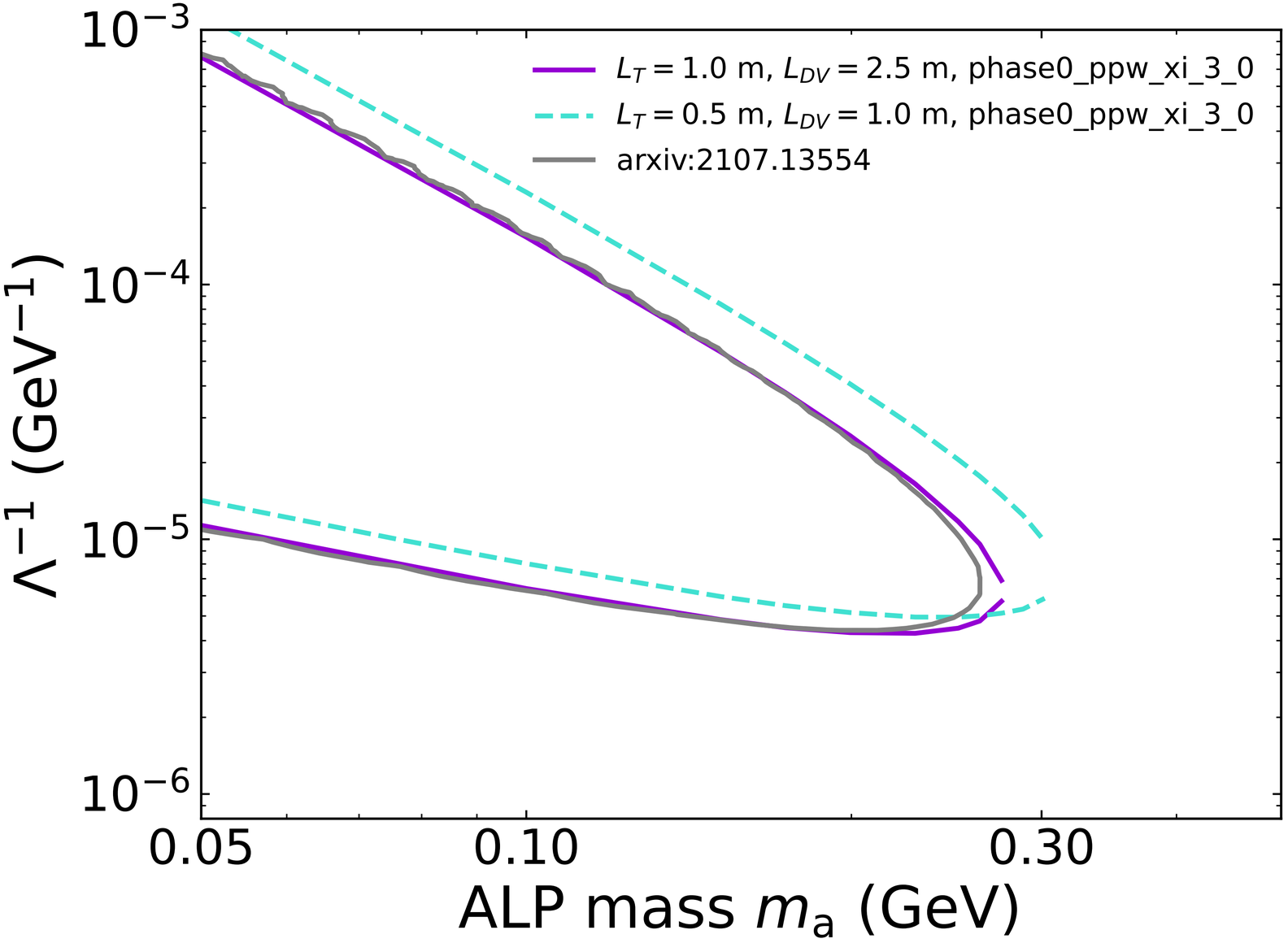


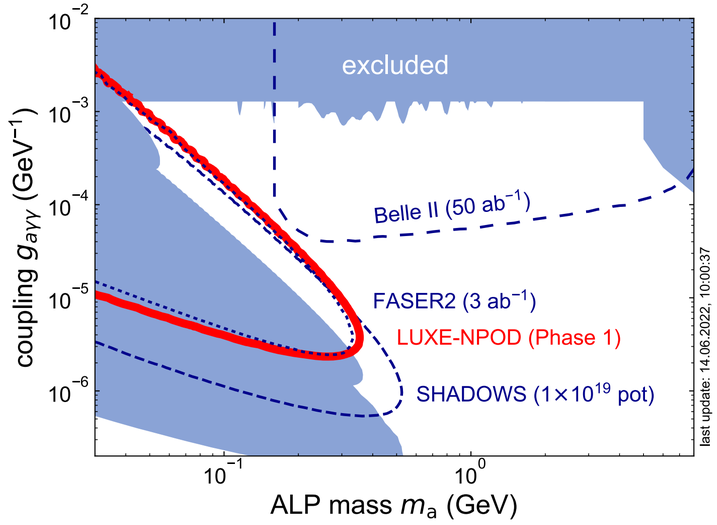






Signal sensitivity



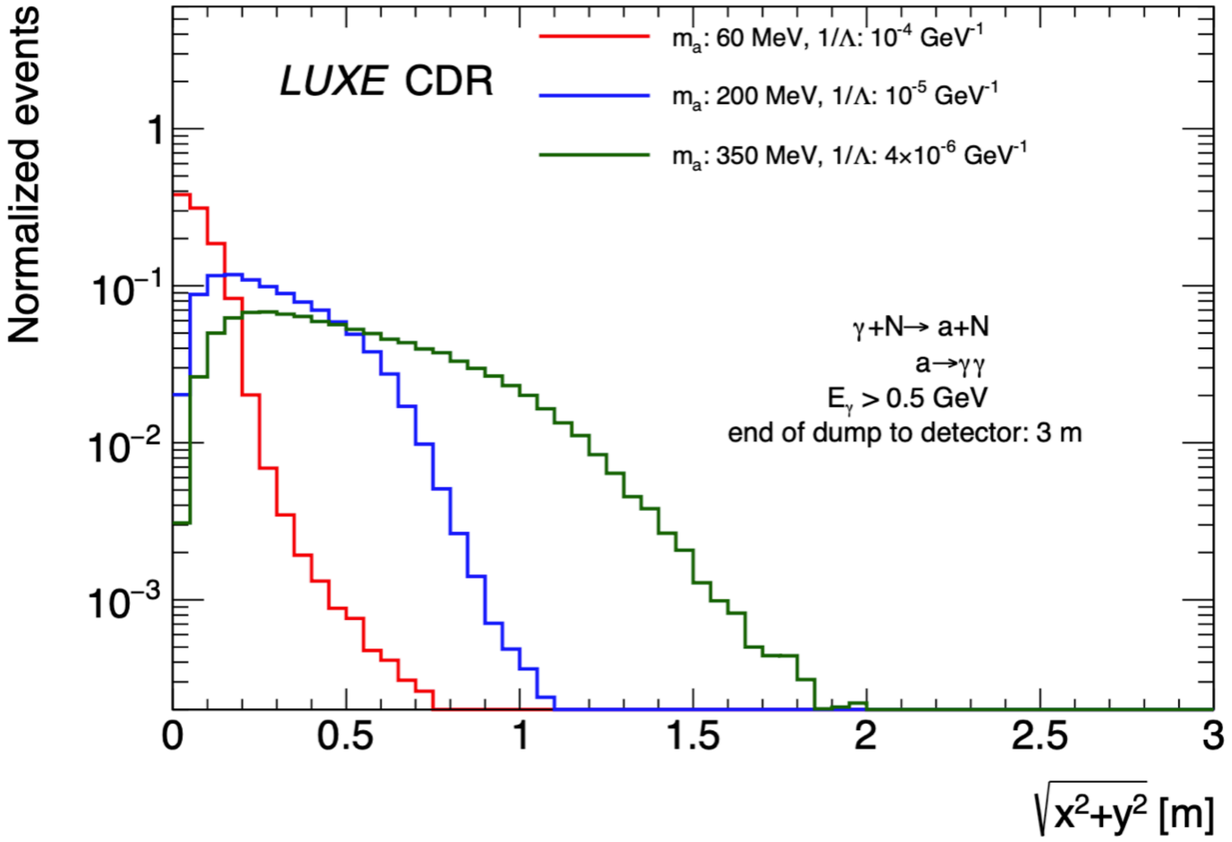


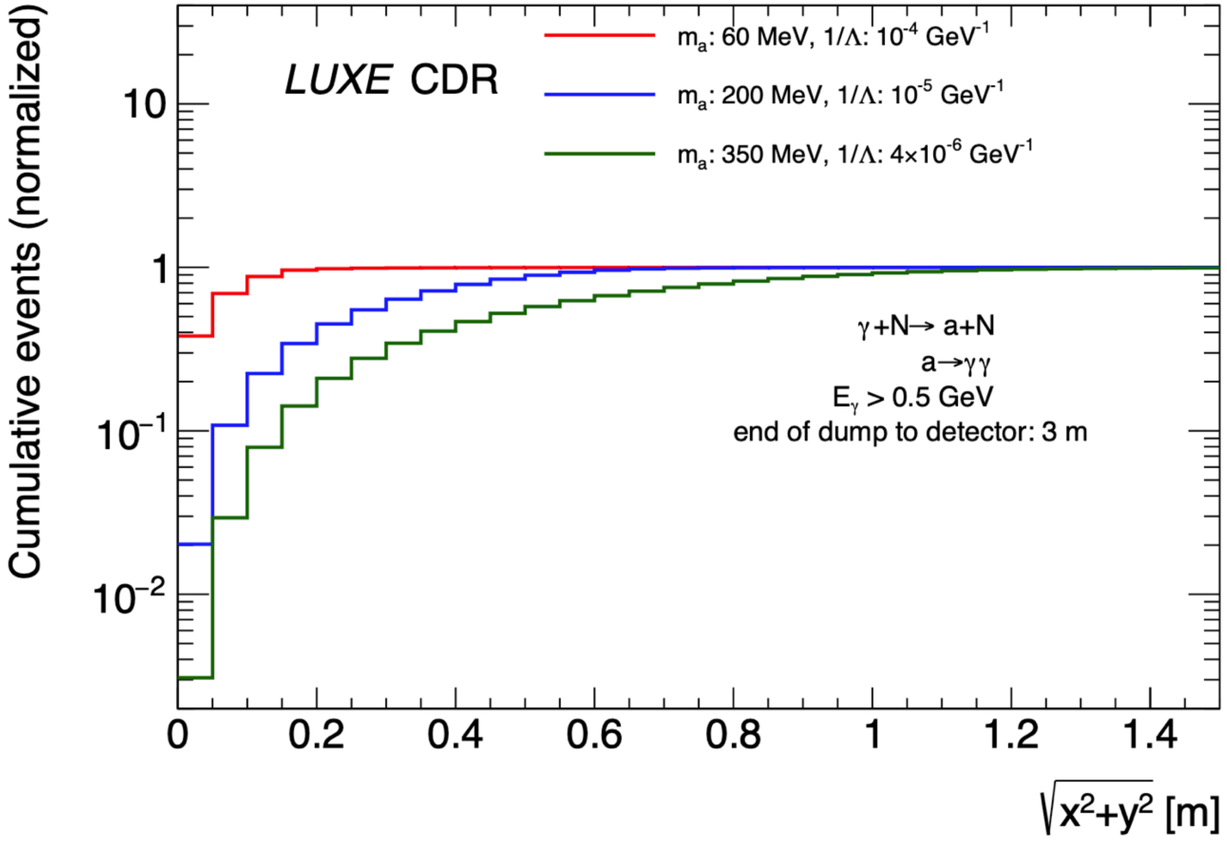
Summary and next steps for signal studies

- We can now scan sensitivities and plot all photon and ALP kinematics (signal only) for any set of selections and target/decay volume geometries automatically on the ETP cluster (~1h per scan of all masses and couplings)
- Finalize incoming photon spectra and add secondary photons
- Resolve/understand potential discrepancy with Arkas result (see backup)
- From a global PBC perspective, it might be interesting to probe larger couplings in the 50-200 MeV range with a shorter target and decay volume.

Backup

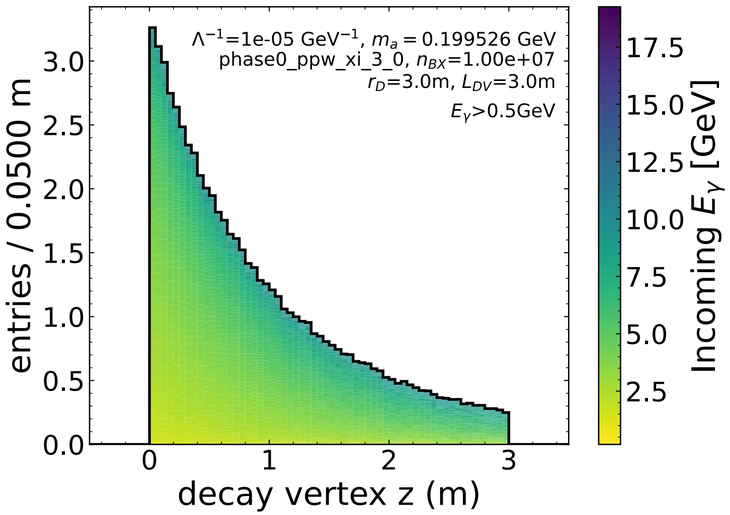
CDR

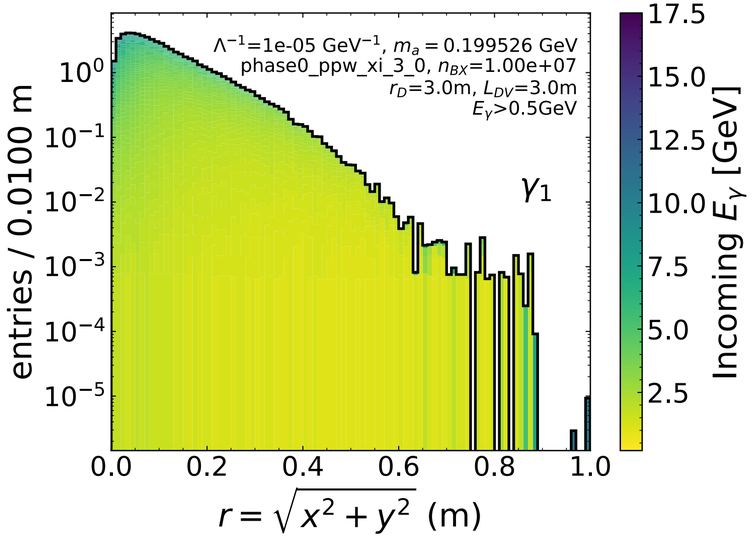


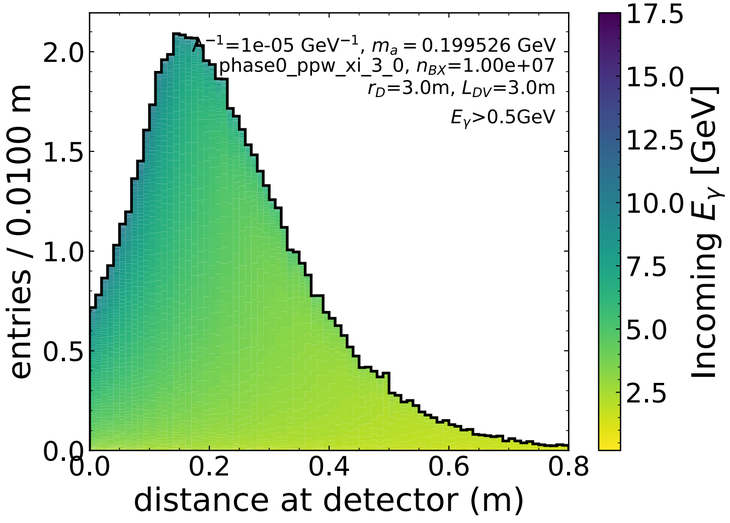


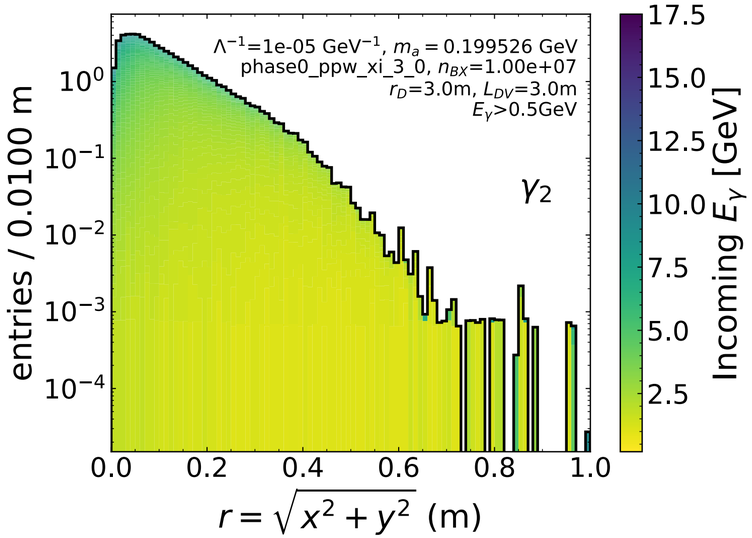
More than 90% of the photons are captured by a detector with radius of 1 m

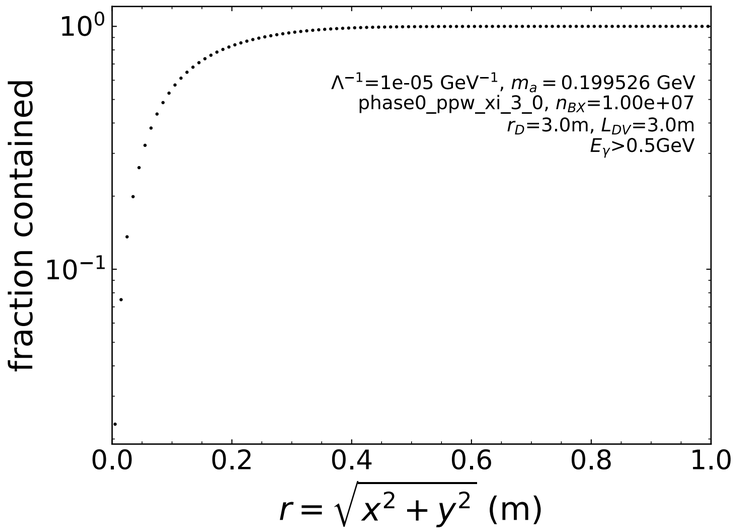
m= 0.199526, 1/Λ=1e-5











Inputs: m= 0.199526, 1/Λ=1e-5, E_γ=2.1 GeV

```
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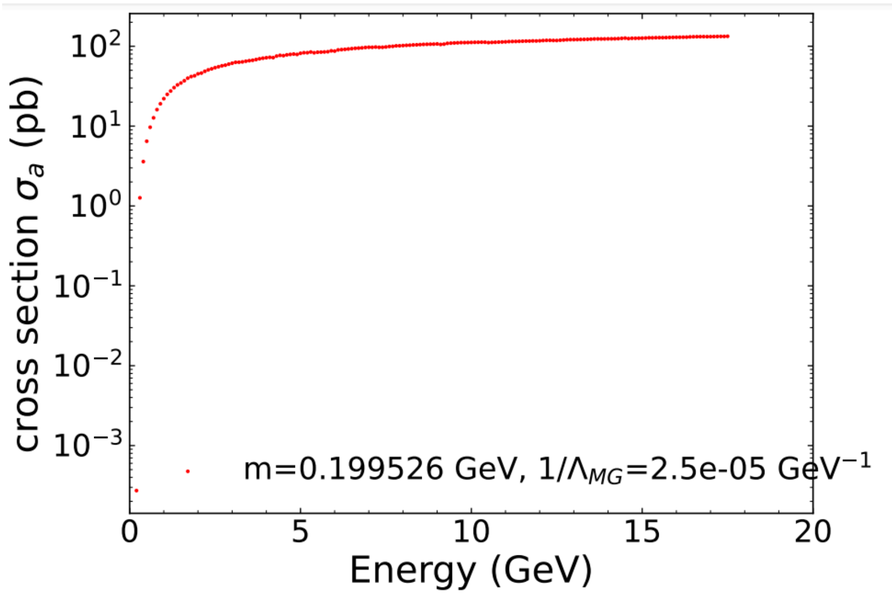


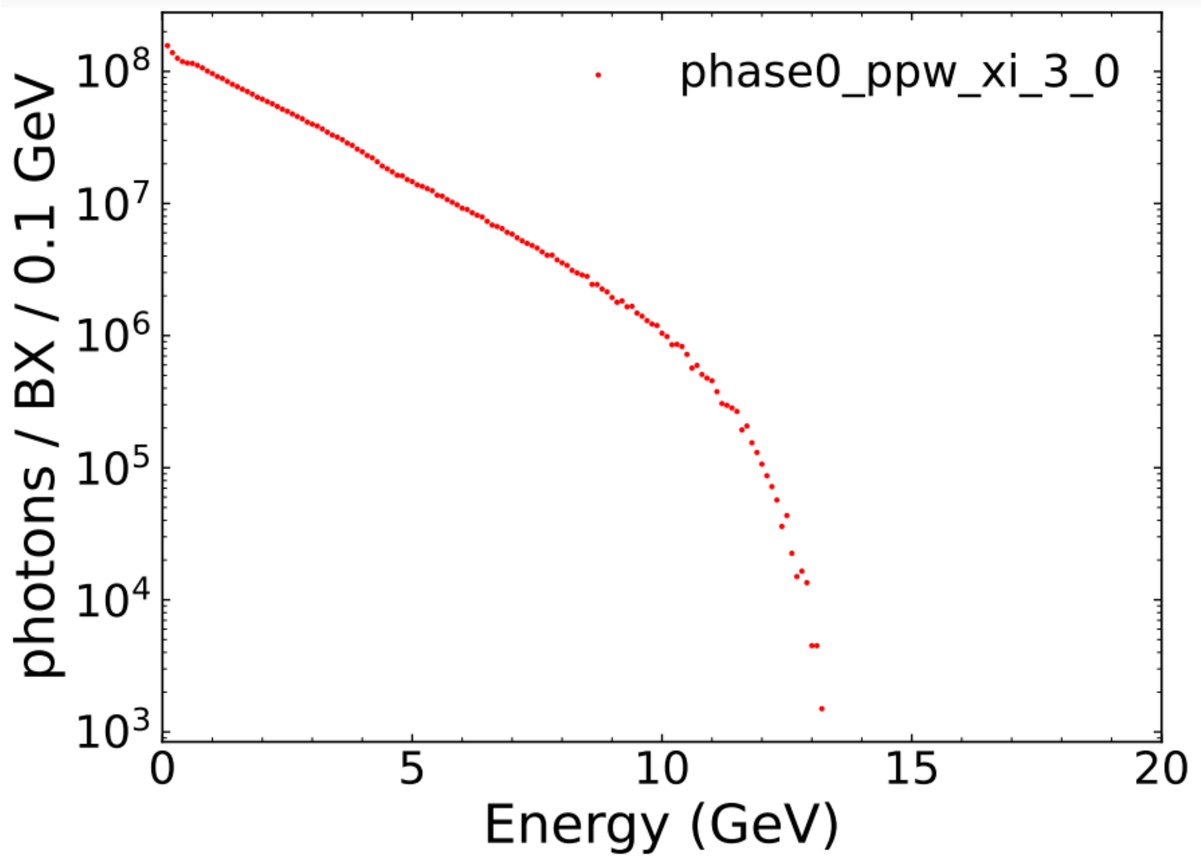
m = 0.199526 GeV, input photon energy E=2.1 GeV
→ input file: LUXE/BSM/sig/1m/TungstenDump/mass0.199526GeV/unweighted_events_mass0.199526GeV_beam2.1GeV_v3.root

cross section from MadGraph: 46.158 pb (for Λ = 1e4 GeV, 1/Λ=1e-4 GeV^-1)
(from LUXE/BSM/sig/1m/TungstenDump/RunTagBannerFiles/mass0.199526GeV/run_01_tag_1_banner_0.199526GeV_beam2.1GeV_v9.txt)

rescaled for new coupling 1/Λ=1e-5: **0.46158 pb**

cτ = 0.04994796842052421 m

Inputs: Photon spectrum



after rebinning in 0.1 GeV steps:

0.039408 photons (E=2.1 GeV) per incoming electron
(1BX = 1.5e7 electrons)

Results: m= 0.199526, 1/Λ=1e-5, E_γ=2.1 GeV