NPOD status

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March 24th , 2025

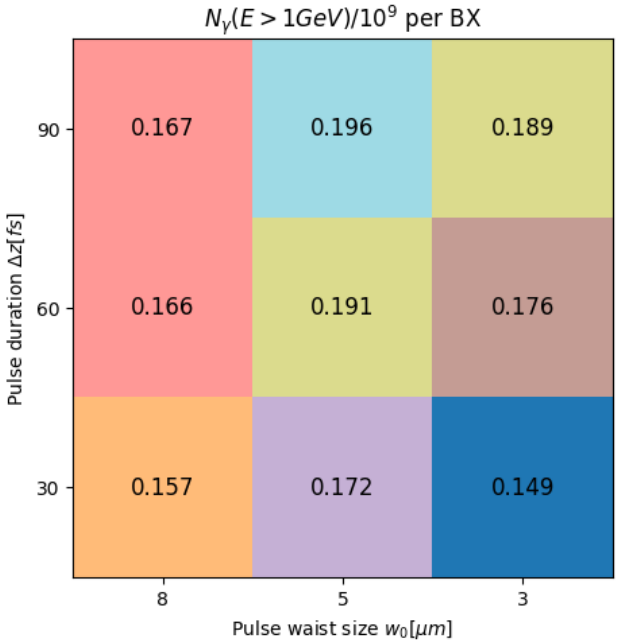
Ptarmigan input (e.g. phase-1)

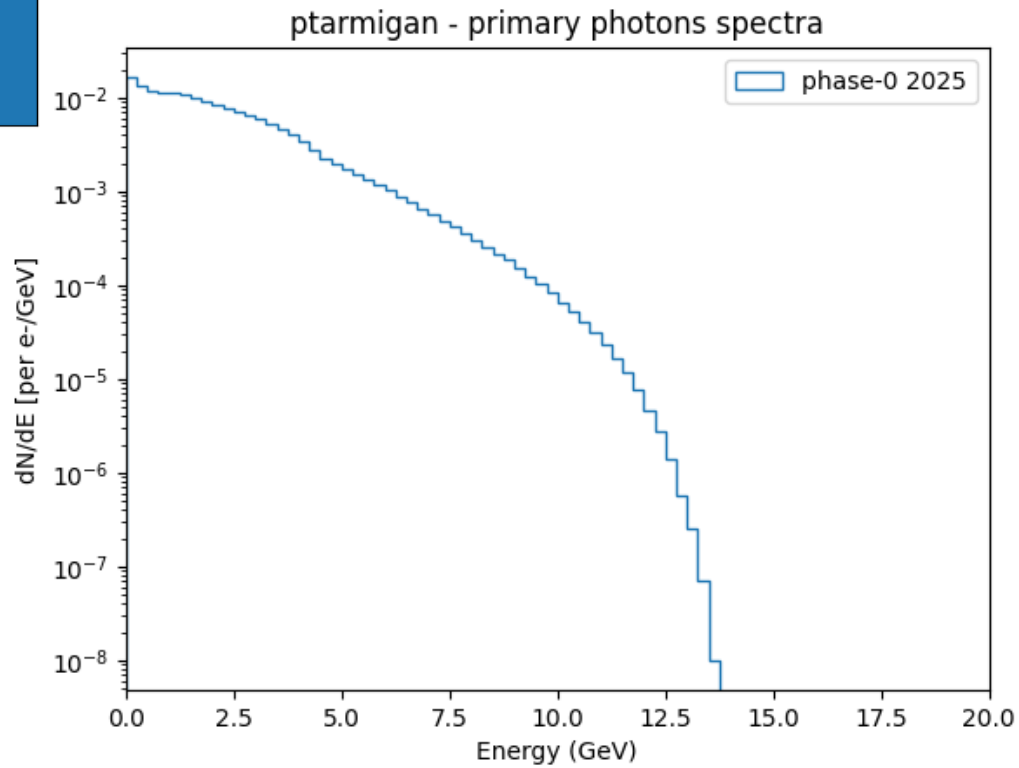
```
---
control:
  dt_multiplier: 0.2
  pair_creation: false
  rng_seed: 17

laser:
  # xi = 147.839 sqrt(E [J]) lambda [micron] / (w0 [micron] sqrt(t [fs]))
  a0: 147.839 * sqrt(laser_energy) * wavelength / (waist * sqrt(tau))
  wavelength: wavelength
  fwhm_duration: tau * femto
  waist: waist
  polarization: circular

beam:
#  ne: 100000000 # 1.0e8 => weight = 15
  ne: 10000000 # 1.0e7 => weight = 15
  charge: 1.5e9 * e
  gamma: initial_gamma
  sigma: 0.001 * initial_gamma
  radius: [5.0 * micro, normally_distributed]
  length: 24.0 * micro
  collision_angle: -17.2 * degree
  rms_divergence: 8.672 * micro
```

```
output:
  ident: auto
  dump_all_particles: hdf5
  discard_background_e: true
  file_format: fits
  electron: [energy]
  photon: [energy]

stats:
  photon:
    - total number
    - total number for energy in (1000; auto)

constants:
  laser_energy: 10.0 # joules
  wavelength: 0.8 * micro
  waist: 10.0 * micro
  tau: 120.0 # femto
  initial_gamma: 16.5 * GeV / (me * c^2)
```

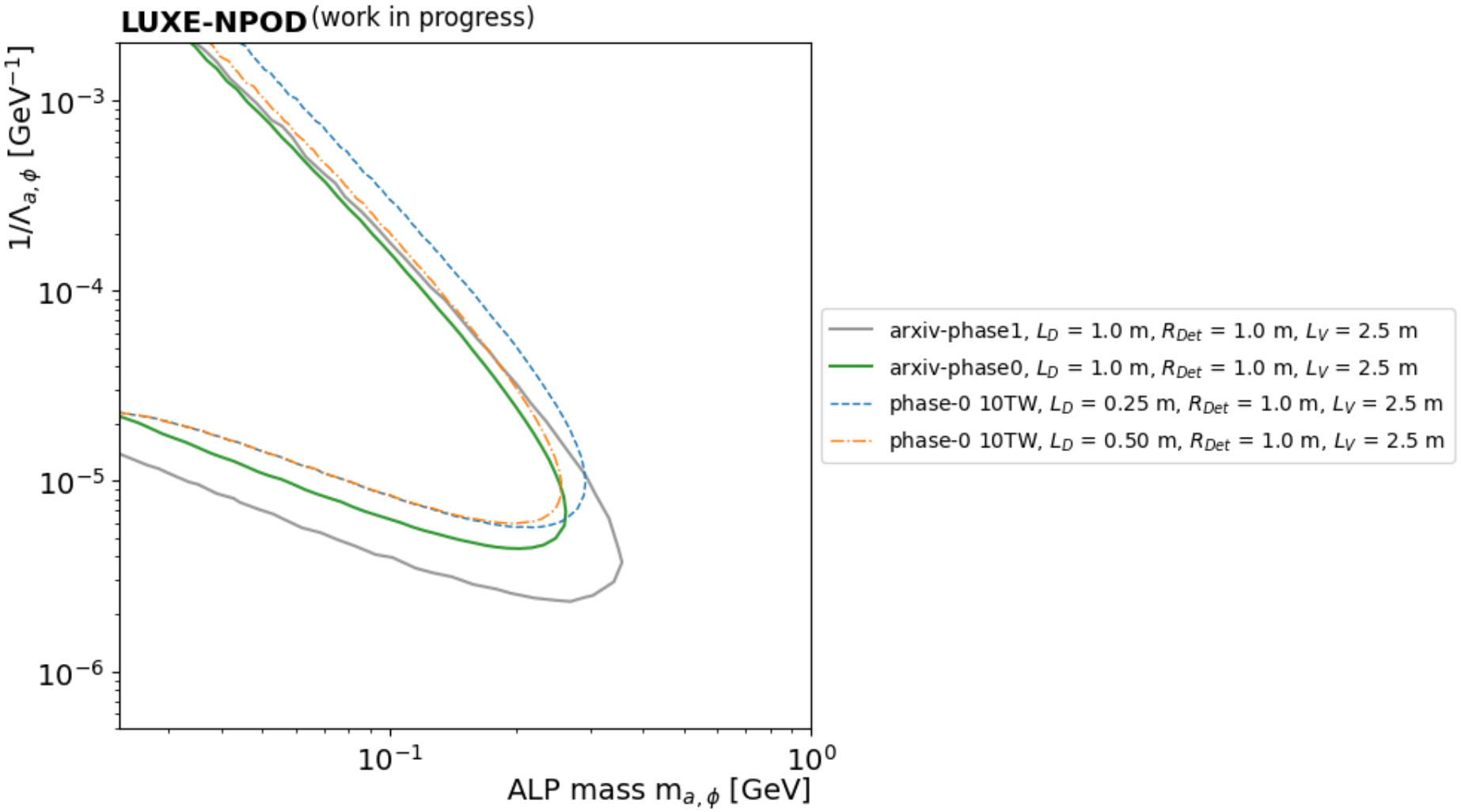
Phase-0 10TW

Phase-1 350TW	today
Ptarmigan	v1.4.2
Focal spot	5 um
Laser pulse duration	30 fs
xi	2.37 (0.25J)
Dump	Tungsten, LD=50cm
Decay volume	2.5 m
G4	Full LUXE setup with W+Pb dump. G4 v11
detector	R=1 m
Simulated full BXs	1



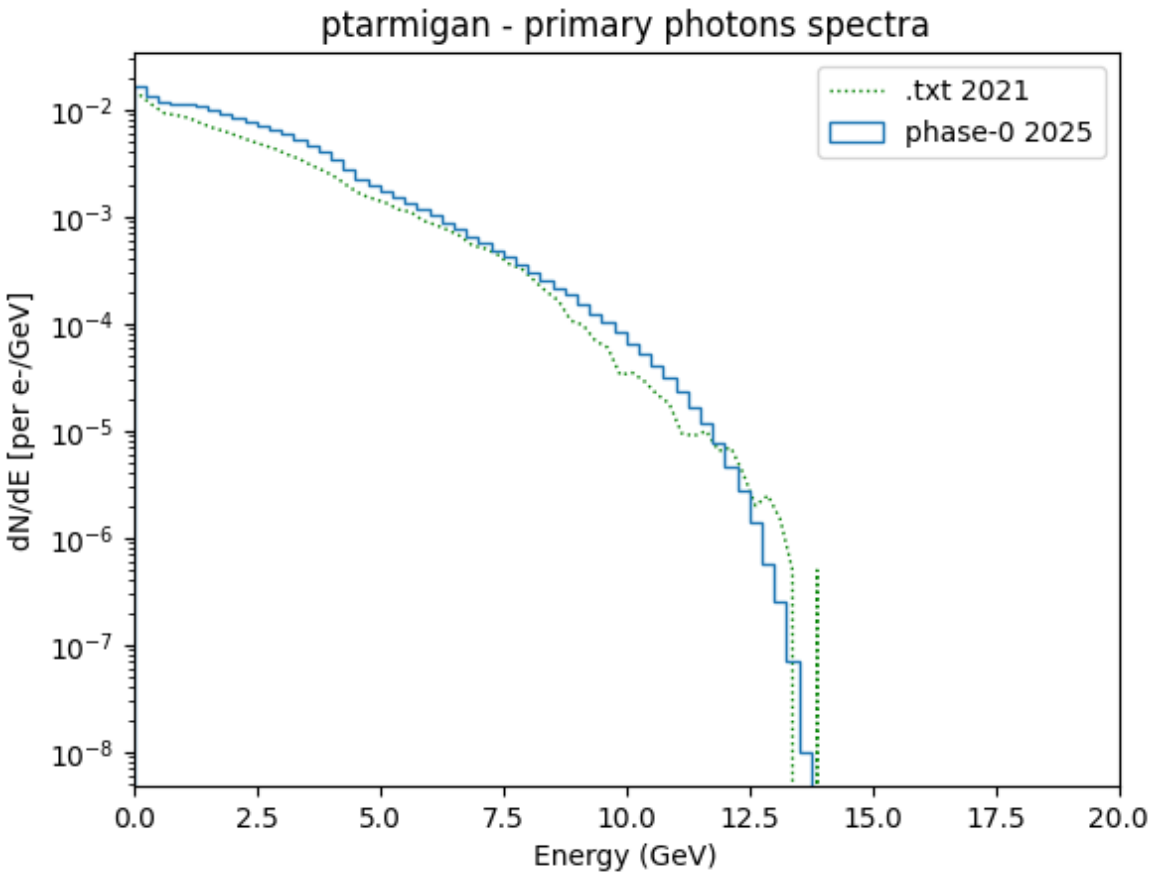


Phase-0 10TW


LUXE-NPOD (work in progress)
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-1}
10^{0}
ALP mass $m_{a,\phi}$ [GeV]
arxiv-phase1, L_D = 1.0 m, R_{Det} = 1.0 m, L_V = 2.5 m
arxiv-phase0, L_D = 1.0 m, R_{Det} = 1.0 m, L_V = 2.5 m
phase-0 10TW, L_D = 0.25 m, R_{Det} = 1.0 m, L_V = 2.5 m
phase-0 10TW, L_D = 0.50 m, R_{Det} = 1.0 m, L_V = 2.5 m

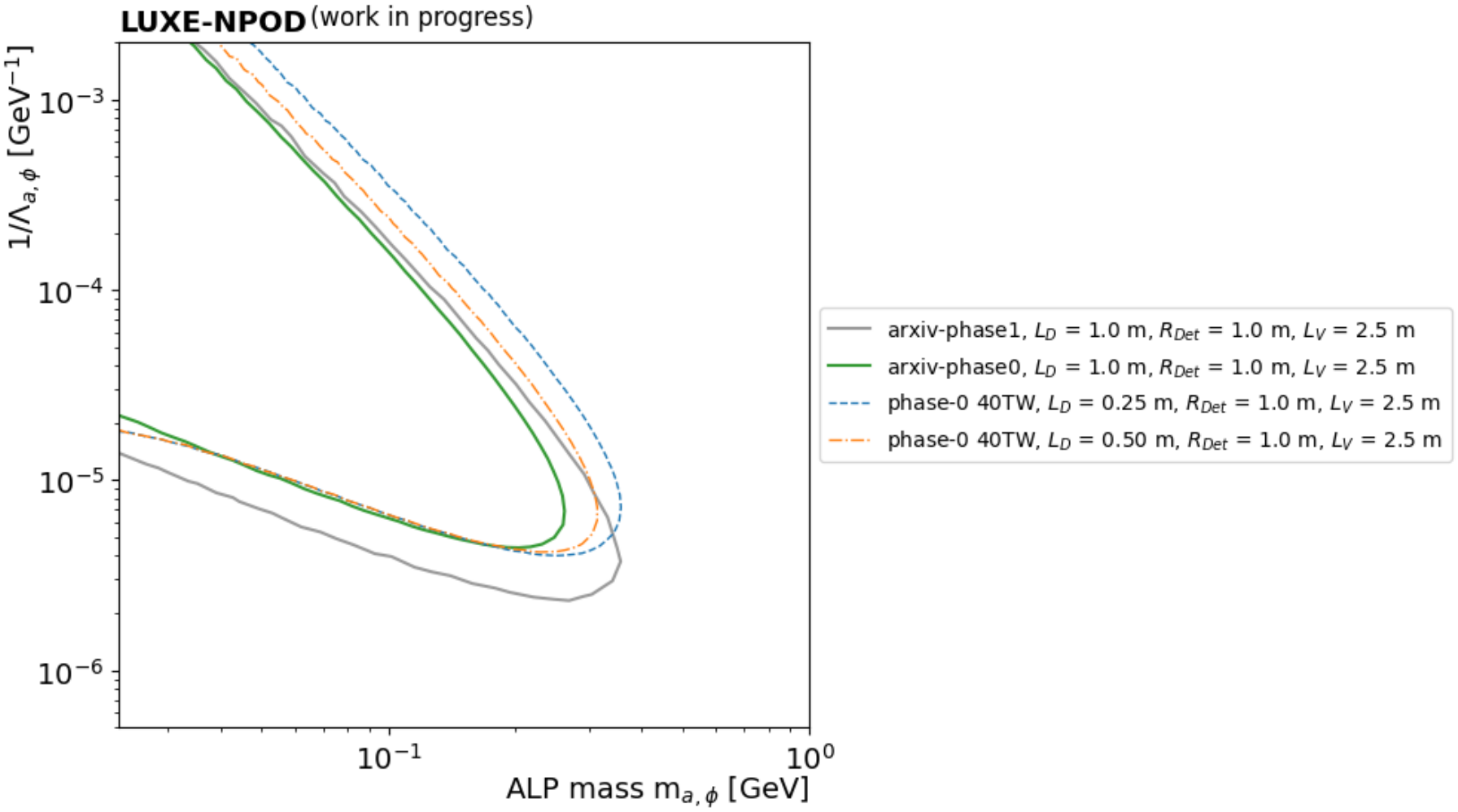
Phase-0 40TW

Phase-0 40TW	2021	today
Ptarmigan	v0.11	v1.4.2
Focal spot	6.5 um	6.5 um
Laser pulse duration	25 fs	25 fs
xi	2.39	3.63 (laser energy 1J)
Dump	W, LD=50cm	W, LD=50cm
Decay volume	2.5 m	1 m
G4	Toy model. G4 v10.06	Full LUXE setup with W+Pb dump. G4 v11
detector	R=1 m	R=1m
Simulated full BXs	2	1

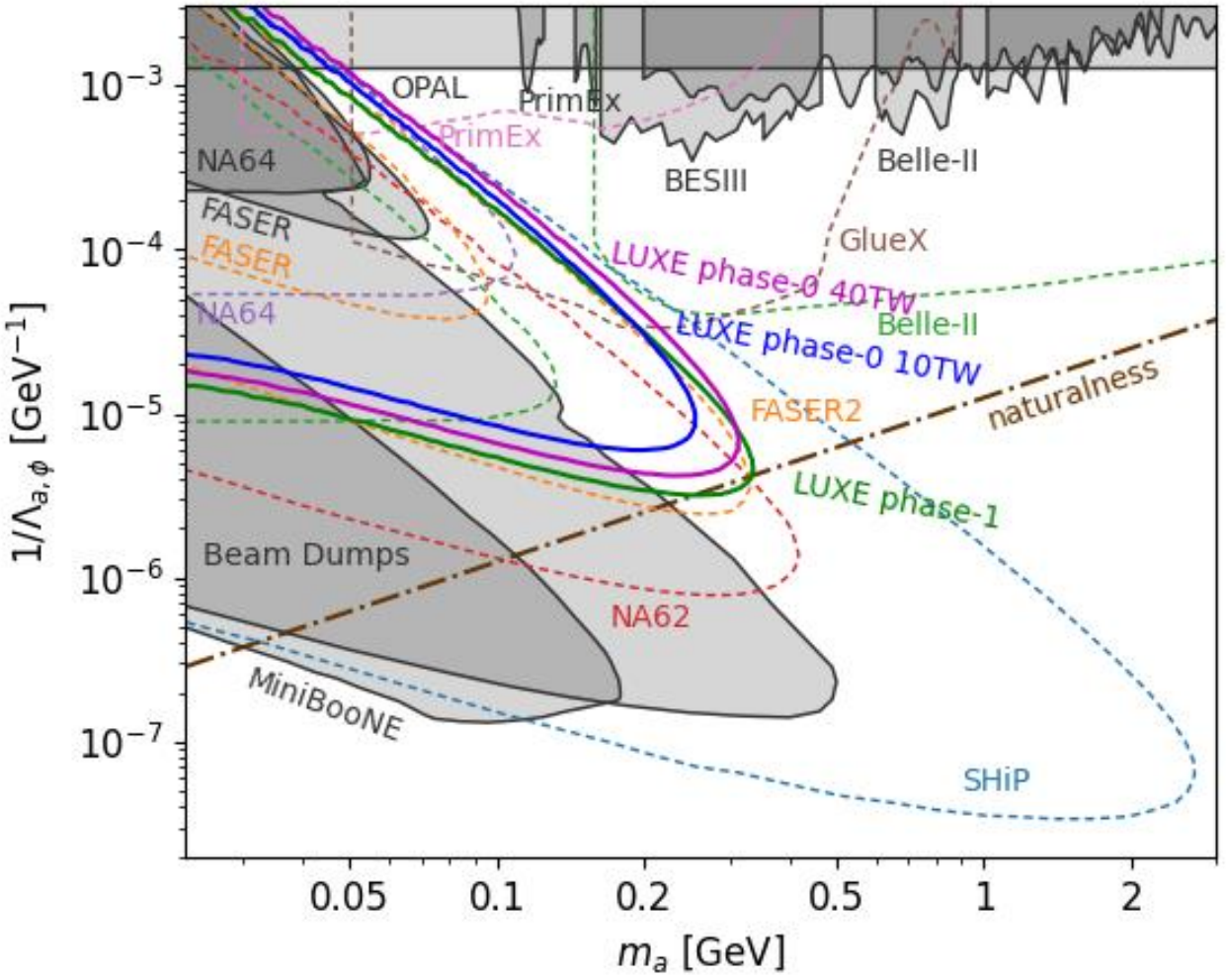


80 bins - (0,20)

Phase-0 40TW


LUXE-NPOD (work in progress)
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-1}
10^{0}
ALP mass $m_{a,\phi}$ [GeV]
arxiv-phase1, L_D = 1.0 m, R_{Det} = 1.0 m, L_V = 2.5 m
arxiv-phase0, L_D = 1.0 m, R_{Det} = 1.0 m, L_V = 2.5 m
phase-0 40TW, L_D = 0.25 m, R_{Det} = 1.0 m, L_V = 2.5 m
phase-0 40TW, L_D = 0.50 m, R_{Det} = 1.0 m, L_V = 2.5 m

LUXE-NPOD sensitivity



- Phase-0 10TW & 40TW:
  - LD=50cm, LV=2.5m
- Phase-1 350TW
  - LD=1m, LV=1m

- No background seen for phase-0 L_D=50cm in G4 simulations (1BX)

- ToDo: G4 simulations for phase-0 L_D=25cm

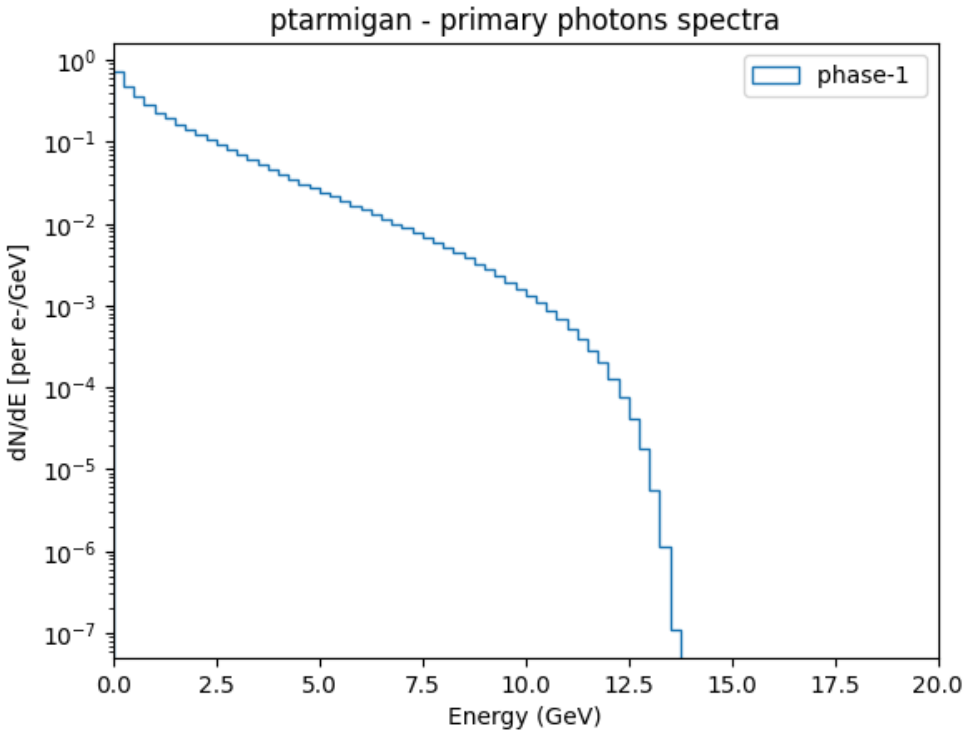
Karlsruher Institut für Technologie

Thanks

backup

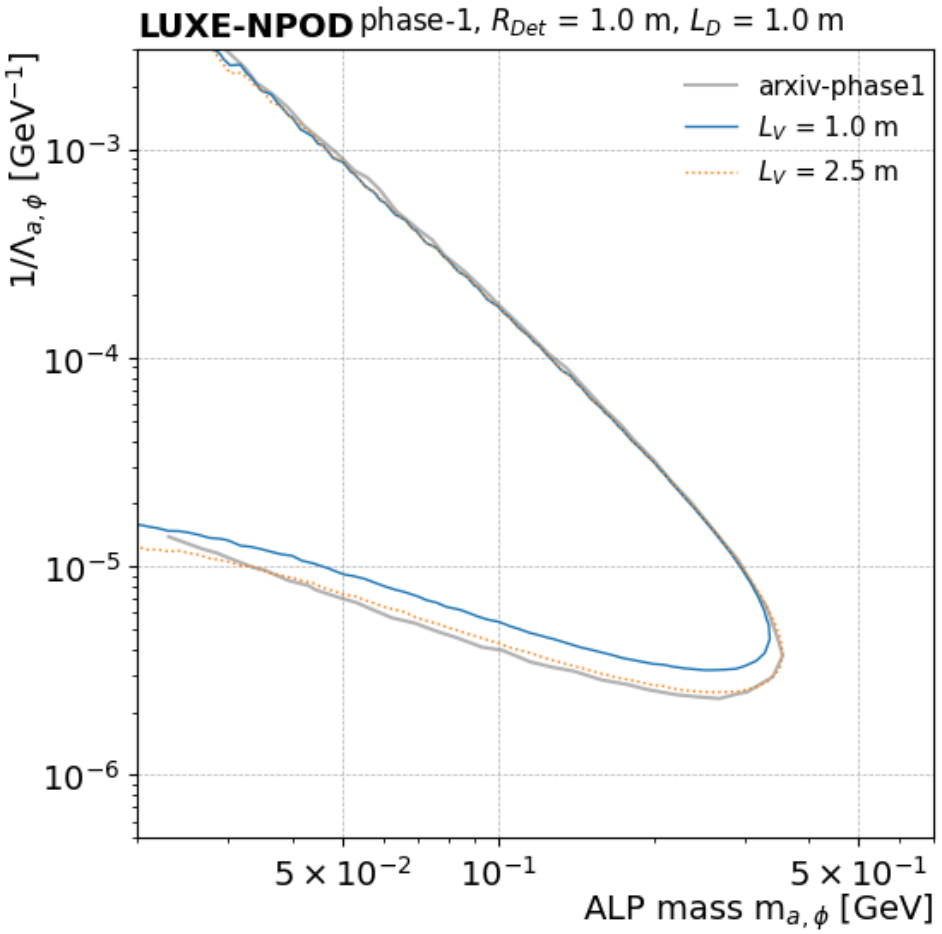
Phase-1

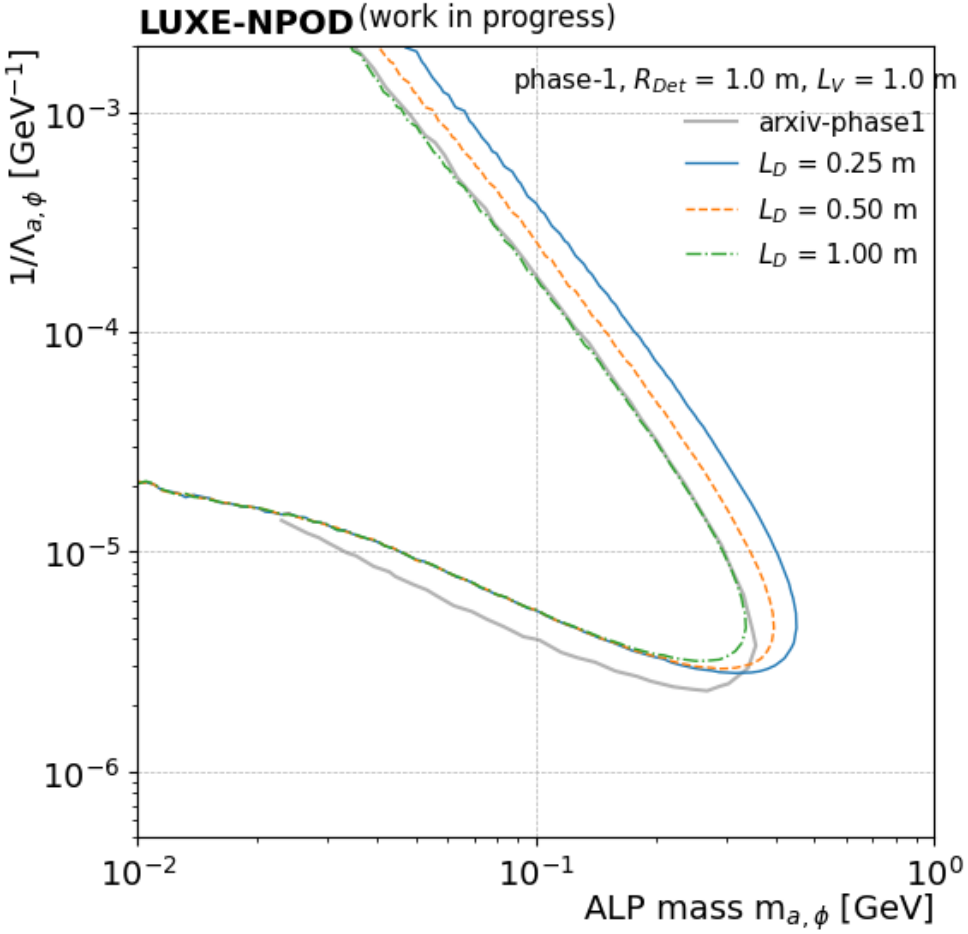
Phase-1 350TW	2021
Ptarmigan	v0.11
Focal spot	10 um
Laser pulse duration	120 fs
xi	3.4
Dump	Tungsten, LD=1 m
Decay volume	2.5m
G4	Toy model. G4 v10.06
detector	R=1 m
Simulated full BXs	2



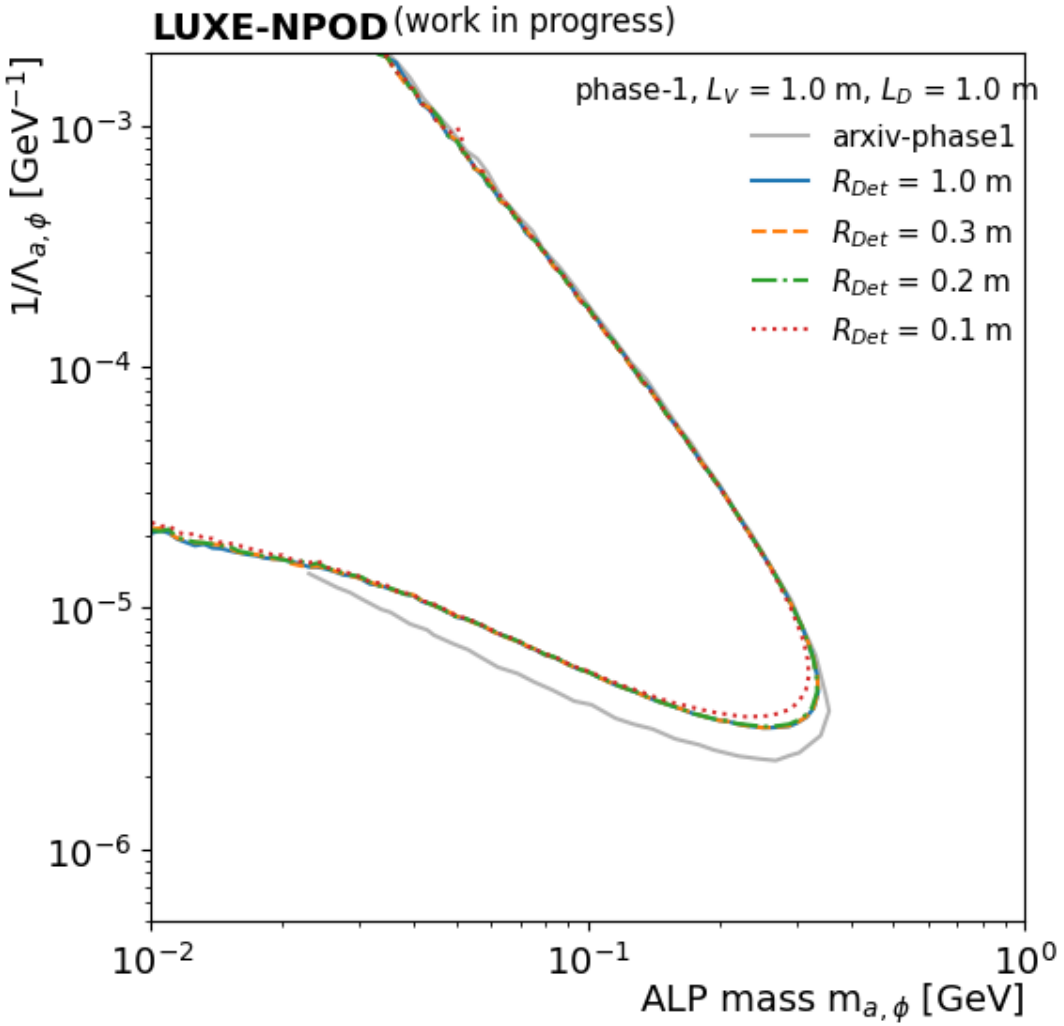
80 bins - (0,20)

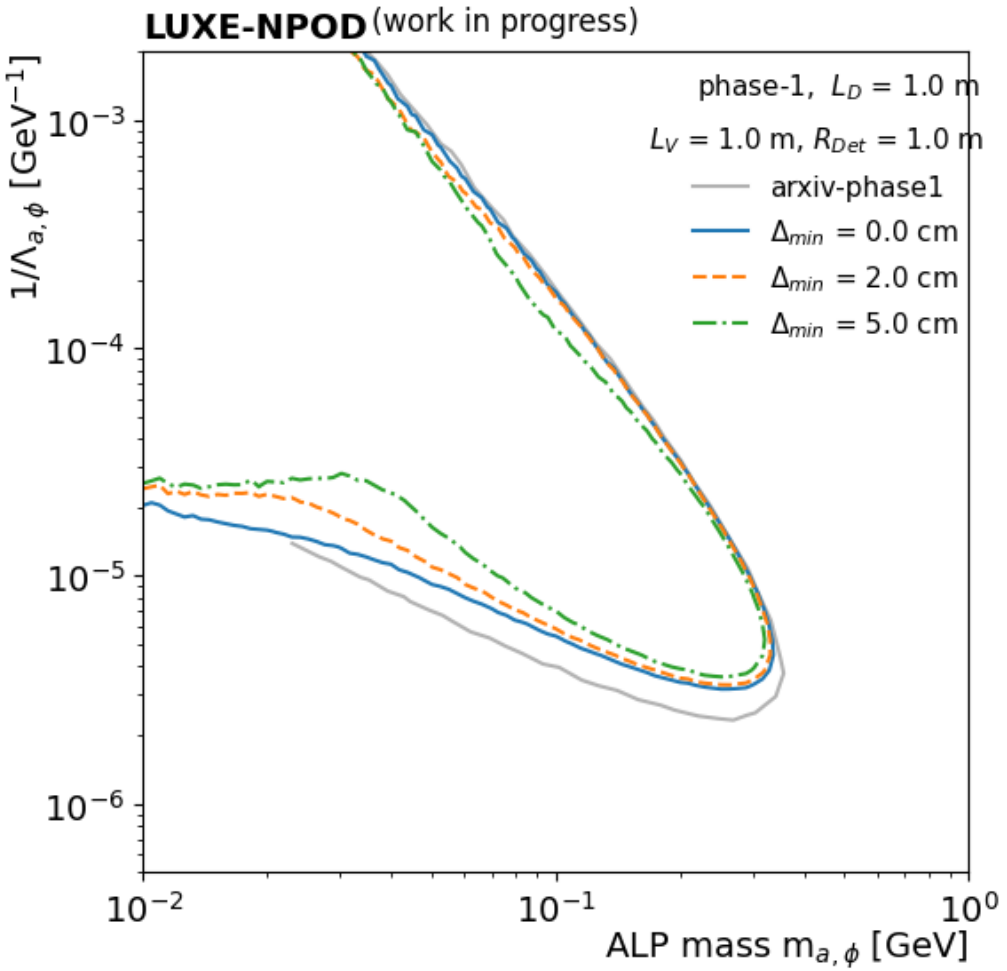
Phase-1


LUXE-NPOD phase-1, R_{Det} = 1.0 m, L_D = 1.0 m
arxiv-phase1
L_V = 1.0 m
L_V = 2.5 m
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
5×10^{-2}
10^{-1}
5×10^{-1}
ALP mass $m_{a,\phi}$ [GeV]

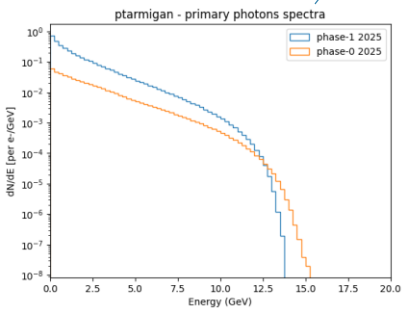

LUXE-NPOD (work in progress)
phase-1, R_{Det} = 1.0 m, L_V = 1.0 m
arxiv-phase1
L_D = 0.25 m
L_D = 0.50 m
L_D = 1.00 m
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-2}
10^{-1}
10^{0}
ALP mass $m_{a,\phi}$ [GeV]

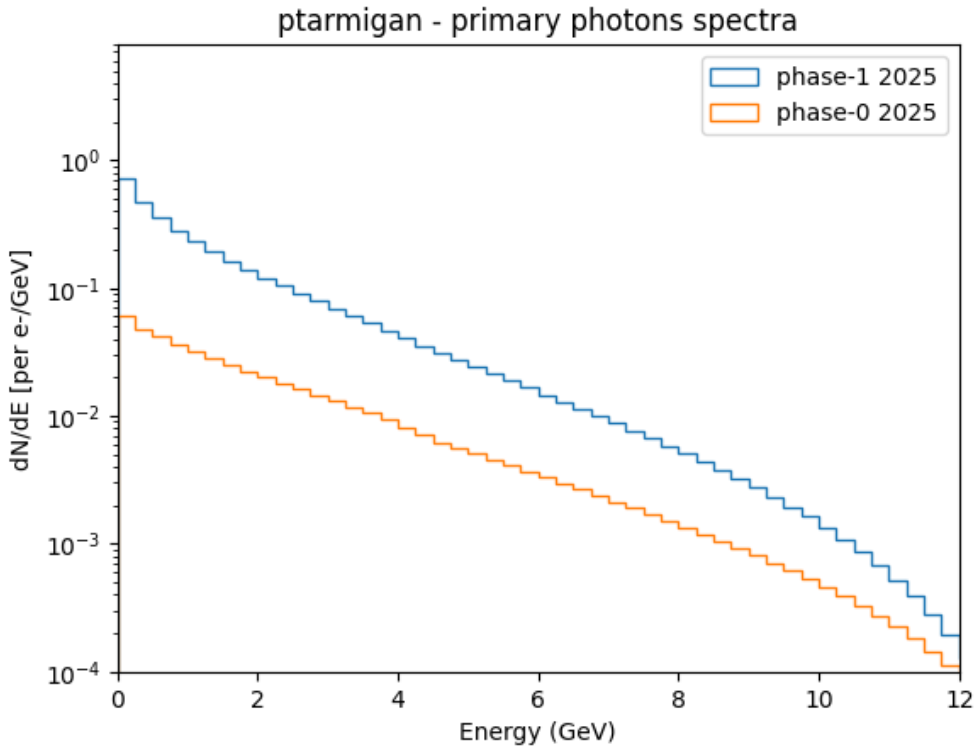
Phase-1

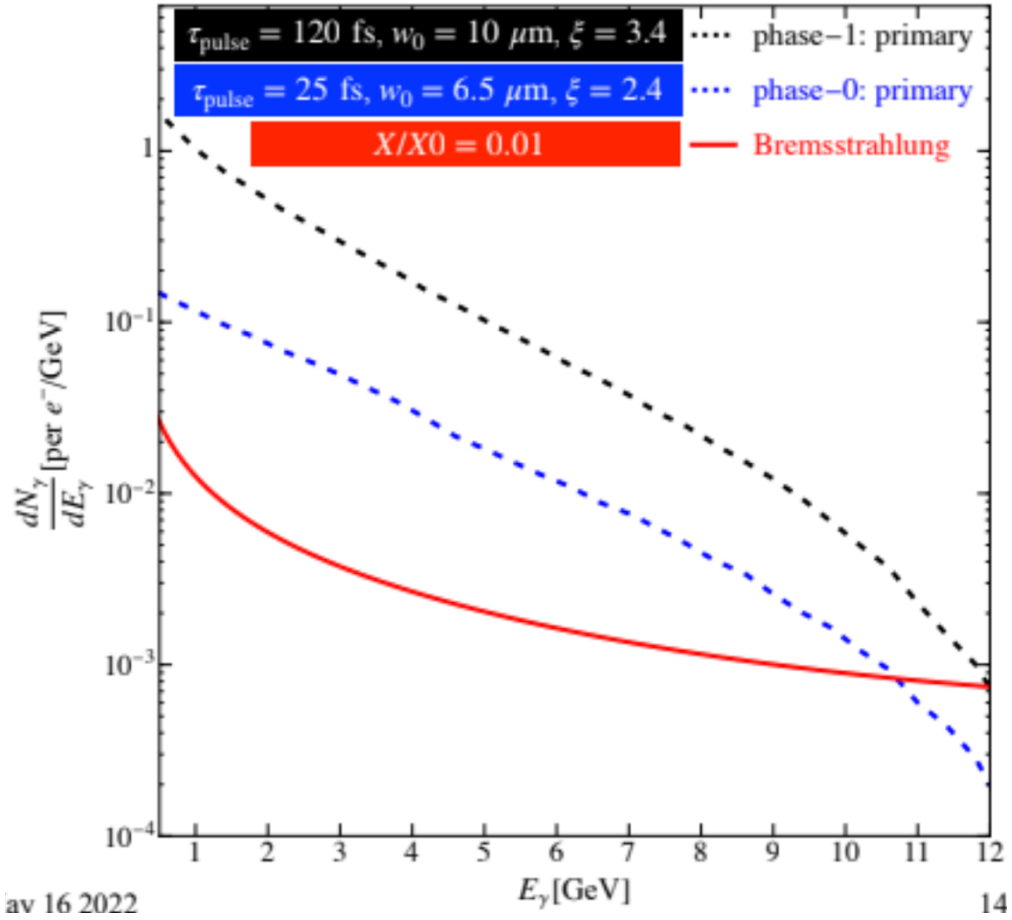

LUXE-NPOD (work in progress)
phase-1, L_V = 1.0 m, L_D = 1.0 m
arxiv-phase1
R_{Det} = 1.0 m
R_{Det} = 0.3 m
R_{Det} = 0.2 m
R_{Det} = 0.1 m
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-2}
10^{-1}
10^{0}
ALP mass $m_{a,\phi}$ [GeV]


LUXE-NPOD (work in progress)
phase-1, L_D = 1.0 m
L_V = 1.0 m, R_{Det} = 1.0 m
arxiv-phase1
Δ_{min} = 0.0 cm
Δ_{min} = 2.0 cm
Δ_{min} = 5.0 cm
$1/\Lambda_{a,\phi}$ [GeV^{-1}]
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-2}
10^{-1}
10^{0}
ALP mass $m_{a,\phi}$ [GeV]

Primary photons spectra





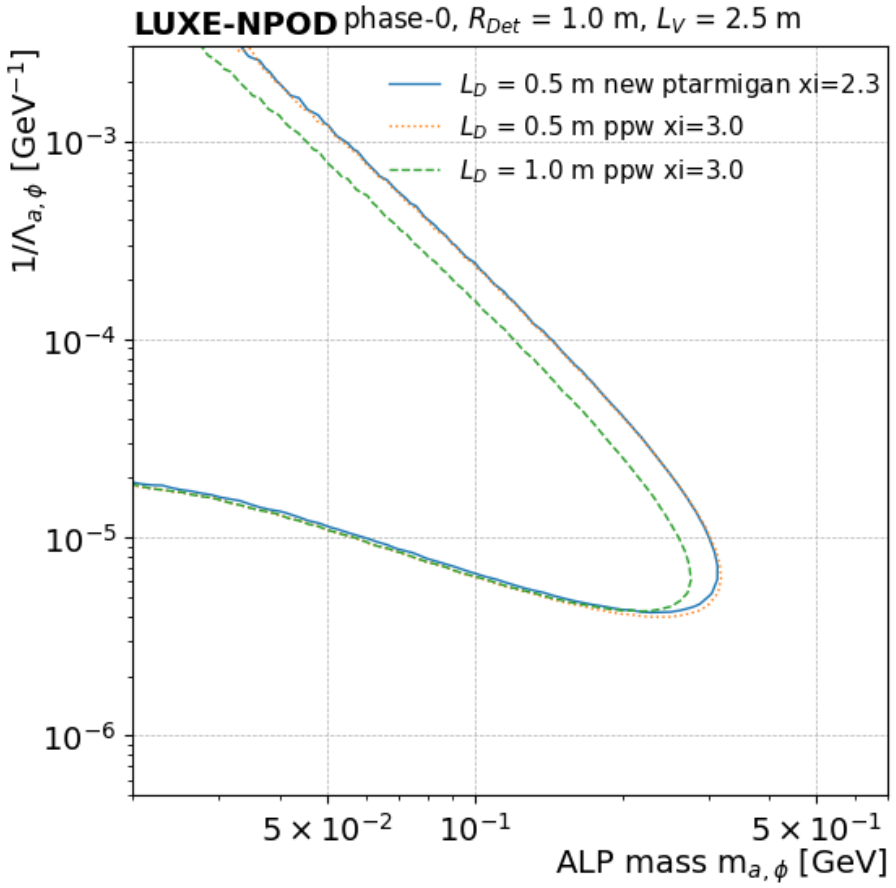


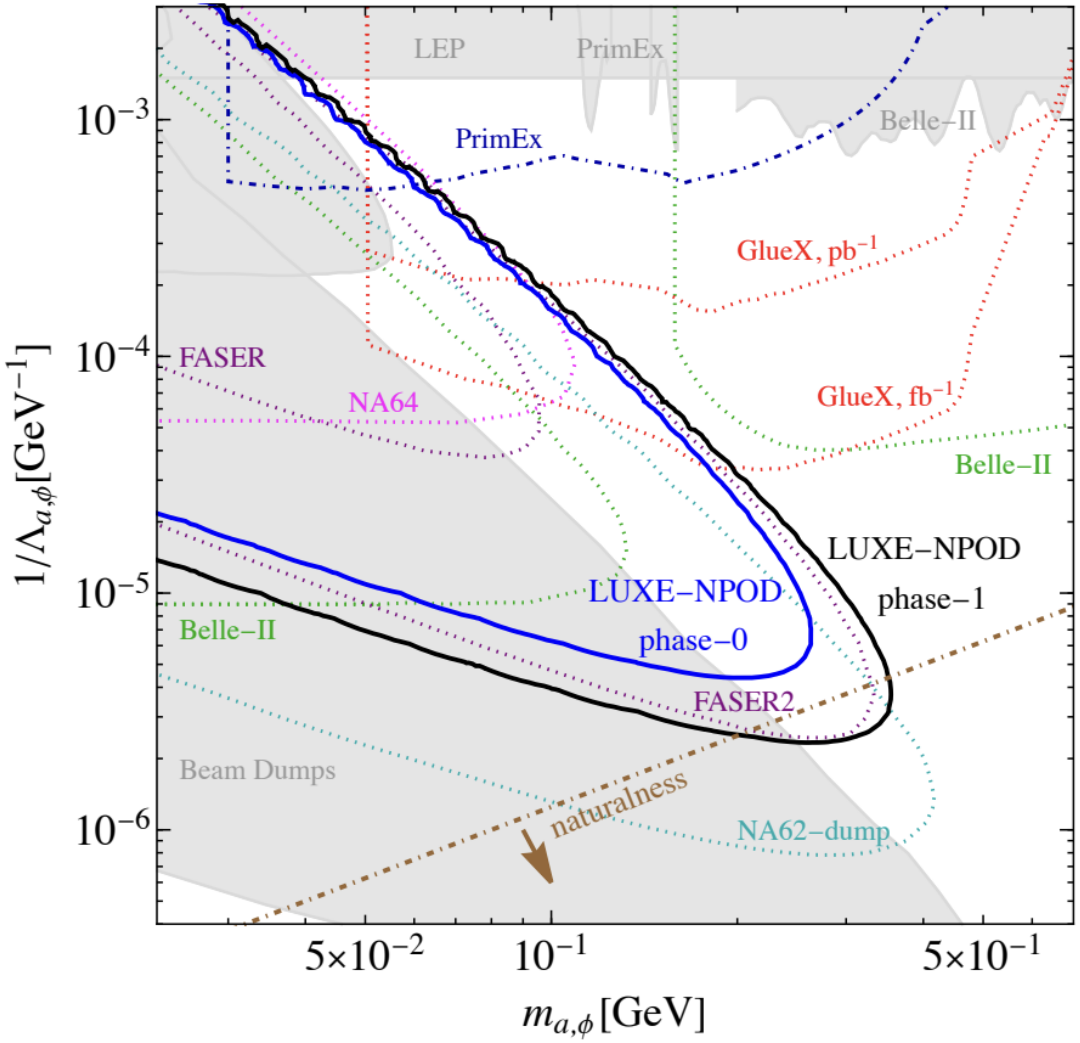
Sensitivity calculation

```
# 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
```

Torben's explanation

NPOD sensitivity with g4





plots