BSM detector ideas

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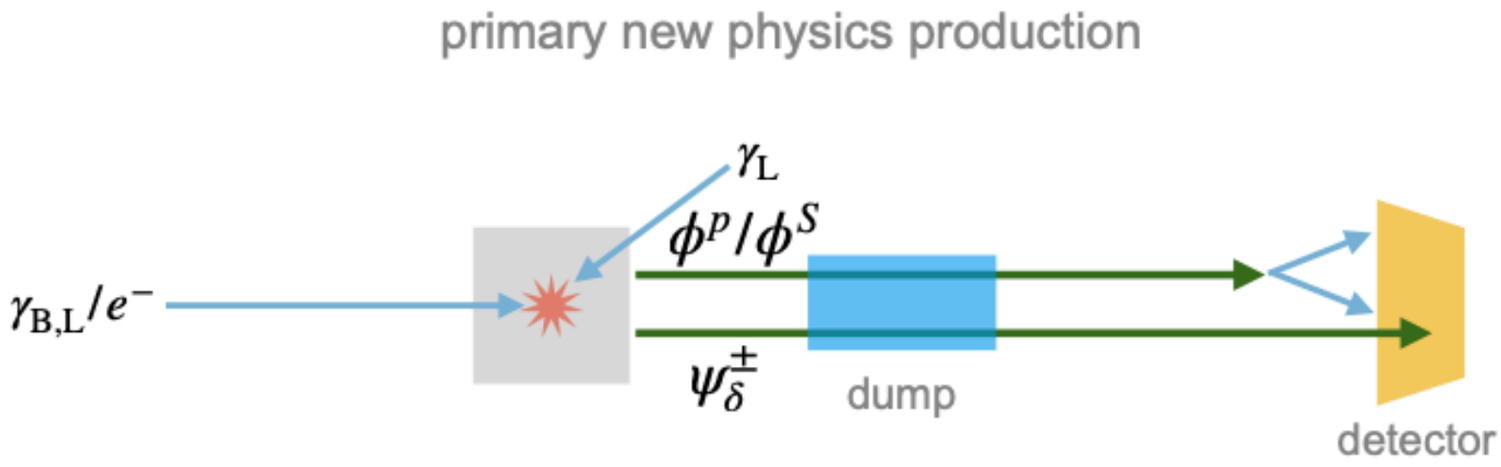
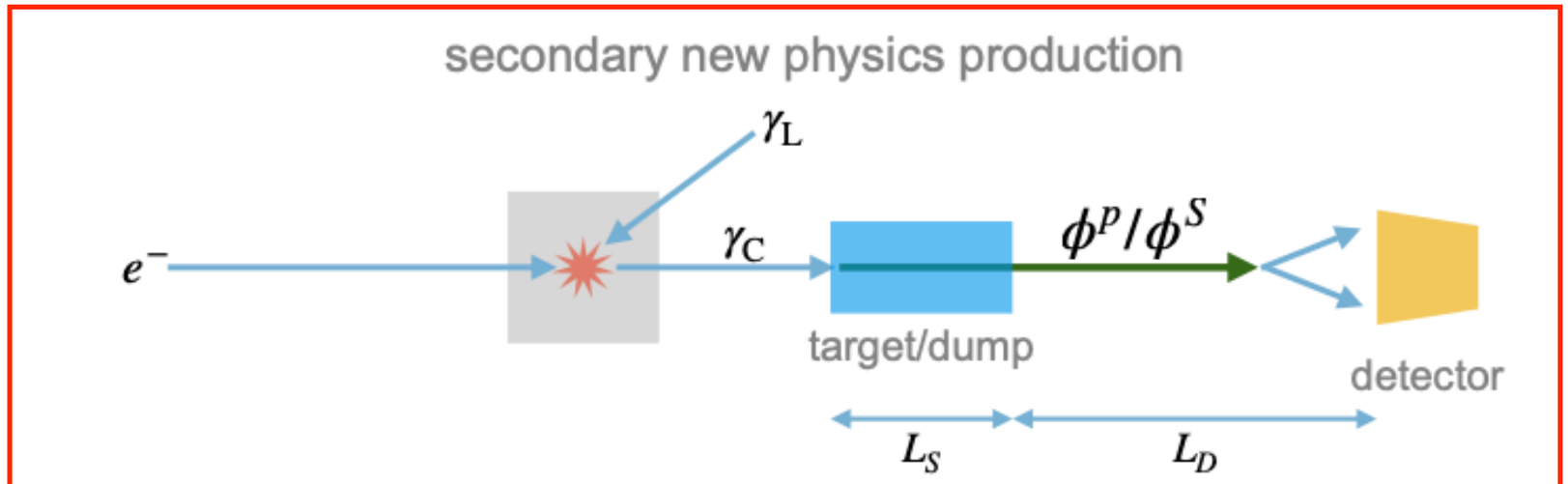
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

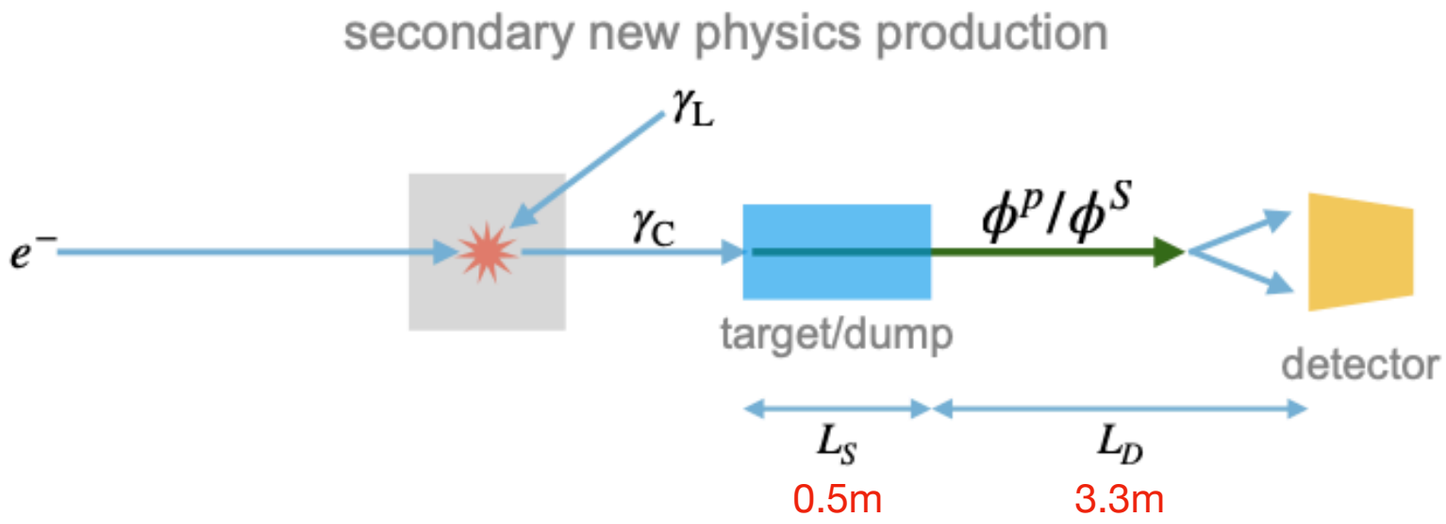
Overview





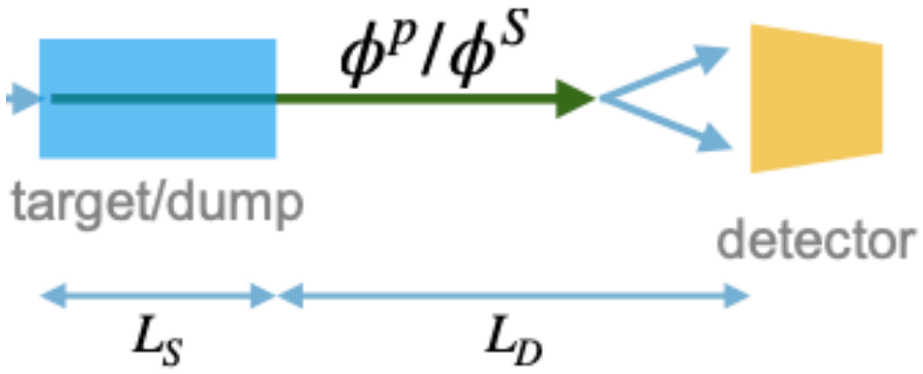
- BSM in LUXE: focusing on secondary production of ALP in photon dump
- consider only ALP decays into two photons
- LUXE sensitive to ALP mass range 10MeV-1GeV
  → requirements for detector?

Geometry



- size of the detector: determined by largest photon opening angle
- angle determined by upper limit of ALP mass (1GeV) and average photon energy (4-5GeV)
  → typical value is 15°, so detector at back wall ~1x1m^2
- segmentation: determined by smallest opening angle (lightest ALP, 10 MeV)
  → 1cm transverse segmentation
- always assuming ALP decays immediately after dump

Detector?



- want to detect photons, reject charged particles
- Photon detection: - Calorimeter?
  - Scintillator?
- Charged particle rejection (e.g. muon pairs):
  - Scintillator veto system
  - deflection using magnetic field (permanent magnet)

- reconstruct invariant mass: $M = 2\varepsilon_1\varepsilon_2(1 - \cos\alpha)$

$$\frac{\delta M}{M} = \sqrt{2\left(\frac{\delta E}{E}\right)^2 + \frac{\sin^2\alpha}{(1-\cos\alpha)^2}(\delta\alpha)^2}$$

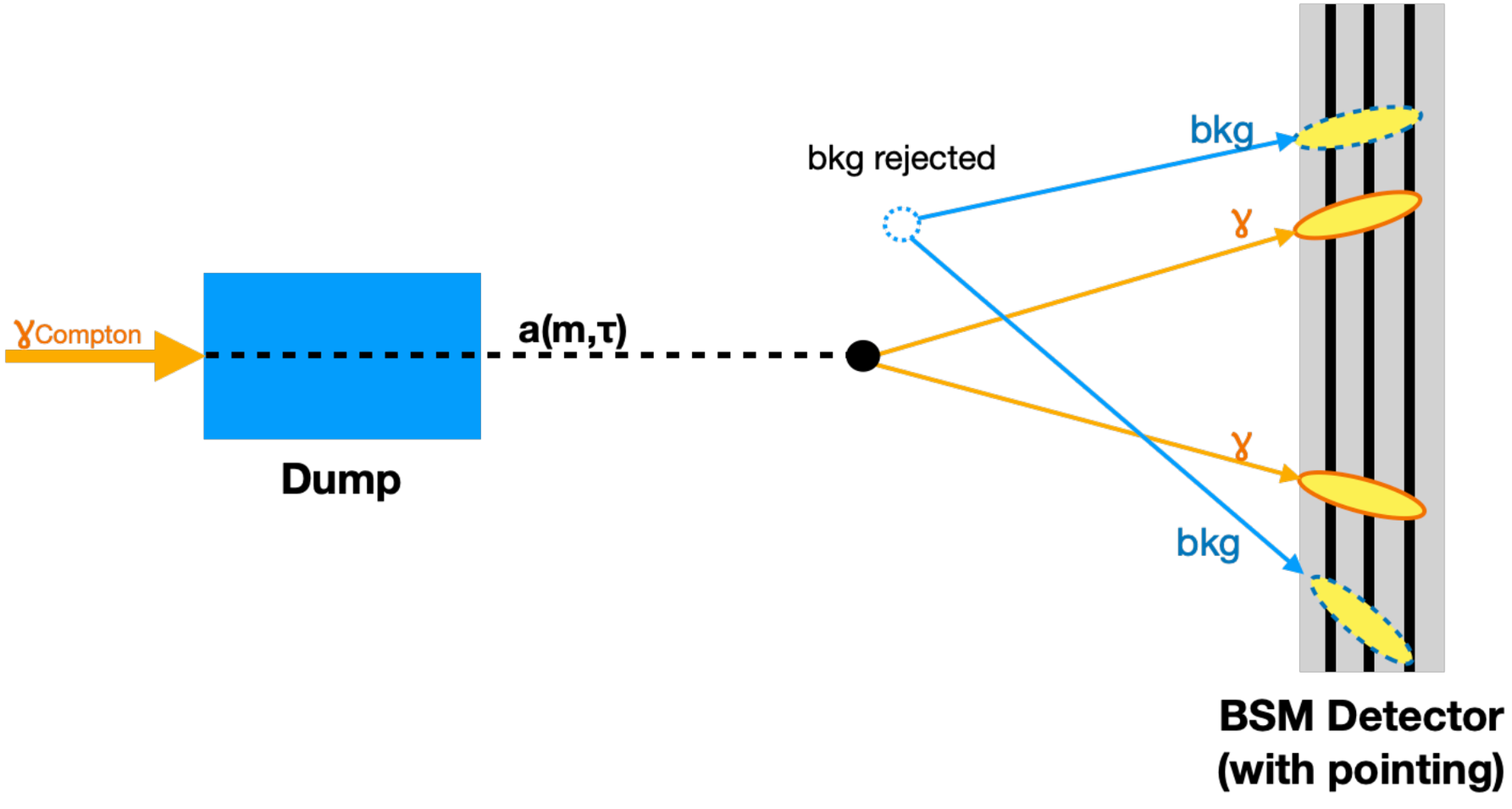
target: 10%

must be <6%

$\approx 4\%$

Pointing?

- we don’t know the position of the ALP decay
- can get this information by measuring the photon angle in the detector
  → point back to the diphoton vertex
- possible in sampling calorimeter (e.g. SHiP uses Lead/Plastic Scintillator + 3 layers of micro-pattern gas detectors)
- can also be used for background rejection



Pointing?

- without pointing: ambiguity between different ALP masses and lifetime
- can still put constraints on ALP production in m-τ-plane!