A preshower for ALP searches at NA62-dump

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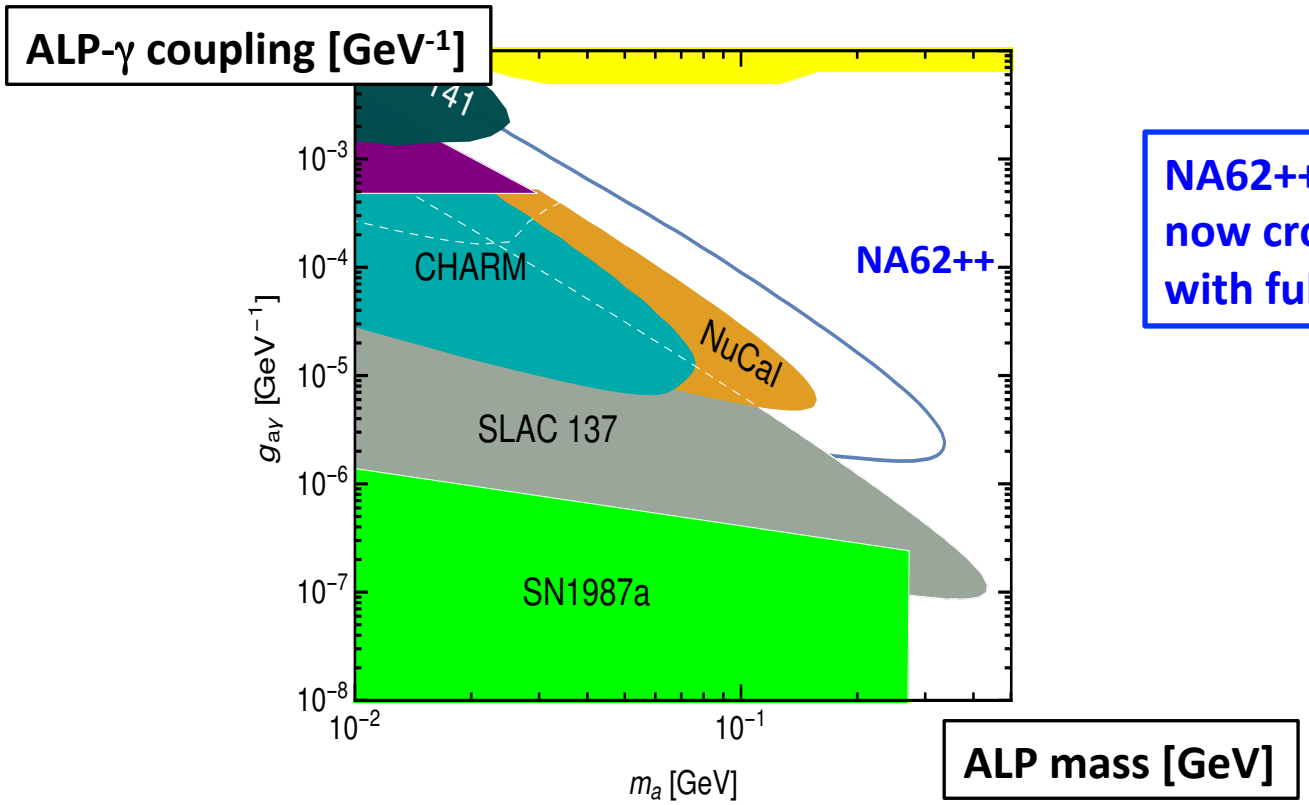
Search for visible decays of ALP's to γγ

Assume 10^{18} 400-GeV POT :

Study ALP Primakoff production [JHEP 1602 (2016) 018] from interaction onto TAX
search for ALP-decay to γγ in NA62 fiducial volume, account for geometrical acceptance
assume zero-background, evaluate expected 90%-CL exclusion plot



NA62++ evaluation now cross-checked with full MC

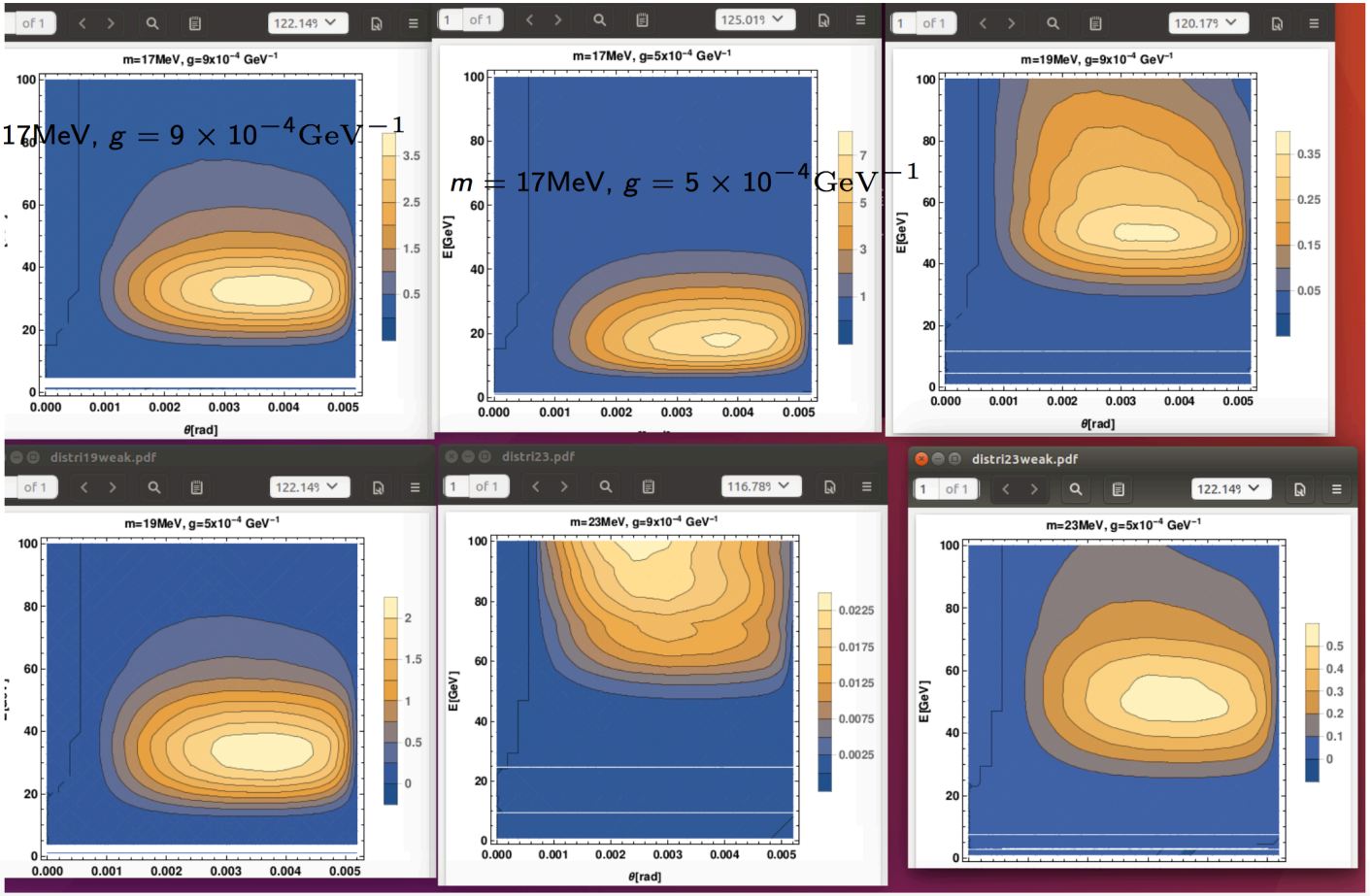
On the zero-background assumption

- Present analysis: signal identification based on the peculiar angular distribution of emitted axions (Primakoff cross section)
- Only variables measured: Etot, θ of photon barycenter

$m = 17\text{MeV}, g = 9 \times 10^{-4}\text{GeV}^{-1}$

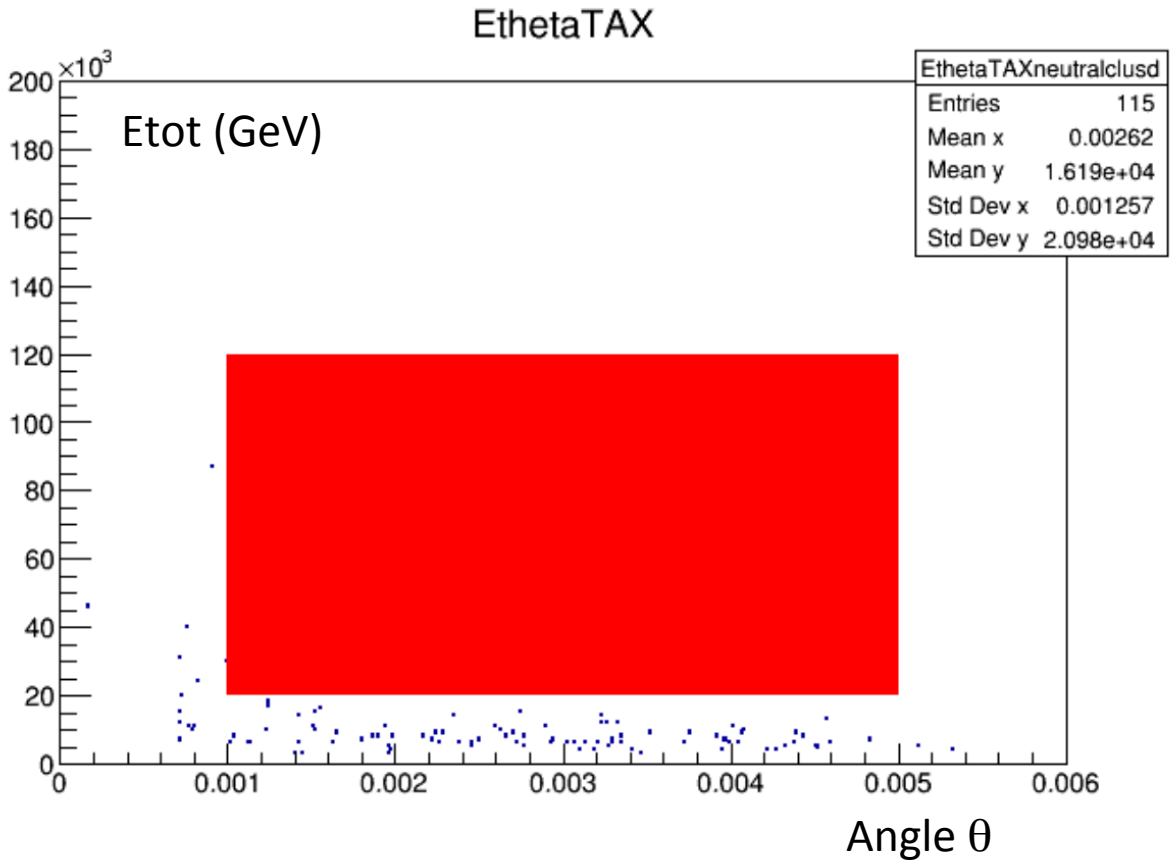
$m = 17\text{MeV}, g = 5 \times 10^{-4}\text{GeV}^{-1}$

$E_{\gamma+\gamma}$ vs θ



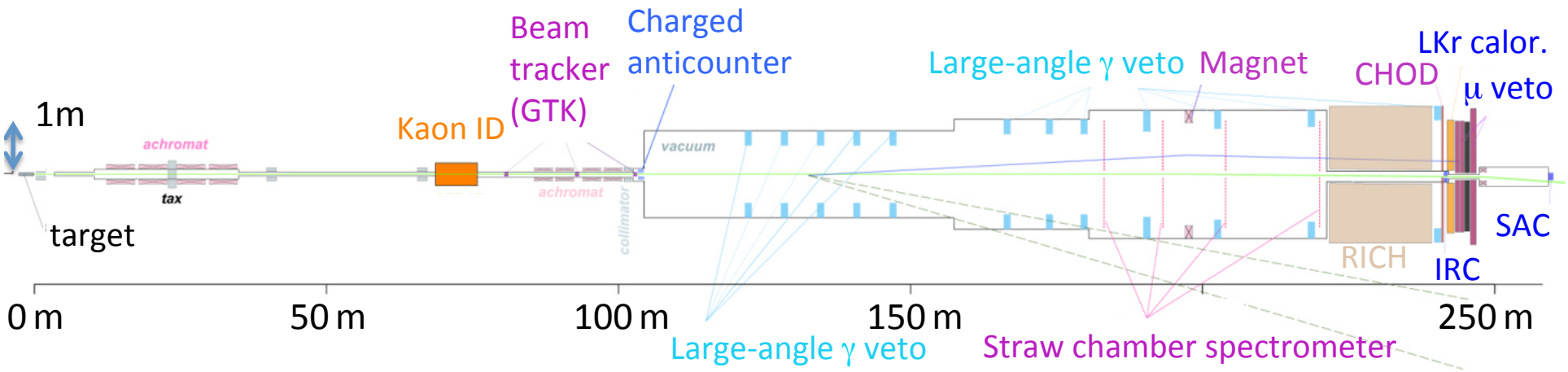
On the zero-background assumption

- Analysis under completion at ~ 10^{16} POT with 2016-17 data
- Background measured in Etot, θ sidebands
- Seems under control at the above intensity…



.. need better bkg rejection @ 10^{18} POT

- The idea: exploit the budget of dead material already present in NA62
- Track e+ e- pairs from photon conversions using two low-Z pixel detector planes



Pre-shower concept:

radiator, ~1 X0 placed at the RICH flange, z = 237.253 m

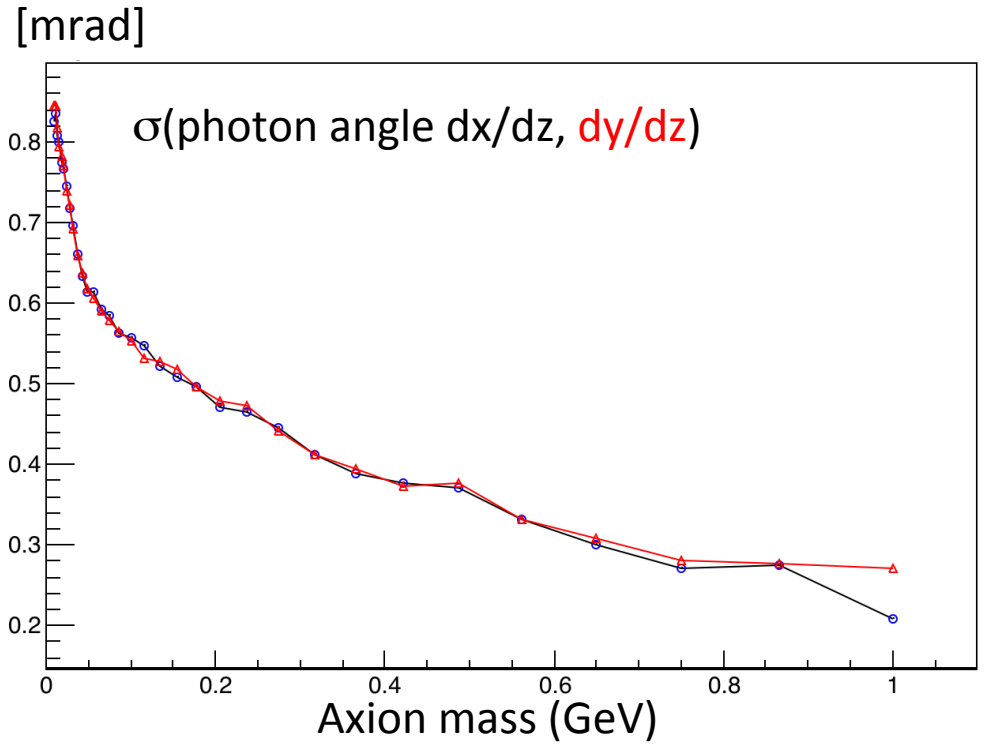
sensitive planes starting 1.8 m downstream, 0.5 m apart: z = 239 m and z = 239.5 m

pixel space resolution: Δ = 100 μm

plane transverse coverage as the LKr → O(10) k channels, not to be read invidually

ALP simulation with preshower

- Toy MC using Primakoff emission of ALP's
- Simulate photon pair production in 1 X0 (Bethe-Heitler)
  - Simulate e+ / e- possible unbalance
  - Assume e+ / e- collinear emission
- Simulate e+, e- multiple Coulomb scattering in passive material
- Reconstruct position per plane by averaging multiple hits → **Photon direction**



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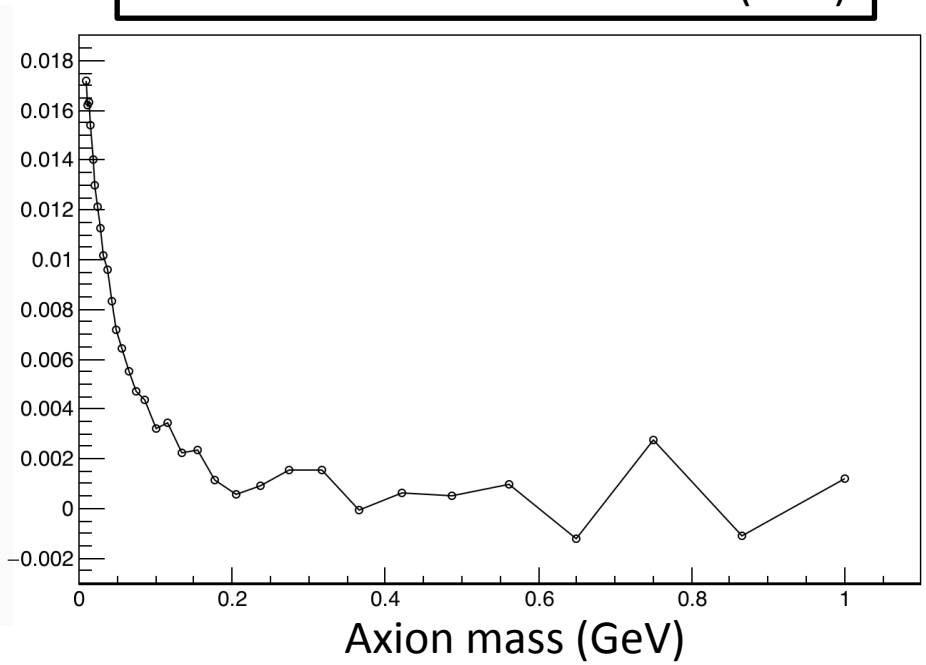
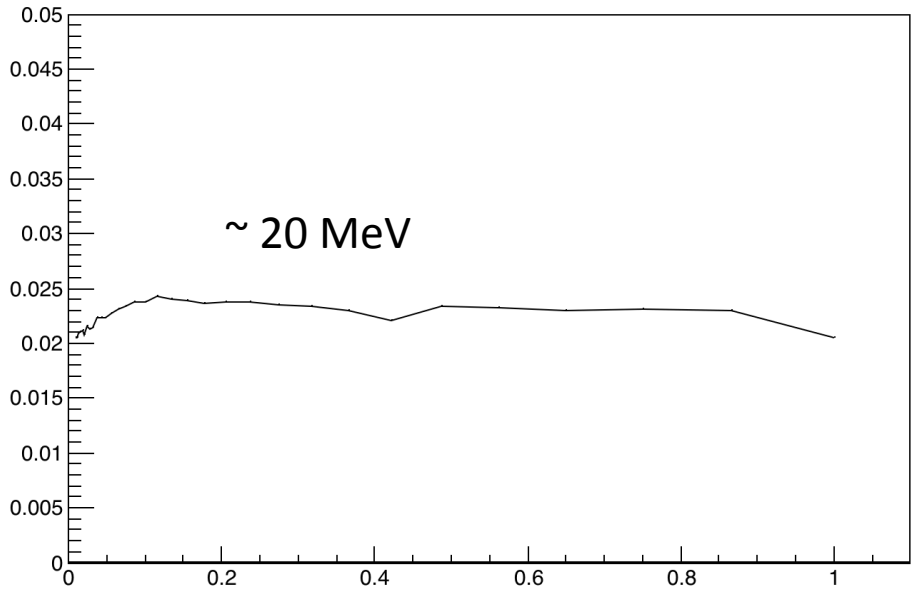
- Assume SigmaE/E = 3%/Sqrt(E[GeV]) from LKr per photon → **Invariant mass**
  - **bias for low masses (small opening angles)**

<invariant mass − axion mass> (GeV)



σ(invariant mass − axion mass) (GeV)



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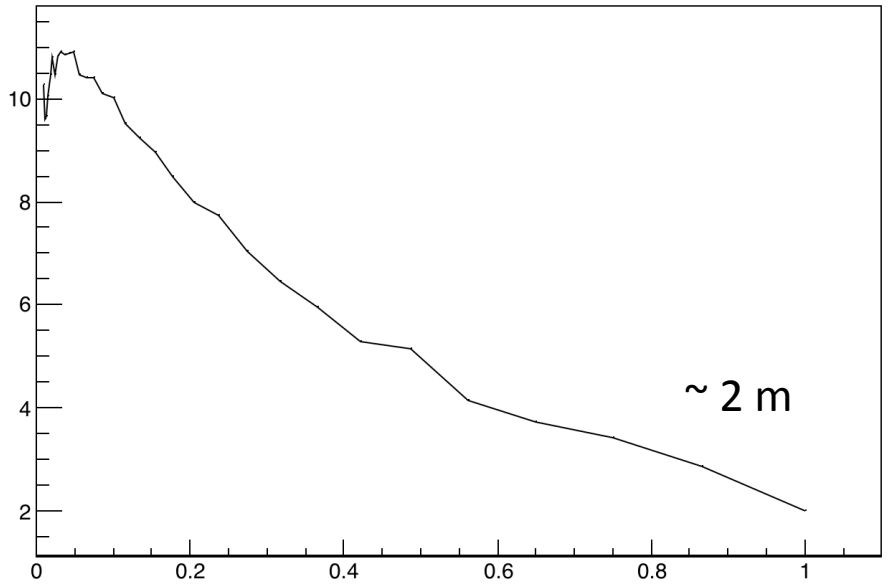
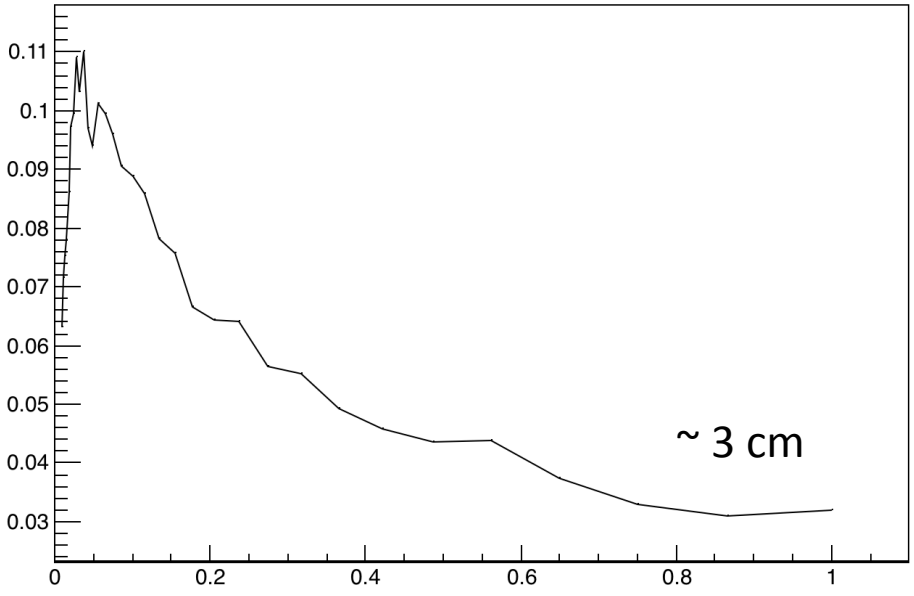
- Track reconstructed directions to mutual minimum approach → **Vertex**

σ(reconstructed z − z of true vertex) [m]



Axion mass (GeV)

<PCA γ-γ> [m]



Axion mass (GeV)

Conclusions

- **Two planes providing 100 μm resolution in x and y placed 1.8 m downstream the RICH flange provide:**
  - **200 μrad angle resolution at 1 GeV ALP mass**
  - **20 MeV invariant mass resolution in the entire mass range**
  - **vertex z position with 2 m resolution at 1 GeV ALP mass**
  - **3 cm γ-γ closest approach at the vertex**

- **The above performance would surely improve the background rejection by order of magnitudes, allowing the 0 background scenario to be reached at 10^{18} POT's**

- **The proposed detector might be constructed with a variety of technologies: micromegas, GEM's, etc.**
  - **Number of channels of the order of 10k → need smart readout system (only read channels nearby newCHOD hits)**

- **Operation of the proposed detector might help other beam-based analyses**
  - **This point has to be better studies**

- **The exact design is under discussion, with the goal of defining a project:**
  - **financially sustainable**
  - **feasible with limited manpower**
  - **synergic with expertise available in the INFN structures involved**