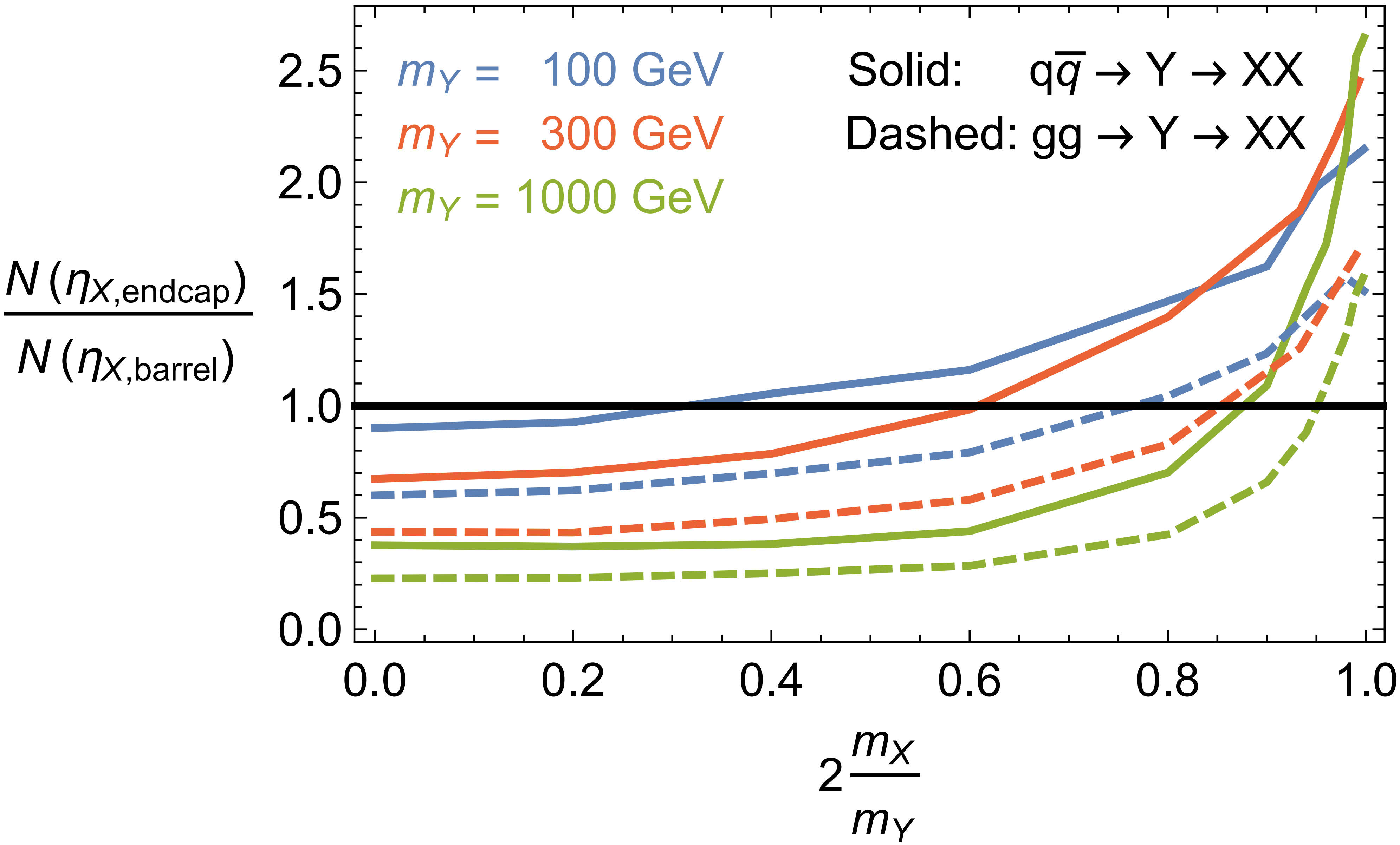
Forward detectors

- The new forward detectors will help with associating forward jets to the correct primary vertex and improves identification of VBF production.
- For example "VBF" production of winos (which can be long-lived if almost mass-degenerate with bino LSP) seems to have a cross section of ~4 fb (with m_chi+ = 100 GeV, m_wino = 150 GeV)
- VBF production can help with triggering (CMS?) and filtering off events to subsample that will undergo special reconstruction which better identifies e.g. displaced vertices (ATLAS)
- What more LLPs could be produced through VBF and would be more easily found if those scenarios were targeted?

Forward Particles



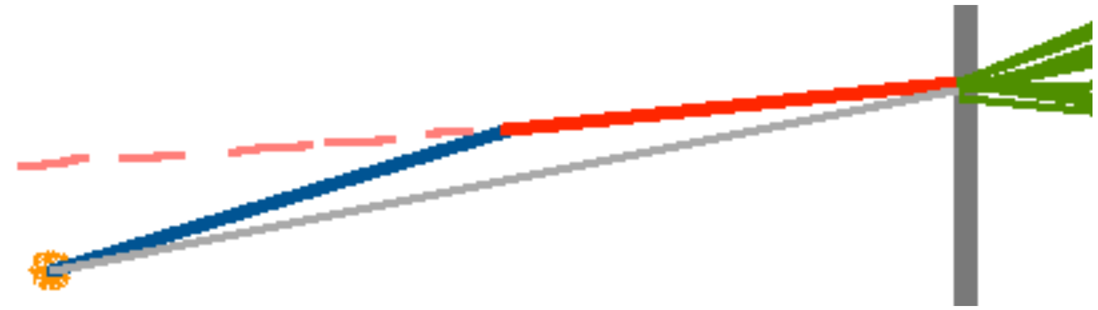
Resonances produce forward particles, especially qq

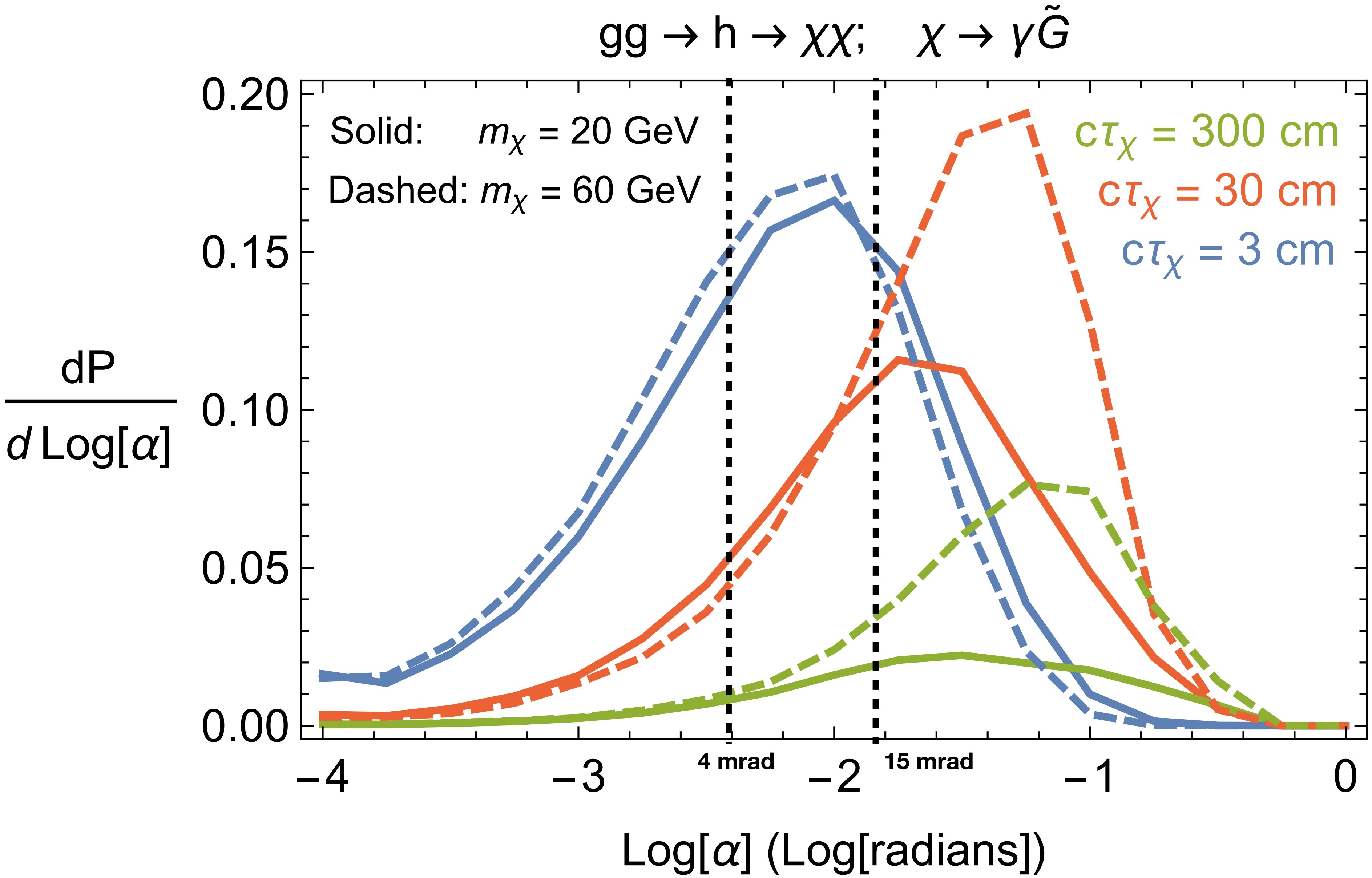
Light resonances (Z, higgs) produce more forward particles

Forward LLPs from Higgs

SM Higgs could yield high angle particles

Compatible with 4 mrad pointing in CMS





~ 10% of h->XX events! (no E threshold included)

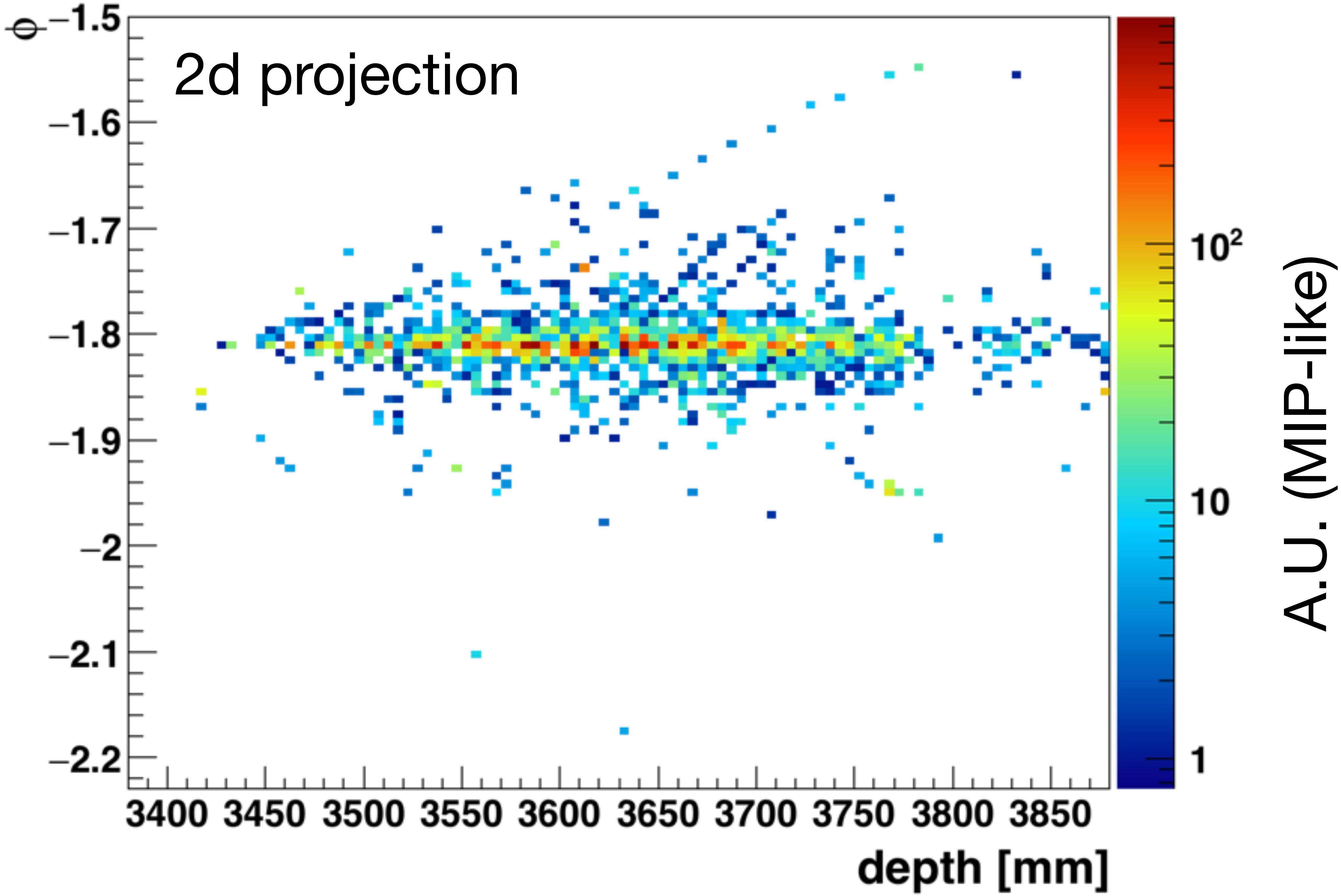
CMS Endcap LLP trigger

Idea: Model a L1 trigger strategy for hadronically-decaying LLPs using CMS HL-LHC endcap calorimeter (CE) only.

- Model the endcap with a simplified G4 simulation.
- Suggest a simple algorithm for finding the impact parameter of a hadronic shower at L1 using only calorimeter information.
- Does the necessary information fit into the hypothesized endcap trigger primitives?

Goal: If useful, something to keep in mind as we refine and finalize the electronic systems for the endcap.

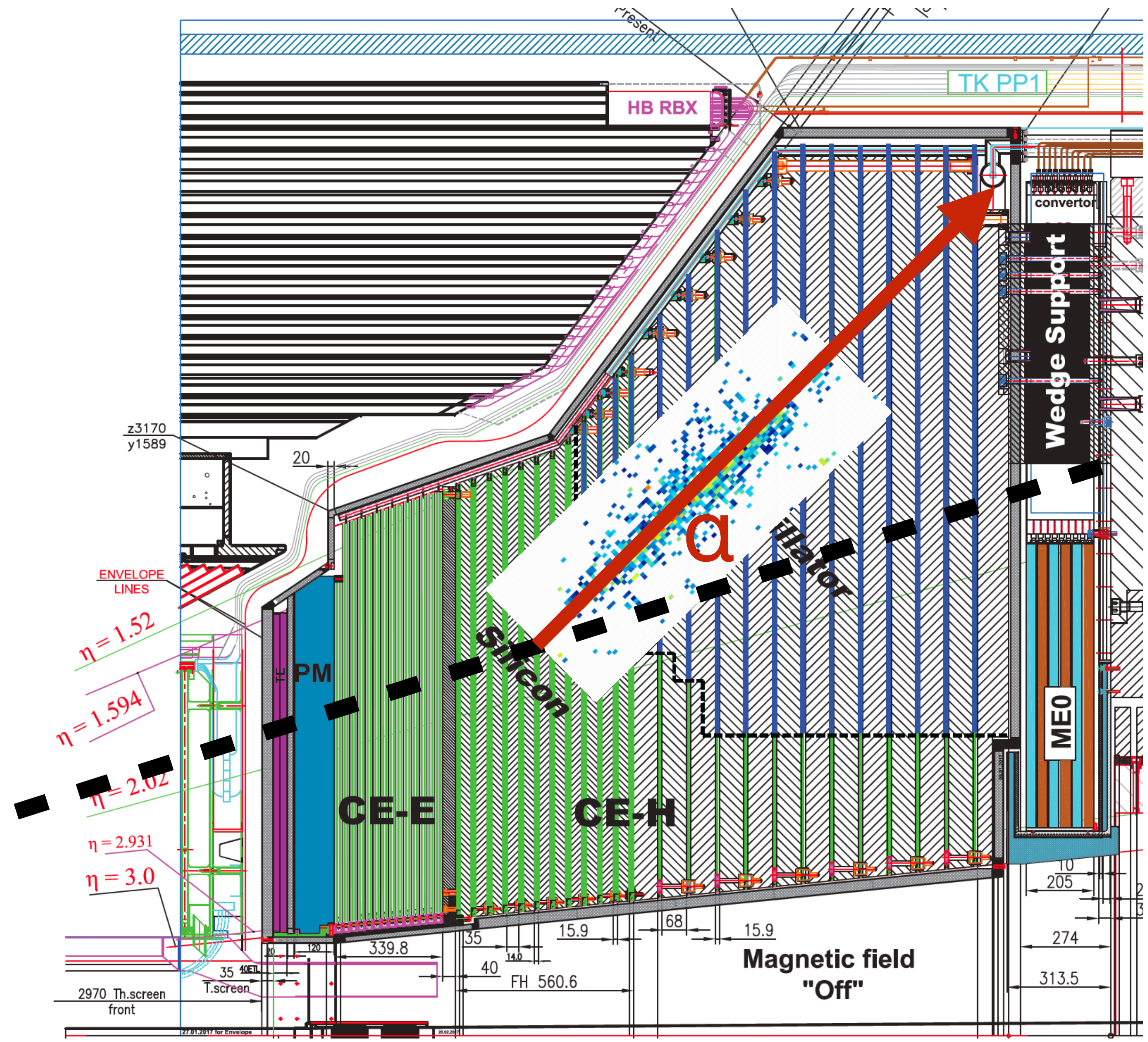
Event display (100 GeV π-)



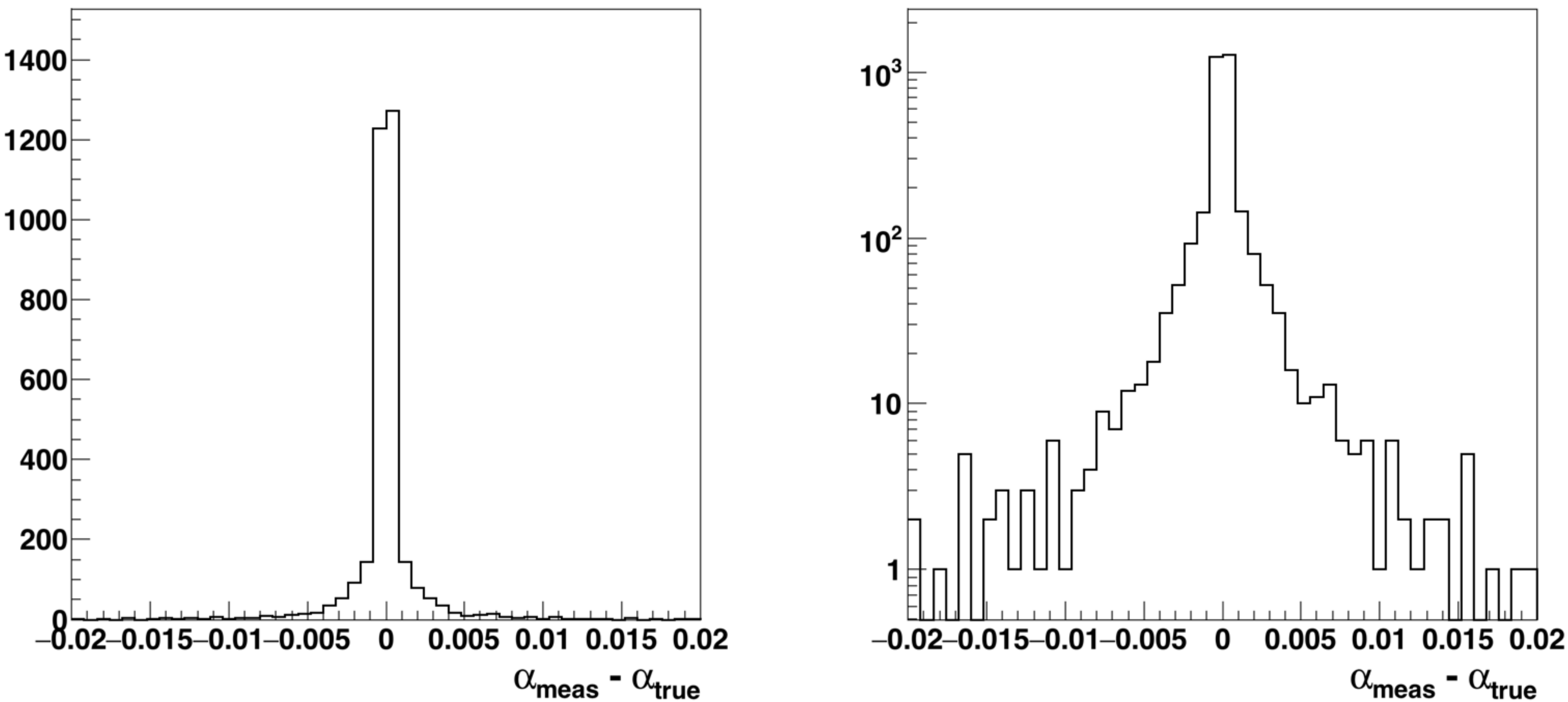
Simple algorithm for finding angle

Follows design of CE off-detector TPG electronics (first form 2d clusters on layers, then make 3d showers from 2d clusters).

- Work in η-ϕ-depth space.
- Trigger cells (2×2 or 3×3) with minimum 2 MIP_T energy are formed.
- Linear fit of energy-weighted η vs. depth and ϕ vs. depth.
- Compute total angle α between shower axis and line back to nominal IP (PV).



Modeled L1 angular resolution



Naively: O(1000) reduction for $|\alpha| > 10$ mrad

CE Trigger Primitives

Quantities	Bits	Total bits
E_T with and without PU subtraction	16, 16	32
Endcap, fraction in CE-E, fraction in back CE-H, max energy layer	1, 13, 12, 6	32
Shower start η, ϕ, z	11, 11, 10	32
Number of cells, quality flags, extra data flags	8, 12, 12	32
Minimum total		128
Optional shape quantities	8×16	128
Optional e/γ reco E_T with and without PU subtraction	16, 16	32
Optional subcluster 0 E_T, $\Delta\eta$, $\Delta\phi$	16, 8, 8	32
Optional subcluster 1 E_T, $\Delta\eta$, $\Delta\phi$	16, 8, 8	32
Optional subcluster 2 E_T, $\Delta\eta$, $\Delta\phi$	16, 8, 8	32
Optional subcluster 3 E_T, $\Delta\eta$, $\Delta\phi$	16, 8, 8	32
Maximum total		416

for each cluster

Preliminary conclusions

- Simplified simulation shows good angular resolution with L1-like algorithm.
- Angular data fits comfortably into foreseen TP format.
- Further study with full CMS software appears warranted.