Simulation status and plans for the W-Si imaging EMCAL

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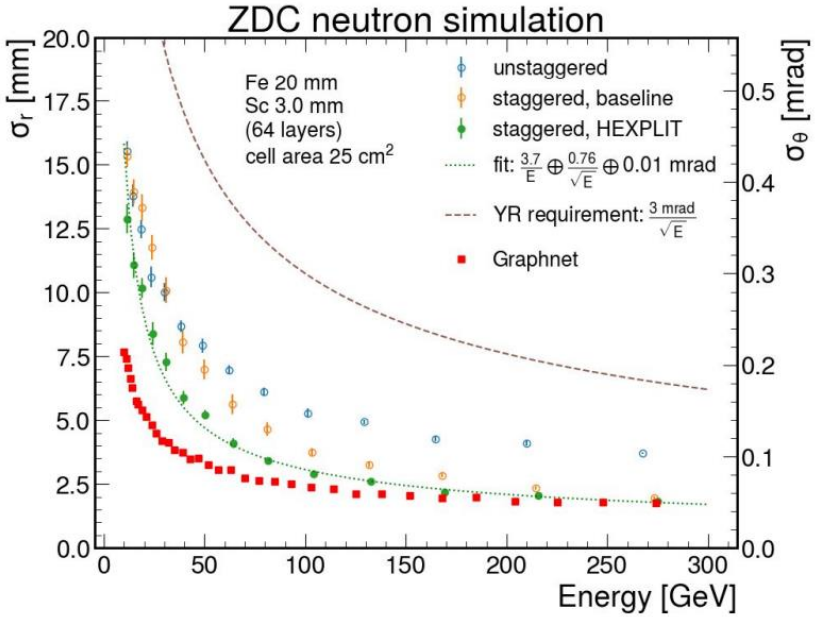
Introduction

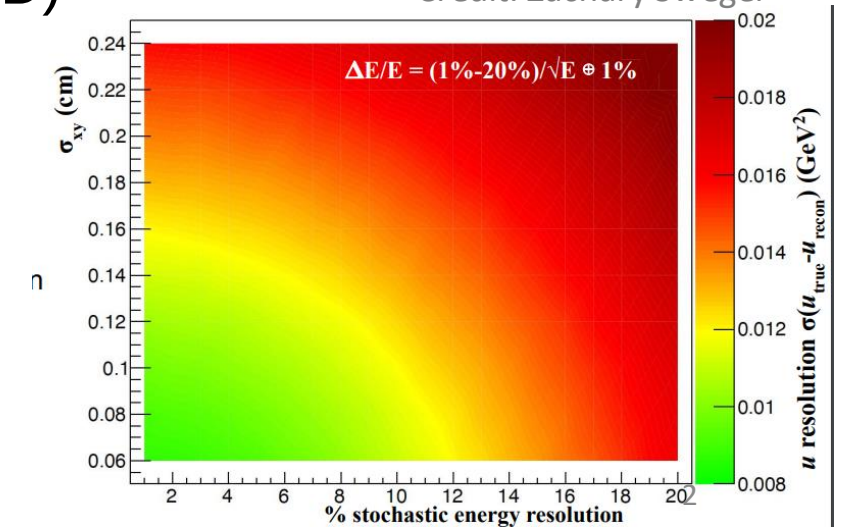
- ZDC design is converging!
- Various studies have already been made
  - HCAL: neutron detection with SiPM-on-tile on Nov 20 at TIC



Credit: Bishnu Karki & Ryan Milton & Sebouh Paul

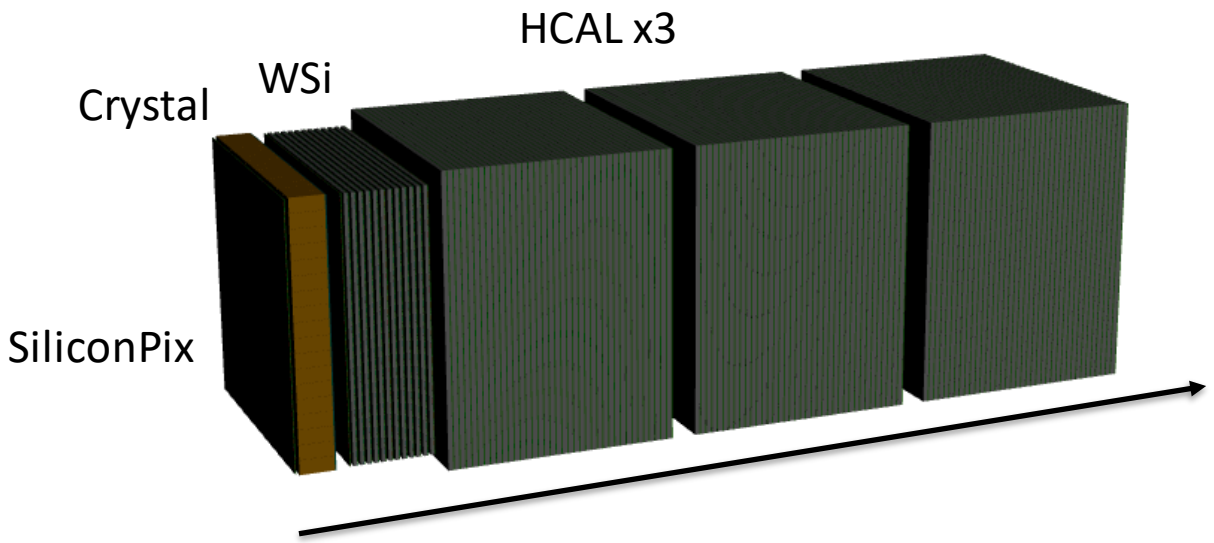
- Several physics cases motivates good prompt photon ID
- For example, u-channel DVCS (Z. Swenger, Nov 7), (pi0 ID)
  - Constant term has dominant effect
  - Need good position resolution (a few mm)

Credit: Zachary Sweger

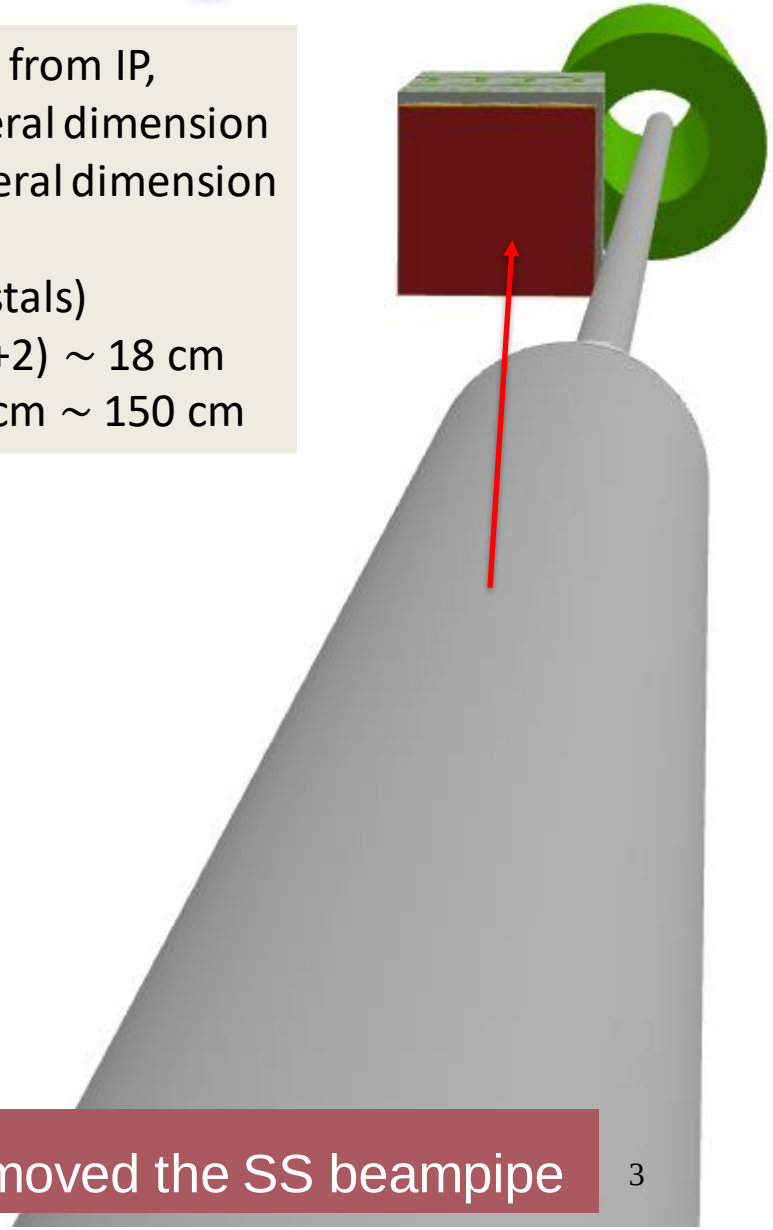


➢ In the next slides, photon response in Wsi is discussed, and reconstruction plans presented

Current simulation design



ZDC starts at 35.8 m from IP,
54x56 cm^2 ECAL lateral dimension
60x60 cm^2 HCAL lateral dimension
1^{st} Si: 0.7 cm
ECAL: 7 cm (3x4 crystals)
WSi: ~ 1.4 cm x (10+2) ~ 18 cm
HCAL: 3 x 38 x 1.25 cm ~ 150 cm



For simulations we removed the SS beampipe

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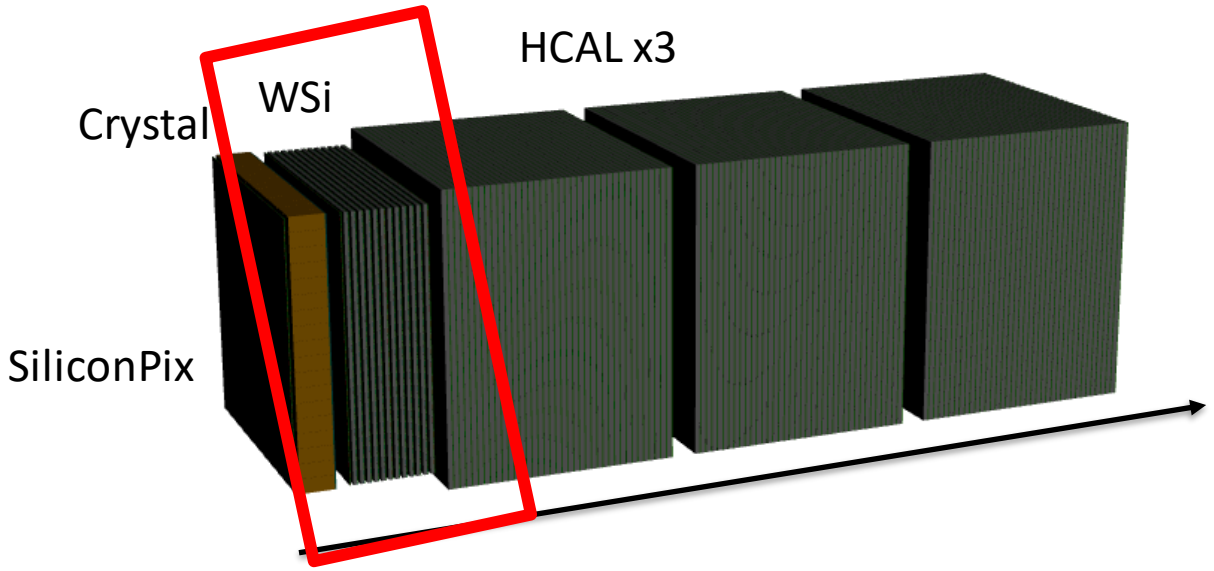

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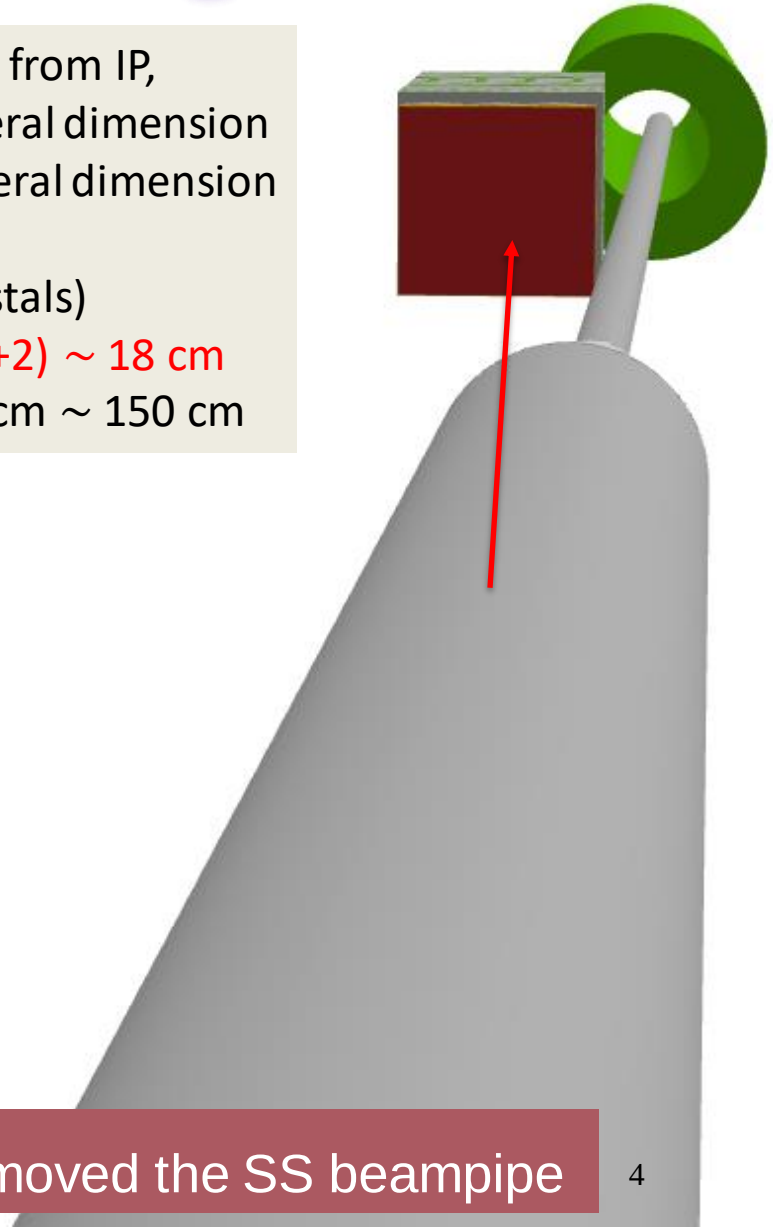

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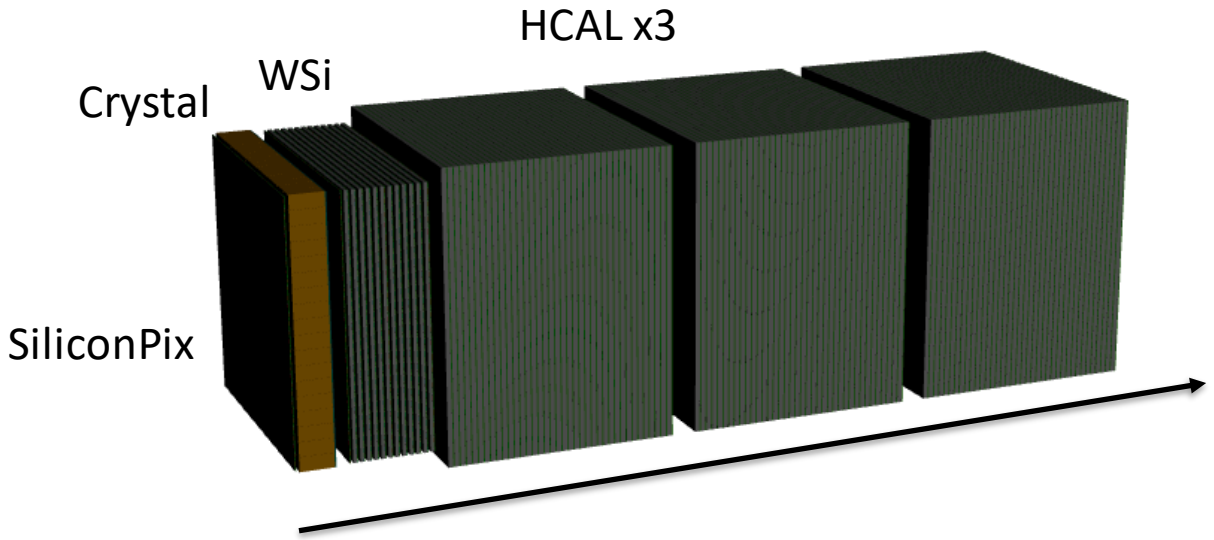

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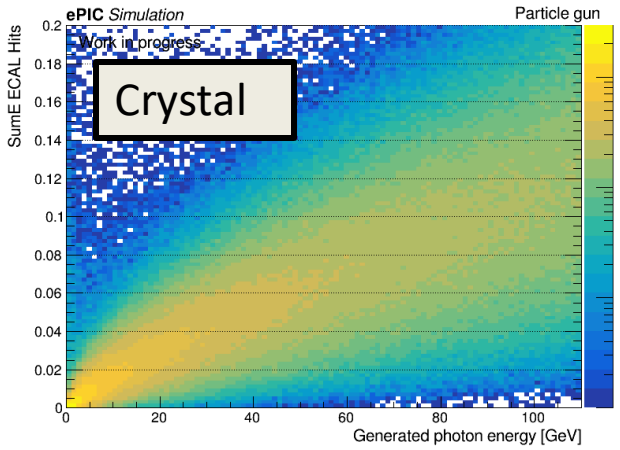
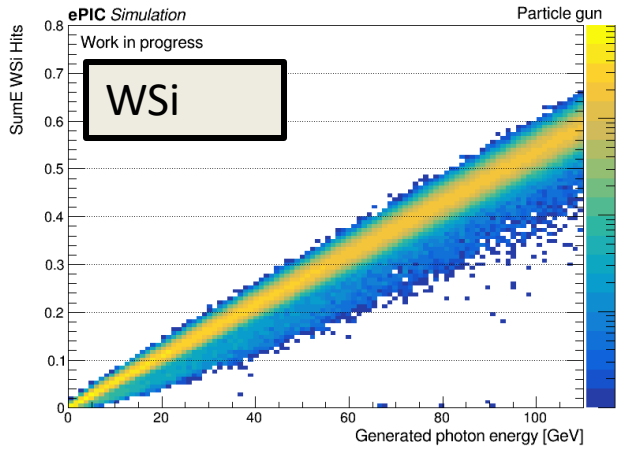
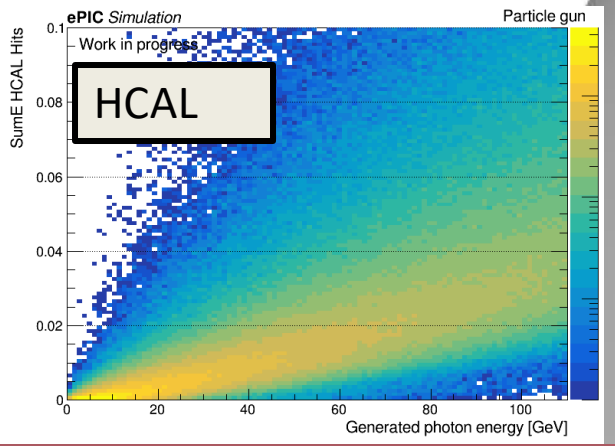
- Response to photons in energy range up to 110 GeV (dated: Oct 2023)







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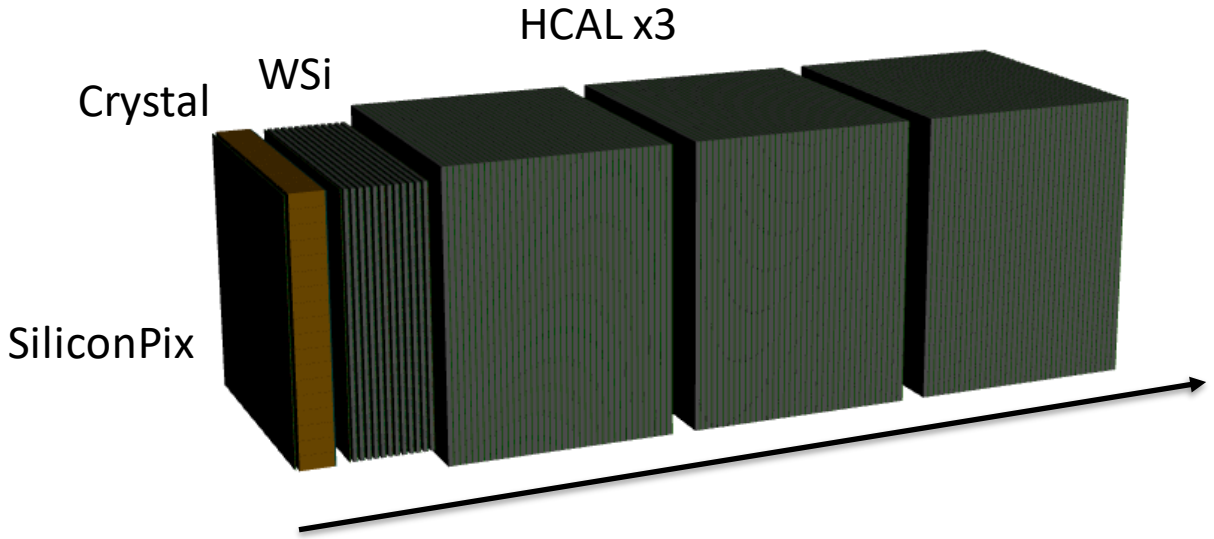

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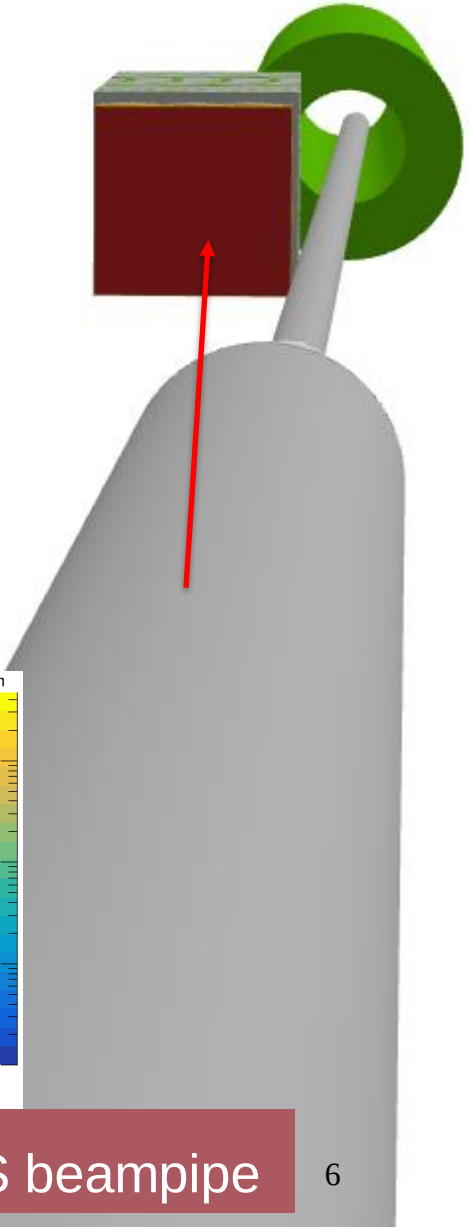
Some leakage to HCAL



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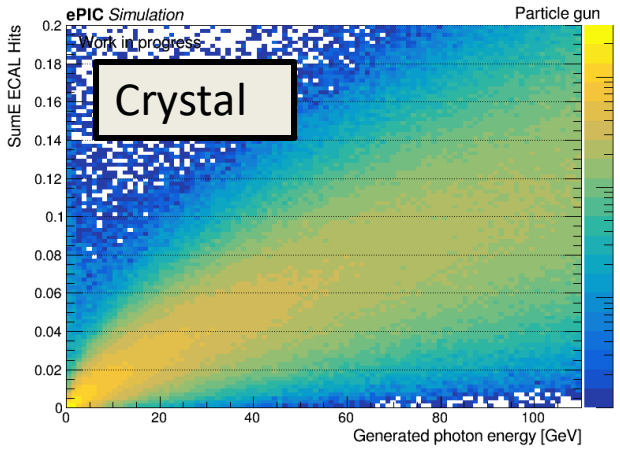
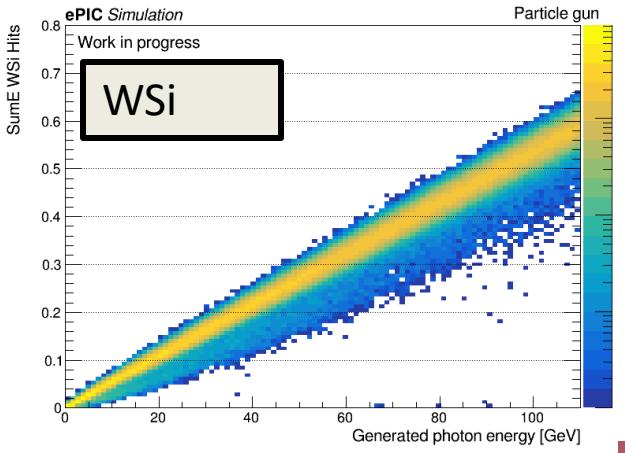
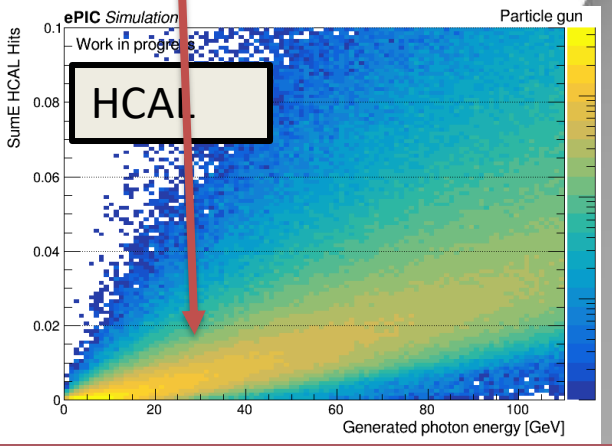


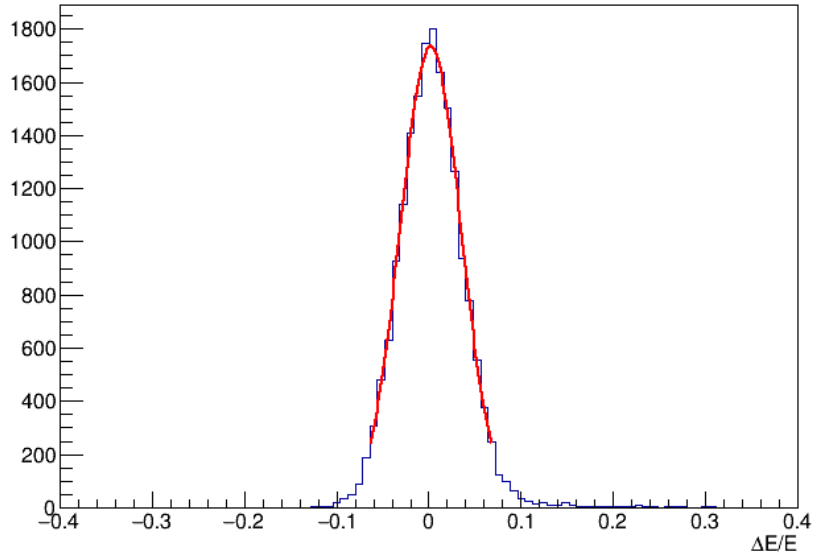


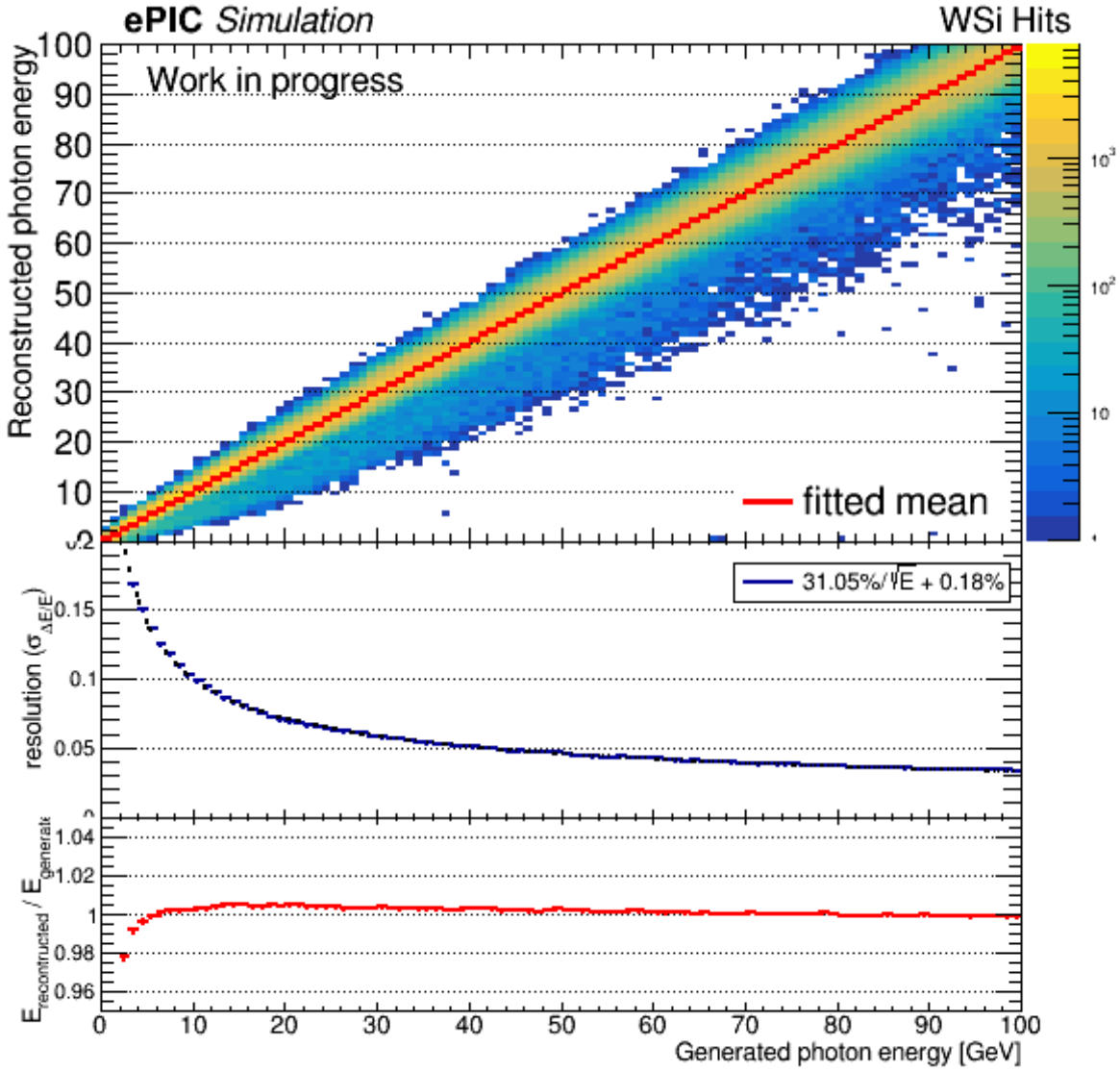


For simulations we removed the SS beampipe

Energy resolution (WSi only)

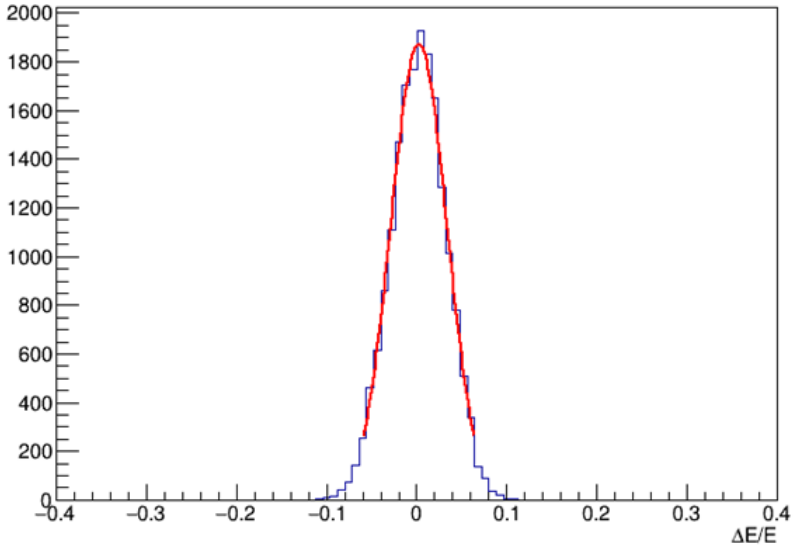
- Particle Gun with photons (θ=0)
- Calibrated energy response for imaging detector only – WSi performance within the ZDC setup
- Small constant term (<<1%)

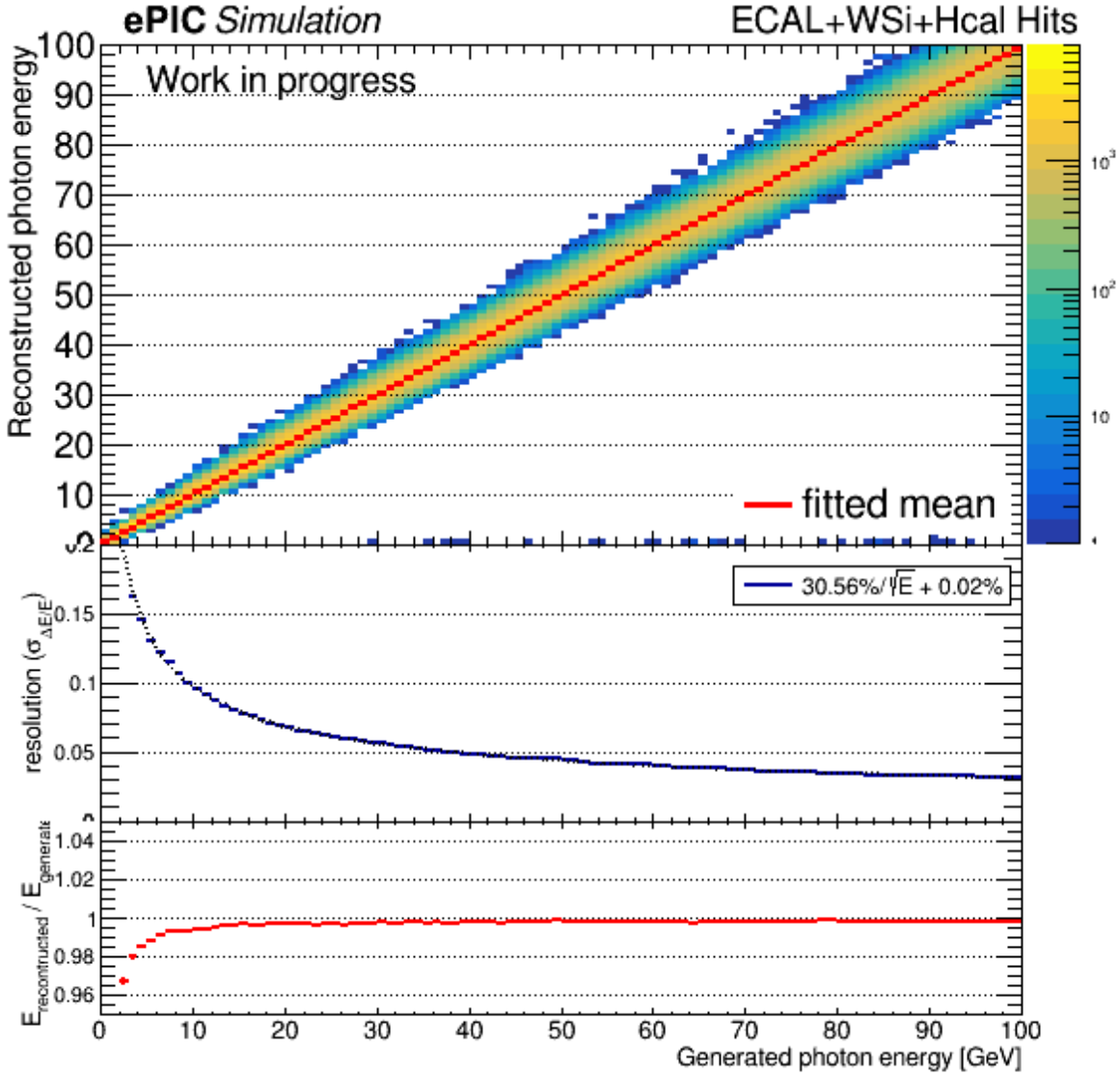




Energy resolution (WSi + leakage)

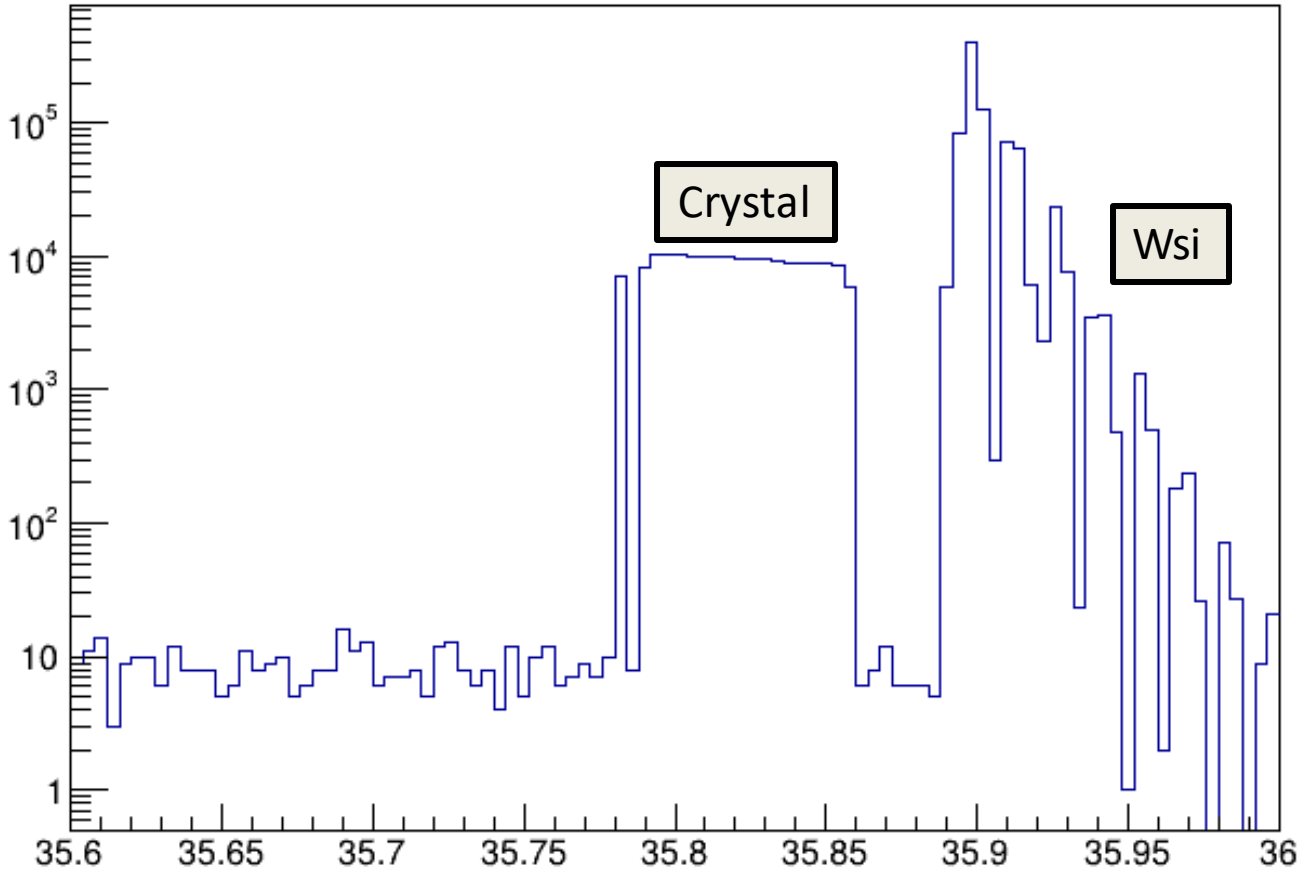
- Particle Gun with photons (θ=0)
- Calibrated energy response for ECAL + HCAL – doesn't make large difference
- Small constant term (<<1%)

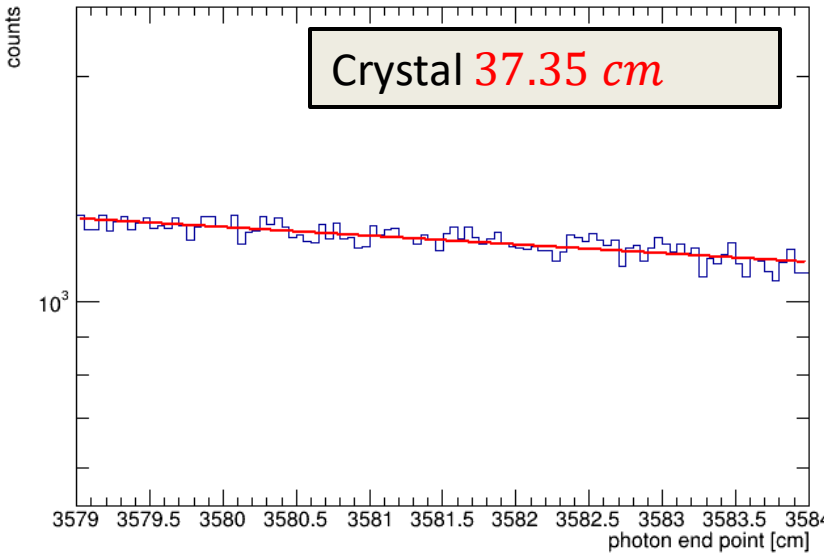


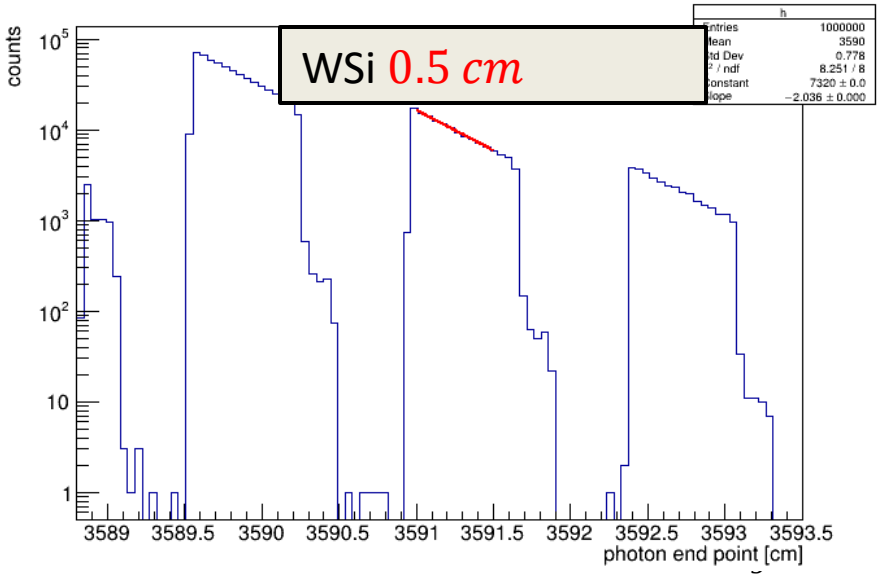


Towards photon ID

- Particle Gun with photons (θ=0, E>20 GeV)
- Photon first interaction position in z (mean free path)

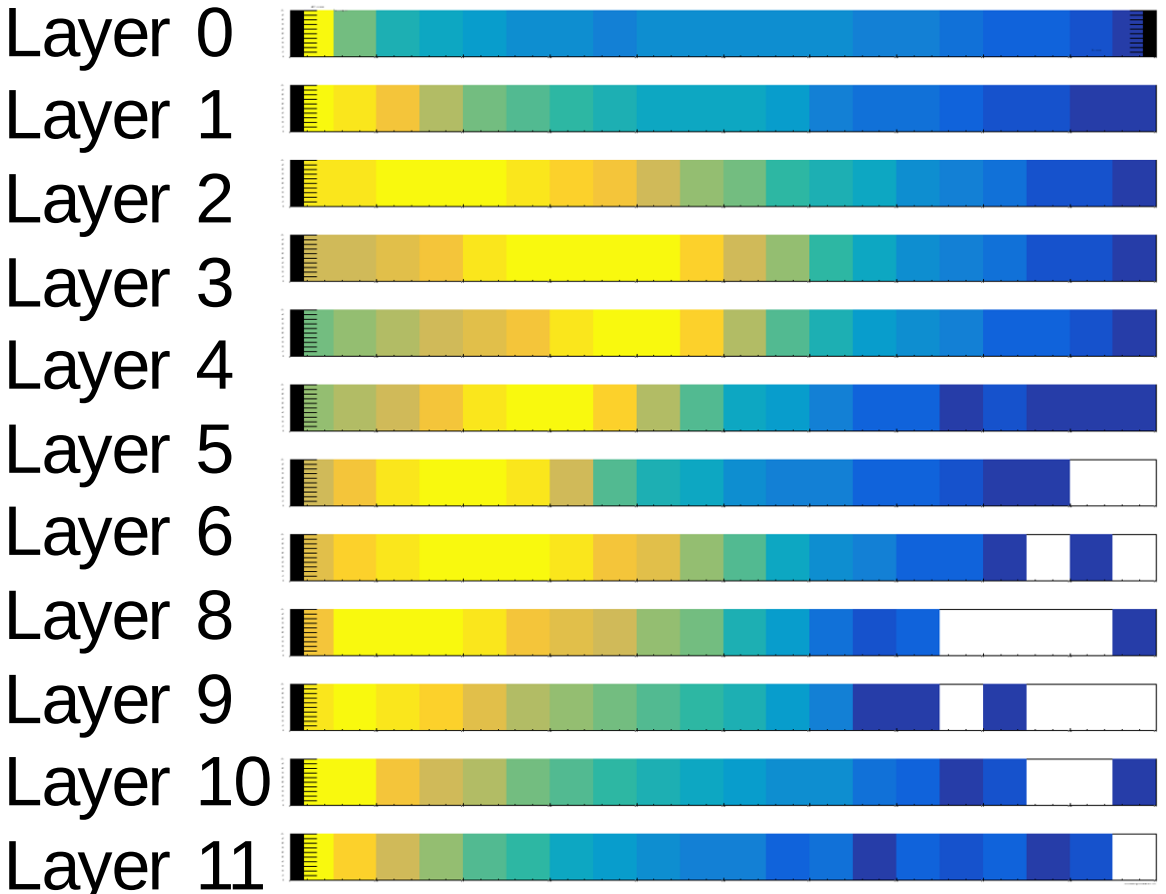




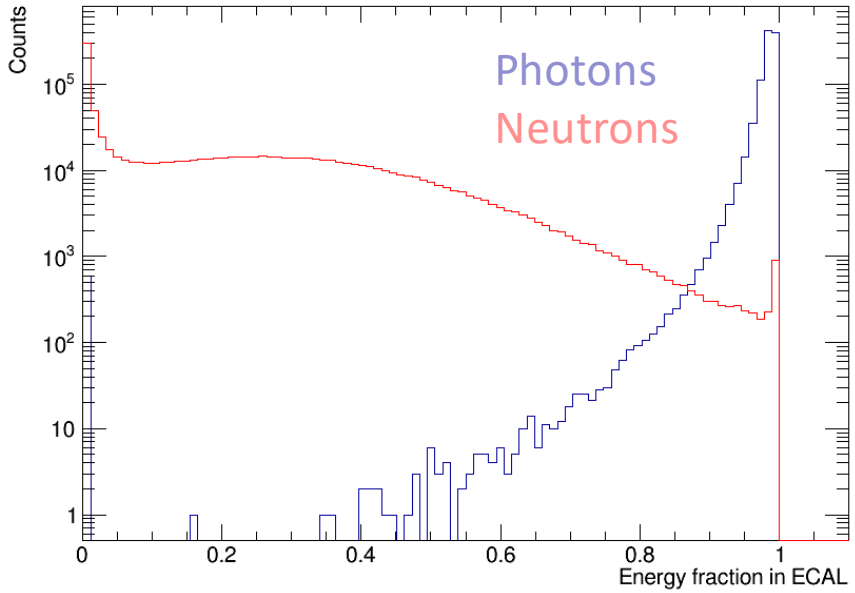


Towards photon ID

- Particle Gun with photons (θ=0)
- Longitudinal granularity – better photon ID?

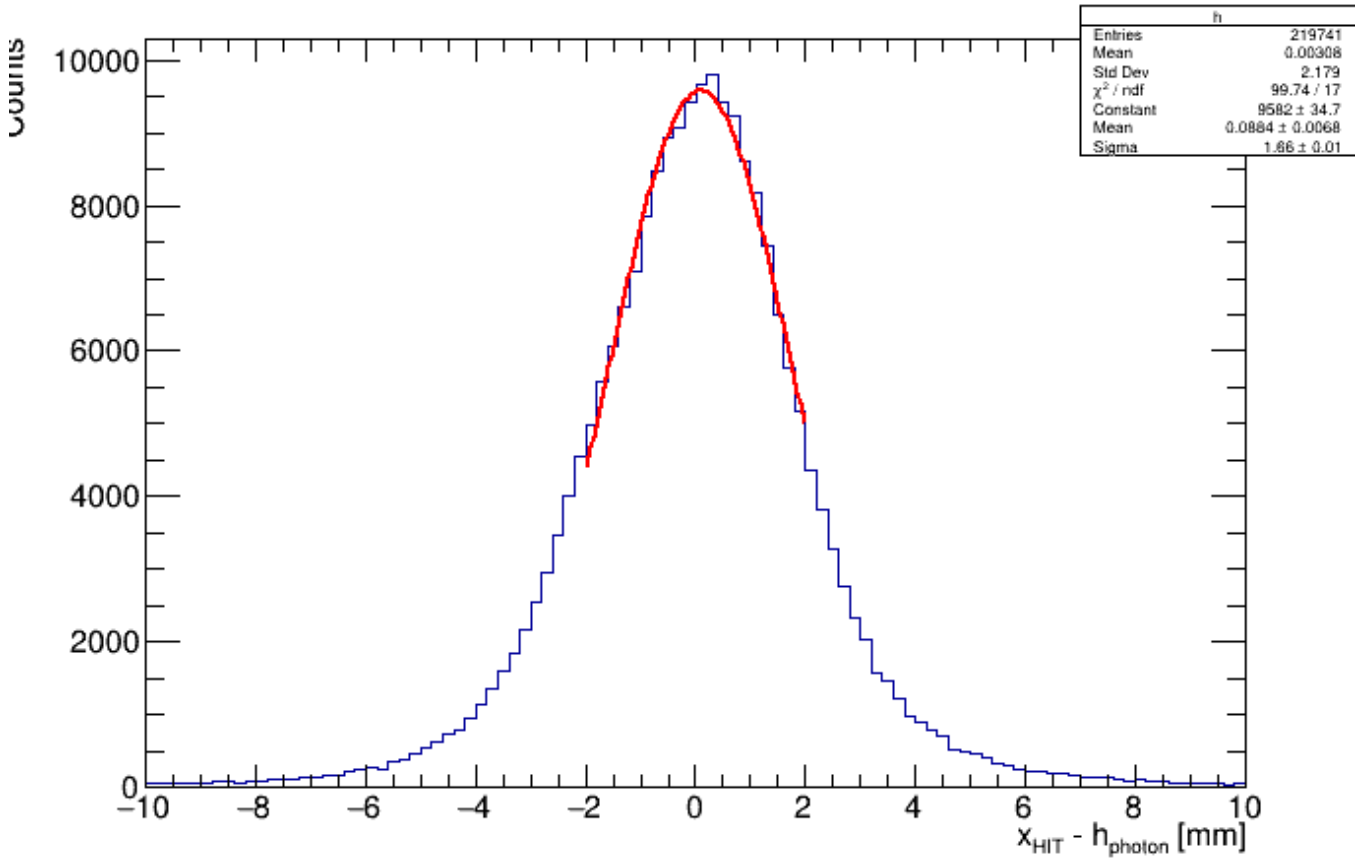


Fraction of energy / Layer i



Towards position resolution

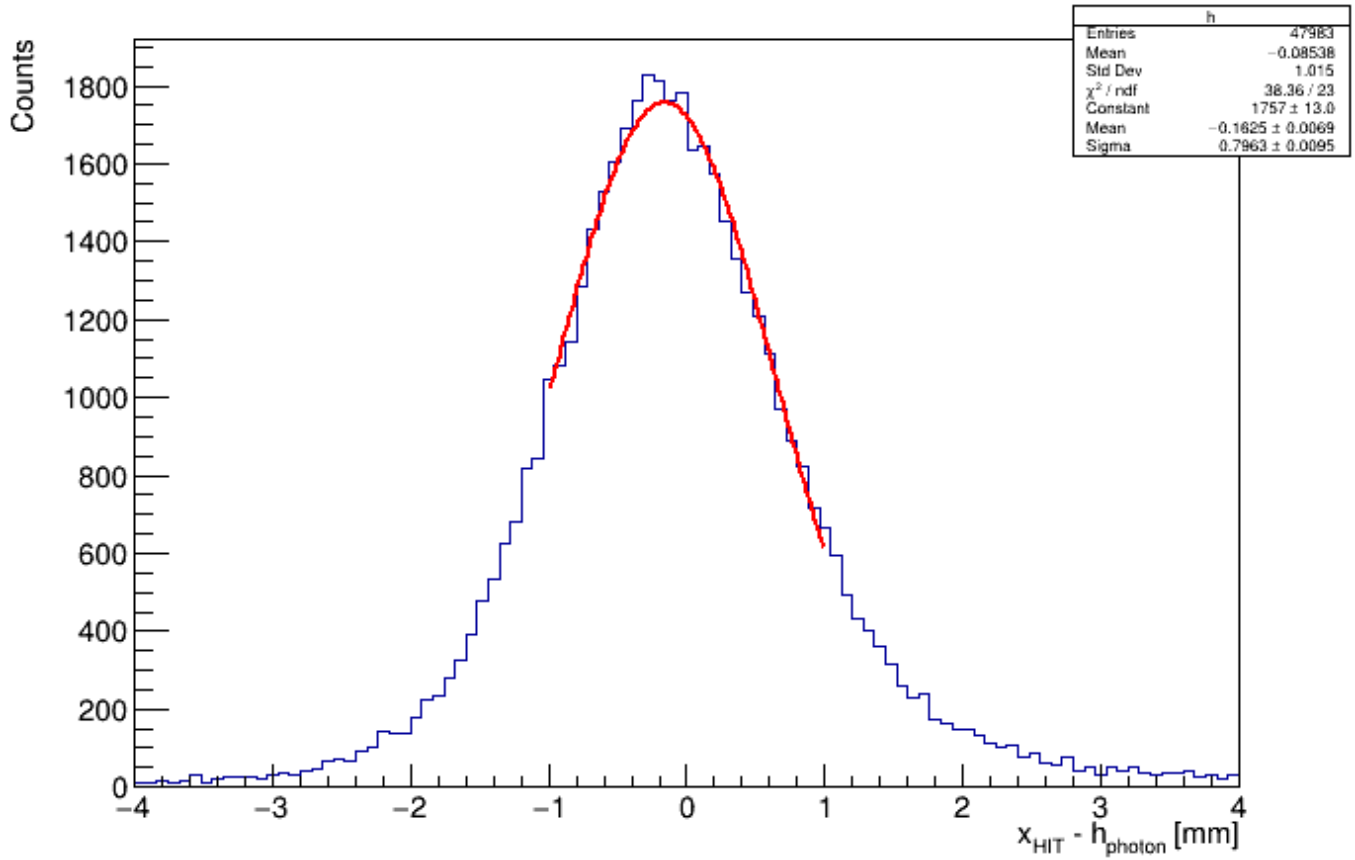
- Main challenge is reconstructing high energy pi0
- Photon eta – position resolution
- Layer by Layer single photon resolution: $\sigma < 2$ mm



Towards position resolution

- Main challenge is reconstructing high energy pi0
- Photon eta – position resolution

- Layer by Layer single photon resolution: $\sigma < 2$ mm
- Combined resolution: $\sigma < 1$ mm
- Pi0 studies are ongoing



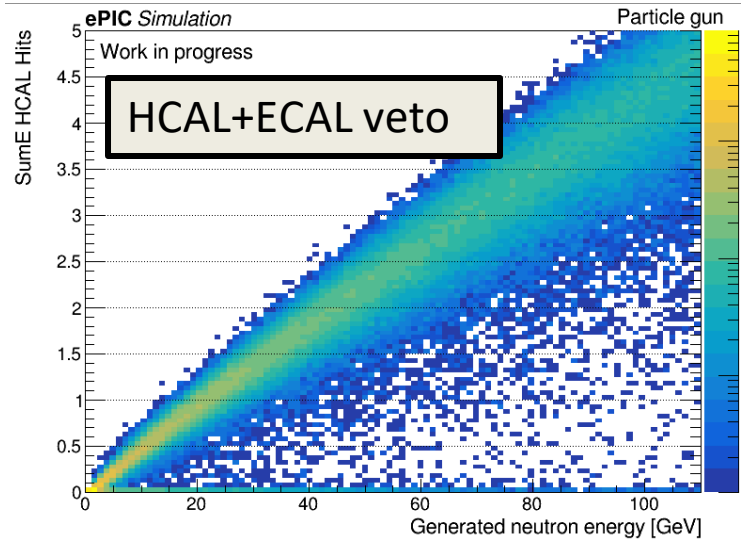
Summary

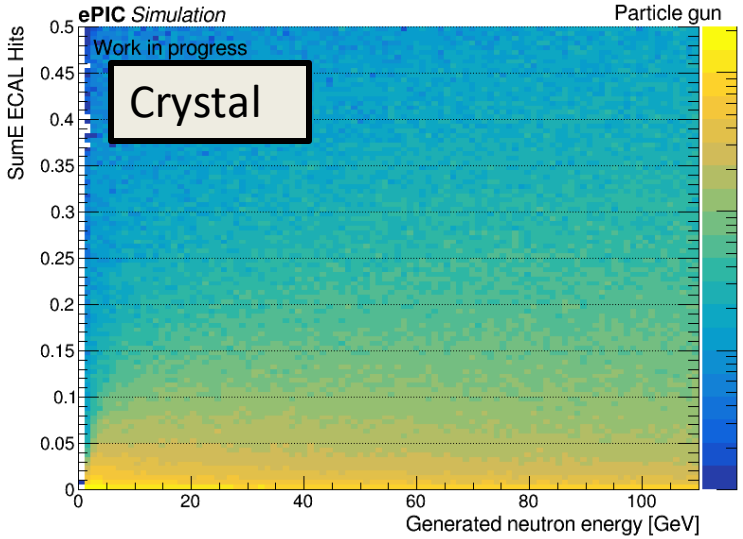
- The ZDC simulation is available
- Beampipe seems to be a showstopper for performance studies for soft photons (in particular, understanding the performance of the Crystal layer)
- Imaging ECAL – has very a small constant term (<<1%)
- Longitudinal segmentation – needed for better photon vs neutron ID
- Angular resolution:
  - Single photon studies ~ 1 mm spatial resolution
  - Cluster reconstruction for the crystal part is available, while for the highly granular WSi imaging part, we need full reconstruction (https://github.com/eic/EICrecon/issues/1184)

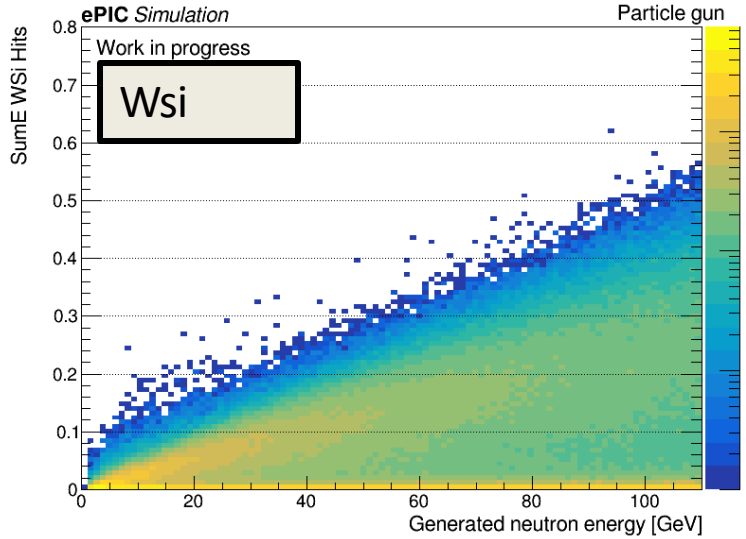
Backup

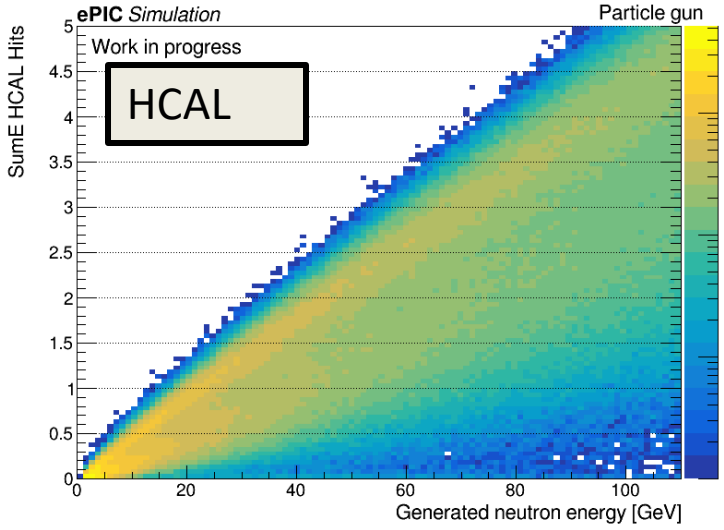
Detector response to neutrons

- Particle Gun with neutrons (θ=0)
- ECAL shows weak correlation (low λ_{int}?)
- Vetoing ECAL, result in linear response of HCAL, with C3 = 22.8557 (60% from EM)

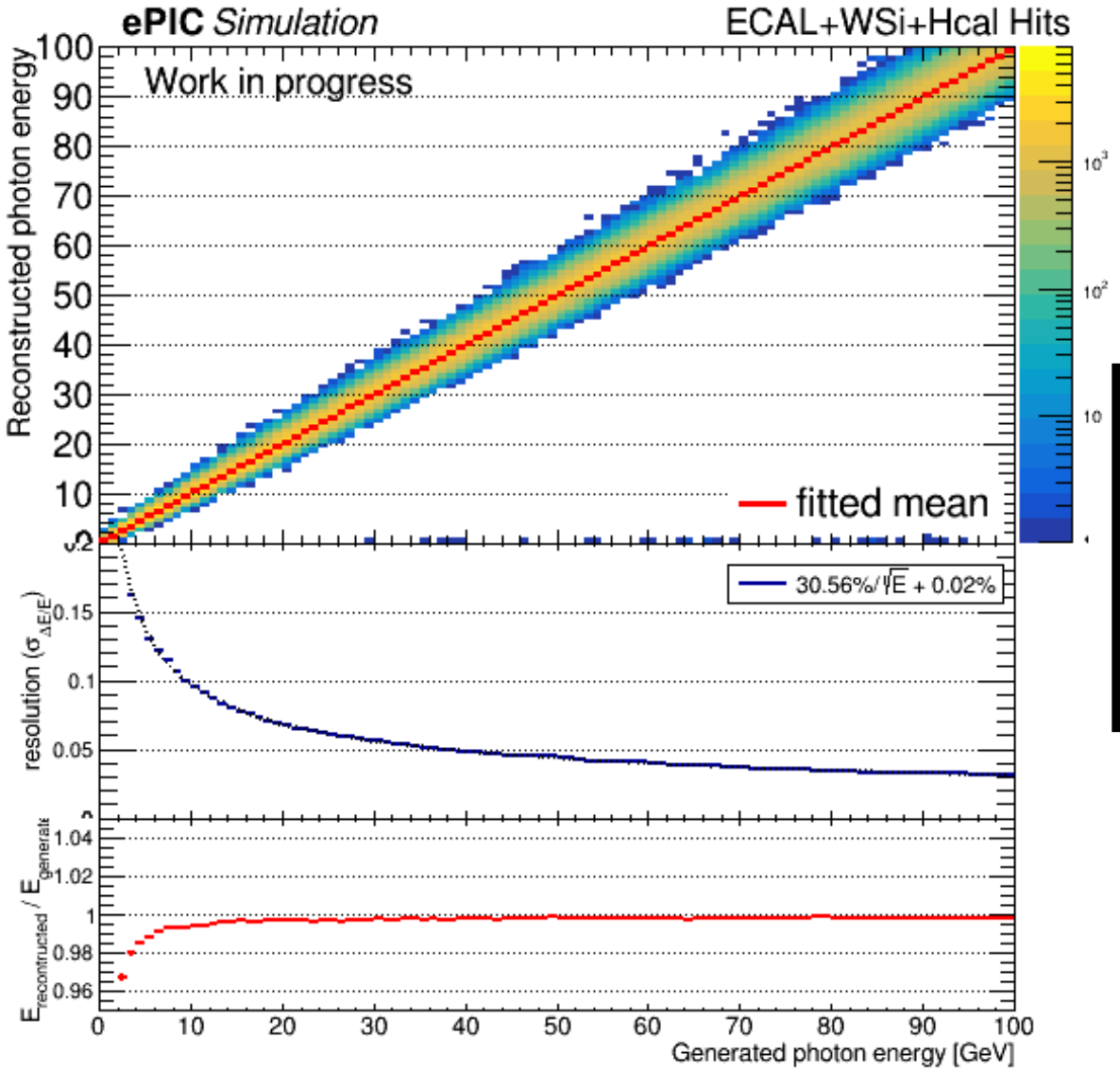








Including the beampipe



+ beampipe