Photon conversion study using Combined Test Beam data and future plans

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Physics Motivation

The promising channel for the discovery of Higgs H→ γ γ

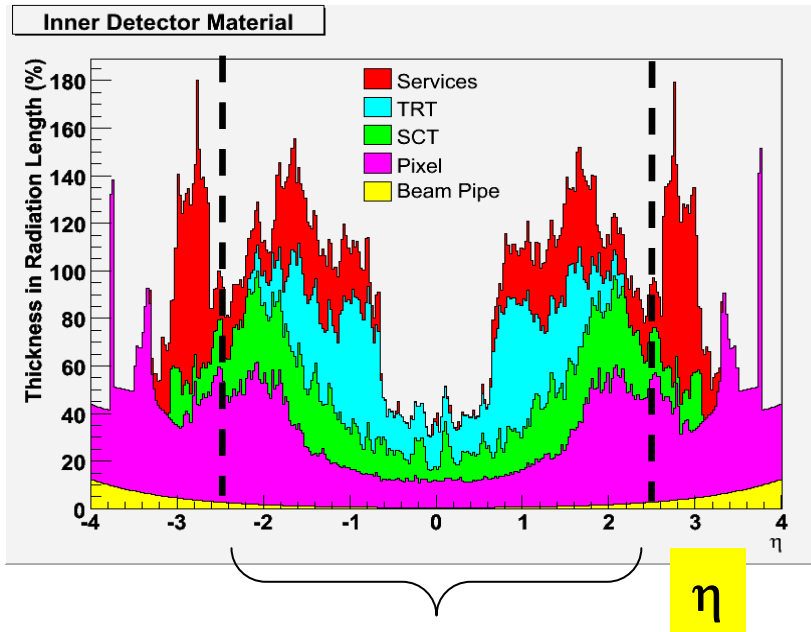
H→ γ γ requires the good γ reconstruction.

But many photons (~30%) converts to e^+ e^-, which subsequently loses their energy in front of the calorimeter due to the bremsstrahlung in ID material. (~ $1.5X_0$ at max)

Using the data of Combined Test Beam,

we need studies of …

1. **Reconstruction of converted photons**
2. **γ energy scale in the EM calorimeter**



Fiducial acceptance

Combined Test Beam (CTB)

-- Main purposes of CTB

1. Test of the combined detector performance

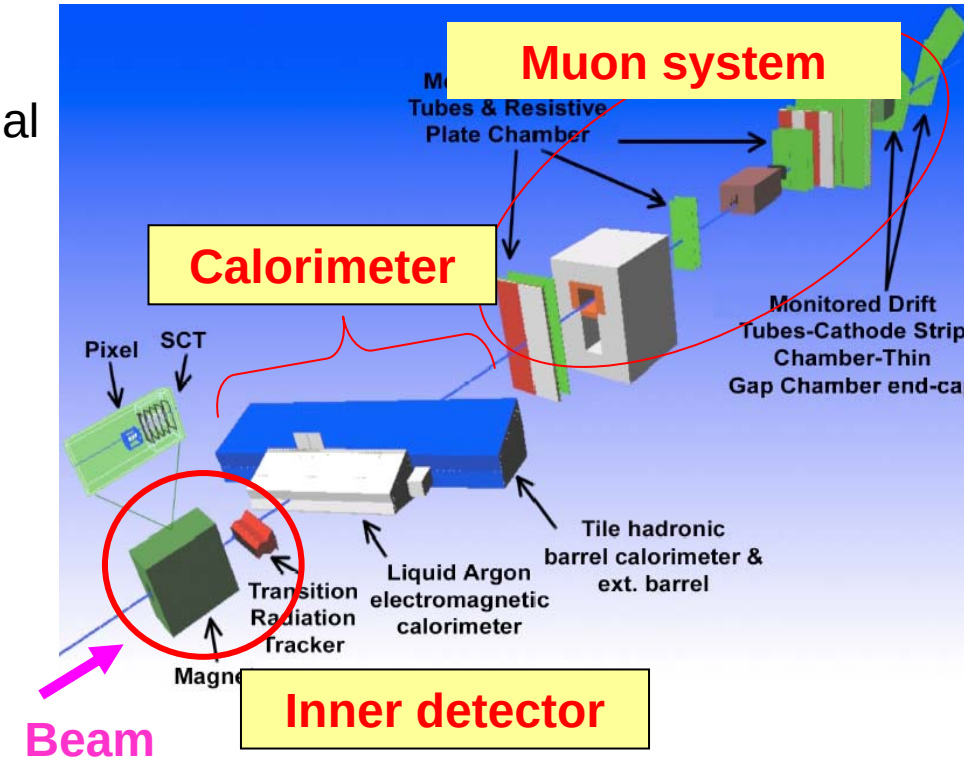
2. Validation of the MC simulation of the detector response.

3. Development and validation of additional functionality in offline software. (calibration, alignment)

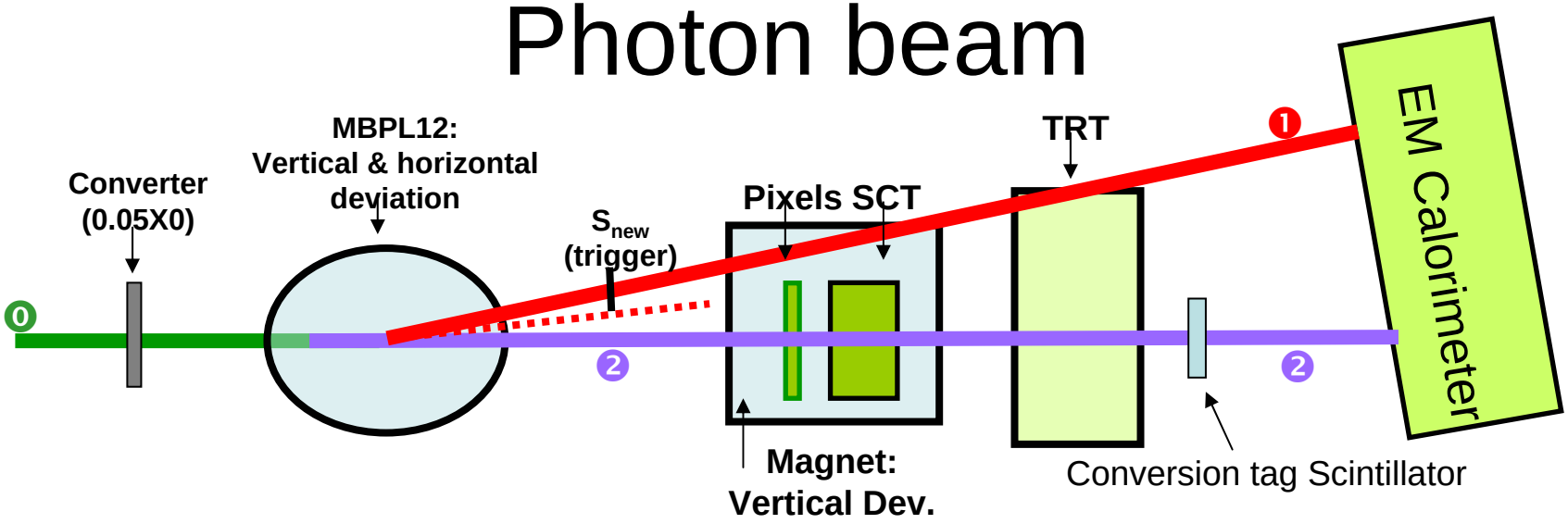
-- The detector configuration is similar to ATLAS detector.

1. Muon system
2. Calorimeters
   （LAr Calorimeter、Tile Calorimeter）
3. Inner detector (tracking system)

-- We took the data in the winter of 2004.
→ Total of 22 M events taken for electrons, pions,muons and photons



Photon beam



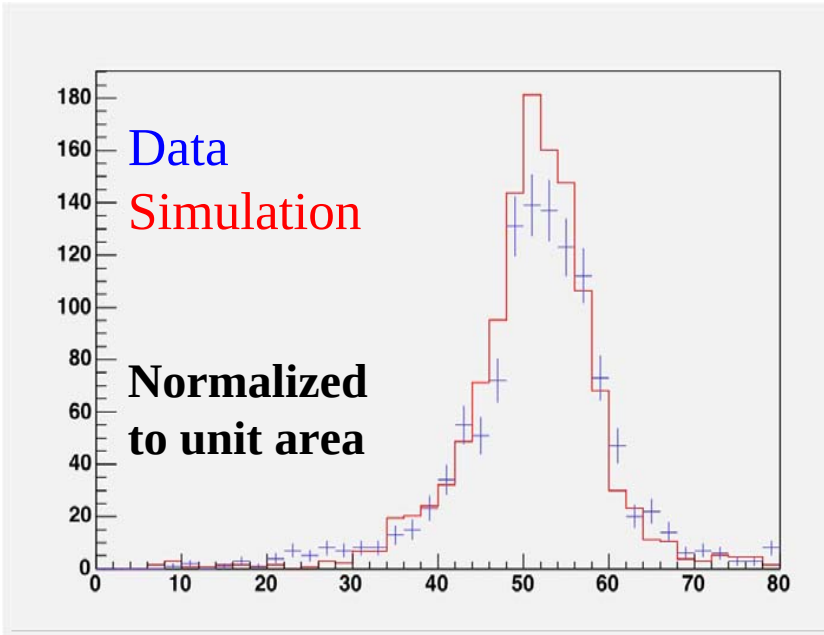
⓪ Initial Positron 180GeV

❶ Positron after Bremsstrahlung

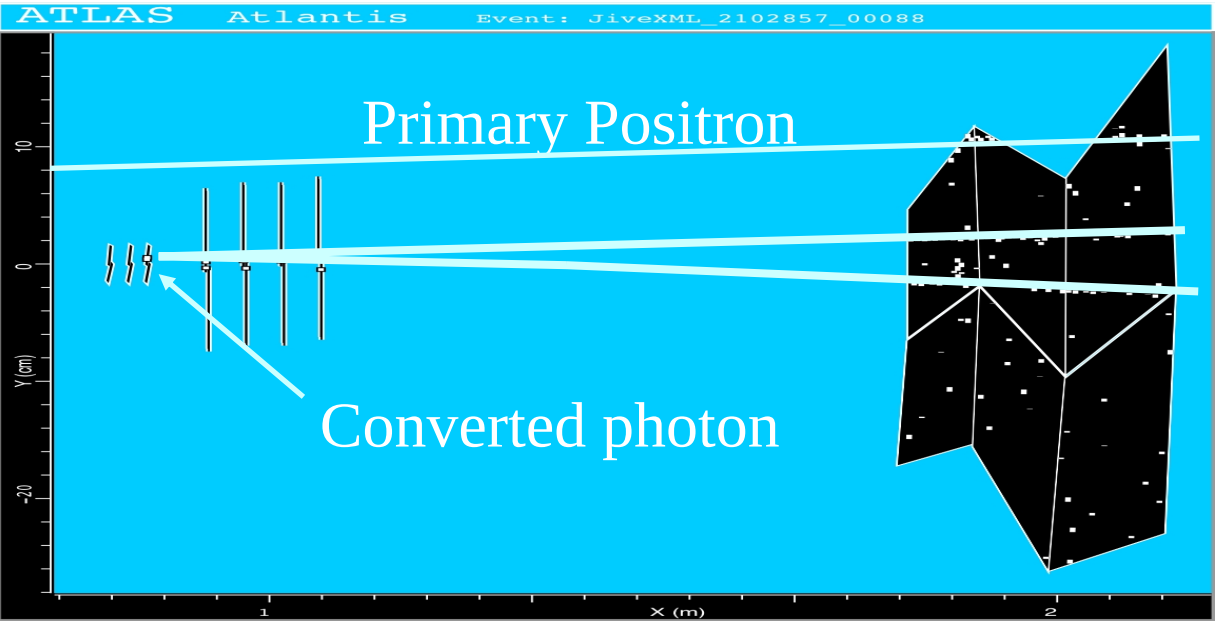
❷ 60GeV photon

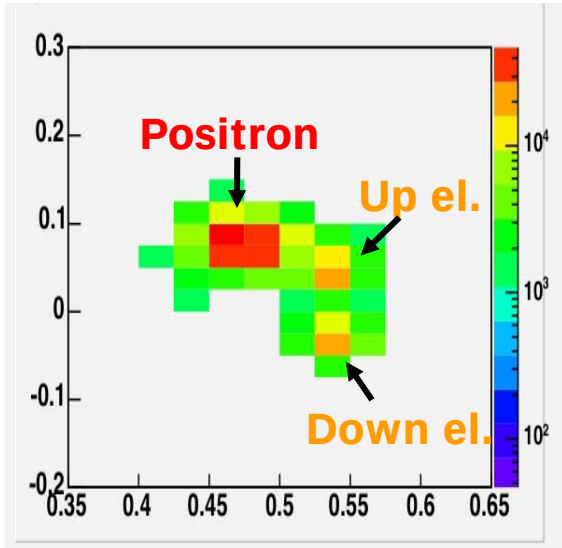
-- Outgoing primary positron was separated using two magnet (MBPL12)

-- Converted photon in the inner detector was tagged with scintillator between TRT and EM CAL.



Photon conversion reconstruction





-- e^+ e^- from the photon conversion are reconstructed in ID

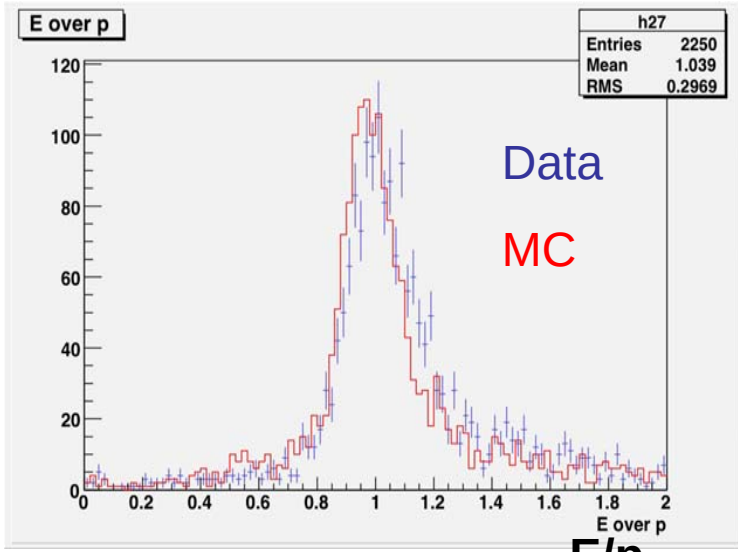
-- Three clusters are observed in EM calorimeter.

- primary e^-
- e^+e^- pair from converted γ

-- Comparison of E/p for converted photon between Data and MC

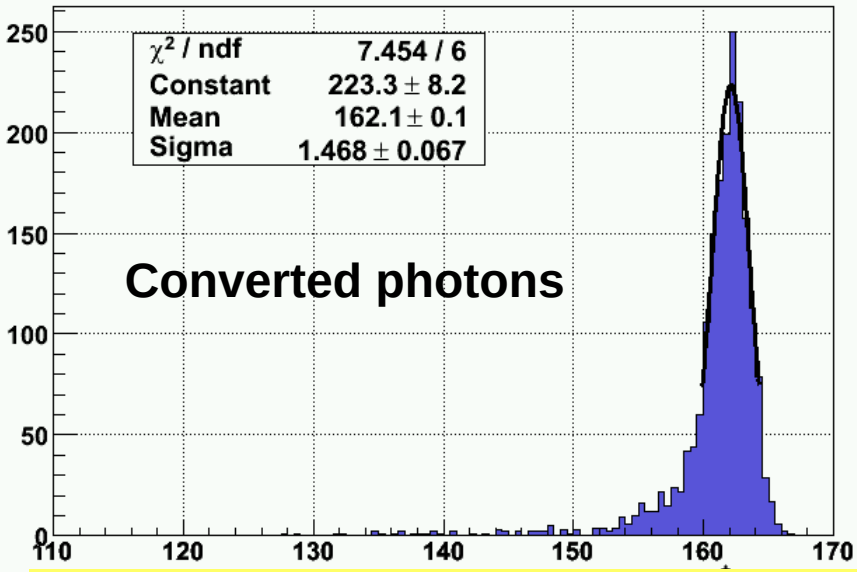
-- work ongoing to evaluate efficiency versus position and energy sharing of photon conversion.

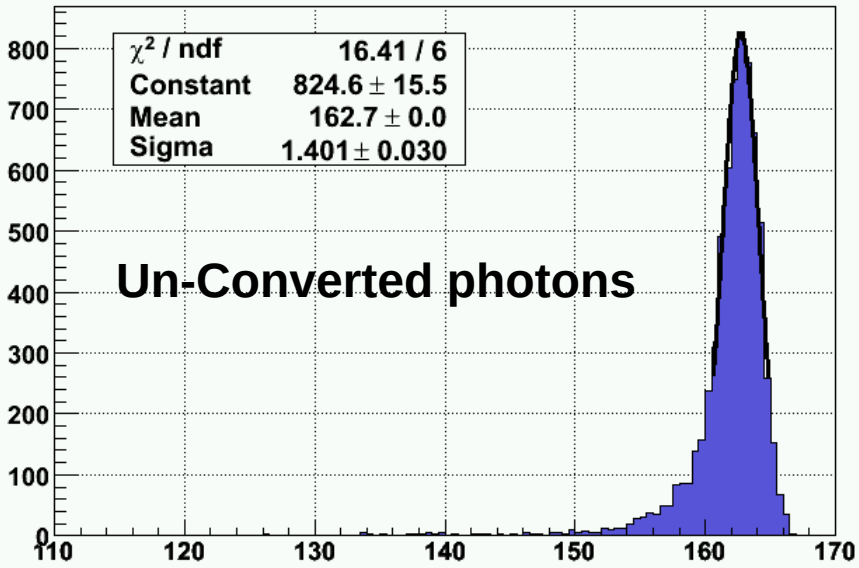
-- difficult to extract γ scale cleanly because γ cluster very close to primary electron cluster.



E/p

Comparison of the total energy between the unconverted photon and converted photon events





Total Energy (e^+ **e^+ e^-**) = 162.1GeV

Total Energy (e^+ γ) = 162.7GeV

-- compare total energy of e+e- from converted photon with the unconverted photon.

-- The e+e- pairs give lower total energy by ~600MeV

→ confirms MC estimates that γ –scale is ~ 1% higher than e –scale.

-- Need to study further γ energy scale (experimental systematics, γ →e^+e^- energy sharing)

Publication of CTB study → next summer

Future Plans (1)

Photon conversion ($\gamma \rightarrow e^+ e^-$) in the ATLAS at Initial physics run (900GeV or 14TeV):

1. Low photon energy (1~2GeV) for the detector understanding

→Mapping of the ID material using $\gamma \rightarrow e^+e^-$

2. Medium photon energy (~ 20GeV) for the initial physics

→ γ/π^0 separation to measure cross section of direct photon production (pp → γ +jet) and extract it from background (pp→jet +jet with jet→π^0).

One method using the converted photons

γ (→e^+e^-) → E_{CAL}/p_{ID} ~ 1.0

π^0(→$\gamma\gamma$ →γ e^+e^-) →E_{CAL}/p_{ID} >1.0

Future plan (2)

Study full simulation samples (CSC samples) for the Higgs discovery in H→ $\gamma\gamma$

-- requires full understanding of $\gamma\gamma$ continuum and residual γ-jet / jet-jet backgrounds.

-- requires topological studies (H +jets) and understanding of vertexing (impact on $M_{\gamma\gamma}$ resolution)