Study of γ Conversion at BESII

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- Motivation
- Monte Carlo Study of γ Conversions
- Converted γ in BESII J/ψ Data
- Conclusions

Motivation

- $J/\psi \to \gamma X$—a rich source of mesons, glueball and hybrids
- Predication—$\xi(2230) \to \pi^0\pi^0$, $\eta\eta$, $\eta\eta'$, $\eta'\eta'$ and so on.
- But our calorimeter BSC has a poor energy resolution $\sim 21\%/\sqrt{E}$
- It is very difficult for us to probe the properties of $\xi(2230)$ completely, even if we have large J/ψ sample presently at BES.
- Improved methods:
  - Changing our calorimeter to BCAL—Money!!
  - Using the advantage of our MDC $\sim 1.8\%\sqrt{1+p^2}$:
    Converted photons: $\gamma \to e^+e^-$, using the energy of e^+e^- system to represent γ energy;
- Actually, E926 at BNL and ALEPH at LEP and so on, had used this technology to reconstruct more π^0s.

We can try to do it at BES?!

Advantage

- The Probability of γ conversion:
  - BESI: $5\% \sim 6\%$
  - BESII: 2.8%
- At the same time, for $J/\psi \to \gamma\xi(2230)$:
  The Branching ratios of $\xi(2230) \to \pi^+\pi^-$, K^+K^-, $K_S\bar{K}_S$ and $p\bar{p}$ are a few percent according to BES and $p\bar{p}$ experiments.
- MDC momentum resolution is much better than BSC energy resolution.
- Assuming Br($J/\psi \to \gamma\xi(2230)) = 3 \times 10^{-3}$ is correct, there should be at least $\sim$ 600 $e^+e^-\xi(2230)$ events, which $\xi(2230)$ to anything, using 10M BESII J/ψ data
  So any narrow peak in the positron plus electron energy distribution will give us a lot of excited information.

Disadvantage

- Large background from no-radiative gamma conversion,
- Some background from π^0 dalitz decays.
- The total energy of e^+ and e^- is really equal to the energy of converted photon.
  How about the accurate?
  How about the approximate?
- Energy loss is a different case from that of charged track emited from the interection point.

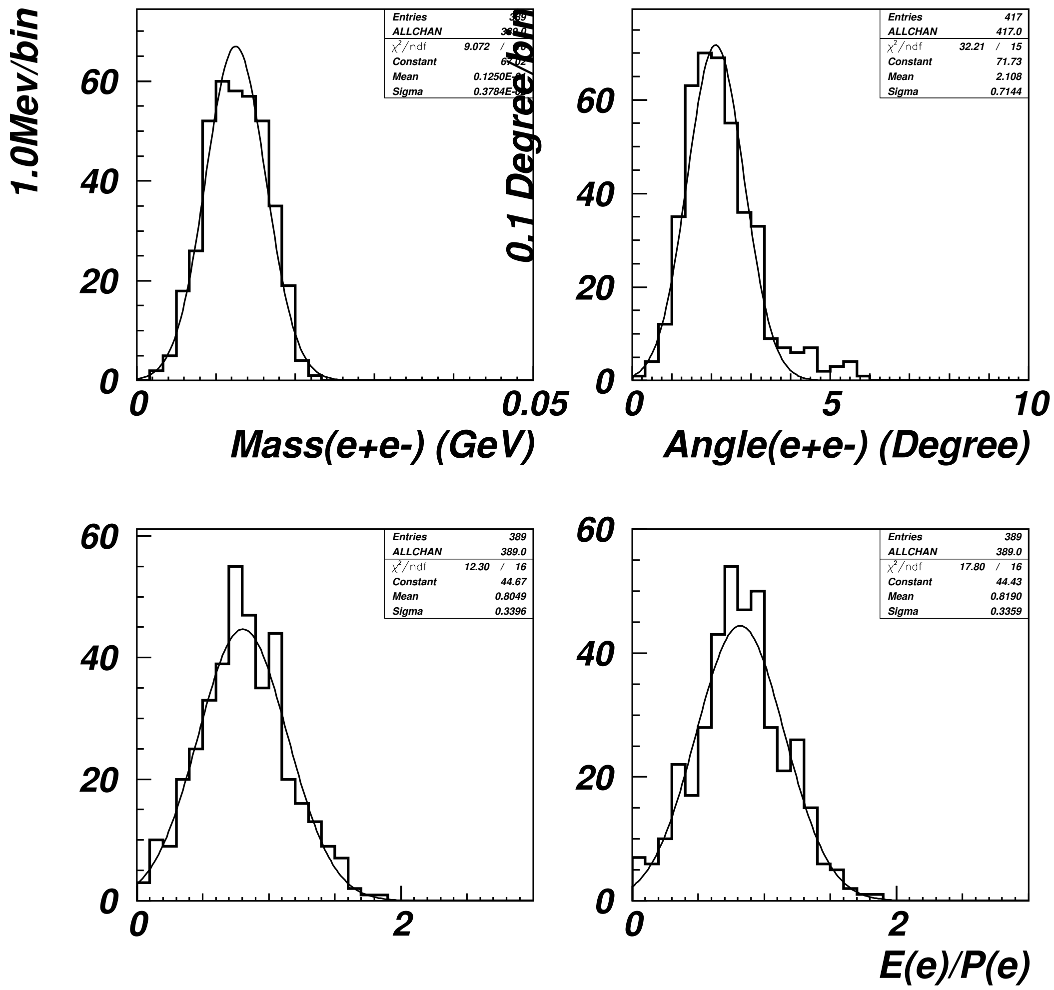
We try to find any possibilities to remove backgrounds.

Event Shape from Monte Carlo Simulation

- Event Shape of candidates from Monte Carlo simulation:
  - Small Angle between e^-e^+;
  - Smaller invariant mass of e^-e^+;
  - Second Vertex near the beam pipe.

Monte Carlo Simulation

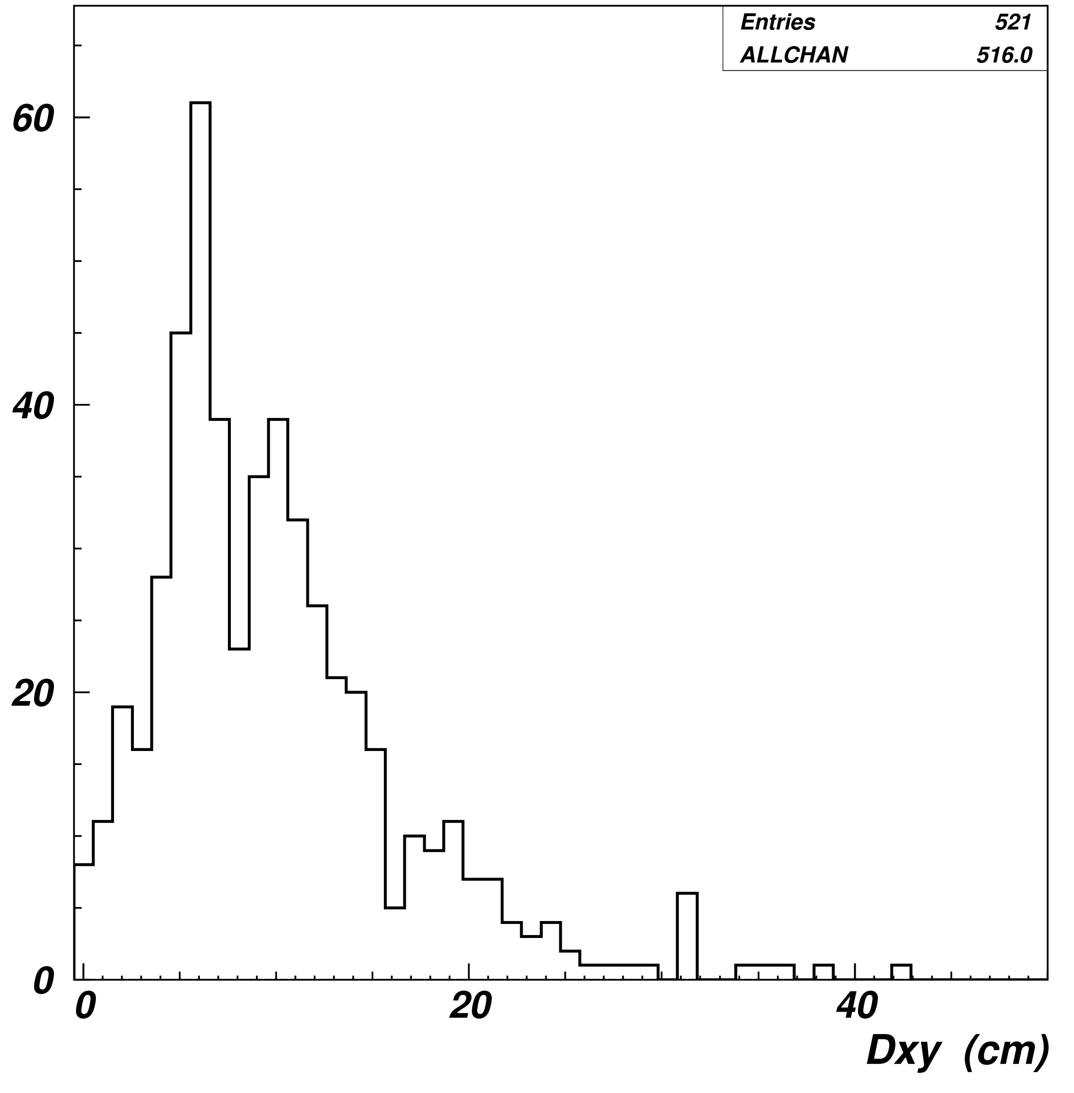
- Monte Carlo Simulation at $E_\gamma = 0.75$GeV:



- The angle between e^+e^- less than 4.0^o;
- The inv. mass of e^+e^- less that 50 MeV(the same cut as above.

Monte Carlo Simulation

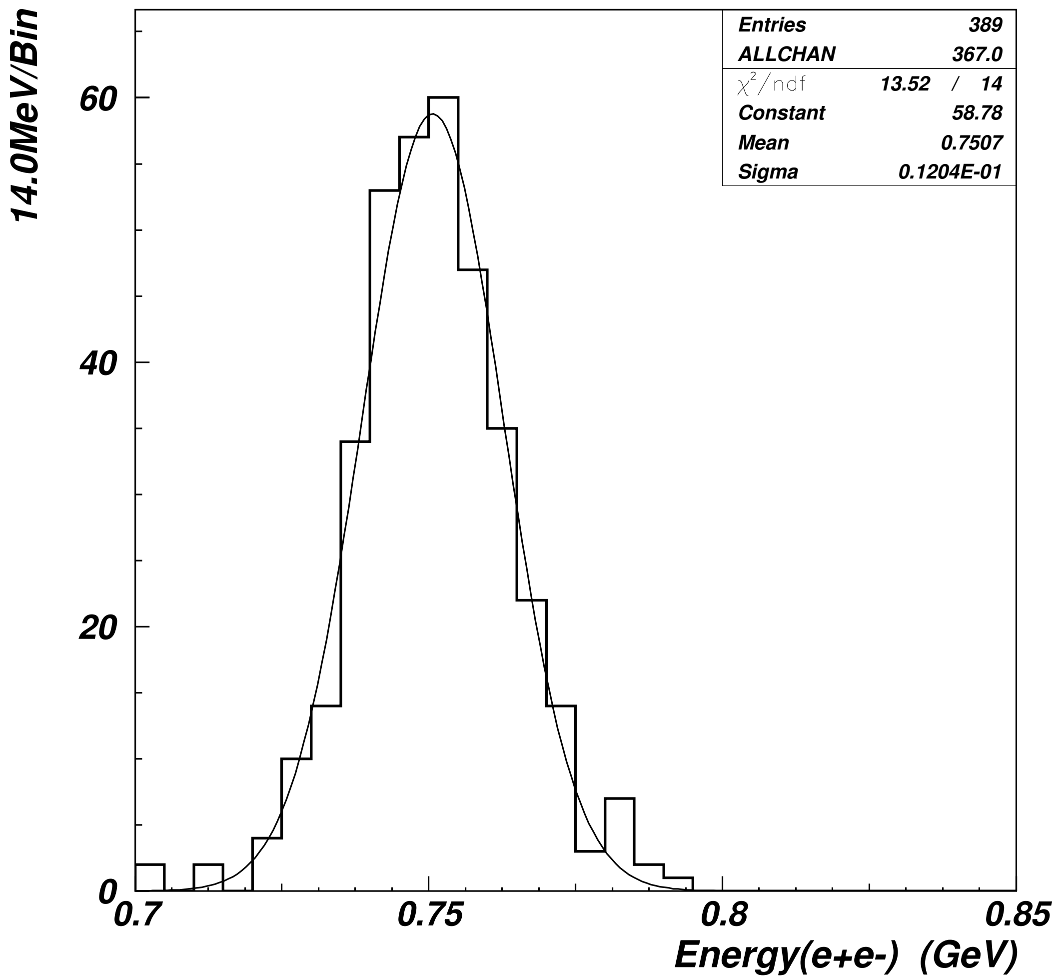
- Monte Carlo Simulation at $E_\gamma = 0.75$GeV: The second vertex position D_{xy}:



- Most of all converted photons start to decay to $e^- e^+$ near the beam pipe $\sim$ 5cm.

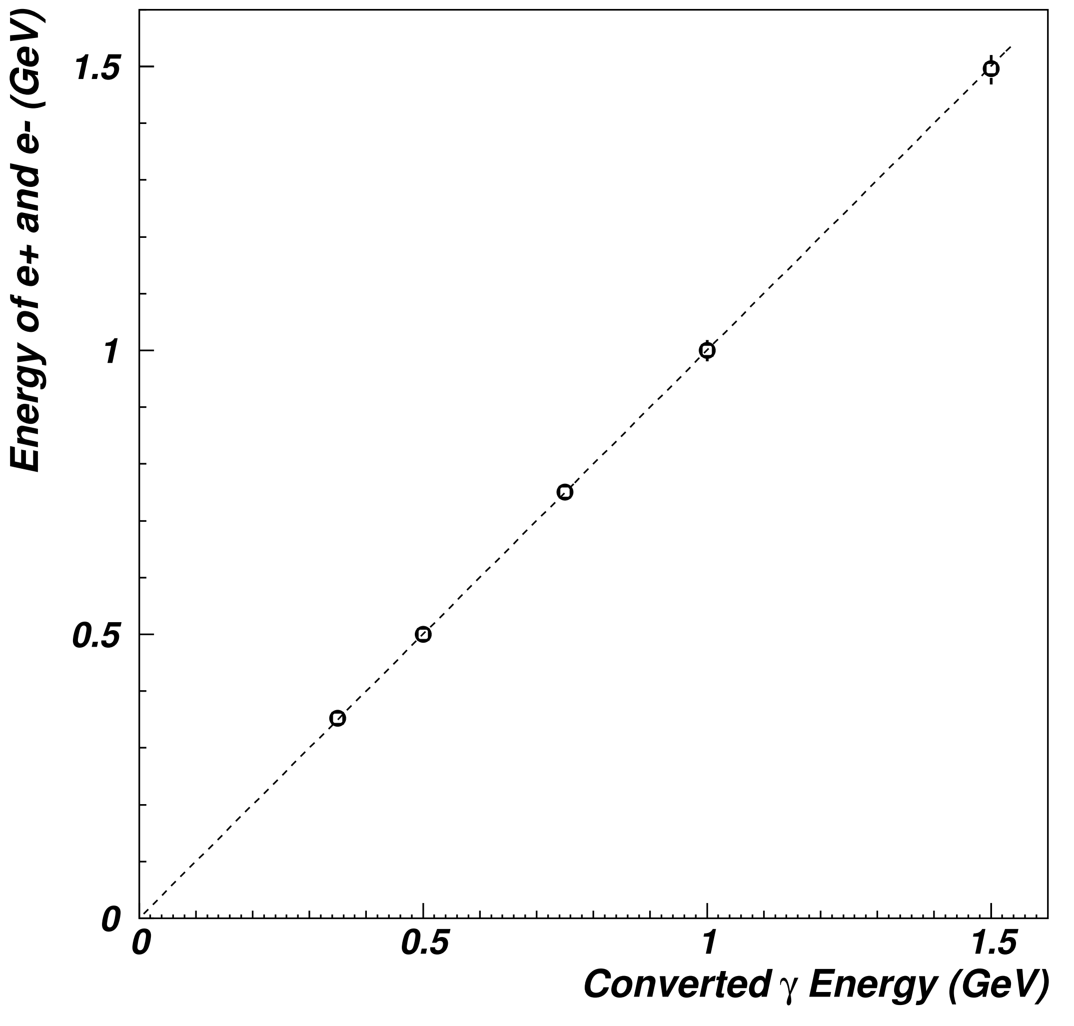
Monte Carlo Simulation

- Monte Carlo Simulation at $E_\gamma = 0.75\text{GeV}$:
  The total energy of $e^- e^+$ system:



Monte Carlo Simulation

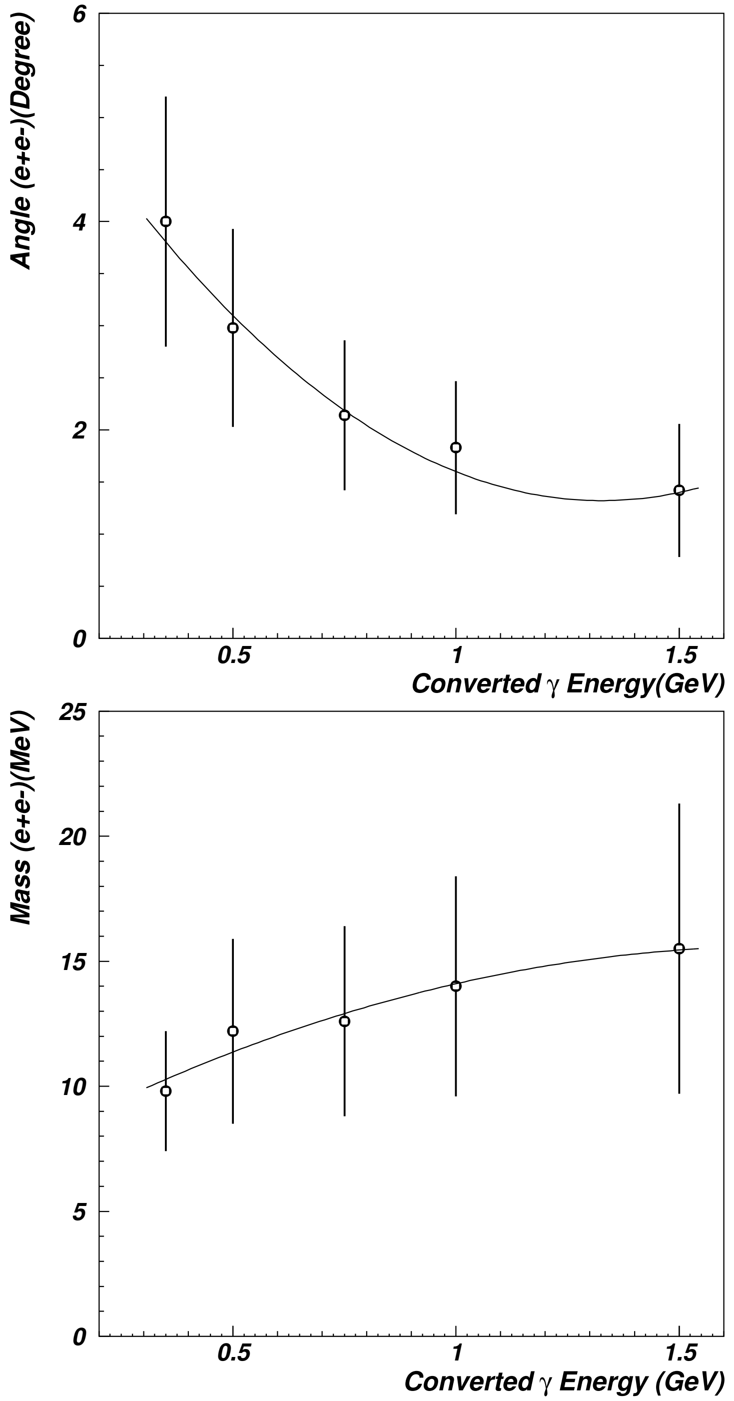
- The total energy of e^+e^- pair VS the energy of converted photon:



- $\frac{|E_{e^-e^+} - E_\gamma|}{E_\gamma} < 0.001$

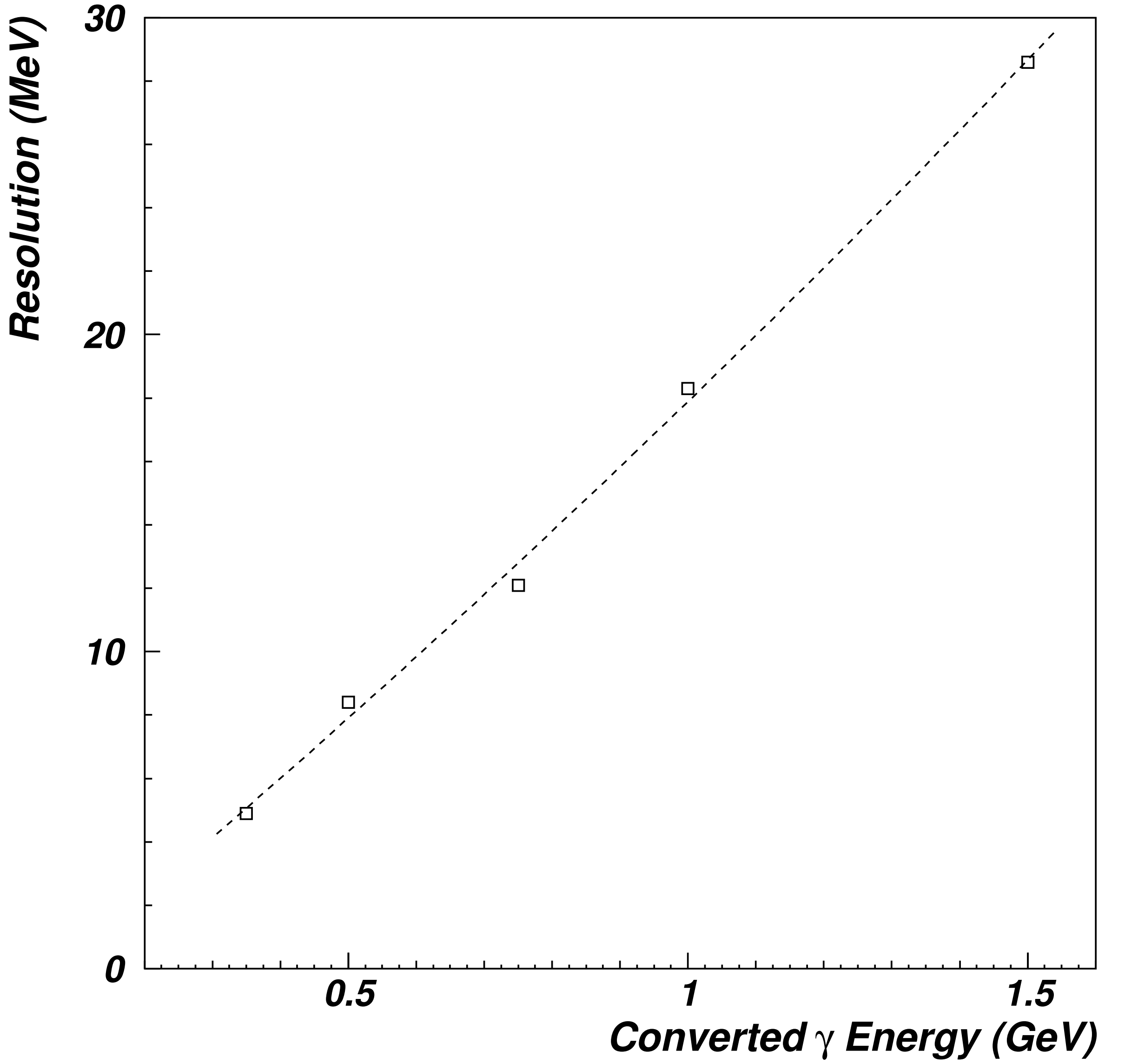
Monte Carlo Simulation

- The angle between e^+e^- (upper plot), and the Inv. mass of e^+e^-(lower plot) at different energy of converted photon:



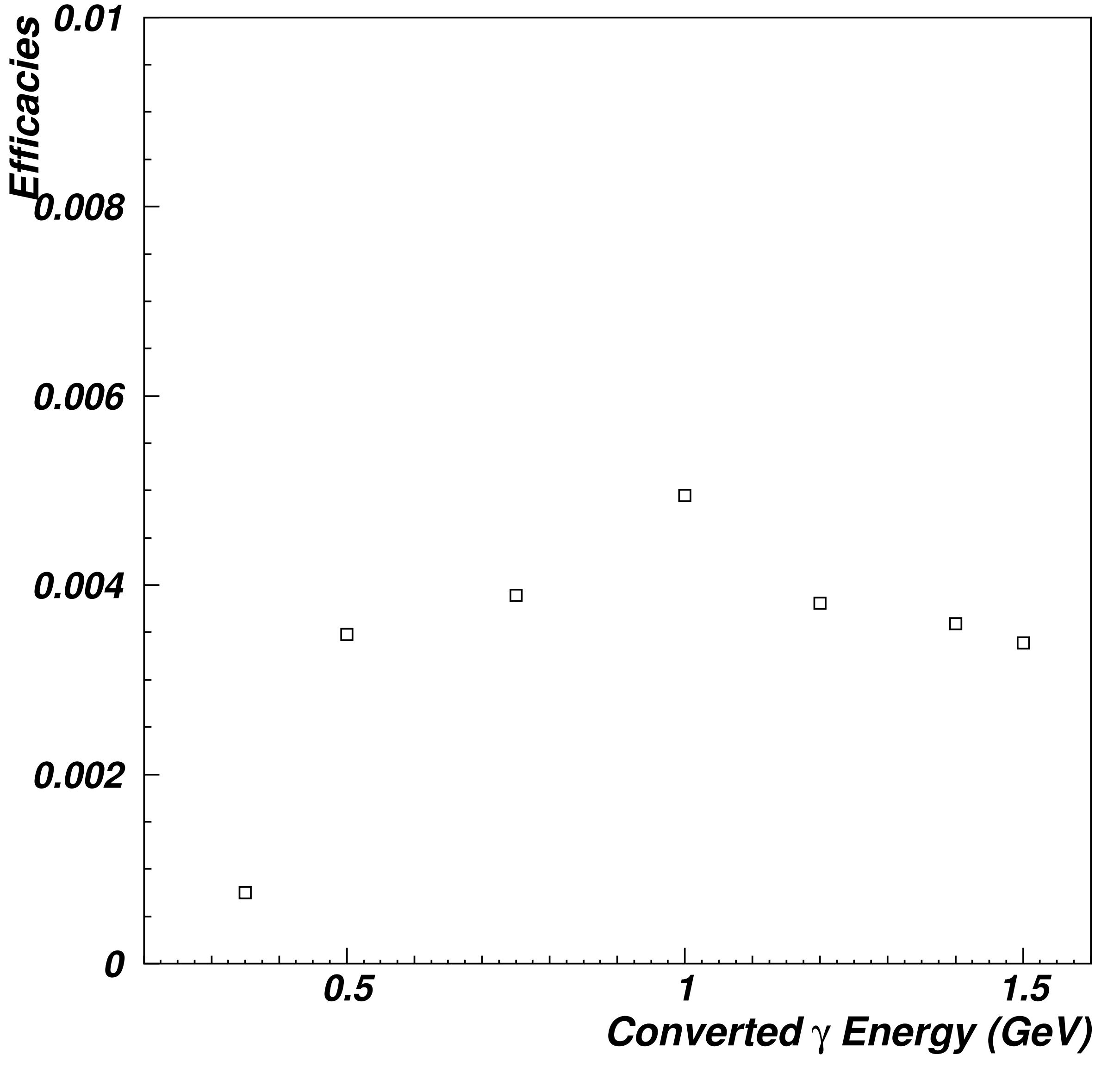
Monte Carlo Data

- The Inv. mass of e^+e^- at different energy of converted photon:



Monte Carlo Data

- The efficencies at different energy of converted photon:

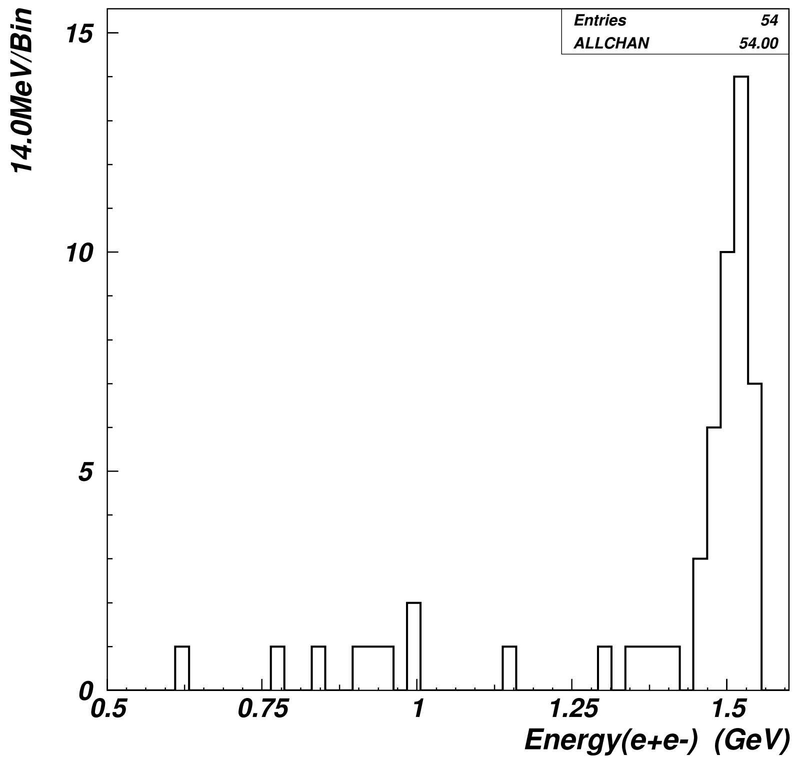


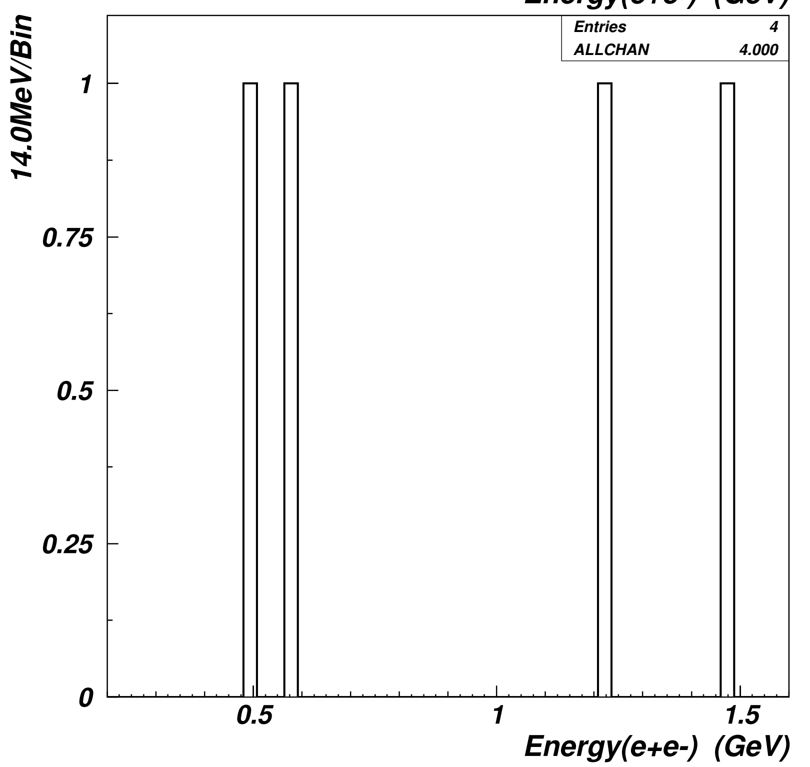
Background Study

- Background from $e^-e^+ \to \gamma\gamma(\gamma)$;
- Background from $e^-e^+ \to e^-e^+(\gamma)$;
- Background from π^0 dalitz decay and $\gamma\gamma$ decay;
- Background from multi-photon final state decays;

Background Study

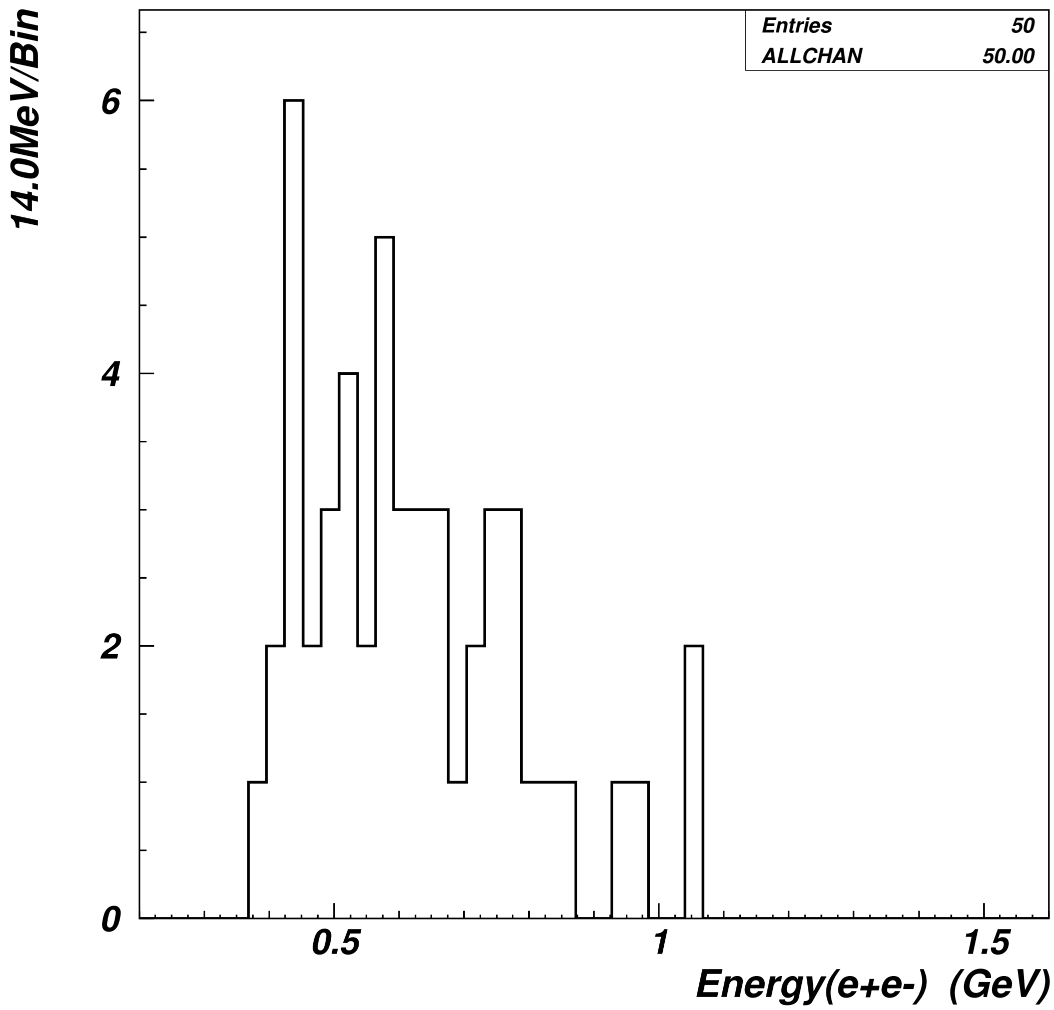
❖ Some $E_{e^-e^+}$ distributions from Background:





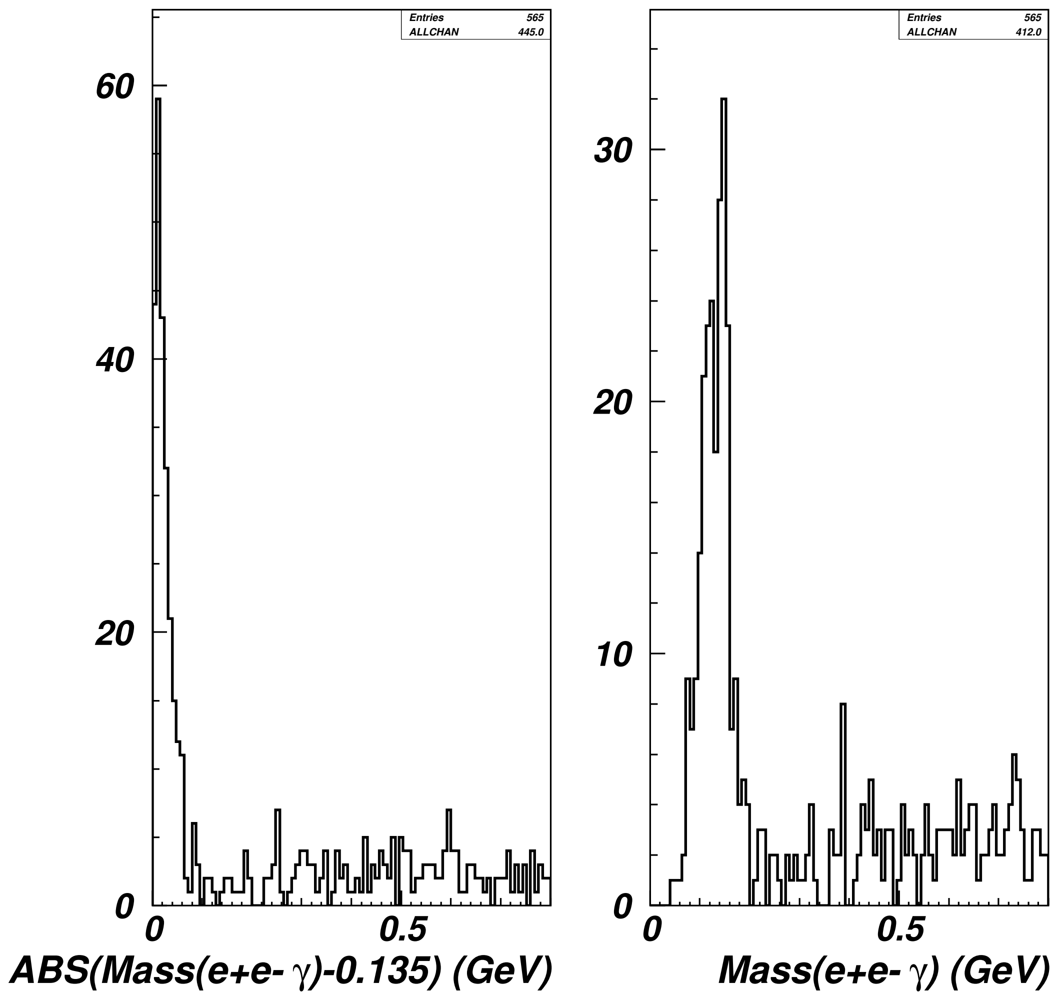
Background Study

❖ $E_{e^-e^+}$ distribution from multi-photon Background:



Background Study

- Background from π^0 dalitz decay and $\gamma\gamma$ decay::



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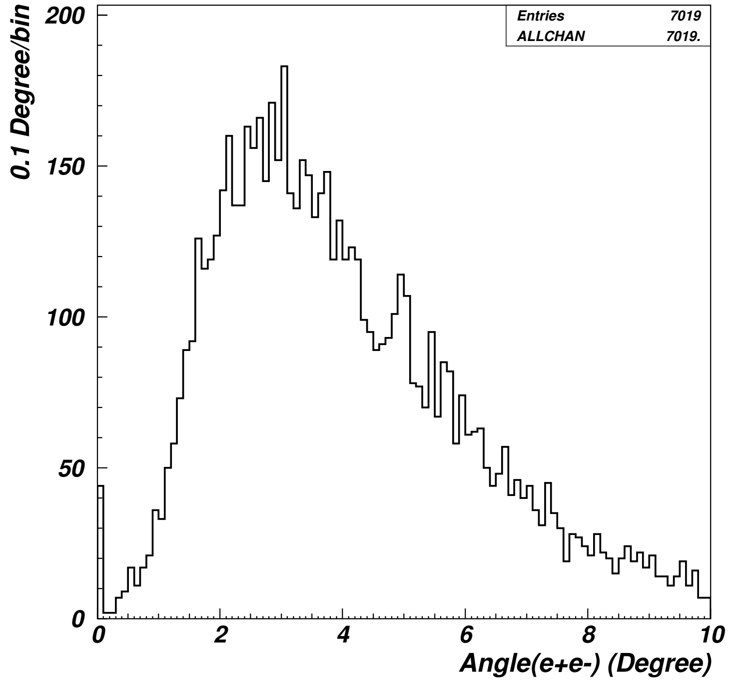
- π^0 rejection:
  $(M_{e^-e^+\gamma} - M_{\pi^0}) > 0.09$GeV;

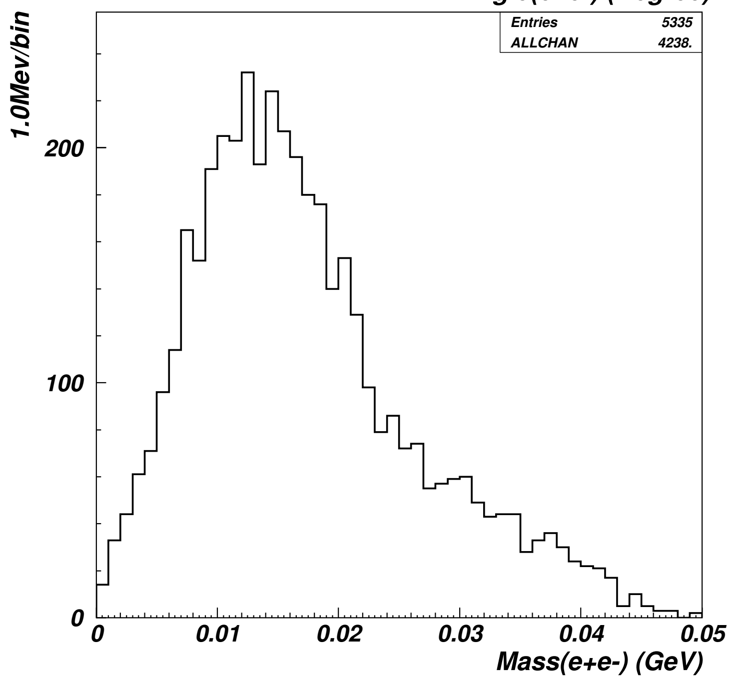
Event Criteria

- N_{chg} is great or equal than 2;
- Electron ID:
  $(PH_{DEDX} - 1270) < 300$
- At least one e^+e^- pairs;
- The angle between e^+e^- less than 3.8^o;
- The inv. mass of e^+e^- less that 50 MeV(the same cut as above one);
- The momentum of any electron or positron should be less than $\frac{E_{cm}}{2}$;
- $0.03 < D_{xy} < 0.4$ cm (the upper limit can be changed):
  D_{xy} is the distance between the second vertex and the interaction point at xy plane
- $CHSQ_{xy} < 50$ (the upper limit can be changed), χ^2 (1 dof) of xy alignment of parent momentum with line from interaction point to crossing point.
- π^0 rejection:
  $(M_{e^-e^+\gamma} - M_{\pi^0}) > 0.09$GeV;
- Energy loss correction;

BESII Real Data

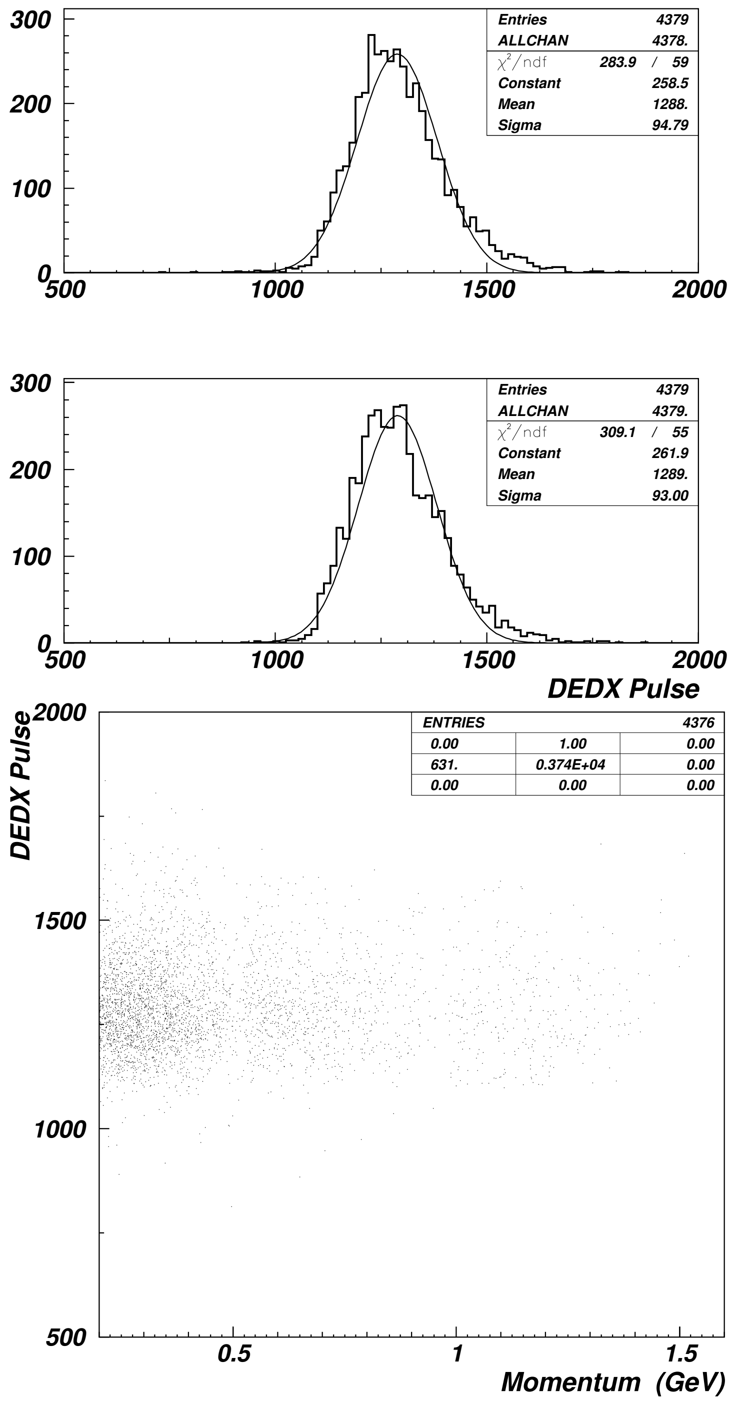
- The angle between e^+e^- (upper plot), and the Inv. mass of e^+e^-(lower plot) at BESII:





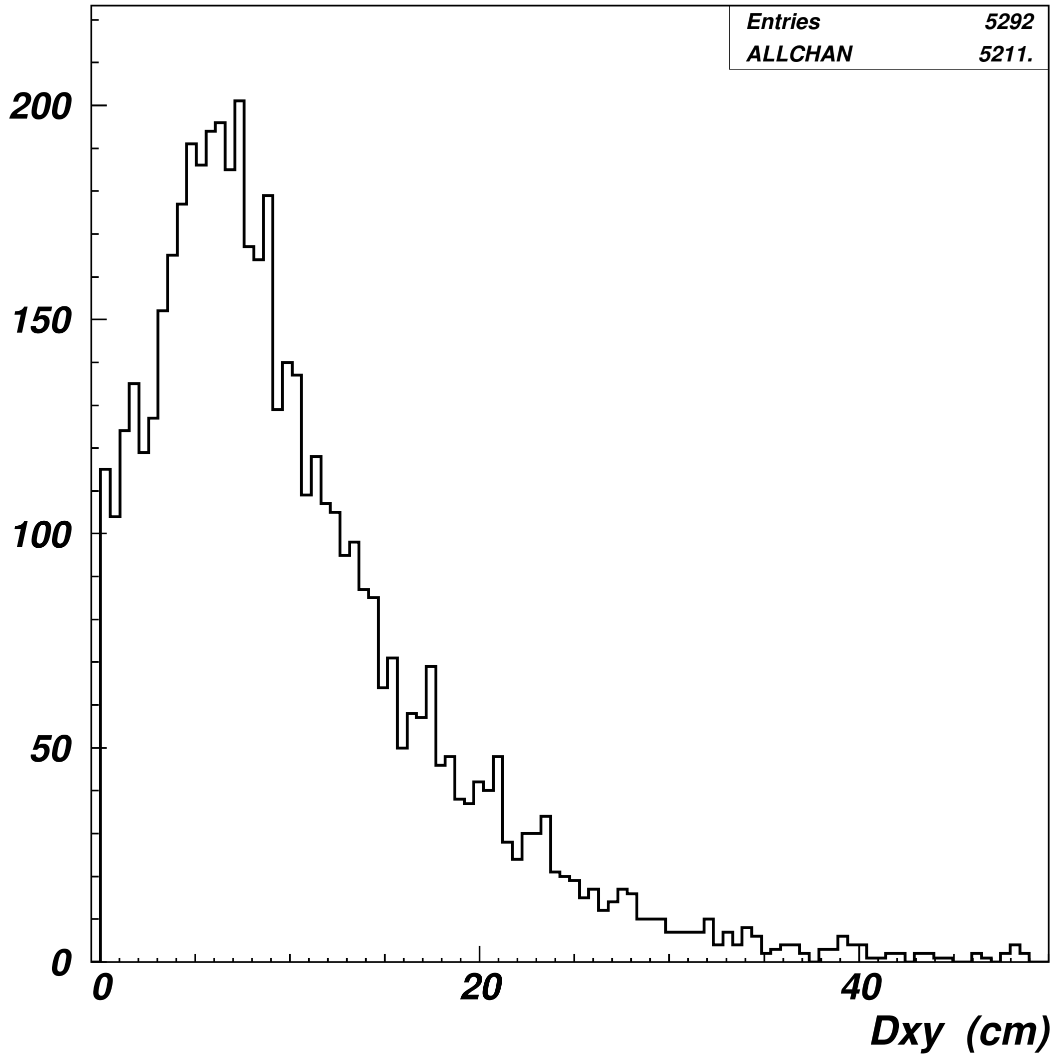
BESII Real Data

- Electron ID using DEDX information:



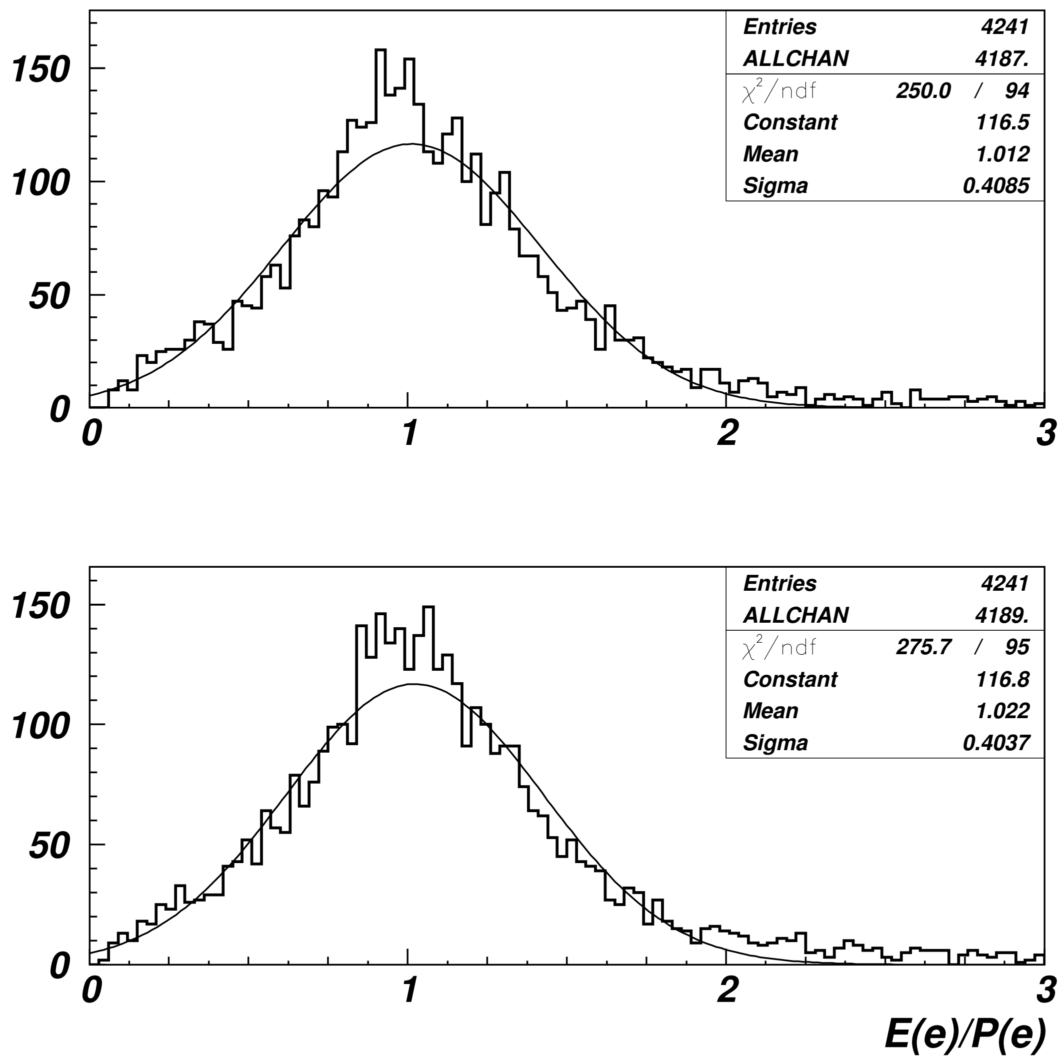
BESII Real Data

- The second vertex distribution D_{xy}:



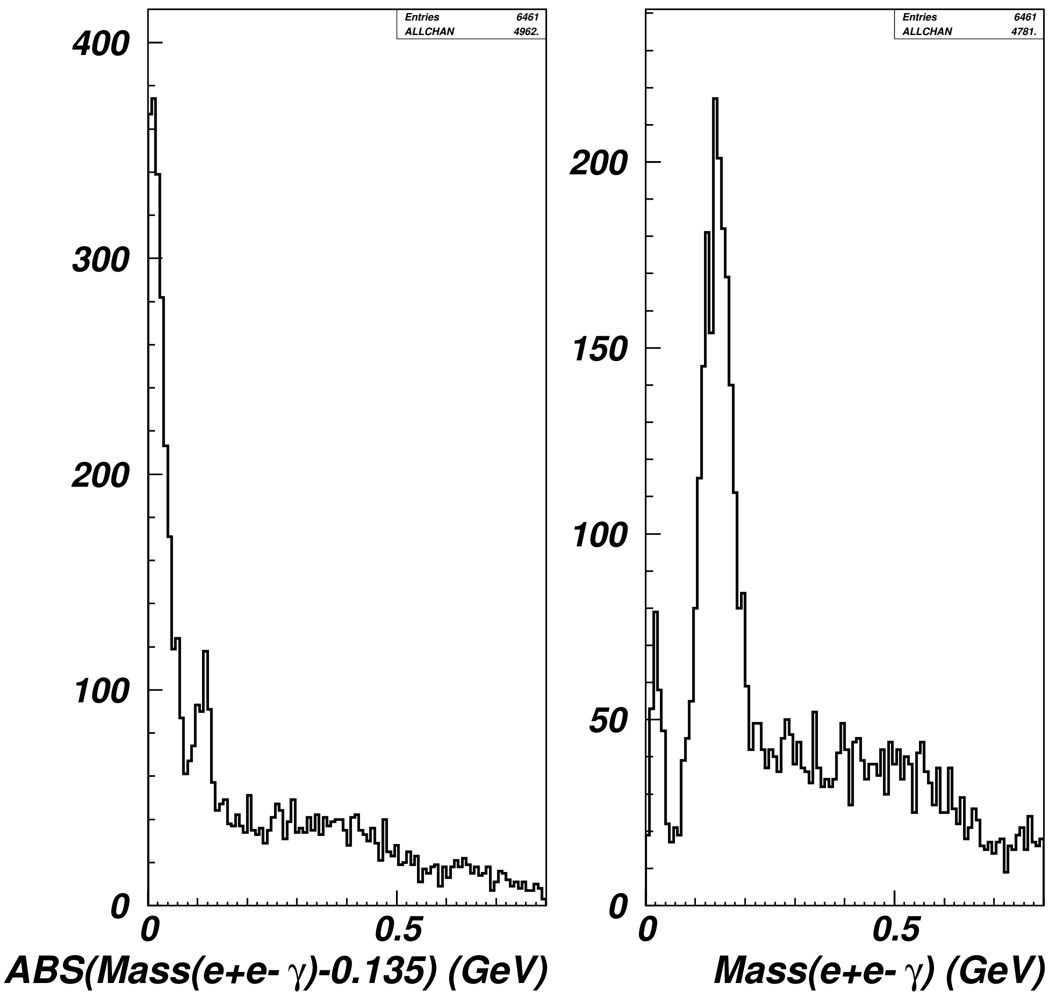
BESII Real Data

✥ Check of Electron ID using BSC:



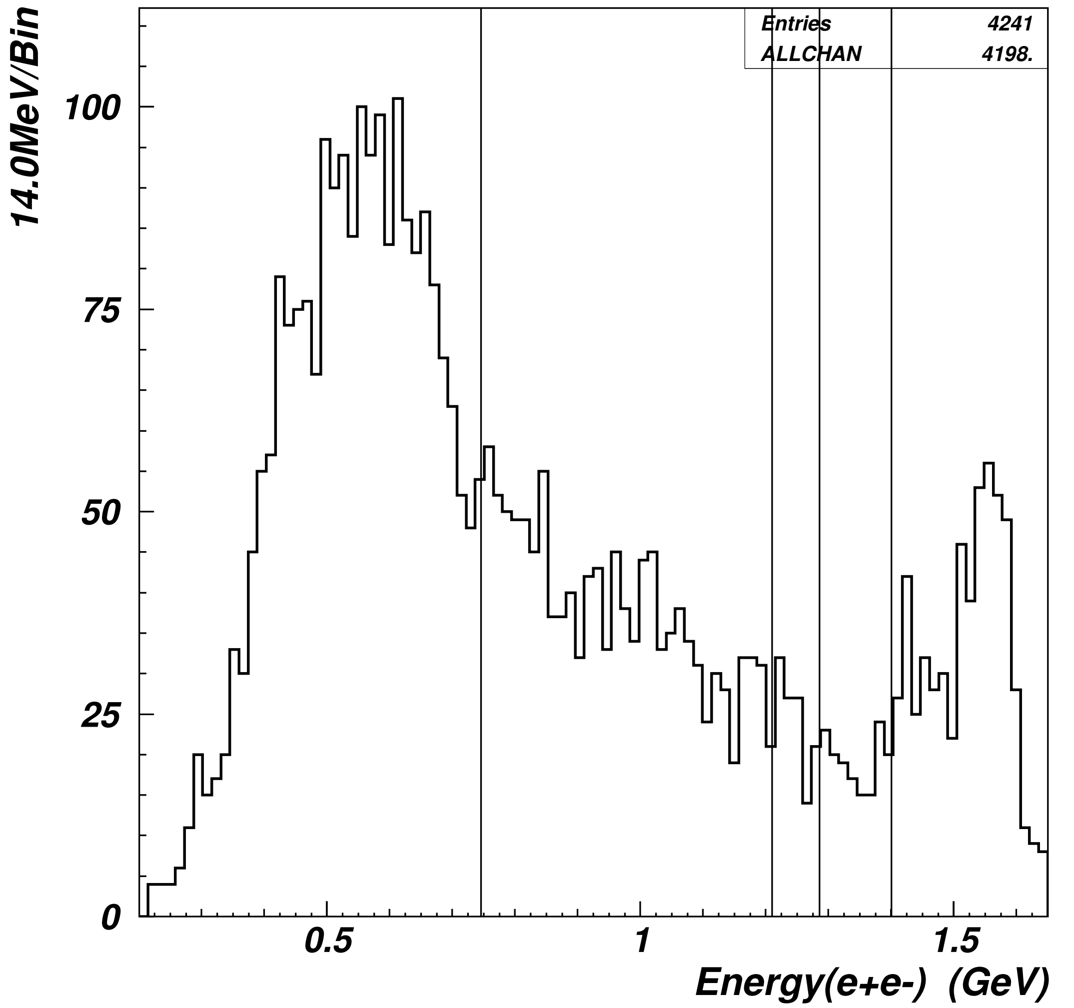
BESII Real Data

- π^0 rejection:



BESII Real Data

- $E_{e^+e^-}$ distribution:

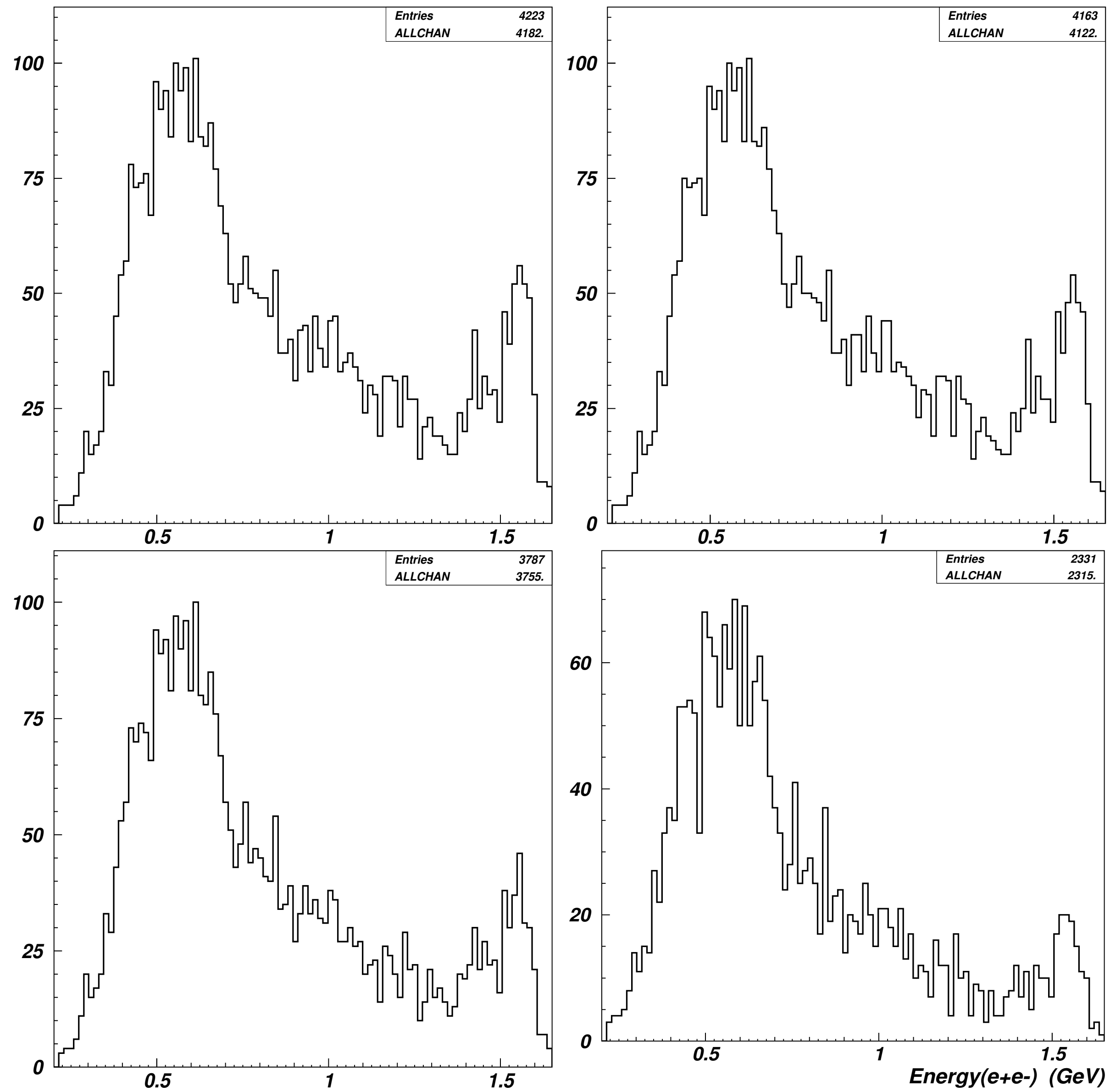


- Clear signals near $E_\gamma = 1.404$GeV, 1.28 GeV and 1.21 GeV are found corresponding to η, $f_2(1270)$ and $\eta(1440)$ respectively;

- A narrow signal appears near $E_\gamma = 0.745$GeV, which suggest a narrow resonance may exist near 2.230 GeV or a little below;

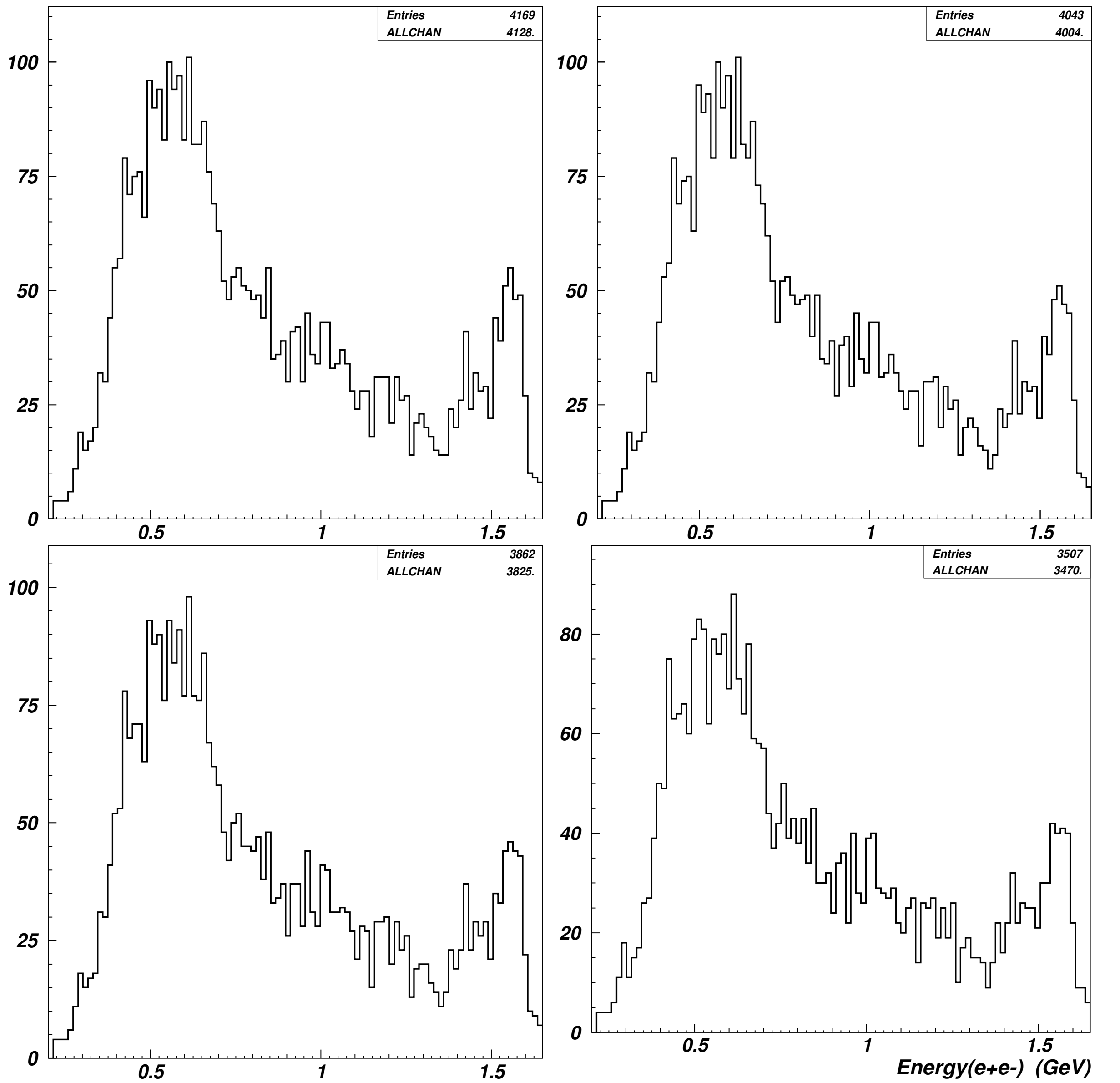
BESII Real Data

- Effect of changing D_{xy} cut: $D_{xy} < 40$, $D_{xy} < 30$, $D_{xy} < 20$, $D_{xy} < 10$ respectively;



BESII Real Data

- Effect of changing $CHSQ_{xy}$ cut: $CHSQ_{xy} < 50$, $CHSQ_{xy} < 40$, $CHSQ_{xy} < 30$,$CHSQ_{xy} < 20$ respectively:



Conclusions

- γ conversion have been studied at BESII;
- γ energy can be represented by that of e^+e^- system, and the energy resolution is improved largely;
- The radiative γ from $J/\psi \to \gamma X$ decay is studied using this method;
- Clear signals near $E_\gamma = 1.404$GeV, 1.28 GeV and 1.21 GeV are found corresponding to η, $f_2(1270)$ and $\eta(1440)$ respectively;
- A narrow signal appears near $E_\gamma = 0.745$GeV, which suggest a narrow resonance may exist near 2.230 GeV or a little below;
- We expect a larger J/ψ sample is collected and see more clear signal.
- This method can prove the existance of $X(2230)$, especially a narrow resonance;
- We expect a BCAL can be setup as soon as possible, it can solve all problem, and produce rich physics results.