Simulation Updates

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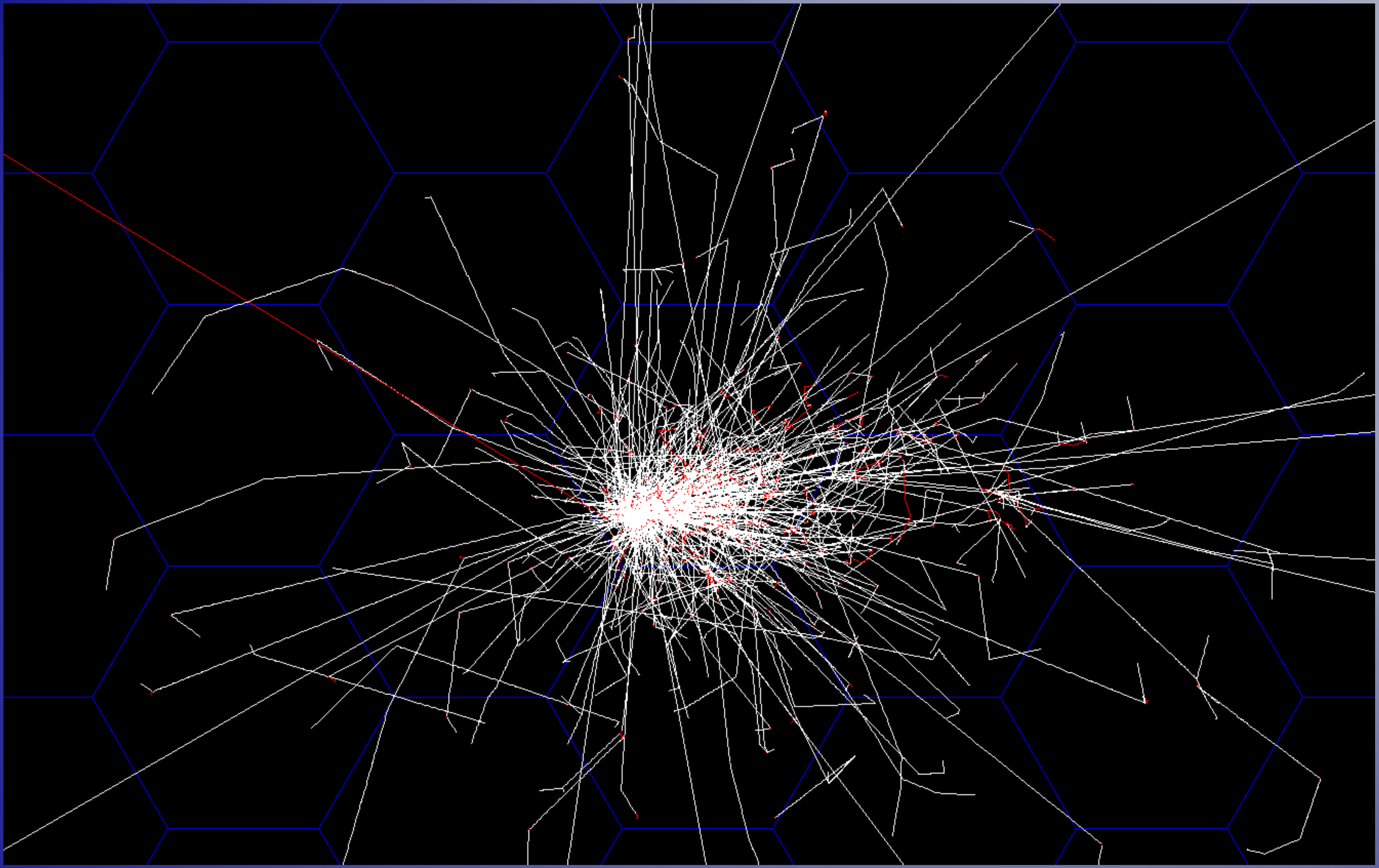
Simulation setup with hexagon calorimeter modules



Hexagon Calorimeter Simulation

- Side size = 6.25 cm, default layering

  3GeV electron shower

  On hexagon calorimeter grid

  Orthographic projection along z axis

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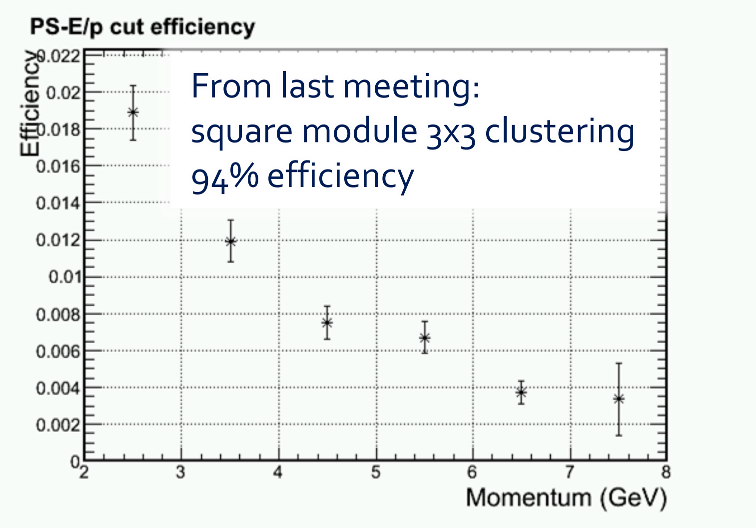
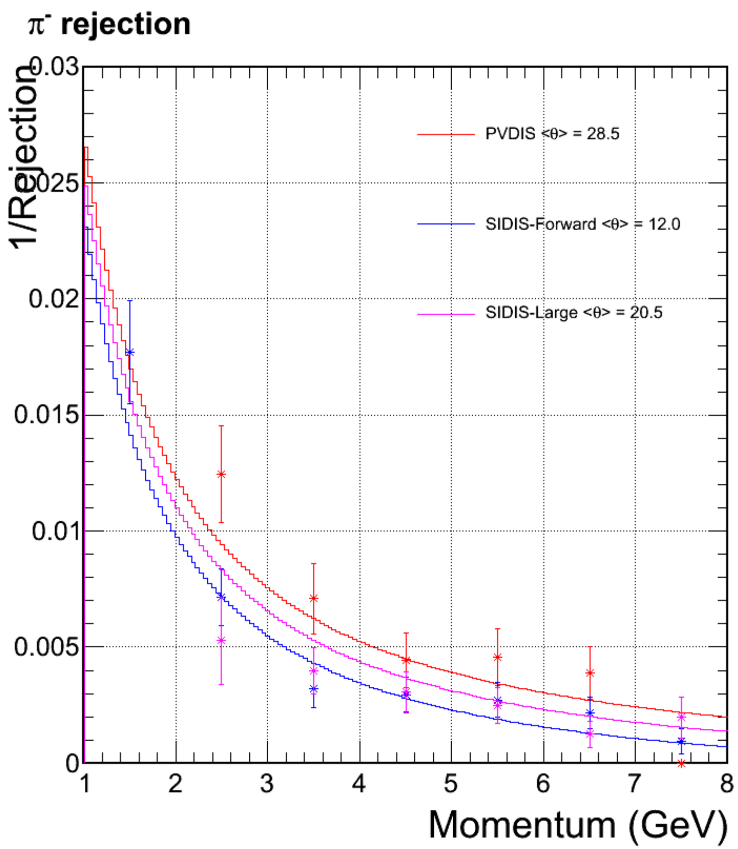
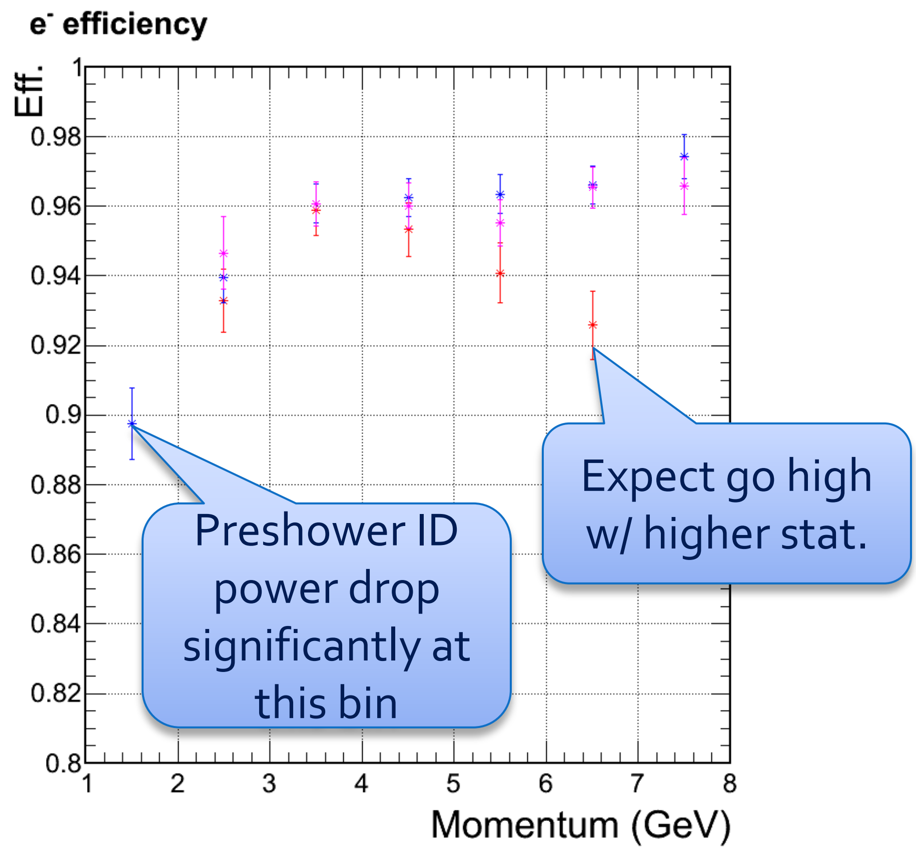
All rejection/efficiency reviewed with hexagon-shape calorimeter modules

- No background yet assumed at this step



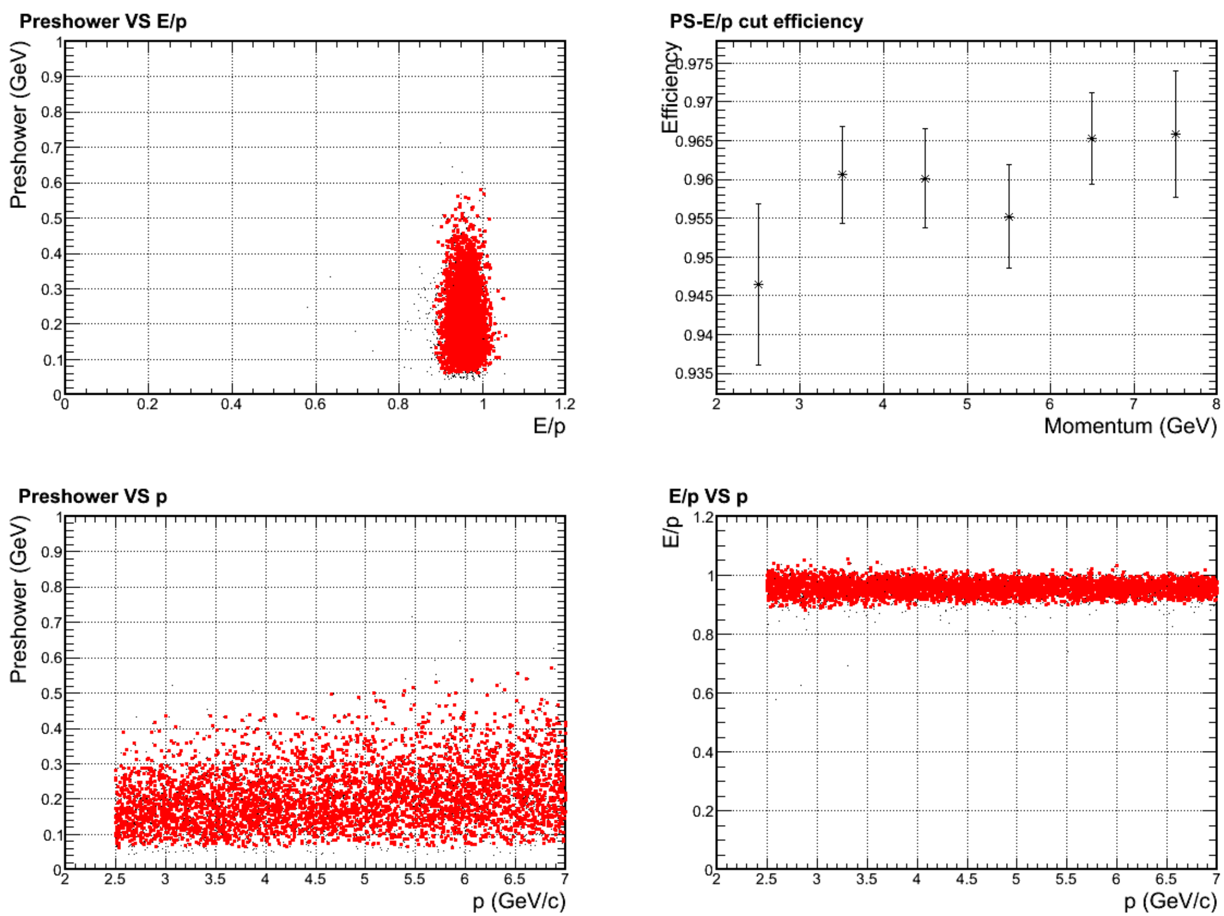




Back up 1/2 for previous slides

Electron eff. for SIDIS large angle calorimeter

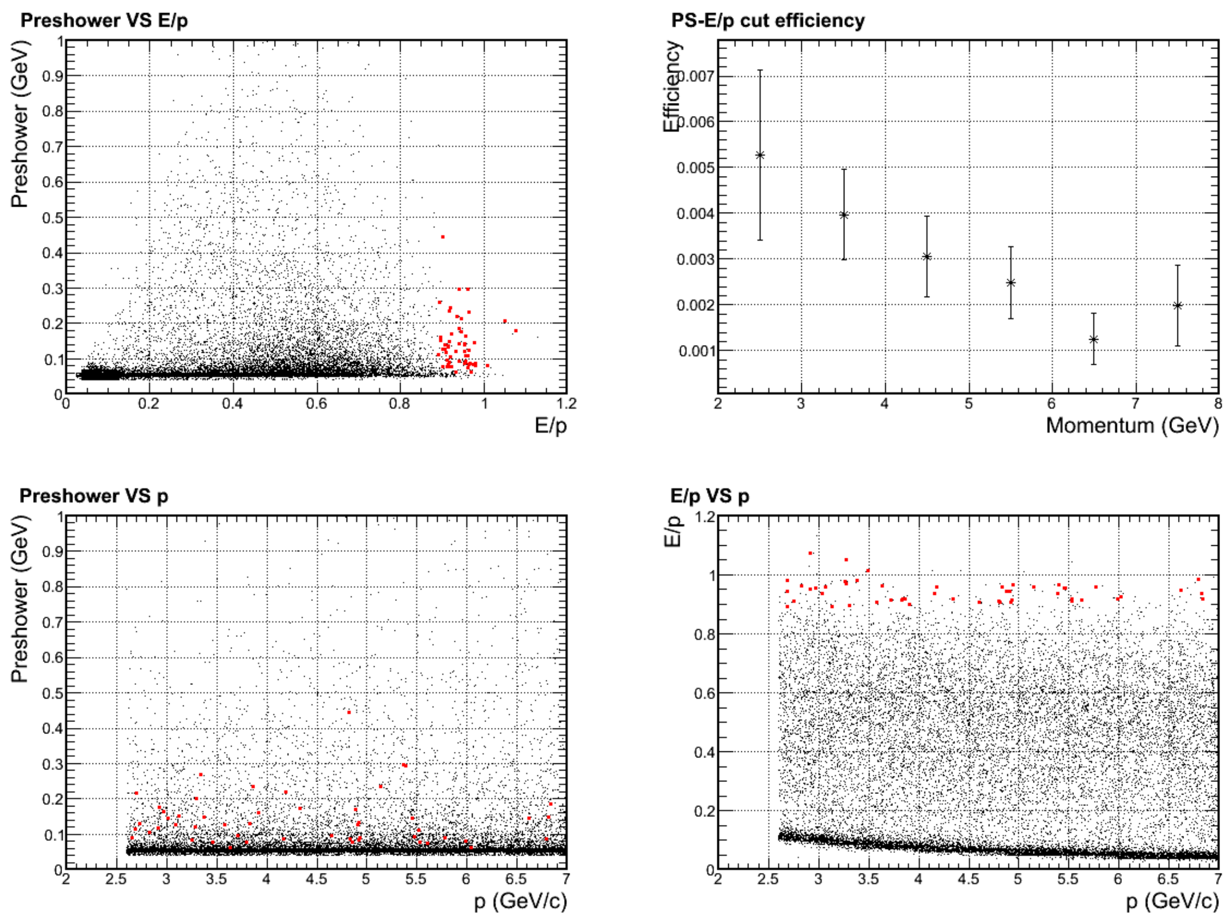
- All events
- Accepted events w/ 3D cut



Back up 2/2 for previous slides

Pion eff. for SIDIS large angle calorimeter

- All events
- Accepted events w/ 3D cut



Review of Background Simulation

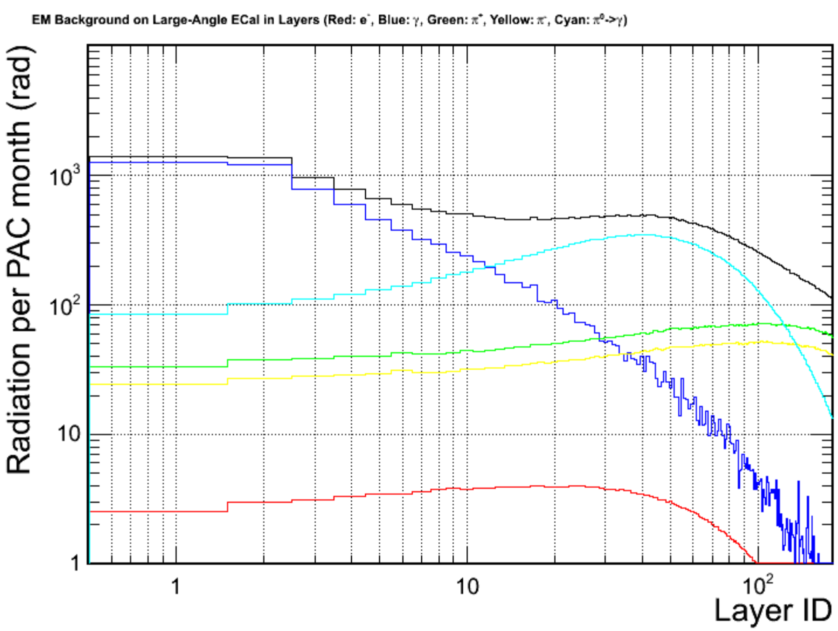
Calorimeter background simulation

1. Simulate background at front surface of calorimeter (Zhiwen)
2. Simulate calorimeter response to a wide range of background particle
3. Combine above two sum over all contributions (EM, DIS, pio, pi+,pi-) -> background distribution
4. Imbed into the signal simulation (high energy e, pi), assuming a 50ns coincidental window

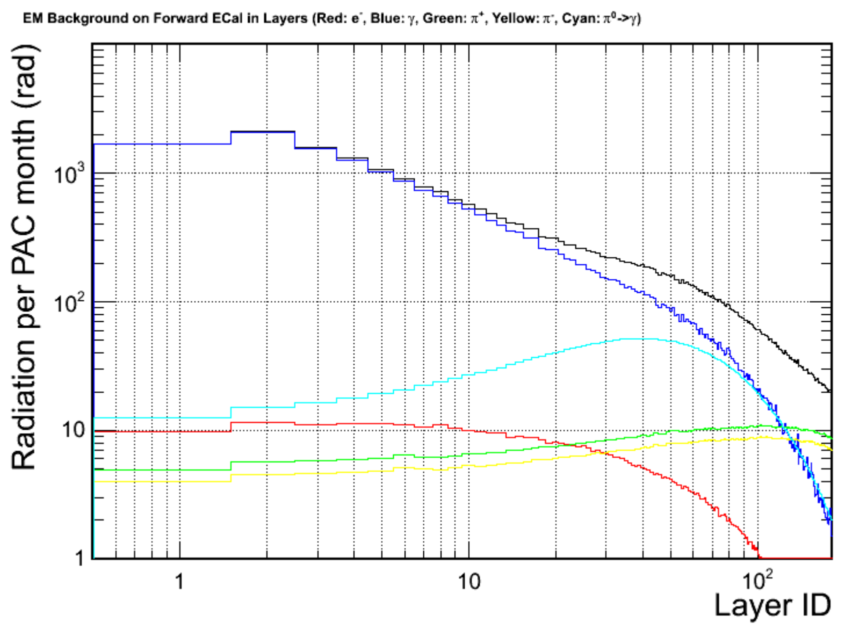
Radiation dose prediction remain stable

- Dose is not a problem for SIDIS configuration
- Still missing final PVDIS radiation dose, need final baffle w/o direct line of sight!

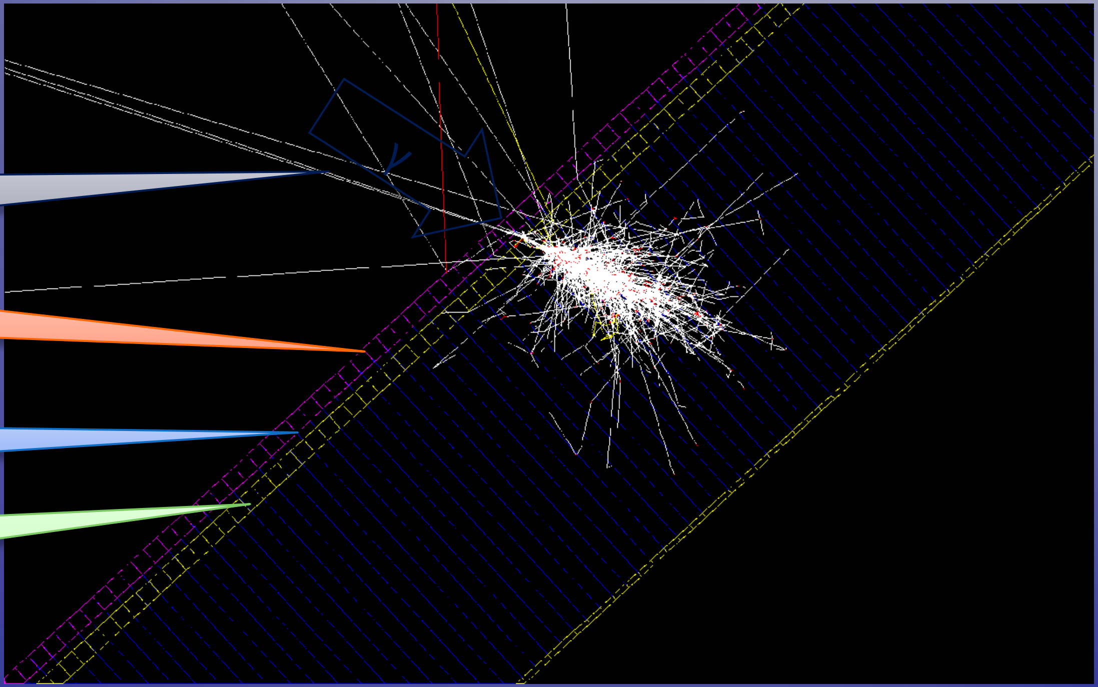
SIDIS – He3– Large Angle Calorimeter



SIDIS – He3– Forward Calorimeter



Geant4 Simulating scintillator before preshower



Lots of back scattering!

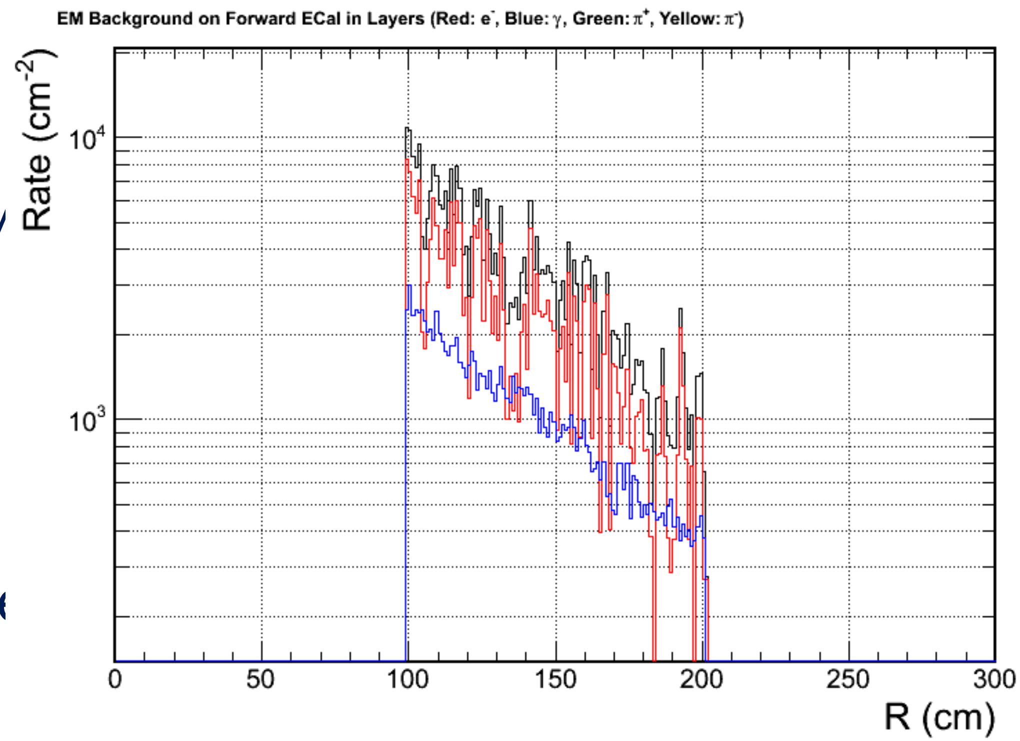
Scintillator Thickness = 5 mm

Preshower Pb

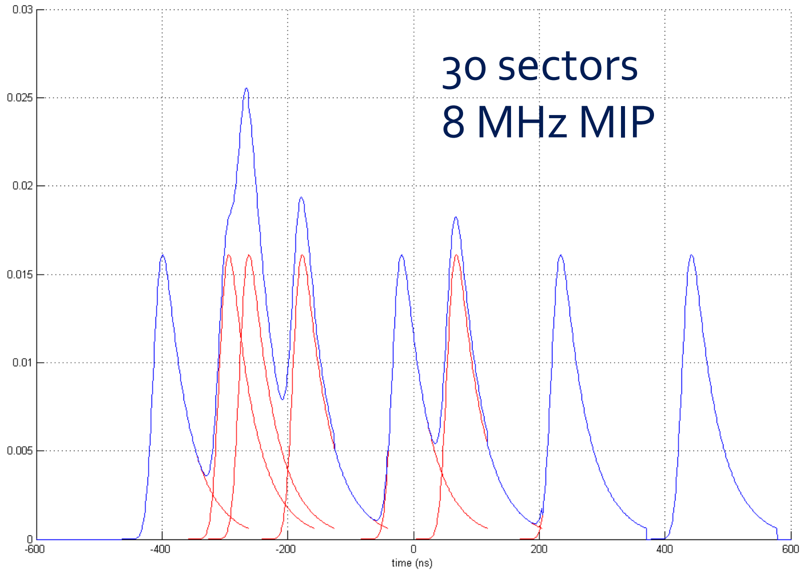
Preshower Scint

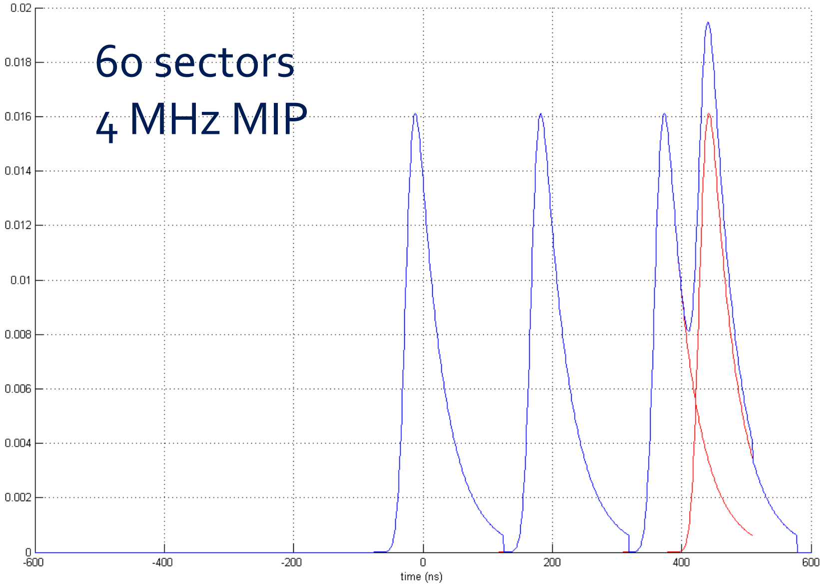
Main concern is back ground rate in open geometry

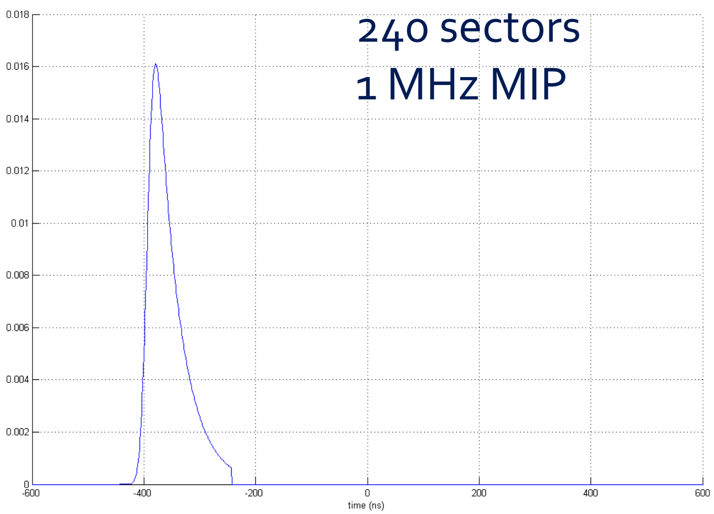
- Dominated by low energy electrons
- Source of low energy electrons
  - 20% from end cap of heavy gas Cerenkov, other from more upstream
  - Have to be placed before MPRC, which have lots of material for conversion!
- Rate: if 120 segment take 2MeV MIP per segment



How signal looks like

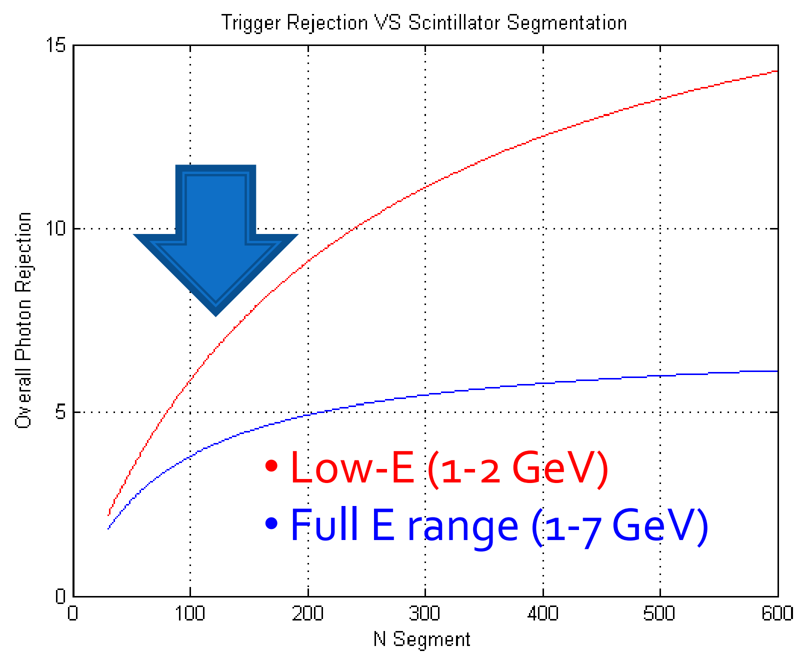






Optimizing the segment

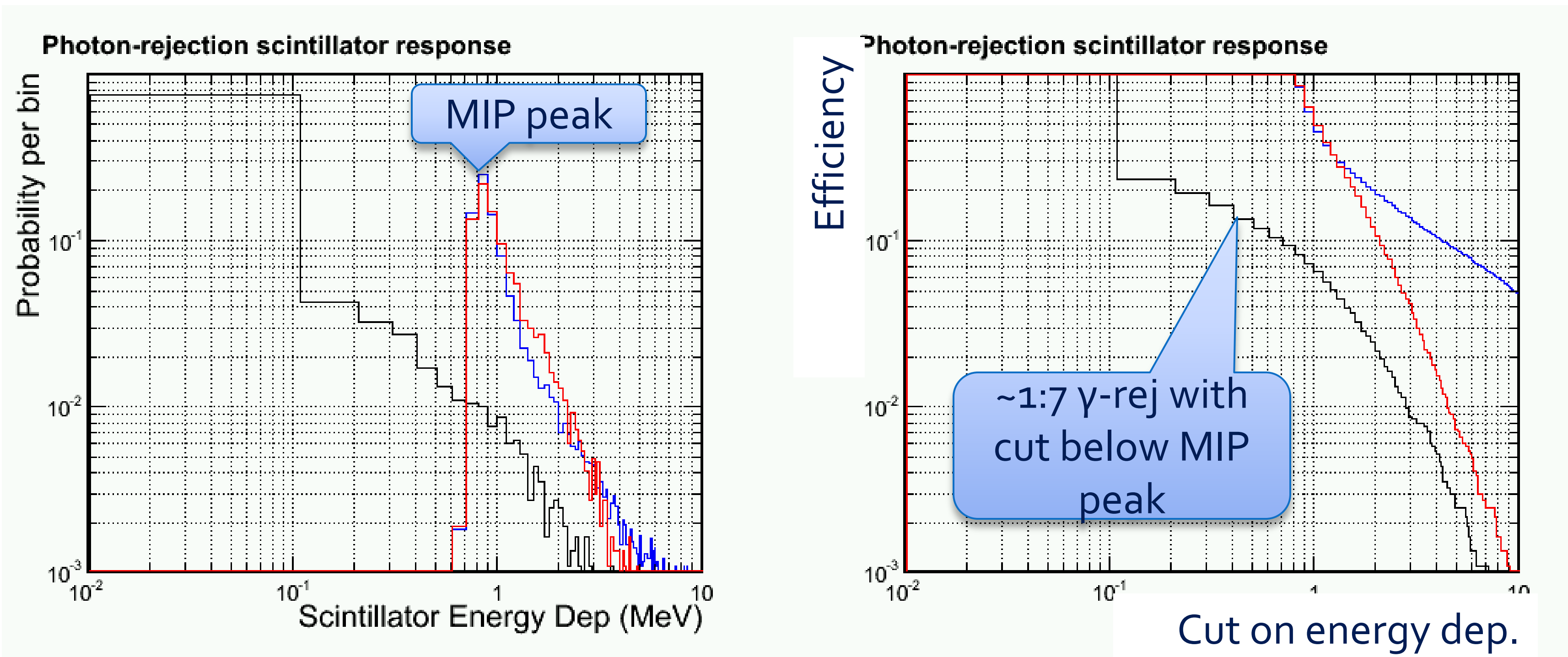
- Lower energy photon (1-2 GeV) are dominant, which we have higher rejection
- Trigger require 5:1 rejection. Satisfied with margin at a 120 segments
- A 50ns coincidental window with calorimeter assumed. Expect improvement in FPGA level



Backup - Simulated efficiency & rejection

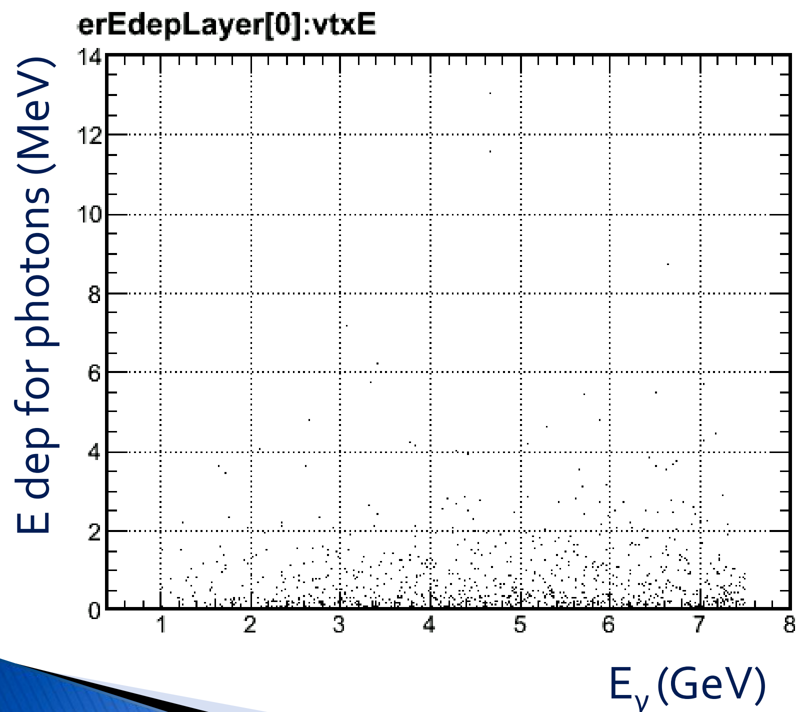
- Electron
- Pion
- Photon

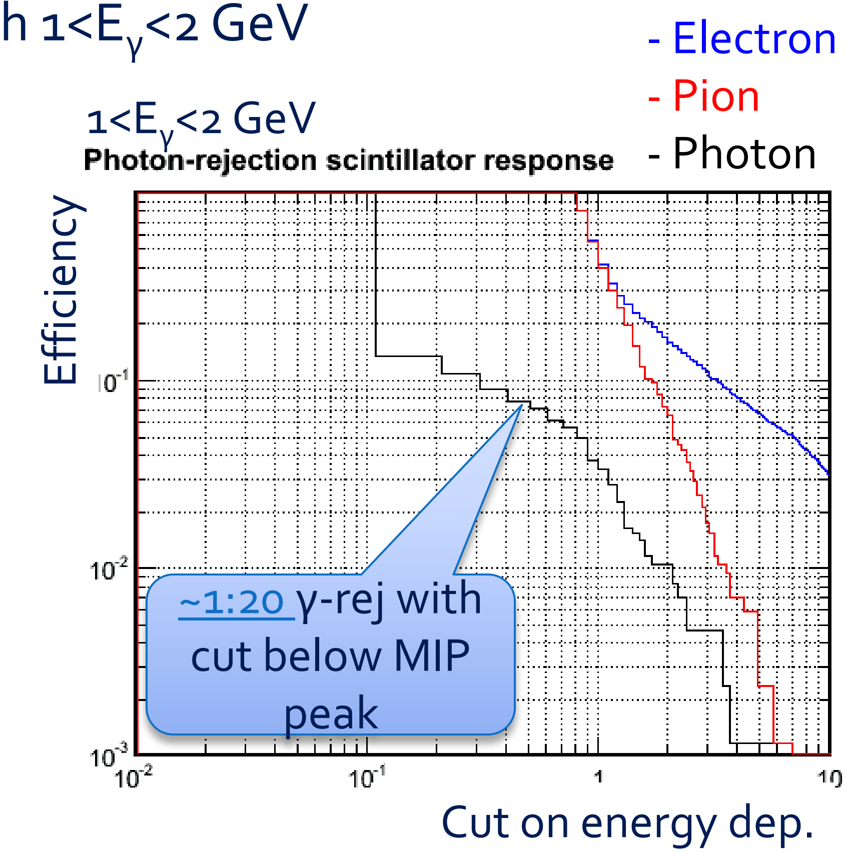
Energy range: 1-7 GeV, flat phase space for SIDIS-forward



Backup - Simulated efficiency & rejection

- Most photon focus on lower energy side (π_o decay)
- And lower energy photon produce less back scattering
- Therefore, do the study again with $1<E_\gamma<2$ GeV

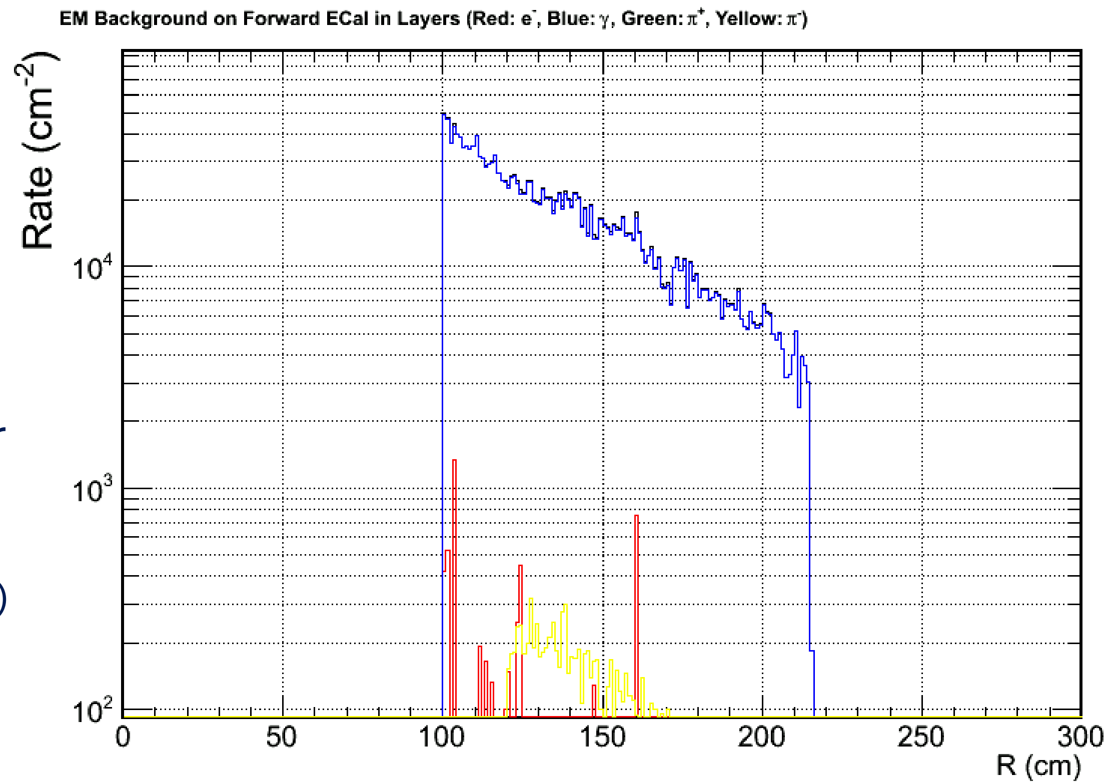




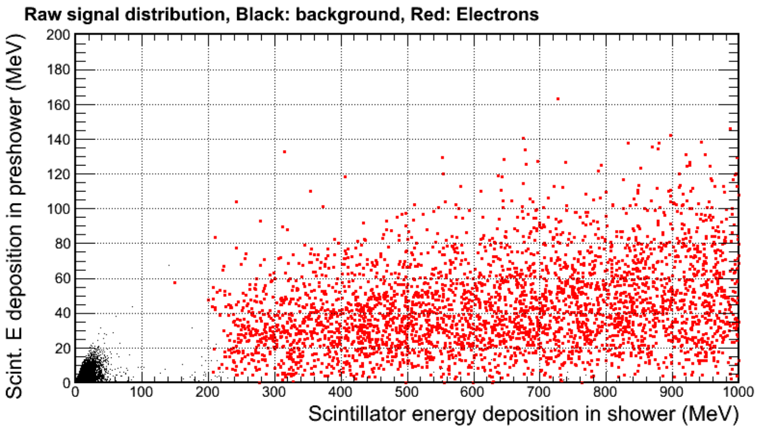
Full background simulation For SIDIS Forward Calorimeter

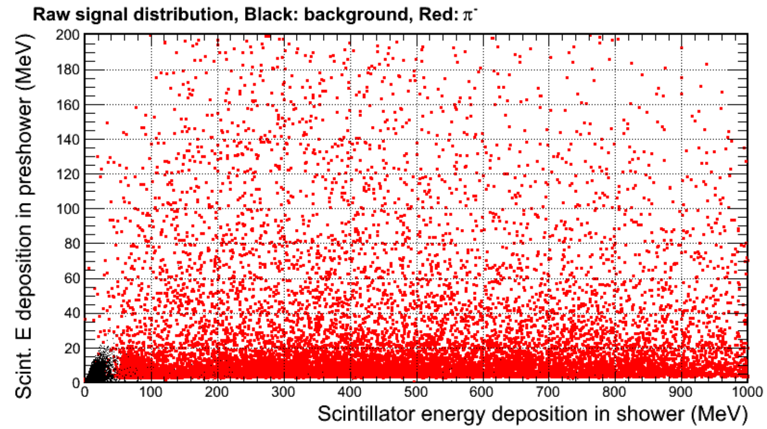
SIDIS forward background

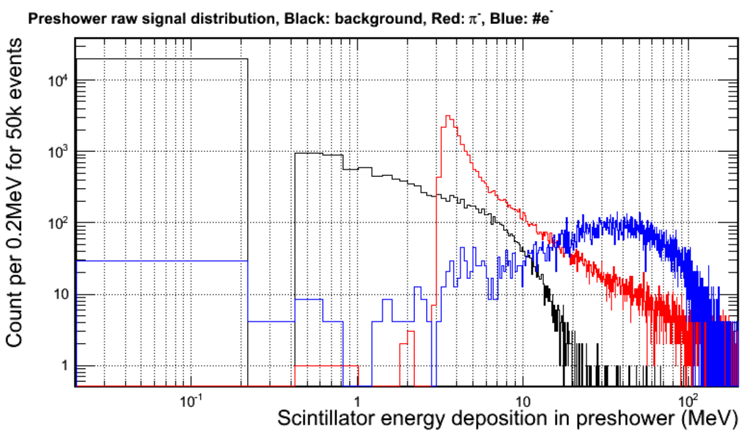
- We have good “shielding” with 2Xo preshower, save us from 1GHz/cm2 photon background
- Dominated background: low energy photon 1-100 MeV, which lead to 10kHz/cm² MIP signal on preshower
- The background on shower is small
- Used in this study:
  - Most inner side (highest rate)
  - 100 cm² segmented preshower
  - For outer radius, rate is 10x lower, cause segmentation can be used

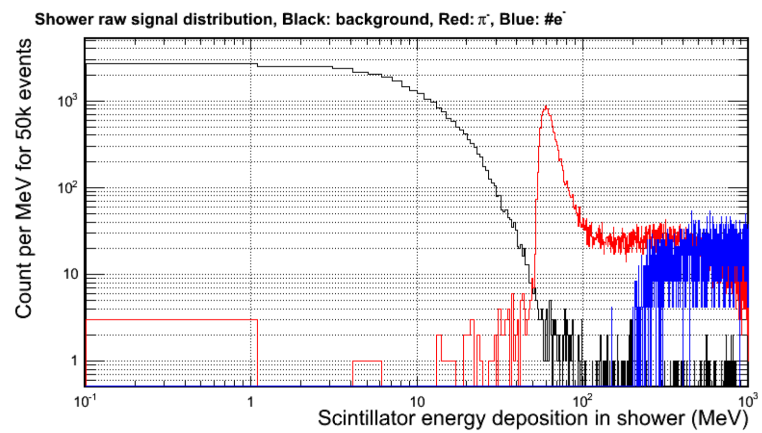


Compare background to signal

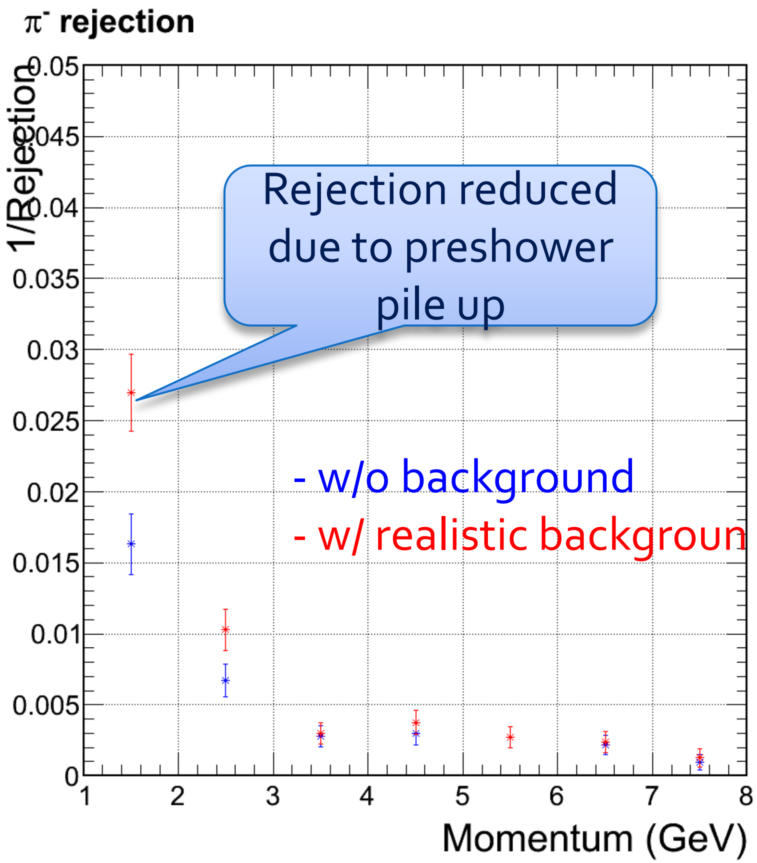


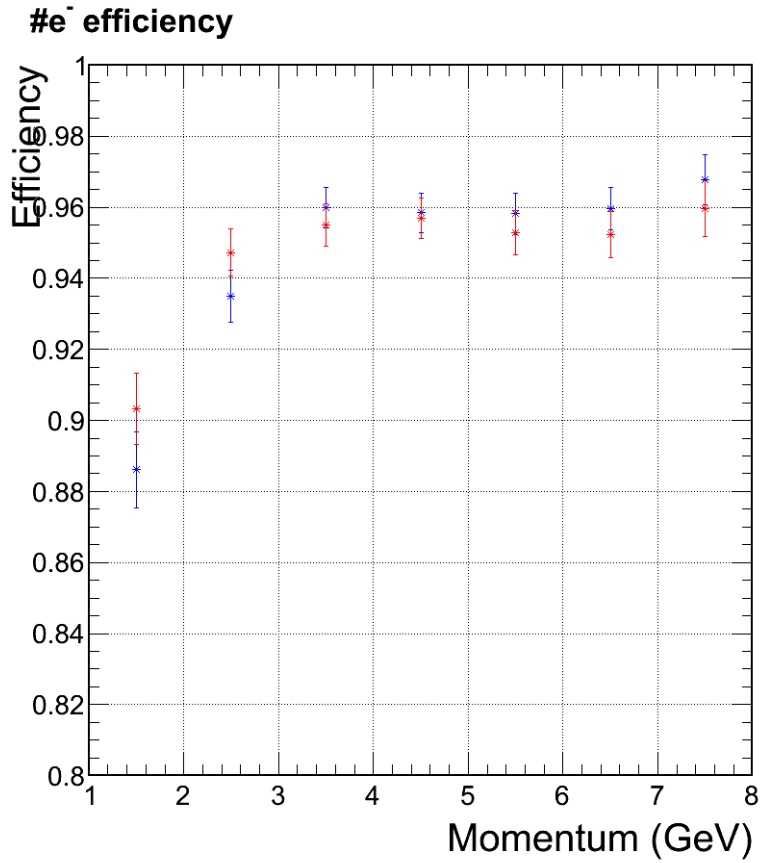


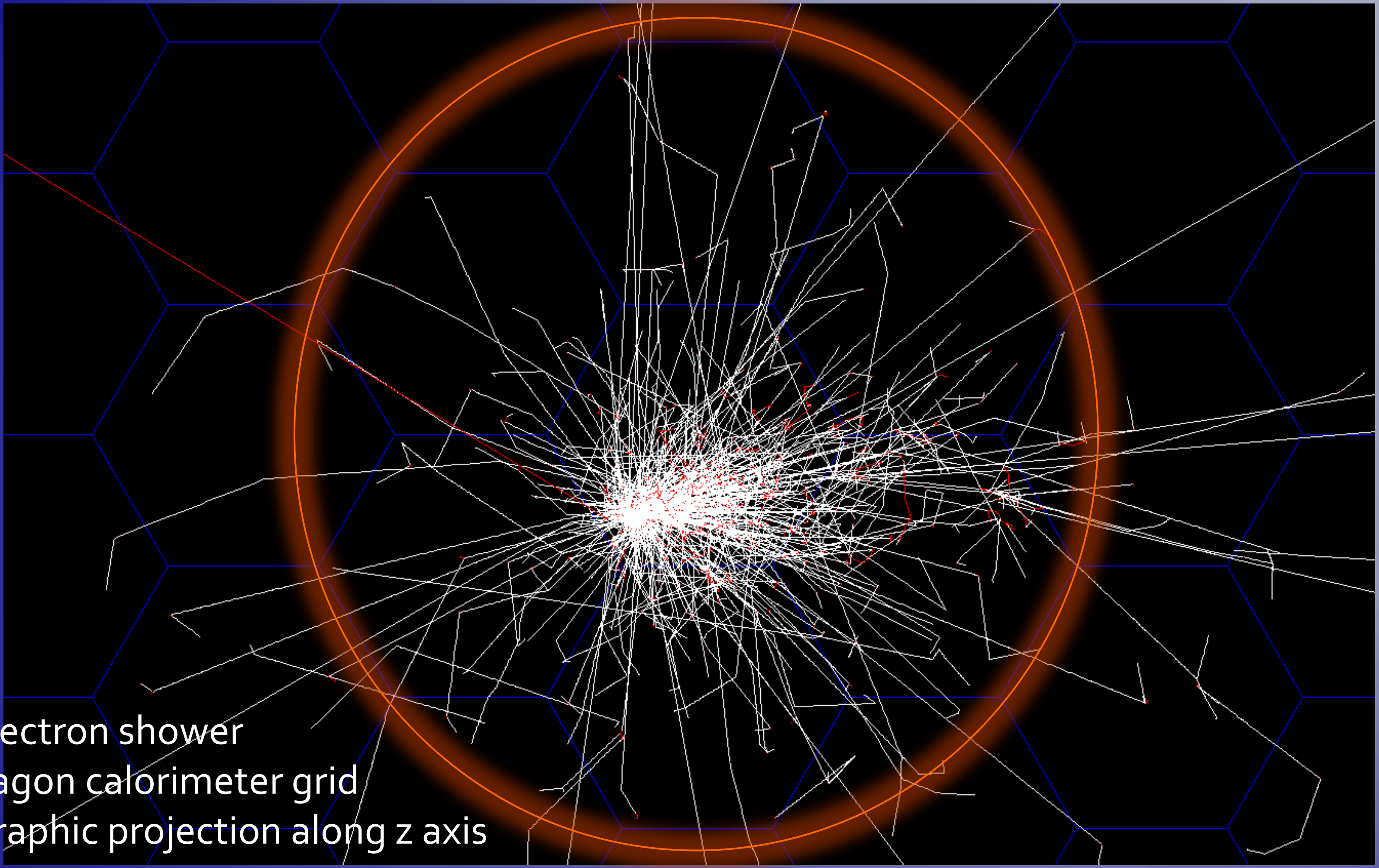




Offline: No change in eff., reduce rejection at low-p end







3GeV electron shower
On hexagon calorimeter grid
Orthographic projection along z axis

Hexagon Calorimeter Trigger

- Hexagon Provide nice shower area cuts – can be used in both online and 1st-order offline analysis
  - clustering – contains ~96% of shower energy
  - FPGA-based pattern trigger (HEX 1+6 trigger)

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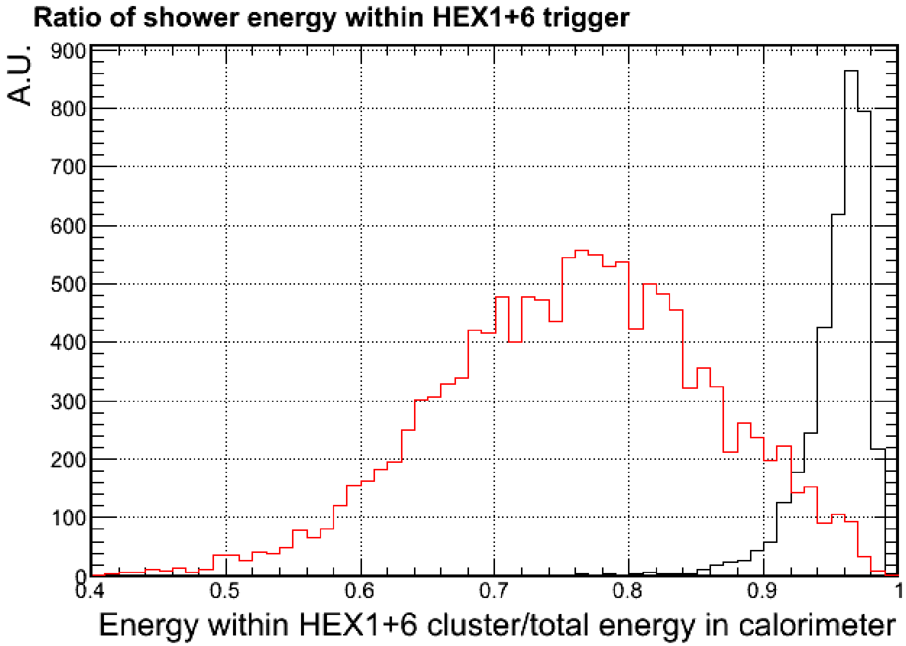
Online: Trigger with background

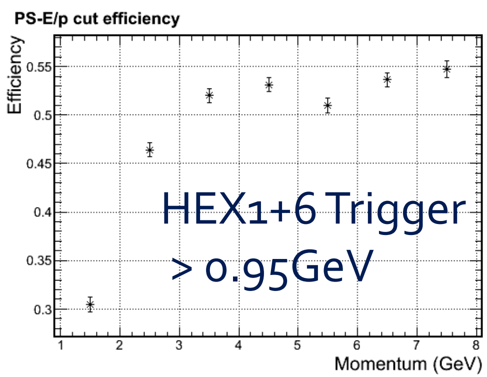
- Hadronic shower which introduce a pion contamination, usually spread into larger area
- A localized trigger, e.g. HEX1+6 trigger and significantly suppress the hadron response, while maintaining high eff. for electrons

- Ratio of EM shower contained
- Ratio of Pion shower contained

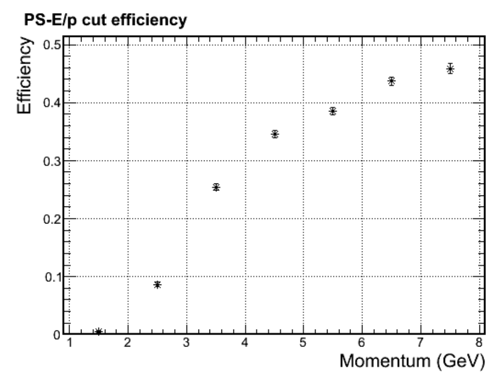


If only trigger on total EM energy

- Do receive very high electron efficiency in simulation
- However, for SoLID, wide momentum range is used.
  - Therefore to accept lowest momentum electrons, the shower cut have to be low.
  - the rejection for high momentum pion **will be very limited**
- Simulated with full background . The pion response is shown below:



HEX1+6 Trigger
> 0.95GeV



HEX1+6 Trigger
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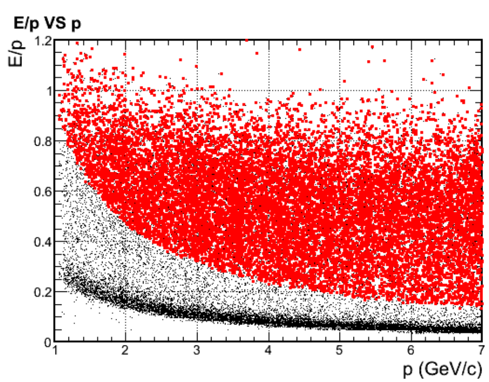
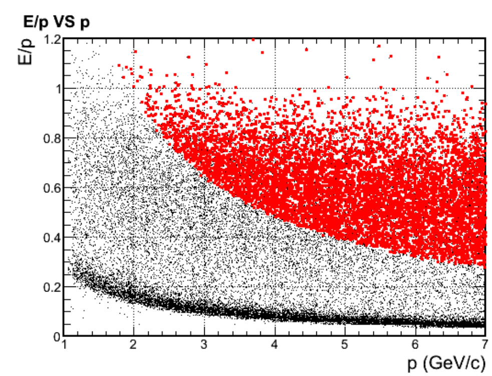


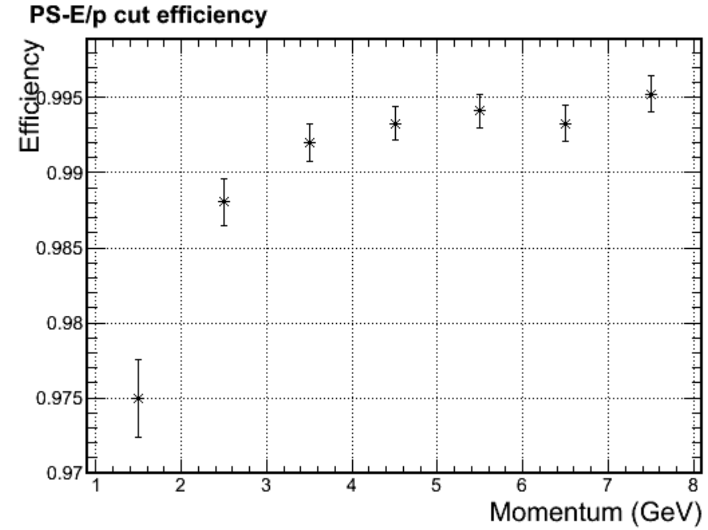


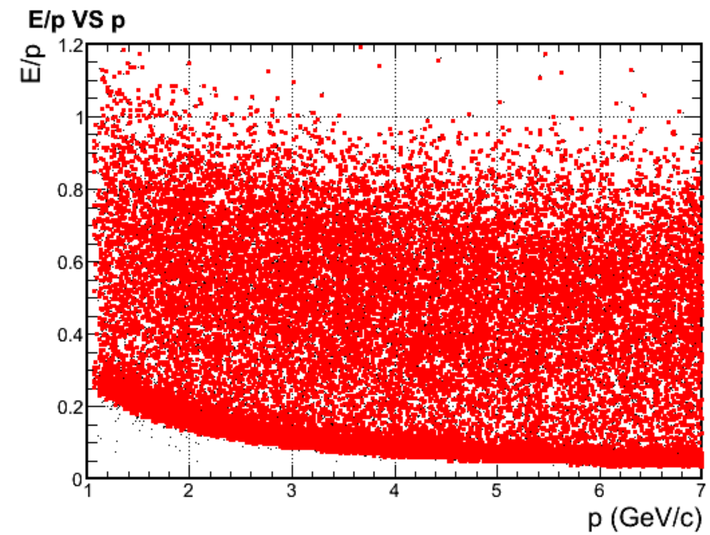
* Accepted
* All

Charged Particle (Pion) trigger efficiency

- Full background simulation for pion efficiency shown on the right.
- Trigger cut is HEX1+6 trigger raw signal is larger than 85% MIP (which is MIP – 2σ = 220MeV calibrated)
- The background which pass this cut
  - rate ~20Mhz
  - is dominated by photon.
  - With an additional 1/5 suppression from scintillator, we get ~4MHz trigger rate, which fit in the DAQ limit (PR12-10-006)

Pion trigger response
* Accepted
* All





Backup

Background simulation

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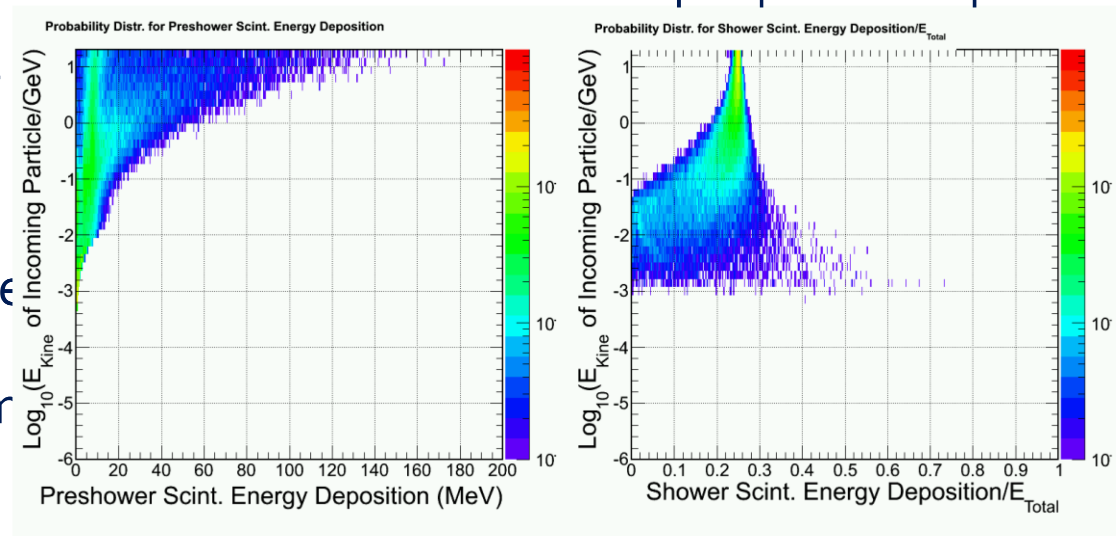
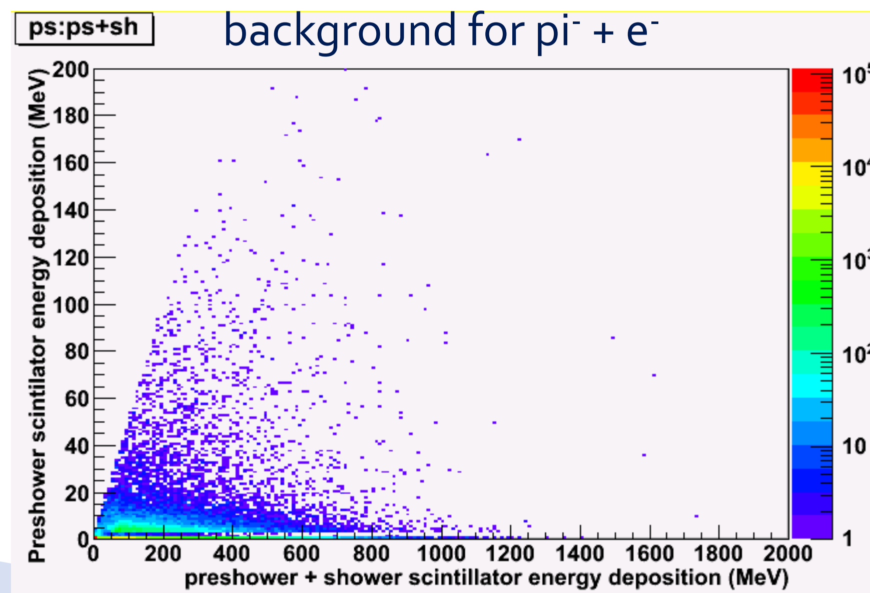
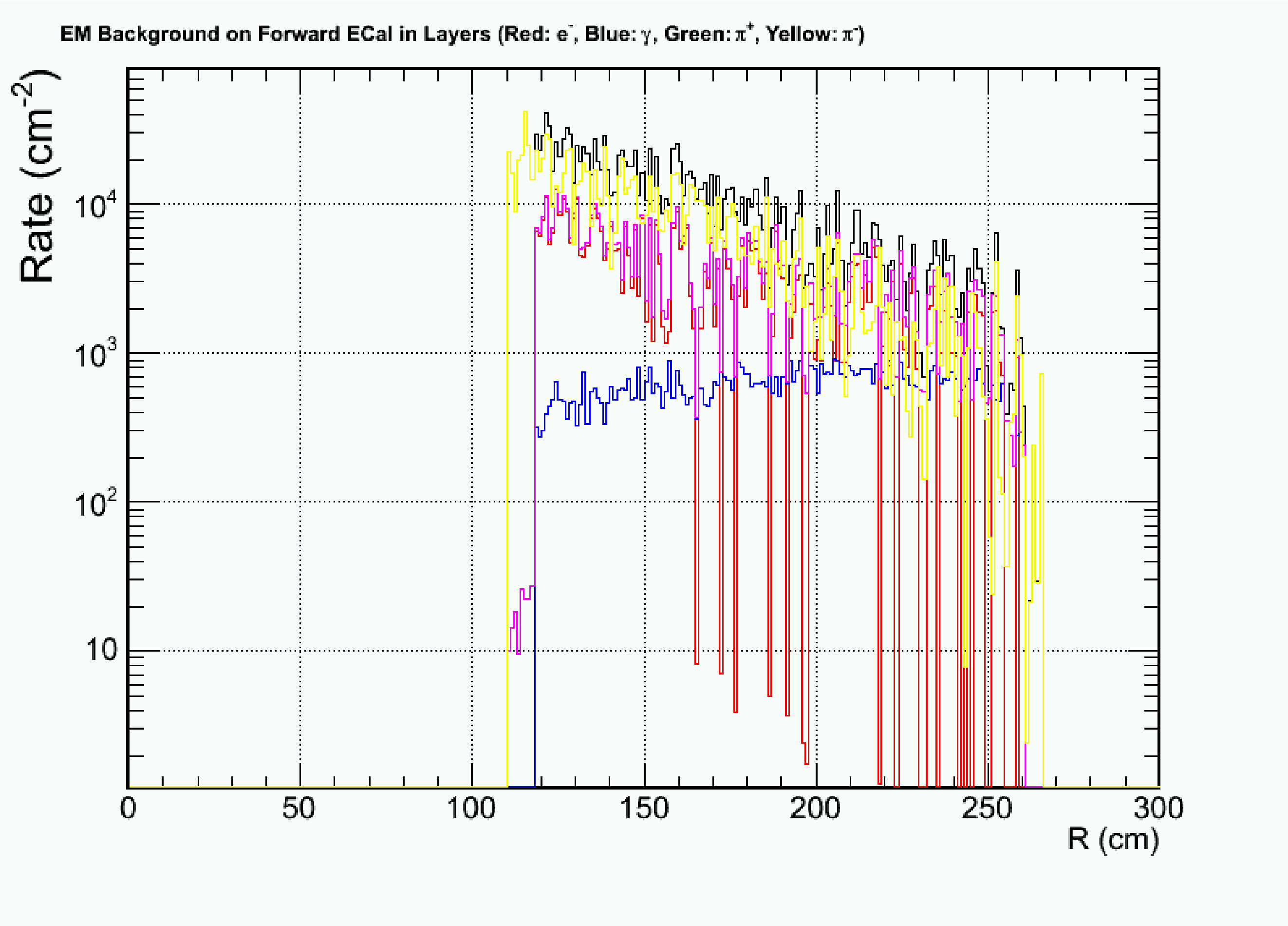
Example: photon response





For PVDIS , MIP rate distribution Dominated by pion and electrons



The result is still under check

- Simulated 1+6 shower cluster + $(10cm)^2$ preshower for pion + electron bgd (do we still have direct photon sight on baffle?)
- It did lead to significant change in pion rejection due to pile ups