Simulation Updates on PVDIS EC

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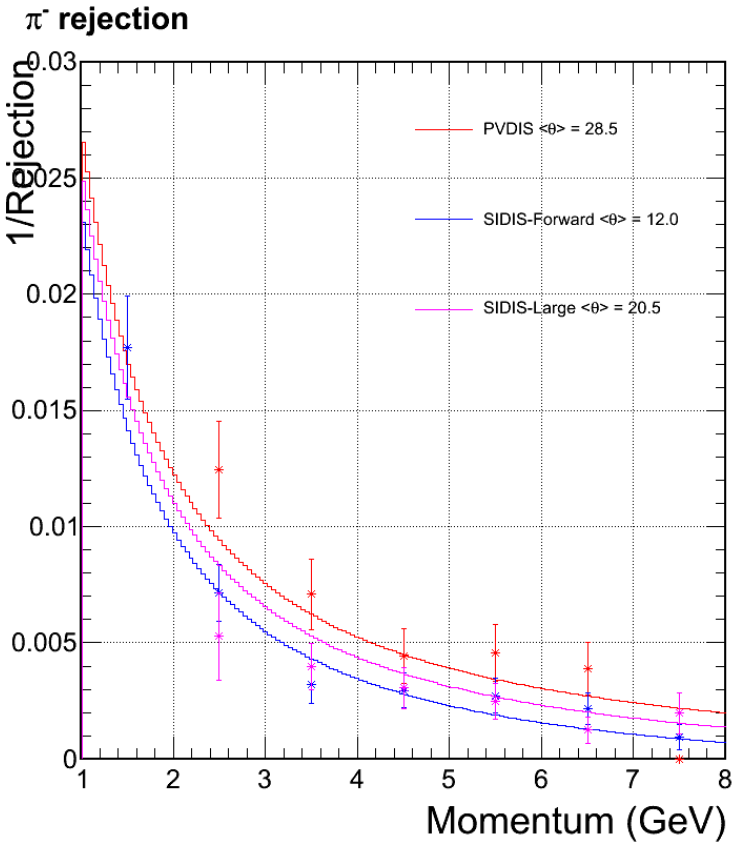
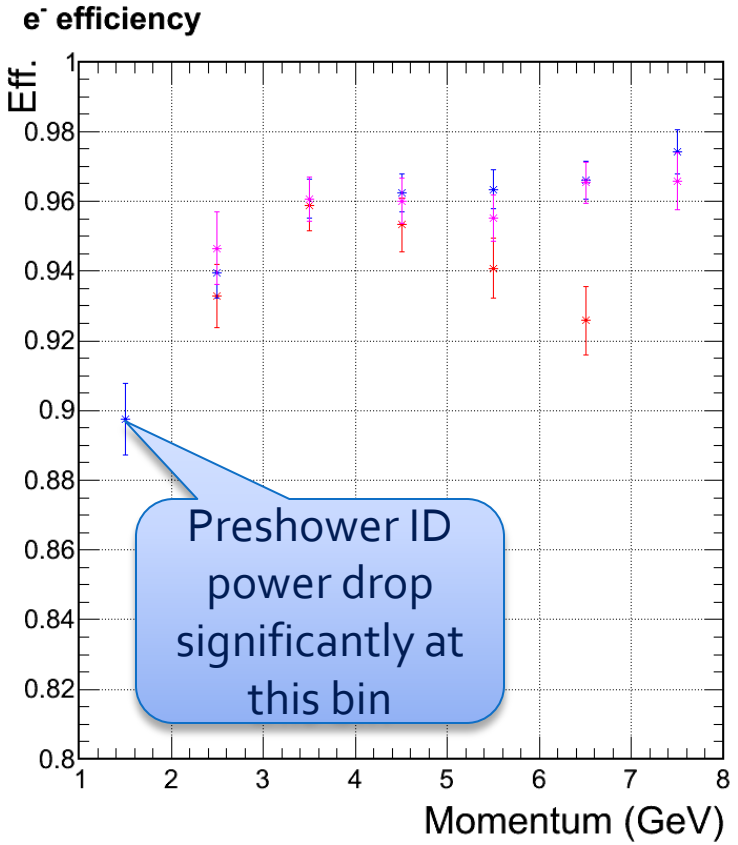
Jefferson Lab

EC performance w/o background

- Cited from March collaboration Meeting



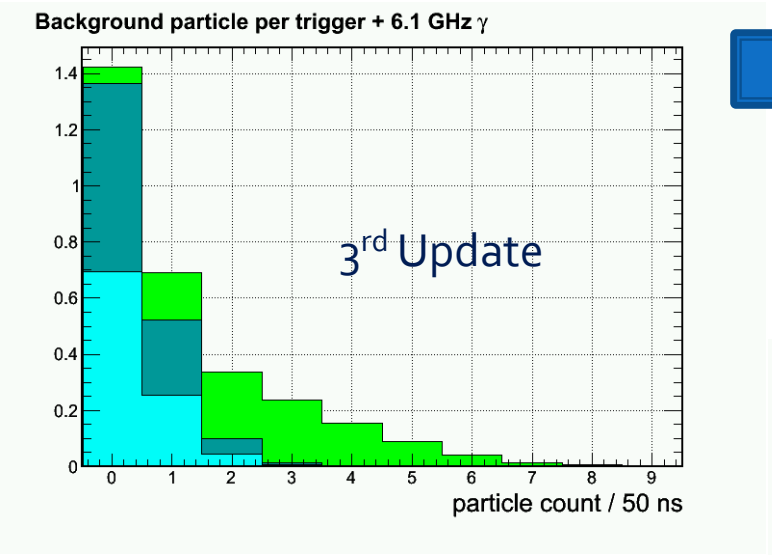


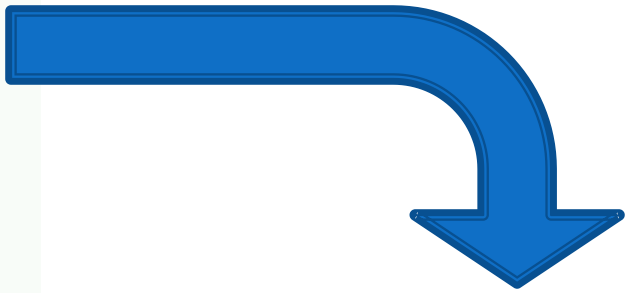
Forth update of CLEO background

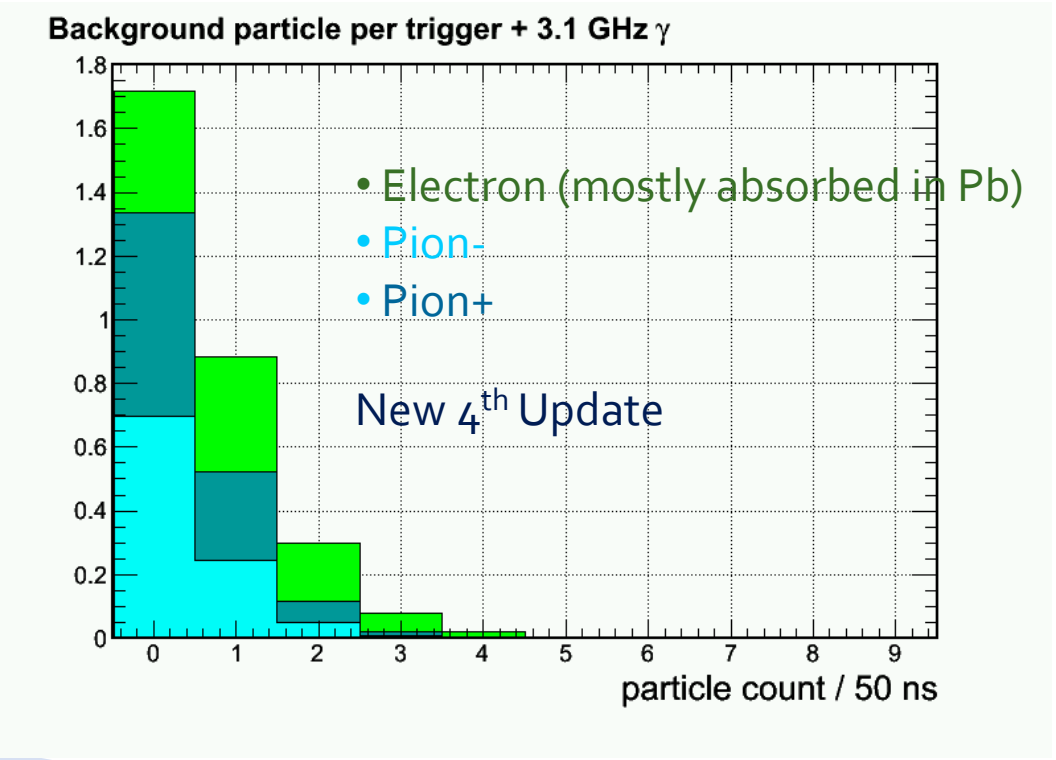
- Cutting 2cm away on 1st baffle inner radius
- Received background simulation from Zhiwen on May 24

Updated: Per-event pion rate

for 1+6 hexagon cluster at Mid radius, high radiation ϕ-slice

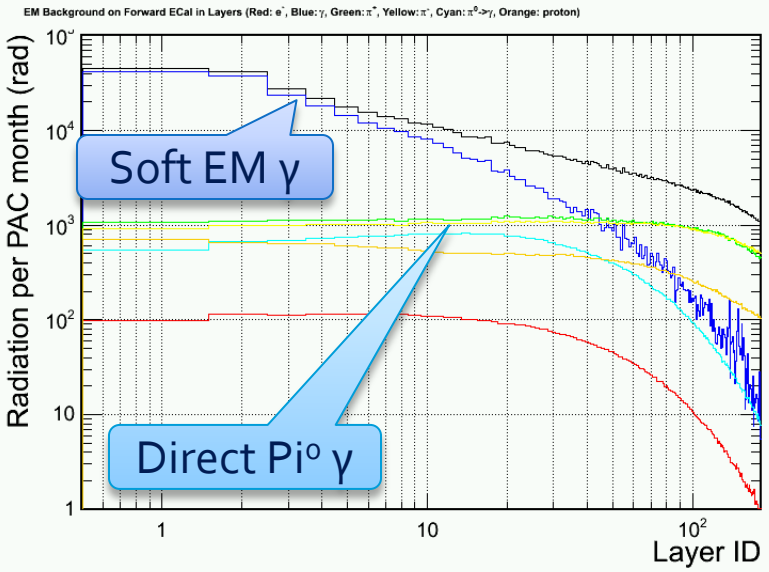


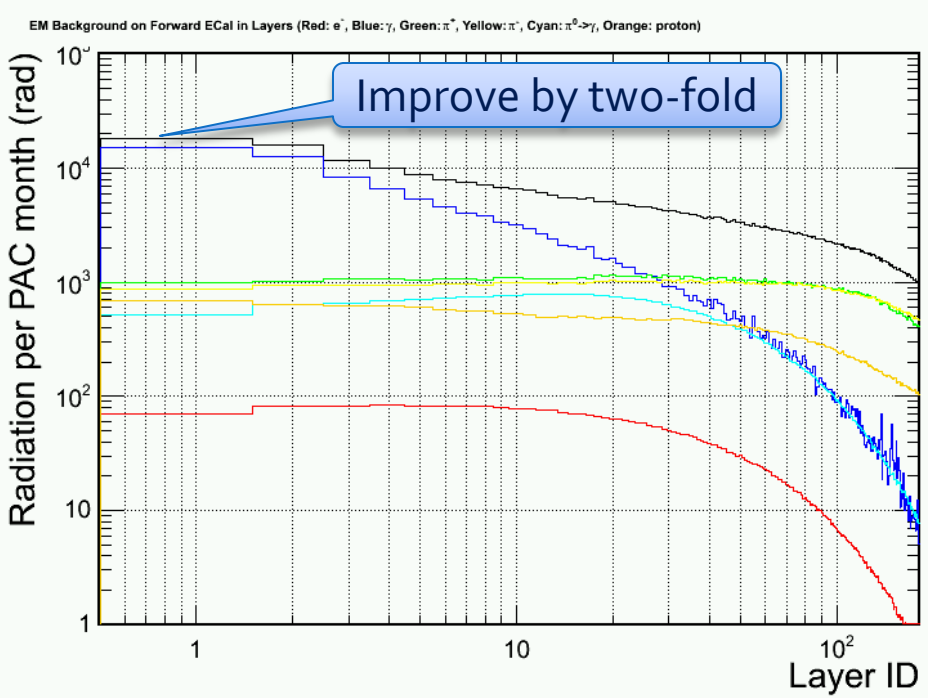




Updated radiation dose VS layers (High radiation ϕ slice)

- Photon (EM) <- dominant!
- Photon (Pi^0)
- Electron
- Pion- Pion+ Proton

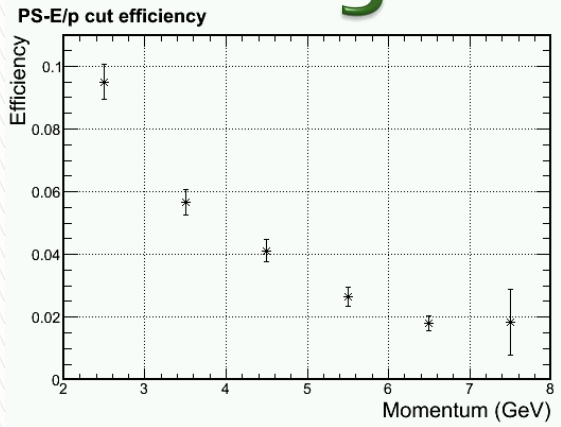


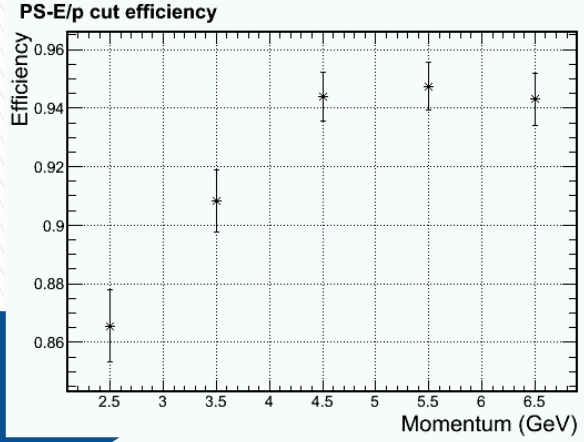


3rd Update

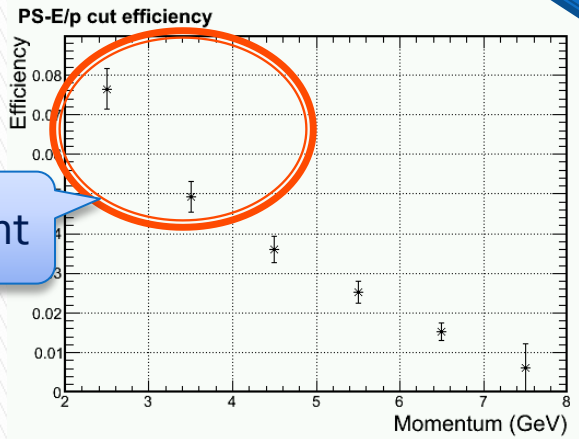
New: 4th Update

Update on PID
Mid radius, higher γ ϕ-band shown
Other configuration also simulated

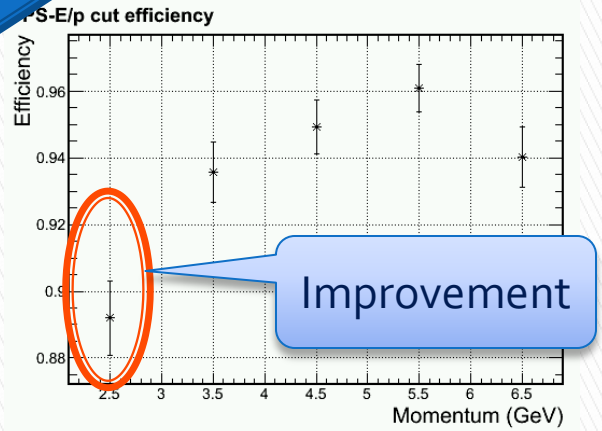




Update



Improvement



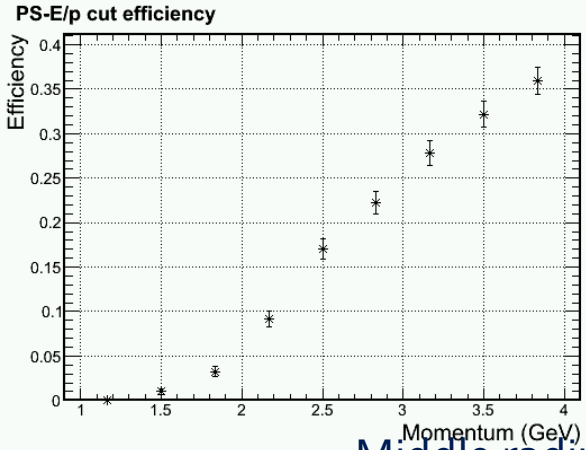
Improvement

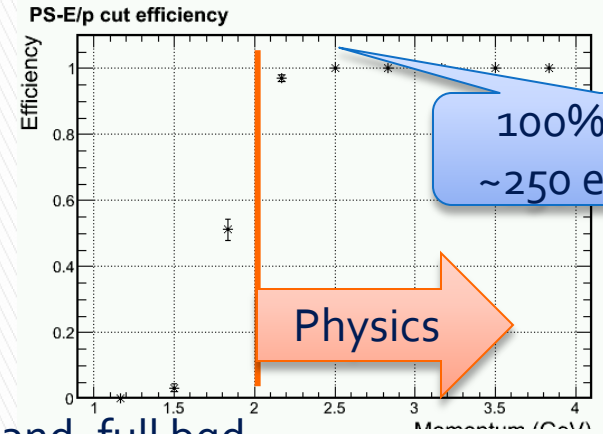
Pion Efficiency

Electron Efficiency

Trigger turn on curve for 2 GeV electron
Shower Hex 1+6 trigger > 1.6 GeV

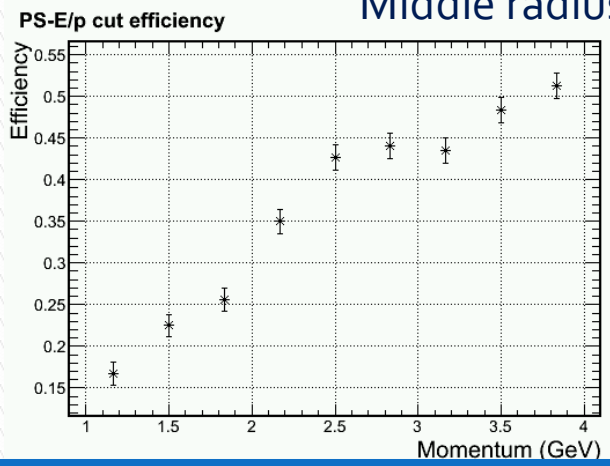
Outer radius, higher γ ϕ-band, full bgd

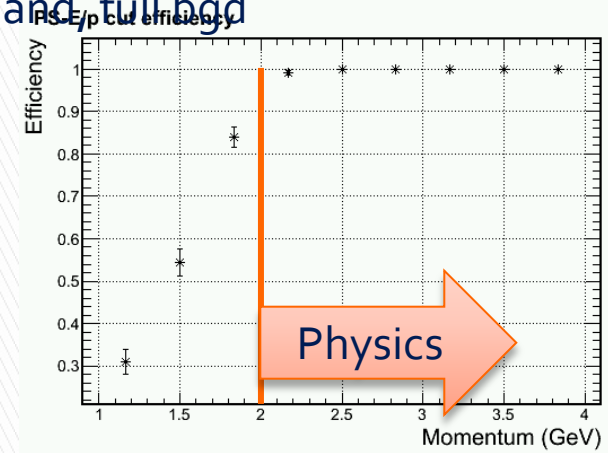




, full bgd

Middle radius, higer γ ϕ-band, full bgd



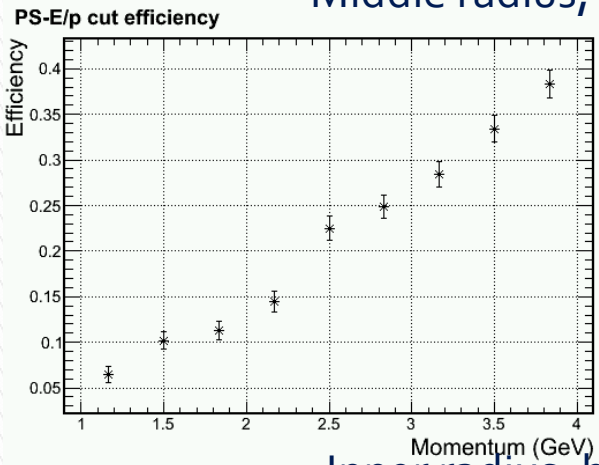


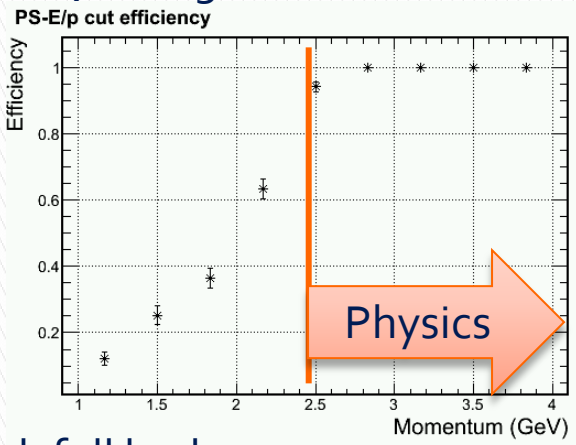
Pion Efficiency

Electron Efficiency

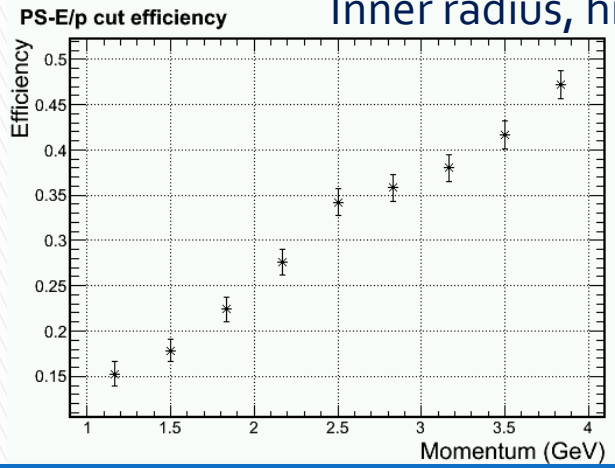
Trigger turn on curve for 2.5 GeV electron
Shower Hex 1+6 trigger > 2.1 GeV

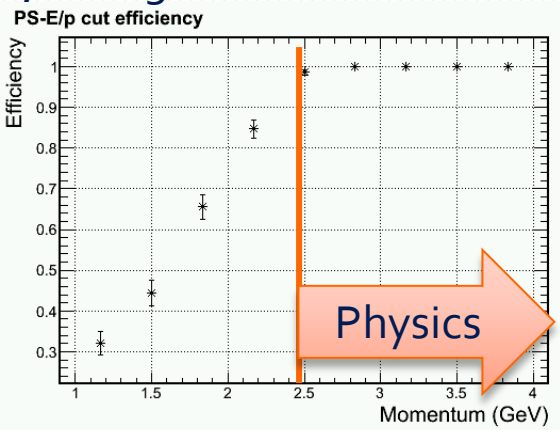
Middle radius, higher γ ϕ-band, full bgd





Inner radius, higer γ ϕ-band, full bgd

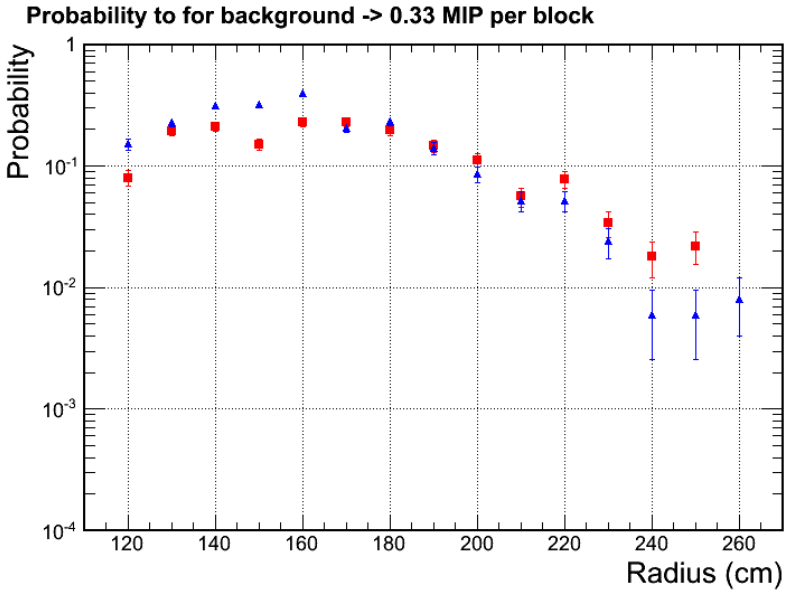


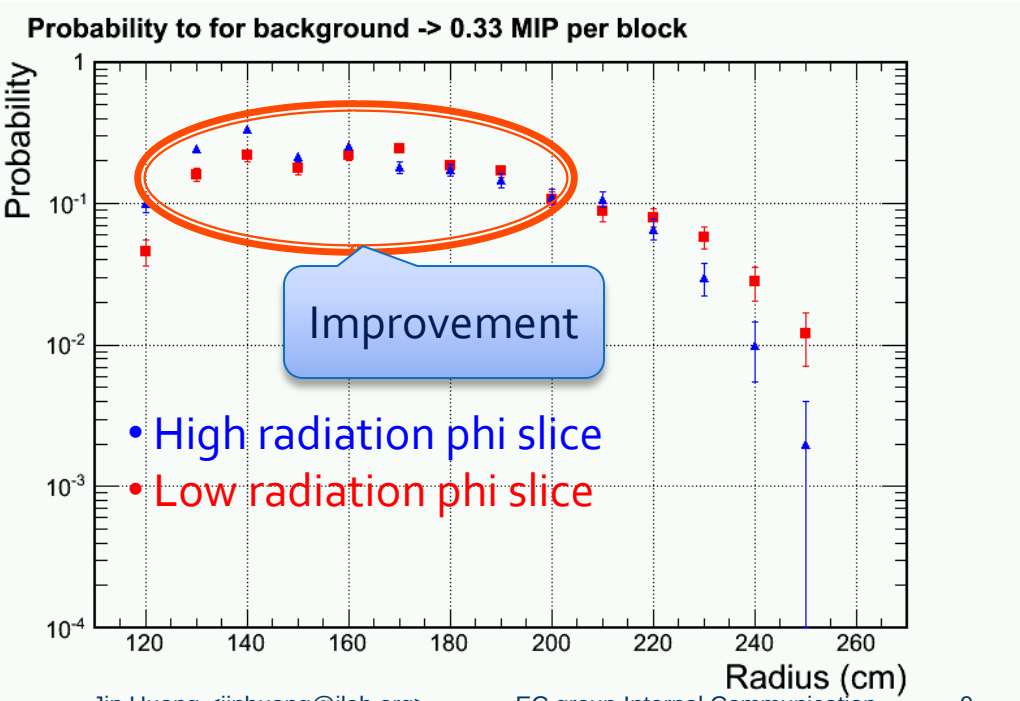


Pion Efficiency

Electron Efficiency

Readout occupancy per shower channel for ~75MeV zero suppression



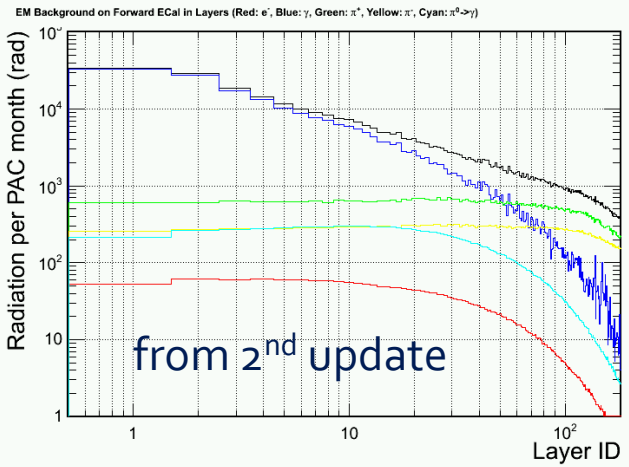


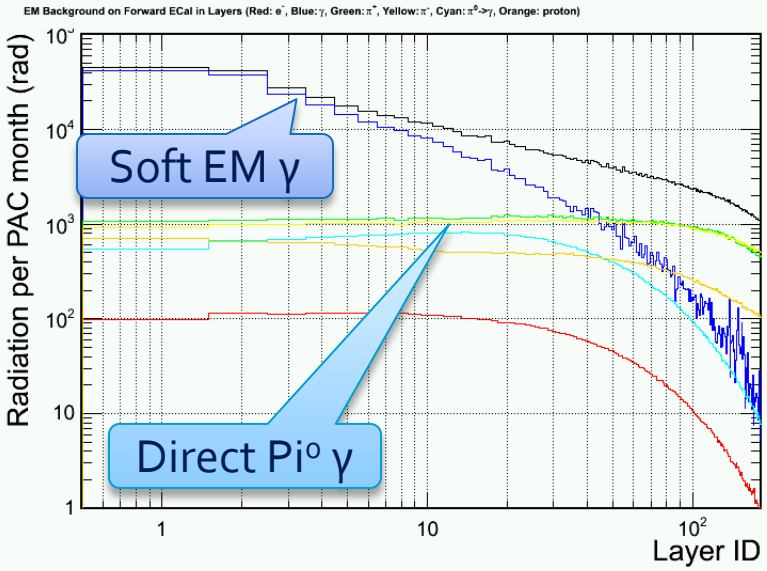
Third update of CLEO background

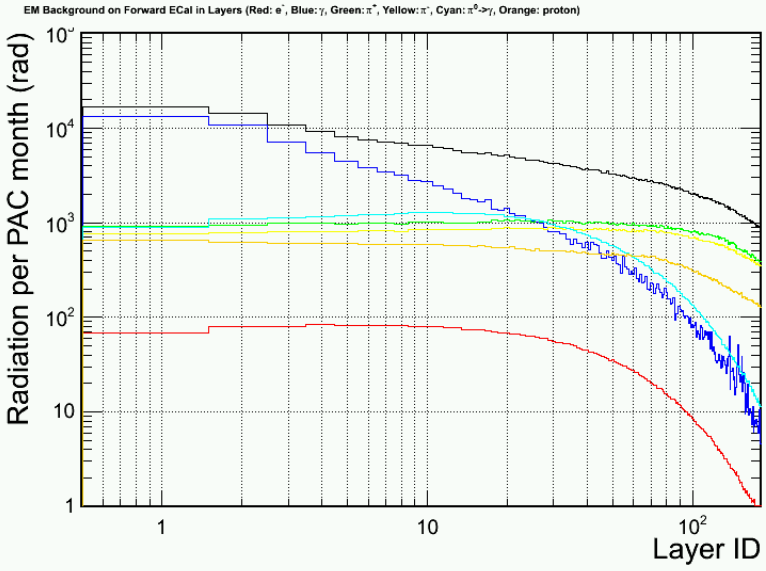
- Received background simulation from Zhiwen on May 19
- Running background imbedding

Updated radiation dose VS layers

- Photon (EM) <- dominant!
- Photon (Pi^0)
- Electron
- Pion- Pion+ Proton





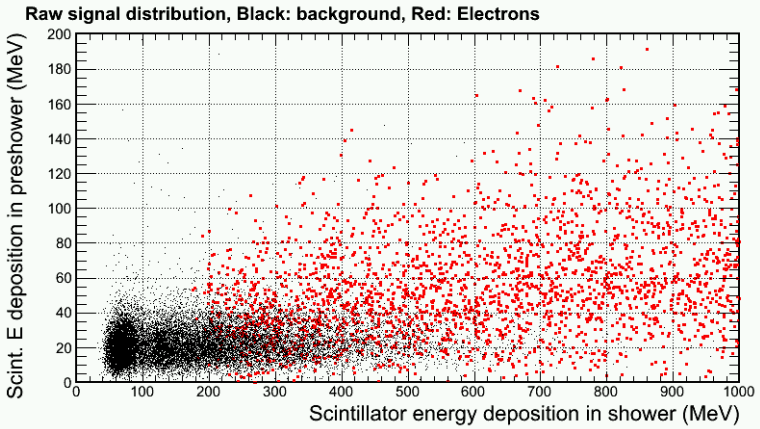


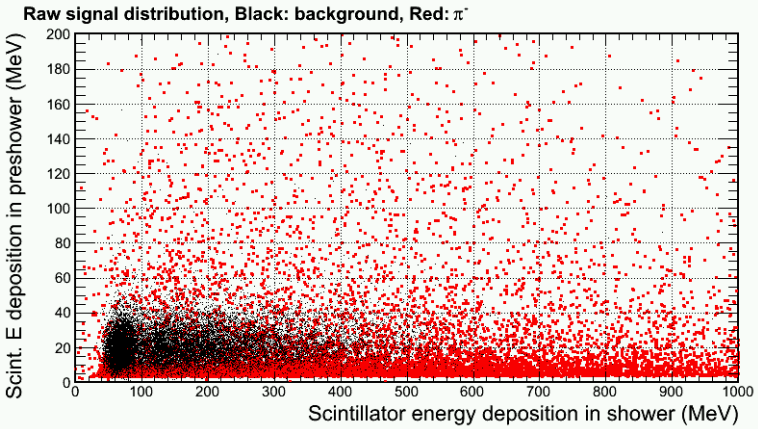
High radiation azimuthal region

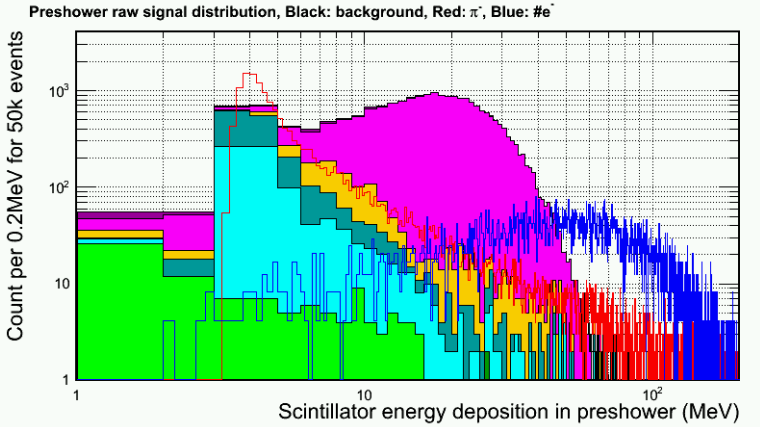
Low radiation azimuthal region

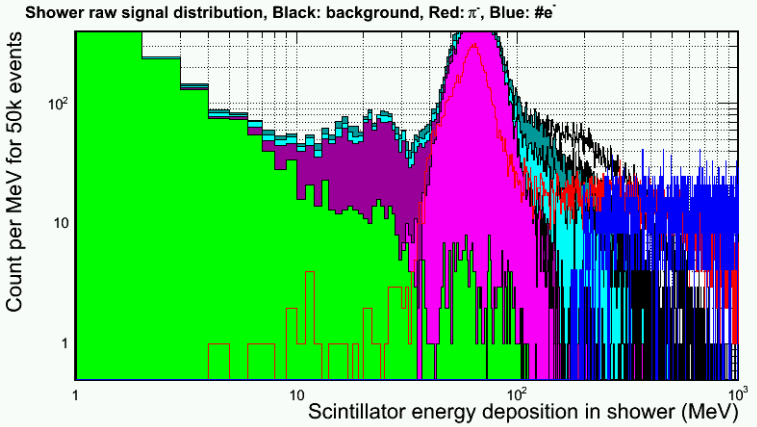
Background imbedding and distribution

Mid-R, High Radiation phi slice





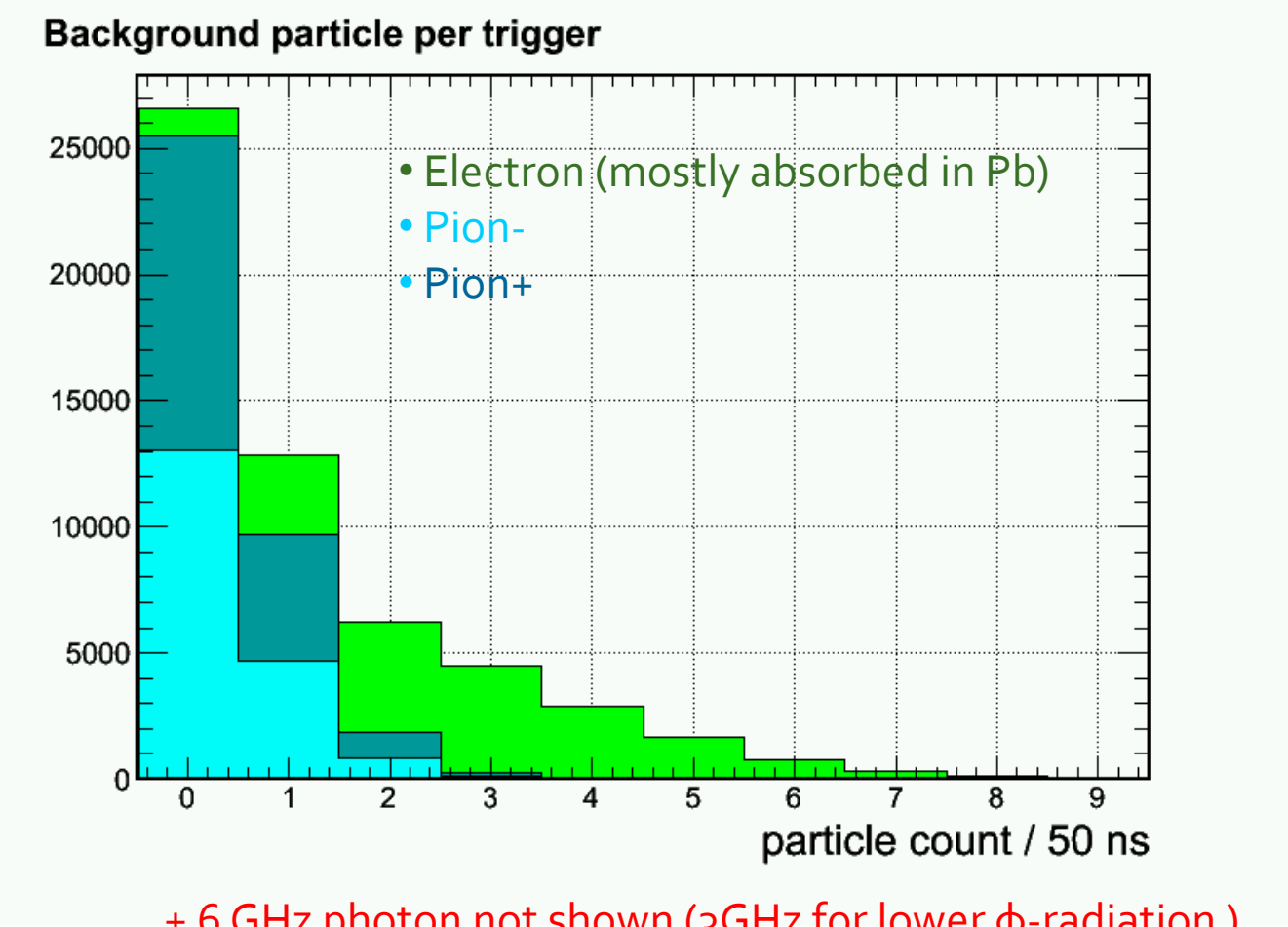




- Photon (6GHz/6+1 Hex cluster)
- Electron
- Pion- Pion+ Proton

Updated: Per-event pion rate

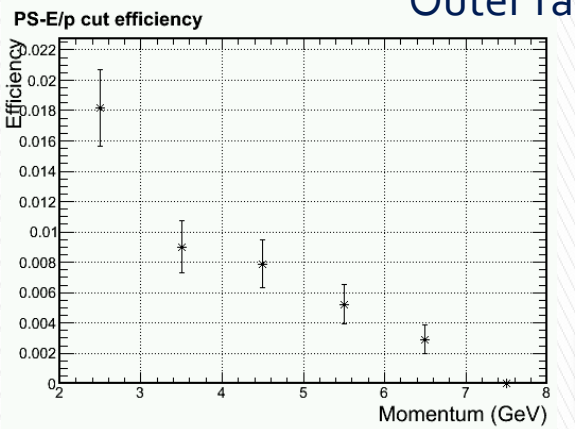
for 1+6 hexagon cluster at Mid radius, high radiation ϕ-slice

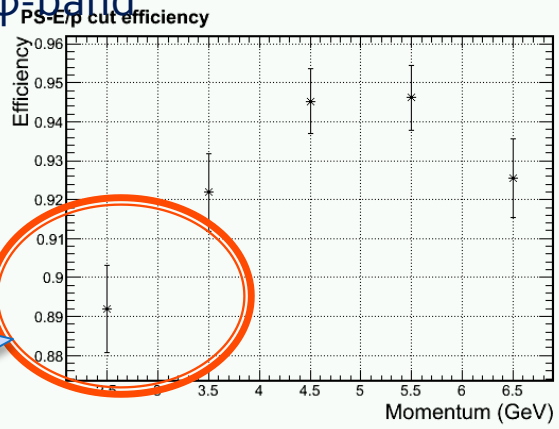


+ 6 GHz photon not shown (3GHz for lower ϕ-radiation)

Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

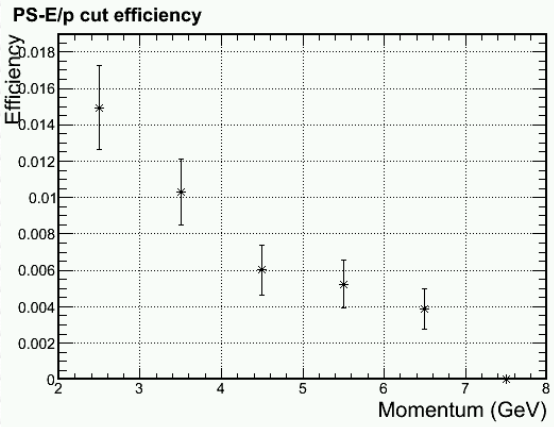
Outer radius, higher γ ϕ-band

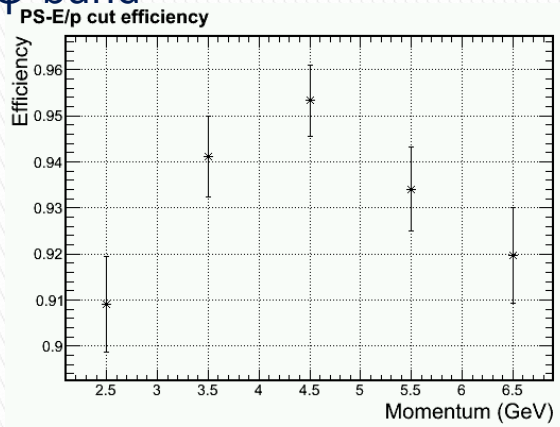




Due to Soft EM γ

Outer radius, lower γ ϕ-band



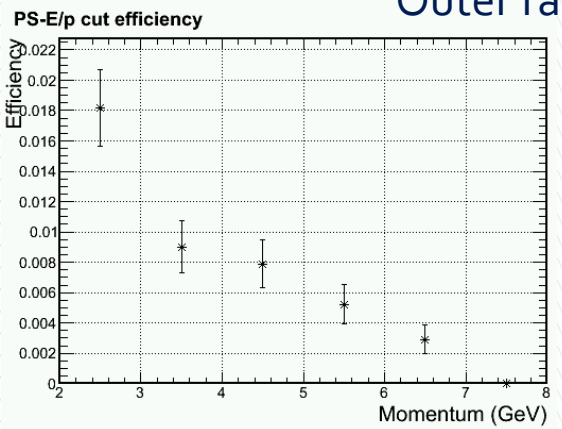


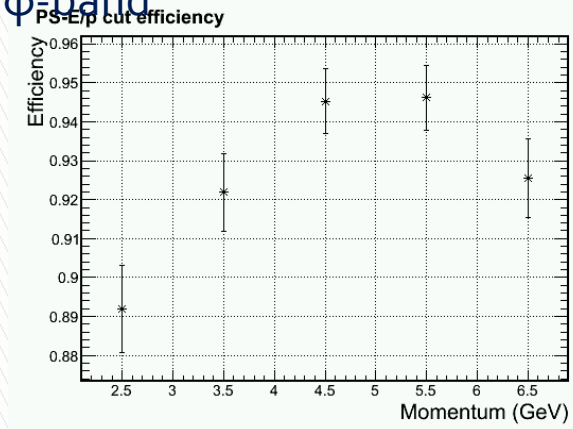
Pion Efficiency

Electron Efficiency

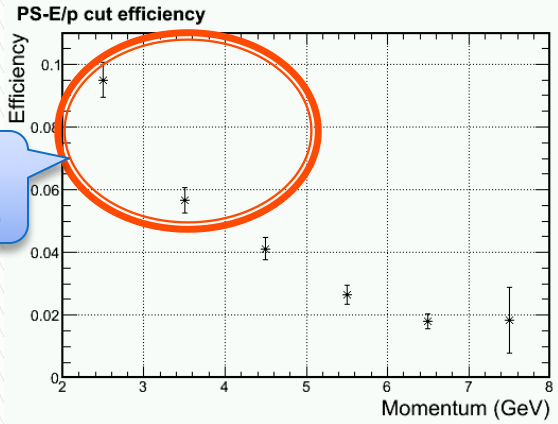
Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

Outer radius, higher γ ϕ-band

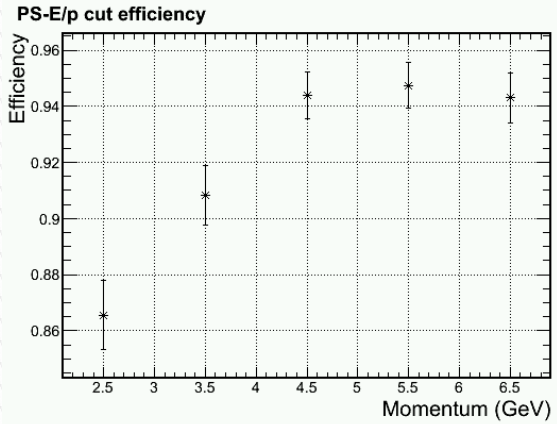




Mid radius, higher γ ϕ-band



Due to Hadron rate

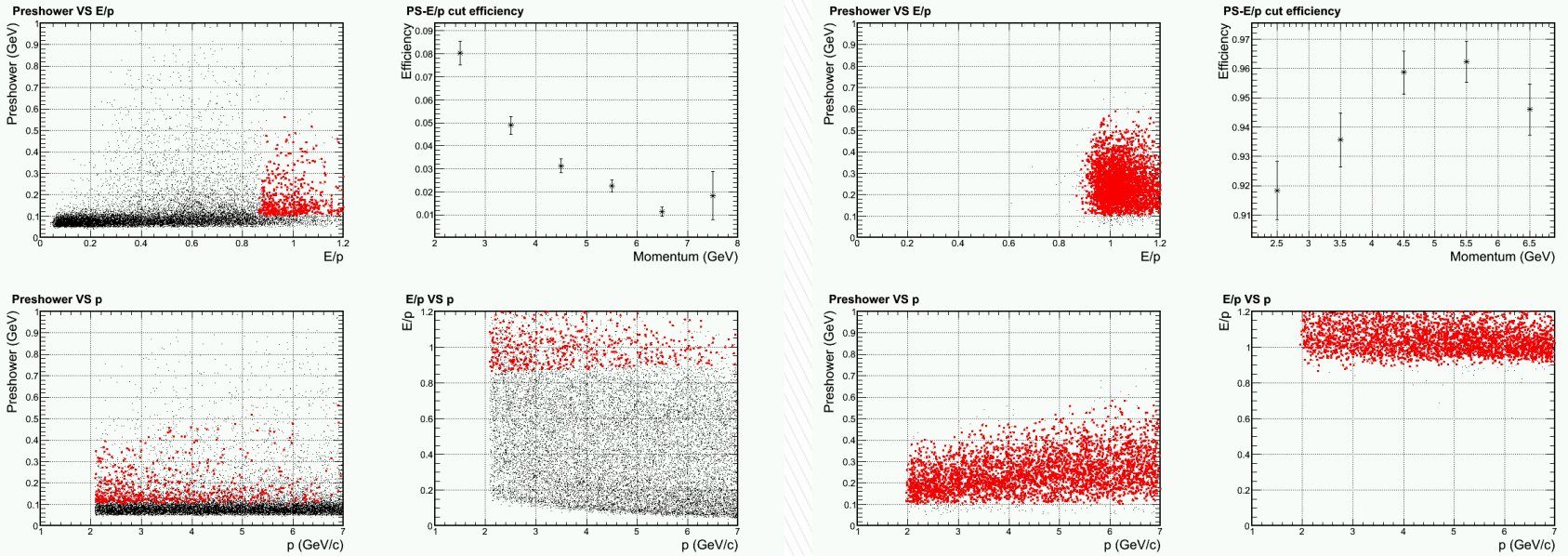


Pion Efficiency

Electron Efficiency

More detail in PID cut

Middle radius, lower γ ϕ-band, full bgd

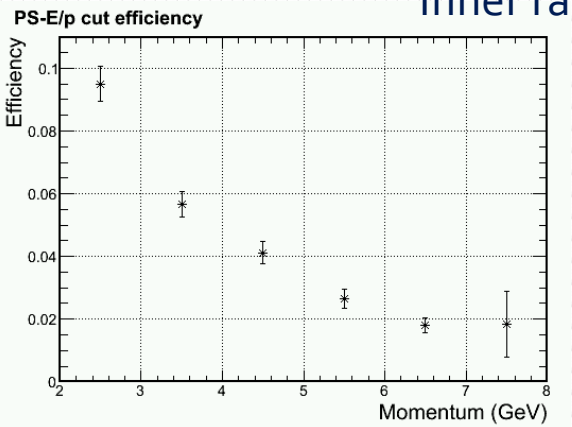


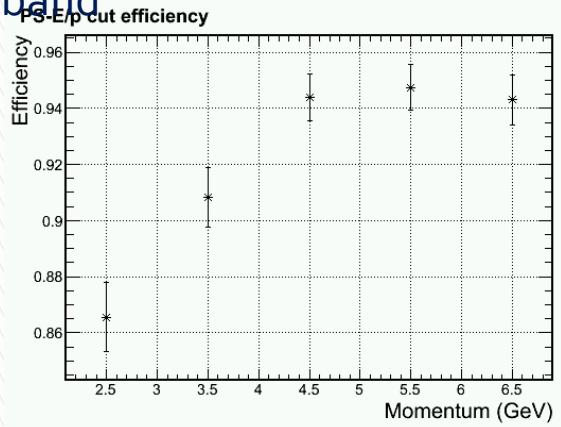
Pion Efficiency

Electron Efficiency

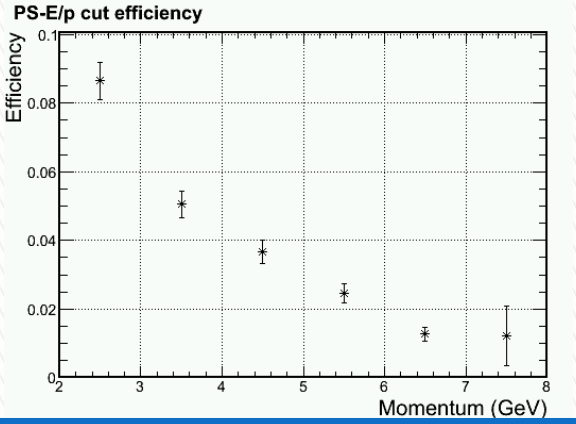
Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

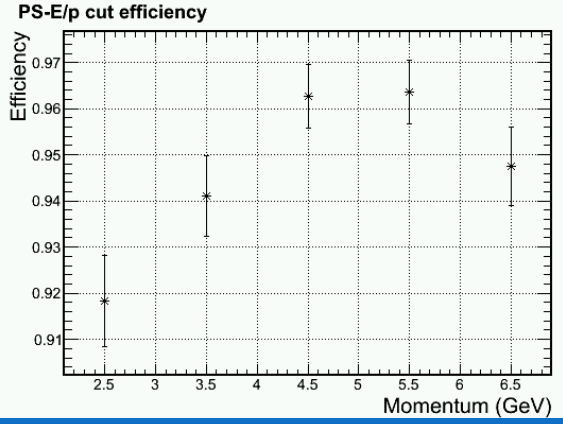
Inner radius, higher γ ϕ-band





Inner radius, lower γ ϕ-band



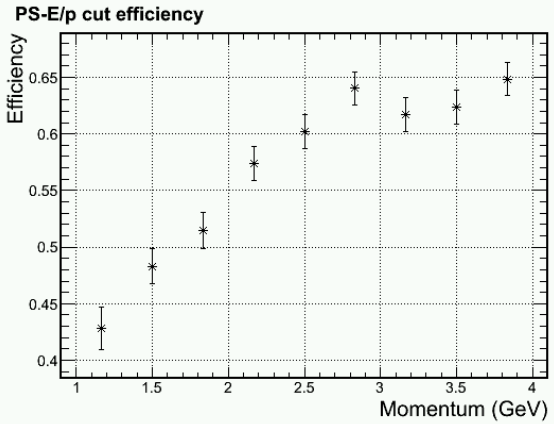


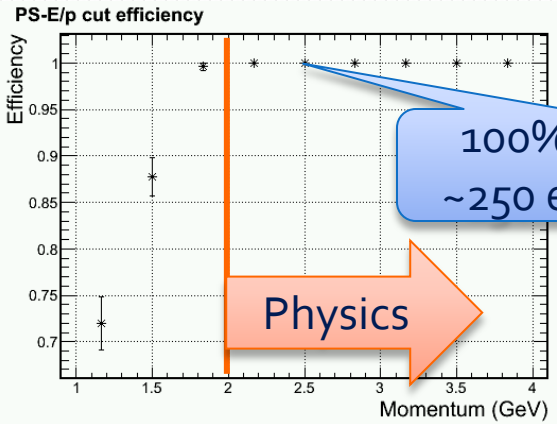
Pion Efficiency

Electron Efficiency

Trigger turn on curve for 2 GeV electron Shower Hex 1+6 trigger > 1.6 GeV

Inner radius, higher γ ϕ-band, full bgd

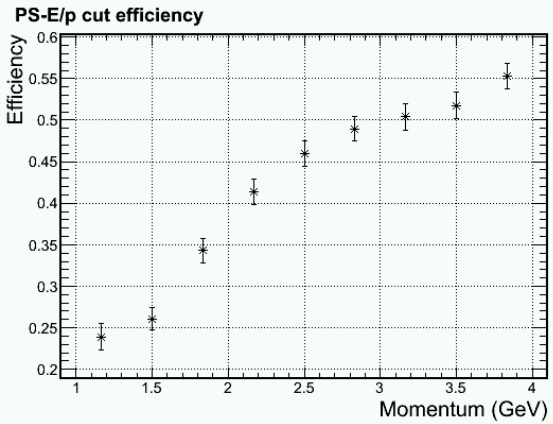


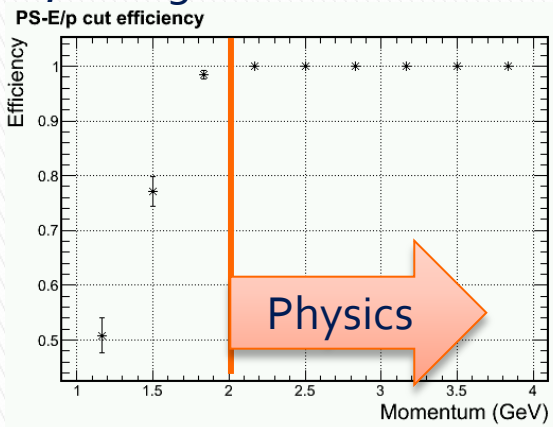


100% pass for ~250 events/bin

, full bgd

Middle radius, higer γ ϕ-band, full bgd



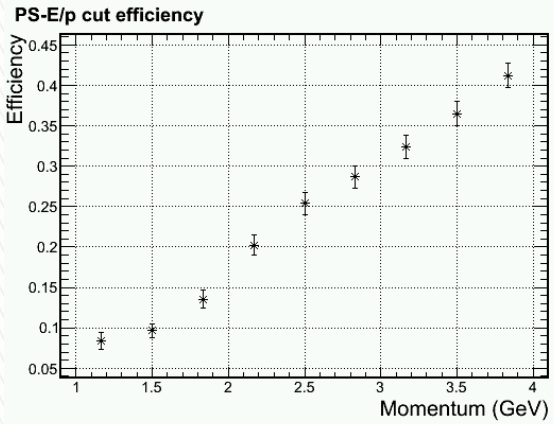


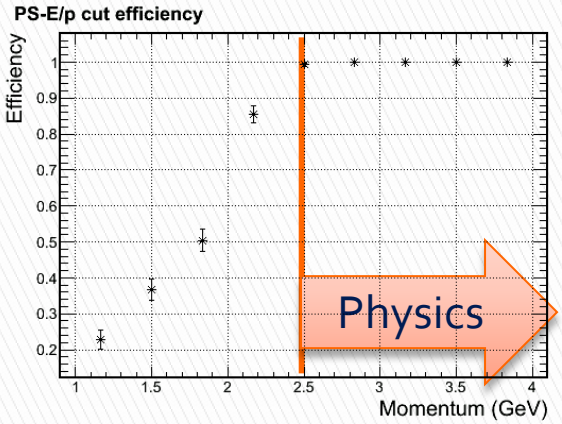
Pion Efficiency

Electron Efficiency

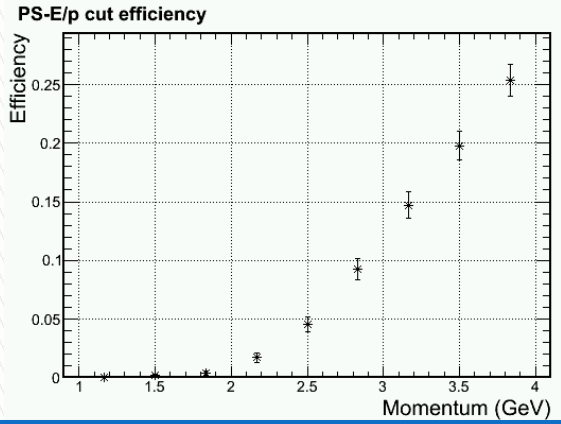
Trigger turn on curve for 2.5 GeV electron
Shower Hex 1+6 trigger > 2.1 GeV

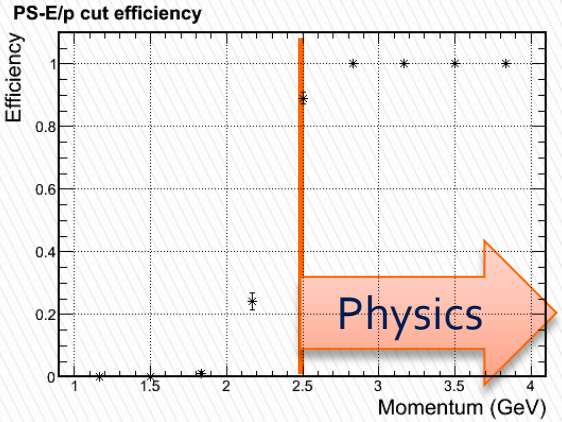
Middle radius, higher γ ϕ-band, full bgd





Outer radius, higer γ ϕ-band, full bgd





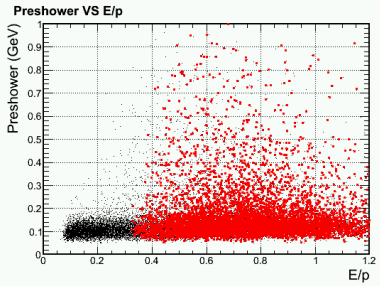
Pion Efficiency

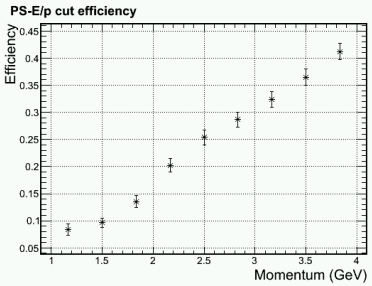
Electron Efficiency

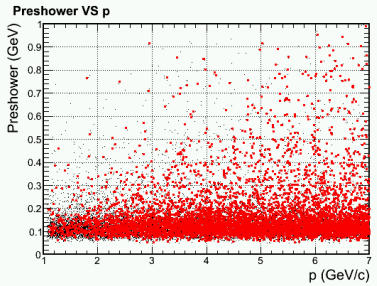
More detail in trigger cut

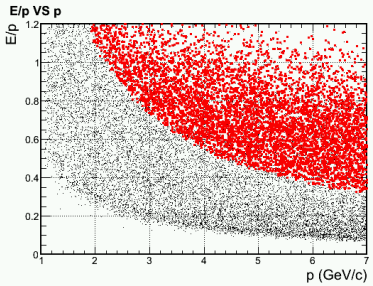
Middle radius, higher γ ϕ-band, full bgd

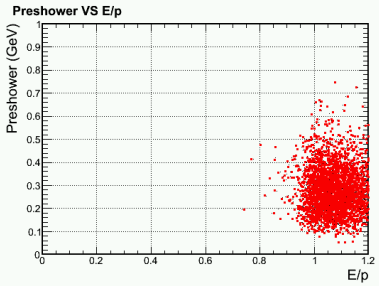
Shower Hex 1+6 trigger > 2.1 GeV

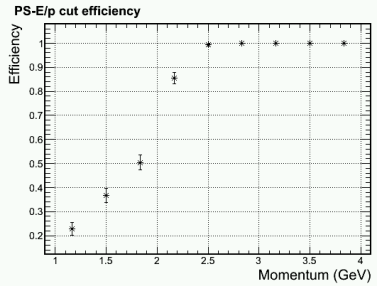


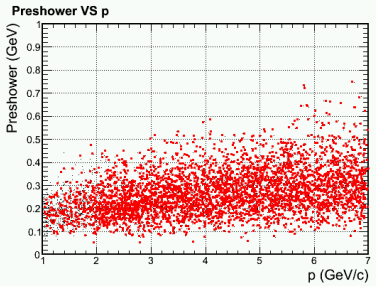


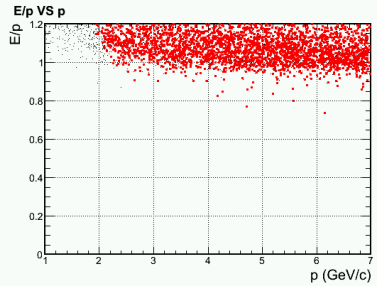








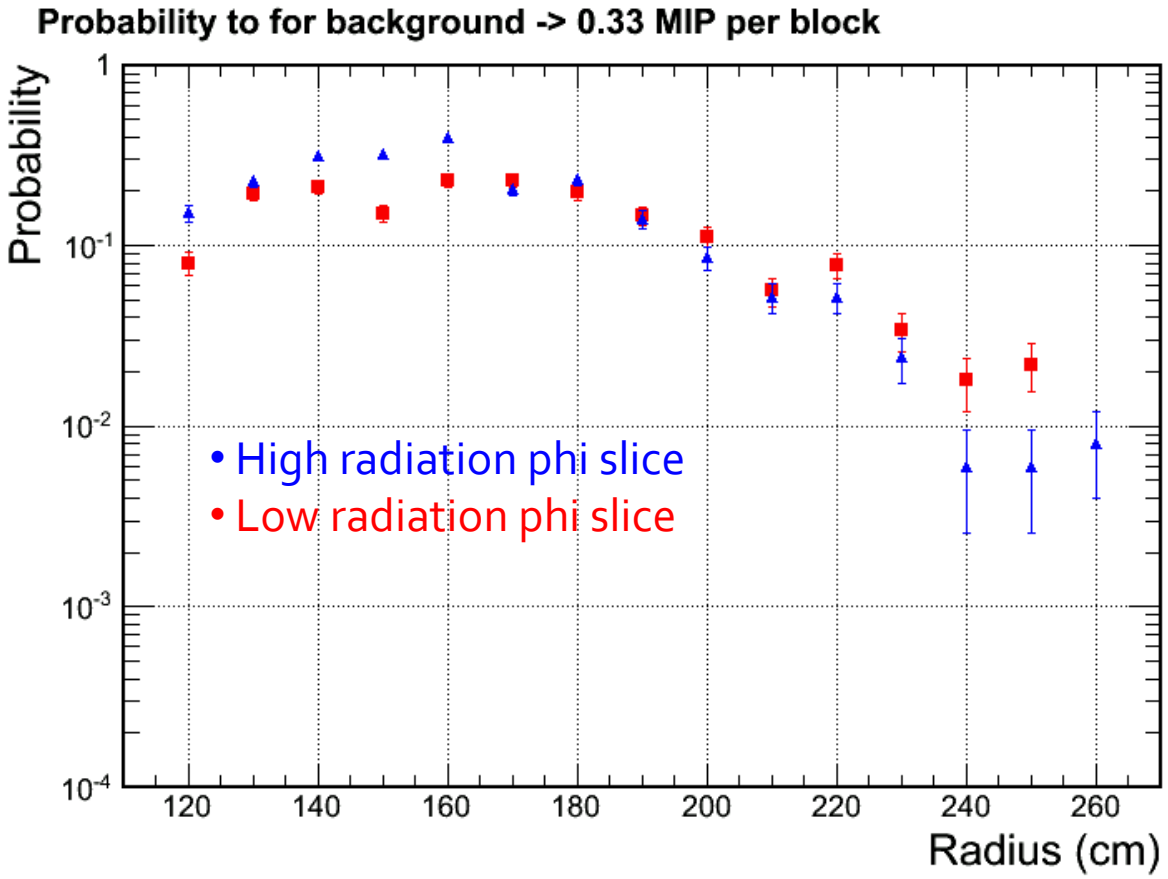




Pion Efficiency

Electron Efficiency

Readout occupancy per shower channel for ~75MeV zero suppression

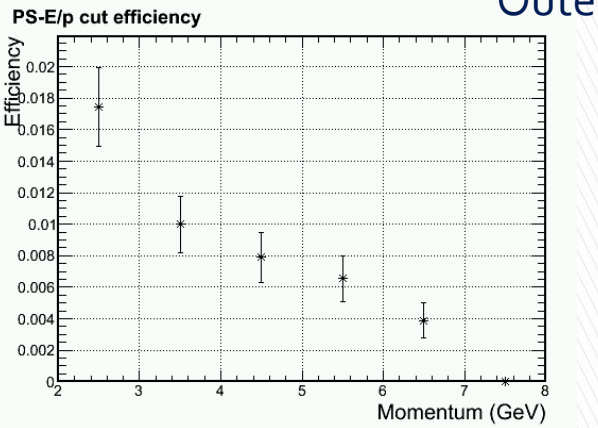


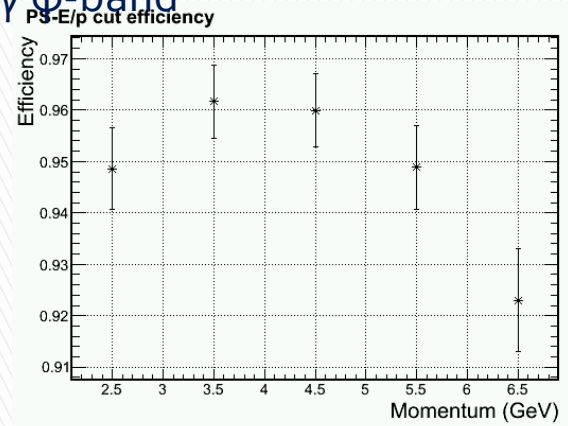
Trigger Study for Second update of CLEO background

- Reported May 7 Calorimeter Meeting

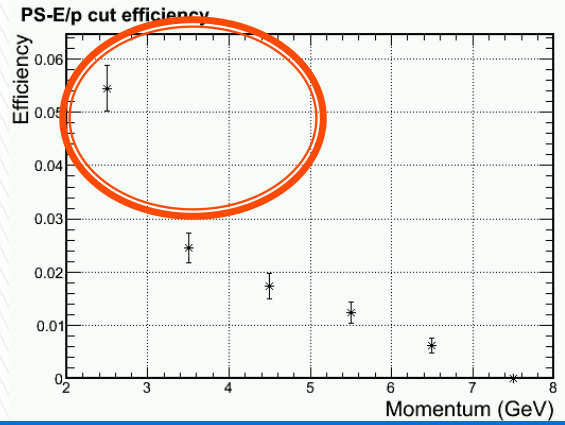
Update on PID with DC component removal (MIP + 2.5 σ)

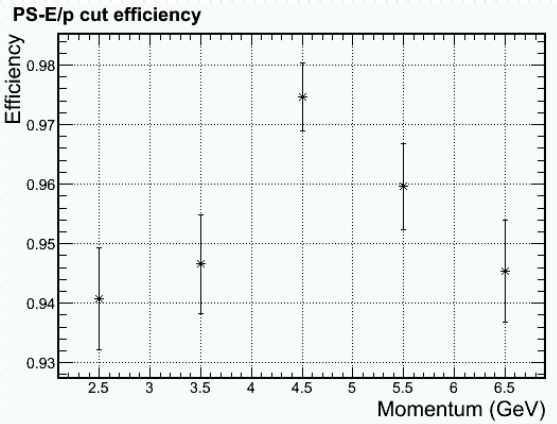
Outer radius, higher γ ϕ-band





Mid radius, higher γ ϕ-band



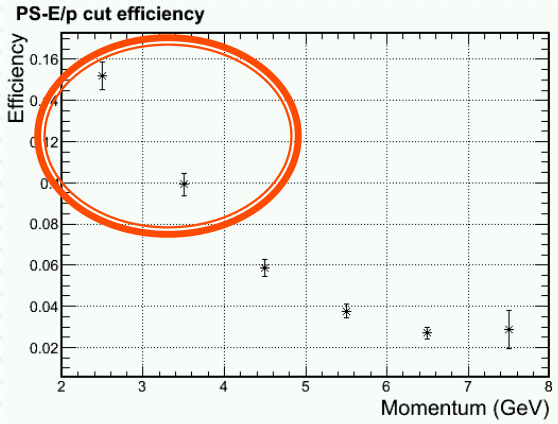


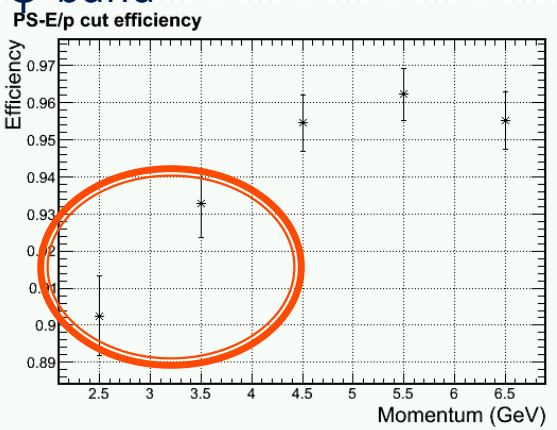
Pion Efficiency

Electron Efficiency

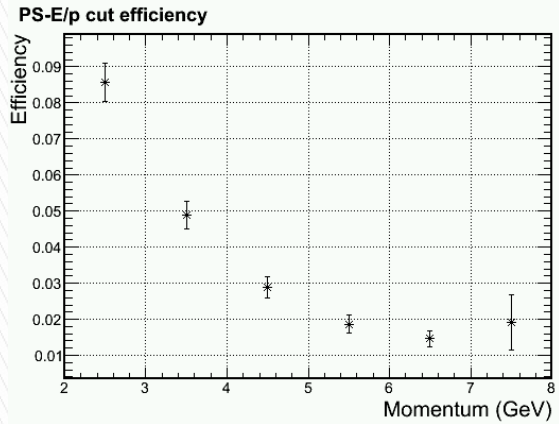
Update on PID with DC component removal (MIP + 2.5 σ)

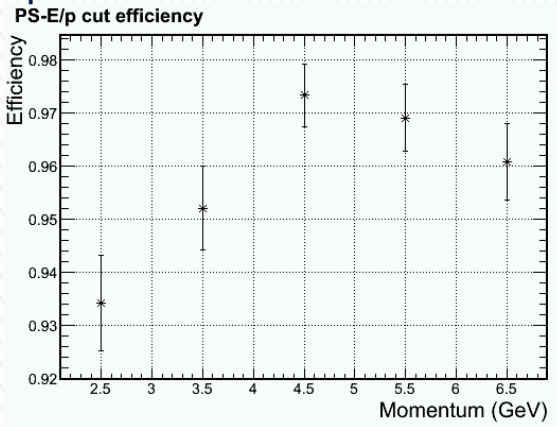
Inner radius, higher γ ϕ-band





Inner radius, lower γ ϕ-band

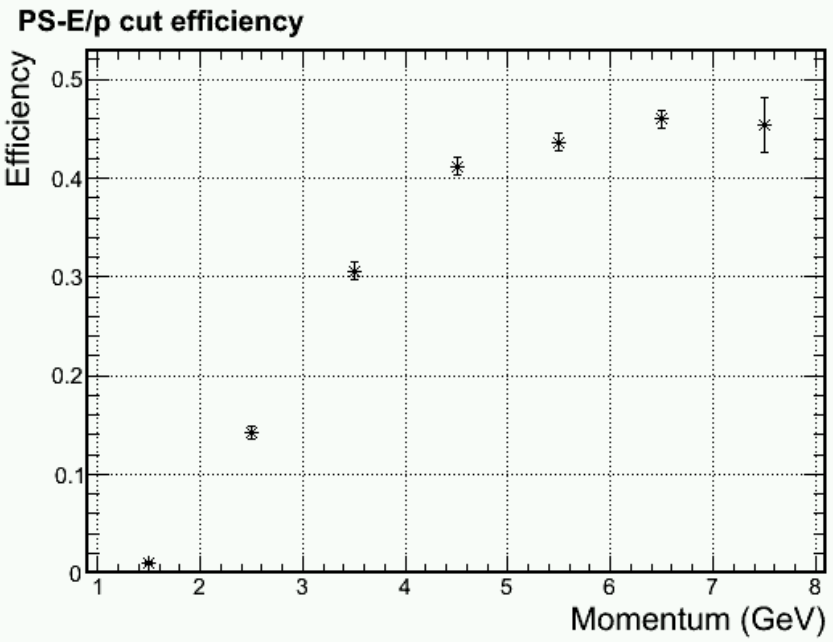


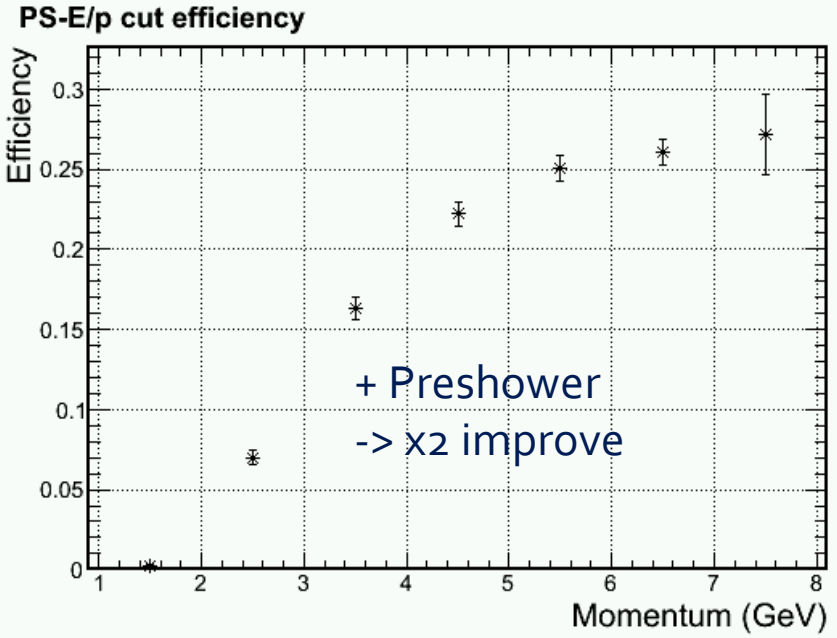


Pion Efficiency

Electron Efficiency

Pion Trigger Turn-On Curve (No background), Electron Eff. > 97%



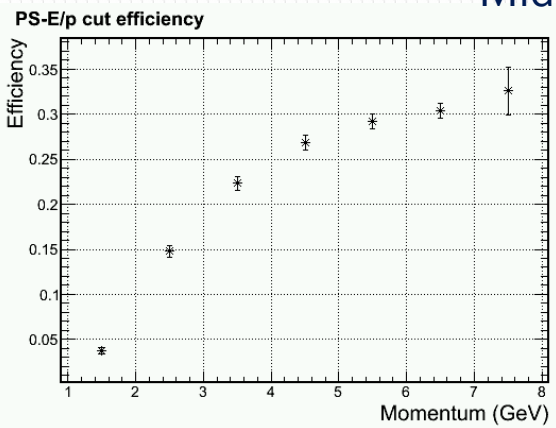


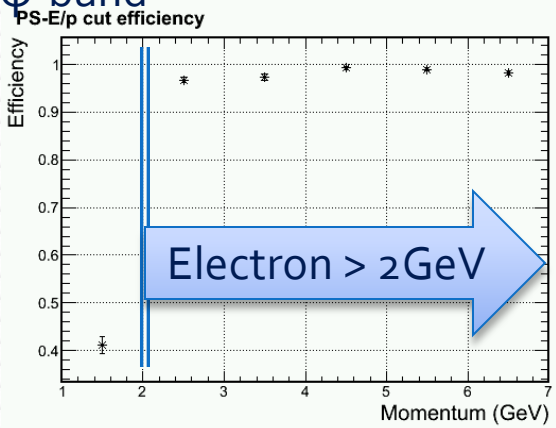
Hex 1+6 Shower Trigger > 1.6GeV (for 2GeV electron)

+ Preshower Pad on top of central shower block > MIP + 1σ

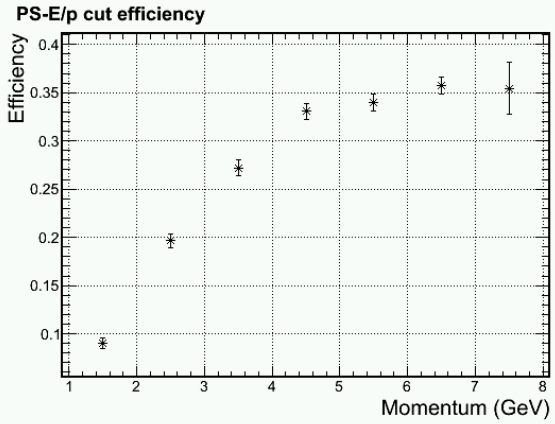
Trigger turn on curve with background

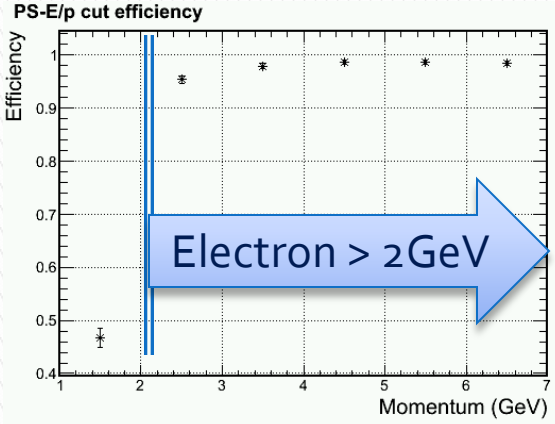
Middle radius, higher γ ϕ-band





Inner radius, higher γ ϕ-band





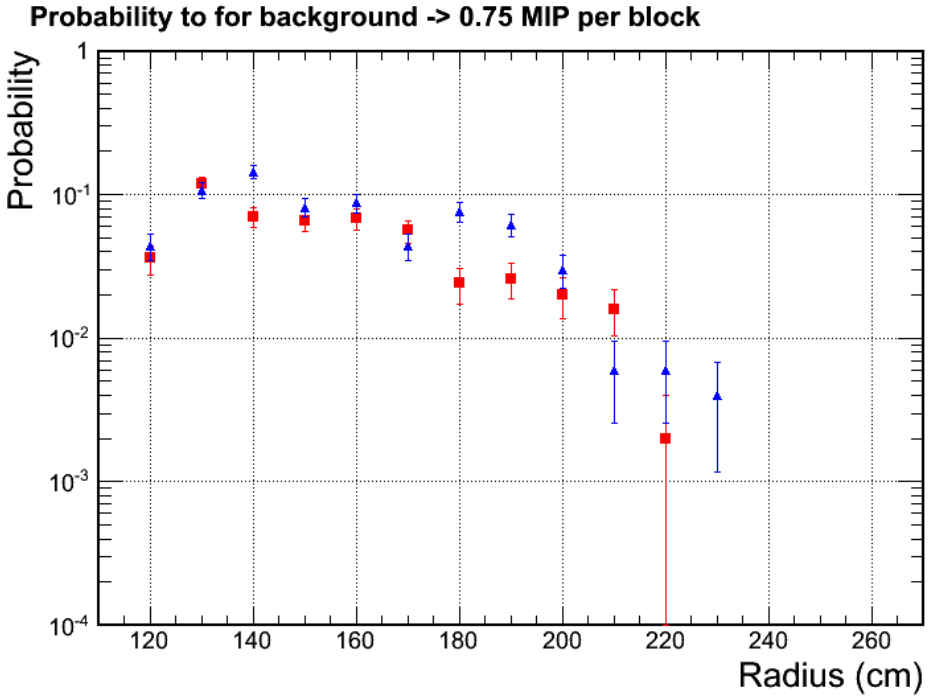
Pion Efficiency

Electron Efficiency

All background particle pile ups

- Look at single Hexagon shower blocks which passed 0.75 MIP cut.
  - Full background spectrum used
  - ADC integration window = 50ns
- ~10% blocks will produce a 0.75MIP signal for clock trigger
  - Data readout is least 10% of modules
  - A shower MIP trigger is likely just trigger on lower energy particles

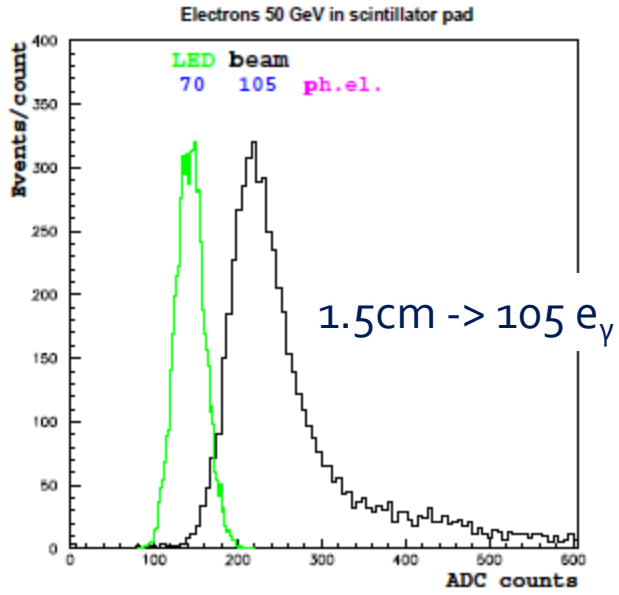
- higher γ ϕ-band
- lower γ ϕ-band



Quick estimation on impact of preshower radiation damage

- Radiation on preshower is high for PVDIS
  - Last meeting we showed that preshower will show radiation damage in a few months run in PVDIS configuration (assuming no cure for photon bgd)
  - Estimated light loss is a fraction depending on the choice of scintillator and fibers
- Our preshower was designed to produce high photon yield
  - Scint . thickness = 2cm with WLS imbedding
  - Expected photon / MIP = 140 e_γ
  - After 50% radiation damage (70 e_γ), MIP resolution from photon fluctuation = 12%
  - Intrinsic fluctuation on MIP sampling = 23%, PID cut on MIP + 2.5 σ
  - Therefore, effect on radiation damage to MIP resolution is expected to be minimal, as long as we calibrate the photon yield online

Beam test for LHCb pad (1.5cm thick)
From LHCb technical design report



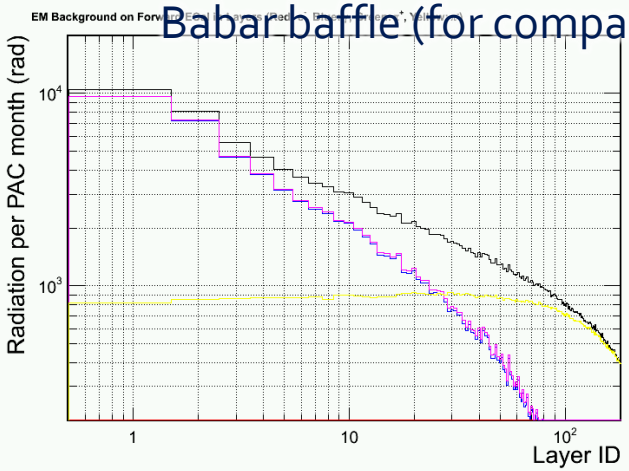
Second update of CLEO background

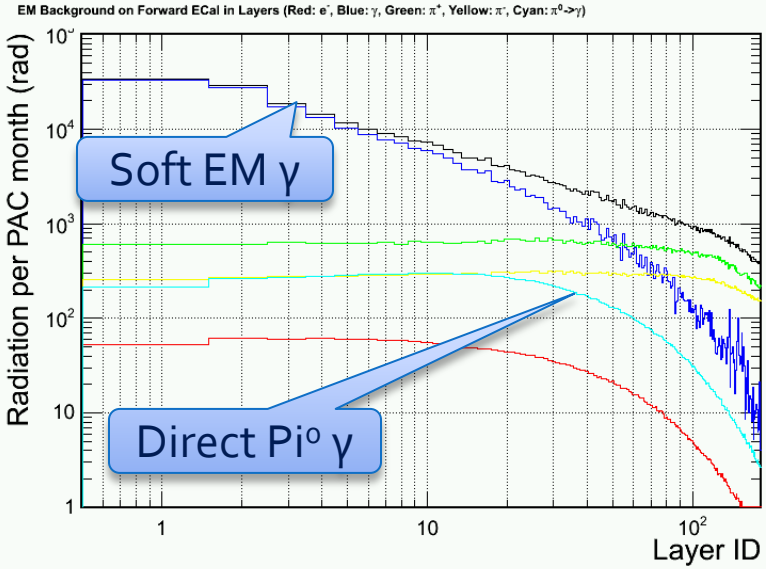
- Reported Apr 30 Calorimeter Meeting

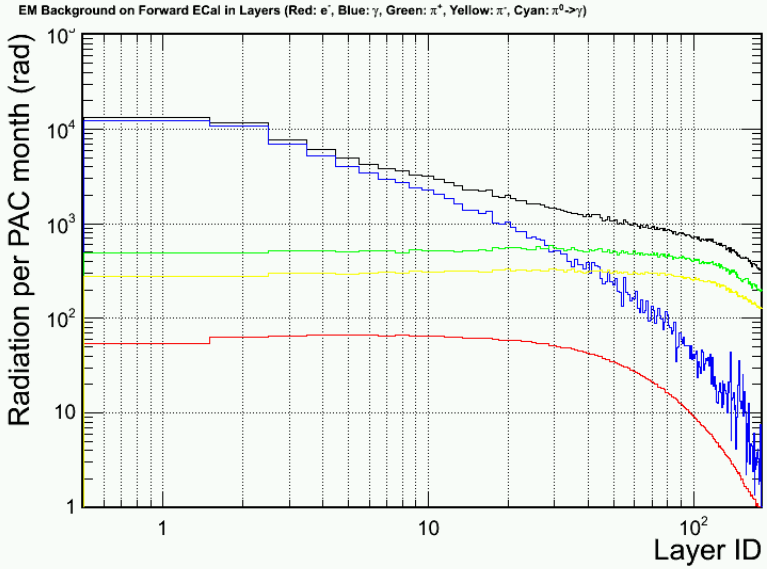
For each sector, background rate were calculated in high and low regions in phi

- Photon (EM) <- dominant!
- Photon (Pi^0)
- Electron
- Pion- Pion+

Babar baffle (for compare)





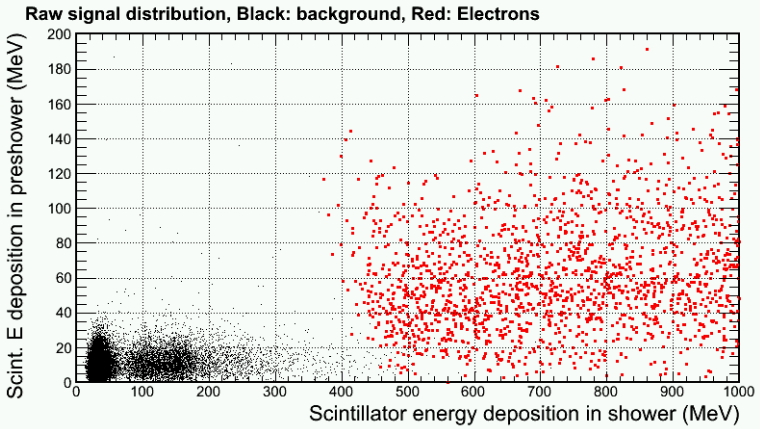


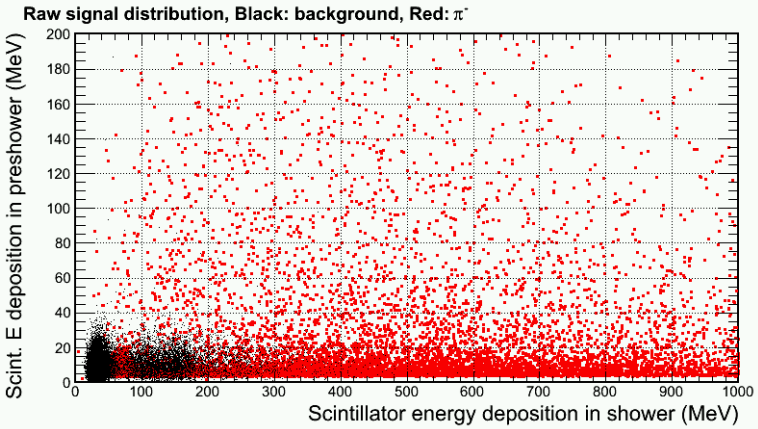
High radiation azimuthal region

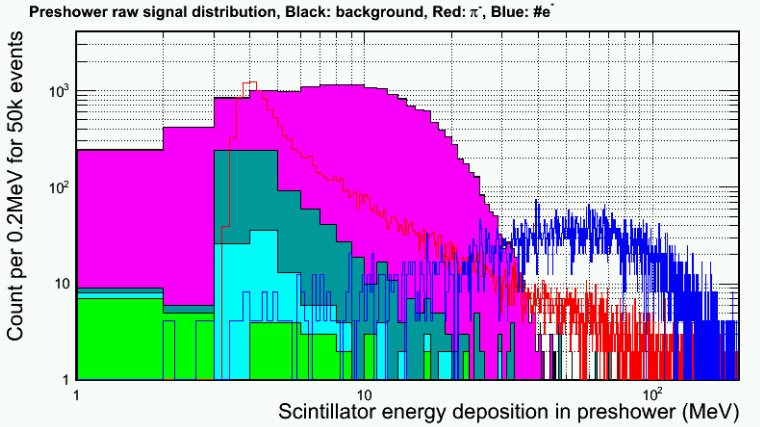
Low radiation azimuthal region

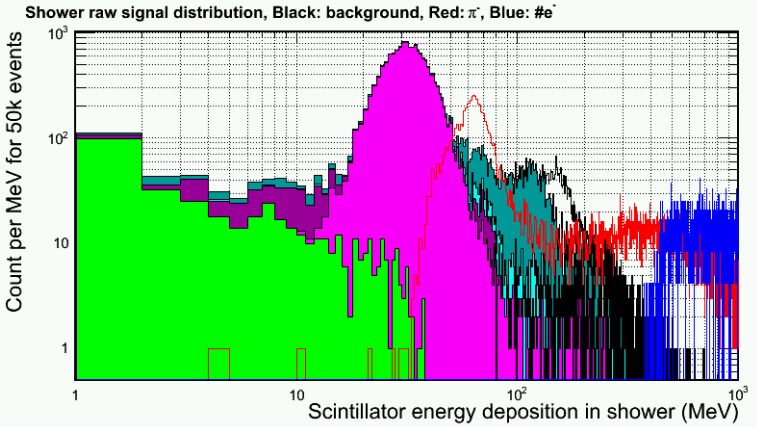
Background distribution

New: with photon and pi+, Mid R, High Rad phi slice





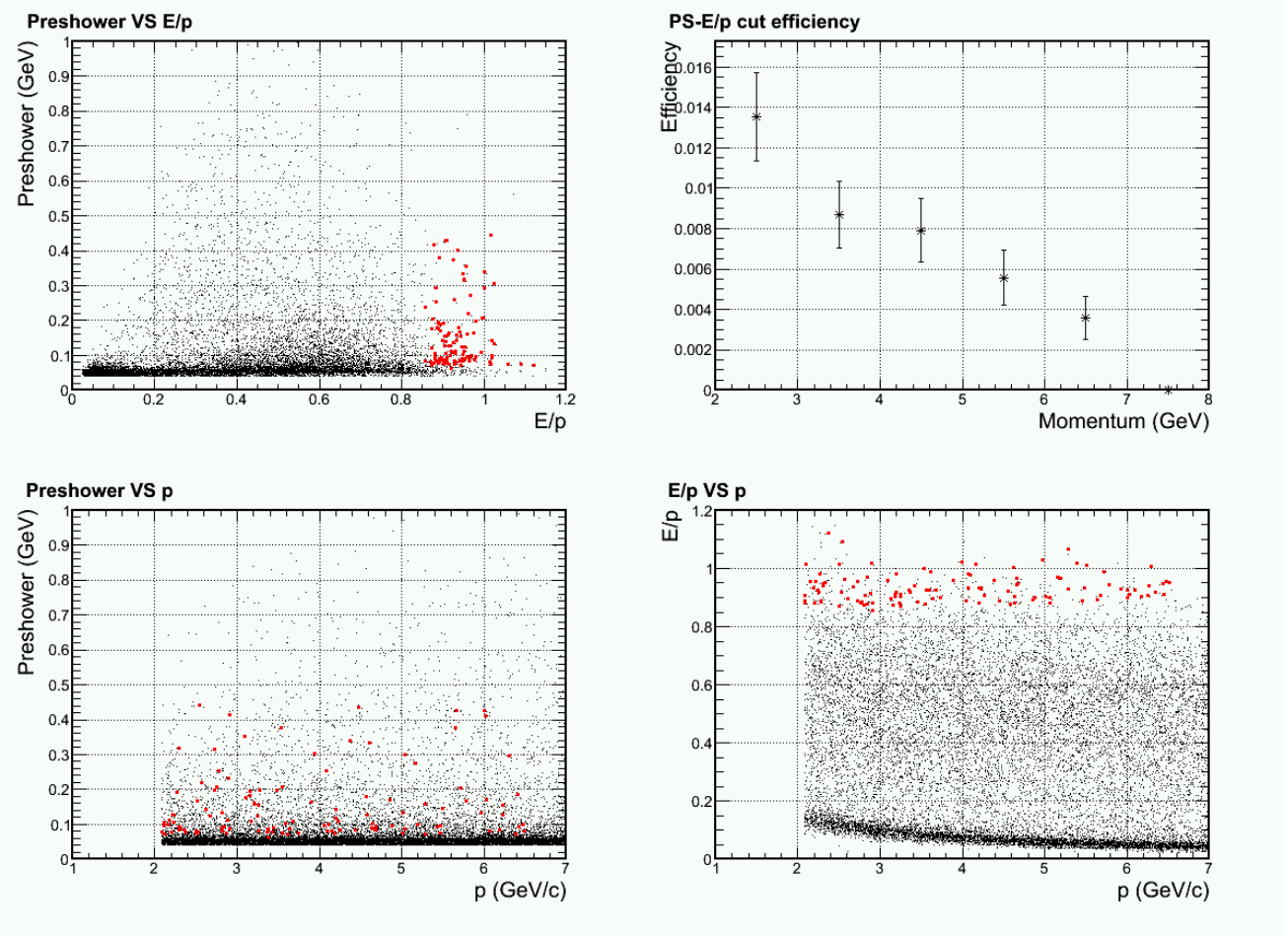




- Photon (7 GHz/6+1 Hex cluster!)
- Electron
- Pion- Pion+

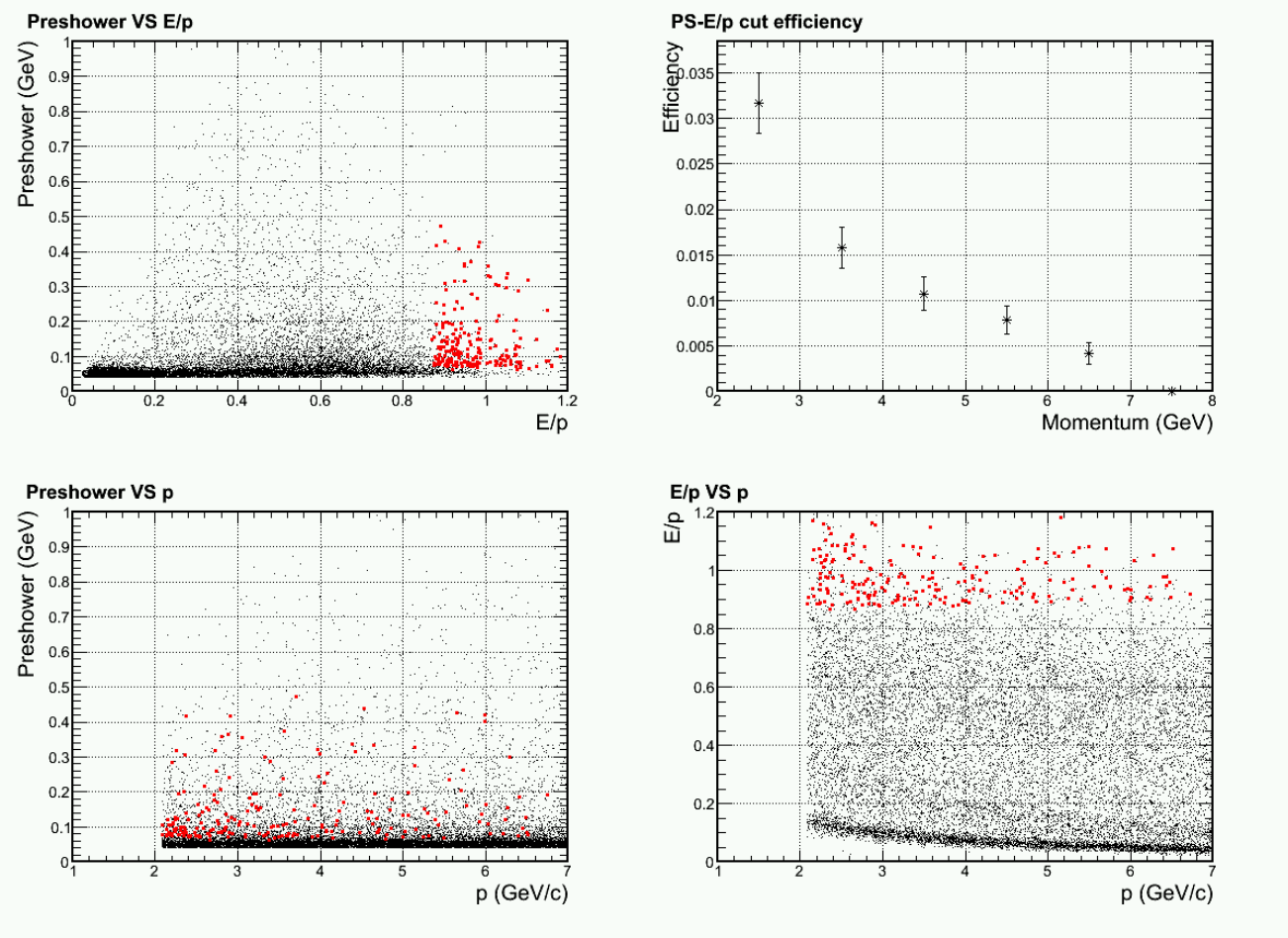
PID Performance (pion eff. w/ 94% elec. eff)

w/o photon and pi+, Mid R, High Rad phi slice

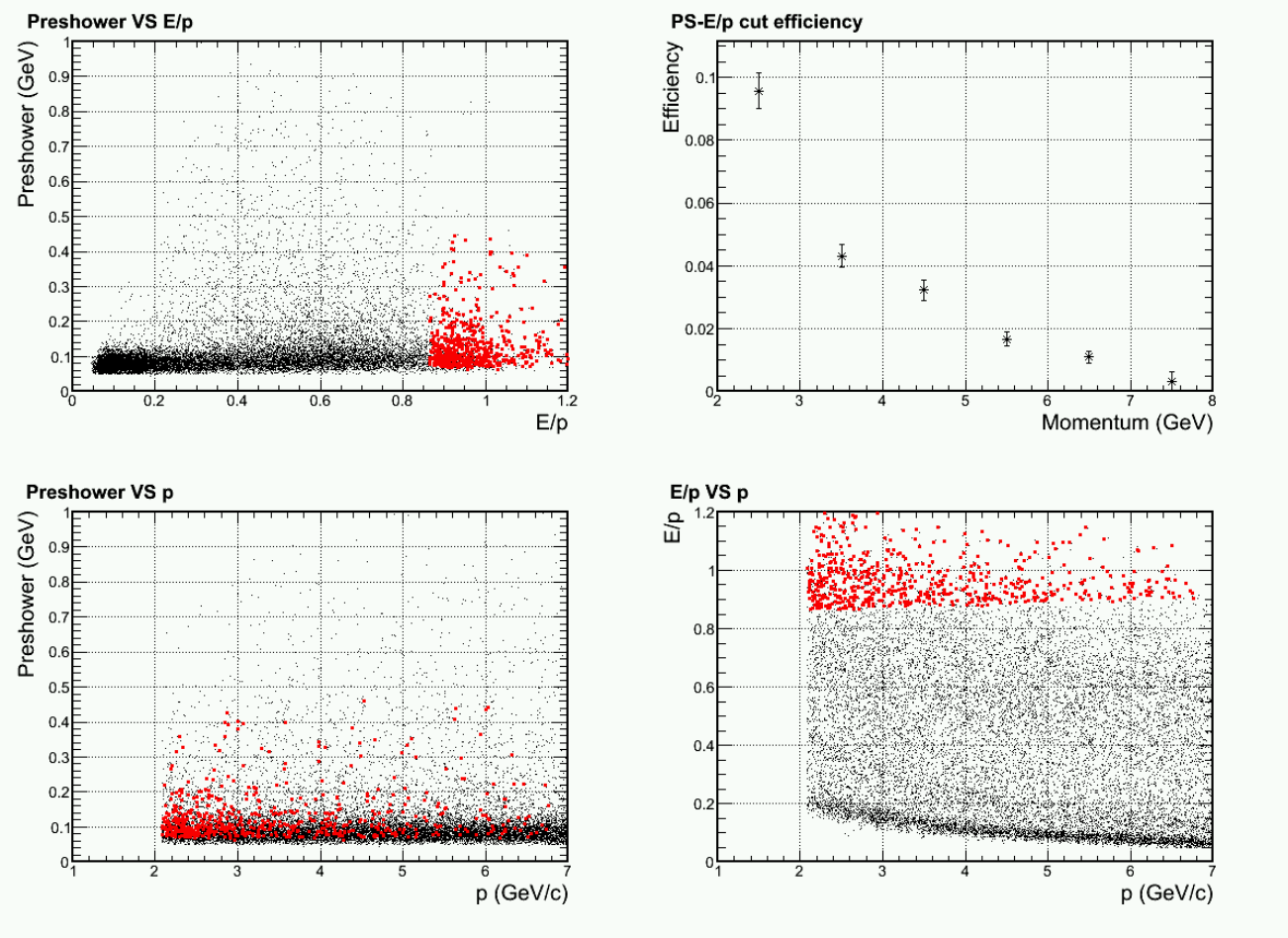


PID Performance (pion eff. w/ 94% elec. eff)

w/o photon, w/ pi+, Mid R, High Rad phi slice

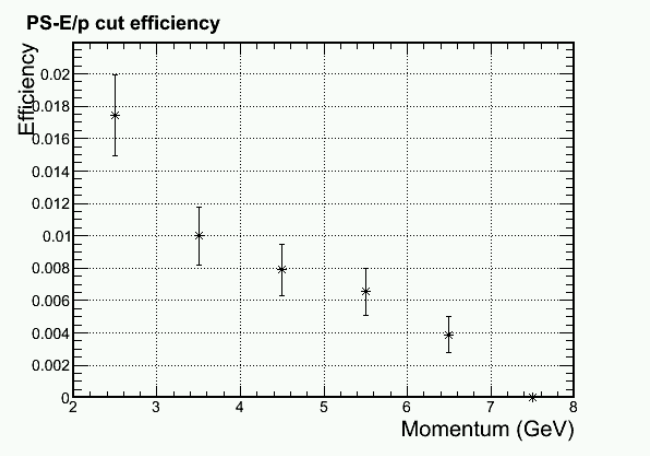


PID Performance (pion eff. w/ 94% elec. eff) w/ photon, w/ pi+, Mid R, High Rad phi slice

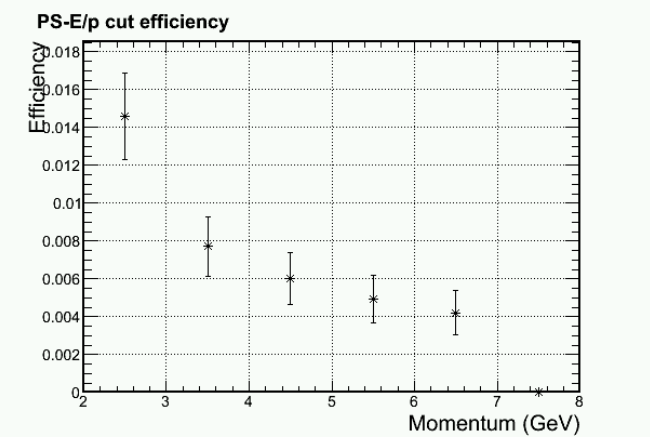


Look elsewhere, Outer/Inner R
PID Performance (pion eff. w/ 94% elec. eff)

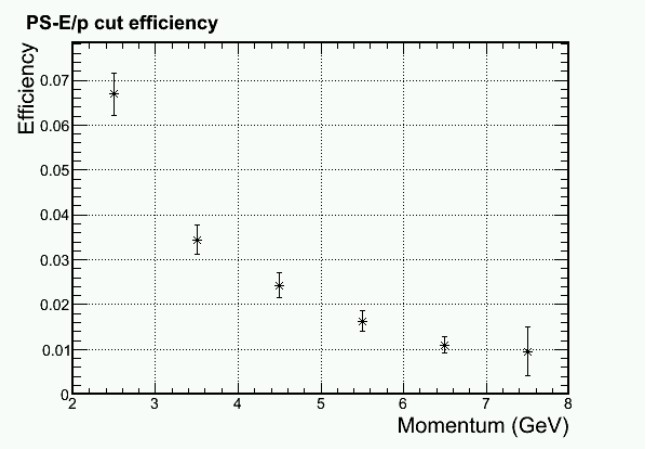
w/ photon, w/ pi+, Outer R, High Rad phi slice



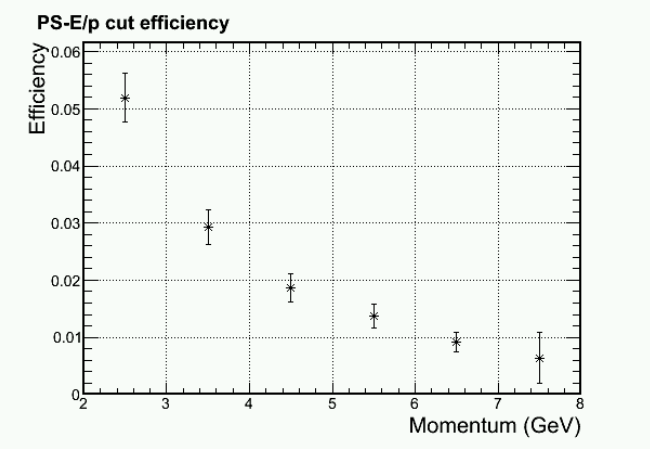
w/ photon, w/ pi+, Outer R, Low Rad phi slice



w/ o photon, w/ pi+, Inner R, High Rad phi slice



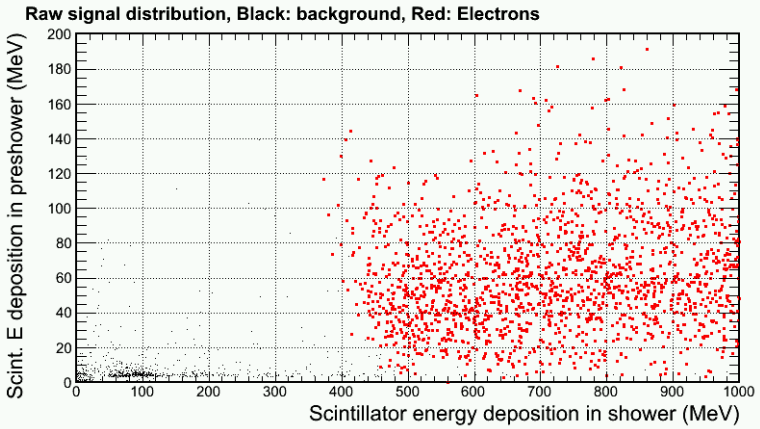
w/ o photon, w/ pi+, Inner R, Low Rad phi slice

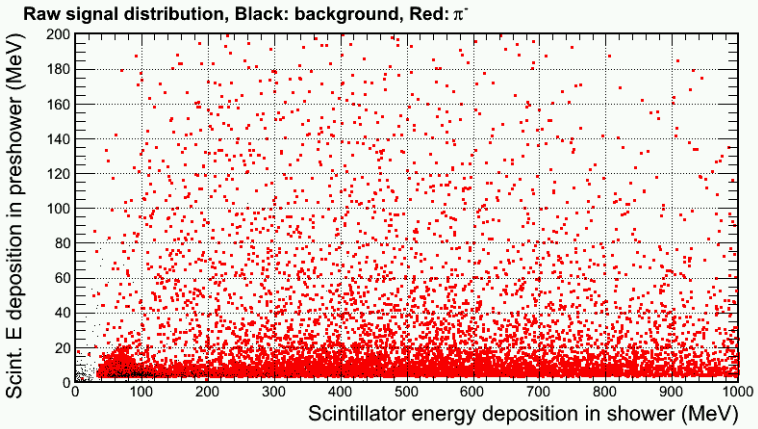


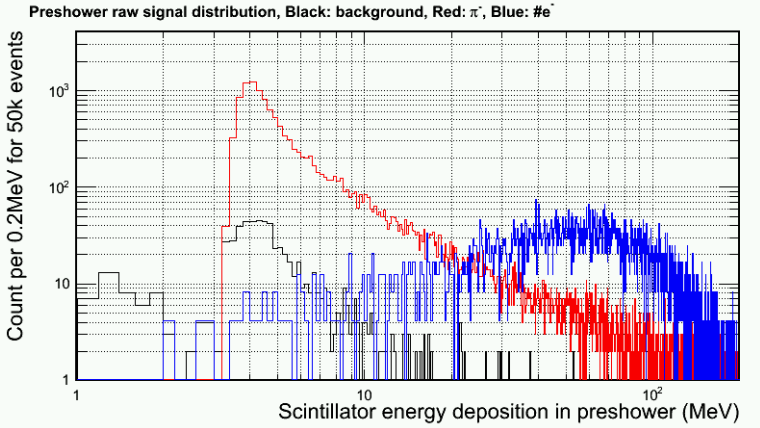
First update of CLEO background

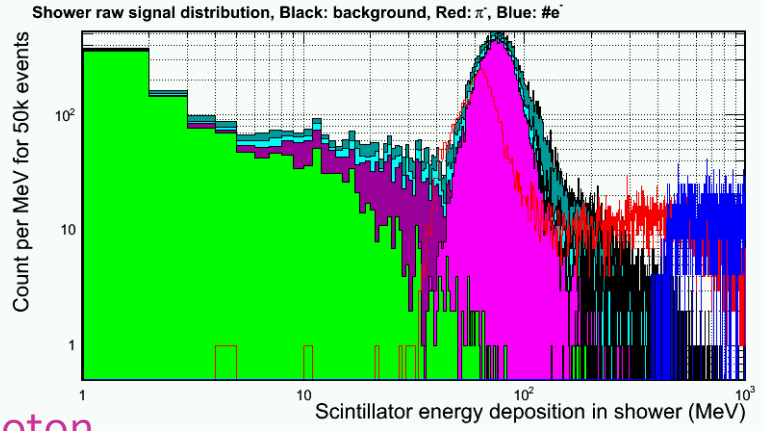
- Reported Apr 23 Calorimeter Meeting

Zhiwen Updated background contribution for all configurations. PVDIS shown here:



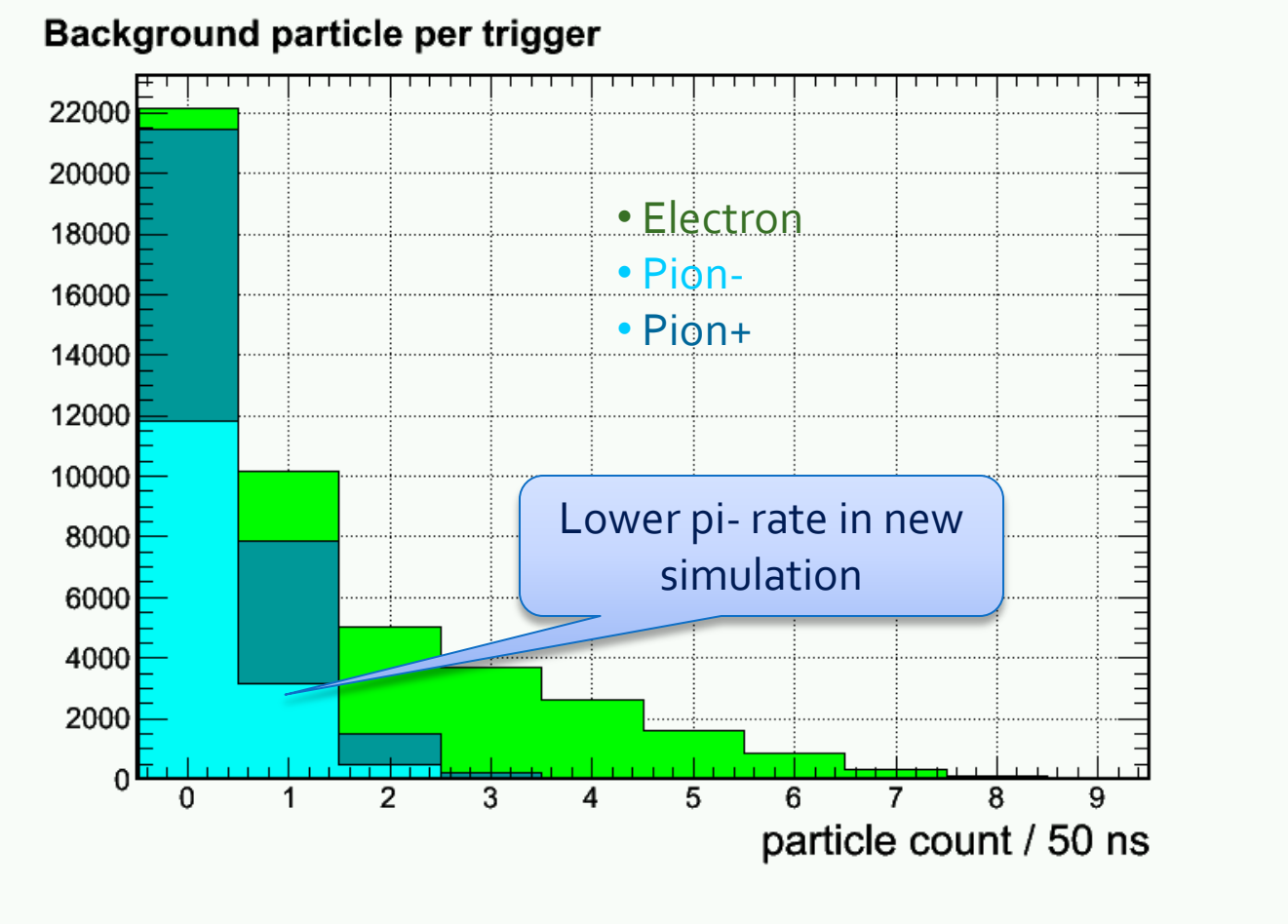




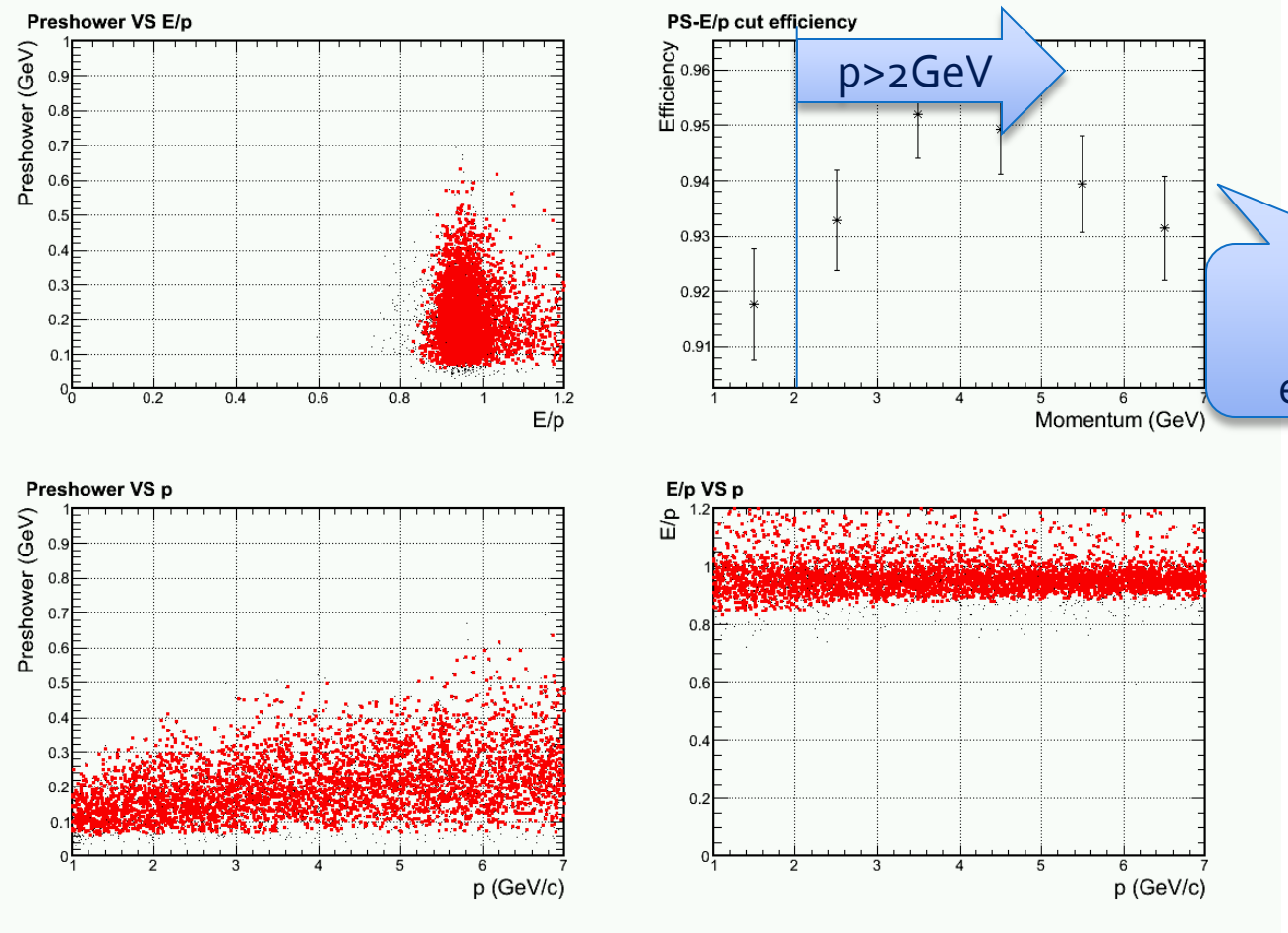


- Photon
- Electron
- Pion- Pion+

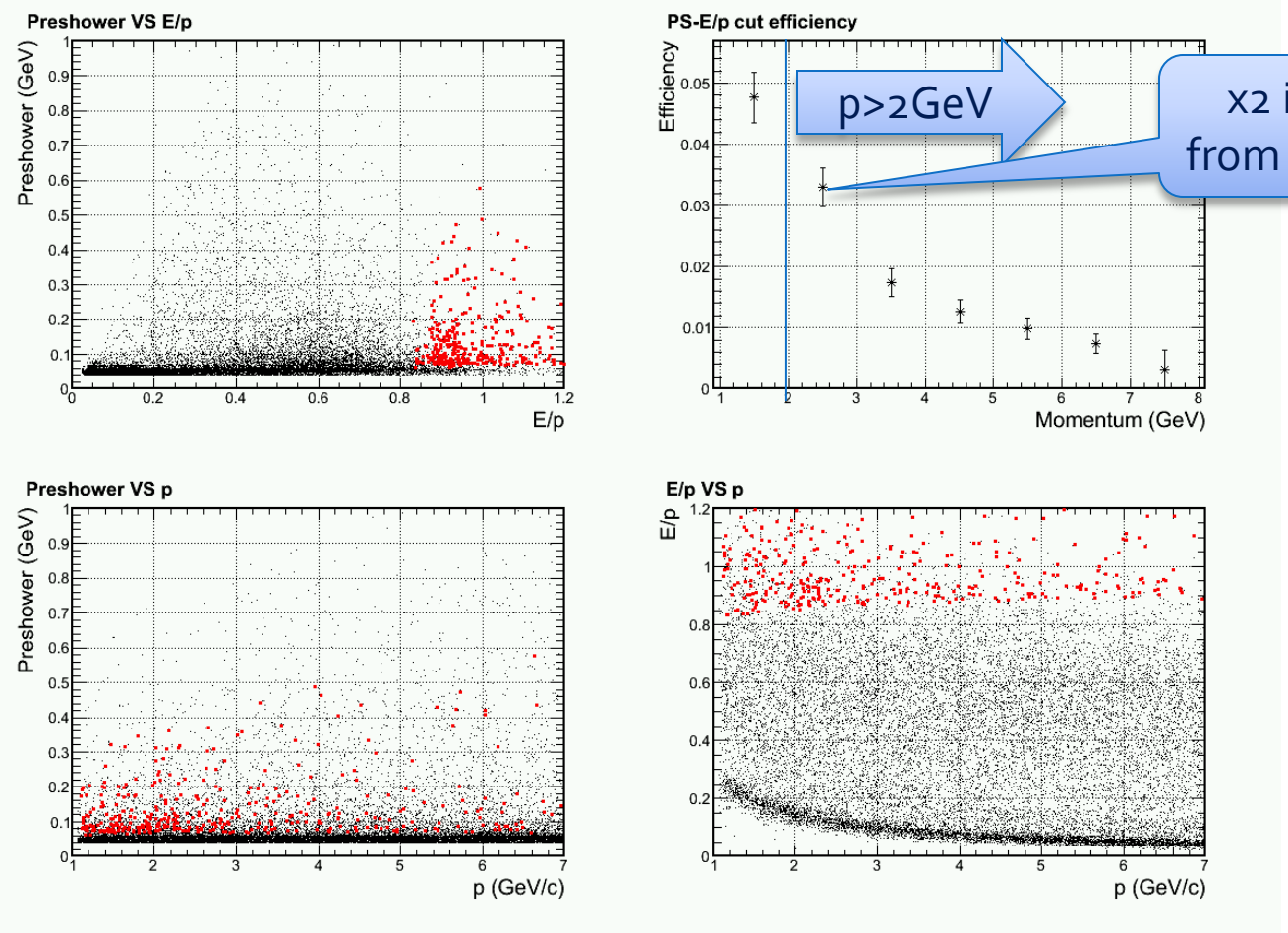
Updated: Per-event pion rate for 1+6 hexagon cluster at inner radius



Updated: electron efficiency
Only electron and pi- background used

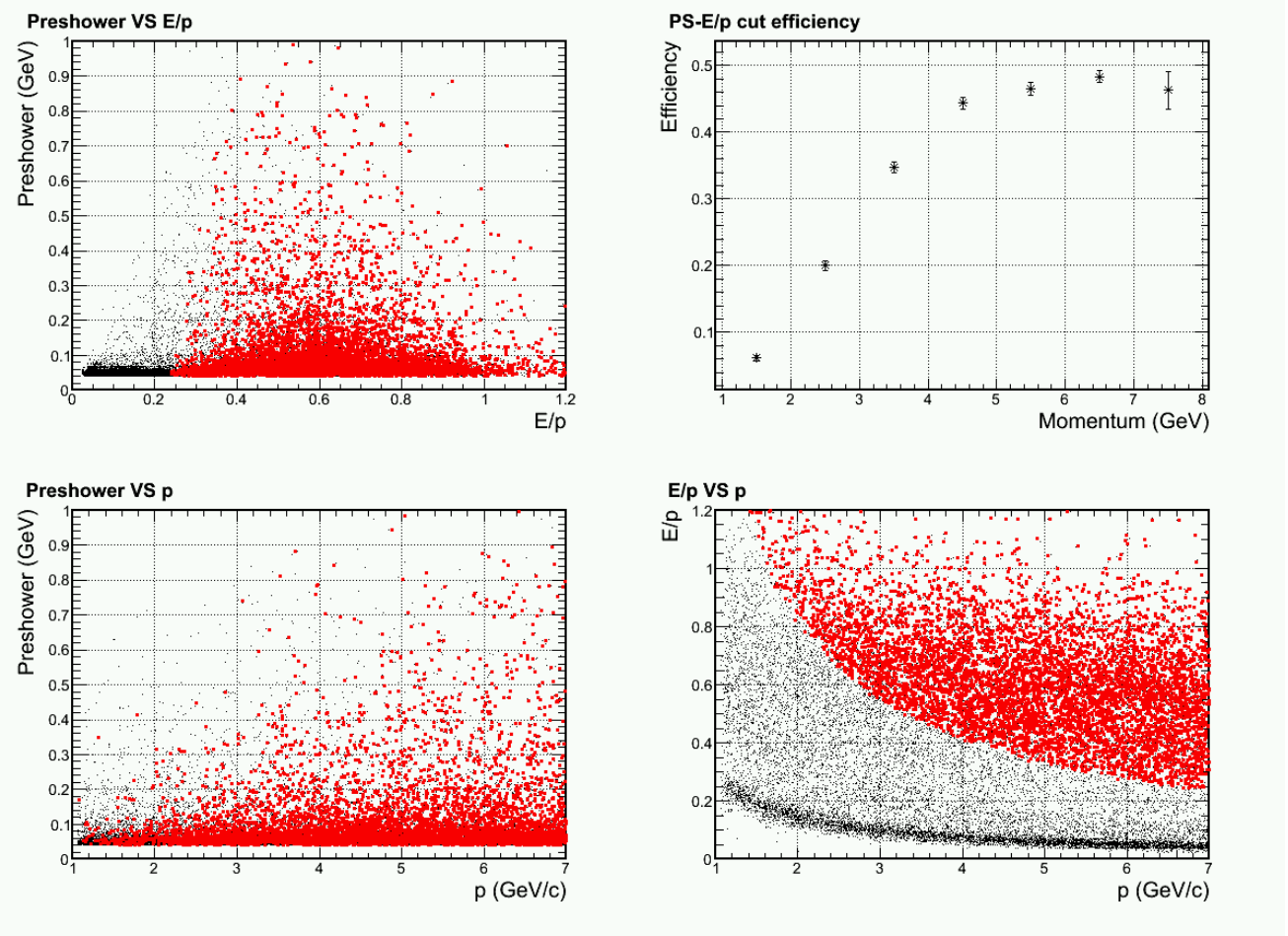


Updated: pion rejection
Only electron and pi- background used



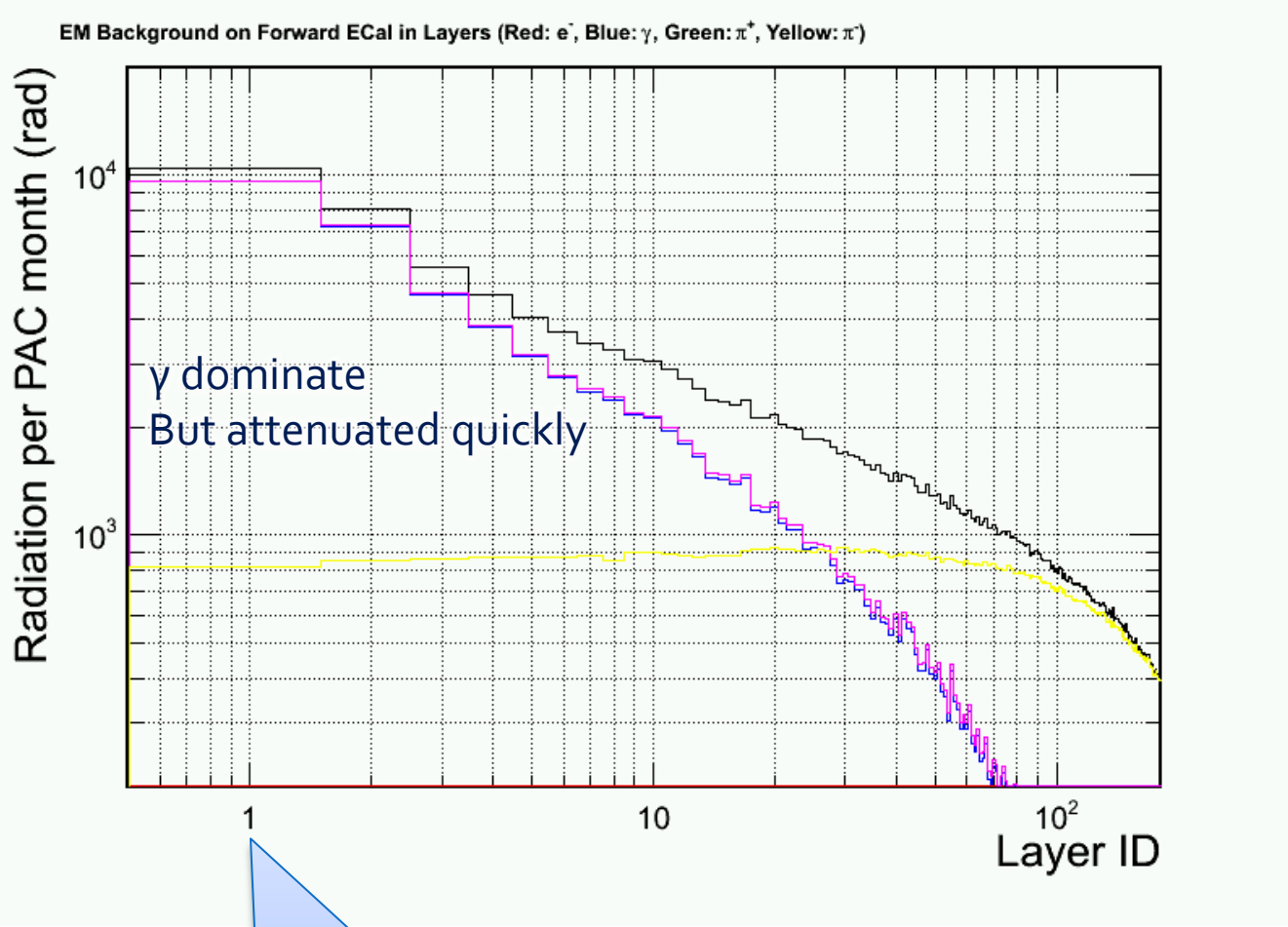
PVDIS trigger turn on curve

2GeV electron cut based on shower Hex1+6 cluster only



PVDIS – current baffle (with direct γ)

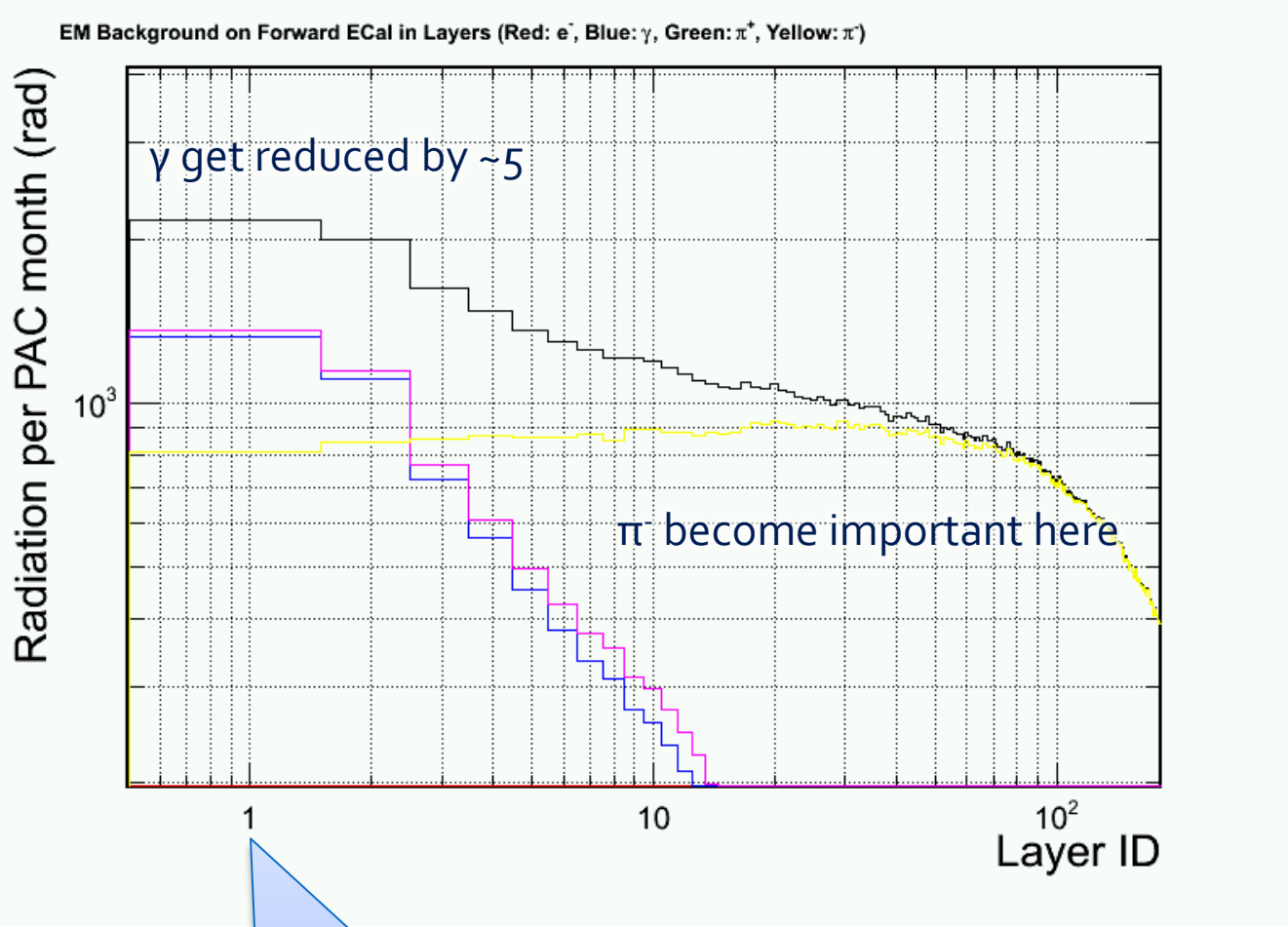
From Dec Collaboration Meeting



Layer #1 is 2cm preshower scint.

PVDIS – preview for a baffle w/o direct γ

From Dec Collaboration Meeting

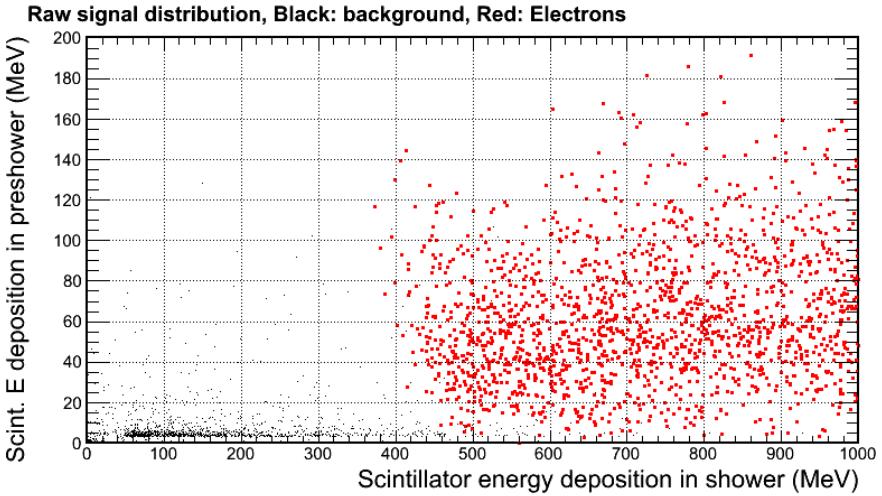


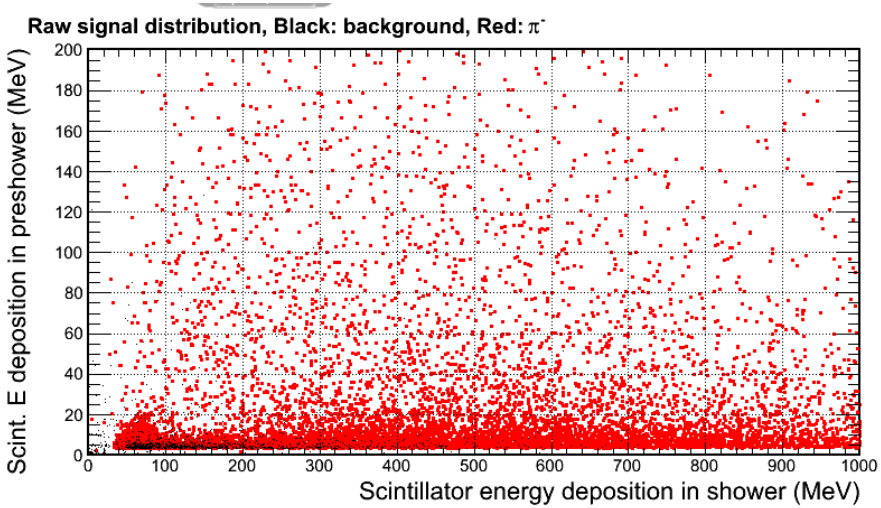
Layer #1 is 2cm preshower scint.

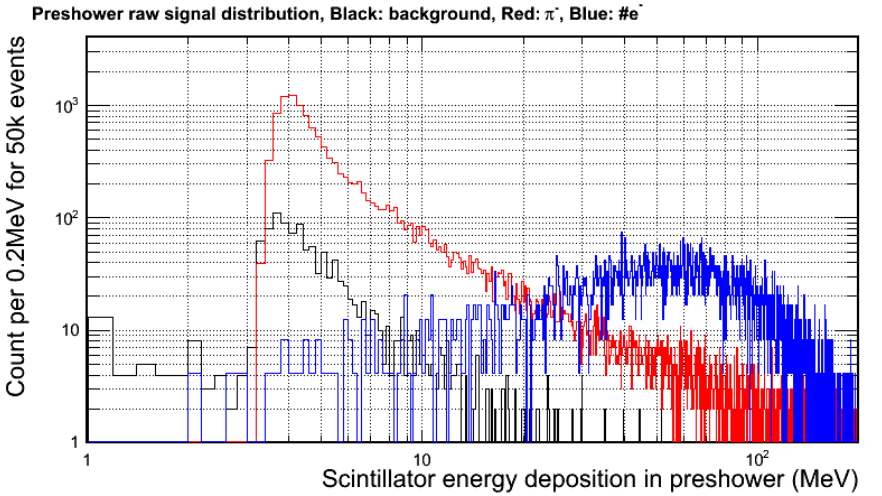
Last Version of Background Simulation (reported last week)

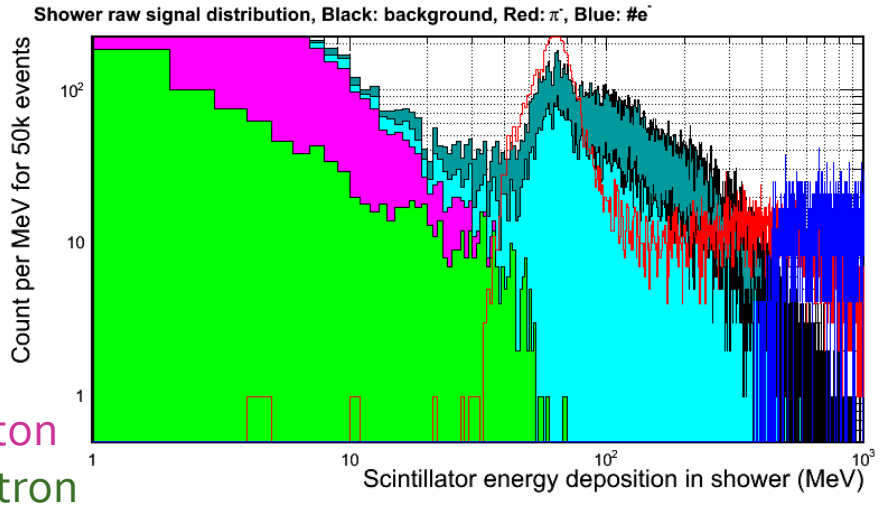
»

Why it is hard – lots of deep pions



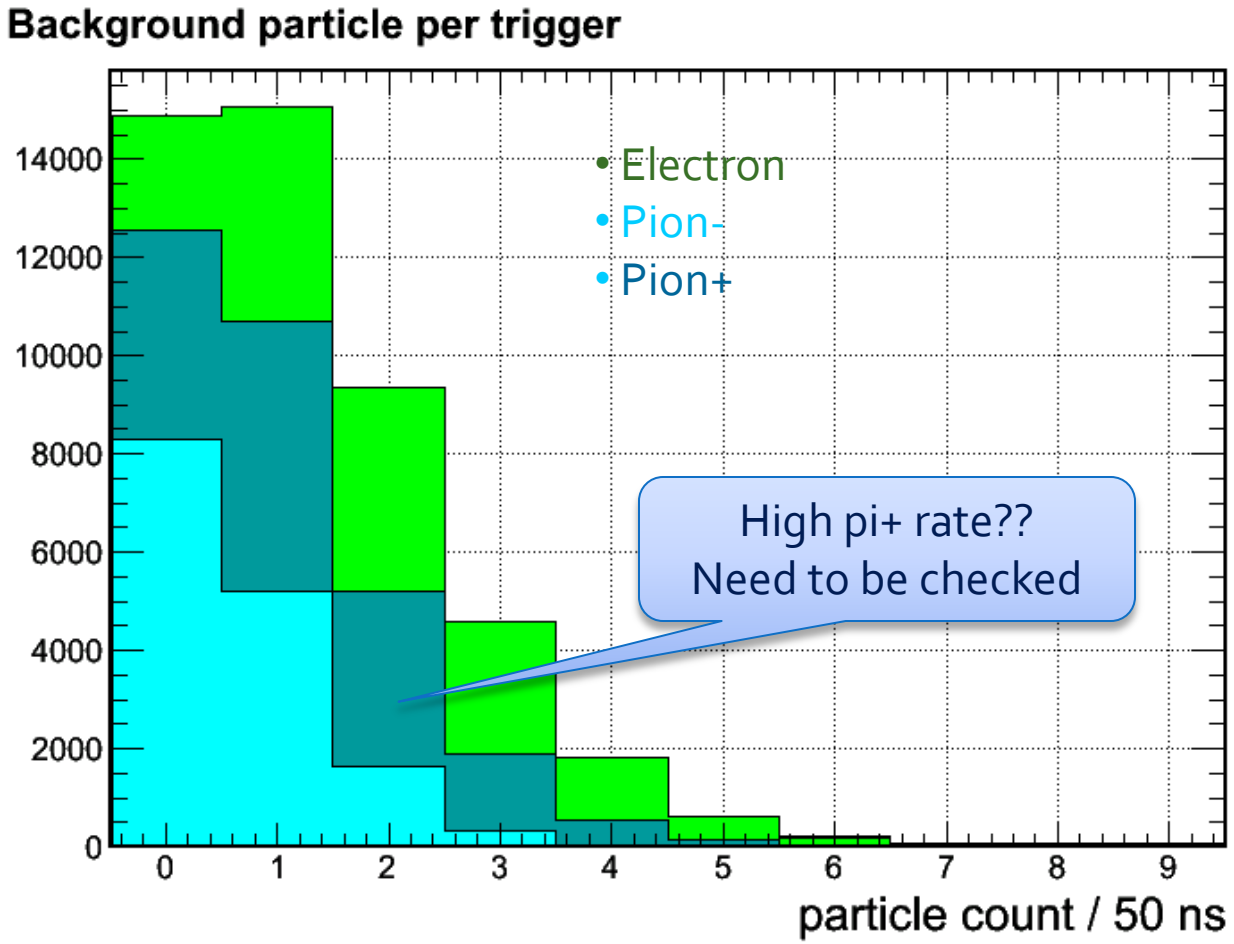




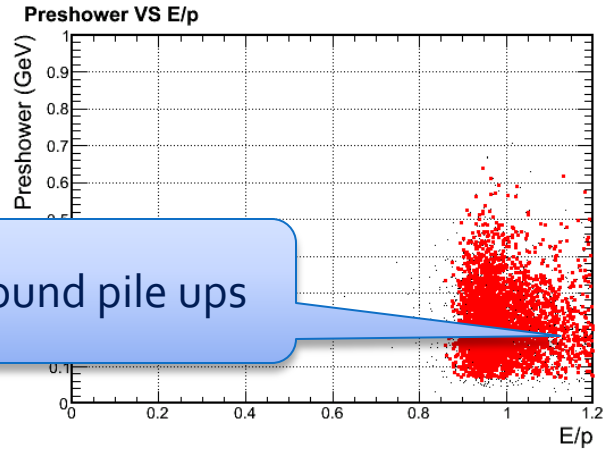


- Photon
- Electron
- Pion- Pion+

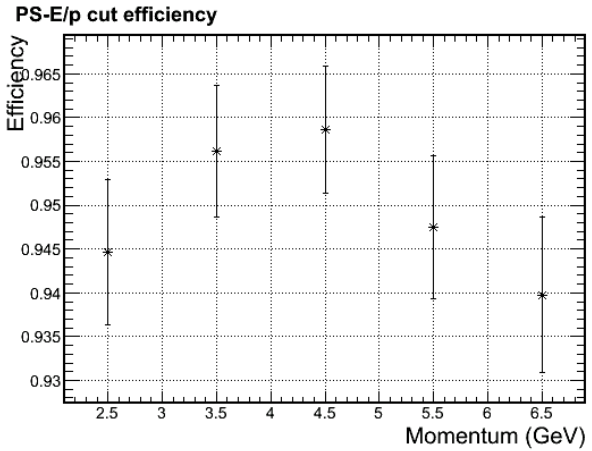
Per-event pion rate for 1+6 hexagon cluster at inner radius

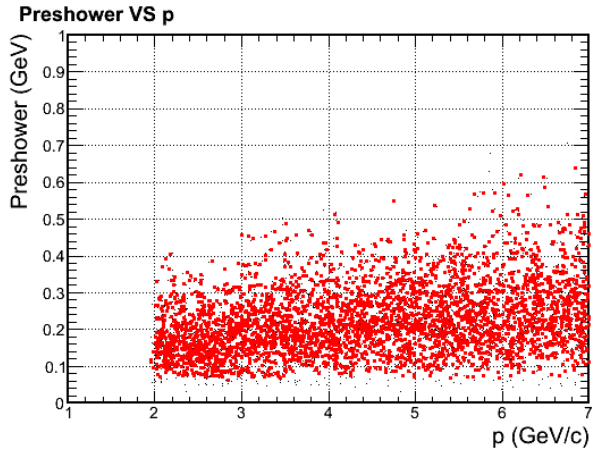


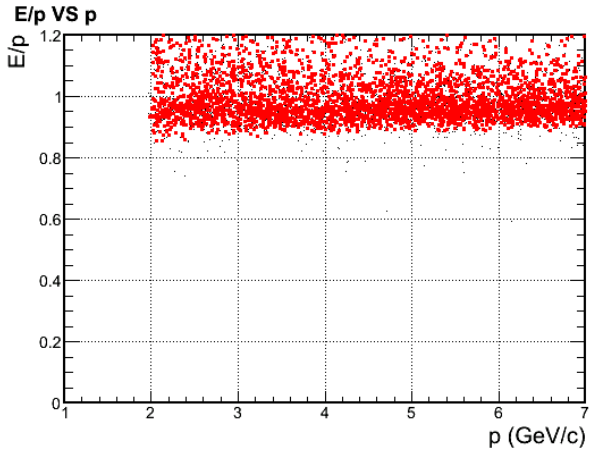
Electron efficiency w/ background at inner radius. Ignore gamma and pi+ bgd



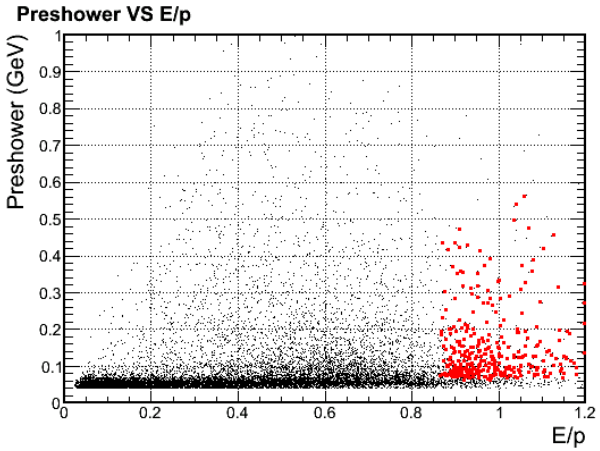
Background pile ups

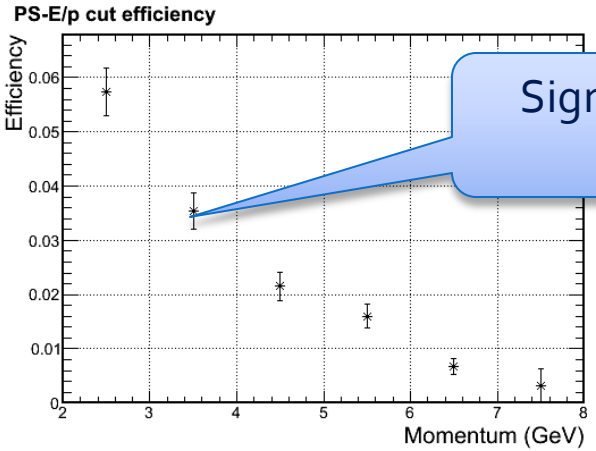




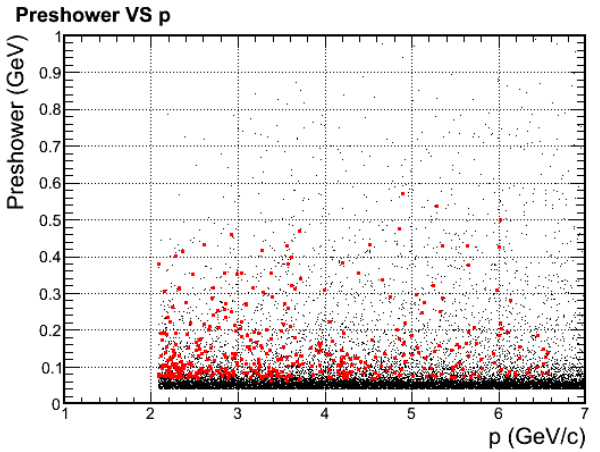


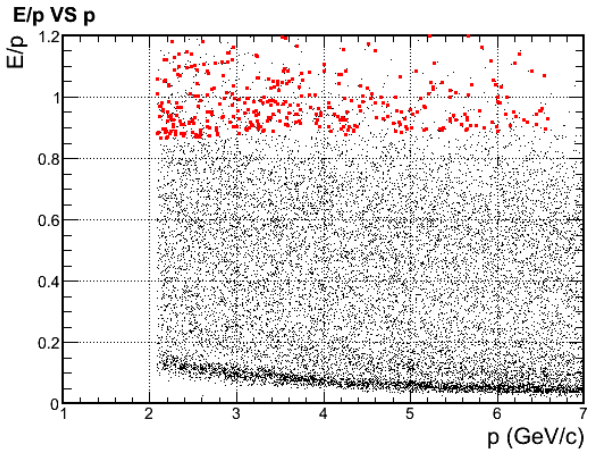
Pion efficiency w/ background at inner radius. Ignore gamma and pi+ bgd





Significant drop in rejection





What we can further try

- Position or kinematic dependent trigger threshold and cut threshold
- Use track multiplicity to assist calorimeter cuts