Exclusive pions and photon correction

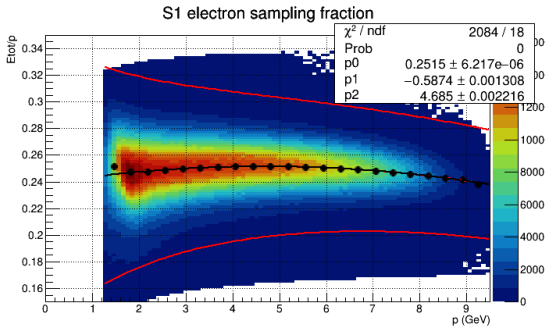
F.-X. Girod

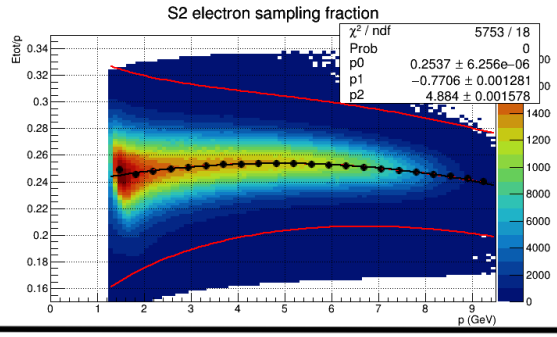
UConn

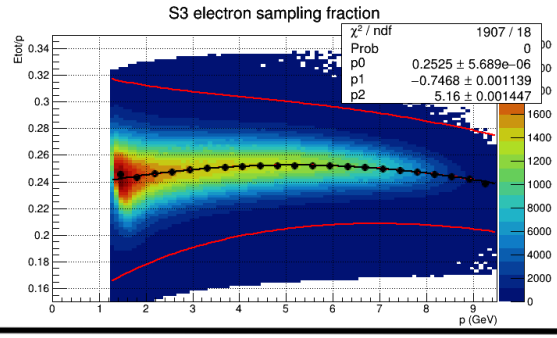
Sept 6th 2019

Outline

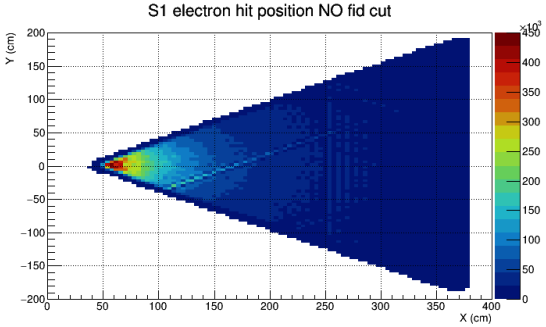
ECal fiducial cuts: electrons

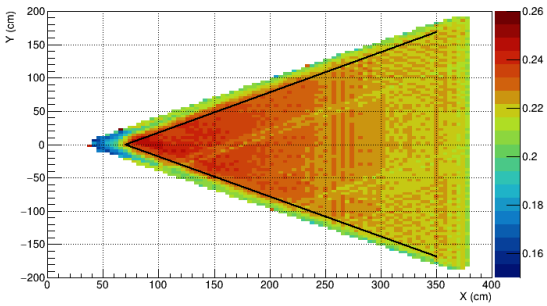




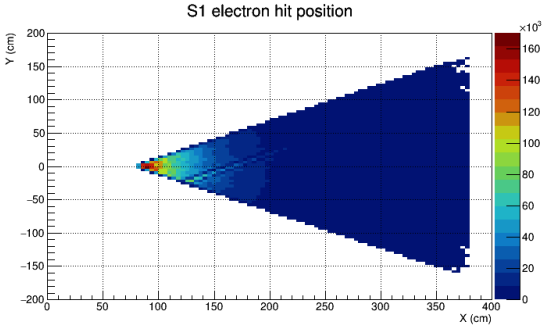


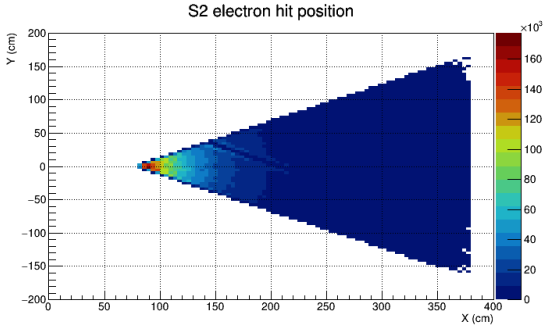
Before fiducial

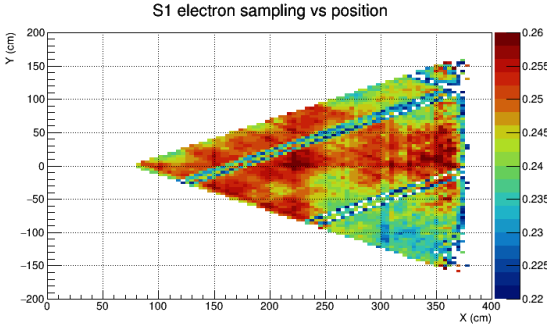


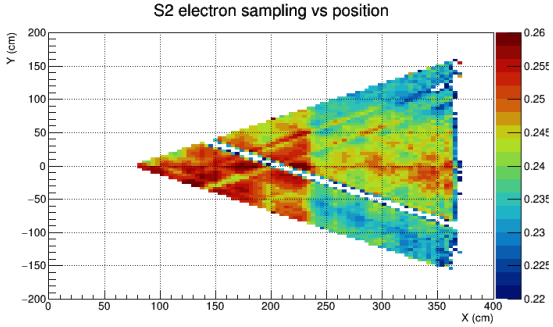


After fiducial









Photon energy correction method

Correction method developped back for DVCS at 6 GeV
documented in CLAS NOTE 2006-015
Uses the two photon invariant mass in π^0 decay as function of photon energy

$$\mathrm{IM}_{\gamma\gamma} = \sqrt{E_1 E_2} \times 2\sin\frac{\theta_{\gamma\gamma}}{2}$$

Define the correction as

$$E_{\mathrm{corrected}} = \frac{4 \times E_{\mathrm{deposited}}}{\mathrm{correction}(4 \times E_{\mathrm{deposited}})}$$

Then

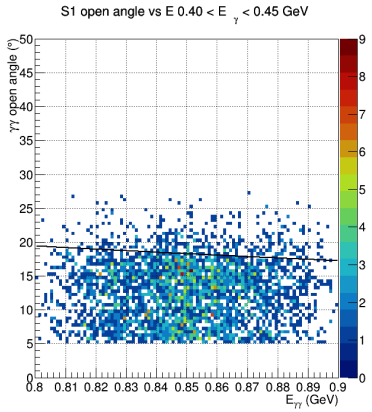
$$\frac{\mathrm{IM}_{\gamma\gamma}}{m_{\pi^0\mathrm{PDG}}} = \sqrt{cor(E_1)cor(E_2)}$$

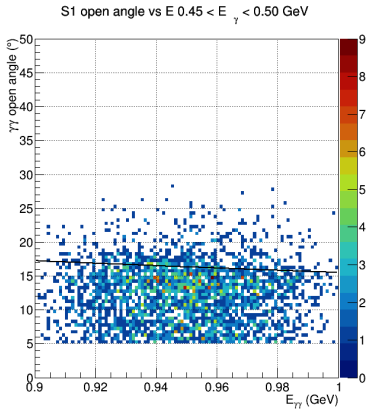
Process in two steps:

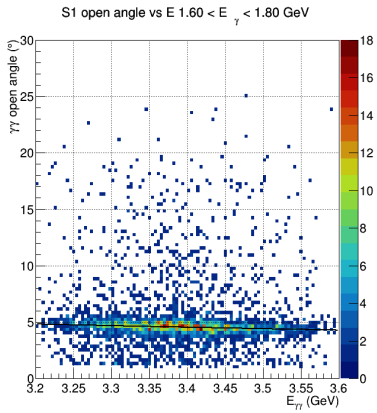
step 1 both photons in same energy bin over restricted energy range
25 bins from 0.4 GeV to 4.5 GeV

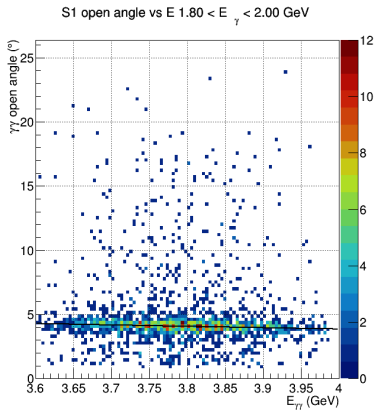
step 2 one photon in the step 1 range corrected, second photon over full range
50 bins from 0.2 GeV to 9 GeV

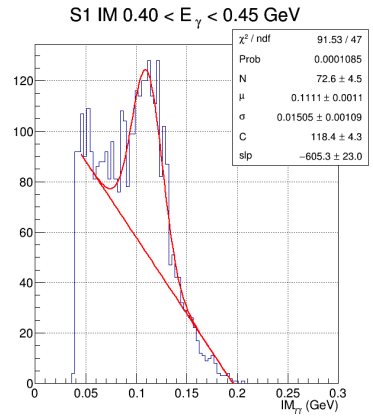
Step 1 energy correction

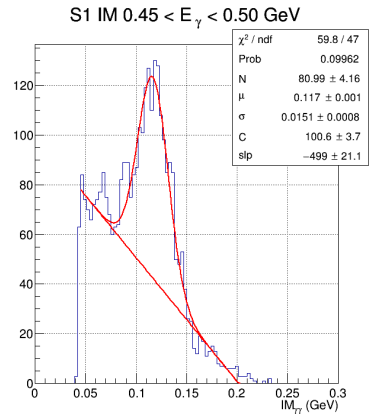


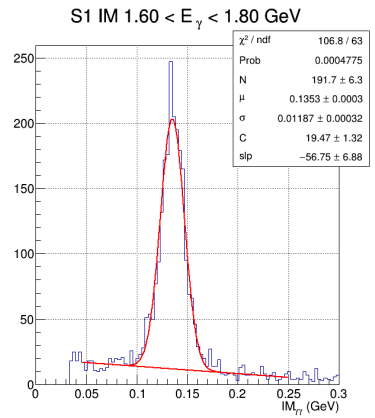


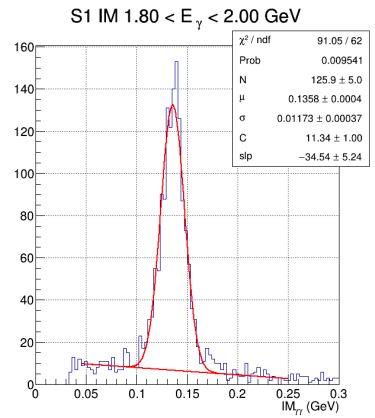






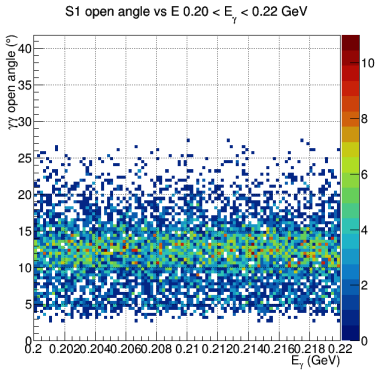


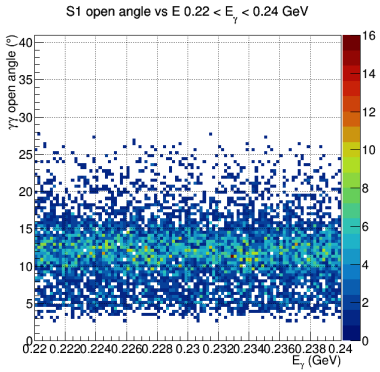


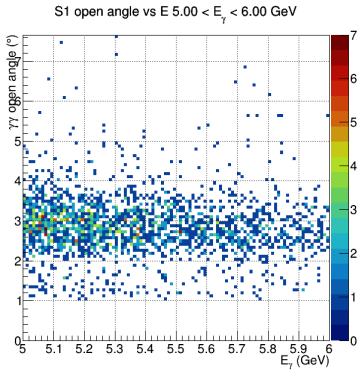


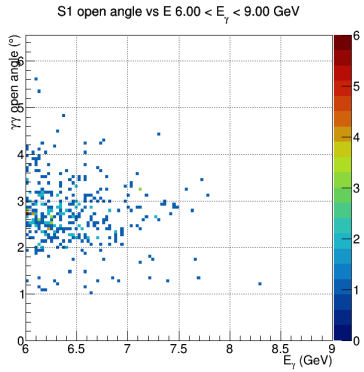
Showing sector 1 only, and four bins only

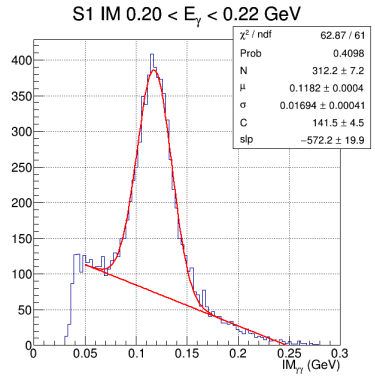
Step 2 energy correction

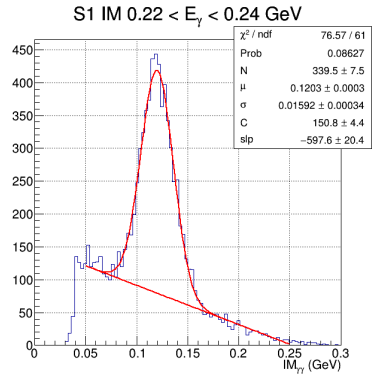


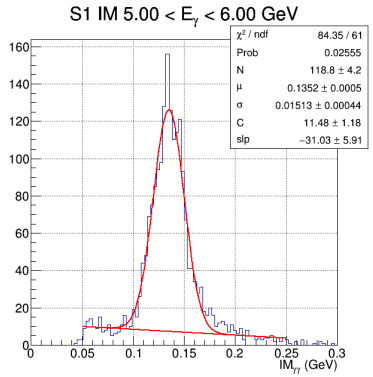


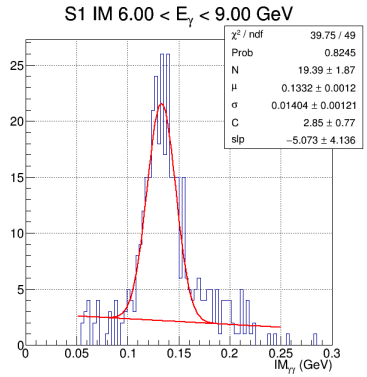






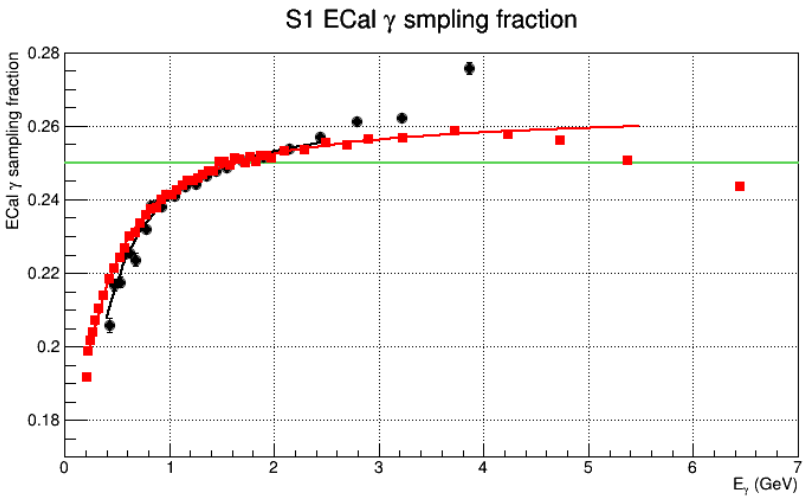


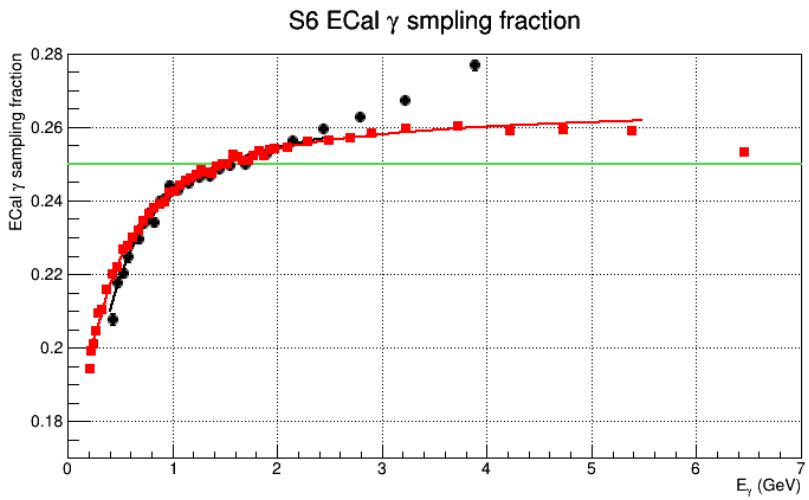


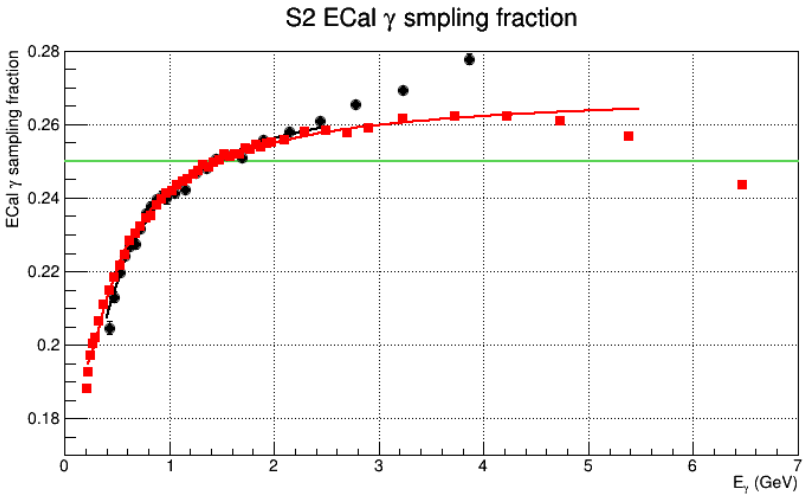


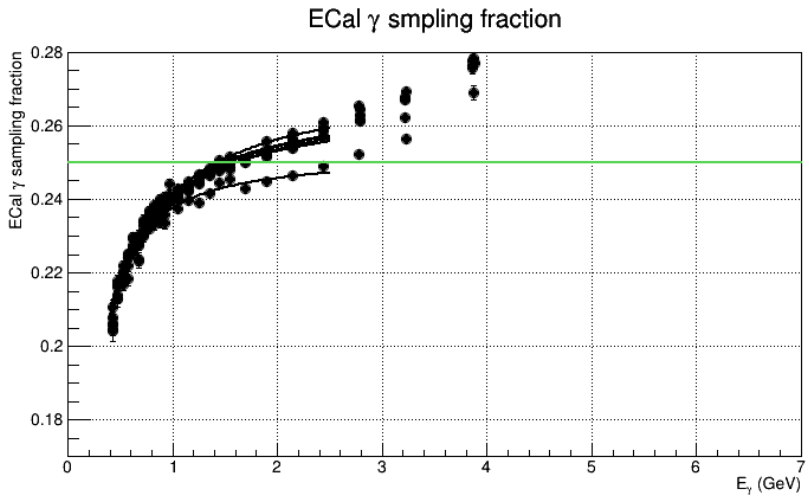
Showing sector 1 only, and four bins only

Result photon energy correction



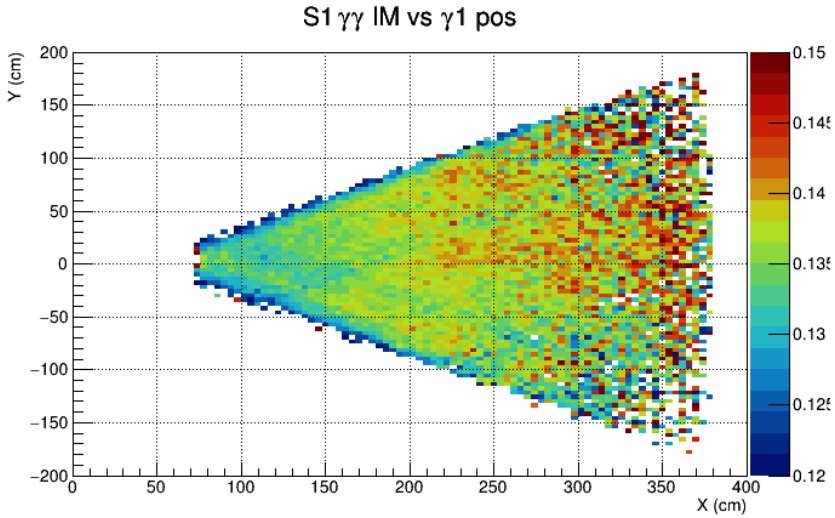


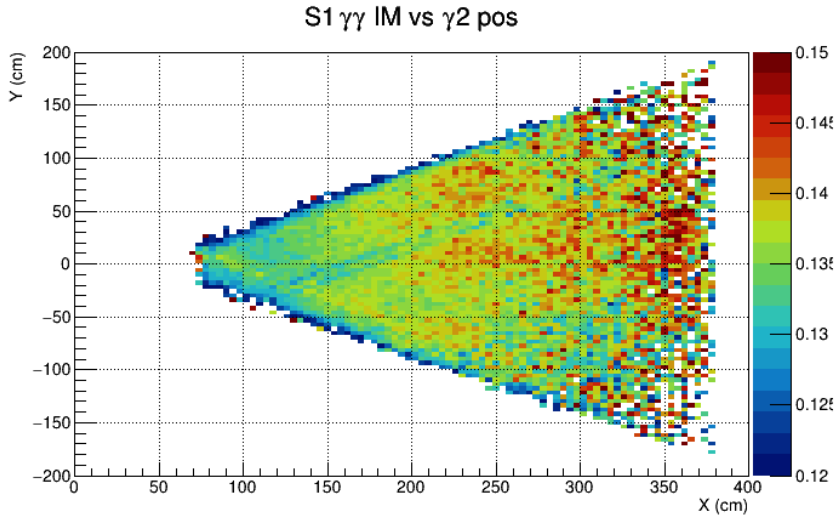


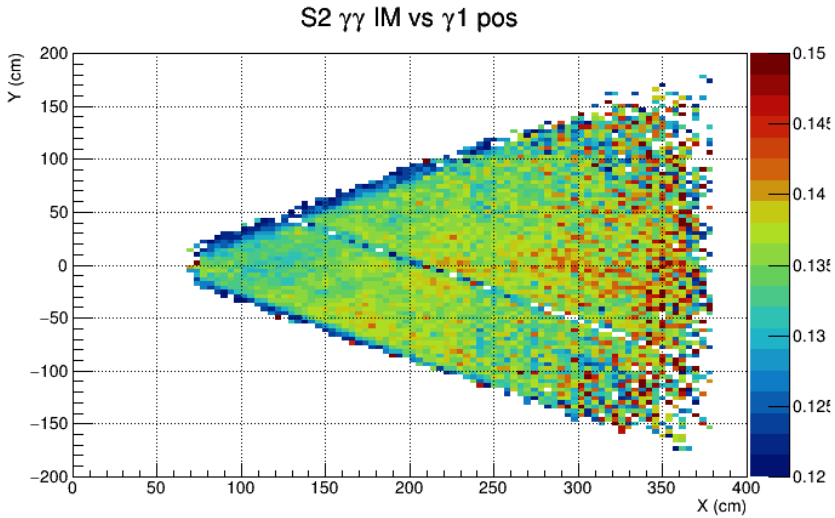


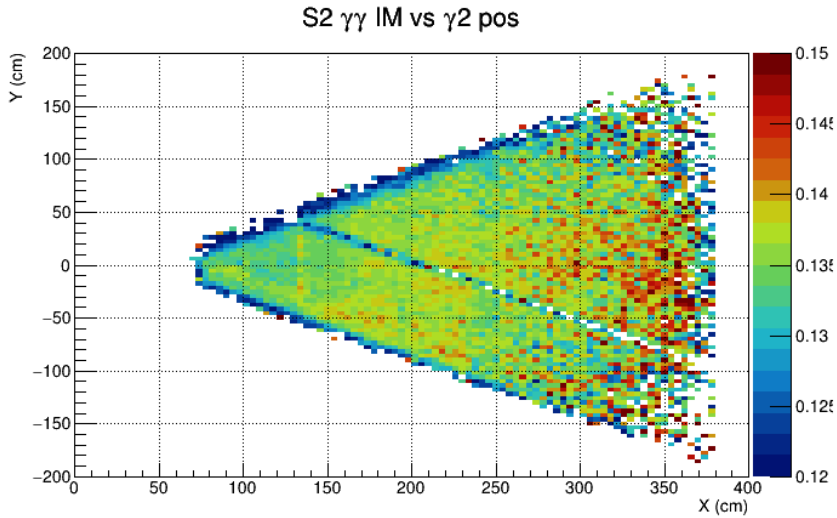
Photon sampling fraction steps 1 and 2 compared

Remaining systematics



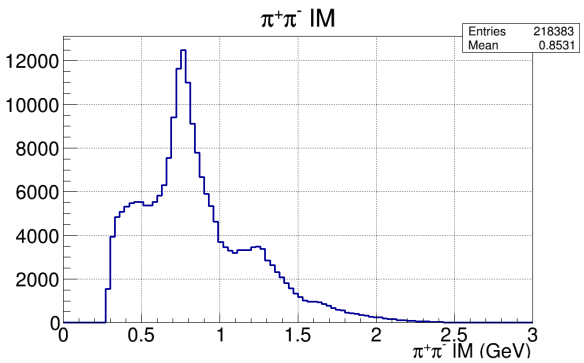


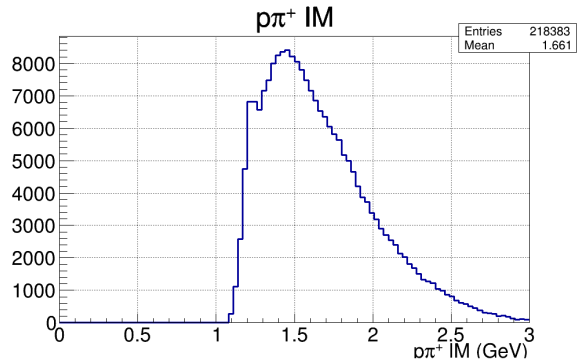


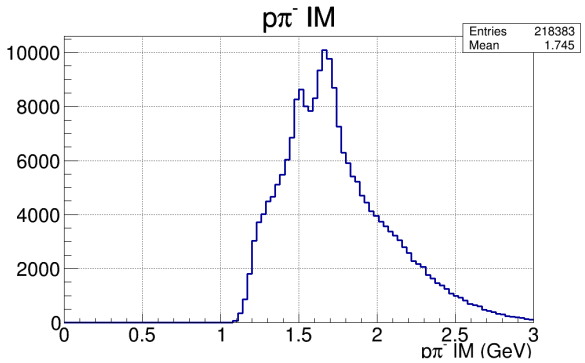


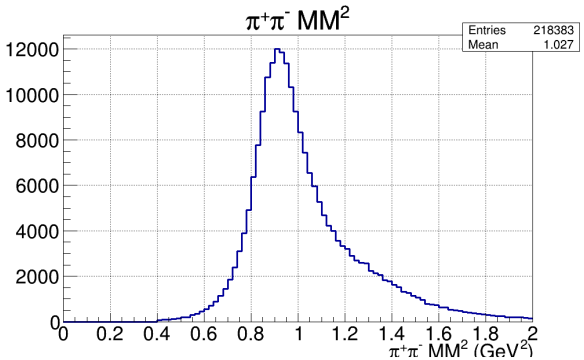
Some dependence on position remains after correction

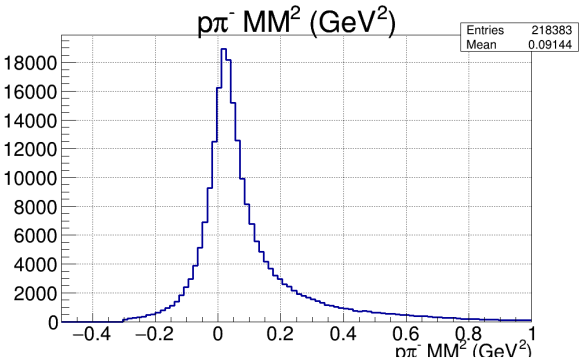
Two pions

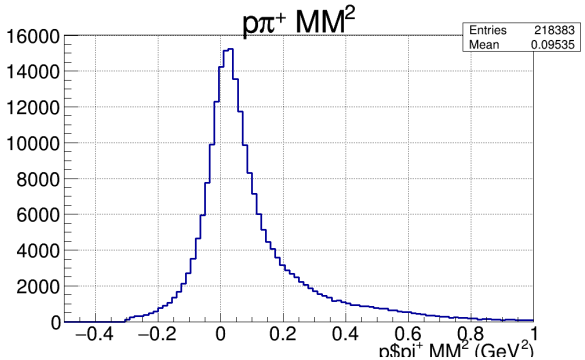

π⁺π⁻ IM
Entries 218383
Mean 0.8531
π⁺π⁻ IM (GeV)

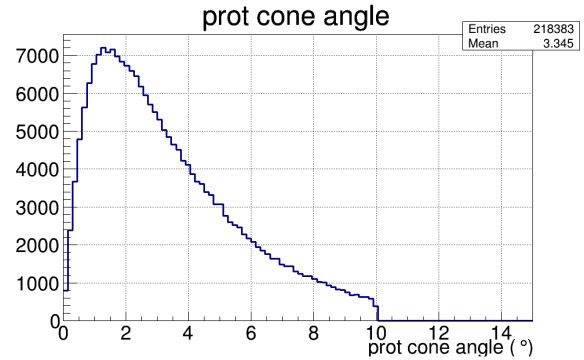

pπ⁺ IM
Entries 218383
Mean 1.661
pπ⁺ IM (GeV)

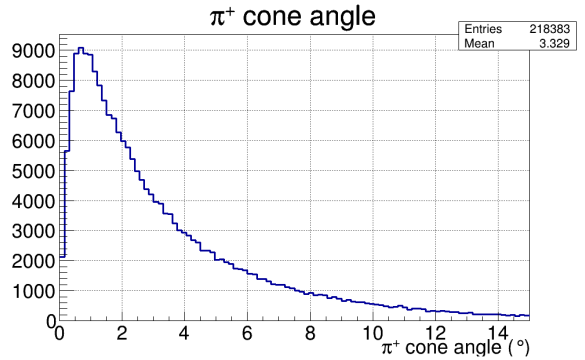

pπ⁻ IM
Entries 218383
Mean 1.745
pπ⁻ IM (GeV)

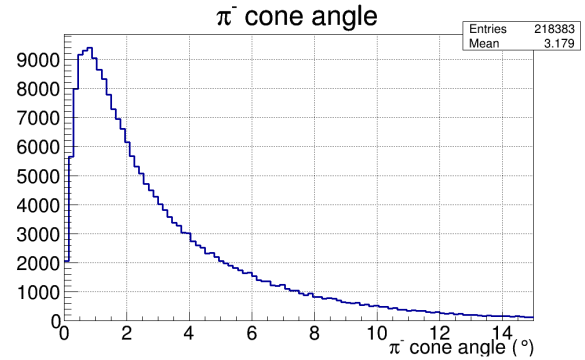

π⁺π⁻ MM²
Entries 218383
Mean 1.027
π⁺π⁻ MM² (GeV²)


pπ⁻ MM² (GeV²)
Entries 218383
Mean 0.09144
pπ⁻ MM² (GeV²)

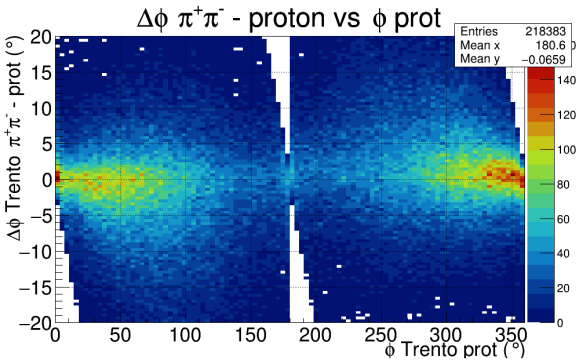

pπ⁺ MM²
Entries 218383
Mean 0.09535
pπ⁺ MM² (GeV²)

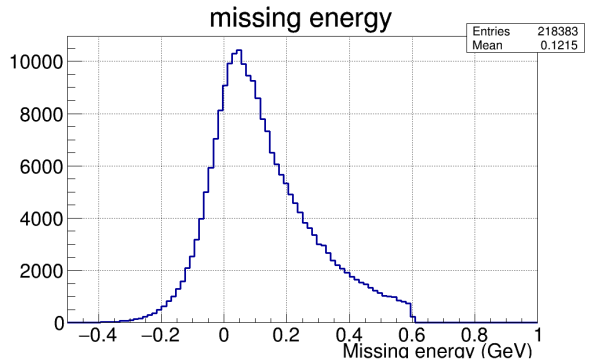

prot cone angle
Entries 218383
Mean 3.345
prot cone angle (°)

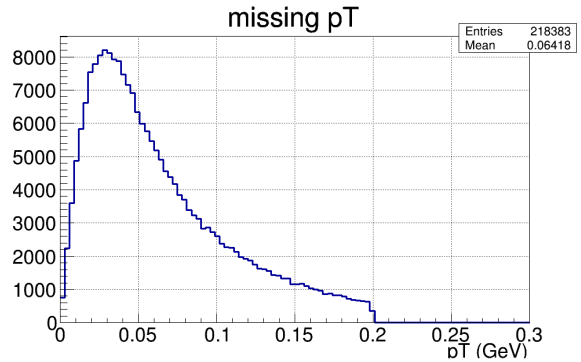

π⁺ cone angle
Entries 218383
Mean 3.329
π⁺ cone angle (°)

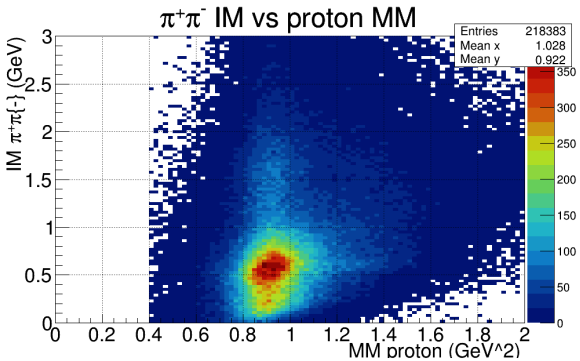

π⁻ cone angle
Entries 218383
Mean 3.179
π⁻ cone angle (°)

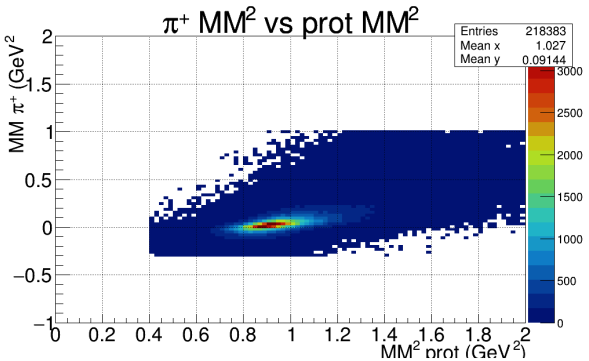
Two pions

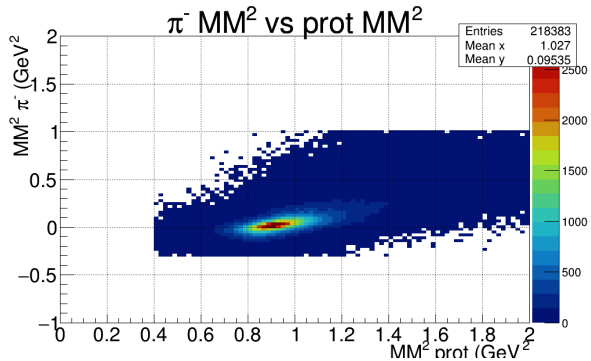

Δϕ π⁺π⁻ - proton vs ϕ prot
Entries 218383
Mean x 180.6
Mean y −0.0659
Δϕ Trento π⁺π⁻ - prot (°)
ϕ Trento prot (°)

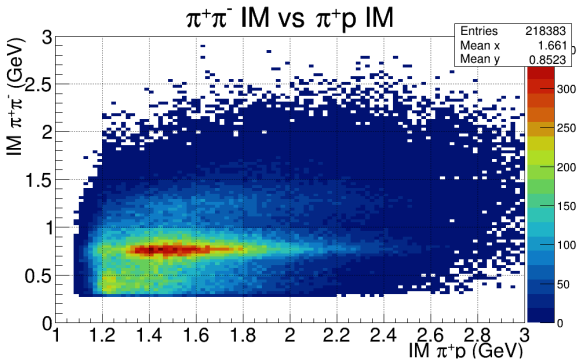

missing energy
Entries 218383
Mean 0.1215
Missing energy (GeV)

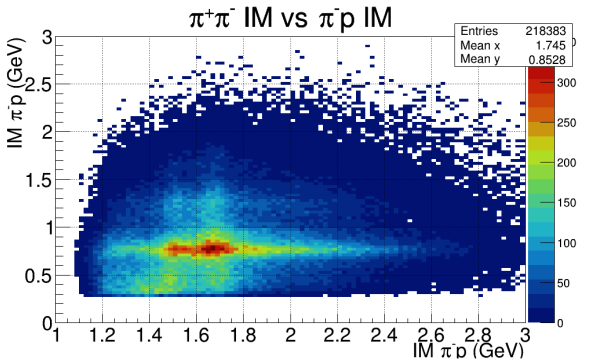

missing pT
Entries 218383
Mean 0.06418
pT (GeV)

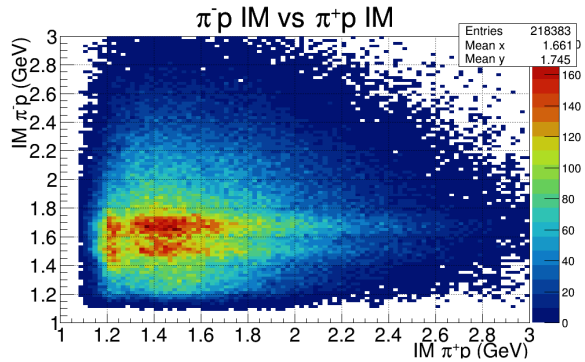

π⁺π⁻ IM vs proton MM
Entries 218383
Mean x 1.028
Mean y 0.922
IM π⁺π⁻ (GeV)
MM proton (GeV^2)


π⁺ MM² vs prot MM²
Entries 218383
Mean x 1.027
Mean y 0.09144
MM π⁺ (GeV²)
MM² prot (GeV²)

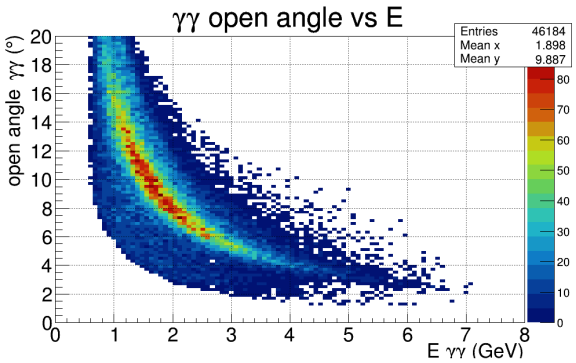

π⁻ MM² vs prot MM²
Entries 218383
Mean x 1.027
Mean y 0.09535
MM² π⁻ (GeV²)
MM² prot (GeV²)

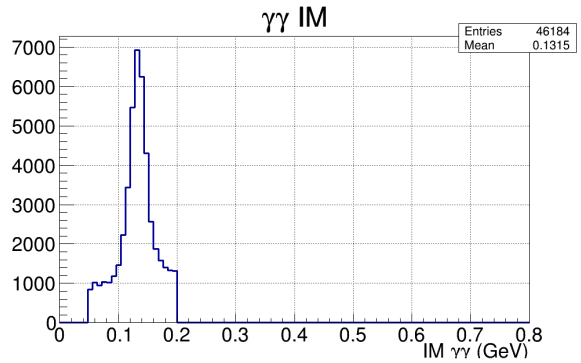

π⁺π⁻ IM vs π⁺p IM
Entries 218383
Mean x 1.661
Mean y 0.8523
IM π⁺π⁻ (GeV)
IM π⁺p (GeV)

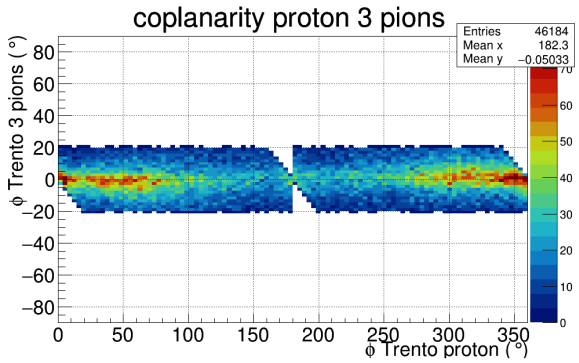

π⁺π⁻ IM vs π⁻p IM
Entries 218383
Mean x 1.745
Mean y 0.8528
IM π⁻p (GeV)
IM π⁻p (GeV)

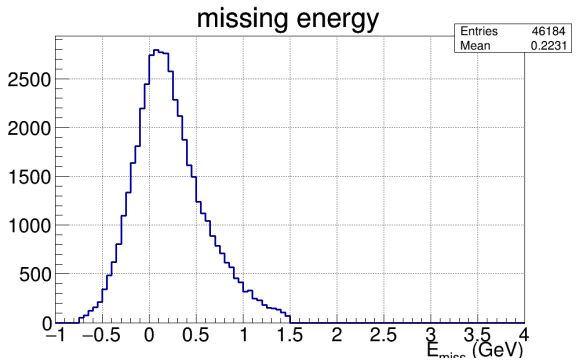

π⁻p IM vs π⁺p IM
Entries 218383
Mean x 1.661
Mean y 1.745
IM π⁻p (GeV)
IM π⁺p (GeV)

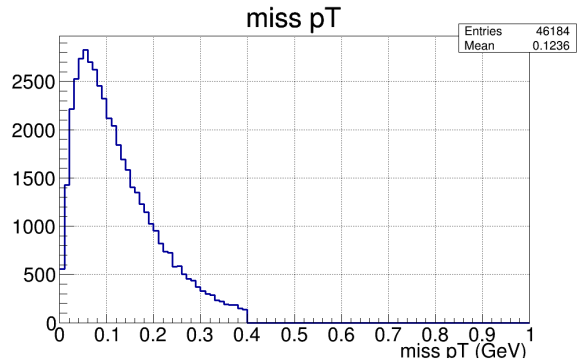
Three pions

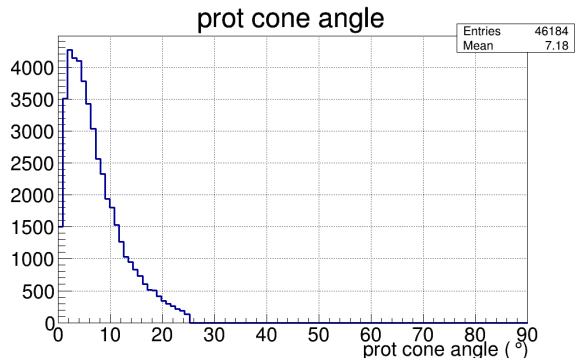

γγ open angle vs E
Entries 46184
Mean x 1.898
Mean y 9.887
open angle γγ (°)
E γγ (GeV)

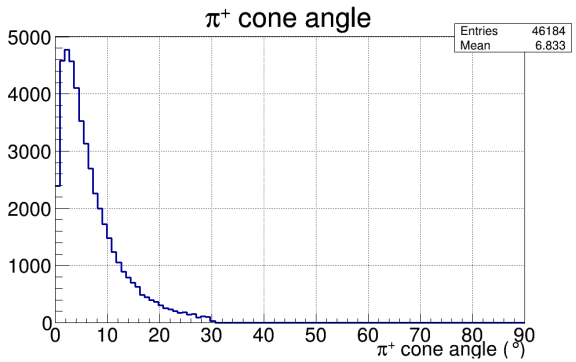

γγ IM
Entries 46184
Mean 0.1315
IM γγ (GeV)

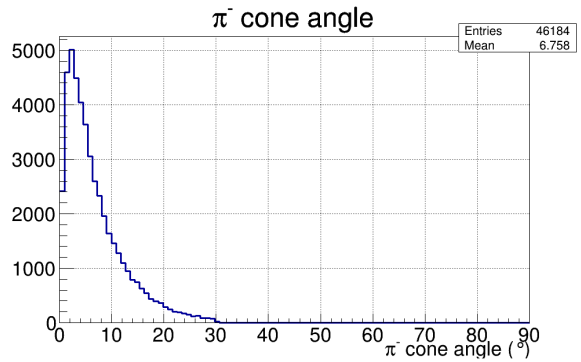

coplanarity proton 3 pions
Entries 46184
Mean x 182.3
Mean y −0.05033
ϕ Trento 3 pions (°)
ϕ Trento proton (°)

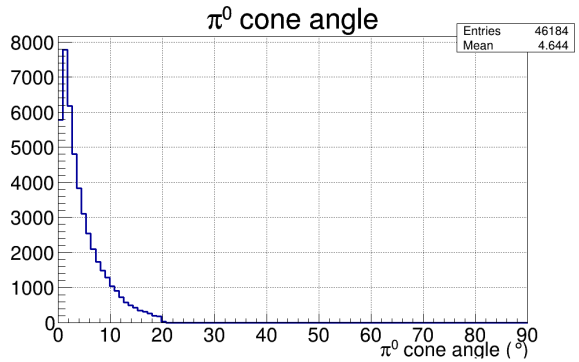

missing energy
Entries 46184
Mean 0.2231
E_miss (GeV)


miss pT
Entries 46184
Mean 0.1236
miss pT (GeV)

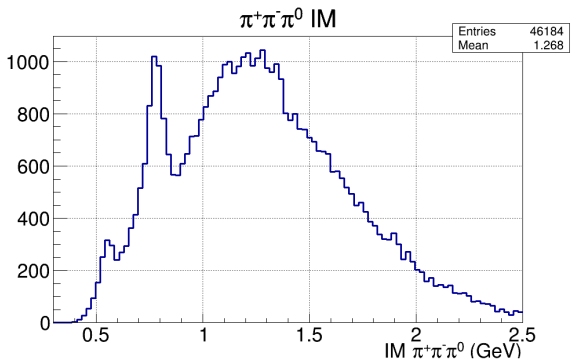

prot cone angle
Entries 46184
Mean 7.18
prot cone angle (°)

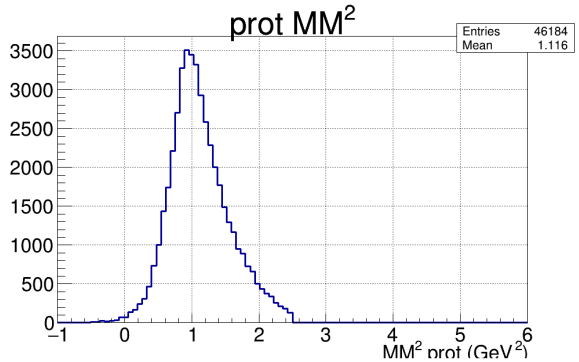

π+ cone angle
Entries 46184
Mean 6.833
π+ cone angle (°)

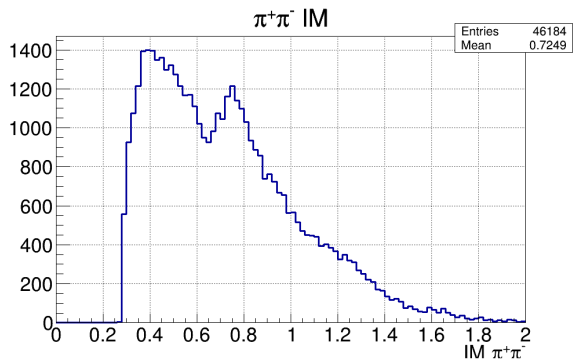

π- cone angle
Entries 46184
Mean 6.758
π- cone angle (°)

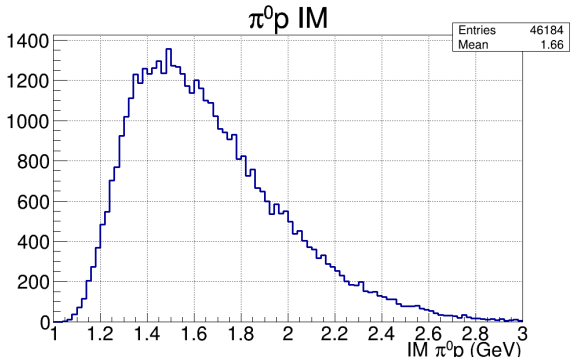

π0 cone angle
Entries 46184
Mean 4.644
π0 cone angle (°)

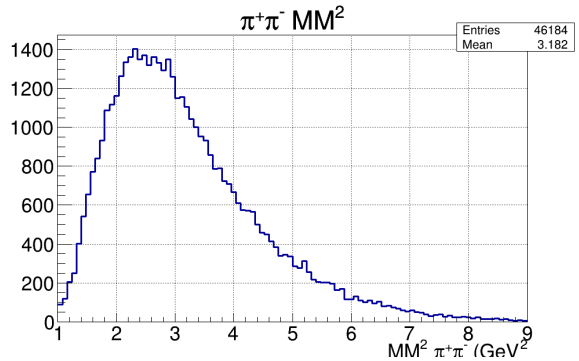
Three pions

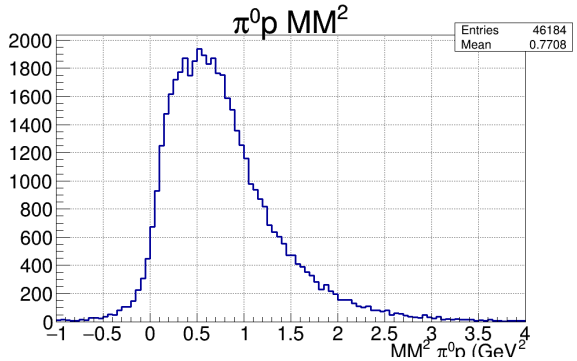

$\pi^+\pi^-\pi^0$ IM
Entries 46184
Mean 1.268
IM $\pi^+\pi^-\pi^0$ (GeV)

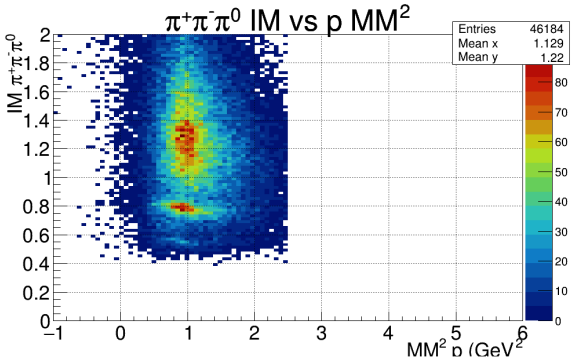

prot MM^2
Entries 46184
Mean 1.116
MM^2 prot (GeV^2)

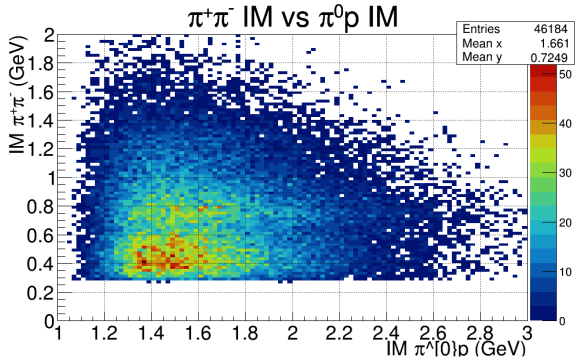

$\pi^+\pi^-$ IM
Entries 46184
Mean 0.7249
IM $\pi^+\pi^-$

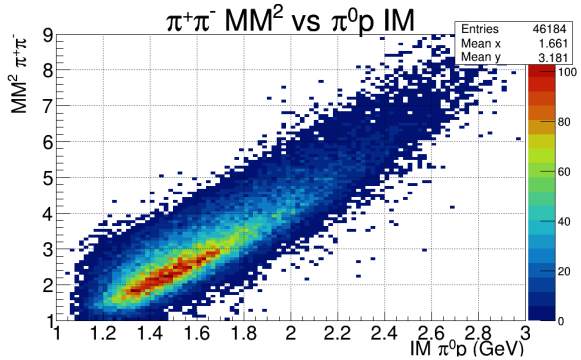

π^0p IM
Entries 46184
Mean 1.66
IM π^0p (GeV)


$\pi^+\pi^-$ MM^2
Entries 46184
Mean 3.182
MM^2 $\pi^+\pi^-$ (GeV^2)


π^0p MM^2
Entries 46184
Mean 0.7708
MM^2 π^0p (GeV^2)


$\pi^+\pi^-\pi^0$ IM vs p MM^2
Entries 46184
Mean x 1.129
Mean y 1.22
IM $\pi^+\pi^-\pi^0$
MM^2 p (GeV^2)


$\pi^+\pi^-$ IM vs π^0p IM
Entries 46184
Mean x 1.661
Mean y 0.7249
IM $\pi^+\pi^-$ (GeV)
IM π^0p (GeV)


$\pi^+\pi^-$ MM^2 vs π^0p IM
Entries 46184
Mean x 1.661
Mean y 3.181
MM^2 $\pi^+\pi^-$
IM π^0p (GeV)

Summary outlook

- Photon energy correction for ECal, must be redone with latest calib for FTCal
- Photon energy correction needed for DVCS and π^0 analysis
- Two pions: exclusive ρ
- Three pions: exclusive ω
- ρ and ω important parts of the GPD program
- Not discussed here: SCHC