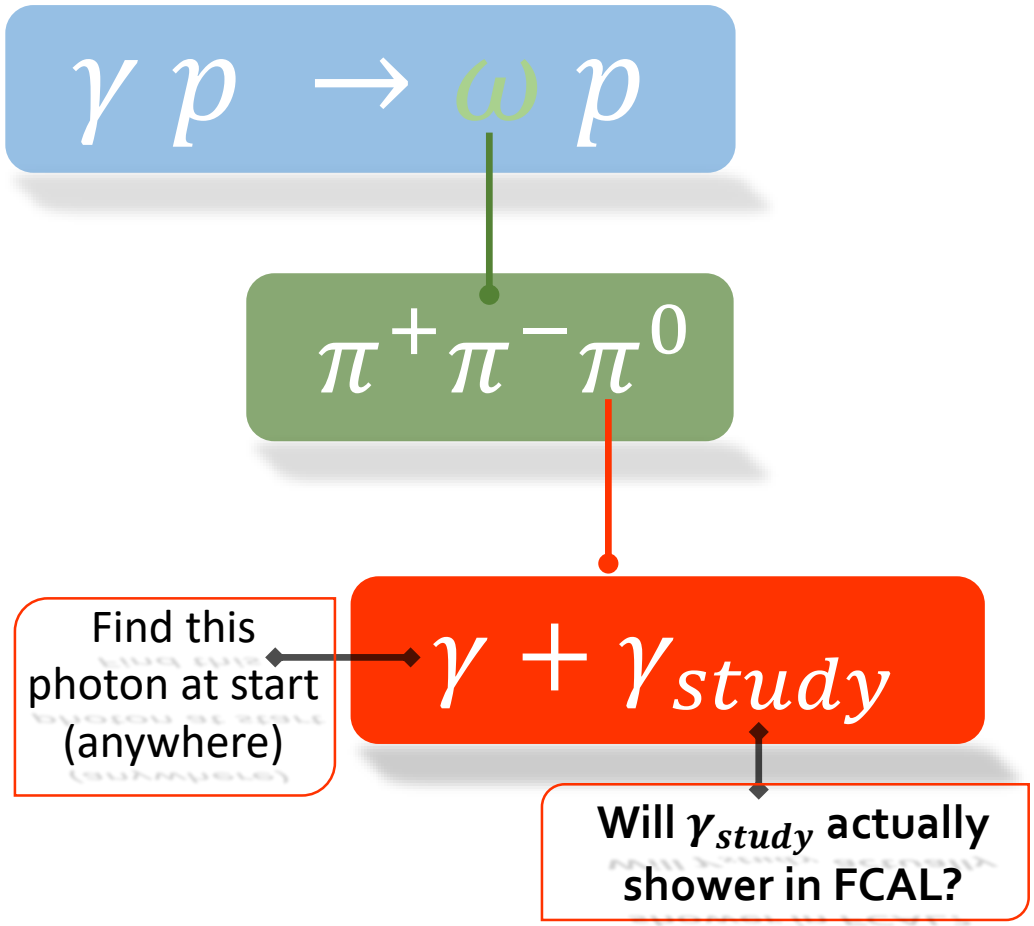
Updates on Efficiency With $\omega \rightarrow 3\pi$

Now with a little bit of BCAL!

Reminder

- Charge from Physics Analysis Plan 2018:
  - Determine photon efficiency (function of E, θ, ϕ) to 5%
  - π^0/η mass calibrations to 5 MeV
  - Agreement between data and MC better than 5% for photon efficiencies and resolution
  - March 2019 proposed deadline
- Want a data-driven way to compare data and MC efficiencies
  - $\omega \to \pi^+\pi^-\pi^0, \pi^0 \to (\gamma)\gamma$ most promising channel

Efficiency with ω Mesons



γ_{study}

- Missing 4-momentum points to FCAL
- Use fitted yields of ω to determine if γ_{study} was found

Method 1

Fit missing ω spectrum before & after loose $\gamma\gamma$ mass cut

Method 2

- Fit invariant ω mass, if candidate found
- Fit missing mass, no candidate found

Reconstruct:

- $\pi^+\pi^+p$ tracks, γ (either calorimeter)
- Extra candidates for γ_{study} in calorimeter of study

Parameterizing Efficiency

Method Pros and Cons

Method 1

$$\epsilon = \frac{\omega_{miss}\ (2\ good\ showers)}{\omega_{miss}\ \ (1\ or\ 2\ showers)}$$

Pro:

- Fitting to same shape in num., den.

Con:

- Cut dependent: efficiency depends how we define "good" candidate

Method 2

$$\epsilon = \frac{\omega_{inv}}{\omega_{inv} + \omega_{miss(no\ candidate\ for\ \gamma_{study})}}$$

ω_{inv}: yield in $\pi^+\pi^-\gamma\gamma$, any quality

$\omega_{miss(1\ shower\ only)}$: missing mass, no candidate found for γ_{study}

Pro:

- No explicit cut dependency

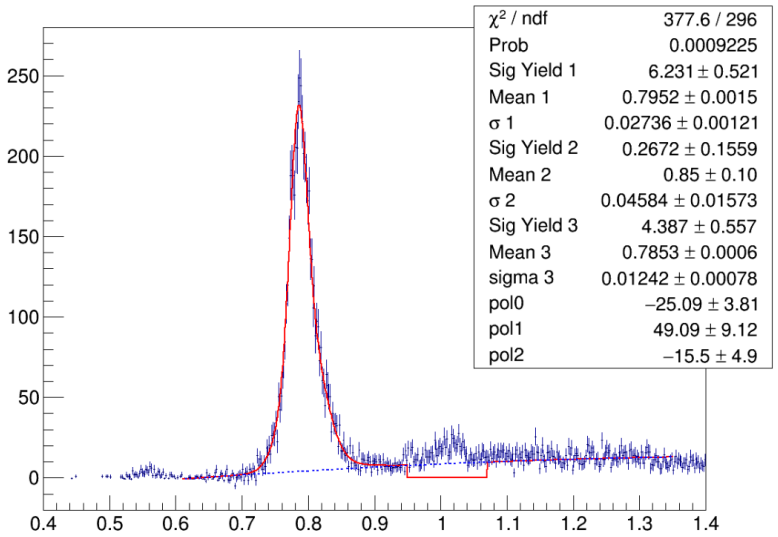
Con:

- Different shapes for ω_{inv} and ω_{rec}
  - Will probably overestimate efficiency by about 1% (workfest study)

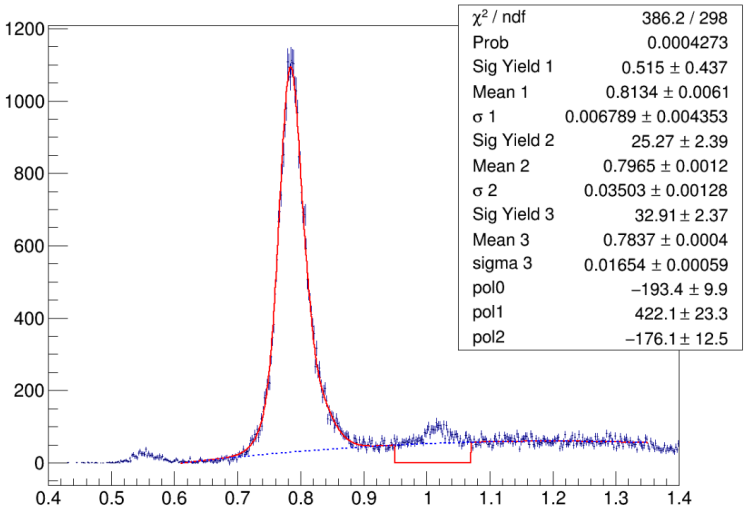
Example Fits

- ω yields: 3 gaussian
- 2nd order polynomial background

Method 1 Numerator
(a missing mass fit)



Method 2: Invariant Mass



Data

- 2017 data, REST ver02:
  - All production runs
  - 8.2-8.8 beam E
  - No extra tracks
  - 1 C kinematic fit
  - 0.1 < missing π^0 mass < 0.17 GeV
- ReactionFilter channel requested, waiting on next analysis launch for REST ver03
- (nothing changed here since collaboration meeting)

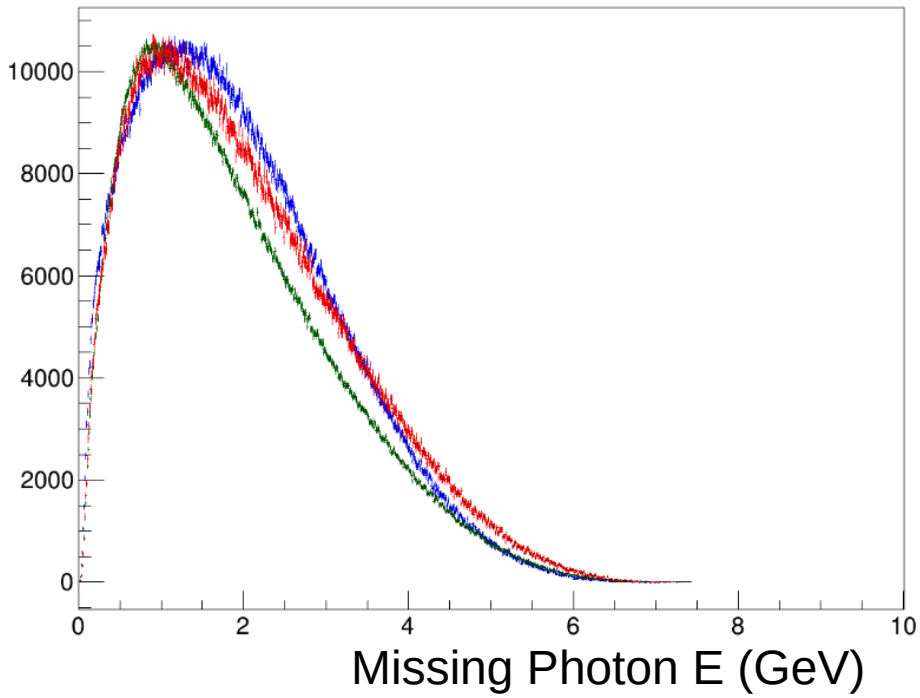
MC Samples

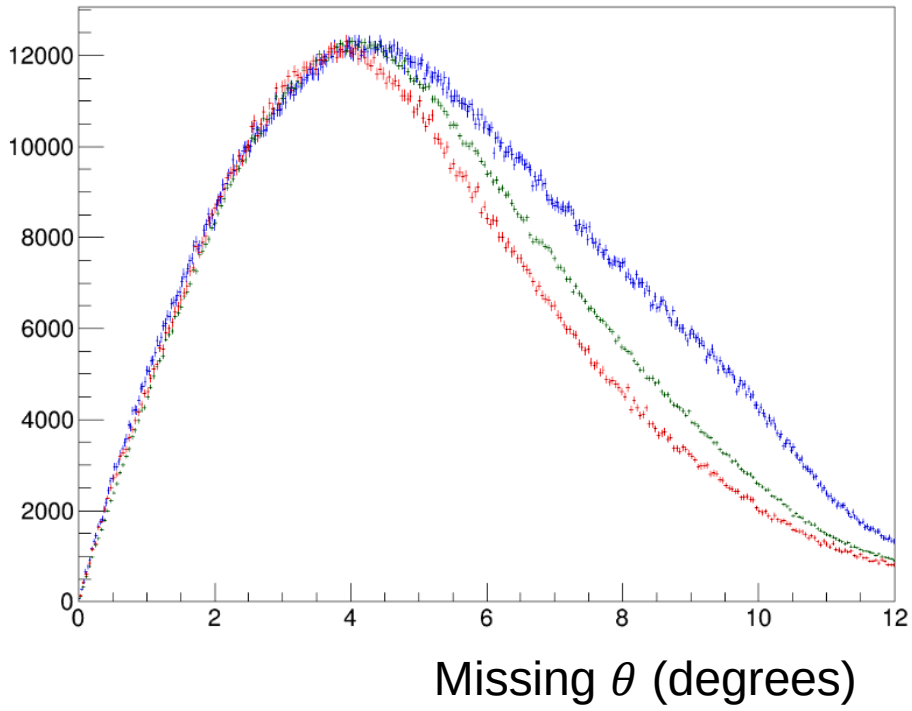
- gen_omega_3pi generator:
  - Reflects previous measurements of ω SDMEs
- Geant3 and geant4
  - ~40 M events generated for each
- Made on OSG in about three days! (thanks Thomas)
- Random triggers
- Up-to-date software and ccdb
- Beam E generated: 8 – 9 GeV
- New since collaboration meeting

Missing Photon Reconstructed

- In mass range of ω

Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

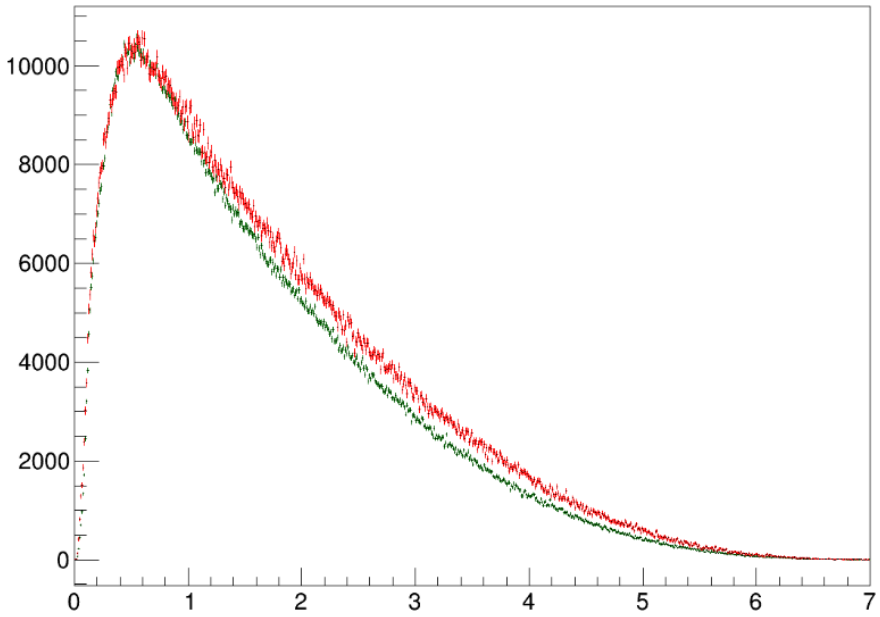




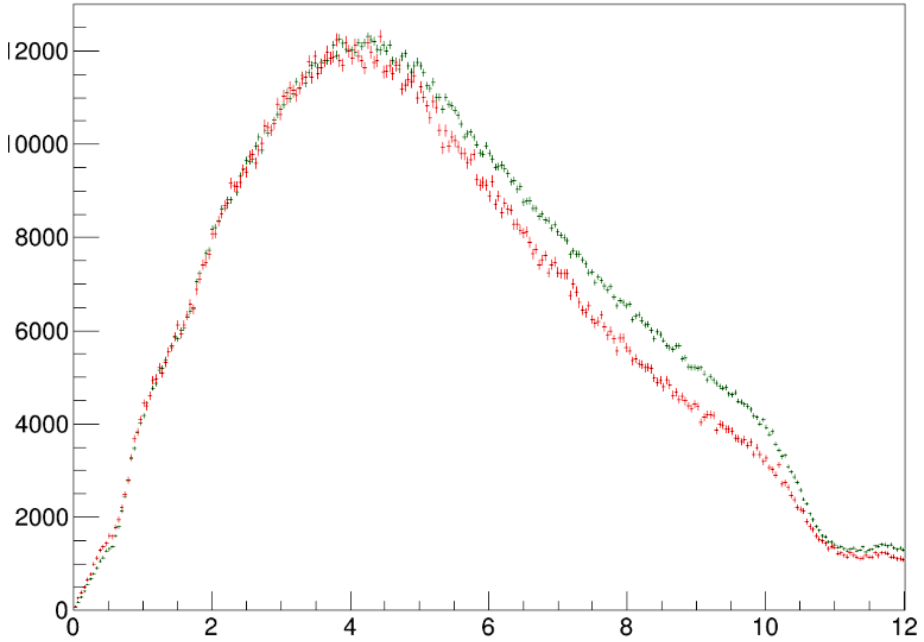
Missing Photon Thrown

- In mass range of ω

Green: geant3 MC
Red: geant4 MC



Missing Photon E (GeV)



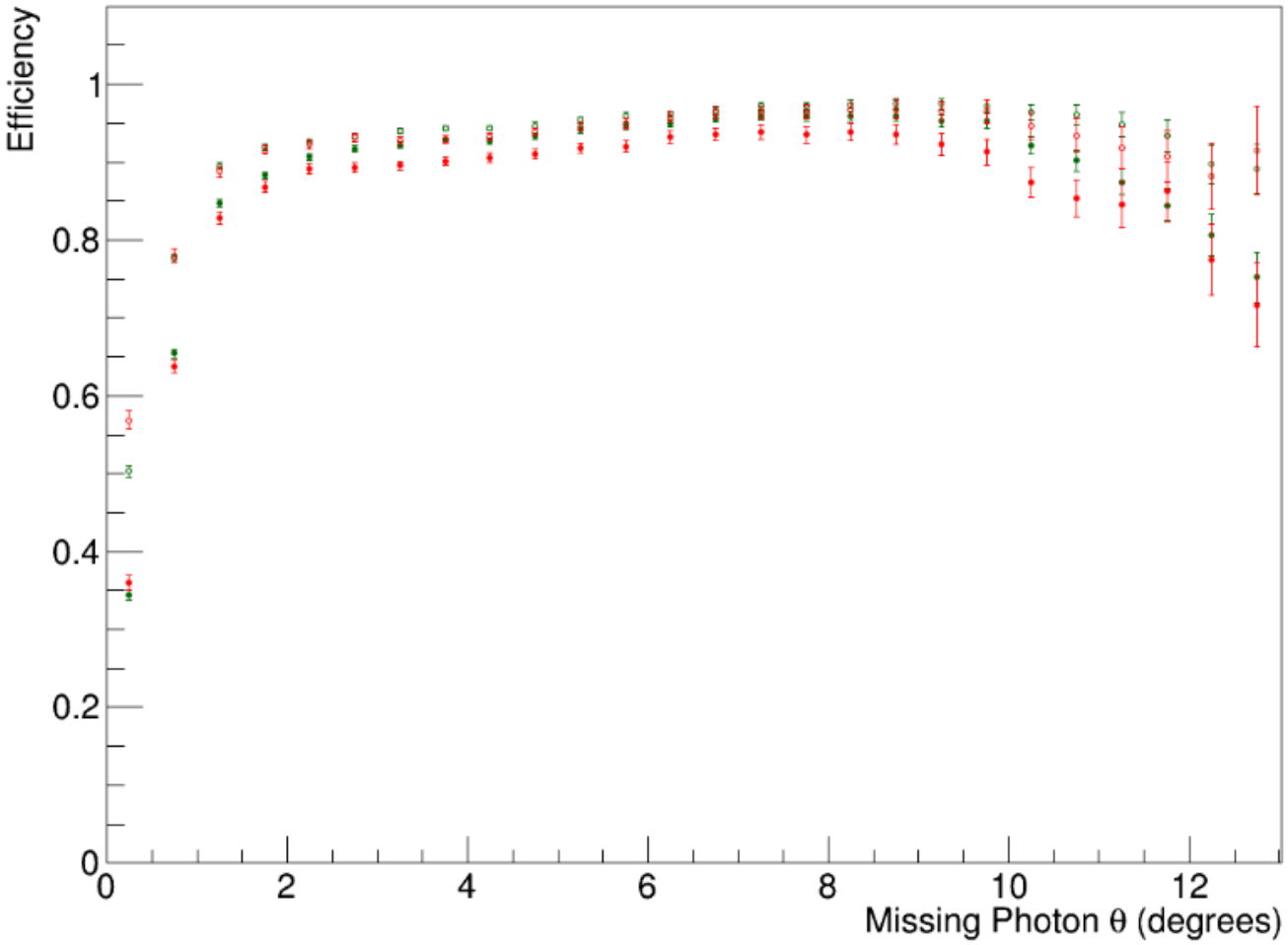
Missing θ (degrees)

Geant3 vs Geant4: θ Efficiency

Green: geant3 MC

Red: geant4 MC

- Filled Circle: method 1
- Open Circle: method 2

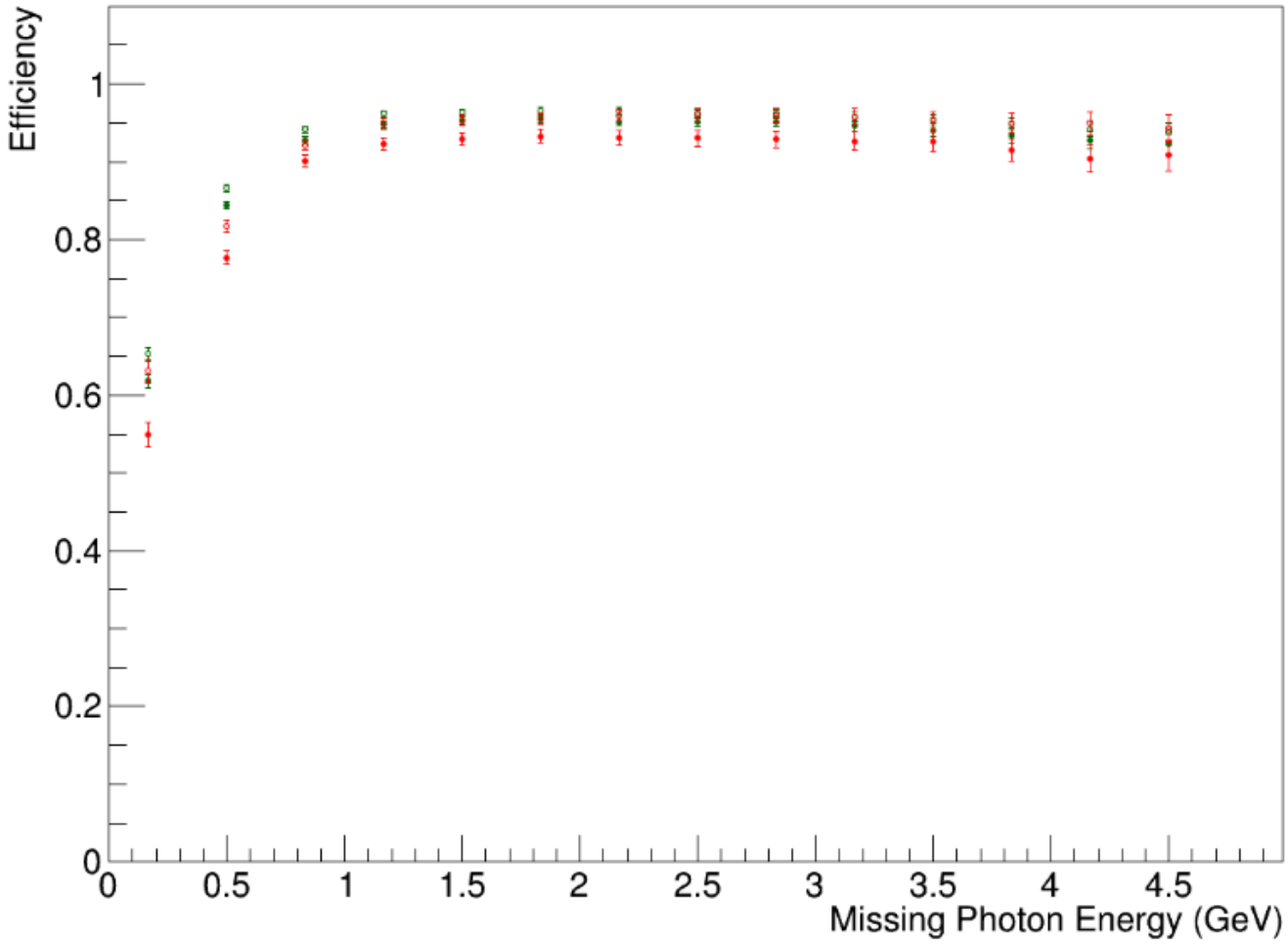


Geant3 vs Geant4: E Efficiency

Green: geant3 MC

Red: geant4 MC

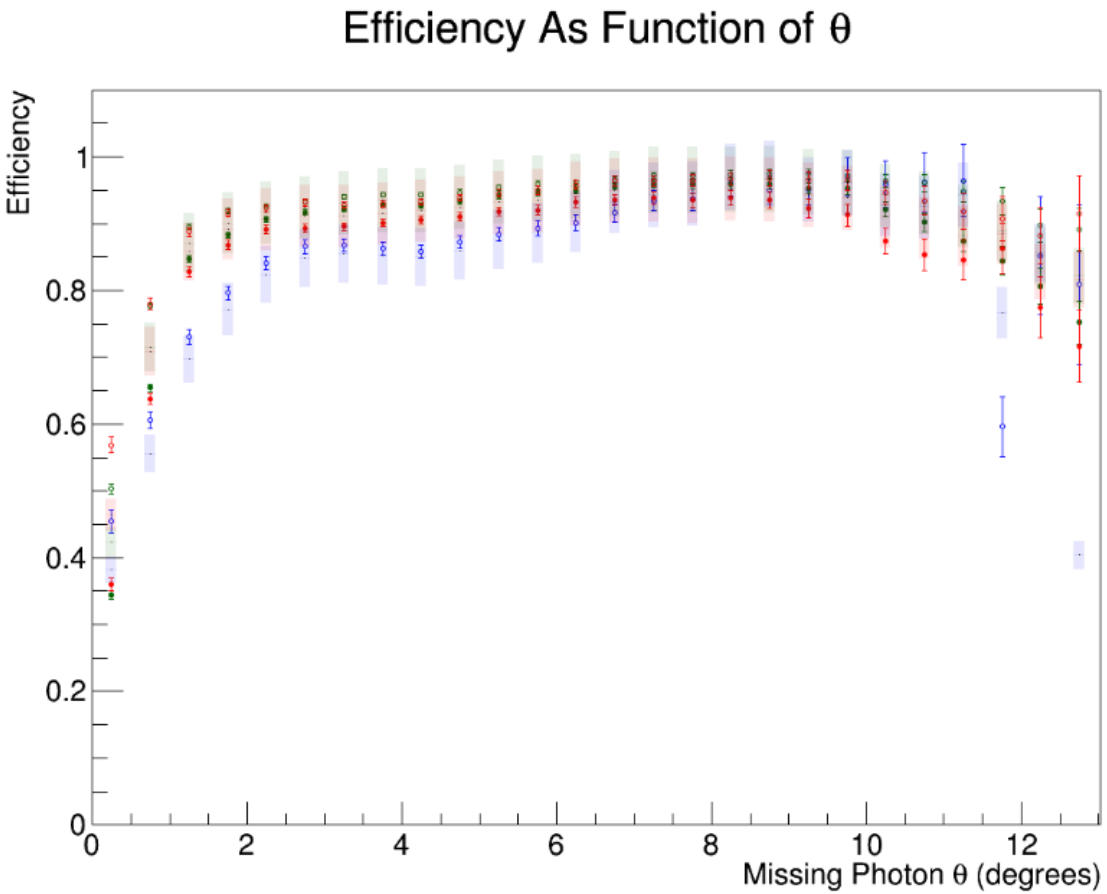
- Filled Circle: method 1
- Open Circle: method 2



Geant3 vs Geant4

- More than a factor of 2 total efficiency difference (driven mostly by tracking, I assume)
  - Distribution of events reconstructed is a little different (reflection of tracking again?)
- Clearly there's a difference in measuring efficiencies, ballpark 2-5% effect
- But ignoring that for now, move on to data comparison…

Efficiency as Function of θ

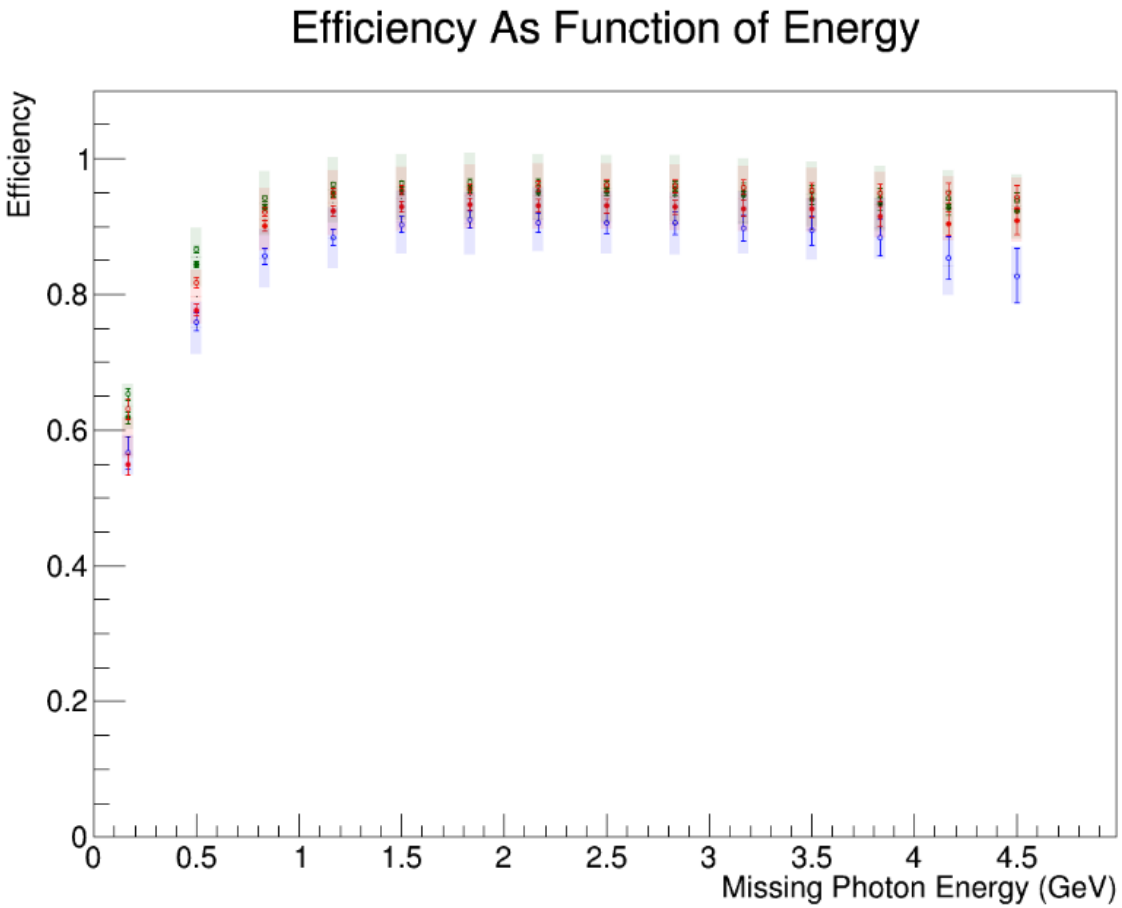


Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

- • Filled Circle: method 1
- ○ Open Circle: method 2
- ❑ Box: 5% target

Missing photon E > 800 MeV

Efficiency as Function of E



Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

- • Filled Circle: method 1
- ○ Open Circle: method 2
- ❑ Box: 5% target

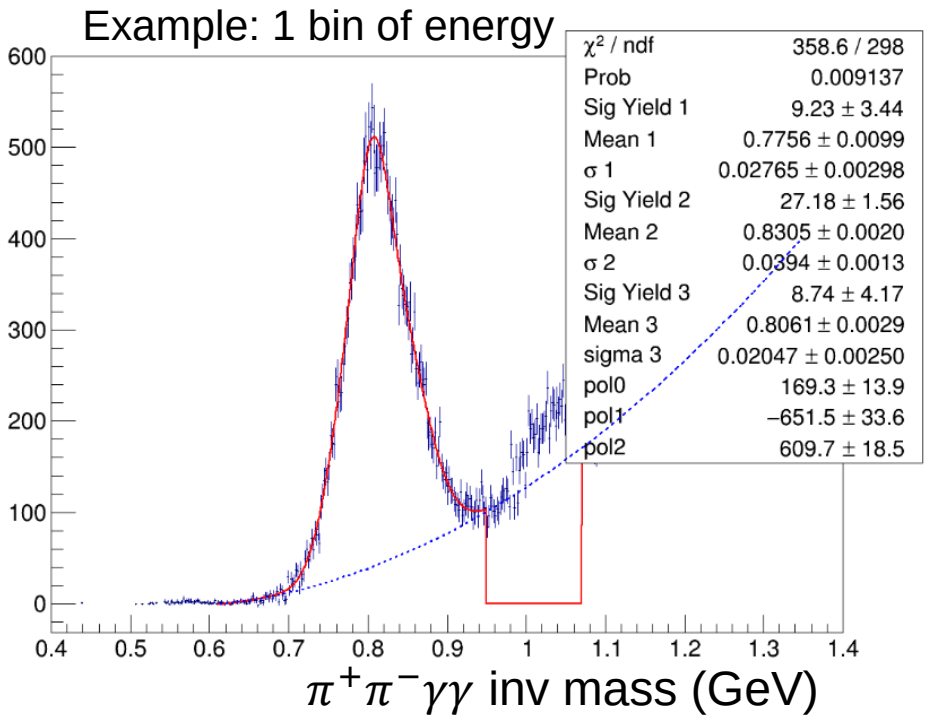
4.5 < Missing photon θ < 7.5°

Comments

- Two methods produce results within 5% target, except for edge cases
- MC efficiency went up significantly
  - Now above REST ver02 data (old MC was below)
  - REST ver03 data might also go up?
- Track matched shower vetos:
  - On here
  - Will need to run over REST ver03 both on and off
- MC shows much higher efficiencies at low θ
  - Lucite? TOF group will add to MC (Ashley)
  - Gains?

BCAL Case

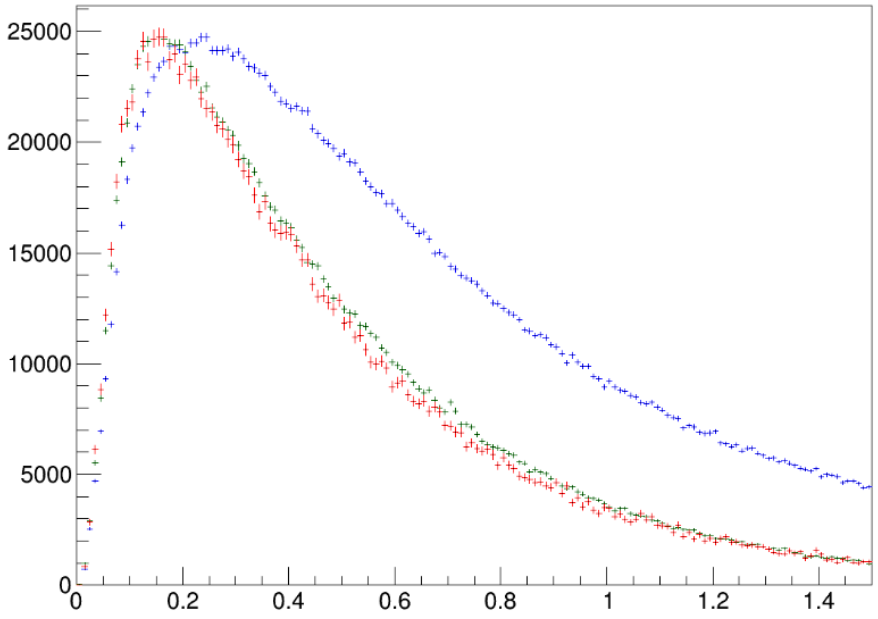
- Now, do same thing for BCAL
- Purity is a lot lower
  - Fits actually perform surprisingly well even so



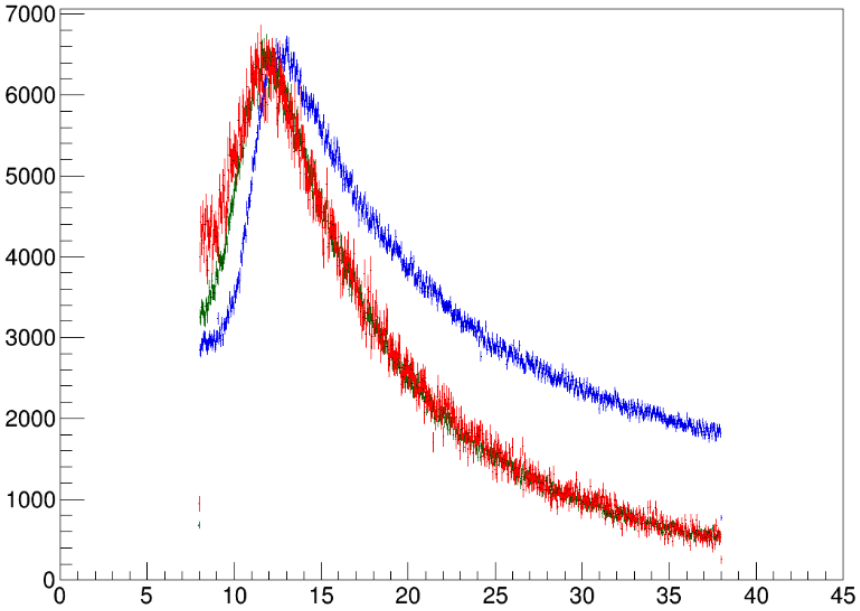
BCAL

- In mass range of ω

Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

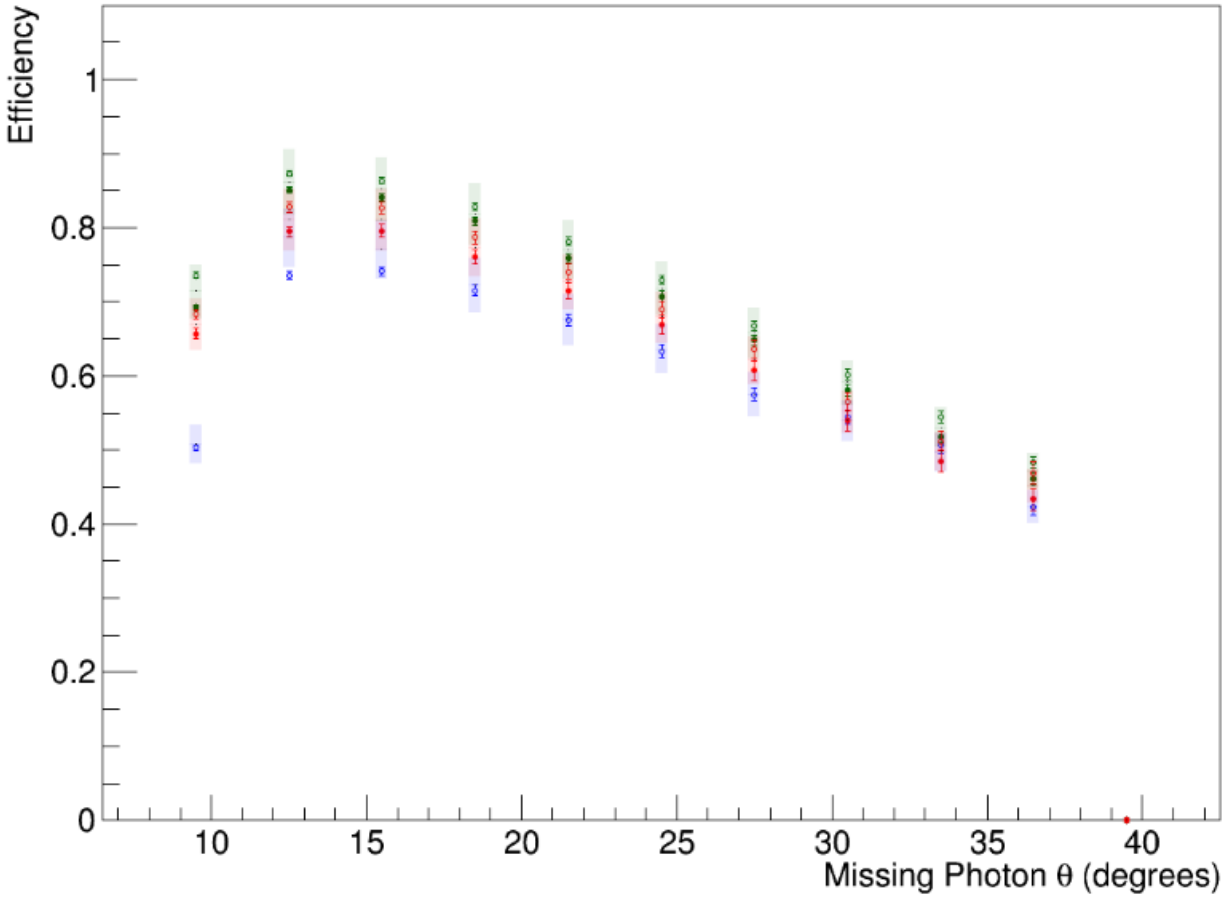


Missing Photon E (GeV)



Missing θ (degrees)

Efficiency as Function of θ

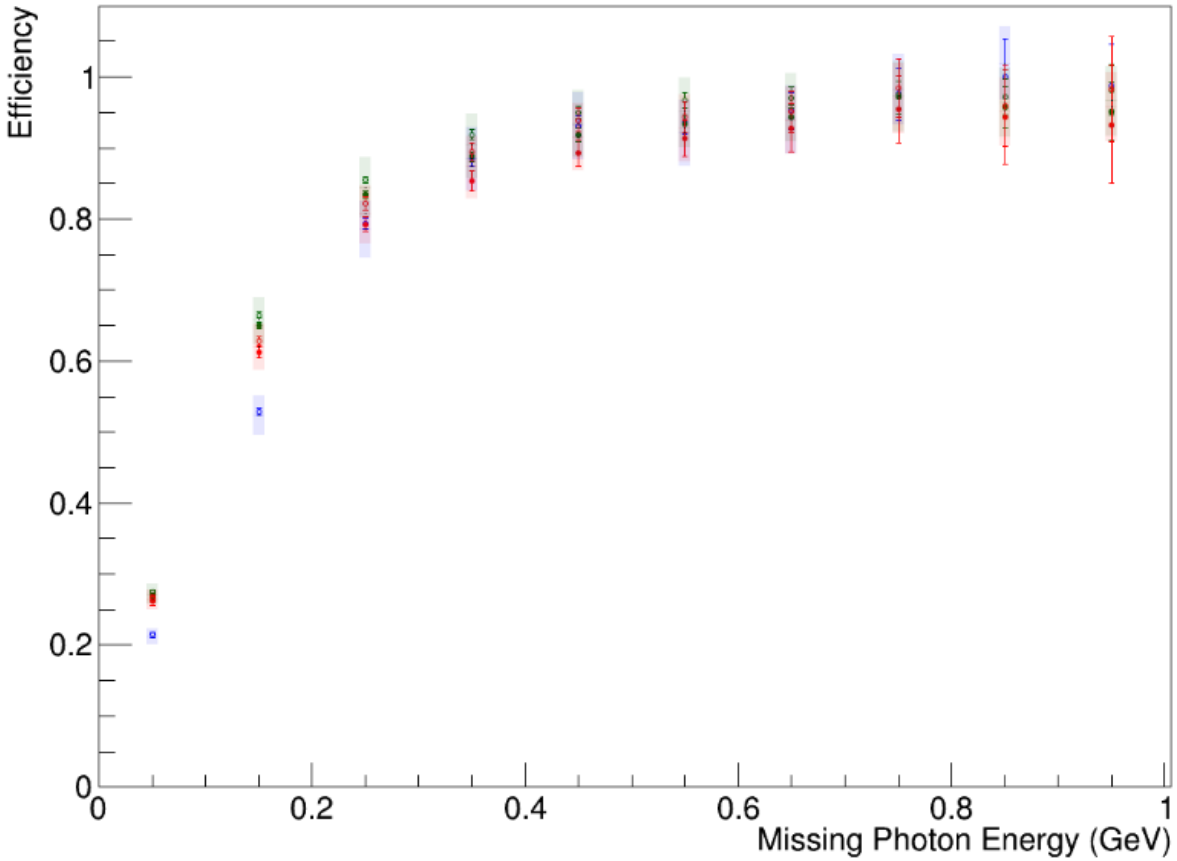


Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

- • Filled Circle: method 1
- ○ Open Circle: method 2
- ❑ Box: 5% target

Missing photon E > 0 MeV (no cut)

Efficiency as Function of E



15 ° < Missing photon θ

Blue: 2017 data
Green: geant3 MC
Red: geant4 MC

- Filled Circle: method 1
- ○ Open Circle: method 2
- ❑ Box: 5% target

OK, Last Slide, I Promise

- A lot of things to redo:
  - Need to run over REST ver03
  - MC needs TOF lucite
  - With/without track match vetoing
- Two different methods are giving consistent results!
- Might be able to study a little bit of BCAL with method/topology