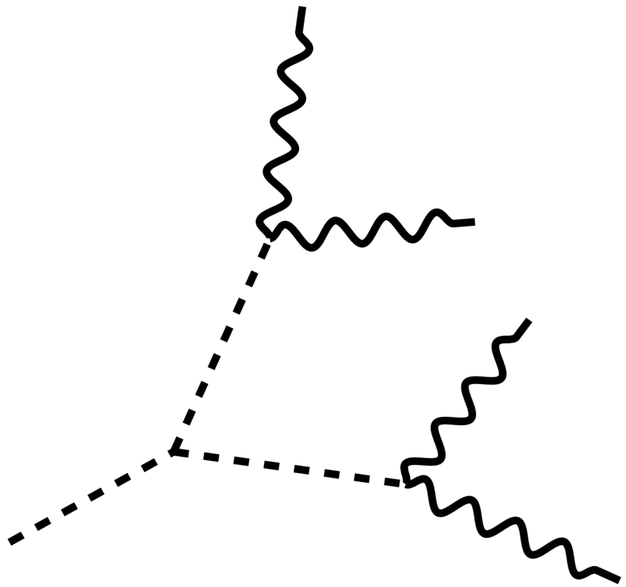
h(125)→aa→γγγγ



Higgs to 4 Gamma Update

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NEU Meeting
10th April 2018

THIS TALK

- I presented last at the Higgs to Gamma Gamma working group meeting and was asked to do efficiency studies @ Gen level to determine which category is important for different mass points.

- Reminder : We are probing m(a) from 100 MeV to 60 GeV

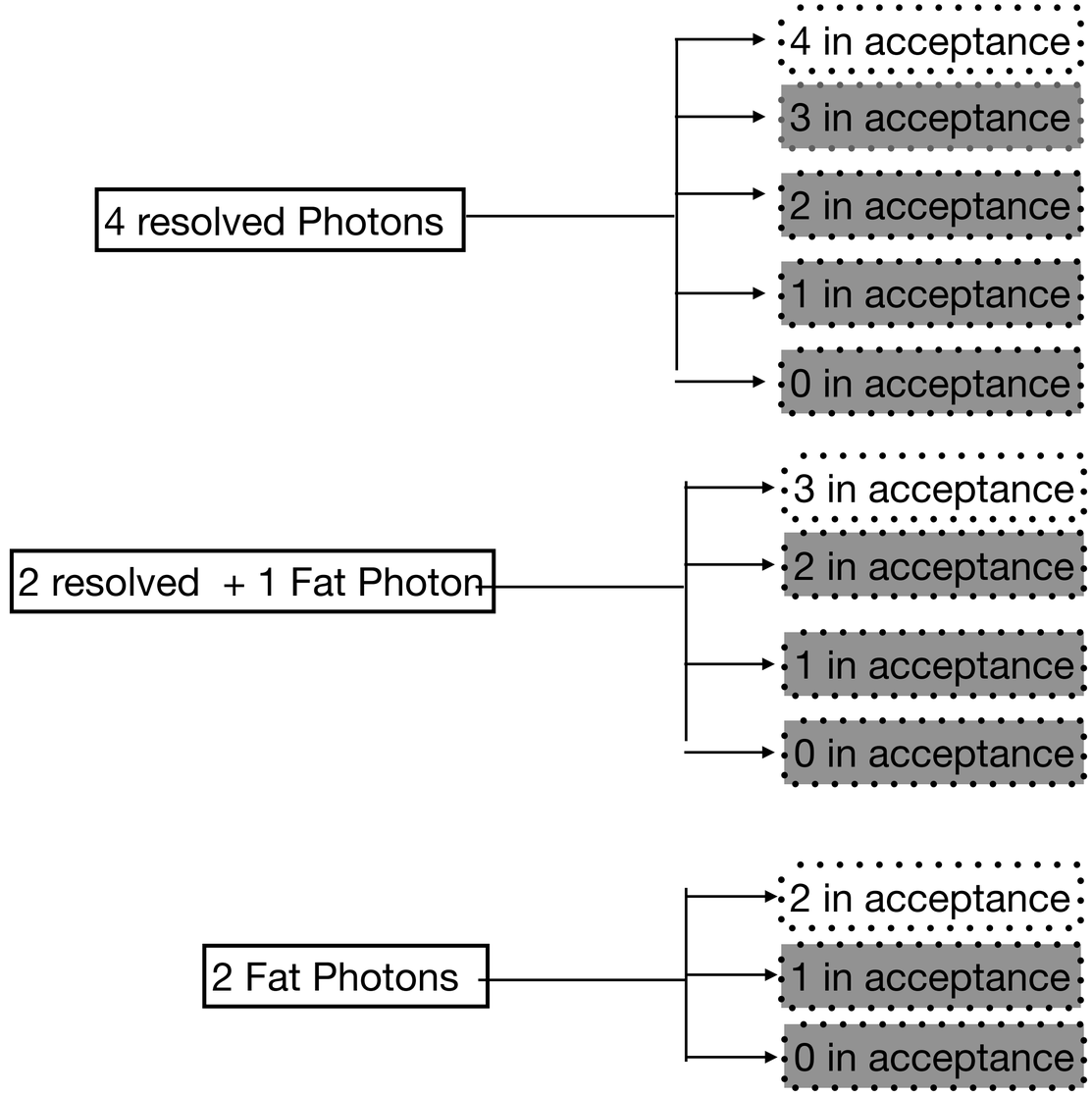
- Will present the Gen and Reco level categorization strategy and categorization efficiency.

GEN LEVEL CATEGORIZATION PROCESS

- Start with 4 photons
- Identify the two photons coming from the same “a”
- Calculate deltaR b/w those 2 photons
- If 0 photon pairs w/ deltaR < 0.3 -> **4 resolved**
- If 1 photon pair w/ deltaR < 0.3 -> **2 resolved + 1 fat**
- If 2 photon pairs w/ deltaR < 0.3 -> **2 fat**

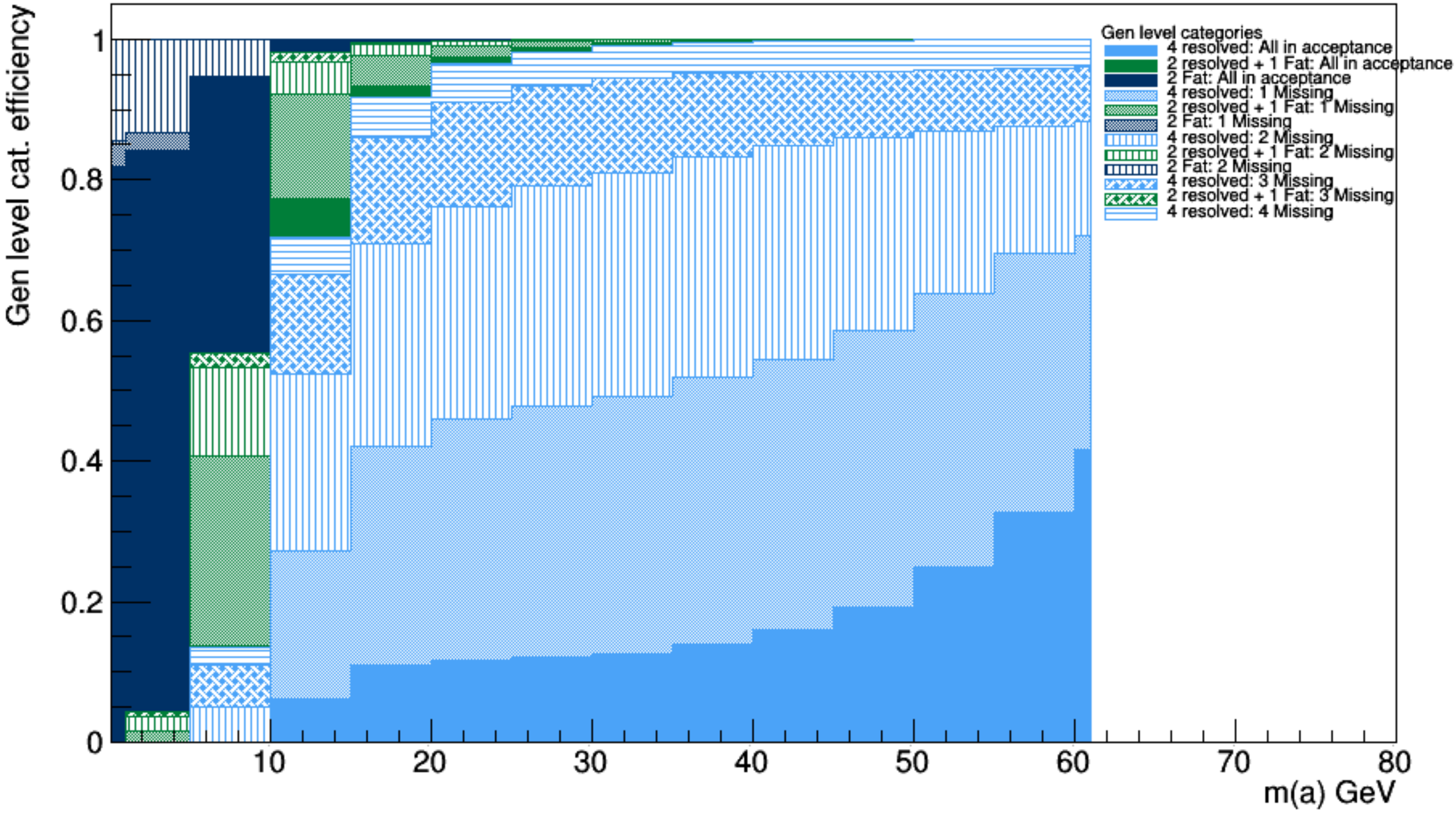
- Current acceptance requirements (on every photon) :

P_T > 15 GeV
|η| < 2.5



Tetraphoton mass peak cannot be observed in these cases

Plot showing the fraction of events falling into each category for all the mass points

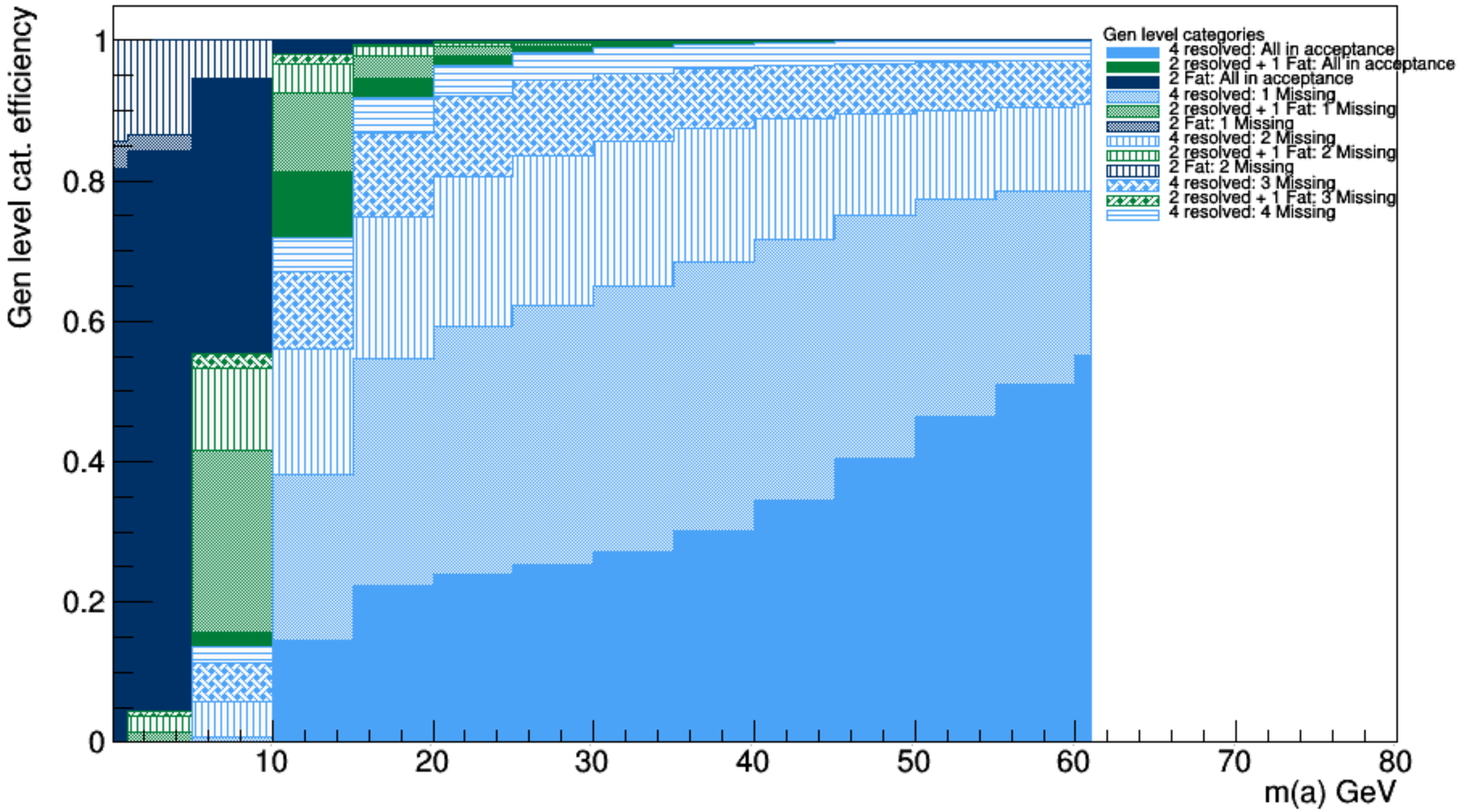


- What if the P_T requirement on the 3rd and 4th photon is brought down to 10 GeV ?
- From ECAL point of view, energy regression for photon should work down to 10 GeV (To be checked)

Same plot but with Pt threshold lowered to 10 GeV

- By lowering the threshold to 10 GeV , for the 4 resolved, all in acceptance case we gain ~22% efficiency for 60 GeV and ~20% for 10 GeV

- Another issue: The current Photon MVA we are using for developed for P_T = 20 GeV
  - Checks to be done: Pt Vs MVA dependence of photons to determine if a re-training is necessary



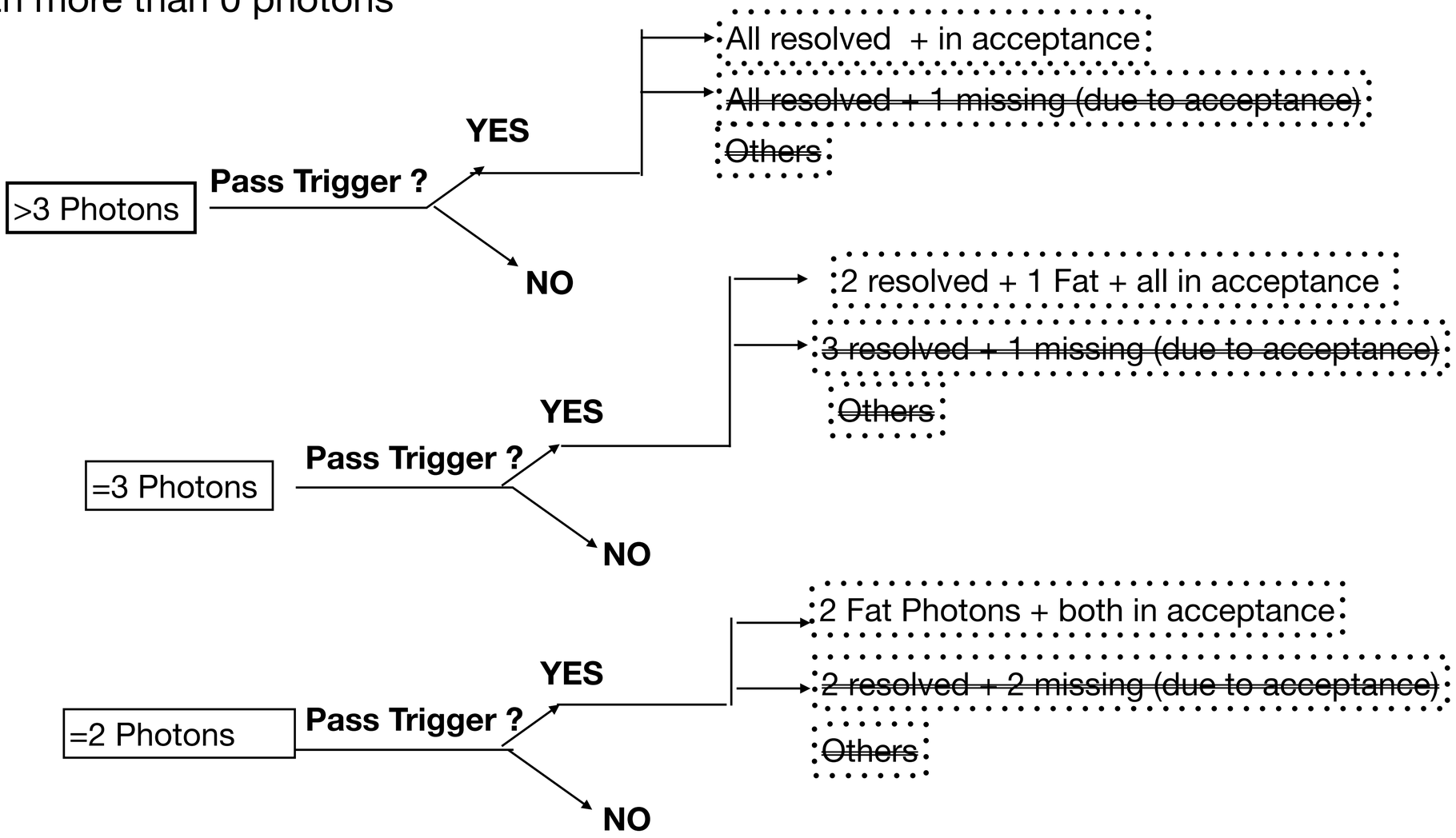
- Now, with the categorization done @ Gen level next logical step is to do a similar categorization @ Reco level

- How to identify Fat Photon @ Reco level?
  - By doing a Gen-Reco matching
  - Loop over all Gen photons and identify fat photons based on delta R (if delta R b/w two gen photons < 0.3 => Fat photon)
  - For every Fat Photon, find a Reco Photon such that the delta R b/w Fat photon and Reco photon is less than 0.1
  - If there is more than one matched Reco photon then keep the one with the least Pt difference

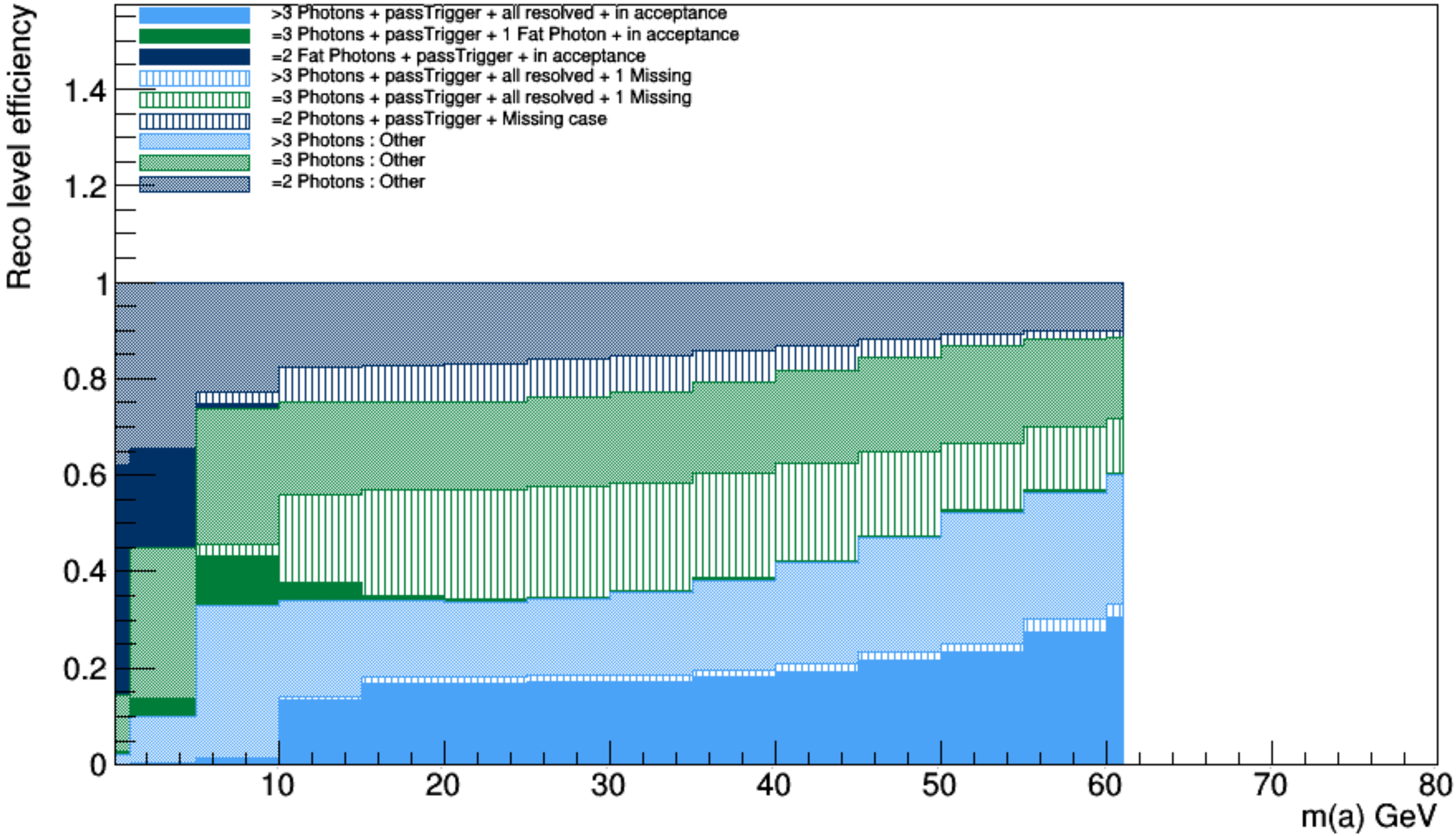
- With a handle on fat photon @ Reco level we can perform similar categorization

RECO LEVEL CATEGORIZATION

- Start with events with more than 0 photons



Reco level categorization

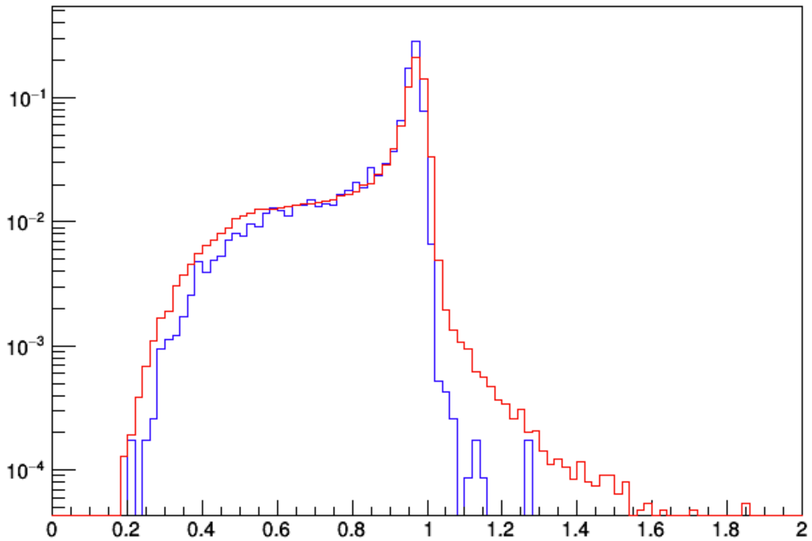


Calo variables to distinguish b/w 1 Fat + 2 resolved and 3 resolved + 1 missing case

Shown here are the distributions for m(a) = 5 GeV

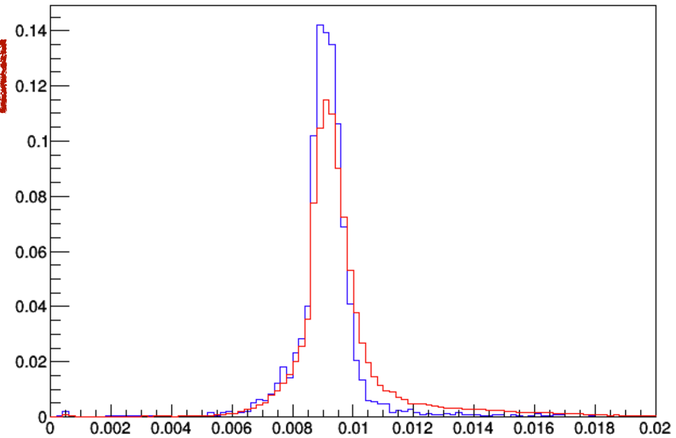
RED LINE : Resolved Photon

BLUE LINE : Fat Photon

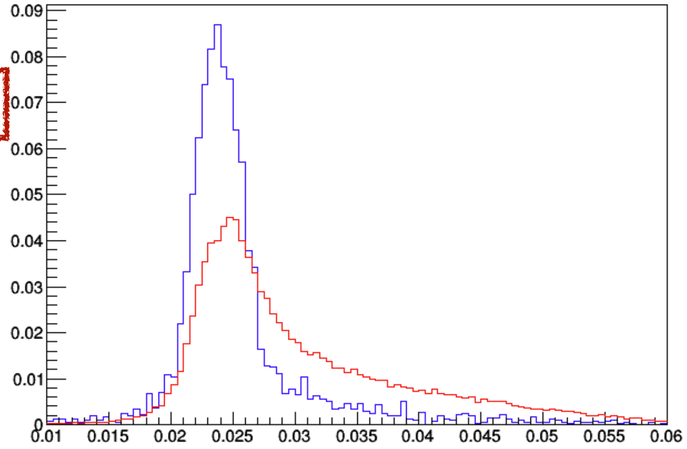


$\sigma_{\eta\eta}$
η width of central 5x5 crystals

Barrel



End Cap



R9
Ratio of inner 3x3 energy to SuperCluster energy (spread in ϕ)

NEXT STEPS

- Lots of possible areas of development (and work to be done!)
- But, first concentrate efforts on the categories where it is possible to reconstruct the tetra photon mass peak.

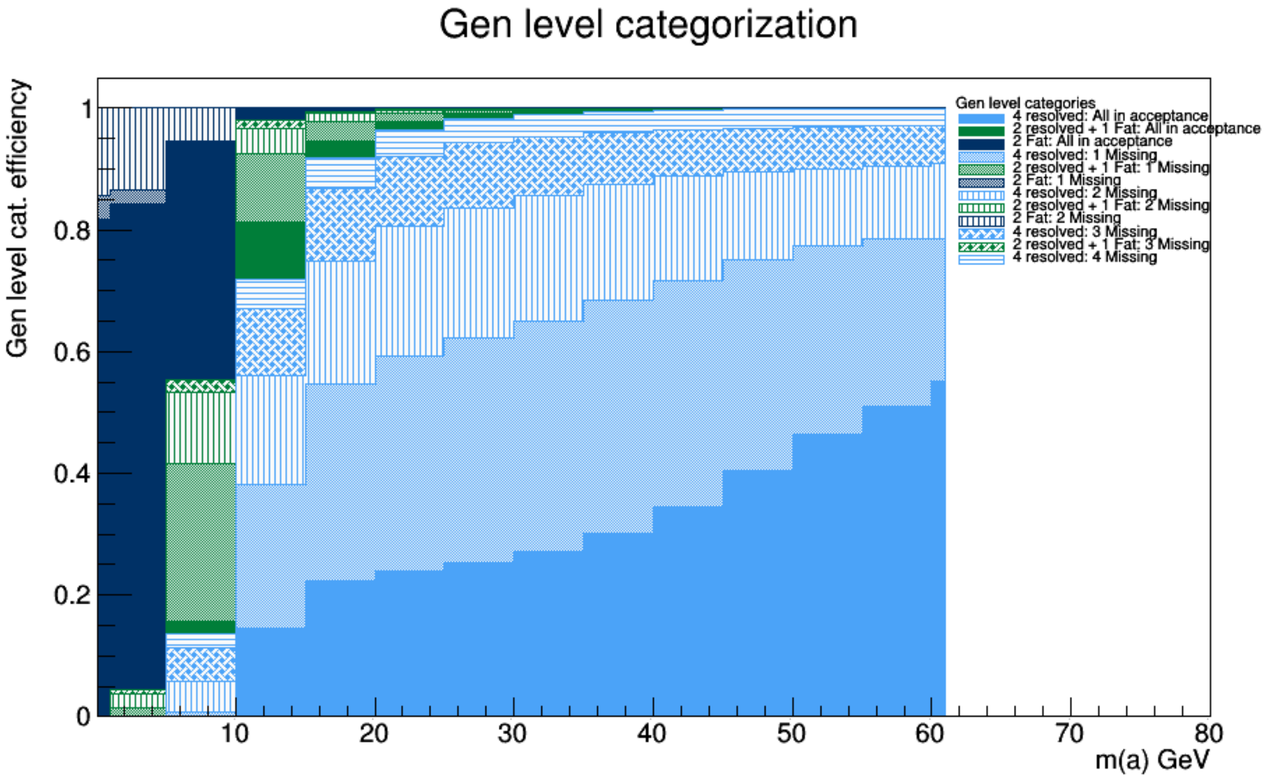
- This could potentially be a very interesting and important analysis from ECAL point of view as well !

- Advice from the Hgg convenors is to work with 2016+2017 Data (and possibly 2018 as well)
  and start writing an Analysis Note

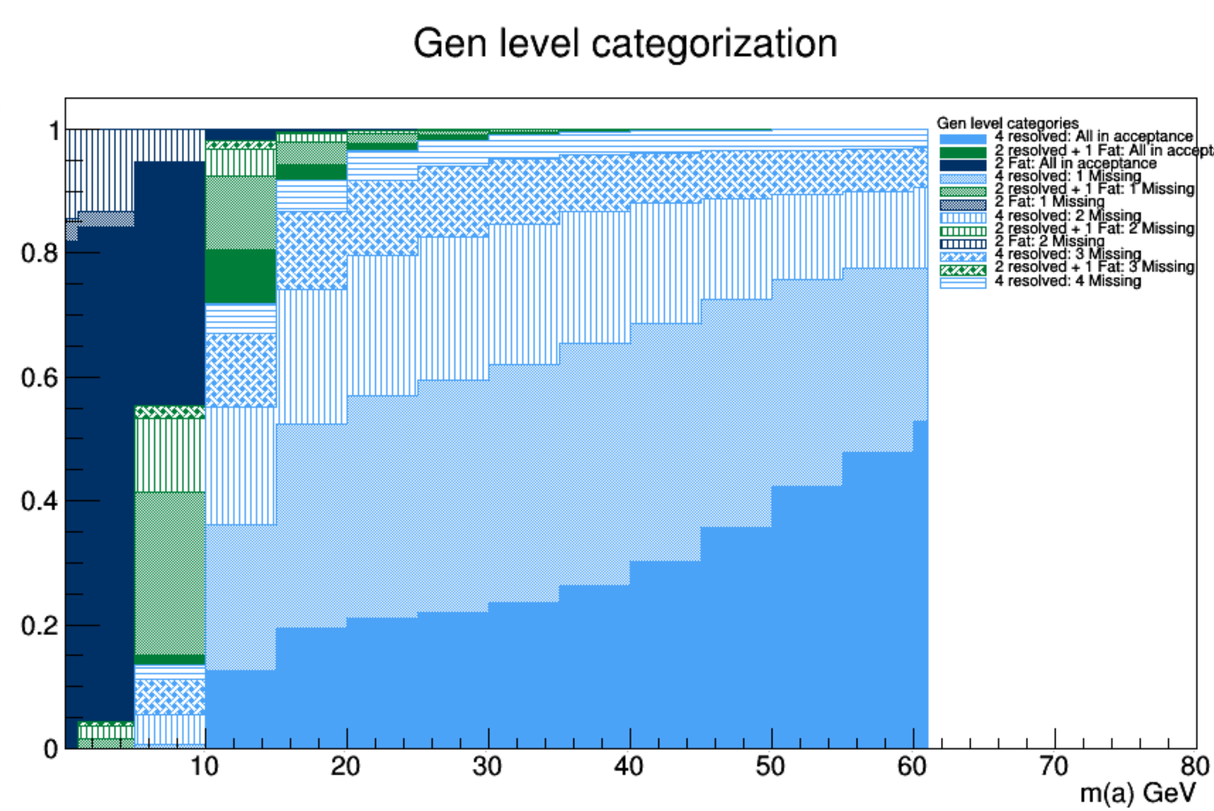
BACKUP

- Produce 6 different efficiency plots by changing the pt cut on ɣ3 and ɣ4 from 10 to 15 GeV (in steps of 1 GeV)

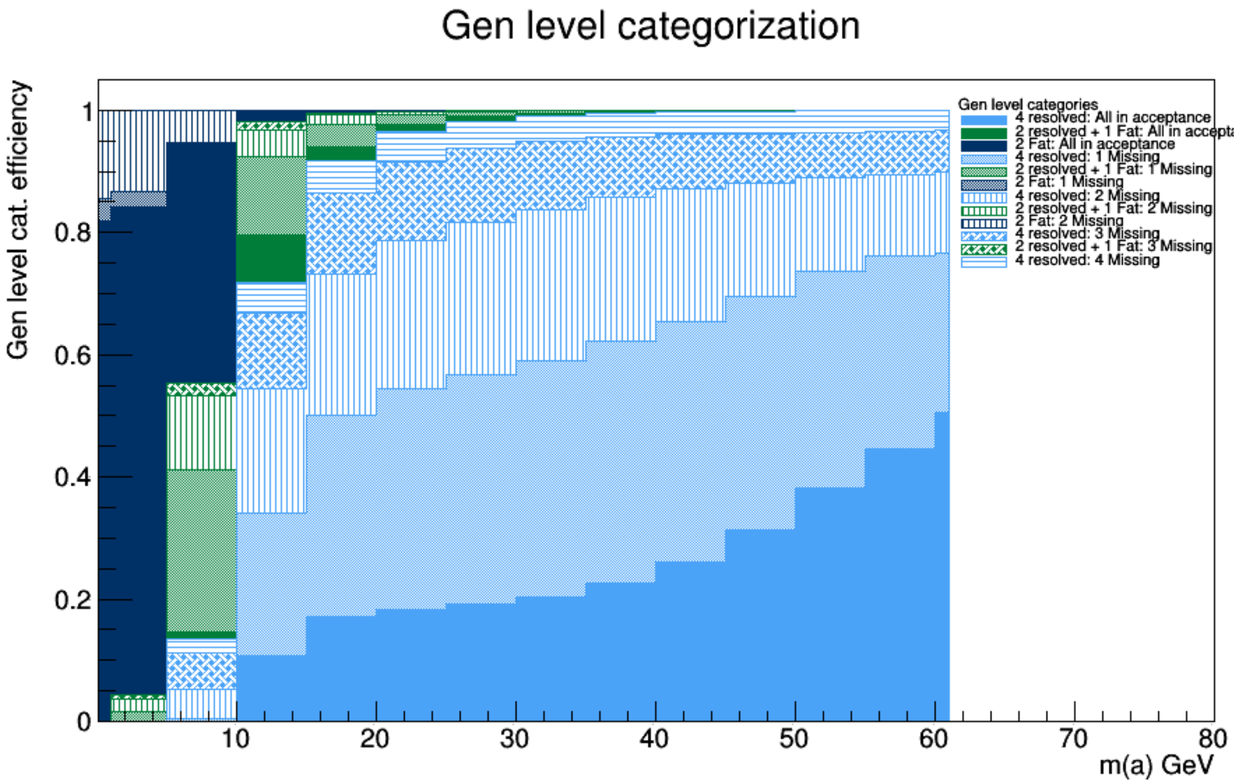
10 GeV cut



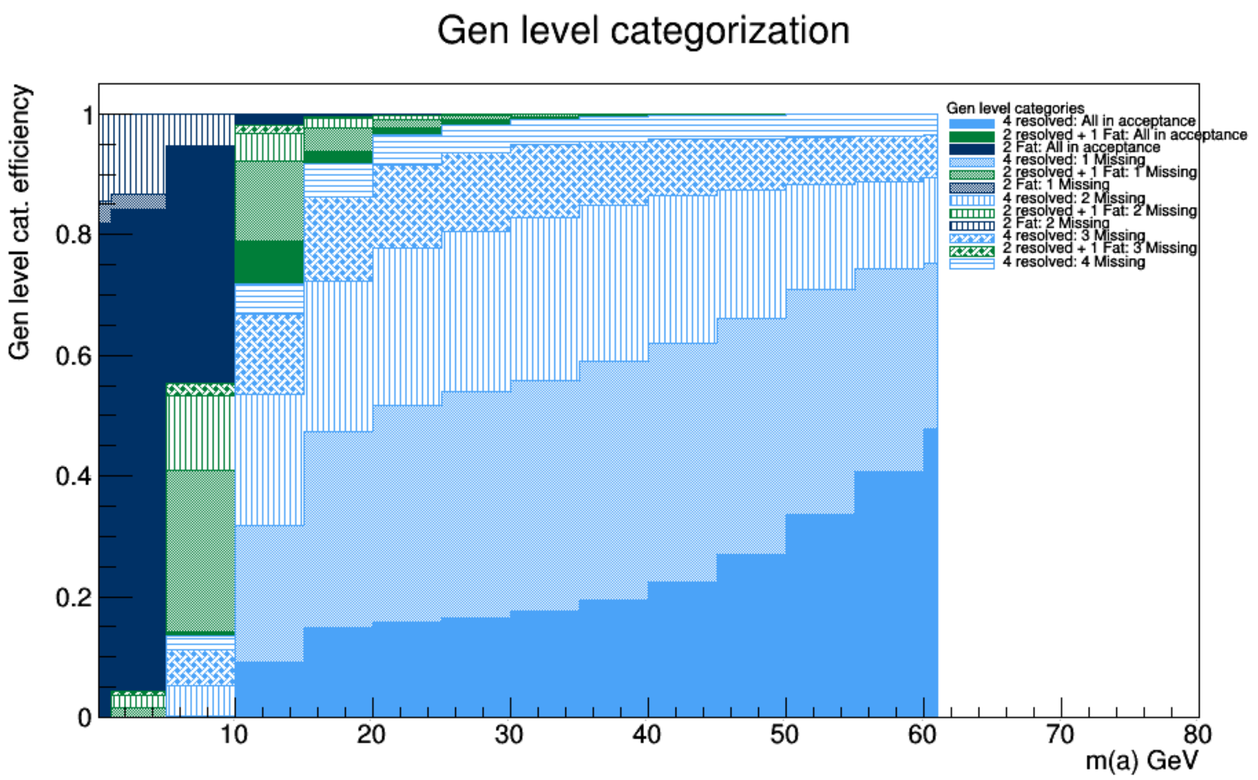
11GeV cut



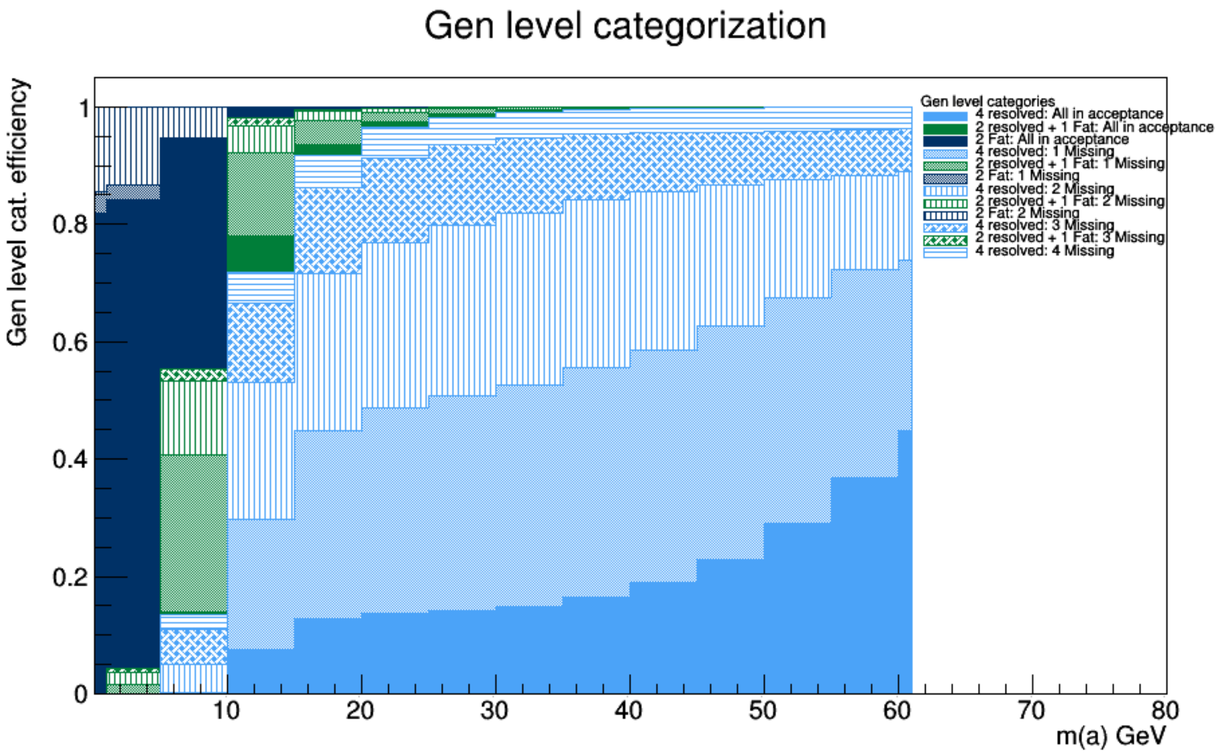
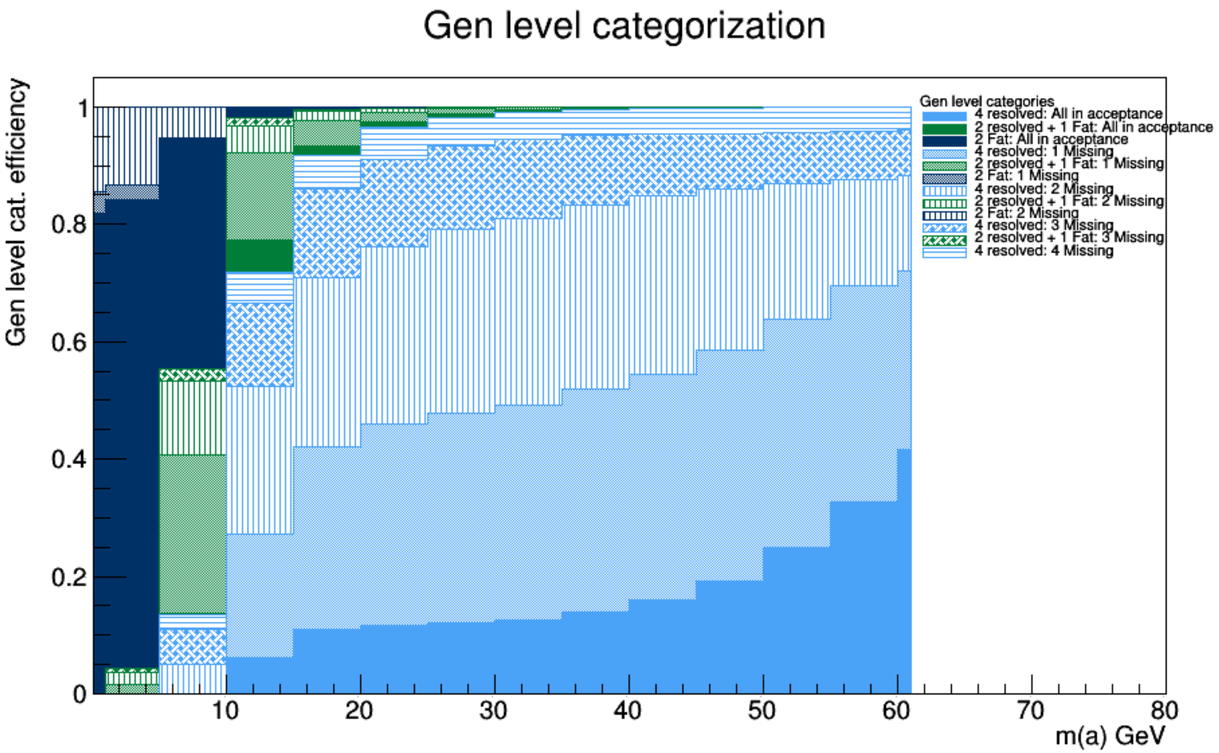
12 GeV cut



13 GeV cut



14 GeV cut



15 GeV cut