h(125)→aa→γγγγ

NEU Meeting

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Overview of the updates

- Discussion of distributions at pre-selection level
- Further selections and optimization
- Technicalities:
  - Data: DoubleEGReReco ReMiniAOD
  - $\mathcal{L}$ = 36 fb^{-1}

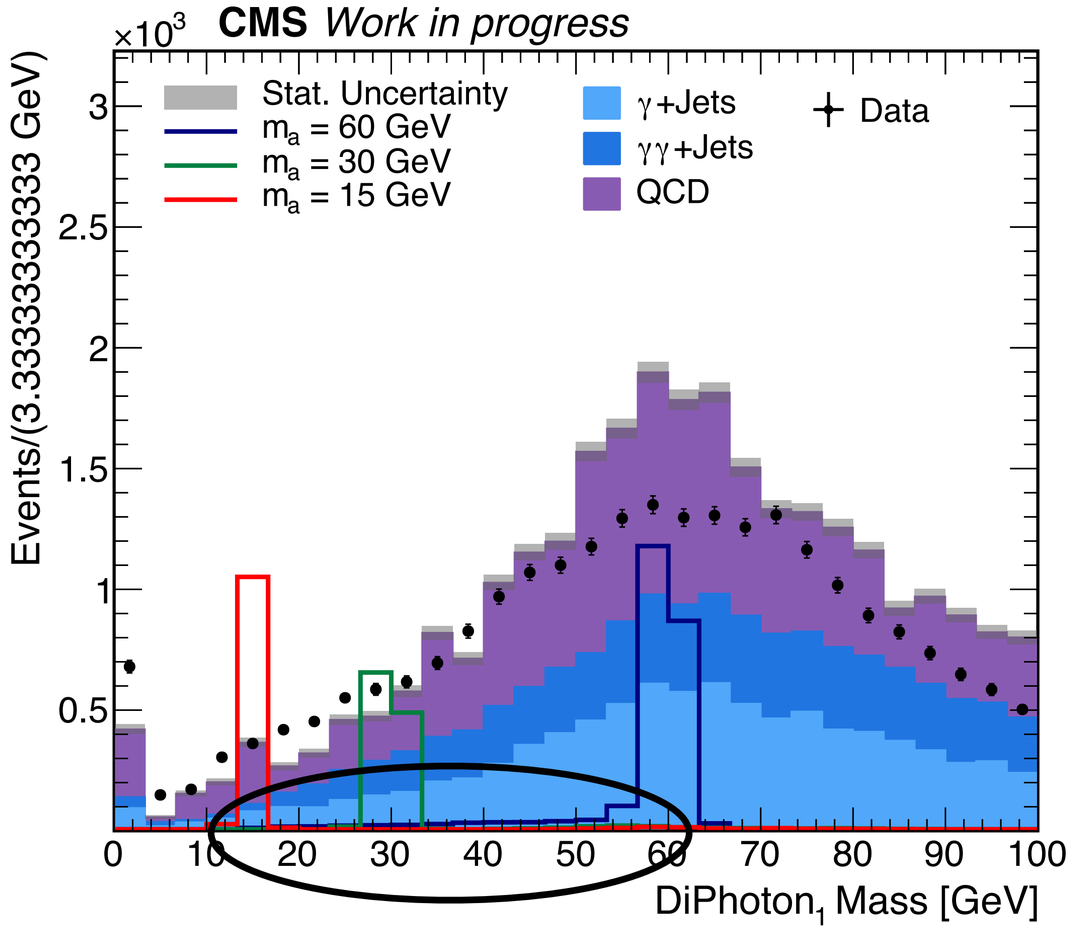
At preselection level

- Require presence of at least one di-photon that has passed the pre-selection criteria
- On top of this selection, the pixel seed veto is applied on all 4**ɣ**'s
  - Note:
    - Pixel seed veto has a ε_{sig} ~75 %
    - Pixel seed veto is tighter than electron veto (Why?); Which selection should be applied to maximally reject e^-'s faking **ɣ**'s ?
    - In this presentation, pixel seed veto has been applied

- Background MC scaled by $\frac{Luminosity * Xsection}{MCWeights}$

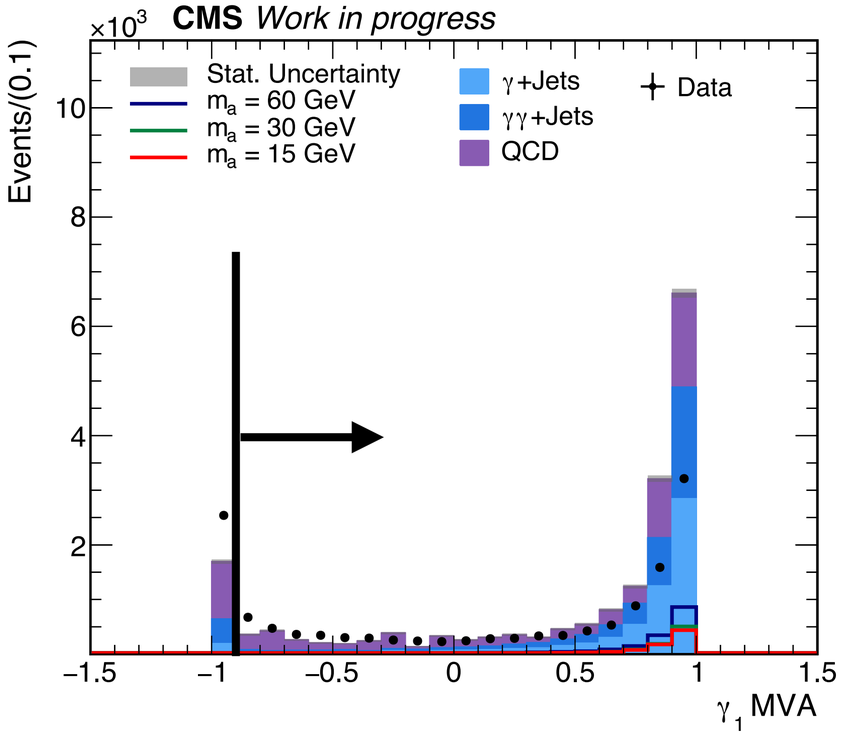
- For signal MC:
  - X-section is an arbitrary choice (have chosen 0.001 pb)
  - Can improve on this: Without any assumption of a model, we know that Br(h→BSM) < 0.34, so for the signal X-sec, I can use the cross-section of the ggF production mode of the SM Higgs boson = 4.858E+01 pb (from CERN Yellow report at 13 TeV) multiplied by 0.34

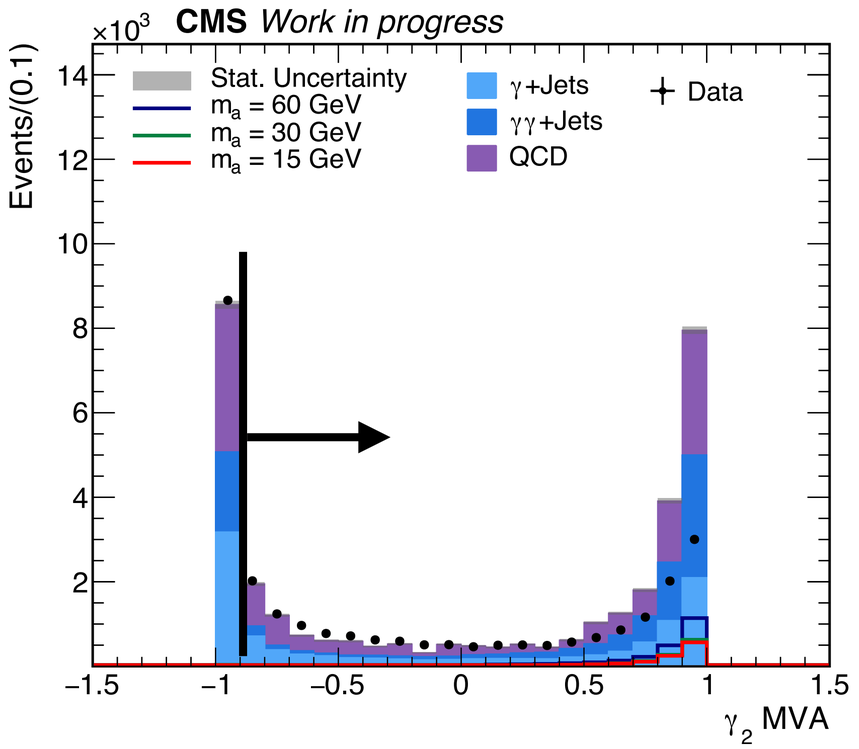
At preselection level



- Investigation ongoing: Where is the tail in the di-photon mass distribution coming from?
- Signal MC is gen-matched
- To be checked:
  - Are the γ's in the tail from ECAL EE or EB?
  - Should an R9 selection be applied on the γ's here?
- Another possibility: No scales and smearing are applied here; could that bring an improvement?

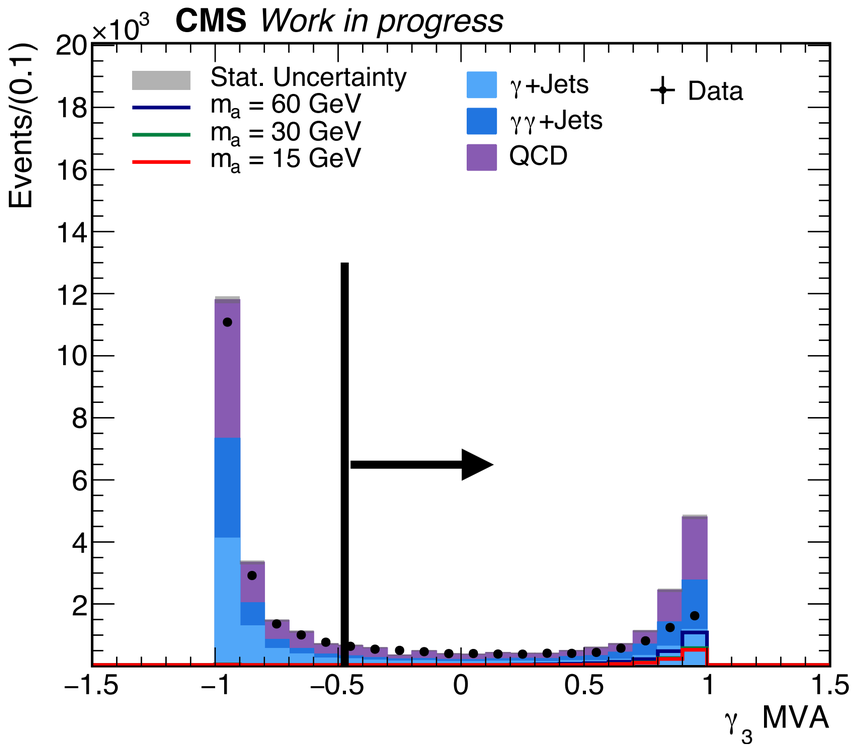
MVA optimization

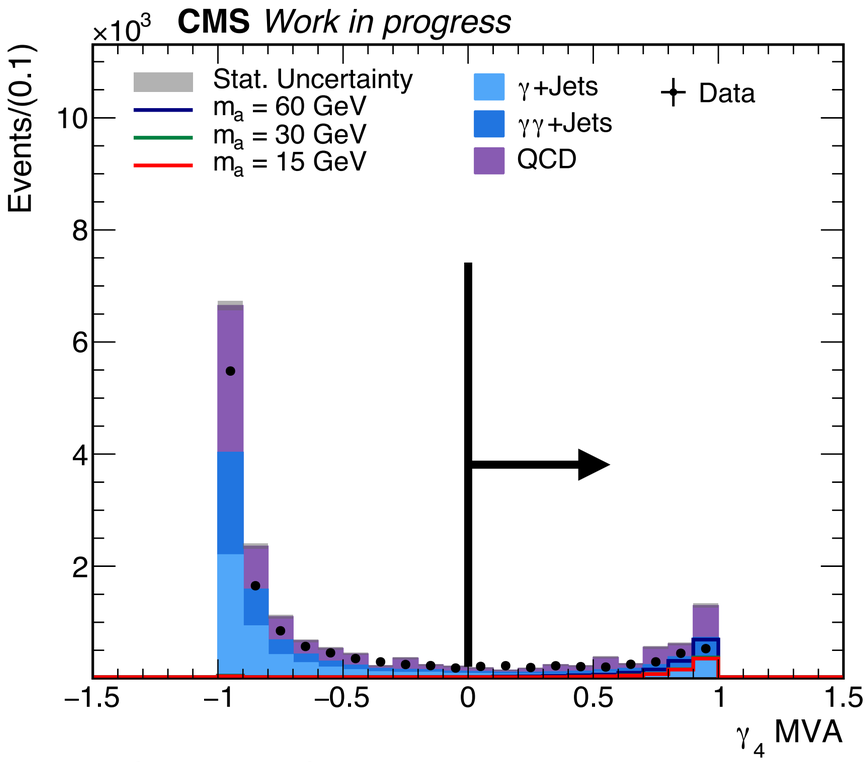




- Note: γ's are p_T ordered
- Apply a selection on MVA score of the highest p_T γ s.t we keep 99% ε_{sig}
- γ1 MVA > -0.9
- After this, add selection on MVA score of second γ
- γ2 MVA > -0. 9

MVA optimization





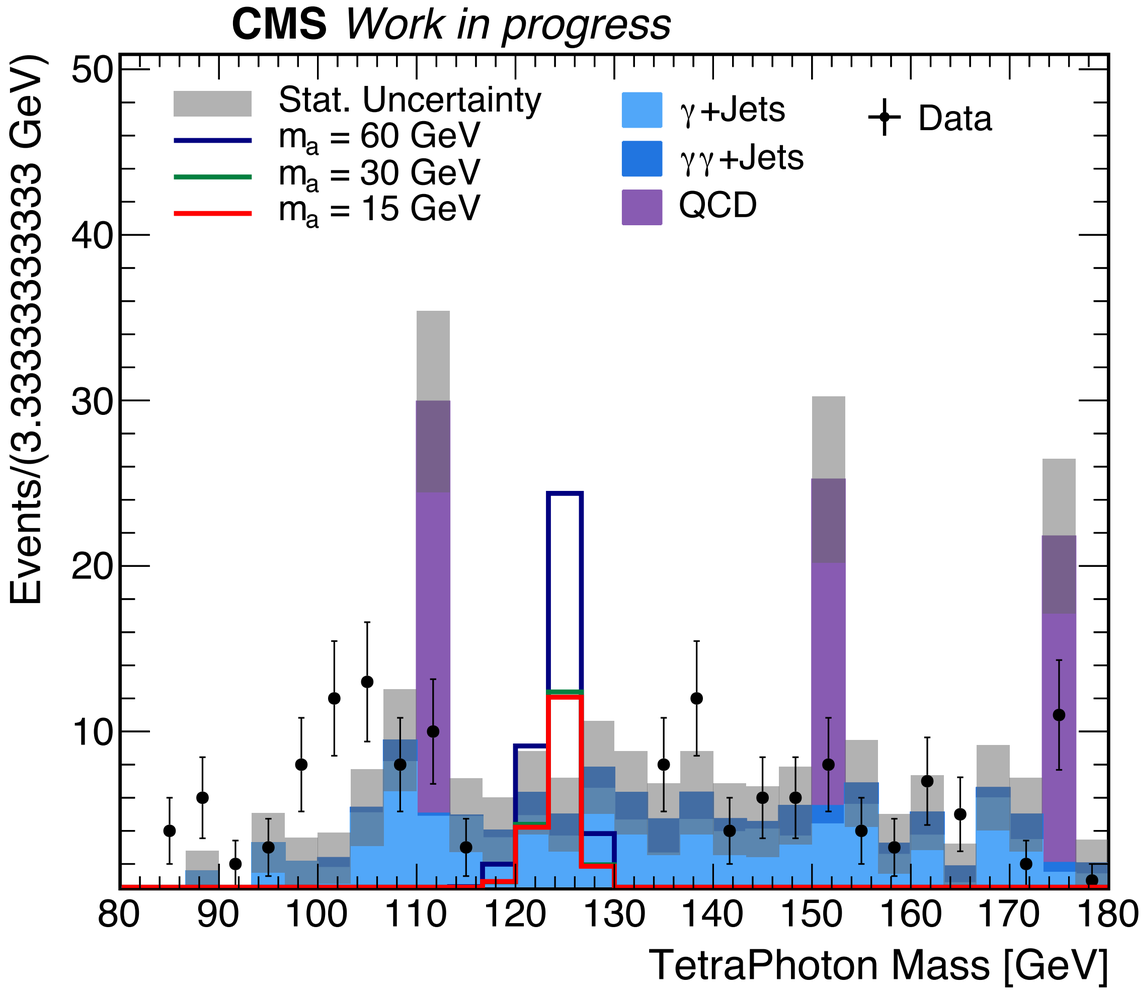
- Iteratively, add selection on the MVA score of the 3rd and 4th γ
- Tried to optimize the selection on the MVA score of the 4 γ's so as to retain a good ε_{sig} and reject maximum background
- γ3 MVA > -0.5
- γ4 MVA > 0

Some numbers..

	@ Pre-selection	W/ MVA selection
Background		
γ + Jets	9047.83	270.87
γγ + Jets	6487.34	86.63
QCD	11403.74	241.53
Signal		
m(a) = 60 GeV	1784.47	1405.48
m(a) = 30 GeV	994.09	709.41
m(a) = 15 GeV	922.44	688.46

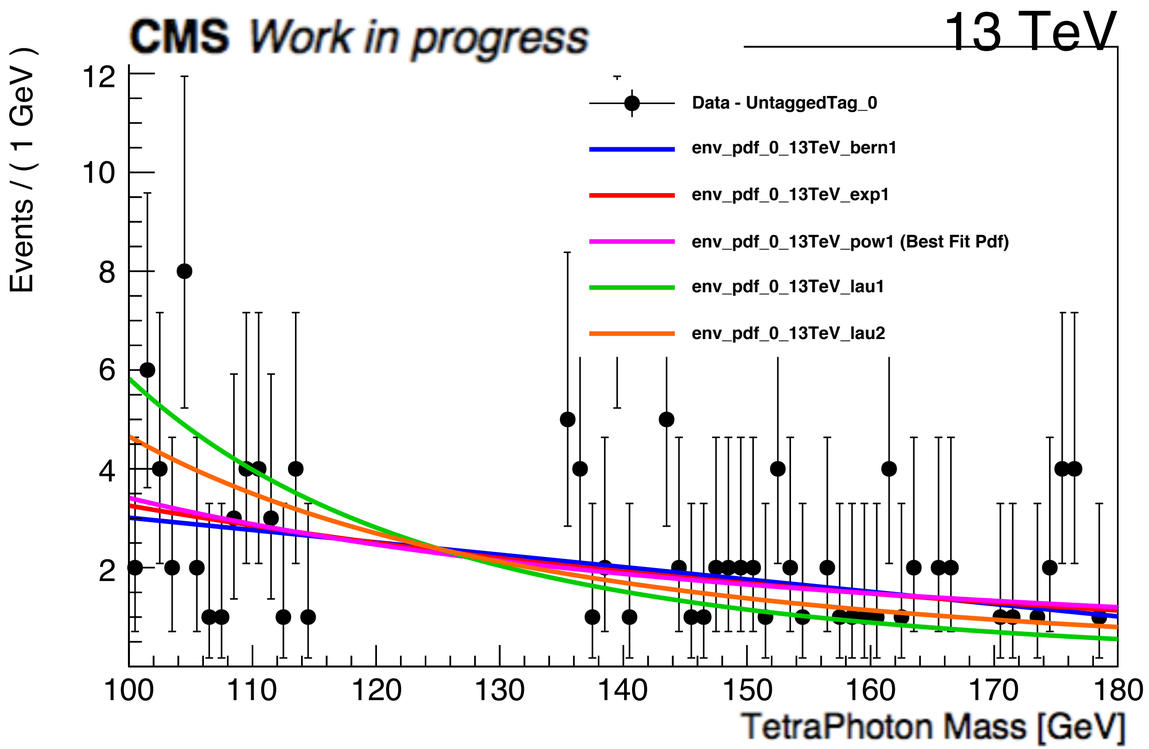
- The MVA selections reject 97% of the background and retain ~70% of the signal
- These values should be interpreted w/ a grain of salt, because the background MC samples are scaled to match data (background modeling is completely data-driven)
- But, they are an indicator of where the analysis stands as of now

Tetraphoton Mass distribution



- Side note:
  - The signal $m_{4\gamma}$ resolution can be improved (?)
  - Since there are 4**γ**'s,
    $\sigma_{eff} = \sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2}$
    $\sigma_{eff} = 2\,\sigma$
  - Can calculate σ_{eff} and compare with that for standard h(125)→aa→**γγγγ**
  - Not a priority, since this is still a search and not a measurement :)

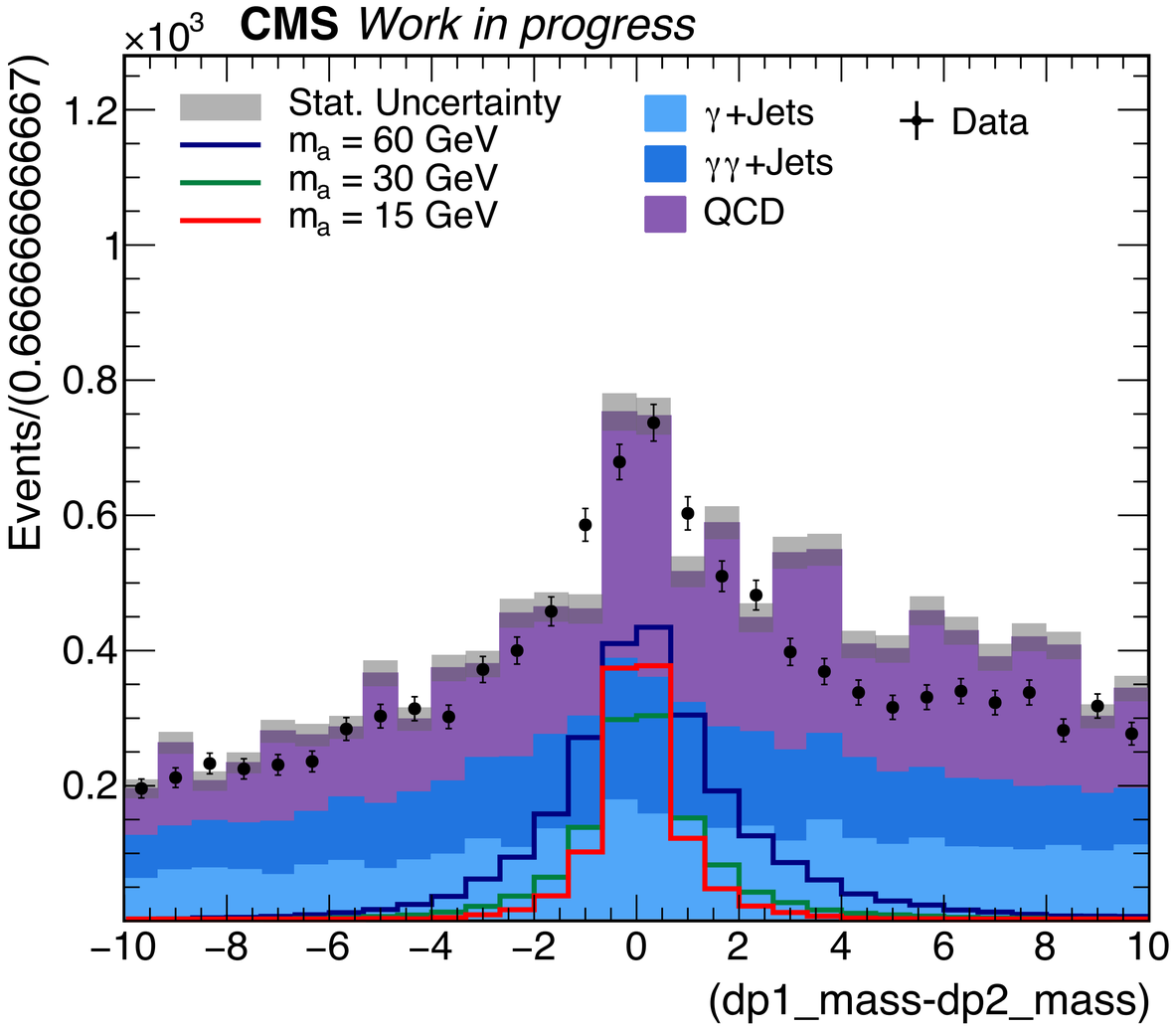
Background model: Envelope method



- Built directly from data from the tetraphoton mass spectrum in the sideband region
- Envelope method or discrete profiling method used, the choice of background function will be treated as a discrete parameter in the likelihood fit
- Four families of analytic functions considered (sums of exponentials, sums of Bernstein polynomials, Laurent series, sum of power laws) and maximum order for each family is determined through F-test

More selections and next steps

- Mass difference of the two diphoton candidates



- Next step: Create windows of diphoton mass and optimize selections for different m(a) signal points