

Search for $\pi^0 \rightarrow \gamma\gamma$ in HPS (redux)

Norman Graf (SLAC)

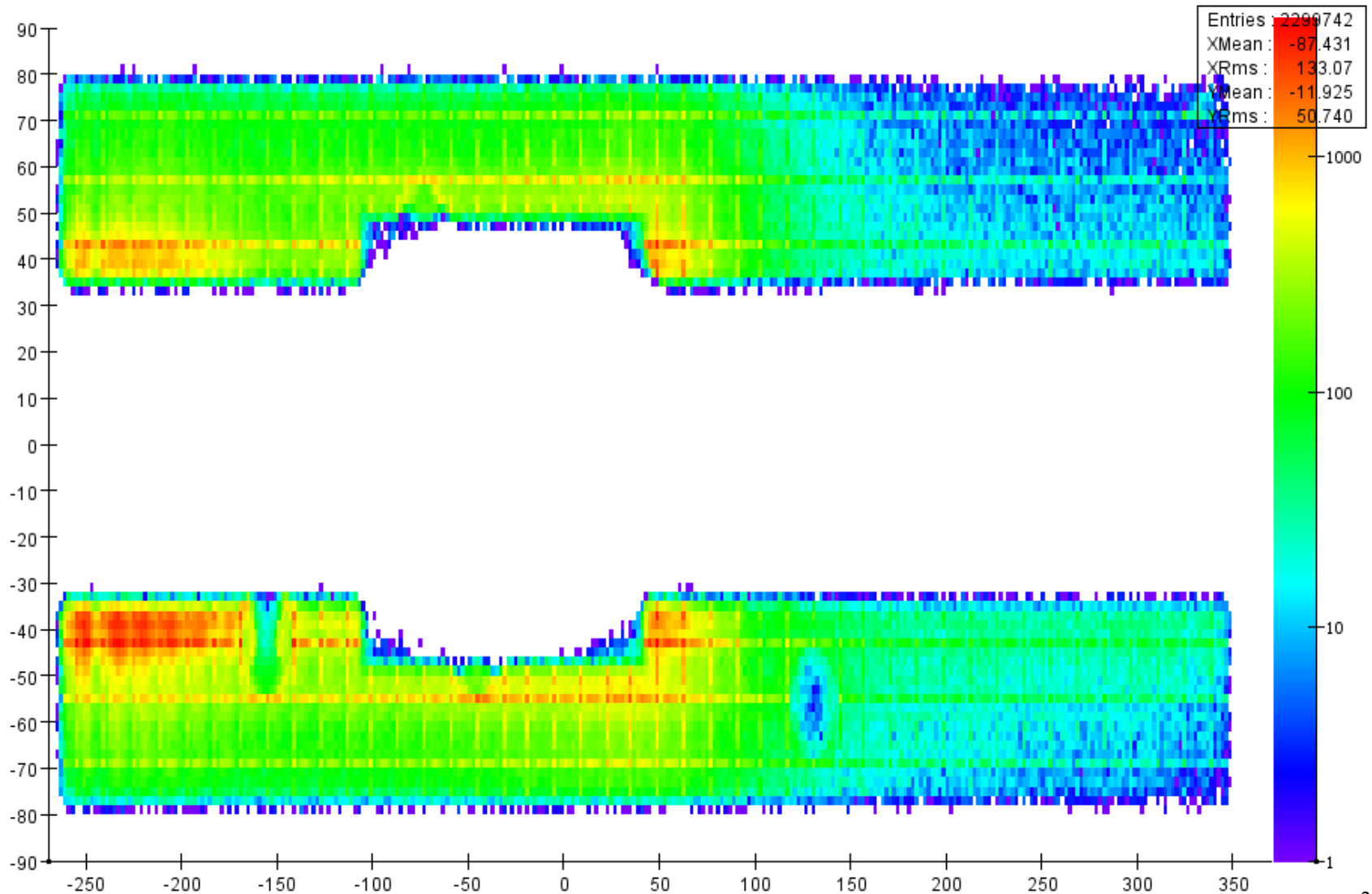
September 1, 2020

Data Samples

- Using data from the 2019 “good” runs.
- Nathan skimmed off the mult2 triggers
`/mss/hallb/hps/physrun2019/production/evio-skims/mult2/`
- Reconstructed with master version of hps-java
 - 2852 files, ~120 million events
- Loop over “photons” in event, create invariant mass of the pairs.
- Cuts:
 - Both fiducial: seed crystal not on edge of calorimeter
 - ~~Opposite: top/bottom and left/right~~
 - Cluster $\Delta t < 5$ ns

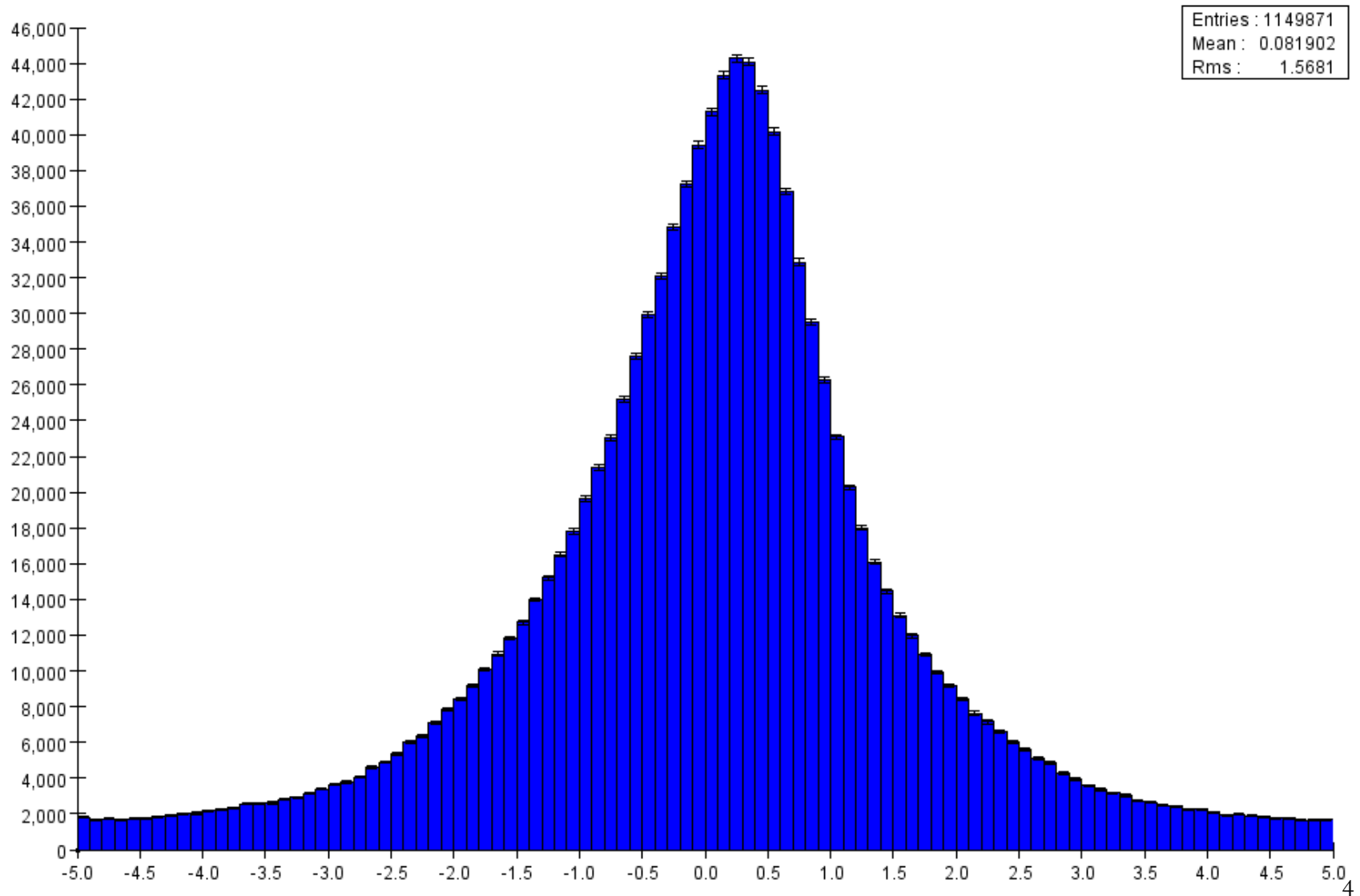
Cluster X vs Y

two fiducial photon cluster x vs y



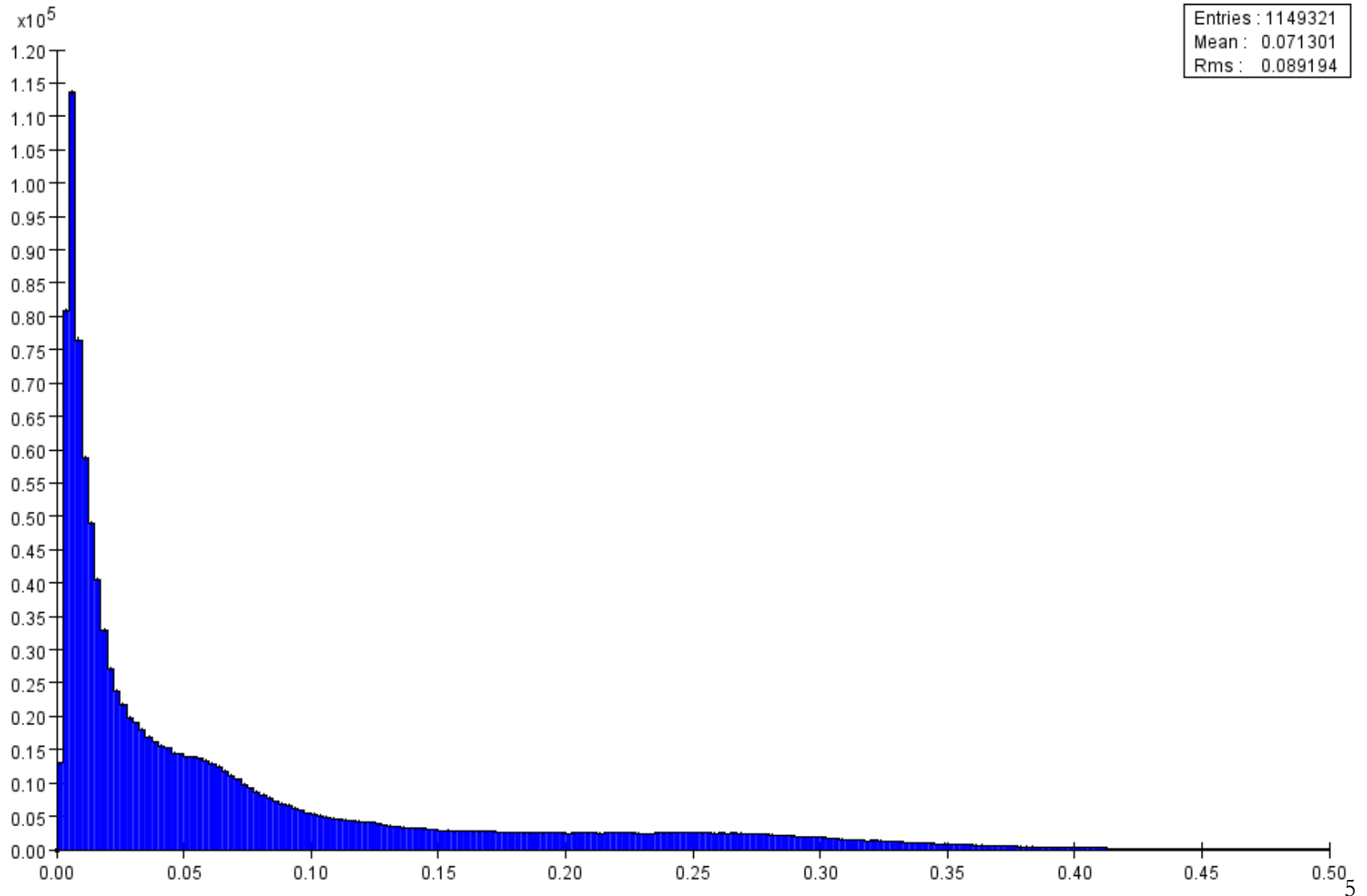
Cluster delta Time

Two photon delta time



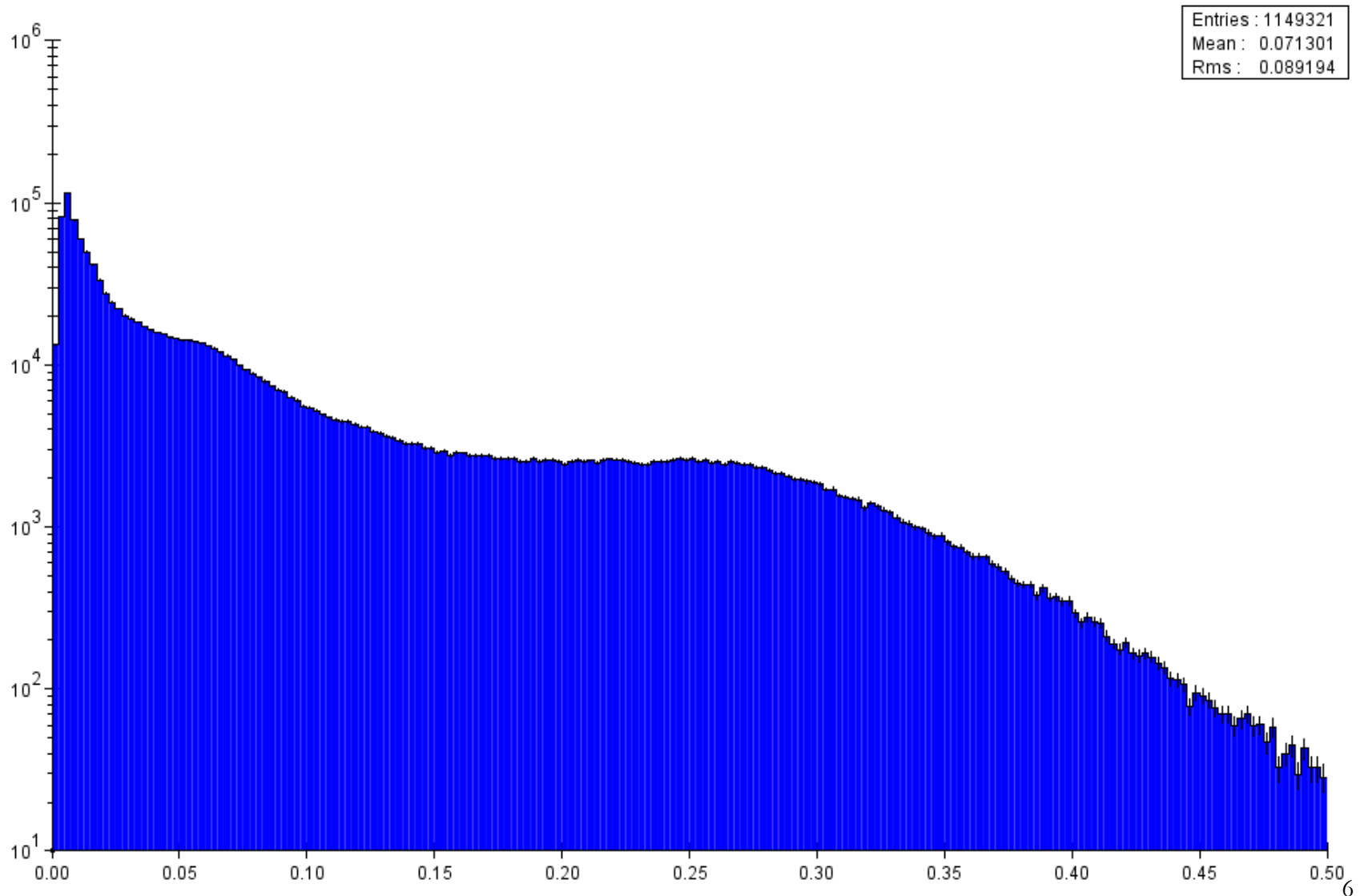
Two-Photon Invariant Mass

two fiducial photon mass opposite

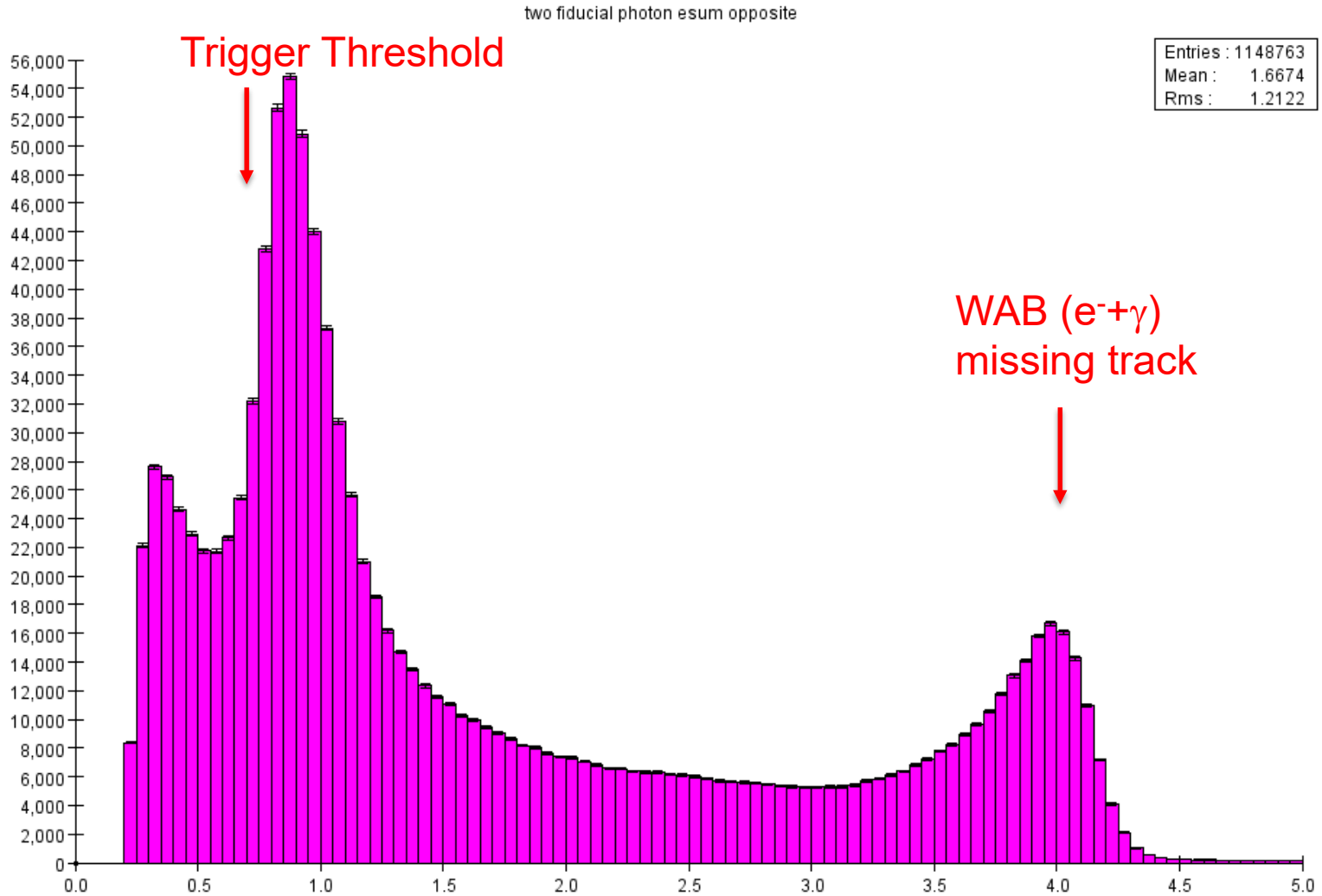


Two-Photon Invariant Mass

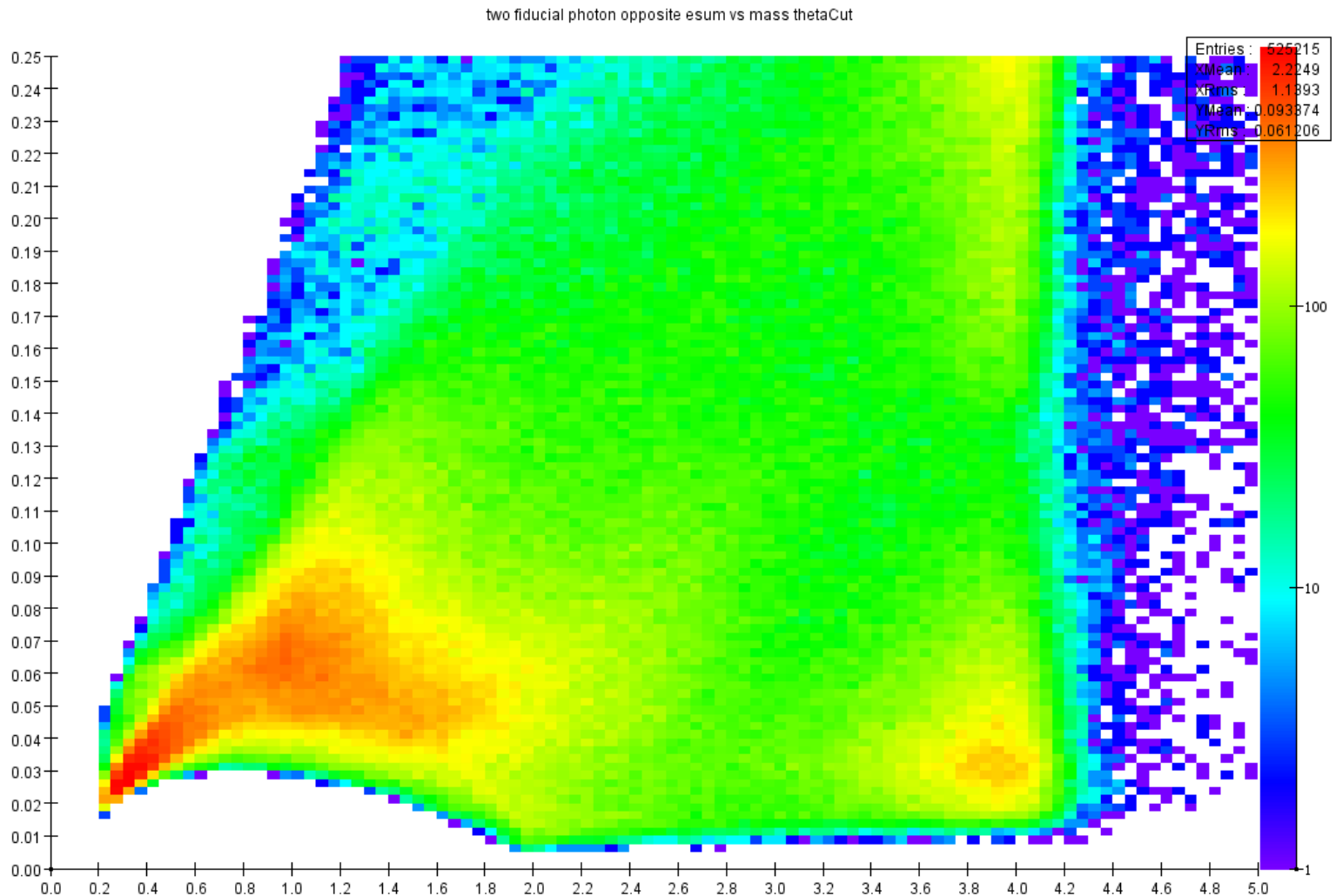
two fiducial photon mass opposite



Two-Photon ESum

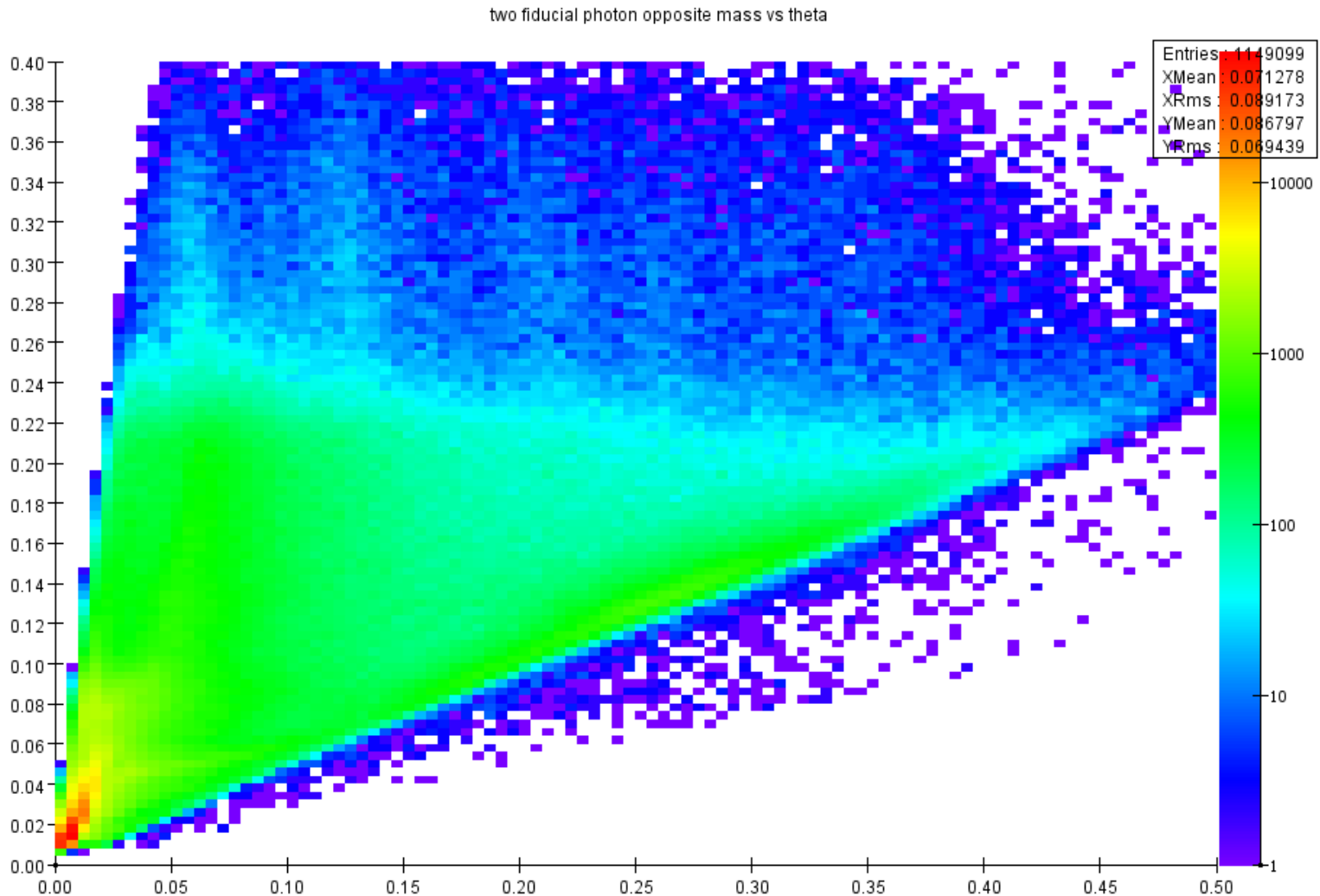


Two-Photon ESum vs Mass



Compare to MC

Two-Photon Mass vs Opening Angle

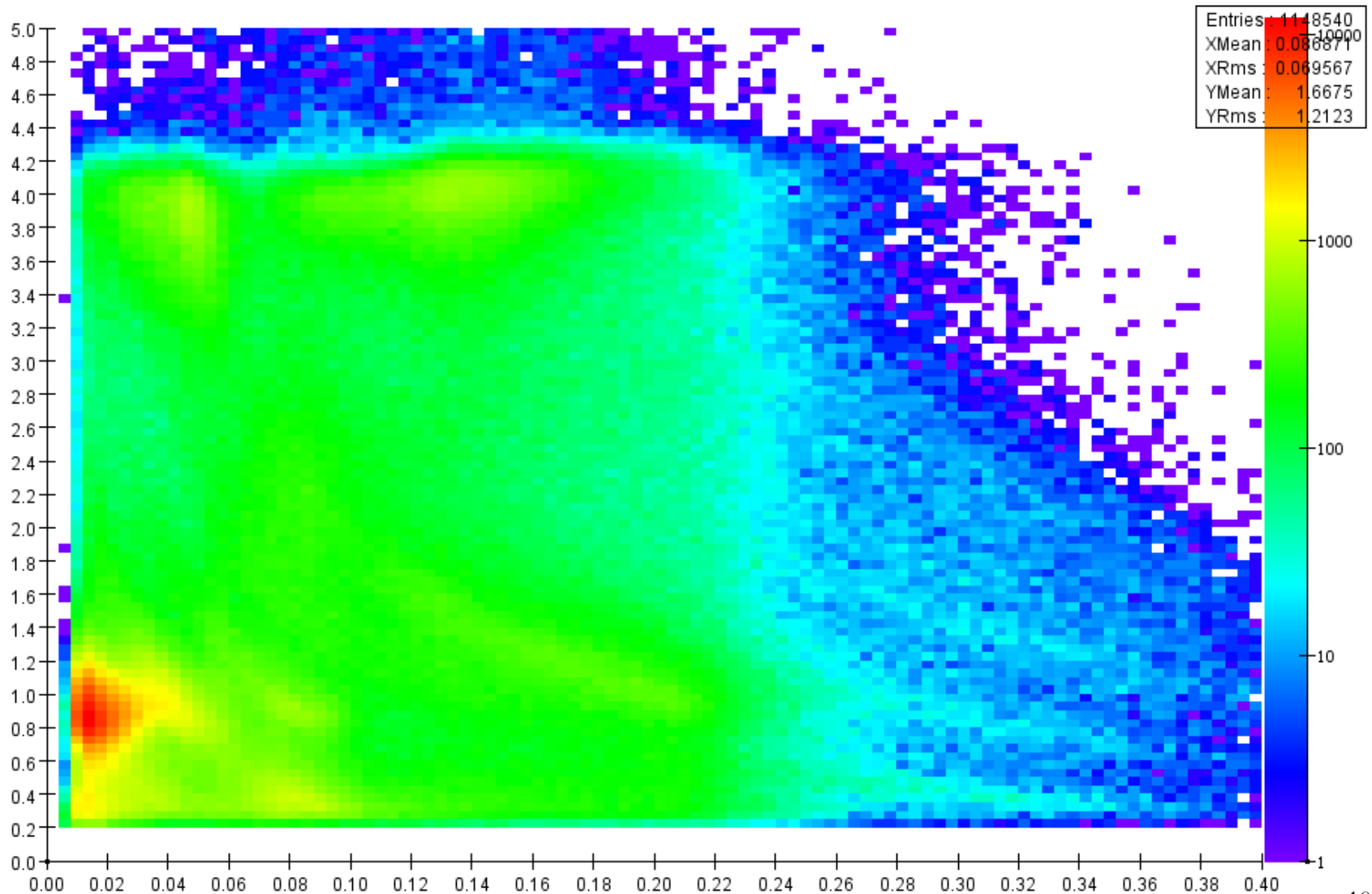


Compare to MC

Theta vs ESum

Compare to MC

two fiducial photon opposite theta vs esum

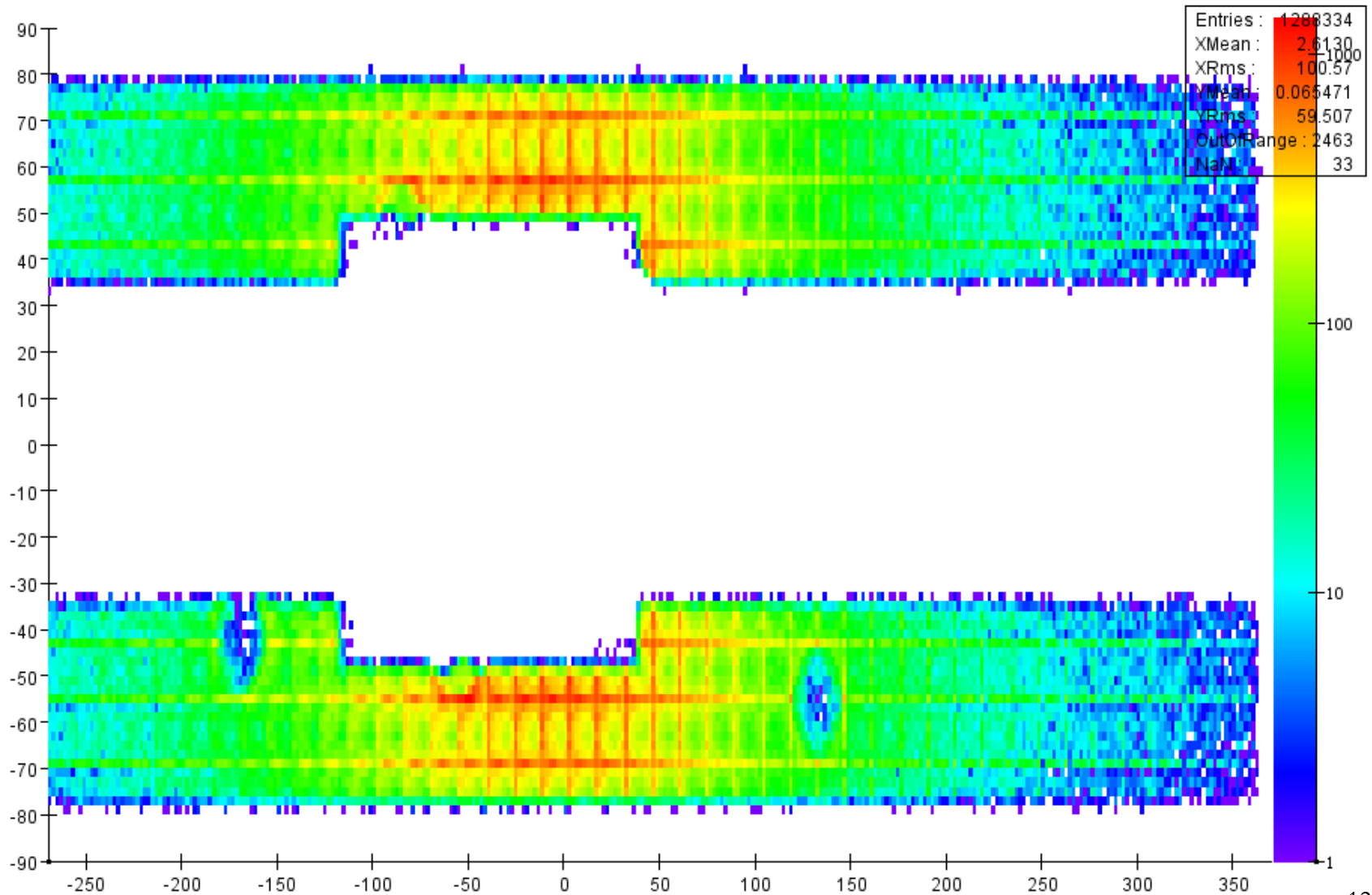


MC Samples

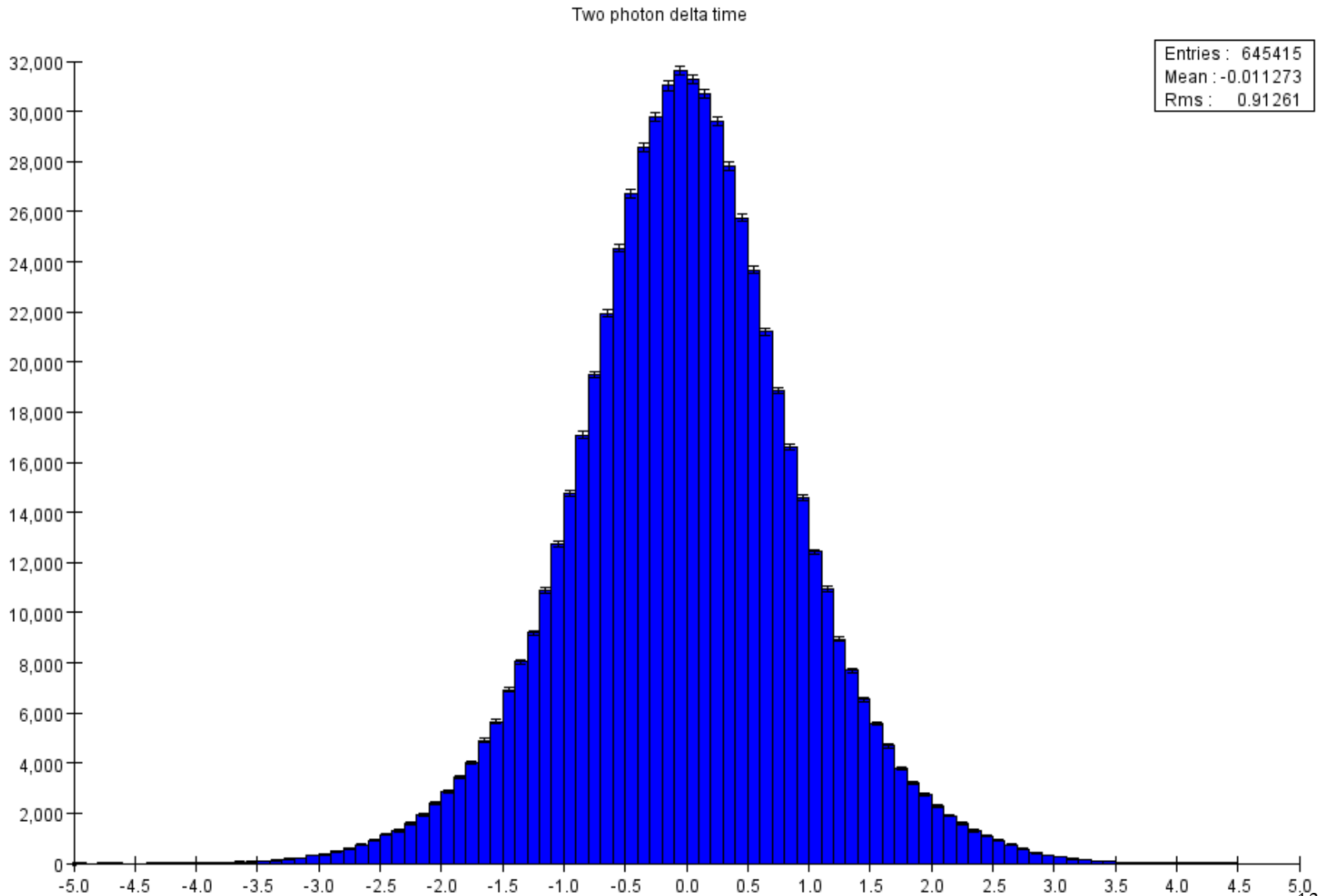
- Generated MC samples of individual $\pi^0 \rightarrow \gamma\gamma$ with π^0 energies flat between 500MeV and 4GeV.
- π^0 direction along z, within +/- 3° of the z axis.
 - Forgot to rotate by 30.5 mrad.
- Simulated with slic
- Processed through full chain of:
 - spacing (but no beam overlay)
 - trigger (using pulser trigger, not mult2)
 - readout
 - reconstruction
- Analyzed using same analysis as data.

MC Cluster X vs Y

two fiducial photon opposite cluster x vs y

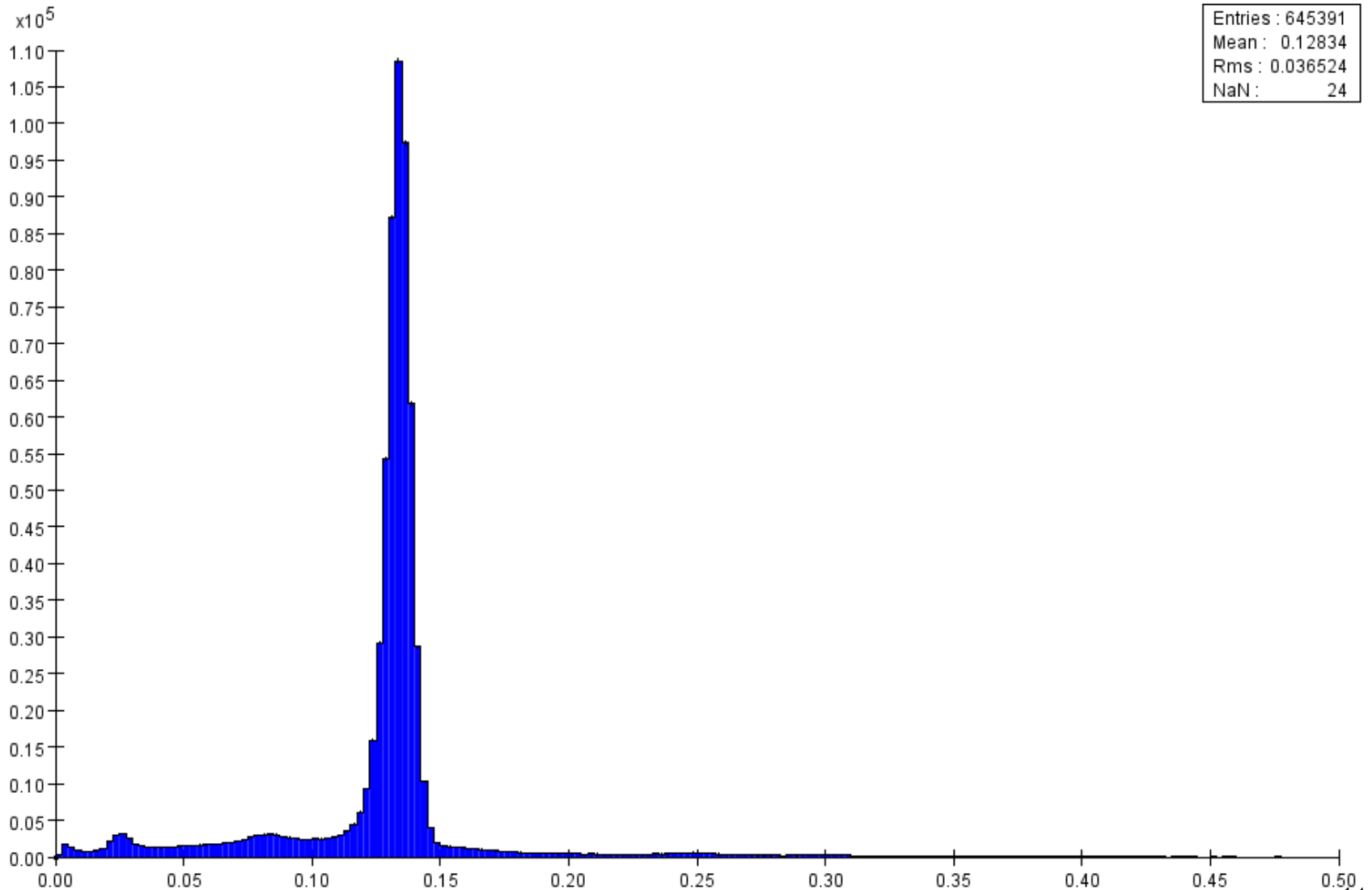


MC Cluster delta Time

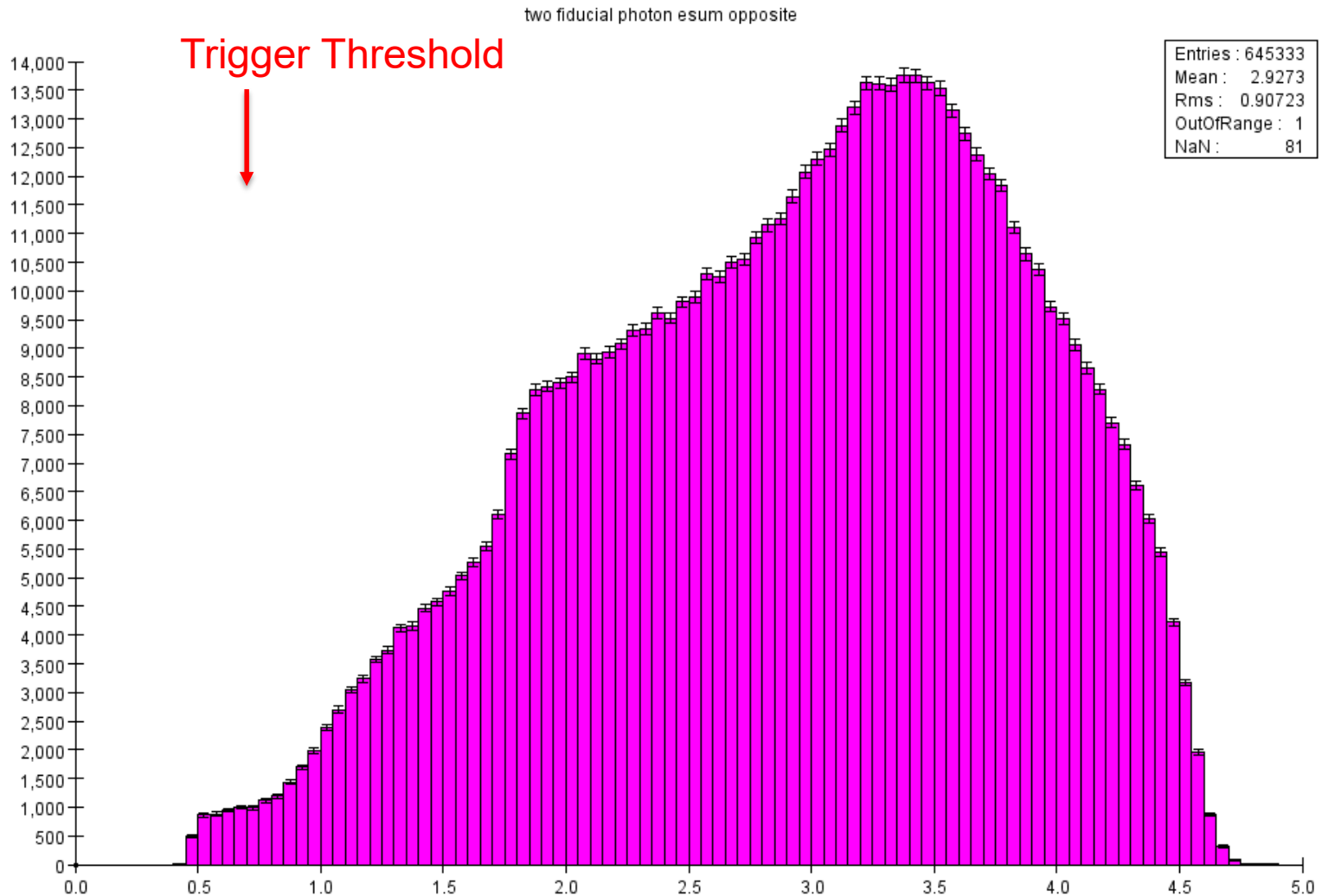


MC Two-Photon Invariant Mass

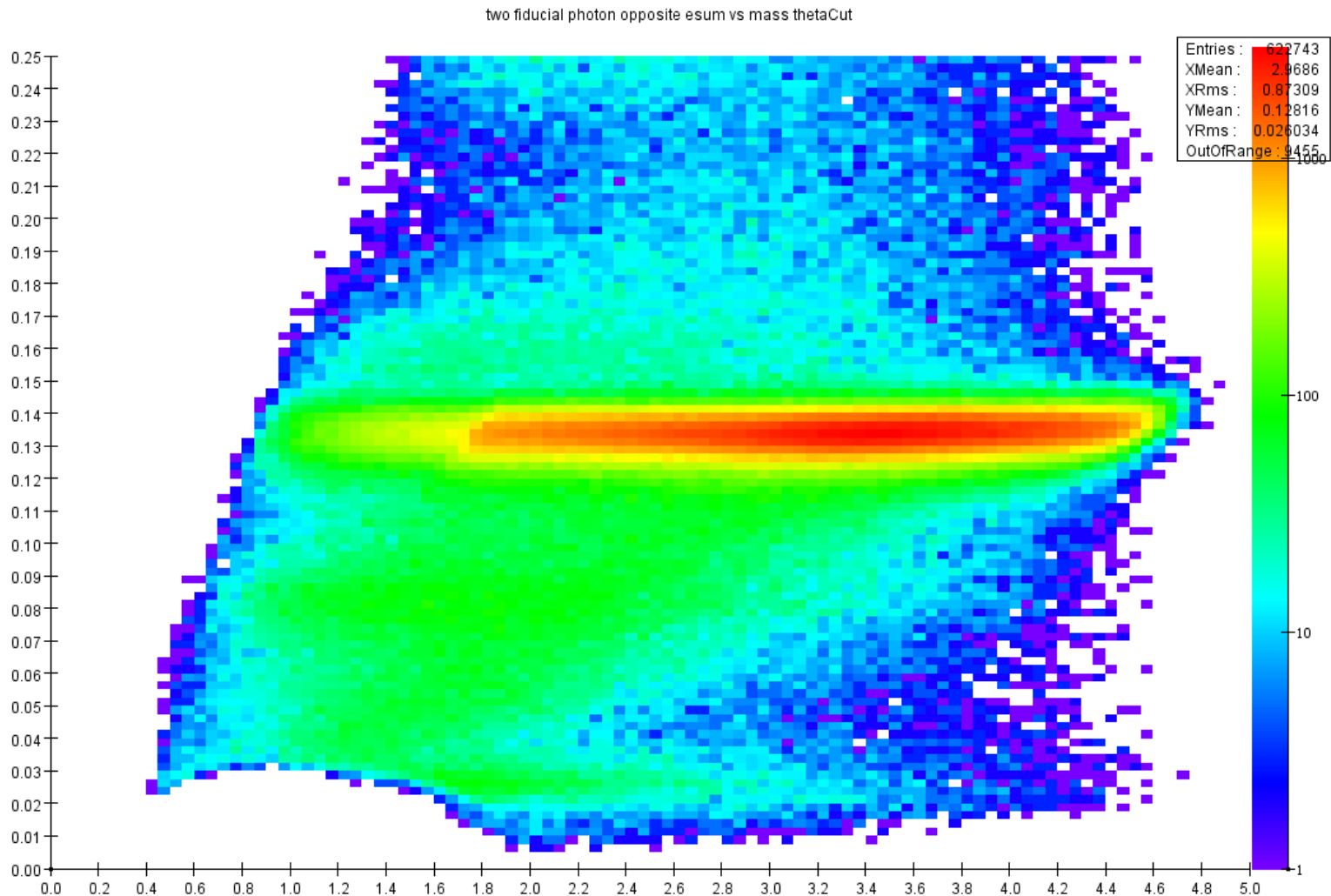
two fiducial photon mass opposite



MC Two-Photon ESum

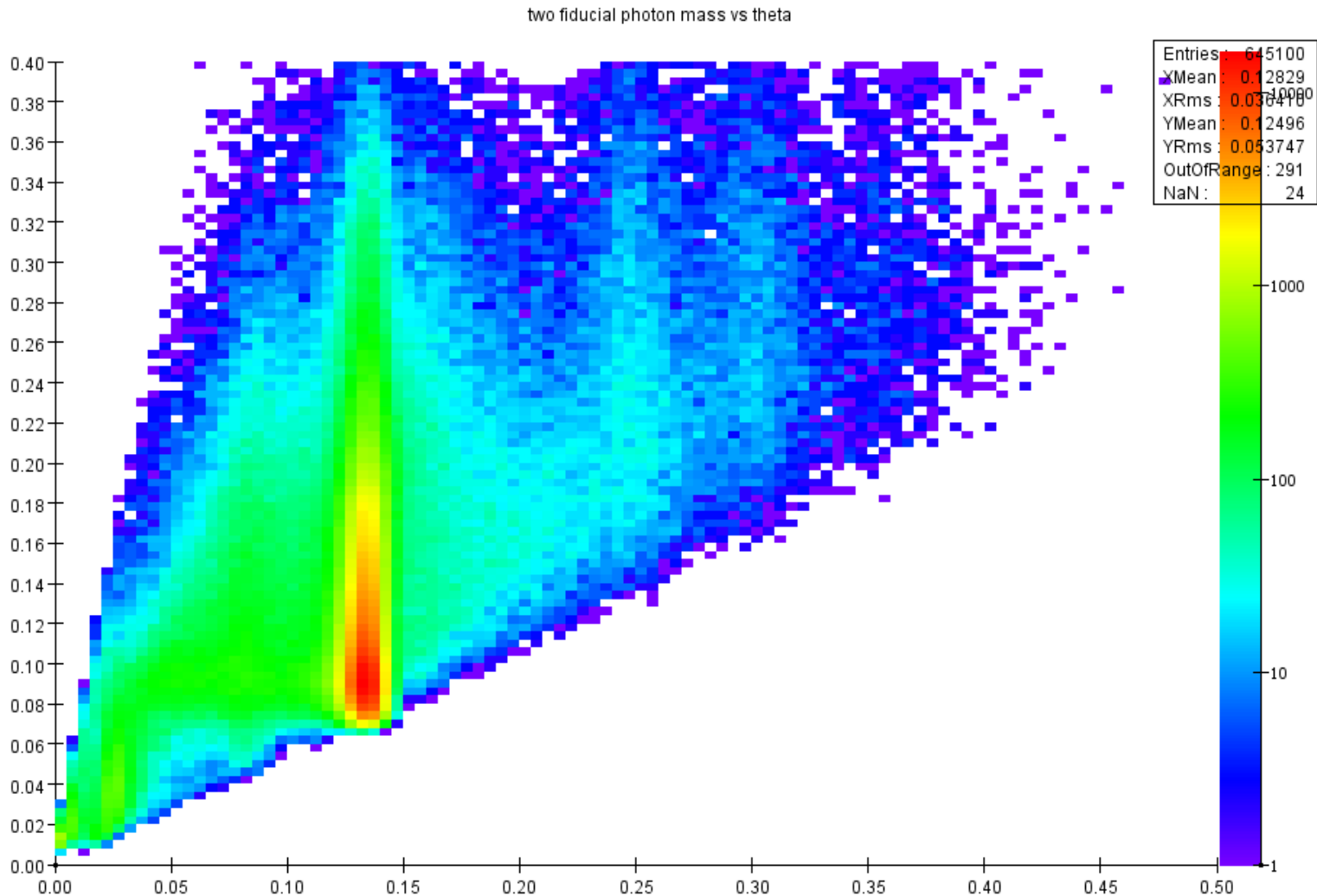


MC Two-Photon ESum vs Mass



Compare to Data

MC Mass vs Opening Angle

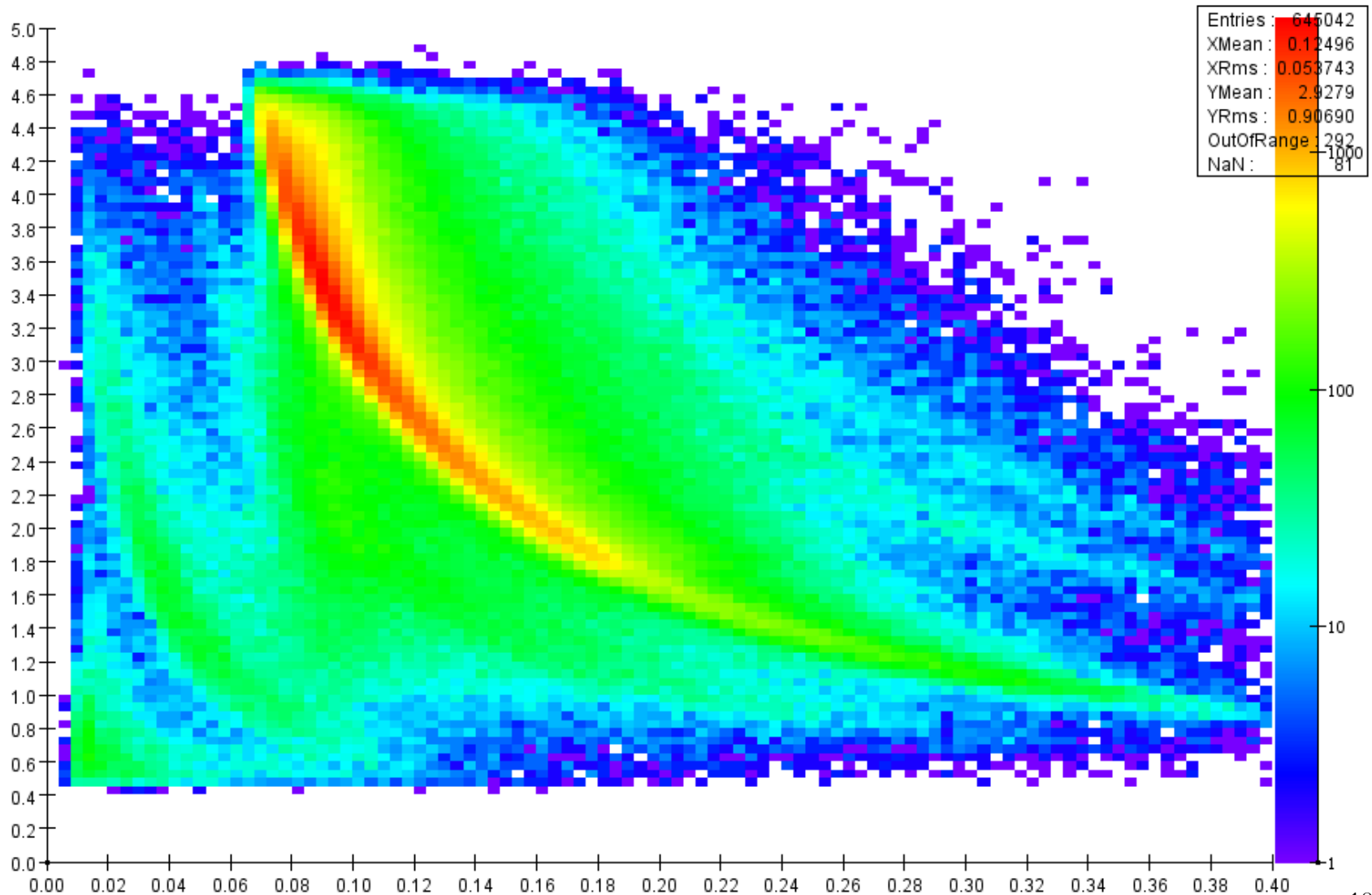


Compare to Data

MC Theta vs ESum

Compare to Data

two fiducial photon opposite theta vs esum



Summary

- A search has been conducted for the process $\pi^0 \rightarrow \gamma\gamma$ using the mult2 trigger skims from the 2019 set of “good” runs.
- 120 million events have been reconstructed and the invariant mass distribution of “photon” pairs has been analyzed.
- Selection cuts have been minimal:
 - Both clusters are in the fiducial region of the calorimeter
 - Clusters are within 5ns of each other in time
- No evidence for a peak at the π^0 mass has been found.
- MC samples of $\pi^0 \rightarrow \gamma\gamma$ with π^0 energies between 500MeV and 4GeV have been generated and analyzed.
- Have not yet checked for trigger bias/efficiency.