

# Updates

Igal Jaeglé

Thomas Jefferson National Accelerator Facility

for the GlueX Collaboration

June 3, 2022



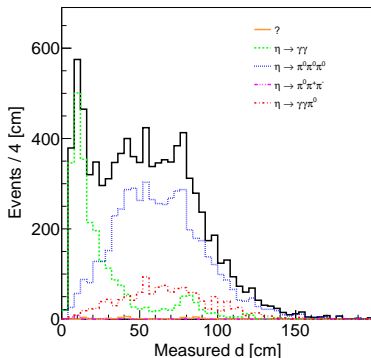
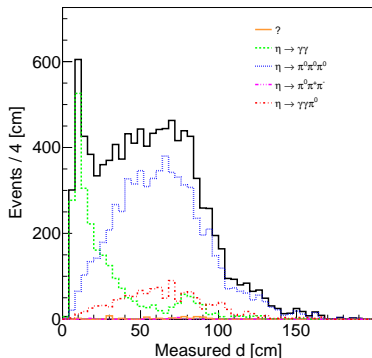
# Table of contents

- 1 Selection criteria
- 2 Default vs Island cluster algo. and COG vs LOG
- 3 Thrown distance between neutral clusters at FCAL2 face
- 4 Measured distance between neutral clusters at FCAL2 face

# Default Algorithm (RADPHI) and distance

10M (tagged and non-tagged)  $\eta$  thrown decaying according to PDG  $\mathcal{B}$

- Reconstruct  $\eta \rightarrow \gamma\gamma\pi^0$  and recoil proton
- Basic selection criteria:
  - ▶ Default ReactionFilter time selection criteria
  - ▶  $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- Distance between two bachelor photons (after  $\eta$  mass cut)
- FCAL1 (DA-COG) ● FCAL2 (DA-COG)

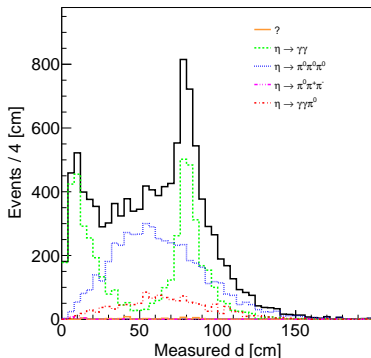
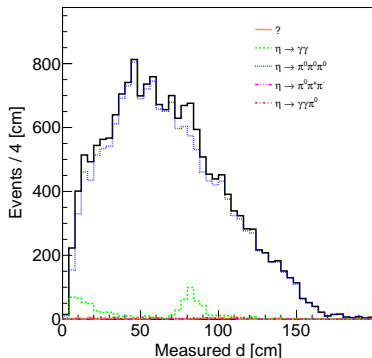


$\eta \rightarrow \gamma\gamma$  and  $\eta \rightarrow \pi^0\pi^0\pi^0$  dominant backgrounds

# Island Algorithm (GAMS) and distance

10M (tagged and non-tagged)  $\eta$  thrown decaying according to PDG  $\mathcal{B}$

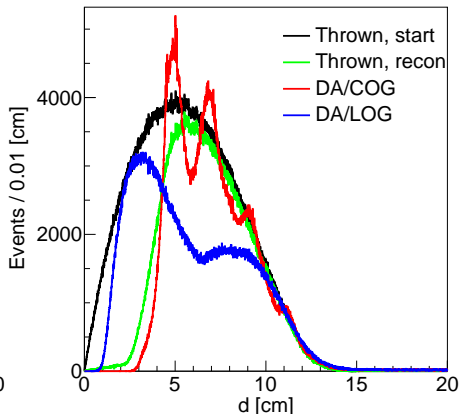
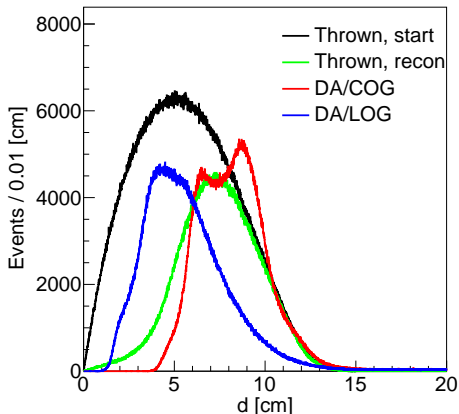
- Reconstruct  $\eta \rightarrow \gamma\gamma\pi^0$  and recoil proton
- Basic selection criteria:
  - ▶ Default ReactionFilter time selection criteria
  - ▶  $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- Distance between two bachelor photons (after  $\eta$  mass cut)
- FCAL1 (IA-COG) ● FCAL2 (IA-COG)



Still some work to do on Island Algorithm, issues with Pb-Glass shower shape parameters?

# Default Algorithm and distance

- Two photons of 1 and 3 GeV thrown simultaneously into FCAL1/2
- Two clusters (only) events
- FCAL1
- FCAL2

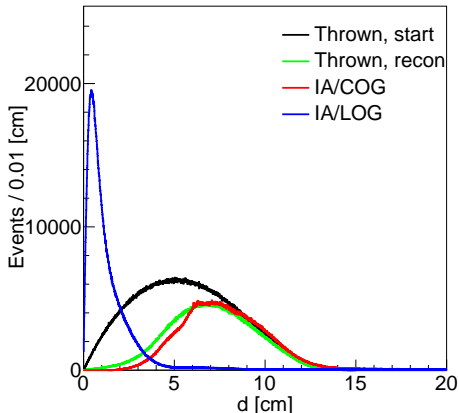


Default Algorithm is doing a bad job at this extreme conditions

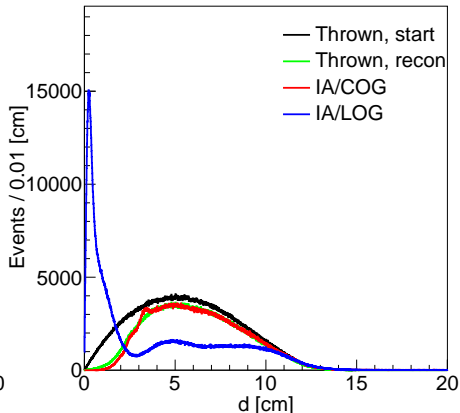
# Default Algorithm and distance

- Two photons of 1 and 3 GeV thrown simultaneously into FCAL1/2
- Two clusters (only) events

• FCAL1



• FCAL2

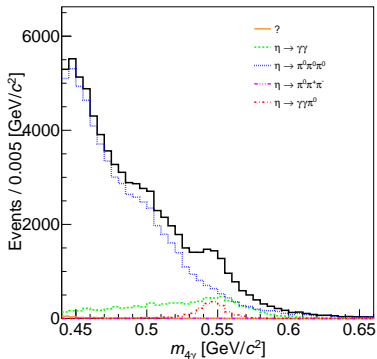
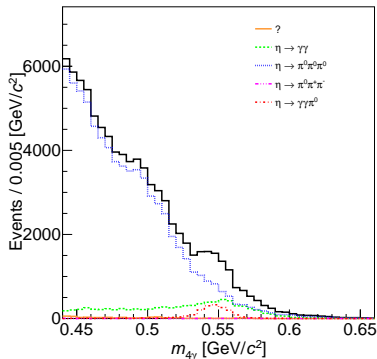


Island Algorithm appears doing a good job at this extreme conditions

# Current status, invariant masses

10M (tagged and non-tagged)  $\eta$  thrown decaying according to PDG  $\mathcal{B}$

- Reconstruct  $\eta \rightarrow \gamma\gamma\pi^0$  and recoil proton
- Basic selection criteria:
  - ▶ Default ReactionFilter time selection criteria
  - ▶  $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- Four photons invariant mass
- FCAL1 (DA-COG) ● FCAL2 (DA-COG)



$\eta \rightarrow \gamma\gamma$  and  $\eta \rightarrow \pi^0\pi^0\pi^0$  dominant backgrounds

# Current status, invariant masses

Reconstruct  $\eta \rightarrow \gamma\gamma\pi^0$  and recoil proton

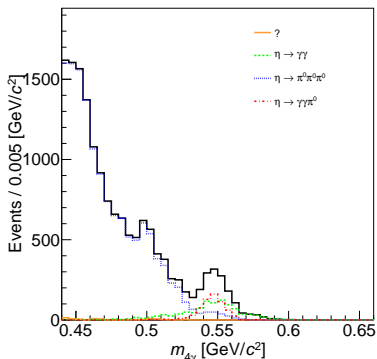
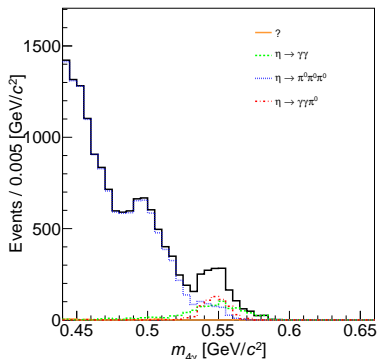
- Selection criteria:

- ▶ Default ReactionFilter time selection criteria
- ▶  $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- ▶ Elasticity
- ▶ Mass conservation

- Four photons invariant mass

- FCAL1 (DA-COG)

- FCAL2 (DA-COG)



$\eta \rightarrow \gamma\gamma$  and  $\eta \rightarrow \pi^0\pi^0\pi^0$  (peaking) backgrounds but not the only one



# Current status, peek at data

In data (PrimEx phase 2),  $\pi^0\pi^0$  background is observed

- Process:  $\gamma^4\text{He} \rightarrow \gamma\gamma\pi^0 p^3\text{H}$

- Selection criteria:

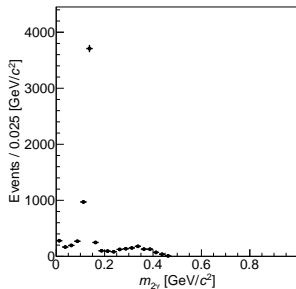
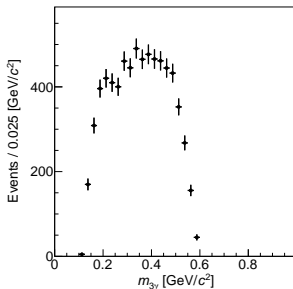
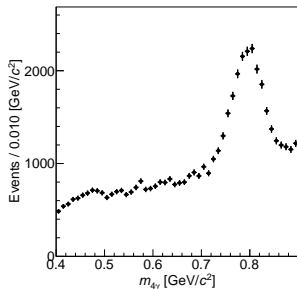
- ▶ Default ReactionFilter time selection criteria
- ▶  $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- ▶ Elasticity
- ▶ Mass conservation

- Four photons, three photons, and two photons invariant masses

- $\eta \rightarrow \gamma\gamma\pi^0$  candidates

- $B \rightarrow \gamma\pi^0$  candidates, two candidates per event

- $S \rightarrow \gamma\gamma$  candidates

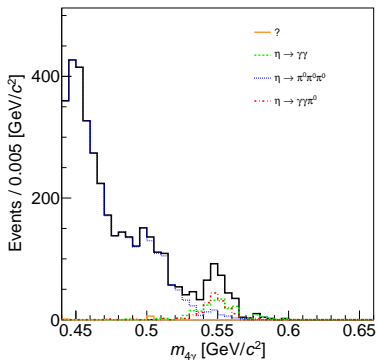
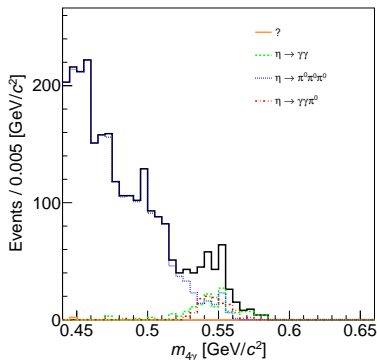


A  $\pi^0\pi^0$  veto must be applied and in general also a  $\eta\eta$  and  $\pi^0\eta$  veto

# Current status, reconstruct $\eta \rightarrow \gamma\gamma\pi^0$ and recoil proton

## Selection criteria:

- Default ReactionFilter time selection criteria
- $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- Elasticity
- Mass conservation
- $\pi^0\pi^0$ ,  $\eta\eta$ , and  $\pi^0\eta$  veto applied
- Coplanarity
- All photons in FCAL with at least one in insert (FCAL2) or below  $4.5^\circ$  (FCAL1)
- FCAL1 (DA-COG) • FCAL2 (DA-COG)

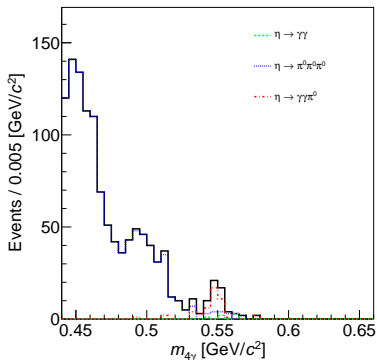
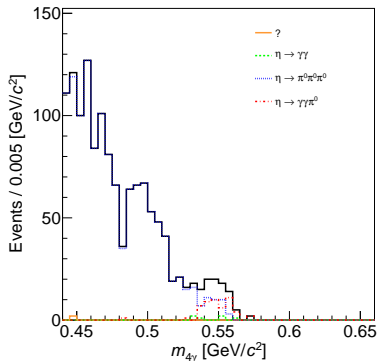


$\eta \rightarrow \gamma\gamma$  “peaking” and  $\eta \rightarrow \pi^0\pi^0\pi^0$  “smooth” backgrounds

# Current status, reconstruct $\eta \rightarrow \gamma\gamma\pi^0$ and recoil proton

## Selection criteria:

- Default ReactionFilter time selection criteria
- $\pi^0$  selected by a  $\chi^2$ -test on the diphoton invariant mass
- Elasticity
- Mass conservation
- $\pi^0\pi^0$ ,  $\eta\eta$ , and  $\pi^0\eta$  veto applied
- Coplanarity
- All photons in FCAL with at least one in insert (FCAL2) or below  $4.5^\circ$  (FCAL1)
- TOF veto
- FCAL1 (DA-COG) • FCAL2 (DA-COG)



Still  $\eta \rightarrow \pi^0\pi^0\pi^0$  “smooth” backgrounds but gamma conversion from  $\eta \rightarrow \gamma\gamma$  strongly reduced

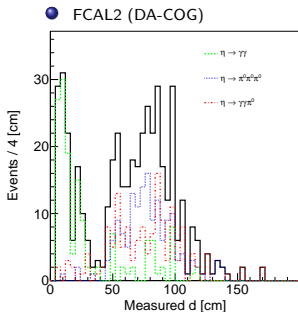
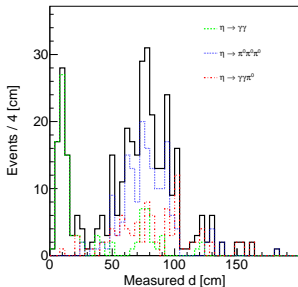
# Current status, summary

After all selection criteria are applied

Channel	$\eta \rightarrow \gamma\gamma\pi^0$	$\eta \rightarrow \gamma\gamma$	$\eta \rightarrow \pi^0\pi^0\pi^0$
Thrown	2700	3.9M	3.2M
Reconstructed in FCAL1	48	6	93
Reconstructed in FCAL2	46	6	36

Detection efficiency is  $\epsilon \sim 1.7\%$

- TOF veto reduced signal by a factor 4
- Peaking background by a factor 30
- Distance between two bachelor photons with all selection criteria except TOF veto
- FCAL1 (DA-COG)
- FCAL2 (DA-COG)



With optimized IA and if beamline background not an issue  $\epsilon$  could be increased