

Updates

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for the GlueX Collaboration

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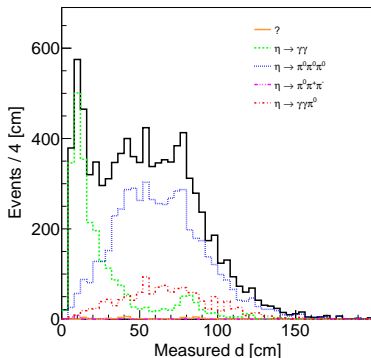
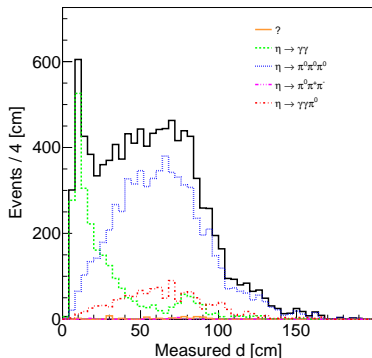
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- 6 $\eta \rightarrow \gamma B$

Default Algorithm (RADPHI) and distance

10M (tagged and non-tagged) η 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
 - ▶ π^0 selected by a χ^2 -test on the diphoton invariant mass
- Distance between two bachelor photons (after η mass cut)
- FCAL1 (DA-COG) ● FCAL2 (DA-COG)

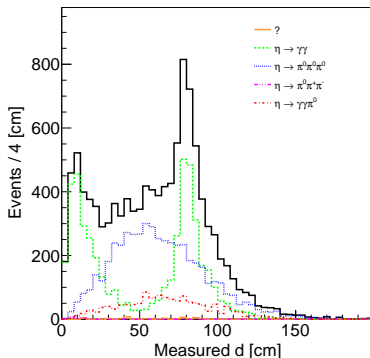
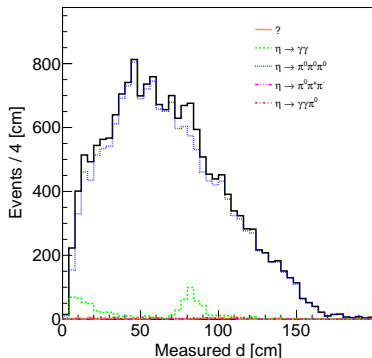


$\eta \rightarrow \gamma\gamma$ and $\eta \rightarrow \pi^0\pi^0\pi^0$ dominant backgrounds

Island Algorithm (GAMS) and distance

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

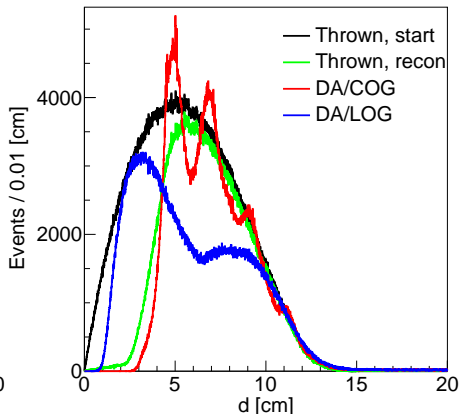
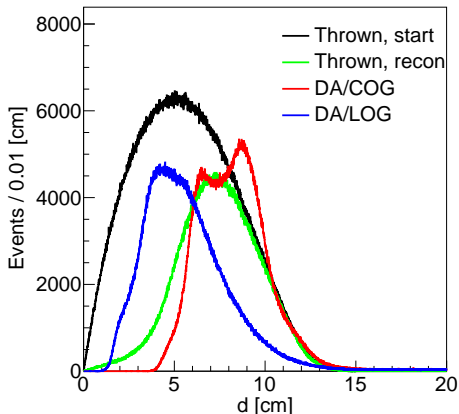
- Reconstruct $\eta \rightarrow \gamma\gamma\pi^0$ and recoil proton
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- Distance between two bachelor photons (after η mass cut)
- FCAL1 (IA-COG) ● FCAL2 (IA-COG)



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

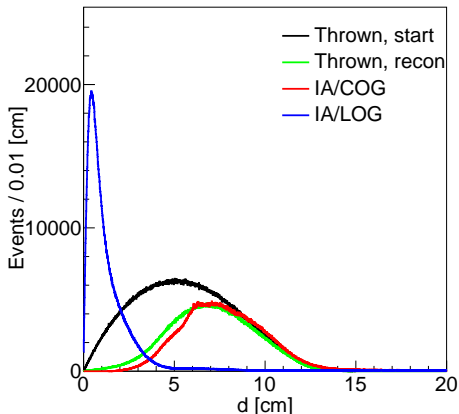


Default Algorithm is doing a bad job at this extreme conditions

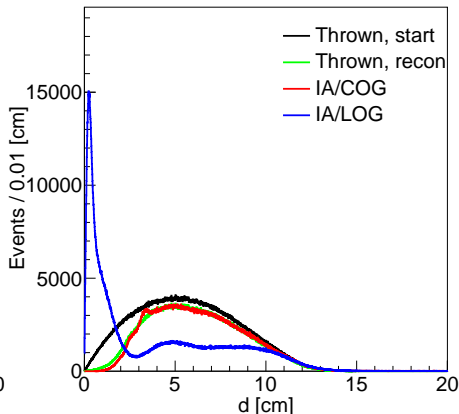
Default Algorithm and distance

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

• FCAL1



• FCAL2

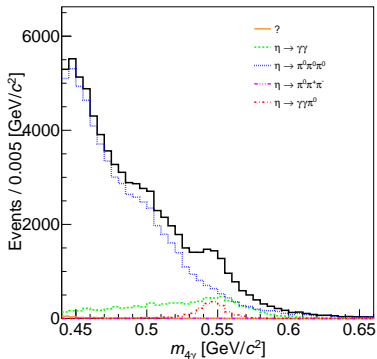
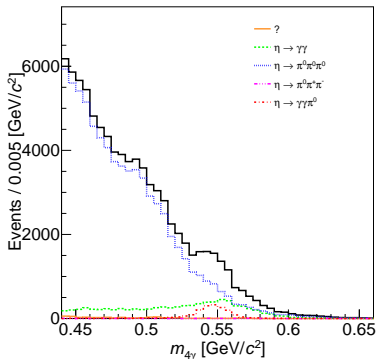


Island Algorithm appears doing a good job at this extreme conditions

Current status, invariant masses

10M (tagged and non-tagged) η 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
 - ▶ π^0 selected by a χ^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

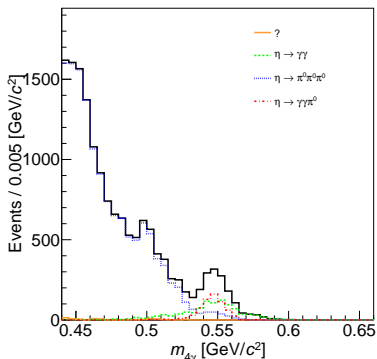
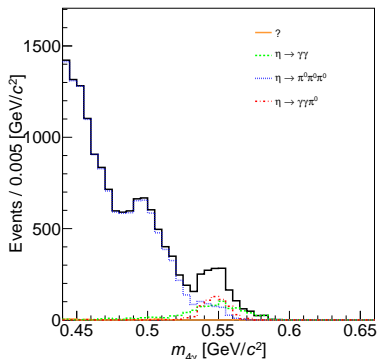
- Selection criteria:

- ▶ Default ReactionFilter time selection criteria
- ▶ π^0 selected by a χ^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:

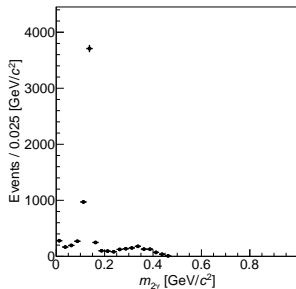
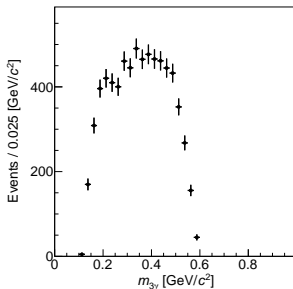
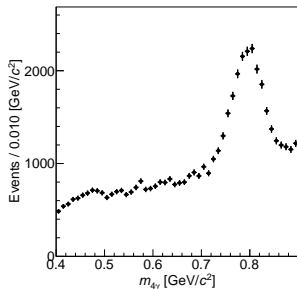
- ▶ Default ReactionFilter time selection criteria
- ▶ π^0 selected by a χ^2 -test on the diphoton invariant mass
- ▶ Elasticity
- ▶ Mass conservation

- 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

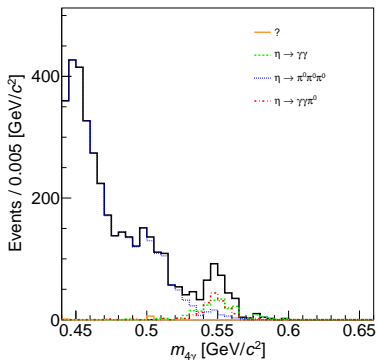
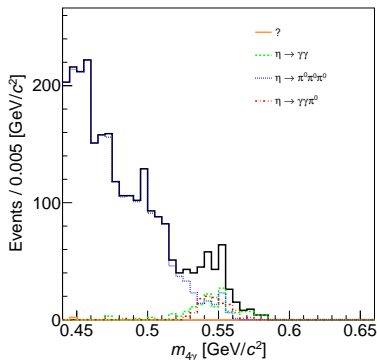


A $\pi^0\pi^0$ veto must be applied and in general also a $\eta\eta$ and $\pi^0\eta$ veto

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

Selection criteria:

- Default ReactionFilter time selection criteria
- π^0 selected by a χ^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° (FCAL1)
- FCAL1 (DA-COG) • FCAL2 (DA-COG)

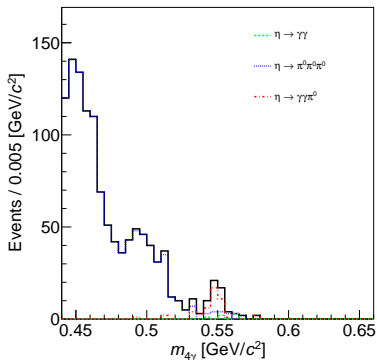
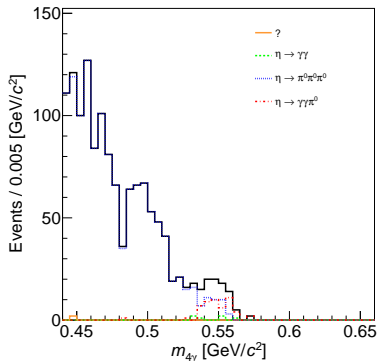


$\eta \rightarrow \gamma\gamma$ “peaking” and $\eta \rightarrow \pi^0\pi^0\pi^0$ “smooth” backgrounds

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

Selection criteria:

- Default ReactionFilter time selection criteria
- π^0 selected by a χ^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° (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

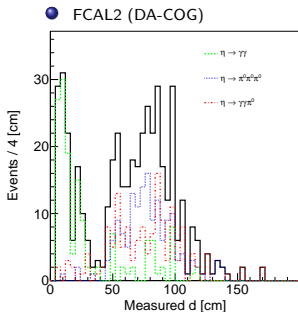
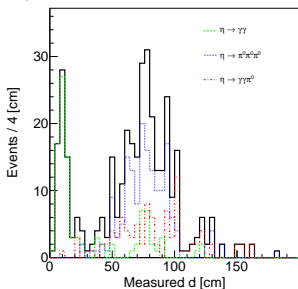
Current status, summary

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

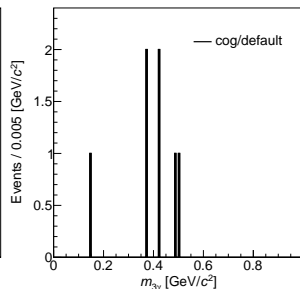
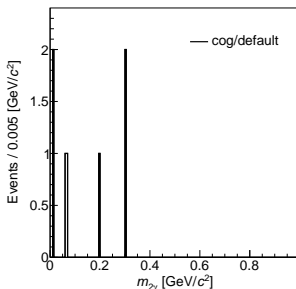
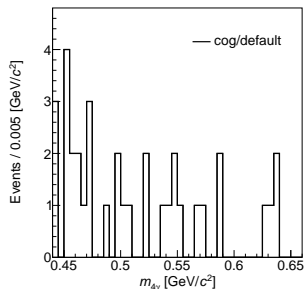
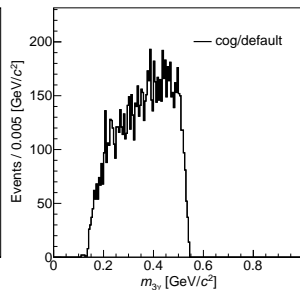
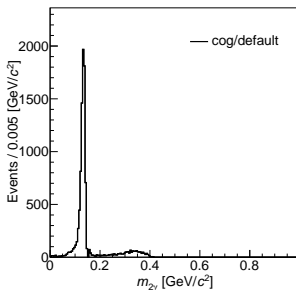
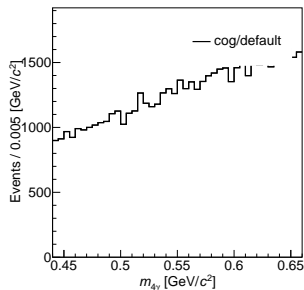
Detection efficiency is $\epsilon \sim 1.7\%$

- 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)



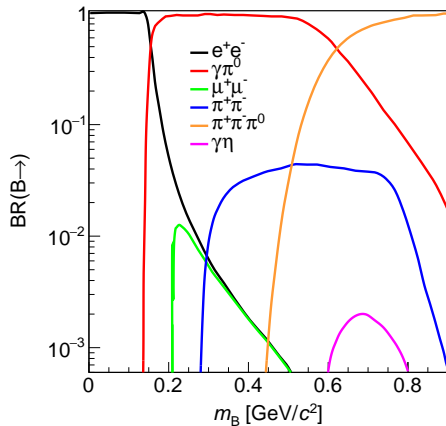
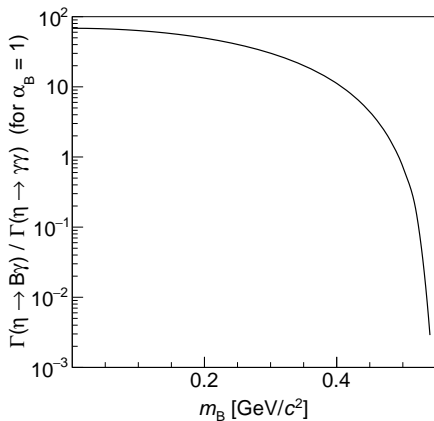
With optimized IA and if beamline background not an issue ϵ could be increased

$2\pi^0$ background



$\eta \rightarrow \gamma B$

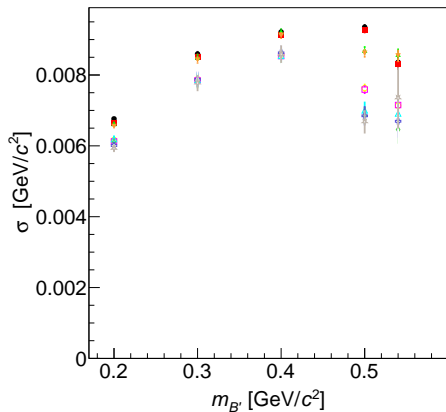
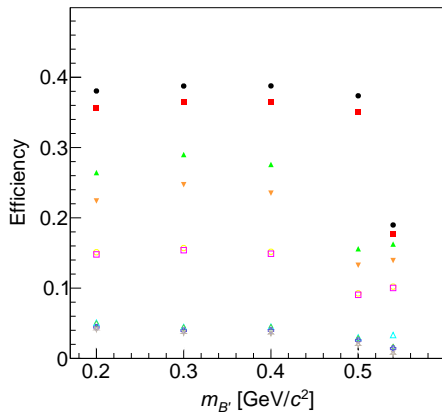
Extract reach using the method described in the PAC note



- $S = N_\eta \cdot \epsilon_\eta \cdot \mathcal{B}(\eta \rightarrow \gamma B) \cdot \mathcal{B}(B \rightarrow \gamma\pi^0) \cdot \epsilon_S$
- $N_{\text{bin}} = N_\eta \cdot \epsilon_\eta \cdot \mathcal{B}(\eta \rightarrow \gamma\gamma\pi^0) \cdot \epsilon_B$

$\eta \rightarrow \gamma B$

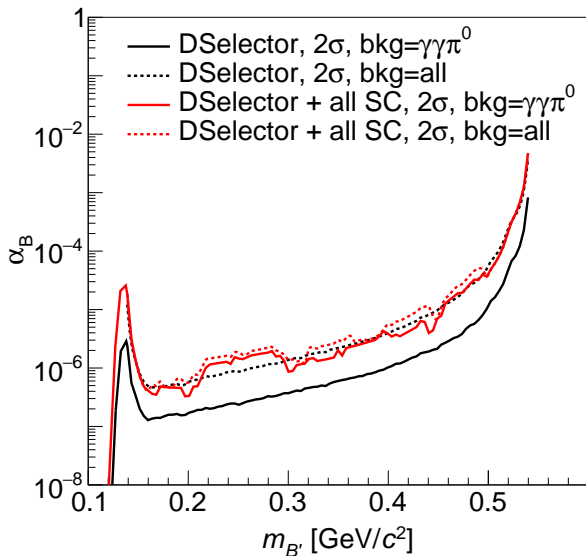
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$\eta \rightarrow \gamma B$

Extract reach using the method described in the PAC note



$$\eta \rightarrow \gamma B$$

Extract reach using the method described in the PAC note

