

EltoPhFF

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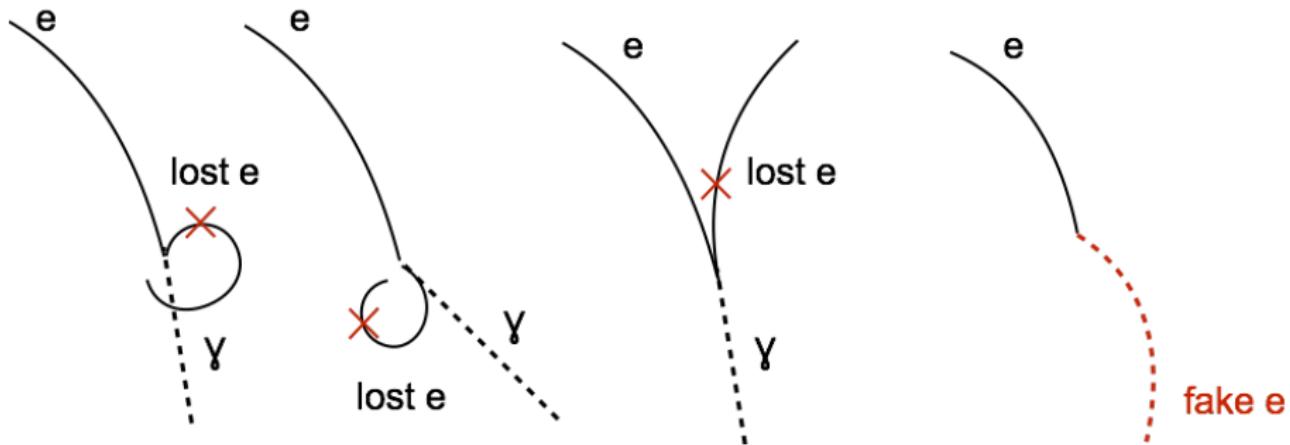


Motivation

- $Z \rightarrow ee$ events present a large background to electron + > 0 photon selections
- This background is principally from electrons that fake photons
- Use data driven background estimate to check MC modeling of fakes
- Such an estimate can provide higher statistics than MC

Example from $W\gamma\gamma$ analysis

Composition of $Z \rightarrow ee$ background, $e + \gamma$ events



Composition of $Z \rightarrow ee$ background, $e + \gamma$ events

Plot

Estimating $Z \rightarrow ee$ background

- Derive a relative fake factor using $Z \rightarrow ee$ events where the electron passes the nominal ID, or passes the photon ID (mutually exclusive)

For all true $Z \rightarrow ee$ events the possible reconstructed states are

| | EX | GX | XX |
|----------------|----------------|----------------|-----------|
| ϵ_G^2 | EG | GG | XG |
| ϵ_E^2 | EE | GE | XE |
| | ϵ_E^1 | ϵ_G^1 | |

Probability to reconstruct a photon fake

- $\epsilon_{E,G}^i$ represents the rate to reconstruct an electron or photon (E, G) for true electron i
- ϵ may depend on kinematic variables (p_T , η , ...). Keep ϵ^1 and ϵ^2 separate for this reason

The number of electron plus photon events is given by,

$$N_{EG} = N_Z (\epsilon_E^1 \epsilon_G^2 + \epsilon_G^1 \epsilon_E^2) \quad (1)$$

And the number of two electron events is,

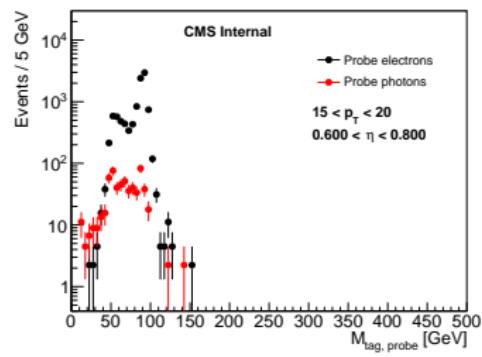
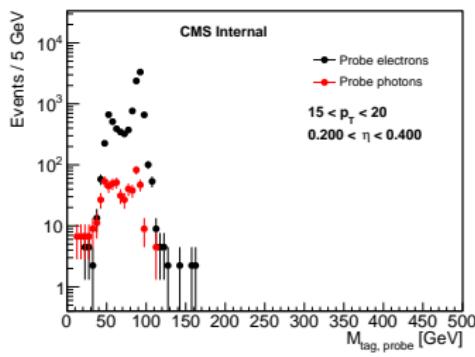
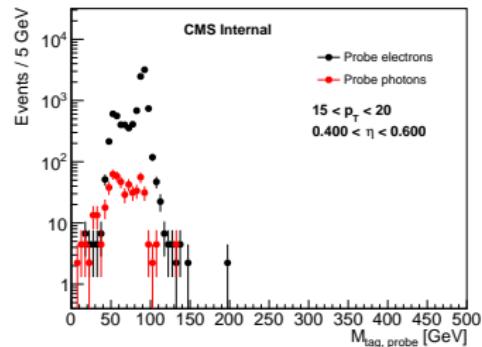
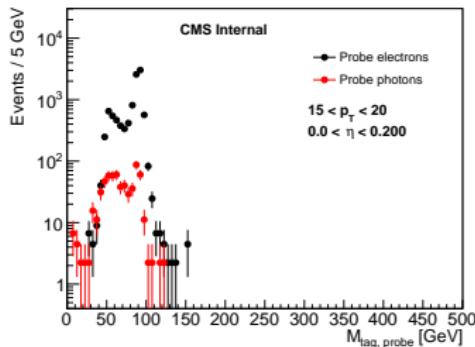
$$N_{EE} = N_Z \epsilon_E^1 \epsilon_E^2 \quad (2)$$

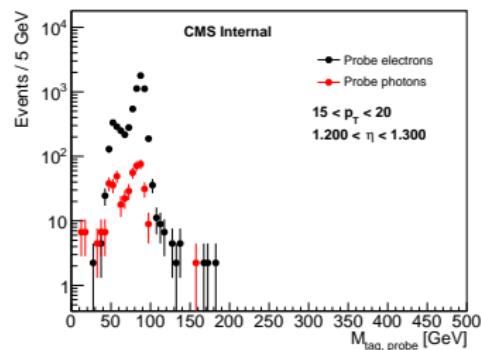
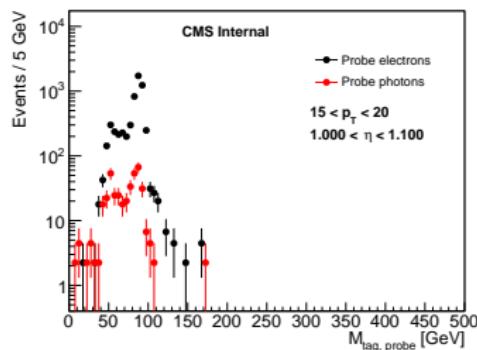
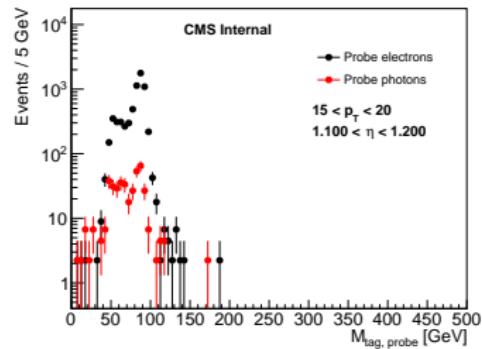
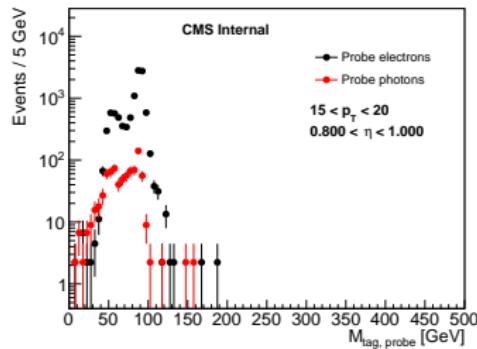
Plug in to remove N_Z

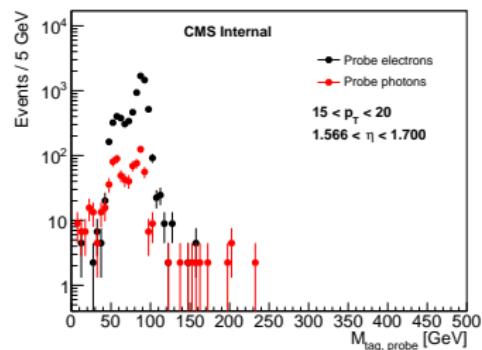
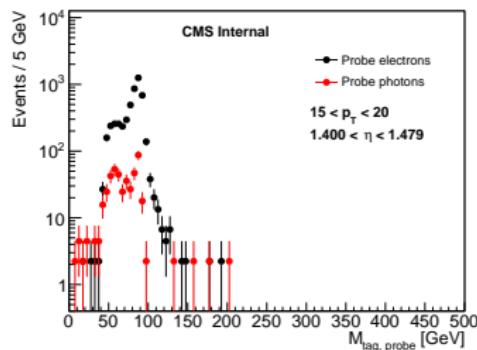
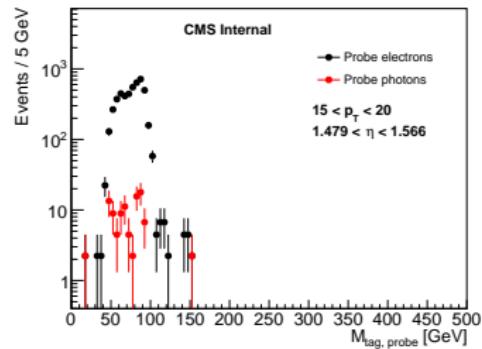
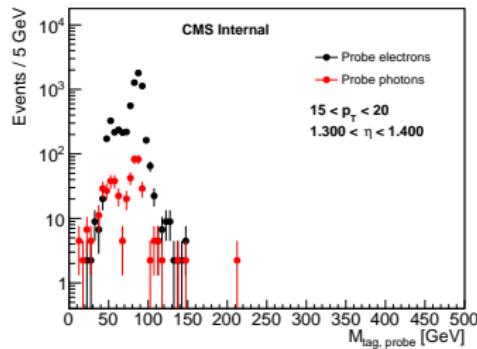
$$\frac{N_{EG}}{N_{EE}} = \frac{\epsilon_G^1}{\epsilon_E^1} + \frac{\epsilon_G^2}{\epsilon_E^2} \quad (3)$$

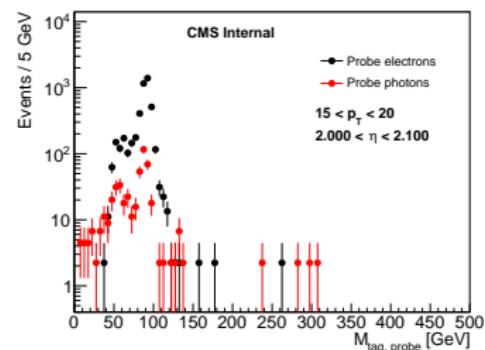
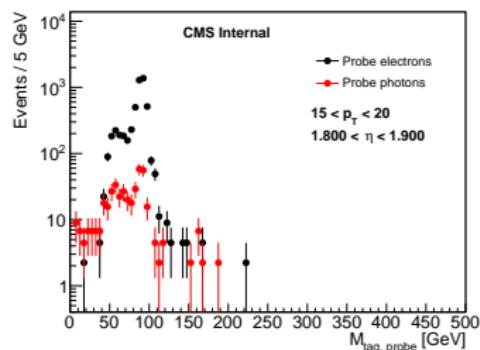
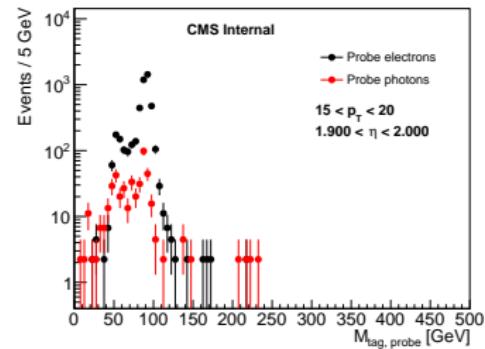
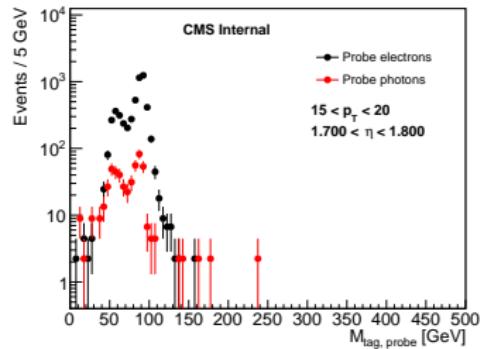
We therefore need N_{EE} and the ratio of the electron reconstruction efficiency to the photon reconstruction efficiency (fake factor)

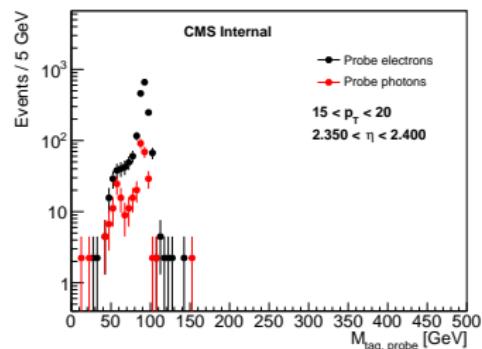
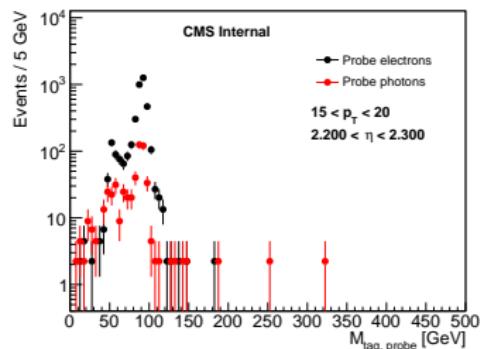
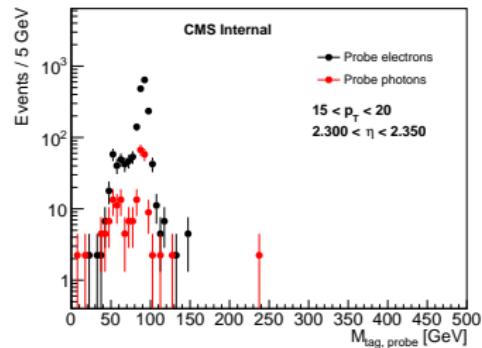
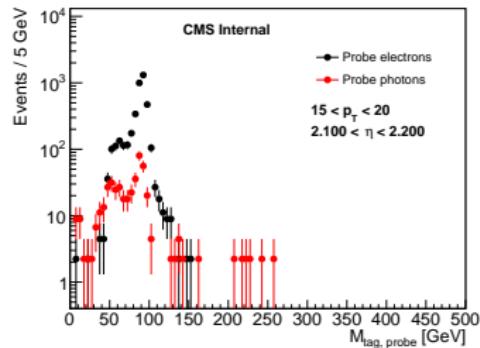
Original binning

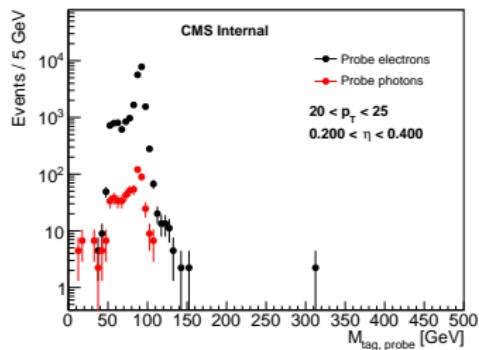
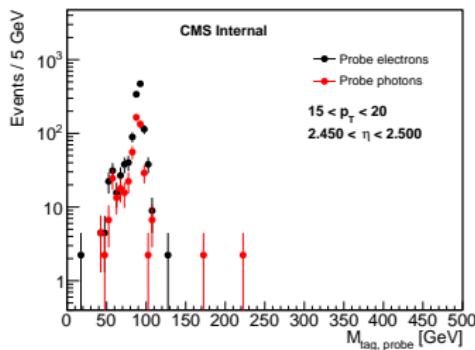
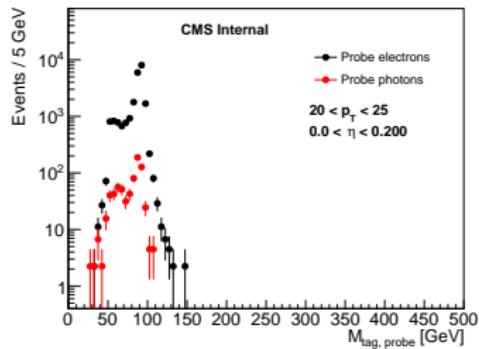
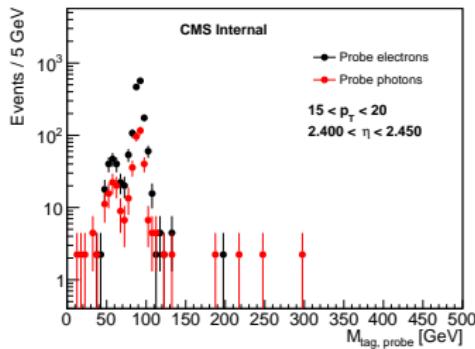


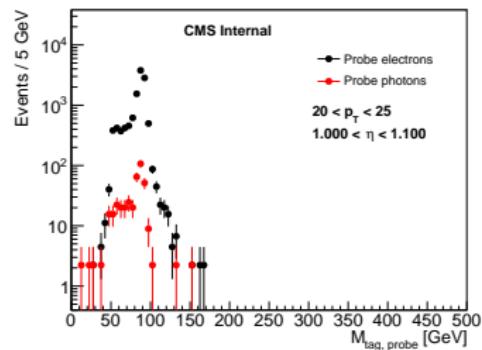
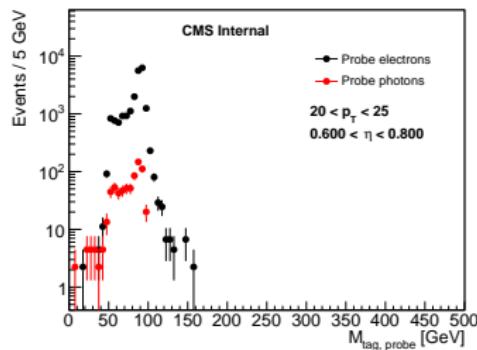
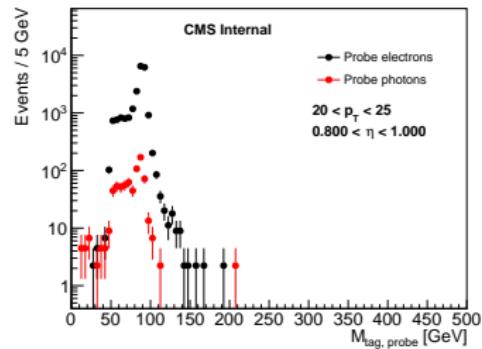
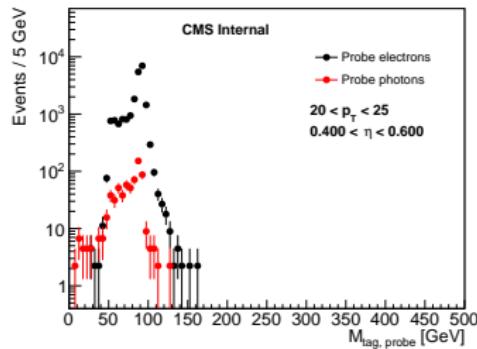


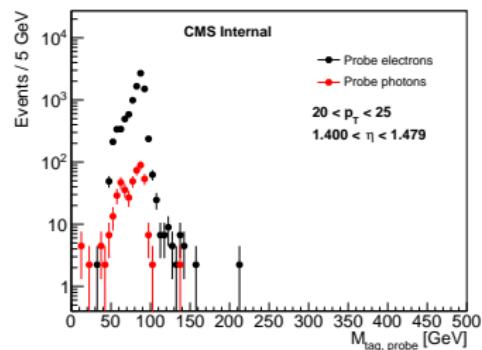
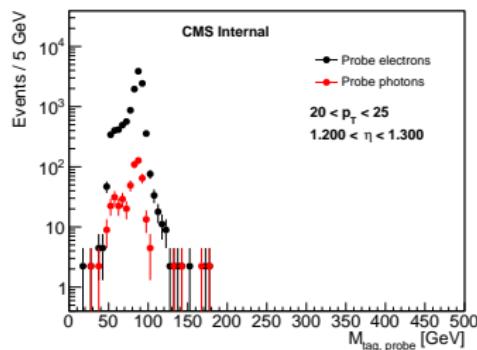
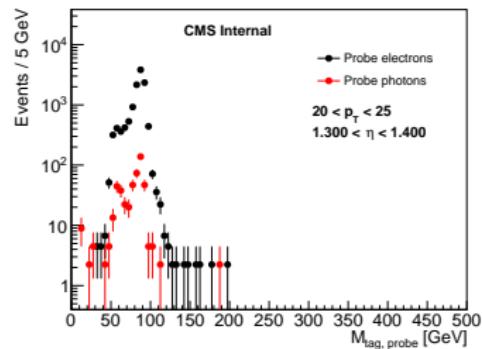
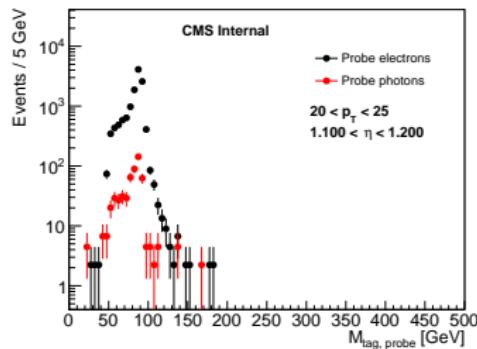


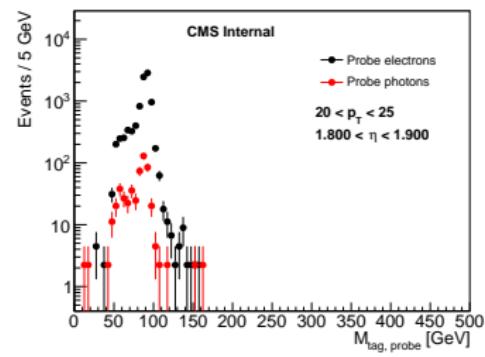
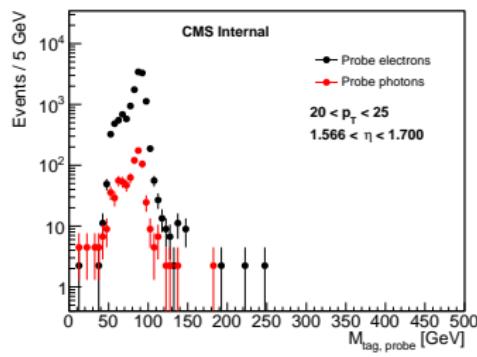
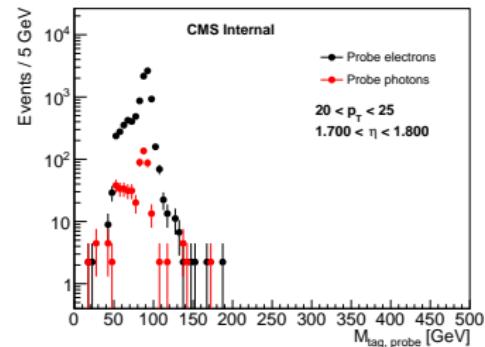
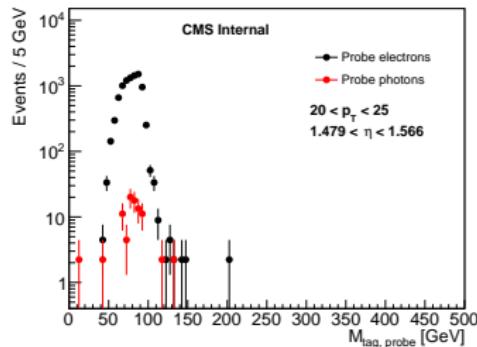


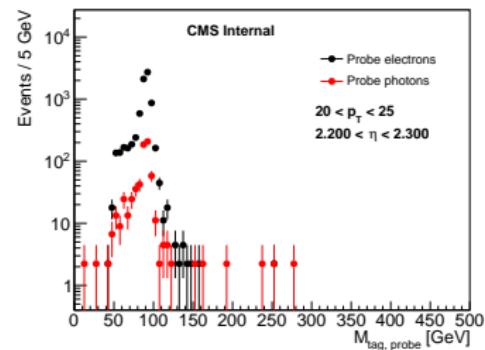
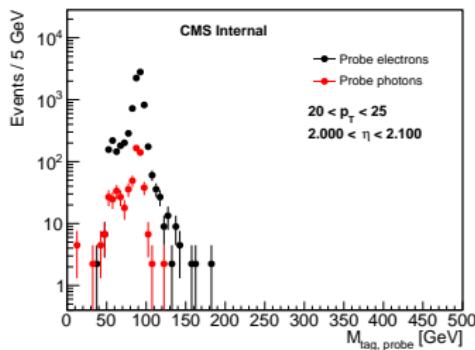
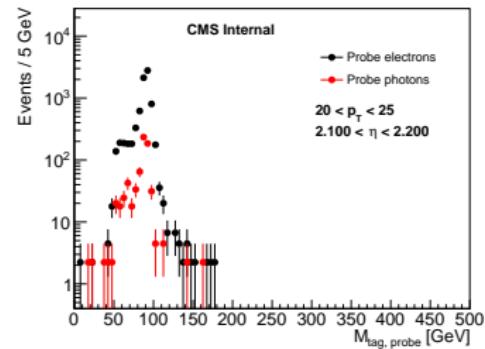
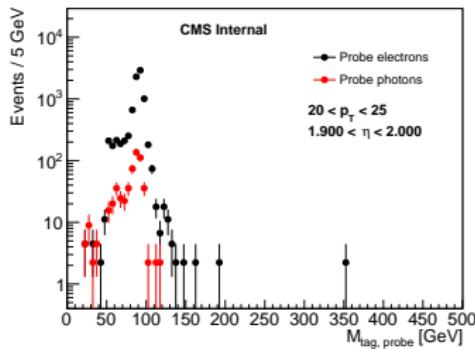


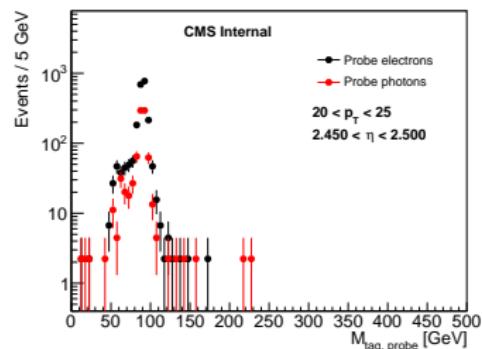
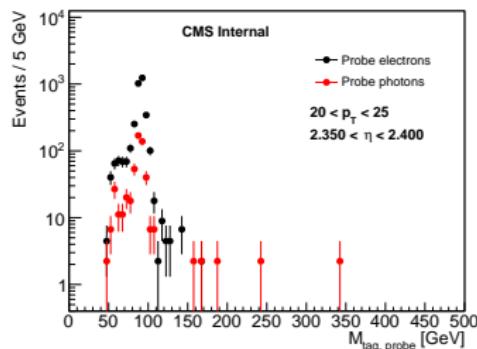
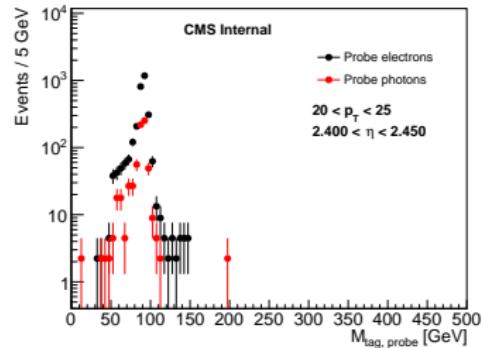
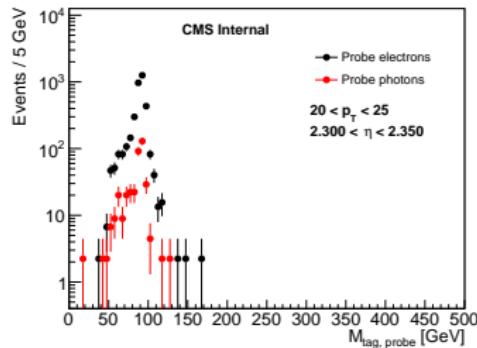


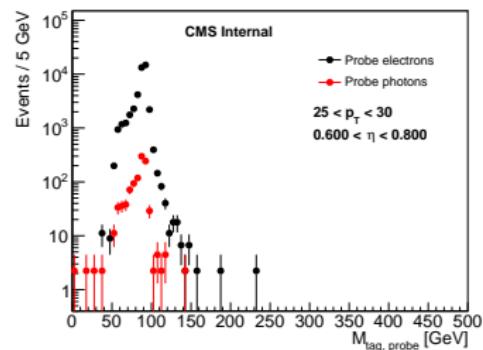
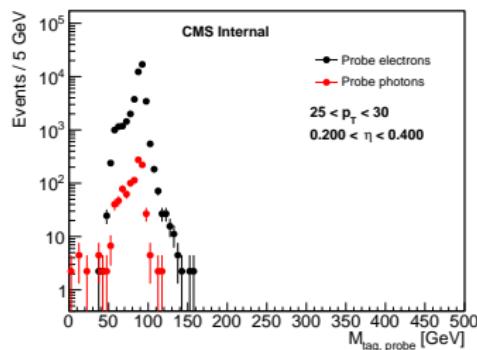
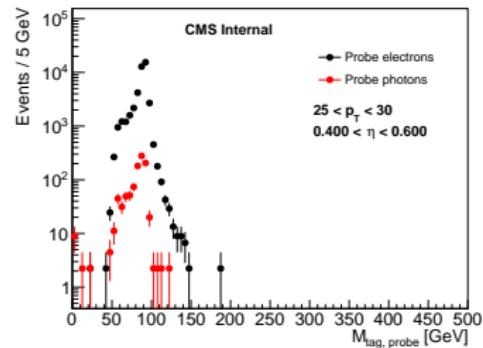
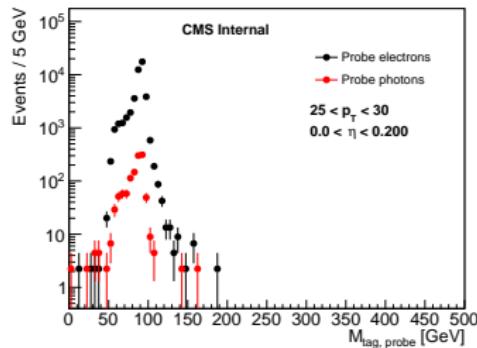


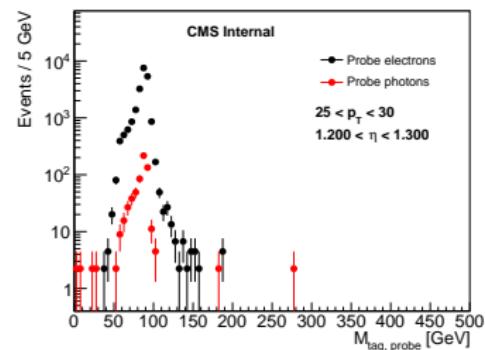
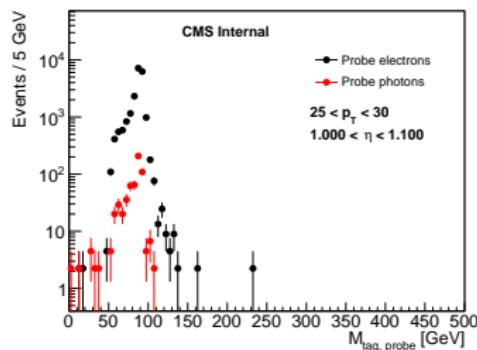
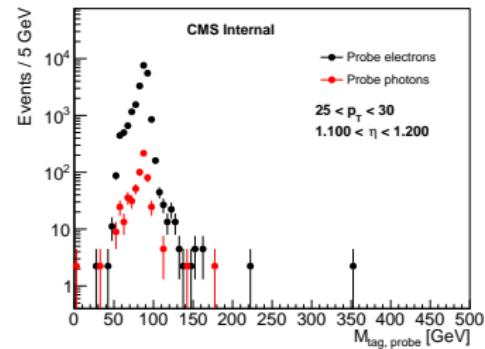
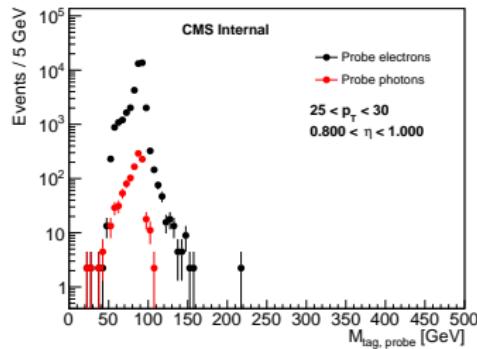


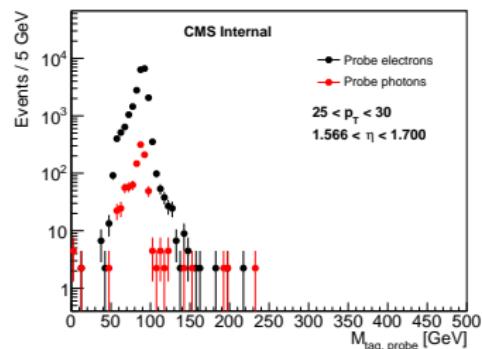
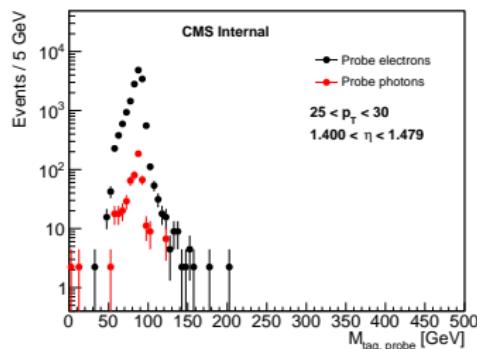
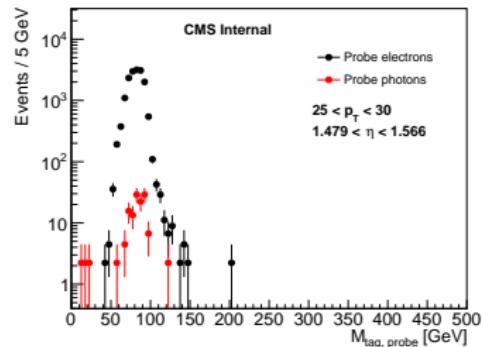
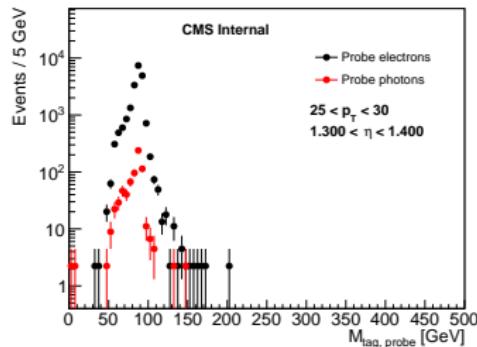


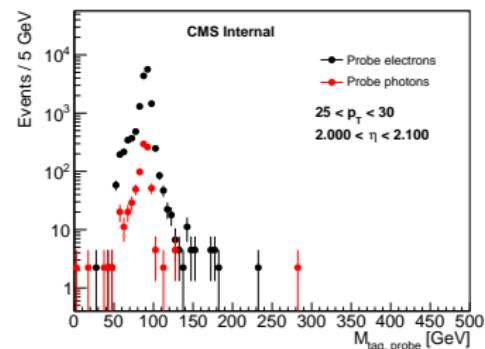
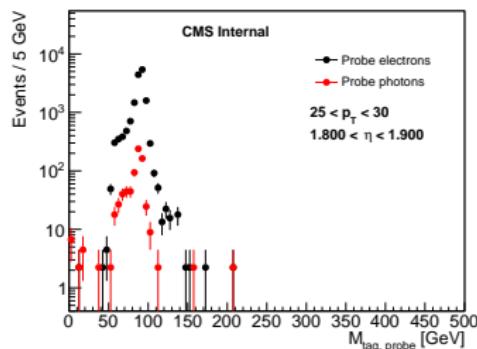
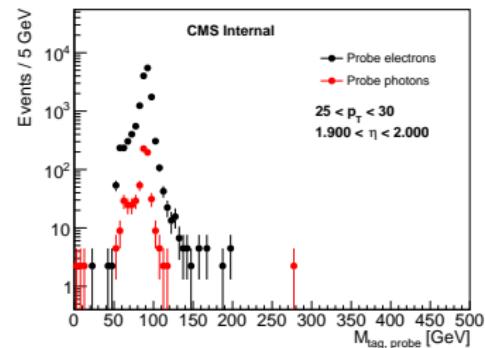
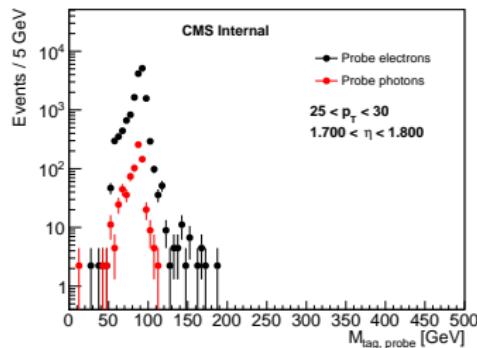


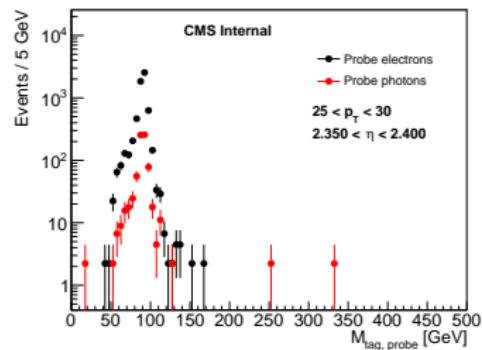
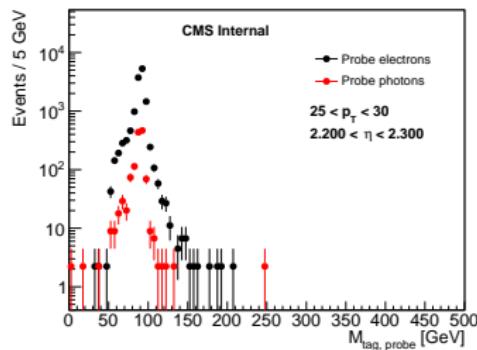
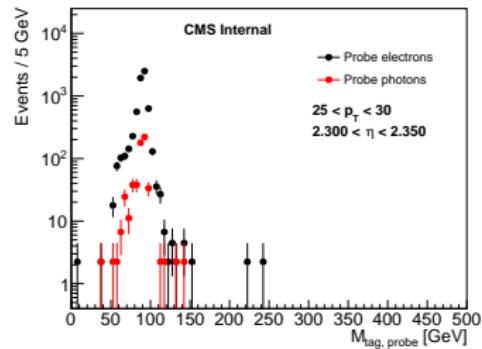
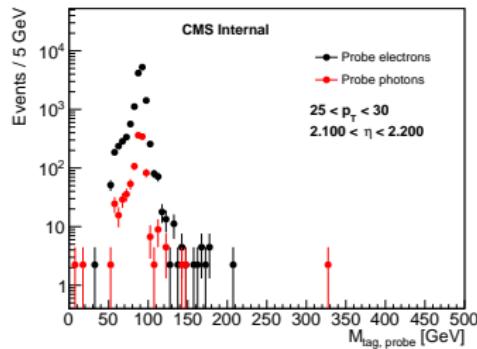


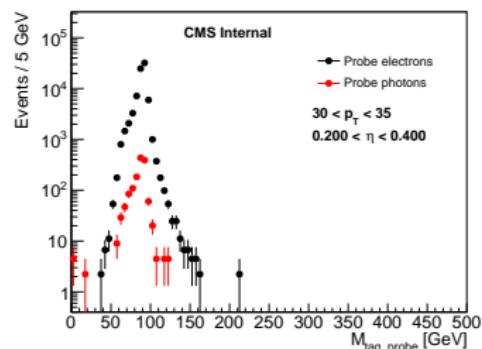
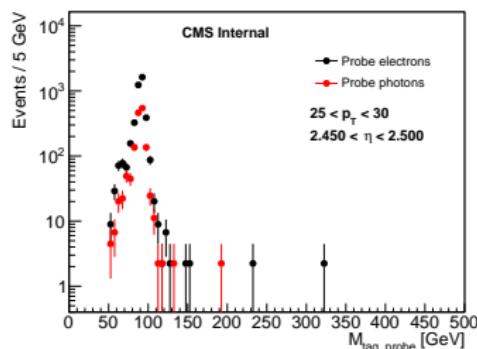
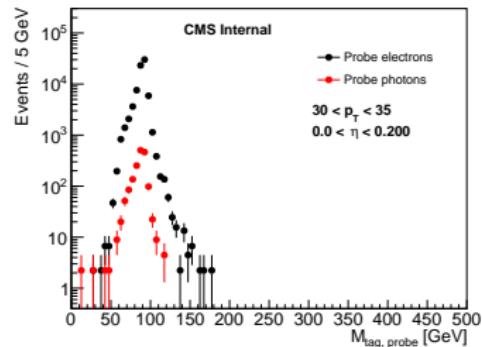
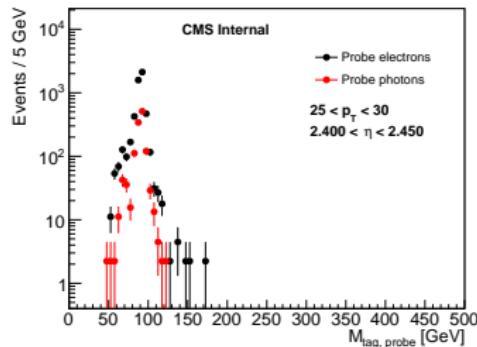


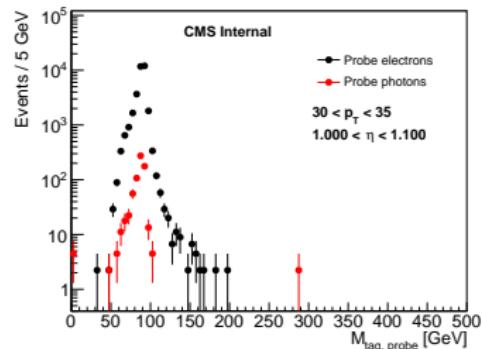
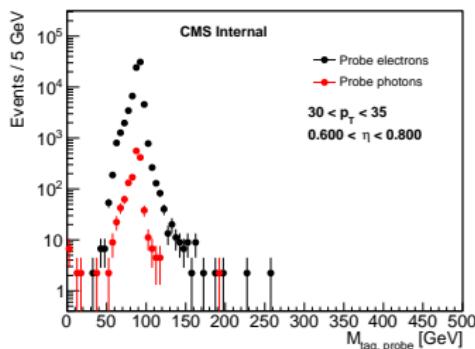
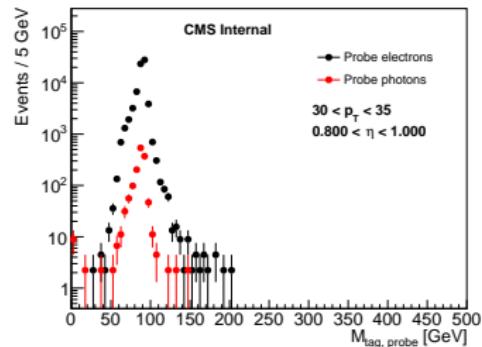
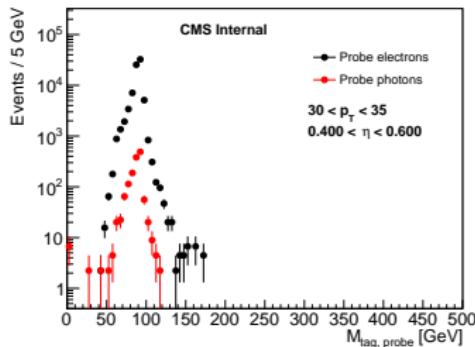


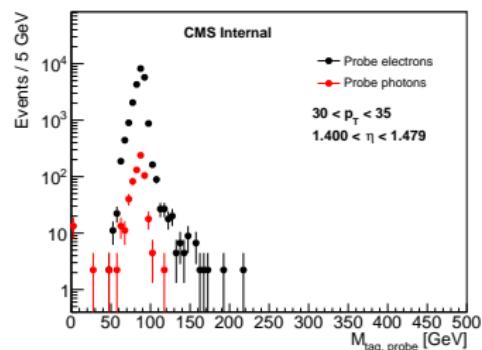
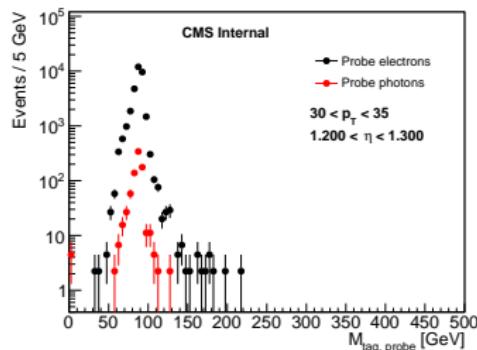
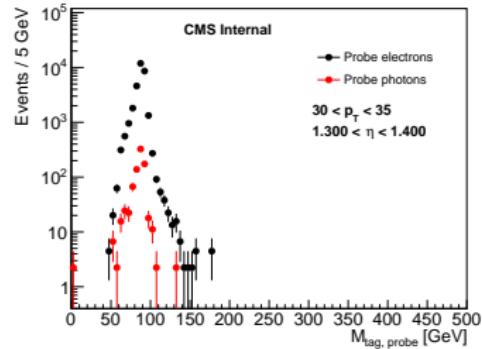
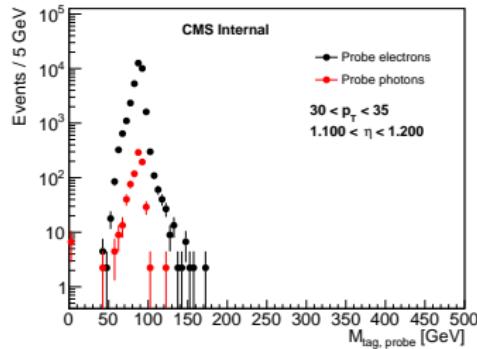


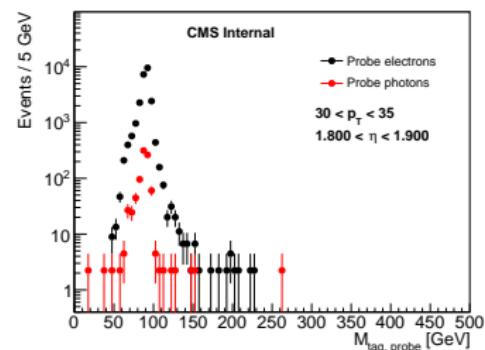
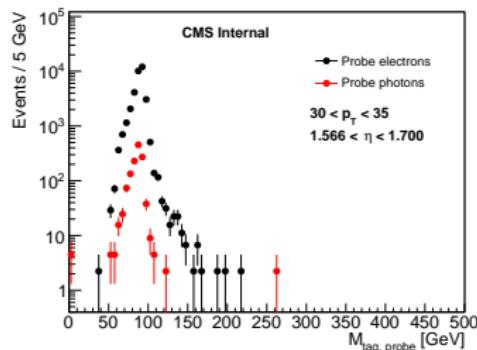
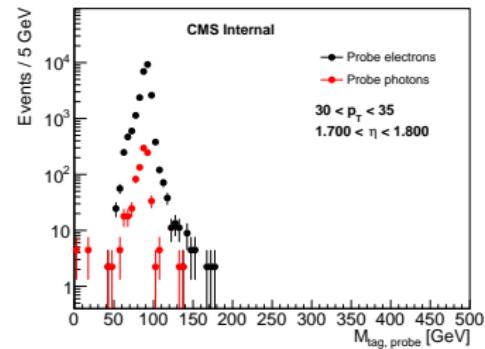
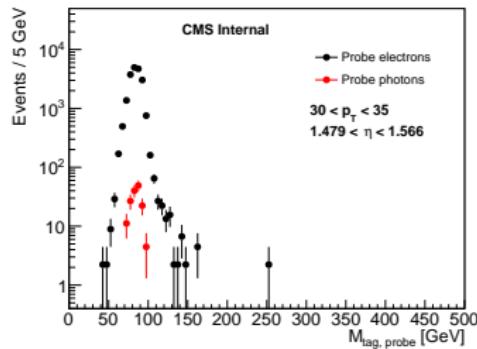




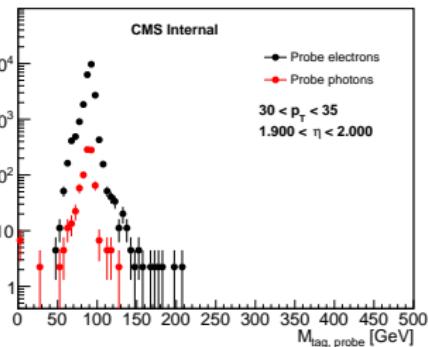




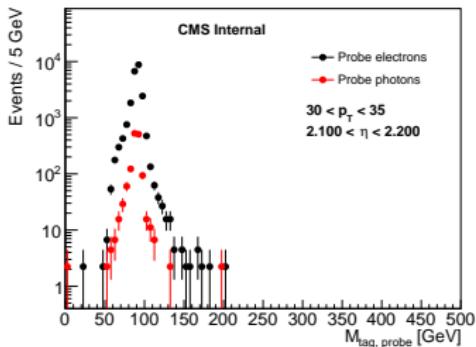




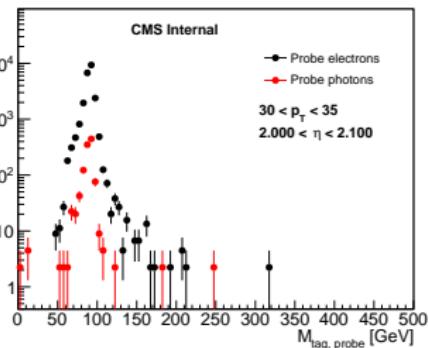
Events / 5 GeV



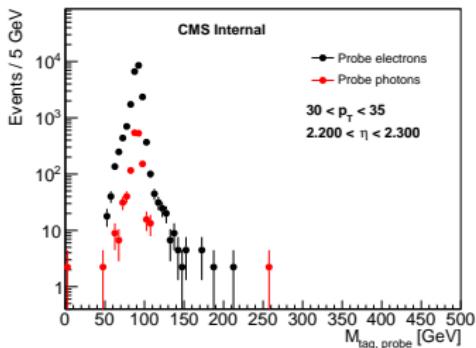
Events / 5 GeV

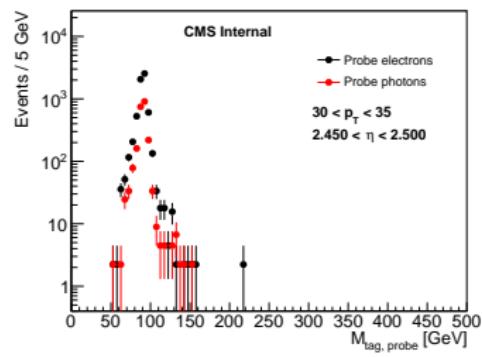
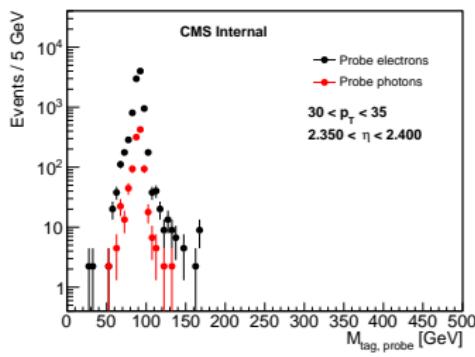
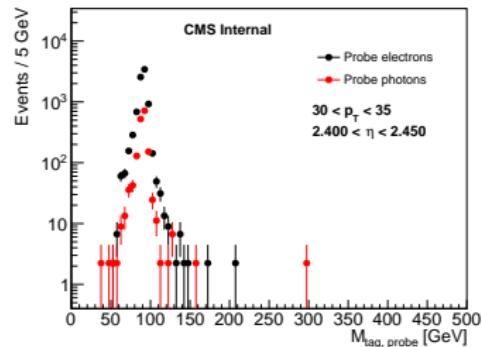
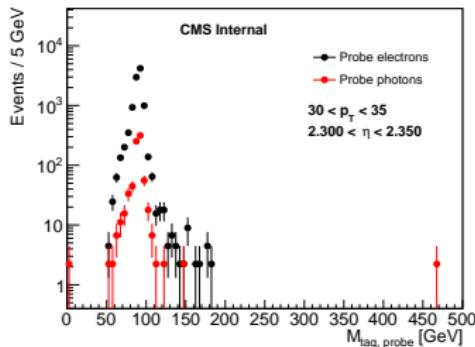


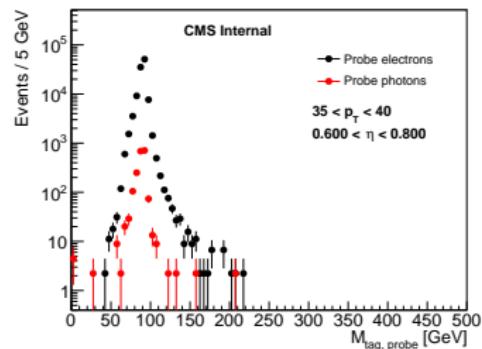
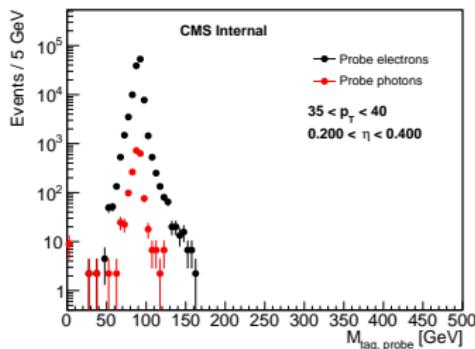
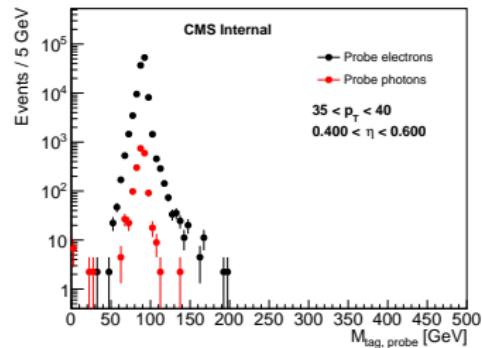
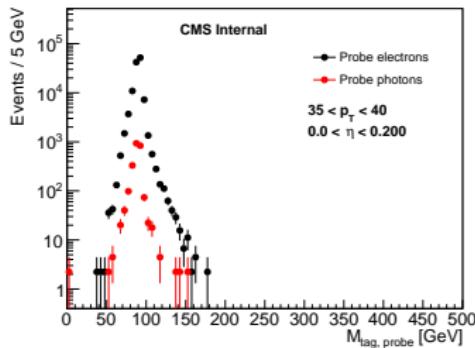
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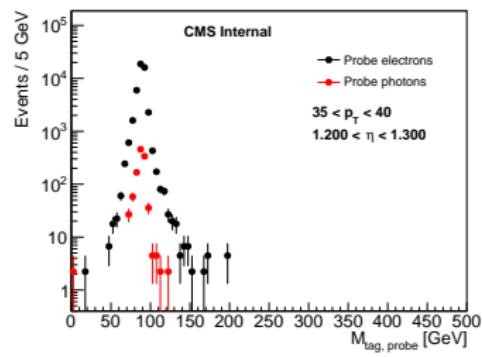
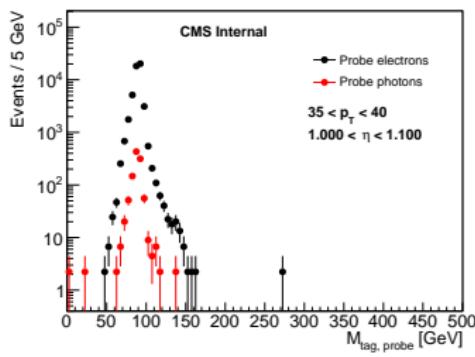
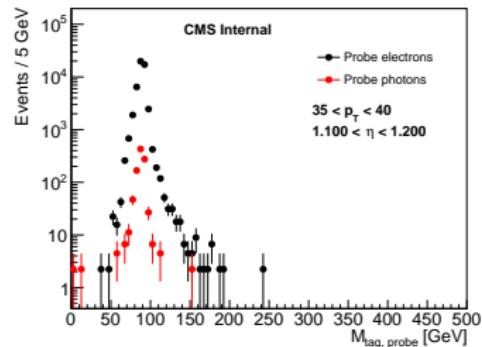
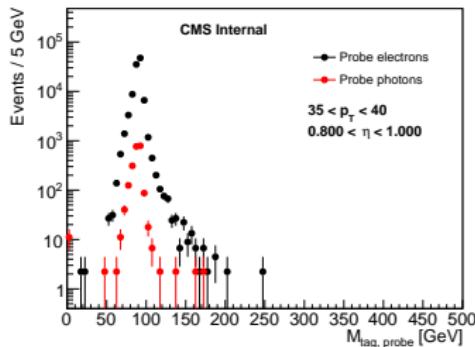


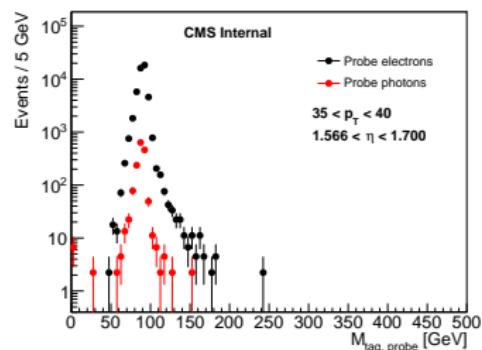
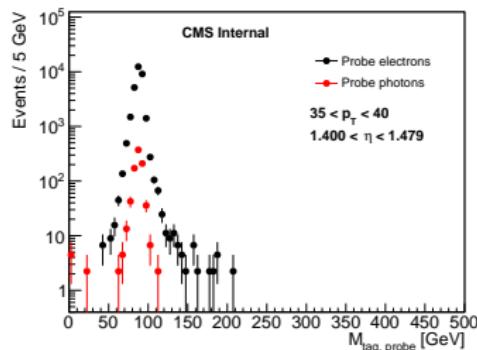
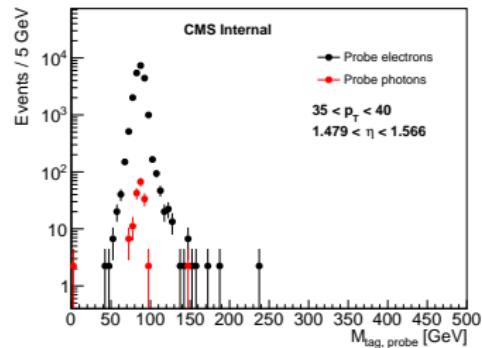
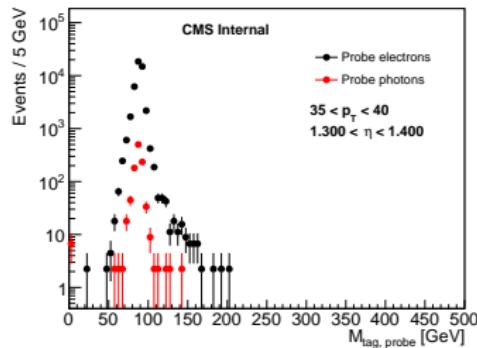
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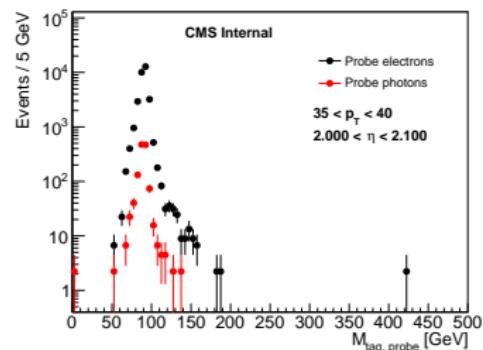
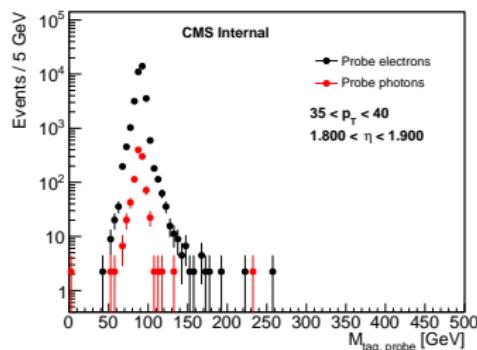
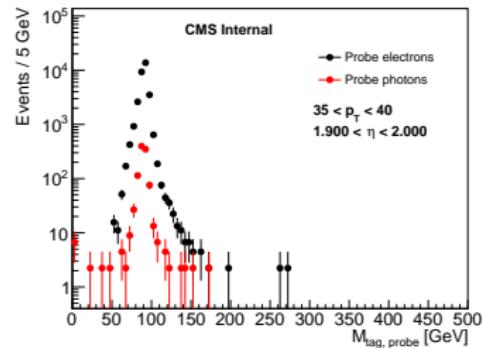
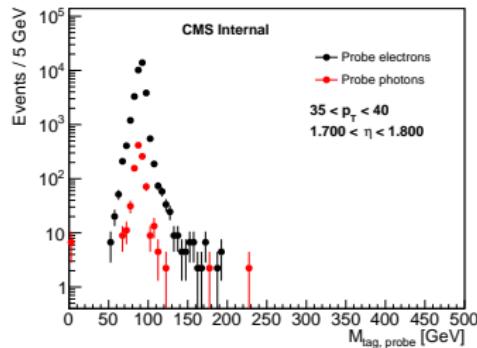


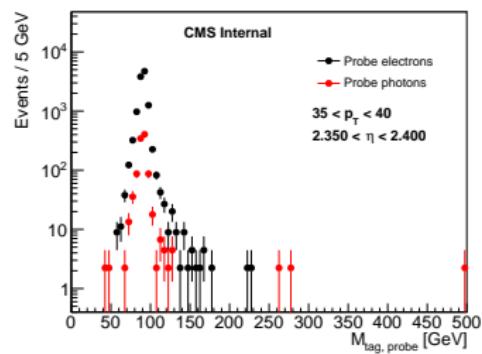
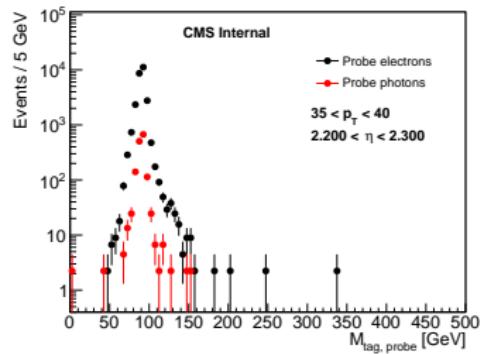
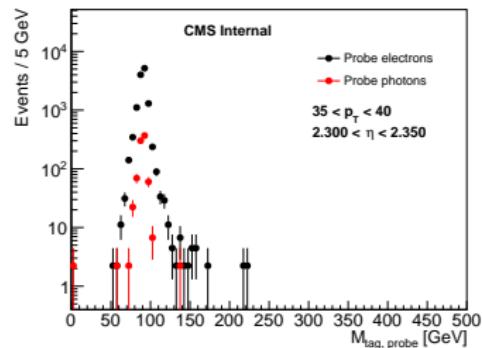
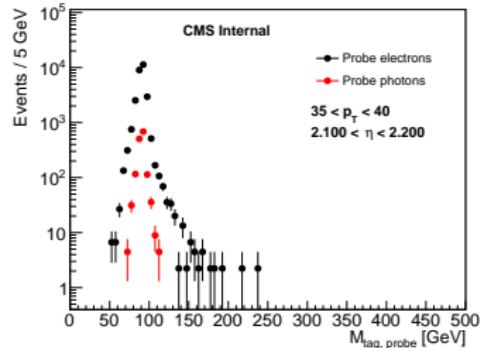


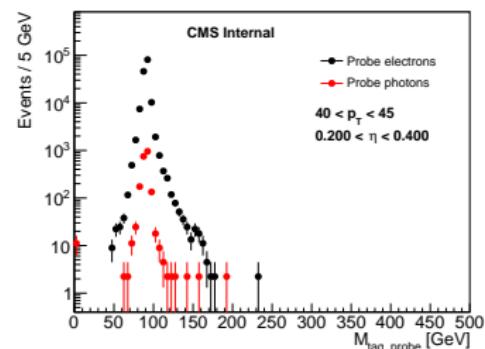
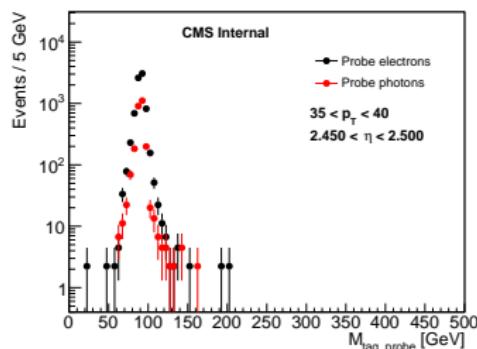
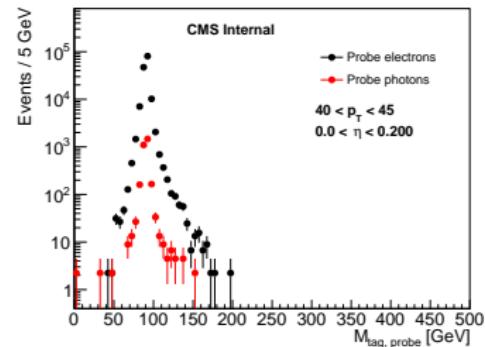
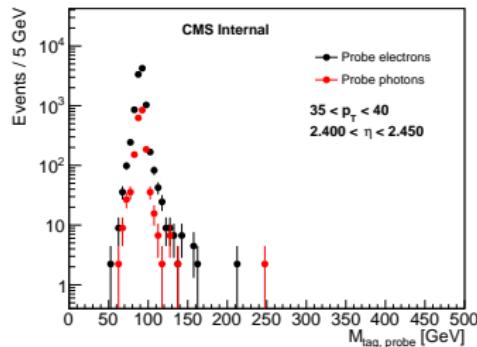


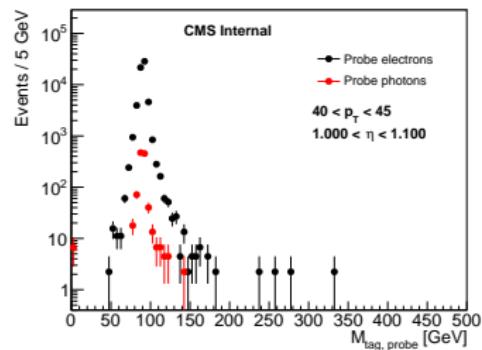
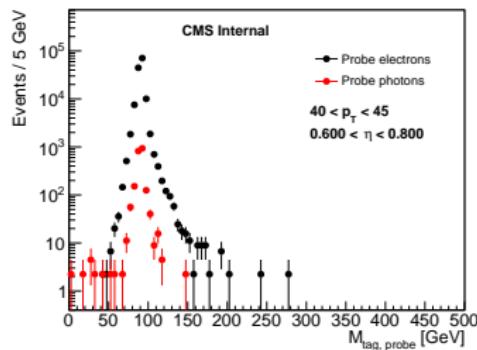
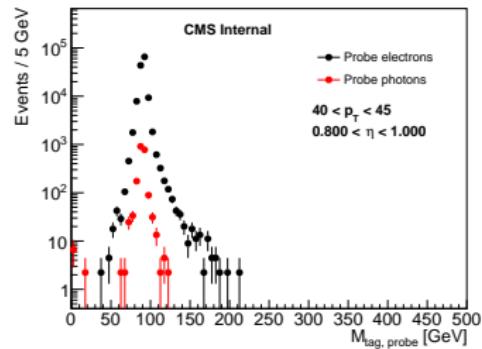
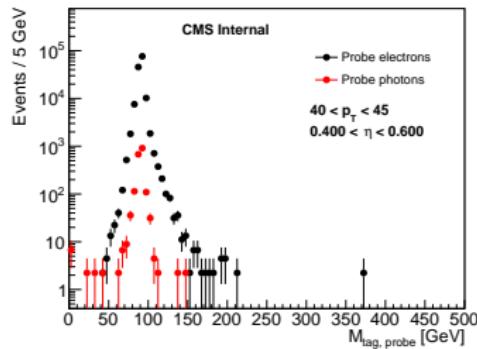


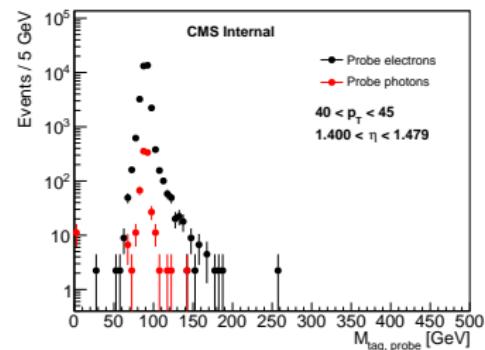
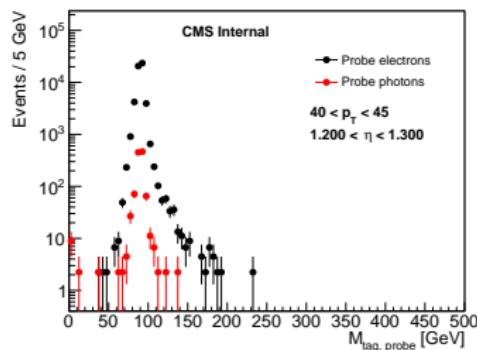
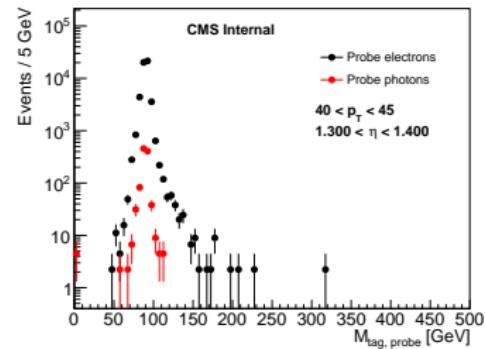
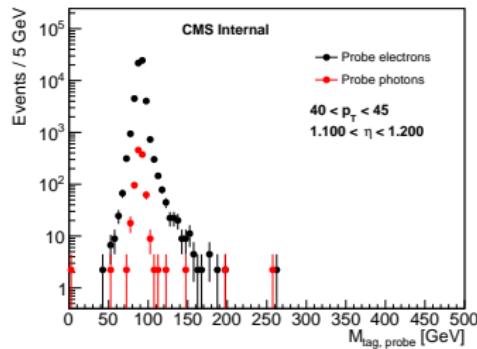


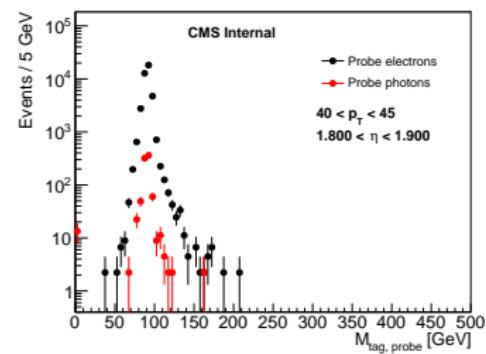
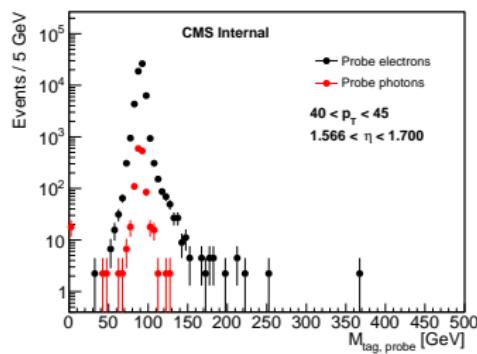
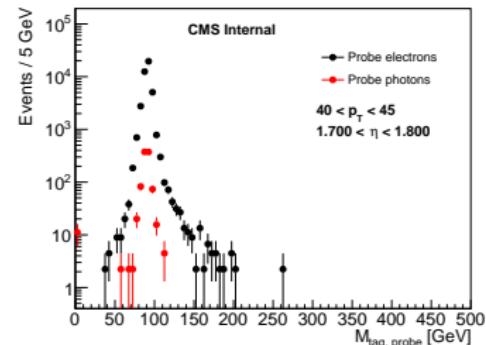
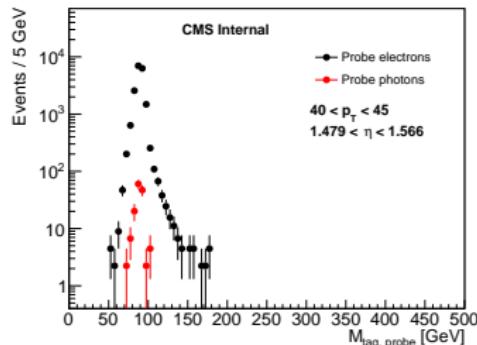


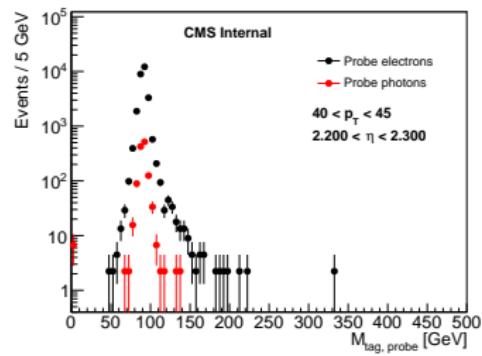
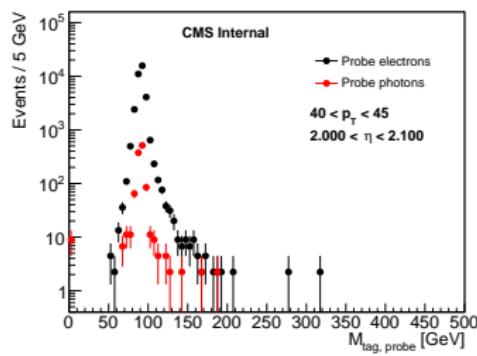
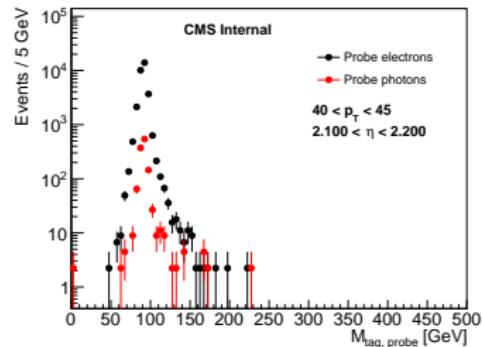
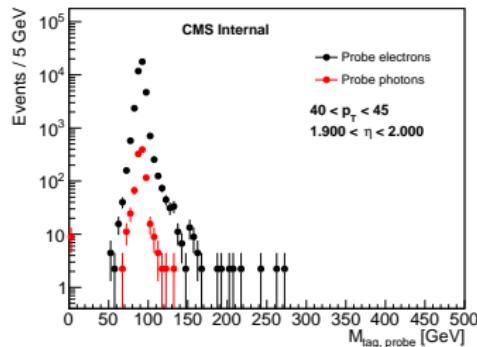


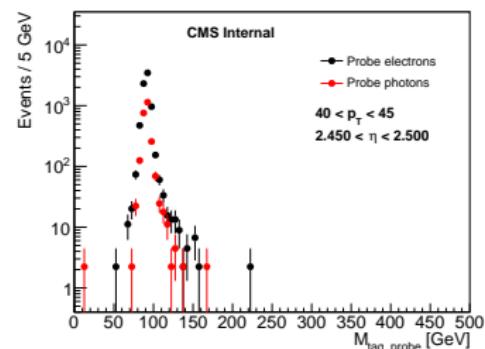
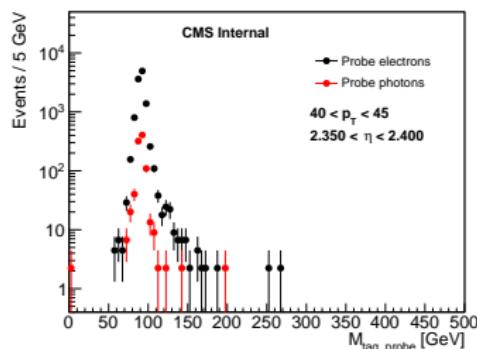
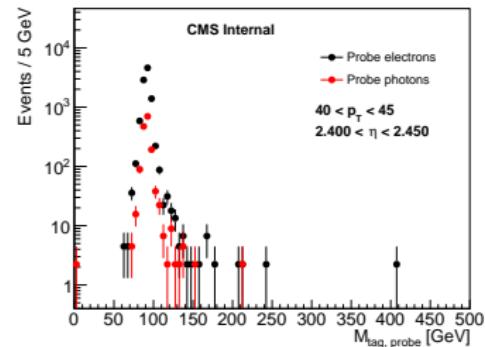
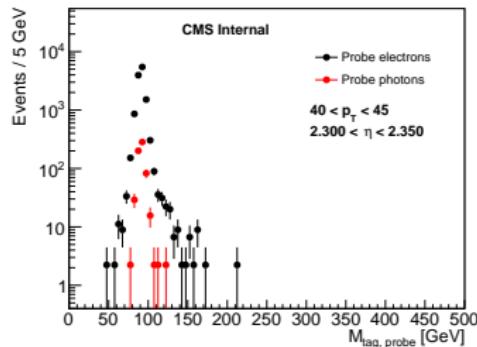


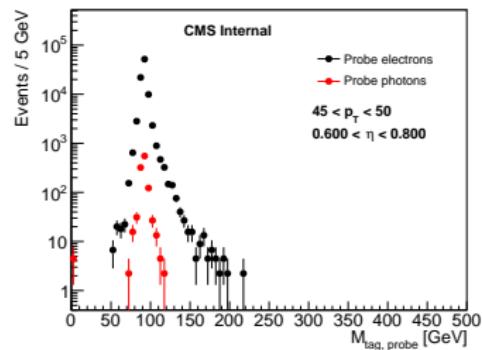
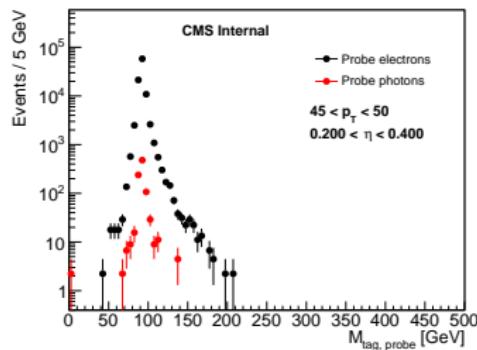
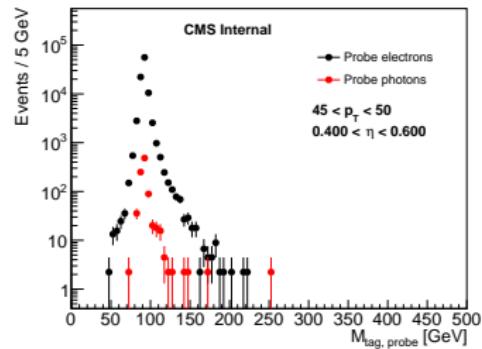
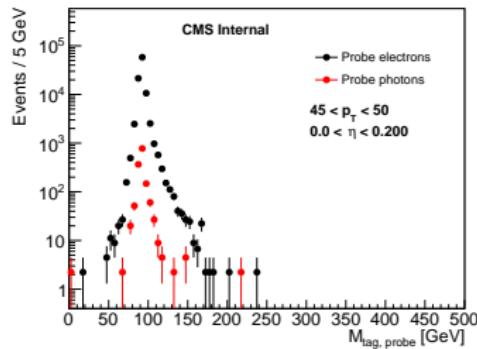


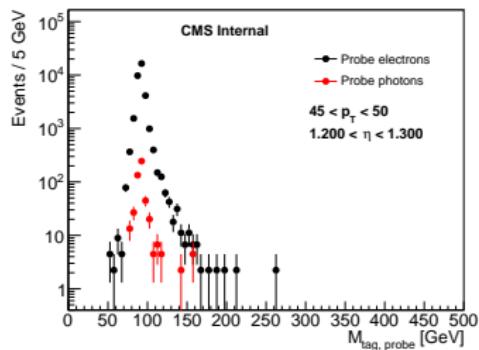
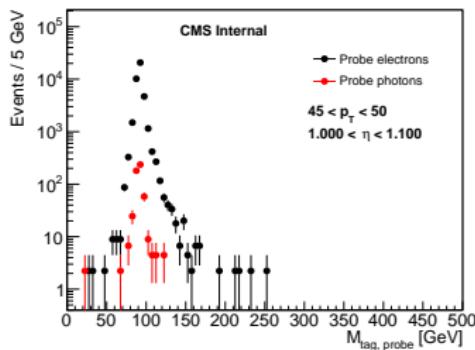
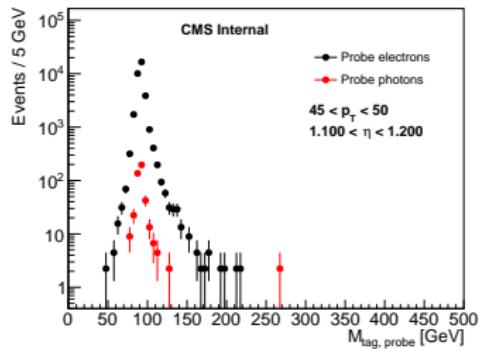
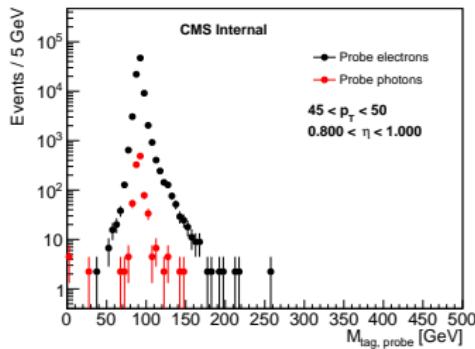


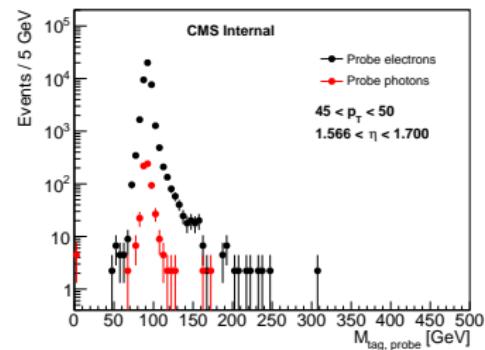
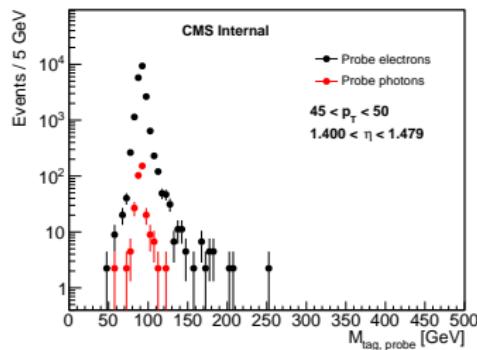
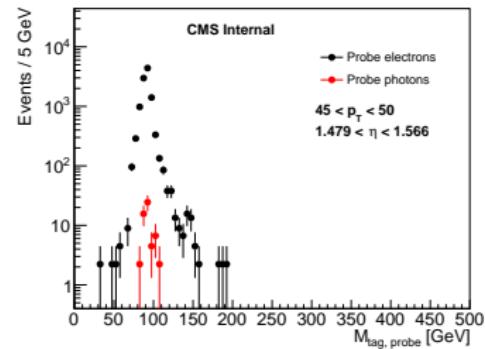
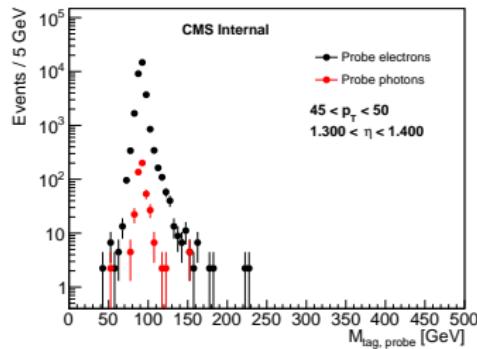


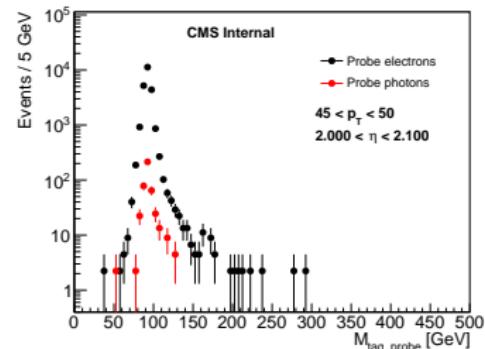
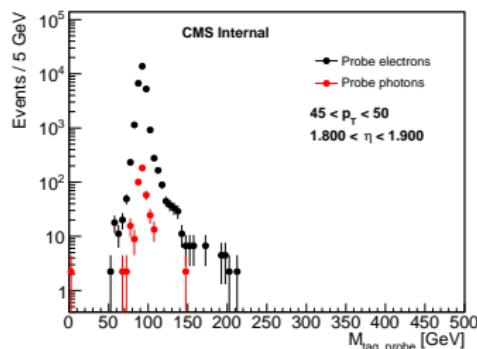
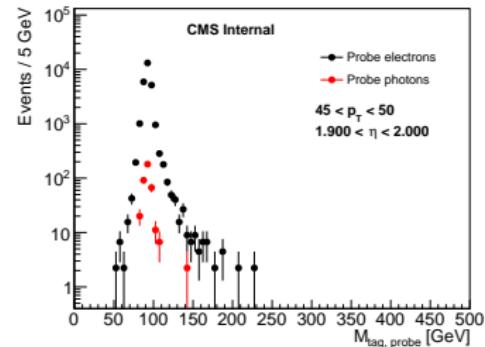
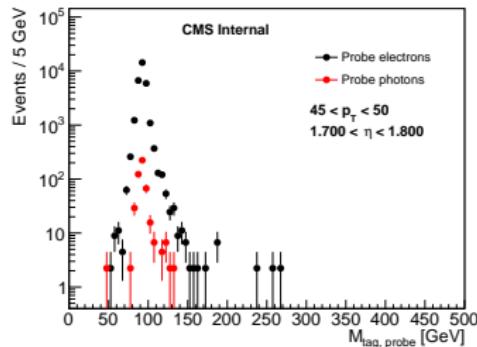


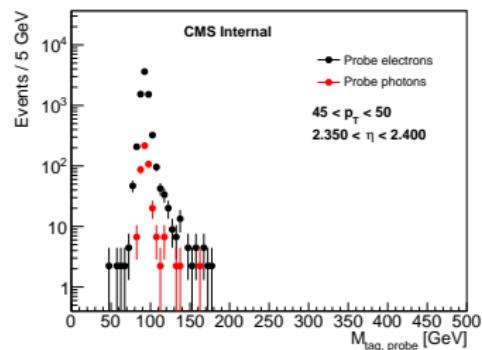
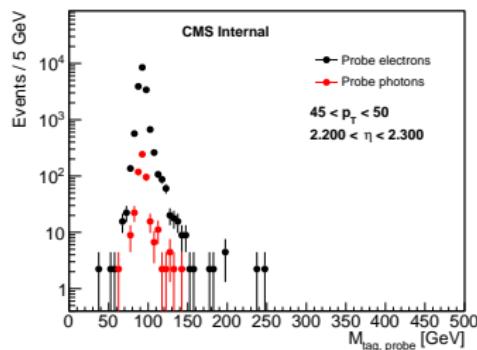
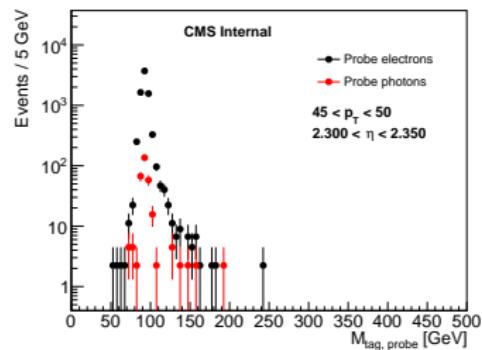
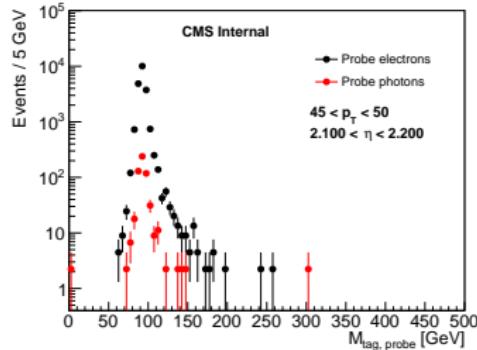


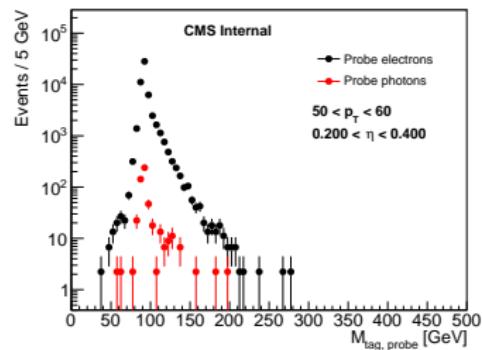
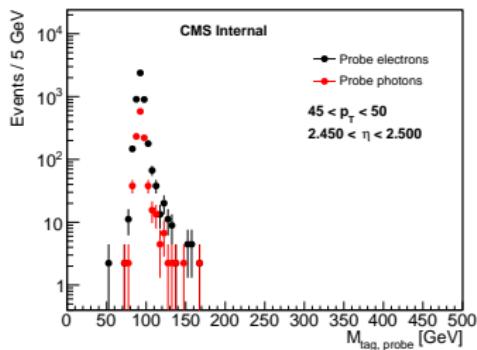
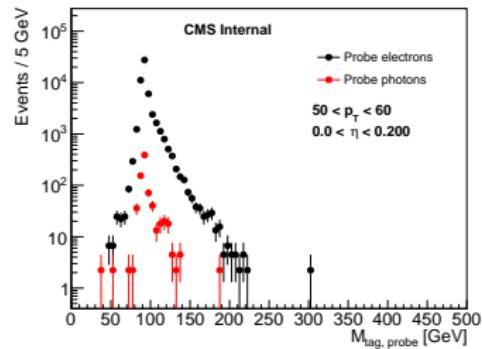
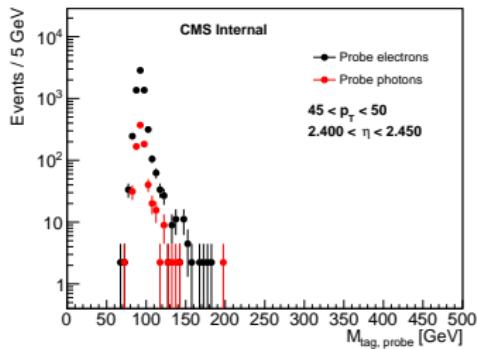


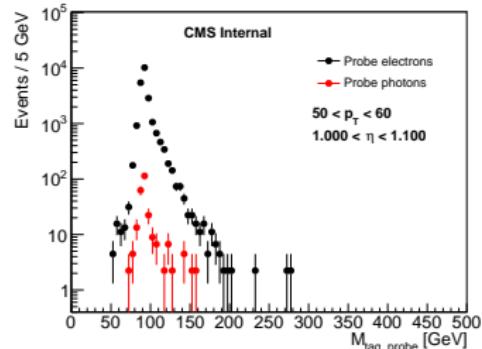
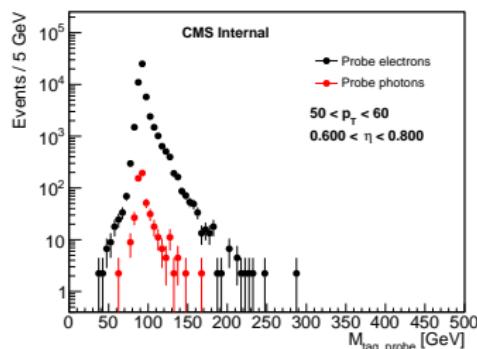
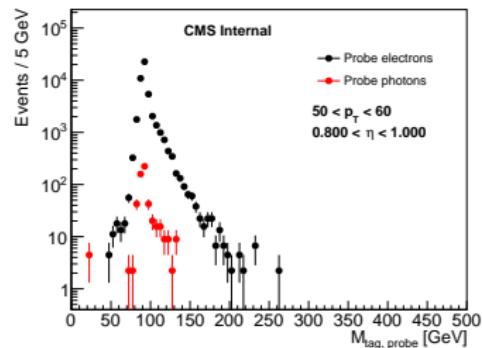
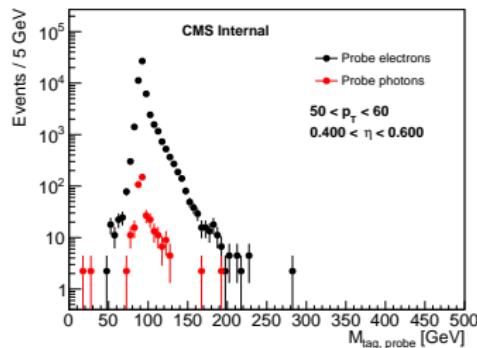


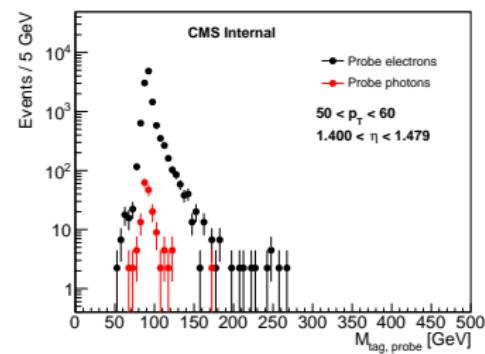
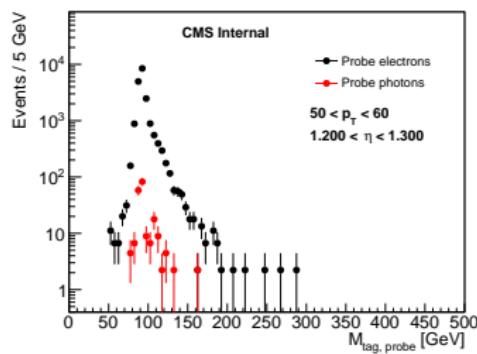
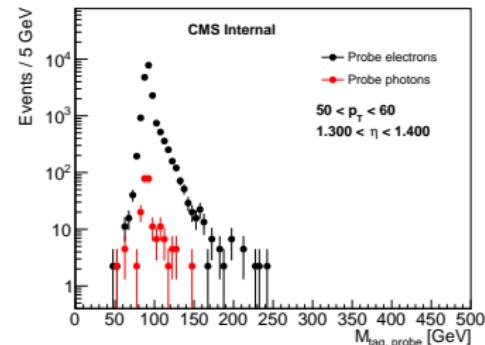
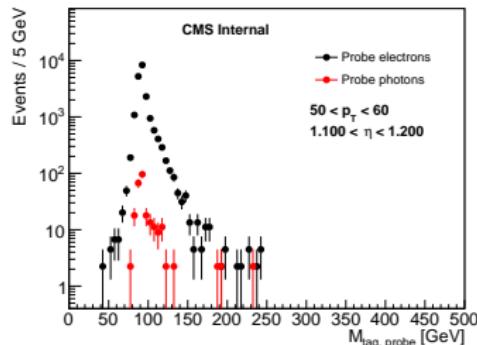


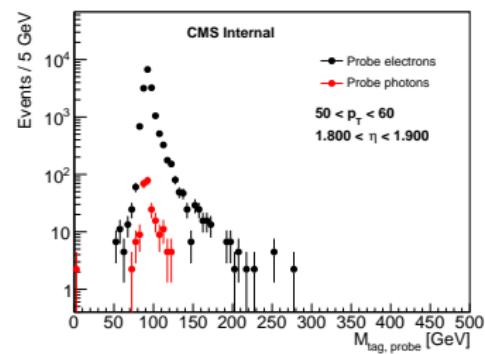
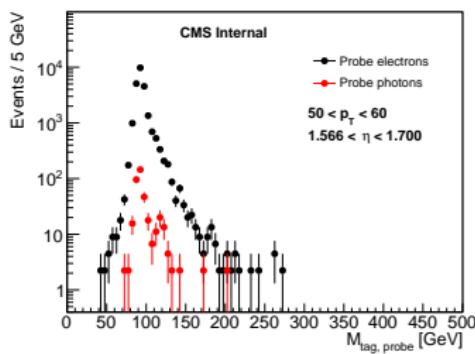
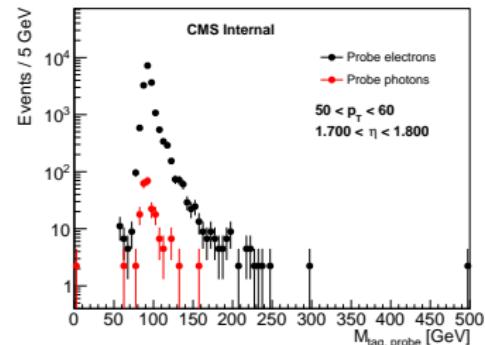
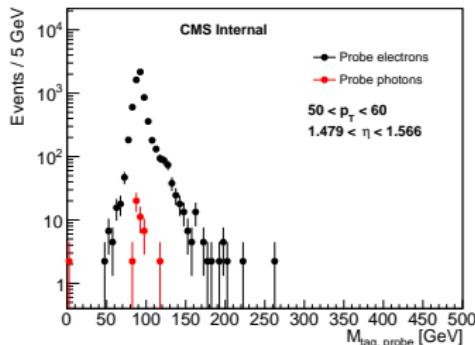


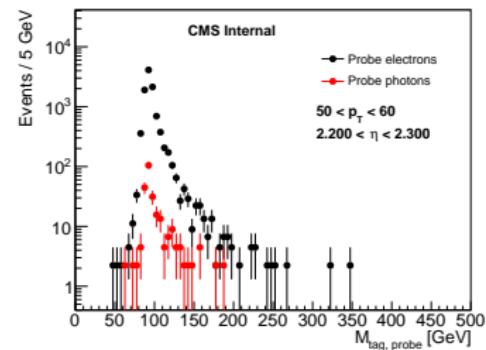
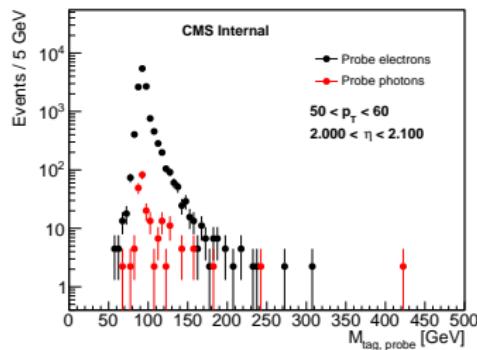
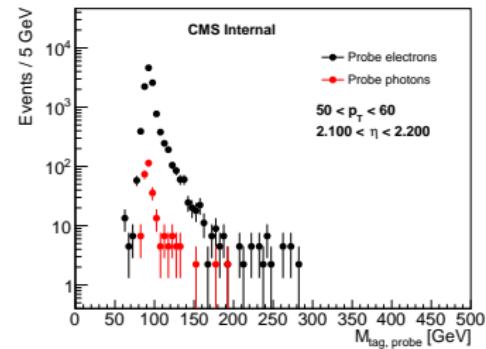
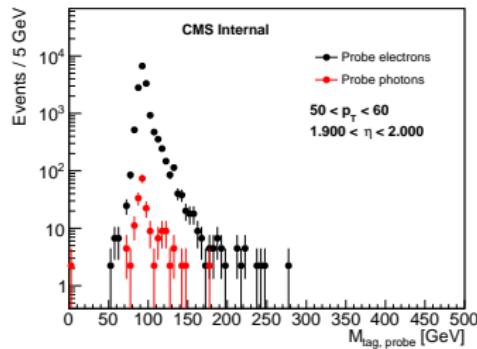


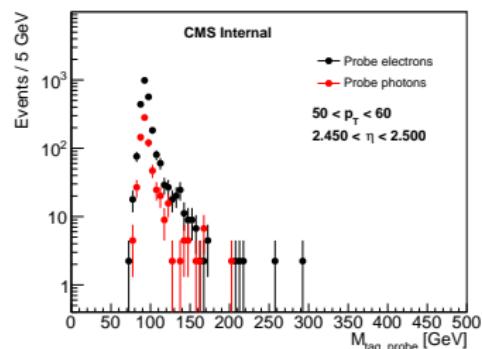
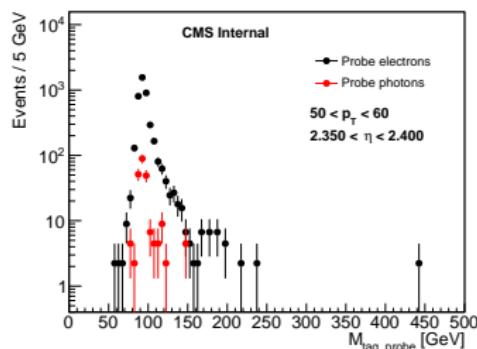
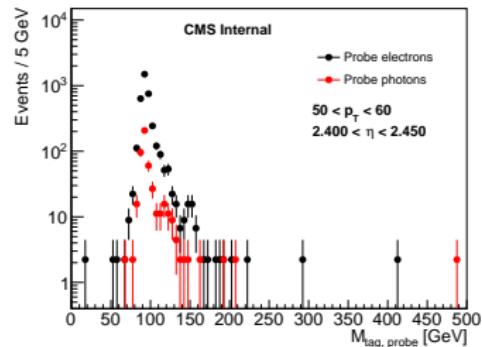
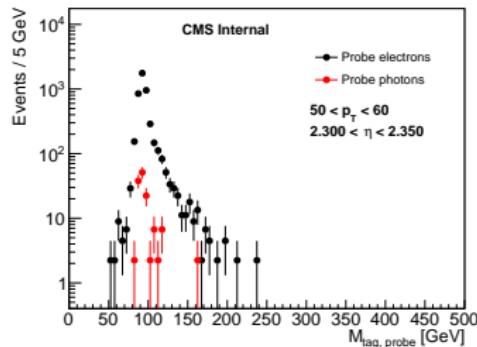


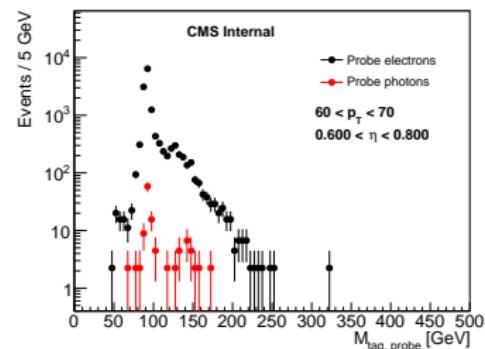
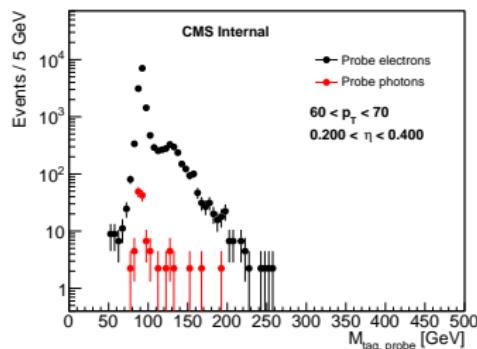
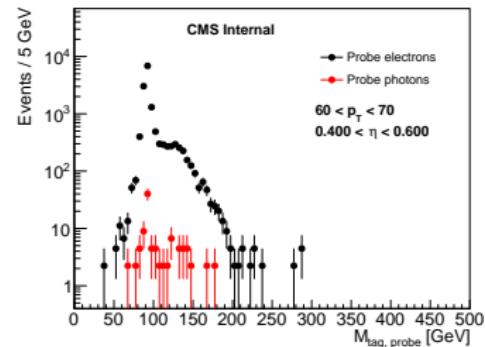
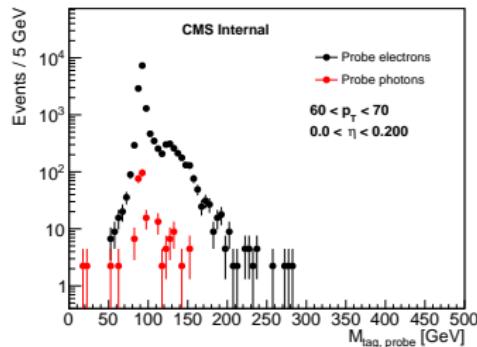


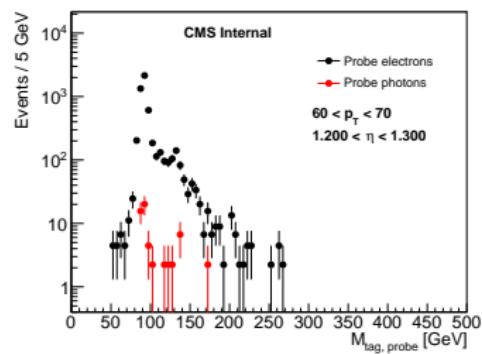
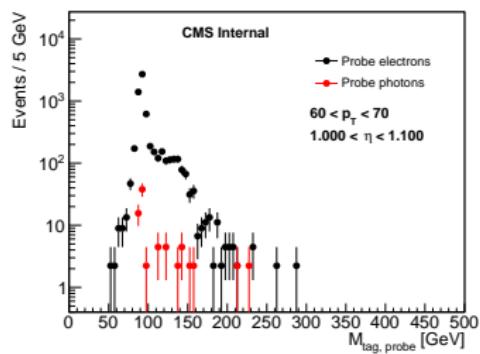
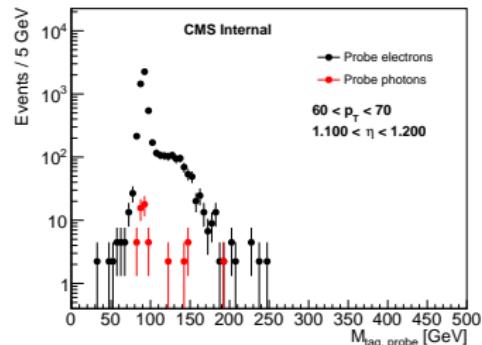
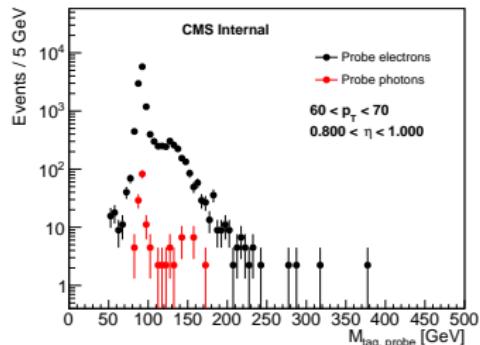


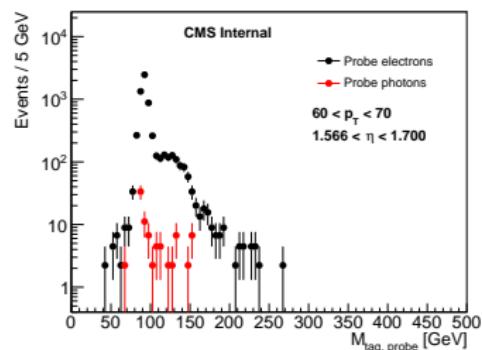
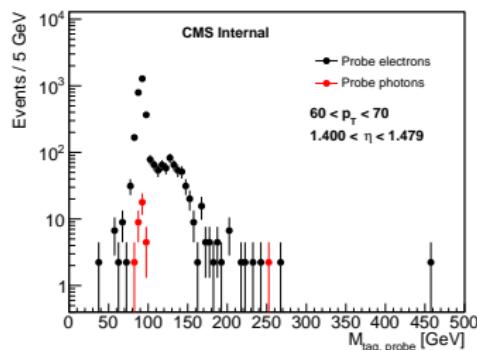
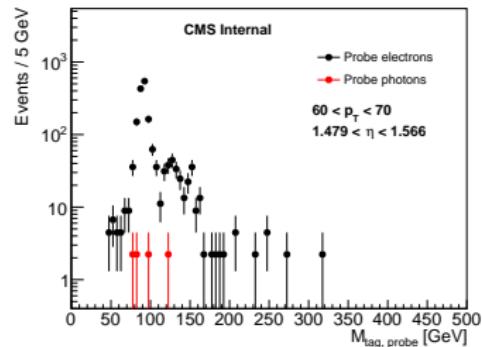
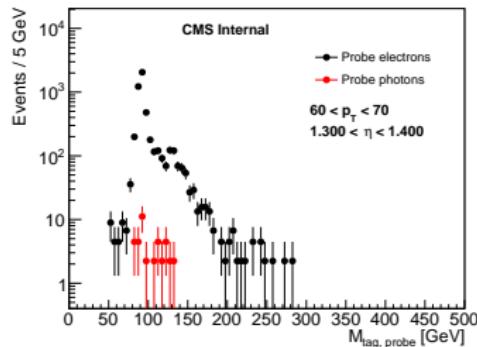


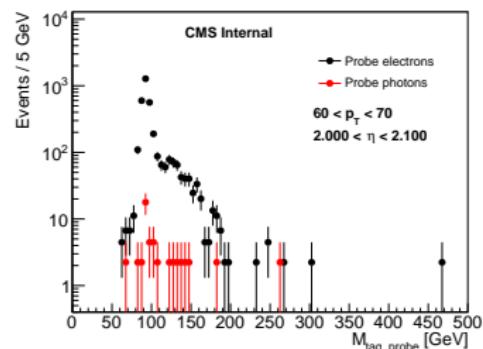
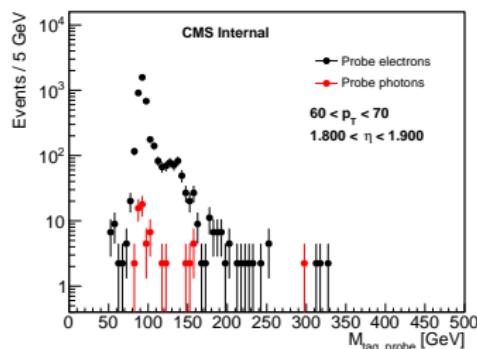
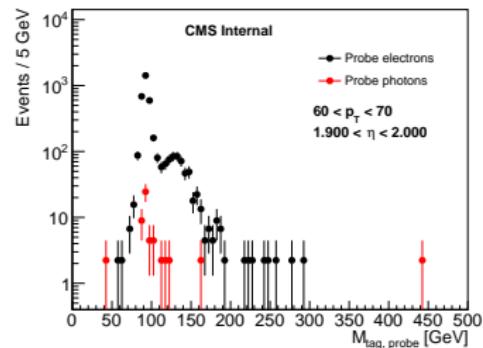
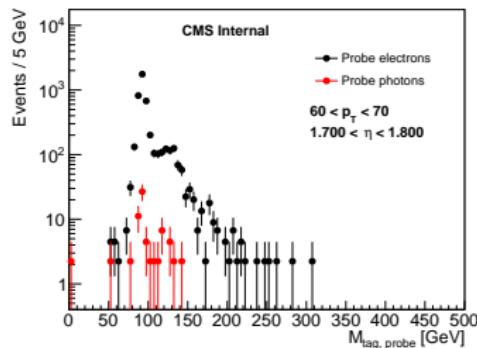


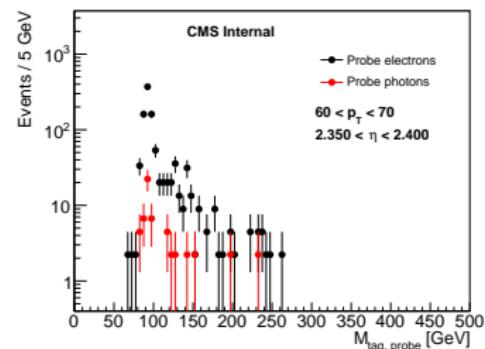
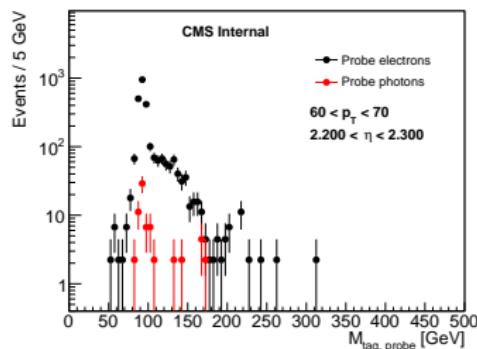
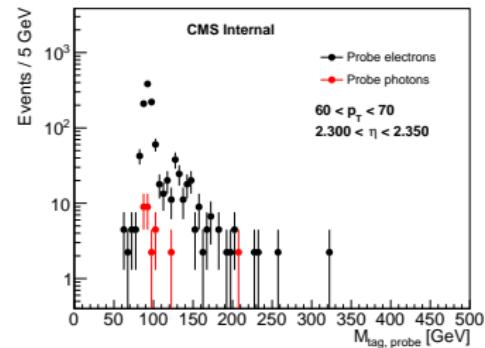
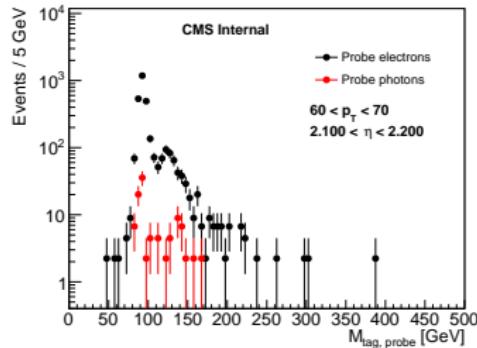


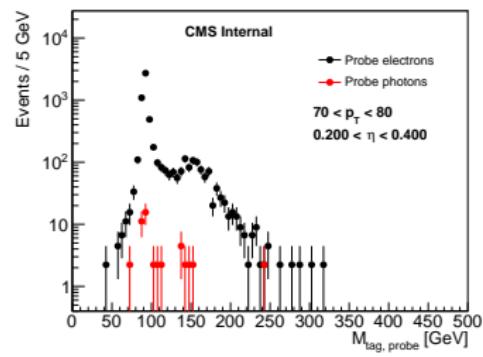
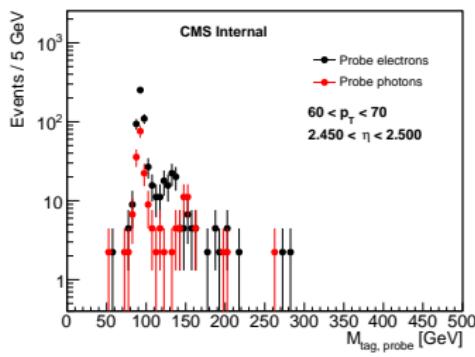
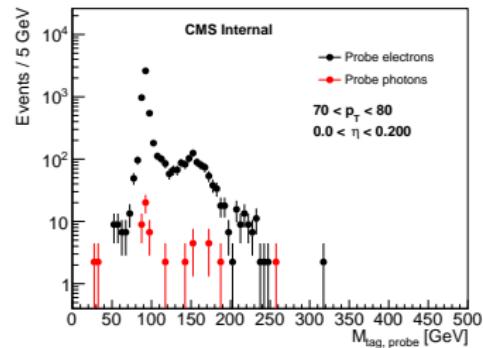
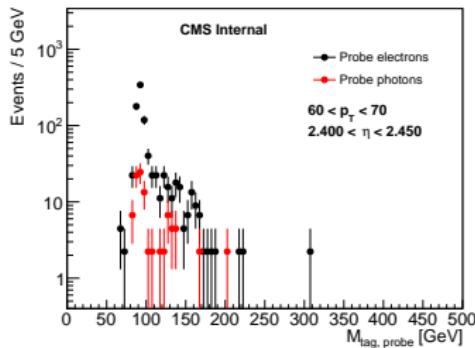


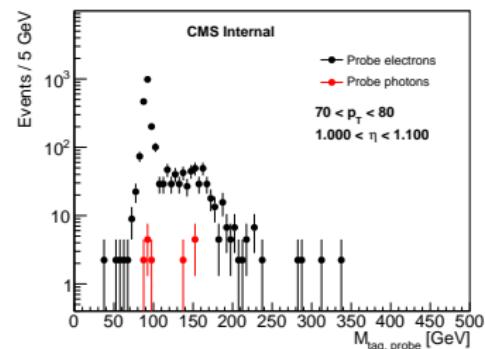
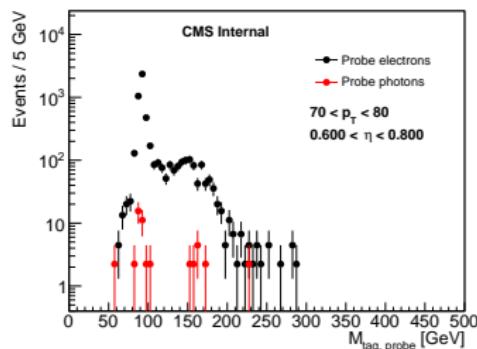
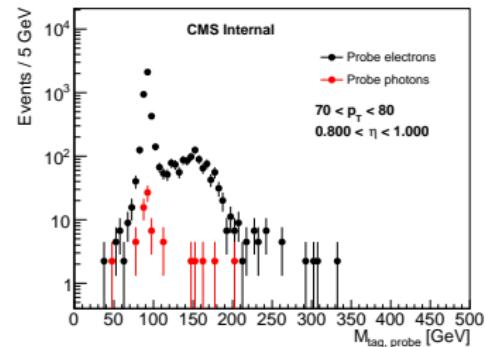
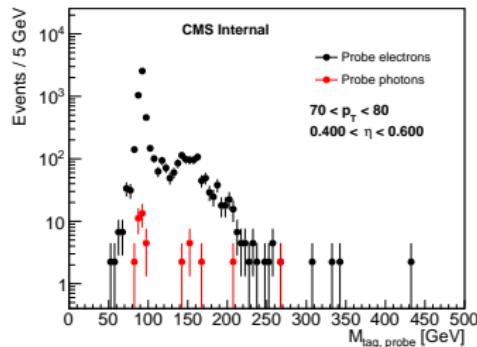


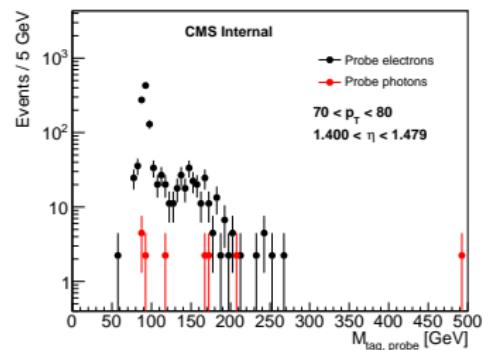
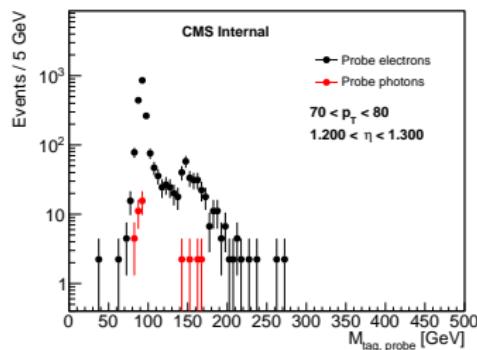
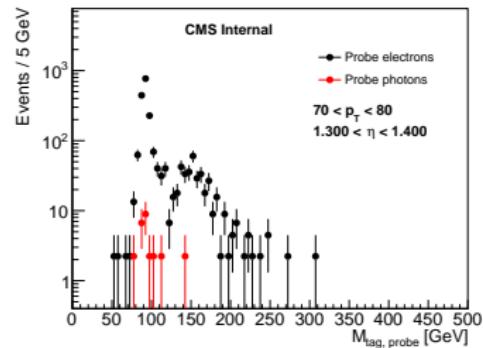
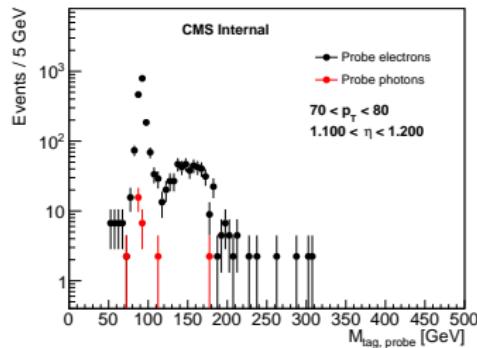


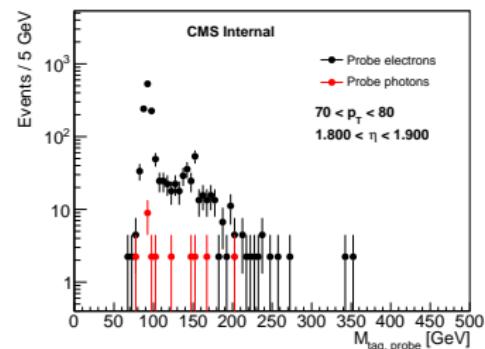
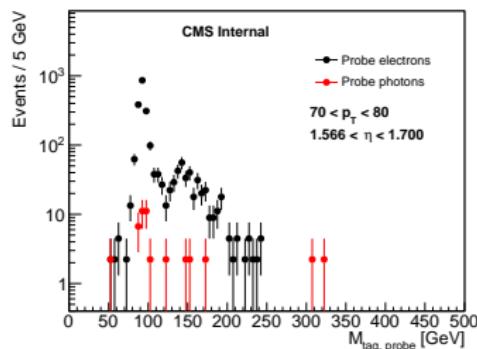
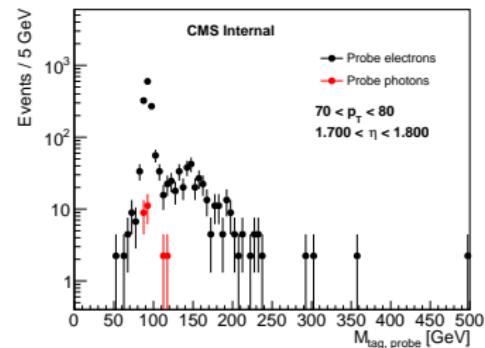
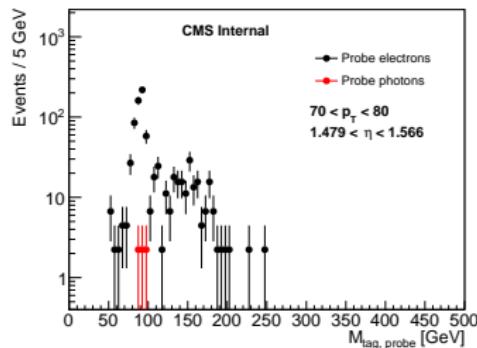


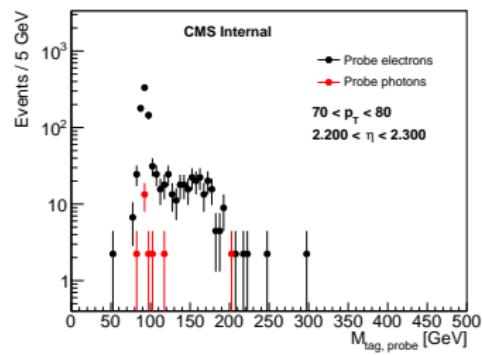
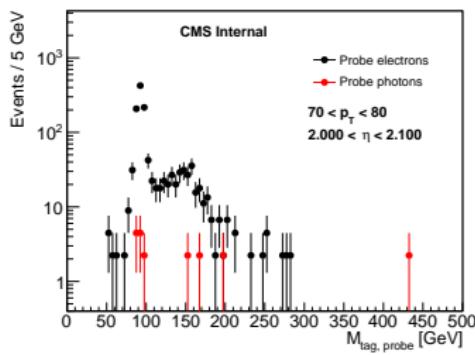
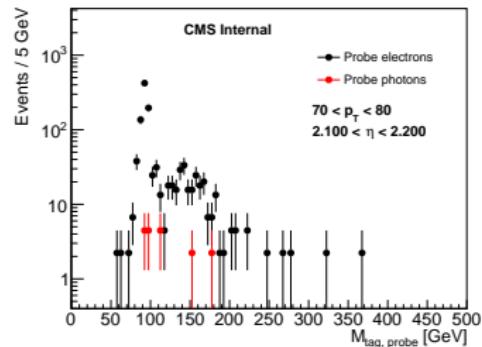
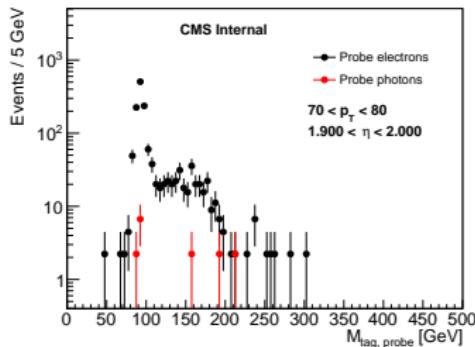


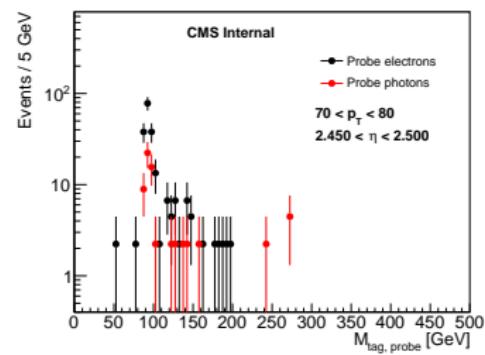
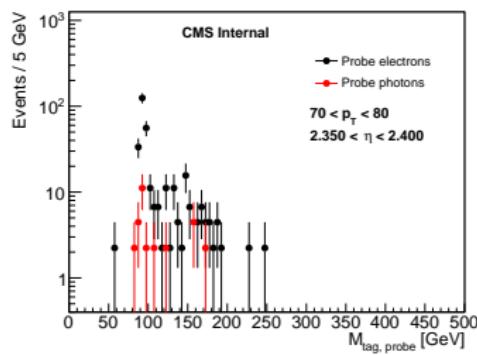
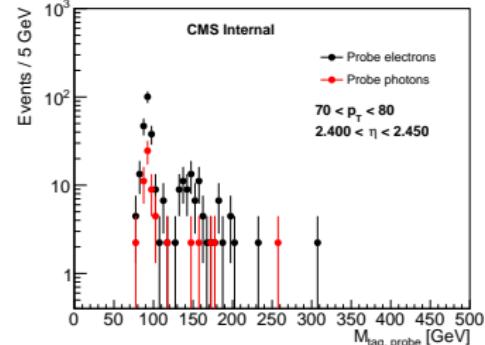
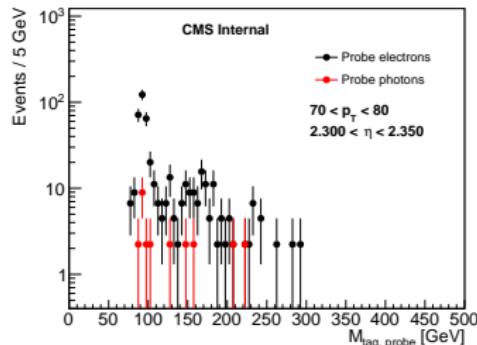


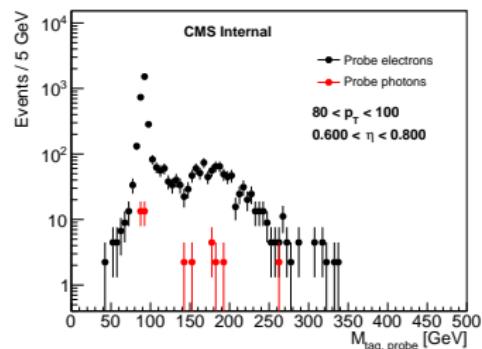
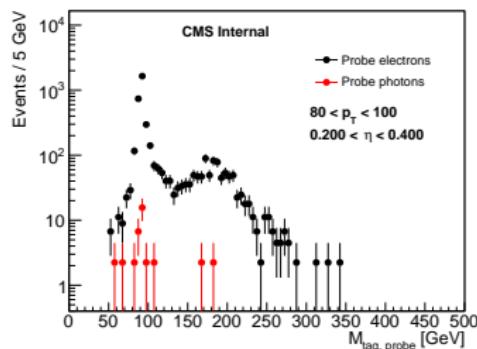
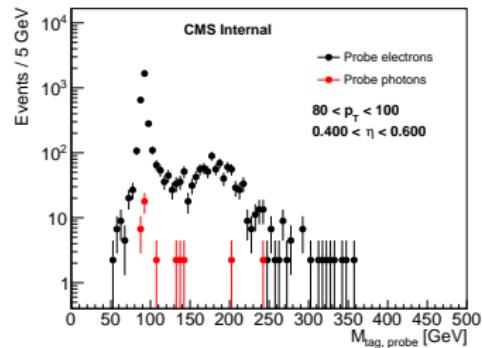
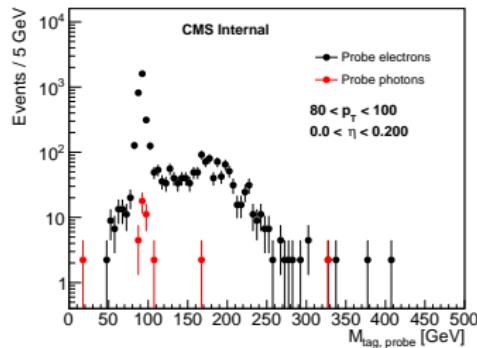


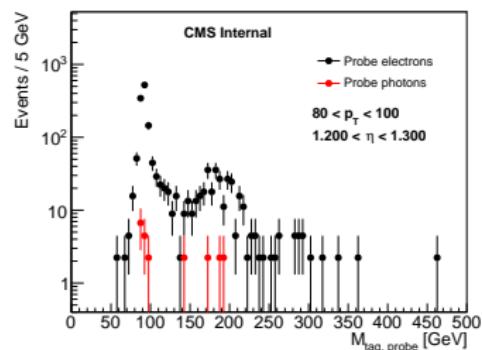
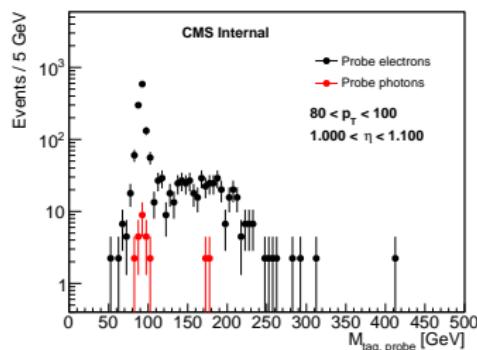
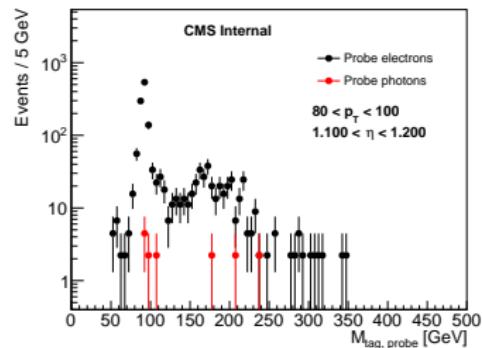
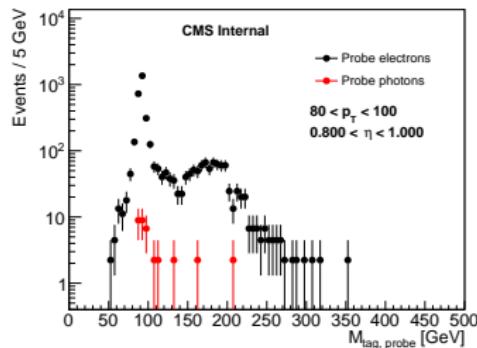


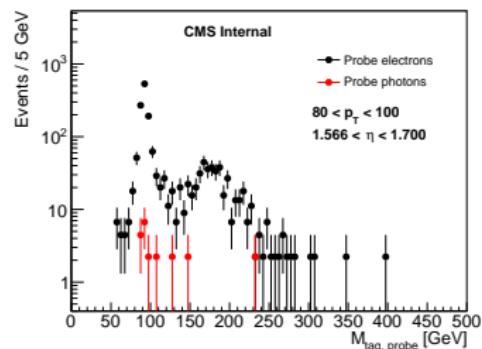
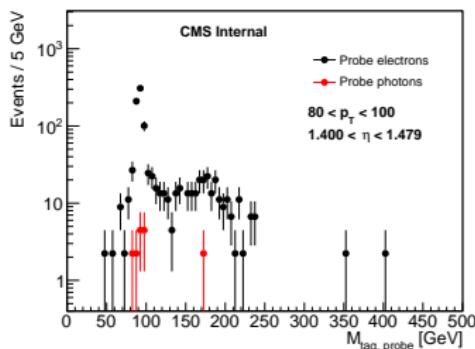
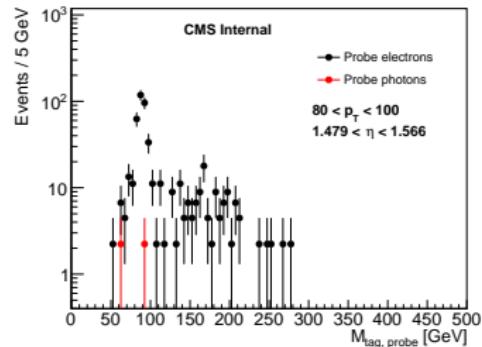
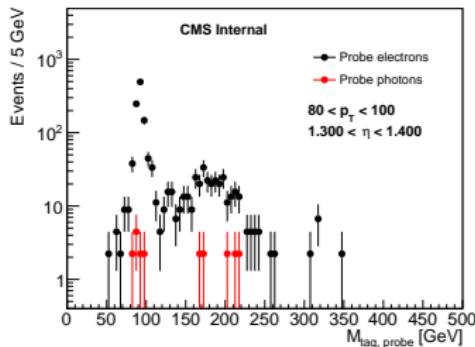


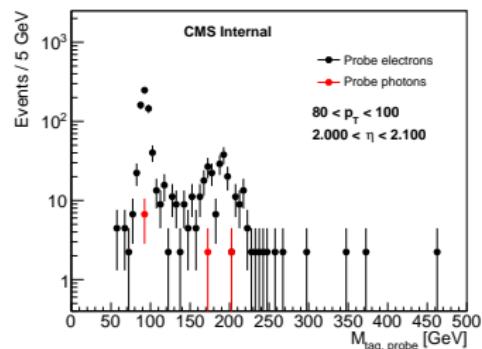
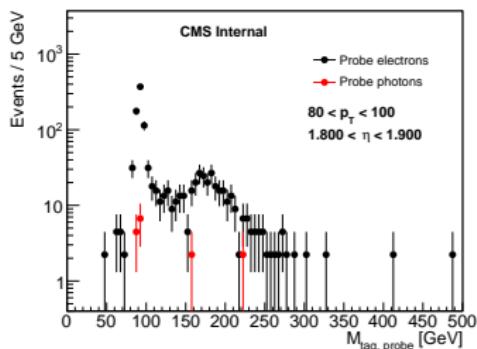
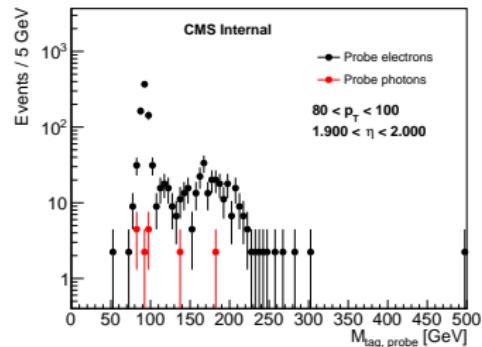
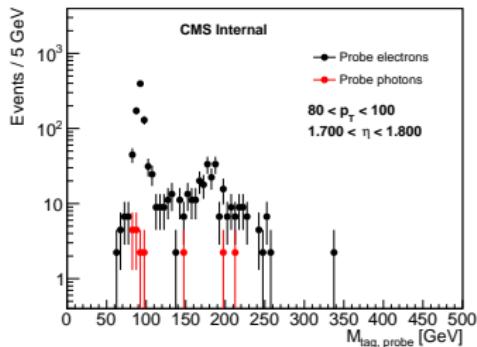


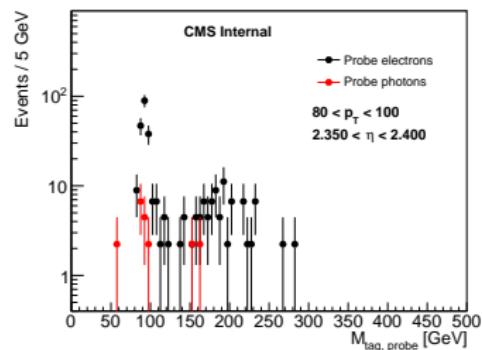
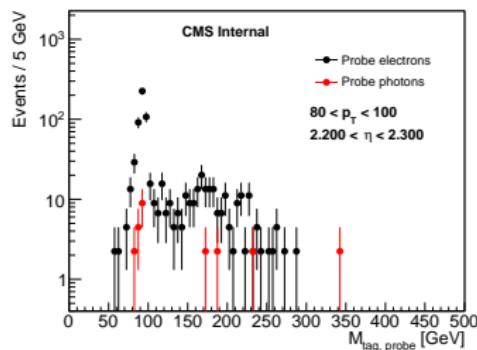
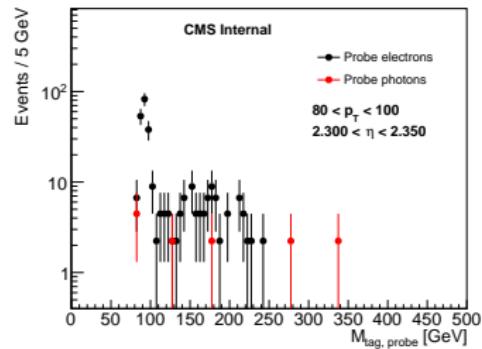
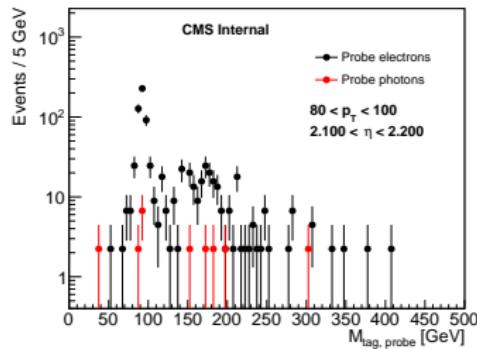


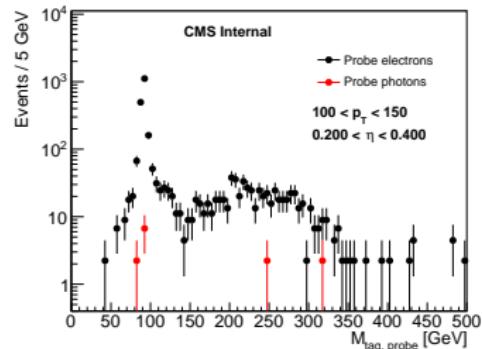
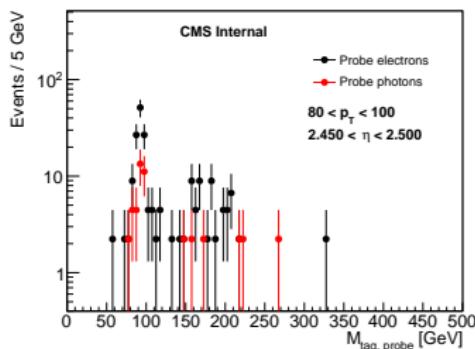
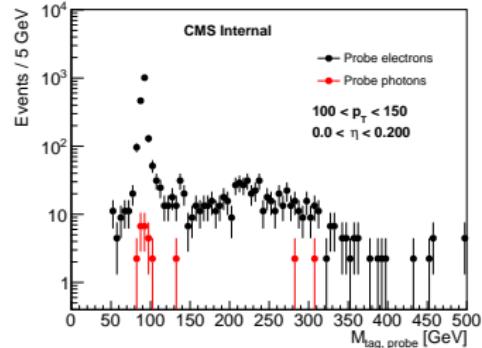
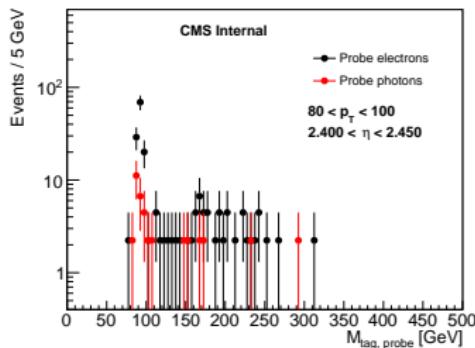


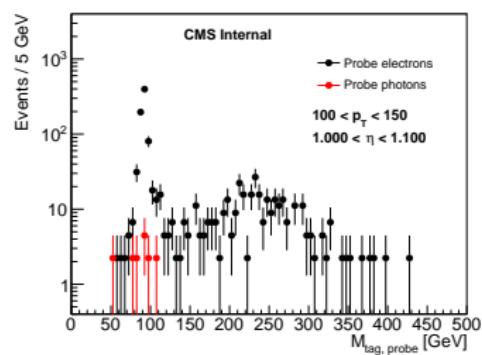
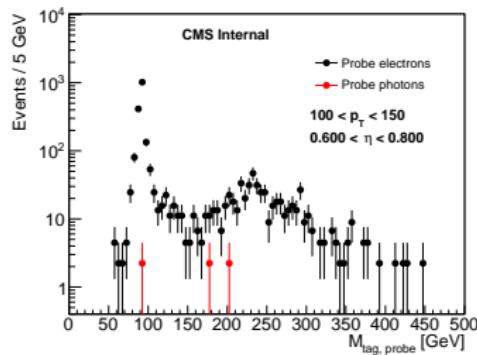
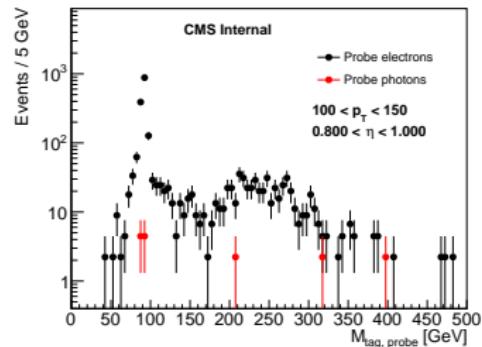
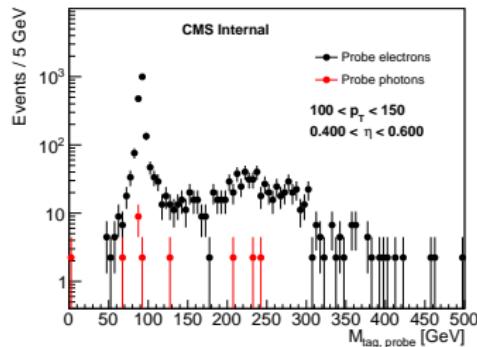


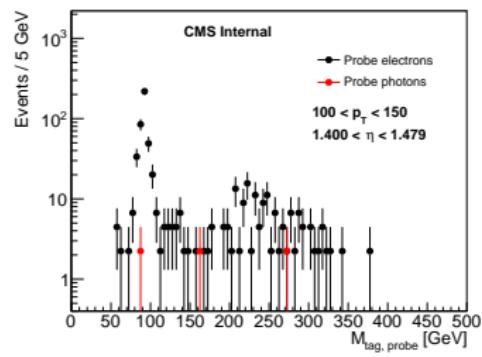
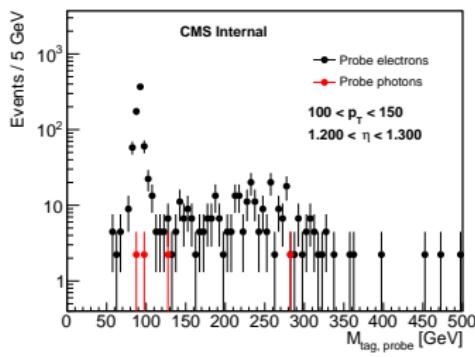
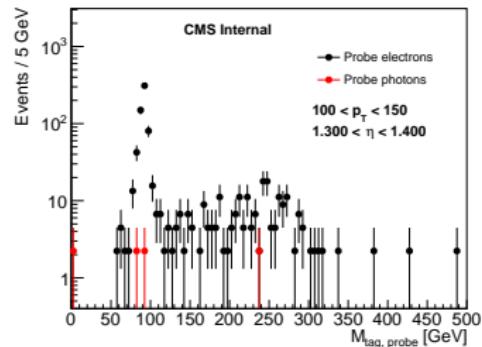
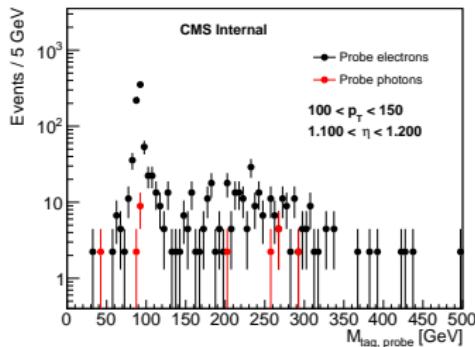


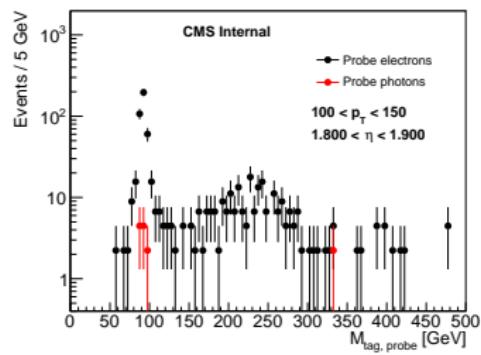
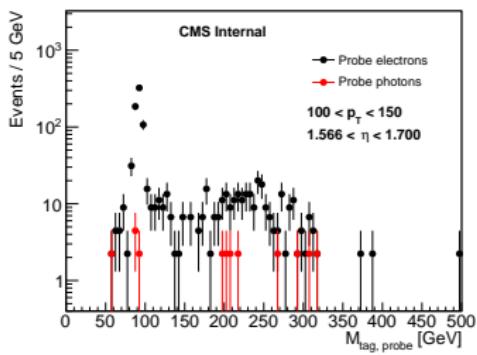
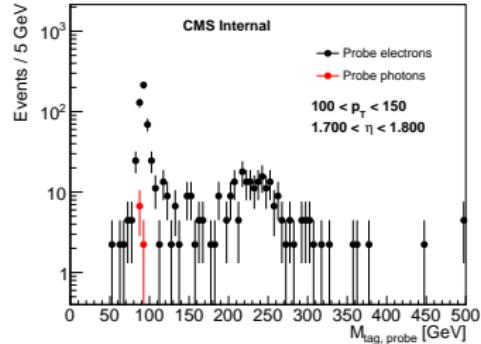
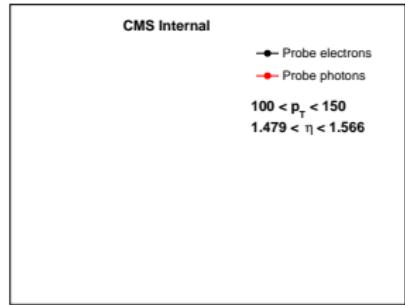


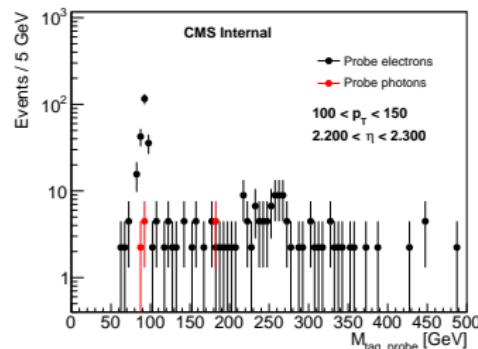
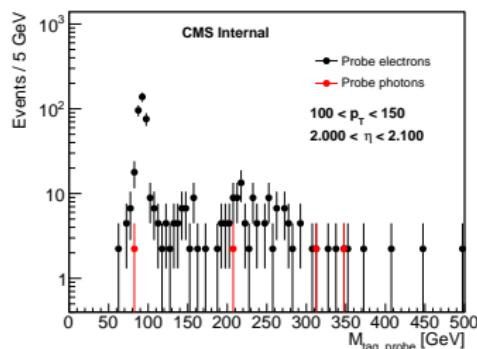
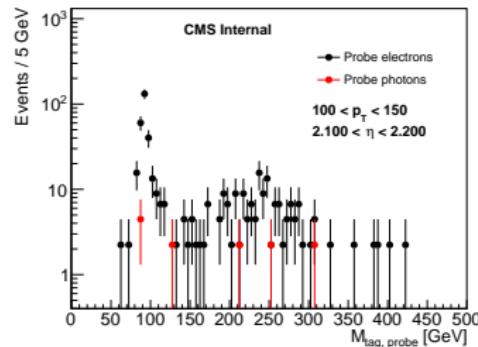
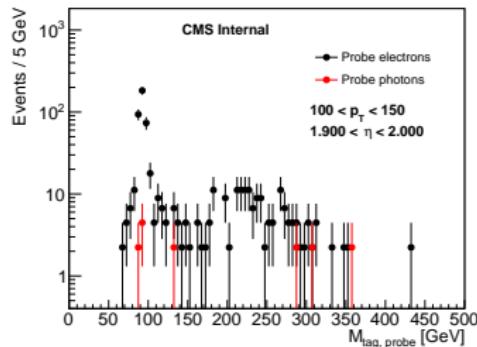


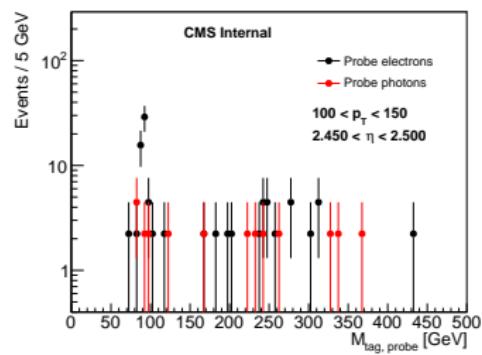
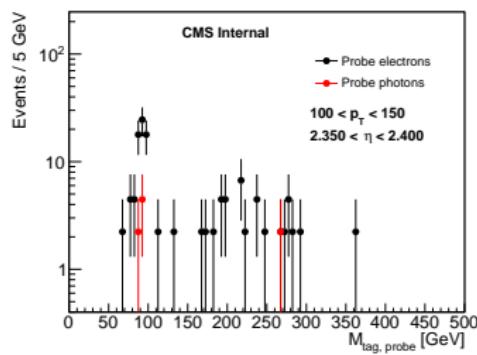
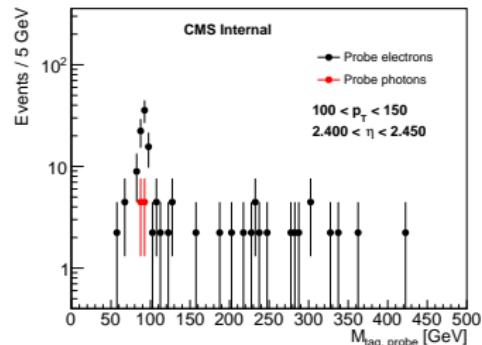
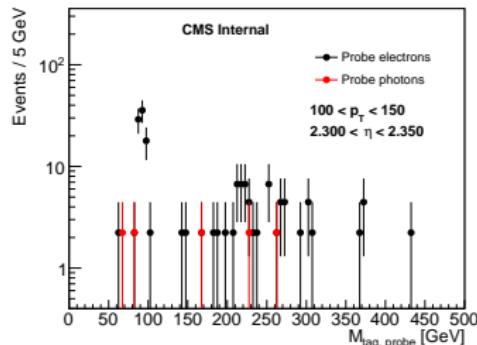


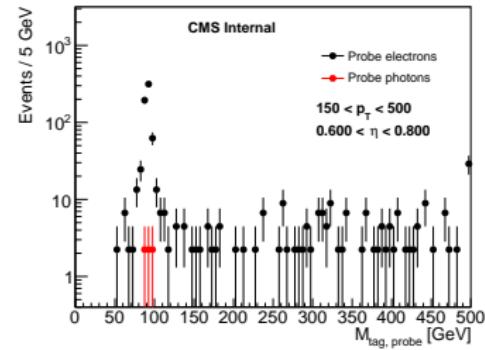
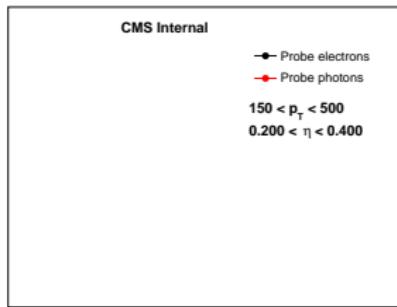
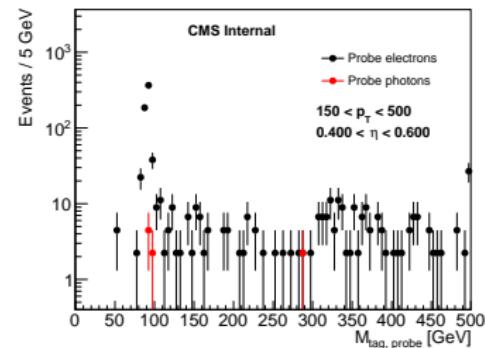
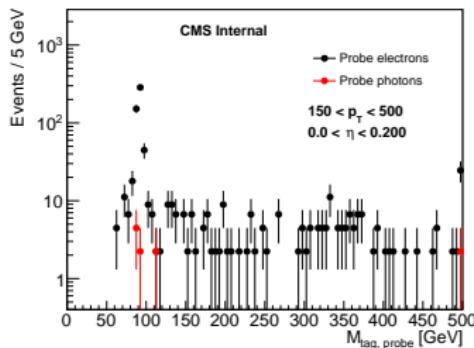


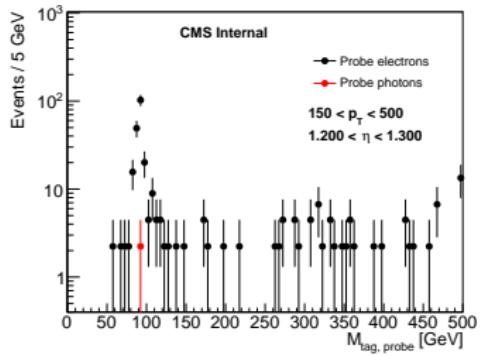
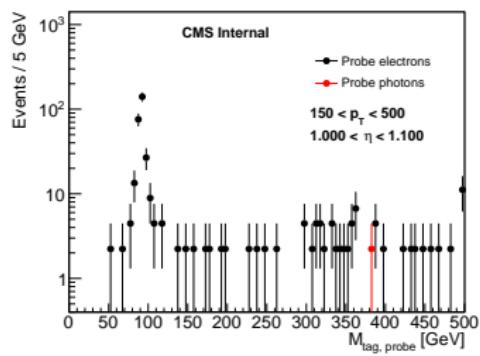
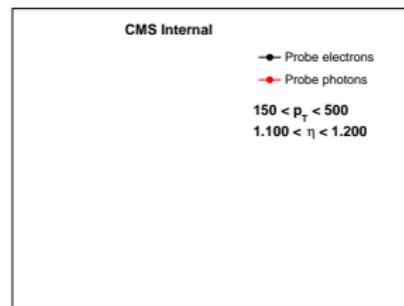
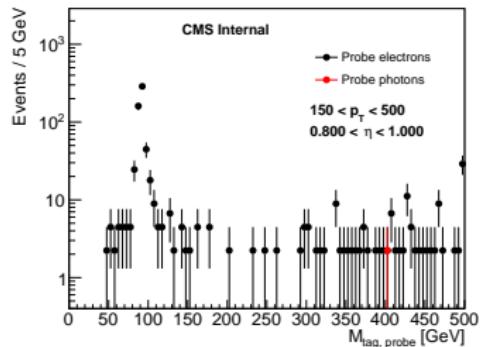


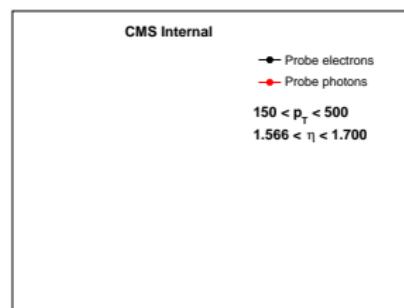
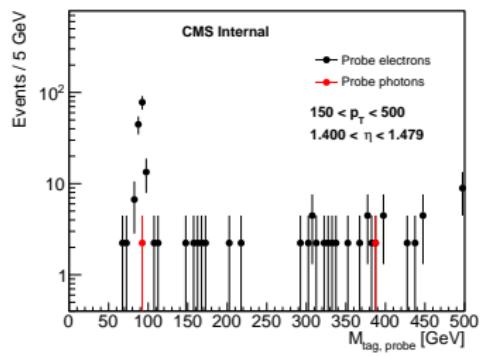
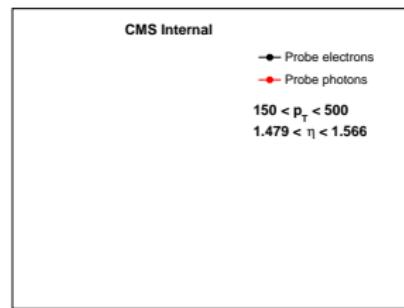
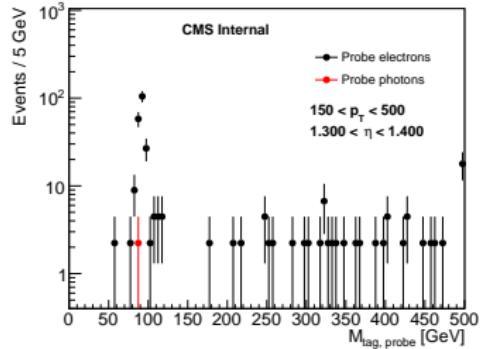


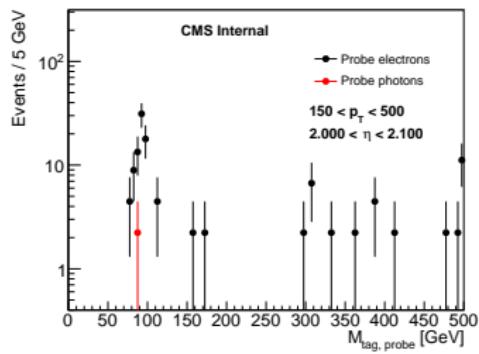
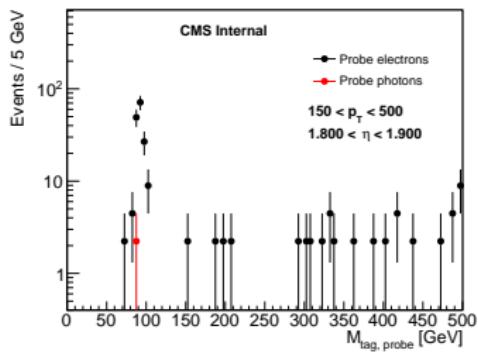
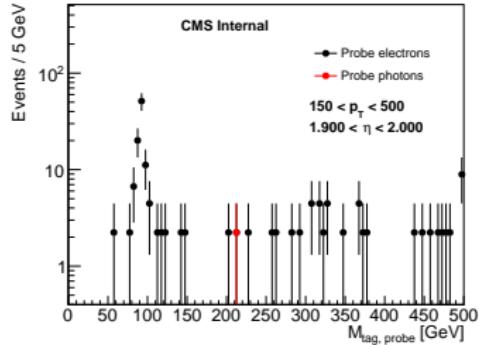
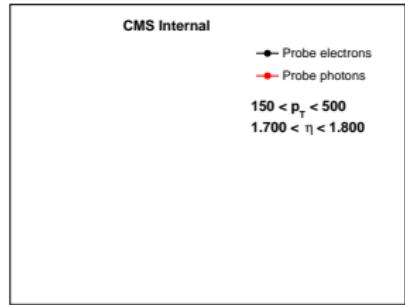












CMS Internal

- Probe electrons
- Probe photons

$150 < p_T < 500$
 $2.100 < \eta < 2.200$

CMS Internal

- Probe electrons
- Probe photons

$150 < p_T < 500$
 $2.300 < \eta < 2.350$

CMS Internal

- Probe electrons
- Probe photons

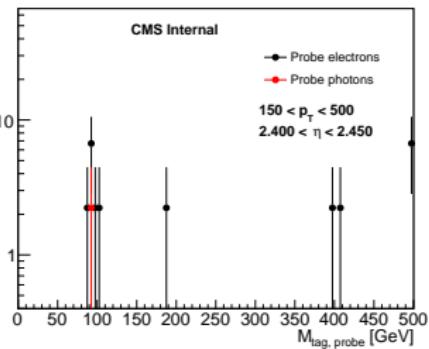
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 $2.200 < \eta < 2.300$

CMS Internal

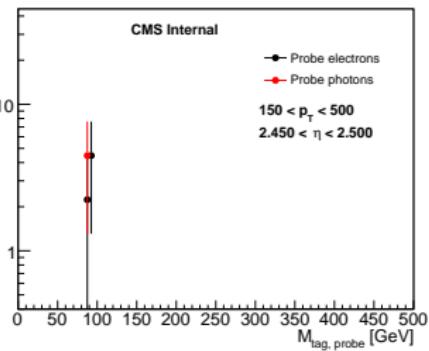
- Probe electrons
- Probe photons

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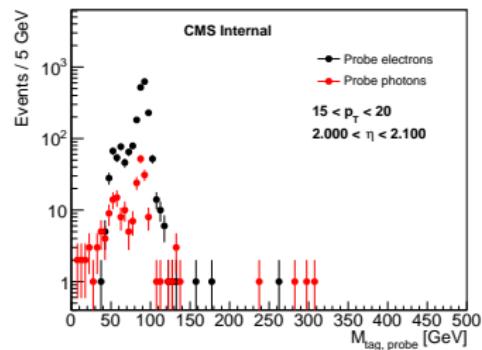
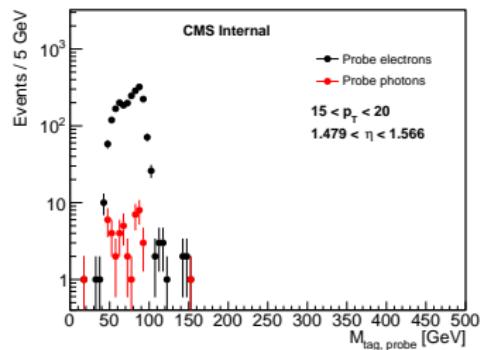
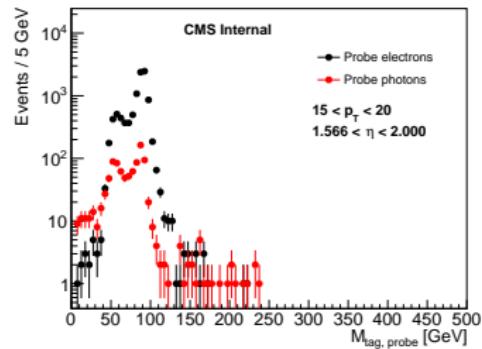
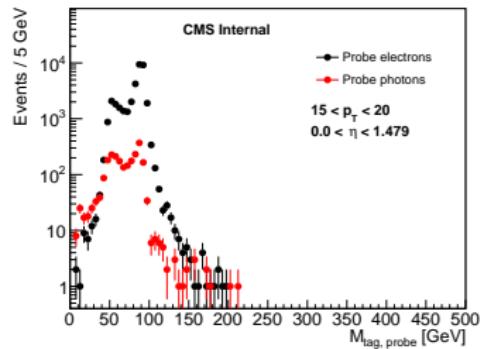
Events / 5 GeV

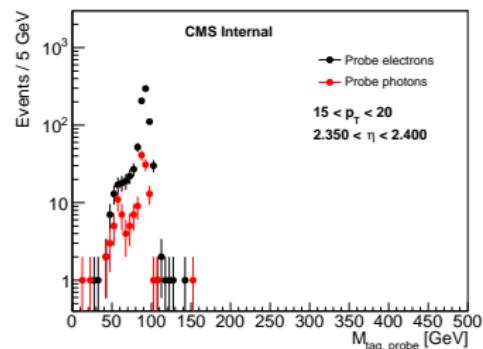
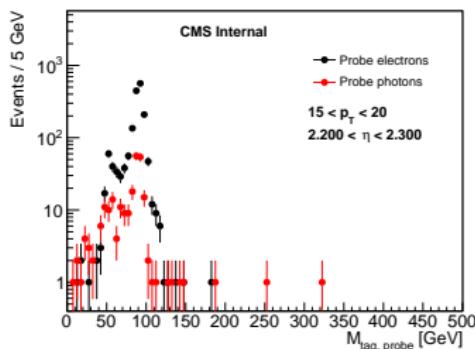
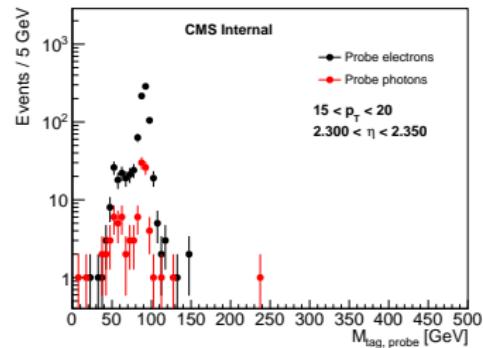
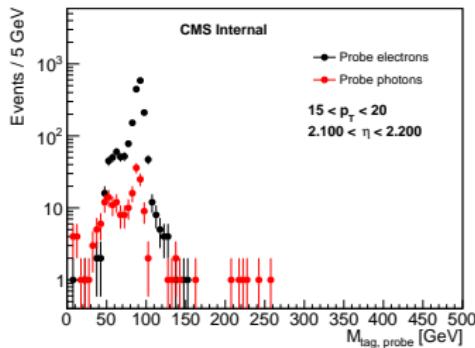


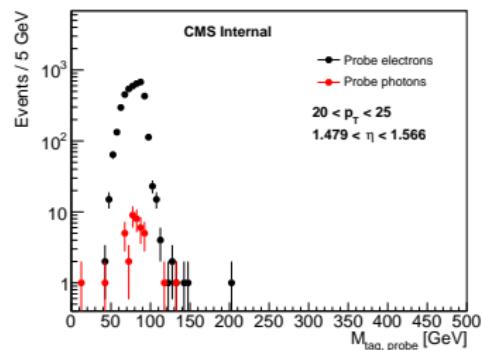
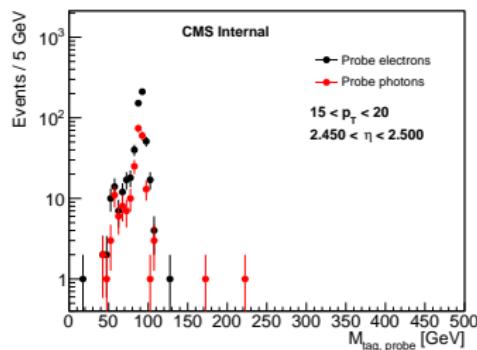
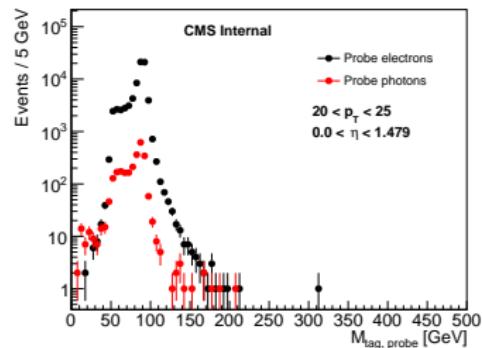
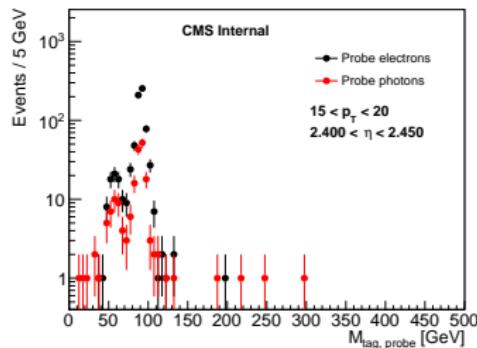
Events / 5 GeV

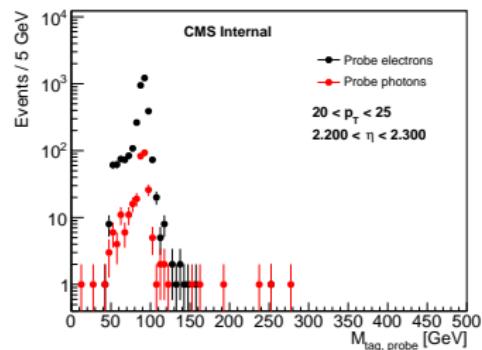
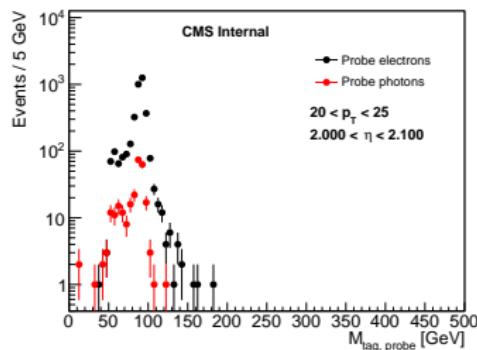
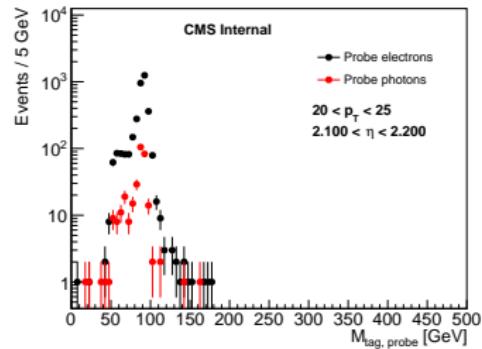
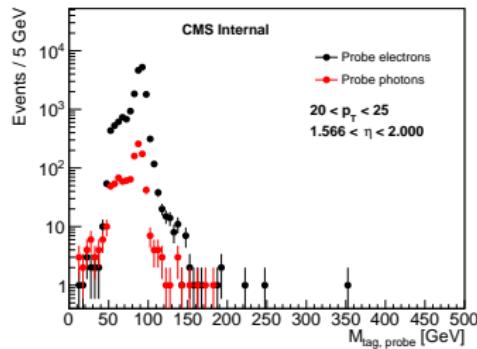


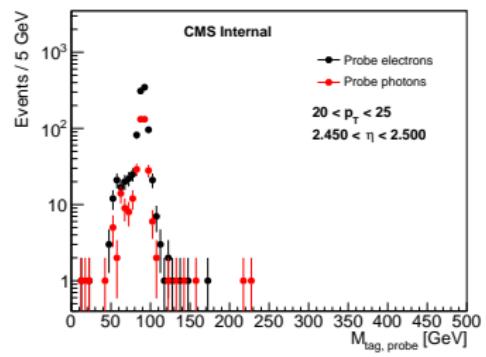
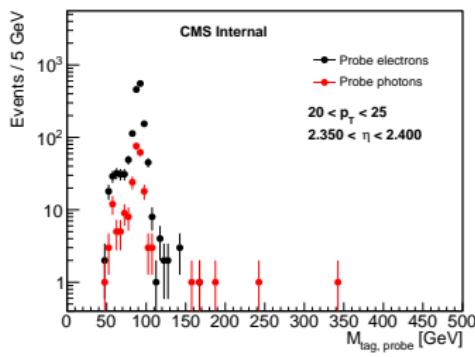
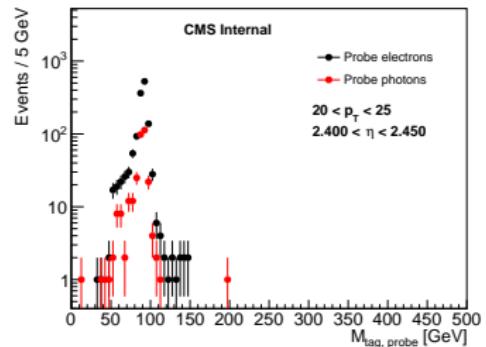
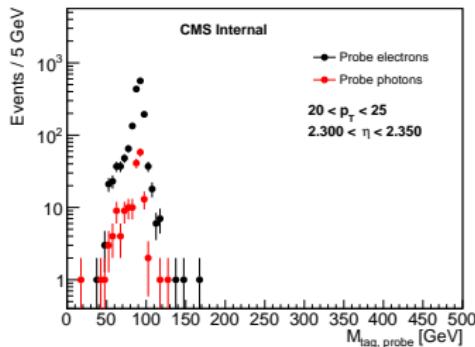
New binning

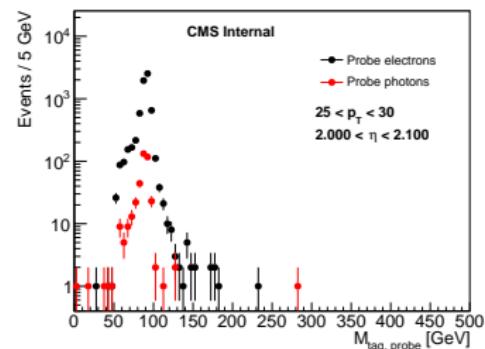
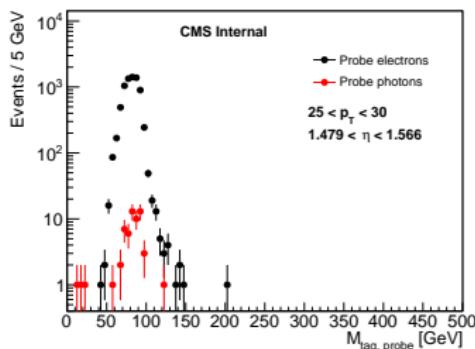
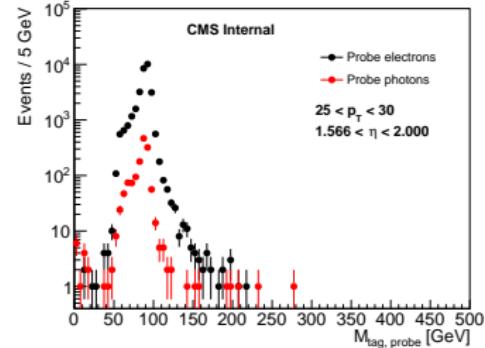
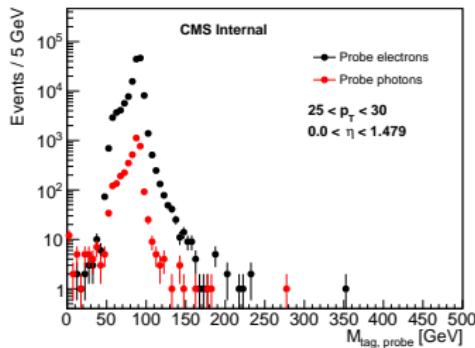


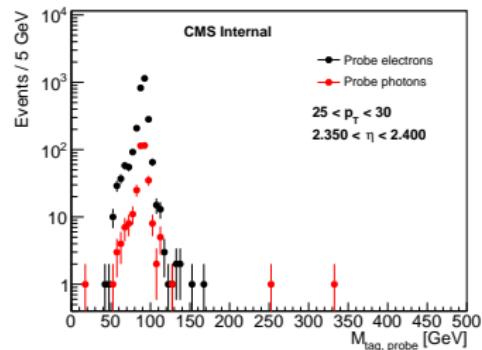
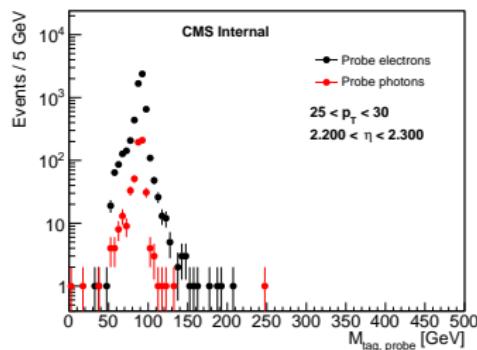
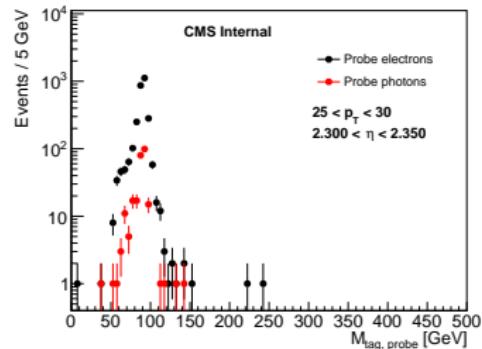
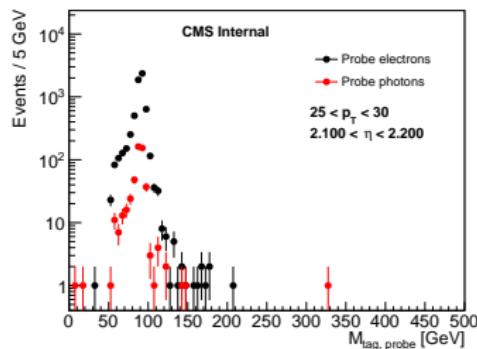


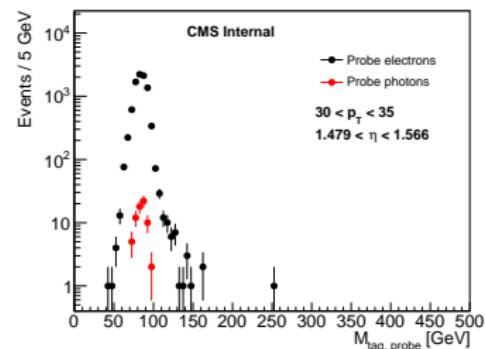
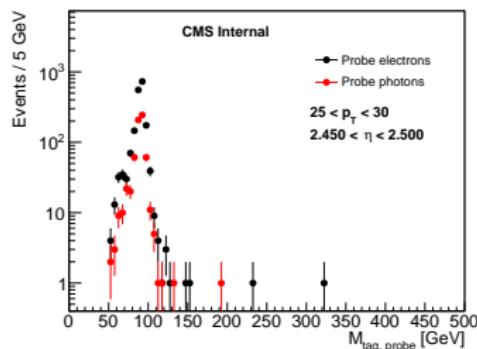
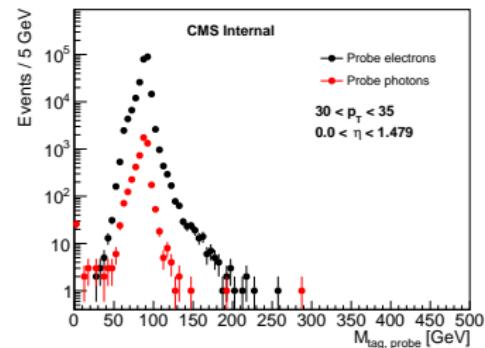
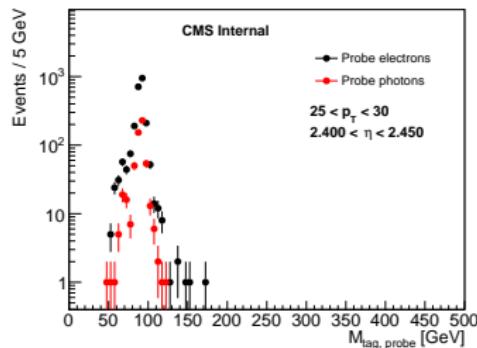


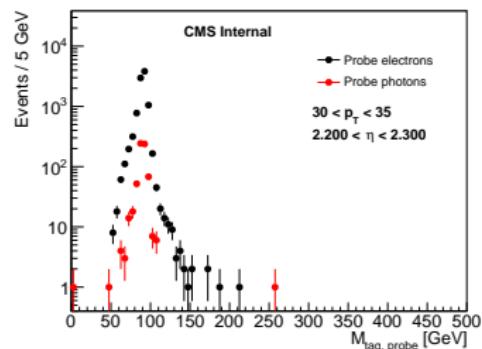
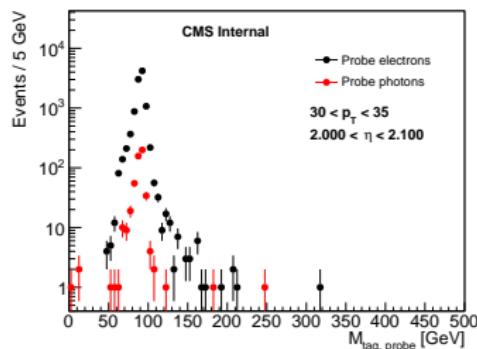
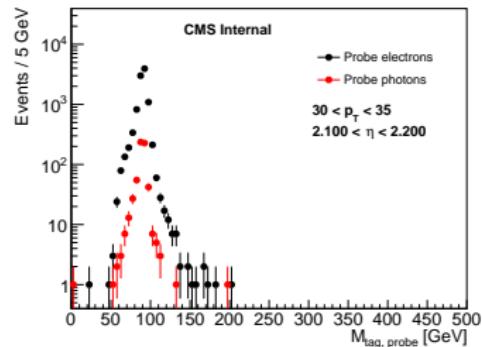
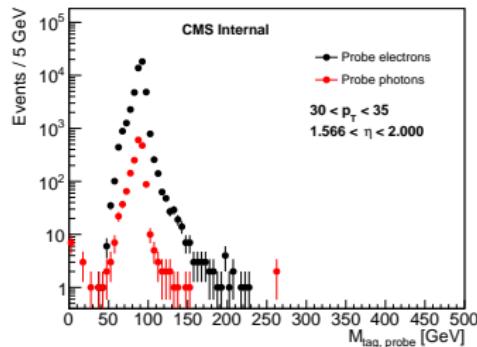


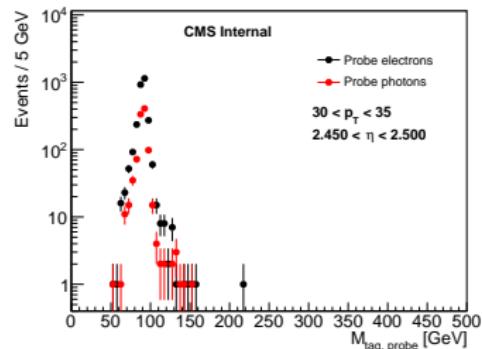
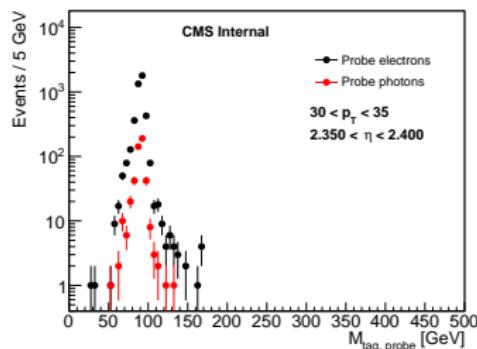
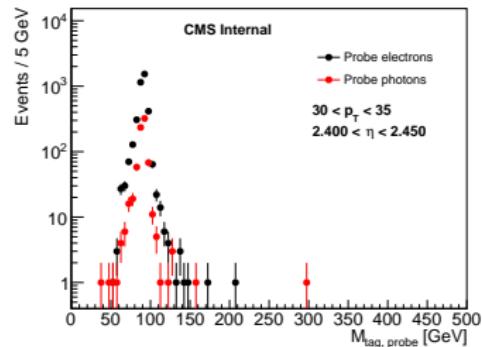
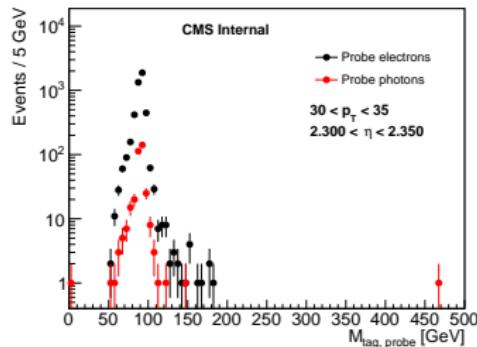


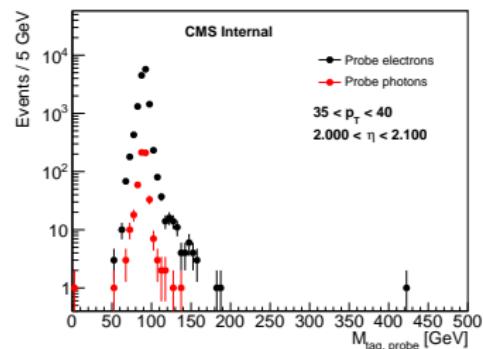
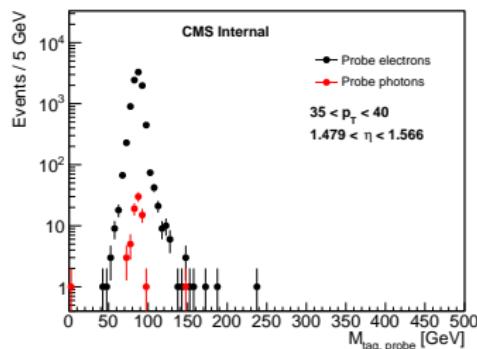
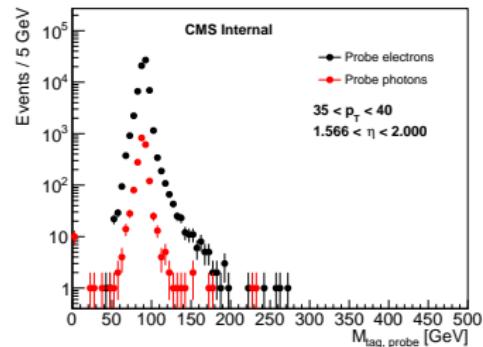
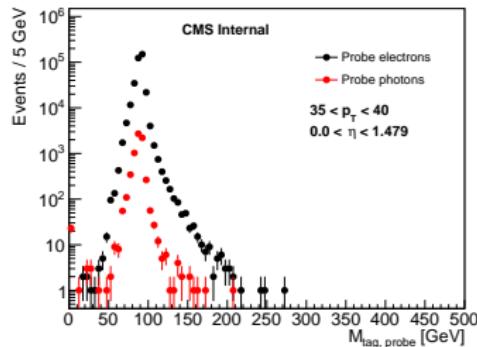


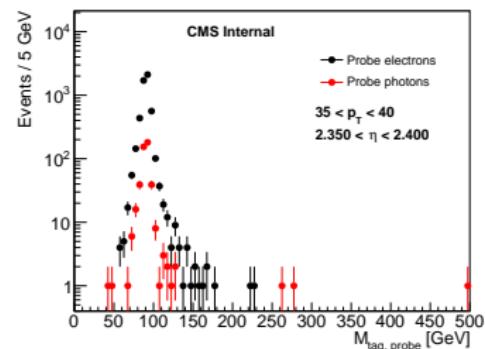
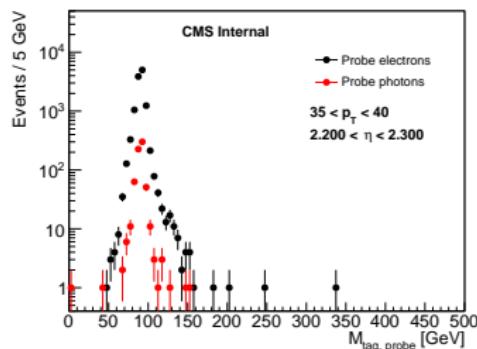
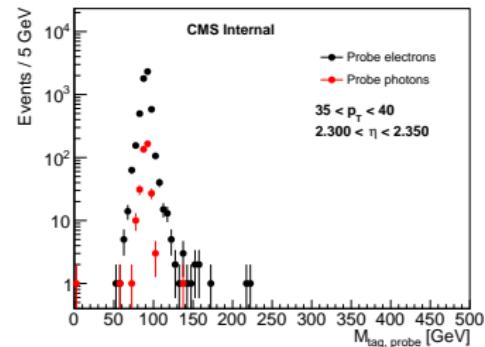
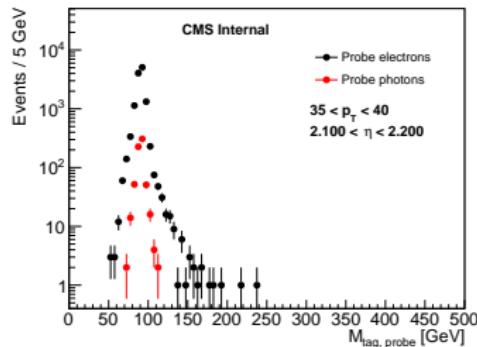


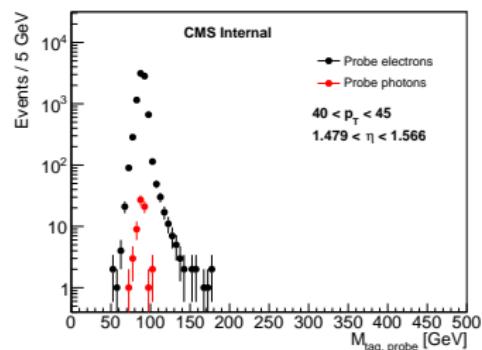
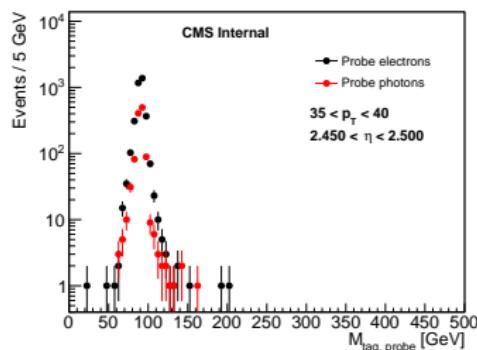
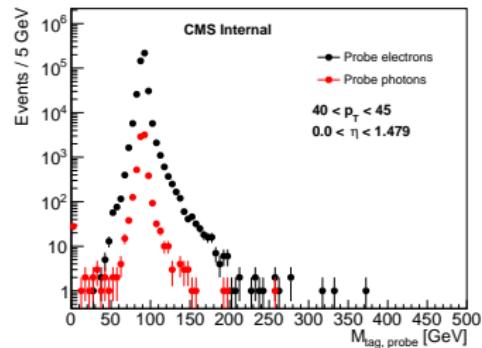
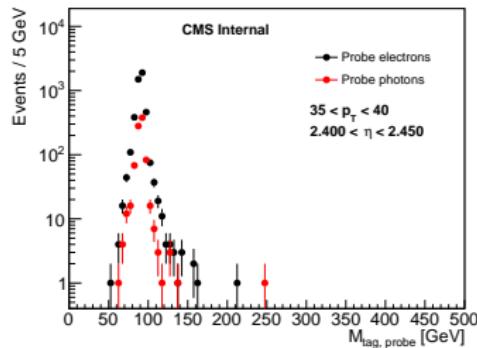


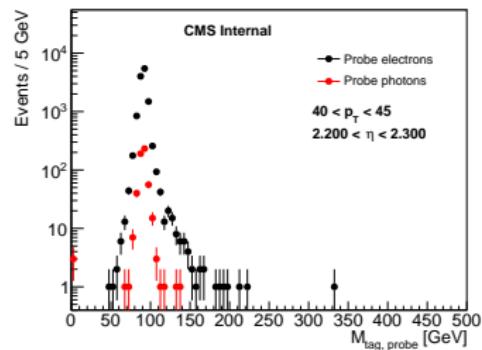
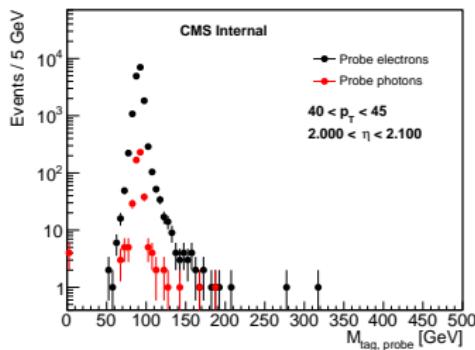
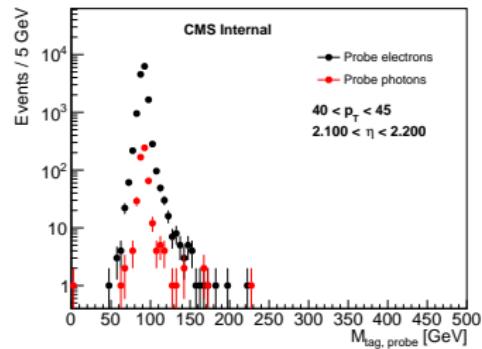
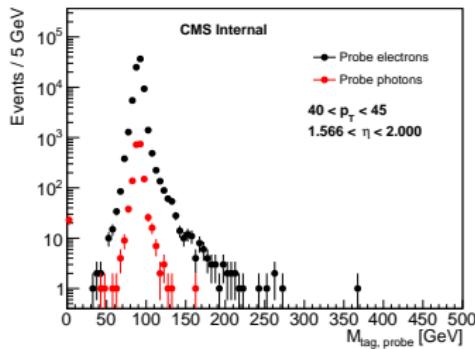


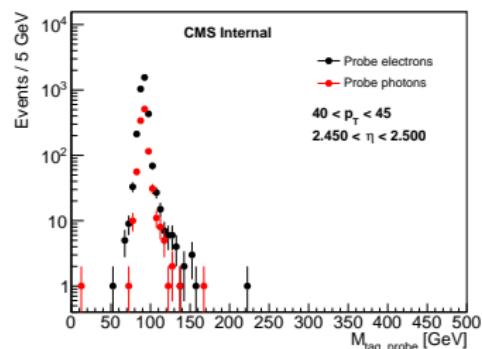
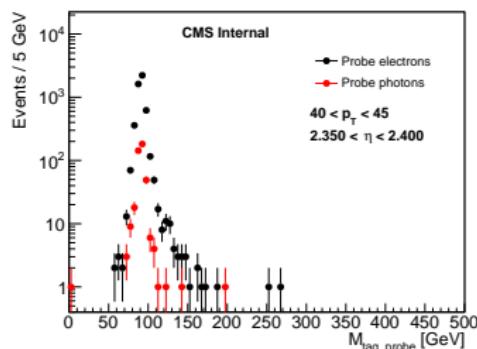
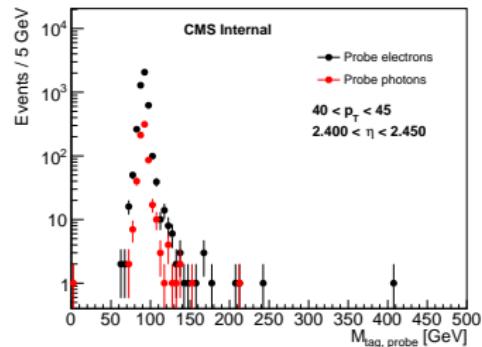
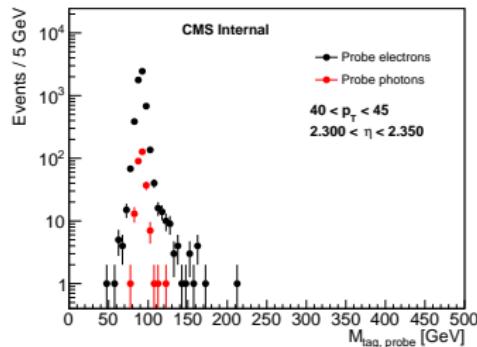


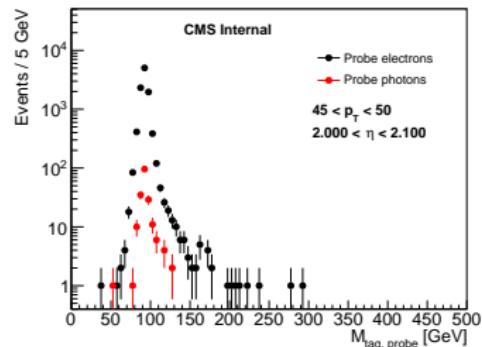
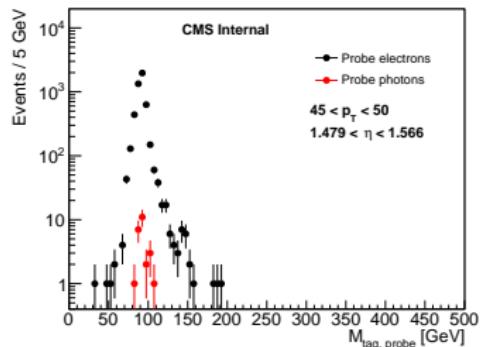
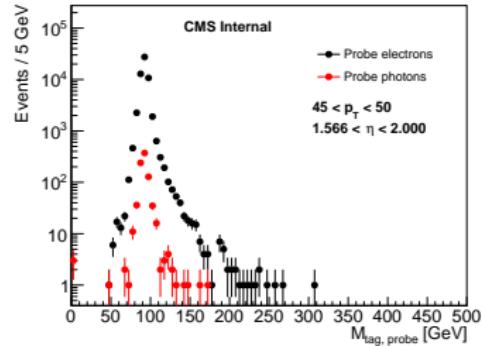
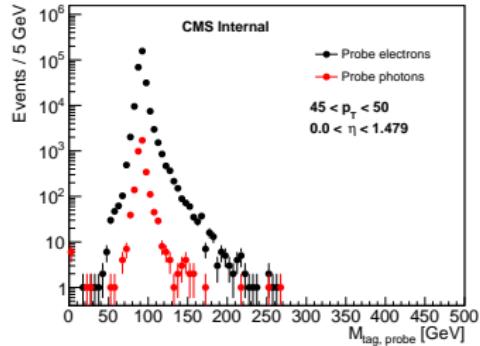


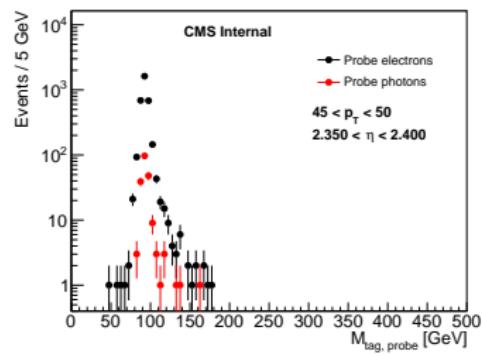
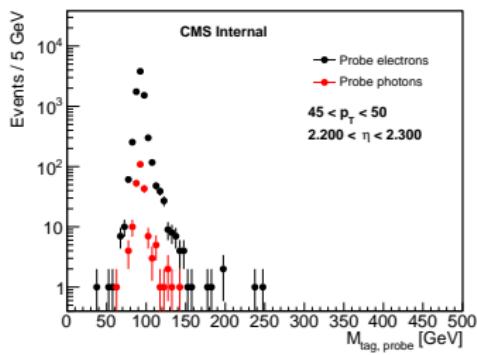
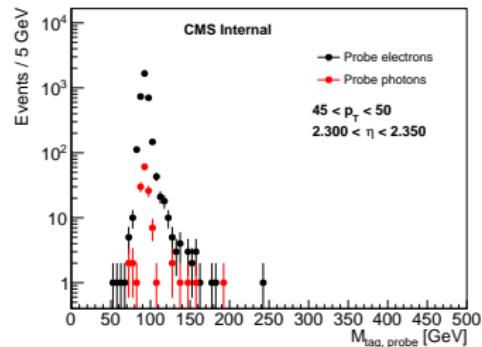
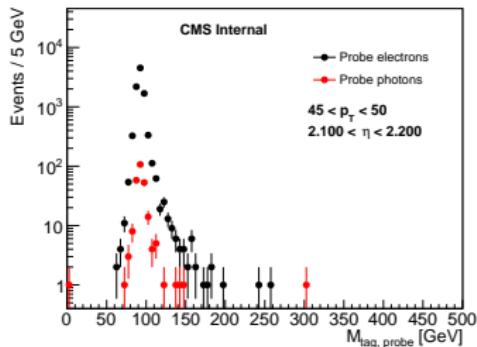


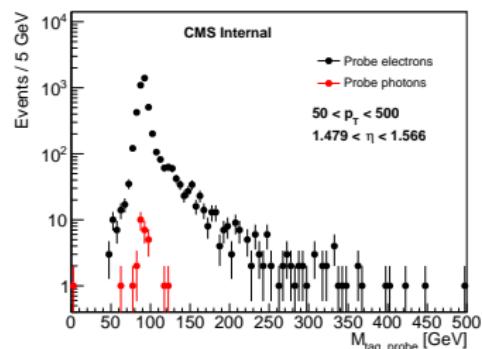
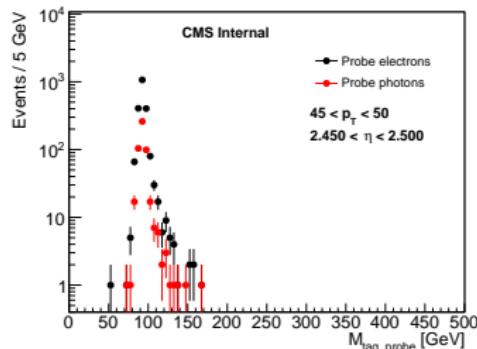
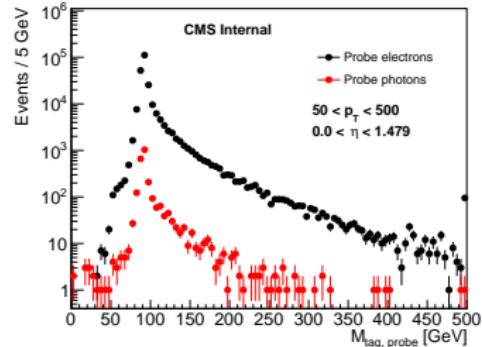
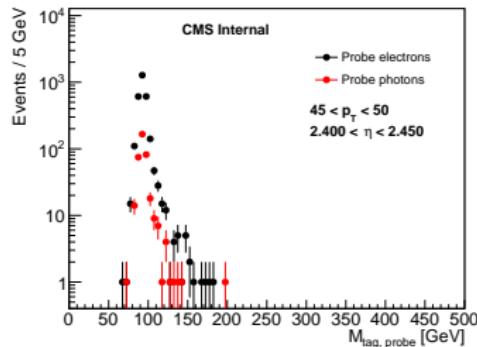


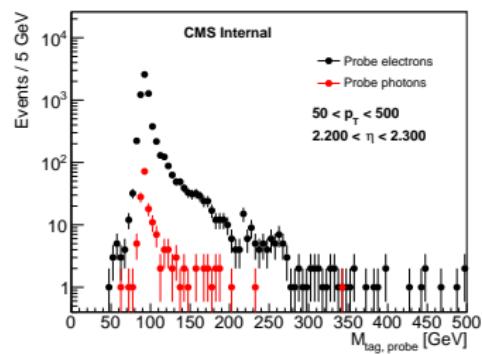
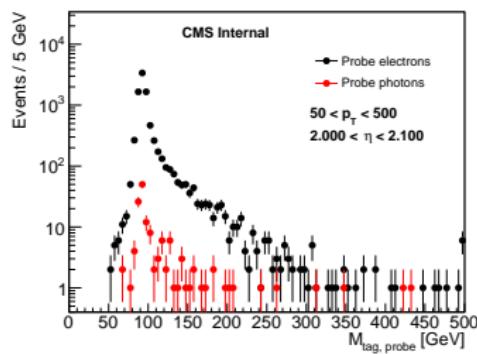
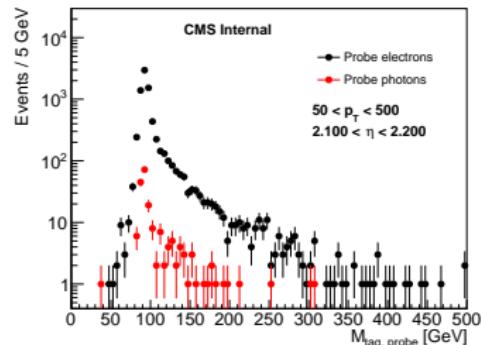
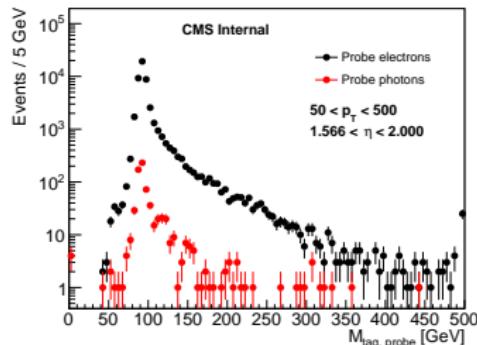


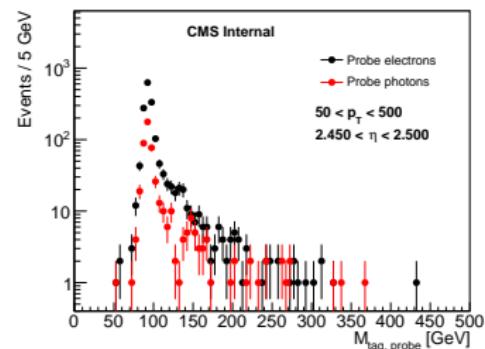
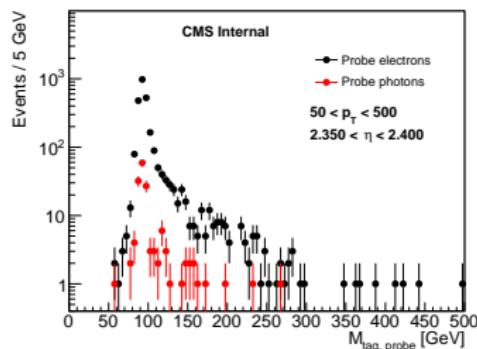
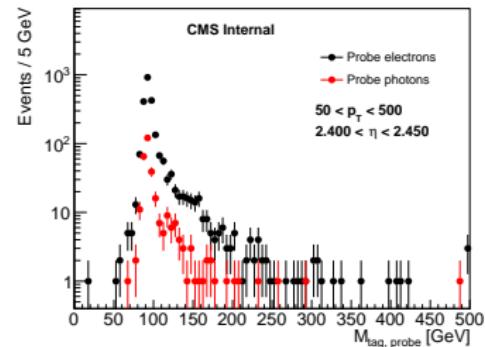
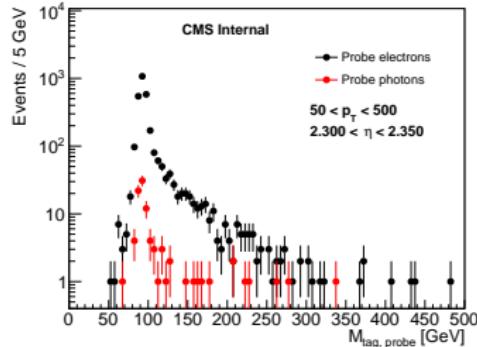




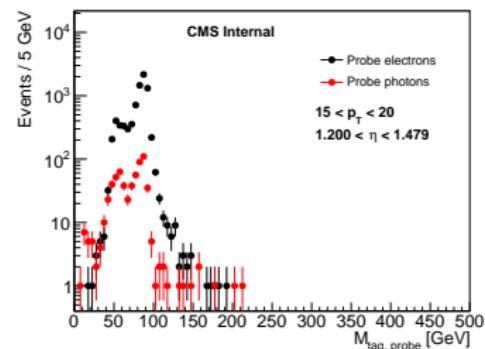
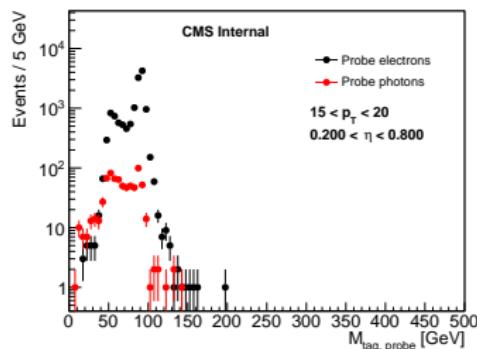
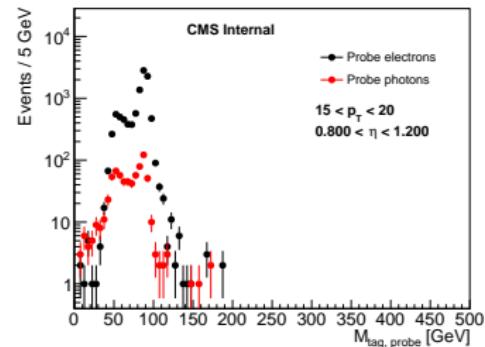
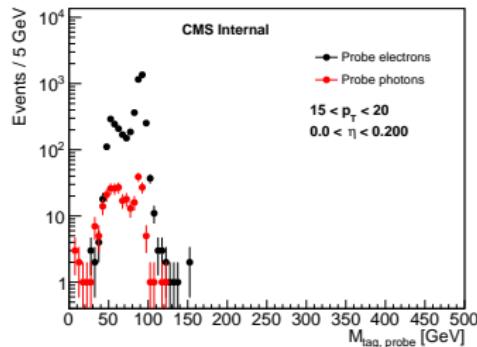


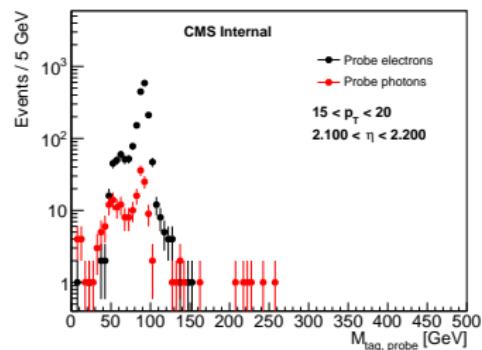
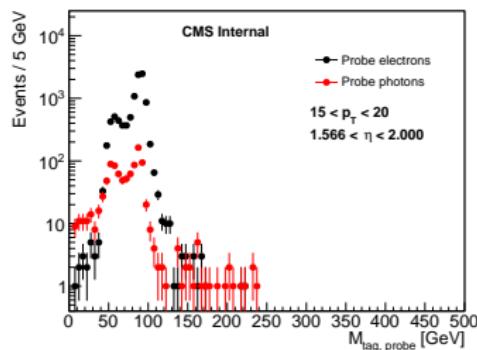
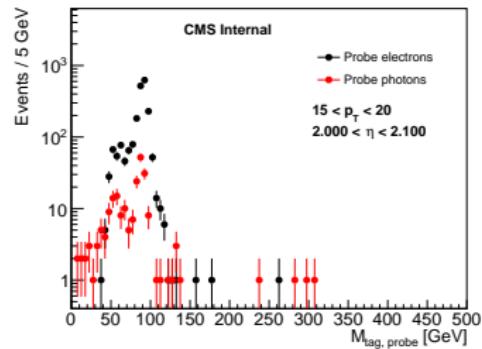
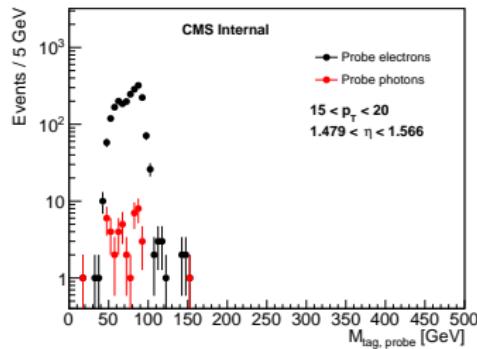


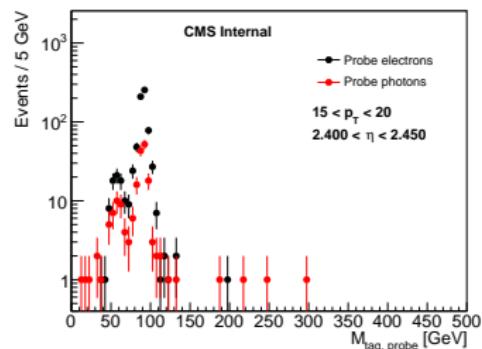
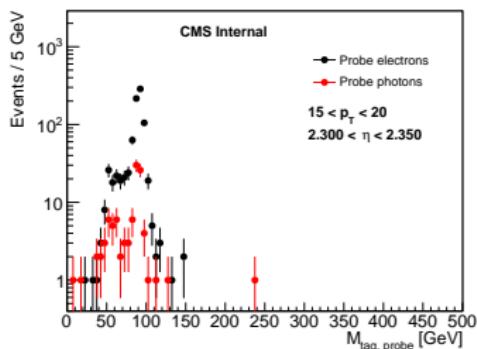
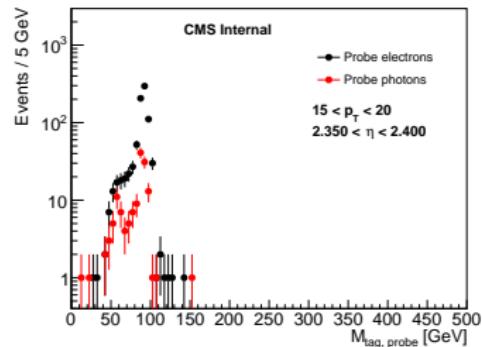
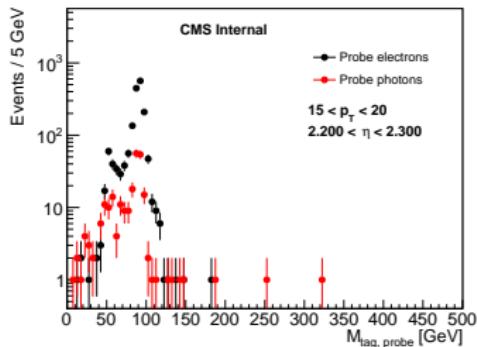


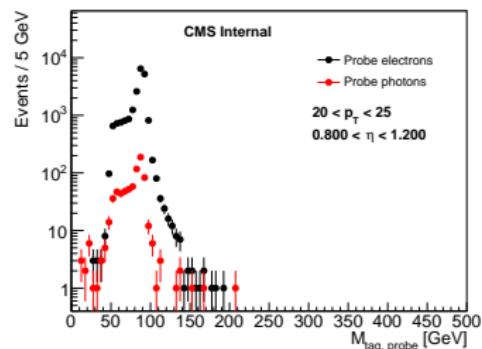
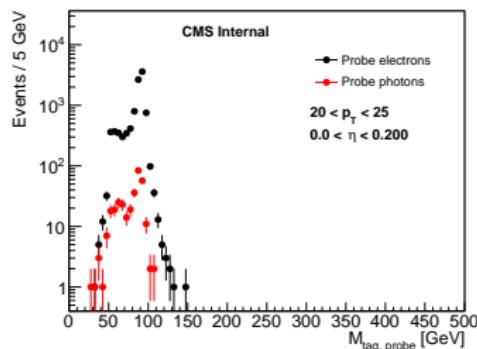
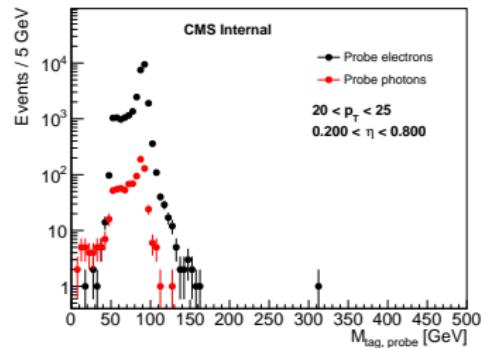
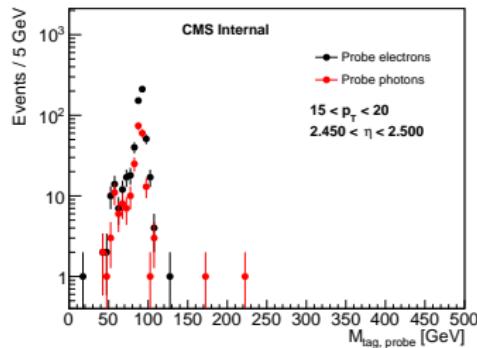


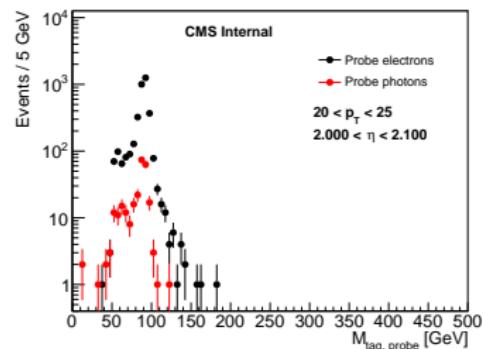
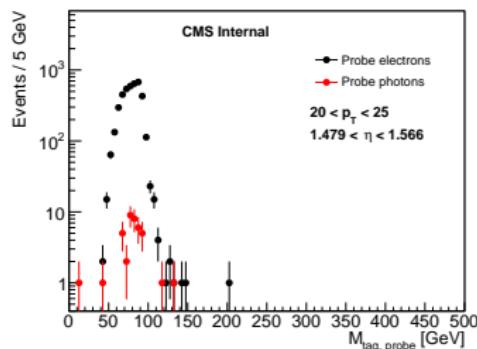
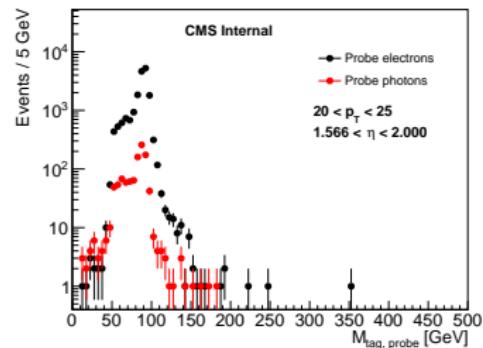
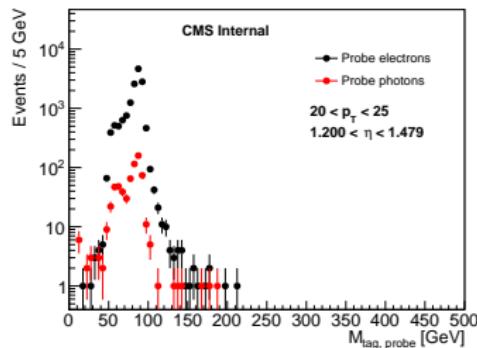
New finer eta binning

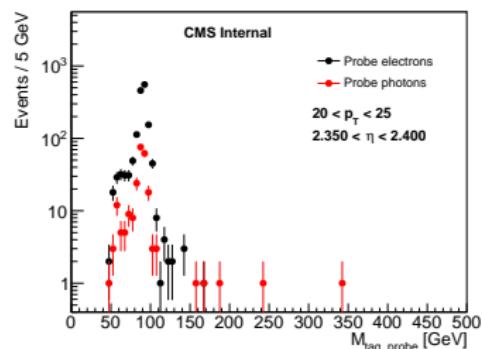
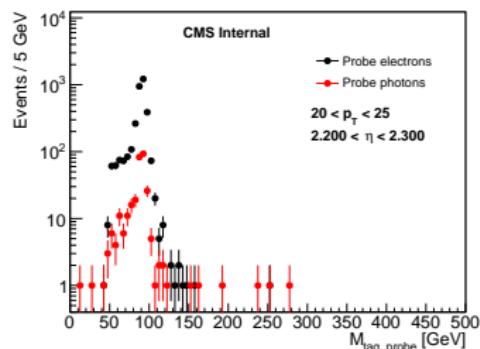
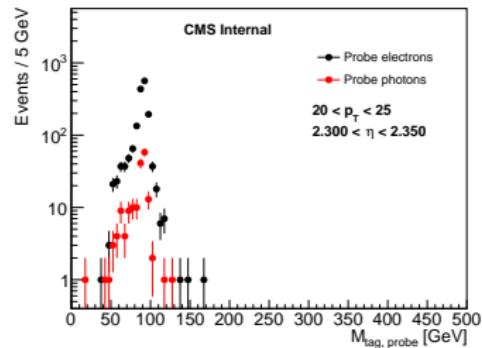
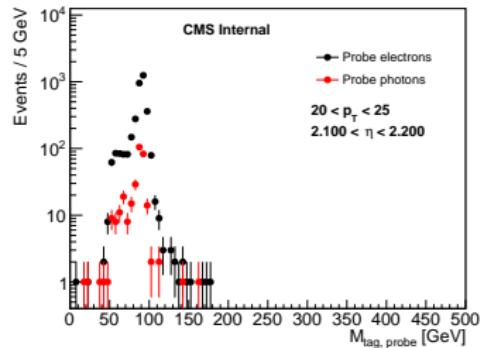




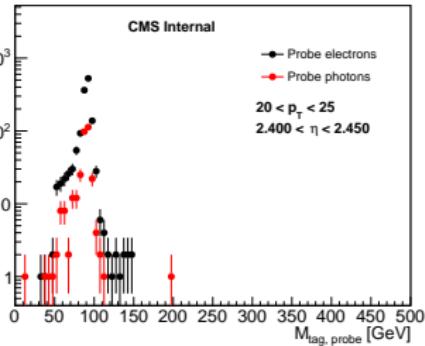




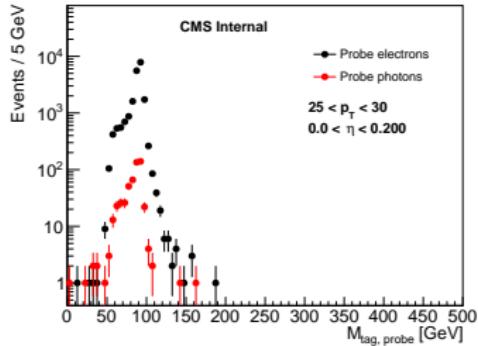




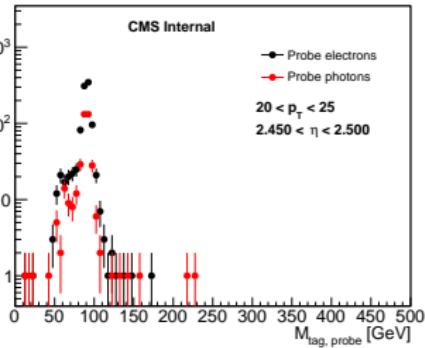
Events / 5 GeV



Events / 5 GeV



Events / 5 GeV



Events / 5 GeV

