



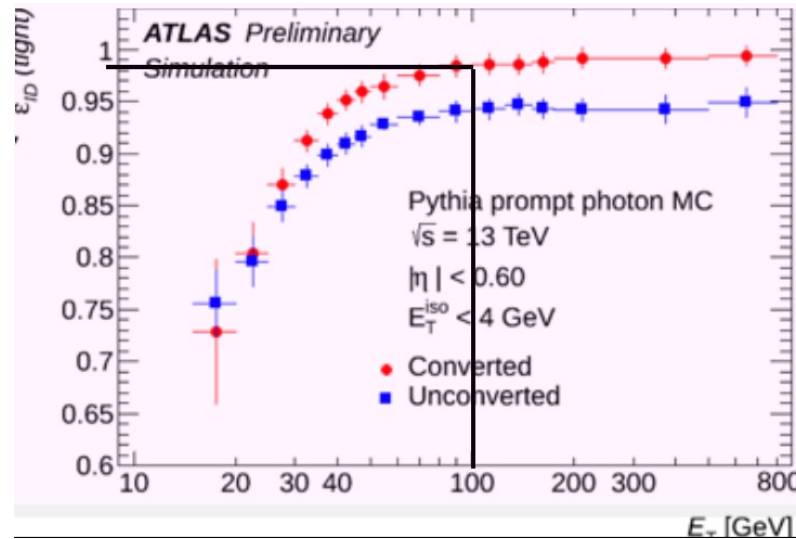
Photon ID study for high mass diphoton analysis *- test of new ID menu -*

Photon ID meeting

28/04/2016

Thibault Guillemin, Alexis Vallier, Isabelle Wingerter

Tight ID for converted



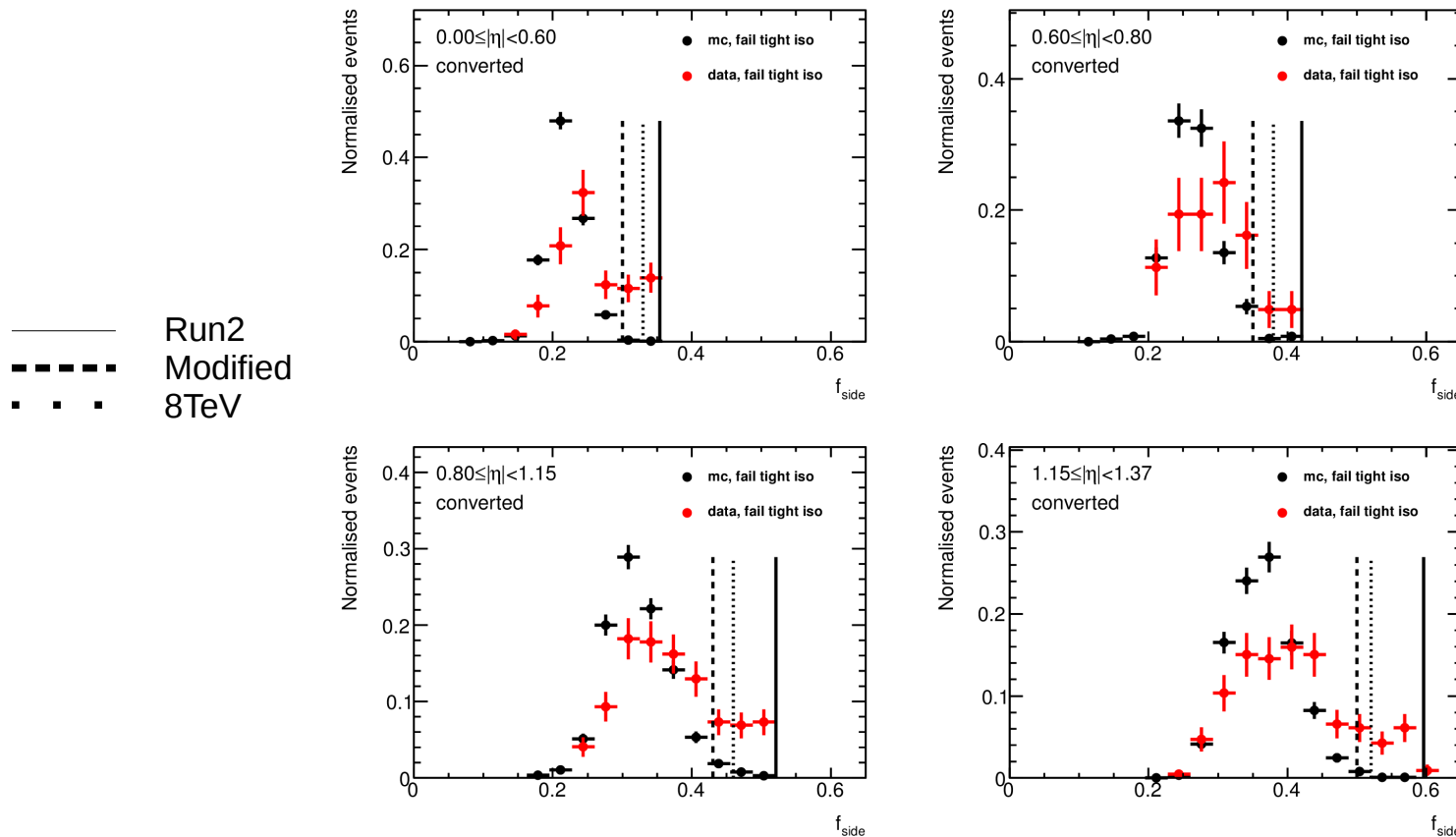
- **The tight ID working point for converted is too loose, see Guillaume's slides:**

- <https://indico.cern.ch/event/521826/contributions/2136996/attachments/1258574/1859020/photonId-15april2016.pdf>

- **Efficiency ~5% higher at high E_T for converted photons.**
- **Look at shower photon shower shapes for the diphoton analysis.**

Modified ID

- Looking at shower shapes of high mass diphoton events: confirmed that the tight ID is not optimal, especially for converted photons (see [previous talk](#)).
- Determine by hand a new tight working point (tighten the SS cuts).



**Photons failing
tight isolation**

Tight ID efficiency

- **Compute tight ID efficiency w.r.t. loose ID photons (Sherpa $\gamma\gamma$):**

- $p_T > 55$ GeV
- Loose isolation: $\text{topoetcone40} - 0.022 * E_t < 7$ GeV

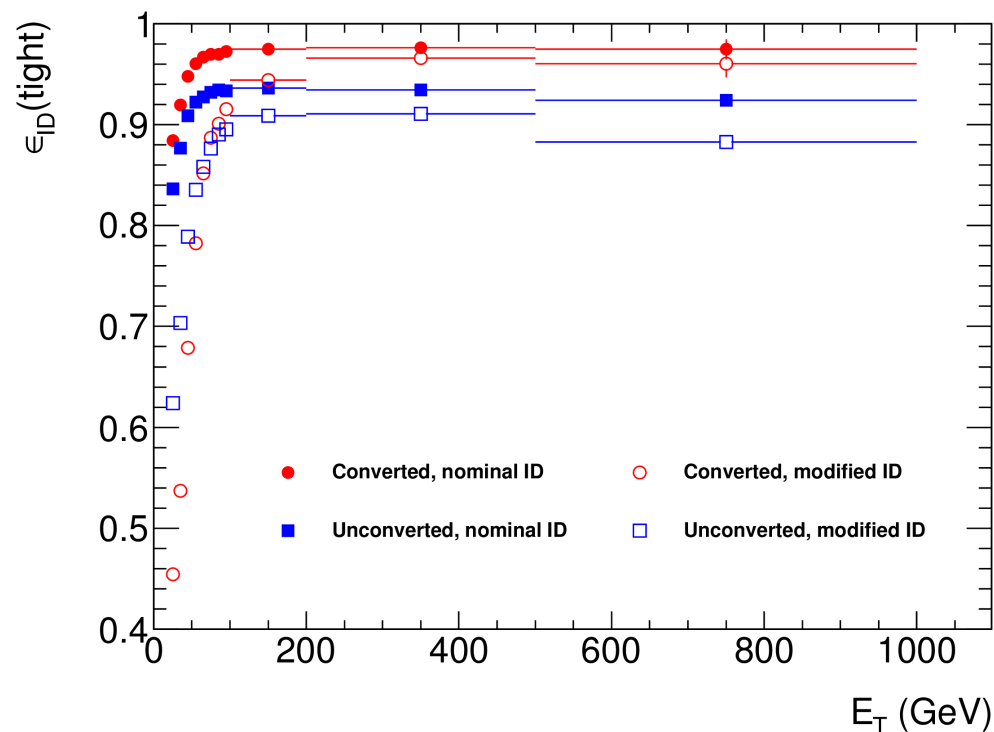
- **Inclusive efficiency:**

- Nominal ID:

- Conv: $(97.17 \pm 0.01)\%$
- Unconv: $(93.09 \pm 0.01)\%$

- Modified ID:

- Conv: $(87.98 \pm 0.03)\%$
- Unconv: $(87.52 \pm 0.02)\%$

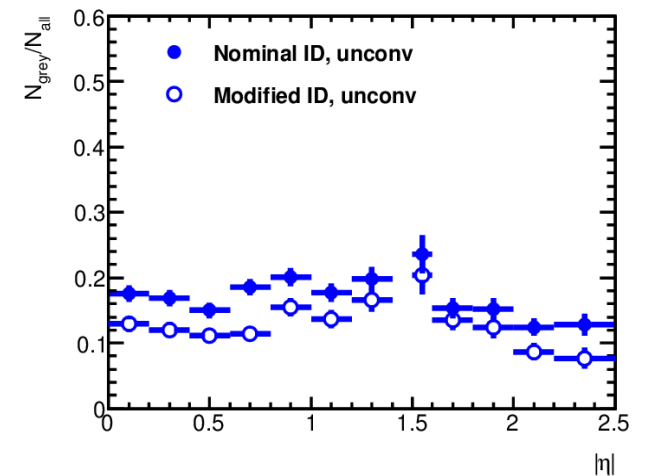
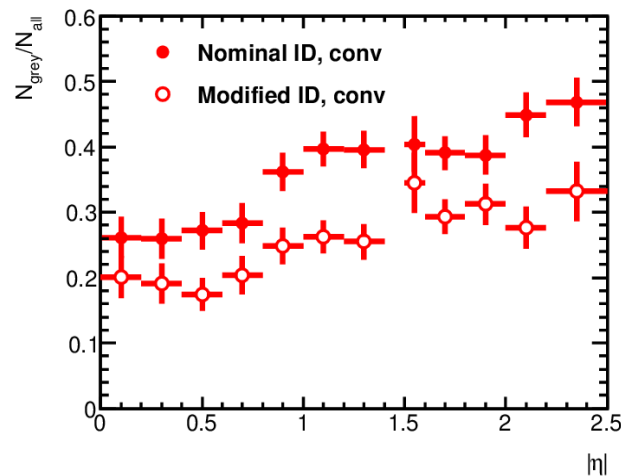
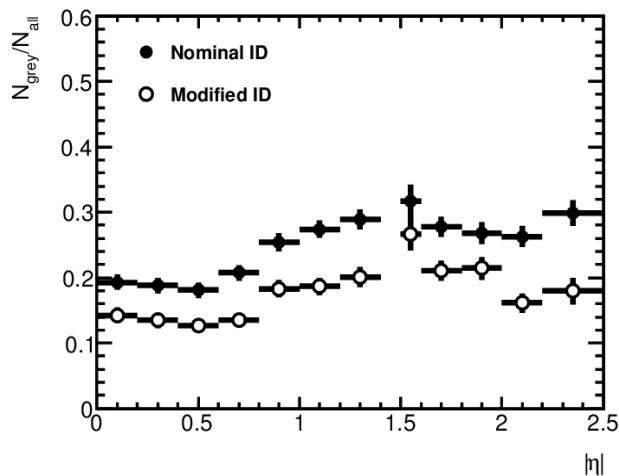


- **With modified working point the Conv/Unconv efficiencies are closer at low E_T .**

Fraction of grey photons

- Grey photons = pass Loose isolation but fail tight isolation.
- Tighter ID reduces fraction of grey photon candidates.
 - Denotes correlation between ID and isolation:

tighter ID \rightarrow less loosely isolated photons



Purity Measurement

- **Compare the diphoton purity obtained with the nominal and modified Tight ID working point.**
- **Use 2x2DSB method.**
 - The ID and isolation efficiencies and fake rates are computed w.r.t. Loose' {2,3,4,5}.
 - Only Loose' variation is considered in the systematics.
- **Consider 3 selections:**
 - Graviton loose isolation
 - Graviton failing loose isolation (grey photons)
 - Graviton tight isolation

Graviton Loose Isolation

Graviton Loose Selection

Nominal Tight ID

Isolation		Identification	
ϵ_{I1}	0.9750 ± 0.0004	ϵ_{T1}	0.9686 ± 0.0005
ϵ_{I2}	0.9285 ± 0.0006	ϵ_{T2}	0.9663 ± 0.0004

ID fake rates of γj	f_{T1}	0.374 ± 0.004
	f_{T2}	0.410 ± 0.003
ID fake rates of jj	f'_{T1}	0.374 ± 0.000
	f'_{T2}	0.410 ± 0.000
Iso. fake rates of γj	f_{I1}	0.384 ± 0.012
	f_{I2}	0.355 ± 0.007
Iso. fake rates of jj	f'_{I1}	0.346 ± 0.005
	f'_{I2}	0.241 ± 0.005
Iso. correlation of jj	ξ_{Ijj}	1.171 ± 0.027

Yields	
$N_{\gamma\gamma}$	$6083 \pm 113^{+169}_{-431}$
$N_{\gamma j}$	$1564 \pm 48^{+191}_{-62}$
$N_{j\gamma}$	$718 \pm 33^{+116}_{-67}$
N_{jj}	$305 \pm 15^{+130}_{-38}$
purity	$(70.2 \pm 1.0^{+1.9}_{-5.0})\%$

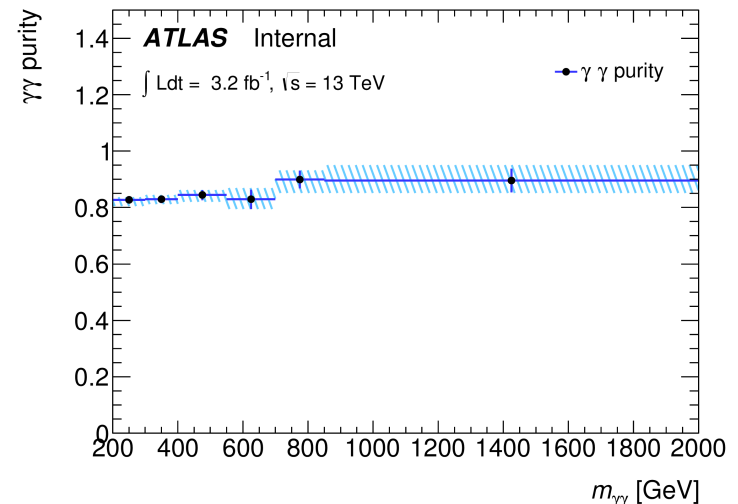
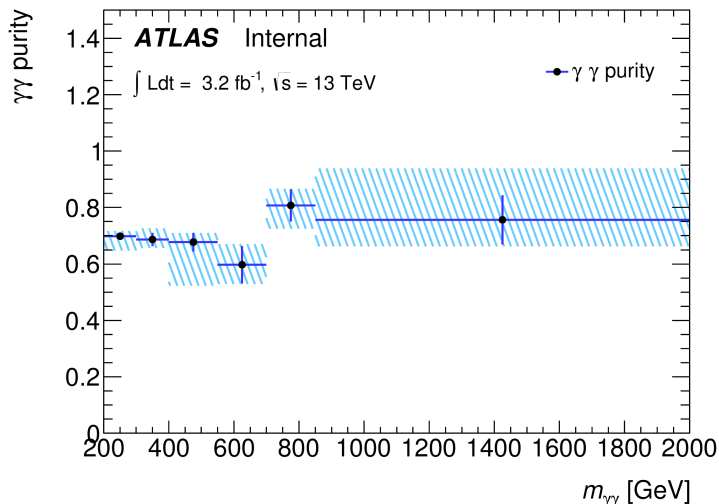
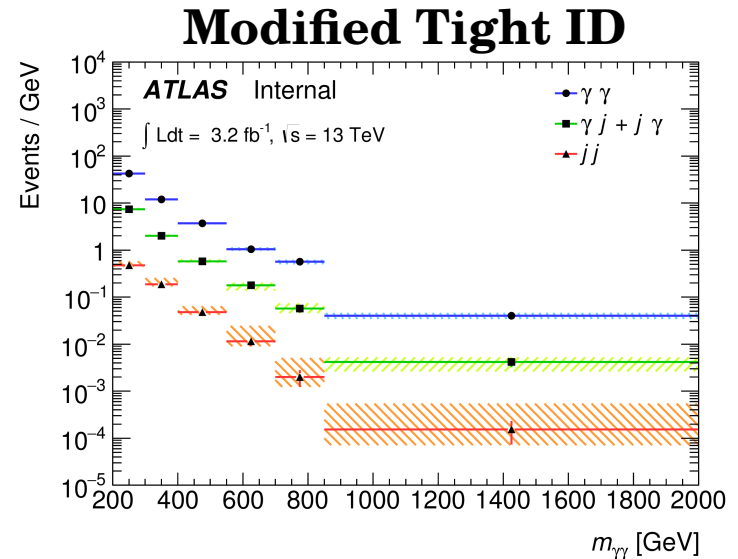
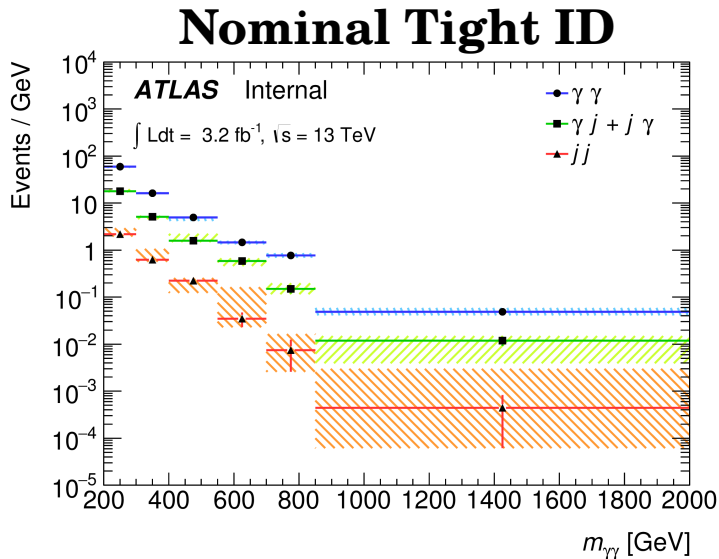
Modified Tight ID

Isolation		Identification	
ϵ_{I1}	0.9752 ± 0.0004	ϵ_{T1}	0.9349 ± 0.0006
ϵ_{I2}	0.9285 ± 0.0006	ϵ_{T2}	0.9117 ± 0.0007

ID fake rates of γj	f_{T1}	0.168 ± 0.003
	f_{T2}	0.177 ± 0.003
ID fake rates of jj	f'_{T1}	0.168 ± 0.000
	f'_{T2}	0.177 ± 0.000
Iso. fake rates of γj	f_{I1}	0.393 ± 0.010
	f_{I2}	0.352 ± 0.006
Iso. fake rates of jj	f'_{I1}	0.356 ± 0.004
	f'_{I2}	0.258 ± 0.004
Iso. correlation of jj	ξ_{Ijj}	1.226 ± 0.020

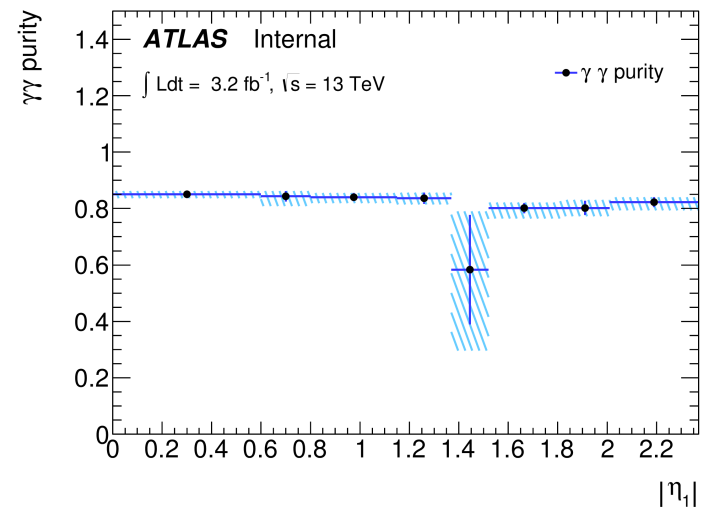
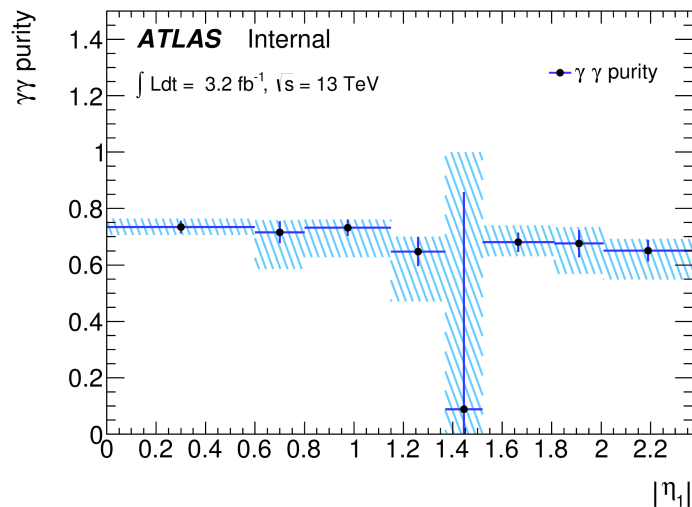
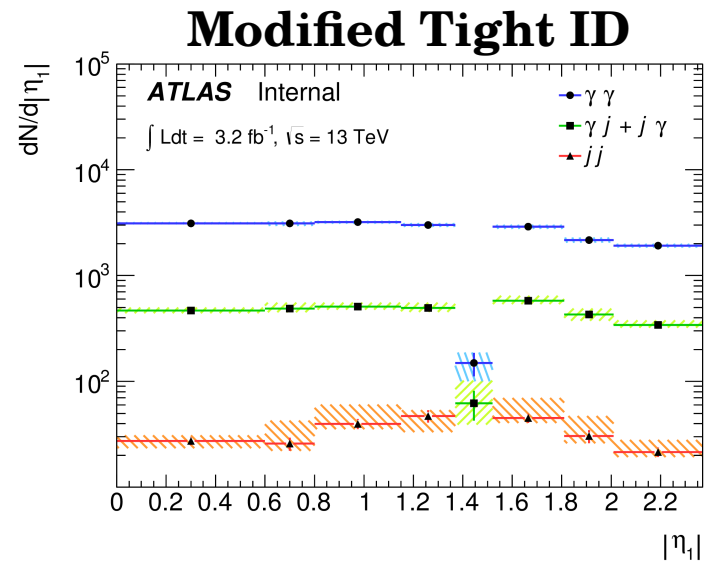
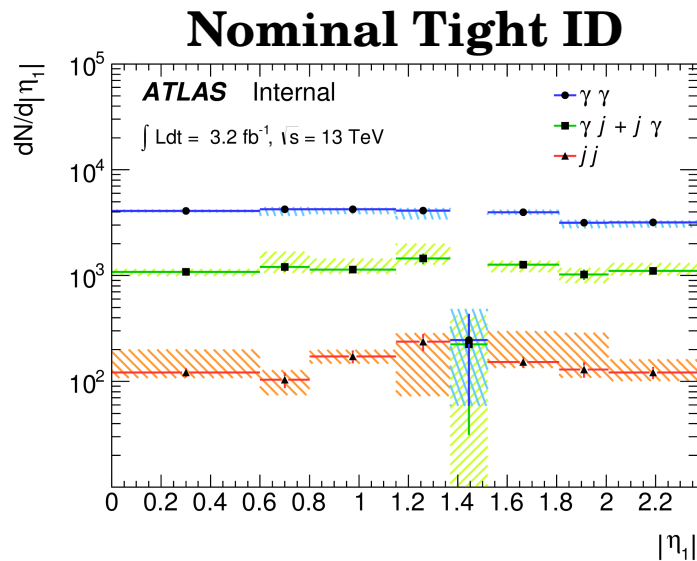
Yields	
$N_{\gamma\gamma}$	$5256 \pm 85^{+3}_{-105}$
$N_{\gamma j}$	$645 \pm 19^{+47}_{-4}$
$N_{j\gamma}$	$307 \pm 13^{+46}_{-7}$
N_{jj}	$70 \pm 3^{+23}_{-1}$
purity	$(83.7 \pm 0.6^{+0.1}_{-1.8})\%$

Graviton Loose Selection - $m_{\gamma\gamma}$



Modified ID improves the purity

Graviton Loose Selection - η_{leading}



Modified ID improves the purity

Failing tight isolation photons (*a.k.a.* grey photons)

Failing tight isolation

Nominal Tight ID

Isolation		Identification	
ϵ_{I1}	0.8839 ± 0.0018	ϵ_{T1}	0.9584 ± 0.0014
ϵ_{I2}	0.7170 ± 0.0021	ϵ_{T2}	0.9525 ± 0.0011
ID fake rates of γj		f_{T1}	0.329 ± 0.005
		f_{T2}	0.361 ± 0.005
ID fake rates of jj		f'_{T1}	0.329 ± 0.000
		f'_{T2}	0.361 ± 0.000
Iso. fake rates of γj		f_{I1}	0.333 ± 0.010
		f_{I2}	0.304 ± 0.006
Iso. fake rates of jj		f'_{I1}	0.343 ± 0.006
		f'_{I2}	0.237 ± 0.005
Iso. correlation of jj		ξ_{Ijj}	1.187 ± 0.028

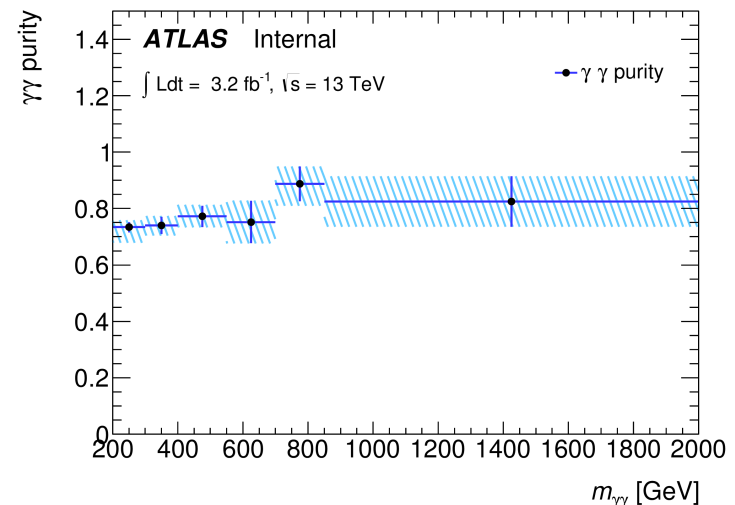
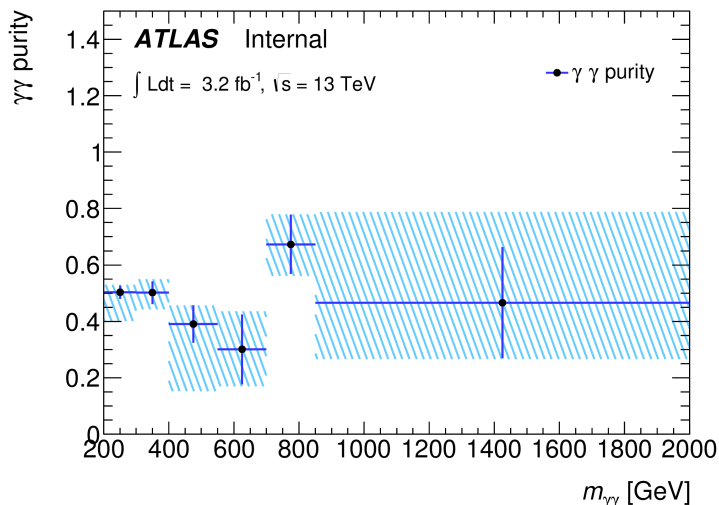
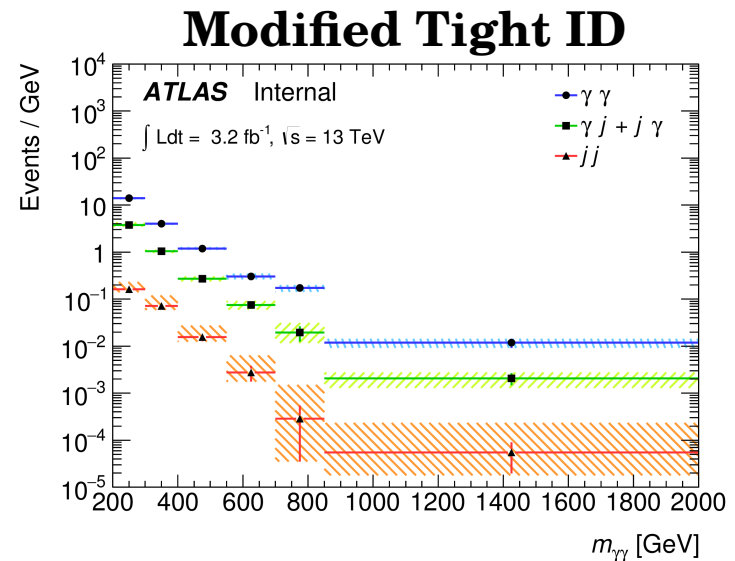
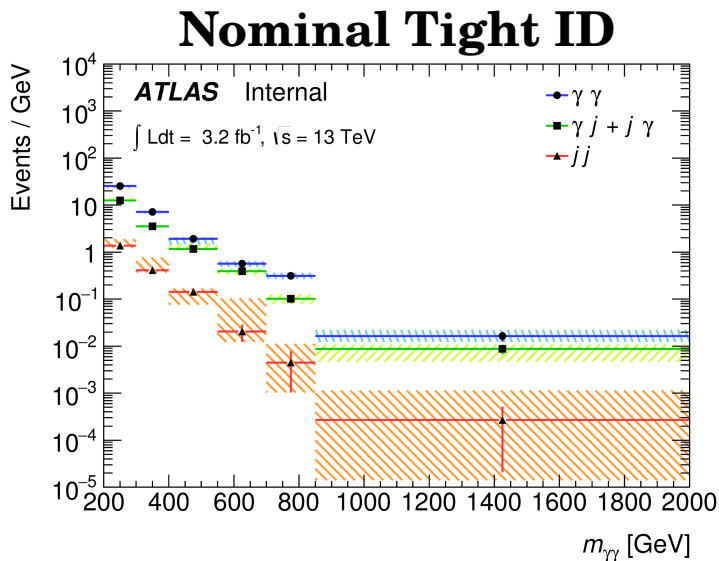
Yields	
$N_{\gamma\gamma}$	$1882 \pm 76^{+25}_{-392}$
$N_{\gamma j}$	$1096 \pm 39^{+204}_{-20}$
$N_{j\gamma}$	$520 \pm 25^{+32}_{-35}$
N_{jj}	$189 \pm 10^{+108}_{-24}$
purity	$(51.1 \pm 1.8^{+0.5}_{-10.1})\%$

Modified Tight ID

Isolation		Identification	
ϵ_{I1}	0.8855 ± 0.0020	ϵ_{T1}	0.7799 ± 0.0025
ϵ_{I2}	0.7216 ± 0.0023	ϵ_{T2}	0.7454 ± 0.0023
ID fake rates of γj		f_{T1}	0.090 ± 0.004
		f_{T2}	0.099 ± 0.004
ID fake rates of jj		f'_{T1}	0.090 ± 0.000
		f'_{T2}	0.099 ± 0.000
Iso. fake rates of γj		f_{I1}	0.334 ± 0.010
		f_{I2}	0.311 ± 0.006
Iso. fake rates of jj		f'_{I1}	0.362 ± 0.005
		f'_{I2}	0.257 ± 0.005
Iso. correlation of jj		ξ_{Ijj}	1.215 ± 0.024

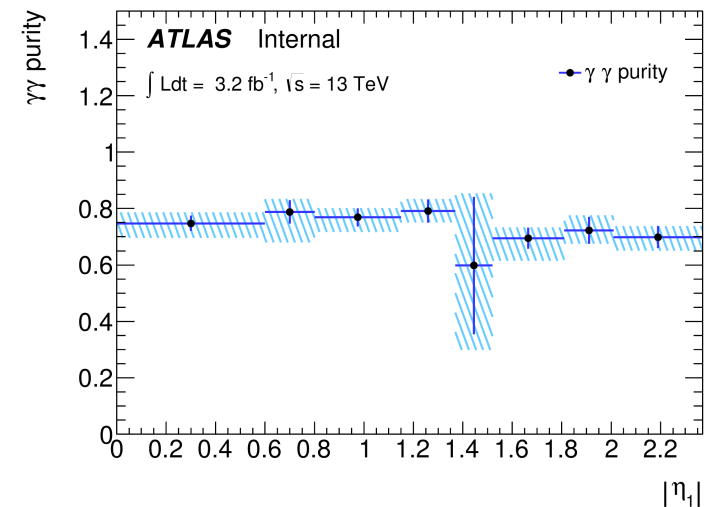
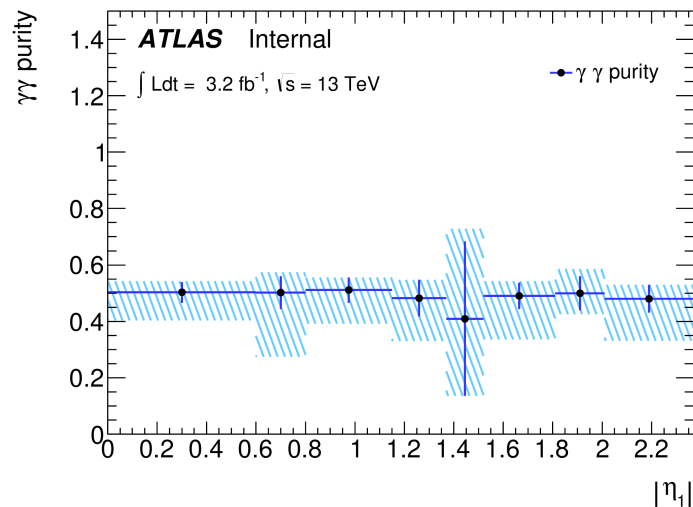
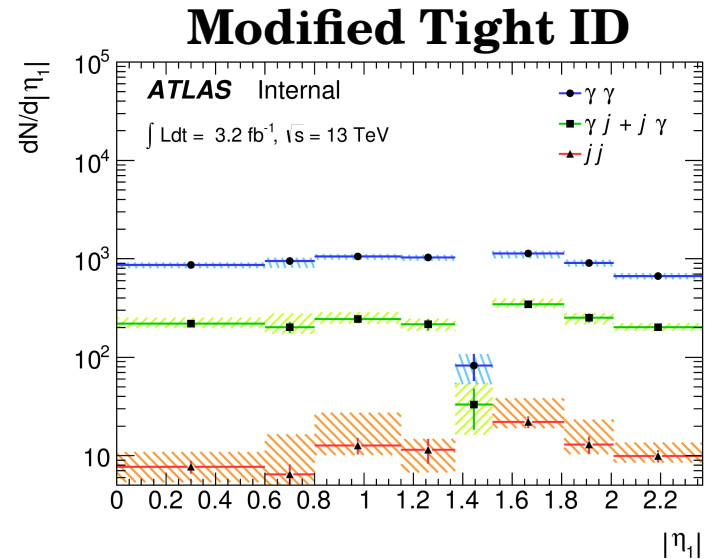
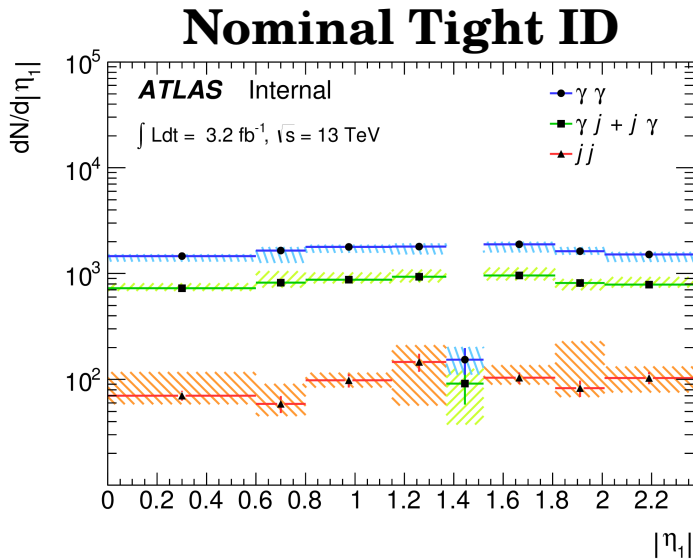
Yields	
$N_{\gamma\gamma}$	$984 \pm 39^{+40}_{-103}$
$N_{\gamma j}$	$246 \pm 12^{+52}_{-19}$
$N_{j\gamma}$	$105 \pm 7^{+14}_{-7}$
N_{jj}	$18 \pm 1^{+14}_{-2}$
purity	$(72.7 \pm 1.7^{+2.3}_{-6.5})\%$

Failing tight isolation - $m_{\gamma\gamma}$



Modified ID improves substantially the purity

Failing tight isolation - η_{leading}



Modified ID improves substantially the purity

Graviton Tight Isolation

Graviton Tight Isolation

Nominal Tight ID

Isolation		Identification	
ϵ_{I1}	0.8883 ± 0.0008	ϵ_{T1}	0.9687 ± 0.0005
ϵ_{I2}	0.8112 ± 0.0009	ϵ_{T2}	0.9665 ± 0.0004
ID fake rates of γj		f_{T1}	0.385 ± 0.003
		f_{T2}	0.421 ± 0.003
ID fake rates of jj		f'_{T1}	0.385 ± 0.000
		f'_{T2}	0.421 ± 0.000
Iso. fake rates of γj		f_{I1}	0.074 ± 0.008
		f_{I2}	0.055 ± 0.004
Iso. fake rates of jj		f'_{I1}	0.059 ± 0.003
		f'_{I2}	0.033 ± 0.002
Iso. correlation of jj		ξ_{Ijj}	1.591 ± 0.413

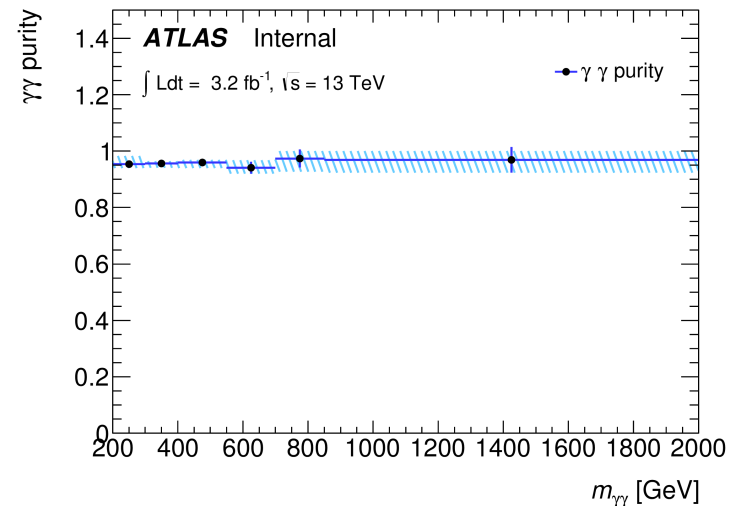
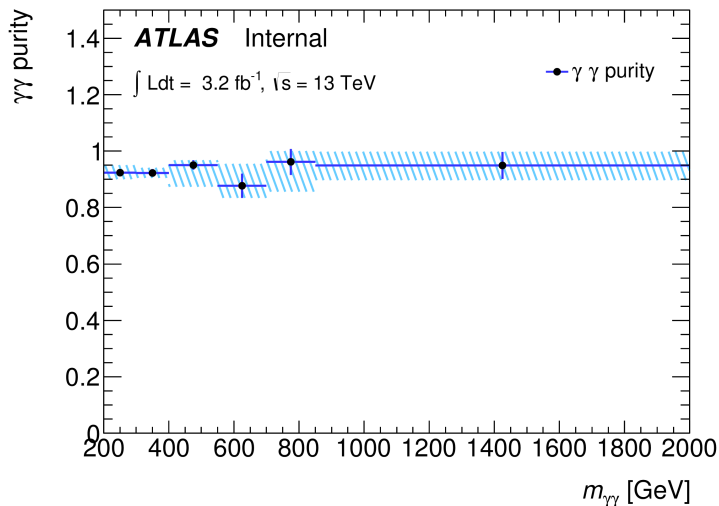
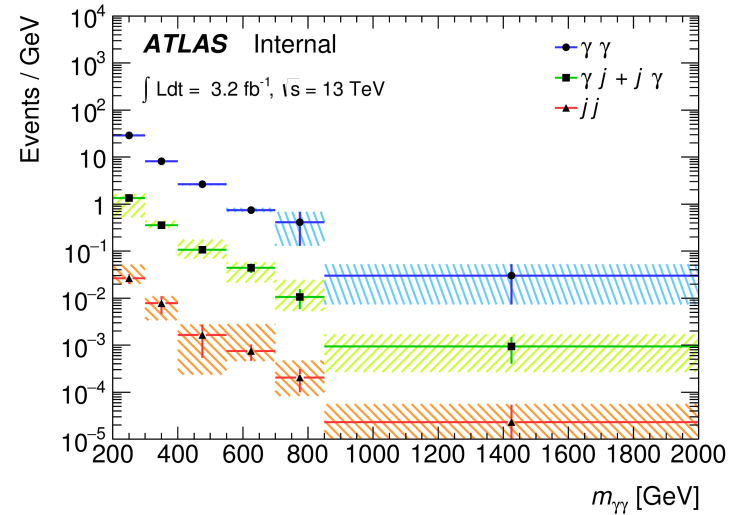
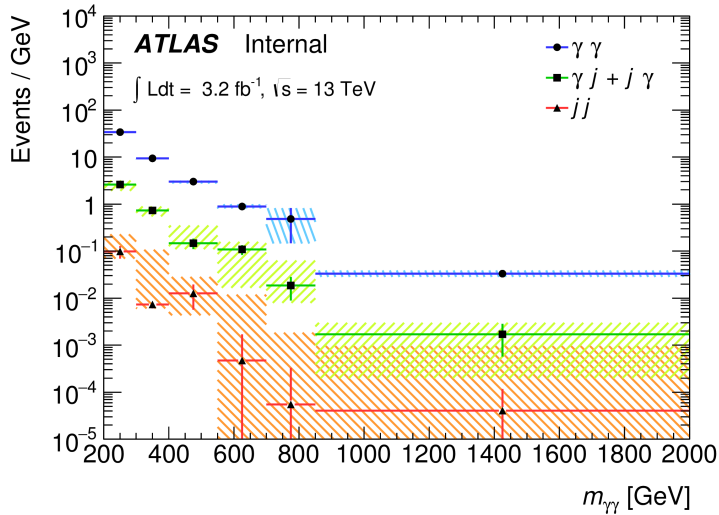
Yields	
$N_{\gamma\gamma}$	$4695 \pm 76^{+124}_{-99}$
$N_{\gamma j}$	$219 \pm 17^{+14}_{-90}$
$N_{j\gamma}$	$114 \pm 13^{+74}_{-31}$
N_{jj}	$11 \pm 3^{+31}_{-0}$
purity	$(93.2 \pm 0.6^{+2.3}_{-2.3})\%$

Modified Tight ID

Isolation		Identification	
ϵ_{I1}	0.8888 ± 0.0008	ϵ_{T1}	0.9354 ± 0.0007
ϵ_{I2}	0.8115 ± 0.0010	ϵ_{T2}	0.9123 ± 0.0007
ID fake rates of γj		f_{T1}	0.180 ± 0.003
		f_{T2}	0.187 ± 0.003
ID fake rates of jj		f'_{T1}	0.180 ± 0.000
		f'_{T2}	0.187 ± 0.000
Iso. fake rates of γj		f_{I1}	0.094 ± 0.008
		f_{I2}	0.058 ± 0.004
Iso. fake rates of jj		f'_{I1}	0.065 ± 0.003
		f'_{I2}	0.039 ± 0.002
Iso. correlation of jj		ξ_{Ijj}	1.725 ± 0.302

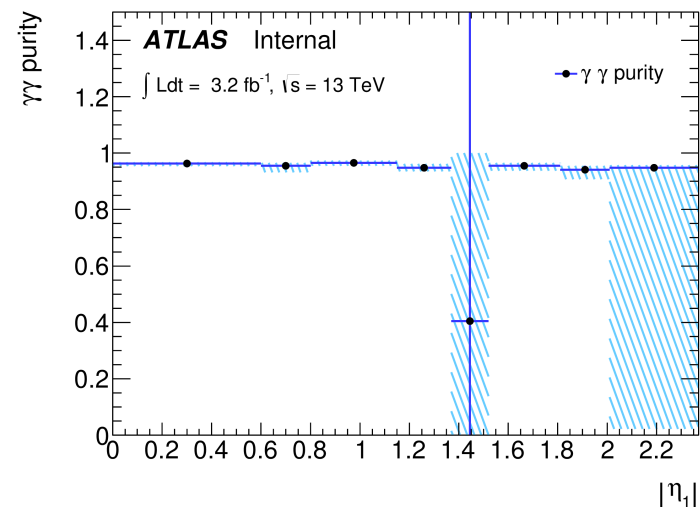
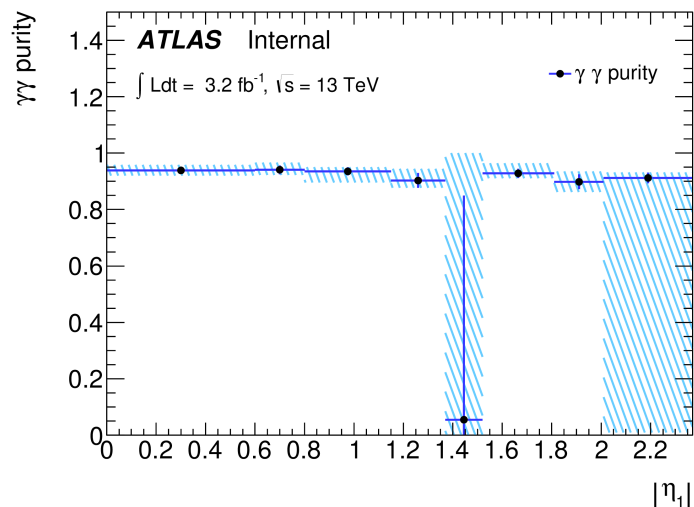
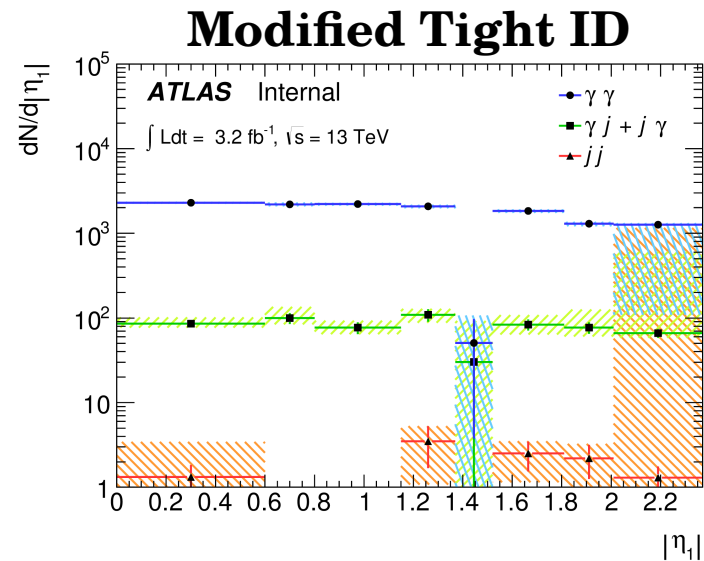
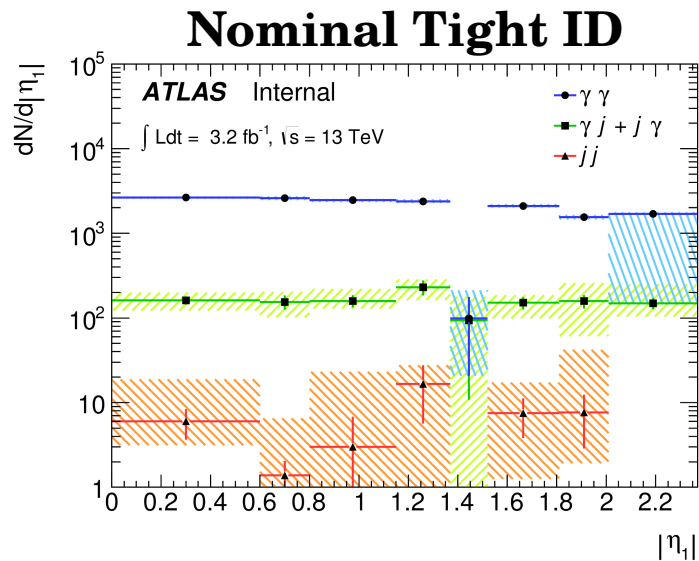
Yields	
$N_{\gamma\gamma}$	$4123 \pm 66^{+16}_{-20}$
$N_{\gamma j}$	$99 \pm 7^{+17}_{-6}$
$N_{j\gamma}$	$65 \pm 6^{+33}_{-0}$
N_{jj}	$3 \pm 1^{+2}_{-0}$
purity	$(96.1 \pm 0.3^{+0.0}_{-1.2})\%$

Graviton Tight Isolation



Modified ID improves slightly the purity

Graviton tight isolation - η_{leading}



Modified ID improves slightly the purity

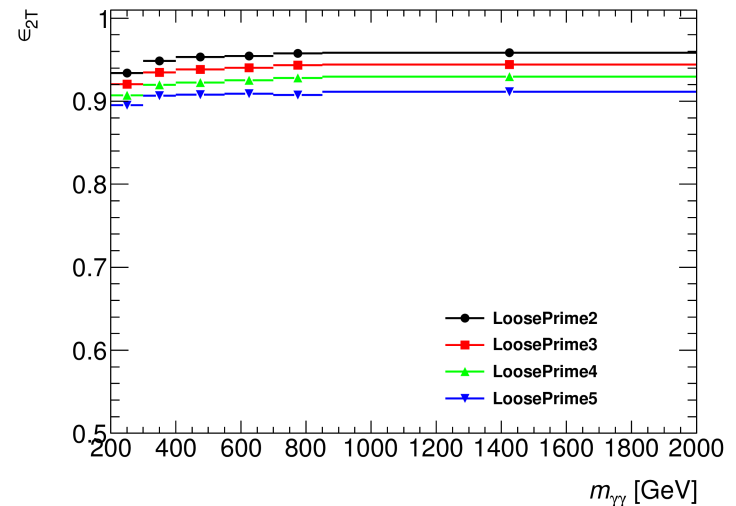
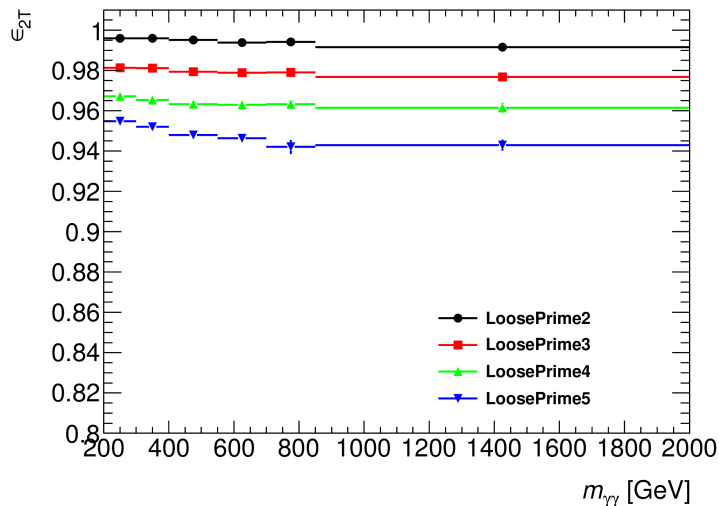
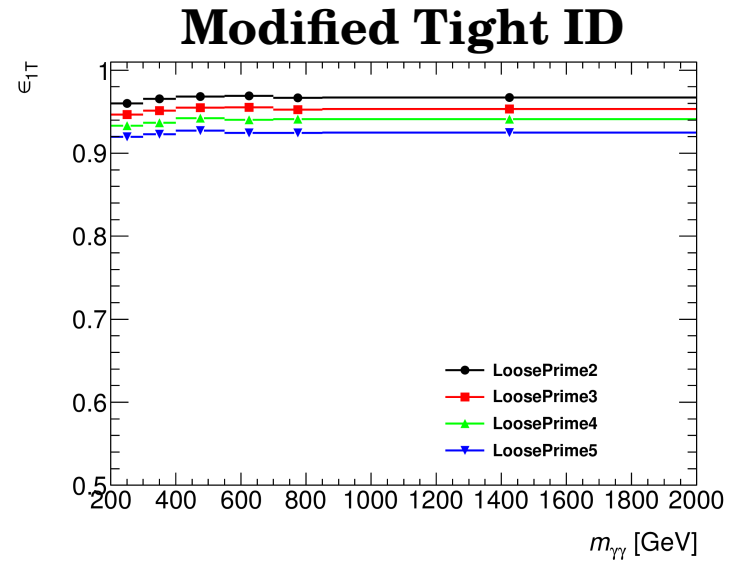
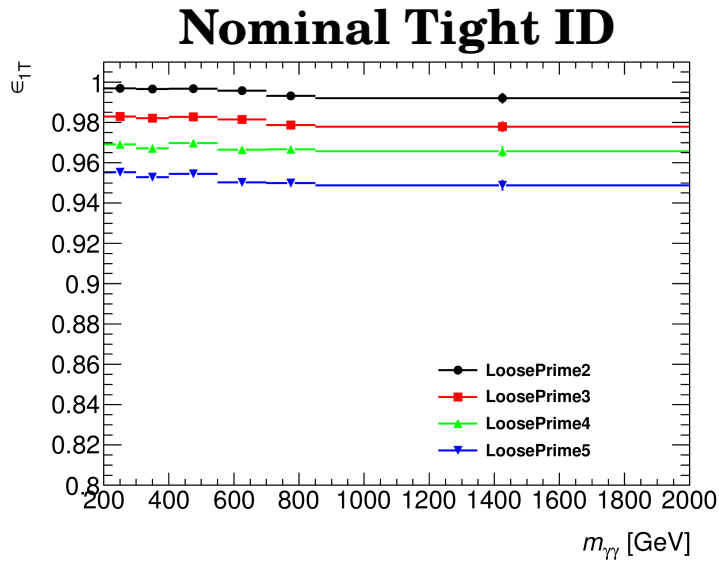
Conclusion

- **Tightening by hand the Tight ID working point improves the purity in the case of the diphoton high mass analysis:**
 - Graviton loose isolation selection
 - Purity: $(70.2 \pm 1.0_{-5.0}^{+1.9})\% \rightarrow (83.7 \pm 0.6_{-1.8}^{+0.1})\%$ absolute gain: 13.5%
 - Diphoton yield: $6083 \pm 113_{-431}^{+169} \rightarrow 5256 \pm 85_{-105}^{+3}$ relative loss: -14%
 - Failing loose isolation
 - Purity: $(51.1 \pm 1.8_{-10.1}^{+0.5})\% \rightarrow (72.7 \pm 1.7_{-6.5}^{+2.3})\%$ absolute gain: 21.6%
 - Diphoton yield: $1882 \pm 76_{-392}^{+25} \rightarrow 984 \pm 39_{-103}^{+40}$ relative loss: -48%
 - Graviton tight isolation selection
 - Purity: $(93.2 \pm 0.6_{-2.3}^{+2.3})\% \rightarrow (96.1 \pm 0.3_{-1.2}^{+0.0})\%$ absolute gain: 2.9%
 - Diphoton yield: $4695 \pm 76_{-99}^{+124} \rightarrow 4123 \pm 66_{-20}^{+16}$ relative loss: -12%
- **TO DO:**
 - Purity is not the only point to consider: we will look now at the expected significance with modified and 8TeV working point (Simone has just made the necessary tuples).
 - Try to reoptimise the ID working points.

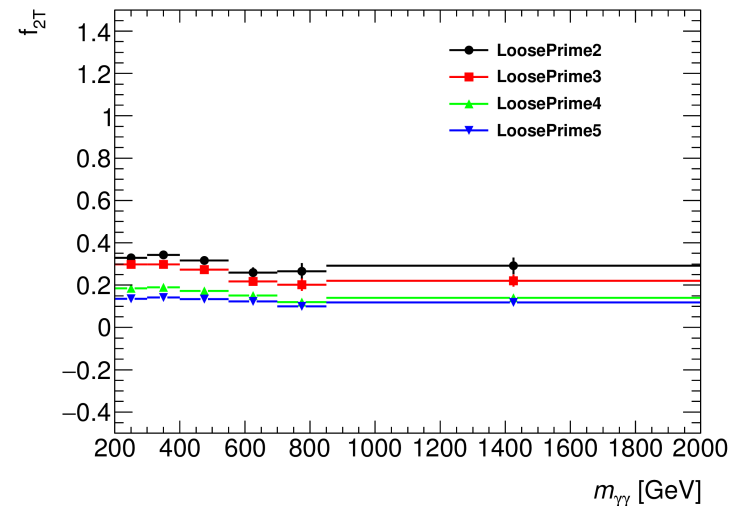
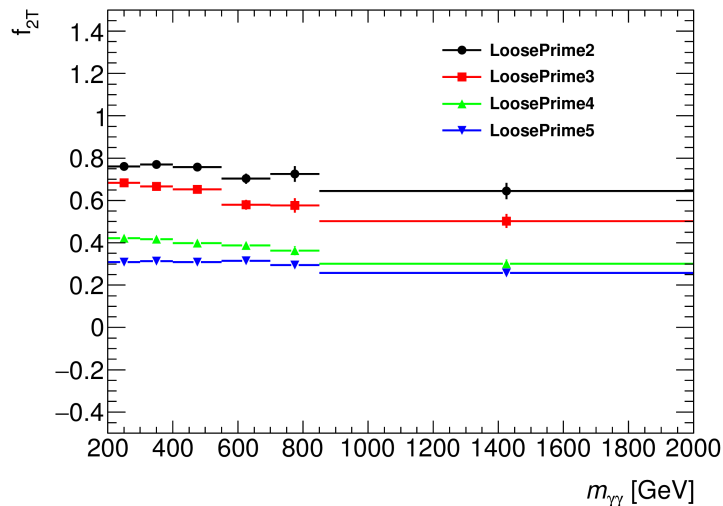
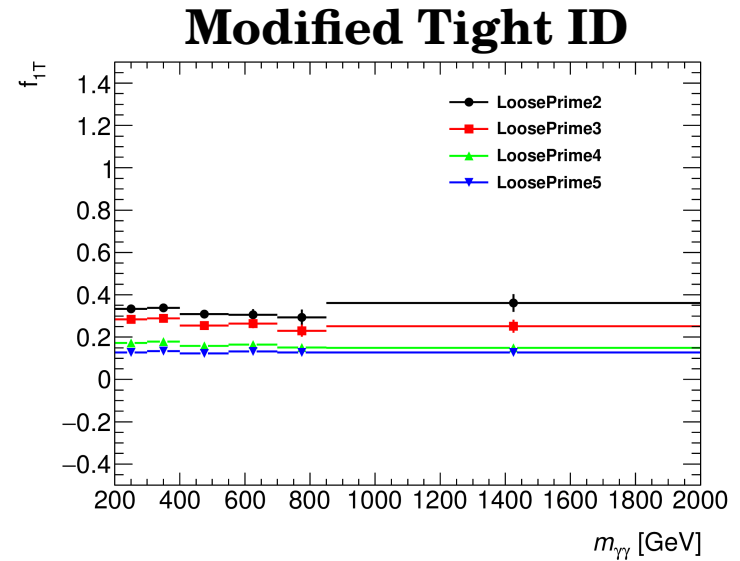
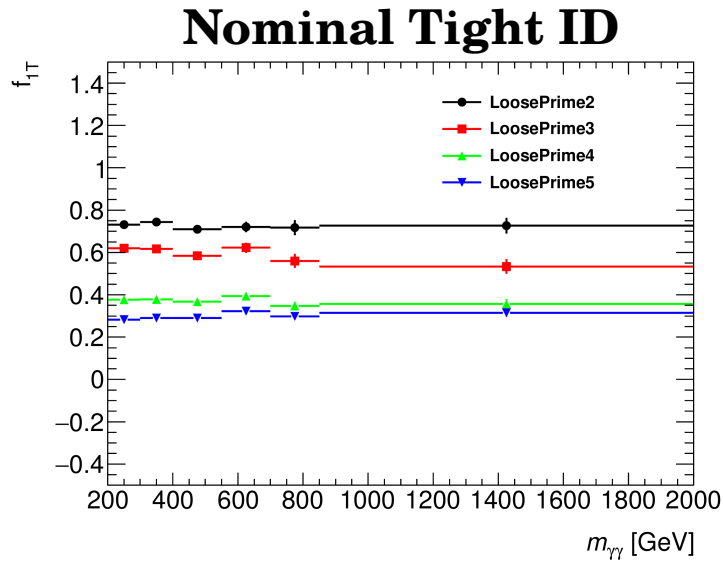
Backup

Graviton Loose Isolation

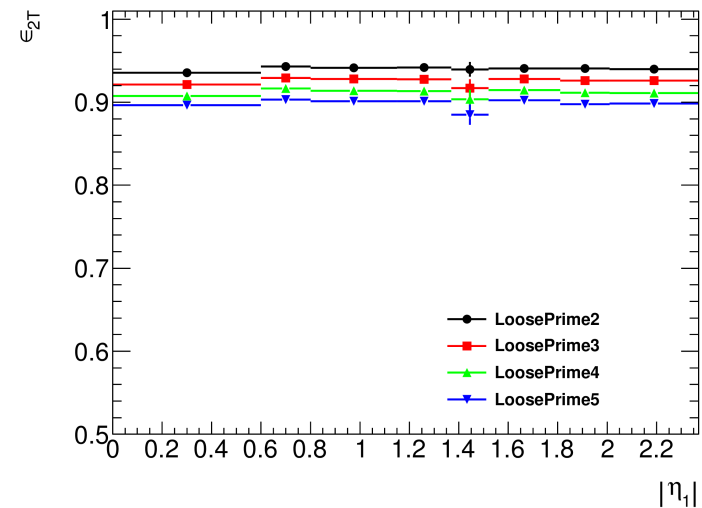
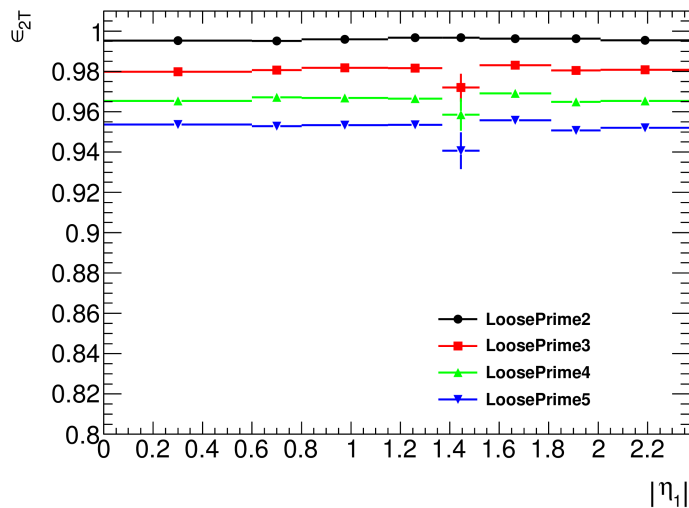
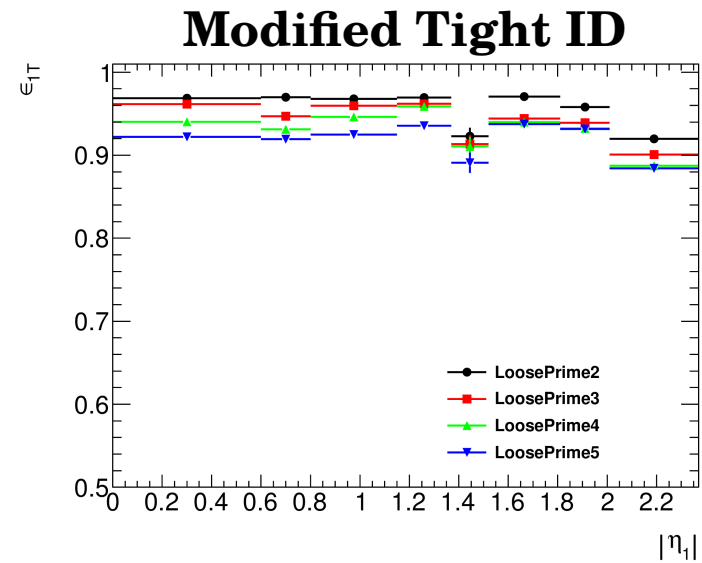
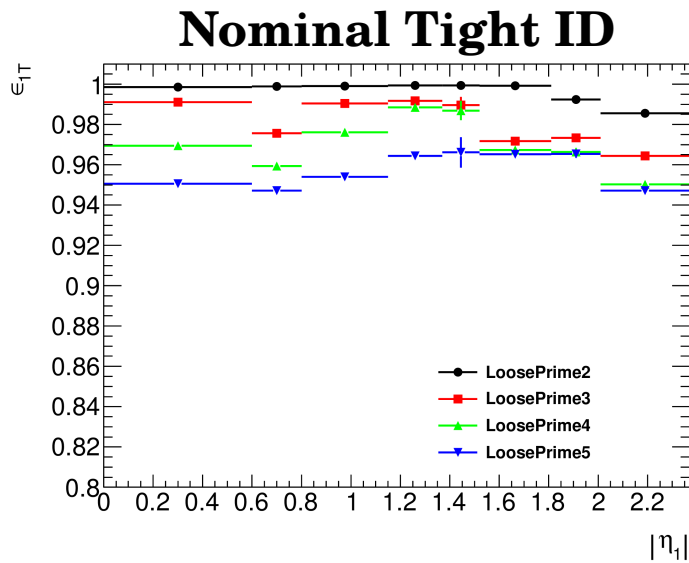
Graviton Loose Selection - $m_{\gamma\gamma}$



Graviton Loose Selection - $m_{\gamma\gamma}$

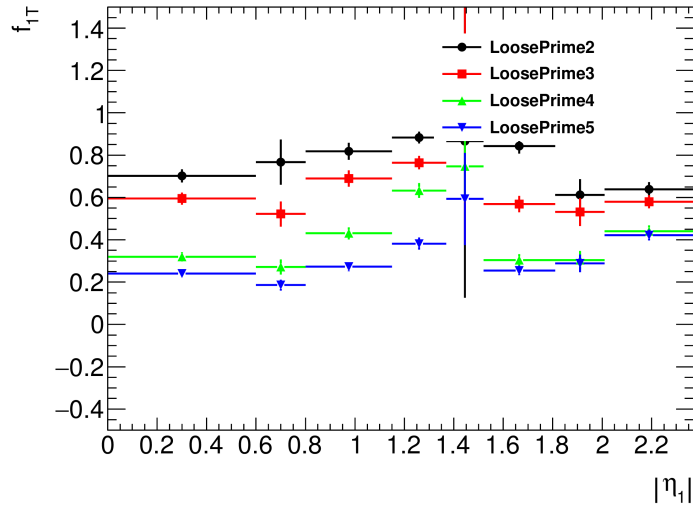


Graviton Loose Selection - η_{leading}

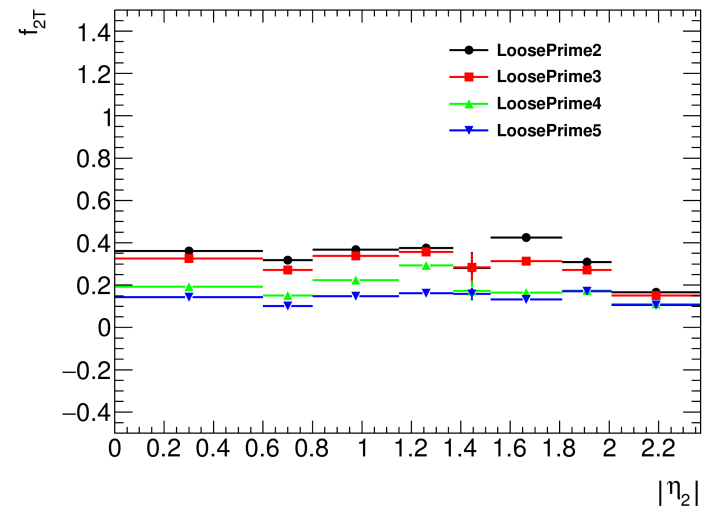
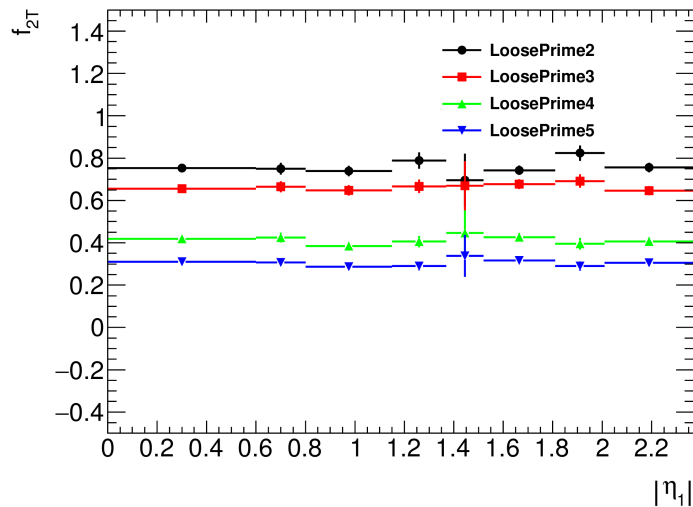
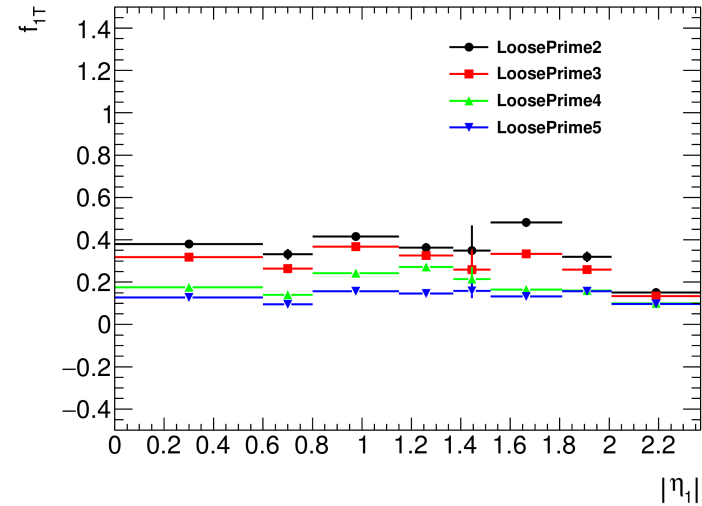


Graviton Loose Selection - η_{leading}

Nominal Tight ID

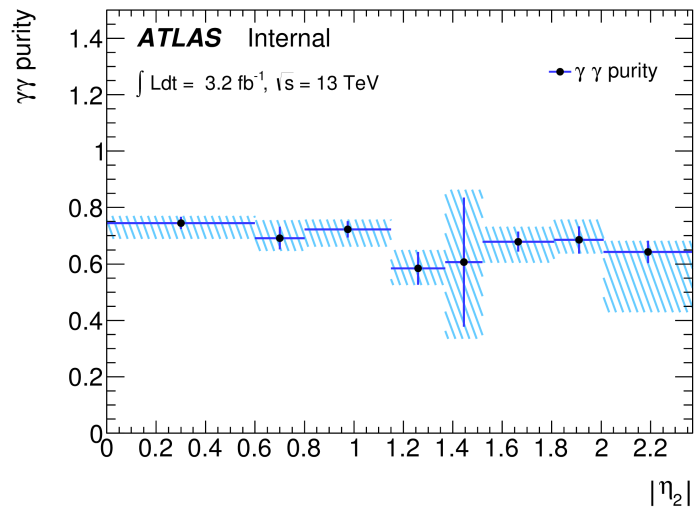
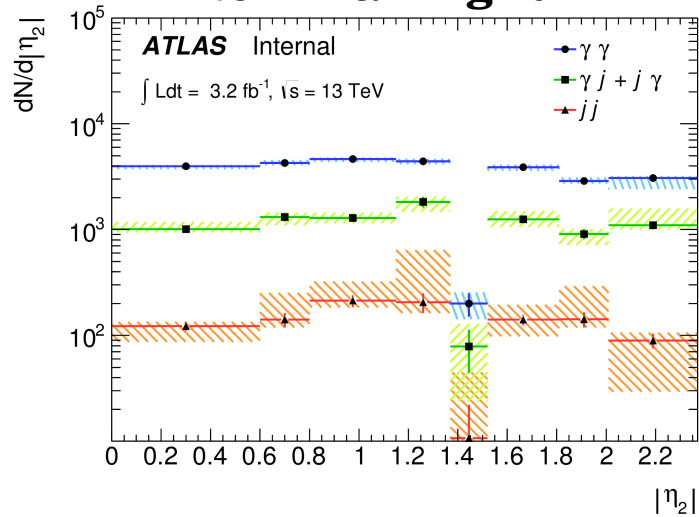


Modified Tight ID

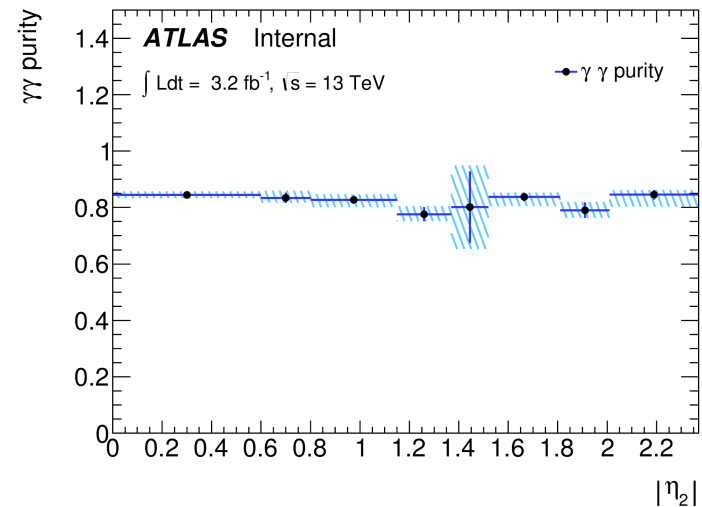
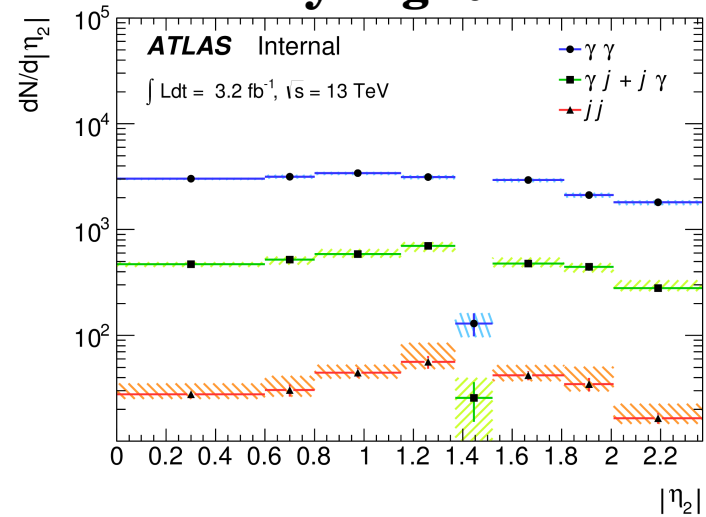


Graviton Loose Selection - $\eta_{\text{subleading}}$

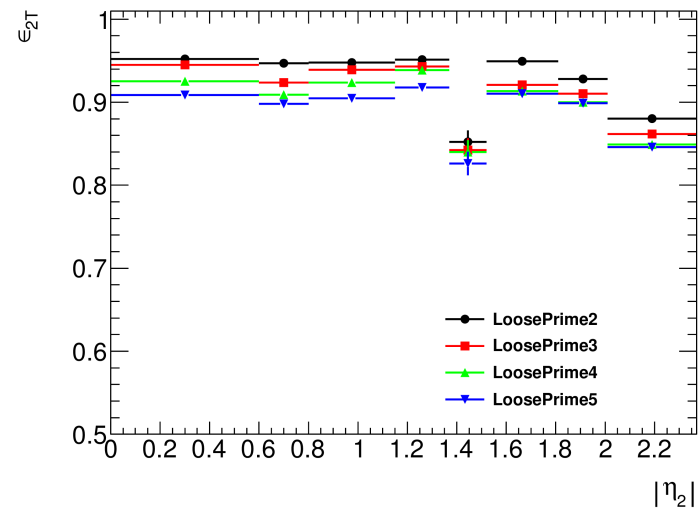
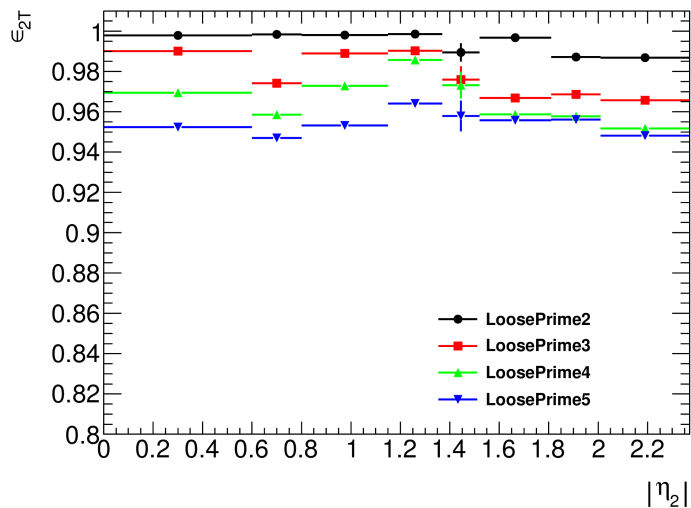
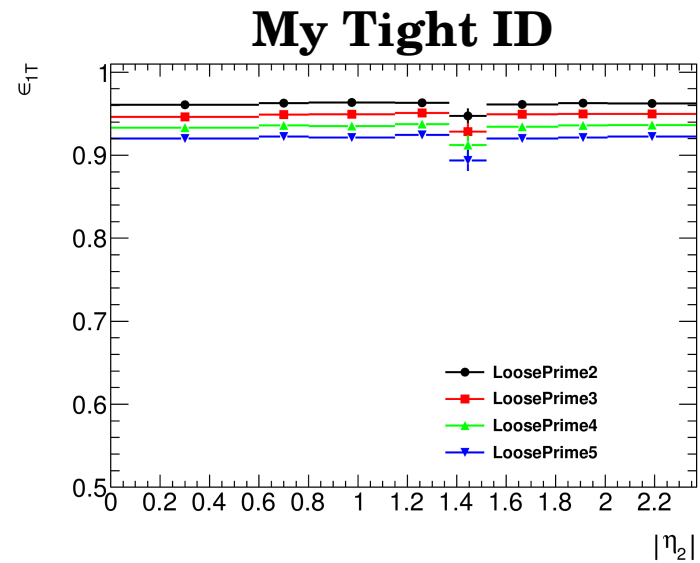
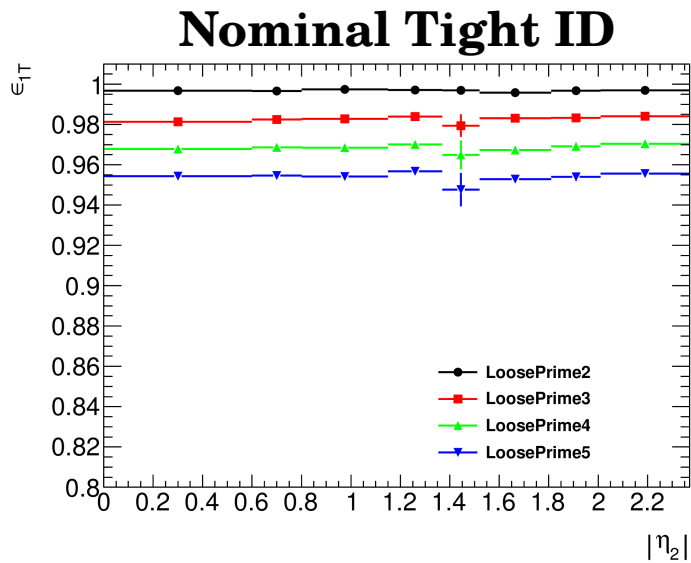
Nominal Tight ID



My Tight ID

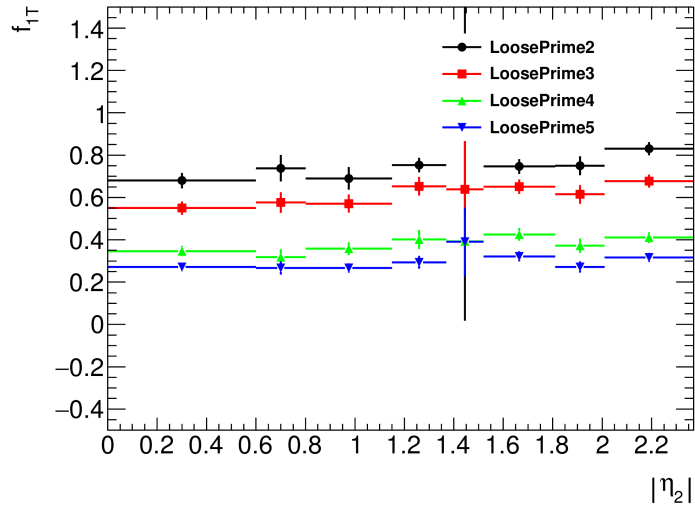


Graviton Loose Selection - $\eta_{\text{subleading}}$

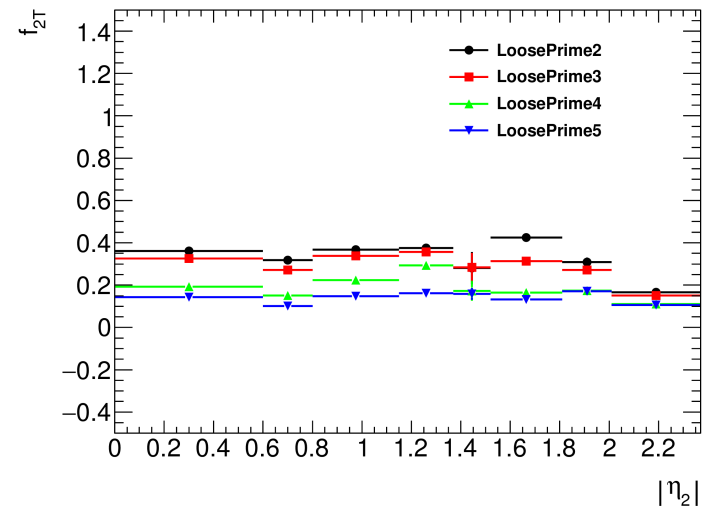
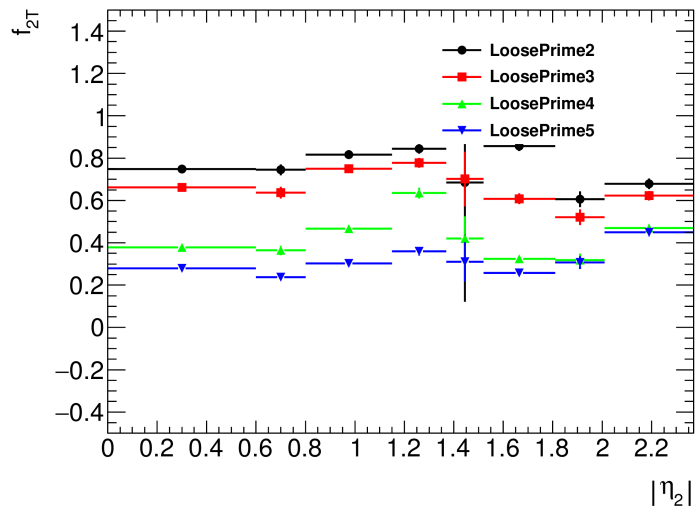
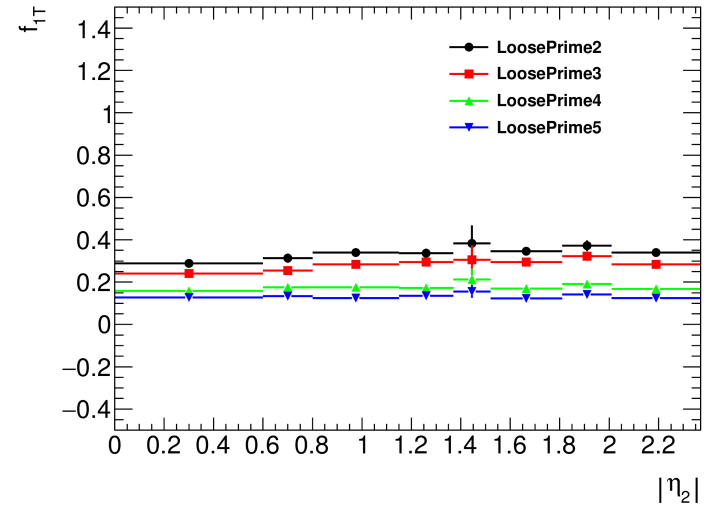


Graviton Loose Selection - $\eta_{\text{subleading}}$

Nominal Tight ID

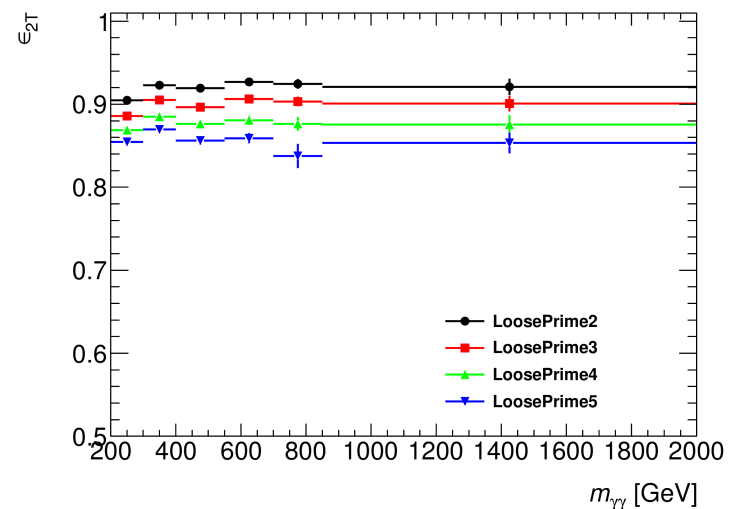
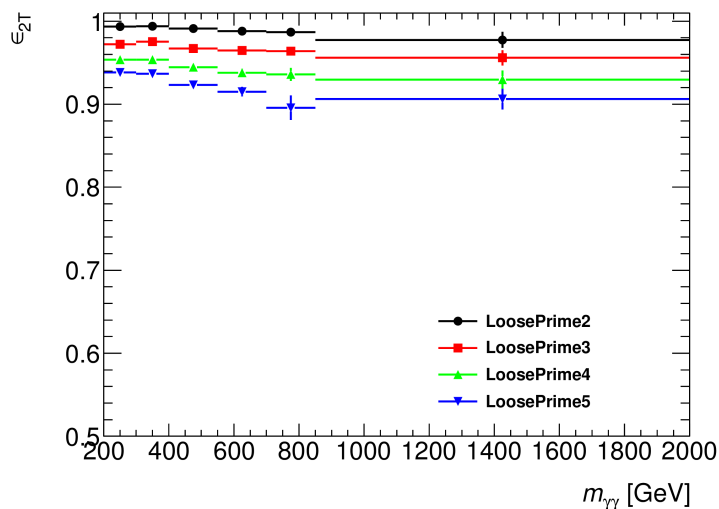
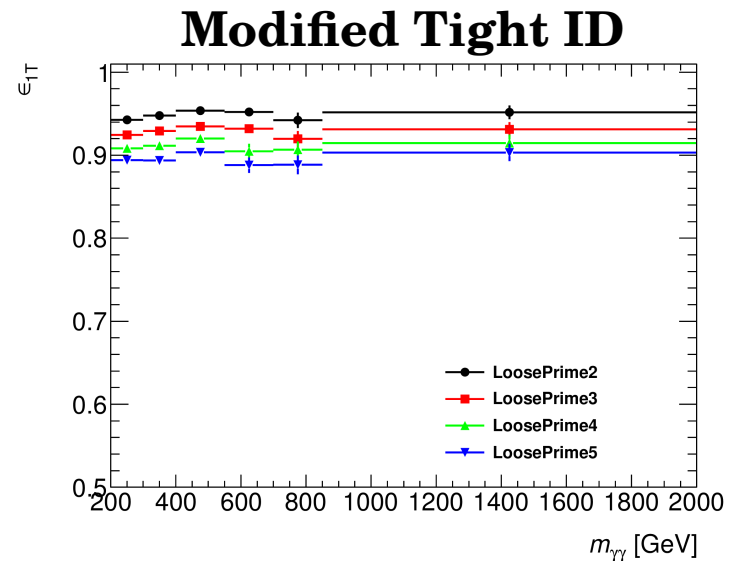
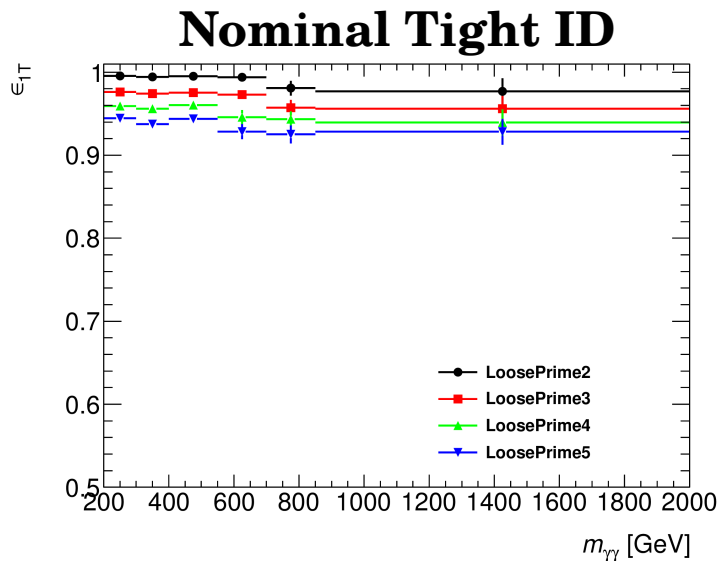


My Tight ID



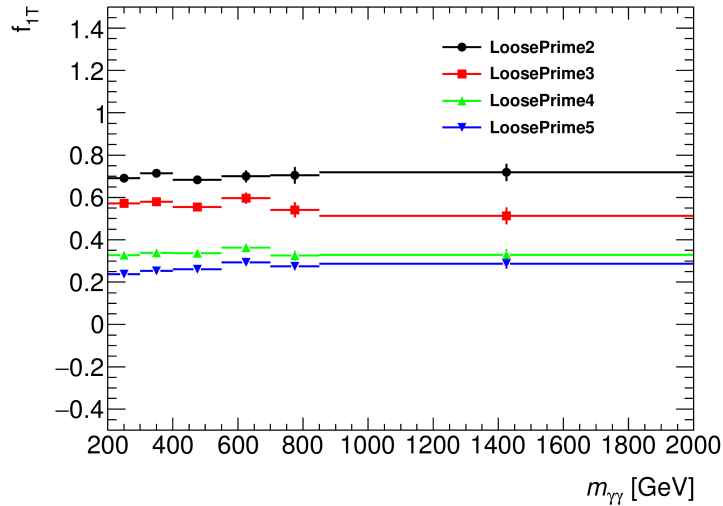
Failing tight isolation photons (*a.k.a.* grey photons)

Failing tight isolation - $m_{\gamma\gamma}$

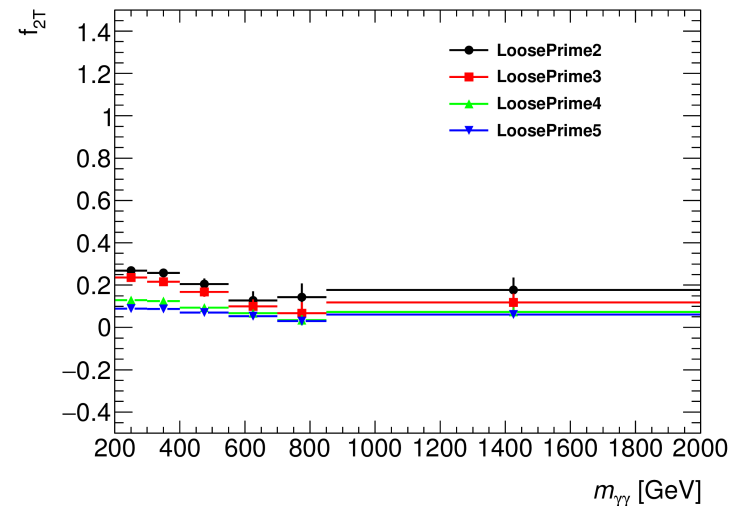
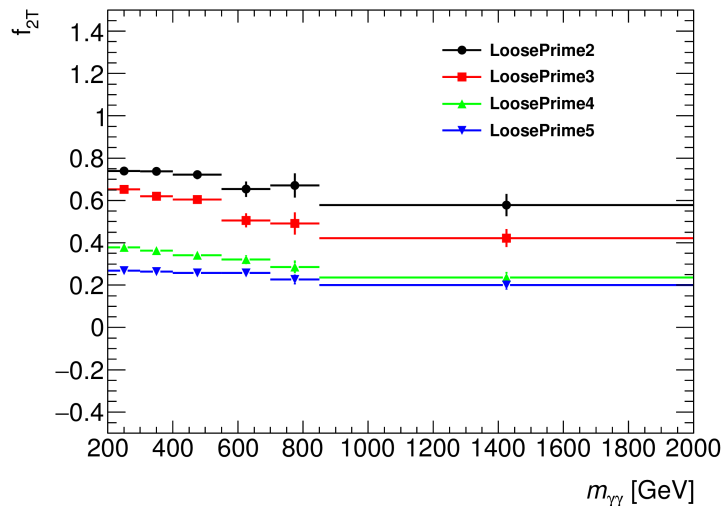
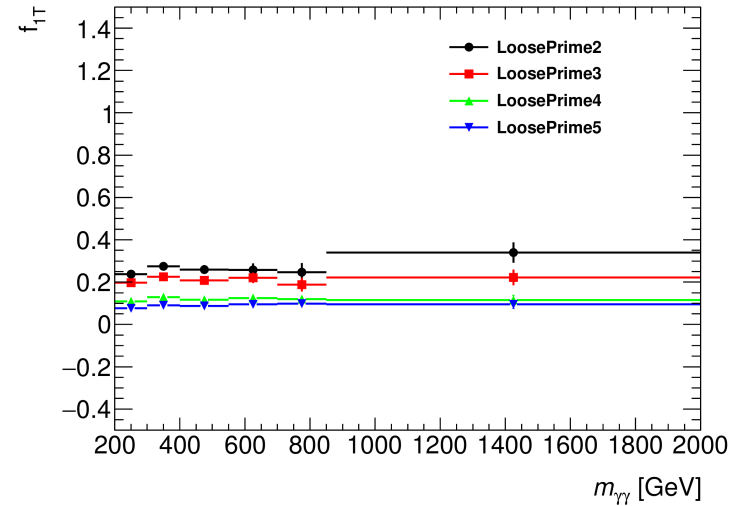


Failing tight isolation - $m_{\gamma\gamma}$

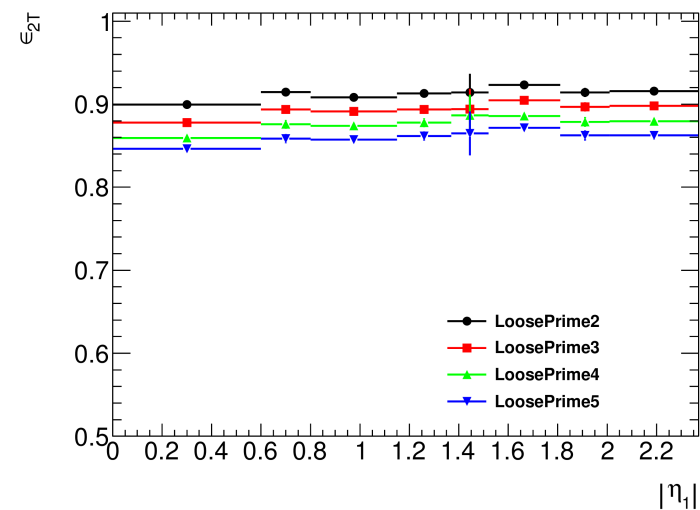
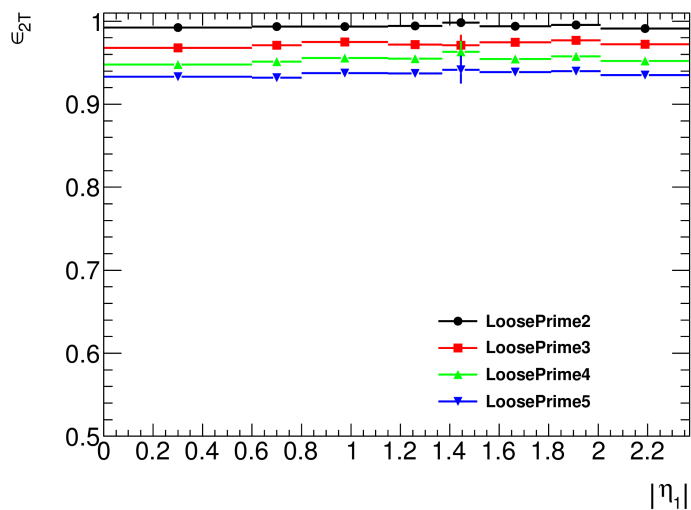
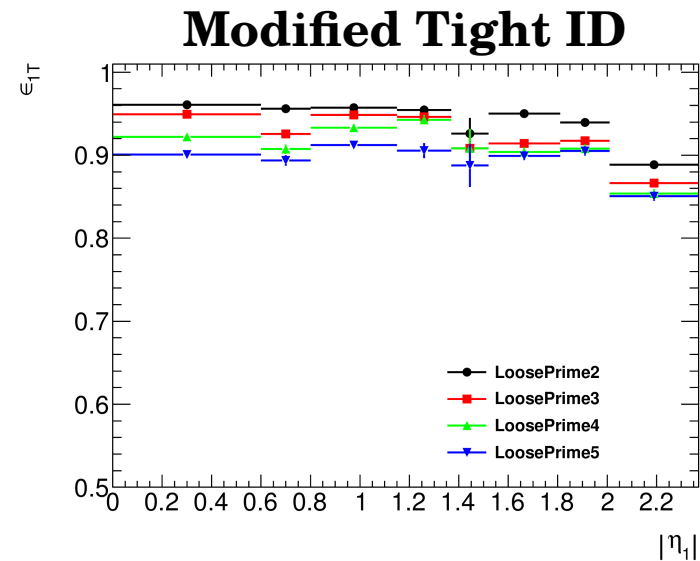
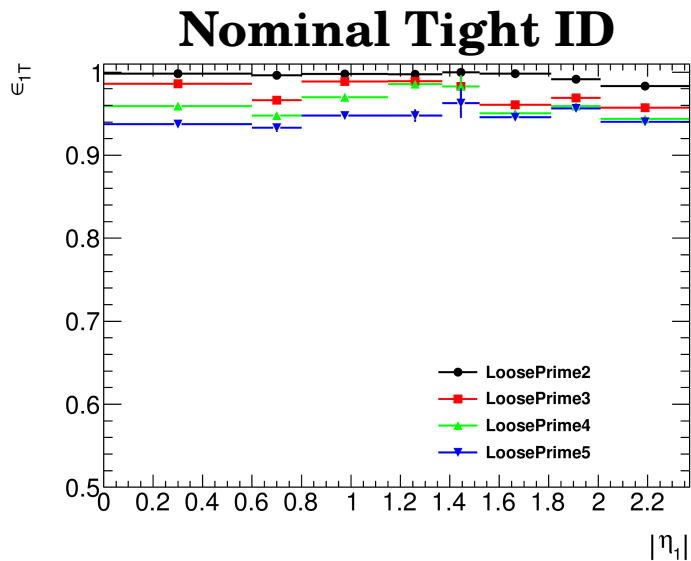
Nominal Tight ID



Modified Tight ID

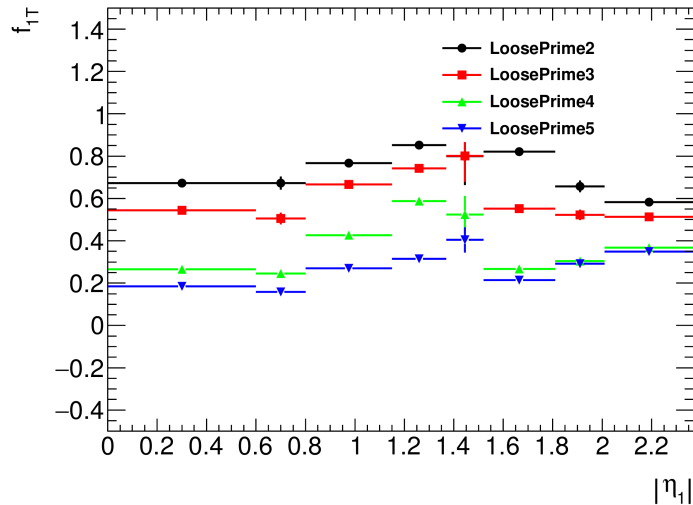


Failing tight isolation - η_{leading}

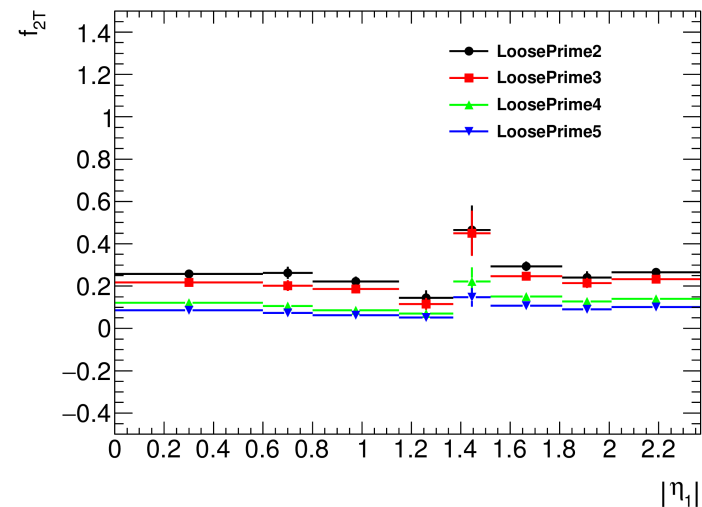
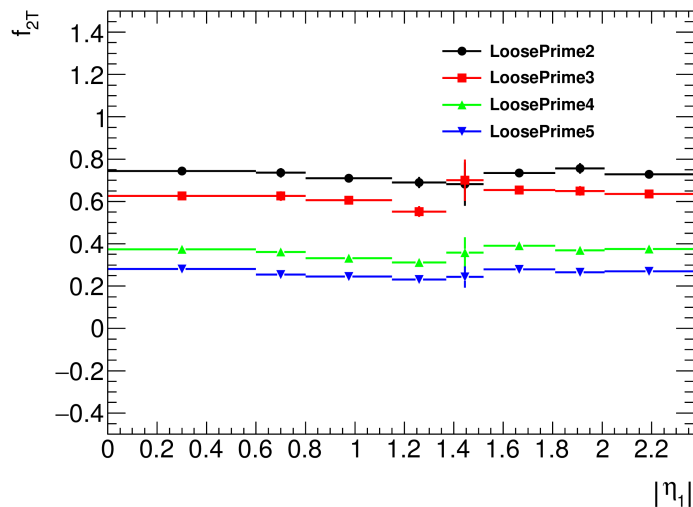
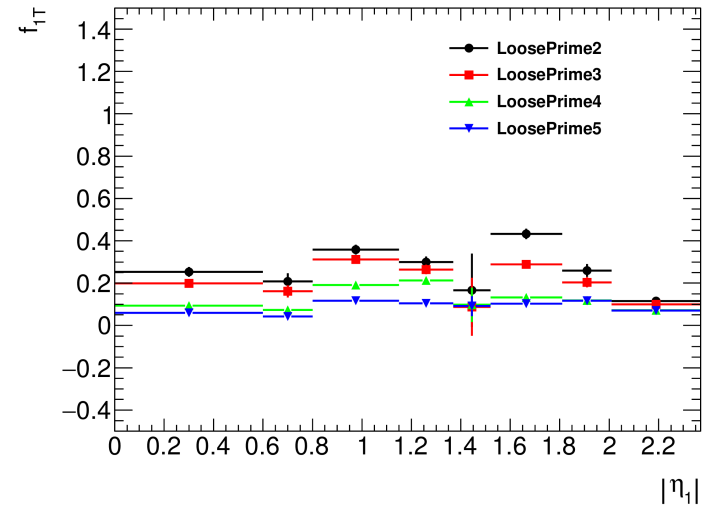


Failing tight isolation - η_{leading}

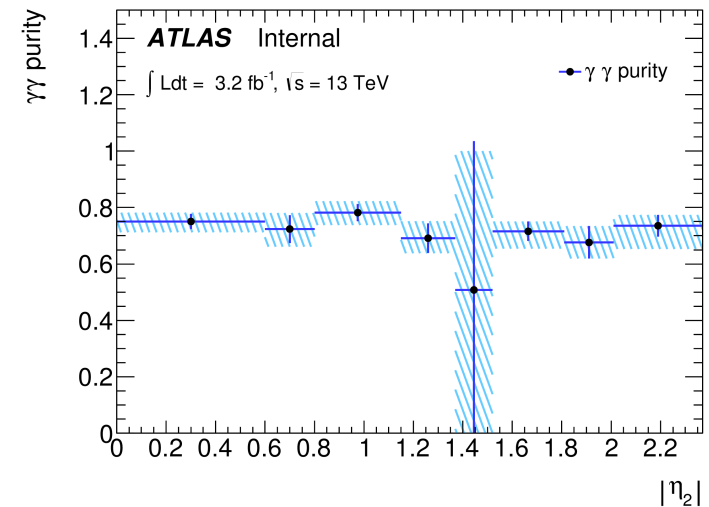
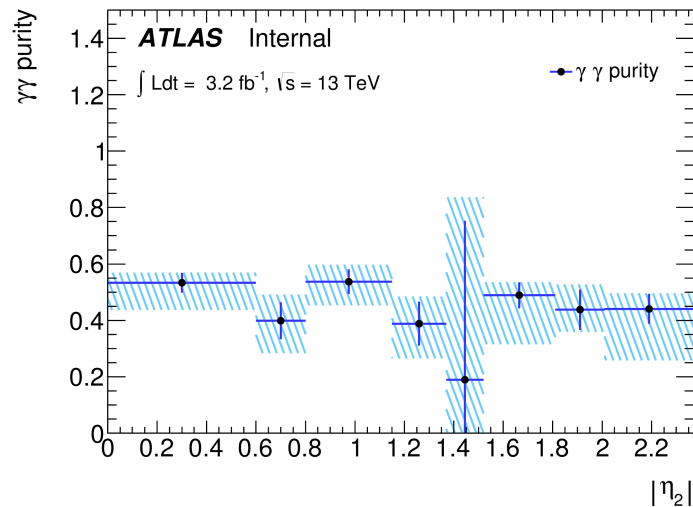
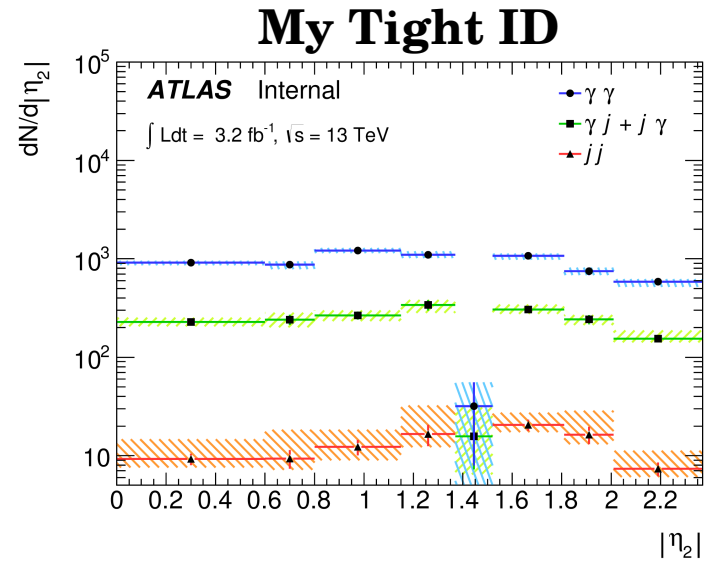
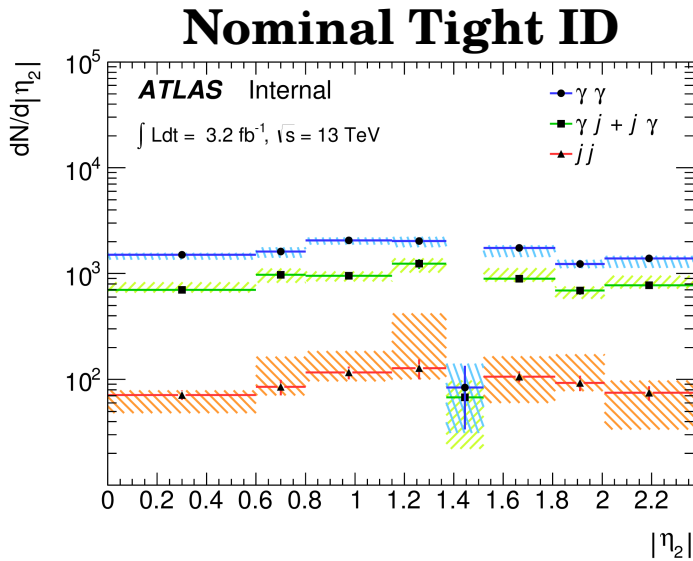
Nominal Tight ID



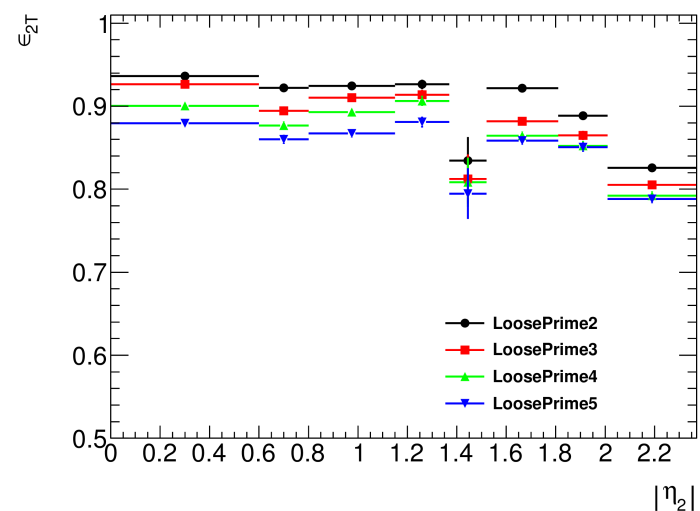
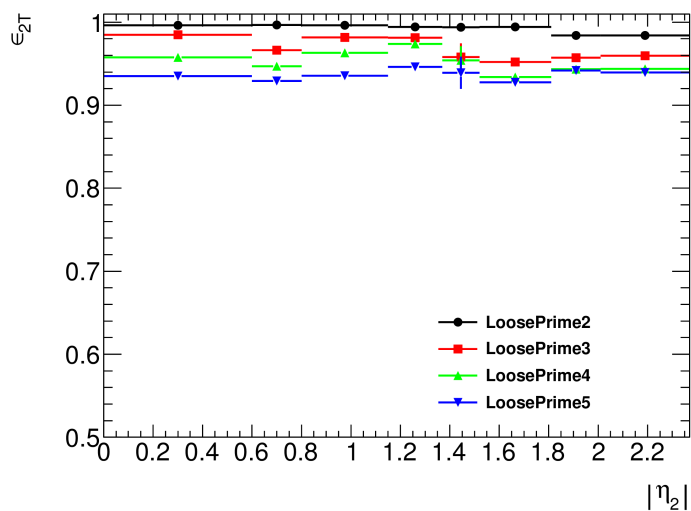
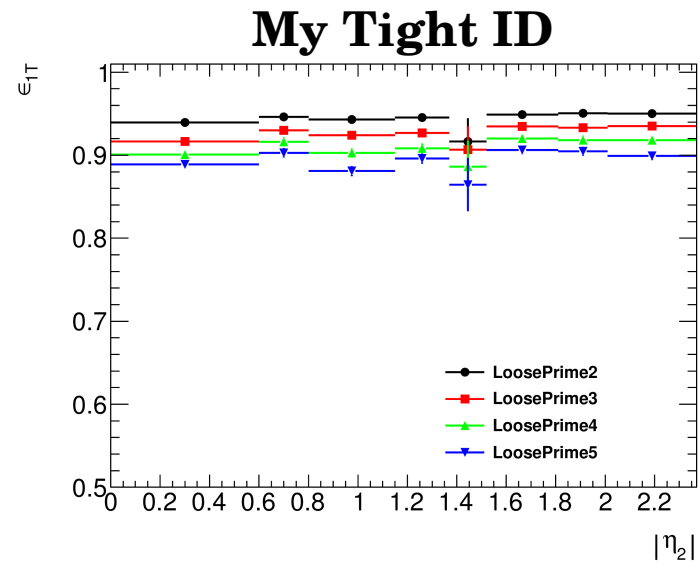
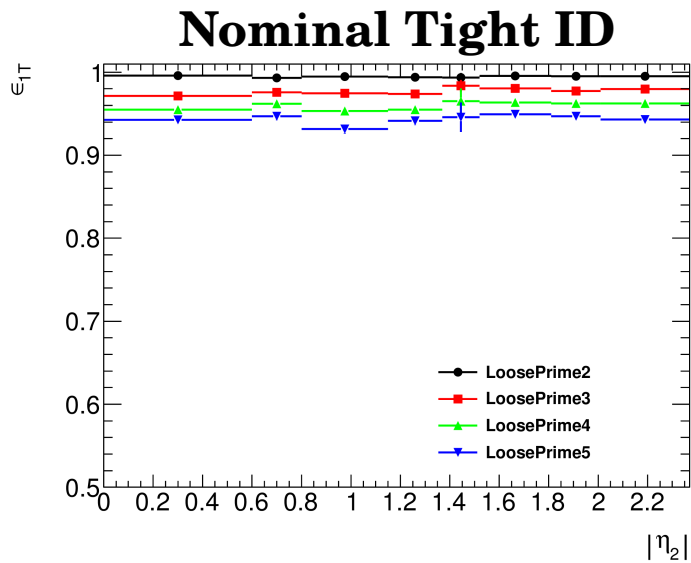
Modified Tight ID



Failing tight isolation - $\eta_{\text{subleading}}$

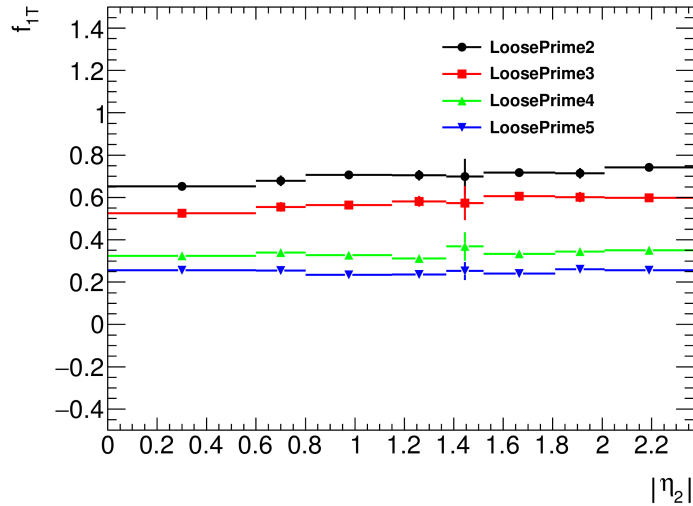


Failing tight isolation - $\eta_{\text{subleading}}$



Failing tight isolation - $\eta_{\text{subleading}}$

Nominal Tight ID



My Tight ID

