$W\gamma\gamma$

Josh Kunkle, Alberto Belloni, Chris Anelli

University of Maryland

Fiducial definition

See Alberto's talk

$$\frac{N_{obs} - N_{bkg}}{\mathcal{L}} = \sigma_{fid.} \times C_{WAA} = \sigma_{tot.} \times A_{WAA} \times C_{WAA}$$

- C_{WAA} = reconstruction efficiency within the fiucial volume
- A_{WAA} = acceptance of the fiducial volume

$$C_{WAA} = \frac{N_{MC}^{reco.}}{N_{MC}^{gen,fiducial}} \times \frac{\epsilon^{data}}{\epsilon^{MC}}$$

$$A_{WAA} = \frac{N_{MC}^{gen,fiducial}}{N_{MC}^{gen,total}}$$

NB - because we have photons in the event, $N_{MC}^{gen,total}$ must also be defined by a minimum photon p_T cut

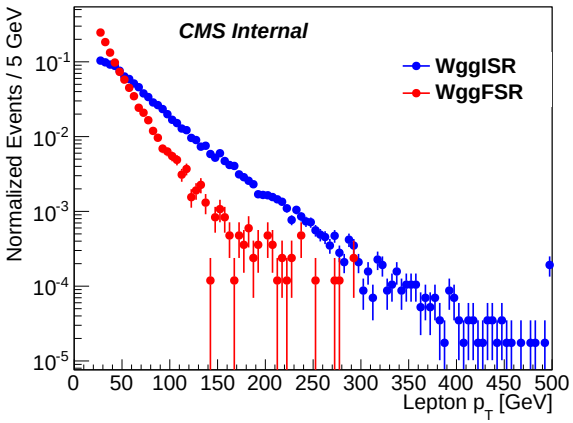
Fiducial definition

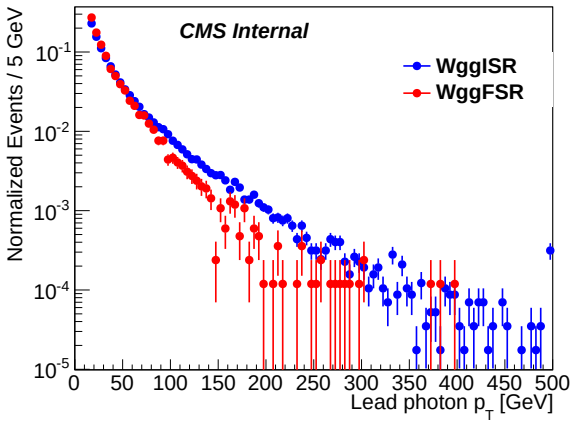
Should closely mimic the reconstruction cuts. Check this once reconstruction cuts are determined.

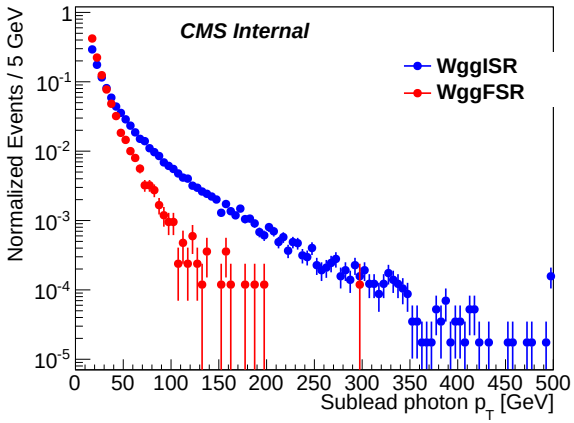
- One e or μ having $p_T > 25$ GeV, $|\eta| < 2.5$ (can orignate from a τ)
- Two photons having $p_T > 15$ GeV, $|\eta| < 2.5$
- Objects should not overlap, $\Delta R(\gamma, \ell) > 0.2$, $\Delta R(\gamma, \gamma) > 0.2$
- Any additional background rejection cuts (m_T, p_T^ν)

Comparing ISR to FSR

- Expect kinematics to differ between ISR and FSR enhanced samples

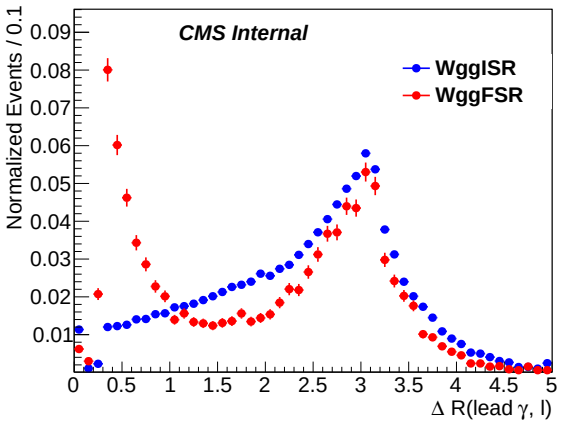


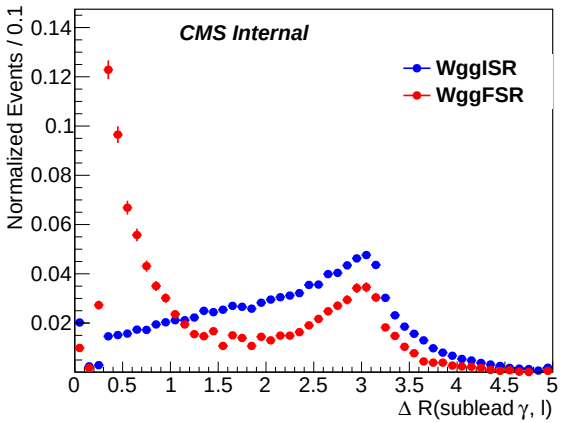


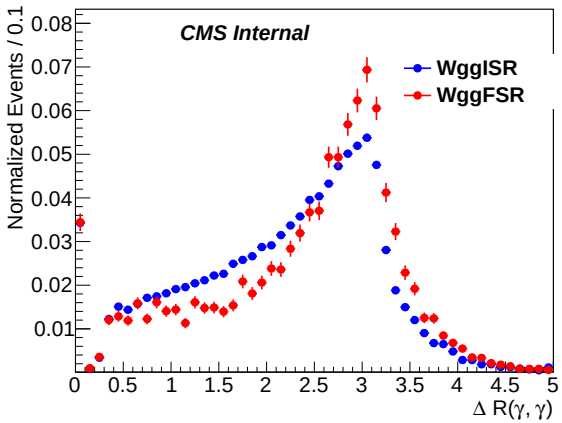


Comparing ISR to FSR

- We must require overlap removal at the truth level. Check these distributions

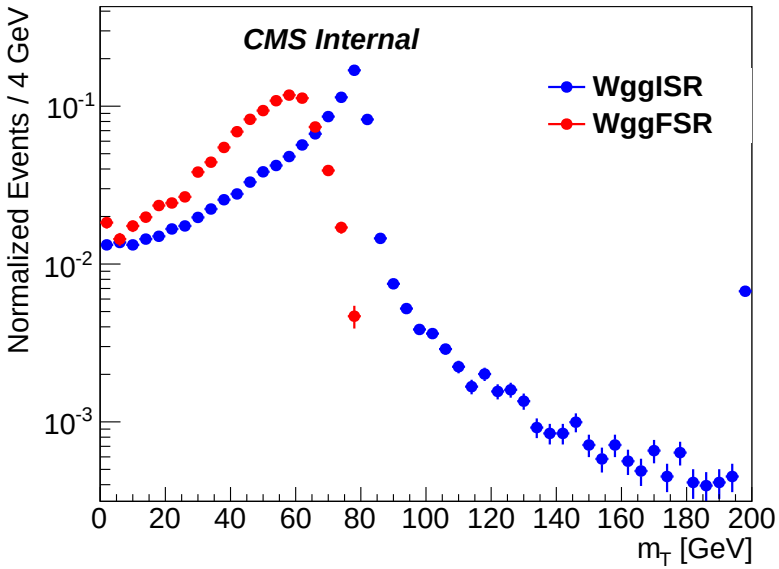


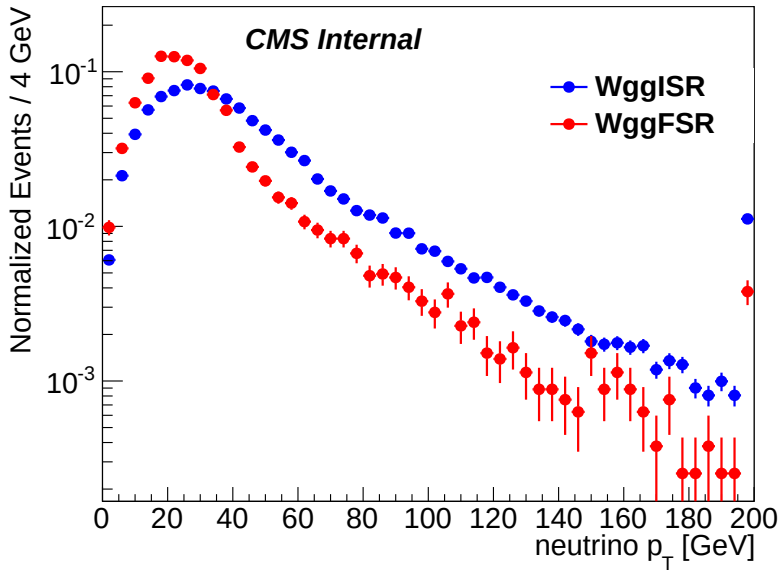




Comparing ISR to FSR

- Additional background rejection cuts (m_T, E_T^{miss} (p_T^{ν}))





Acceptances

- Acceptances should be different for the FSR and ISR enhanced samples

Cuts	WggISR	Acceptance	WggFSR	Acceptance	Combined	Acceptance
One Lepton	422782	0.4211 $\pm$ 0.0008	116125	0.1161 $\pm$ 0.0004	538907	0.2689 $\pm$ 0.0004
Two Photons	57252	0.0570 $\pm$ 0.0002	8393	8.390e-03 $\pm$ 9.2e-05	65645	0.0328 $\pm$ 0.0001
Overlap Rm	53240	0.0530 $\pm$ 0.0002	7922	7.920e-03 $\pm$ 8.9e-05	61162	0.0305 $\pm$ 0.0001
$m_T > 40$	44124	0.0440 $\pm$ 0.0002	5691	5.689e-03 $\pm$ 7.6e-05	49815	0.0249 $\pm$ 0.0001

$A_{WAA} = 0.03$ before additional background rejection cuts

Lepton acceptances

- The total acceptance is a combination of $W \to e, \mu$ and $W \to \tau \to e, \mu$. However tau decays produce lower p_T leptons and thus have lower acceptance

Only $W \to e, \mu$

Cuts	WggISR	Acceptance	WggFSR	Acceptance	Combined	Acceptance
One Lepton	404854	0.605 ± 0.001	113931	0.1597 ± 0.0005	518785	0.3751 ± 0.0006
Two Photons	54090	0.0808 ± 0.0004	8133	0.0114 ± 0.0001	62223	0.0450 ± 0.0002
Overlap Rm	50253	0.0751 ± 0.0003	7680	0.0108 ± 0.0001	57933	0.0419 ± 0.0002
$m_T > 40$	42150	0.0629 ± 0.0003	5555	0.0078 ± 0.0001	47705	0.0345 ± 0.0002

Only $W \to \tau$ (BR $tau \to \ell = 35\%$)

Cuts	WggISR	Acceptance	WggFSR	Acceptance	Combined	Acceptance
One Lepton	17928	0.0536 ± 0.0004	2194	0.0077 ± 0.0002	20122	0.0325 ± 0.0002
Two Photons	3162	0.0095 ± 0.0002	260	9.150e-04 ± 5.7e-05	3422	5.533e-03 ± 9.5e-05
Overlap Rm	2987	0.0089 ± 0.0002	242	8.516e-04 ± 5.5e-05	3229	5.221e-03 ± 9.2e-05
$m_T > 40$	1974	0.0059 ± 0.0001	136	4.786e-04 ± 4.1e-05	2110	3.412e-03 ± 7.4e-05

$$A_{WAA} = 0.042 \text{ for } W \to e, \mu$$
$$A_{WAA} = 0.0052 \text{ for } W \to \tau, \; 0.015 \text{ for } W \to \tau \to e, \mu$$

TGC and QGC acceptances

- Check how acceptances differ between QGC, TGC, and remaining events
- Require 0, 1, or 2 photons to have a W as a mother

Sample	2 W photons	1 W photons	0 W photons
FSR	14112	294051	692147
ISR	13	13238	990669

Combine FSR and ISR samples below

Cuts	0 W photons	Acceptance	1 W photons	Acceptance	2 W photons	Acceptance
One Lepton	511314	0.3038 ± 0.0005	27105	0.0882 ± 0.0006	488	0.035 ± 0.002
Two Photons	57226	0.0340 ± 0.0001	7998	0.0260 ± 0.0003	421	0.030 ± 0.001
Overlap Rm	52825	0.0314 ± 0.0001	7926	0.0258 ± 0.0003	411	0.029 ± 0.001
$m_T > 40$	43740	0.0260 ± 0.0001	5841	0.0190 ± 0.0003	234	0.017 ± 0.001