Data quality check about HEM issue

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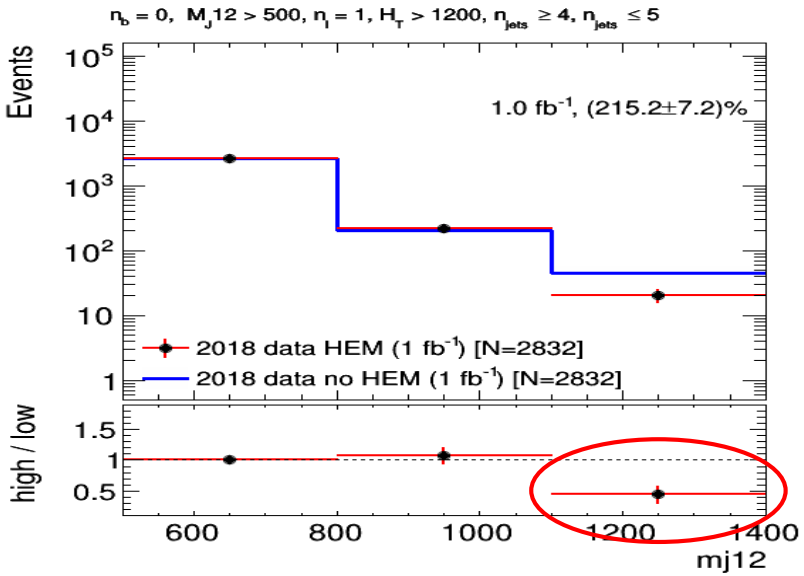
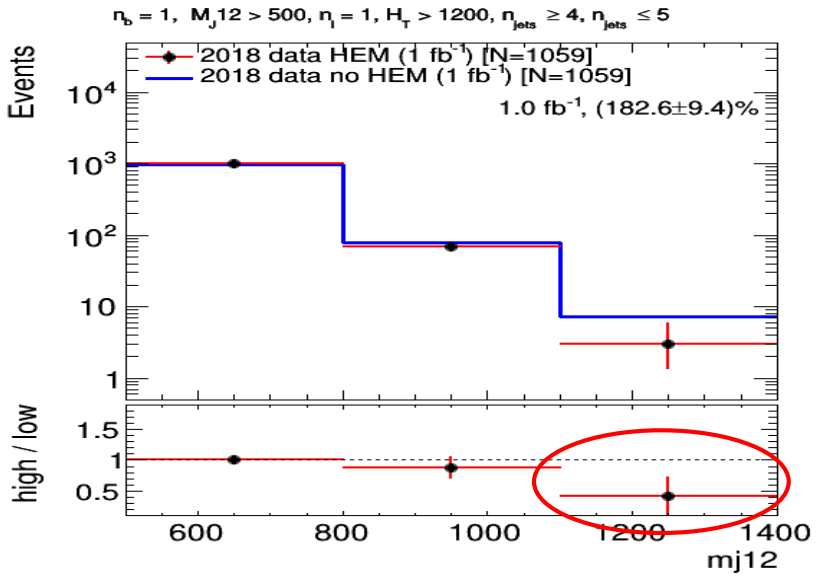
201130

Last issue about 2018 data

N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
1	CR	CR	CR
2	VR	VR	SR
3	CR	SR	SR
4+	CR	SR	SR

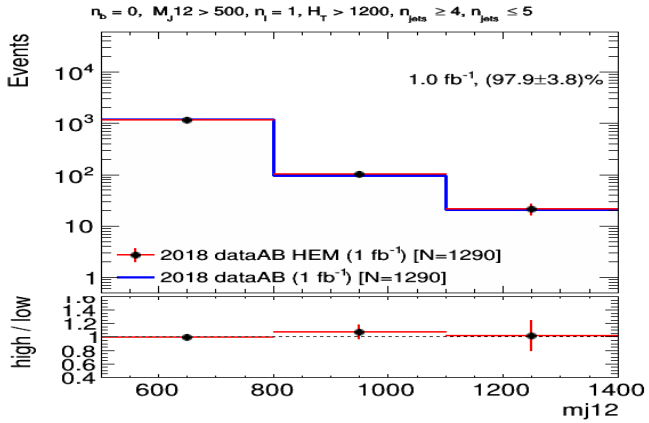


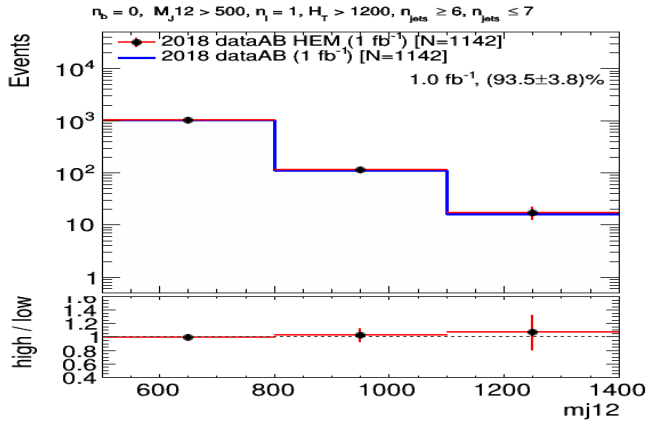


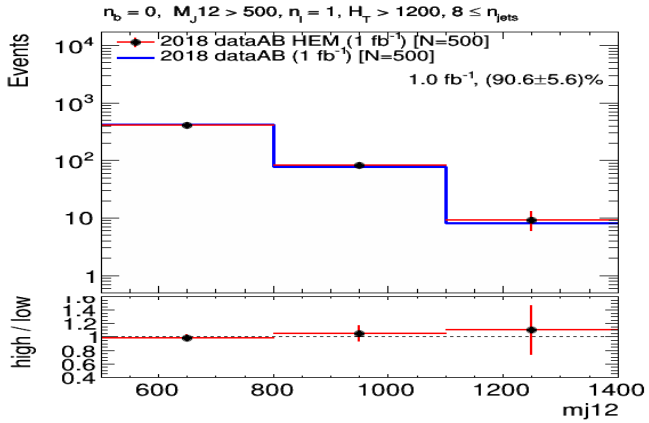
Left figure is MJ distribution in $4 \leq njets \leq 5$ with nb=0, and right figure is nb=1 region.
The difference is approximately 50%, so we need an additional study for this region.

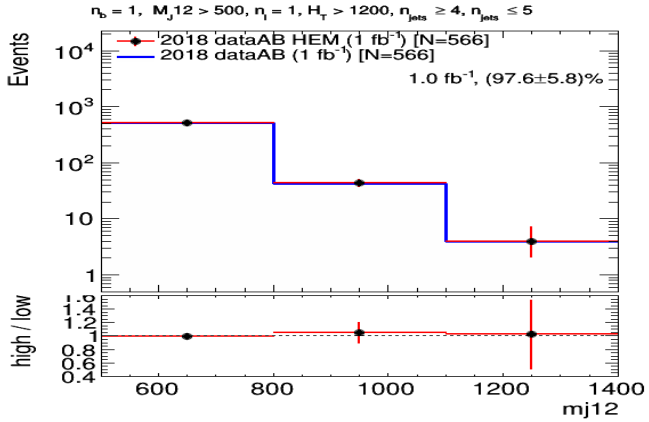
HEM difference in 2018 pre HEM region

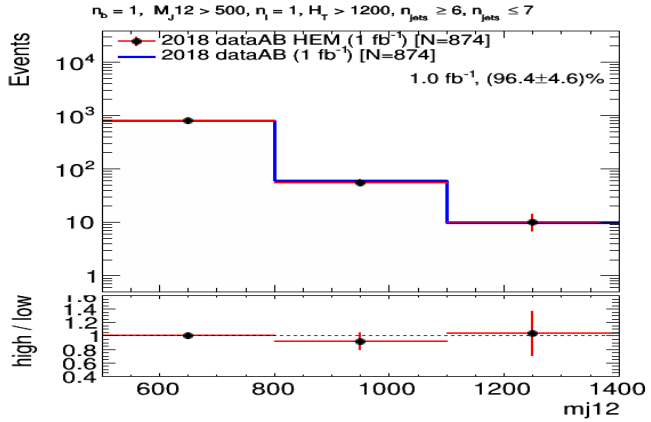
N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
1	CR	CR	CR
2	VR	VR	SR
3	CR	SR	SR
4+	CR	SR	SR

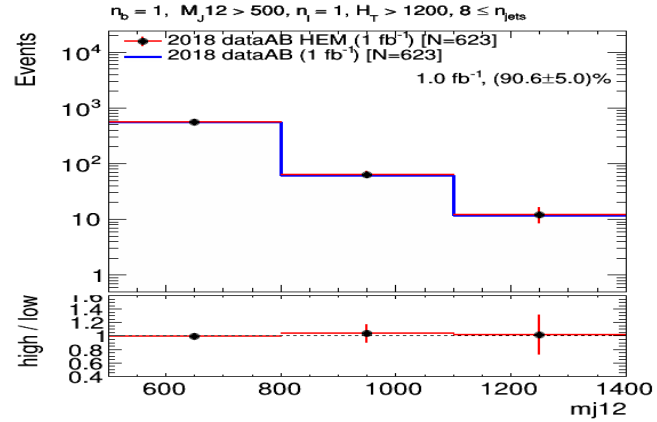












The MJ distribution 2018 data sample, blue line is no HEM issue,
The red line is applied HEM issue before run 319077

Conclusion

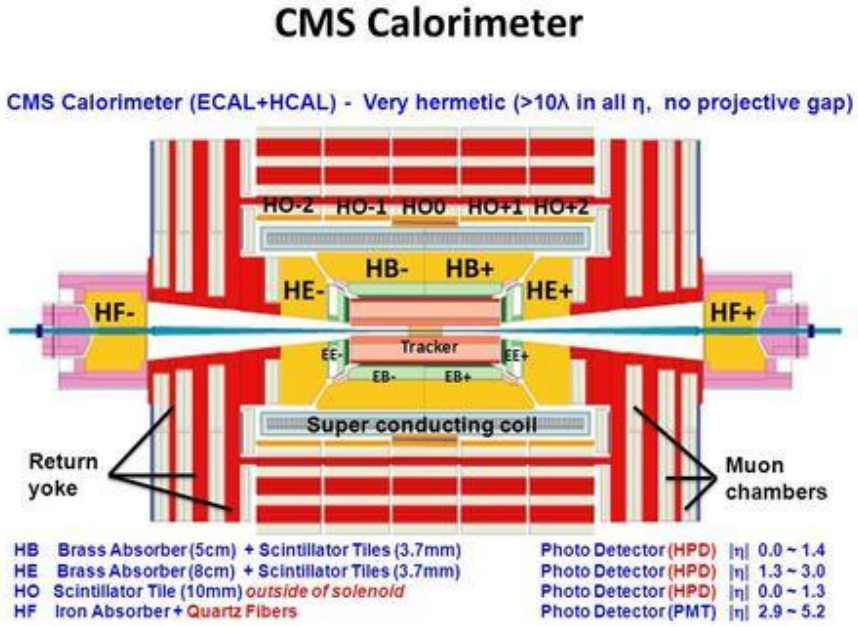
- When applied HEM effect before the run 319077, the difference of each sample is up to 10%

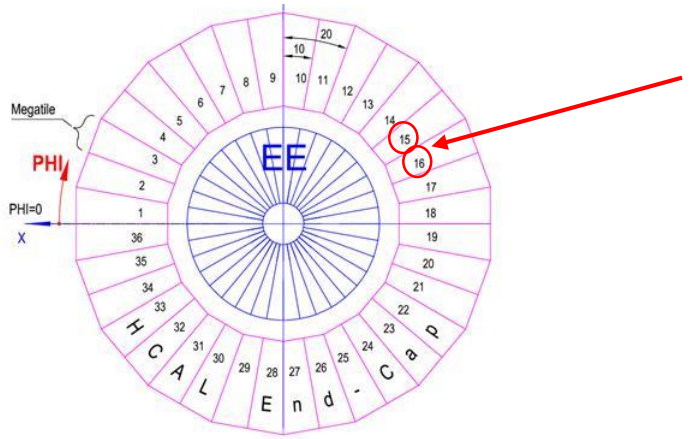
- This difference is included in the statistic uncertainty

Back up

Effect of HCAL Endcap Minus side(HEM)15/16 failure

- A relevant 60% fraction of the 2018 dataset if affected by the failure of several sectors which were turned off in the HCAL.
  - After run 319077
- A loss of dataset in the HCAL performance is expected to happen around the solid angle
- Contained in the
  $-3.0 < \eta < -1.3, \qquad -1.57 < \phi < -0.87$





Method of Comparison before and after HEM issue.

- A data to data comparison is performed by splitting 2018 data into two datasets before and after the HCAL failure.

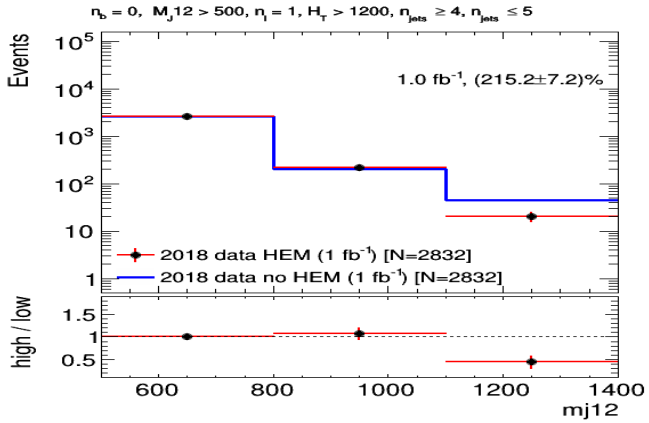
- Two datasets(20 and 39fb^{-1}) are renormalized to the same luminosity(1 fb^{-1}) in order to perform this comparison.
  - Run 315257~318877 : Apr/26~Jun/28, no HEM issue
  - Run 319077~325172 : Jul/1~Oct/24, HEM issue

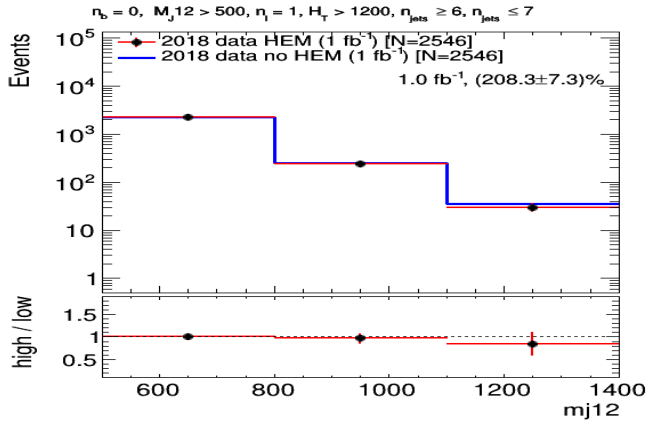
Main effect of HEM15/16 issue

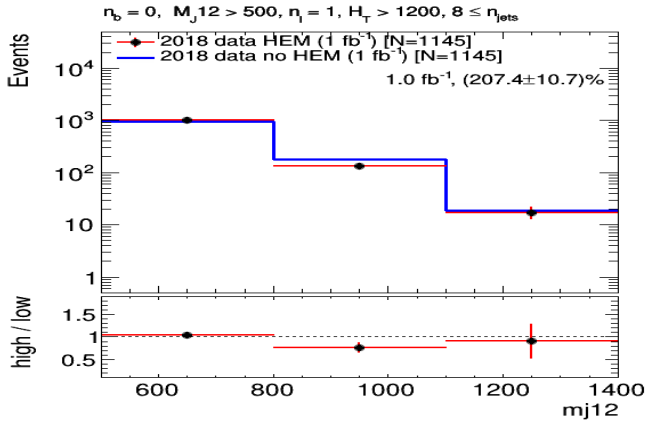
- Jet energy mismeasurements that produce different effects of the b jet veto.
- Jet energy mismeasurements that are propagated towards the missing transverse momentum.
- An increase in the lepton fake-rate in the associated region due to dependence of the lepton ID in jet related variables.
  - but this third issue does not affect our analysis

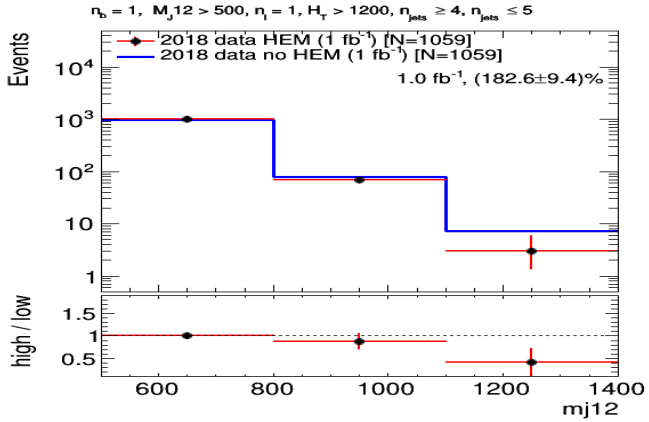
HEM difference CR in 2018 data nl=1

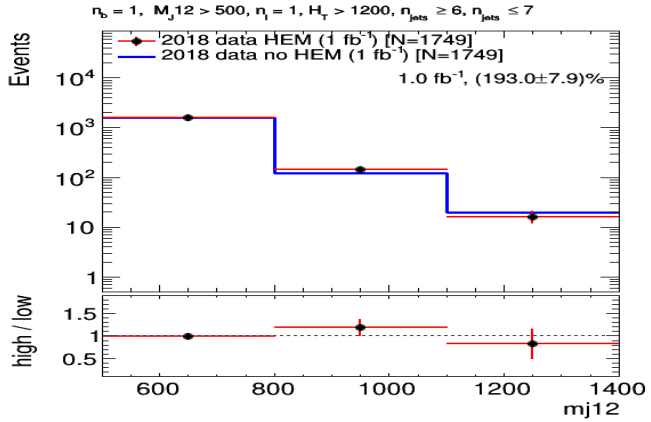
N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
1	CR	CR	CR
2	VR	VR	SR
3	CR	SR	SR
4+	CR	SR	SR

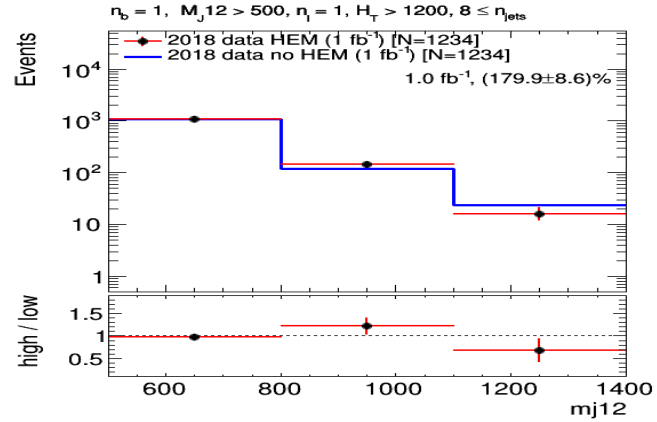








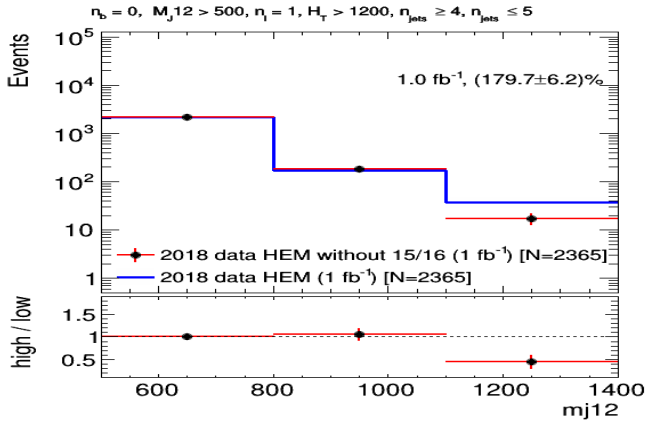


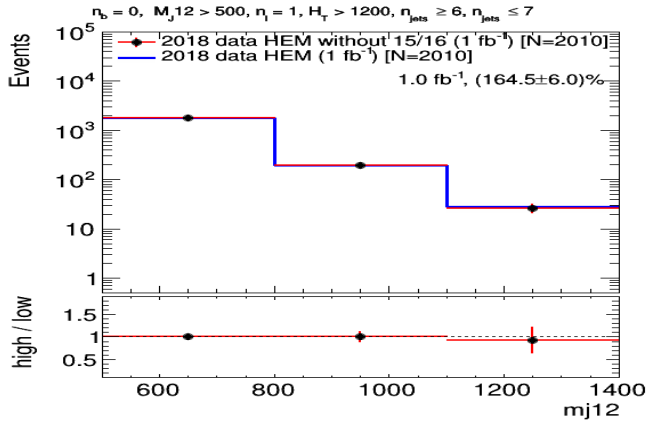


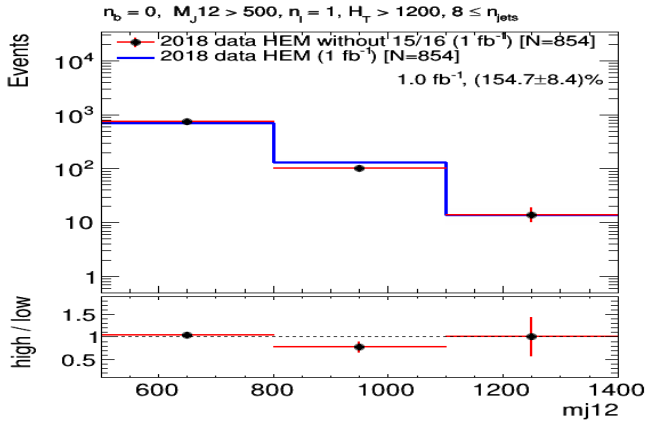
The MJ distribution 2018 data sample, blue line is no HEM failure, and red line is HEM failure. up side plots are N_b=0, bottom side plots are N_b=1.

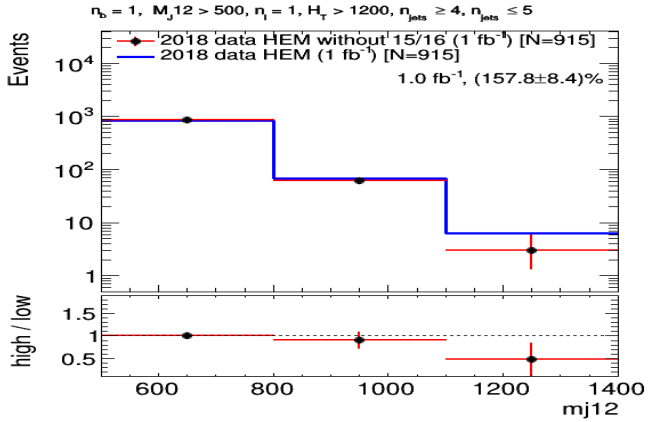
HEM difference CR in 2018 data nl=1

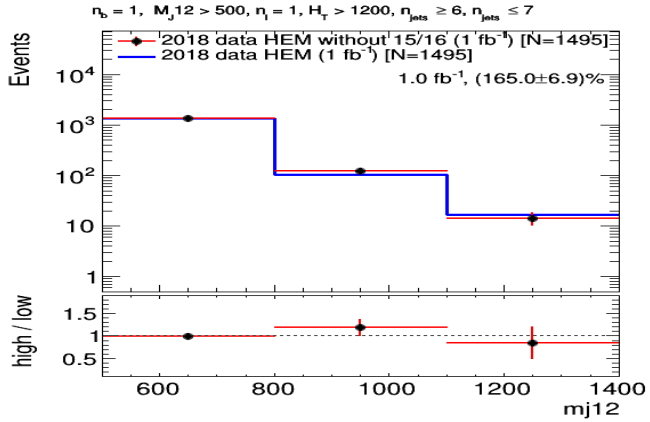
N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
1	CR	CR	CR
2	VR	VR	SR
3	CR	SR	SR
4+	CR	SR	SR

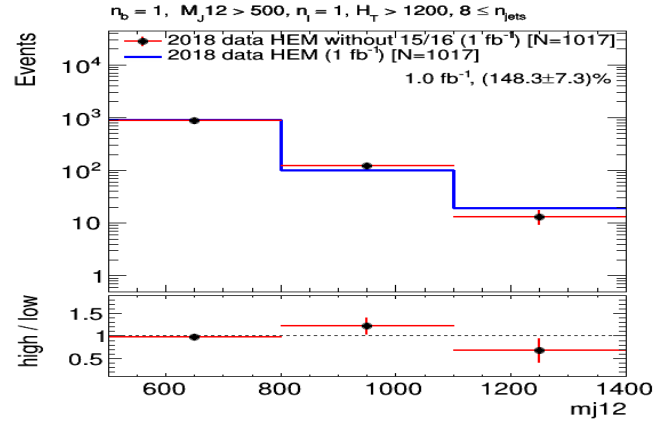








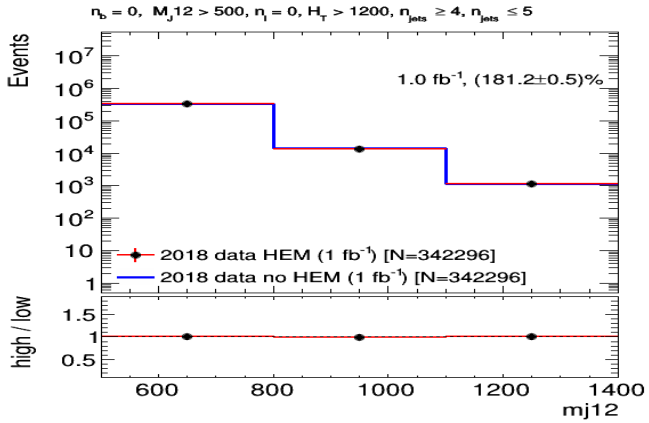


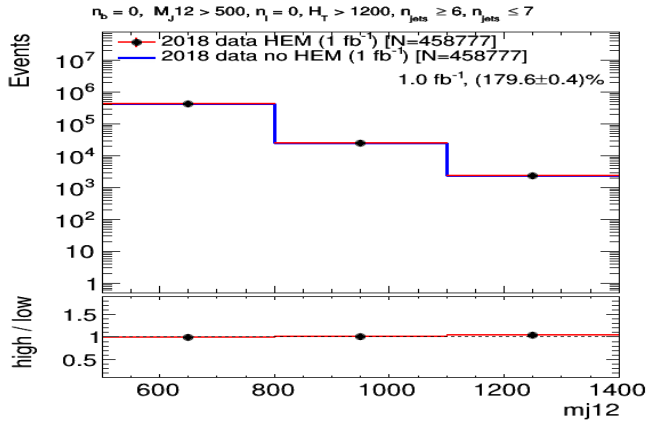


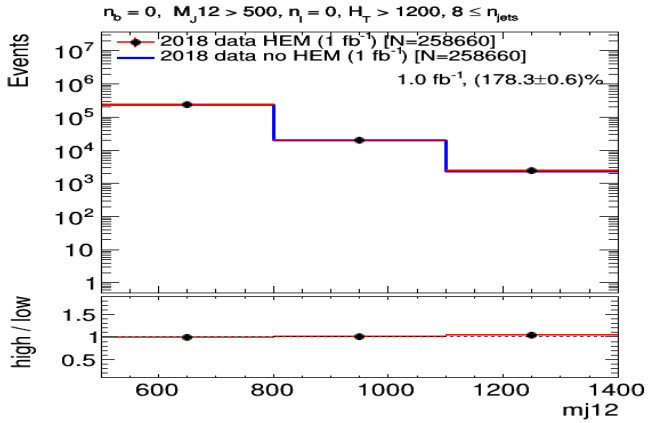
The MJ distribution 2018 data sample, blue line is no HEM failure, and red line is HEM failure without sector 15/16. up side plots are N_b=0, bottom side plots are N_b=1.

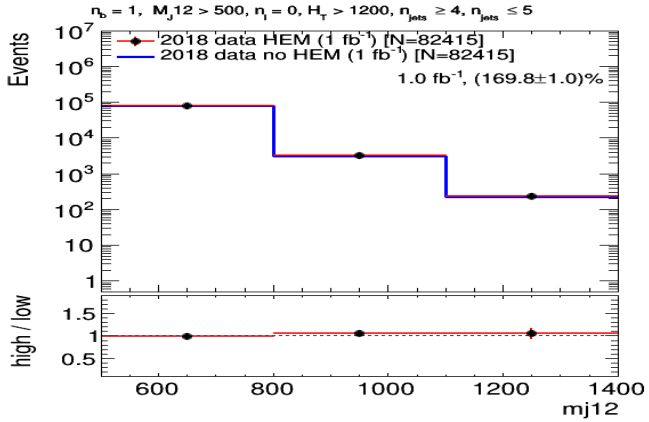
HEM difference CR in 2018 data nl=0

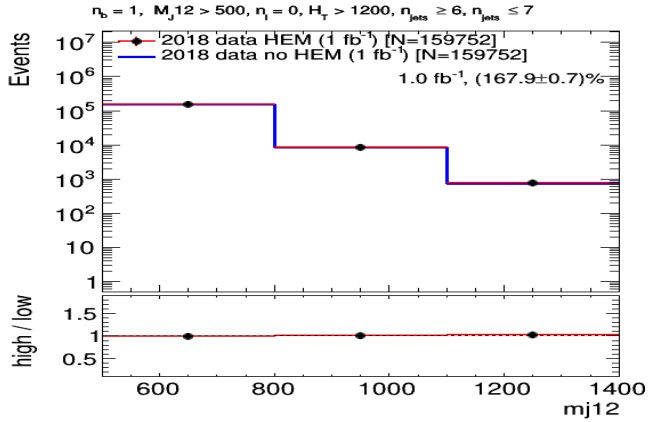
N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
1	CR	CR	CR
2	VR	VR	SR
3	CR	SR	SR
4+	CR	SR	SR

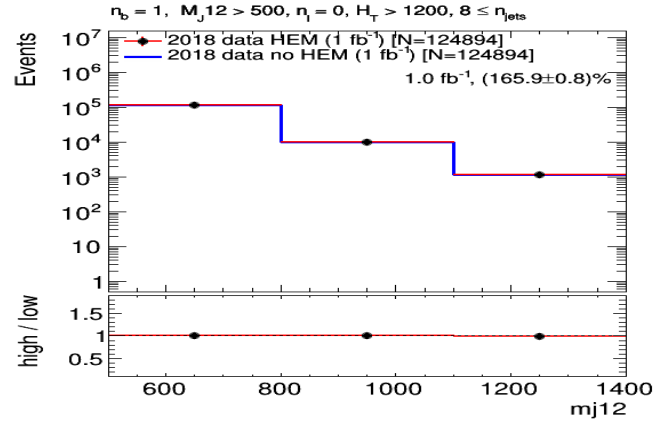












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HEM difference CR in 2018 data nl=1

N_b	N_{jet}		
	4, 5	6, 7	8+
0	CR	CR	CR
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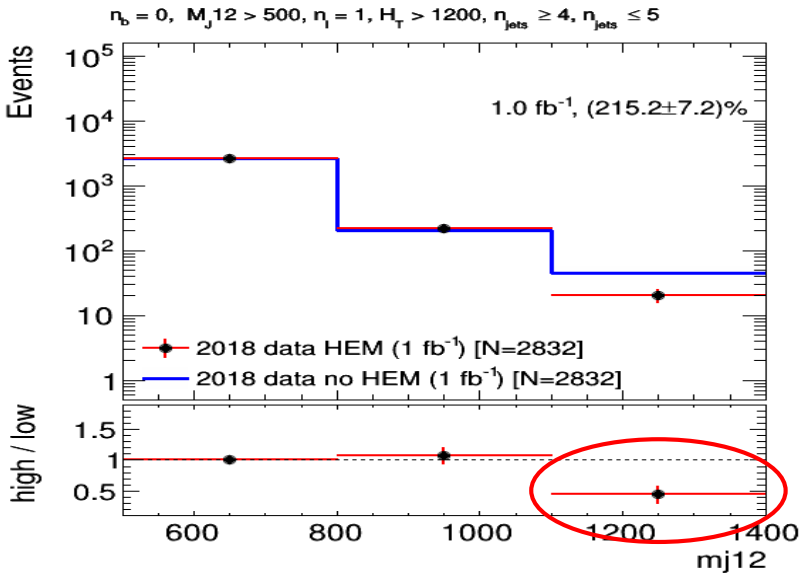
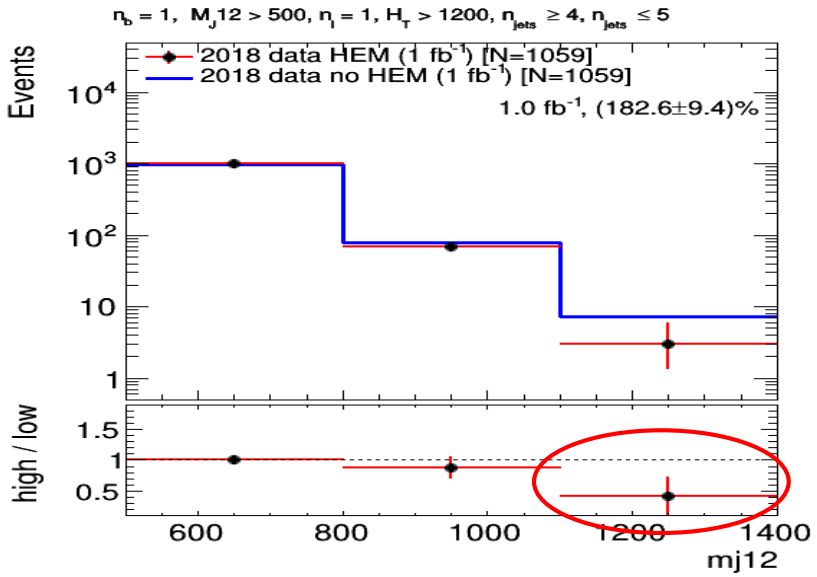
4+	CR	SR	SR





Left figure is MJ distribution in $4 \leq njets \leq 5$, nb=0, and right figure is nb=1 region.
The difference is approximately 50%.

Extremely decreased the events affected by HEM issue

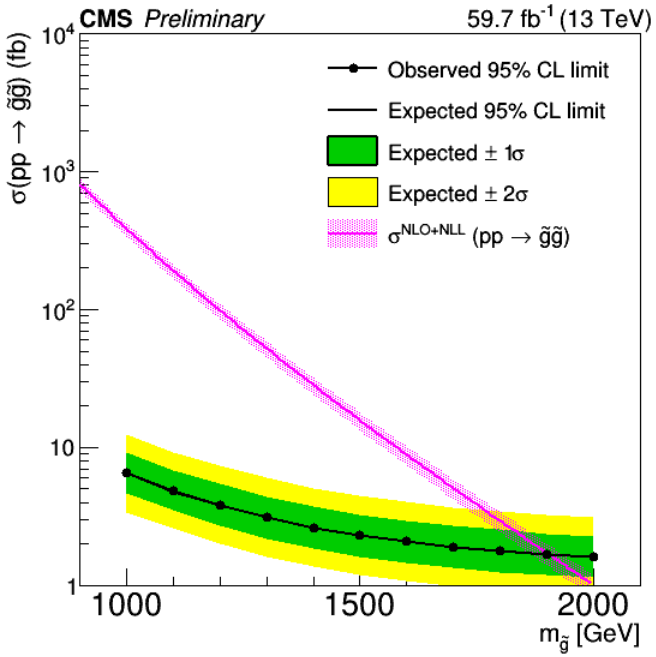
Mj	QCD	$t\bar{t}$	W+jets	Other	All bkg.	Data	$m_{\tilde{g}} = 1900$GeV
$N_{leps} = 1, H_T > 1200$ GeV, $4 \leq N_{jets} \leq 5, N_b = 0$							
500 800	978.1 ± 39.2	310.5 ± 1.6	2445.5 ± 6.0	282.2 ± 6.6	4016.3 ± 40.3	4016	0.4
800 1100	91.8 ± 9.5	36.4 ± 0.5	243.1 ± 1.6	31.4 ± 2.7	402.8 ± 10.0	403	0.2
1100	8.4 ± 1.8	5.5 ± 0.2	32.4 ± 0.4	7.5 ± 2.4	53.8 ± 3.0	54	0.1

- 60%

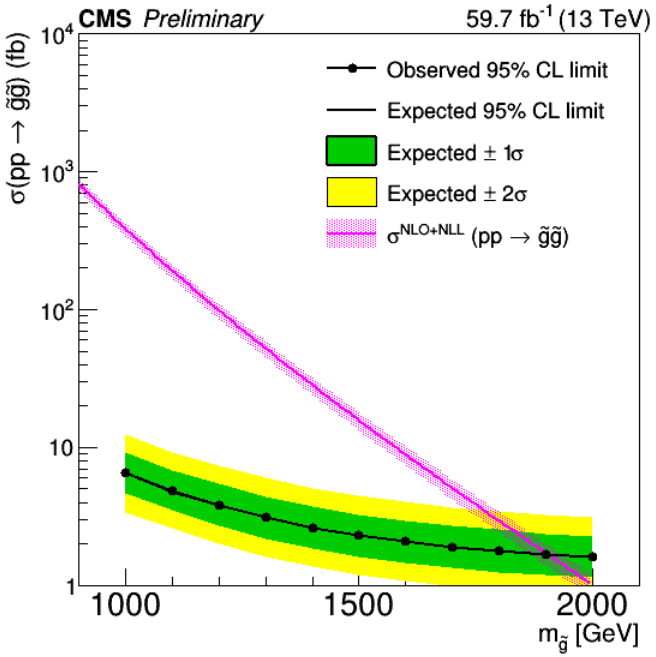
Mj	QCD	$t\bar{t}$	W+jets	Other	All bkg.	Data	$m_{\tilde{g}} = 1900$GeV
$N_{leps} = 1, H_T > 1200$ GeV, $4 \leq N_{jets} \leq 5, N_b = 0$							
500 800	978.1 ± 39.2	310.5 ± 1.6	2445.5 ± 6.0	282.2 ± 6.6	4016.3 ± 40.3	4016	0.4
800 1100	91.8 ± 9.5	36.4 ± 0.5	243.1 ± 1.6	31.4 ± 2.7	402.8 ± 10.0	403	0.2
1100	3.3 ± 0.7	2.2 ± 0.1	13.0 ± 0.2	3.0 ± 1.0	21.5 ± 1.2	22	0.1

In the third bin, 60% of MCs affected by the HEM problem were removed

Comparison pre & post HEM issue of the limit



Observed Limit of 1900 GeV: **r < 0.9715**



Observed Limit of 1900 GeV: **r < 0.9722**

The expected upper limits, left figure is not included HEM effect, right one is included HEM effect.