Low PT Analysis Update

Lina Galtieri(LBNL), Corrinne Mills (Edinburgh)

for the Lowpt/W+jets group

Outline

- New baseline for the DF channels
  Control Regions Results
- Comparing Results in different conditions
- Contribution to the H --> WW sample
- Normalized SS-CR for Low and All Pt's
  Control Regions plots for Low and All Pt's
  SS validation plots
- Low PT Signal Region plots
- Summary of observations

Analysis Conditions

- Analysis code revision 570789, Nov 15. Ntuples tag-02-25

- New baseline: see Jonathan talk at the ggF optimization meeting: Nov 8
  WW CR cuts: 55 < Mℓℓ < 110 GeV, DF l < 2.6, PTll > 15 GeV
  Change METRel cut to METTrackHWW-CL
  M_T calculated with METTrackHWW-CL
  Njet=0 $E_{T,miss}^{Track-Cl}$ > 20. Njet=1 $E_{T,miss}^{Track-Cl}$ > 10. Max (MWT) > 50
  Njet=0 $E_{T,miss}^{Track-Cl}$ > 20. Njet=1 $E_{T,miss}^{Track-Cl}$ > 10. Max (MWT) > 50

- Improved lepton selections: isolation cuts, VTLH
  W+jets V8.2 (see Keisuke's talk)

- Content
  Cutflows for (2012 only) all DF channels em and me. Both 0-jet, 1jet channels}
  Missing latest improvements: Z tau tau CR's and WW MC changes (had problems with the latest CAF code).
  Only DF analysis shown here: SF, VBF, 2011 analyses are in progress.

Normalization Factors

Control Region Strategy

WW	0 jet			1 jet		
	purity	N_{data}	NF	purity	N_{data}	NF
$10 < p_T^{sublead} < 15$	31%	208	0.84 ± 0.25	23%	92	1.15 ± 0.48
$15 < p_T^{sublead} < 20$	50%	381	1.52 ± 0.14	32%	165	1.11 ± 0.27
$p_T^{sublead} > 20$	74%	2273	1.15 ± 0.03	41%	2934	1.09 ± 0.05

top	0 jet*			1 jet		
	purity	N_{data}	NF	purity	N_{data}	NF
$10 < p_T^{sublead} < 15$	88%	449	1.01 ± 0.12	84%	340	0.97 ± 0.07
$15 < p_T^{sublead} < 20$	85%	1179	1.14 ± 0.09	90%	714	1.04 ± 0.05
$p_T^{sublead} > 20$	95%	7789	0.97 ± 0.03	95%	5250	0.96 ± 0.02

$Z \rightarrow \tau\tau$	0 jet			1 jet		
	purity	N_{data}	NF	purity	N_{data}	NF
$10 < p_T^{sublead} < 15$	90%	2413	1.01 ± 0.03	86%	1256	1.01 ± 0.04
$15 < p_T^{sublead} < 20$	89%	1457	0.97 ± 0.03	90%	1489	1.05 ± 0.03
$p_T^{sublead} > 20$	85%	931	0.95 ± 0.05	88%	2320	1.05 ± 0.03

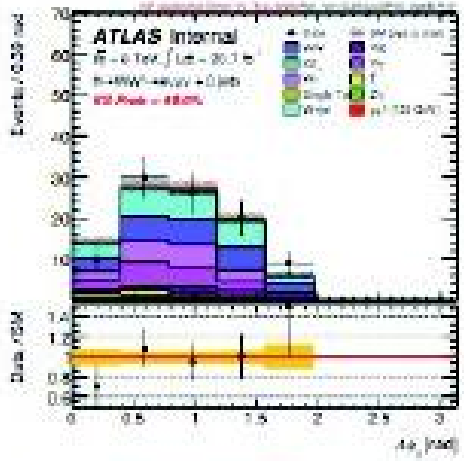
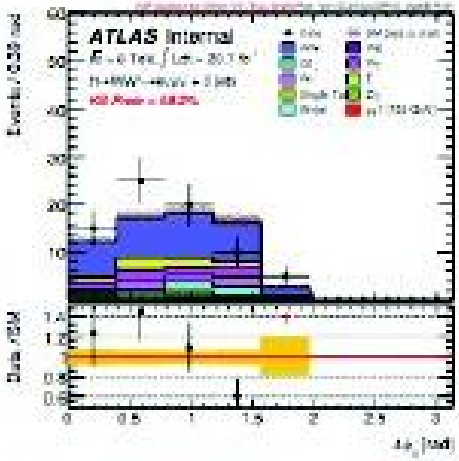
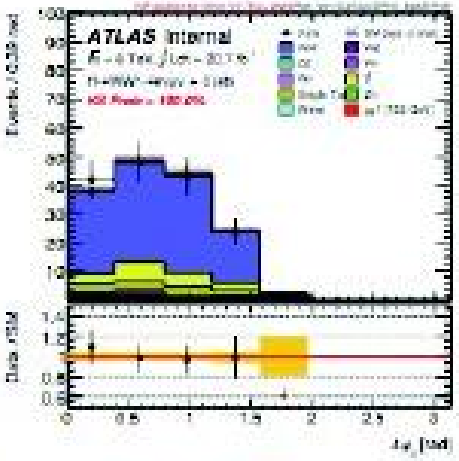
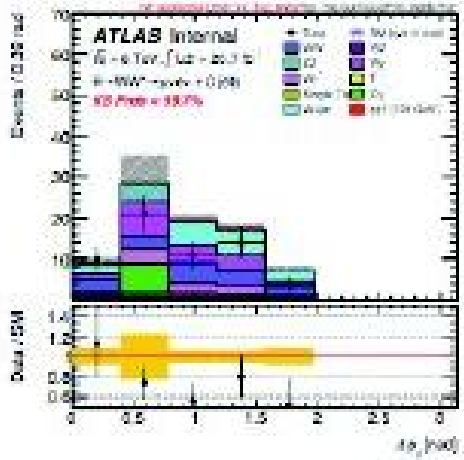
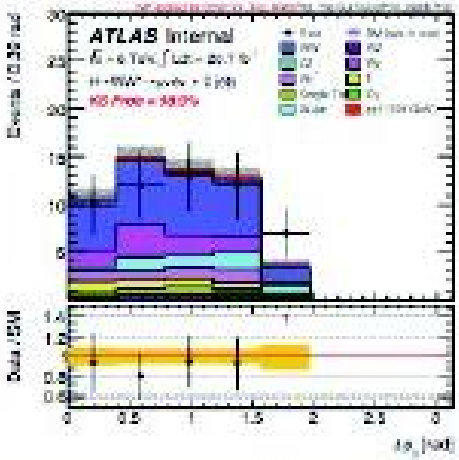
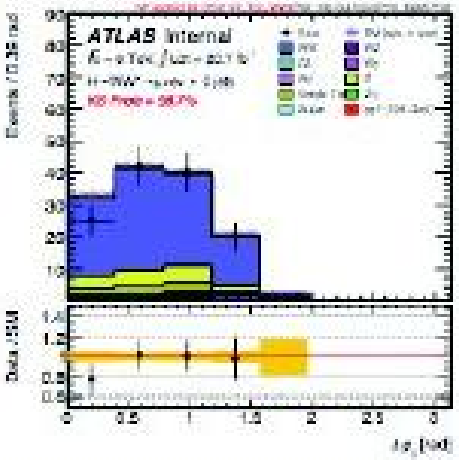
- NFs consistent, but tend to be high for $15 < p_T^{sublead} < 20$
- CR purity only depends strongly on $p_T^{sublead}$ for WW

→ *Exclude $10 < p_T^{sublead} < 15$ from WW CR*

22 Nov. 2013 c. mills (Edinburgh) 11

Background in different PT bins

0-jet Blinded SR (after $\Delta\varphi(ll) < 1.8$)

	$10 < p_T^{\text{sublead}} < 15$	$15 < p_T^{\text{sublead}} < 20$	$p_T^{\text{sublead}} > 20$
eμ			
μe			

22 Nov. 2013 c. mills (Edinburgh) 16

Low PT: tag-02-23 and tag-02-25 NJ=0

- Comparison, after the DF_{ll} cut, of many steps in the analysis

Low PT	Njet=0								
tag-02-24	Signal	WW	nonWW	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	20.5 ± 0.5	91.1 ± 2.6	61.3 ± 2.7	8.6 ± 1.0	5.2 ± 0.3	0.9 ± 0.4	64.2 ± 2.9	231.3 ± 4.8	0.089
μe	13.6 ± 0.4	64.1 ± 2.2	70.3 ± 3.1	5.1 ± 0.9	3.8 ± 0.3	0.1 ± 0.1	82.8 ± 1.1	226.2 ± 4.0	0.060
$e\mu + \mu e$	34.1 ± 0.7	155.2 ± 3.4	131.6 ± 4.1	13.7 ± 1.3	9.0 ± 0.4	1.0 ± 0.4	147.0 ± 3.2	457.5 ± 6.3	0.075
F(bark.) (%)		33.8%	28.6%	3.0%	2.0%	0.2%	32.0%		
Low PT	Njet=0	V8.1							
tag-02-25	Signal	WW	nonWW	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	23.9 ± 0.6	103.2 ± 2.7	72.6 ± 2.8	10.8 ± 1.2	6.7 ± 0.4	2.5 ± 1.3	85.6 ± 3.3	282.6 ± 5.4	0.085
μe	15.6 ± 0.4	74.2 ± 2.3	81.6 ± 3.3	7.0 ± 1.0	4.9 ± 0.3	7.7 ± 6.4	89.6 ± 1.1	264.9 ± 7.7	0.069
$e\mu + \mu e$	39.8 ± 0.7	177.4 ± 3.5	155.2 ± 4.3	17.8 ± 1.5	11.6 ± 0.5	10.2 ± 6.6	175.1 ± 3.5	547.4 ± 9.4	0.073
F(bark.) (%)		32.4%	28.4%	3.3%	2.1%	1.9%	32.0%		
Low PT	Njet=0	V8.2							
tag-02-25	Signal	WW	nonWW	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	23.9 ± 0.6	106.9 ± 2.8	77.0 ± 2.9	9.8 ± 1.1	6.1 ± 0.3	2.5 ± 1.3	81.6 ± 3.2	284.0 ± 5.4	0.085
μe	15.9 ± 0.4	76.8 ± 2.3	85.4 ± 3.4	6.4 ± 0.9	4.4 ± 0.3	7.7 ± 6.4	82.5 ± 1.2	263.2 ± 7.8	0.078
$e\mu + \mu e$	39.8 ± 0.7	183.6 ± 3.6	162.4 ± 4.5	16.2 ± 1.4	10.5 ± 0.4	10.2 ± 6.6	164.1 ± 3.5	547.1 ± 9.5	0.072
F(bark.) (%)		33.6%	29.7%	3.0%	1.9%	1.9%	30.0%		

W+jets FF's change

LH added

- The FF changes reduced the μe background in W+jets, but analysis changes increased both signal and backgrounds
- The LH change reduced the overall background by ~5% but the TrackMET increased both signal and backgrounds

Low PT tag-03-23 to 02-25 Njet=1

- For Nj=1 after the $\Delta\Phi_{ll}$ cut, we see a different pattern

Low PT	Njet=1								
tag-02-24	Signal	WW	$nonWW$	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	8.5 ± 0.3	28.1 ± 1.4	11.0 ± 1.2	21.1 ± 1.6	6.9 ± 0.5	13.6 ± 1.3	31.7 ± 2.0	112.3 ± 3.4	0.076
μe	5.2 ± 0.2	17.3 ± 1.1	13.3 ± 1.4	13.6 ± 1.3	4.7 ± 0.4	6.9 ± 0.9	20.5 ± 0.8	76.2 ± 2.5	0.068
$e\mu + \mu e$	13.6 ± 0.4	45.3 ± 1.7	24.3 ± 1.8	34.6 ± 2.1	11.6 ± 0.6	20.5 ± 1.5	52.2 ± 2.2	188.5 ± 4.3	0.072
F(back.)(%)		24.0%	12.9%	18.4%	6.2%	10.9%	27.7%		

Low PT	Njet=1	V8.1							
tag-02-25	Signal	WW	$nonWW$	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	10.3 ± 0.4	31.6 ± 1.4	12.3 ± 1.1	25.6 ± 1.8	8.8 ± 0.5	7.3 ± 1.2	37.0 ± 2.1	122.6 ± 3.6	0.084
μe	6.6 ± 0.3	20.3 ± 1.1	14.9 ± 1.4	17.1 ± 1.5	6.6 ± 0.5	3.6 ± 0.8	24.7 ± 0.9	87.2 ± 2.7	0.076
$e\mu + \mu e$	16.9 ± 0.5	51.8 ± 1.8	27.2 ± 1.8	42.7 ± 2.4	15.4 ± 0.7	11.0 ± 1.4	61.7 ± 2.3	209.7 ± 4.5	0.080
F(back.)(%)		24.7%	12.9%	20.3%	7.4%	5.2%	29.4%		

Low PT	Njet=1	V8.2							
tag-02-25	Signal	WW	$nonWW$	$t\bar{t}$	Sing.Top	Z+jets	W+jets	All Bkg.	S/B
$e\mu$	10.3 ± 0.4	33.1 ± 1.5	16.2 ± 1.5	23.8 ± 1.7	8.2 ± 0.5	7.6 ± 1.2	32.4 ± 1.2	121.4 ± 3.6	0.085
μe	6.6 ± 0.3	21.3 ± 1.2	19.7 ± 1.8	15.9 ± 1.4	6.1 ± 1.4	3.8 ± 0.8	22.6 ± 0.9	89.2 ± 2.9	0.074
$e\mu + \mu e$	16.9 ± 0.5	54.4 ± 1.9	35.9 ± 2.3	39.7 ± 2.2	14.4 ± 0.7	11.4 ± 1.5	54.9 ± 2.3	210.6 ± 2.3	0.080
F(back.)(%)		25.8%	17.0%	18.8%	6.8%	5.3%	26.1%		

W+jets FF's changed

LH added

- FF's change reduced the W+jets somewhat, but also here other changes increased both signal and background
- The TrackMET change improved the signal as well as the S/B
- The LH affected the WW background.

Low PT Statistics

Sample Njets=0,1	Signal		Background		S/B	
	eμ	μe	eμ	μe	eμ	μe
All PT bins	158.8	89.4	1701	1510	0.093	0.059
Low PT	**34.2**	**22.6**	**405**	**352**	**0.084**	**0.064**
Low PT fraction	21.5%	25.3%	23.8%	23.3%		

- Low PT contributes 21.5% of the events and 23.8% of the background in the eμ channel
- It contributes 25.3% of the events and 23.3% of the background in the μe channel
- S/B are comparable to the All Pt bins samples
- Only the stat analysis can tell us what the real contribution is

Comments on cutflows and plots

- Recent efforts have improved the low PT sample.
  - For Njet=1 we have: background is down by 6.6%.
- Signal is up by 22%. S/B is increased by 14%

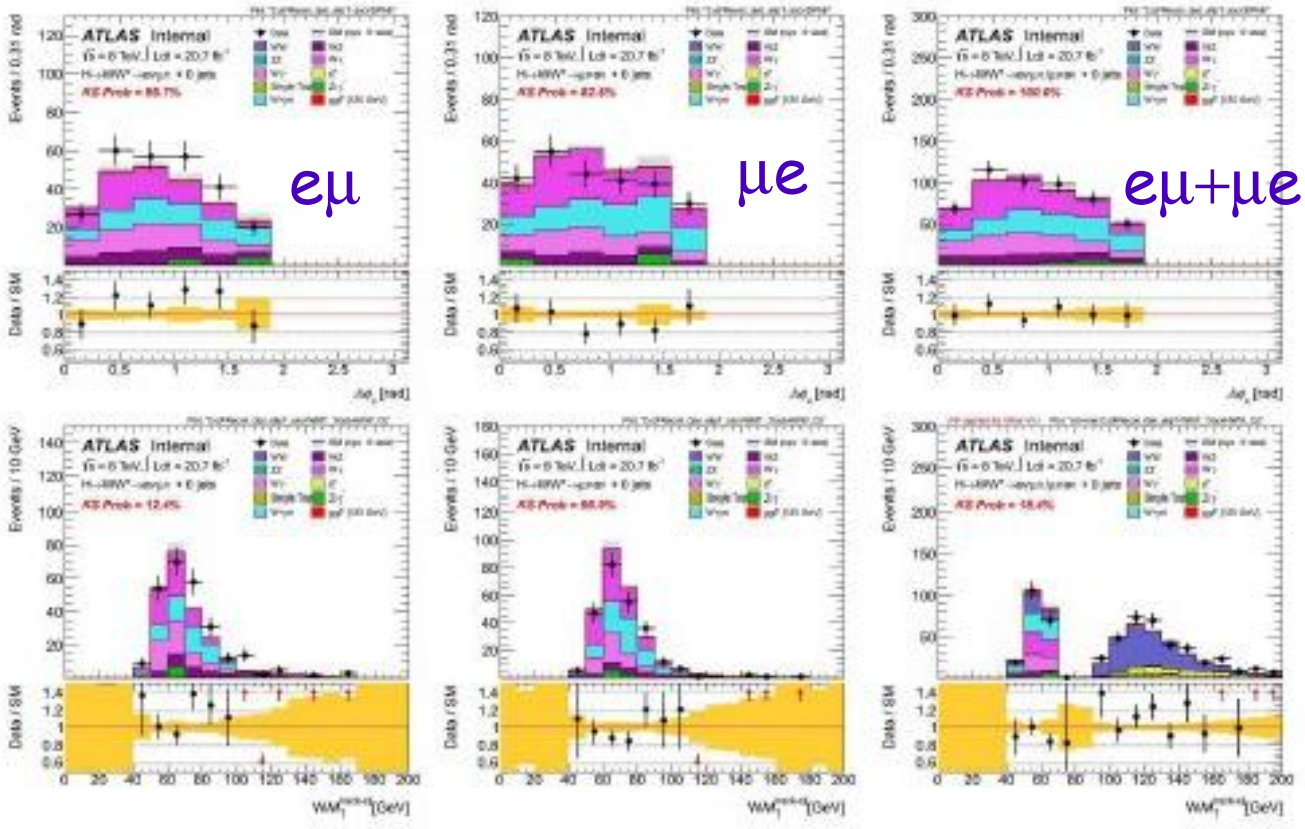
- Most important issue is related to the systematic uncertainties that will enter in the final fit. The W+jets background is about 30% of the total, but it has the largest systematics. Work on this is still going on.

- Will show a few plots here.
  A more complete set will be posted on share point
- Look at SSCR plots first, CR next, SR at the end

Normalized SS-CR, All PT : $\Delta\varphi(\ell\ell)$, MW_T

- All PT, Normalized SS-CR Njet=0: $\Delta\varphi(\ell\ell)$ (top), MW_T (bottom)
- From left: $e\mu$, μe, $e\mu + \mu e$

All Pt's



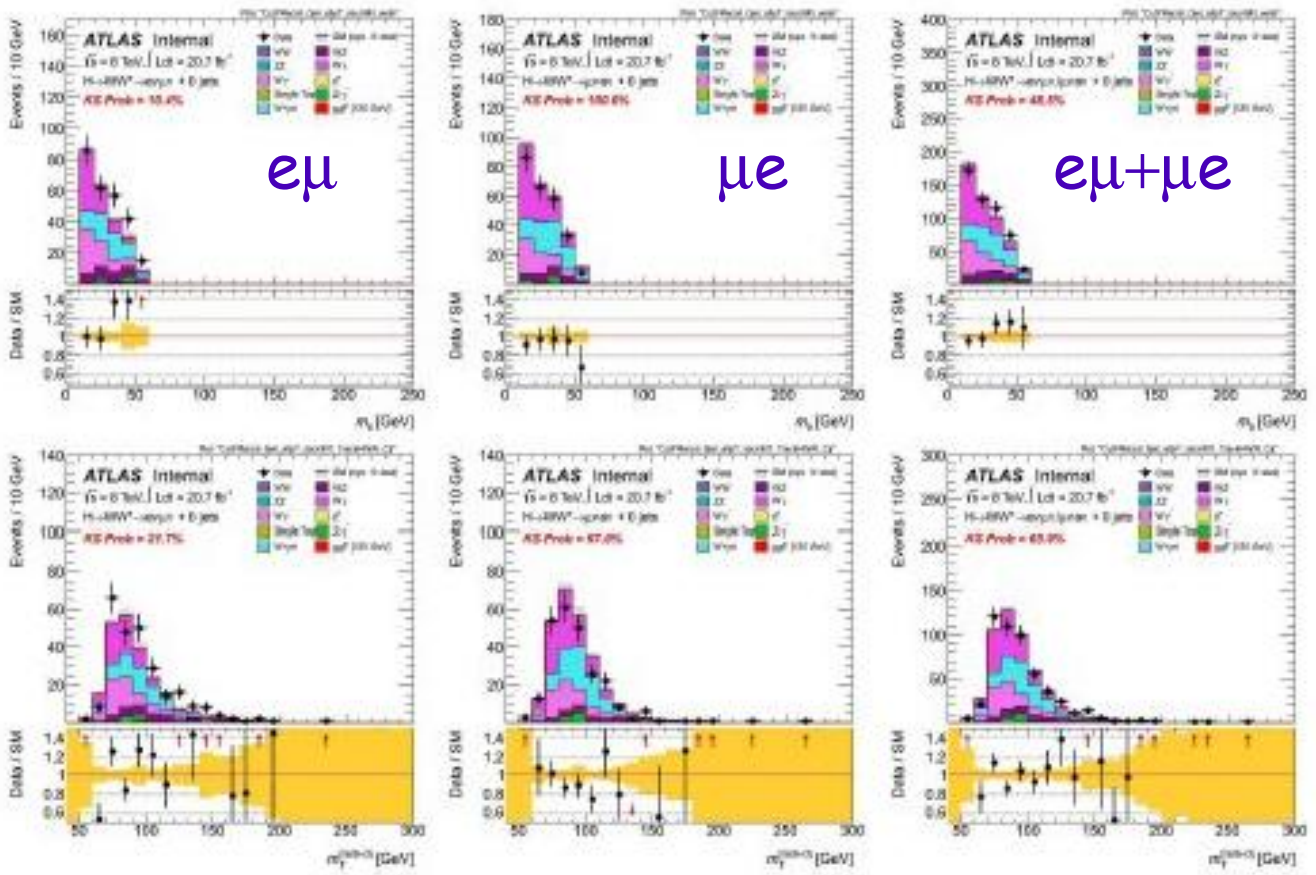
Dec 3, HSG3 Meeting | Lina Galtieri | Status of the Low PT Analysis | (7/23)

eμ: still a bit underestimated

μe: clear improvement is seen

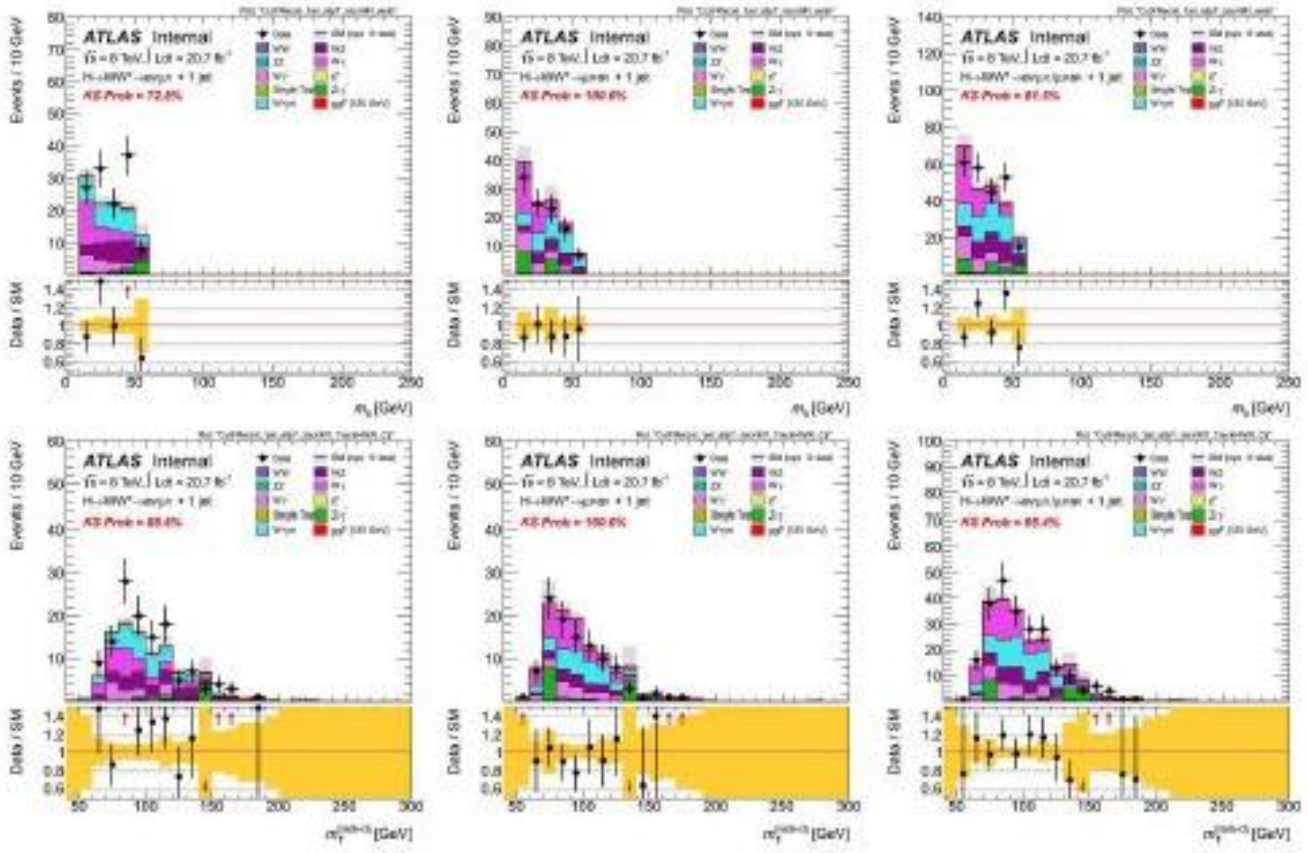
Normalized SS-CR, All PT: M_{ll}, M_T

- All PT, Normalized SS-CR Njet=0: M_{ll} (top), M_T (bottom)
- From left: $e\mu$, μe, $e\mu + \mu e$



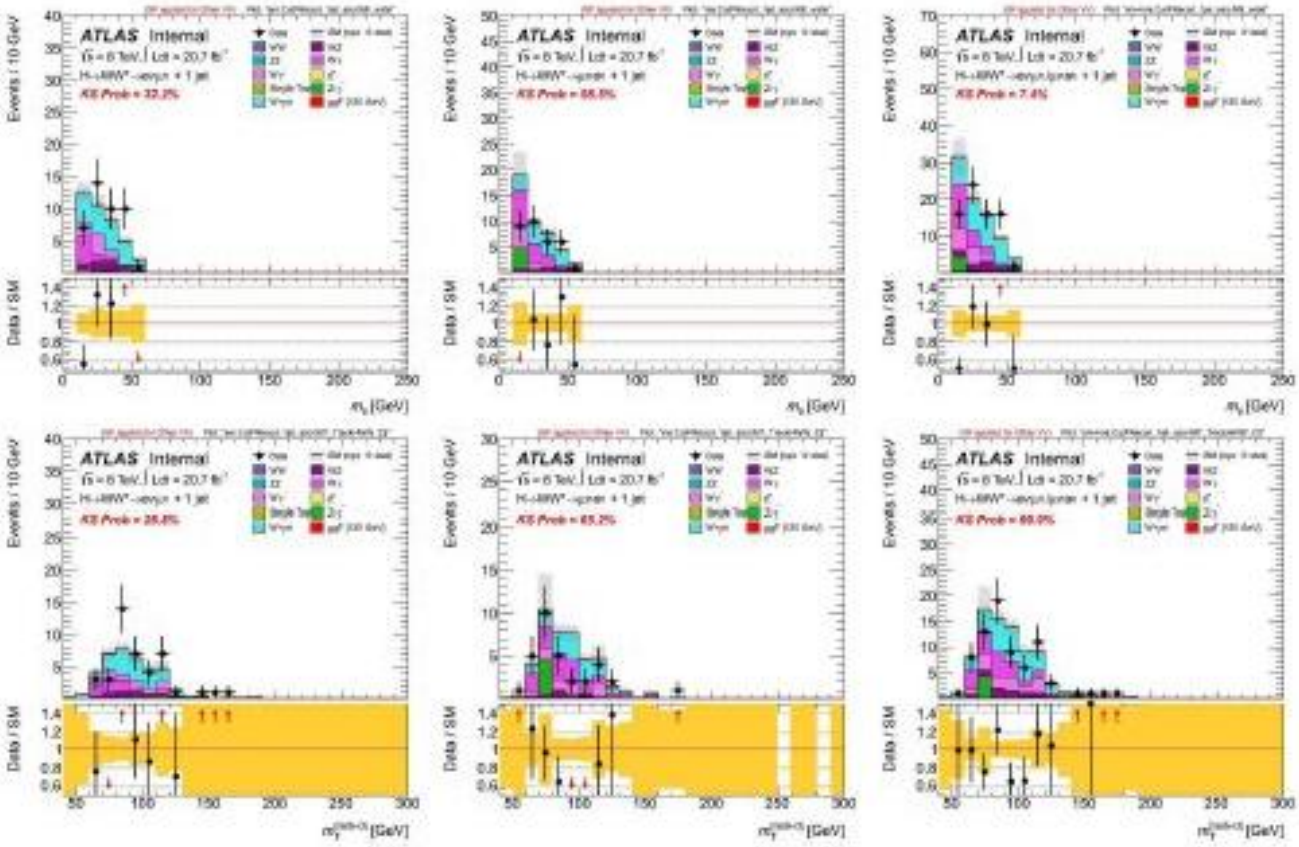
Normalized SS-CR, All PT: M_{ll}, M_T, Njet=1

- All PT, Normalized SS-CR Njet=1: M_{ll} (top), M_T (bottom)
- From left: $e\mu$, μe, $e\mu + \mu e$



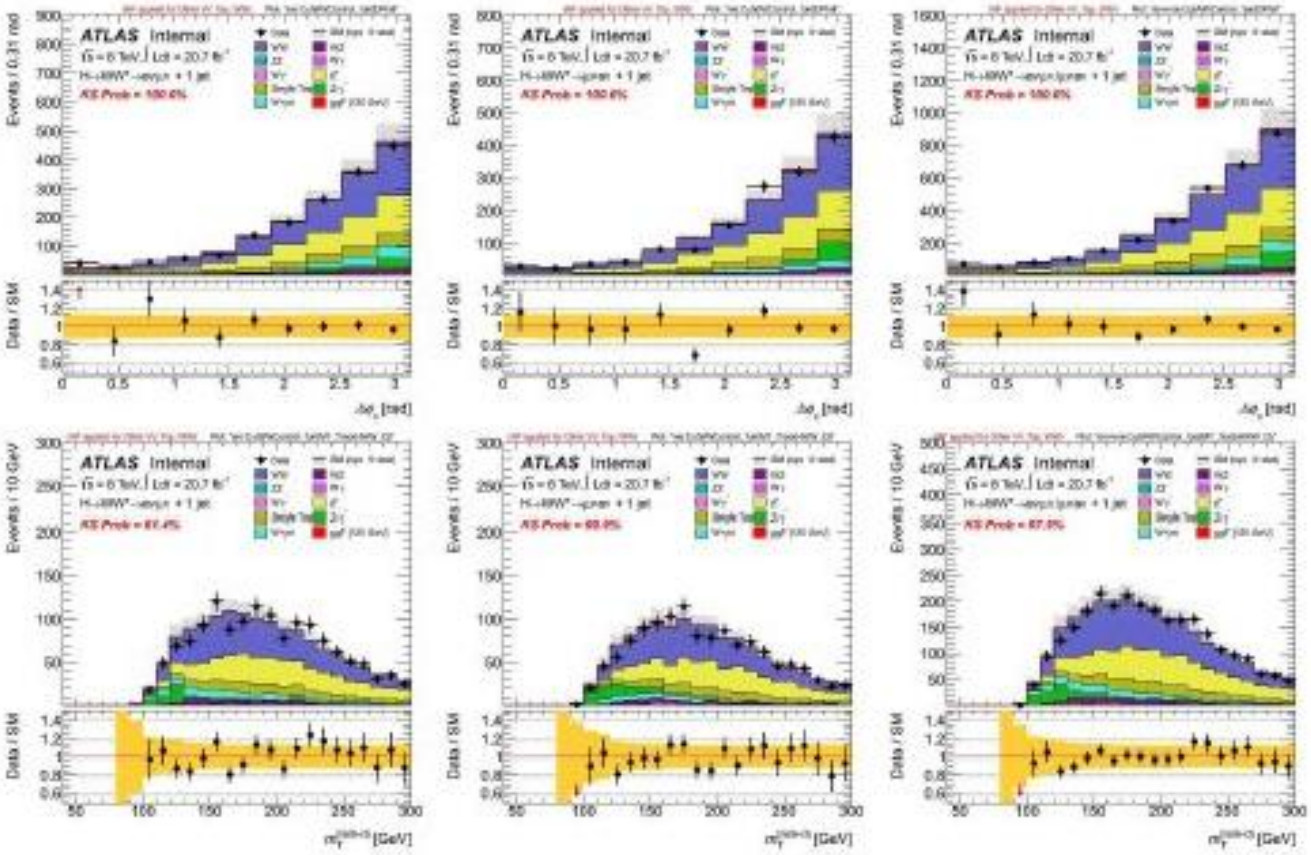
Normalized SS-CR, Low PT: M_{ll}, M_T, Njet=1

- Low PT, Normalized SS-CR Njet=1: M_{ll} (top), M_T (bottom)
- From left: $e\mu$, μe, $e\mu + \mu e$



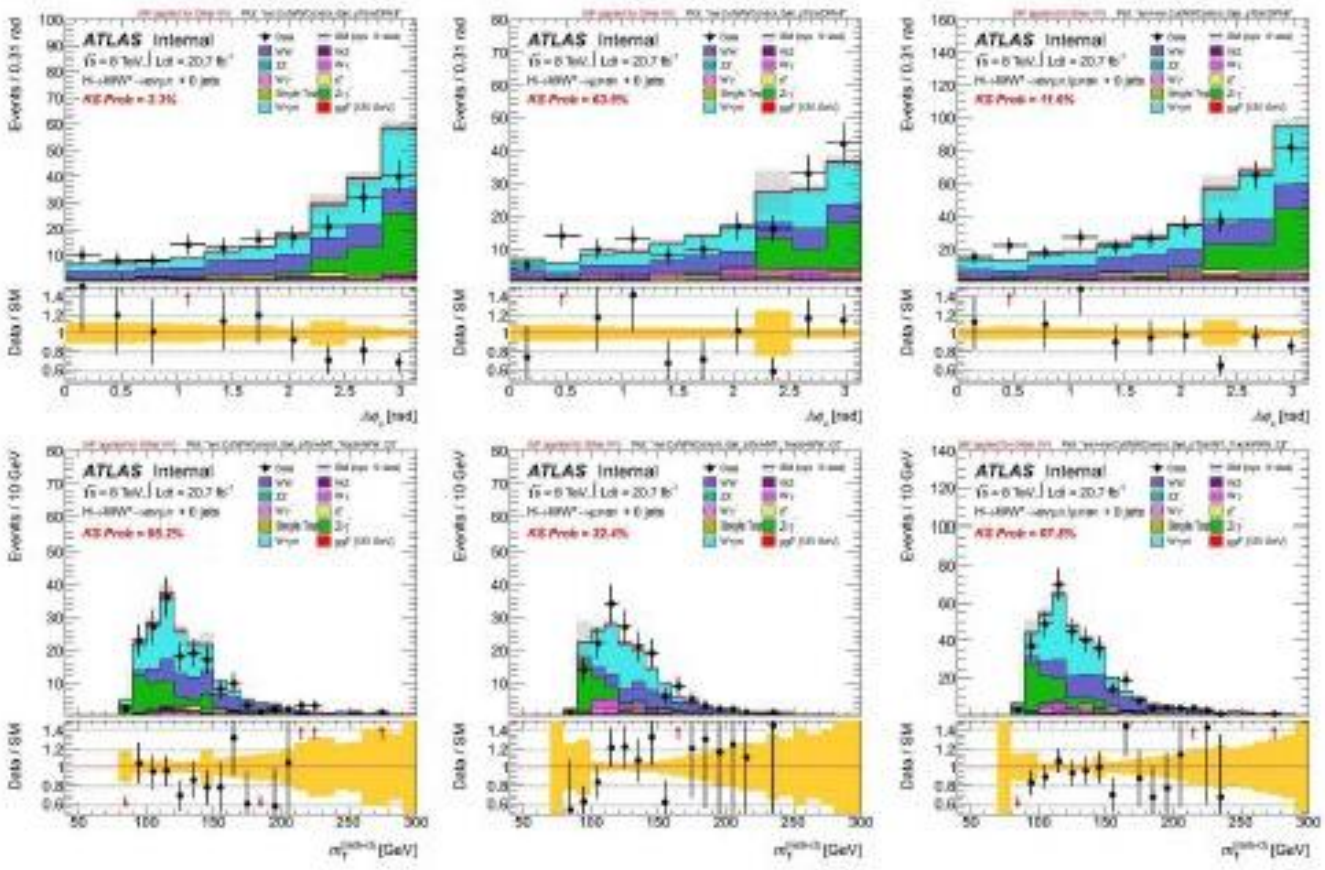
All PT, WW 1-jet CR: $\Delta\varphi(\ell\ell)$ and M_T

- ALL PT, Njets = 1, WW CR: $\Delta\varphi(\ell\ell)$ (top), M_T(bottom).
- From left: $e\mu$, μe, $e\mu + \mu e$



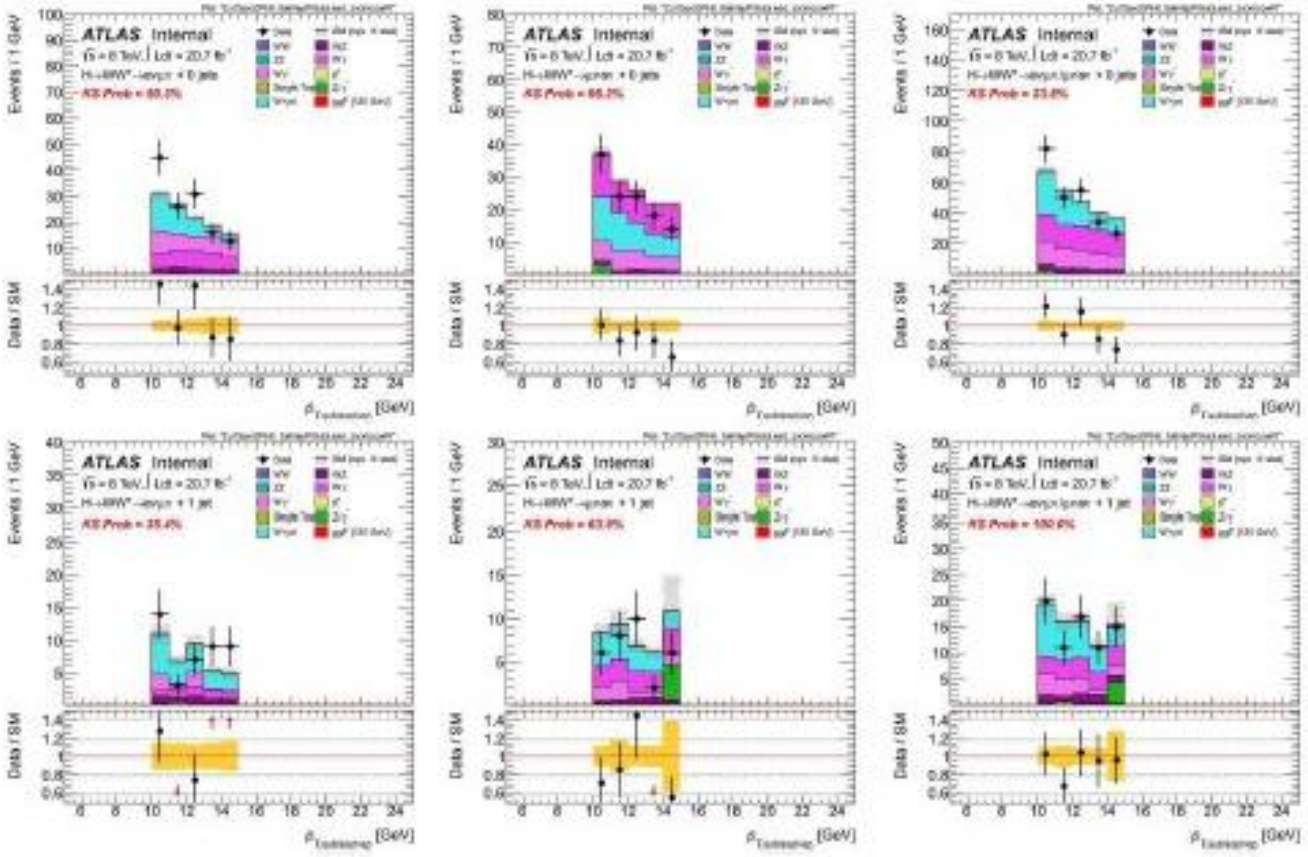
$\Delta\varphi(\ell\ell)$ and M_T in WW 0 jets CR. ALL PT

- Low PT, Njet=0, WW CR: $\Delta\varphi(\ell\ell)$ (top), M_T(bottom).
- From left: $e\mu$, μe, $e\mu + \mu e$



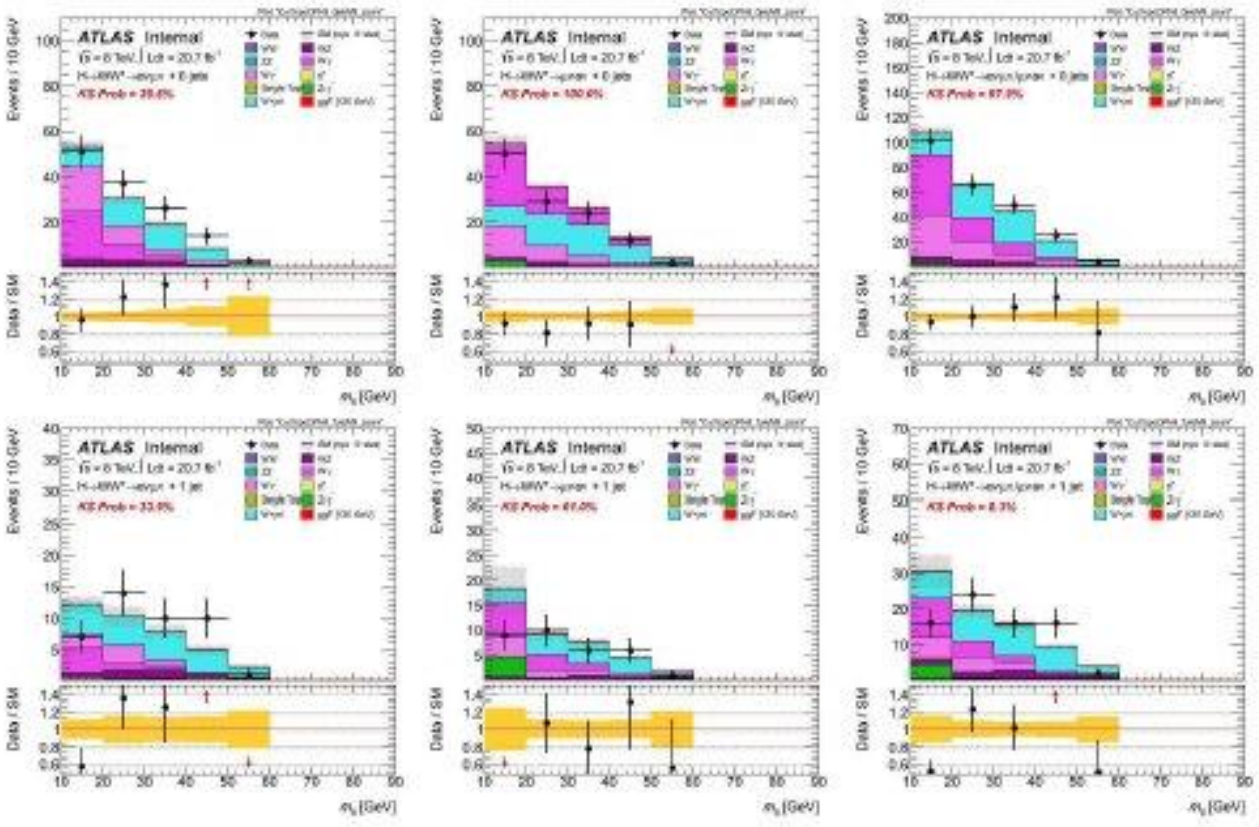
SS after $\Delta\varphi(\ell\ell)$ cut: SubLeading Lepton P_T

- SS after $\Delta\varphi(\ell\ell)$ cut: SubLeading Lepton P_T, Njet=0 (top), Njet=1 (bottom)
- From left for: $e\mu$, μe, $e\mu + \mu e$.



SS after $\Delta\varphi(\ell\ell)$ cut: $M_{\ell\ell}$

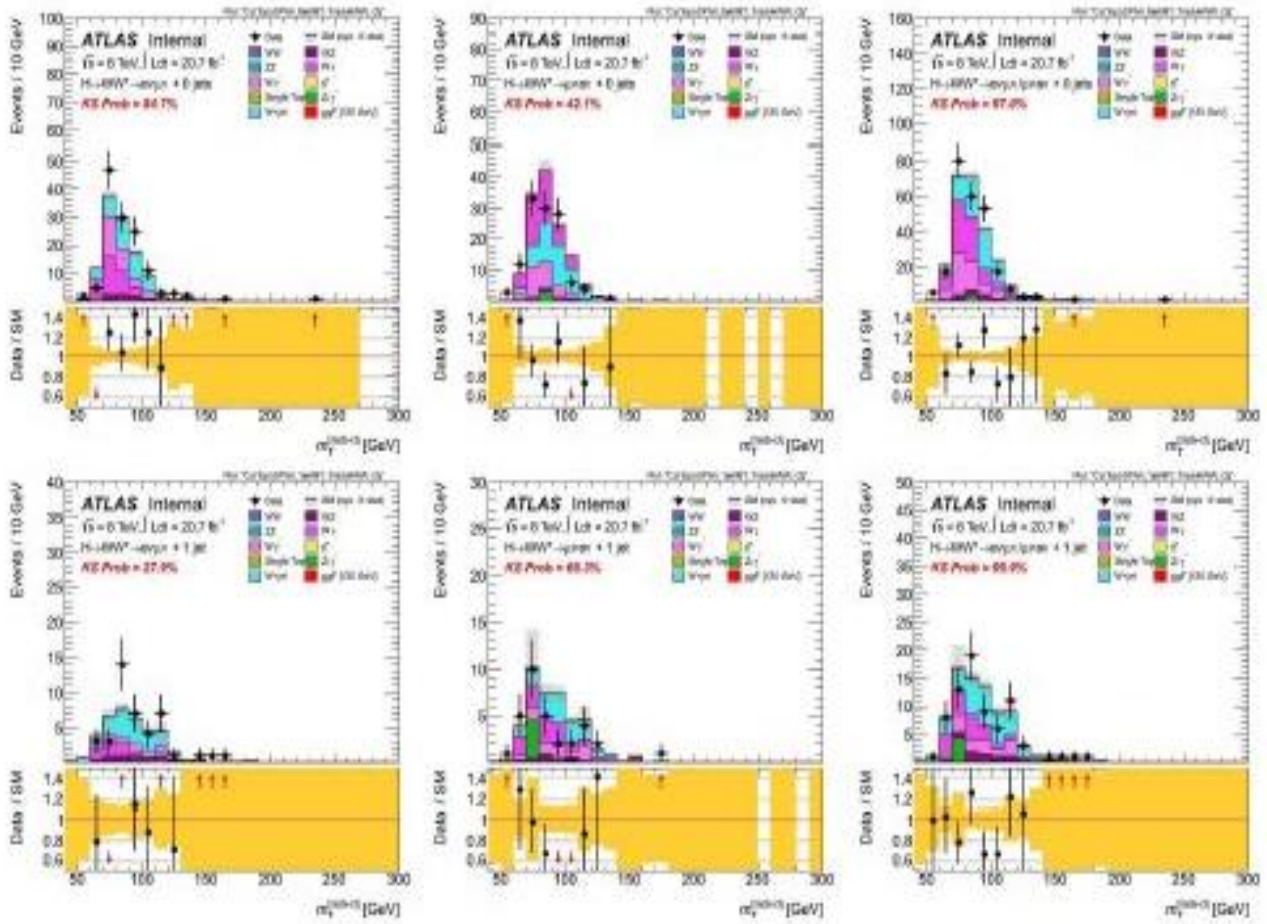
- SS $M_{\ell\ell}$ after $\Delta\varphi(\ell\ell)$ cut: Njet=0 (top), Njet=1 (bottom)
- From left for: $e\mu$, μe, $e\mu + \mu e$



good Data/MC agreemen

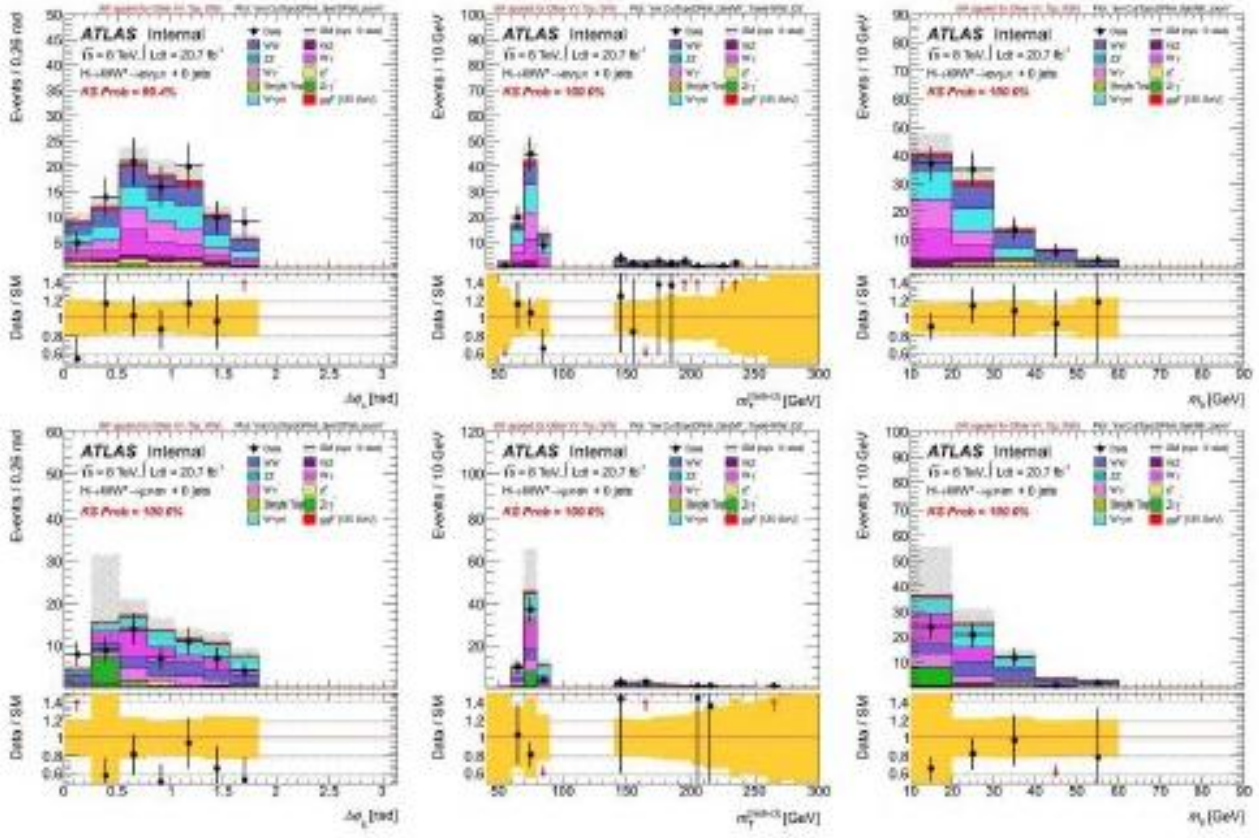
SS Plots after $\Delta\varphi(\ell\ell)$ cut: M_T

- Top: SS M_T after $\Delta\varphi(\ell\ell)$ cut, Njet=0 for $e\mu$, μe, $e\mu + \mu e$
- Bottom: SS M_T after$\Delta\varphi(\ell\ell)$ cut, Njet=1 for $e\mu$, μe, $e\mu + \mu e$



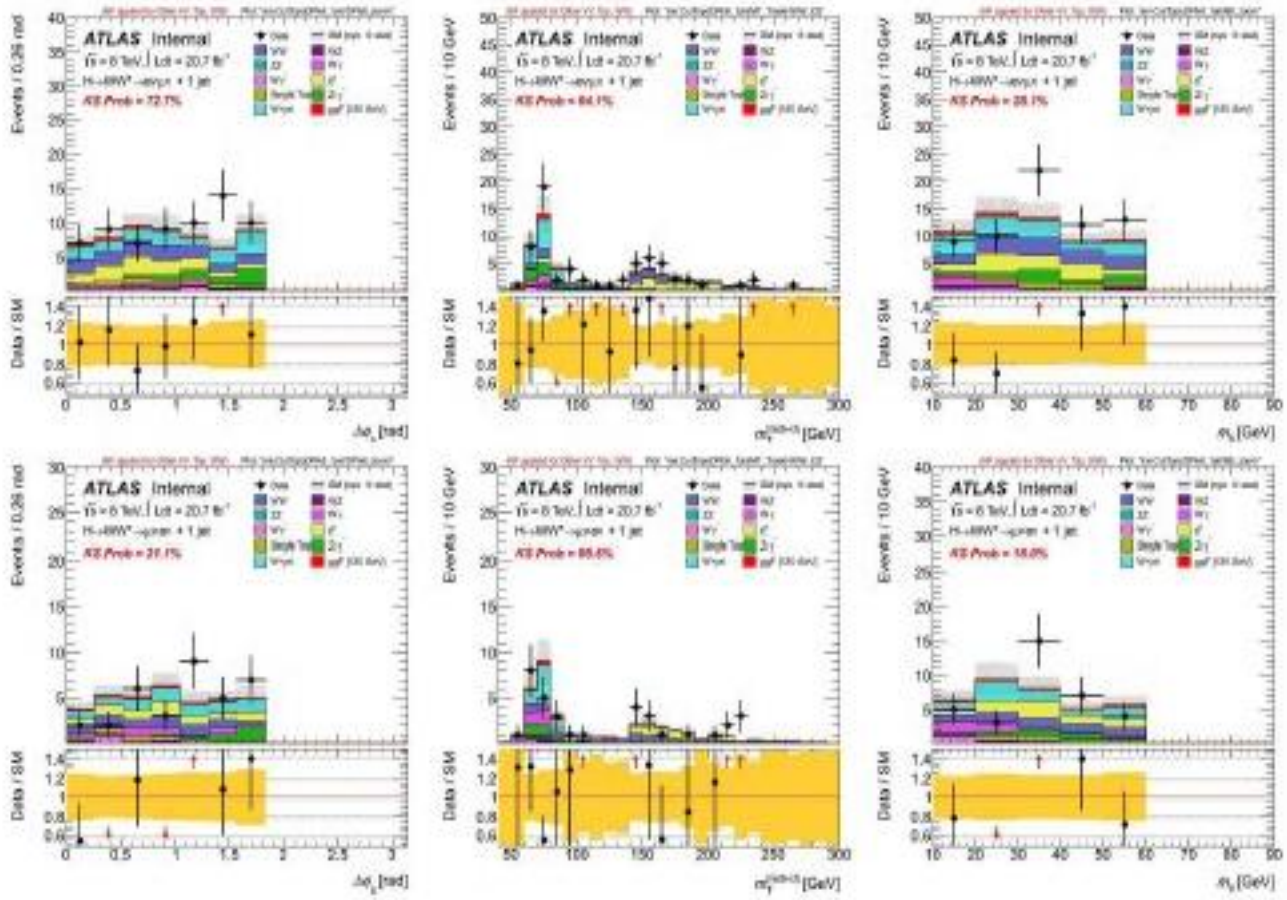
Blinded SR, $\Delta\varphi(\ell\ell) < 1.8$: $\Delta\varphi(\ell\ell)$,M_T,M_{ll}, Njet=0

- Blinded SR, Njet=0, $\Delta\varphi(\ell\ell) < 1.8$: $\Delta\varphi(\ell\ell)$, M_T, M_{ll}
- Top: $e\mu$. Bottom: μe



Blinded SR, $\Delta\varphi(\ell\ell) < 1.8$: $\Delta\varphi(\ell\ell), M_T, M_{ll}$, Njet=1

- Njet=1 Blinded SR after $\Delta\varphi(\ell\ell) < 1.8$ cut: $\Delta\varphi(\ell\ell)$, M_T, M_{ll},
- Top: $e\mu$. Bottom: μe



Summary of Observations

- Cutflows: low pT contribution is 22-25% of the signal, and 23% contribution to the background
- The new lepton selection has decreased the em W+jets background by over 20%. However, with the new TrackMet baseline, we increase a bit this background.
- SSCR plots of low pT events look good
- Opposite sign CR's: data/MC for eμ and μe channel look good
- The eμ channel background has improved, but still is somewhat underestimated. For the μe channel Data/MC agreement has improved, but it is not perfect.

What remains to be done

- Finalize W+jet background:
  Fake factors, systematics etc
  (see Keysuke's talk)
- Add Same Flavor Analysis
- Add 2011 Data
- Include low Pt in the VBF Analysis

Backup

Normalization Factors

Normalization Factors obtained with the new baseline except
Recent changes to Z-> tt CR's and new WW MC

HWWAnalysisCode 2012: Normalization factors:
HWWAnalysisCode 2012: SSCR(em,me) 0jet = 1.043 +/- 0.073
HWWAnalysisCode 2012: SSCR(em,me) 1jet = 1.061 +/- 0.132
HWWAnalysisCode 2012: Ztautau(em,me) 1jet = 1.055 +/- 0.019
HWWAnalysisCode 2012: Ztautau(em,me) 0jet = 0.996 +/- 0.020
HWWAnalysisCode 2012: Top(em,me) 0jet = 0.993 +/- 0.000
HWWAnalysisCode 2012: Top(em,me) 1jet = 0.968 +/- 0.014
HWWAnalysisCode 2012: Top(em,me) incl = 1.001 +/- 0.005
HWWAnalysisCode 2012: WW(em,me) 0jet = 1.198 +/- 0.034
HWWAnalysisCode 2012: WW(em,me) 1jet = 1.081 +/- 0.049