

Strong SUSY 2L Search with ATLAS

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on behalf of the ATLAS Collaboration

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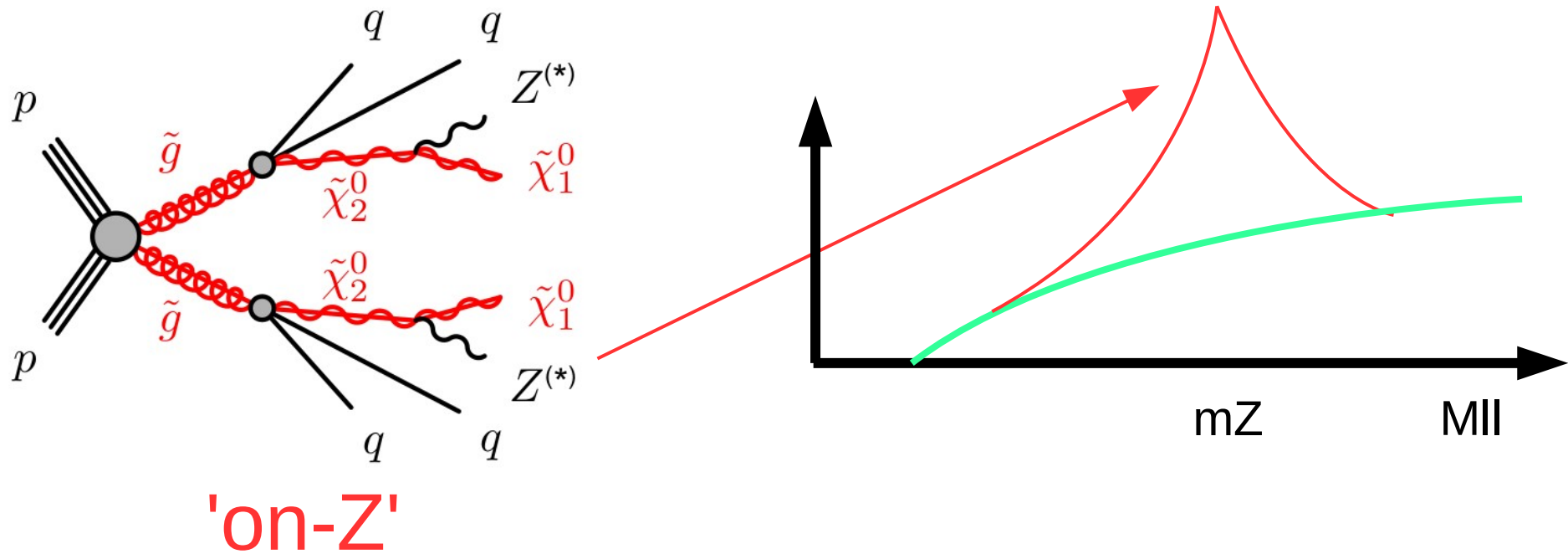


July 4th, 2016

SUSY 2016



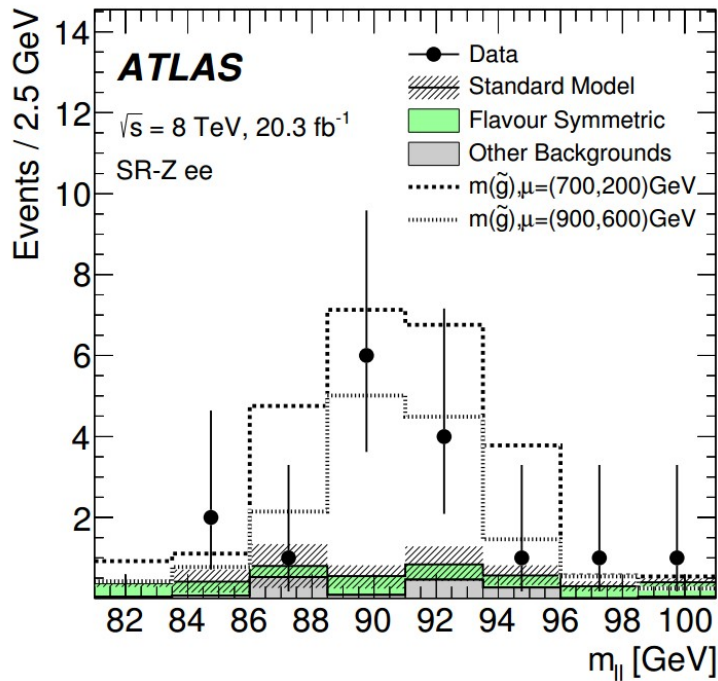
Analysis Overview



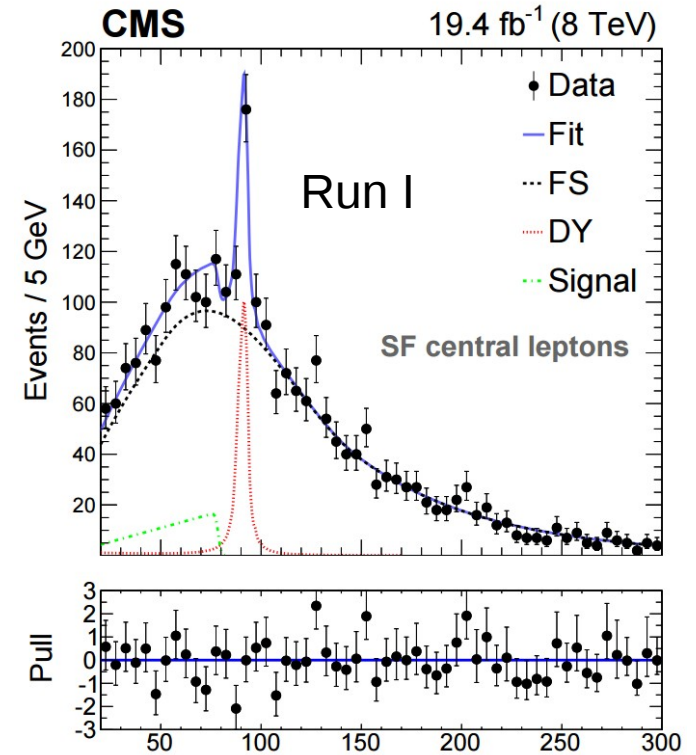
- Two opposite-sign leptons ($\geq 2L$)
 - $p_T > 50/25$ GeV
- At least two jets (30 GeV)
- MET > 225 GeV

December CONF:
[ATLAS-CONF-2015-082](#)

Run I Recap



Run I ATLAS
Run I CMS



- **ATLAS**
 - On-Z: 3 sigma (mostly ee)
 - Edge: No Excesses
- **CMS**
 - Run I: 2.6 sigma below Z, 0 sigma on-Z
 - Run II: See Next Talk

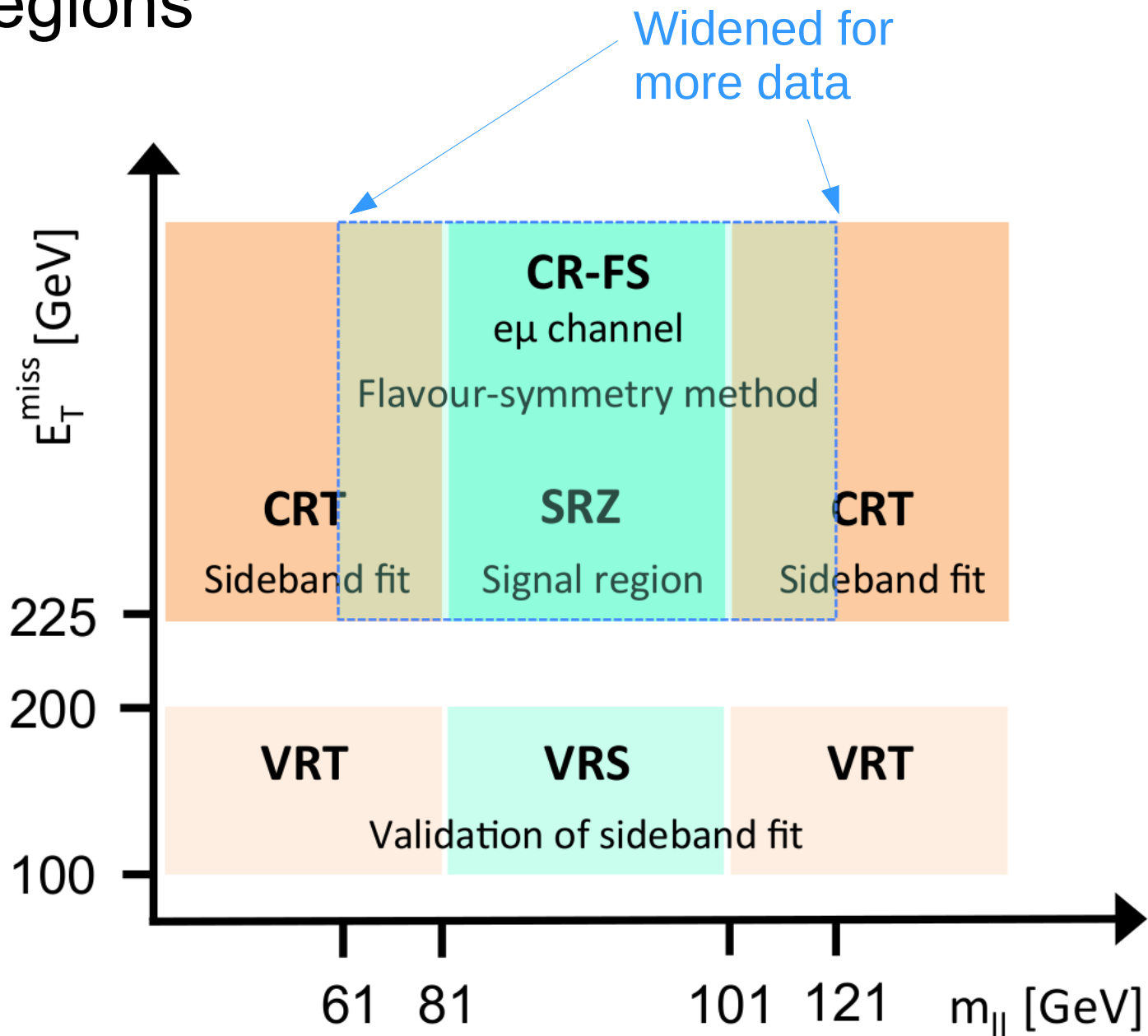
Region Definitions

H_T includes jets
and leptons

- On-Z, same selection as Run I: $\text{MET} > 225 \text{ GeV}$, $H_T > 600 \text{ GeV}$
- Many validation regions

Region	E_T^{miss} [GeV]	H_T [GeV]	n_{jets}	$m_{\ell\ell}$ [GeV]	SF/DF	$\Delta\phi(\text{jet}_{12}, p_T^{\text{miss}})$	$m_T(\ell_3, E_T^{\text{miss}})$ [GeV]	$n_{\text{b-jets}}$
Signal regions								
SRZ	> 225	> 600	≥ 2	$81 < m_{\ell\ell} < 101$	SF	> 0.4	-	-
Control regions								
Z normalisation	< 60	> 600	≥ 2	$81 < m_{\ell\ell} < 101$	SF	> 0.4	-	-
CR-FS	> 225	> 600	≥ 2	$61 < m_{\ell\ell} < 121$	DF	> 0.4	-	-
CRT	> 225	> 600	≥ 2	$m_{\ell\ell} \notin [81, 101]$	SF	> 0.4	-	-
Validation regions								
VRZ	< 225	> 600	≥ 2	$81 < m_{\ell\ell} < 101$	SF	> 0.4	-	-
VRT	100–200	> 600	≥ 2	$m_{\ell\ell} \notin [81, 101]$	SF	> 0.4	-	-
VRS	100–200	> 600	≥ 2	$81 < m_{\ell\ell} < 101$	SF	> 0.4	-	-
VR-FS	100–200	> 600	≥ 2	$61 < m_{\ell\ell} < 121$	DF	> 0.4	-	-
VR-WZ	100–200	-	-	-	3ℓ	-	< 100	0
VR-ZZ	< 100	-	-	-	4ℓ	-	-	0
VR-3L	60–100	> 200	≥ 2	$81 < m_{\ell\ell} < 101$	3ℓ	> 0.4	-	-

On-Z Regions



Background Estimation

- Flavor-symmetric backgrounds (50%)
 - _ $t\bar{t}$, WW , $Z \rightarrow \tau\tau$
 - _ Data-driven from $e\mu$ data
- Z+jets (20%)
 - _ Enters SR via fake MET
 - _ MET estimated with γ +jets data
- $t\bar{t}+V$ (<5%) and dibosons (30%)
 - _ Taken from MC
- Fakes (negligible)
 - _ Checked in MC and with data-driven estimate (matrix method)

Bkg. Est: Flavor Symmetric Backgrounds

Use DF data to predict SF

- ~75% ttbar, ~10% Wt, ~10% WW $N_{ee}^{\text{est}} = \frac{1}{2} \times N_{e\mu}^{\text{data}} \times k_{ee}(p_T, \eta) \times \alpha(p_T, \eta) f_{Z\text{-mass}} f_{\text{non-FS}}$
- MII 61-121 GeV DF data (CR-FS) $N_{\mu\mu}^{\text{est}} = \frac{1}{2} \times N_{e\mu}^{\text{data}} \times k_{\mu\mu}(p_T, \eta) \times \alpha(p_T, \eta) f_{Z\text{-mass}} f_{\text{non-FS}}$
 - pT and eta dependent corrections measured (on-Z with ≥ 2 jets) in data and MC applied
- On-Z fraction from ttbar MC
- Cross-check with sideband fit and in on-Z but low MET region (VRS)

$$k_{ee}(p_T, \eta) = \sqrt{\frac{N_{ee}^{\text{meas}}}{N_{\mu\mu}^{\text{meas}}}}$$

$$k_{\mu\mu}(p_T, \eta) = \sqrt{\frac{N_{\mu\mu}^{\text{meas}}}{N_{ee}^{\text{meas}}}}$$

$$\alpha(p_T, \eta) = \frac{\sqrt{\epsilon_{\text{trig}}^{ee} \times \epsilon_{\text{trig}}^{\mu\mu}}}{\epsilon_{\text{trig}}^{e\mu}}$$

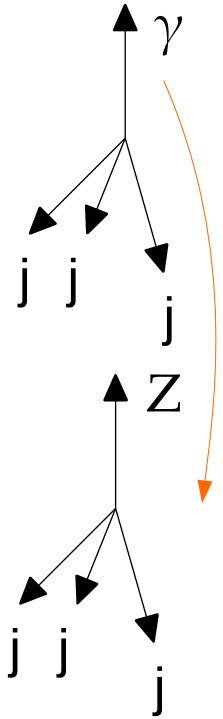
efficiency
trigger

Region	Flavour-symmetry	Sideband fit
SRZ	5.1 ± 2.0	6.1 ± 1.7
VRS	18.9 ± 4.8	20.5 ± 5.6

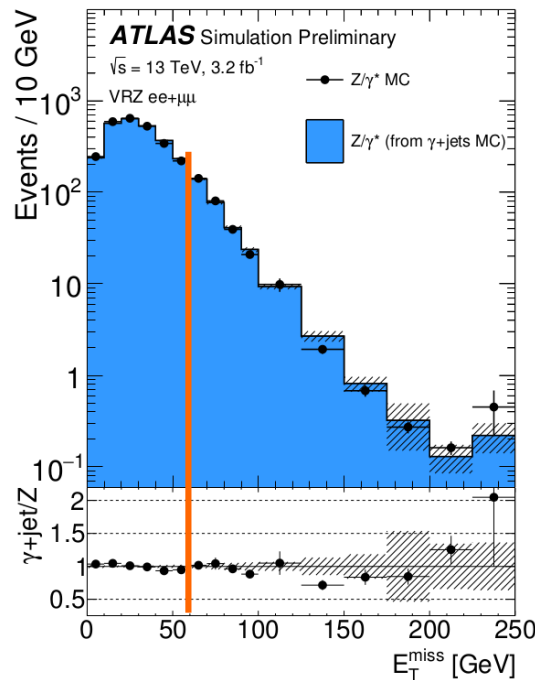
Bkg. Est: Z+jets

$$(p_T(Z) \gg m_Z)$$

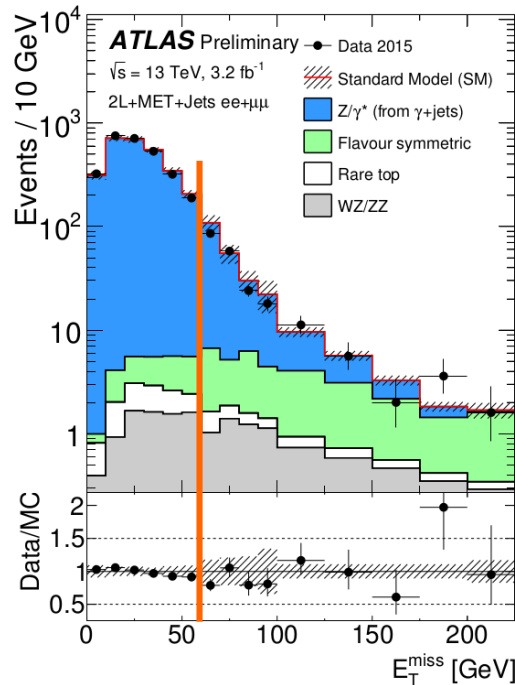
- Z+jets and photon+jets are similar in the right regime
- Use photon+jets as MET template and Z+jets MC for MII shape
- Reweight photon p_T to match Z p_T spectrum
- Smear photon resolution to match that of Z, for $\mu\mu$ channel
 - Lepton mismeasurement is important after $\Delta\Phi(\text{jet}, \text{MET})$



MC
Closure
on-Z



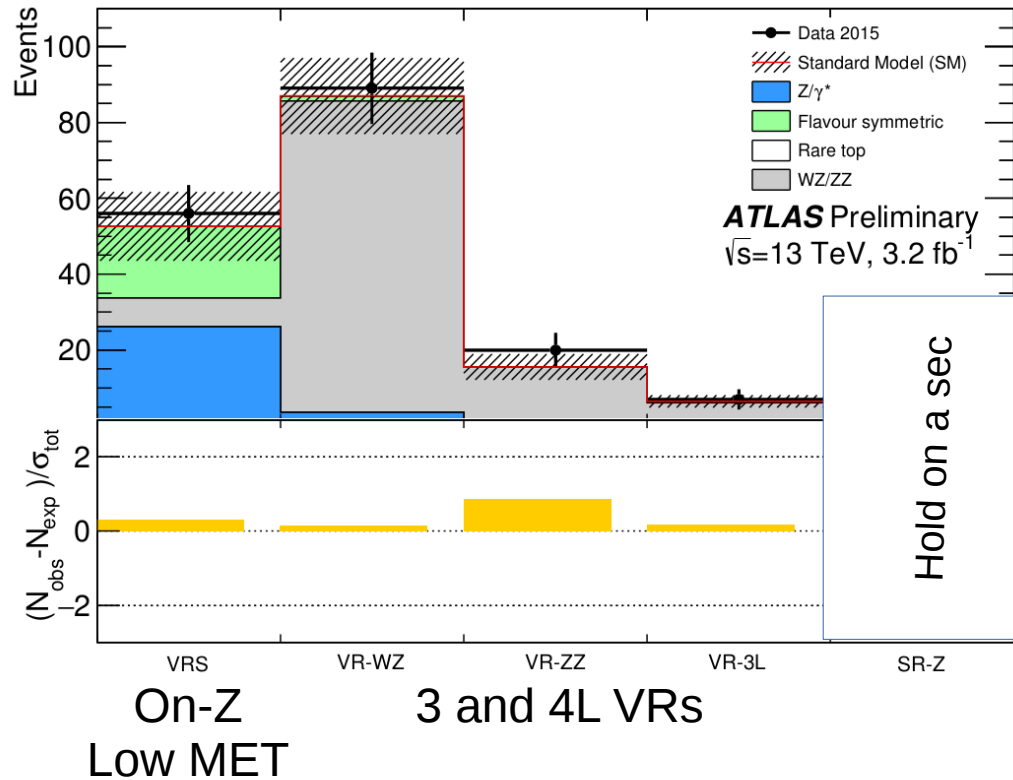
Data
Closure
on-Z



Normalize to MET < 60 GeV

Bkg. Est: Dibosons and Other

- Diboson
 - $WZ \rightarrow l\nu ll$ and $ZZ \rightarrow ll\nu\nu$
 - MC based
 - 3 and 4L validation regions
- Other
 - $tt+V(V)$ from MC

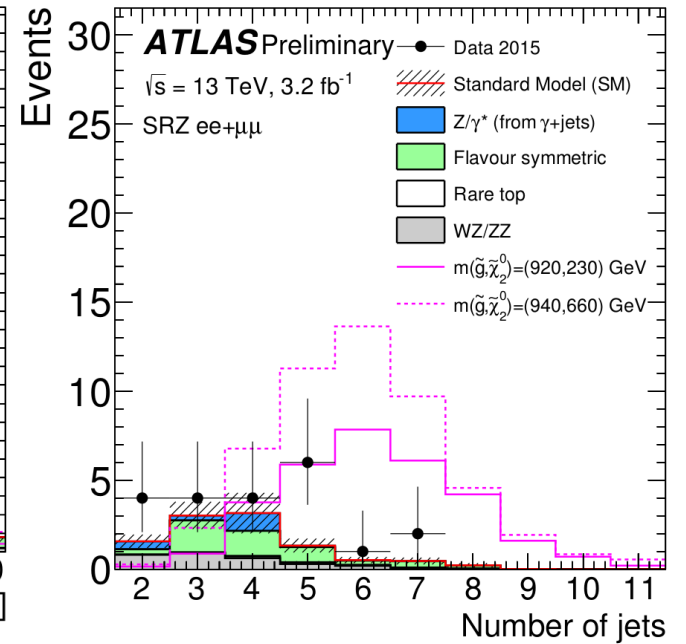
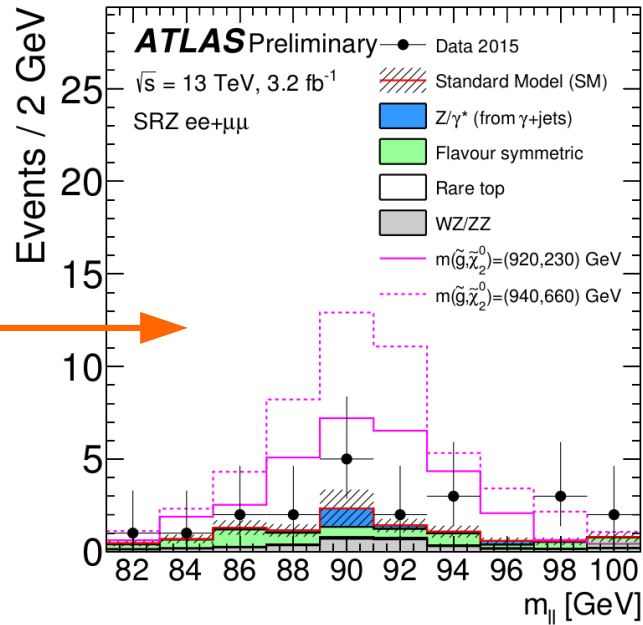
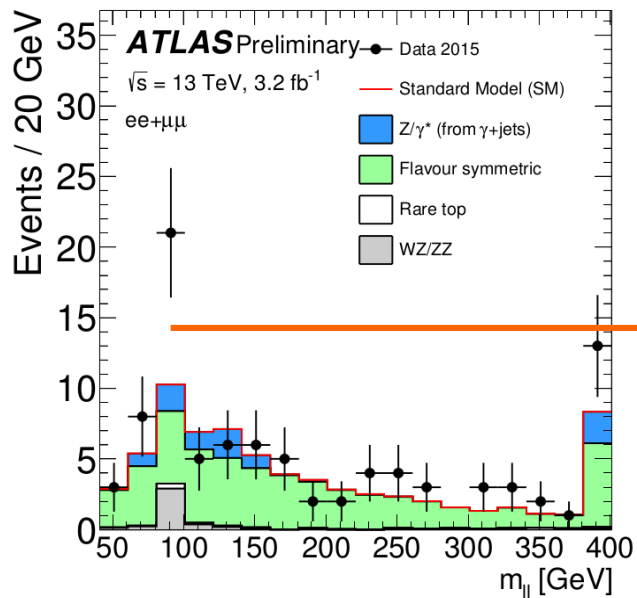


Uncertainties

- Mostly flavor-symmetry CR-FS yields and systematics
- Flavor-symmetry systs from measurement of correction factors, Mll extrapolation, and MC non-closure
- Z+jets syst mostly from boson pT reweighting

Source	Relative to total background Relative systematic uncertainty [%]
	SRZ
Total systematic uncertainty	22
Flavour symmetry (statistical)	14
Flavour symmetry (systematic)	12
Z/ γ^* + jets (systematic)	7.8
WZ generator uncertainty	7.6
Z/ γ^* + jets (statistical)	2.2

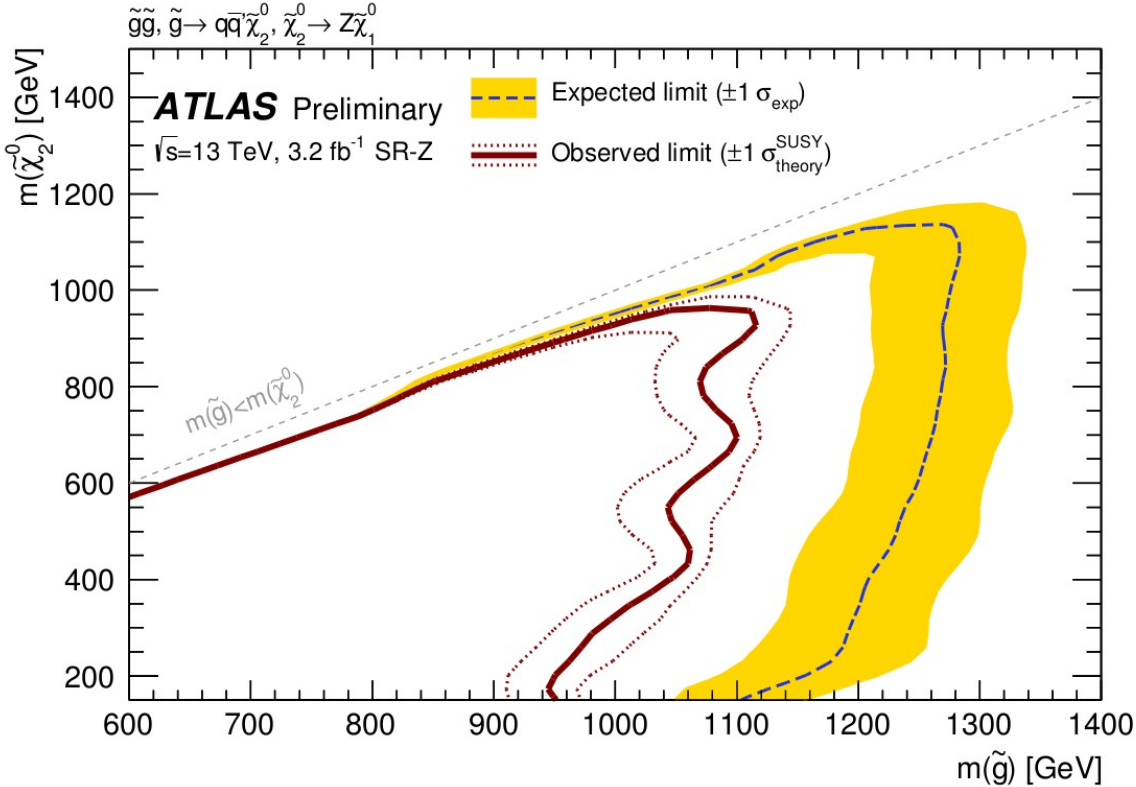
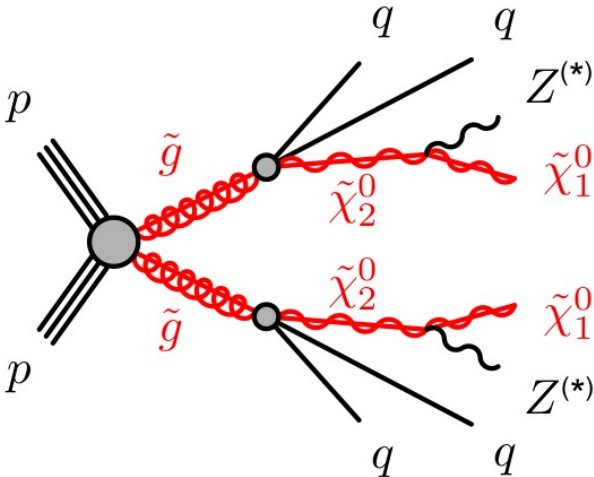
On-Z Results



- 21 events observed (10 ee, 11 $\mu\mu$)
- 10.3 ± 2.3 expected bkg.
- 2.2σ excess

Interpretation

- Simplified model
- Probing > 1 TeV gluino masses
- LSP mass of 1 GeV (GGM inspired)



Conclusion

- Preliminary ATLAS Strong 2L SUSY search results in Run II
- We observe an excess in the on-Z analysis at the level of 2.2σ
- A simplified model is used to interpret the data and set limits probing >1 TeV gluino masses

Looking forward to 2016 data!

Thanks,
and Happy Higgs-dependence day!

Backup

VR Yields

	VRS	VR-WZ	VR-ZZ	VR-3L
Observed events	56	89	20	7
Total expected background events	52.6 ± 9.1	87 ± 10	15.5 ± 3.4	6.5 ± 1.6
Flavour symmetric ($t\bar{t}$, Wt , WW and $Z \rightarrow \tau\tau$) events	18.9 ± 4.8	1.3 ± 0.4	0	0.3 ± 0.2
WZ/ZZ events	7.5 ± 1.7	82 ± 10	15.5 ± 3.4	4.9 ± 1.6
$Z/\gamma^* + \text{jets}$ events	24.8 ± 7.6	2.7 ± 2.8	0	0.2 ± 0.2
Rare top events	1.4 ± 0.2	0.9 ± 0.4	0.04 ± 0.02	1.0 ± 0.1

Further SRZ Distributions

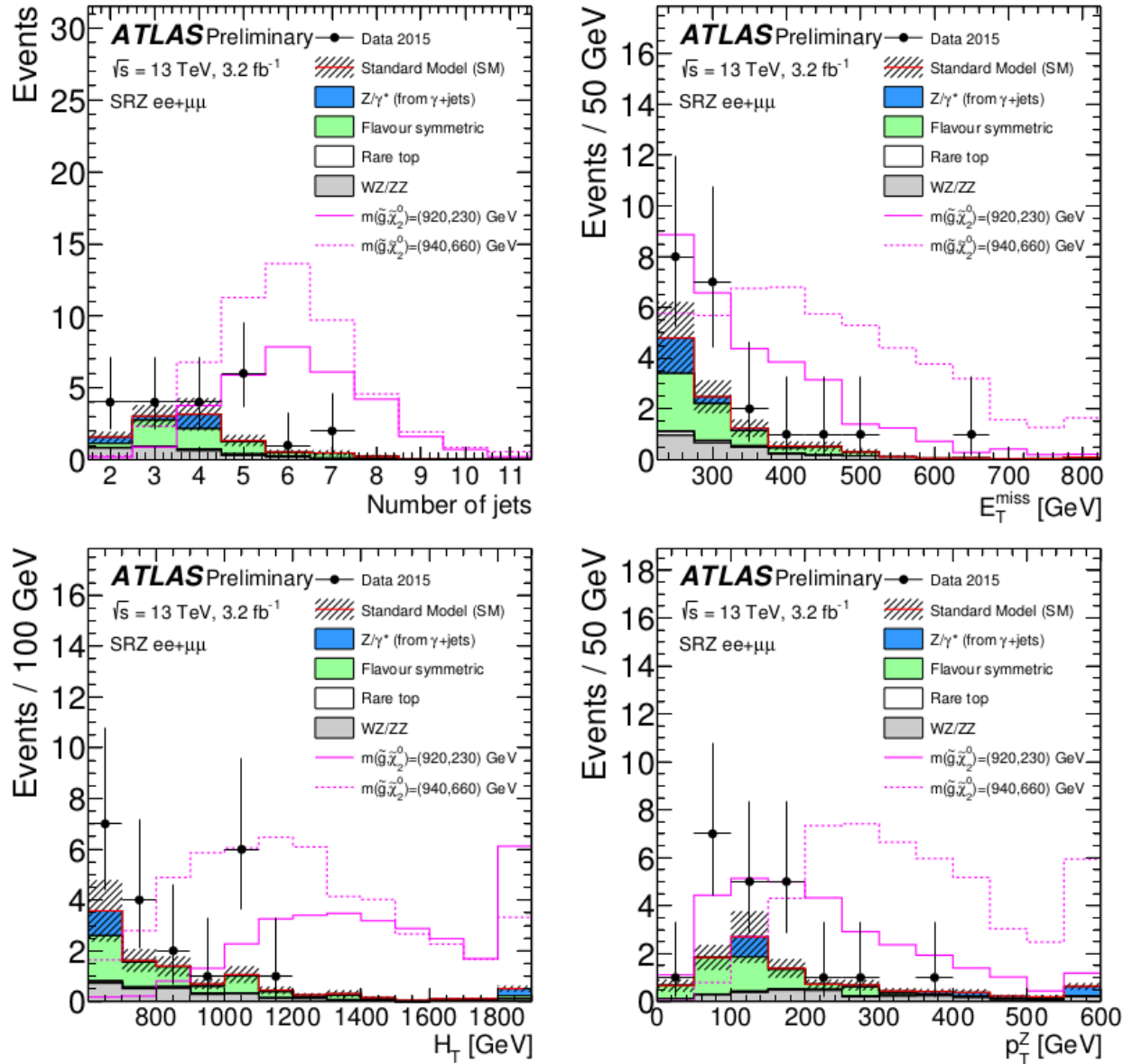


Figure 6: The jet multiplicity (top left), E_T^{miss} (top right), H_T (bottom left) and p_T^Z (bottom right) distributions in SRZ. Two example signal models with $(m(\tilde{g}), m(\tilde{\chi}_2^0)) = (940, 660) \text{ GeV}$ and $(m(\tilde{g}), m(\tilde{\chi}_2^0)) = (920, 230) \text{ GeV}$ are overlaid. In the case of the E_T^{miss} , H_T and p_T^Z distributions, the last bin contains the overflow. The hatched uncertainty band includes the statistical and systematic uncertainties on the background prediction.

- Different flavor region of SRZ, normalized to FS estimate in SRZ

