

Supersymmetry searches: 2L-EWK analysis

Eric Ballabene

ATLAS Milano Meeting

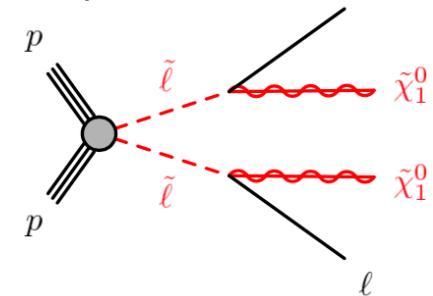
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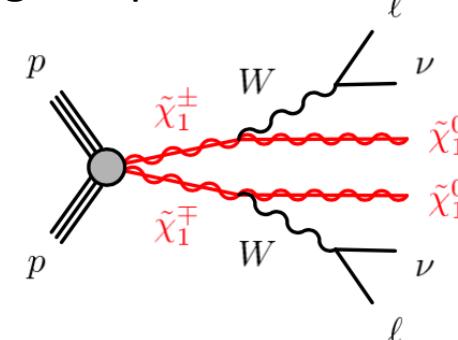
Introduction

- 2nd wave analysis (2nd analysis exploiting full run2) targets two different scenarios

Slepton production

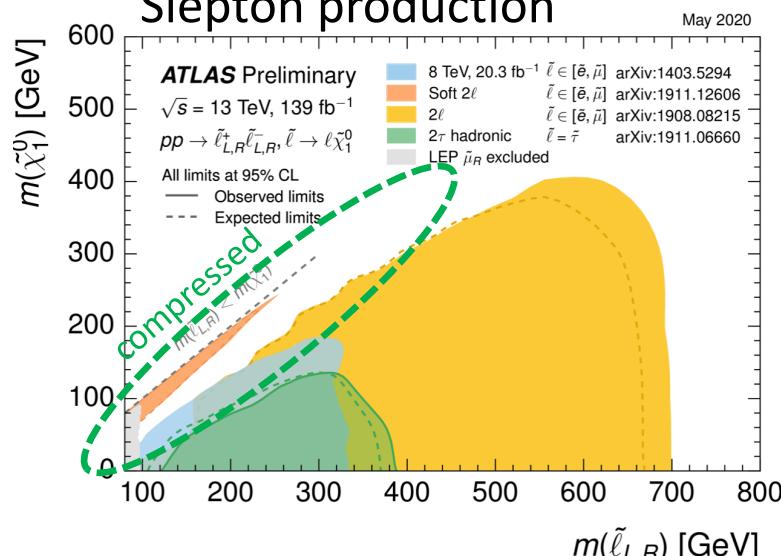


Charginos production

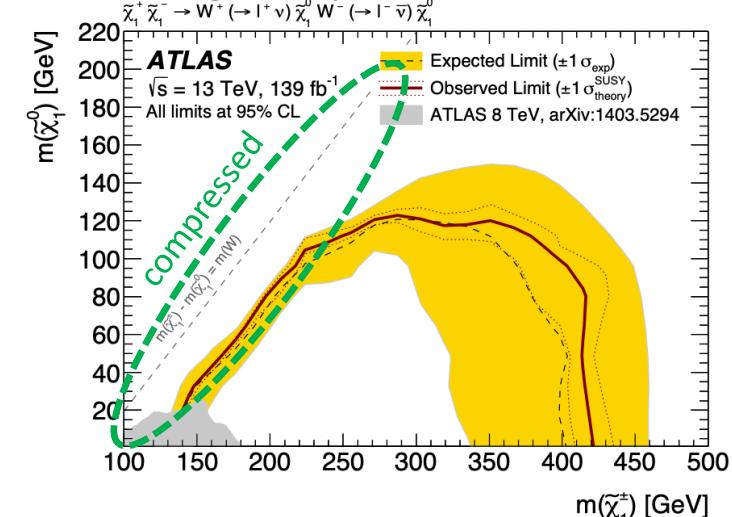


- New search to target the compressed mass spectra

Slepton production



Charginos production



Timescale

- Analysis targeting directly for a paper ~ early next year.
- EB request accepted, INT note [here](#)

Milestones:

✓ PAR

✓ EB request, accepted:
Jonathan Long (chair)
Antonella De Santo
Elodie Deborah Ressegue

✗ 1st complete int. note
draft to the EB

✗ FAR

✗ Unblinding

✗ ...



ATLAS Note

ANA-SUSY-2019-02-INT1

5th November 2020



Search for direct production of charginos and sleptons with mass splittings near the electroweak scale decaying into final states with two leptons and missing transverse momentum in $\sqrt{s} = 13 \text{ TeV}$ pp collision with the ATLAS detector

J. Assahsah⁸, E. Ballabene⁵, A. Barr¹, S. Carrà², G. Gallardo¹, E. Gorini³, E. Gramstad⁴, F. Gravili³, M. Greco³, T. Lari⁵, C. Lester⁷, L. Longo⁶, F. Meloni², D. Noel⁷, H. Oppen⁴, F. Ould-Saada⁴, H. Pacey⁷, C. Potter⁷, M. Primavera³, M. Reale³, J. Sabater Iglesias², H. Sandaker⁴, A. Ventura³, S. Williams⁷

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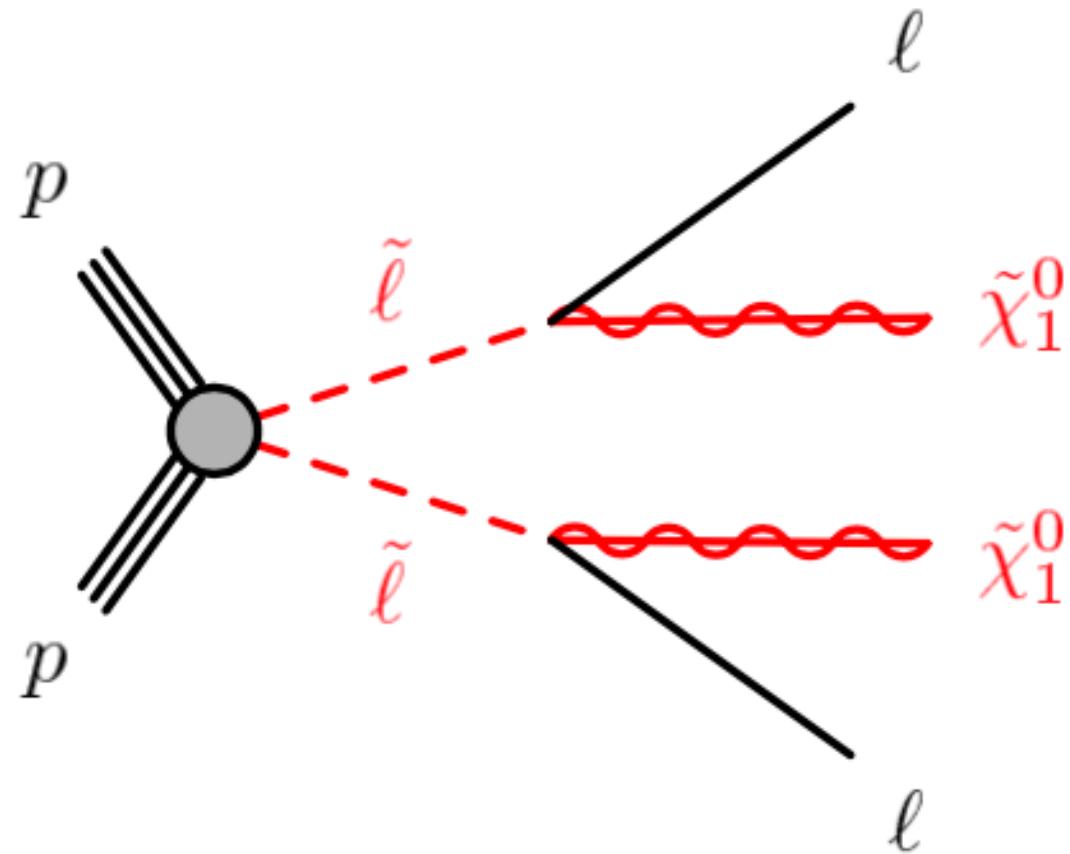
Object definition

- Object definition criteria are the default ones across all EWK analyses and they are applied before performing the overlap removal between objects.
- Hadronic taus are not selected, but there is no explicit veto on them.

Baseline electron		Baseline muon		Baseline jet	
Acceptance	$p_T > 9 \text{ GeV}, \eta^{\text{clust}} < 2.47$	Acceptance	$p_T > 9 \text{ GeV}, \eta < 2.6$	Collection Acceptance	AntiKt4EMPFlowJets
PID Quality	LooseAndBLayerLLH	PID Quality	Medium		$p_T > 20 \text{ GeV}, \eta < 2.8$
Impact parameter	$ z_0 \sin \theta < 0.5 \text{ mm}$	Impact parameter	$ z_0 \sin \theta < 0.5 \text{ mm}$		Signal jet
Signal electron		Signal muon		JVT Acceptance	Tight
Acceptance	$p_T > 9 \text{ GeV}, \eta^{\text{clust}} < 2.47$	Acceptance	$p_T > 9 \text{ GeV}, \eta < 2.4$		$p_T > 20 \text{ GeV}, \eta < 2.4$
PID Quality	TightLLH	PID Quality	Medium		
Isolation	FCLoose	Isolation	FCLoose	<i>b</i> -tagger Algorithm	DL1r
Impact parameter	$ d_0/\sigma_{d_0} < 5$	Impact parameter	$ d_0/\sigma_{d_0} < 3$	Efficiency	FixedCutBEff_85
				Acceptance	$p_T > 20 \text{ GeV}, \eta < 2.4$

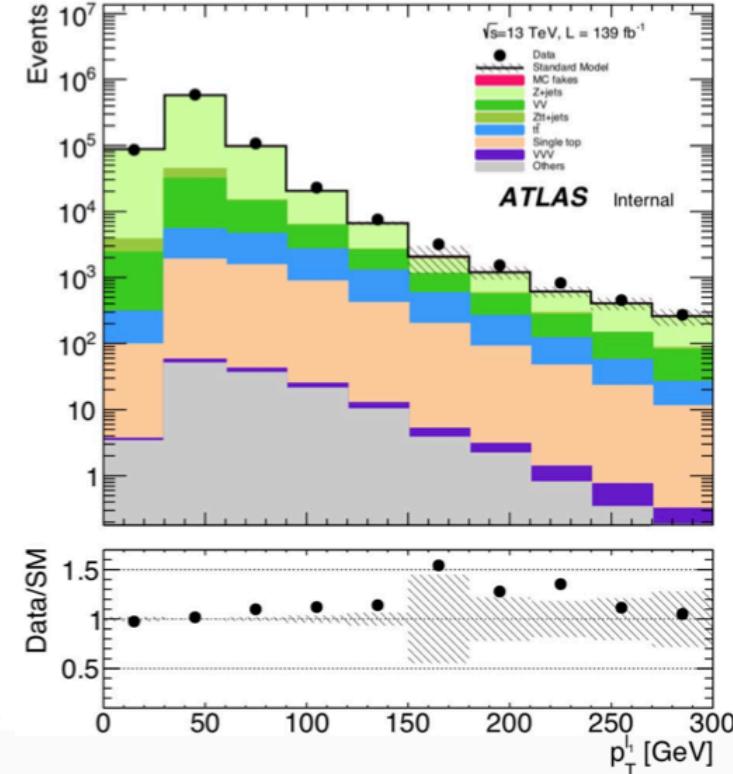
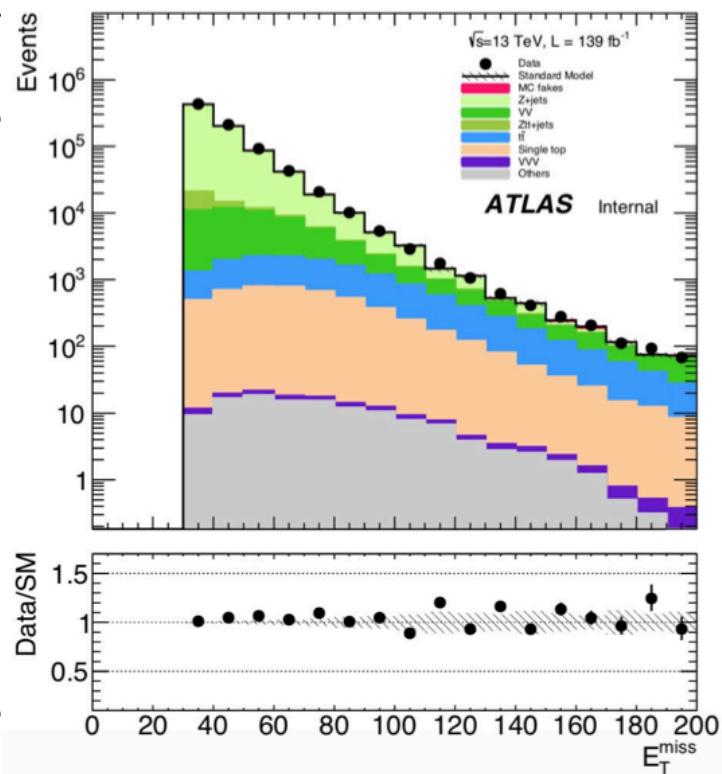
- Single lepton triggers currently adopted

Sleptons analysis



Preselection

Variable	Cut
$N_{\text{OS}} \text{ leptons}$	= 2
$p_T^{\ell_1}$	$> 27 \text{ GeV}$
$p_T^{\ell_2}$	$> 9 \text{ GeV}$
$m_{\ell\ell}$	$> 11 \text{ GeV}$
$n_{\text{jet}-20}$	< 2
$n_{b\text{jet}-20}$	= 0
E_T^{miss} significance	> 3
$ m_{\ell\ell} - m_Z $	$> 15 \text{ GeV} (\text{for SF only})$



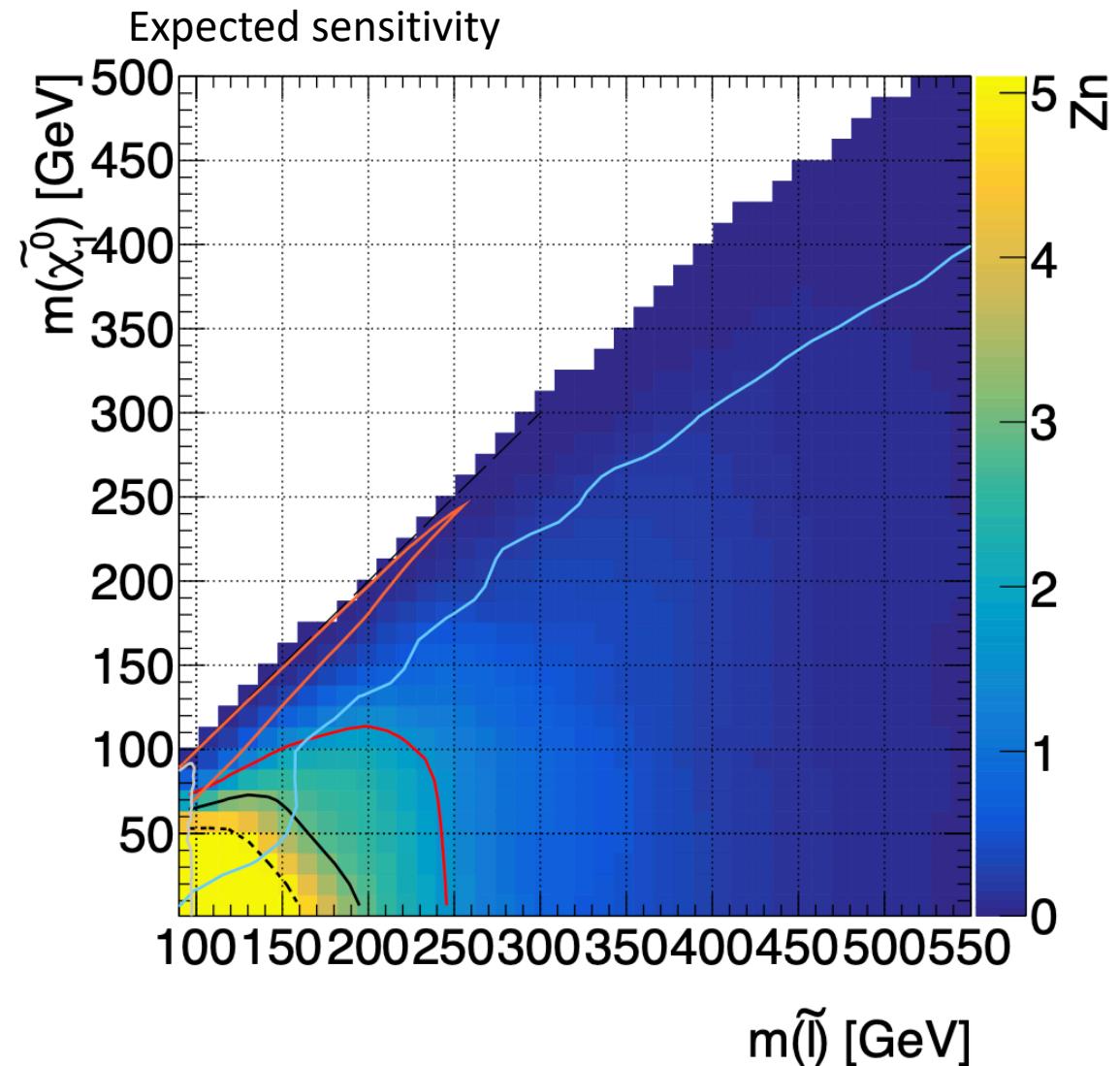
- Using MC Fakes for the moment, then fakes will be estimated with Matrix Method (MM)

Analysis strategy

- Cut and count based analysis

OJ SR definition

Variable	Cut
n_{jet-20}	= 0
$n_{bjet-20}$	= 0
$N_{\text{OS SF leptons}}$	= 2
$p_T^{\ell_1}$	$> 140 \text{ GeV}$
$p_T^{\ell_2}$	$> 20 \text{ GeV}$
$E_T^{\text{miss}} \text{ significance}$	> 7
$m_{\ell\ell}$	$> 11 \text{ GeV}$
$ m_{\ell\ell} - m_Z $	$> 15 \text{ GeV}$
$\mathbf{p}_{\text{T,boost}}^{\ell\ell}$	$< 5 \text{ GeV}$
$\cos \theta_{\ell\ell}^*$	< 0.2
$\Delta\phi_{\ell,\ell}$	> 2.2
$\Delta\phi_{E_T^{\text{miss}},\ell\ell}$	> 2.8
$\Delta\phi_{E_T^{\text{miss}},\ell_1}$	> 2.2



Data driven estimation of the background

- The flavour symmetric backgrounds (i.e. WW , $t\bar{t}$, Wt and $Z(\rightarrow \tau\tau) + \text{jets}$) produce SF and DF leptons in the final state with equal probabilities. The slepton signal, however, only generates SF leptons in the final state. Therefore, there is no signal contamination in the DF channel. We can use this fact, and look at the SR but with in the DF channel in order to predict the backgrounds in the SF channel.
- Event-by-event weights corrections accounting for the different identification, isolation, reconstruction and trigger efficiencies needed to extrapolate the count of DF events to the estimate of SF background events. Corrections computed as a function of $|\eta|$.

Efficiency correction method

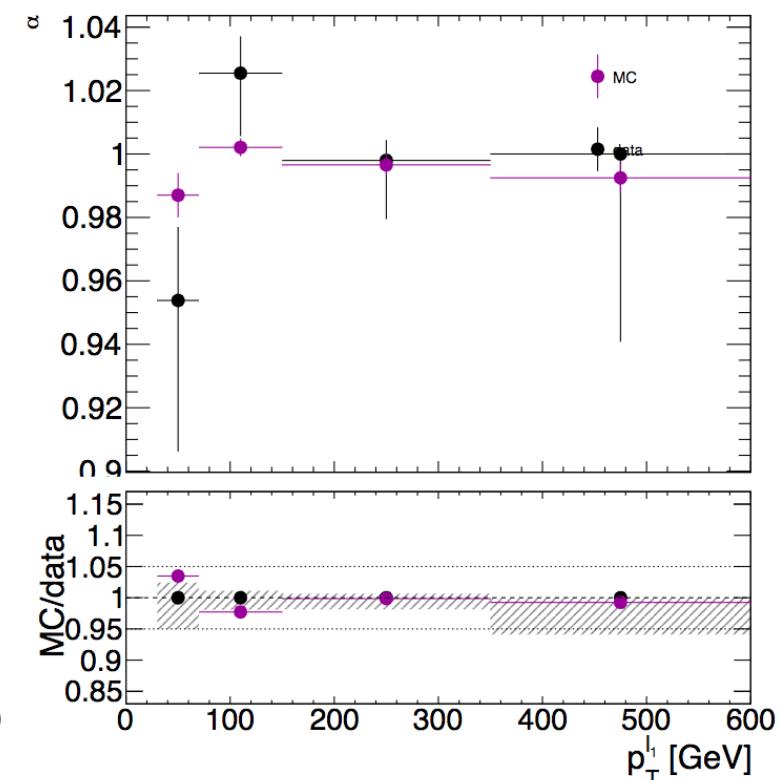
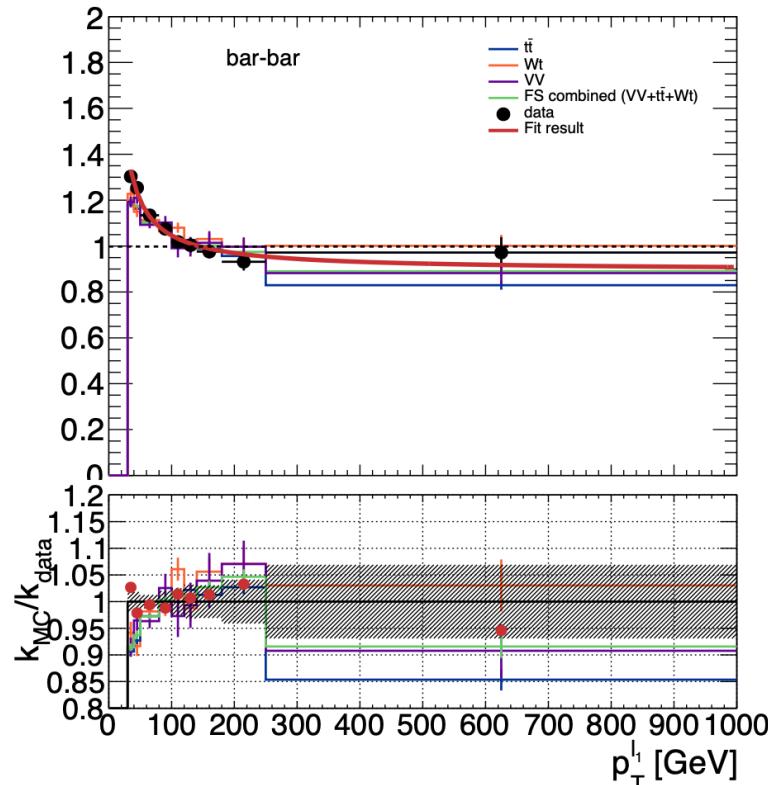
$$N_{ee}^{expected} = 0.5 \times \frac{1}{\kappa} \times \alpha \times N_{DF}$$

$$N_{\mu\mu}^{expected} = 0.5 \times \kappa \times \alpha \times N_{DF}$$

$$N_{SF}^{expected} = 0.5 \times \left(\kappa + \frac{1}{\kappa} \right) \times \alpha \times N_{DF}$$

$$\kappa = \sqrt{\frac{N_{\mu^+\mu^-}}{N_{e^+e^-}}}$$

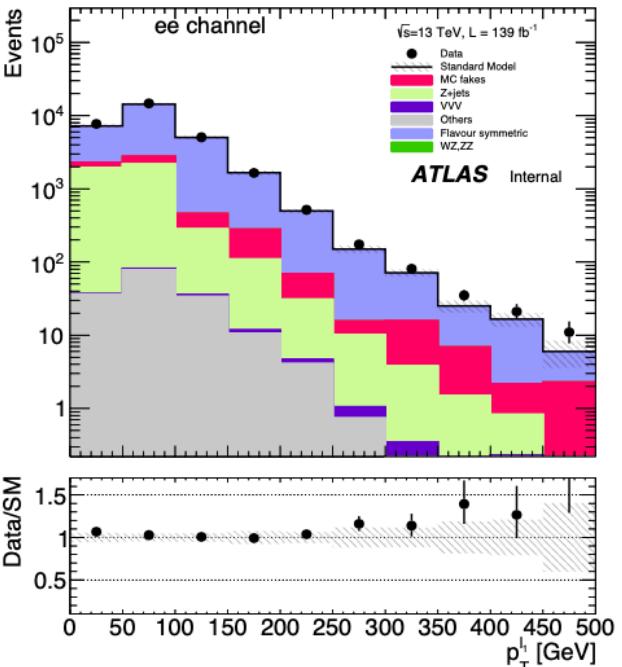
$$\alpha = \frac{\sqrt{\epsilon_{\mu\mu}^{trig} \epsilon_{ee}^{trig}}}{\epsilon_{e\mu}^{trig}}$$



CR/VR definition

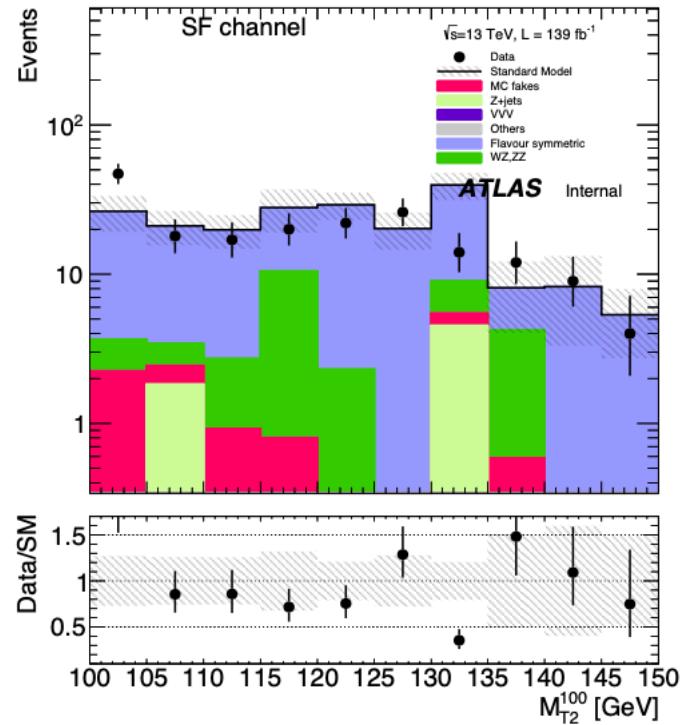
CR definition

Variable	Cut
n_{jet-20}	< 2
N_{OS} SF leptons	= 2
$p_T^{\ell_1}$	> 30 GeV
$p_T^{\ell_2}$	> 20 GeV
E_T^{miss}	> 230
$m_{\ell\ell}$	> 11 GeV
$ m_{\ell\ell} - m_Z $	> 15 GeV



VR OJ definition

Variable	Cut
n_{jet-20}	= 0
$n_{bjet-20}$	= 0
N_{OS} SF leptons	= 2
$p_T^{\ell_1}$	> 140 GeV
$p_T^{\ell_2}$	> 20 GeV
E_T^{miss} significance	> 7
$m_{\ell\ell}$	> 11 GeV
$ m_{\ell\ell} - m_Z $	> 15 GeV
$\mathbf{p}_{T,\text{boost}}^{\ell\ell}$	< 5 GeV
$\cos \theta_{\ell\ell}^*$	> 0.2
$\Delta\phi_{\ell,\ell}$	> 2.2
$\Delta\phi_{E_T^{\text{miss}},\ell\ell}$	> 2.8
$\Delta\phi_{E_T^{\text{miss}},\ell_1}$	> 2.2

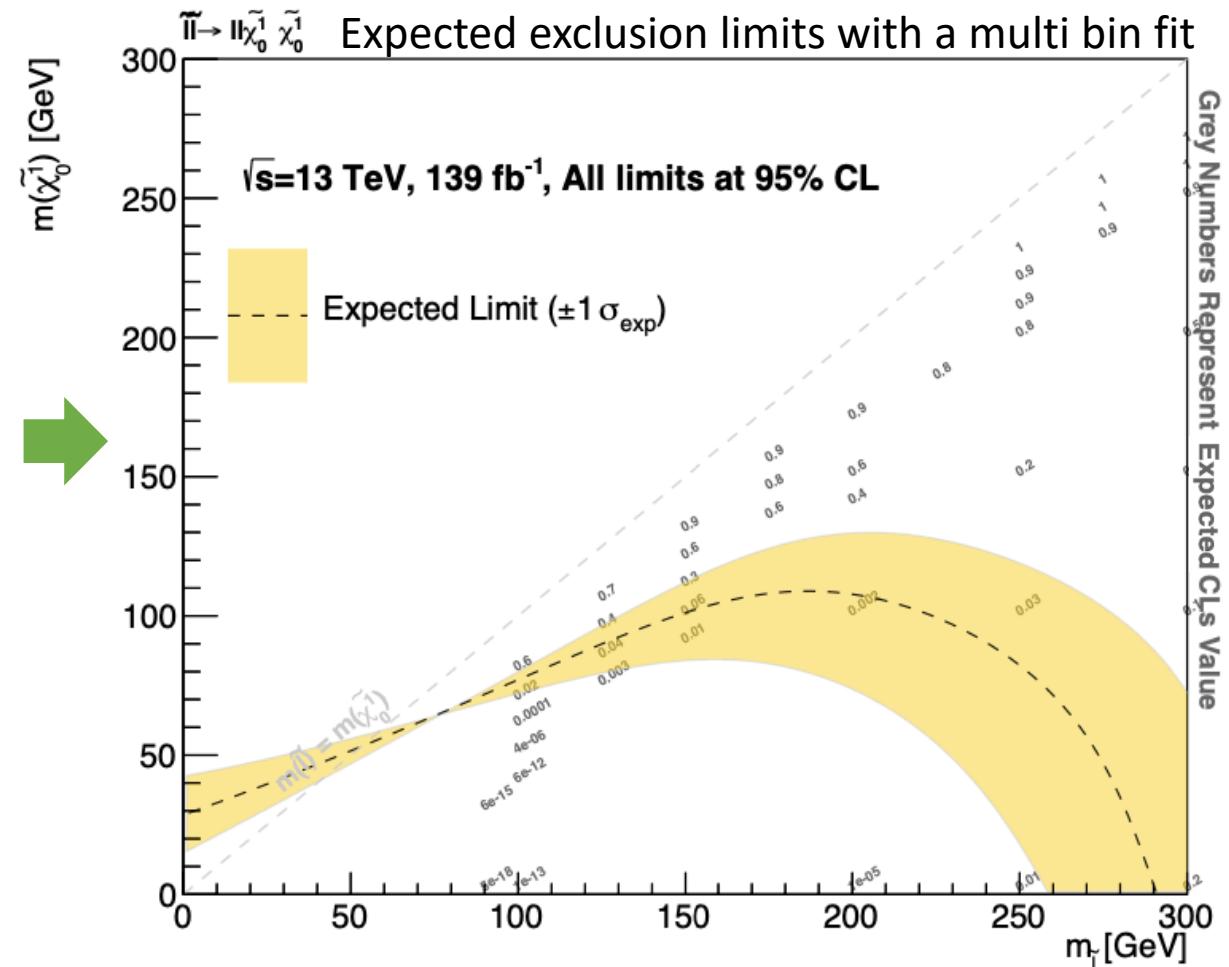
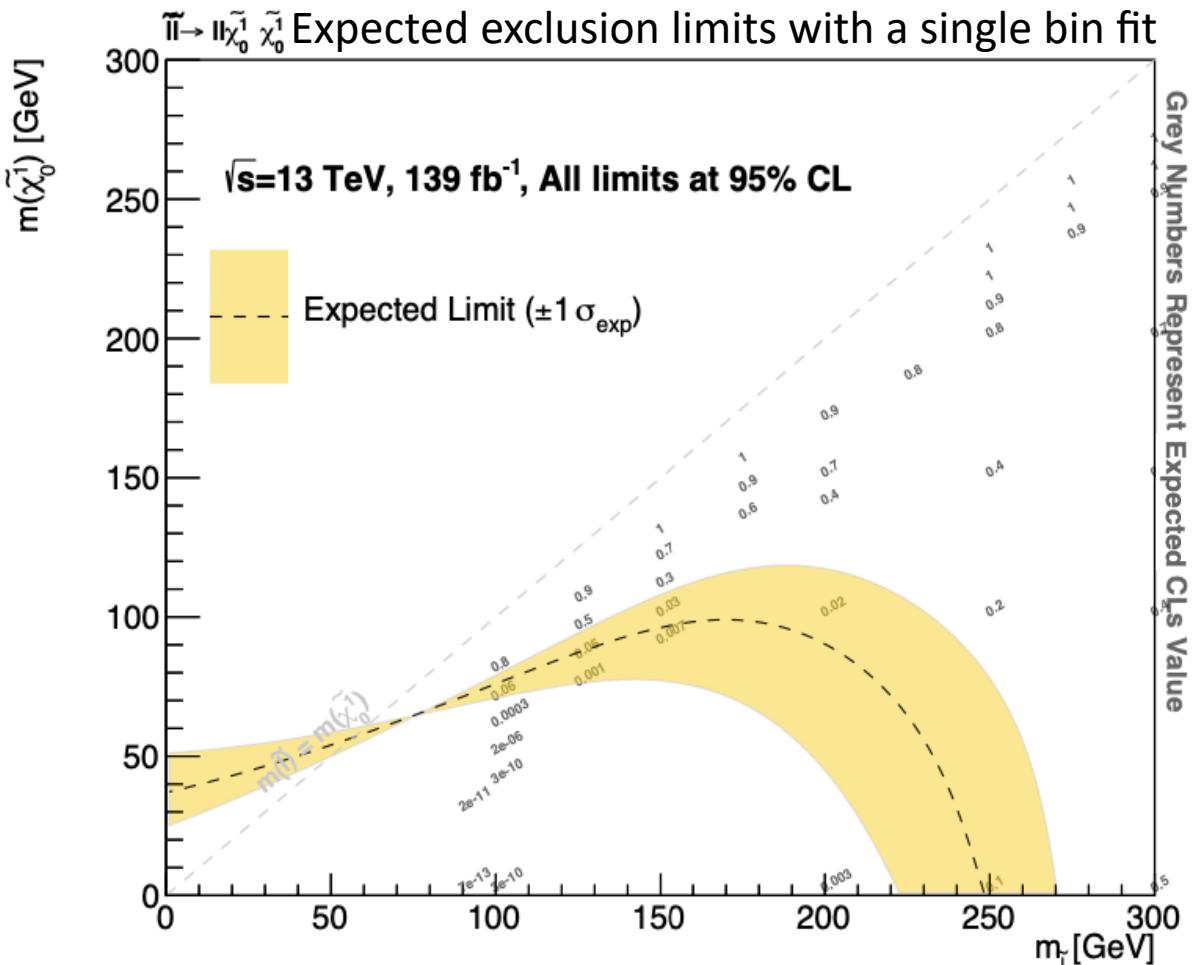


Validation of the flavour symmetric background with an orthogonal estimation technique

Method	ee Events	$\mu\mu$ Events	Total
Efficiency correction factors	34.62 ± 3.47	35.33 ± 5.05	69.95 ± 8.52
Transfer Factor	34.79 ± 5.93	33.37 ± 5.32	68.16 ± 11.25

Statistical interpretation

- Statistical interpretation of the final results performed using HistFitter
- Single bin/Multi-bin fit performed as a function of m_{T2}^{100} .
 - Optimal choice of bin widths: $m_{T2}^{100} = [100, 105, 110, 115, 120, 125, 130, 140, \infty)$.



Statistical interpretation

- Combination of 0J+1J channels.

SR 0J channel

Variable	Cut
n_{jet-20}	= 0
$n_{bjet-20}$	= 0
N_{OS} SF leptons	= 2
$p_T^{\ell_1}$	> 140 GeV
$p_T^{\ell_2}$	> 20 GeV
E_T^{miss} significance	> 7
$m_{\ell\ell}$	> 11 GeV
$ m_{\ell\ell} - m_Z $	> 15 GeV
$\mathbf{p}_{T,\text{boost}}^{\ell\ell}$	< 5 GeV
$\cos \theta_{\ell\ell}^*$	< 0.2
$\Delta\phi_{\ell,\ell}$	> 2.2
$\Delta\phi_{E_T^{\text{miss}},\ell\ell}$	> 2.8
$\Delta\phi_{E_T^{\text{miss}},\ell_1}$	> 2.2

SR 1J channel

Variable	Cut
n_{jet-20}	= 1
$n_{bjet-20}$	= 0
N_{OS} SF leptons	= 2
$p_T^{\ell_1}$	> 100 GeV
$p_T^{\ell_2}$	> 50 GeV
E_T^{miss} significance	> 7
$m_{\ell\ell}$	> 60 GeV
$ m_{\ell\ell} - m_Z $	> 15 GeV
$\cos \theta_{\ell\ell}^*$	< 0.1
$\Delta\phi_{\ell,\ell}$	> 2.8

SR 0J channel

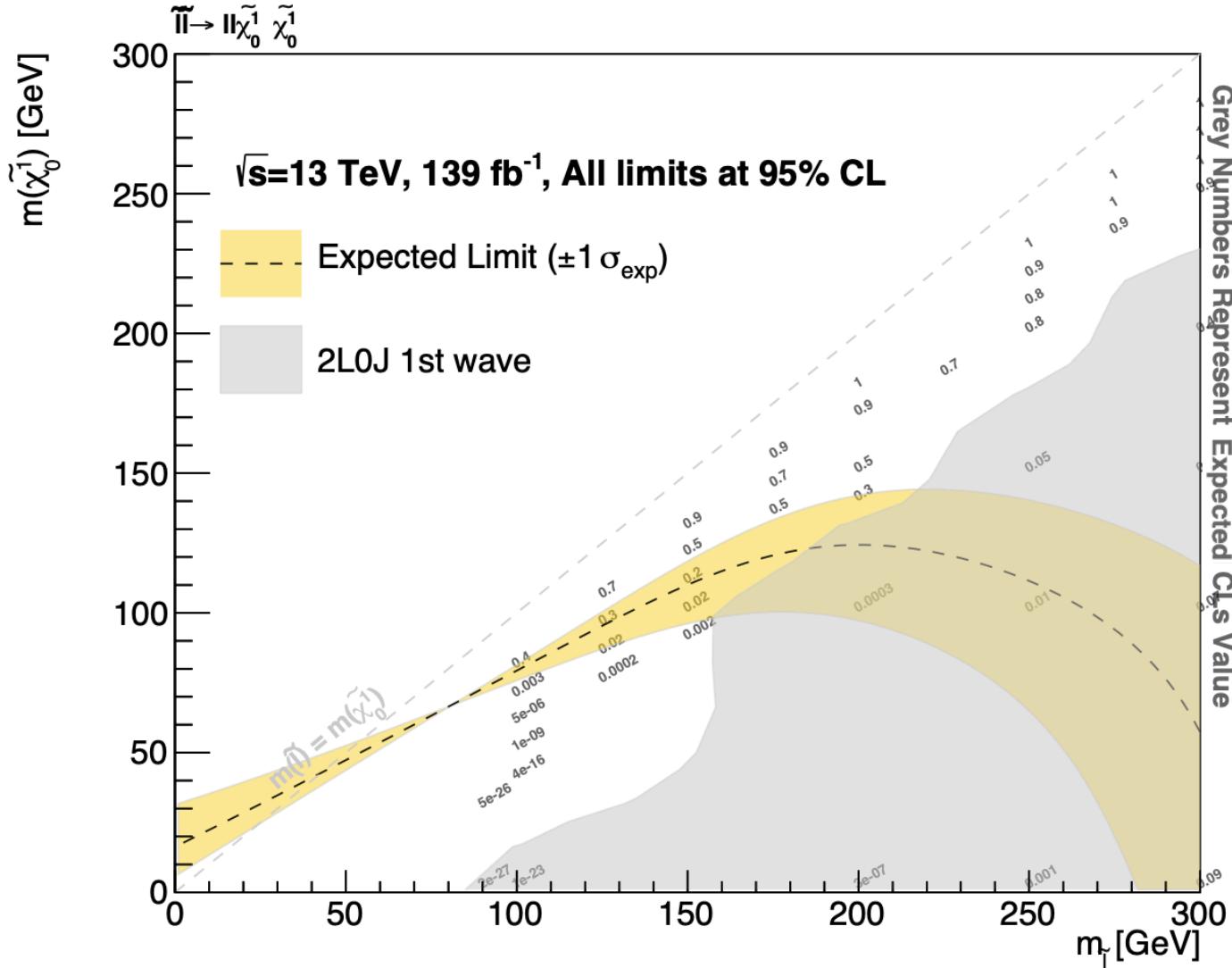
table.results.yields channel	SRinclusive
Observed events	-
Fitted bkg events	78.32 ± 7.08
Fitted other events	$0.05^{+0.08}_{-0.05}$
Fitted VVV events	0.13 ± 0.03
Fitted ZZ events	7.16 ± 1.66
Fitted dataDF events	64.11 ± 6.00
Fitted MCfakes events	6.76 ± 1.37
MC exp. SM events	78.32 ± 11.95
MC exp. other events	$0.05^{+0.08}_{-0.05}$
MC exp. VVV events	0.13 ± 0.03
MC exp. ZZ events	7.16 ± 1.93
MC exp. dataDF events	64.11 ± 9.80
MC exp. MCfakes events	6.76 ± 1.67

SR 1J channel

table.results.yields channel	SRinclusive_1J
Observed events	-
Fitted bkg events	118.76 ± 9.16
Fitted other events	0.55 ± 0.18
Fitted VVV events	0.12 ± 0.02
Fitted ZZ events	3.35 ± 0.79
Fitted dataDF events	86.59 ± 7.49
Fitted Zjets events	6.95 ± 1.83
Fitted MCfakes events	21.19 ± 3.71
MC exp. SM events	118.76 ± 17.22
MC exp. other events	0.55 ± 0.19
MC exp. VVV events	0.12 ± 0.02
MC exp. ZZ events	3.35 ± 0.88
MC exp. dataDF events	86.59 ± 12.04
MC exp. Zjets events	6.95 ± 2.27
MC exp. MCfakes events	21.19 ± 5.05

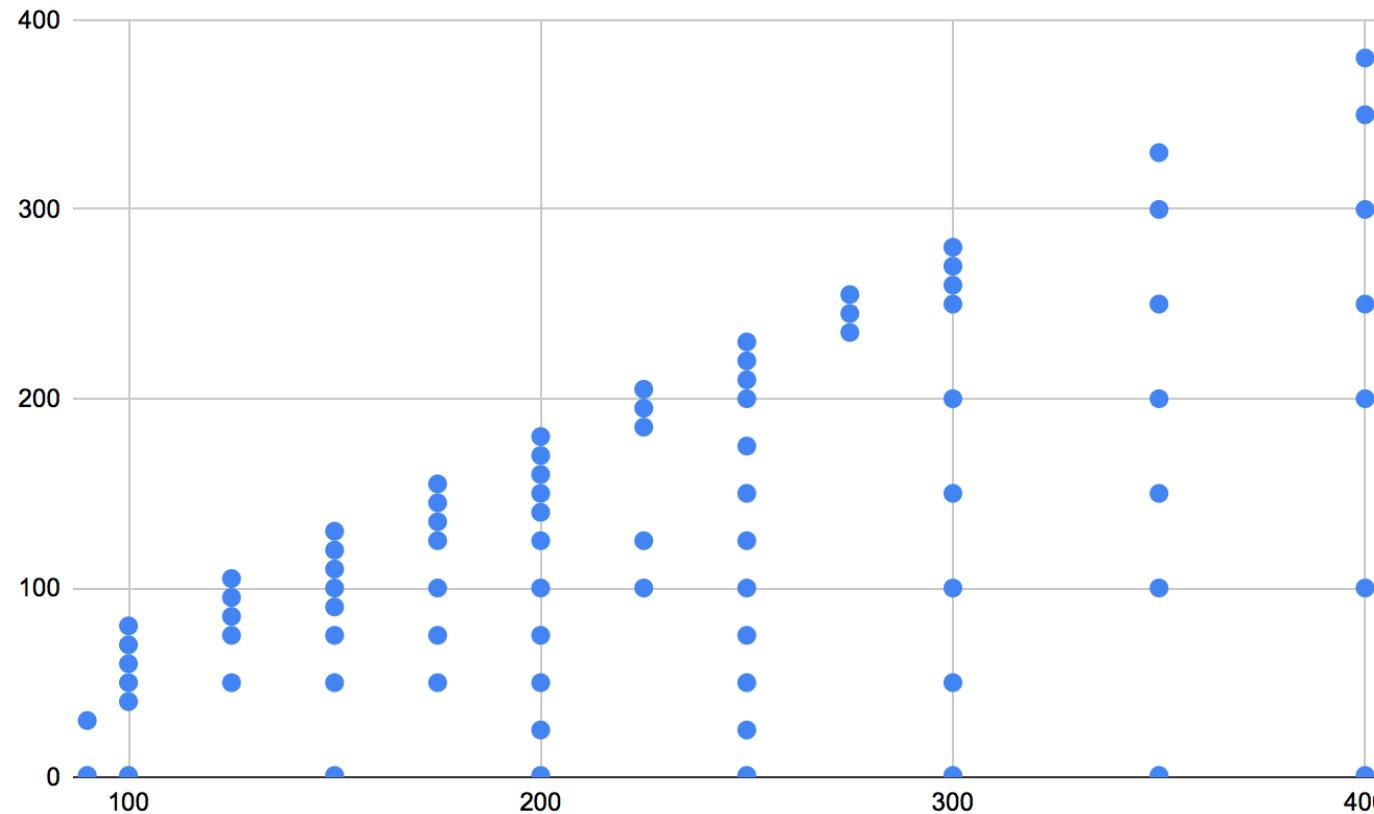
Expected exclusion limits

- Expected exclusion contour from the combination of the 0J+1J channels

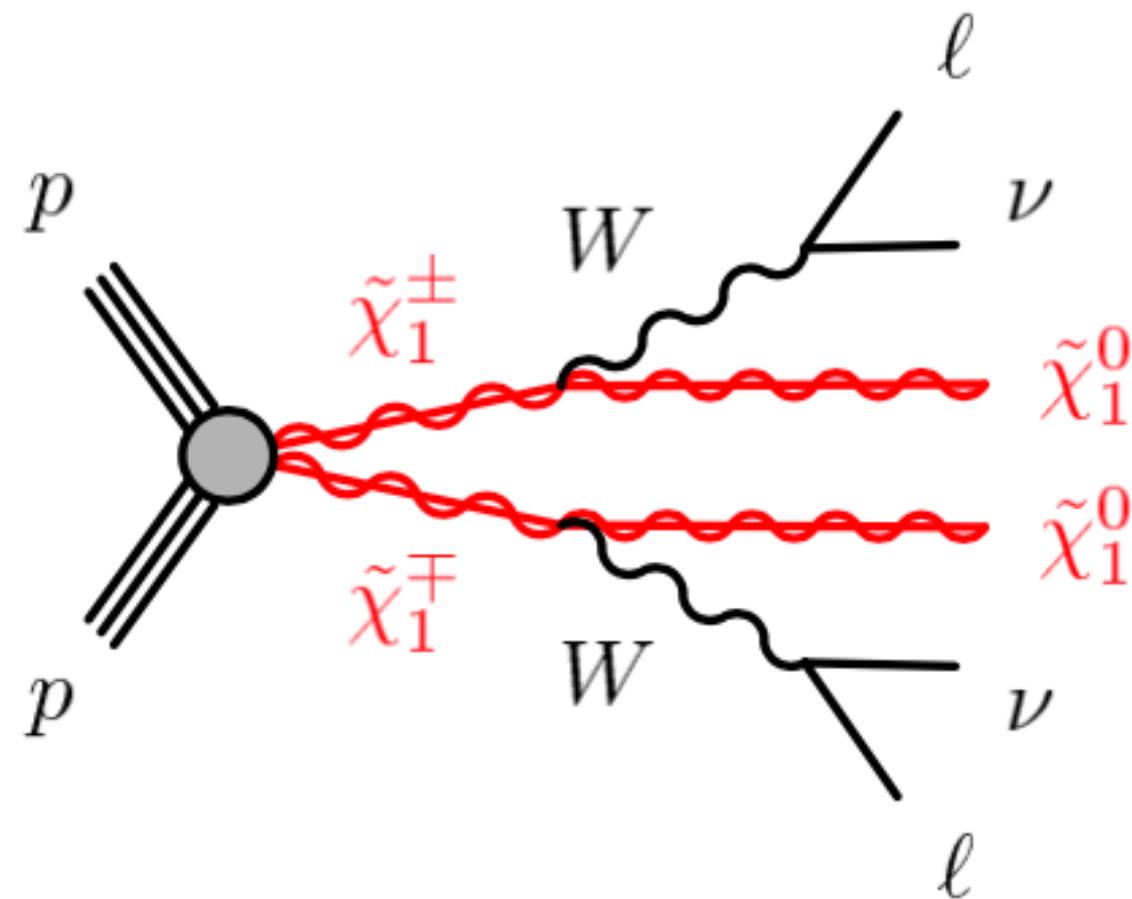


Signal grid extension request

- Signal grid request for sleptons to have a larger coverage around the expected limit (link [here](#))
- The request should be done in R21 (\rightarrow existing grid has also to be resubmitted)
When doing R21 vs R19 checks it was found that the merging weight was not being taken into account by pythia \rightarrow Fixed in AthGeneration, 21.6.46 (released this week)
- Total events to be generated: 10 million events

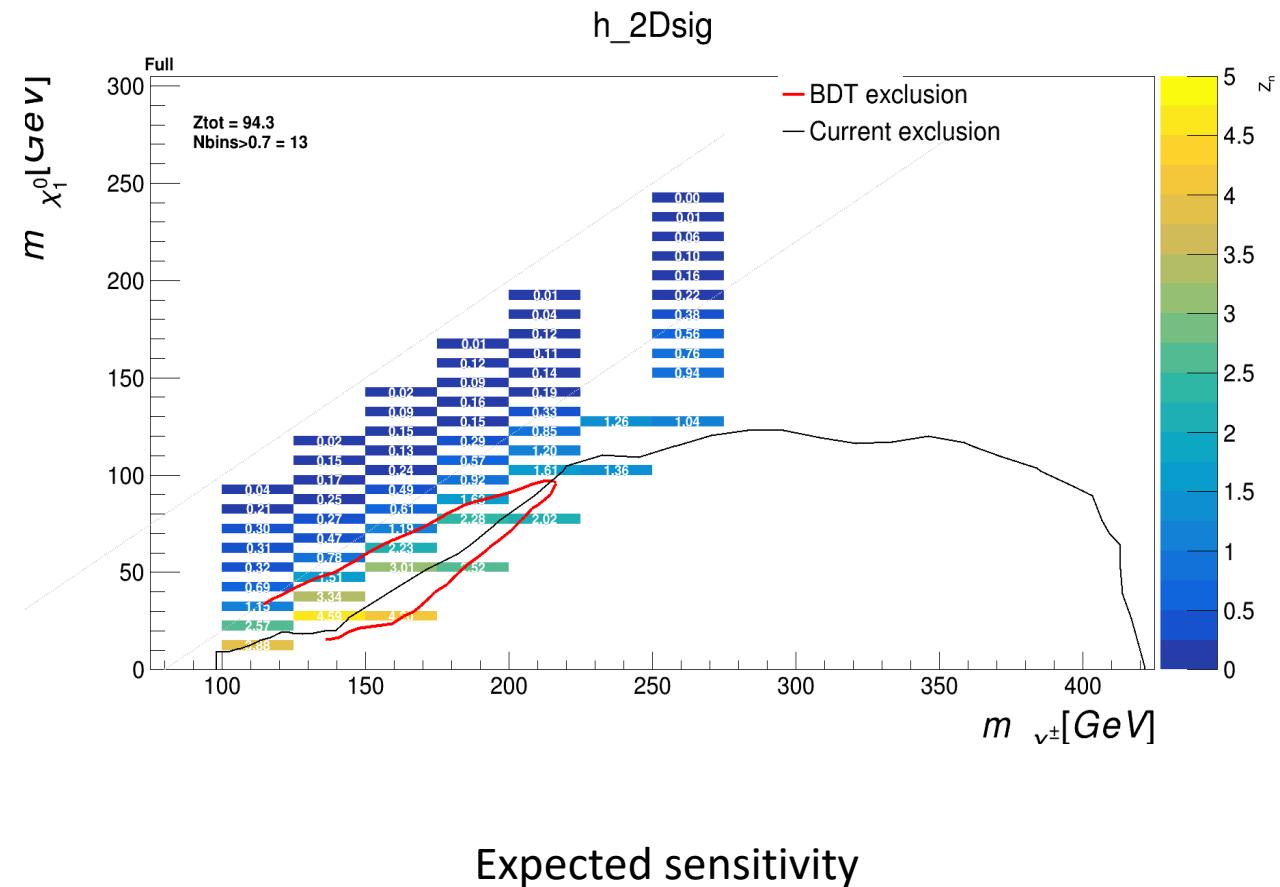


Charginos analysis



Analysis strategy

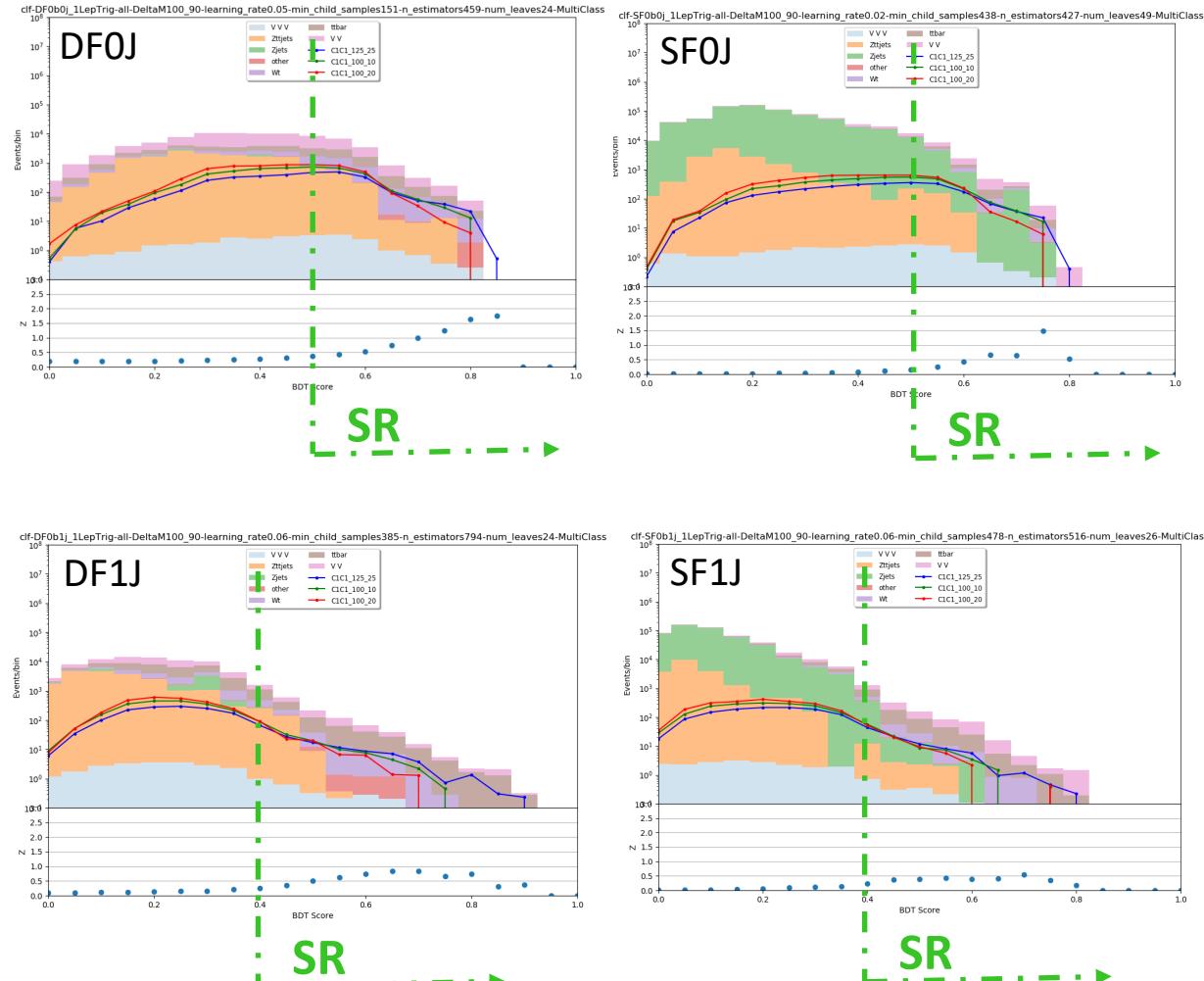
- Analysis strategy based on machine learning techniques
 - BDT training with gradient boosting performed with LightGBM framework
 - High statistics smeared truth samples used for the training
 - Variables used for the training: $p_T^{\ell_1}$, $p_T^{\ell_2}$, E_T^{miss} , m_{T2} , $m_{\ell\ell}$, $\Delta\phi_{boost}$, $\Delta\phi_{E_T^{miss}-\ell_1}$, $\Delta\phi_{E_T^{miss}-\ell_2}$, $\cos\theta_{\ell\ell}^*$ (and p_T^{jet1} , $\Delta\phi_{E_T^{miss}-jet}$ for the 1-jet channels)
 - Hyperparameters: the number of trees, the maximum number of leaves of each tree, the learning rate and the minimum number of samples per each leaf



SRs definitions - Less compressed scenario ($\Delta m > 80$ GeV)

- BDT multiclassifier trained over 4 different regions according to lepton flavour (SF/DF) and jet multiplicity (0J/1J)
- Shape fit on signal BDT score to find the optimal binning

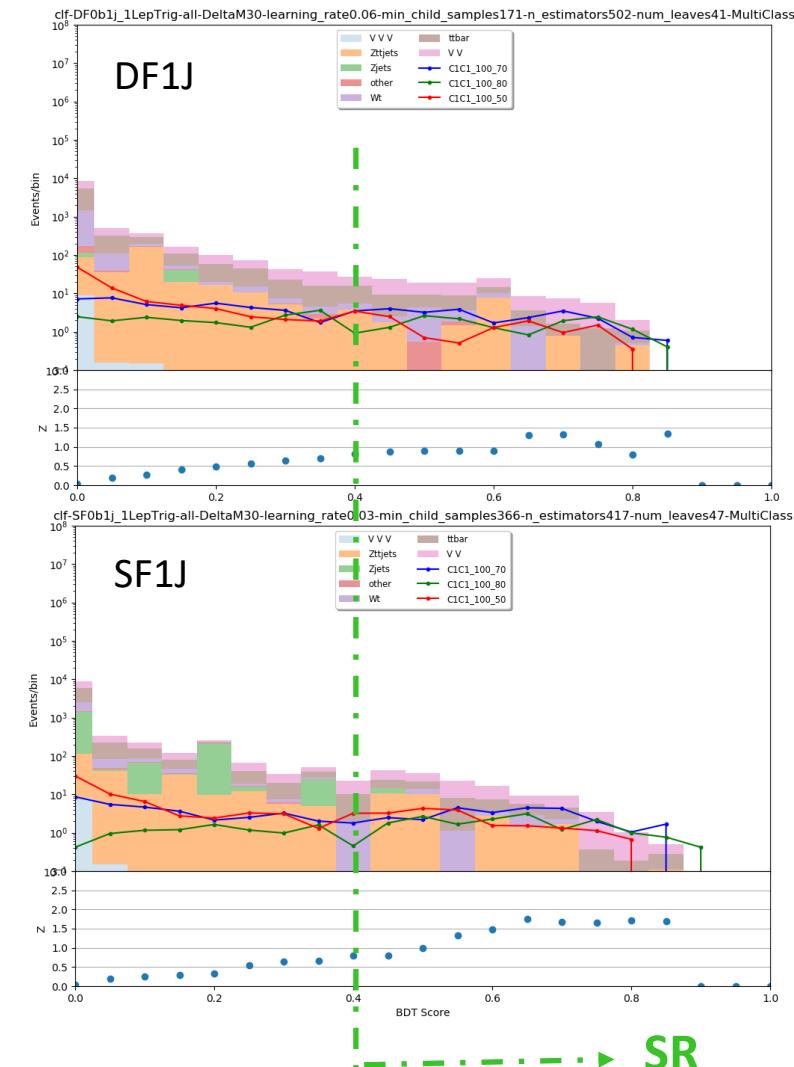
SR (less-compressed)	SR-DF-0J	SR-DF-1J	SR-SF-0J	SR-SF-1J
Lepton flavour	DF	DF	SF	SF
$n_{\text{non-b-tagged-jets}}$	=0	=1	=0	=1
$m_{\ell_1 \ell_2}$ [GeV]	-			
$E_T^{\text{miss}} - \text{significance}$			> 8	
$n_{\text{b-tagged-jets}}$			$= 0$	
$m_{\ell \ell}$				> 20
Binned SRs, BDT_DM100 score cut				
bin0	$\in [0.50, 0.52)$	$\in [0.40, 0.50)$	$\in [0.50, 0.52)$	$\in [0.40, 0.50)$
bin1	$\in [0.52, 0.54)$	$\in [0.50, 0.60)$	$\in [0.52, 0.54)$	$\in [0.50, 0.60)$
bin2	$\in [0.54, 0.56)$	$\in [0.60, 0.65)$	$\in [0.54, 0.56)$	$\in [0.60, 0.65)$
bin3	$\in [0.56, 0.58)$	$\in [0.65, 0.70)$	$\in [0.56, 0.58)$	$\in [0.65, 0.70)$
bin4	$\in [0.58, 0.60)$	$\in [0.70, 0.75)$	$\in [0.58, 0.60)$	$\in [0.70, 0.75)$
bin5	$\in [0.60, 0.62)$	$\in [0.75, 1)$	$\in [0.60, 0.62)$	$\in [0.75, 1)$
bin6	$\in [0.62, 0.64)$		$\in [0.62, 0.64)$	
bin7	$\in [0.64, 0.66)$		$\in [0.64, 0.66)$	
bin8	$\in [0.66, 0.68)$		$\in [0.66, 0.68)$	
bin9	$\in [0.68, 0.70)$		$\in [0.68, 0.70)$	
bin10	$\in [0.70, 0.72)$		$\in [0.70, 0.72)$	
bin11	$\in [0.72, 0.74)$		$\in [0.72, 0.74)$	
bin12	$\in [0.74, 0.76)$		$\in [0.74, 0.76)$	
bin13	$\in [0.76, 0.78)$		$\in [0.76, 0.78)$	
bin14	$\in [0.78, 0.80)$		$\in [0.78, 0.80)$	
bin15	$\in [0.80, 0.82)$		$\in [0.80, 1)$	
bin16	$\in [0.82, 1)$			



SRs definitions - More compressed scenario ($\Delta m \leq 80$ GeV)

- BDT multiclassifier trained over 4 different regions according to lepton flavour (SF/DF)
- Only the 1-jet channels are considered since the 0-jet channels don't show any sensitivity
- Shape fit on signal BDT score to find the optimal binning

SR (more-compressed)	SR-DF-1J	SR-SF-1J
Lepton flavour	DF	SF
$n_{\text{non-b-tagged jets}}$	=1	=1
$m_{\ell_1 \ell_2}$ [GeV]		<76.2 or >106.2
$E_T^{\text{miss}} - \text{significance}$		>8
$n_{\text{b-tagged-jets}}$		=0
$m_{\ell \ell}$		> 20 GeV
Binned SRs, BDT_DM30 score cut		
bin0		$\in [0.40, 0.45)$
bin1		$\in [0.45, 0.50)$
bin2		$\in [0.50, 0.55)$
bin3		$\in [0.55, 0.60)$
bin4		$\in [0.60, 0.65)$
bin5		$\in [0.65, 0.70)$
bin6		$\in [0.70, 0.75)$
bin7		$\in [0.75, 0.80)$
bin8		$\in [0.80, 1)$



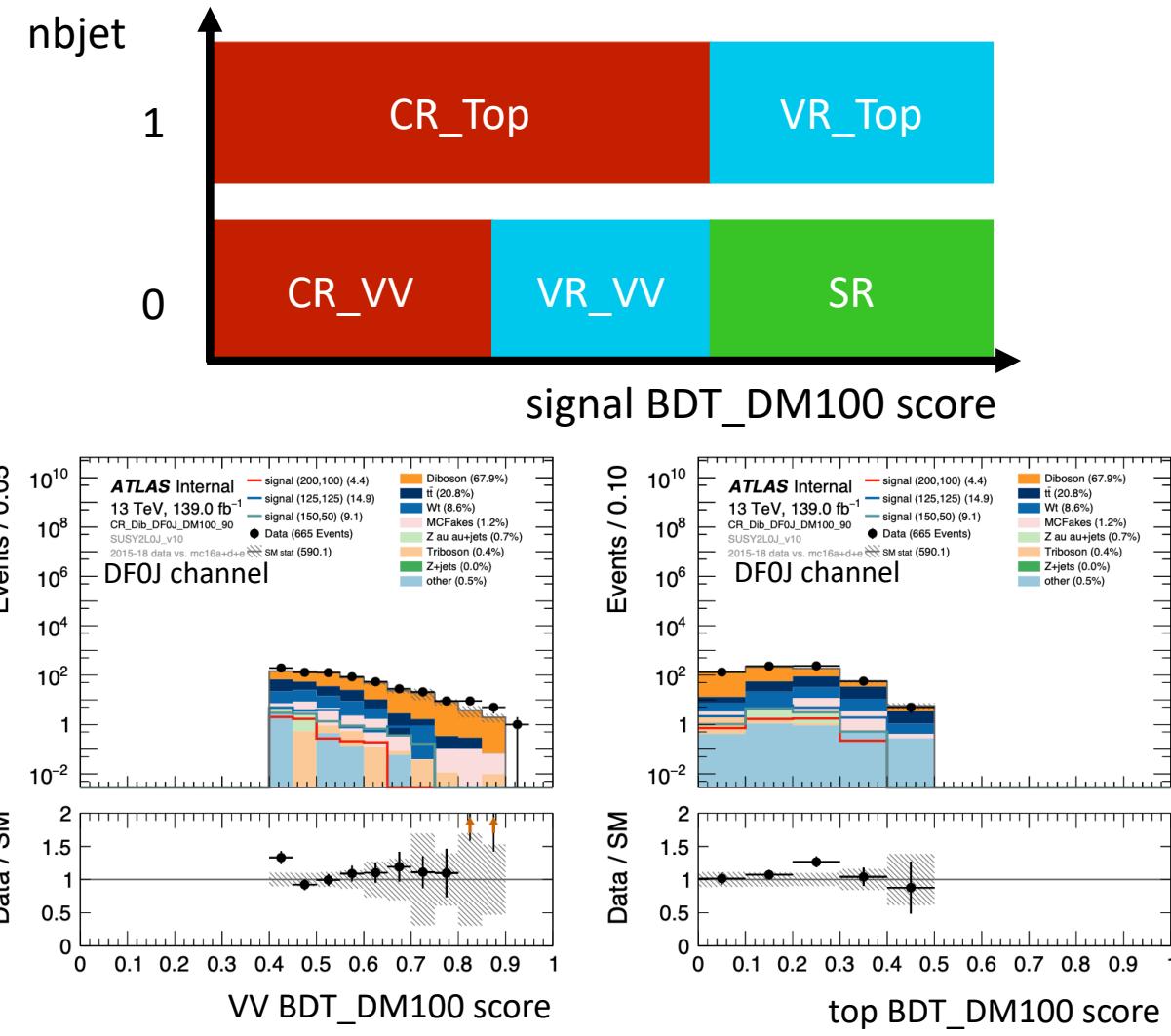
CRs/VRs definitions - Less compressed scenario

- 4 CRs/VRs for VV background, 2 CRs/VRs for top background, 2 normalization factors (μ_{VV} , μ_{top}).
- BDT multiclass classification: 4 BDTs (signal, VV, top, others) exploited to enhance purities in CRs

Region	CR_VV_DF0J	VR_VV_DF0J	CR_VV_SF0J	VR_VV_SF0J
isSF	False	False	True	True
njet	= 0	= 0	= 0	= 0
nbjet	= 0	= 0	= 0	= 0
mll	> 20	> 20	> 20	> 20
METsig	> 8	> 8	> 8	> 8
signal BDT_DM100 score	0.0-0.4	0.4-0.5	0.0-0.4	0.4-0.5
top BDT_DM100 score	-	-	-	-
VV BDT_DM100 score	> 0.4	> 0.4	> 0.6	> 0.35

Region	CR_VV_DF1J	VR_VV_DF1J	CR_VV_SF1J	VR_VV_SF1J
isSF	False	False	True	True
njet	= 1	= 1	= 1	= 1
nbjet	= 0	= 0	= 0	= 0
mll	> 20	> 20	> 20	> 20
METsig	> 8	> 8	> 8	> 8
signal BDT_DM100 score	0.3-0.35	0.35-0.4	0.3-0.35	0.35-0.4
top BDT_DM100 score	< 0.2	< 0.2	< 0.2	< 0.2
VV BDT_DM100 score	> 0.3	> 0.25	> 0.3	> 0.25

Region	CR_Top_DF	VR_Top_DF	CR_Top_SF	VR_Top_SF
isSF	False	False	True	True
njet	= 1	= 1	= 1	= 1
nbjet	= 1	= 1	= 1	= 1
mll	> 20	> 20	> 20	> 20
METsig	> 8	> 8	> 8	> 8
signal BDT_DM100 score	0.4-0.5	> 0.5	0.4-0.5	> 0.5
top BDT_DM100 score	-	-	-	-
VV BDT_DM100 score	-	-	-	-

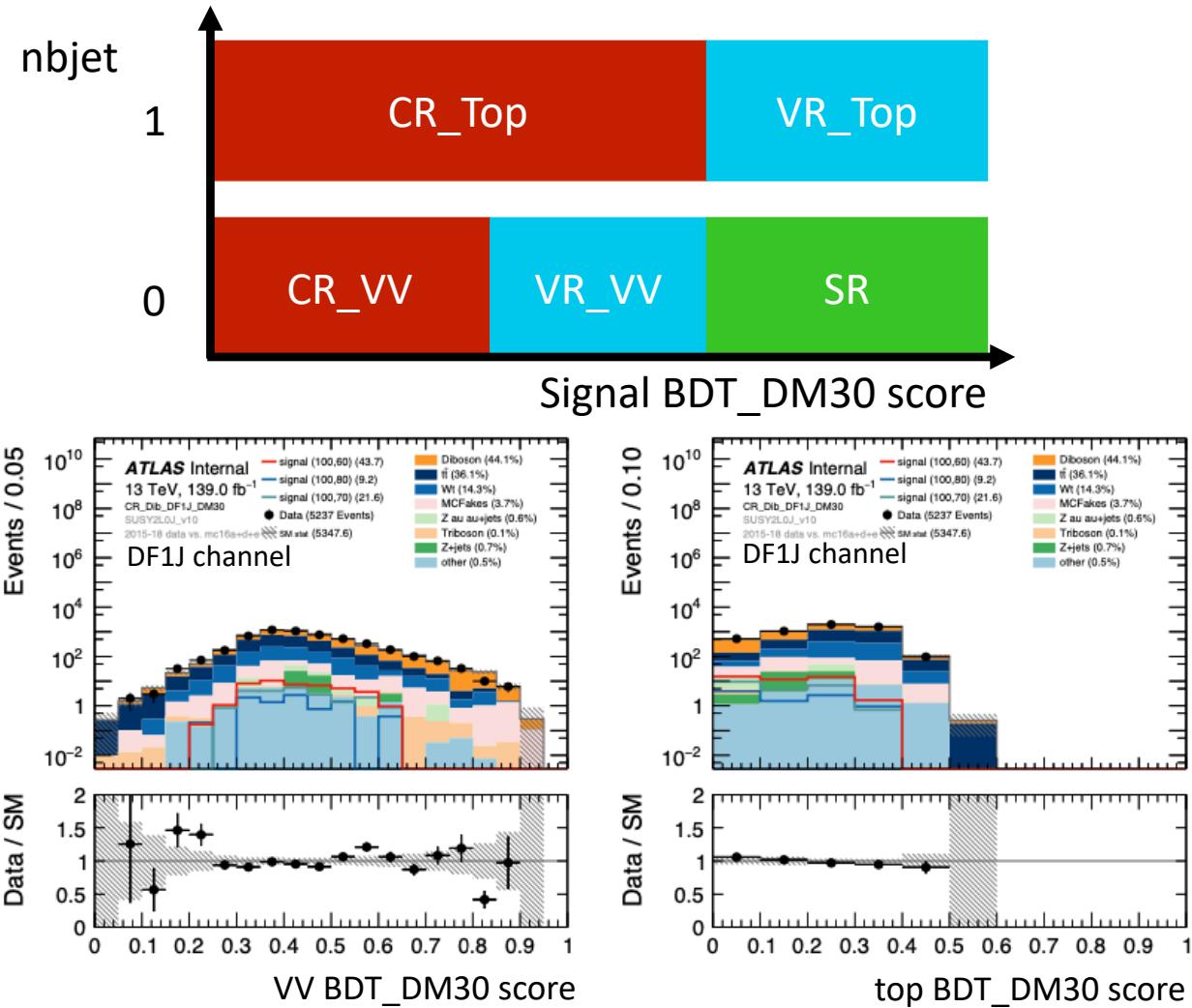


CRs/VRs definitions - More compressed scenario

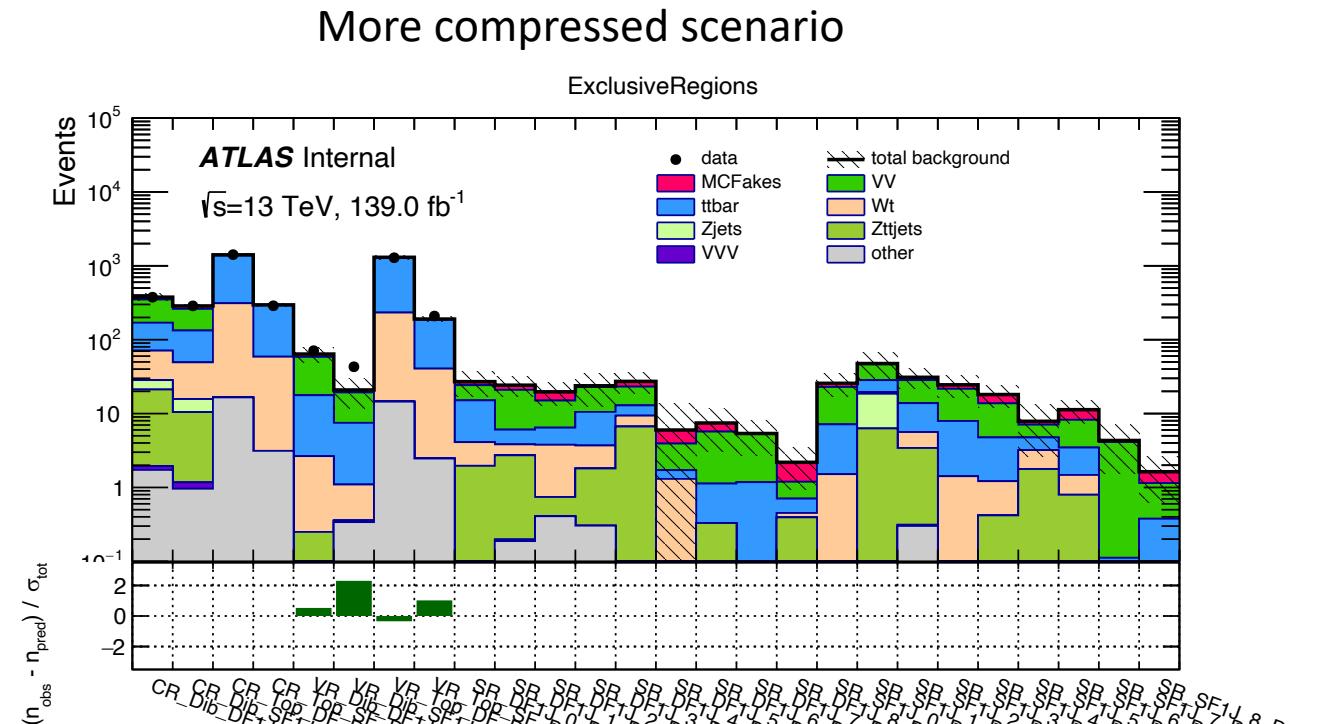
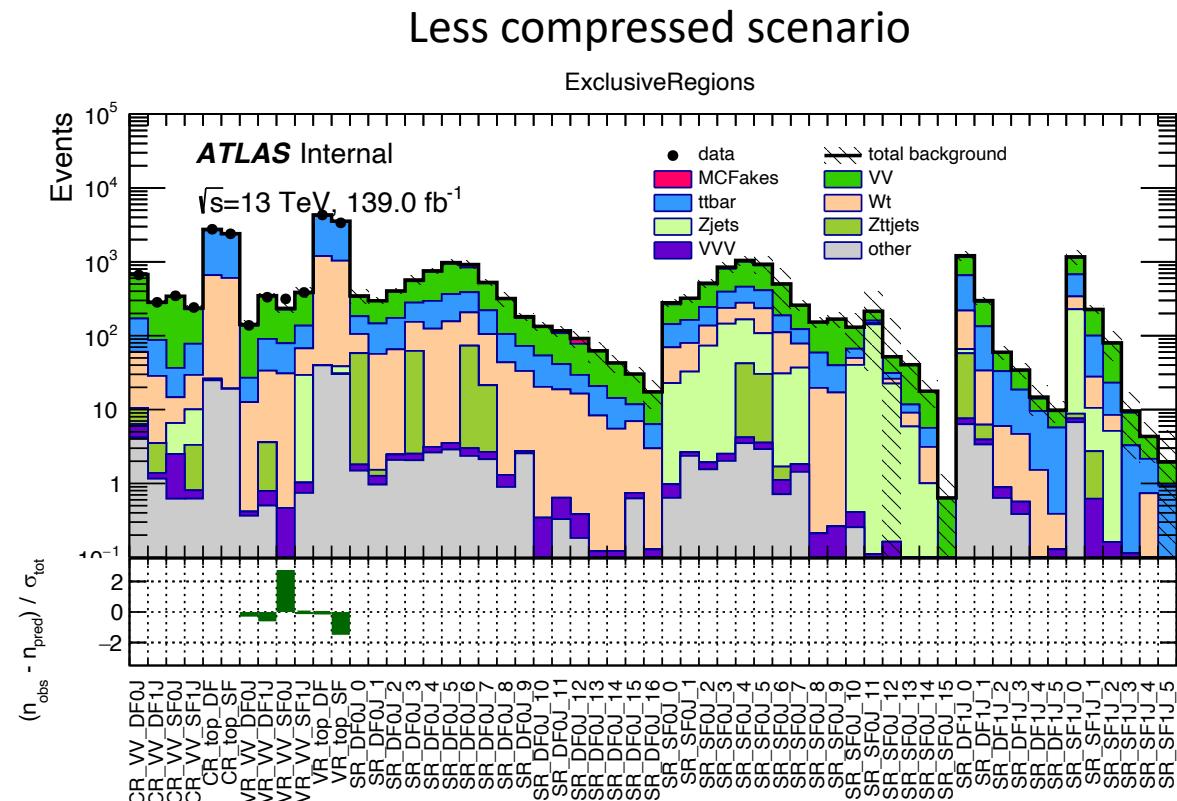
- 2 CRs/VRs for VV background, 2 CRs/VRs for top background, 2 normalization factors (μ_{VV} , μ_{top}).
- BDT Multiclass classification: 4 BDTs (signal,VV,top,others) exploited to enhance purities in CRs

Region	CR_VV_DF1J	VR_VV_DF1J	CR_VV_SF1J	VR_VV_SF1J
isSF	False	False	True	True
njet	= 1	= 1	= 1	= 1
nbjet	= 0	= 0	= 0	= 0
mll	> 20	> 20	> 20	> 20
METsig	> 8	> 8	> 8	> 8
signal BDT_DM30 score	0.05-0.2	0.2-0.4	0.05-0.2	0.2-0.4
top BDT_DM30 score	-	-	-	-
VV BDT_DM30 score	> 0.5	> 0.5	> 0.5	> 0.5
others BDT_DM30 score	-	-	-	> 0.023

Region	CR_Top_DF	VR_Top_DF	CR_Top_SF	VR_Top_SF
isSF	False	False	True	True
njet	= 1	= 1	= 1	= 1
nbjet	= 1	= 1	= 1	= 1
mll	> 20	> 20	> 20	> 20
METsig	> 8	> 8	> 8	> 8
signal BDT_DM30 score	0.05-0.2	0.2-0.4	0.05-0.2	0.2-0.4
top BDT_DM30 score	> 0.5	> 0.5	> 0.5	> 0.5
VV BDT_DM30 score	-	-	-	-



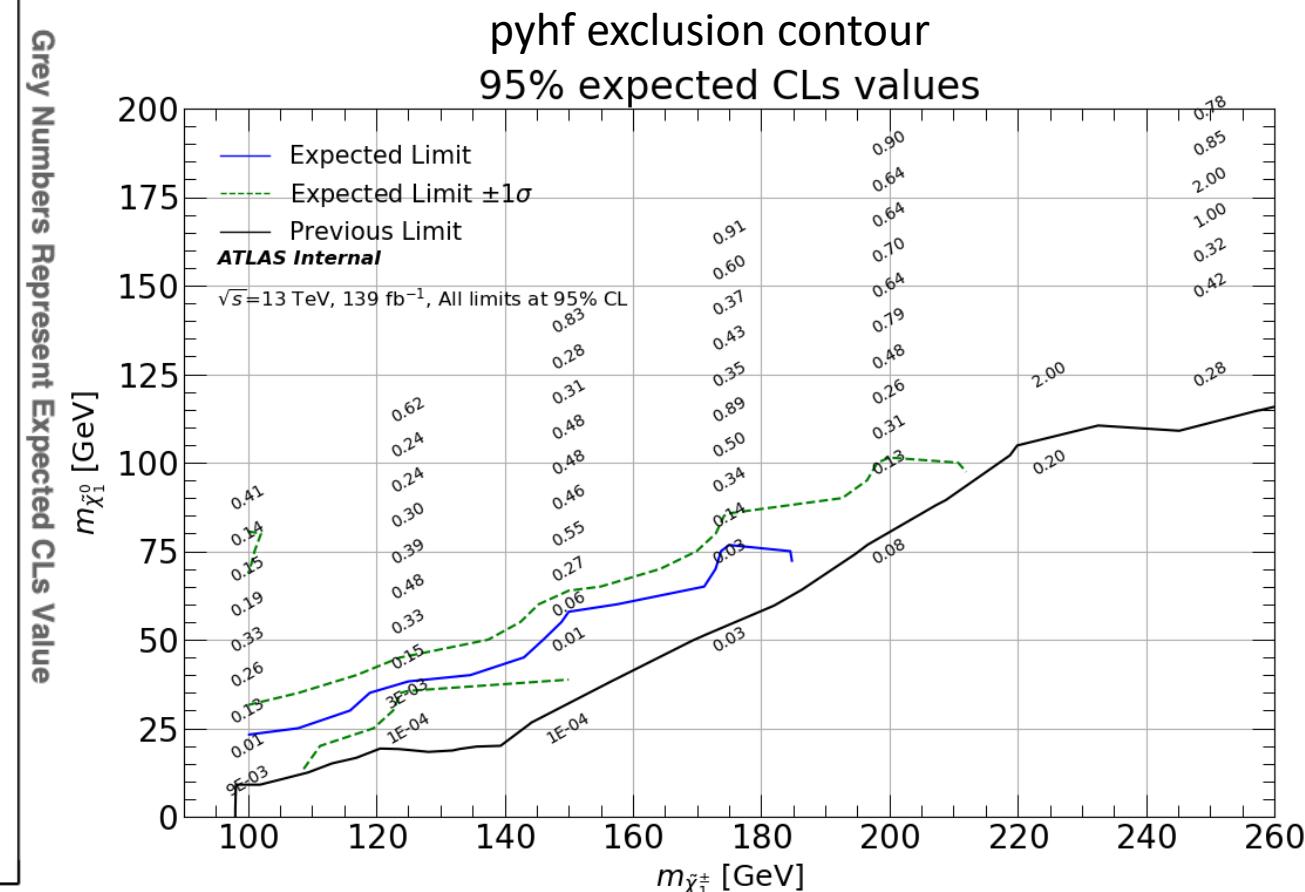
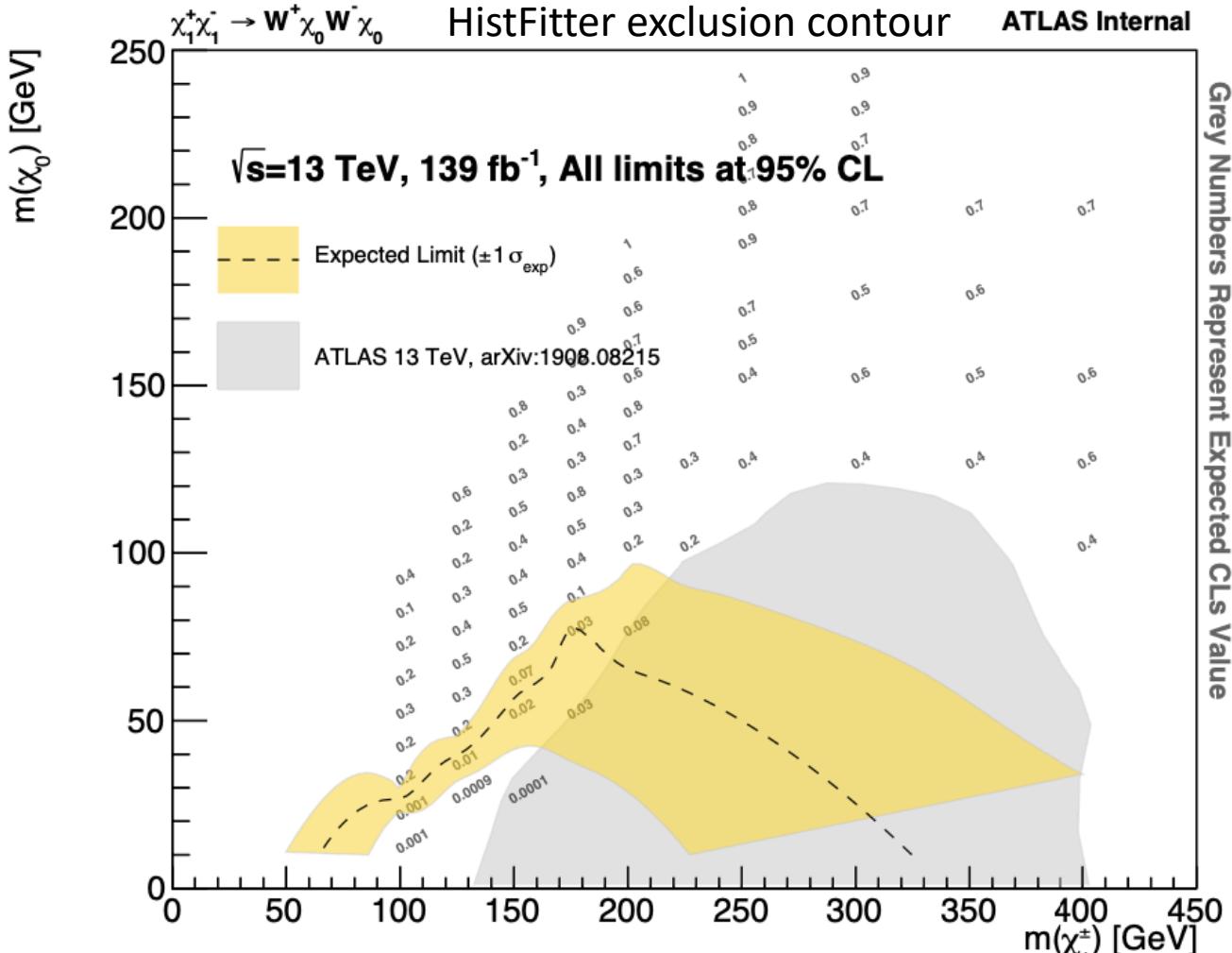
Pullplots



- Some SRs are covered by systematics → binning needs to be optimized (merging bins due to low statistic or large systematics)

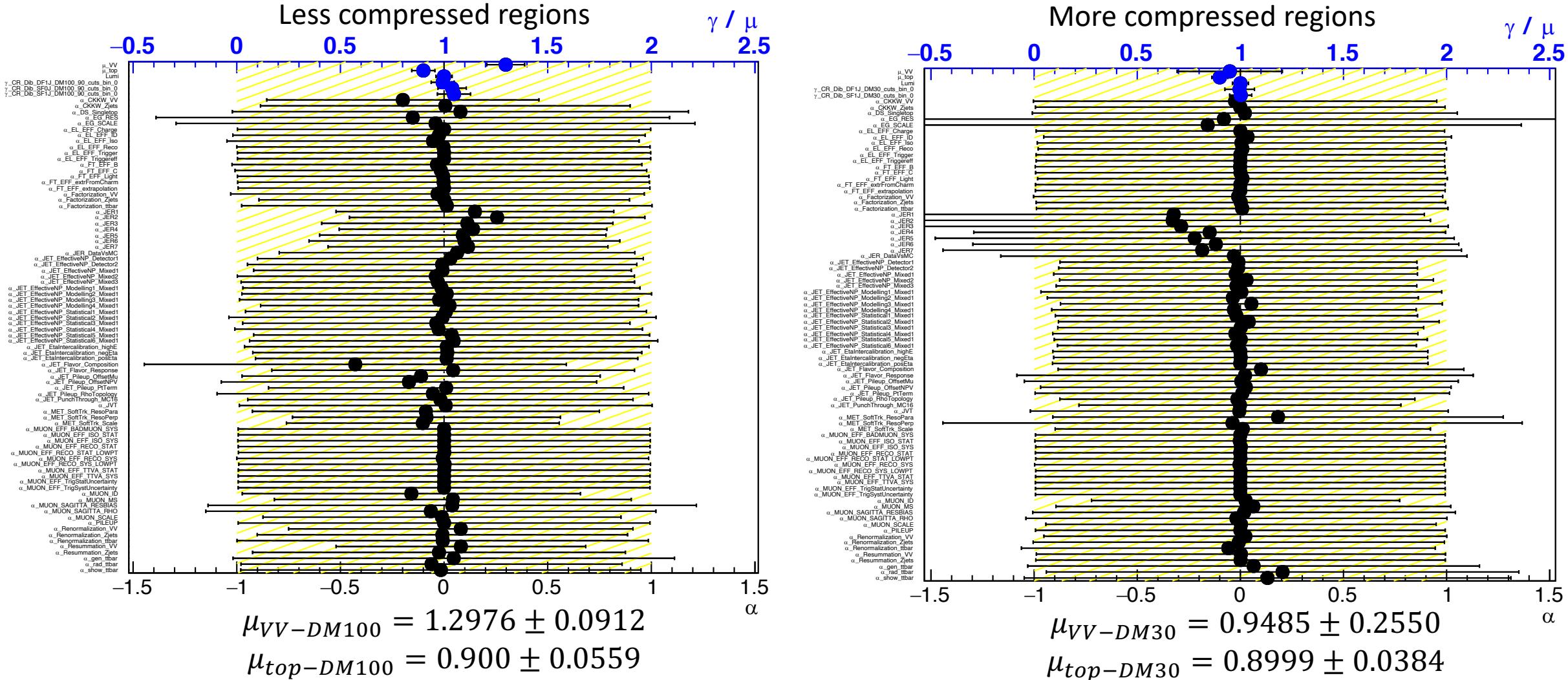
Statistical interpretation

- Expected exclusion limits computed with HistFitter (left) and pyhf (right).
- Contour obtained including the exclusion limits from the less/more compressed scenarios
- Pyhf used to crosscheck limits (computed in pyhf with pytorch backend from HistFitter XML workspace)



Pull plot systematics

- Pull plot systematics at the bkg-only level



- The dominant uncertainties are coming from theory or related to jets.

Conclusions

- Analysis in progress, aiming for a paper (\sim early next year)
- Next step: 1st complete draft to the EB

Pending items

- Currently using b-tagging aware overlap removal, to be changed in the next ntuple production
- Fakes estimated using Matrix Method
- Switch to new R21 signal grid for slepton search
- Improve the SR binning for the C1C1WW search (merging bins due to low statistic or large systematics)

Backup

Yields Tables for C1C1 analysis

CRs/VRs less compressed scenario

	CR_VV_DF0J_DM100	CR_VV_DF1J_DM100	CR_VV_SF0J_DM100	CR_VV_SF1J_DM100	CR_Top_DF_DM100	CR_Top_SF_DM100
Observed events	665	283	347	241	2759	2395
Fitted bkg events	673.23 \pm 25.95	284.65 \pm 15.65	342.19 \pm 18.86	236.57 \pm 18.48	2747.56 \pm 48.54	2405.87 \pm 42.24
Fitted MCFakes events	6.93 \pm 0.27	9.95 \pm 0.68	0.00 \pm 0.00	9.42 \pm 0.80	32.60 \pm 1.27	26.27 \pm 1.02
Fitted VV events	495.74 \pm 26.45	187.36 \pm 15.98	305.60 \pm 18.23	149.43 \pm 22.07	51.25 \pm 32.91	25.39 \pm 8.84
Fitted ttbar events	110.03 \pm 11.08	58.82 \pm 6.53	21.92 \pm 5.71	48.26 \pm 7.31	2003.75 \pm 69.09	1749.68 \pm 65.79
Fitted Wt events	50.13 \pm 4.79	25.01 \pm 2.88	8.10 \pm 2.47	19.42 \pm 2.93	633.82 \pm 41.53	585.37 \pm 36.44
Fitted Zjets events	0.00 \pm 0.00	0.00 \pm 0.00	4.07 \pm 4.02	6.72 ^{+8.58} _{-4.72}	0.00 \pm 0.00	0.00 \pm 0.00
Fitted Zttjets events	4.04 \pm 0.27	2.14 \pm 1.23	0.00 \pm 0.00	2.52 ^{+3.47} _{-2.52}	1.24 \pm 0.20	0.00 \pm 0.00
Fitted VVV events	2.18 \pm 0.13	0.22 \pm 0.05	1.88 \pm 0.18	0.18 \pm 0.06	0.05 \pm 0.03	0.11 \pm 0.03
Fitted other events	4.18 \pm 1.85	1.16 \pm 0.35	0.62 \pm 0.30	0.62 ^{+0.77} _{-0.62}	24.86 \pm 2.35	19.05 \pm 2.44
MC exp. SM events	584.20 \pm 30.77	251.30 \pm 26.60	264.58 \pm 35.94	188.03 \pm 41.72	2935.40 \pm 131.15	2604.25 \pm 107.49
MC exp. MCFakes events	6.93 \pm 0.27	10.02 \pm 0.74	0.00 \pm 0.00	8.99 \pm 1.02	32.60 \pm 1.27	26.27 \pm 1.02
MC exp. VV events	396.66 \pm 26.62	149.26 \pm 20.69	229.73 \pm 32.65	95.84 \pm 32.62	31.93 \pm 26.75	19.55 \pm 7.55
MC exp. ttbar events	121.27 \pm 13.33	64.16 \pm 8.17	20.55 \pm 7.58	50.64 \pm 9.83	2220.34 \pm 89.28	1956.57 \pm 81.41
MC exp. Wt events	50.12 \pm 5.09	23.17 \pm 2.94	7.72 \pm 2.61	18.80 \pm 3.28	625.10 \pm 45.01	584.25 \pm 43.48
MC exp. Zjets events	0.00 \pm 0.00	0.00 \pm 0.00	4.37 ^{+4.76} _{-4.37}	11.12 ^{+12.34} _{-11.12}	0.00 \pm 0.00	0.00 \pm 0.00
MC exp. Zttjets events	3.93 \pm 0.26	3.30 \pm 1.41	0.00 \pm 0.00	2.03 ^{+4.62} _{-2.03}	1.30 \pm 0.15	0.00 \pm 0.00
MC exp. VVV events	2.13 \pm 0.13	0.21 \pm 0.05	1.74 \pm 0.22	0.14 \pm 0.04	0.05 \pm 0.04	0.10 \pm 0.02
MC exp. other events	3.17 \pm 1.66	1.19 \pm 0.43	0.47 \pm 0.25	0.48 ^{+0.67} _{-0.48}	24.08 \pm 2.65	17.50 \pm 2.08

	VR_VV_DF0J_DM100	VR_VV_DF1J_DM100	VR_VV_SF0J_DM100	VR_VV_SF1J_DM100	VR_Top_DF_DM100	VR_Top_SF_DM100
Observed events	138	332	315	385	4308	3370
Fitted bkg events	142.00 \pm 17.61	348.11 \pm 26.62	234.56 \pm 26.43	386.34 \pm 57.26	4315.76 \pm 154.24	3550.07 \pm 116.55
Fitted MCFakes events	6.24 \pm 0.54	11.36 \pm 0.44	9.81 \pm 0.75	14.13 \pm 1.29	72.85 \pm 2.83	41.63 \pm 1.62
Fitted VV events	108.85 \pm 14.67	246.33 \pm 25.90	145.84 \pm 21.19	235.52 \pm 37.99	67.19 \pm 14.23	56.64 \pm 12.62
Fitted ttbar events	14.30 \pm 2.90	56.84 \pm 9.25	48.09 \pm 7.16	69.39 \pm 12.32	2978.84 \pm 108.21	2417.35 \pm 85.78
Fitted Wt events	12.21 \pm 2.40	29.98 \pm 4.31	30.35 \pm 5.34	37.92 \pm 5.11	1156.84 \pm 103.38	996.02 \pm 85.60
Fitted Zjets events	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00	28.35 ^{+35.92} _{-28.35}	0.00 \pm 0.00	7.77 \pm 4.55
Fitted Zttjets events	0.00 \pm 0.00	2.81 \pm 1.25	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00
Fitted VVV events	0.05 \pm 0.03	0.29 \pm 0.06	0.40 \pm 0.05	0.28 \pm 0.06	0.43 \pm 0.08	0.45 \pm 0.10
Fitted other events	0.37 \pm 0.24	0.50 \pm 0.17	0.06 \pm 0.03	0.74 \pm 0.52	39.61 \pm 5.97	30.21 \pm 4.28
MC exp. SM events	120.61 \pm 18.95	300.11 \pm 31.07	213.15 \pm 27.95	348.02 \pm 59.09	4585.86 \pm 310.77	3778.70 \pm 241.16
MC exp. MCFakes events	6.24 \pm 0.54	11.36 \pm 0.44	9.81 \pm 0.75	14.13 \pm 1.29	72.85 \pm 2.83	41.63 \pm 1.62
MC exp. VV events	86.48 \pm 15.52	191.78 \pm 25.12	121.50 \pm 21.48	192.63 \pm 36.93	56.86 \pm 14.47	48.31 \pm 11.38
MC exp. ttbar events	15.54 \pm 4.47	62.26 \pm 12.23	53.30 \pm 9.18	76.63 \pm 15.29	3294.22 \pm 198.50	2675.87 \pm 149.88
MC exp. Wt events	12.11 \pm 2.64	30.90 \pm 3.71	28.07 \pm 5.14	38.26 \pm 5.30	1122.96 \pm 121.53	973.97 \pm 102.19
MC exp. Zjets events	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00	25.18 ^{+39.23} _{-25.18}	0.00 \pm 0.00	9.41 \pm 5.11
MC exp. Zttjets events	0.00 \pm 0.00	2.94 \pm 1.16	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00	0.00 \pm 0.00
MC exp. VVV events	0.04 \pm 0.03	0.30 \pm 0.05	0.40 \pm 0.06	0.32 \pm 0.05	0.41 \pm 0.08	0.48 \pm 0.10
MC exp. other events	0.20 \pm 0.18	0.56 \pm 0.15	0.07 \pm 0.03	0.86 \pm 0.59	38.55 \pm 7.71	29.03 \pm 5.21

Yields Tables for C1C1 analysis

Exclusive DF SRs less compressed scenario

	SR_DF0J_0_DM100	SR_DF0J_1_DM100	SR_DF0J_2_DM100	SR_DF0J_3_DM100	SR_DF0J_4_DM100	SR_DF0J_5_DM100
Observed events	313	268	353	525	676	854
Fitted bkg events	345.68 ± 72.34	297.00 ± 27.64	403.64 ± 27.28	567.90 ± 77.62	754.48 ± 52.77	975.91 ± 83.73
Fitted MCFakes events	11.37 ± 2.16	3.09 ± 0.21	8.53 ± 0.33	23.22 ± 2.95	24.64 ± 0.96	38.62 ± 1.50
Fitted VV events	151.24 ± 40.12	147.66 ± 19.95	221.37 ± 23.16	264.64 ± 45.11	433.88 ± 43.71	572.22 ± 69.70
Fitted tbar events	77.64 ± 18.19	89.51 ± 8.72	108.51 ± 15.64	126.19 ± 21.27	171.54 ± 18.60	208.97 ± 22.53
Fitted Wt events	47.48 ± 12.41	55.21 ± 8.00	62.76 ± 7.32	91.63 ± 16.66	121.28 ± 18.14	152.58 ± 21.21
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	56.15 ± 10.98	0.26 ± 0.03	0.00 ± 0.00	59.70 ± 10.86	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.31 ± 0.08	0.30 ± 0.05	0.38 ± 0.04	0.47 ± 0.07	0.50 ± 0.07	0.65 ± 0.12
Fitted other events	1.49 ± 0.67	0.96 ± 0.48	2.08 ± 1.13	2.06 ± 0.55	2.62 ± 0.51	2.88 ± 0.62
MC exp. SM events	313.86 ± 68.13	268.71 ± 26.31	353.79 ± 25.85	525.18 ± 77.70	676.94 ± 54.13	854.68 ± 96.98
MC exp. MCFakes events	11.37 ± 2.16	3.09 ± 0.21	8.53 ± 0.33	23.23 ± 2.96	24.65 ± 0.96	38.63 ± 1.51
MC exp. VV events	110.11 ± 32.87	114.96 ± 16.76	172.52 ± 19.59	216.02 ± 47.99	345.65 ± 35.78	438.96 ± 70.31
MC exp. tbar events	85.54 ± 21.89	98.34 ± 12.85	110.31 ± 20.86	135.41 ± 26.94	190.73 ± 29.82	227.68 ± 34.60
MC exp. Wt events	48.46 ± 12.94	50.84 ± 7.44	60.27 ± 6.96	87.99 ± 16.45	112.93 ± 20.64	145.78 ± 23.53
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	56.72 ± 11.07	0.26 ± 0.03	0.00 ± 0.00	59.97 ± 9.18	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.31 ± 0.08	0.30 ± 0.06	0.38 ± 0.05	0.44 ± 0.07	0.50 ± 0.09	0.64 ± 0.10
MC exp. other events	1.36 ± 0.73	0.92 ± 0.53	1.79 ± 1.11	2.12 ± 0.56	2.49 ± 0.46	3.00 ± 0.58

	SR_DF0J_6_DM100	SR_DF0J_7_DM100	SR_DF0J_8_DM100	SR_DF0J_9_DM100	SR_DF0J_10_DM100	SR_DF0J_11_DM100
Observed events	853	483	273	160	116	102
Fitted bkg events	918.71 ± 110.49	526.23 ± 52.76	318.54 ± 68.22	181.12 ± 19.81	133.71 ± 17.46	116.58 ± 17.91
Fitted MCFakes events	81.56 ± 7.46	15.82 ± 0.61	5.42 ± 0.55	7.84 ± 0.62	1.46 ± 0.13	8.59 ± 0.94
Fitted VV events	450.25 ± 80.84	290.31 ± 44.96	207.78 ± 59.94	100.74 ± 13.89	78.44 ± 14.50	66.81 ± 12.44
Fitted tbar events	180.55 ± 22.11	114.99 ± 13.76	61.78 ± 12.46	39.27 ± 7.07	33.52 ± 7.32	22.45 ± 6.67
Fitted Wt events	133.25 ± 19.74	83.78 ± 8.58	42.26 ± 5.79	30.53 ± 7.14	19.95 ± 4.67	18.09 ± 2.98
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	70.11 ± 7.29	18.67 ± 1.16	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.64 ± 0.08	0.54 ± 0.05	0.41 ± 0.07	0.19 ± 0.04	0.25 ± 0.08	0.31 ± 0.07
Fitted other events	2.36 ± 0.60	2.13 ± 0.52	0.90 ± 0.43	2.55 ± 0.42	0.09 ^{+0.11} _{-0.09}	0.33 ± 0.26
MC exp. SM events	853.05 ± 119.64	483.93 ± 67.59	273.74 ± 71.89	160.82 ± 22.00	116.29 ± 14.72	103.00 ± 18.11
MC exp. MCFakes events	81.57 ± 7.47	15.83 ± 0.62	5.42 ± 0.55	7.84 ± 0.62	1.46 ± 0.13	8.59 ± 0.94
MC exp. VV events	372.30 ± 86.82	239.10 ± 52.74	155.78 ± 60.52	82.65 ± 13.95	60.60 ± 12.21	54.71 ± 12.51
MC exp. tbar events	196.28 ± 28.67	126.58 ± 22.85	68.95 ± 17.54	41.02 ± 9.73	35.59 ± 9.68	21.66 ± 9.05
MC exp. Wt events	129.05 ± 22.11	81.05 ± 9.44	42.51 ± 6.98	26.61 ± 8.07	18.36 ± 4.43	17.39 ± 2.65
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	70.90 ± 7.34	18.76 ± 1.04	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.64 ± 0.09	0.55 ± 0.06	0.38 ± 0.07	0.19 ± 0.05	0.26 ± 0.11	0.29 ± 0.07
MC exp. other events	2.33 ± 0.68	2.07 ± 0.55	0.69 ± 0.38	2.51 ± 0.43	0.01 ^{+0.10} _{-0.01}	0.35 ± 0.34

	SR_DF0J_12_DM100	SR_DF0J_13_DM100	SR_DF0J_14_DM100	SR_DF0J_15_DM100	SR_DF0J_16_DM100
Observed events	82	54	36	26	16
Fitted bkg events	91.72 ± 22.64	62.49 ± 18.54	42.84 ± 10.87	30.31 ± 7.28	17.38 ± 7.06
Fitted MCFakes events	14.08 ± 1.91	0.95 ± 0.14	0.59 ± 0.07	0.29 ± 0.04	0.22 ± 0.04
Fitted VV events	48.20 ± 19.00	40.81 ± 16.43	27.93 ± 9.39	18.27 ± 5.59	10.82 ± 5.43
Fitted tbar events	13.04 ± 3.83	12.44 ± 5.01	8.82 ± 3.85	4.80 ± 2.41	3.35 ± 1.92
Fitted Wt events	16.03 ± 5.16	8.18 ± 2.73	5.38 ± 3.34	6.21 ± 1.85	2.86 ± 1.06
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.20 ± 0.04	0.12 ± 0.03	0.12 ± 0.02	0.12 ± 0.04	0.13 ± 0.04
Fitted other events	0.18 ± 0.06	0.00 ± 0.00	0.00 ± 0.00	0.63 ± 0.46	0.00 ± 0.00
MC exp. SM events	82.50 ± 19.55	54.24 ± 17.09	36.49 ± 10.65	26.94 ± 6.78	16.49 ± 7.64
MC exp. MCFakes events	14.08 ± 1.91	0.95 ± 0.14	0.59 ± 0.07	0.29 ± 0.04	0.22 ± 0.04
MC exp. VV events	38.84 ± 16.09	32.42 ± 14.92	22.97 ± 8.03	15.47 ± 5.22	8.99 ± 5.32
MC exp. tbar events	14.95 ± 5.42	12.12 ± 6.10	9.19 ± 4.94	4.54 ± 3.03	4.31 ± 2.82
MC exp. Wt events	14.26 ± 5.06	8.60 ± 3.22	3.63 ± 3.09	5.91 ± 1.79	2.85 ± 1.08
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.20 ± 0.04	0.15 ± 0.03	0.12 ± 0.02	0.10 ± 0.03	0.12 ± 0.03
MC exp. other events	0.17 ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.64 ± 0.46	0.00 ± 0.00

	SR_DF1J_0_DM100	SR_DF1J_1_DM100	SR_DF1J_2_DM100	SR_DF1J_3_DM100	SR_DF1J_4_DM100	SR_DF1J_5_DM100
Observed events	1245	264	54	31	13	9
Fitted bkg events	1210.07 ± 154.55	298.69 ± 35.28	59.70 ± 12.47	34.32 ± 7.69	14.76 ± 6.35	9.83 ± 3.15
Fitted MCFakes events	53.83 ± 6.15	12.89 ± 0.50	0.00 ± 0.00	0.74 ± 0.09	0.73 ± 0.15	0.36 ± 0.07
Fitted VV events	499.91 ± 76.77	152.01 ± 22.29	26.64 ± 8.05	15.00 ± 6.80	4.47 ± 3.54	3.77 ± 1.85
Fitted tbar events	437.57 ± 70.07	100.08 ± 14.75	27.08 ± 8.08	13.91 ± 3.09	8.04 ± 3.25	5.32 ± 1.83
Fitted Wt events	153.03 ± 22.87	27.48 ± 5.69	5.10 ± 1.72	4.11 ± 1.44	1.45 ± 0.67	0.26 ± 0.18
Fitted Zjets events	7.96 ^{+45.69} _{-7.96}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	50.18 ± 17.15	2.30 ^{+12.75} _{-2.30}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	1.25 ± 0.18	0.56 ± 0.09	0.25 ± 0.05	0.18 ± 0.05	0.05 ± 0.03	0.13 ± 0.03
Fitted other events	6.33 ± 1.24	3.37 ± 0.66	0.64 ± 0.26	0.38 ± 0.11	0.02 ^{+0.10} _{-0.02}	0.00 ± 0.00
MC exp. SM events	1245.77 ± 172.25	264.63 ± 46.43	54.80 ± 14.42	31.43 ± 7.99	13.36 ± 7.37	9.46 ± 3.65
MC exp. MCFakes events	53.84 ± 6.16	12.89 ± 0.50	0.00 ± 0.00	0.74 ± 0.09	0.73 ± 0.15	0.36 ± 0.07
MC exp. VV events	396.46 ± 60.82	115.03 ± 26.35	21.09 ± 7.70	10.17 ± 6.59	2.87 ^{+3.74} _{-2.87}	2.76 ± 1.89
MC exp. tbar events	468.77 ± 86.11	104.41 ± 21.88	28.35 ± 11.02	15.42 ± 4.17	8.35 ± 4.11	5.97 ± 2.35
MC exp. Wt events	158.32 ± 23.10	27.82 ± 6.36	4.61 ± 1.71	4.50 ± 1.52	1.36 ± 0.53	0.22 ± 0.14
MC exp. Zjets events	20.64 ^{+70.50} _{-20.64}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	140.67 ± 16.28	0.43 ± 0.22	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	1.18 ± 0.17	0.49 ± 0.07	0.23 ± 0.05	0.20 ± 0.04	0.03 ^{+0.04} _{-0.03}	0.13 ± 0.03
MC exp. other events	5.89 ± 1.21	3.55 ± 0.69	0.52 ± 0.23	0.41 ± 0.15	0.03 ^{+0.14} _{-0.03}	0.00 ± 0.00

Yields Tables for C1C1 analysis

Exclusive SF SRs less compressed scenario

	SR_SF0J_0_DM100	SR_SF0J_1_DM100	SR_SF0J_2_DM100	SR_SF0J_3_DM100	SR_SF0J_4_DM100	SR_SF0J_5_DM100
Observed events	256	318	447	735	958	791
Fitted bkg events	279.13 ± 30.86	321.34 ± 41.14	513.63 ± 69.66	847.31 ± 138.77	1044.88 ± 143.27	928.21 ± 236.24
Fitted MCFakes events	13.80 ± 1.24	8.44 ± 0.69	20.11 ± 1.92	43.81 ± 3.99	45.55 ± 3.67	36.98 ± 2.67
Fitted VV events	122.15 ± 17.33	149.47 ± 30.36	248.65 ± 50.66	409.66 ± 68.45	539.74 ± 65.54	480.04 ± 236.86
Fitted tbar events	73.67 ± 8.93	83.78 ± 11.27	108.13 ± 16.20	156.33 ± 16.67	180.85 ± 19.09	176.39 ± 22.02
Fitted Wt events	46.68 ± 10.82	47.03 ± 5.85	63.53 ± 10.54	92.26 ± 12.64	113.06 ± 14.04	126.90 ± 18.44
Fitted Zjets events	21.85 ± 14.10	29.97 ± 13.45	71.28 ± 30.92	142.73 ± 93.22	123.49 ± 105.62	77.54 ± 51.33
Fitted Zttjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	37.98 ± 4.93	26.80 ± 3.43
Fitted VVV events	0.33 ± 0.08	0.29 ± 0.05	0.37 ± 0.06	0.50 ± 0.06	0.69 ± 0.10	0.65 ± 0.06
Fitted other events	0.64 ± 0.34	2.36 ± 0.69	1.55 ± 1.26	2.02 ± 1.40	3.51 ± 1.76	2.92 ± 1.06
MC exp. SM events	256.35 ± 33.40	318.75 ± 51.35	447.64 ± 67.32	735.29 ± 145.94	958.81 ± 183.05	791.31 ± 248.30
MC exp. MCFakes events	13.81 ± 1.24	8.44 ± 0.69	20.11 ± 1.92	43.82 ± 4.00	45.56 ± 3.67	36.98 ± 2.68
MC exp. VV events	98.52 ± 15.26	131.56 ± 38.60	195.05 ± 43.31	327.14 ± 55.91	423.10 ± 57.81	358.28 ± 230.16
MC exp. tbar events	80.47 ± 10.48	95.72 ± 16.38	110.03 ± 20.89	175.01 ± 21.25	203.63 ± 29.26	185.06 ± 27.91
MC exp. Wt events	44.92 ± 12.77	44.84 ± 6.03	61.60 ± 11.45	88.12 ± 14.05	107.82 ± 15.76	121.71 ± 21.27
MC exp. Zjets events	17.61 ^{+19.53} _{-17.61}	35.44 ± 13.30	59.32 ± 31.51	98.18 ^{+112.48} _{-98.18}	137.81 ^{+152.78} _{-137.81}	59.38 ± 53.71
MC exp. Zttjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	37.42 ± 3.25	26.81 ± 2.10
MC exp. VVV events	0.32 ± 0.07	0.26 ± 0.05	0.39 ± 0.07	0.49 ± 0.06	0.64 ± 0.09	0.66 ± 0.07
MC exp. other events	0.71 ± 0.23	2.50 ± 0.73	1.13 ^{+1.42} _{-1.13}	2.53 ± 1.57	2.82 ± 1.99	2.44 ± 1.07

	SR_SF0J_6_DM100	SR_SF0J_7_DM100	SR_SF0J_8_DM100	SR_SF0J_9_DM100	SR_SF0J_10_DM100	SR_SF0J_11_DM100
Observed events	431	232	135	138	113	218
Fitted bkg events	502.59 ± 307.35	258.81 ± 40.48	153.01 ± 24.30	167.74 ± 39.57	130.44 ± 71.36	214.15 ± 180.75
Fitted MCFakes events	12.08 ± 0.88	0.00 ± 0.00	0.00 ± 0.00	2.26 ± 0.46	0.64 ± 0.10	0.83 ± 0.62
Fitted VV events	302.79 ^{+306.81} _{-302.79}	136.52 ± 29.55	94.07 ± 24.99	125.77 ± 31.90	63.22 ± 14.57	53.50 ± 42.16
Fitted tbar events	76.74 ± 10.52	44.25 ± 8.84	39.29 ± 10.01	22.70 ± 6.05	16.68 ± 5.98	11.00 ± 8.57
Fitted Wt events	80.21 ± 9.03	41.12 ± 6.89	19.43 ± 4.58	16.75 ± 5.58	9.69 ± 2.93	6.38 ± 5.62
Fitted Zjets events	29.08 ± 26.95	35.10 ± 12.55	0.00 ± 0.00	0.00 ± 0.00	39.80 ^{+65.96} _{-39.80}	142.33 ± 134.96
Fitted Zttjets events	0.58 ^{+2.13} _{-0.58}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.40 ± 0.05	0.38 ± 0.05	0.21 ± 0.03	0.16 ± 0.04	0.15 ± 0.03	0.11 ± 0.09
Fitted other events	0.71 ± 0.19	1.43 ± 1.04	0.00 ± 0.00	0.10 ^{+0.24} _{-0.10}	0.26 ^{+0.26} _{-0.26}	0.00 ± 0.00
MC exp. SM events	431.96 ± 283.25	232.22 ± 34.75	135.83 ± 25.23	138.55 ± 32.85	113.54 ± 92.46	218.39 ± 182.65
MC exp. MCFakes events	12.08 ± 0.89	0.00 ± 0.00	0.00 ± 0.00	2.26 ± 0.46	0.64 ± 0.10	0.83 ± 0.62
MC exp. VV events	221.55 ^{+279.32} _{-221.55}	109.12 ± 24.92	81.91 ± 29.47	97.07 ± 25.25	49.86 ± 12.16	38.66 ± 32.62
MC exp. tbar events	84.67 ± 13.91	49.78 ± 13.21	36.15 ± 14.24	23.15 ± 6.78	15.88 ± 7.86	11.66 ± 9.51
MC exp. Wt events	76.84 ± 8.89	37.44 ± 6.28	17.55 ± 5.37	15.86 ± 5.45	9.44 ± 3.53	5.83 ± 5.54
MC exp. Zjets events	35.49 ± 32.93	33.90 ± 11.87	0.00 ± 0.00	0.00 ± 0.00	37.21 ^{+86.11} _{-37.21}	161.31 ± 144.85
MC exp. Zttjets events	0.25 ^{+2.68} _{-0.25}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.39 ± 0.06	0.38 ± 0.05	0.22 ± 0.03	0.16 ± 0.03	0.16 ± 0.03	0.10 ± 0.08
MC exp. other events	0.68 ± 0.18	1.60 ± 1.12	0.00 ± 0.00	0.07 ^{+0.18} _{-0.07}	0.34 ± 0.33	0.00 ± 0.00

	SR_SF0J_12_DM100	SR_SF0J_13_DM100	SR_SF0J_14_DM100	SR_SF0J_15_DM100
Observed events	35	31	16	0
Fitted bkg events	51.92 ^{+121.25} _{-51.92}	40.50 ± 21.80	17.73 ± 7.09	0.64 ^{+0.69} _{-0.64}
Fitted MCFakes events	0.36 ± 0.10	0.11 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
Fitted VV events	20.43 ± 12.76	28.69 ± 8.45	12.08 ± 5.48	0.64 ^{+0.69} _{-0.64}
Fitted tbar events	5.04 ± 2.97	2.64 ± 2.32	2.53 ± 2.24	0.00 ± 0.00
Fitted Wt events	3.61 ± 1.62	3.16 ± 0.98	2.12 ± 0.92	0.00 ± 0.00
Fitted Zjets events	22.31 ^{+119.96} _{-22.31}	5.81 ^{+17.34} _{-5.81}	0.94 ± 0.46	0.00 ± 0.00
Fitted Zttjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.11 ± 0.03	0.09 ± 0.02	0.06 ± 0.03	0.00 ± 0.00
Fitted other events	0.05 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. SM events	35.51 ^{+108.94} _{-35.51}	31.23 ± 11.45	16.81 ± 7.10	0.46 ^{+0.63} _{-0.46}
MC exp. MCFakes events	0.36 ± 0.10	0.11 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
MC exp. VV events	13.66 ± 10.45	22.19 ± 8.44	10.85 ± 5.12	0.46 ^{+0.63} _{-0.46}
MC exp. tbar events	5.91 ± 3.94	3.70 ± 3.25	2.71 ^{+3.01} _{-2.71}	0.00 ± 0.00
MC exp. Wt events	3.16 ± 1.65	3.47 ± 0.94	2.21 ± 1.04	0.00 ± 0.00
MC exp. Zjets events	12.26 ^{+110.39} _{-12.26}	1.67 ^{+7.63} _{-1.67}	0.99 ± 0.55	0.00 ± 0.00
MC exp. Zttjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.11 ± 0.03	0.09 ± 0.02	0.05 ± 0.03	0.00 ± 0.00
MC exp. other events	0.05 ± 0.03	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

	SR_SF1J_0_DM100	SR_SF1J_1_DM100	SR_SF1J_2_DM100	SR_SF1J_3_DM100	SR_SF1J_4_DM100	SR_SF1J_5_DM100
Observed events	1083	212	64	12	3	2
Fitted bkg events	1167.73 ± 250.00	226.91 ± 28.59	80.03 ± 34.42	9.59 ± 7.43	4.33 ± 2.39	1.96 ^{+3.29} _{-1.96}
Fitted MCFakes events	37.81 ± 6.90	5.94 ± 0.44	1.44 ± 0.59	0.53 ± 0.10	0.01 ± 0.00	0.02 ± 0.01
Fitted VV events	455.08 ± 93.76	120.92 ± 15.87	55.51 ± 24.93	5.78 ^{+6.80} _{-5.78}	0.99 ^{+2.66} _{-0.99}	1.67 ^{+3.41} _{-1.67}
Fitted tbar events	335.28 ± 68.52	72.20 ± 19.12	14.62 ± 7.25	3.16 ± 1.53	1.42 ± 1.06	0.94 ^{+0.95} _{-0.94}
Fitted Wt events	111.97 ± 22.09	17.30 ± 2.41	3.32 ± 2.00	0.00 ± 0.00	0.66 ± 0.41	0.00 ± 0.00
Fitted Zjets events	218.82 ± 120.96	7.81 ± 6.03	4.98 ^{+5.53} _{-4.98}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Zttjets events	1.21 ± 0.77	2.11 ± 0.44	0.00 ^{+0.00} _{-0.00}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.83 ± 0.18	0.53 ± 0.07	0.11 ± 0.05	0.01 ± 0.01	0.05 ± 0.02	0.00 ± 0.00
Fitted other events	6.75 ± 2.46	0.09 ^{+0.11} _{-0.09}	0.05 ± 0.03	0.10 ± 0.03	0.02 ± 0.01	0.00 ± 0.00
MC exp. SM events	1083.82 ± 250.22	212.76 ± 36.61	64.87 ± 28.62	12.56 ± 9.17	3.97 ± 2.70	2.95 ^{+4.54} _{-2.95}
MC exp. MCFakes events	37.81 ± 6.90	5.94 ± 0.44	1.44 ± 0.59	0.53 ± 0.10	0.01 ± 0.00	0.02 ± 0.01
MC exp. VV events	360.76 ± 80.55	95.25 ± 13.98	41.34 ± 20.21	7.86 ^{+8.07} _{-7.86}	1.78 ± 1.65	1.67 ^{+3.41} _{-1.67}
MC exp. tbar events	361.15 ± 76.50	80.09 ± 24.91	16.48 ± 8.67	4.08 ± 2.19	1.42 ^{+1.46} _{-1.42}	1.25 ^{+1.44} _{-1.25}
MC exp. Wt events	107.81 ± 21.22	17.49 ± 2.91	2.22 ± 1.51	0.00 ± 0.00	0.70 ± 0.42	0.00 ± 0.00
MC exp. Zjets events	208.72 ± 136.30	11.40 ± 5.81	3.21 ^{+5.52} _{-3.21}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Zttjets events	1.13 ± 0.81	1.96 ± 0.46	0.00 ^{+0.00} _{-0.00}	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.83 ± 0.18	0.55 ± 0.05	0.11 ± 0.05	0.01 ± 0.01	0.05 ± 0.02	0.00 ± 0.00
MC exp. other events	5.62 ± 2.36	0.08 ^{+0.08} _{-0.08}	0.06 ± 0.03	0.08 ± 0.02	0.02 ± 0.01	0.00 ± 0.00

Yields Tables for C1C1 analysis

Inclusive SF SRs less compressed scenario

	SRD_DF0J_DM100
Observed events	5145
Fitted bkg events	5145.29 ± 702.25
Fitted MCFakes events	246.33 ± 11.51
Fitted VV events	2481.56 ± 474.90
Fitted ttbar events	1382.84 ± 305.62
Fitted Wt events	856.41 ± 113.23
Fitted Zjets events	0.00 ± 0.00
Fitted Zttjets events	151.30 ± 11.96
Fitted VVV events	5.56 ± 0.45
Fitted other events	20.39 ± 3.02
MC exp. SM events	5146.28 ± 789.46
MC exp. MCFakes events	246.33 ± 11.67
MC exp. VV events	2482.03 ± 489.83
MC exp. ttbar events	1383.18 ± 321.83
MC exp. Wt events	856.49 ± 117.72
MC exp. Zjets events	0.00 ± 0.00
MC exp. Zttjets events	151.30 ± 12.09
MC exp. VVV events	5.56 ± 0.47
MC exp. other events	20.40 ± 3.10
	SRD_SF0J_DM100
Observed events	4824
Fitted bkg events	4824.19 ± 668.69
Fitted MCFakes events	173.66 ± 9.81
Fitted VV events	2178.52 ± 526.40
Fitted ttbar events	1083.28 ± 210.76
Fitted Wt events	640.76 ± 80.45
Fitted Zjets events	672.89 ± 277.17
Fitted Zttjets events	54.83 ± 3.65
Fitted VVV events	4.41 ± 0.33
Fitted other events	14.85 ± 2.59
MC exp. SM events	4825.17 ± 989.75
MC exp. MCFakes events	173.66 ± 10.05
MC exp. VV events	2179.00 ± 650.52
MC exp. ttbar events	1083.52 ± 236.42
MC exp. Wt events	640.82 ± 90.97
MC exp. Zjets events	673.08 ± 316.57
MC exp. Zttjets events	54.83 ± 3.81
MC exp. VVV events	4.41 ± 0.37
MC exp. other events	14.85 ± 2.93

	SRD_DF1J_DM100
Observed events	1619
Fitted bkg events	1619.16 ± 105.05
Fitted MCFakes events	68.36 ± 5.42
Fitted VV events	548.07 ± 88.64
Fitted ttbar events	630.87 ± 100.33
Fitted Wt events	196.81 ± 22.57
Fitted Zjets events	$20.56^{+65.84}_{-20.56}$
Fitted Zttjets events	140.93 ± 11.44
Fitted VVV events	2.27 ± 0.22
Fitted other events	10.33 ± 1.43
MC exp. SM events	1620.04 ± 236.69
MC exp. MCFakes events	68.36 ± 6.28
MC exp. VV events	548.39 ± 115.33
MC exp. ttbar events	631.27 ± 122.83
MC exp. Wt events	196.83 ± 24.98
MC exp. Zjets events	$20.64^{+70.29}_{-20.64}$
MC exp. Zttjets events	140.94 ± 13.21
MC exp. VVV events	2.27 ± 0.25
MC exp. other events	10.33 ± 1.55
	SRD_SF1J_DM100
Observed events	1380
Fitted bkg events	1380.97 ± 164.38
Fitted MCFakes events	45.75 ± 5.90
Fitted VV events	508.31 ± 112.38
Fitted ttbar events	464.19 ± 91.37
Fitted Wt events	128.19 ± 17.86
Fitted Zjets events	223.06 ± 120.69
Fitted Zttjets events	3.09 ± 0.82
Fitted VVV events	1.56 ± 0.22
Fitted other events	5.86 ± 2.12
MC exp. SM events	1381.93 ± 290.21
MC exp. MCFakes events	45.76 ± 6.72
MC exp. VV events	508.65 ± 130.68
MC exp. ttbar events	464.47 ± 105.44
MC exp. Wt events	128.22 ± 20.65
MC exp. Zjets events	223.33 ± 136.70
MC exp. Zttjets events	3.09 ± 0.85
MC exp. VVV events	1.56 ± 0.24
MC exp. other events	5.86 ± 2.28

Yields Tables for C1C1 analysis

CRs/VRs more compressed scenario

	CR_VV_DF1J_DM30	CR_VV_SF1J_DM30	CR_Top_DF_DM30	CR_Top_SF_DM30
Observed events	376	287	1417	288
Fitted bkg events	376.60 ± 42.21	286.46 ± 17.19	1408.67 ± 40.53	296.21 ± 12.11
Fitted MCFakes events	27.13 ± 2.22	25.25 ± 1.67	15.05 ± 0.58	3.10 ± 0.12
Fitted VV events	179.92 ± 62.89	128.19 ± 25.13	8.26 ± 4.81	0.00 ± 0.50
Fitted tbar events	98.46 ± 15.26	83.67 ± 10.76	1074.00 ± 46.23	234.26 ± 13.21
Fitted Wt events	42.74 ± 7.22	33.63 ± 4.37	294.81 ± 18.97	55.73 ± 8.34
Fitted Zjets events	$7.19^{+48.59}_{-7.19}$	$5.25^{+10.76}_{-5.25}$	0.00 ± 0.00	0.00 ± 0.00
Fitted Zttjets events	19.21 ± 2.06	9.30 ± 2.96	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.22 ± 0.04	0.21 ± 0.06	0.01 ± 0.00	0.00 ± 0.00
Fitted other events	1.73 ± 1.43	0.96 ± 0.36	16.54 ± 2.22	3.13 ± 0.72
MC exp. SM events	407.75 ± 82.95	312.70 ± 34.06	1513.13 ± 30.88	336.33 ± 15.51
MC exp. MCFakes events	27.22 ± 2.28	25.20 ± 1.70	15.04 ± 0.59	3.10 ± 0.12
MC exp. VV events	179.64 ± 29.95	144.60 ± 24.88	9.35 ± 4.56	$0.39^{+0.84}_{-0.39}$
MC exp. tbar events	114.38 ± 15.56	92.24 ± 9.73	1180.41 ± 23.56	269.42 ± 14.02
MC exp. Wt events	44.22 ± 7.24	34.76 ± 3.60	291.98 ± 18.22	59.73 ± 8.63
MC exp. Zjets events	$20.64^{+70.38}_{-20.64}$	$5.39^{+10.63}_{-5.39}$	0.00 ± 0.00	0.00 ± 0.00
MC exp. Zttjets events	19.66 ± 2.09	9.35 ± 2.93	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.22 ± 0.04	0.20 ± 0.06	0.01 ± 0.00	0.00 ± 0.00
MC exp. other events	1.76 ± 1.41	0.96 ± 0.38	16.34 ± 1.47	3.71 ± 0.65
	VR_VV_DF1J_DM30	VR_VV_SF1J_DM30	VR_Top_DF_DM30	VR_Top_SF_DM30
Observed events	71	43	1287	209
Fitted bkg events	63.95 ± 15.07	20.88 ± 9.00	1304.50 ± 67.29	190.26 ± 15.43
Fitted MCFakes events	5.50 ± 0.58	1.58 ± 0.24	10.76 ± 0.42	2.41 ± 0.09
Fitted VV events	40.76 ± 14.32	11.81 ± 6.23	5.38 ± 3.36	$1.51^{+2.06}_{-1.51}$
Fitted tbar events	15.04 ± 3.19	6.40 ± 4.16	1055.61 ± 66.43	145.78 ± 14.73
Fitted Wt events	2.40 ± 1.08	$0.74^{+1.28}_{-0.74}$	218.22 ± 13.75	38.10 ± 3.94
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Zttjets events	0.20 ± 0.16	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted VVV events	0.02 ± 0.01	0.02 ± 0.00	0.03 ± 0.01	0.00 ± 0.00
Fitted other events	$0.02^{+0.06}_{-0.02}$	0.34 ± 0.27	14.50 ± 3.07	2.46 ± 0.45
MC exp. SM events	76.13 ± 18.84	26.73 ± 11.11	1426.58 ± 49.13	210.56 ± 14.86
MC exp. MCFakes events	5.49 ± 0.58	1.57 ± 0.24	10.76 ± 0.42	2.41 ± 0.09
MC exp. VV events	49.88 ± 17.04	15.29 ± 7.29	5.75 ± 2.89	$1.70^{+1.85}_{-1.70}$
MC exp. tbar events	17.13 ± 3.17	9.08 ± 4.47	1178.16 ± 44.76	165.09 ± 13.63
MC exp. Wt events	2.30 ± 1.15	$0.41^{+1.31}_{-0.41}$	214.95 ± 13.03	38.96 ± 3.67
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Zttjets events	1.14 ± 0.69	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. VVV events	0.02 ± 0.01	0.02 ± 0.00	0.03 ± 0.02	0.00 ± 0.00
MC exp. other events	$0.17^{+0.23}_{-0.17}$	0.35 ± 0.26	16.94 ± 2.25	2.40 ± 0.47

Yields Tables for C1C1 analysis

Exclusive SRs more compressed scenario

	SR_DF1J_0_DM30	SR_DF1J_1_DM30	SR_DF1J_2_DM30	SR_DF1J_3_DM30	SR_DF1J_4_DM30
Observed events	27	26	23	20	28
Fitted bkg events	27.05 ± 10.03	24.23 ± 7.25	19.70 ± 6.74	23.78 ± 11.29	27.26 ± 8.52
Fitted MCFakes events	2.85 ± 0.55	3.28 ± 0.52	4.71 ± 1.05	0.97 ± 0.22	4.14 ± 0.97
Fitted VV events	9.12 ± 5.58	14.89 ± 6.88	8.54 ± 4.89	12.27 ± 8.49	10.23 ± 5.79
Fitted ttbar events	10.98 ± 4.56	$2.23^{+5.22}_{-2.23}$	$2.66^{+3.19}_{-2.66}$	6.85 ± 3.68	3.52 ± 2.26
Fitted Wt events	2.14 ± 0.91	$1.11^{+1.70}_{-1.11}$	3.04 ± 1.83	1.89 ± 0.50	2.71 ± 1.16
Fitted Zjets events	0.00 ± 0.00				
Fitted Ztjets events	$1.93^{+3.87}_{-1.93}$	$2.52^{+4.08}_{-2.52}$	$0.34^{+0.87}_{-0.34}$	$1.50^{+1.81}_{-1.50}$	6.63 ± 2.42
Fitted VVV events	0.01 ± 0.00	0.01 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	$0.01^{+0.02}_{-0.01}$
Fitted other events	$0.02^{+0.05}_{-0.02}$	$0.19^{+0.35}_{-0.19}$	0.41 ± 0.36	0.30 ± 0.18	$0.02^{+0.07}_{-0.02}$
MC exp. SM events	27.37 ± 8.93	26.33 ± 8.73	23.67 ± 7.51	20.11 ± 10.30	28.20 ± 7.77
MC exp. MCFakes events	2.85 ± 0.55	3.28 ± 0.52	4.71 ± 1.05	0.97 ± 0.22	4.14 ± 0.97
MC exp. VV events	11.38 ± 5.30	14.33 ± 5.28	9.75 ± 4.33	10.07 ± 6.58	9.44 ± 4.67
MC exp. ttbar events	10.17 ± 4.80	$6.67^{+7.33}_{-6.67}$	4.71 ± 3.57	5.42 ± 4.22	4.33 ± 2.18
MC exp. Wt events	1.64 ± 0.77	$0.76^{+0.95}_{-0.76}$	3.82 ± 1.37	1.84 ± 0.47	2.62 ± 0.91
MC exp. Zjets events	0.00 ± 0.00				
MC exp. Ztjets events	$1.31^{+3.52}_{-1.31}$	$1.28^{+3.43}_{-1.28}$	$0.13^{+0.87}_{-0.13}$	1.47 ± 1.45	7.65 ± 2.39
MC exp. VVV events	0.01 ± 0.00	0.01 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	$0.01^{+0.02}_{-0.01}$
MC exp. other events	$0.01^{+0.06}_{-0.01}$	$0.00^{+0.17}_{-0.00}$	0.56 ± 0.26	0.35 ± 0.16	$0.00^{+0.03}_{-0.00}$

	SR_SF1J_0_DM30	SR_SF1J_1_DM30	SR_SF1J_2_DM30	SR_SF1J_3_DM30	SR_SF1J_4_DM30
Observed events	25	38	33	24	18
Fitted bkg events	25.68 ± 8.89	47.57 ± 19.45	30.98 ± 9.35	24.51 ± 7.85	18.10 ± 5.88
Fitted MCFakes events	2.81 ± 0.42	1.14 ± 0.19	2.64 ± 0.36	2.88 ± 0.44	4.35 ± 0.78
Fitted VV events	15.74 ± 10.32	18.14 ± 8.42	14.52 ± 8.15	13.69 ± 6.66	9.00 ± 5.11
Fitted ttbar events	5.62 ± 4.42	8.77 ± 3.63	8.20 ± 3.97	6.52 ± 2.76	3.53 ± 2.29
Fitted Wt events	1.51 ± 0.68	$0.98^{+1.29}_{-0.98}$	2.20 ± 1.57	1.34 ± 0.97	0.80 ± 0.18
Fitted Zjets events	0.00 ± 0.00	$12.26^{+13.98}_{-12.26}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	0.00 ± 0.00	6.19 ± 5.58	3.11 ± 2.70	$0.07^{+0.32}_{-0.07}$	0.42 ± 0.35
Fitted VVV events	$0.00^{+0.01}_{-0.00}$	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.00 ± 0.00
Fitted other events	0.00 ± 0.00	0.09 ± 0.04	0.30 ± 0.17	0.00 ± 0.00	0.00 ± 0.00
MC exp. SM events	25.92 ± 6.81	38.00 ± 11.37	33.34 ± 8.68	24.27 ± 6.90	18.01 ± 4.79
MC exp. MCFakes events	2.81 ± 0.42	1.14 ± 0.19	2.64 ± 0.36	2.88 ± 0.44	4.35 ± 0.78
MC exp. VV events	12.90 ± 7.85	18.01 ± 6.81	14.12 ± 5.94	13.45 ± 5.11	8.88 ± 3.69
MC exp. ttbar events	8.21 ± 4.83	8.96 ± 3.67	8.35 ± 3.61	6.84 ± 2.71	3.61 ± 2.34
MC exp. Wt events	1.99 ± 0.66	$0.05^{+1.07}_{-0.05}$	3.50 ± 1.58	1.06 ± 1.05	0.77 ± 0.16
MC exp. Zjets events	0.00 ± 0.00	$3.83^{+3.15}_{-3.83}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	0.00 ± 0.00	5.92 ± 5.29	4.38 ± 2.81	$0.04^{+0.30}_{-0.04}$	0.40 ± 0.29
MC exp. VVV events	$0.00^{+0.01}_{-0.00}$	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.00	0.00 ± 0.00
MC exp. other events	0.00 ± 0.00	0.09 ± 0.04	0.33 ± 0.17	0.00 ± 0.00	0.00 ± 0.00

	SR_DF1J_5_DM30	SR_DF1J_6_DM30	SR_DF1J_7_DM30	SR_DF1J_8_DM30
Observed events	10	9	5	2
Fitted bkg events	$5.99^{+7.74}_{-5.99}$	7.45 ± 4.42	5.37 ± 2.64	2.19 ± 1.24
Fitted MCFakes events	2.06 ± 0.51	1.76 ± 0.52	0.00 ± 0.00	1.00 ± 0.36
Fitted VV events	$2.21^{+5.92}_{-2.21}$	4.57 ± 3.91	4.20 ± 2.40	$0.49^{+0.57}_{-0.49}$
Fitted ttbar events	$0.41^{+2.05}_{-0.41}$	$0.80^{+1.03}_{-0.80}$	1.18 ± 0.70	$0.25^{+0.59}_{-0.25}$
Fitted Wt events	1.23 ± 1.05	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.03
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	0.00 ± 0.00	0.29 ± 0.20	0.00 ± 0.00	0.39 ± 0.21
Fitted VVV events	$0.01^{+0.03}_{-0.01}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted other events	0.06 ± 0.04	0.04 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
MC exp. SM events	10.59 ± 9.21	9.06 ± 4.19	5.60 ± 2.77	2.99 ± 1.63
MC exp. MCFakes events	2.06 ± 0.51	1.75 ± 0.52	0.00 ± 0.00	1.00 ± 0.36
MC exp. VV events	$4.86^{+6.19}_{-4.86}$	5.69 ± 3.42	4.37 ± 2.45	0.88 ± 0.76
MC exp. ttbar events	$2.25^{+3.52}_{-2.25}$	$0.78^{+0.92}_{-0.78}$	1.23 ± 0.65	$0.62^{+0.73}_{-0.62}$
MC exp. Wt events	1.34 ± 0.84	0.00 ± 0.00	0.00 ± 0.00	0.06 ± 0.03
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	0.00 ± 0.00	0.79 ± 0.57	0.00 ± 0.00	0.44 ± 0.18
MC exp. VVV events	$0.01^{+0.02}_{-0.01}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. other events	0.07 ± 0.03	0.04 ± 0.02	0.00 ± 0.00	0.00 ± 0.00

	SR_SF1J_5_DM30	SR_SF1J_6_DM30	SR_SF1J_7_DM30	SR_SF1J_8_DM30
Observed events	10	12	3	2
Fitted bkg events	7.86 ± 5.28	11.30 ± 3.93	4.33 ± 2.79	1.63 ± 1.00
Fitted MCFakes events	0.80 ± 0.23	3.06 ± 0.80	0.22 ± 0.07	0.49 ± 0.26
Fitted VV events	$2.32^{+4.24}_{-2.32}$	4.77 ± 2.82	4.00 ± 2.87	0.77 ± 0.63
Fitted ttbar events	$1.55^{+2.32}_{-1.55}$	1.99 ± 1.04	$0.11^{+0.30}_{-0.11}$	0.28 ± 0.17
Fitted Wt events	1.43 ± 0.46	0.68 ± 0.29	0.00 ± 0.00	0.00 ± 0.00
Fitted Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Fitted Ztjets events	1.77 ± 0.85	0.80 ± 0.52	0.00 ± 0.00	0.08 ± 0.06
Fitted VVV events	$0.00^{+0.00}_{-0.00}$	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01
Fitted other events	$0.00^{+0.00}_{-0.00}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. SM events	10.08 ± 6.30	12.67 ± 4.22	3.72 ± 2.12	2.01 ± 1.24
MC exp. MCFakes events	0.80 ± 0.23	3.06 ± 0.80	0.22 ± 0.07	0.49 ± 0.26
MC exp. VV events	$3.89^{+4.41}_{-3.89}$	5.11 ± 2.66	3.13 ± 2.26	1.05 ± 0.83
MC exp. ttbar events	2.68 ± 2.51	2.22 ± 1.01	$0.37^{+0.45}_{-0.37}$	0.35 ± 0.20
MC exp. Wt events	1.47 ± 0.46	0.63 ± 0.24	0.00 ± 0.00	0.00 ± 0.00
MC exp. Zjets events	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
MC exp. Ztjets events	1.23 ± 0.61	1.65 ± 1.11	0.00 ± 0.00	0.10 ± 0.07
MC exp. VVV events	$0.01^{+0.01}_{-0.01}$	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01
MC exp. other events	$0.00^{+0.00}_{-0.00}$	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Yields Tables for C1C1 analysis

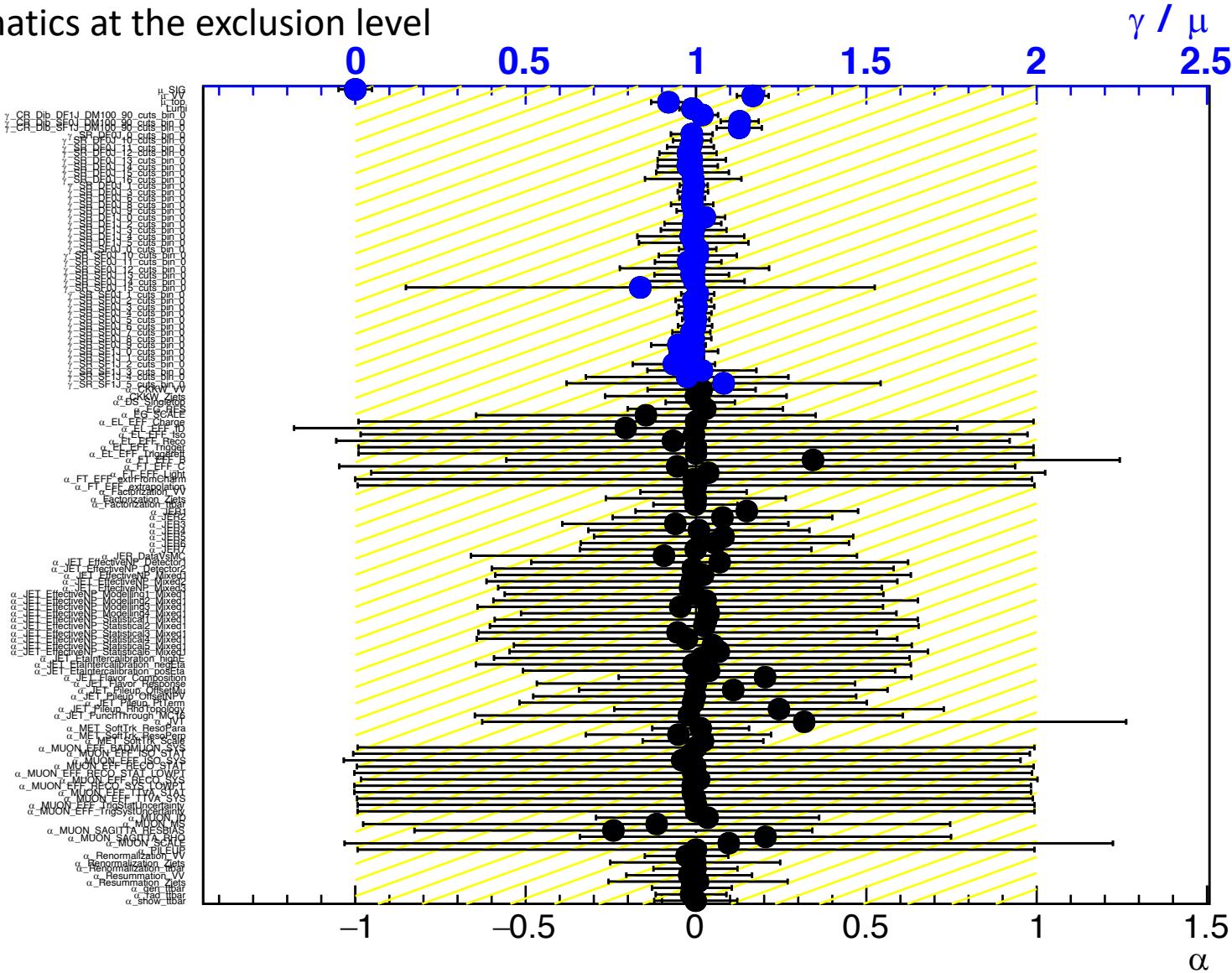
Inclusive SRs more compressed scenario

	SRD_DF1J_DM30
Observed events	151
Fitted bkg events	151.61 ± 30.13
Fitted MCFakes events	20.56 ± 1.79
Fitted VV events	70.36 ± 14.25
Fitted ttbar events	35.96 ± 9.01
Fitted Wt events	12.06 ± 1.22
Fitted Zjets events	0.00 ± 0.00
Fitted Zttjets events	10.75 ± 3.44
Fitted VVV events	0.04 ± 0.01
Fitted other events	1.03 ± 0.12
MC exp. SM events	152.48 ± 24.63
MC exp. MCFakes events	20.59 ± 1.87
MC exp. VV events	70.77 ± 15.74
MC exp. ttbar events	36.16 ± 9.67
MC exp. Wt events	12.08 ± 1.27
MC exp. Zjets events	0.00 ± 0.00
MC exp. Zttjets events	10.81 ± 3.63
MC exp. VVV events	0.04 ± 0.01
MC exp. other events	1.03 ± 0.13

	SRD_SF1J_DM30
Observed events	154
Fitted bkg events	154.31 ± 30.28
Fitted MCFakes events	18.36 ± 1.35
Fitted VV events	80.02 ± 18.61
Fitted ttbar events	41.45 ± 10.30
Fitted Wt events	9.47 ± 1.32
Fitted Zjets events	$3.79^{+8.80}_{-3.79}$
Fitted Zttjets events	0.00 ± 0.00
Fitted VVV events	0.06 ± 0.01
Fitted other events	0.31 ± 0.04
MC exp. SM events	155.18 ± 24.45
MC exp. MCFakes events	18.38 ± 1.39
MC exp. VV events	80.53 ± 20.51
MC exp. ttbar events	41.59 ± 10.56
MC exp. Wt events	9.48 ± 1.34
MC exp. Zjets events	$3.83^{+8.98}_{-3.83}$
MC exp. Zttjets events	0.00 ± 0.00
MC exp. VVV events	0.06 ± 0.01
MC exp. other events	0.31 ± 0.04

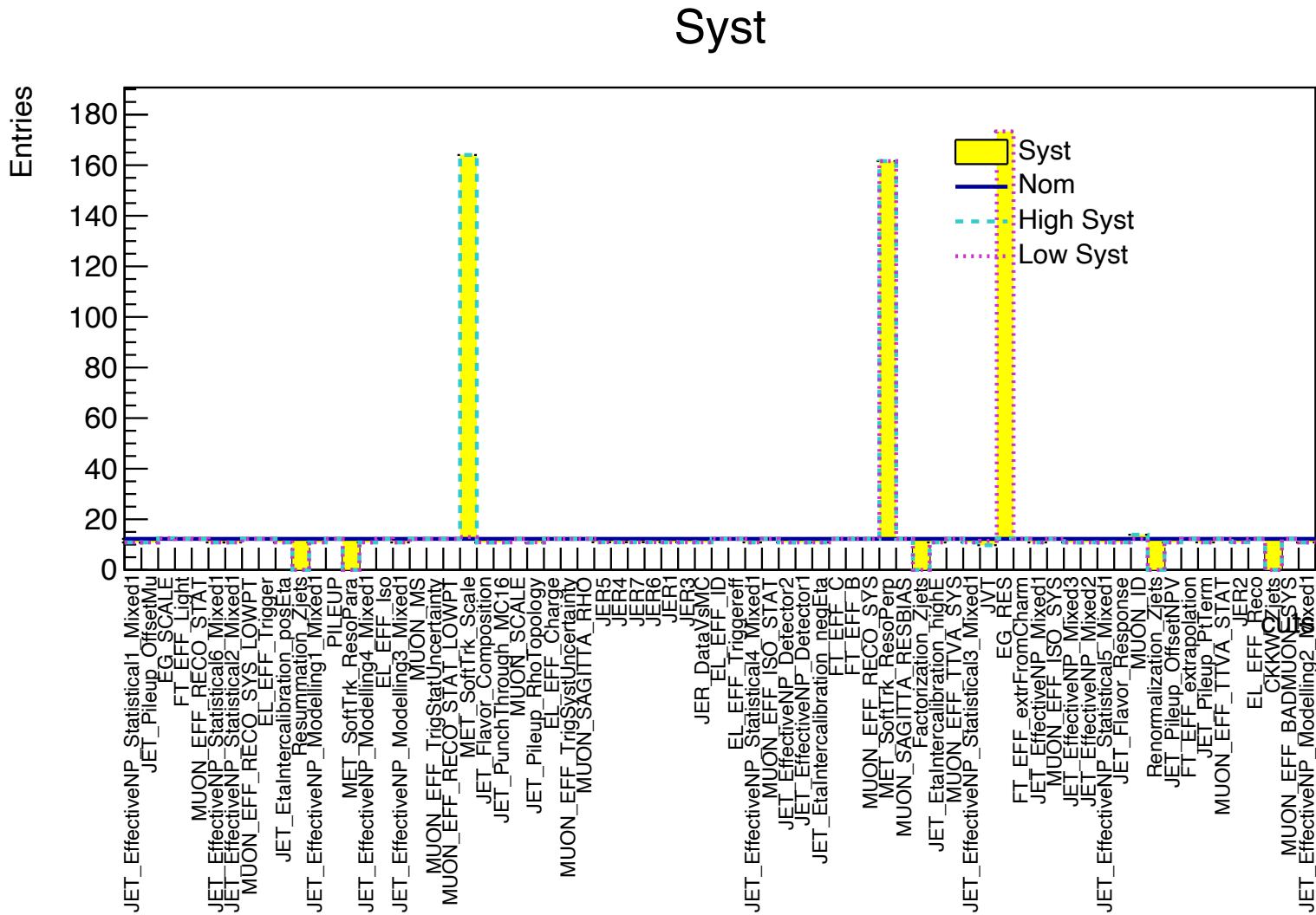
Systematics pull plots – C1C1 search

- Pull plot systematics at the exclusion level



Systematics - C1C1 search

Z+jets in SR_SF0J_12



Systematics - C1C1 search

VV in SR_SF0J_12

Syst

