



Experience from ATLAS

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- Search for Supersymmetry in final states with leptons, jets and \cancel{E}_T
- Main selection requirements
 - ▲ Transverse mass: $M_T > 100 \text{ GeV}$ Rejects W+jets and $t\bar{t}$ events
 - ▲ Missing transverse energy: $\cancel{E}_T > 250 \text{ GeV}$ Rejects QCD (W+jets and $t\bar{t}$)
 - ▲ Effective mass: $M_{\text{eff}} > 600 \text{ GeV}$ Rejects QCD, W+jets ($t\bar{t}$)

Electron channel	4JL SR	4JT SR	Top CR	W CR
Observed events	41	9	1382	1872
Fitted top events	38 ± 15 (34)	4.5 ± 2.6 (4.1)	1258 ± 44 (1138)	391 ± 14 (354)
Fitted W/Z events	9.5 ± 7.5 (9.2)	3.5 ± 2.2 (3.4)	88 ± 21 (86)	1242 ± 89 (1202)
Fitted multijet events	$0.90^{+0.54}_{-0.37}$	$0.00^{+0.02}_{-0.00}$	35 ± 13	239 ± 78
Sum of background events	48 ± 18	8.0 ± 3.7	1382 ± 37	1872 ± 43



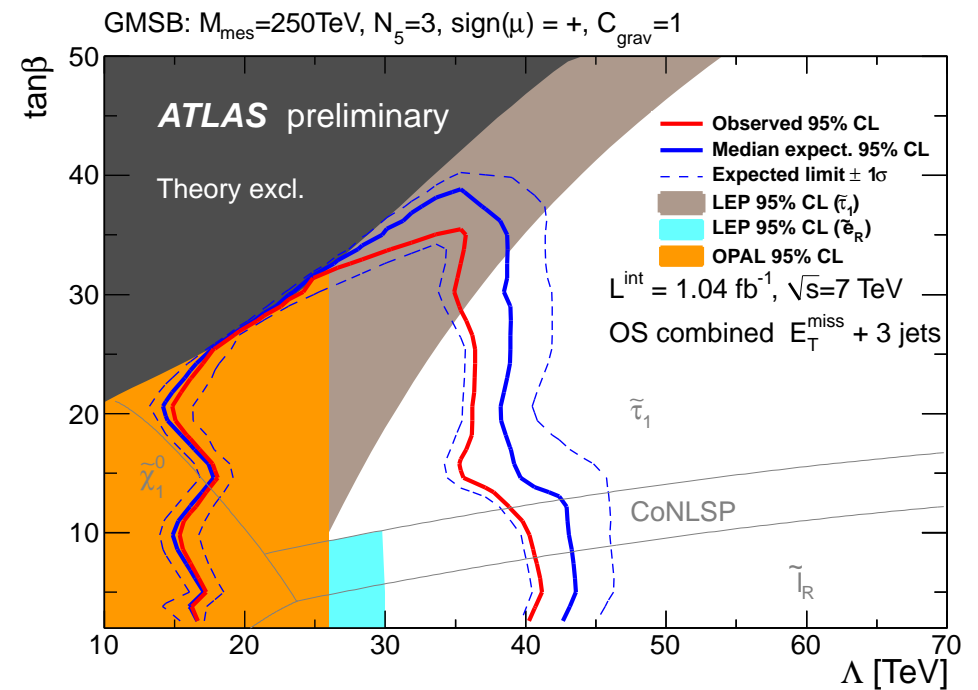
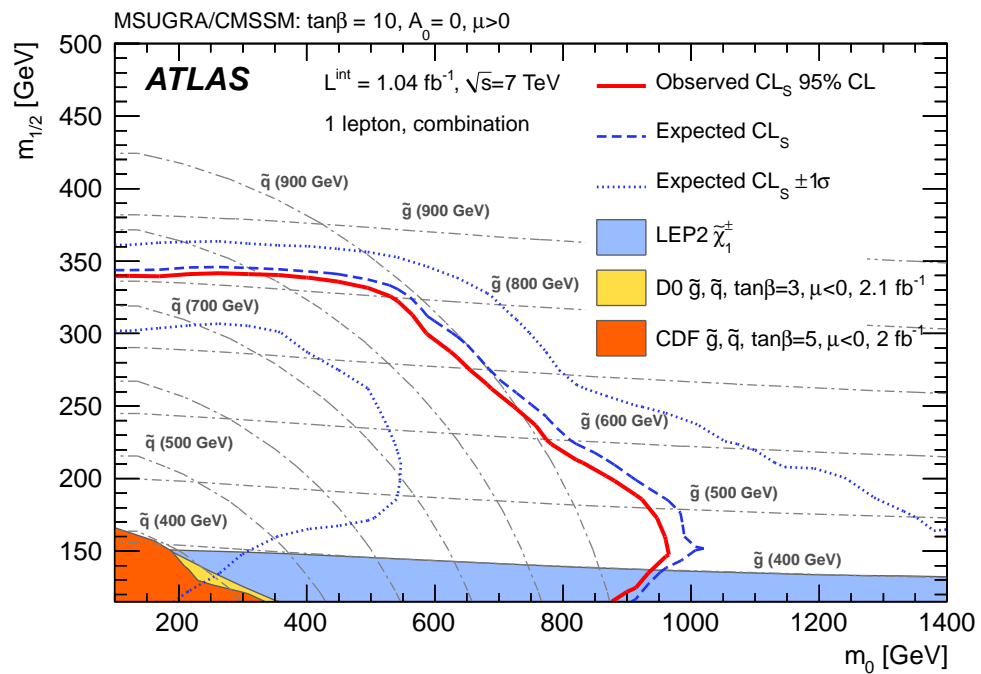
SUSY Analysis (Overview)



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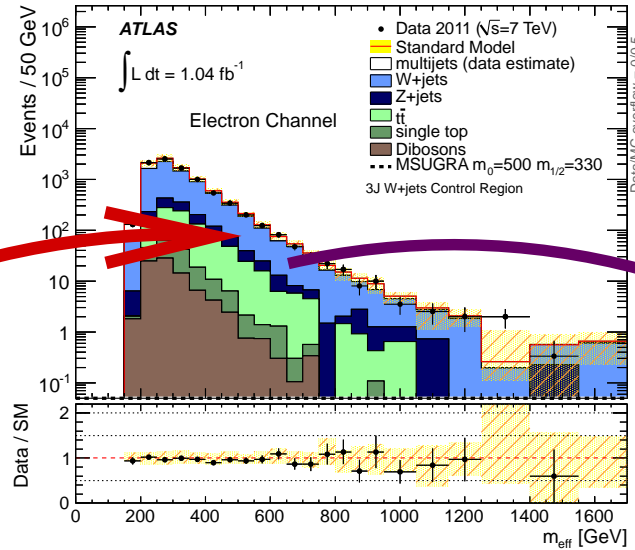
Rejects W+jets and $t\bar{t}$ events
 Rejects QCD (W+jets and $t\bar{t}$)
 Rejects QCD, W+jets ($t\bar{t}$)



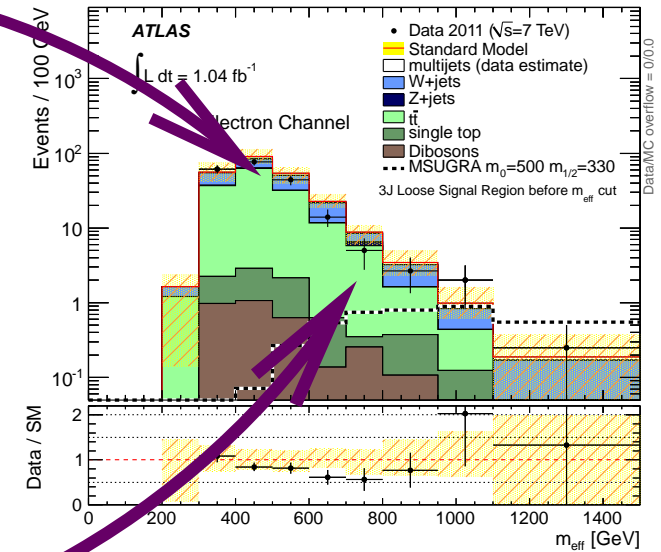
W and $t\bar{t}$ Background



M_{eff} distribution in CR

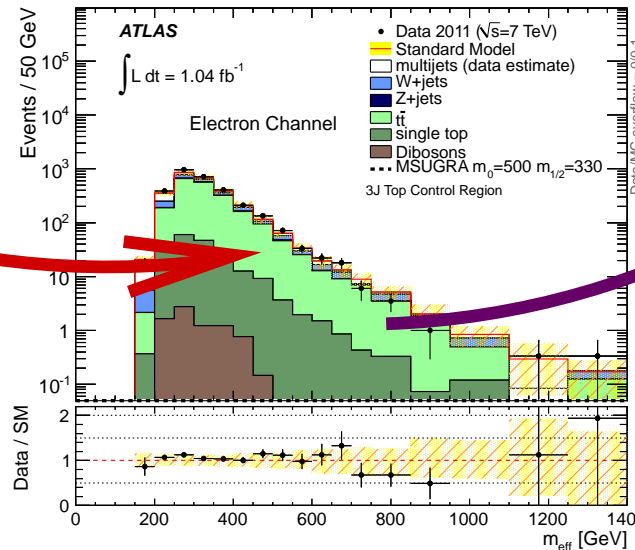
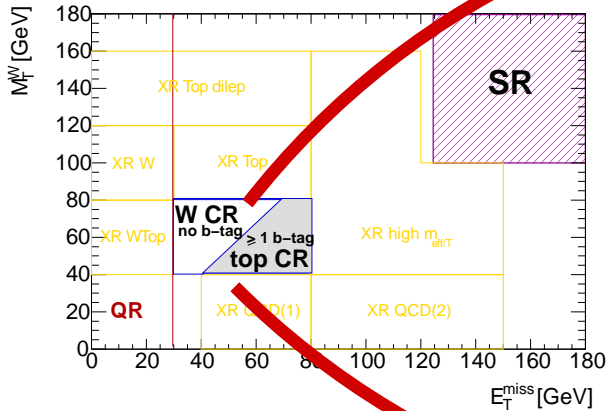


M_{eff} distribution in SR



Normalize in control region

Extrapolate to signal region



Systematic Uncertainties



Electron channel	3JL	3JT	4JL	4JT
Total statistical ($\sqrt{N_{\text{obs}}}$)	± 8.4	± 3.7	± 6.4	± 3.0
Total background systematic	± 30.2	± 7.4	± 17.9	± 3.7
Jet/ \cancel{E}_T energy resolution	± 5.9	± 0.5	± 4.2	± 0.8
Jet/ \cancel{E}_T energy scale	± 18.6	± 4.1	± 13.6	± 2.4
Lepton energy resolution	± 0.5	± 0.3	± 0.1	± 0.3
Lepton energy scale	± 1.1	± 0.3	± 0.4	± 0.5
b-tagging	± 1.2	± 0.2	± 0.7	± 0.1
MC stat. top	± 5.8	± 2.0	± 3.8	± 1.4
MC stat. W	± 4.4	± 2.3	± 2.2	± 1.3
Lepton misidentification rate	± 1.4	± 0.1	± 0.2	< 0.1
Real lepton rate	± 1.5	± 0.3	± 0.8	± 0.1
Top background modeling	± 15.9	± 2.1	± 9.8	± 1.2
W background modeling	± 19.0	± 5.6	± 5.1	± 1.9
Pile-up	± 5.1	± 1.0	± 2.5	± 0.4





- Run Alpgen in stand alone mode for $t\bar{t}$ and W +jets
 - ▲ Generate events for 0NP–5NP
 - ▶ Running time increases as number of light partons increases
 - ▲ Do this for different setups
 - ▶ Impact of NLO: Vary renormalization and factorization scale
 - ▶ Functional form of the scale
 - ▶ MLM matching: Vary p_T threshold for PS/ME boundary
- Showering of events
 - ▲ Compare Pythia and Herwig
- Run Athena: ATLAS jet and E_T reconstruction
- Run SUSY selection on Ntuples
- Running Alpgen (with many partons) is CPU intensive
- Showered events also need some disk space



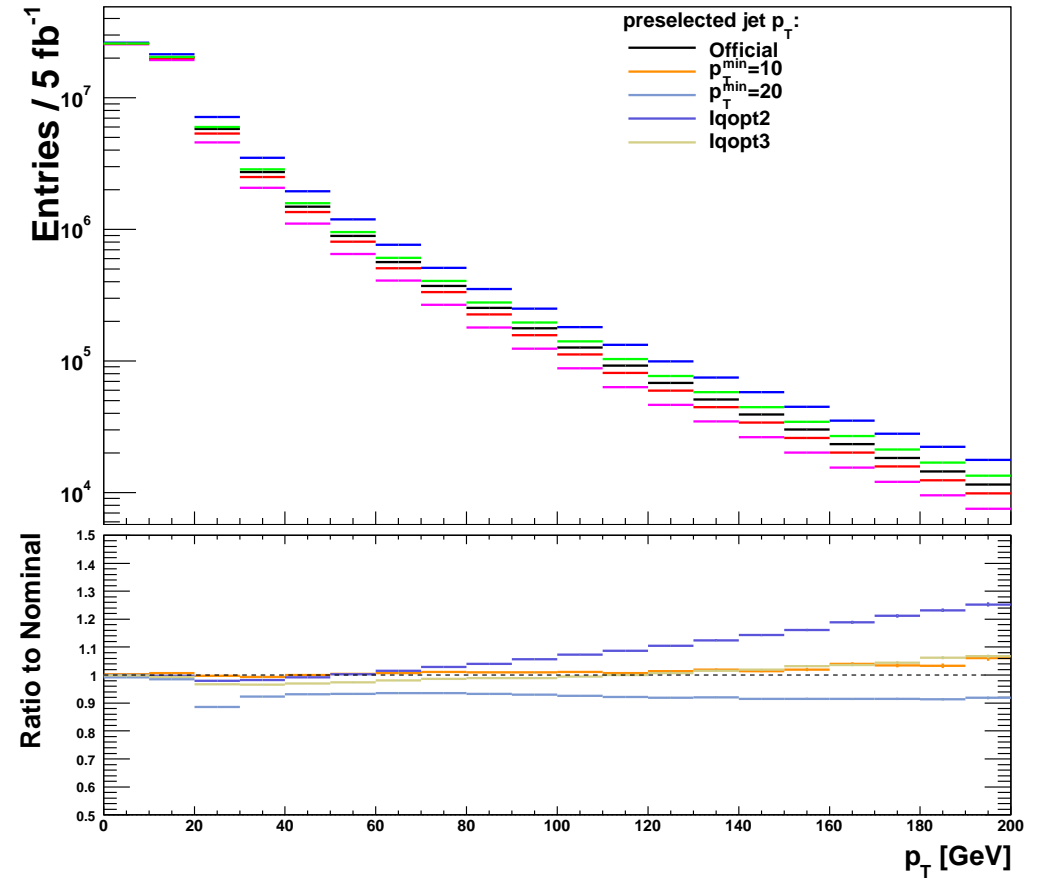
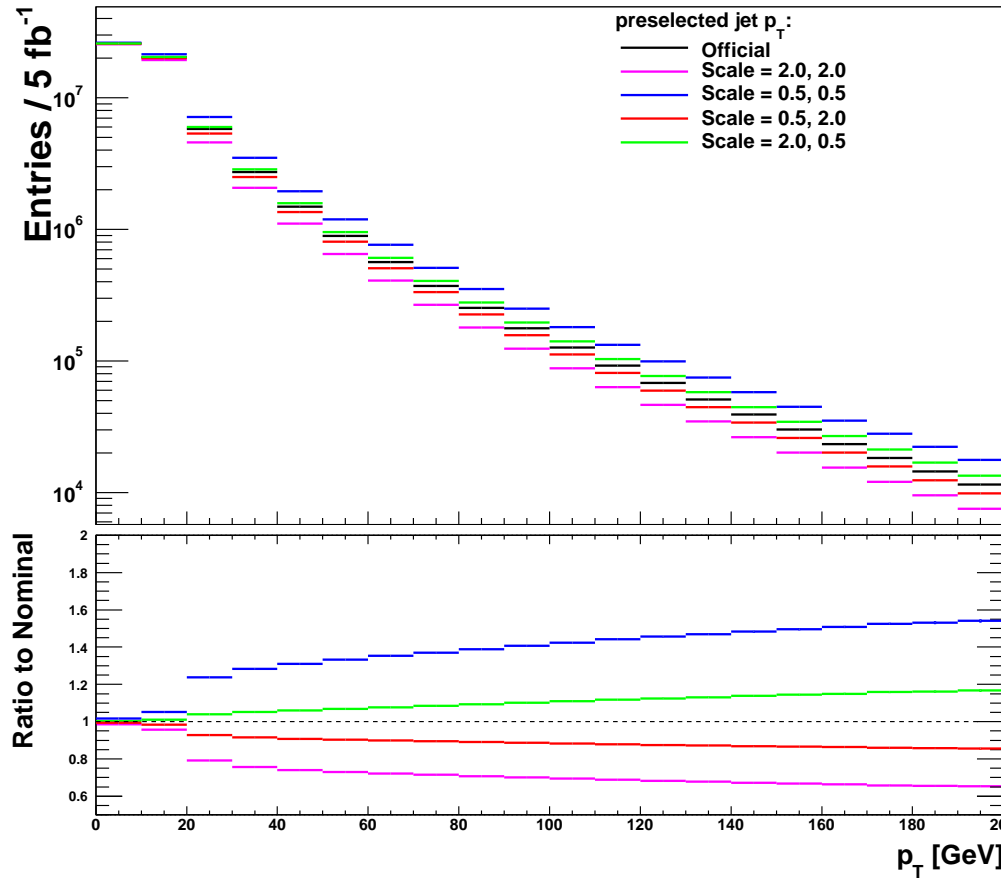
Generated Statistics (at the NAF)



	Number of partons	0	1	2	3	4	5
Nominal	Generated Events	113347961	43304656	15853711	5875926	2139689	536174
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	13646.65	27667.88	34924.07	48275.71	68924.40	63830.24
Ptmin 10	Generated Events	129523281	100131348	32229424	12483279	3695546	961449
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	15594.09	63975.15	70998.05	102560.71	119042.20	114458.21
Ptmin 20	Generated Events	116844681	116533585	33507071	14368741	3534379	1646480
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	14067.64	74454.74	73812.58	118051.37	113850.63	196009.52
lqopt2	Generated Events	135343988	108154039	30663153	15191751	4049488	1062387
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	16294.88	69100.95	67547.72	124813.10	130443.50	126474.64
lqopt3	Generated Events	107798083	108272922	32772209	15055539	3900956	1010229
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	12978.46	69176.90	72193.75	123694.00	125658.94	120265.36
ScaleUpDown	Generated Events	101688582	42855431	4823725	3123876	771941	121928
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	12242.90	27380.86	10626.16	25665.29	24866.03	14515.24
ScaleDownUp	Generated Events	161252418	43941217	4225919	3079279	813885	152205
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	19414.15	28074.58	9309.26	25298.88	26217.14	18119.64
ScaleUp	Generated Events	326985400	214408100	9117200	783500	532500	90900
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	39367.75	136987.98	20084.24	6437.12	17153.07	10821.43
ScaleDown	Generated Events	193090800	111919449	9088889	1580664	965805	330444
	Cross section [pb]	8305.92	1565.16	453.95	121.72	31.04	8.4
	Generated Cross Section [pb]	23247.37	71506.71	20021.87	12986.49	31110.84	39338.57



W+Jets Systematics (at the NAF)





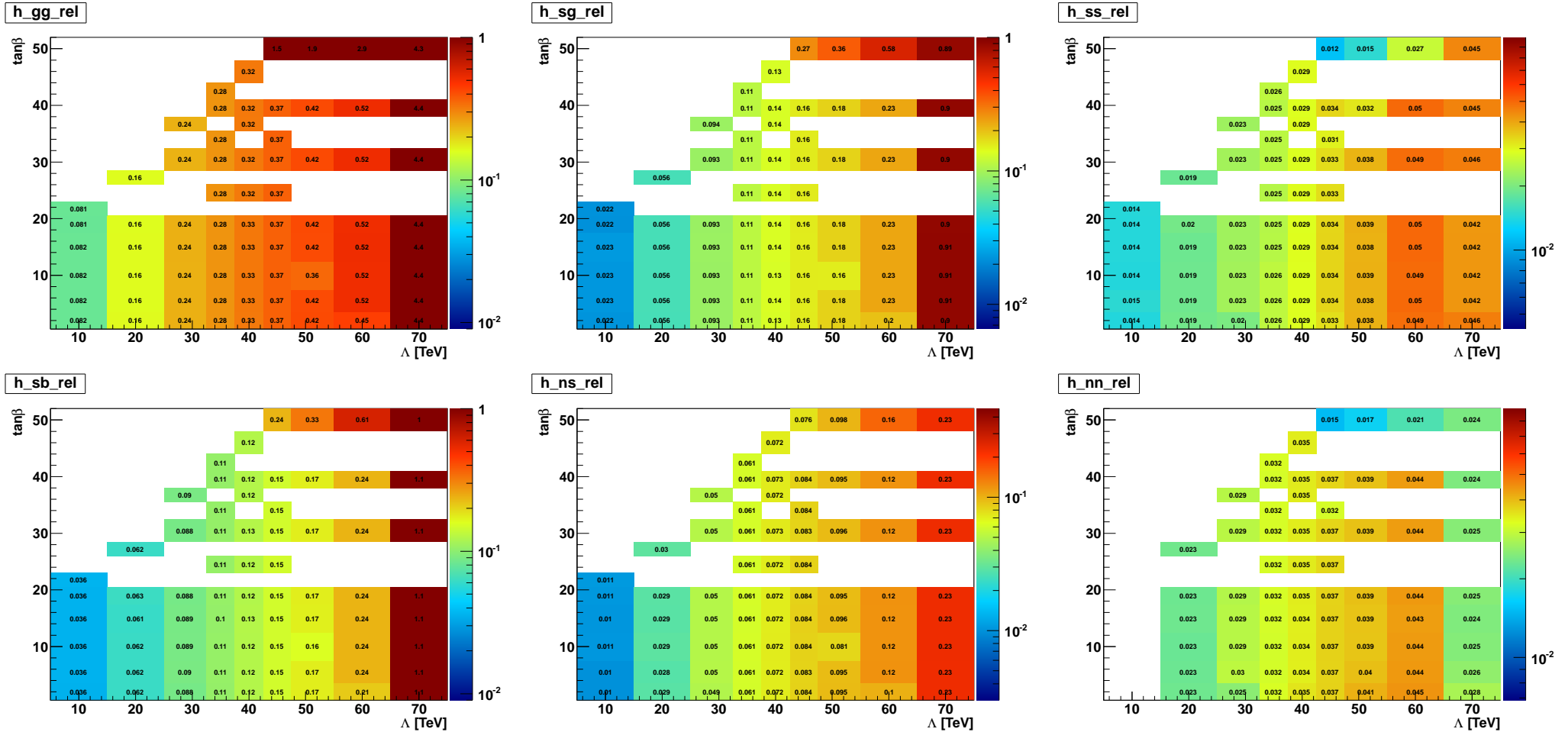
- Running at the NAF simplifies life
 - ▲ Run stand alone program
 - ▶ Would need to verify every side on the grid
 - ▲ Need to run scripts on the whole generated samples
 - ▶ Easy if everything is on disk at one site
- Needed to run 50k-100k jobs
 - ▲ Usually jobs started quickly
 - ▲ Number of job failures close to 0





- Also need signal systematics: here GMSB model
 - ▲ Scale variations
 - ▲ Impact of PDF errors
- Run Prospino to calculate these errors
 - ▲ Need to do this separately for every production channel
 - ▶ $\tilde{q}\tilde{q}$, $\tilde{q}\tilde{\bar{q}}$, $\tilde{q}\tilde{g}$, $\tilde{g}\tilde{g}$, $\tilde{q}\tilde{\chi}$, $\tilde{\chi}\tilde{\chi}$







W. Ehrenfeld

- SFrame:
 - ▲ <http://sourceforge.net/projects/sframe/>
 - ▲ main developer in ATLAS
 - ▲ simple ROOT based framework written in C++ (code) and XML (configuration)
 - ▲ easy to add and share different analysis modules
 - ▲ some ATLAS packages prepared for SFrame
 - ▲ easy to share dataset configuration
 - ▲ easy to switch between local, PROOF Lite and PROOF processing





- SUSY Analysis Setup at DESY:

- ▲ start from ATLAS SUSY ntuples

- ▶ use ATLAS DDM tools to get data to LOCALGROUPDISK (if not already on SUSY GROUPDISK)
- ▶ data slimming can be advantageous (done on Grid)
- ▶ MC slimming usually not worse the effort
- ▶ IO intensive

- ▲ divide analysis in two cycles/steps

- ▶ preselection (runs less often, but takes time)
- ▶ final selection (runs fast and often)
- ▶ store output from first cycle on Lustre

- ▲ limit calculation

- ▶ CPU intensive
- ▶ good turn around needed as this is the very last step in the analysis





- Some examples of SUSY analysis performed at the NAF: W. Ehrenfeld

- ▲ dilepton search (35 pb^{-1} , 1 fb^{-1})
- ▲ diphoton search (35 pb^{-1} , 1 fb^{-1})
- ▲ ditau search (2 fb^{-1})

- Diphoton search:

- ▲ 2 photons with $p_T > 25 \text{ GeV}$
- ▲ missing $E_T > 125 \text{ GeV}$
- ▲ estimate background from data
- ▲ 5 events observed
- ▲ $4.1 \pm 0.6 \pm 1.6$ events expected
- ▲ no SUSY found \rightarrow set limits

