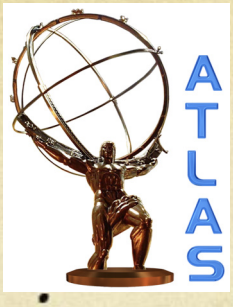

SUSY Searches in Tau Channels at ATLAS

LHC Discussions

Hamburg, January 9th 2012

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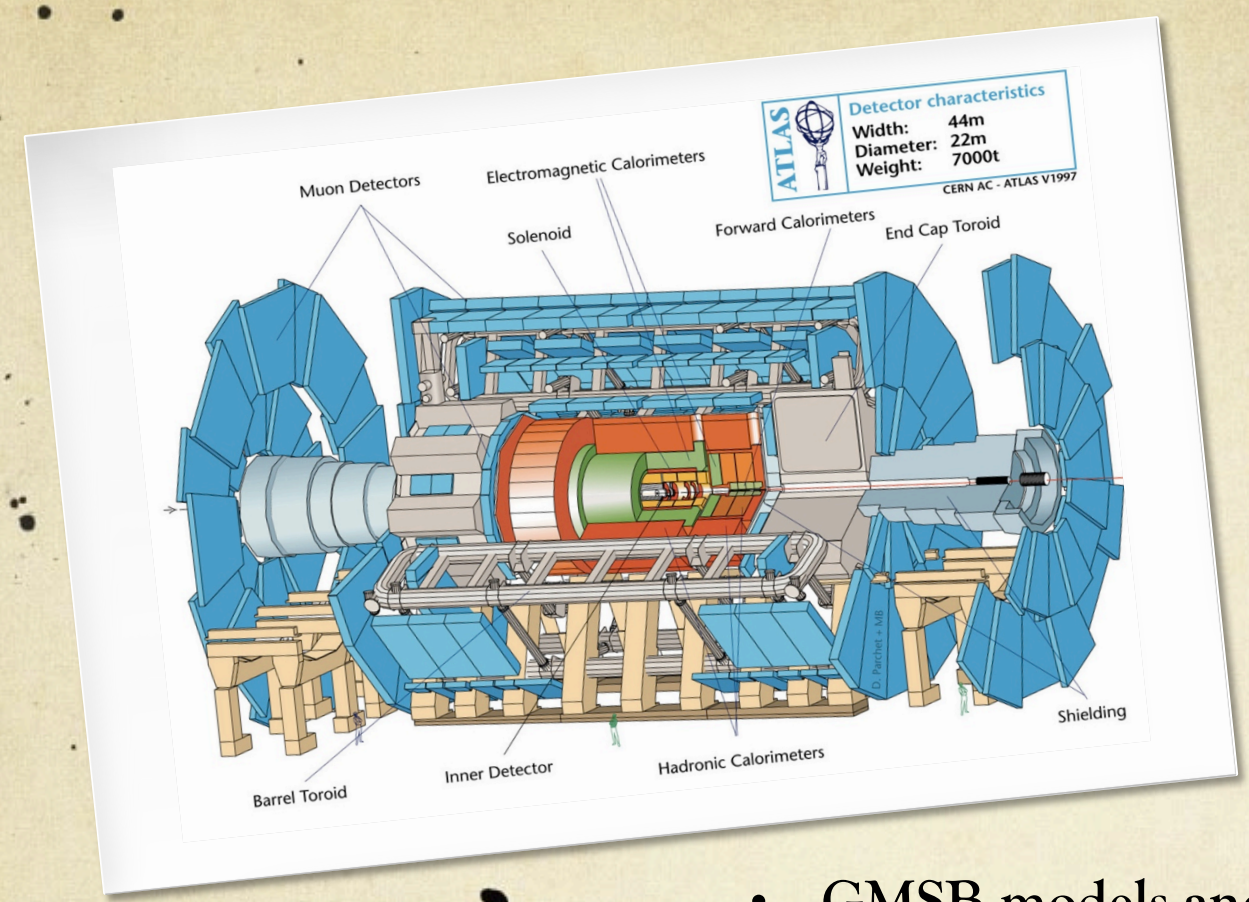
DESY

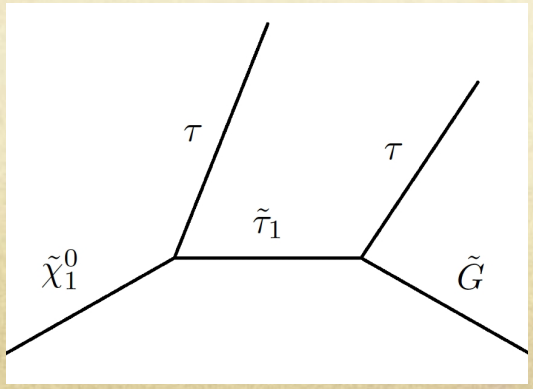


Outline

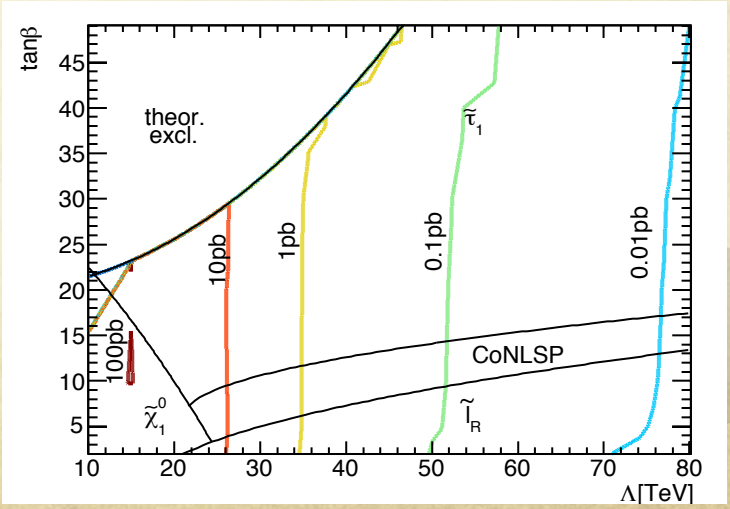
- GMSB models and Tau-Channels
- Object and Event Selection
- Background estimation
  W + top, QCD
- Systematic Uncertainties
- Results

GMSB Models

- Taus – final state in various SUSY breaking mechanisms
- mSugra: stau - lightest slepton due to RGE
  - can have large left handed component (in contrast to selectron/smuon)
- Gauge Mediated Symmetry Breaking (GMSB) – alternative breaking mechanism
- LSP is very light Gravitino (≪1keV)
- NLSP strongly determines the phenomenology



- Stau NLSP -> multi tau final state
- 6 parameters in simplest approach
- Λ and tanβ - largest influence on mass hierarchy
- Signal grid - other parameters fixed to ensure slepton or stau NLSP
- only very few Standard Model processes have multiple taus and MET in the final state



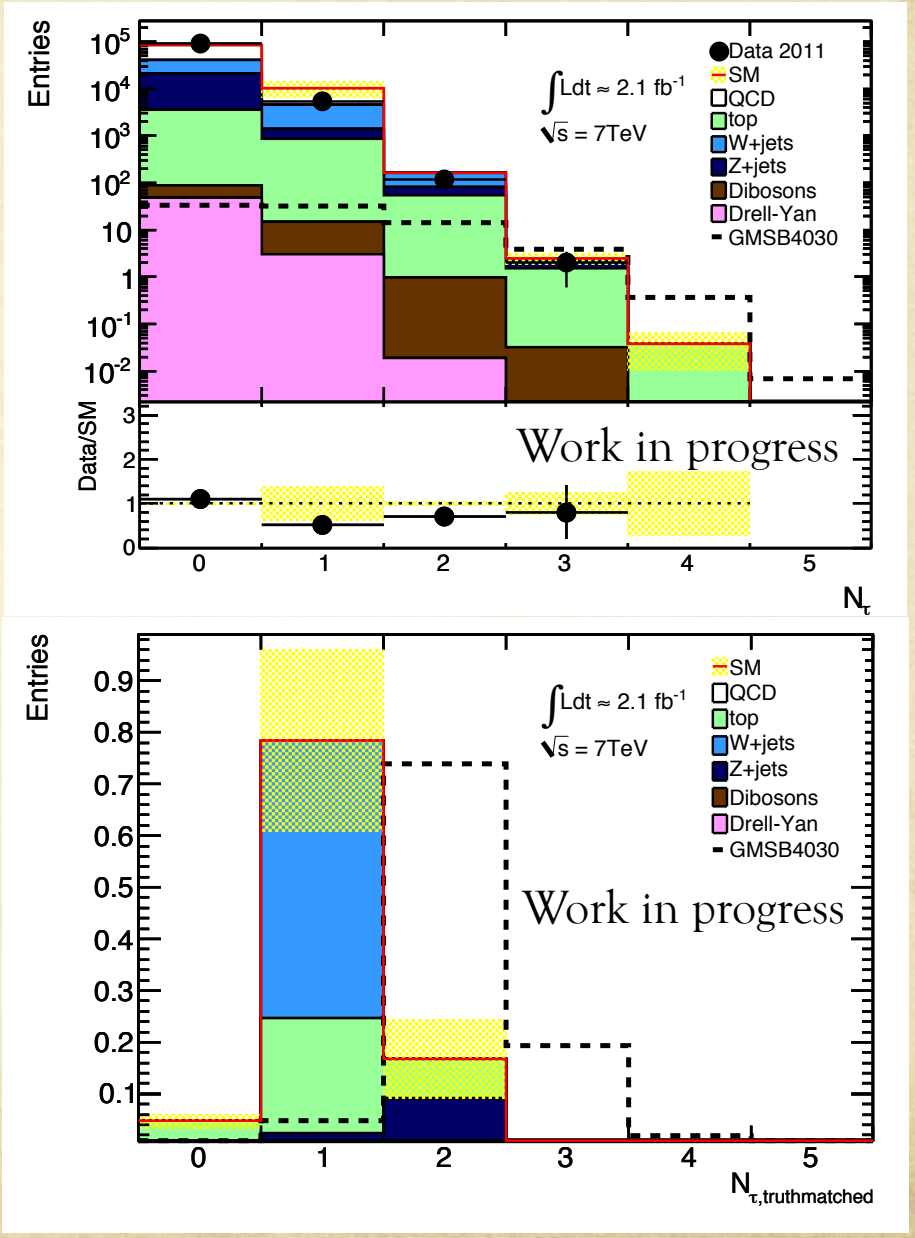
Tau Channels

- 3 Analyses ($2fb^{-1}$)
  - ≥ 1 Tau
  - **≥ 2 Taus (presented in detail)**
  - 1 Tau + 1 Muon
- Updates ($5fb^{-1}$) in preparation for Moriond
- Triggers
  - Jet + MET
  - Muon
- Lepton veto for only tau channels for easy combination of channels (to come)

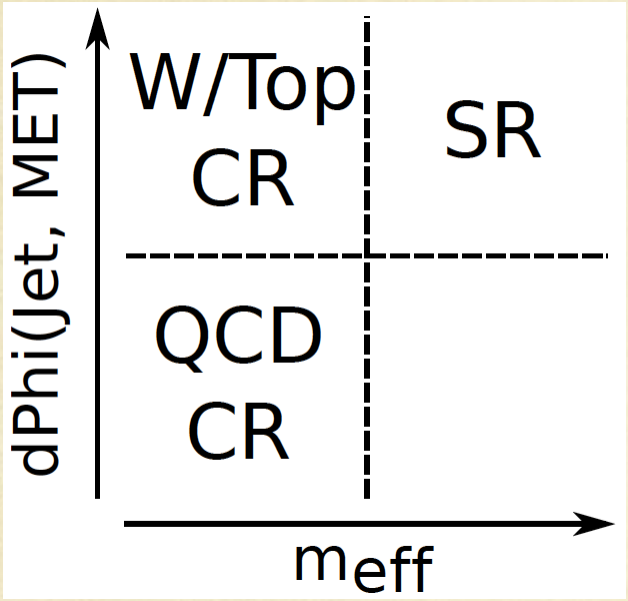
- Tau candidates seeded from calo clusters – hadronically decaying taus
- One or three tracks in $|\eta| < 2.5$ Charge $|q| = 1$
- Discriminant versus jets by BDT output
  - based on 11 input variables
- 3 predefined working points
  - loose, medium, tight
  - 60% - 50% - 30% signal efficiency
  - at 10% - 3% - 0.5% background efficiency

Event selection – ditau channel

- Event cleaning
- Trigger plateau cuts (MET > 130 GeV, 1.Jet pT > 130 GeV)
- 2.Jet pT > 30 GeV
- Lepton veto
- 1. loose Tau, pT > 20 GeV
- 2. loose Tau, pT > 20 GeV
- $\Delta\phi$(1./2.Jet; MET) > 0.4
- meff > 700 GeV
- mT (1.Tau) + mT (2.Tau) > 80 GeV
- other channels use similar selections

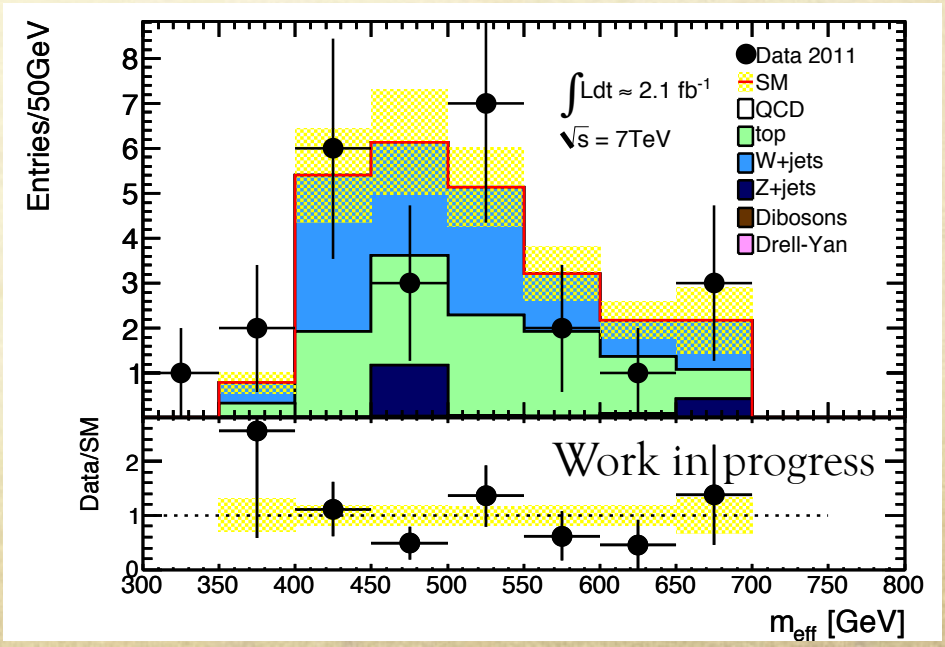


Background estimation – W + top



- W/top CR: inverting meff cut
- QCD CR: additionally inverting $\Delta\phi$ cut
- General technique: Obtain scale factors from control region and apply in signal region
- MC - overestimating tau fakes

- Subtract remaining non-W/Top contribution from data, scale W and Top MC to data
- Obtained scale factor: 0.50±0.12
- Agrees well with H->ττ search (0.57, ATLAS-CONF-2011-132)
- separating regions suffers from low statistics



Background estimation - QCD

- Invert meff and $\Delta\phi$ cuts
- MET/meff < 0.4
- Split the QCD CR into three regions
  - 0tau, 1tau, ≥2taus
- From 0 tau sideband calculate QCD scale factor w_0 = 1.02±0.13:

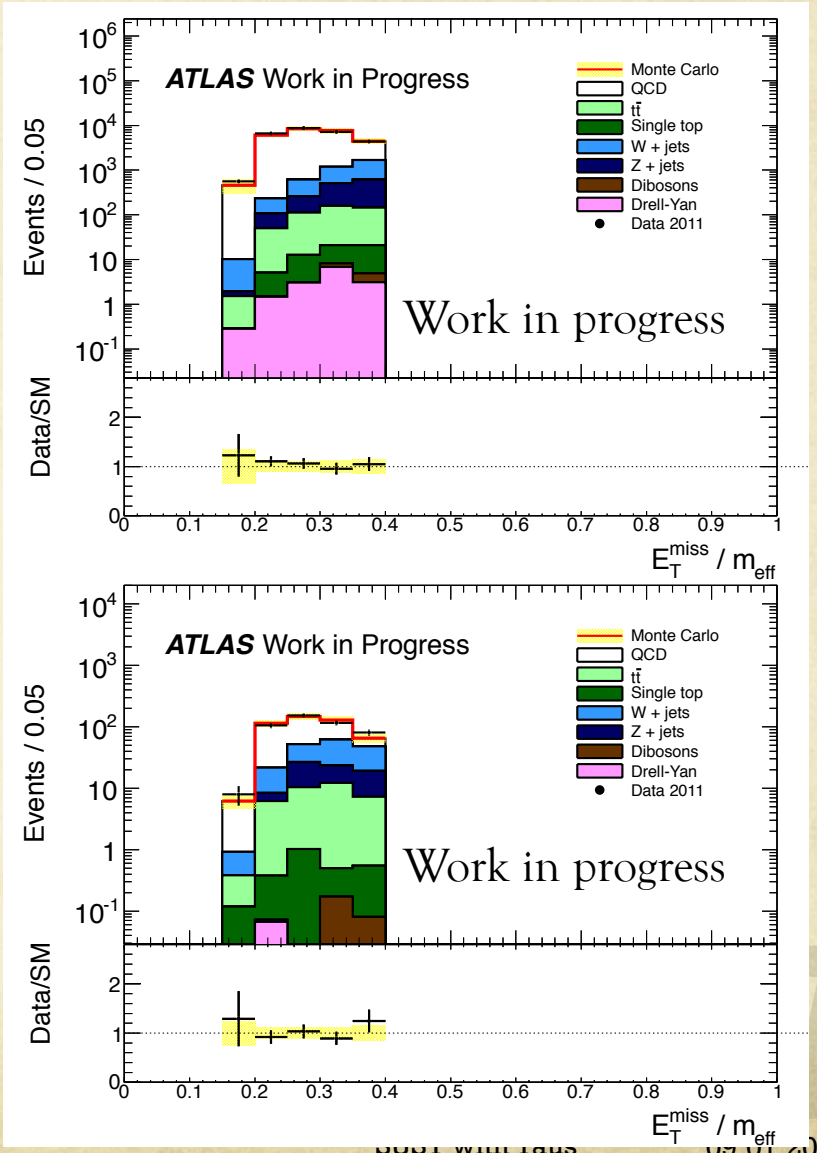
$$w_0 = \frac{N_{0\tau}^{data} - N_{0\tau}^{nonQCD}}{N_{0\tau}^{QCD}}$$

- From 1tau sideband calculate fake rate f = 0.46±0.34:

$$f = \frac{w_1}{w_0} = \frac{N_{1\tau}^{data} - N_{1\tau}^{nonQCD}}{w_0 \cdot N_{1\tau}^{QCD}}$$

- Can be used for calculation of fake rate in signal region 0.21±0.22:

$$w_2 = w_0 \cdot f^2$$



Systematic Uncertainties

- Systematics studied for this analysis:
  - Jet energy scale
  - Jet energy resolution
  - Tau energy scale
  - Tau identification uncertainty
  - Tau fake uncertainty
  - Pileup
  - Luminosity

- Systematic dominated by jet systematics
- Uncertainties on W and Top drive total uncertainty
- Values compatible with those found in the one tau analysis

Systematic Variation	Number of events	Relative deviation
Nominal	5.31	
Scaling	6.53	23.1%
JER	4.62	-12.9%
JES down	3.86	-27.2%
JES up	4.88	-8.1%
Pileup	5.35	0.9%
TauID	5.44	2.5%
TauFake	5.28	-0.5%
TES down	5.01	-5.6%
TES up	4.91	-7.5%
Luminosity	5.35	0.8%
Total		36.0%

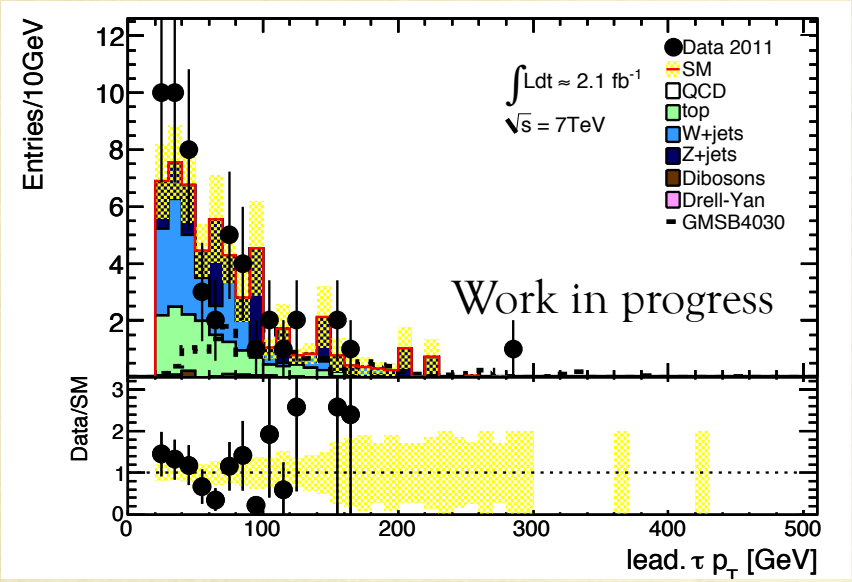
Work in progress

Results - Cutflow

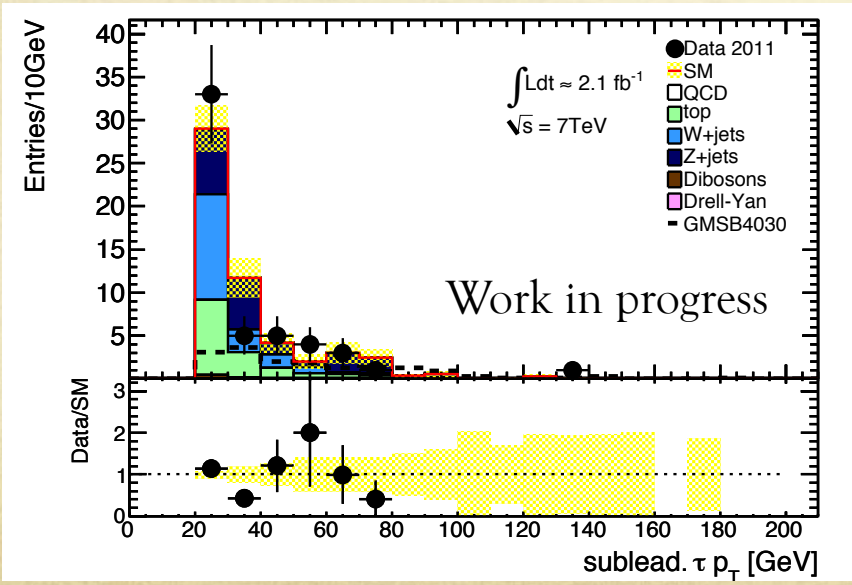
Work in progress	All MC	Data	GMSB4030
Preselection	$4.56 \cdot 10^9 \pm 3.91 \cdot 10^6$	$2.5892 \cdot 10^7$	696 ± 13
$E_{\mathrm{T}}^{\mathrm{miss}} > 130$ GeV	258903 ± 5956	509069	462 ± 12
$p_{\mathrm{T}}^{\mathrm{jet1}} > 130$ GeV	174165 ± 4340	440351	407.4 ± 9.5
$p_{\mathrm{T}}^{\mathrm{jet2}} > 30$ GeV	116967 ± 4280	116655	400.0 ± 9.5
Lepton Veto	95534 ± 4258	99078	123.6 ± 6.4
$N_\tau \geq 1$	4038 ± 172	3647	71.6 ± 5.7
$N_\tau \geq 2$	53.0 ± 6.7	52	25.1 ± 3.5
$\Delta\phi(E_{\mathrm{T}}^{\mathrm{miss}}, \mathrm{jet1/2}) > 0.4$	46.7 ± 6.2	43	22.2 ± 3.4
$m_{\mathrm{eff}} > 700$ GeV	10.2 ± 2.1	10	21.7 ± 3.4
$m_{T1} + m_{T2} > 80$ GeV	$5.3 \pm 1.3 \pm 1.9$	[redacted]	$20.9 \pm 3.4 \pm 5.7$

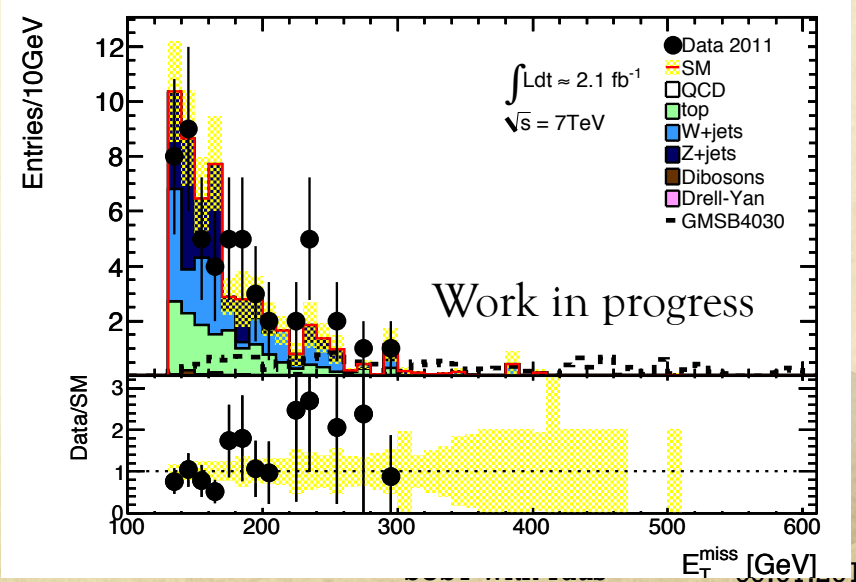
- Data and SM expectation compatible within 1σ after the 2tau requirement
- set limit

Results - Kinematics



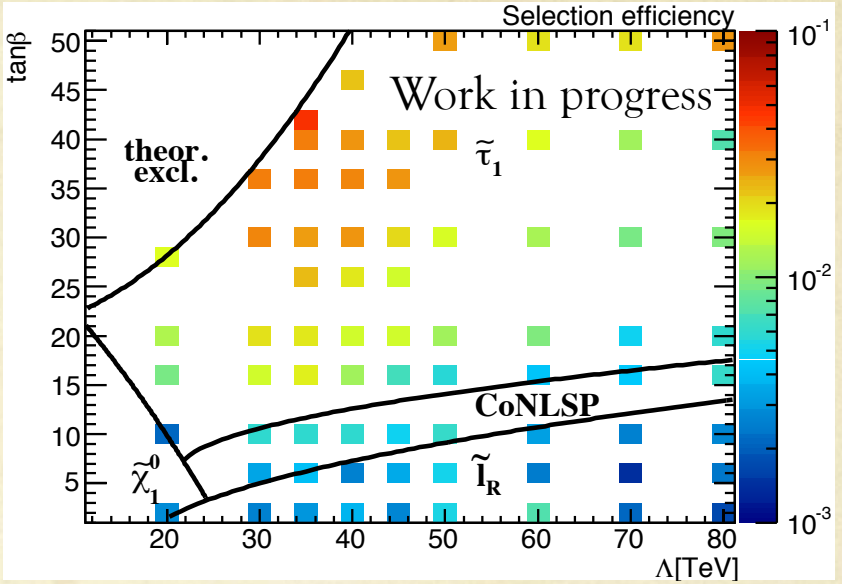
- (Sub)Leading tau pt
  - after 2 tau requirement
  - scaling obtained in CR applied
  - yellow bands stat. error only
- Etmiss

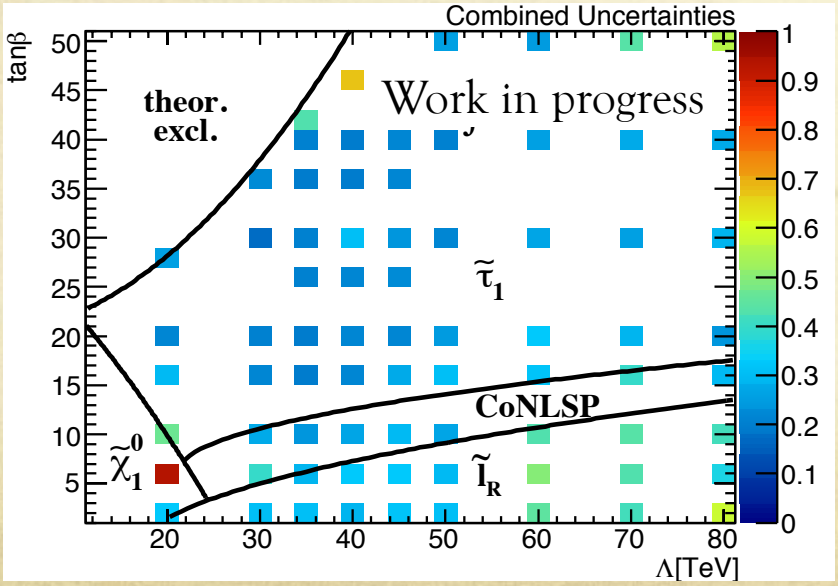


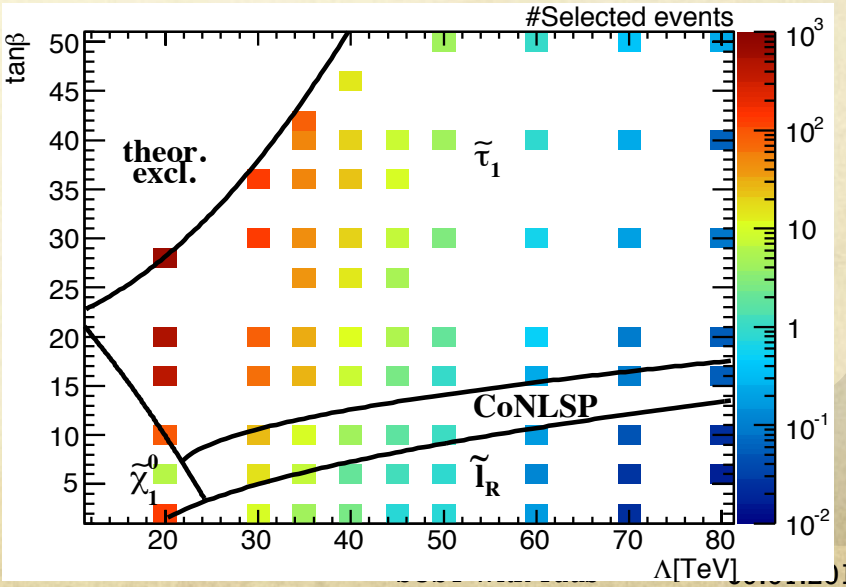


Results – GMSB grid

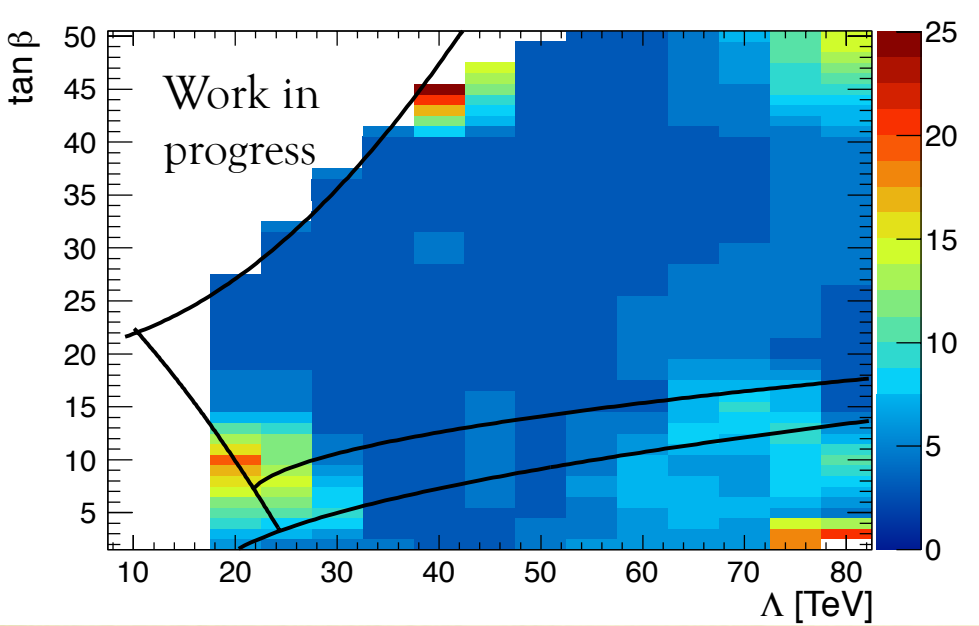
- Selection efficiency and # of selected events
  - in stau region: 1% – 3%
  - lower in other NLSP regions
- Uncertainties: Systematic, Statistical, Theoretical



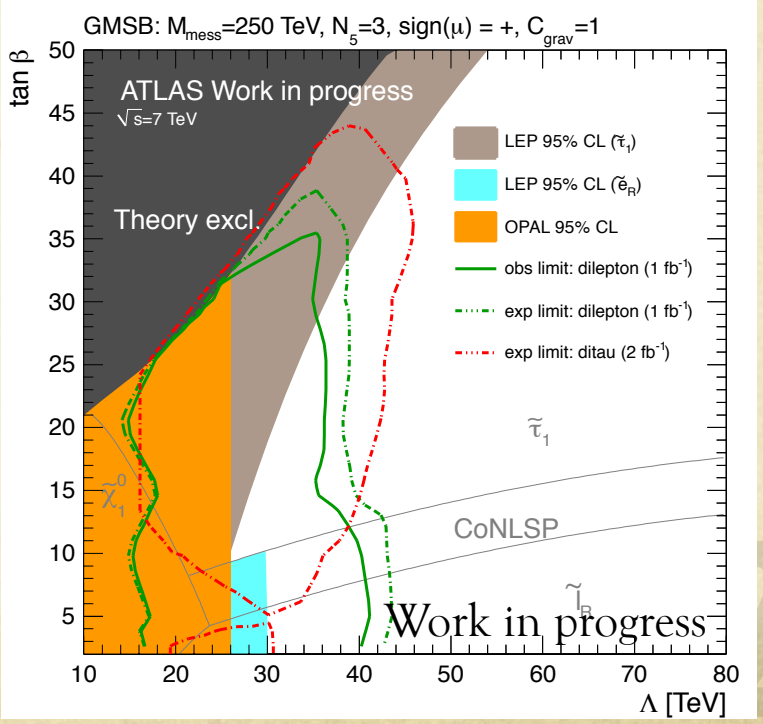




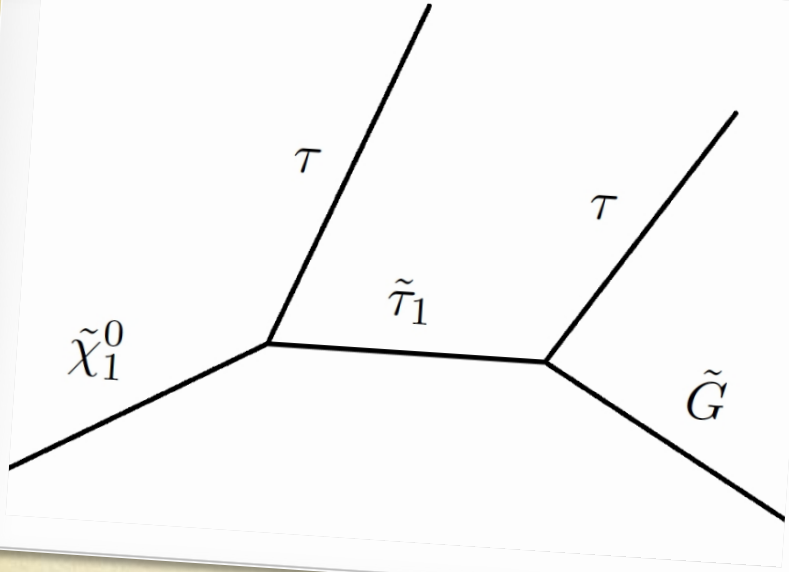
Results – (Expected) Limits

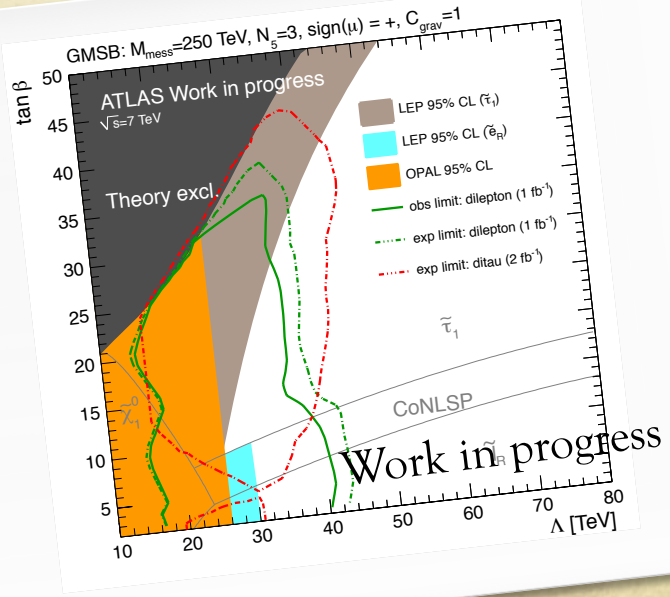


- Expected limit in the GMSB grid
- $\Lambda > 40$ TeV in stau region
- most stringent limit



- Expected limit on the cross section in fb
- flat in most of the stau region: ≈5fb
- structure due to systematic uncertainties





Conclusion

- 3 channels to exploit Tau final states looking for SUSY
- SR and CR well defined and well understood
- individual publications are in the making – all 3 channels have started the official ATLAS review process
- limits on cross section and GMSB parameters

Thank you

for your attention!

Questions?

Backup