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On Behalf of the ATLAS Collaboration

Searches for W', Z' and Supersymmetry in Early ATLAS Data

General Outline

I. Introduction
II. Early Searches for W' and Z'
III. Early Searches for SUSY
IV. Prospects

I. Introduction

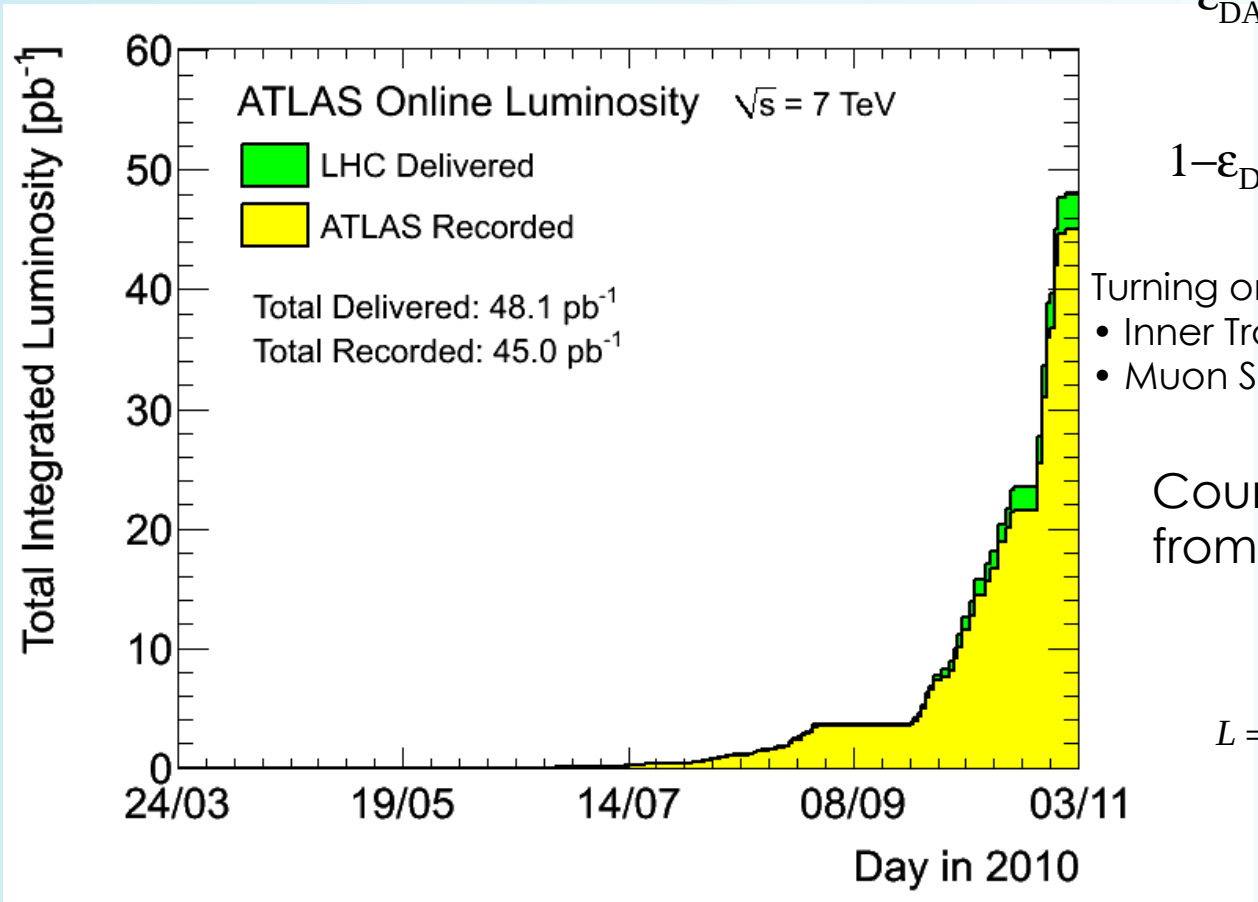
I. Detailed Outilne

I.1. LHC 2010 Run

I.2. ATLAS 2010 Data Taking

I.1. LHC 2010 Run

Integrated Luminosity



$\varepsilon_{DAQ} = 93.6\%$

$1-\varepsilon_{DAQ} = 2.0\% + 4.4\%$

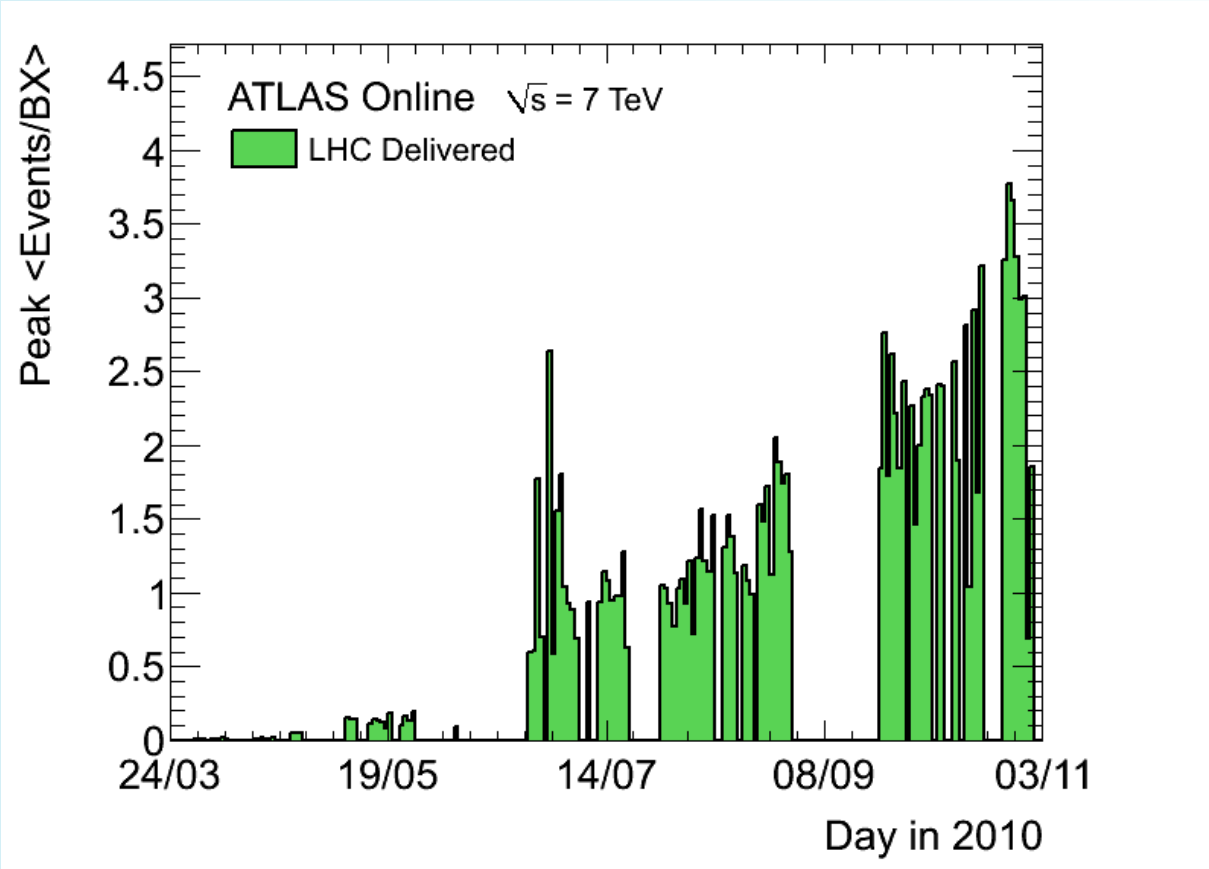
Turning on HV:
- Inner Tracker
- Muon Spectro

- Dead time
- Sub-detectors pbs

Counting rate from the $\mathcal{L}$ detectors

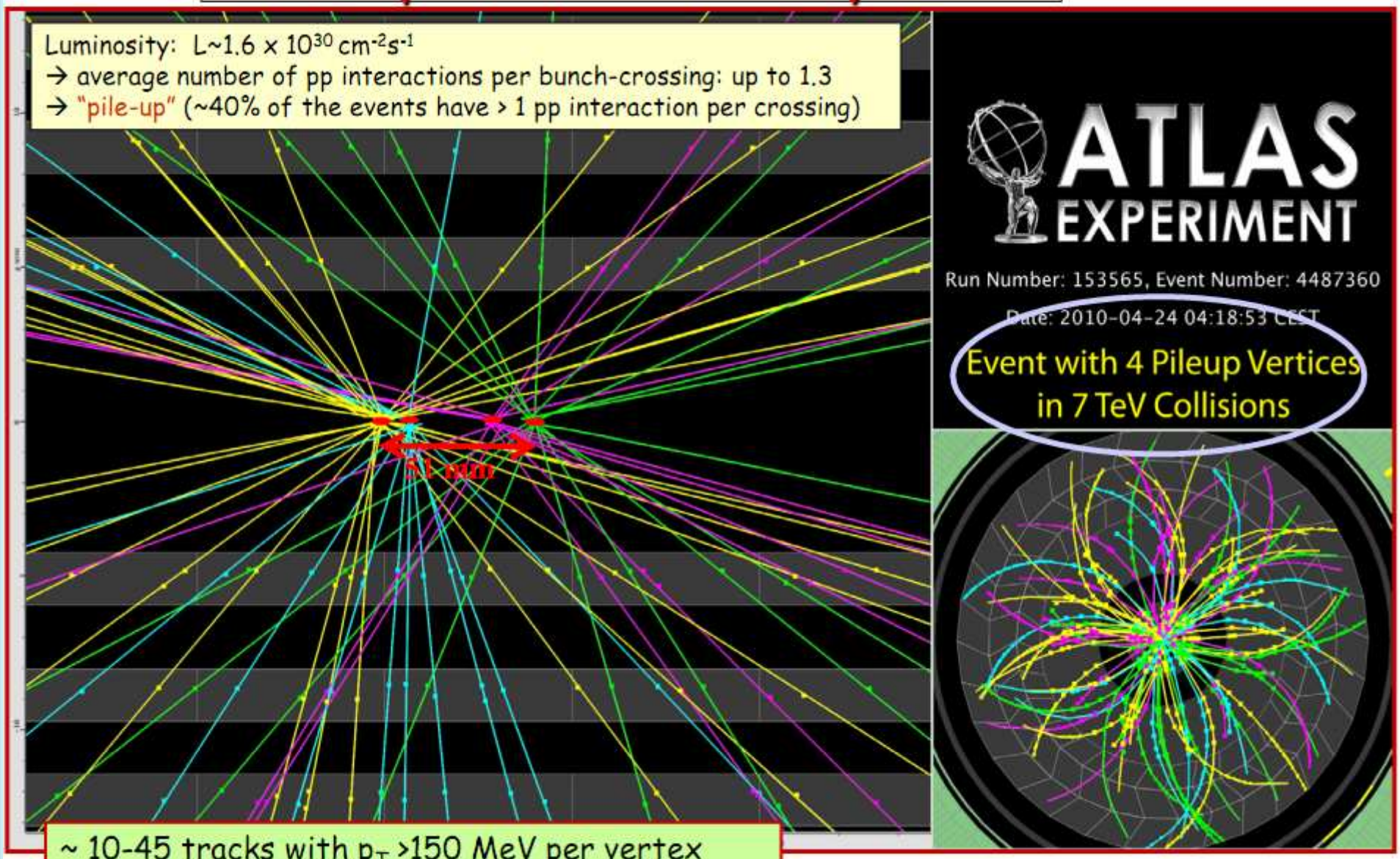
$$L = \int \mathcal{L} dt \qquad \frac{\Delta L}{L} = 11\%$$

Multiple pp Collisions



Based upon: $\sigma_{pp}^{inel} = 71.5\ mb$

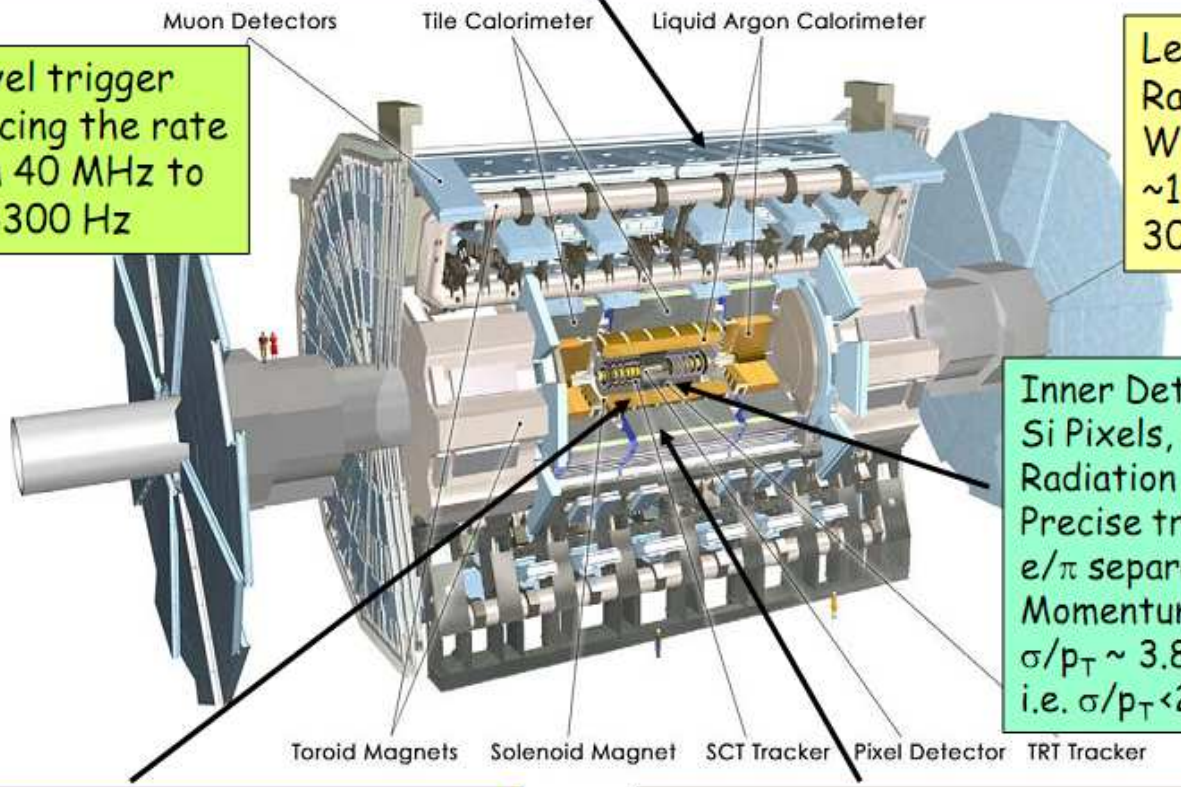
Event Display w/ 4 p+p Collisions



I.2. ATLAS 2010 Data Taking

The ATLAS detector

Muon Spectrometer ($|\eta|<2.7$) : air-core toroids with gas-based muon chambers
Muon trigger and measurement with momentum resolution < 10% up to E_μ ~ 1 TeV



3-level trigger reducing the rate from 40 MHz to 200-300 Hz

Length : ~ 46 m
Radius : ~ 12 m
Weight : ~ 7000 tons
~10^8 electronic channels
3000 km of cables

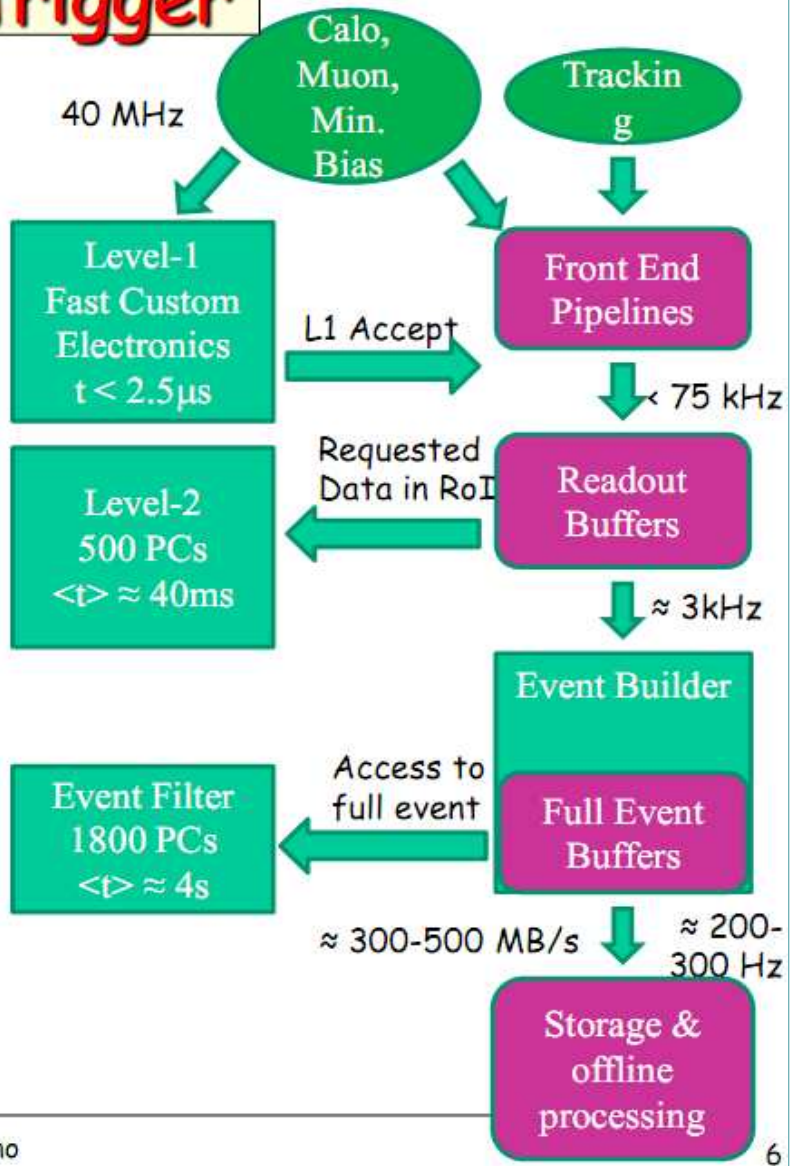
Inner Detector ($|\eta|<2.5$, B=2T):
Si Pixels, Si strips, Transition Radiation detector (straws)
Precise tracking and vertexing, e/π separation
Momentum resolution:
$\sigma/p_T \sim 3.8\times10^{-4}\ p_T(\text{GeV}) \oplus 0.015$
i.e. $\sigma/p_T<2\%$ for pt < 35 GeV

EM calorimeter ($|\eta|<3.2$):
Pb-LAr Accordion; e/γ trigger, identification and measurement
E-resolution: $\sigma/E \sim 10\%/\sqrt{E}$

HAD calorimetry ($|\eta|<5$): segmentation, hermeticity
Fe/scintillator Tiles (central), Cu/W-LAr (fwd)
Trigger and measurement of jets and missing E_T
E-resolution: $\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

Architecture of ATLAS trigger

- Level 1 (L1):
  - Fast **Custom-built electronics**
  - Input mainly from **Calorimeter** and **Muon** spectrometer
  - Inputs combined in Central Trigger Processor
- High Level Trigger (HLT):
  - Level 2 & Event Filter (third level)
  - **Software based** running on large PC farm
- Level 2 (L2):
  - **Fast** custom algorithms
  - reconstruction mainly in **Regions of Interest** (RoI)→limited data access
- Event Filter (EF):
  - Third trigger level
  - **Offline** tools inside custom wrappers,
  - Access to **full event** information



II. Early Searches for W' and Z'

II. Detailed Outilne

II.1. W'→eν Search in Collider Data

II.2. Z'→ee MC Sensitivity Study

I'll present the so-called « sequential » W' and Z' searches:

- V' have the same couplings to fermions than the SM EW V boson
- this is choice is completely aribtrary
- but it make it easy to compare sensitivities of different experiments wrt m(V')
- ref: G. Altarelli, B. Mele, M. Ruiz-Altaba, Z. Phys. C45 (1989) 109

II.1. Searches for W’

W'→eν (1)

L=317 nb^{-1}

Trigger:
- LVL1:

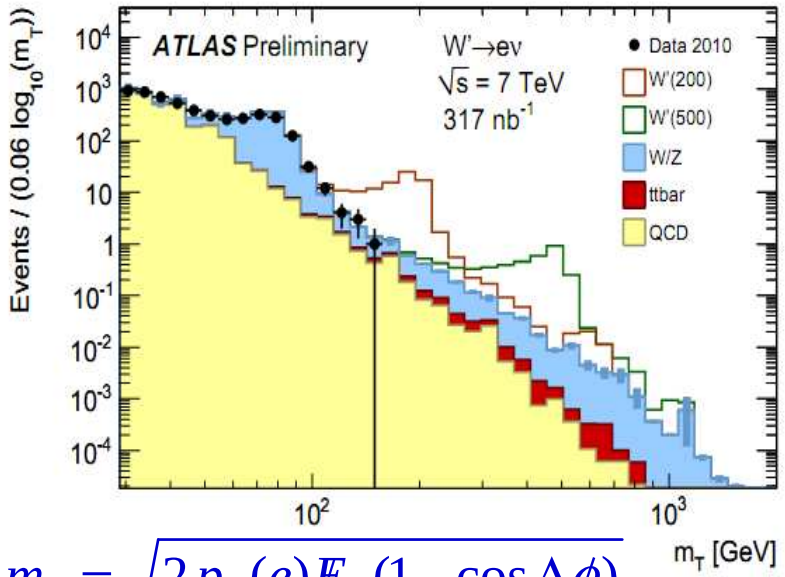
single EM cluster w/ p_T >10 GeV
- HLT: no further requirements
- Perf: ε=99.5% for p_T > 10 GeV

(in agreement wrt trigger simulation)

Data Quality:
- Remove bad L blocks

(sub-detectors malfunctions)
- Remove evts w/ bad jets

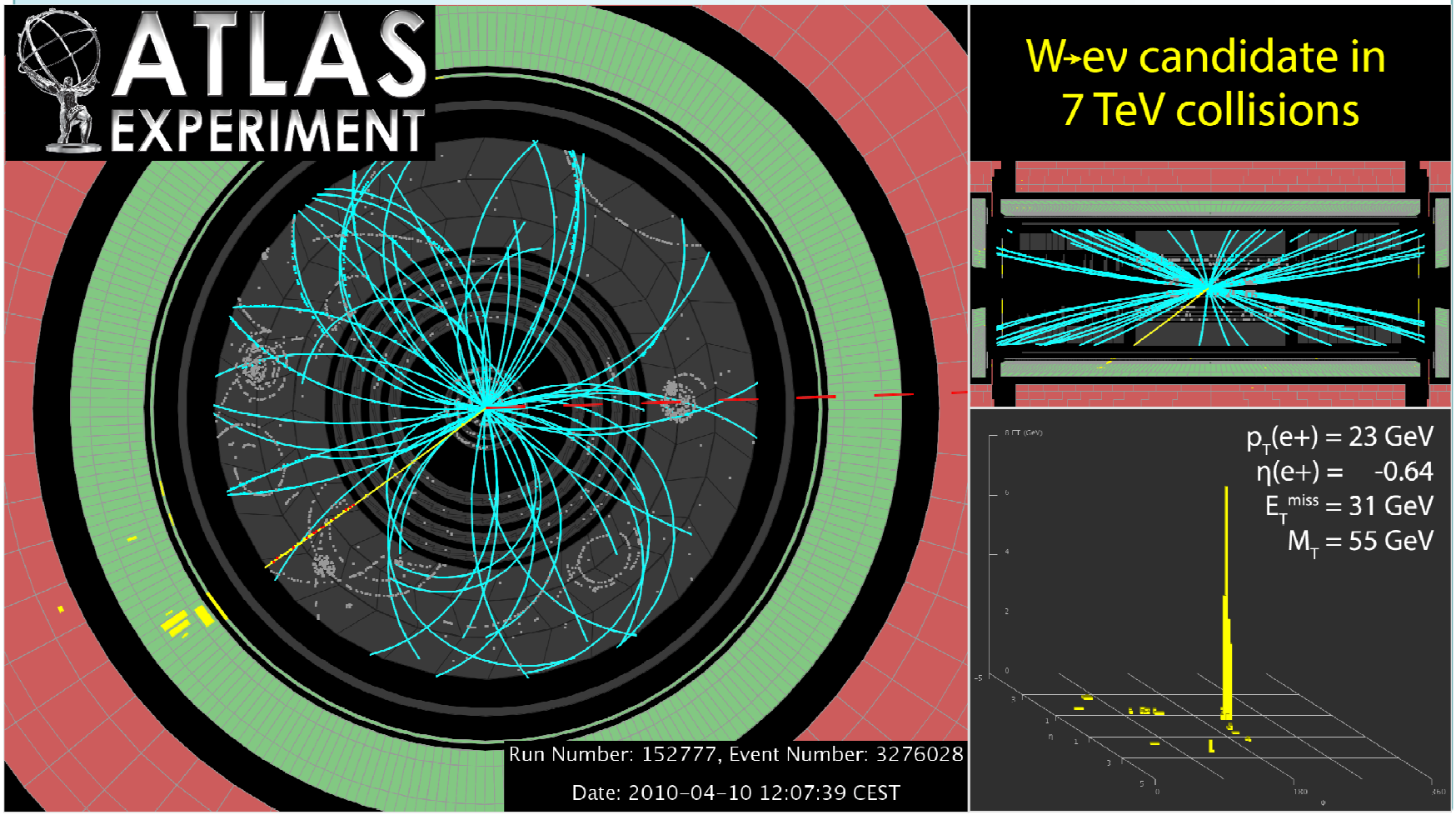
Offline Preselection:
- 1 good PV (>2 trks w/ p_T > 150 MeV)
- Electron ID:
  - 1 medium e (e=94%, R~1000)
    - p_T > 20 GeV
    - |η|<1.37 or 1.52<|η|<2.47
    - shower shape
    - matching track (close to PV)
    - had-leakage,…
  - reject evts w/ > 1 e candidate



$$m_T = \sqrt{2 p_T(e) E_T (1-\cos\Delta\phi)}$$

W'→eν (2)

A « Usual Suspect »



Interlude #1: MC Settings (1)

I. MC Shapes/Acceptance/Efficiencies

Generators:

- Pythia v6.421
  - LO ME
  - Parton Shower:
    - partial LL
    - p_T-ordered showers interleaved w/ MPI
  - Tuning to Tevatron Run I/II data
    - PDF: MRST LO*
- Herwig+Jimmy, MC@NLO+Herwig+Jimmy
- Alpgen+Pythia, Alpgen+Herwig+Jimmy
- Powheg+Herwig+Jimmy
- AcerMC+(Herwig+Jimmy/Pythia)
- Sherpa, Herwig++, Pythia8

Detector Simulation: (NB: None of those are public!)

- Full: Geant 4 (default)
- Semi-Fast: Atlfast II (full tracking/muon + calo. shower param.)
- Fast: Atlfast (smearing of MC truth)

Interlude #1: MC Settings (2)

II. MC Normalization

Cross Section Integrators:

- Default: NLO-QCD
- Tools:
  - MCFM: NLO-QCD (SM & Higgs)
  - FEWZ: NNLO-QCD (W,Z)
  - FONLL: NLO-QCD & full NLL (QQ)
  - Prospino: NLO-QCD (SUSY, LQ)
  - …

W'→eν (3)

Bakground modeling:

MC based:

- Normalized to L and to σ
- Processes: Pythia for all (except ttbar)

Signal

Mass [GeV]	Γ(GeV)	B	σB [pb]	N_{evt} [k]
150	3.88	0.1084	1296	60
200	5.34	0.1054	495	60
300	9.18	0.0924	109	60
400	12.98	0.0874	36.8	60
500	16.68	0.0852	15.5	60
600	20.34	0.0840	7.6	54

Sequential W':
- same couplings as the SM W
- BR(W'→WZ)=0

Normalization: σ_{LO}

$$\Gamma_{W'} = \frac{4}{3}\left(\frac{M_{W'}}{M_W}\right)\Gamma_W$$

W'→eν (4)

MC@NLO 3.41: NLO ME
Herwig 6.50: matched PS, partial NLL
Jimmy 4.31: MPI
m_t=172.5 GeV, PDF: CTEQ6.6
Normalization: ~σ_{NNLO}

FEWZ:
- $\sigma_{NNLO\text{-}QCD}$
- PDF: MSTW2008

Not corrected for NLO EW

Background

Category	Process	σB [nb]	N_{evt} [k]
W/Z	$W \to e\nu$	10.45	7000
	$W \to \tau\nu \to \ell\nu\nu$	3.68	1000
	$W \to l\nu(200,500)$	0.01041	60
	$W \to l\nu(500,1500)$	0.000283	60
	$Z \to ee$	0.989	5300
$t\bar{t}$	$t\bar{t} \to lX$	0.161	1000
QCD	$jj(8,17)$	9860000	1400
	$jj(17,35)$	673000	1400
	$jj(35,70)$	41200	1400
	$jj(70,140)$	2190	1400
	$jj(140,280)$	87.9	1400
	$jj(280,560)$	2.33	1400
	$jj(560,1120)$	0.339	1400

Normalized to data in the low m_T region
SF: 0.455

W'→eν (5)

Main Bakground Sources:

- W high-m_T tail:
  - Irreducible
- ttbar
- QCD

QCD Reduction:

- e isolation:

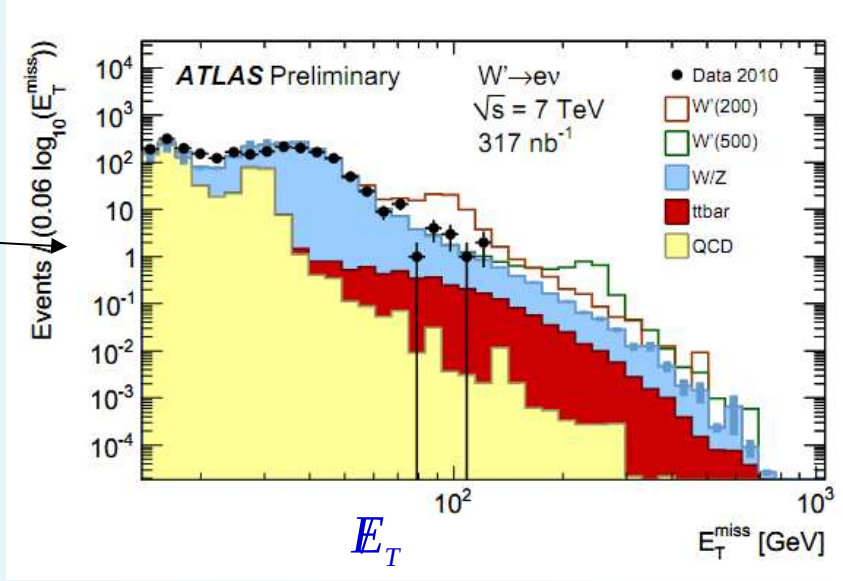
$$R_{isol} = \frac{\sum_{\Delta R=0.3} p_T(Tracks)}{p_T(e)} < 0.05$$

- mE_T:
  - cut: $\not{E}_T > 25\ GeV$
  - Perf: $\sigma(\not{E}_T) = 0.41 \times H_T$
  - e measurement >> UE >> …

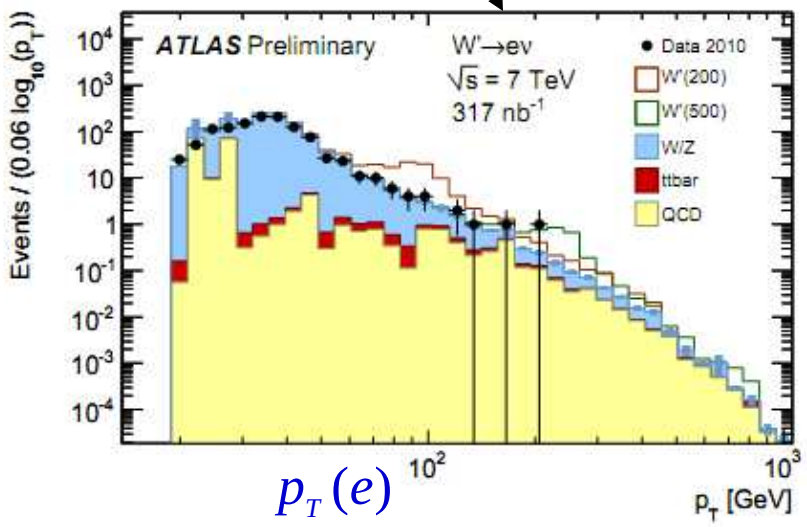
Process	Initial	Isolation	Final	$m_T > 140$	$m_T > 350$
Collision Data	12242	6615	1180	1	0
W'(200)	105	103	101	75	
W'(500)	3.8	3.75	3.74		2.5
W/Z	1709	1656	1250	3.71	0.11
$t\bar{t}$	7.0	6.5	5.5	0.45	0.0093
QCD	12929	5277	178	1.18	0.007

W'→eν (6)

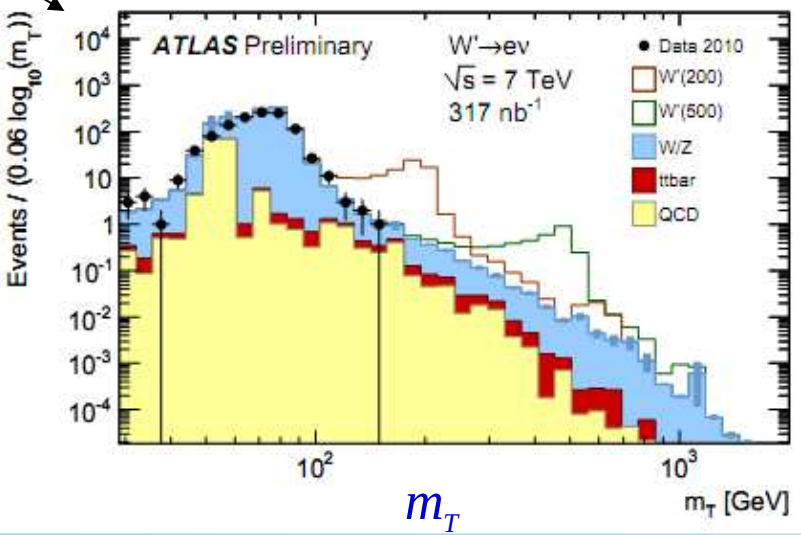
Selection LVL:
- Preselection + e isolation
- Above + mE_T



$\not\!\!E_T$



$p_T(e)$



m_T

W'→eν (7)

Systematic Uncertainties

Vary EM-scale by ±3%

Source	Size [%]
Event selection	
Identification, material, fiducial cuts	8.0
Electron energy scale	2.0
Low energy component of E_T^{miss}	0.6
Background	
Mass dependence, scale and PDF variation	7.0
QCD scale factor for m_T > 300 GeV	<5.0
Common	
Total integrated luminosity	11.0

W'→eν (8)

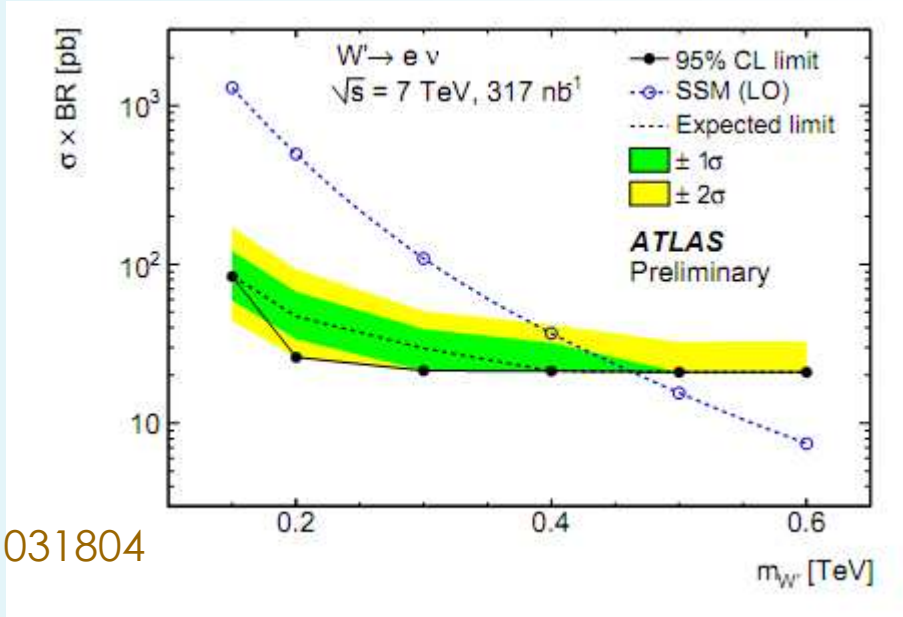
Limit Setting:

- Counting evts w/ $m_T > 0.7 \times m_{W'}$

- 1 bin LLR (including systematics)

Result:

- $m_{W'} > 465$ GeV, @ 95% CL
- Current best:
  - $m_{W'} > 1$ TeV, @ 95% CL
  - ref: D0, Phys Rev Lett 100 (2008) 031804

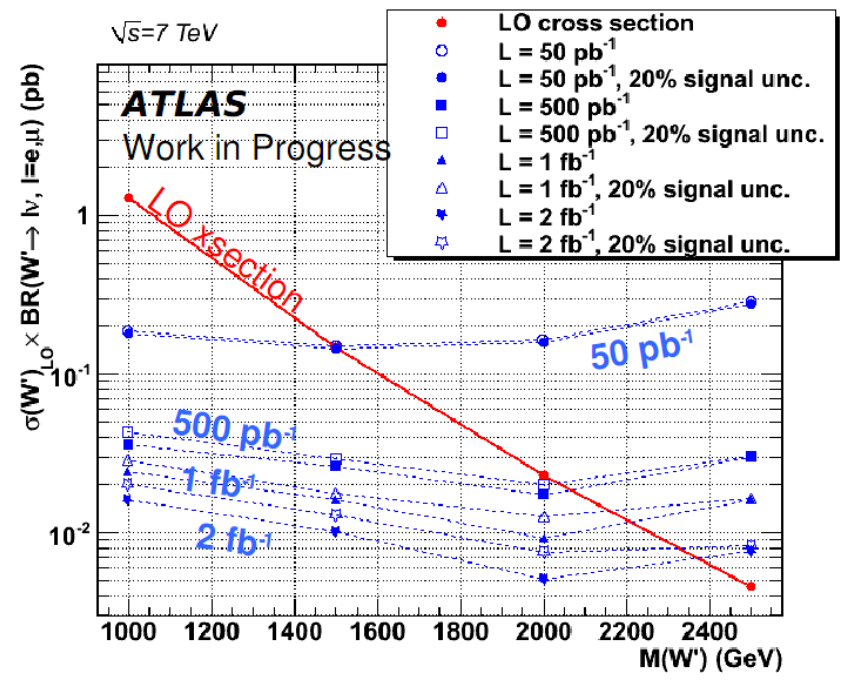


W'→eν (9)

Prospects:

- The above limit should be competitive with the Tevatron one (1 TeV) w/ L~5 pb^{-1}

- $m_{W'} > 1.5$ TeV, 50 pb^{-1}
- $m_{W'} > 2.3$ TeV, 2 fb^{-1}
- 20% signal uncert => -50 GeV on the limit



II.2. Searches for Z'

SSM Z' → e^+e^- or $\mu^+\mu^-$

$Z' \rightarrow l^+l^-$ (1)

- No public results based on collider data so far => MC-based study
  - MC Samples:
    - Generated at 10 TeV
    - rescaled to 7 TeV through PDF RW
    - MC@NLO for ttbar, Pythia for Z' and other Bkgd
    - Normalization: LO norm. (ttbar NLO)
    - $M_{Z'}$ = 1 and 1.5 TeV

Trigger:

- single EM cluster w/ p_T > 10 GeV
- single muon w/ p_T > 10 GeV

$Z' \rightarrow l^+l^-$ (2)

Offline Preselection:

- Electron ID:
  - 2 medium e
- Muon ID:
  - 2 « Combined » μ

- Common requirements:
  - $p_T > 20$ GeV
  - $|\eta| < 2.5$
  - Isolation:

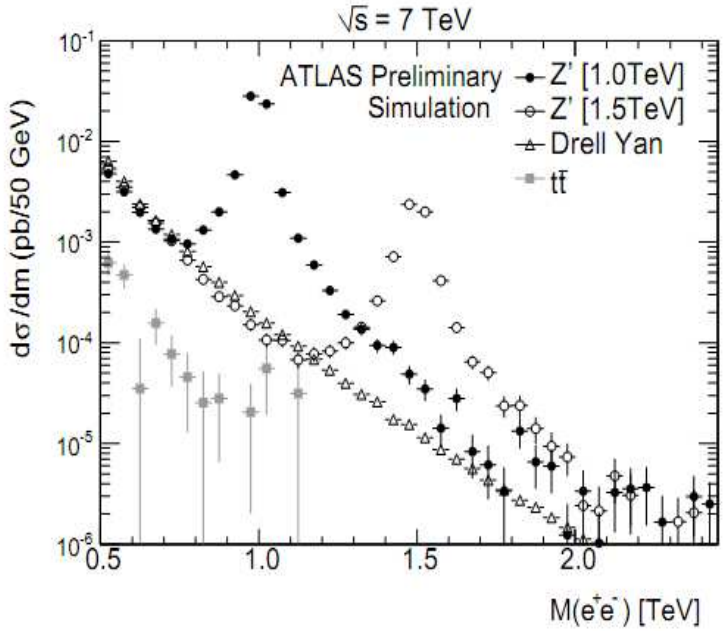
$$R_{isol} = \frac{\sum_{\Delta R=0.3} p_T(Tracks)}{p_T(e)} < 0.05$$

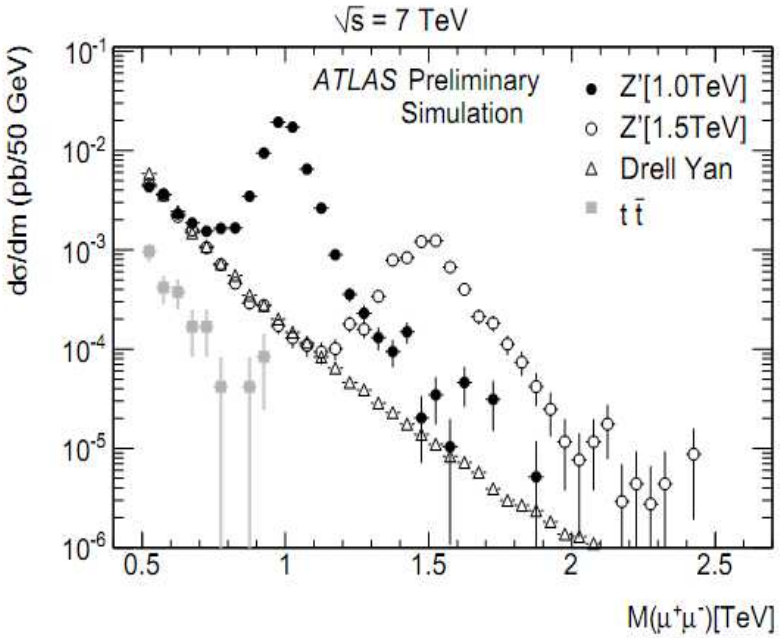
  - No explicit sign imposed

Z'→l^+l^- (3)

Typical resolution for electrons (resp. muons) in signal region: ~1% (~8%)

m(ll) after all cuts





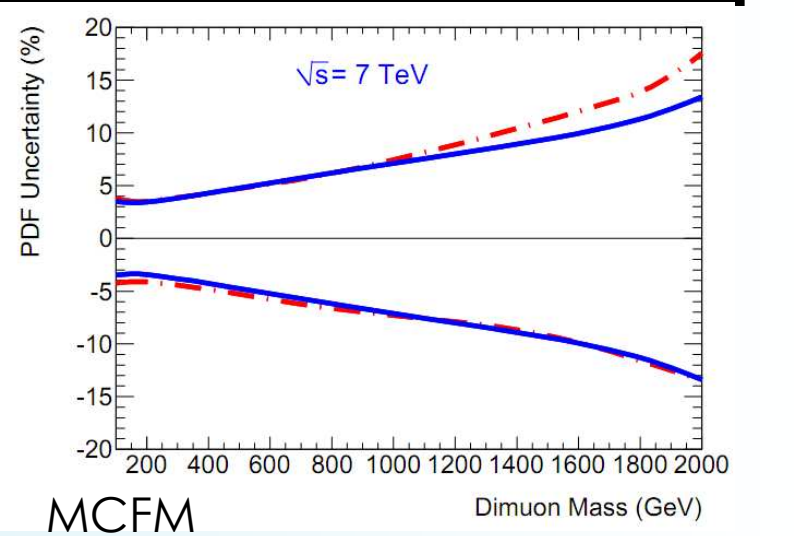
$Z' \rightarrow l^+l^-$ (4)

Systematic Uncertainties

- Estimated for L=10 pb^{-1}

Source	Value
Lepton Energy scale	3%
Lepton Energy Resolution	100% (all e) 100% (fwd μ) 200% (central μ)
Luminosity	10%

- Signal:
  - ee: 14%
  - μμ: 21%



$Z' \rightarrow l^+l^-$ (5)

Limit Setting:

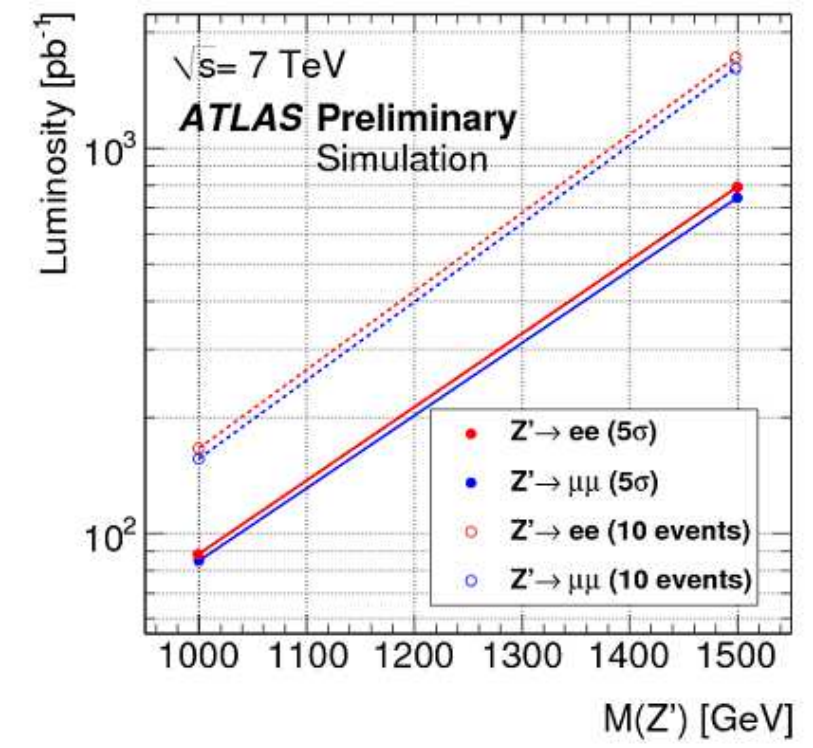
- Counting evts w/:
  - $m_{ll} > 0.8$ TeV ($m_{Z'}$ =1.0 TeV)
  - $m_{ll} > 1.2$ TeV ($m_{Z'}$ =1.5 TeV)

- LLR (including systematics):
  - Low stat. approximation:
  - Expected σ(fb) after all cuts

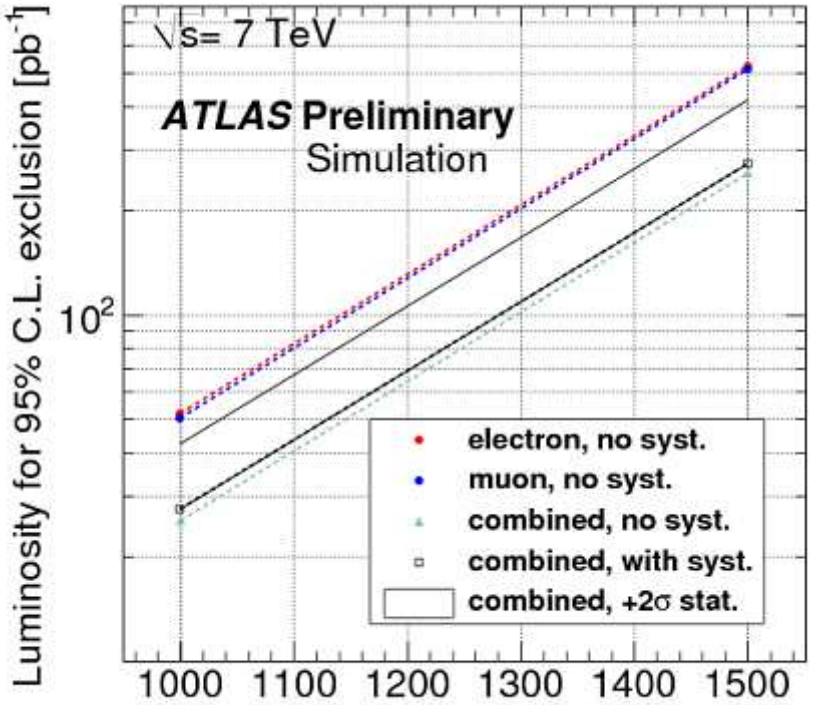
$$S = \sqrt{2((s+b)\ln(1+s/b) - s)}$$

Process	$M_{Z'} = 1.0$ TeV	$M_{Z'} = 1.5$ TeV
$Z' \rightarrow ee$	58.0(8)	5.73(11)
$Z \rightarrow ee$	1.86(2)	0.129(2)
$t\bar{t} \rightarrow ee$	0.08(6)	~ 0
$Z' \rightarrow \mu\mu$	59.6(8)	5.87(11)
$Z \rightarrow \mu\mu$	2.04(2)	0.139(2)
$t\bar{t} \rightarrow \mu\mu$	0.12(7)	~ 0

$Z' \rightarrow l^+l^-$ (6)



Discovery potential (5σ)



Exclusion limits (95% CL)

Ref: ATLAS-PHYS-PUB-2010-077

III. Early Searches for SUSY

III. Detailed Outilne

III.1. Search in jets+mET+0l inclusive topologies

III.2. Search in b-jets+leptons+mET inclusive topologies

III.3. Search in leptons+mET inclusive topologies

Restricted to:

- Gravity Mediated SUSY
- R-Parity Conservation

III.1. SUSY → Jets+mET wo/ Leptons

SUSY → Jets+mET (1)

Trigger:
- LVL1: calo. jets w/ p_T > 15 GeV
- HLT: no filtering
- Perf:
  - ε plateaus for p_T > 50 GeV
  - ε > 99% for p_T > 70 GeV
  - agreement data vs trigger simulation ~1%

Current Jet Energy Scale:
- Start w/ clusters calibrated at EM scale:
  - from test-beam of a full sector
  - in agreement with the full simulation
- MC-based hadronic factors correct for:
  - Non-compensation
  - Effect of dead material

Data Quality:
- Remove bad L blocks
- Remove evts w/ bad jets
- Reject evts w/ cosmics

L=70 nb^{-1}

Object ID:
- Jets:
  - anti-k_T, ΔR=0.4
  - p_T > 20 GeV
  - $|\eta|$ <2.5
- e: medium, p_T > 10 GeV, $|\eta|$ <2.47
- μ: matched, p_T > 10 GeV, $|\eta|$ <2.5
- lepton isolation: E_{cone} (ΔR=0.2)<10GeV
- mET:
  - from topo-clusters (EM)

SUSY → Jets+mET (2)

Signal:

- SU4 mSUGRA Point:
  - m_0 = 200 GeV
  - m1/2 = 160 GeV
  - A0 = -400 GeV
  - tanβ = 10
  - μ > 0
- Mass spectrum:
  - RGEs from Isajet 7.75
  - Squarks & gluinos mass: 405-420 GeV
    - chosen just above the curr. Tevatron limits: $\begin{cases} m_{\tilde{g}} > 308\ GeV \\ m_{\tilde{q}} > 379\ GeV \end{cases}$
- Event generation:
  - Herwig++ (using MRST2007LO*)
- Normalization:
  - Prospino: $\sigma_{\text{Incl SUSY}}$ =59.9 pb

Ref: D0 Collab., Phys. Lett. B660 (2008) 449

SUSY → Jets+mET (3)

Background Modeling:

- Gen:
  - Pythia: QCD

    multijet (4Q, 5q/g) diff. between Pythia and Alpgen found to be < curr. uncert.
  - Alpgen+Herwig+Jimmy: V+jets (PDF: CTEQ6L1)
  - MC@NLO+Herwig+Jimmy: ttbar (PDF: CTEQ6.6)

- Normalization:
  - NNLO: W(→lν) & Z(→νν)
  - NLO+NLL: ttbar
  - LO: QCD and Z(→ll)

- Data-driven normalization for QCD MC:
  - Select events:
    - mET < 40 GeV
    - Njets =2
    - pT(j1) > 70 GeV, pT(j2) > 30 GeV
  - Scale Factor: $SF=N_{MC}/N_{data}=108239/176000=0.61$

SUSY → Jets+mET (4)

Event Selection:

- 1 good PV w/ 5 tracks

Number of jets	Monojets	≥ 2 jets	≥ 3 jets	≥ 4 jets
Leading jet p_T (GeV)	> 70	> 70	> 70	> 70
Subsequent jets p_T (GeV)	veto if > 30	> 30	> 30 (Jets 2 and 3)	> 30 (Jets 2 to 4)
E_T^{miss}	> 40 GeV	> 40 GeV	> 40 GeV	> 40 GeV
$\Delta\phi(\text{jet}_i, \vec{E}_T^{miss})$	no cut	[> 0.2, > 0.2]	[> 0.2, > 0.2, > 0.2]	[> 0.2, > 0.2, > 0.2, > 0]
$E_T^{miss} > f \times M_{eff}$	no cut	$f = 0.3$	$f = 0.25$	$f = 0.2$

Event Yield:

	Monojet		≥ 2 jets		≥ 3 jets		≥ 4 jets	
	Data	Monte Carlo	Data	Monte Carlo	Data	Monte Carlo	Data	Monte Carlo
After jet cuts	21 227	$23\,000^{+7000}_{-6000}$	108 239	$108\,000^{+31\,000}_{-25\,000}$	28 697	$31\,000^{+10\,000}_{-8000}$	5329	5600^{+2300}_{-1600}
$\cap E_T^{miss}$ cut	73	46^{+22}_{-14}	650	450^{+190}_{-120}	325	230^{+100}_{-70}	116	84^{+45}_{-30}
$\cap \Delta\phi$ and E_T^{miss} cuts	–	–	280	200^{+110}_{-65}	136	100^{+55}_{-30}	54	43^{+26}_{-16}
$\cap E_T^{miss}/M_{eff}$, $\Delta\phi$ and E_T^{miss} cuts	–	–	4	6.6 ± 3	0	1.9 ± 0.9	1	1.0 ± 0.6

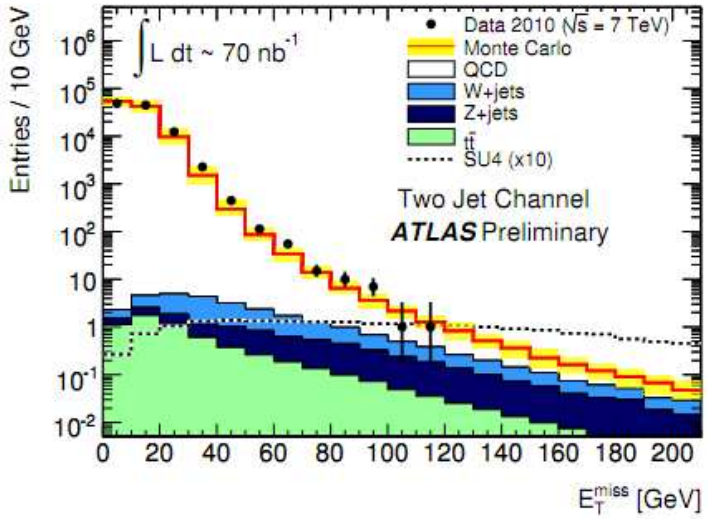
SUSY → Jets+mET (5)

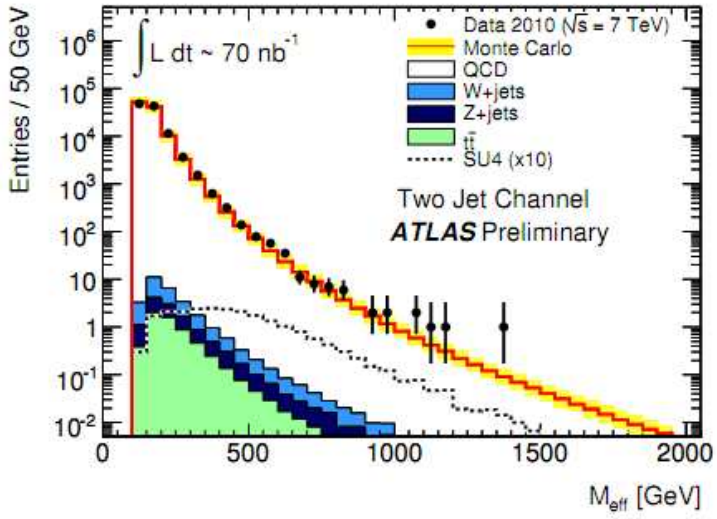
Systematic Uncertainties

- JES:
  - 10% for low pT jets: $20 < p_T < 60$ GeV
  - 7% for higher pT jets
- Effect on selection ε:
  - 25% for monojet and 2j+mET analyses
  - 40% for 3j+mET
  - 50% for 4j+mET
- Luminosity: 11%

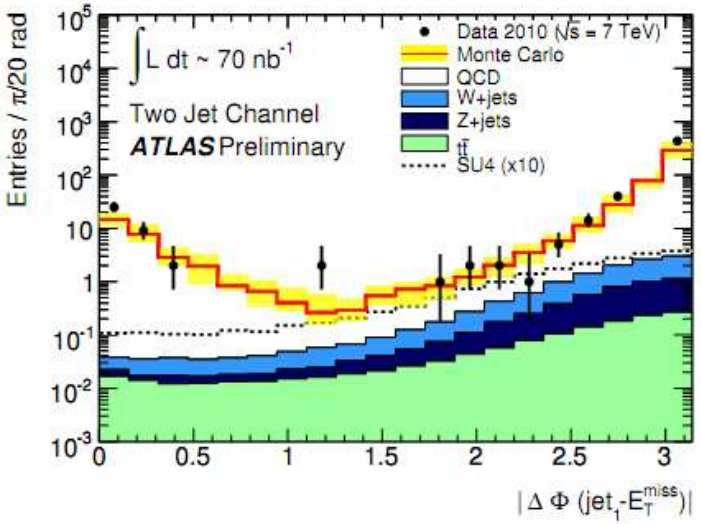
SUSY → 2Jets+mET (1)

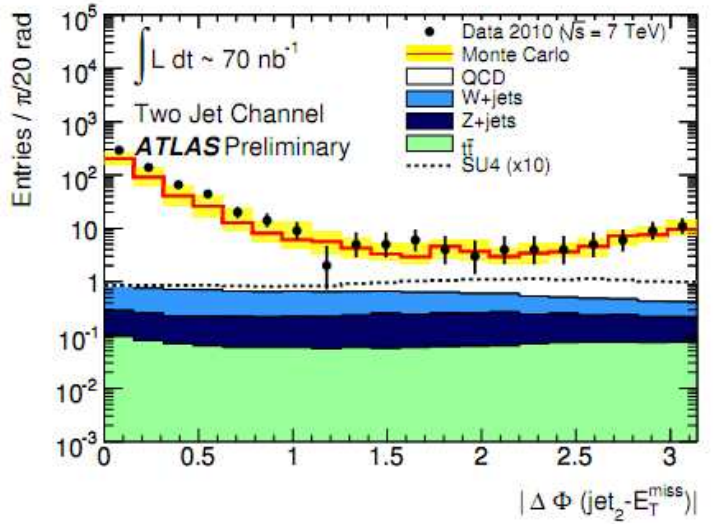
After jet cuts:





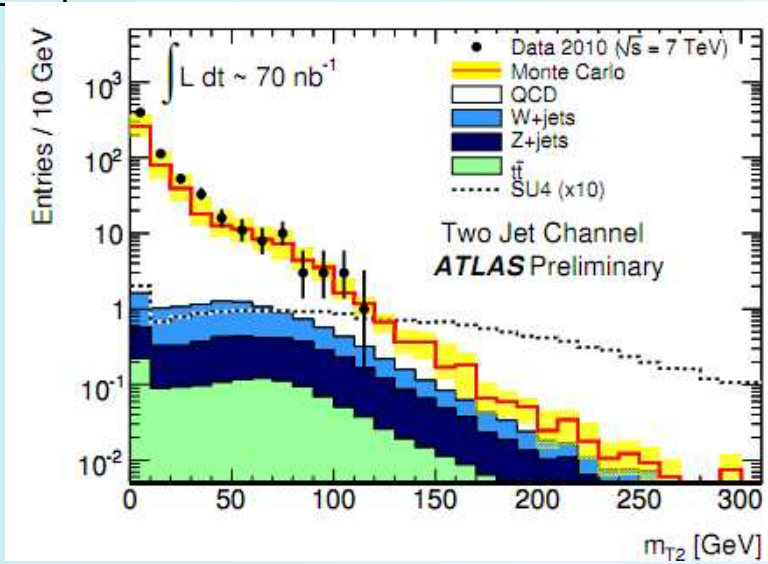
After jet+mET>40 GeV cuts:

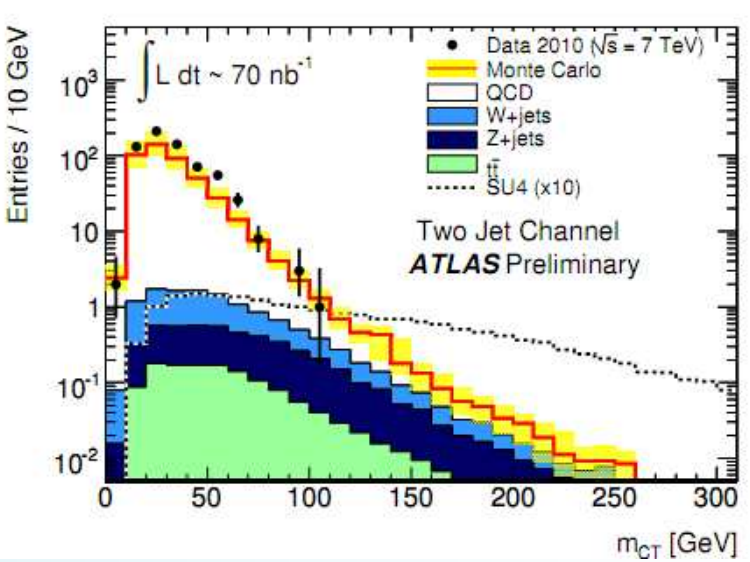




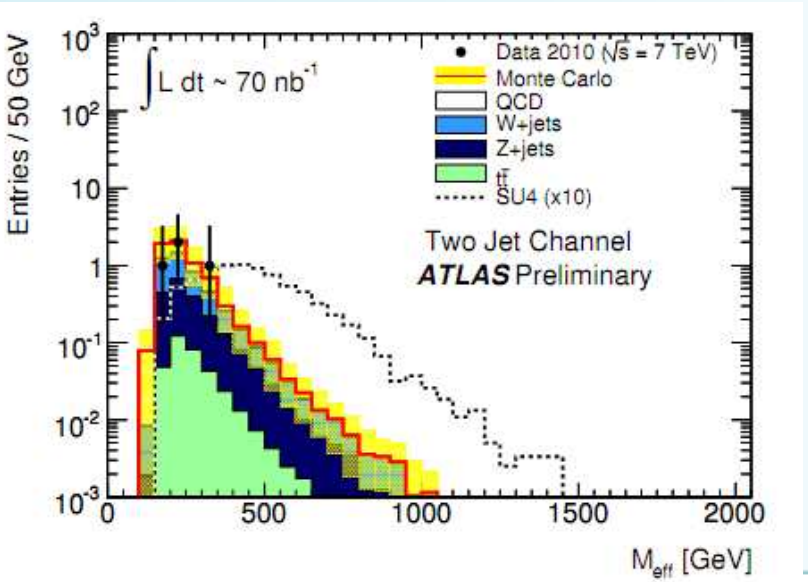
SUSY → 2Jets+mET (2)

After jet+mET>40 GeV cuts:



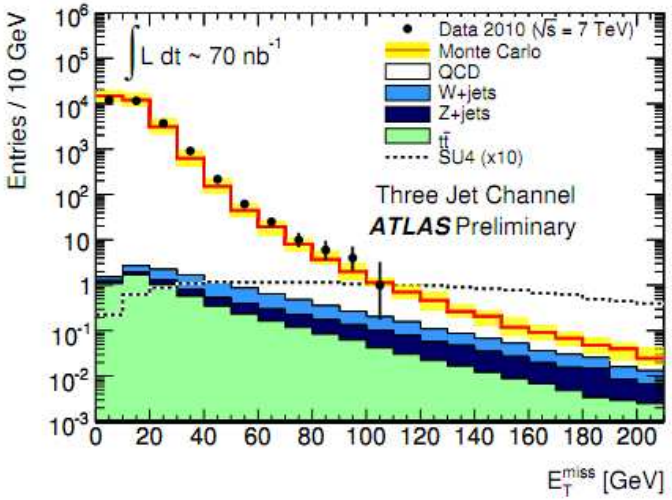


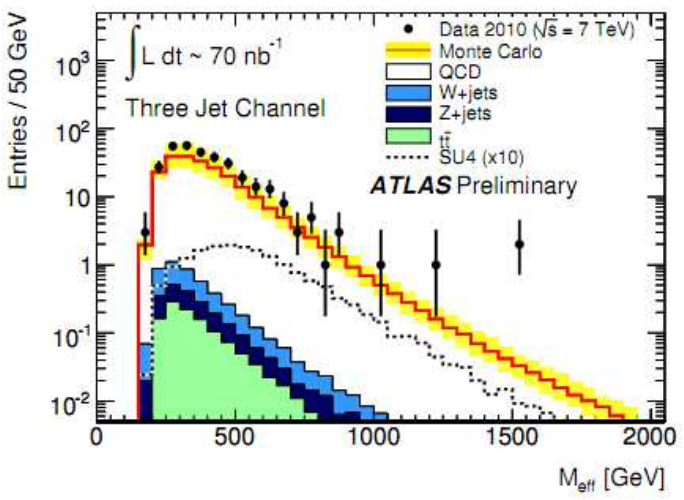
After all cuts:



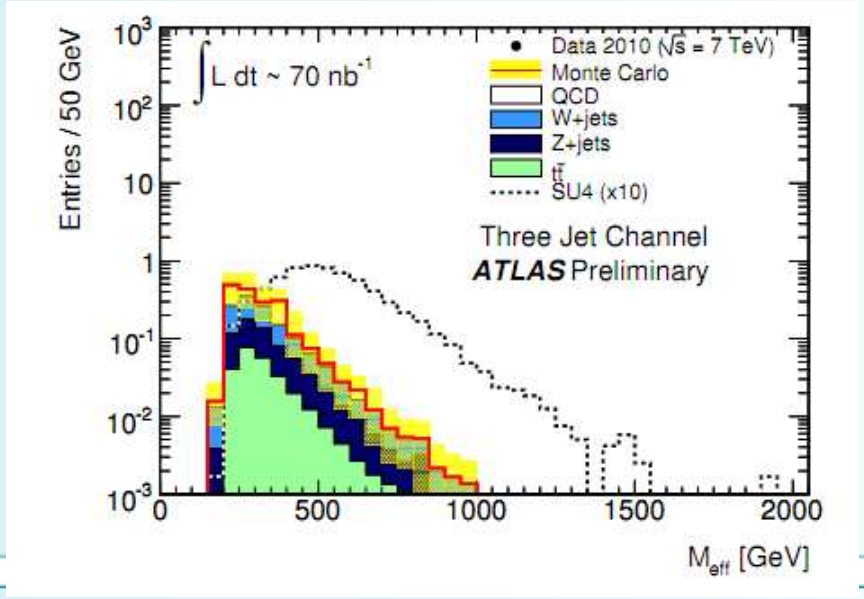
SUSY → 3Jets+mET

After jet + mET>40 GeV cuts:



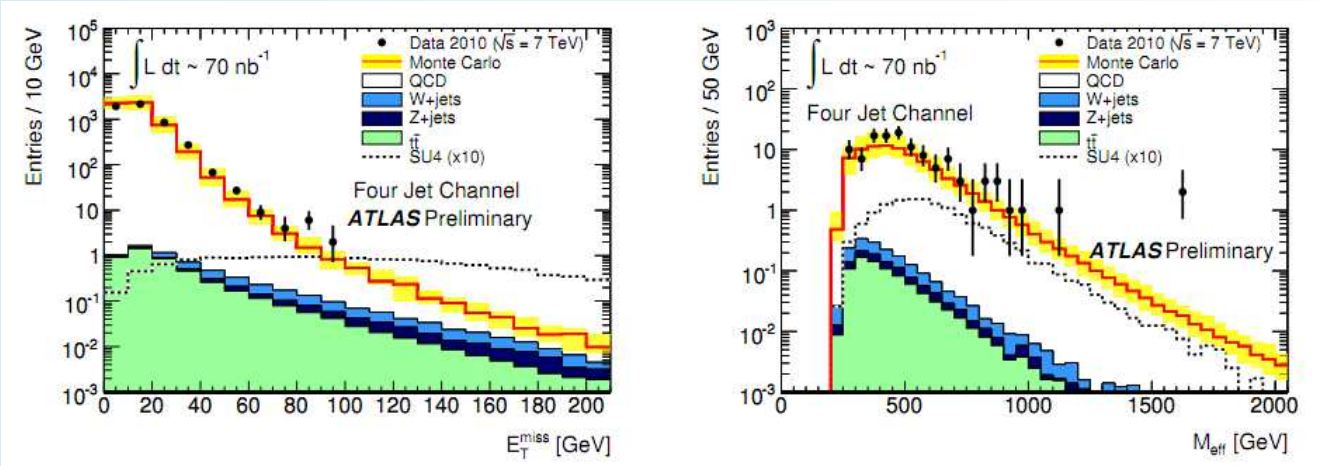


After all cuts:

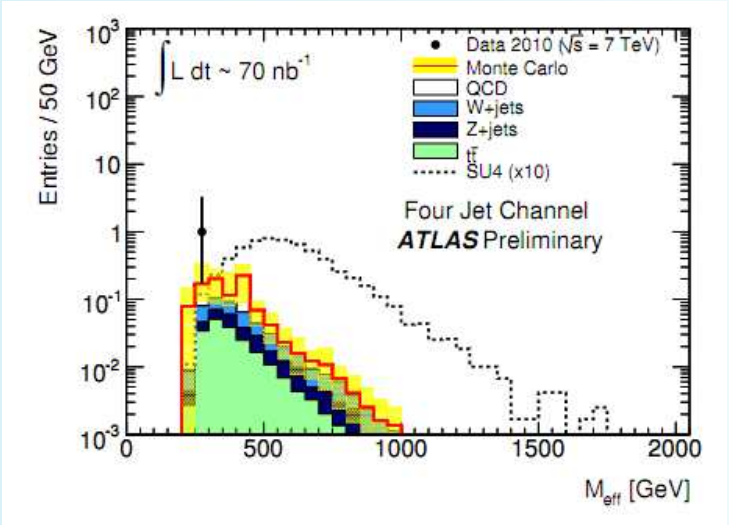


SUSY → 4Jets+mET

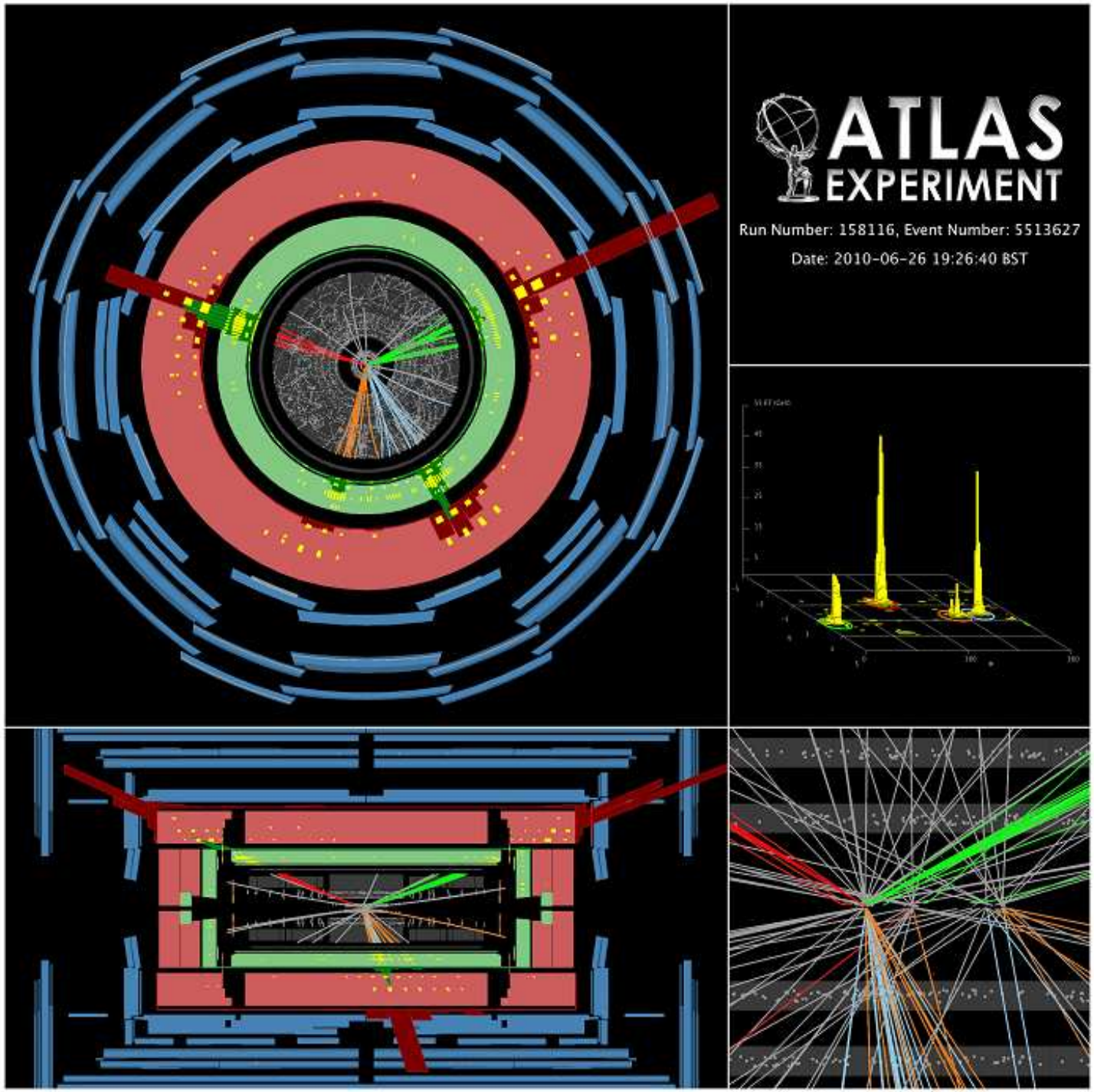
After jet + mET>40 GeV cuts:



After all cuts:

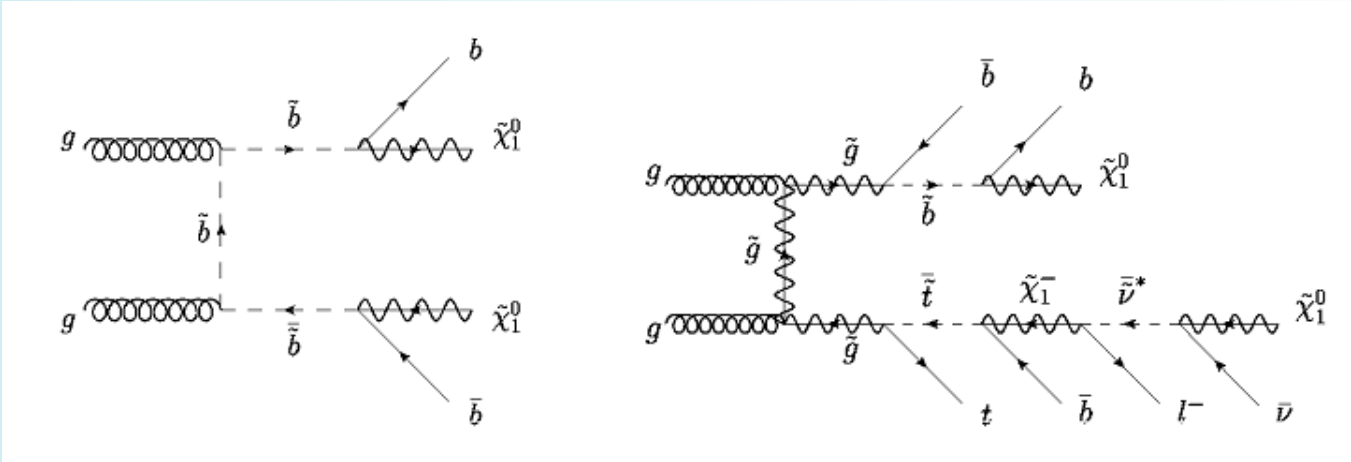


- Njets = 4
- mET = 100 GeV
- Meff = 1.65 TeV
- mET aligned w/ a b-tagged jet



III.2. SUSY → b-jets+Leptons+mET

SUSY → b-jets+mET (1)



Trigger:

- Jets: same as jets+mET analyses
- e: L1_EM5 + EF_g10_loose
  - Perf: for p_T > 15 GeV
    - $\varepsilon_{data}=(100^{+0}_{-10})\%$
    - $\varepsilon_{MC}=(96+/-3)\%$
- μ: L1_MU6
  - Perf: ε plateaus for p_T > 10 GeV
    - (73+/-5)%for $|\eta|<1.05$
    - (82+/-4)%for $1.05<|\eta|<2.4$
    - agreement data vs trigger simulation

Data Quality:

- Remove bad L blocks
- Remove evts w/ bad jets
- Reject evts w/ cosmics

L=305 nb^{-1}

SUSY → b-jets+mET (2)

Object ID:

- Same as jets+mET
- b-tagging: 2^{ndary} vertex in jet w/ $p_T > 30$ GeV
  - Perf: ε=40-65%, R_{light}=50-100

Background Modeling:

- Gen:
  - same as jets+mET
  - plus MC@NLO single top

SUSY → b-jets+mET (3)

Data-driven normalization for QCD MC:

- 0l channel:

Selection	data	QCD	data/QCD
MetSig < 2 GeV$^{1/2}$ (inclusive)	463180	752913	0.61
MetSig < 2 GeV$^{1/2}$ (≥ 1 *b*-tag jet)	28638	42562	0.67

Control region (mET < 30 GeV)

QCD MC Scale Factor

- 1l channel:
  - Control region:
    - 1l, 2 jets w/ $p_T > 30$ GeV, $m_T < 40$ GeV, MetSig < 2

Selection	data	QCD	non-QCD	(data – non-QCD) /QCD
Electron channel	353	1070±170	7.23±0.07	0.32 ±0.05
Electron channel after *b*-tagging	15	70±20	0.65±0.01	0.21 ± 0.08
Muon channel	70	143±5	5.07±0.06	0.45±0.05
Muon channel after *b*-tagging	9	29±2	0.55±0.01	0.30± 0.10

SUSY → b-jets+mET (4)

Event Selection:

•

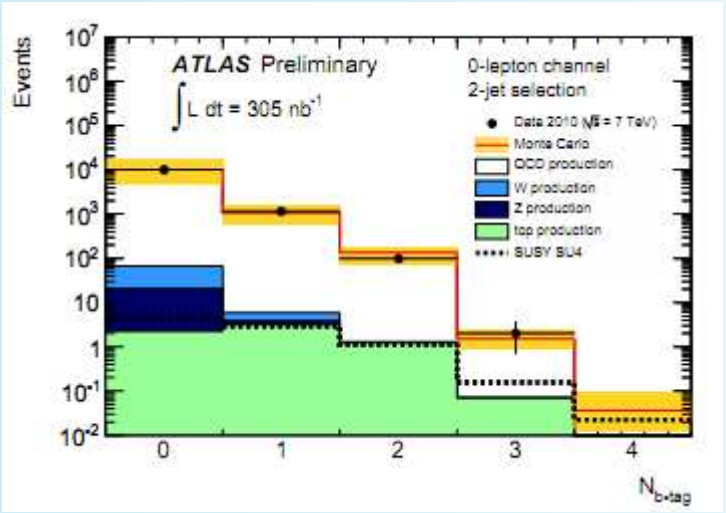
0-lepton	Electron	Muon
Pre-selection cuts: data quality, trigger requirements clean up for misidentified jets; electron fiduciality; $\geq$1 primary vertex with $\geq$5 tracks		
No lepton ($p_T > 10$ GeV)	$\geq$ 1 electron ($p_T > 20$ GeV)	$\geq$ 1 muon ($p_T > 20$ GeV)
2-jet: jet $p_T > (70, 30)$ GeV 3-jet: 3rd jet $p_T > 30$ GeV	jet $p_T > (30, 30)$ GeV -	jet $p_T > (30, 30)$ GeV -
$E_T^{miss} / \sqrt{\sum E_T} > 2$ GeV$^{1/2}$		
At least 1 b-tagged jet ($L/\sigma(L) > 6$, $p_T > 30$ GeV)		

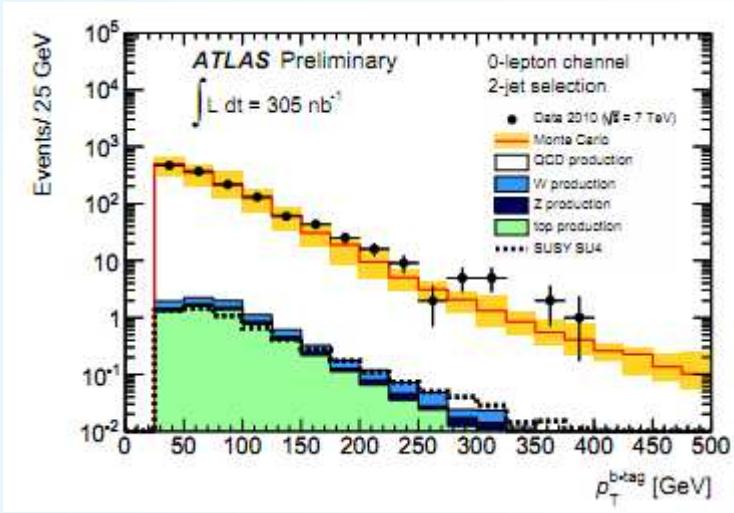
SUSY → b-jets+mET (5)

2 b-jets+0l+mET

2-jet selection	data	Standard Model expectation	SU4
Jets $p_T > (70, 30)$ GeV	474243	$(4.7^{+2.1}_{-1.9}) \cdot 10^5$	9.95±0.06
MetSig > 2 GeV$^{1/2}$	11190	$(1.1^{+0.5}_{-0.6}) \cdot 10^4$	8.71±0.06
At least 1 *b*-tagged jet	1253	1190 ± 430	4.23±0.04

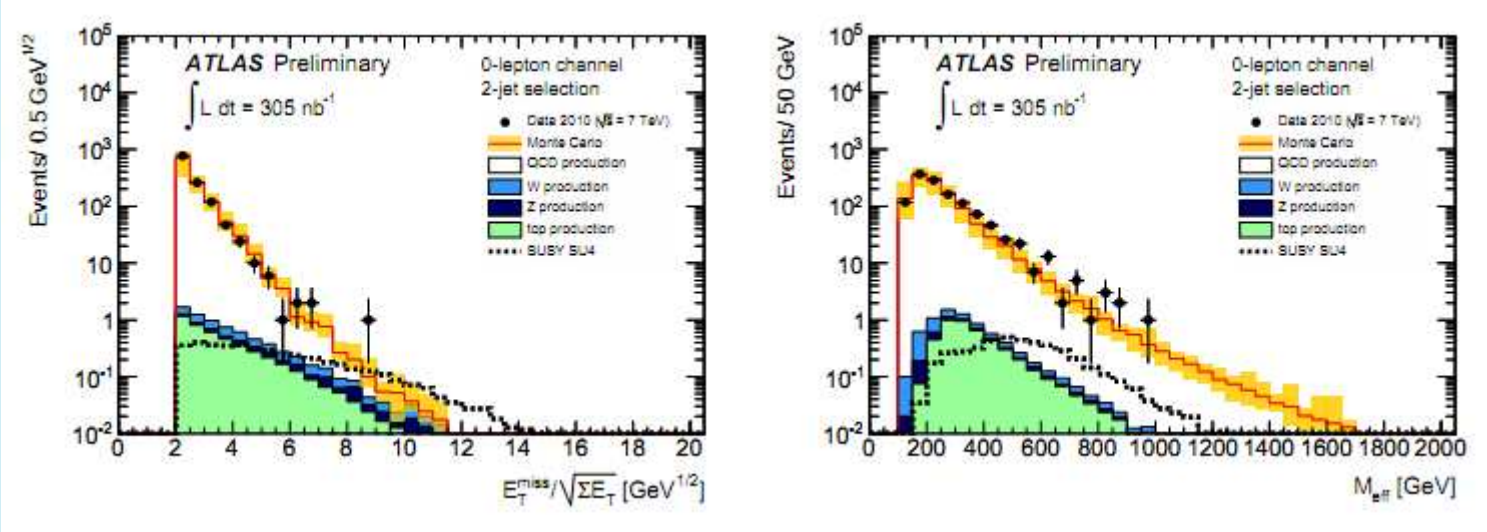
2-jet selection	QCD	W+jets	Z+jets	top
Jets $p_T > (70, 30)$ GeV	$(4.72 \pm 0.01) \cdot 10^5$	71.1 ± 0.3	28.6 ± 0.2	26.4 ± 0.07
MetSig > 2 GeV$^{1/2}$	$(1.11 \pm 0.02) \cdot 10^4$	47.4 ± 0.2	19.3 ± 0.2	6.73 ± 0.02
At least 1 *b*-tagged jet	1181 ± 36	2.18 ± 0.04	0.74 ± 0.03	4.51 ± 0.02

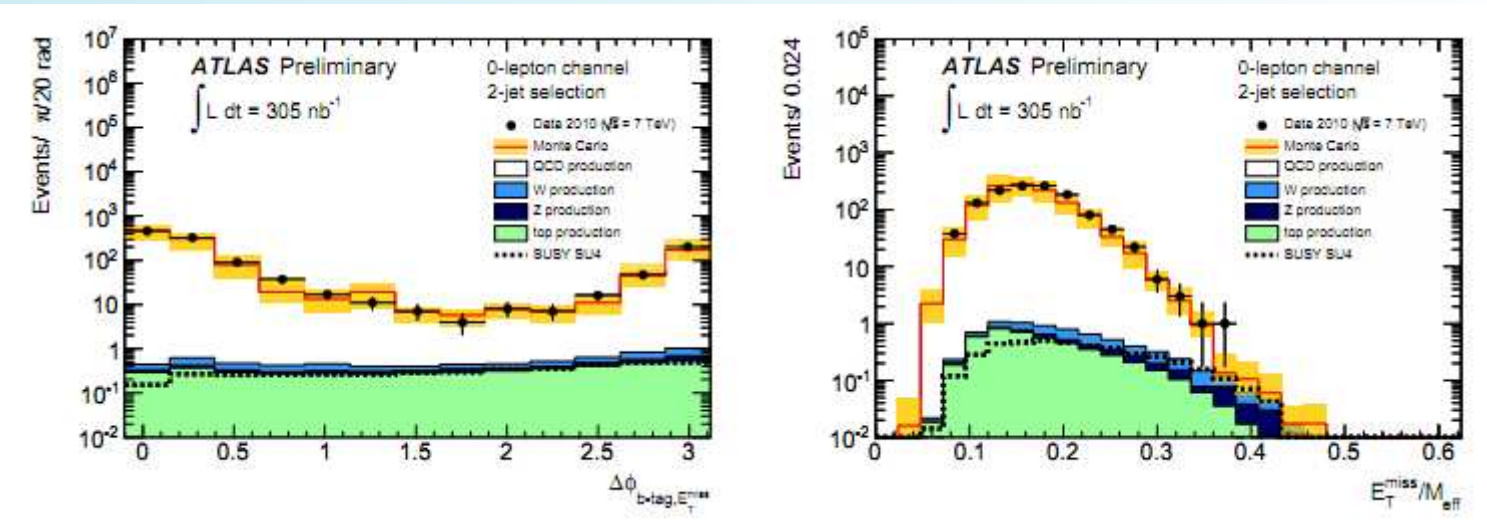




SUSY → b-jets+mET (6)

2 b-jets+0l+mET



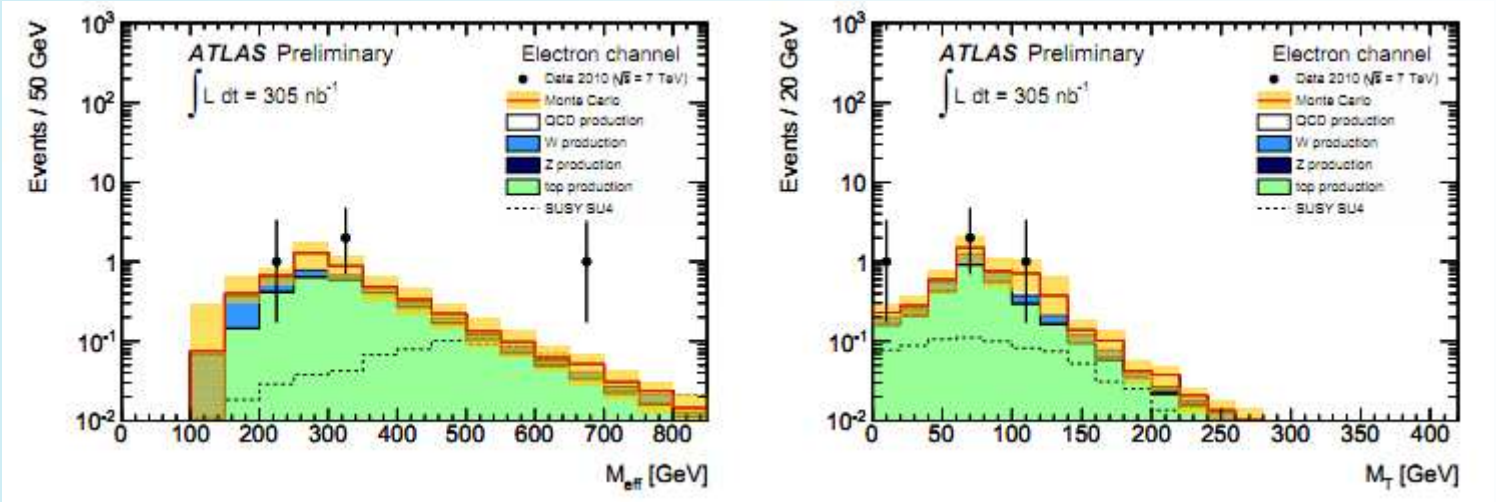


SUSY → b-jets+mET (7)

b-jets+1e+mET

Electron channel	data	Standard Model	SU4
≥ 1 electron and 2 jets $p_T > (30,30)$ GeV	557	520^{+360}_{-330}	1.65 ± 0.02
MetSig > 2 GeV$^{1/2}$	31	39^{+28}_{-20}	1.40 ± 0.02
At least 1 b-tagged jet	4	$4.8^{+1.7}_{-1.5}$	0.81 ± 0.02

Electron channel	QCD	W+jets	Z+jets	top
≥ 1 electron and 2 jets $p_T > (30,30)$ GeV	470 ± 57	38.3 ± 0.2	8.42 ± 0.08	7.22 ± 0.02
MetSig > 2 GeV$^{1/2}$	8.0 ± 1.0	25.4 ± 0.1	1.20 ± 0.03	4.67 ± 0.01
At least 1 b-tagged jet	0.78 ± 0.31	1.00 ± 0.03	0.10 ± 0.01	2.95 ± 0.01

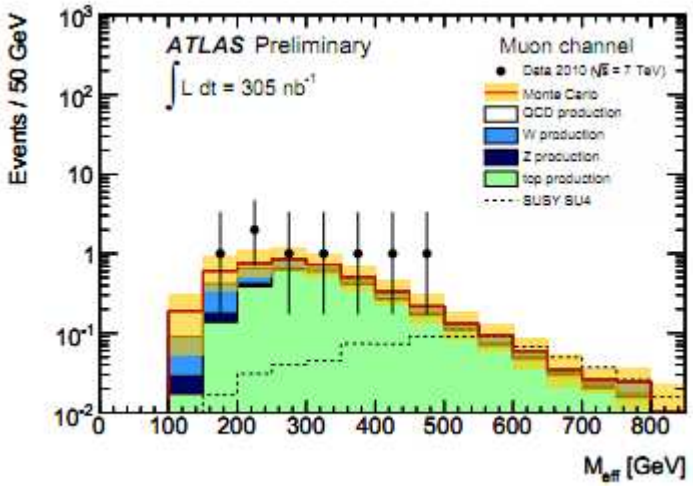


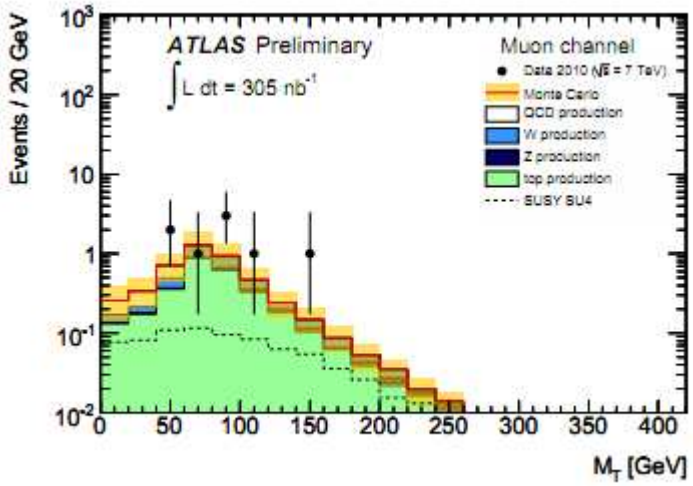
SUSY → b-jets+mET (8)

b-jets+1μ+mET

Muon channel	data	Standard Model	SU4
≥ 1 muon and 2 jets $p_T > (30, 30)$ GeV	138	130^{+70}_{-60}	1.58 ± 0.02
MetSig > 2 GeV$^{1/2}$	40	37^{+28}_{-19}	1.34 ± 0.02
At least 1 b-tagged jet	8	$4.7^{+1.7}_{-1.5}$	0.80 ± 0.02

Muon channel	QCD	W+jets	Z+jets	top
≥ 1 muon and 2 jets $p_T > (30, 30)$ GeV	74.4 ± 2.3	38.5 ± 0.2	7.14 ± 0.07	6.77 ± 0.02
MetSig > 2 GeV$^{1/2}$	1.7 ± 0.3	27.9 ± 0.1	2.83 ± 0.05	4.60 ± 0.01
At least 1 b-tagged jet	0.49 ± 0.14	1.09 ± 0.03	0.20 ± 0.01	2.93 ± 0.01





SUSY → b-jets+mET (9)

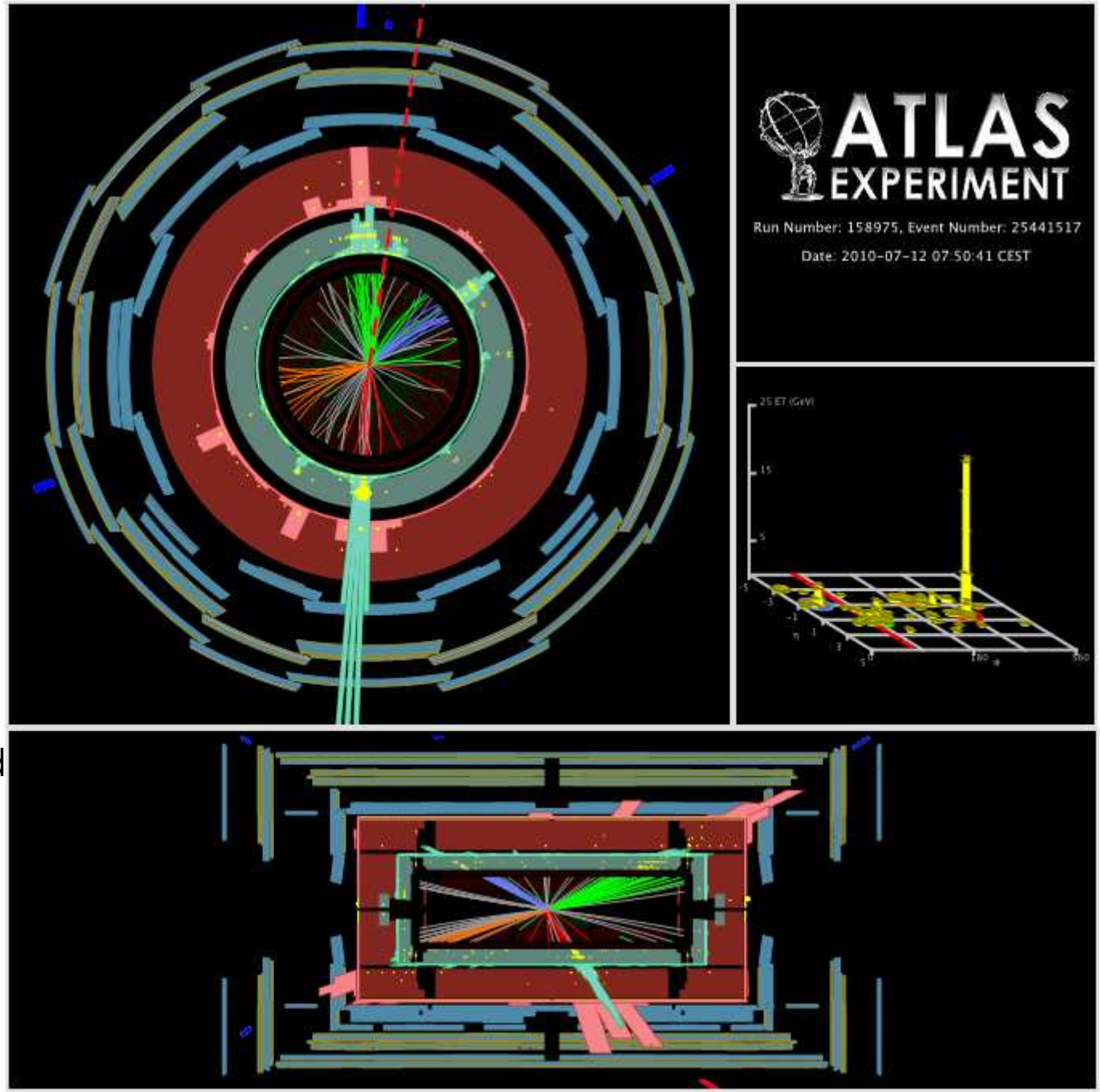
Systematic Uncertainties

Source of uncertainty	0-lepton	1-lepton
Jet Energy Scale (including pile-up)	$\sim \pm 30\%$	$\sim \pm 25\%$
Unclustered Energy	$\pm 20\%$	$\pm 20\%$
Tagging Performance	$\pm 20\%$	$\pm 20\%$
Lepton Identification Performance	–	$\pm 50\%$
Luminosity	$\pm 11\%$	$\pm 11\%$
Theory	$\pm 60\%$	$\pm 60\%$

Effect on MetSig

Normalization & modeling of V+jets and top:
scale, PDF, ISR/FSR

- N_{jets} = 5
- mET = 41 GeV
- MetSig = 2.1
- M_{eff} = 432 GeV
- pT(j1)= 182 GeV
- pT(j5)= 21.9 GeV
- Jets 2,3,4 b-tagged



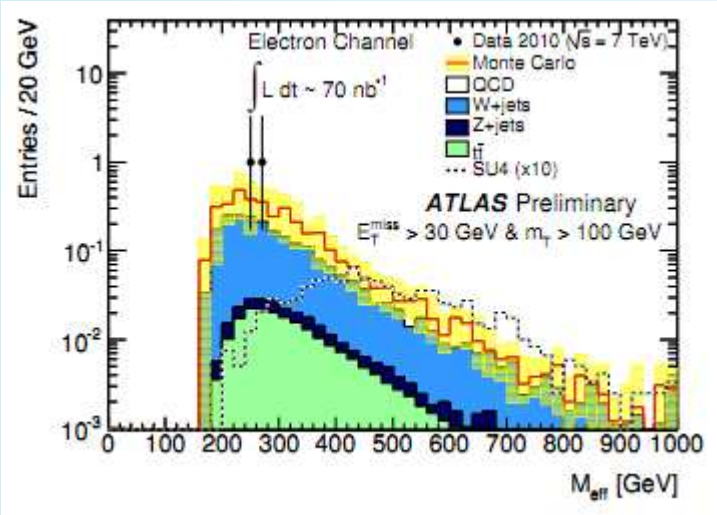
III.2. SUSY → Leptons+mET

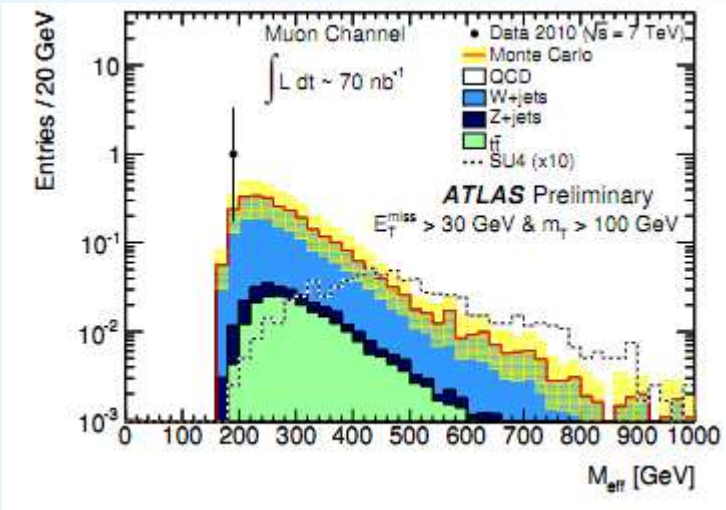
SUSY → Leptons+mET (1)

1l+mET

L=70 nb^{-1}

Selection	Electron channel Data	Electron channel Monte Carlo	Muon channel Data	Muon channel Monte Carlo
$p_T(\ell) > 20$ GeV ∩ ≥ 2 jets with $p_T > 30$ GeV	143	157 ± 85	40	37 ± 14
∩ $E_T^{miss} > 30$ GeV	13	16 ± 7	17	15 ± 7
∩ $m_T > 100$ GeV	2	3.6 ± 1.6	1	2.8 ± 1.2

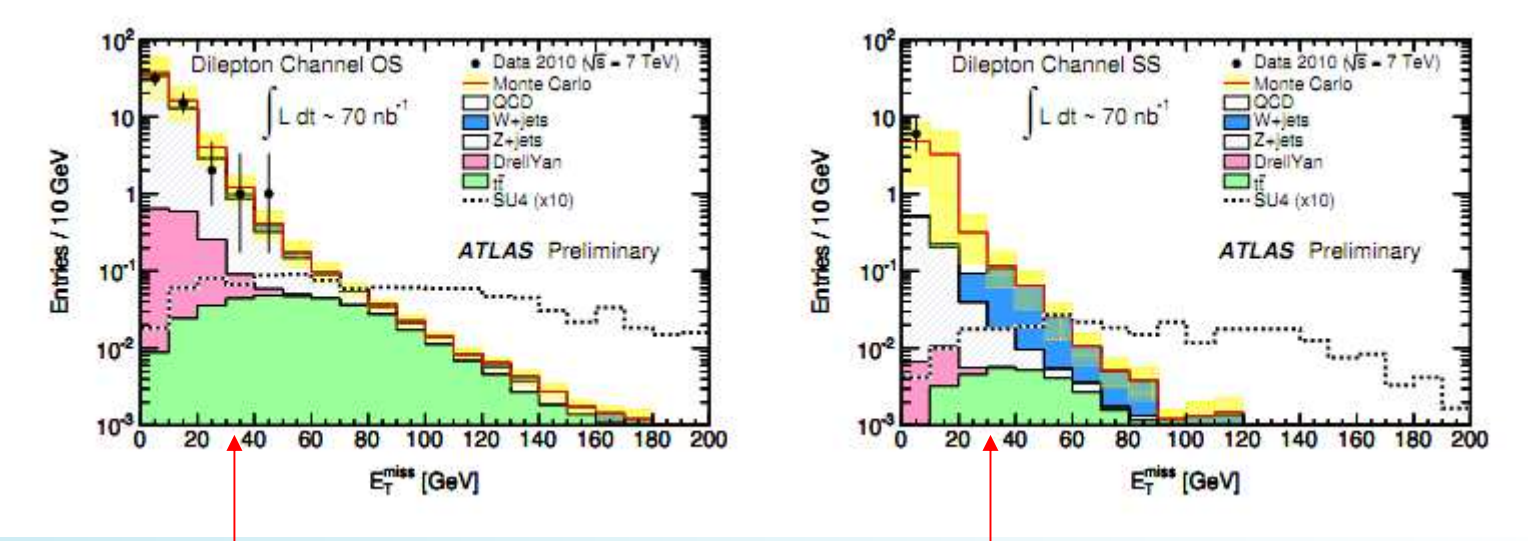




SUSY → Leptons+mET (1)

2l+mET

- 2l
- $p_T(l1) > 20$ GeV, $p_T(l2) > 10$ GeV
- $m(l1,l2) > 5$ GeV



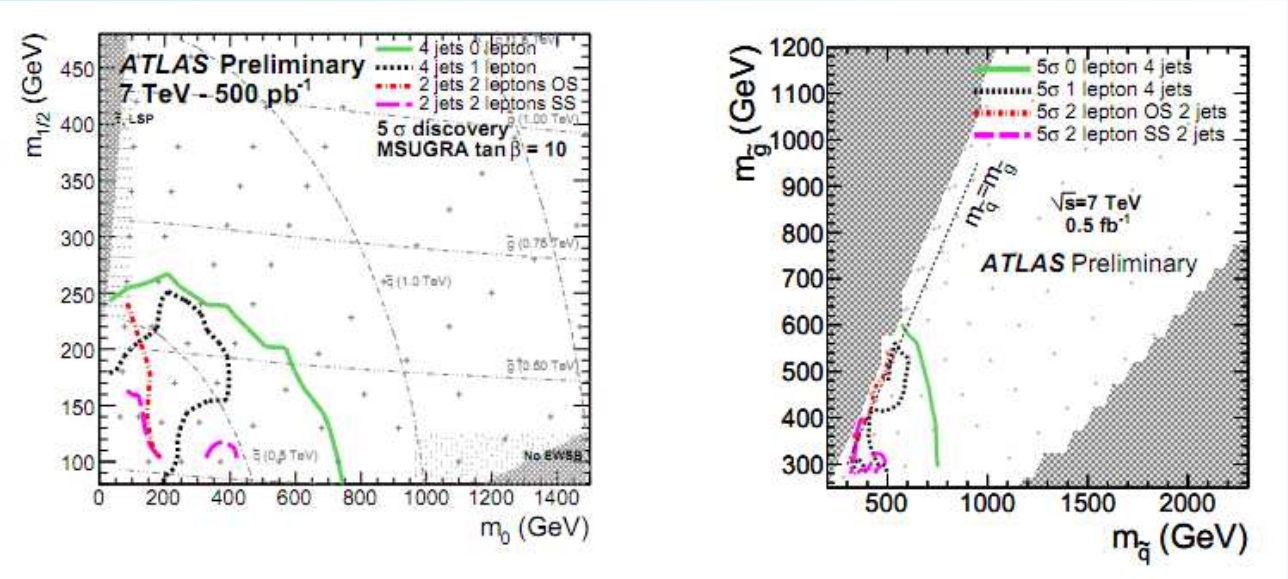
mET > 30 GeV

- $N_{obs} = 2$
- $N_{exp} = 2.0 +/- 0.8$

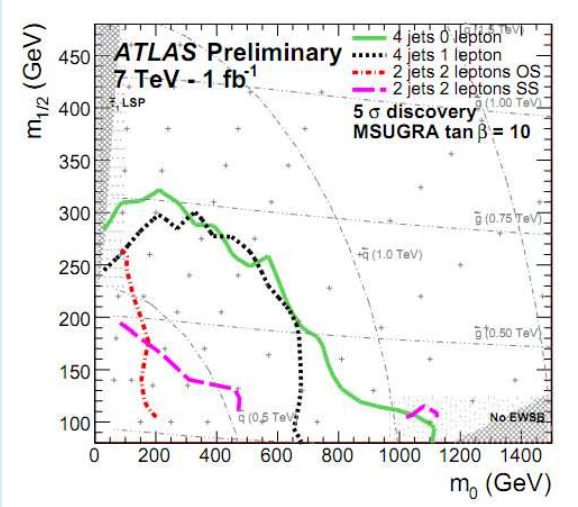
IV. Prospects

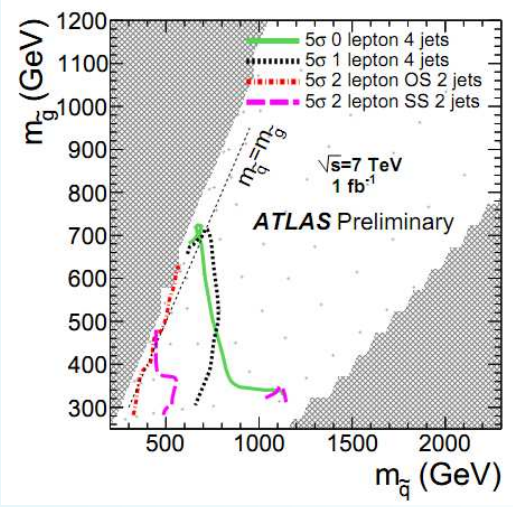
Based on MC studies at 7 TeV

L=500 pb^{-1}

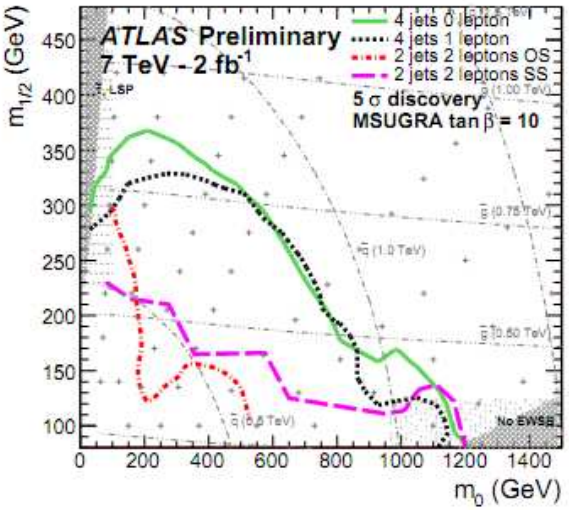


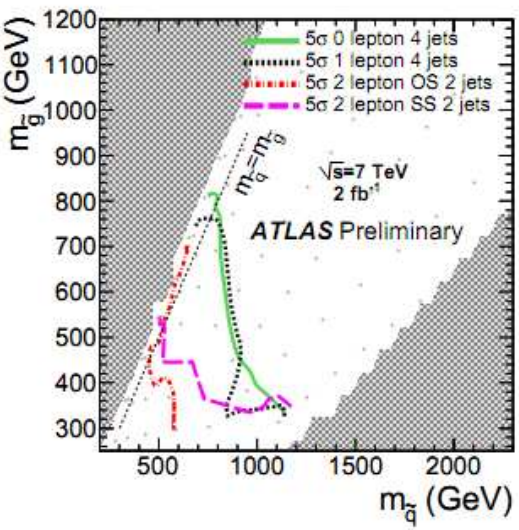
L=1 fb^{-1}


ATLAS Preliminary
7 TeV - 1 fb-1
5 σ discovery
MSUGRA tan β = 10
4 jets 0 lepton
4 jets 1 lepton
2 jets 2 leptons OS
2 jets 2 leptons SS
No EWSB
m1/2 (GeV)
m0 (GeV)

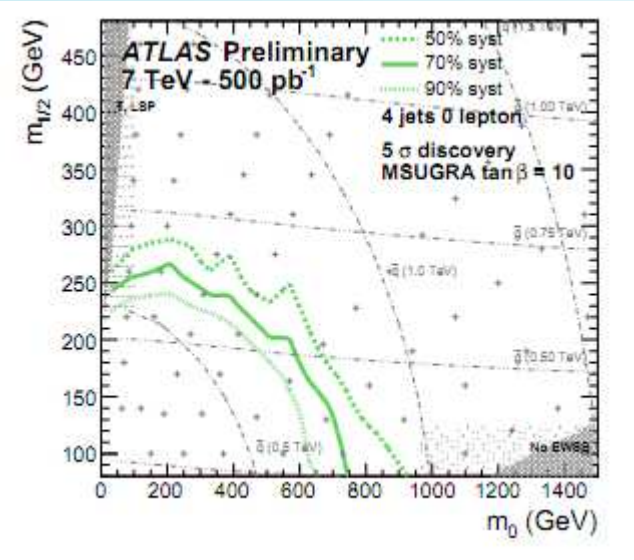

5σ 0 lepton 4 jets
5σ 1 lepton 4 jets
5σ 2 lepton OS 2 jets
5σ 2 lepton SS 2 jets
√s=7 TeV
1 fb-1
ATLAS Preliminary
mg̃ (GeV)
mq̃ (GeV)

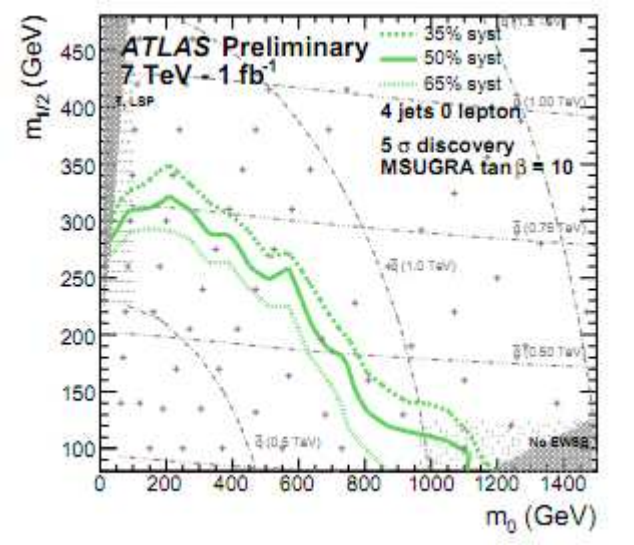
L=2 fb^{-1}

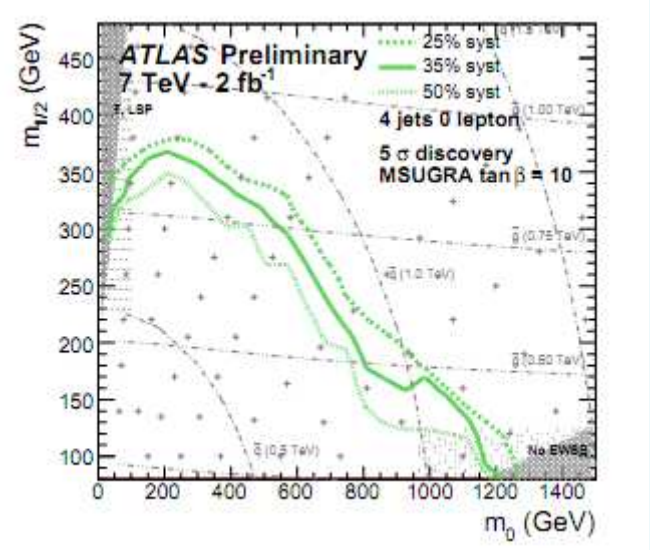

ATLAS Preliminary
7 TeV - 2 fb-1
5 σ discovery
MSUGRA tan β = 10
4 jets 0 lepton
4 jets 1 lepton
2 jets 2 leptons OS
2 jets 2 leptons SS
No EWSB
m1/2 (GeV)
m0 (GeV)


5σ 0 lepton 4 jets
5σ 1 lepton 4 jets
5σ 2 lepton OS 2 jets
5σ 2 lepton SS 2 jets
√s=7 TeV
2 fb-1
ATLAS Preliminary
mg̃ (GeV)
mq̃ (GeV)

Effect of the systematics

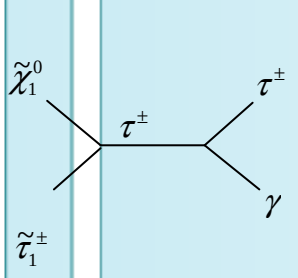




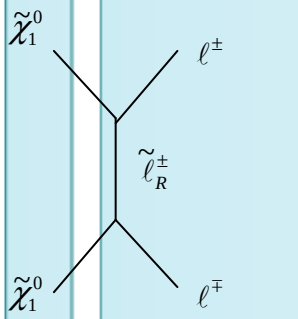


BACK-UP

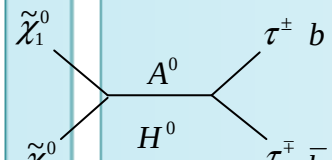
Isajet 7.71, m(top)=175 GeV, Large tanβ, μ>0



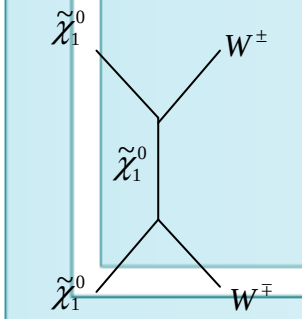
- light $\tilde{\tau}_1^{\pm}$
- in equilibrium w/ LSP
- heavy bino LSP



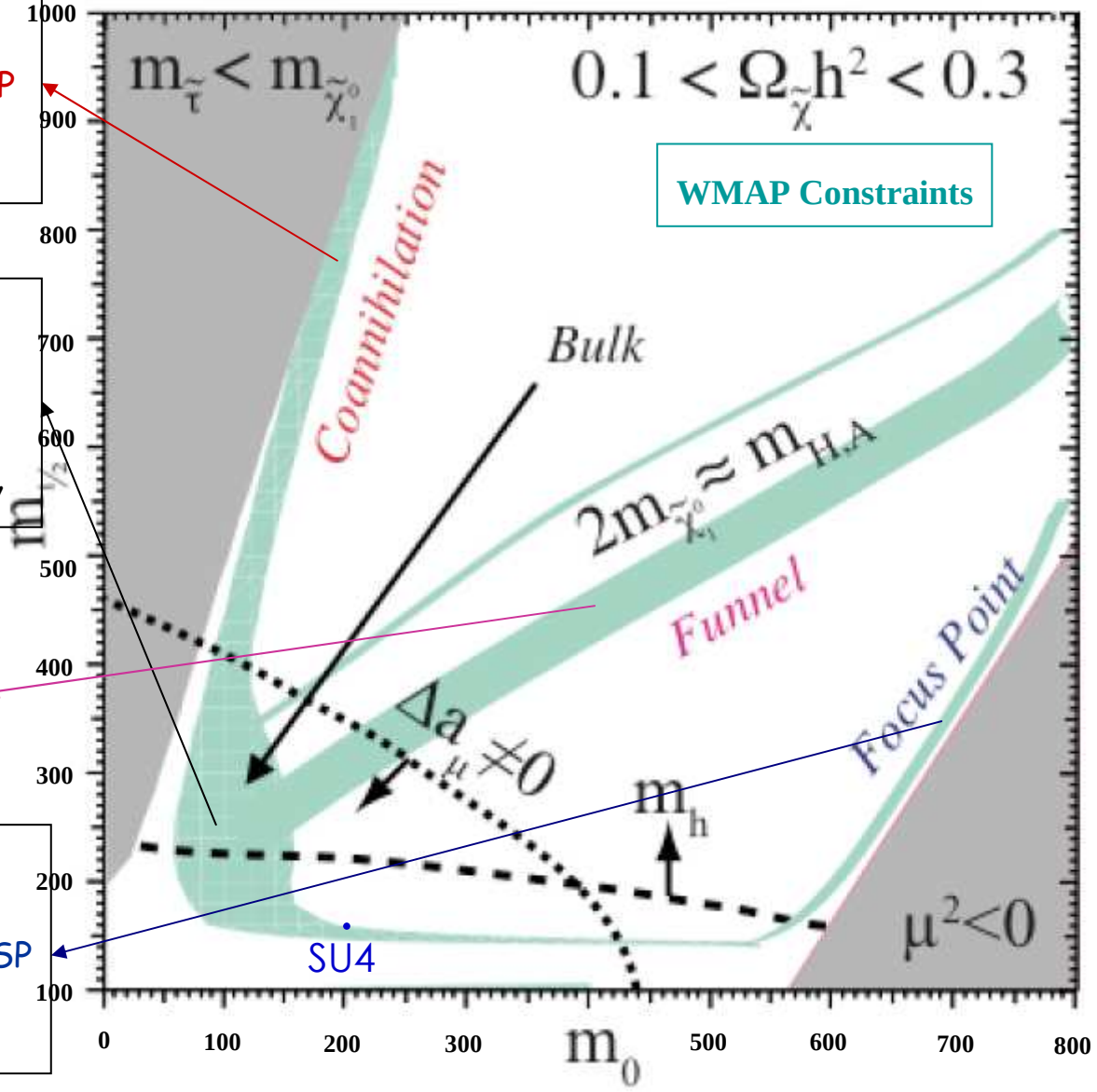
- bino LSP
- light $\tilde{\ell}_R^{\pm}$
- (g-2) ok, FCNC risky



- H, A poles
- large tanβ
- heavy bino LSP



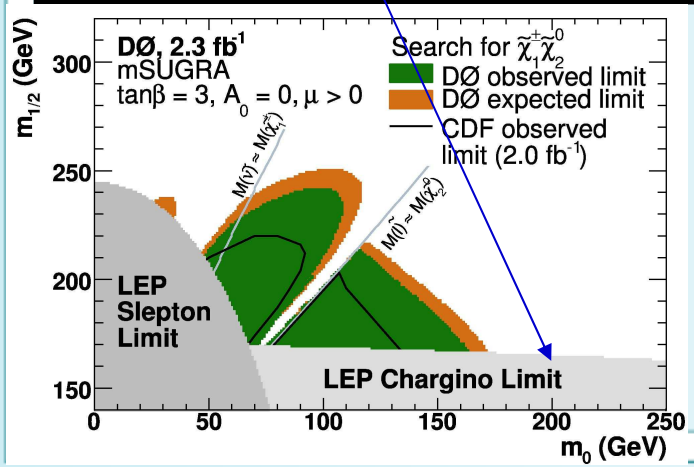
- small μ
- higgsino light LSP
- heavy $\tilde{\ell}_R^{\pm}$



ATLAS SUSY Benchmarks

mSUGRA

Point	m_0 (GeV)	$m_{1/2}$ (GeV)	A_0 (GeV)	tanβ	SIGN(μ)	σ_{NLO} / σ_{LO} (pb)
Coannihilation (SU1)	70	350	0	10	+1	10.86 / 8.15
Focus Point (SU2)	3550	300	0	10	+1	7.18 / 5.17
Bulk (SU3)	100	300	-300	6	+1	27.68 / 20.85
Low Mass (SU4)	200	160	-400	10	+1	402.19 / 294.46
Funnel (SU6)	320	375	0	50	+1	6.07 / 4.47
Coannihilation (SU8.1)	210	360	0	40	+1	8.70 / 6.48
Bulk (SU9)	300	425	20	20	+1	3.28 / 2.46



b→sγ: favours μ>0 (in mSUGRA)

Cross sections:

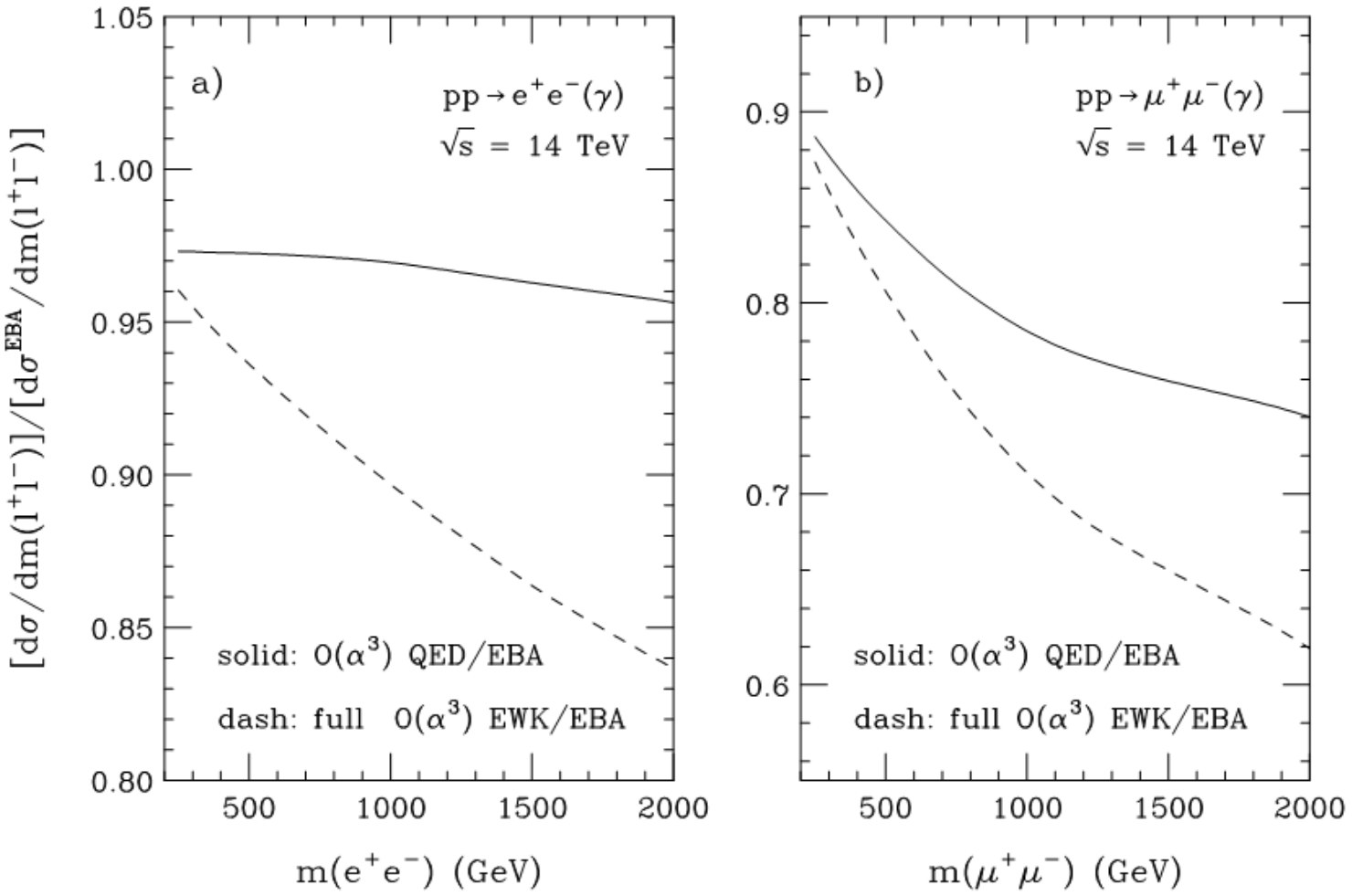
- $s^{1/2}$ = 14 TeV
- CTE6M/CTEQ6L1

Sparticle	SU1	SU2	SU3	SU4	SU6	SU8.1	SU9
$<\tilde{q}_L>$	762.7	3563.7	633.9	416.0	868.8	799.1	954.3
$<\tilde{q}_R>$	734.5	3575.2	611.3	405.6	841.2	772.8	922.2
$\tilde{t}_1$	573.0	2131.1	424.1	206.0	641.6	603.7	725.0
$\tilde{b}_1$	697.9	2924.8	575.2	358.5	716.8	690.3	868.1
$\tilde{e}_L$	255.1	3547.5	230.5	231.9	411.9	325.4	417.2
$\tilde{e}_R$	154.1	3547.5	155.5	212.9	351.1	253.4	340.9
$\tilde{\nu}_e$	238.3	3546.3	217.0	217.9	401.9	315.3	407.9
$\tilde{\tau}_1^+$	146.5	3519.6	150.0	200.5	181.3	151.9	320.2
$\tilde{\nu}_\tau$	237.6	3532.3	216.3	215.5	358.3	297.0	401.1
$\tilde{g}$	832.3	856.6	717.5	413.4	894.7	856.5	999.3
$\tilde{\chi}_1^+$	262.1	149.2	218.3	113.2	288.3	274.3	326.0
$\tilde{\chi}_2^0$	263.6	160.4	218.6	113.5	288.0	274.0	325.4
$\tilde{\chi}_1^0$	137.0	103.4	117.9	59.8	149.6	142.5	173.3
t	175.0	175.0	175.0	175.0	175.0	175.0	175.0
h^0	115.8	119.0	114.8	114.0	116.9	116.7	114.5
H^0	516.0	3529.7	512.9	370.5	388.9	430.5	632.8
A^0	512.4	3506.6	511.3	368.2	386.5	427.7	628.6
H^+	521.9	3530.6	518.2	378.9	401.2	440.2	638.9

ATLAS Detector Status

Subdetector	Nber of Channels	Approximate Operational Fraction
Pixels	80 M	97.3%
SCT Silicon Strips	6.3 M	99.2%
TRT Transition Radiation Tracker	350 k	97.1%
LAr EM Calorimeter	170 k	97.9%
Tile calorimeter	9800	96.8%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%
LVL1 Calo trigger	7160	99.9%
LVL1 Muon RPC trigger	370 k	99.5%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.5%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Chambers	370 k	97.0%
TGC Endcap Muon Chambers	320 k	98.4%

NLO-EW Corrections



Anti-k_T Jets

- Definition: It's a recombination algorithm
- Properties:
  - it is IR-safe
  - it can easily be implemented in theoretical or experimental analyses
  - it can be defined at any order of the perturbation theory
- Description:
  - Recombines successively closest pairs

$$d_{ij} = \min[k_T^{2p}(i), k_T^{2p}(j)] \cdot R_{ij}^2 \qquad R_{ij}^2 = (\Delta y_{ij})^2 + (\Delta \varphi_{ij})^2$$

$\begin{cases} p = 1: \ k_T \text{ algorithm} \longrightarrow \text{area fluctuates and depend on } p_T \\ p = 0: \text{Aachen/Cambrigde algorithm} \longrightarrow \text{area fluctuates, depends less on } p_T \\ p = -1: \ \text{anti} - k_T \text{ algorithm} \longrightarrow \text{constant area (circular jets)} \end{cases}$

- Implementation: http://www.fastjet.fr

Kinematic Variables

- Effective Mass:
  - sensitive to $\sqrt{\hat{s}}$

$$M_{\text{eff}} \equiv \sum_{i=1}^{n} |\mathbf{p}_{\text{T}}^{(i)}| + E_{\text{T}}^{\text{miss}}$$

H_T

- Stransverse mass:
  - lower bound on mass of particle decaying semi-invisibly

$$m_{\text{T2}}\left(\mathbf{p}_{\text{T}}^{(1)}, \mathbf{p}_{\text{T}}^{(2)}, \not{\mathbf{p}}_{\text{T}}\right) \equiv \min_{\mathbf{q}_{\text{T}}^{(1)}+\mathbf{q}_{\text{T}}^{(2)}=\vec{E}_{\text{T}}^{\text{miss}}} \left\{\max\left(m_{\text{T}}\left(\mathbf{p}_{\text{T}}^{(1)}, \mathbf{q}_{\text{T}}^{(1)}\right), m_{\text{T}}\left(\mathbf{p}_{\text{T}}^{(2)}, \mathbf{q}_{\text{T}}^{(2)}\right)\right)\right\}$$

visible invisible

where $m_{\text{T}}^2\left(\mathbf{p}_{\text{T}}^{(i)}, \mathbf{q}_{\text{T}}^{(i)}\right) \equiv 2|\mathbf{p}_{\text{T}}^{(i)}||\mathbf{q}_{\text{T}}^{(i)}| - 2\mathbf{p}_{\text{T}}^{(i)} \cdot \mathbf{q}_{\text{T}}^{(i)}$

- Cotransverse mass:
  - useful for identical parent particles decay semi-invisibly

$$m_{\text{CT}}^2\left(j^{(1)}, j^{(2)}\right) \equiv 2E_{\text{T}}^{(1)}E_{\text{T}}^{(2)} + 2\mathbf{p}_{\text{T}}^{(1)} \cdot \mathbf{p}_{\text{T}}^{(2)}$$