Search of Dark Matter Candidates in ATLAS

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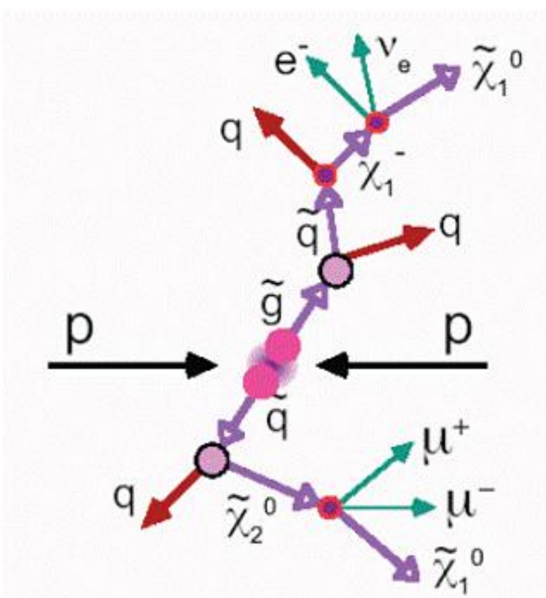
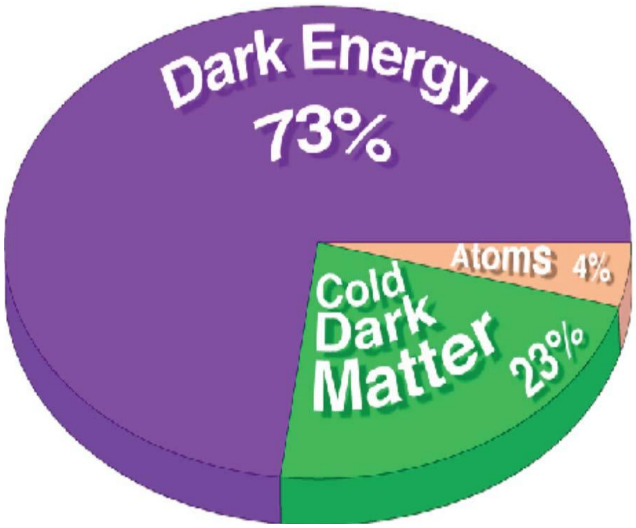
On Behalf of the ATLAS Collaboration

Beyond 2010, Cape Town



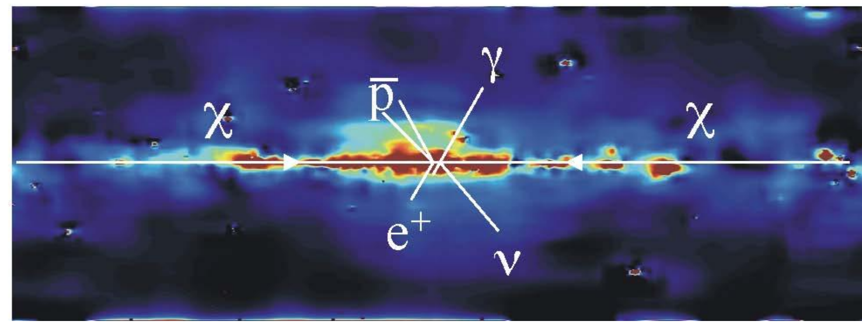
What do we know about Dark Matter

- From Astronomical observations
  - Neutral, cold, stable
  - Not baryonic, weakly interacting
  - $\rho_\chi \approx 0.3 GeV/cm^3$ $V \approx 220$ km/s
- What we would like to know?
  - Is it a fundamental particle?
  - What are its properties?
  - How does it interact?
  - What is the symmetry origin of the dark matter particle?
  - Is dark matter composed of one particle species or many?
  - How and when was it produced?



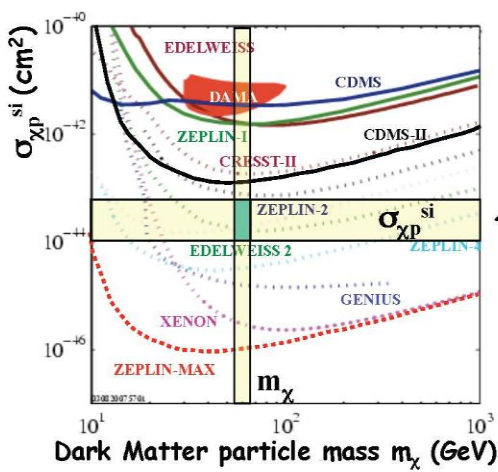
Experimental Searches for Dark Matter

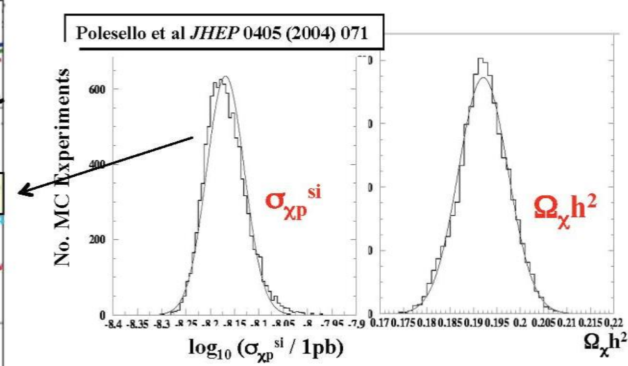
- Astrophysical experiments
  - Direct detection
  - Indirect detection
    - Long-based
    - High altitude
    - Space based



- Collider experiments (LHC)
  - Measurements are complementary to astrophysical searches
  - LHC discovery of new physics, such as SUSY, and measurements of the underlying model parameters.
    - Compare to DM hypothesis
    - Predict Dark Matter

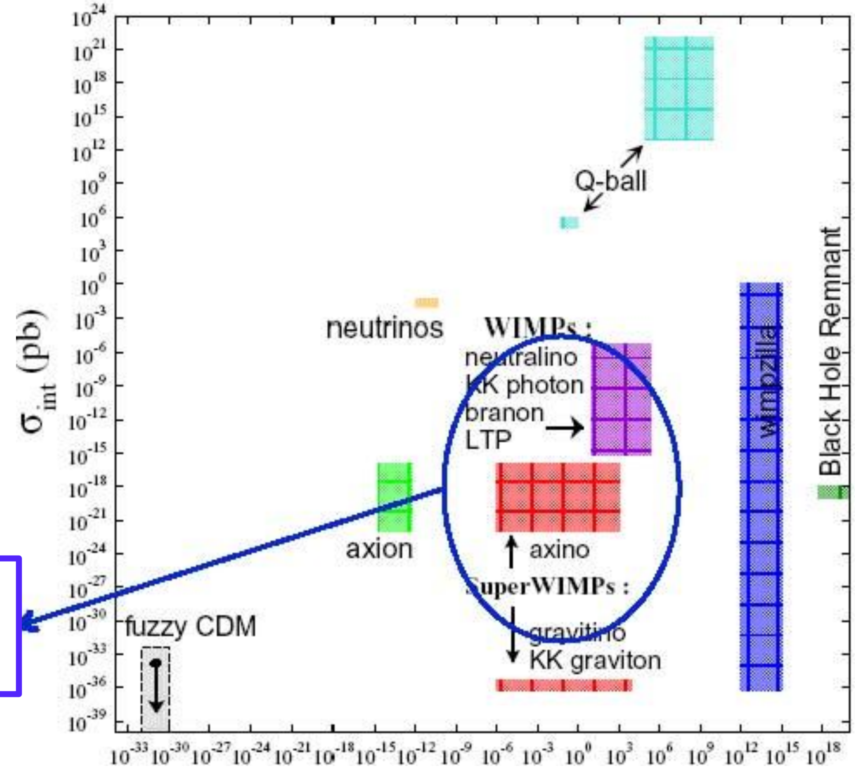
parameters $\Omega_\chi h^2$, m_χ, $\sigma_{\chi p}^{Si}$ etc.
compare with astrophysics data





Nature of Dark Matter?

- Constraints from experimental observations were no match to theorists imagination.
- Variations of models, but not all of them are equally motivated

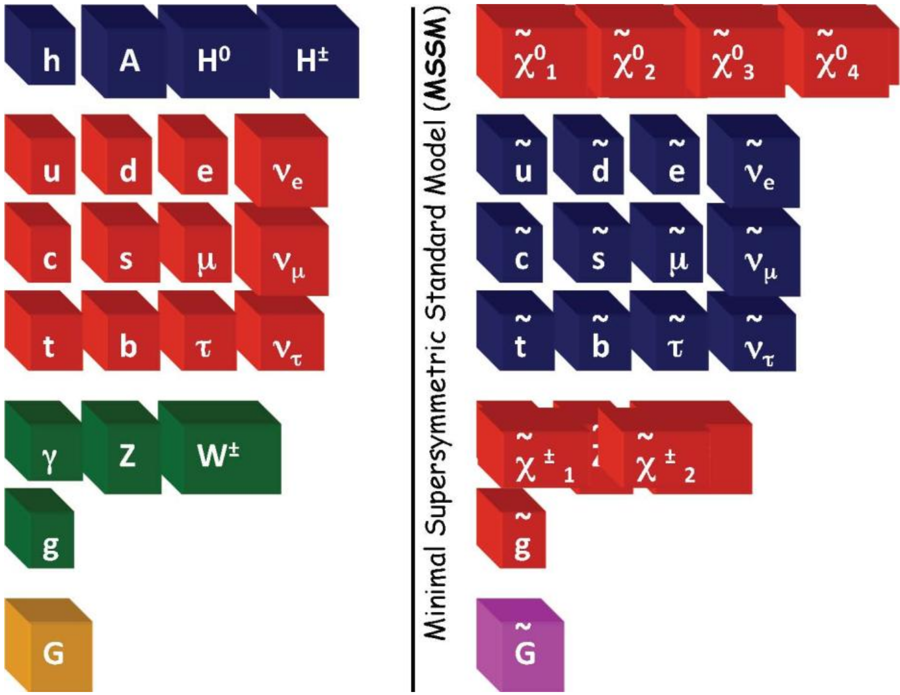


Wimps and SuperWimps could be produced
In colliders

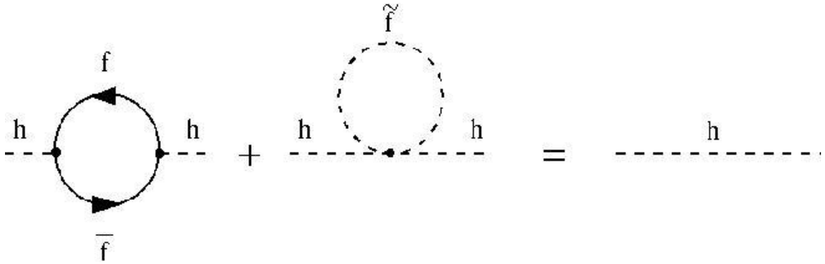
- WIMPS could be the ideal DM candidates
  - Naturally produced in many models like SUSY, extra-dimension, little Higgs…
  - Gives naturally the correct Dark Matter relic density
    - Amount of remaining dark matter is inversely proportional to its annihilation cross section: $\Omega_{DM} \sim \ <\sigma v>^{-1} \sim 0.1$

SUPERSYMMETRY

- Well motivated extension to the Standard Model. Introduces fundamental continuous fermions-boson symmetry
  - SM particle have supersymmetric partners, differ by spin ½
  - Sparticles should have the same mass as SM particles:
    - Not observed! SUSY must be a broken symmetry at low energy



- SUSY stabilizes Higgs mass against large loop correction
  - Predict Higgs mass ≤ 135GeV

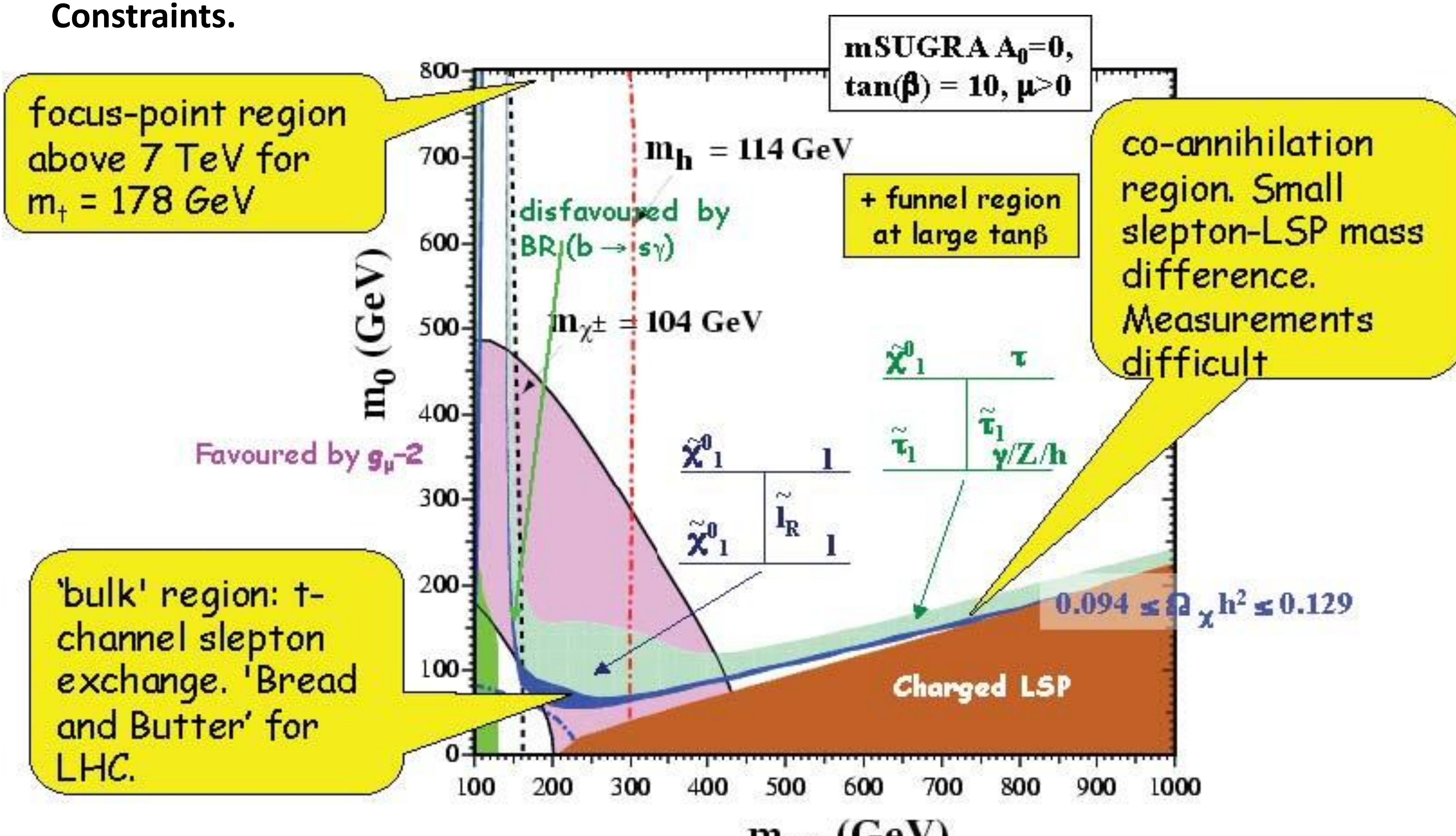


SUSY and Dark Matter

- R-parity conservation introduced to avoid proton decay:
  - Sparticles are produced in pairs.
  - Lightest Supersymmetric Particle (LSP) is absolutely stable
- LSP is a neutral, weakly interacting massive particle (WIMP)
  - Good candidate for Dark Matter
- Which LSP depends on the point of the parameter space
  - LSP could be Neutralino (WIMP), Gravitino (SuperWIMP)
- mSUGRA
  - SUSY masses unify at GUT-scale m_0, $m_{1/2}$
  - $\tan\beta$, A_0, sign(μ)
  - Neutralino LSP
- Four regions with $\Omega_{NEUTRALINO} \approx \Omega_{DM}$ due to enhanced annihilation in early universe

mSUGRA parameter space

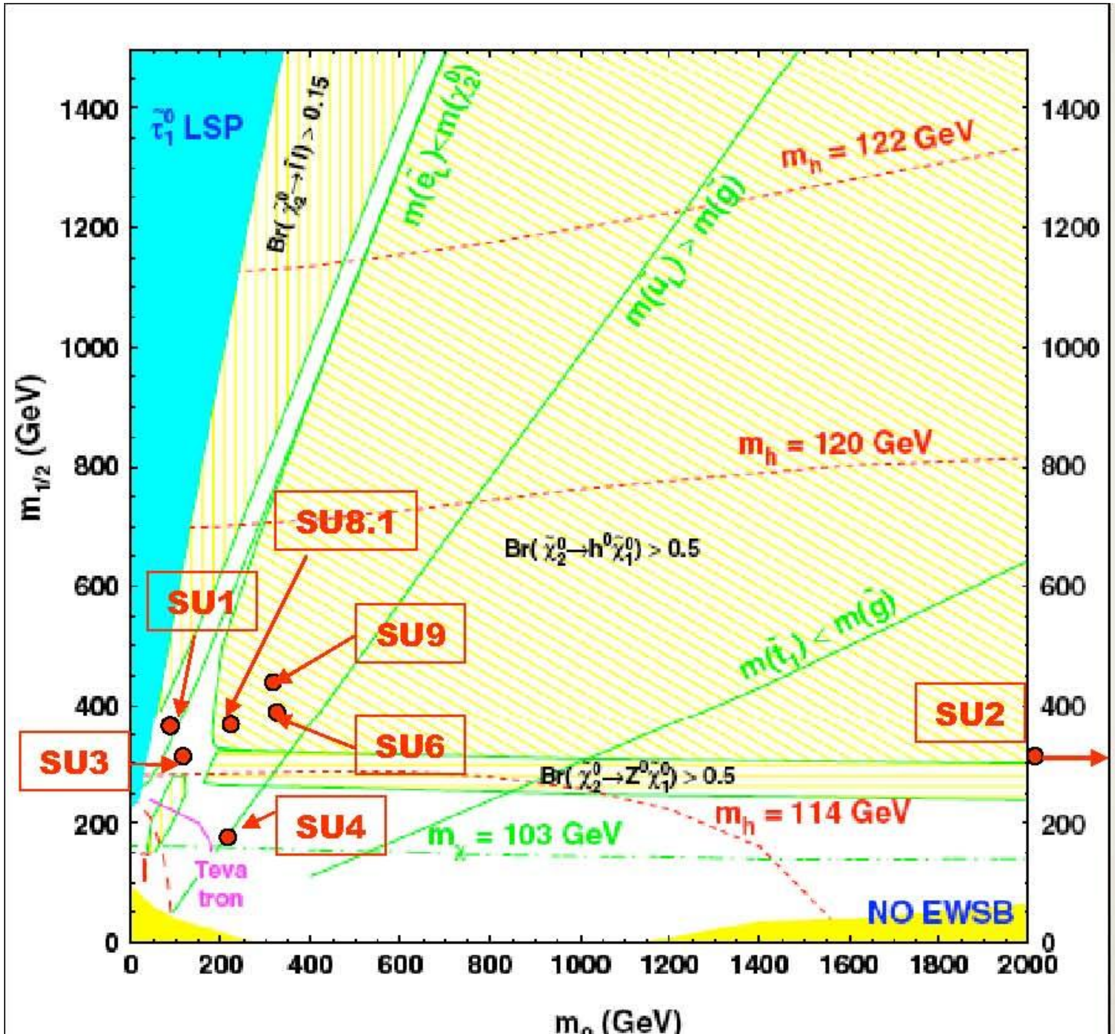
Within mSUGRA parameter space, only few regions are compatibles with experimental Constraints.



(Ellis et al., Phys. B565 (2003))

ATLAS Benchmark Points for mSUGRA

Exclusion regions for A_0 = 0, μ > 0, tanβ = 10



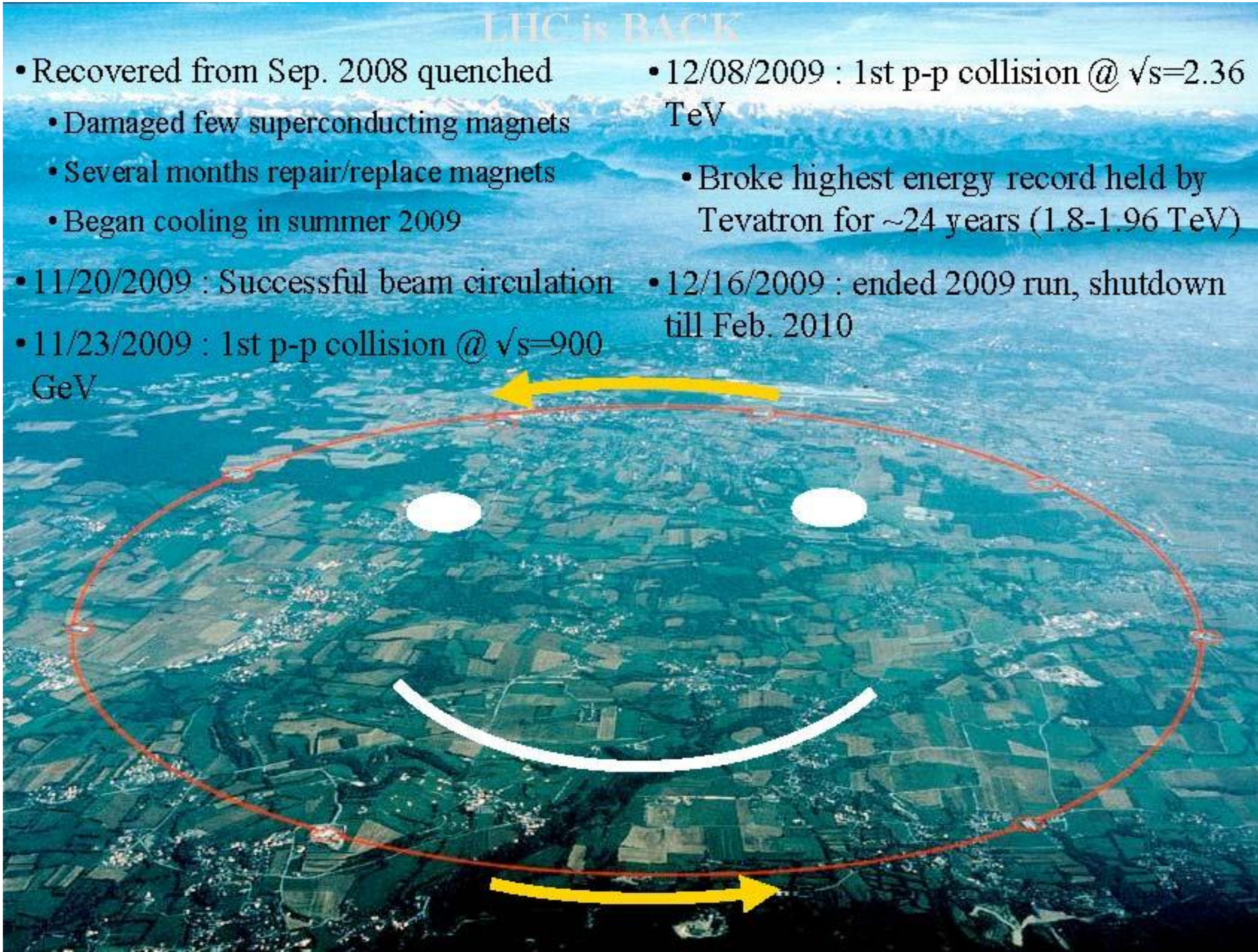
	M_0 [GeV]	$M_{1/2}$ [GeV]	A_0 [GeV]	$\tan\beta$	$\arg\mu$	σ_{LO} [pb]
SU1	70	350	0	10	+	8.15
SU2	3550	300	0	10	+	5.17
SU3	100	300	-300	6	+	20.85
SU4	200	160	-400	10	+	294.46
SU6	320	375	0	50	+	4.47
SU8.1	210	360	0	40	+	6.48

Particle	SU1	SU2	SU3	SU4	SU6	SU8.1	SU9
$\tilde{d}_L$	764.90	3564.13	636.27	419.84	870.79	801.16	956.07
$\tilde{u}_L$	760.42	3563.24	631.51	412.25	866.84	797.09	952.47
$\tilde{b}_1$	697.90	2924.80	575.23	358.49	716.83	690.31	868.06
$\tilde{t}_1$	572.96	2131.11	424.12	206.04	641.61	603.65	725.03
$\tilde{d}_R$	733.53	3576.13	610.69	406.22	840.21	771.91	920.83
$\tilde{u}_R$	735.41	3574.18	611.81	404.92	842.16	773.69	923.49
$\tilde{b}_2$	722.87	3500.55	610.73	399.18	779.42	743.09	910.76
$\tilde{t}_2$	749.46	2935.36	650.50	445.00	797.99	766.21	911.20
$\tilde{e}_L$	255.13	3547.50	230.45	231.94	411.89	325.44	417.21
$\tilde{\nu}_e$	238.31	3546.32	216.96	217.92	401.89	315.29	407.91
$\tilde{\tau}_1$	146.50	3519.62	149.99	200.50	181.31	151.90	320.22
$\tilde{\nu}_\tau$	237.56	3532.27	216.29	215.53	358.26	296.98	401.08
$\tilde{e}_R$	154.06	3547.46	155.45	212.88	351.10	253.35	340.86
$\tilde{\tau}_2$	256.98	3533.69	232.17	236.04	392.58	331.34	416.43
$\tilde{g}$	832.33	856.59	717.46	413.37	894.70	856.45	999.30
$\tilde{\chi}_1^0$	136.98	103.35	117.91	59.84	149.57	142.45	173.31
$\tilde{\chi}_2^0$	263.64	160.37	218.60	113.48	287.97	273.95	325.39
$\tilde{\chi}_3^0$	466.44	179.76	463.99	308.94	477.23	463.55	520.62
$\tilde{\chi}_4^0$	483.30	294.90	480.59	327.76	492.23	479.01	536.89
$\tilde{\chi}_1^+$	262.06	149.42	218.33	113.22	288.29	274.30	326.00
$\tilde{\chi}_2^+$	483.62	286.81	480.16	326.59	492.42	479.22	536.81
h^0	115.81	119.01	114.83	113.98	116.85	116.69	114.45
H^0	515.99	3529.74	512.86	370.47	388.92	430.49	632.77
A^0	512.39	3506.62	511.53	368.18	386.47	427.74	628.60
H^+	521.90	3530.61	518.15	378.90	401.15	440.23	638.88
t	175.00	175.00	175.00	175.00	175.00	175.00	175.00

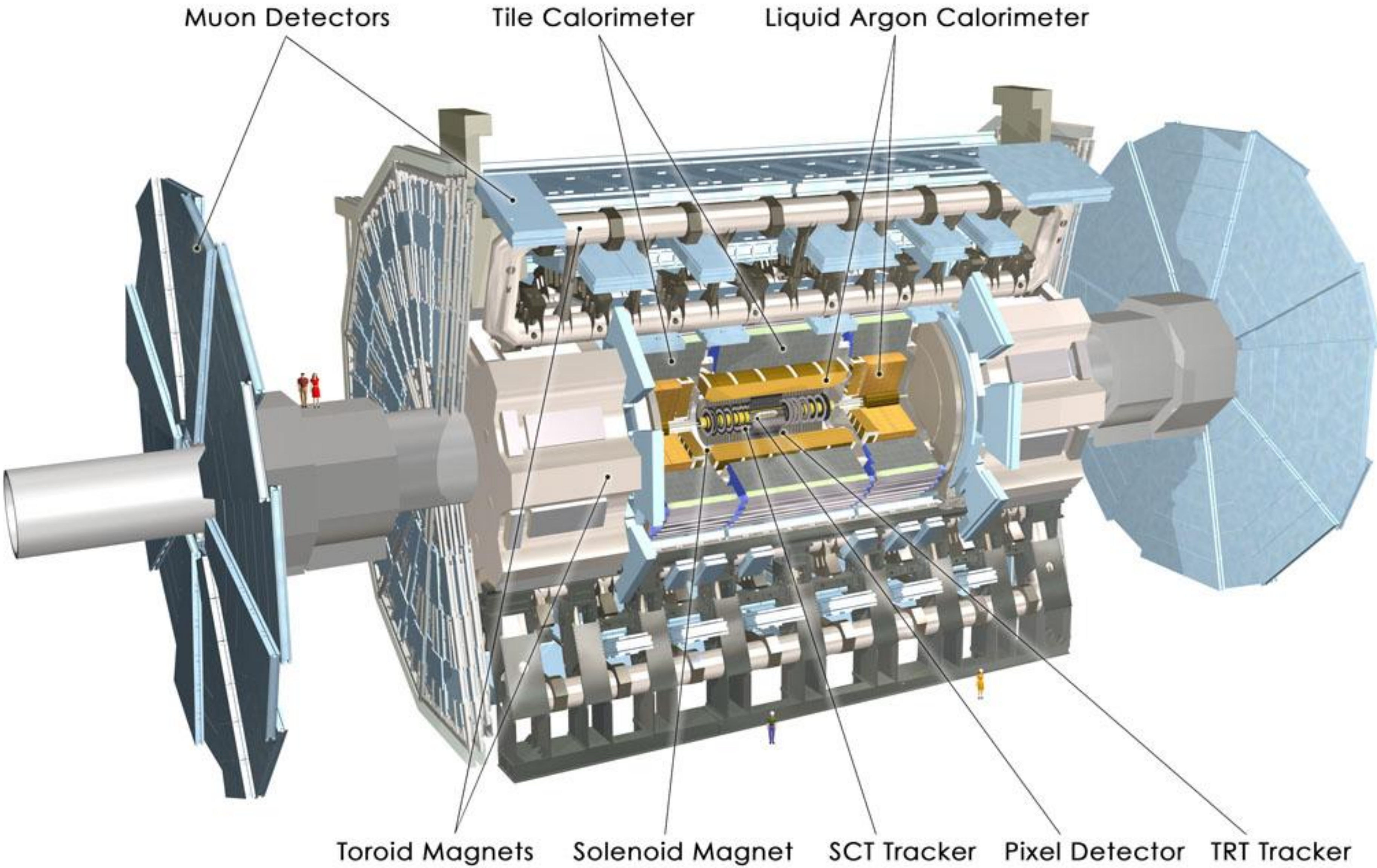
The LHC and the ATLAS detector

- Large Hadron Collider Design parameters
- p-p beam @ 14 TeV CM energy
- Luminosity 10^{33}-$10^{34}cm^{-2}s^{-1}$
- Bunch crossing rate 40 MHz
- Events per bunch crossing ~20
- L_{int} = $10fb^{-1}$ – $100fb^{-1}$ /year

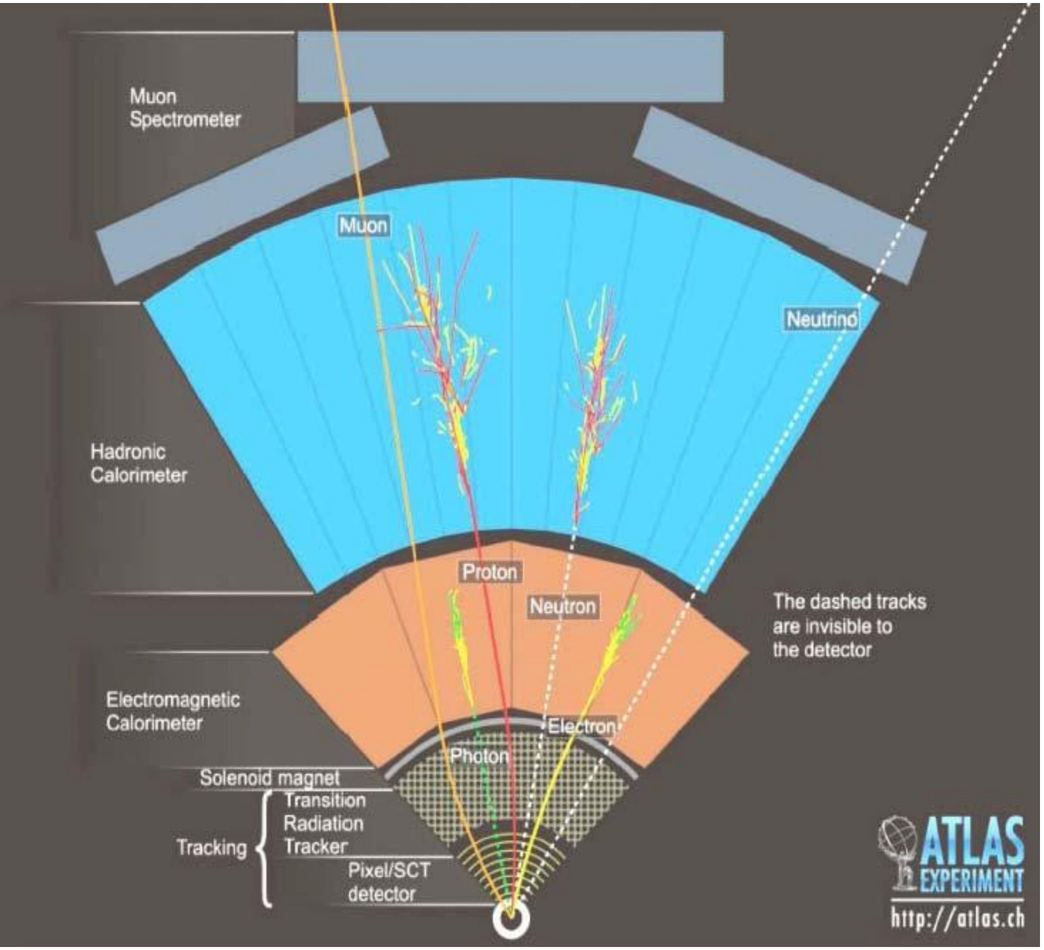
LHC is back!!!


LHC is BACK
• Recovered from Sep. 2008 quenched
• Damaged few superconducting magnets
• Several months repair/replace magnets
• Began cooling in summer 2009
• 11/20/2009 : Successful beam circulation
• 11/23/2009 : 1st p-p collision @ √s=900 GeV
• 12/08/2009 : 1st p-p collision @ √s=2.36 TeV
• Broke highest energy record held by Tevatron for ~24 years (1.8-1.96 TeV)
• 12/16/2009 : ended 2009 run, shutdown till Feb. 2010

The ATLAS detector



The ATLAS detector



- Precise tracking:
  - Charged particles
  - Vertex reconstruction
- Electomagnetic calorimeter
  - electron/photon identification
- Hadronic +EM calorimetry
  - Jets
  - Missing transverse energy (MET)
- Muon Spectomer
  - Standalome muon identification
- Full 4π coverage, but longitudinal boost unknown. Only transverse momentum is conserved.
- Some variable used for SUSY/DM analysis

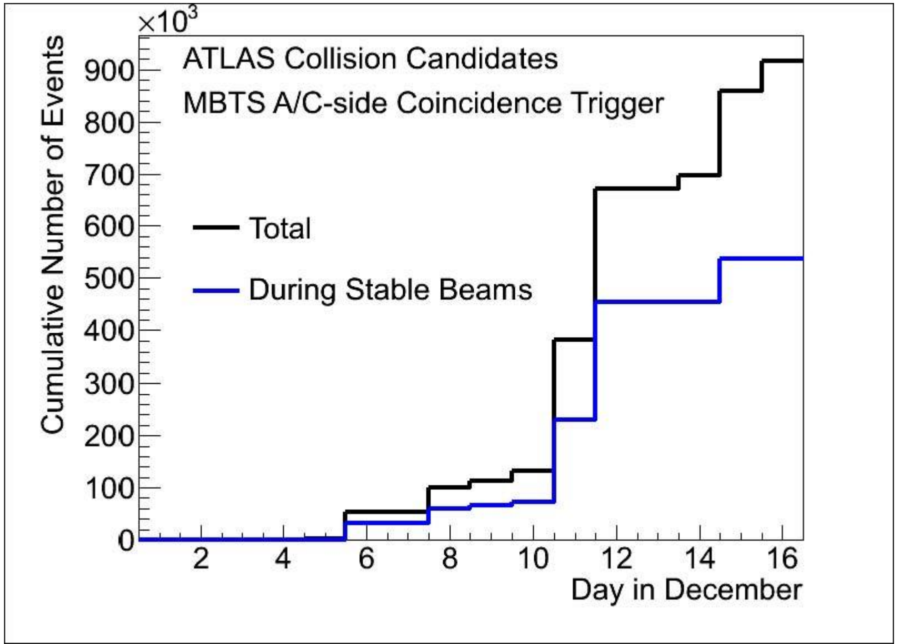
$$M_{\mathrm{eff}} \equiv \sum_{i=1}^{4} p_T^{\mathrm{jet},i} + \sum_{i=1} p_T^{\mathrm{lep},i} + E_{\mathrm{T}}^{\mathrm{miss}} \qquad S_T \equiv \frac{2\lambda_2}{(\lambda_1+\lambda_2)} \quad S_{ij} = \Sigma_k p_{ki} p^{kj}$$

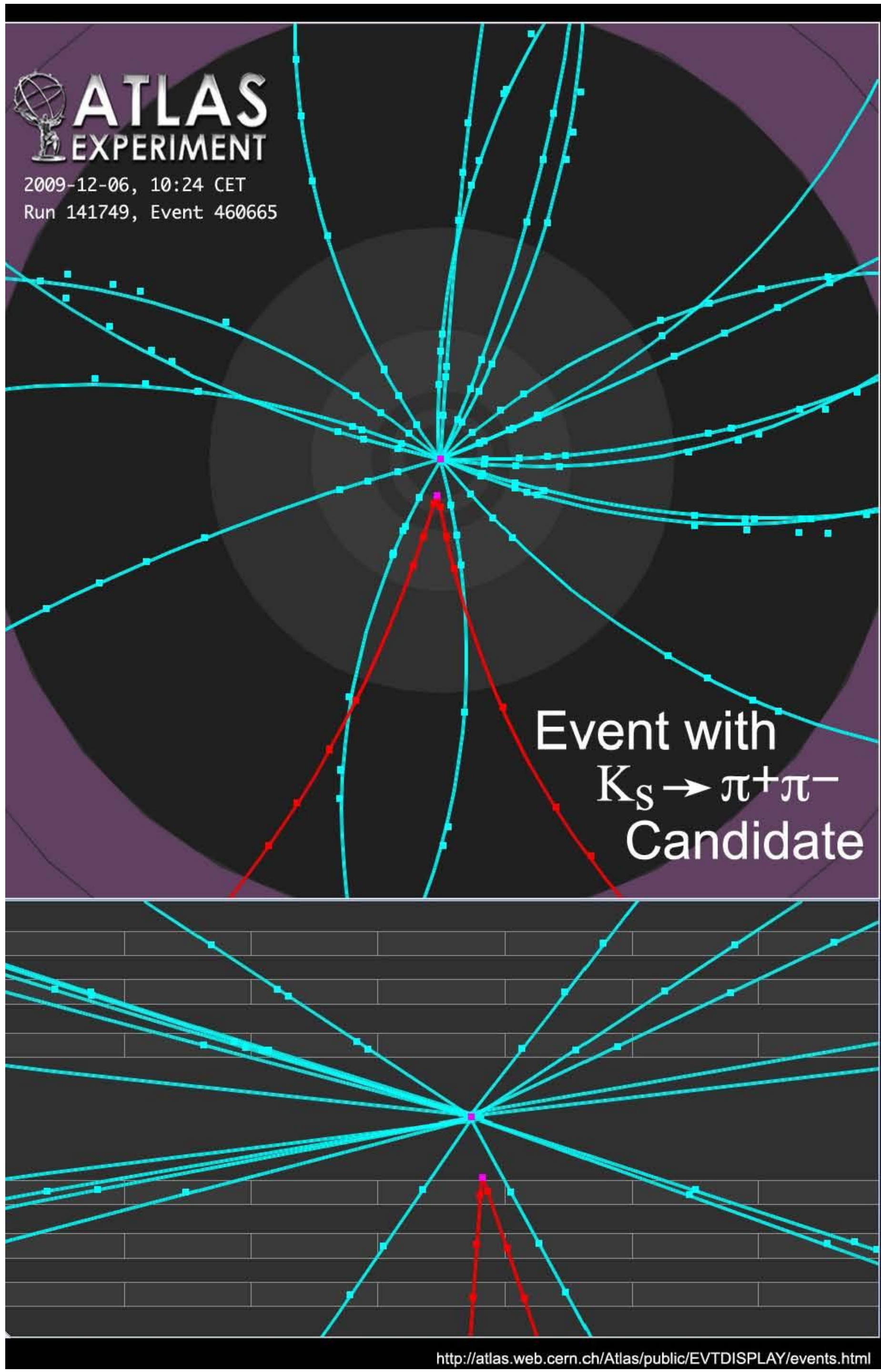
$$M_T^2(\mathbf{p}_T^{\alpha}, \mathbf{p}_T^{\mathrm{miss}}, m_\alpha, m_\chi) \equiv m_\alpha^2 + m_\chi^2 + 2\left(E_T^{\alpha} E_T^{\mathrm{miss}} - \mathbf{p}_T^{\alpha} \cdot \mathbf{p}_T^{\mathrm{miss}}\right)$$

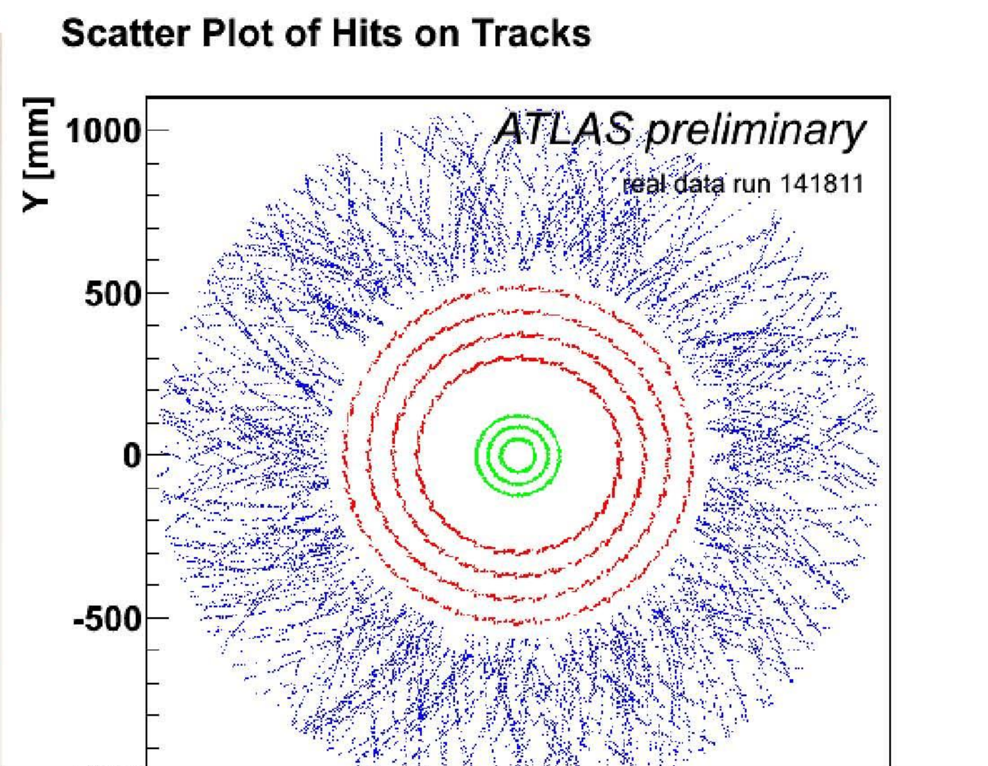
The ATLAS detector with first LHC data

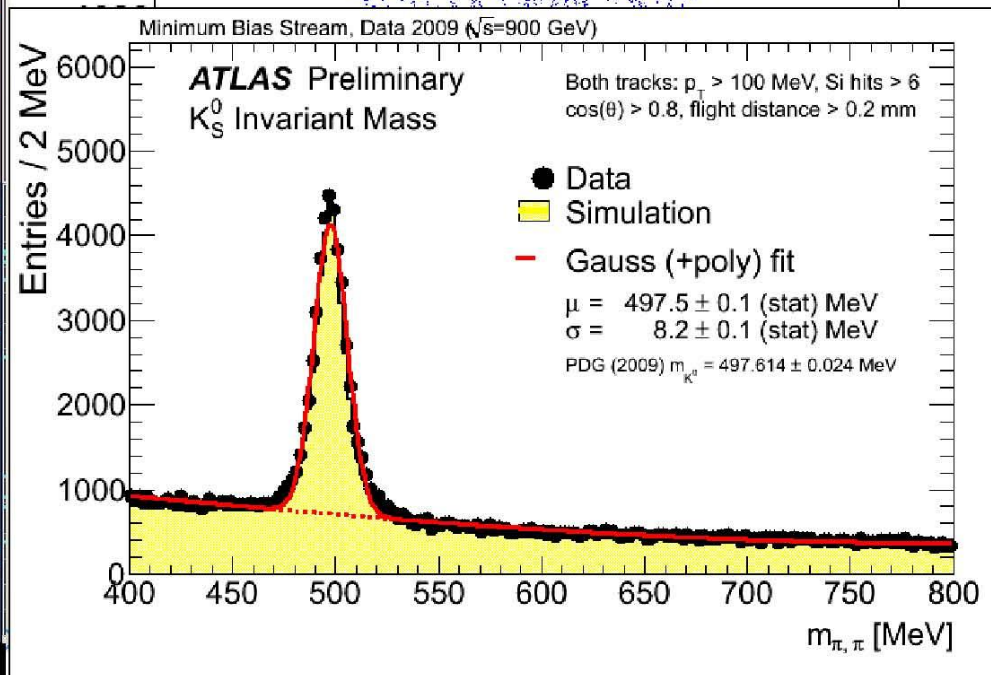
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.9%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	98.2%
LAr EM Calorimeter	170 k	98.8%
Tile calorimeter	9800	99.2%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.4%
RPC Barrel Muon Trigger	370 k	98.5%
TGC Endcap Muon Trigger	320 k	99.4%
LVL1 Calo trigger	7160	99.8%

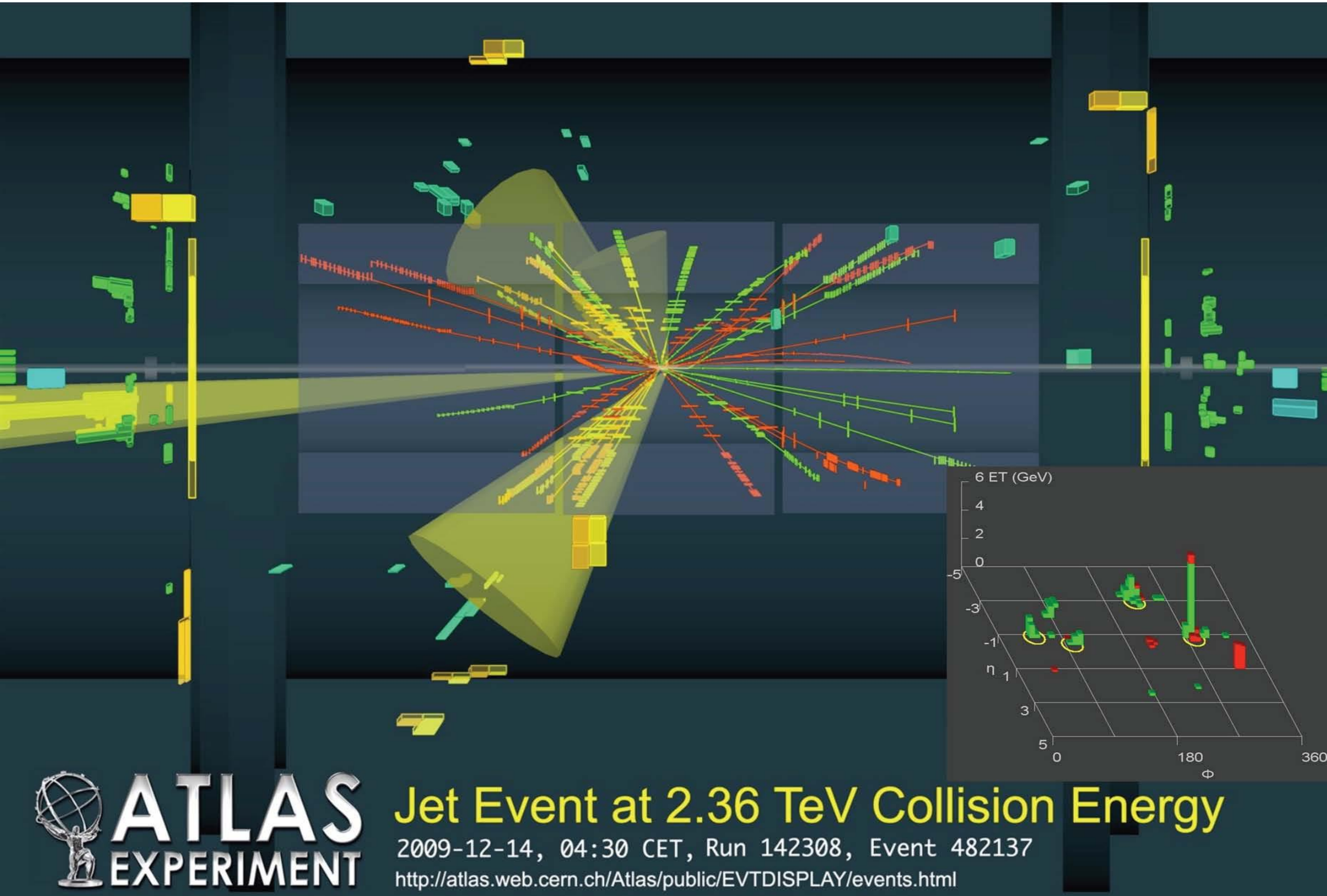
- ~98-100% operational
- Tracking system (pixel, SCT, TRT) fully operational when stable beam
- Peak instantaneous Luminosity 7×10^{26} cm^2s^{-1}
- Average data taking efficiency ~ 90%
- Collected luminosity ~20 μb^{-1} (~ 12 μb^{-1} during stable beam)



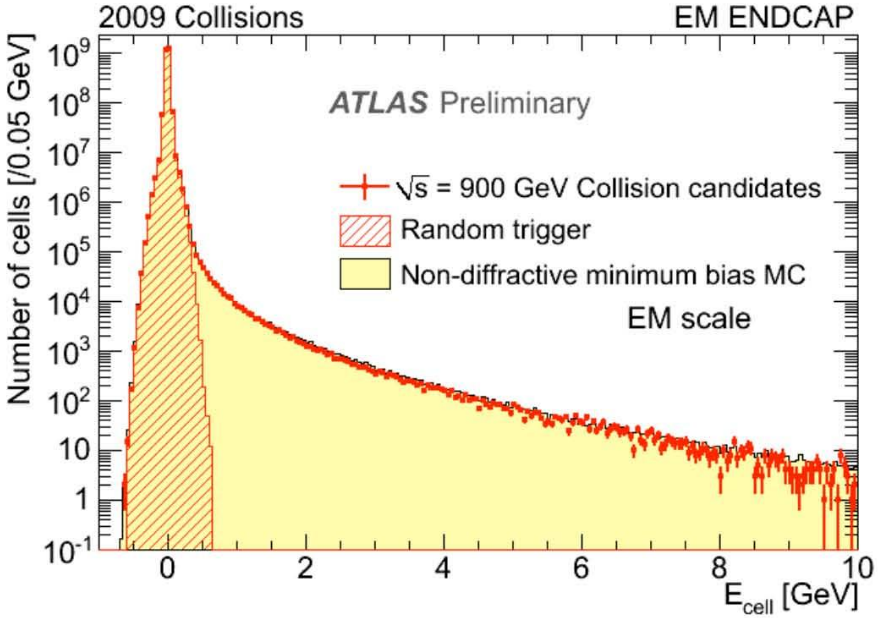

ATLAS EXPERIMENT
2009-12-06, 10:24 CET
Run 141749, Event 460665
Event with
$K_S \rightarrow \pi^+\pi^-$
Candidate
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

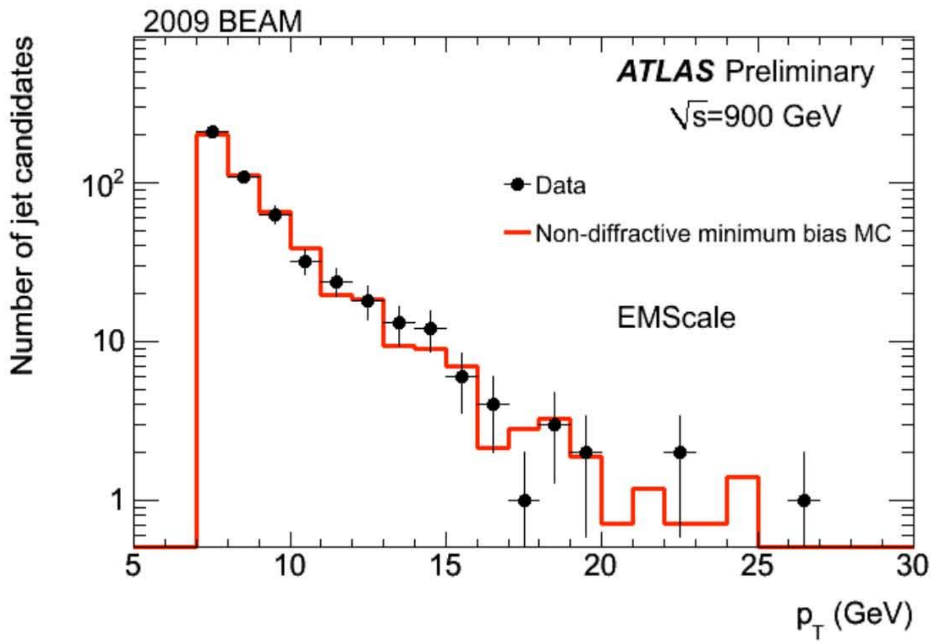

Scatter Plot of Hits on Tracks
ATLAS preliminary
real data run 141811
Y [mm]
1000
500
0
-500

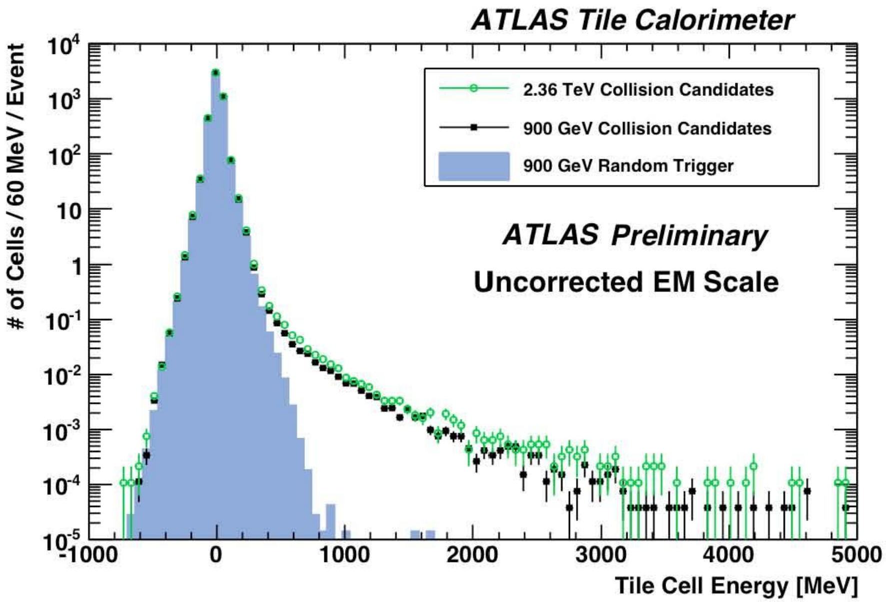

Minimum Bias Stream, Data 2009 ($\sqrt{s}$=900 GeV)
ATLAS Preliminary
K^0_S Invariant Mass
Both tracks: p_T > 100 MeV, Si hits > 6
cos(θ) > 0.8, flight distance > 0.2 mm
Data
Simulation
Gauss (+poly) fit
μ = 497.5 ± 0.1 (stat) MeV
σ = 8.2 ± 0.1 (stat) MeV
PDG (2009) m_{K^0} = 497.614 ± 0.024 MeV
Entries / 2 MeV
0
1000
2000
3000
4000
5000
6000
400
450
500
550
600
650
700
750
800
$m_{\pi,\pi}$ [MeV]

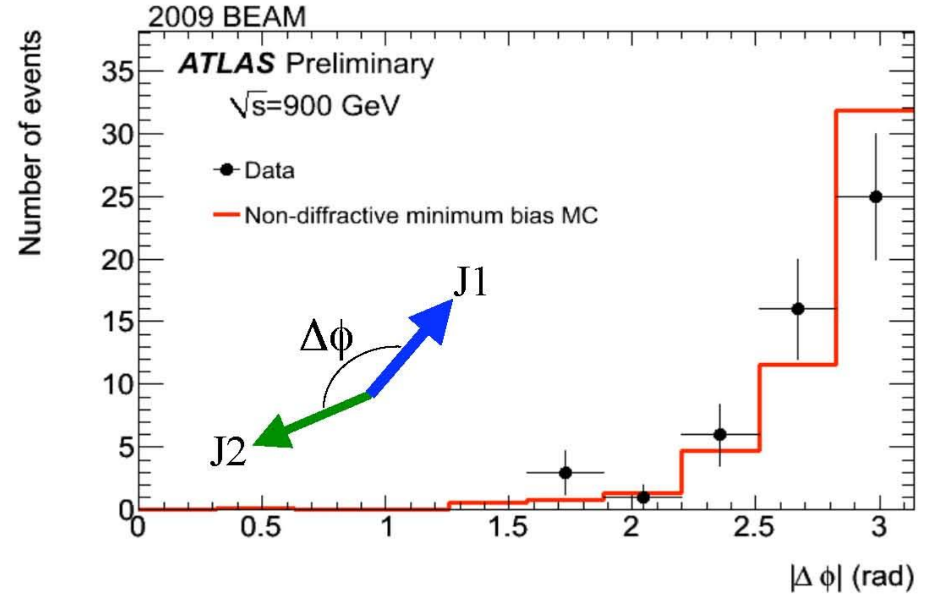

6 ET (GeV)
4
2
0
-5
-3
-1
η
1
3
5
0
180
360
Φ
ATLAS EXPERIMENT
Jet Event at 2.36 TeV Collision Energy
2009-12-14, 04:30 CET, Run 142308, Event 482137
http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

ATLAS Calorimeters response

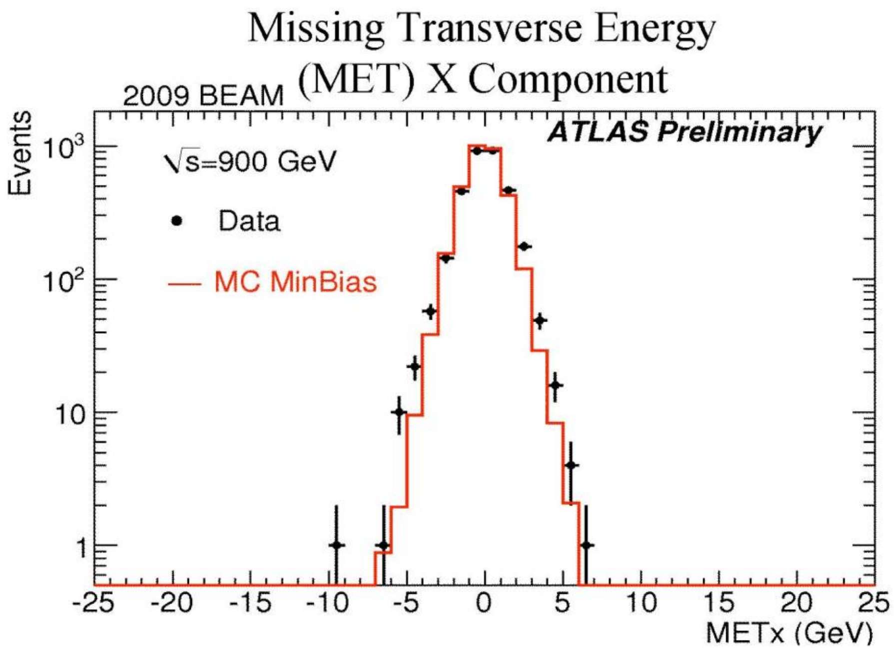


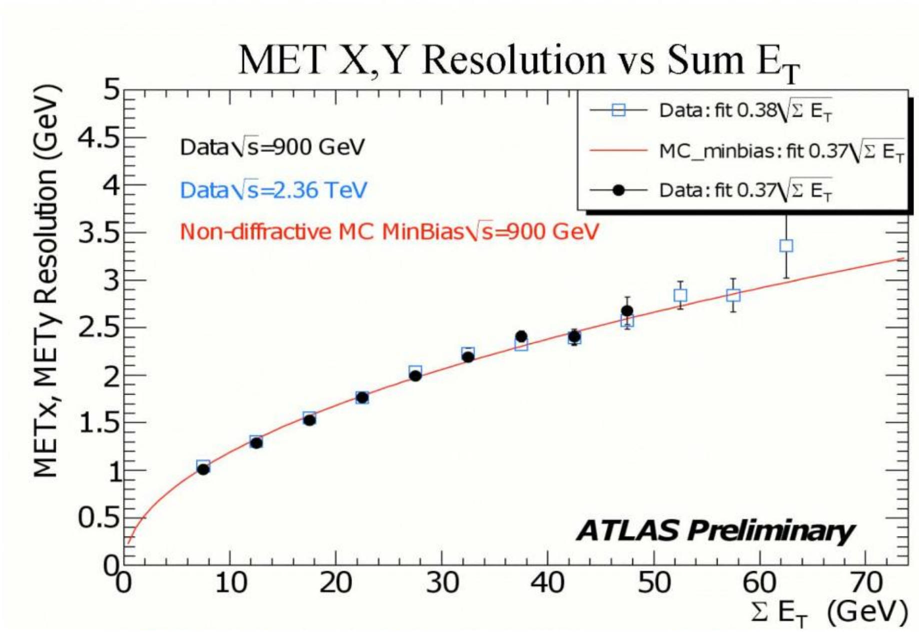


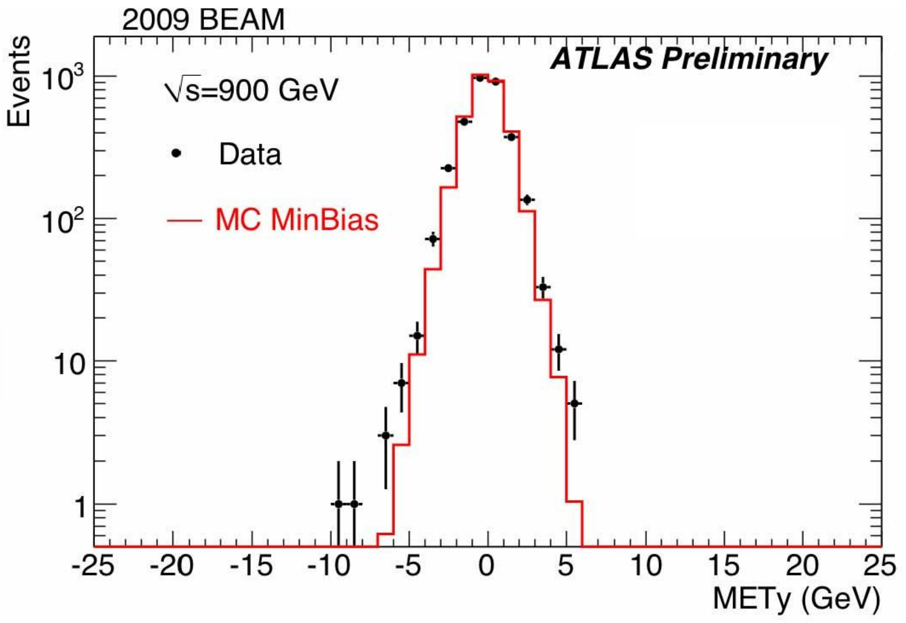




Missing Transverse Energy







- Sensitive to calorimeter performance (noise, coherent noise, dead cells, mis-calibrations, cracks, etc.) and backgrounds from cosmics, beams, …
- Measurement over full calorimeter coverage (3600 in ϕ, $|\eta| < 5$, ~ 200000 cells)

SUSY / Dark Matter searches with ATLAS

SUSY / Dark Matter Search Strategy

1. Look for deviation from SM predictions, e.g. jets + MET
2. Is it SUSY? If so establish the SUSY mass scale using inclusive variables, e.g. effective mass distribution.

   Relevance to Dark Matter:

   – Inclusive studies: Verify if the discovered signal provides a possible Dark Matter candidate
   – Exclusive studies: Model-independent calculation of LSP mass, compare to observation
3. Which SUSY flavor? Determine model parameters. Needs high luminosity.

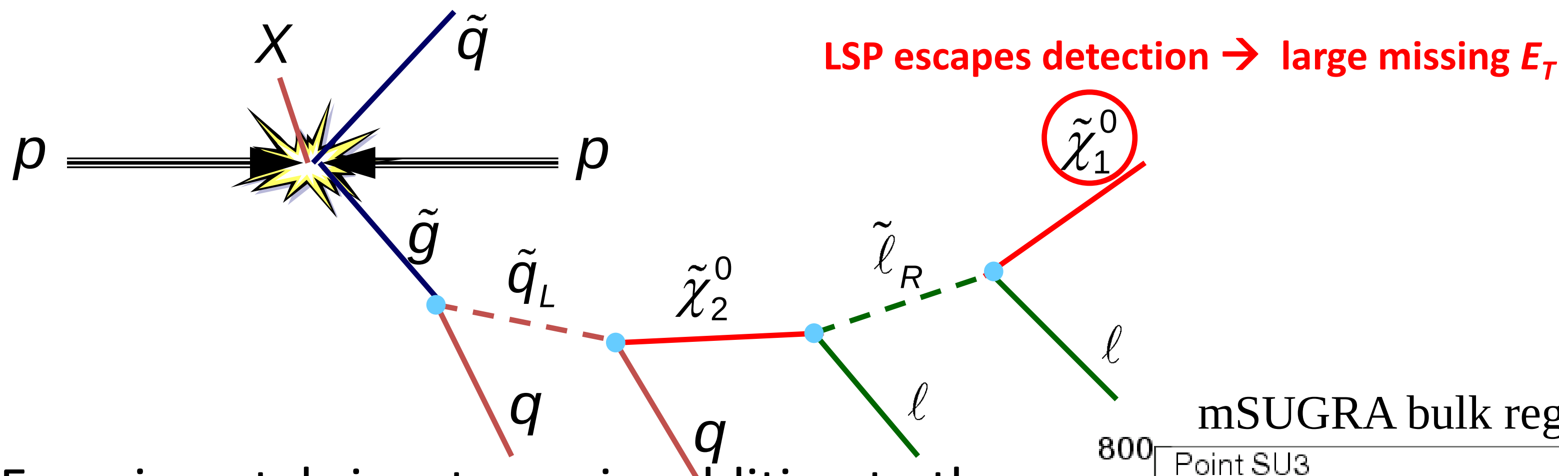
   Strategy: select particular decay chains and use kinematics to determine mass combination

   Relevance to Dark Matter

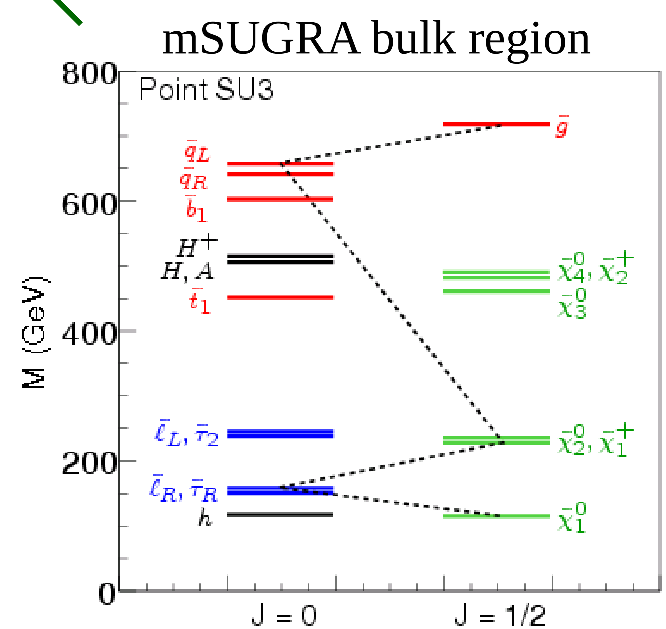
   – model-dependent calculation of relic density, $\sigma(\chi p^{si})$, etc

SUSY Signatures

- Consider only R-Parity conserving models
- Long decay chain down to LSPs and large mass differences between SUSY states. Many high-pT objects (jets, leptons, b-jets)



- Experimental signatures, in addition to the large MET from the escaping LSP:
  - 0 leptons, 1 lepton and di-leptons (SS and OS) analyses with MET and >=N jets, where N=2,3,4
  - tri-lepton + MET
  - tri-lepton + jets,
  - tau + jets +MET
  - b-jets + light jets + MET analyses.



Inclusive Searches: 0 leptons mode

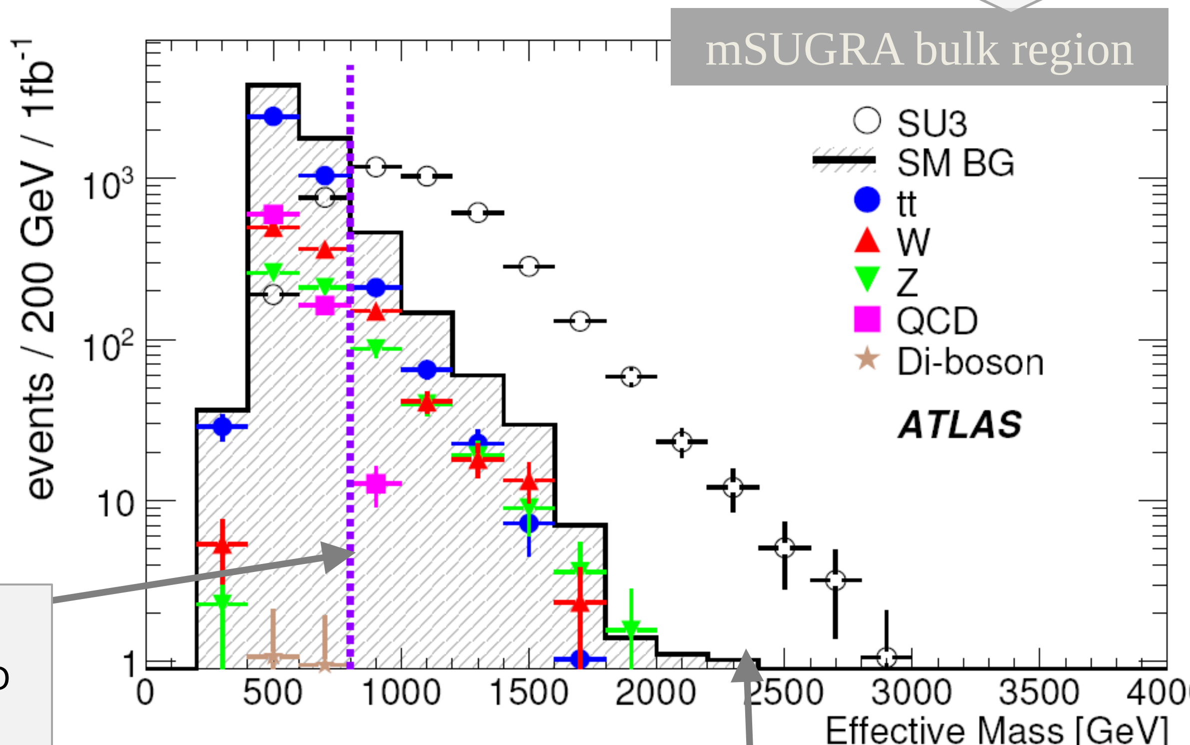
- SUSY signature: Missing E_T + 4 high-p_T jets + 0 isolated leptons (e, μ)
- Sensitive variable to detect SUSY is the "effective mass"

$$M_{eff} = \Sigma|p_T^i| + E_T^{miss}$$

Detailed event selection:

- Hardest Jets p_T>100 GeV
- Jets 2,3,4 with p_T> 50 GeV
- E_T^{MISS} > 100 GeV
- E_T^{MISS} > 0.2 Meff
- Transverse Sphericity > 0.2
- min $\Delta\phi(jet^i, E_T^{MISS})$ > 0.2
- veto isolated leptons

One of several SUSY benchmark points



Events with several hard, (often miss-measured) QCD jets: Monte Carlo large systematic uncertainties

Excess at large $M_{effective}$ potential discovery of SUSY

Main SM backgrounds: t-tbar, W(lν)+jets, Z(νν)+jets, QCD jets

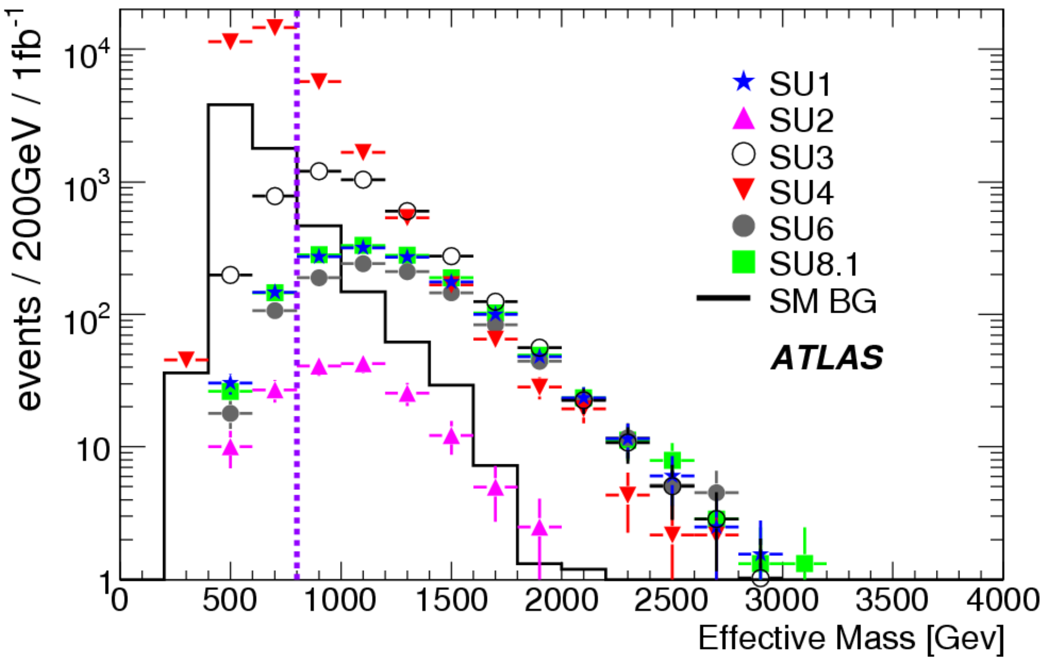
- Very Good S/B ≈ 6430 / 1210 for L=1fb^{-1}
- Many (difficult) background contributions to control

Inclusive Searches: 1 lepton mode

SUSY signature: Missing E_T + 4 high-p_T jets + 1 isolated leptons (e, μ)

Detailed event selection:

- Hardest Jets p_T>100 GeV
- Jets 2,3,4 with p_T> 50 GeV
- E_T^{MISS} > 100 GeV
- E_T^{MISS} > 0.2 Meff
- Transverse Sphericity > 0.2
- **Transverse Mass (l, E_T^{MISS}) > 100 GeV**
- **Exactly 1 isolated lepton p_T>20 GeV**



Other inclusive Search channels considered:

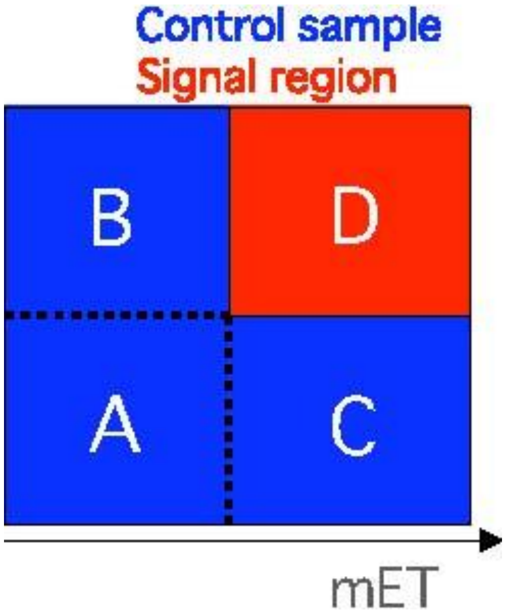
- Relax N jets from 4 to 3 or 2 …
- 2 lepton same sign, opposite sign
- 3 leptons + jet (no E_T^{MISS} !)
- 3 leptons + E_T^{MISS} (no jets !)
- Tau mode: e, μ replaced by hadronically decaying τ, can dominate over e, μ (high tanβ)
- B-jet mode: exploit SUSY's richness in b-jets

Main SM background: t-tbar, W(lν)+jets

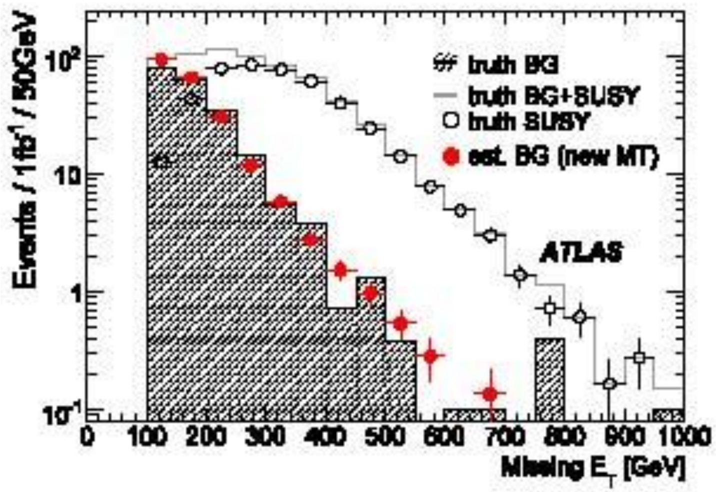
- Very Good S/B ≈ 230 / 40 for L=1fb^{-1}
- More robust (QCD less critical here)

Background Estimation

- Aim is to understand SM backgrounds using data
- Data-driven techniques relies on:
  - Excellent undestanding of detector effects
  - Defining control samples (regions) where signals are suppressed but are still representative of SM background(s).
  - Defining independent variables (usually 2) to parameterize these regions
  - Different techniques, depending on the considered background. analysis.
- Example: Side bands techniques:
  - **D = BxC / A**
  - **Example: top/W background for 1-lepton mode**

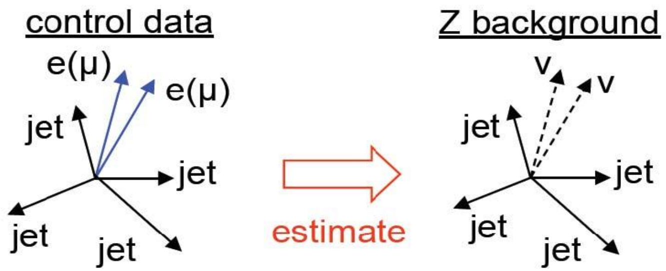


- MT (lepton, MET)
- Control: M_T<100 GeV
- Signal: M_T>100 GeV
- Normalization region: 100 GeV<MET<150 GeV

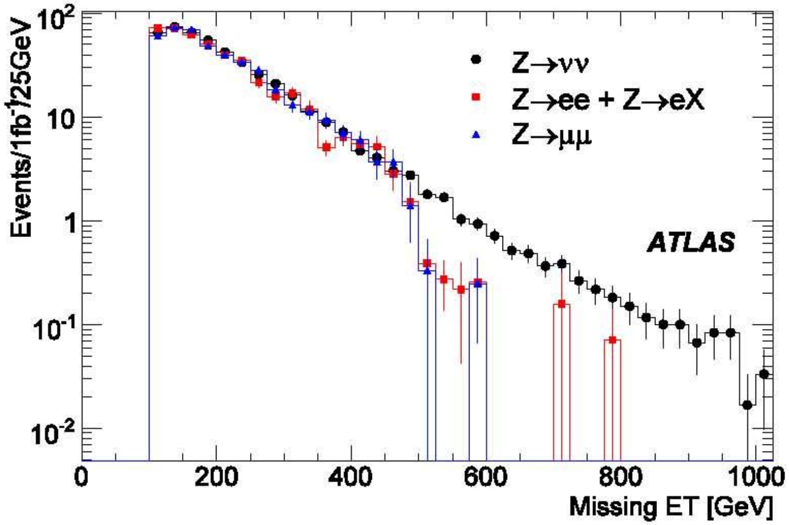


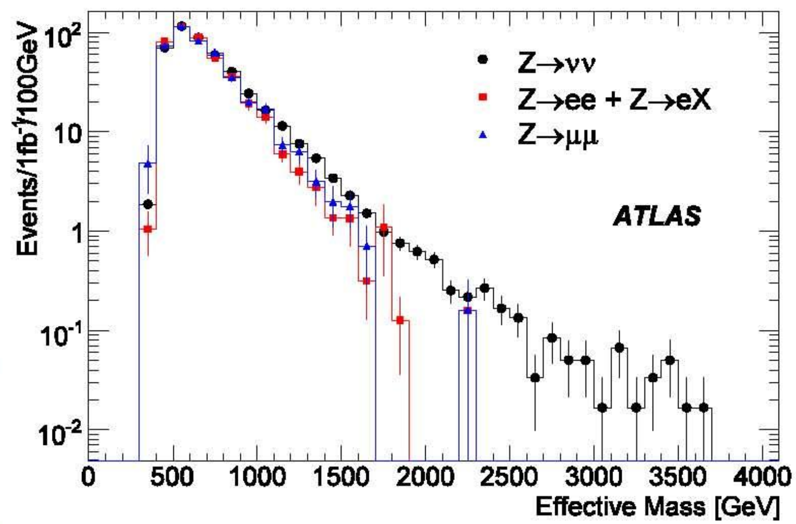
Example: Z $\rightarrow \nu\nu$ estimation for 0 leptons mode

- Measure Z $\rightarrow$ll from data, replace charged leptons with neutrinos.



- Use standard selections for 0leptons mode with pT(l^+l^-) substitution for MET.
- Shape fit of SM + generic signal PDFs to E_T^{MISS}, $M_{effective}$, Σjet-p_T
- Acceptance (η,p_T) and BR corrections must be applied.



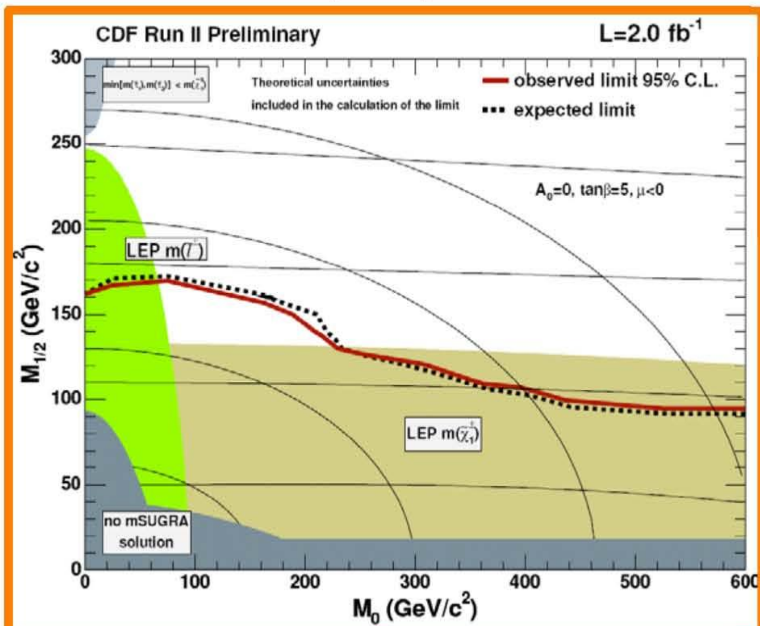


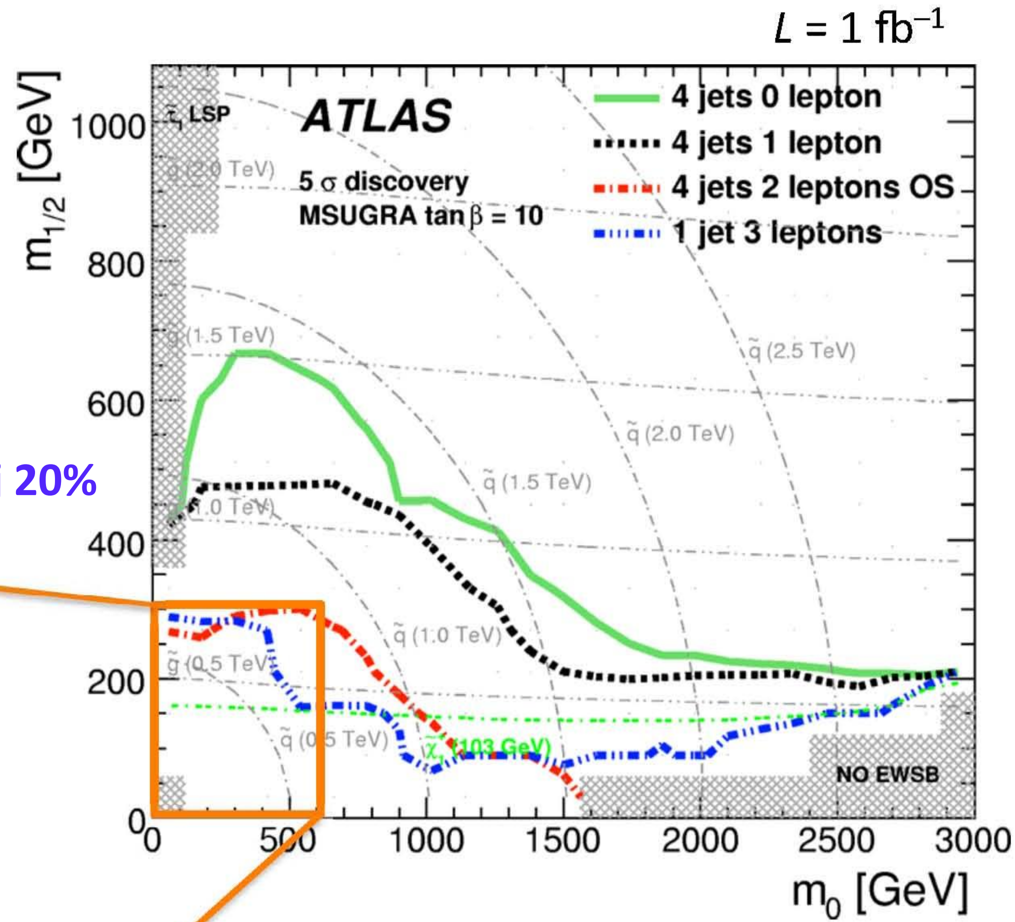
ATLAS Discovery Reach

- mSUGRA parameter scan
- Fast detector simulation to interpolate between the fully simulated 'SU' benchmark points
- Best sensitivity in 0 lepton + jets + missing E_T channel (despite more background than the others)
- Initial discovery channel: 1 lepton + jets + missing E_T
  - less QCD background, which will take time to understand

Assumed uncertainties: QCD 50%, tt, V+j 20%

Tevatron reach (CDF)

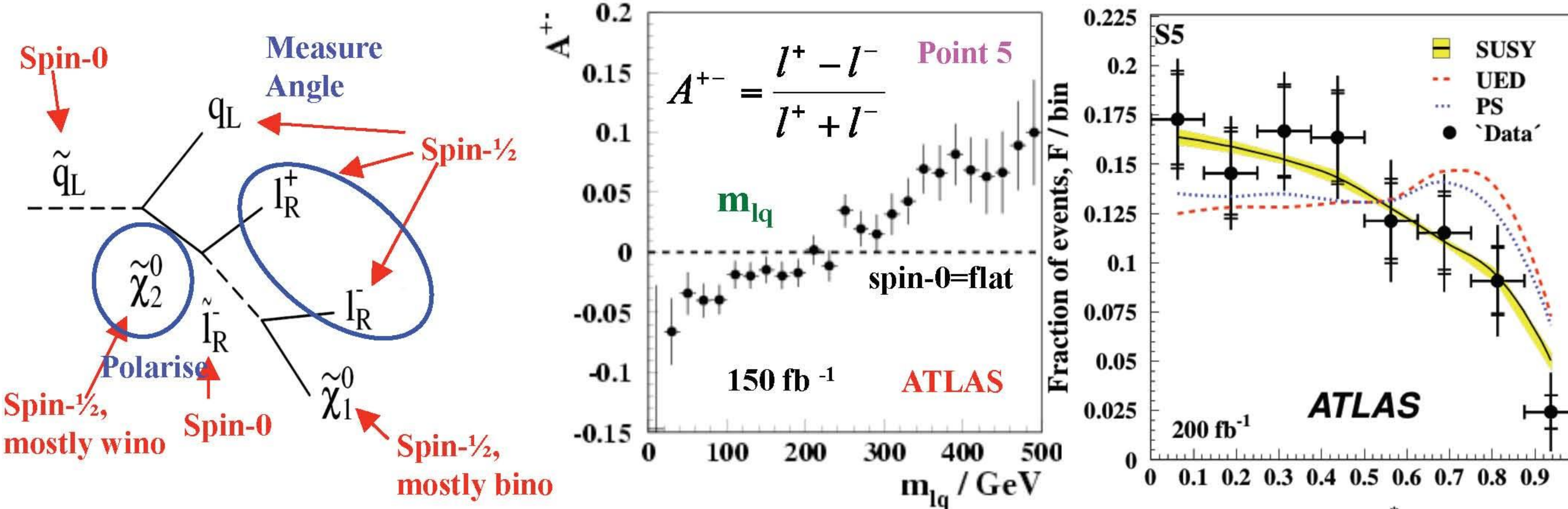




Reach for squark & gluino masses using 4-jets + 0-lepton mode:	0.1 fb^{-1}	→	M ~ 750 GeV
	1 fb^{-1}	→	M ~ 1350 GeV
	10 fb^{-1}	→	M ~ 1800 GeV

Is it SuperSymmetry?

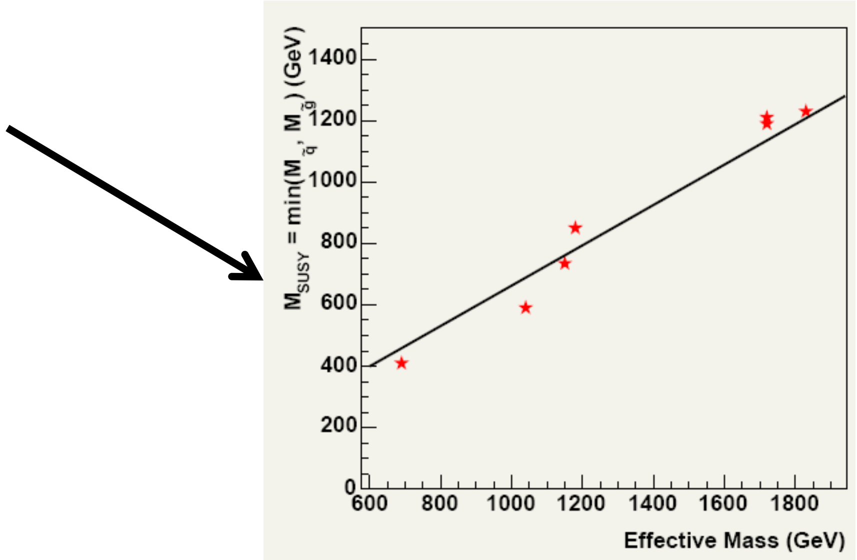
- Need to demonstrate that excess w-r-t SM is SUSY and not another model $\rightarrow$ Spin measurement
  - Charge asymmetry of lq pairs measures the spin of $\chi^0{}_2$
  - Shape of dilepton invariant mass measures slepton spin



- Several SUSY models: mSUGRA, GMSB, AMBS,…
  - Different constraints and different final states
  - Different LSPs

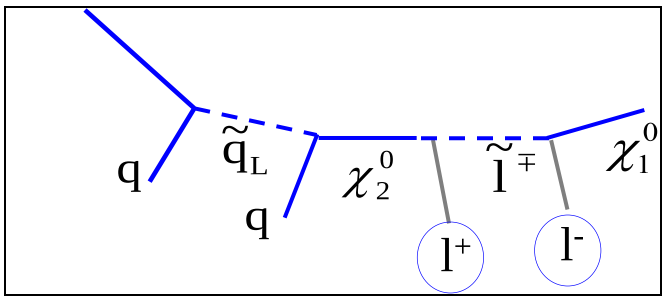
Inclusive Searches

- Once SUSY signatures are established, first task to test broad features of potential dark matter candidates.
- Question 1: Do we get a significant MET signal ? Is R-Parity conserved?
  - If so, possible Dark Matter candidate
  - However, LHC experiments sensitive cannot measure the LSP lifetime if it lives longer than $\sim$1ms (<< $t_U \sim$ 13.7 Gyr).
- Question 2: Could we have hints on SUSY parameters? What decays produces LSP?
  - Relative Significance in 0,1,2 lepton channels $\rightarrow m_0, m_{1/2}$
  - 3rd generation $\rightarrow \tan\beta$
  - $M_{effective} \rightarrow$ Mass scale



Exclusive Searches

- Measure weak scale SUSY parameters through exclusive decays modes
  - SUSY mass spectrum measurement → sparticles mass, couplings,…
- Mass reconstruction:
  - Most promising channel : opposite-sign, same flavor dilepton

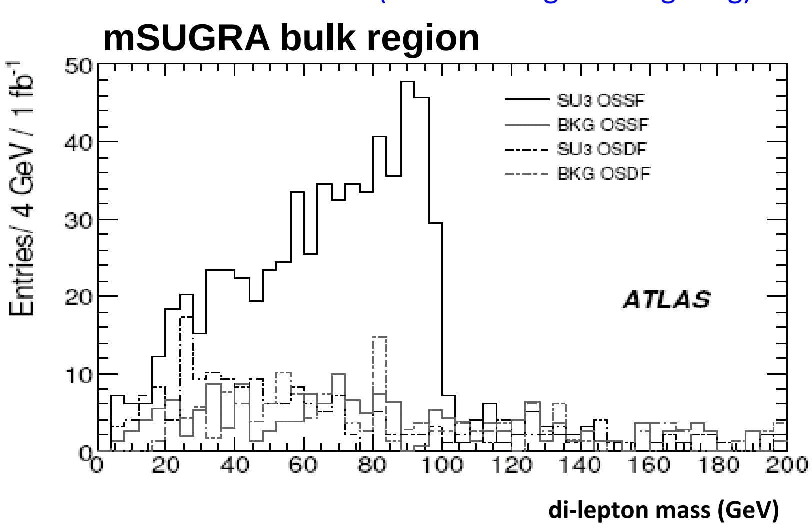


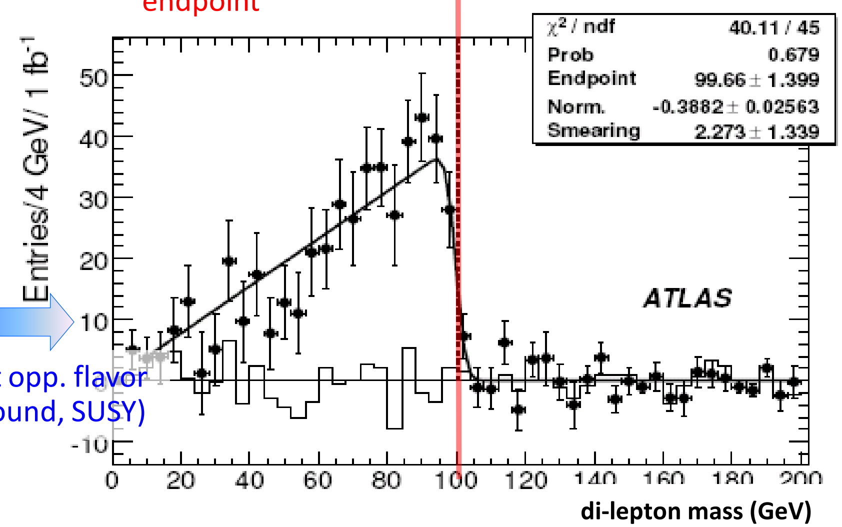
leptons have same flavour !
(use for background fighting)

Di-lepton kinematic endpoint:

$$m_{\ell\ell}^{max} = \frac{1}{m_{\tilde{\ell}_R}} \sqrt{\left(m_{\tilde{\chi}_2^0}^2 - m_{\tilde{\ell}_R}^2\right)\left(m_{\tilde{\ell}_R}^2 - m_{\tilde{\chi}_1^0}^2\right)}$$

"edge" of kinematic endpoint





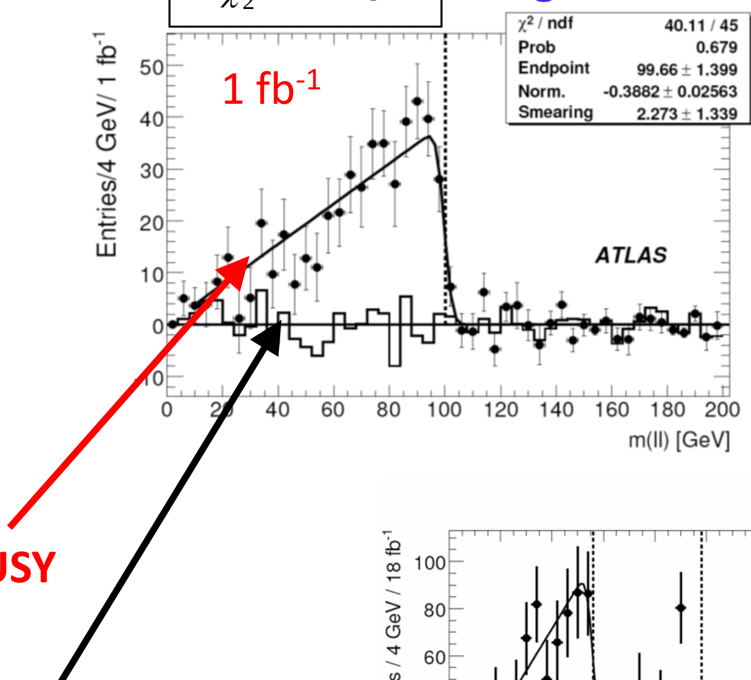
Subtract opp. flavor
(background, SUSY)

Di-lepton edge after Flavor Subtraction

- Method sensitive to any sleptons lighter than 2nd neutralino
  - Subtract background (from Standard Model *and SUSY itself*) using flavor information $e^+e^- + \mu^+\mu^- - e^+\mu^- - e^-\mu^+$
  - Position of mass-edge sensitive to combination of sparticle masses

$m_{\tilde{\chi}_2^0} > m_{\tilde{l}^{+/-}}$

Bulk region

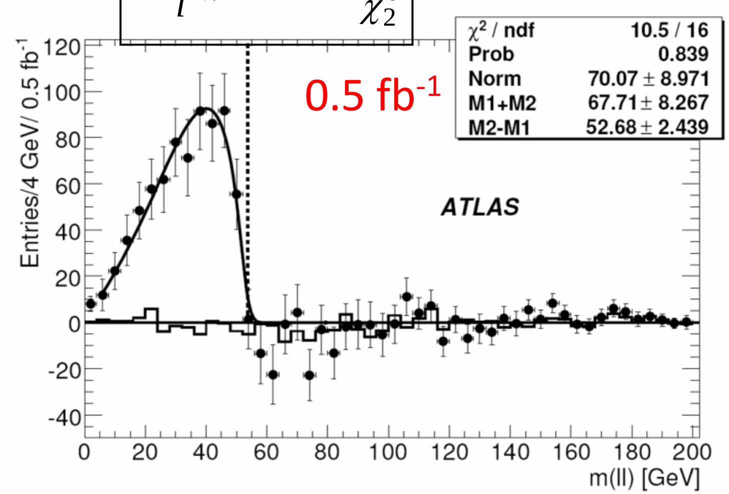


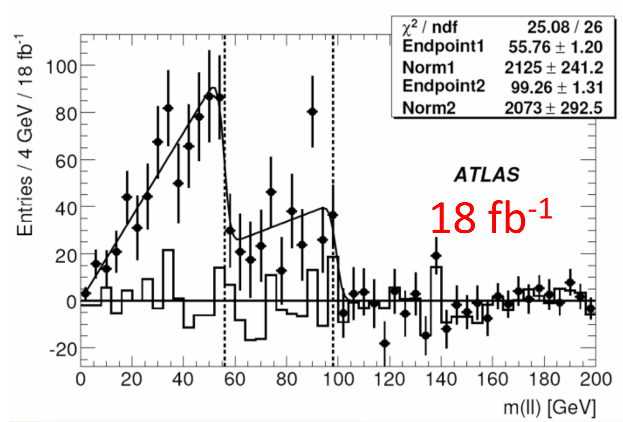
SUSY

Standard Model

$m_{\tilde{l}^{+/-}} > m_{\tilde{\chi}_2^0}$

Low mass point



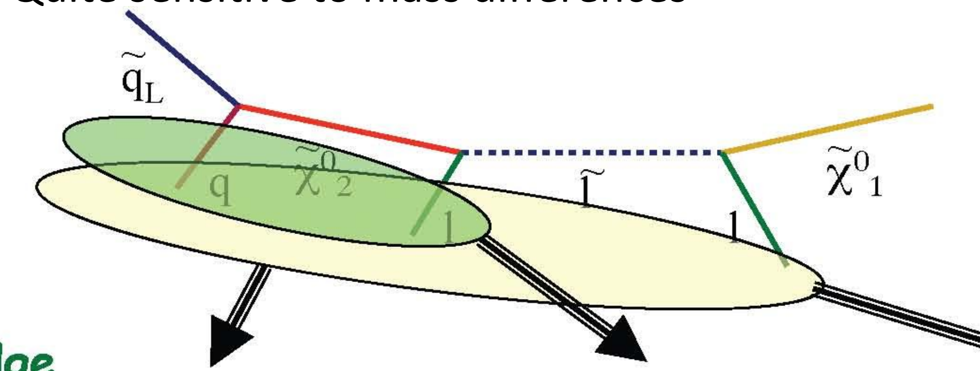


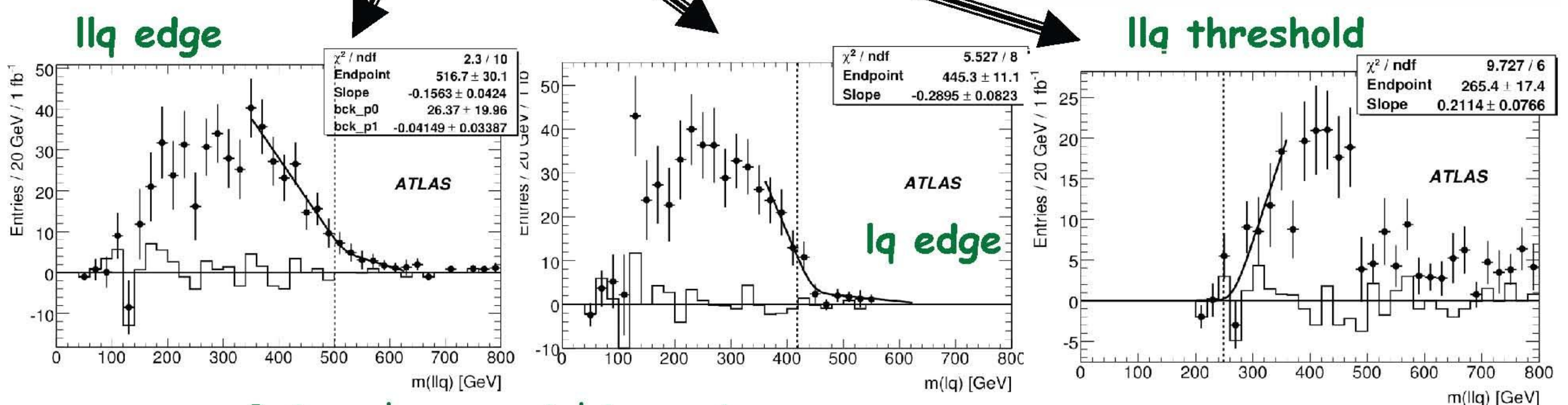
Two light sleptons, Coannihilation region

Including quarks

- Use same dilepton events, similar mass-edge extraction for lepton(s)-jet invariant mass m_{lq} and m_{llq}
- Use position of all edges to fit for sparticle masses
  - Fit assumes we know mass hierarchy, e.g. from di-lepton edge shape
  - Otherwise model-independent
  - Need more data for precise masses
  - Quite sensitive to mass differences

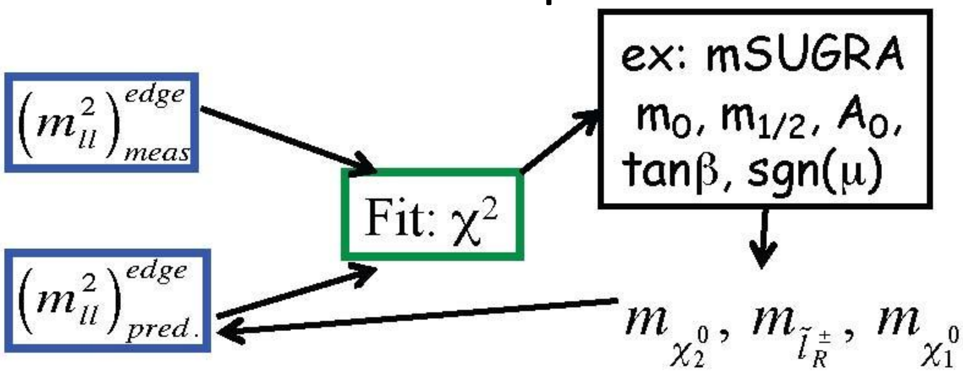
	Measured $[\mathrm{GeV}/c^2]$	Monte Carlo $[\mathrm{GeV}/c^2]$
$m_{\tilde{\chi}_1^0}$	$88 \pm 60 \mp 2$	118
$m_{\tilde{\chi}_2^0}$	$189 \pm 60 \mp 2$	219
$m_{\tilde{q}}$	$614 \pm 91 \pm 11$	634
$m_{\tilde{\ell}}$	$122 \pm 61 \mp 2$	155
Observable	SU3 Δm_{meas} $[\mathrm{GeV}/c^2]$	SU3 Δm_{MC} $[\mathrm{GeV}/c^2]$
$m_{\tilde{\chi}_2^0} - m_{\tilde{\chi}_1^0}$	$100.6 \pm 1.9 \mp 0.0$	100.7
$m_{\tilde{q}} - m_{\tilde{\chi}_1^0}$	$526 \pm 34 \pm 13$	516.0
$m_{\tilde{\ell}} - m_{\tilde{\chi}_1^0}$	$34.2 \pm 3.8 \mp 0.1$	37.6





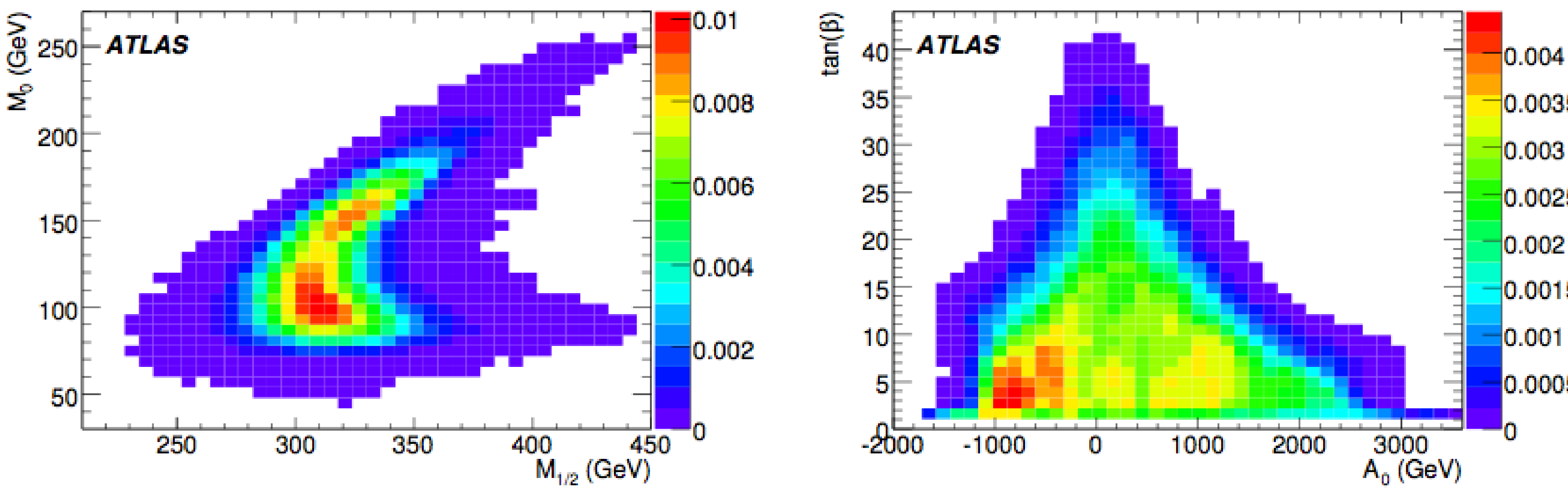
Measurement of Model Parameters

- Assuming a known model (e.g. mSUGRA), perform global fit to extract model parameters from observables



Parameter	SU3 value	fitted value	exp. unc.	theo. + exp. unc.
		sign(μ) = +1		
$\tan\beta$	6	7.4	4.6	–
M_0	100 GeV	98.5 GeV	±9.3 GeV	±9.5 GeV
$M_{1/2}$	300 GeV	317.7 GeV	±6.9 GeV	±7.8 GeV
A_0	−300 GeV	445 GeV	±408 GeV	–
		sign(μ) = −1		
$\tan\beta$		13.9	±2.8	–
M_0		104 GeV	±18 GeV	–
$M_{1/2}$		309.6 GeV	±5.9 GeV	–
A_0		489 GeV	±189 GeV	–

mSUGRA bulk region, 1 fb^{-1}



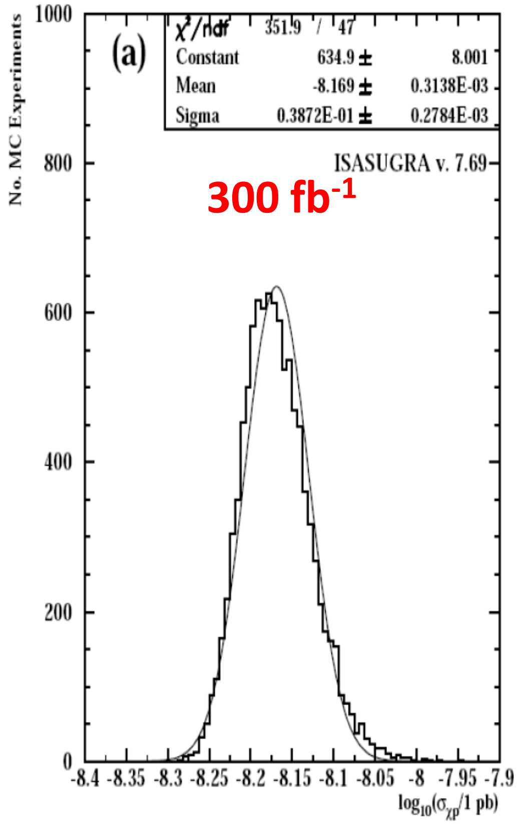
Connection to Dark Matter Searches

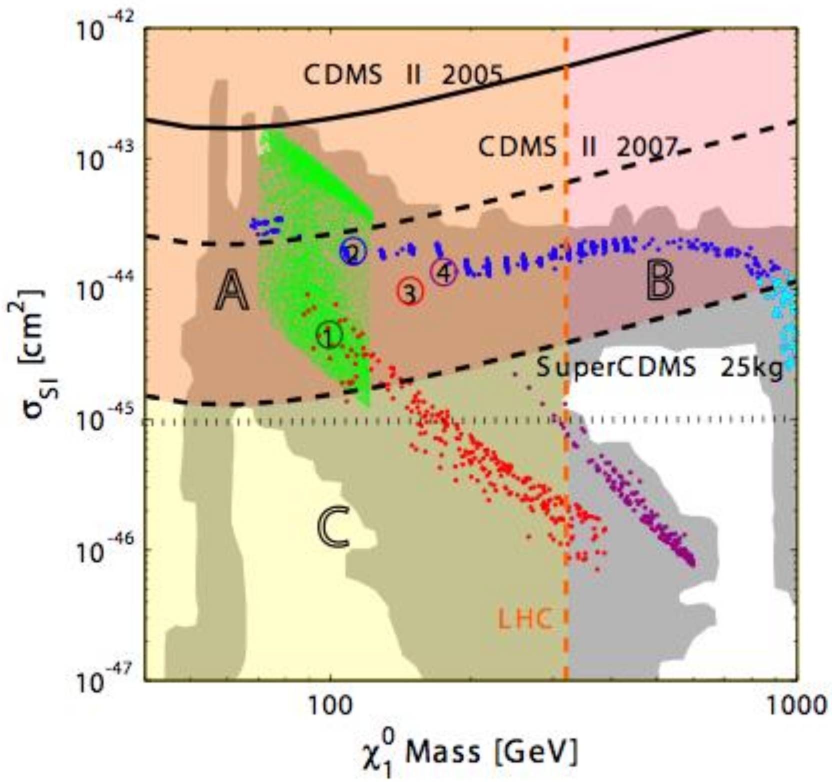
Dark Matter Parameters

- To compare with results from direct/indirect detection, need to calculate χ-nucleon elastic cross-section and relic density.
- Calculate rate for all possible neutralino annihilation processes
  - slepton exchange, slepton masses < 200 GeV
  - annihilation to vector bosons (LSP has a wino or higgsino component)
  - coannihilation with light sleptons
  - annihilation to third-generation fermions.
- Not possible to access all SUSY parameters (masses, couplings, spin…) needed for the calculation, BUT possible to identify which processes are relevant or not.
- Compare collider-astrophysical results within specific SUSY models

Comparing with Direct Measurements

- Calculate neutralino mass m_χ and cross section $\sigma_{\chi\text{-nucleon}}$
- Compare with direct detection





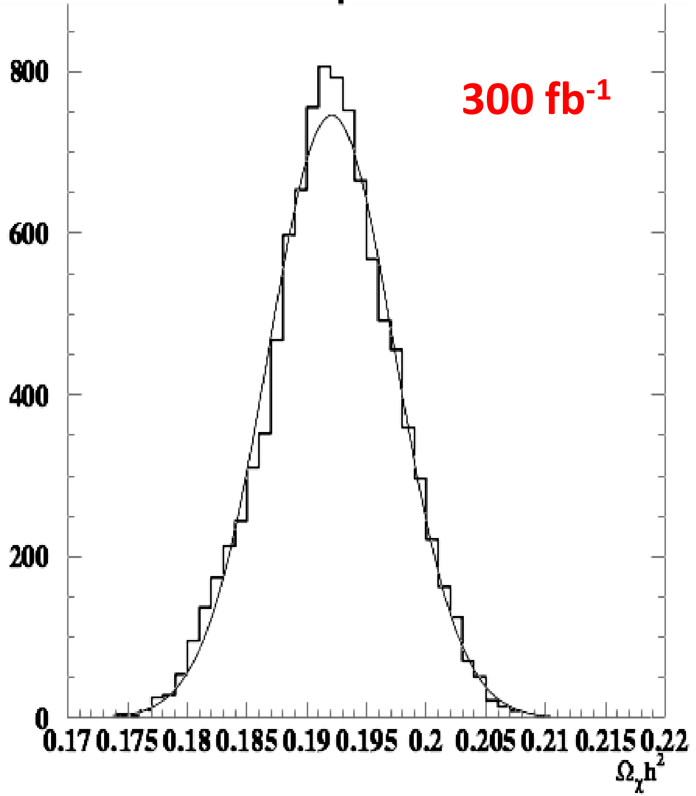
$$m_{\tilde{\chi}_1^0} = 96.05 \pm 4.7 \text{ GeV}$$

$$\log_{10}(\sigma_{\chi p}/1\text{pb}) = -8.17 \pm 0.039$$

Same WIMP in lab and space?

Comparing with Cosmological Observations

- Calculate neutralino relic density
- Precision comparable to that from cosmology: $\Omega_\chi = \Omega_{DM}$?



- $\Omega_\chi h^2 = 0.192 \pm 0.005$ (stat) ± 0.006 (sys)
- What fraction of the dark matter is neutralinos?

(simulated point is *pre-WMAP)*

- This precision depends on assuming very constrained SUSY breaking scenario. In more general scenario: much looser constraints.

Model independent approach

- In calculations of m_χ, σ_χ , Ω_χ
  - mSUGRA unification assumption constraints
- MSSM analysis not assuming specific SUSY breaking scenario needs more measurements
- e.g. to calculate Ω_χ need
  - LSP mass, LSP mixing matrix
  - to establish which processes are relevant to LSP annihilation…
  - …and measure them

OR

- Several mSUGRA points also analyzed as MSSM to evaluate LHC + ILC prospects by Baltz et al.
- Bulk region, 300 fb^{-1}:
  - Ω_χ precision in agreement with Polesello et al.
  - $\sigma_{\chi\text{-nucleon}}$ not well constrained, as it depends on heavy Higgs mass (not observable at LHC in this model)

Nojiri, Polesello,Tovey JHEP 0603:063 (2006)

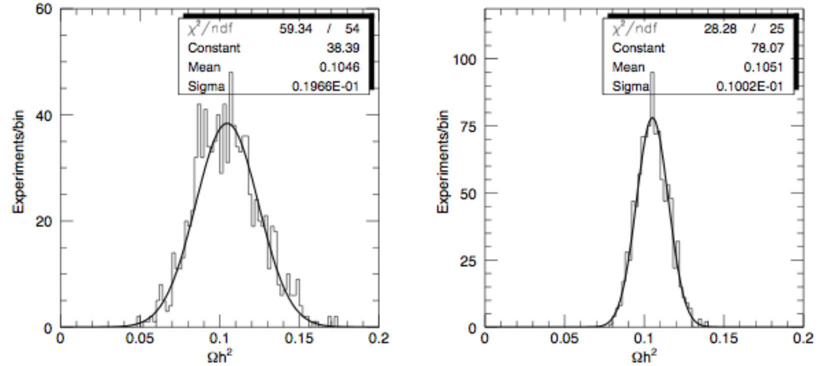
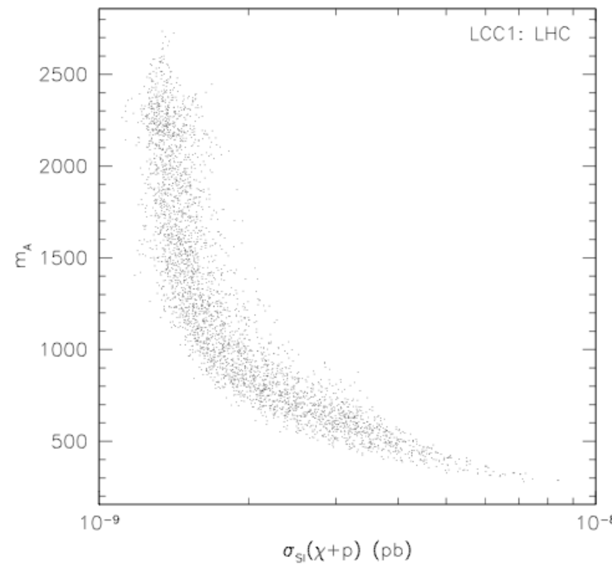


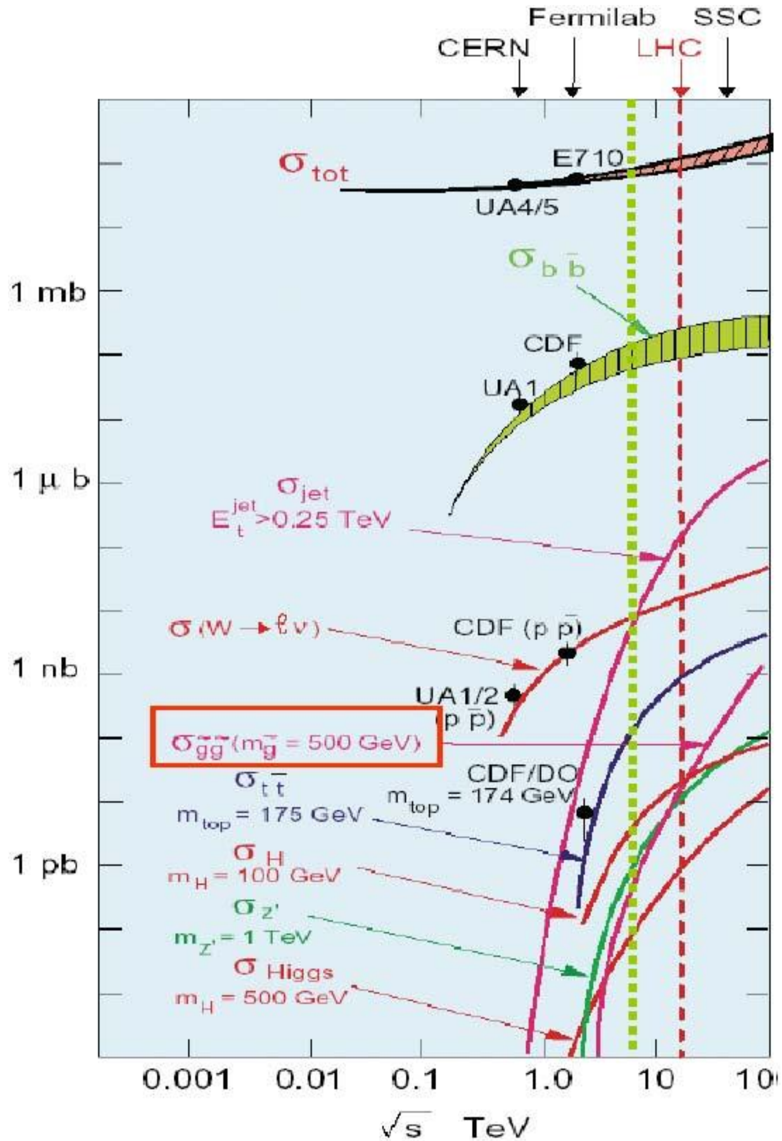
Figure 7: *Distributions of the predicted relic density $\Omega_\chi h^2$ incorporating the experimental errors. The distributions are shown for an assumed error on the $\tau\tau$ edge respectively of 5 GeV (left) and 0.5 GeV (right).*

300 fb^{-1}

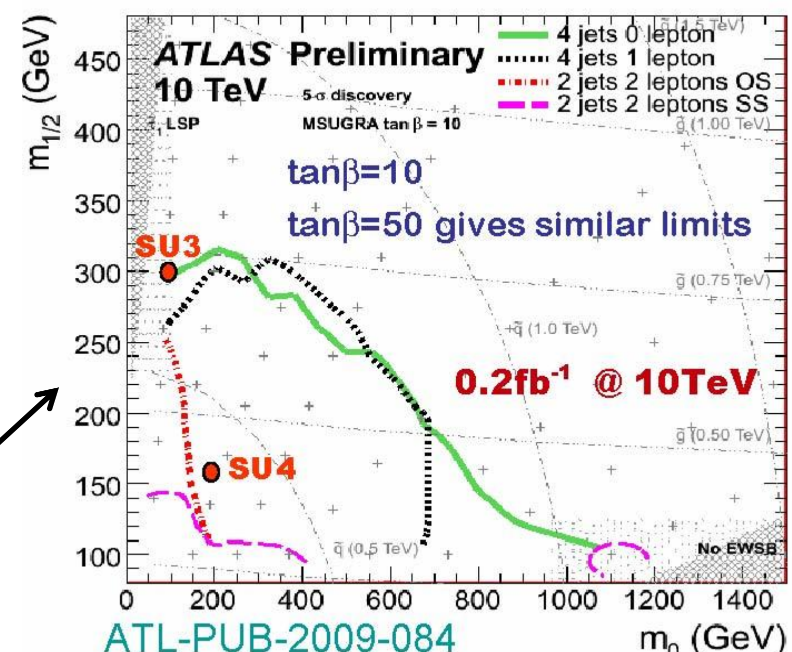


Baltz, Battaglia, Peskin, Wizansky *PRD* 74:103521 (2006)

What could we expect @ 7 TeV?



- LHC will run @7 TeV to collect ~1 fb^{-1}
- Cross-section steeply falling for heavy objects production (e.g. sparticle pair)
- Predictions @ lower √s and lower nontrivial:
  - x-sections change rapidly
  - background systematics are L_{int} dependent
- We may see a glimpse of low mass SUSY (SU3/SU4 -like)…



Recent update to 200pb-1 @ 10TeV

Conclusions

- The ATLAS detector is fully operational for the LHC 2010-2011 7 TeV run.
  - Updates on 7 TeV expectations would help on tuning SUSY searches, though efforts are now towards exploiting data.
- SUSY discovery is possible if SUSY mass scale is within kinematically accessible
- Following a "SUSY" discovery, the LHC experiments will aim to test the SUSY Dark Matter hypothesis.
- While the LHC cannot distinguish between stable and long-lived SUSY matter particles, it can provide mass and properey measurements. The impact on Dark matter will depend on the nature of SUSY.
- Favorable scenarios suggest precise calculations of m_{χ}, σ_{χ}, Ω_{χ} possible with ~300fb^{-1} of data
- When combined with Astroparticle & Cosmology measurements, this would reveal the relation of the SUSY LSP to the Dark Matter