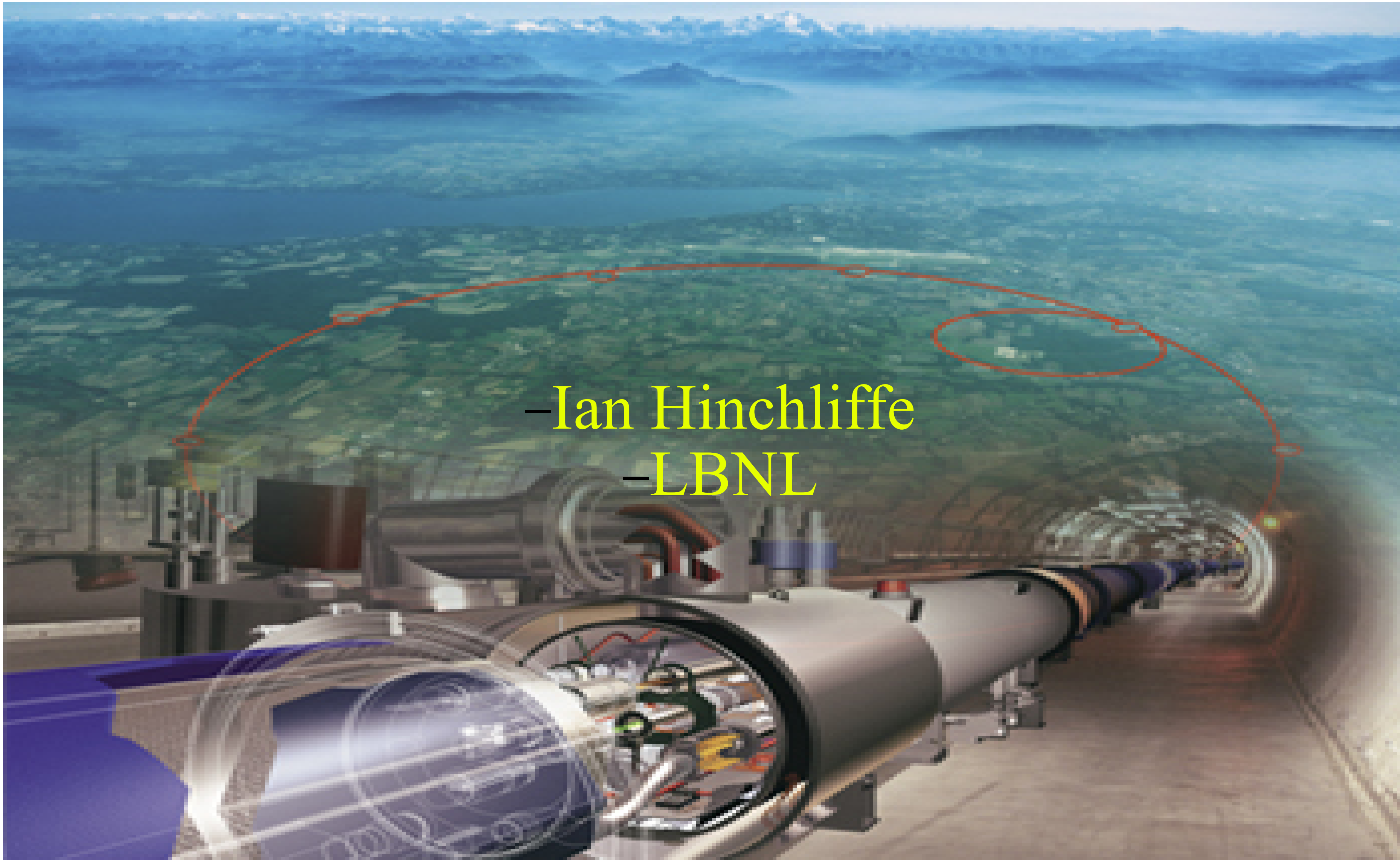
SUSY and LHC



– Ian Hinchliffe
– LBNL

Outline

- Detector issues
- Model issues
- Inclusive searches (discoveries we hope)
- Exclusive searches: specific final states
- Timescale
- Comments and conclusions
- CMS plots are from CMS TDR J Phys G, vol 34, 6
- Atlas plots are PRELIMINARY and will be fully documented shortly, many studies are more careful and detailed versions of those in TDR (LHCC/99)
- Recent work tends to focus on early data
- All plots are at 14 TeV
- In such a short talk I can only give you a flavor of the results

Getting ready for new physics

- For SUSY, top quark studies are an ideal benchmark
  - Physics is known: simulation and detector performance is unvalidated
  - Top and SUSY have
    - Isolated and non isolated leptons
    - Missing ET
    - Large jet multiplicity
    - B-jets
    - Taus decaying hadroncially
  - Top cross section, mass and decays are well understood from Tevatron
  - SUSY may have some other features , but these can come later
    - Long lived particles ("cannon balls")
- Part of the strategy to "rediscover the standard model"
- This is not a talk on top, but it probably should have been

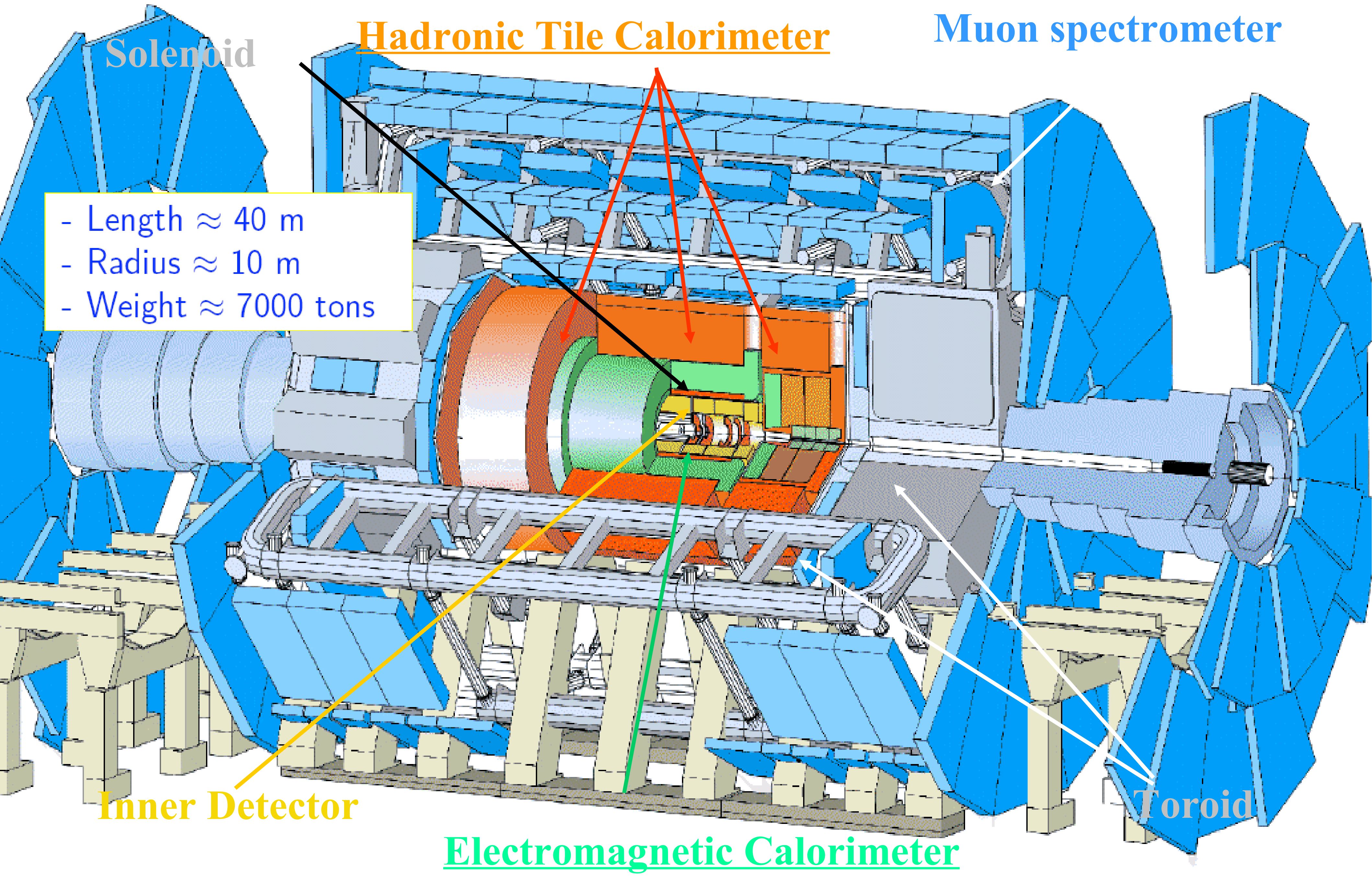
Detector issues

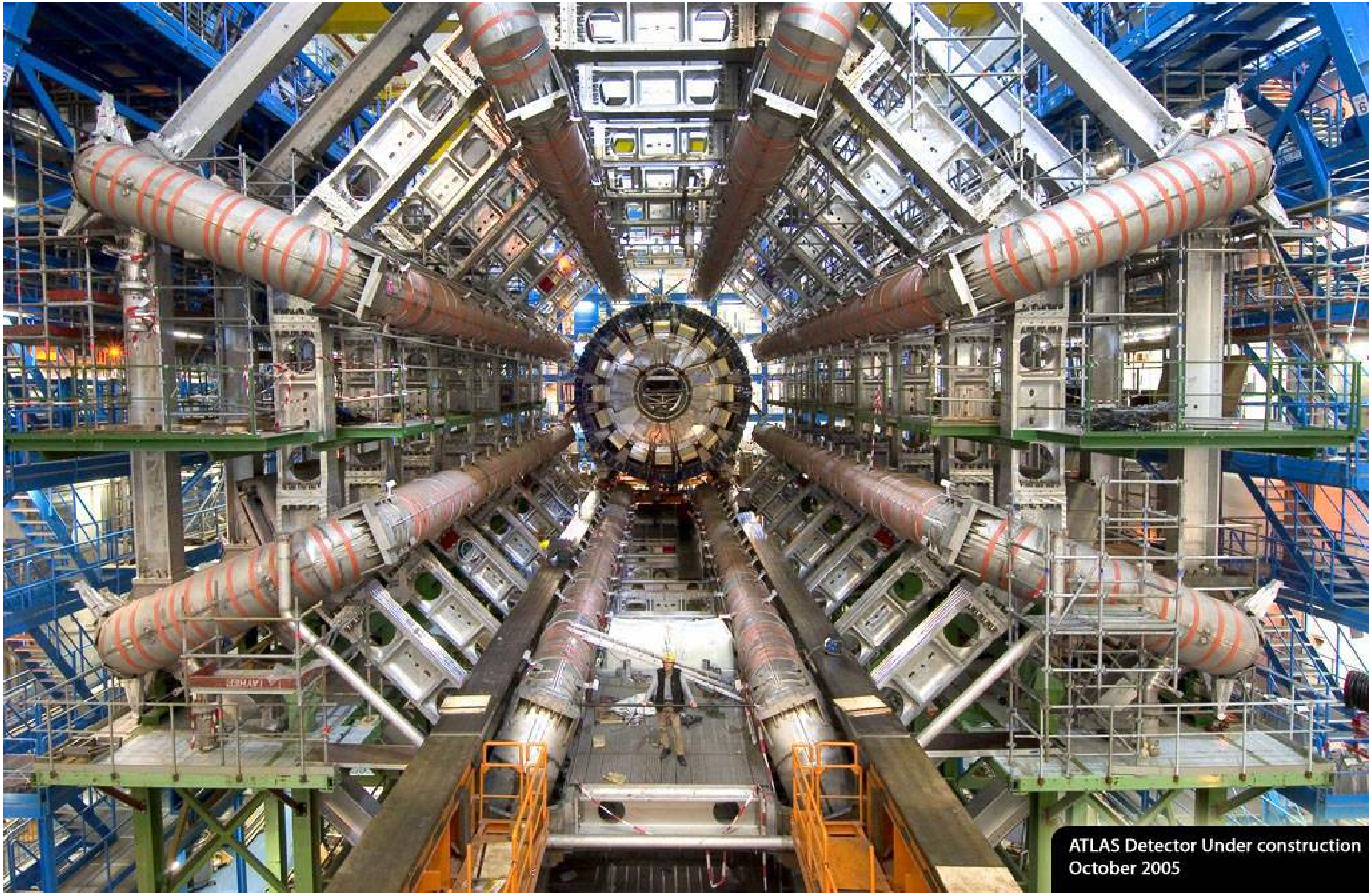
- Must detect all decay products of SUSY particles
  - Quarks, gluons: i.e. Jets
    - SUSY partners of b and t may be lightest squarks
    - B-jet identification important both for S/B and measurements
  - Stable leptons: e and mu
  - Unstable leptons: tau
    - Large $\tan\beta$ implies more tau than e or mu in decays
    - Hadronic decays unambiguous: e or mu may not be from tau
  - (Quasi)stable (N)LSP
    - Neutral: Missing ET
    - Charged: "heavy muon"
- ATLAS and CMS made different technology choices: but performance should be similar for this and other new physics

Detector comments

- See Leandro's talk on Monday for detector and machine status.
- I would like to make a personal remark.
- The fact that ATLAS is essentially complete is a small miracle: one year ago many people would not have expected it
  - All the people who worked so hard to do this are to be congratulated
- Next step is detector commissioning and calibration
  - This will be the main focus for the 2008 data
  -

A Toroidal LHC Apparatus (ATLAS)

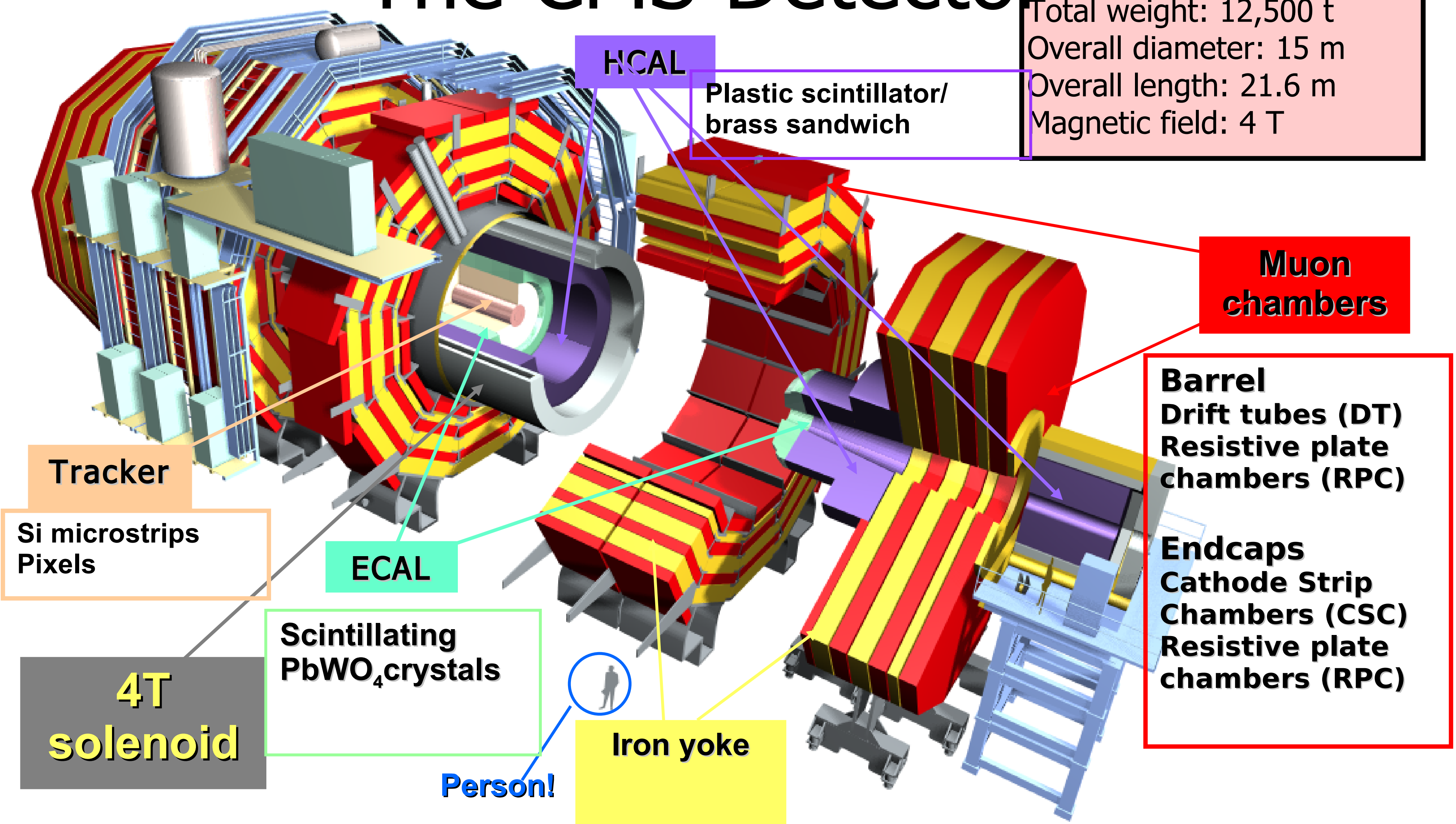




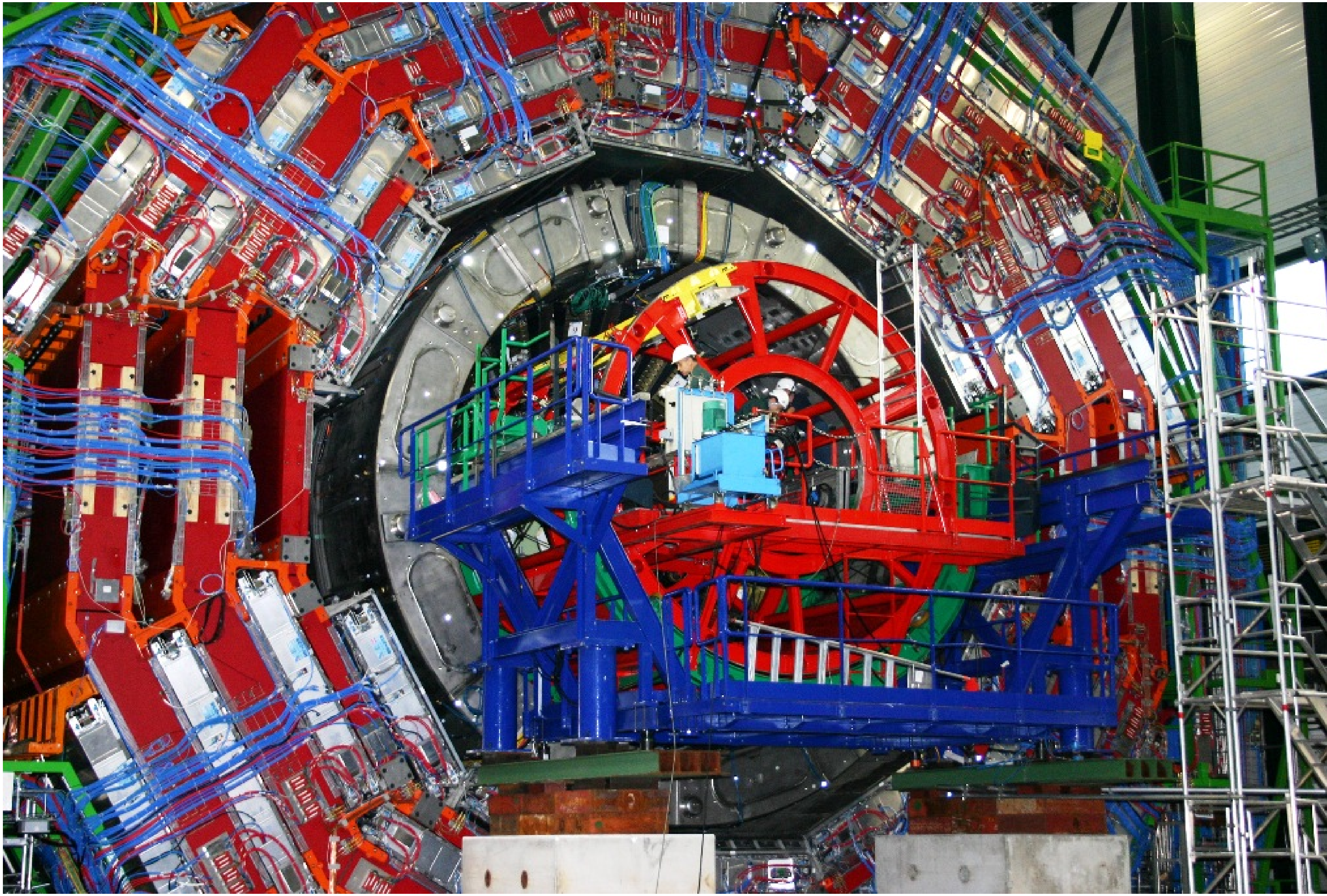
ATLAS Detector Under construction
October 2005

The CMS Detector

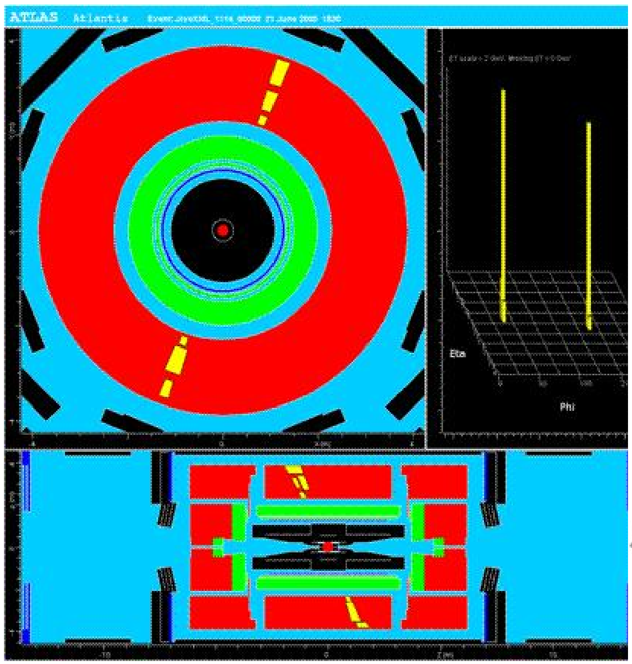
Total weight: 12,500 t
Overall diameter: 15 m
Overall length: 21.6 m
Magnetic field: 4 T



General purpose detector : High TeV scale discovery capability
Very complex detector : Need deep knowledge of detector behaviour, systematics



Data taking has started with cosmics



Message ID: 940	Entry time: Mon Aug 28 00:02:23 2006
Author:	Austin Ball, Austin.Ball@cern.ch
Type:	Run plan
Subject:	10M reached. Tentative plans for next 12 hours

We have (within 50k) reached the target of 10M useful events at 3.8T
Congratulations to the whole (worldwide) team!!!!

Overall efficiency of recording "cosmic beam" this evening
was 90% or more, comparable to what we have to aim at
during LHC operation.

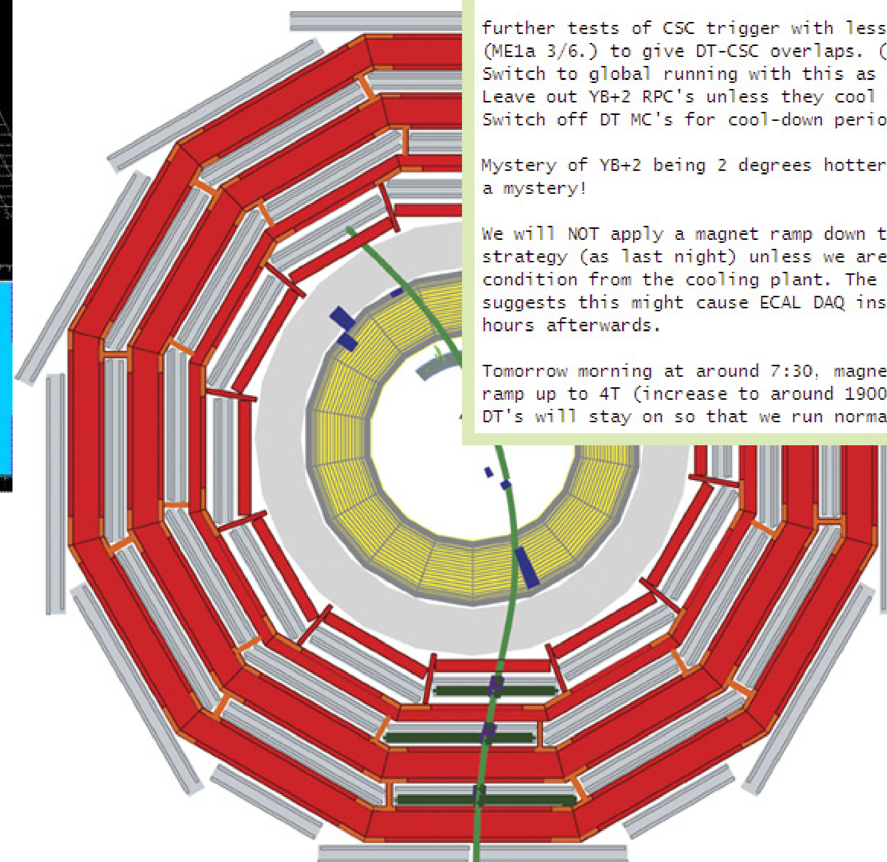
Tentative plans for next 12 hours are as follows.

further tests of CSC trigger with less jitter wrt DT's
(ME1a 3/6.) to give DT-CSC overlaps. (useful also for HE).
Switch to global running with this as the CSC trigger.
Leave out YB+2 RPC's unless they cool in the night.
Switch off DT MC's for cool-down periods as necessary.

Mystery of YB+2 being 2 degrees hotter than YB+1 still
a mystery!

We will NOT apply a magnet ramp down to 3T as a cool-down
strategy (as last night) unless we are close to alarm
condition from the cooling plant. The empirical evidence
suggests this might cause ECAL DAQ instability for several
hours afterwards.

Tomorrow morning at around 7:30, magnet will start a slow
ramp up to 4T (increase to around 19000A over about 1 hour).
DT's will stay on so that we run normally.



Now to SUSY.........

Comments on SUSY Models

- I don't believe in any one model, however
  - SUSY is complicated and many particles and decays happen at the same time
  - Studying how to find Particle X in decay mode Y in isolation is dangerous
  - Using a model give a self consistent picture
    - Ensures that some claim is tenable
- Limits are (will) be very difficult in model independent way
- Very large model and parameter space at the moment
  - Impossible to do detailed studies for all cases
- Situation will be easier once we get data
  - Large numbers of models/parameters will be DOA

Comments on Models II

- SUGRA model is most studied
  - Few parameters
- Must be aware of limitations
- Doing a full study of a model is time consuming: must do a "cost-benefit" analysis
- Studies are aimed at developing strategies, not on exhaustive study of particular set of parameters
- Some model constraints are often ignored
  - Many can be vitiated without changing LHC signals
  - See Xerxes comments on Monday
- Many more exotic models are actually easier to disentangle: e.g quasi stable particles
- Two notable difficult cases:
  - Very small mass gaps
  - R-parity violation with LSP decay to jets

Sparticles

SM Particles	SUSY Particles			
quarks: q	q	squarks: $\tilde{q}$		
leptons: l	l	sleptons: $\tilde{l}$		
gluons: g	g	gluino: $\tilde{g}$		
charged weak boson: $W^{\pm}$	$W^{\pm}$	Wino: $\widetilde{W}^{\pm}$	$\tilde{\chi}^{\pm}_{1,2}$	chargino
Higgs: H^0	$H^{\pm}$	charged higgsino: $\widetilde{H}^{\pm}$		
	h^0, A^0, H^0	neutral higgsino: $\tilde{h}^0, \tilde{A}^0$,	$\widetilde{H}^0$	higgsino
neutral weak boson: Z^0	Z^0	Zino: $\tilde{Z}^0$	$\tilde{\chi}^0_{1,2,3,4}$	neutralino
photon: γ	γ	photino: $\tilde{\gamma}$		

In reading the sugra plots, recall the rules of thumb

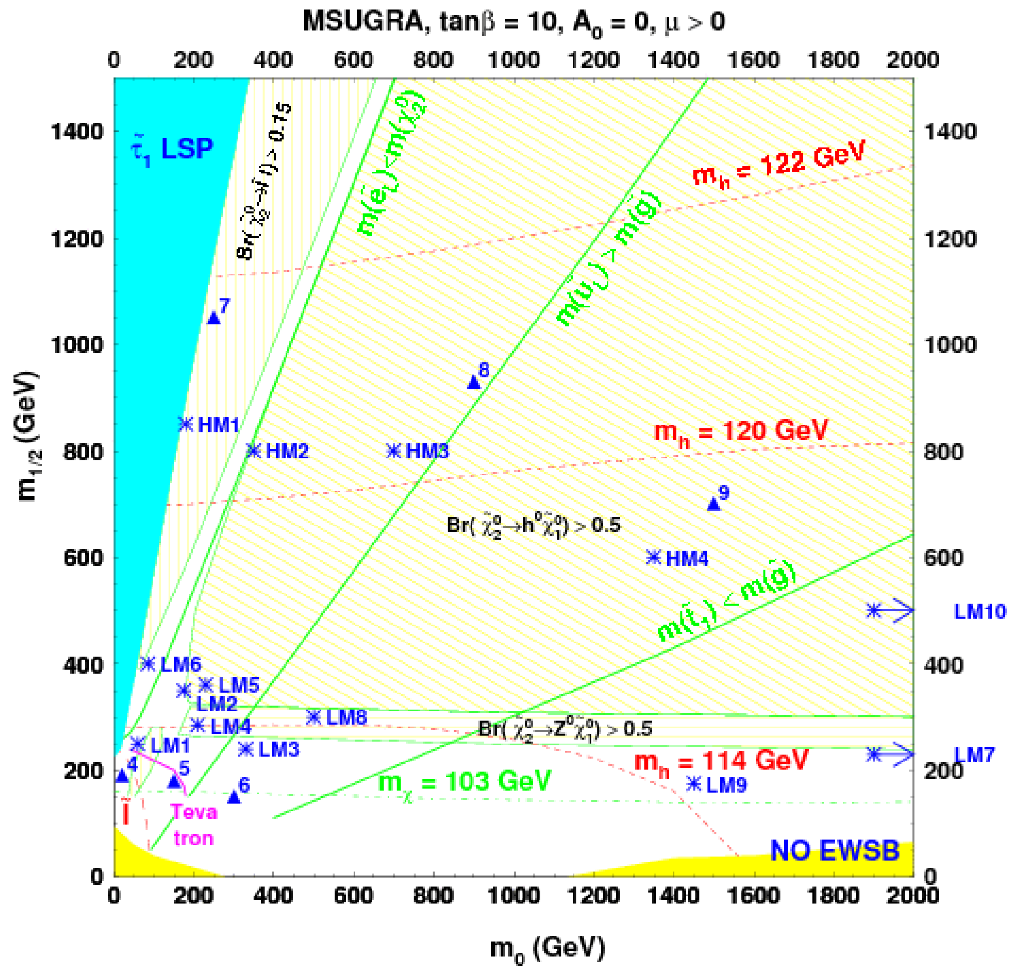
$m(\text{gluino}) = 2.7\, m_{1/2}$

$m^2(\text{slepton}) = m_0^2 + 0.5m^2_{1/2}\ , m^2_0 + 0.15m^2_{1/2}$

$m^2(\text{squark}) = m_0^2 + 5m_{1/2}$

CMS benchmarks

Point	m_0	$m_{1/2}$	$\tan\beta$	sgn(μ)	A_0
LM1	60	250	10	+	0
LM2	185	350	35	+	0
LM3	330	240	20	+	0
LM4	210	285	10	+	0
LM5	230	360	10	+	0
LM6	85	400	10	+	0
LM7	3000	230	10	+	0
LM8	500	300	10	+	-300
LM9	1450	175	50	+	0
LM10	3000	500	10	+	0
HM1	180	850	10	+	0
HM2	350	800	35	+	0
HM3	700	800	10	+	0
HM4	1350	600	10	+	0



ATLAS benchmarks: SUGRA

Table 2: Masses in GeV for the fully simulated SUSY samples.

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

These were subject to full Geant based simulation

Rates and numbers of simulated events

Signal	σ^{LO} (pb)	σ^{NLO} (pb)	N
SU1	8.15	10.86	200 K
SU2	5.17	7.18	50 K
SU3	20.85	27.68	500 K
SU4	294.46	402.19	200 K
SU6	4.47	6.07	30 K
SU8.1	6.48	8.70	50 K

ATLAS benchmarks: Not SUGRA

Table 1: Summary of the neutralino NLSP samples. Dataset GMSB1 is a prompt photon decay sample, while dataset GMSB2 and GMSB3 are the non-pointing photon samples. $N_5 = 1, \tan\beta = 5, sgn(\mu) = +$ are used at each point.

name	NLO (LO) σ [pb]	Λ [TeV]	M_m [TeV]	C_G	$c\tau$ [mm]	$M_{\tilde{\chi}_1^0}$ [GeV]
GMSB1	7.8 (5.1)	90	500	1.0	1.1	118.8
GMSB2	7.8 (5.1)	90	500	30.0	$9.5 \cdot 10^2$	118.8
GMSB3	7.8 (5.1)	90	500	55.0	$3.2 \cdot 10^3$	118.8

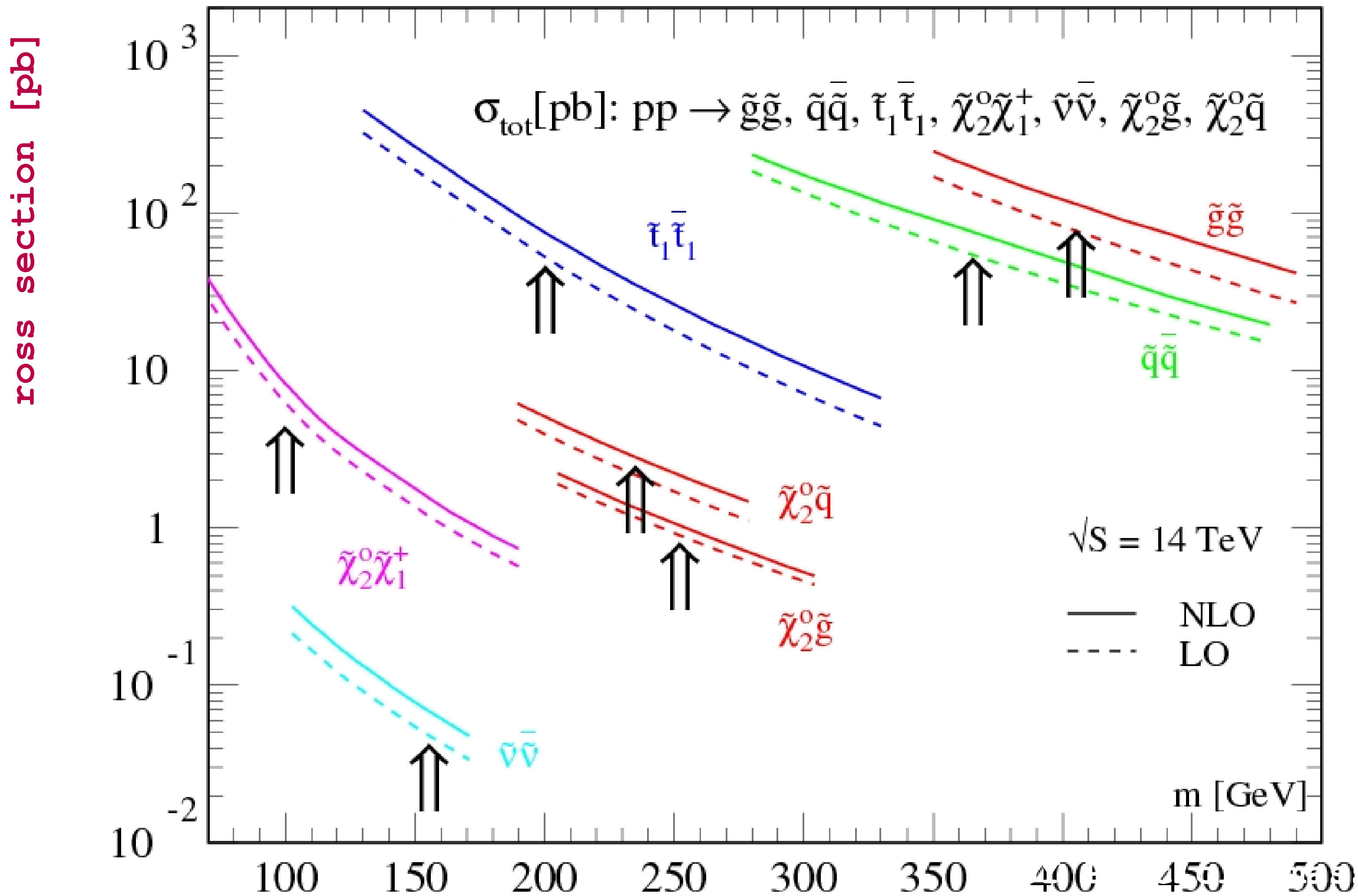
Table 2: Summary of the slepton NLSP sample. $N_5 = 3, \tan\beta = 5, sgn(\mu) = -$, and no decay of slepton is assumed.

name	NLO (LO) σ [pb]	Λ [TeV]	M_m [TeV]	$M_{\tilde{\tau}_1}$ [GeV]
GMSB5	21.0 (15.5)	30	250	102.3

Table 3: R-hadron samples. Dataset R-Hadron1 – R-Hadron6 are the $R_{\tilde{g}}$ samples, while dataset R-Hadron7 – R-Hadron9 are the $R_{\tilde{t}}$ samples.

name	NLO (LO) cross section [pb]	sparticle	Mass [GeV]
R-Hadron1	567 (335)	$\tilde{g}$	300
R-Hadron2	12.2 (6.9)	$\tilde{g}$	600
R-Hadron3	0.43 (0.23)	$\tilde{g}$	1000
R-Hadron4	0.063 (0.033)	$\tilde{g}$	1300
R-Hadron5	0.011 (0.006)	$\tilde{g}$	1600
R-Hadron6	0.0014 (0.00075)	$\tilde{g}$	2000
R-Hadron7	11.4 (7.8)	$\tilde{t}$	300
R-Hadron8	0.27 (0.18)	$\tilde{t}$	600
R-Hadron9	0.010 (0.0064)	$\tilde{t}$	900

Rates



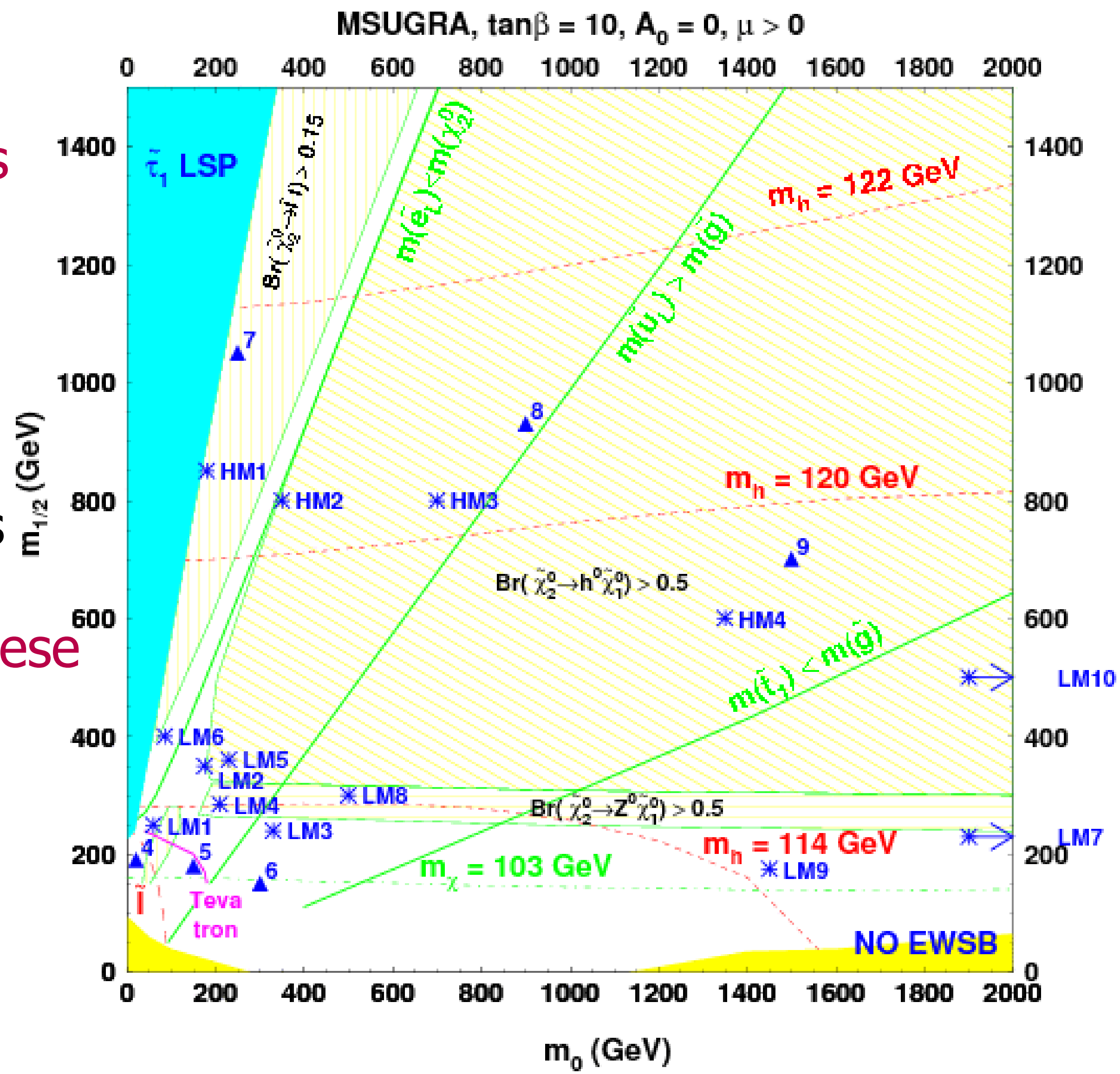
prospino

Dominant characteristic decays

Lots of jets leptons and etmiss almost everywhere

Three characteristic regions
Chi_2 to chi_1_1 higgs
Chi_2 to Ch1_1 Z
Chi_2 to Chi1_1 plus dileptons

Inclusive searches focus on these



Comments on Simulation

- Must correctly model detector response
- Full Geant based simulation is needed to give confidence
  - Many more simulations now use this than at time of ATLAS TDR
  - But these simulations are time consuming
- Parametrized response can be used once it has been validated

Backgrounds

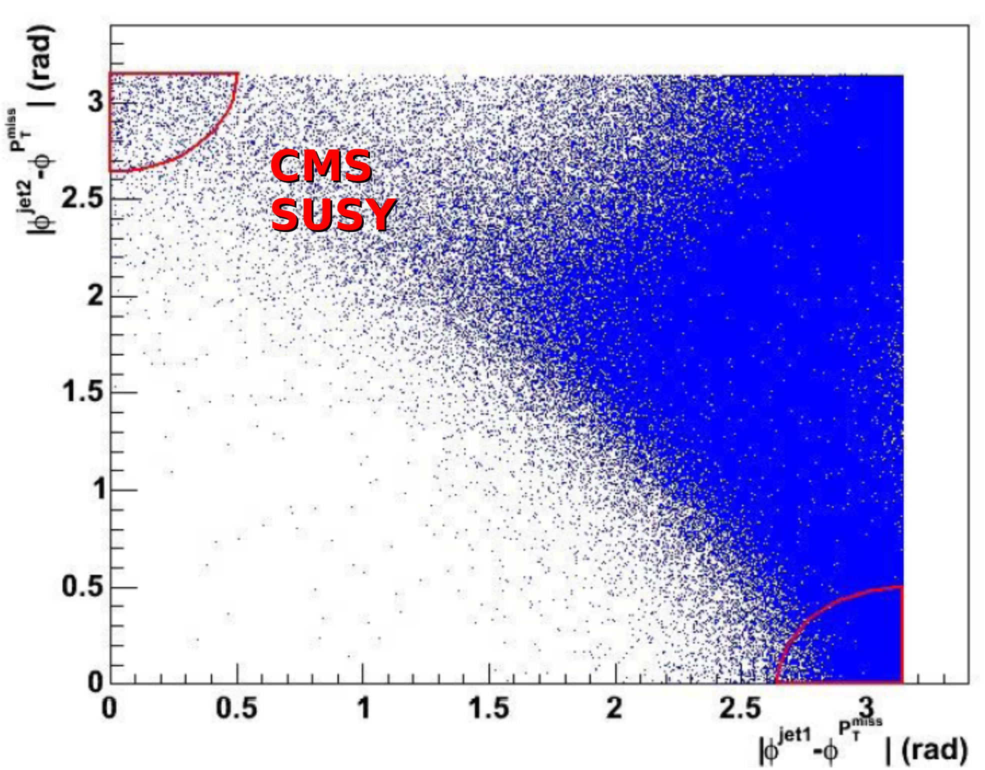
- These must be measured and understood before any claims can be made
- All we have now is Monte Carlo
- Real experiment will be combination of MC and data
  - Validate the MC against data in regions with no signal
  - Use data itself to estimate some backgrounds
- Peaks/edges are harder to fake
- CMS uses Phythia and CompHep
- ATLAS uses Alpgen to try to get a better estimate of final states with large numbers of separated jets, and mc@NLO for top.
- Some simple examples follow

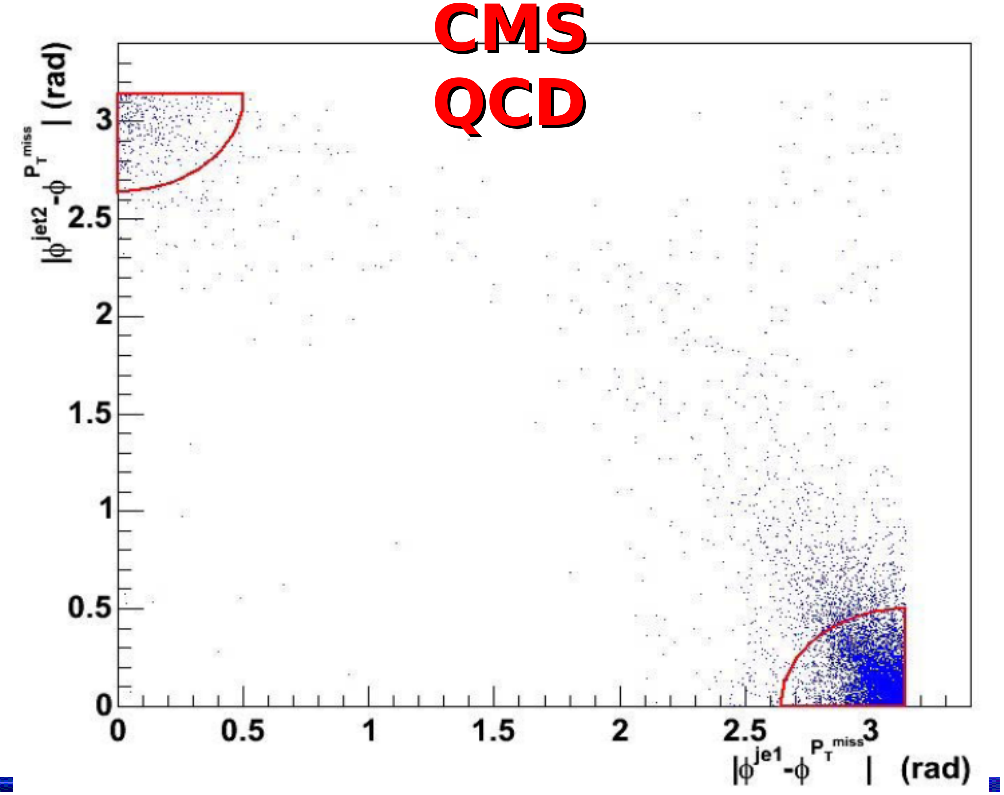
Backgrounds:QCD

fake' Etmiss due to jet mis-measurement => reducible with cuts => Δφ cut as etmiss points along a jet direction

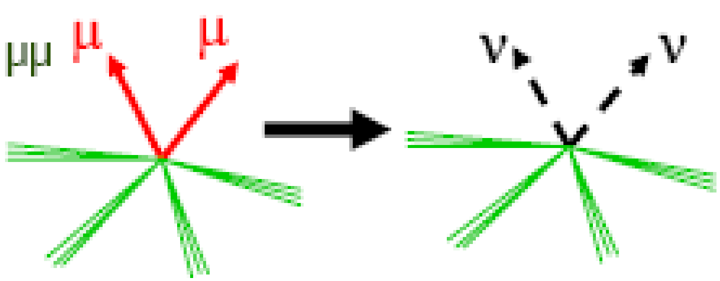
'real'etmiss due to decays into neutrinos (heavy flavor, B hadrons,…)

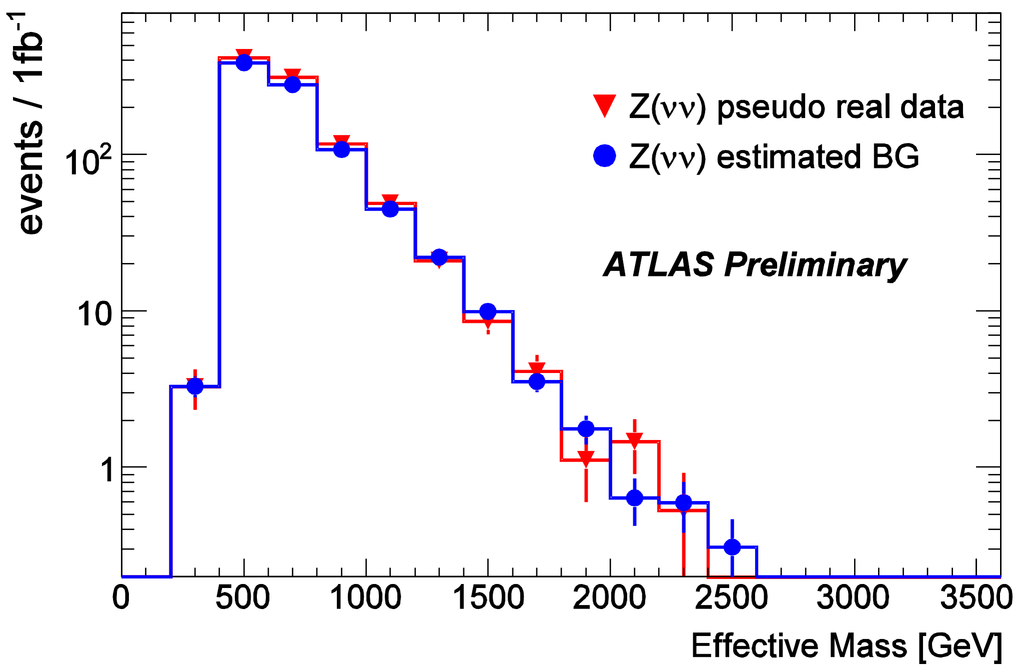
Plot shows corrleation between direction of etmiss and jets





Backgrounds:jets+etmiss





A trivial example:

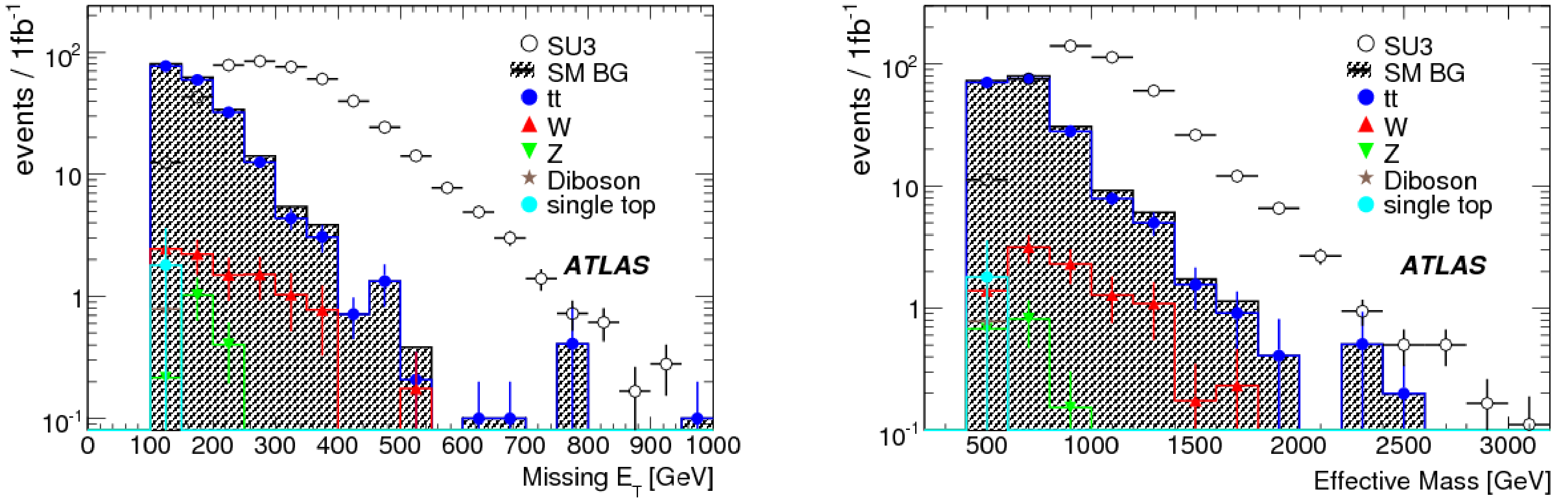
If you believe that etmiss is coming from Z decays you can measure it.

Must correct for acceptance.

Limited by available statistics in ee and mumu final states

Backgrounds:Lepton+jets

1 fb^{-1}



Events selected with lepton pt>20 GeV and 4 jets Pt>50 GeV

Meff= sum(ET)(jets +lepton +etmiss)

If you saw this data and this background estimate from Monte Carlo, would you be booking a flight to Stockholm?

Do you really believe the Monte Carlo?

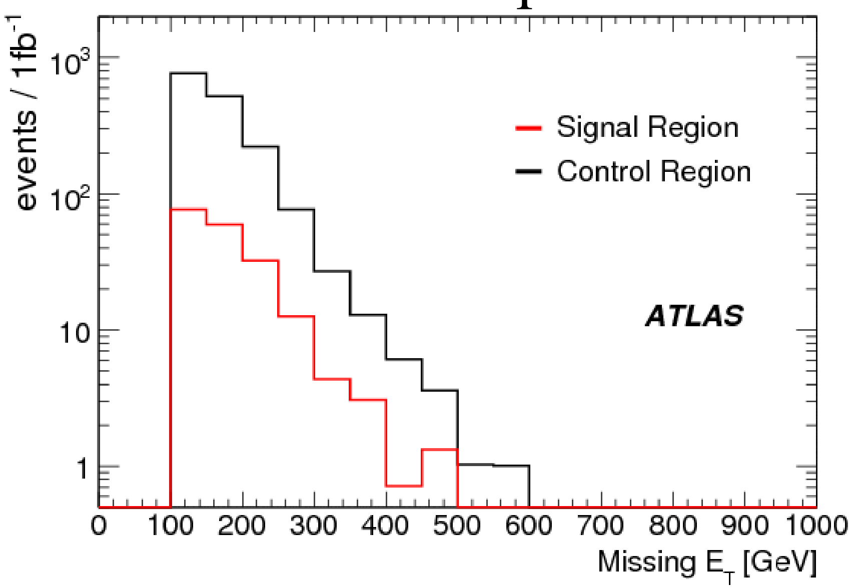
Backgrounds:Lepton+ jets

The dominant background has W's in it
If so there is correlation between etmiss and the lepton
Can you prove this from the data?

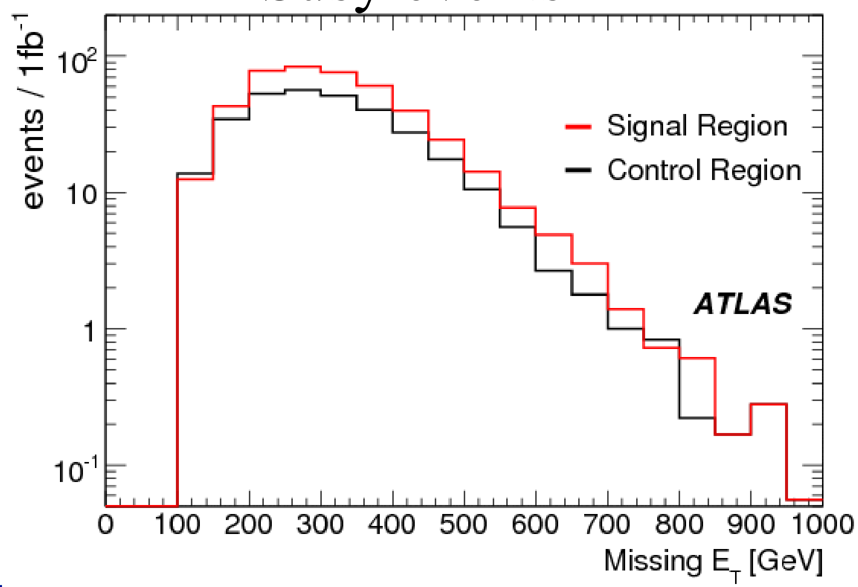
Make a transverse mass (M_T) from lepton and etmiss: divide it at 100 GeV
Black is below red is above,

Background is mostly in the black region, signal is equal: Enhance the background!

Top events



Susy events



Backgrounds:Lepton+ jets

Use Mt<100 to define a control region
Now look at the Et miss plot again.
Its supposed to be all background at the low end.
If this is true then the ratio of events in signal/control is predicted.
Is this true? If yes then you can normalize that region by assuming it is all background.
Now you only need the Et miss shape from the Monte Carlo and can extrapolate under the signal

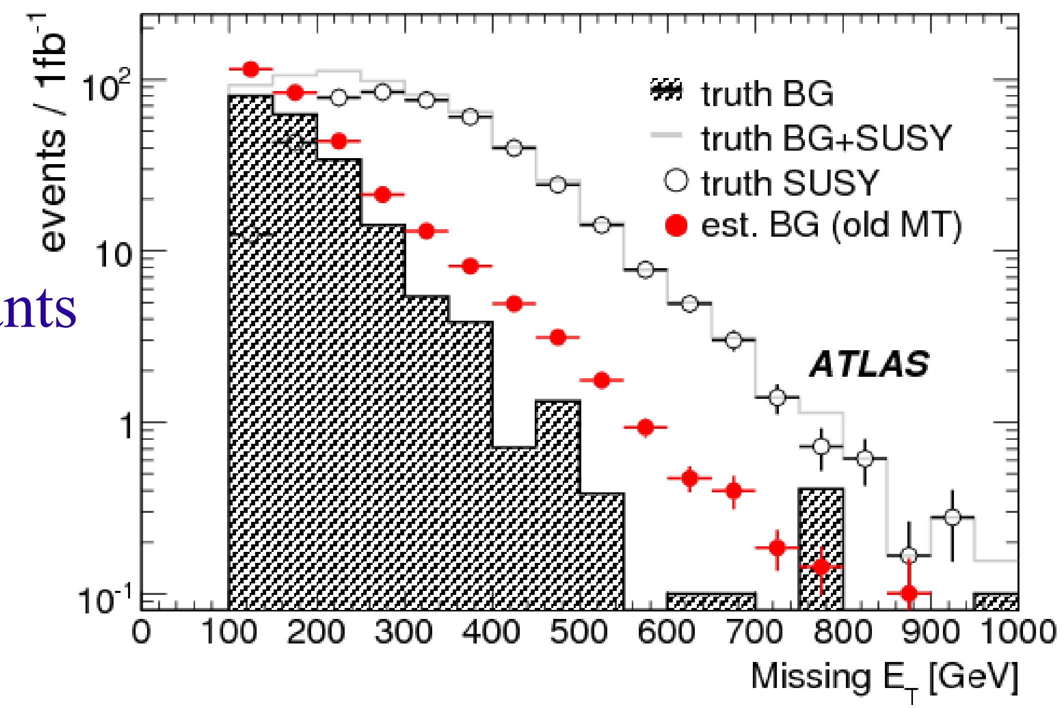
You can do a toy MC to test this method. It will not work if the the dominant background does not come from W's

Backgrounds:Lepton+ jets

Since this is MC, you can cheat and ask how well it worked
It overestimates the background a bit

Warning: you should not be convinced by this alone

There are many more discriminants to study



Triggering

No signal if there is no trigger

LHC trigger menus are complex
and will evolve rapidly with data

Combining triggers is non-trivial

Trigger efficiency must be measured

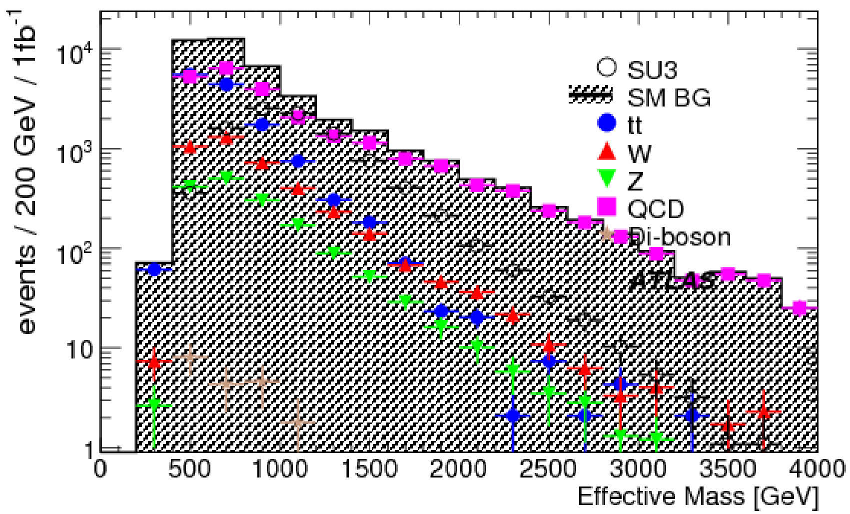
“each trigger is a seperate expermiment”

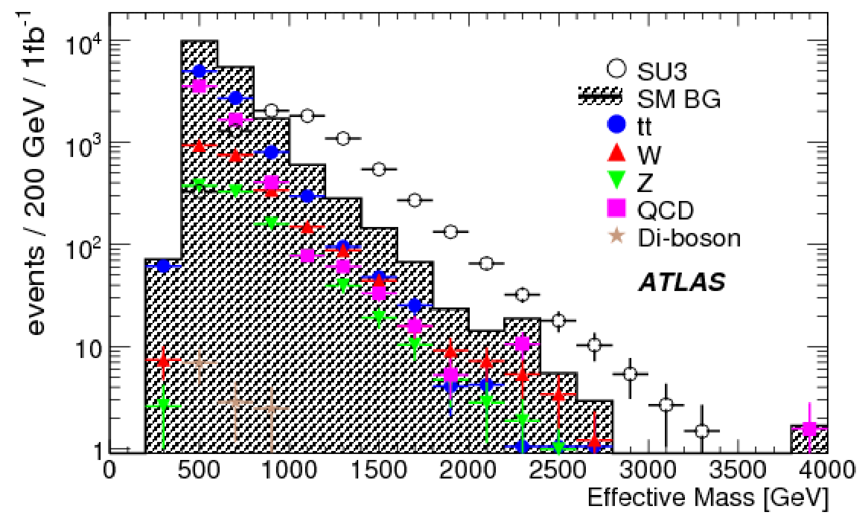
Best, if one trigger is highly efficient

Trigger	SU1	SU2	SU3	SU4	SU6	SU8.1
	0-lepton, 4-jet selection [Section 2.1]					
JETS	44.6	51.0	33.8	7.7	51.7	48.2
j70_xE70	99.7	98.7	99.5	97.2	99.6	99.7
	0-lepton, 3-jet selection [Section 2.2]					
Trigger	SU1	SU2	SU3	SU4	SU6	SU8.1
JETS	64.9	71.1	54.9	34.3	71.8	66.8
j70_xE70	100.	99.8	100.	99.9	100.	100.
	0-lepton, 2-jet selection [Section 2.2]					
JETS	44.1	39.9	30.1	8.8	53.6	47.6
j70_xE70	100.	100.	100.	99.9	100.	100.
	1-lepton, selection [Section 3]					
JETS	41.8	50.5	31.7	8.1	48.4	45.6
j70_xE70	99.6	99.0	98.9	95.6	98.9	99.1
1LEP (mu20 OR e22i)	81.2	81.0	79.9	80.3	80.4	79.5
	OS 2-lepton, selection [Section 4.1]					
JETS	36.7	47.3	34.0	6.7	47.2	40.8
j70_xE70	99.2	100.0	98.9	94.3	99.6	100.0
1LEP (mu20 OR e22i)	87.0	90.0	87.5	84.8	79.6	86.4
2LEP (2mu10 OR 2e15i)	20.5	35.5	27.0	18.0	26.0	14.6
	SS 2-lepton, selection [Section 4.2]					
JETS	39.9	48.8	29.2	1.6	46.6	34.5
j70_xE70	99.3	100.0	98.9	84.1	98.3	100.0
1LEP (mu20 OR e22i)	94.2	92.7	95.9	95.2	89.7	96.6
2LEP (2mu10 OR 2e15i)	32.6	41.5	32.2	25.4	25.9	31.0
	3-lepton, selection [Section 5]					
JETS	43.7	60.2	40.1	17.6	46.4	48.3
j70_xE70	95.6	85.4	93.5	79.8	96.4	98.3
1LEP (mu20 OR e22i)	95.2	94.2	95.8	94.7	94.6	96.7
2LEP (2mu10 OR 2e15i)	49.1	60.2	51.0	44.7	47.3	53.3

Atlas preliminary

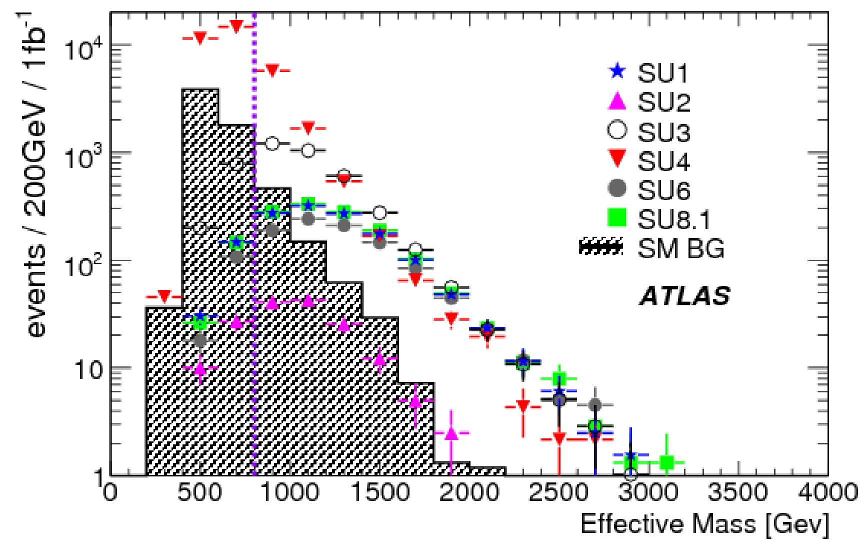
Inclusive SUSY search: jets and etmiss





ATLAS plots showing cut flow
Top: basic selection
Etmiss >100, 4 jets
Right: tighten missing ET cut
Bottom: toplogical cuts, lepton vet

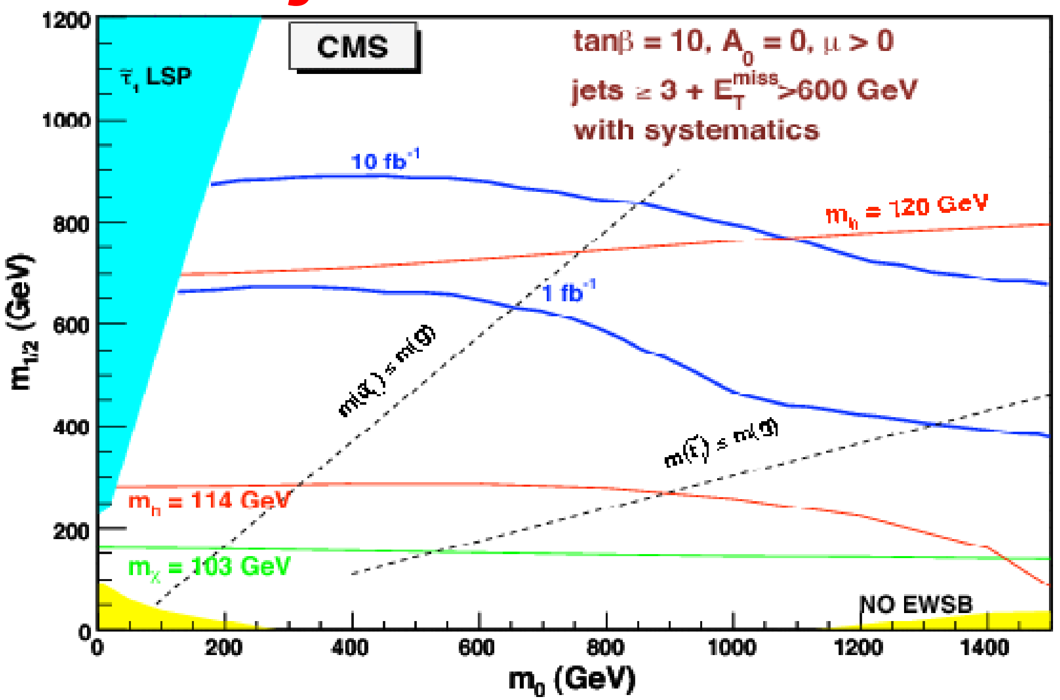
This is a 4 jet etmiss analysis



Preliminary

Inclusive SUSY search: jets and etmiss

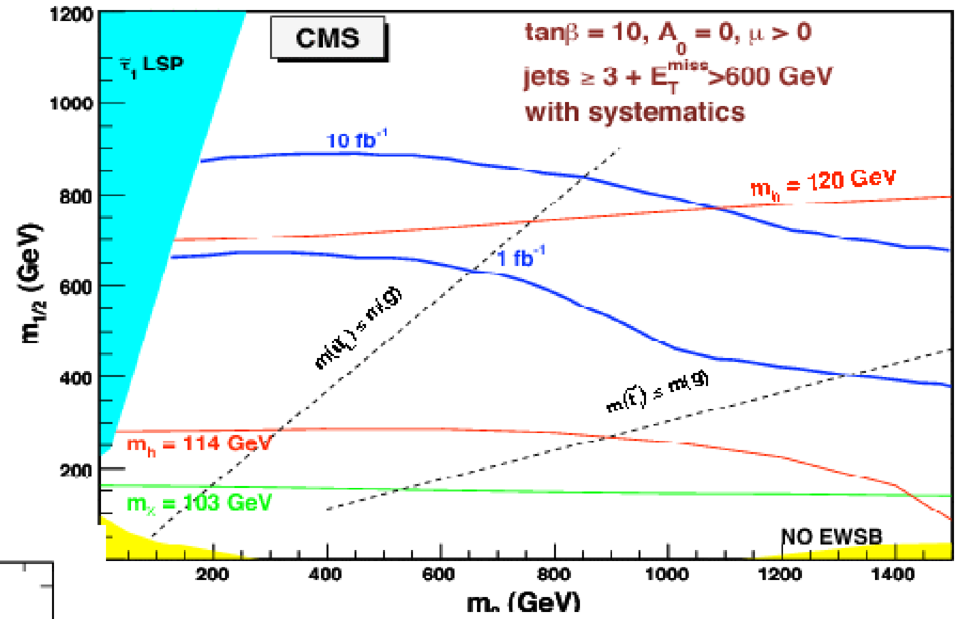
Events with jets and Etmiss
Selections used by ATLAS and CMS are differant

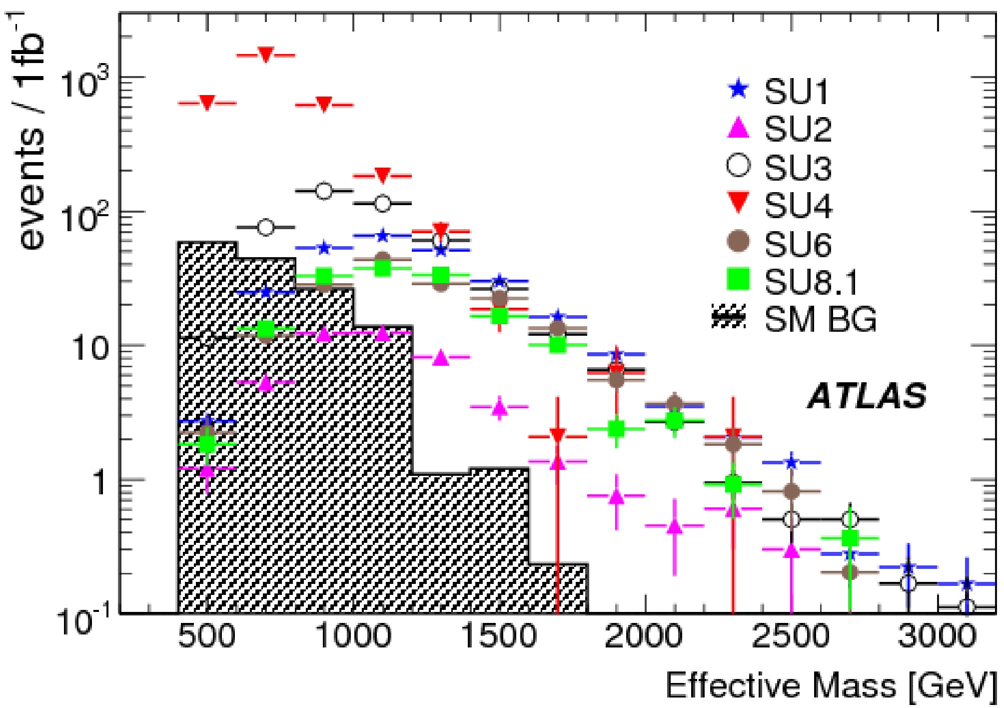


Biggest issue in making this plot is careful understanding of background systematics

Inclusive searches: jets+ leptons

- Background is easier to control
- And usually smaller
- Reach is comparable

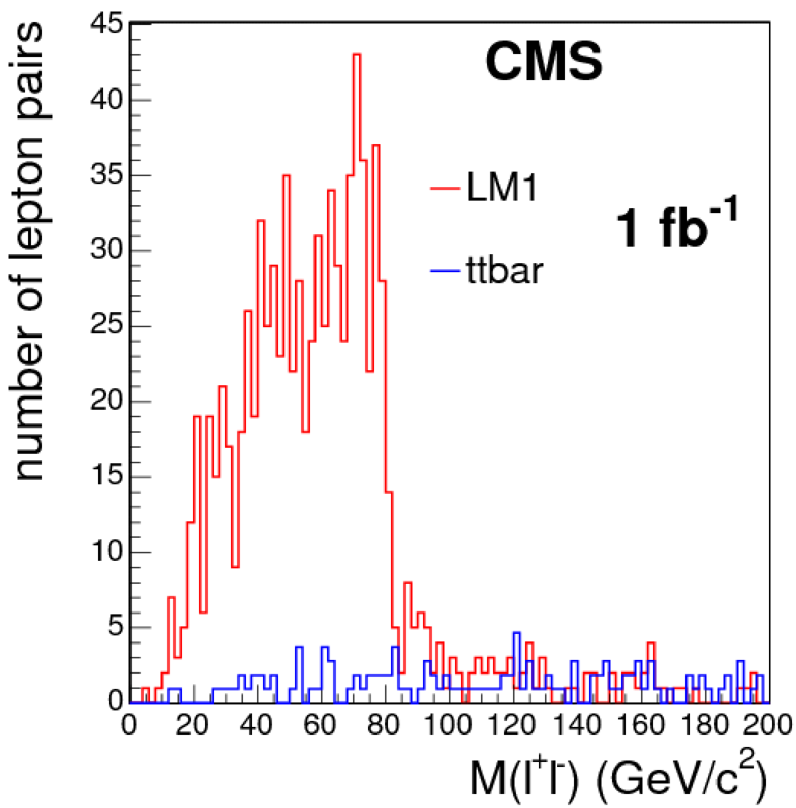


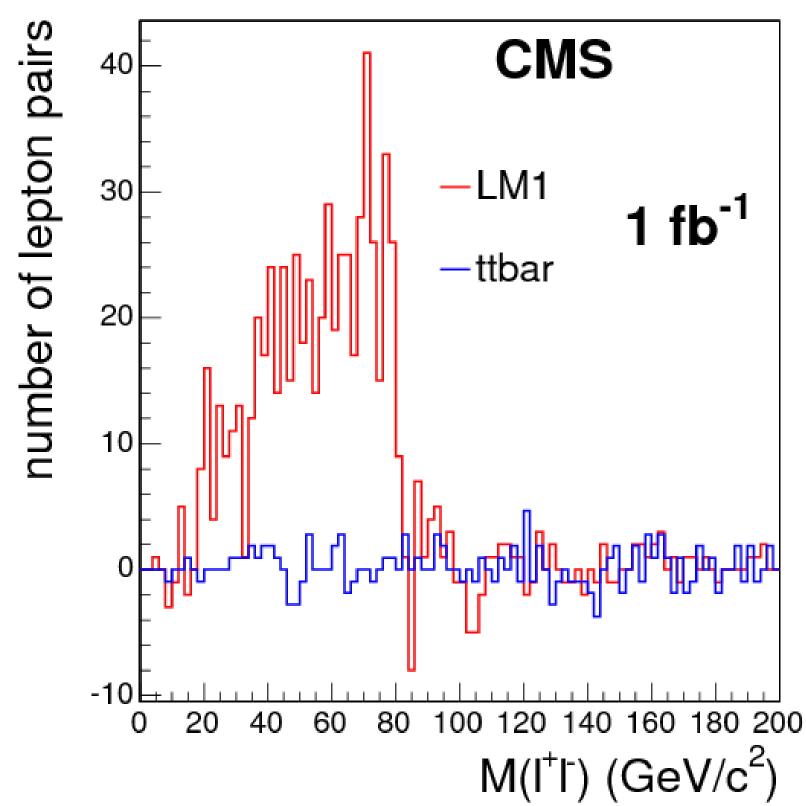


Same cuts used for all signal cases

Inclusive searches: dileptons

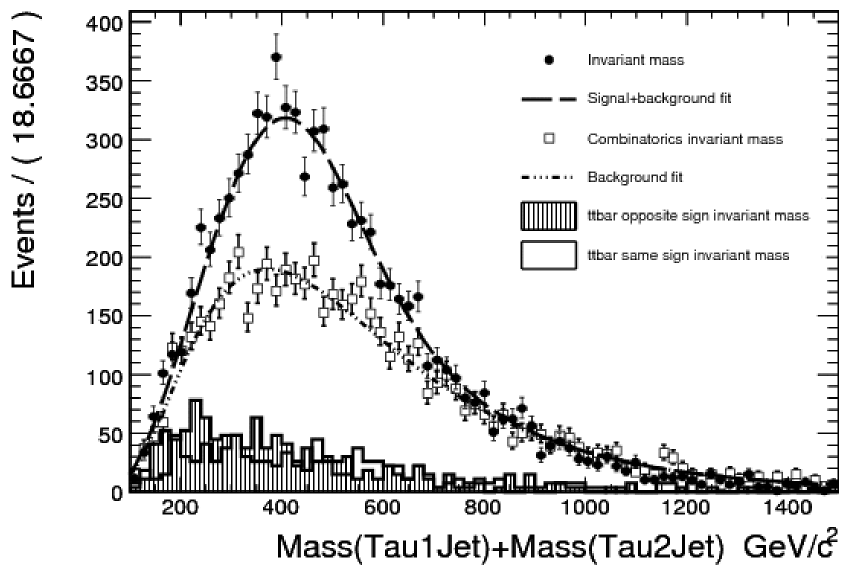
- Leptons can come from independent decays
- Leptons can come from a single decay chain: flavor and sign correlated: This is essentually background free after subtraction
- Plot shows e+e- and μ +μ- and subtraction of μe which removes independent decays and top background

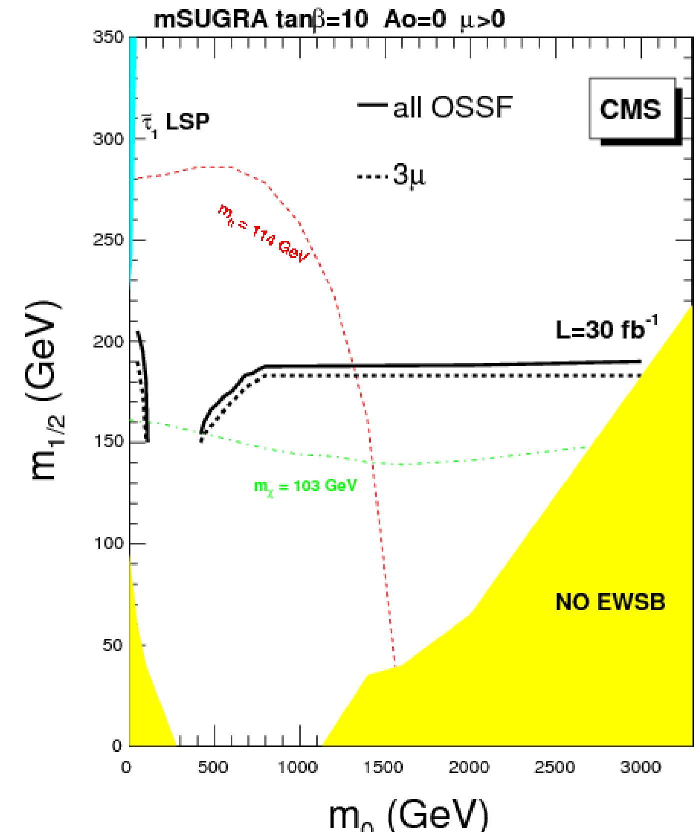




Inclusive searches: Taus

Important at large tanb where stau is lighter than selectron
Identify taus from jets with “small mass and low track multiplicity



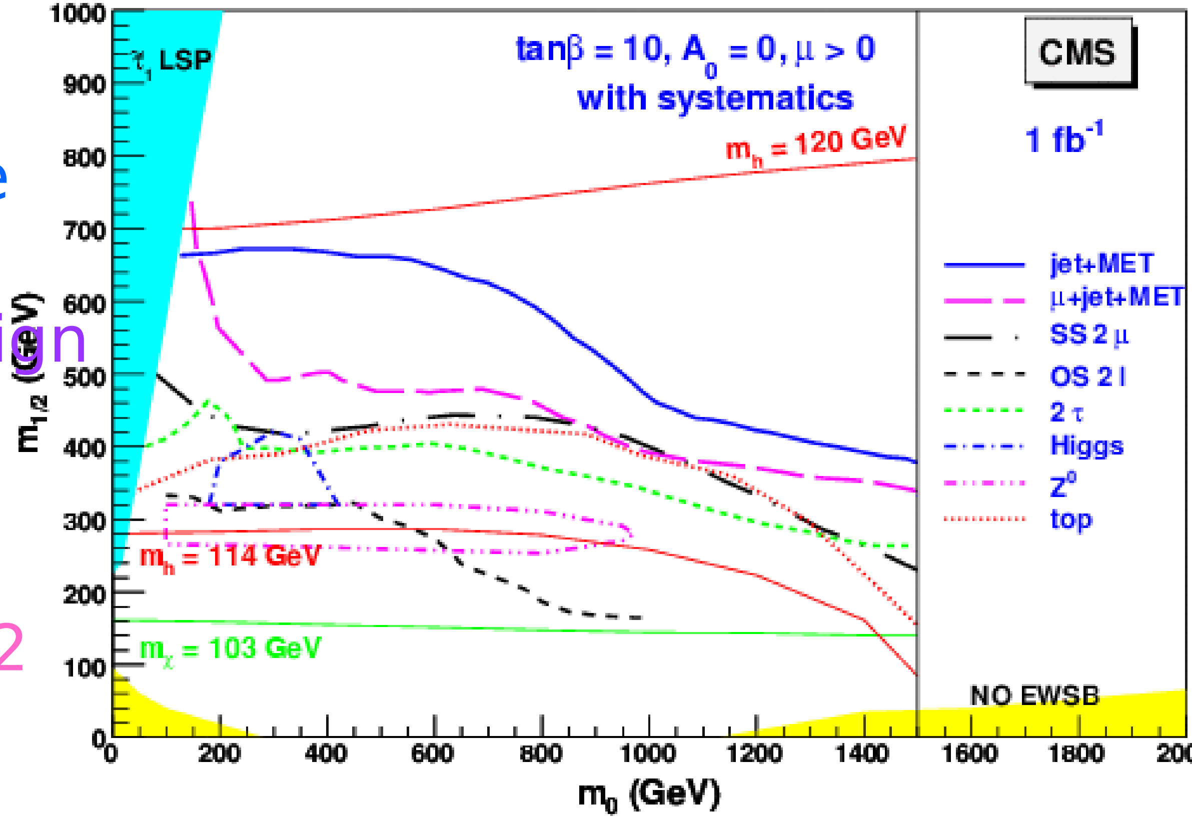


Inclusive searches: CMS summary

- jets(≥3) + E_T^{miss} + μ isolated
- jets(≥3) + E_T^{miss} + same sign 2-μ
- jets(≥2) + E_T^{miss} + op. sign dilep (e,μ,τ) ($\chi_2^0 \rightarrow \ell_R \ell \rightarrow \ell^+ \ell^- \chi_1^0$)

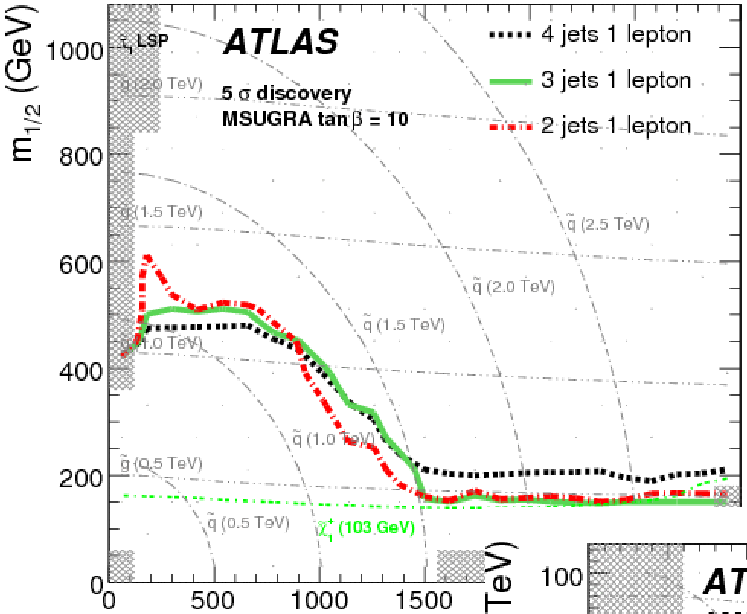
h^0 in cascades. $h^0 \rightarrow bb$ + 2 jets + E_T^{miss}

- Z + E_T^{miss} ($\chi_2^0 \rightarrow Z \chi_1^0$)
- t + jets(≥4 1 b) + isol. ℓ (≥1) ($t_1 \rightarrow t \chi_2^0 \rightarrow t \ell \ell \chi_1^0$)

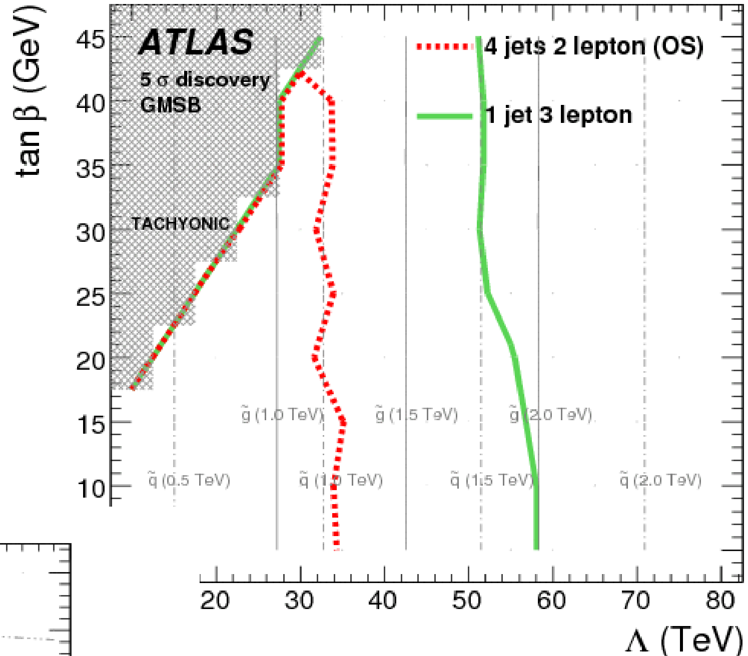


1 inverse fb gets to gluino mases of 1.4 TeV: life will be tough if nothing has shown up at that point

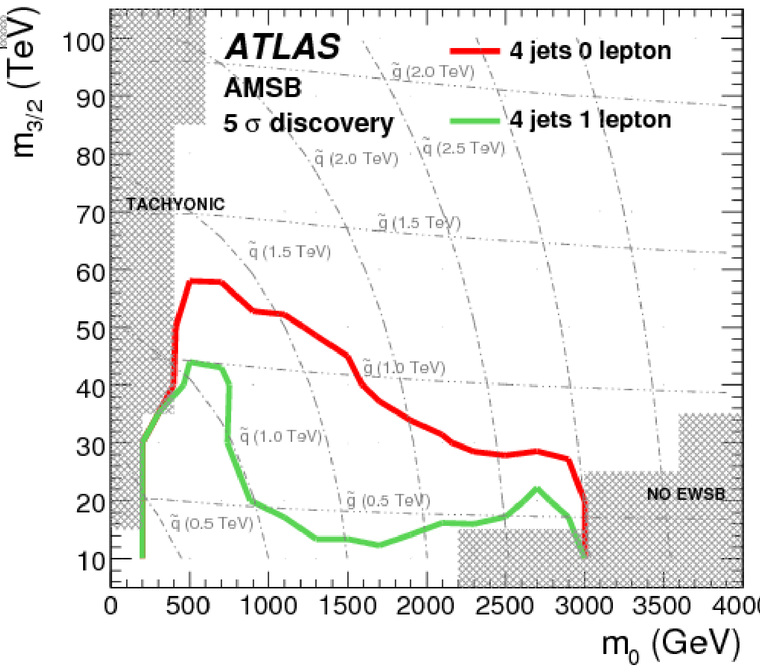
Inclusive searches: ATLAS summary



gmsb



sugra



amsb

Exclusive analyses

- Goal is to reconstruct decay chains and final states
- Much more powerful than inclusive measurements:even for some searches
- More model dependent: but sometimes you only need a feature such as a decay chain
- Needs more integrated luminosity
- I can only give a few examples

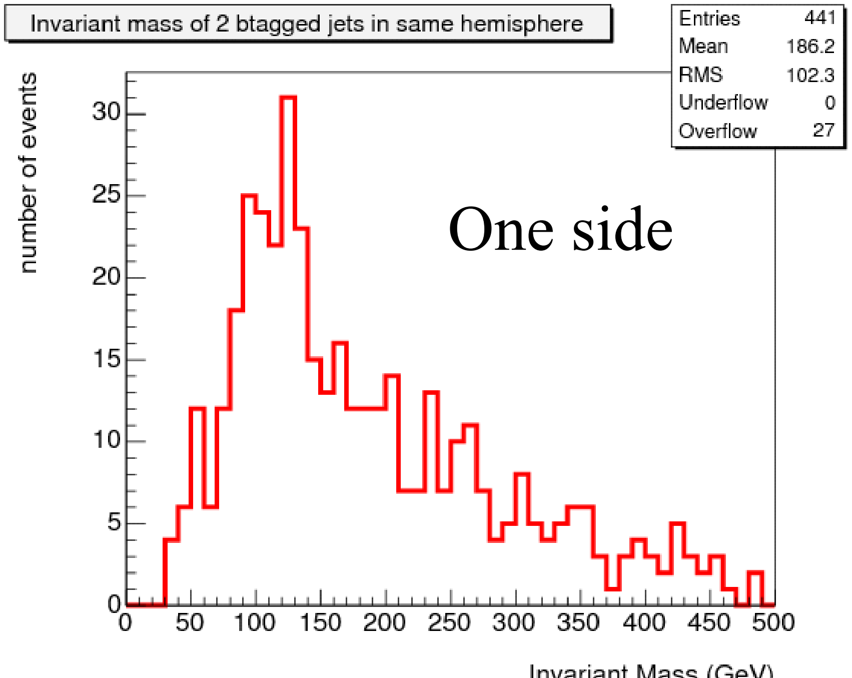
CMS "hemisphere" method

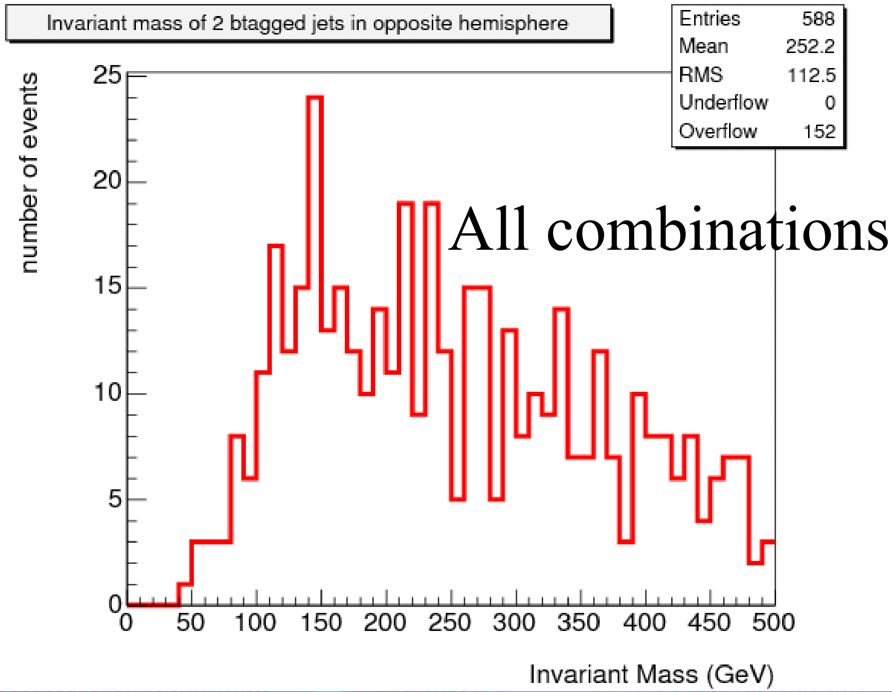
An important issue is the combinatorial background in complex events

SUSY particles are produced with significant momentum

Divide the event into two parts using the biggest jets: then only allowing combinations within a hemisphere

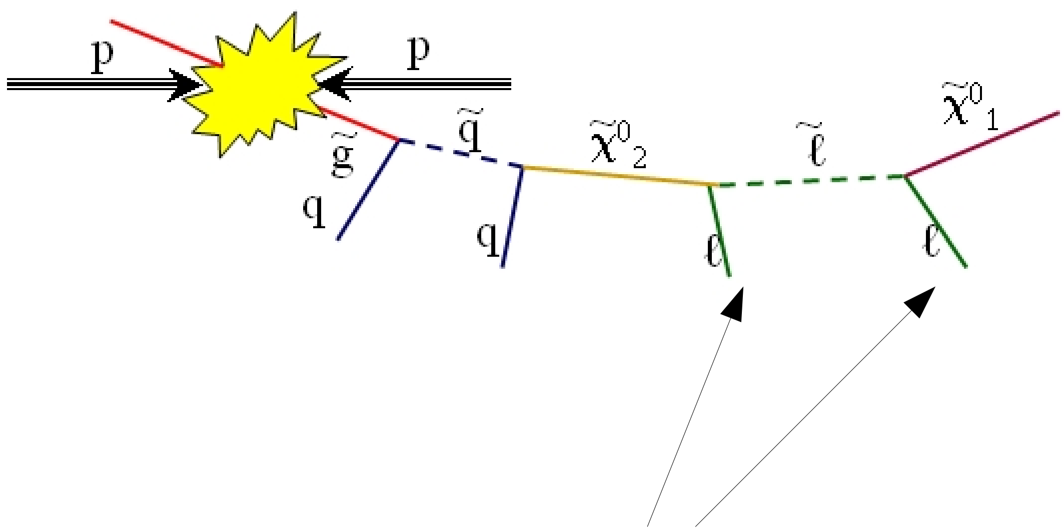
This example shows the improvement in Higgs finding in SUSY events





Kinematic structures

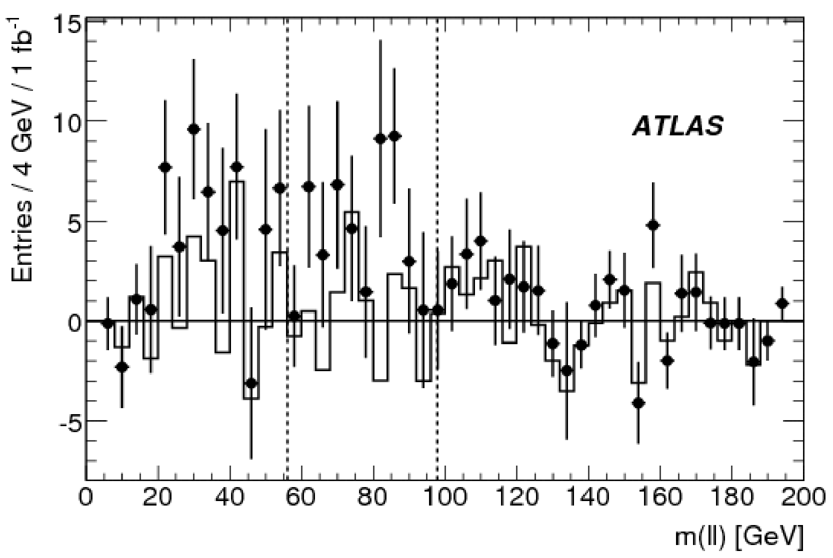
- A typical decay chain
- I'll use this in examples



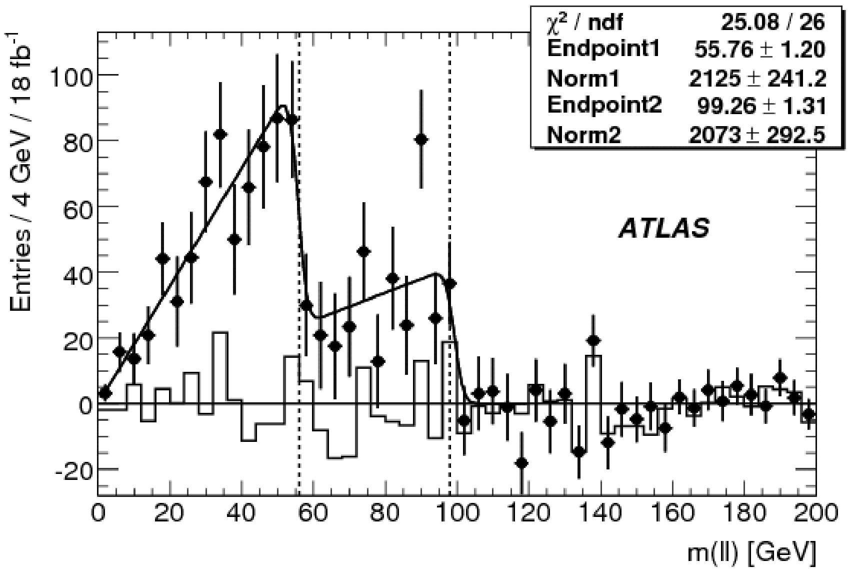
$$m_{\ell\ell}^{edge} = m_{\tilde{\chi}_2^0}\sqrt{1-\left(\frac{m_{\tilde{\ell}}}{m_{\tilde{\chi}_2^0}}\right)^2}\sqrt{1-\left(\frac{m_{\tilde{\chi}_1^0}}{m_{\tilde{\ell}}}\right)^2}$$

Dilepton end points

- Note that the leptons have the same charge so a flavor subtraction cleans up the signal
- Recall the plot on slide 31 for CMS. Sometimes you get more complex structure and sometimes you will need more luminosity
-



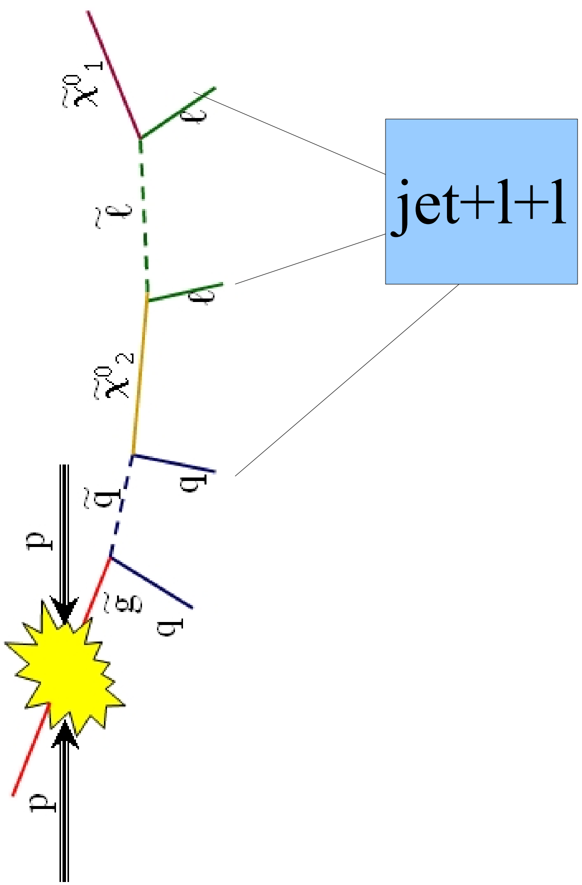
1 inverse fb



18 inverse fb

Kinematic structures

This combination has a minimum and maximum value



Atlas Preliminary

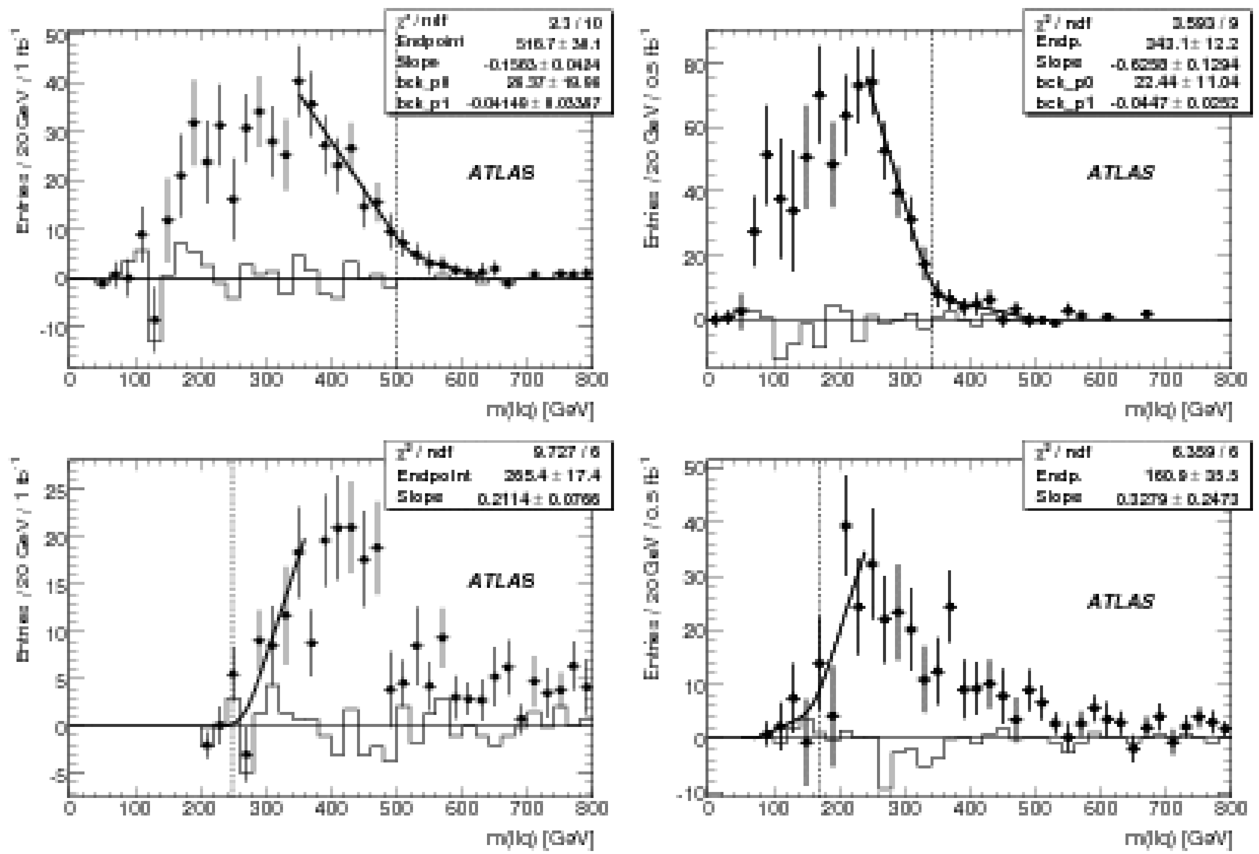
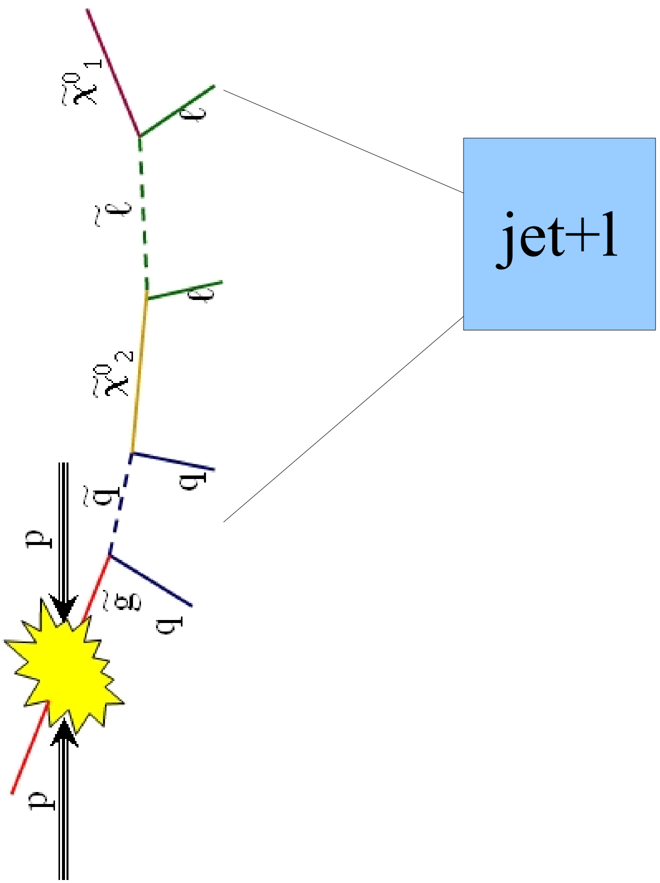


Figure 4: Efficiency-corrected flavour-subtracted distributions of m_{llq} (top) and m^{thr}_{llq} (bottom) for SU3 (left) with 1 fb^{-1} and SU4 (right) with 0.5 fb^{-1} of data are shown. The points with error bars show SUSY plus Standard Model, the solid line shows the Standard Model contribution alone. The fitted function is superimposed, the vertical line indicates the theoretical endpoint value.

Kinematic structures

Atlas Preliminary



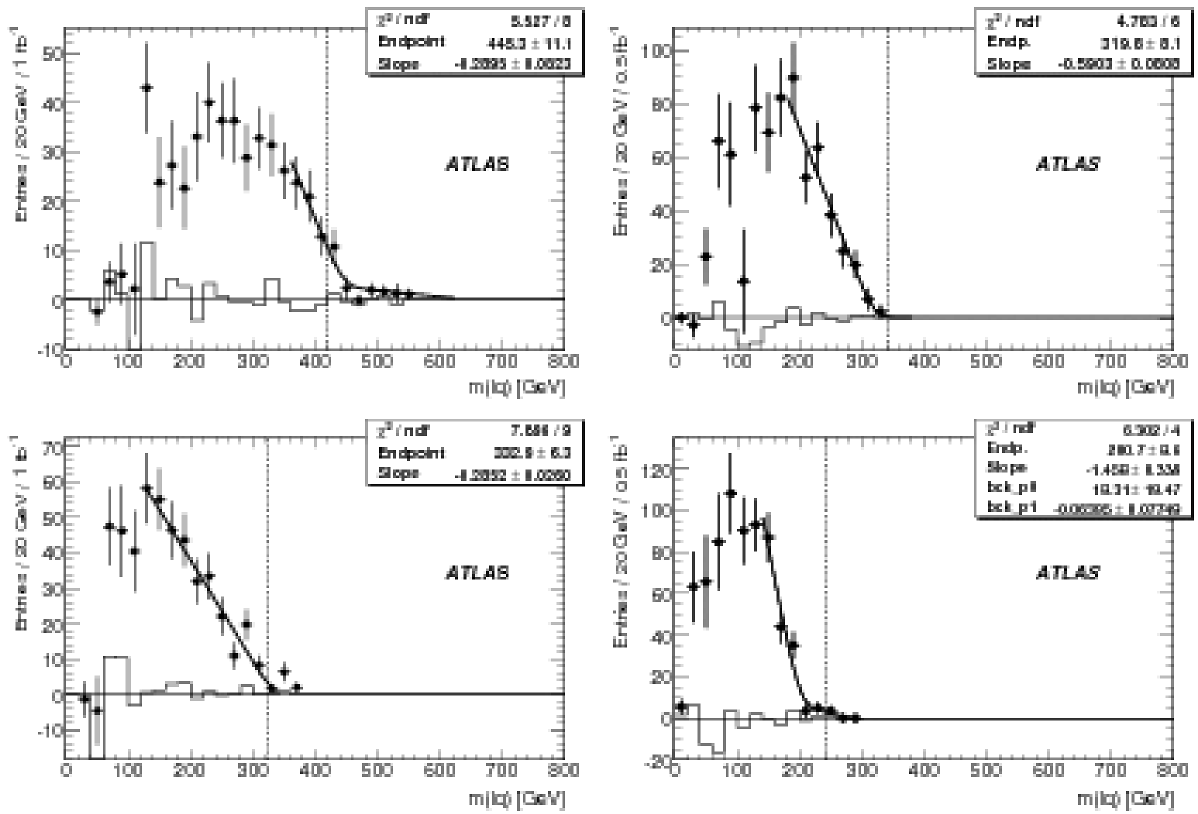


Figure 5: Efficiency-corrected flavour-subtracted distributions of $m_{\ell q(\mathrm{high})}$ (top) and $m_{\ell q(\mathrm{low})}$ (bottom) for SU3 (left) with 1 fb^{-1} and SU4 (right) with 0.5 fb^{-1} of data are shown. The points with error bars show SUSY plus Standard Model, the solid line shows the Standard Model contribution alone. The fitted function is superimposed, the vertical line indicates the theoretical endpoint value.

Measurements of end points

- 1 fb^{-1} for SU3: 0.5$fb^{-1}$for SU4
- Errors are stat, systematic and jet energy scale

Atlas preliminary

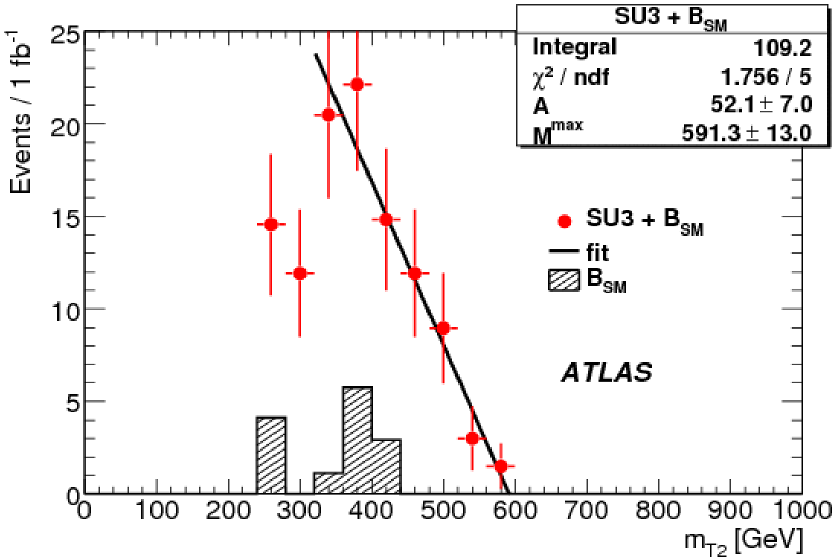
Endpoint	SU3 truth	SU3 measured	SU4 truth	SU4 measured
m_{llq}^{max}	501	$517 \pm 30 \pm 10 \pm 13$	340	$343 \pm 12 \pm 3 \pm 9$
m_{llq}^{min}	249	$265 \pm 17 \pm 15 \pm 7$	168	$161 \pm 36 \pm 20 \pm 4$
$m_{lq(low)}^{max}$	325	$333 \pm 6 \pm 6 \pm 8$	240	$201 \pm 9 \pm 3 \pm 5$
$m_{lq(high)}^{max}$	418	$445 \pm 11 \pm 11 \pm 11$	340	$320 \pm 8 \pm 3 \pm 8$

Add the squark right from the “stansverse mass of dijet+etmiss events

Dijet plus etmiss

- Classic signature for squark(right) pairs
- Only 2 jets with pt>200 GeV
- Etmiss >200 GeV
- No leptons
- Topological cuts (recall etmiss backgrounds)
- 1 inverse fb, 640 GeV squark

Atlas preliminary



Exclusive Final state with Higgs

- Look for the Higgs in bbar, then add a jet to try to see squark to

Atlas preliminary

A
l

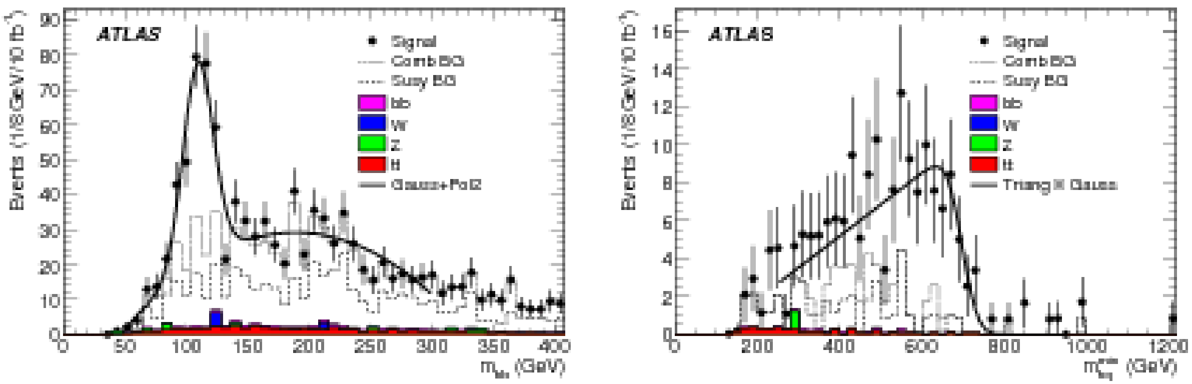


Figure 11: Invariant mass of the selected b-jet pairs (left) and invariant mass of the system consisting of the Higgs plus the jet minimising m_{hq} (right) after 10 fb^{-1} of integrated luminosity.

Degenerate models??

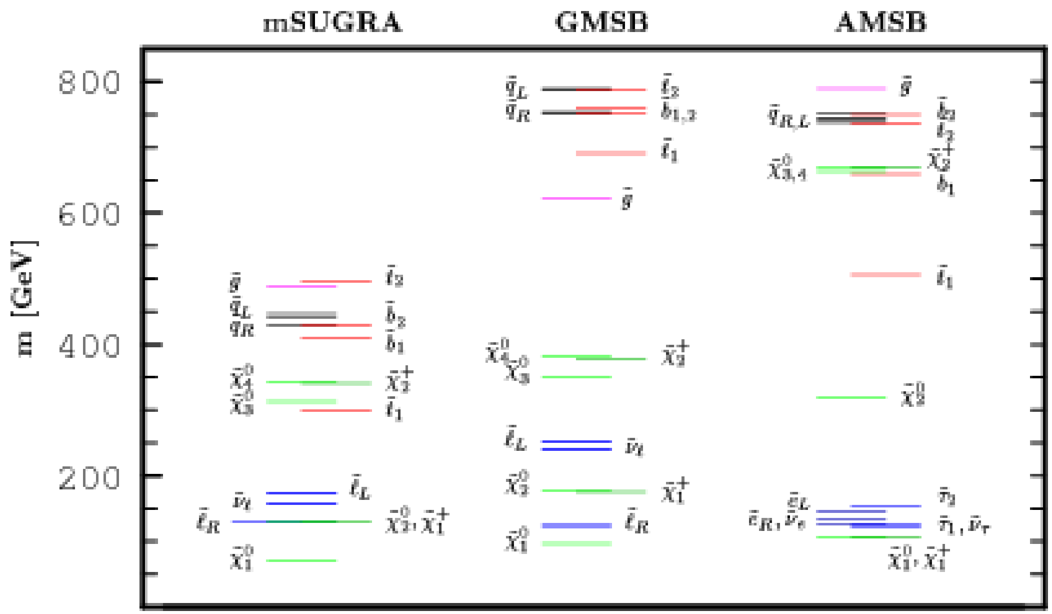
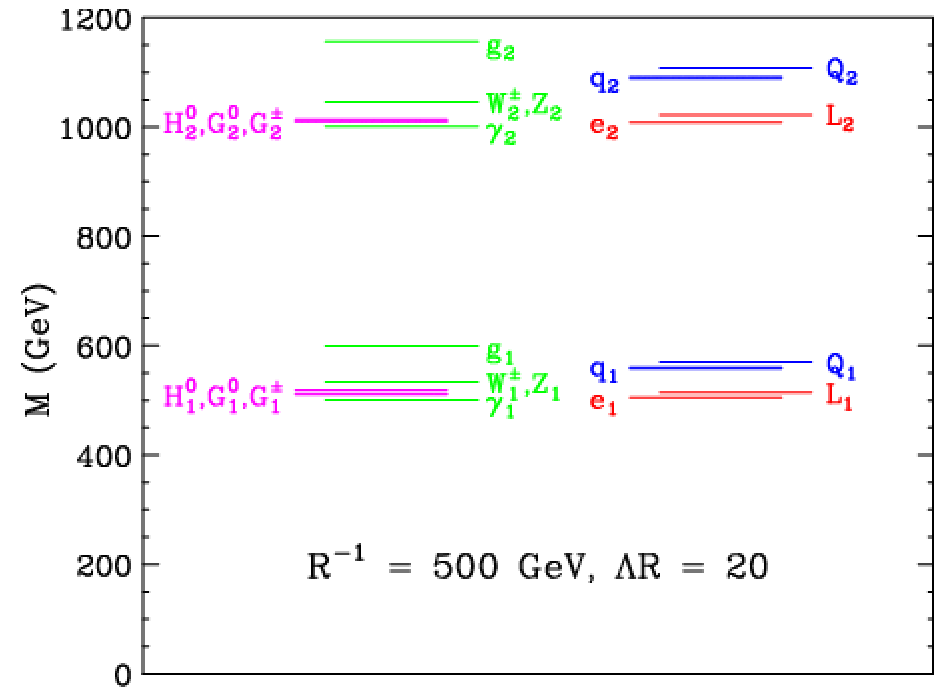


Figure 3.0.1: *Examples of mass spectra in mSUGRA, GMSB and AMSB models for* $\tan\beta = 3$, *sign* $\mu > 0$. *The other parameters are* $m_0 = 100$ *eV*, $m_{1/2} = 200\,GeV$ *for mSUGRA;* $M_{mess} = 100\,TeV$, $N_{mess} = 1$, $\Lambda = 70\,TeV$ *for GMSB; and* $m_0 = 200\,GeV$, $m_{3/2} = 35\,TeV$ *for AMSB.*



Much theoretical angst over this problem

This is a problem that we need to keep us all busy!!

Determining parameters: my opinion

- Those of you who are old enough should remember EW fitting before we all believed the standard model
  - Most general four fermi interaction? $\gamma^{\mu}(g_v - g_a\gamma_5)$? Huge numbers of parameters
  - Could fit this lot, or just fit $\sin^2\theta_W$
  - Remember Occam
- Rates are difficult to use without a model
  - Many different processes and decays might contribute
  - If acceptance corrections can be done, very powerful model test

Timescale

- LHC will have first collisions in the next few months
- This year will be at 10 TeV
  - Vital to provide shake down of detectors
  - Integrated luminosity unknown
- There will be a winter shutdown
  - Detector accesses to fix problems and complete missing items
- 2009 run at 14 TeV: 1-2 inverse fb?
  - Susy discovered < 2 years from now??
- Expect to accumulated several inverse fb before 2011
- Full LHC luminosity (10**34) will be reached in a few years
- After this year we will have much clearer idea of long term

Taus: polarization issues

Atlas preliminary