Searches for supersymmetry with the ATLAS detector

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ATLAS Detector Under construction
October 2005

Outline

- The accelerator LHC and the experiment ATLAS
  - Status of installation and commissioning
  - When will we get the data, and how much of them ?
- Searches for supersimmetry
  - Supersimmetry: what is this?
  - Search strategies for mSUGRA models
  - Commissioning of the detector
  - Measurement and control of backgrounds

My talk will be about the SUSY searches with the first LHC data, based on the "classical" jets+EtMiss+n-leptons signature.

Giacomo will cover other search strategies, measurements of SUSY particle properties, and constraints of model parameters.

The Large Hadron Collider

LHC, Collider *pp*

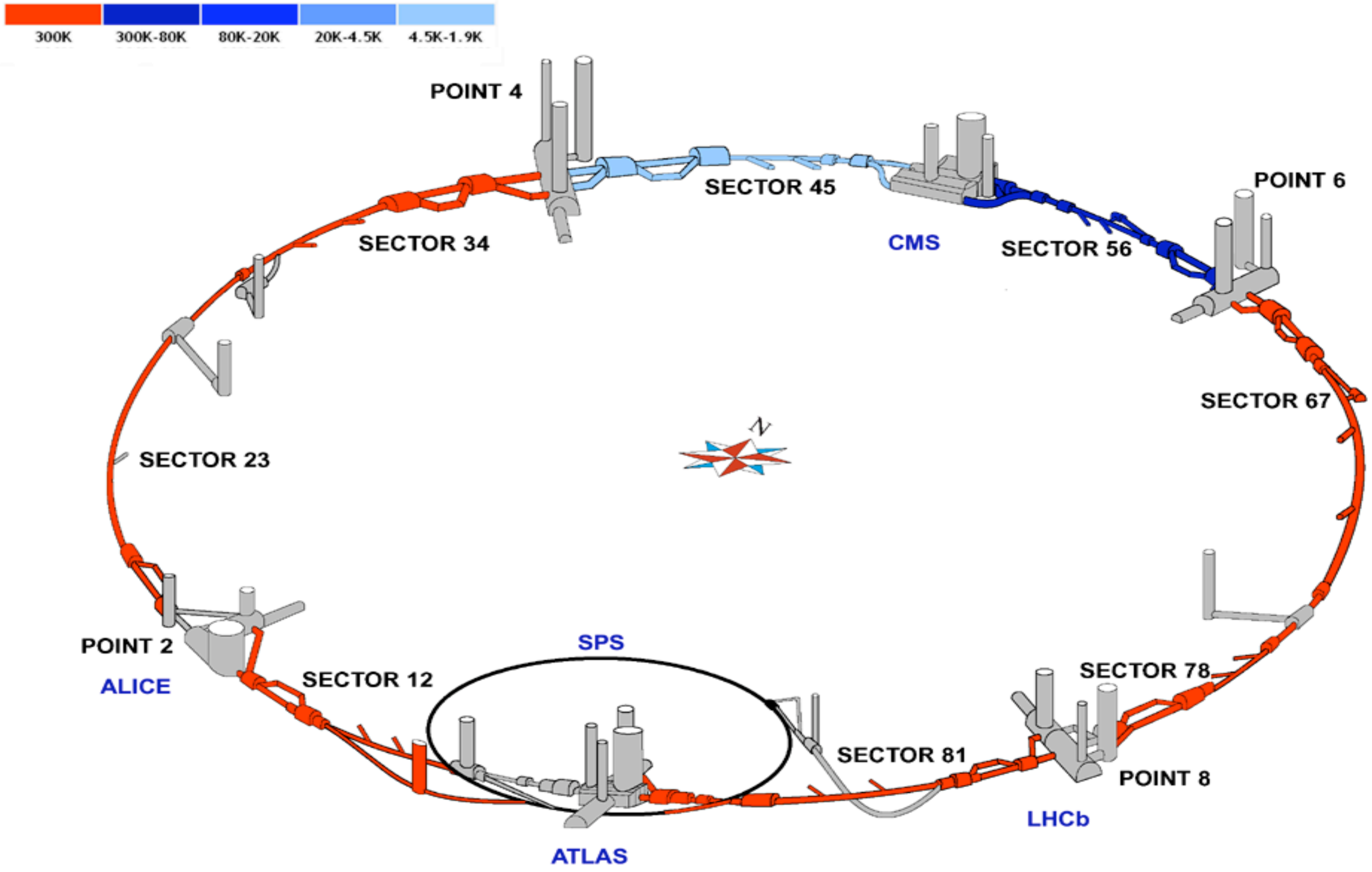
27 km ring at CERN

Data taking starts in 2008

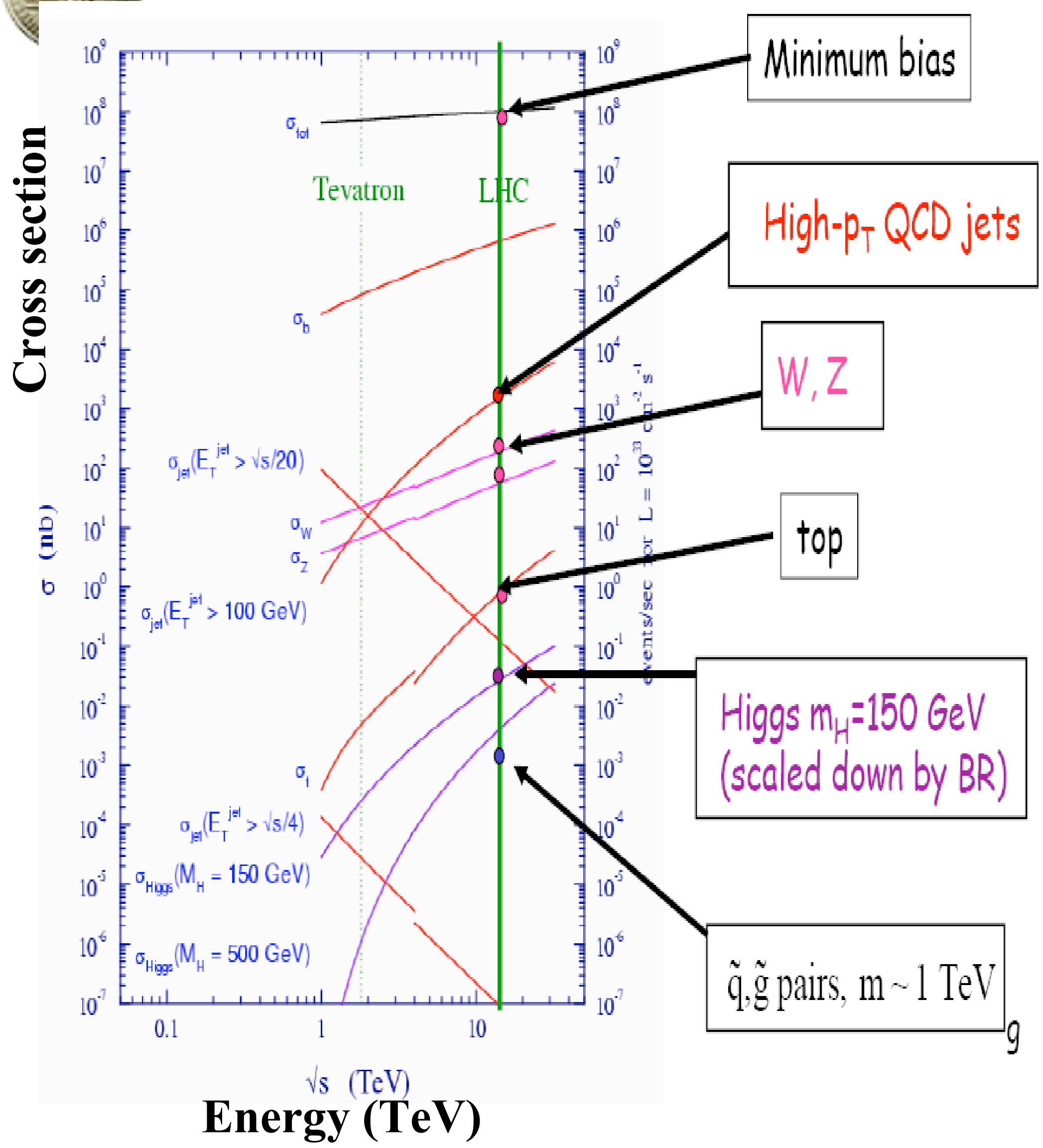
E_{cm}=14 TeV

Luminosity L = 10^{34} cm^{-2} s^{-1}

(~20 pp collisions every 25 ns)



A needle in an haystack



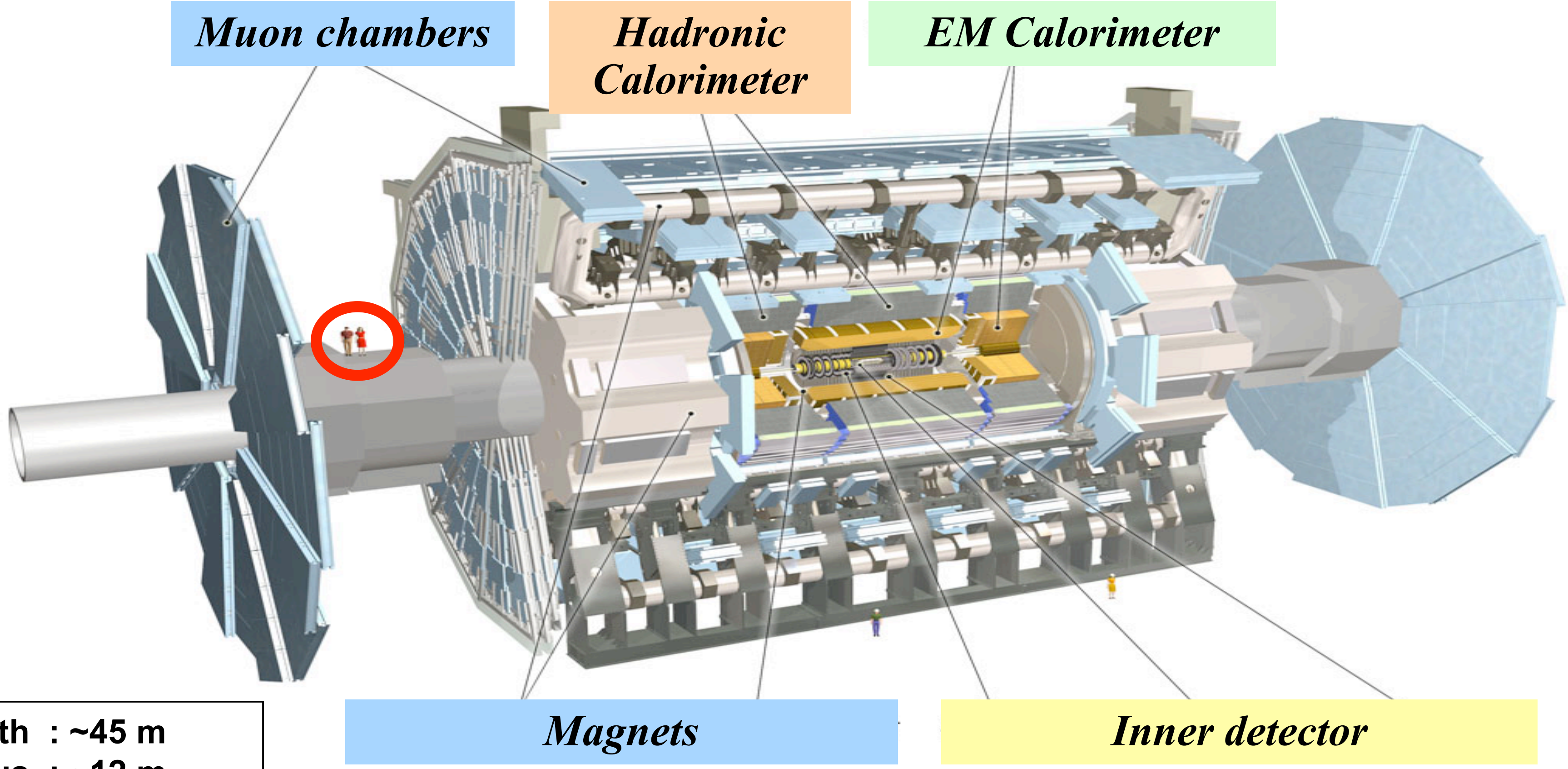
Only one event (= pp collision) in **one bilion** may contain an Higgs boson or a squark….

Need **high luminosity**

Need an **efficient online selection** (trigger) to select interesting events: cannot register everything for further processing

ATLAS (A ToroidaL ApparatuS)

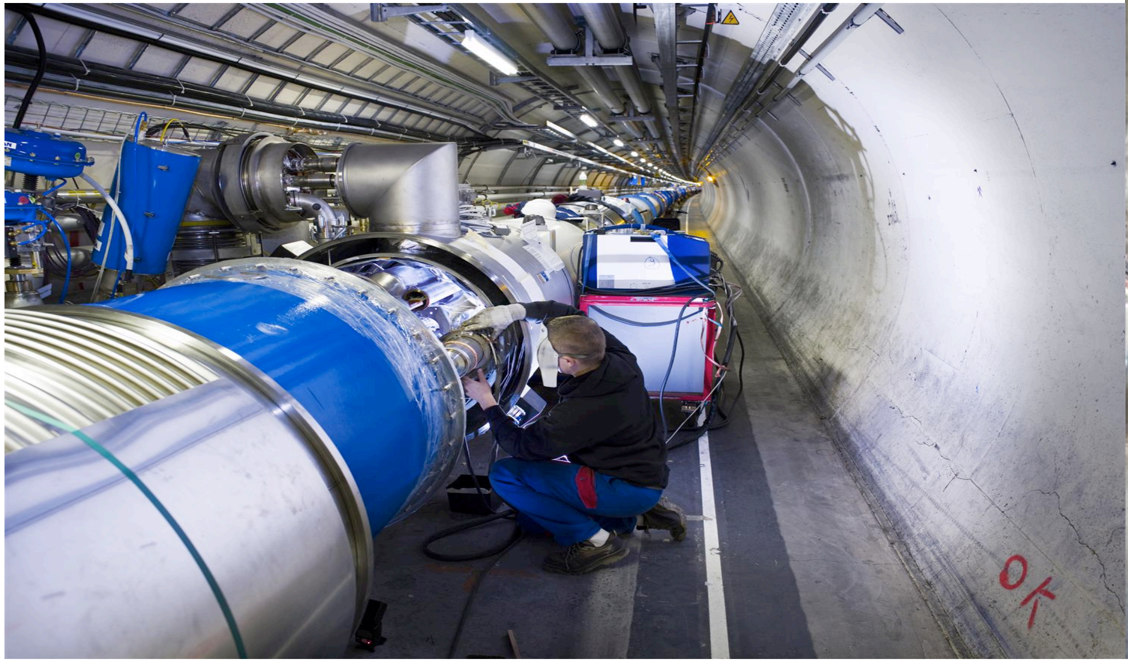
- ☐ Identify and measure the energy of (charged and neutral) **hadrons, electrons**, **photons, and taus**
- ☐ Measure precisely the **trasverse momentum** p_T of charged particles; reconstruct decay vertices
- ☐ Measurement of **missing trasverse energy**
- ☐ Identify and measure the momentum of **muons**



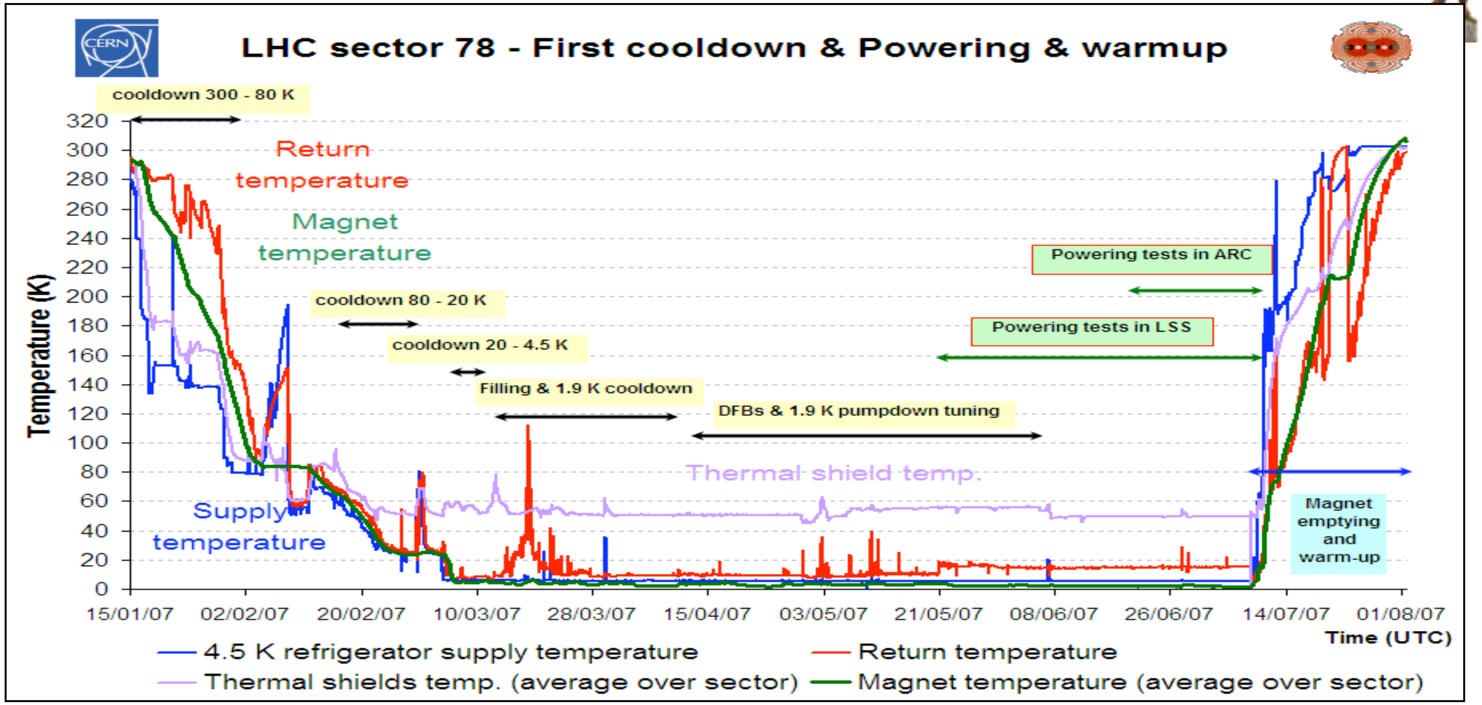
Length : ~45 m
Radius : ~12 m
Weight : ~ 7000 tons

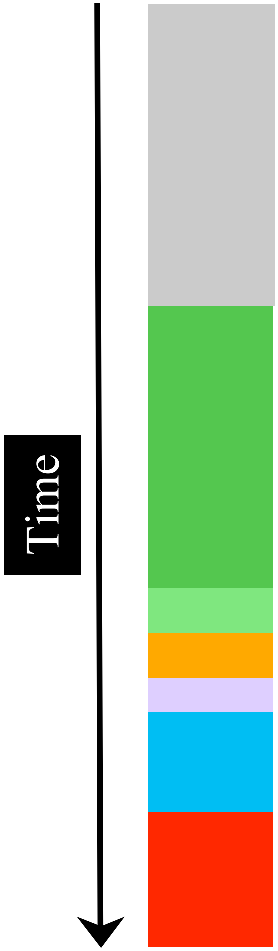
LHC status

- The last of 1746 superconducting magnets was installed in the tunnel on April 26th
- Interconnection to the cryogenic system completed on November 7th
- Now, each of the eight sectors of the accelerator must be commissioned



Sector tests



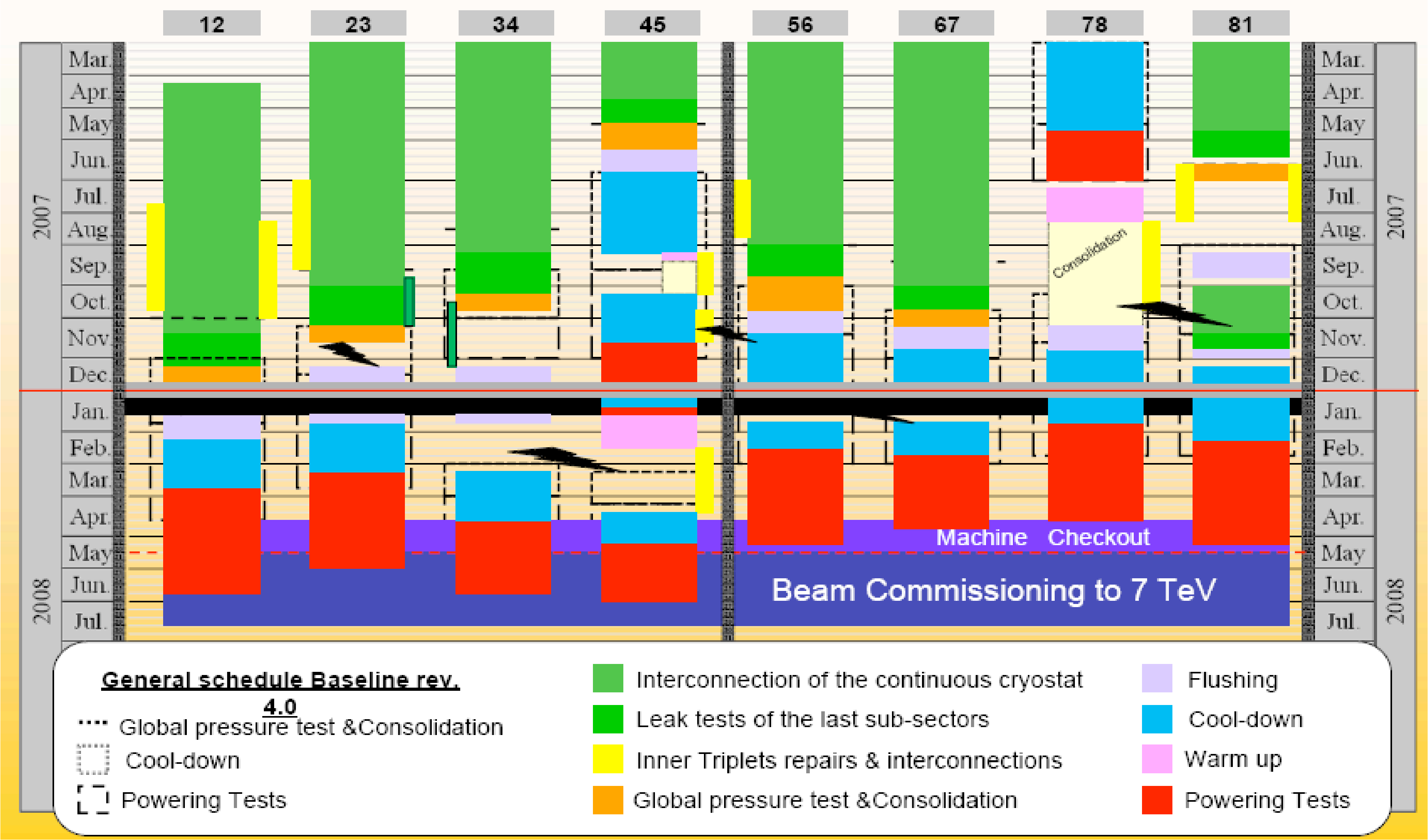


Each of the eight sector must be commissioned
Already done the whole procedure for sector 78

🟪 Installation
🟩 Interconnection of the continuous cryostat
🟩 Leak tests of the last sub-sectors
🟧 Global pressure test & Consolidation

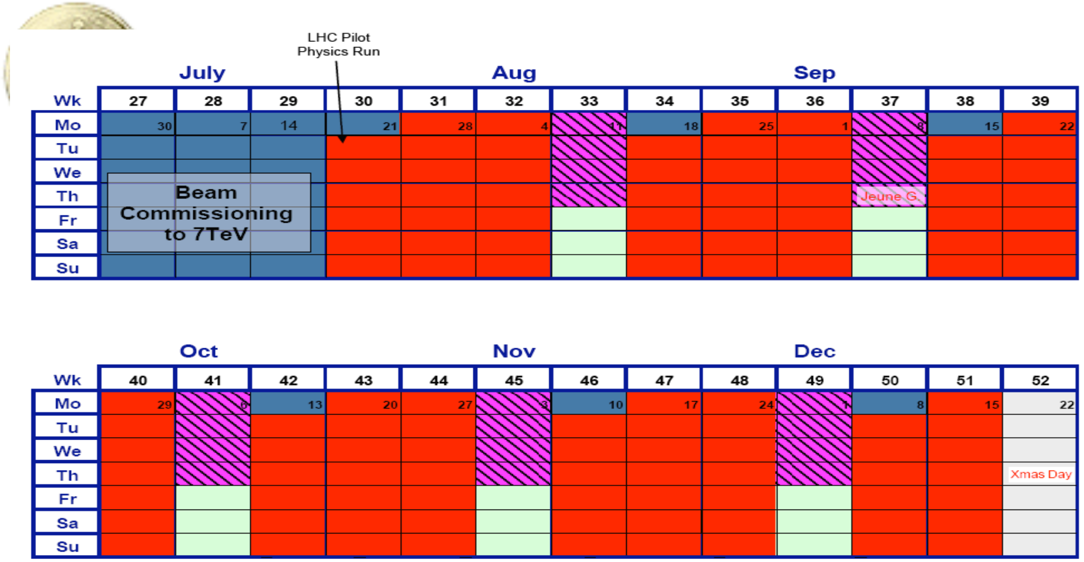
🟪 Flushing
🟦 Cool down
🟥 Powering Tests

LHC sector commissioning



- First collisions scheduled for July
- Success-oriented schedule: assumes no problem found during commissioning

The LHC pilot physics run (2008)



Pilot physics run 2008

17 weeks

Live time = 4·10^6 seconds

Rate = 200 Hz

Raw Data = 8·10^8 events (1300 TB)

Luminosity = ?

Nominal LHC luminosity is 10^{34} cm^{-2} s^{-1}

We will only achieve that after installation of additional hardware (in 2010?)

In 2008-2009, up to 2 10^{33} cm^{-2} s^{-1} are possible

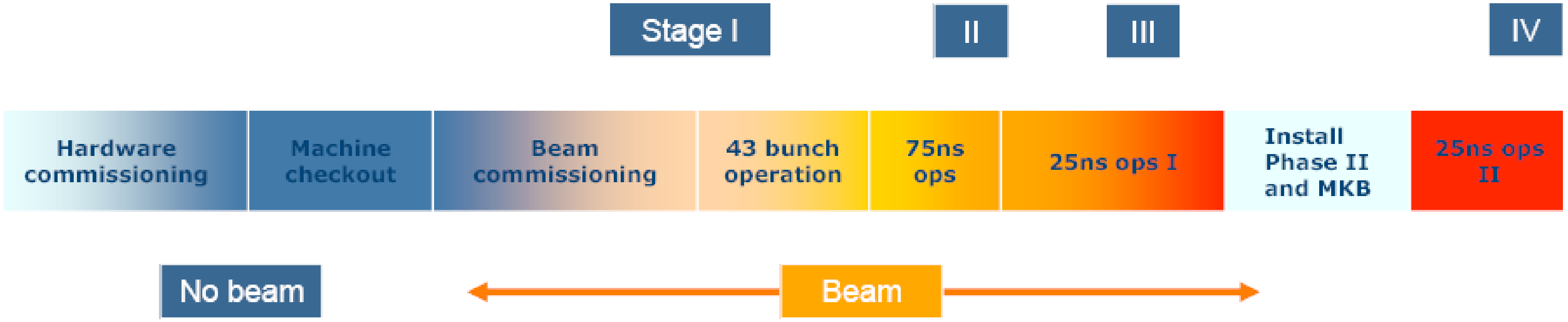
In practice, luminosity will gradually increase up to this value: it takes time to operate an hadron collider at the nominal performance.

It is impossible to know in advance how much time it will take to get the maximum luminosity.

~20 pp interaction each 25 ns -> 1 GHz of collisions

We can afford to register about 200 Hz -> a tight online event selection (trigger) is needed. As luminosity increases, the trigger selection will get tighter, but the event rate will be close to 200 Hz from day-1.

How much data, when ?



I. Pilot physics run

- First collisions
- 43 bunches, no crossing angle, no squeeze, moderate intensities
- Expected performance ~10^{31} cm^{-2} s^{-1} at ~1 event/crossing
- Push performance (156 bunches, partial squeeze in 1 and 5, push intensity)
- Performance limit 10^{32} cm^{-2} s^{-1} (event pileup)

II. 75ns operation

- Establish multi-bunch operation, moderate intensities
- Relaxed machine parameters (squeeze and crossing angle)
- Expected performance ~10^{32} cm^{-2} s^{-1} at ~1 event/crossing
- Push squeeze and crossing angle
- Performance limit 10^{33} cm^{-2} s^{-1} (event pileup)

III. 25ns operation I

- Nominal crossing angle
- Push squeeze
- Increase intensity to 50% nominal
- Performance limit 2 10^{33} cm^{-2} s^{-1}

IV. 25ns operation II

- Push towards nominal performance

More details – phase A

This may give us peraphs 100 pb^{-1} - end 2008?

Parameters			Beam levels		Rates in 1 and 5		Rates in 2	
k_b	N	β* 1,5 (m)	I_{beam} proton	E_{beam} (MJ)	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing
1	10^{10}	11	$1\ 10^{10}$	10^{-2}	$1.6\ 10^{27}$	<< 1	$1.8\ 10^{27}$	<< 1
43	10^{10}	11	$4.3\ 10^{11}$	0.5	$7.0\ 10^{28}$	<< 1	$7.7\ 10^{28}$	<< 1
43	$4\ 10^{10}$	11	$1.7\ 10^{12}$	2	$1.1\ 10^{30}$	<< 1	$1.2\ 10^{30}$	0.15
43	$4\ 10^{10}$	2	$1.7\ 10^{12}$	2	$6.1\ 10^{30}$	0.76	$1.2\ 10^{30}$	0.15
156	$4\ 10^{10}$	2	$6.2\ 10^{12}$	7	$2.2\ 10^{31}$	0.76	$4.4\ 10^{30}$	0.15
156	$9\ 10^{10}$	2	$1.4\ 10^{13}$	16	$1.1\ 10^{32}$	3.9	$2.2\ 10^{31}$	0.77

More details – phase A

This may give us a few fb^{-1} - end 2009?
At nominal luminosity, ~60 fb^{-1}/year

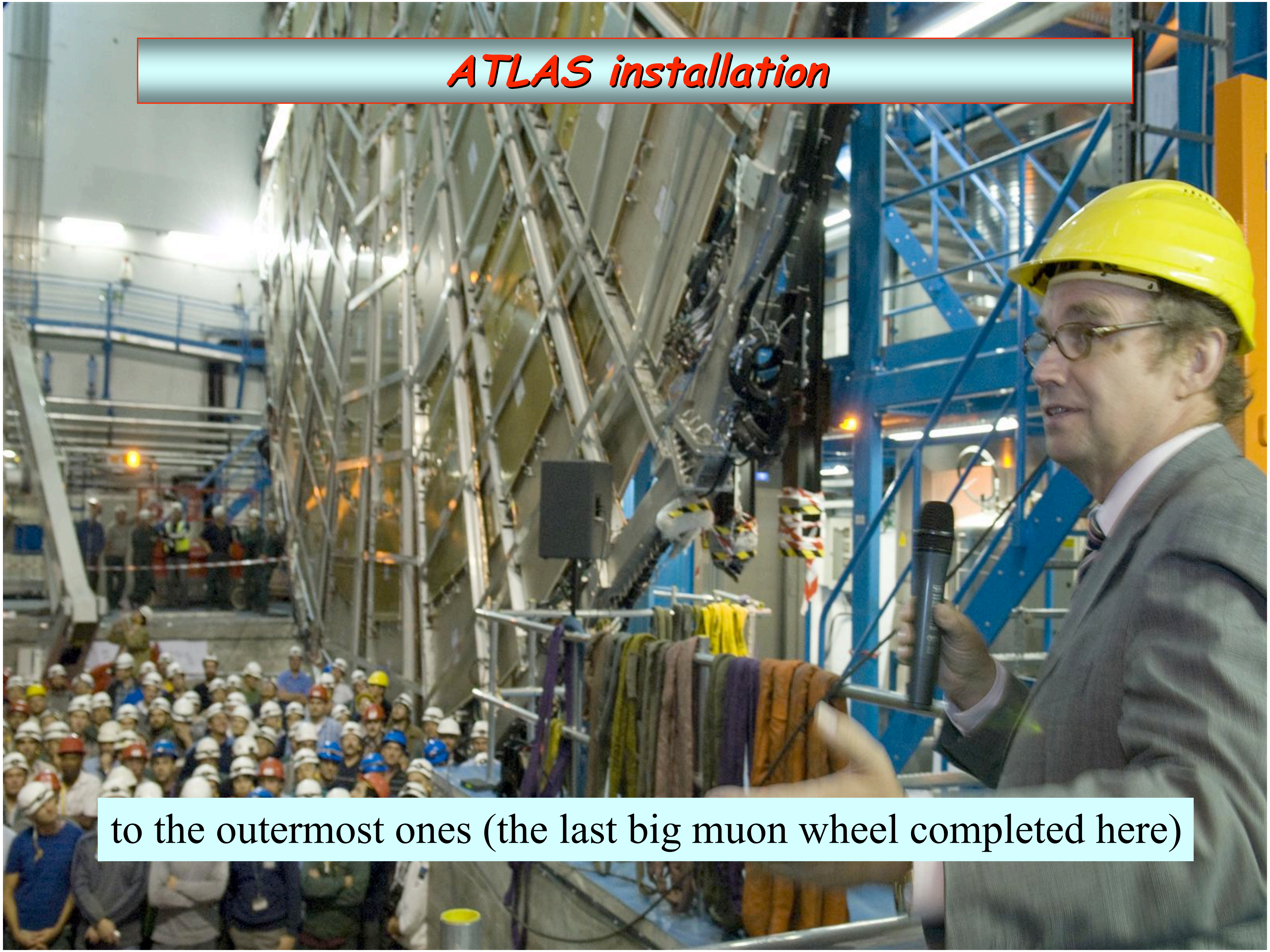
Parameters			Beam levels		Rates in 1 and 5		Rates in 2 and 8	
k_b	N	β* 1,5 (m)	I_{beam} proton	E_{beam} (MJ)	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing
936	$4\ 10^{10}$	11	$3.7\ 10^{13}$	42	$2.4\ 10^{31}$	<< 1	$2.6\ 10^{31}$	0.15
936	$4\ 10^{10}$	2	$3.7\ 10^{13}$	42	$1.3\ 10^{32}$	0.73	$2.6\ 10^{31}$	0.15
936	$6\ 10^{10}$	2	$5.6\ 10^{13}$	63	$2.9\ 10^{32}$	1.6	$6.0\ 10^{31}$	0.34
936	$9\ 10^{10}$	1	$8.4\ 10^{13}$	94	$1.2\ 10^{33}$	7	$1.3\ 10^{32}$	0.76

Parameters			Beam levels		Rates in 1 and 5		Rates in 2 and 8	
k_b	N	β* 1,5 (m)	I_{beam} proton	E_{beam} (MJ)	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing	Luminosity ($cm^{-2}s^{-1}$)	Events/ crossing
2808	$4\ 10^{10}$	11	$1.1\ 10^{14}$	126	$7.2\ 10^{31}$	<< 1	$7.9\ 10^{31}$	0.15
2808	$4\ 10^{10}$	2	$1.1\ 10^{14}$	126	$3.8\ 10^{32}$	0.72	$7.9\ 10^{31}$	0.15
2808	$5\ 10^{10}$	2	$1.4\ 10^{14}$	157	$5.9\ 10^{32}$	1.1	$1.2\ 10^{32}$	0.24
2808	$5\ 10^{10}$	1	$1.4\ 10^{14}$	157	$1.1\ 10^{33}$	2.1	$1.2\ 10^{32}$	0.24
2808	$5\ 10^{10}$	0.55	$1.4\ 10^{14}$	157	$1.9\ 10^{33}$	3.6	$1.2\ 10^{32}$	0.24
Nominal			$3.2\ 10^{14}$	362	10^{34}	19	$6.5\ 10^{32}$	1.2

ATLAS installation

The detector installation is also close to completion, from the innermost components (beam pipe being inserted here)

ATLAS installation

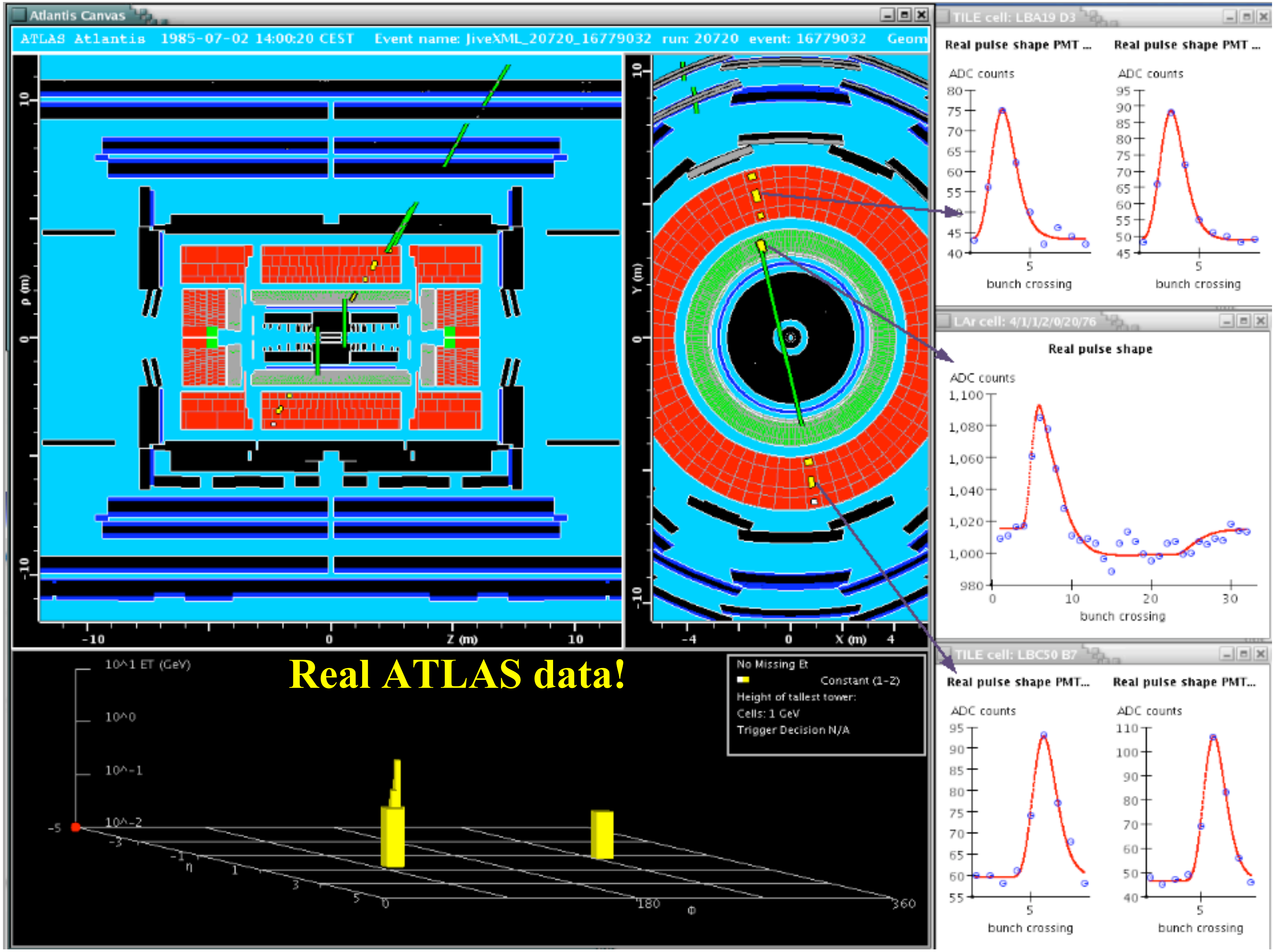


to the outermost ones (the last big muon wheel completed here)

ATLAS commissioning

Meanwhile, we are commissioning the detector and the software using cosmics data

- Integrate all subdetectors in a common data acquisition
- Monitoring software in place
- Trigger software in place
- First timing, alignment and calibration



```
ATLAS Atlantis   1985-07-02 14:00:20 CEST   Event name: JiveXML_20720_16779032   run: 20720   event: 16779032   Geom
```

```
No Missing Et
          Constant (1-2)
Height of tallest tower:
Cells: 1 GeV
Trigger Decision N/A
```

Real ATLAS data!

What do we do when we get the data?

Before we can claim discovery of “New Physics” we have to do some homework…

- Understand and calibrate detector and trigger in situ using well-known physics samples: Z/W →leptons, semileptionic tt
- Understand basic SM physics at 14 TeV: first measurements and publications
  - jets and W, Z cross-section top mass and cross-section
  - Event features: Min. bias, jet distributions, PDF constraints
- Understand tails of SM processes as backgrounds (tt, W/Z + jets), go for discovery: Z', SUSY, Higgs

But let’s have a look at our main SUSY discovery strategy, to understand what we need to understand to get there…

Supersymmetry: what is?

Supersimmetry (SUSY) in a nutshell

Standard particles	*Superpartners*
Quarks, leptons, neutrinos (spin 1/2)	Squarks, sleptons, sneutrinos (spin-0)
W, Z, gluino (spin-1)	Wino, zino, gluino (spin 1/2)
Higgs (spin-0)	Higgsino (spin ½)

At least two Higgs doublets are needed → **five Higgs bosons**
Wino, Zino, Higgsino mix → 4 charged (chargino) and 4 neutral (neutralino) states

SUSY particles not observed yet → must be heavy → **simmetry is broken**

It is possible to put directly SUSY mass terms in the lagrangian. This gives about **100 free parameters** with the minimal field content above (MSSM model)

Constrained models (with assumptions on the structure of SUSY breaking) have only a few parameters – but assumptions may be wrong.

Supersymmetry: why?

Supersimmetry can solve several problems of the Standard Model at once

Hierarchy problem:

- Fermions and bosons contribute with opposite sign to the Higgs mass
- $\delta m_H \sim m_{SUSY}$ [SUSY mass scale]
- Hierarchy ok if SUSY masses near the Higgs scale (**accessible to a TeV-scale collider)**

True also for other SM extensions adressing hierarchy.

The TeV-scale new physics and the Higgs are the main motivations for the Large Hadron Collider

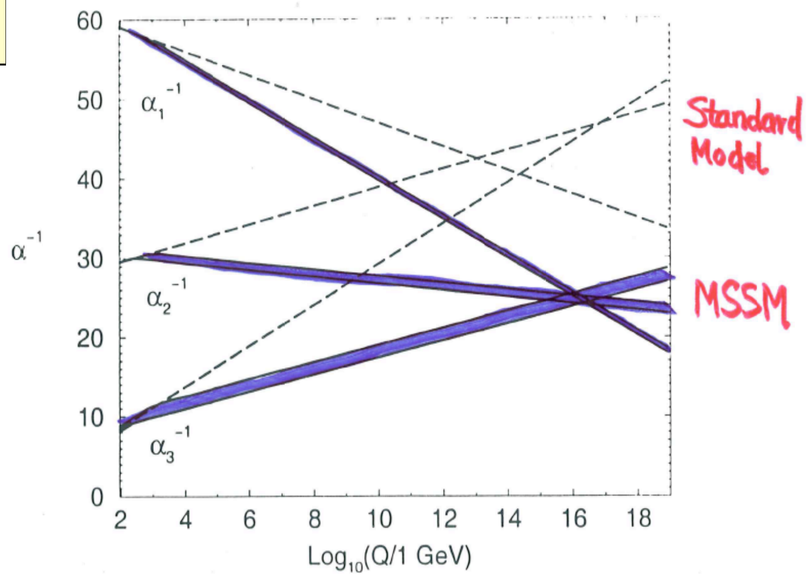
Dark Matter

Need a conserved quantum number to avoid proton decay: R=+1 for SM particles, R=-1 for SUSY particles. Consequences:

- **SUSY particles are produced in pairs**
- The **lightest SUSY particle is stable**. If weakly interacting, it's a good candidate for Dark Matter

Unification of forces:

Better convergence of interaction strenght as a function of energy



mSUGRA models

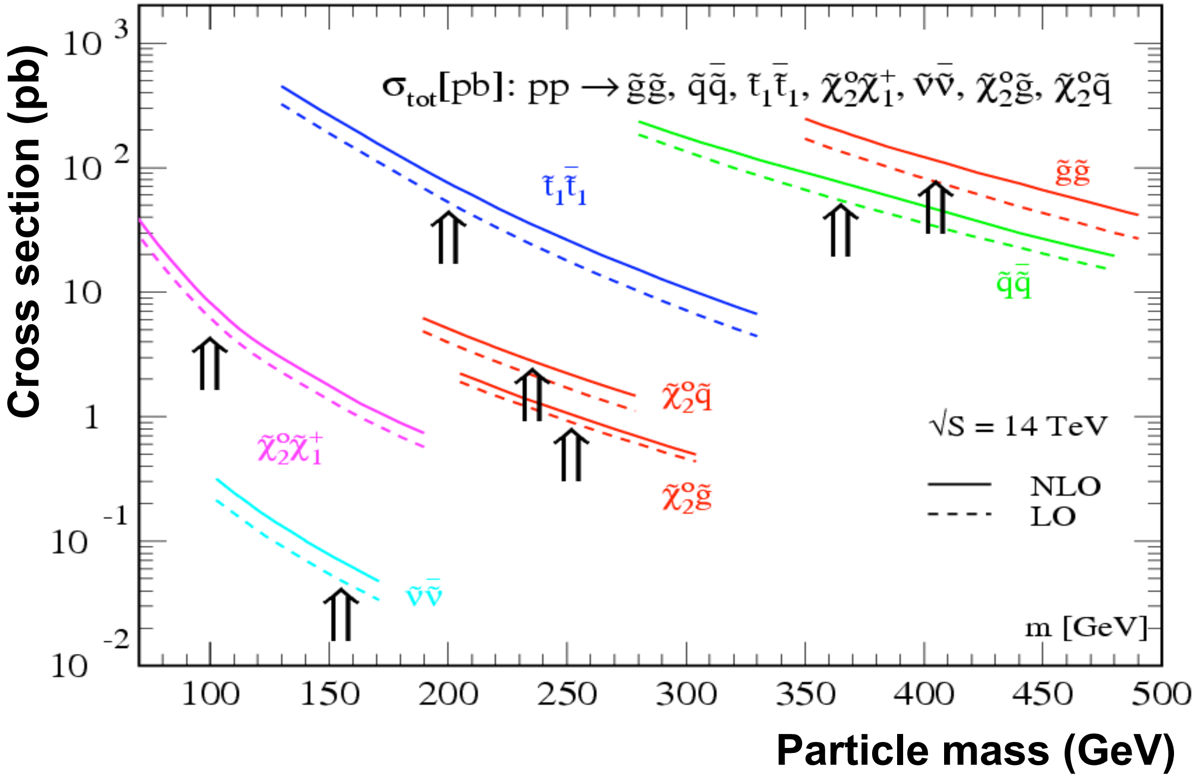
- **A random choice of the 105 MSSM parameters violates limits** from B/D/K physics, electric dipole moments, FCNC, …
- **Need** some **assumption** on the structure **of SUSY breaking lagrangian**. In **mSUGRA** (5 free parameters, most studied by ATLAS and CMS):
  - **Conserved R-parity**
  - **Common mass** m_0 for susy scalars, $m_{1/2}$ for fermions (at GUT scale).
  - **Common value** A_0 for the trilinear coupling of the s-fermions with the 2 Higgs doublets.

Then 5 free parameters: $m_0,\ m_{1/2},\ A_0,\ \tan\beta,\ \operatorname{sgn}\mu$

Further constraints if it is required that the Big Bang has produced the right amount of stable neutralinos to explain observed Dark Matter density

May be too constrained. Experiments at colliders are interested mostly in identify signatures to develop and study search strategies

Production cross sections



NLO cross sections in the pb range (QCD)

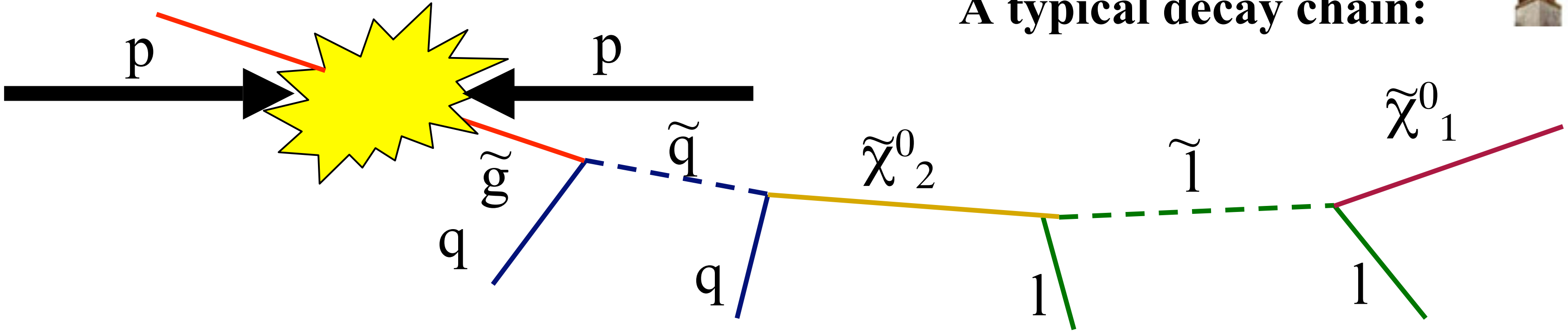
Mass depend on SUSY model

Cross section is model independent

If not too heavy, gluino and squark dominate production cross section at LHC

SUSY signatures at an hadron collider

A typical decay chain:



- Assuming R-parity conservation
- Strongly interacting sparticles (squarks, gluinos) should dominate production unless very heavy.
- Cascade decays to the stable, weakly interacting lightest neutralino follows.
- Event topology:
  - high p_T jets (from squark/gluino decay)
  - Large E_T^{miss} signature (from LSP)
  - High p_T leptons, b-jets, τ-jets (depending on model parameters)

Event topologies and baseline selection

Early searches try to cover a broad range of experimental signatures, but they are classified based on the event topology:

Large E_T^{miss} +

Jet multiplicity	*Additional signature*	*SUSY scenario*	*Backgrounds*
≥ 4	*No lepton*	*mSUGRA, AMSB, split SUSY, heavy squark*	*QCD, ttbar, W/Z*
	One lepton (e,μ)	*mSUGRA, AMSB, split SUSY, heavy squark*	*ttbar, W*
	di-lepton	*mSUGRA, AMSB, GMSB*	*ttbar*
	di-tau	*GMSB, large tanβ*	*ttbar, W*
	$\gamma\gamma$	*GMSB*	*free*
~2		*light squark*	*Z*

Baseline selection (to be optimized)

- Jet multiplicity ≥ 4, $p_T^{1st} > 100$GeV, $p_T^{others} > 50$GeV
- $E_T^{miss} > \max(100\text{GeV}, 0.2\text{x}M_{eff})$
- Transverse sphericity > 0.2
- (Additional cuts depending on signature)
  - Transverse mass > 100GeV , $p_T^{lepton} > 20$GeV (for one-lepton mode)

SUSY search strategies

Most promising search strategy:
jets + E_T^{miss} + n-leptons

- **Backgrounds:**

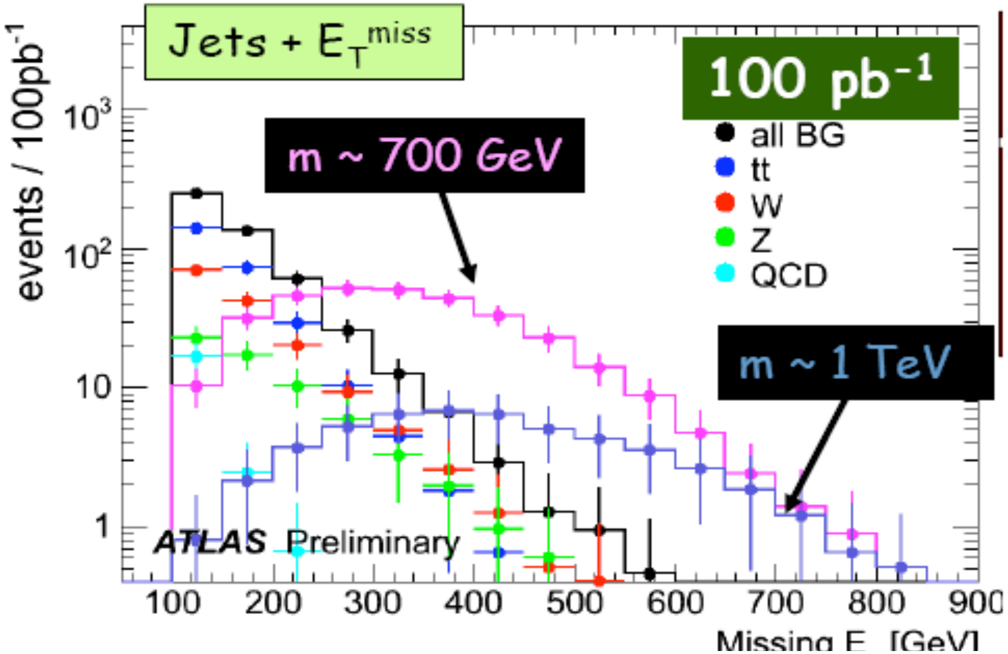
- Real missing energy from SM processes with hard neutrino (tt, W+jets, Z+jets, bb*, cc*)

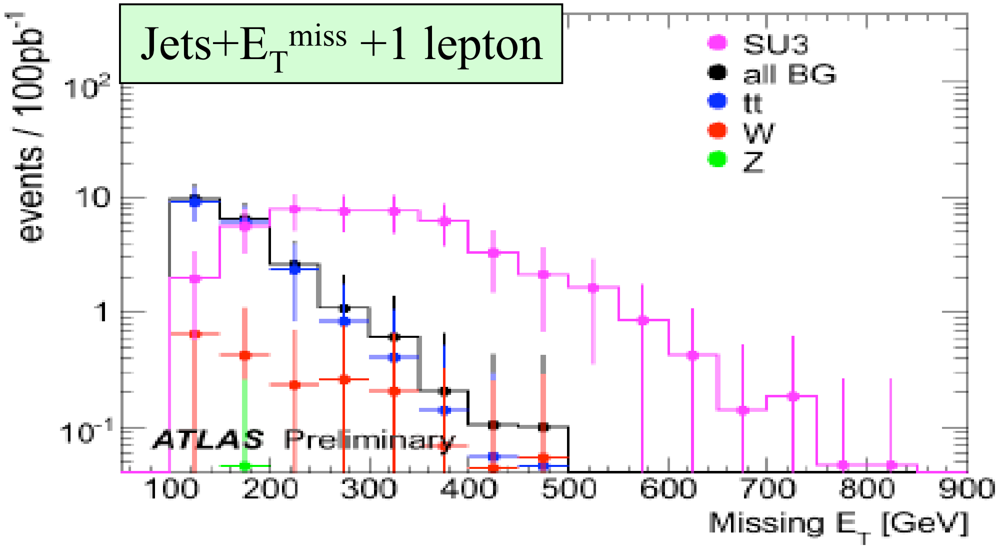
* n from semileptonic B/D decay

- Fake missing energy from detector

Jet energy resolution (expecially non-gaussian tails) critical

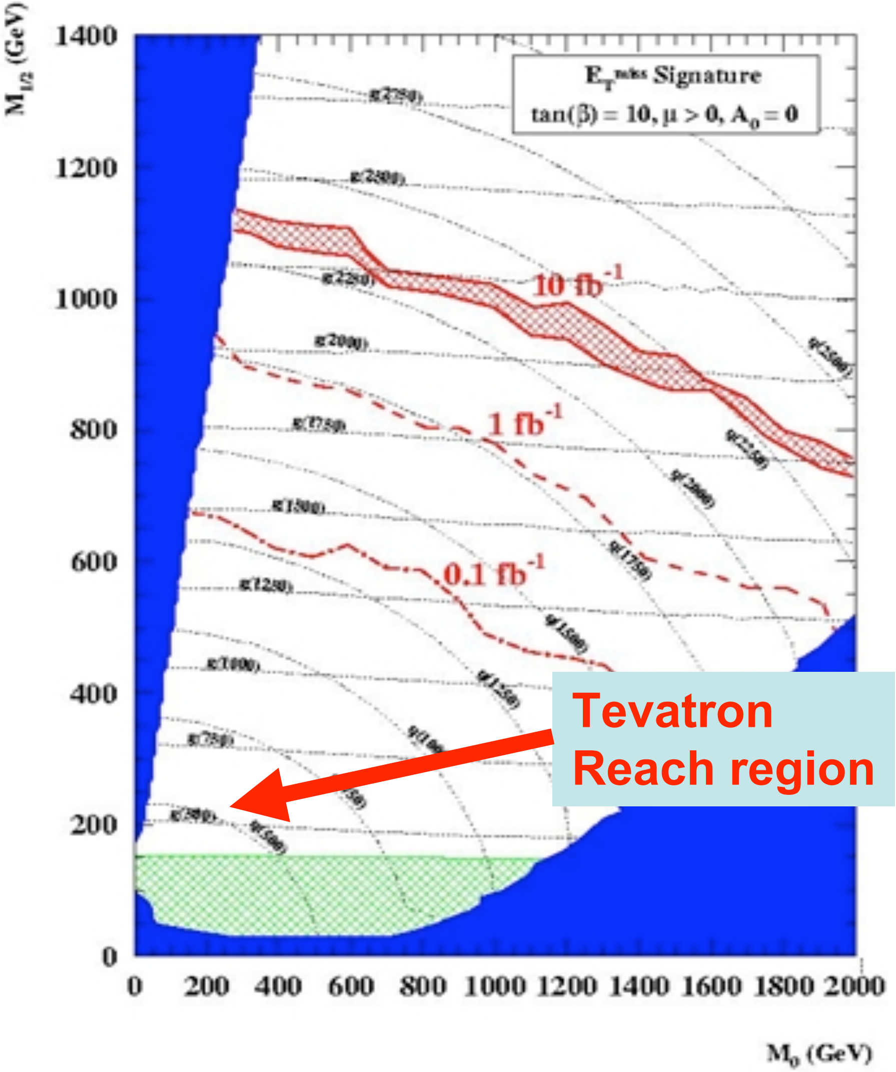
A good understanding of both SM physics and detector (missing energy expecially) critical to claim excess over SM predictions





How much data will we need?

5σ discovery reach (stat. errors only) of ATLAS in mSUGRA plane



Tevatron Reach region

Statistical reach with 100 pb^{-1} is actually already ~1300 GeV, well beyond Tevatron limits (~400 GeV) BUT

- only in a few cases SUSY has distinctive kinematical features

- main selection tool at both trigger and analysis level is to select event with large missing Et, difficult to muster experimentally

More luminosity (for control samples) and/or time may be needed to understand backgrounds

Let’s go back to detector commissioning and SM background studies…

EtMiss commissioning: event cleaning

Raw E_T^{miss} in early data is expected to have large tails

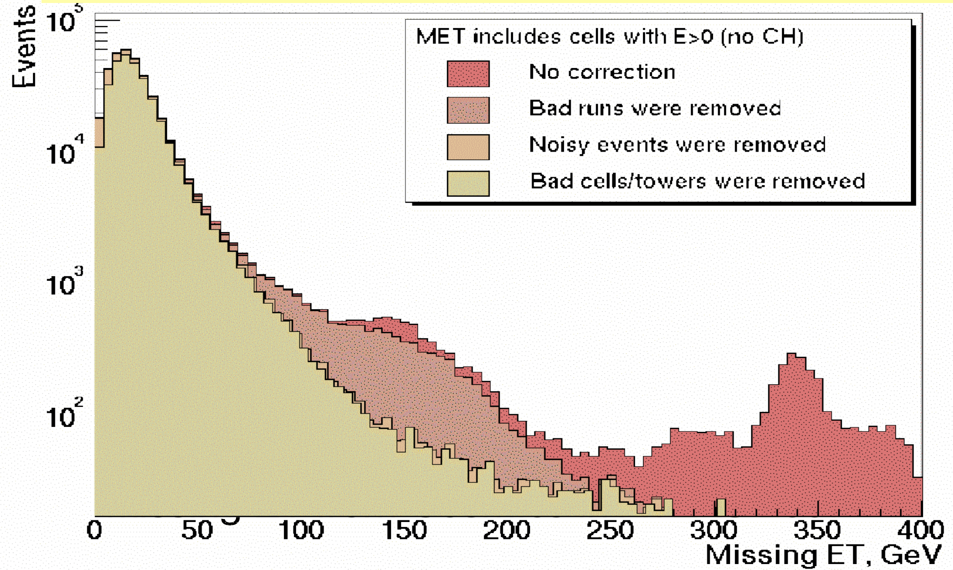
- Cosmic events
- Beam halo muons, beam gas interactions, cavern background (neutrons)
- Noisy and dead calorimeter cells
- Dead material, calorimeter cracks
- Fake muons
- …

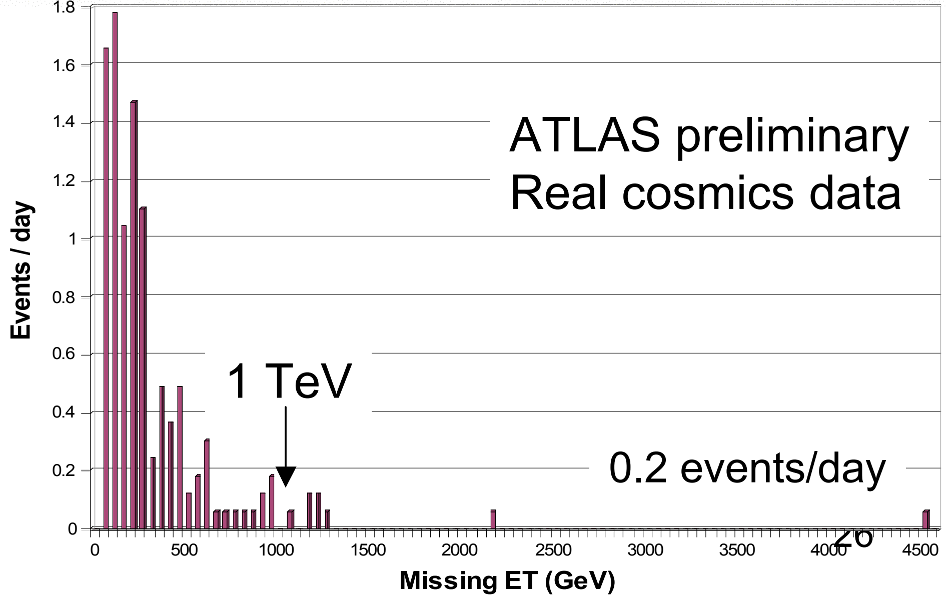
All machine and detector garbage collected by E_T^{miss} trigger!

We are developing tools for event cleaning

- Online and offline monitoring
- detect noisy/dead cells
- Reject beam halo and cosmics events
- E_T^{miss} correlation with hardest jet, muons,
- Stability of E_T^{miss} trigger rate

Effect of event cleaning on D0 E_T^{miss}





ATLAS preliminary
Real cosmics data

0.2 events/day

Detector calibration and alignment

The jet energy scale affects directly SUSY discovery plots trough the cut on the presence of hard jets.

Also, E_T^{miss} depends on the correct reconstruction of the energies of jets, photons, electrons, and muons!

- We will start from the knowledge obtained from testbeam data, electronics calibrations, survey measurements during installation of the tracking detectors, and cosmics data.
- We will then use well-known SM processes (standard candles) to improve

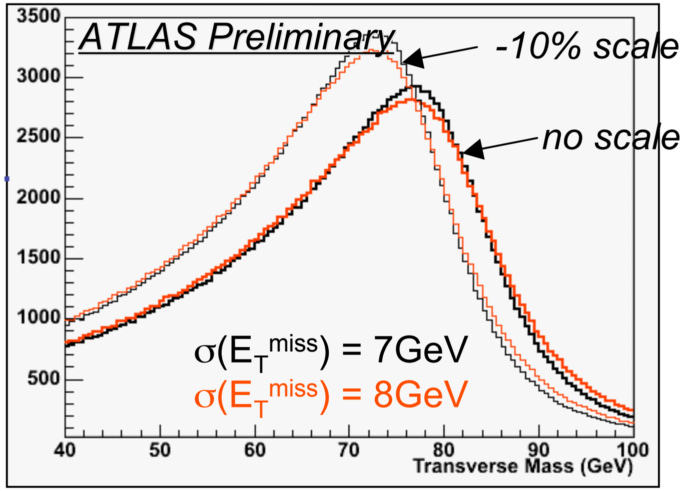
Examples: leptonic decays of Z, W mass in semileptonic top events

	Expected performance day-1	Physics samples to improve (examples)
ECAL uniformity	1-2% (~0.5% locally)	Isolated electrons, $Z \rightarrow ee$
e/γ E-scale	~ 2 %	$Z \rightarrow ee$
HCAL uniformity	~ 3 %	Single pions, QCD jets
Jet E-scale	< 10%	$\gamma/Z + 1j$, $W \rightarrow jj$ in $t\bar{t}$ events
Tracking alignment	10-200 μm in Rφ Pixels/SCT ?	Generic tracks, isolated μ, $Z \rightarrow \mu\mu$

Process	$\sigma \times BR$		Events selected for 100 pb^{-1}
$W \rightarrow \ell\nu$	20 nb	$\sim 20\%$	~ 400000
$Z \rightarrow \mu\mu$	2 nb	$\sim 20\%$	~ 40000
$\bar{t}t$ (semileptonic)	370 pb	$\sim 1.5\%$	< 1000

Available statistics, with conservative estimates of reconstruction efficiencies

EtMiss commissioning



Just two examples, several other physics process can be used: minimum bias, Z(ll), ttbar, …

W(lν) sample: Shape of transverse mass distribution depends on E_T^{miss} scale and resolution.

Z(ττ) sample: Z mass can be reconstructed with collinear aproximation (since the τ are boosted, ν are along visible τ energy). Can be used to calibrate E_T^{miss} scale.

$M_{\tau\tau}$ vs. E_T^{miss} scale

(signal only)

ττ Invariant mass (100pb^{-1})

mean = 90.7 GeV

σ = 14.2 GeV

Z→ττ

QCD jets

W →μν

W→eν

ttbar

10% in E_T^{miss} scale ⇔ 3% shift in Z mass

Towards SUSY searches…

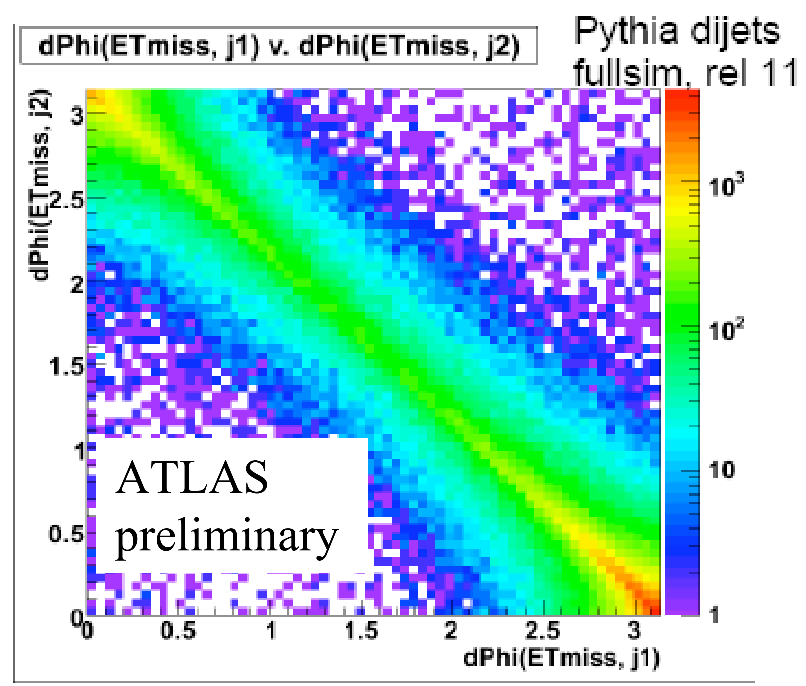
Once detector effects are understood, the next steps are:

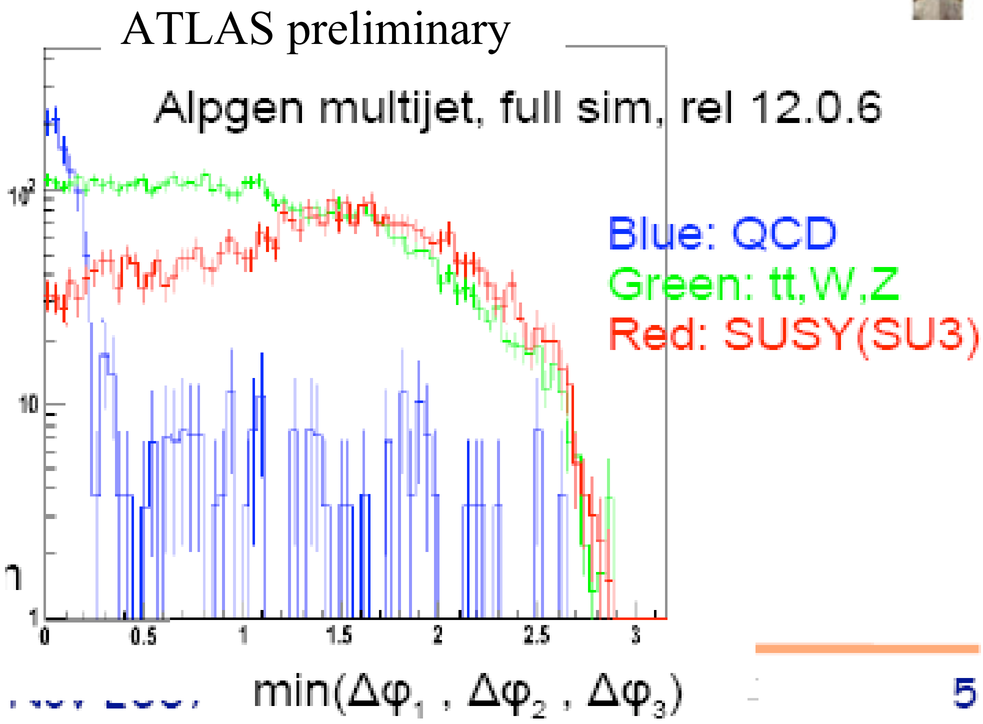
- Fiducial cuts: reject E_T^{miss} pointing along leading jets, events with jets or electrons in calorimeter crack…
- Measure Z,W,ttbar cross sections and PDFs
- Understand residual tails in E_T^{miss} performance and distribution of real E_T^{miss} in SM events

Use data-driven estimates, do not rely on MC predictions
Some examples in next slides, several other techniques are being studied. Results should be available early next year

The aim is to estimate the background for each channel with at least two independent technique and compare the results to get confidence that we really understand the SM background

Towards SUSY searches…

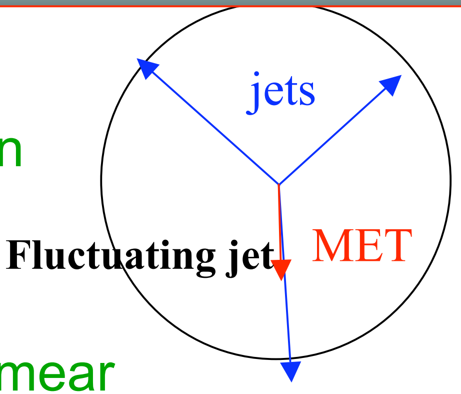


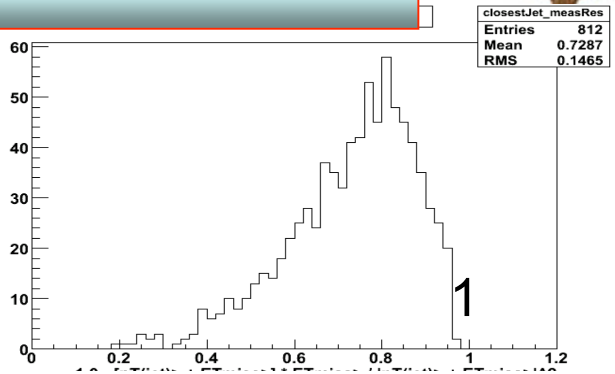


The azimuthal separation between E_T^{Miss} and the leading jets in the event is a powerful cut to reject QCD background (and fake E_T^{miss} related to jets)

QCD background

① Measure smearing function in events with large E_T^{miss}

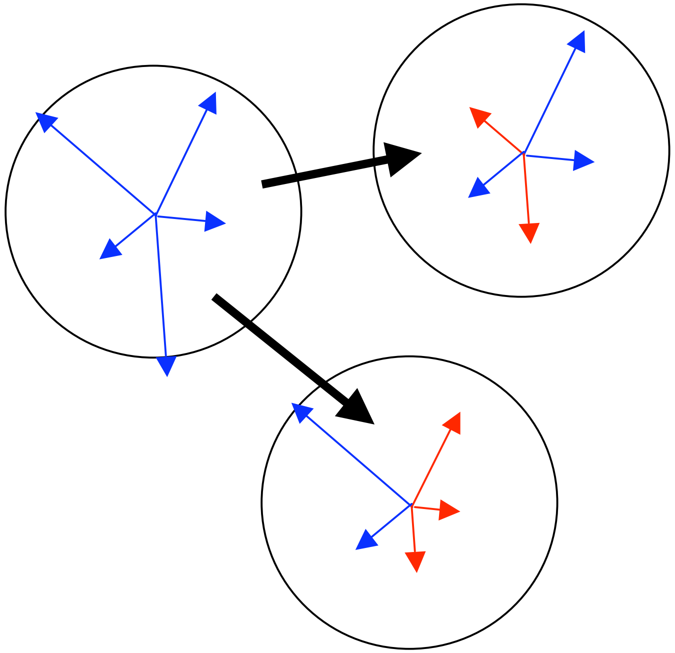




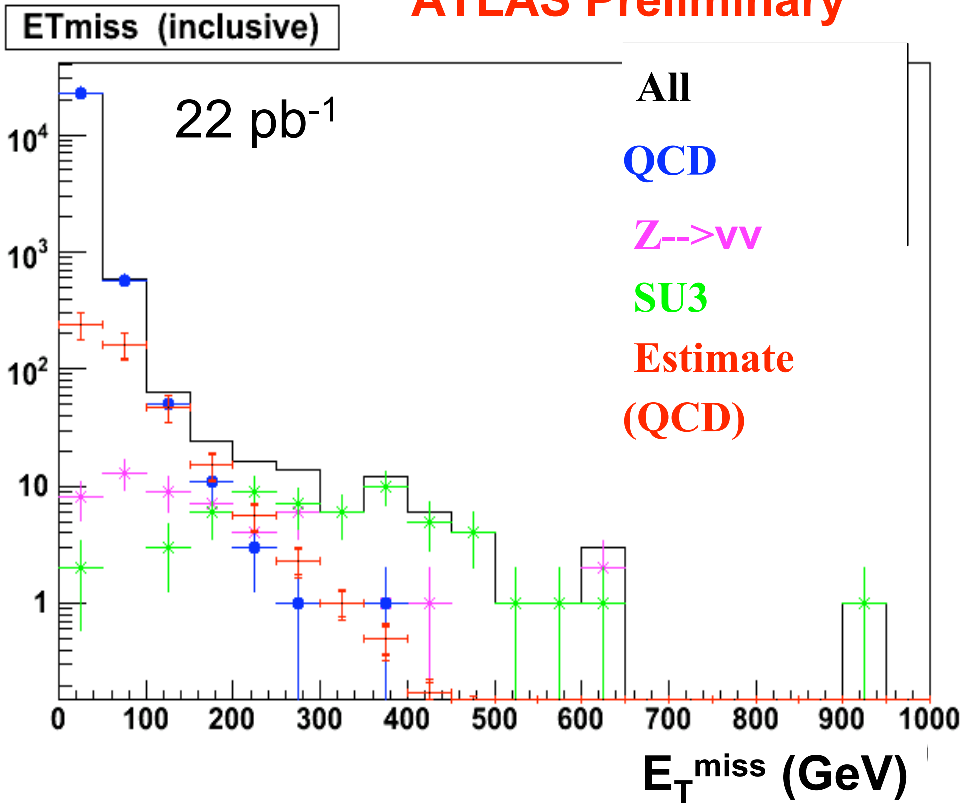
E_T^{reco} / $E_T^{true, est.}$

ATLAS Preliminary

② Select seed events and smear



Seed events: low E_T^{miss}/ ΣE_T



③ Normalize estimate to data

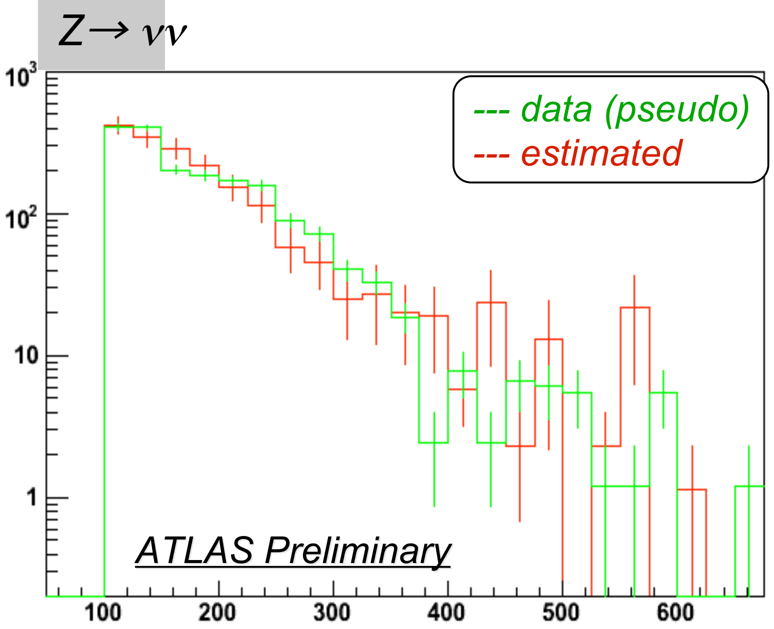
Z and W background (0-lepton mode)

$Z \rightarrow \nu\nu$ and $W \rightarrow l\nu$ can be estimated from $Z \rightarrow \ell^{+}\ell^{-}$

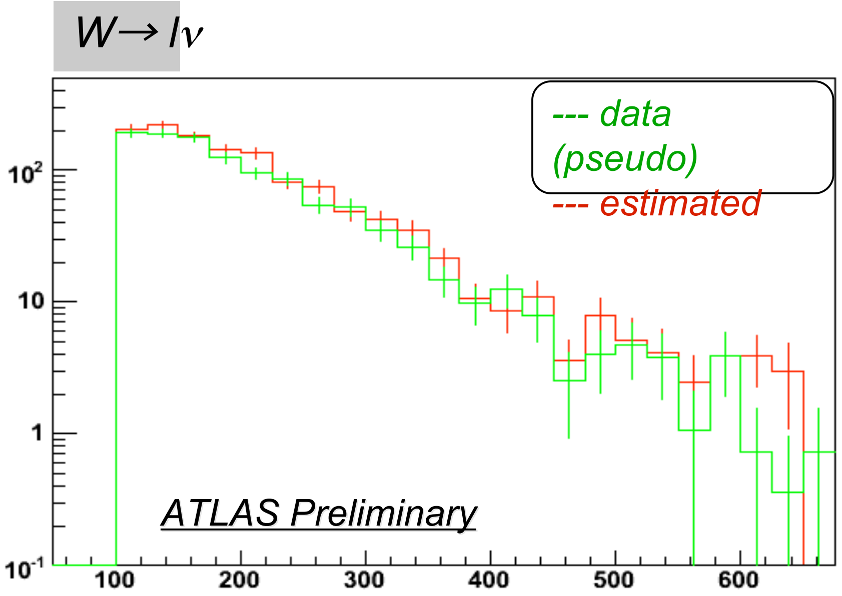
Either **replace** the two leptons with neutrinos correcting for acceptance and efficiency

Or determine the **MC normalization** from Z(ll) and apply it to normalize the MC distribution of $Z(\nu\nu)$ and $W(l\nu)$ (almost same production mechanism)

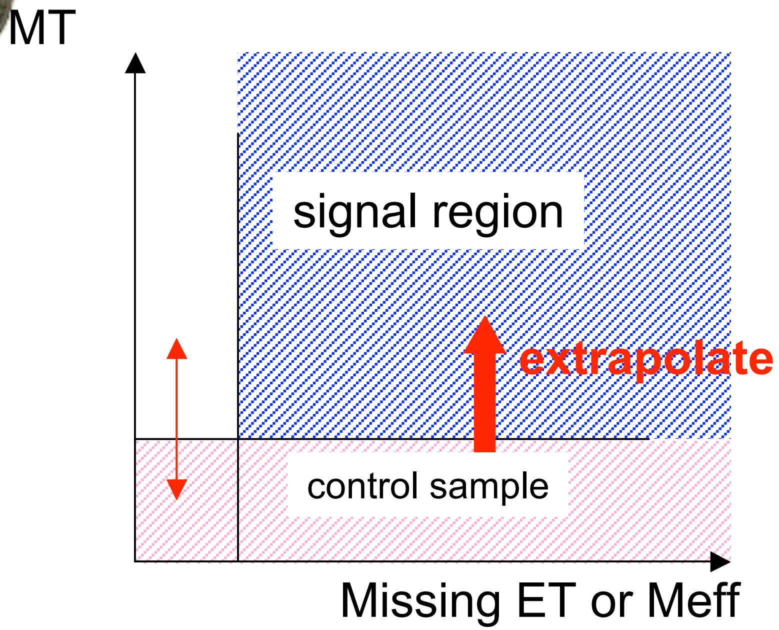
$Z \rightarrow \nu\nu$

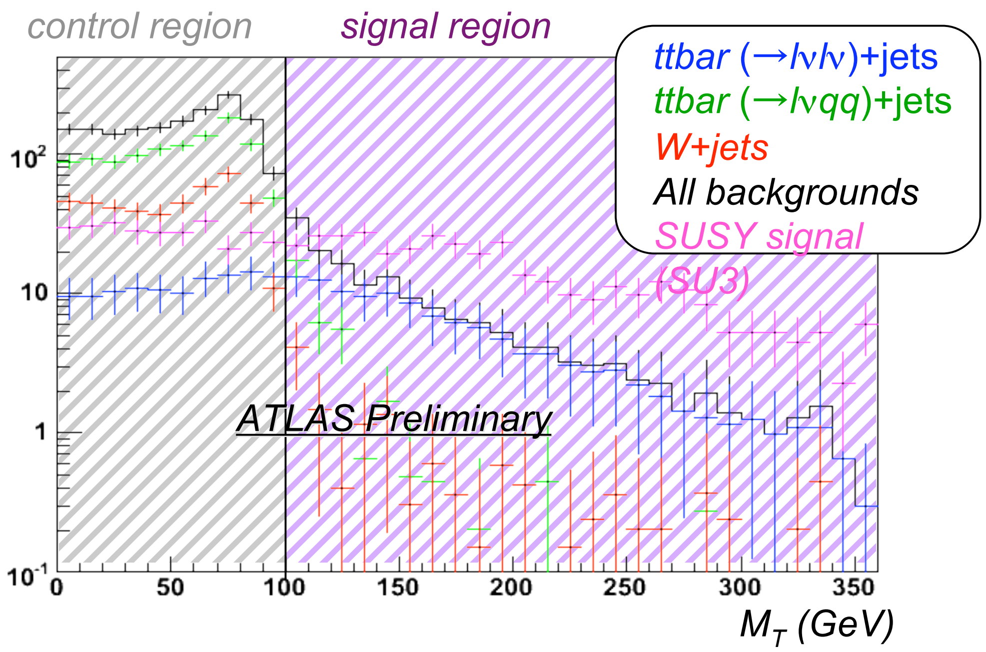


$W \rightarrow l\nu$



Trasverse mass method



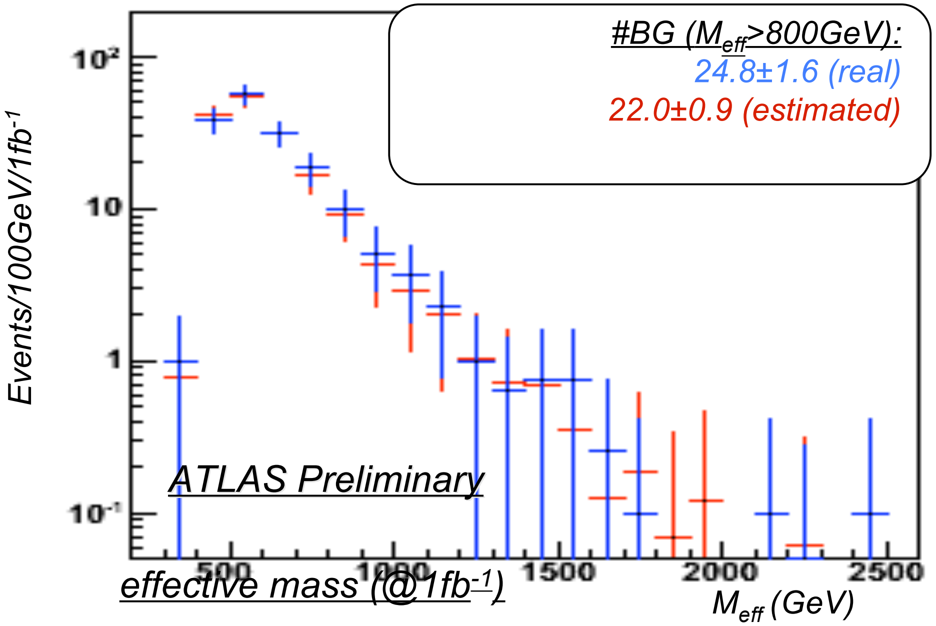


- Define control sample with transverse mass <100GeV
- Estimate the E_T^{miss}/M_{eff} shapes of background processes using control sample
- Determine the normalization of backgrounds with low E_T^{miss} regions of control and signal samples.

Can be used for both W and top backgrounds in 0-lepton, 1-lepton and 2-lepton channels (results shown here for 1-lepton)

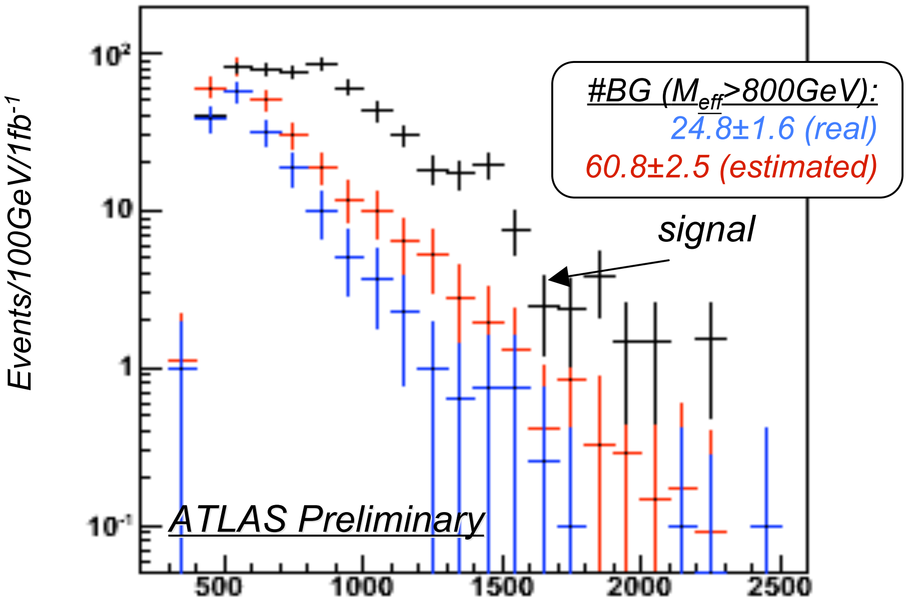
M_{eff} (GeV)

Trasverse mass method



effective mass (@1fb^{-1})

Including SUSY signal (SU3)



- *Satisfying performances with the M_T discrimination technique.*
- *However, taking account of SUSY signal contamination in the control sample, this estimate appears to be over the mark (By a factor of 2.5 for SU3). It would not prevent discovery.*

HT2 method

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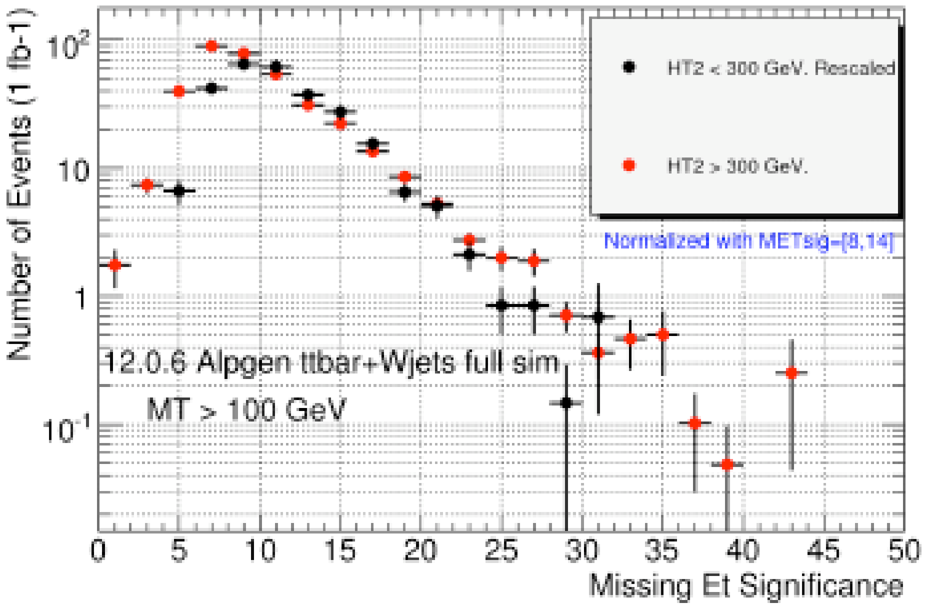
An other variable which has small correlation with MET is

$$HT2 \equiv \sum(pt\ jets\ 2,3,4) + \sum(pt\ e,\mu)$$

- leading jet is not included in order to avoid correlation with MET
- use MET significance rather than MET to reduce correlation

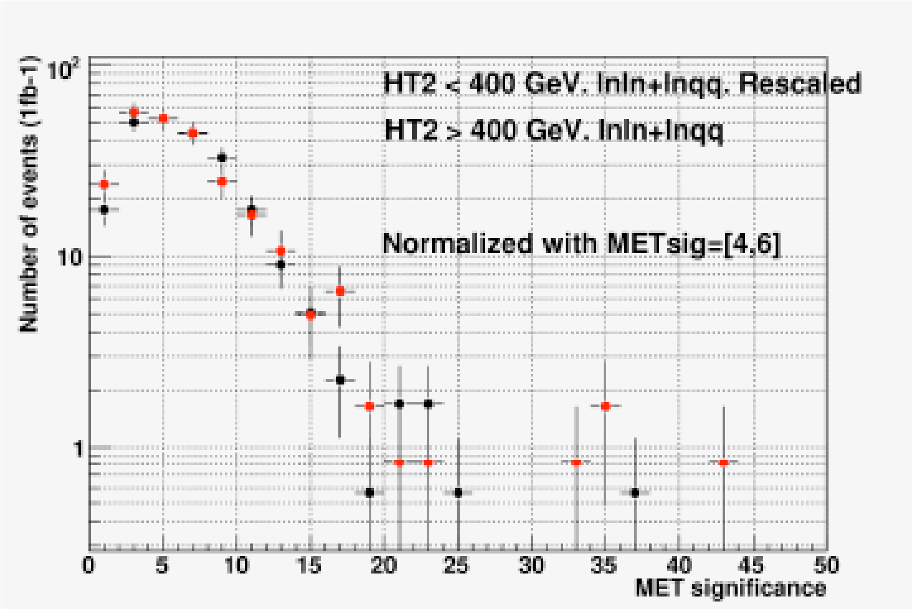
one lepton mode

ttbar (ℓvℓv and ℓvqq), W(ev)+jets, W(μv)+jets



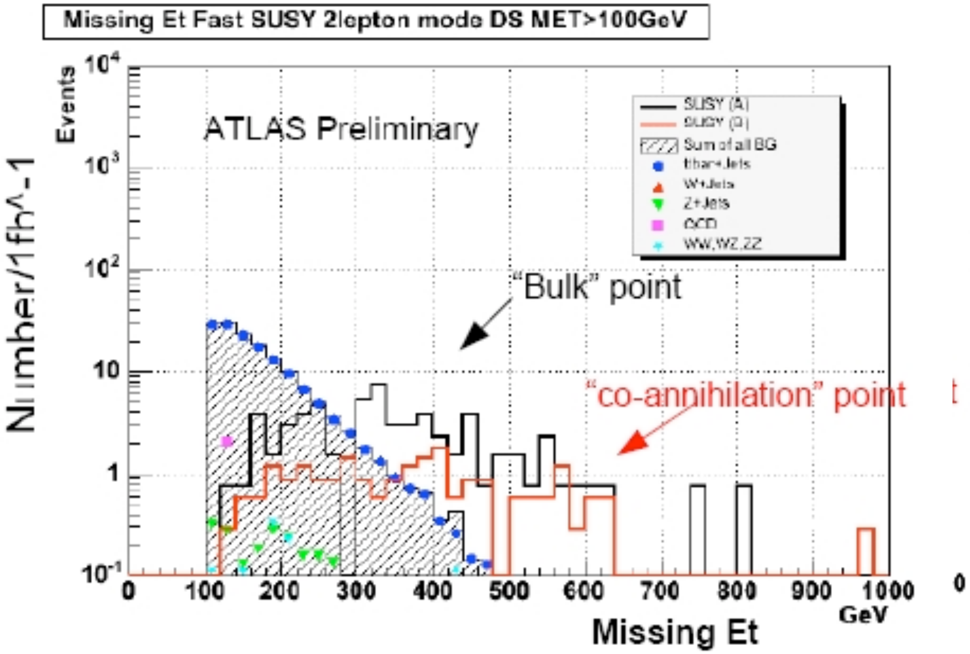
MET/0.49sqrt(etsum)

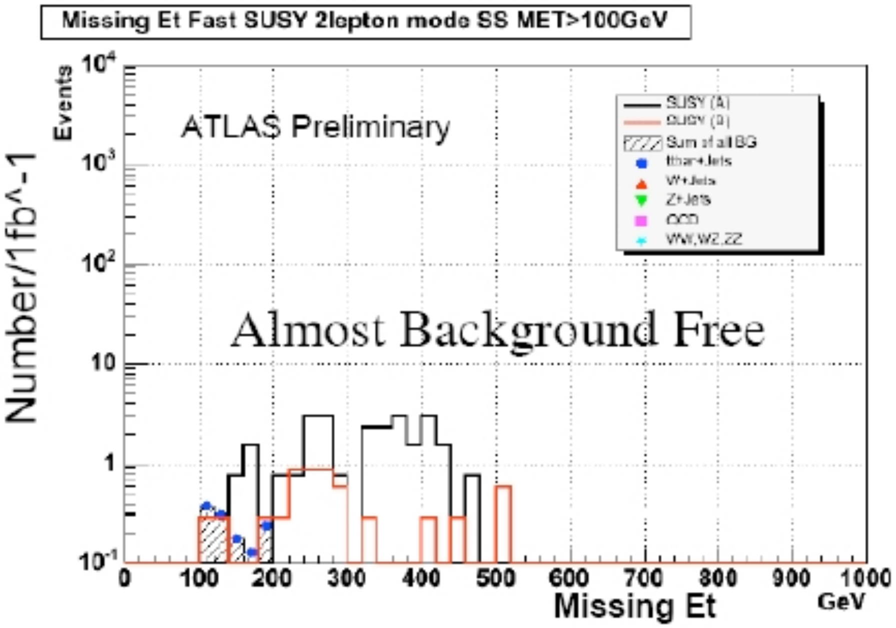
also works for **OS di-lepton mode**



2-lepton channel

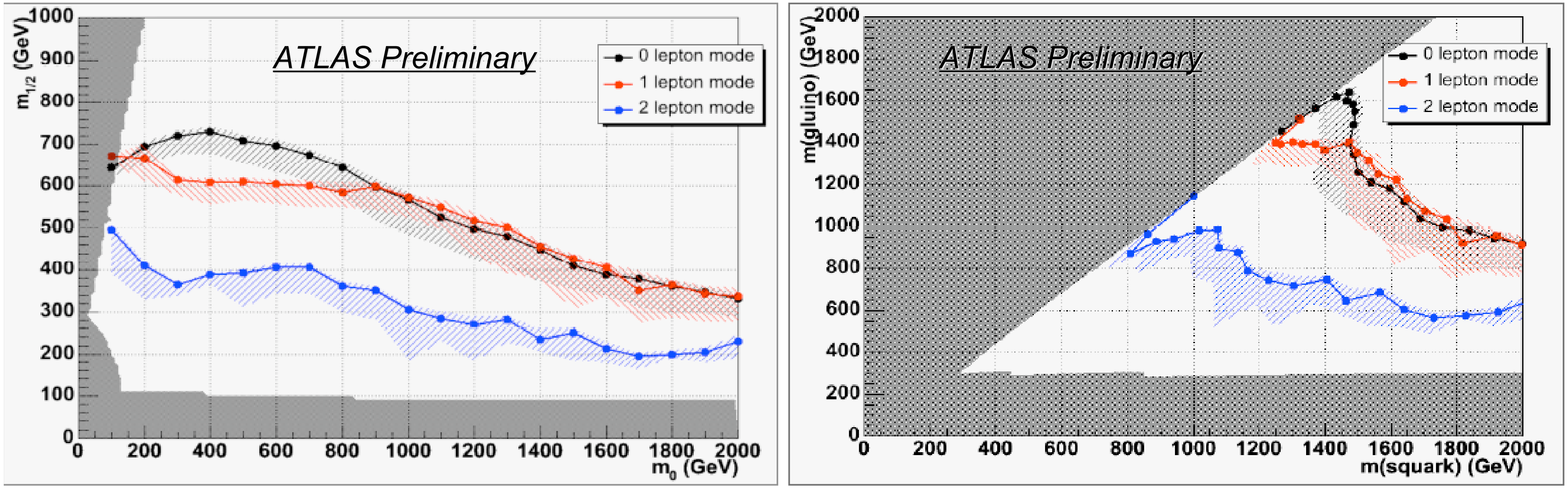
- Increasing the number of leptons
  - Reduces the signal because of (model dependent) leptonic BRs
  - Heavily supresses the background
  - Statistical significance is smaller but S/B ratio larger. Top is dominant background
  - The Same Sign channel has the best S/B ratio – but limited by signal rate





Back to SUSY discovery

- When the detector performance and the 14 TeV SM physics will be understood, we will be able to use the full power of our experiments for SUSY searches.
- Hopefully, we will still have an excess….



*5σ-discovery potential on $m_{1/2}$-m_0 (m_{gluino}-m_{squark}) space is shown for **1 fb^{-1}***

Require S>10 and S/sqrt(B)>5

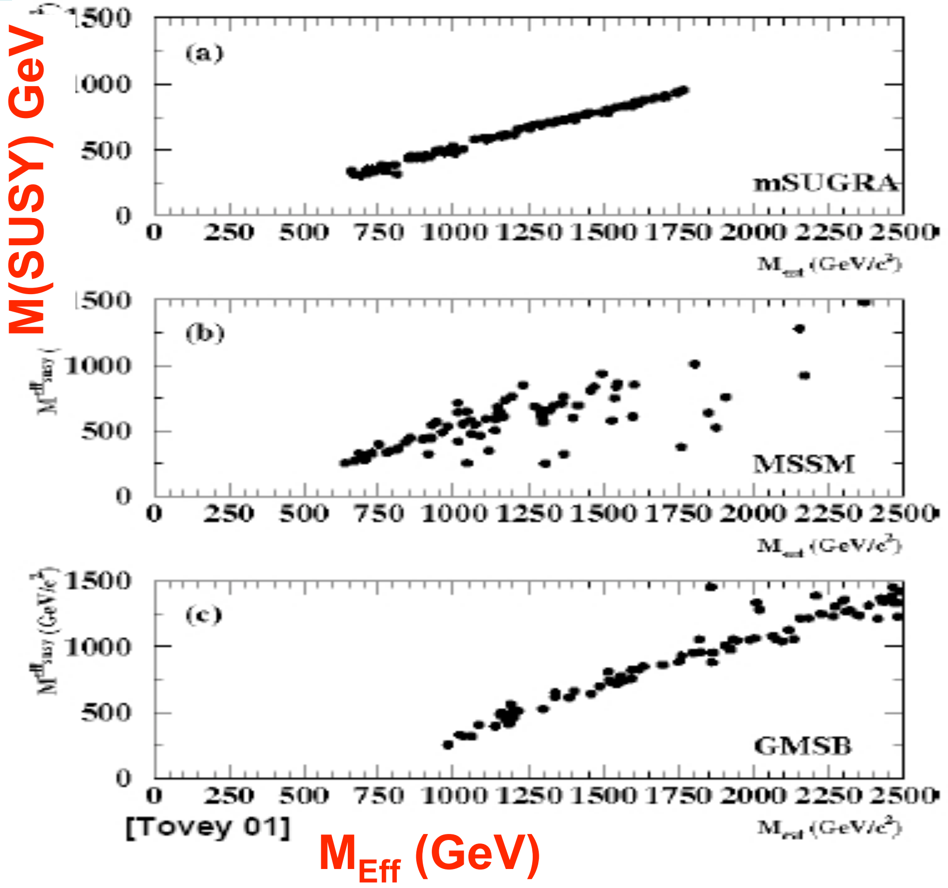
***Factor of 2** generator-level uncertainty included (hatched)*

What next ?

"Observation of an excess of events in multijet+MET events in pp collisions at 14 TeV with the ATLAS detector"

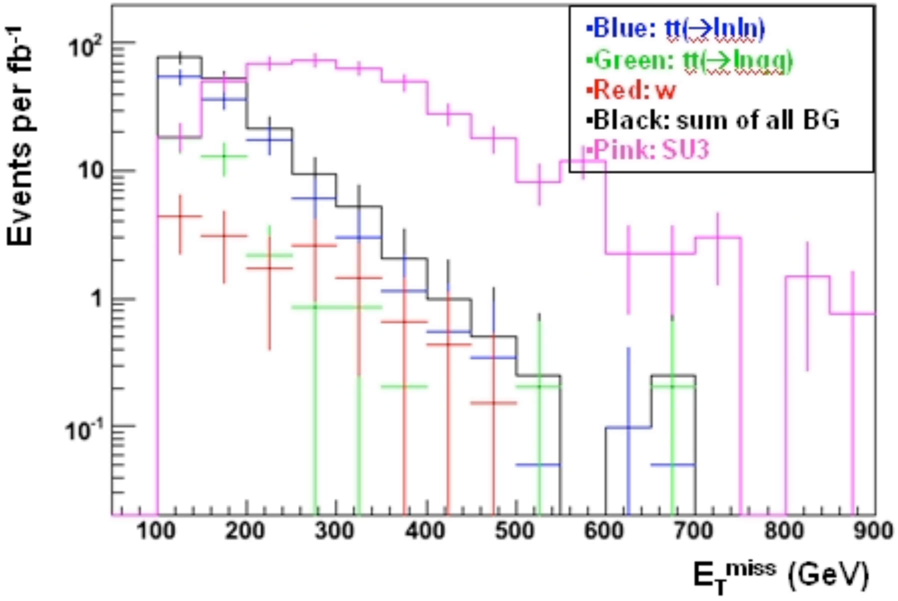
Is it SUSY?

<u>If yes</u>, what are the model parameters?



[Tovey 01]

Large (>100GeV) Missing ET events: Smoking gun of SuperSymmetry



Measurement of the "effective mass" peak correlates with the SUSY mass scale (average squark, gluino mass)

Meff = MET+PT,1+PT,2+PT,3+PT,4

15% (40%) precision on M(SUSY) with $10fb^{-1}$ for mSUGRA (MSSM)

Conclusions

- The installation and commissioning of the LHC accelerators and the detectors is well advanced
- Next year, first pp collision at 14 TeV will push the energy frontier back by one order of magnitude
- Hopefully, they will also lead to a deeper understanding of the laws of Nature. It's time to move beyond the Standard Model !

- Supersymmetry is a particularly promising possibility
- The key to uncover evidence for SUSY signals will be the understanding of our detector and Standard Model physics at 14 TeV
- ATLAS physicist are working hard to be prepared to exploit the potential of the LHC
- We will have to work even harder when first collision data will be recorded on disk…. but we are looking forward to those days nevertheless!

Backup slides

Table from J. Wenninger (CERN-FNAL LHC school) with guesses by F. Gianotti

Parameter	**Phase A**	**Phase B**	**Phase C**	**Nominal**
k / no. bunches	**43-156**	**936**	**2808**	**2808**
Bunch spacing (ns)	**2021-566**	**75**	**25**	**25**
N (10^{11} protons)	**0.4-0.9**	**0.4-0.9**	**0.5**	**1.15**
Crossing angle (μrad)	**0**	**250**	**280**	**280**
$\sqrt{(\beta^*/\beta^*_{nom})}$	**2**	$\sqrt{2}$	**1**	**1**
σ* (μm, IR1&5)	**32**	**22**	**16**	**16**
L ($cm^{-2}s^{-1}$)	6×10^{30}-10^{32}	10^{32}-10^{33}	$(1\text{-}2) \times 10^{33}$	10^{34}
Year ? (June schedule)	2008	2009	2009-2010	> 2010
∫Ldt ? (my guess)	≤ 100 pb^{-1}	1-few fb^{-1}		

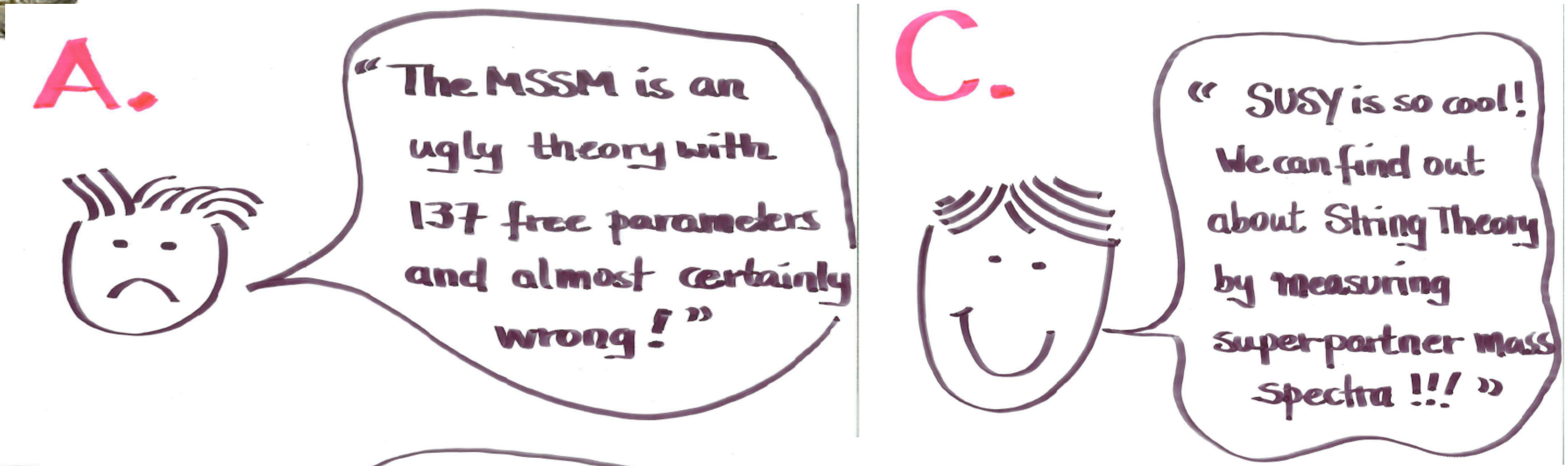
To achieve 100 pb^{-1} need 10^6s of good running at $\mathcal{L} = 10^{32}$

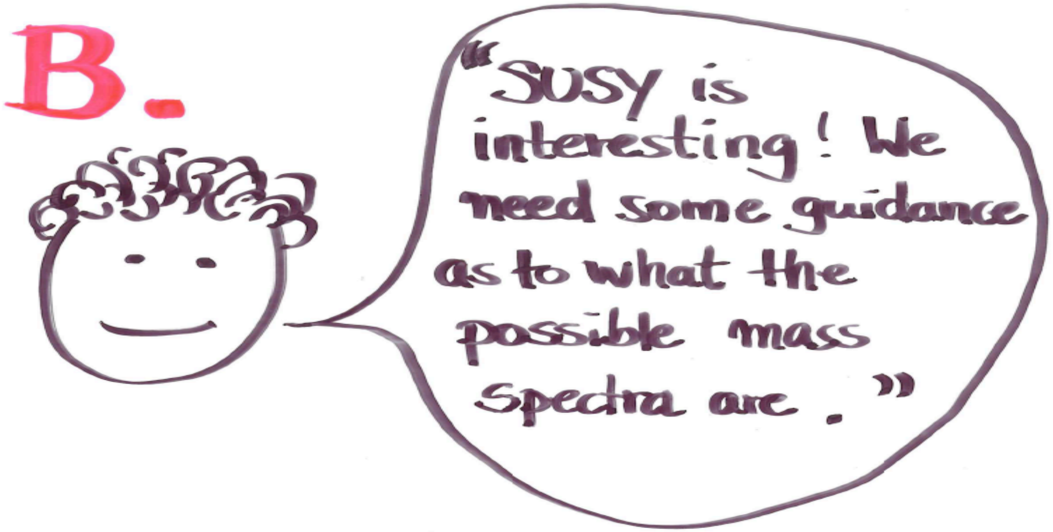
One year at regime now corresponds to $\sim 6 \times 10^6$ s $\longrightarrow$ 6 fb^{-1} at 10^{33}

Pileup at 10^{32} $cm^{-2}s^{-1}$ running with 156 bunches: ~ 5 events per crossing

Pileup at 10^{33} $cm^{-2}s^{-1}$ running with 75 ns beam spacing: ~ 7 events per crossing

Supersymmetry: how promising?





Naturally, different opinions exist about how promising is supersymmetry….

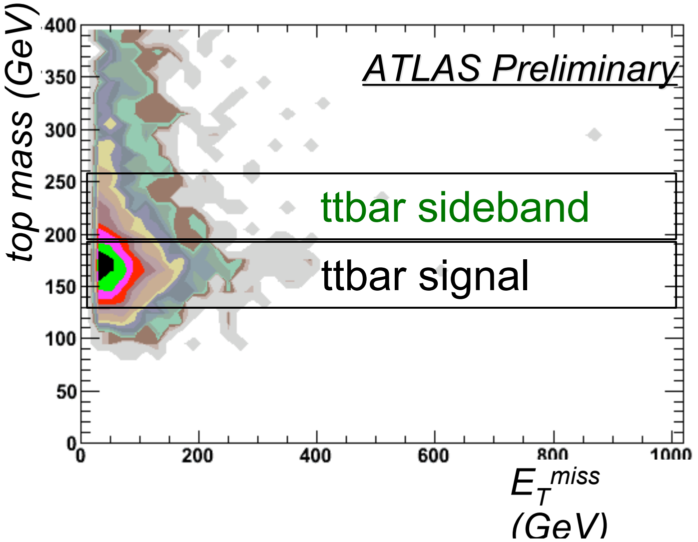
The LHC will tell….

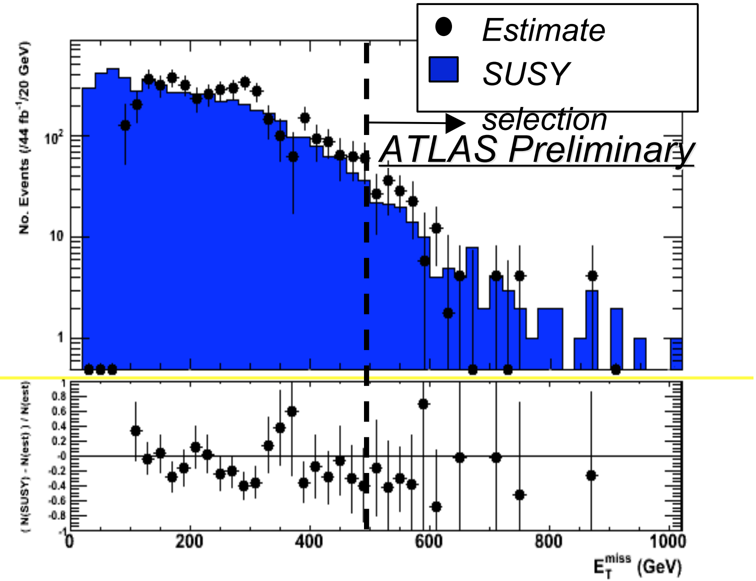
ttbar background

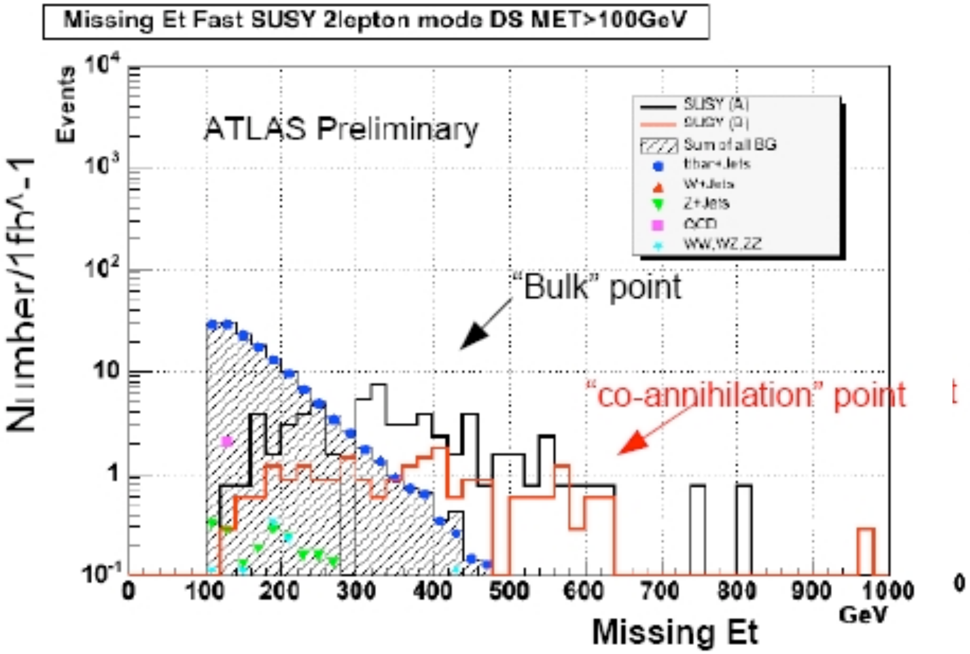
- Top mass is largely uncorrelated with E_T^{miss}
  - used as a calibration variable
- Select semi-leptonic top candidates
  - mass window: 140-200 GeV
- Contributions of combinatorial BG to top mass are estimated from the side-band events ($200GeV<m_{top}<260GeV$)
- Normalize the E_T^{miss} distribution in low E_T^{miss} region where SUSY signal contamination is small.

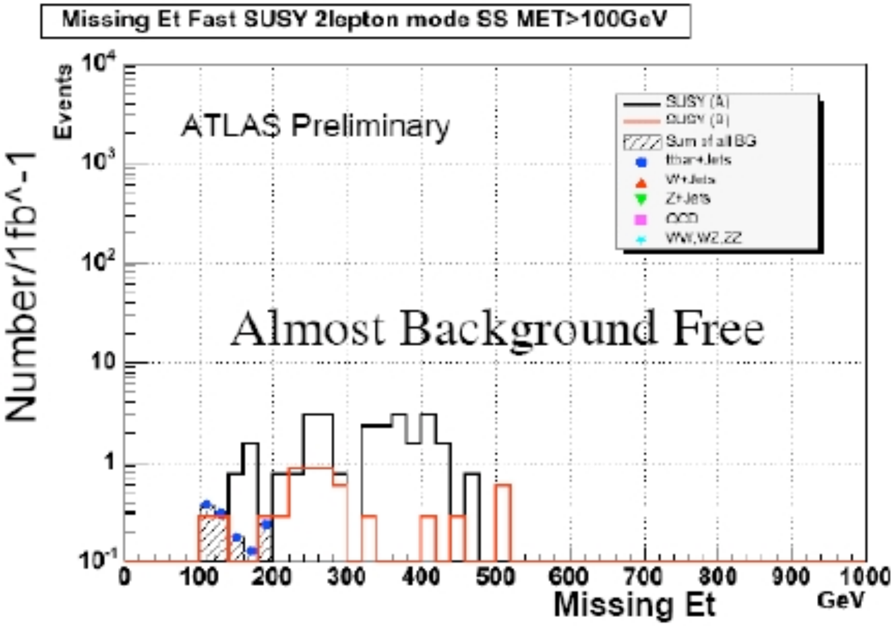
5. Extrapolate it to high E_T^{MISS} region and estimate the background with SUSY signal selection.

Several other techniques also under investigation






Missing Et Fast SUSY 2lepton mode DS MET>100GeV
ATLAS Preliminary
SUSY (A)
SUSY (B)
Sum of all BG
tbar+Jets
W+Jets
Z+Jets
QCD
WW,WZ,ZZ
"Bulk" point
"co-annihilation" point
Events
Number/1fb^-1
10^4
10^3
10^2
10
1
10^{-1}
0
100
200
300
400
500
600
700
800
900
1000
GeV
Missing Et


Missing Et Fast SUSY 2lepton mode SS MET>100GeV
ATLAS Preliminary
SUSY (A)
SUSY (B)
Sum of all BG
tbar+Jets
W+Jets
Z+Jets
QCD
WW,WZ,ZZ
Almost Background Free
Events
Number/1fb^-1
10^4
10^3
10^2
10
1
10^{-1}
0
100
200
300
400
500
600
700
800
900
1000
GeV
Missing Et