Taking and interpreting the first data from ATLAS and CMS

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Possible LHC startup scenario

$\sim$ Mid 2007: start machine cool-down followed by machine commissioning (mainly with single beam)

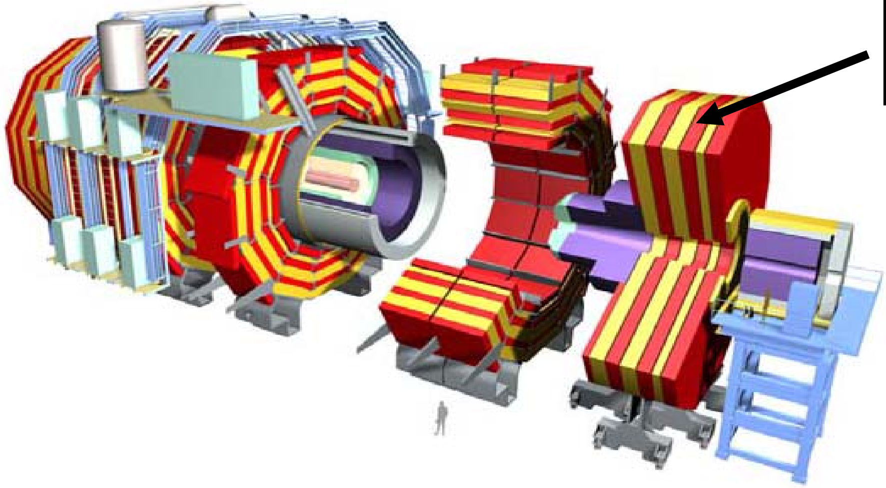
$\sim$ Summer 2007: two beams in the machine $\rightarrow$ first collisions

- 43+43 bunches $\mathcal{L} = 6 \times 10^{31}$cm^{-2}s^{-1}(possible scenario: tuning machine parameters)
- pilot run: 936+936 bunches (75 ns), $\mathcal{L} > 5 \times 10^{32}$cm^{-2}s^{-1}
- 2-3 months shut-down ?
- 2808+2808 bunches (25 ns), $\mathcal{L}$ up to 2×10^{33}cm^{-2}s^{-1}
  $\rightarrow$ 7 months of physics run

Collect $\sim$10-100 pb^{-1} before shutdown $\Rightarrow$ calibration

Canonical 10 fb^{-1} integrated luminosity after physics run

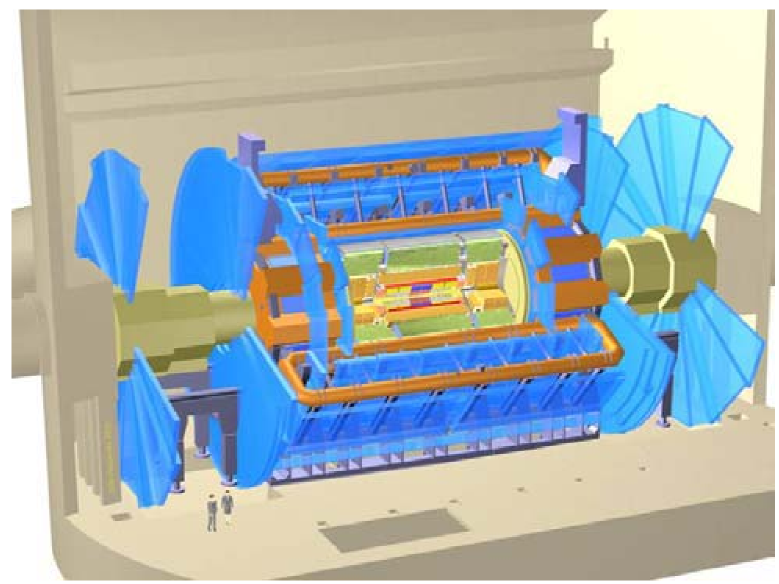
Status of experiments at startup



RPC over $|\eta|<1.6$ (instead of $|\eta|< 2.1$)
4th layer of end-cap chambers missing

Pixels and end-cap ECAL installed during first shut-down

ATLAS: because of staging TRT coverage over $|\eta| > 2.0$ instead of $|\eta| > 2.4$



For both detectors: reduced trigger bandwidth due to deferrals on HLT processors

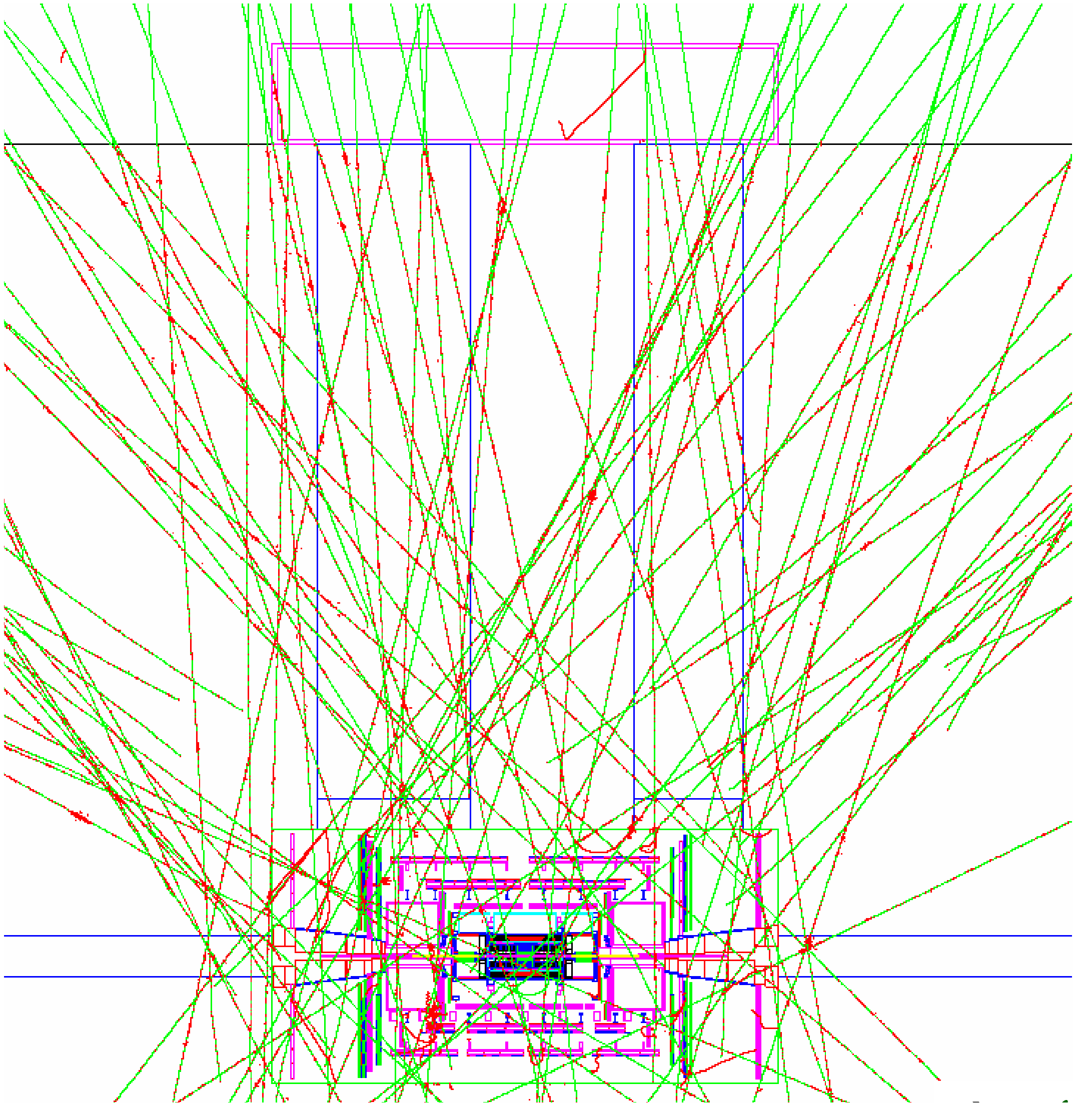
Pre-Collision phase

First detector understanding before commissioning with real collisions.

- Cosmics running (spring 2007)
  - Initial alignment of detector with particles
  - Timing-in of detectors
  - Debugging of sub-systems, mapping of dead channels, etc.
- One beam in the machine
  - beam halo muons and beam-gas events
  - more detailed alignment/calibrations for relevant detectors

Both ATLAS and CMS have developed simulation studies in order to better understand how to use these data

Cosmics



Rate from full simulation of ATLAS (including cavern overburden) validated by measurement with a scintillator telescope in cavern

0.01 seconds shown in figure

Location	Cut	Rate (Hz) (E(surface) >10 GeV)
UX15		4900
Ecal	$E_T^{total} > 5$ GeV	0.4
Tile Cal	$E^{total} > 20$ GeV	1.2
HEC	$E^{total} > 20$ GeV	0.1
FCAL	$E^{total} > 20$ GeV	0.02

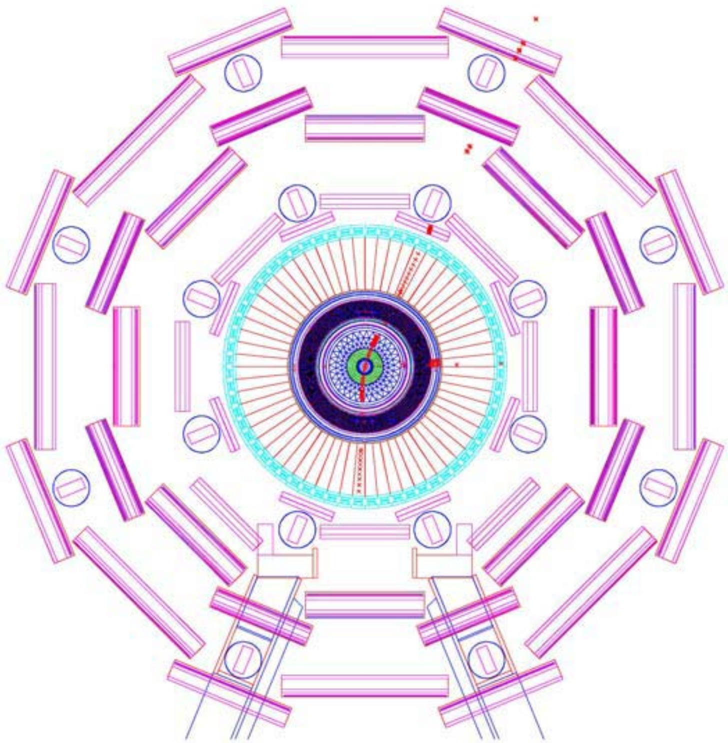
CMS is developing simulation now. Expect ∼1800 Hz over full detector

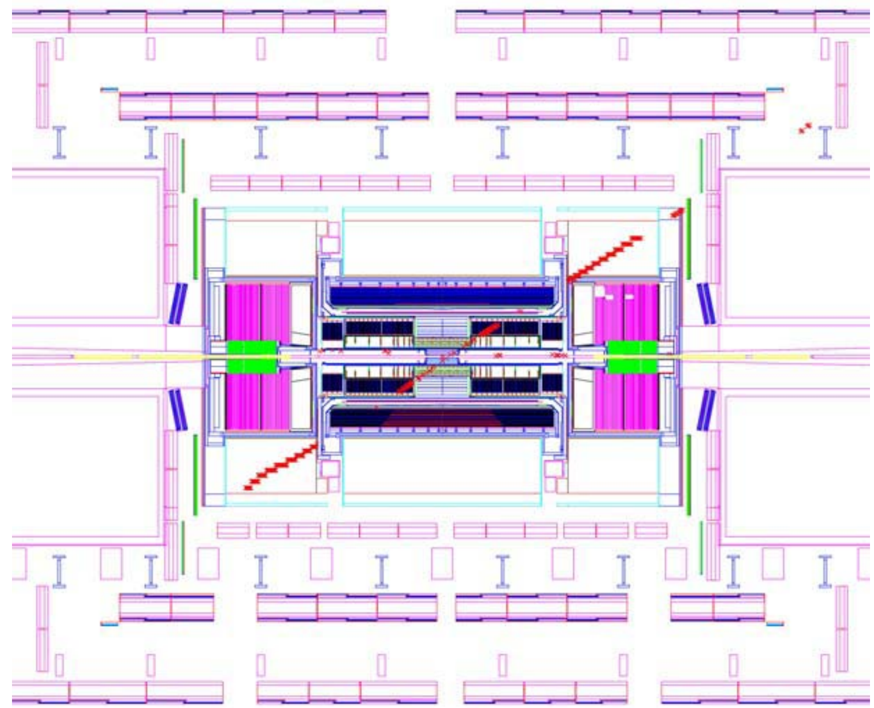
"Typical" cosmic event from ATLAS full sim

One track reconstructed in Muon chambers

Two tracks reconstructed in Inner Detector

Will happen every ∼10 s

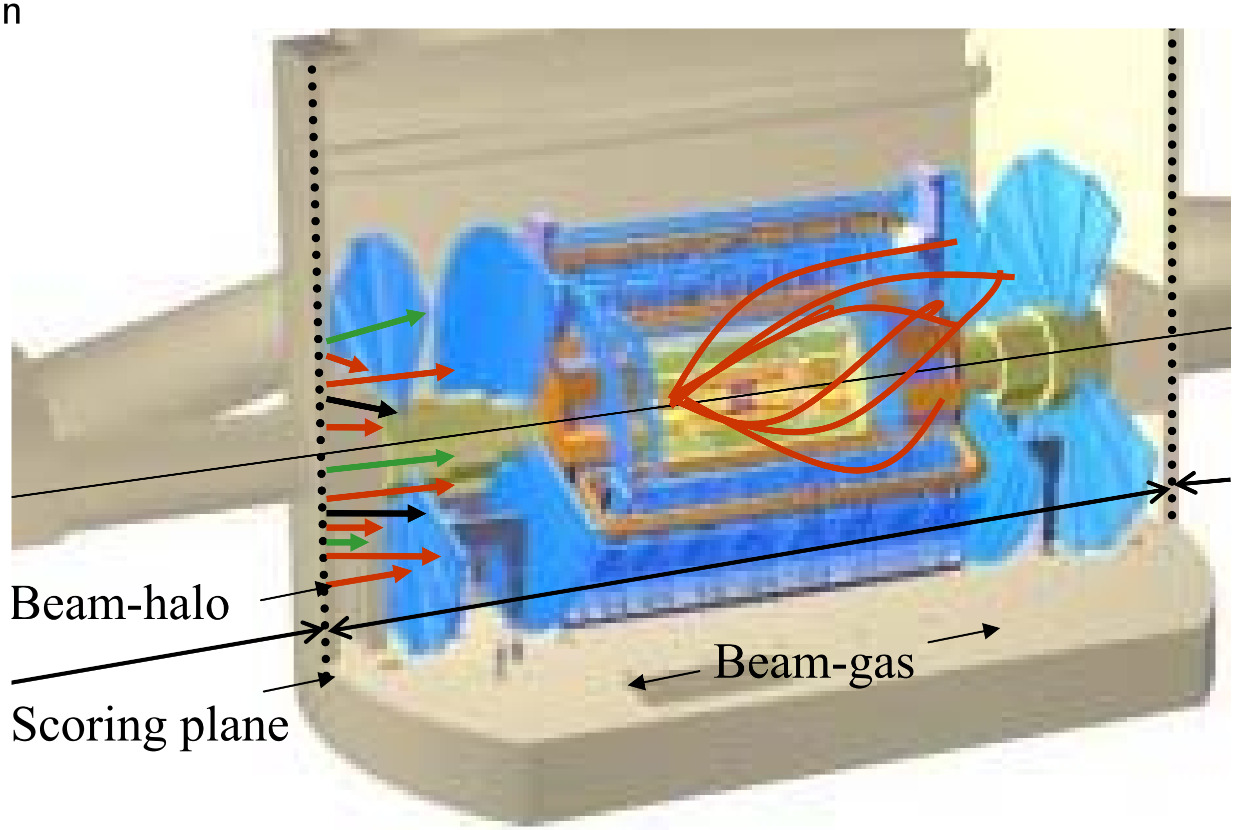




Single beam period

Beam halo:

- Low p_T muons particles from the machine
- Simulation of machine background by machine experts (V. Talanov), transported into full simulation of detectors
- Use for alignment and calibration in endcaps



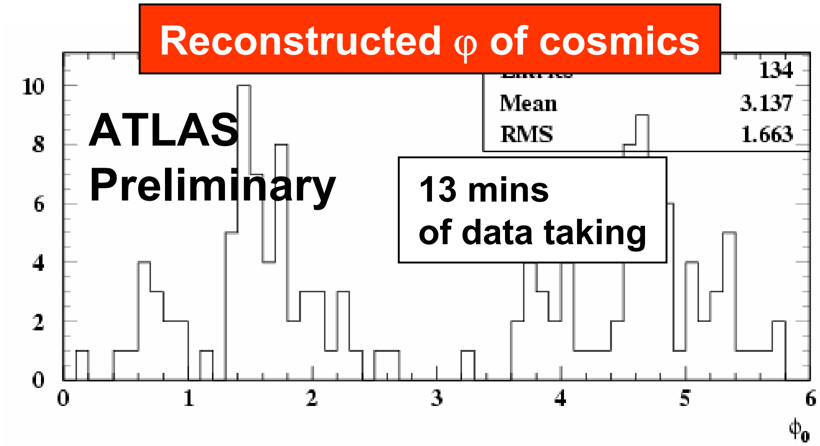
Beam-gas

- Vacuum not perfect 3×10^{-8} Torr
- Proton-nucleon p(7 TeV)+p(rest)
- Resemble collision events but with soft spectrum

Use of pre-collision data for ATLAS inner detector

Cosmics : O (1Hz) tracks in Pixels+SCT+TRT

- **useful statistics for debugging readout, maps of dead modules, etc.**
- **check relative position Pixels/SCT/TRT and of ID wrt ECAL and Muon Spectrometer**
- **first alignment studies: may achieve statistical precision of ~ 10 μm in parts of Pixels/SCT**
- **first calibration of R-t relation in straws**



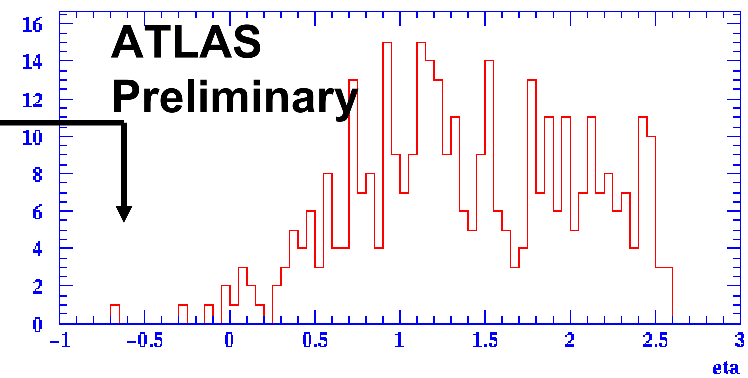
standard ATLAS pattern recognition (no optimisation for cosmics …)

Beam-gas :

- **~ 25 Hz of reconstructed tracks with p_T > 1 GeV and |z|<20 cm**

→ >10^7 tracks (similar to LHC events) in 2 months

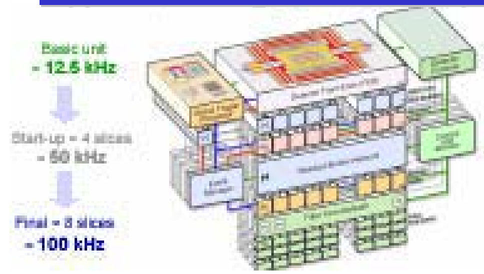
- **enough statistics for alignment in "relaxed" environment → exceed initial survey precision of 10-100 μm**

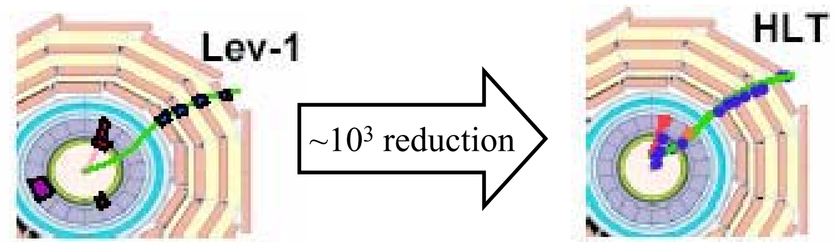


η of beam-gas tracks

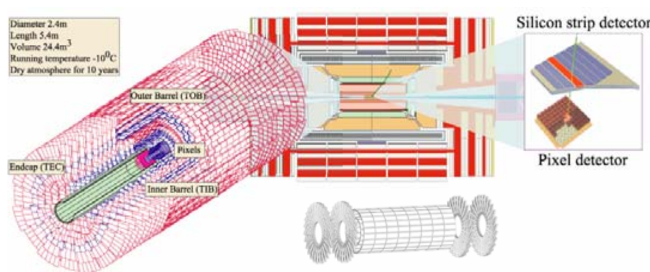
Major Commissioning Challenges

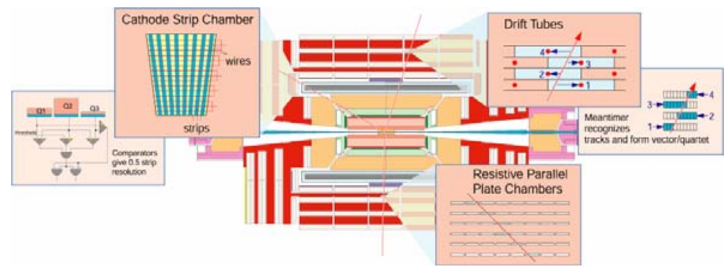
Efficient operation of Trigger (Level1/HLT) and DAQ System



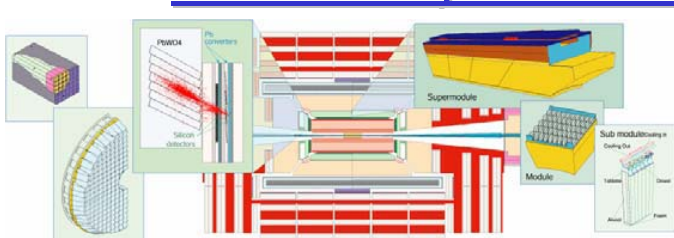


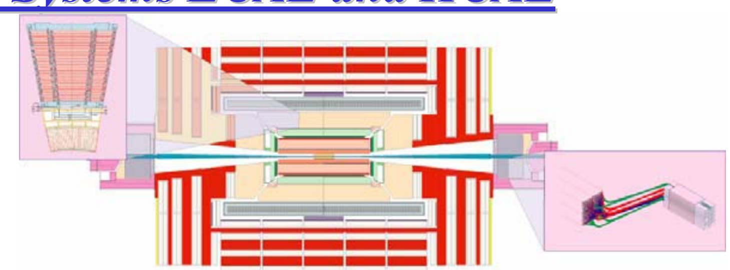
Alignment of the tracking devices Tracker(PIXEL,Strip) and Muon System





Calibration of the Calorimeter Systems ECAL and HCAL





Steps in detector calibration/alignment

- Strict quality control on construction tolerances
- Redundant hardware calibration and alignment systems
- Extensive test beam characterization of prototypes and final modules

  $\longrightarrow$ Also used for validation of G4 simulations
- "In situ" detector calibration:
  - Cosmics runs (end 2006-2007)
  - Single beam and beam gas runs during LHC commissioning
  - Calibration with physics processes (e.g $Z \to \ell\ell$, $\bar{t}t$)

Procedure valid for all sub-detectors, ECAL, HCAL, inner trackers, Muon Chambers

As an example, concentrate on ECAL and inner silicon trackers

Example of calibration steps: ATLAS EM calorimeter

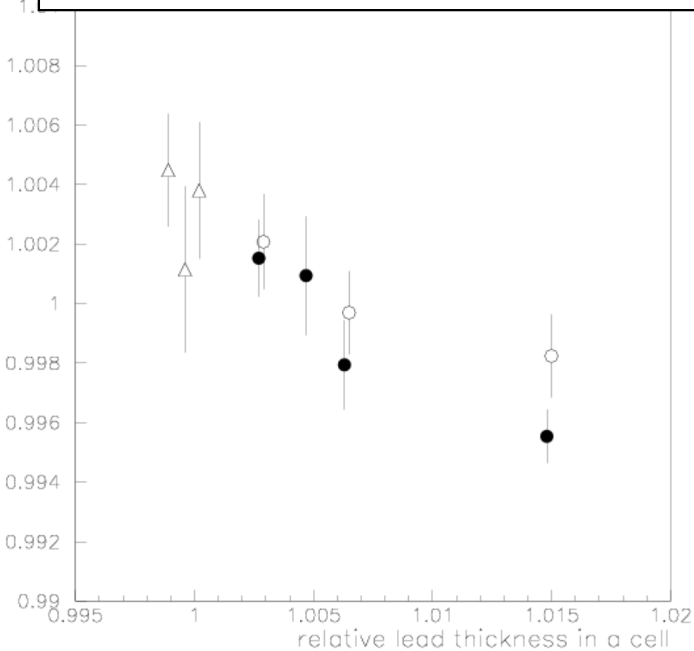
Pb-liquid argon sampling calorimeter with Accordion shape

Main requirement: response uniformity $\leq 0.7\%$ over $|\eta| < 2.5$ driven by $h \rightarrow \gamma\gamma$ search

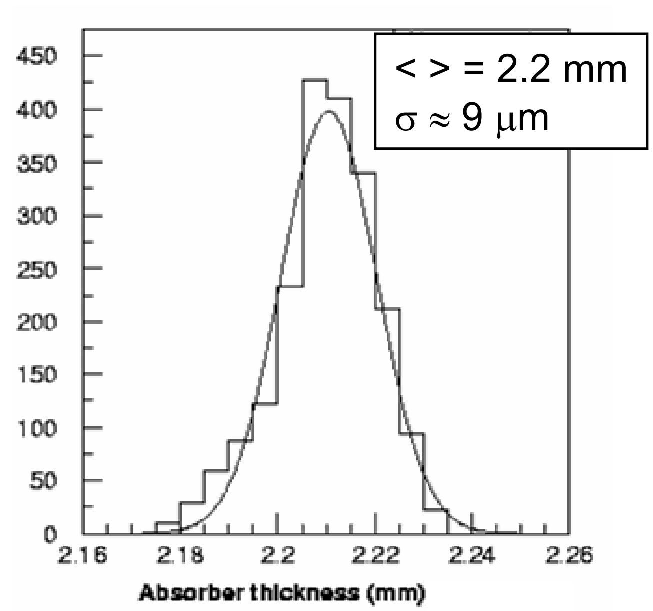
Step 1: Tight control of mechanical tolerances

1% more lead in cell leads to response drop of 0.7% $\Rightarrow$ control plate thickness to 0.5% ($\sim 1\mu$m)

287 GeV electron response variation with Pb thickness from '93 test-beam data



Thickness measurement of 1536 absorber plates



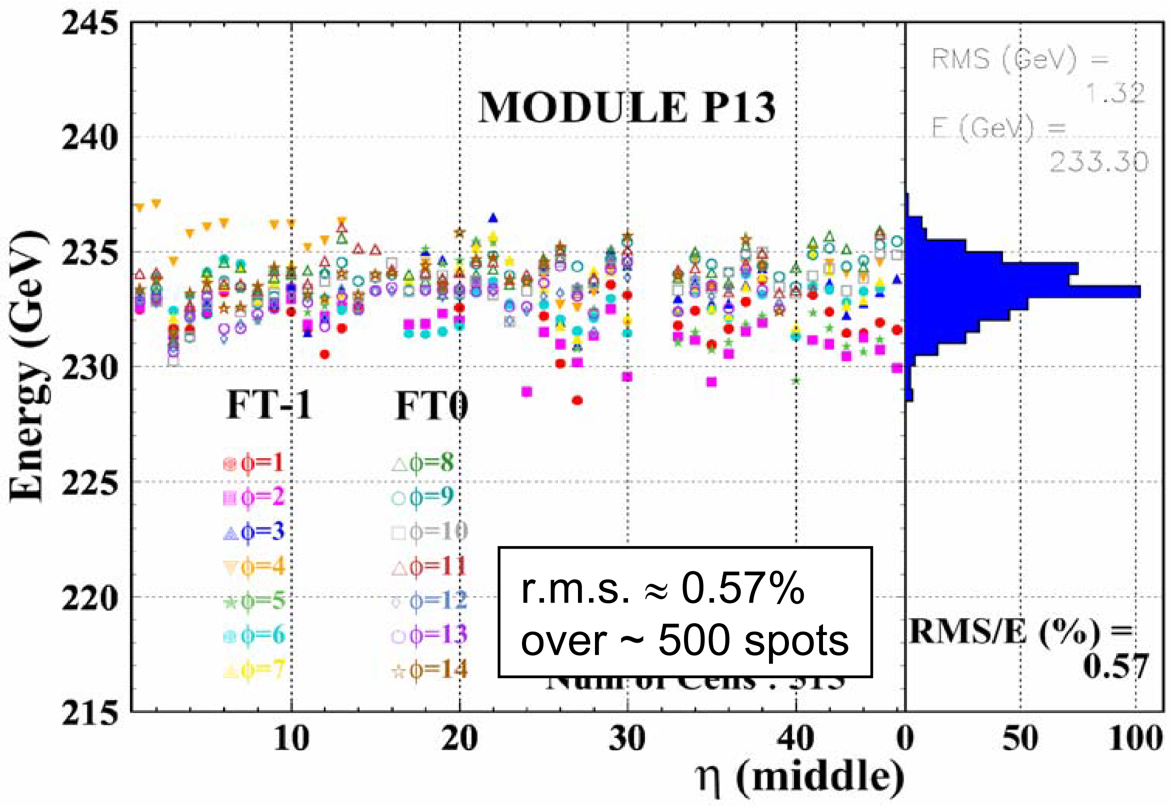
Step 2: Test beam uniformity studies

Beam test of 4 (out of 32) barrel modules and 3 (out of 16) EC modules

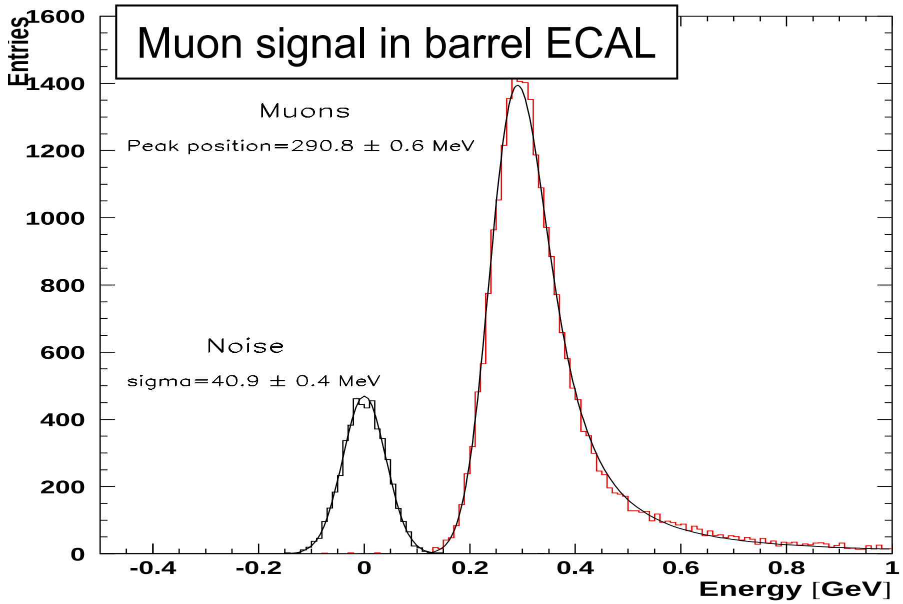
Uniformity over "units" of size $\Delta\eta \times \Delta\phi = 0.2 \times 0.4 :\sim 0.5\%$

400 such units over the full ECAL

Scan of a barrel module with 245 GeV e^-



Step 3: Calibration check with cosmic muons



- Through-going muons ~ 25 Hz

  (hits in ID $+$ top and bottom muon chambers)

- Pass by origin ~ 0.15 Hz

  ($|z| < 60$ cm, $R < 20$ cm, hits in ID)

- Useful for ECAL calibration ~ 0.5 Hz

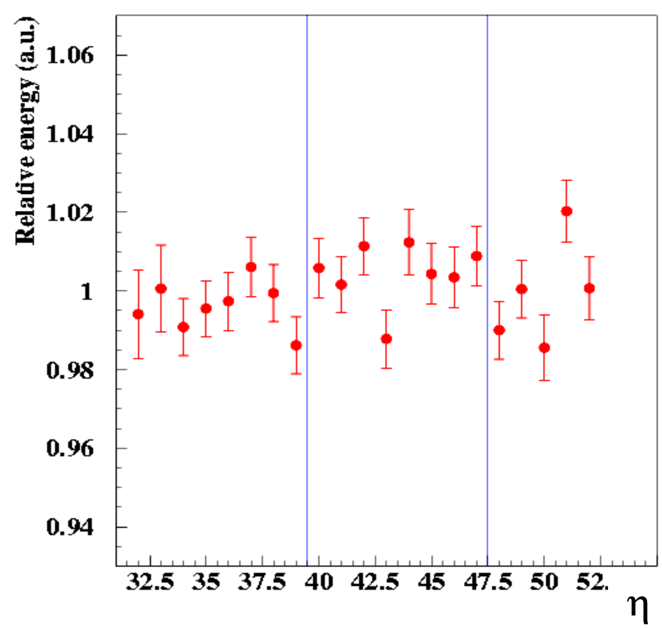
  ($|z| < 30$ cm, $E_{cell} > 10020$ MeV, $\sim 90°$)

$\sim 10^6$ events in ~3 months data taking

From test-beam results:

With this μ statics can check calorimeter response

variations versus η to 0.5%



Step 4: Equalization with $Z \to e^+e^-$

Constant term $c_{tot} = c_L + c_{LR}$ composed of two terms:

- c_L: local term. $c_L \simeq 0.5\%$ demonstrated at the test-beam over units of $\Delta\eta \times \Delta\phi = 0.2 \times 0.4$
- c_{LR} long-range response non-uniformities from unit to unit (400 in total): from module-to-module variations, different upstream material, etc.

Use $Z \to ee$ and Z mass constraint to correct for long-range uniformities

From full simulation: $\sim 250\ e^{\pm}$ per unit to achieve $c_{LR} \leq 0.4\%$

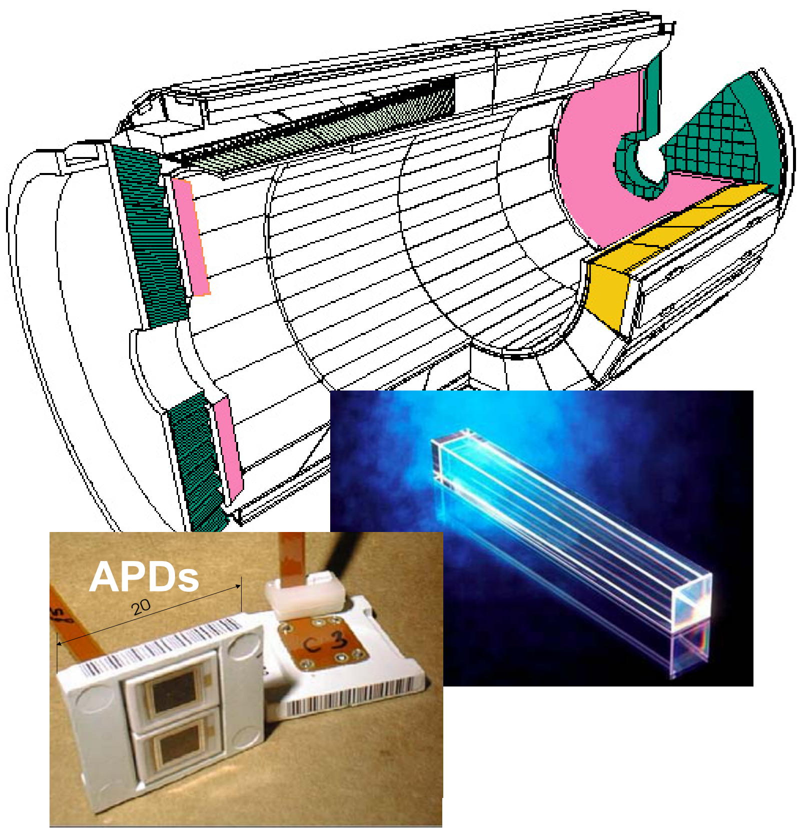
$\Rightarrow \sim 10^5\ Z \to ee$ events, few days of data-taking at 10^{33}

Worst case scenario: no corrections applied

$c_L = 1.3\%$ "on-line" non uniformity of individual modules

$c_{LR} = 1.5\%$ no $Z \to ee$ corrections, poor knowledge of upstream material

CMS ECAL Calibration



Total ~85.000 channels

1. **Lab measurements** of all modules; light yield, APD gain etc. → 4.5 %
2. **Testbeam** precalibration transported to CMS (for 25% of detector) → 2.0 %
   - Distributed within detector, as "standard candle"
3. **Min-bias** phi symmetry → 2 %
   - Fast calibration to reduce number of calibration constants
4. **Z → e^+e^-** → 0.5 % (design value)
   - Needs tracking in Si-tracker
   - Within ~2 months
5. Laser **monitoring system** over time to monitor crystal transparency

Equalization with minimum bias of CMS ECAL

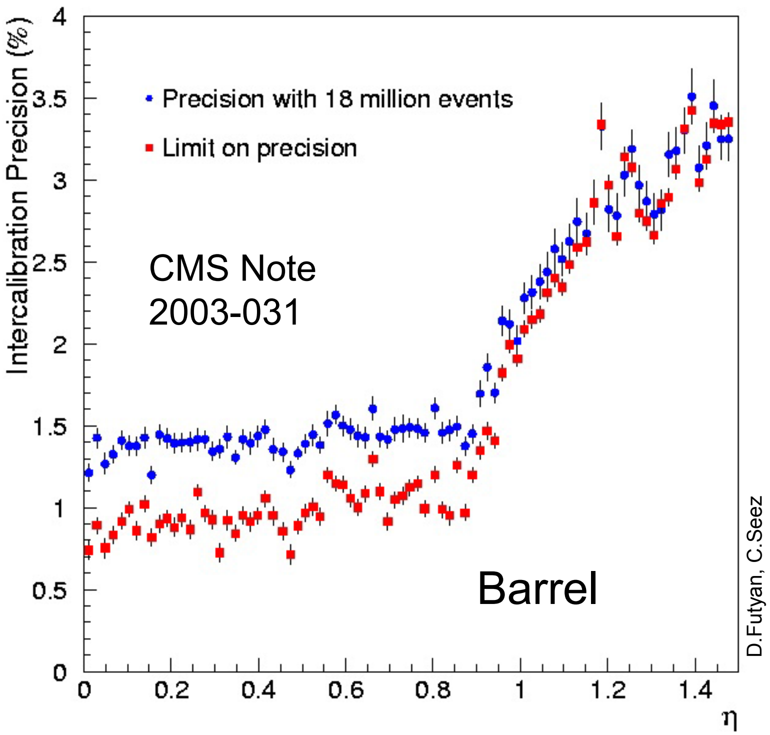
Use phi symmetry of deposited energy to intercalibrate crystals within rings of constant η

Thresholds:

- low $=$ 120 MeV (el. noise)
- high$=$ Lower $+$ 800 MeV

Precision limited by inhomogeneity of material

Method can provide precision at the percent level in a few hours



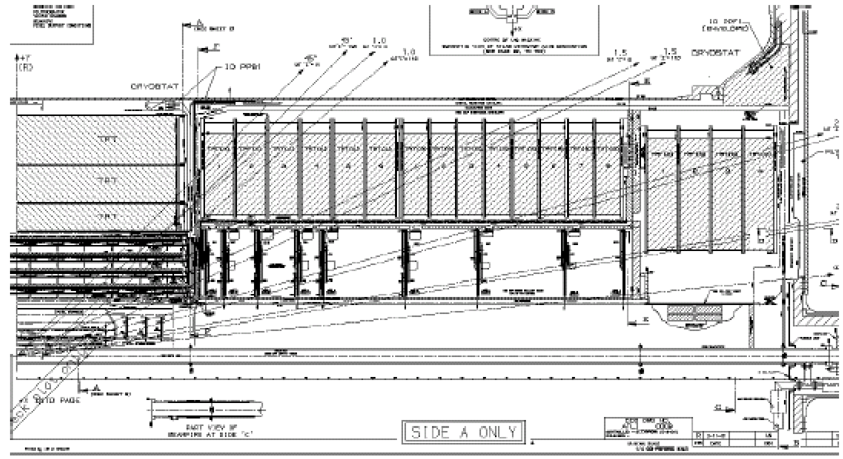
ATLAS Tracker alignment

Module positioning on supports to 17-100 μm

Supports positioned to 20-200μm

ID positioned to ± 3 mm wrt beam axis

Rotation < 1mrad wrt solenoid axis



With initially foreseen misalignment can build tracks with 40-60% precision

Can use either all tracks or just overlaps

Can collect statistics for alignment of pixels to 1-2 μm and SCT to 2-3 μm in one day, but probably dominated by systematic

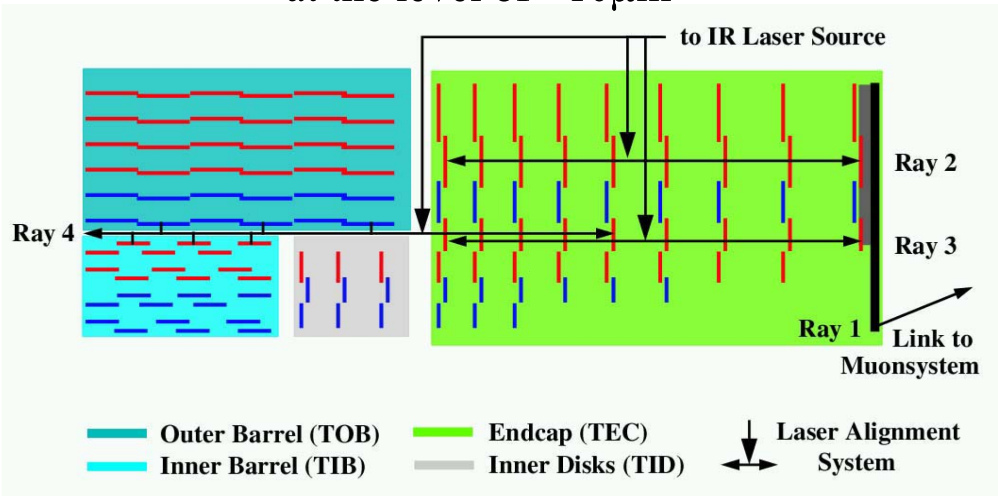
Monitoring of detector conditions necessary for systematics

Thermal instability relevant below 100 μm

Tracker Alignment Concept in a Nutshell

Challenge: Alignment uncertainties must not degrade intrinsic tracker resolution: ≈20µm

LAS: Aligns global support structures and will monitor relative movements at the level of ≈10µm



Mechanical Constraints:
Sensors on Modules: ≈10µm
Composted Structures: 0.1-0.5 mm

First Data Taking:

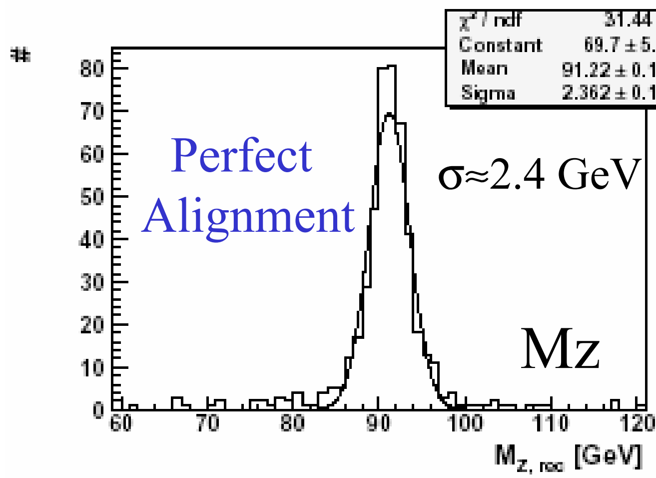
Laser Alignment
⊗
Mechanical Constraints
♥ ≈100µm alignment uncertainties

Sufficient for a first efficient pattern recognition.

Final Alignment: Use Tracks in order to achieve the desired level of alignment uncertainties of ≈10µm. A combination of track based alignment and laser alignment will insure an accurate monitoring of time dependent alignment effects.

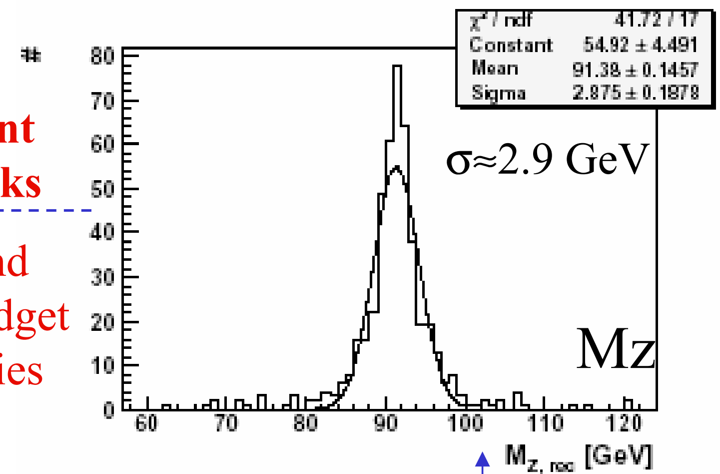
Mis-Alignment: Impact on Physics

- Use $Z \rightarrow \mu\mu$ to illustrate the impact of mis-alignment on physics



Alignment with tracks

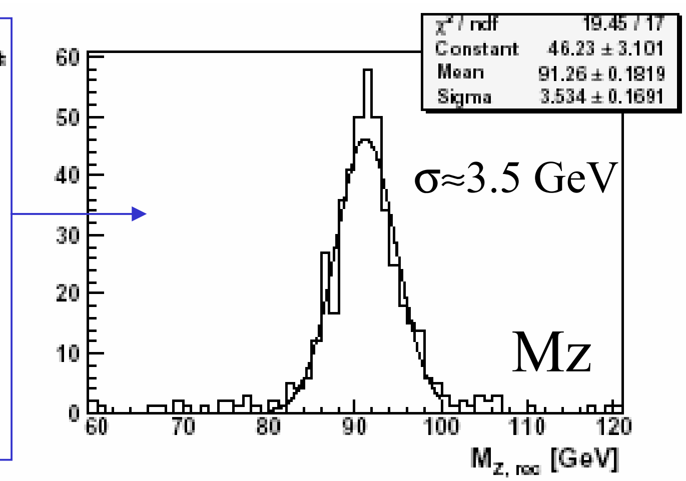
B field and material budget uncertainties



First Data Taking
<1fb⁻¹

Laser Alignment
⊗
Mechanical Constraints

- ≈100µm alignment uncertainties



First Data Taking:
≈1fb⁻¹

First results of Alignment with tracks

- ≈20µm alignment uncertainties

Physics impact of alignment: b-tagging (ATLAS)

Largest impact of pixel alignment is on b-tagging performance

Study performance as a function of time on $\bar{t}th$.

Include in study effect of detector inefficiencies

Period	Precision		R_u	R/R_0
3 months	$\sigma_{R\varphi}$=20 μm σ_z=60μm	ε_b=50%	175 ±4	0.67
		ε_b=60%	57 ±1	0.71
6 months	$\sigma_{R\varphi}$=10 μm σ_z=30 μm	ε_b=50%	237 ±7	0.91
		ε_b=60%	74 ±1	0.92
9 months	$\sigma_{R\varphi}$=5 μm σ_z=15 μm	ε_b=50%	259 ±8	0.99
		ε_b=60%	79 ±1	0.97
ideal	$\sigma_{R\varphi}$=0 μm σ_z=0 μm	ε_b=50%	262 ±8	1.
		ε_b=60%	81 ±1	1.

Calibration with early data: jet scale with $\bar{t}t$ events (ATLAS preliminary)

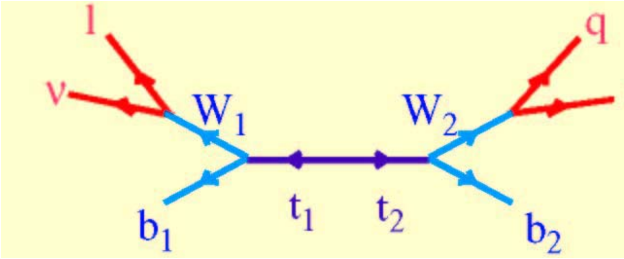
Fast simulation study on $\bar{t}t$ sample (D. Pallin)

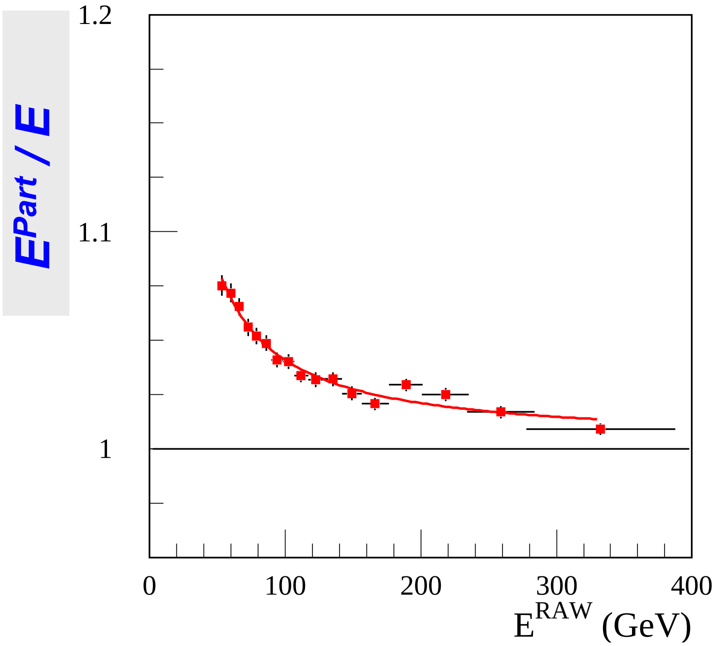
Use top semileptonic decay

Require 1 or two b-tags, different assumptions on b-tag performance

jet reconstructed with $\Delta R = 04$ cone algo

For $\epsilon(b - tag) = 0.6$, 100-200 evts/day at 10^{33} depending on cuts, with 80-90% purity





$$M_W^2 = 2E_{j1}E_{j2}(1 - \cos\theta_{j1j2})$$

$< M_W >$=74.8 GeV for 80.25 GeV generated

Due to jet non-calibration because of cone algorithm ($\Delta R = 04$) in presence of FSR

Additional effect from $\cos\theta_{jj}$ measurement

Determination of correction factors

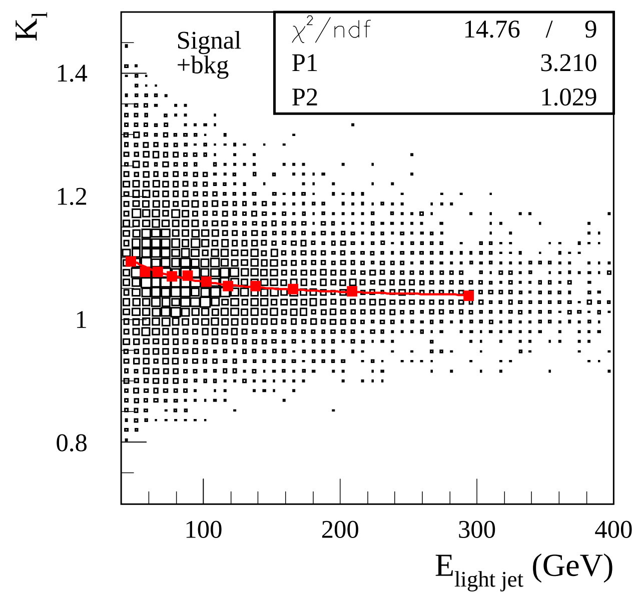
Evaluate $\alpha = E_{parton}/E_{jet}$

Perform fit constraining M_{jj} to M_W

$$\chi^2 = \left(\frac{m_{jj} - M_W}{\sigma_W}\right)^2 + \sum_{1,2}^{X=E,\eta,\phi} \left[\frac{X_i - \alpha_E^i X_i}{\sigma_X}\right]^2$$

Event by event compute α_E^1 and α_E^2 for two jets

Deduce function $\alpha_F = f(E)$



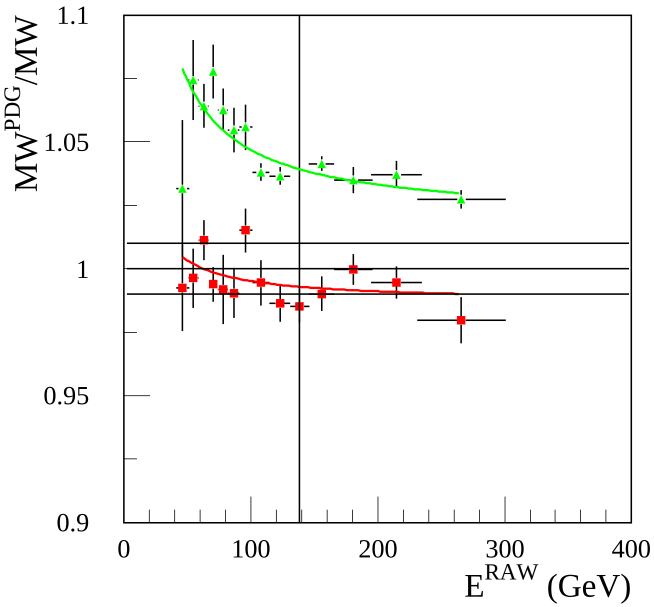
Results (preliminary)

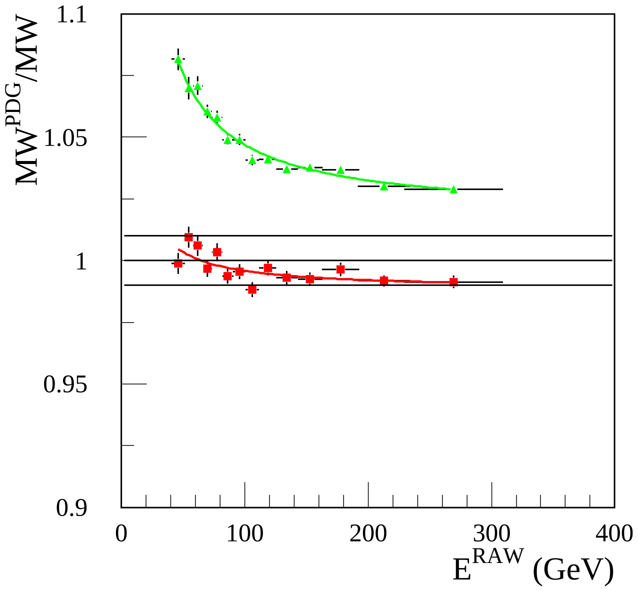
Compare M_W deviation before (green) and after (red) correction

Consider 10^{33} luminosity

Left plot: 12 days (b-tag=0.6)/1.5 months (b-tag=0.3) ⇒ 3% precision

Right plot: 2 months (b-tag=0.6)/1 year (b-tag=0.3) ⇒ 1% precision





Physics with early data

Process	Events to tape/exp for 10 fb^{-1}
$W \rightarrow \mu\nu$	7×10^7
$Z \rightarrow \mu\mu$	1.1×10^7
$\bar{t}t$ (semileptonic)	0.08×10^7
$\tilde{g}\tilde{g}$ (m$_{\tilde{q}}$ =1 TeV)	$10^3 - 10^4$

Statistics of low p_T jets and minimum bias only limited by allocated trigger bandwidth

Already in first year, large statistics expected from:

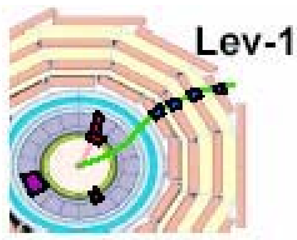
- Known SM processes $\rightarrow$ understand detector and physics at the LHC
- Several new physics scenarios

Overall statistics limited by ~ 100 Hz rate-to-storage

Concentrate on early studies on: Minimum bias/UE, top, Supersymmetry

Triggers for early data taking (CMS)

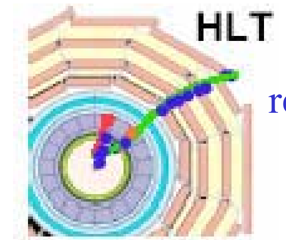
Tot Rate x Safety = Rate
50 kHz x 1/3 ~ 16kHz
~1/4 per class
(e/γ, muon, tau, jet)
+ 1kHz calibration



Channel	Threshold [GeV] ε = 95%	Individual Rate [kHz]
Inclusive isolated e/γ	29	3.3
Di-electrons/di-photons	17	1.3
Inclusive isolated muon	14	2.7
Di-muons	3	0.9
Single tau-jet trigger	86	2.2
Two tau-jets	59	1.0
1-jet, 3-jets, 4-jets	177 , 86 , 70	3.0
Jet * E_T^{miss}	88 * 46	2.3
Electron * jet	21 * 45	0.8
Min-bias (Calibration)		0.9

Sum ~16kHz

Event Selection: ~10^3 reduction from Level-1 to HLT



Utilize dedicated offline reconstruction tools at HLT. No intermediate level (i.e. Level-2) required.

Channel	Threshold [GeV] ε = 90...95%	Rate [Hz]
1 e, 2 e	29 , 17 + 17	34
1 γ, 2 γ	80 , 40 + 25	9
1 μ, 2 μ	19 , 7 + 7	29
1 τ, 2 τ	86, 59 + 59	4
1-jet OR 3-jet OR 4	657 , 247, 113	9
e * jet	19 + 45	2
Jet * E_T^{miss}	180 + 123	5
Inclusive b-jets	237	5
Calibration,Other		~10
Sum		~105 Hz

Efficient Level1/HLT operation is insured when:

ECAL and HCAL calibrated to ~2%; Muon System aligned ~500 μm,
Silicon Strip Detector aligned ~20 μm; PIXEL detector aligned to ~10 μm.

♥ **Most of these requirements can already be met during the Pilot Physics Run**

Minimum bias and Underlying Event studies

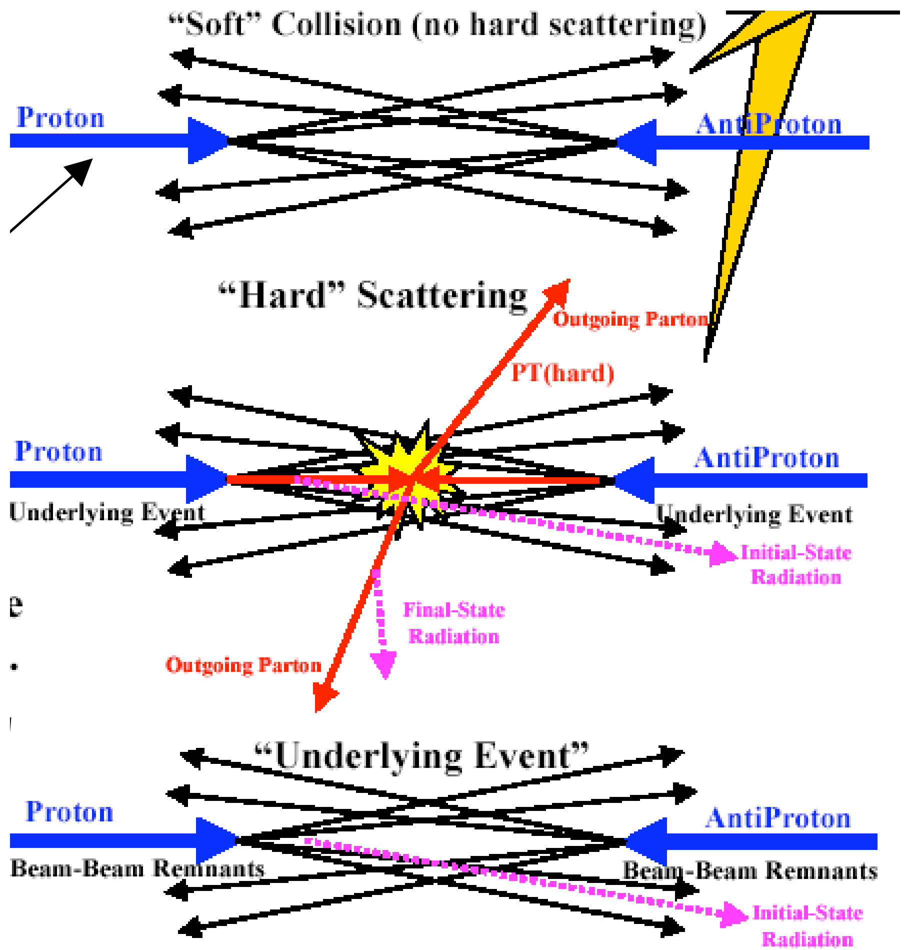
Hadronic interactions:

- Hard processes (high p_T): well described by PQCD
- Soft interactions low p_T): require non-perturbative phenomenological models:
  - Minimum bias: non single-diffractive events: $\sigma \sim 60 - 70$ mb
  - Underlying event: everything except two outgoing hard scattered jets

First physics available at the LHC

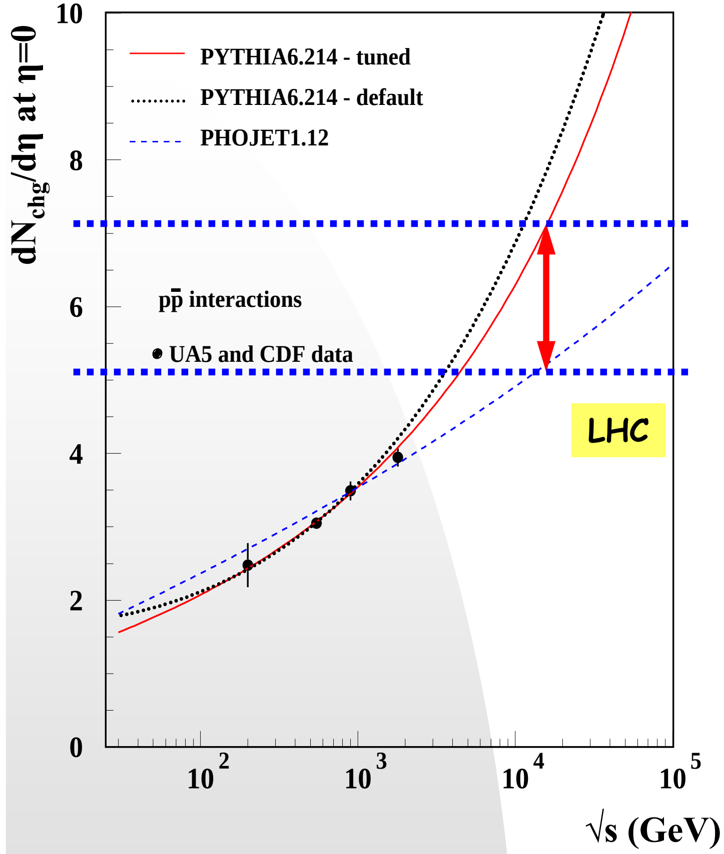
Interesting $per\,se$

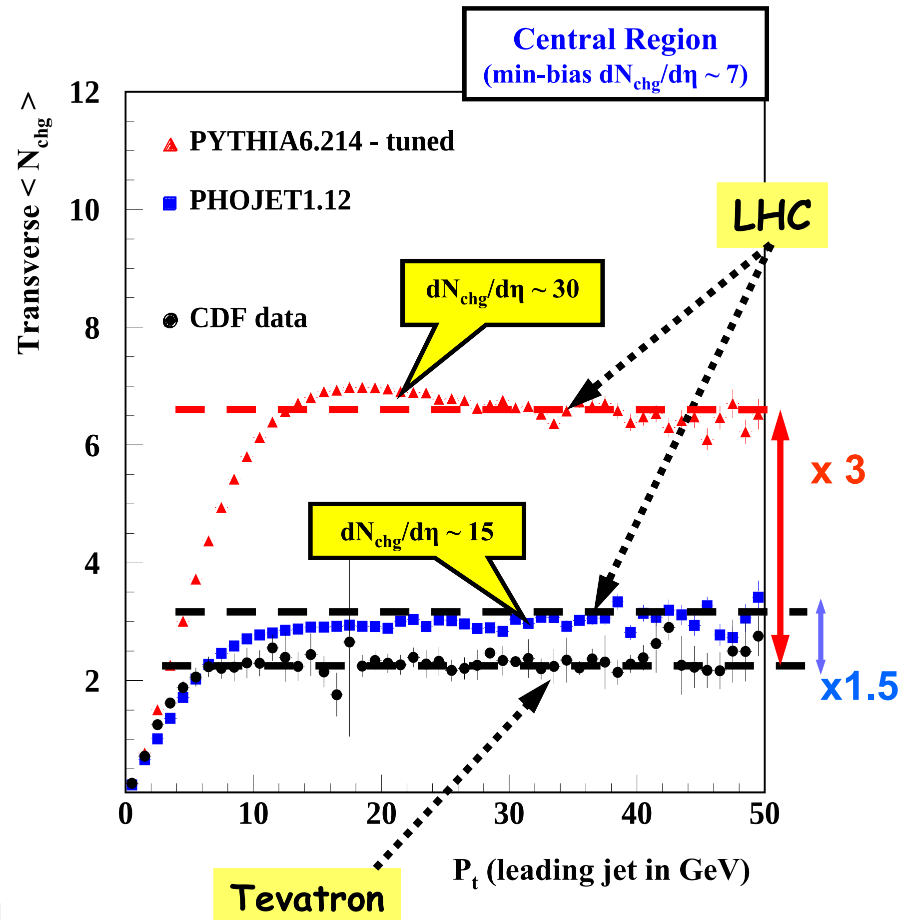
Modelling of minimum bias pile-up and underlying event necessary tool for high P_T physics



Extrapolation to LHC

Dependence on $\sqrt{s}$ of charged particle density at $\eta = 0$

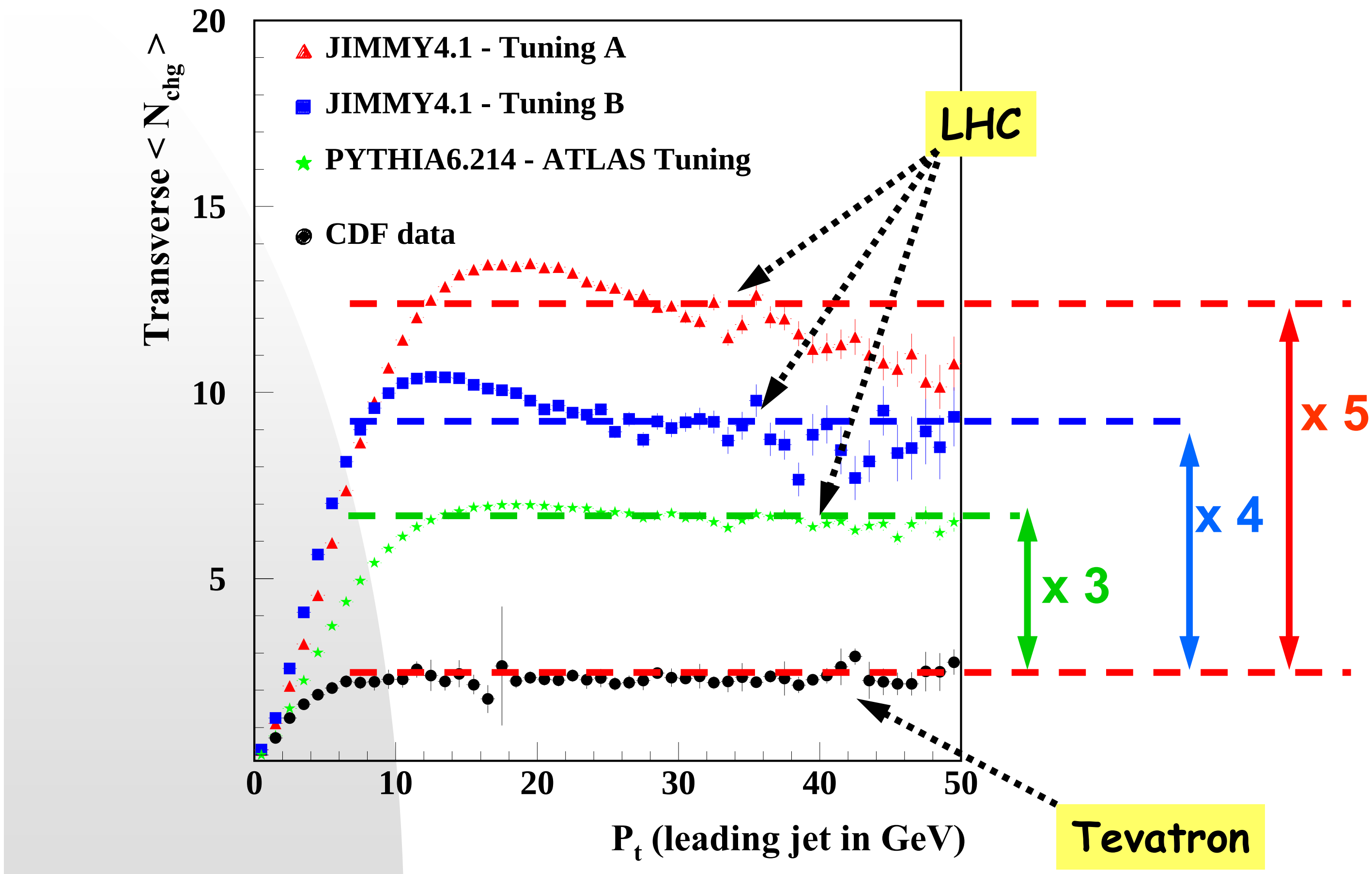




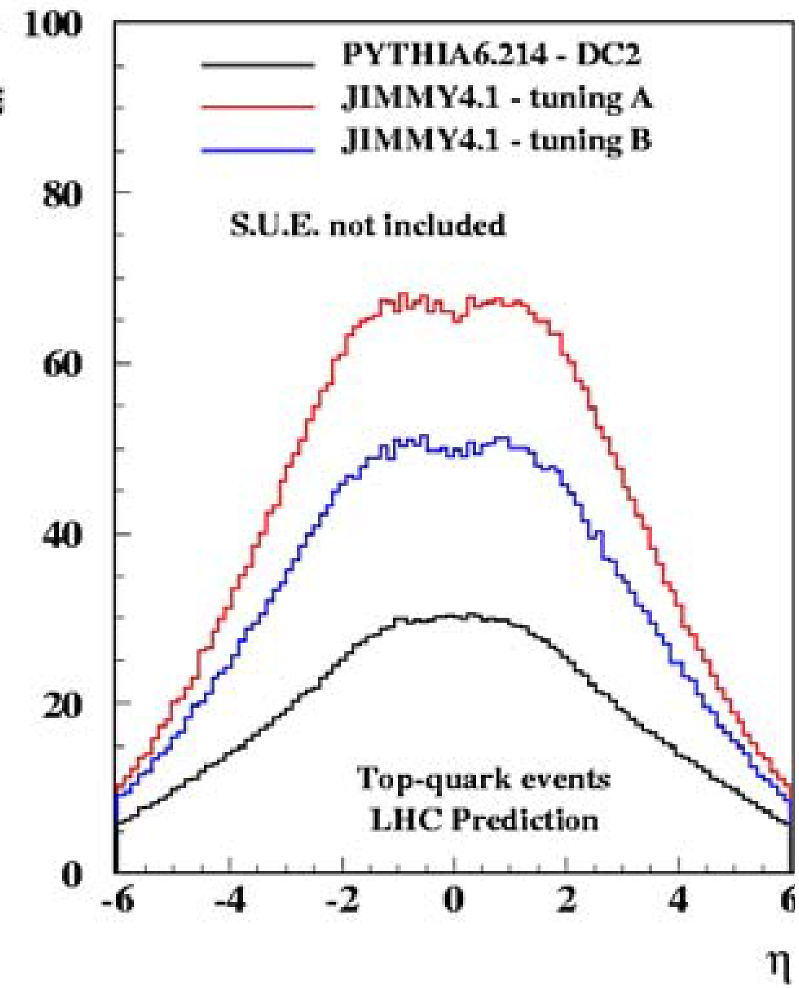
- PYTHIA models favour $\ln^2(s)$;
- PHOJET suggests a $\ln(s)$ dependence.

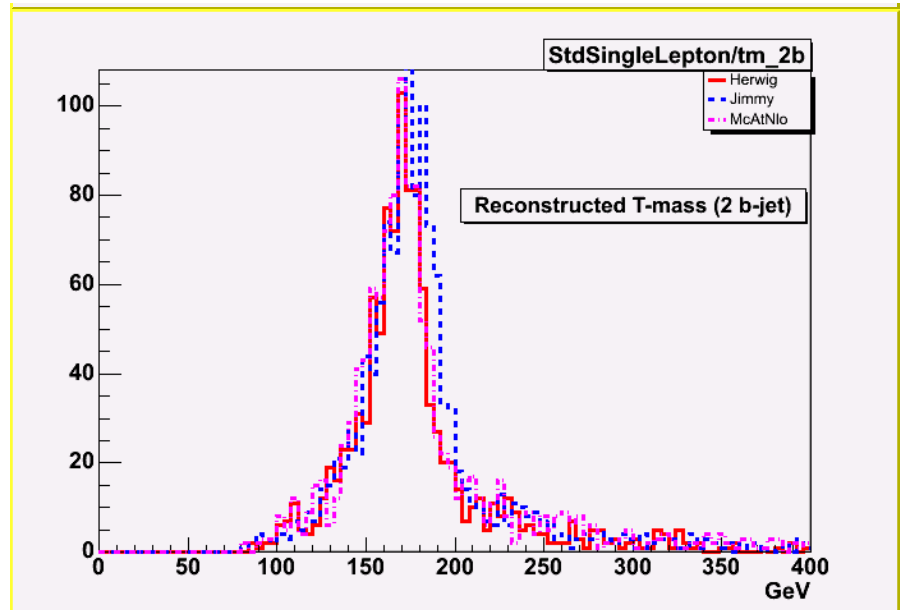
LHC predictions for different generators

Consider PYTHIA and JIMMY underlying events tuned to the Tevatron data



Example: Impact on top mass measurement





Different UE models can shift top mass by up to 5 GeV

Need excellent UE modelling to perform subtraction

Early top physics in ATLAS

Top production is ideal laboratory for initial studies

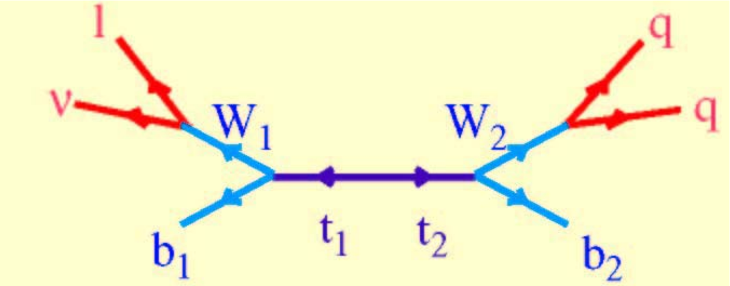
Very high cross-section at the LHC: $\sigma_{\bar{t}t} = 830$ pb

Semi-leptonic signature: $\bar{t}t \to b\ell\nu bqq$:

Easy to trigger on and to extract

involves many detector signatures:

lepton-id, $\not{E}_T$, Jet reconstruction and calibration, b-tagging



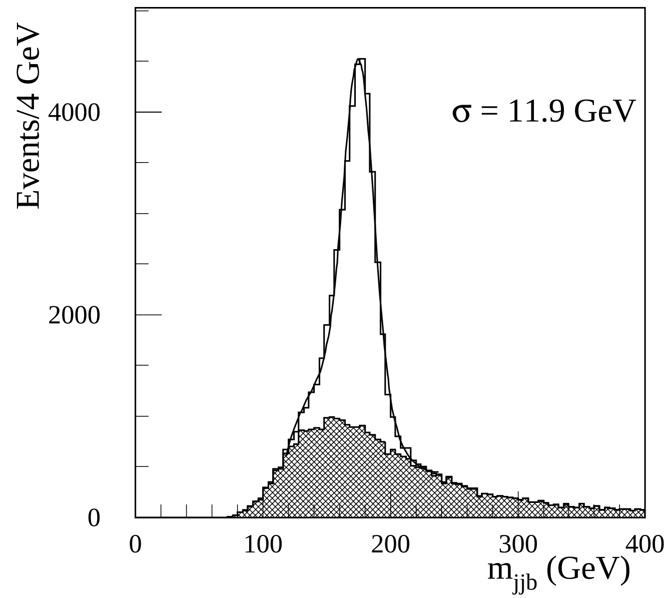
Two main aspects of early top studies:

- Initial measurements of mass, σ_{tt}, possible deviations due to new physics
- Use as a calibration tool for jet scale, b-tagging
- Learn how to control top as a background

Statistical uncertainties on σ and mass

Standard ATLAS TDR analysis: require:

- $P_t(lep) > 20$ GeV
- $\not{E}_T > 20$ GeV
- ≥ 4 jets with $P_T > 40$ GeV
- ≥ 2 b-tagged jets
- $|m_{jjb} - < m_{jjb} > | < 20$GeV



For initial run:

$\mathcal{L} = 10^{33}$ cm^{-2}s^{-1}

Time	Events	dM_{top} (stat)	$\delta\sigma/\sigma$ (stat)
1 year	3×10^5	0.1 GeV	0.2%
$\sim$ month	7×10^4	0.2 GeV	0.4%
$\sim$ week	2×10^3	0.4 GeV	2.5%

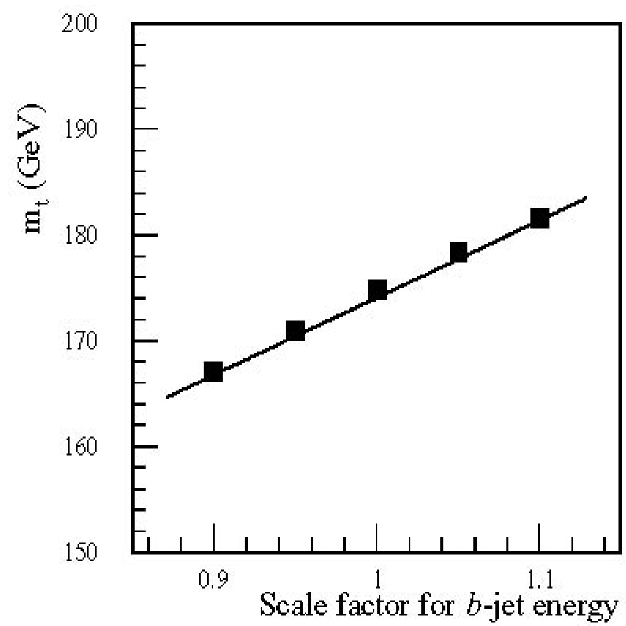
Systematic error on M_{top} (TDR performance, 10 fb^{-1})

Source of uncertainty	Hadronic part δM_{Top} (GeV)	Kinematic fit δM_{Top} (GeV)	Comments
Light jet energy scale	0.9	0.2	1% error
b–jet energy scale	0.7	0.7	1% error
b–quark frag.	0.1	0.1	$(\varepsilon_b = -0.006) - (\varepsilon_b = -0.035)$
ISR	0.1	0.1	20%(ON–OFF)
FSR	1.9	0.5	20%(ON–OFF)
Combinatorial Bkg	0.4	0.1	
Total	2.3	0.9	

Initial performance: uncertainty on b-jet scale dominate

cfr: 10% on q-jet scale $\rightarrow$ 3 GeV om M_{top}

b-jet scale uncertainty	dM_{top}
1%	0.5 GeV
5%	3.5 GeV
10%	7 GeV



Commissioning scenarios

Nominal performance of b-tagging only can be achieved for an alignment of the ID of order 5 μm

Several months required to achieve this level of alignment

Top events can be used to monitor the efficiency of b-tagging:

- Count number of events with at least one tagged jet
- Compare 0 vs 1 vs 2 b-tagged jets in top events
- Want to use data, detailed detector effect might not be completely taken into account in MC

$\Rightarrow$ Need to select top sample independently of b-tagging

Perform study in most pessimistic scenario: no b-tagging

Show exploratory work in fast simulation (S Bentvelsen et al.): complete sample in full G4 simulation available now, results by early June (ATLAS physics workshop)

Use MC@NLO for signal and ALPGEN for $W + 4$ jets background (dominant)

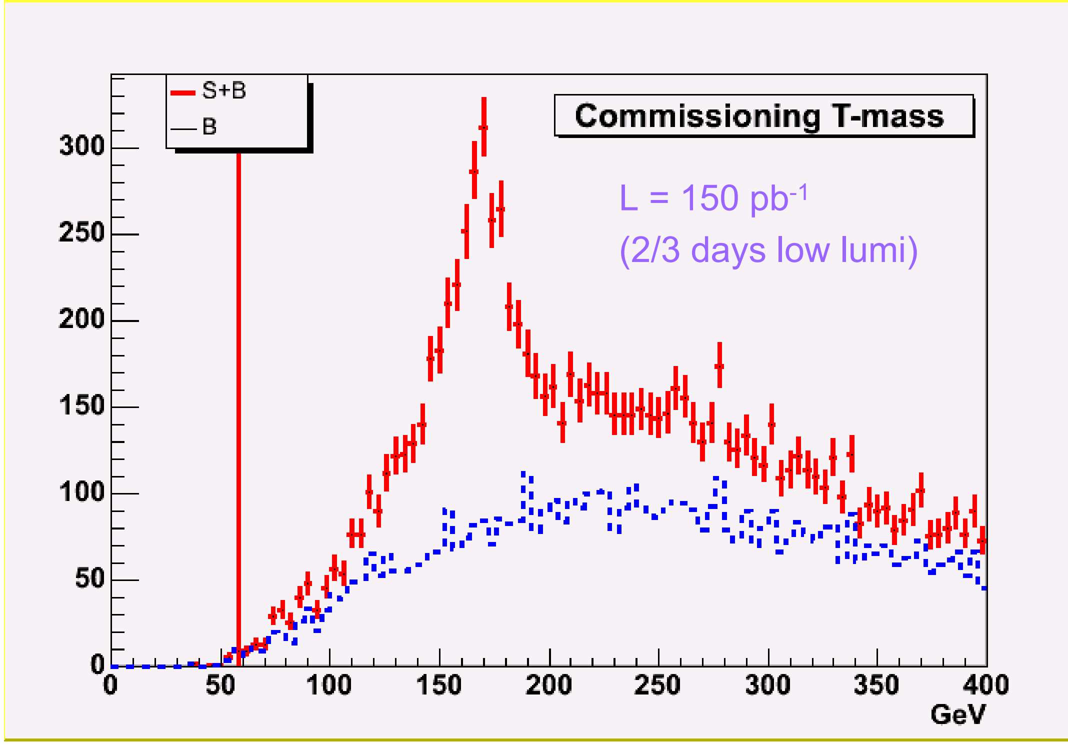
No b-tag analysis

Assume nominal lepton-id performance (jet rejection $\sim 10^5$) Selection criteria:

- Isolated lepton with $p_T > 20$GeV
- Exactly 4 jets ($\Delta R = 0.4$) with $p_T > 40$GeV

Reconstruction:

- Select 3 jets with maximal resulting p_T



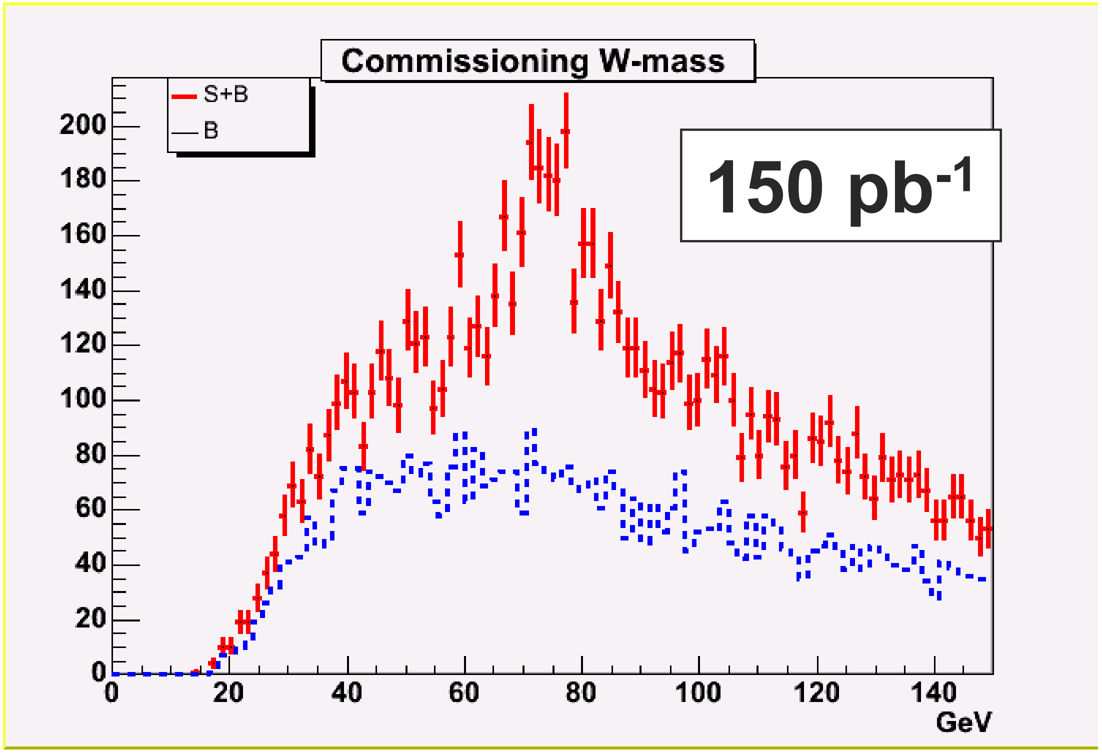
Main background: W+4 Jets

Event with very simple selection and reconstruction top peak should be visible at the LHC in few days of running

Can the W be seen over the combinatorial?

Select 2 jets with highest resulting P_T

- W peak visible in signal
- No peak in background
- Algorithm for jet pairing could be optimised



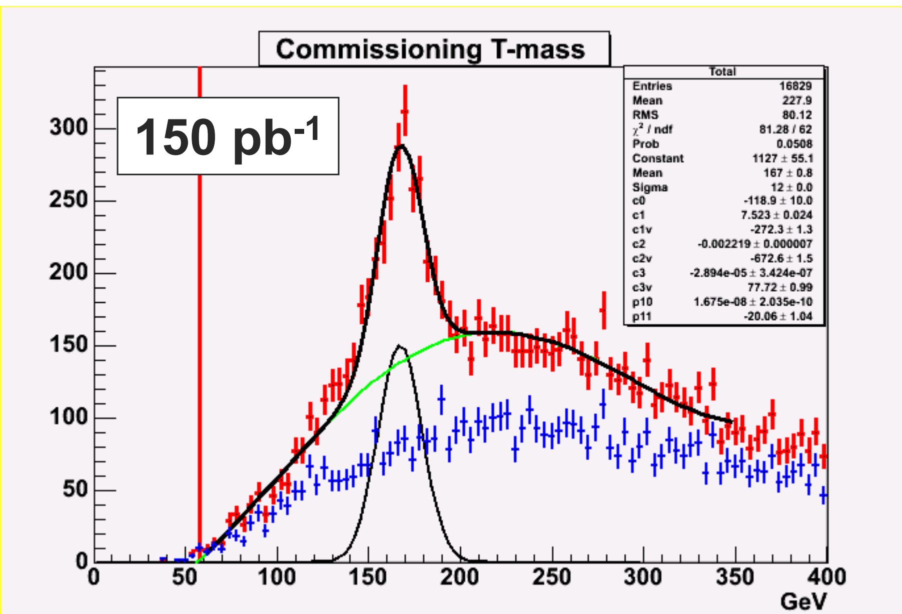
Perform fit to top and W mass

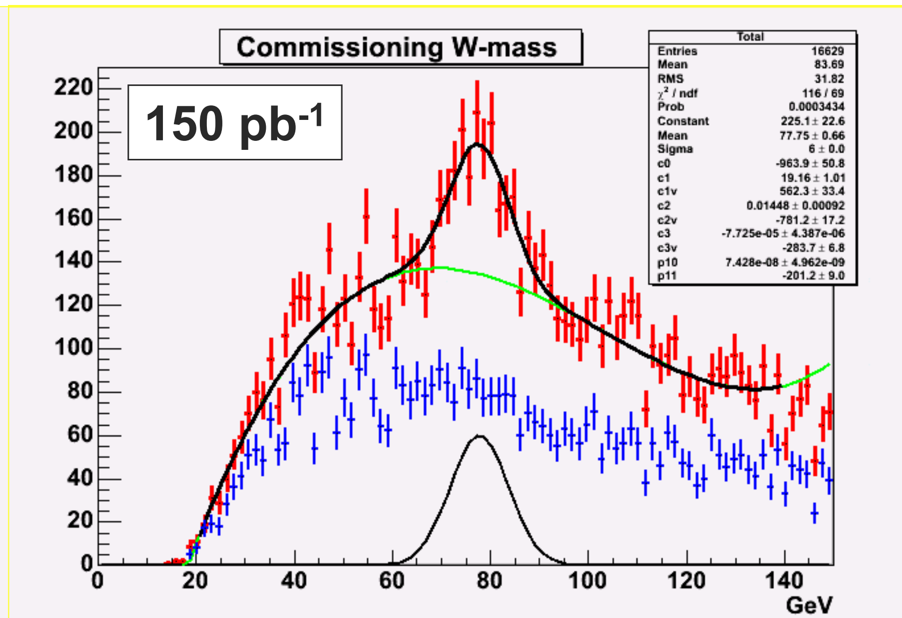
ATLAS Preliminary

150 pb^{-1}	mean	σ(stat)
Mtop	167.0	0.8
Mw	77.8	0.7

Fit to signal and background:

- Gaussian signal
- Polynomial background
- Fix width of W to 6 GeV and of top to 12 GeV





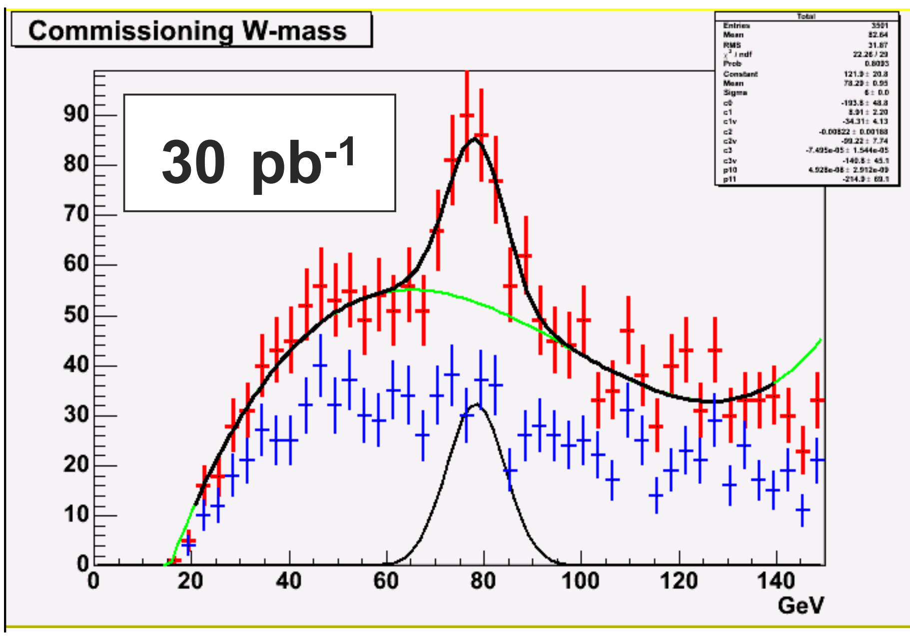
Lower luminosity?

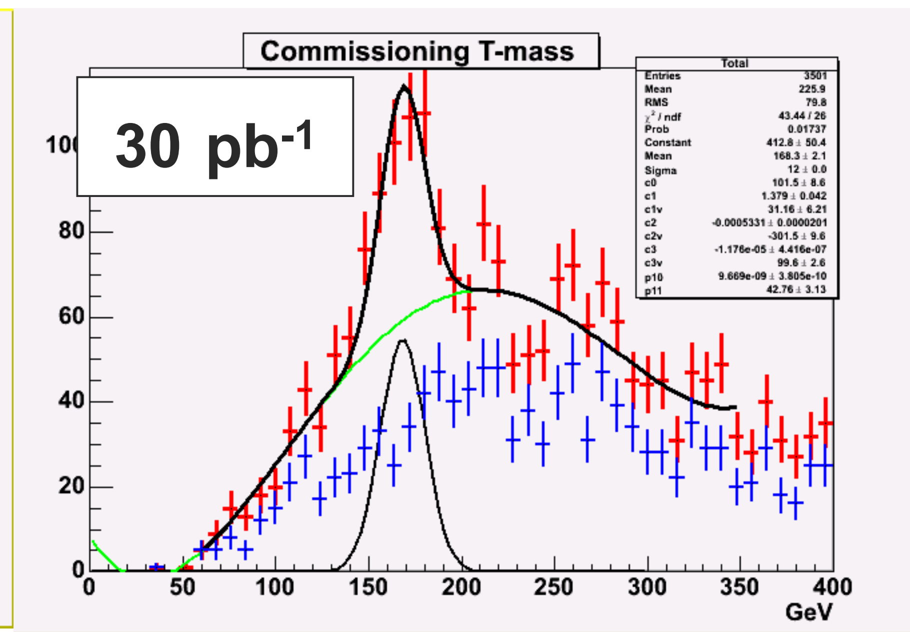
Assume lower lumi: 30 pb^{-1}

Both top and W peak still observable

ATLAS Preliminary

30 pb^{-1}	mean	σ(stat)
Mtop	170.0	3.2
Mw	78.3	1.0





Same plots with b-tagging on

Assume full b-tagging: efficiency 60%, mistag 1%

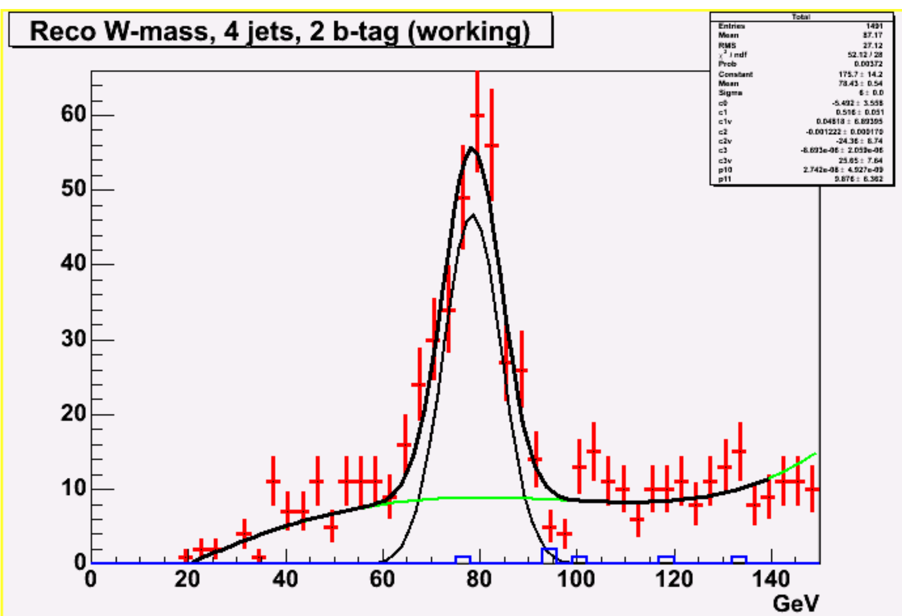
Require 2 b-tagged jets:

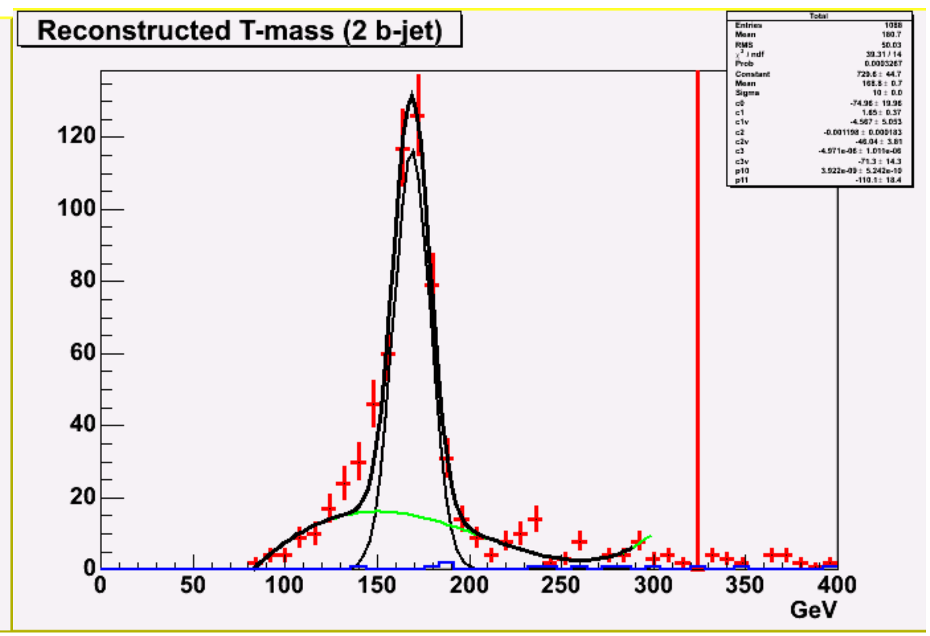
$W + 4$ jets background essentially disappears $\Rightarrow$ result strongly dependent on assumed mistag rate

Sharp top mass peaks with little background

For top mass only use events for which $|M_{jj} - 80.4| < 20$ GeV

Use standard kinematic top reconstruction





SUPERSYMMETRY

SUSY is best candidate for early discovery at the LHC:

$\tilde{g}$ and $\tilde{q}$ strongly produced, cross-section comparable to QCD at same $Q^2 \Rightarrow$ dominant

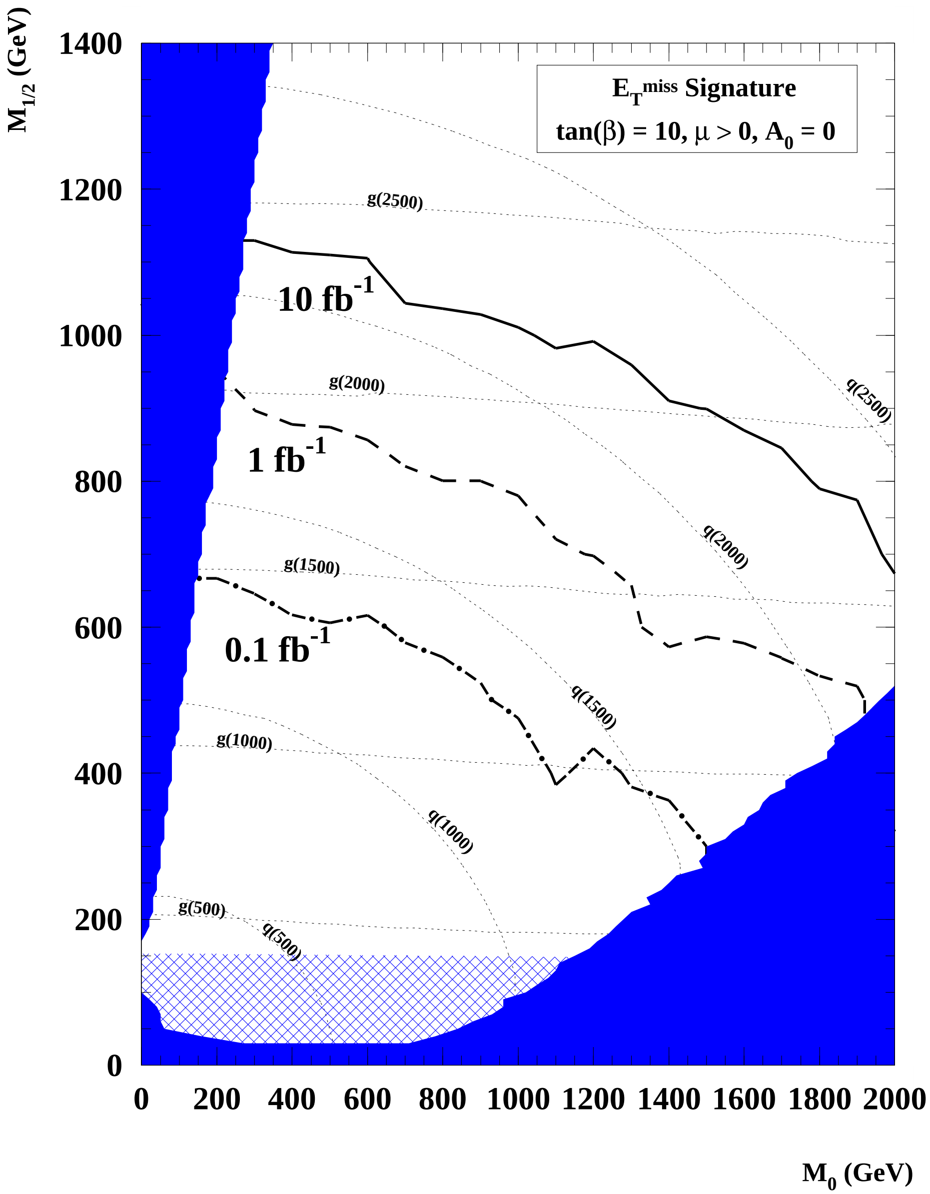
If R_p conserved, $\tilde{g}$ and $\tilde{q}$ cascade to undetected LSP. Multiple inclusive signatures:

- $\not{E}_T$: from LSP escaping detection
- High E_T jets: guaranteed if unification of gaugino masses assumed, otherwise can devise degenerate models where jets are very soft.
- Spherical events: From Tevatron limits squarks/gluinos must be heavy ($\gtrsim$ 400 GeV).
- Multiple leptons: from decays of Charginos/neutralinos typically present in cascade

$\not{E}_T$+jets is least model dependent and has highest reach

Experimentally most difficult to keep under control

Significant reach from $\not\!\!E_T$ signature from earliest phases of the experiment



Assume 10^{33} cm^{-2}s^{-1}:

- ∼1300 GeV in "one week"
- ∼1800 GeV in "one month"
- ∼2200 GeV in one year

Main time limitation not from signal statistics, but from understanding the detector performance.

Need large amounts of $W, Z, \bar{t}t$ data for firm background evaluation

Backgrounds to $\not\!\!E_T+$ jets analysis

- Real $\not\!\!E_T$ from ν production in SM events: $W, Z+$n jets, $\bar{t}t$

  Need to use combination of Montecarlo predictions and of fully reconstructed data events to correctly estimate this background

- Instrumental $\not\!\!E_T$ from mismeasured multi-jet events:

  Many sources: gaps in acceptance, dead/hot cells, non-gaussian tails, etc.

  Harder than SM backgrounds: require detailed understanding of tails of detector performance.

  – Reject events where fake $\not\!\!E_T$ likely: beam-gas and machine backgrounds, displaced vertexes, hot cells, $\not\!\!E_T$ pointing along jets, jets falling onto regions of poor response (all detector and machine garbage will end up in $\not\!\!E_T$ trigger)

  – At the beginning hard cuts to steer away from more problematic region

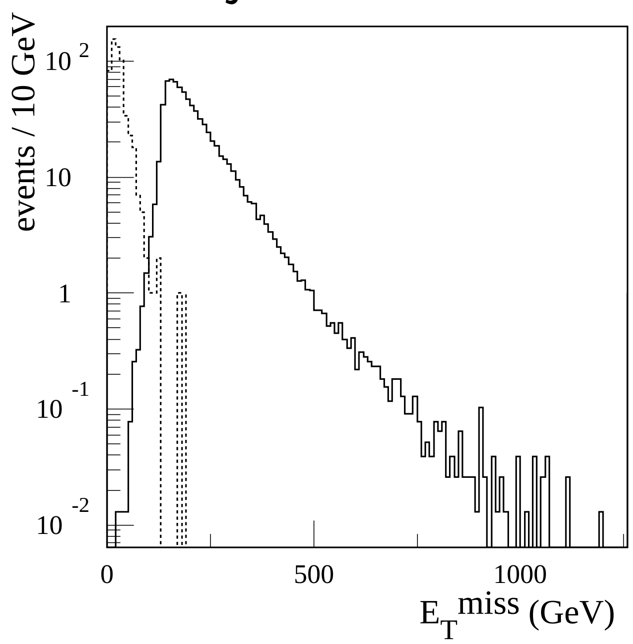
  – Need fast Monte Carlo with good reproduction of detector response: normalise MC to data at low $\not\!\!E_T$ and use it to predict high $\not\!\!E_T$ background in "signal" region

Example: control of instrumental $\not\!\!E_T$ (ATLAS TDR)

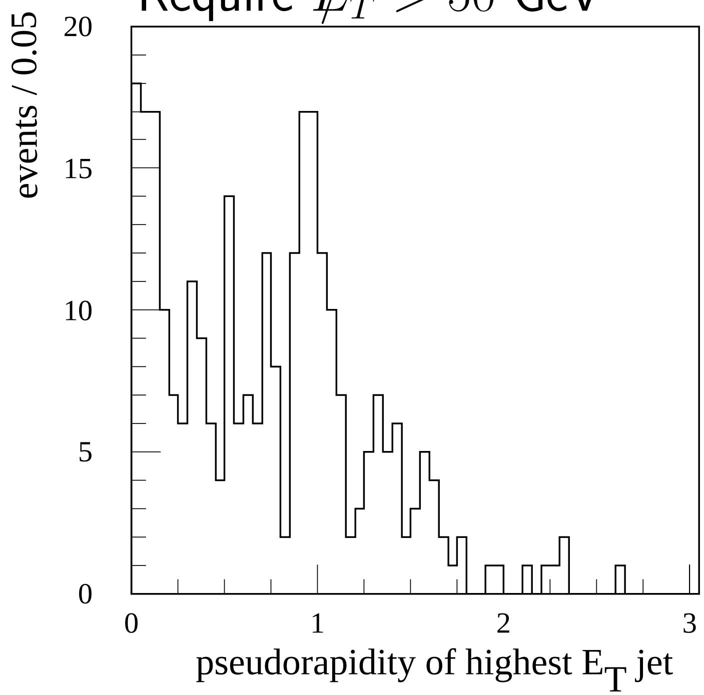
ATLAS study: study event balance in fully simulated $Z \to \mu\mu$ with $p_T(Z) > 200$ GeV

Dotted: measured $\not\!\!E_T$

. Full: jet undetected



Require $\not\!\!E_T > 50$ GeV



. Two events with high $\not\!\!E_T$: real ν

Control of $\not{E}_T$ from Standard Model processes

Need good understanding of production of $\bar{t}t$, Z, W+n jets

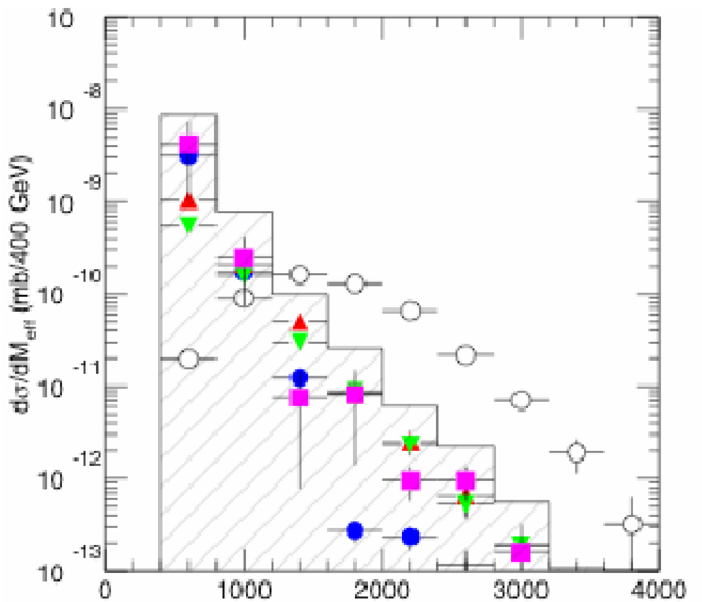
Use both Monte Carlo and data (complementary)

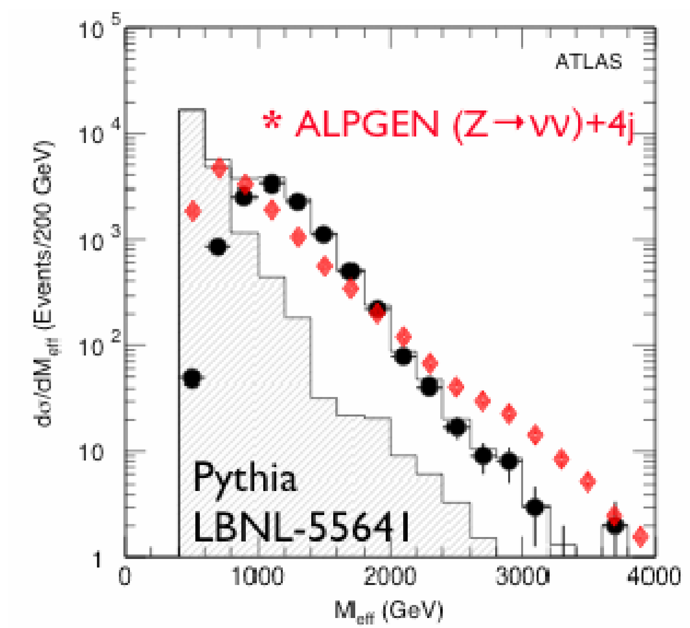
Follow theoretical development in understanding/modelling multi-body final states:

PYTHIA/Herwig $\Rightarrow$ ALPGEN, Sherpa, ...

Example (from M. Mangano): repeat ATLAS $\not{E}_T$+jets TDR analysis with ALPGEN

With ALPGEN much larger $Z \to \nu\nu$ (green triangles), bg shape indistinguishable from signal





. $M_{\text{eff}} = \Sigma_i |p_{T(i)}| + \not{E}_T$

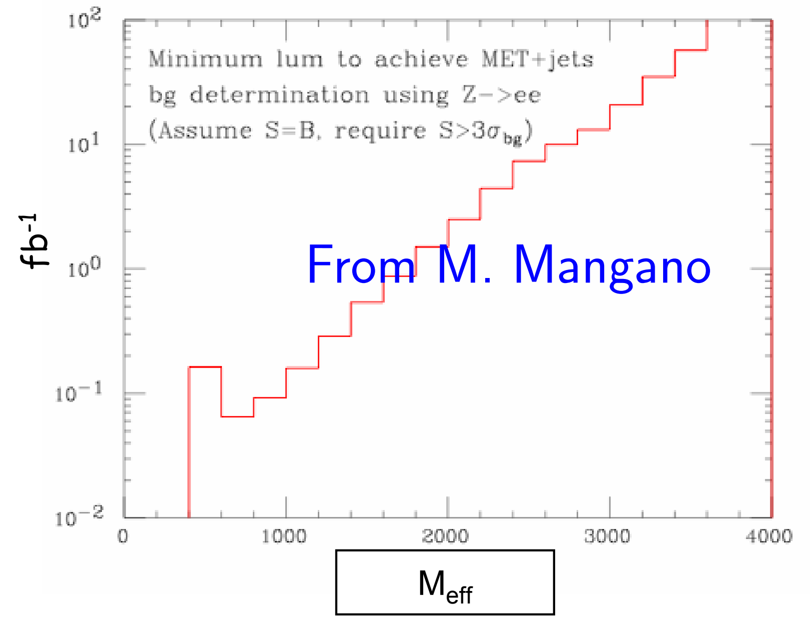
Control of $\not{E}_T$ from Standard Model: statistics

Use $Z \to ee$+multijets, apply same cuts as for $\not{E}_T$, and replace $\not{E}_T$ with $E_T(e^+e^-)$

Extract bin-by bin $Z \to \nu\nu$ by scaling results by $BR(Z \to \nu\nu)/BR(Z \to ee)$

Assuming SUSY signal $\sim Z \to \nu\nu$ bg, evaluate luminosity necessary for having $N_{SUSY} > 3 \times \sigma_{bg}$

$\sigma_{bg} = \sqrt{N(Z \to ee)} \times BR(Z \to \nu\nu)/BR(Z \to ee)$



Several hundred pb^{-1} required. Sufficient if we believe in MC shape, and only need normalisation. Much more needed to keep search completely MC independent

Control of $\not{E}_T$ from Standard Model: top

Try to use data to understand top background

Preliminary ATLAS exercise (D. Tovey), performed on fast simulation

Standard semileptonic top analysis:

- $P_t(lep) > 20$ GeV, $\not{E}_T > 20$ GeV
- ≥ 4 jets with $P_T > 40$ GeV
- ≥ 2 b-tagged jets

Very similar to cuts for SUSY analysis with looser $\not{E}_T$ requirement

If harden $\not{E}_T$ cuts, sample contaminated with SUSY

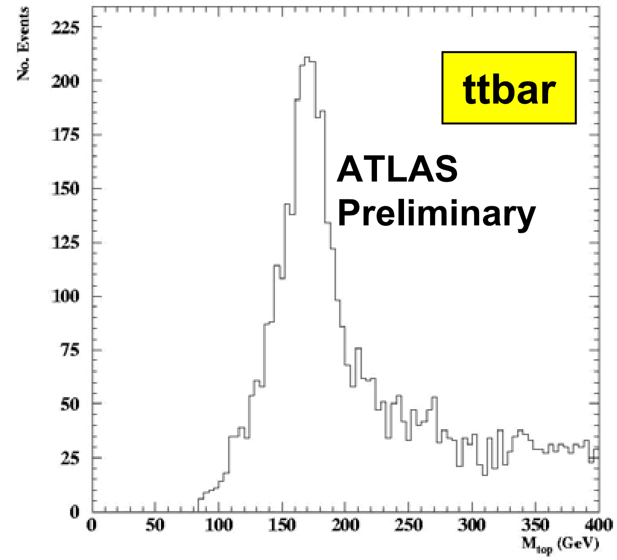
Possible approach:

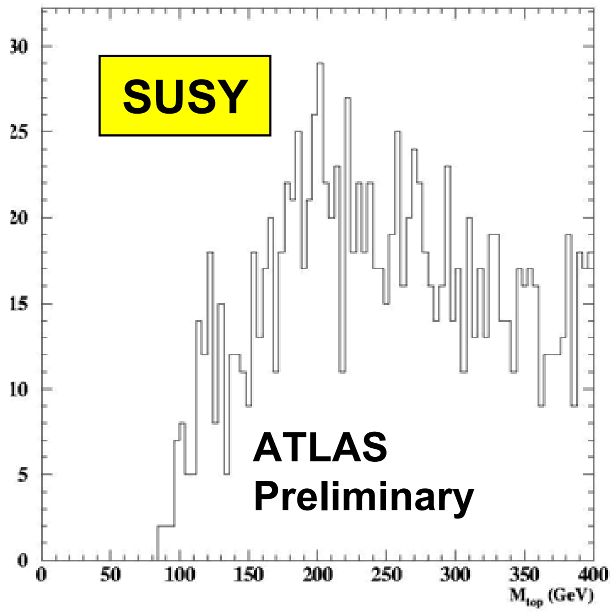
- Select semi-leptonic top candidates (what b-tag available?)
- Fully reconstruct top events from $\not{E}_T$ and W mass constraint
- Reject SUSY background with mass cut and and m_{top} sideband subtraction
- Use to validate top production in MC/ estimate remaining $\not{E}_T$ background

Top background evaluation

Show fully reconstructed semileptonic top mass peak

Significant combinatorial background under peak for $\bar{t}t$ events

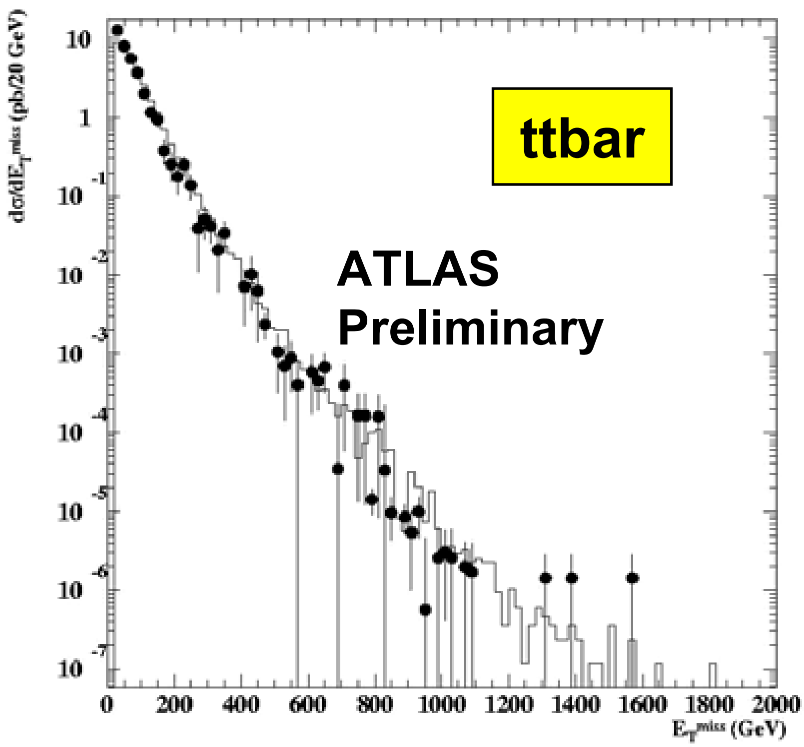




Use mSUGRA point SPS1a for comparison

No top peak present in SUSY sample

Results



Histogram:

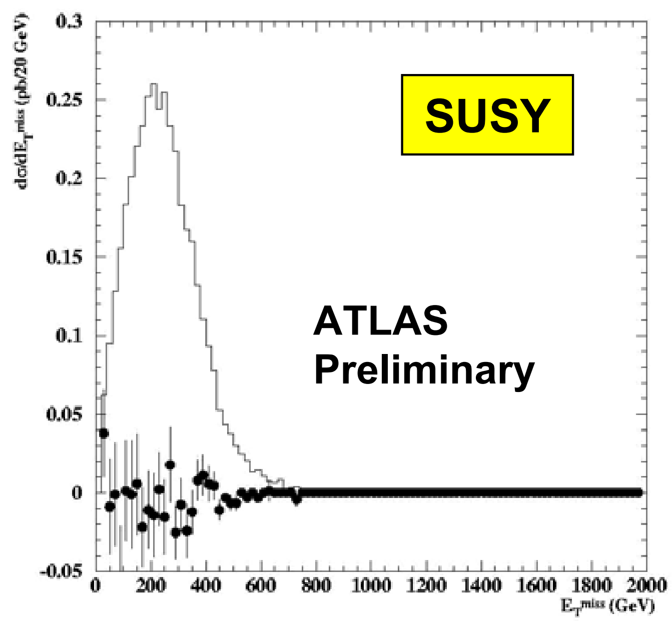
$\not{E}_T$ distribution of $\bar{t}t$ for 1-lepton SUSY selection (no b-tag)

Data points:

Background estimate from full top reconstruction

Verify on SUSY sample if any SUSY event is selected with this approach

No evidence for this



Conclusions

ATLAS and CMS getting ready for LHC startup in 2007

Large effort to define strategy for detector commissioning

Detailed planning for exploiting pre-collision data and pilot run for initial detector calibration

Many studies of how to use collision data for detailed calibration of detectors to achieve baseline performance

First physics work focused at fast understanding of benchmark standard model processes

Ongoing work on techniques for estimating/subtracting standard model backgrounds to discovery physics

ATLAS and CMS will be ready to make optimum use of physics data when it arrives