First ATLAS Results from the LHC, and Prospects for Discovery:

Will We Party Like it's 1974?

Paul Tipton, *Yale University*

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Outline

- Introduction to Particle Physics, the LHC, and ATLAS
- First Physics Results:
  – The Standard Model—Like déjà vu all over again
  – First look for New Physics
- Outlook for 2011 and Beyond: Search for New Physics and the Higgs

Prelude to the Standard Model

- A bit of history and some undergraduate QM:
- If you start with SE:

$$\left(\frac{1}{2m}\right)(-i\vec{\nabla})^2\Psi(\vec{r},t) = i\frac{\partial\Psi(\vec{r},t)}{\partial t}$$

- And require local U(1) Gauge invariance:

$$\Psi'(\vec{r},t) = e^{i\alpha(\vec{r},t)}\Psi(\vec{r},t)$$

- Then Ψ' will not satisfy SE unless it is modified to be

$$\left(\frac{1}{2m}\right)\left[(-i\vec{\nabla} - \mathbf{q}\vec{A})^2 + \mathbf{qV}\right]\Psi(\vec{r},t) = i\frac{\partial\Psi(\vec{r},t)}{\partial t}$$

- With

$$\vec{A}' = \vec{A} + \left(\frac{1}{q}\right)\vec{\nabla}\alpha(\vec{r},t)$$

$$V' = V - \left(\frac{1}{q}\right)\frac{\partial\alpha(\vec{r},t)}{\partial t}$$

Prelude, Cont.

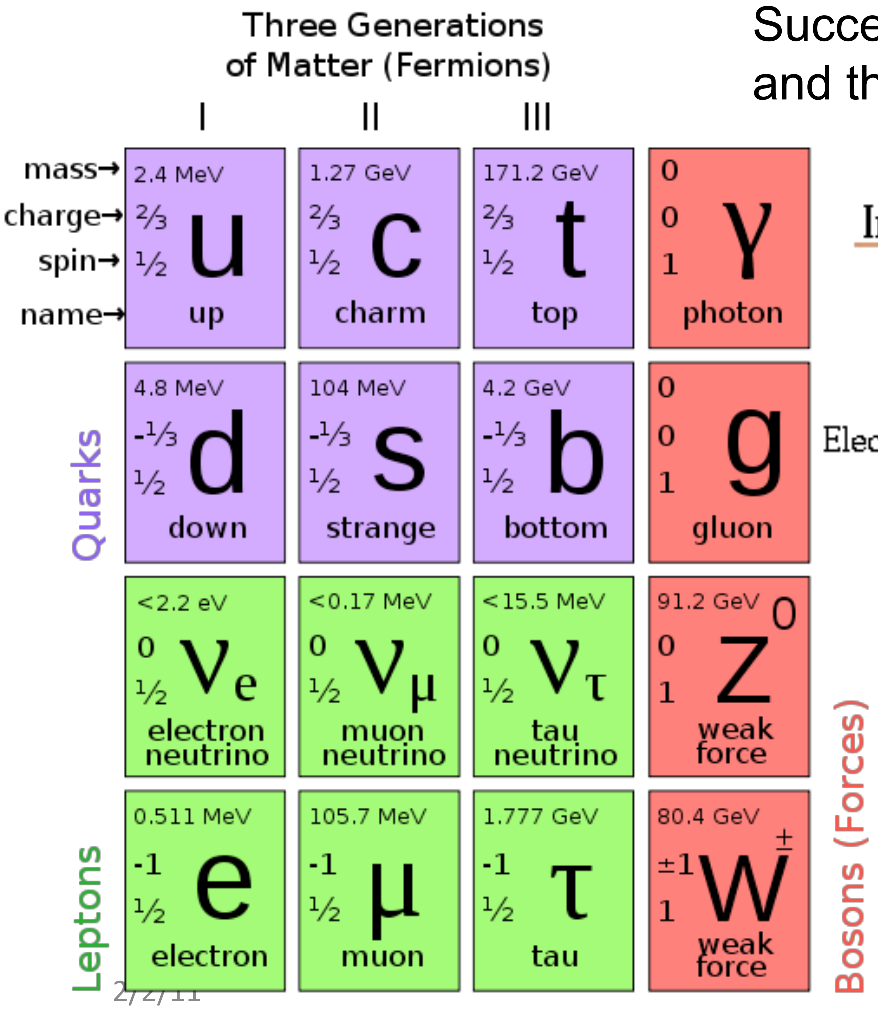
- By requiring local U(1) gauge invariance we arrive at S.E. for Electrodynamics…very suggestive…
- Mills and Yang (1954):

“Perhaps the dynamics of all field theories can be derived from local gauge invariance”

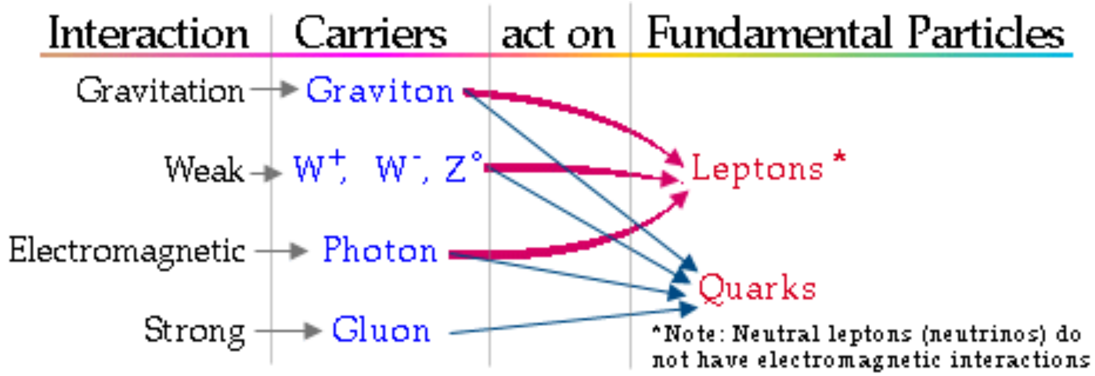
- The answer appears to be ‘yes’

The Standard Model

A Quantitative **Gauge Theory** based on $SU(3)_C x SU(2)_L x U(1)_Y$

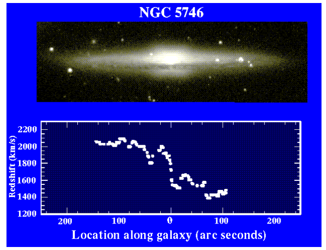


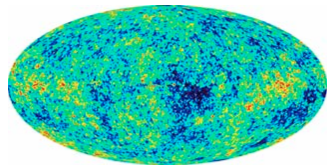
Successfully explains hundreds of particles and their interactions



Fundamental particles get masses via interactions with Higgs field, H boson (not yet directly observed)

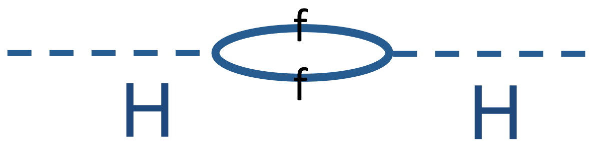
Flaws in the Standard Model include:





- Doesn't address what is apparently 95% of the Universe
  - No dark matter candidate (DM)
  - No dark energy (or gravity, for that matter)
- Hierarchy Problem
  - EW radiative corrections to the M_H
  - integrated to scale Λ, shifts bare Mass by:

$$\delta m_H^2 \cong (115 GeV)^2 [\frac{\Lambda}{400 GeV}]^2$$



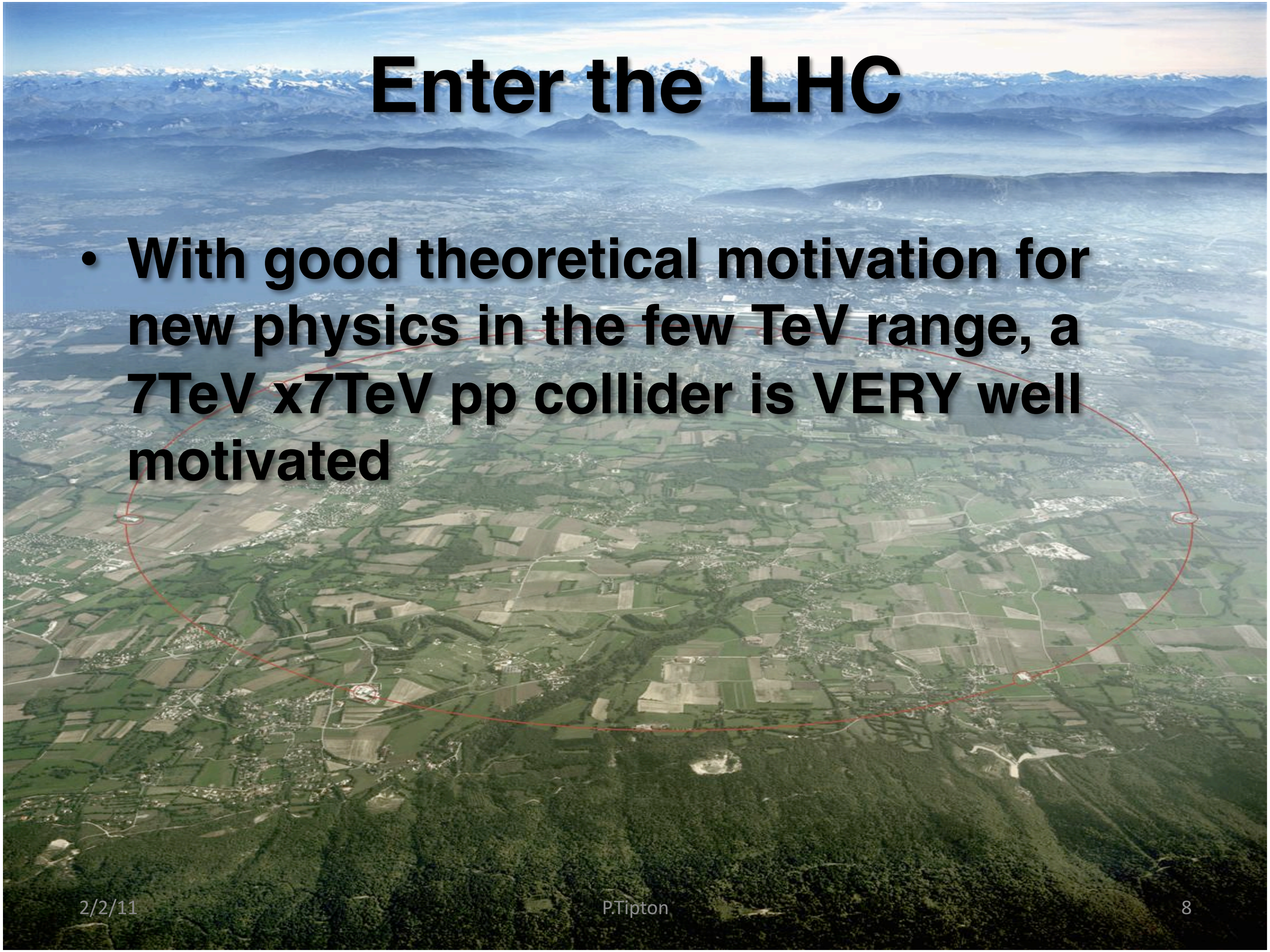
❖Need either:

- canceling counter terms (CT)
- some other New Physics by ~ 1-few TeV to maintain fine tuning at $O(10^{-3})$

Alternatives/Extensions to the Standard Model

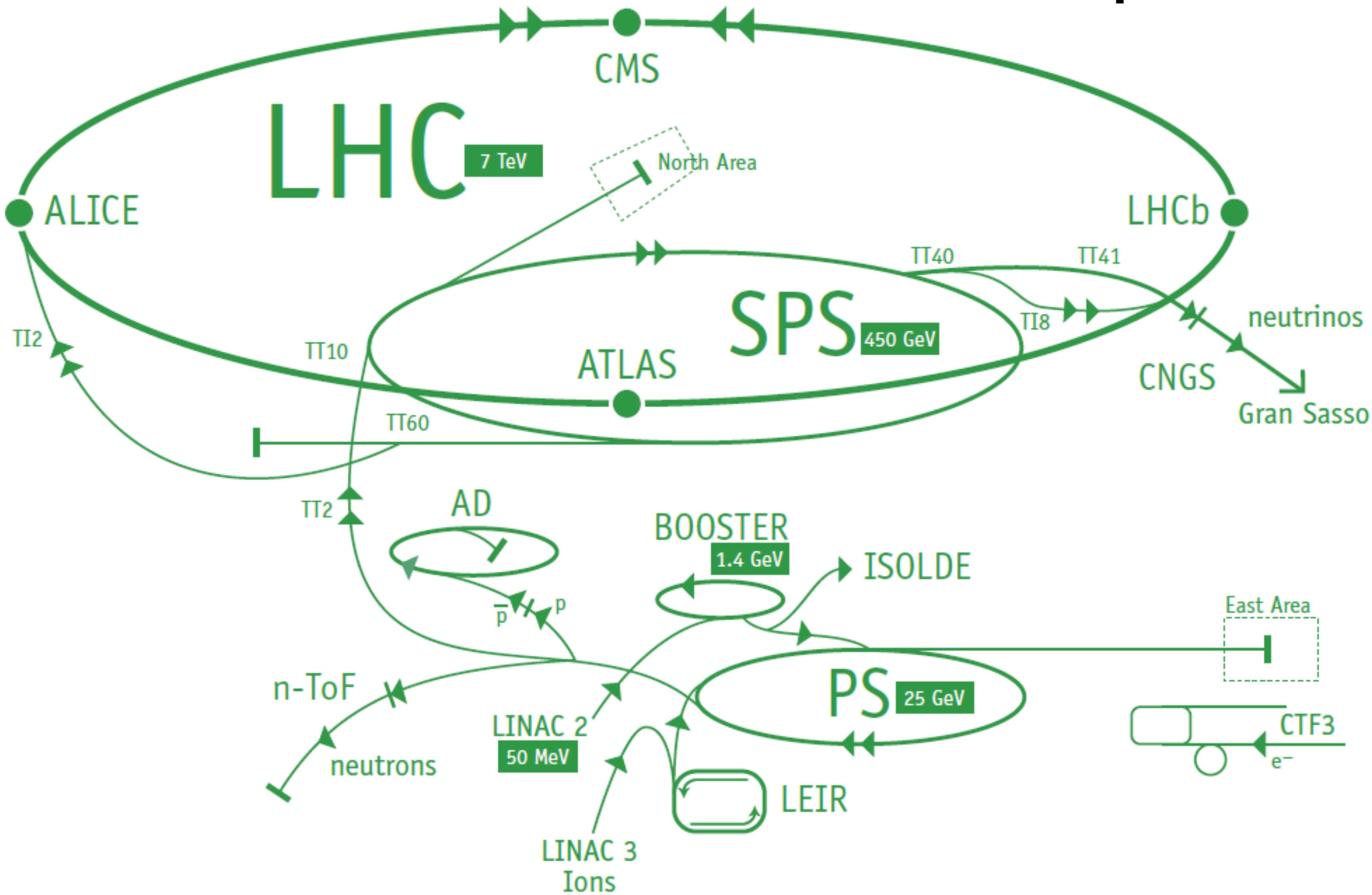
- SUSY provides cancelling CT and DM candidate
  - However in MSSM, lower limit on M_H pushes SUSY scale to few TeV
  - on edge of being acceptable as 'natural' solution
- Technicolor/topcolor/Composite Higgs models
- Little higgs models, using a different symmetry to generate CT
- Randall-Sundrum Warped Extra Dimensions, lower Λ to TeV scale
- Higgsless Models use warped ED, infinite additional Ws and Zs

Enter the LHC

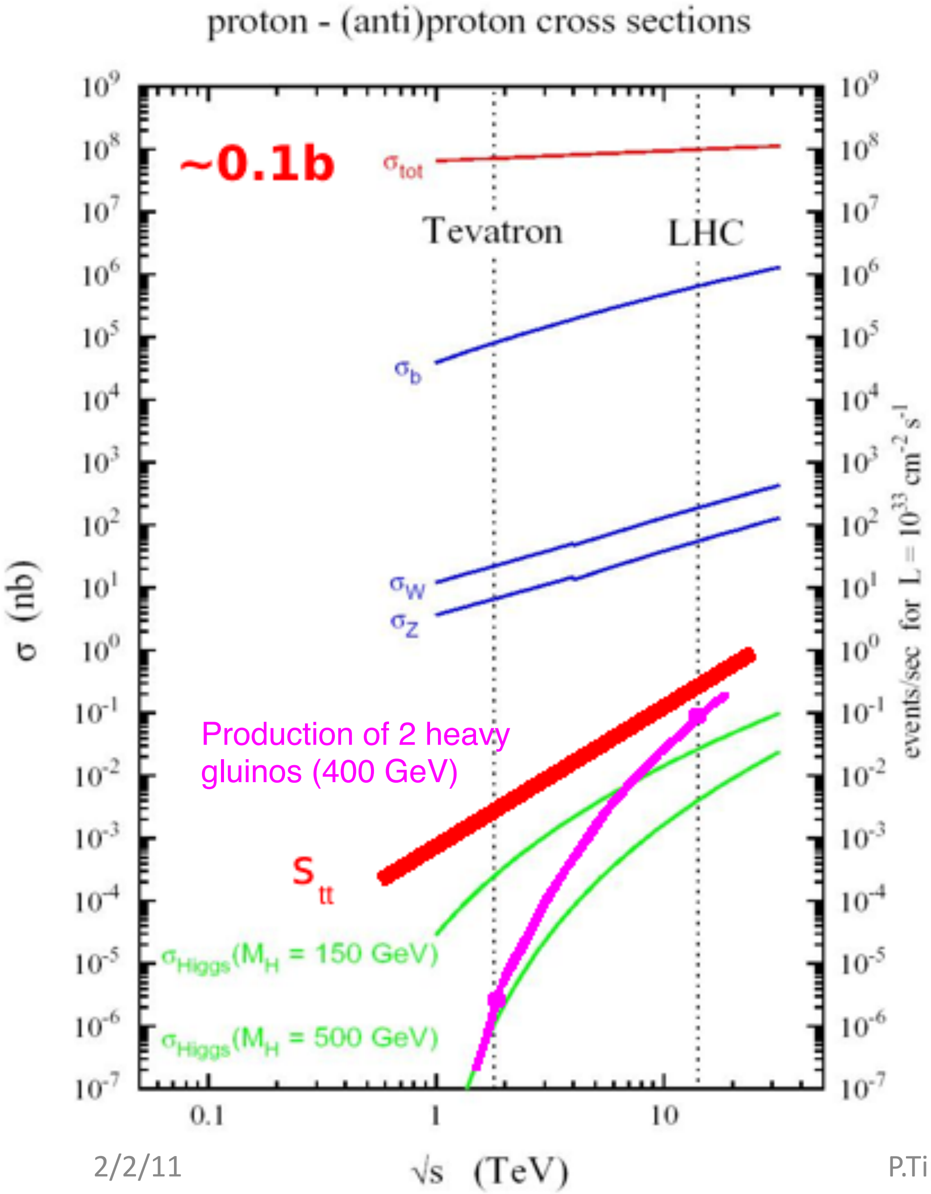


- **With good theoretical motivation for new physics in the few TeV range, a 7TeV x7TeV pp collider is VERY well motivated**

The Cern Accelerator Complex



The 2 Important LHC Parameters



- Energy √s
- Luminosity L

- Luminosity
  - The number of interactions is proportional to the **cross section** for that process, and the accelerator **luminosity**, or
  - $N = L \times \sigma$
  - Need to squeeze the maximum number of protons into the smallest beam spot to maximize L
- σ, the probability of a process
  - Varies with collision energy
  - Most interesting processes are often rare

The LHC Design Parameters

- Large: 27-km circumference
  - Maximum energy scales with radius and magnetic dipole field (8.33 T, superconducting)

- Collide Hadrons (protons)
  - The more massive the particles the smaller their energy loss due to synchrotron radiation

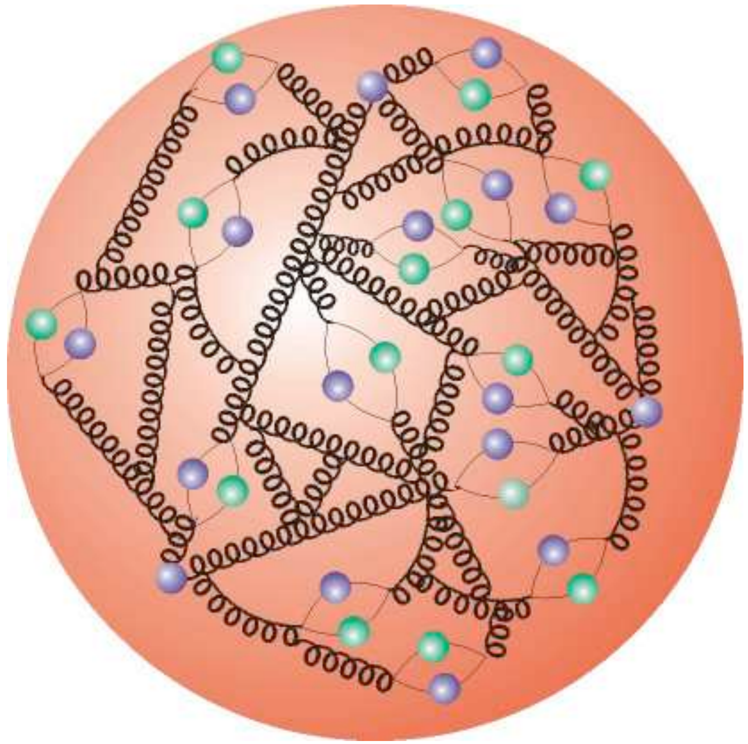
- Luminosity depends on
  - Number of particles in each bunch: 1.1×10^{11}
  - Collision frequency: 40 MHz
  - Number of bunches: 2808
  - Beam cross-section: 16 μm

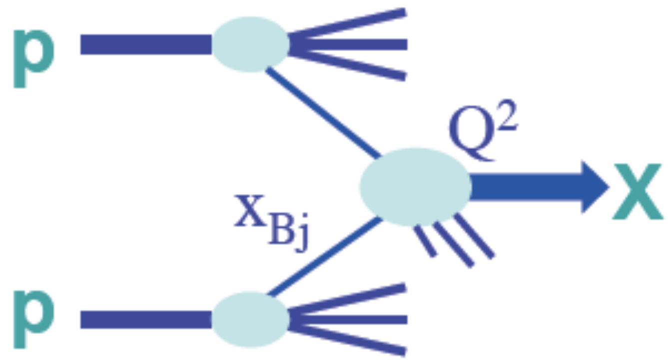
- Huge Stored Energy:
  - 700 MJ in the beams (think 400 ton passenger train at 95 mph)
  - 11GJ stored in the magnets/magnetic field (think 30 such trains)

The Ugly Truth About the Proton

- It's complicated: Proton comprised of:
  - Valence quarks, Gluons, quark-antiquark pairs
- So we really are probing the interactions of the quarks and gluons that comprise the proton
- Momentum fraction of interacting parts is called x
- Momentum along beam direction of interacting system is unknown
- Energy available to make new object:

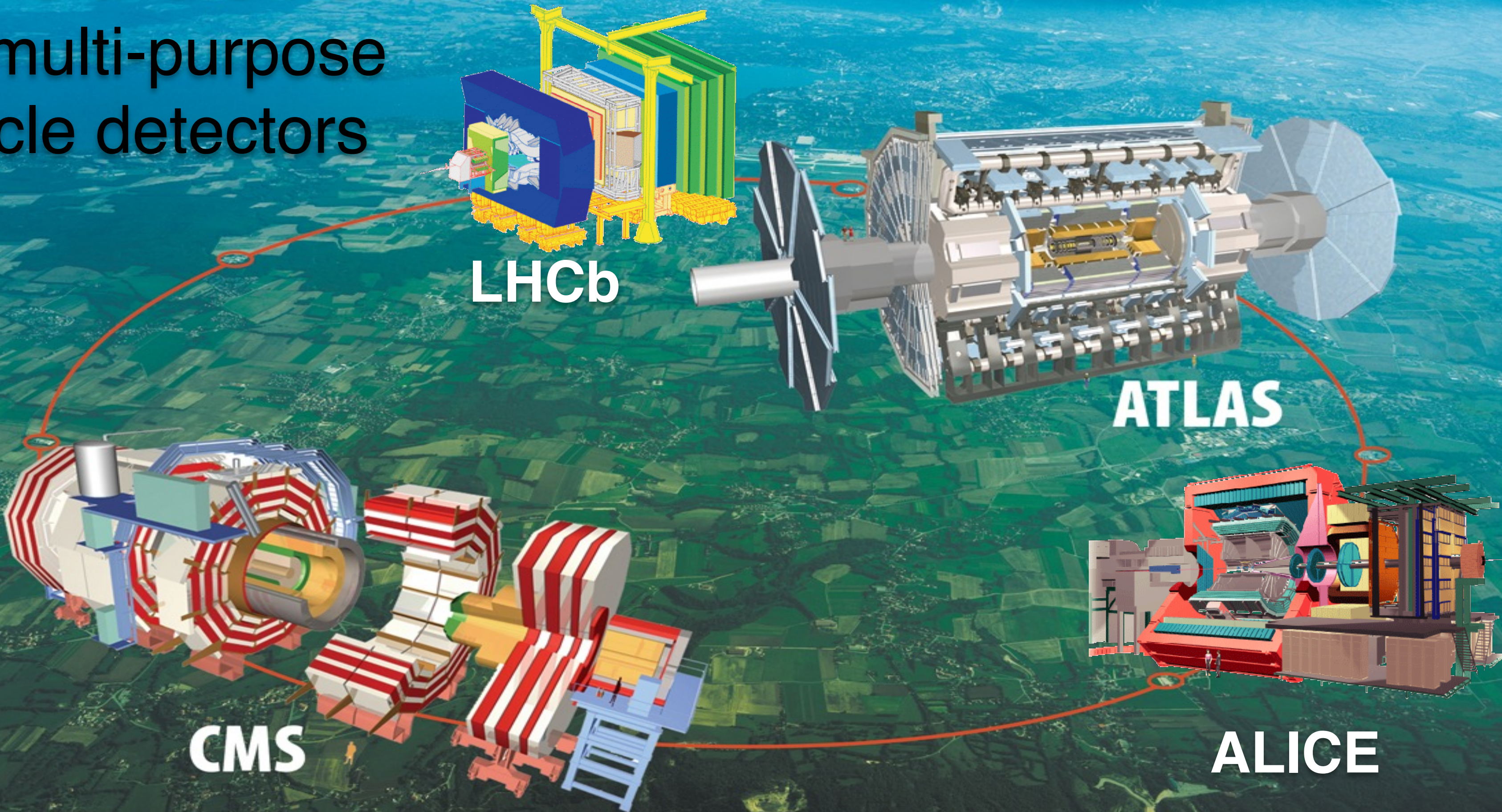
$$M_X = \sqrt{x_1 \cdot x_2 \cdot s}$$





Where the Particles Collide

ATLAS and CMS –
two multi-purpose
particle detectors



The ATLAS Detector

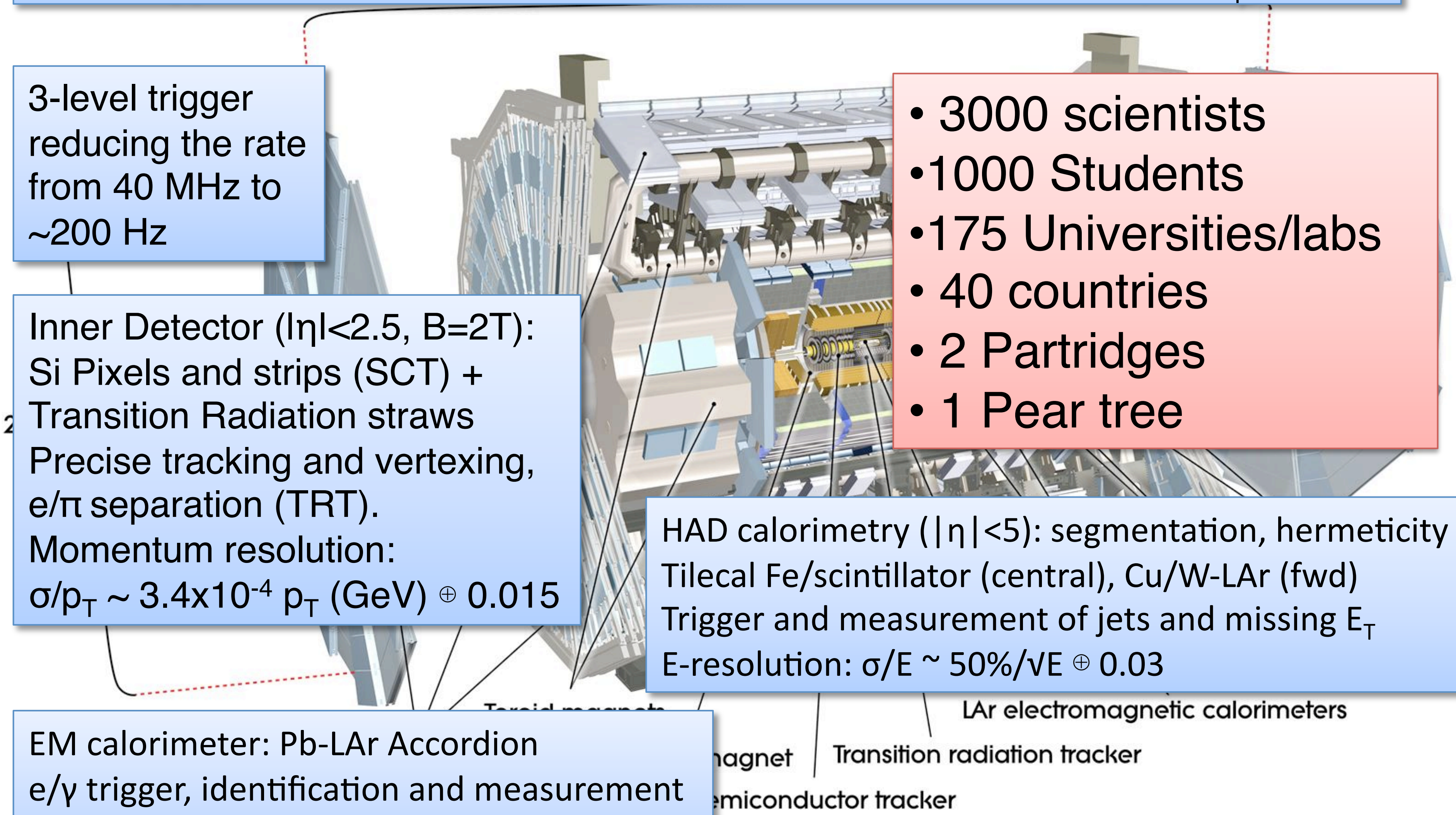
Muon Spectrometer (|η|<2.7) : air-core toroids with gas-based chambers
Muon trigger and measurement with momentum resolution < 10% up to E_{μ} ~ TeV

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

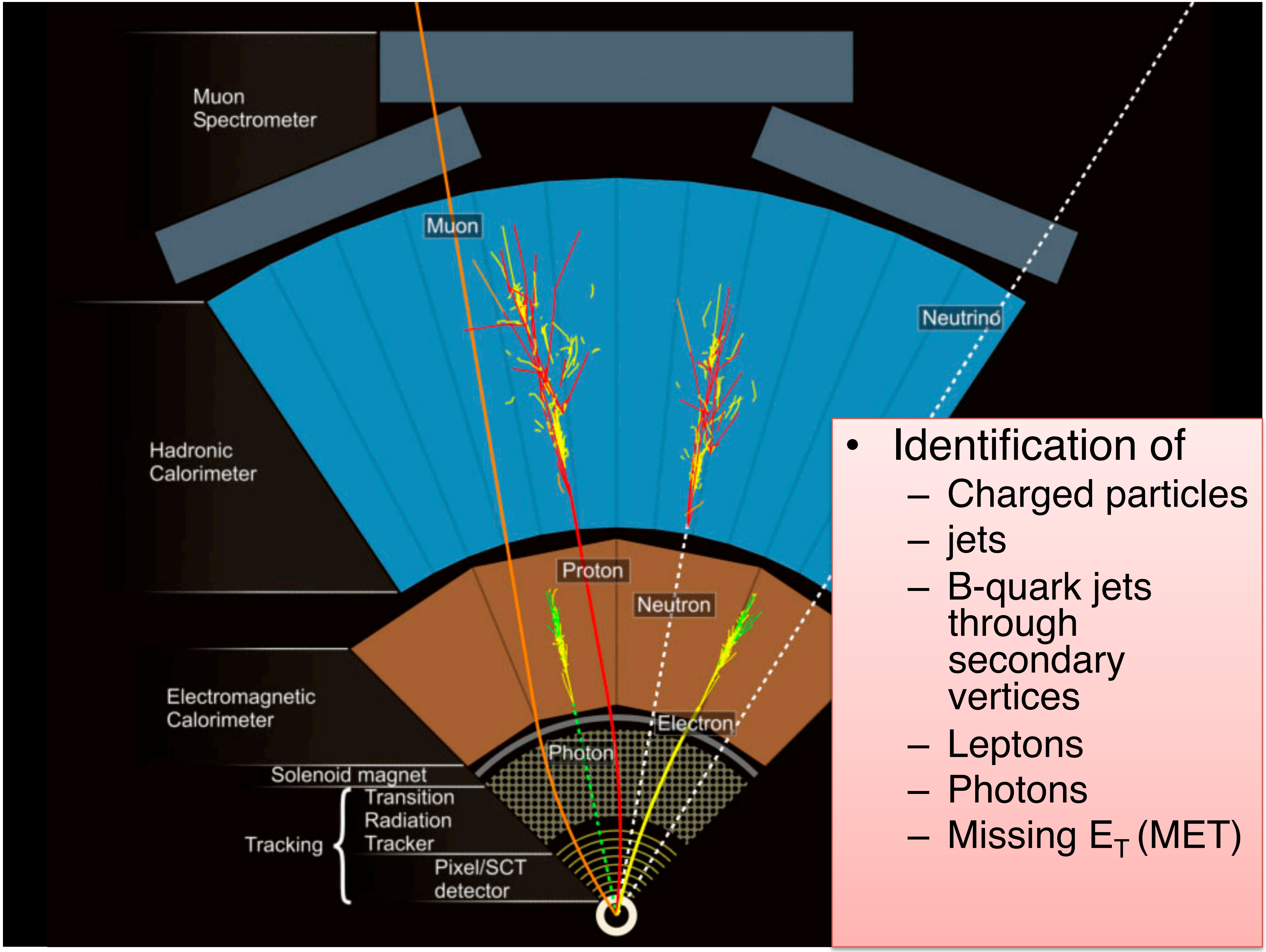
- 3000 scientists
- 1000 Students
- 175 Universities/labs
- 40 countries
- 2 Partridges
- 1 Pear tree

Inner Detector (|η|<2.5, B=2T):
Si Pixels and strips (SCT) +
Transition Radiation straws
Precise tracking and vertexing,
e/π separation (TRT).
Momentum resolution:
$\sigma/p_T \sim 3.4\times10^{-4}\, p_T\,(\mathrm{GeV}) \oplus 0.015$

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



EM calorimeter: Pb-LAr Accordion
e/γ trigger, identification and measurement
E-resolution: ~ 1% at 100 GeV, 0.5% at 1 TeV



- Identification of
  - Charged particles
  - jets
  - B-quark jets through secondary vertices
  - Leptons
  - Photons
  - Missing E_T (MET)

First LHC Data

- We have collision data from September 2008
- Unfortunately they were magnet-magnet collisions

- On to better times……2009

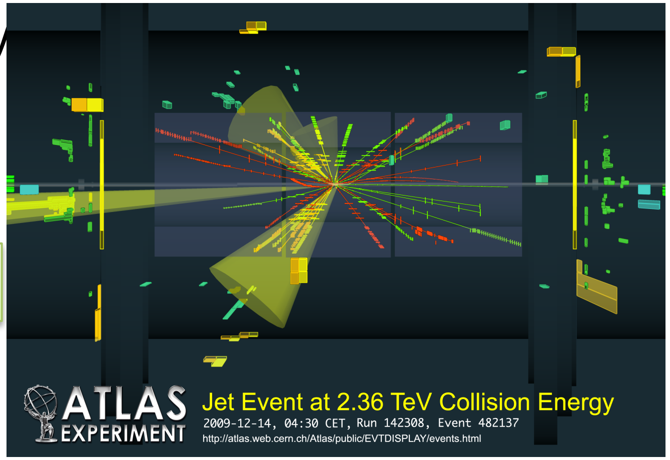
Beam collision Timeline

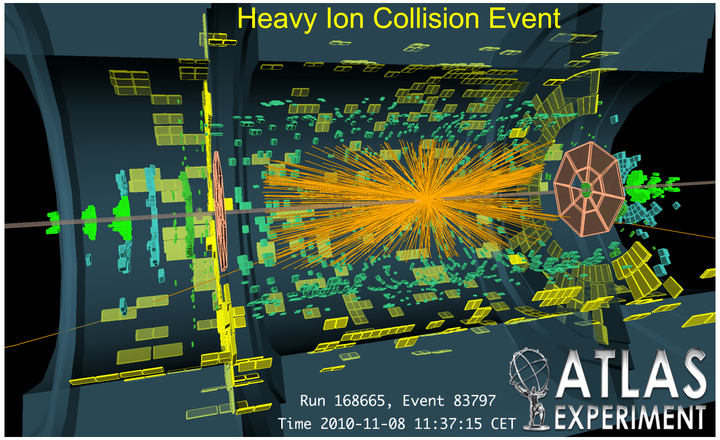
Nov 29 2009

World record - 1.18 TeV beam energy

Dec 8 2009

First collisions at $\sqrt{s}$ = 2.36 TeV

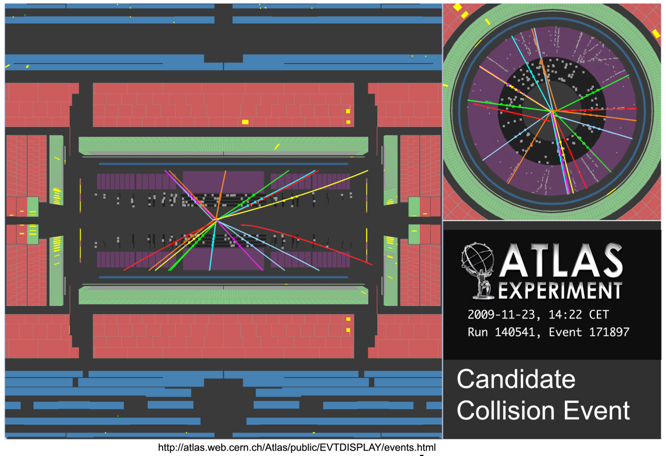




Nov 7 2010

First Heavy Ion collisions at $\sqrt{s_{NN}}$ = 2.76 TeV

Nov 23 2009



First collisions at $\sqrt{s}$ = 900 GeV

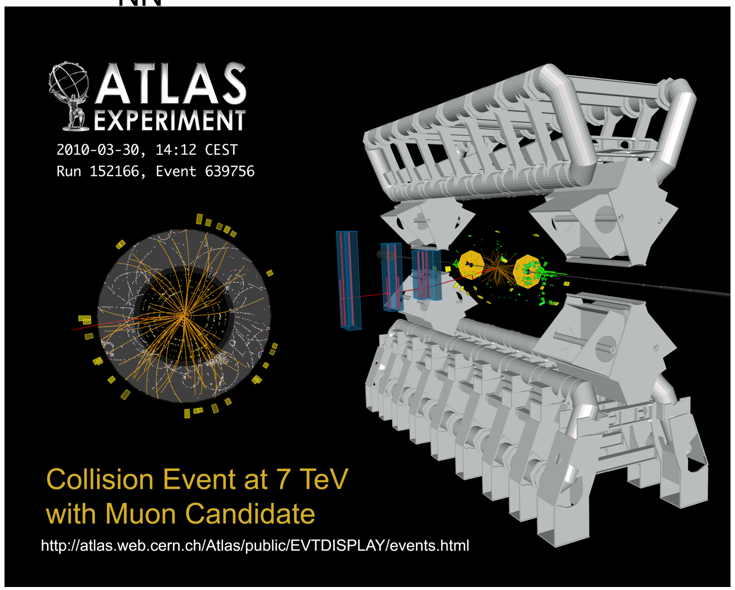
Mar 19 2010

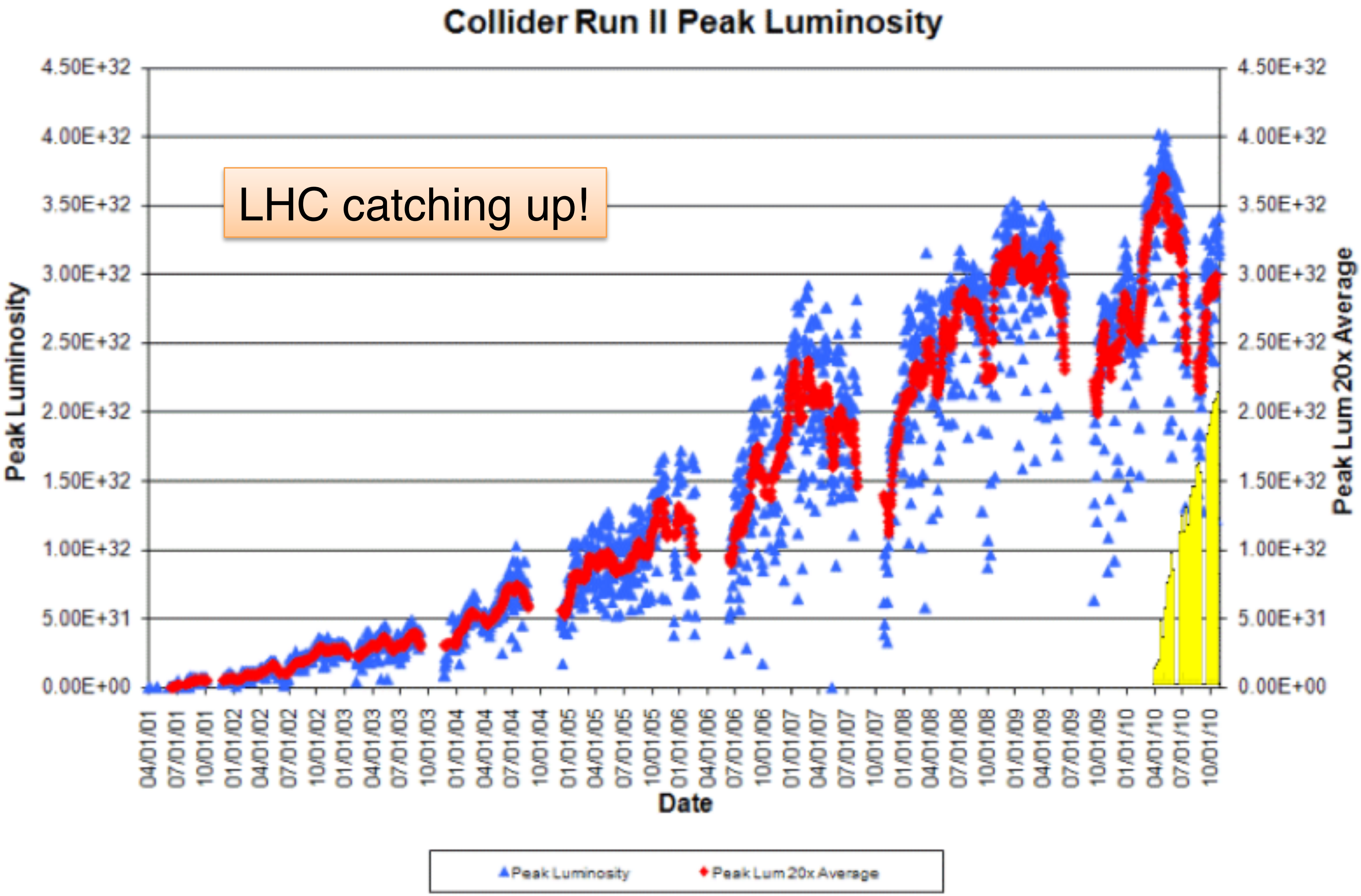
3.5 TeV beam energy

Mar 30 2010

First collisions at $\sqrt{s}$ = 7 TeV

Until Nov 4 2010




Collider Run II Peak Luminosity
LHC catching up!
Peak Luminosity
Peak Lum 20x Average
Date
4.50E+32
4.00E+32
3.50E+32
3.00E+32
2.50E+32
2.00E+32
1.50E+32
1.00E+32
5.00E+31
0.00E+00
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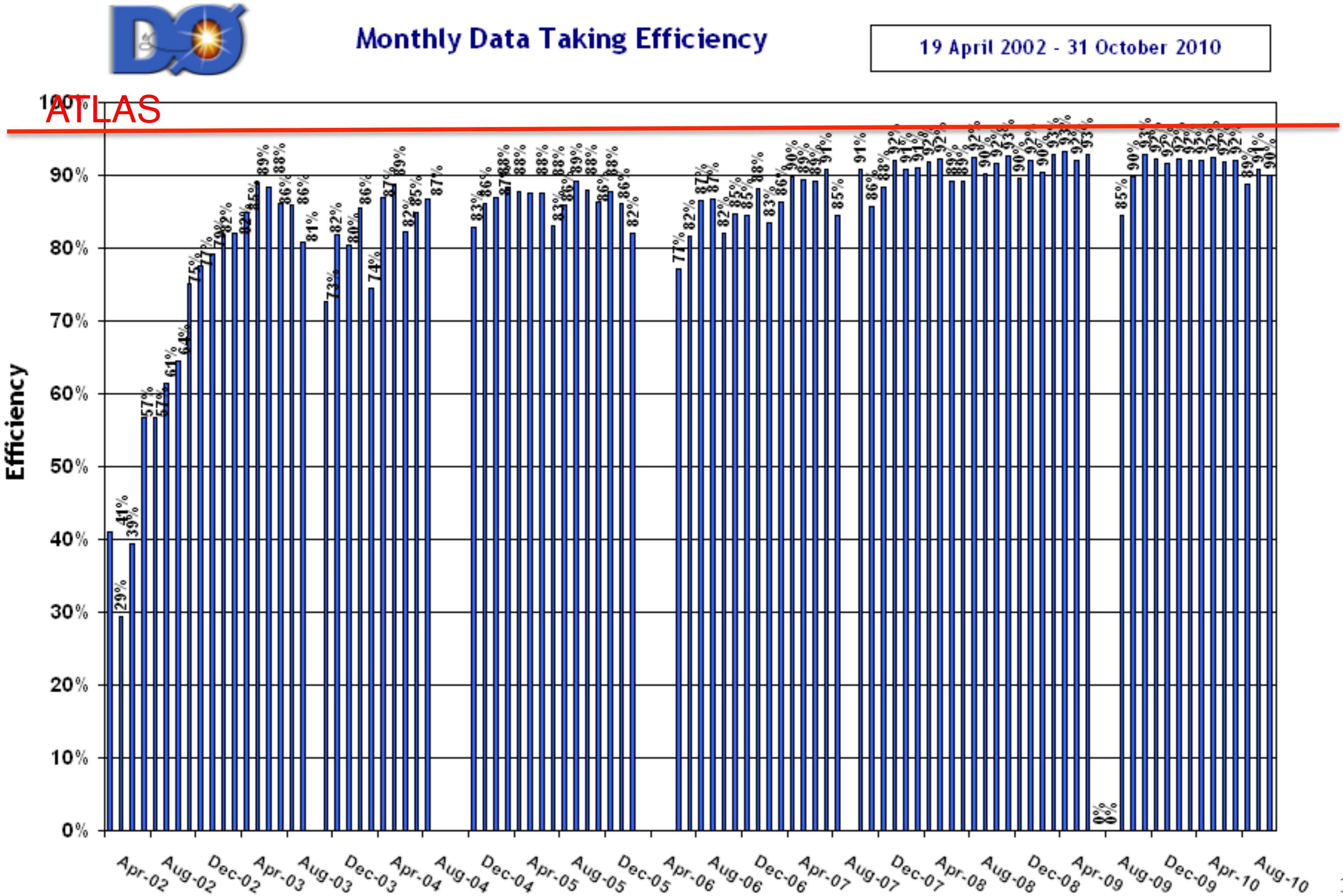
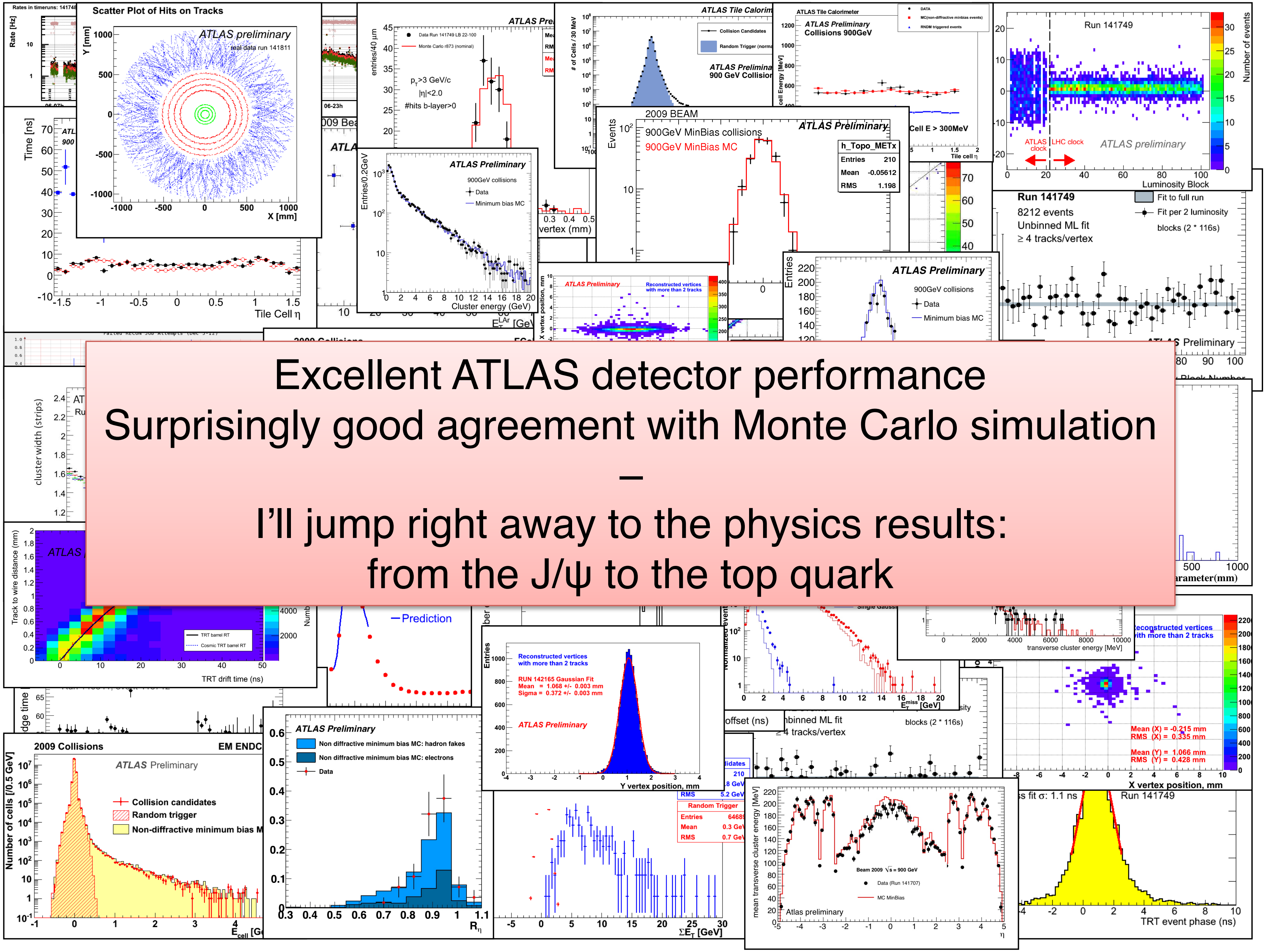
Peak Luminosity
Peak Lum 20x Average

ATLAS Data Taking Efficiency





Excellent ATLAS detector performance

Surprisingly good agreement with Monte Carlo simulation

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I’ll jump right away to the physics results:

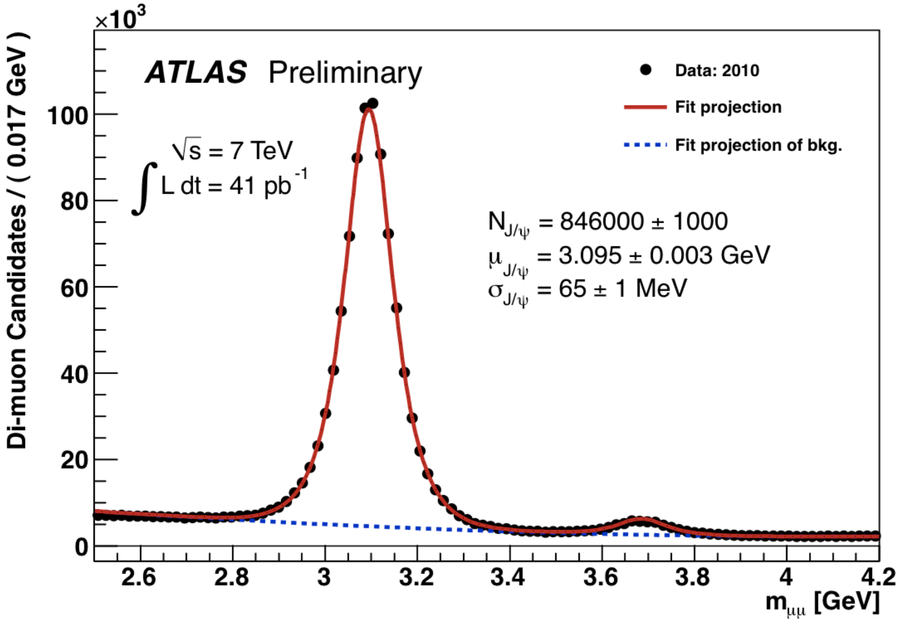
from the J/ψ to the top quark

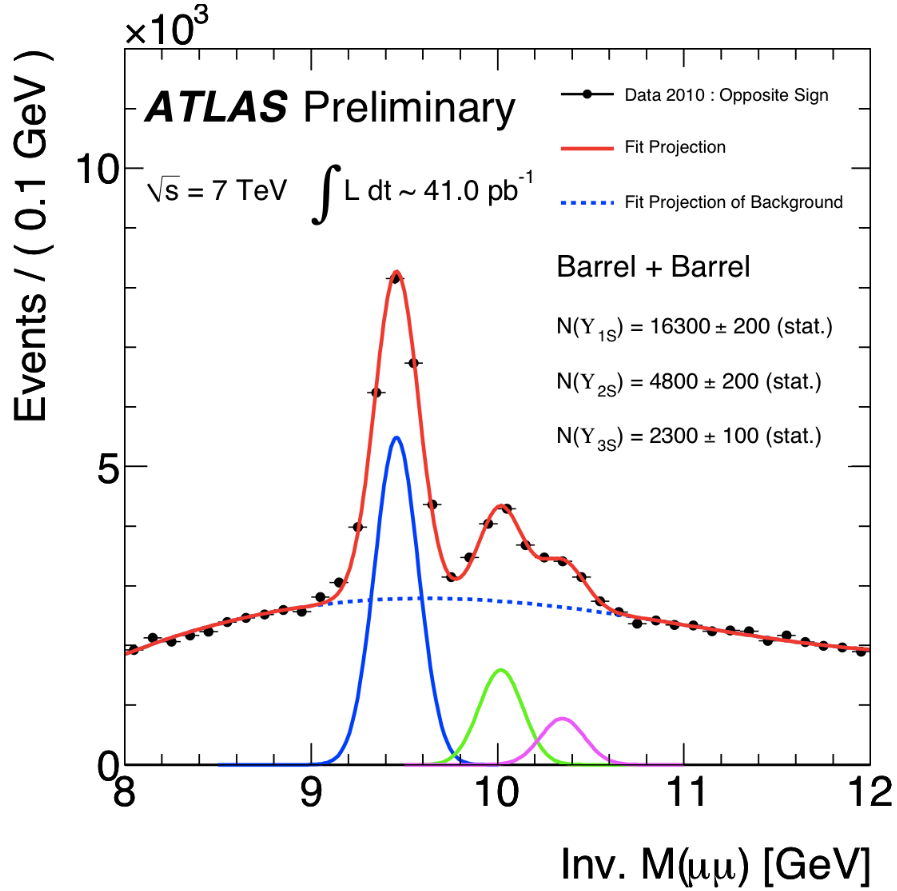
Observing Standard Model Signatures

- A tour of past Nobel Prizes

J/ψ and ϒ Decaying to μμ

- Oppositely charged muons with $p_T(\mu1,\mu2)>(2.5,4)$ GeV
- For J/ψ & ψ(2S) fit tracks to a common vertex and recalculate mass

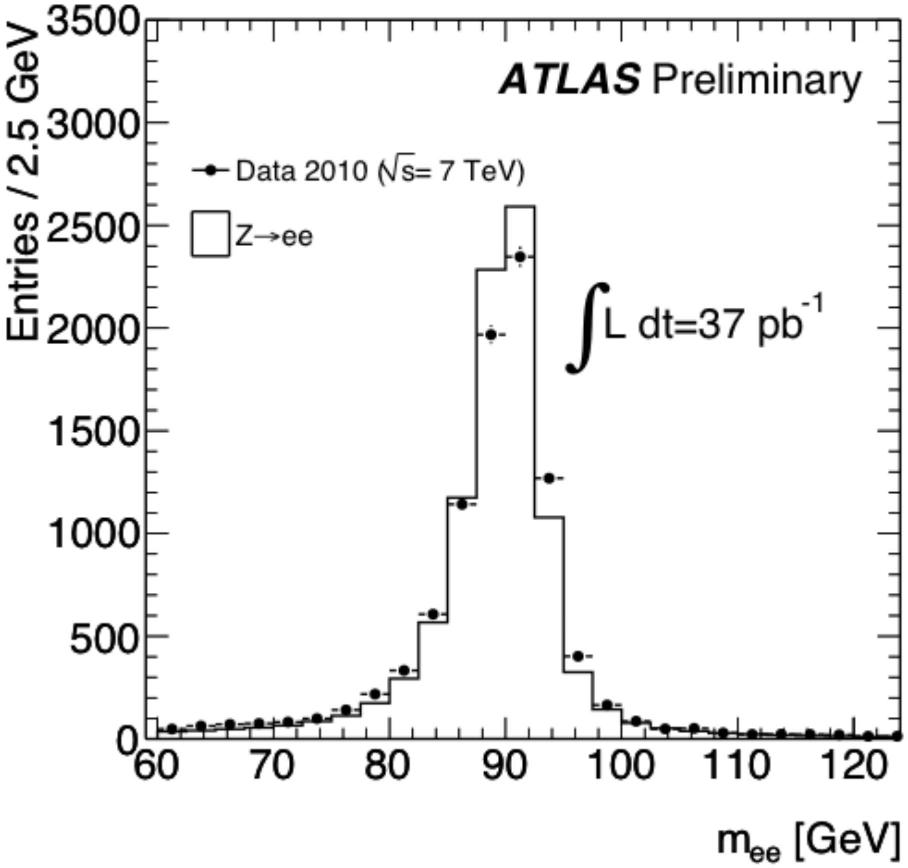


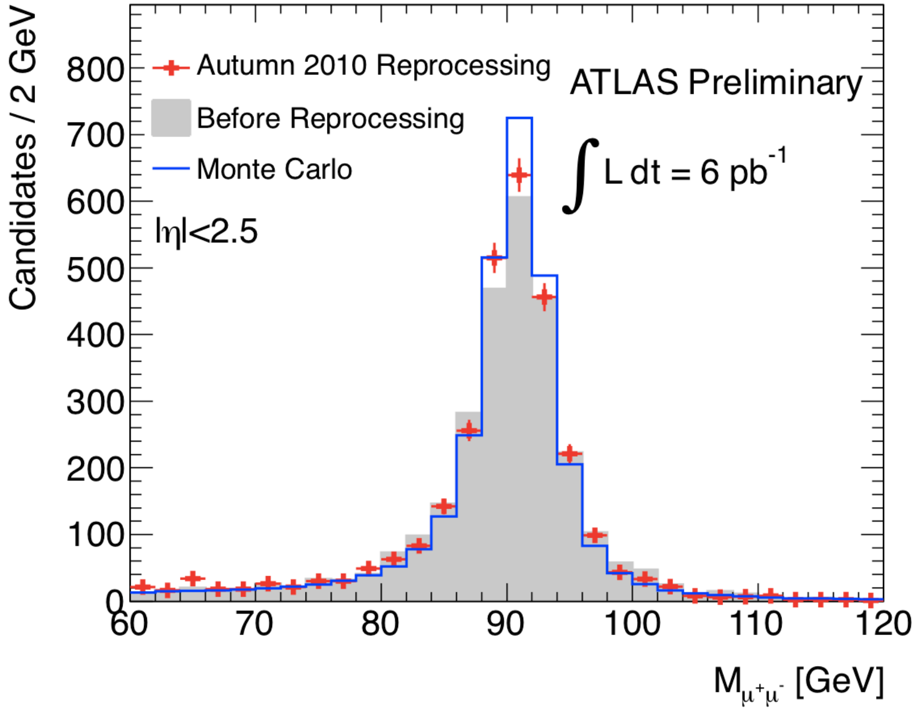


60k ϒ candidates over full acceptance

Differential cross sections in preparation

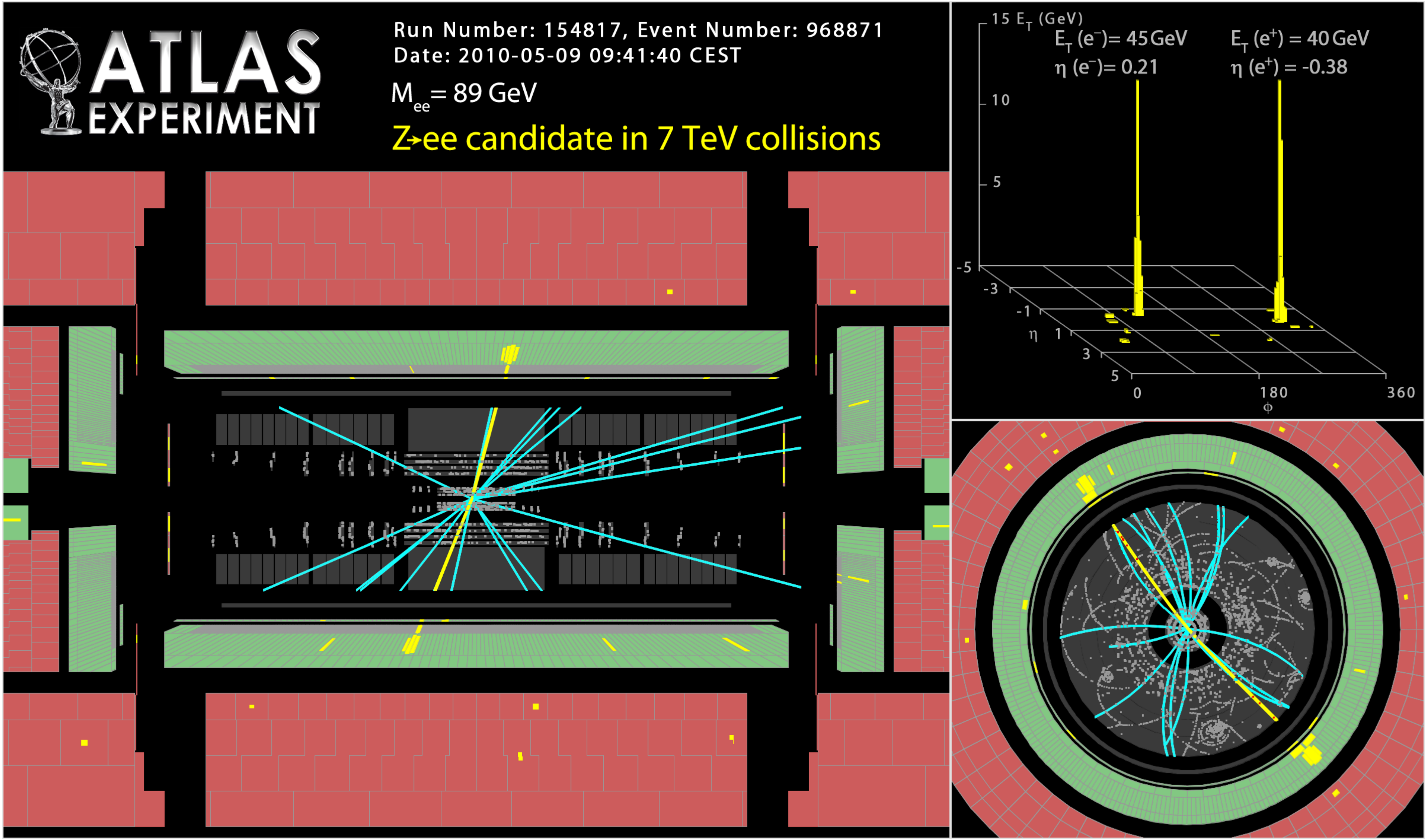
Z Boson decaying to l^+l^-



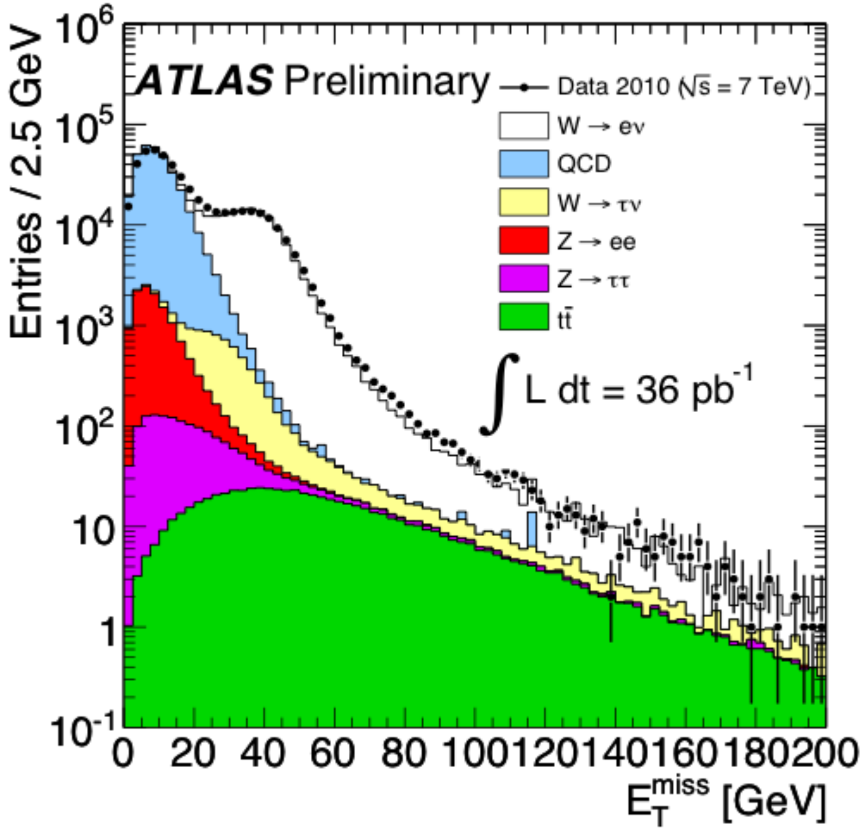


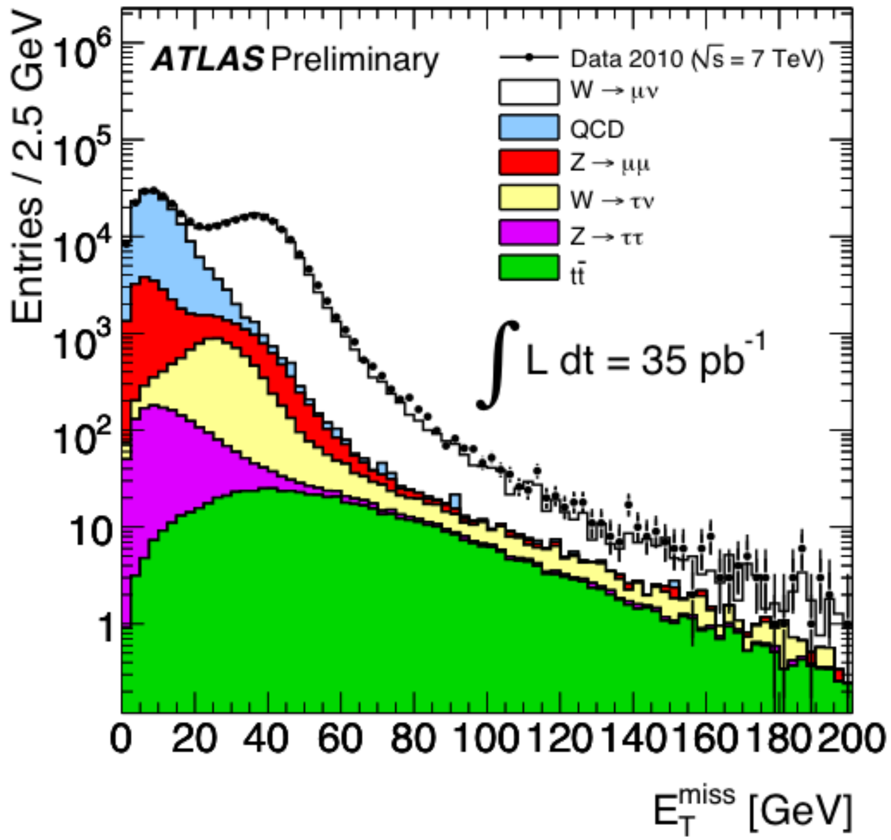
- Invariant mass of Z candidates with first pass processing
  - Much improved data-MC agreement in reprocessing (improved muon system alignment and material description)
- MC normalized to data
- 9k electron and 14k muon pair events

Z→ee Candidate



Missing Transverse Energy in Charged Lepton Events

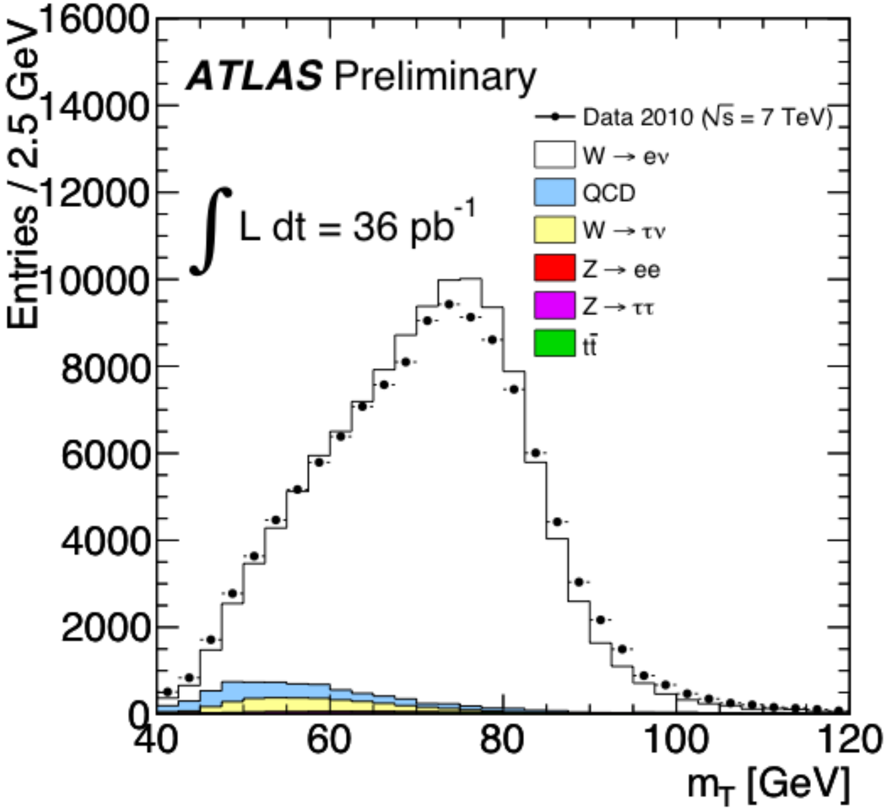


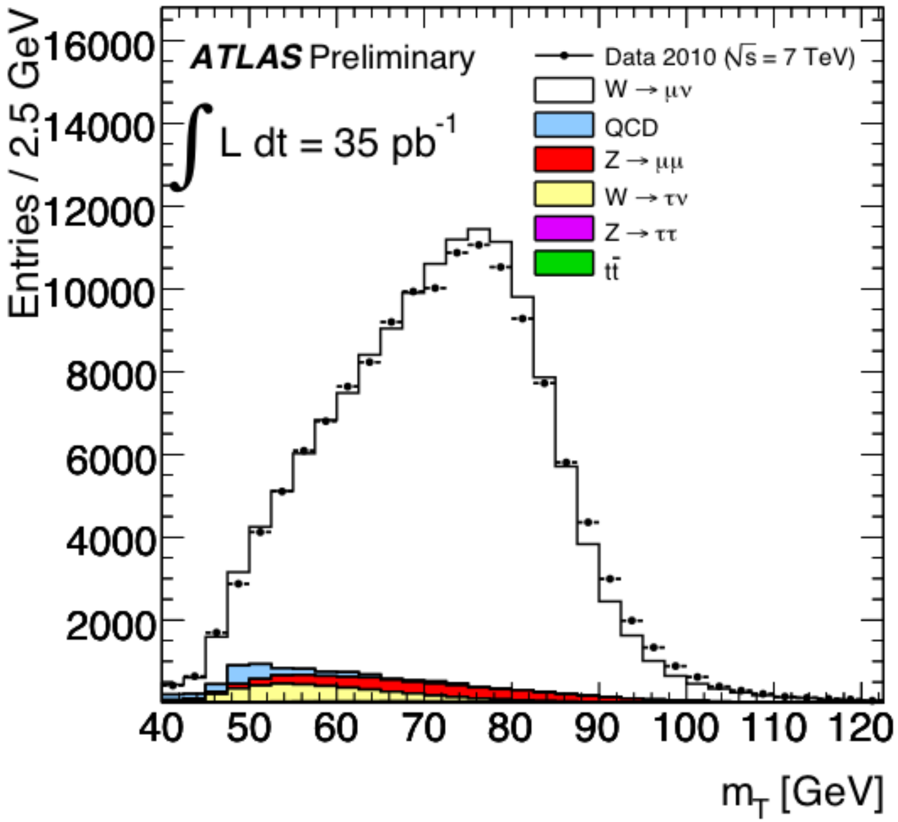


- Distribution for energy imbalance (signature of escaping neutrino) in events with e or μ with p_T>20 GeV

W Transverse Mass

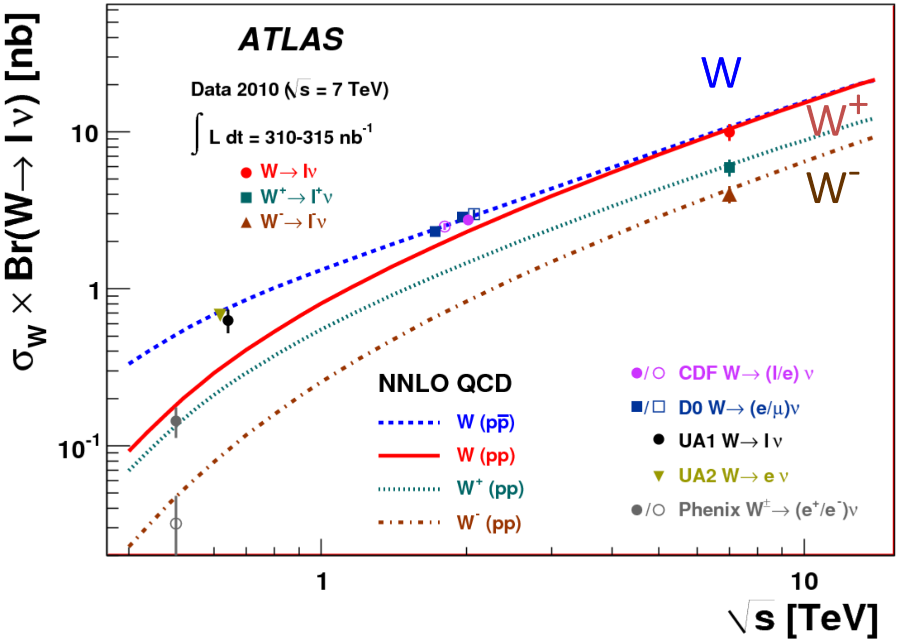
$$m_T = \sqrt{2\, p_T^{\ell}\, E_T^{miss}\, (1 - \cos\Delta\phi)}$$

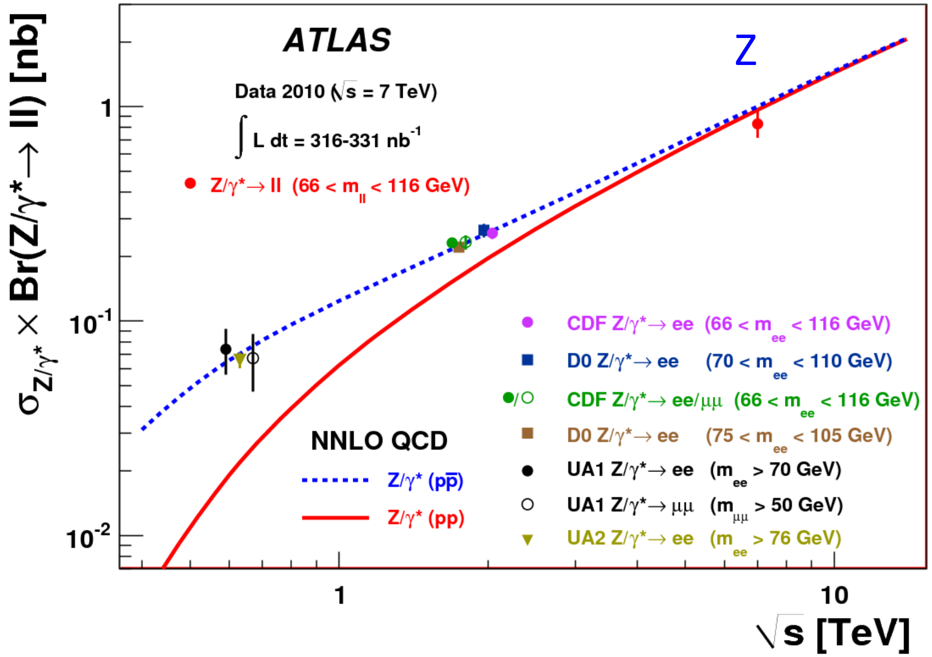




- e or μ with p_T>20 GeV, MET>25GeV
- MC normalized to data
- 119k electron and 135k muon candidates

W and Z Cross Section to e and μ





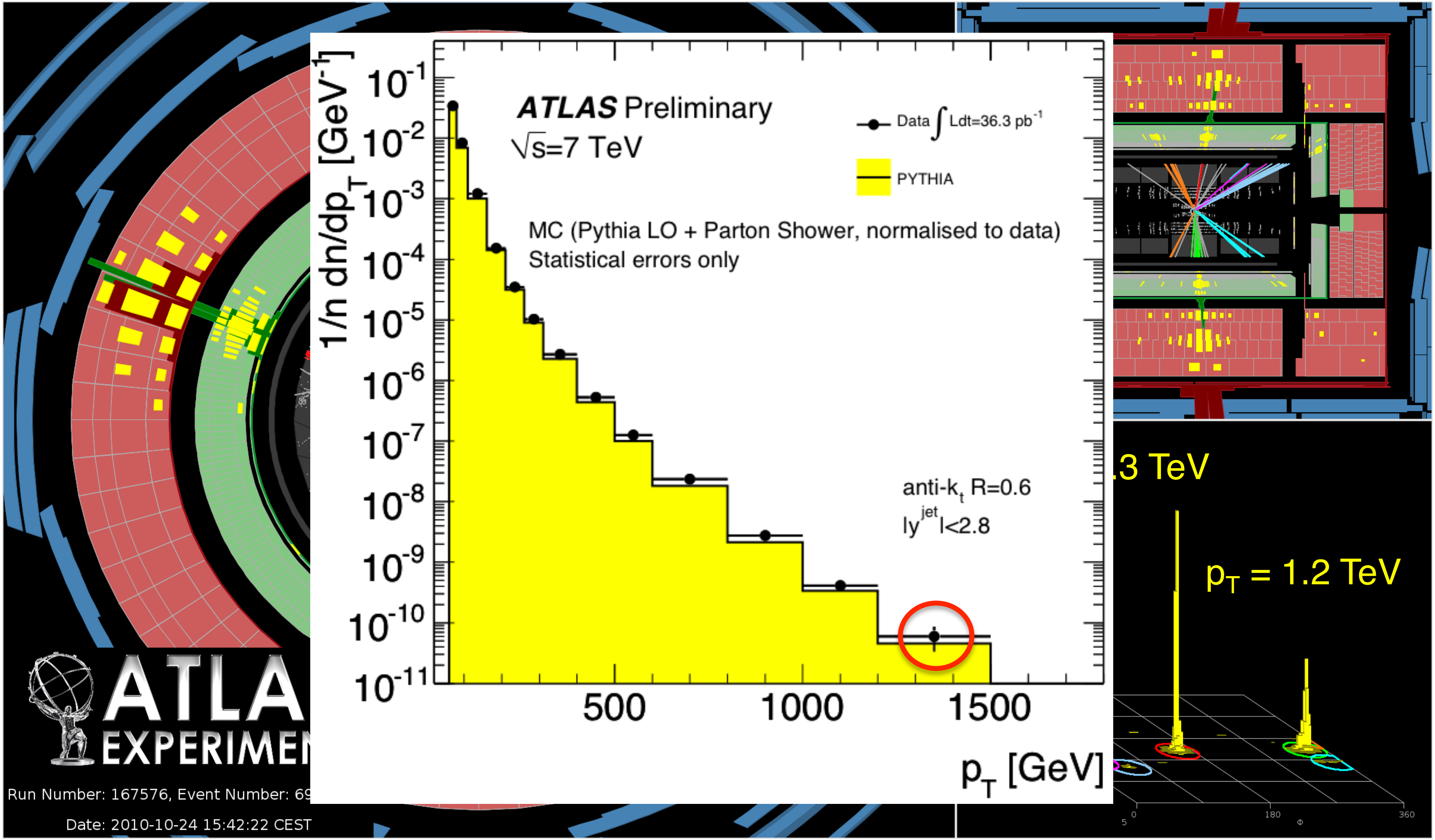
$$\sigma_W^{tot} \cdot \mathrm{BR}(W \to \ell\nu) = 9.96 \pm 0.23(\mathrm{stat}) \pm 0.50(\mathrm{syst}) \pm 1.10(\mathrm{lumi})\ \mathrm{nb}$$

$$\sigma_{Z/\gamma^*}^{tot} \cdot \mathrm{BR}(Z/\gamma^* \to \ell\ell) = 0.82 \pm 0.06(\mathrm{stat}) \pm 0.05(\mathrm{syst}) \pm 0.09(\mathrm{lumi})\ \mathrm{nb}$$

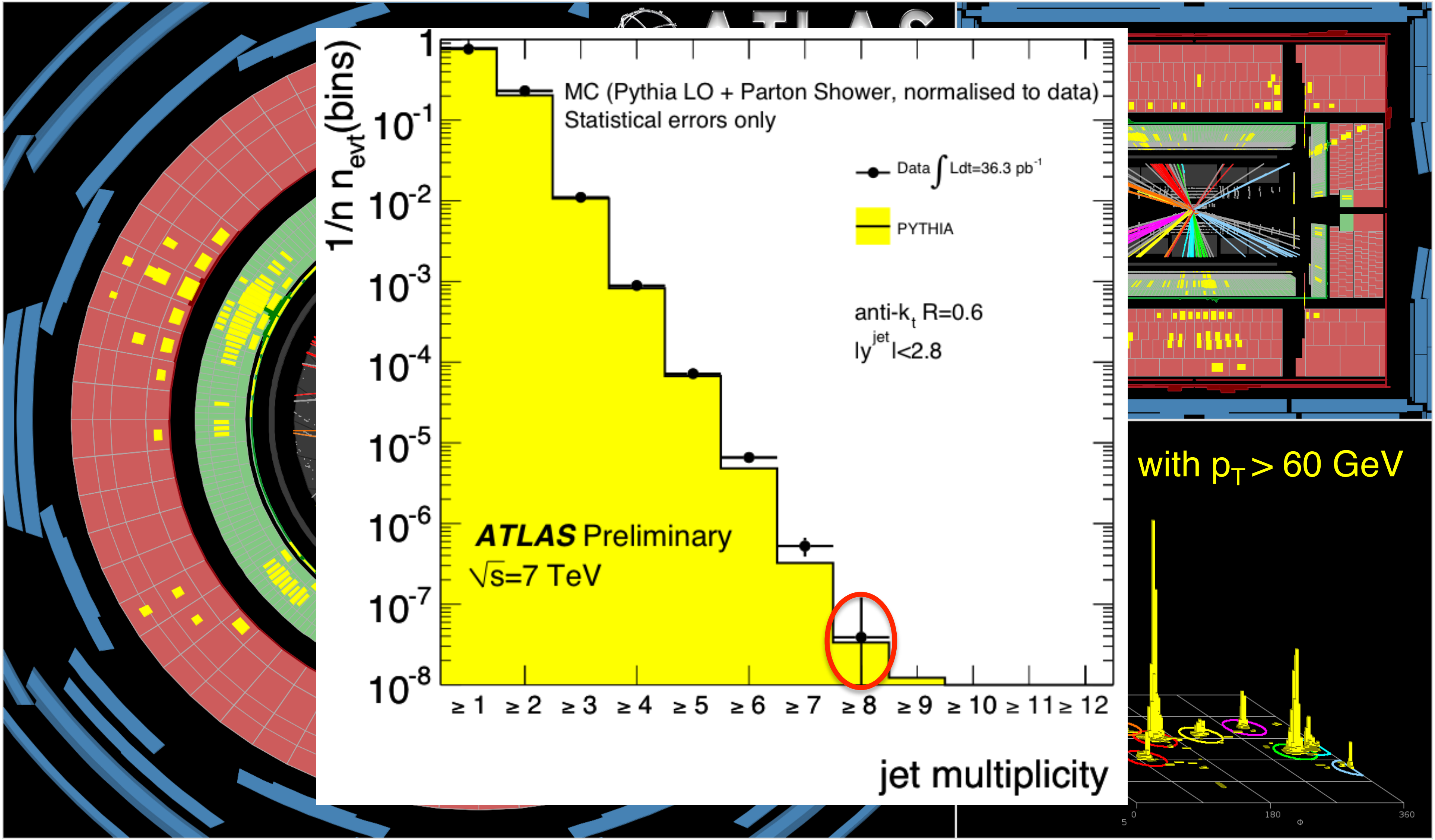
$$(66 < m_{\ell\ell} < 116\ \mathrm{GeV})$$

- Dominant uncertainty (11%) in luminosity will be reduced
- Submitted to JHEP

Typical Jet Event

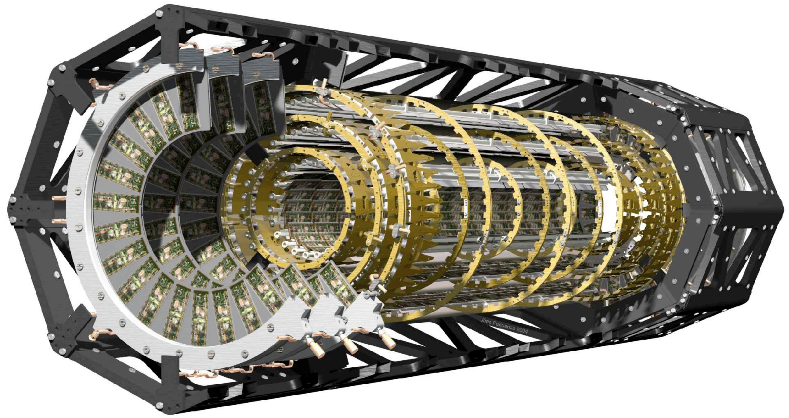


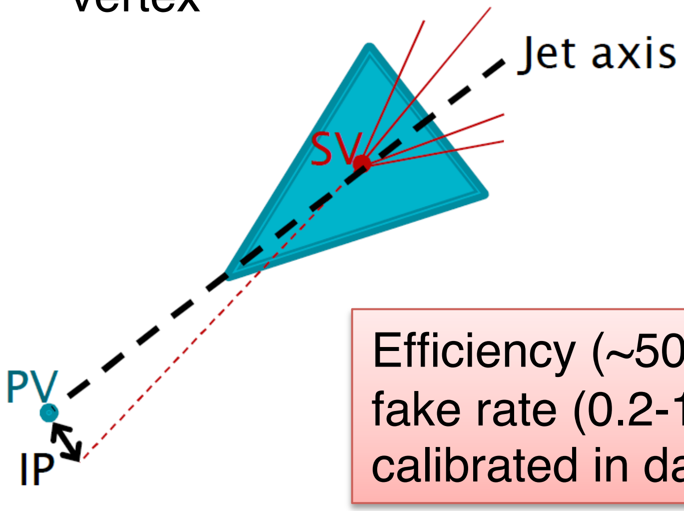
Typical 8-Jet Event



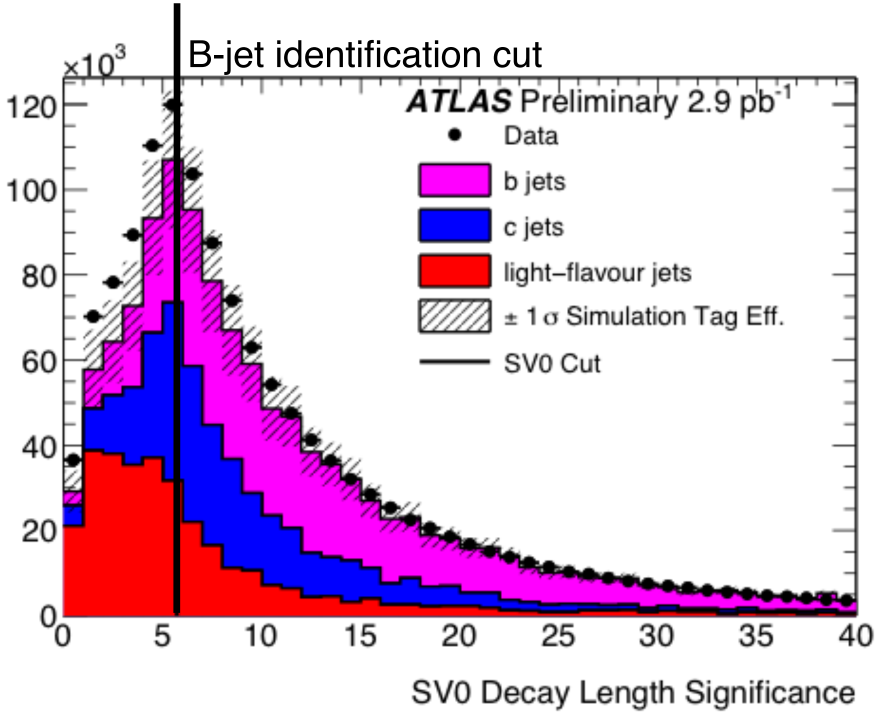
B-Tagging

- Long lifetime of B hadron ($\tau \sim 10^{-12}$ s)
- Largest pixel detector ever: 80 million pixels
  - Excellent performance
  - Track seeding
  - Vertex resolution
- Measure B hadron decay vertex significantly displaced from primary vertex

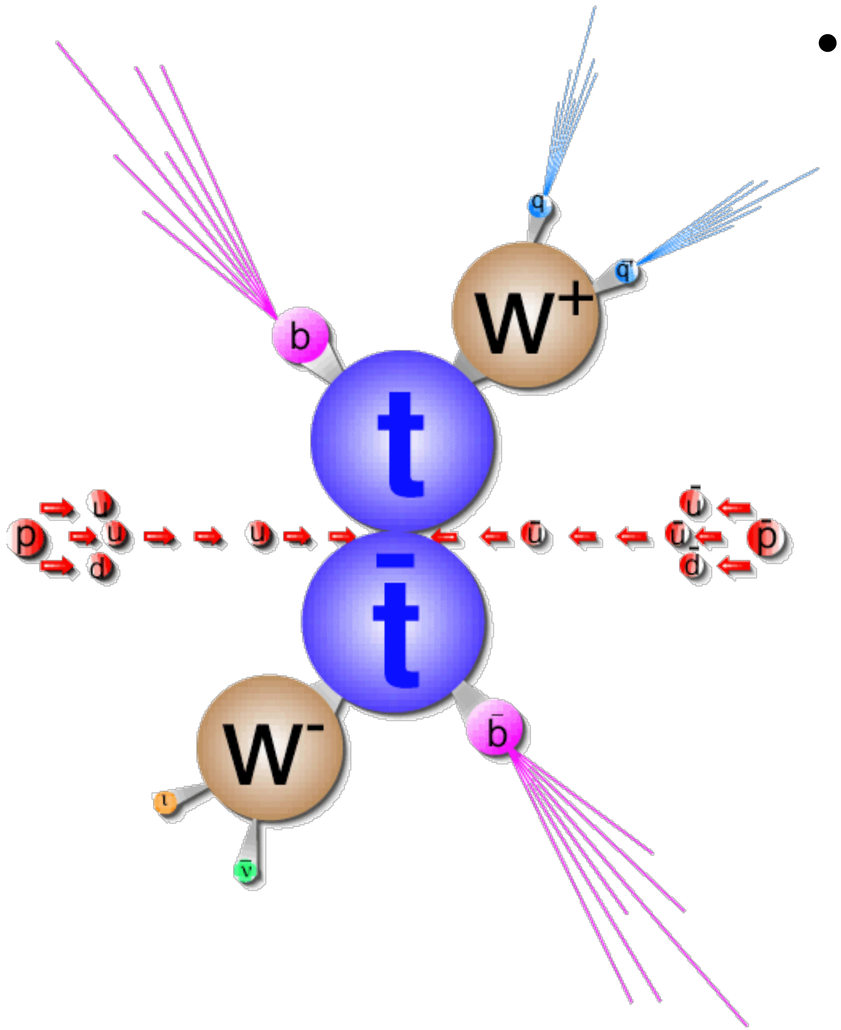




Efficiency (~50%) and fake rate (0.2-1%) calibrated in data



Top Quarks

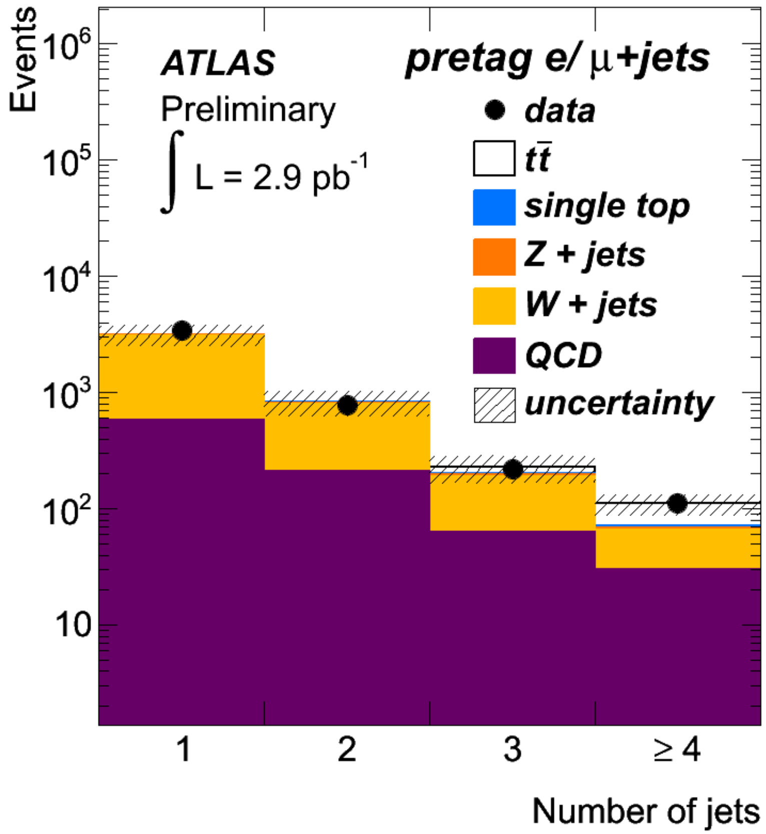


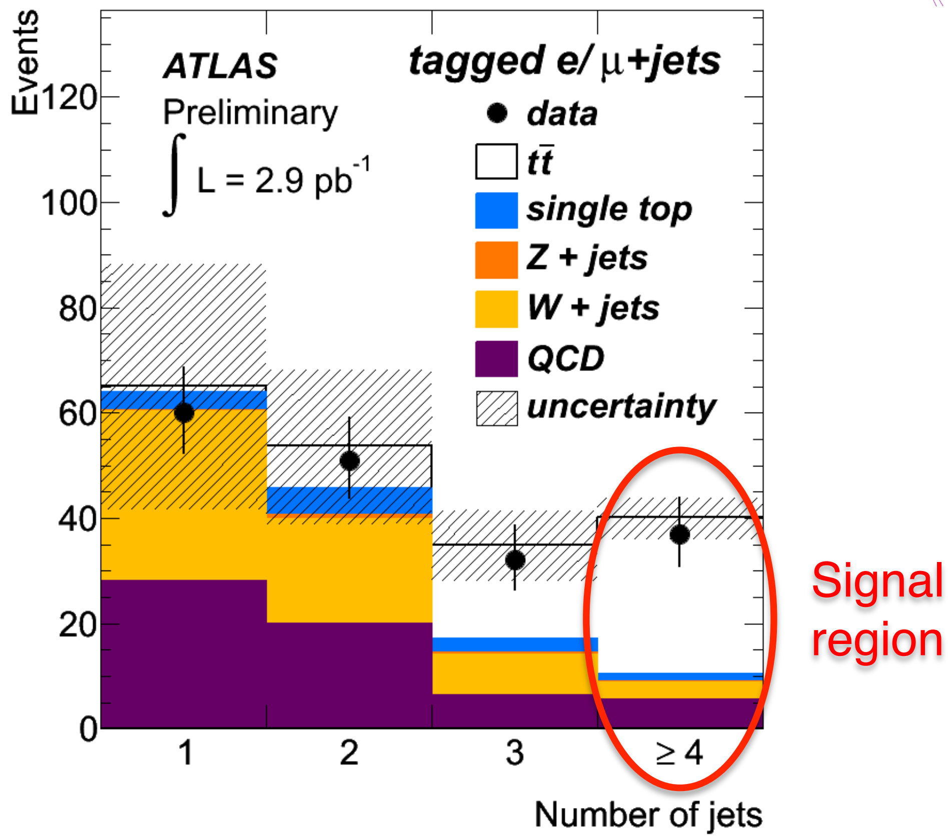
- Complete set of ingredients to investigate production of ttbar, which is the next step in verifying the SM at the LHC:
  - e, μ, MET, W, jets, b-tagging

- Data-driven methods to control QCD and W+jets backgrounds

- Counting experiment

Single Lepton Channel

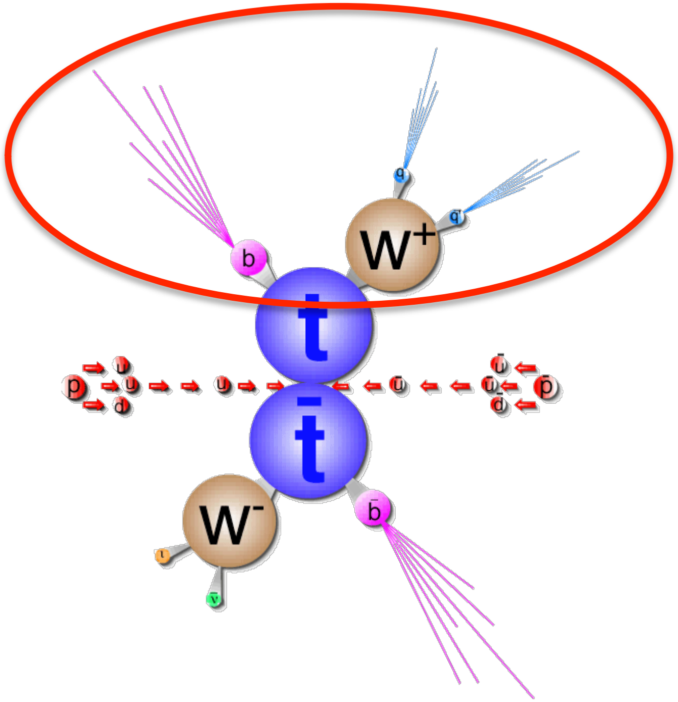


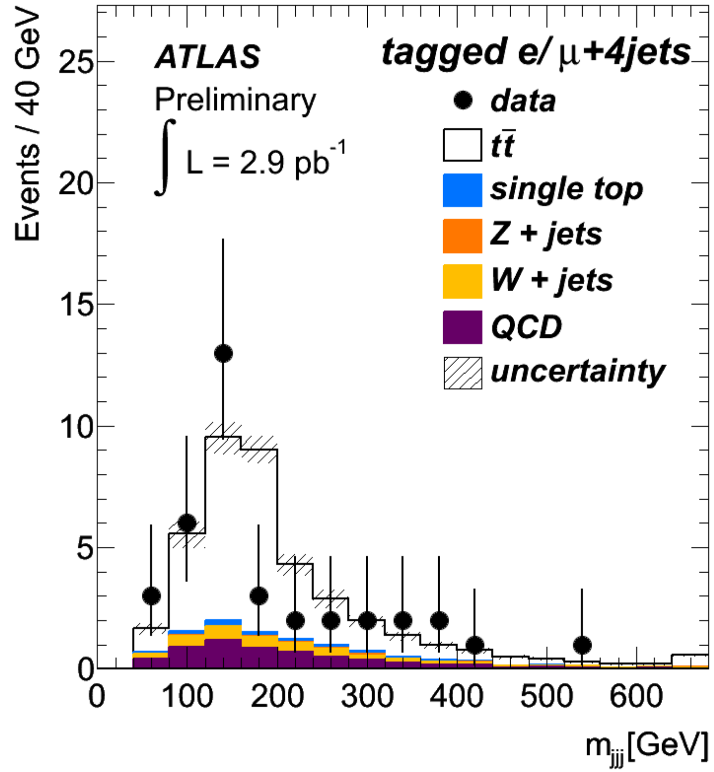


- 1 e or μ with p_T>20 GeV, E_T^{miss}>20 GeV, E_T^{miss}+m_T(W)>60 GeV
- N_{jets} with p_T>25 GeV, with no b-tag requirement or at least one b-tag
- Signal defined to have 4 or more jets, and at least 1 b-tag

Cross Check: 3-Jet Mass

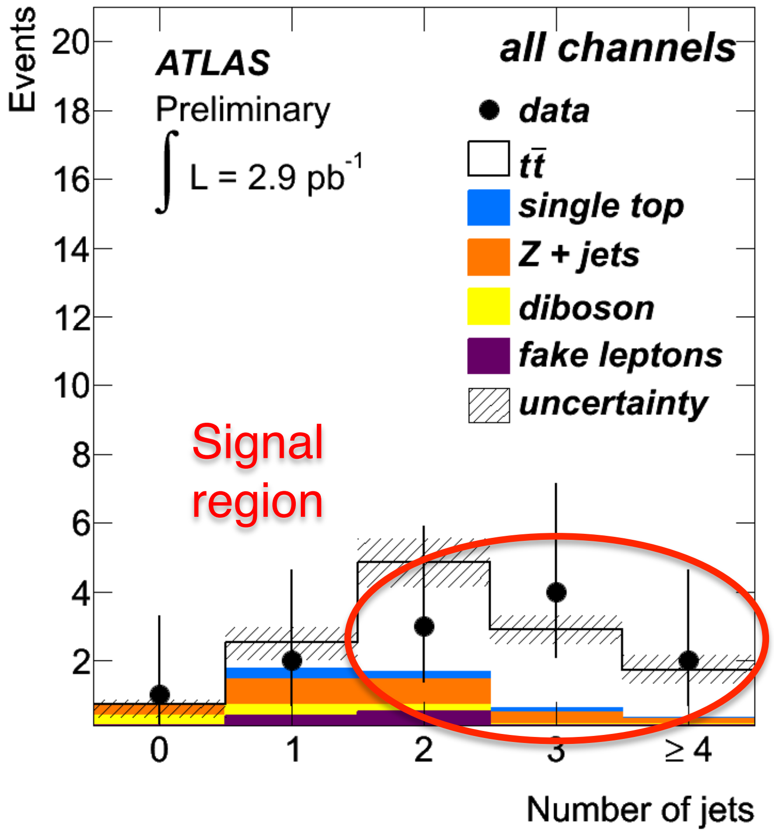
- Invariant mass of the highest p_T 3-jet combination for tagged events

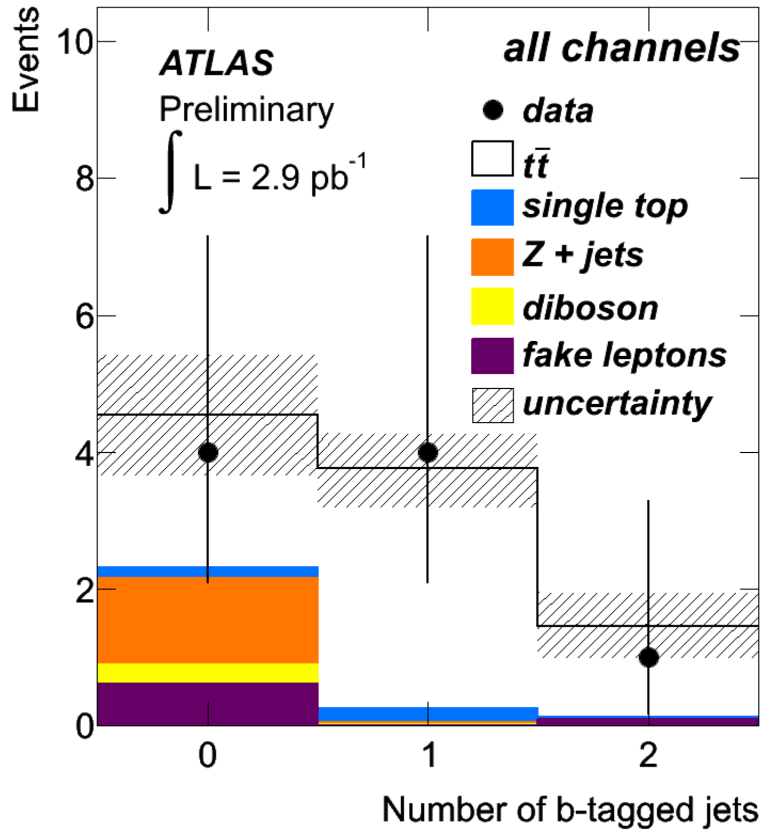




Agrees well with top hypothesis

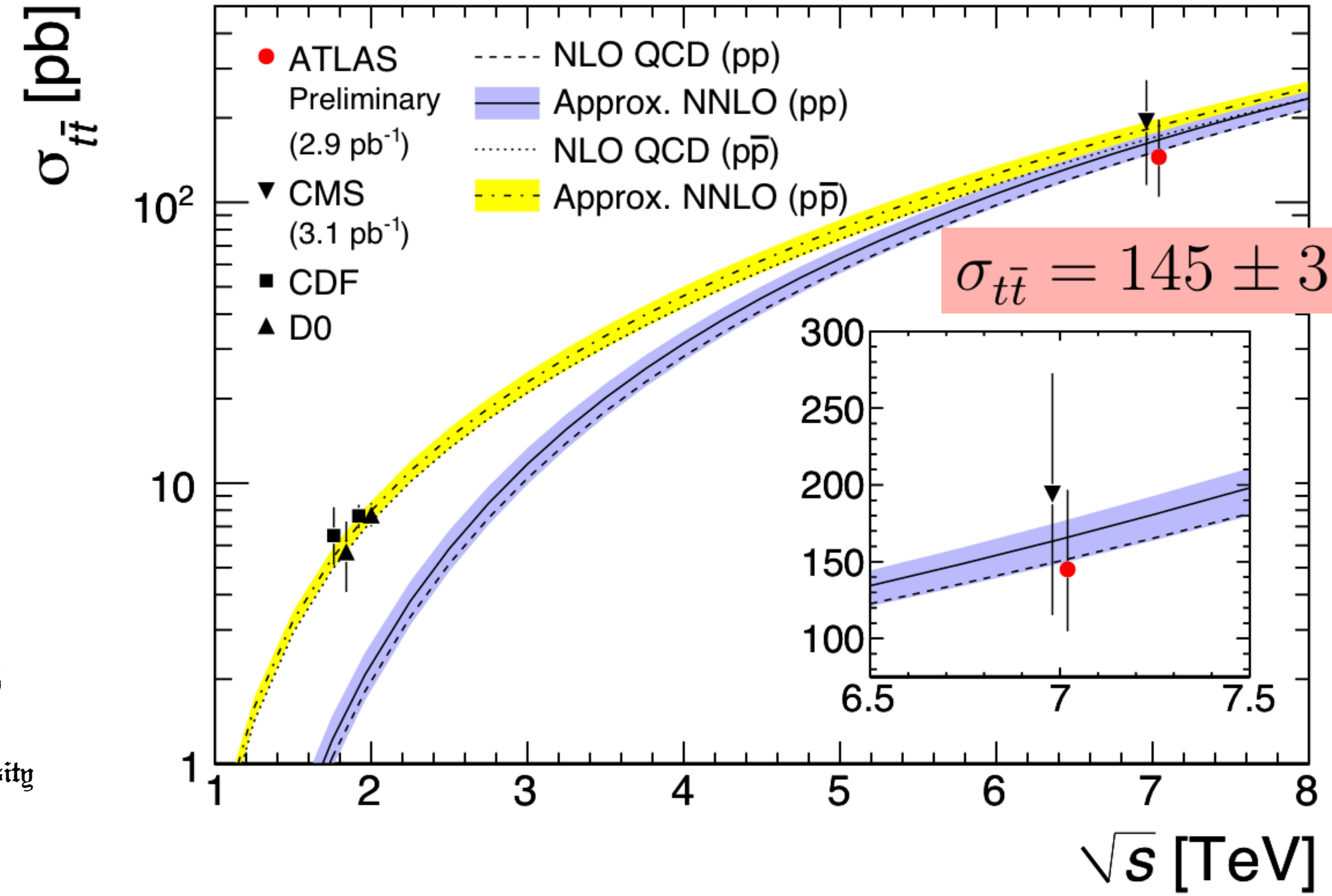
Dilepton Channel





- Count events with two or more jets: 2 ee, 3 $\mu\mu$, 4 eμ
- b-tag is not used in the analysis, but is a cross-check

ttbar Production Cross Section

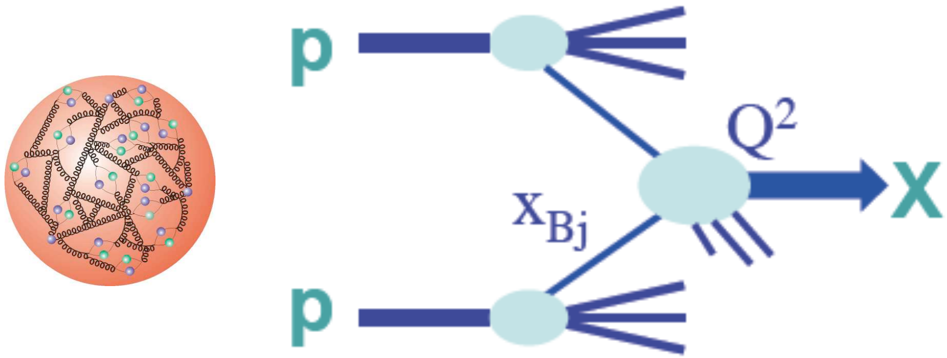


$\sigma_{t\bar{t}} = 145 \pm 31^{+42}_{-27}$ pb

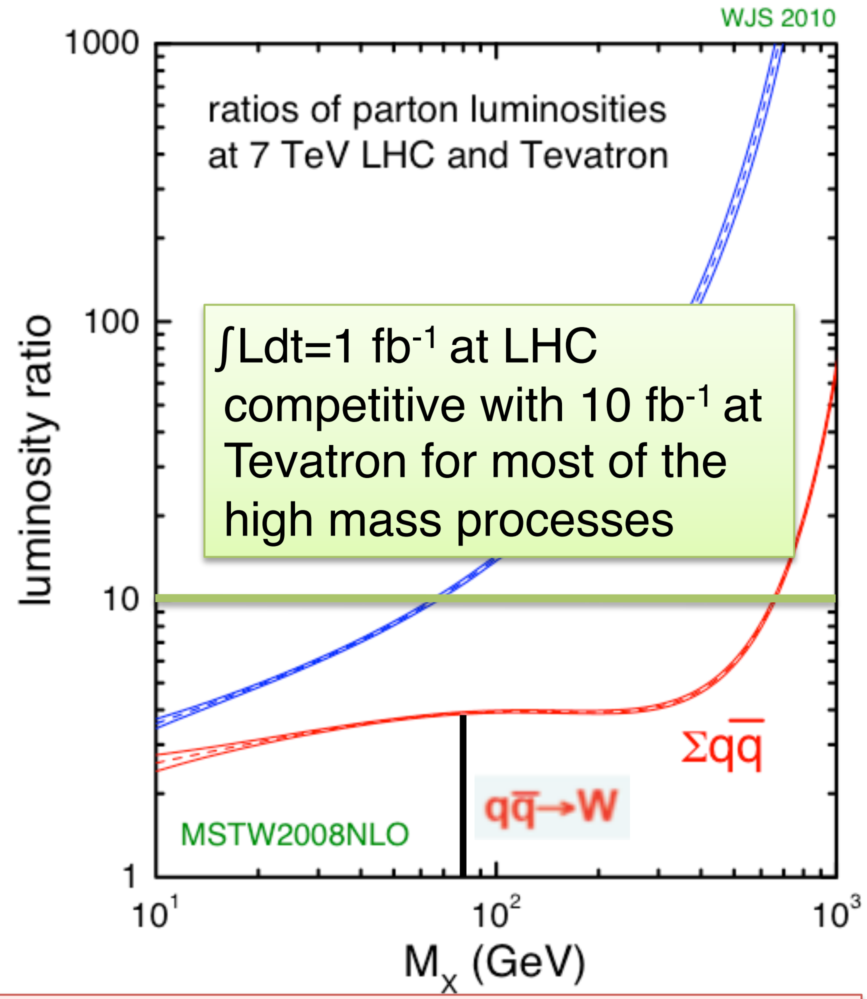
- Simultaneous likelihood fit to all channels to derive cross section
- Significance of ~4.8σ w.r.t. background only hypothesis

First Look for New Physics

$$M_X = \sqrt{x_1 \cdot x_2 \cdot s}$$



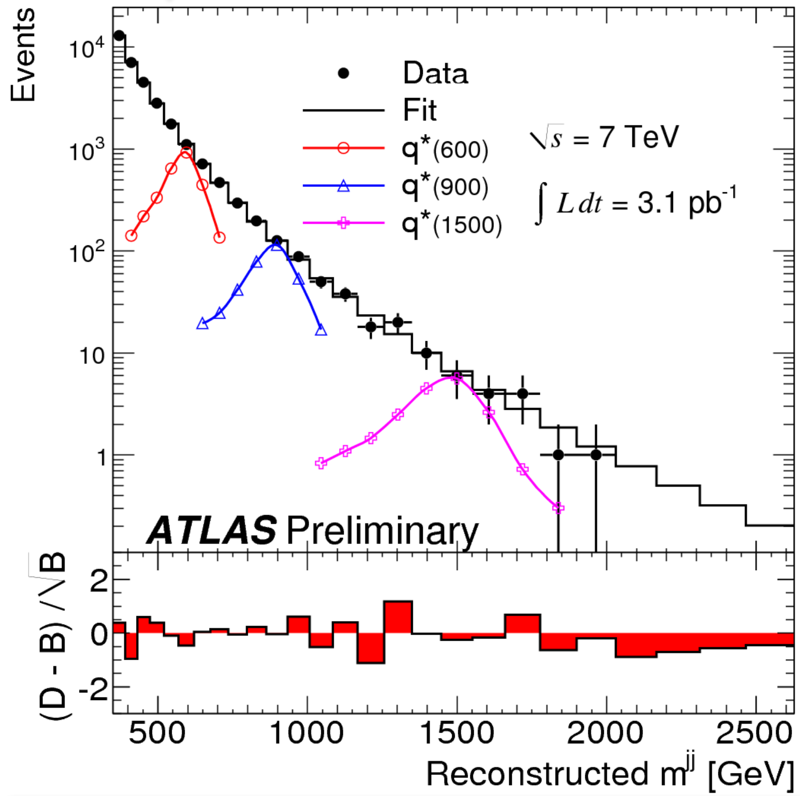
Process	M_X	$\frac{\sigma(\text{LHC @ 7 TeV})}{\sigma(\text{Tevatron})}$
$q\bar{q} \to W$	80 GeV	3
$q\bar{q} \to Z'_{SM}$	1 TeV	50
$gg \to H$	120 GeV	20
$q\bar{q}/gg \to t\bar{t}$	2x173 GeV	15
$gg \to \tilde{g}\tilde{g}$	2x400 GeV	1000



Already more sensitive than Tevatron for many new physics scenarios

Channeling Rutherford: Dijet Mass & Angular Distributions

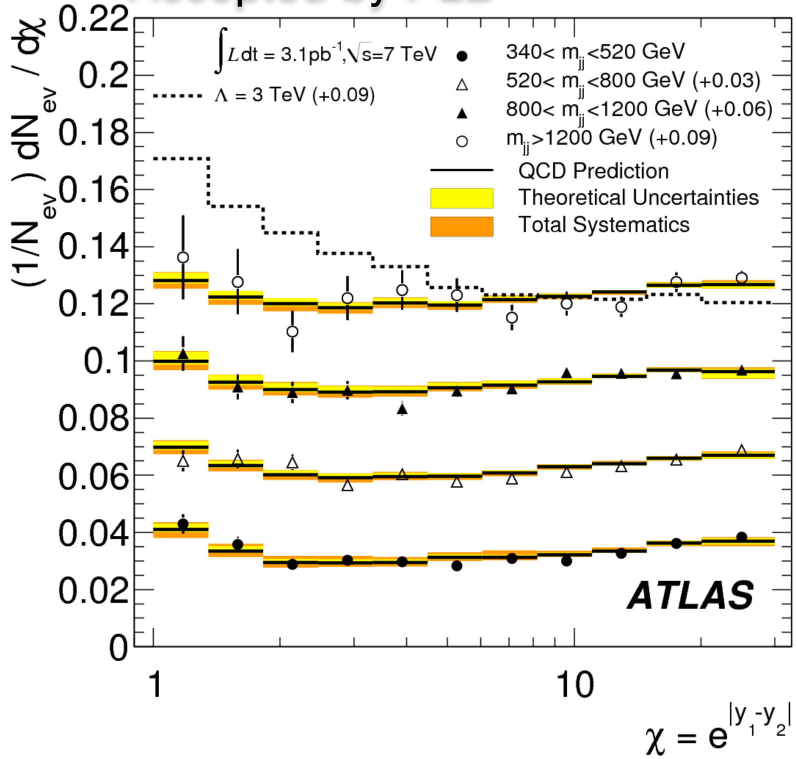
Search for New Particles in Two-Jet Final States, Phys. Rev. Lett. 105, 161801 with 315 nb^{-1}



0.50 < m(q*) < 1.53 TeV @ 95% CL

Tevatron exclusion : 0.26 < m(q*) < 0.87 TeV @ 95% CL (1.1 fb^{-1})

Search for Quark Sub-Structure in Dijet Angular Distributions, Accepted by PLB

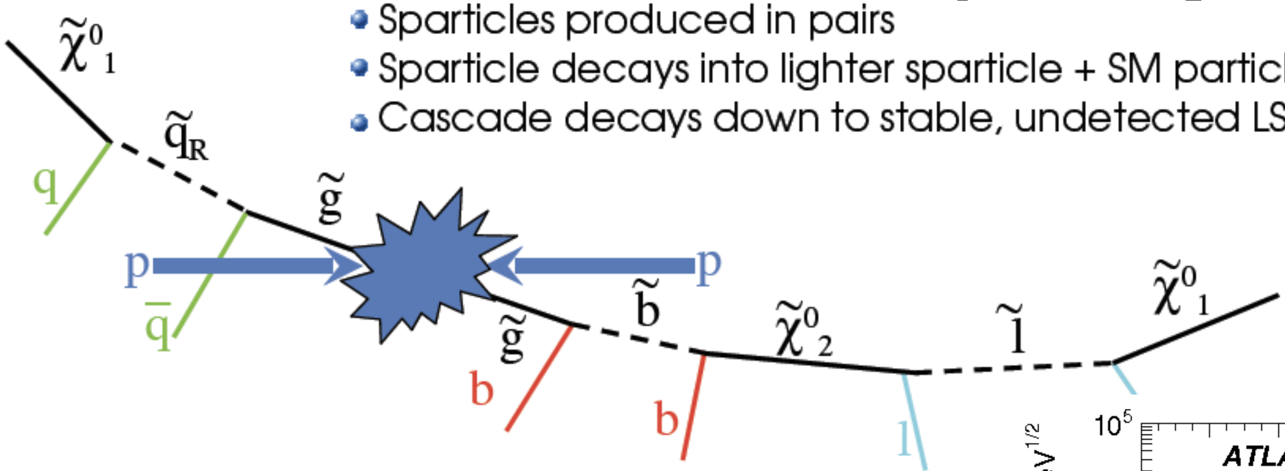


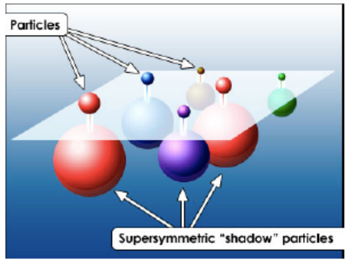
Quark contact interactions with scale Λ < 3.4 TeV @ 95% CL

Tevatron exclusion : Λ < 3.1 TeV @ 95% CL (0.7 fb^{-1})

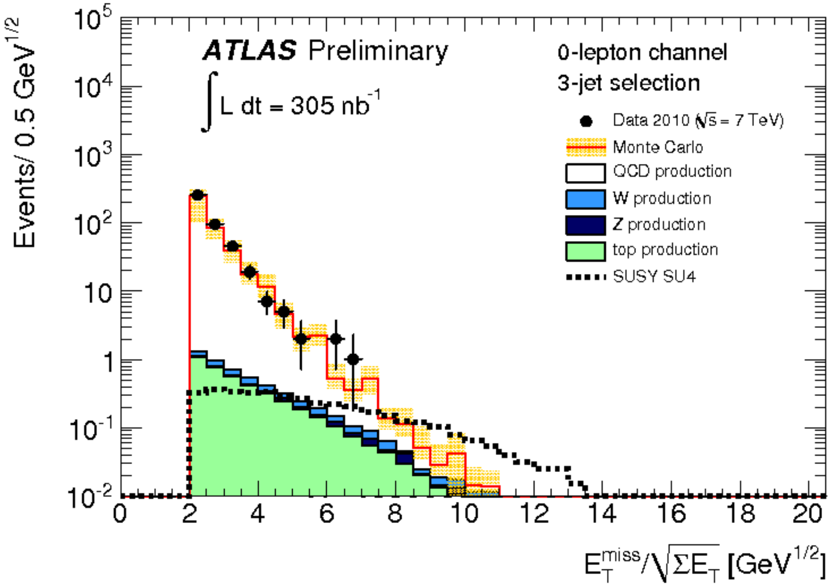
Search for Supersymmetry

- Sparticles produced in pairs
- Sparticle decays into lighter sparticle + SM particle
- Cascade decays down to stable, undetected LSP ⇒ **Large E_T^{miss}**





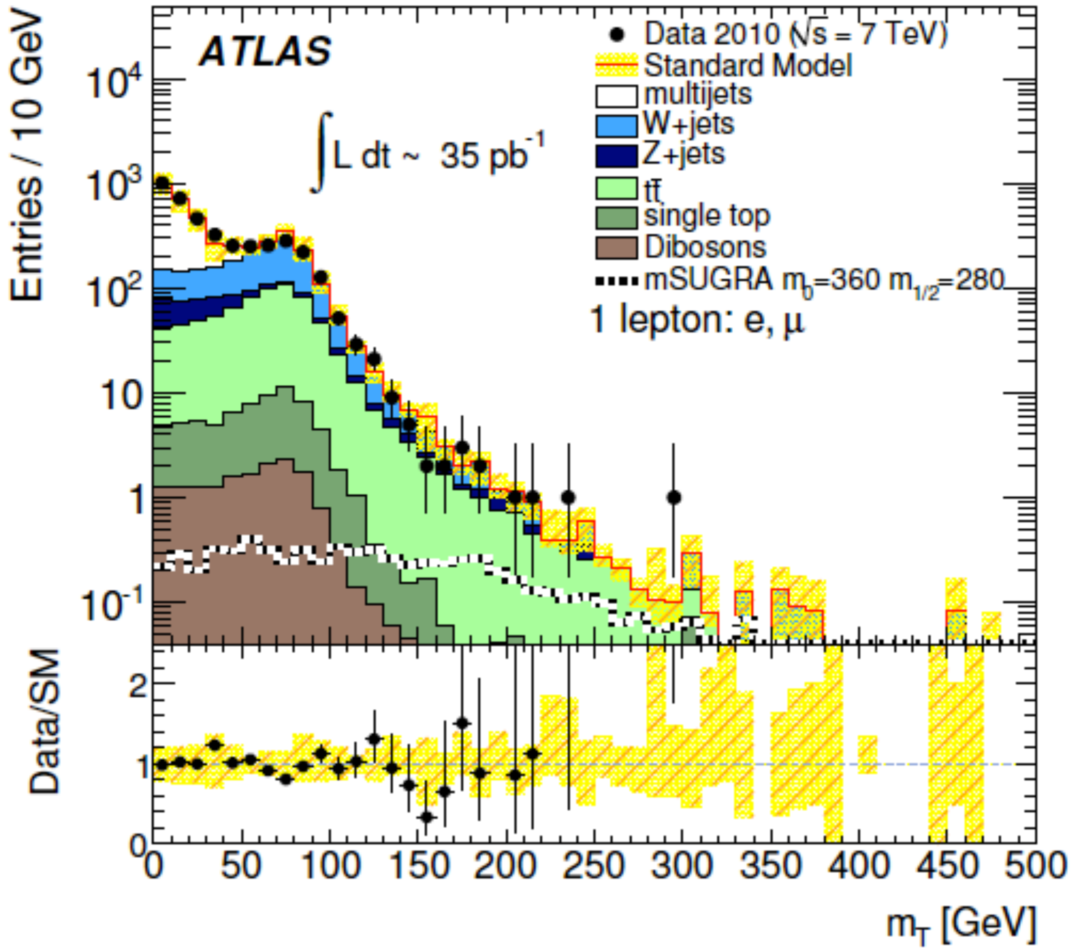
- Huge production rate
- Spectacular final states
  - Many jets
  - Leptons
  - Missing E_T
- Lightest neutralino stable, weakly interacting ⇒ dark matter candidate



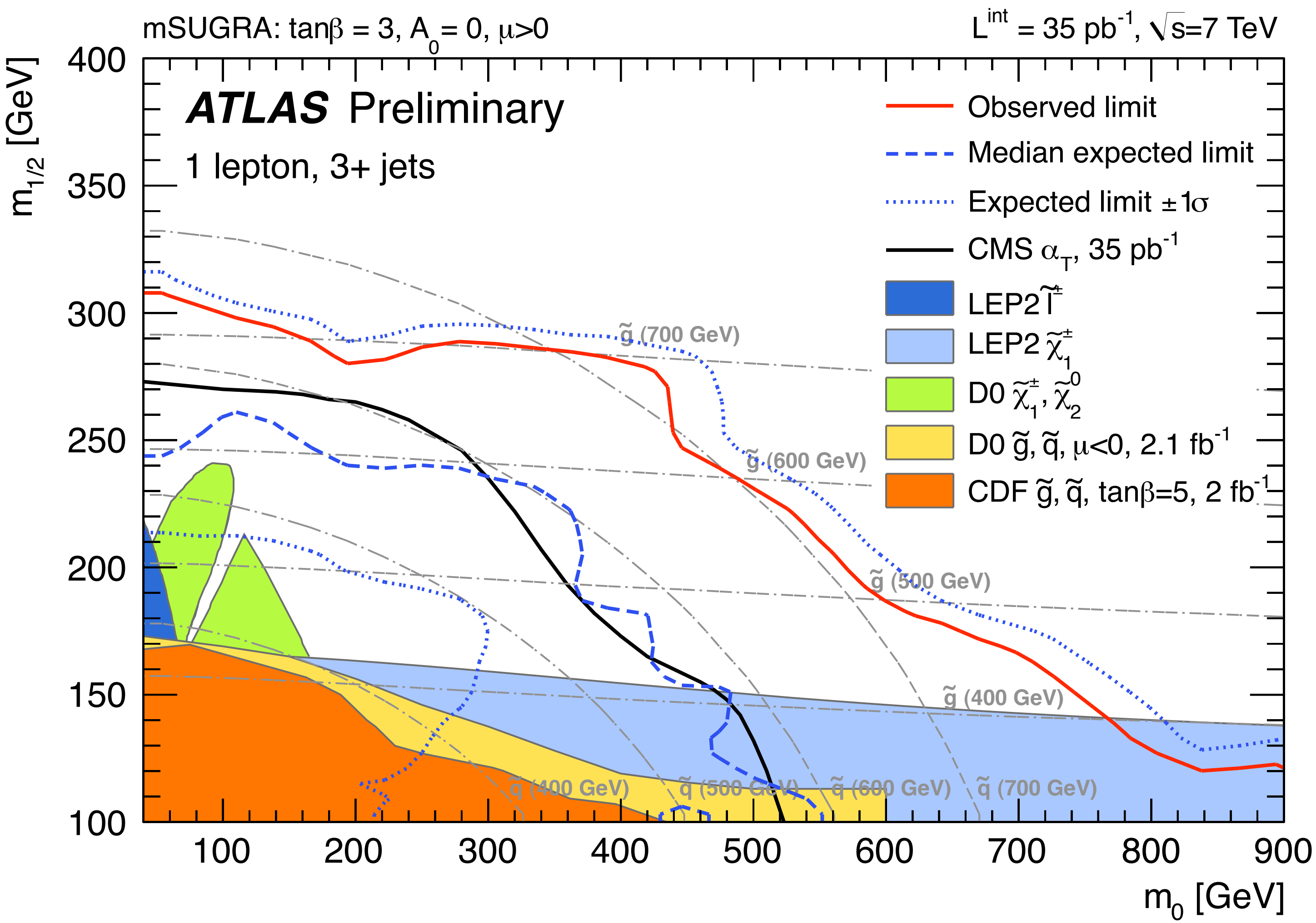
- Data consistent with background
- 100× more data being analyzed ⇒ sensitivity beyond Tevatron reach

New Results on SUSY

- 1 lepton+jets +Missing Transverse Energy
- Plot “transverse Mass”-ignore Z information

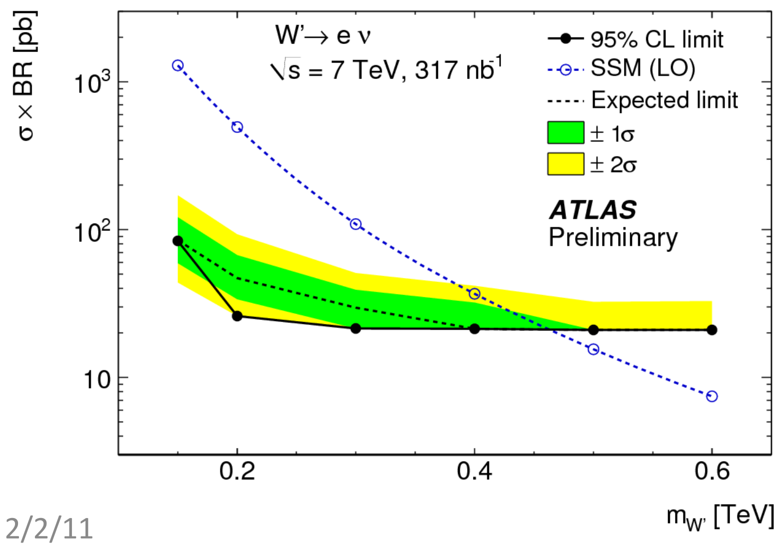


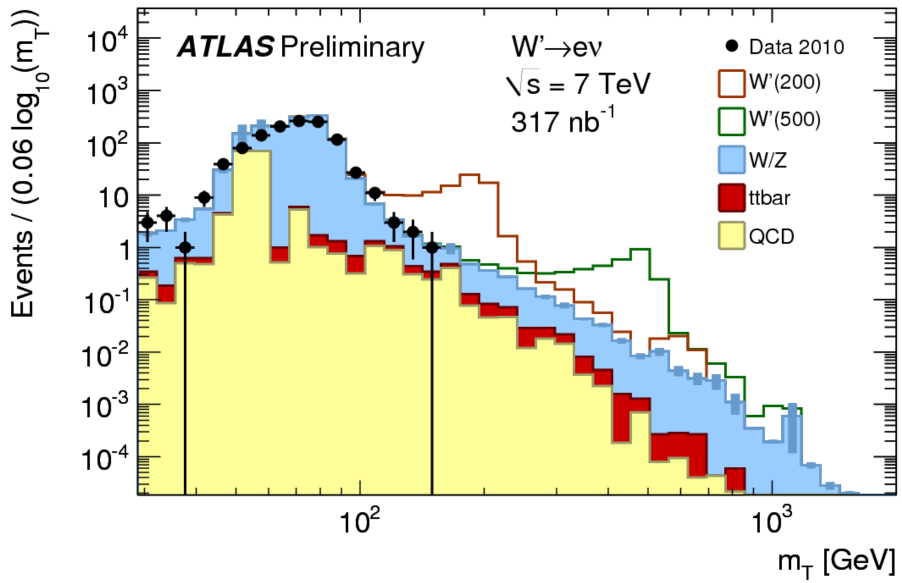
New Limits on Squark and Gluino Masses



W’ Search

- Analysis uses 317 nb-1 of data
- Data consistent with SM predictions
- Current limit that can be set (electrons): 465 GeV
  - Present Tevatron limit is 1 TeV





Plans for 2011 and 2012

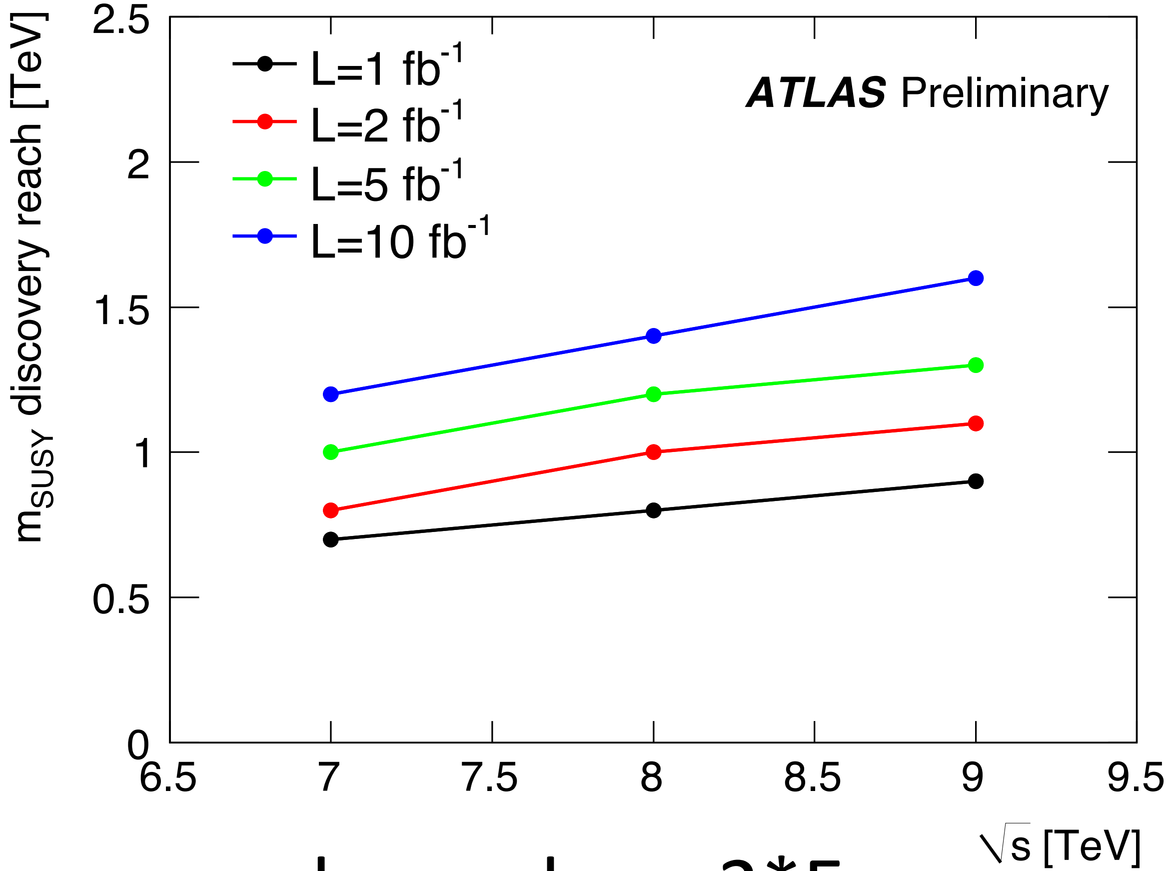
	Reached in 2010	Planned for 2011	Design
Collision energy	7 TeV	7-8 TeV	14 TeV
Protons/Bunch	1.1×10^{11}	$1.2\text{-}1.5 \times 10^{11}$	1.1×10^{11}
Bunch spacing	150 ns	50-75 ns	25 ns
# colliding bunch	348	348-1400	2808
Peak luminosity	2.1×10^{32} $cm^{-2}s^{-1}$	2.1×10^{32} - 2.2×10^{33} $cm^{-2}s^{-1}$	1×10^{34} $cm^{-2}s^{-1}$
Integrated luminosity	50 pb^{-1}	2.2-7.6 fb^{-1}	30 fb^{-1}

Hope to reach an instantaneous luminosity of $\sim 10^{33}$ by mid May, 2011,
Integrate 2-3fb^{-1} in 2011, guess an additional 3-8fb^{-1} delivered in 2012

New Physics Search in 2011-2012

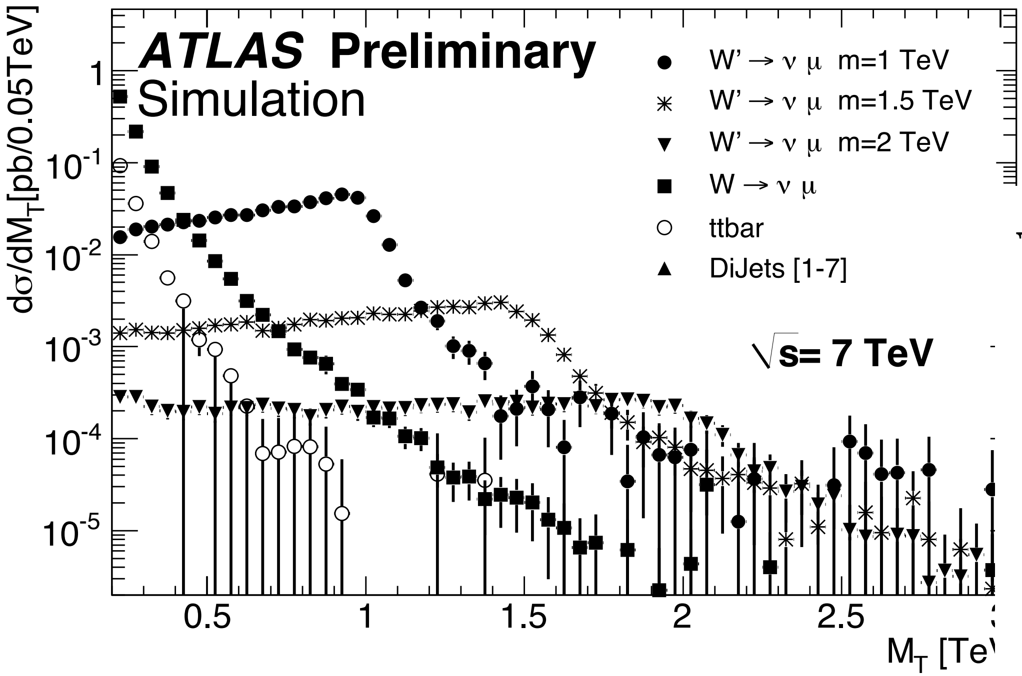
- SUSY
- W', Z'

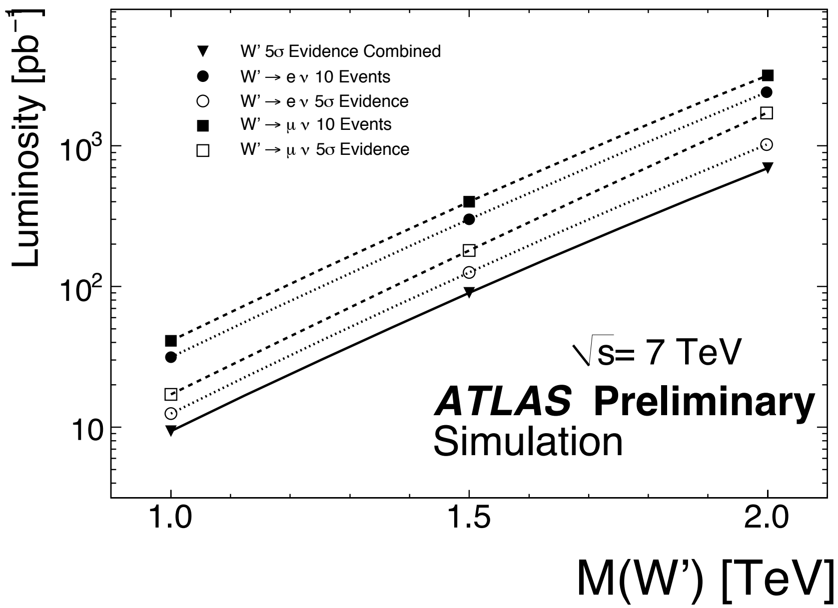
SUSY Searches



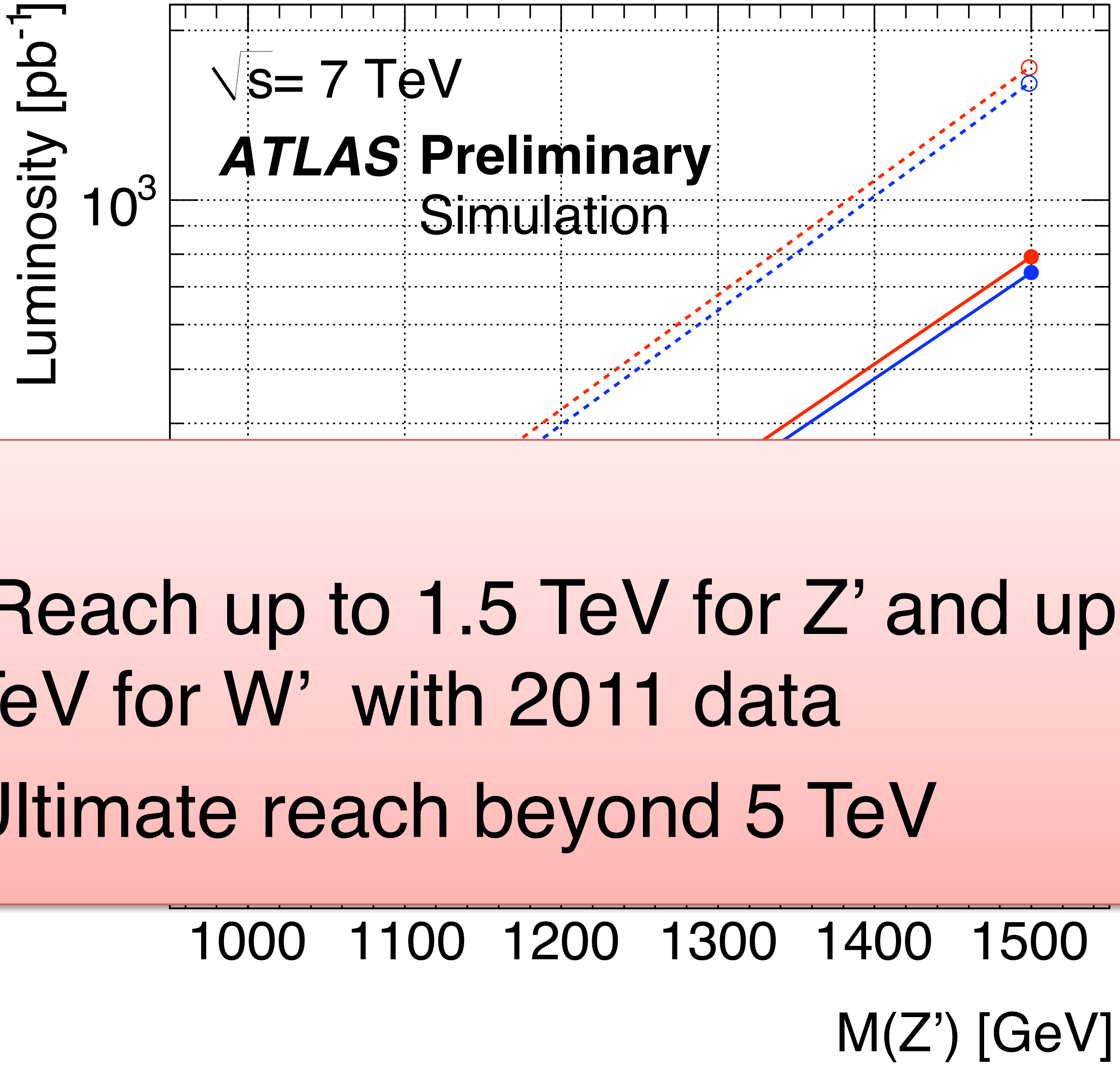
- SUSY mass scale reach vs. 2*E_{beam}

W’ Search





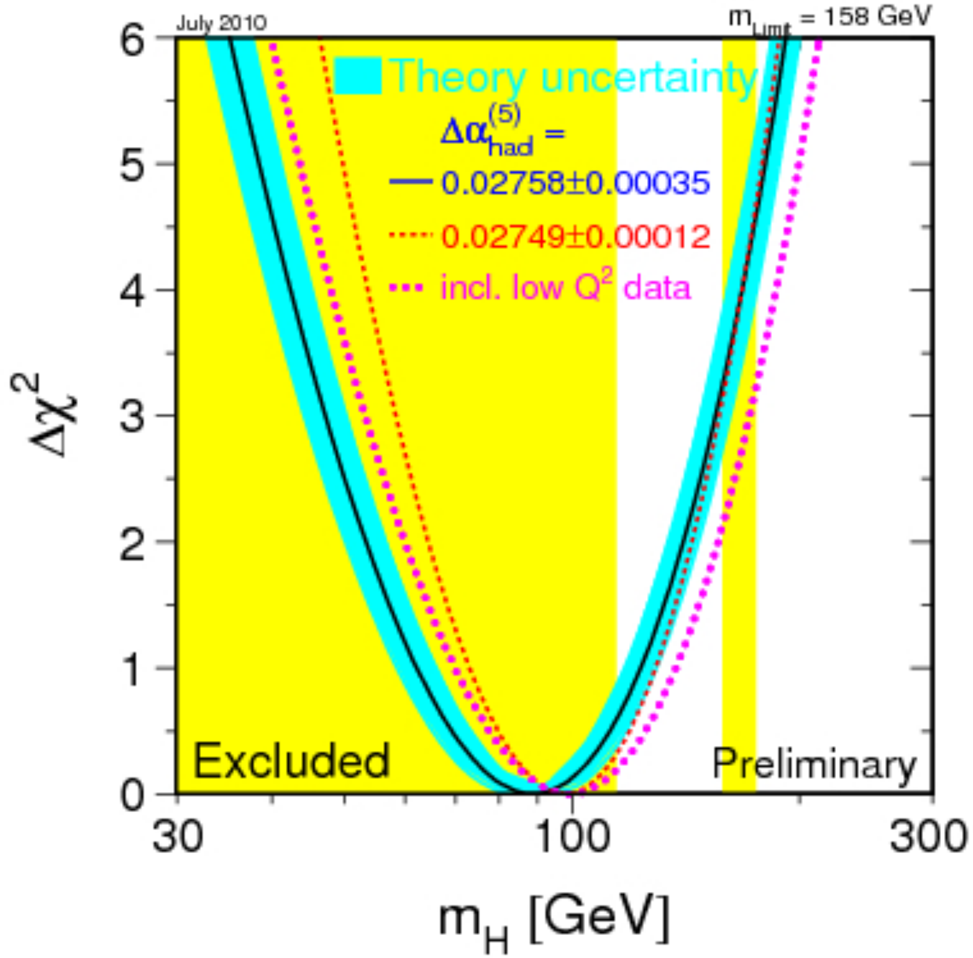
Luminosity needed to observe 10 W’ events or have 5 sigma excess



- Reach up to 1.5 TeV for Z' and up to 1.9 TeV for W' with 2011 data
- Ultimate reach beyond 5 TeV

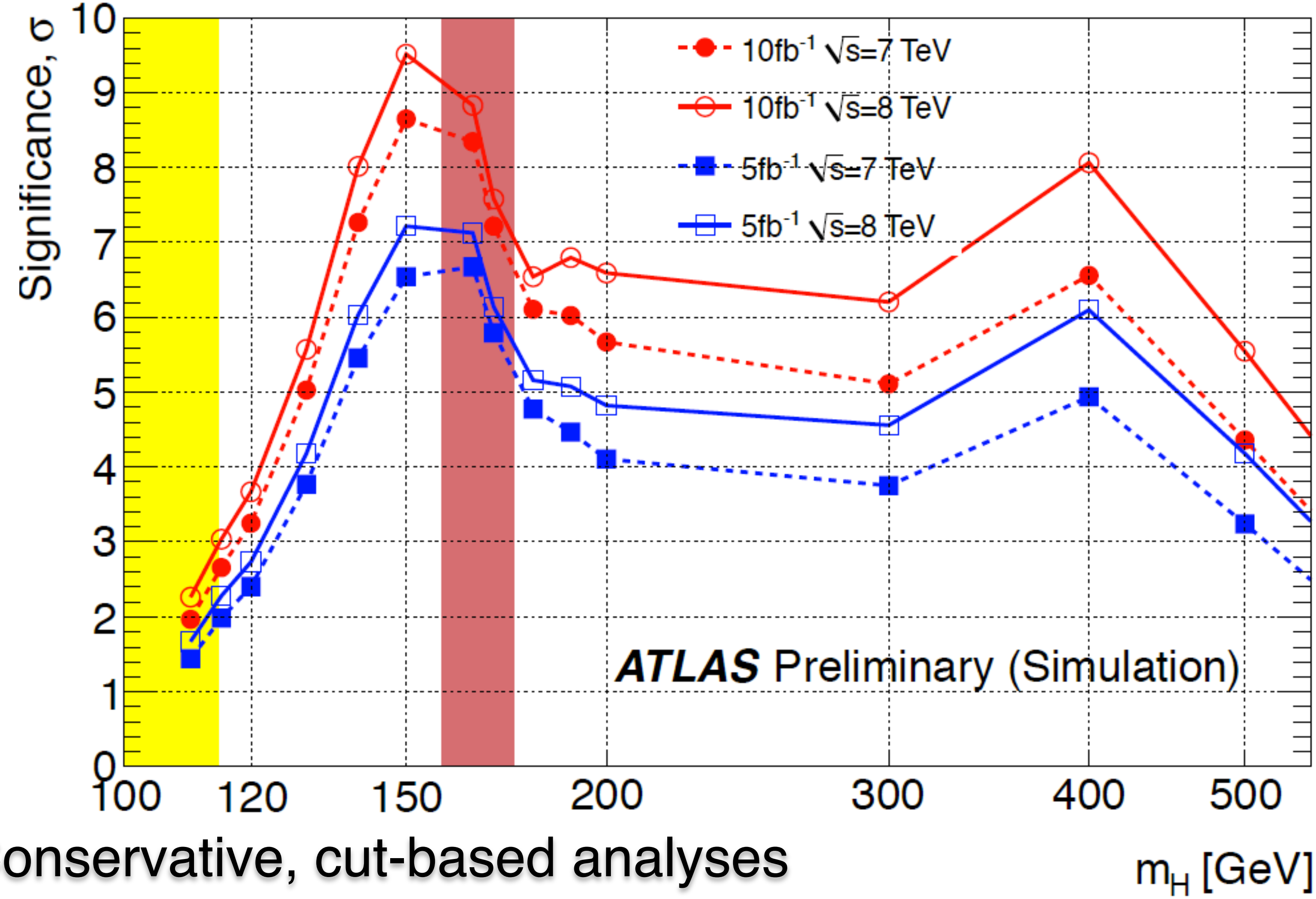
The Higgs Boson

Experimental Constraints on the Higgs Mass



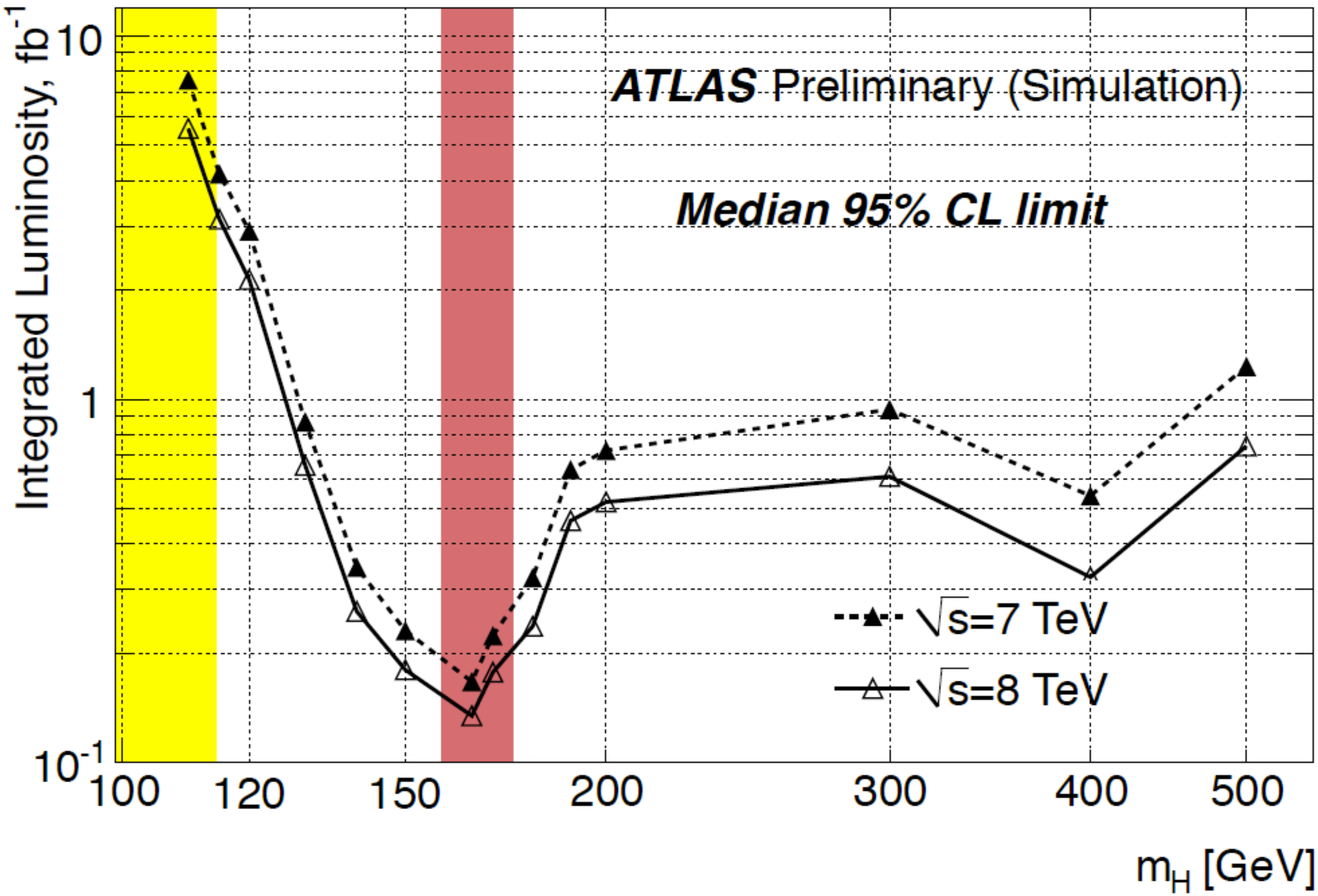
Not yet excluded: 115 GeV < m_H<158 GeV

Higgs Discovery Potential



- Conservative, cut-based analyses
- Robust systematic error estimates

Or Ruling out a Standard Model Higgs



- Integrated Luminosity needed for exclusion vs. Higgs Mass

Conclusions

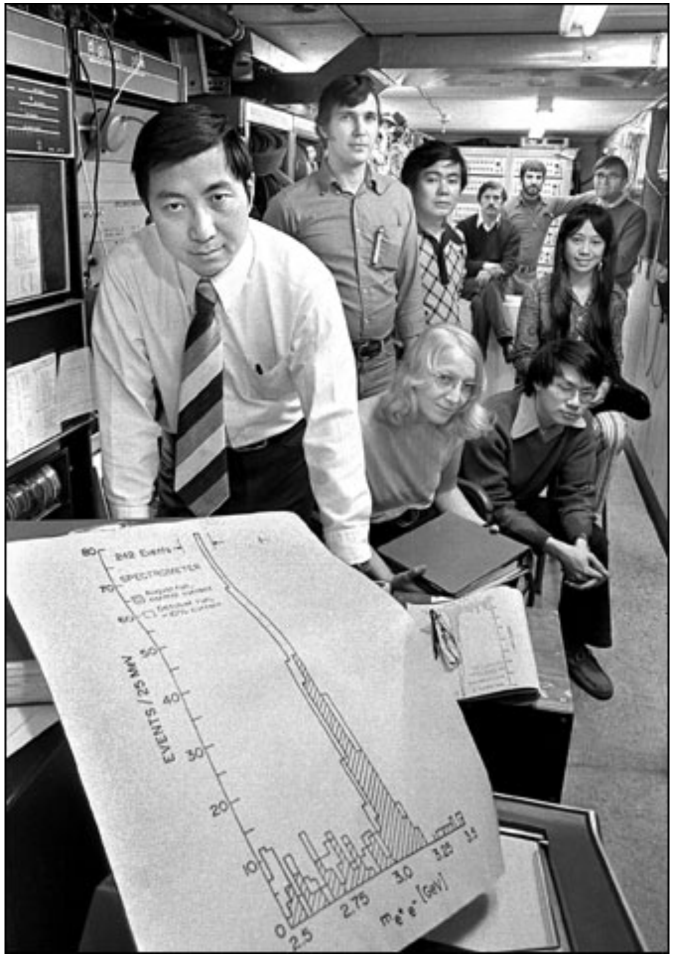
- After a very bad false-start in 2008, the LHC turn-on in 2009-2010 has been remarkably smooth
- Surprisingly, ATLAS first data look as beautiful as simulations predicted (ditto for CMS)
- We have healthy standard-candle signatures like W and Z bosons and the top quark
- First look beyond the discovery scope of the Tevatron yields no new physics (not too surprising)
- Much bigger phase-space for discovery in 2011&2012

A Possible Future

- In 1974 the Quark Model was confirmed by the Discovery of Charm (J/ψ)
- It was one of many viable theories at the time, and prior to 1974, very many in the field would have bet against it
  - It was the cause of great celebration


1974

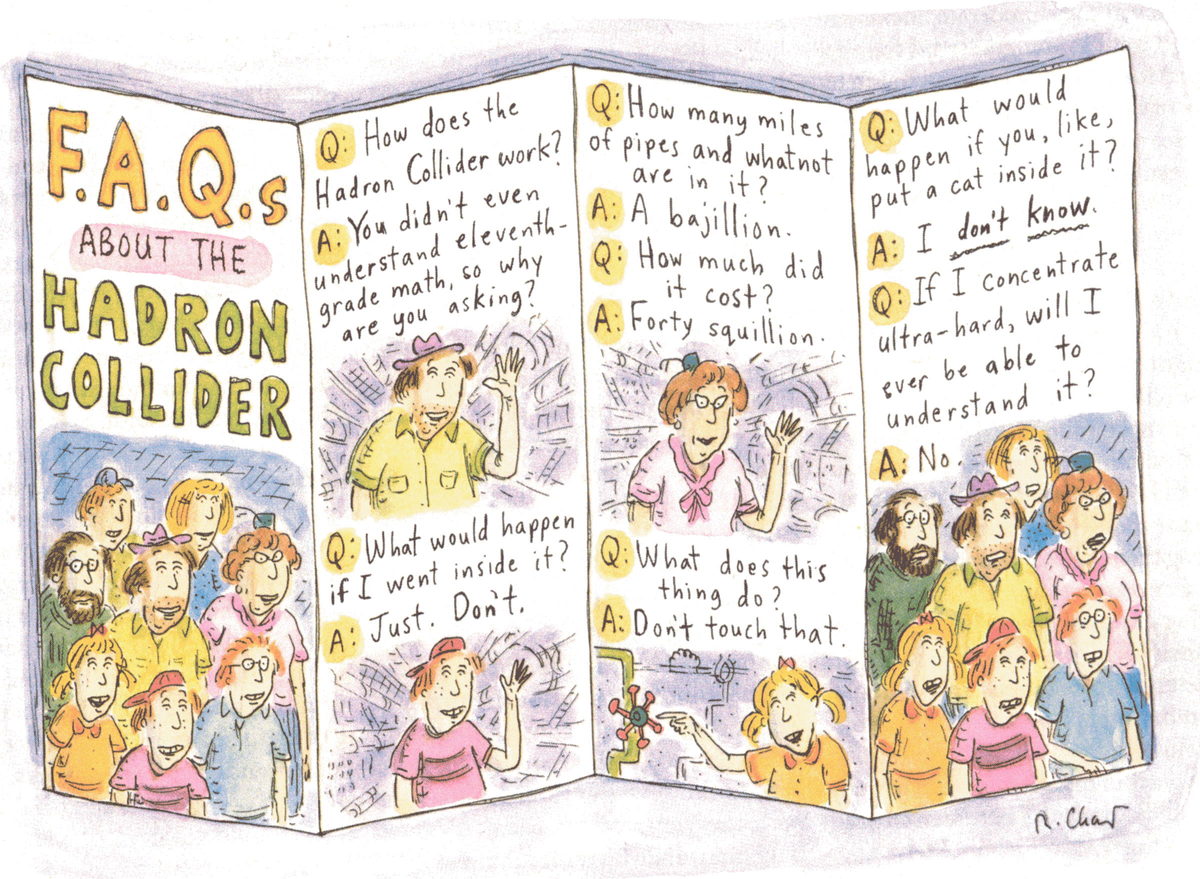
Physics Party Animals, circa 1974



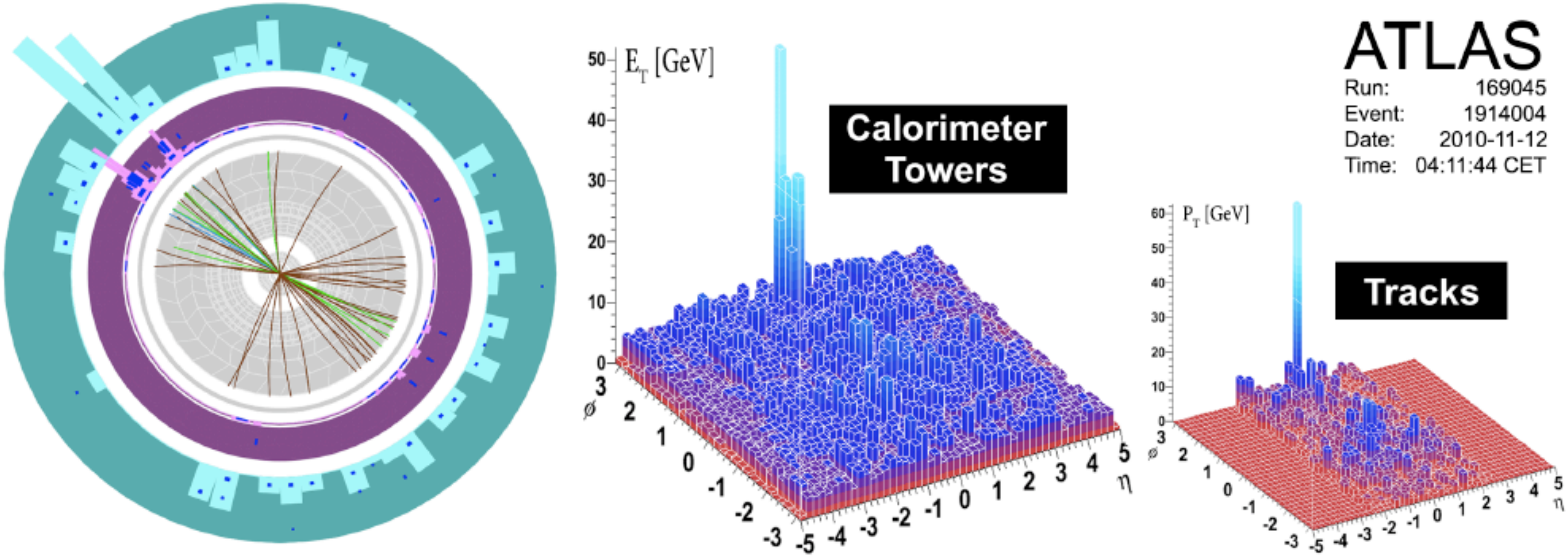
Get your bellbottoms ready

It could happen again

Backup

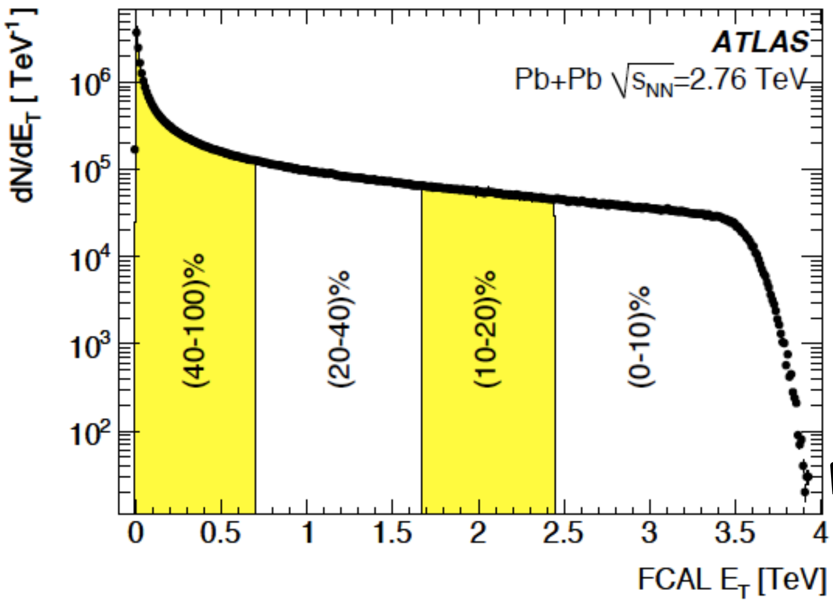

F.A.Q.s
ABOUT THE
HADRON COLLIDER
Q: How does the Hadron Collider work?
A: You didn't even understand eleventh-grade math, so why are you asking?
Q: What would happen if I went inside it?
A: Just. Don't.
Q: How many miles of pipes and whatnot are in it?
A: A bajillion.
Q: How much did it cost?
A: Forty squillion.
Q: What does this thing do?
A: Don't touch that.
Q: What would happen if you, like, put a cat inside it?
A: I don't know.
Q: If I concentrate ultra-hard, will I ever be able to understand it?
A: No.
R. Chast

Jet Quenching

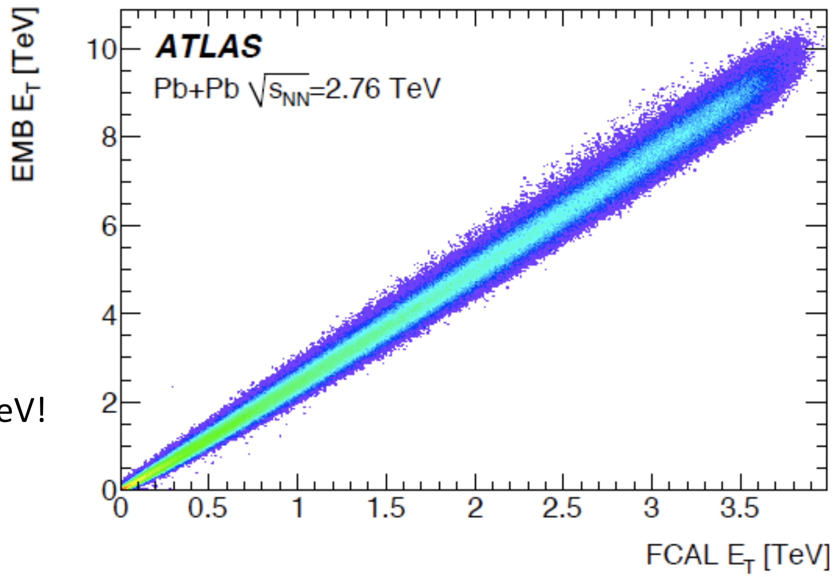


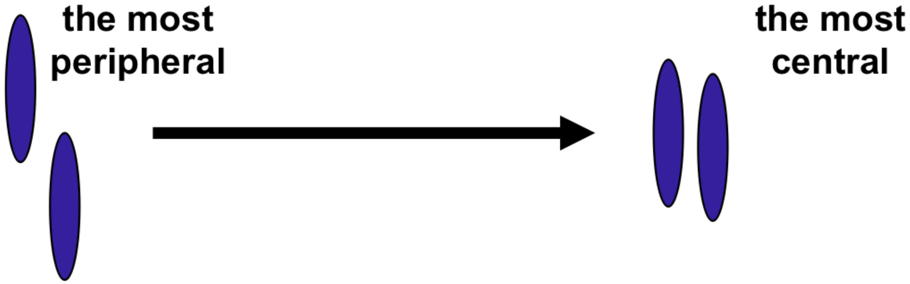
- Highly unbalanced jets when one jet is produced at the periphery of the collision
- Proposed by Bjorken in 1982
- Consistent with RHIC results: reduced rate of high p_T hadrons of up to factor 5 in central events (R_{AA} measurement)

Centrality



$dE_T/d\eta$ ~ 1 TeV!





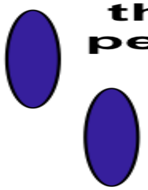
- Number of participants and E_T varies with centrality
- Confirmed with tracks

- Strong correlation between total E_T in the barrel and forward calorimeters

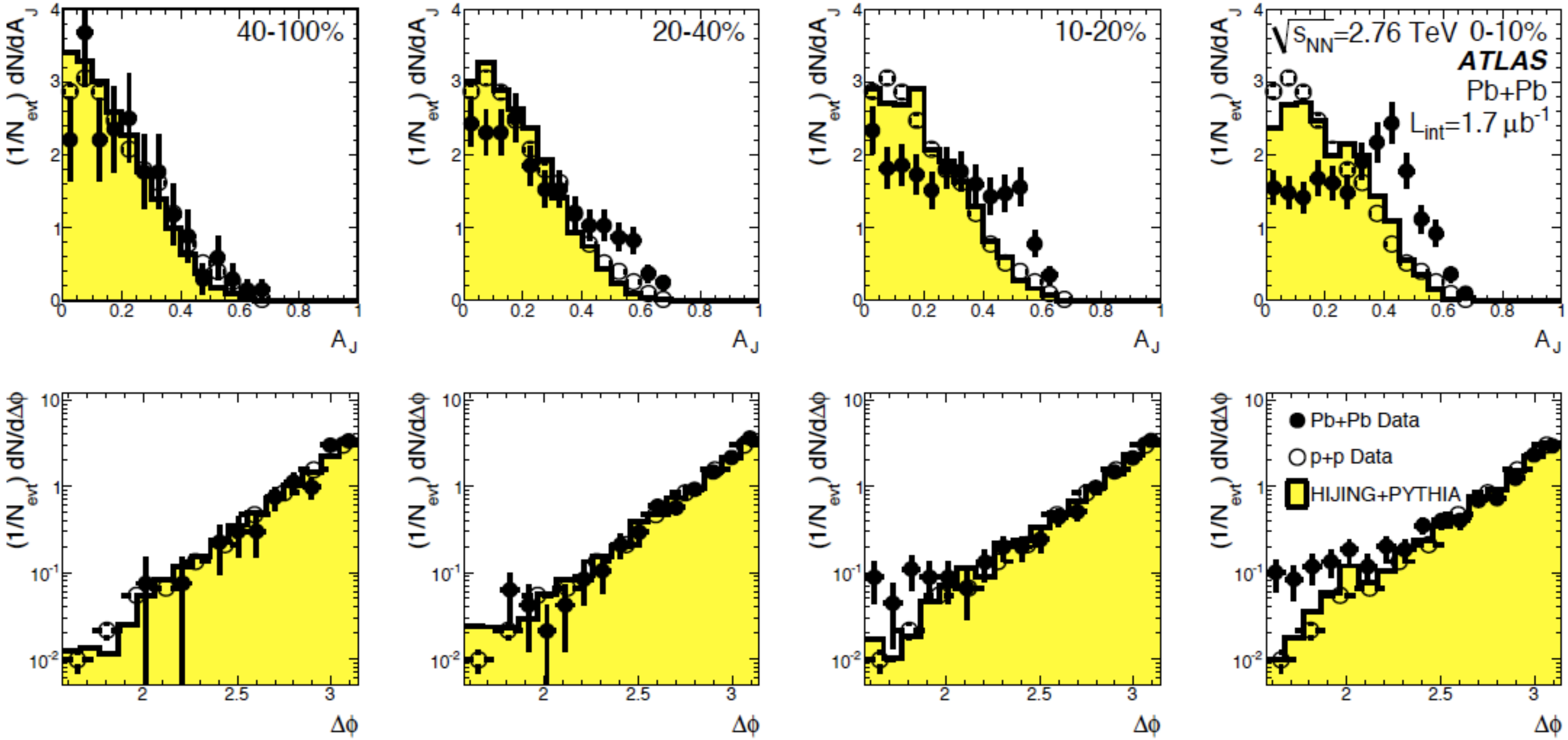
Asymmetry

$$A_J = \frac{E_{T1} - E_{T2}}{E_{T1} + E_{T2}}, \Delta\phi > \frac{\pi}{2}$$

the most peripheral



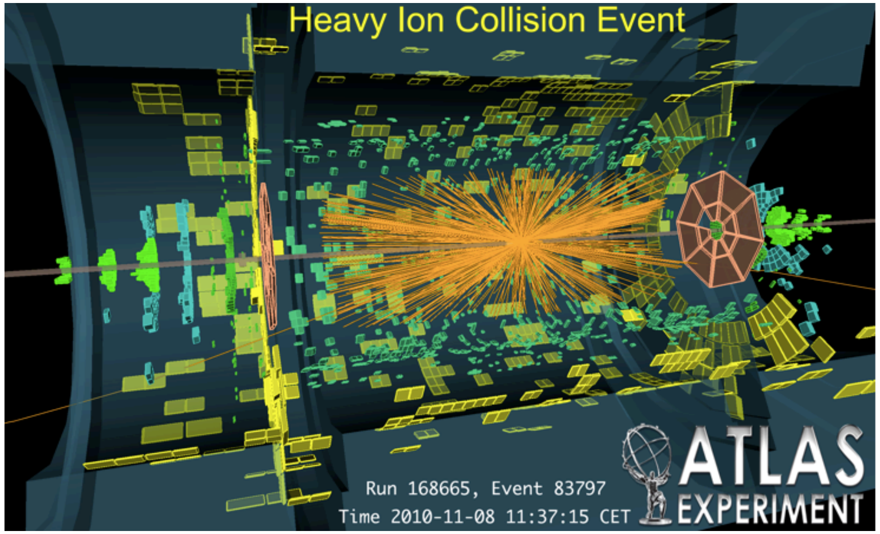
the most central

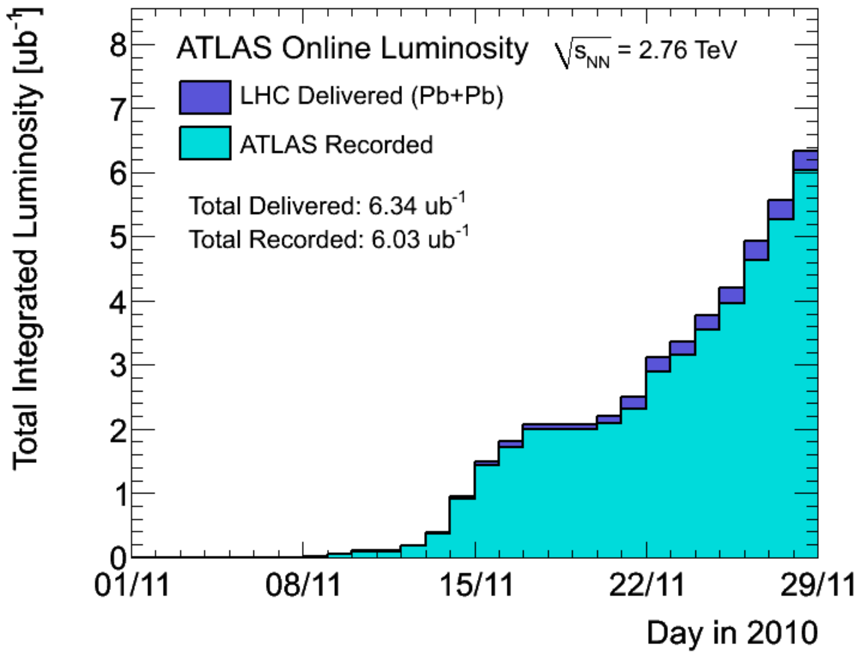


- As the event gets more central
  - Asymmetry increases
  - Jets remain back-to-back, 2nd jet slightly increases angle wrt recoil

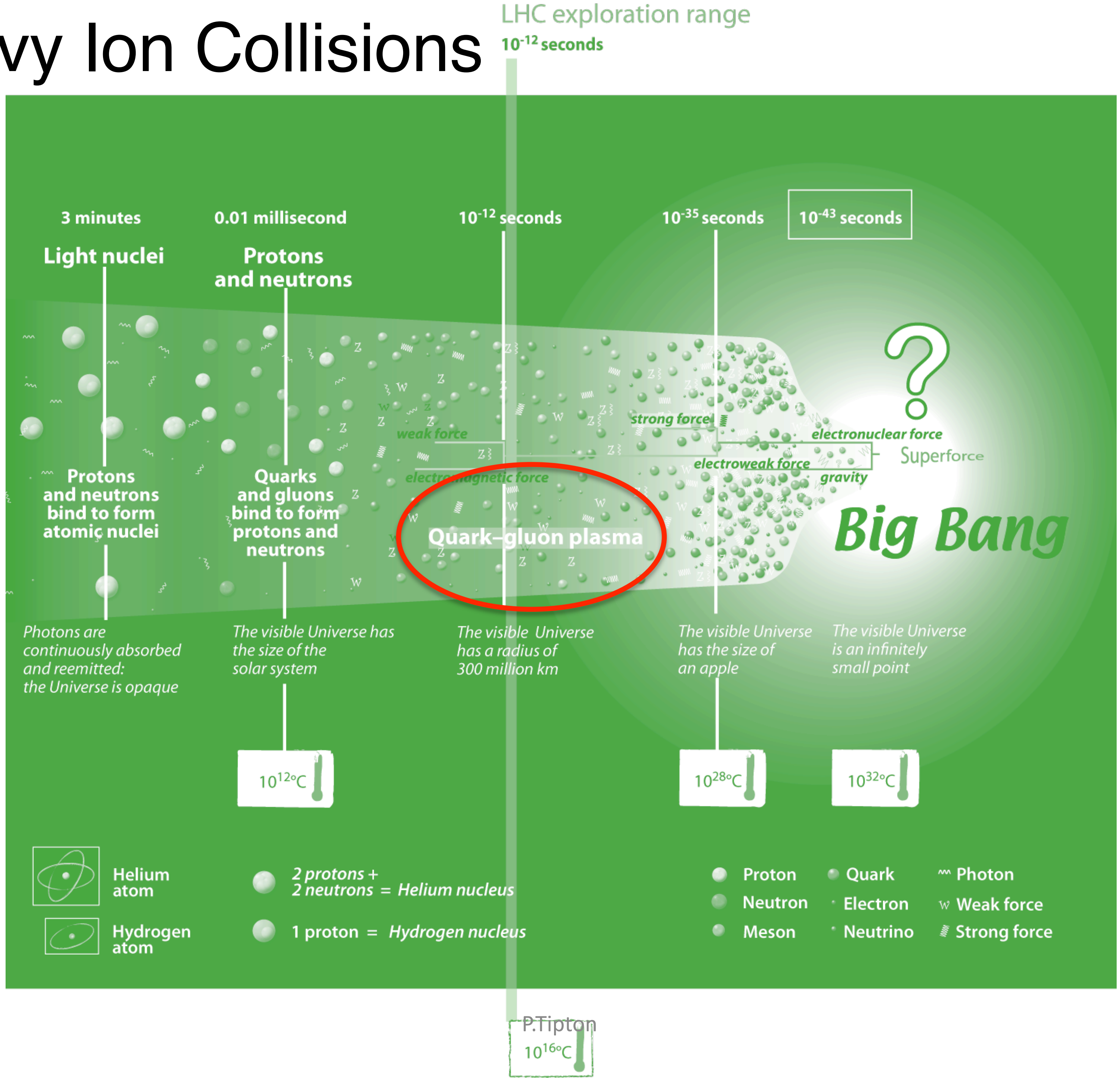
Pb-Pb Collisions

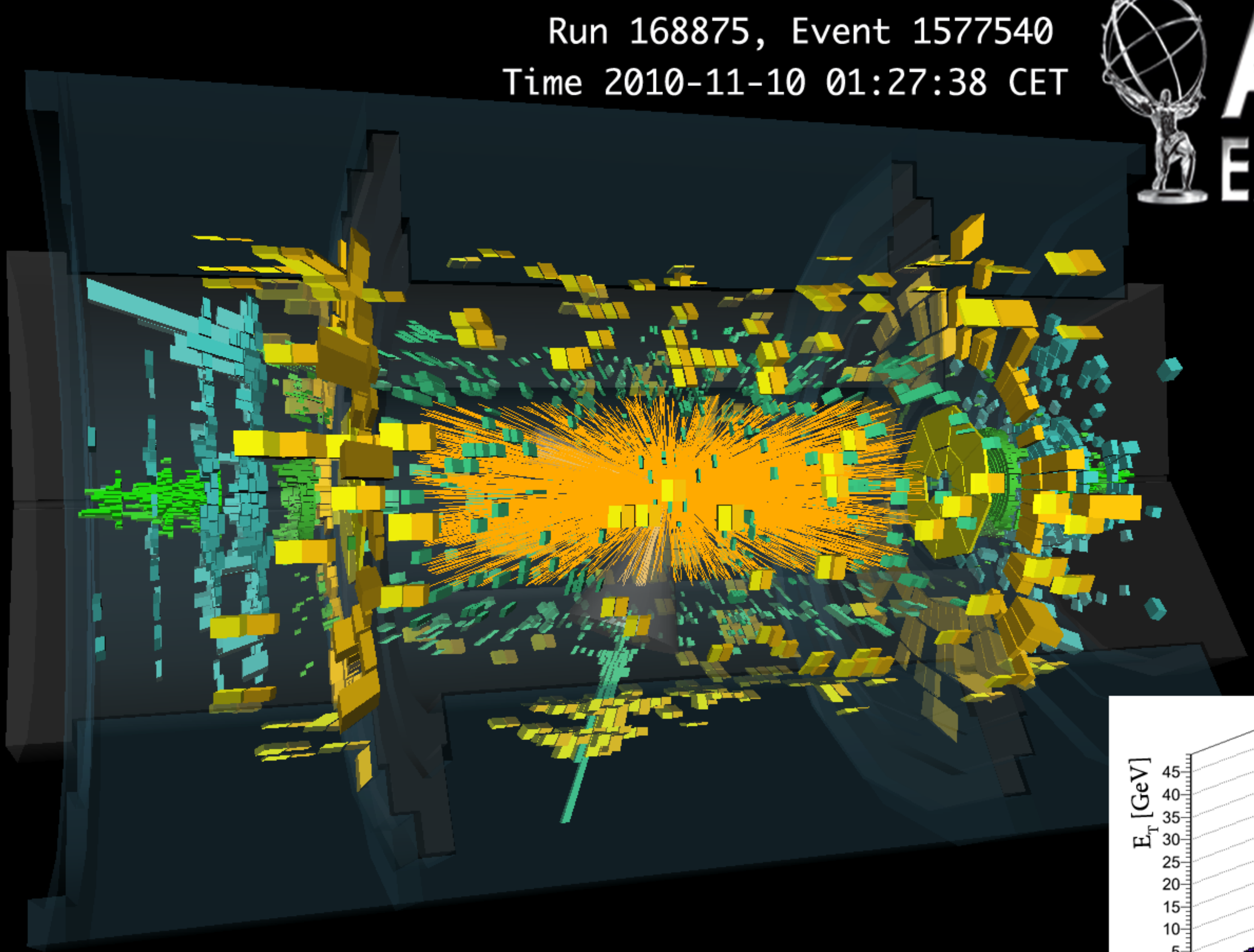
- Nov 4 – end of pp run
- Nov 7 – first Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV
- Nov 8 – stable beam
- Smooth data taking scheduled until Dec 6



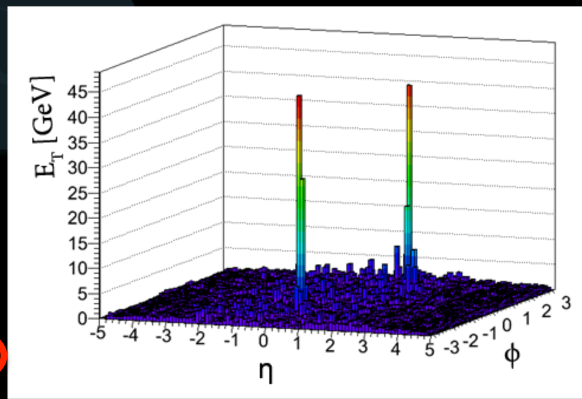


Heavy Ion Collisions

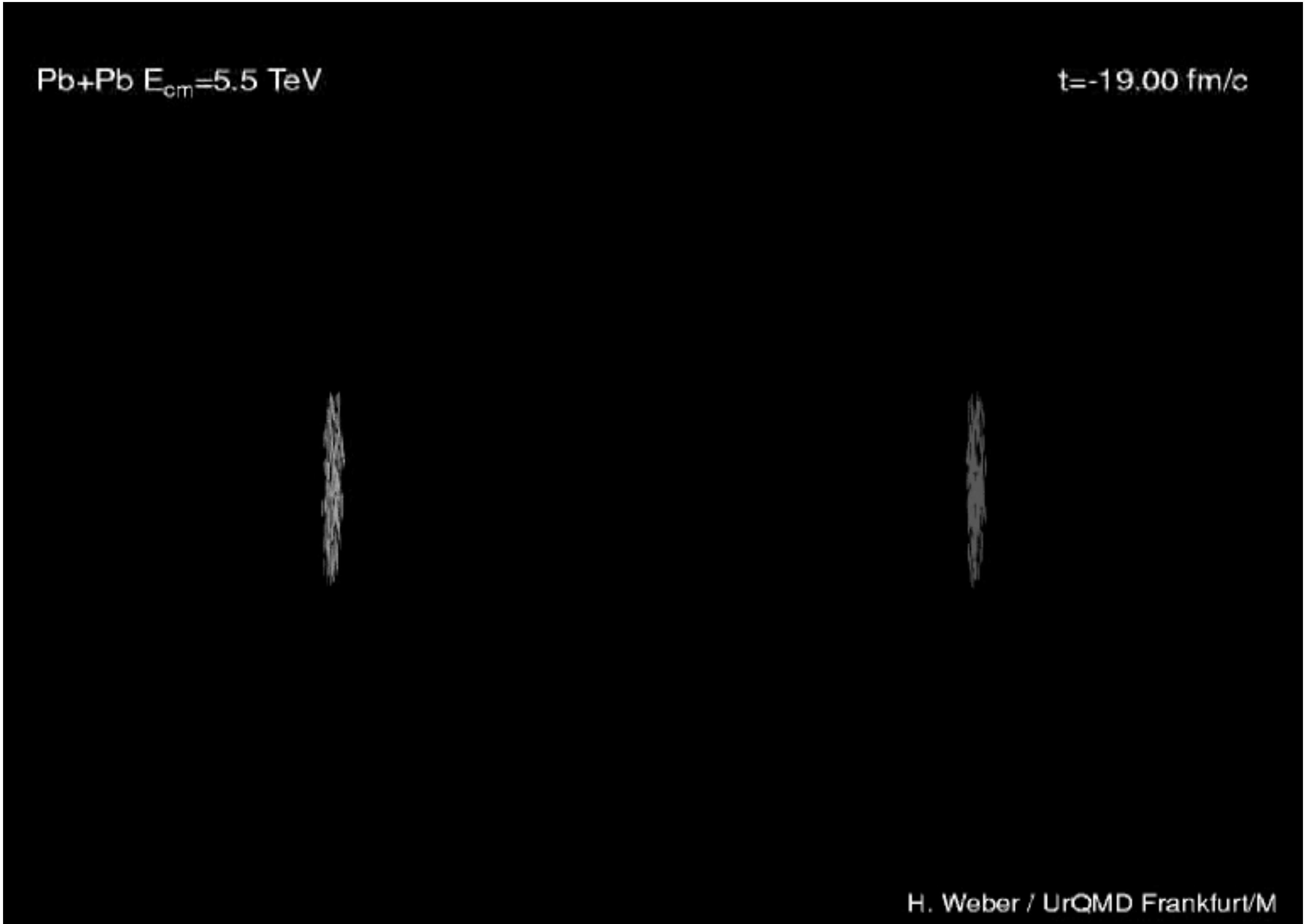




ATLAS EXPERIMENT



Heavy Ion Collision Event with 2 Jets


Pb+Pb E_{cm}=5.5 TeV
t=-19.00 fm/c
H. Weber / UrQMD Frankfurt/M

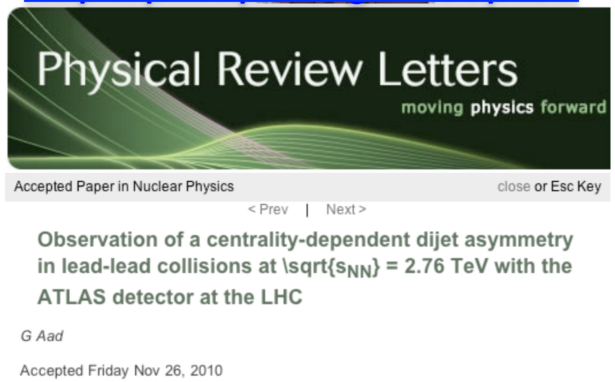
Observation of a Centrality-Dependent Dijet Asymmetry in Lead-Lead Collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS Detector at the LHC

G. Aad *et al.* (The ATLAS Collaboration)*

Using the ATLAS detector, observations have been made of a centrality-dependent dijet asymmetry in the collisions of lead ions at the Large Hadron Collider. In a sample of lead-lead events with a per-nucleon center of mass energy of 2.76 TeV, selected with a minimum bias trigger, jets are reconstructed in fine-grained, longitudinally-segmented electromagnetic and hadronic calorimeters. The underlying event is measured and subtracted event-by-event, giving estimates of jet transverse energy above the ambient background. The transverse energies of dijets in opposite hemispheres is observed to become systematically more unbalanced with increasing event centrality leading to a large number of events which contain highly asymmetric dijets. This is the first observation of an enhancement of events with such large dijet asymmetries, not observed in proton-proton collisions, which may point to an interpretation in terms of strong jet energy loss in a hot, dense medium.

- Nov 23 – Draft 1
- Nov 24 – Inform CERN DG, ALICE and CMS
- Nov 25
  - Draft 2
  - Dedicated ATLAS plenary meeting: decision taken to publish immediately ("super-fast-track")
  - Submit paper to PRL the same evening
- Nov 26 – a few hours later the paper is accepted by PRL (fast-track)

http://prl.aps.org/accepted



Physical Review Letters
moving physics forward

Accepted Paper in Nuclear Physics close or Esc Key

< Prev | Next >

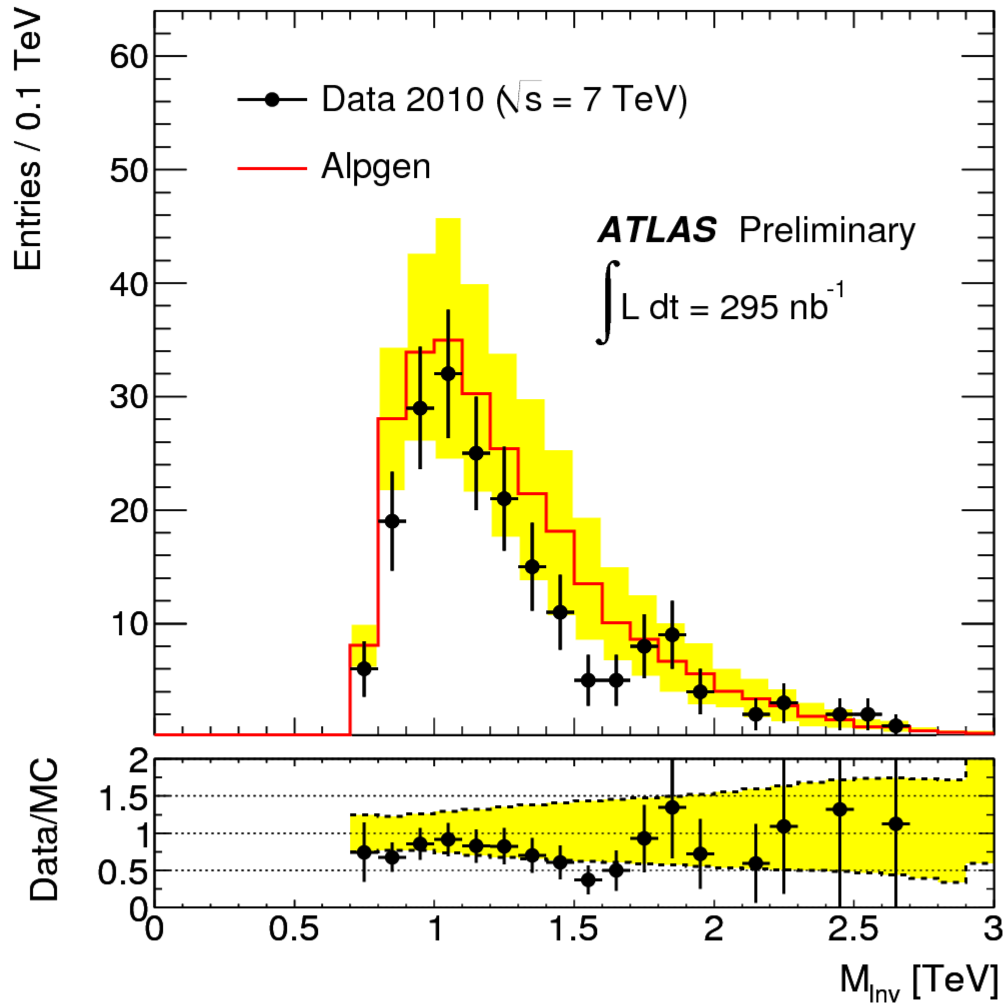
Observation of a centrality-dependent dijet asymmetry in lead-lead collisions at \sqrt{s_{NN}} = 2.76 TeV with the ATLAS detector at the LHC

G Aad

Accepted Friday Nov 26, 2010

Search for Micro-Black Holes

- Search for high-multiplicity events

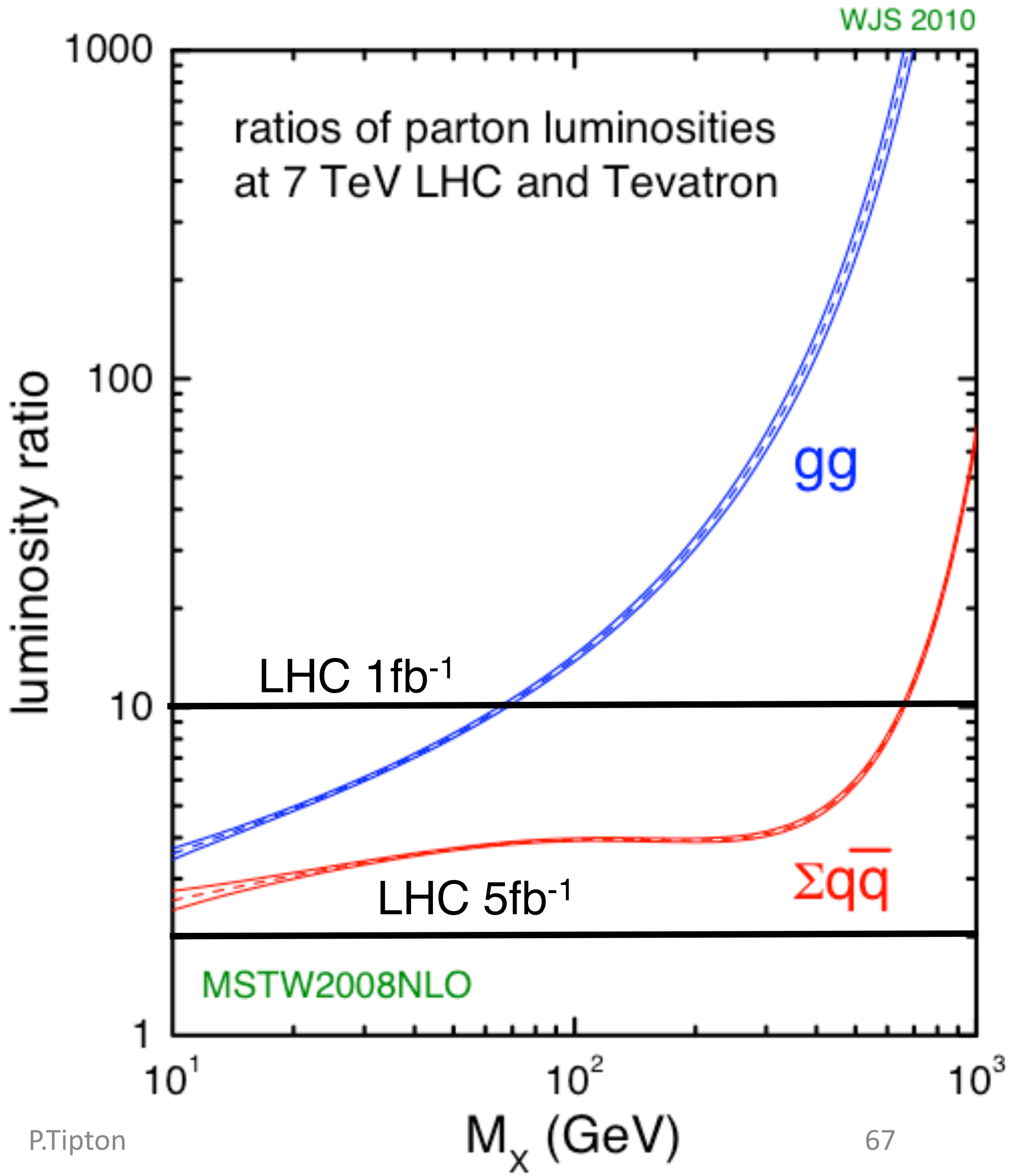


2011: LHC vs Tevatron (simplified!)

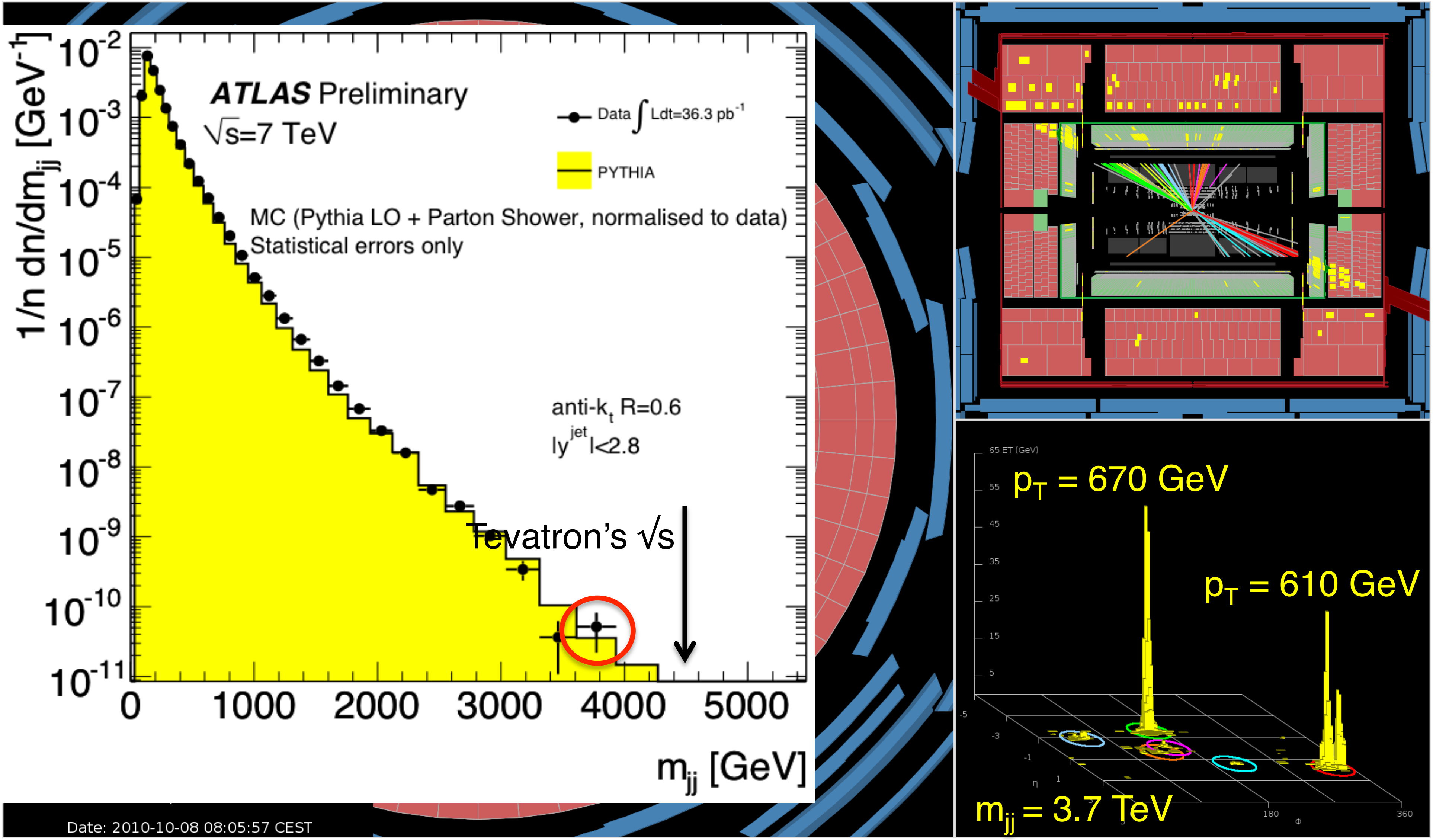
- Tevatron: ~10 fb^{-1} analyzed
- LHC: 1-5 fb^{-1}

- LHC: 1fb^{-1}
  - LHC "beats" Tevatron
    - if X gg produced and $M_X \geq$ 70 GeV
    - if X qq produced and $M_X \geq$ 700 GeV
- LHC: 5fb^{-1}
  - LHC "beats" Tevatron for whole mass range!

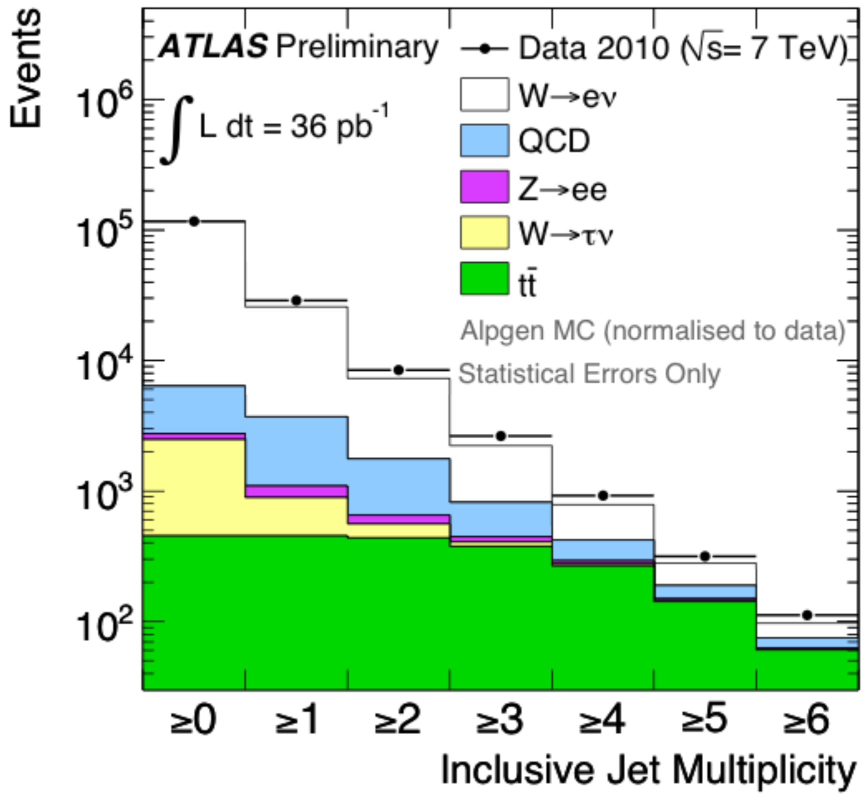
Backgrounds and systematics not considered

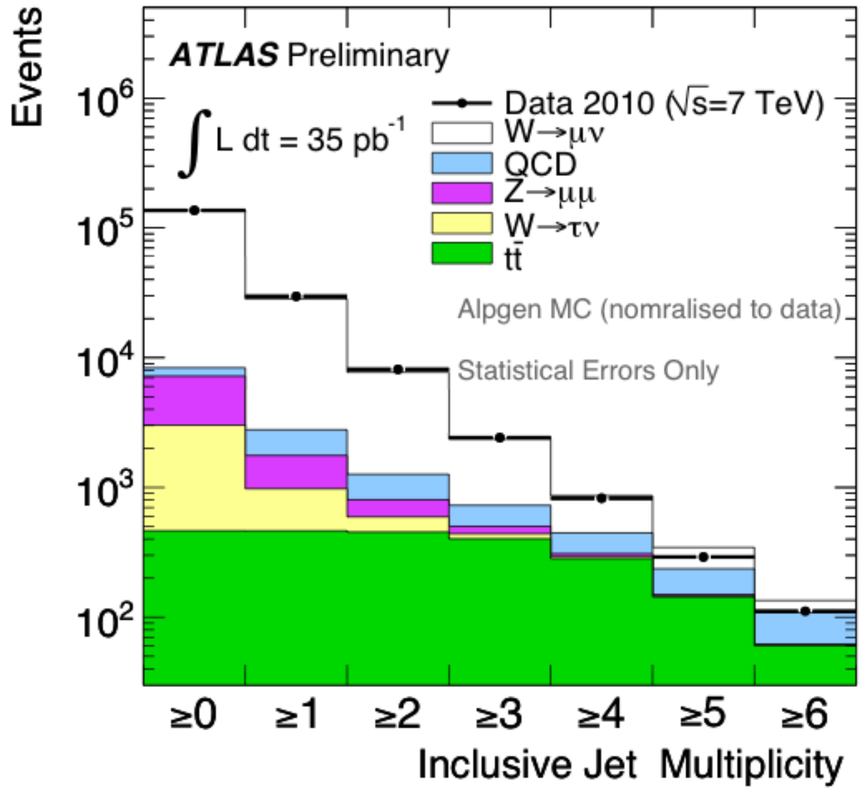


Highest Di-Jet Mass



W Plus Jets



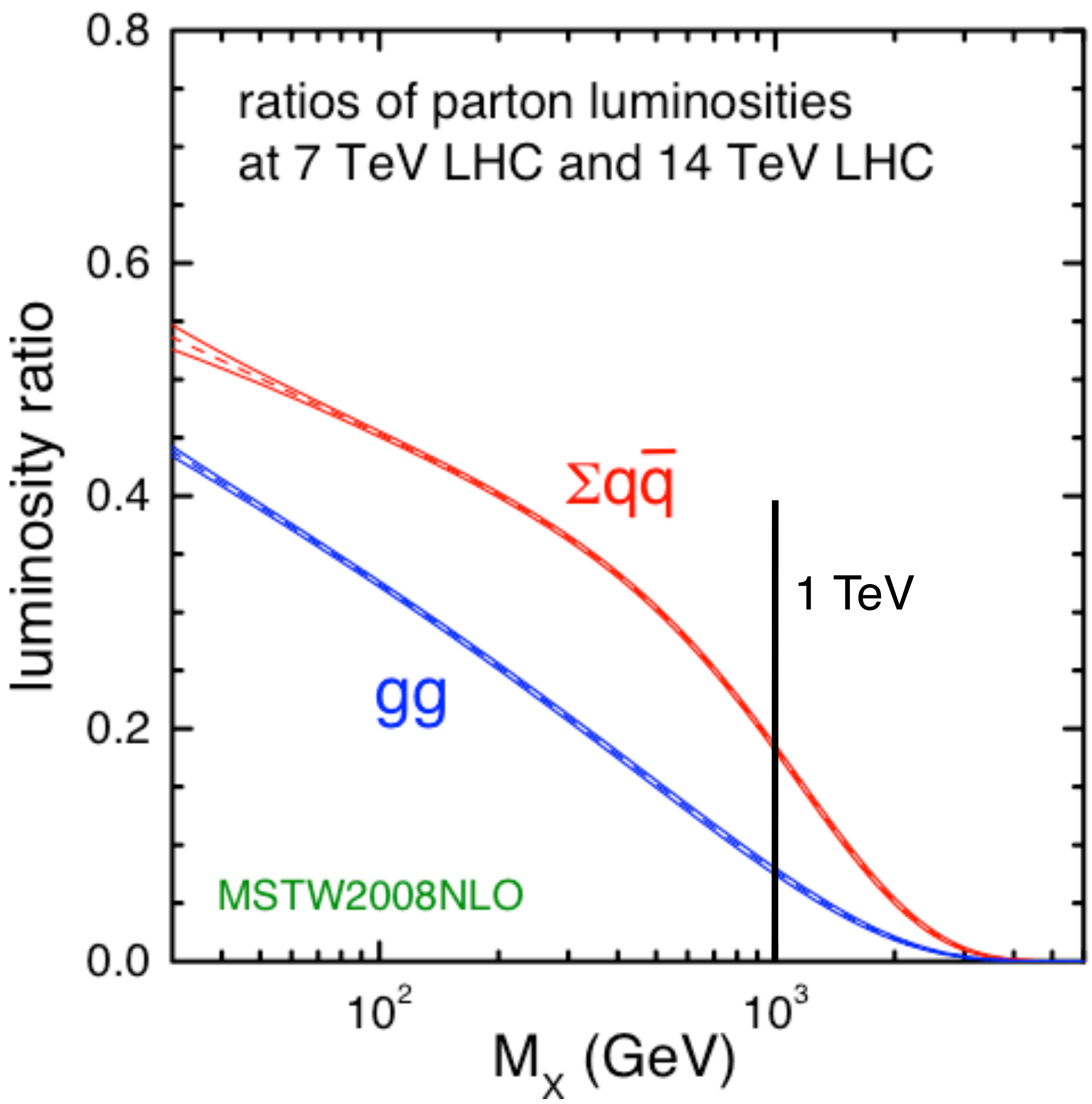


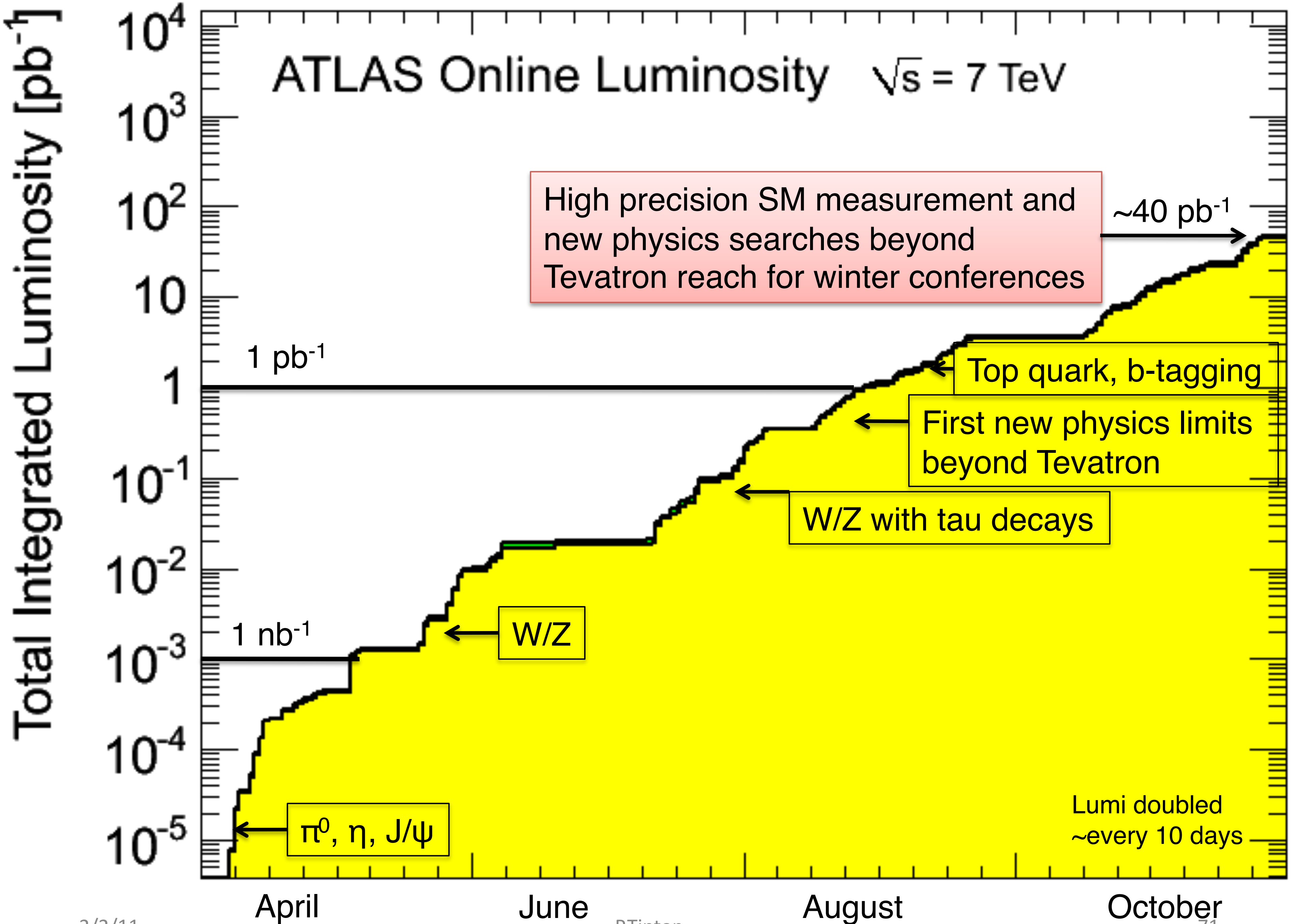
- Distribution of number of jets in selected W events
- ALPGEN MC normalized to data

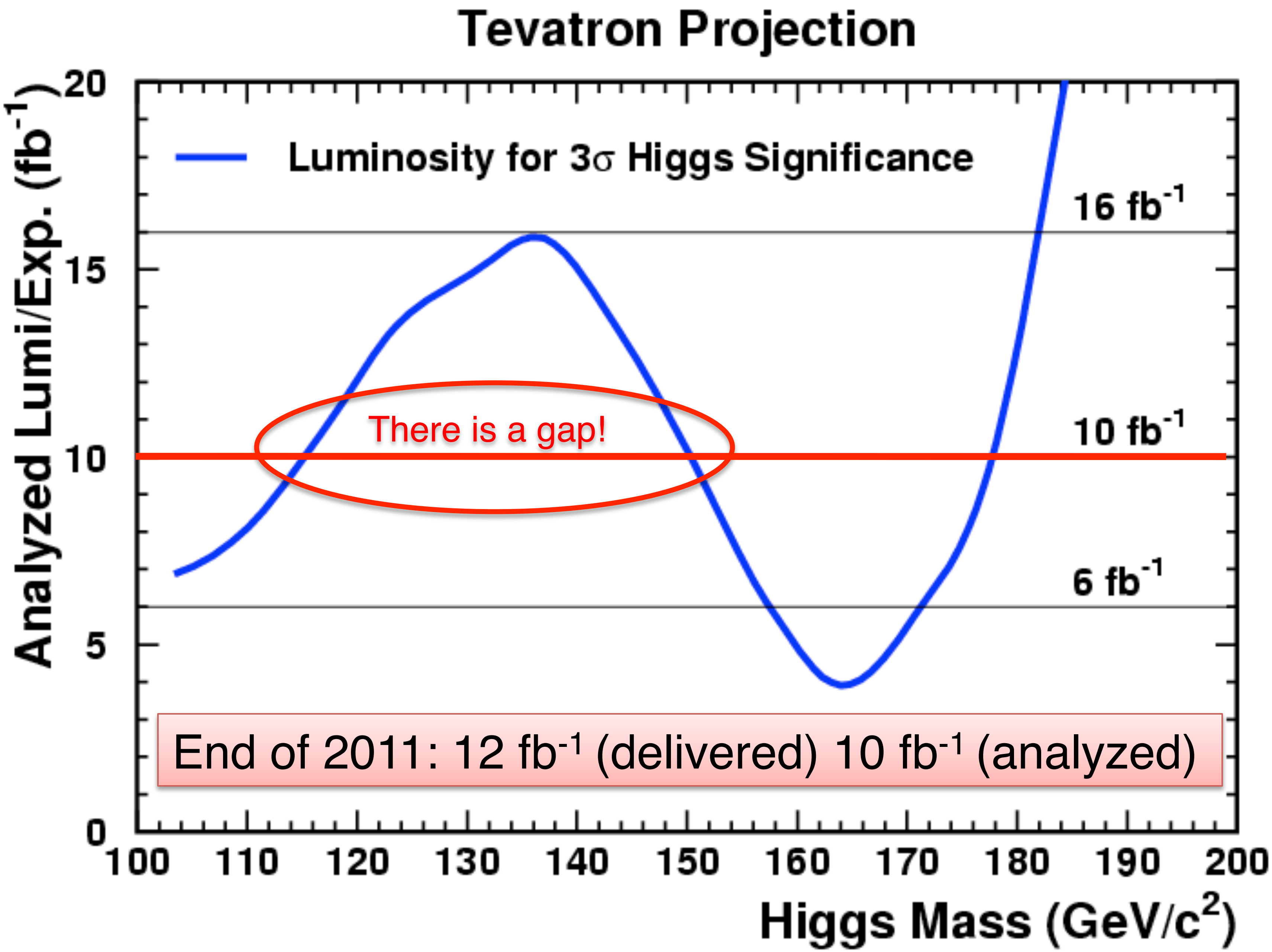
7 TeV → 14 TeV

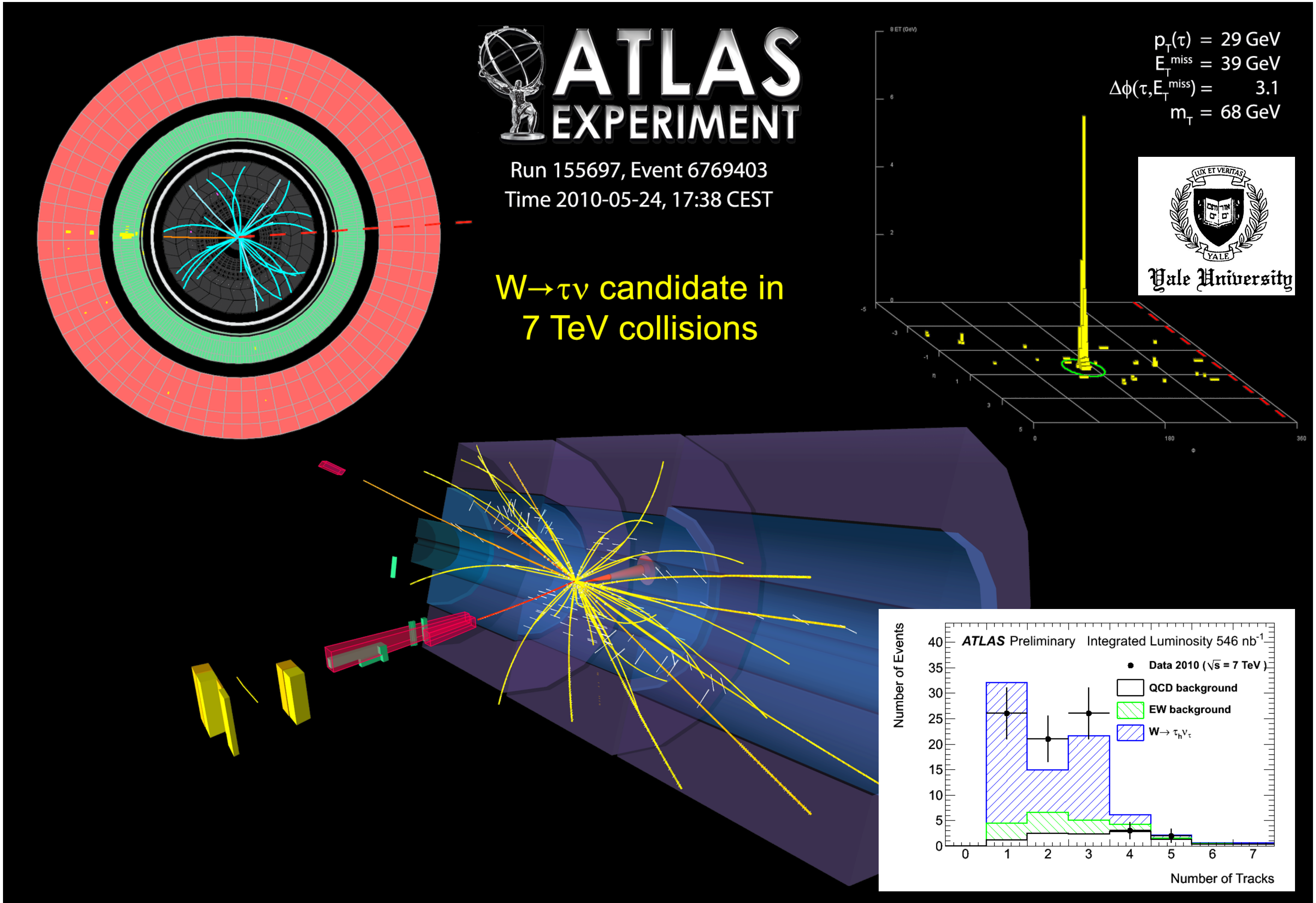
	Design
Collision energy	14 TeV
Protons/Bunch	1.1×10^{11}
Bunch spacing	25 ns
# colliding bunch	2808
Peak luminosity	1×10^{34} $cm^{-2}s^{-1}$
Integrated luminosity	30 fb^{-1}

- Shutdown to prepare LHC for 14 TeV
- Design luminosity
- Design energy

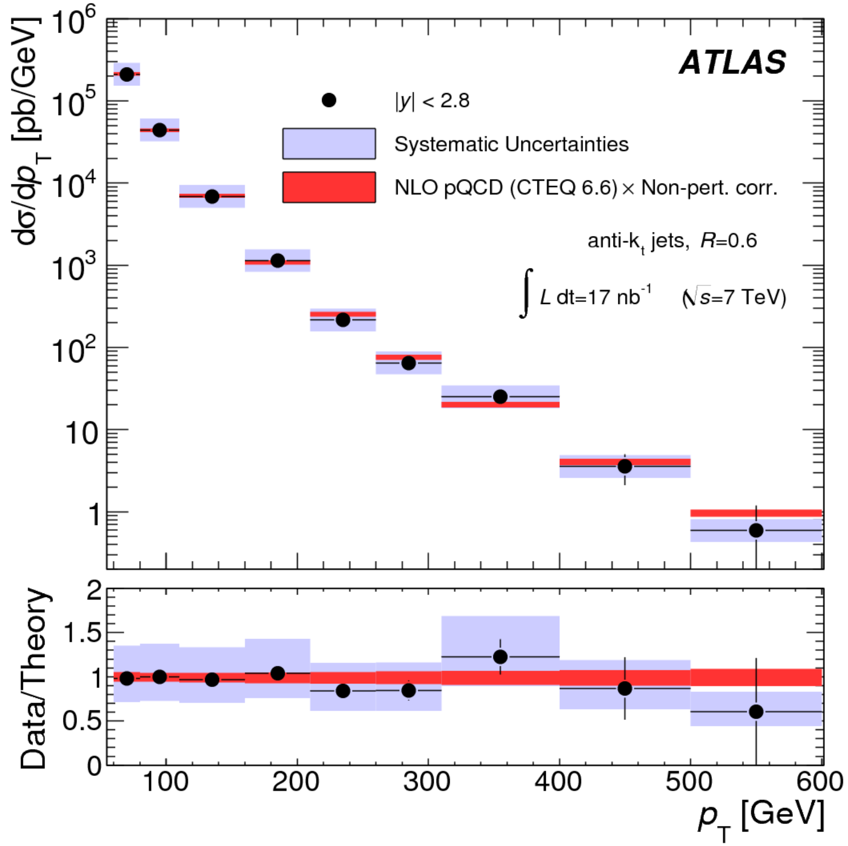


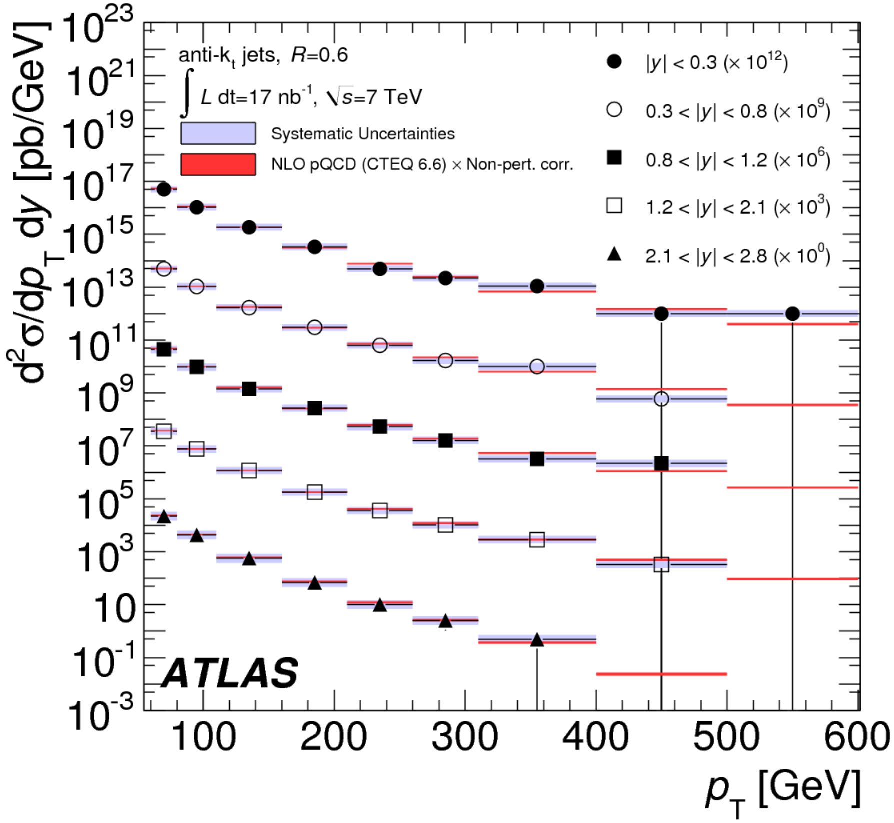

ATLAS Online Luminosity √s = 7 TeV
Total Integrated Luminosity [pb-1]
10^4
10^3
10^2
10
1
10^-1
10^-2
10^-3
10^-4
10^-5
High precision SM measurement and new physics searches beyond Tevatron reach for winter conferences
~40 pb-1
1 pb-1
Top quark, b-tagging
First new physics limits beyond Tevatron
W/Z with tau decays
W/Z
1 nb-1
π0, η, J/ψ
Lumi doubled ~every 10 days
April
June
August
October


Tevatron Projection
Analyzed Lumi/Exp. (fb-1)
Luminosity for 3σ Higgs Significance
16 fb-1
10 fb-1
6 fb-1
There is a gap!
End of 2011: 12 fb-1 (delivered) 10 fb-1 (analyzed)
0
5
10
15
20
100
110
120
130
140
150
160
170
180
190
200
Higgs Mass (GeV/c2)


ATLAS EXPERIMENT
Run 155697, Event 6769403
Time 2010-05-24, 17:38 CEST
W→τν candidate in 7 TeV collisions
p_T(τ) = 29 GeV
E_T^miss = 39 GeV
Δφ(τ,E_T^miss) = 3.1
m_T = 68 GeV
Yale University
ATLAS Preliminary Integrated Luminosity 546 nb^-1
Data 2010 (√s = 7 TeV)
QCD background
EW background
W→ τ_h ν_τ
Number of Events
Number of Tracks

Measured Jet Cross Section

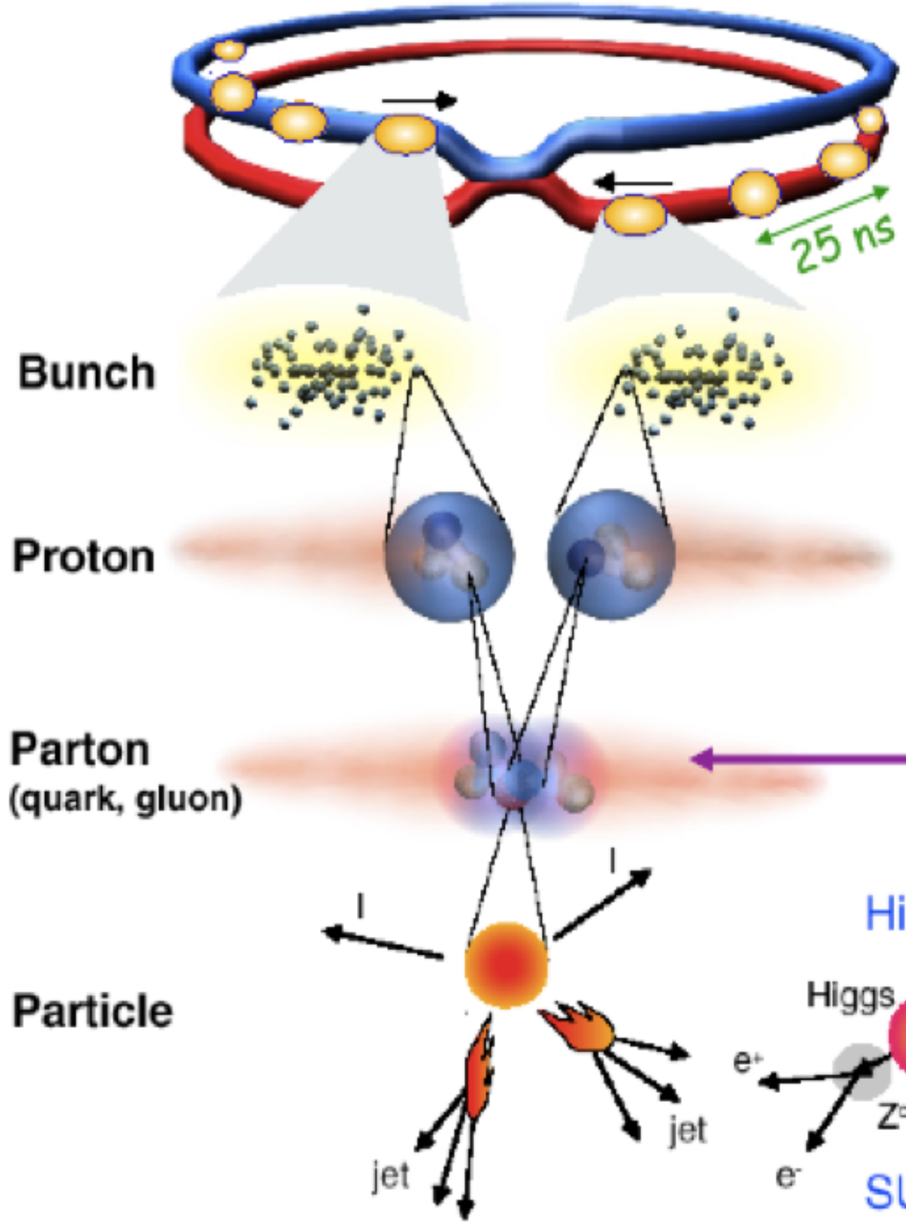




- Measurement of inclusive jet and dijet cross sections (EPJC arXiv:1009.5908)
- Uncertainty dominated by Jet Energy Scale (at present ~7%)

Excellent agreement of data with QCD prediction

Closer Look at LHC Collisions



Proton-Proton

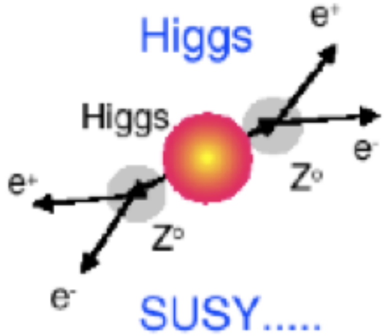
Protons/bunch	10^{11}
Beam energy	7 TeV (7×10^{12} eV)
Luminosity	10^{34} cm^{-2} s^{-1}

Event rate in ATLAS :

$N = L \times \sigma$ (pp) ≈ 10^9 interactions/s

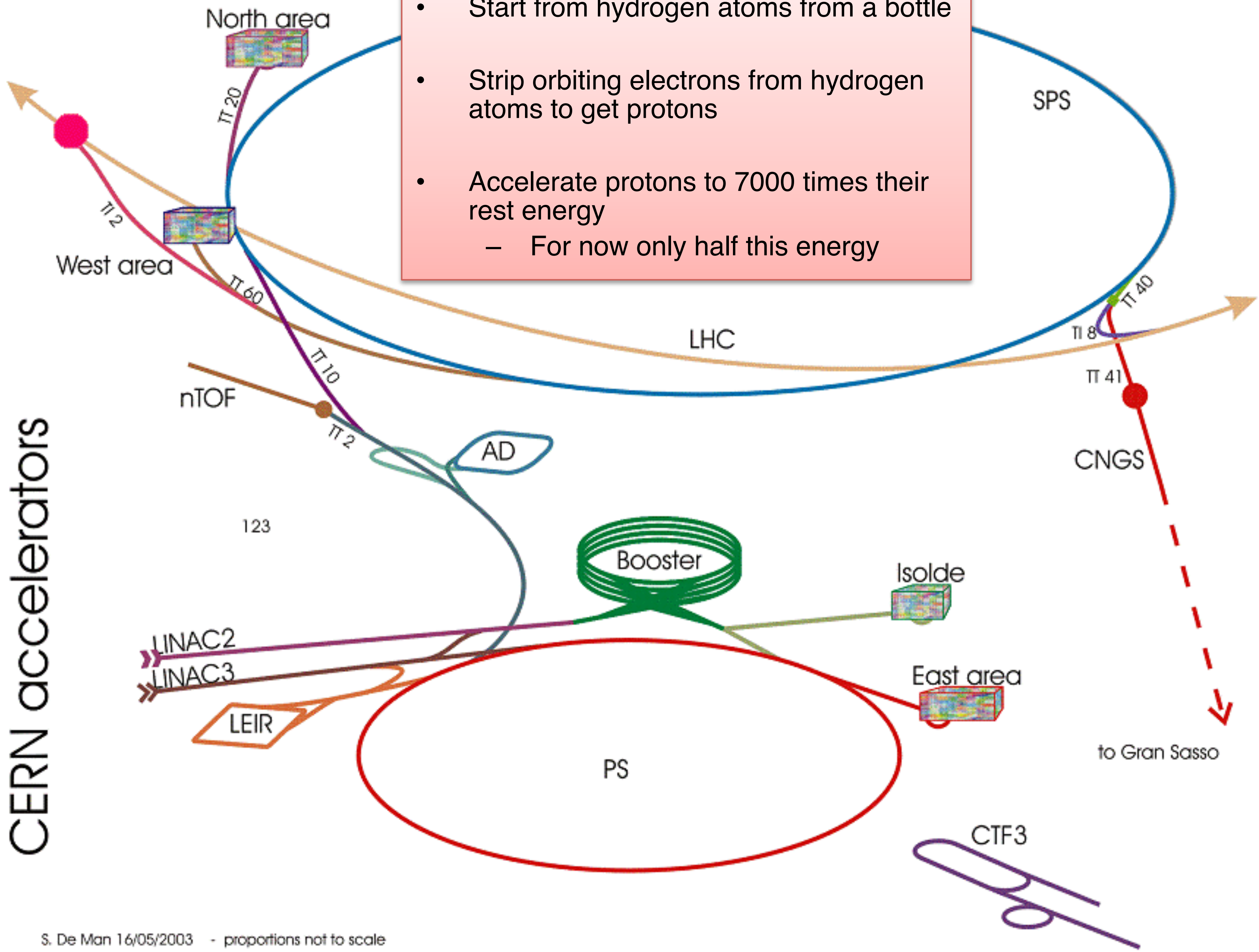
Mostly soft (low p_T) events

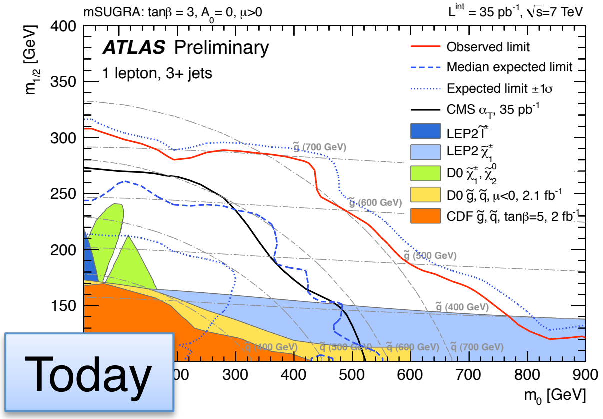
Interesting hard (high-p_T) events are rare



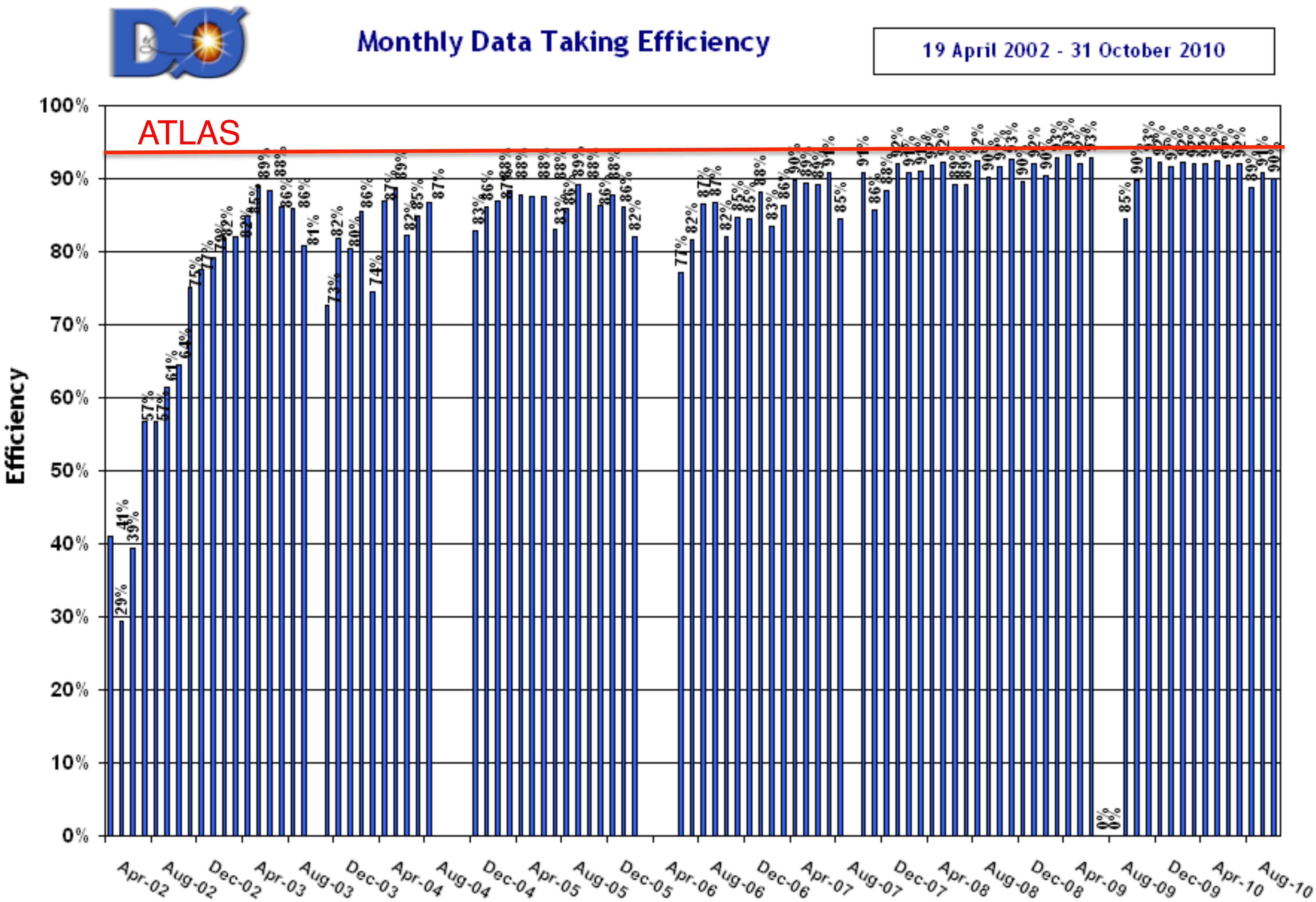
Selection of 1 in 10,000,000,000,000

- Start from hydrogen atoms from a bottle
- Strip orbiting electrons from hydrogen atoms to get protons
- Accelerate protons to 7000 times their rest energy
  - For now only half this energy

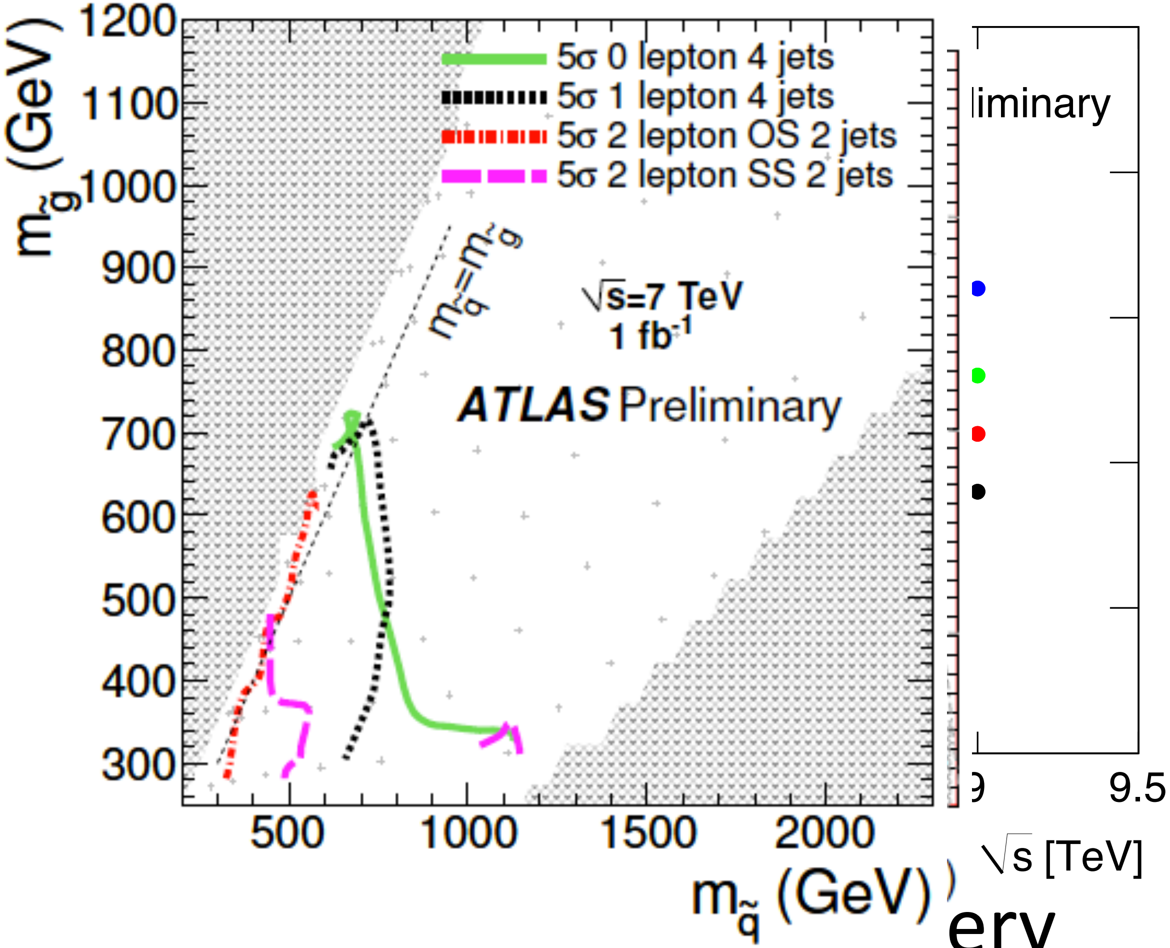




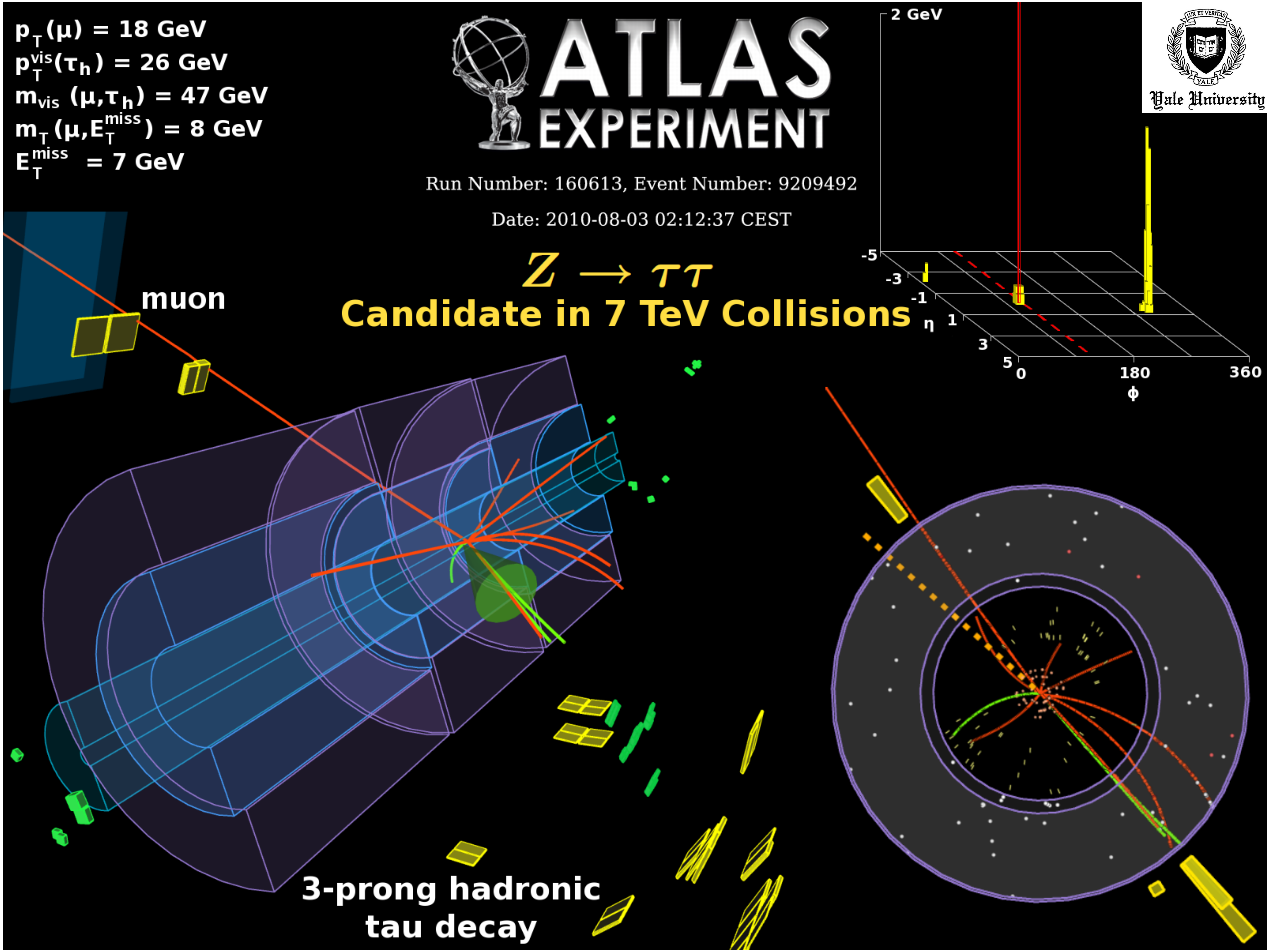
Significant limits on SUSY Parameters


Monthly Data Taking Efficiency
19 April 2002 - 31 October 2010
ATLAS
Efficiency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Apr-02
Aug-02
Dec-02
Apr-03
Aug-03
Dec-03
Apr-04
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Dec-08
Apr-09
Aug-09
Dec-09
Apr-10
Aug-10

SUSY Searches

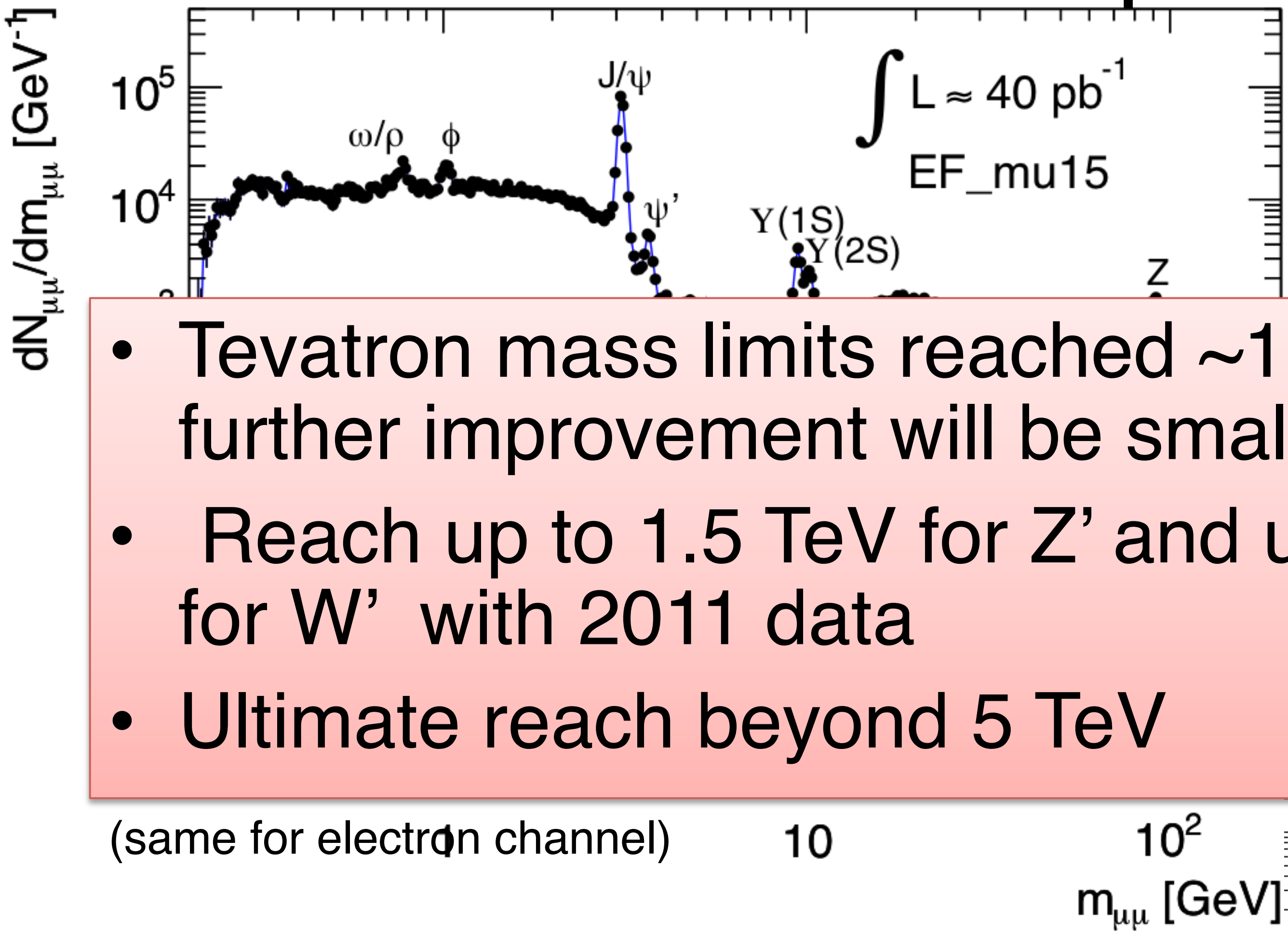


- Median ! ery
  Contours vs. Squark- Gluino masses



$p_T(\mu)$ = 18 GeV
$p_T^{vis}(\tau_h)$ = 26 GeV
$m_{vis}(\mu,\tau_h)$ = 47 GeV
$m_T(\mu,E_T^{miss})$ = 8 GeV
E_T^{miss} = 7 GeV
ATLAS EXPERIMENT
Run Number: 160613, Event Number: 9209492
Date: 2010-08-03 02:12:37 CEST
$Z \rightarrow \tau\tau$
Candidate in 7 TeV Collisions
muon
3-prong hadronic tau decay
2 GeV
-5
-3
-1
η
1
3
5
0
180
360
ϕ
LUX ET VERITAS
YALE
Yale University

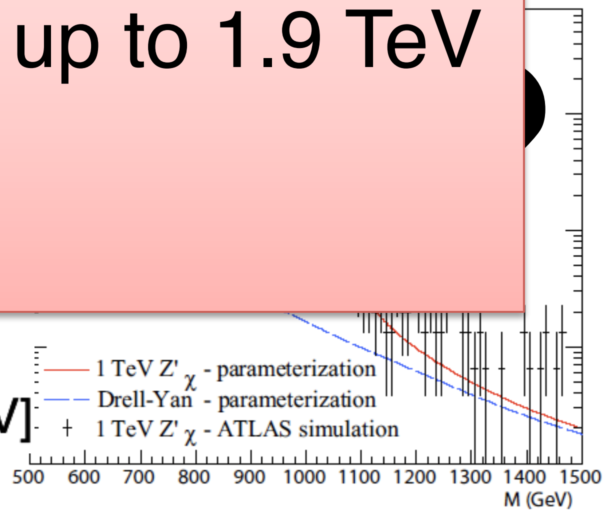
W' and Z' Search
Di-muon Mass Spectrum



(same for electron channel)

- Leptonic Z' decays to electrons or muons predicted by many models,

…ns



- Tevatron mass limits reached ~1 TeV but further improvement will be small
- Reach up to 1.5 TeV for Z' and up to 1.9 TeV for W' with 2011 data
- Ultimate reach beyond 5 TeV