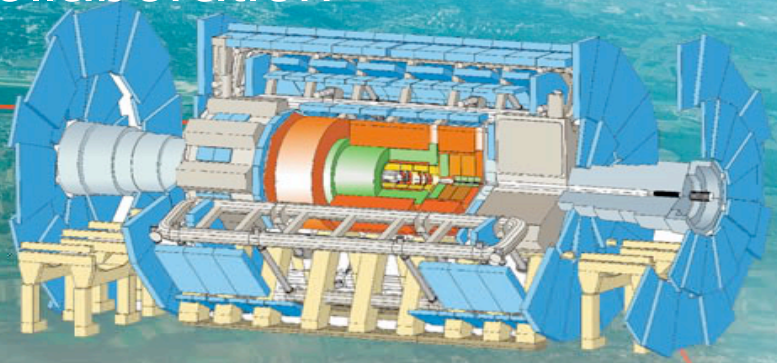
ATLAS

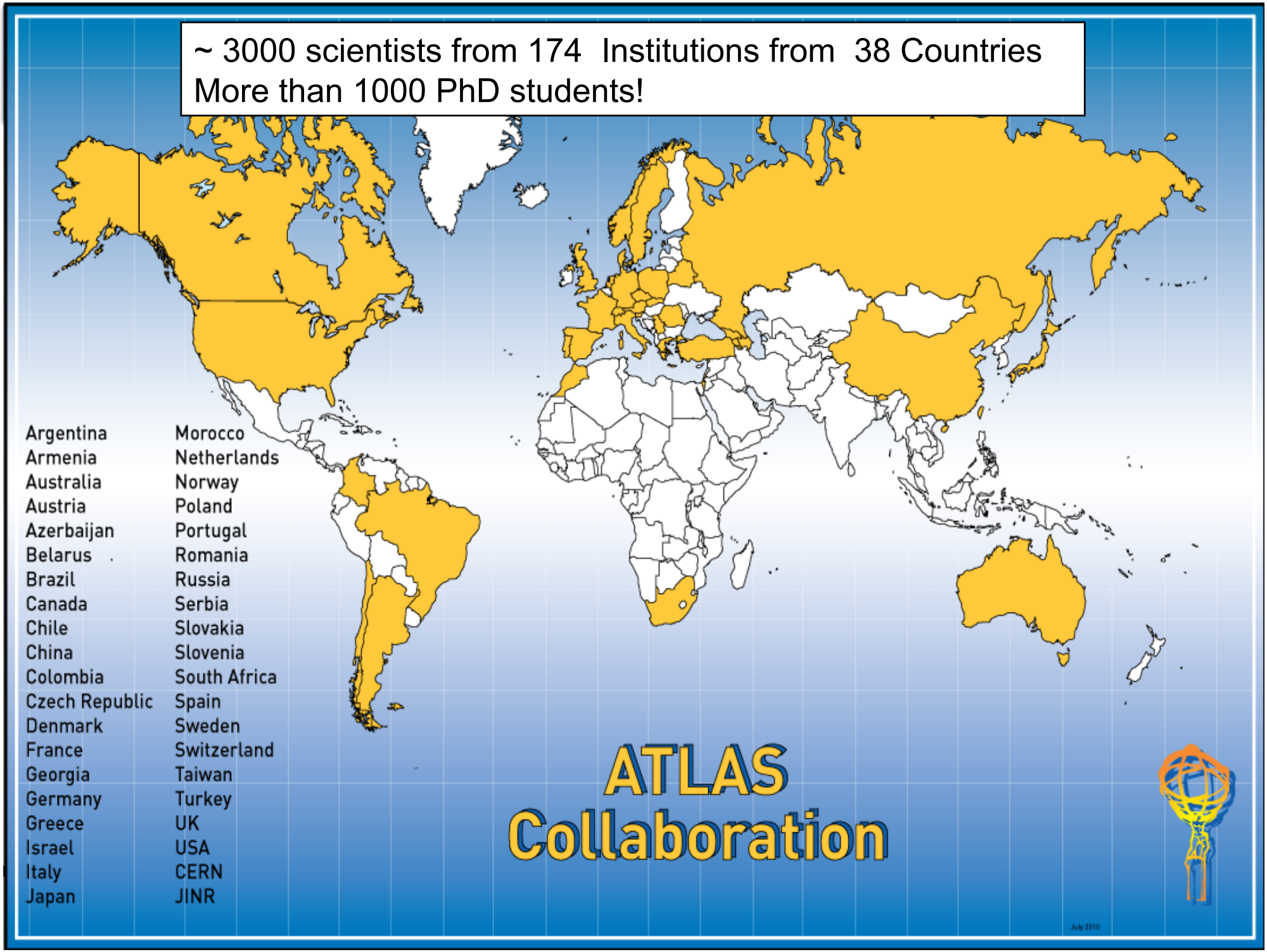
LHC Jamboree, 17th December 2010

Emily Nurse (UCL)

For the ATLAS collaboration



~ 3000 scientists from 174 Institutions from 38 Countries
More than 1000 PhD students!



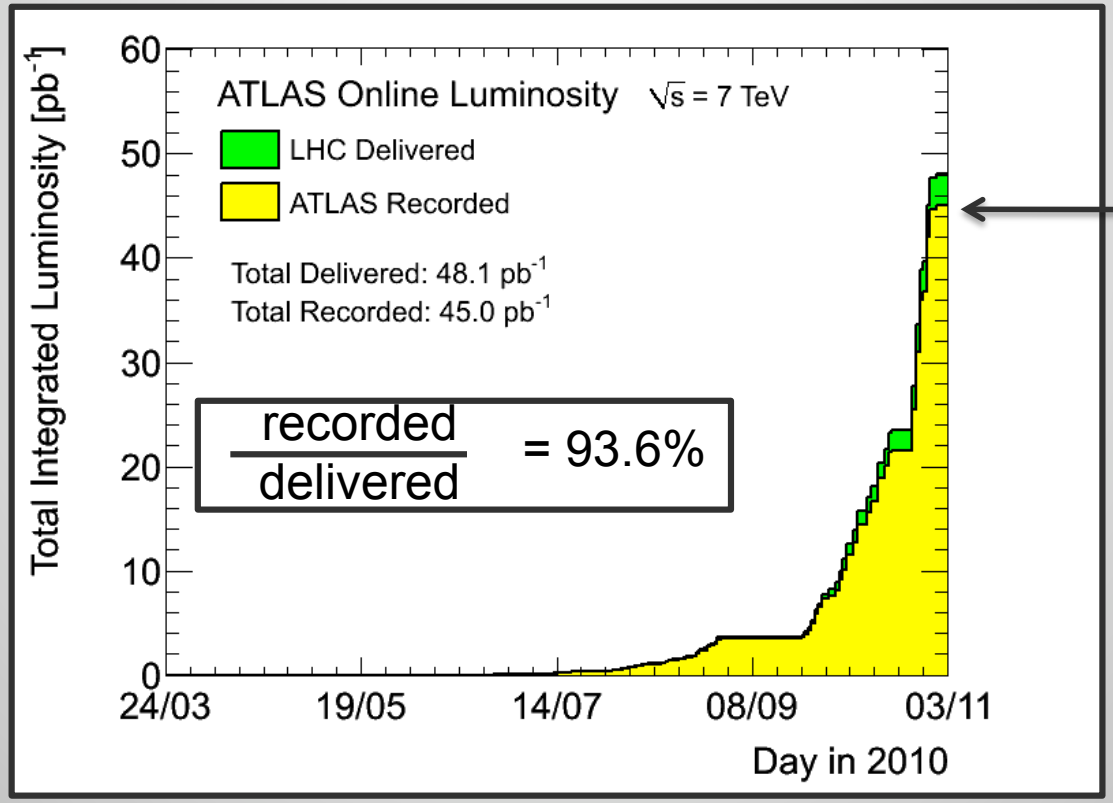
ATLAS physics

- We aim to :
  - Understand and continue to scrutinise the Standard Model of Particle Physics in a new energy regime
  - Search for new Physics beyond the Standard Model
- By :
  - Discovering new particles
  - Making precise measurements of properties of known particles/forces

Counting events

number of events = Luminosity × Cross section

[pb^{-1}] [pb]

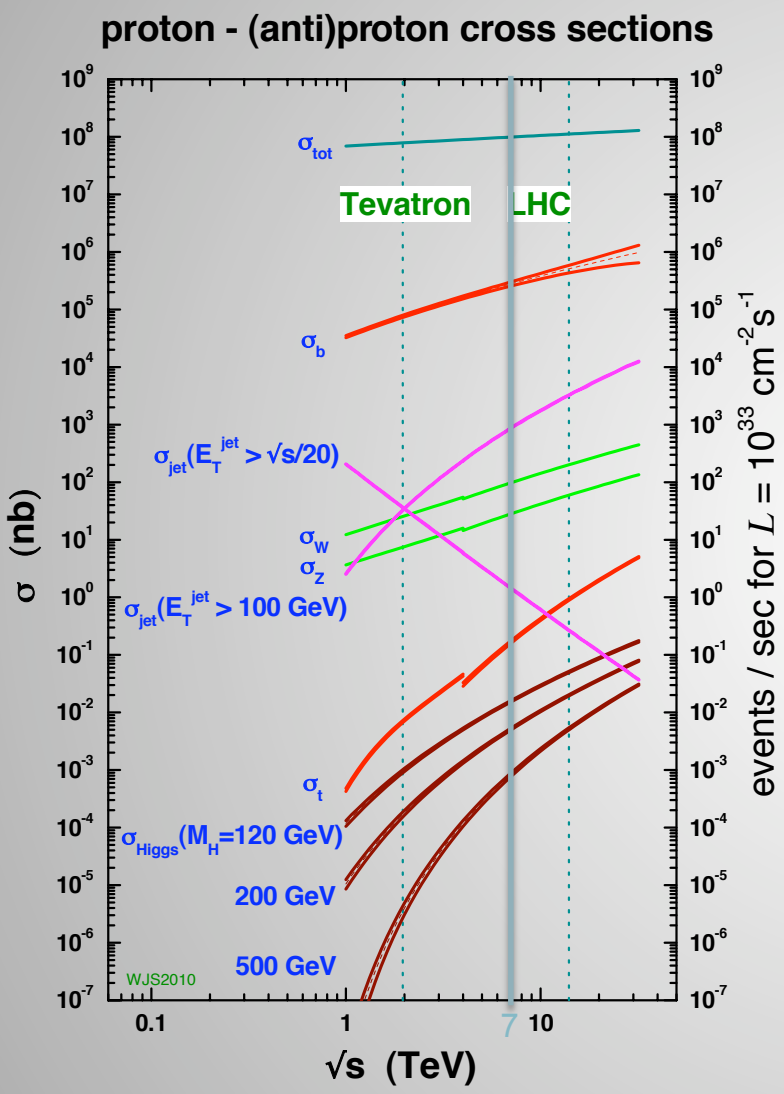


Excellent detector performance!

Inner Tracking Detectors			Calorimeters				Muon Detectors			
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC
99.0	99.9	100	90.5	96.6	97.8	94.3	99.9	99.8	96.2	99.8

% of good quality data

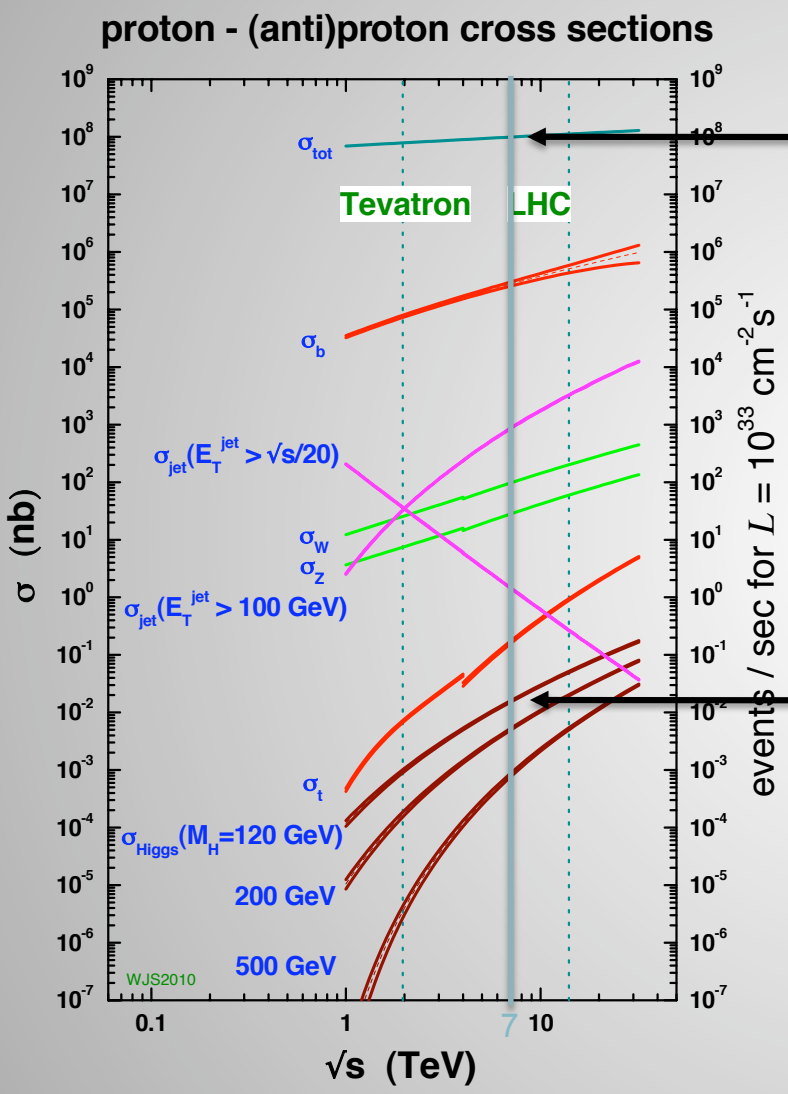
Numbers of events in 45 pb^{-1}



number of events = Luminosity × Cross section

The LHC is unprecedented in both!

Numbers of events in 45 pb^{-1}



number of events = Luminosity × Cross section

70 billion pb → **3 trillion events!** *

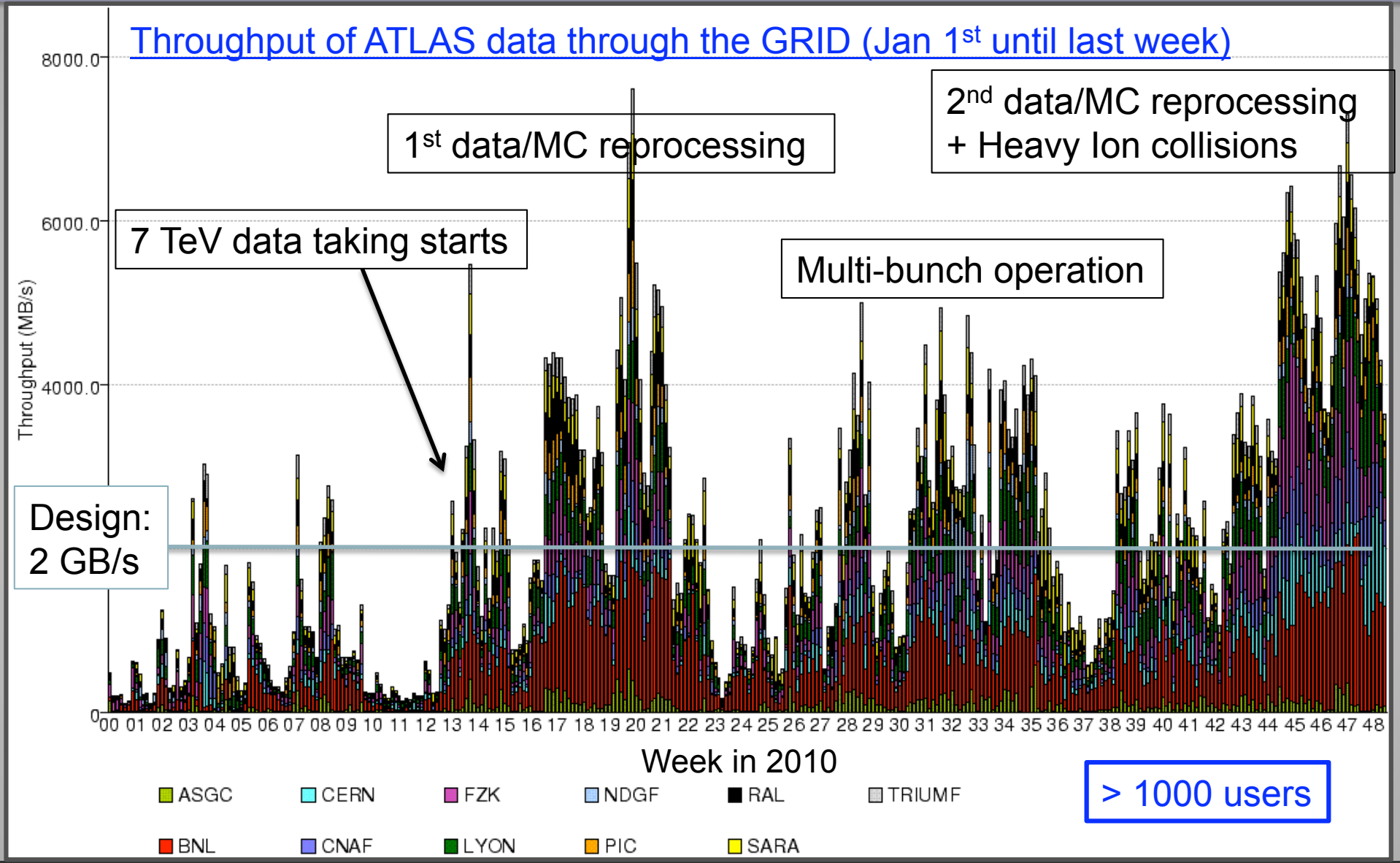
* N.B. only a very small fraction saved!

Higgs (m_H=120 GeV) : 17 pb → **750 events**

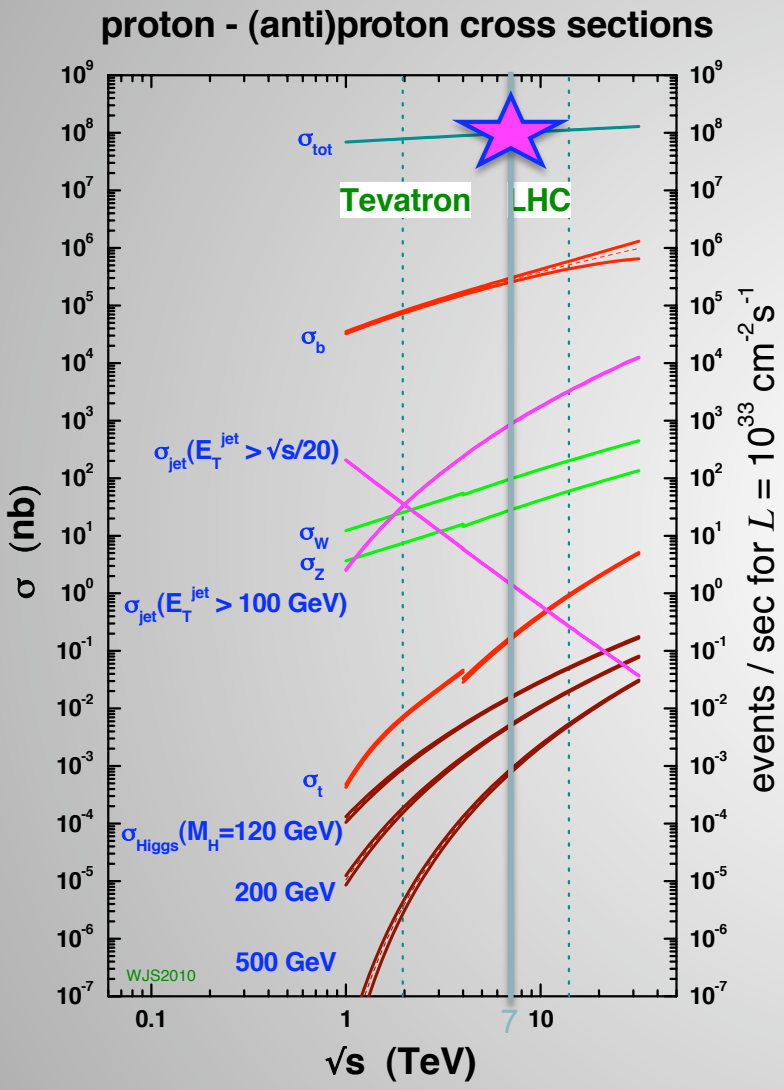
e.g. potentially ~1 Higgs in every 300 billion interactions!

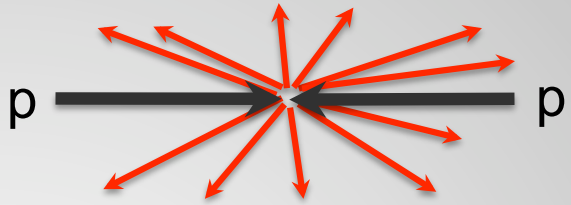
GRID computing

Essential to analyze all this data!



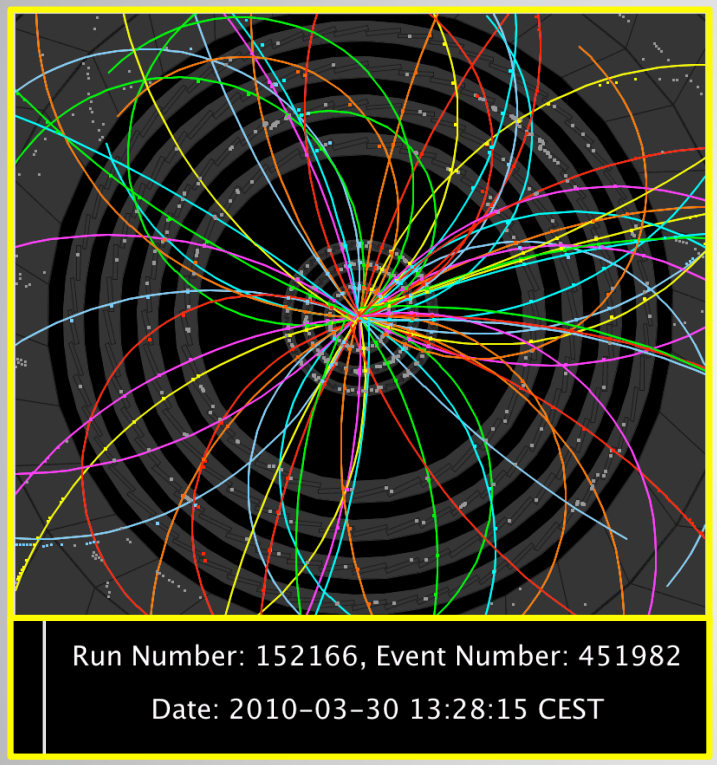
Soft physics



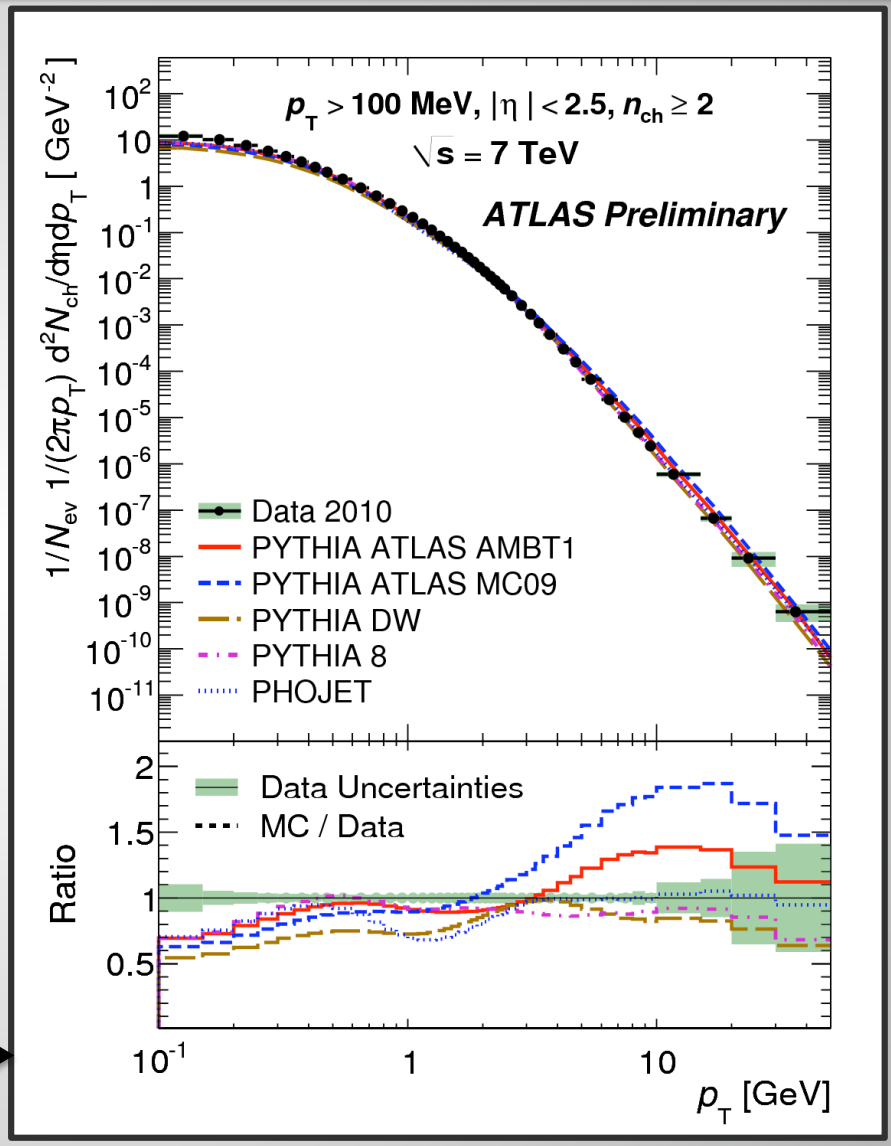


Soft physics

soft charged particles bend a lot in magnetic field



p_T = momentum component transverse to the beam



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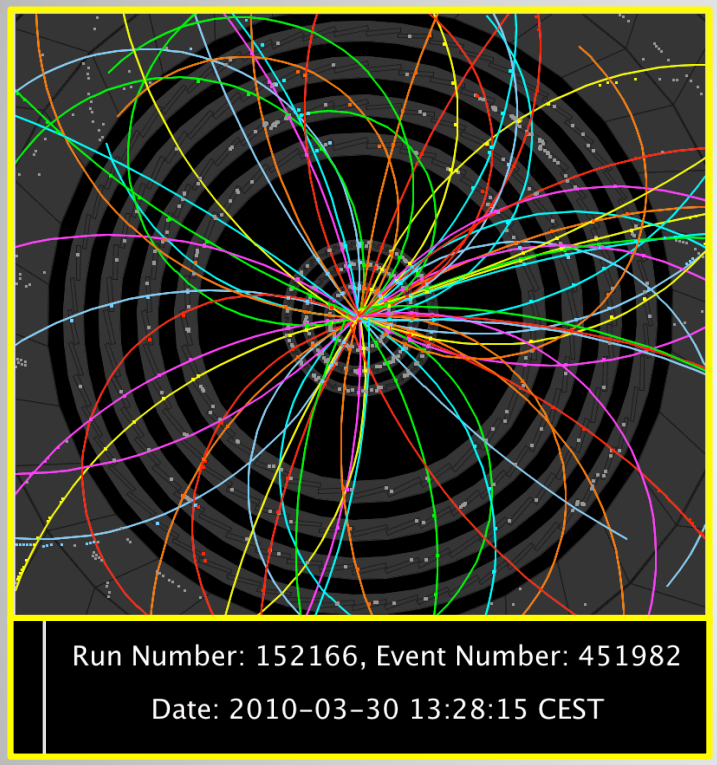

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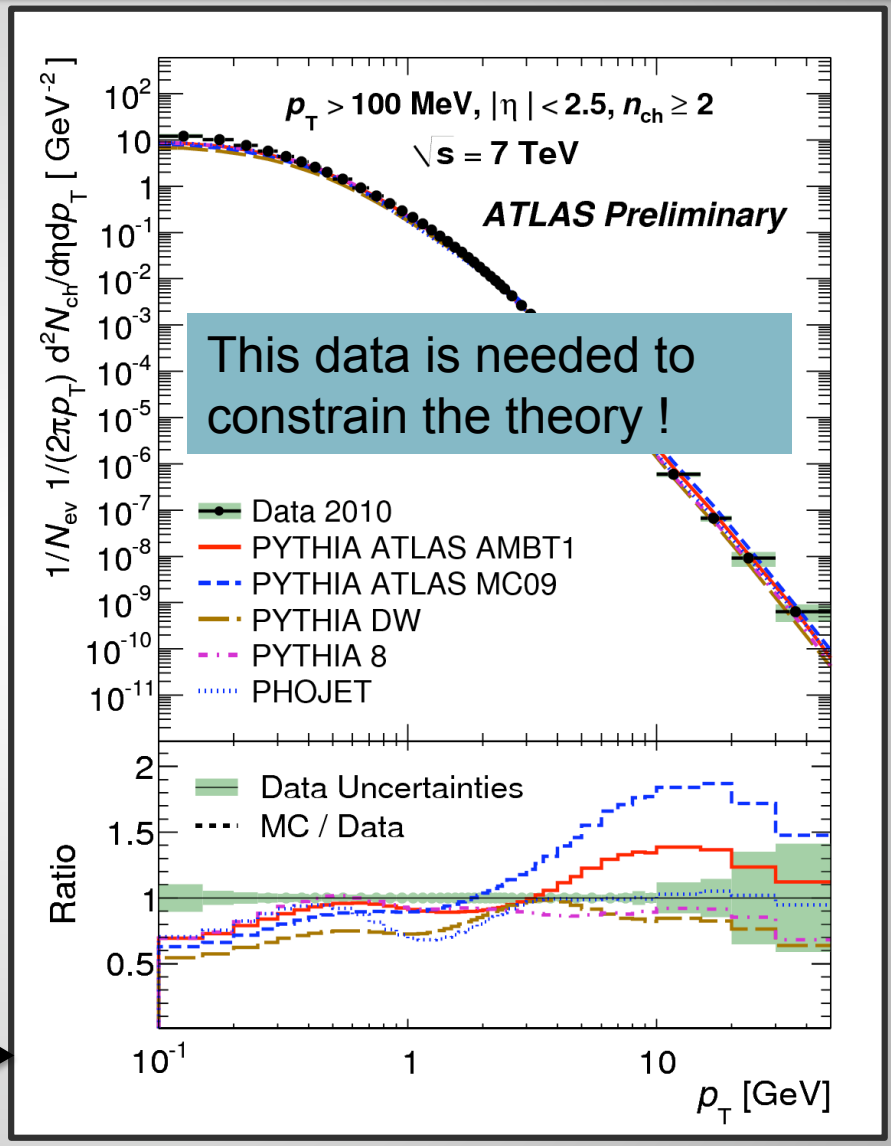
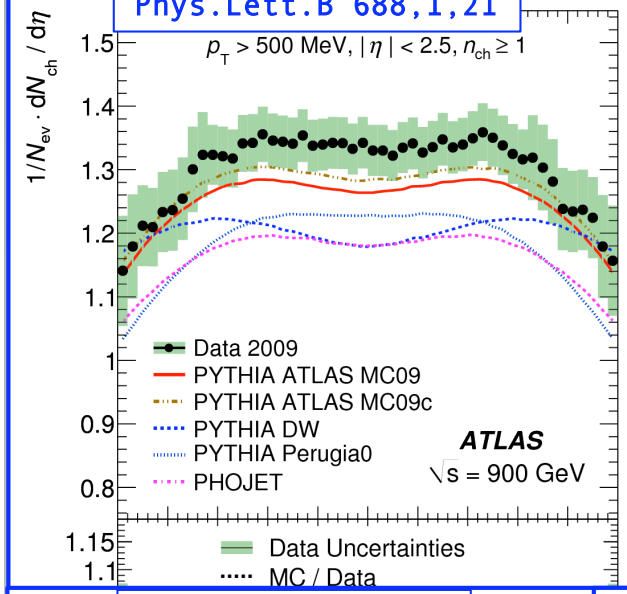
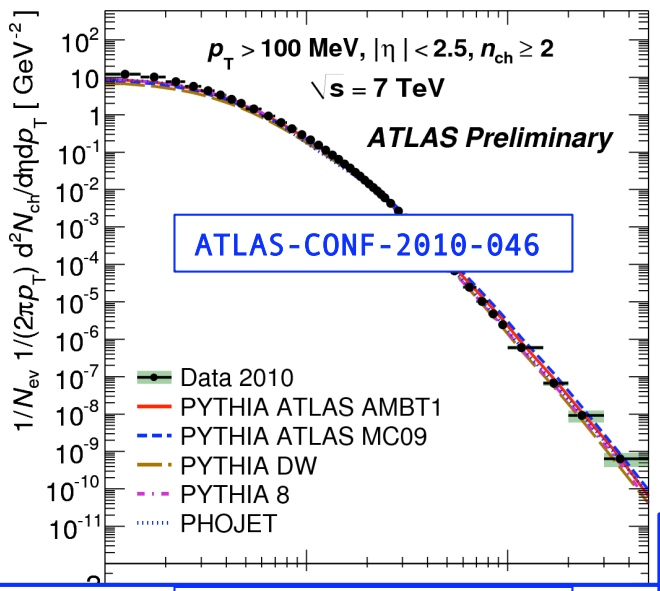
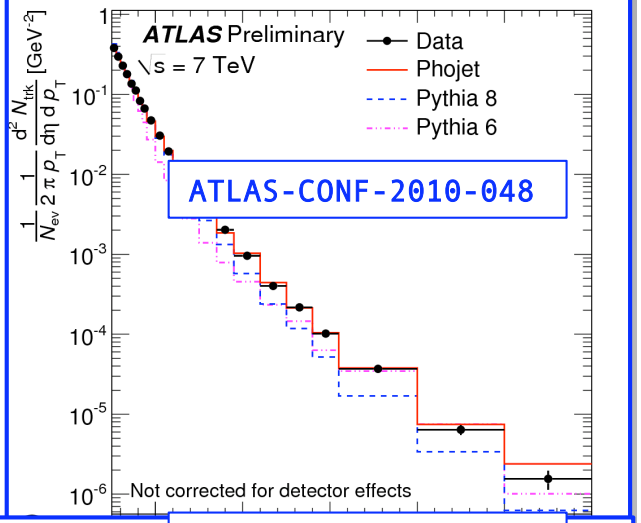


Soft Physics Measurements

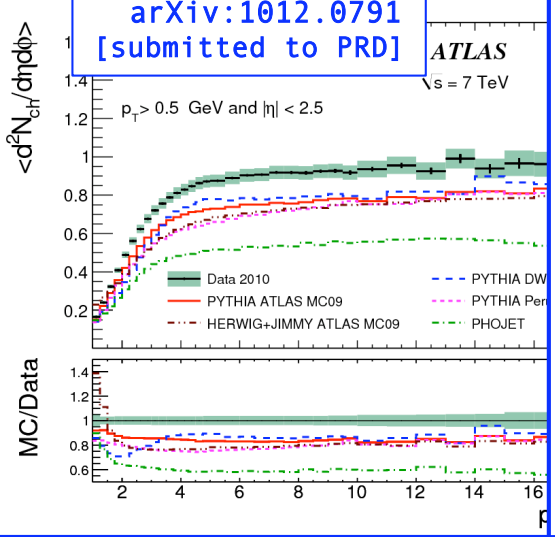
Phys.Lett.B 688,1,21



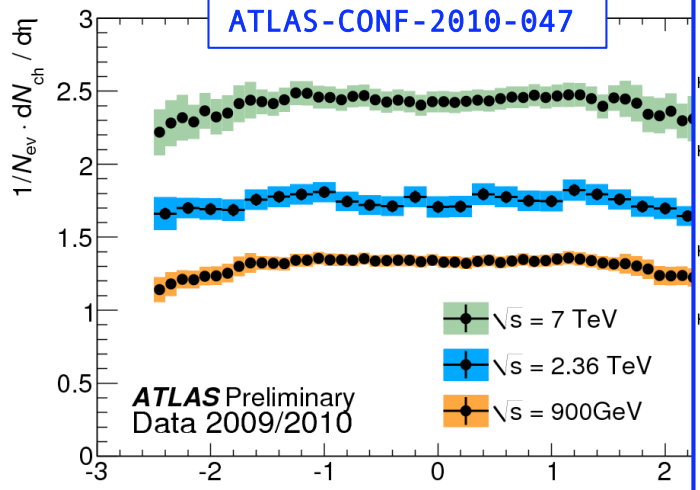




arXiv:1012.0791
[submitted to PRD]



ATLAS-CONF-2010-047



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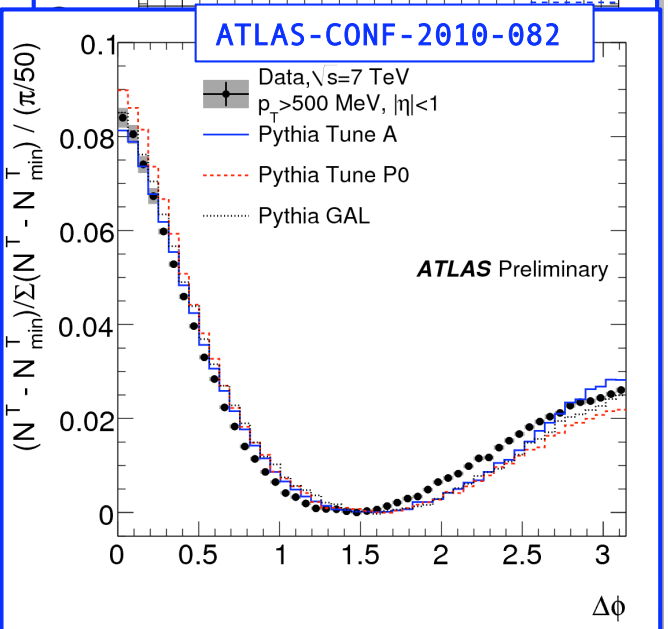
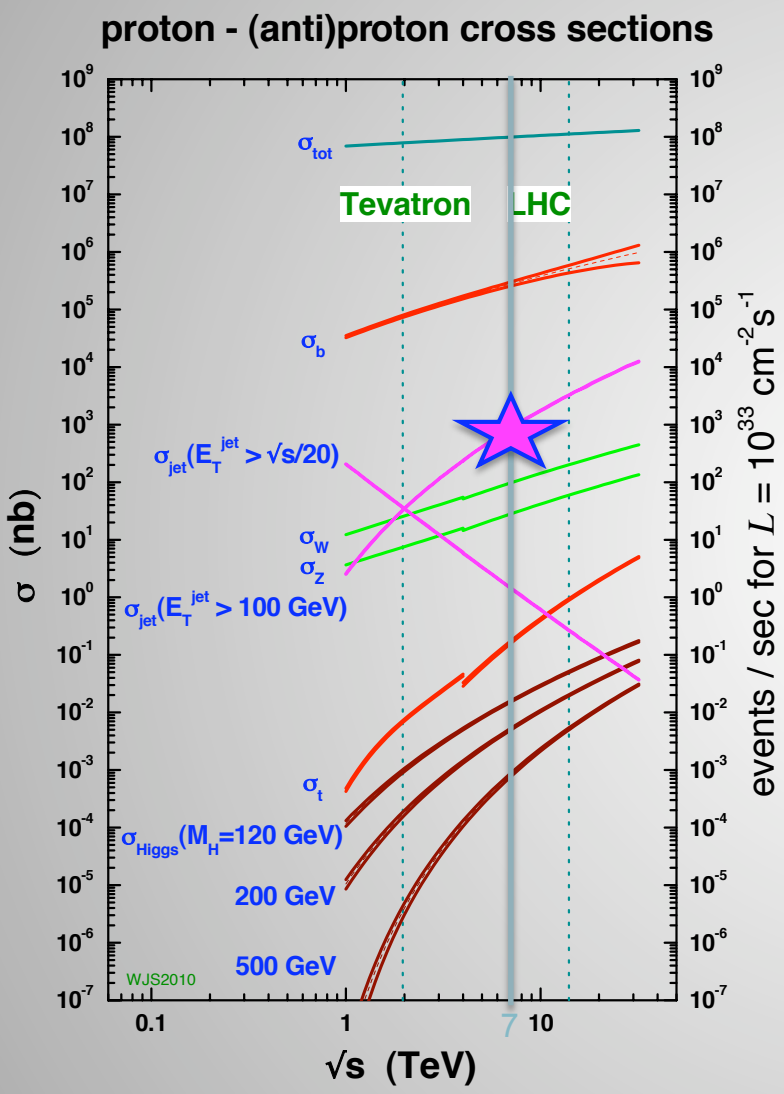
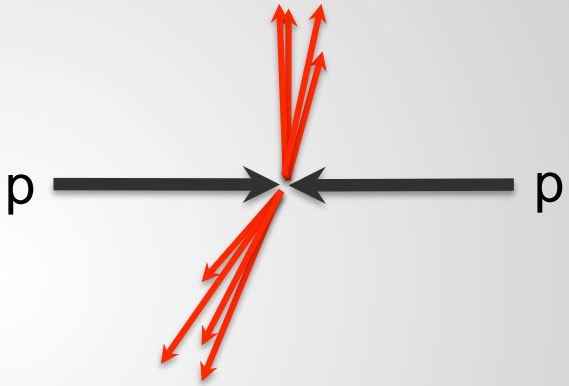
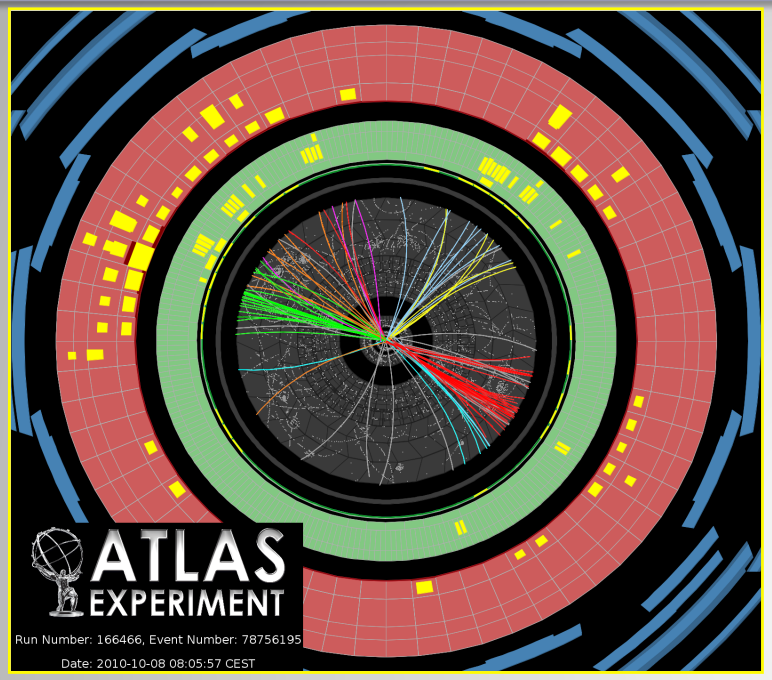


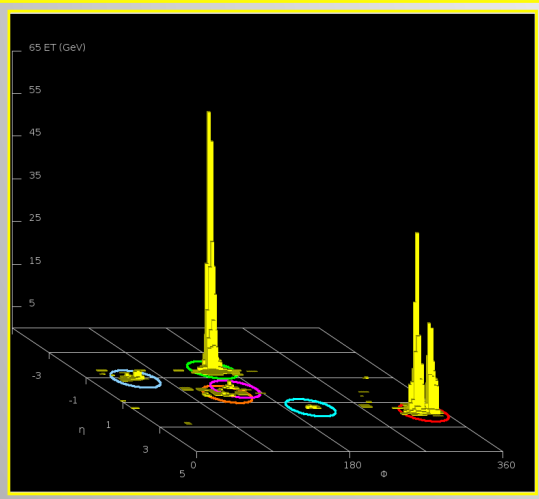
Jets


proton - (anti)proton cross sections
σ_tot
Tevatron
LHC
σ_b
σ_jet(E_T^jet > √s/20)
σ_W
σ_Z
σ_jet(E_T^jet > 100 GeV)
σ_t
σ_Higgs(M_H=120 GeV)
200 GeV
500 GeV
WJS2010
σ (nb)
√s (TeV)
events / sec for L = 10^33 cm^-2 s^-1

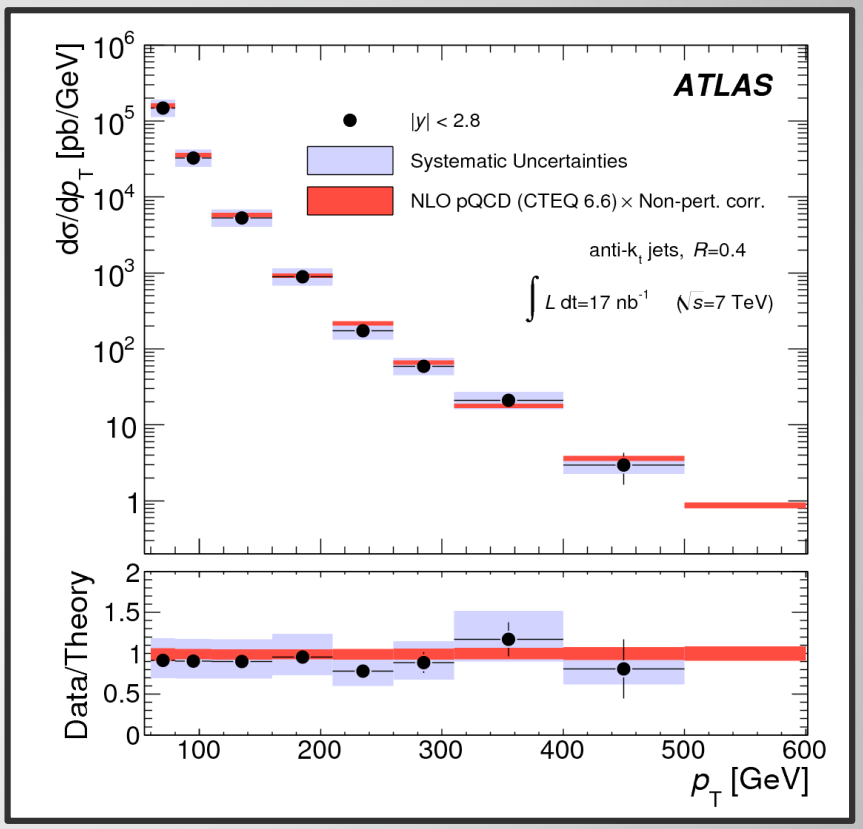

p
p

Jets

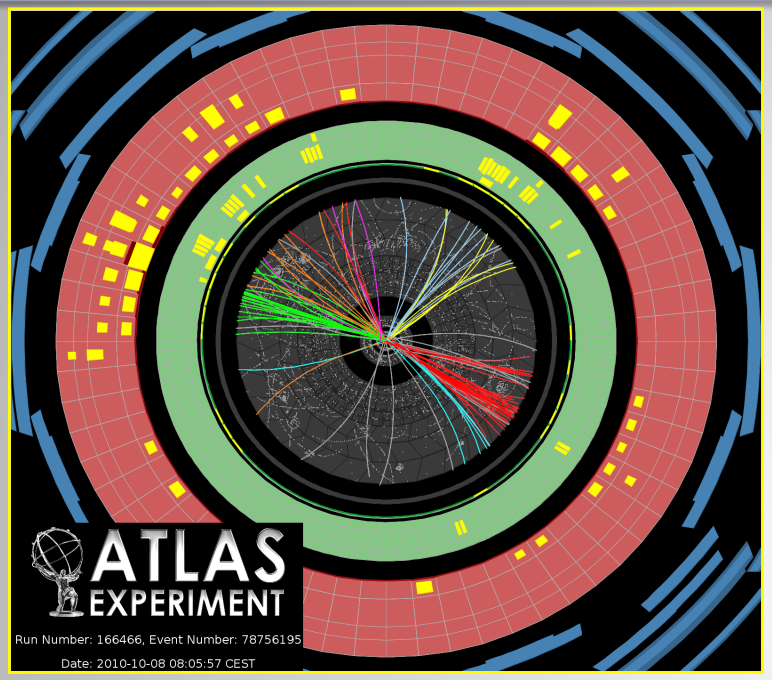


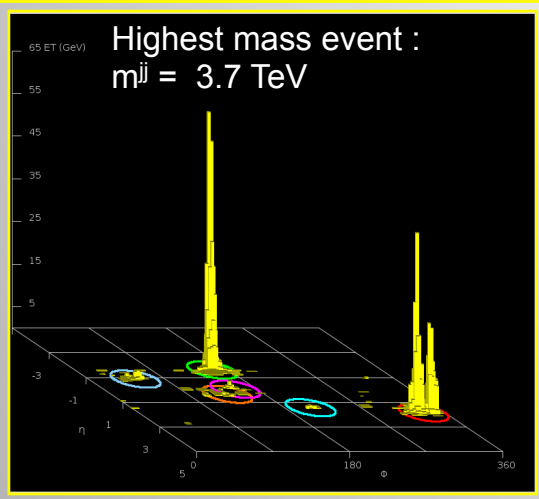


arXiv:1009.5908
[accepted by EPJC]

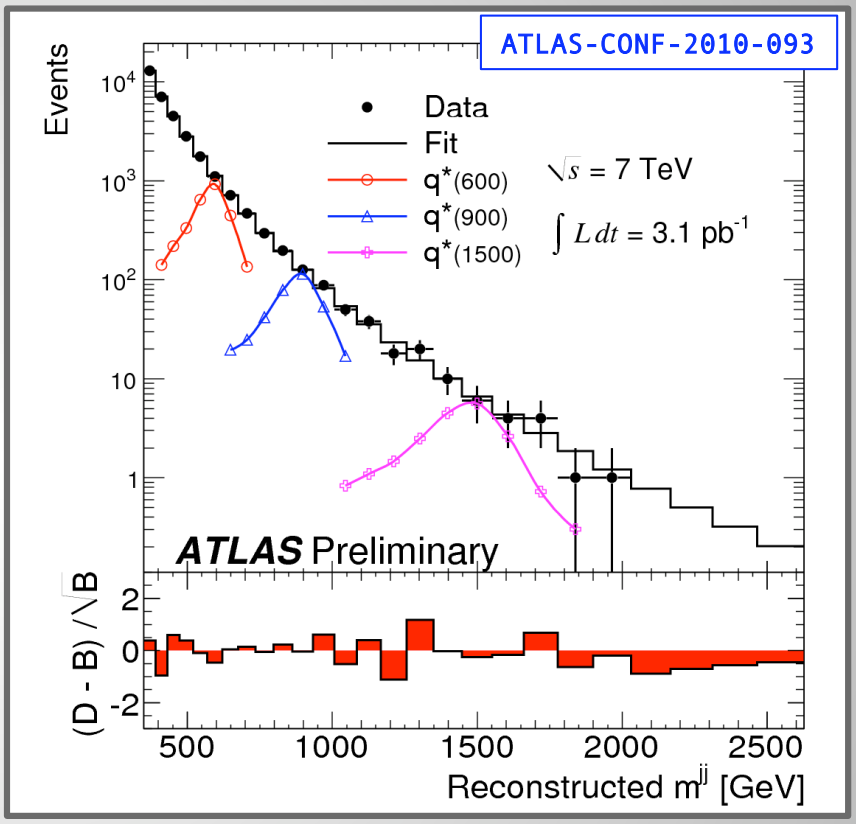


Jets (searching for new particles!)





Invariant Mass : The mass of a decayed particle can be reconstructed from the energy/momenta of its decay products

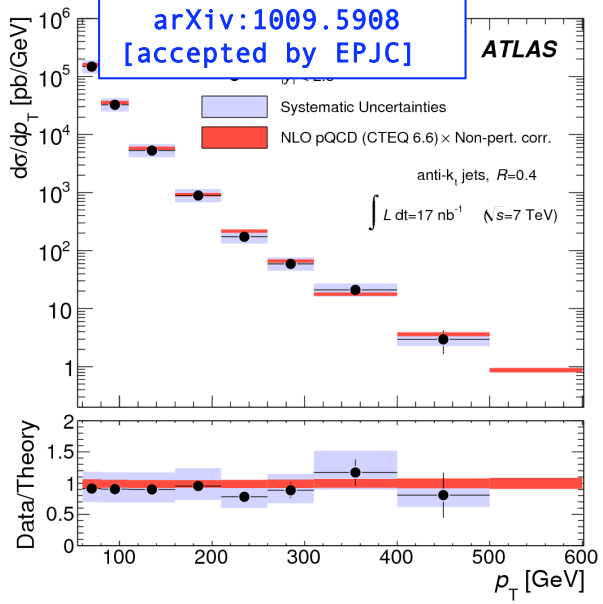


excited quark production excluded in mass interval 0.3 < m < 1.5 TeV

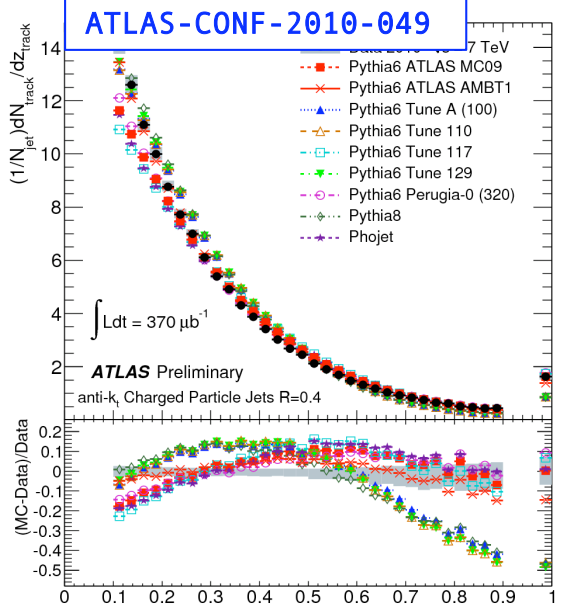
0.7 TeV above Tevatron limits!

Jet measurements

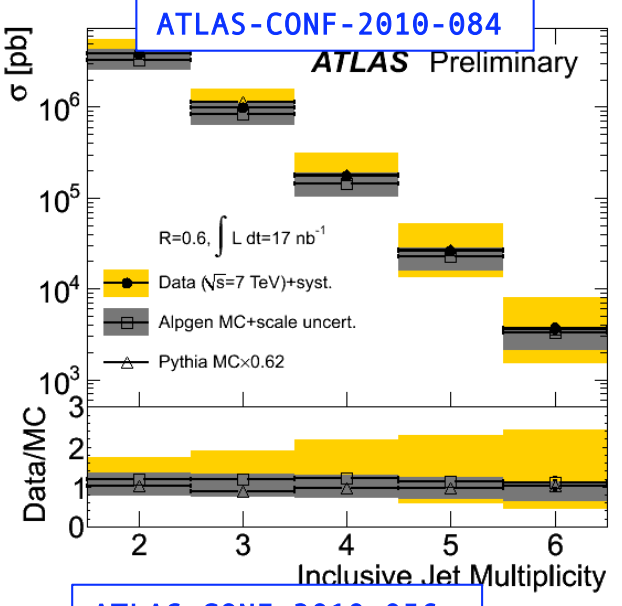
arXiv:1009.5908 [accepted by EPJC]



ATLAS-CONF-2010-049



ATLAS-CONF-2010-084



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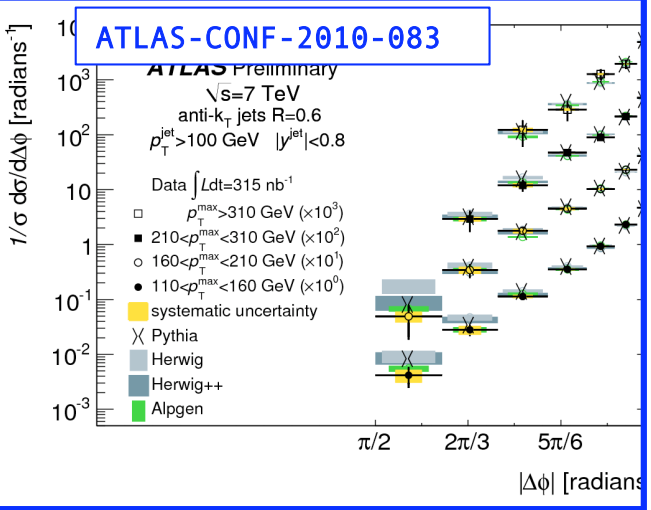
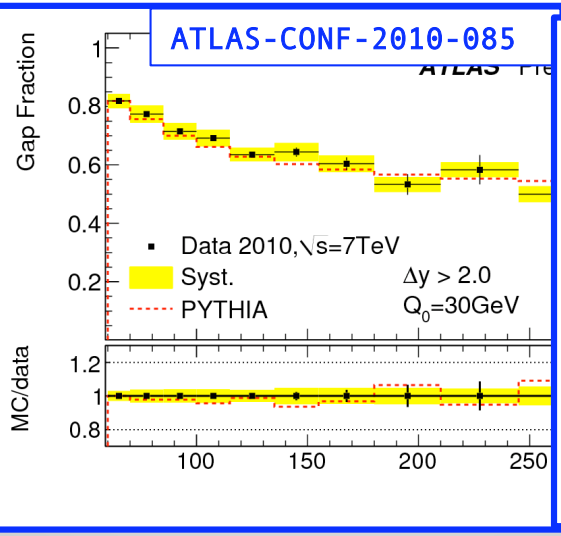
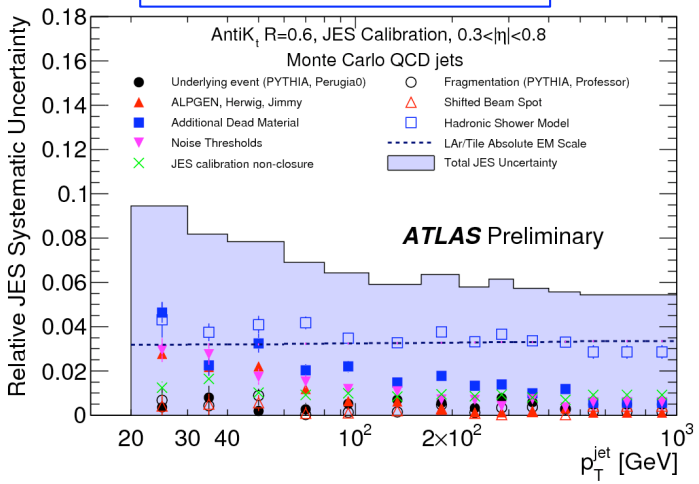


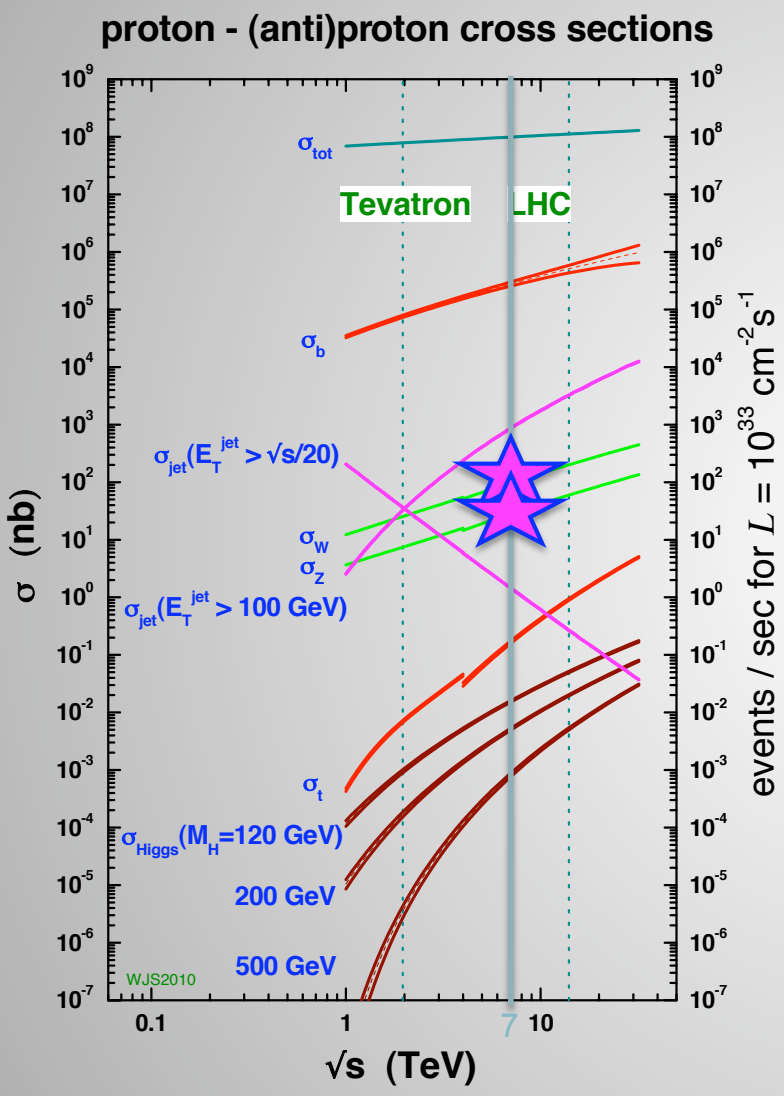
ATLAS-CONF-2010-085



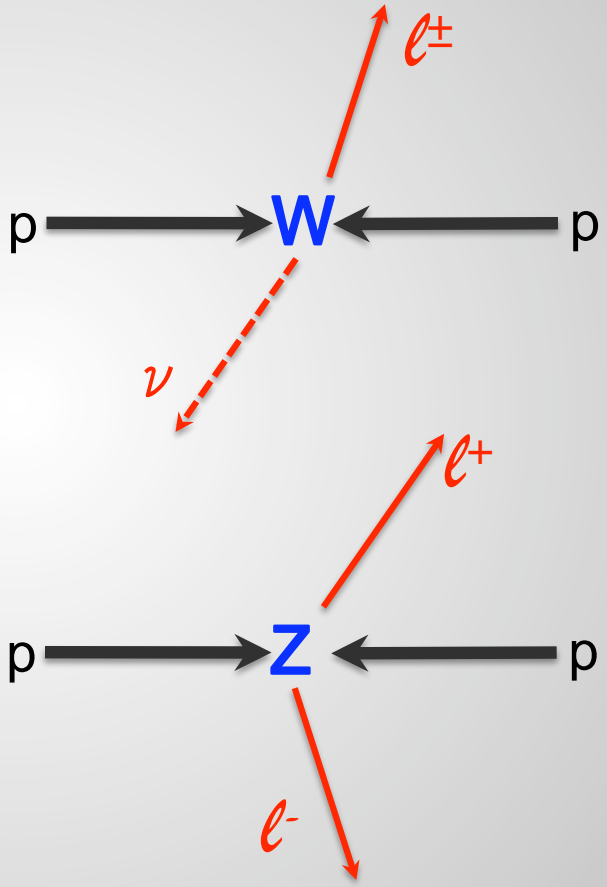
ATLAS-CONF-2010-056



W and Z physics

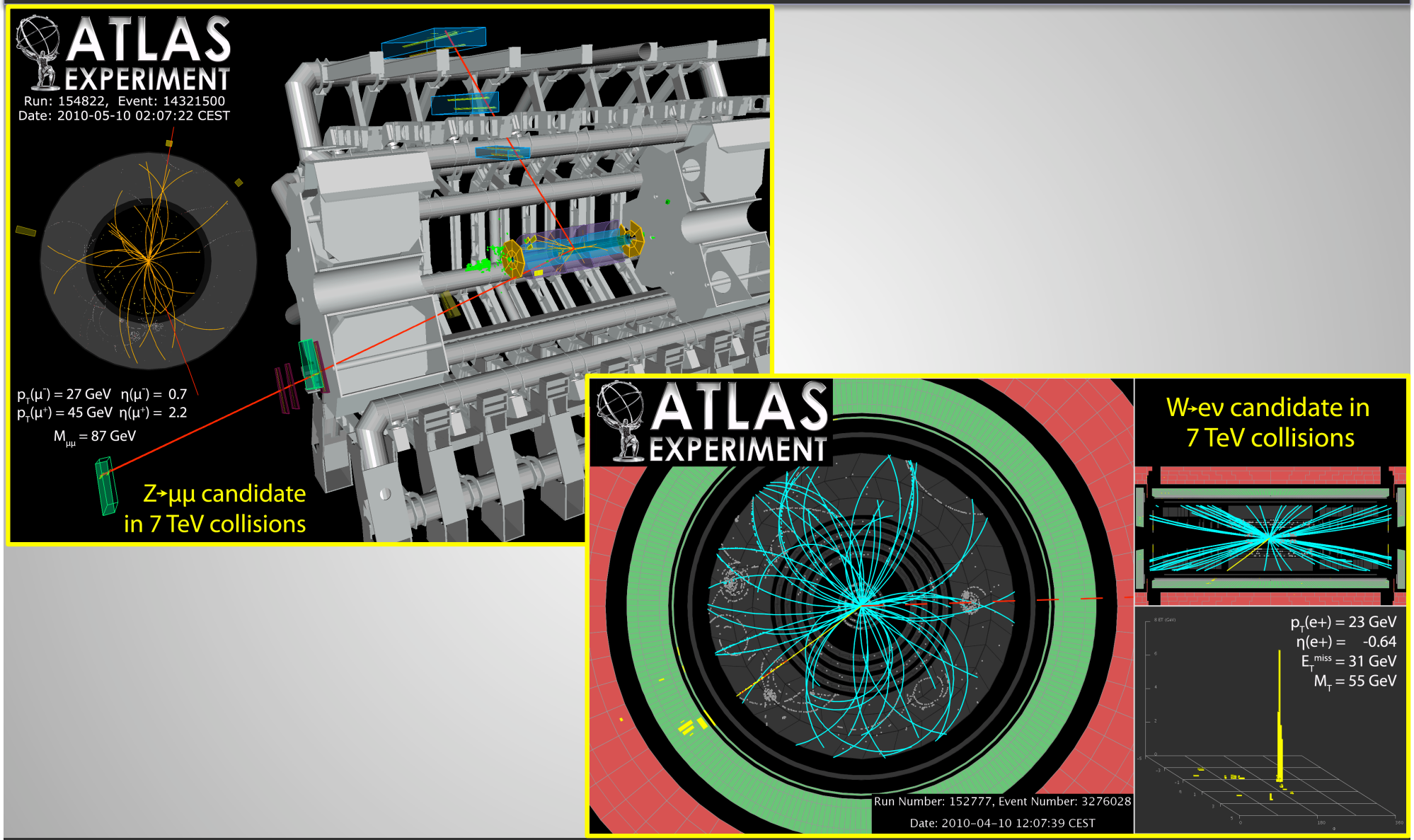


W,Z bosons : mass ~100 times the proton mass

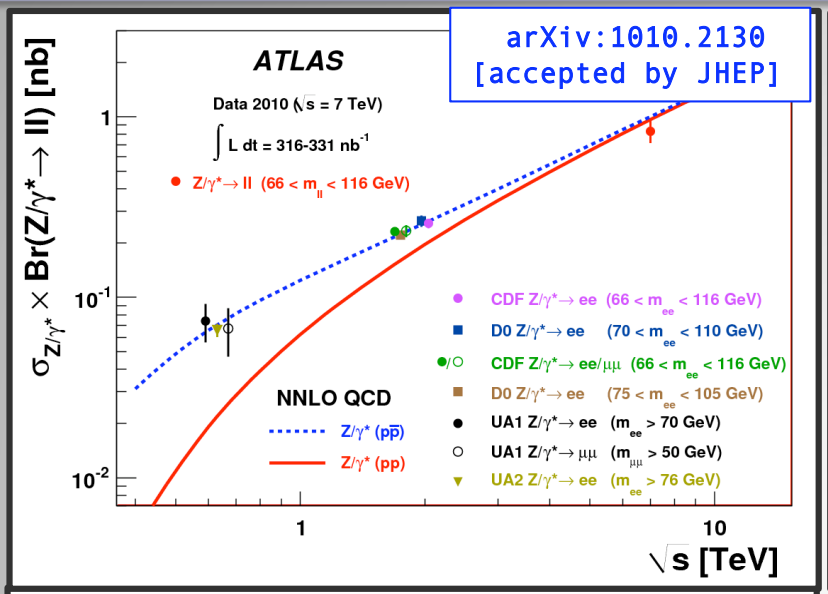


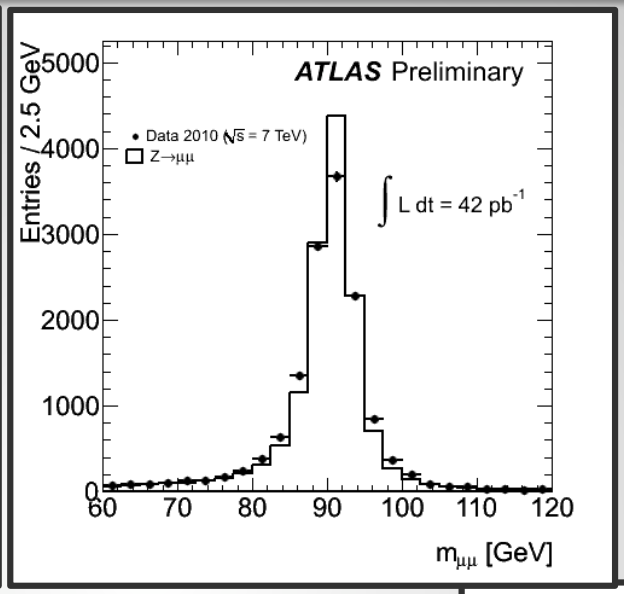
Discovered at CERN in the early 1980s

W and Z events

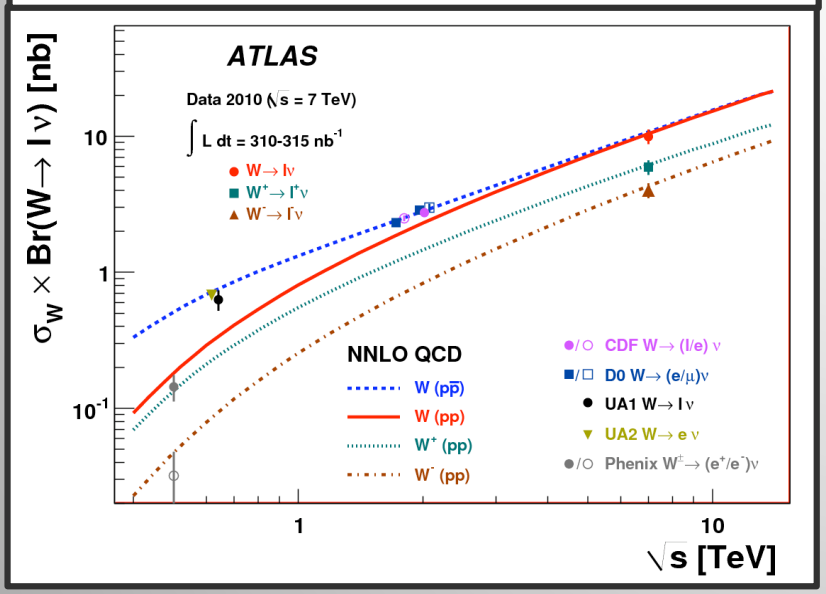


W and Z physics

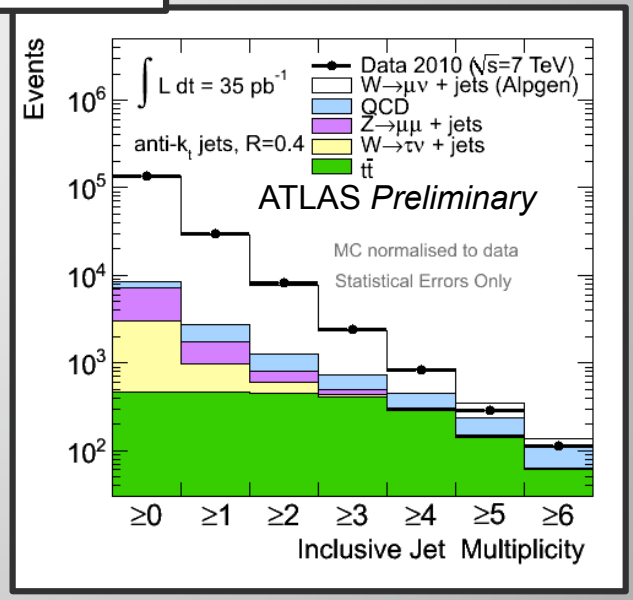




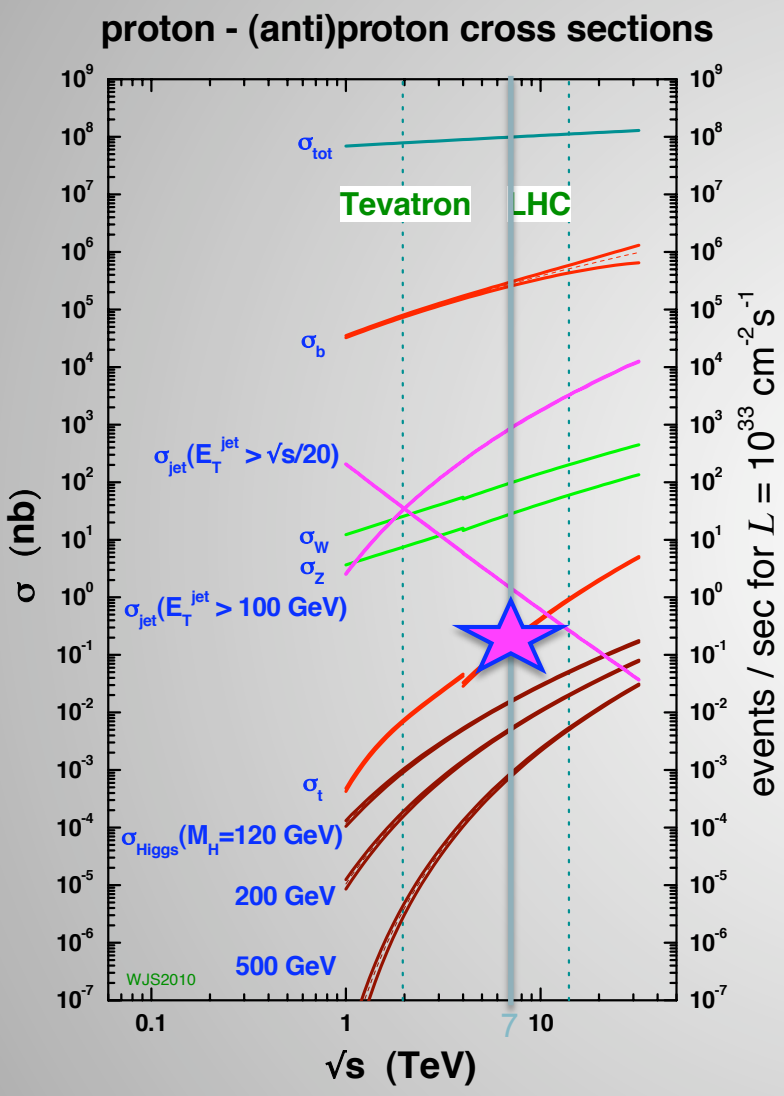
We now have:
250,000 W→μν,eν events
23,000 Z→μμ, ee events



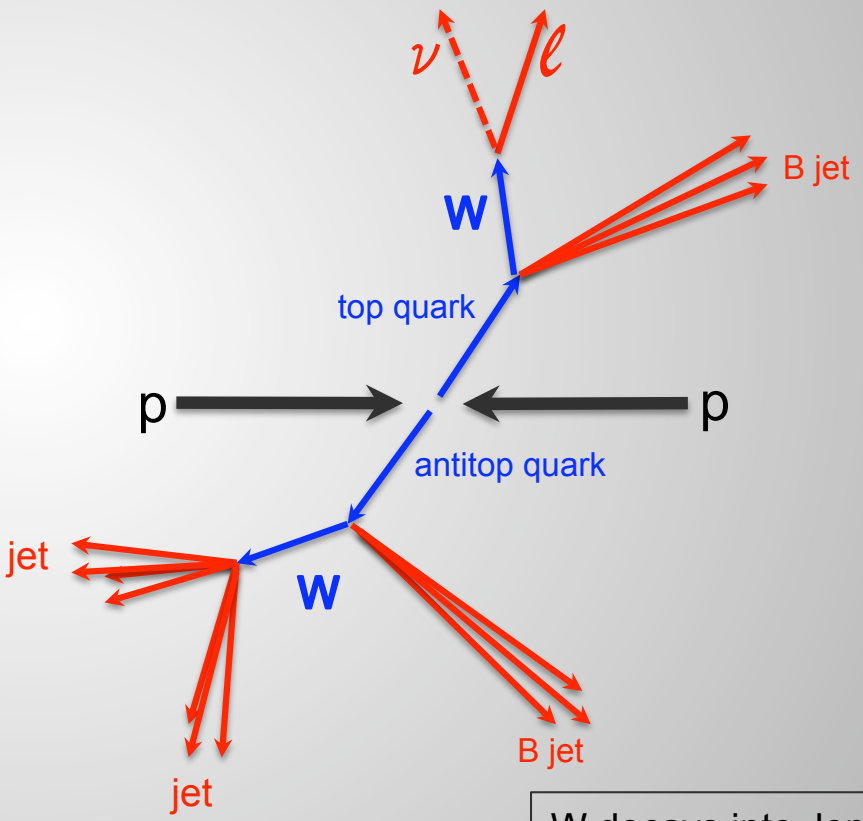
W/Z + jets : important backgrounds to searches



top quark physics

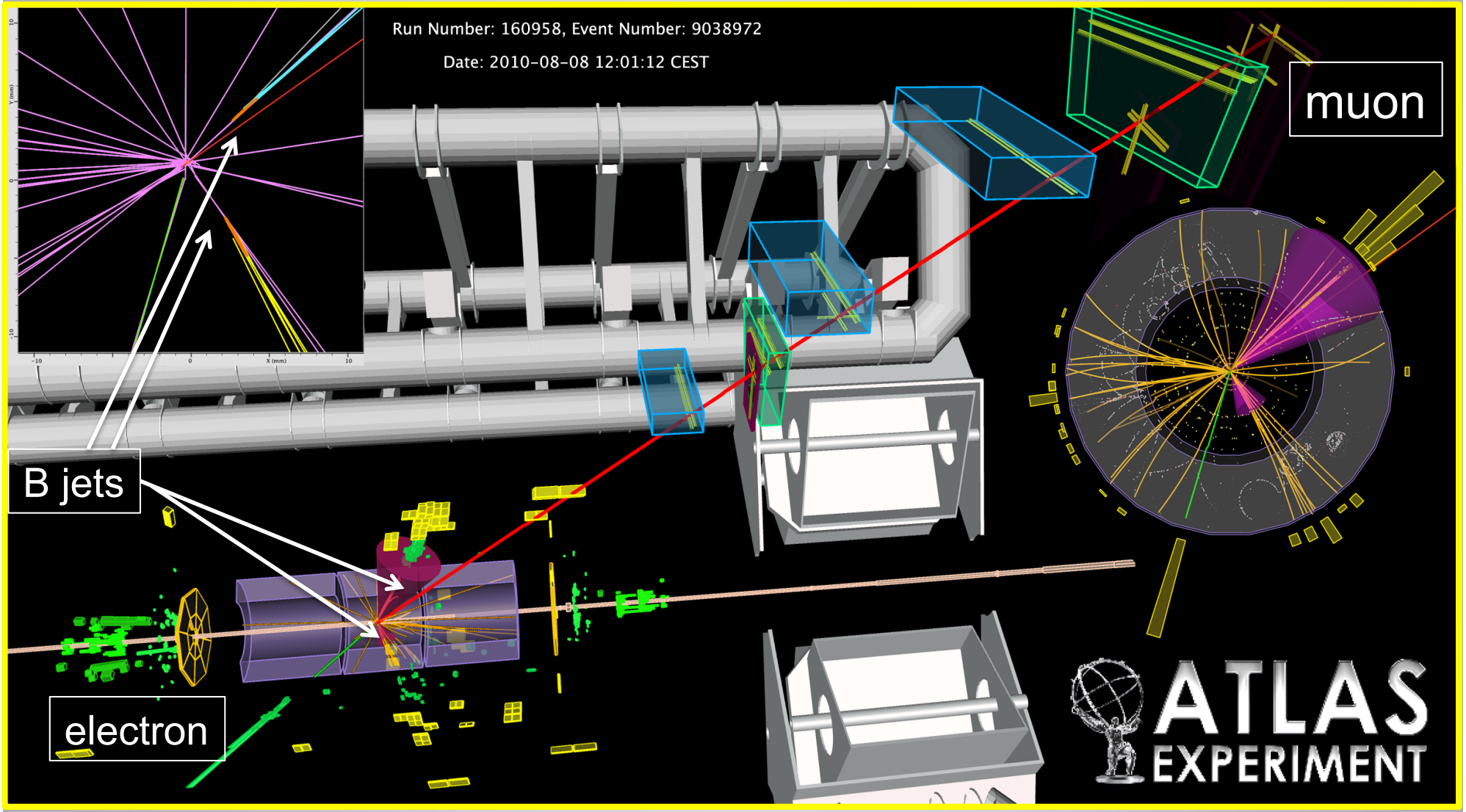


top mass ~200 times proton mass!



W decays into leptons or jets (hadrons)

top-antitop candidate



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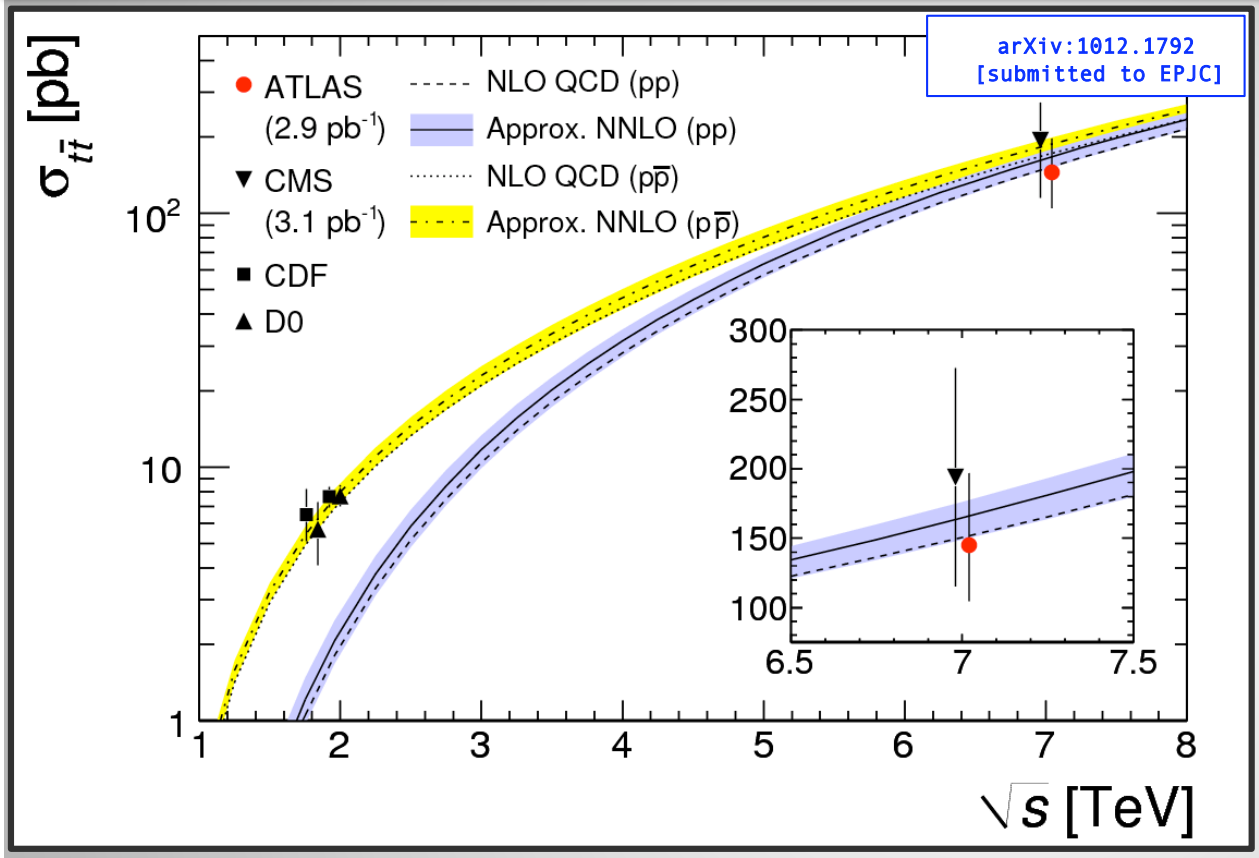
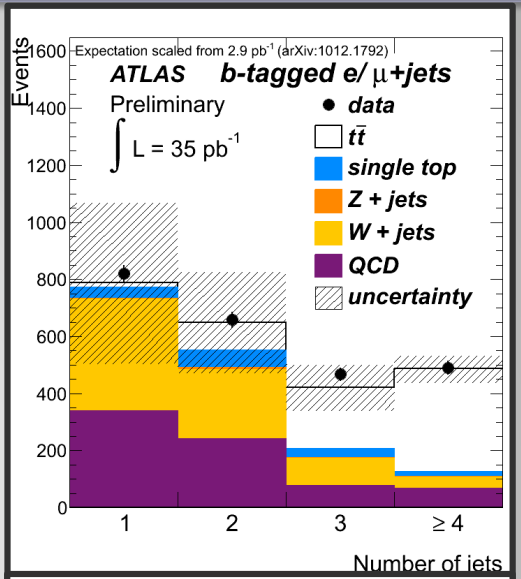
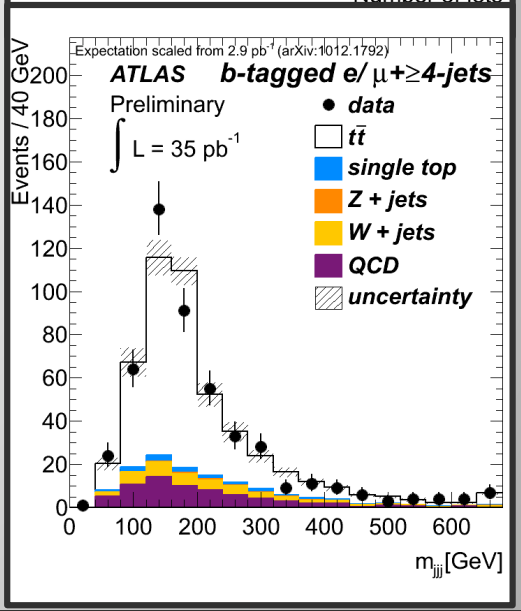
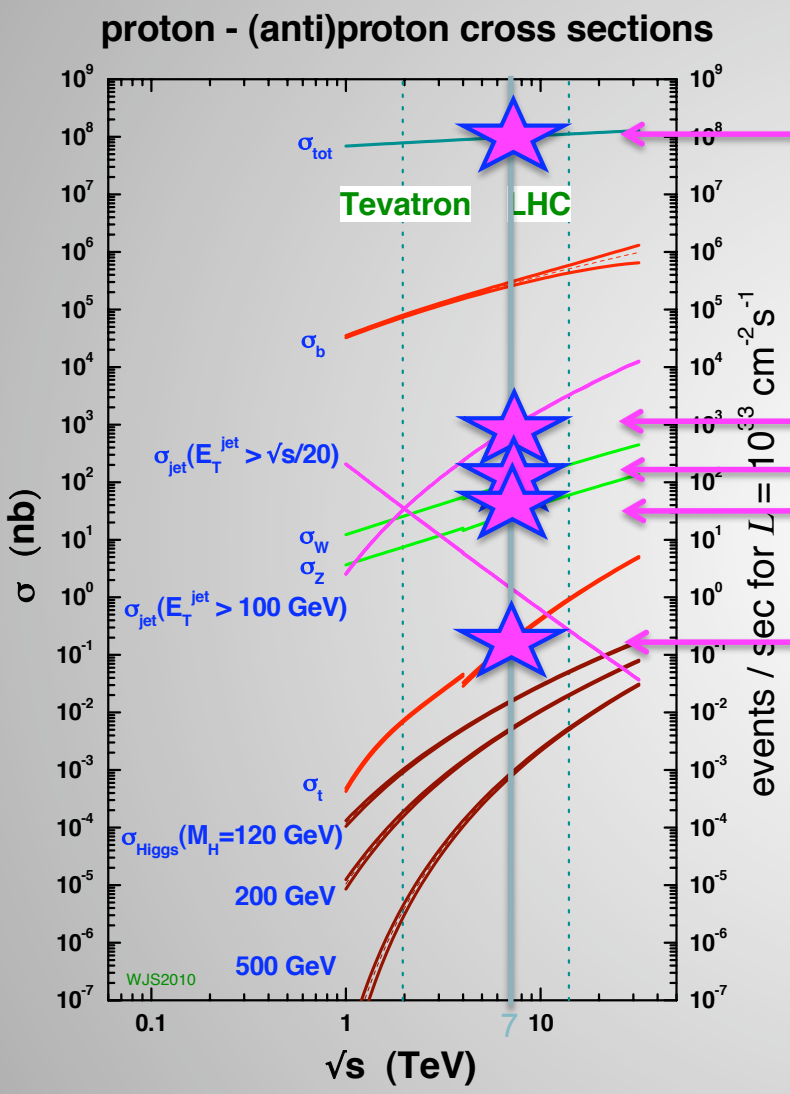






Measurement performed in both single-lepton and di-lepton channels for optimum precision

Summary of proton-proton results



Soft events ✓

Jets ✓

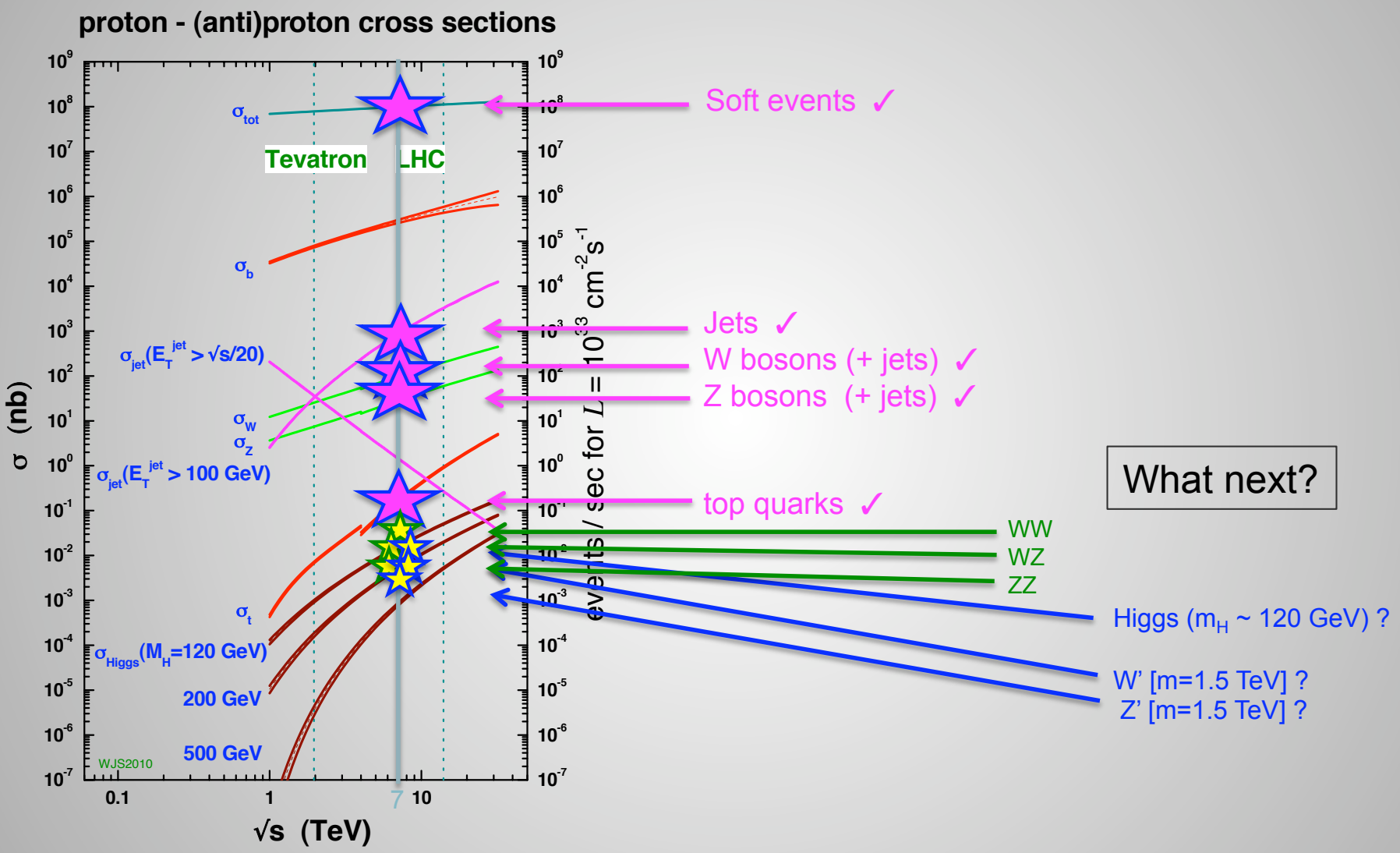
W bosons (+ jets) ✓

Z bosons (+ jets) ✓

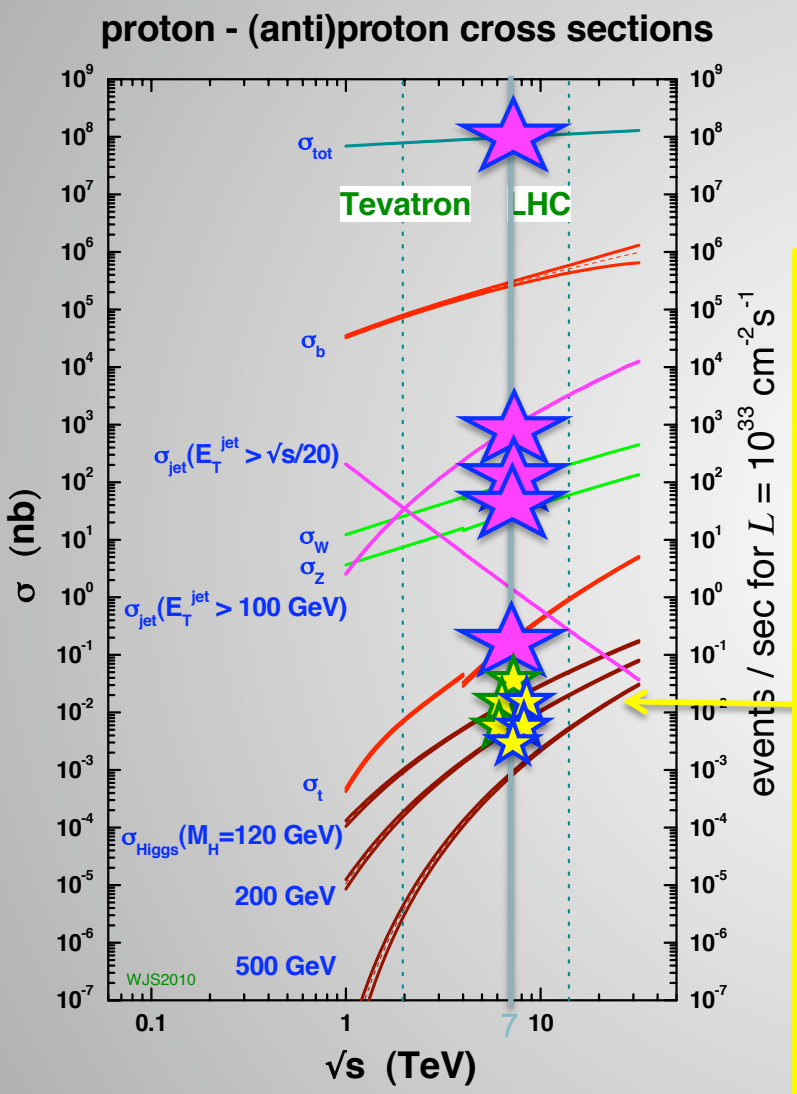
top quarks ✓

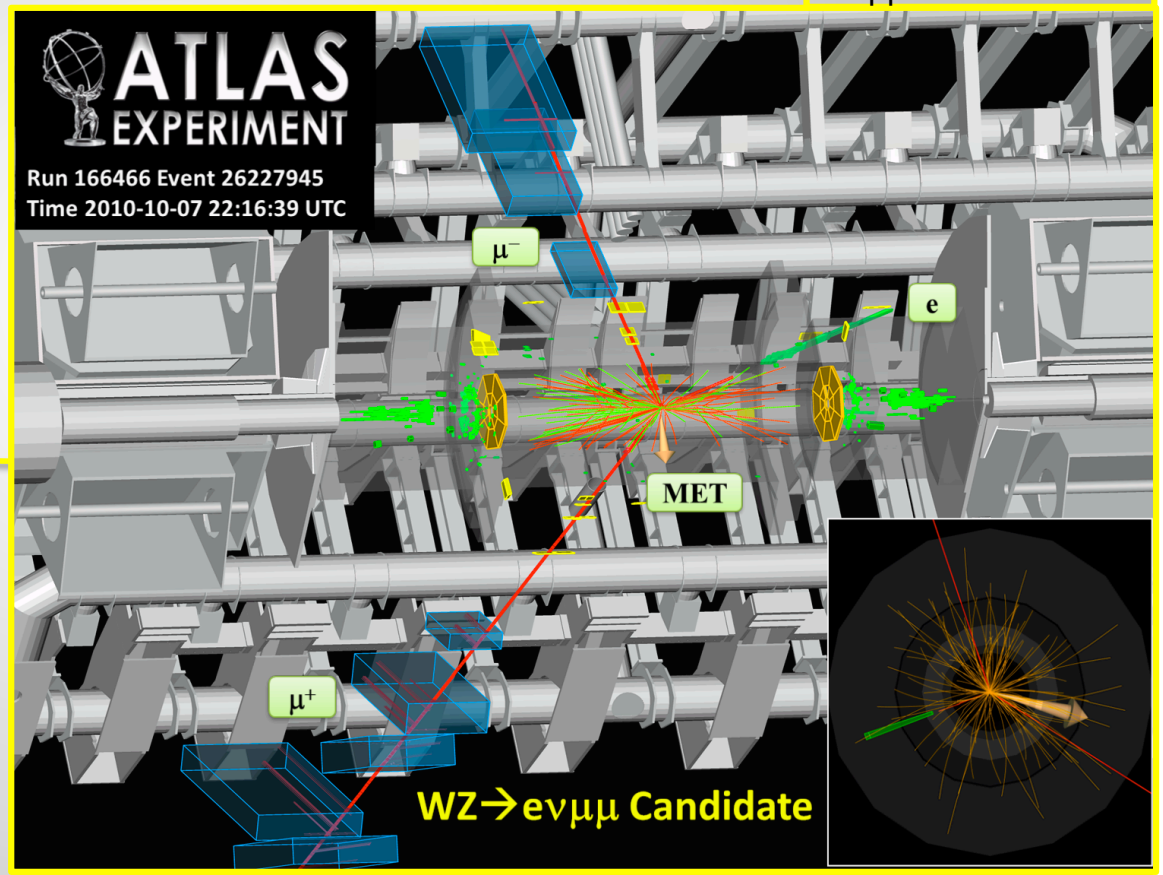
In only 8 months already very well advanced in our SM exploration!

Summary of proton-proton results

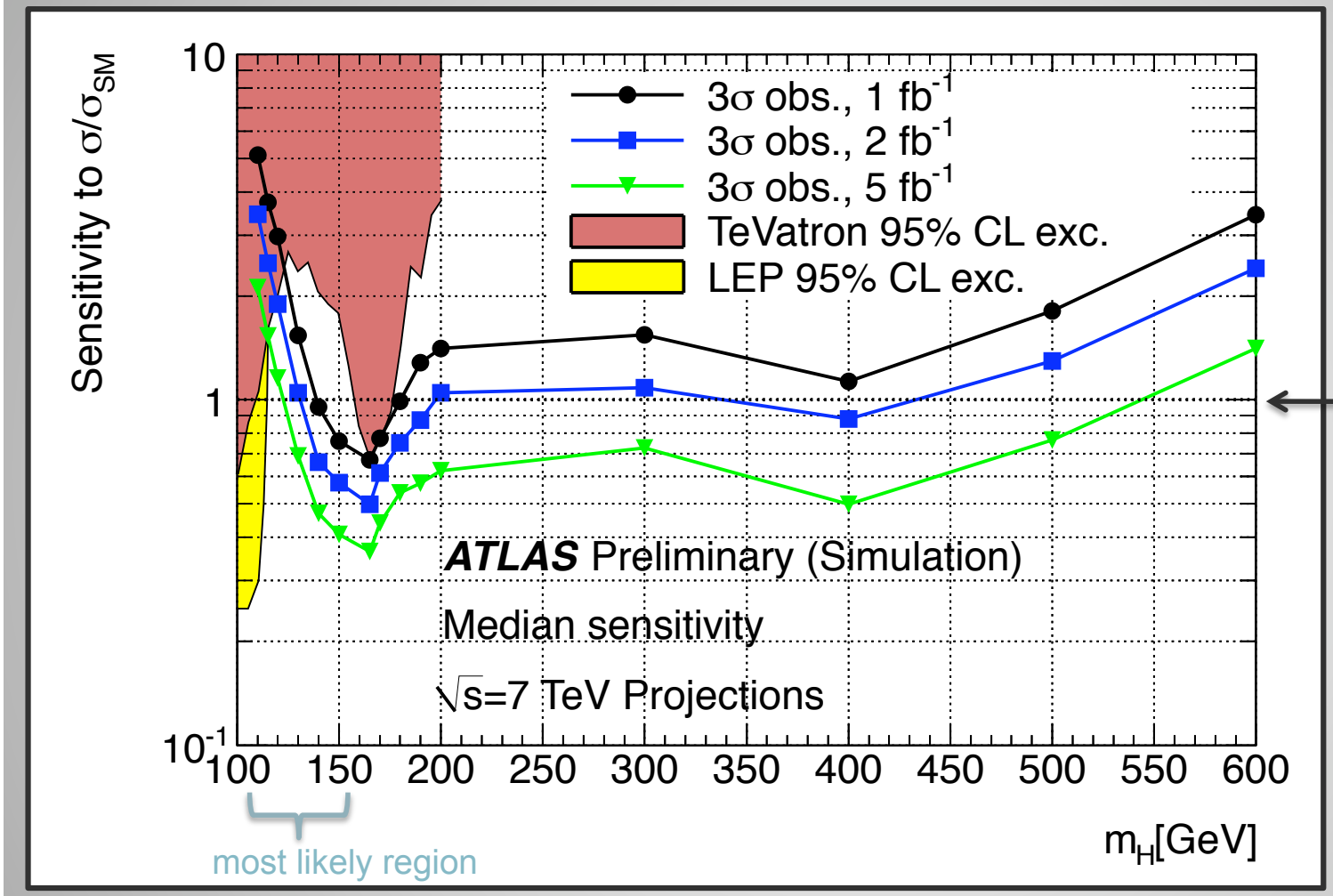


Summary of proton-proton results





Higgs in 2011?



Need 5σ for *discovery*

look at this line

Improvements possible with further optimised analysis techniques

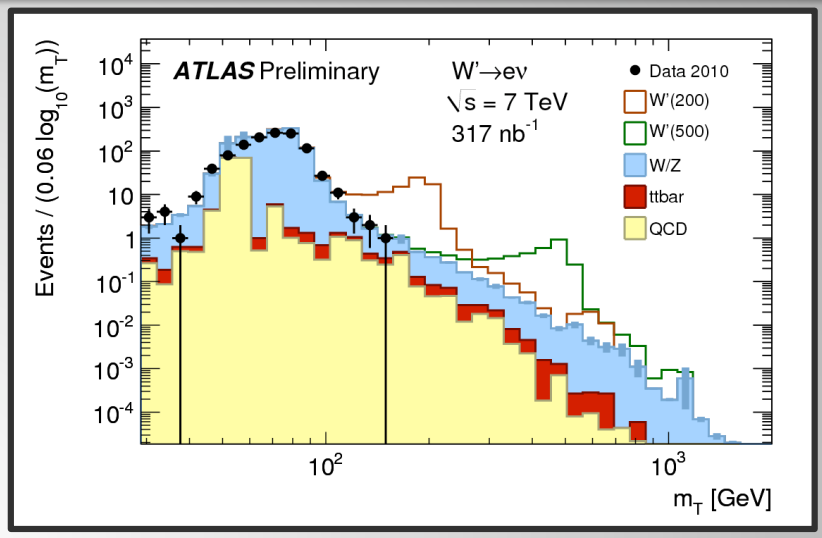
Other search prospects in 2011

Massive W' and Z' particles

Preliminary estimates for 10 events at 7 TeV :

	1 fb^{-1}	5 fb^{-1}
W' mass	2 TeV	2.4 TeV
Z' mass	1.5 TeV	2 TeV

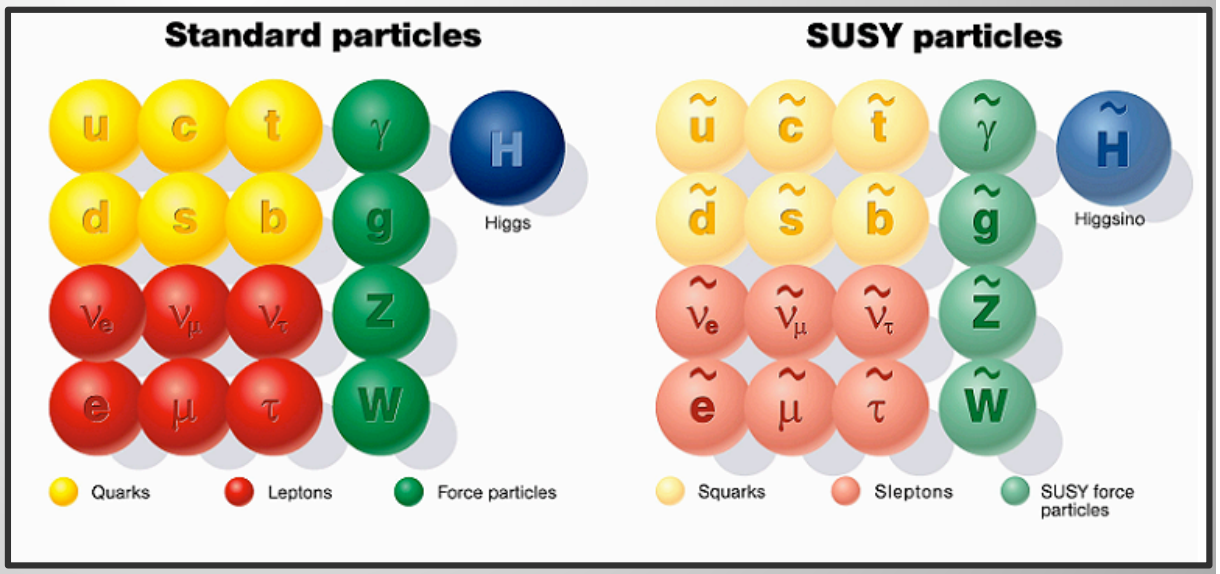
Tevatron limits currently ~1 TeV



SUperSYmmetry (SUSY)

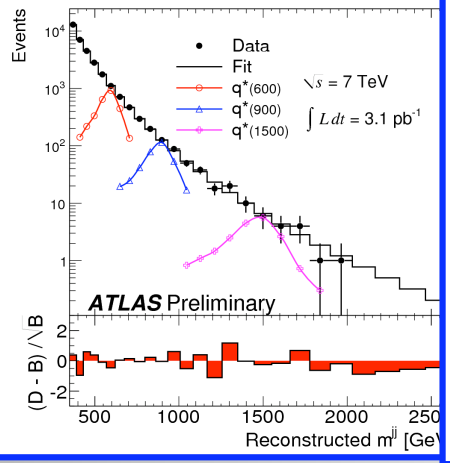
1 fb^{-1}	5 fb^{-1}
0.7 TeV	1 TeV

$\tilde{q}$ mass (~ $\tilde{g}$ mass)

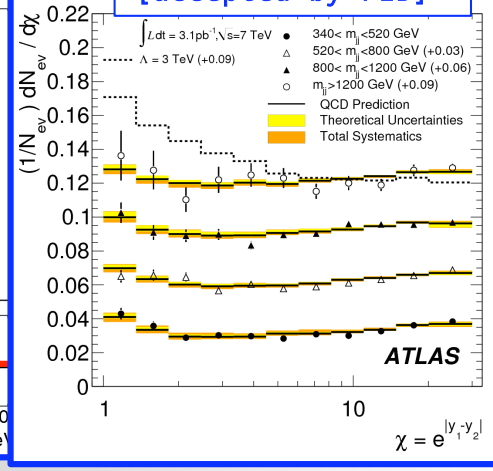


Searches

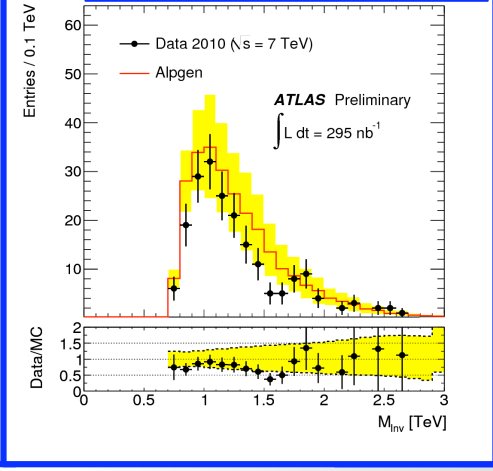
ATLAS-CONF-2010-093



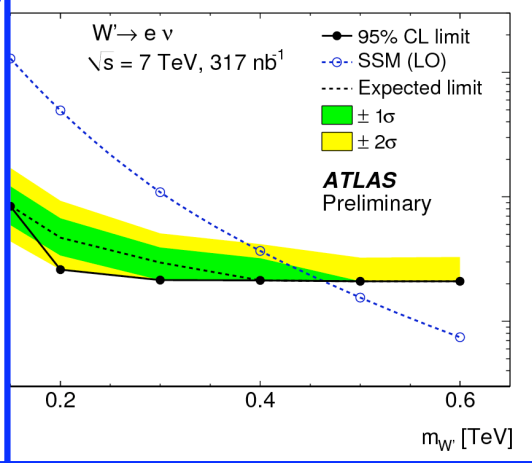
arXiv:1009.5069
[accepted by PLB]



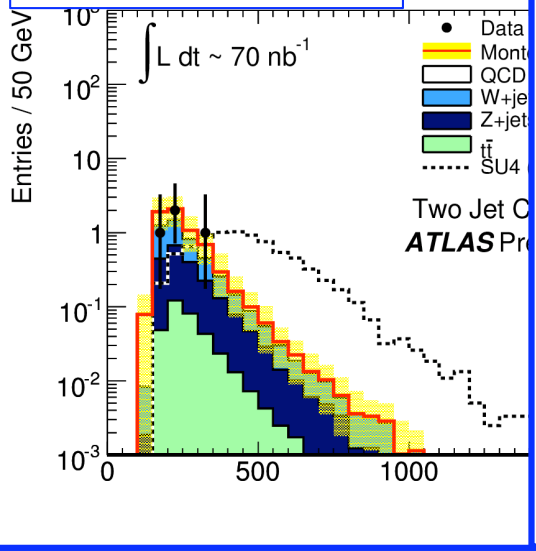
ATLAS-CONF-2010-088



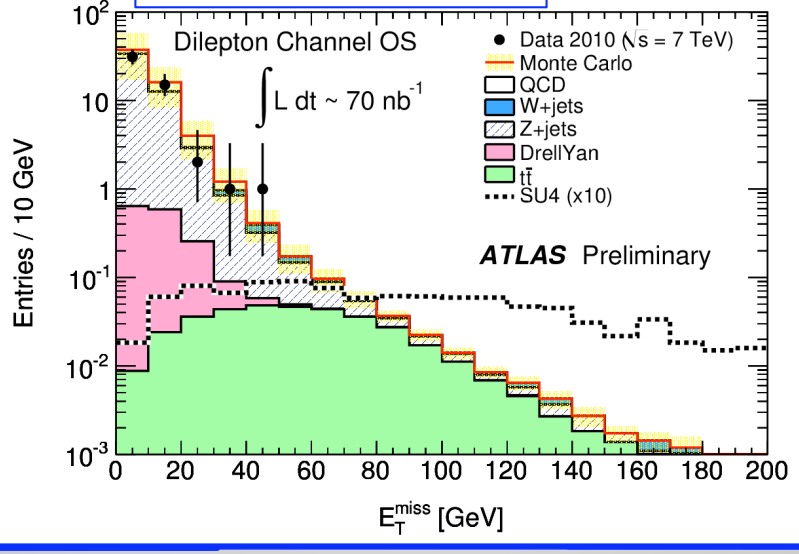
ATLAS-CONF-2010-089



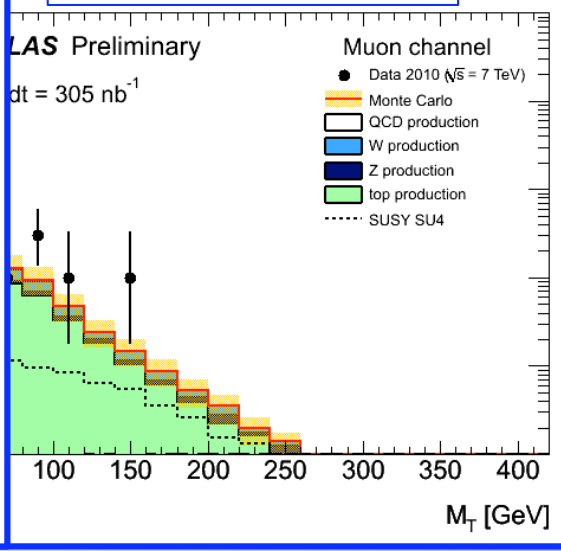
ATLAS-CONF-2010-065



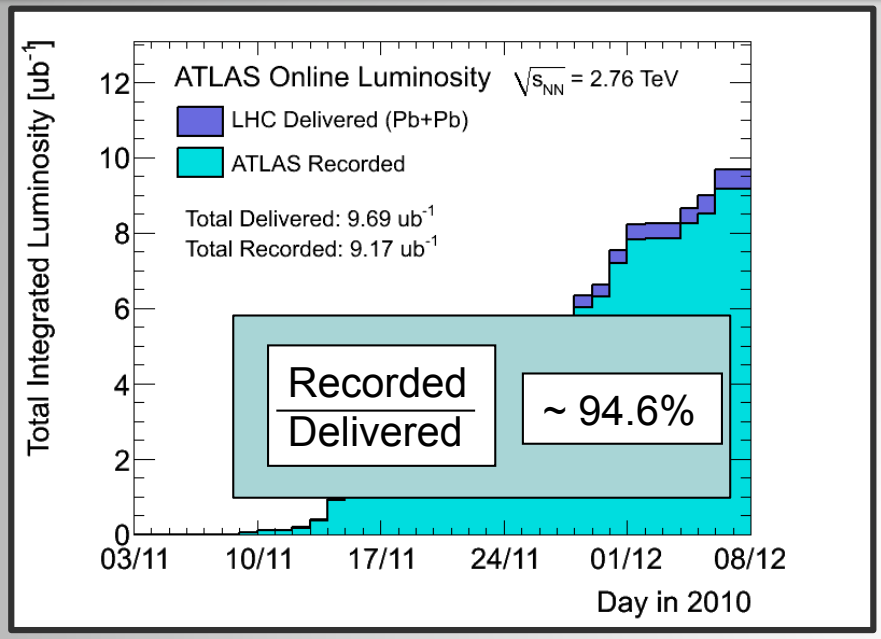
ATLAS-CONF-2010-066

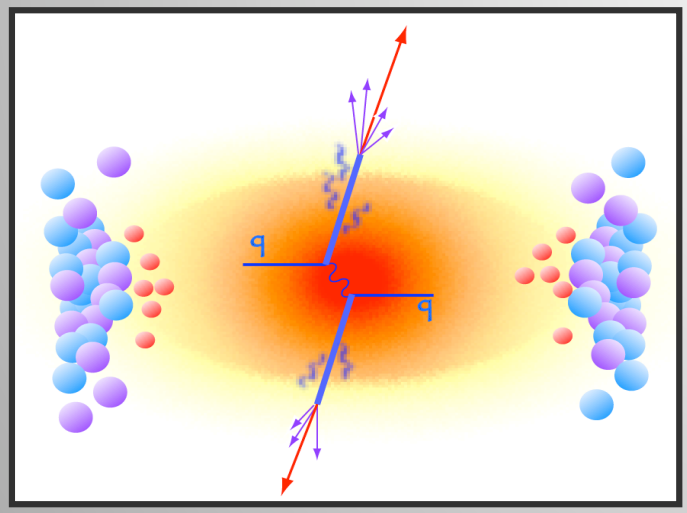


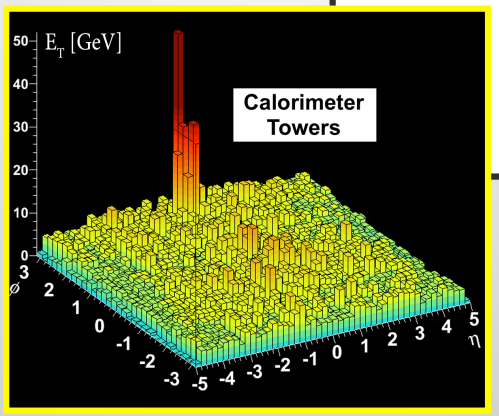
ATLAS-CONF-2010-079

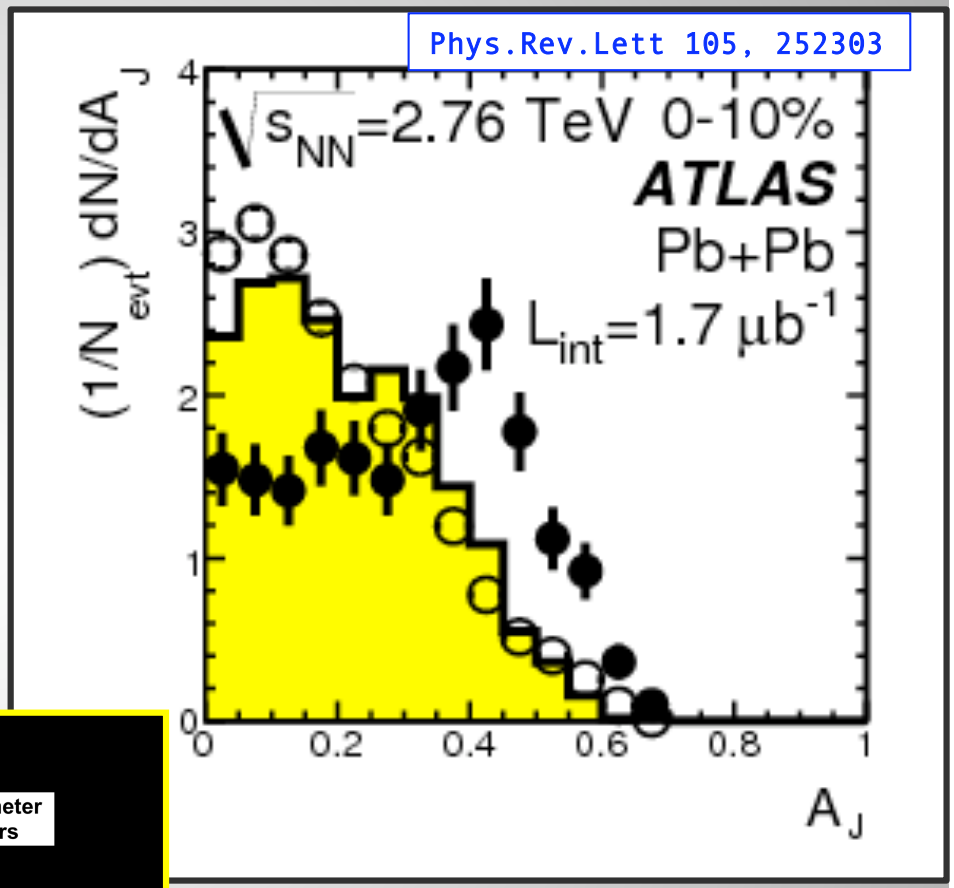


Heavy Ion (lead) collisions





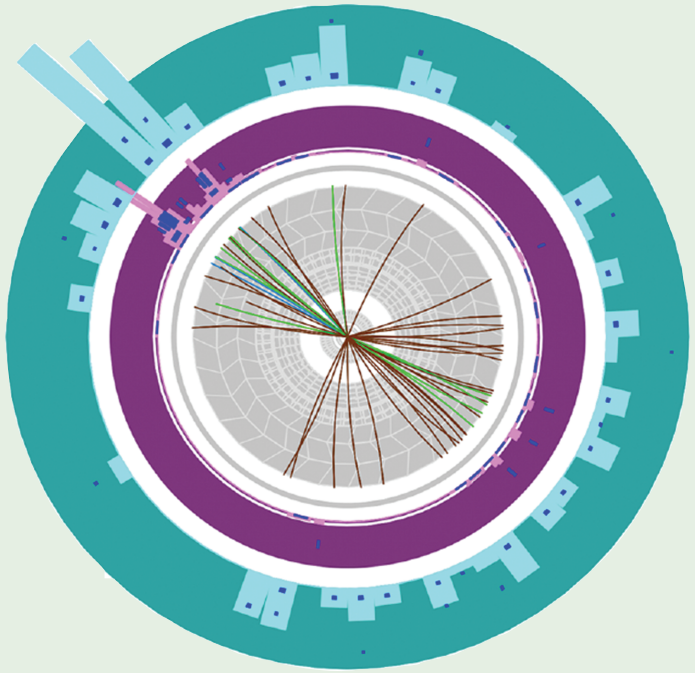




First observation of di-jet asymmetry! : awarded the PRL "viewpoint" label!

PHYSICAL REVIEW LETTERS

Articles published week ending 17 DECEMBER 2010



Published by the
American Physical Society

APS physics

Volume 105, Number 25

The ATLAS detector has performed exceptionally well!
A total of 15 physics papers and 100 conference notes!
A fantastic year for ATLAS!

A huge thanks to the LHC team for delivering such beautiful data to the experiments!

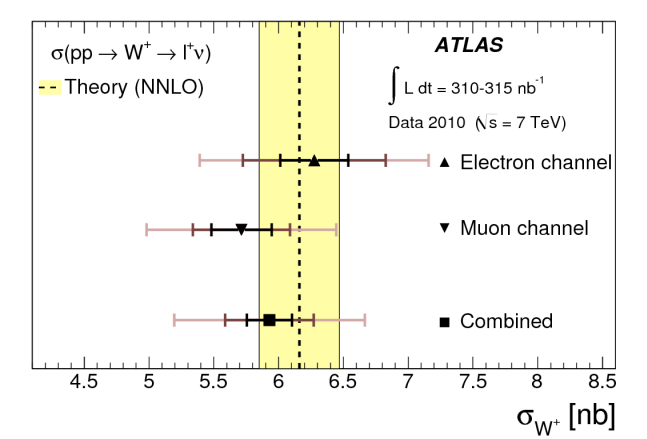
A huge thanks to the collaborating institutes and funding agencies for support for over 20 years!

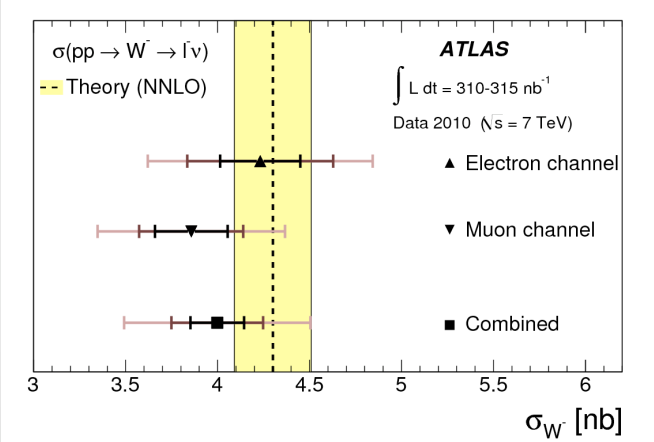
EXTRA SLIDES

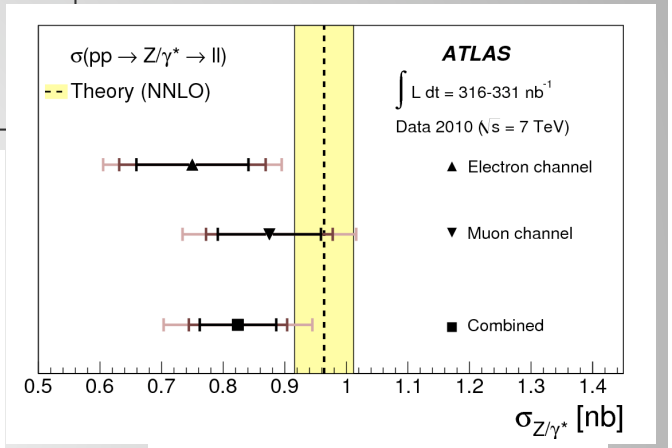
Result details

$\sigma(W \to l\nu) = 9.96 \pm 0.23\ (stat.) \pm 0.50\ (syst.) \pm 1.10\ (lumi.)$ nb
$\sigma(Z \to ll) = 0.82 \pm 0.06\ (stat.) \pm 0.05\ (syst.) \pm 0.09\ (lumi.)$ nb
Ratio = 11.7 ± 0.9 (stat.) ± 0.4 (syst.)

syst. dominated by lepton ID

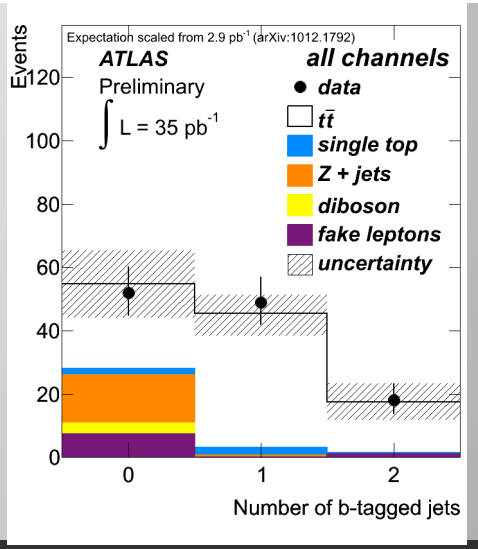




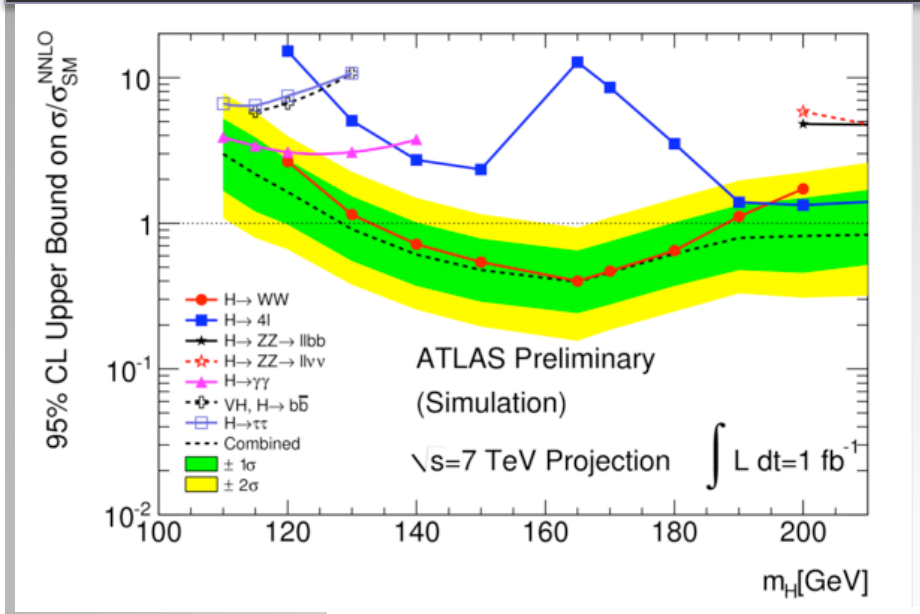


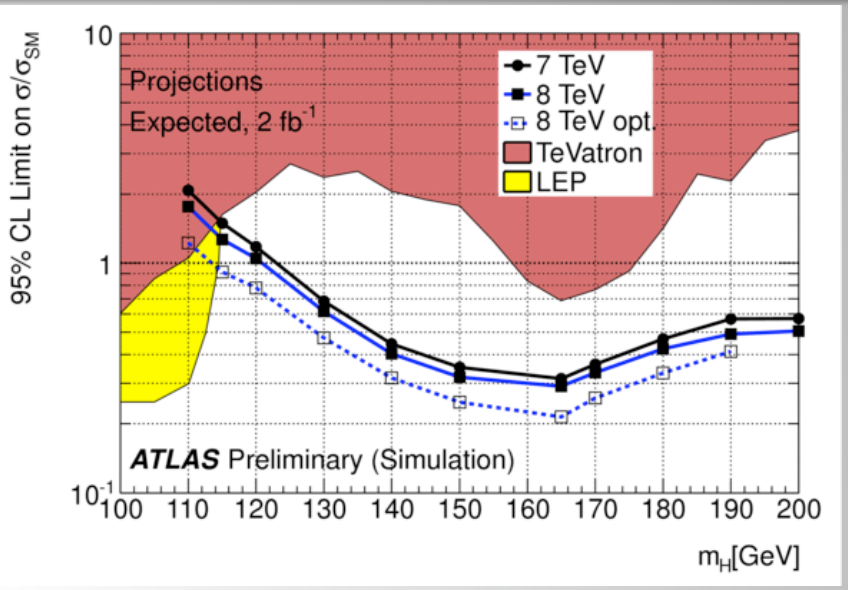
$\sigma(t\bar{t}bar) = 145 \pm 31\ (stat.)\ ^{+42}_{-27}\ (syst.)$ pb

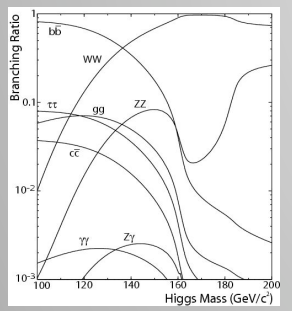
semi-leptonic: syst. from background, b-tagging, ISR/FSR, JES, lumi.
fully leptonic: stat. limited

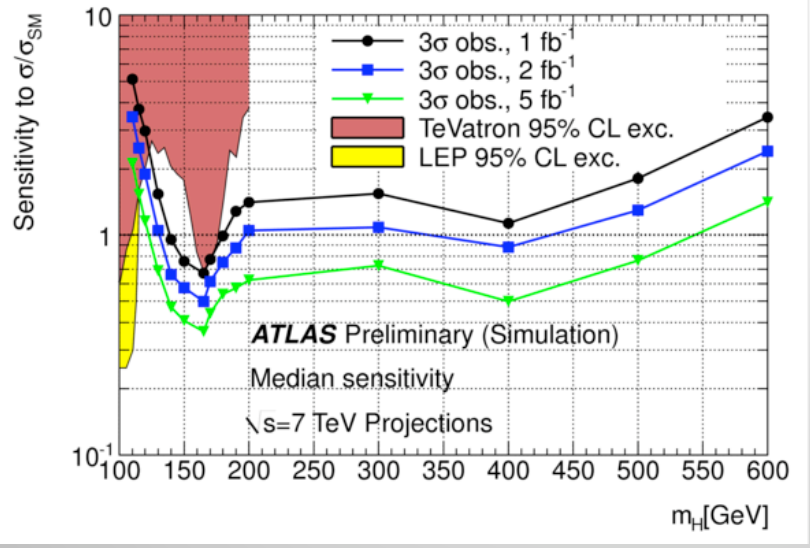


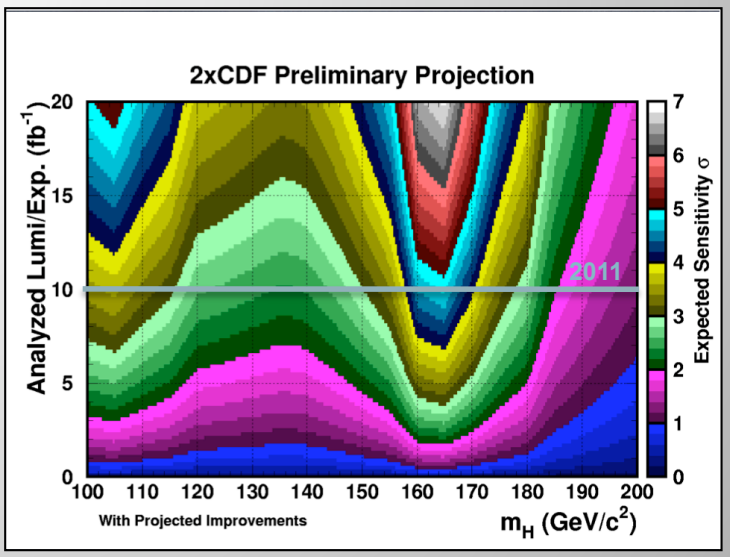
Higgs details



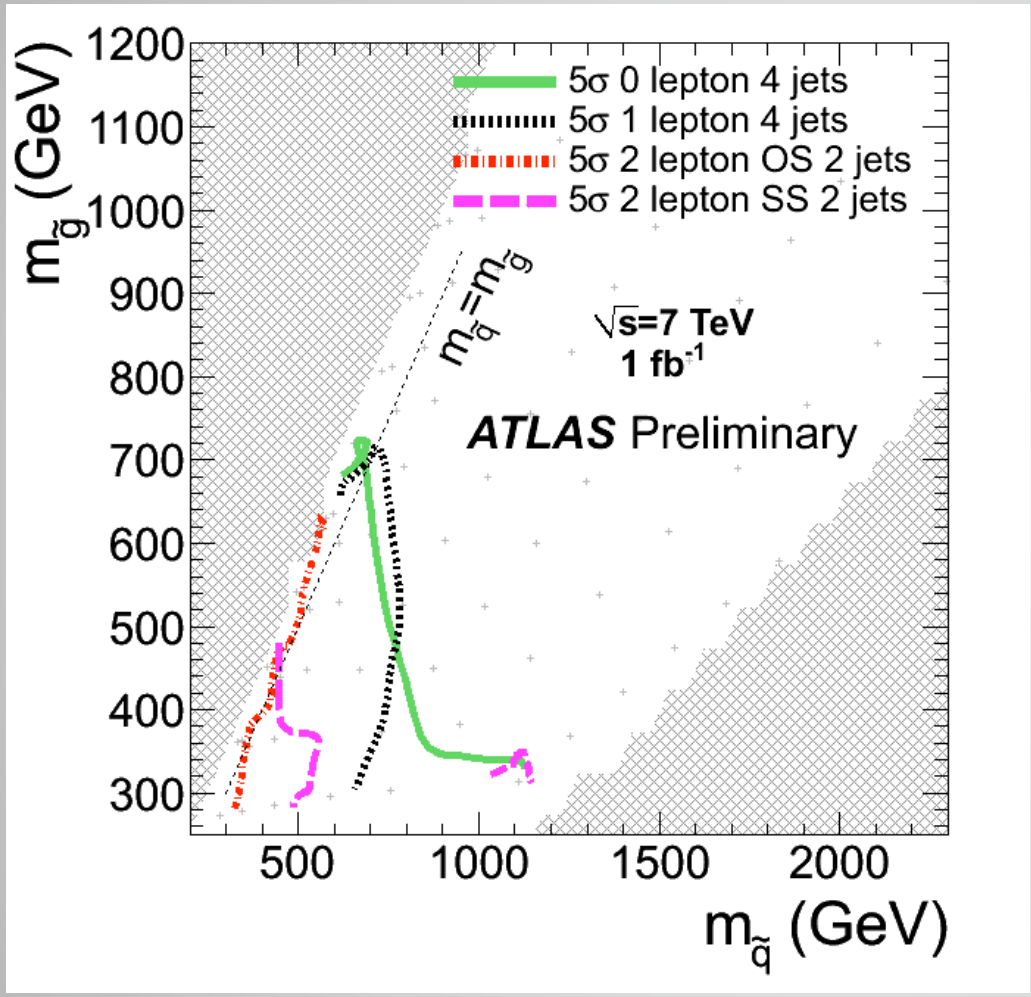






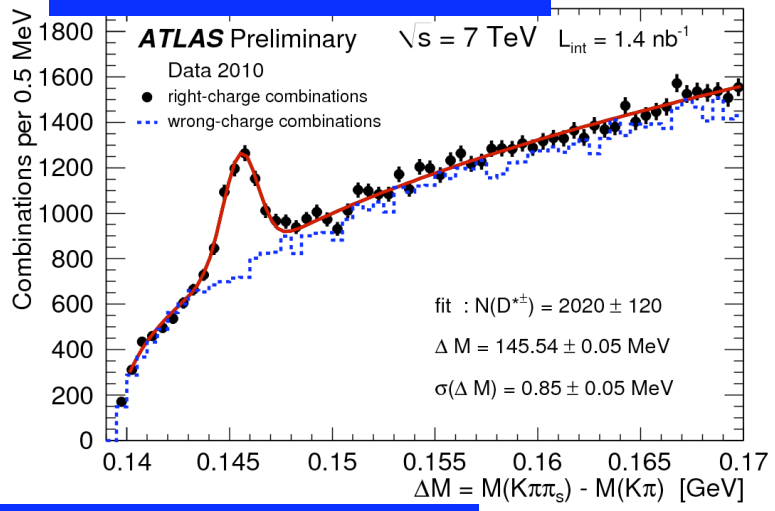


SUSY reach

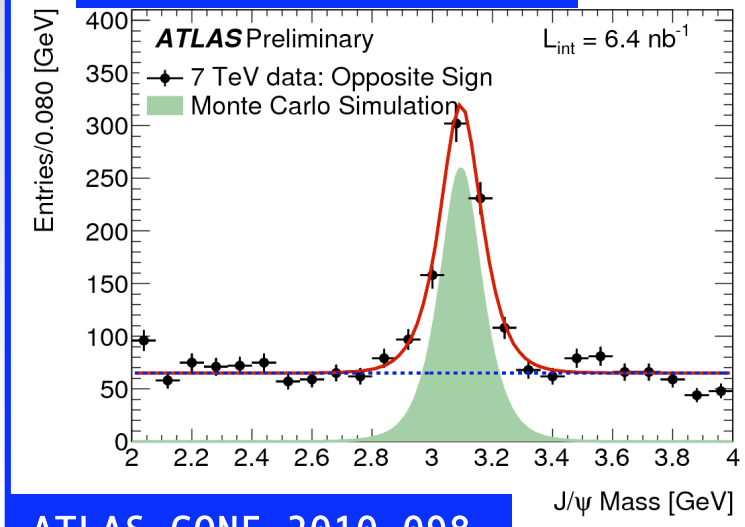

5σ 0 lepton 4 jets
5σ 1 lepton 4 jets
5σ 2 lepton OS 2 jets
5σ 2 lepton SS 2 jets
$m_{\tilde{q}}=m_{\tilde{g}}$
$\sqrt{s}$=7 TeV
1 fb^{-1}
ATLAS Preliminary
$m_{\tilde{g}}$ (GeV)
$m_{\tilde{q}}$ (GeV)
1200
1100
1000
900
800
700
600
500
400
300
500
1000
1500
2000

B physics

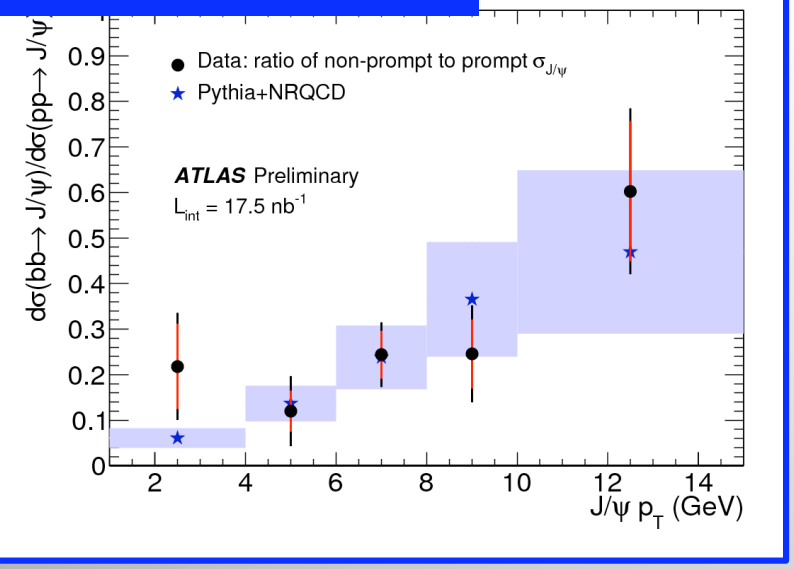
ATLAS-CONF-2010-034



ATLAS-CONF-2010-045



ATLAS-CONF-2010-062



ATLAS-CONF-2010-098