ATLAS in 2011: Status and Prospects

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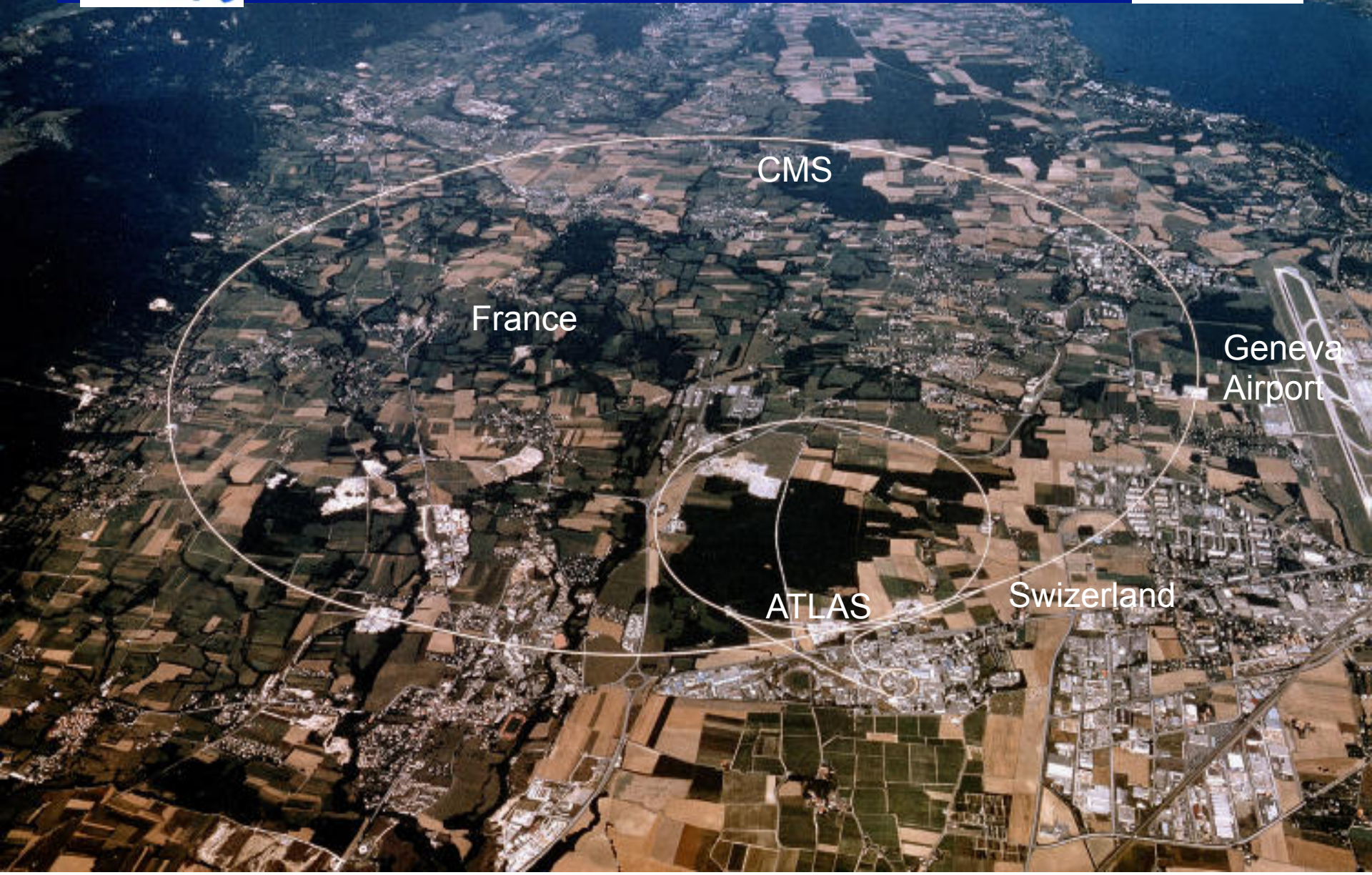
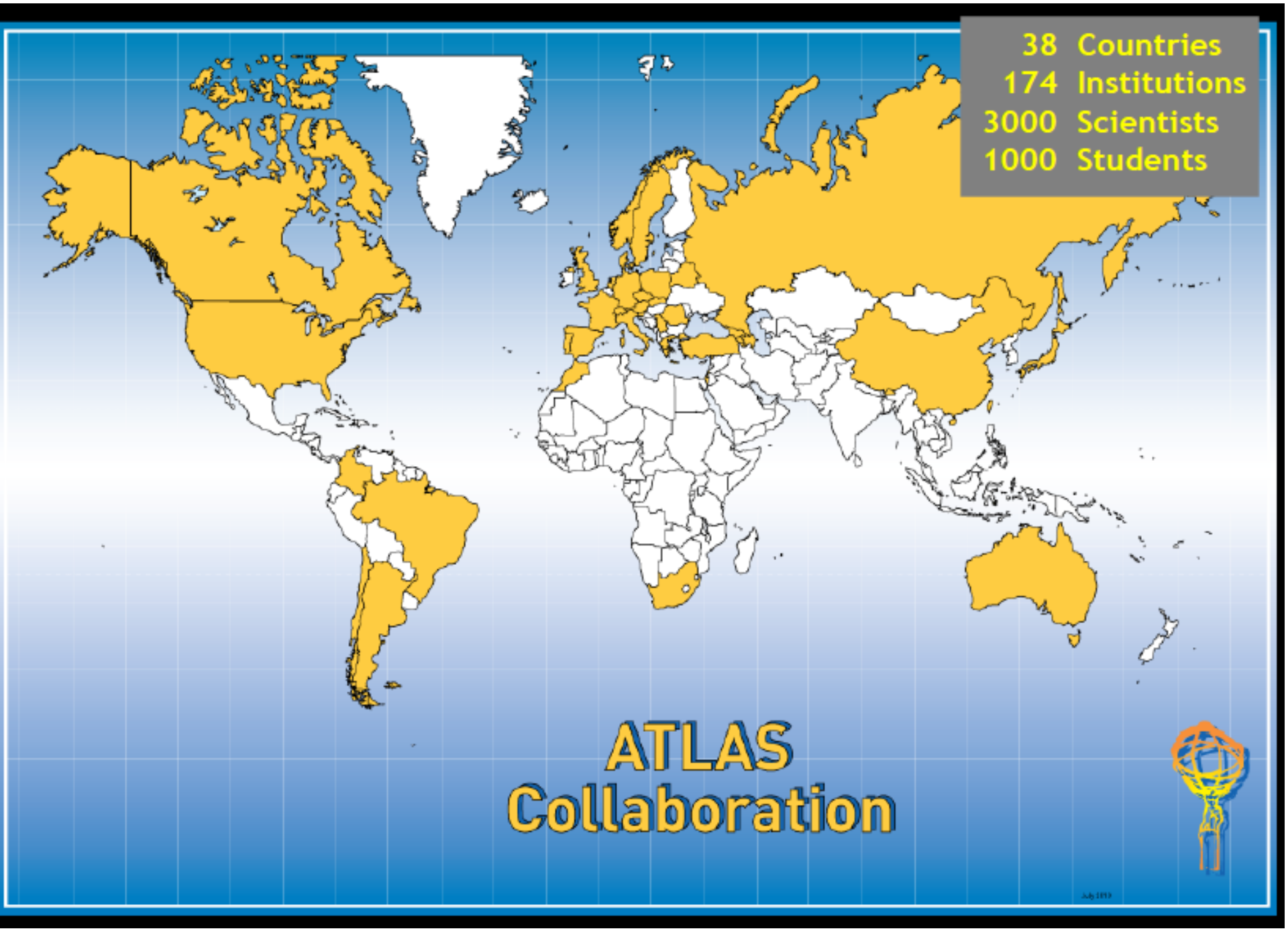
OUTLINE

- The LHC and the Collider Community
- The ATLAS Detector – an overview
- Luminosity 2010-2011
- Brief description of how we do Physics at colliders
- Selected Physics Results
- Plans for the future
- Conclusions

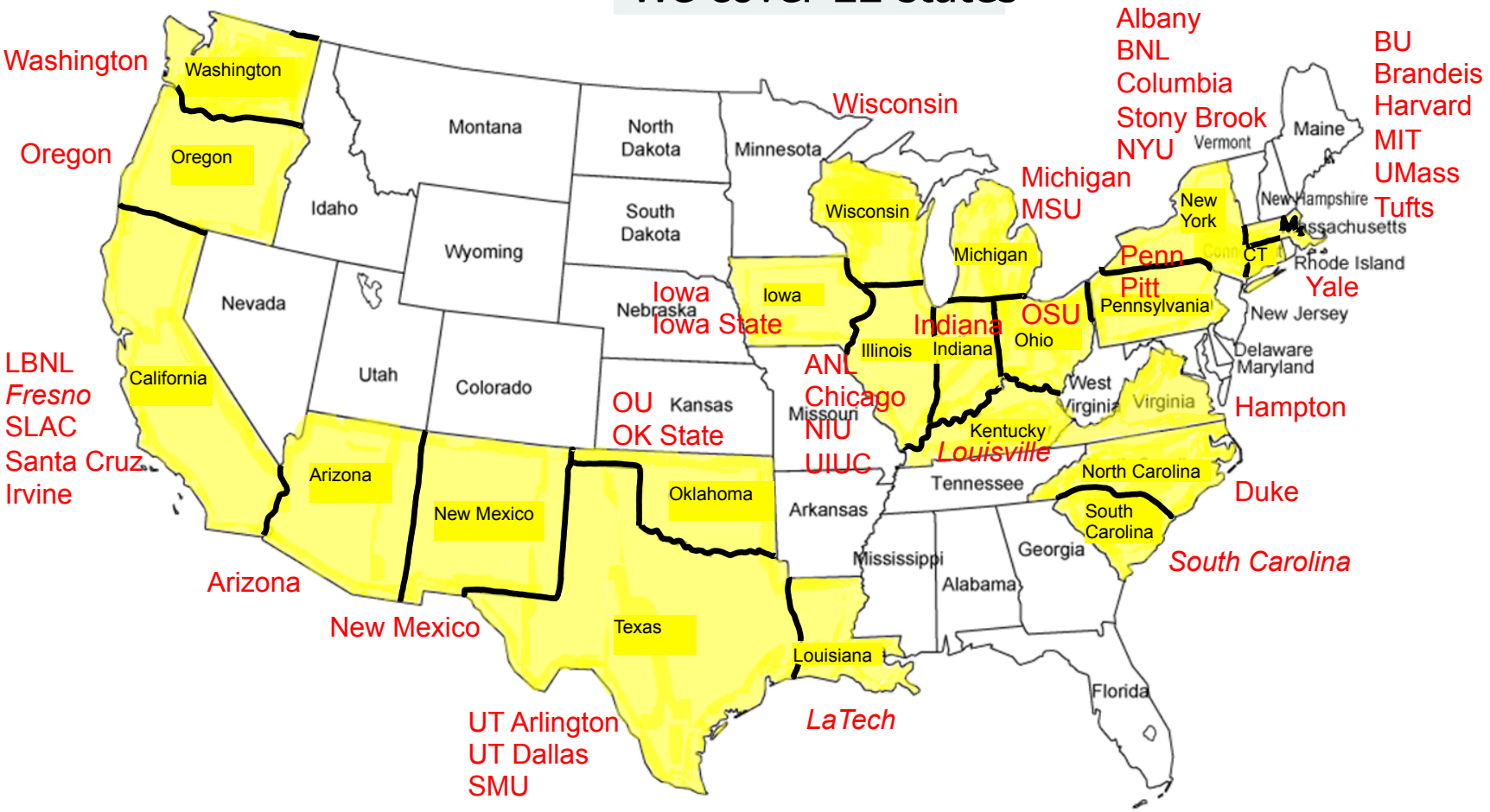
LHC @ CERN Aerial View



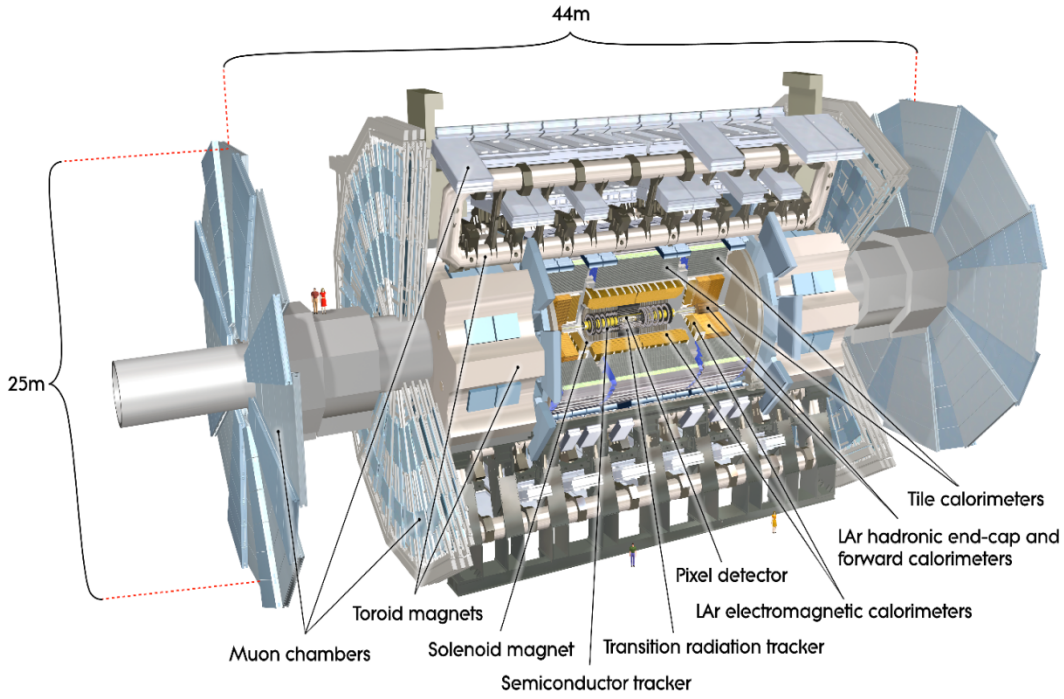

38 Countries
174 Institutions
3000 Scientists
1000 Students
ATLAS
Collaboration

US ATLAS Members

We cover 22 states



The ATLAS Detector



7000 Tons
25 m height
46 m length
0.1 billion channels
3000 km of cables

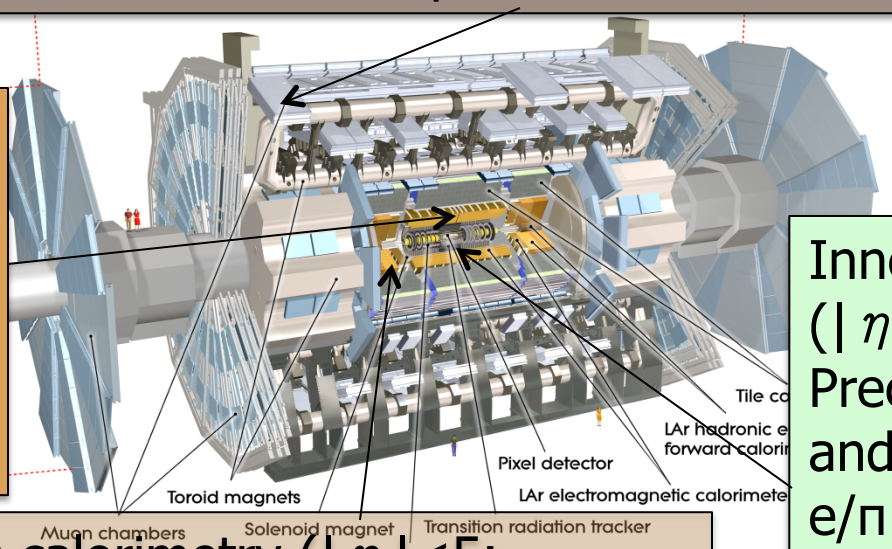
Detector	Channels	% Operational
Pixel	80 M	96.8
SCT	6.3 M	99.1
TRT	350 K	97.5
Lar EM CAL	170 K	99.8
Tile Cal	9800	97.5
HEC	5600	99.6
Forward Lar	3500	99.8
Calo Trigger	7160	99.9
muon RPC Trigger	320 K	99.5
muon TGC Trigger	350 K	100
MDT	350 K	99.7
CSC	31 K	97.7
RPC	370 K	97.0
TGC	320 K	98.1

ATLAS: "A Toroidal LHC ApparatuS"

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

Muon Spectrometer ($|\eta|<2.7$) : air-core toroids gas-based chambers Trigger 6 to 40 GeV & Reconstruction $\Delta P\mu / P\mu < 10\%$ up to $P\mu \sim 1$ TeV

EM calorimeter: Pb-LAr Accordion
e/γ trigger, identification measurement
E-resolution: $\sigma/E \sim 10\%/\sqrt{E}$

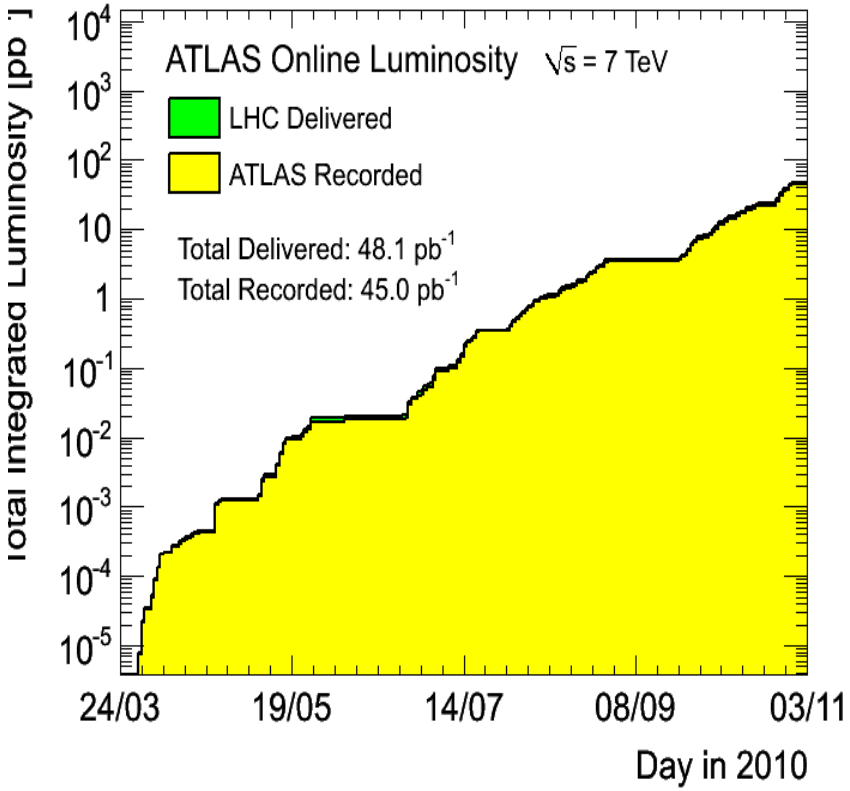


Inner Detector ($|\eta|<2.5$, B=2T): Precise tracking and vertexing
e/π separation
$\sigma/pT \sim 3.8\text{x}10\text{-}4\ pT\ (GeV) \oplus 0.01$

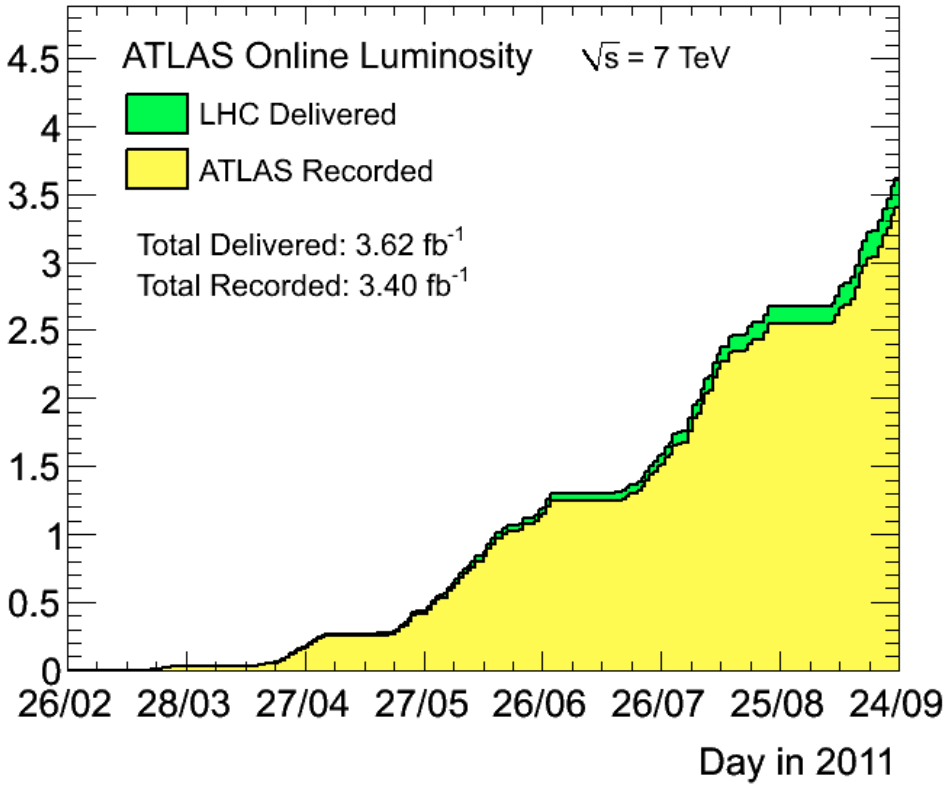
HAD calorimetry ($|\eta|<5$: segmentation, hermeticity
Fe/scintillator Tiles (central), Cu/W-LAr (fwd)
Trigger and measurement of jets and missing E_T E-resolution:
$\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

LHC Performance: Integrated Luminosity

Exponential increase in 2010



Continued steady delivery of beam in 2011

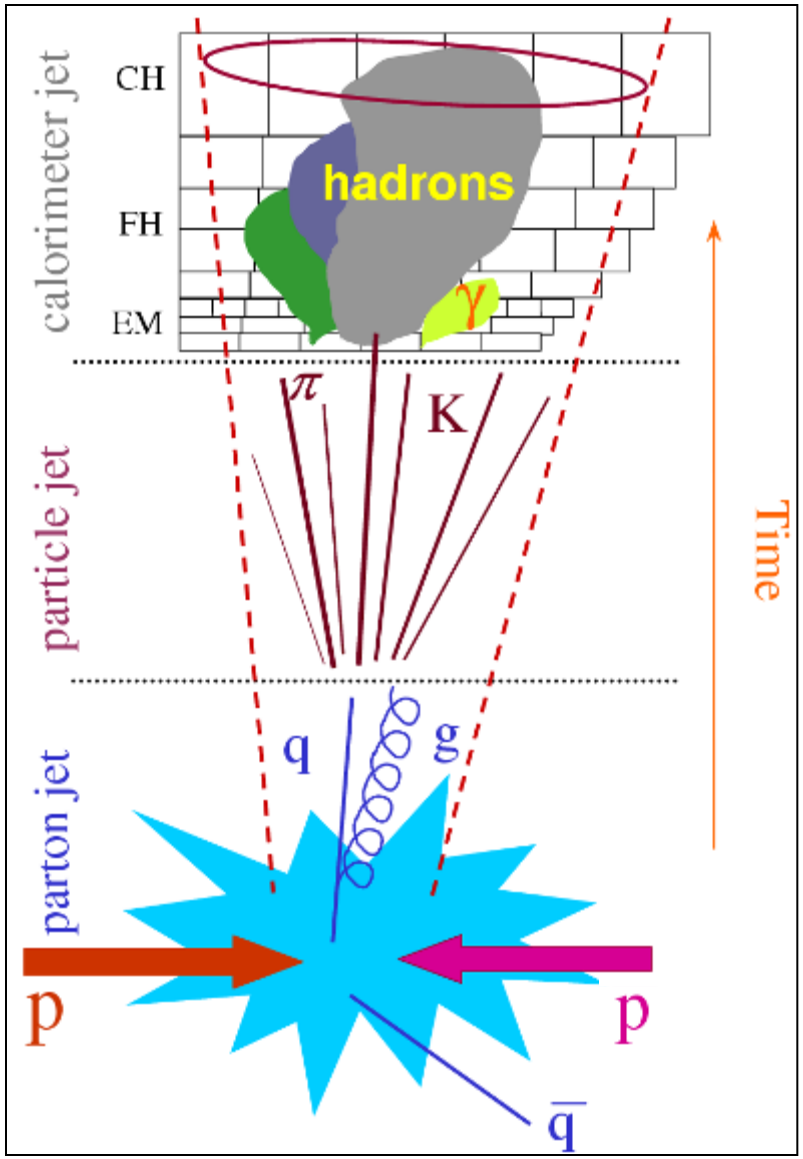


Note: Luminosity in units of inverse cross section

ATLAS Measures Energy Deposits & Tracks of "Objects of Interest"

- These objects are:
  - Hadronic Jets
  - Electrons, muons,taus
  - Photons
  - Missing E_T
  - …
- "Patterns" of identified objects are:
  - Recognized by sophisticated triggers (hardware & software);
  - compiled: saved as "event" data (stored, distributed, histogrammed);
  - then analyzed: compared to predictions of theoretical models (SM & Beyond SM).
- These analyses are done by individual Physics groups: QCD, Electroweak, Higgs, Top, B-physics, Exotics, SUSY, etc.

Parton-, Particle-, Detector- "Jets"



- Use Jet Definition to relate Observables defined on Partons, Particles, Detector

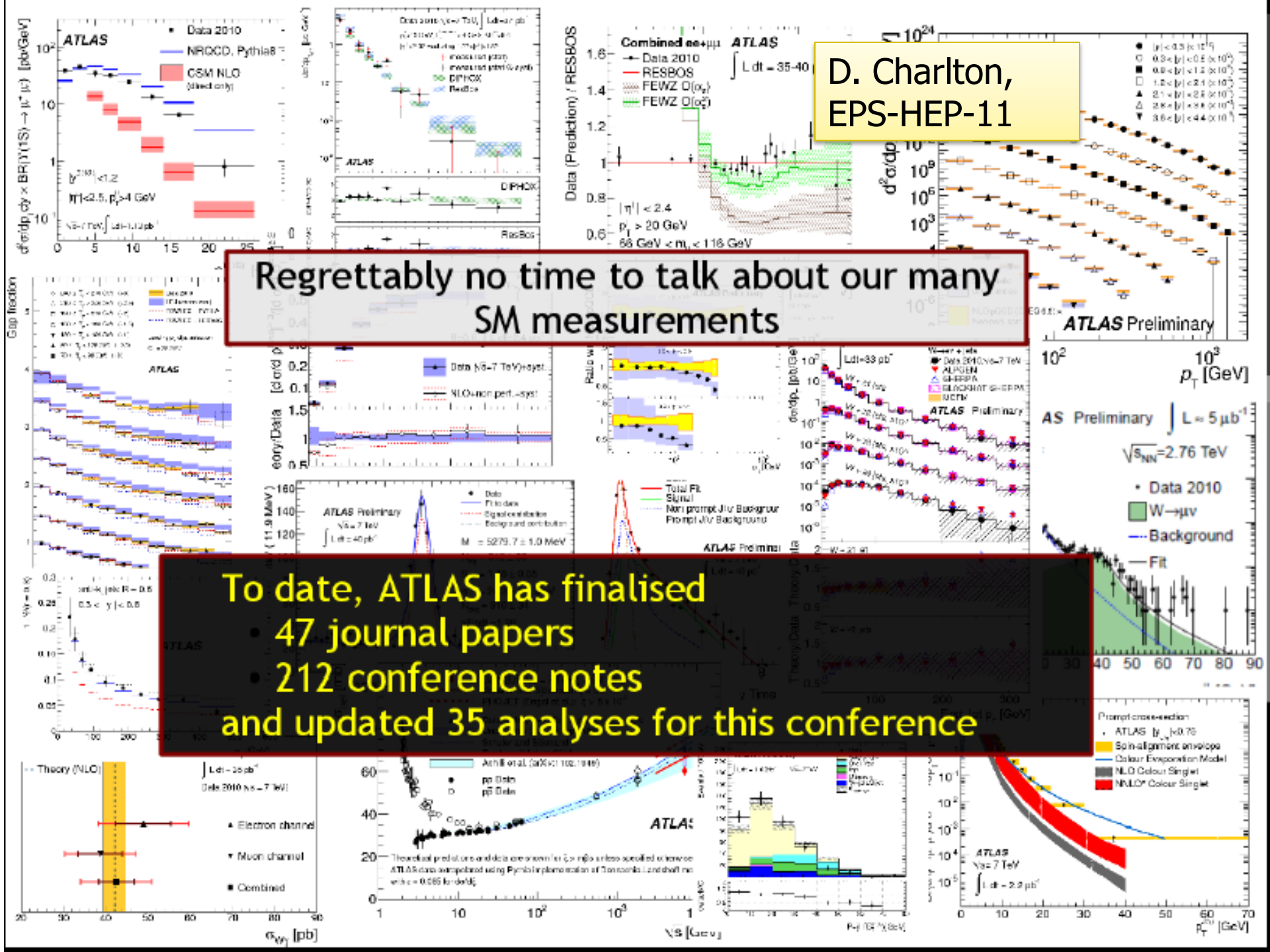
- Direct Observation:
  Energy Deposits / Tracks

- Stable Particles (=True Observable)

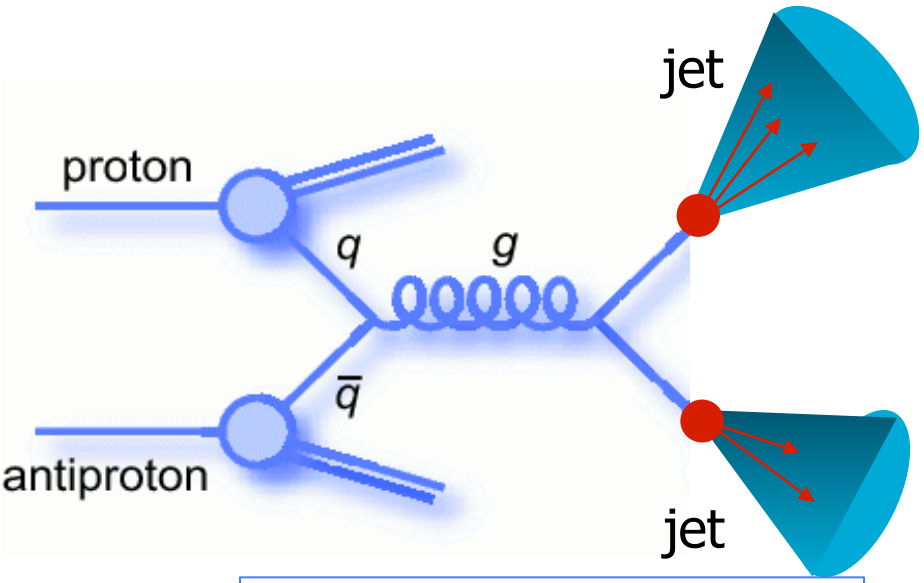
- Idealized: Parton-Jets

  no Observable (color confinement)

  but: quantity predicted in pQCD

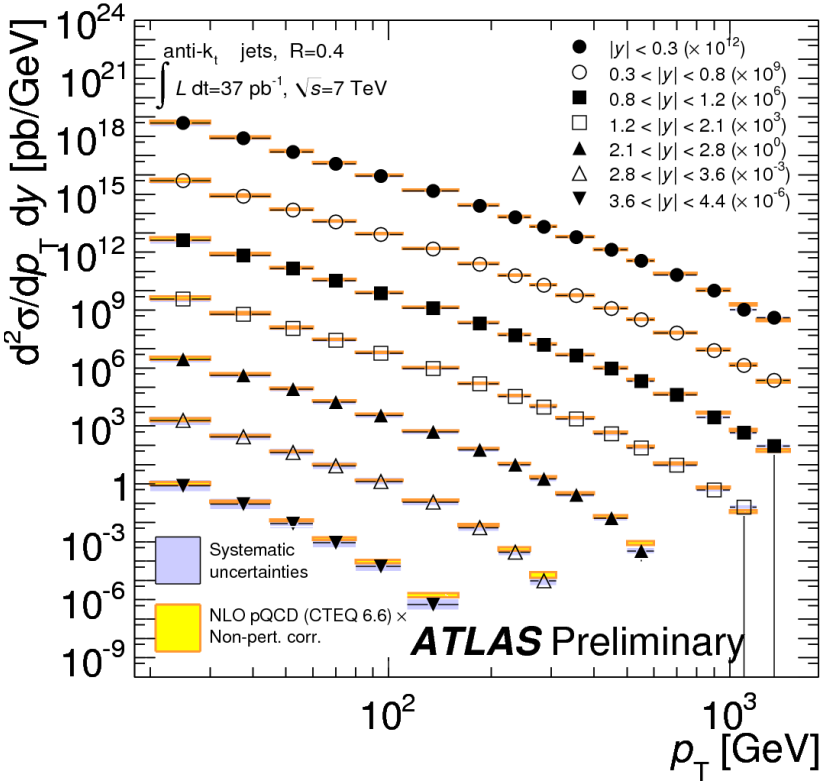

D. Charlton,
EPS-HEP-11
Regrettably no time to talk about our many SM measurements
To date, ATLAS has finalised
• 47 journal papers
• 212 conference notes
and updated 35 analyses for this conference

Selected QCD Results



Count sizeable jets
-predicted by theory (pQCD)
-Full agreement of the data with the NLO calculation

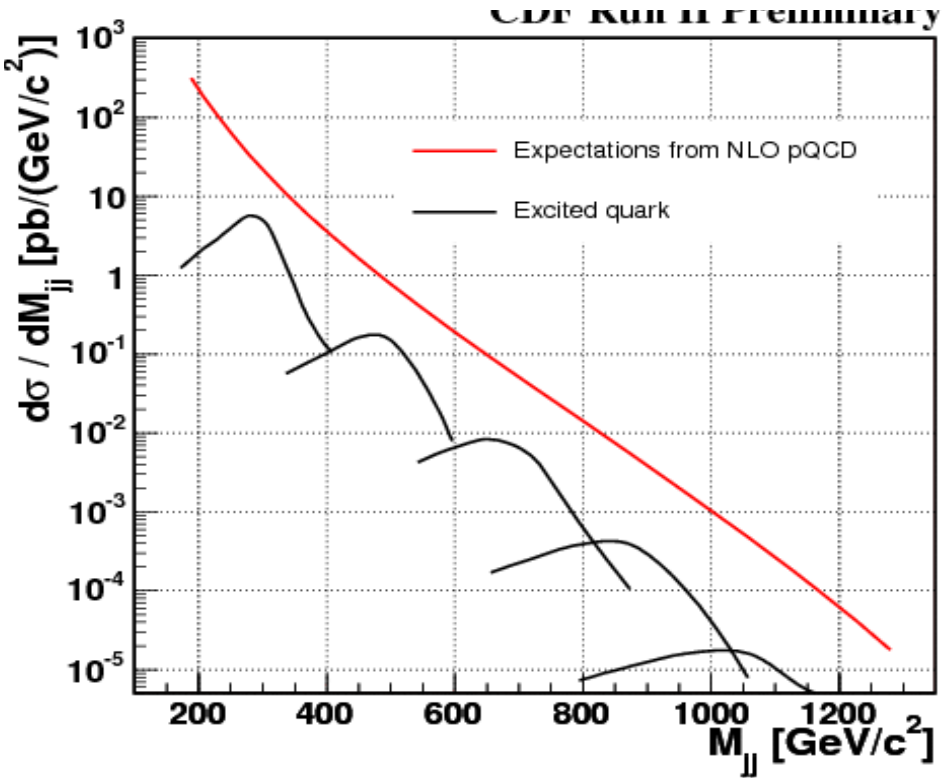
Inclusive jet cross-sections

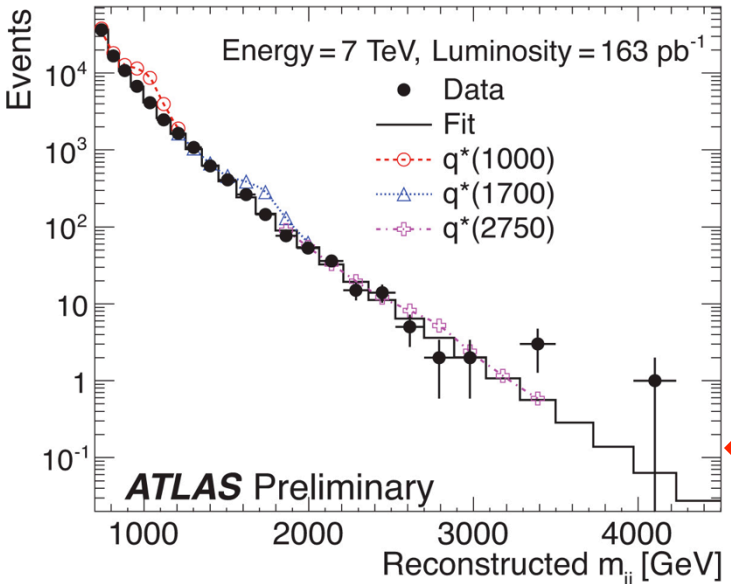


Dijet Production

central dijet production |y|<1

- test pQCD predictions
- sensitive to new particles decaying into dijets: excited quarks, Z' , W' , Randall-Sundrum gravitons, color-octet, techni-rho, axigluons, colorons





2010 + early 20ll data

Dijet Production

central dijet production |y|<1

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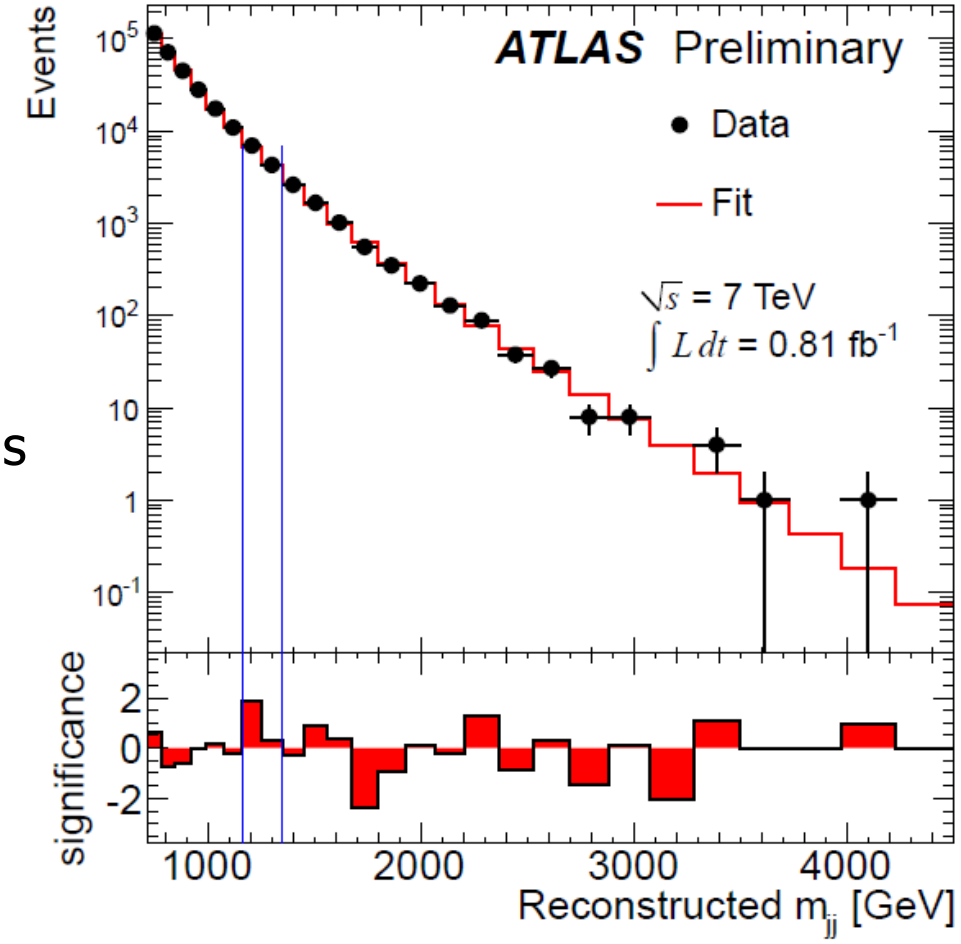
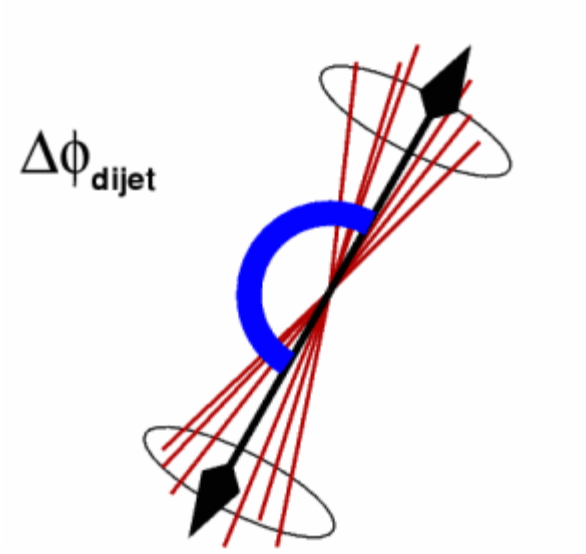


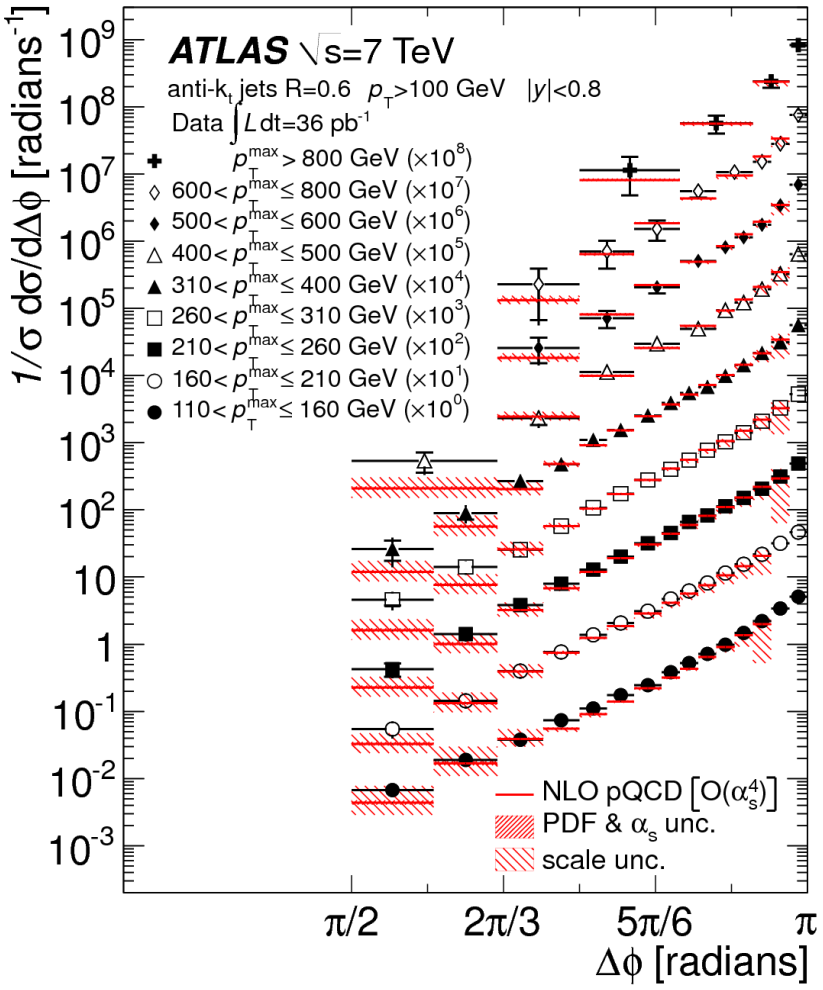
Dijet Azimuthal Decorrelations

Idea: Dijet Azimuthal Angle is sensitive to QCD radiation (additional jets)

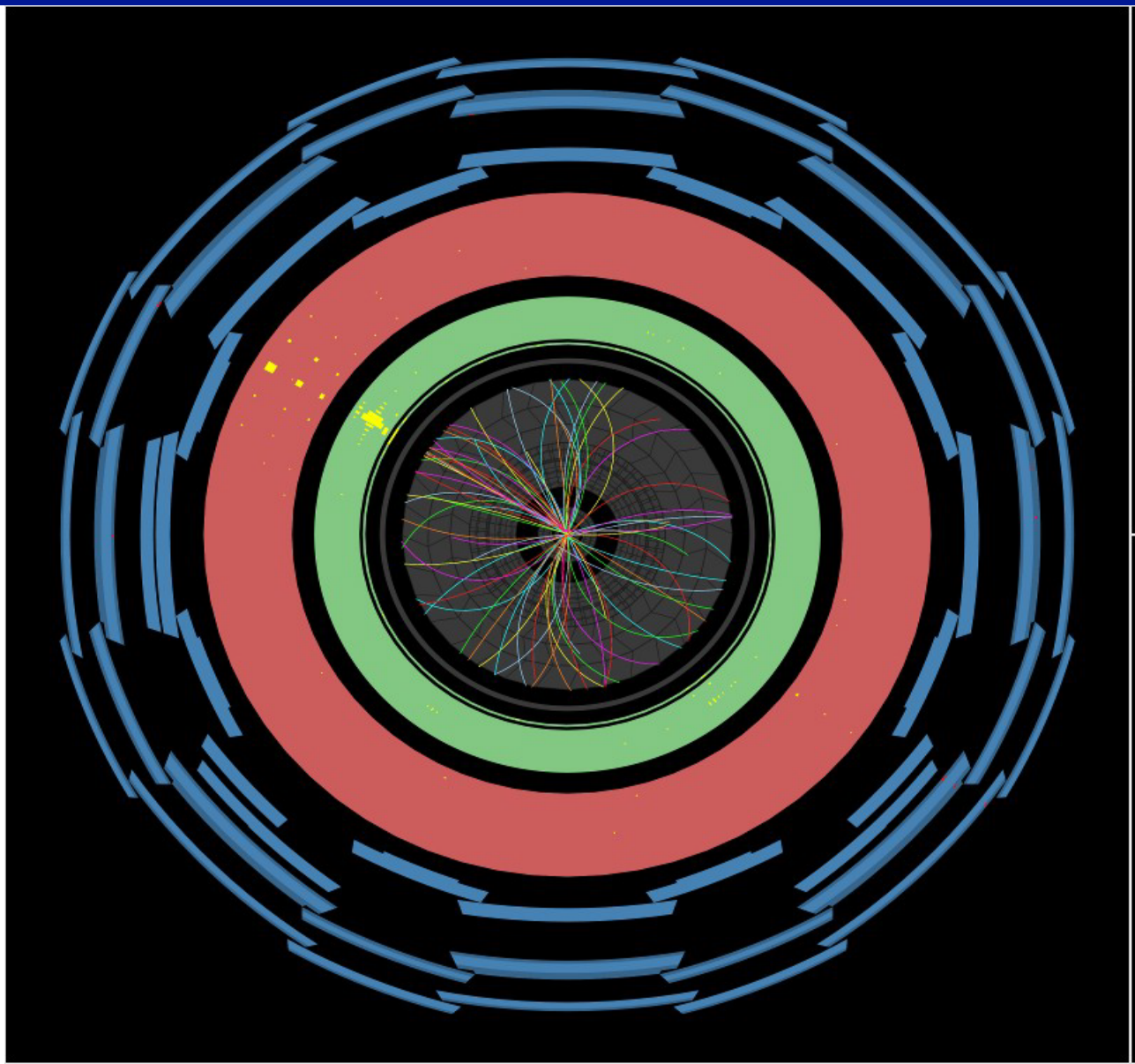
Test Parton-Shower

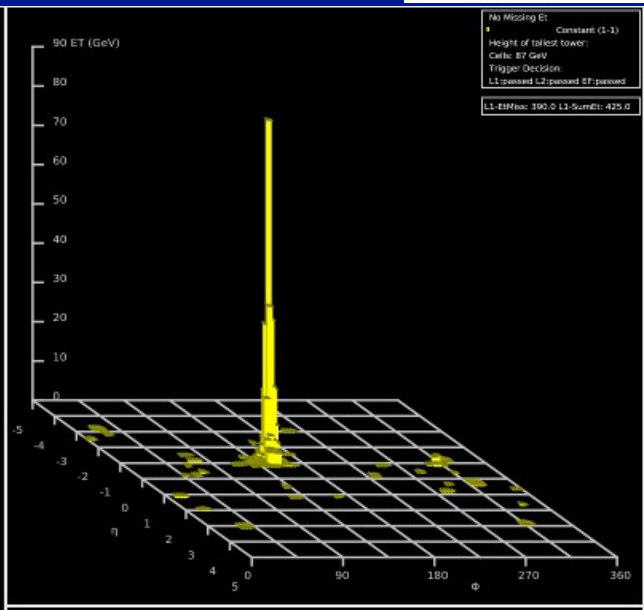
Test 3-Jet NLO





A high-pT monojet event – SM interpretation Z → $\nu\ \nu$ + jet





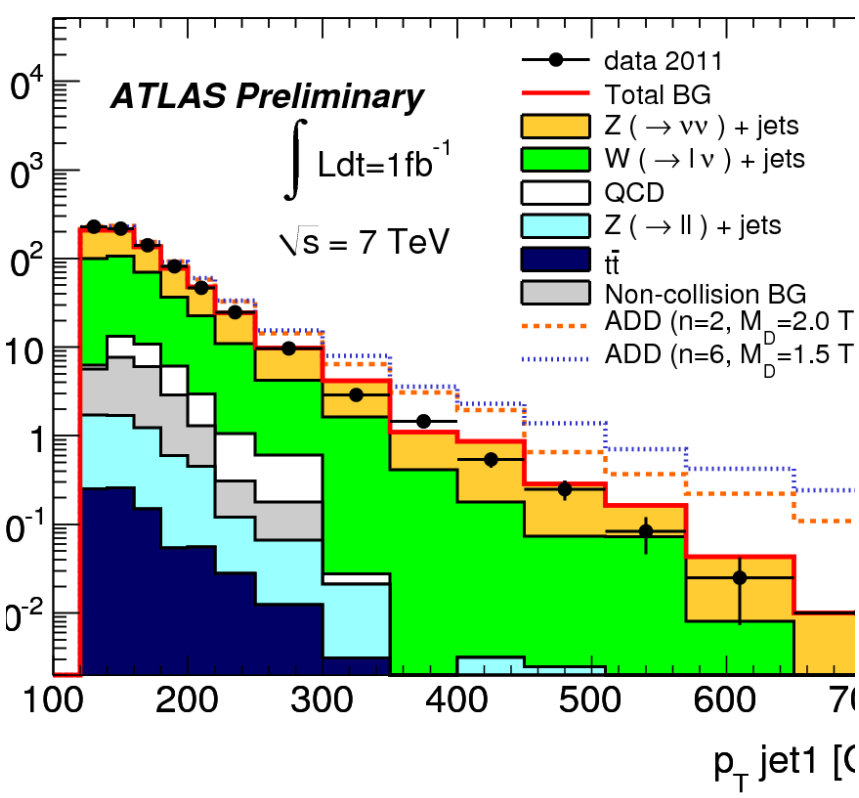
ATLAS EXPERIMENT

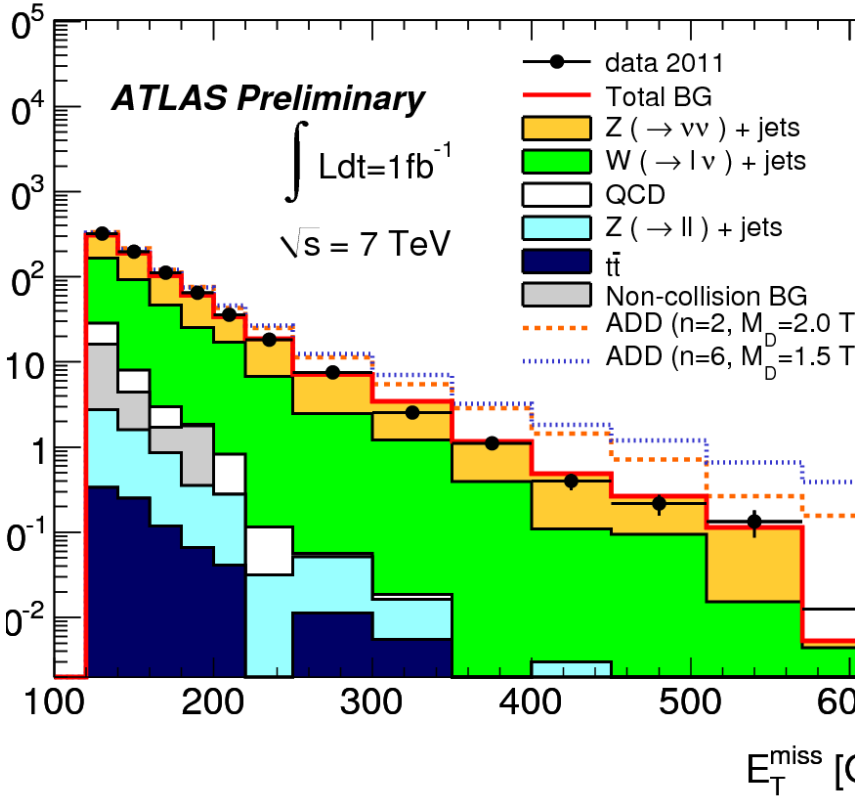
Run Number: 180309, Event Number: 36060682

Date: 2011-04-27 02:33:15 CEST

Monojet (Jet + ET_{miss})

High-pT jet opposite ~no activity:Standard Model: Z→ ν ν or Large-extra dimensions with unobserved graviton



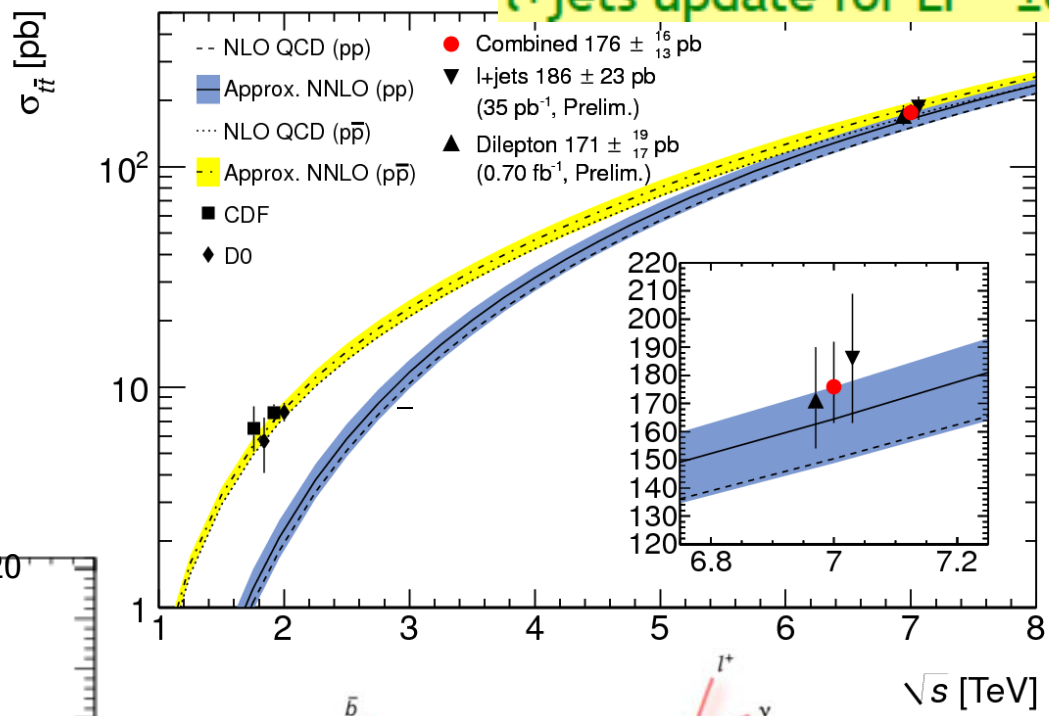


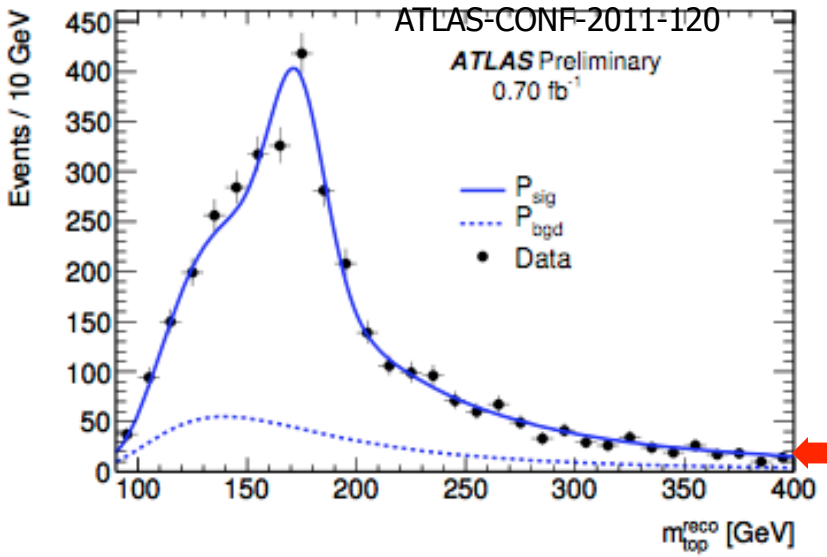
Selected Top Physics results

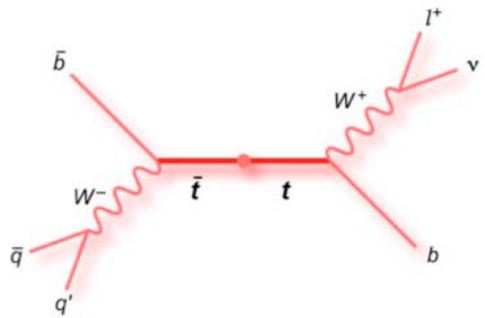
Wide range of analyses completed this summer with 0.7 fb^{-1} with 2011 data:

- mass, cross-section updates
- spin correlations
- W helicity
- top to tau decays
- ….

Dileptonic tt cross-section, l+jets update for LP ~±6.5%

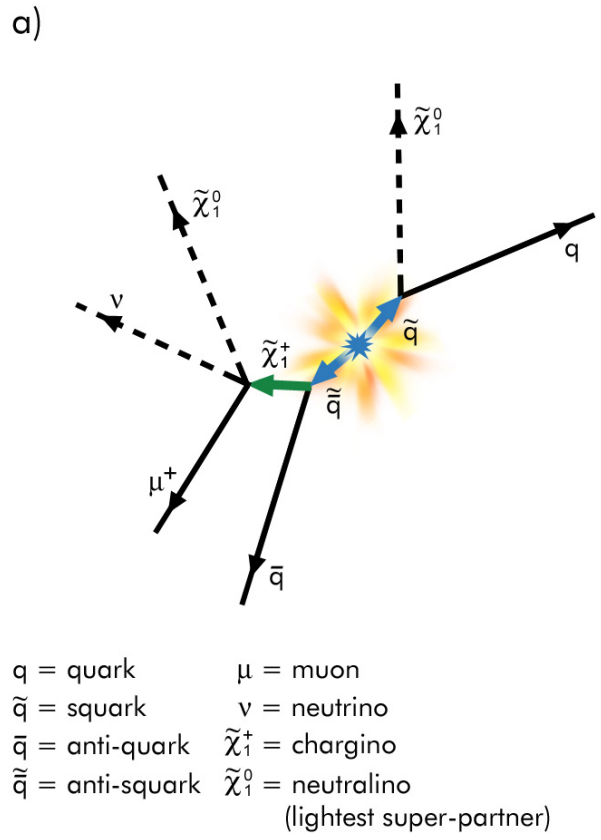


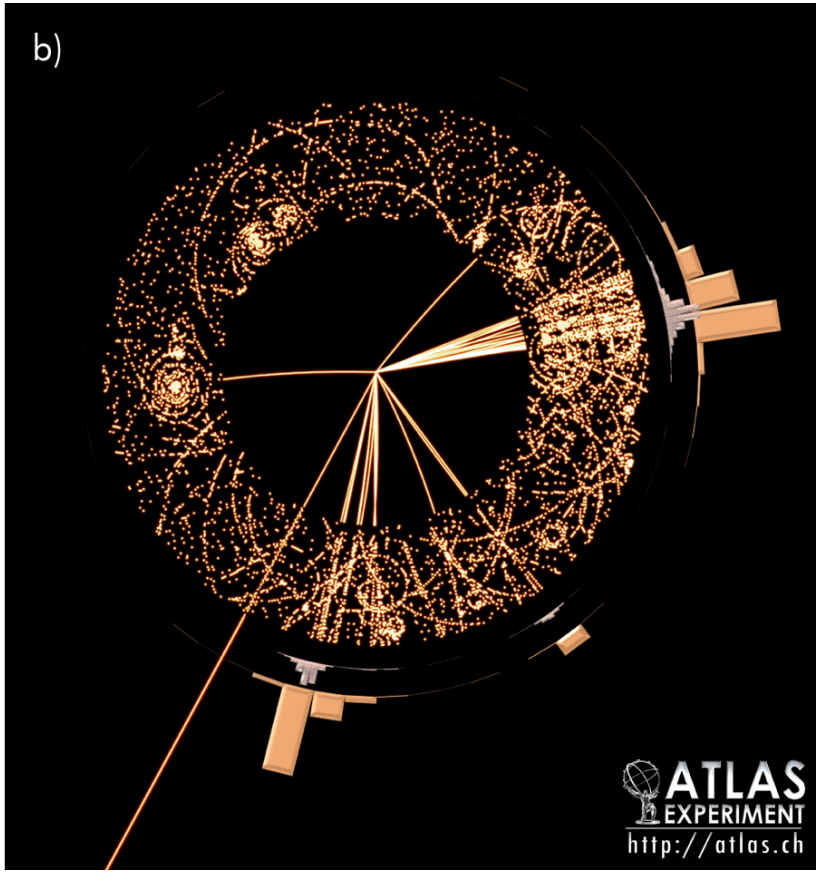




m_{top}=175.9 ±0.9(stat)±2.7(syst) GeV

Selected SUSY Search

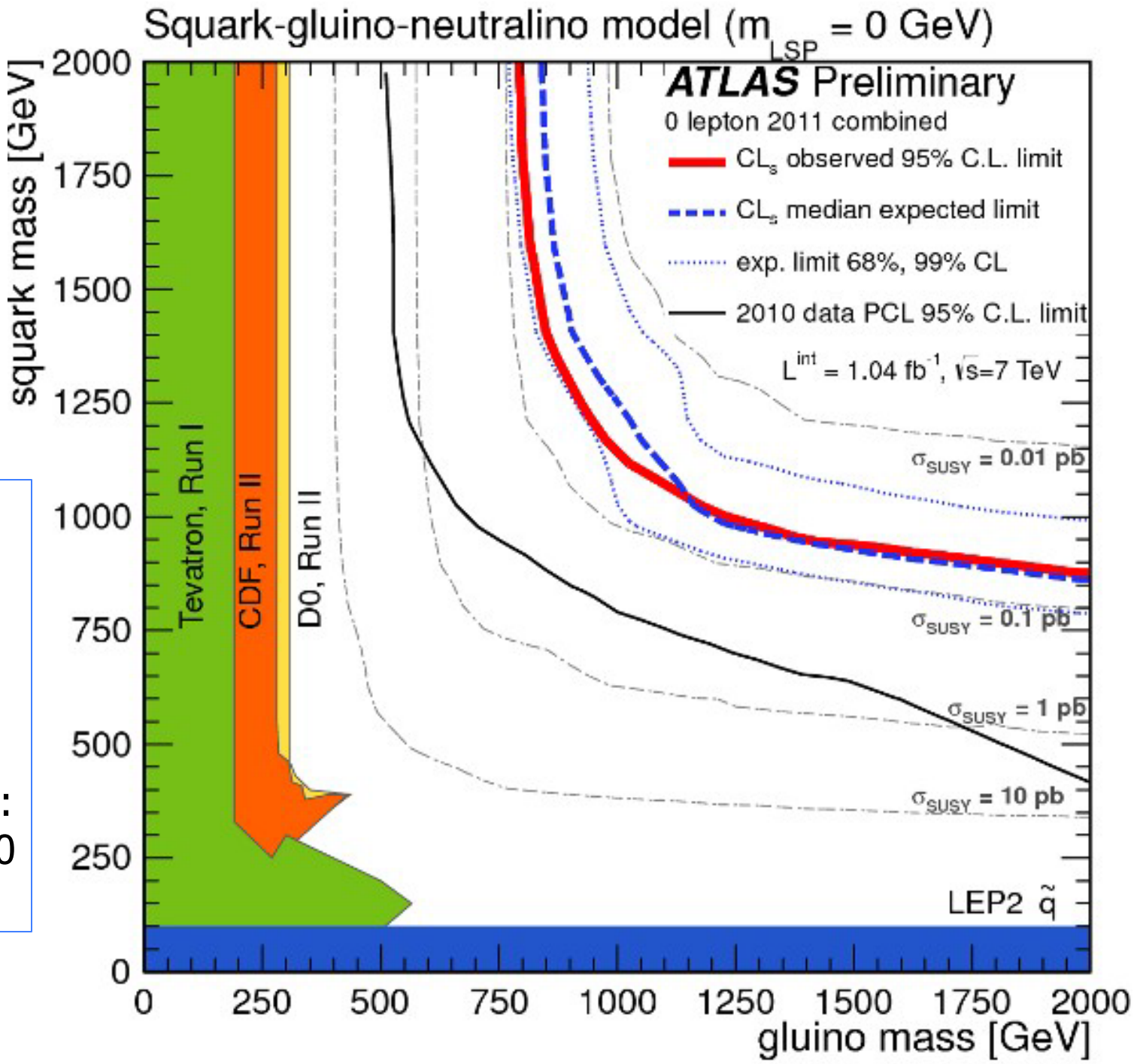




The collision of two protons results in the production of a squark and an antisquark (the super-partner of the quark and its antiparticle). These decay into lighter particles, one of which,a "chargino", also decays into still more particles.

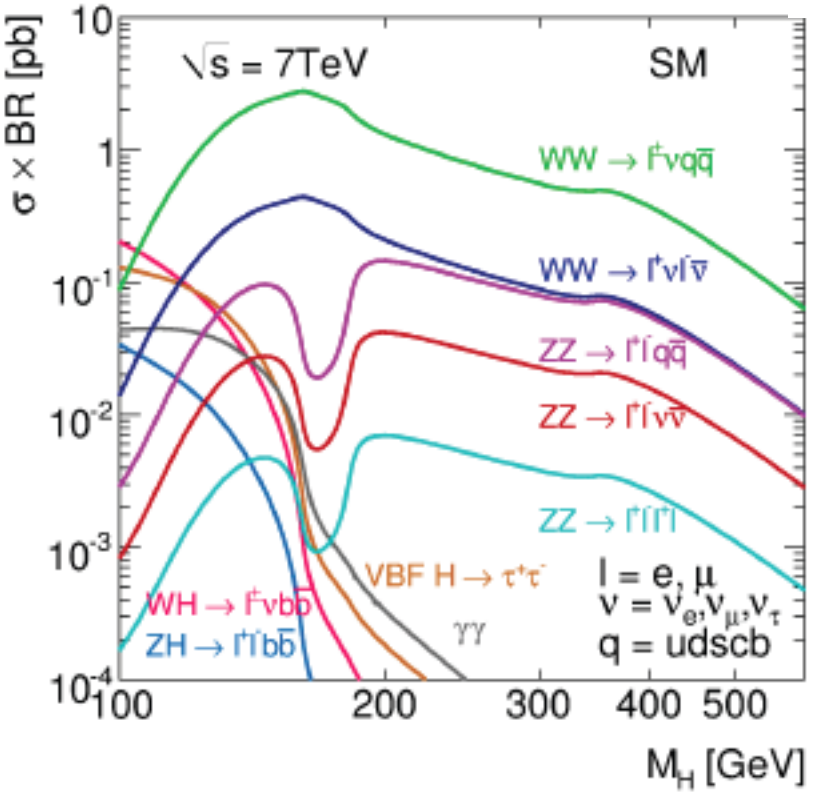
SELECTED SUSY EXCLUSION PLOT

ATLAS Limit Curves:
Black = 2010
Red = 2011



Selected Higgs results

- **H→γγ**: rare channel, but the best for low mass
- **H→WW(*)**:
  - →lvlv: very important in the intermediate mass range
  - → lvqq: highest rate, important at high mass
- **H→ZZ(*)**:
  - → 4l: golden channel
  - → llvv: good for high mass
  - → llbb: also high mass
- **H→ττ**: good signal/ background, important at low mass, rare
- Associated prod. **H→ bb-bar**
  - ttH, WH, ZH
  - It is useful for the discovery
  - It is very important for Higgs property studies if SM Higgs is discovered

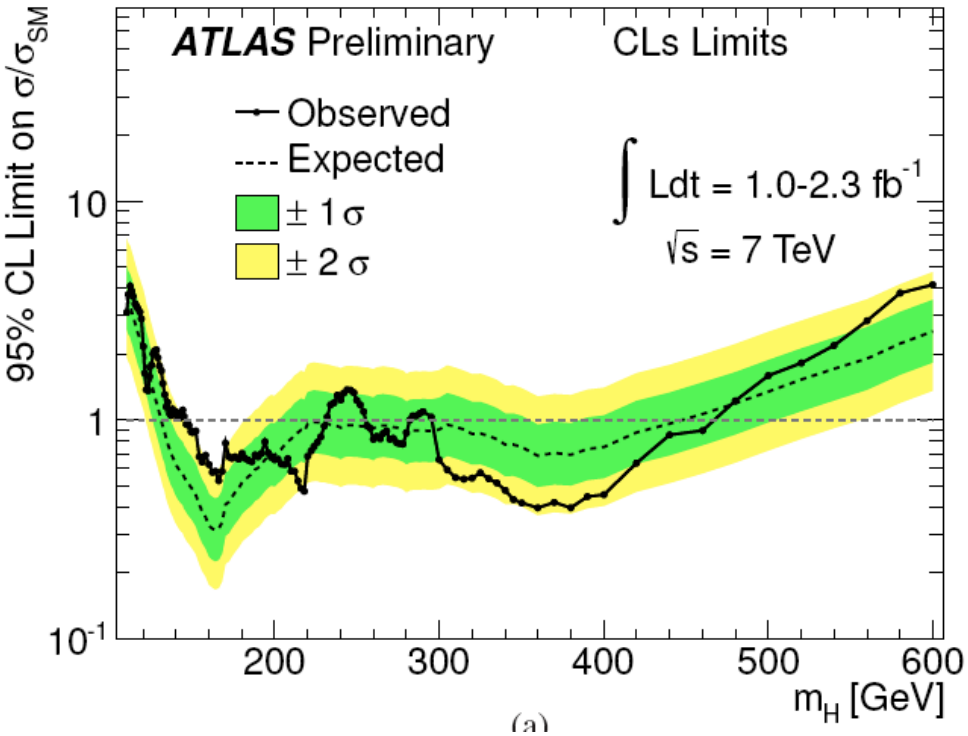


A. Nisati, LP11

Events expected to be produced with L=1 fb^{-1}

m_H, GeV	WW→lvlv	ZZ→4l	γγ
120	127	1.5	43
150	390	4.6	16
300	89	3.8	0.04

Selected Higgs results



The combined upper limit on the Standard Model Higgs boson production cross section divided by the Standard Model expectation as a function of m_H is indicated by the solid line. This is a 95% CL limit using the CLs method in the entire mass range.

Channels used in the Combination:

1. $H \rightarrow \gamma\gamma$
2. $VH, H \rightarrow bb$
3. $H \rightarrow \tau\tau$
4. $H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$
5. $H \rightarrow ZZ^{(*)} \rightarrow llll$
6. $H \rightarrow ZZ^{(*)} \rightarrow ll\nu\nu$
7. $H \rightarrow ZZ^{(*)} \rightarrow llqq$

A. Nisati, LP11

Standard Model Higgs boson mass excluded at 95% C.L.:
146<mH<232, GeV
256 <mH< 282 GeV
296 <mH< 466 GeV

Plans for 2011-2012

- Many of the present analyses will be updated to 2 fb^{-1} in next few weeks
- Proton physics will continue for ~two weeks, expecting >4.6 fb^{-1}
- Heavy ion physics during last 3 weeks of November up to Christmas shutdown starting ~Dec. 7
- Planning of analysis strategies for the next round of Winter Conferences is ongoing
- 2012 LHC running parameters still to be fully defined- looking into higher beam energy but cautiously
- Early LHC upper limits on the presence of new physics underscore the importance of developing the tools necessary to understand the Standard Model at a level of precision necessary to be able to recognize deviations due to new physics
- Certainly challenging and exciting times are ahead!

Conclusions

- Since SESAPS 2010, the LHC and ATLAS continue to work very well!
- Many important measurements now available at $\sqrt{s}$ = 7 TeV
- No evidence yet of Beyond-SM physics
- After more than 2 fb^{-1} of data has been analyzed by ATLAS to perform

Higgs searches, no significant excess ($< 2.1\sigma$) is found in the mass range 110-600 GeV studies by ATLAS; exclusion limits at 95%C.L. are placed in the mass regions:

– 146 < mH< 232 GeV

– 256 < mH< 282 GeV

– 296 < mH< 466 GeV

- Early LHC upper limits on the presence of new physics underscore the importance of developing the tools necessary to understand the Standard Model with even greater precision.