# ATLAS group report

Judith Katzy PRC meeting 25.10.2011

# ATLAS GROUP PROJECTS

Current detector

Upgrade

**ALFA**

commissioning
calibration
measurement

**SCT Operations**

Monitoring
Calibration

**IBL**

Module assembly

**Strip upgrade**

Module R&D

Detector simulations
Test beam studies /telescope

Frozen showers

Detector work

**Top**

$\sigma_{Ttbar}$

Ttbar+jets

resonances

Boosted top

**Vector Bosons**

$\sigma_{W,Z}$

$Z_{pt}$

$W \rightarrow \tau \nu$

$Z \rightarrow \tau\tau$

Electron calib.

**Higgs**

$H \rightarrow \gamma\gamma$

Material map.

**SUSY**

0 lept+jets+MET
1 lept+jets+MET
2 lept+jets+MET
$\gamma\gamma$ + MET
$\tau\tau$+jets

MC Tuning

Electron+photon trigger

Analysis

# People & positions

- Publication Committee Chair + EB member (K.Moenig)
- Top egamma liaison position (H.Zhu)
- Top MC production manager (L.Mijovic)
- Deputy trigger coordinator of egamma group (T.Kono)
- Deputy conditions data base coordinator (D.South starting ~1st Nov.)
- MC tuning forum convener (J.Katzy)
- MC software manager (J.Kotanski)
- Chair of German LHC Outreach Group GELOG (T.Naumann)

- Coordinator of ALFA run (K.-H.Hiller)
- Module convener for Phase 2 (I.Gregor)
- Inner tracker upgrade simulation conveners (P.Vankov, N.Styles)

14 permanent
3 tenure track (incl.1 YIG)
20 postdoc
20 PhD
+ 1 YIG (top physics) funded,
start latest in spring

57 Total (not including dipl/masters)

① "Measurement of the inclusive W ± and Z/$\gamma$ * cross sections in the e and μ decay channels in pp collisions at √s = 7 TeV with the ATLAS detector" (submitted to Phys.Rev.D)

② "Measurement of the transverse momentum distribution of Z/$\gamma$ * bosons in proton-proton collisions at √s = 7 TeV with the ATLAS detector "arXiv:1107.2381 (accepted by PLB)

③ "Measurement of the W to tau nu Cross Section in pp Collisions at sqrt(s) = 7 TeV with the ATLAS experiment", arXiv:1108.4101 (submitted to PLB)

④ "Measurement of the b-jet cross section in events with a W boson" arXiv:1109.1470 [hep-ex] (submitted to PLB)

⑤ "Measurement of multi-jet cross sections in proton-proton collisions at a 7 TeV center-of-mass energy", arXiv:1107.2092 (accepted by EPJC)

⑥ "Measurement of the inclusive isolated prompt photon cross-section in p p collisions at √s = 7 TeV using 35 pb−1 of ATLAS data" arXiv:1108.0253 (submitted to Phys.Lett.B)

⑦ "Search for the Standard Model Higgs boson in the two photon decay channel with the ATLAS detector at the LHC" arXiv:1108.5895 (submitted to Phys.Lett.B)

⑧ "Measurement of Jet Mass and Substructure for Inclusive Jets in √s = 7 TeV pp Collisions with the ATLAS Experiment" (ATLAS-CONF-2011-073)

⑨ "A Search for New High-Mass Phenomena Producing Top Quarks with the ATLAS Experiment" (ATLAS-CONF-2011-070)

⑩ "A Search for tt Resonances in the Lepton Plus Jets Channel in 200 $pb^{-1}$ of pp Collisions at √s =7 TeV (ATLAS-CONF-2011-087)

11 "Boosted objects: a probe of beyond the Standard Model physics" Eur.Phys.J.C71:1661,2011 (arXiv:1012.5412)

12 "Determination of the Top-Quark Mass from the ttbar Cross Section Measurement in pp Collisions at sqrt(s)=7 TeV with the ATLAS detector" (ATLAS-CONF-2011-054)

13 "Reconstructed jet multiplicities from the top-quark pair decays and associated jets in pp collisions at √s = 7 TeV measured with the ATLAS detector at the LHC" (ATLAS-CONF-2011-142)

14 "New ATLAS event generator tunes to 2010 data" (ATLAS-PHYS-PUB-2011-008)

15 "ATLAS tunes of PYTHIA6 and Pythia8 for MC11"(ATLAS-PHYS-PUB-2011-009)

16 "Monte Carlo Tuning in the presence of matching", B.Cooper, J.Katzy, M.L.Mangano, A.Messina, L.Mijovic, P.Skands, arXiv:1109.5295

17 "Performance of the ATLAS Trigger System in 2010", arXiv:1110.1530 (submitted to EPJC)

18 "Electron performance measurements with the ATLAS detector using the 2010 LHC proton-proton collision data" arXiv:1110.3174 (submitted to EPJC)

19 "Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS detector in sqrt(s) = 7 TeV proton-proton collisions", arXiv:1109.6572 (submitted to Phys. Lett. B)

20 „Search for supersymmetry with jets, missing transverse momentum and one lepton at sqrt(s) = 7 TeV " (ATLAS-CONF-2011-090)

**21** "SUSY Search with identical flavour lepton pairs and Etmiss",EPJC 71 (2011) 1647

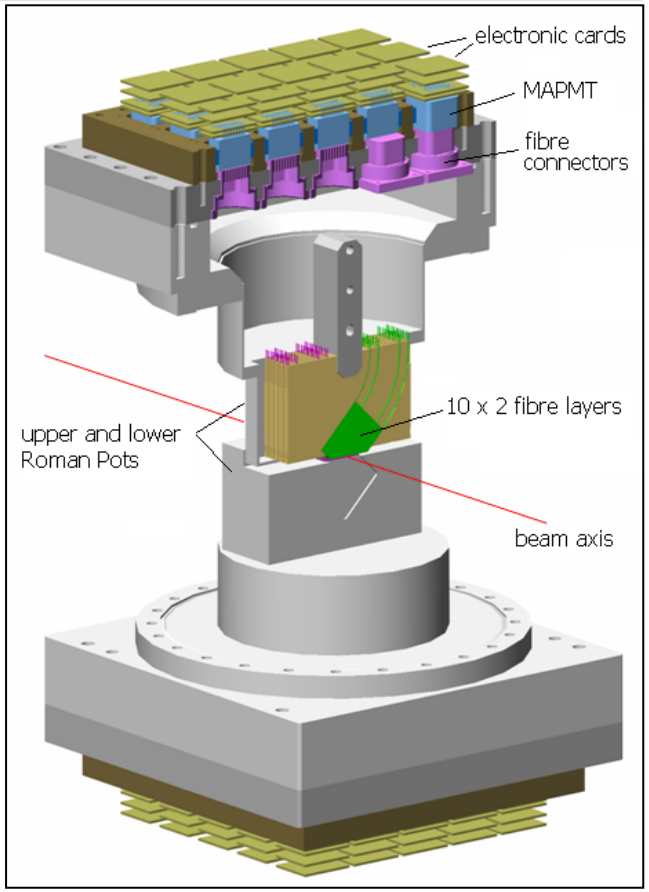
22 CERN-PH-EP-2011-165, to be submitted to Phys. Lett. B

23 „SUSY Search with Diphoton and Etmiss",EPJC 71 (2011) 1744

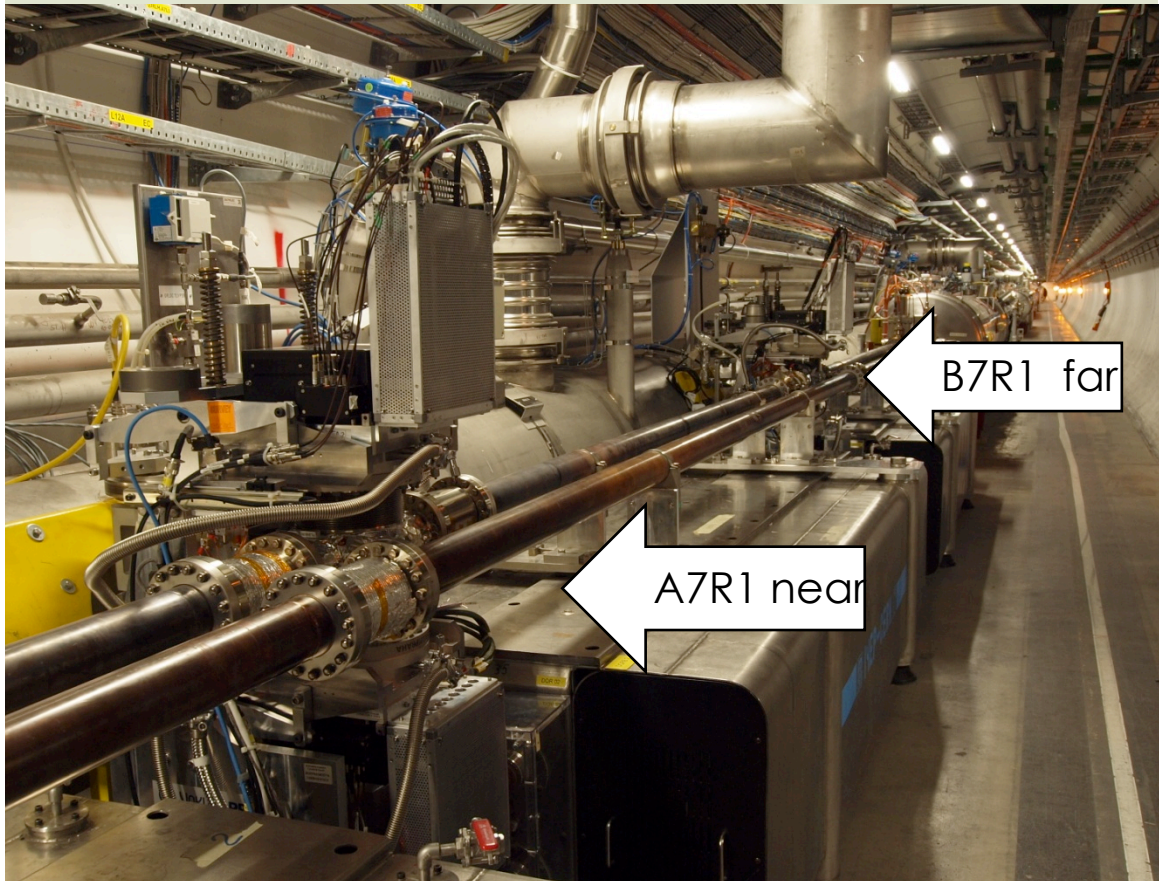
15 papers & 6 conference notes
& 2 pub notes

# ALFA Status

2 fiber detectors approaching the beam in the vertical axis




2 Roman Pot stations at each LHC arm 240m away of the IP



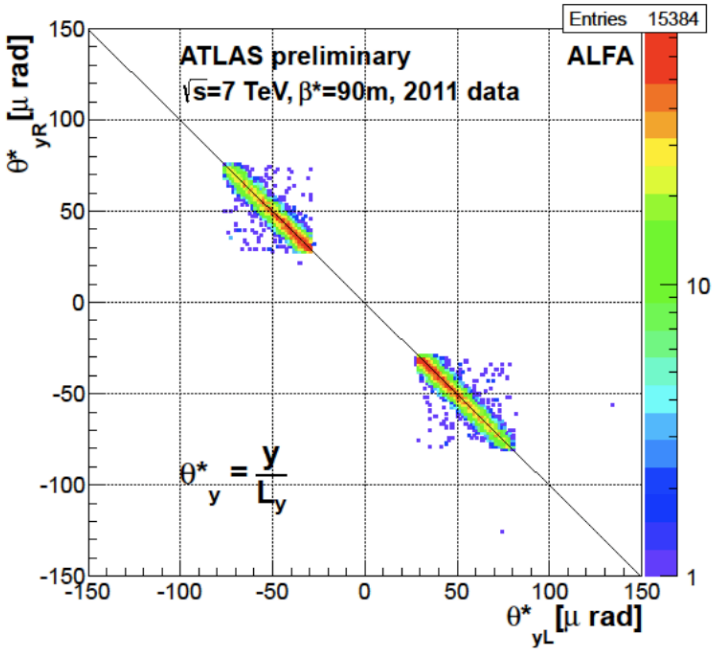

Installation, integration in ATLAS and commissioning finished

# Physics run 2 on 18. -20. October

Precise measurement of the 90m optics:

- needed as input for precision analysis
- beam based alignment done (scraping with Roman Pots at the position of the primary collimators, was 5 sigma ~ 4.5 mm)
- data taking combined with ATLAS with trigger menu for elastics and diffractive events ~100 million triggers

**SUCCESFULLY DONE: Plenty of data for physics analysis!**



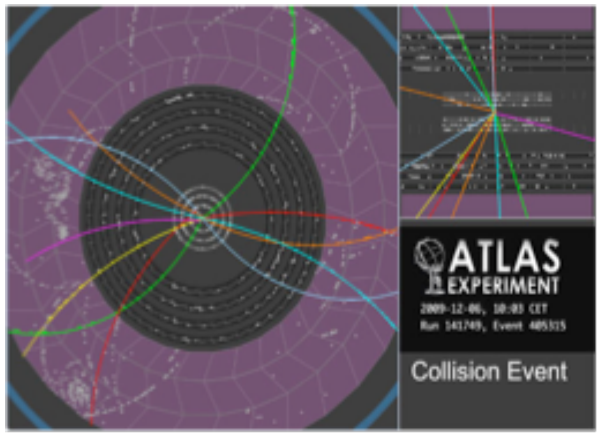

Goal for 2011: measure $\sigma_{tot}$ with 3% precision

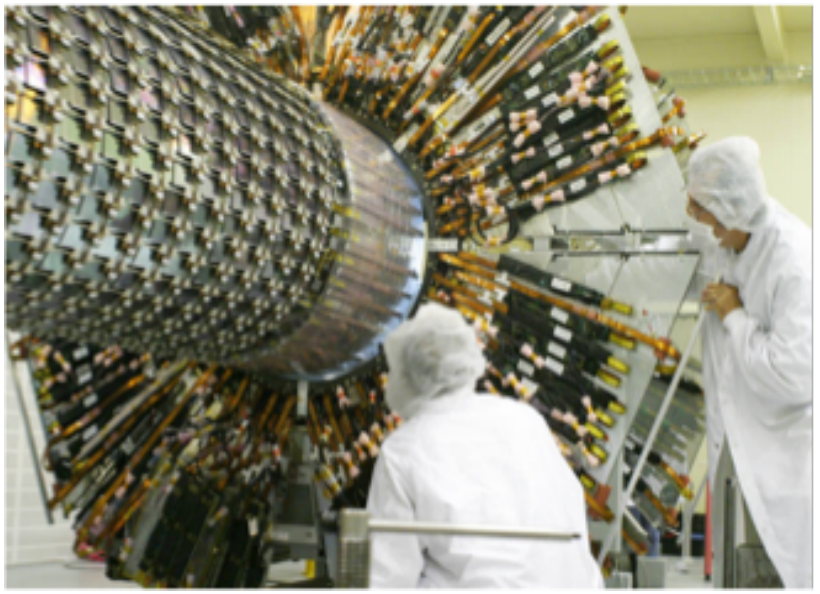
2012: proceed toward higher beta* ~ 1000m

Optics → $\theta_X$, $\theta_Y$ at IP → momentum transfer $t = p\sqrt{\theta X2 + \theta Y2}$

# SCT Operations

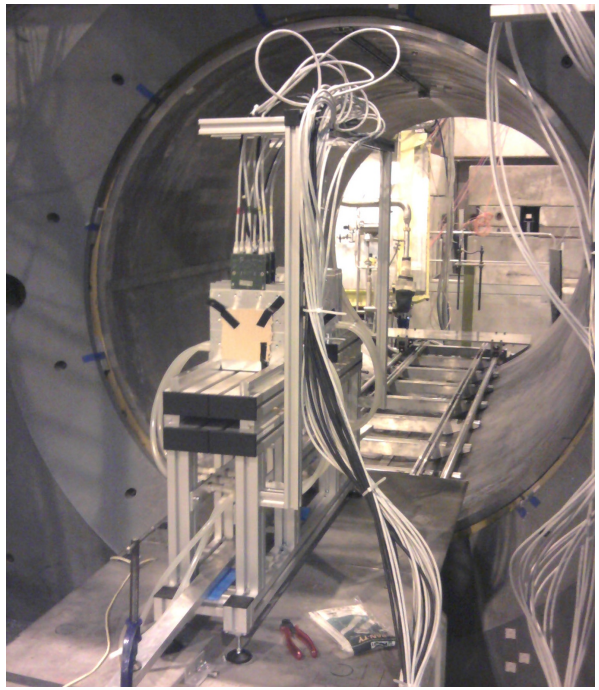
- In light of SCT Upgrade work put more weight on SCT Operations
  - learn from current SCT for future ATLAS Strip Upgrade
- Initial project: SCT Calibration & Monitoring
  - off-line monitoring (running on Tier 0)
  - maintaining offline-calibration loop
  - shifts (CERN+ DESY)
  - long-term studies
  - To be available as service task at DESY



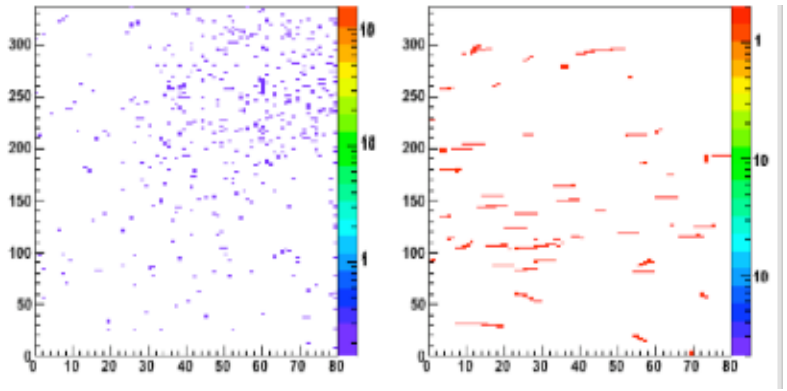
DESY applied to join SCT Collaboration

# Phase 0: Insertable B-Layer



- Due to change of overall time line the IBL schedule is rather tight -> installation in 2013.
- Sensor review in July resulted in a decision for 75% of Planar Pixel Sensors (PPS) and 25% of 3D highest eta modules on stave.
- To reduce the possible risk 100% PPS and 25% 3D are being ordered.

Hit map



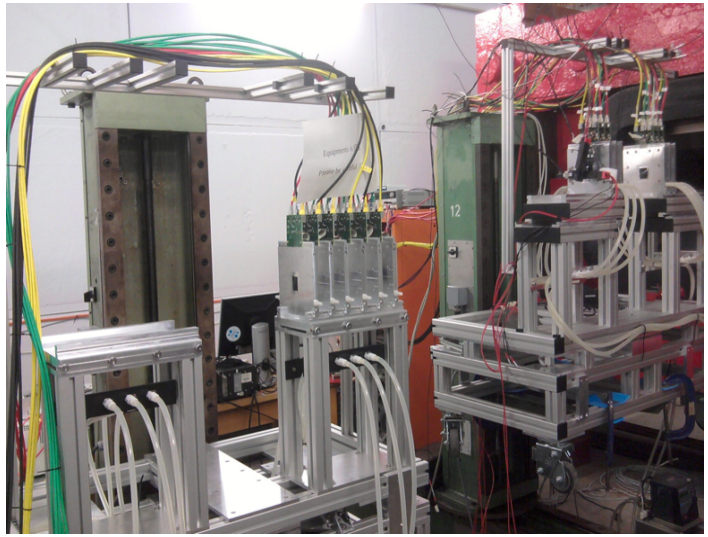
central High eta

- DESY main contribution is test beam studies
  - Performing test beam studies using EUDET telescope at DESY and CERN
  - Implementation of magnetic field reconstruction in EUDETTelescope
  - Reconstruction of 85% of all the test beam data.
  - High eta study including new tracking software.

# EUDET Telescope

## "Victims of Success"

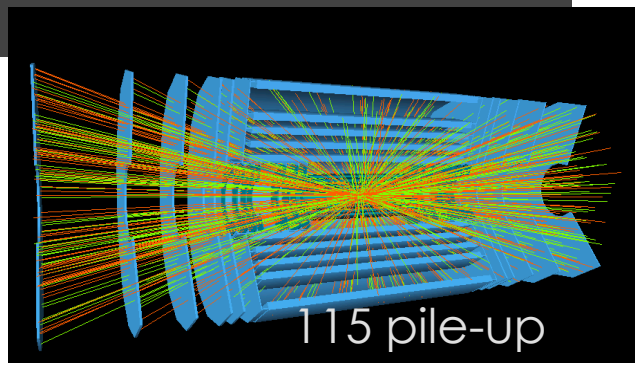
- Three telescope copies are being built
- Allianz copy for Bonn (ANEMONE) ready
- Under way:
  - ATLAS copy (ACONITE)
  - DESY test beam -> shared with CMS and FLC group (DATURA)

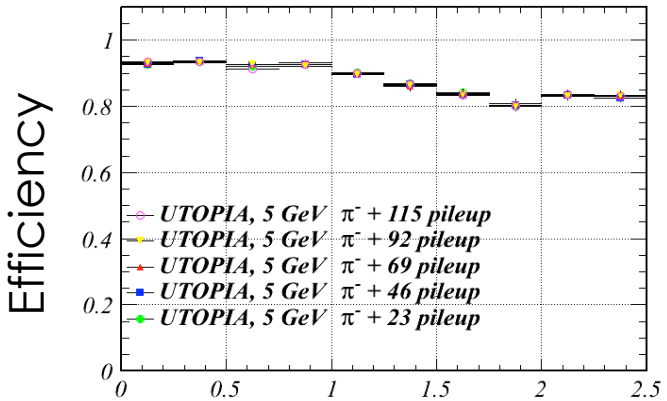


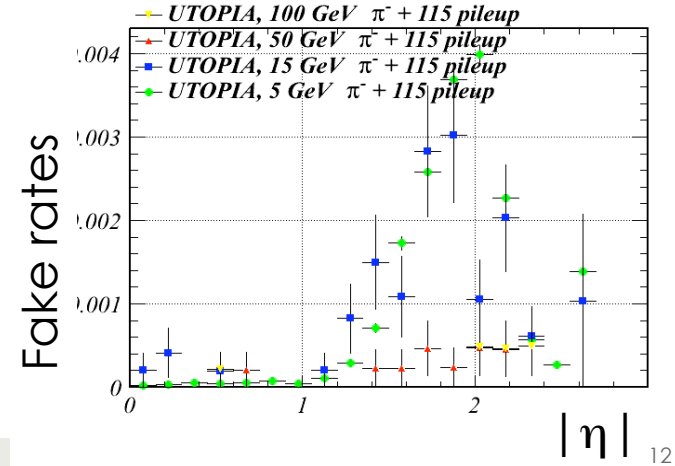
- Most important feature of EUDET copies: new DAQ hardware -> based on a commercial system (National Instruments PXIe)
  - Enables "easy" copies and faster readout speed
  - Increases from ~700Hz during spill -> 2.5kHz during spill (factor 3-4)
- At DESY test beam we can take up to 30 Million triggers in one night !

# Upgrade: Inner Detector Simulations

- DESY contribution (2 conveners)
  - building new Inner Tracker layouts
  - running MC production (with/without pileup)
  - performance analysis (efficiency, fake-rate, resolutions, B-tagging)
- Phase-2 studies: tracking performance parameters for UTOPIA layout:
  - tracking efficiency, fake rates
  - d0/z0/pT resolution
  - all as a function of pile-up
  - B-tagging performance
- Complete simulations for the Letter of Intent (mid 2012)



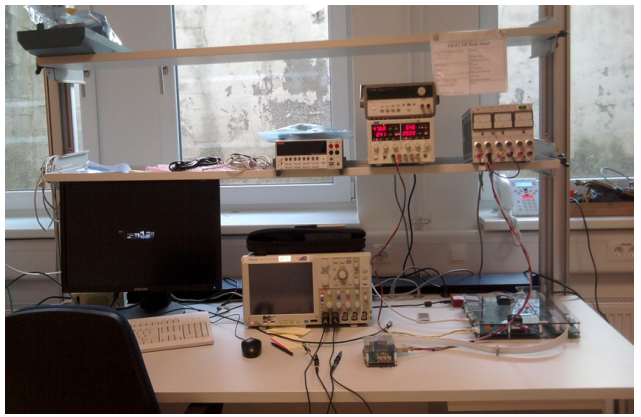



# PETAL

- Project to build complete prototype end cap sector
- Warming up exercise: Barrel Stave Module Construction
  - Involved to learn for petal R&D: gluing, bonding, testing
  - Module production in Zeuthen is becoming proficient in all areas
  - Well synchronised with other institutes in ATLAS Upgrade collaboration
  - Module readout systems setup to do full set of tests in Hamburg + Zeuthen

HSIO setup in lab Zeuthen

- New equipment / lab space
  - Zeuthen two labs: One for assembly and bonding, one for testing and storage
  - Hamburg new labs, currently being set up, ~250m$^2$ of lab space and infrastructure shared with other FH groups



HSIO setup in new lab Hamburg

# Physics Analysis & performance studies

Vector Boson measurement
Top
Higgs
SUSY

# Inclusive $W^+$, $W^-$ and $Z/\gamma^*$ cross sections

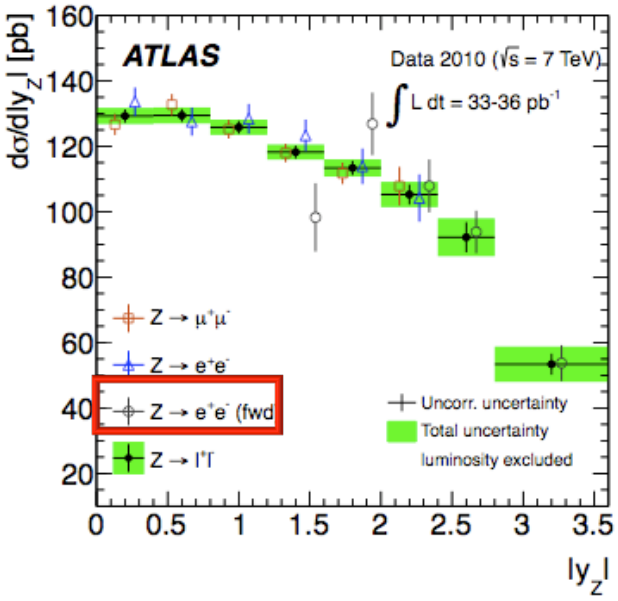
Sensitive test of pQCD and PDFs at VB mass scale and Bjorken $10^{-3} < x < \sim 0.01$

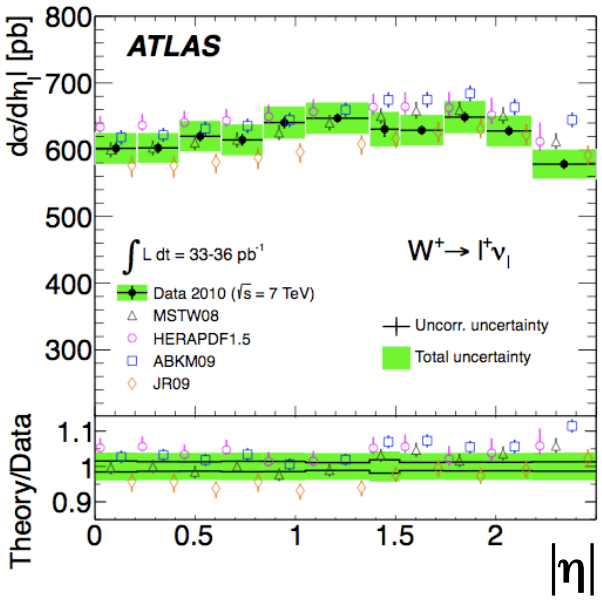
2010 data set: Z analysis: -> 10-12k candidates, 1-2% background
W analysis: ->131-140K candidates, 7-9% background

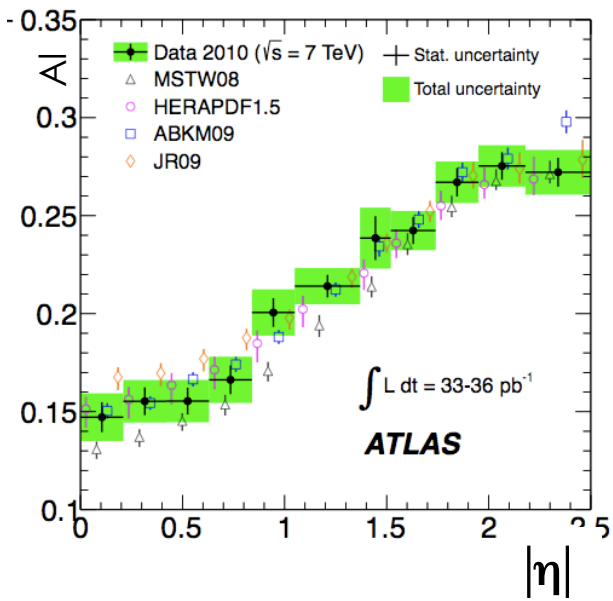
$W^{+/-}$, Z production fiducial cross section measured with 1-2 %

Comparison of NNLO QCD predictions with different PDFs
Combinations done by DESY using HERA tool

submitted to Phys.Rev.D

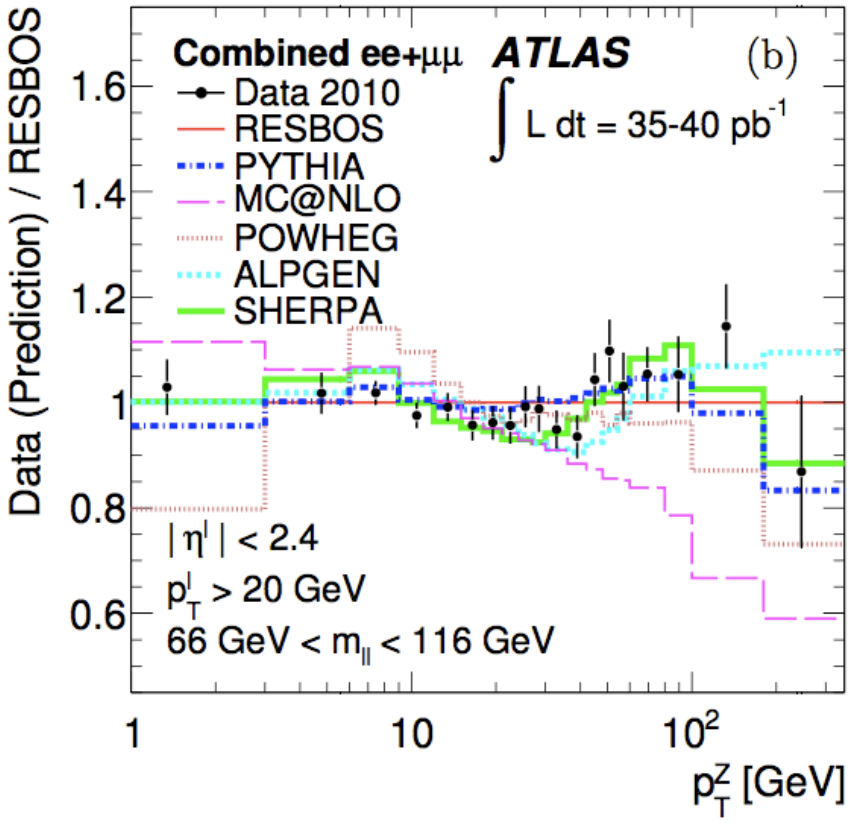


# Transverse momentum of Z/γ*

Phys.Rev.Lett.B



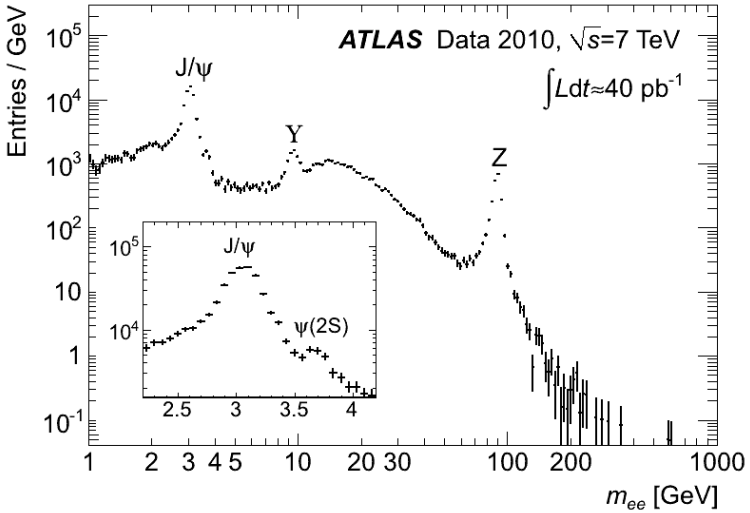

Study dynamical effects of pQCD
-> $m_W$ precision measurement
-> phenomenological models
-> used for MC Tuning in DESY group

Same selection as inclusive
cross section measurement

NLO generators fail to describe the data
-> under investigation

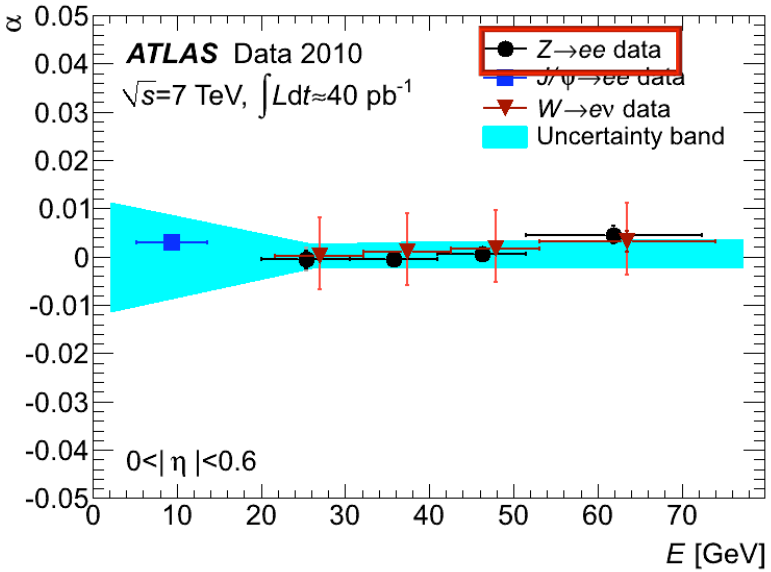
DESY performed Z->ee cross check analysis
+ combinations

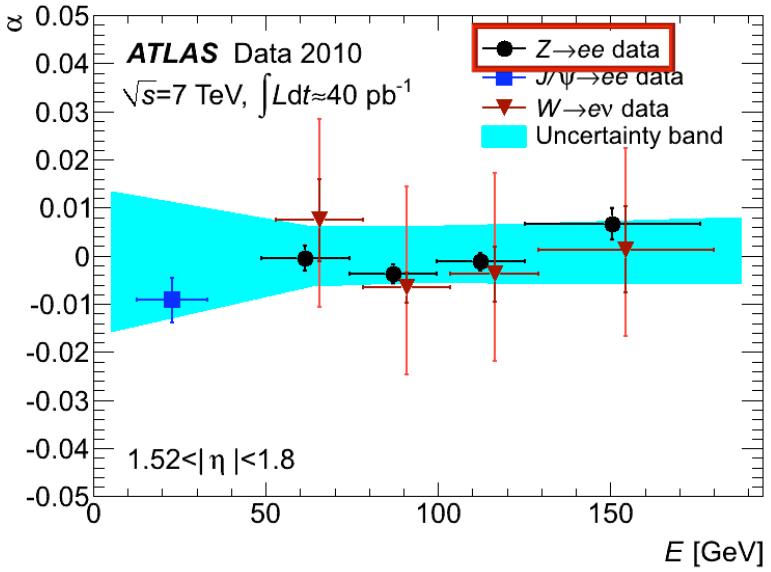
# Electron calibration




Energy scale uncertainty depends on $E_T$ and $\eta$ e.g.
0.4% for $E_T$=40 GeV central region

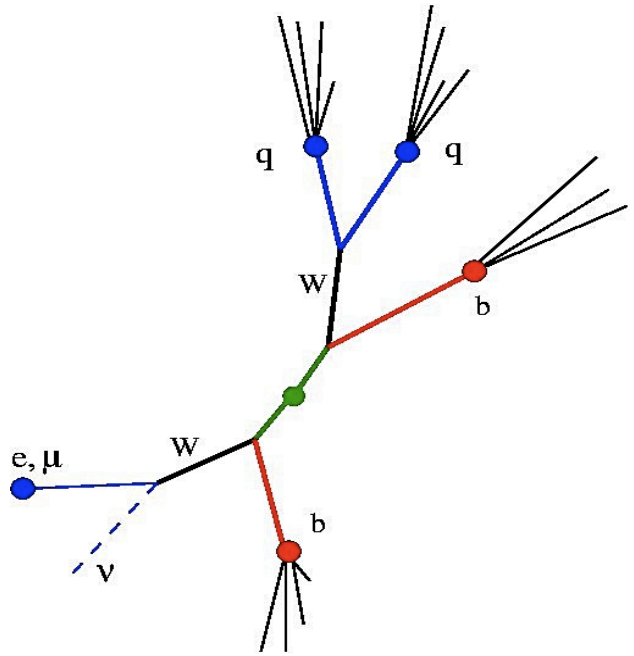
Z->ee analysis only done by DESY




Submitted to Eur. Phys. J

# Top physics



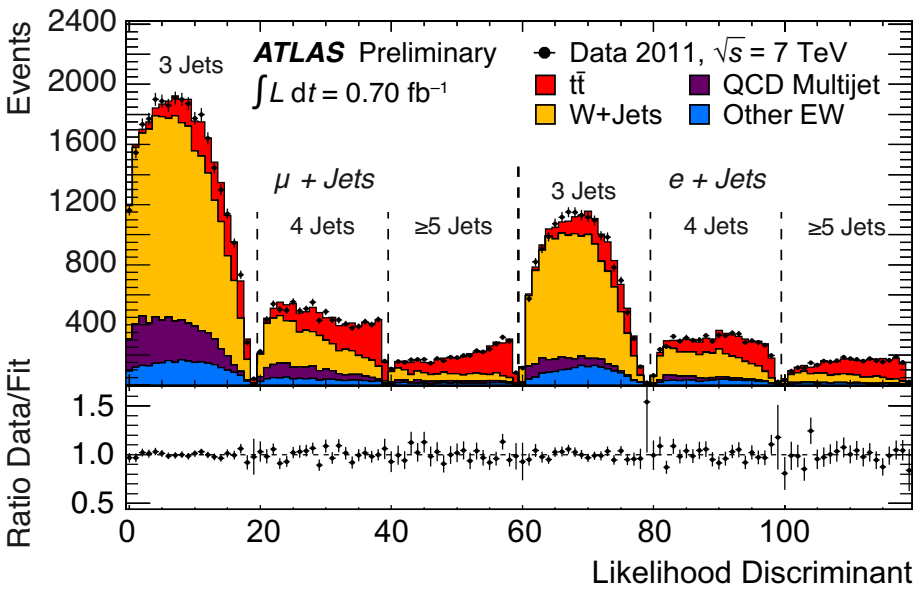

Reconstruct top in lepton+jets ,
dilepton and all hadronic events
with and without b-tagging

B-tagging by reconstruction of secondary vertices

Typical event selection for lepton plus jets:
Exact one isolated lepton with $p_T$>25 (20) GeV e (muon)
$E_{Tmis}$ > 35 (20)GeV, $m_T$(W)>25 GeV ($E_{Tmis}$+$m_T$>60 GeV muon)
>=4 jets with $p_T$>25 GeV and $|\eta|$<2.5
>=1 jet btagged

# Top pair cross-section measurement

- Measured in lepton+jets channel, using kinematic information of lepton +jets events
- Projective likelihood discriminant reconstructed from *lepton eta, aplanarity, $H_{T,3p}$* and *the leading jet $p_T$*
- Combined binned profile likelihood fit
  - in 6 channels: e/mu +jets (3, 4 and ≥5)
  - Systematic uncertainties included as nuisance parameters in fit
- most precise single-measurement



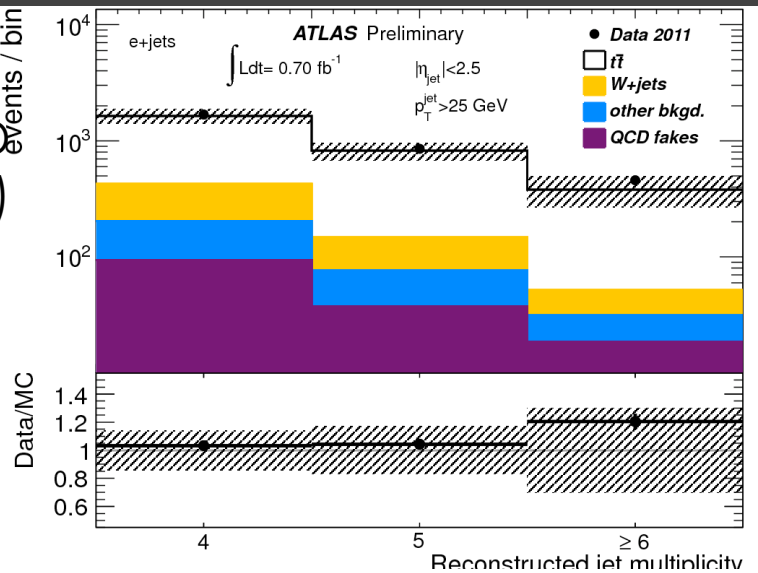

ATLAS-CONF-2011-121(LP2011)

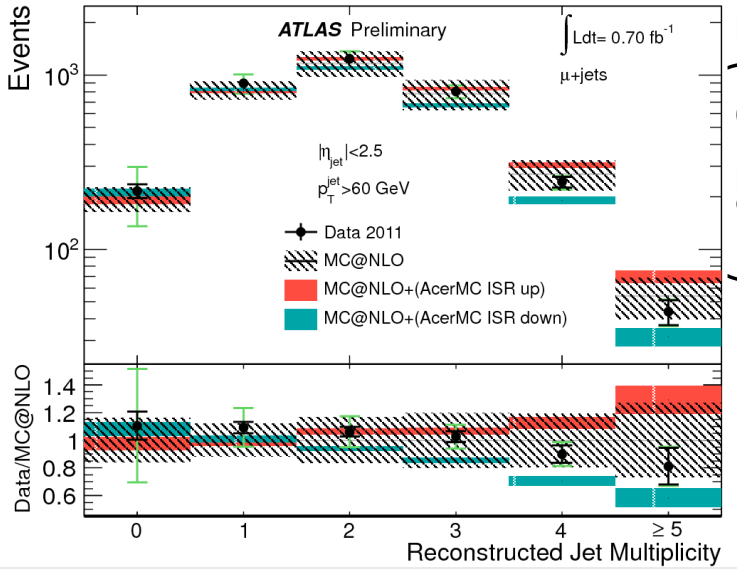
$$\sigma_{t\bar{t}} = 179.0 \pm 3.9\ (\text{stat}) \pm 9.0\ (\text{syst}) \pm 6.6\ (\text{lumi})\ \text{pb}$$

# Top pair production plus jets

- Sensitive to dynamical effects in pQCD
  - important input to MC models (ISR)
- One of the dominant systematic uncertainties for top mass & cross section measurements
- Major background for searches

- Use standard single lepton ttbar selection incl. b-tagging
  - Measure number of additional jets with various pt cuts (25, 40,60 GeV
- Analysis in progress with increased statistics (2 $fb^{-1}$), reduced systematic uncertainties, unfolding to particle level

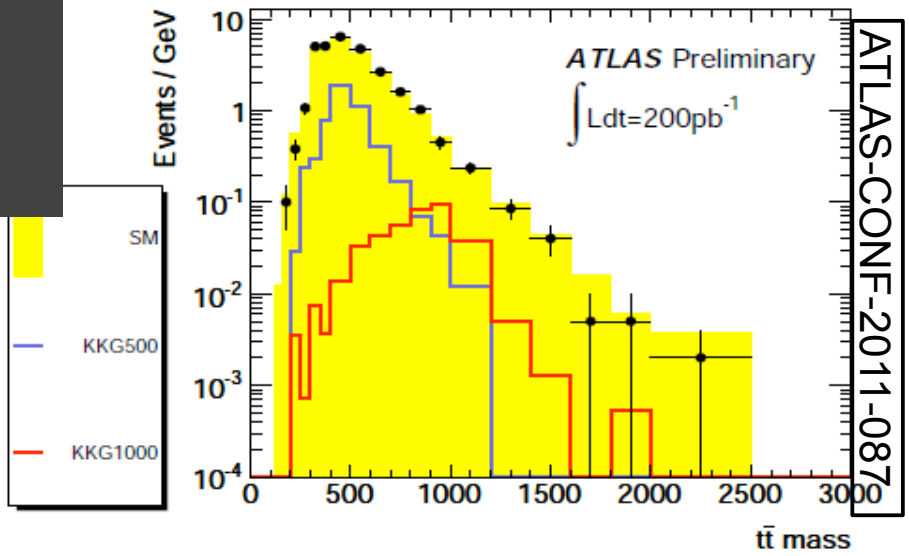


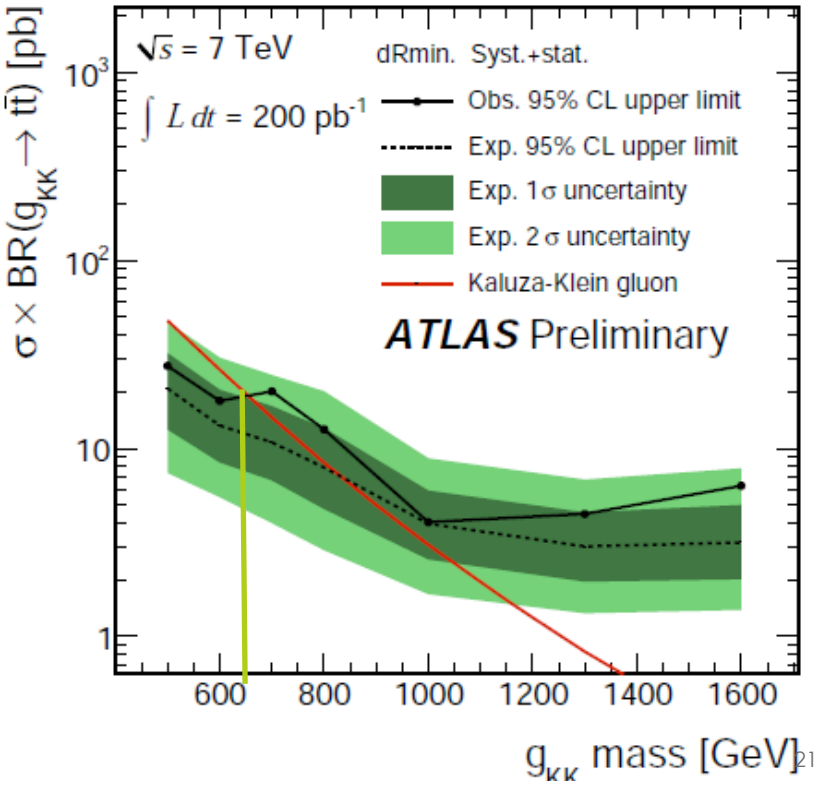



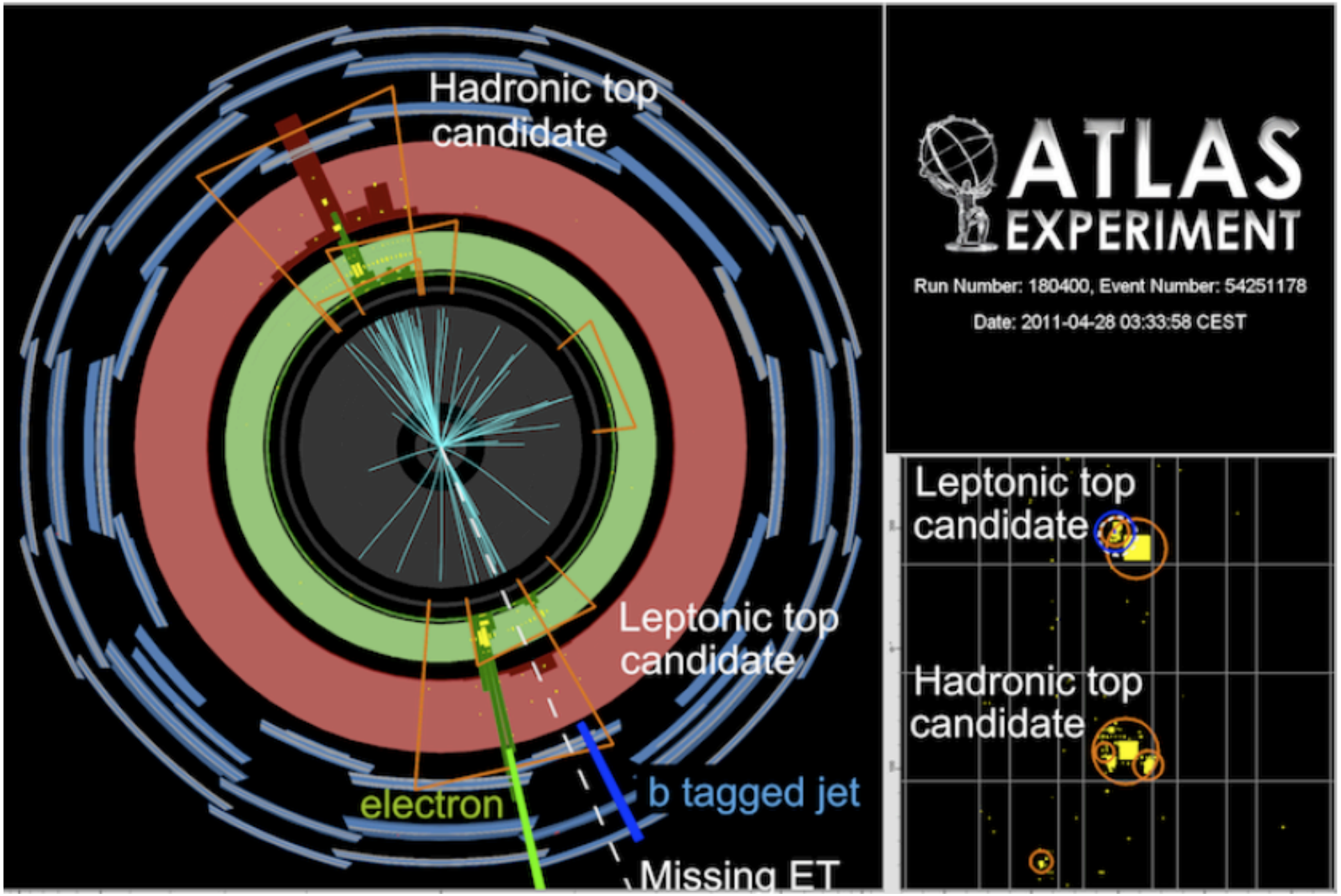

ATLAS-CONF-2011-142 (TOP2011)

# Search for top pair resonances

- Search for $X \to t\,t$,
  $X$ is a $g_{KK}$, $G_{KK}$, $Z'$, ...?
  $t\,t \to l\,\nu j_b\; j\,j\,j_b$
- "Resolved" case: 1 ele or muo, MET, 4 (3) jets, 1 *b*-tag.
- Look for deviations in the spectra
- Exlcude m(gKK) < 650 GeV
- In progess: studies on "Boosted top" where the decay products overlap

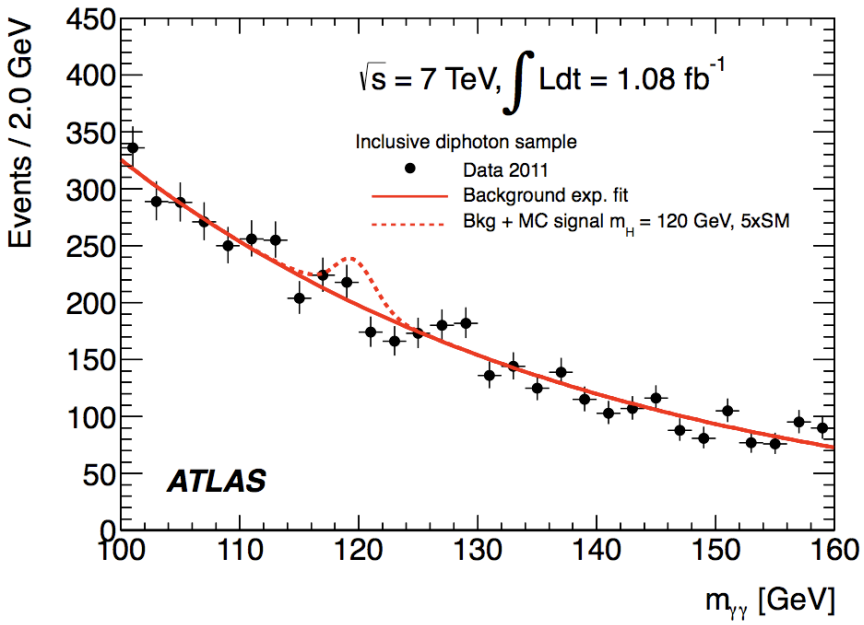


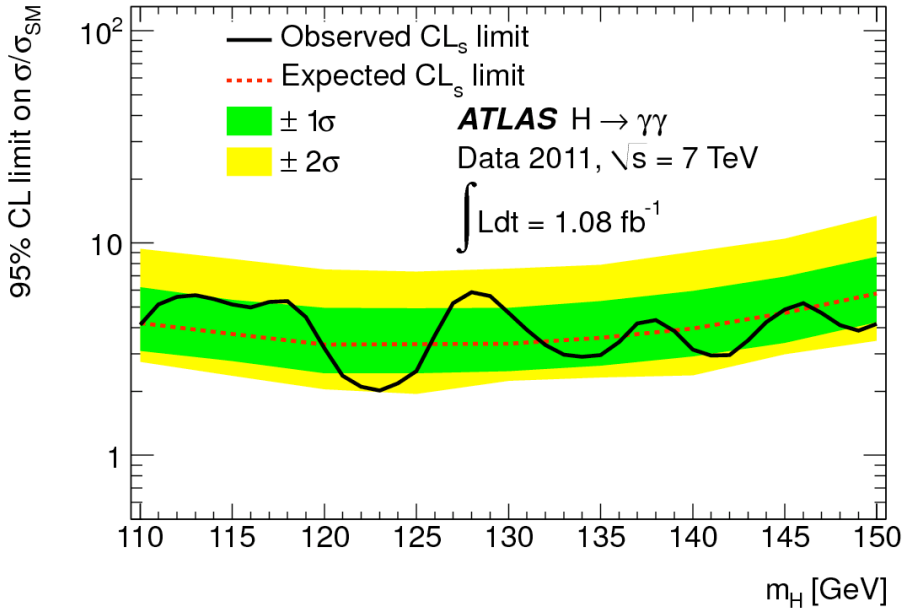




Hadronic top candidate
Leptonic top candidate
electron
b tagged jet
Missing ET
ATLAS EXPERIMENT
Run Number: 180400, Event Number: 54251178
Date: 2011-04-28 03:33:58 CEST
Leptonic top candidate
Hadronic top candidate

# H→ γ γ

Two high-quality isolated high-$p_T$ photons in central region




We exclude ~ 2-6 the SM production cross-section × BR (Expected sensitivity: 3-4)

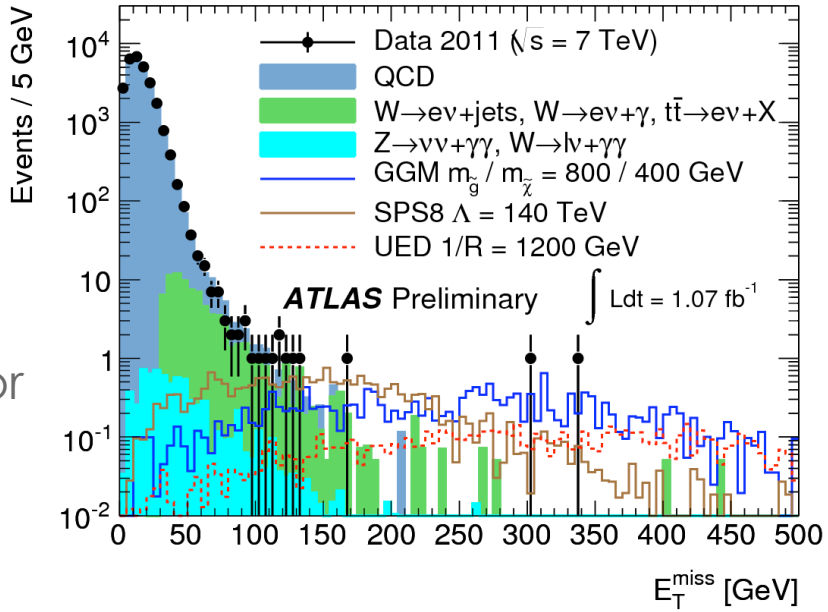
DESY contribution:
Categorization of converted vs unconverted photons
(15% improvement in limits)

Outlook: new analysis of full 2011 data set (as of 23.10. 5 $fb^{-1}$ recorded) including data driven efficiency measurements

# Searches for SUSY

- SUSY Analysis performed at DESY:
  - Searches in 0,1,2-lepton, ditau, diphoton channels
  - interpretation using Fittino

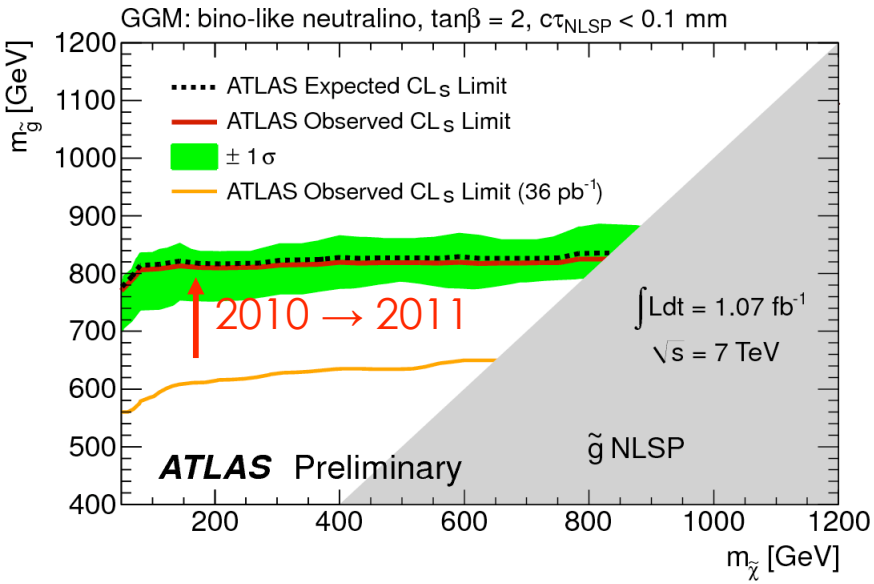
- Example: diphoton + MET final state
  - sensitive to $\tilde{\chi}^0 \rightarrow \gamma\tilde{G}$
  - Data driven background estimates for QCD and W
  - DESY: significant contribution to 36 $pb^{-1}$ and 1 $fb^{-1}$ analysis



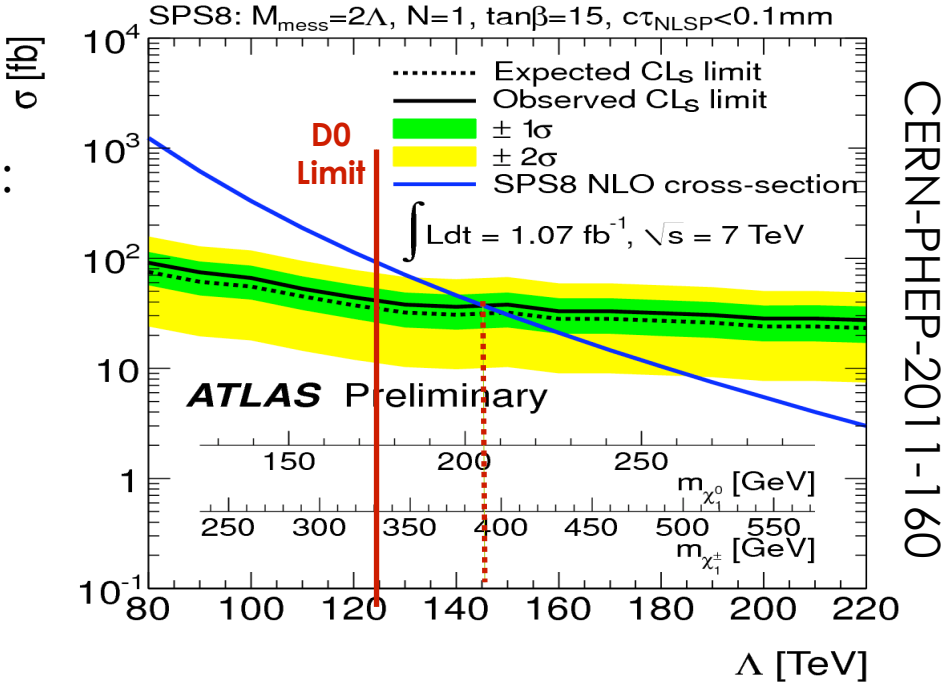
# SUSY limits

…example from diphoton analysis

**General Gauge Mediation (GGM)**
simplified model with reduced content:
gluino/neutralino/gravitino




Significant improvement in new limits




CERN-PHEP-2011-160

**Minimal Gauge Mediation (GMSB)**
SPS8 slope (used by Tevatron)
**Universal Extra Dimensions (UED)**

Stricter limits than Tevatron

# Summary & Outlook

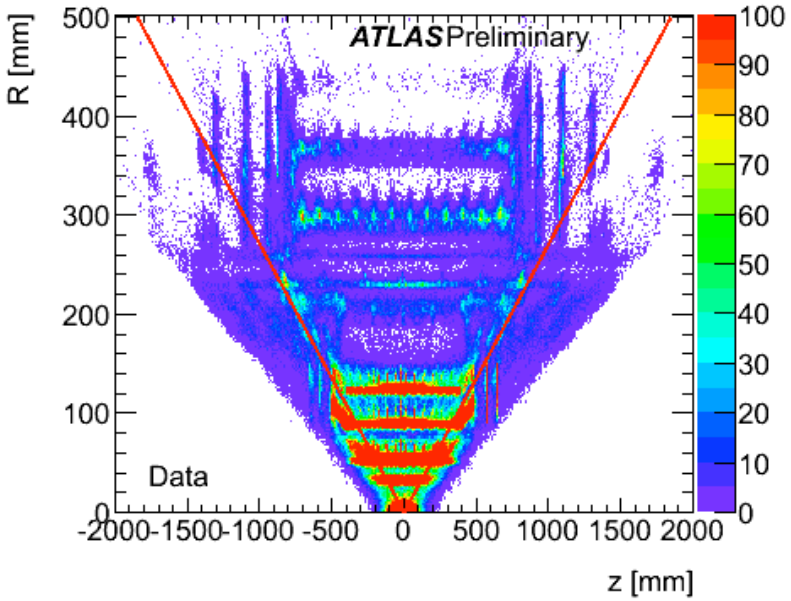
- Significant progress on detector work, preparations for upgrade
- Physics analysis completed
  - high precision SM measurement – sensitivity to PDFs
  - top measurements – new observables to measure pQCD at high scales; searches for new physics involving new reconstruction algorithms
  - Light Higgs searches are prepared for high statistics analysis with 2011 data
  - SUSY searches obtaining limits beyond Tevatron reach
- Look forward to analyse the $5fb^{-1}$ on tape

# Backup slides

# Conversion photons

Excellent description of material needed for:

- photon and Higgs mass resolution
- Conversion probability
- Identification efficiencies
- Electro magnetic signatures & tracking

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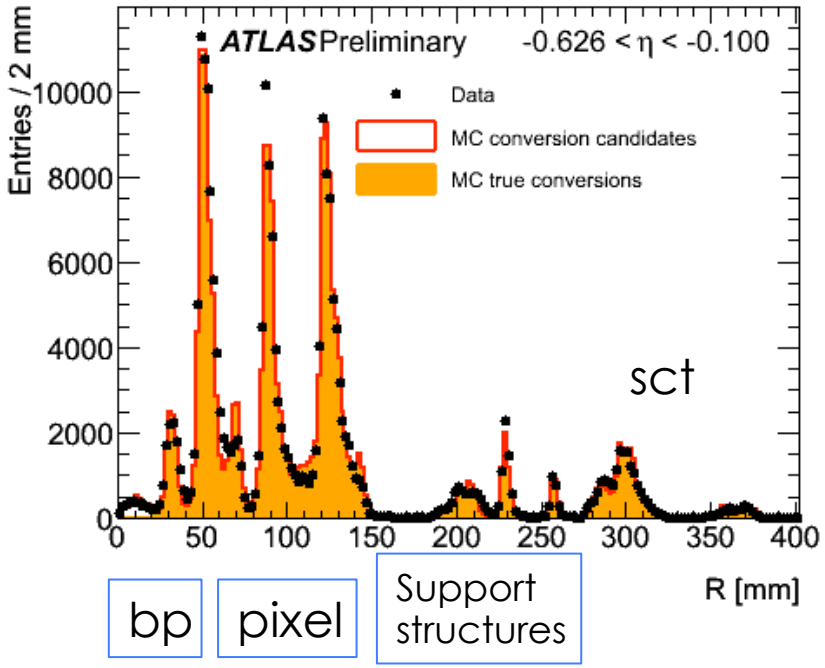


**Work ongoing for quantitative material estimations in barrel using 2010 data**


TAG DER
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DER GRÖSSTEN RÄTSEL DES UNIVERSUMS
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und Forschung
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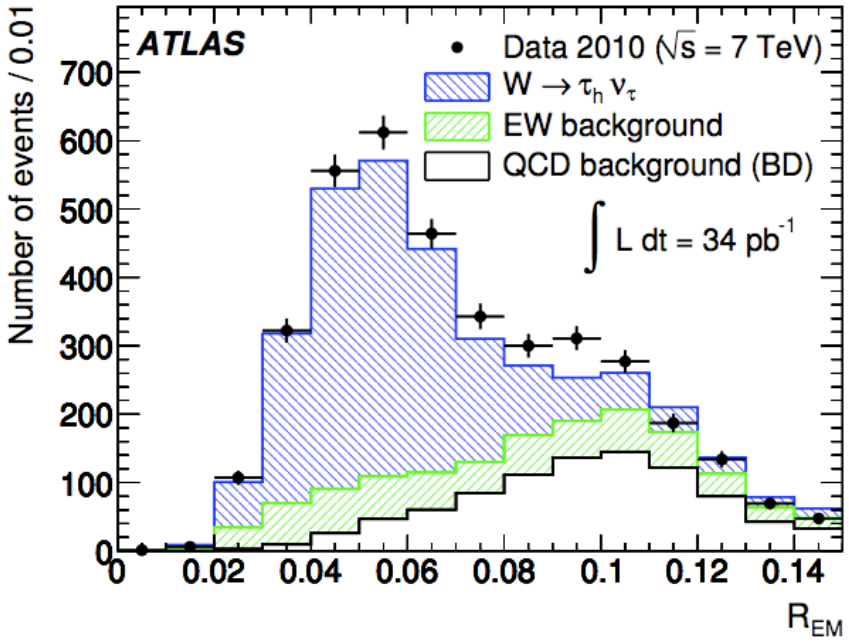
# Back-up slides

P.Bechtle,M.Boehler G.Fischer, S.Johnert, D.Kennedy

# W->tau nu cross section measurement

To be submitted to Phys. Lett. B

Background to Higgs, SUSY searches




Involves studies of hadronic tau reconstruction

$$R_i<0.4 \qquad E_{T,i}^{EM}$$

Acceptance & systematic studies done by DESY

$$\sum_i \Delta R_i<0.4 \qquad E_T$$

DESY also performs

- Z->tau tau analysis in di-lepton channel on 1.5 fb-1 data
- SUSY searches in tau tau + jets channel approaching publication

# MC Tuning

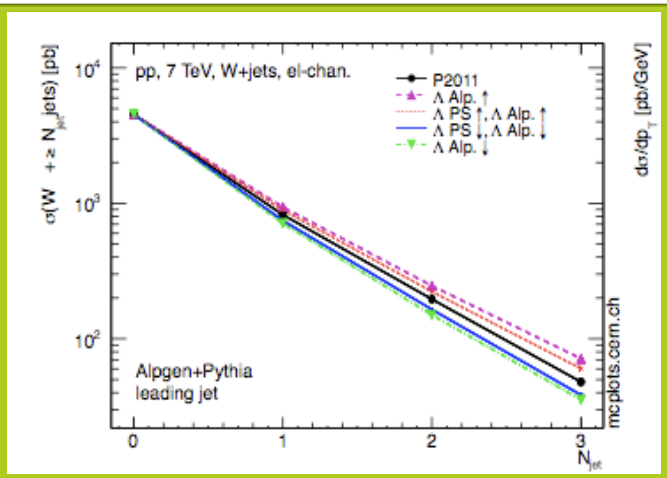
Tunes of parameters of various models (parton shower, Zpt, fragmentation, multi-parton-interaction, color reconnection) in pythia6, pythia8 and Herwig

First tune to pythia parton shower with LHC data (DESY contribution) – important to constraint systematic uncertainties on ISR for measurements involving hard probes

Tunes to up to 10 different pdfs to study pdf dependence of model description

Updates using a rather complete set of shower sensitive observables recently published by ATLAS is ongoing

ATLAS PUB notes




Study on "Tuning in the Presence of matching" using alpgen+pythia Generators (independent of ATLAS) – results used by ATLAS

Phenomenology pape

J. Katzy, S.Piec

# Search for New Physics: SUSY

- significant contributions from DESY
  - 5 students, 4 fellows, 1 (ex)-YIG
- to analysis aspects
  - D3PD (Ntuple) production
  - trigger development and efficiency estimates
- and to various analysis channels
  - 0,1,2-lepton, ditau, diphoton
- interpretation using Fittino

Conference notes and papers:

- zero lepton search:
  - 2011: 1 $fb^{-1}$: arXiv:1109.6572, submitted to Phys. Lett. B
- one lepton search:
  - 2011: 165 $pb^{-1}$: ATLAS-CONF-2011-090
- dilepton search
  - 2010, 36 $pb^{-1}$: EPJC 71 (2011) 1647
  - 2011, 1 $fb^{-1}$: CERN-PH-EP-2011-165, to be submitted to Phys. Lett. B
- diphoton search
  - 2010, 36 $pb^{-1}$: EPJC 71 (2011) 1744
  - 2011, 1 $fb^{-1}$: CERN-PH-EP-2011-160, to be submitted to Phys. Lett. B

# The boosted l+jets ttbar event

When lots of energy is available in the system, the top can be sufficiently boosted for the decay products to merge in the detector.

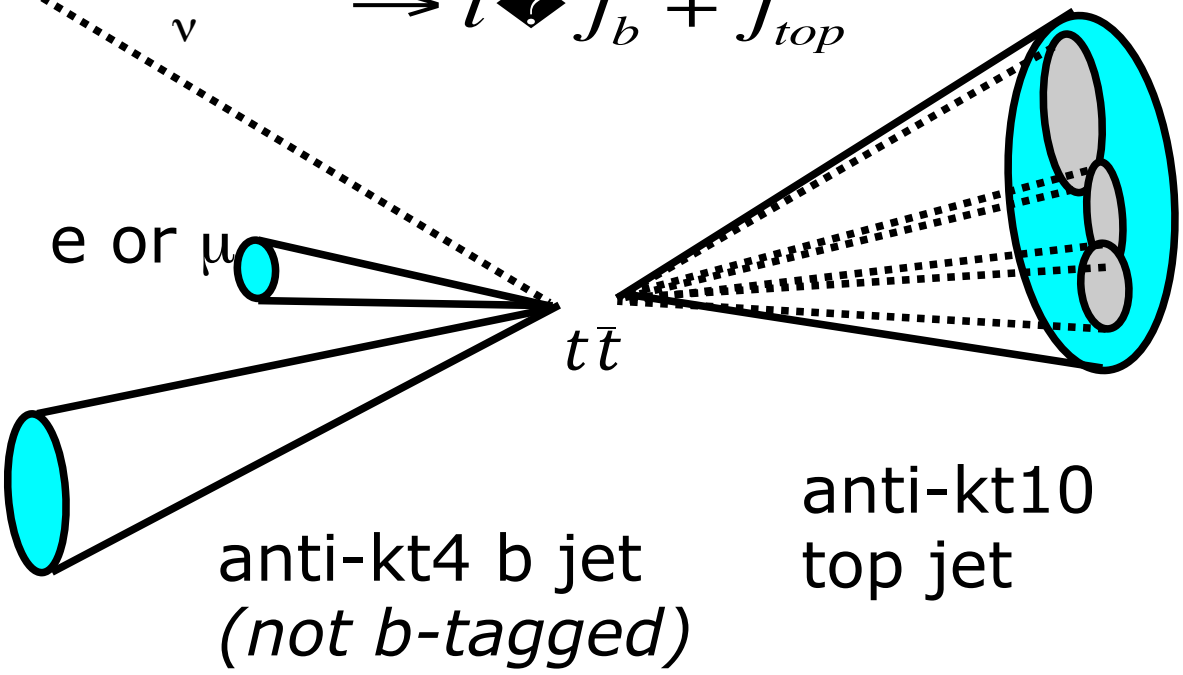
<u>Reconstruction</u>

Leptonic side:
- 1 standard lepton
- Standard MET
- 1 standard anti kt4 jet (no b-tagging)

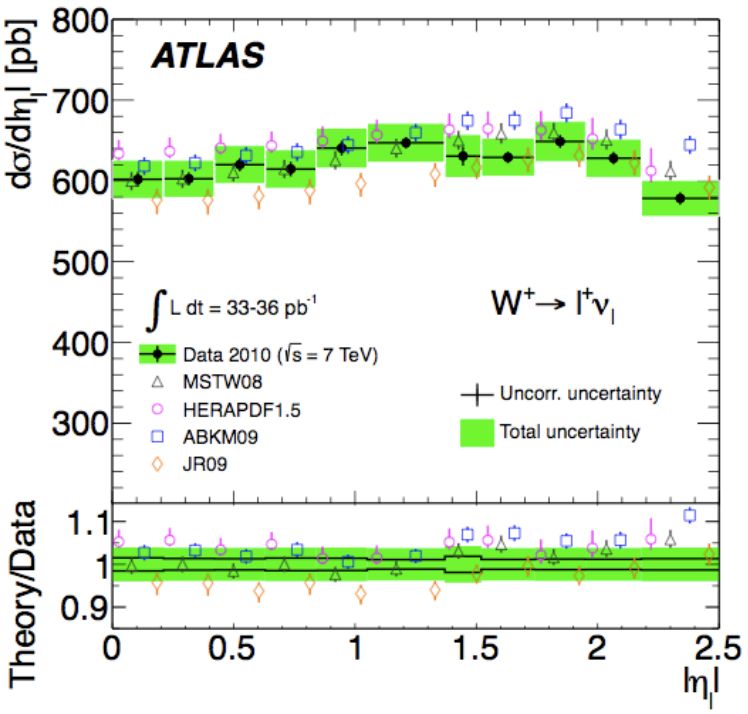
Hadronic side:
- 1 akt10 jet (LC) with substructure

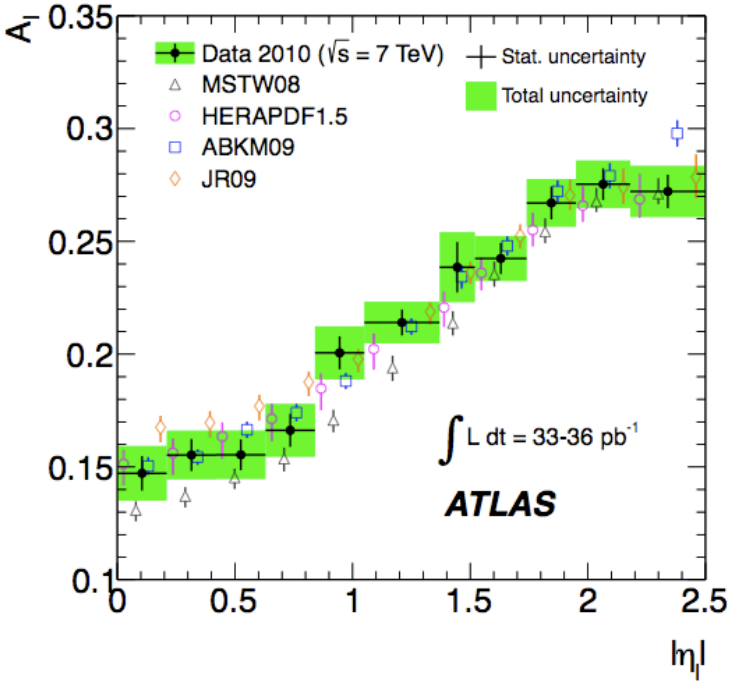
$$t\bar{t} \rightarrow Wb + Wb$$

$$\rightarrow l\nu j_b + j_{top}$$



# Inclusive $W^{+/-}$ and Z/g* cross sections - pdf sensitivity




Lepton distributions separated for $W^+$ $W^-$ are better to constraint pdfs