

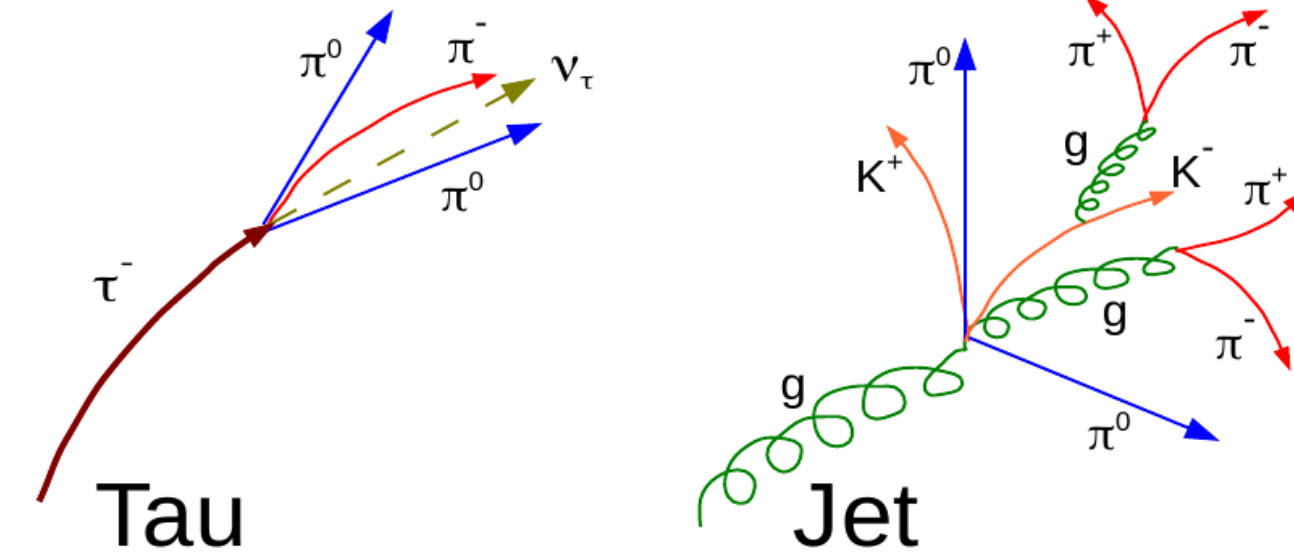
Motivation

The production and decay of the Z boson is an important SM process, sensitive to the proton PDFs and to the $Z \rightarrow \tau\tau$ branching ratio (BR), as well as a crucial background in searches for the Higgs boson at the LHC in the $H \rightarrow \tau\tau$ decay channel.

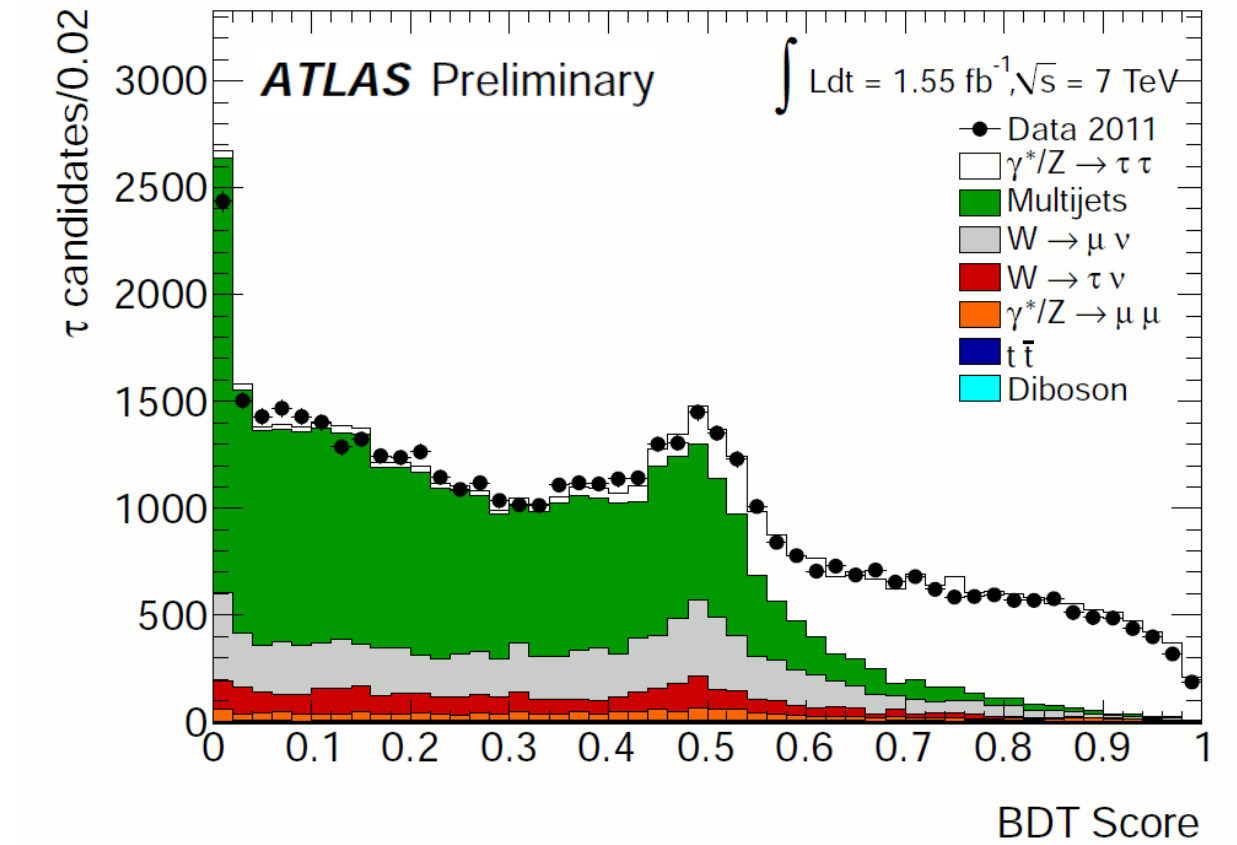
The new resonance discovered at around 126 GeV by the LHC experiments, ATLAS and CMS, is likely to be a Higgs boson, but more of its properties have to be measured. For example, its decay into two tau leptons has not yet been observed, but must be measured to confirm its nature. This $H \rightarrow \tau\tau$ decay is rare and the main background of $Z \rightarrow \tau\tau$ events has to be understood as precisely as possible.

Hadronic Tau Identification Method

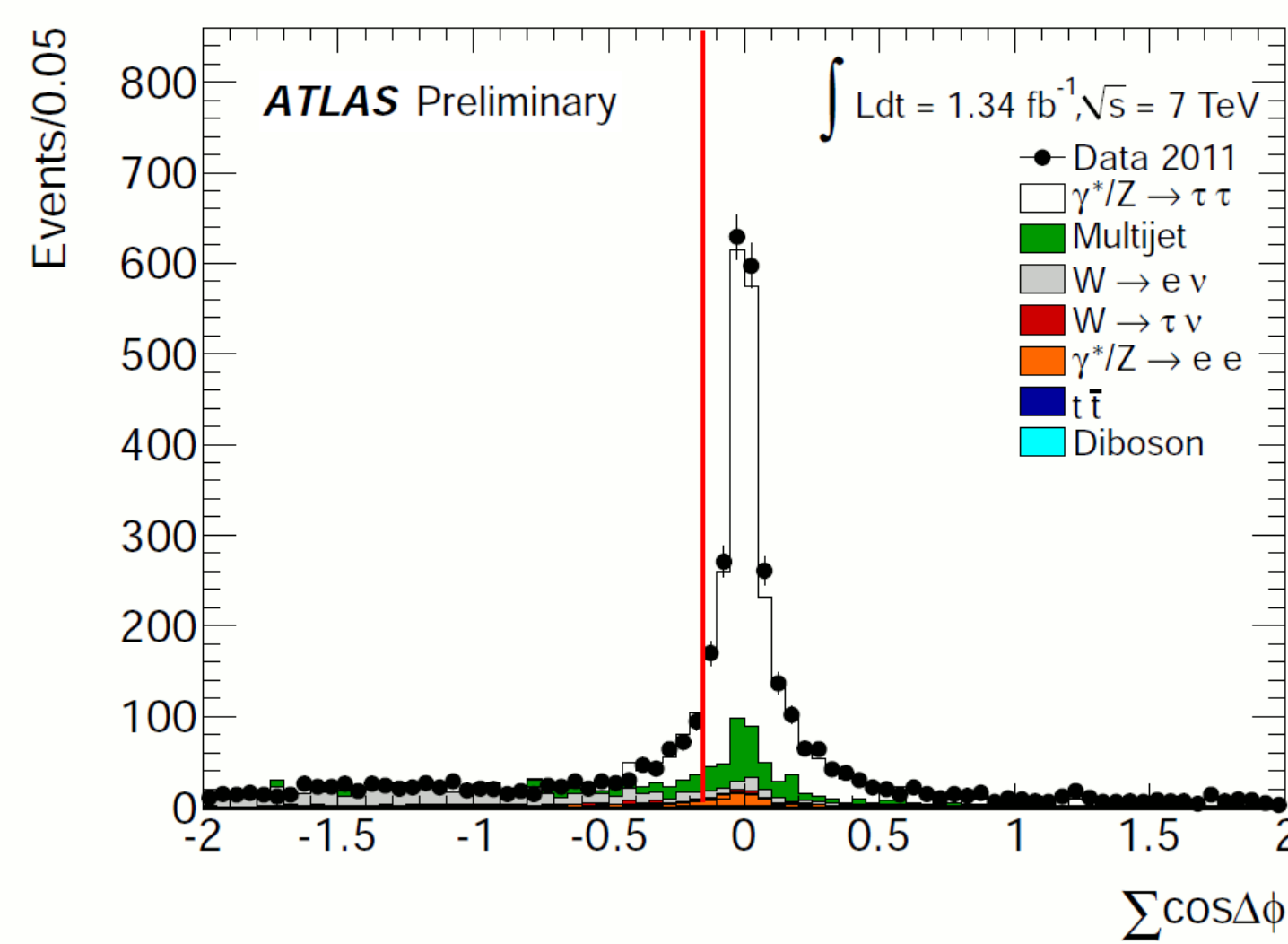
QCD processes are the most challenging background for tau reconstruction and identification due to their large cross section and similar signatures. Electrons can also fake tau candidates. **Characteristic** differences between quark or gluon jets and taus can be used to distinguish them on a statistical basis.



The identification with **boosted decision trees** uses several **variables** in a **series of cuts** which are applied **recursively** to classify tau candidates by assigning a **continuous score** between 0 (backg.-like) and 1 (signal-like).



$Z \rightarrow \tau\tau$ event selection

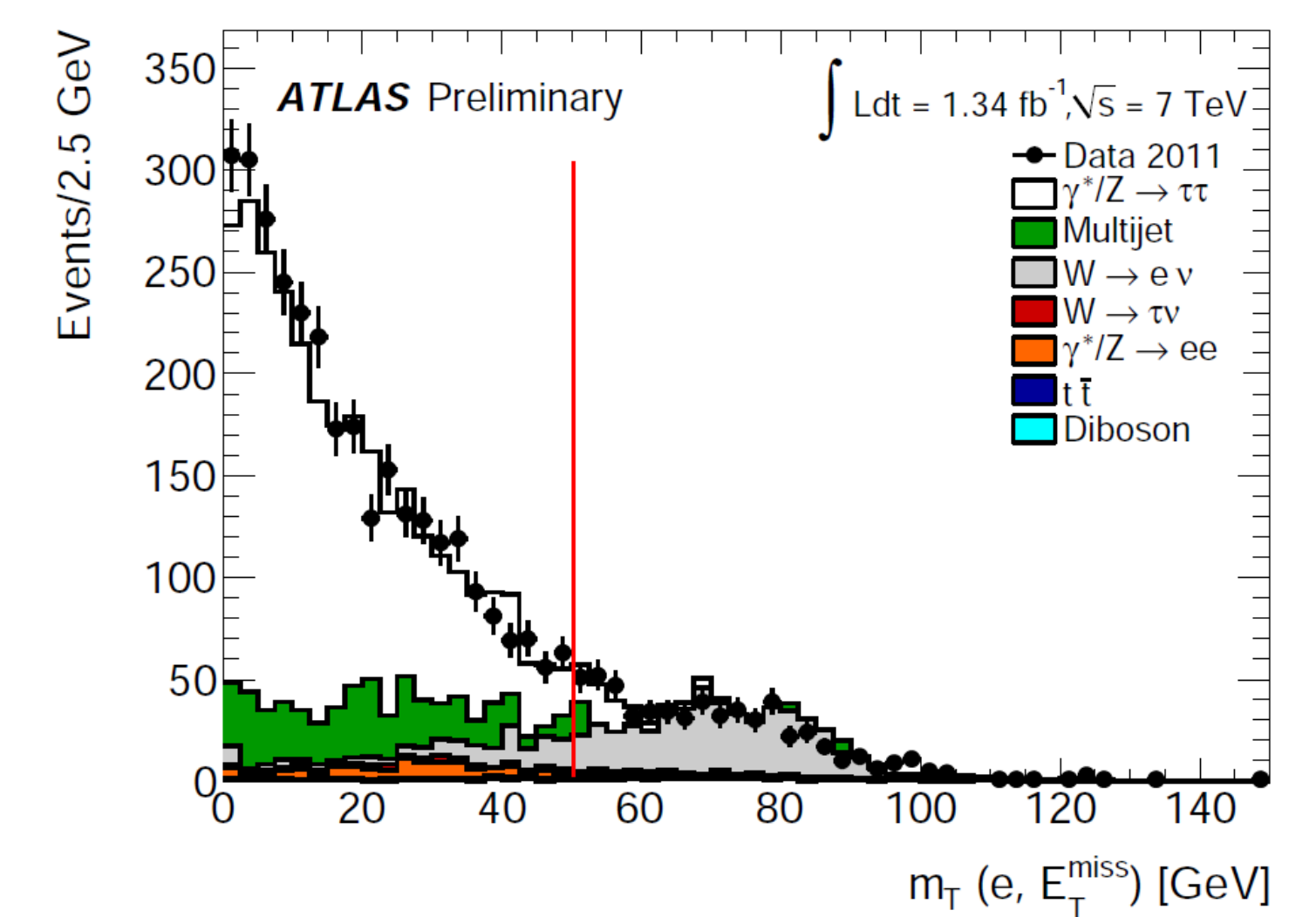
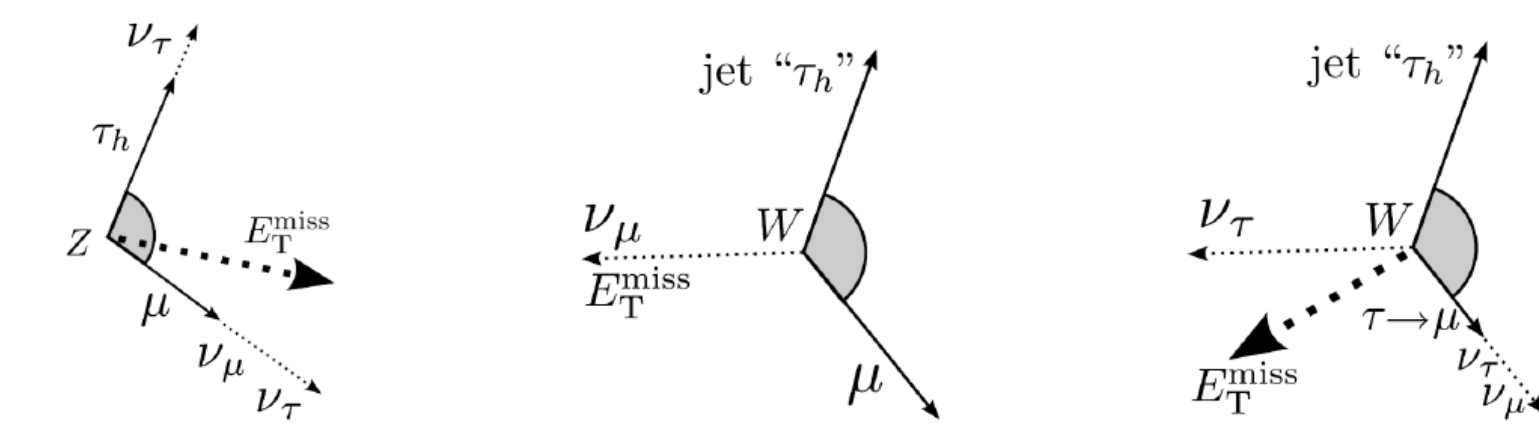


Mainly cuts on two kinematic variables are used to suppress background from W+jets events. These variables are defined as:

$$\bullet \Sigma \cos \Delta \phi = \cos[\varphi(\ell) - \varphi(E_{T, \text{miss}})] + \cos[\varphi(\tau_h) - \varphi(E_{T, \text{miss}})]$$

$$\bullet m_T = (2 p_T(\ell) \cdot E_{T, \text{miss}})^{1/2} \cdot (1 - \cos \varphi(\ell, E_{T, \text{miss}}))$$

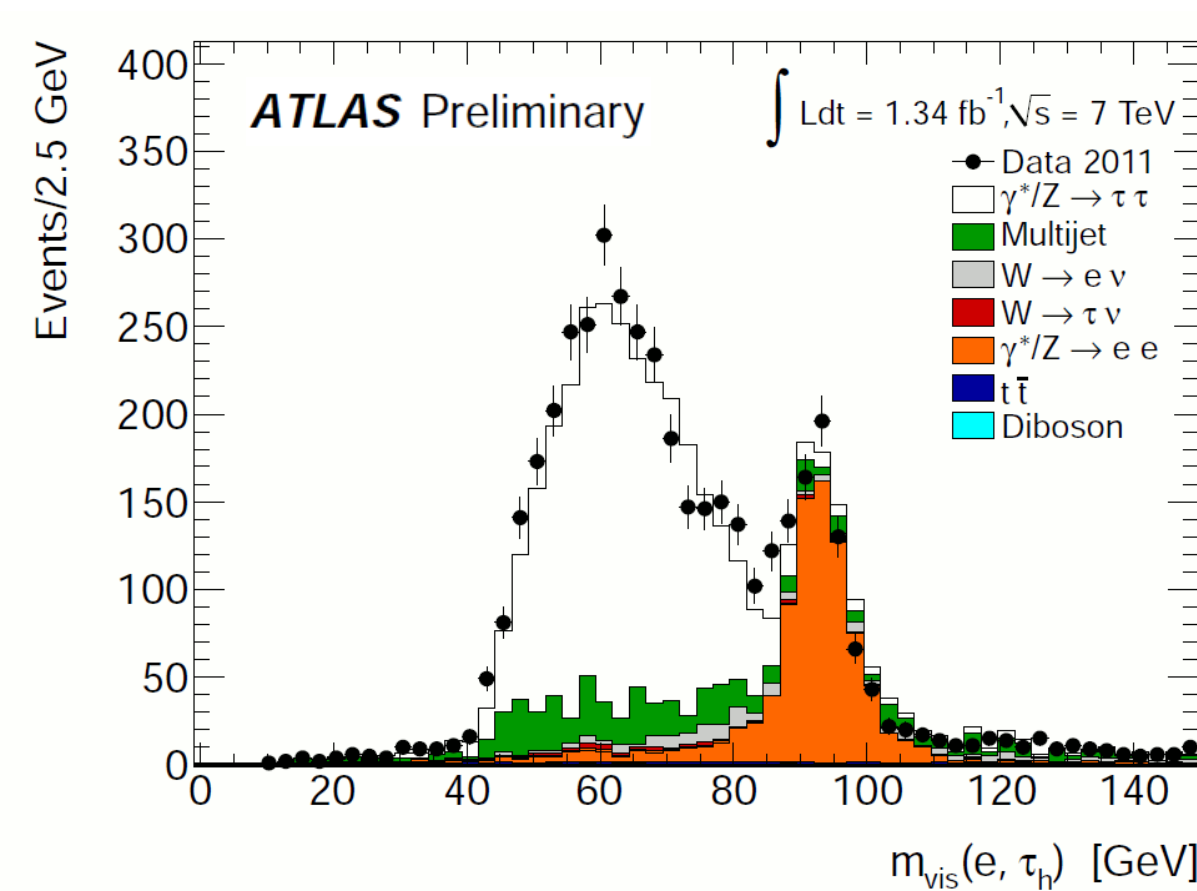
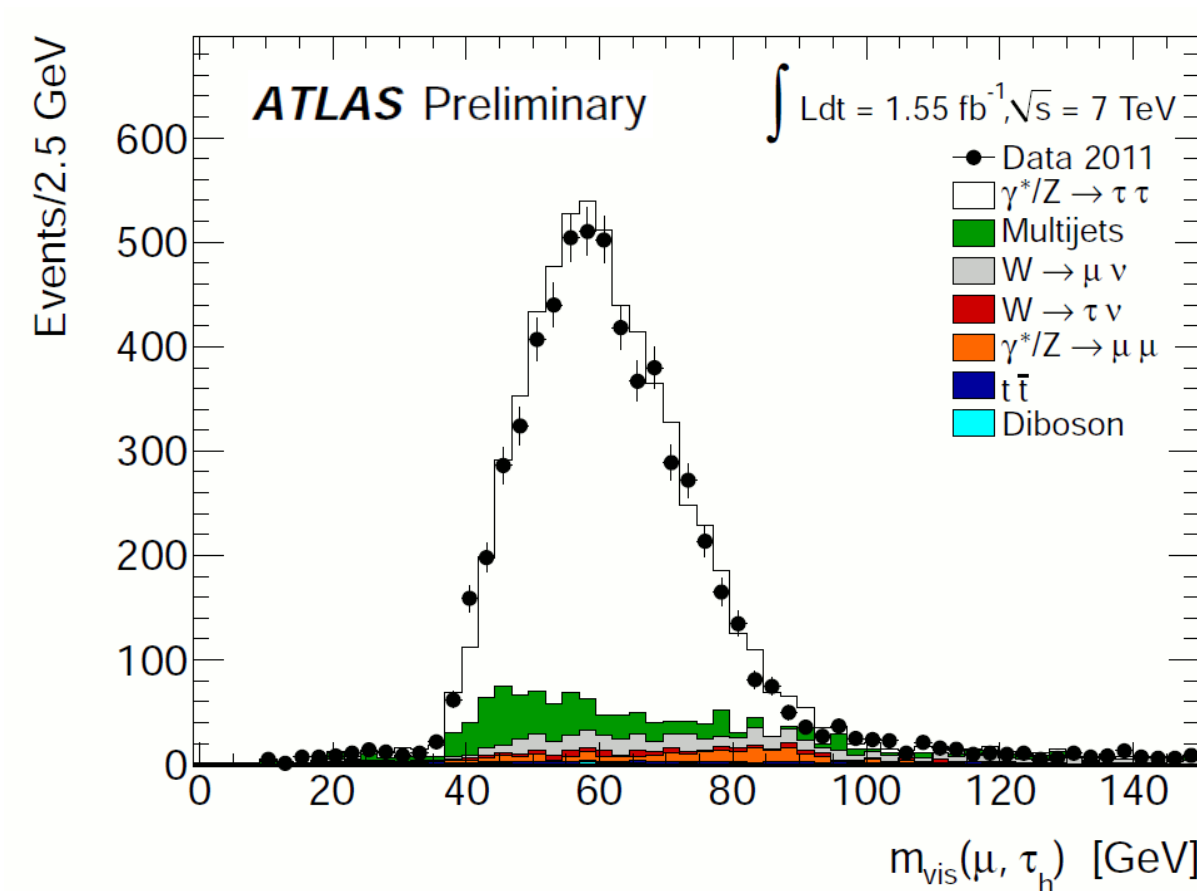
They use the different configuration of the directions of $E_{T, \text{miss}}$, the leptonic and the hadronic tau decay product of W boson background processes compared to the Z boson decays.



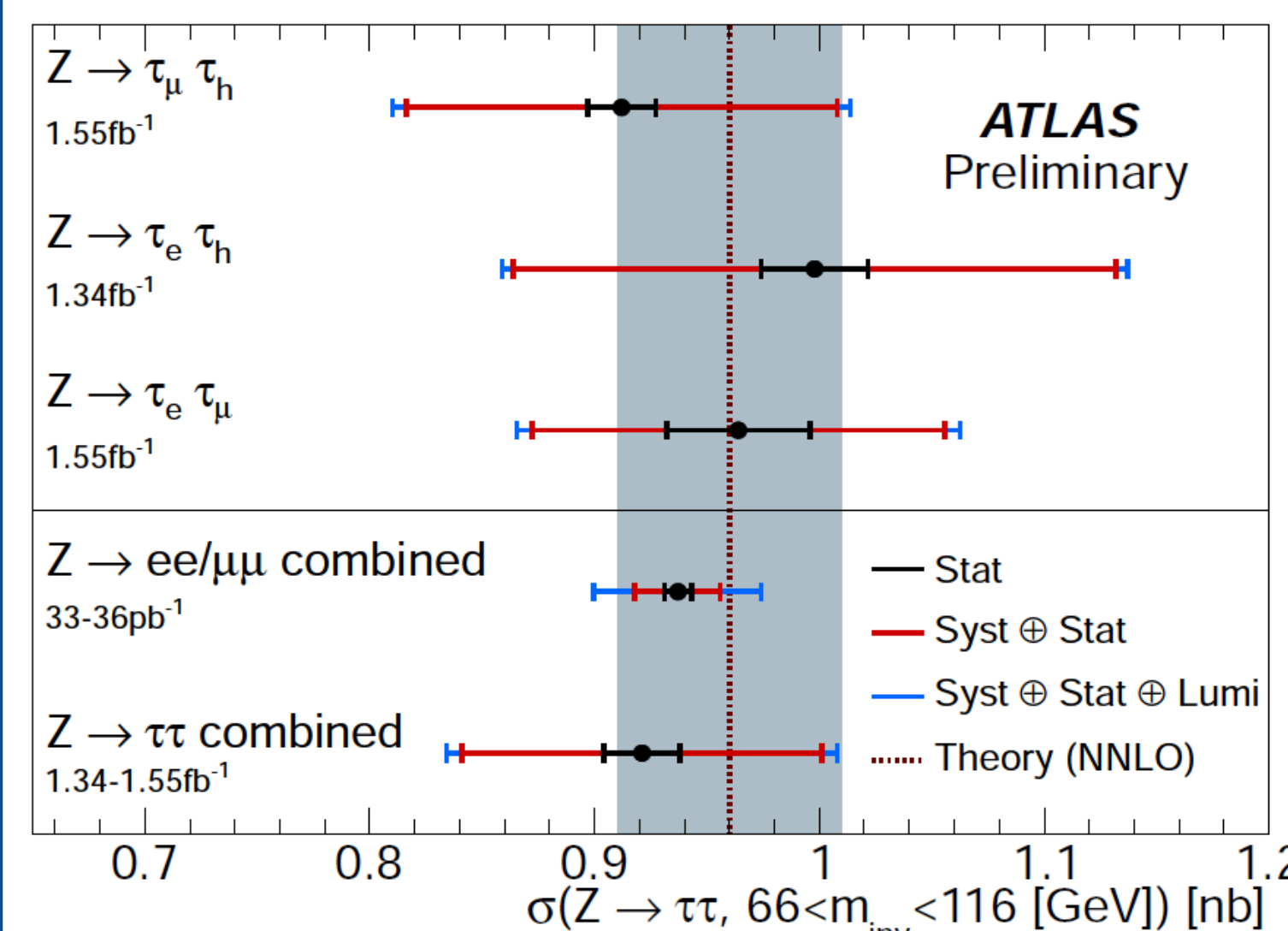
Results

A cut on the final visible mass distributions between 35 and 75 GeV yields the data sample used for the cross section measurement. This is done in the $Z \rightarrow \tau\tau \rightarrow \tau_h e$ and $Z \rightarrow \tau\tau \rightarrow \tau_h \mu$ decay channels and the combined result obtained is: $\sigma = 0.92 \pm 0.02(\text{stat}) \pm 0.08(\text{syst}) \pm 0.03(\text{lumi})$ nb.

This is in agreement with theoretical predictions from NNLO calculations of $\sigma^{\text{theo}} = 964 \pm 48$ pb and measurements done by the CMS experiment.

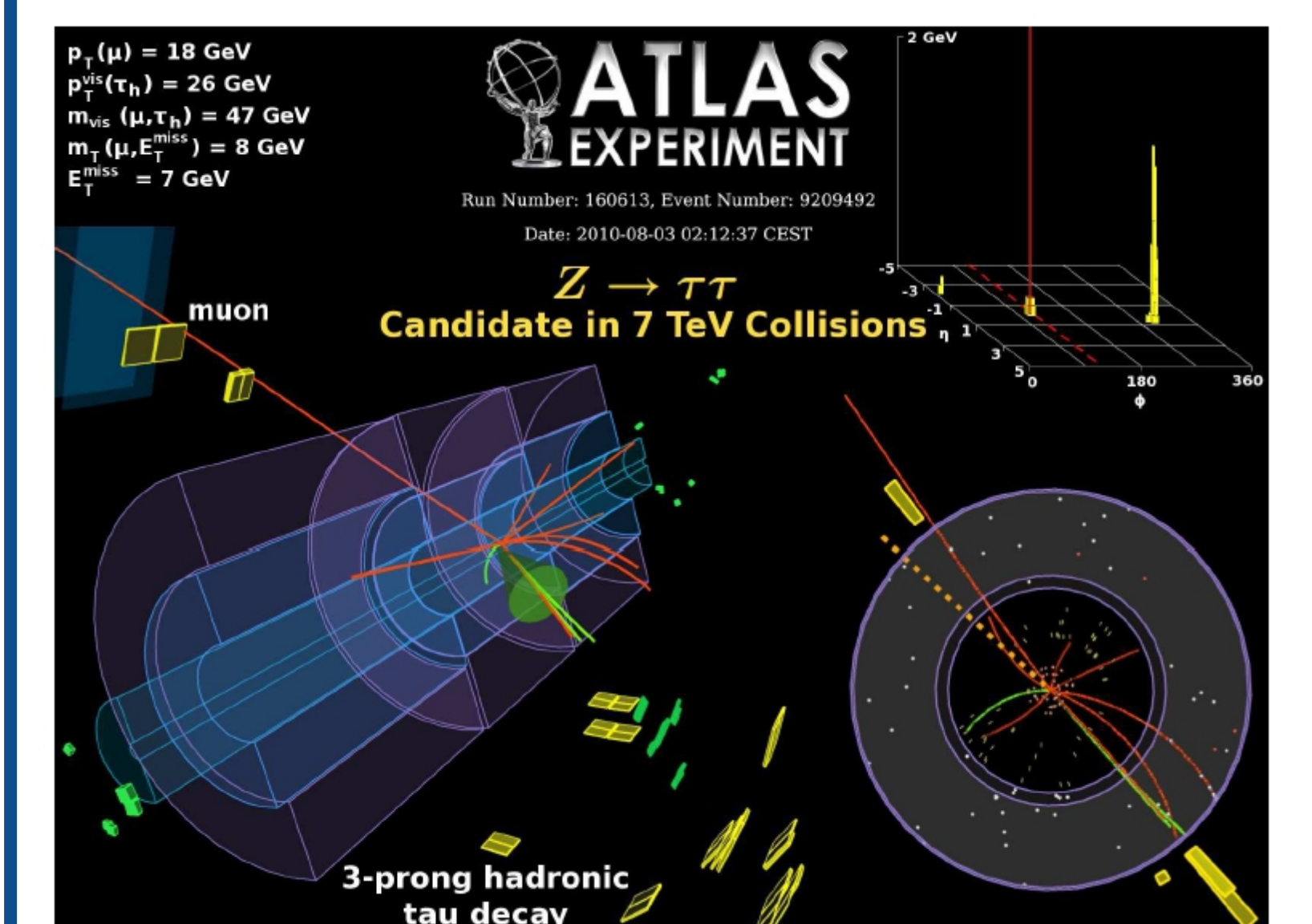


Overview of the Results



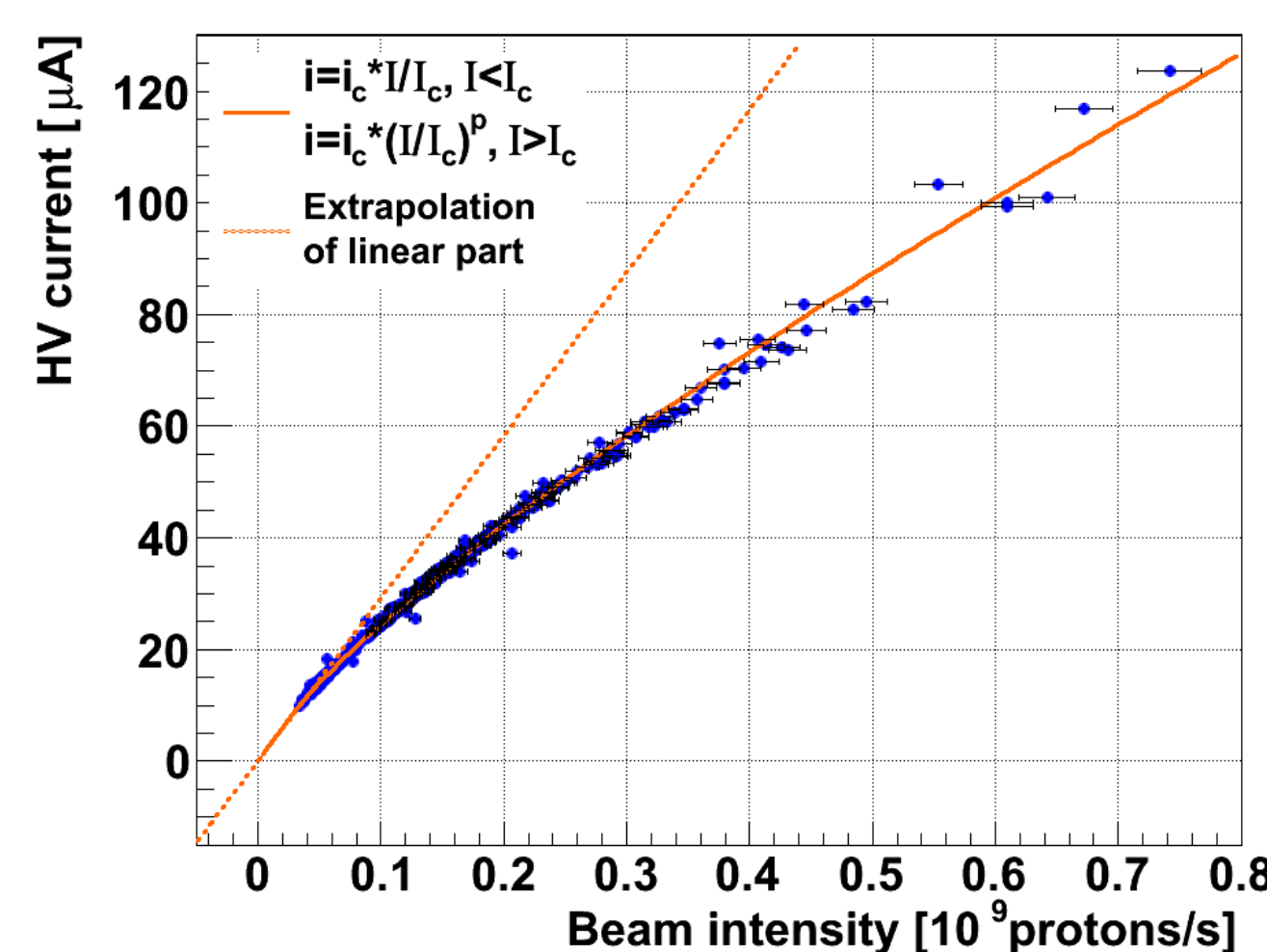
[Reference for theory calculation]: J. Butterworth et al., Single Boson and Diboson Production Cross Sections in pp Collisions at $\sqrt{s} = 7$ TeV, ATL-COM-PHYS-2010-695, 2010.

ATLAS event display of a $Z \rightarrow \tau\tau$ decay



LAr calorimeter performance at high rates

- To investigate the properties of the new resonance and possible further new physics discoveries, the LHC is planned to be upgraded in several steps to achieve luminosities of $3\text{-}7 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$.
- An increased instantaneous luminosity is challenging for the detector operation due to the increased particle flux and irradiation.
- Small-size LAr endcap (EMEC, HEC) and forward (FCal) calorimeter modules were tested in a high-intensity proton beam in Protvino, Russia.



- The HV return currents of the EMEC module have been analysed in dependence of the beam intensity. The results have been compared to model predictions and simulations to extract the point of critical operation.
- It could be confirmed that the HV currents depend linearly on the beam intensity until the critical intensity is reached. Model predictions for the beyond-critical operation were confirmed within the measurement uncertainties.
- The results show, that the EMEC can be operated in the high luminosity environment of the upgraded LHC up to 5 times the design luminosity.

References

- [1] The ATLAS Collaboration, Reconstruction, Energy Calibration, and Identification of Hadronically Decaying Tau Leptons, ATLAS-CONF-2011-077, 2011.
- [2] F. Seifert, Performance of Tau Identification and Associated Systematic Uncertainties in ATLAS, ATL-PHYS-PROC-2011-206, EPS HEP, 2011.
- [3] The ATLAS Collaboration, Measurement of the $Z \rightarrow \tau\tau$ cross section with the ATLAS detector, Phys. Rev. D 84 112006, 2011
- [4] The ATLAS Collaboration, $Z \rightarrow \tau\tau$ cross section measurement in proton-proton collisions at 7 TeV with the ATLAS experiment, ATLAS-CONF-2012-006, 2012.
- [5] F. Seifert et al., Relative luminosity measurement of the LHC with the ATLAS forward calorimeter, JINST 5 P05005, 2010 [arXiv:1005.1784].
- [6] Hilum ATLAS Liquid Argon Endcap Collaboration, Liquid argon calorimeter performance at high rates, Nucl. Inst. A 669 (2012) 47-65, 2012.
- [7] F. Seifert, Upgrade plans for the ATLAS calorimeters, ATL-COM-CAL-2012-005, <http://dx.doi.org/10.1016/j.nima.2012.08.078>, 12th Pisa Meeting on Advanced Detectors, 2012.

Selected Presentations

- Tau Identification in ATLAS*, Poster, EPS conference, Grenoble, 2011.
- Upgrade plans for the ATLAS Calorimeters*, PISA conference on advanced detectors, Elba, May 2012.
- Liquid argon calorimeter performance at high rates*, CALOR conference, Santa Fe, June 2012.

Gain from the GK

- Financial support for international conferences and schools
- Contact to experimental colleagues within the GK
- Possibility to attend GK courses and lectures

Contact Details and further Information

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