Towards the search for the Standard Model Higgs boson in the dimuon decay channel at √s = 8TeV at ATLAS

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Motivation

The newly discovered boson marks a turning point in high energy particle physics. In order to measure its properties, upper limits on the boson's coupling to muons are set. Due to the overwhelming number of non-Higgs Standard Model (SM) processes with a similar dimuon signature, the number of expected signal events after analysis cuts has to be known to high precision. However, this number is extracted from Monte Carlo simulated events, which are subject to systematic effects due to theoretical uncertainties on the parameters of the simulation. This study aims to quantify these systematic effects to improve the precision of the extracted upper limits.

Methods

The study is carried out by simulating SM Higgs events with POWHEG, applying the parton shower algorithms in PYTHIA and analysing the output of these generator-level events with the RIVET analysis package, resembling the event selection procedure also used for collision data events. The following uncertainties are investigated:

- renormalisation and factorisation scale
- initial and final state radiation modeling
- parton density (pdf) uncertainties

The limits on the cross-section of the decay $H \rightarrow \mu\mu$ are determined by performing a combined fit of the expected signal and background shapes of the dimuon invariant mass distribution $m_{\mu\mu}$ in the range of 110 to 150 GeV. The extracted theoretical uncertainties enter the fit as nuisance parameters for the signal strength.

Dimuon event selection

- Since the background from $Z \rightarrow \mu\mu$ events is fitted, the study only involves minimal event selection cuts on kinematics.
- Select 2 well-reconstructed, isolated, opposite charge muons with transverse momenta above 25 and 15 GeV, respectively
- Apply a cut on the invariant dimuon transverse momentum p_T^{ll} to be larger than 15 GeV

Recent results

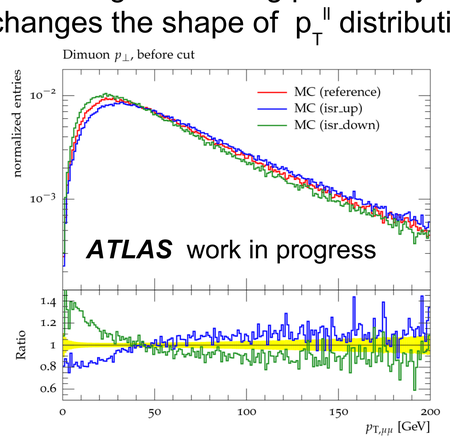
- The systematic effects on signal acceptance are found to be of the order of a few percent
- Analysis is split into two resolution categories to improve sensitivity
- The relative change in acceptance is given in % and can be asymmetric

investigated uncertainty	resolution category		
	inclusive	central	non-central
ren./fac scale	-0.2%	-1.3%	+0.4%
initial state radiation	+1.3% -2.5%	+2.5% -3.4%	+0.7% -2.0%
final state radiation	+0.3% -0.6%	-0.2%	+0.1% -0.5%
PDF	±0.2%	±1.2%	±0.3%

Findings and Outlook

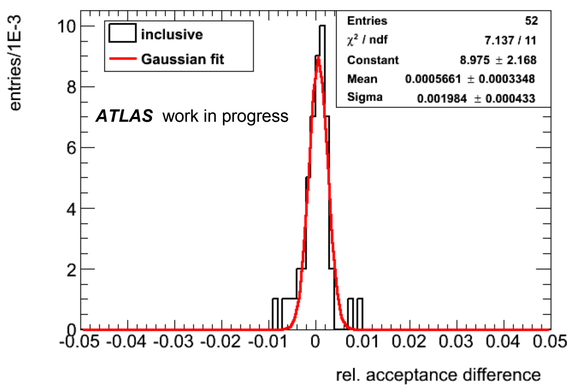
Initial State Radiation

- modeling uncertainty addressed by increasing/decreasing probability of emissions
- changes the shape of p_T^{ll} distribution



Parton Distribution Function uncertainties

- each of the 52 error pdfs within the CT10 pdf set is used to determine a signal acceptance
- the ensemble of acceptances is then compared to the central value, the spread of the relative differences is taken as the systematic uncertainty due to pdf uncertainties



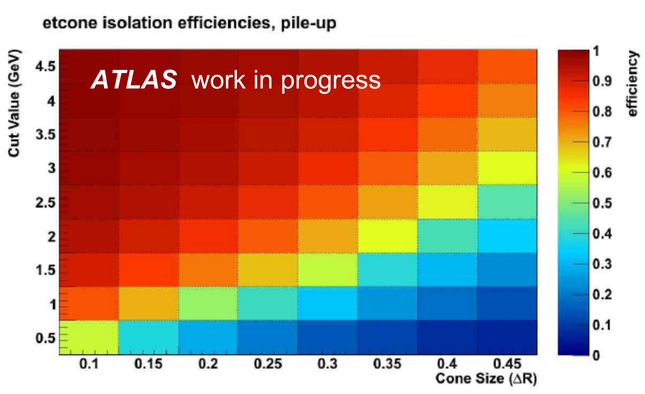
Outlook:

- use similar approach for MSSM interpretation of the measurement
- include further Higgs production modes (b-associated production, vector-boson fusion)
- develop and improve additional signal and background modeling functional forms

Related Studies

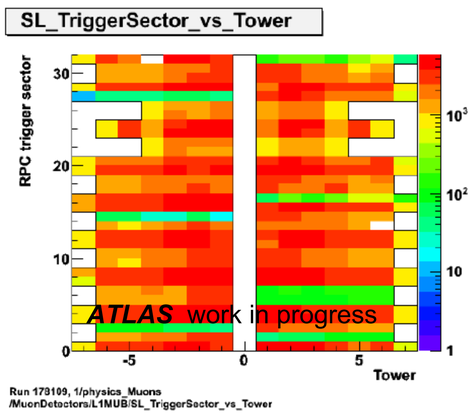
Muon isolation efficiency

Muons originating from the decay of a heavy particle like the Z or Higgs bosons tend to be isolated, i.e. are usually not accompanied by close-by other particles in the detector. The efficiency of three different isolation algorithms – ptcone, etcone and nucone – have been studied on Monte Carlo simulated events. The efficiency depends on the width ΔR of the cone and the applied cut value.



Muon RPC sector logic monitoring

An important part of the ATLAS muon trigger system are the resistive plate chambers (RPCs), which are subject to continuous online and offline monitoring. An offline monitoring algorithm for the sector logic circuits within the RPC trigger system has been developed and implemented in the ATLAS trigger monitoring framework.



Selected Talks and References

- *"Muon isolation efficiency monte-carlo studies in (Z->μμ)+Jets events"*", DPG Frühjahrstagung, March 2010, Bonn
- "*ATLAS RPC sector logic offline monitoring at Tier0*", ATL-COM-DAQ-2011-028, May 2011

Profit from the GK

- Financial support for conferences and international schools
- Contact to experimental colleagues within the GK
- Insight to other fields of high energy physics during GK Block Courses

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DRESDEN concept

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