# A measurement of the Cross Section of the Z decay in muon channel and prediction of the rate of the Z decay in tau-lepton channel

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## The Z at LHC

❑The Z production mechanism at the LHC:

❑ The Drell-Yan process: a quark and anti-quark fuse into Z,

❑ The NLO mechanism : quark gluon scattering,

❑ Higgs; H -> ZZ.

## The Z at ATLAS

❑ The Z boson has a very short lifetime , it decays shortly after its production.

❑ The Z0 boson is not detected directly in the ATLAS experiment and it must be reconstructed from its decay products.

❑ The Z0 boson decays to fermions and anti-fermion pairs.

❑ Z -> μμ , Z-> ττ have the same rate.

## Data and MC used in this analyses

❑ Data collected by ATLAS detector in late 2010.

❑ The proton beam had energy of 3.5 TeV.

❑ The integrated luminosity of the machine was 36 $pb^{-1}$ .

❑ MC sample generated by using PYTHIA.

## The Z decays in Muon Channel

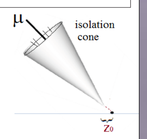
### Selection

❑ Initial criteria approved quailed events for the study.

❑ The authenticity of the muon is checked. Only muons that have expected properties of muons from Z decays selected and muons from backgrounds are rejected.

❑ Events that carry the specific Z properties passed.

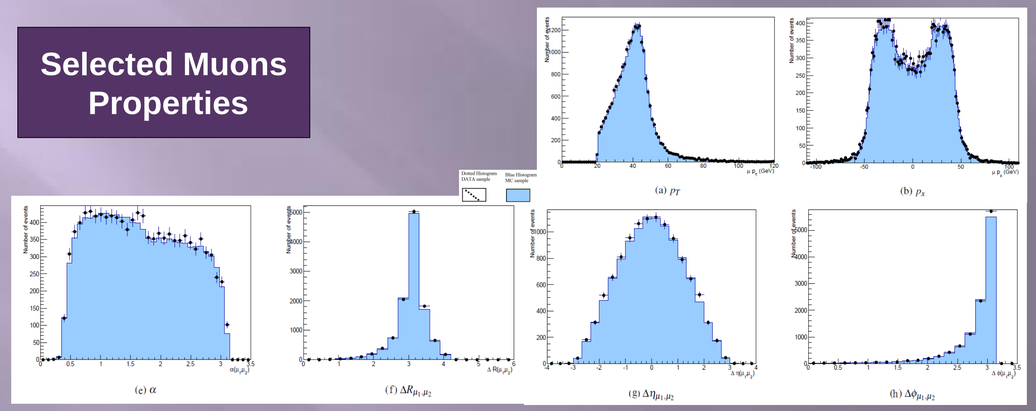
| Event Selection I | |
|---|---|
| Collision event selection | data quality information coded in Good Run Lists |
| Number of muons | $> 1$ |
| **Muon Selection** | |
| High $p_T$ selection | $p_T > 20$ GeV |
| Selection on $\eta$ | $\lvert\eta\rvert < 2.4$ |
| Type of muon | CB muon |
| Cosmic muon rejection | $\lvert z_0\rvert < 10$ mm |
| ID hit requirements | number of B layer Hits $> 0$<br>number of the hits at Pixel $> 1$<br>number of the hits at SCT $\geq 6$<br>number of pixel holes + number of SCT holes $< 3$<br>TRT hit requirements<br>$\lvert\eta\rvert \leq 1.9 \rightarrow$ Hits + Outliers $> 5$ and $\frac{\text{Outliers}}{\text{Hits+Outliers}} > 0.9$<br>$\lvert\eta\rvert > 1.9$ for (Hits + Outliers $> 5$) $\rightarrow$ $\frac{\text{Outliers}}{\text{Hits+Outliers}} < 0.9$ |
| Isolation | $\sum p_T^{ID}/p_T < 0.2$ tracks inside cone of 0.4 |
| **Event Selection II** | |
| Pair of good muons | at least two good muons that pass all muon selection criteria |
| Invariant mass | $66 < m_{\mu\mu} < 116$ GeV |
| Opposite charge | $Charge_{\mu_1} + Charge_{\mu_2} = 0$ |



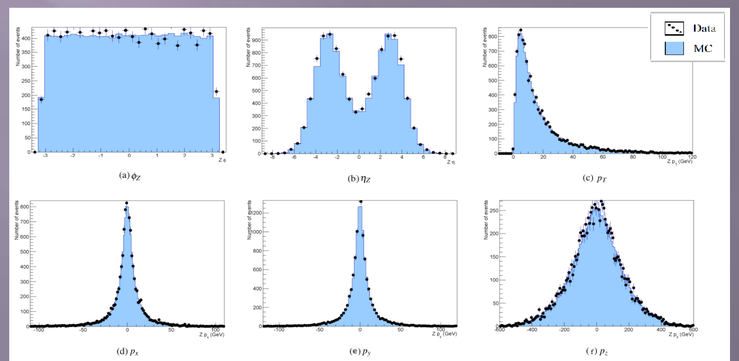

### Cut Efficiency

| Event selection | Data | | MC | |
|---|---|---|---|---|
| Requirement | Number of Events | Cut Efficiency Compare to Prev. | Number of Events | Cut Efficiency Compare to Prev. |
| Total Number of events | 1 857 054 | 100% | 494 926 | 100% |
| Collision Event Selection | 1 647 095 | 88.69% | — | — |
| Pair of Muons | 725 512 | 44.04% | 324 815 | 65.63% |
| Pair of Good Muons | 12 006 | 1.65% | 183 076 | 56.36% |
| Invariant Mass | 11 250 | 93.70% | 177 724 | 97.07% |
| Opposite Charge | 11 246 | 99.96% | 177 716 | 99.99% |

### Selected Muons Properties



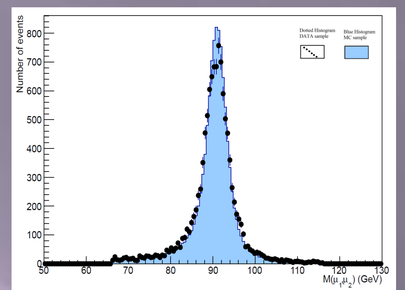

### Reconstructed the Z Properties




## The Invariant Mass

The Invariant Mass:

❑ MC 91.18 GeV
❑ Data 90.13 GeV
❑ established value for Z mass is 91.187 GeV




## The Cross Section of the Z decays in Muon channel

❑ The Z boson decay cross section in the fiducial volume of the detector is measured by using formula (1).
❑ The total cross section was extrapolated by formula (2).
❑ The correction factor C and the acceptance factor which are used in the (1),(2) are calculated from the (3) and (4).
❑ The measured cross-section are presented in the following Table.

$$\sigma_{fid} = \frac{N_{Z^0}^{sig}}{C_{Z^0} \cdot L_{int}}. \quad (1)$$

$$\sigma_{tot} = \sigma_{Z^0} \times BR(Z^0 \rightarrow \mu^-\mu^+) = \frac{\sigma_{fid}}{A_Z^0}. \quad (2)$$

$$C_{Z^0} = \frac{N_{MC,rec}}{N_{MC,gen,cut}}. \quad (3) \qquad A_{Z^0} = \frac{N_{MC,gen,cut}}{N_{MC,gen,all}}. \quad (4)$$

| | value | | |
|---|---|---|---|
| $N_{Z^0}^{sig}$ | 11 246 | | |
| **Correction** $C_{Z^0}$ | 0.782 | ±0.003 | |
| **Acceptance** $A_{Z^0}$ | 0.483 | ±0.002 | |
| **Luminosity** $L$ | 3 5955 | ± 1 222 | ($nb^{-1}$) |

| | value | stat | syst | lumi | |
|---|---|---|---|---|---|
| **Fiducial Cross-Section** $\sigma_{fid}$ | 0.400 | ±0.009 | ±0.015 | ±0.014 | (nb) |
| **Total Cross-Section** $\sigma_{tot}$ | 0.828 | ±0.009 | ±0.035 | ±0.028 | (nb) |

## The Z decays in tau-lepton channel

### Selection

❑ Initial criteria approved quailed events for the study.

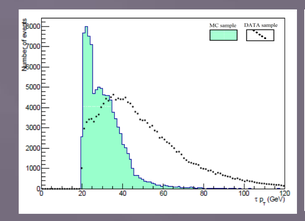
❑ The authenticity of the tau-lepton is checked.

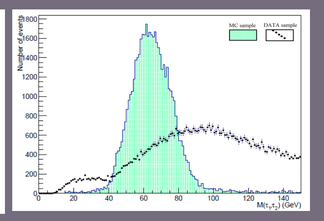
❑ Events that carry the specific Z properties passed.

| Event Selection I | |
|---|---|
| Collision event selection | data quality information coded in Good Run Lists |
| Number of $\tau-$leptons | $> 1$ |
| **$\tau-$leptons Selection** | |
| High $E_T$ selection | $E_T > 20$ GeV |
| Selection on $\eta$ | $\lvert\eta\rvert < 2.5$ |
| Number of track | = 1 or 3 |
| Electron and Muon veto | This criterion distinguishes and rejects the $\tau$-candidate which decays leptonicly and select only $\tau$-candidate that decays hadronicly. |
| Rejection of jet | to distinguish the jet which is disguised as a $\tau$-lepton |
| Charge of $\tau$-candidate | $\pm 1$ |
| **Event Selection II** | |
| Pair of good $\tau-$leptons | at least two good $\tau$-candidates is presented in the sample after passing all $\tau-$leptons selection criteria |
| Opposite charge | $Charge_{\tau_1} + Charge_{\tau_2} = 0$ |

### Selected Tau-lepton Properties

❑ Plots suggest there are considerable background events after selection.




## Conclusion

Since the measurement of Z->μμ cross section agrees with theoretical prediction. This indicates that Z->ττ cross section should be well described by theory and can be used to predict the Z->ττ rate in ATLAS.