$Z \rightarrow \mu\mu$ event selection and first look at pileup

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Outline

- Performed full analysis for the selection of $Z \rightarrow \mu\mu$ events using AOD and comparison with M.Schott et al. results (post CSC)

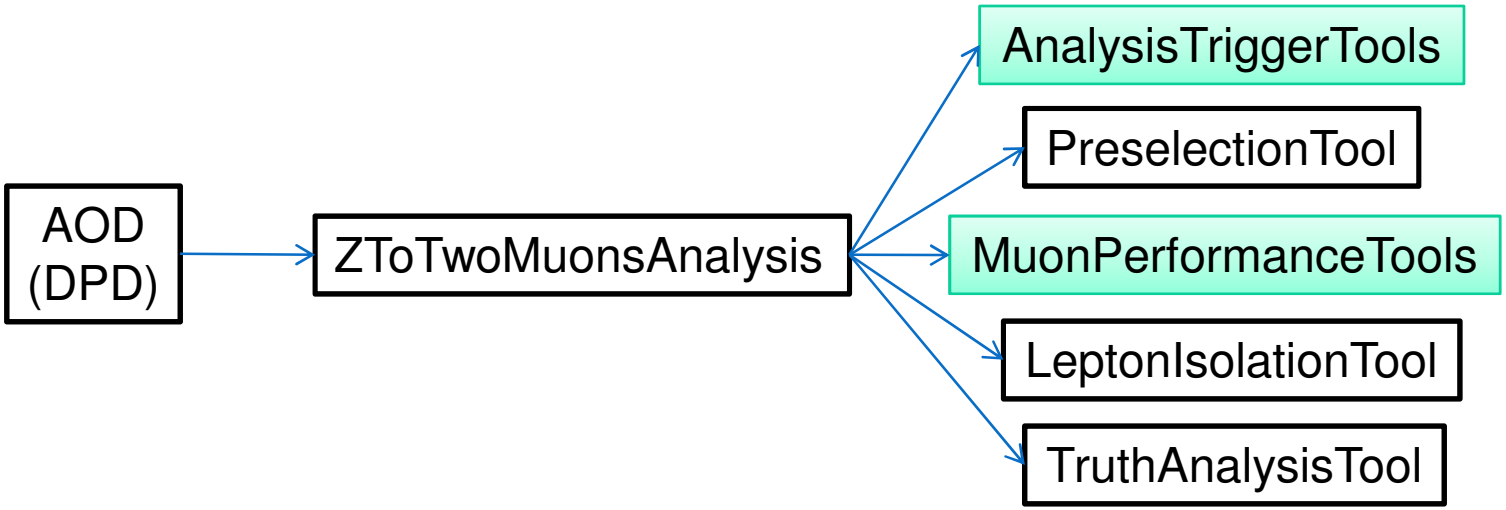
  http://indico.cern.ch/getFile.py/access?contribId=0&resId=1&materialId=slides&confId=39694

- Preliminary analysis on FDR-c MC data

- A first look at $Z \rightarrow \mu\mu$ MC sample generated with pile up

$Z \rightarrow \mu\mu$ Analysis

The analysis has been performed with an ATHENA analysis package developed ad-hoc for this studies.



In blue are indicated the External common tool used:

/offline/PhysicsAnalysis/MuonID/MuonPerformanceTools

/offline/PhysicsAnalysis/AnalysisTrigger/AnalysisTriggerTools

MC samples used (13.0.4)

All MC samples used were reconstructed with ATHENA v 13.0.4

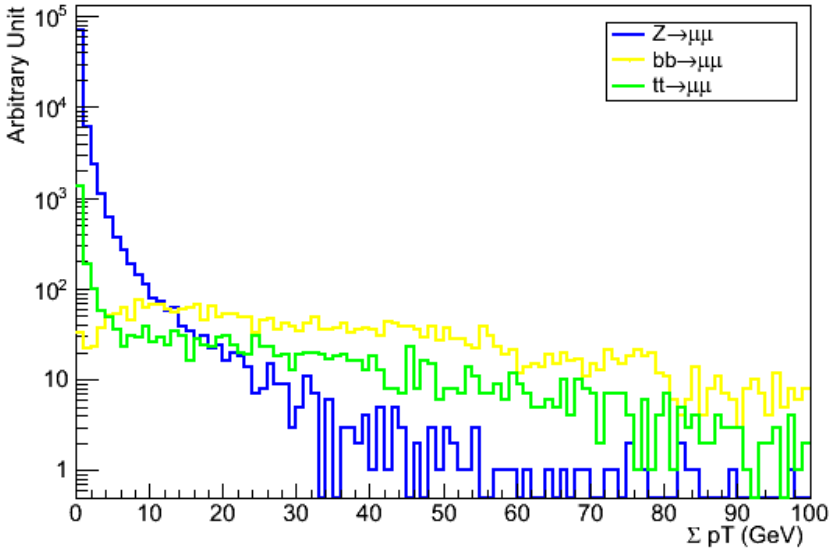
Sample	Cross Section (pb)*filter eff	Sample number
Zmumu	1854	5145
Wmunu	14490	5105
Ztautau	104.15	5146
ttbar	5.83	5205
bbmu15	270000	5701
bbmu5mu15	1000	5714

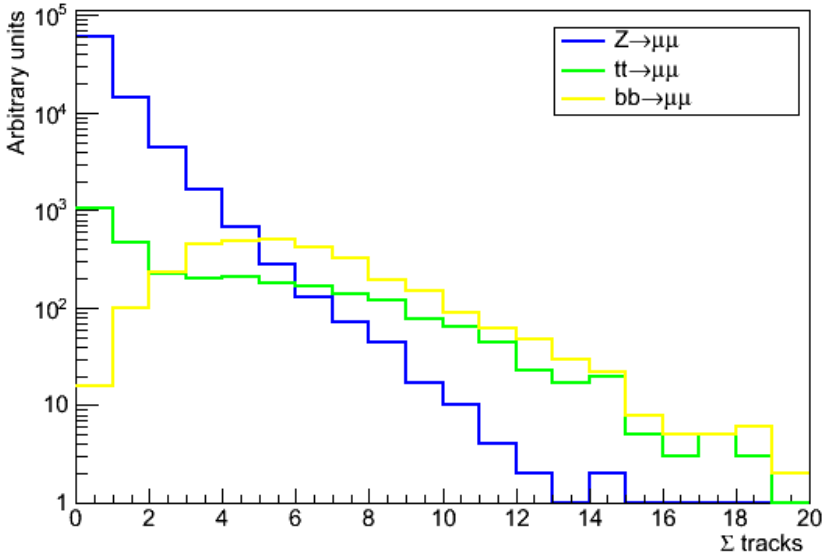
The next step will be to perform again the analysis with the dataset reconstructed with Athena v 14

Z boson selection

SELECTION CUTS

- **mu10 EF trigger selection**
- **Preselection requiring at least 2 combined tracks with pT>5GeV & $|\eta|<2.5$**
- **At least 2 muons with pT>20GeV**
- **Opposite charge & ID isolation within cone of 0.4 ($\Sigma pT<5GeV$, $\Sigma tracks<6$)**
- **Invariant Mass $80GeV<M_{\mu\mu}<100GeV$**



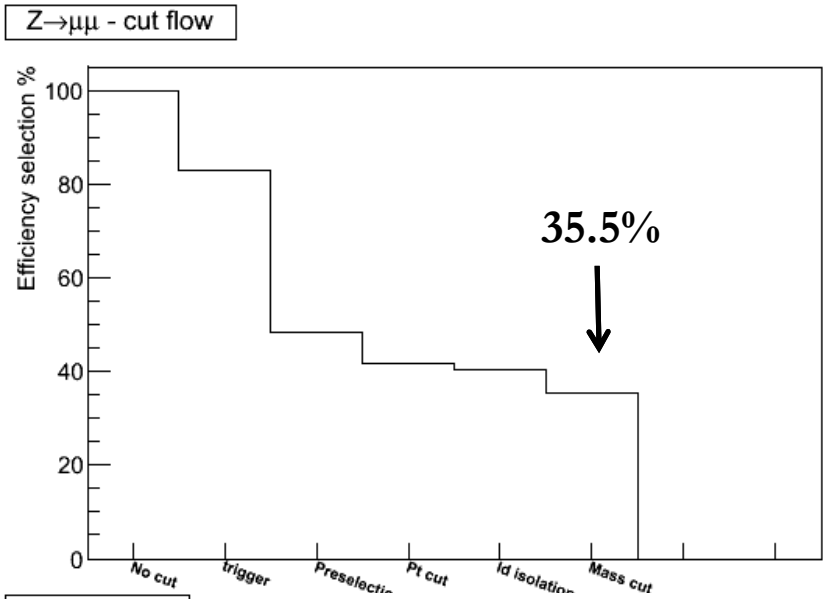


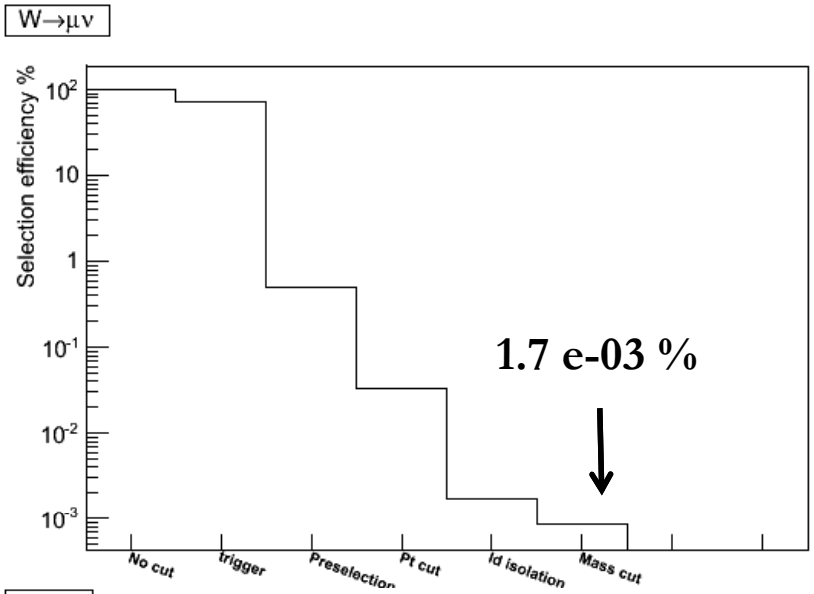
Cut flow

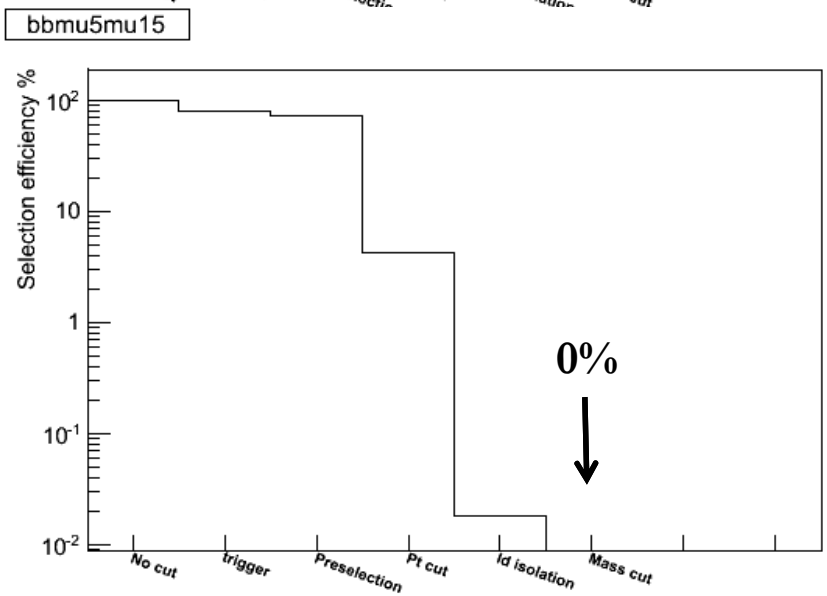
	Zmumu	Wmunu	tt	bbmu15	bbmu5mu15	Ztautau
Sample size	196000	115000	145000	165000	89000	137600
Trigger	162566	82245	54900	131977	71703	65048
Preselection	95051	564	14828	7951	65233	23709
ptcut	81766	38	4149	104	3767	3244
Id isolation	78986	2	1172	1	16	3024
Mass cut	69647	1	206	0	0	90

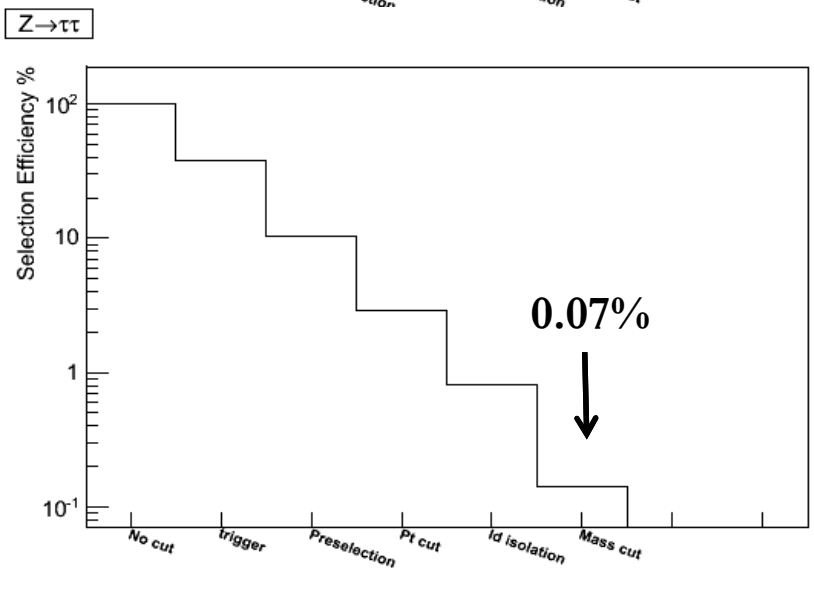
- **76.7% of the event generated in the acceptance are selected**
- **Looking at the MC truth the wrong muon coupling is also evaluated.**
  - **Only 12 events (0.01%) after the mass cut have no matching with muons coming from Z in the MC truth**

Cut flow

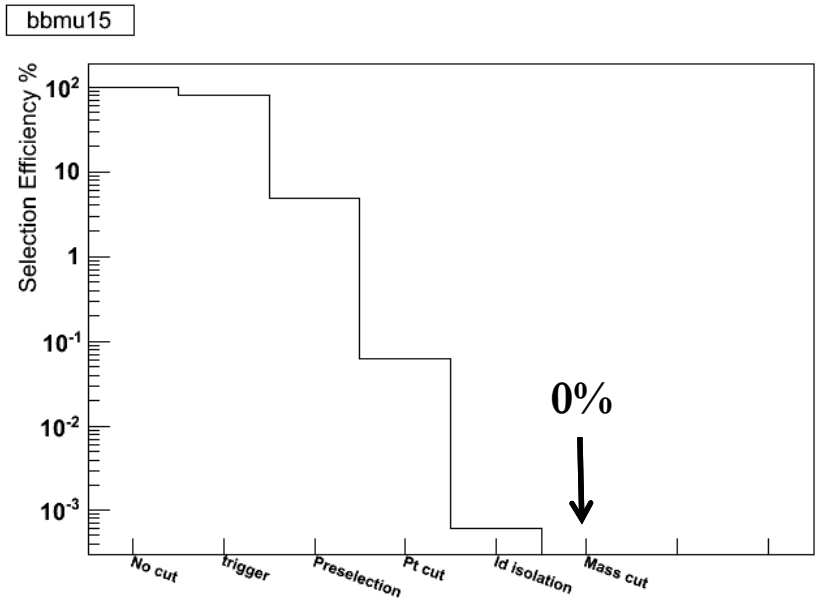

Z→μμ - cut flow
Efficiency selection %
100
80
60
40
20
0
35.5%
No cut
trigger
Preselecti
Pt cut
Id isolatio
Mass cut

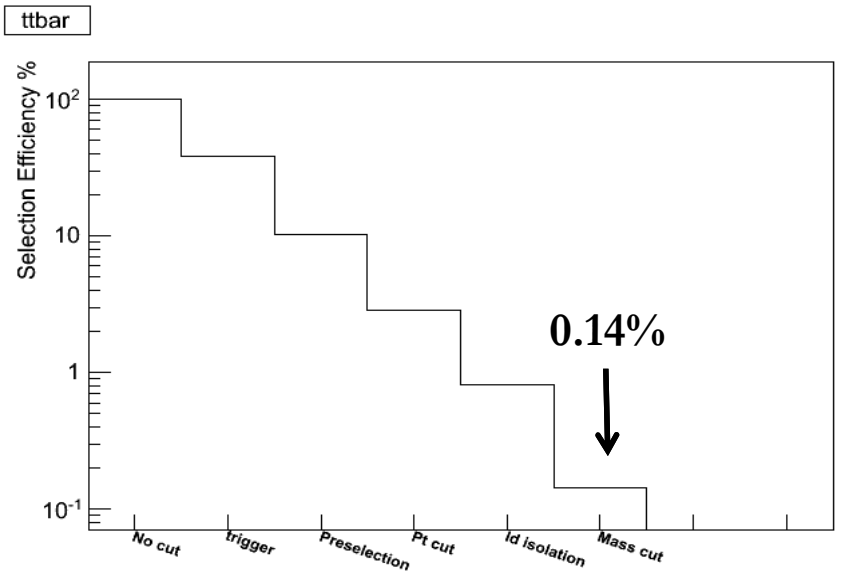

W→μν
Selection efficiency %
10²
10
1
10⁻¹
10⁻²
10⁻³
1.7 e-03 %
No cut
trigger
Preselection
Pt cut
Id isolation
Mass cut

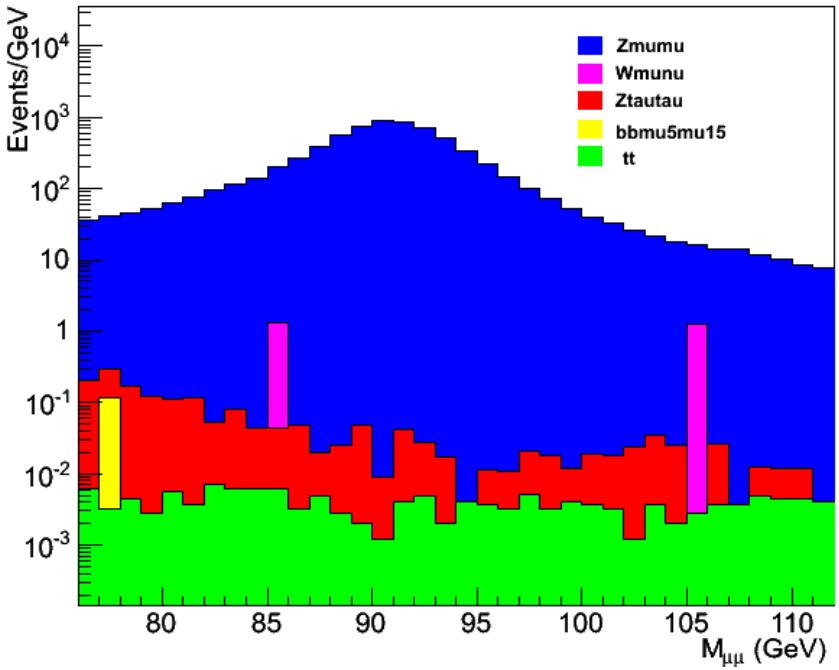

bbmu5mu15
Selection efficiency %
10²
10
1
10⁻¹
10⁻²
0%
No cut
trigger
Preselection
Pt cut
Id isolation
Mass cut

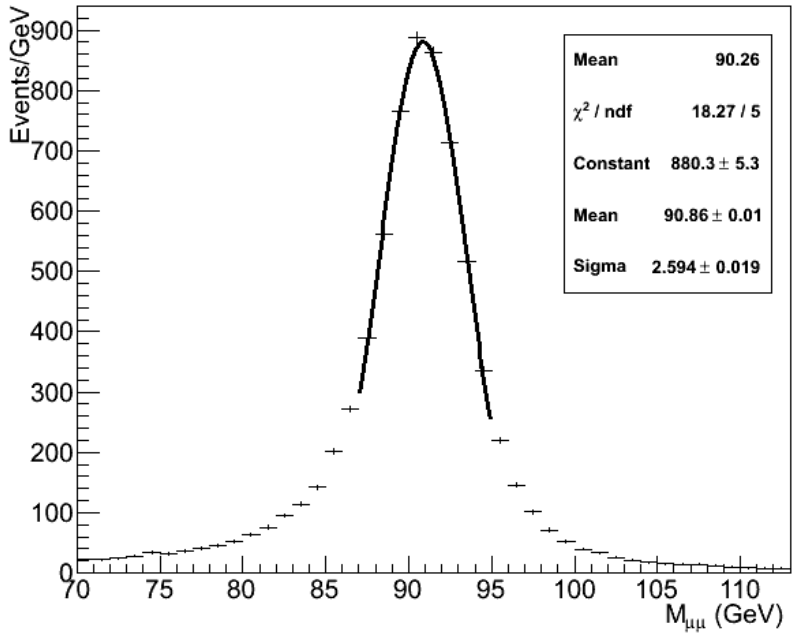

Z→ττ
Selection Efficiency %
10²
10
1
10⁻¹
0.07%
No cut
trigger
Preselection
Pt cut
Id isolation
Mass cut

Cut flow


bbmu15
Selection Efficiency %
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
0%
No cut
trigger
Preselection
Pt cut
Id isolation
Mass cut


ttbar
Selection Efficiency %
10^2
10
1
10^{-1}
0.14%
No cut
trigger
Preselection
Pt cut
Id isolation
Mass cut


Events/GeV
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
Zmumu
Wmunu
Ztautau
bbmu5mu15
tt
80
85
90
95
100
105
110
$M_{\mu\mu}$ (GeV)


Events/GeV
900
800
700
600
500
400
300
200
100
0
Mean 90.26
χ^2 / ndf 18.27 / 5
Constant 880.3 ± 5.3
Mean 90.86 ± 0.01
Sigma 2.594 ± 0.019
70
75
80
85
90
95
100
105
110
$M_{\mu\mu}$ (GeV)

FDR

The same analysis has been on FDR-c samples.

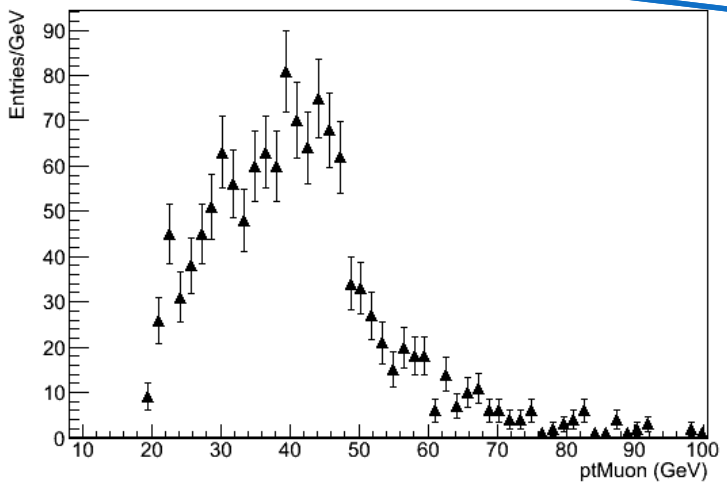
Muon stream has been used :

- **Run 52290**
- **Run 52293**

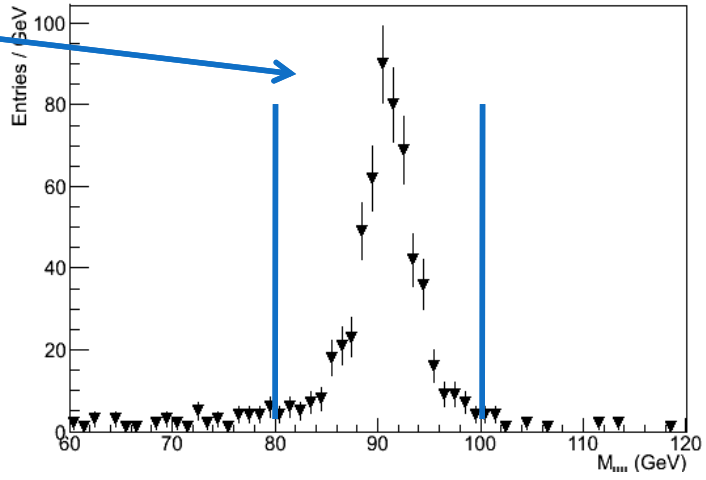
Perfect aligned samples

$\int Ldt = 0.36 pb^{-1}$ for each file (L=10^32 for 1 hour – 60 luminosity block)

Reconstructed pT of Z muon candidate



565 events after the mass cut



Rough xsec·BR ($Z \rightarrow \mu\mu$) estimation with FDR samples

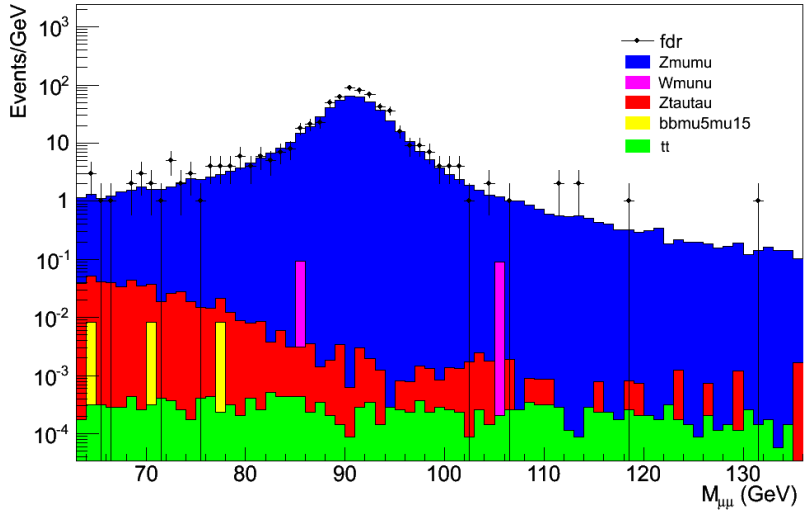
$$\sigma = \frac{N - B}{\int Ldt} \frac{1}{\varepsilon_{selection}}$$

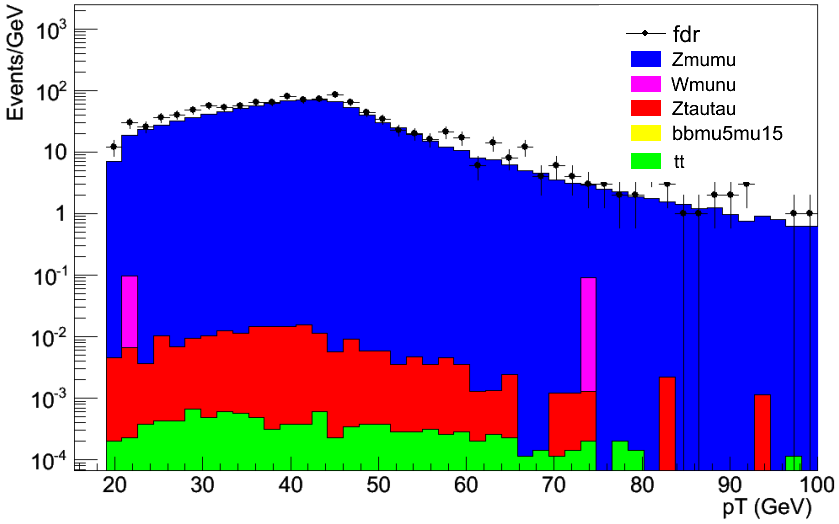
N_Z=565±24 events

B= 0.14 events(estimated by MC)

$\varepsilon_{selection}$=35.5%

(σ·BR) =2210±94 pb





Pile-up sample

- **Understand the impact of the pile-up in the signal event selection.**

- **At design luminosity (10^34 cm-2s-1), the average number of minimum-bias events is 23 per bunch crossing, varying according to a Poisson distribution (long tail → big fraction of the bunch crossings will have more than the average number of interactions).**

- **Dataset used for this study:**

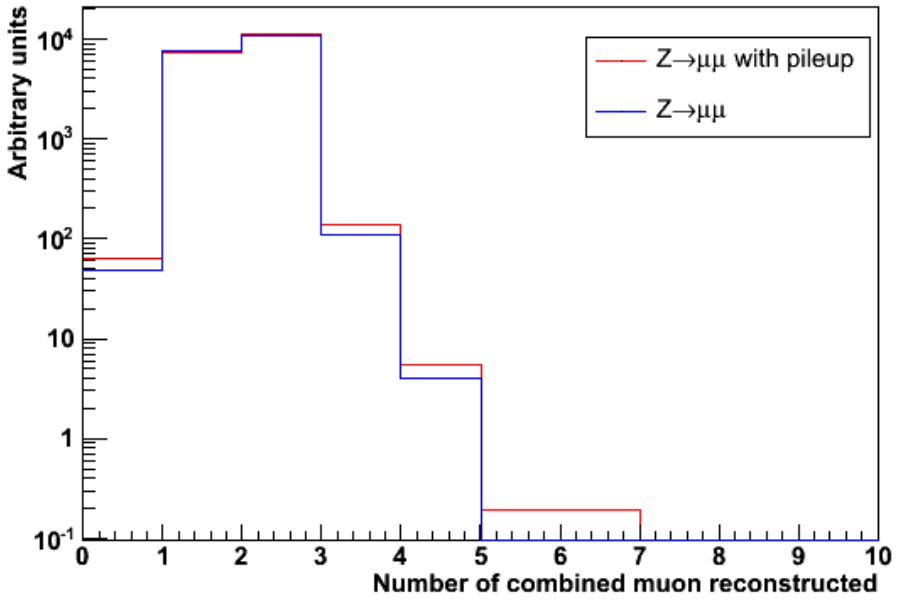
  trig1_pile1sf05_misal1_csc11_V1.005145.PythiaZmumu.recon.AOD.v13003003

- **All the result that are shown are normalized at 10pb^-1 equivalent**

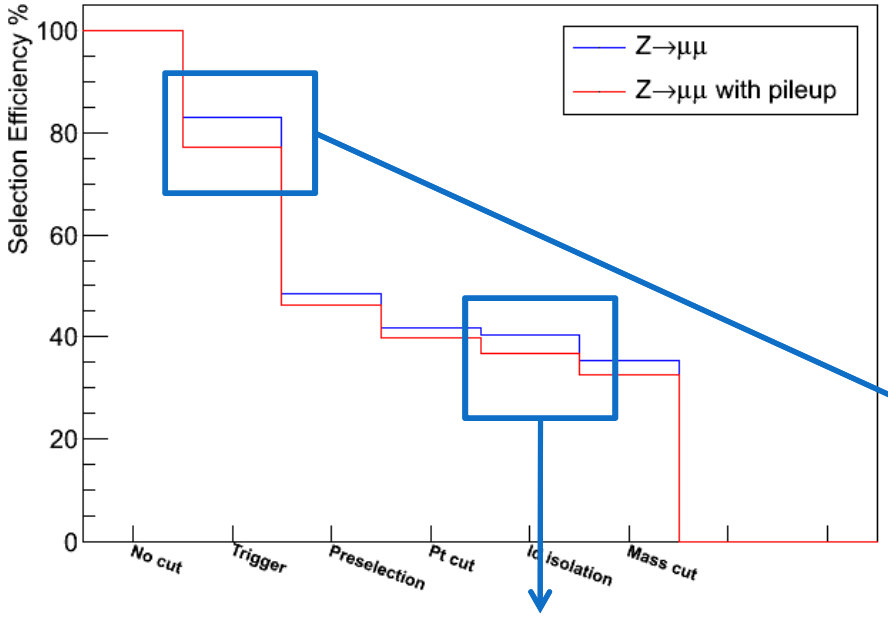
Cut Flow

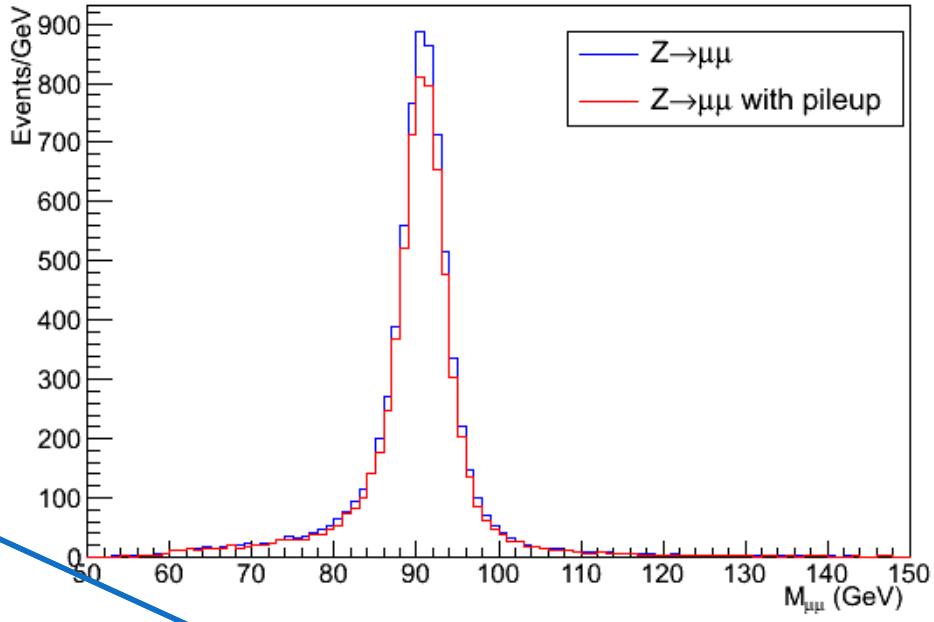
	Zmumu	Zmumu with pileup
Sample size	196000	96500
Trigger	162566	74382
Preselection	95051	44631
ptcut	81766	38354
Id isolation	78986	35626
Mass cut	69647	31504

The distribution of number of STACO muon combined reconstructed for Zmumu sample with and without pileup



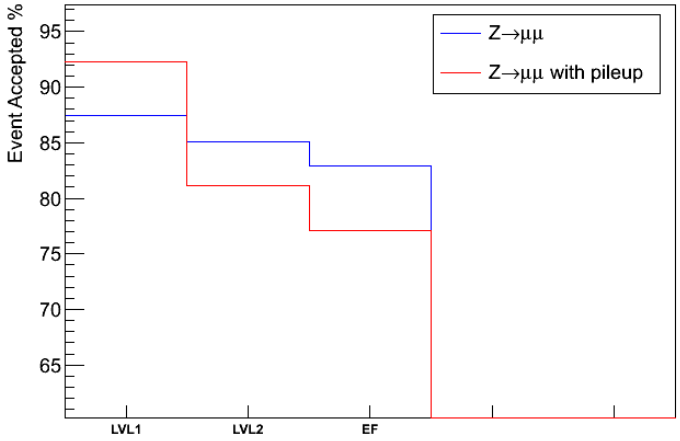
Pile-up





- The ID isolation request have a bigger impact on the pile up sample as expected

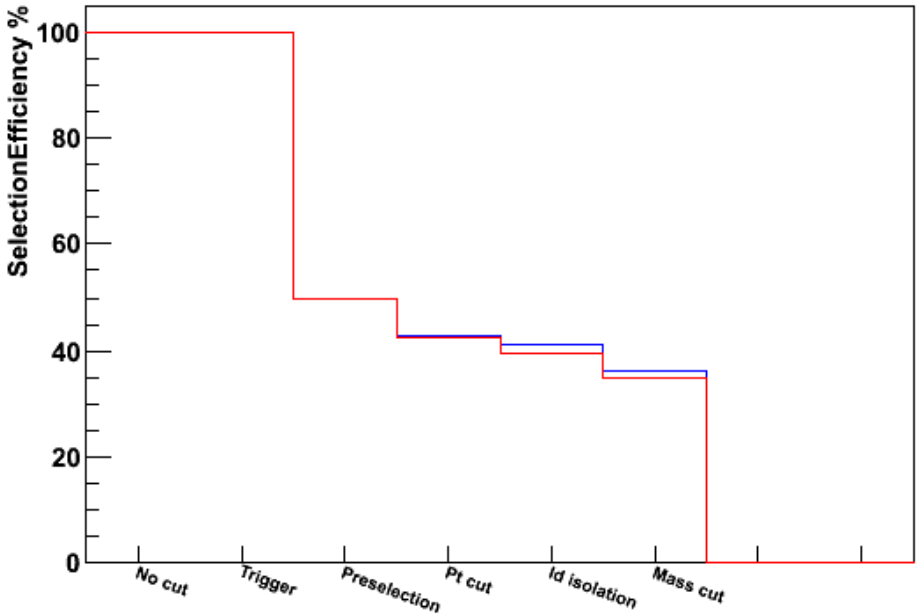
- Big difference at the trigger decision level

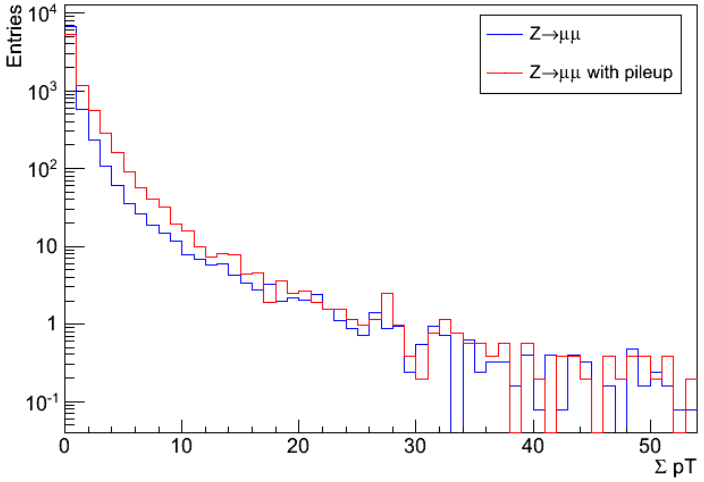


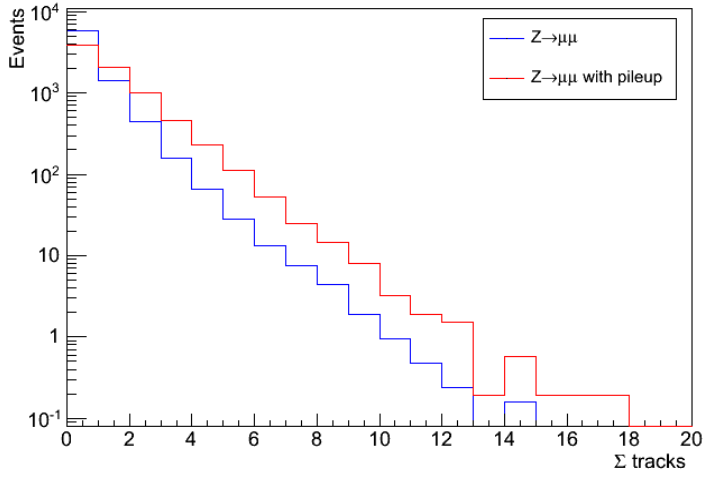
- Selection efficiency $Z \rightarrow \mu\mu$: 35.5%
- Selection efficiency $Z \rightarrow \mu\mu$ with pileup : 32.6%

Pile-up

- The analysis was also performed without the trigger filter







- Selection efficiency $Z \rightarrow \mu\mu$: 36.3%
- Selection efficiency $Z \rightarrow \mu\mu$ with pileup : 34.8%

Conclusion

- **First exercise to perform a full analysis for the selection of the $Z \rightarrow \mu\mu$ events.**

- **Very good agreement with the analysis performed by M.Schott et al. (35.47% vs 35.53% in selection efficiency)**

- **First look at the impact of the pileup in the selection efficiency.**
  - **To be understood (with the help of experts) the impact of trigger**