Electroweak bosons and quarkonium resonances in di-muon mass spectra

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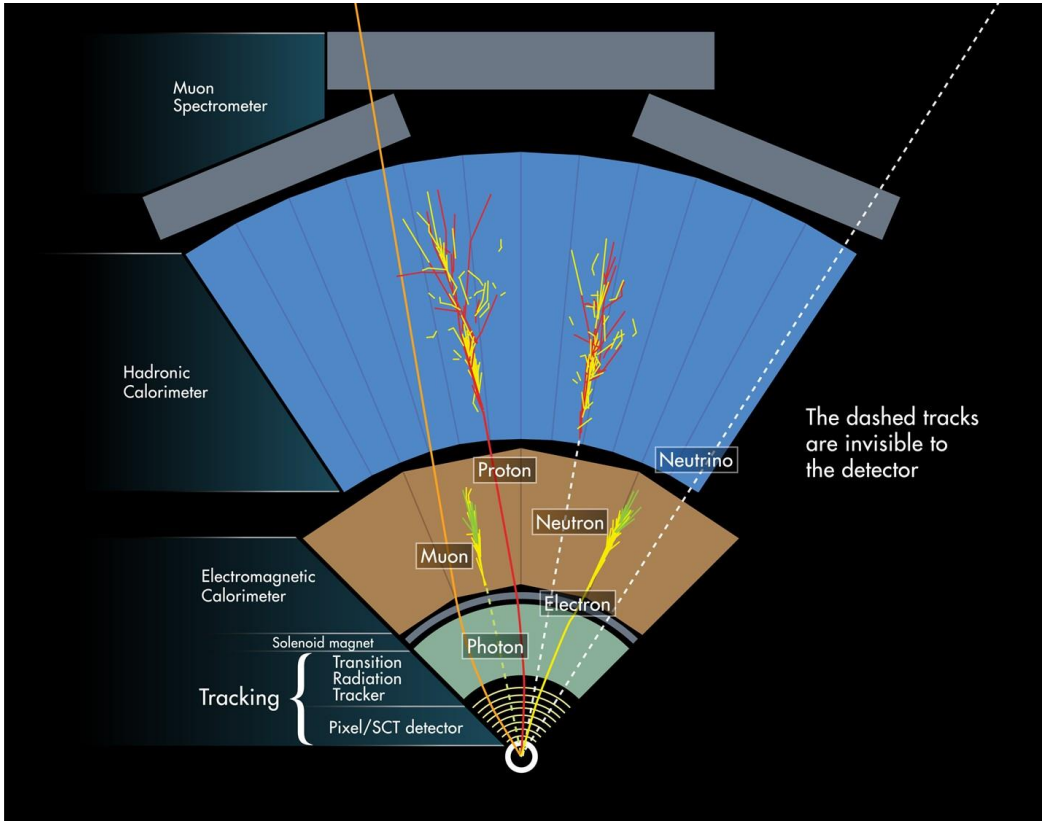
Introduction and motivation

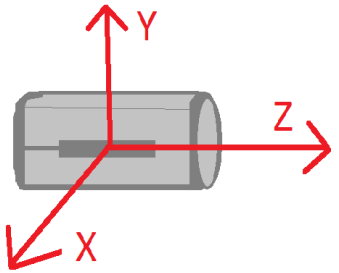
Motivation

- General motivation
  - Examination of standard model
  - New physics
- Our project
  - Simulation and real data analysis
  - ATLAS analysis framework
- Encountered problems
  - Learning Linux, Vim and C++
  - Technical problems

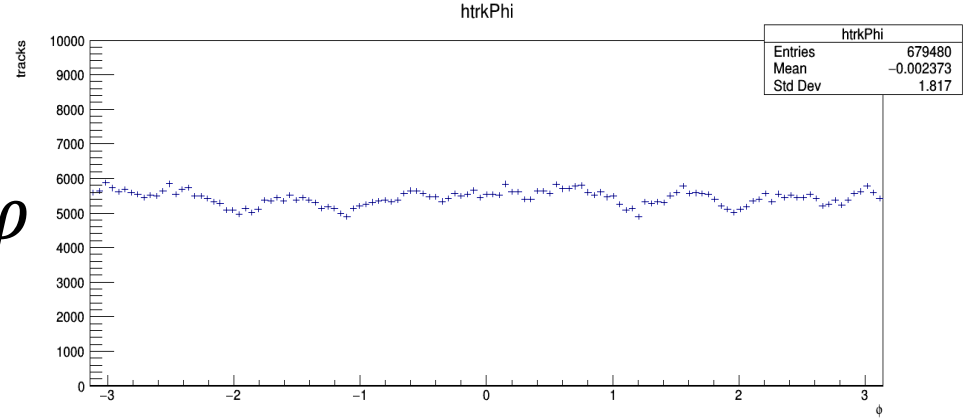
Detector, measured observables



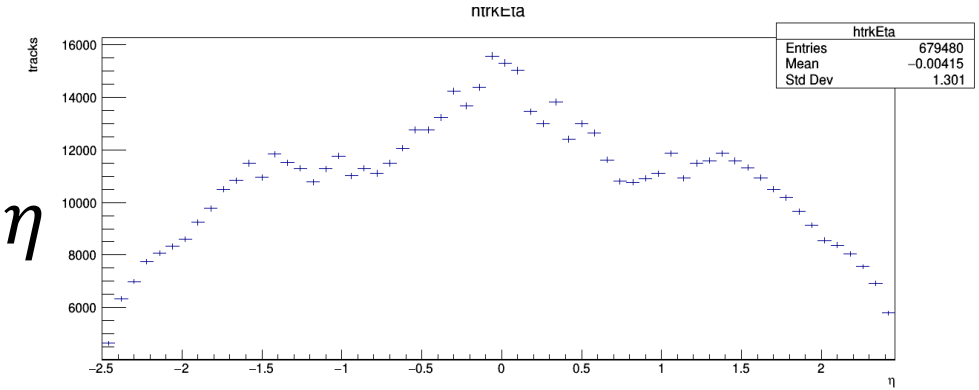
- P_T = momentum
- Vertex = reconstructed area of hit particles
- Eta, Phi = angles in detector



Histograms

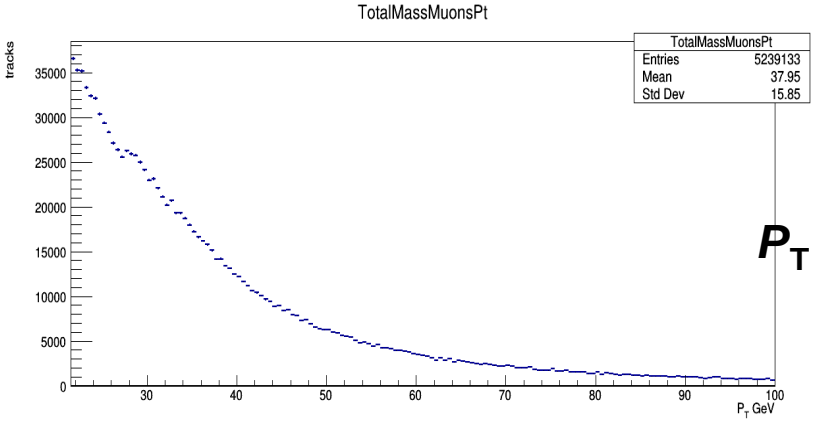


φ



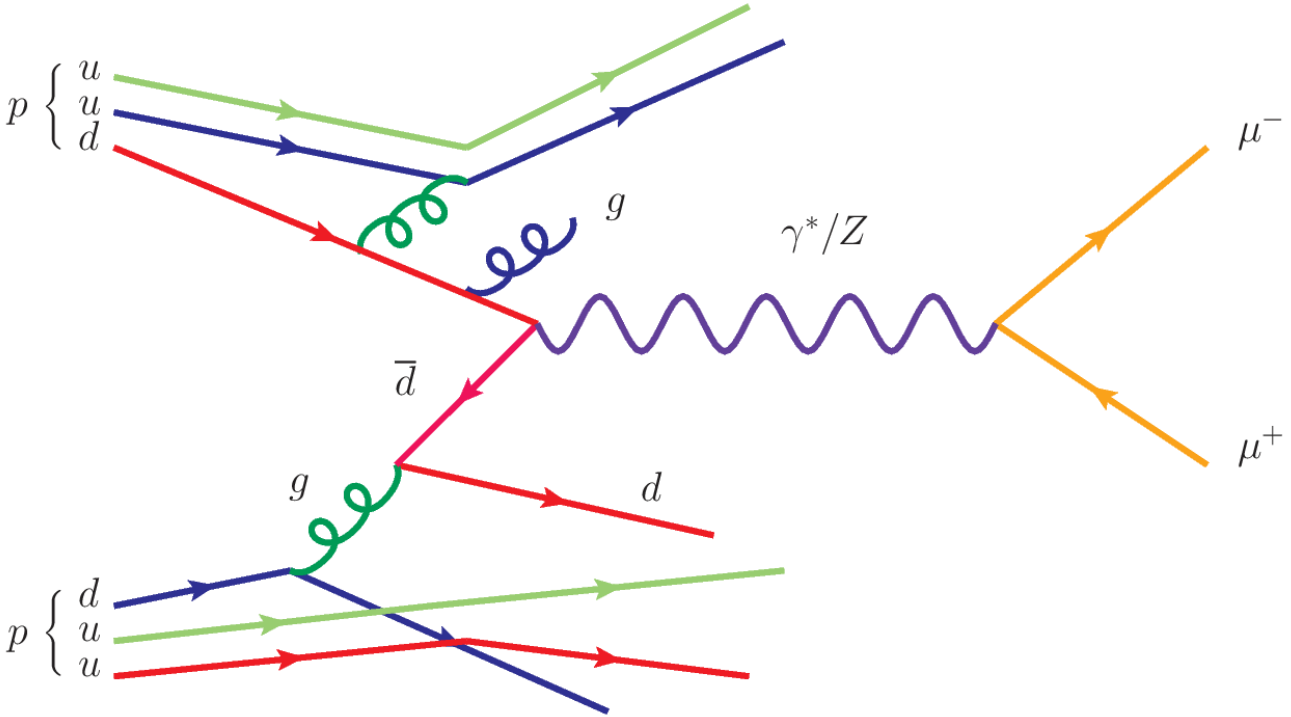
η

- $\varphi \rightarrow$ uniform histogram
- $\eta \rightarrow$ max on 90°
- $P_T \rightarrow$ momentum of Z boson

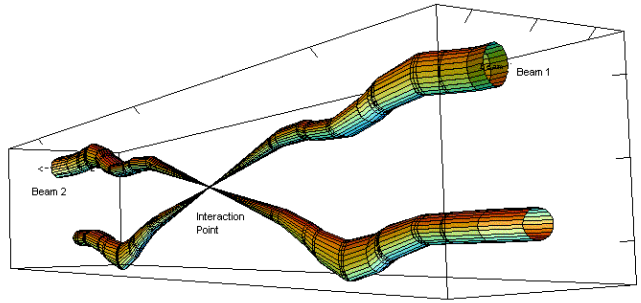


P_T

pp reaction example



LHC (2008)

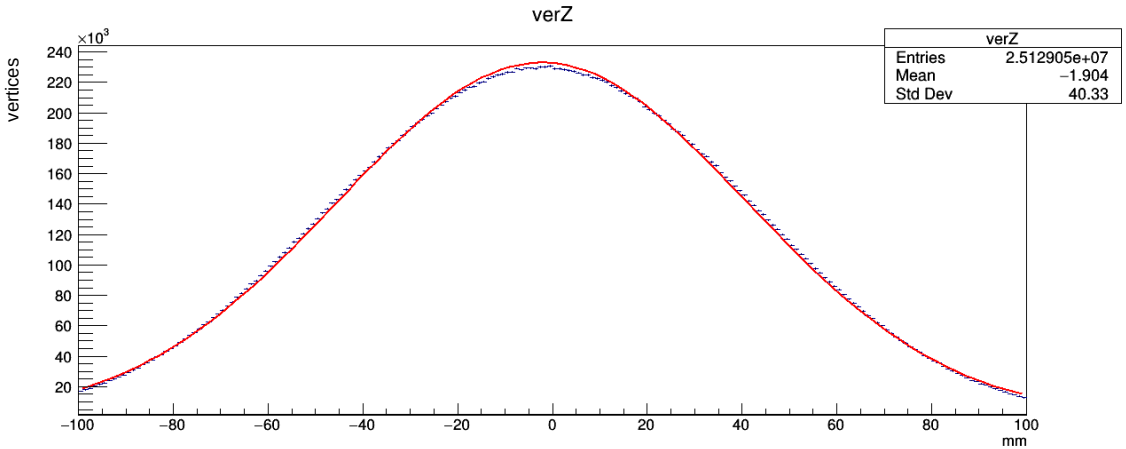


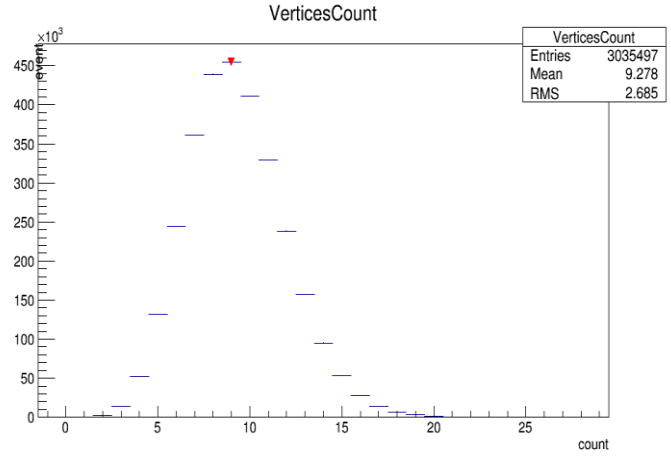
Relative beam sizes around IP1 (Atlas) in collision

Maximum energy 6.5 TeV per beam

Proton-proton collision (10^{11} protons)

Synchrotron with 27 kilometers perimeter

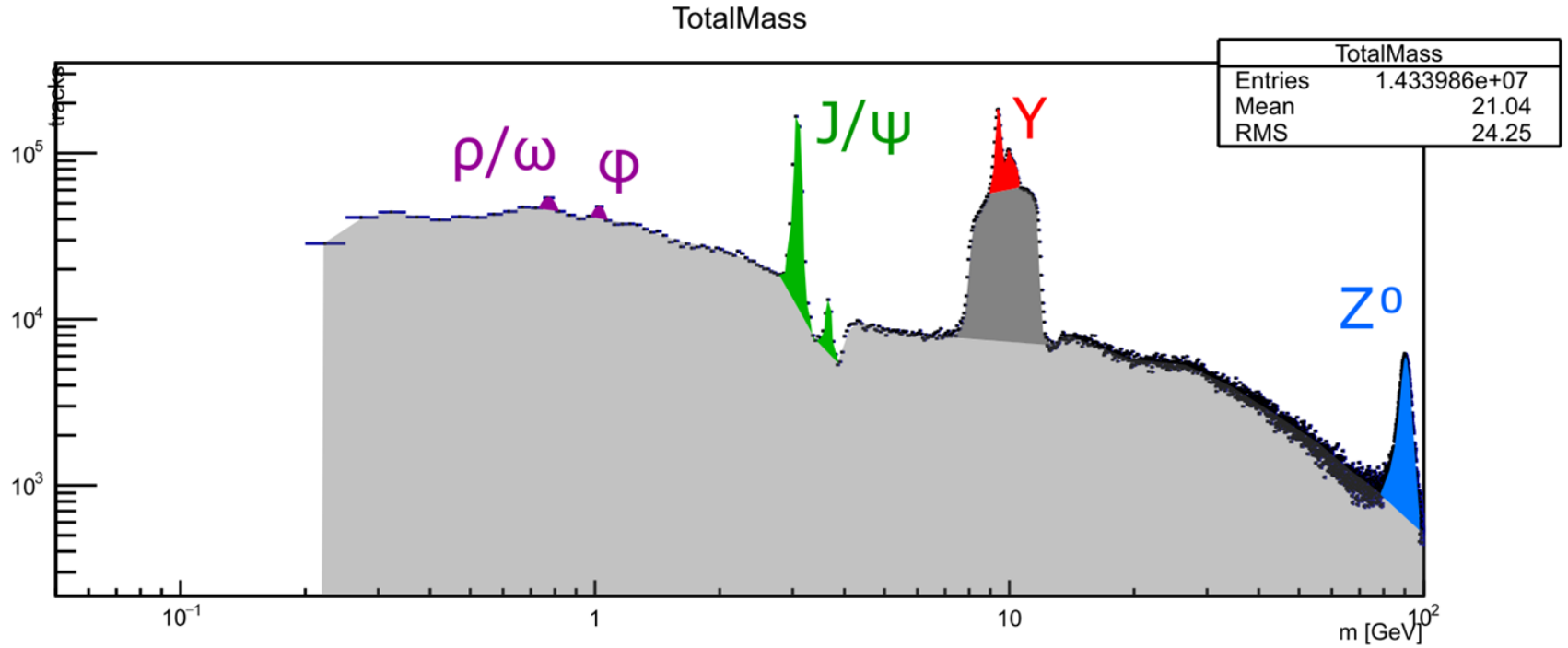




Di-muon spectra

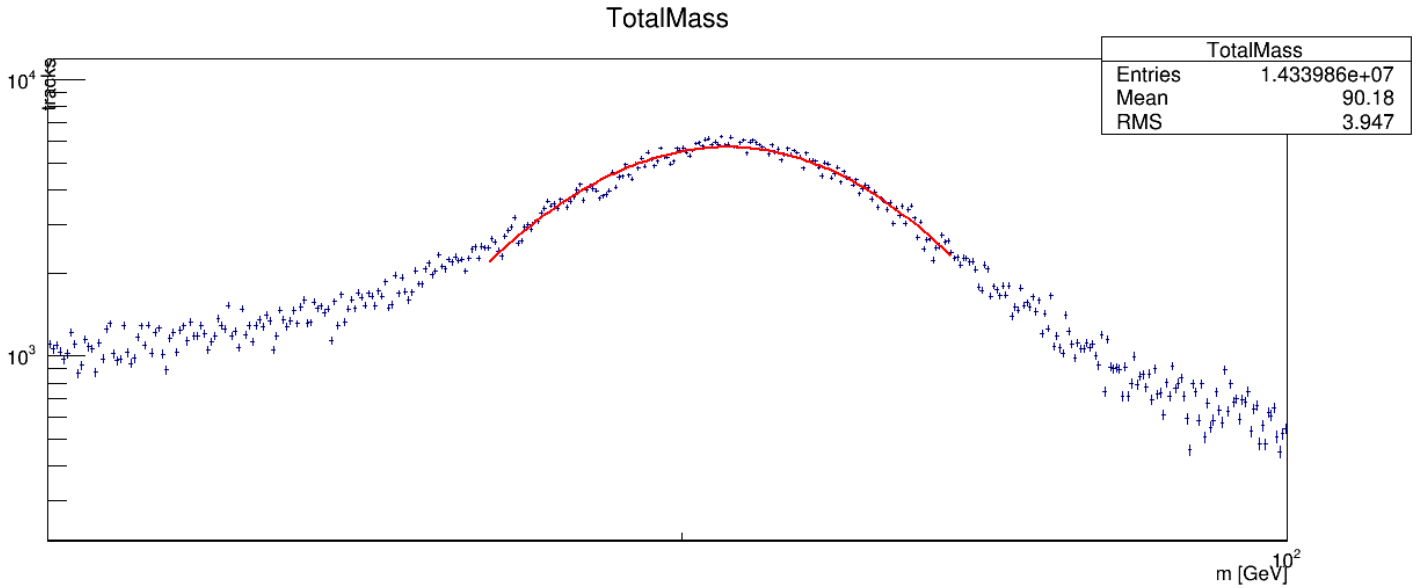
Obtained spectrum

- Particle and event selections (2 muons)



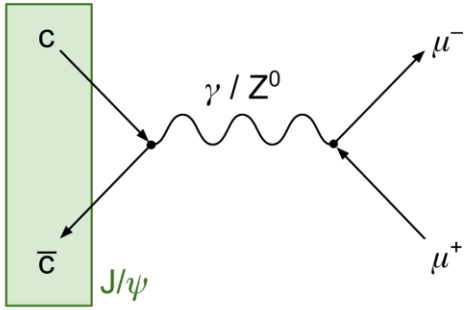
Parameter extraction

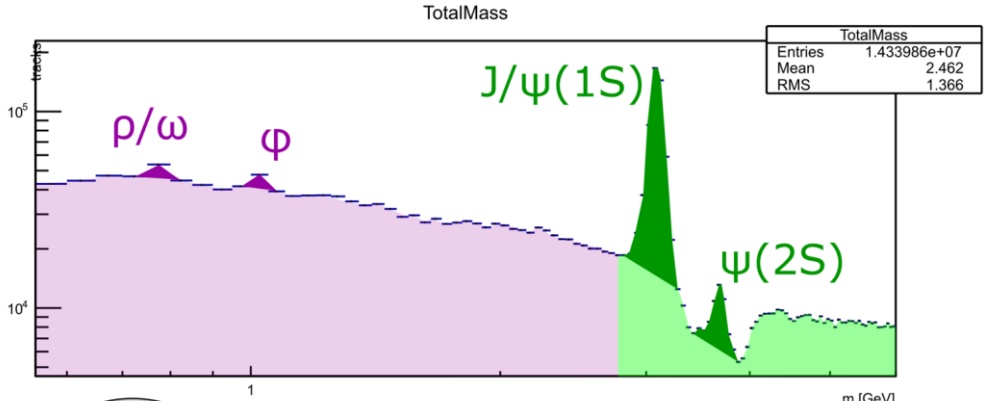
- Fitting Gauss function
  - parameters evaluation (mean, sigma)

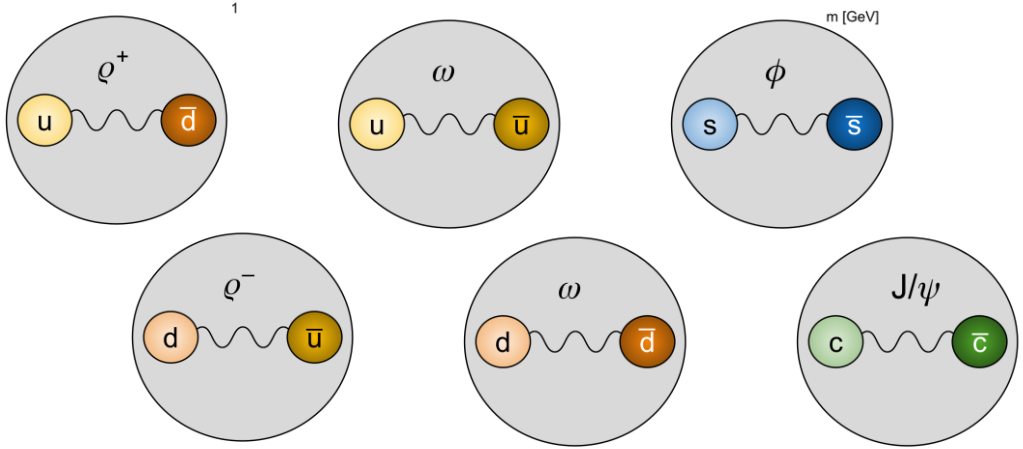


ϱ, ω, ϕ and J/ψ quarkonia

	Content	Mass (measured) [GeV]	Mass (tables) [GeV]
ϱ	$u\bar{d}$, $d\bar{u}$	0.7712 (5)	0.77526 (25)
ω	$u\bar{u}$, $d\bar{d}$		0.78265 (12)
ϕ	$s\bar{s}$	1.02050 (55)	1.019461 (19)
J/ψ (1S)	$c\bar{c}$	3.0883 (1)	3.096900 (6)
ψ (2S)	$c\bar{c}$	3.6634(8)	3.686097 (25)

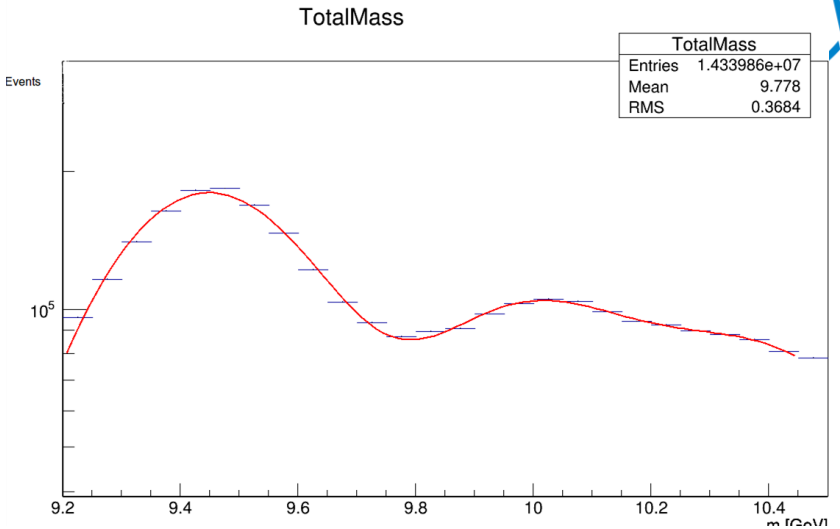


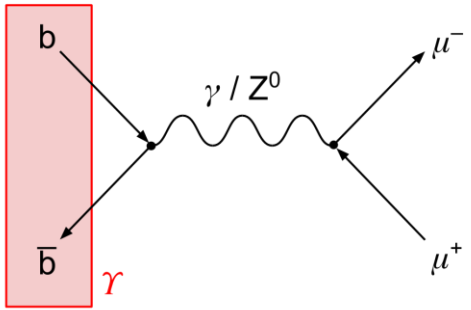


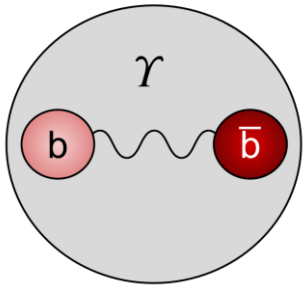


Υ quarkonium

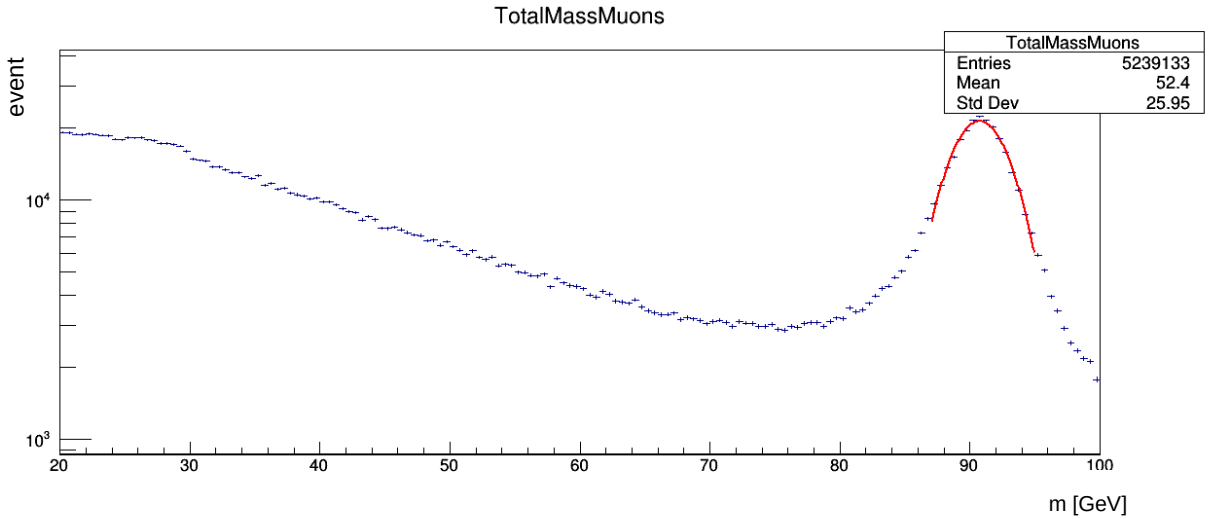
	Mass (measured) [GeV]	Mass (tables) [GeV]
Υ(1S)	9.4670(28)	9.46030(26)
Υ(2S)	10.0330(25)	10.02326(31)
Υ(3S)	10.097(32)	10.3552(5)



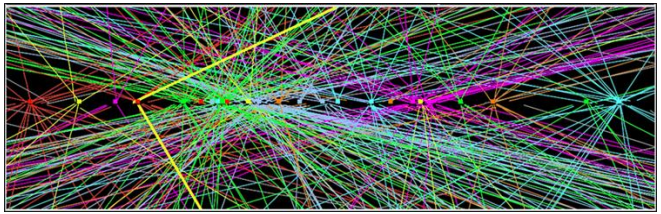




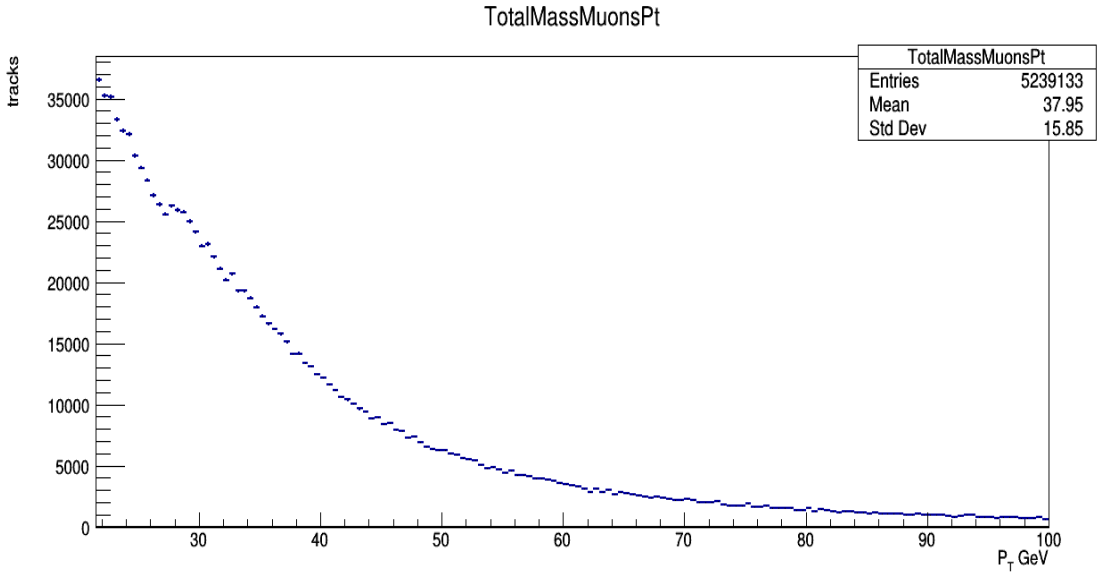
Electroweak bosons Z and W

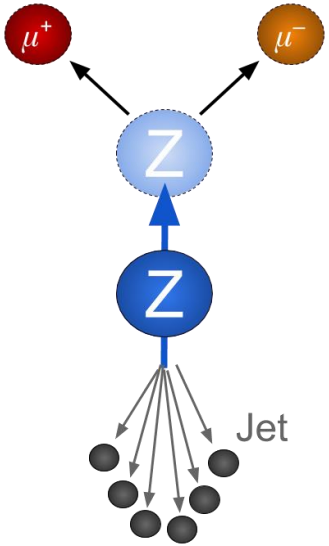


	Mass (measured) [GeV]	Mass (tables) [GeV]	Γ (measured) [GeV]	Γ (tables) [GeV]
Z^0	90.7480 (79)	91.1876 ± (21)	2.4952 ± (23)	2.5736 ± (11)



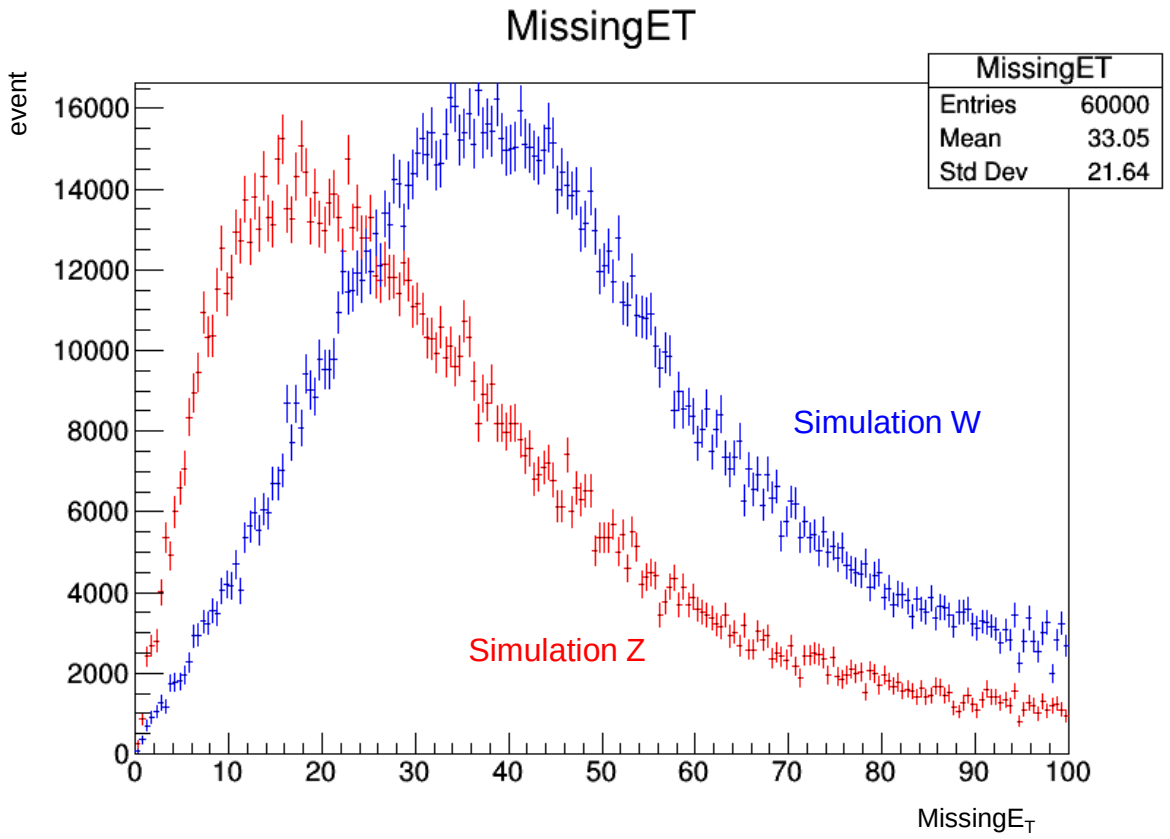
Properties of Z boson – P_T





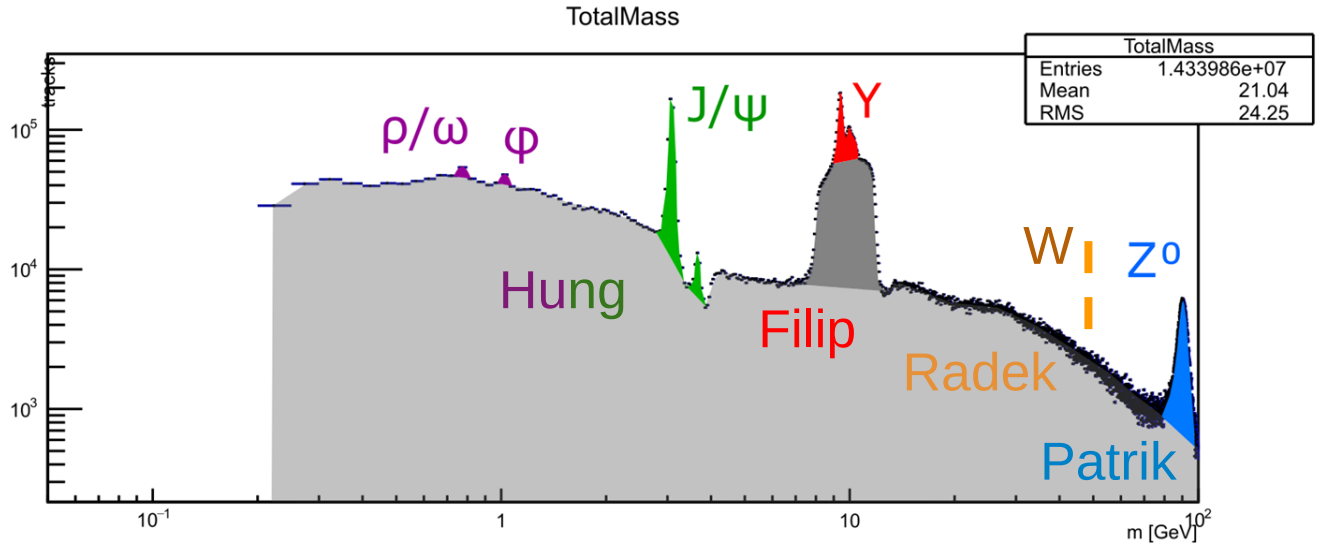
How to see W – Missing E_T

- $W \rightarrow \ell + \nu$
- Large missing E_T
- MET = $|\sum P_T|$



Conclusion

- ATLAS analysis tools
- High accuracy data obtained



References

LHC collision, page 7 - LHC

Pile up Z -> μμ, page 12 - IOPSCIENCE

Detector ATLAS, page 4 - ATLAS

Tux the Penguin, page 3 - By lewing@isc.tamu.edu Larry Ewing and The GIMP, Attribution, https://commons.wikimedia.org/w/index.php?curid=574842

Monte Carlo, page 17 - WIKIMEDIA

Monte Carlo

- physics simulation type
- used for estimating the results before the experiment and comparing them to standard model
- testing of our algorithms