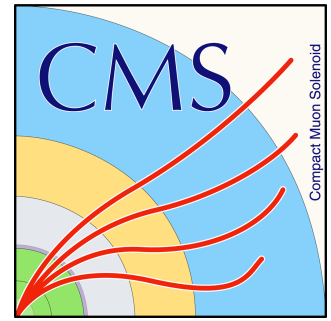

nanoAOD(plus) validation from comparison to 2010 MuMonitor and MuOnia Open Data examples

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2 September 2019

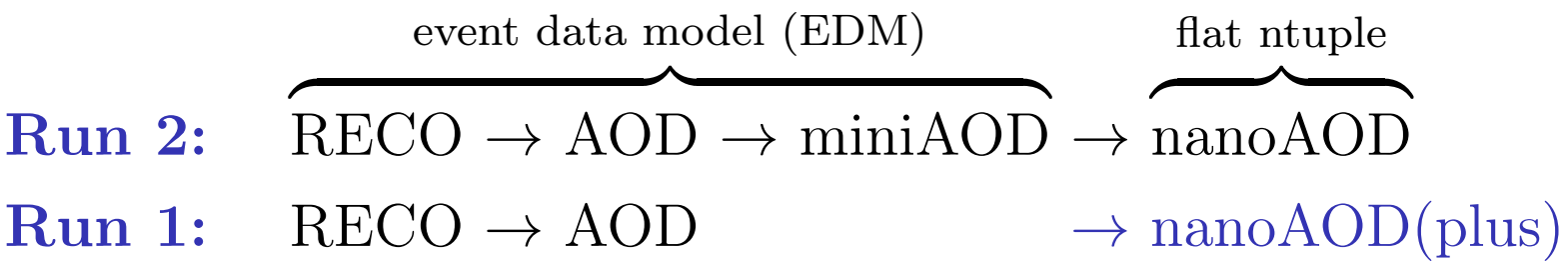
Supervisors: Achim Geiser, Josry Metwally

Introduction

Run 2: $\overbrace{\text{RECO} \rightarrow \text{AOD} \rightarrow \text{miniAOD}}^{\text{event data model (EDM)}} \rightarrow \overbrace{\text{nanoAOD}}^{\text{flat ntuple}}$

Run 1: $\text{RECO} \rightarrow \text{AOD}$

Introduction



- introduce nanoAOD(plus) for Run 1
- same variables as nanoAOD for Run 2 (where possible)
- (plus) some useful additional variables

nanoAOD(plus)

- analyzing the nanoAOD(plus) data is much simpler and faster
- independence from CMSSW
  → higher accessibility (no need for virtual machines)
- Run 2 nanoAOD-based analyses can be run on Run 1 and vice versa with the same code
  → identical variable names
  → same variable content (where possible)

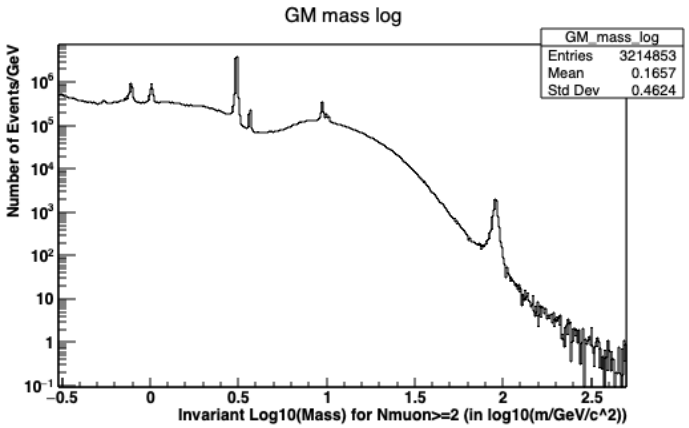
Validation of nanoAOD(plus)

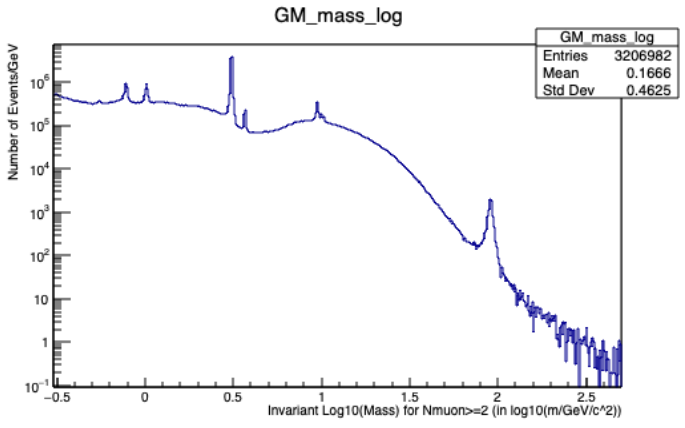
- nanoAOD for Run 2 is created from miniAOD
  Run 2: AOD $\rightarrow$ miniAOD $\rightarrow$ nanoAOD
- nanoAOD(plus) for Run 1 has to be created from AOD
  Run 1: AOD $\rightarrow$ nanoAOD(plus)

Validation of nanoAOD(plus)

- nanoAOD for Run 2 is created from miniAOD
  Run 2: AOD → miniAOD → nanoAOD
- nanoAOD(plus) for Run 1 has to be created from AOD
  Run 1: AOD → nanoAOD(plus)

- direct validation by comparing variable distributions
  → only possible for Run 2
- indirect validation by reproducing known Run 1 physics distributions from nanoAOD(plus) ntuple





CMS Open Data

- CMS Open Data is original data from CMS that is made available to the public via CERN Open Data portal (`http://opendata.cern.ch/docs/about-cms`)
  $\rightarrow$ for research and educational purposes

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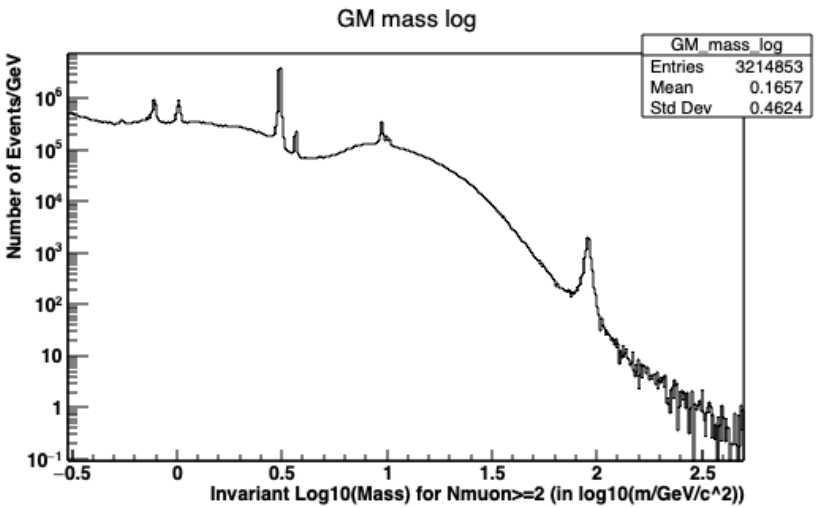
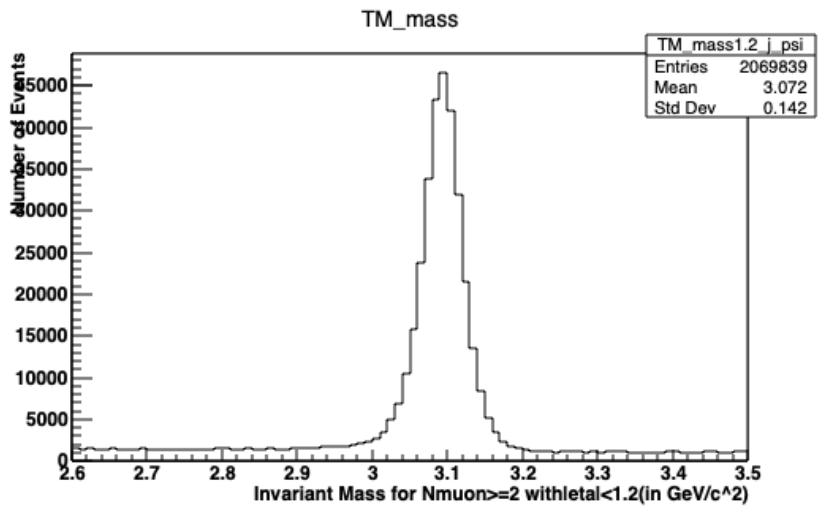
- indirect validation using Open Data MuMonitor and MuOnia examples with 2010 Muon, MuOnia, and Electron datasets

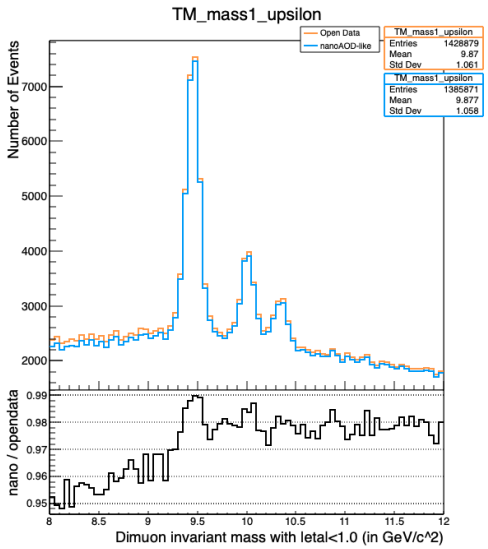


dimuon mass spectrum (MuMonitor example)



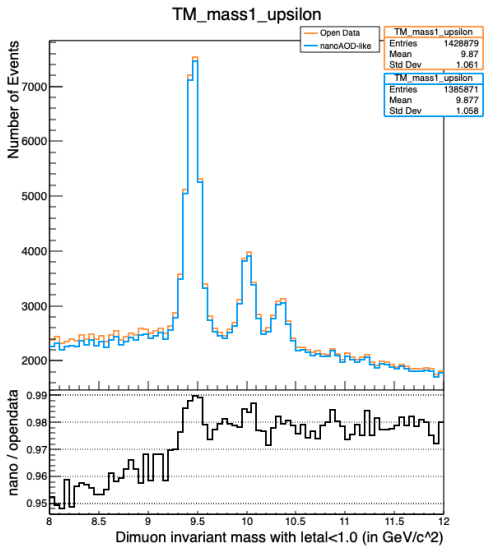
$J/\psi \rightarrow \mu^+\mu^-$ peak (MuOnia example)

Validation of nanoAOD(plus) variables



1) pick histogram from Open Data example (e.g. $\Upsilon \to \mu^+\mu^-$ in 2010 Muon dataset)

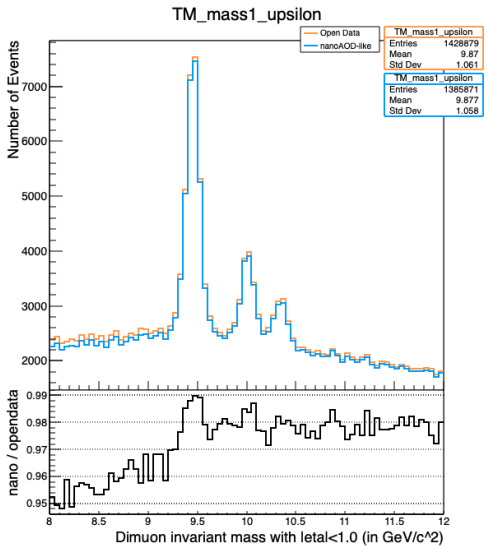
Validation of nanoAOD(plus) variables



1) pick histogram from Open Data example (e.g. $\Upsilon \to \mu^+\mu^-$ in 2010 Muon dataset)

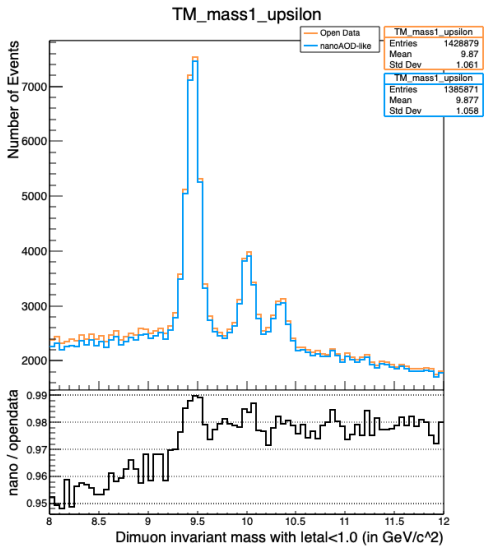
2) read the code to see which cuts were made

Validation of nanoAOD(plus) variables



1) pick histogram from Open Data example (e.g. $\Upsilon \to \mu^+\mu^-$ in 2010 Muon dataset)
2) read the code to see which cuts were made
3) make same cuts on nanoAOD(plus) variables

Validation of nanoAOD(plus) variables



1) pick histogram from Open Data example (e.g. $\Upsilon \to \mu^+\mu^-$ in 2010 Muon dataset)
2) read the code to see which cuts were made
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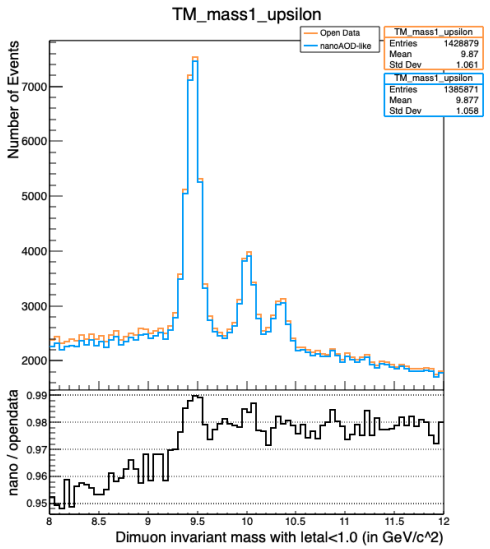
4) think about why there is still a difference 🤔

Validation of nanoAOD(plus) variables



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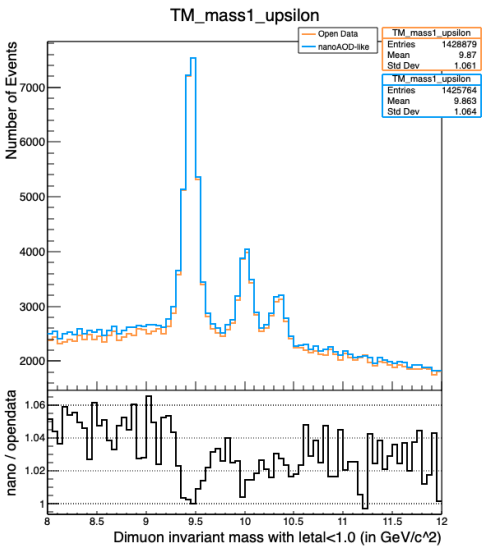
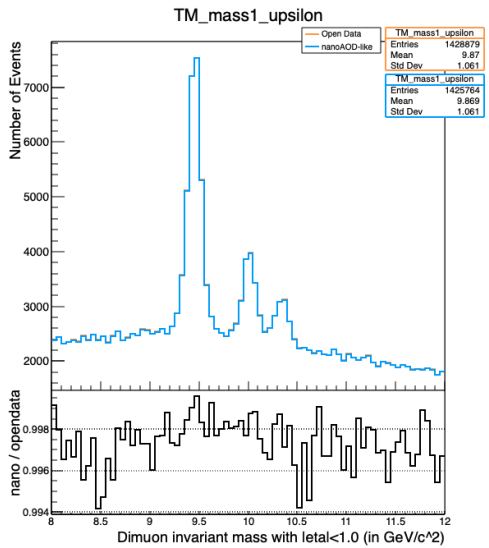
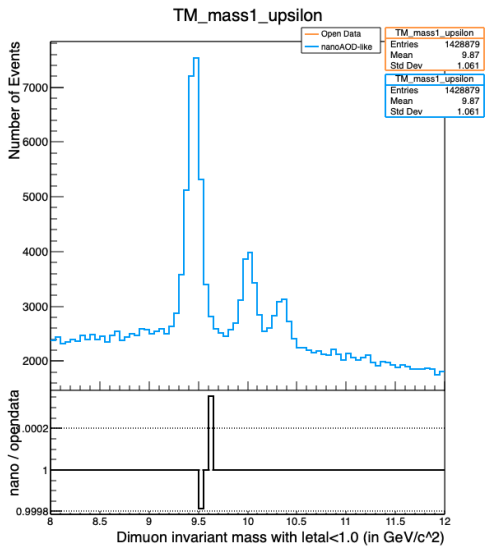
2) read the code to see which cuts were made
3) make same cuts on nanoAOD(plus) variables
4) think about why there is still a difference 🤔
5) make some changes on the ntuple and repeat steps 2) to 4)

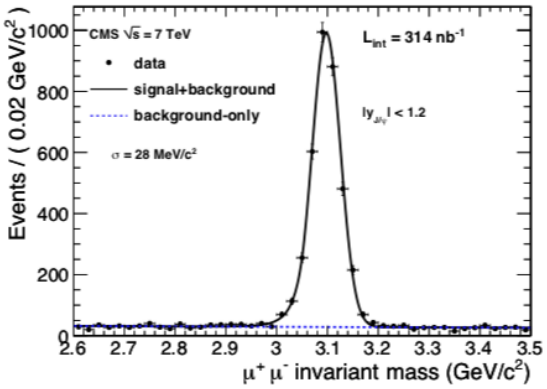


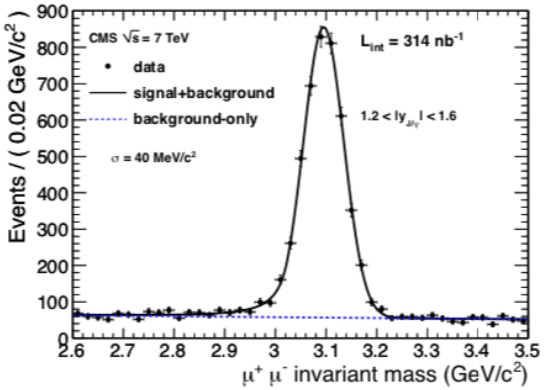


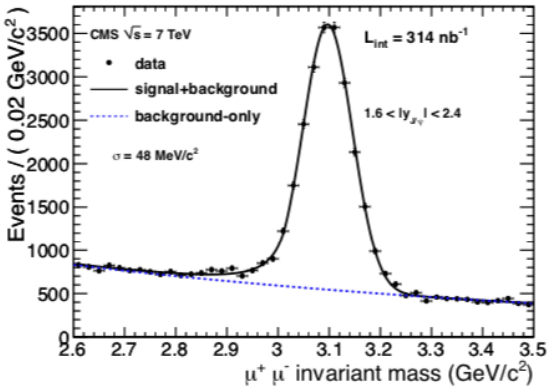


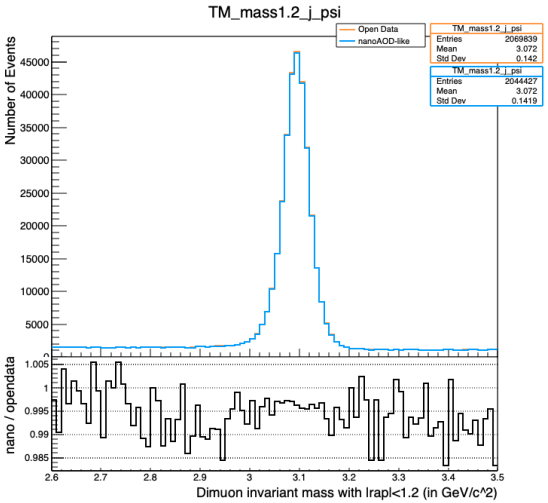
Validation: $J/\psi \to \mu^+\mu^-$

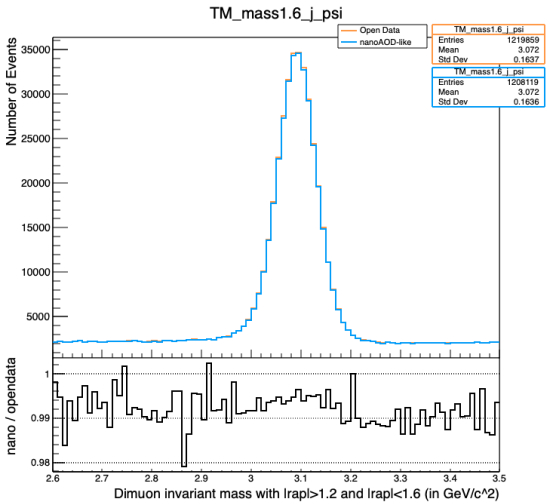
public plots: CMS-BPH-10-002

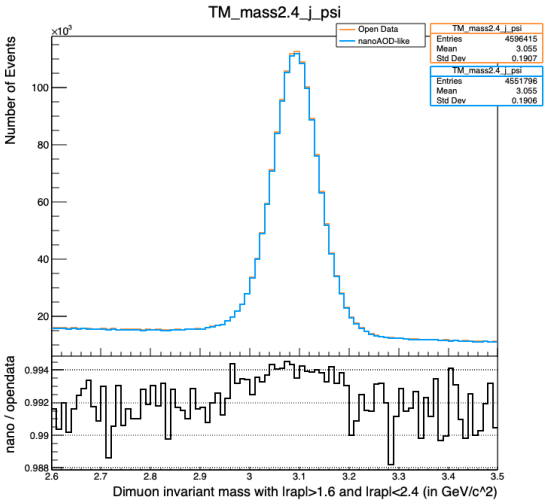








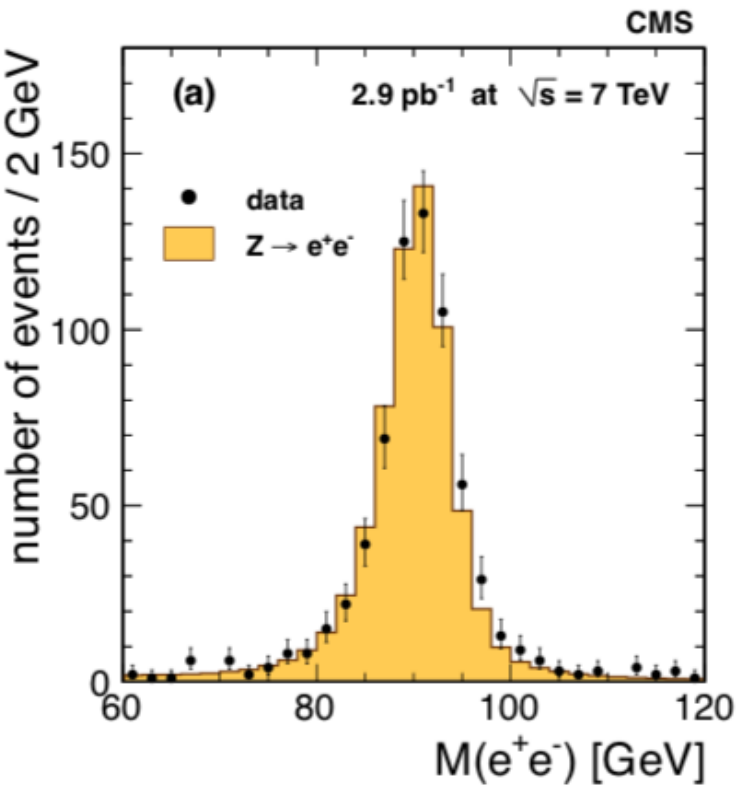


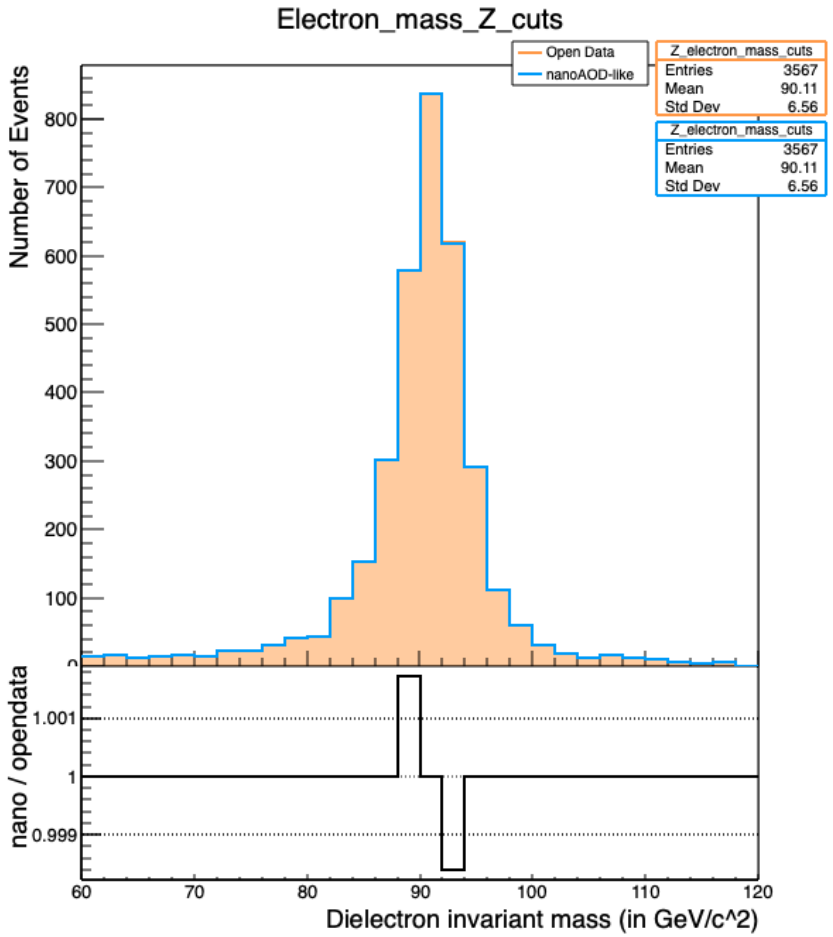


- $\sim 2\%$ difference remaining

Validation: $Z \to e^+e^-$

public plot: CMS-EWK-10-002

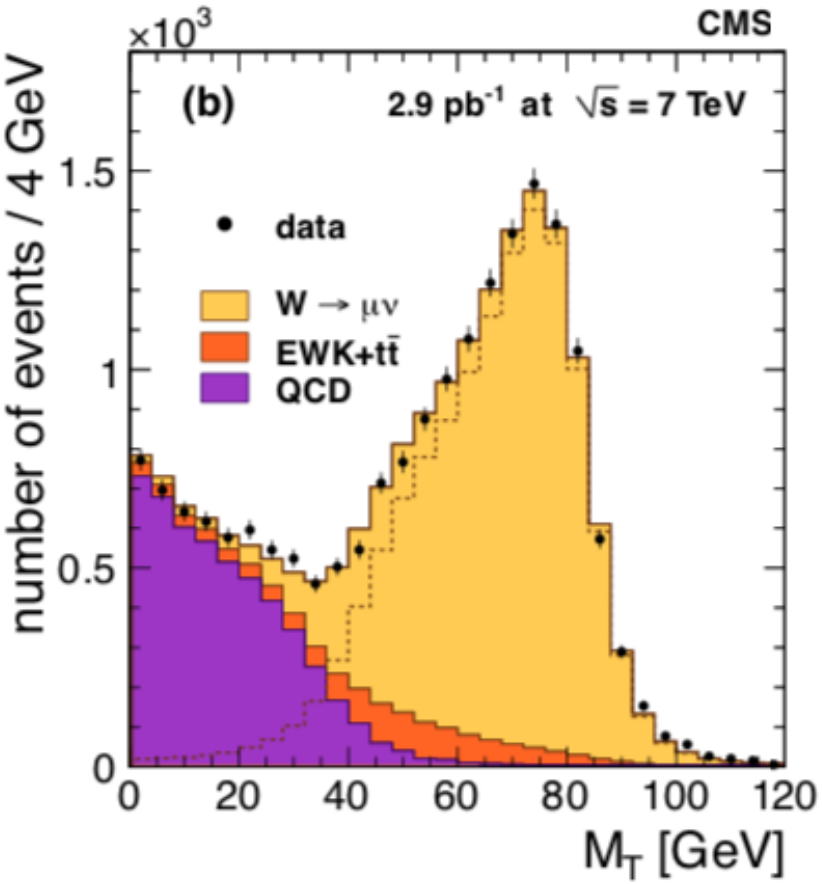


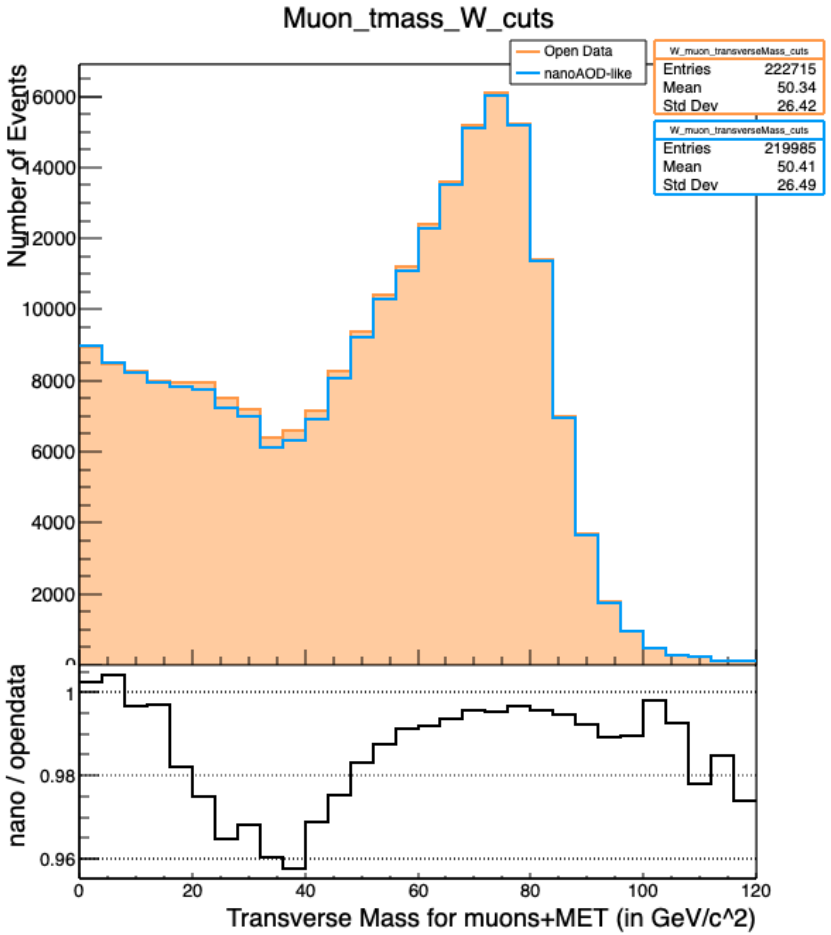


- exactly reproduced

Validation: $W \to \mu\,\nu_\mu$

public plot: CMS-EWK-10-002

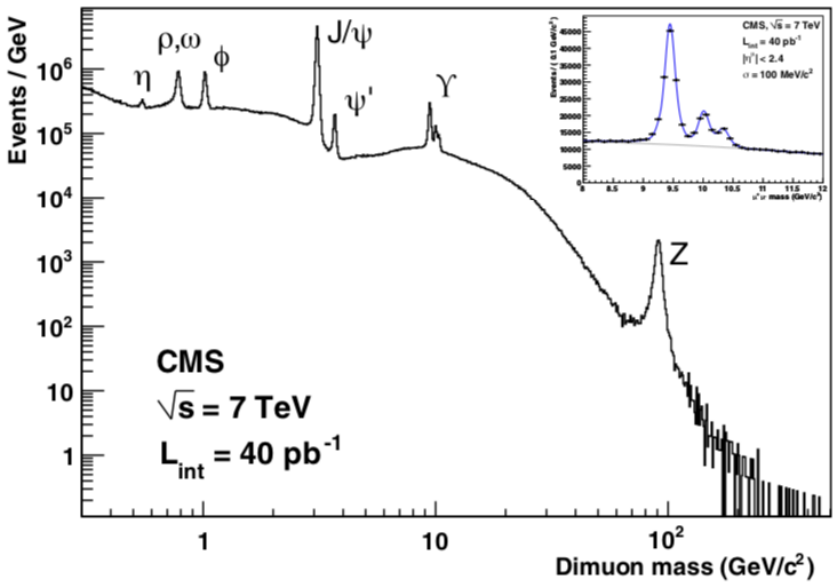


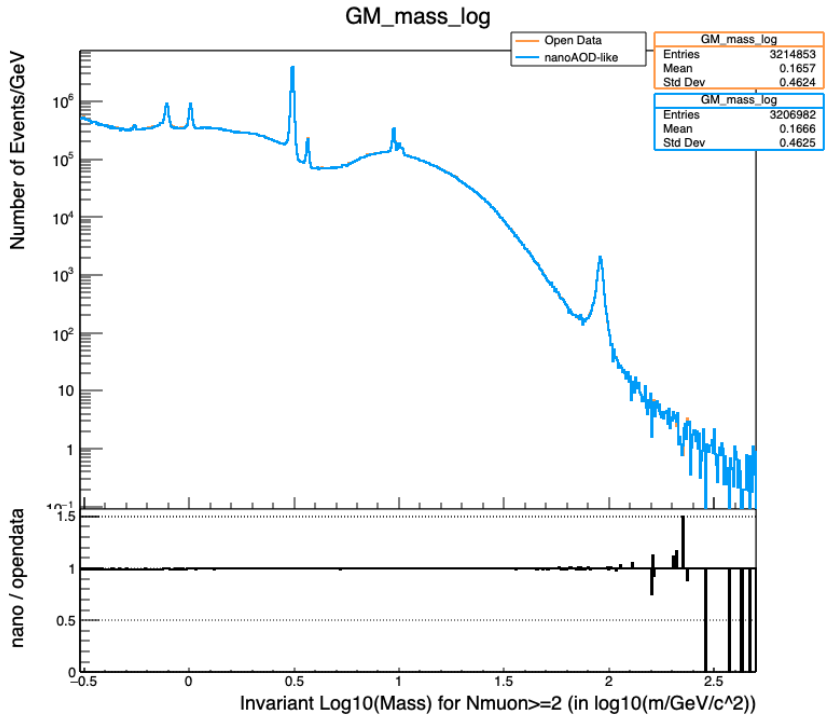


- $\sim 1\%$ difference remaining

Validation: dimuon spectrum

public plot: CMS-MUO-10-004





- $\sim 2‰$ difference remaining

Conclusion

- electron histograms in MuOnia example reproduced exactly
  → all tested electron variables validated on 2010 data
- muon histograms reproduced exactly or very close
  → all tested muon variables at least partially validated
  → another iteration needed to eliminate the remaining differences
- found some bugs in (not yet public) MuOnia example
- next: try to reproduce some of the histograms using only official nanoAOD variables
  → see which of the introduced (plus) variables are needed
  → get one step closer to the goal of analyzing Run 1 and Run 2 data using the same nanoAOD algorithms