

UM-CERN research abroad: VBS (Inuqq and Inulnu) and using SFrame



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Intro (review)

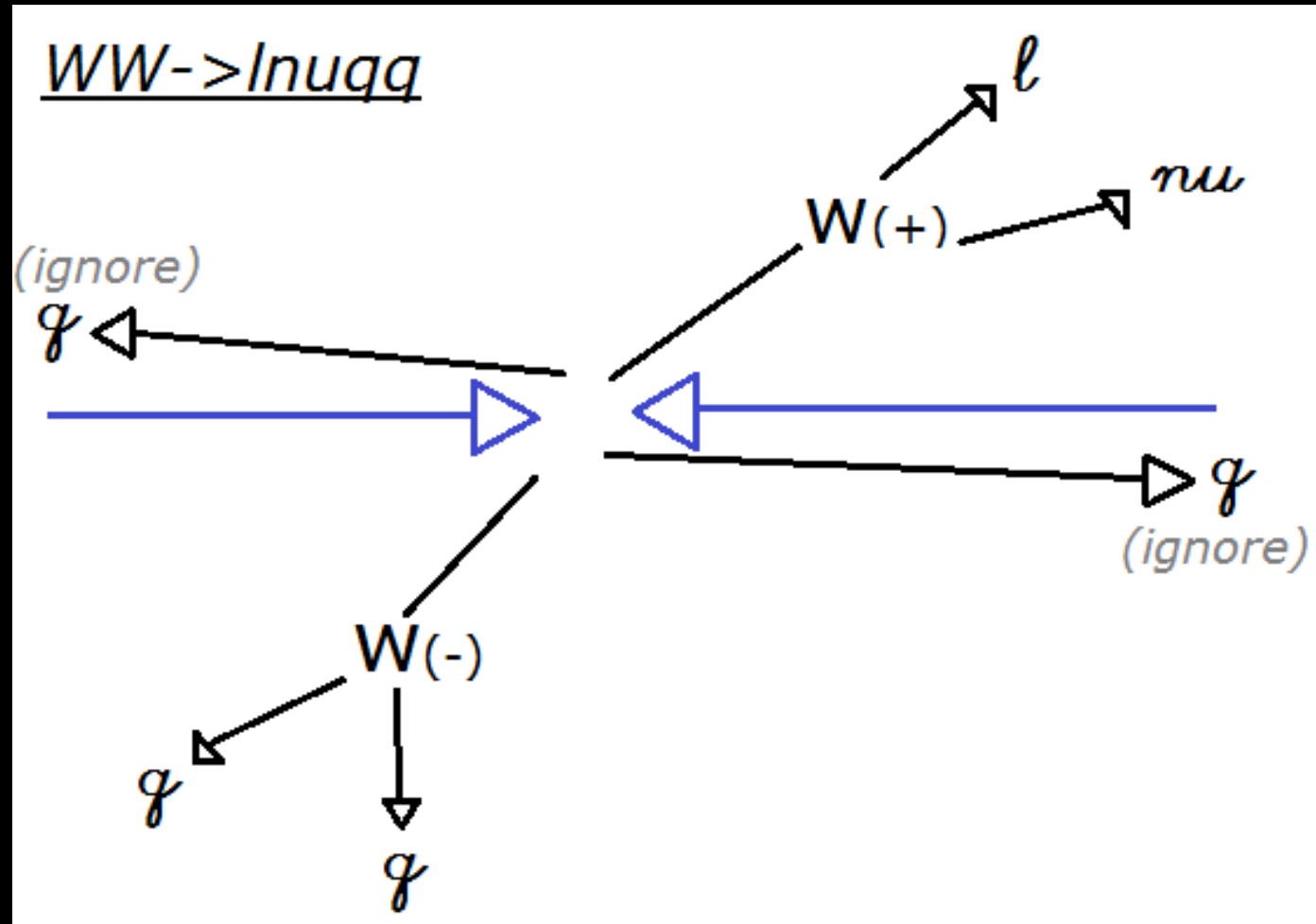
- Title: Merged jet performance studies and event optimization for the $qqWW \rightarrow qq+lnujj$ VBS at the LHC.
- Goal?
 - Study $WW/WZ \rightarrow lnqq$ (mainly) and $lnlnu$ at 14TeV
 - Beyond Standard Model: VBS is related to EWSB and Higgs mechanism
 - Substructure Technique and jet grooming
 - Optimization of event selection with forward jet tagging
 - Data analysis using SFrame ☹ ☹ ☹

VBS: $qqWW \rightarrow qq + l\nu qq$ (review)

* But this is not what LHC actually detects!

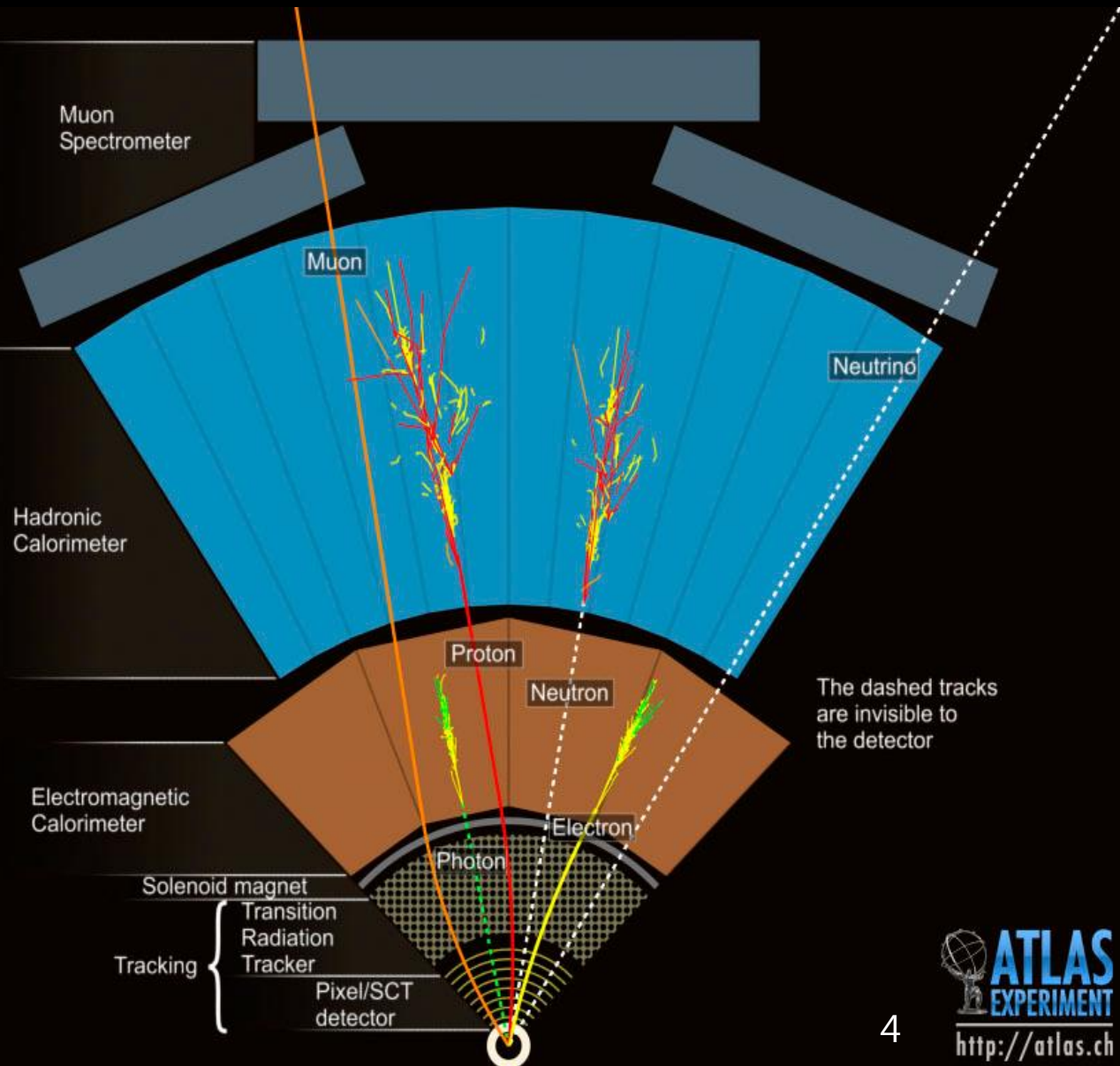
* Detector detects particle showers and we combine them to get info. of each particle

* So actually data (root files) look ugly

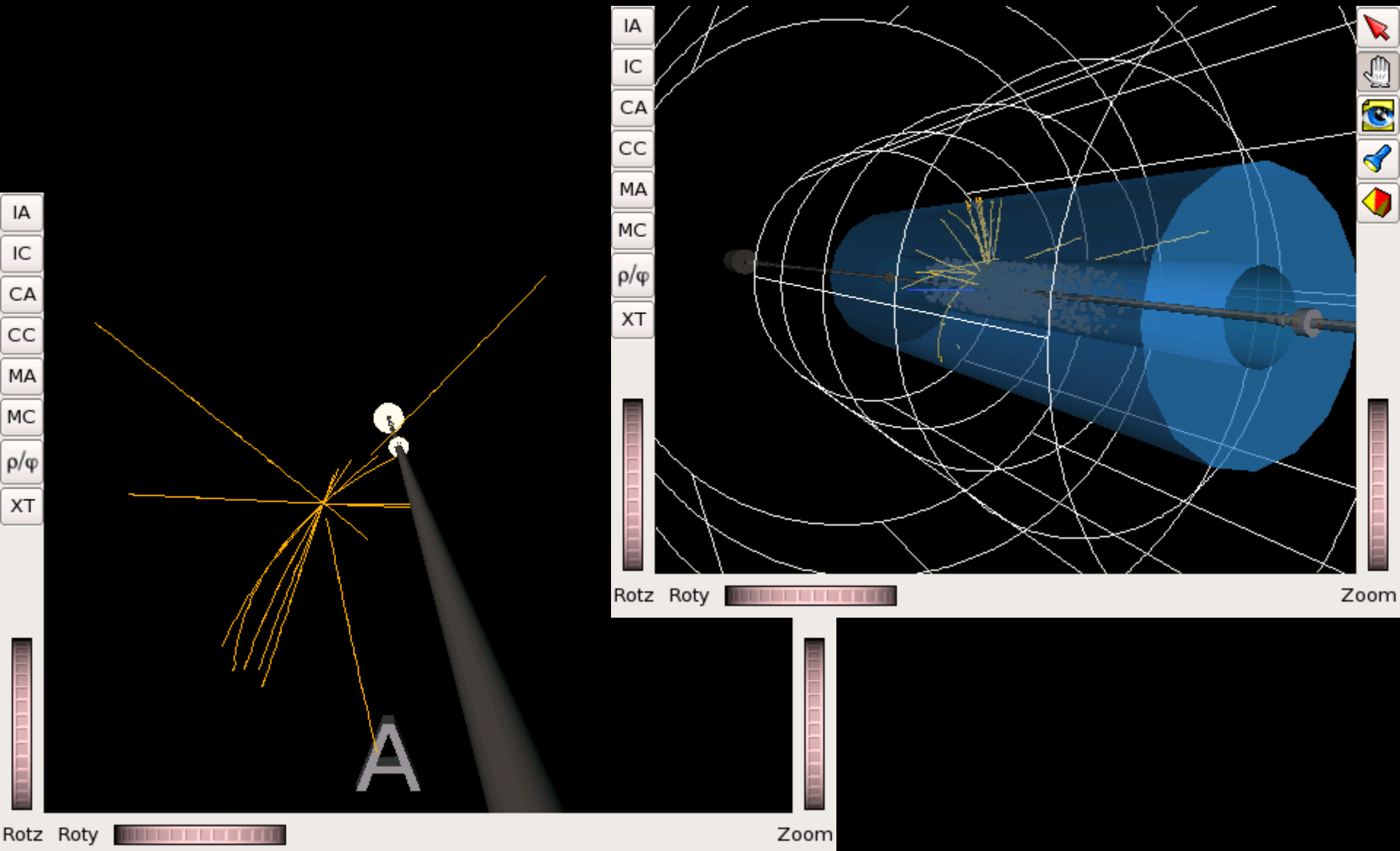


Basic: How detector detects

- Current from charged particle is tracked and measured.
- Electrons and photons are absorbed by the **electromagnetic calorimeter(Orange)**, which create a particle shower and its energy is measured.
- Proton and Neutron by the **Hadronic Calorimeter(Blue)**



Collisione!



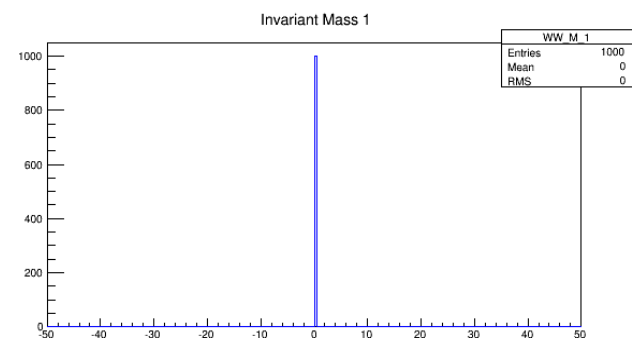
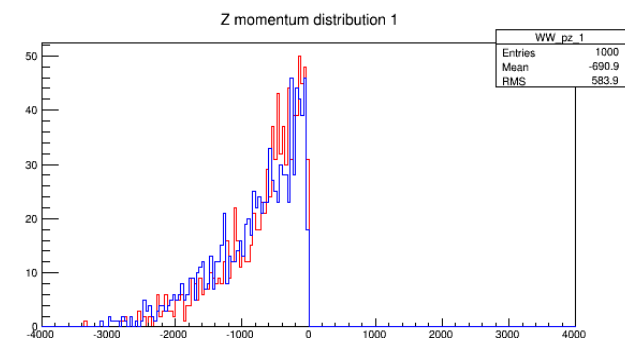
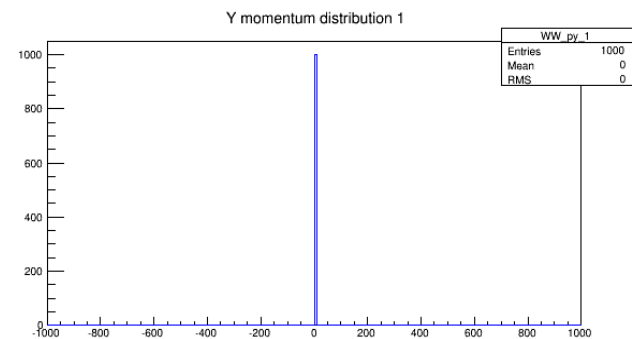
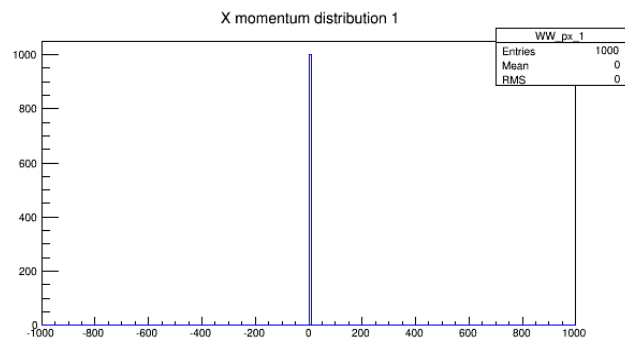
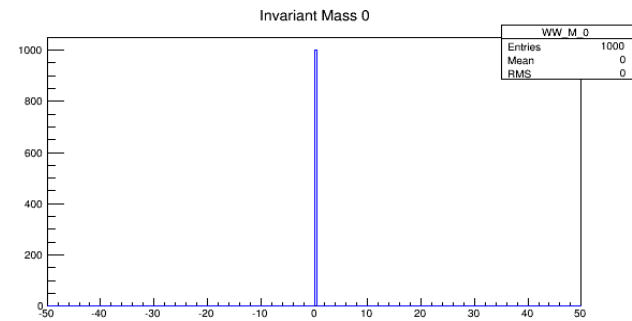
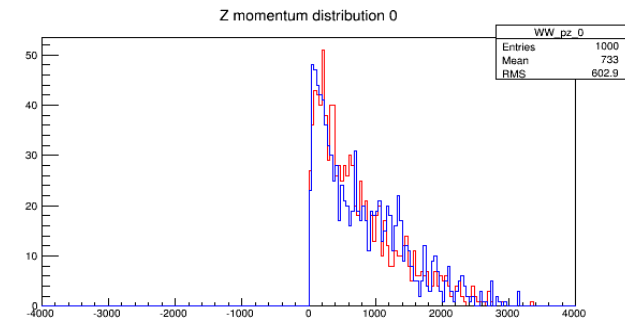
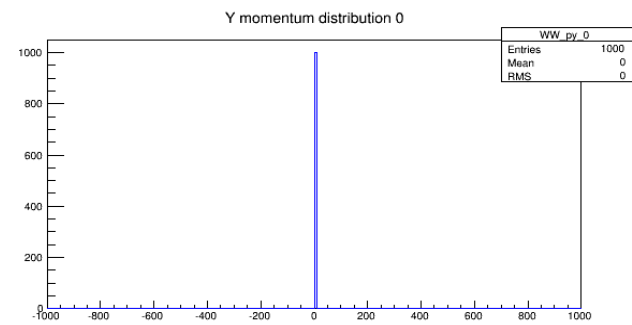
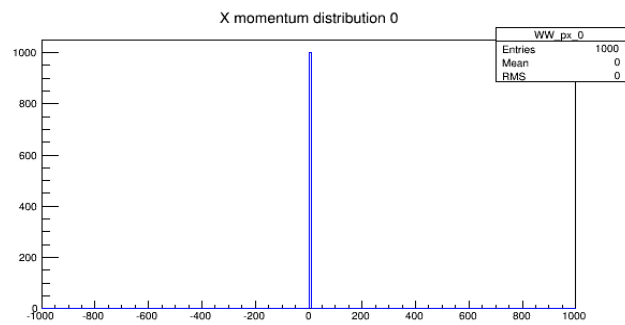
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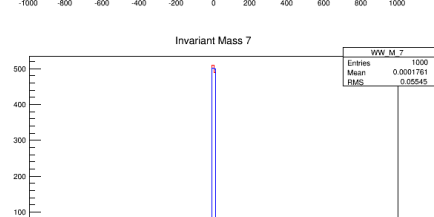
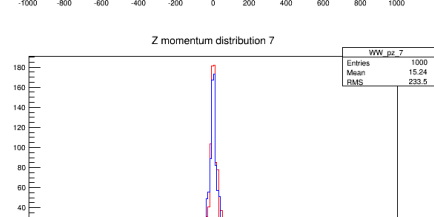
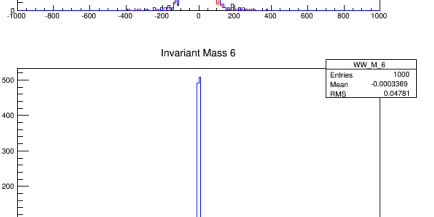
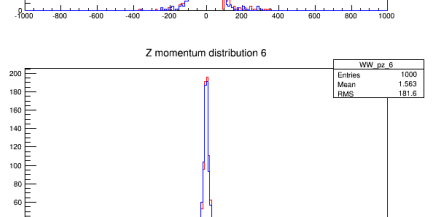
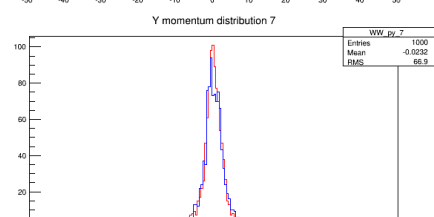
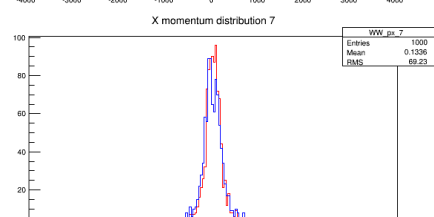
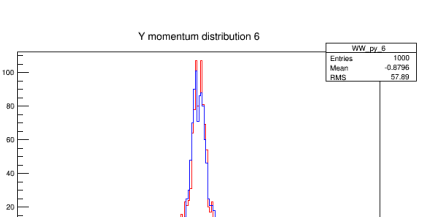
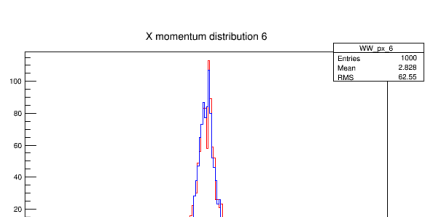
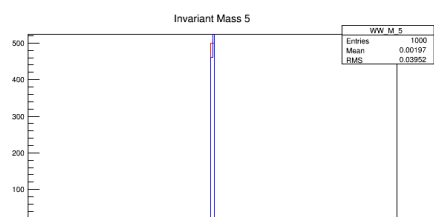
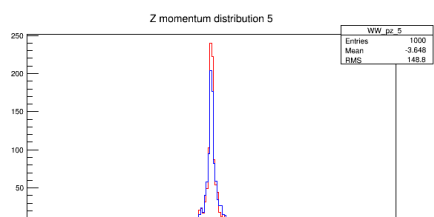
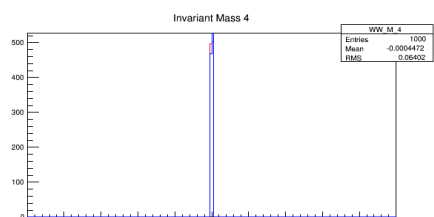
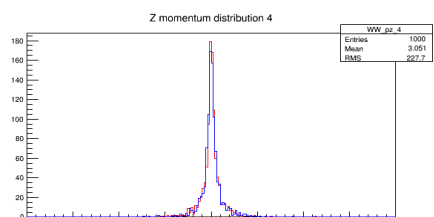
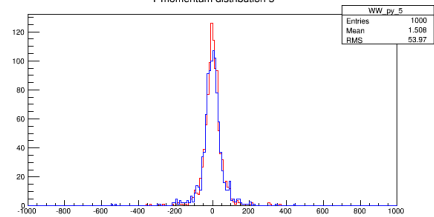
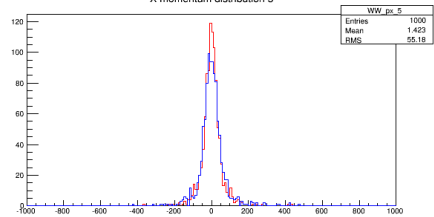
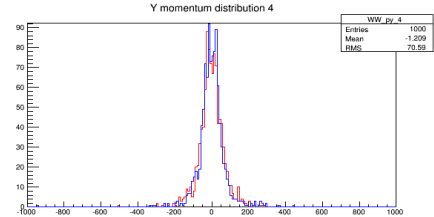
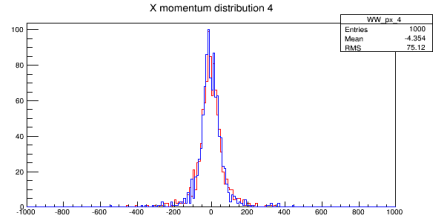
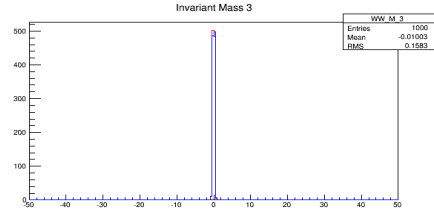
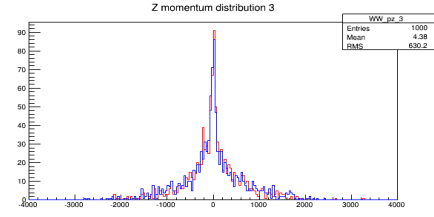
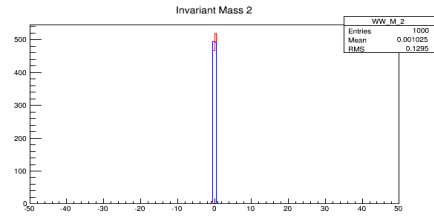
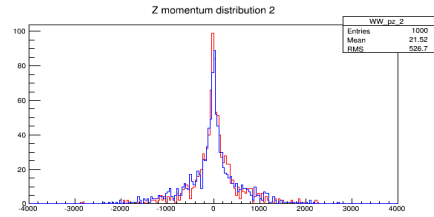
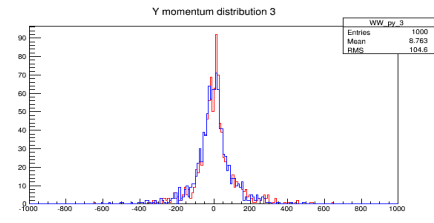
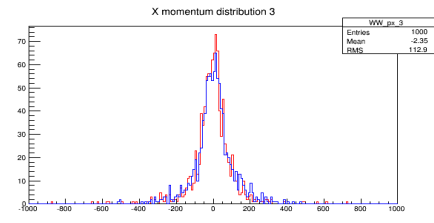
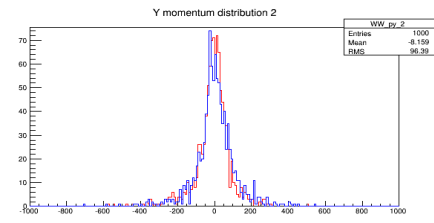
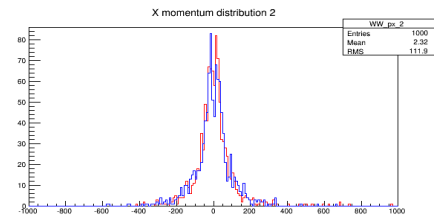
- Just received huge and complicated data
~125GB
- ROOT is too slow to handle this size of data, but SFrame will save my butt from decomposition.
- Before SFrame, let's see baby plots from small size data.

[Comparison] Inulnu vs. Inuqq

- Mix of WW/WZ (incoming patrons)
- Expected: their momentum and mass should be nearly the same
- Result: yes

- Red: Inulnu
- Blue: Inuqq



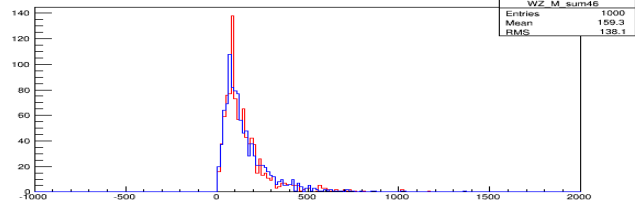
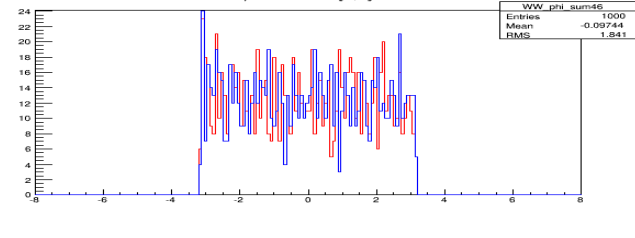
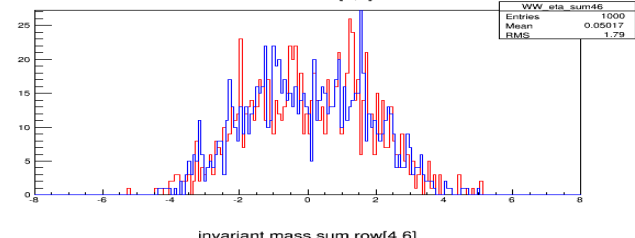
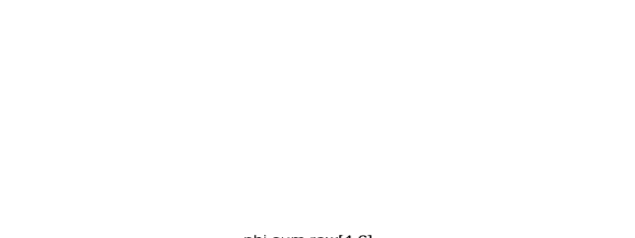
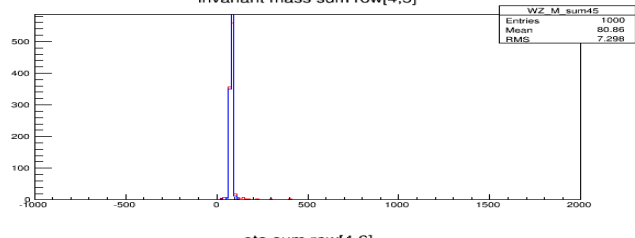
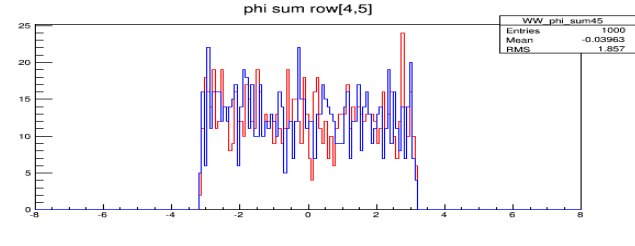
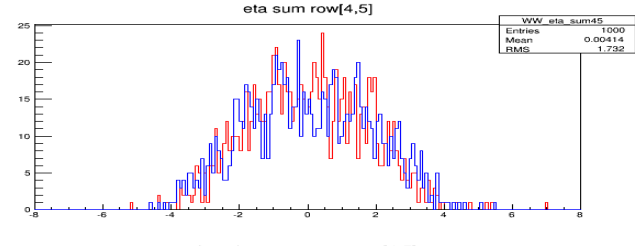
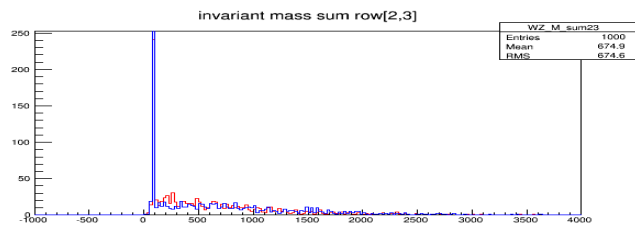
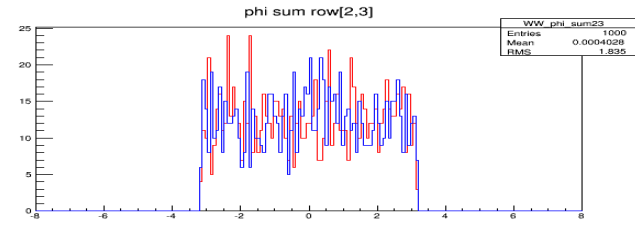
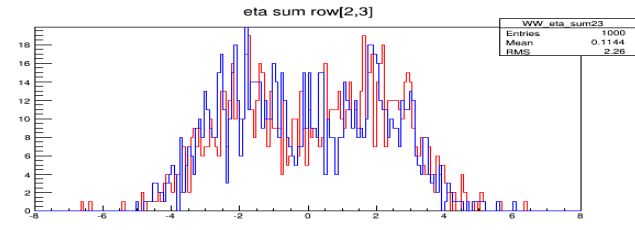


Eta, phi, invariant mass of outgoing quarks
 $qqWW \rightarrow qq + l\nu l\nu$
 $qqWW \rightarrow qq + l\nu qq$
Large peak!? Will talk later

Eta, phi, invariant mass of 1st $l\nu$
 ($l\nu l\nu$)
 ($l\nu qq$)

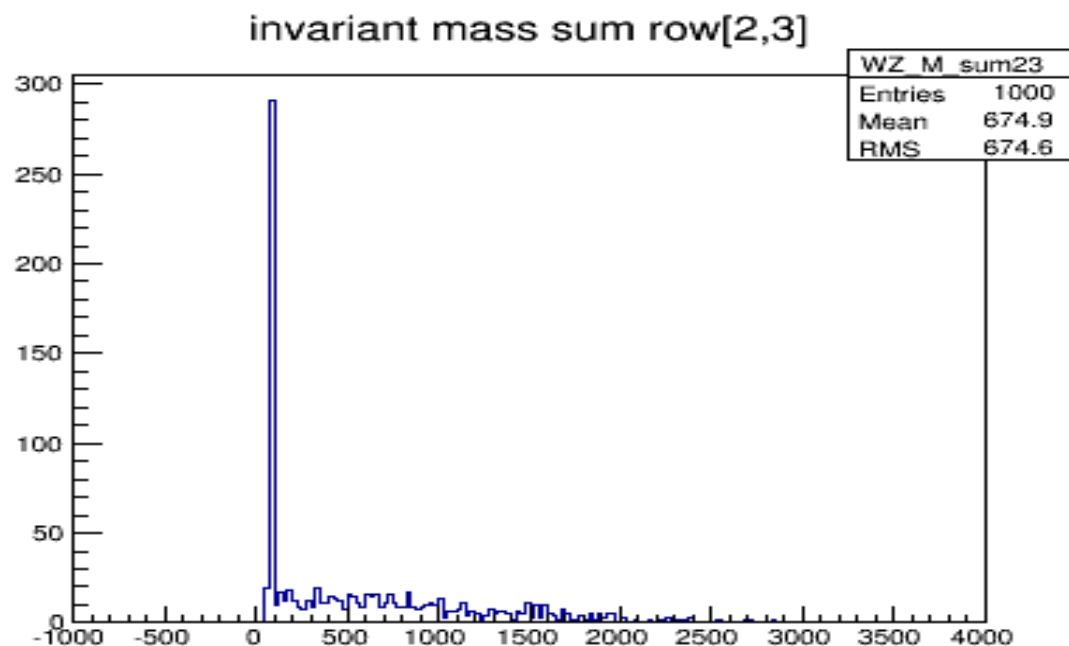
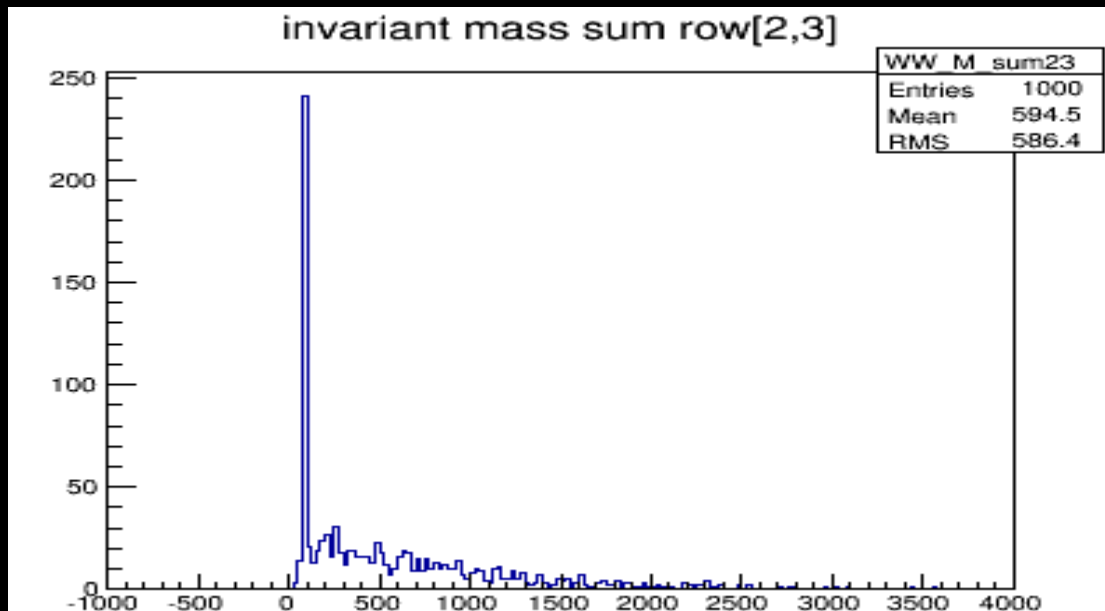
Eta, phi, invariant mass of $l+l$ & $l+q$
 ($l\nu l\nu$)
 ($l\nu qq$)

Not same →



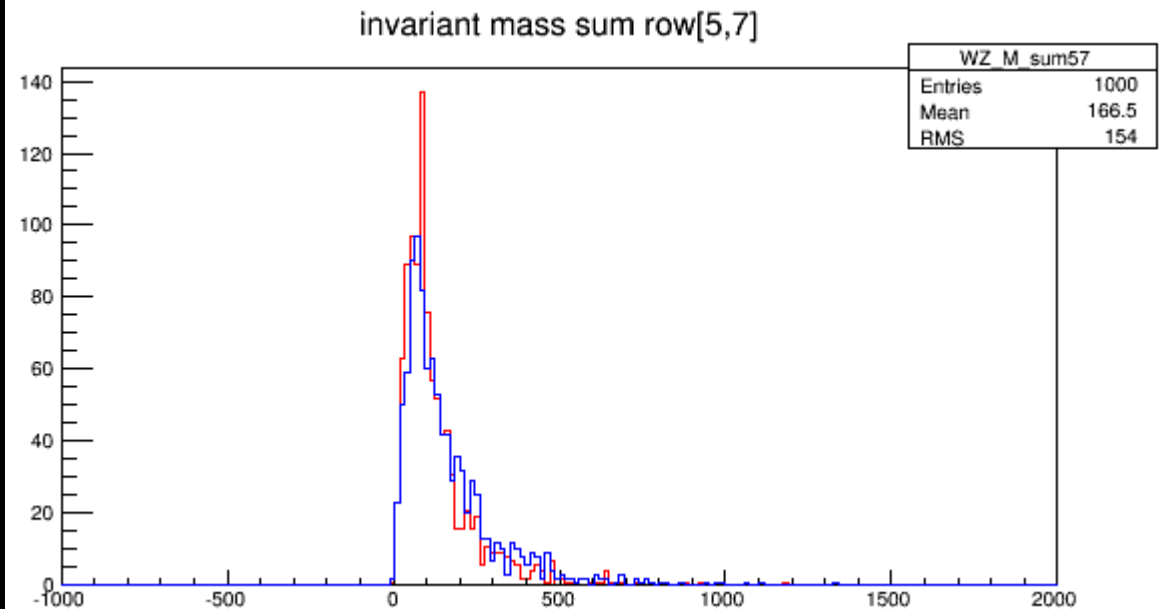
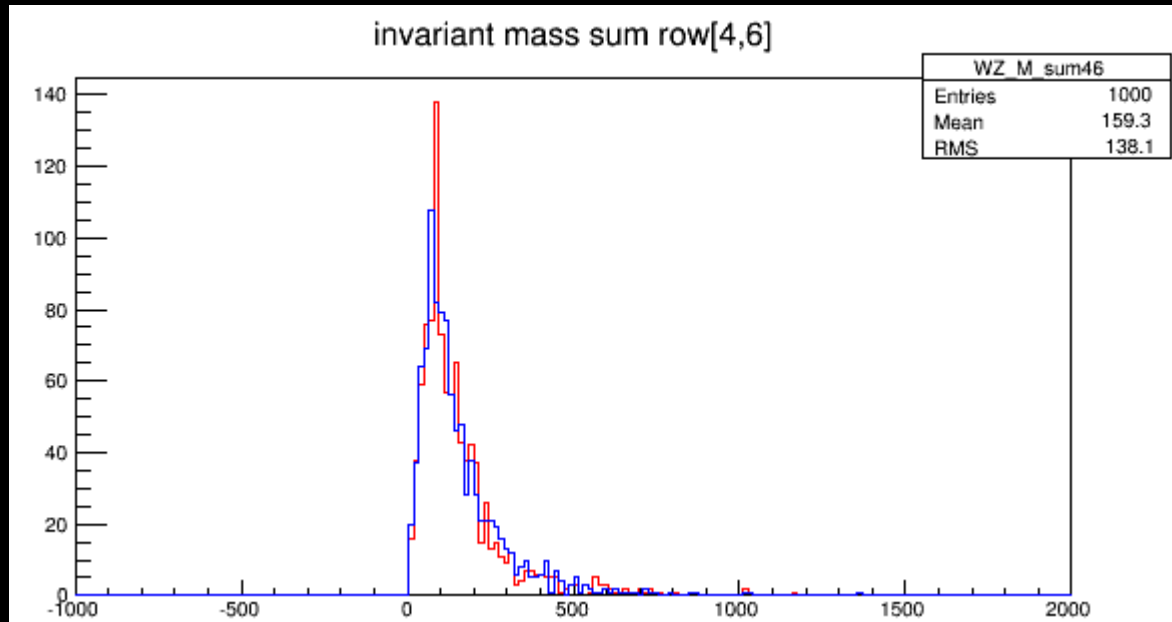
Invariant mass of outgoing q

- Invariant mass of combined row[2,3] has three components: W, Z and high-mass event. W,Z are part of three boson processes like WWW or ZWW



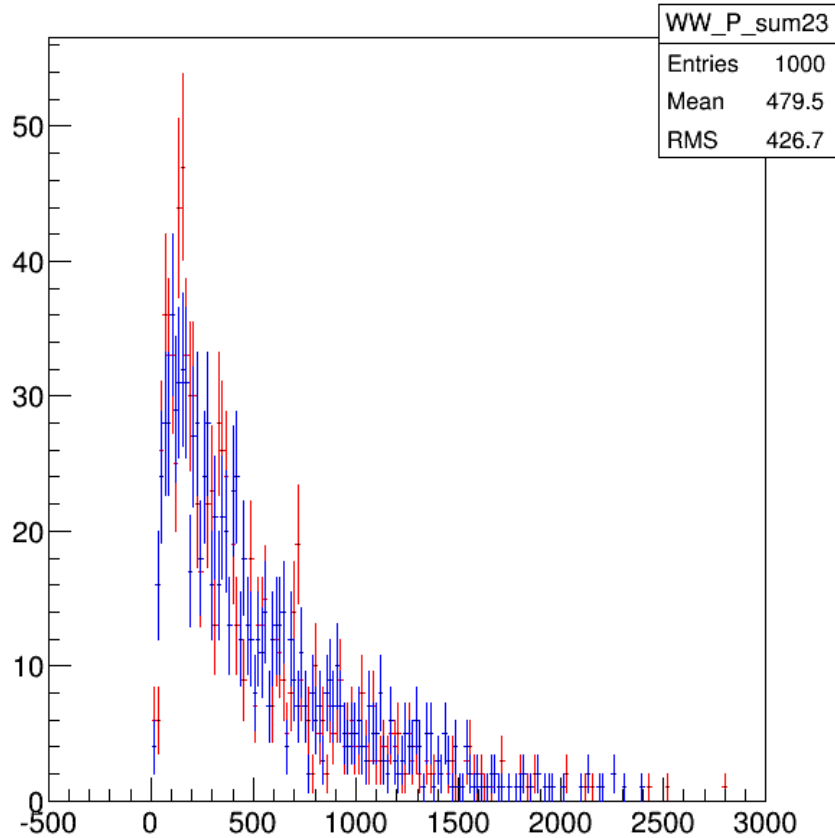
Z peak at 90GeV

- Red: $WW \rightarrow l\nu l\nu$
- Blue: $WW/WZ \rightarrow l\nu qq$
- Peak at 90GeV = invariant mass of two leptons from $l\nu l\nu$
- Z boson can decay into two leptons and this 90GeV peak corresponds to this.
- But there was no Z in $WW \rightarrow l\nu l\nu$ process?
- This process(event) was actually generated like $q+q \rightarrow q+q+l+\nu_{\bar{l}}+l'+\nu_{l'}$
- When an event is created in this way, both $l+l'$ and $\nu_{\bar{l}}+\nu_{l'}$ can come from Z boson decay!

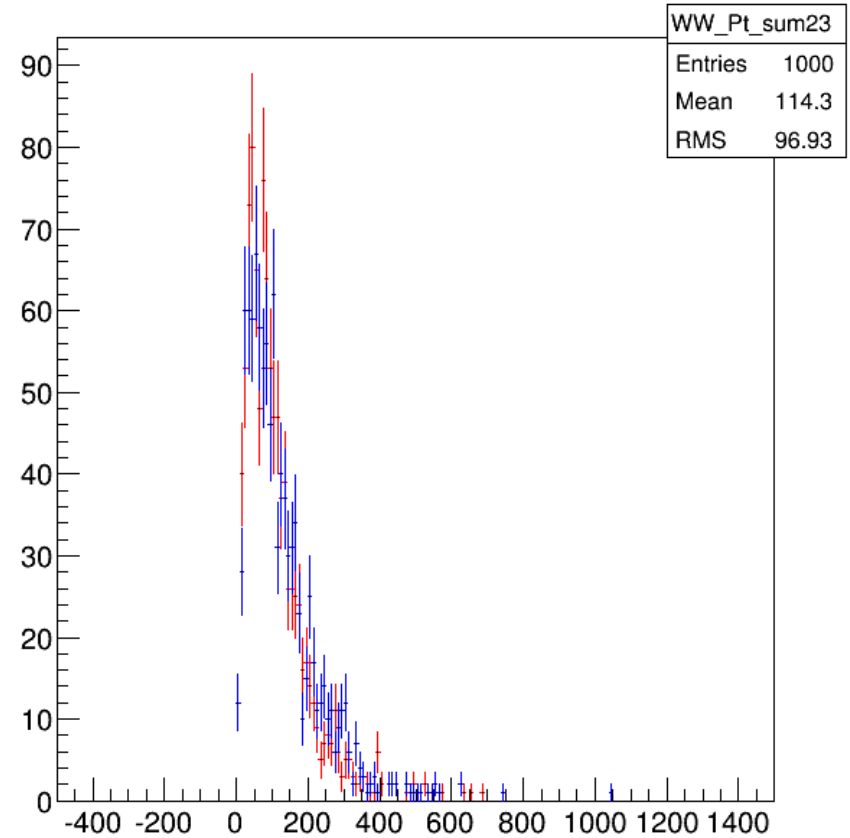


Total momentum and Transverse momentum

total momentum sum row[2,3]



transverse momentum sum row[2,3]

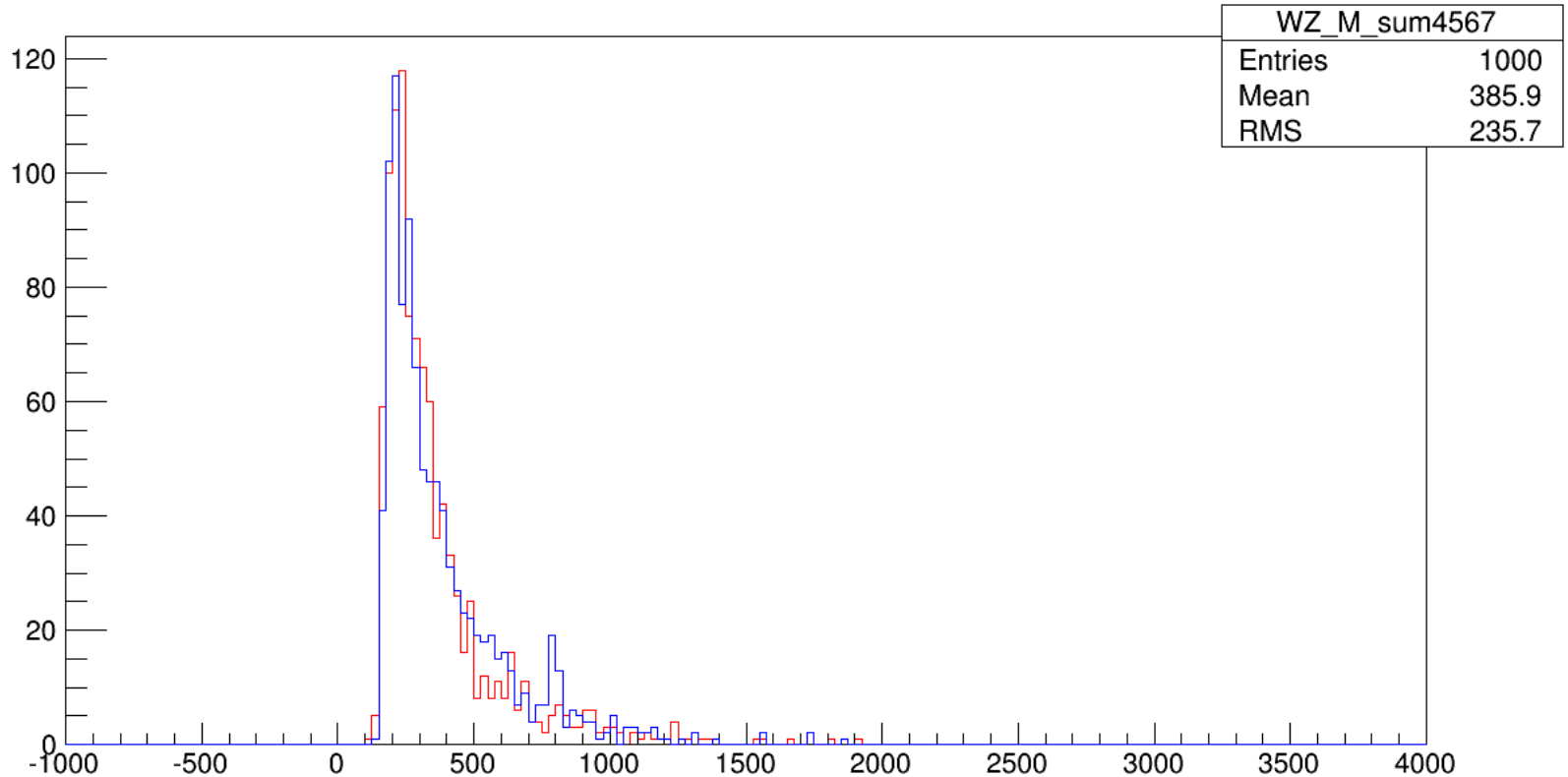


$$|p| = p_T \cosh \eta \quad \text{Pseudorapidity (eta) = } \eta$$

Total momentum = momentum along the beam pipe, which is non-interacting patrons
Transverse momentum = stuff resulting from interacting partons

WW/WZ system

invariant mass sum row[4567]



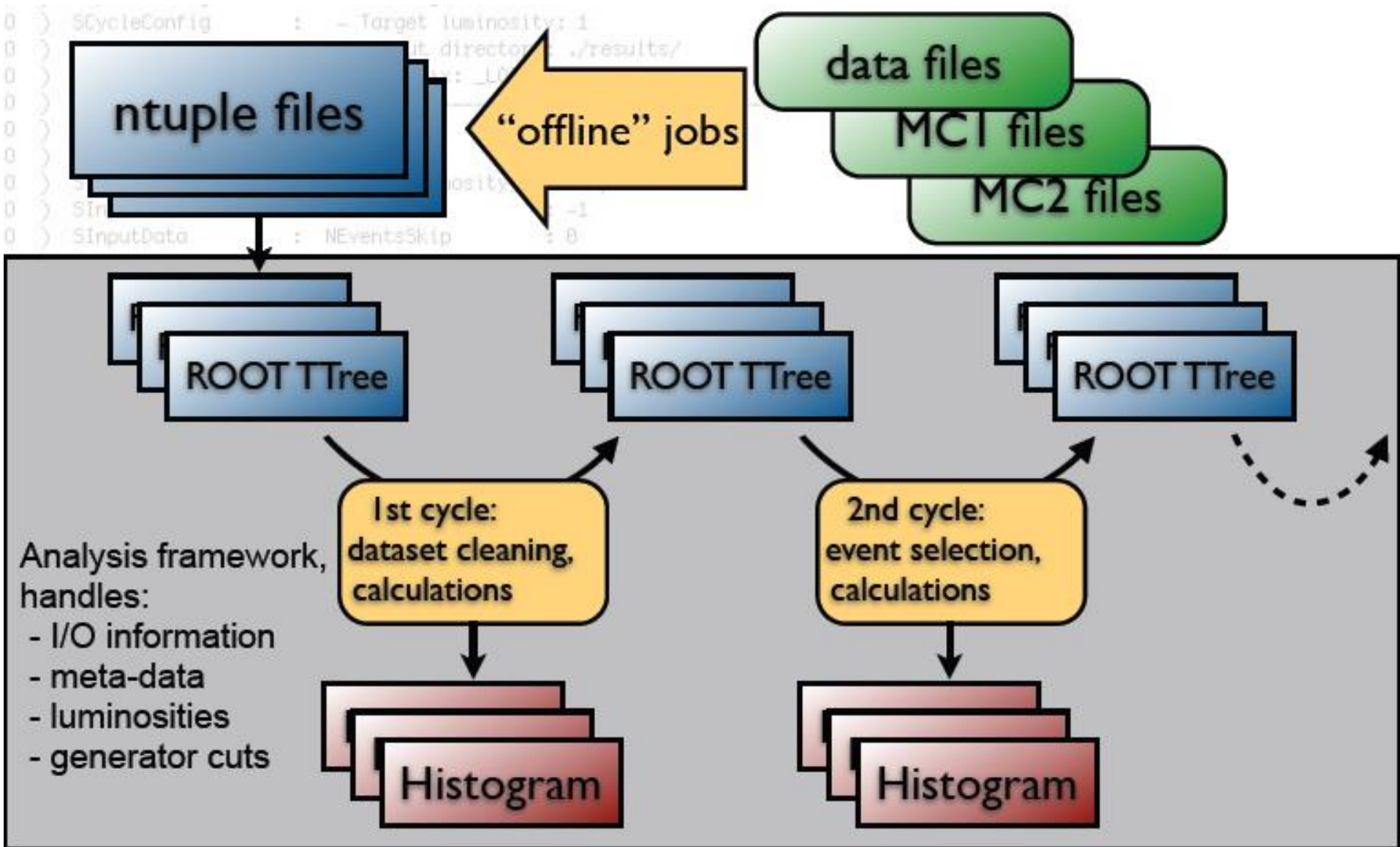
- Both Inulnu and Inuqq look similar 😊

Why/What Sframe? (reference A. Krasznahorkay)

- LHC data $\sim 300\text{MB/s}$ = large!
- Need something can read data from ROOT, create event, and result histograms efficiently (fast)
- Easy to develop and debug
- Can normalize data by setting luminosity

- Well, I'm still studying SFrame

Sframe (reference A. Krasznahorkay)



Trip....

Just came back
from Rome
Ciao!

*Great arts by Michelangelo,
Raffaello, Leonardo da Vinch
*Beautiful cathedrals, architecture

*... and skilled people! 😊😊😊😊😊



who summoned me...?

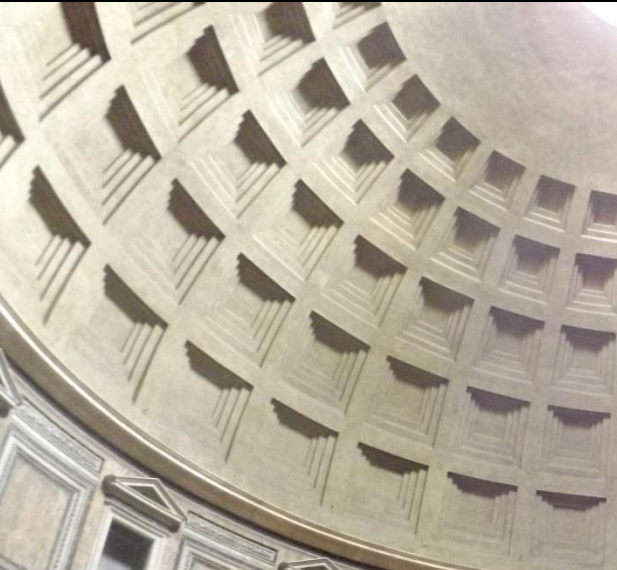
City of freedom and share ☺

without permission... (I love gipsy ☺) "Non andare a Roma"





Pantheon



St. Pietro Basilica

