Exercise Zprime to Mu Mu

- **Welcome to Zprime → MuMu exercise**
- **Main webpage for exercise**
  - https://twiki.cern.ch/twiki/bin/view/CMS/SWGuideCMSDataAnalysisSchoolNTU2016ZprimeDiLeptons
- **Exercise in NTU**
  - https://github.com/yangyuchul/ZprimeNTU
  - readme (for setup) and runAll.sh (for running exercies)

- **Please go to each directory in ZprimeNTU**
- **See the code(or ROOT macro) and try to understand it and run.**

➢ Just running might be not helpful.

Contents

- Step1: Ntuple creation
- Step2: Histogram creation

  - A lot of dataset(time cost), we can use pre-creation samples
  - Run for only 1 ~ 2 files for exercise step1 and step2

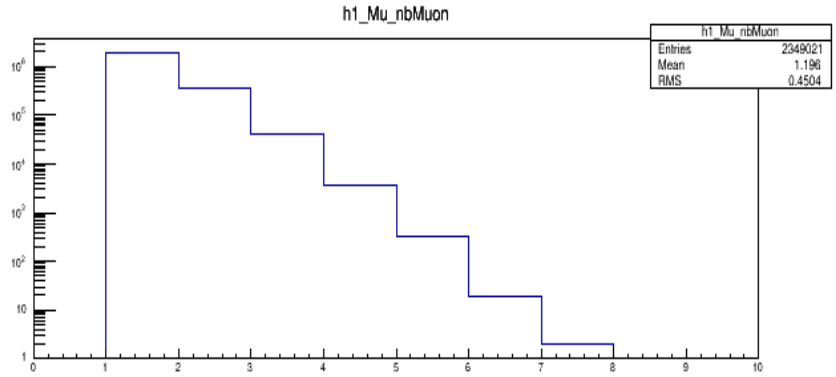
- Exercise 1) Physics observables
- Exercise 2): Invariant mass plot
- Exercise 2b): Event display
- Exercise 3) Efficiency and Tag & probe
- Exercise 4) Background estimation (fake rate)
- Exercise 5) Evaluation of the significance of the discovery

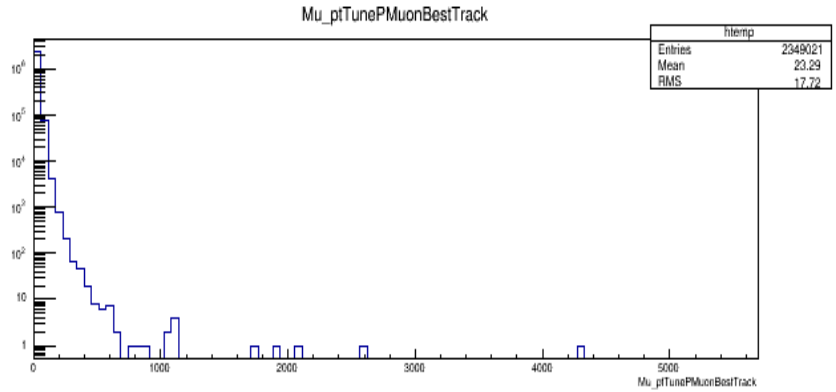
- Simple Procedure

  - Ntuples → EventSelection(Histos) → Data VS. Bkg → Stats.

Step1: Ntuple Creation

- AOD or MINIAOD → ntuple
- dir: step1_NtupleCreation
- Number of Muon and pT in ntuple





- A lot of dataset
  - Datasets
    - /SingleMuon/Run2015B-16Oct2015-v1/AOD
    - /SingleMuon/Run2015C_25ns-05Oct2015-v1/AOD
    - /SingleMuon/Run2015C-PromptReco-v1/AOD
    - /SingleMuon/Run2015D-PromptReco-v3/AOD
    - /SingleMuon/Run2015D-PromptReco-v4/AOD
    - /QCD_Pt_1000to1400_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_10to15_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_120to170_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_1400to1800_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_15to30_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_170to300_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_1800to2400_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_2400to3200_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_300to470_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_30to50_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_3200toInf_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - /QCD_Pt_470to600_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_50to80_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_5to10_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_600to800_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v3/AODSIM
    - /QCD_Pt_800to1000_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v2/AODSIM
    - /QCD_Pt_80to120_TuneCUETP8M1_13TeV_pythia8/RunIISpring15DR74-Asympt25ns_MCRUN2_74_V9-v1/AODSIM
    - And more ....

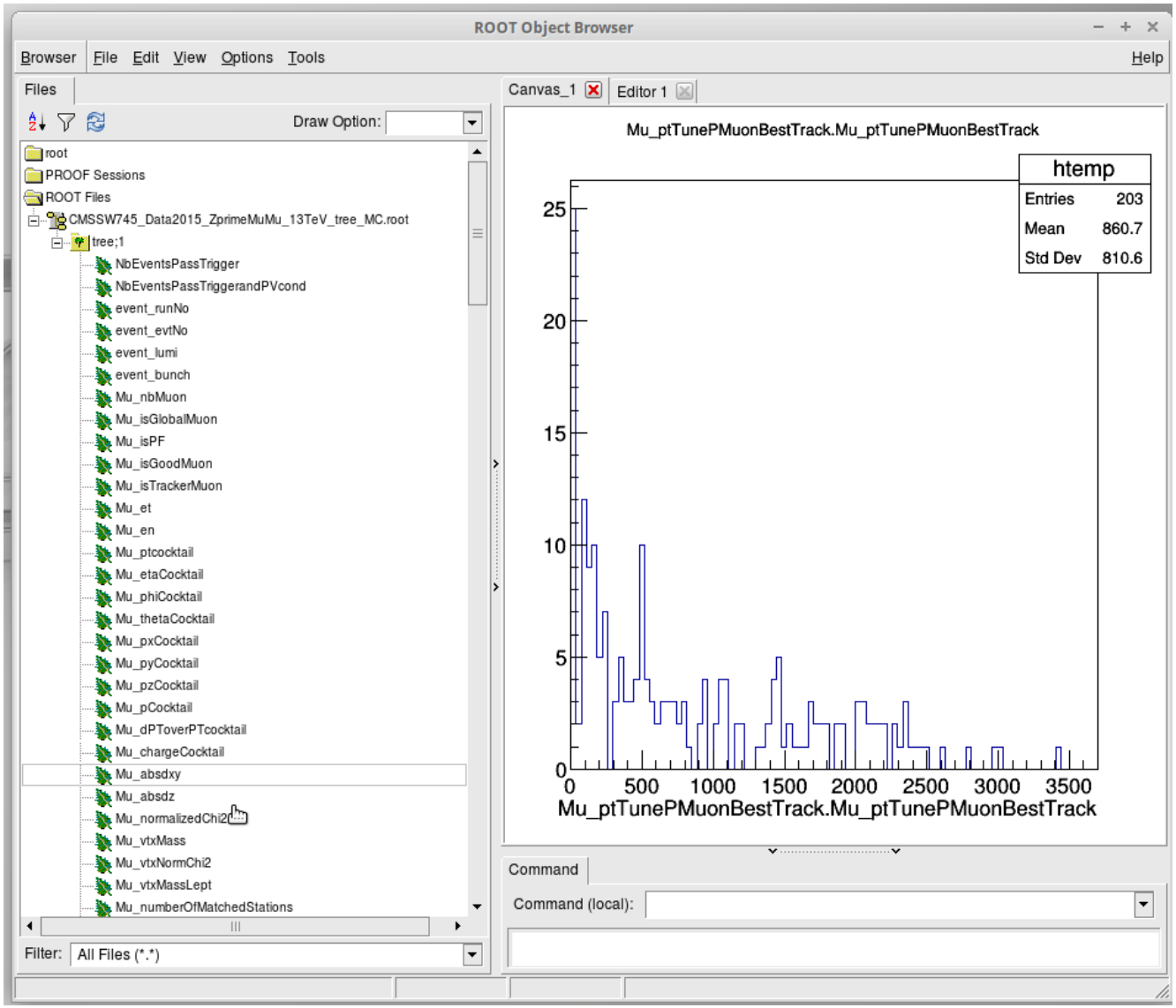
- Nutples location in NTU

/wk3/cmsdas/store/user/cmsdas/2016/LONG_EXERCISES/ZprimeDiLeptons/Data2015_ZprimeMuMu_13TeV_merged
/wk3/cmsdas/store/user/cmsdas/2016/LONG_EXERCISES/ZprimeDiLeptons/Spring15_25ns_merged

To do
- Open TBrowser and see what kind of variable is in ntuple
- Make Plot for number of muon and pt, etc in ntuple

Ntuple (TTree)

- **Open TBrowser**



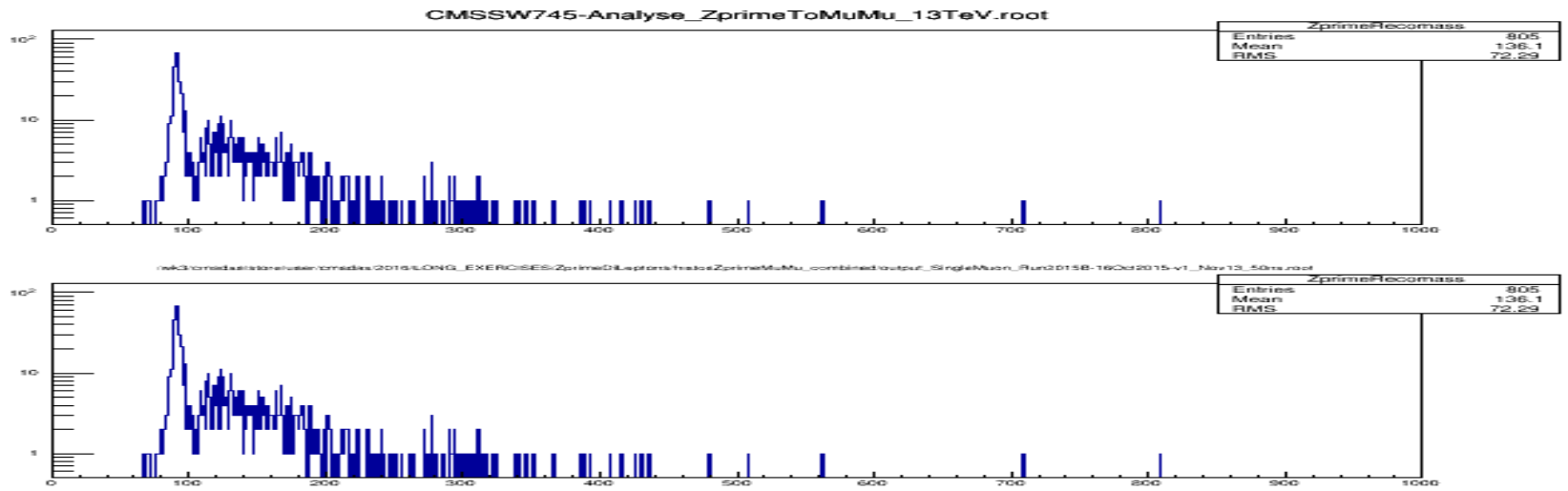
Step2: The Analysis Code

- Ntuple → (event selection) → histogram
- Two isolated Muon Object selection
- Make some histograms of interesting variable (pt, eta, phi, mass, etc…)
- dir: step2_AnaCode
- Histograms for all data samples

/wk3/cmsdas/store/user/cmsdas/2016/LONG_EXERCISES/ZprimeDiLeptons/histosZprimeMuMu_combined/

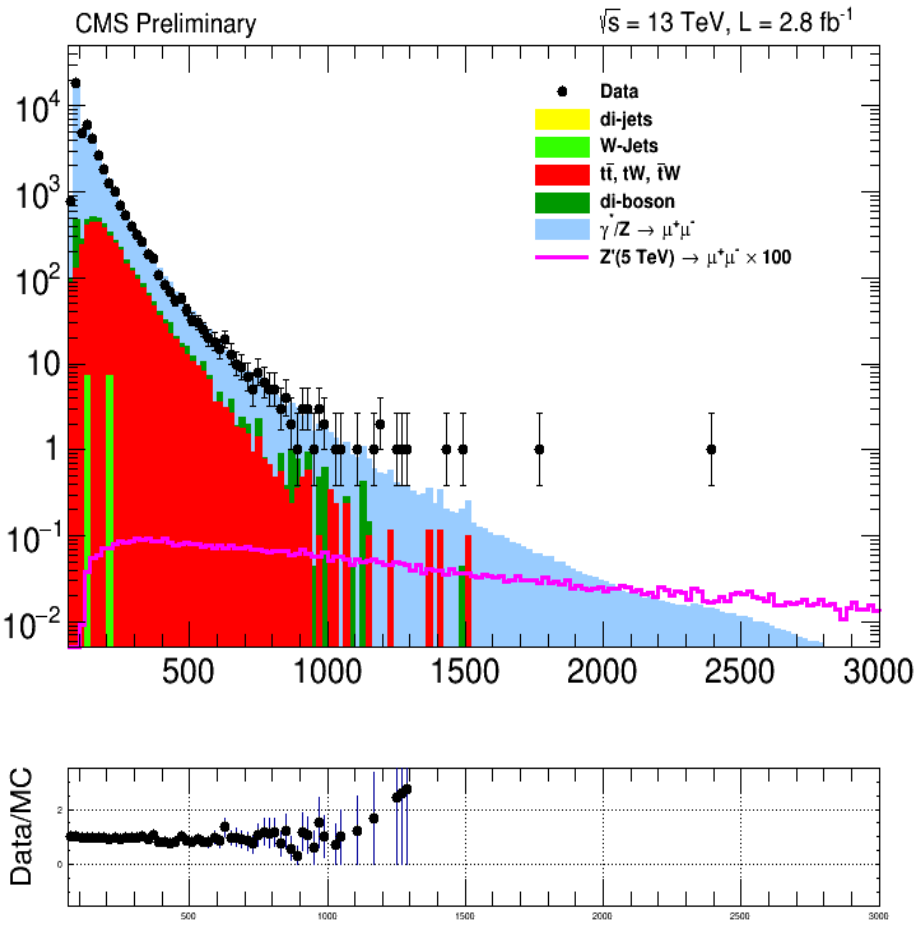
- To do

- Make a di-muon distribution, and muon pt, eta, etc…



Ex1: Physics Observables

- **Comparison data and MC**
- **dir: ex1a_PhysObs**
- **root -l -b -q drawStack.C**
- **ls -al drawStack.pdf**
- **To do:**
  - Draw Muon pT, eta, other observable
- **MC weighting**
  - #GenEvent : 4000
  - X-sec : 11 pb
  - Lumi : 4000/pb
  - weight : ???

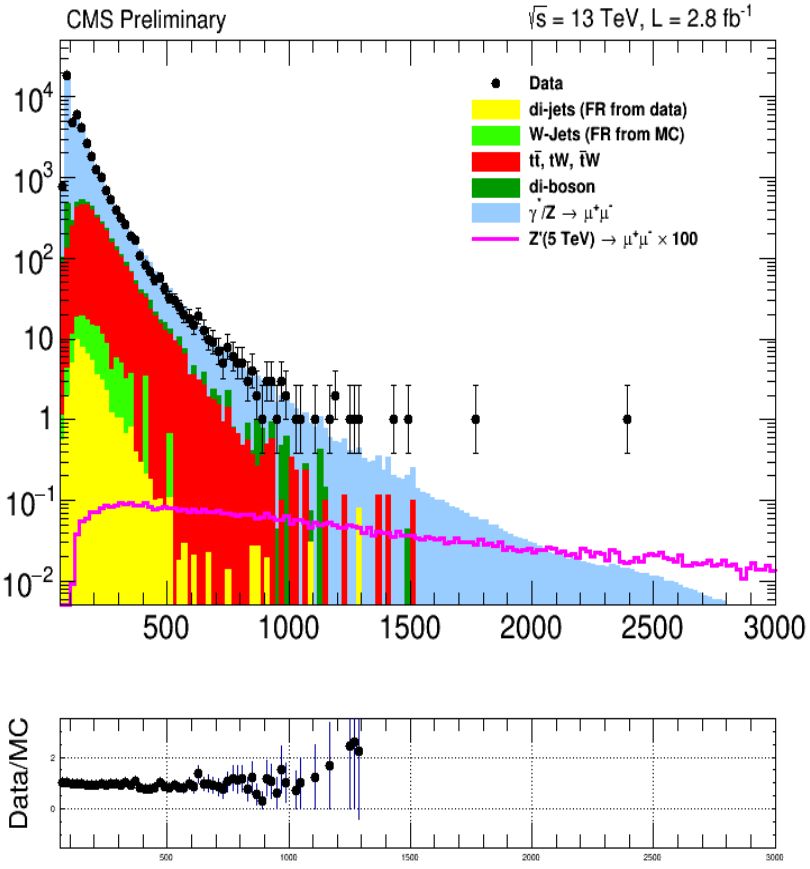


Ex2: Invariant Mass

- Almost same as Ex1
- QCD bkg estimation is used data driven method(FakeRate) instead of MC QCD(dijets)

- root -l -b -q drawStack.C'(true)'
- ls -al drawStack_QCDfromData.pdf

- FakeRate : ex4_fakeRate

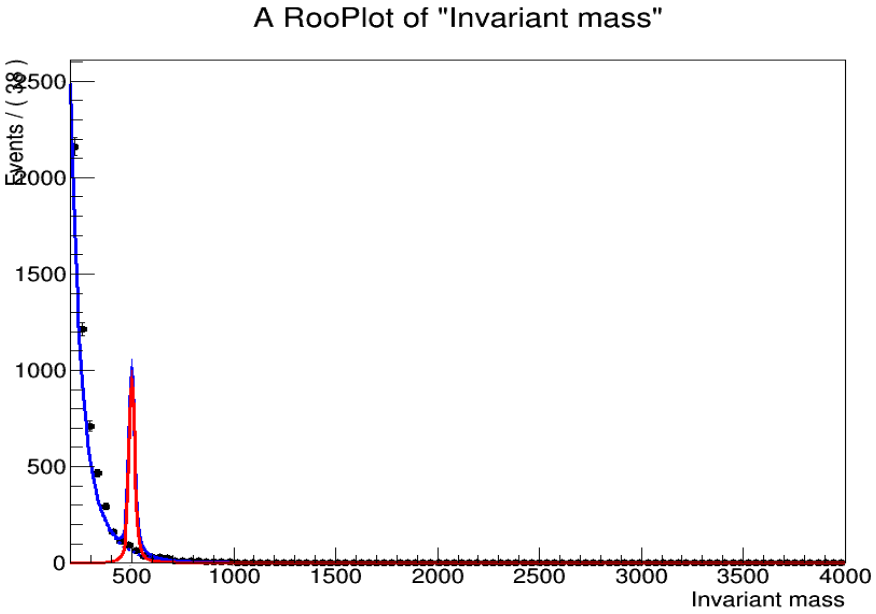


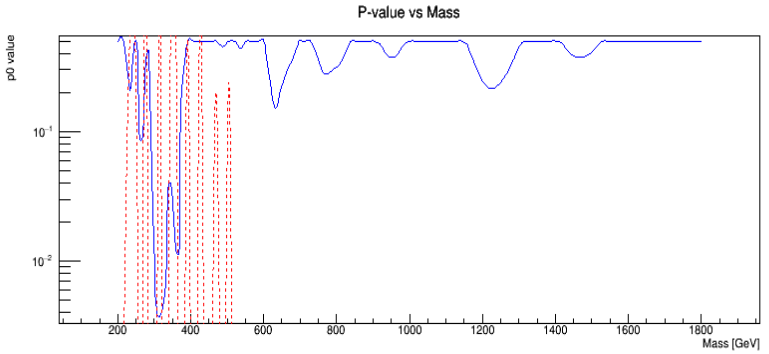
Ex5: Significance

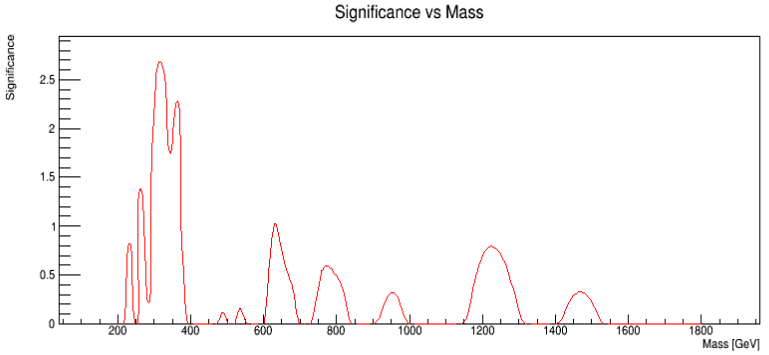
- Dir: ex5_significance
- Change it in sig.C (to reduce time cost for test)

```
double massMin = 200;
double massMax = 700;
int nbins = 5;
```

- root -l -b -q sig.C
- ls -al *.pdf

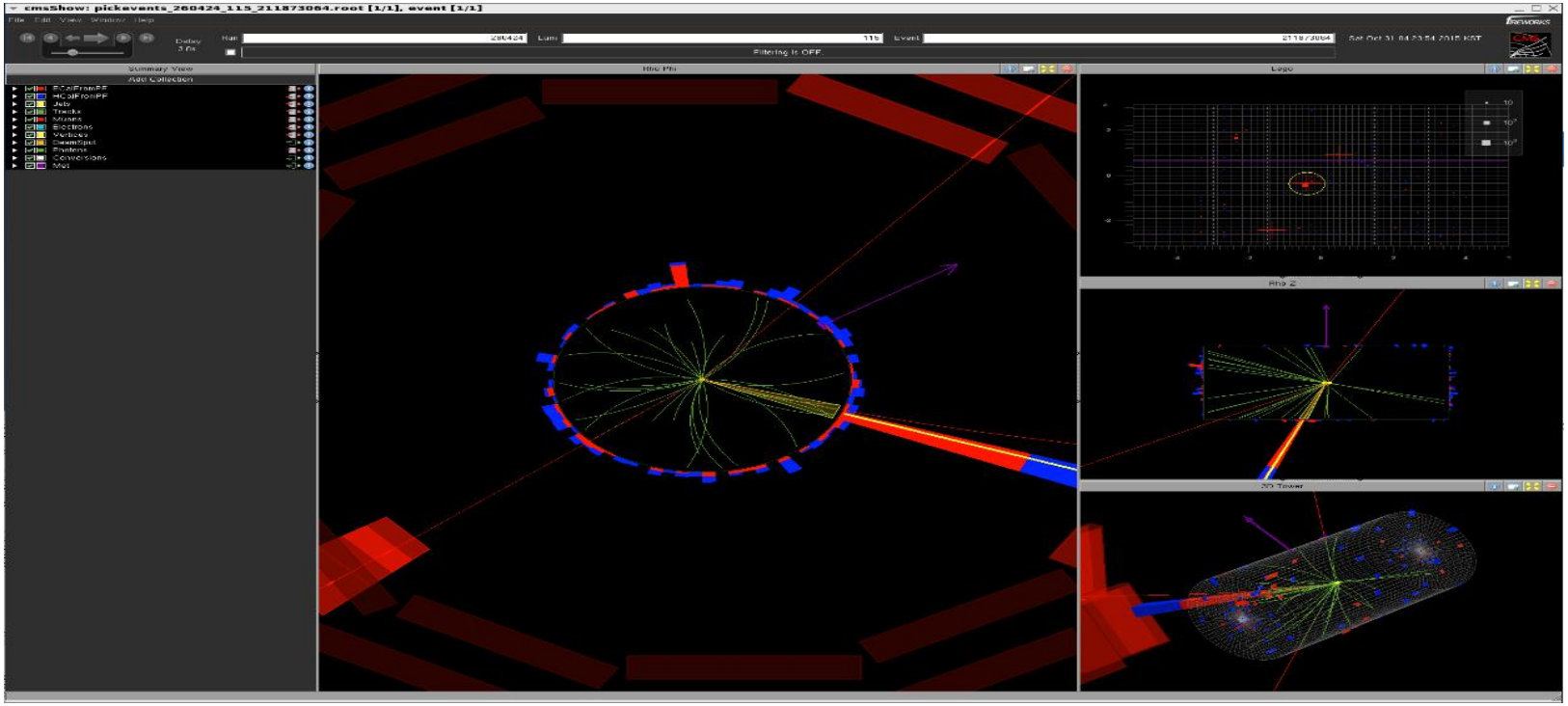






Ex2b: Event display

- Re-login in ntugrid1.phys.edu.tw (no need cmssw setup)
- wget http://cern.ch/cmsshow/cmsShow-7.6.linux.tar.gz
- tar xzf cmsShow-7.6.linux.tar.gz
- cd cmsShow-7.6
- ./cmsShow ZprimeDiLeptons/Analyzer/test/pickevents_260424_115_211873064.root



Let's go

- Please remember that
- Just running might be not helpful you.
- Try to understand code and modify it for your interesting.