HCAL Analysis

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Introduction

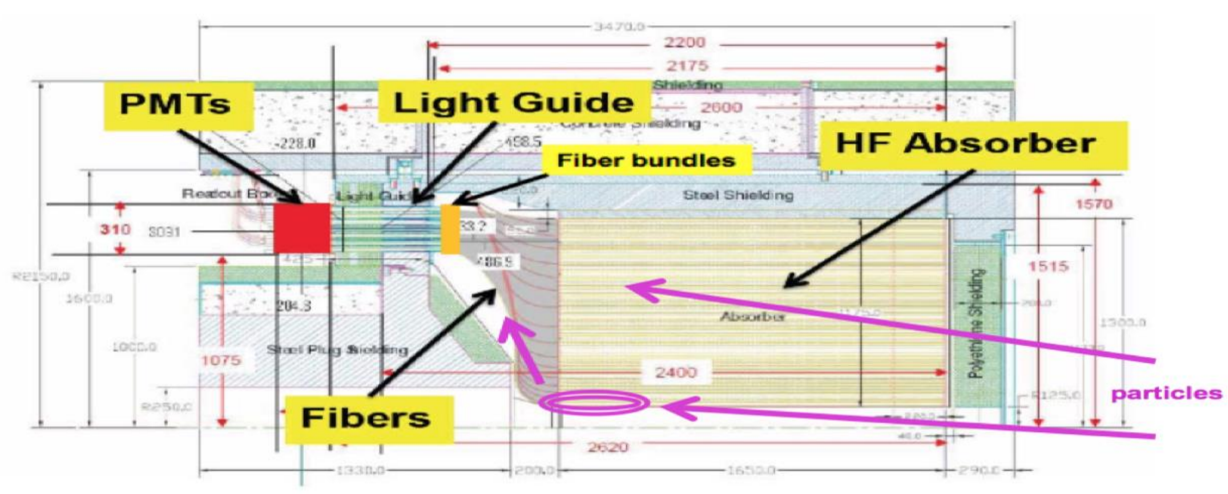
- We will present analysis of new PMTs and HF noise in this talk.

- We have updated the code for HF noise analysis.

- PMTs were upgraded to new models in HF
  - Reduce anomalous signals

- The purpose of this presentation is to compare the response of the old and new PMTs looking their energy.

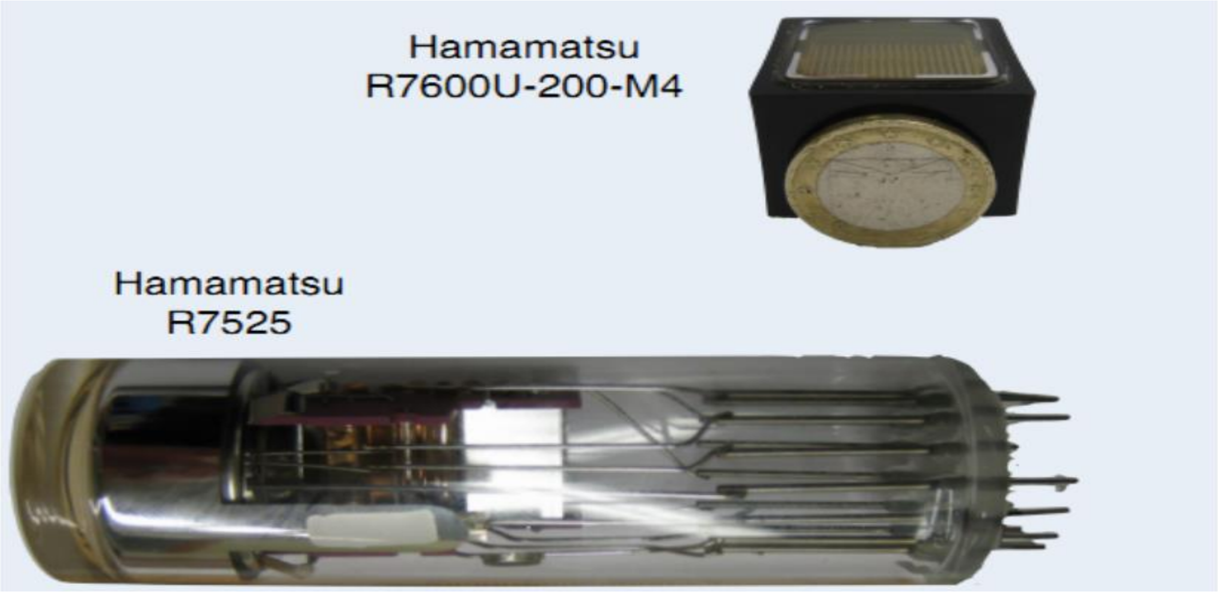
Hadron Forward Calorimeter



- The Hadron Forward Calorimeter (HF) is an important part of the CMS.
  - Serving to improve jet detection,
  - missing transverse energy resolution in eta region changed from 3.0 to 5.0 .
- The HF detector includes quartz fibers embedded in steel absorbers, which generate Cerenkov Radiation that is picked up by photomultiplier tubes.
- Every wedge has two RBXs servicing it, housing 24 PMTs each.
- HF has total of 1728 PMTs, in HF+ and HF- combined (PMT).

New HF PMT

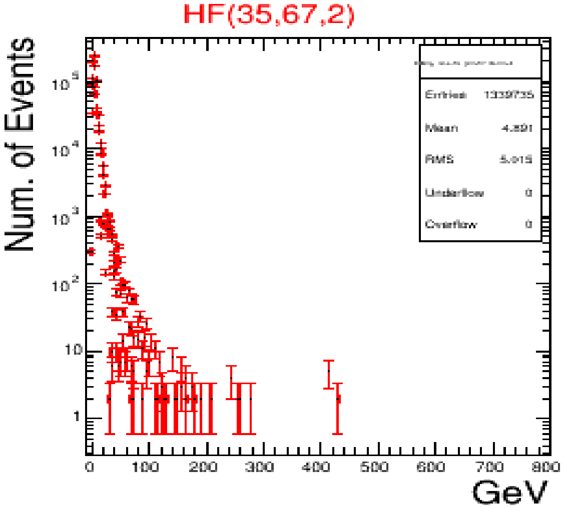
- The new quad-anode PMTs were installed to cope with the noise created by window hits.
- selected to replace the current ones in the HF during the 2012 upgrade.
- The new PMTs feature a window segmented into four quadrants.

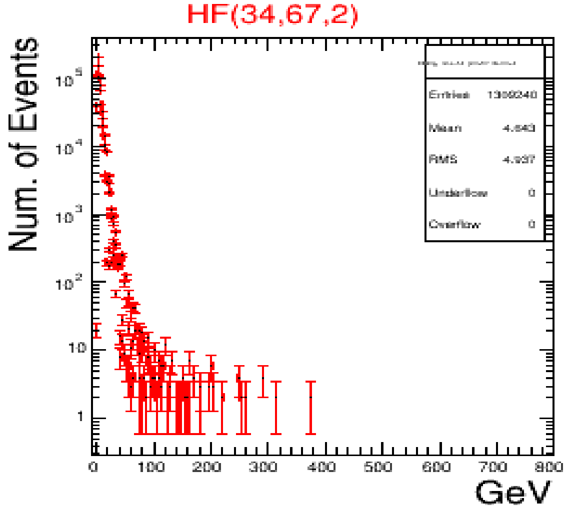


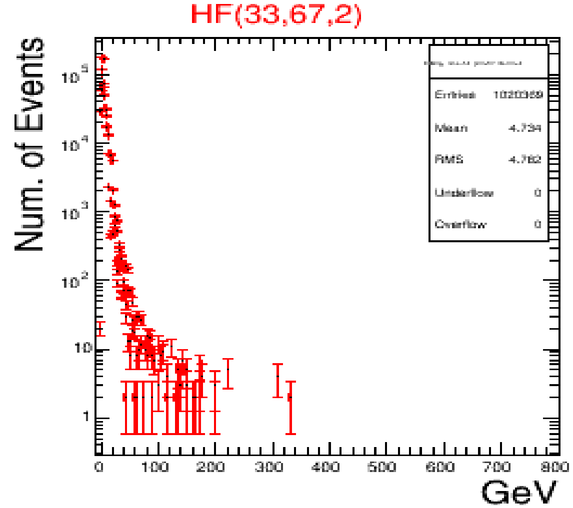
Info for the analysis

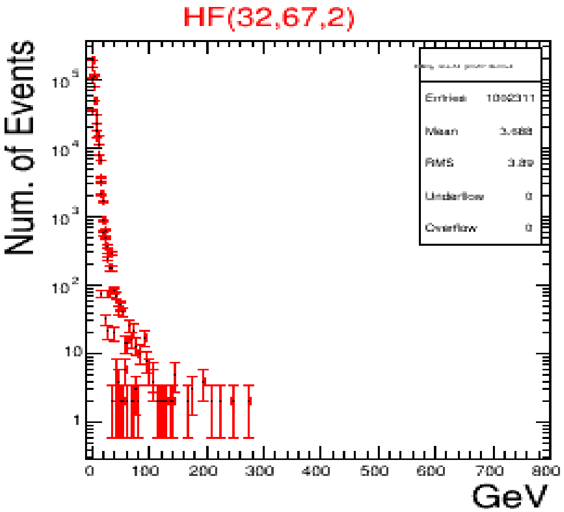
- We use
  - CMSSW_7_1_7
  - /MinimumBias/Run2012D-22Jan2013-v1/RECO

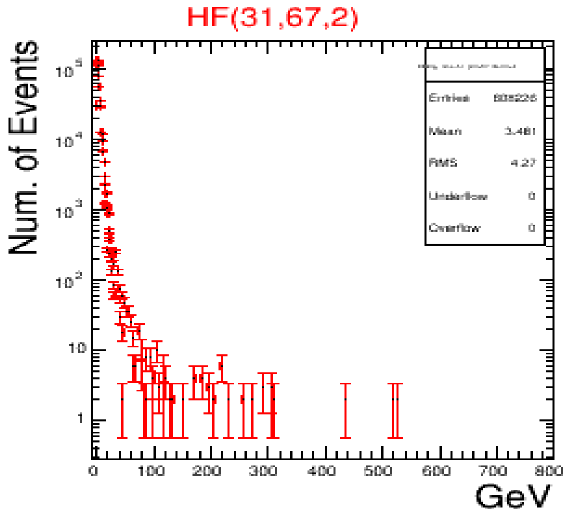
Energy distribution for iphi=67

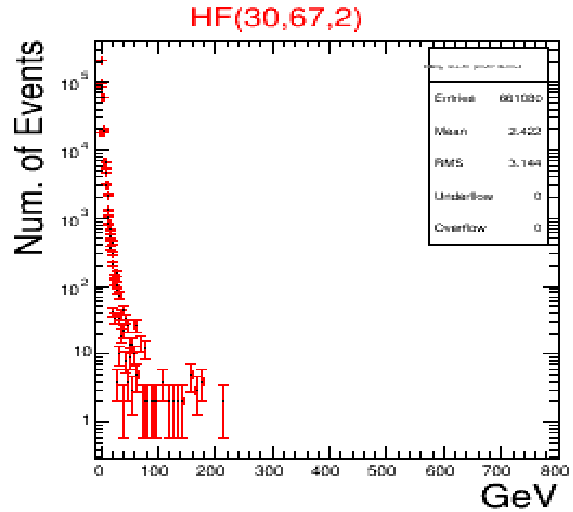




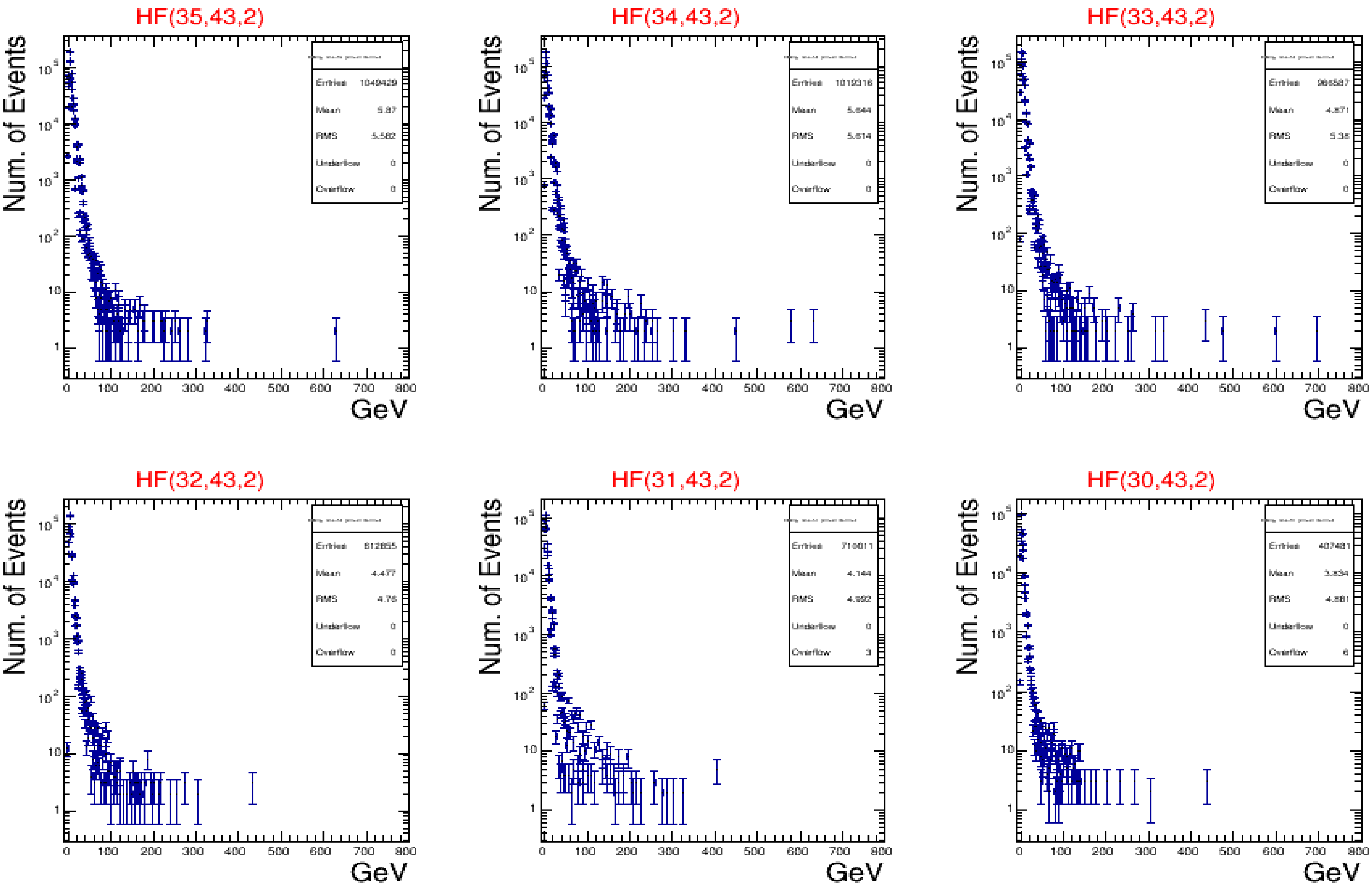




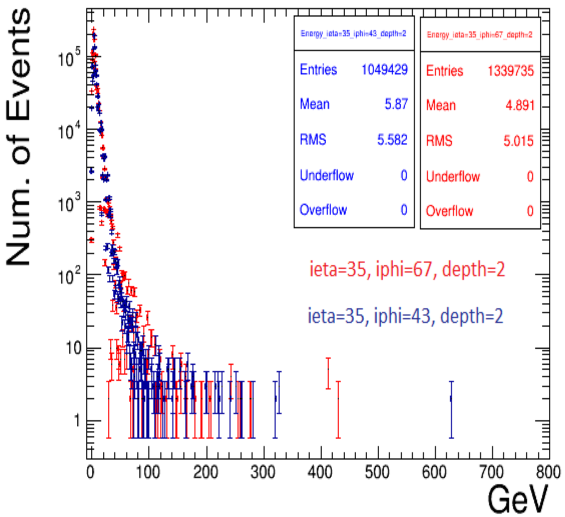


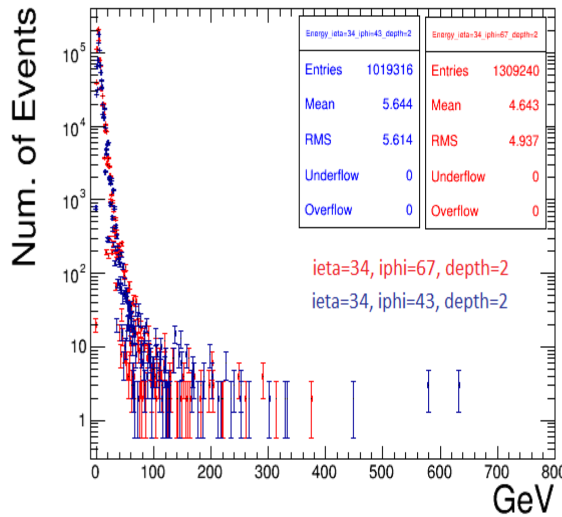


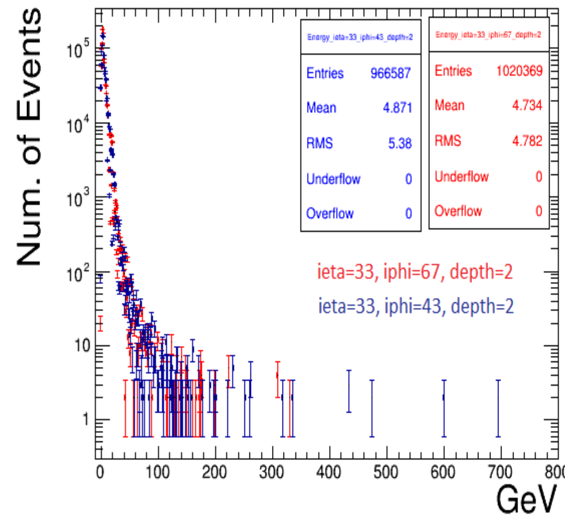
Energy distribution for iphi=43

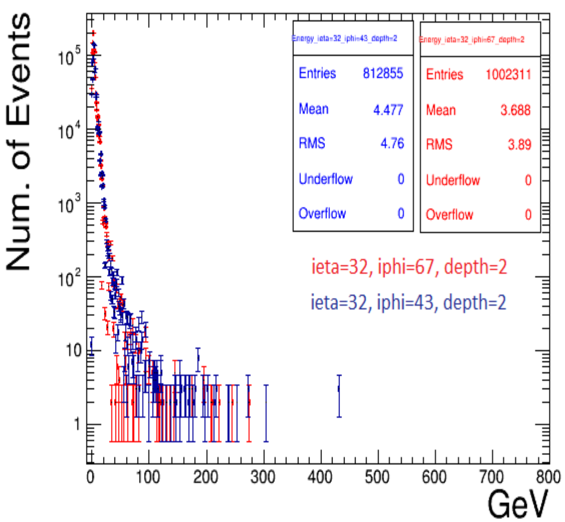


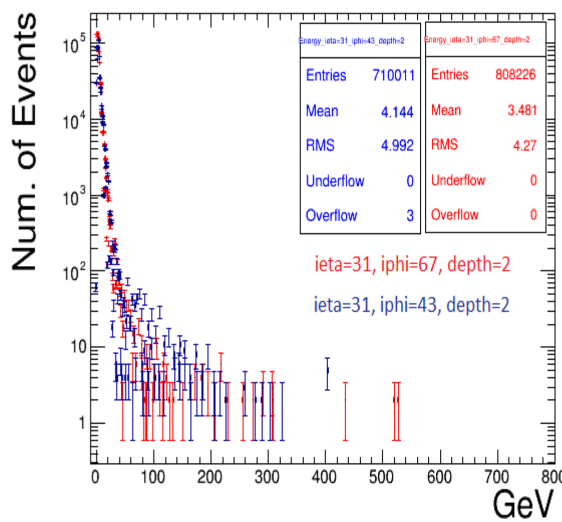
Comparison of Energy distributions with superposing

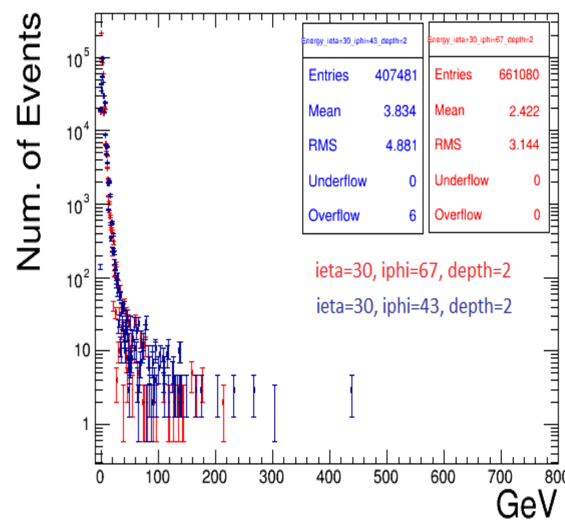




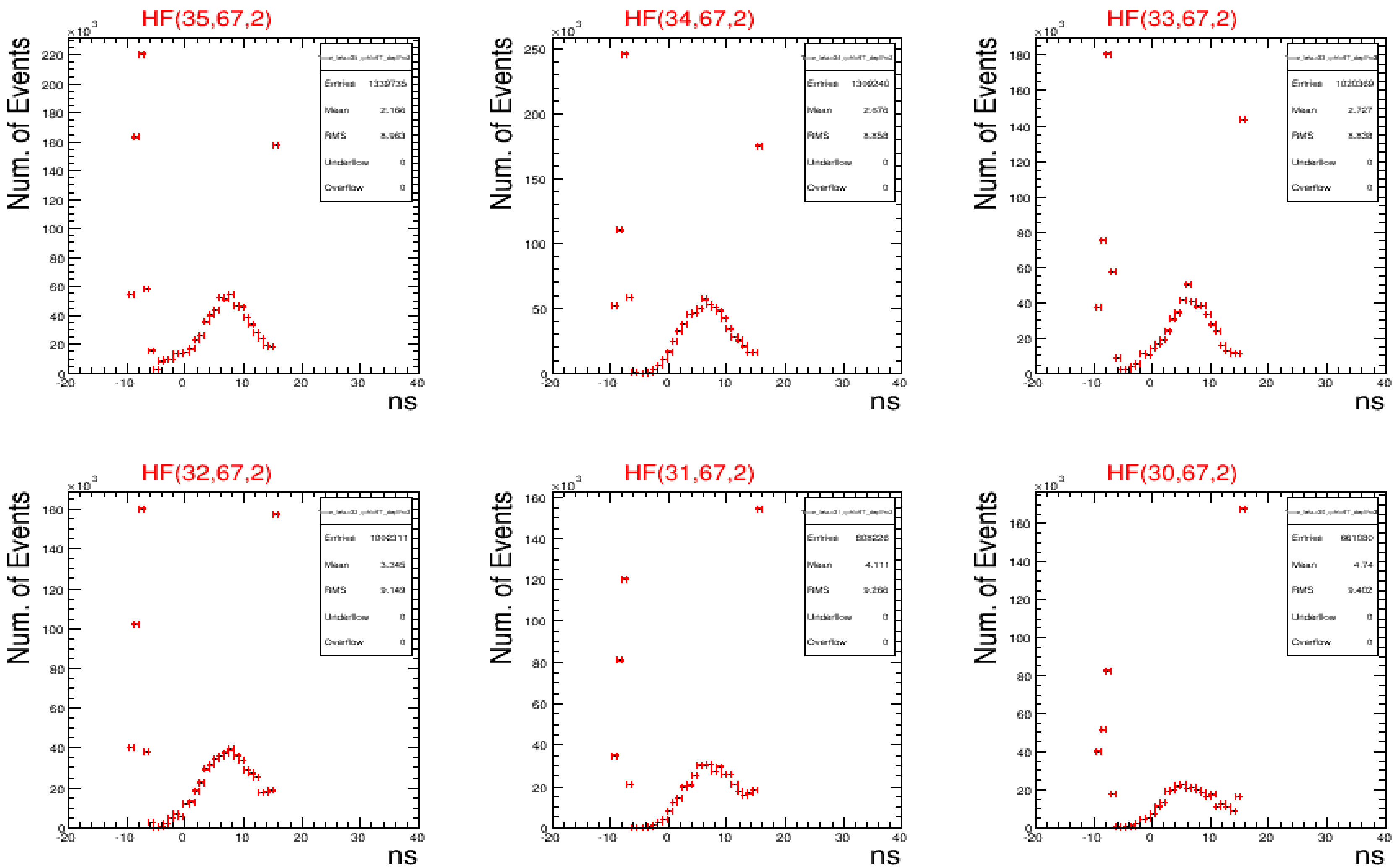




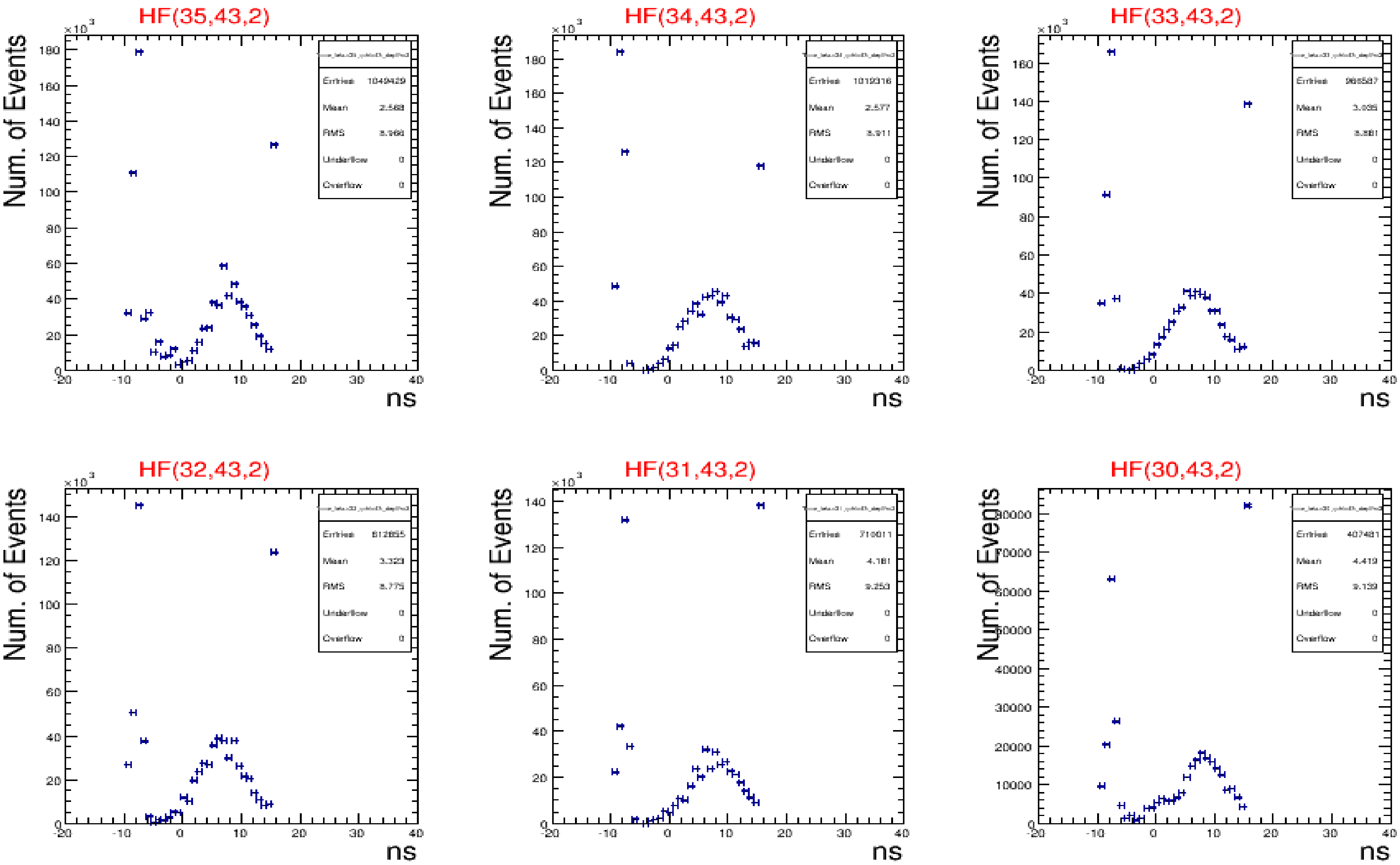




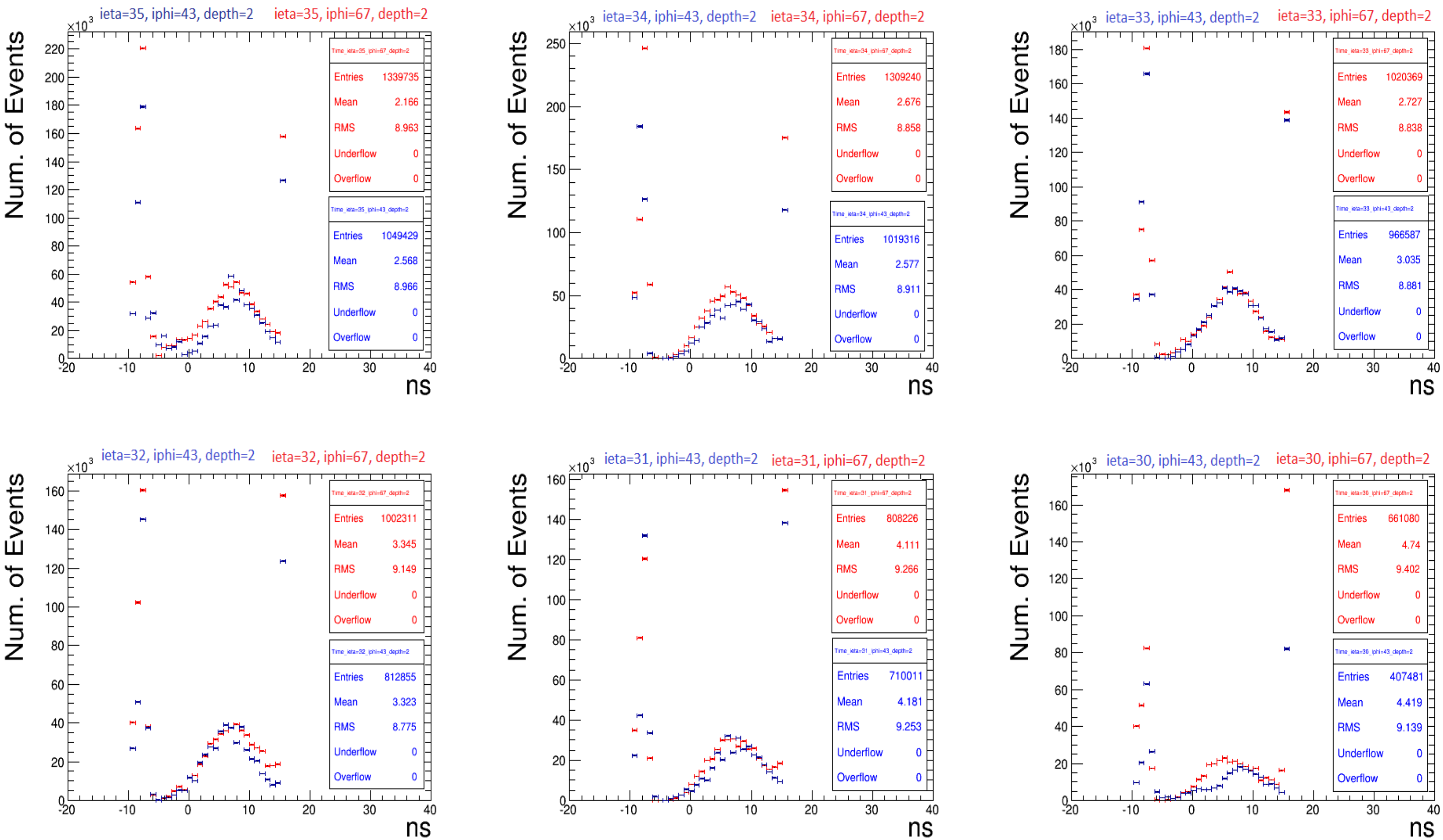
Time distribution for iphi=67



Time distribution for iphi=43



Comparison of Time distributions with superposing



HF Ntuple Code part

```
try {
    std::vector<edm::Handle<HFRecHitCollection> > colls;
    iEvent.getManyByType(colls);
    std::vector<edm::Handle<HFRecHitCollection> >::iterator i;
    int NumRecHits = 0;
    fRunNo = iEvent.id().run();
    fEventNo = iEvent.id().event();
    int nHits = 0;
        for (i=colls.begin(); i!=colls.end(); i++) {
            for (HFRecHitCollection::const_iterator j=(*i)->begin(); j!=(*i)->end(); j++) {
                HEneVsEta->Fill(j->id().ieta(), j->energy());
                    if (j->id().subdet() == HcalForward) {
                        ++NumRecHits;
                        fEnergy[nHits] = j->energy();
                        fTime[nHits] = j->time();
                        fEta[nHits] = j->id().ieta();
                        fPhi[nHits] = j->id().iphi();
                        fDepth[nHits] = j->id().depth();
                        fPMTHitLS[nHits] = (j->flagField(HcalCaloFlagLabels::HFLongShort)) ? 1 : 0;   // if there is a rechit same time , flag is «1»
                        fPMTHitS8S1[nHits] = (j->flagField(HcalCaloFlagLabels::HFS8S1Ratio)) ? 1 : 0;
                        fTimingError[nHits] = (j->flagField(HcalCaloFlagLabels::HFDigiTime)) ? 1 : 0;
                        HFRecHitTime->Fill(j->time());
                        HFRecHitEnergy->Fill(j->energy());
                        ++nHits;
        }
            }
            fNumRecHits = nHits;
            fTree->Fill();
        }
  } catch (...) {
        std::cout << "No HF RecHits." << std::endl;
  }
```

HF Ntuple analyzer Code part

```
double nevt = fTree->GetEntries();
for(int i = 0; i < nevt;++i){
    if(i%10000==0)cout << "finished " << i << endl;
    fTree->GetEntry(i);
    for(int id=0;id<fNumRecHits;++id){
        int iphi = fPhi[id];
        int idepth = fDepth[id];
        int ieta = fEta[id];
        float energy = fEnergy[id];
        float time = fTime[id];
        int flag = fPMTHitLS[id];
        fHists->getHisto1D(histSumRecHitEnergyinHF)->Fill(energy);     // Sum Rechit Energy in HF
        if (fDepth[id]==1)fHists->getHisto1D(histLongRecHitEnergyinHF)->Fill(energy);     // Long Fiber RecHit Energy  (EM)
        if (fDepth[id]==2)fHists->getHisto1D(histShortRecHitEnergyinHF)->Fill(energy);    // Short Fiber RecHit Energy  (HM)
        if (flag==0){      //  There is no  RecHit  same time  in Long an d Short Fibers
            fHists->getHisto1D(histNoiseCleanSumRecHitEnergyinHF)->Fill(energy);   // after noise  clean Sum Rechit Energy in HF
            if (fDepth[id]==1)fHists->getHisto1D(histNoiseCleanLongRecHitEnergyinHF)->Fill(energy); // after noise  clean  Long Fiber
            if (fDepth[id]==2)fHists->getHisto1D(histNoiseCleanShortRecHitEnergyinHF)->Fill(energy); // after noise  clean  ShortFiber
        }
        int seqId = fMap->getSequenceId(ieta,iphi,idepth);    // Specific channel  ieta, iphi, idepth
        if(seqId != -999) {
            histEnergy.Form("Energy_ieta=%i_iphi=%i_depth=%i",ieta,iphi,idepth);
            fHists->getHisto1D(histEnergy)->Fill(energy);
        }
    }
}
```

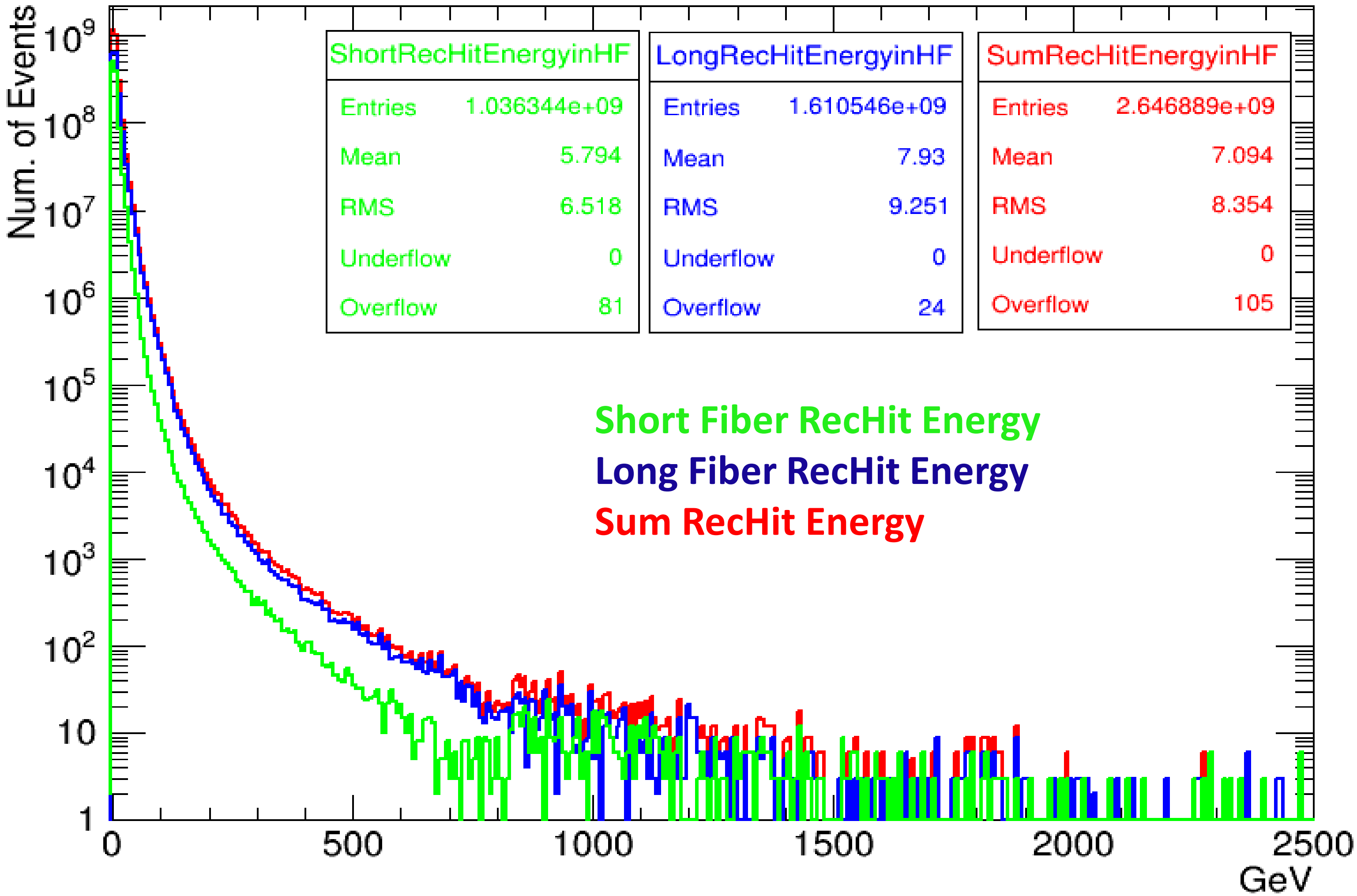
Noise Clean Method

We use flag info.

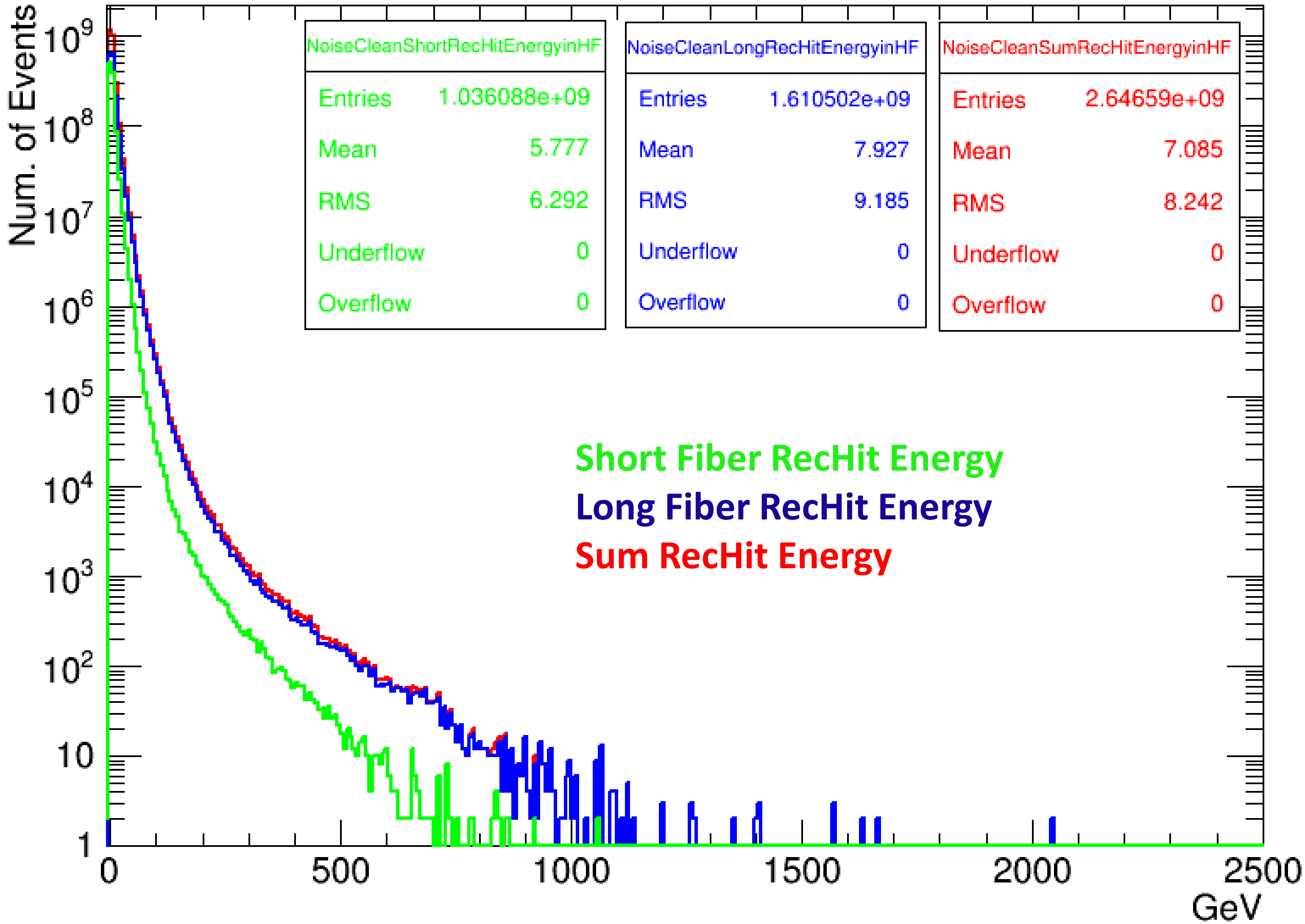
If flag ==1 this means it is noise.

We skip this rechit .

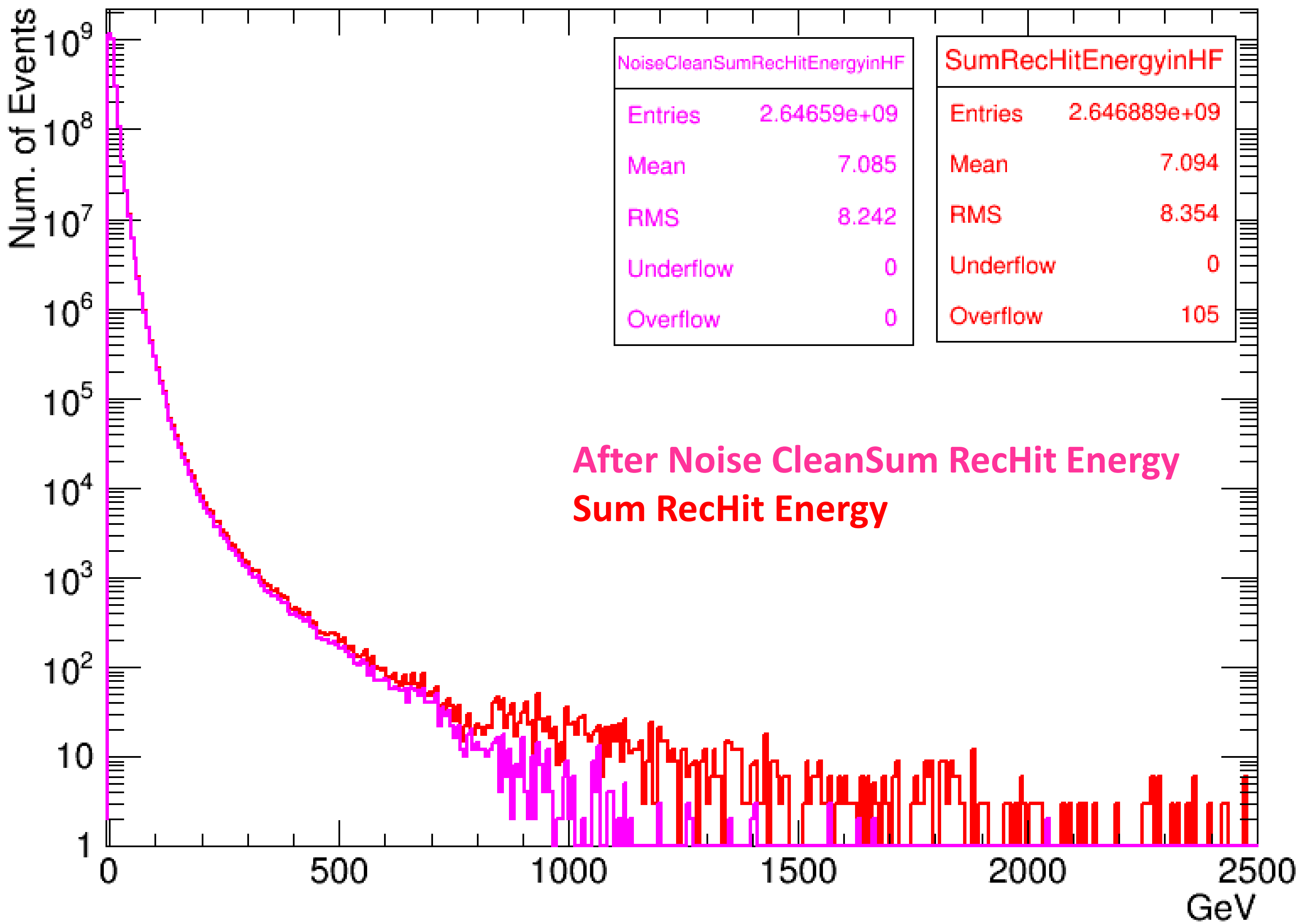
Rechit Energy before Noise Clean



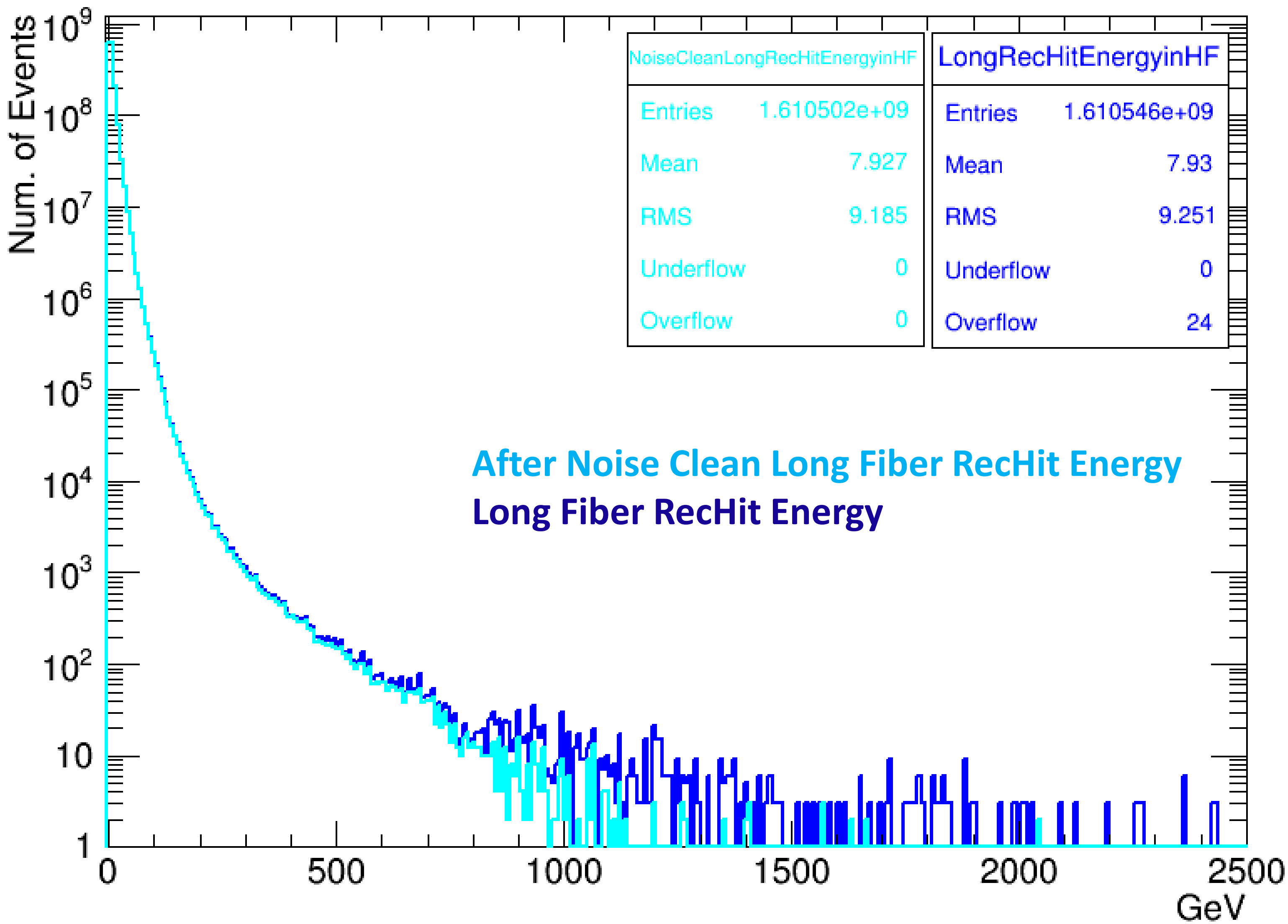
After Noise Clean RecHit Energy



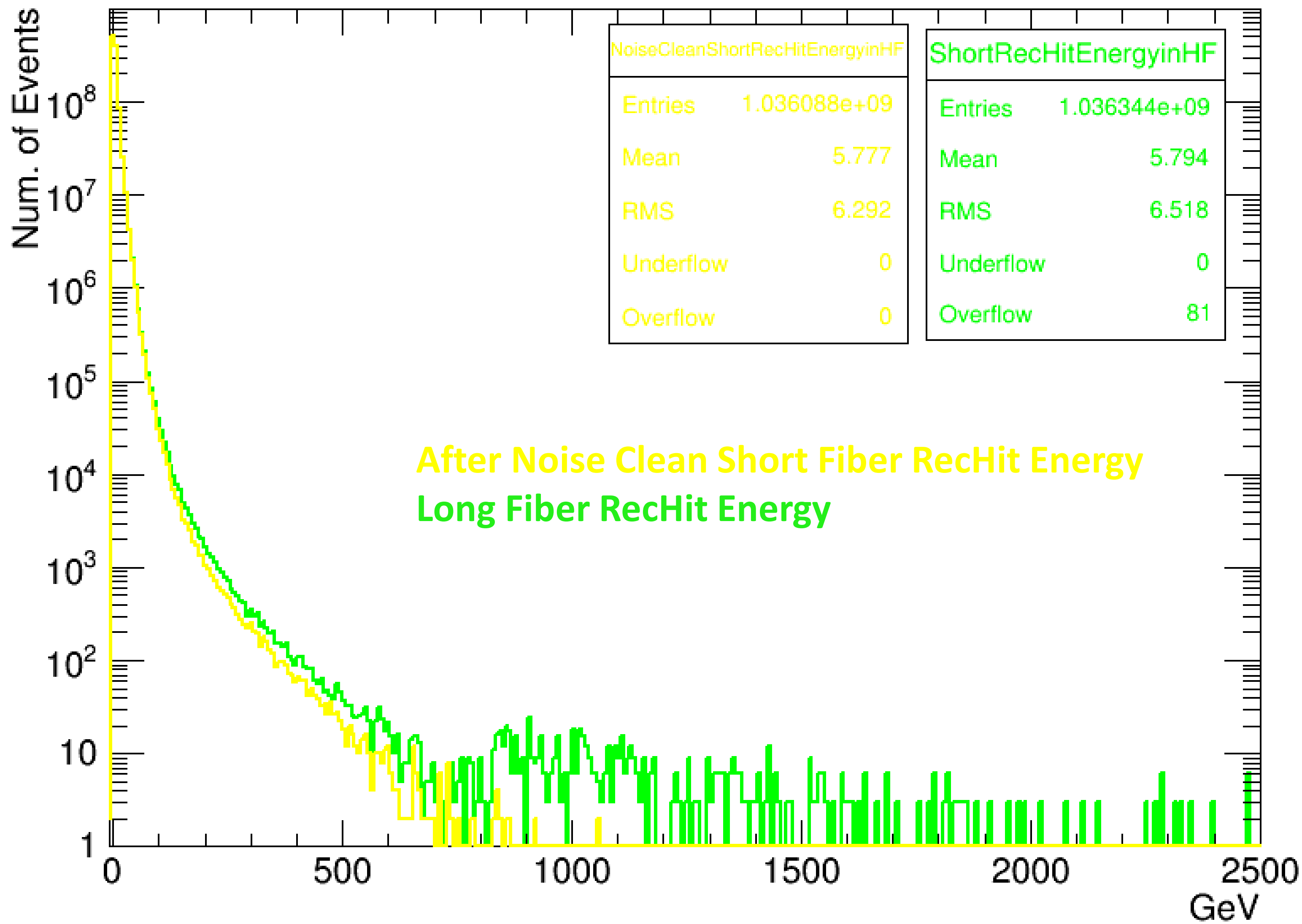
Comparison of SumRecHit Energy



Comparison of Long Fiber RecHit Energy



Comparison of Short FiberRecHit Energy

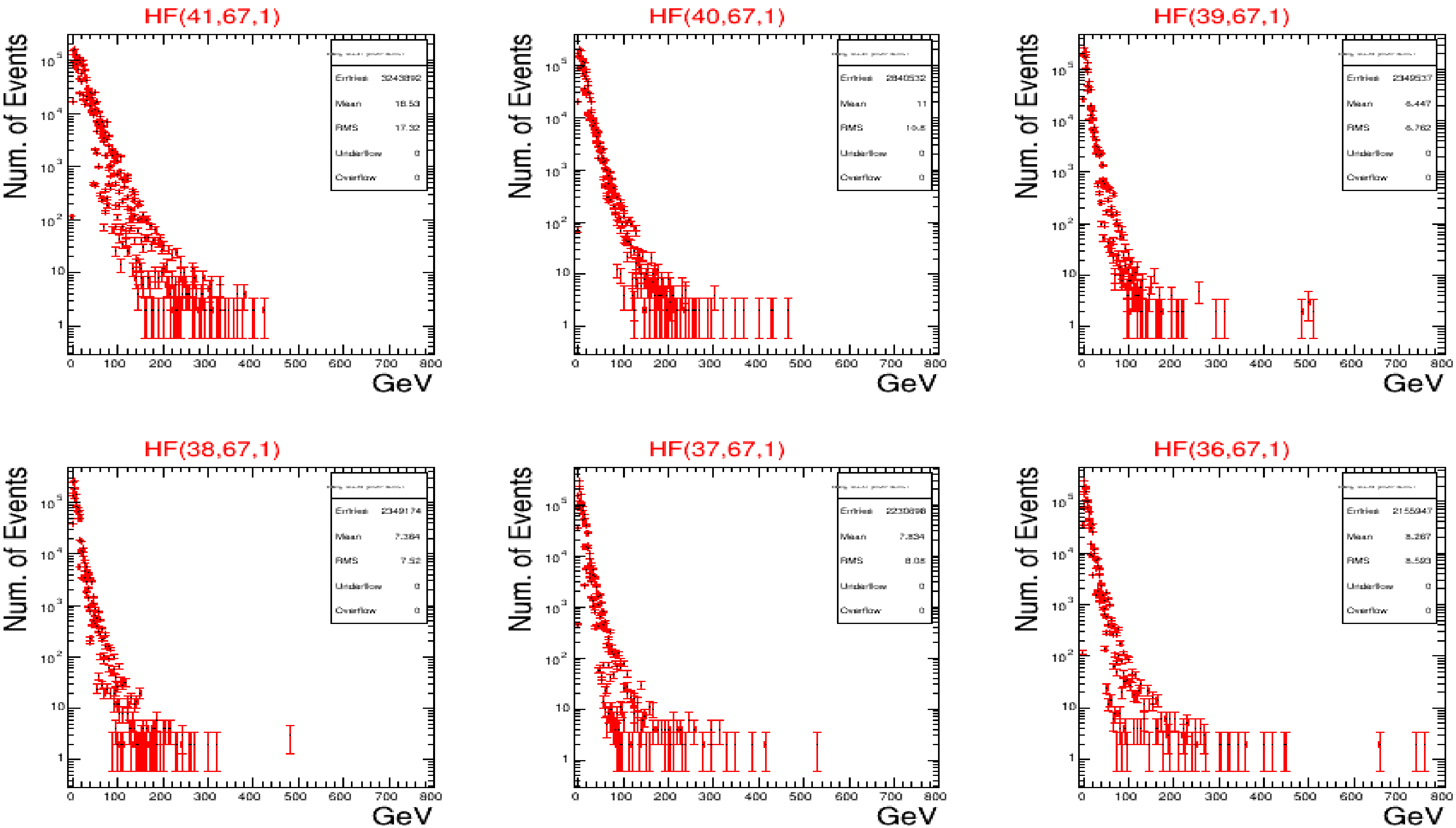


Conclusion

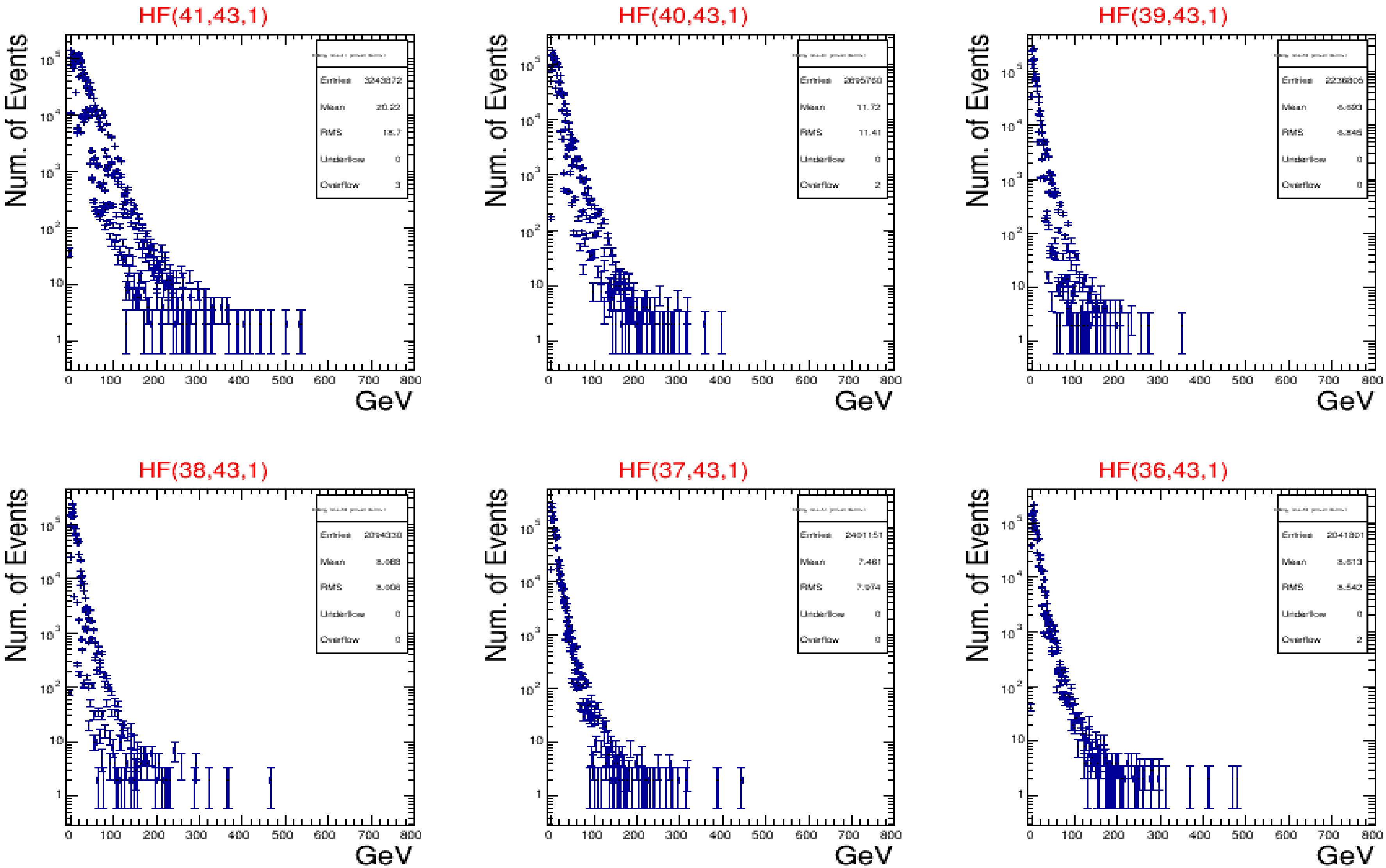
- We analyzed the new PMTs using 2012_D data
- We compared the energy resolution and time of new PMTs and others PMTs (iphi=43 vs iphi= 67).
- We are not sure map of 24 PMTs.
  - Need to be investiged.
- We get preliminary results for HF noise clean. We need to understand Noise clean Algorithm.

Back-up

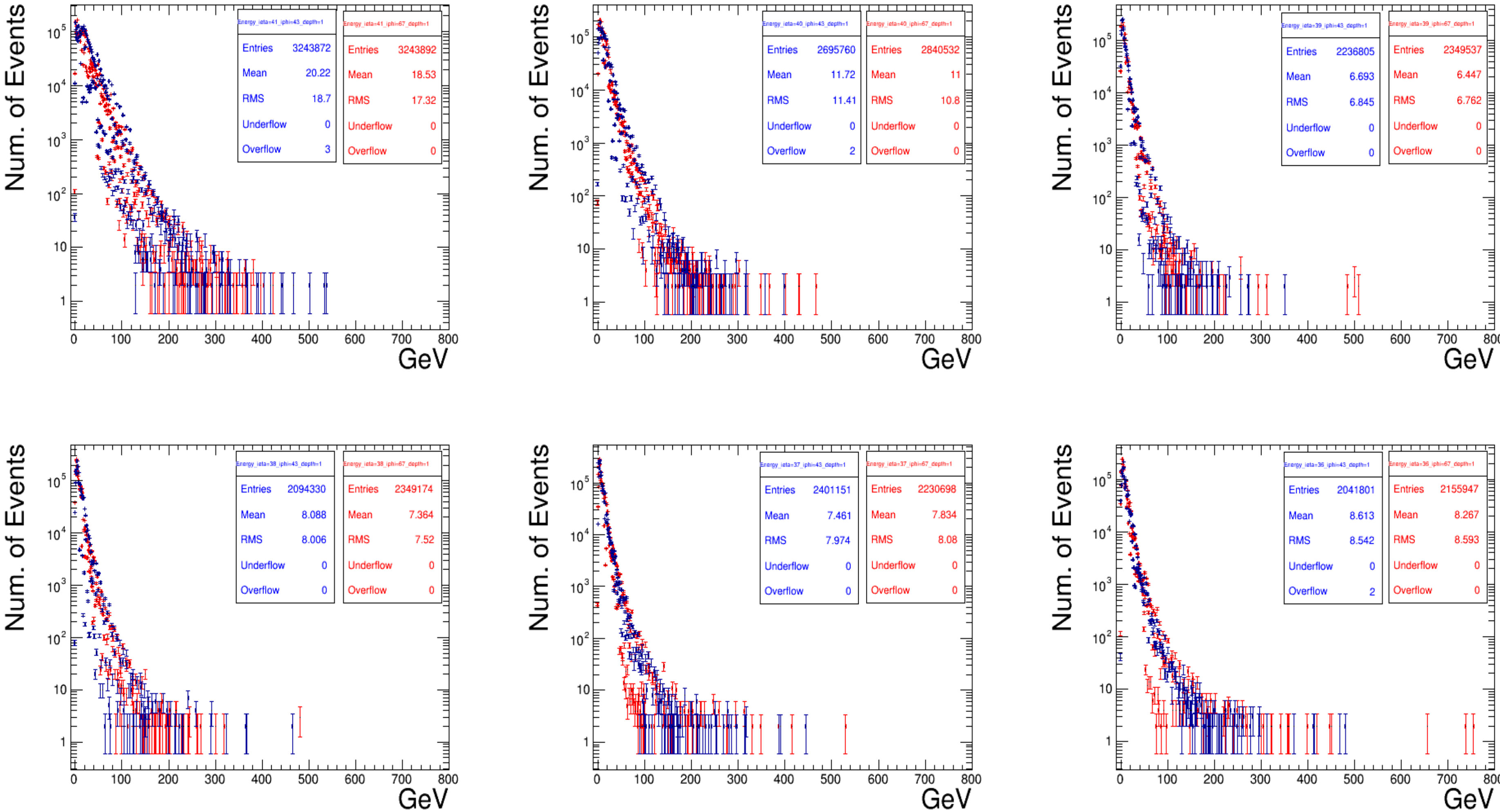
Energy distributions for iphi=67, ieta=36-41, depth=1



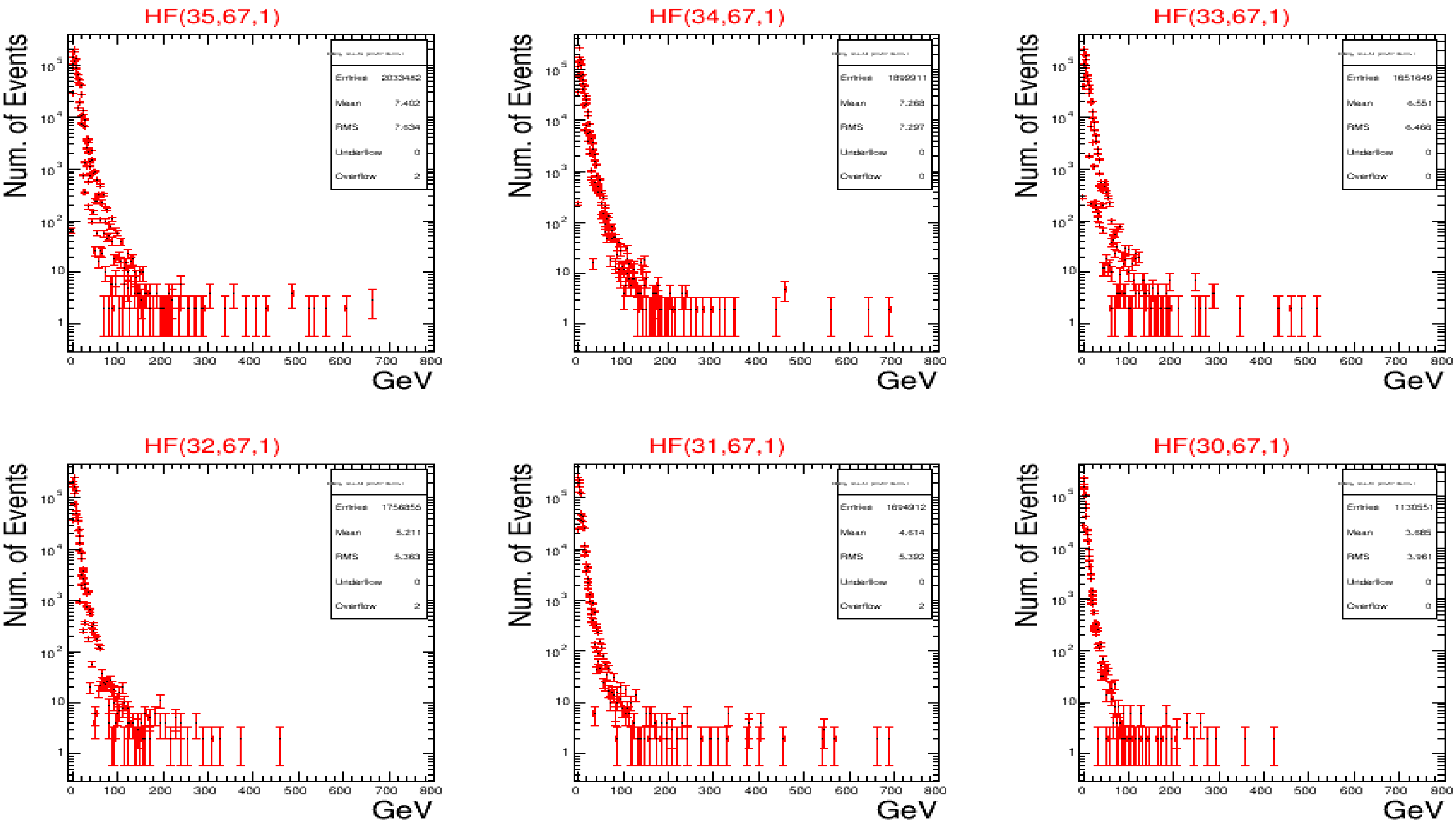
Energy distributions for iphi=43, ieta=36-41, depth=1



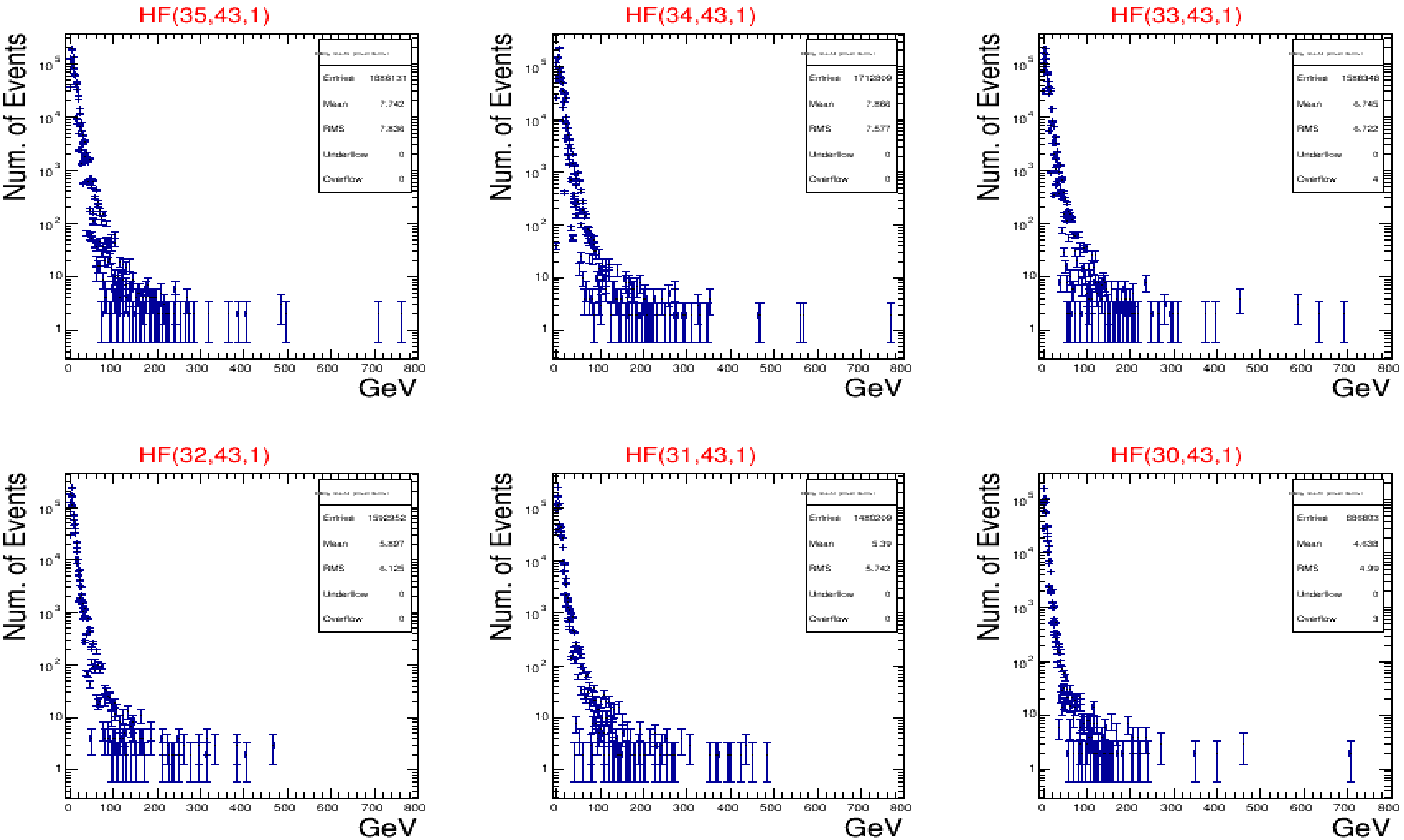
Comparison of Energy distributions for iphi=67&43, ieta=36-41, depth=1



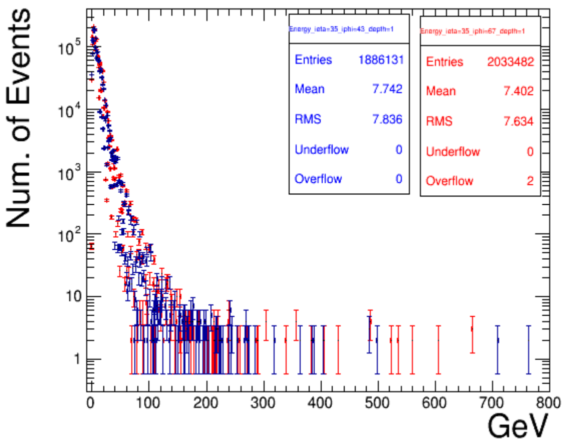
Energy distributions for iphi=67, ieta=30-35, depth=1

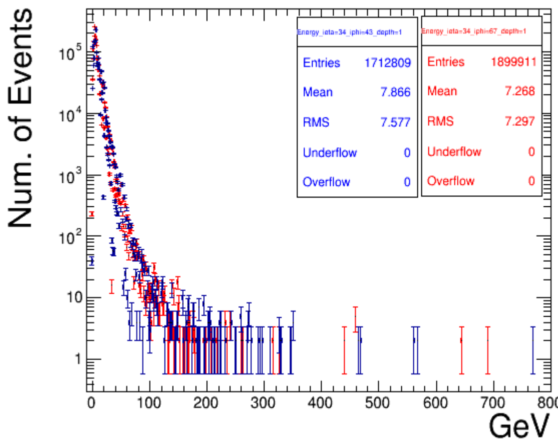


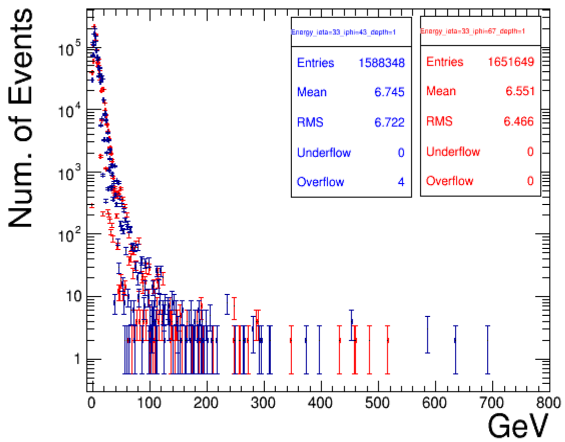
Energy distributions for iphi=43, ieta=30-35, depth=1

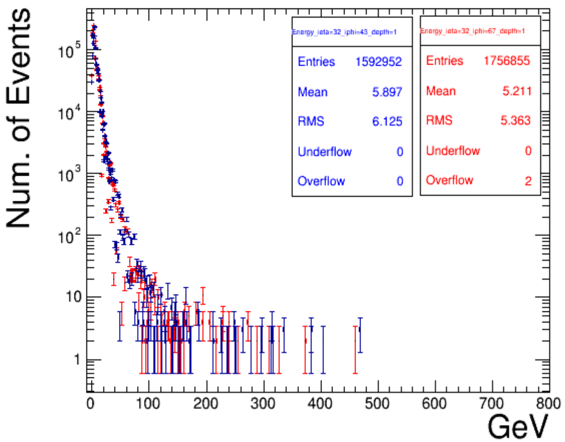


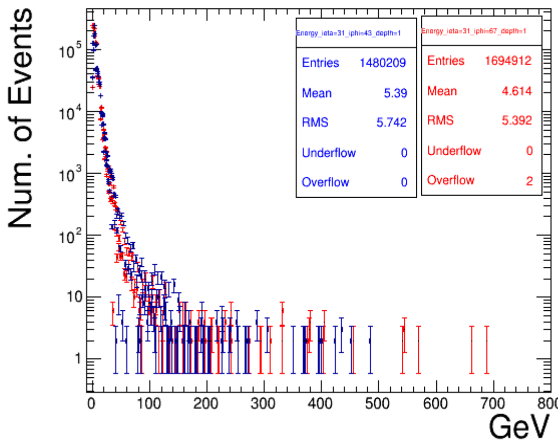
Comparison of Energy distributions for iphi=67&43, ieta=30-35, depth=1

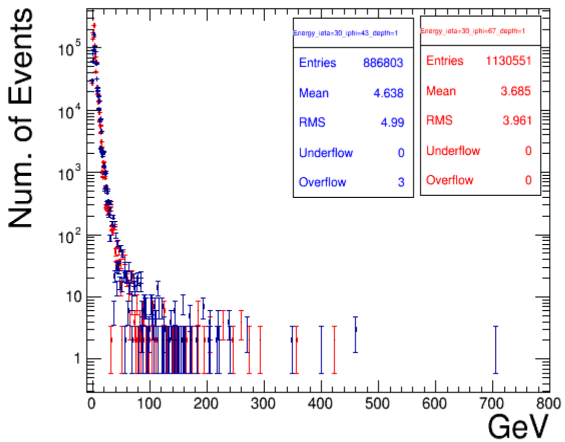




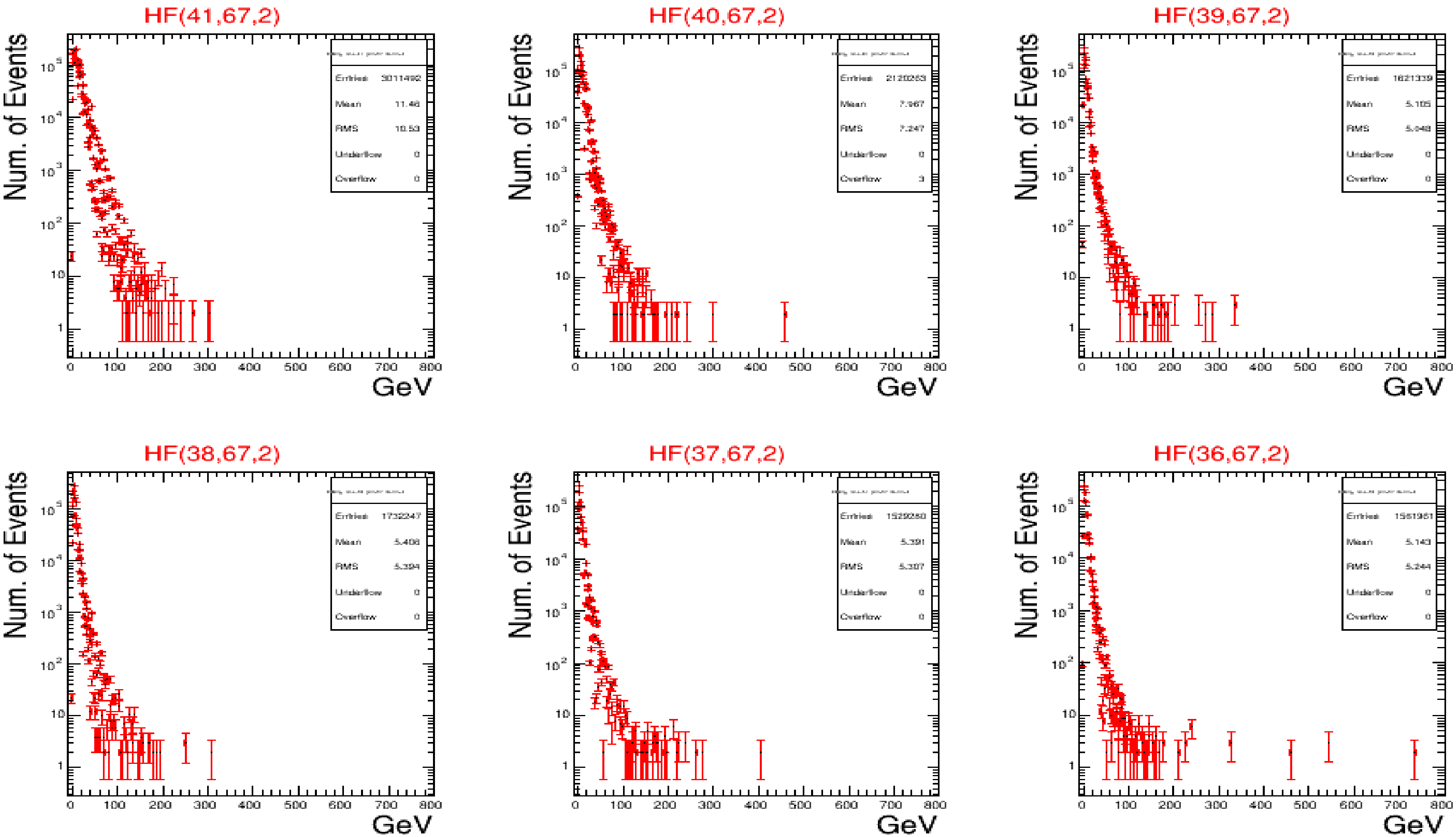




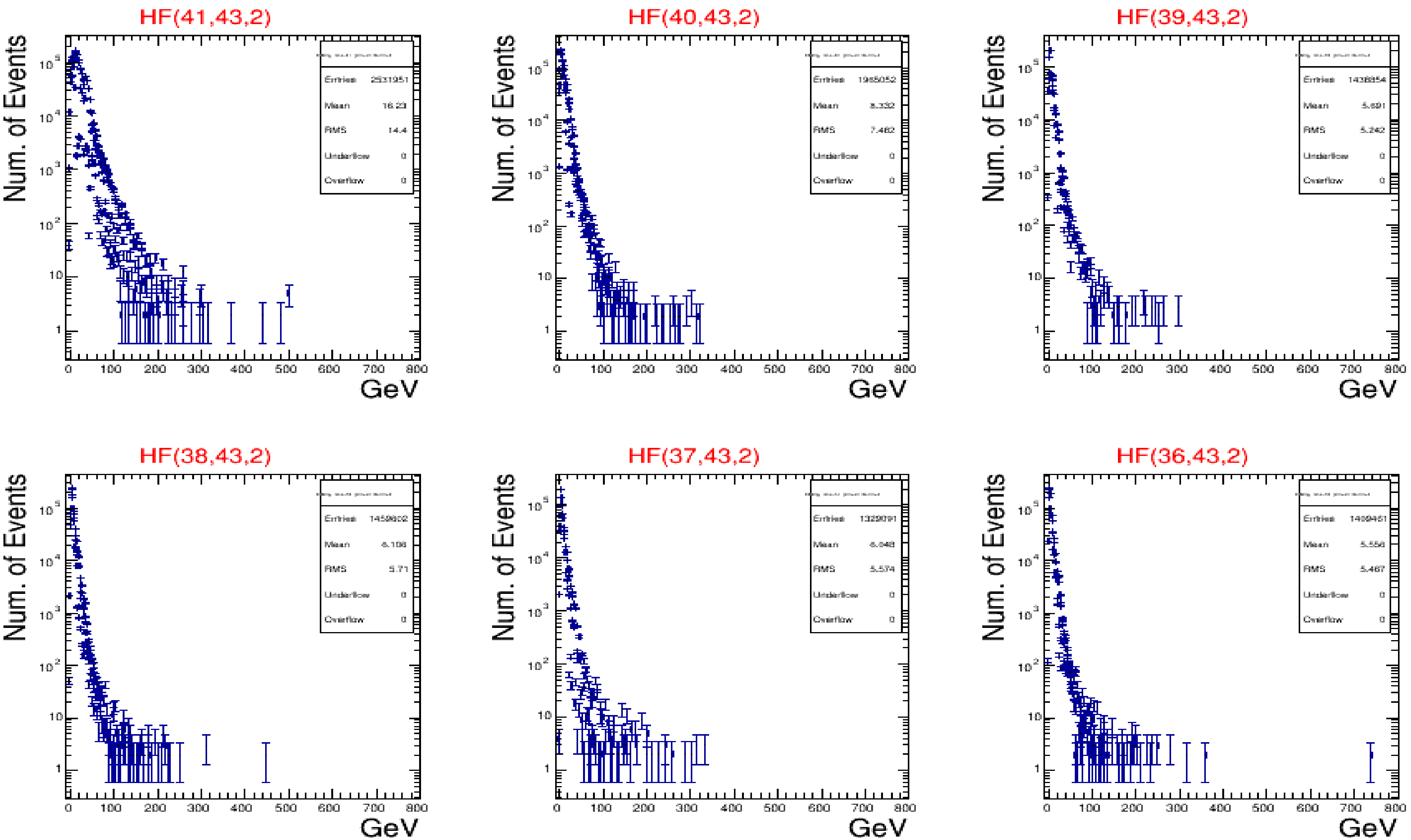




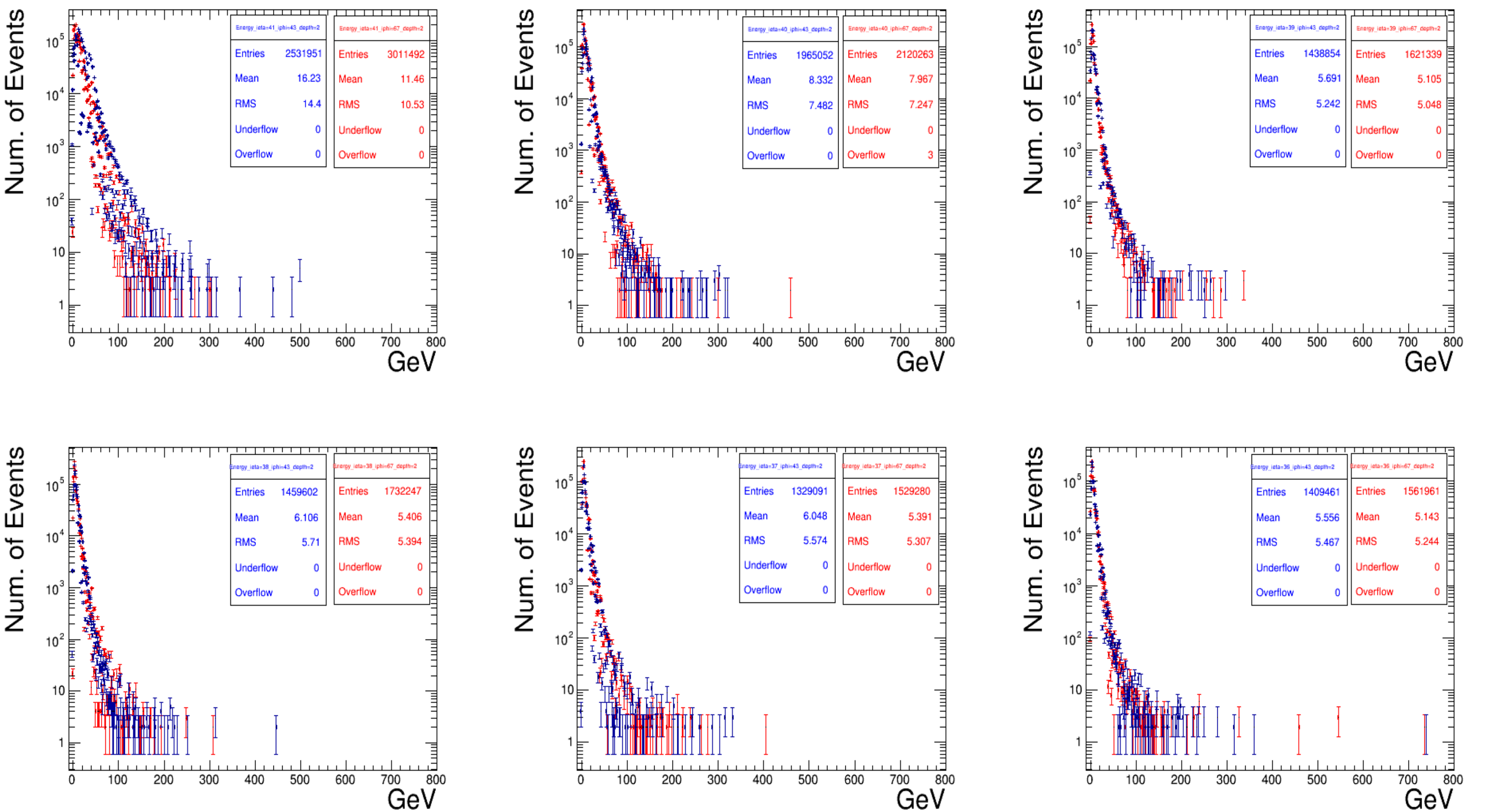
Energy distributions for iphi=67, ieta=36-41, depth=2



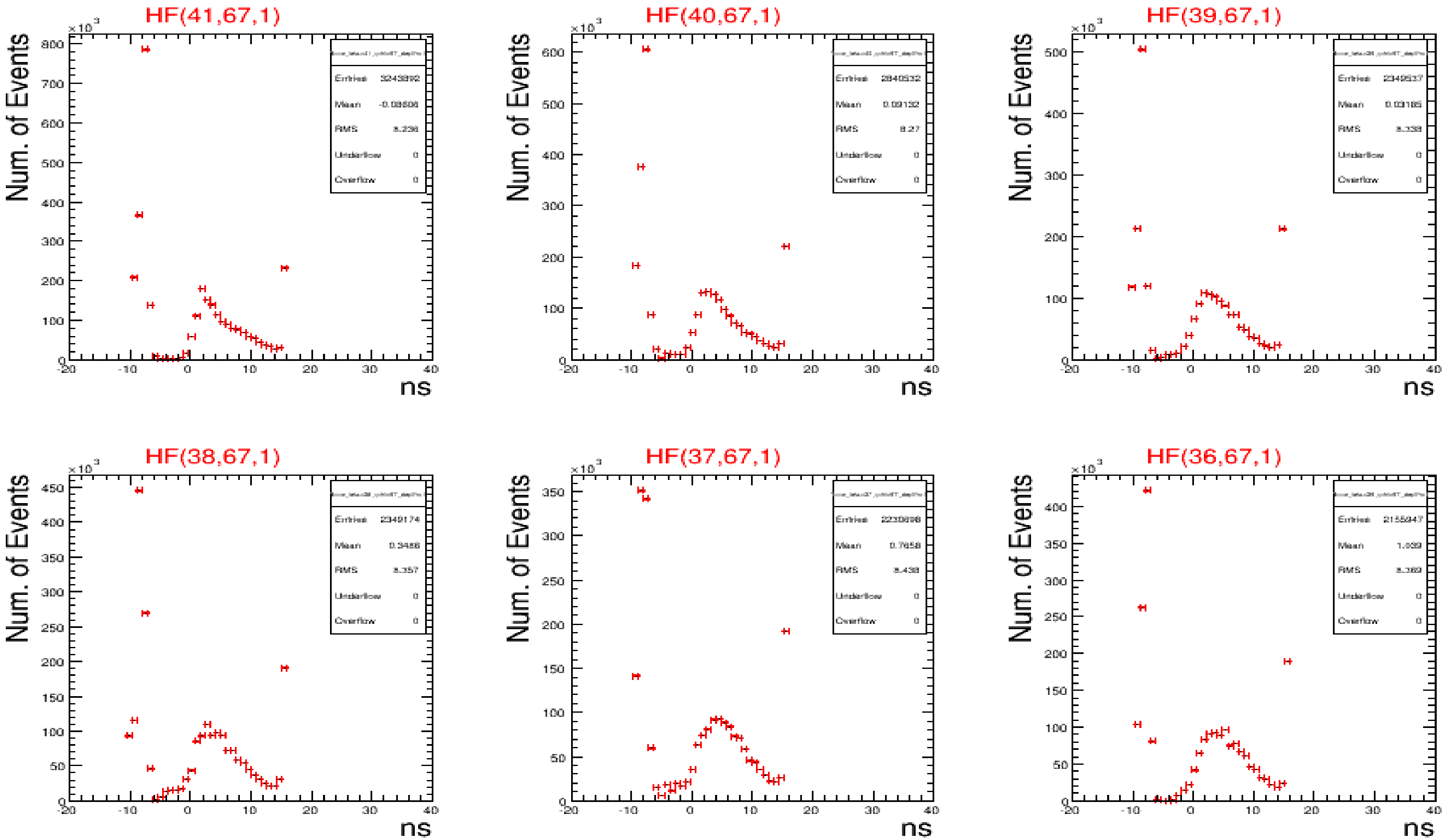
Energy distributions for iphi=43, ieta=36-41, depth=2



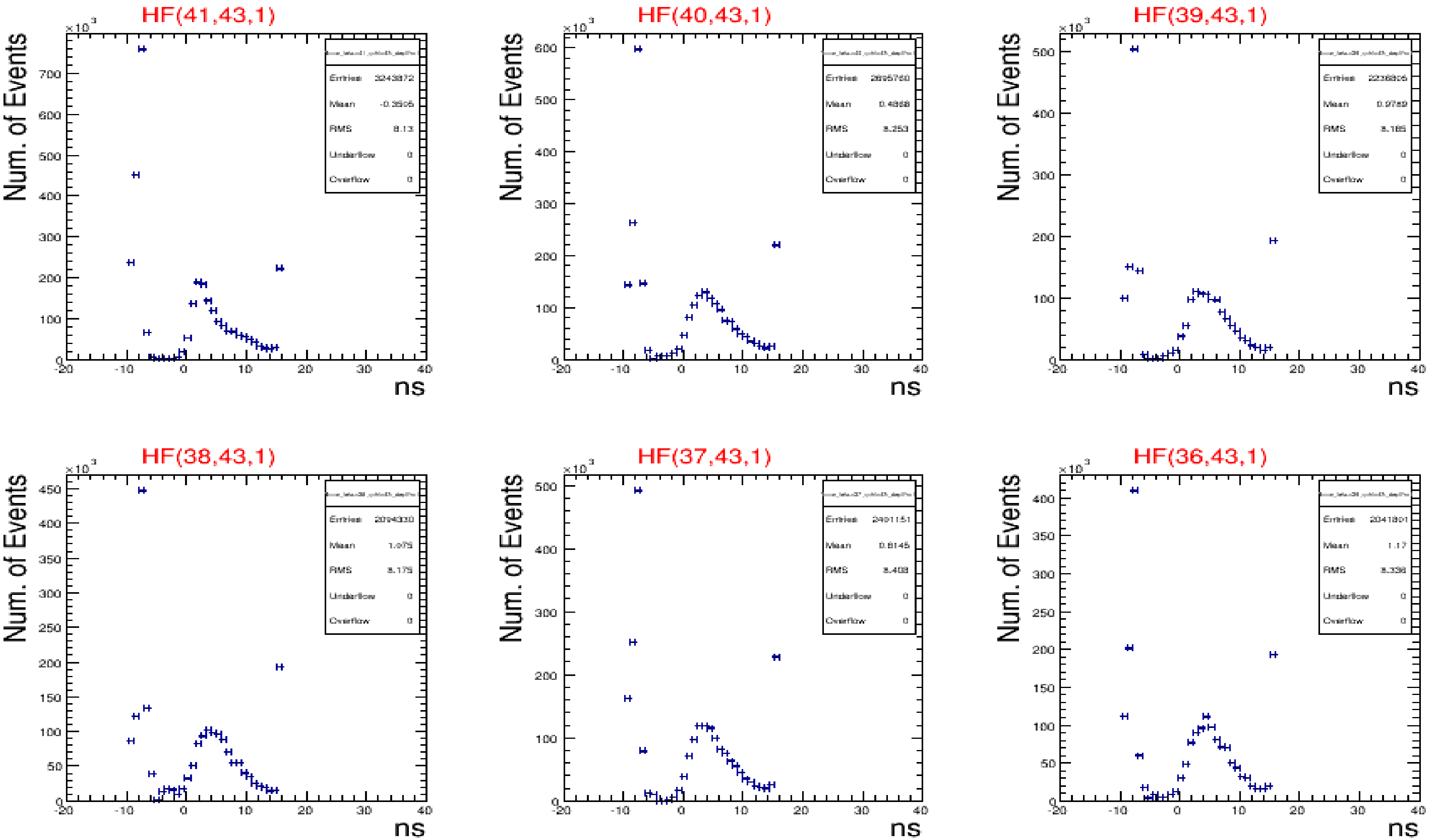
Comparison of Energy distributions for iphi=67&43, ieta=36-41, depth=2



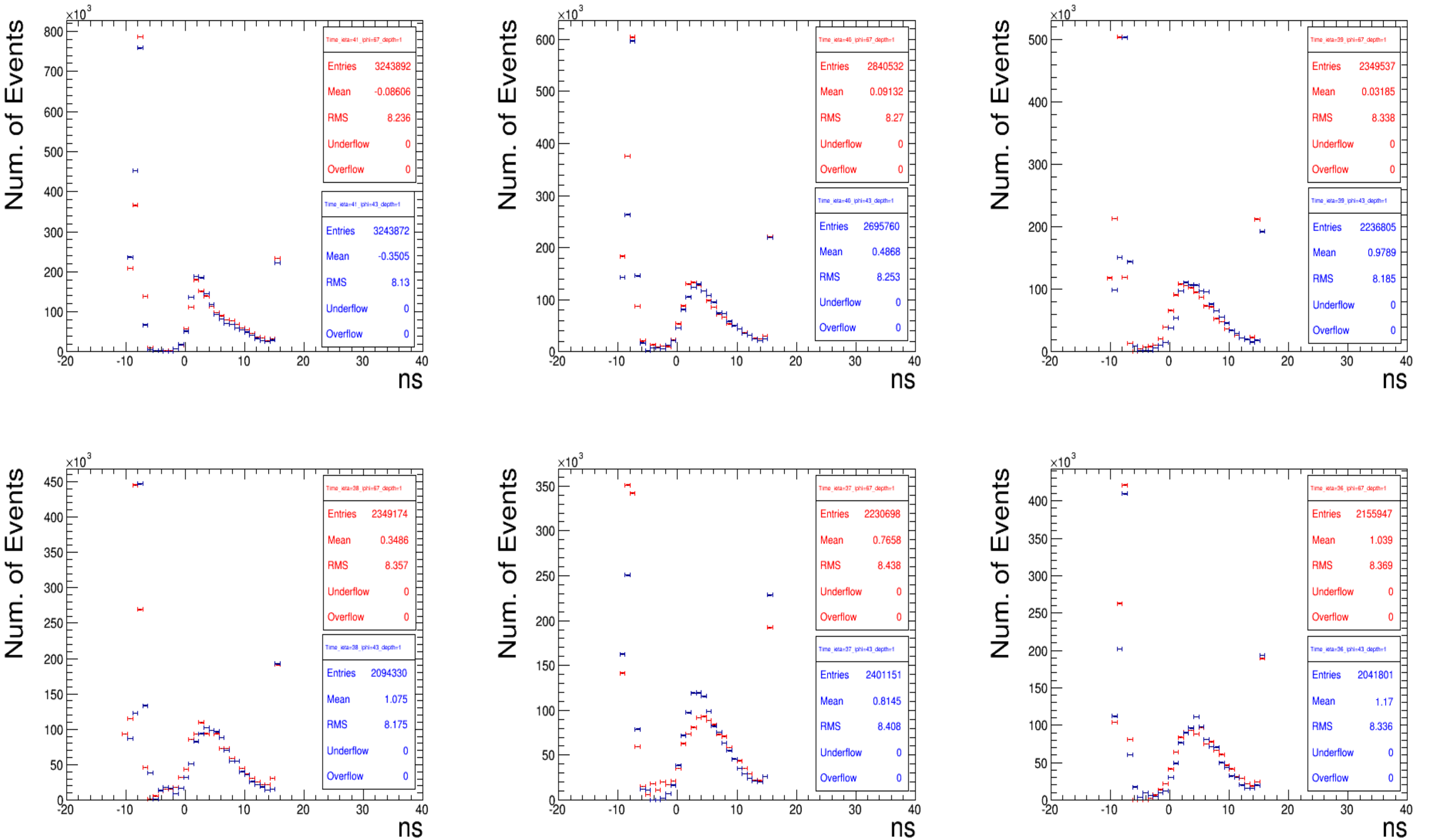
Time distributions for iphi=67, ieta=36-41, depth=1



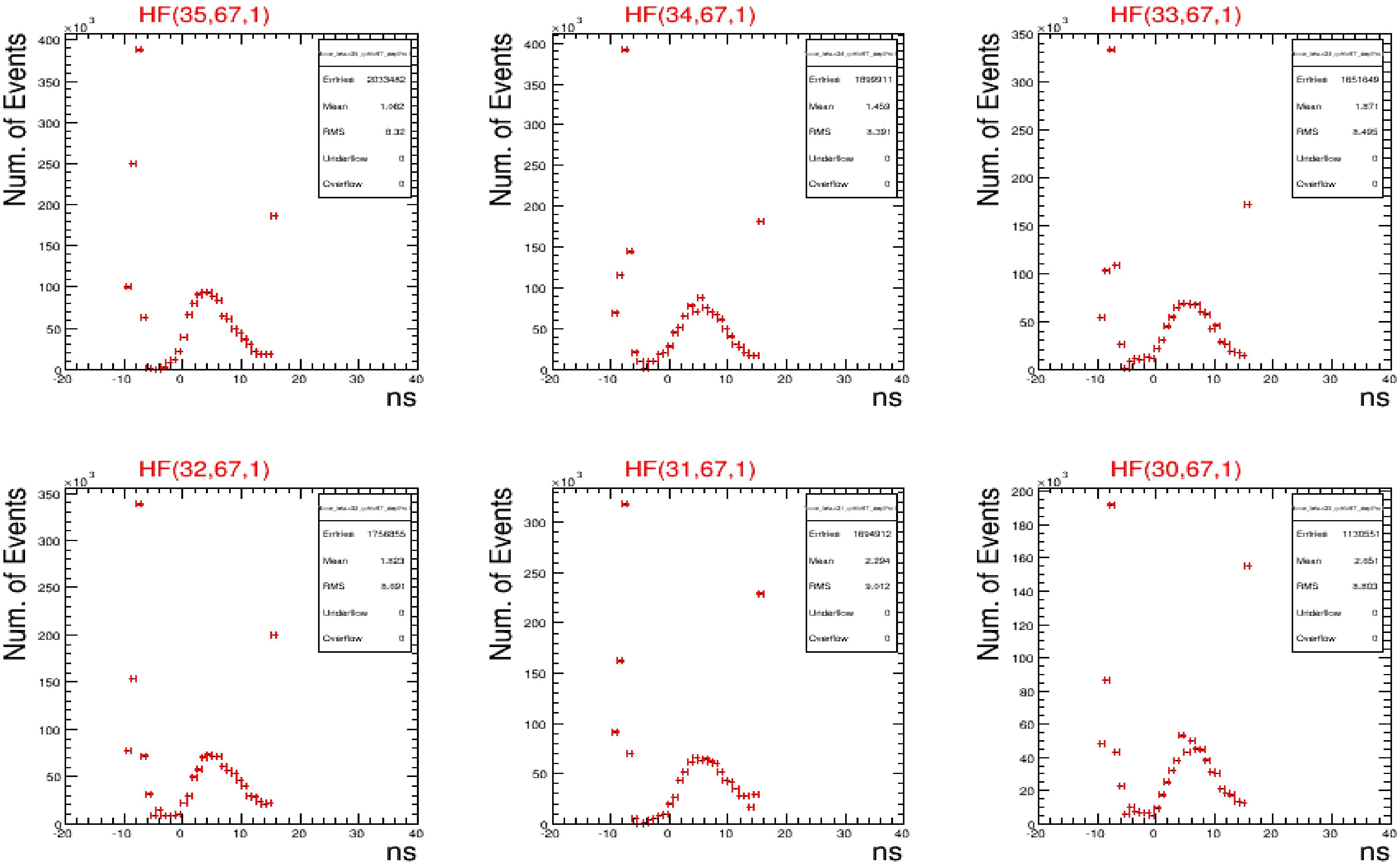
Time distributions for iphi=43, ieta=36-41, depth=1



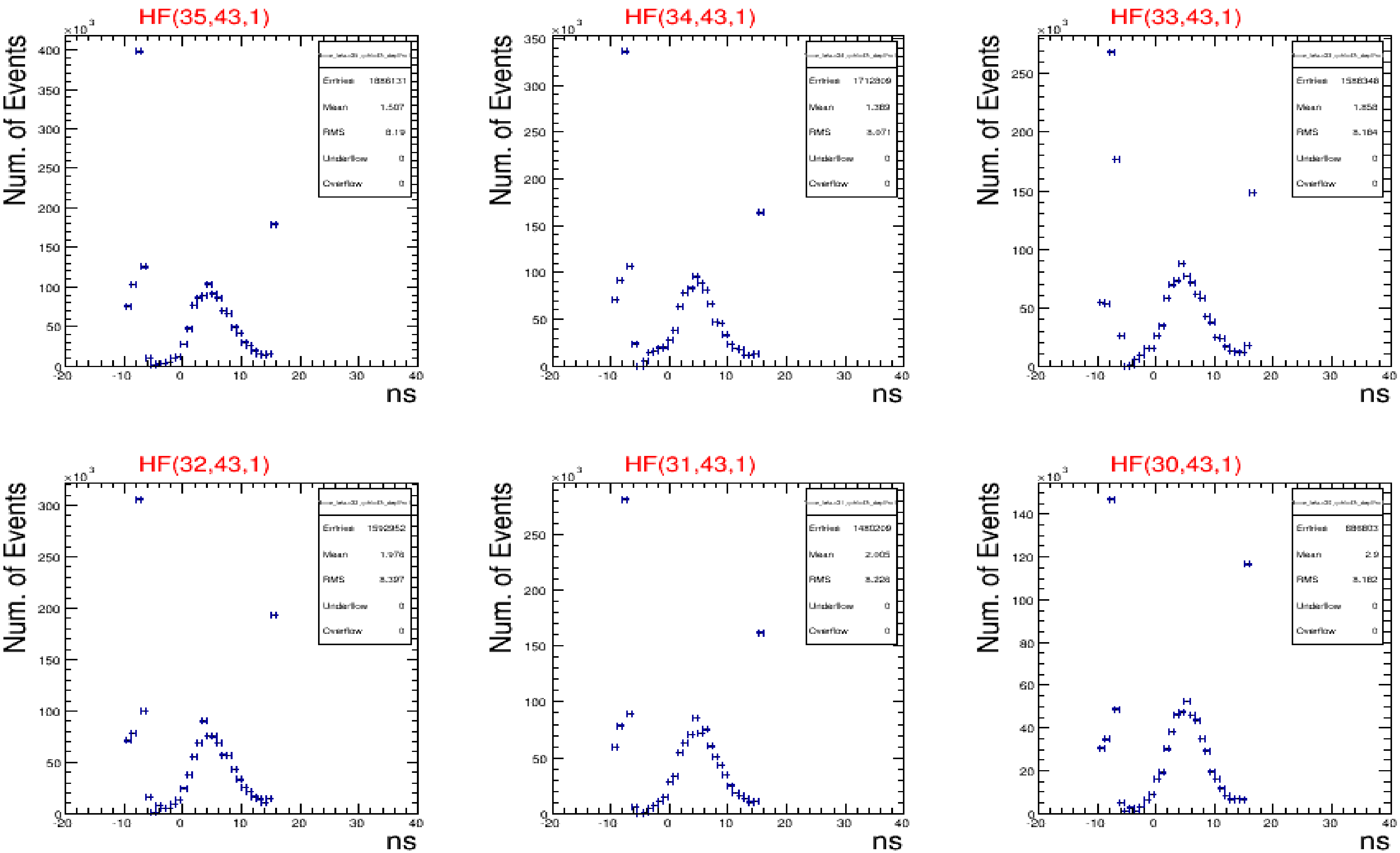
Comparison of Energy distributions for iphi=67&43, ieta=36-41, depth=1



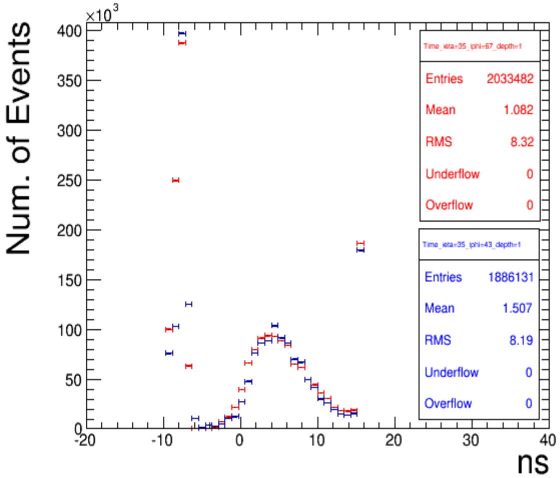
Time distributions for iphi=67, ieta=30-35, depth=1

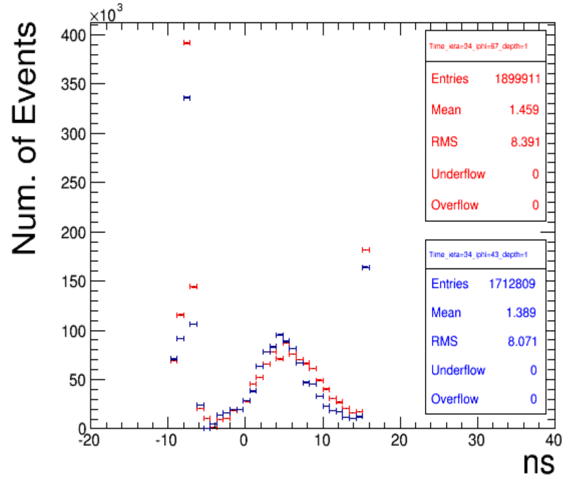


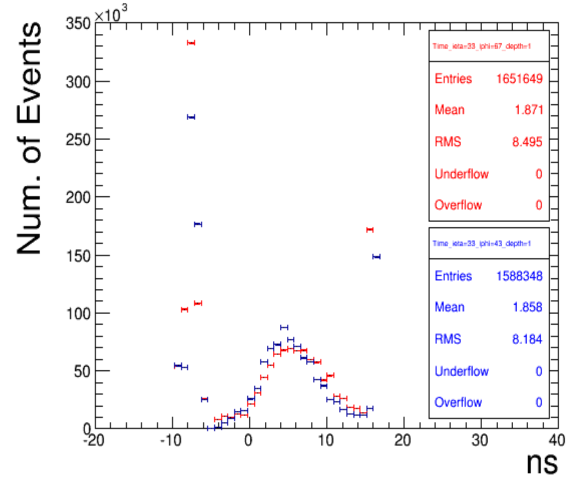
Time distributions for iphi=43, ieta=30-35, depth=1

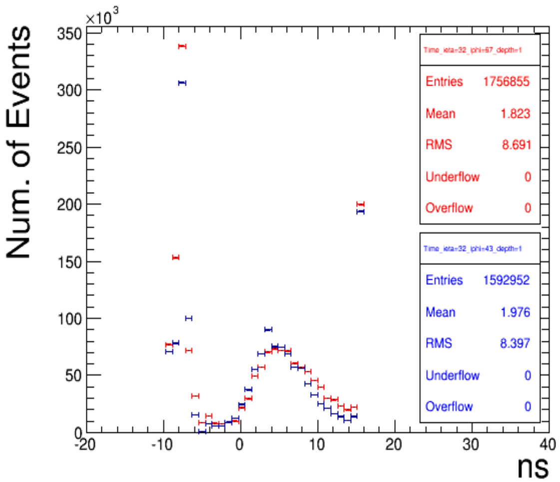


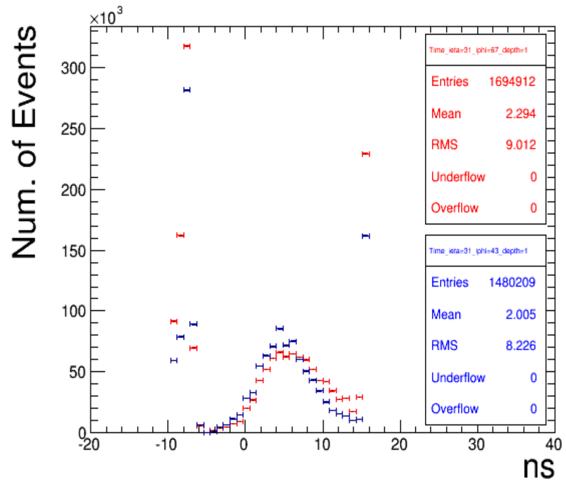
Comparison of Energy distributions for iphi=67&43, ieta=30-35, depth=1

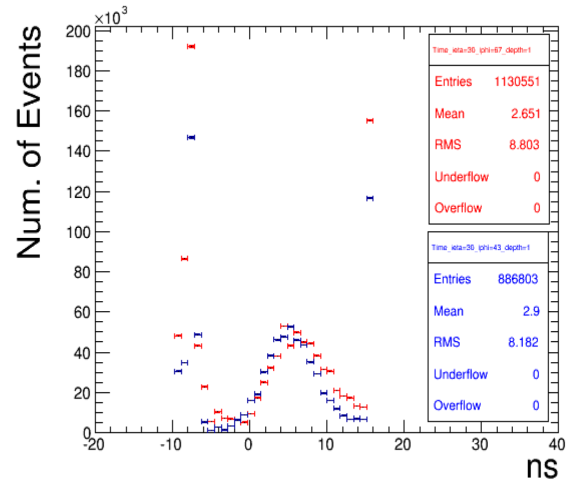




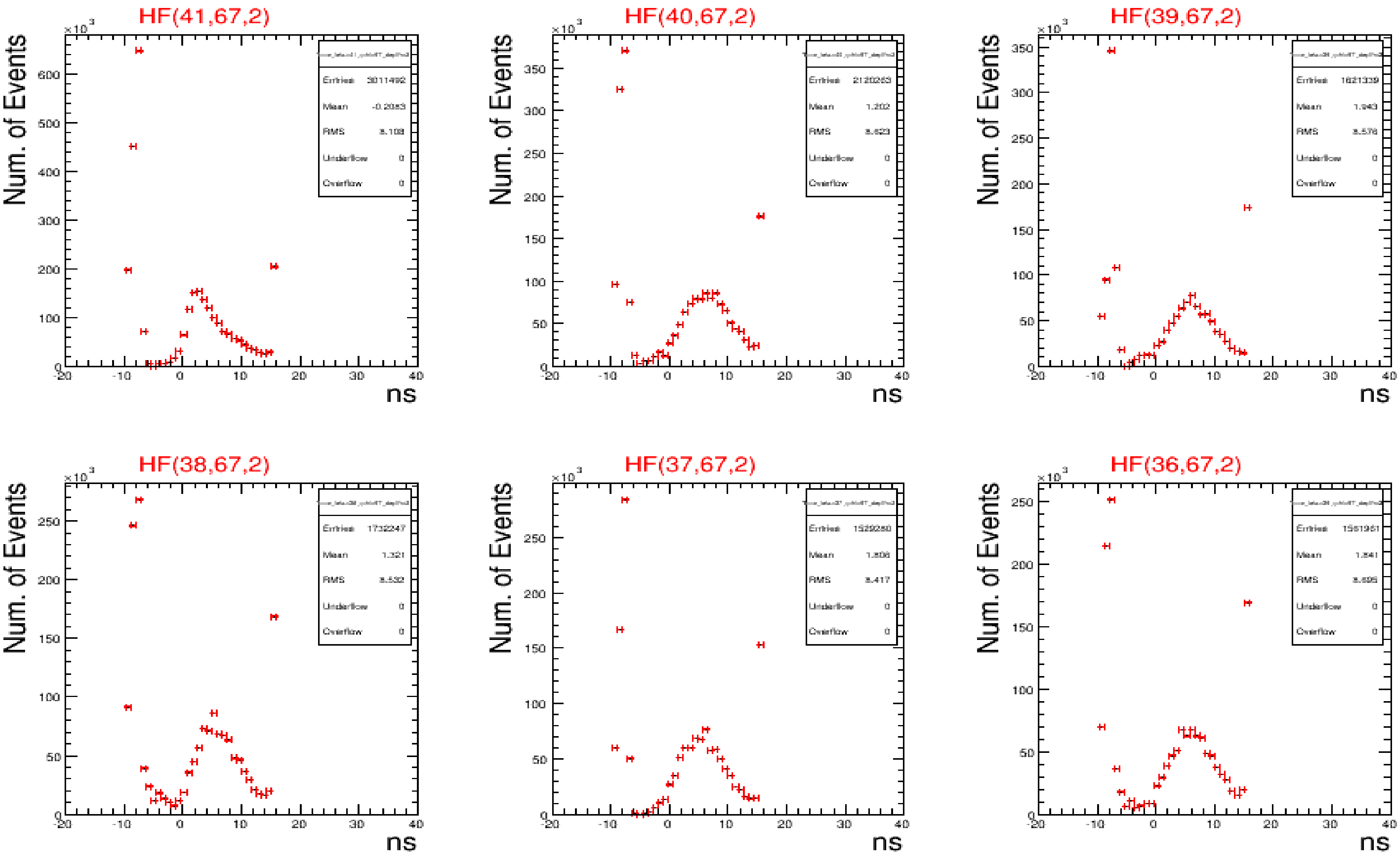




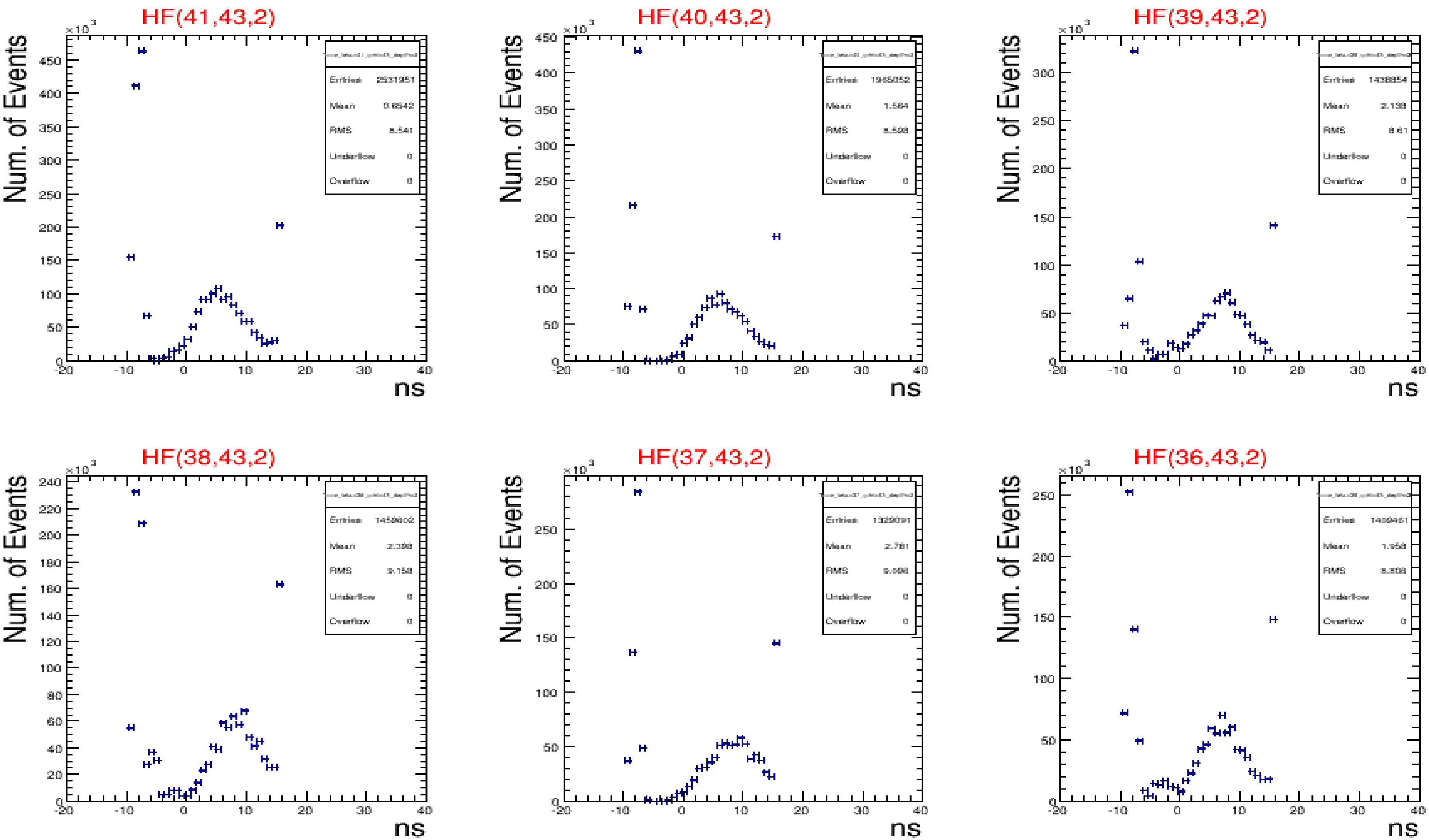




Time distributions for iphi=67, ieta=36-41, depth=2



Time distributions for iphi=43, ieta=36-41, depth=2



Comparison of Energy distributions for iphi=67&43, ieta=36-41, depth=2