Progress Update

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Run WCSim with sk_wcsim.mac

- The no-trigger problem with **sk_wcsim.mac** has been solved by specifying the intercept of the energy spectrum.

```
/mygen/generator gps
/gps/ang/type iso
/gps/particle mu+
/gps/ene/type Lin
/gps/ene/min 200 MeV
/gps/ene/max 1 GeV


/gps/pos/type Volume
/gps/pos/shape Cylinder
/gps/pos/centre 0 0 0
/gps/pos/radius 14.5 m
/gps/pos/halfz 18 m
```

```
/mygen/generator gps
/gps/ang/type iso
/gps/particle mu+
/gps/ene/type Lin
/gps/ene/min 200 MeV
/gps/ene/max 1 GeV
/gps/ene/intercept 1
#/gps/ene/mono 500 MeV


/gps/pos/type Volume
/gps/pos/shape Cylinder
/gps/pos/centre 0 0 0
/gps/pos/radius 14.5 m
/gps/pos/halfz 18 m
```

Run WCSim with sk_wcsim.mac

```
WCSimWCDigitizerSKI::DigitizeHits START WCHCPMT->entries() = 1688
WCSimWCDigitizerSKI::DigitizeHits END DigiStore->entries() 1391
WCSimWCTriggerBase::AlgNDigits. Number of entries in input digit collection: 1391
Found 1 NDigit triggers
WCSimWCTriggerBase::FillDigitsCollection. Number of entries in output digit collection: 1228
 Filling Root Event
ngates =  1
start[0][0]: 0
start[0][1]: 0
start[0][2]: 0
start[1][0]: 0
start[1][1]: 0
start[1][2]: 0
part 2 start[0]: -971.395
part 2 start[1]: -499.237
part 2 start[2]: -1554.89
part 2 start[0]: -1229.64
part 2 start[1]: -400.822
part 2 start[2]: -1491.76
part 2 start[0]: -1229.64
part 2 start[1]: -400.822
part 2 start[2]: -1491.76
part 2 start[0]: -1229.64
part 2 start[1]: -400.822
part 2 start[2]: -1491.76
>>>Root event      9
```

Modify the WCSim read program

- The original scripts:
  - **read_wcsim_images_sub_e.cc** (for electron) and **read_wcsim_images_sub_mu.cc** (for muon)

- Modified:
  - **read_wcsim.C**

- The difference is that output images and information are stored in a tree in root file instead of two separate text files.

```cpp
// output file
TFile *f = new TFile(output_filename, "RECREATE");

// build the tree and branches
TH2F* image = new TH2F("h", "PMT Display", NUM_PIXELS, -1., 1., NUM_PIXELS, -1., 1.);
TVector3 particle_vertex;
TVector3 particle_direction;
Int_t particle_out_id = ((electron)? 11 : 13);
Double_t track_energy;
Int_t set;
Double_t distance_to_wall;
Double_t radius;
Double_t image_width;
TVector3 phi_vec;
TVector3 theta_vec;

TTree *T = new TTree("T","images and information");
T->Branch("image","TH2F",&image,32000,0);
T->Branch("true_vertex","TVector3",&particle_vertex,32000,0);
T->Branch("true_direction","TVector3",&particle_direction,32000,0);
T->Branch("particle_id",&particle_out_id,"particle_out_id/I");
T->Branch("track_energy",&track_energy,"track_energy/D");
T->Branch("data_set",&set,"set/I");
T->Branch("distance_to_wall",&distance_to_wall,"distance_to_wall/D");
T->Branch("radius",&radius,"radius/D");
T->Branch("image_width",&image_width,"image_width/D");
T->Branch("phi_vec","TVector3",&phi_vec,32000,0);
T->Branch("theta_vec","TVector3",&theta_vec,32000,0);

TObject *tr;
WCSimRootTrack *track;

// Now loop over events
```
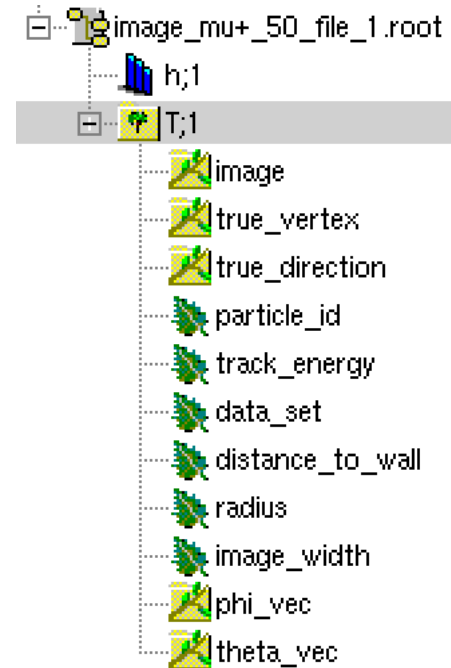
119,3   22%

Submit a batch job

- When the number of events > about 50, the time of running the read program becomes too long to do it interactively.

- I went to *GPC Quickstart* to learn how to submit a job. But when I do it, I meet an unexpected error about writing the output file.

   SysError in <TFile::TFile>: file image_mu+_10_file_1.root can not be opened (Read-only file system)

   Warning in <TFile::Write>: file image_mu+_10_file_1.root not opened in write mode

Machine learning

- Theo's scripts:
  - SKheader.py   SKinput.py   SKgraph.py   SKalgorithm.py   Setup.py

- I plan to first try to train with a simple script and add more stuff in later.

- I wrote a script *algorithm.py* based on Theos's codes, but the reading data part is still unfinished.

Next Step

- 1. Get large number of images.

- 2. Complete the simple machine learning script and see the training results.