EiccRoot ECal simulation and reconstruction software

---Update of EicC ECal Study

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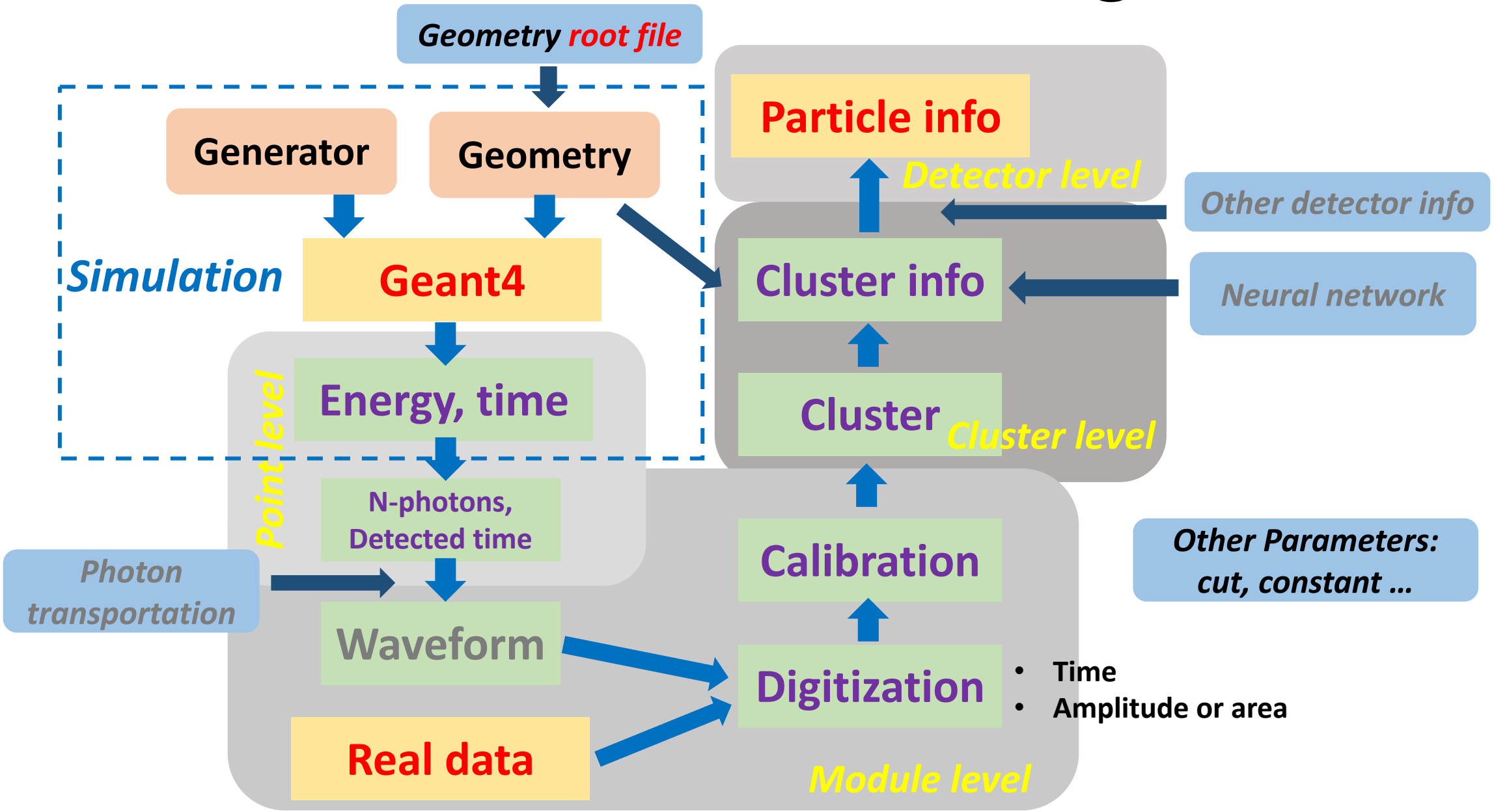
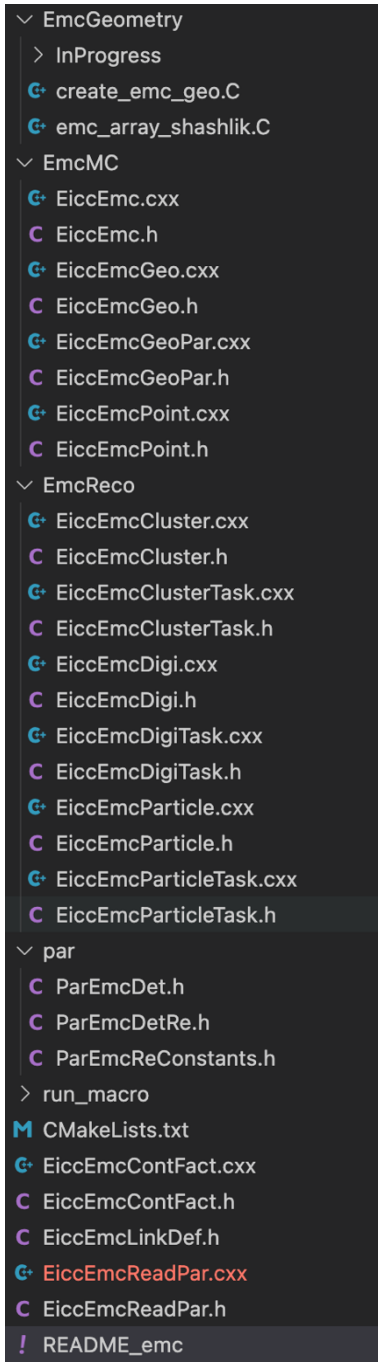
ECal reconstruction flow diagram



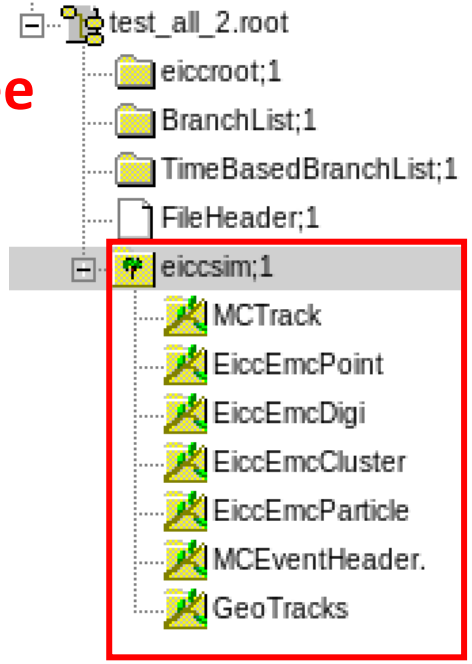
EiccRoot ECal Simu & Reco class structure

- Refer to **PandaRoot** and **MpdRoot(NIKA)** EMC software structure.
- Perform both **simulation and reconstruction** with one script.
- **Input:**
  - **Geometry root file**
  - **Geometry parameters for reconstruction**: par/ParEmcDetRe.h. Re-compile is required when parameters are changed.
  - **Other necessary parameters:** run_macro/EmcParams.par. Load when each run starts.
- **Output:**
  - Tree contains the result of each task
  - Parameters root file

EiccEmc



Full output tree



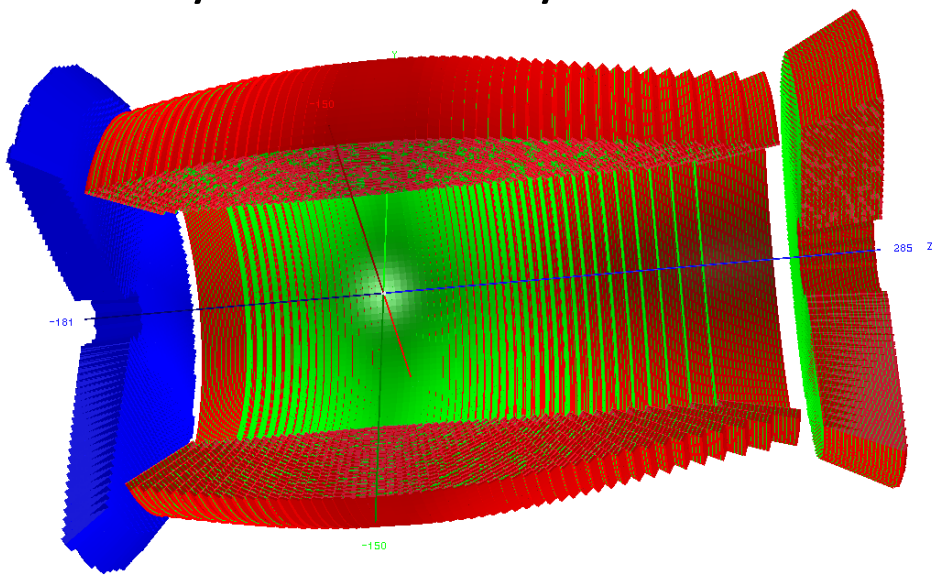
Input parameters in EmcParams.par

```
[EiccEmcReadPar]
Deposit_ratio_shashlik:  Double_t 0.3297
Deposit_ratio_e: Double_t 0.98
W0: Double_t 4.2
Cluster_enenrgy_cut: Double_t 0.01
Block_energy_cut: Double_t 0.001
Reverse_phi_k: Int_t 6
N_loop_safety: Int_t 6
Max_cluster: Int_t 20
Max_blocks: Int_t 200
Total_max_cluster: Int_t 6
M_particle: Double_t 0
[EiccEmcOtherPar]
~
```

Different parameter classes (parameters space)

EMC geometry in EiccRoot

- Root file must be specified before running simulation
- Run **EmcGeometry/creat_emc_geo.c** to create root file. Geometry will be controlled with different **versions**.
- Geometry main parameters could be adjusted through par/ParEmcDet.h
- Mainly refer to **E-endcap, barrel and ion-endcap.** Shashlik or CsI crystal 7*7 array could be chosen too.



Geometry main parameters

```
namespace DetPar{
    const double Size=4;
    const int N_layer_barrel=240;
    const int N_layer_hadron=240;
    const double Thickness_scin = 0.15;
    const double Thickness_lead = 0.035;
    const int Layer_zoom = 20; // for draw; the remi

    ///   pesudorapidity eta
    const double Psrad_lw_e = -3;
    const double Psrad_hg_e = -1;
    const double Psrad_lw_h = 1.5;
    const double Psrad_hg_h = 3;

    // Barrel
    const double R_barrel=90;
    const int N_phi_barrel = int(2*TMath::Pi()*R_bar

    // hadron endcap
    const double Zdist_hadron = 240;//cm
    const double Module_shrink_hadron = 1;  //not us

    // electron forward endcap
    // crystal: CsI(Tl), radiation length: 1.86 cm/X
    // Configuration of the crystal: 28 cm -> 15.03
    // 38 -> 20.39
    const double Crys_length = 30.0;
    const double Crys_short = 4.0;
    const double Zdist_e = 150.00;   // distance of

    //tags
    const int Verbose_print = 0; // 0 should be more
    const bool Barrel_build = true;
    const bool Hadron_endcap_build = true;
    const bool E_endcap_build = true;
    const bool Draw_tag = false; // use to decrease

    //map information: detector tag: barral:0, hadro

    // draw color 为什么不声明const会报错？？？？重复定义
    const EColor color_lead = kGreen;
    const EColor color_scin = kRed;
    const EColor color_crys = kBlue;

}
#endif
```

How to run EMC Simu&Reco in EiccRoot

- The whole EMC code in **/home/eicc/software/EiccRoot/emc @172.17.102.53 of IMP farm**
- The only script that need to modify: run_macro/**run_sim_emc.C**
- To add EMC Simu&Reco in EiccRoot:
  - Source EiccRoot environment
  - Get EiccRoot with emc folder and compile
  - Run **run_sim_emc.C,** and all useful information will be stored to output file
- Check README_emc for more detail.

```
// Parameter file name
TString EmcParFile = "./EmcParams.par";
```

Parameter file

Detector simulation

EMC Geant4 simulation

Choose if store it

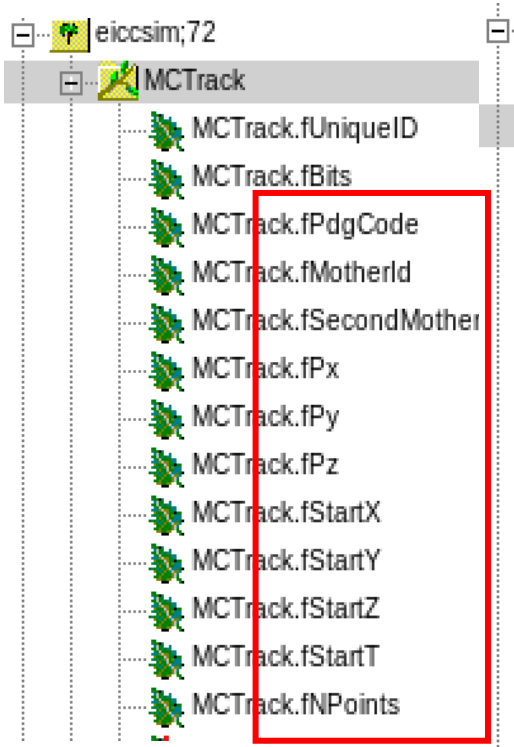
EMC reconstruction

Add Emc reconstruction task

```
// ---------EMC Simu and Reco-----------------------------------------------------
EiccEmc* EmcDet = new EiccEmc("EMcDet", kTRUE);
EmcDet->SetGeometryFileName("emc_v0.root"); // default path location is /geometry
EmcDet->SetPersistance(kTRUE); // close this will extremely decrease the storage usage
run->AddModule(EmcDet);
EiccEmcDigiTask* emcDigi = new EiccEmcDigiTask();
emcDigi->SetPersistance(kTRUE);
run->AddTask(emcDigi);
EiccEmcClusterTask* emcCluster = new EiccEmcClusterTask();
emcCluster->SetPersistance(kTRUE);
run->AddTask(emcCluster);
EiccEmcParticleTask* emcParticle = new EiccEmcParticleTask();
emcParticle->SetPersistance(kTRUE);
run->AddTask(emcParticle);
```

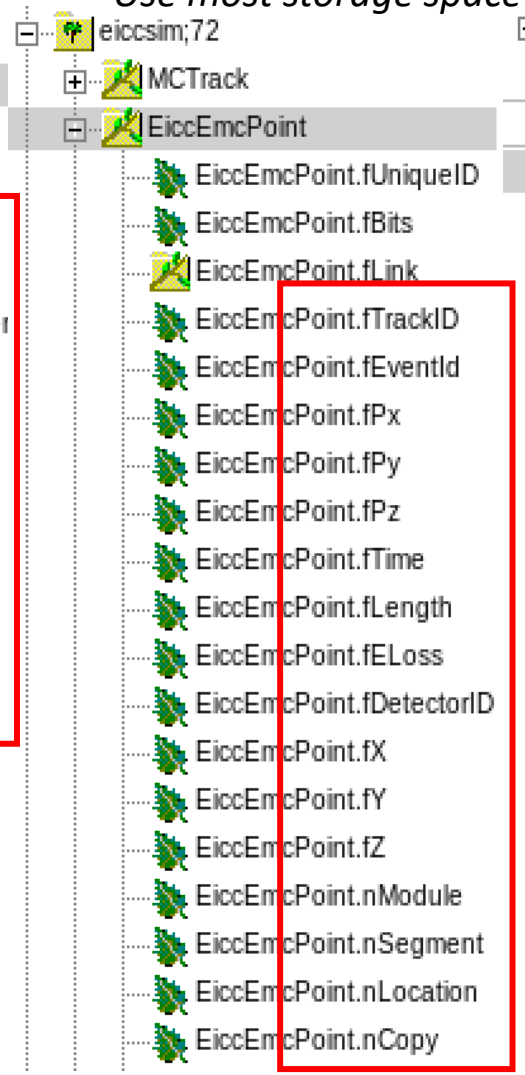
Eiccsim tree strorage information

MCTrack

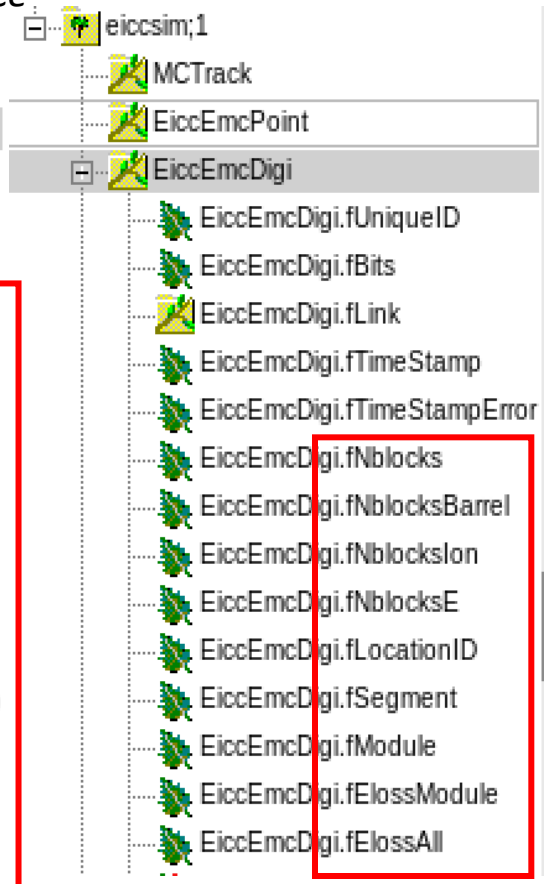


EmcPoint

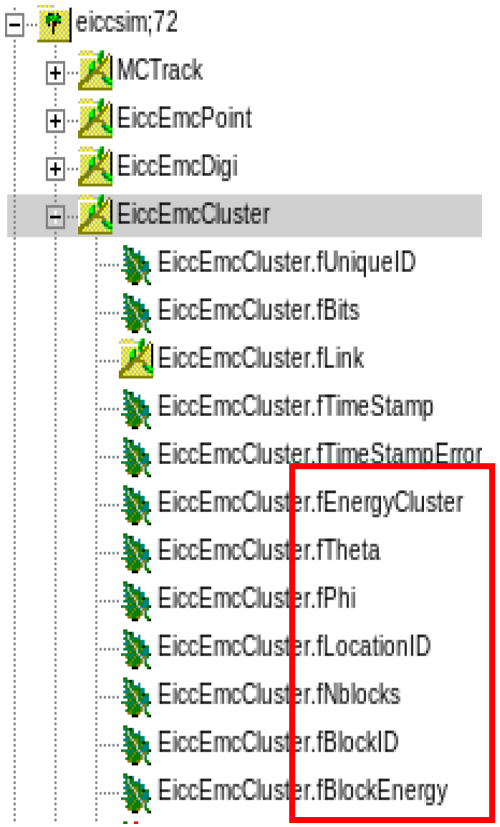
Use most storage space



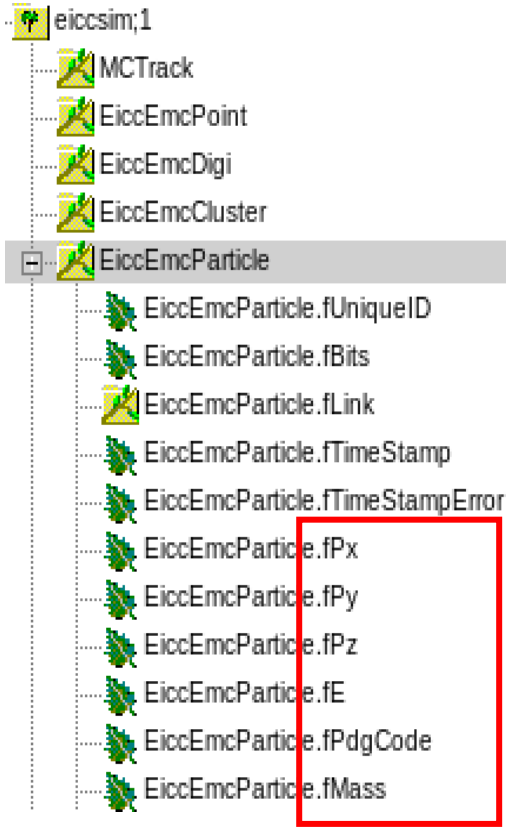
EmcDigi



EmcCluster



EmcParticle



Electron/photon

CPU/MEM/Disk performance

- **CPU and time consuming**: (Simu&Reco, 1 core, IMP farm)
  - 1000 * 1 GeV e- : 55s
  - 10000 * 1 GeV e- : 553s
  - 1000 * **10** GeV e-: 600s
  - Simulation cost 99% of total time
    - 1000 * 1 GeV e- simulation time: 54.3s

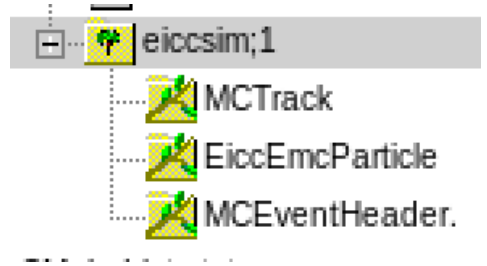
0.06s/(1GeV*1event)

- **Memery consuming**: about 100M byte(total 30G)(for both 1 and 10GeV e-)

```
%Cpu(s):  0.9 us,  0.0 sy,  0.0 ni, 99.1 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 23074195+total,   839468 free,  4681264 used, 22522121+buff/cache
KiB Swap:  7999484 total,  7008292 free,   991192 used. 22442489+avail Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
48837 ytian     20   0  969460 590032 325428 R  94.8  0.3  10:15.30 root.exe
```

- **Disk usage**:
  - Full: 200k byte/ 1 GeV(e-) (include all trackings info.)
  - Simu&Reco data: 52k byte/ 1 GeV(e-) (without tracking)
  - Minimum: 8.5k byte / 1 GeV(e-)



Conclusion and Next work plan

✓The EMC software could finish basic simulation and reconstruction task.

✓Now the EMC software is adapted to a user-friendly version.

Next work:

➢Add other related drawing and analysis macro, and more function.

➢Using this software to perform simulation and get more result.

➢Add more reliable and elaborate energy-to-Nphotons transformation, then add time and waveform.

➢Cooperate with other detectors, add magnetic filed

➢***Neural network method In ECal reconstruction***

THANK YOU!