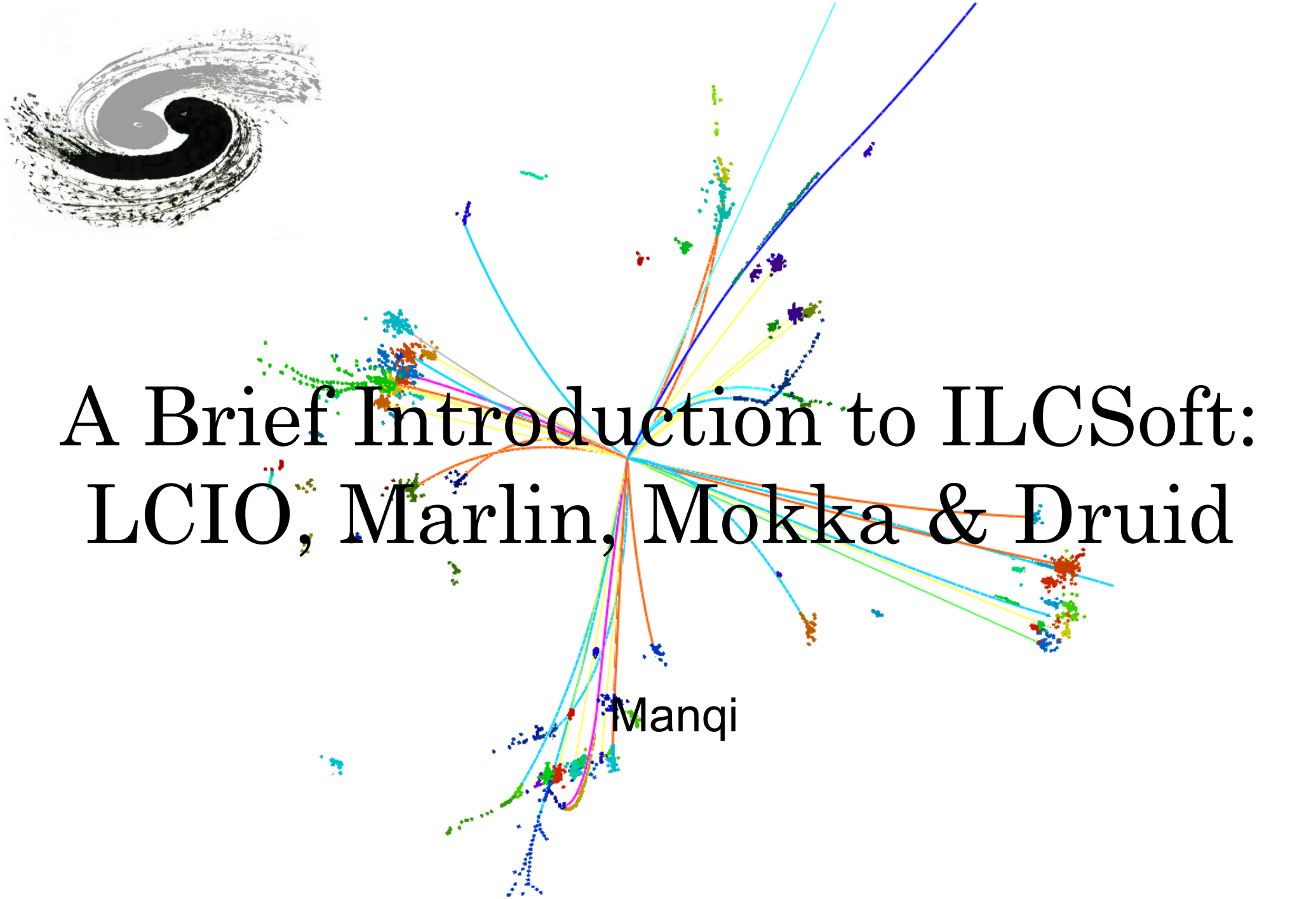


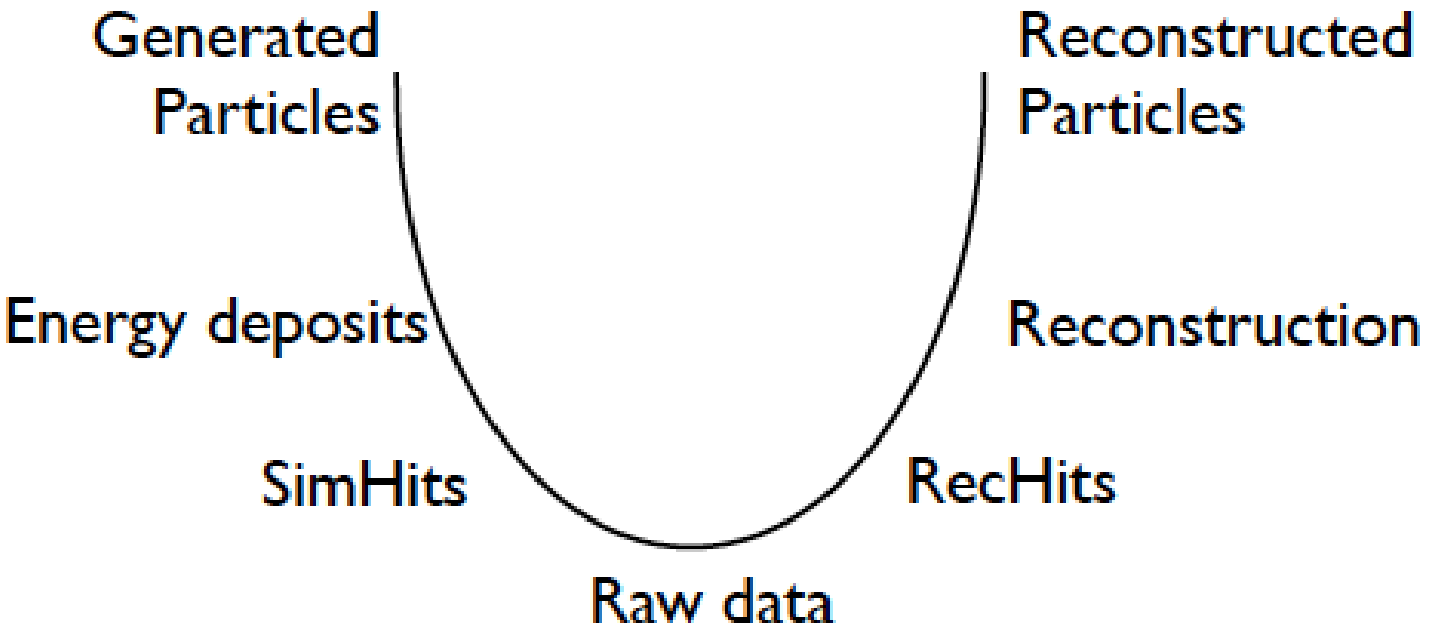
# A Brief Introduction to ILCSoft: LCIO, Marlin, Mokka & Druid

Manqi

# Foreword:

This introduction is prepared
PURELY from the user's P.o.V

# Data flow




Very simplified view on data flow

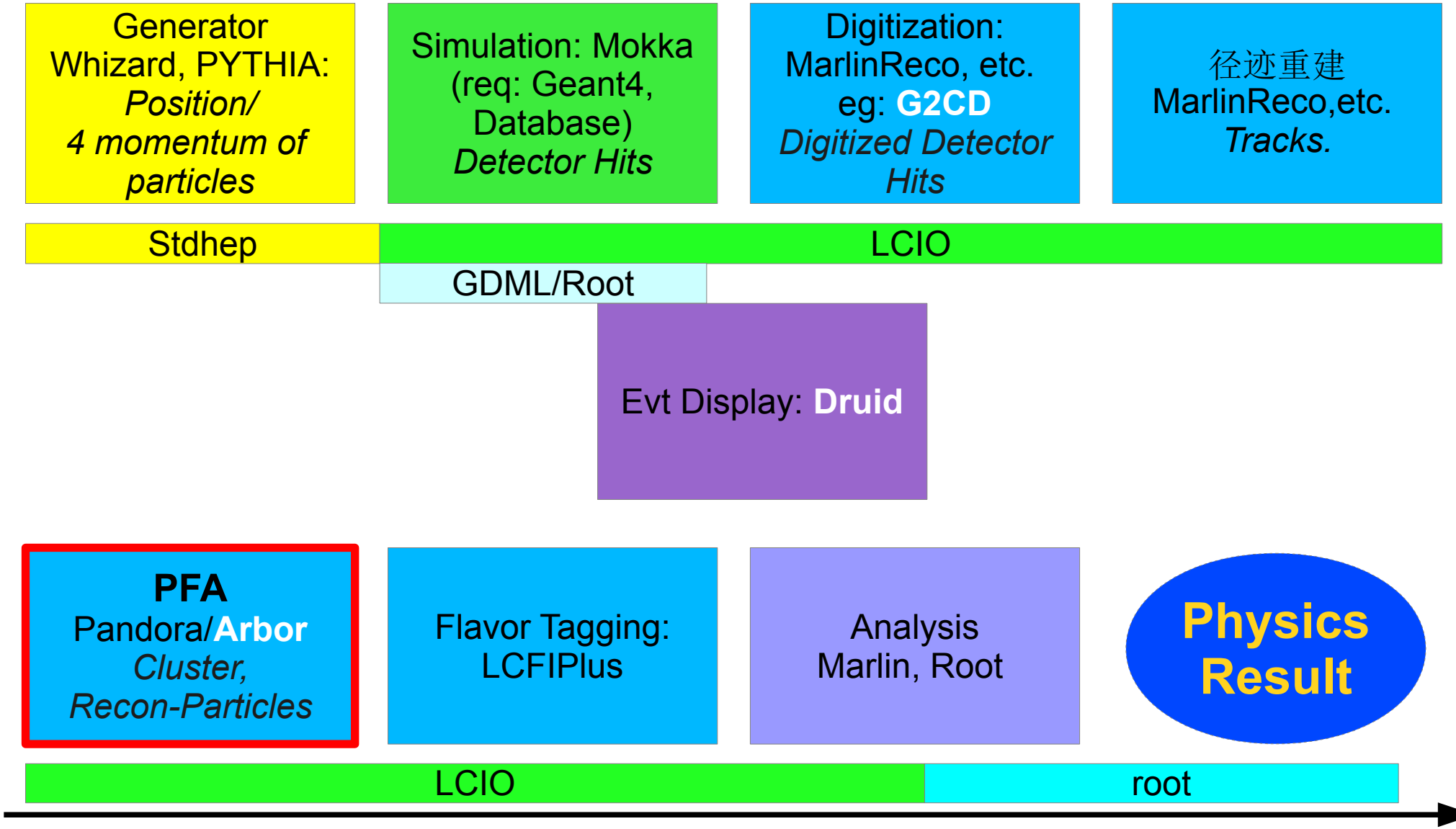
# ILCSoft:

Over 40 packages with complex dependence...

```
[manqi@lxslc510 ~]$ cd /besfs/groups/higgs/Software/ilcsoft_v01-16/
[manqi@lxslc510 ilcsoft_v01-16]$ ls
bbq                 geant4              lccd                MarlinUtil
CED                 gear                LCFIPlus            Mokka
CEDViewer           gsl                 LCFIVertex          mysql
cernlib             ILCSoft.cmake       lcio                Overlay
CLHEP               ILCSoft.cmake.env.sh LCTuple            PandoraAnalysis
Clupatra            ilcutil             Marlin              PandoraPFANew
CMake               ilcutilbk           MarlinFastJet       pathfinder
CondDBMySQL         init_ilcsoft.sh     MarlinKinfit        QT
Druid               java                MarlinPandora       RAIDA
FastJet             KalDet              MarlinReco          root
FastJetClustering   KalTest             MarlinTPC
ForwardTracking     KiTrack             MarlinTrk
Garlic              KiTrackMarlin       MarlinTrkProcessors
[manqi@lxslc510 ilcsoft_v01-16]$
```

Three core softwares (LCIO, Marlin & Mokka), ~10 useful command

# Data flow & Software landscape



# A short version dedicated for Training

/home/ihep/ilcsoft/v01-17-05

```
[ihep@localhost v01-17-05]$ ls -ltr
total 172
drwxrwxr-x 3 ihep ihep 4096 Jun 30 17:32 ilcutil
drwxrwxr-x 3 ihep ihep 4096 Jun 30 17:33 lcio
drwxrwxr-x 3 ihep ihep 4096 Jun 30 17:34 gear
drwxrwxr-x 3 ihep ihep 4096 Jun 30 17:35 CondDBMySQL
drwxrwxr-x 3 ihep ihep 4096 Jun 30 17:35 RAIDA
drwxrwxr-x 3 ihep ihep 4096 Jul  1 08:14 Mokka
drwxr-xr-x 3 ihep ihep 4096 Jul  1 08:23 root
drwxrwxr-x 3 ihep ihep 4096 Jul  1 08:53 xercesc
drwxr-xr-x 3 ihep ihep 4096 Jul  1 09:04 CMake
drwxr-xr-x 3 ihep ihep 4096 Jul  1 09:08 CLHEP
drwxr-xr-x 3 ihep ihep 4096 Jul  1 09:26 QT
drwxr-xr-x 3 ihep ihep 4096 Jul  1 09:58 gsl
drwxr-xr-x 3 ihep ihep 4096 Jul  1 11:13 Marlin
drwxrwxr-x 2 ihep ihep 4096 Jul  1 11:18 mysql
drwxrwxr-x 2 ihep ihep 4096 Jul  1 11:18 cernlib
-rw-r--r-- 1 ihep ihep  839 Jul  1 11:18 ILCSoft.cmake.env.sh
-rw-r--r-- 1 ihep ihep  947 Jul  1 11:18 ILCSoft.cmake
drwxr-xr-x 3 ihep ihep 4096 Jul  1 11:18 lccd
drwxrwxr-x 3 ihep ihep 4096 Jul  1 13:14 geant4
drwxr-xr-x 7 ihep ihep 4096 Aug  8 09:06 Druid
-rw-rw-r-- 1 ihep ihep 5864 Aug  8 14:53 init_ilcsoft.sh
[ihep@localhost v01-17-05]$
```

/home/ihep/Training/env_ilcsoft.sh

```
#!/bin/bash

export LCIO=/home/ihep/ilcsoft/v01-17-05/lcio/v02-04-03
export MARLIN=/home/ihep/ilcsoft/v01-17-05/Marlin/v01-05
export MOKKA=/home/ihep/ilcsoft/v01-17-05/Mokka/mokka-08-03
export DRUIDDIR=/home/ihep/ilcsoft/v01-17-05/Druid
export CMAKE=/home/ihep/ilcsoft/v01-17-05/CMake/2.8.12
export PATH=$LCIO/bin:$MARLIN/bin:$MOKKA/bin:$DRUIDDIR/bin:$PATH

alias HFcmake='cmake -C /home/ihep/ilcsoft/v01-17-05/ILCSoft.cmake ..'

source $MOKKA/build_env.sh

echo "ILCSoft Env Loaded"
~
```

# LCIO:
# Data format

Path: /home/ihep/ilcsoft/v01-17-05/lcio/v02-04-03

Virtual Box User name: ihep
Passwd: cepc

# LCIO: Linear Collider I/O

- Official webpage http://lcio.desy.de/

- Event information organized into different collections – C++ classes
  - Read: $LCIO/include/EVENT
  - Write: $LCIO/include/IMPL

- A very useful command: dump the data information into text
  - $LCIO/bin/dumpevent *.slcio $EventNum | less

- A less useful command: output the general event information and number of objects in each collection
  - $LCIO/bin/anajob *slcio | less

# LCIO classes

```
[manqi@lxslc507 Training]$ cd $LCIO/include/EVENT
[manqi@lxslc507 EVENT]$
[manqi@lxslc507 EVENT]$ ls
CalorimeterHit.h   LCIO.h          RawCalorimeterHit.h      TrackerHitZCylinder.h
Cluster.h          LCObject.h      ReconstructedParticle.h  TrackerPulse.h
LCCollection.h     LCParameters.h  SimCalorimeterHit.h      TrackerRawData.h
LCEvent.h          LCRelation.h    SimTrackerHit.h          Track.h
LCFlag.h           LCRunHeader.h   TPCHit.h                 TrackState.h
LCFloatVec.h       LCStrVec.h      TrackerData.h            Vertex.h
LCGenericObject.h  MCParticle.h    TrackerHit.h
LCIntVec.h         ParticleID.h    TrackerHitPlane.h
[manqi@lxslc507 EVENT]$
[manqi@lxslc507 EVENT]$
[manqi@lxslc507 EVENT]$
```

- Important collections
  - Generator: MCParticles
  - Simulated Detector Hits: SimTrackerHit, SimCalorimeterHit
  - Digitized Hits: TrackerHit, CalorimeterHit
  - Intermediate reconstructed objects: Vertex, Track, Cluster
  - Final reconstructed objects: ReconstructedParticle
  - ...

# Example: Cluster.h

include — manqi@

manqi@lxslc512:...is/Arbor/ArborF1 ... | manqi@bl-1-1:~/Simulation

```
// -*- C++ -*-
// AID-GENERATED
// ======================================================================
// This class was generated by AID - Abstract Interface Definition
// DO NOT MODIFY, but use the org.freehep.aid.Aid utility to regenerate it.
// ======================================================================
#ifndef EVENT_CLUSTER_H
#define EVENT_CLUSTER_H 1

#include "EVENT/CalorimeterHit.h"
#include "EVENT/Cluster.h"
#include "EVENT/LCObject.h"
#include "EVENT/ParticleID.h"
#include "LCIOSTLTypes.h"
#include "empty_ignore.h"

namespace EVENT {


class Cluster ;
/**Vector of (pointers to) Clusters.*/
typedef std::vector<Cluster*> ClusterVec ;
/** The LCIO cluster.
 *
 * @author gaede
 * @version $Id: Cluster.aid,v 1.14 2006-08-03 16:53:34 gaede Exp $
 */

class Cluster : public LCObject {

public:
    /// Destructor.
    virtual ~Cluster() { /* nop */; }


    /** Useful typedef for template programming with LCIO */
    typedef Cluster lcobject_type ;

    /** Flagword that defines the type of cluster. Bits 0-15 can be used to denote the subdetectors
     *  that have contributed hits to the cluster. For the definition of the bits
     *  check/Set the collection variables ClusterTypeBitNames and ClusterTypeBitIndices.
     *  </br>Bits 16-31 are used internally.
     */
    virtual int getType() const = 0;

    /** Energy of the cluster.
     */
    virtual float getEnergy() const = 0;

    /** Returns the error on the energy of the cluster.
     */
    virtual float getEnergyError() const = 0;

    /** Position of the cluster.
     */
    virtual const float* getPosition() const = 0;

    /** Covariance matrix of the position (6 Parameters)
    */
    virtual const FloatVec & getPositionError() const = 0;
```

LCEvent * evtP

LCCollection * ClusterColl
= evtP ->getCollection(“MyClusterCollection”);

Cluster * a_Clu
= dynamic_cast<Cluster*>(ClusterColl->getElementAt(#Num));

a_Clu->getSOMETHING()

# Dumpevent *slcio EventNumber

```
[manqi@lxslc507 Training]$
[manqi@lxslc507 Training]$ ls
Analysis  env_ilcsoft.sh  Simulation
[manqi@lxslc507 Training]$
[manqi@lxslc507 Training]$ cd Simulation/
[manqi@lxslc507 Simulation]$
[manqi@lxslc507 Simulation]$ ls
Geocooking  Muon1mm.sh  Muplus_10GeV.slcio  ZH.sh
[manqi@lxslc507 Simulation]$
[manqi@lxslc507 Simulation]$ dumpevent Muplus_10GeV.slcio 1 | grep collection
 collection name : COILCollection
--------------- print out of SimTrackerHit collection ---------------
 collection name : EcalBarrelSiliconCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : EcalBarrelSiliconPreShowerCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : EcalEndcapSiliconCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : EcalEndcapSiliconPreShowerCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : HcalEndCapsCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : MCParticle
--------------- print out of MCParticle collection ---------------
 collection name : MuonEndCapCollection
--------------- print out of SimCalorimeterHit collection ---------------
 collection name : SETCollection
--------------- print out of SimTrackerHit collection ---------------
 collection name : SITCollection
--------------- print out of SimTrackerHit collection ---------------
 collection name : TPCCollection
--------------- print out of SimTrackerHit collection ---------------
 collection name : VXDCollection
--------------- print out of SimTrackerHit collection ---------------
[manqi@lxslc507 Simulation]$
[manqi@lxslc507 Simulation]$
[manqi@lxslc507 Simulation]$
```

# Anajob *slcio

```
/Mokka/init/lcioFilename /besfs/groups/higgs/data/Simu/HiggsSignal/pffh.eR.pL.I106473_005_9
/Mokka/init/initialMacroFile  /besfs/groups/higgs/yangy/HiggsSimu/test/pffh.eR.pL.I106473_05/tmp_steer_9/event.macro
/Mokka/init/MokkaGearFileName /besfs/groups/higgs/data/Simu/HiggsSignal/Track_pffh.eR.pL.I106473_005_9.xml

#/Mokka/init/globalModelParameter    Ecal_cells_size   1
/Mokka/init/globalModelParameter    Hcal_cells_size   1
/Mokka/init/globalModelParameter    DHcal_max_step    1
/Mokka/init/globalModelParameter    PadSeparation     0

/Mokka/init/lcioDetailedShowerMode true
/Mokka/init/userInitBool WriteCompleteHepEvt true
/Mokka/init/lcioWriteMode WRITE_NEW
/Mokka/init/lcioStoreCalHitPosition true
/Mokka/init/BatchMode true
# /Mokka/init/startEventNumber <SOMENUMBER>
```

```
# ********* end *** end *** Mokka steering file **** end ***** end *****
,
 parameter MOKKA_SubDetector [string]: ,
 parameter PhysicsList [string]: QGSP_BERT,
 parameter SimulatorName [string]: Mokka,
 parameter SimulatorVersion [string]: tag mokka-08-00-03,
 ------------------------------------------------------------------

 will reopen and read from files:
     Arbor_ZH_F1_005_009.slcio
////////////////////////////////////
EVENT: 4800
RUN: 0
DETECTOR: ILD_o2_v05
COLLECTIONS: (see below)
////////////////////////////////////

--------------------------------------------------------------------------------
COLLECTION NAME               COLLECTION TYPE          NUMBER OF ELEMENTS
================================================================================
ArborCHPtoMCP                 LCRelation                   41
ArborChargedCluster           Cluster                      41
ArborNeutralCluster           Cluster                      46
ArborParticle                 ReconstructedParticle        87
COILCollection                SimTrackerHit                52
CaloToSimuCaloLink            LCRelation                 5695
CleanEcalHits                 CalorimeterHit             4565
CleanHcalHits                 CalorimeterHit             1130
ECALBarrel                    CalorimeterHit             3428
ECALEndcap                    CalorimeterHit             1100
ECALMergedBush                Cluster                      75
ECALOther                     CalorimeterHit               37
EHBush                        Cluster                      19
EHLinkBush                    Cluster                      19
EcalBarrelSiliconCollection   SimCalorimeterHit          4475
EcalBarrelSiliconPreShowerCollectionSimCalorimeterHit              98
EcalBushSke                   Cluster                     111
EcalBushes                    Cluster                     111
EcalEndcapRingCollection      SimCalorimeterHit            51
EcalEndcapRingPreShowerCollectionSimCalorimeterHit                 4
EcalEndcapSiliconCollection   SimCalorimeterHit          1470
```

Access to Event Header
(Simulation software version, steering file)

Statistic of number of object in each Collection

Small Exercise: anajob will print the Simulation Steering file at the beginning: try to find The detector module name: i.e, ILD_o2_v05/06...

# To get a LCIO file

- Generator:
  - Marlin can convert the stdhep files into lcio files with only MCParticle collection
- Simulation:
  - Mokka: Geant4 based full simulation software
- Real data:
  - Raw data: DAQ software can use LCGenericObject to store the ADC counts, Cell ID...
- Reconstruction:
  - Real data: converted into detector hits
  - Simulated hits: converted Digitized detector hits
  - Detector hits then be reconstructed into other objects

# Mokka:
# Full Simulation

# Mokka

- Mokka:
  - Geant 4 based Full Simulation package: organize virtual volume/material into virtual detector
  - Supports lots of detector geometries
  - Depend on mysql database: store geometry information
    - Official Servers at IHEP, France, Germany.
    - You can also create your own db (see Emilia's talk)
- Usage:
  - Event: particle gun/generator
  - Select/edit geometry
  - Output: lcio data file, gear/gdml geometry description file

# Mokka steering

Specify event type/statistics

Select/edit geometry

Specify mysql database server

Specify IO...

*cd $Training/Simulation*
*vim Muon1mm.sh*

manqi — manqi@lxslc507:~/higgs/users/manqi/Training/Simulation — ssh — 103×59

manqi@lxslc508:...lysis/AnaGeo/src | manqi@lxslc507:...aining/Simulation

```
#!/bin/bash
#fi

mkdir -p tmp_steer

output_file=Muplus_10GeV

source $MOKKA/build_env.sh

echo \
"
#/generator/generator /besfs/groups/higgs/data/GeneratorSample/higgs/E250-TDR_ws.Pe1e1h.Gwhizard-1_95.e
L.pL.I106475.001.stdhep

/generator/generator particleGun
/gun/position 0 0 5 mm
/gun/direction 0.0 0.0 1.0
/gun/energy 10.0 GeV
/gun/momentumSmearing 0.0 GeV
/gun/phiSmearing 180 deg
/gun/thetaSmearing 90 deg
/gun/directionSmearingMode uniform
/gun/particle mu+
/run/beamOn 1000

exit
" > tmp_steer/event.macro

echo \
"
/Mokka/init/BatchMode true
/Mokka/init/detectorModel ILD_o2_v05
/Mokka/init/EditGeometry/rmSubDetector SServices_02_v00
#/Mokka/init/globalModelParameter TPC_outer_radius 1365

/Mokka/init/lcioFilename ${output_file}
/Mokka/init/initialMacroFile $PWD/tmp_steer/event.macro
/Mokka/init/MokkaGearFileName ILD_o2_v05.xml

/Mokka/init/dbHost 202.122.37.75
/Mokka/init/user consult
/Mokka/init/dbPasswd consult

/Mokka/init/globalModelParameter Hcal_cells_size   1
/Mokka/init/globalModelParameter DHcal_max_step    1
/Mokka/init/globalModelParameter PadSeparation     0
/Mokka/init/lcioDetailedShowerMode true
/Mokka/init/userInitBool WriteCompleteHepEvt true
/Mokka/init/lcioWriteMode WRITE_NEW
/Mokka/init/lcioStoreCalHitPosition true

" > tmp_steer/init.macro

Mokka -U $PWD/tmp_steer/init.macro
~
~
```

# sh ./MyLaunchMokka.sh

```
>>> Event 3, scanning sub-detectors

VXDCollection from the VXD sensitive detector has 262 hits.
EcalBarrelSiliconCollection from the EcalBarrelSilicon sensitive detector has 5461 hits.
EcalBarrelSiliconPreShowerCollection from the EcalBarrelSilicon sensitive detector has 111 hits.
EcalEndcapSiliconCollection from the EcalEndcapSilicon sensitive detector has 413 hits.
EcalEndcapSiliconPreShowerCollection from the EcalEndcapSilicon sensitive detector has 35 hits.
EcalEndcapRingCollection from the EcalEndcapRing sensitive detector has 26 hits.
EcalEndcapRingPreShowerCollection from the EcalEndcapRing sensitive detector has 1 hits.
LumiCalCollection from the LumiCal sensitive detector has 10 hits.
HcalBarrelCollection from the HcalBarrel sensitive detector has 552 hits.
HcalEndCapsCollection from the HcalEndCaps sensitive detector has 86 hits.
HcalEndCapRingsCollection from the HcalEndCapRings sensitive detector has 14 hits.
LHcalCollection from the LHcal sensitive detector has 0 hits.
LHcalPreShowerCollection from the LHcal sensitive detector has 0 hits.
TPCCollection from the TPC sensitive detector has 20035 hits.
TPCSpacePointCollection from the TPC sensitive detector has 2578 hits.
TPCLowPtCollection from the TPC sensitive detector has 0 hits.
SITCollection from the SIT sensitive detector has 461 hits.
FTD_PIXELCollection from the FTD_PIXEL sensitive detector has 15 hits.
FTD_STRIPCollection from the FTD_STRIP sensitive detector has 135 hits.
SETCollection from the SET sensitive detector has 230 hits.
COILCollection from the COIL sensitive detector has 5 hits.
MuonBarrelCollection from the MuonBarrel sensitive detector has 0 hits.
MuonEndCapCollection from the MuonEndCap sensitive detector has 0 hits.
BeamCalCollection from the BeamCal sensitive detector has 0 hits.


[manqi@lxslc509 Simulation]$ ls
ILD_o2_v05.xml  Muon1mm.sh  tmp_steer  ZH_eL_pL_I106475.001.slcio  ZH.sh
[manqi@lxslc509 Simulation]$
[manqi@lxslc509 Simulation]$
```

# Exercise: have fun with Druid...

```
[ihep@localhost Simulation]$ cd
[ihep@localhost ~]$ ls
Training  do_job.sh  generator  ilcsoft  simulation
[ihep@localhost ~]$ cd Training/
[ihep@localhost Training]$ . env_ilcsoft.sh
ILCSoft Env Loaded
[ihep@localhost Training]$ cd Simulation/
[ihep@localhost Simulation]$ sh ./Muon1mm.sh
```

Wait for sometime... then do

Druid Muplus_10GeV.slcio

# Marlin:
# Data manager

# Marlin

- Marlin:
  - LCIO data Manager
  - Reconstruction/Analysis framework
  - *More than half of the ilc soft packages are Reconstruction modules that can be used by Marlin*
- Typical functions:
  - Read LCIO informations and write it into root files: More details in Xiangyu's talk
  - Reconstructions: read lcio data, reconstruct into new objects, add new collections into the same data: dedicated examples will be presented.

# Usage of Marlin

- Write/Modify your own reconstruction/analysis code
- Cmake: create a makefile according to its dependency

  cd $MyAnalyis

  mkdir build

  cd build

  cmake -C $ILCSoft/ILCSoft.cmake ..

  - *Makefile can be reused*
- Compile your own code into Marlin Libraries

  make

  make install

# Usage of Marlin

- Load the library to Marlin by setting the environment variable MARLIN_DLL

```
[manqi@lxslc512 ArborF1]$ ls
Arbor_ZH_F1_005_009.slcio  Arbor_ZH.root  build  buildbk  BushAna_ZH.root  cdb.log  CMakeLists.txt  include  IsoHit.root  lib  loadLDD.sh  src  steer
[manqi@lxslc512 ArborF1]$
[manqi@lxslc512 ArborF1]$
[manqi@lxslc512 ArborF1]$ cat loadLDD.sh
#! /bin/bash

#source env.sh
unset MARLIN_DLL
export MARLIN_DLL=$PWD/lib/libRangerF1.so
[manqi@lxslc512 ArborF1]$
```

- Control your module with steering file:
  - Useful command: print the reference steering file/verify if your module is properly loaded

    $MARLIN/bin/Marlin -l or $MARLIN/bin/Marlin -x
  - To execute:

    $MARLIN/bin/Marlin mymodule.steer

# Example: Convert stdhep file into lcio

## $Training/Analysis/StdhepReader/conv.steer

manqi — manqi@lxslc509:~/Training/Analysis/StdHepReader — ssh — 122×29

```
.begin Global  ---------------------------------------

ActiveProcessors MyStdHepReader
ActiveProcessors MyLCIOOutputProcessor

MaxRecordNumber 5000070
SkipNEvents  0

.end   -----------------------------------------------

.begin MyStdHepReader
ProcessorType StdHepReader

StdHepFileName /besfs/groups/higgs/data/GeneratorSample/higgs/E250-TDR_ws.Pffh.Gwhizard-1_95.eR.pL.I106473.005.stdhep

.end -------------------------------------------------

.begin MyLCIOOutputProcessor
ProcessorType LCIOOutputProcessor

LCIOOutputFile     Pffh_RL_005.slcio

.end -------------------------------------------------
```

# MCParticle collection in the generator

manqi — manqi@lxslc514:~/higgs/users/manqi/Training/Analysis/StdhepReader — ssh — 225×52

```
================================================================================
        Event  : 0 - run:  0 - timestamp 0 - weight 1
================================================================================
 date:      01.01.1970  00:00:00.000000000
 detector : unknown
 event parameters:

 collection name : MCParticle
 parameters:

--------------- print out of MCParticle collection ---------------

  flag:  0x0
 parameter _weight [float]: 0,
  simulator status bits: [sbvtcls]  s: created in simulation b: backscatter v: vertex is not endpoint of parent t: decayed in tracker c: decayed in calorimeter l: has left detector s: stopped o: overlay


[   id   ]index|      PDG |    px,     py,        pz    | energy  |gen|[simstat ]| vertex x,     y   ,   z     | endpoint x,    y  ,   z     |    mass |  charge |           spin            | colorflow | [parents] - [daughte
rs]

[00000004]    0|       22| 6.39e-03,-5.83e-04, 4.28e-02| 4.33e-02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [5]
[00000005]    1|       22| 2.82e-05, 1.32e-04,-3.56e-01| 3.56e-01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [6]
[00000006]    2|       15|-1.62e+00, 1.46e+01,-4.11e+01| 4.36e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.78e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [7]
[00000007]    3|      -15|-1.91e+01,-6.23e+01, 3.21e+00| 6.53e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.78e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [8]
[00000008]    4|       25| 2.08e+01, 4.77e+01, 3.81e+01| 1.41e+02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.25e+02| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [] - [9]
[00000009]    5|       22| 6.39e-03,-5.83e-04, 4.28e-02| 4.33e-02| 1 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [0] - []
[00000010]    6|       22| 2.82e-05, 1.32e-04,-3.56e-01| 3.56e-01| 1 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [1] - []
[00000011]    7|       15|-1.62e+00, 1.46e+01,-4.11e+01| 4.36e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.78e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [2] - [10]
[00000012]    8|      -15|-1.91e+01,-6.23e+01, 3.21e+00| 6.53e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.78e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [3] - [10]
[00000013]    9|       25| 2.08e+01, 4.77e+01, 3.81e+01| 1.41e+02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.25e+02| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [4] - [15,16]
[00000014]   10|       94|-2.08e+01,-4.77e+01,-3.78e+01| 1.09e+02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 8.79e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [8,7] - [11,12]
[00000015]   11|       15|-1.62e+00, 1.46e+01,-4.11e+01| 4.36e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00|-8.97e-02, 8.09e-01,-2.27e+00| 1.78e+00|-1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [10] - [52,53]
[00000016]   12|      -15|-1.91e+01,-6.23e+01, 3.21e+00| 6.53e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 1.78e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [10] - [13,14]
[00000017]   13|      -15|-1.91e+01,-6.23e+01, 3.21e+00| 6.53e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00|-5.17e-01,-1.69e+00, 8.69e-02| 1.78e+00| 1.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [12] - [56,57]
[00000018]   14|       22|-2.65e-04,-7.39e-04, 1.73e-05| 7.86e-04| 1 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [12] - []
[00000019]   15|       23| 1.88e+01, 3.90e+00,-1.51e+00| 3.07e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 2.38e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [9] - [17,18]
[00000020]   16|       23| 1.92e+00, 4.38e+01, 3.96e+01| 1.10e+02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.28e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [9] - [19,20]
[00000021]   17|        1| 1.84e+01, 1.23e+01,-1.67e+00| 2.22e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 3.30e-01|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [15] - [21]
[00000022]   18|       -1| 4.35e-01,-8.42e+00, 1.54e-01| 8.44e+00| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 3.30e-01| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [15] - [21]
[00000023]   19|        3| 2.94e+01, 2.78e+01, 5.99e+01| 7.23e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 5.00e-01|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [16] - [26]
[00000024]   20|       -3|-2.75e+01, 1.61e+01,-2.03e+01| 3.77e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 5.00e-01| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [16] - [26]
[00000025]   21|       94| 1.88e+01, 3.90e+00,-1.51e+00| 3.07e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 2.38e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [17,18] - [22,23]
[00000026]   22|        1| 1.82e+01, 1.22e+01,-1.65e+00| 2.20e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 3.30e-01|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [21] - [41]
[00000027]   23|       -1| 6.22e-01,-8.30e+00, 1.37e-01| 8.67e+00| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 2.42e+00| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [21] - [24,25]
[00000028]   24|       -1| 1.19e+00,-7.04e+00,-4.68e-01| 7.17e+00| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 3.30e-01| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [23] - [43]
[00000029]   25|       21|-5.63e-01,-1.25e+00, 6.06e-01| 1.50e+00| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [23] - [42]
[00000030]   26|       94| 1.92e+00, 4.38e+01, 3.96e+01| 1.10e+02| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 9.28e+01| 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [19,20] - [27,28]
[00000031]   27|        3| 2.76e+01, 2.88e+01, 5.85e+01| 7.47e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 2.37e+01|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [26] - [29,30]
[00000032]   28|       -3|-2.57e+01, 1.50e+01,-1.89e+01| 3.53e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 2.58e+00| 3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [26] - [31,32]
[00000033]   29|        3| 2.59e+01, 2.33e+01, 3.60e+01| 5.06e+01| 2 |[    0   ]| 0.00e+00, 0.00e+00, 0.00e+00| 0.00e+00, 0.00e+00, 0.00e+00| 7.15e+00|-3.33e-01| 0.00e+00, 0.00e+00, 0.00e+00|  (0, 0)   | [27] - [33,34]
:
```

Marlin conv1.steer

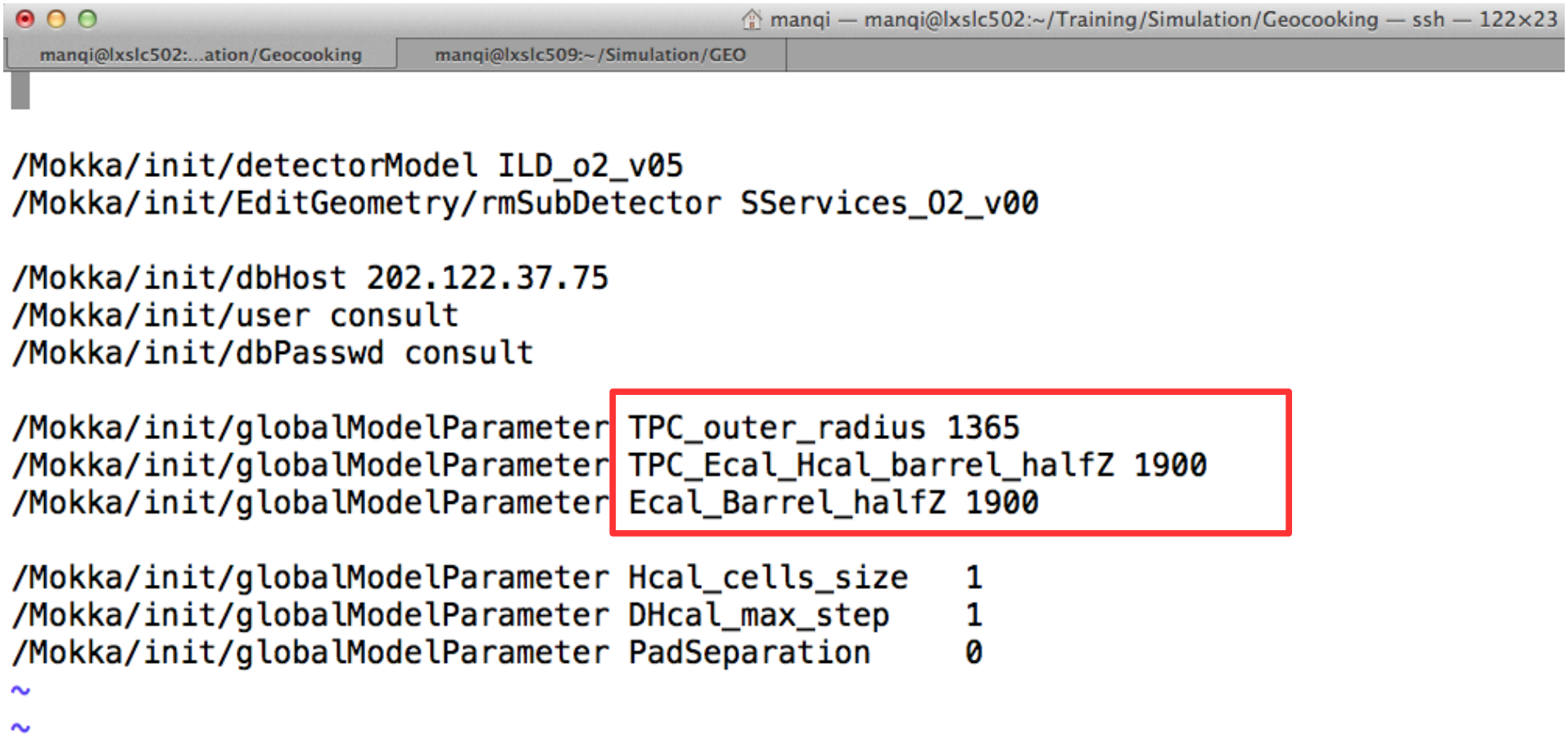
dumpevent Pffh_RL_005.slcio 1 | less

MCParticle List of a ffH events: ZH with Z->tautau and H->ZZ*

# Full Simulation: Edit, verify/validation of new detector geometry

# Edit geometry with Mokka

$Training/Simulation/Geocooking/GeoHZ.macro




By using globalModelParameter...

# Exercise 2: dump Geometry

cd $Training/Simulation/Geocooking/
Mokka -U GeoHZ.macro

Type following command here:

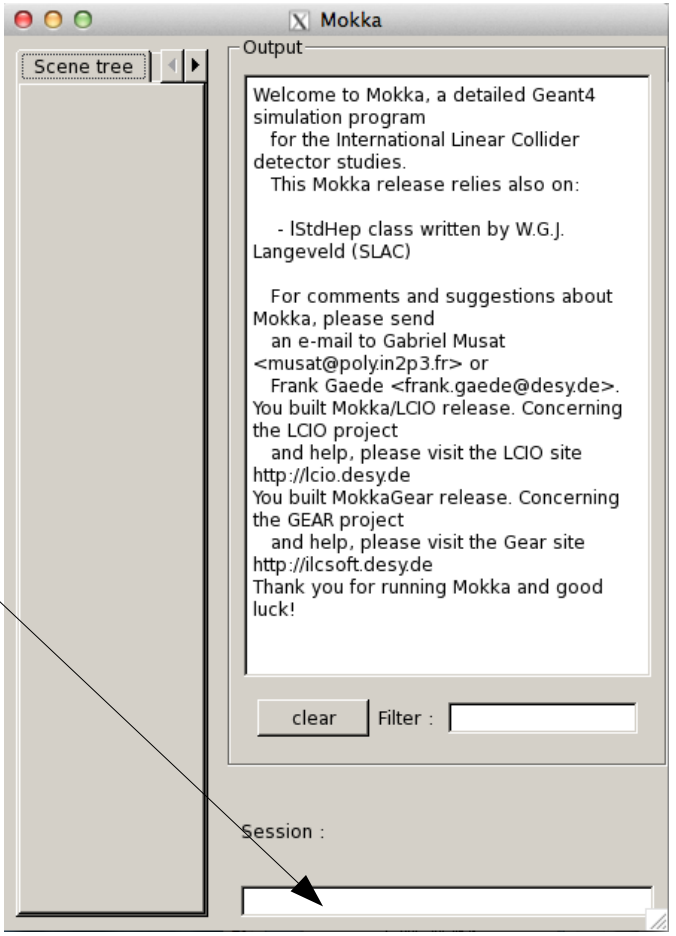
Mokka/Visu/Detector/DumpGDML

Then, you will get a file named

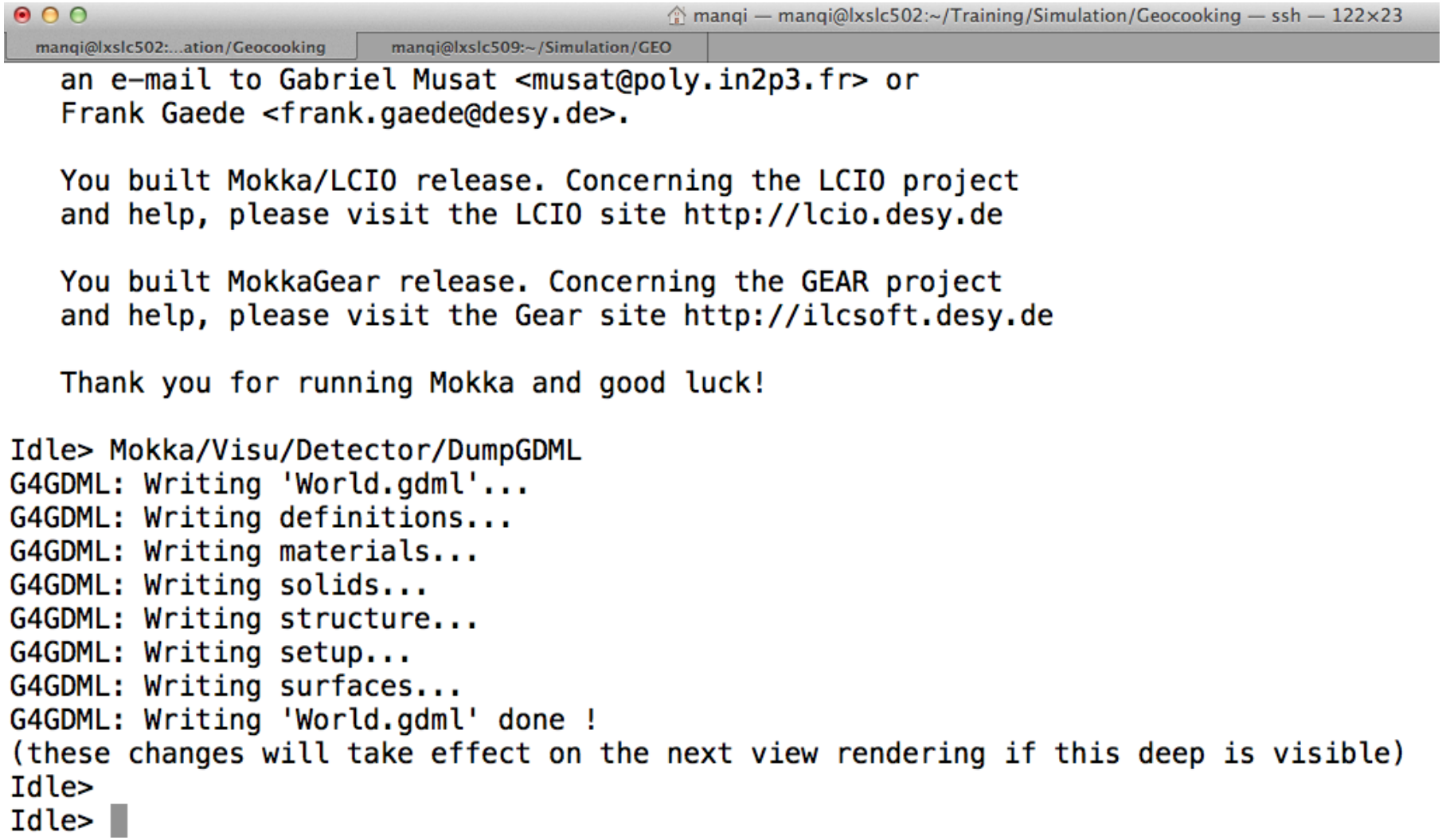
World.gdml

Do:

root -l Geo.C



# Init Mokka with geometry macro, and dump gdml file out

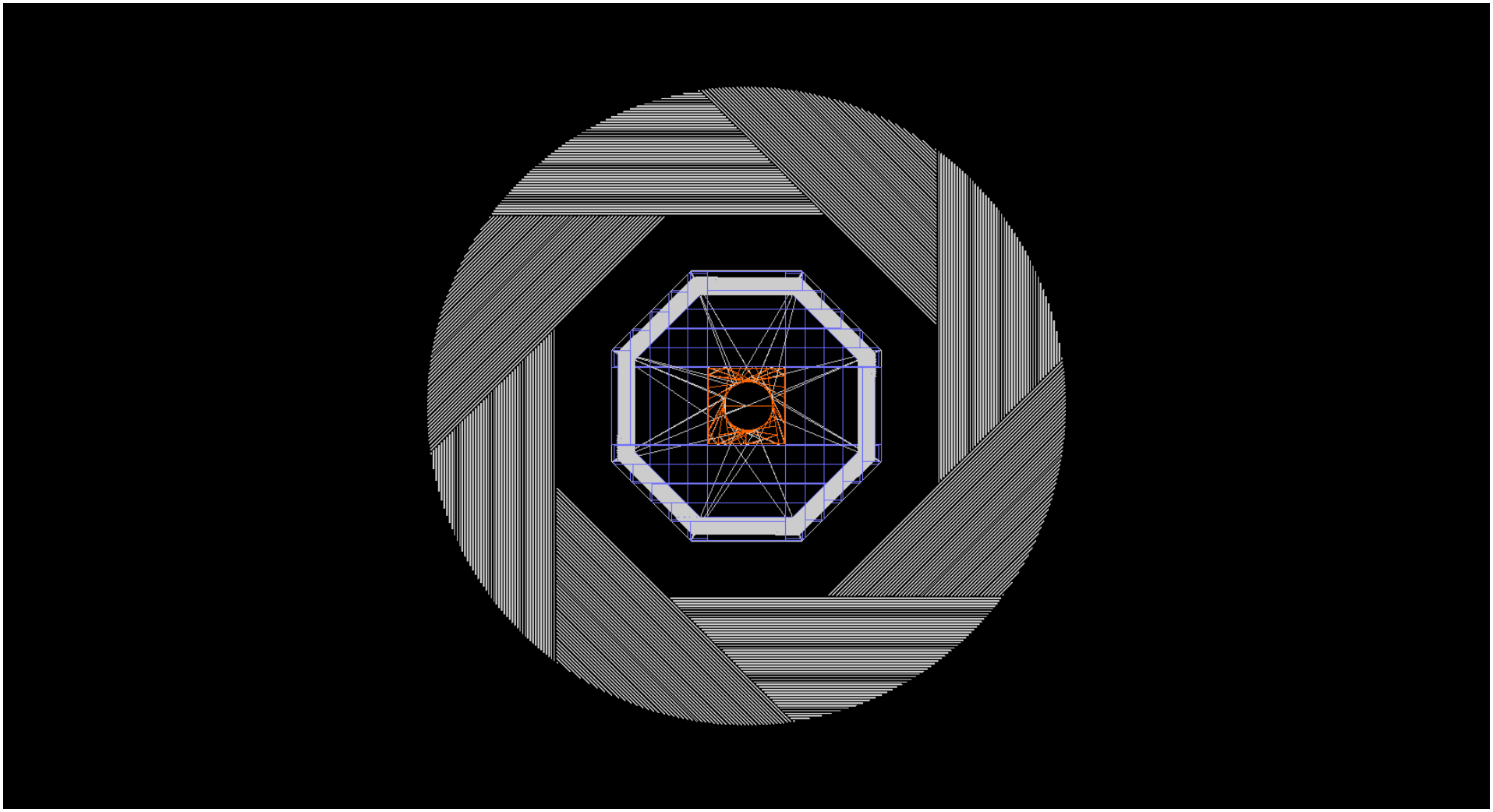



Launch Mokka: Mokka -U GeoHZ.macro

# If root is compiled with gdml option...

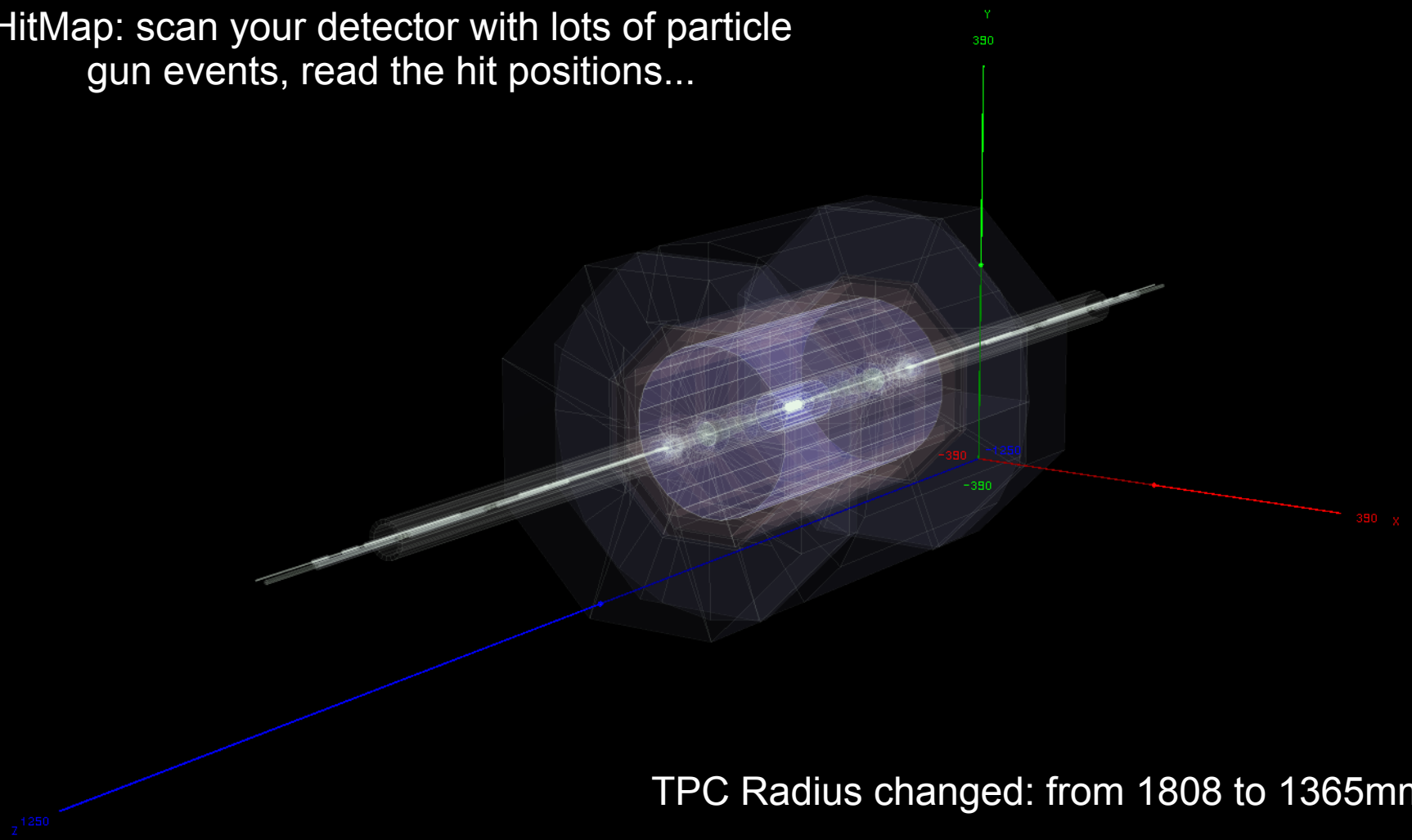
```
[manqi@lxslc502 Geocooking]$ cat Geo.C

{
        TGeoManager::Import("World.gdml");
        gGeoManager->GetTopVolume()->Draw("ogl");
        TFile *f = new TFile("ShortTPC.root","recreate");
        gGeoManager->Write();
        f->Close();
}
[manqi@lxslc502 Geocooking]$
[manqi@lxslc502 Geocooking]$
[manqi@lxslc502 Geocooking]$ ls -ltr
total 5743
-rw-r--r-- 1 manqi physics     784 Oct 15 20:32 init.macro
-rw-r--r-- 1 manqi physics     520 Oct 15 20:57 GeoHZ.macro
-rw-r--r-- 1 manqi physics   34812 Oct 15 21:03 GearOutput.xml
-rw-r--r-- 1 manqi physics 5455835 Oct 15 21:04 World.gdml
-rw-r--r-- 1 manqi physics  386565 Oct 15 21:08 ShortTPC.root
-rw-r--r-- 1 manqi physics     171 Oct 15 21:15 Geo.C
[manqi@lxslc502 Geocooking]$
```

# Therefore, you should be able to find...



# Geometry could/should also be Xchecked from Hit Map

HitMap: scan your detector with lots of particle gun events, read the hit positions...




TPC Radius changed: from 1808 to 1365mm

# Not a exercise

Try to do:

Druid *.slcio *.root

The root file is geometry file: you have plenty of them located at $DRUID/geometryfile

# I am the exercise

Use the generator file as input

/home/ihep/Training/Analysis/StdhepReader/E250-TDR_ws.Pnnh.Gwhizard-1_95.eL.pR.I106483.004.stdhep

Edit your geometry by changing TPC radius & Half Z to some reasonable value you like;

Simulate several physical event with new geometry

Get a event display wi/wo the geometry

# Example Marlin Process: To make Hitmap

$Training/Analysis/AnaGeo/

# PrintHit Header

```
#include <string>
#include <iostream>
#include <fstream>
#include <marlin/Processor.h>
#include <EVENT/CalorimeterHit.h>
#include <IMPL/LCEventImpl.h>
#include <TNtuple.h>
#include <TObject.h>

#include <TTree.h>
#include <TFile.h>
#include <TH1.h>
#include <TH2.h>
#include <TH3.h>
class TTree;

class PrintHit  : public marlin::Processor
{
        public:

                Processor*  newProcessor() { return new PrintHit ; }

                PrintHit();

                ~PrintHit() {};

                void init();

                void processEvent( LCEvent * evtP );

                void end();

        protected:
                std::string _treeFileName;
                std::string _treeName;
                std::string _colName;
                std::vector<std::string> _hcalCollections;
```

# Define the steering parameters

```
PrintHit aPrintHit ;
PrintHit::PrintHit()
        : Processor("PrintHit"),
        _output(0)
{
        _description = "Print MC Truth" ;


        _treeFileName="MCTruth.root";
        registerProcessorParameter( "TreeOutputFile" ,
                        "The name of the file to which the ROOT tree will be written" ,
                        _treeFileName ,
                        _treeFileName);

        _colName="MCParticle";
        registerProcessorParameter( "MCObjects" ,
                        "The name of the PFOs" ,
                        _colName ,
                        _colName);

        std::vector<std::string> hcalCollections;
        hcalCollections.push_back(std::string("HCALBarrel"));
        hcalCollections.push_back(std::string("HCALEndcap"));
        hcalCollections.push_back(std::string("HCALOther"));
        hcalCollections.push_back(std::string("ECALBarrel"));
        hcalCollections.push_back(std::string("ECALEndcap"));

        registerInputCollections( LCIO::CALORIMETERHIT,
                        "HitCollections" ,
                        "Hit Collection Names" ,
                        _hcalCollections ,
                        hcalCollections);


        _treeName="DHCAL";
        registerProcessorParameter( "TreeName" ,
                        "The name of the ROOT tree" ,
                        _treeName ,
                        _treeName);
```

# Steering of Marlin Module

Druid — manqi@bl-1-1:~/Analysis/AnaGeo — ssh — 231×59

manqi@lxslc512:...is/Arbor/ArborF1 ... | bash | manqi@bl-1-1:~/Analysis/AnaGeo

```
.begin Global  ----------------------------------------

#LCIOInputFiles /home/manqi/Softwares/MarlinTools/GeneralGasCaloDigi/data/Muon_1mmCellDHCAL_100GeV.slcio
#LCIOInputFiles /home/manqi/Travail/MarlinTools/FullPandoraReco/ParticleGun/pi+_R_1600.slcio
#LCIOInputFiles /home/manqi/MarlinTools/FullPandoraReco/ParticleGun/R1365_HalfZ_2000/mu+_R_1400_Z_2000_10GeV.slcio
LCIOInputFiles mokka_1600_pi+_70.1.slcio

ActiveProcessors MyPrintHit
#ActiveProcessors MyPrintTrack
MaxRecordNumber 100001

.end   ------------------------------------------------
.begin MyPrintHit
ProcessorType PrintHit

#    HitCollectionName  HcalBarrelCollection
#     HitCollections   HCALBarrel HCALEndcap HCALOther ECALBarrel ECALEndcap
     HitCollections EcalBarrelSiliconCollection EcalBarrelSiliconPreShowerCollection EcalEndcapSiliconCollection EcalEndcapSiliconPreShowerCollection
llection MuonEndCapCollection

#      HitCollections  LHcalCollection LumiCalCollection

#       The name of the PFOs
#        type:  [string]
#        default: MCParticle
#        MCObjects   MCParticle

OverwriteFile   0

TreeName   HCAL

TreeOutputFile   Pion_R1600_70GeV.root
#       TreeOutputFile   QQ_RanXcheckMarkSample_3100GeV_Hit.root
.end ------------------------------------------------
```

# Define the output root file

```
void PrintHit::init() {

        printParameters();

        TFile *tree_file=new TFile(_treeFileName.c_str(),(_overwrite ? "RECREATE" : "UPDATE"));

        if (!tree_file->IsOpen()) {
                delete tree_file;
                tree_file=new TFile(_treeFileName.c_str(),"NEW");
        }

        _outputTree = new TTree(_treeName.c_str(),_treeName.c_str());
        _outputTree->SetAutoSave(32*1024*1024);  // autosave every 32MB
        _outputTree->Branch("EventNr", &_eventNr, "EventNr/I");
        _outputTree->Branch("NumHit",&_NHits,"NumHit/I");
        _outputTree->Branch("NHitT",&_NHitsT,"NHitT/I");
        _outputTree->Branch("PosX",&HitPosX,"HitX/F");
        _outputTree->Branch("PosY",&HitPosY,"HitY/F");
        _outputTree->Branch("PosZ",&HitPosZ,"HitZ/F");
        _outputTree->Branch("HitEn",&HitE,"HitEn/F");
        _outputTree->Branch("HitEnErr",&HitEnError,"HitEnErr/F");
        _outputTree->Branch("MCPID", &MCPID, "MCPID/I");
        _outputTree->Branch("MCTrkID", &MCTrkPID, "MCTrkID/I");
        _outputTree->Branch("MCPEx", &MCPEx, "MCPEx/F");
        _outputTree->Branch("MCPEy", &MCPEy, "MCPEy/F");
        _outputTree->Branch("MCPEz", &MCPEz, "MCPEz/F");
        _outputTree->Branch("MCPER", &MCPER, "MCPER/F");        //Radius of EndP
        _outputTree->Branch("HitFlag",&HitFlag,"HitFlag/I");
        _outputTree->Branch("ID0",&_ID0,"ID0/I");
        _outputTree->Branch("ID1",&_ID1,"ID1/I");
        _outputTree->Branch("M",&_M,"M/I");
        _outputTree->Branch("S",&_S,"S/I");
        _outputTree->Branch("I",&_I,"I/I");
        _outputTree->Branch("J",&_J,"J/I");
        _outputTree->Branch("K",&_K,"K/I");
        _outputTree->Branch("M2",&_M2,"M2/I");
        _outputTree->Branch("M1",&_M1,"M1/I");
        _outputTree->Branch("Seg",&_Seg,"Seg/I");
```

# Event loop: fill your root file

```
void PrintHit::processEvent( LCEvent * evtP )
{
        if (evtP)
        {
                try
                {
                        _eventNr=evtP->getEventNumber();
                        _Num++;

                        if(_Num%100==0)
                        {
                                std::cout<<_Num<<" events have been processed"<<std::endl;
                                std::cout<<" Number of Collections "<< _hcalCollections.size() <<std::endl;
                        }

                                                        ...

                                                        _outputTree->Fill();
                                                }
                                        }
                                        else
                                        {
                                                std::cout<<"Cannot found Simulated CaloHits or CaloHits!"<<std::endl;
                                        }

                                }catch (lcio::DataNotAvailableException zero) { }
                        }

                }
                catch (lcio::DataNotAvailableException err) { }

        }

}
```

# Read the data: use lcio class

```
else if (col->getTypeName() ==LCIO::SIMCALORIMETERHIT)
{
        CellIDDecoder<SimCalorimeterHit> idDecoder1( col ) ;

        for (int j(0); j < numElements; ++j) {
                SimCalorimeterHit *a_DHcalhit = dynamic_cast<SimCalorimeterHit*>( col->getElementAt( j ) ) ;

                HitPosX=a_DHcalhit->getPosition()[0];
                HitPosY=a_DHcalhit->getPosition()[1];
                HitPosZ=a_DHcalhit->getPosition()[2];
                HitE=a_DHcalhit->getEnergy();
                _ID0=a_DHcalhit->getCellID0();

                _M=_ID0 & 0x00000007;
                _S=(_ID0 & 0x00000038)>>3;
                _I=(_ID0 & 0x00007FC0)>>6;
                _J=(_ID0 & 0x00FF8000)>>15;
                _K=(_ID0 & 0x3F000000)>>24;
                _M2=(_M2 & 0x40000000)>>30;
                _M1=(_M1 & 0x80000000)>>31;
```

# Output the root file

```
void PrintHit::end()
{

        if (_outputTree) {

                TFile *tree_file = _outputTree->GetCurrentFile(); //just in case we switched to a new file
                tree_file->Write();
                delete tree_file;

        }

}
```

# Usage of Marlin

- Write/Modify your own source code
- Generate the make file using Cmake:

  cd $AnaGeo

  mkdir build

  cd build

  HFcmake ( = cmake -C $ILCSoft.cmake ..)
- Compile

  make install
- Load your module to Marlin: export the Marlin_LDD variable

  cd $AnaGeo

  . loadLDD.sh

# CMake

Druid — manqi@lxslc512:~/Analysis/Arbor/ArborF1/build — ssh — 231×59

```
`builds' -> `build'
[manqi@lxslc512 ArborF1]$ cd build
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$ which HFcmake
alias HFcmake='cmake -C /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ILCSoft.cmake ..'
        ~/Software/ilcsoft/v01-16/CMake/2.8.5/bin/cmake
[manqi@lxslc512 build]$ HFcmake
loading initial cache file /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ILCSoft.cmake
-- The C compiler identification is GNU
-- The CXX compiler identification is GNU
-- Check for working C compiler: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/mysql/usr/bin/gcc
-- Check for working C compiler: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/mysql/usr/bin/gcc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Check for working CXX compiler: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/mysql/usr/bin/c++
-- Check for working CXX compiler: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/mysql/usr/bin/c++ -- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Check for ILCUTIL (1.0.0)
-- Found ILCSOFT_CMAKE_MODULES: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ilcutil/v01-00/cmakemodules
-- Found ILCUTIL: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ilcutil/v01-00
-- Check for Marlin (1.4.0)
-- Check for Marlin_LIBRARIES: Marlin
-- Check for Marlin_MARLIN_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/Marlin/v01-04/lib/libMarlin.so -- ok
-- Found Marlin: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/Marlin/v01-04 (Required is at least version "1.0")
-- Check for MarlinUtil (1.5.3)
-- Check for MarlinUtil_LIBRARIES: MarlinUtil
-- Check for MarlinUtil_MARLINUTIL_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinUtil/v01-05-03/lib/libMarlinUtil.so -- ok
-- Found MarlinUtil: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinUtil/v01-05-03 (Required is at least version "1.0")
-- Check for ROOT_CONFIG_EXECUTABLE: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/bin/root-config
-- Check for ROOT (5.28.00)
-- Check for ROOT_EXECUTABLE: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/bin/root
-- Check for ROOT_CINT_EXECUTABLE: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/bin/rootcint
-- Check for ROOT_LIBRARIES: Core;Cint;RIO;Net;Hist;Graf;Graf3d;Gpad;Tree;Rint;Postscript;Matrix;Physics;MathCore;Thread
-- Check for ROOT_CORE_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libCore.so -- ok
-- Check for ROOT_CINT_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libCint.so -- ok
-- Check for ROOT_RIO_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libRIO.so -- ok
-- Check for ROOT_NET_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libNet.so -- ok
-- Check for ROOT_HIST_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libHist.so -- ok
-- Check for ROOT_GRAF_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libGraf.so -- ok
-- Check for ROOT_GRAF3D_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libGraf3d.so -- ok
-- Check for ROOT_GPAD_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libGpad.so -- ok
-- Check for ROOT_TREE_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libTree.so -- ok
-- Check for ROOT_RINT_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libRint.so -- ok
-- Check for ROOT_POSTSCRIPT_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libPostscript.so -- ok
-- Check for ROOT_MATRIX_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libMatrix.so -- ok
-- Check for ROOT_PHYSICS_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libPhysics.so -- ok
-- Check for ROOT_MATHCORE_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libMathCore.so -- ok
-- Check for ROOT_THREAD_LIBRARY: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib/libThread.so -- ok
-- Check for libdl.so: /usr/lib64/libdl.so
-- Found ROOT: /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/include
--
-- ------------------------------------------------------------------------------
-- Change values with: cmake -D<Variable>=<Value>
```

# Make install

Druid — manqi@lxslc512:~/Analysis/Arbor/ArborF1/build — ssh — 231×59

```
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinFastJet/v00-01;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/LCTuple/v01-01;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinKinfit/v00-01-02;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinTrk/v01-10-01;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/KiTrack/v01-04;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/KiTrackMarlin/v01-04;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinTrkProcessors/v01-09;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/Clupatra/v00-09-01;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/LCFIPlus/v00-05-02;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ForwardTracking/v01-07;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/pathfinder/v00-02;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinTPC/v00-10;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/bbq/v00-01-02;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/Garlic/v2.10.1;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/CLHEP/2.1.1.0;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/gsl/1.14;
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/QT/4.7.4;
-- CMAKE_MODULE_PATH =
--    /afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ilcutil/v01-00/cmakemodules;
-- ------------------------------------------------------------------------------
--
-- Configuring done
-- Generating done
-- Build files have been written to: /afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/build
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$
[manqi@lxslc512 build]$ make install
Scanning dependencies of target RangerF1
[ 12%] Building CXX object CMakeFiles/RangerF1.dir/src/BushConnect.cc.o
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc: In member function 'void BushConnect::ParticleReco(EVENT::LCEvent*)':
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc:572: warning: unused variable 'MissTrkE'
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc: In member function 'void BushConnect::RecoFromMCP(EVENT::LCEvent*)':
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc:828: warning: unused variable 'totalTRKEn'
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc:914: warning: unused variable 'tmpMCPBushDis'
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/BushConnect.cc:919: warning: unused variable 'BushDist'
[ 25%] Building CXX object CMakeFiles/RangerF1.dir/src/BranchConnect.cc.o
[ 37%] Building CXX object CMakeFiles/RangerF1.dir/src/ArborTool.cc.o
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/ArborTool.cc: In function 'TVector3 ECALHitPos(EVENT::MCParticle*, TVector3&)':
/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/src/ArborTool.cc:859: warning: unused variable 'Coff_B'
[ 50%] Building CXX object CMakeFiles/RangerF1.dir/src/BranchAna.cc.o
[ 62%] Building CXX object CMakeFiles/RangerF1.dir/src/G2CD.cc.o
[ 75%] Building CXX object CMakeFiles/RangerF1.dir/src/BushMeasure.cc.o
[ 87%] Building CXX object CMakeFiles/RangerF1.dir/src/ArborPID.cc.o
[100%] Building CXX object CMakeFiles/RangerF1.dir/src/Ranger.cc.o
Linking CXX shared library lib/libRangerF1.so
[100%] Built target RangerF1
Install the project...
-- Install configuration: "RelWithDebInfo"
-- Installing: /afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/lib/libRangerF1.so.0.0.0
-- Up-to-date: /afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/lib/libRangerF1.so.0.0
-- Up-to-date: /afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/lib/libRangerF1.so
-- Set runtime path of "/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/lib/libRangerF1.so.0.0.0" to "/afs/ihep.ac.cn/users/m/manqi/Analysis/Arbor/ArborF1/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/Marlin/v01-04
/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/lcio/v02-03-01/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/mysql/usr/lib64:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/gear/v01-02-02/lib:/afs/ihep.
ac.cn/users/m/manqi/Software/ilcsoft/v01-16/CLHEP/2.1.1.0/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/ilcutil/v01-00/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/MarlinUtil/v01-05-03/lib:/afs/ihep.ac.cn/u
sers/m/manqi/Software/ilcsoft/v01-16/CED/v01-07/lib:/afs/ihep.ac.cn/users/m/manqi/Software/ilcsoft/v01-16/root/5.28.00f/lib"
[manqi@lxslc512 build]$
```

# Usage of Marlin

- Load the library to Marlin by setting the environment variable MARLIN_DLL

```
[manqi@lxslc512 ArborF1]$ ls
Arbor_ZH_F1_005_009.slcio  Arbor_ZH.root  build  buildbk  BushAna_ZH.root  cdb.log  CMakeLists.txt  include  IsoHit.root  lib  loadLDD.sh  src  steer
[manqi@lxslc512 ArborF1]$
[manqi@lxslc512 ArborF1]$
[manqi@lxslc512 ArborF1]$ cat loadLDD.sh
#! /bin/bash

#source env.sh
unset MARLIN_DLL
export MARLIN_DLL=$PWD/lib/libRangerF1.so
[manqi@lxslc512 ArborF1]$
```

- Control your module with steering file:
  - Useful command: print the reference steering file/verify if your module is properly loaded

    $MARLIN/bin/Marlin -l or $MARLIN/bin/Marlin -x
  - To execute:

    $MARLIN/bin/Marlin mymodule.steer

# Run

```
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 1918661907 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 2423952053 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 2423952053 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 2925365505 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 2925365505 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 1887322515 as seed for srand( seed )
[ DEBUG "Marlin"] ProcessorEventSeeder: Refresh Seeds using 1887322515 as seed for srand( seed )
[ VERBOSE "MyPrintHit"] 1000 events have been processed
[ VERBOSE "MyPrintHit"]  Number of Collections 9
[ MESSAGE "Marlin"]  ------------------------------------------------------------
[ MESSAGE "Marlin"]   Events skipped by processors :
[ MESSAGE "Marlin"]   Total: 0
[ MESSAGE "Marlin"]  ------------------------------------------------------------
[ MESSAGE "Marlin"]
[ MESSAGE "Marlin"]  ------------------------------------------------------------
[ MESSAGE "Marlin"]       Time used by processors ( in processEvent() ) :
[ MESSAGE "Marlin"]
[ MESSAGE "Marlin"] MyPrintHit                          9.900000e-01 s in         1000 events  ==> 9.900000e-04 [ s/evt.]
[ MESSAGE "Marlin"]            Total:                   9.900000e-01 s in         1000 events  ==> 9.900000e-04 [ s/evt.]
[ MESSAGE "Marlin"]  ------------------------------------------------------------
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$ ls
build  cdb.log  CMakeLists.txt  include  lib  loadLDD.sh  Muon_R1365_80GeV.root  src  steer
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$
[manqi@lxslc509 AnaGeo]$ root -l Muon_R1365_80GeV.root
```

# Summary

- 40 packages, ~10 commands.
- LCIO: data format
- Marlin: data manger
- Mokka: Geant4 Full Simulation

# Important Executable

- LCIO: dumpevent, anajob
- Mokka: sh ./MuonSimu.sh
- Marlin:
  - Usage:
    - loadLDD.sh
    - Marlin -l
    - Marlin Mysteer.steer
  - Compile:
    - Cmake: Hfcmake = cmake -C ILCSoft.cmake .
    - Make install
- Druid: Druid *.slcio *gdml.root

# Homework: Event Display

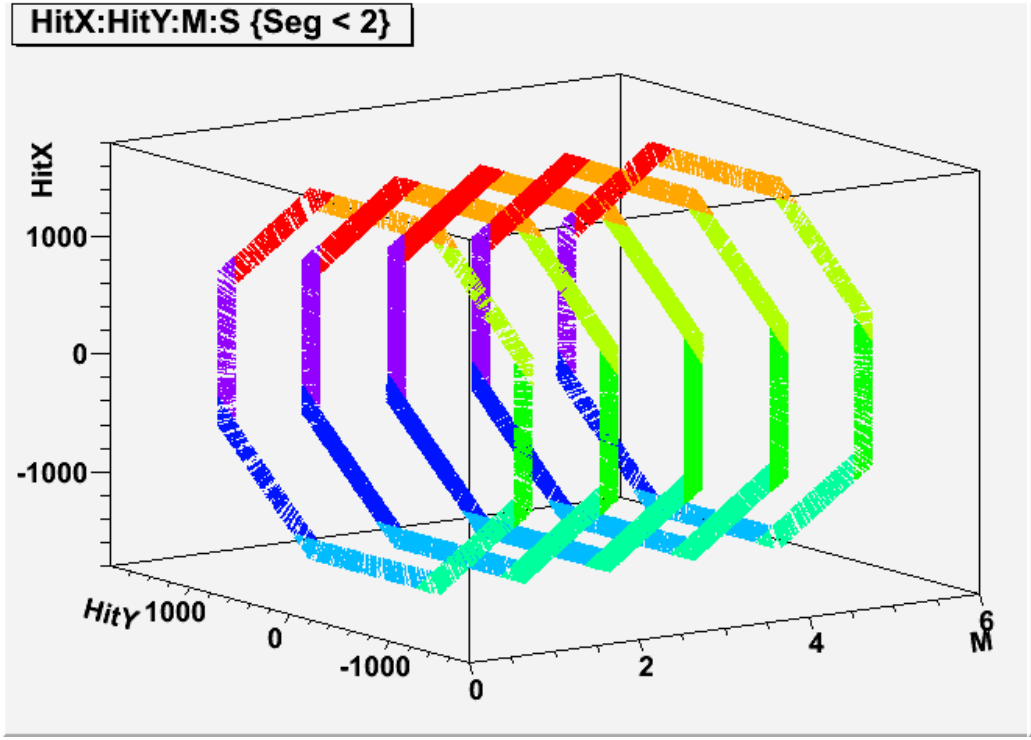
- Explore Druid, using hotkeys (w, e, r, j, k), your mouse, and ...
- Snapshot/Save with whatever geometry, whatever data sample (better matched with geometry) and whatever style
- Send your favorite Event Display to

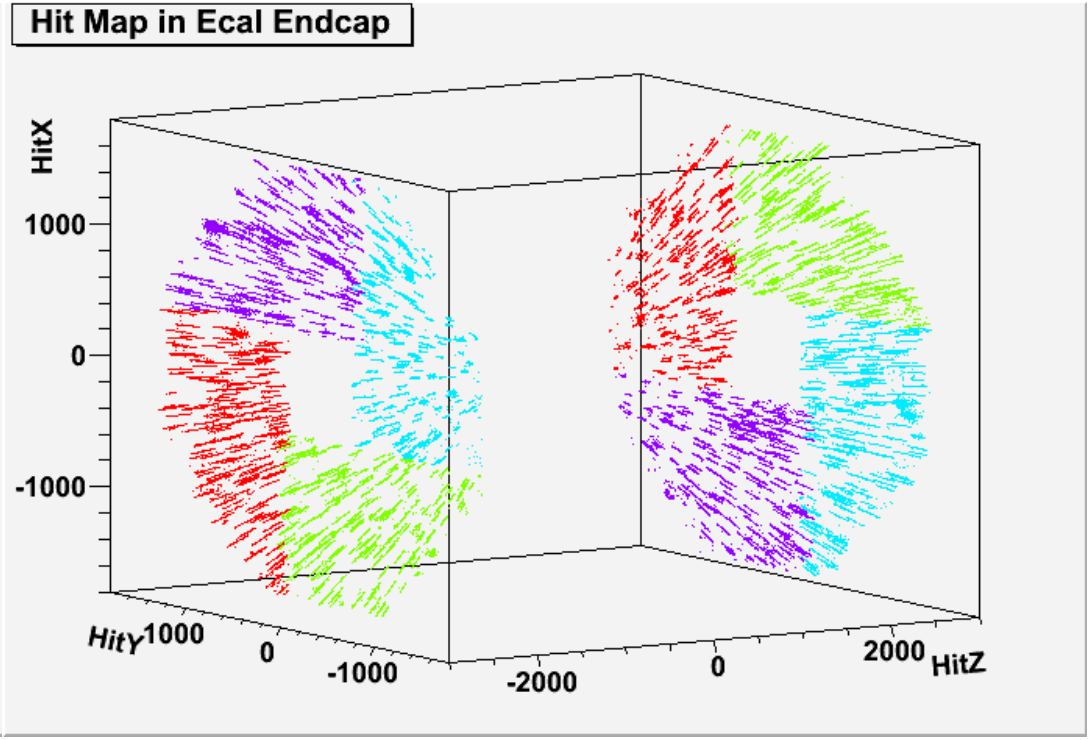
  *(the mail should be named “Event display at Nankai Training”)*

Manqi.ruan@ihep.ac.cn

# Backup

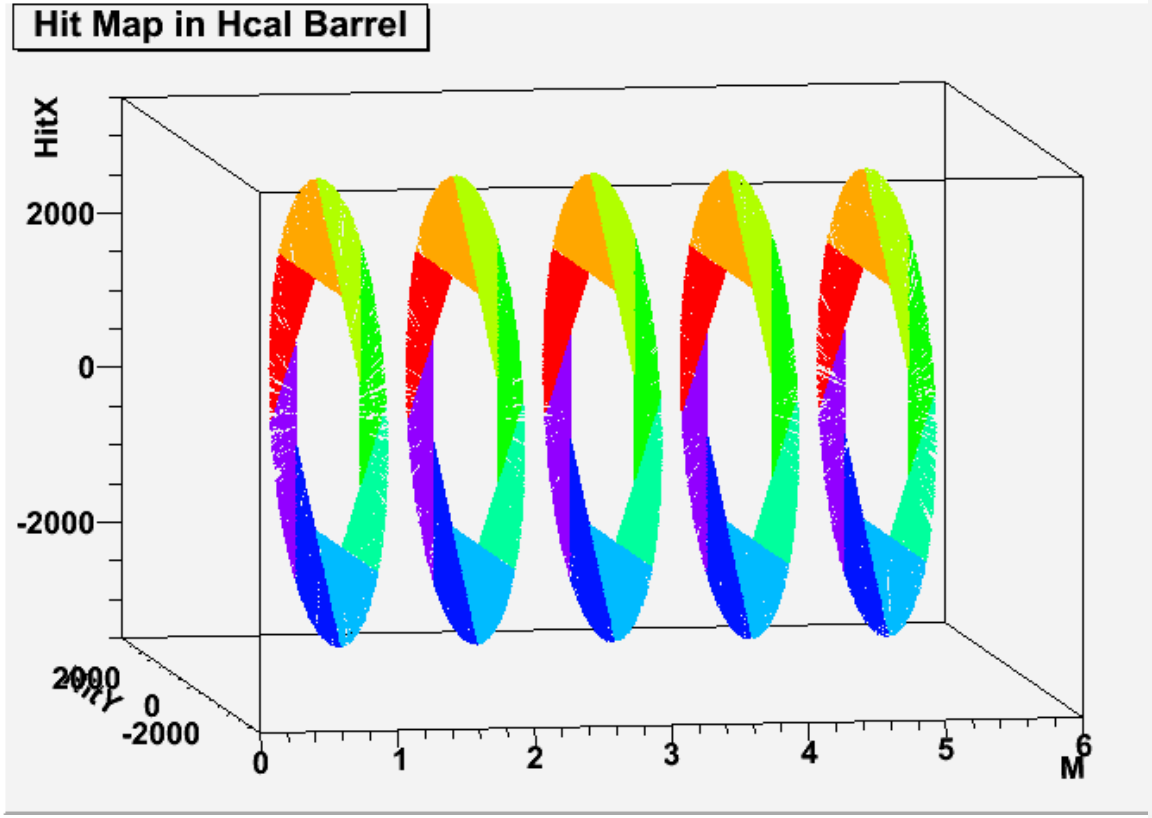
# Hit Map: Ecal

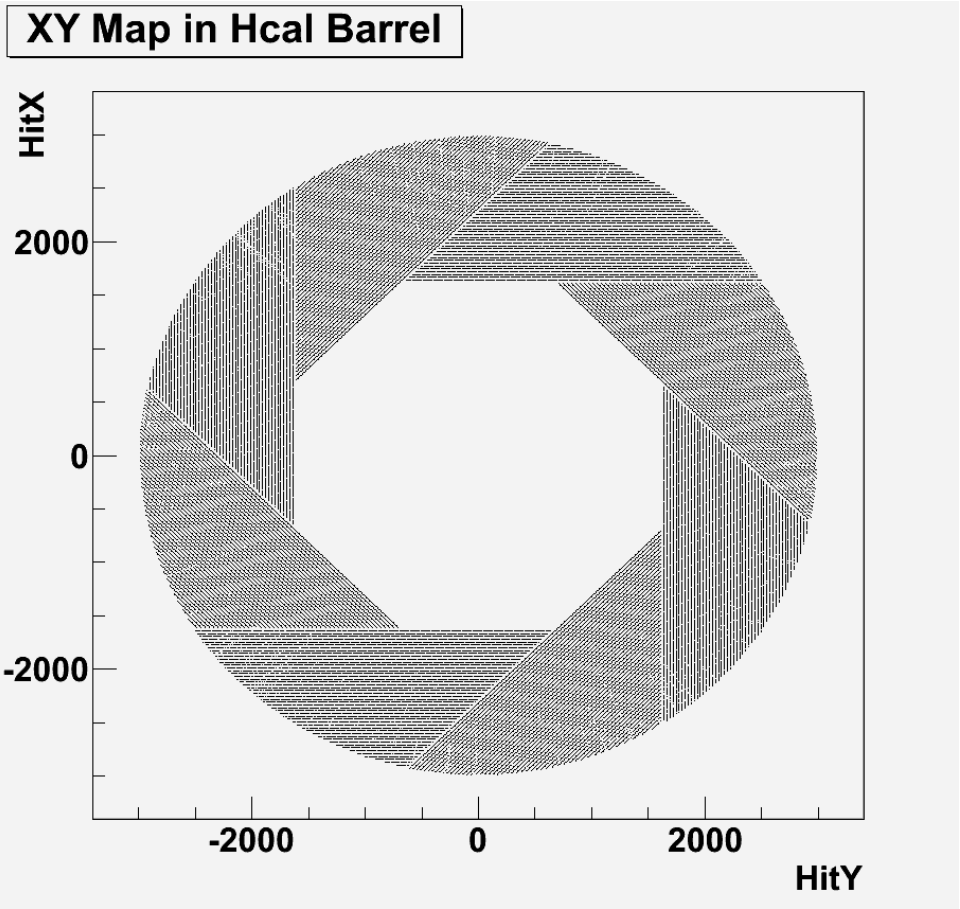



Index M: Module number: Ecal/Hcal Barrel is divided into 5 modules along Z direction.

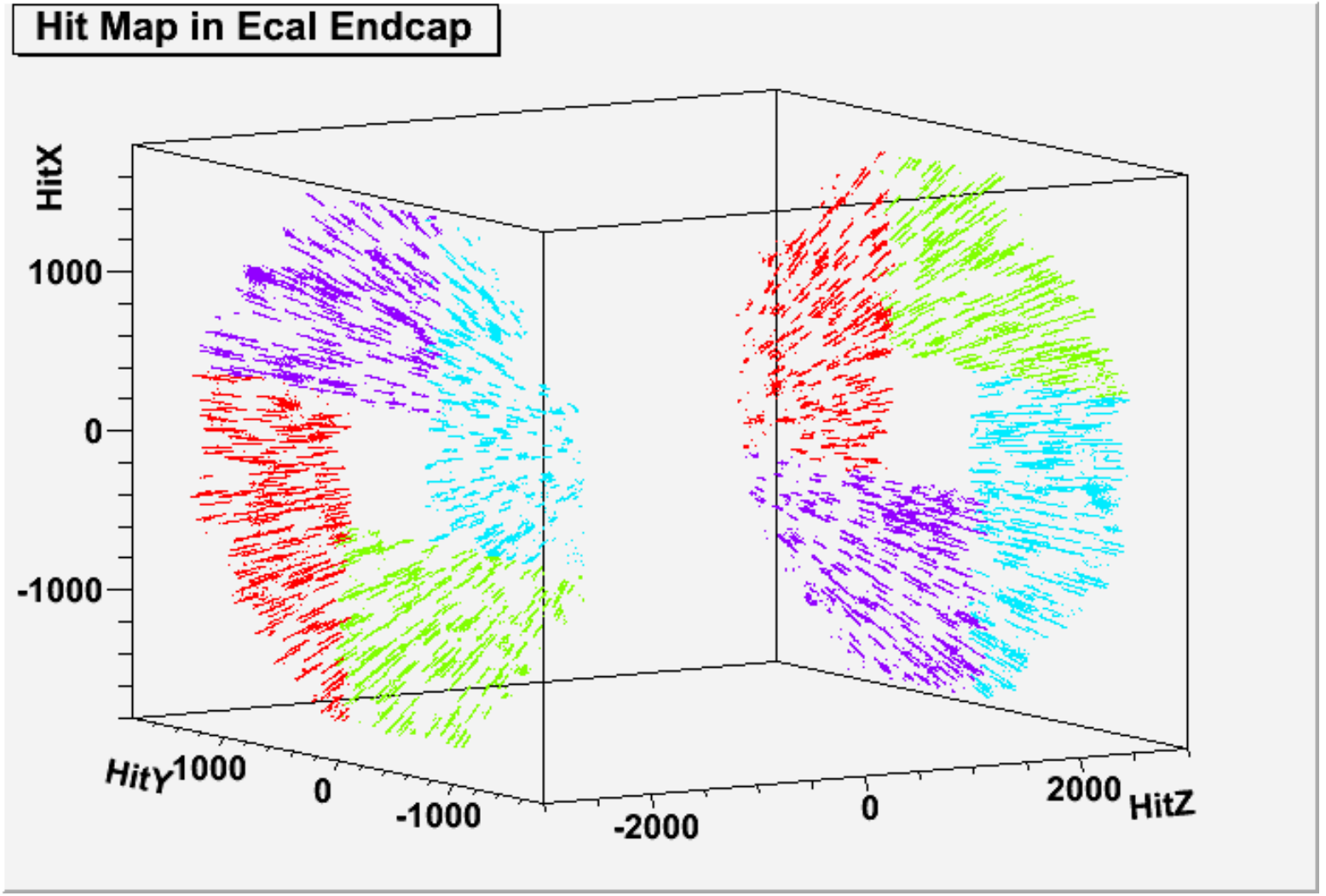
# Hit Map: Hcal Barrel



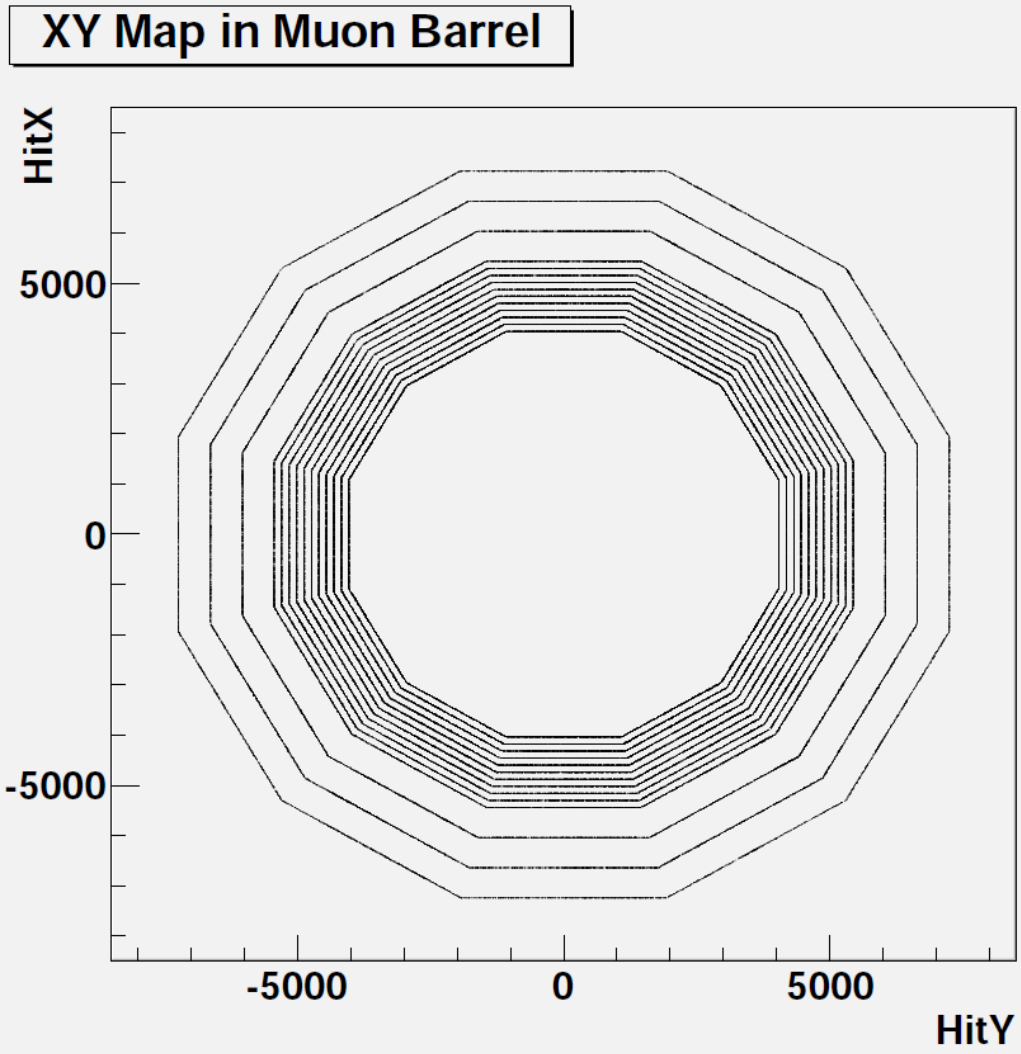



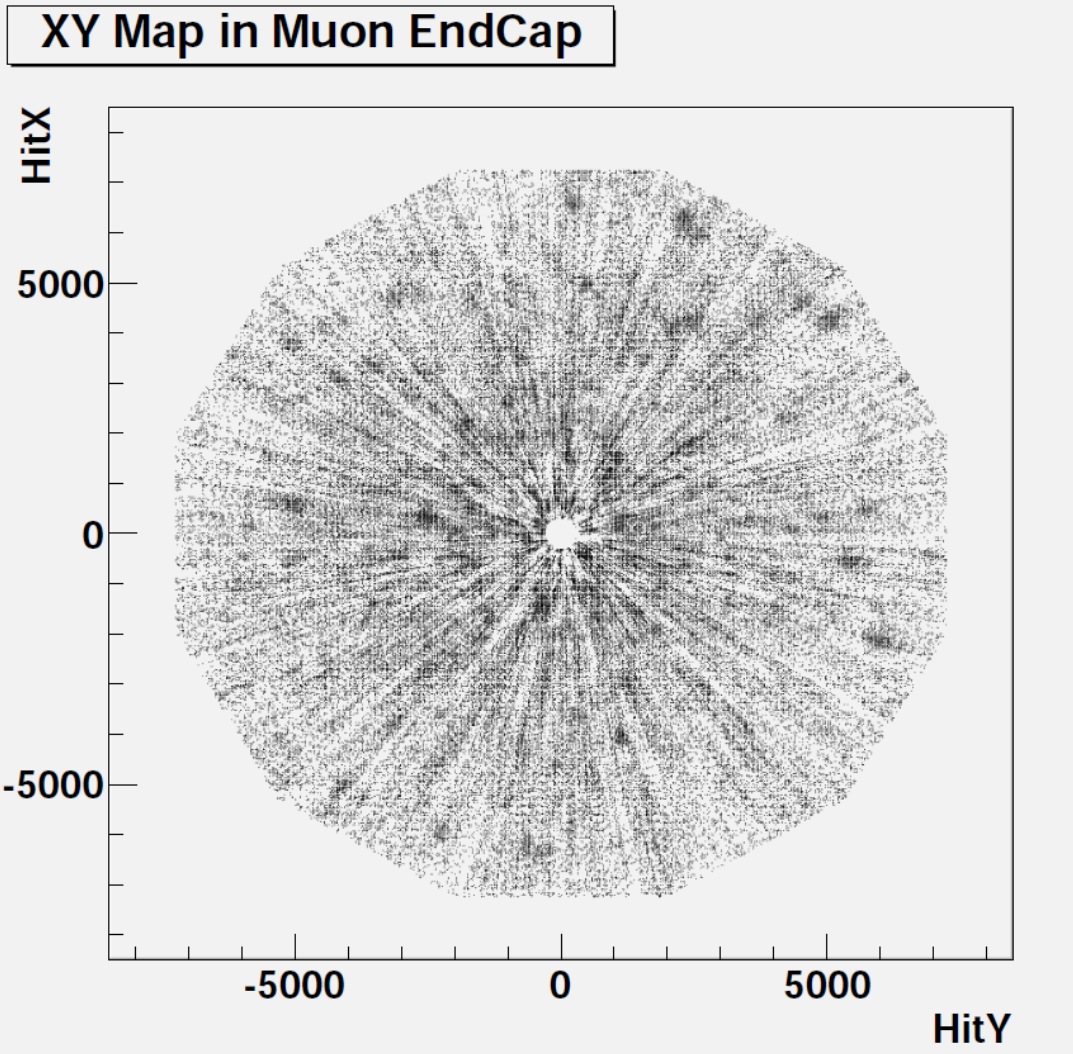

A la videau structure

# Hit Map: Hcal Endcap



# HitMap: Muon




No obvious defect tagged.