

Training plan

- Introduction to Higgs Physics (this morning)
- General introduction/usage of ilcsoft: LCIO, Mokka, Marlin & Druid
- Generator: official ILC Sample
 - Access to generator information and Fast Simulation (Yangying, MQ)
- Simulation:
 - Browser/Edit/Validation of detector geometry: Druid & HitMap Method
 - Mokka experience (Xu Yin)
- Reconstruction:
 - Digitization - G2CD
 - Track Reconstruction – MarlinTrk (Libo)
 - PFA - Arbor
- Analysis: Pattern tagging at high-granularity detector

A Brief Introduction to ILCSoft: LCIO, Marlin & Mokka

Manqi

Foreword:

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

Apologize if our server is slow...

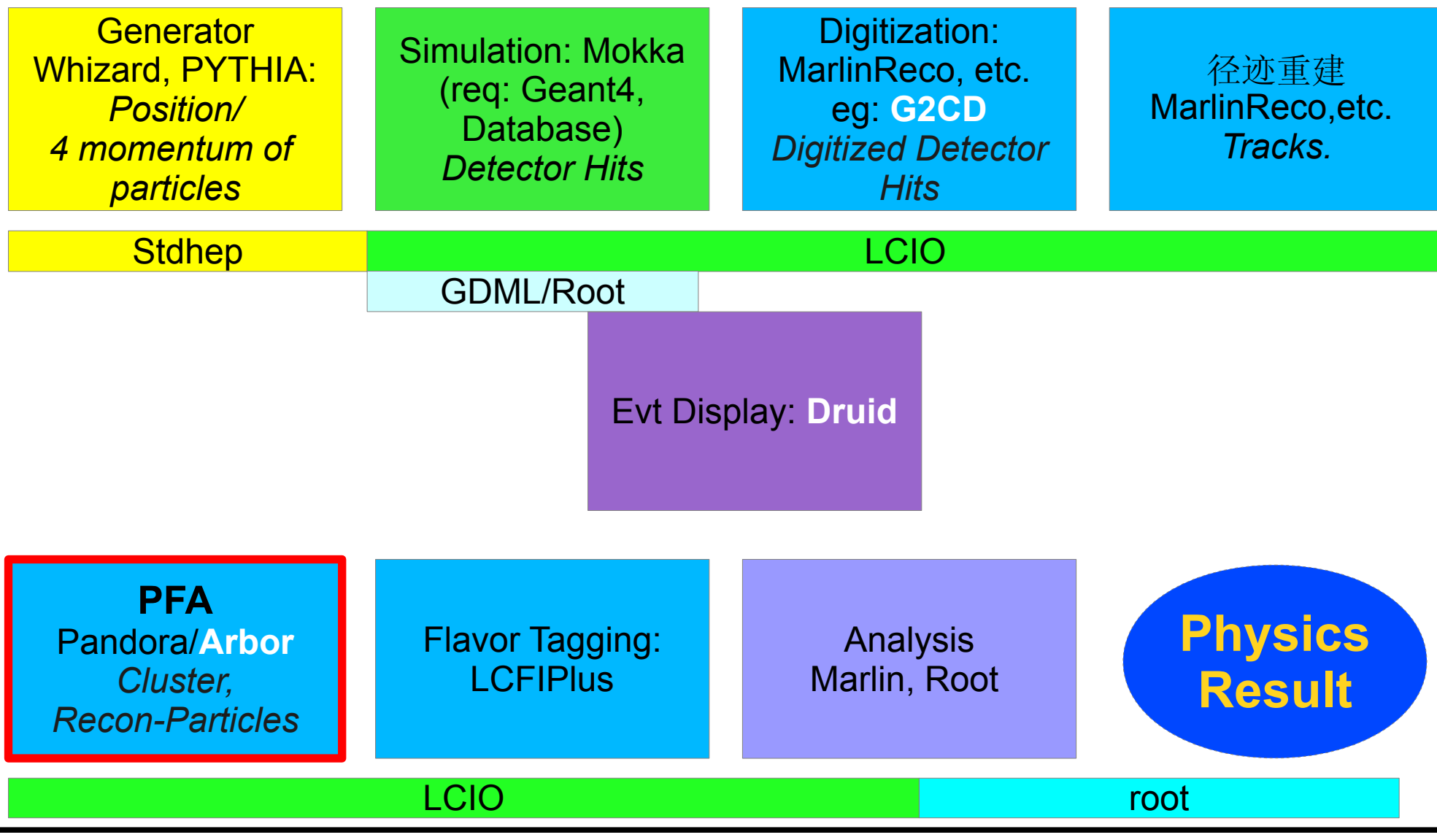
ILCSoft:

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



LCIO: Data format

Path: `/besfs/groups/higgs/Software/ilcsoft_v01-16/lcio/v02-03-01`

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`

Training package

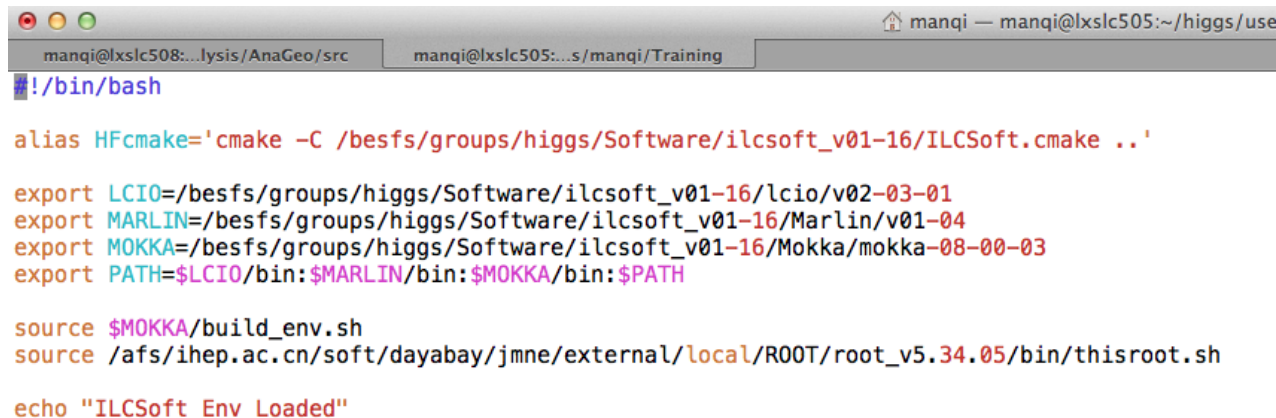
- At lxslc5.ihep.ac.cn: /besfs/groups/higgs/users/manqi/Training
- Copy to your own directory & set the environment

```
cd
```

```
cp -r /besfs/groups/higgs/users/manqi/Training .
```

```
cd Training
```

```
./env_ilcsoft.env
```



```
manqi@lxslc508:...ysis/AnaGeo/src  manqi@lxslc505:...s/manqi/Training  manqi — manqi@lxslc505:~/higgs/use
#!/bin/bash

alias HFcmake='cmake -C /besfs/groups/higgs/Software/ilcsoft_v01-16/ILCSoft.cmake ..'

export LCIO=/besfs/groups/higgs/Software/ilcsoft_v01-16/lcio/v02-03-01
export MARLIN=/besfs/groups/higgs/Software/ilcsoft_v01-16/Marlin/v01-04
export MOKKA=/besfs/groups/higgs/Software/ilcsoft_v01-16/Mokka/mokka-08-00-03
export PATH=$LCIO/bin:$MARLIN/bin:$MOKKA/bin:$PATH

source $MOKKA/build_env.sh
source /afs/ihep.ac.cn/soft/dayabay/jmne/external/local/ROOT/root_v5.34.05/bin/thisroot.sh

echo "ILCSoft Env Loaded"
```


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

```
manqi@xslc512:~/Arbor/ArborF1 ... manqi@bl-1-1:~/Simulation include -- manqi@
// -*- 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_Cluster
= dynamic_cast<Cluster*>(ClusterColl->getElementAt(#Num));

a_Cluster->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	
EcalBarrelSiliconPreShowerCollection	SimCalorimeterHit		98
EcalBushSke	Cluster	111	
EcalBushes	Cluster	111	
EcalEndcapRingCollection	SimCalorimeterHit	51	
EcalEndcapRingPreShowerCollection	SimCalorimeterHit		4
EcalEndcapSiliconCollection	SimCalorimeterHit	1470	

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

Statistic of number of object in each
Collection

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
 - Servers at IHEP, France, Germany.
- Usage:
 - Event: particle gun/generator
 - Select/edit geometry
 - Output: Icio 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@lxslc507:~/higgs/users/manqi/Training/Simulation — ssh — 103x59  
manqi@lxslc508:~/analysis/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]$
```

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 Yangying'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 Icio

\$Training/Analysis/StdhepReader/conv.steer

```
manqi@lxslc509:~/Training/Analysis/StdHepReader — ssh — 122x29
.begin Global -----
ActiveProcessors MyStdHepReader
ActiveProcessors MyLCI00outputProcessor

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 MyLCI00outputProcessor
ProcessorType LCI00outputProcessor

LCI00outputFile Pffh_RL_005.slcio

.end -----
```

MCParticle collection in the generator

manqi — manqi@xlslc514:~/higgs/users/manqi/Training/Analysis/StdhepReader — ssh — 225x52

```
=====
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: [sbtvctls]  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
```

Marlin conv1.steer

dumpevent Pffh_RL_005.slcio 1 | less

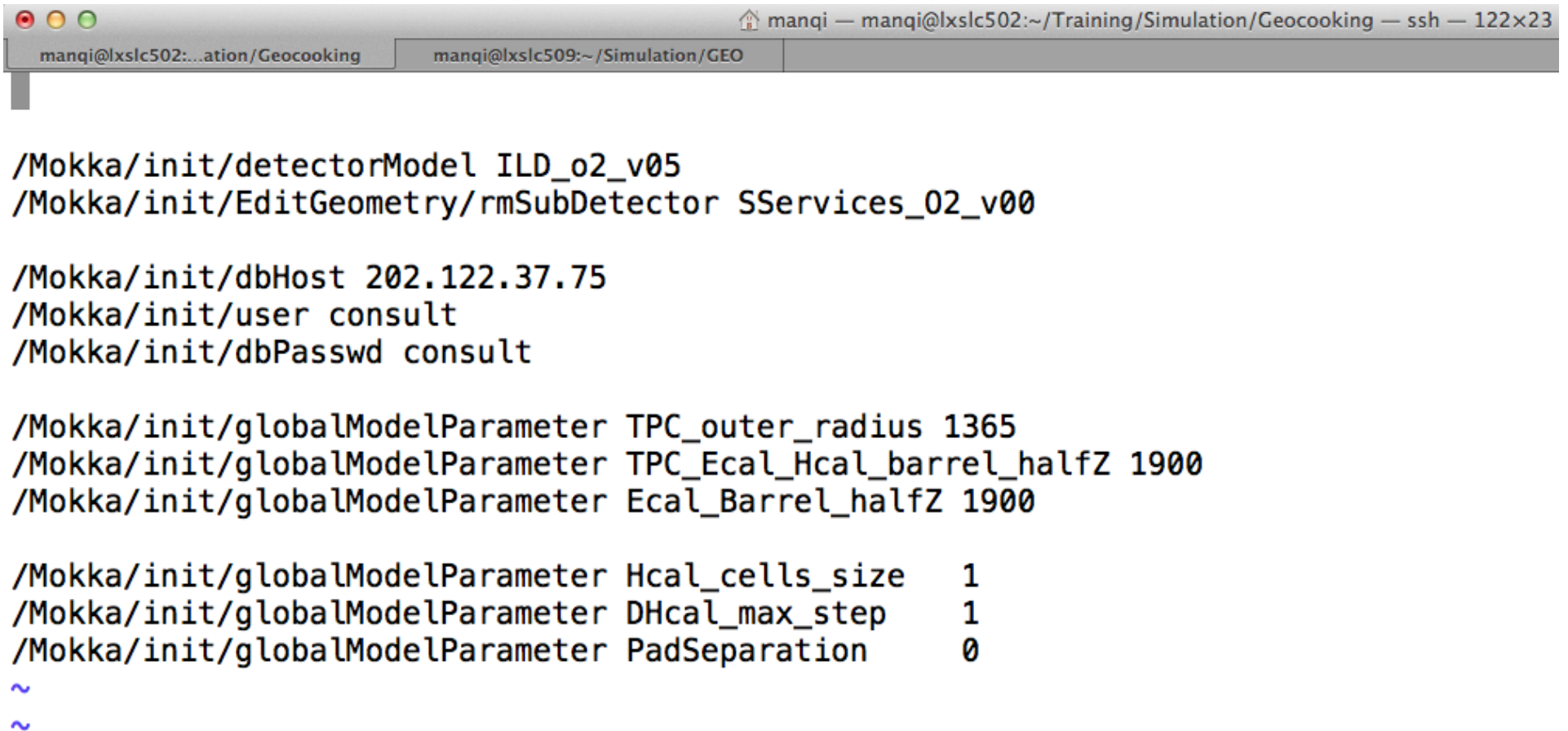
[id]	[index]	PDG	px	py	pz	energy	[gen]	[simstat]	vertex x	y	z	endpoint x	y	z	mass	charge	spin	colorflow	[parents]	- [daughte
[00000004]	0	22	6.39e-03	-5.83e-04	4.28e-02	4.33e-02	2	[	0	]	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	0.00e+00	(0, 0)	[] - [5]
[00000005]	1	22	2.82e-05	1.32e-04	-3.56e-01	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, 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	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	1.78e+00	1.00e+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	1.25e+02	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, 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, 0)	[] - []
[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	0.00e+00	(0, 0)	[] - [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	1.78e+00	1.00e+00	0.00e+00	(0, 0)	[] - [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	1.25e+02	0.00e+00	0.00e+00	(0, 0)	[] - [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	8.79e+01	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, 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	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, 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, 0)	[] - []
[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	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	9.28e+01	0.00e+00	0.00e+00	(0, 0)	[] - [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	3.30e-01	-3.33e-01	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	3.30e-01	3.33e-01	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	5.00e-01	-3.33e-01	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	5.00e-01	3.33e-01	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	2.38e+01	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	3.30e-01	-3.33e-01	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	2.42e+00	3.33e-01	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	3.30e-01	3.33e-01	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, 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	9.28e+01	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	2.37e+01	-3.33e-01	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	2.58e+00	3.33e-01	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	7.15e+00	-3.33e-01	0.00e+00	(0, 0)	[] - [27] - [33,34]

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



```
manqi@lxslc502:~/Training/Simulation/Geocooking — ssh — 122x23
manqi@lxslc502:~/Training/Simulation/Geocooking
manqi@lxslc509:~/Simulation/GEO

/Mokka/init/detectorModel ILD_o2_v05
/Mokka/init/EditGeometry/rmSubDetector SServices_02_v00

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

/Mokka/init/globalModelParameter TPC_outer_radius 1365
/Mokka/init/globalModelParameter TPC_Ecal_Hcal_barrel_halfZ 1900
/Mokka/init/globalModelParameter Ecal_Barrel_halfZ 1900

/Mokka/init/globalModelParameter Hcal_cells_size 1
/Mokka/init/globalModelParameter DHcal_max_step 1
/Mokka/init/globalModelParameter PadSeparation 0
~
~
```

By using globalModelParameter...

Init Mokka with geometry macro, and dump gdml file out

```
manqi@lxslc502:~/Training/Simulation/Geocooking — ssh — 122x23
manqi@lxslc502:~/Training/Simulation/Geocooking
manqi@lxslc509:~/Simulation/GEO
an e-mail to Gabriel Musat <musat@poly.in2p3.fr> or
Frank Gaede <frank.gaede@desy.de>.

You built Mokka/LCIO release. Concerning the LCIO project
and help, please visit the LCIO site http://lcio.desy.de

You built MokkaGear release. Concerning the GEAR project
and help, please visit the Gear site http://ilcsoft.desy.de

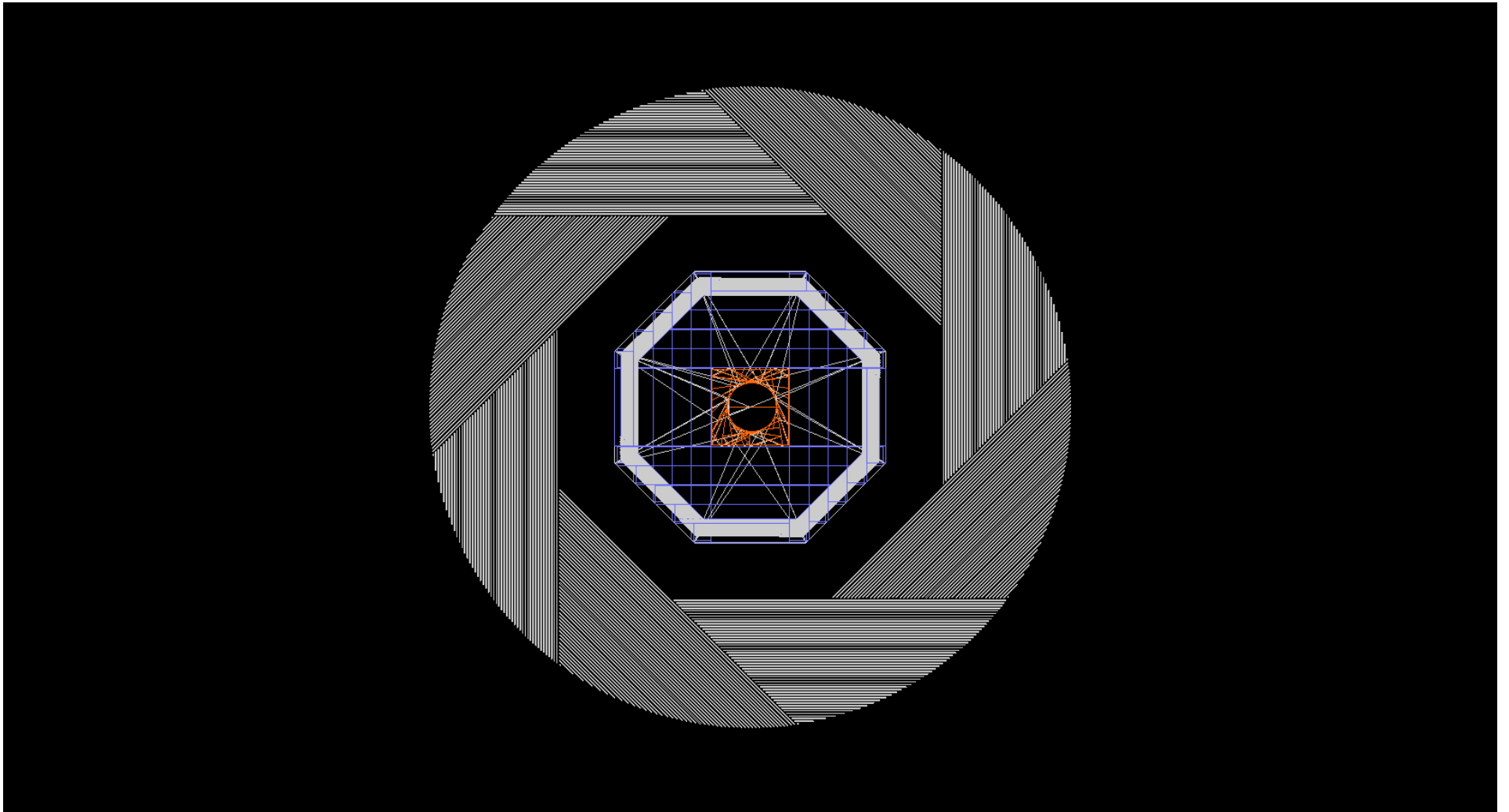
Thank you for running Mokka and good luck!

Idle> Mokka/Visu/Detector/DumpGDML
G4GDML: Writing 'World.gdml'...
G4GDML: Writing definitions...
G4GDML: Writing materials...
G4GDML: Writing solids...
G4GDML: Writing structure...
G4GDML: Writing setup...
G4GDML: Writing surfaces...
G4GDML: Writing 'World.gdml' done !
(these changes will take effect on the next view rendering if this deep is visible)
Idle>
Idle> █
```

If root is compiled with gdml option...

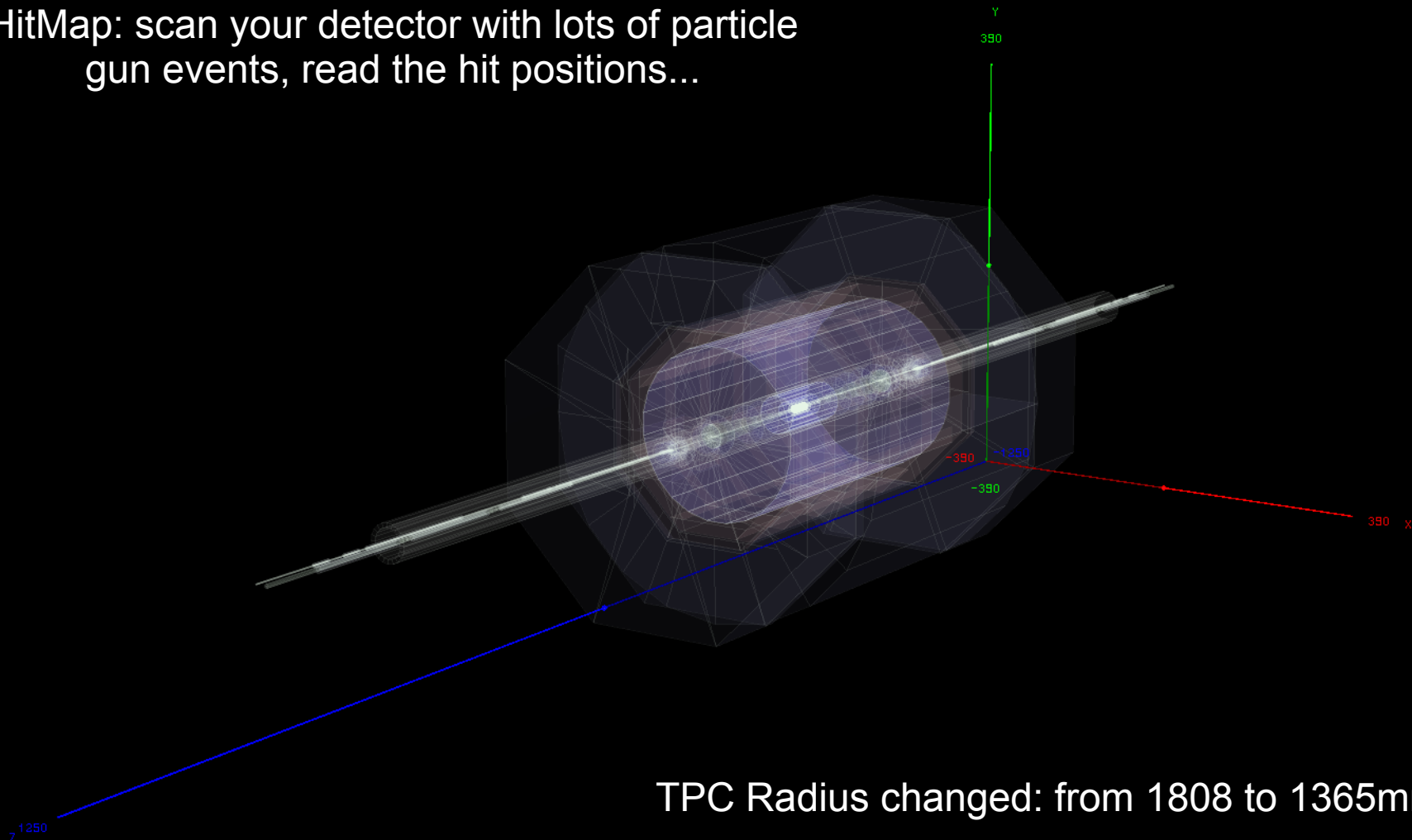
```
[manqi@lxslc502 Geocooking]$ cat Geo.C
{
    TGeoManager::Import("World.gdml");
    gGeoManager->GetTopVolume()->Draw("ogl");
    TFile *f = new TFile("ShortTPC.root","recreate");
    gGeoManager->Write();
    f->Close();
}
[manqi@lxslc502 Geocooking]$
[manqi@lxslc502 Geocooking]$
[manqi@lxslc502 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...



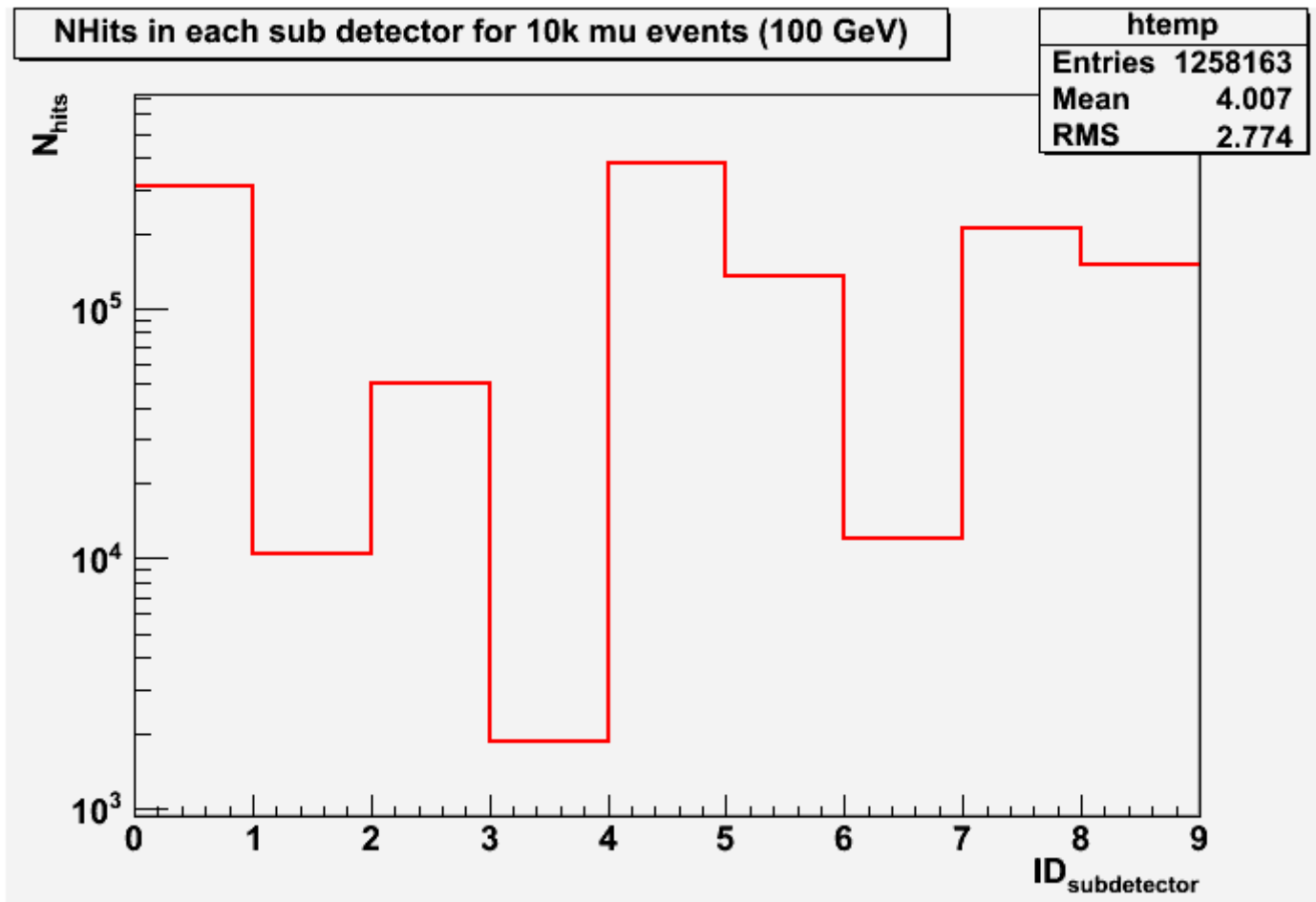
Geometry could/should also be Xchecked from Hit Map

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



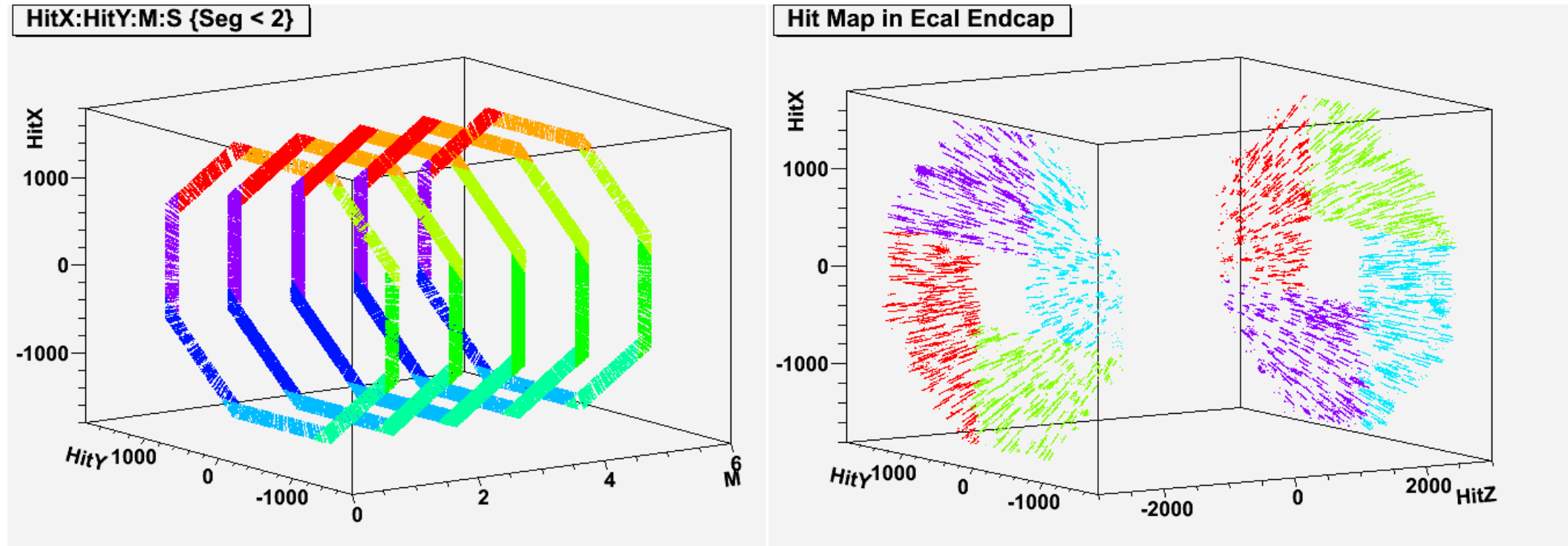
TPC Radius changed: from 1808 to 1365mm

Hit Map



- ID Coding:
- 0: Ecal Barrel (NL = 29)
 - 1: Ecal Barrel Pre shower (first sensitive layer of Ecal: before absorber)
 - 2: Ecal Endcap (29)
 - 3: Ecal Endcap Pre Shower
 - 4: Hcal Barrel (48)
 - 5: Hcal Endcap (48)
 - 6: Hcal Endcap ring (6)
 - 7: Muon Barrel (14)
 - 8: Muon Endcap (12)

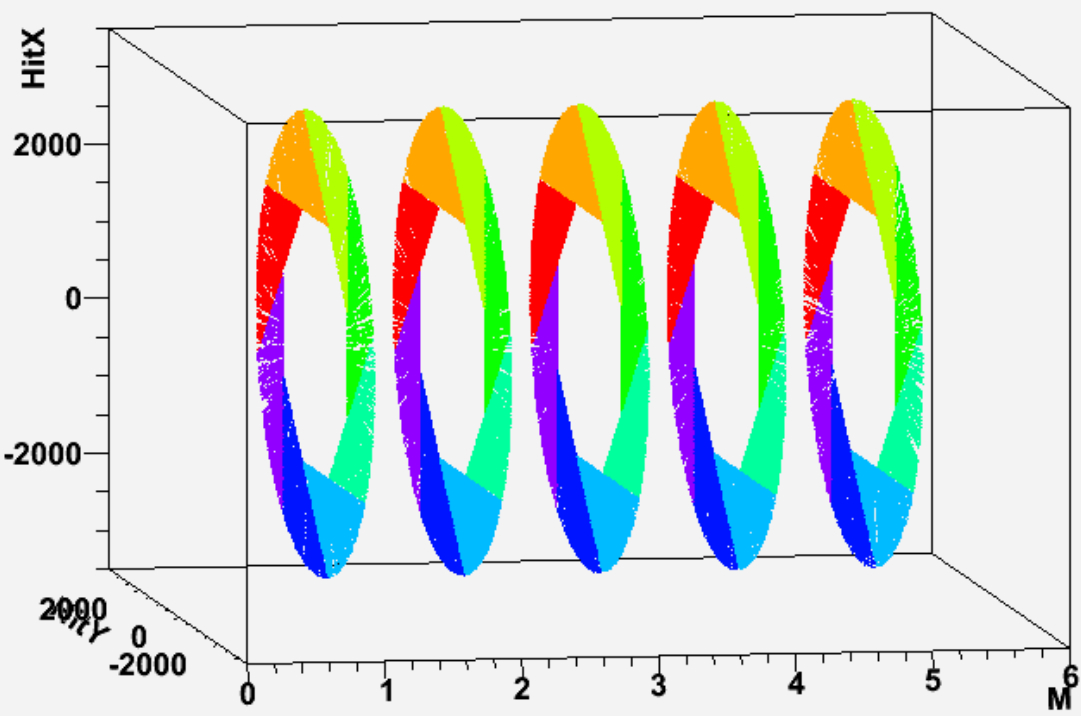
Hit Map: Ecal



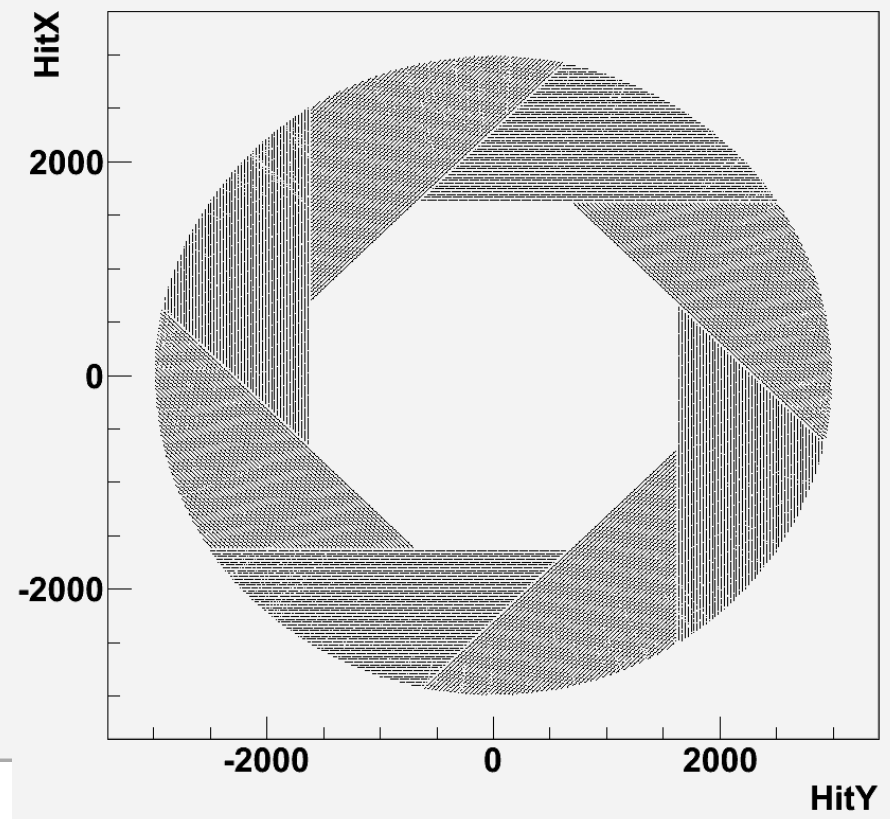
Index M: Module number: Ecal/Hcal Barrel is divided into 5 modules along Z direction.

Hit Map: Hcal Barrel

Hit Map in Hcal Barrel

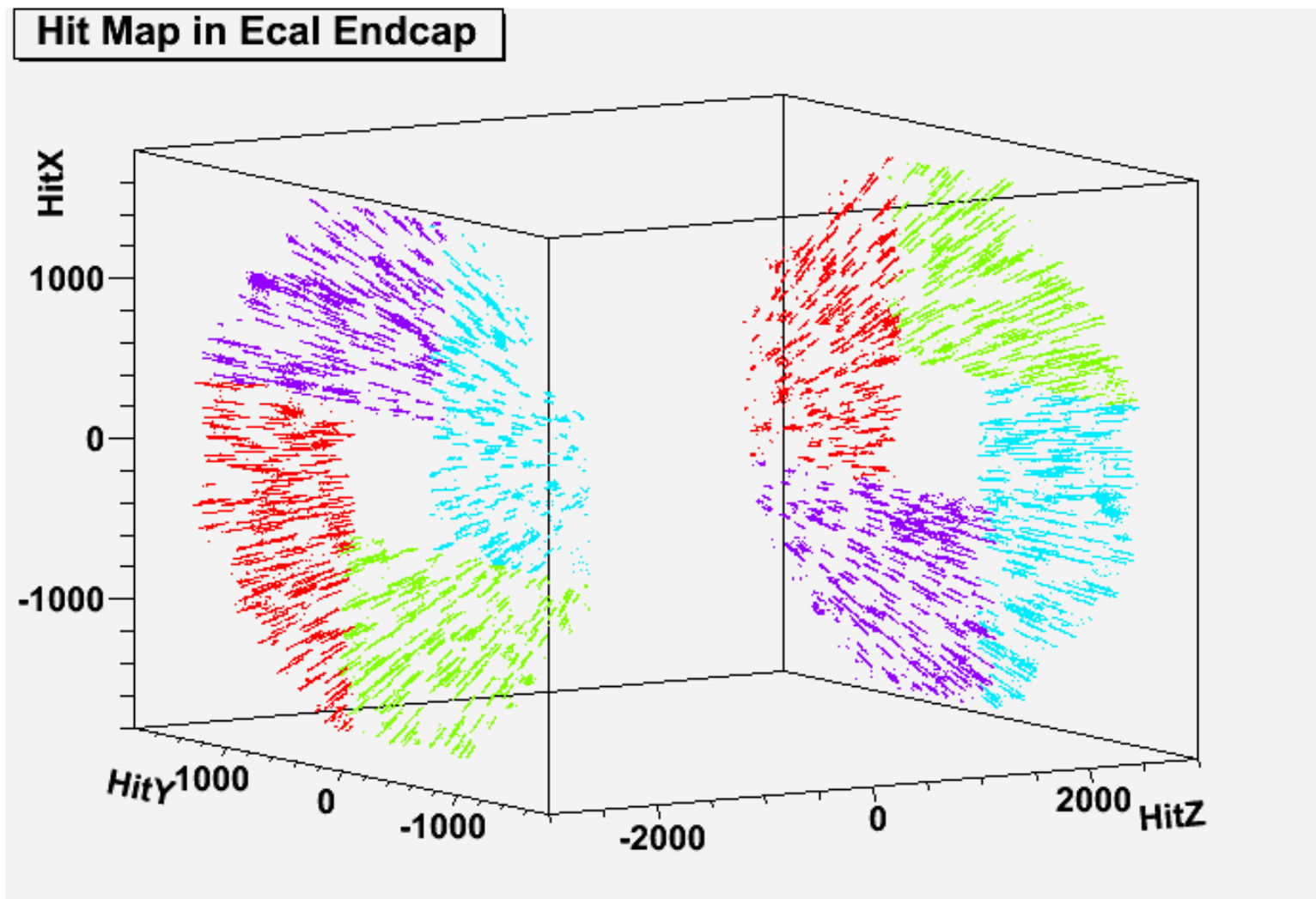


XY Map in Hcal Barrel



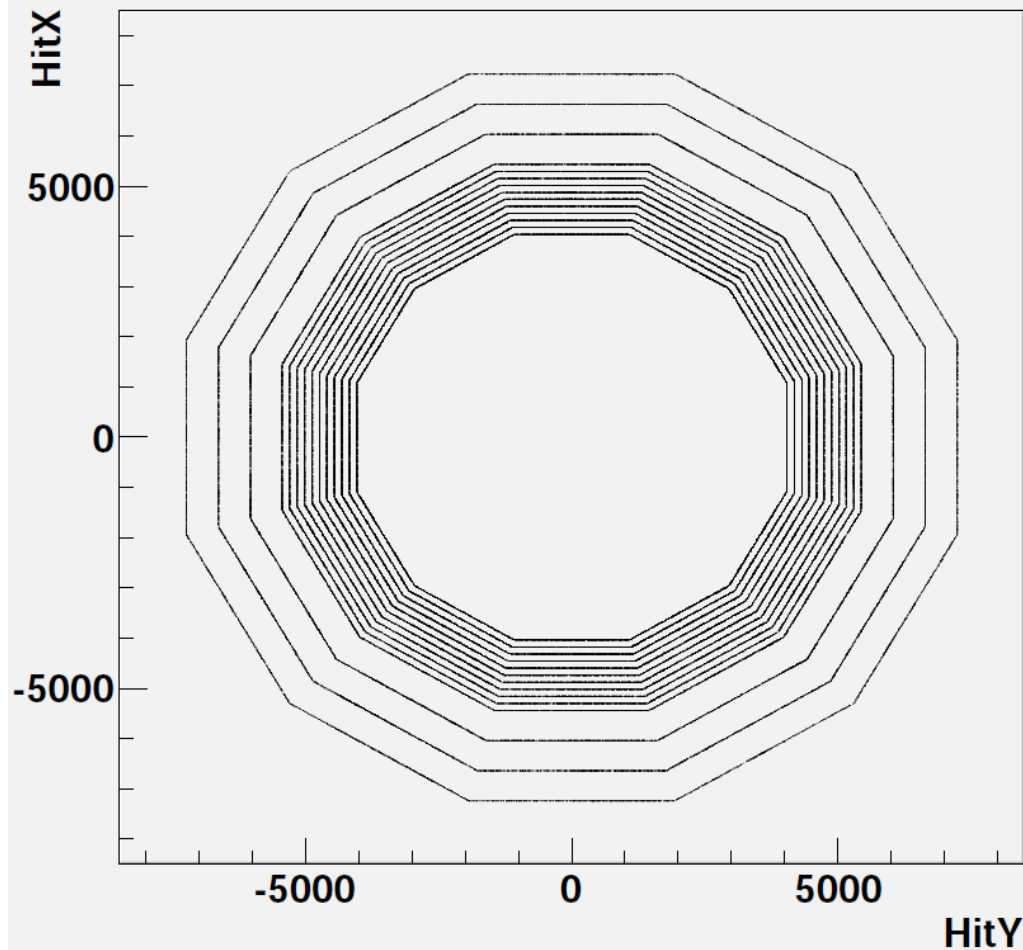
A la videau structure

Hit Map: Hcal Endcap

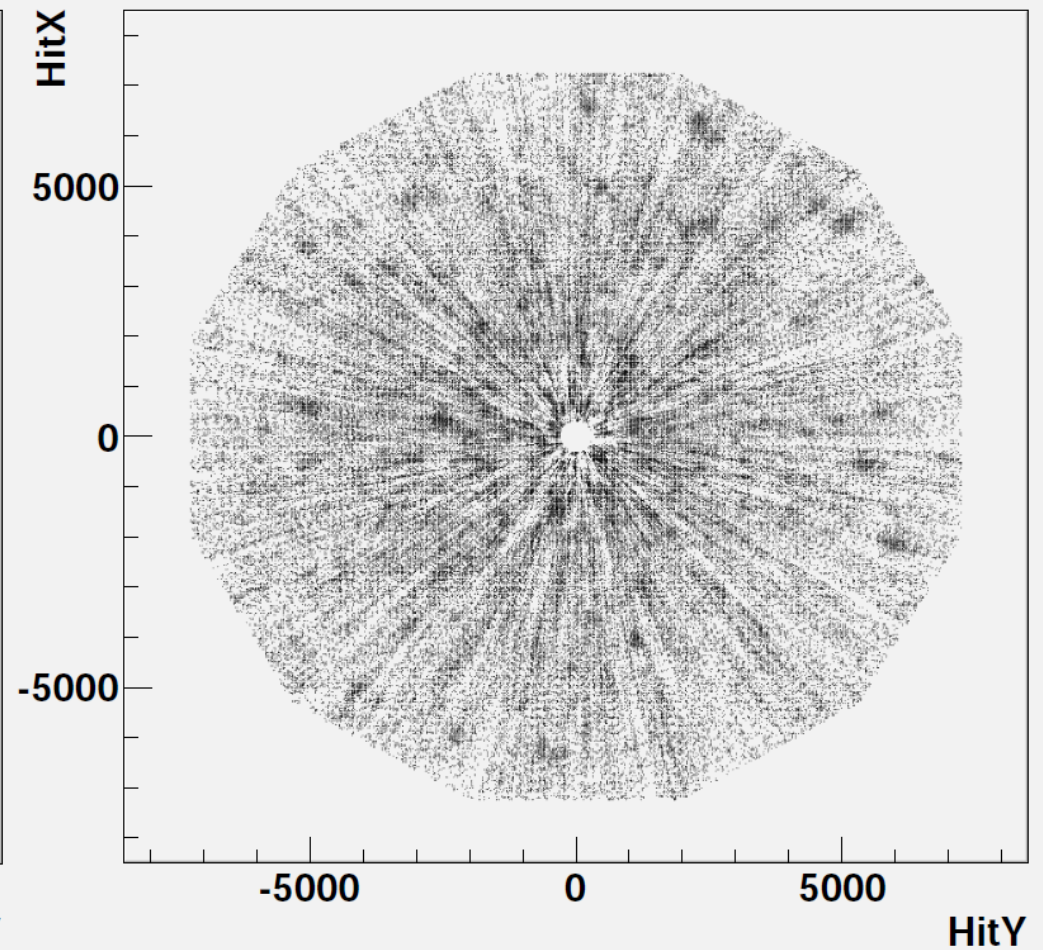


HitMap: Muon

XY Map in Muon Barrel



XY Map in Muon EndCap



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 — 231x59
manqi@lxslc512:~/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
# MCOjects 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 — 231x59

```
`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 ILCMAKE_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 — 231x59
-- /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
-- 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/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/users/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" ] 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 Myster.steer
 - Compile:
 - Cmake: Hfcmake = cmake -C ILCSoft.cmake .
 - Make install
- **Druid: Druid *.slcio *gdml.root**