Status of Geometry Management

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JUNO Physics and Software Workshop@WHU

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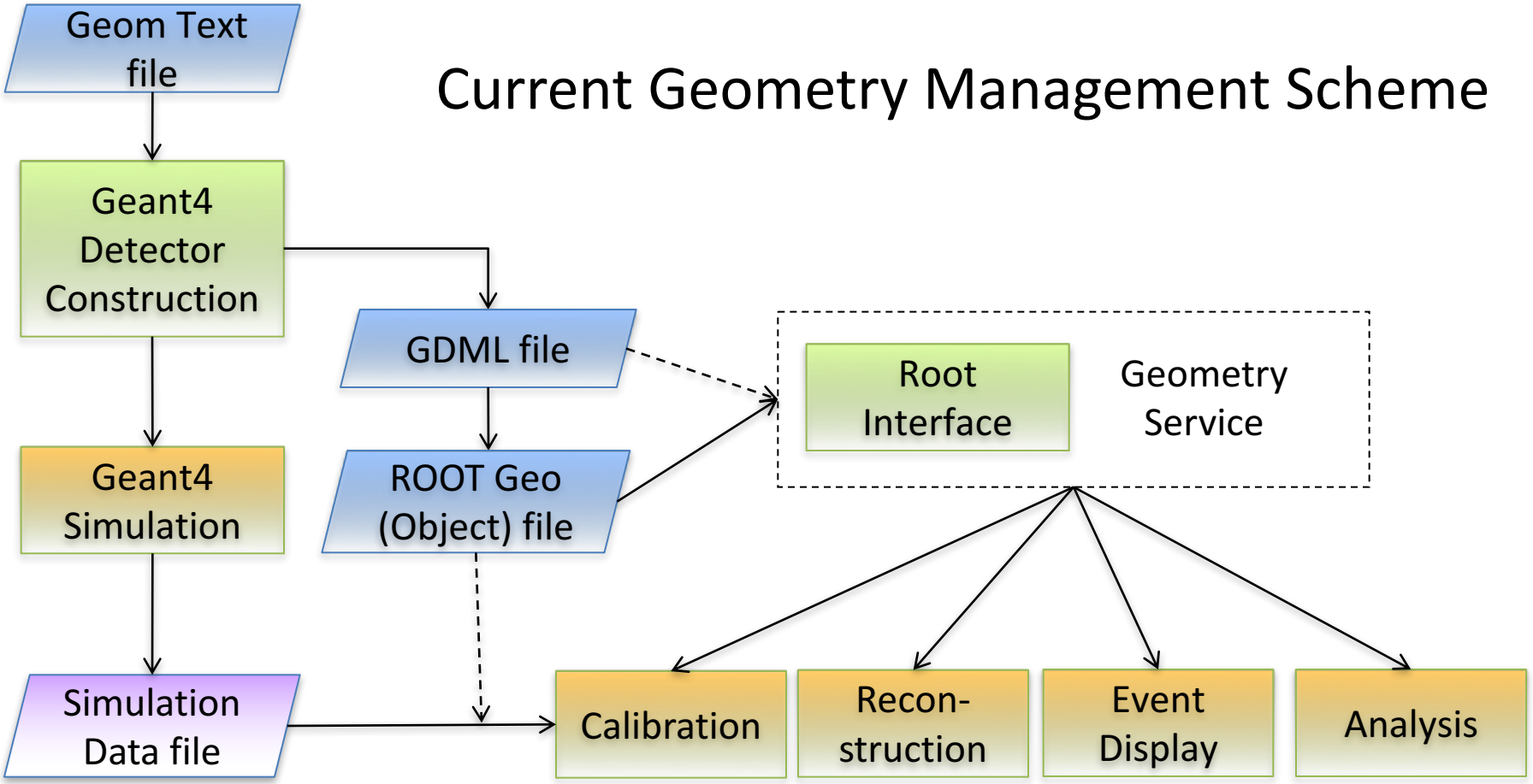
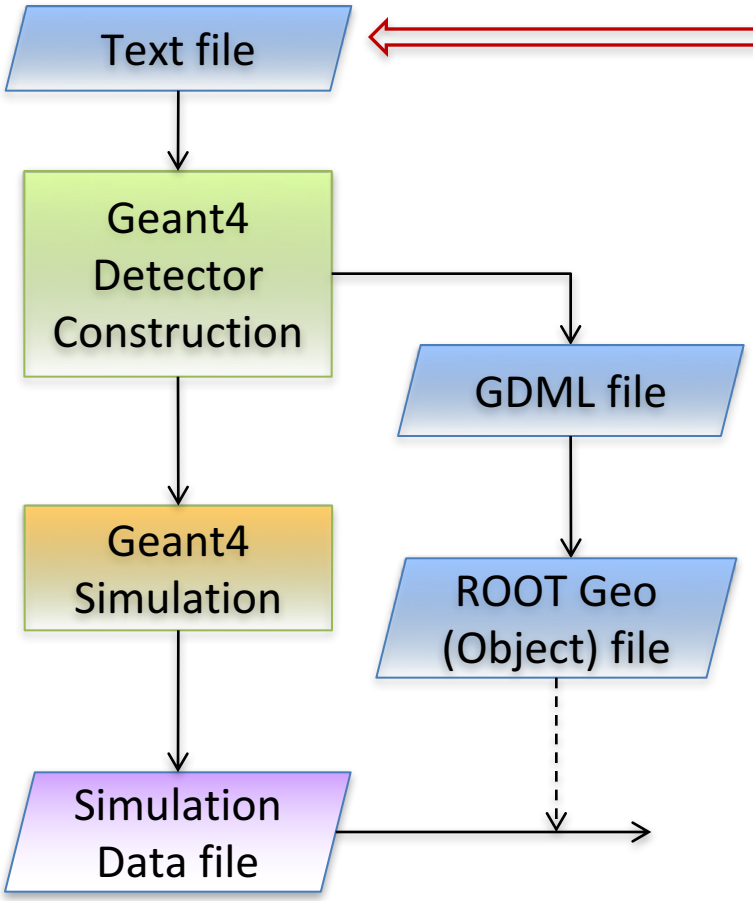
Outline

- Overview
- Identifier
- Geometry service
- Summary
- Next work

Geometry Overview



Geometry Data



Geom Raw Data

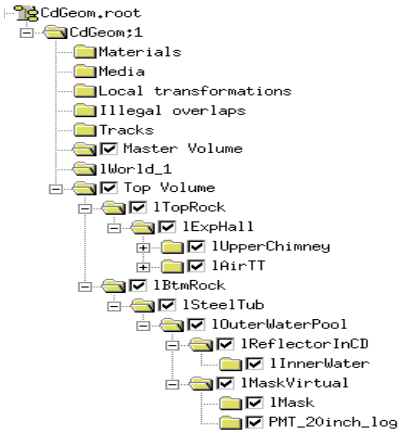
- 3inch_pos.csv
- Det1PMTPos_new.csv
- PMTPos_Acrylic.csv
- PMTPos_Balloon.csv
- Strut_Acrylic.csv
- Strut_Balloon.csv

Line			
1	2	4.2282	10
2	2	4.2282	50
3	2	4.2282	90
4	2	4.2282	130
5	2	4.2282	170
6	2	4.2282	210
7	2	4.2282	250
8	2	4.2282	290
9	2	4.2282	330
10	4	7.3602	17.419355
11	4	7.3602	40.645161

Geom GDML Data

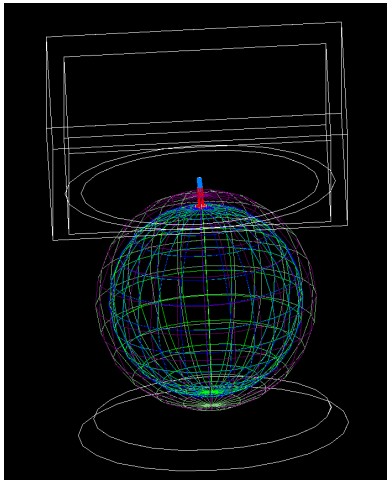
```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<gdml xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:

  <define>
    <matrix coldim="2" name="ABSLENGTH0x3656ca0" values="1.3778e
    <matrix coldim="2" name="FASTCOMPONENT0x365c800" values="1.5
    <matrix coldim="2" name="GammaFASTTIMECONSTANT0x3663950" val
```

Geom ROOT Data

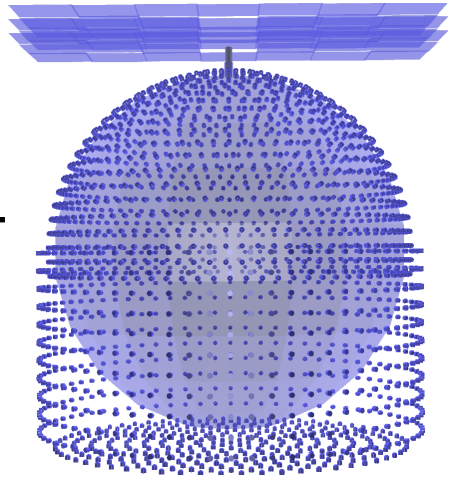


Geometry Consistency

- A single source of detector description shared by all applications
- Consistency between APPs is guaranteed by G4-GDML-ROOT automatic conversion
- Some special detector information (e.g. optical surfaces, matrix) are not supported

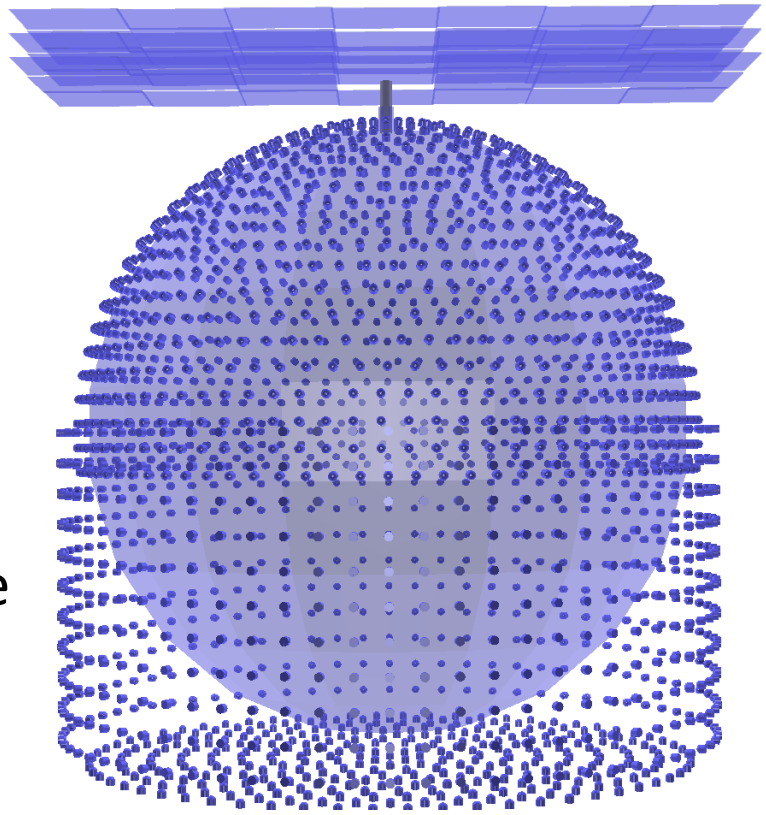


Geant4 ↔ GDML ↔ ROOT



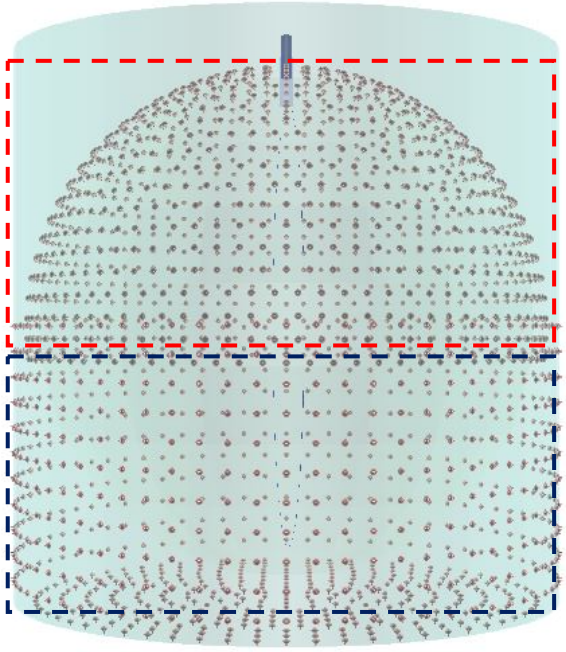
Identifier

- Coding for each specific unit in all sub detectors;
- Mapping identifier in offline with 32 bits unsigned integer 0xFFFFFFFF;
- Current status
  - Cd(0x10), Wp(0x20), Tt(0x30) are ready;



Updates of Identifier

- Some updates of Identiifer
  - Cd: Install 20” and 3” PMTs;
    - Distinguish between 20” and 3” PMTs with 4 bits;
    - 20” PMTs(0x10) && 3” PMTs(0x11);
  - Wp: 3 parts PMTs;
    - Distinguish between 3 parts PMTs;
    - Sphere(0x20), Wall(0x21) , Bottom(0x22);
    - To be updated again;



TT Identifier

– Tt: 63488 channels JUNO-doc-3405-v3
  - 8 bits: sub-detector(0x30)
  - 5 bits: not used
  - 3 bits: layer
  - 3 bits: column
  - 3 bits: row
  - 4 bits: PMT
  - 6 bits: strip

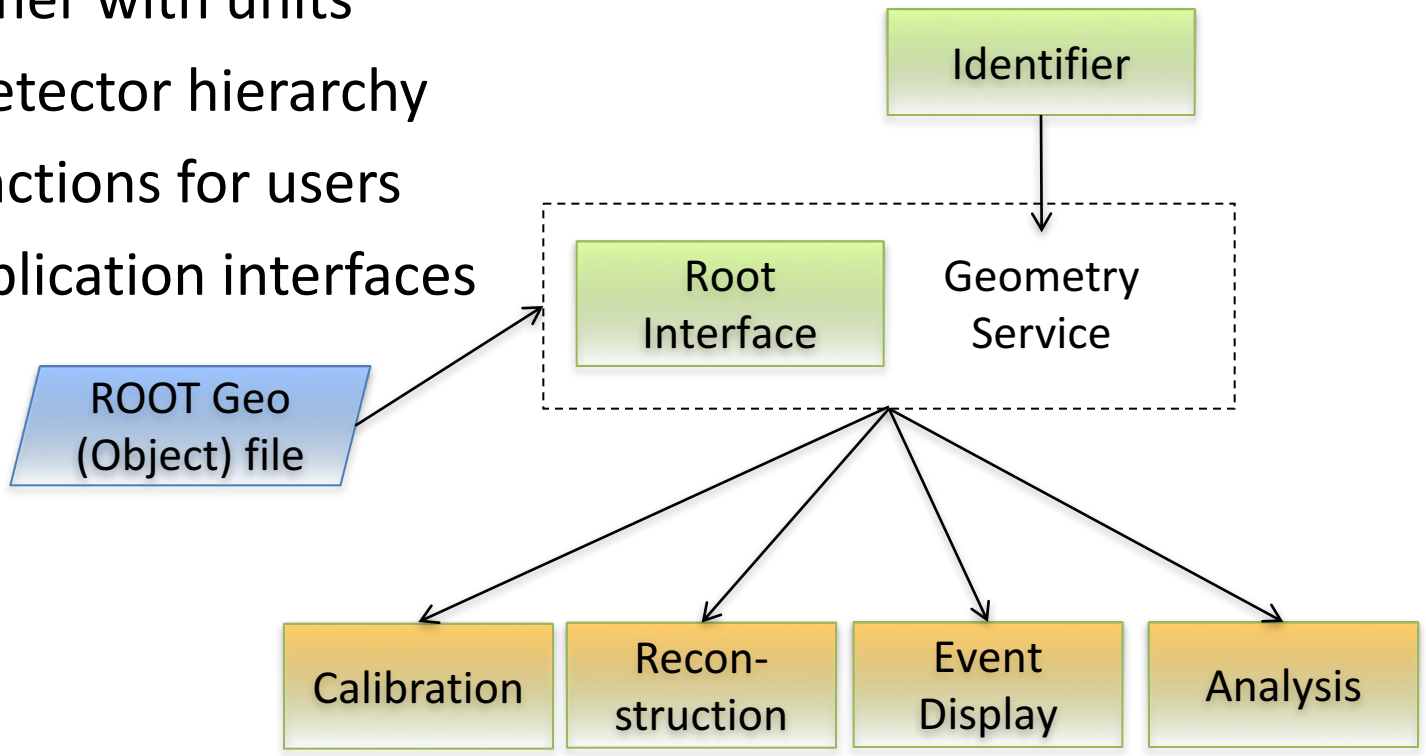
– Tt convention from Joao(has committed to SVN);

Status

- The update of identifer is successful. However, the current JUNO offline has not used the updated Identifier yet;
- Some identifer related applications also need to be updated;
- Temporarily keep the update in local working environment, not commit to SVN

Geometry Service

- Construct every unique unit (PhysicalNode)
- Map Identifier with units
- Organize detector hierarchy
- Provide functions for users
- Provide application interfaces



Input

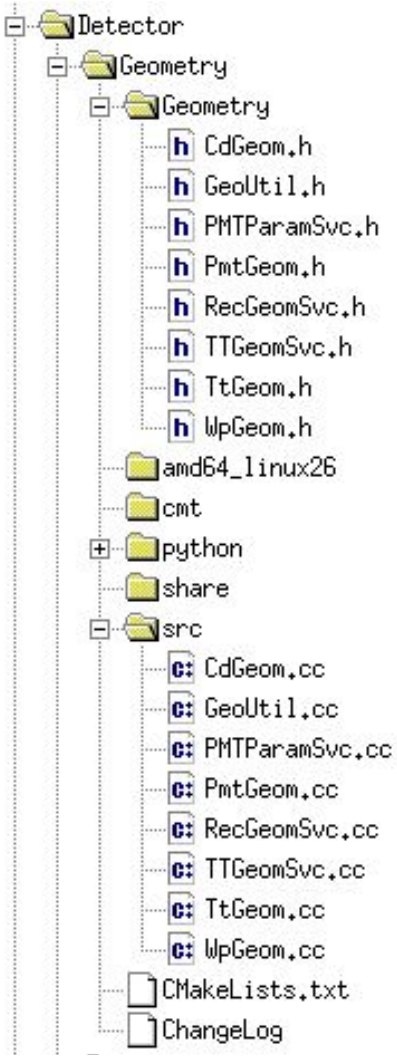
- The input file of geometry service
  - ROOT Geo Object file (standard)
    - Hierarchy helps organization
    - File size 3MB
    - Time of geometry service initialization <10 sec, with all 3” PMTs
  - GDML file
    - Easy to read and modification
    - File size 22MB
    - Time of geometry service initialization ~30 sec
    - Source of ROOT geometry file

Geometry structure

- Implement an algorithm to analyze the geometry structure in offline
  - Work with different geometry structure
  - Work with different PMT numbers
  - Any volume naming
  - Analyze the node tree traversal
  - Associate the PMT ID and corresponding unique root geometry node

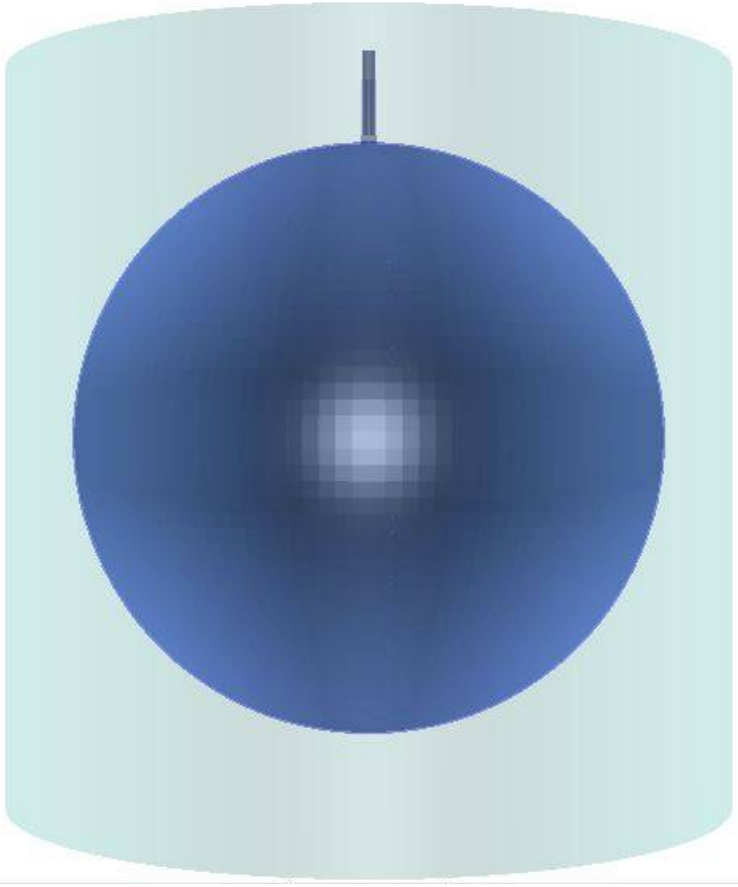
Geometry Class

- PmtGeom
  - Single PMT geometry class
  - Get every pmt information
- CdGeom,WpGeom,TtGeom
  - Sub-detectors geometry class
  - Analyze every sub-detector
  - Provide detector information
  - Get a pointer to every PmtGeom with an identifier
- RecGeomSvc
  - Top geometry service
  - Control all sub-detectors



Geometry Information

- Geometry Service can provide detetcor information
  - Dimensions, Shapes,Material ...;
  - By single functions
    - CdGeom::getCdBallRmax();
    - CdGeom::getCdBallRmin();
    - CdGeom::getCdChimneyRmax();
    - WpGeom::getWpR();
    - WpGeom::getWpH();
    - …



PMTs

- Print out central detetcor PMTs ID, center and direction

```
Pmt 0x10000000 Center(     1065.41,           0,      19470.9) Dir(     3.08693,      3.14159)
Pmt 0x10000100 Center(     922.674,      532.706,      19470.9) Dir(     3.08693,     -2.61799)
Pmt 0x10000200 Center(     532.706,      922.674,      19470.9) Dir(     3.08693,      -2.0944)
Pmt 0x10000300 Center( 6.52355e-14,      1065.41,      19470.9) Dir(     3.08693,      -1.5708)
Pmt 0x10000400 Center(    -532.706,      922.674,      19470.9) Dir(     3.08693,      -1.0472)
Pmt 0x10000500 Center(    -922.674,      532.706,      19470.9) Dir(     3.08693,    -0.523599)
```

20” PMTs

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```
Pmt 0x11454b00 Center(     1402.84,      247.359,      19397.8) Dir(     3.06829,     -2.96706)
Pmt 0x11454c00 Center(     1233.64,      712.241,      19397.8) Dir(     3.06829,     -2.61799)
Pmt 0x11454d00 Center(      915.64,      1091.22,      19397.8) Dir(     3.06829,     -2.26893)
Pmt 0x11454e00 Center(     487.202,      1338.58,      19397.8) Dir(     3.06829,     -1.91986)
```

3” PMTs

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Useful functions

- Some useful functions provided by geometry service
  - Boundary of a detector unit;
    - Easy to judge whether a point is inside a volume or not
  - Coordinate transformation;
    - Easy to transform coordinates between local and global coordiante or between any two levels in the geometry hierarchy
  - Check geometry conflicts in detector description

RecGeomSvc

- RecGeomSvc declared as a service module
  - DECLARE_SERVICE(RecGeomSvc)
- How to use geometry service in other APPs

```
//Retrieve Geometry service
SniperPtr<RecGeomSvc> rgSvc("RecGeomSvc");
if ( rgSvc.invalid()) {
    LogError << "Failed to get RecGeomSvc instance!" << std::endl;
    return false;
}
m_cdGeom = rgSvc->getCdGeom();
//the same as other sub-detector
return true;
```

Current Status

- Current status
  - CentralDetector, WaterPool and TopTracker work well;
- Other appliciations initialize geometry through declared RecGeomSvc;
- Considering change RecGeomSvc to GeomSvc due to not only Reconstruction need geometry;

Summary

- Identifier
  - Sub-detectors Identifiers are ready
  - Test and improve redefined identifier
  - Will be committed to SVN soon.
- Geometry service has been developed
  - Geometry service works well;
  - Plan to update naming of geometry service;

Next Work(I)

- The reality geometry
  - The PMTs misalignment after installation;
  - Acrylic ball and truss deformation;
  - Consider how to describe the detectors to reality as closely as possible;

Next Work(II)

- Query of geometry data
  - Use the browser to query;
  - The format of organization and view;
  - Input detector ID to get position or vice verse;
  - Bind to hardware devices;
    - Bind reality PMT to identifier, real response time and quantum efficiency, …

Thanks!