ComPair Geometry for Beam Test Simulations.

Michela Negro

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ComPair is composed of three main subsystems: a double sided silicon detector (the tracker), a CZT calorimeter, and CsI calorimeter. A simplified view of the geometry is shown in Fig. 1. OIn this document it is reported the description of the geometry used for beam test simulations. The whole setup is built making use of the files described in the following sections.

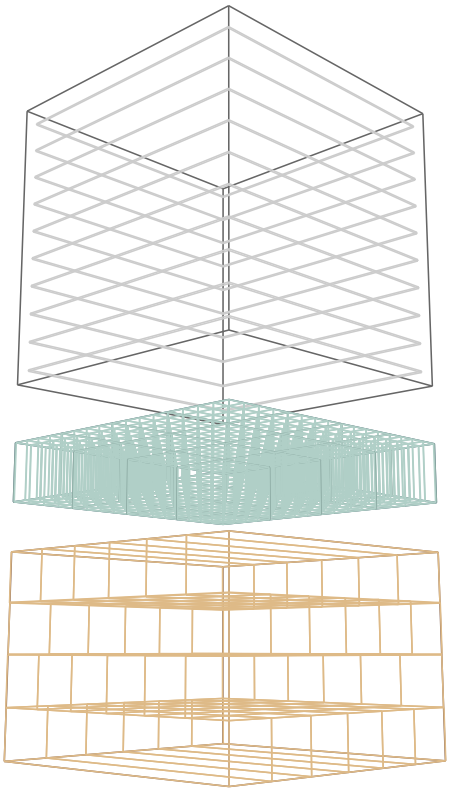

Figure 1: ComPair geometry.

1 DSSDTracker.geo

The tracker system geometry is built with the following volumes:

- Tracker: void box (10x10x10) cm
- Wafer: Si box (9.5x9.5x0.05) cm

A for loop fit 10 wafer layers to the tracker volume.

```
//------------//----------------//------------//
//------------//   DSSD TKR     //------------//
//------------//----------------//------------//

Volume Tracker
Tracker.Material Vacuum
Tracker.Visibility 1
Tracker.Color 13
Tracker.Shape BRIK 5. 5. 5.

Volume Wafer
Wafer.Material Silicon
Wafer.Visibility 1
Wafer.Color 17
Wafer.Shape BOX 4.75 4.75 0.025

For I 10 -4.5 1.0
    Wafer.Copy Wafer_%I
    Wafer_%I.Position 0.0 0.0 $I
    Wafer_%I.Mother Tracker
Done

//------------------//
```

2 DSSDTkrProperties.det

From Carolyn's branch: Define Silicon Planes and whole volume to contain planes. The Total number of strips is given by the width of a plane/(strip pitch). We assume a strip pitch of 0.50 mm.

```
//------------//--------------------//------------//
//------------// DSS TKR Properties //------------//
//------------//--------------------//------------//

MDStrip2D SStrip
SStrip.SensitiveVolume Wafer
SStrip.DetectorVolume Wafer

SStrip.StructuralPitch 0.0 0.0 1.0
SStrip.StripNumber   190.0 190.0
SStrip.Offset        0.0  0.0

//### Set Physical properties of planes/strips
SStrip.NoiseThreshold    40
SStrip.TriggerThreshold  60

SStrip.EnergyResolution Gauss 662 662 8.5
SStrip.EnergyResolution Gauss 122 122 4.38

//-----------------//
```

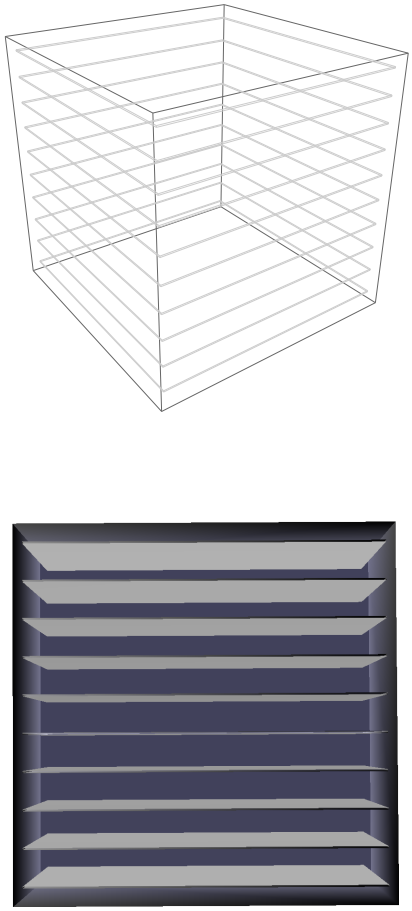

Figure 2: Two views of the tXracker system.

3 CZTCalorimeter.geo

The following volumes compose the CZT Calorimeter geometry:

- CZTBar: CZT box (0.8x0.8x4) cm
- CZTBlock: void box (2.5x2.5x2) cm
- CZTLayer: void box (40x40x4.2) cm

A CZT block contains 4x4 CZT bars; The single CZT layer contains 4x4 CZT blocks.

```
//_____________//________________//_____________//
//_____________//    CZT CAL     //_____________//
//_____________//________________//_____________//

Volume CZTBar
CZTBar.Visibility 1
CZTBar.Color 29
CZTBar.Material CZT
CZTBar.Shape BRIK 0.3 0.3 1.0

Volume CZTBlock
CZTBlock.Visibility 1
CZTBlock.Color 31
CZTBlock.Material Vacuum
CZTBlock.Shape BRIK 1.25 1.25 1.

Volume CZTLayer
CZTLayer.Material Vacuum
CZTLayer.Visibility 1
CZTLayer.Color 36
CZTLayer.Shape BRIK 5.0 5.0 1.

For I 4 -0.93 0.62
    For J 4 -0.93 0.62
        CZTBar.Copy CZTBar_%I_%J
        CZTBar_%I_%J.Position $I $J 0.0
        CZTBar_%I_%J.Mother CZTBlock
    Done
Done

For I 4 -3.75 2.5
    For J 4 -3.75 2.5
        CZTBlock.Copy CZTBlock_%I_%J
        CZTBlock_%I_%J.Position $I $J 0.0
        CZTBlock_%I_%J.Mother CZTLayer
    Done
Done

//------------------//
```

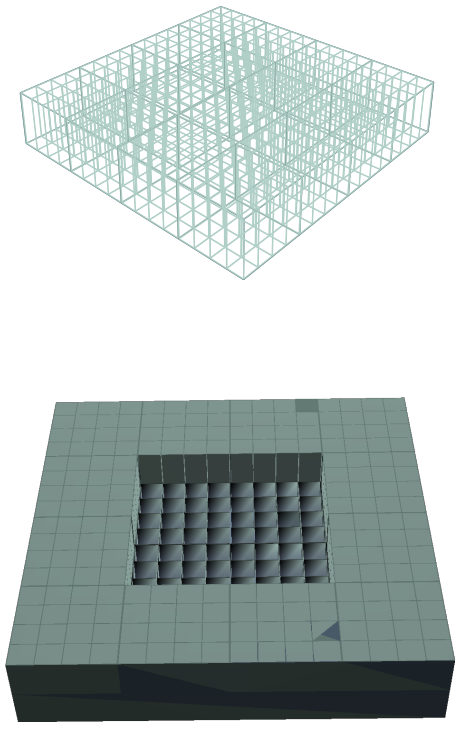

Figure 3: Two views of the CZT calorimeter.

4 CZTProperties.det

From Carolyn's branch. The Anger Camera gives an energy weighted position: if there are more that one interaction in a single detector volume, only a single position will be returned (this is how we expect the CZT to behave).

```
//____________//------------------//____________//
//____________// CZT Cal Properties //____________//
//____________//------------------//____________//

AngerCamera DCalCZT
DCalCZT.SensitiveVolume CZTBar

DCalCZT.Positioning XYZ
DCalCZT.PositionResolution 200 0.1
DCalCZT.PositionResolution 1000 0.3

//### Calibration data:
DCalCZT.TriggerThreshold 50
DCalCZT.NoiseThresholdEqualsTriggerThreshold true

DCalCZT.EnergyResolution Gauss 40  40  1.8
DCalCZT.EnergyResolution Gauss 100 100 2
DCalCZT.EnergyResolution Gauss 500 500 2.5
DCalCZT.EnergyResolution Gauss 1000 1000 5
DCalCZT.EnergyResolution Gauss 2000 2000 10
DCalCZT.EnergyResolution Gauss 5000 5000 25

//-----------------//
```

5 CsICalorimeter.geo

The following volumes compose the CsI calorimeter geometry:

- CsILog: CsI box (10x1.7x1.7) cm
- CsITower: void box (10x10x6.8) cm

The tower is made of 4 layers, made of 6 logs each, in hodoscopic configuration.

```
//____________//------------------//____________//
//____________//    CsI CAL    //____________//
//____________//------------------//____________//
//### Build 4 layers of 6 logs of CsI in hodoscopic
    configuration;
//### LOG: single log 10.0cm x 1.7cm x 1.7 cm
    aligned along the y direction.
//### TOWER: one tower of the CsI Detector
    10.2x10.2x6.8
//### Fill The tower with 6 logs per layer (4 layers
    in total)

Volume CsILog
CsILog.Material CsI
CsILog.Visibility 1
CsILog.Color 42
CsILog.Shape BOX 0.85 0.85 5.1

Volume CsITower
CsITower.Material Vacuum
CsITower.Visibility 1
CsITower.Color 28
CsITower.Shape BRIK 5.1 5.1 3.4

For I 6 -4.25 1.7
    CsILog.Copy CsILog_y_%I_1
    CsILog_y_%I_1.Rotation 0 90 0
    CsILog_y_%I_1.Position 0.0 $I 2.55
    CsILog_y_%I_1.Mother CsITower
Done

For I 6 -4.25 1.7
    CsILog.Copy CsILog_x_%I_1
    CsILog_x_%I_1.Rotation 90 0 0
    CsILog_x_%I_1.Position $I 0.0 0.85
    CsILog_x_%I_1.Mother CsITower
Done

For I 6 -4.25 1.7
    CsILog.Copy CsILog_y_%I_2
    CsILog_y_%I_2.Rotation 0 90 0
    CsILog_y_%I_2.Position 0.0 $I -0.85
    CsILog_y_%I_2.Mother CsITower
Done

For I 6 -4.25 1.7
    CsILog.Copy CsILog_x_%I_2
    CsILog_x_%I_2.Rotation 90 0 0
    CsILog_x_%I_2.Position $I 0.0 -2.55
    CsILog_x_%I_2.Mother CsITower
Done

//------------------//
```

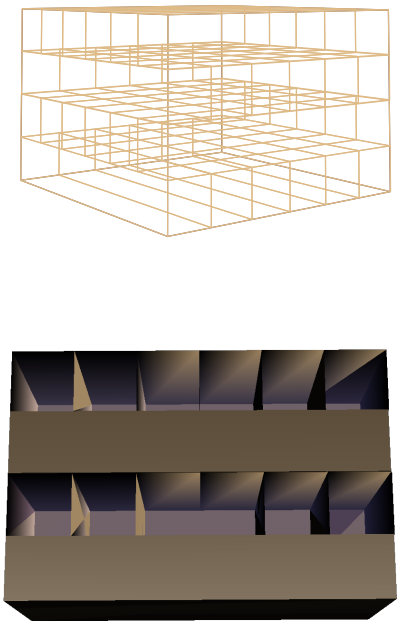

Figure 4: Two views of the CsI calorimeter.

6 CsIProperties.det

From Carolyn's branch. The CsILogs have no space in between them at this point, so the structural pitch and structural offset are both 0.

```
//____________//------------------//____________//
//____________// CsI Cal Properties //____________//
//____________//------------------//____________//
```

```
MDCalorimeter DCalCsI
DCalCsI.SensitiveVolume CsILog
DCalCsI.DetectorVolume CsITower

DCalCsI.StructuralPitch 0. 0. 0.
DCalCsI.StructuralOffset 0. 0. 0.

DCalCsI.NoiseThreshold 30
DCalCsI.TriggerThreshold 100
DCalCsI.DepthResolution 662 2

DCalCsI.EnergyResolution Gauss 40  40   5
DCalCsI.EnergyResolution Gauss 100 100  7.5
DCalCsI.EnergyResolution Gauss 662 662  20
DCalCsI.EnergyResolution Gauss 2000 2000 33
DCalCsI.EnergyResolution Gauss 5000 5000 50

//-----------------//
```

7 ComPairBase.geo.setup

This file includes the files discussed above, locates the subsystems in the world volume, and defines the basic event triggers.

```
//_____________//-----------------//_____________//
//_____________//    PARAMETERS    //_____________//
//_____________//-----------------//_____________//

///////////////////////
// Name and Version //
///////////////////////
Name ComPair4BeamTest
Verision 0.0

///////////////////////
// Include section //
///////////////////////
Include ../materials/Materials.geo

//////////////////////////
// Some other settings //
//////////////////////////
DefaultRangeCut 0.000002
SurroundingSphere 150.0 0.0 0.0 0.0 150.0



//_____________//-----------------//_____________//
//_____________//    DETECTORS    //_____________//
//_____________//-----------------//_____________//

////////////////////
// World volume //
////////////////////
Volume World
World.Material Vacuum
World.Visibility 0
World.Color 0
World.Shape BRIK 500. 500. 500.
World.Mother 0

///////////////////////
```

```
// Tracker SiStrip //
/////////////////////
Include DSSDTracker.geo
Include DSSDTkrProperties.det
Tracker.Position 0. 0. 0.
Tracker.Mother World

///////////////////////
//  CZT calorimeter //
///////////////////////
Include CZTCalorimeter.geo
Include CZTProperties.det
CZTLayer.Position 0.0 0.0 -8.0
CZTLayer.Mother World

/////////////////////
// CsI calorimeter //
/////////////////////
Include CsICalorimeter.geo
Include CsIProperties.det
CsITower.Position 0.0 0.0 -14.0
CsITower.Mother World



//_____________//-----------------//_____________//
//_____________//    TRIGGERS    //_____________//
//_____________//-----------------//_____________//

///////////////////////
// DSSD TKR TRIGGER //
///////////////////////
//### only 2 hits in Si Detector
Trigger MainTriggerSi
MainTriggerSi.Veto false
MainTriggerSi.TriggerByChannel true
MainTriggerSi.Detector SStrip 1

/////////////////////
// CsI CAL TRIGGER //
/////////////////////
//### only 1 hit in the CsI cal
Trigger MainTriggerCsI
MainTriggerCsI.Veto false
MainTriggerCsI.TriggerByDetector true
MainTriggerCsI.Detector DCalCsI 1

/////////////////////
// CZT CAL TRIGGER //
/////////////////////
//### only 1 hit in the CZT cal
Trigger MainTriggerCZT
MainTriggerCZT.Veto false
MainTriggerCZT.TriggerByDetector true
MainTriggerCZT.Detector DCalCZT 1

//-----------------//
```

8 ACD or not ACD?

Currently the geometry does not include an ACD. A simple code to simulate it is anyway present in the code, but needs to be uncommented to be activated. In order to activate the ACD go into “ComPairBase.geo.setup” file and

just uncomment the following part of code:

```
//////////////////////
// Anticoincidence //
//////////////////////
Include ACDscintillator.geo
Include ACDProperties.det
ACDbox.Position 0. 0. 0.
ACDbox.Mother World

//////////////////////
// ACD VETO TRIGGER //
//////////////////////
//### TBD TBD TBD
Trigger MainTriggerACD
MainTriggerACD.Veto true
MainTriggerACD.TriggerByDetector true
MainTriggerACD.Detector ACD 0
```

The included "ACDscintillator.geo" looks like this:

```
//____________//__________________//____________//
//____________//       ACD        //____________//
//____________//__________________//____________//
//### Build the plastic scintillator all around the
    tracker;
//### TILE: single ACD tile (TBD: 7.x7.x0.5) cm
//### BOX: just to fill it with the sensitive tiles
//### 5 tiles all around the sides of the tracker

Volume ACDbox
ACDbox.Material Vacuum
ACDbox.Visibility 0
ACDbox.Shape BOX 6. 6. 6.

Volume ACDtile
ACDtile.Material PEN
ACDtile.Visibility 1
ACDtile.Color 38
ACDtile.Shape BOX 6. 6. 0.25
ACDtile.Position 0.0 0.0 5.75
ACDtile.Mother ACDbox

ACDtile.Copy ACDtileSide1
ACDtileSide1.Rotation 90 0 0
ACDtileSide1.Position 0 -6.25 -0.5

ACDtile.Copy ACDtileSide2
ACDtileSide2.Rotation 90 0 0
ACDtileSide2.Position 0 6.25 -0.5

ACDtile.Copy ACDtileSide3
ACDtileSide3.Rotation 0 90 0
ACDtileSide3.Position -6.25 0 -0.5

ACDtile.Copy ACDtileSide4
ACDtileSide4.Rotation 0 90 0
ACDtileSide4.Position 6.25 0 -0.5

//------------------//
```

So this ACD is designed as 5 tiles covering the tracker on all sides. The material is Polyethylene Naphthalate (PEN) and has to be added in the "Material.geo" file this way:

```
//Plastic scintillator defined by components
Material PEN
PEN.Density                    1.36
PEN.ComponentByAtoms           C   12
PEN.ComponentByAtoms           H   10
PEN.ComponentByAtoms           O   4
```

and "ACDProperties.det" look like this The properties of the ACD has to be defined eventually if it has to be included, for now they are just exemplary.

```
//____________//____________________//____________//
//____________// ACD Properties //____________//
//____________//____________________//____________//
//### From Carolyn's branch. This is to define ACD
    as a scintillator.

Scintillator ACD
ACD.SensitiveVolume ACDtile

ACD.TriggerThreshold 200
ACD.EnergyResolution Ideal
ACD.NoiseThresholdEqualsTriggerThreshold true

//------------------//
```

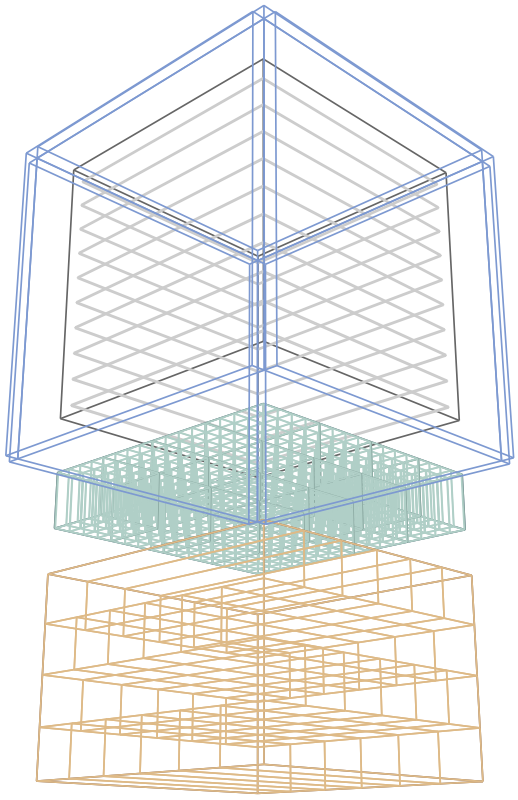

Figure 5: View of ComPair detectors with ACD included.

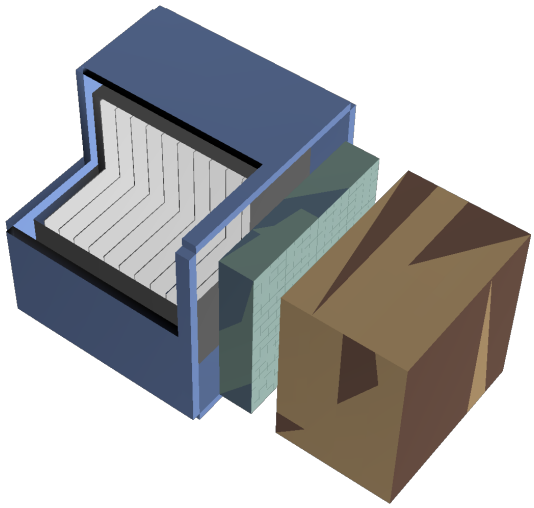

Figure 6: View of ComPair detectors with ACD included (GL view).