Identifying Detector Components

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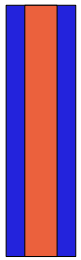
Hierarchy Of Volumes

- Let's have volumes:

- And place a Wire in a Chamber:



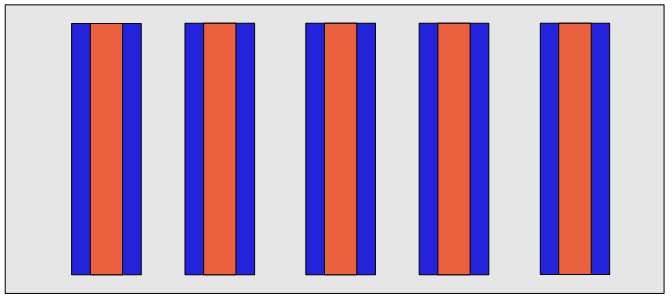
```
new G4PVPlacement(0, G4ThreeVector(),
      WireLV, "Wire_plane", ChamberLV,  false, 0);
```

0 Wire CopyNo

Wire Copy Number: 0

Hierarchy Of Volumes (2)

- Then place 5 Chambers in Arm:



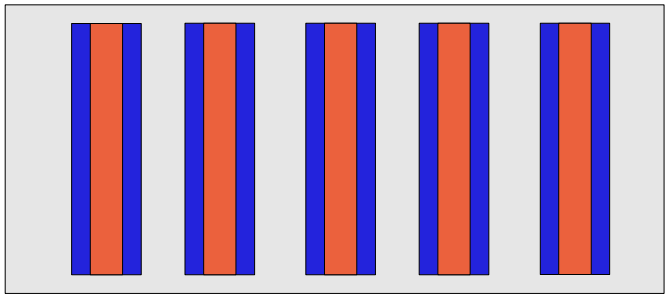
0	1	2	3	4	Chamber CopyNo
0	0	0	0	0	Wire CopyNo

```
for ( G4int i=0; i<5; i++ ) {
   G4ThreeVector position = ...
   new G4PVPlacement(0, position,
                     ChamberLV, "Chamber", ArmLV,  false, i );
}
```

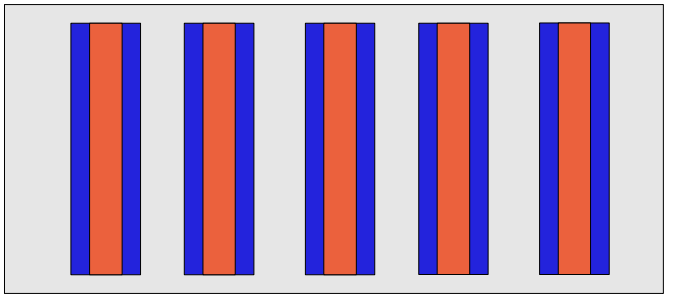
Chamber Copy Number = 0, 1, 2, 3, 4

Hierarchy Of Volumes (3)

- And finally 2 Arms in World:



Arm CopyNo = 0



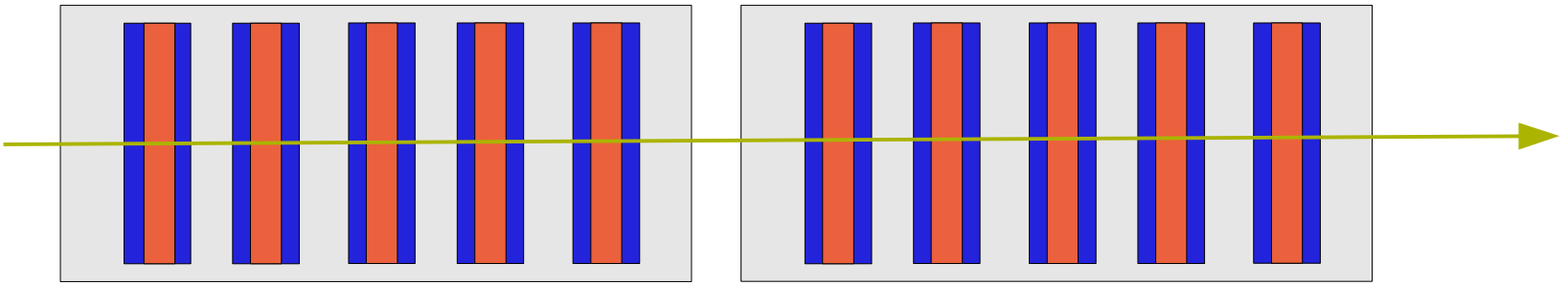
Arm CopyNo = 1

```
for ( G4int i=0; i<2; i++) {
   G4ThreeVector position = ...
   new G4PVPlacement(0, position,
                     ArmLV, "Arm", WorldLV,  false, i );
}
```

Arm Copy Number = 0, 1

Hierarchy Of Volumes (4)

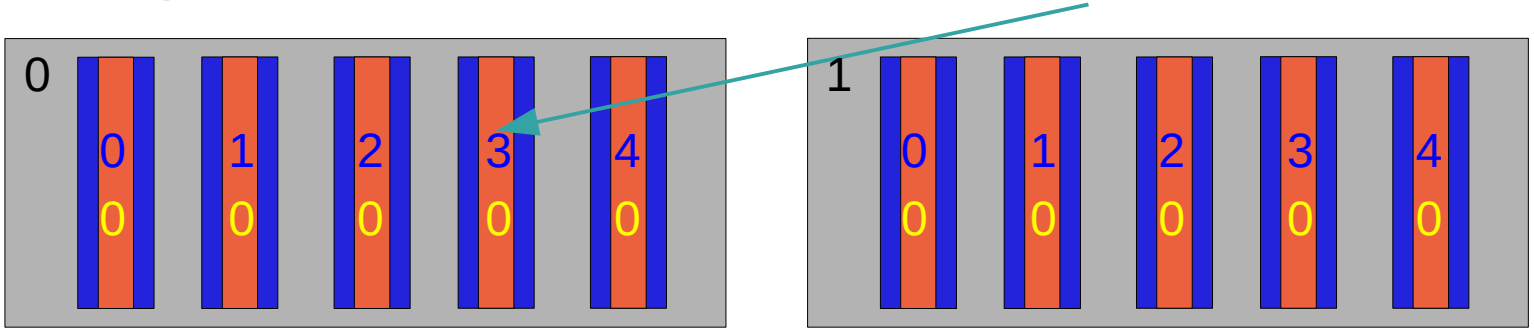
- We have placed a Wire in a Chamber, 5 Chambers in Arm and 2 Arms in World



How can we identify which of 10 wires is just traversed by the track ?

Touchable

- A touchable for a volume serves the purpose of providing a unique identification for a detector element
- It is a geometrical entity (volume or solid) which has a unique placement in a detector description
  - It can be uniquely identified by providing the copy numbers for all daughters in the geometry hierarchy, in our case these are
    - CopyNo of Wire in Chamber: 0
    - CopyNo of Chamber in Arm: 0, 1, 2, 3, 4
    - CopyNo of Arm in World: 0, 1
- Example of a touchable identification: Arm.0/Chamber.3/Wire.0



Touchable (2)

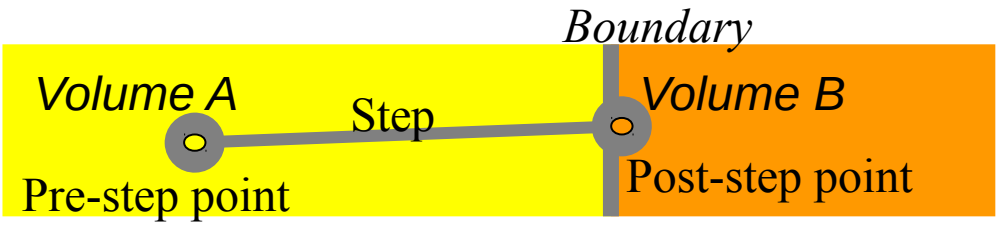
- G4VTouchable, a base class for all touchable implementations, provides the functions which can be used to inspect the geometrical information in each level (depth) of geometry hierarchy:
  - GetCopyNumber(G4int depth =0)
  - GetTranslation(G4int depth = 0), GetRotation(G4int depth=0)
  - GetSolid(G4int depth =0)
  - GetVolume(G4int depth =0)
- Where the *depth* represents:
  - depth = 0 : the bottom level (volume Wire in Chamber)
  - depth = 1 : the level of its mother volume (volume Chamber in Arm)
  - depth = 2 : the grandmother volume (volume Arm in World)

Step and Touchable History

- The vector of information for each level on geometrical hierarchy of the track current position is available from the pre-step point
- It is defined via G4TouchableHistory class
  - which is derived from G4VTouchable base class
- It can be accessed from G4StepPoint object

```
G4VTouchable* touchable = preStepPoint>GetTouchable());
```

- The touchable history of the current step is available from the pre-step point



Touchable History

- An example of use G4VTouchable to get the layer number in geometry hierarchy

```
G4bool MySD::ProcessHits(G4Step* step,
                         G4TouchableHistory* /*history*/)
{
  // Layer (Chamber) number
  // = copy number of the mother volume of Wire
  G4StepPoint* preStepPoint = step->GetPreStepPoint();
  const G4VTouchable* touchable = preStepPoint->GetTouchable();

  G4VPhysicalVolume* motherPhysical = touchable->GetVolume(1);
  G4int copyNo = motherPhysical->GetCopyNo();

  // store the layer number in a previously created hit
  newHit->SetLayerNumber(copyNo);
  // ...
}
```

Touchable History (2)

- An example of use G4VTouchable to get a track position in a local reference frame.

```
G4bool MySD::ProcessHits(G4Step* step,
                         G4TouchableHistory* /*history*/)
{
  // Get hit position in the Wire reference frame
  // (the leaf of geometry volume hierarchy)
  G4StepPoint* preStepPoint = step->GetPreStepPoint();
  G4VTouchable* touchable = preStepPoint->GetTouchable();

  G4ThreeVector worldPos
     = preStepPoint->GetPosition();
  G4ThreeVector localPos
     = touchable->GetHistory()
       ->GetTopTransform().TransformPoint(worldPos);
  // ...
}
```

Summary

- The physical volume copy number is not sufficient for unique identification of the real volume position in geometry
  - As the mother volume can be also placed more times
- G4VTouchable provides a vector of information for each level in geometrical hierarchy:
  - copy number
  - transformation / rotation to its mother