



GEANT4
A SIMULATION TOOLKIT



More on Geometry Touchable

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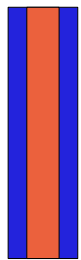
Geant4 ED PHENIICS Tutorial,
13 - 17 May 2019, Orsay

Hierarchy Of Volumes

- Let's have volumes:



- And place a Wire in a Chamber:



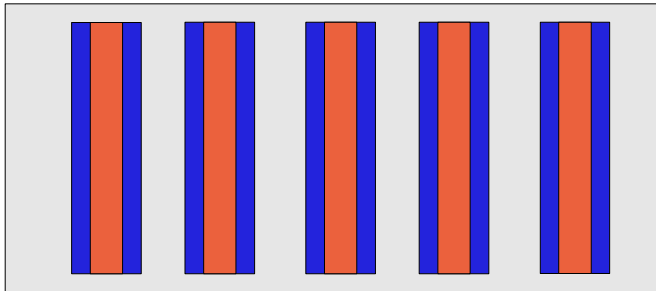
```
new G4PVPlacement(0, G4ThreeVector(),  
    WireLV, "Wire_plane", ChamberLV, false, 0);
```

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

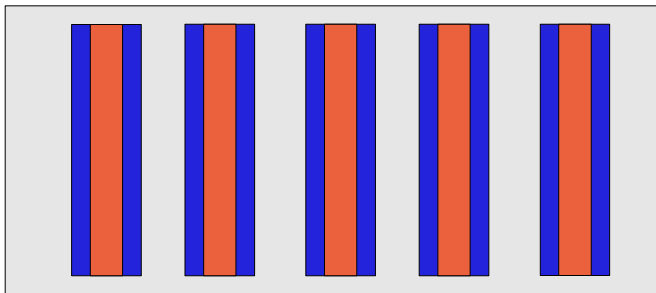
Wire CopyNo

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

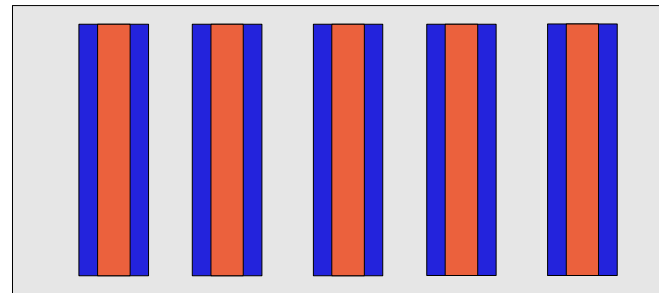
Chamber Copy Number = 0, 1, 2, 3, 4

Hierarchy Of Volumes (3)

- And finally 2 Arms in World:



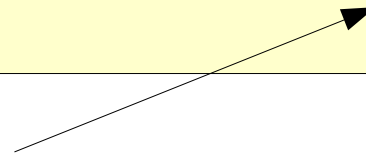
Arm CopyNo = 0



Arm CopyNo = 1

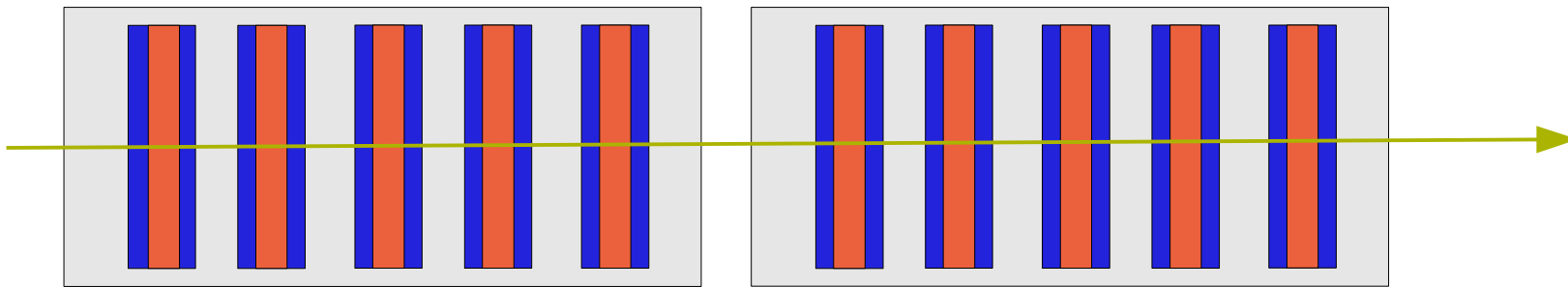
```
for ( G4int i=0; i<2; i++) {  
  G4ThreeVector position = ...  
  new G4PVPlacement(0, position,  
                    ArmLV, "Arm", WorldLV, false, i );  
}
```

Arm Copy Number = 0, 1



Hierarchy Of Volumes (4)

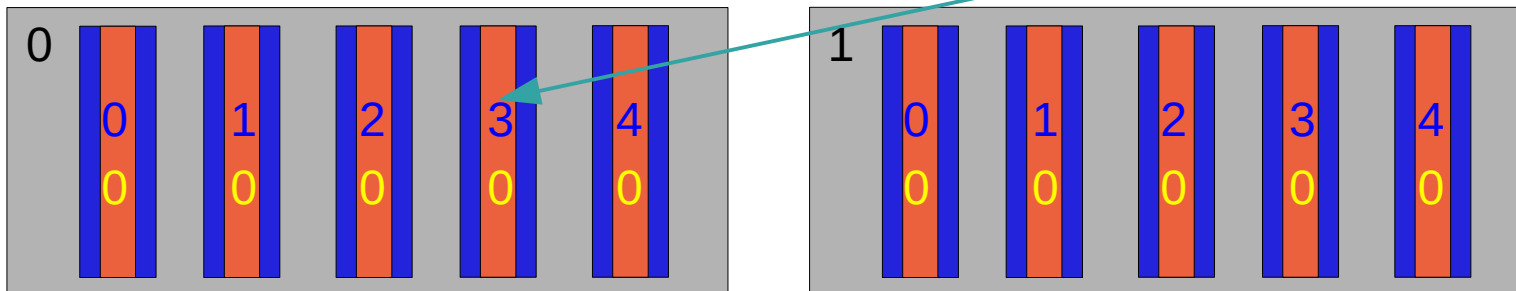
- We have placed a Wire in a Chamber, 5 Chambers in Arm and 2 Arms in World



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)

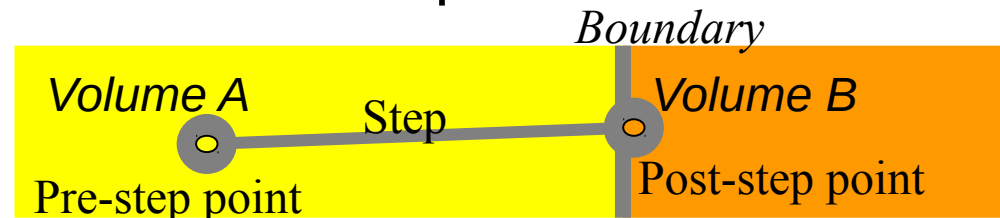
- **G4VTouchable**, a base class for all touchable implementations, provides the functions which can be used to inspect the geometrical information in each level (depth) of geometry hierarchy:
 - **GetCopyNumber**(G4int depth =0)
 - **GetTranslation**(G4int depth = 0), **GetRotation**(G4int depth=0)
 - **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();  
G4TouchableHistory* history = (G4TouchableHistory*)touchable;
```

- 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