



**GEANT4**  
A SIMULATION TOOLKIT



# More on Geometry Touchable

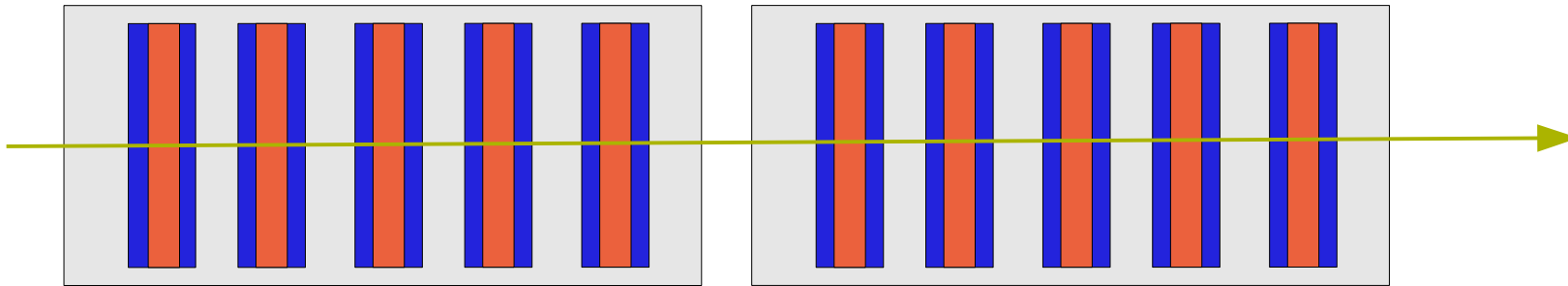
Igor Semeniouk  
LLR, CNRS – Ecole Polytechnique

Credits:  
I. Hrivnacova (IJCLAB)

Geant4 Tutorial,  
22 - 26 May 2023, IJCLab, Orsay

# Introduction

In our application we have 10 tracking chambers, each with a detection wire, placed in 2 arms



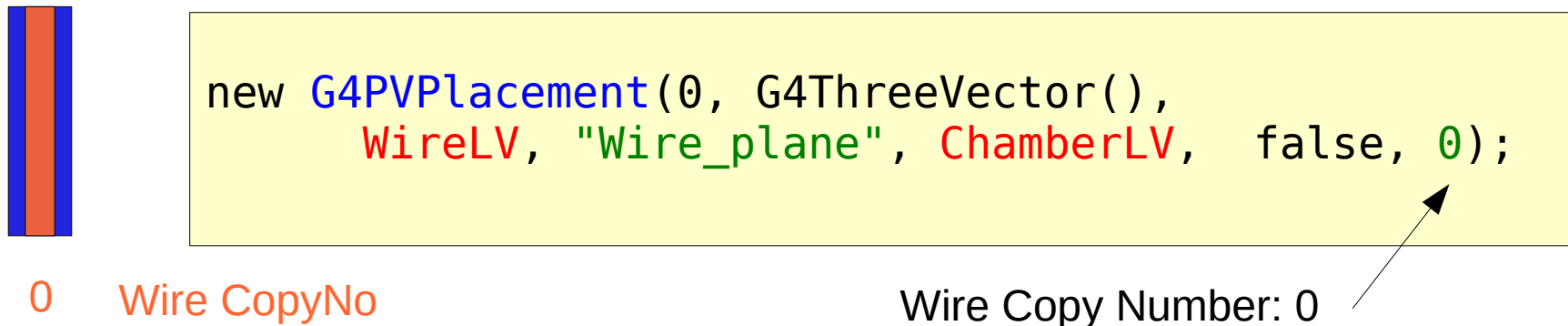
How can we identify which of these 10 detectors (wires) has been just traversed by a track ?

# Hierarchy Of Volumes

- Let's have volumes:

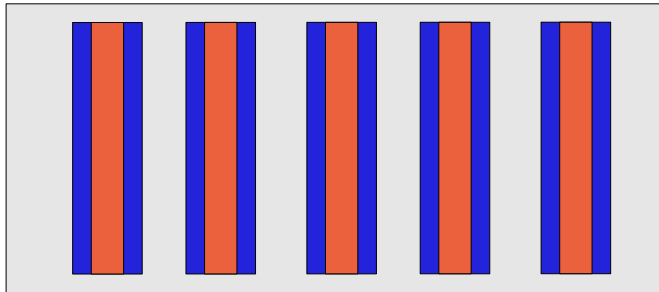


- And place a Wire in a Chamber:



# Hierarchy Of Volumes (2)

- Then place 5 Chambers in Arm:



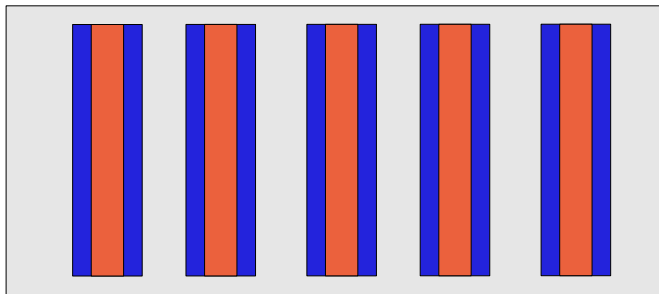
0	1	2	3	4	Chamber CopyNo
0	0	0	0	0	Wire CopyNo

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

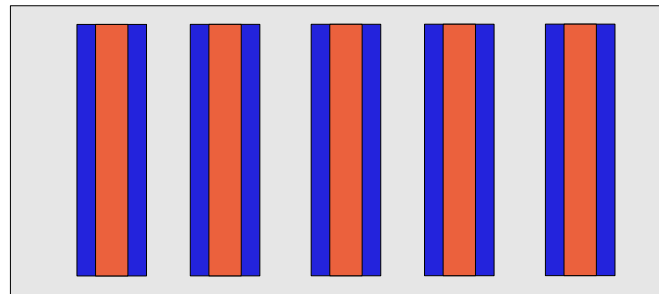
Chamber Copy Number = 0, 1, 2, 3, 4

# Hierarchy Of Volumes (3)

- And finally 2 Arms in World:



Arm CopyNo = 0



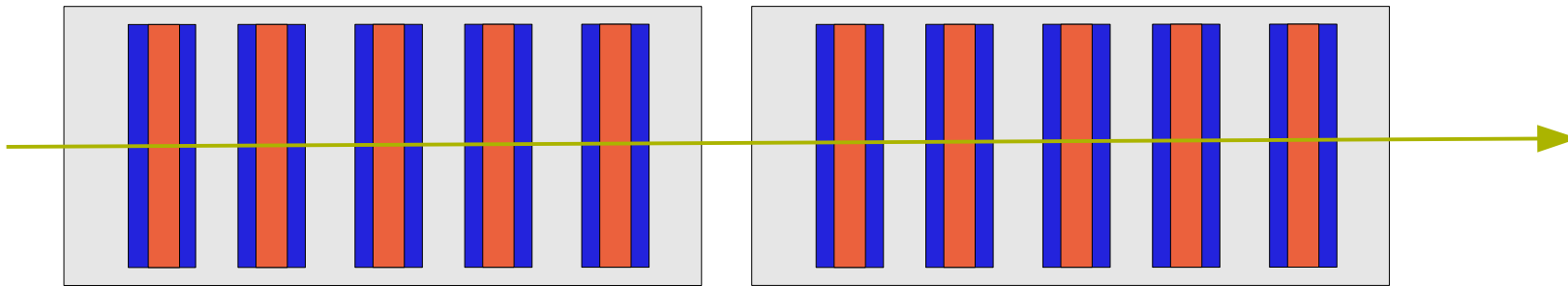
Arm CopyNo = 1

```
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)

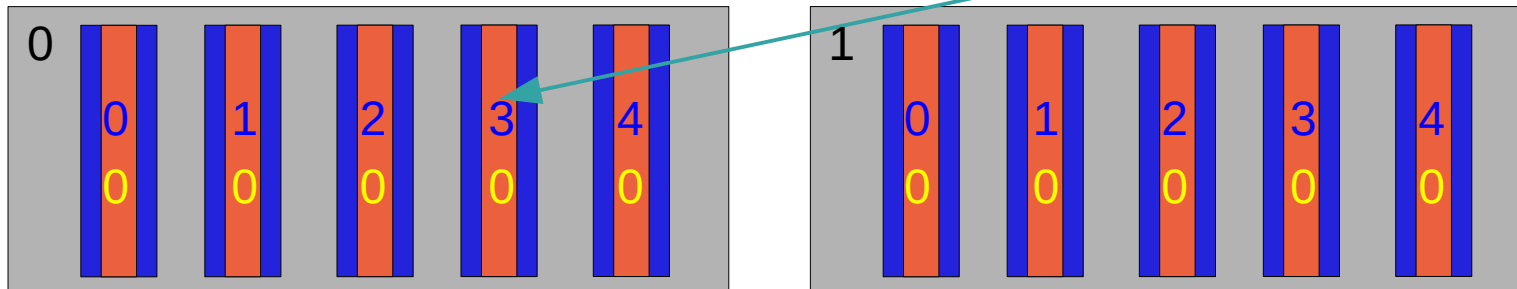
- We have placed a Wire in a Chamber, 5 Chambers in Arm and 2 Arms in World



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)

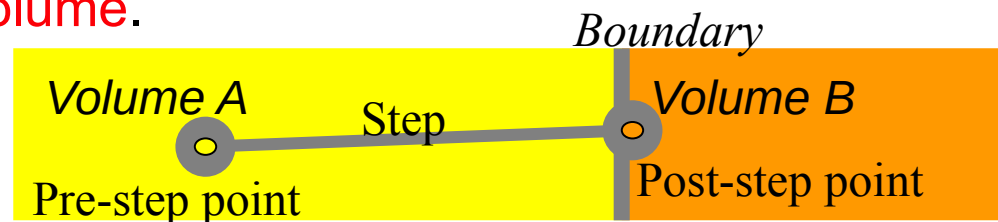
- [G4VTouchable](#), a base class for all touchable implementations, provides the functions which can be used to inspect the geometrical information in each level (depth) of geometry hierarchy:
  - [GetCopyNumber](#)(G4int depth =0)
  - [GetTranslation](#)(G4int depth = 0), [GetRotation](#)(G4int depth=0)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

- Step has two points and also “delta” information of a particle (energy loss on the step, time-of-flight spent by the step, etc.).
- Each point knows the volume (and material). In case a step is limited by a volume boundary, the end point physically stands on the boundary, and it **logically belongs to the next volume**.

**Note** : you must get the volume information from the “PreStepPoint”.



- It is defined via [G4TouchableHistory](#) class
  - which is derived from [G4VTouchable](#) base class
- It can be accessed from [G4StepPoint](#) object

```
G4StepPoint* preStepPoint = aStep->GetPreStepPoint();  
G4VTouchable* touchable = preStepPoint->GetTouchable();  
G4TouchableHistory* history = (G4TouchableHistory*)touchable;
```

# 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 (depth=1)
    G4StepPoint* preStepPoint = step->GetPreStepPoint();
    const G4VTouchable* touchable = preStepPoint->GetTouchable();
    G4int copyNo = touchable->GetCopyNumber(1);

    // 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

- You must get the volume information from the “PreStep Point”.
- 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