Experimental Techniques in Particle Physics

Geant4: Geometry Replicas

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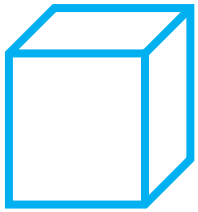
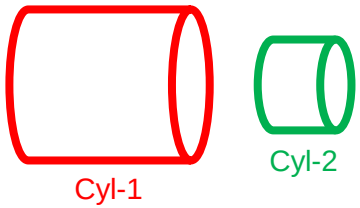
Hierarchy of Volumes

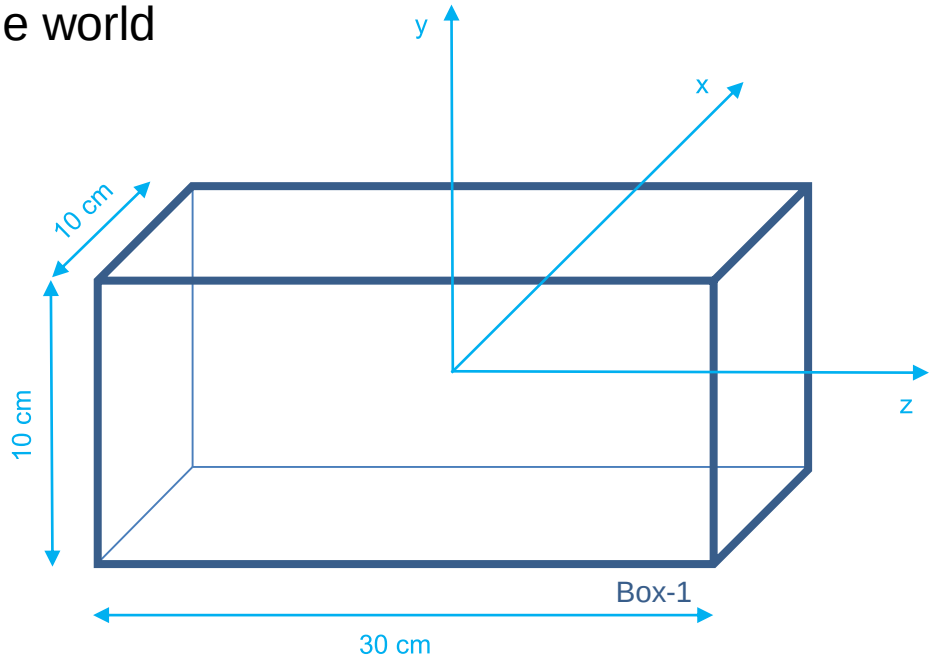
Recap

logical volume Box-1 with 10 cm × 10 cm × 30 cm
at (0, 0, 0) cm in the world

additional
logical volumes:



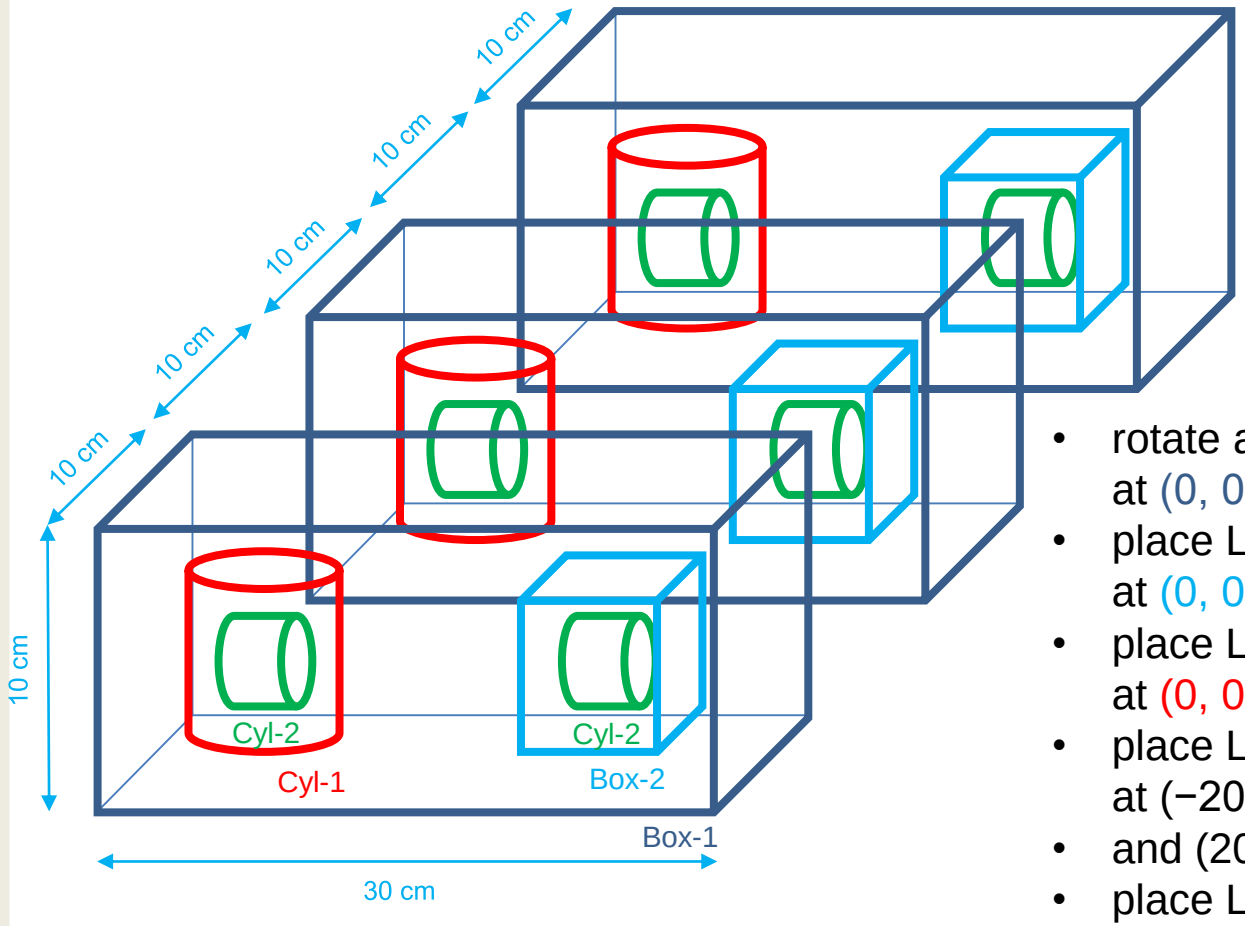




- Box-2: 5 cm × 5 cm × 5 cm
- Cyl-1: diameter 5 cm and height 5 cm
- Cyl-2: diameter 2 cm and height 2 cm

Multiple Placements of Volumes

Recap

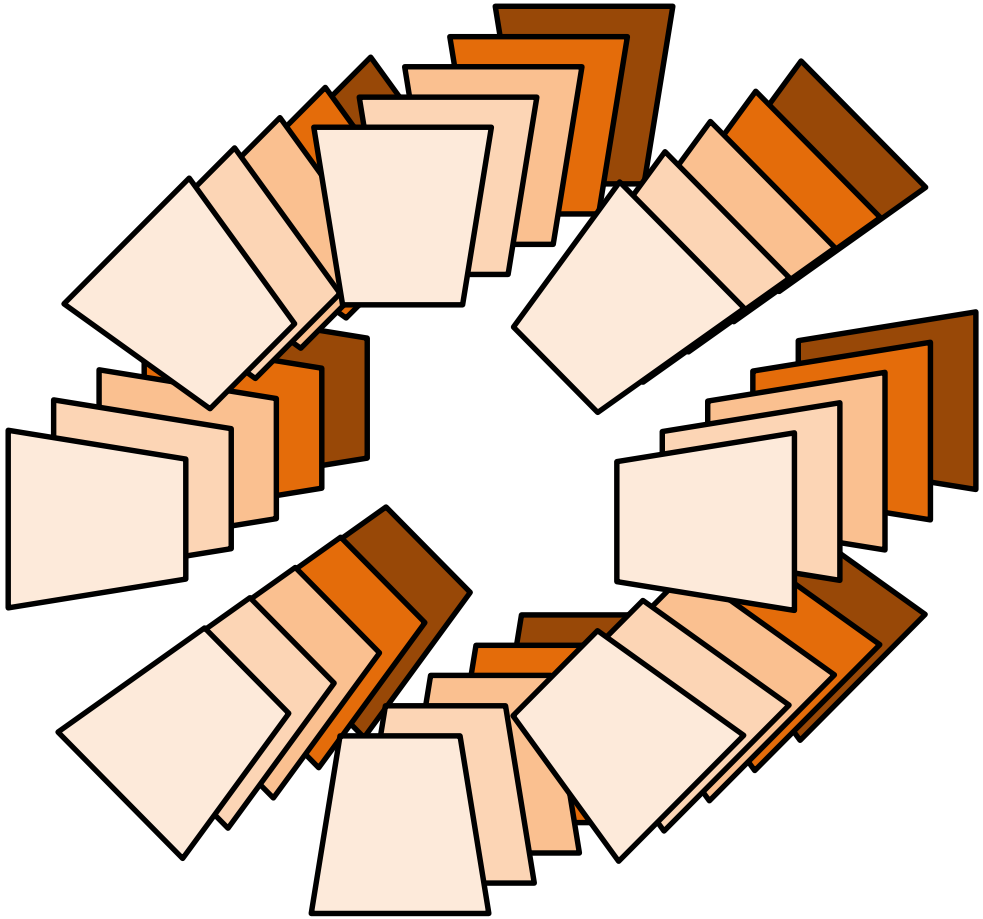


- rotate and place LV Cyl-1
  at (0, 0, −10) cm in LV Box-1
- place LV Cyl-2
  at (0, 0, 0) cm in LV Box-2
- place LV Cyl-2
  at (0, 0, 0) cm in LV Cyl-1
- place LV Box-1
  at (−20, 0, 0) cm
- and (20, 0, 0) cm in the world
- place LV Box-2
  at (0, 0, 10) cm in LV Box-1

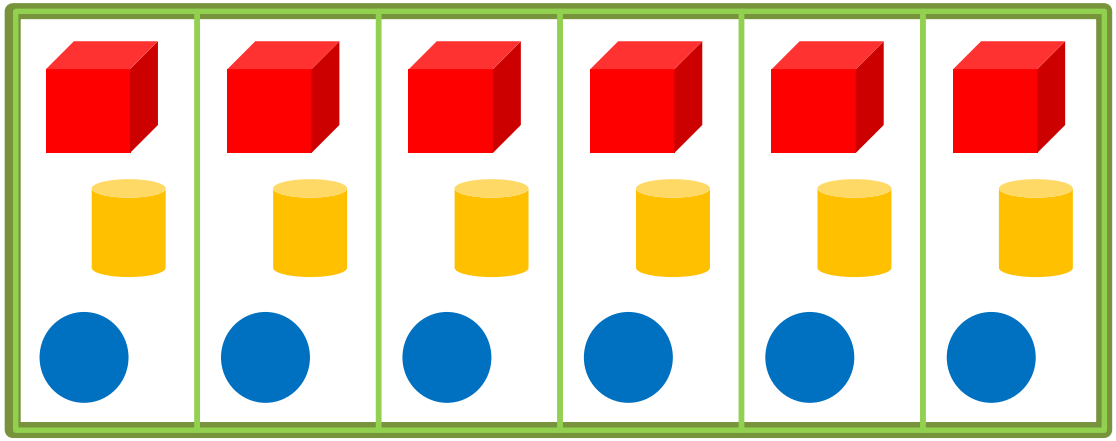
Replicas

- easy way to repeat a given structure
- no need to manually calculate the individual coordinates of the objects

- G4PVReplica represents *n* volumes
  - differing only in their positioning
  - completely filling the containing mother volume
  - no gaps between repeated volumes
  - no other volumes in the mother volume



Replicas—Linear Repetition

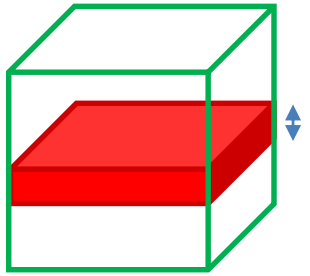


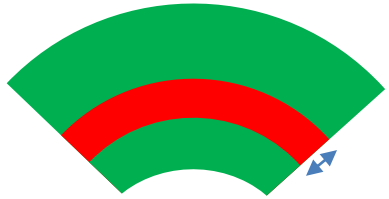
- mother volume (envelope) is divided into *n* equal daughter volumes (divisions)
- each division contains the same content

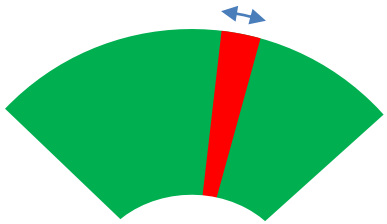
```
#include "G4PVReplica.hh"
repBoxes = new G4PVReplica("linear array",  // name
                           logicalBox,      // daugther
                           logicalEnvelope, // mother
                           kZAxis,          // axis
                           6,               // number of replicas
                           10.*cm);         // width along axis
                           // (optional parameter offset = 0)
```

Replicas and Axes

- **Cartesian axes** (`kXAxis`, `kYAxis`, `kZAxis`)
  - offset shall not be used
  - centre of n-th daughter: -width*(nReplicas-1)*0.5+n*width
  - origins of the replicas are at the centre of each replica
- **Radial axis** (`kRho`)
  - cons/tubs sections, centred on the origin and are unrotated
  - centre of n-th daughter: width*(n+0.5)+offset
  - coordinate system is unchanged with respect to the mother.
- **Phi axis** (`kPhi`)
  - phi sections or wedges, and of cons/tubs form
  - centre of n-th daughter: width*(n+0.5)+offset
  - new coordinate system is rotated (X axis bisects the angle made by each wedge, Z parallel to the mother's Z axis)
- solid of the replicated logical volume
  - dimensions of the first volume created
  - must be of the correct symmetry/type in order to assist in good visualisation

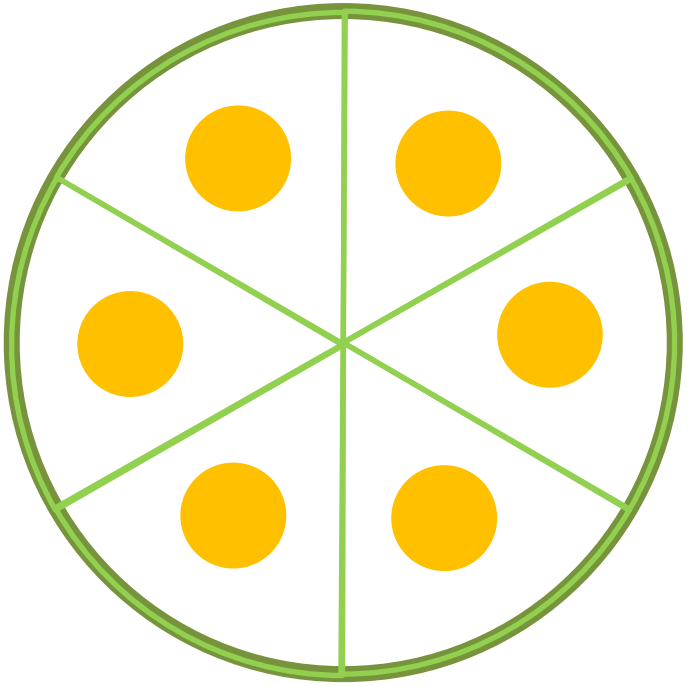






Replicas—Circular Repetition

- mother volume (envelope) is divided into *n* equal daughter volumes (divisions)
- each division contains the same content



```
#include "G4PVReplica.hh"
repWedges = new G4PVReplica("circular array", // name
                            logicalWedge,     // daugther
                            logicalEnvelope,  // mother
                            kPhi,             // axis
                            6,                // number of replicas
                            M_PI/3.*rad,      // width along axis
                            0);               // offset
```

Exercise

1. Download DetectorPhys_T4.tar.gz and decompress it.
2. Model the set-up shown in the figure using the template DetectorPhysDetectorConstruction.cc.
   Follow instructions and create 21 components in nine steps.
3. Check your geometry with:
   `/geometry/test/run`