Experimental Techniques in Particle Physics

Geant4: Geometry Advanced Exercises

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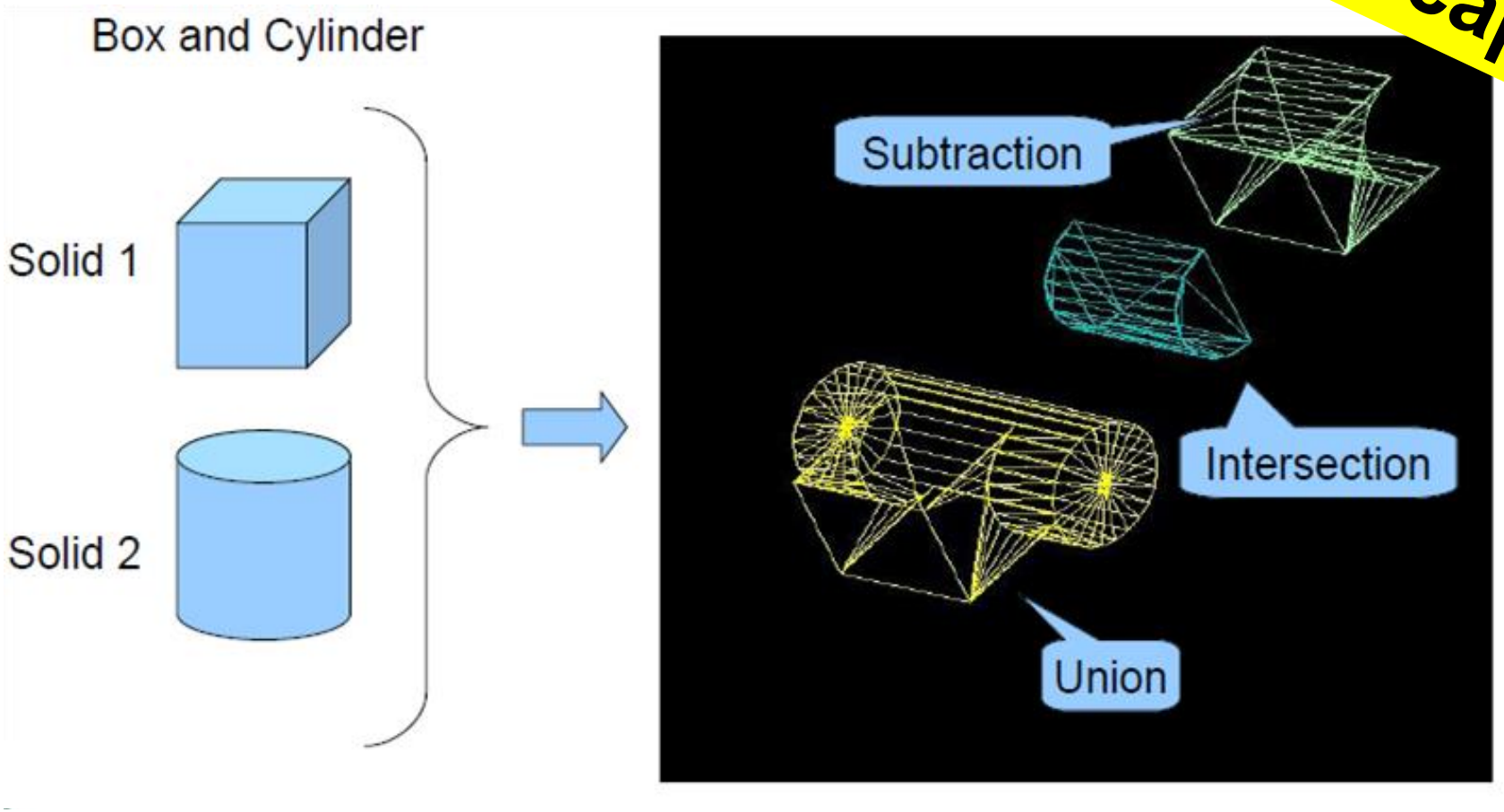
Solids Made by Boolean Operations

Recap



Problems with Boolean Operations

- Union and subtraction can produce errors:

```
ERROR: G4VSceneHandler::RequestPrimitives
  Polyhedron not available for BoxCylinderUnion
  Touchable path: World 0 PhysicalBoxTubsUnion 0
  This means it cannot be visualized on most systems (try RayTracer).
  1) The solid may not have implemented the CreatePolyhedron method.
  2) For Boolean solids, the BooleanProcessor, which attempts to create
     the resultant polyhedron, may have failed.
```

- Reasons:
  - one face of solid A coincides with another face of solid B
  - both solids share one or more edges
- Work-around:
  - change the dimensions slightly (e.g. by a fraction of a mm)
- Result:
  - avoid ‘fake’ surfaces due to precision loss (see Book for Application Developers, section 4.1.2, “Solids made by Boolean operations”. p. 117)

- Important:
  - a Boolean solid should represent a single “closed” solid
  - all parts should be connected

Composing Solids Step by Step

Recap

1. Define only solid 1
   (mathematical shape of predefined CSG or previous Boolean operation)
   You do not need logical volume and placement!

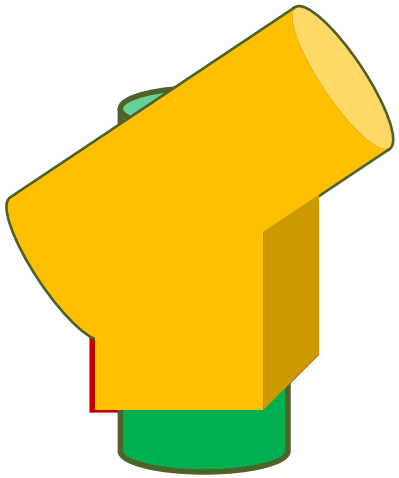
2. Define only solid 2
   (mathematical shape of predefined CSG or previous Boolean operation)
   You do not need logical volume and placement!

3. Translation and Rotation of solid 2

4. Boolean operation to make a new solid

5. Logical Volume for the new solid

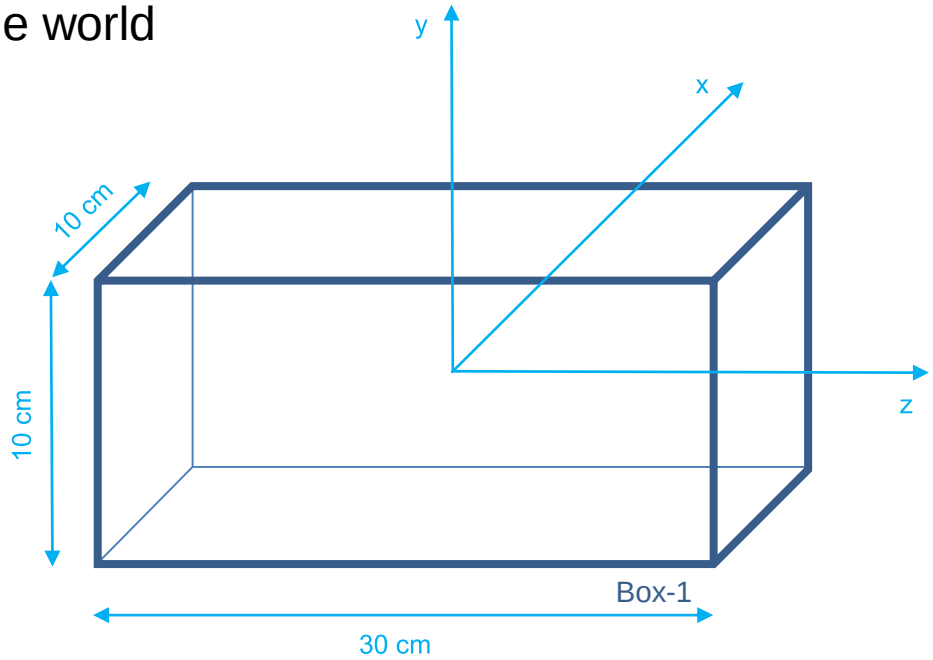
6. Physical Volume (placement) for the new solid

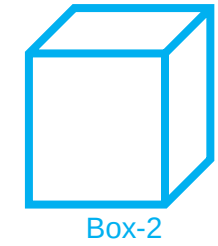


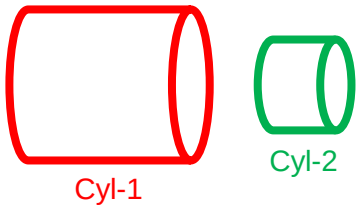
Hierarchy of Volumes

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

additional
logical volumes:



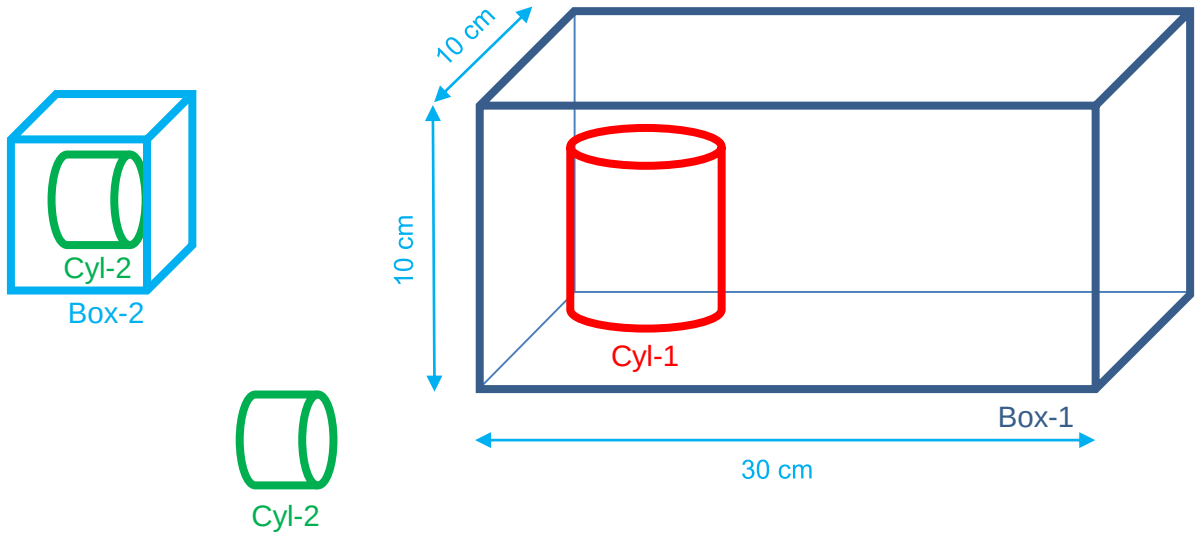




- Box-2: 5 cm × 5 cm × 5 cm
- Cyl-1: diameter 5 cm and height 5 cm
- Cyl-2: diameter 2 cm and height 2 cm

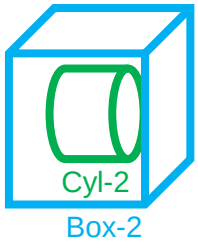
Hierarchy of Volumes

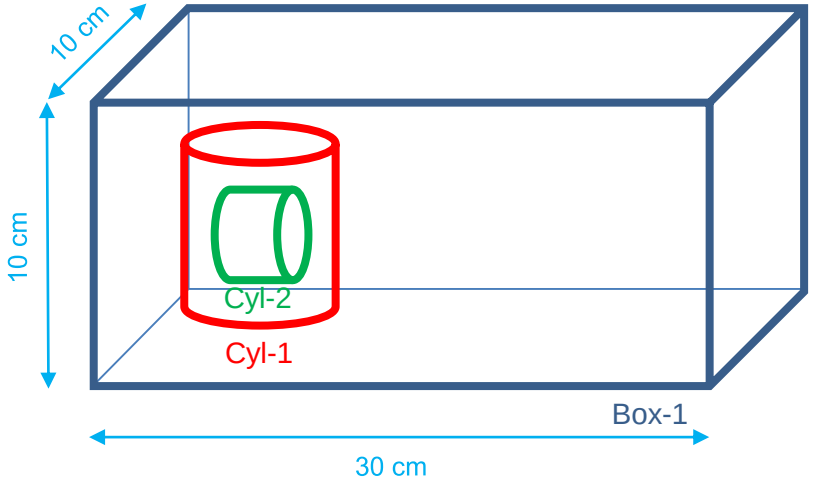
- rotate and place LV Cyl-1 at (0, 0, −10) cm in LV Box-1
- place LV Cyl-2 at (0, 0, 0) cm in LV Box-2



Multiple Placements of Volumes

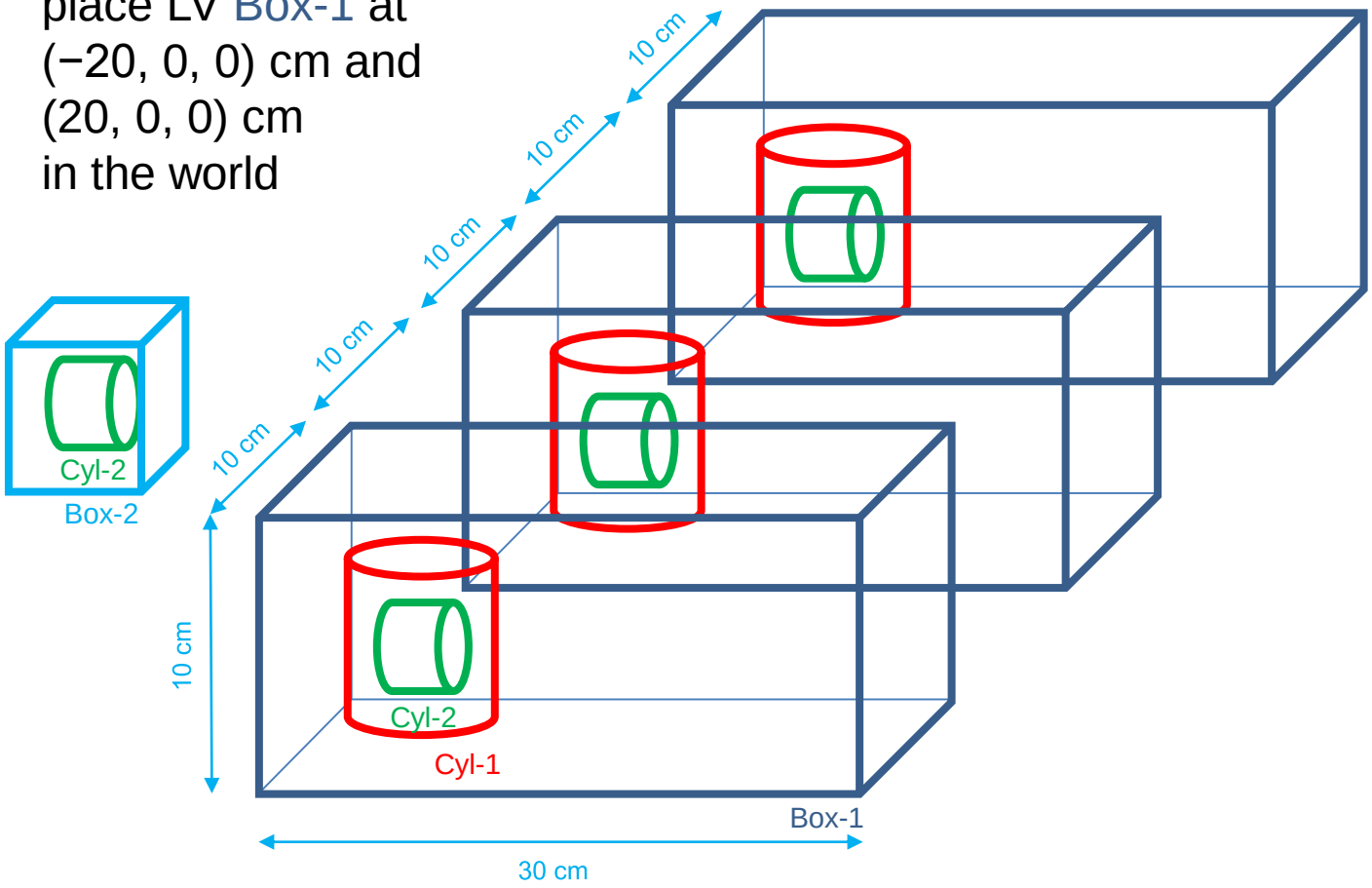
- place LV Cyl-2 at (0, 0, 0) cm in LV Cyl-1





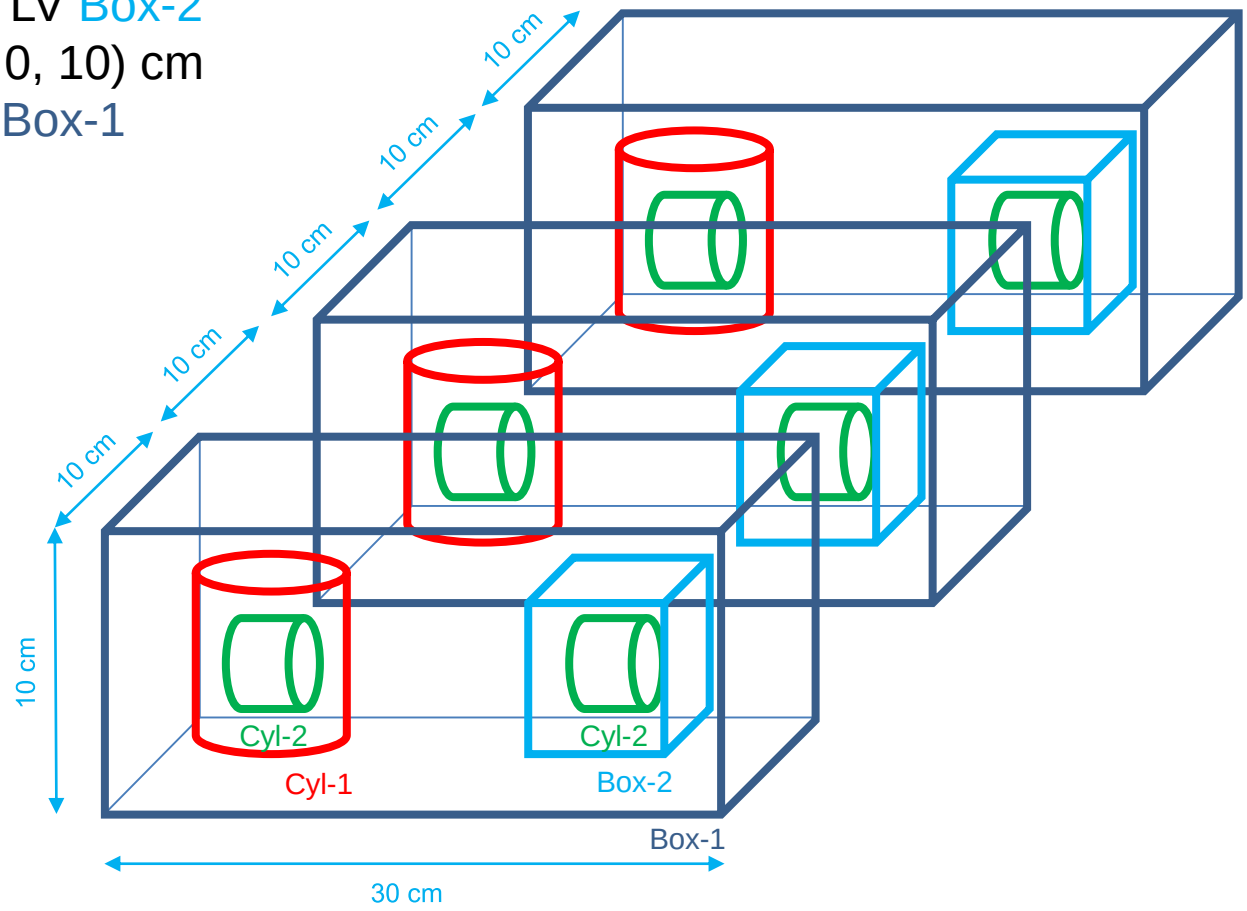
Multiple Placements of Volumes

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



Multiple Placements of Volumes

- place LV Box-2 at (0, 0, 10) cm in LV Box-1

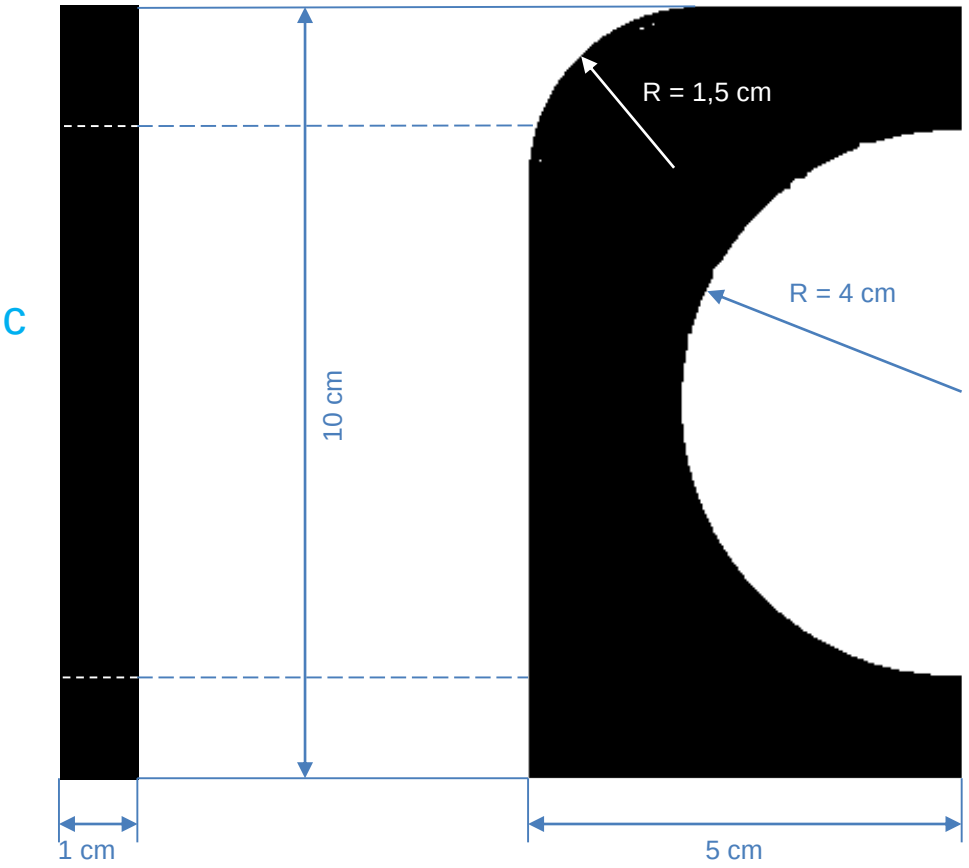


Remarks: Placements of Volumes

- a logical volume can be placed more than once
- one or more volumes can be placed in a mother volume
- mother-daughter relationship is an information of the logical volume
  - the mother volume can be specified by either the physical or the logical volume
  - but the information about the daughters is always stored in the logical volume of the mother
- if the mother volume is placed more than once, all daughters appear in each placed physical volume
- the order of placements is not important
- the world volume defines the global coordinate system. The origin of the global coordinate system is at the center of world volume
- the position of a particle is given with respect to the global coordinate system

Exercise 1 of 4

1. Download DetectorPhys_T3a.tar.gz and decompress it.
2. Model the object shown in the figure using the template DetectorPhysDetectorConstruction.cc.
3. Check your geometry with: `/geometry/test/run`



Exercise 2 of 4

1. Download DetectorPhys_T3b.tar.gz and decompress it.
2. Model the object shown in the figure using the template DetectorPhysDetectorConstruction.cc. The inner diameter of the cylinder is 3 cm and the outer diameter 10 cm. Think about the geometry.
3. Check your geometry with: `/geometry/test/run`

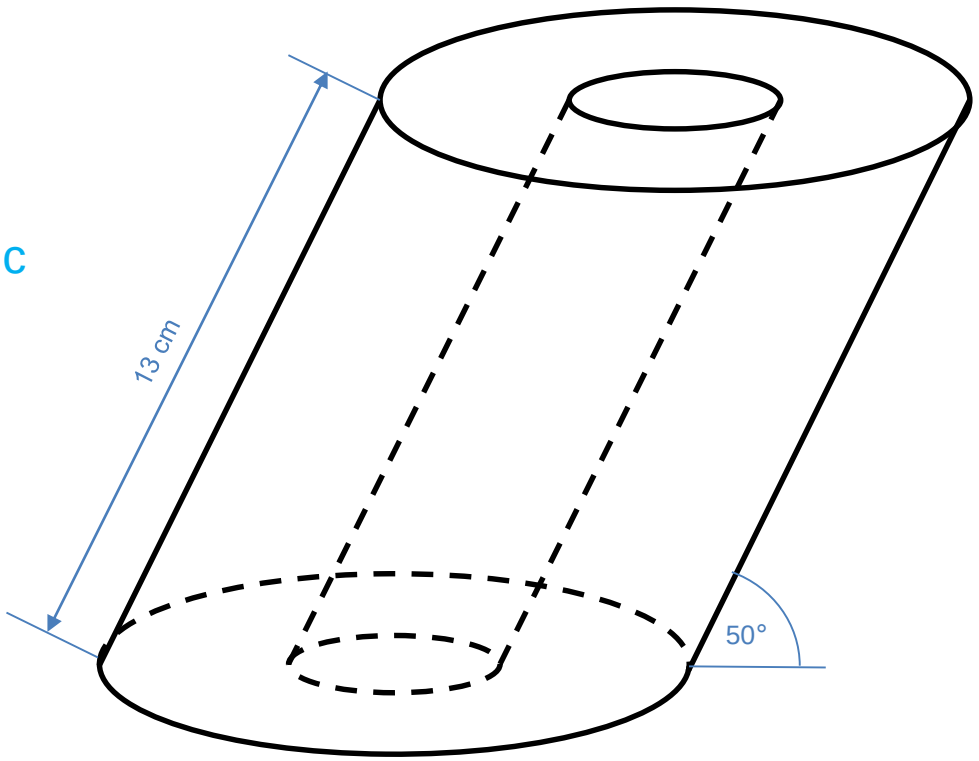


figure not to scale

Exercise 3 of 4

1. Download DetectorPhys_T3c-d.tar.gz and decompress it.
2. Model this ring of trapezoids using the template DetectorPhysDetectorConstruction.cc. The thickness of the trapezoids is 500 µm.
   Think about the coordinates and then rotate the trapezoids.
3. Check your geometry with:
   `/geometry/test/run`

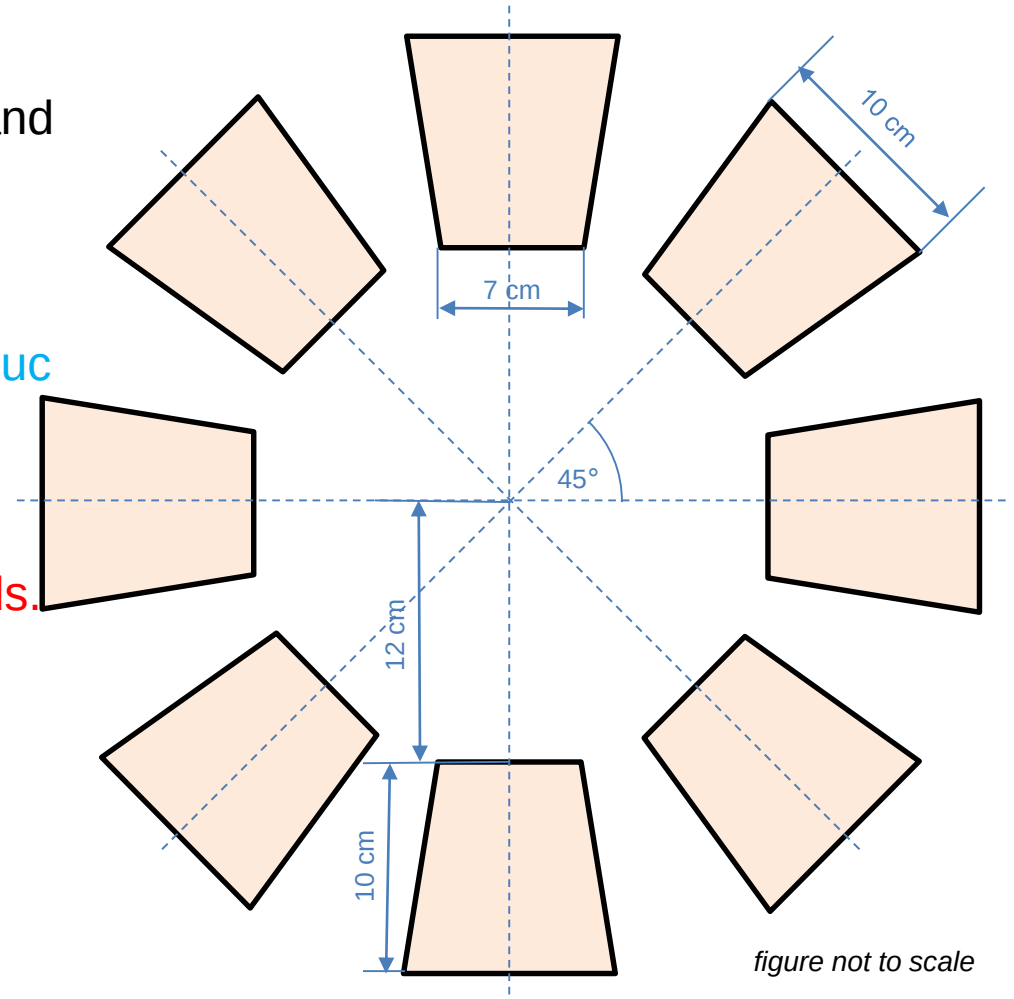
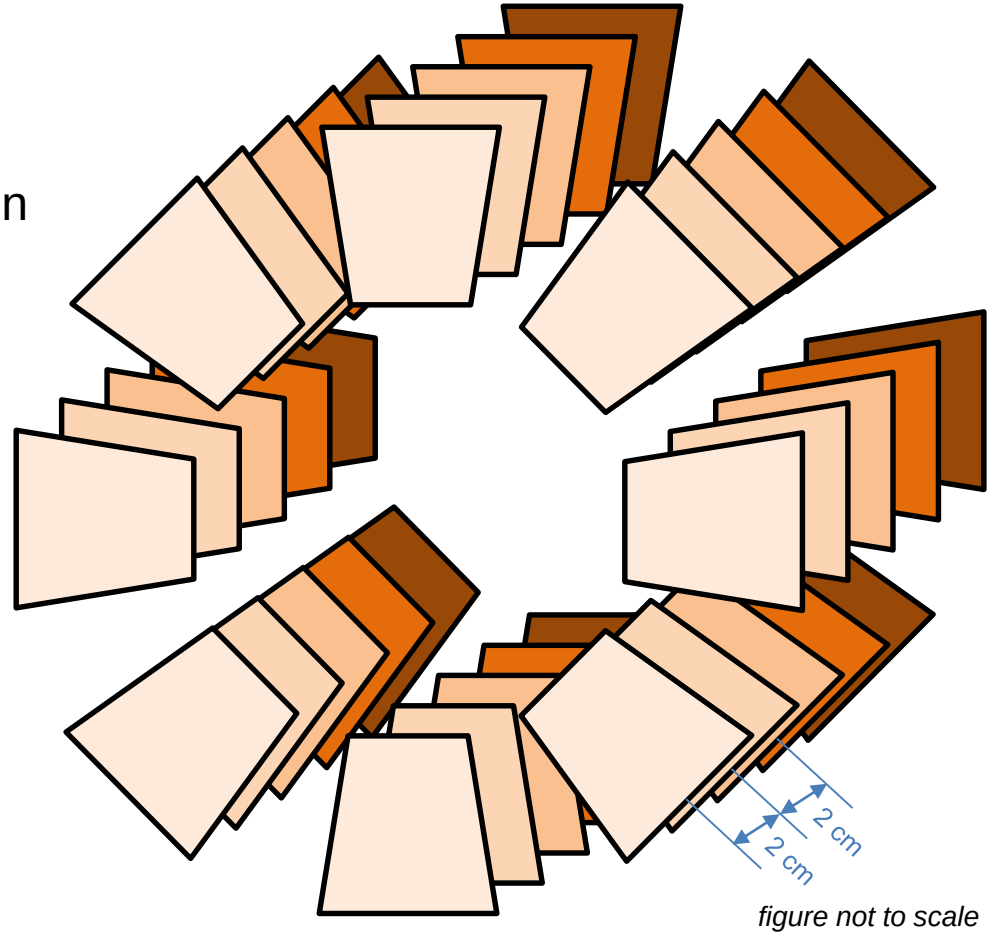


figure not to scale

Exercise 4 of 4

1. Continue with DetectorPhys_T3c-d.tar.gz.
2. Repeat the ring of trapezoids 50 times. The spacing between the layers is 2 cm.
3. Check your geometry with: `/geometry/test/run`



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