

CLD detector with ARC (eating tracker space)

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Fullsim meeting

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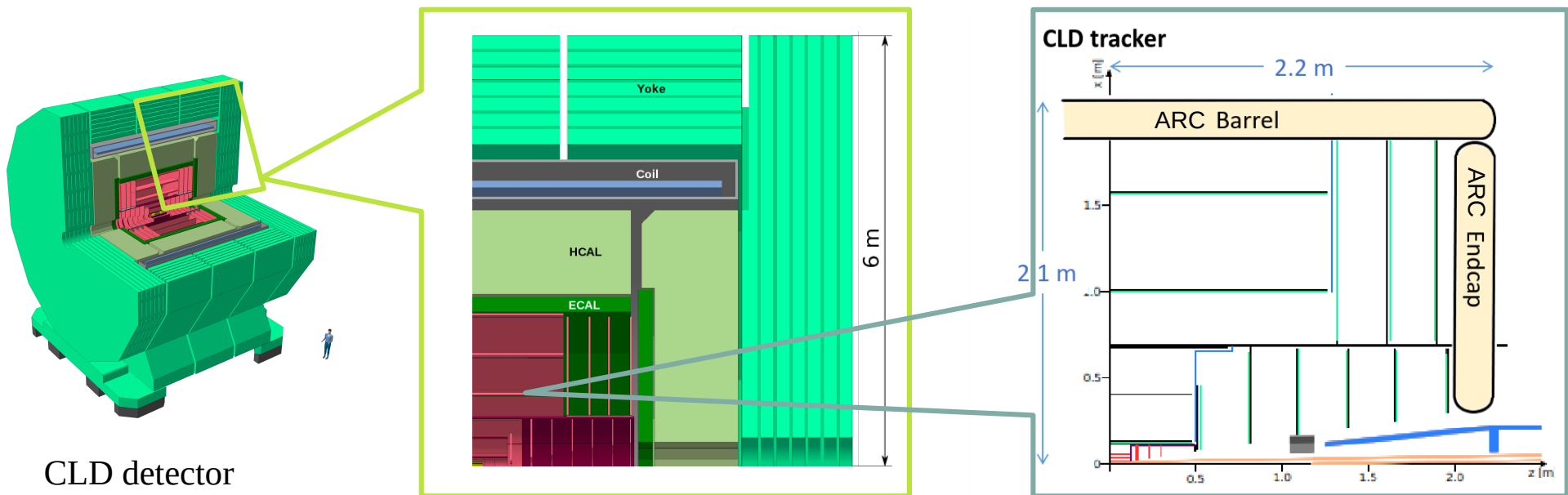


**FUTURE
CIRCULAR
COLLIDER**



Design of Array of RICH Cells (ARC)

- The ARC was designed to be integrated with the CLD detector, between the tracker and the ECAL
- The ARC thickness is 20 cm, the barrel length is 4.4 m and the endcaps are placed as the bases of the barrel

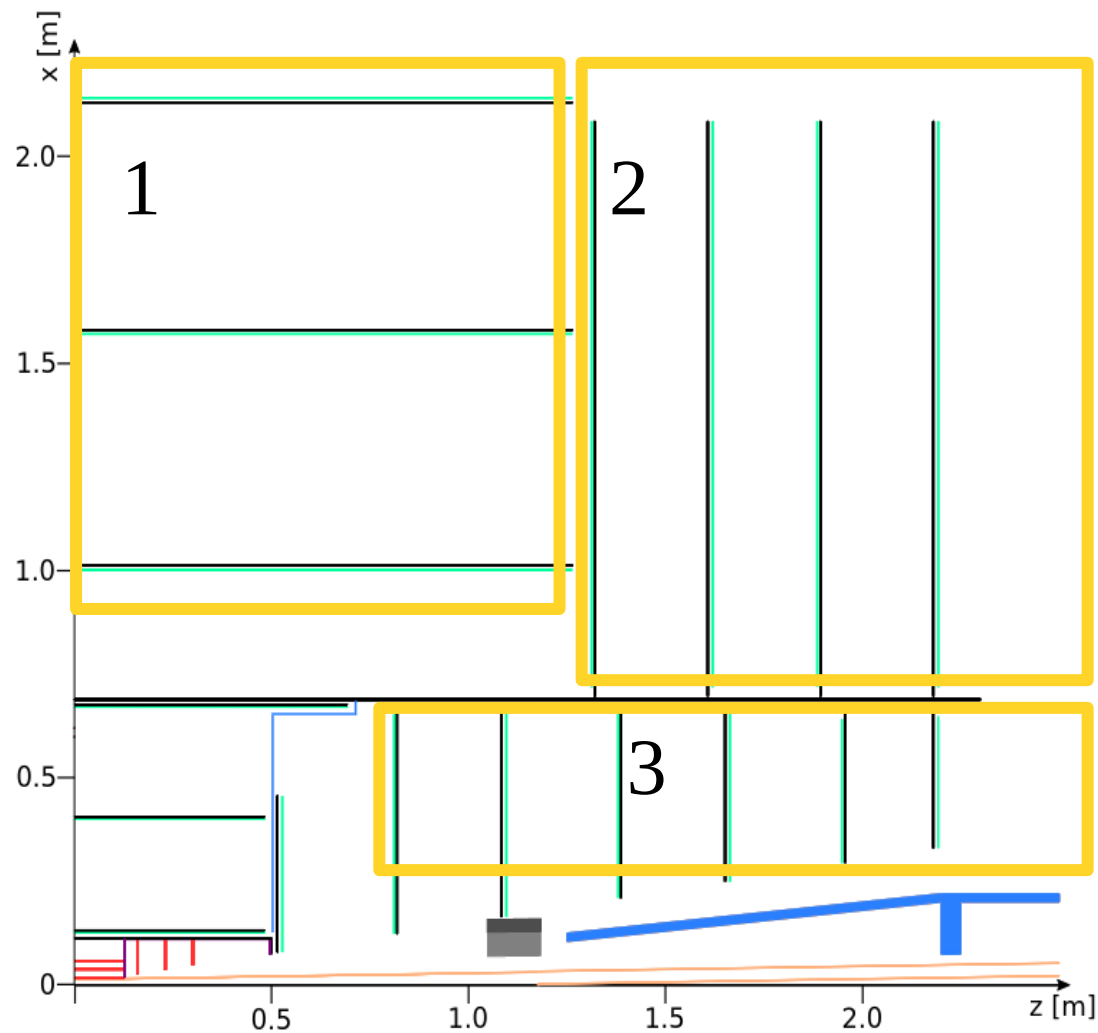


CLD tracker parts

CLD o2 v05 is taken as starting point

The following parts have to be shrunk by 20 cm inwards:

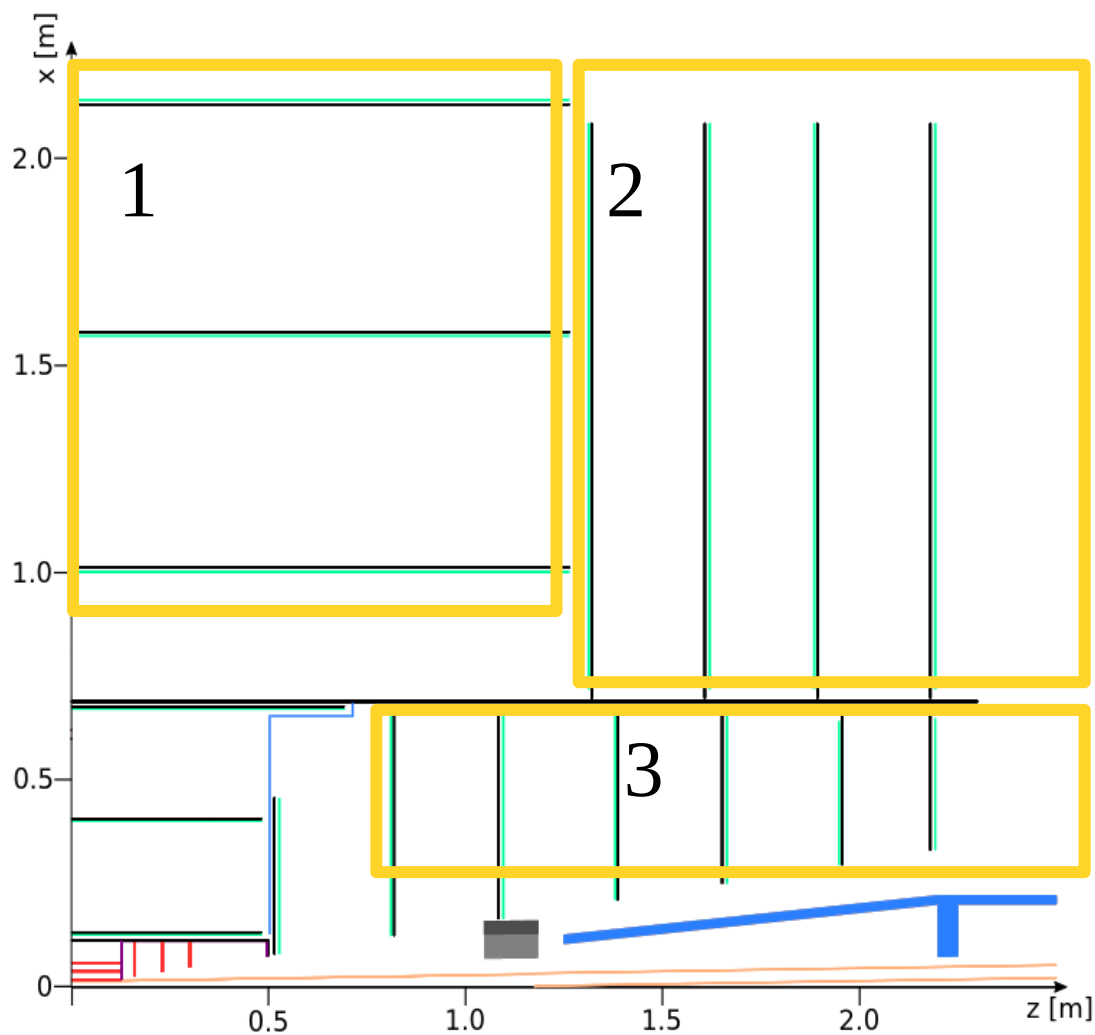
1. Outer tracker barrel
2. Outer tracker endcap
3. Inner tracker endcap



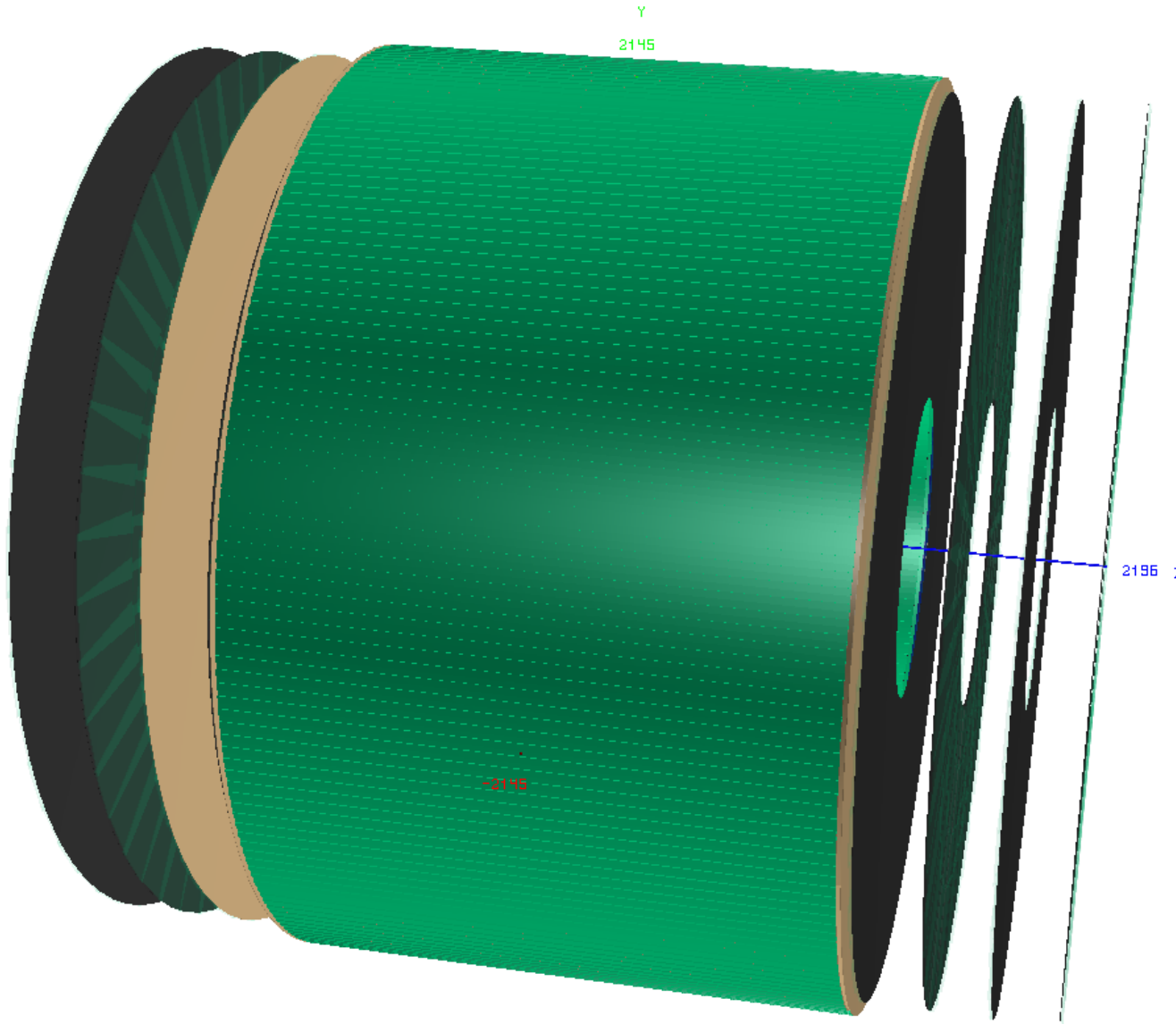
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- 1. Outer tracker barrel**
2. Outer tracker endcap
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CLD outer tracker original



Original size:

$$Z_{\text{out}}/2 = 220 \text{ cm}$$

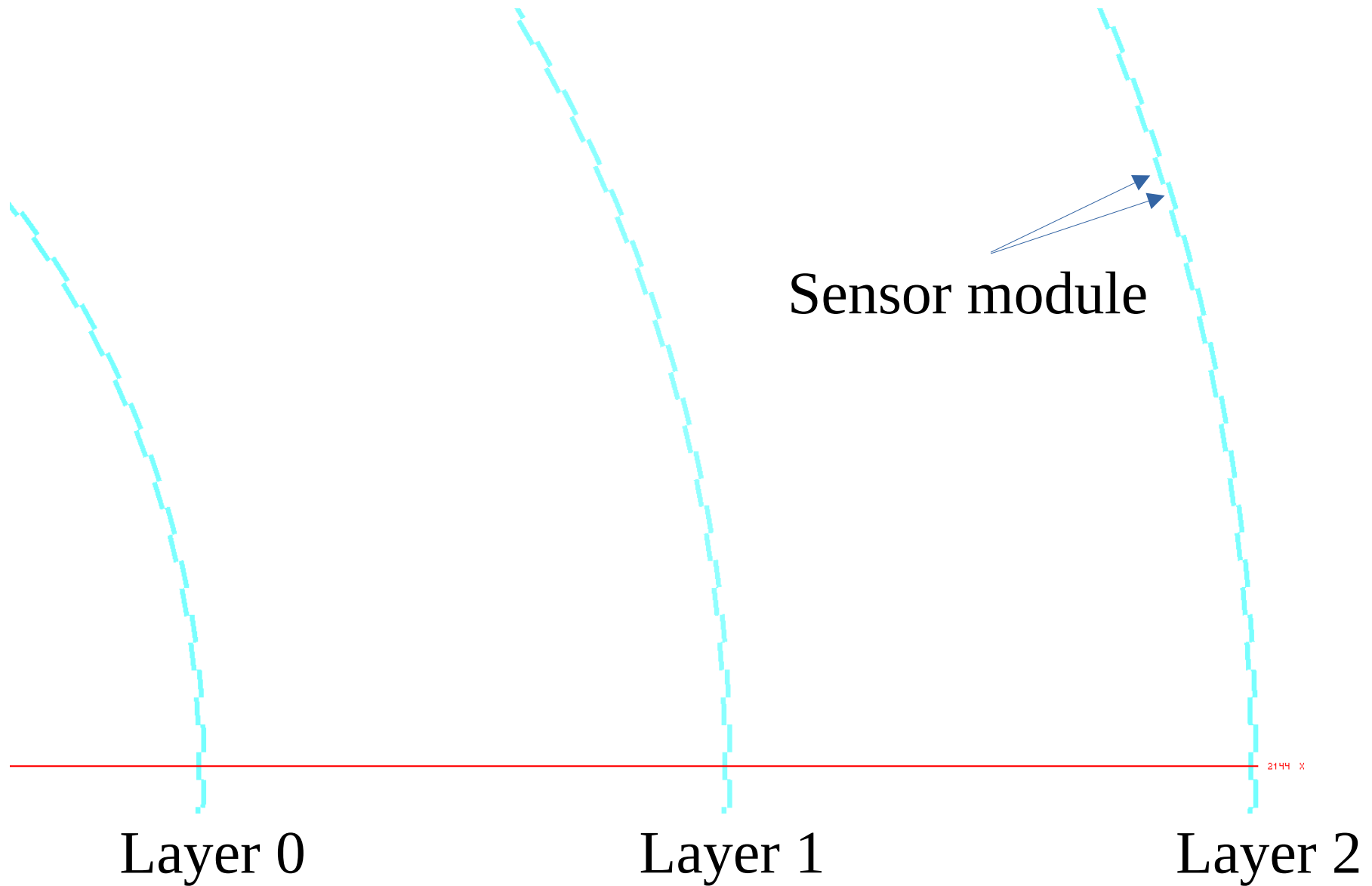
$$R_{\text{out}} = 215 \text{ cm}$$

Goal:

$$Z_{\text{out}}/2 = 200 \text{ cm}$$

$$R_{\text{out}} = 190 \text{ cm}$$

CLD outer tracker barrel



How to determine the number of sensors for a given radius? My approach (not consistent with previous work): change slightly the radius so an integer number of sensors can be fitted inside the ring without overlaps/gaps

```
double sideXY = 30.1; //mm
```

```
void OT_bestRadius(double Rin /*in mm*/ ) // return in mm
```

```
{std::cout << "nphi = " << floor(2*3.141592*Rin/sideXY) << "\t R = " <<
```

```
floor(2*3.141592*Rin/sideXY)*sideXY/(2*3.141592) << "*mm" << std::endl;}
```

```
OT_bestRadius(1450 /*mm*/)
```

```
nphi = 302  R = 1446.75*mm
```

Changes in file: OuterTracker_o2_v06_02.xml

In order to change radius of layer 1, change the **radius** and the number of sensor modules **nphi** of that specific layer:

Line 5: `<constant name="OuterTracker_Barrel_radius_1" value="1447*mm"/>`

Line 85: `<rphi_layout phi_tilt="0*deg" nphi="302" phi0="0"
rc="OuterTracker_Barrel_radius_1" dr="5.5*mm"/>`

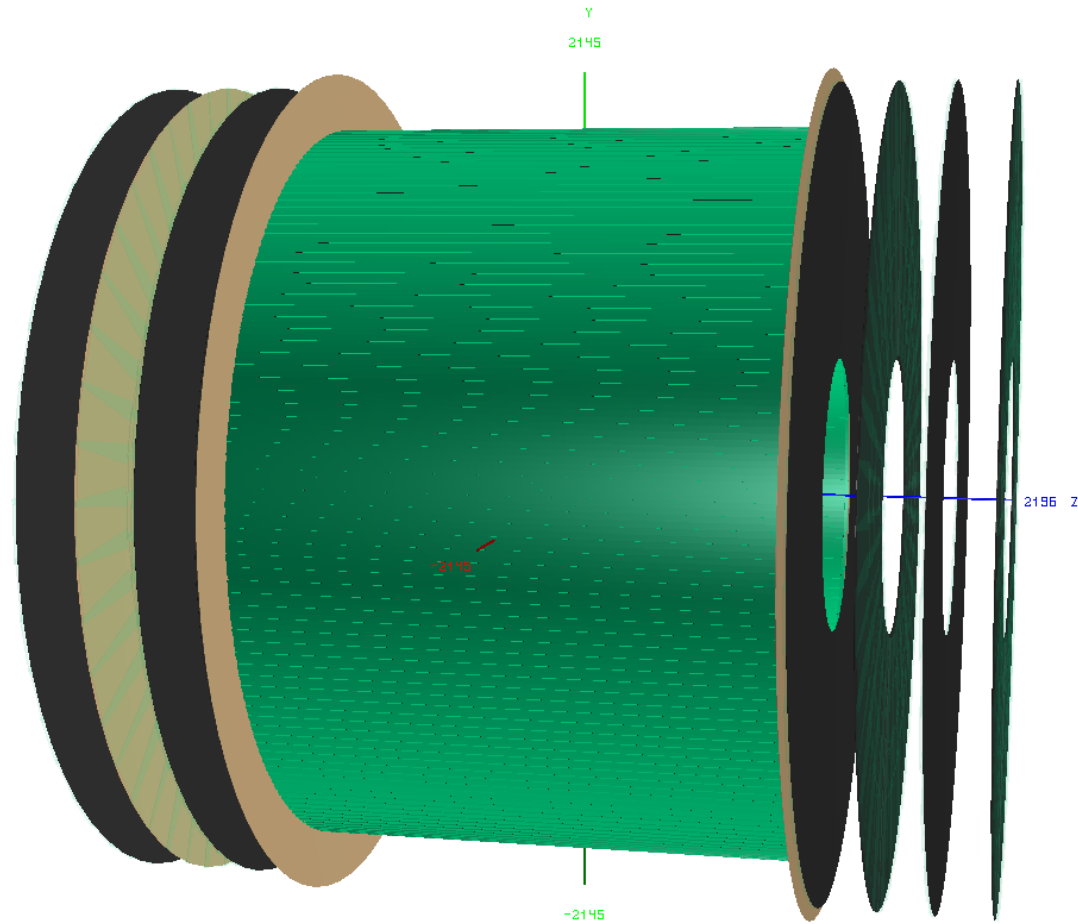
Changes in file: OuterTracker_o2_v06_02.xml

In order to change radius of layer 2, change the **radius** and the number of sensor modules **nphi** of that specific layer:

Line 6: `<constant name="OuterTracker_Barrel_radius_2" value="1849*mm"/>`

Line 88: `<rphi_layout phi_tilt="0*deg" nphi="386" phi0="0"
rc="OuterTracker_Barrel_radius_2" dr="5.5*mm"/>`

CLD outer tracker barrel



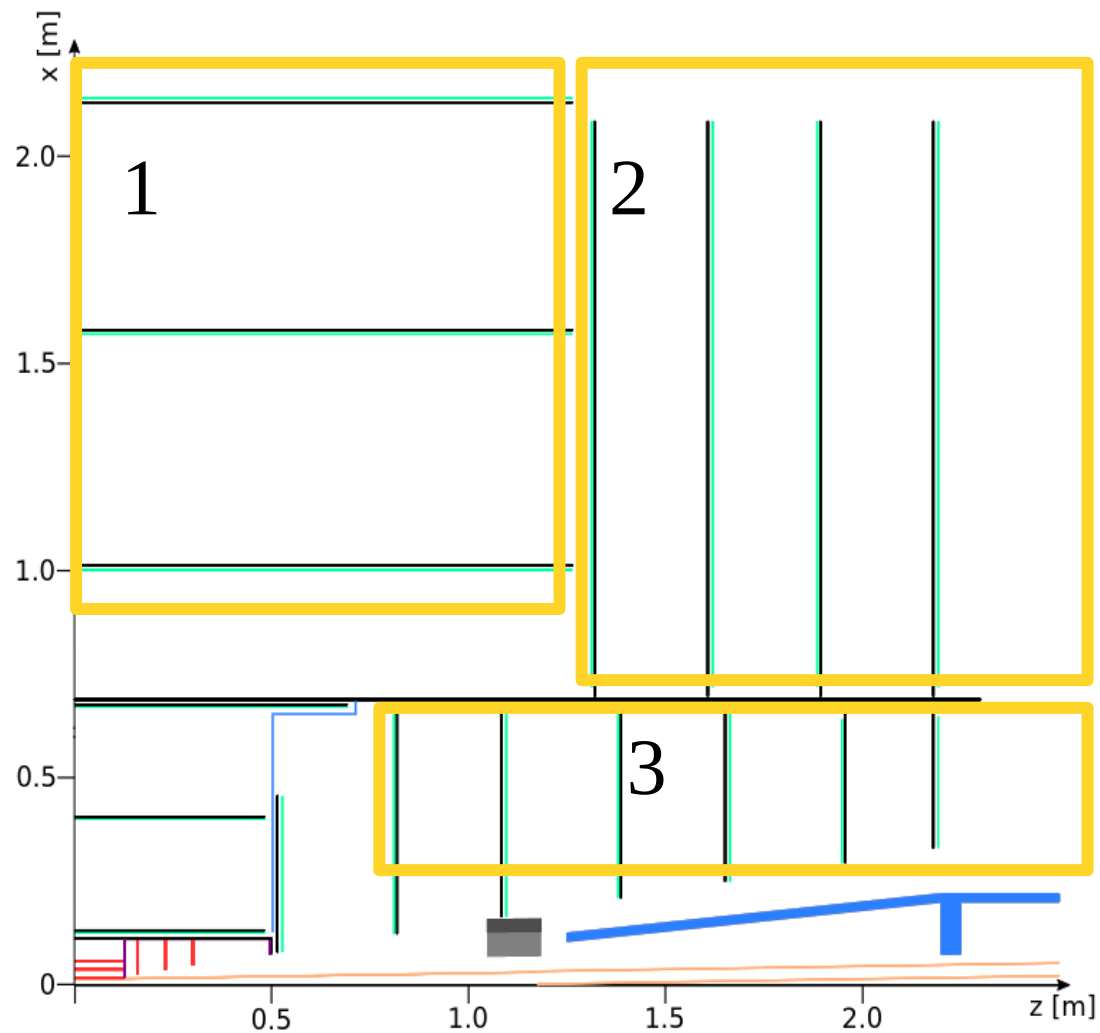
After shrinking the OT barrel...

CLD tracker parts

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The following parts have to be shrunk by 20 cm inwards:

1. Outer tracker barrel
2. Outer tracker endcap
3. Inner tracker endcap

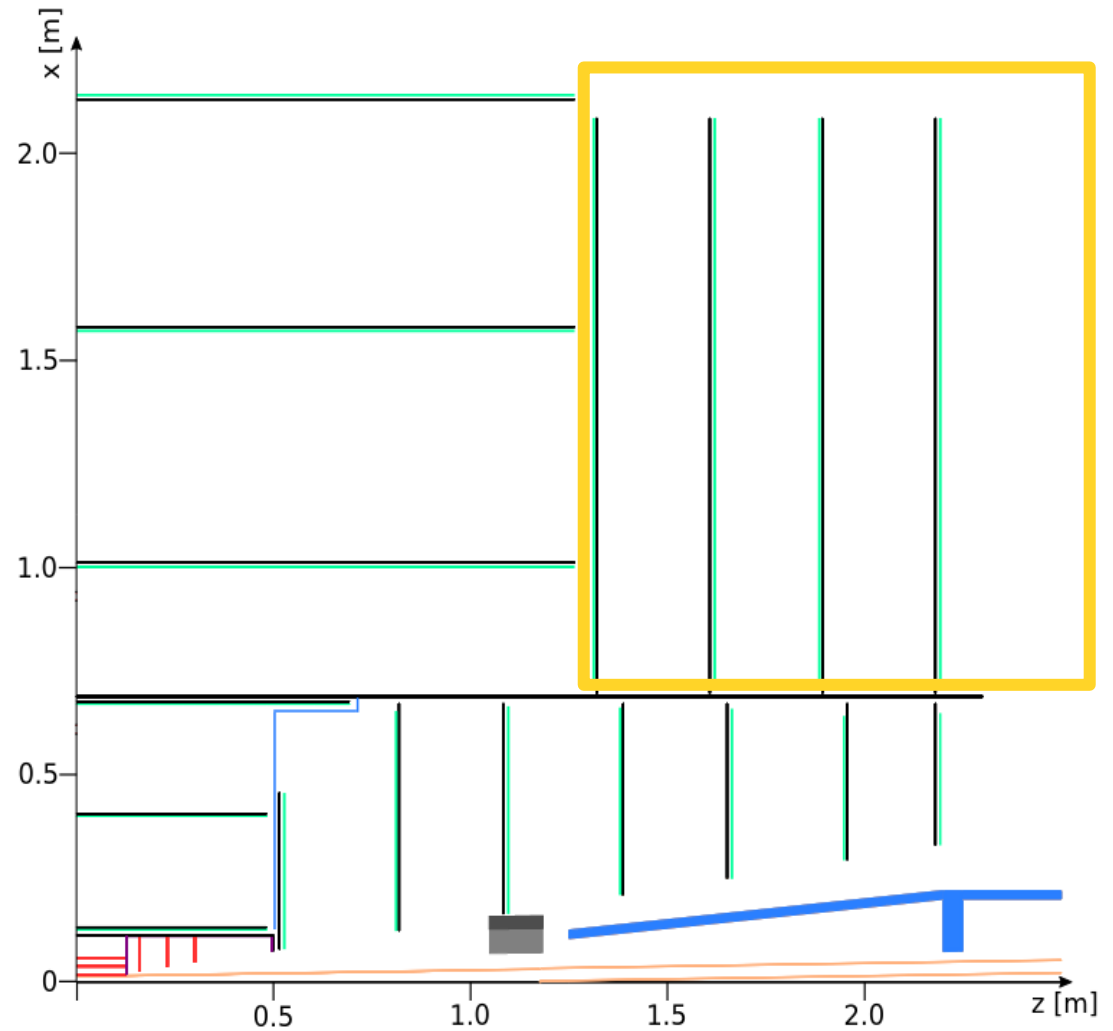
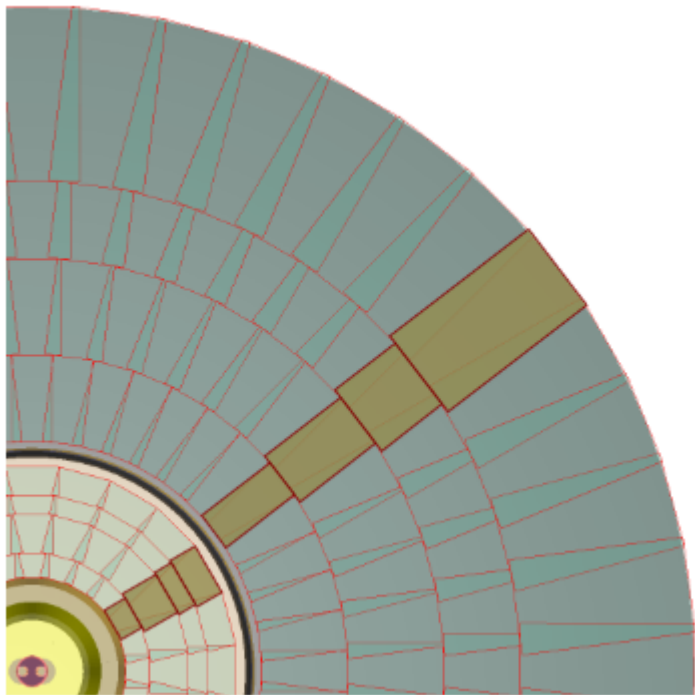


CLD outer tracker endcap



The radius of outer tracker endcap must be reduced by 20 cm

Layer z position must move closer to z=0





CLD outer tracker endcap

The radius of outer tracker endcap must be reduced by 20 cm

| → Solution: reduce outer tracker envelope radius

In main compact file, CLD_oX_v0Y.xml:

```
<constant name="OuterTracker_outer_radius" value="1900*mm" /> <!-- to avoid overlap with
```

CLD outer tracker endcap



The radius of outer tracker endcap must be reduced by 20 cm

| → Solution: reduce outer tracker envelope radius

| → Solution: reduce support structure radius

In tracker compact file:

Change support structure radius

```
<constant name="OuterTracker_Endcap_outer_radius" value="1900*mm"/>
```

CLD outer tracker endcap



The radius of outer tracker endcap must be reduced by 20 cm

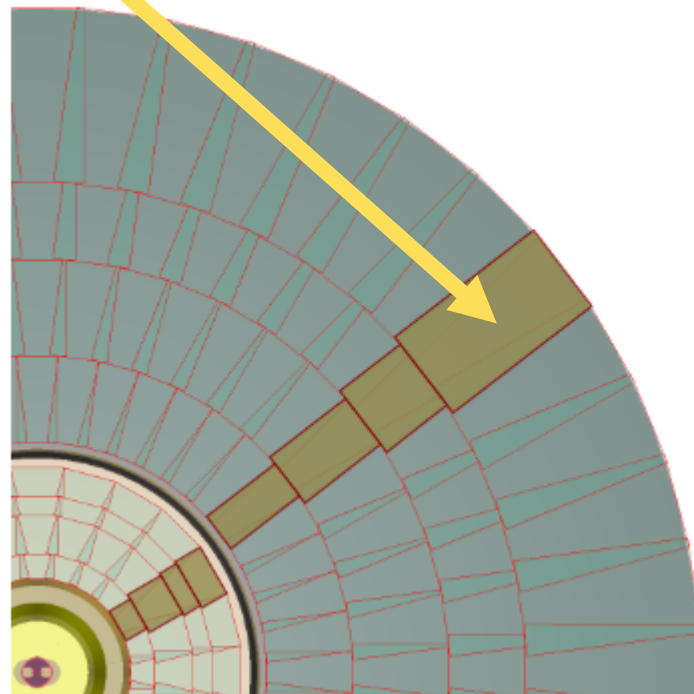
| →

| → Solution: reduce Y-size of the last ring module

In tracker compact file:

```
<module name="OuterTrackerEndcapModule_3_In"  
vis="OuterTrackerModuleVis"> <trd x="300*mm"  
y="349.4*mm"/> <include  
ref="TrackerDiskModuleIn.xml"/> </module>
```

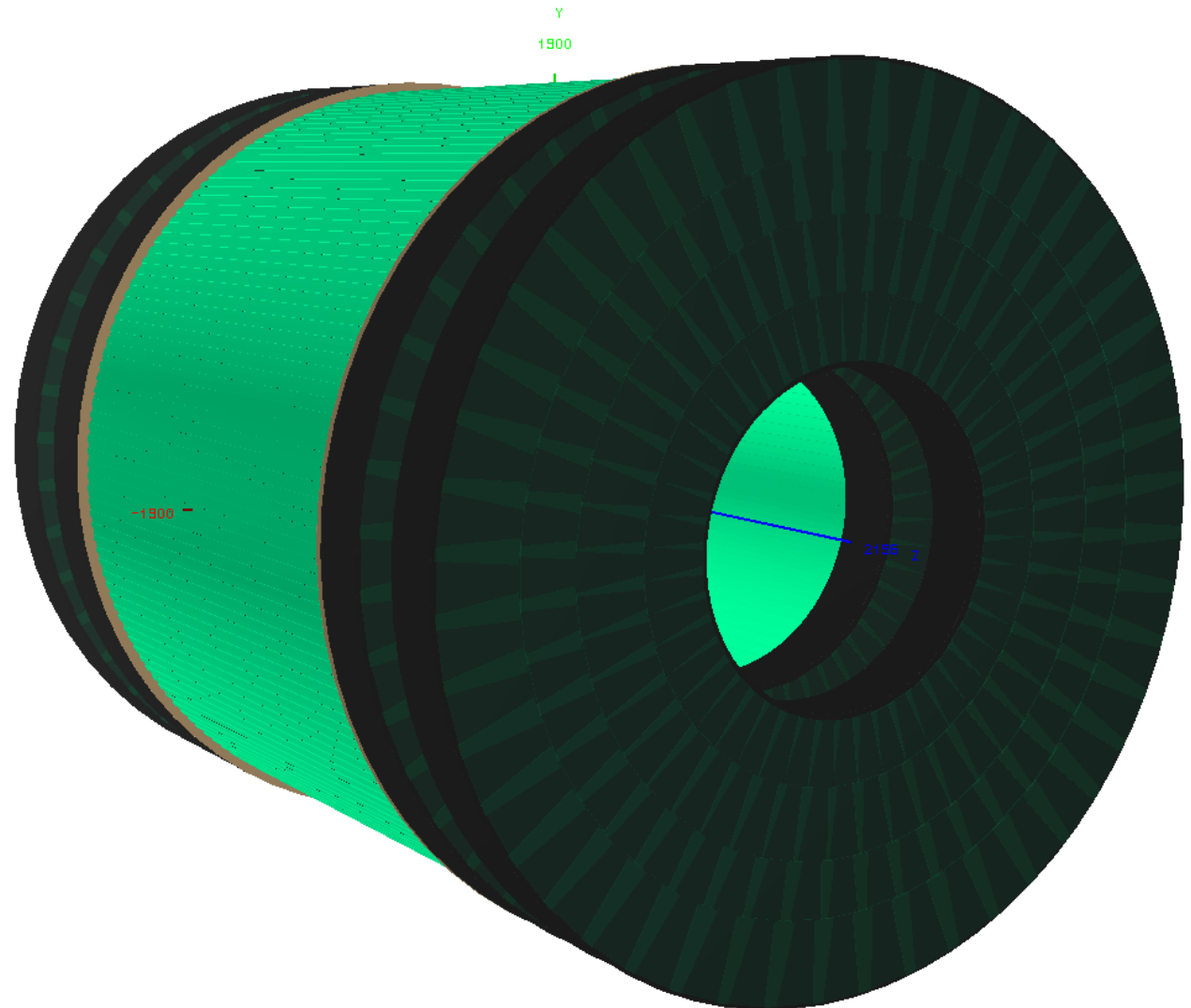
```
<module name="OuterTrackerEndcapModule_3_Out"  
vis="OuterTrackerModuleVis"> <trd x="300*mm"  
y="349.4*mm"/> <include  
ref="TrackerDiskModuleOut.xml"/> </module>
```



CLD outer tracker endcap



Resulting radius: 190 cm

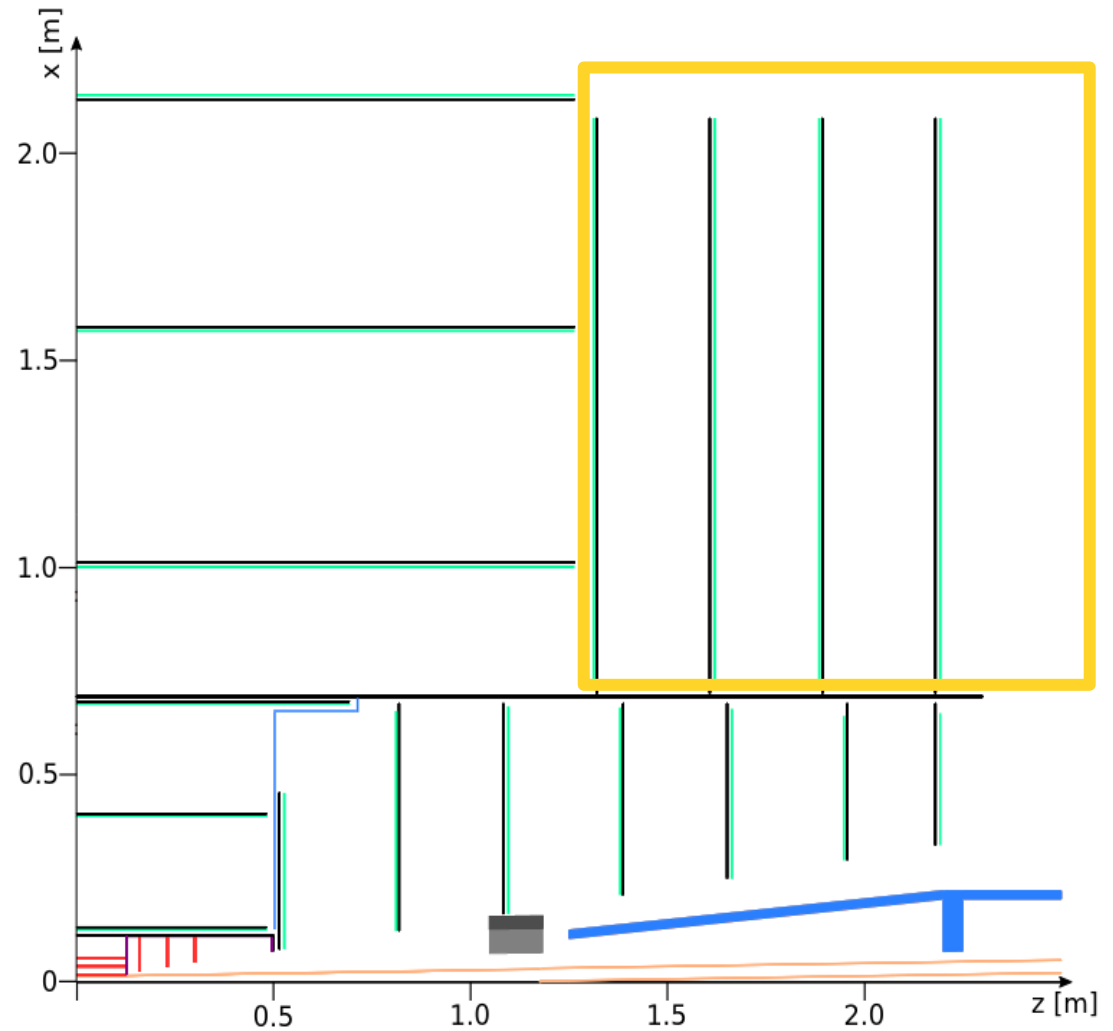
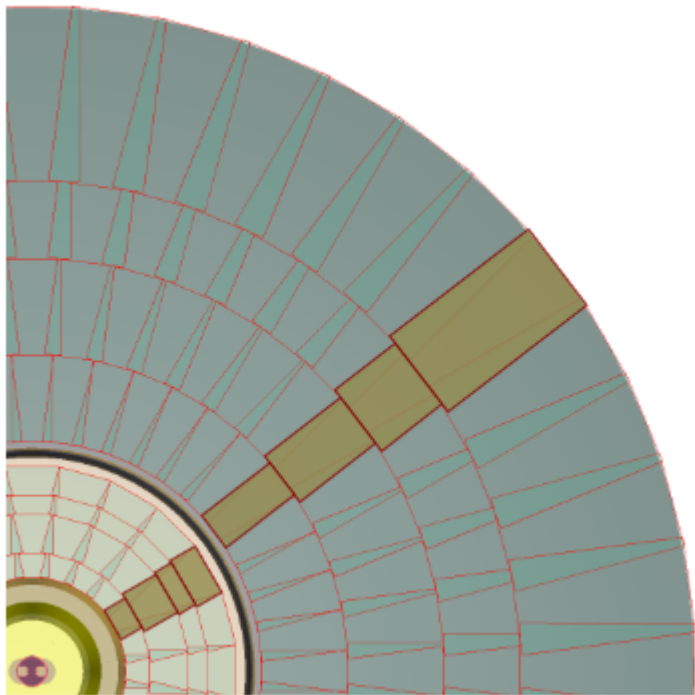


CLD outer tracker endcap



The radius of outer tracker endcap must be reduced by 20 cm

Layer z position must move closer to z=0



Layer z position must move closer to z=0 by 20cm

| → Solution: reduce 23% the inter-spaces $\Delta 1$ and $\Delta 2$,

by changing the position

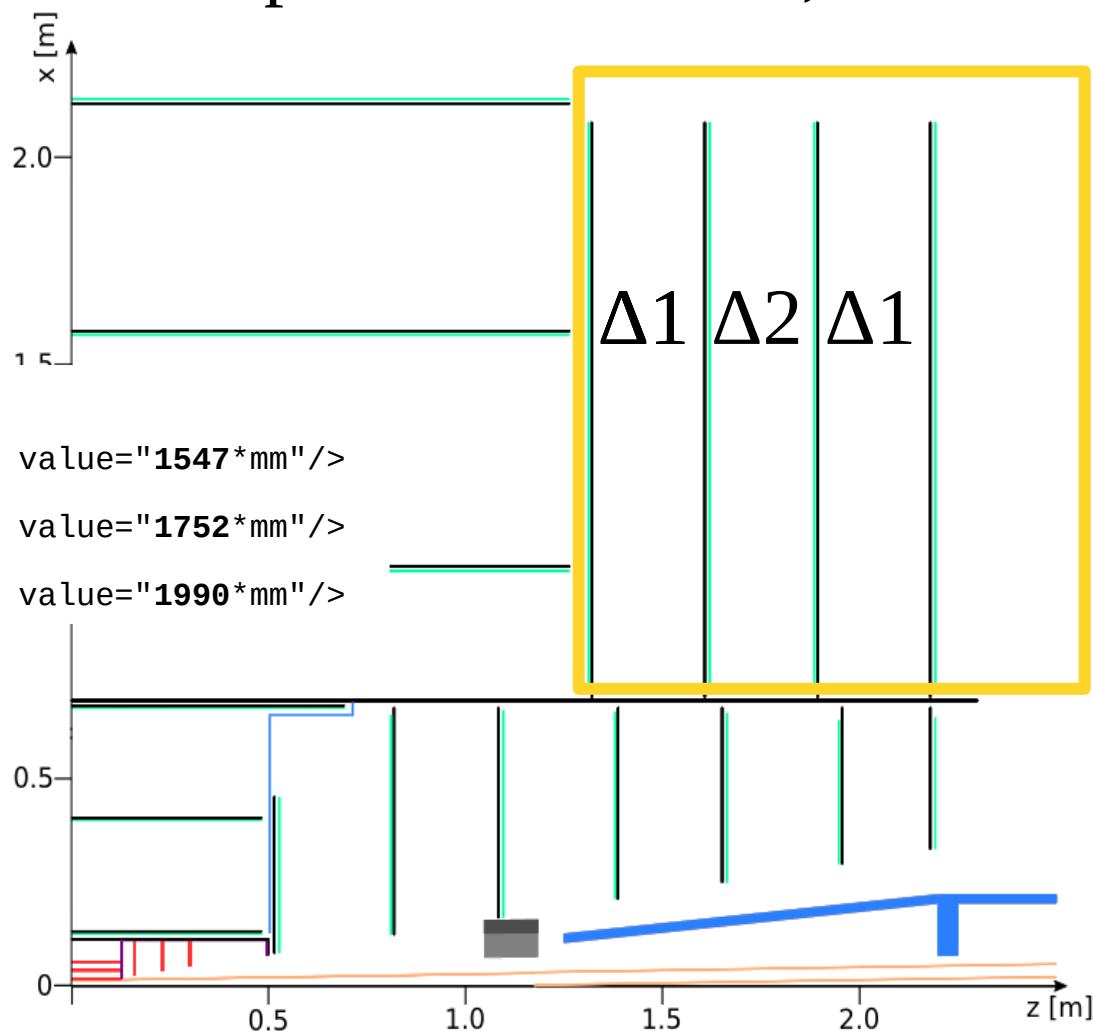
Of layer 1,2,3 (0 stays)

In the outer tracker compact file:

```
<constant name="OuterTracker_Endcap_z_1" value="1547*mm"/>
```

```
<constant name="OuterTracker_Endcap_z_2" value="1752*mm"/>
```

```
<constant name="OuterTracker_Endcap_z_3" value="1990*mm"/>
```



CLD outer tracker endcap

Layer z position must move closer to $z=0$ by 20cm

| → Solution: reduce 23% the inter-spaces $\Delta 1$ and $\Delta 2$,
by changing the position

Of layer 1,2,3 (0 stays)

In the outer tracker compact file:

```
<constant name="OuterTracker_Endcap_z_1" value="1547*mm"/>
```

```
<constant name="OuterTracker_Endcap_z_2" value="1752*mm"/>
```

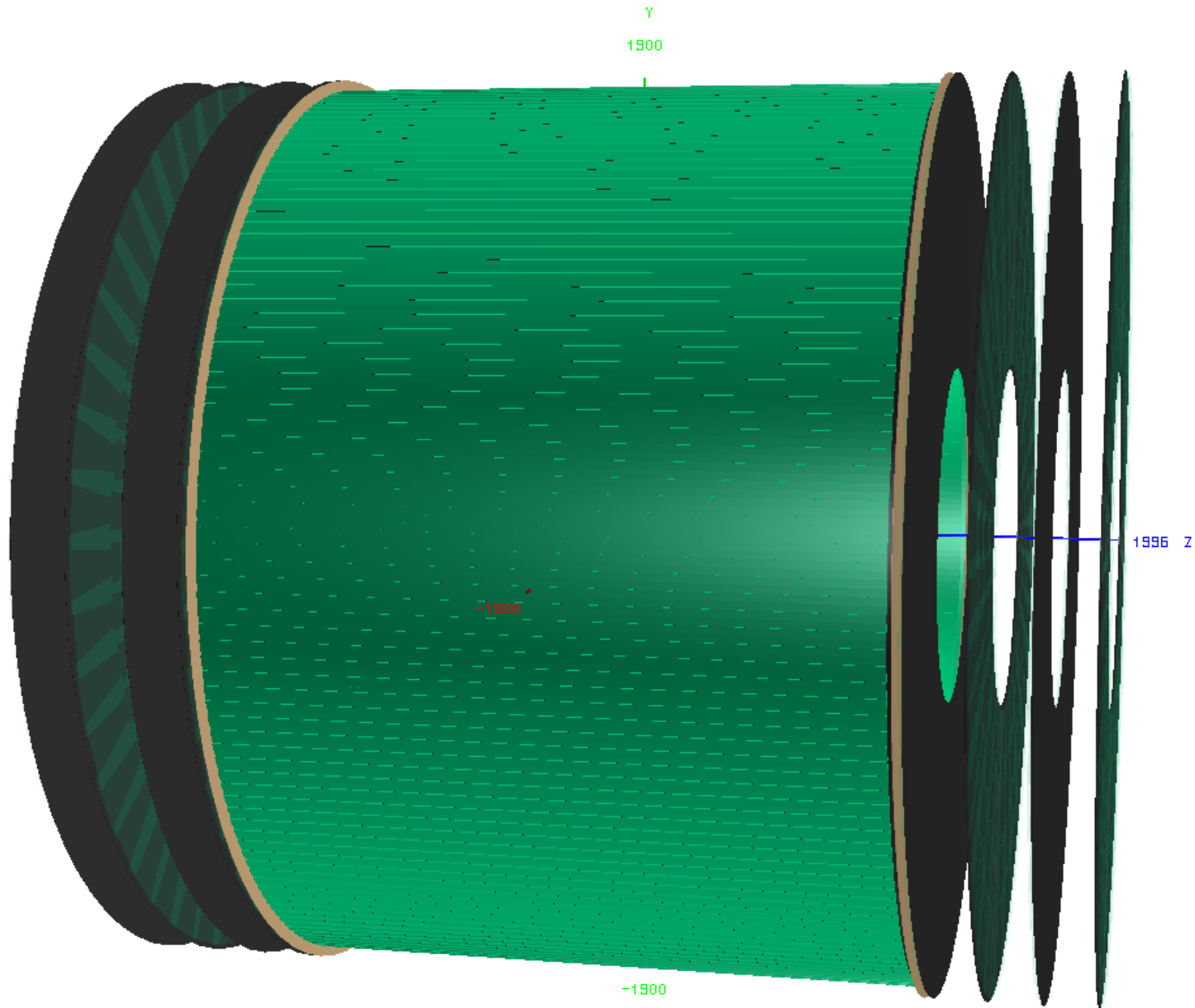
```
<constant name="OuterTracker_Endcap_z_3" value="1990*mm"/>
```

| → And reduce the global length of the outer tracker

In the main compact file:

```
<constant name="OuterTracker_half_length" value="2000*mm" />
```

CLD outer tracker after these changes

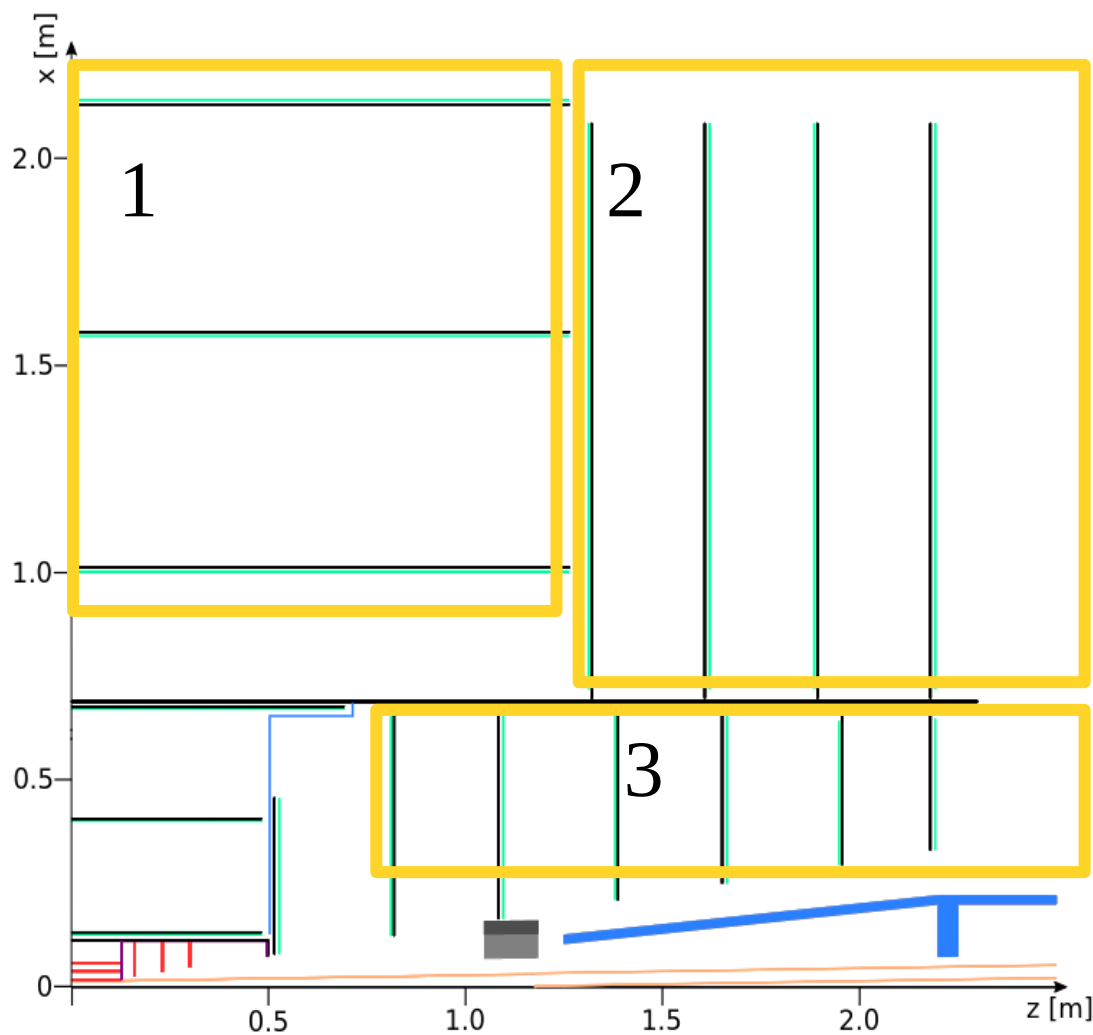


CLD tracker parts

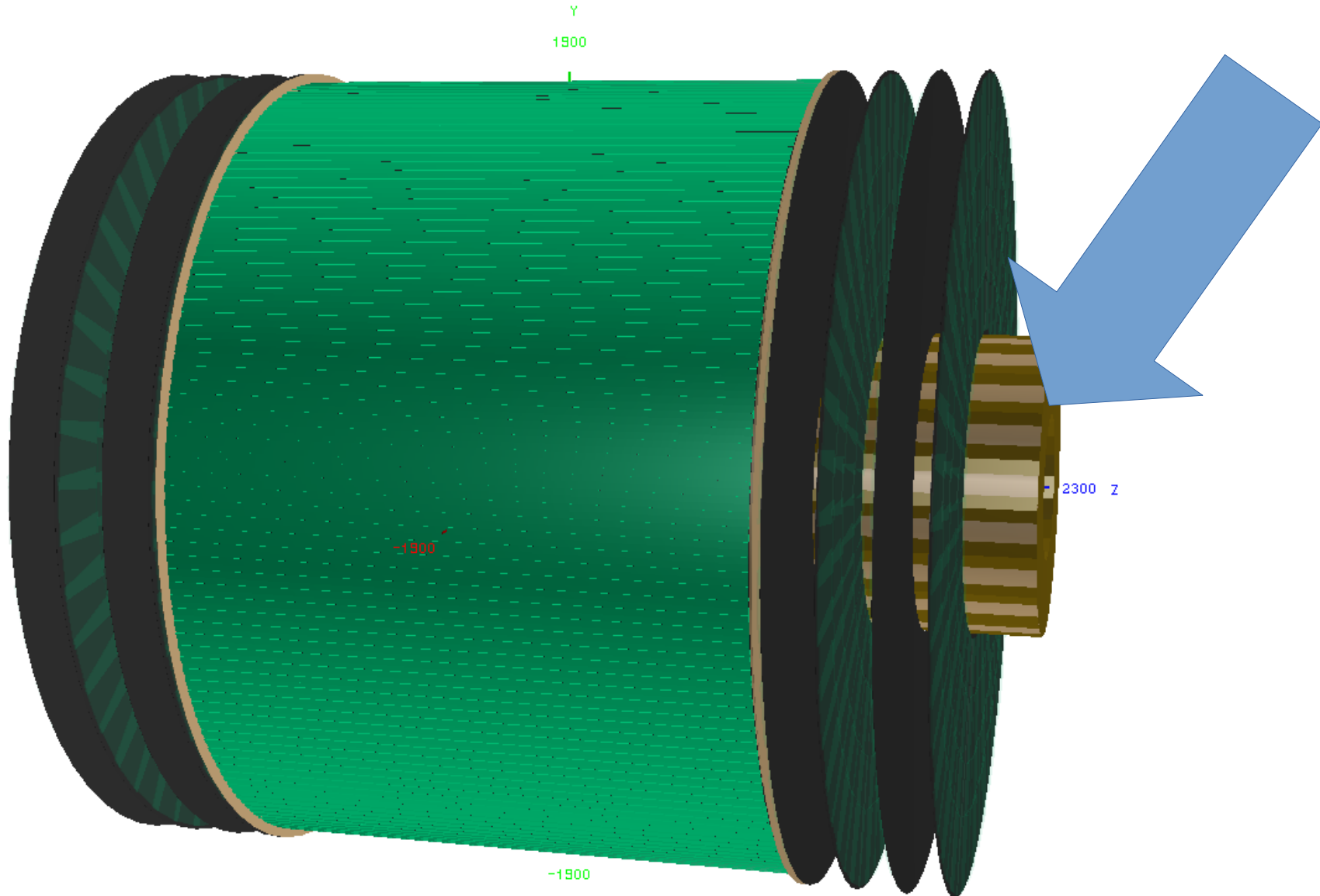
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The following parts have to be shrunk by 20 cm inwards:

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CLD inner tracker endcap



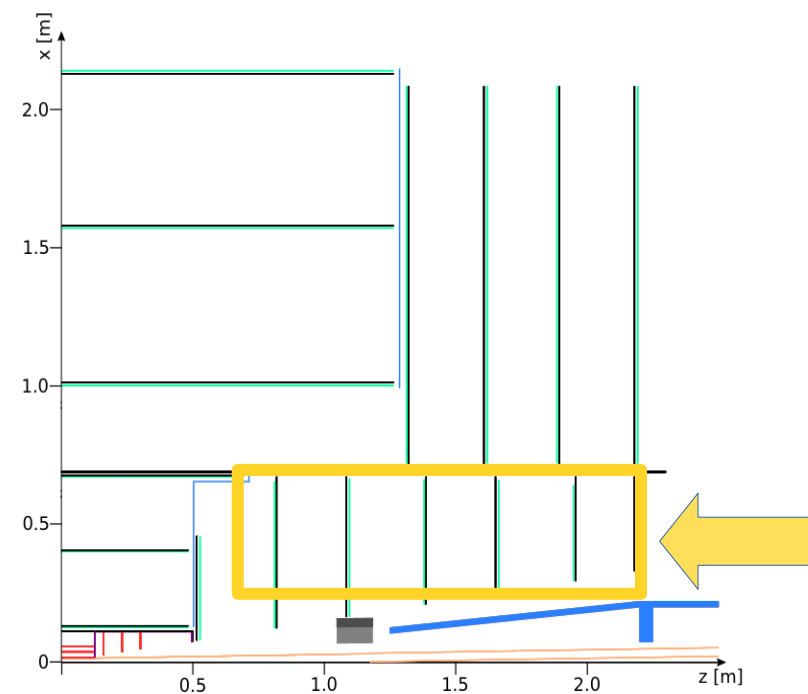
CLD inner tracker endcap



Layer z positions must move closer to $z=0$
| → Solution: reduce the inter-space by 13%

In the inner tracker compact file change:

```
<constant name="InnerTracker_Endcap_z_0" value="524*mm" />  
<constant name="InnerTracker_Endcap_z_1" value="773*mm" />  
<constant name="InnerTracker_Endcap_z_2" value="1024*mm" />  
<constant name="InnerTracker_Endcap_z_3" value="1274*mm" />  
<constant name="InnerTracker_Endcap_z_4" value="1524*mm" />  
<constant name="InnerTracker_Endcap_z_5" value="1775*mm" />  
<constant name="InnerTracker_Endcap_z_6" value="1990*mm" />
```



CLD inner tracker endcap

Layer z positions must move closer to $z=0$

| → Solution: reduce the inter-space by 13%

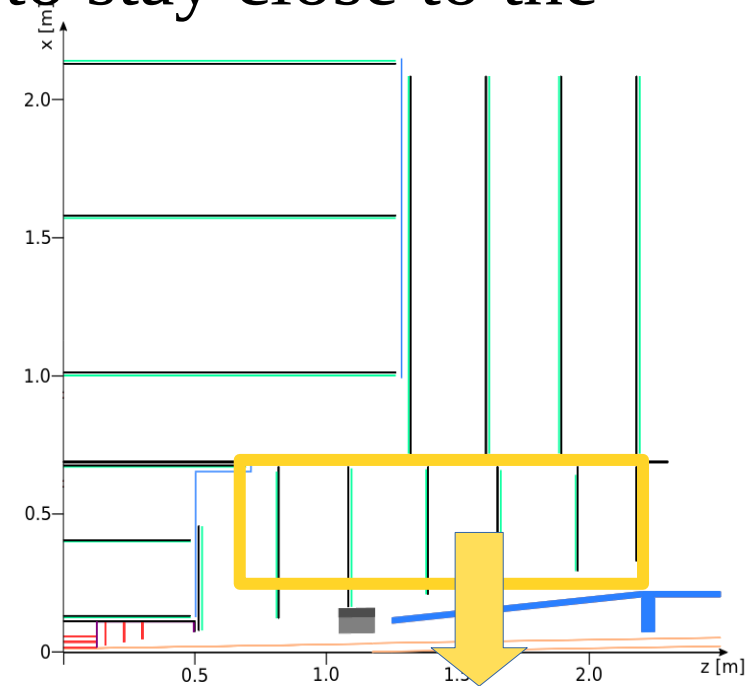
| → Along with the z position change we would need to reduce the inner radius accordingly to stay close to the 150 mrad coverage

In the inner tracker compact file change:

```

<constant name="InnerTracker_Endcap_radius_1" value="117*mm" />
<constant name="InnerTracker_Endcap_radius_2" value="154.6*mm" />
<constant name="InnerTracker_Endcap_radius_3" value="192.4*mm" />
<constant name="InnerTracker_Endcap_radius_4" value="230.1*mm" />
<constant name="InnerTracker_Endcap_radius_5" value="268*mm" />
<constant name="InnerTracker_Endcap_radius_6" value="300.5*mm" />

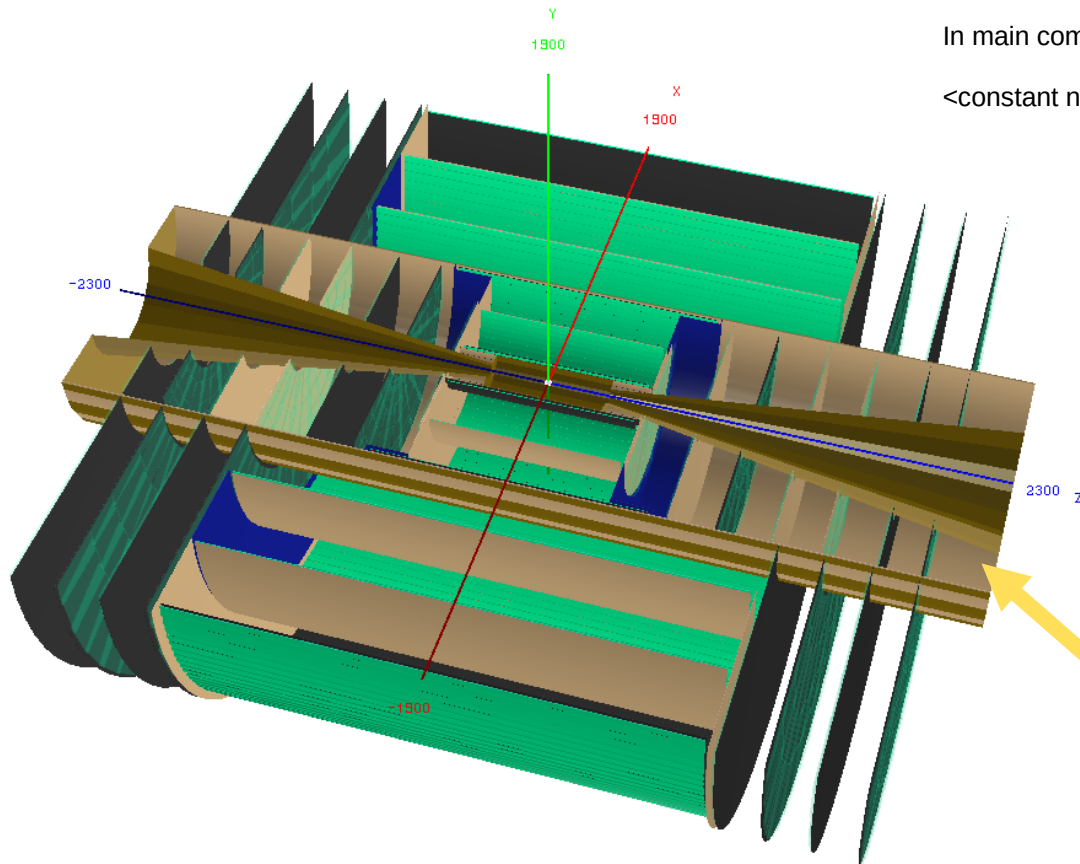
```



CLD inner tracker endcap



The support structure still extends for $z > 2\text{m}$

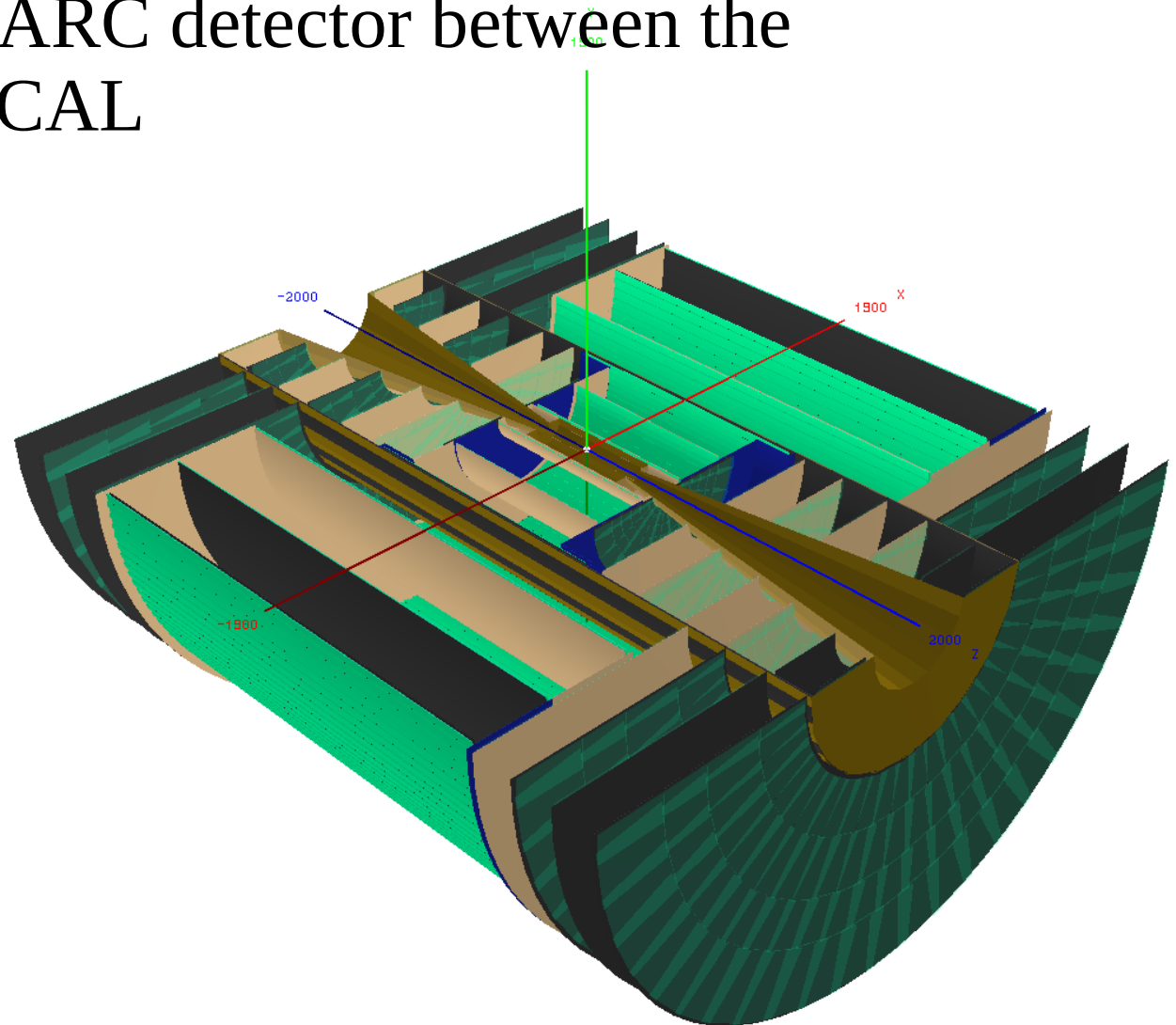
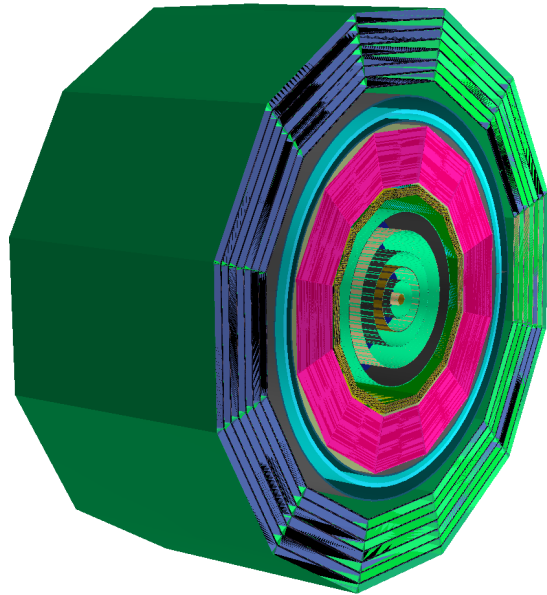


In main compact CLD_oX_v0Y file, change

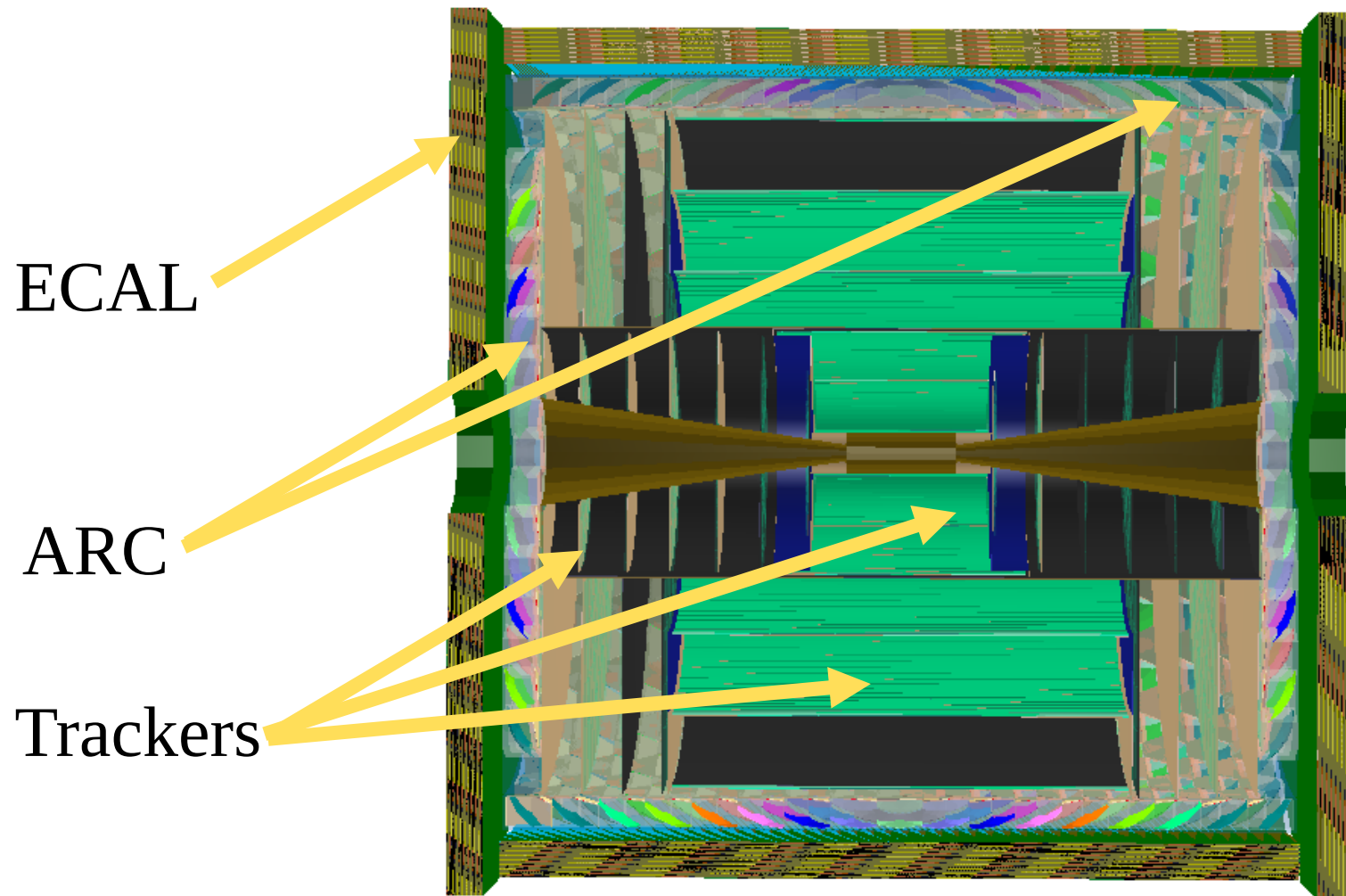
```
<constant name="InnerTracker_half_length" value="2000*mm" />
```

Support structure

After these modifications, CLD is ready to accommodate the ARC detector between the trackers and the ECAL



CLD is ready to accommodate the ARC detector between the trackers and the ECAL



Detector concepts are stored in k4geo repository

Each concept is described by DD4hep compact files, fully contained inside a directory, named by the concept, option and version

The master compact file has the same name as the directory (+ .xml extension)

The master XML file calls every subdetector compact file

Subdetectors should be implemented in such a way they can be replaced in the master XML file without (big) modifications

Global variables must be placed in the main compact file

Envelope geometry of each subdetector (eg, inner/outer radius) must be defined by global constants in the main compact file