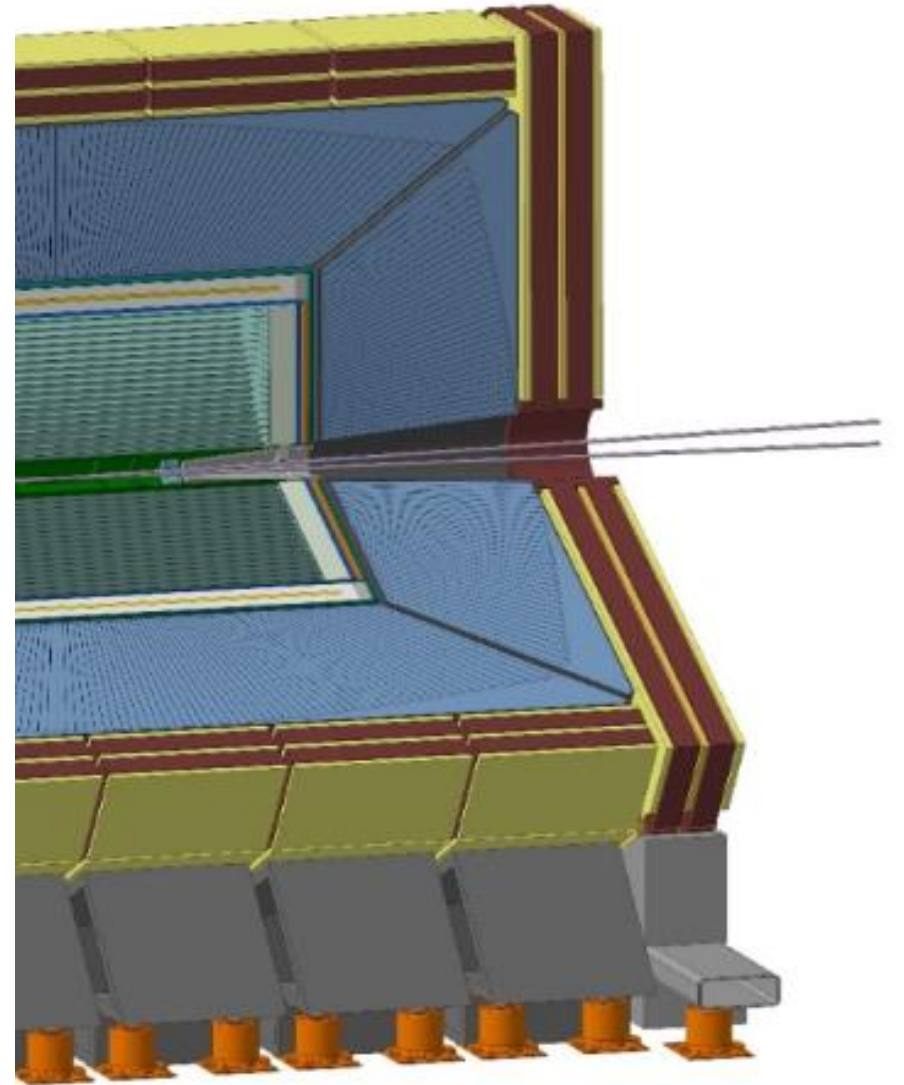


Mahmoud Ali

# FULL SIMULATION OF IDEA MUON SYSTEM

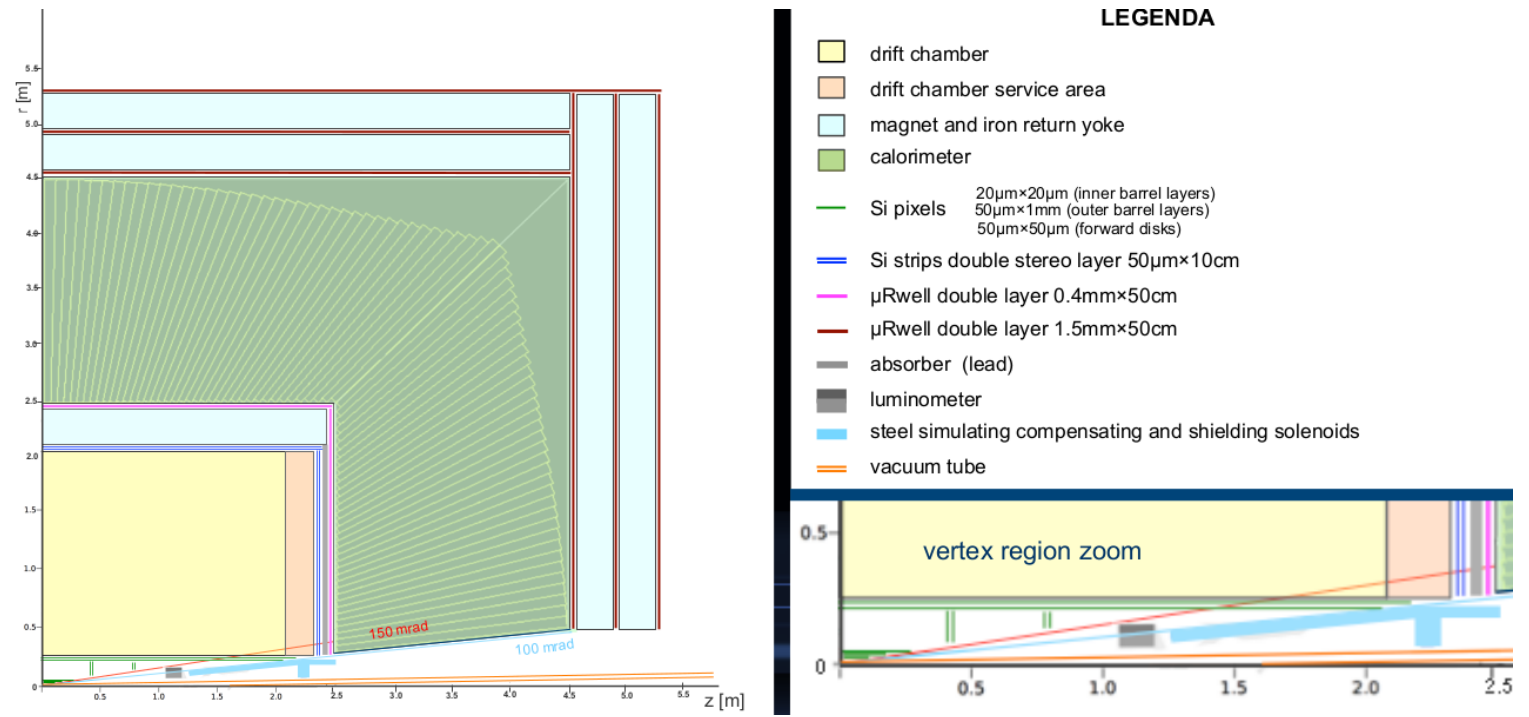
Full-SIM meeting, Wednesday, 22 November 2023



# IDEA Muon system

IDEA detector concept foresees a muon detection system that would be realized using the  $\mu$ RWELL<sup>1</sup> technology.

Each station will consist of a large mosaic of  $50 \times 50 \text{ cm}^2$   $\mu$ RWELL detectors.



IDEA detector layout

<sup>1</sup>JINST 10 (2015), P02008.

# Full-Sim of the muon system

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## IMPLEMENTATION OF THE MUON SYSTEM IN **DD4HEP**

The implementation of the muon system has been through two tracks:

1. As a first approach as a **simple cylindrical shaped**, which describe the muon system as layers of cylinders contains the different materials of our detector.
2. Then gradually a description of complicated and **detailed muon system**, which describe the mosaics of  $50 \times 50 \text{ cm}^2$  detailed  $\mu$ RWELL chambers.

The advantage of a simple description approach is to provide us with:

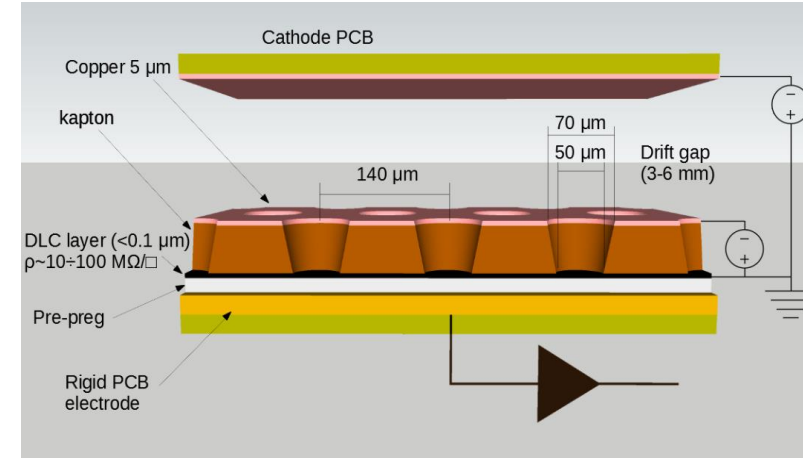
- A functional version in a short time, facilitating numerous pertinent physics investigations.
- It offers great adaptability, considering that the muon chamber, being the final detector in the sequence, is susceptible to adjustments necessitated by alterations in other sub-detectors.

# Full-Sim of the muon system

## SIMPLE CYLINDRICAL SHAPED

- A complete description of the materials of the  $\mu$ RWELL and the geometry of the system has been done.

Component	Thickness of each layer	Material
	1.6 mm	FR <sub>4</sub>
Cathode	35 $\mu$ m	Copper
Gas gap	6 mm	ArCO <sub>2</sub> CF <sub>4</sub>
	5 $\mu$ m	Copper
	50 $\mu$ m	Kapton
	0.1 $\mu$ m	DLC
$\mu$ -RWELL + readout PCB	35 $\mu$ m	Copper
	100 $\mu$ m	Film glue (same DLC density)
	35 $\mu$ m	Copper
	1.6 mm	FR <sub>4</sub>

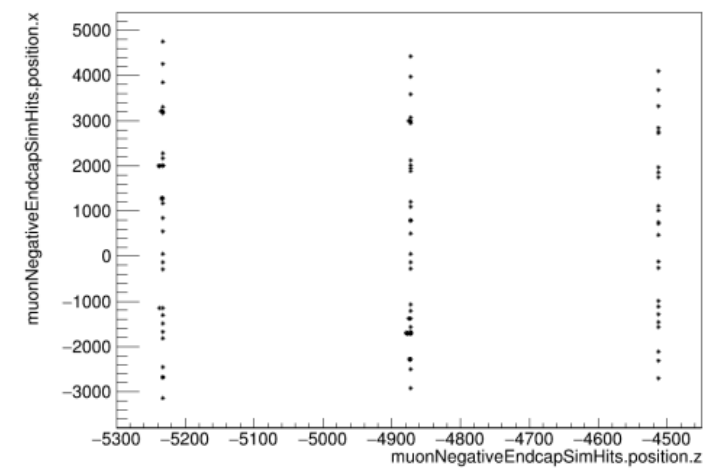
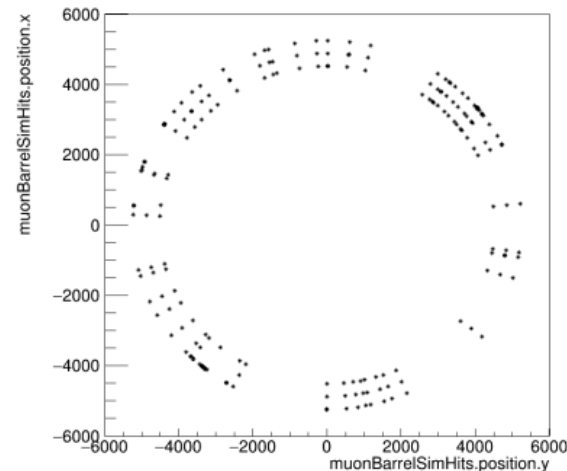


A schematic view of the various layers involved in the description of the  $\mu$ -RWELL detector

# Full-Sim of the muon system

## SIMPLE CYLINDRICAL SHAPED

- A complete simple description of the materials of the  $\mu$ RWELL and the geometry of the system has been done.
- A simple readout system has been implemented for the cylindrical shape, with a segmentation in  $\varphi$  and  $\theta$  direction.



**Left:** Hits from the barrel muon system. **Right:** Hits from one of the endcap muon system.

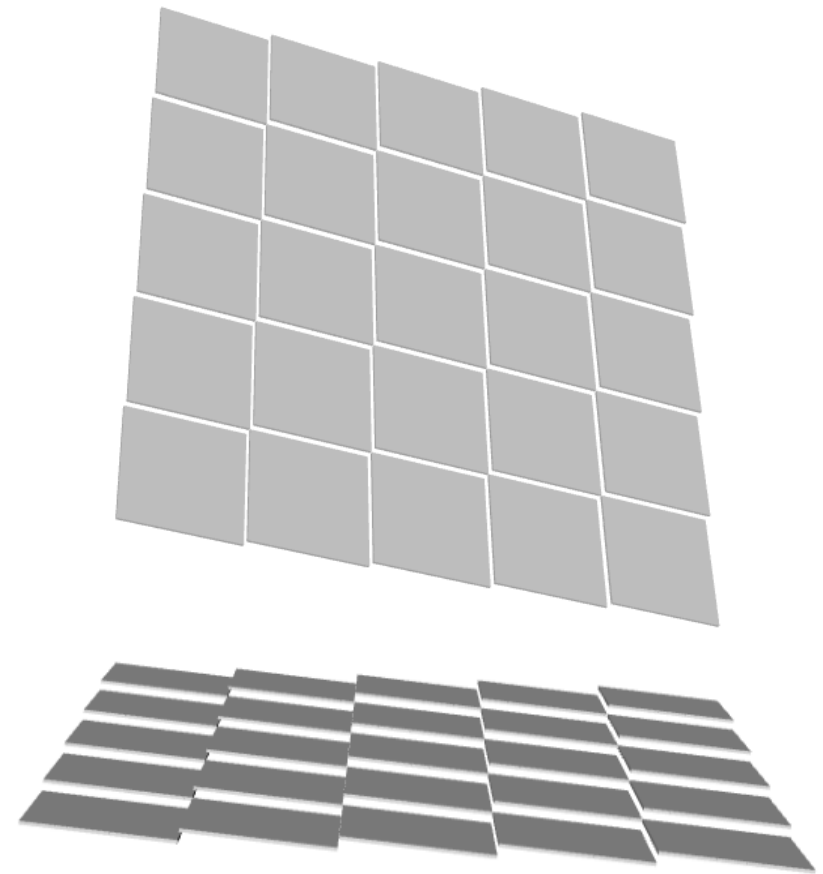
# Full-Sim of the muon system

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## DETAILED VERSION OF THE MUON SYSTEM

The aims:

- Building the muon system based on  $50 \times 50 \text{ cm}^2$   $\mu$ RWELL chambers.
- Taking into account the overlap between the chambers in 2 dimensions (to minimize the dead area as much as possible).
- A readout system for every single chamber have been created (CartesianGridXY).
- **The structure of the detector starting from creating an envelope for the side volume, which contains an array of our  $\mu$ RWELL chambers.**
- **Then the envelope will be copied in different rotation angles to create the barrel part.**



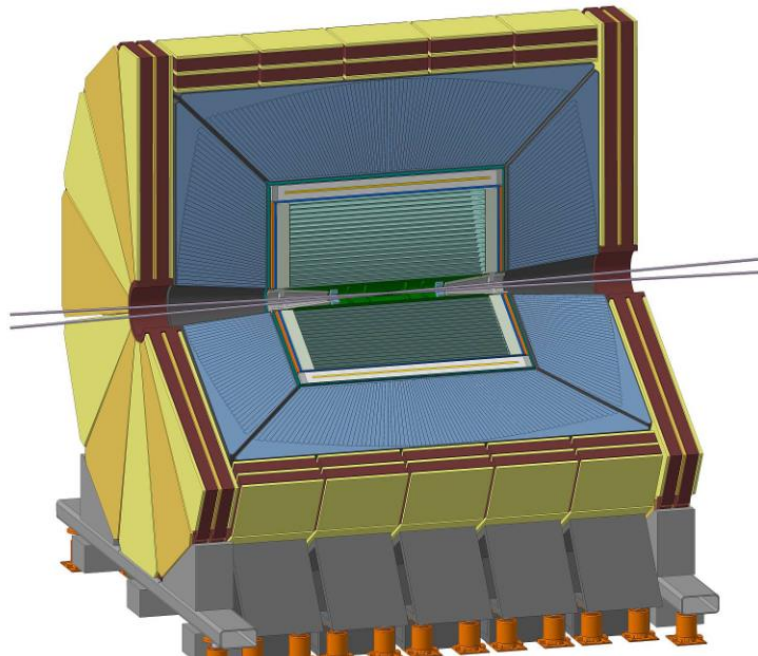
# Full-Sim of the muon system

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## DETAILED VERSION OF THE MUON SYSTEM

The aims:

- Making the design flexible, where the user can choose the number of sides of the shape (hexagon, octagon, ...), and automatically the builder will calculate the number and places of the copied chambers.



# Full-Sim of the muon system

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## DETAILED VERSION OF THE MUON SYSTEM

The aims:

- Making the design flexible, where the user can choose the number of sides of the shape (hexagon, octagon, ...), and automatically the builder will calculate the number and places of the copied chambers.

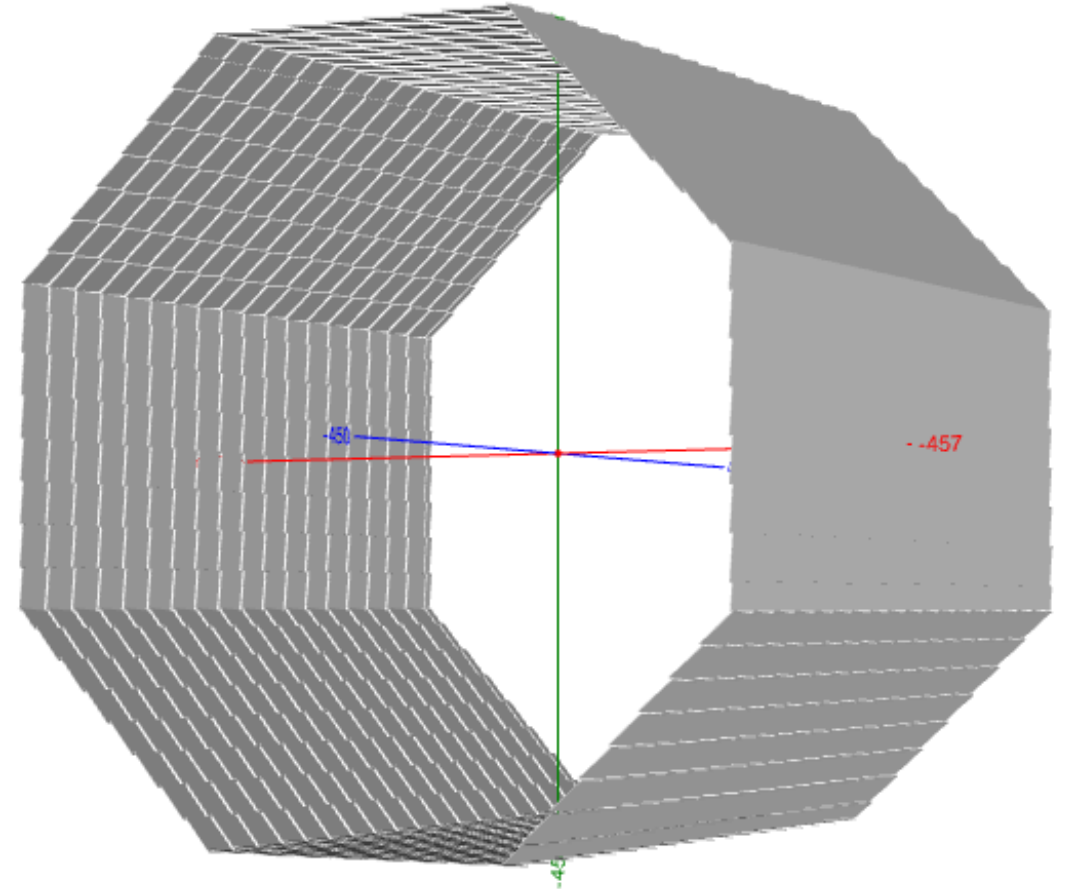
```
<!-- Specify the detector parameters and the overlap -->  
<detectorParameters radius="4520*mm" barrelLength="9000*mm" numSides="8" overlapY="1*cm" overlapZ="1*cm" />
```

The user only needs to enter in the xml file: the **inner radius**, his detector **barrel length**, and the **number of the detector sides** and his detector barrel will be ready.



# Example: 08

Sides detector, depending on  
50\*50 cm<sup>2</sup> chambers.

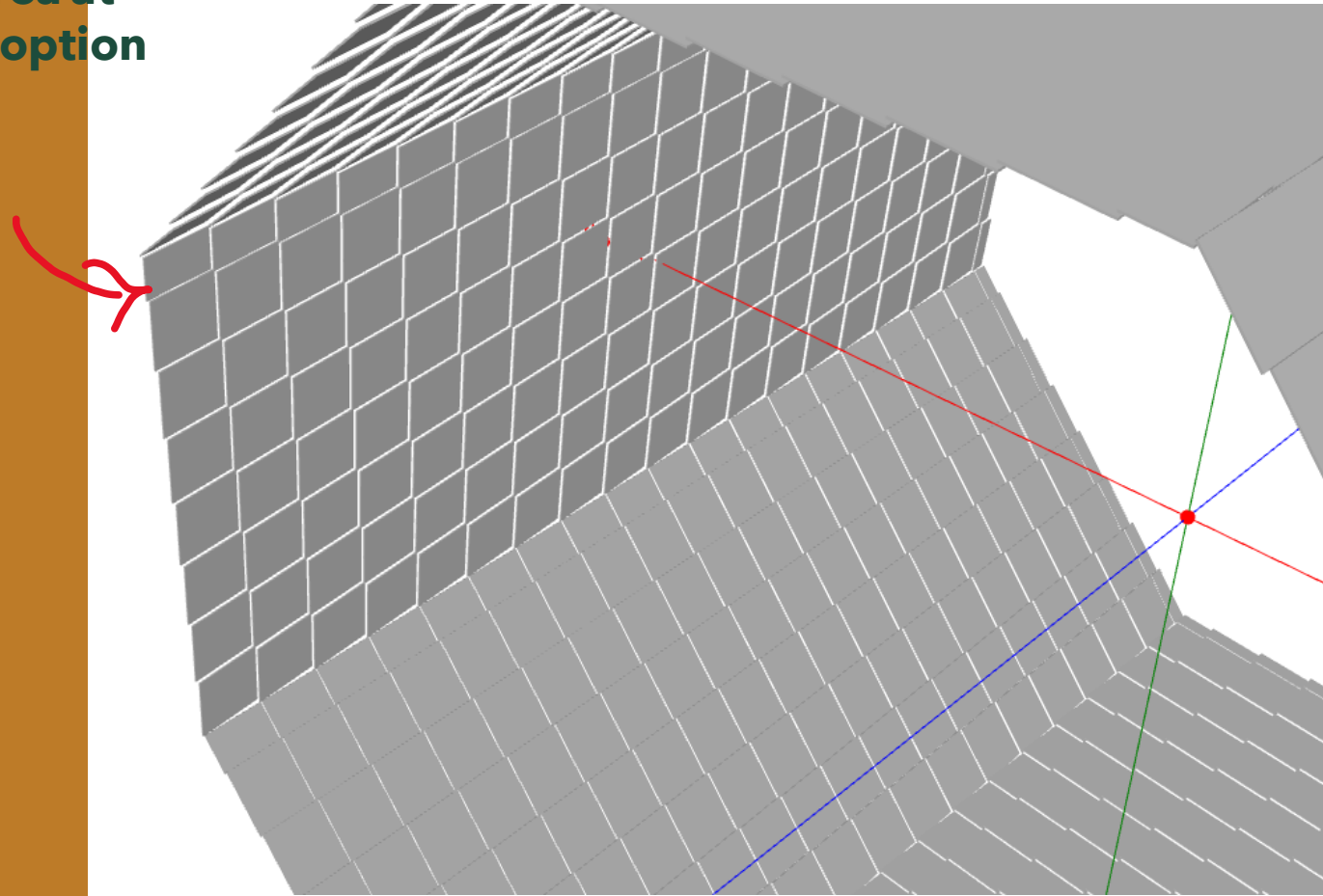


If the side length do not fit with an integer number of  $50 \times 50 \text{ cm}^2$ , the builder can make a chamber with unusual dimensions, which can fit the excess area at the end of the side (the R&D group makes this option available in manufacturing too).

**Example:**

**08**

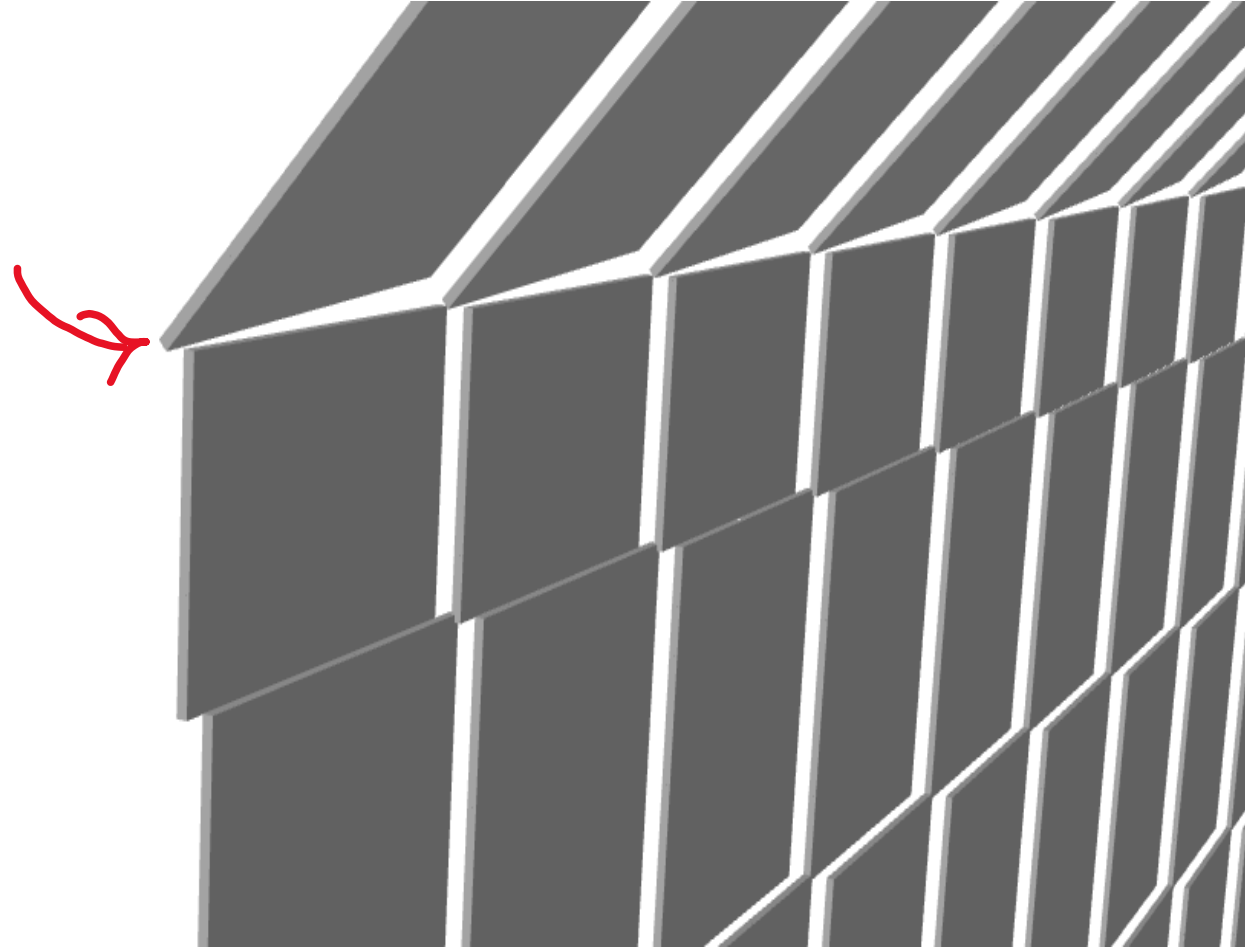
Sides detector, depending on  $50 \times 50 \text{ cm}^2$  chambers.



The sides too have overlap with a slight rotation to avoid the intersection.

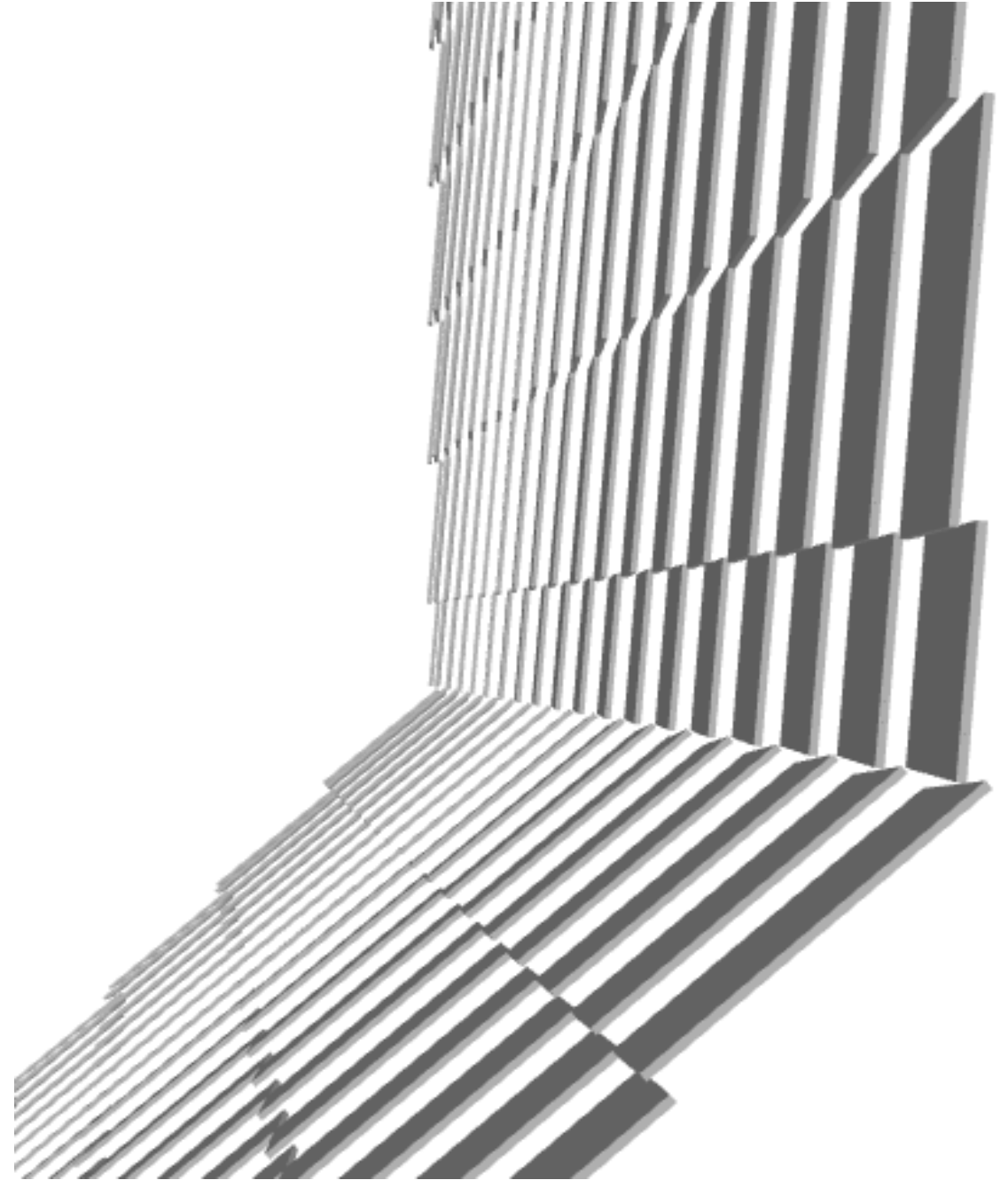
# Example: 08

Sides detector, depending on  
50\*50 cm<sup>2</sup> chambers.



# Example: 08

Sides detector, depending on  
50\*50 cm<sup>2</sup> chambers.

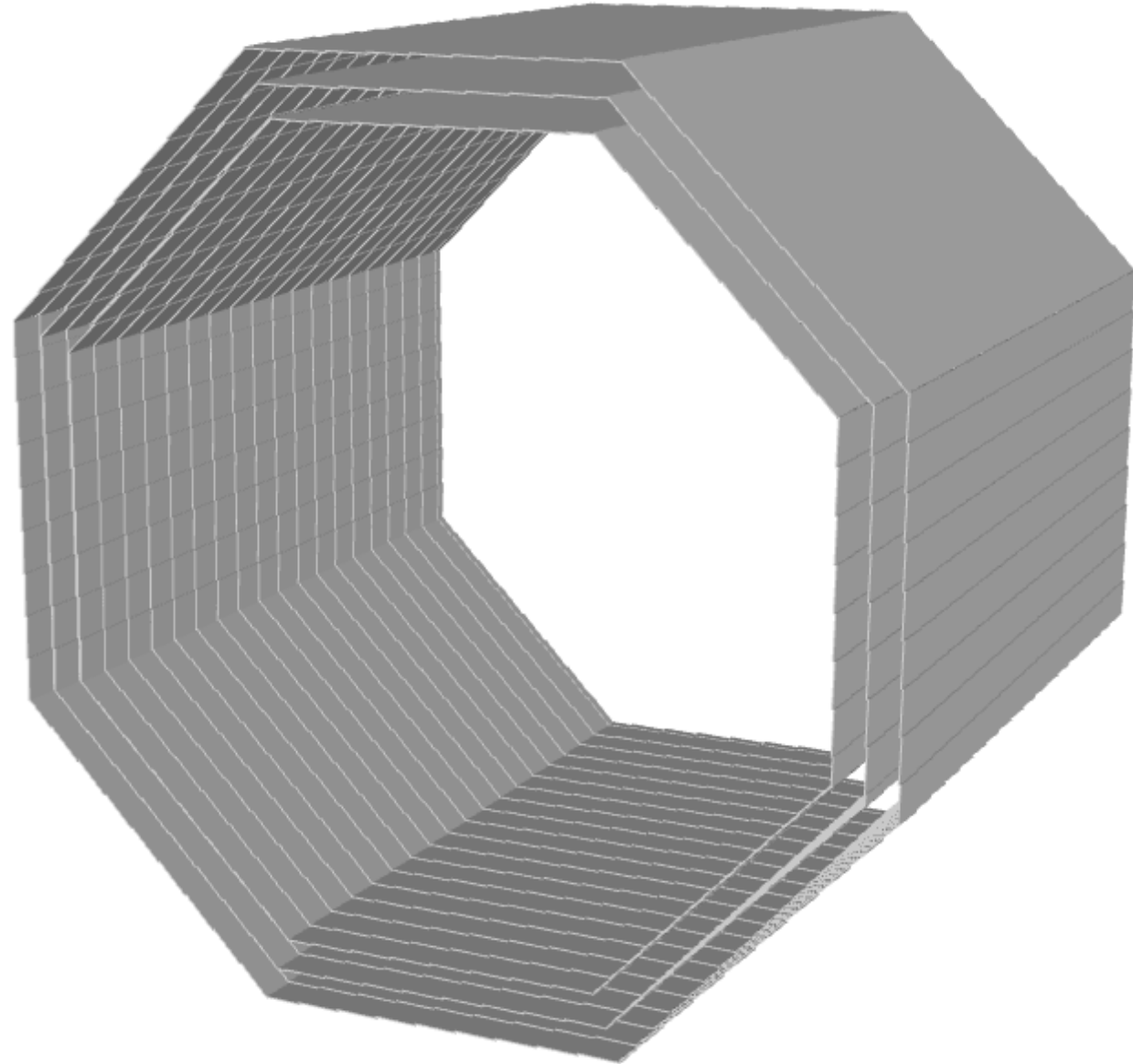


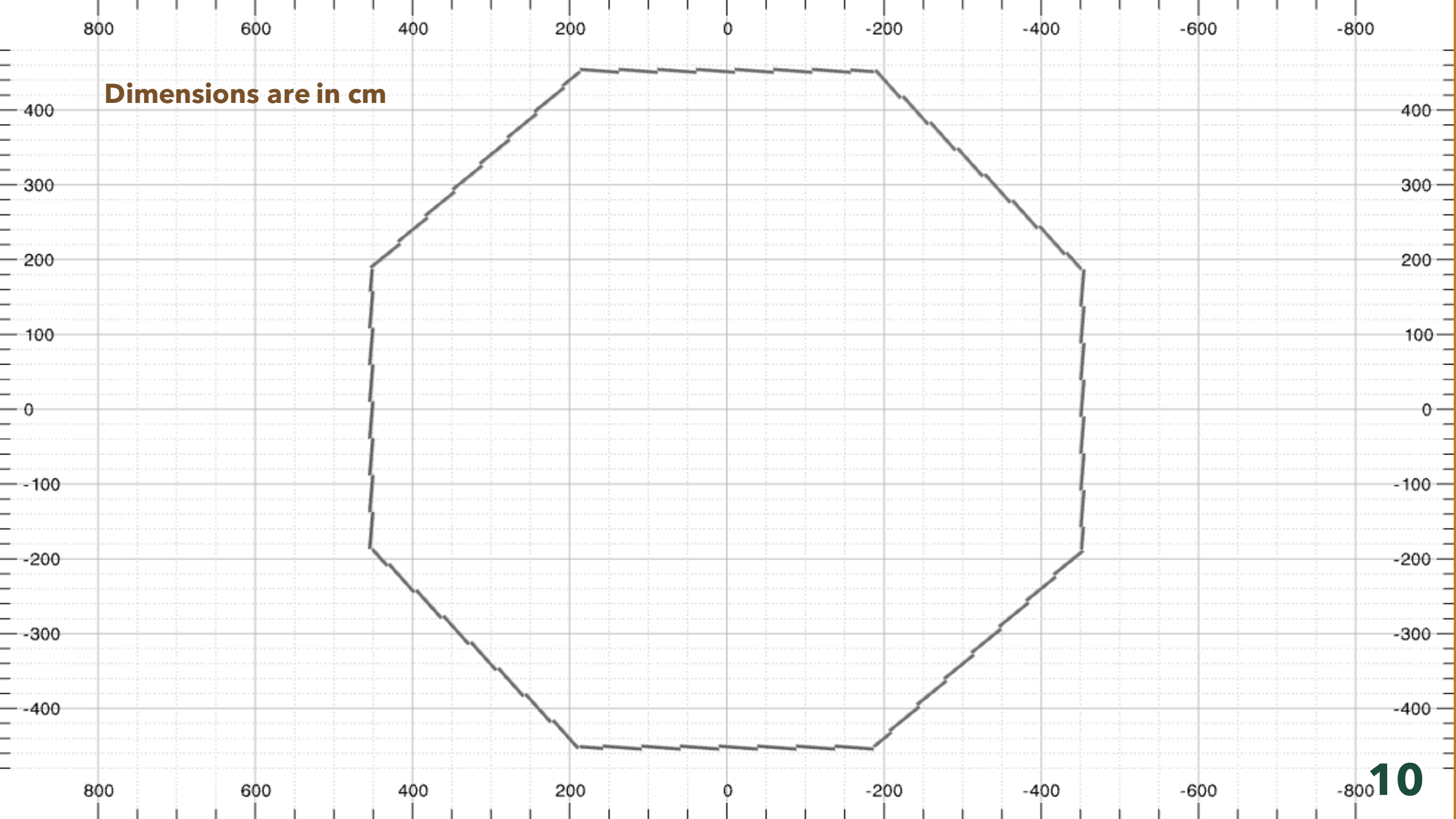
The availability to make multiple layers with different inner radius and barrel length.

Example:

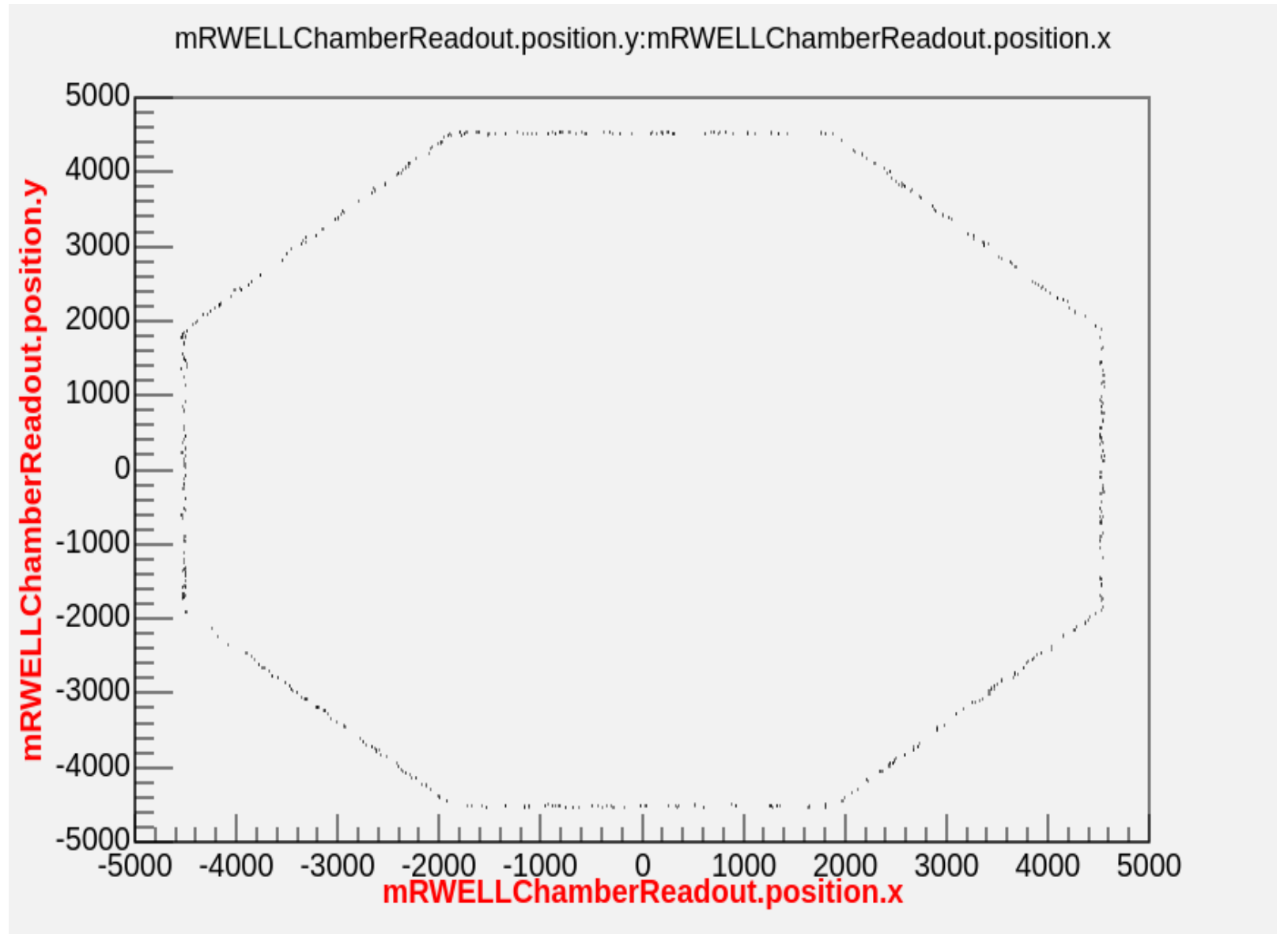
08

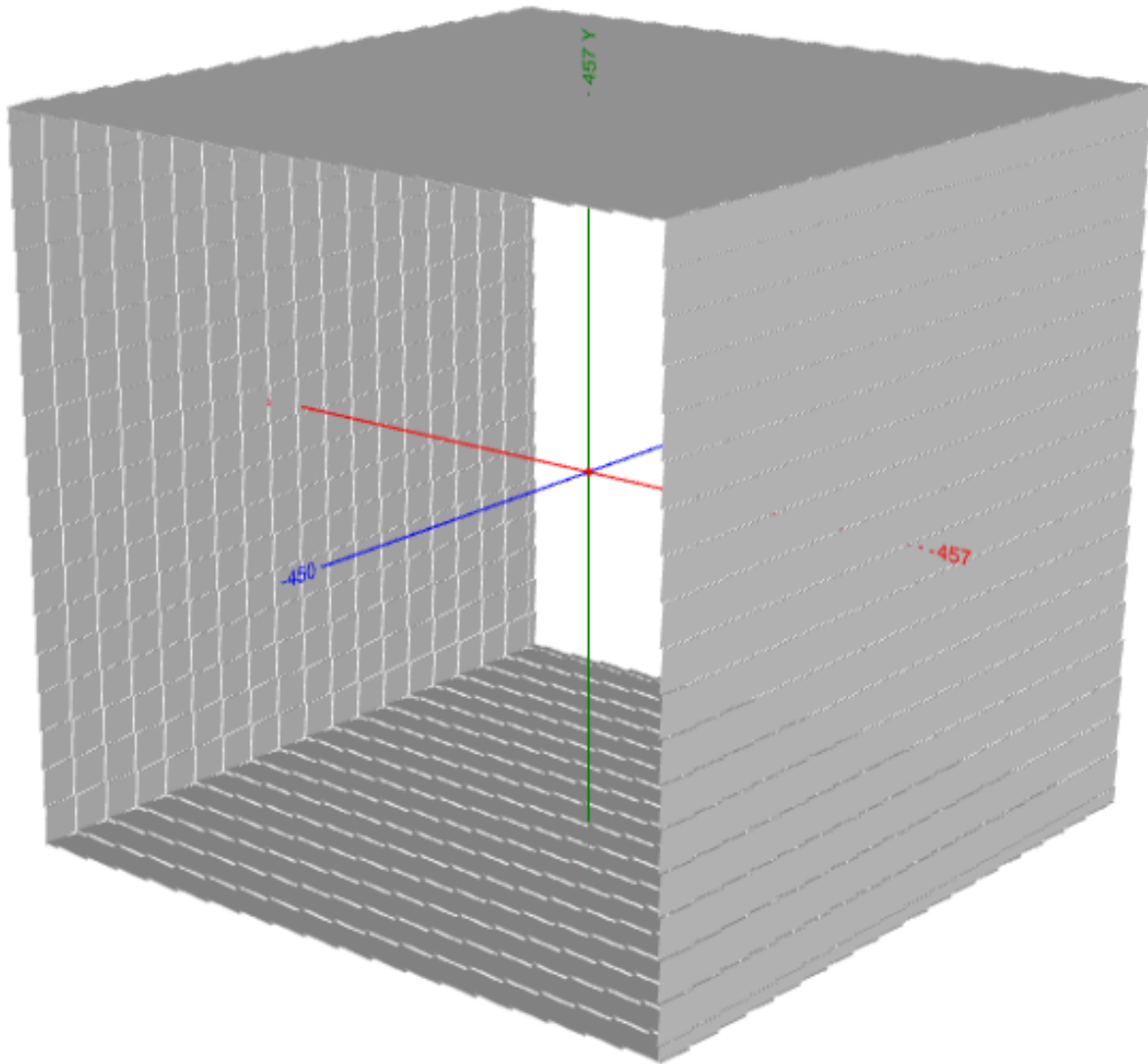
Sides detector, depending on 50\*50 cm<sup>2</sup> chambers.





Simulation Of 1000 events hits of muons as it appeared of our chambers readout system for a single layer taking the octagon shape.





Example:

04

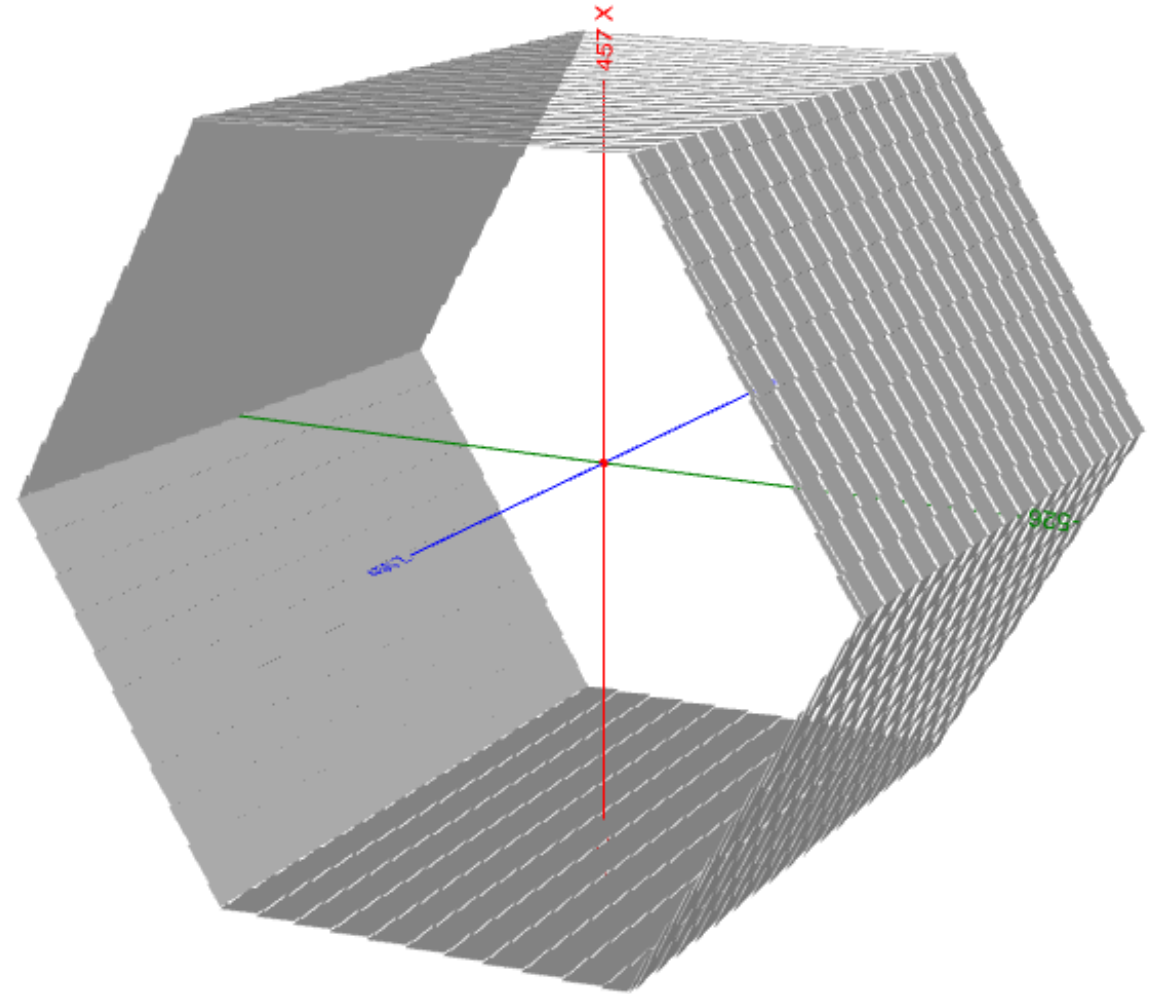
Sides detector, depending on  
 $50 \times 50$  cm<sup>2</sup> chambers.



Example:

06

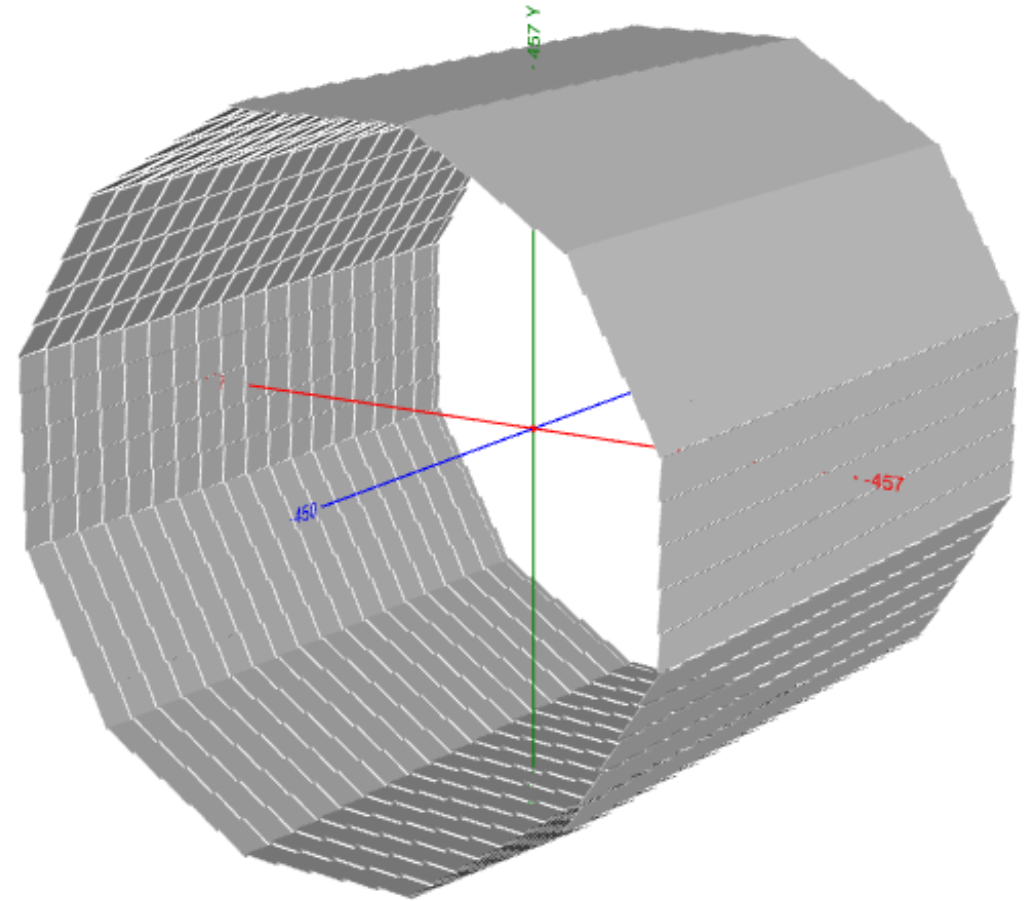
Sides detector, depending on  
50\*50 cm<sup>2</sup> chambers.



Example:

# 12

Sides detector, depending on  
50\*50 cm<sup>2</sup> chambers.



# Further developments:

- Building the iron-yokes "radiators", it has to be the same number of sides like the detector.
- Performing efficiency and physics studies on the different number-of-sides detectors, to choose the suitable configuration of IDEA muon system.
- Building the endcap.

**Thanks**