MOLLER Detector Simulations

Parametrized Geometry Update

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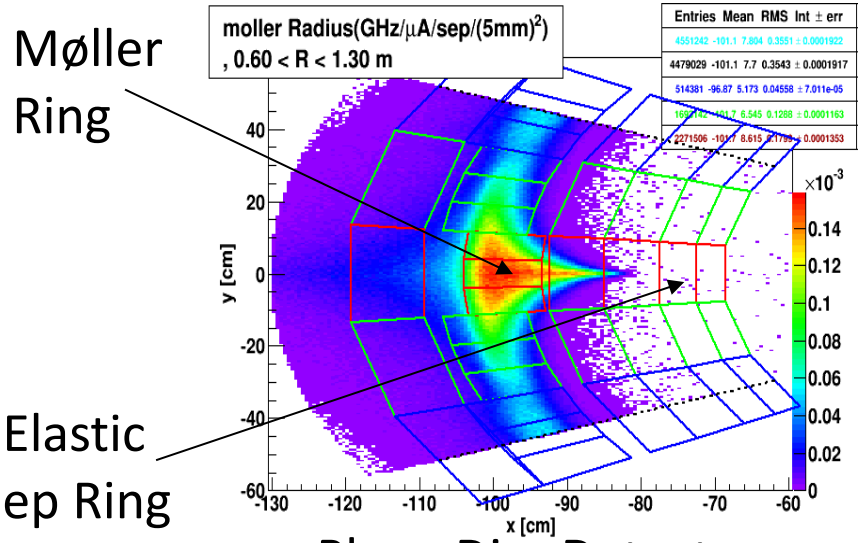
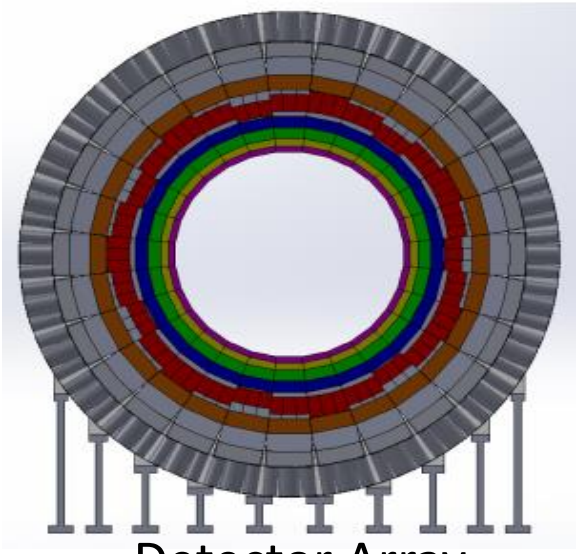
Detector Geometry Parametrization



Plane Disc Detector
(Currently In GDML)



Detector Array
(Currently In CAD)

Input
CSV file

→

Perl
Scripts

→

CAD and GDML
Detector
Geometry

Dimensions or positions of detectors can be easily changed to perform backgrounds study for different detector geometry configurations.

Single Detector Dimension Parameters

Other Parameters

t_m = thickness of mirror

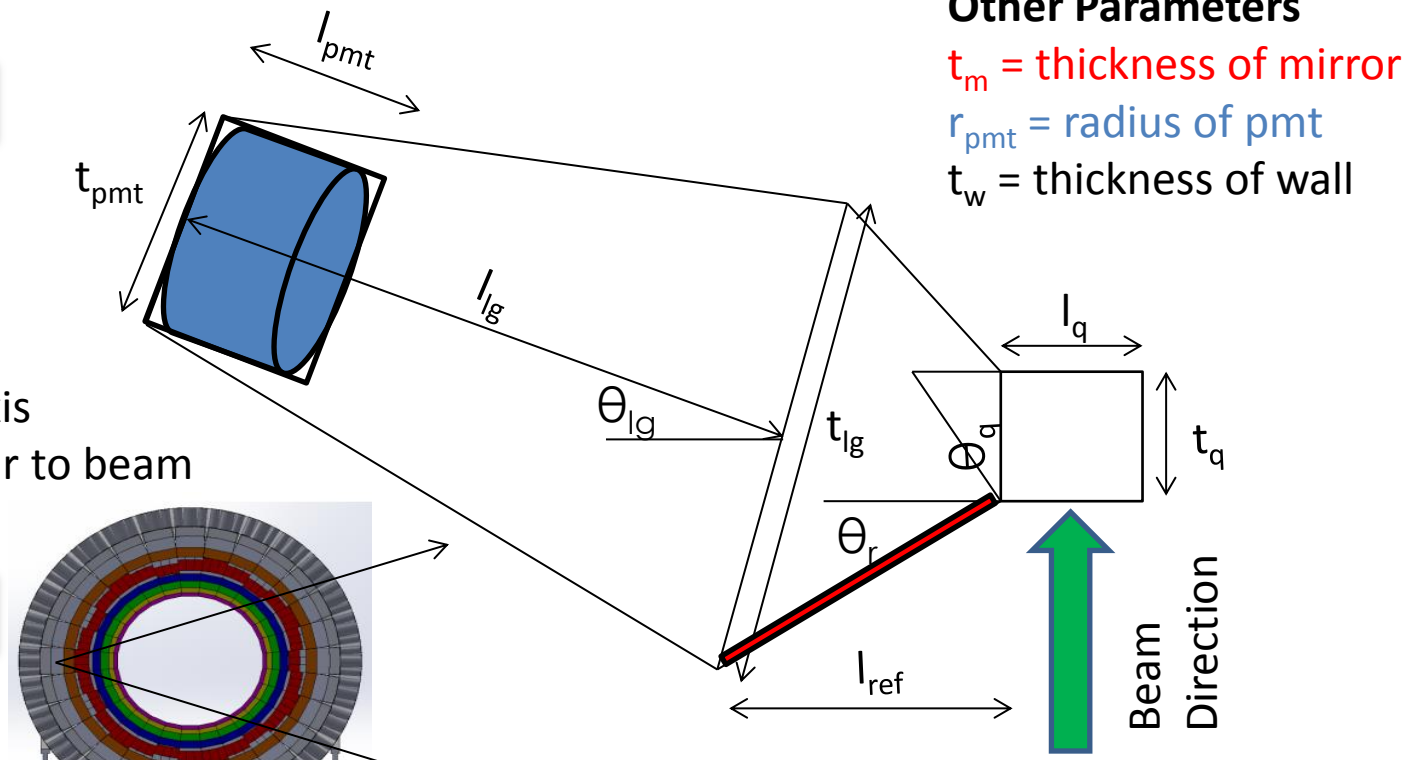
r_{pmt} = radius of pmt

t_w = thickness of wall

Side View

Beam Axis

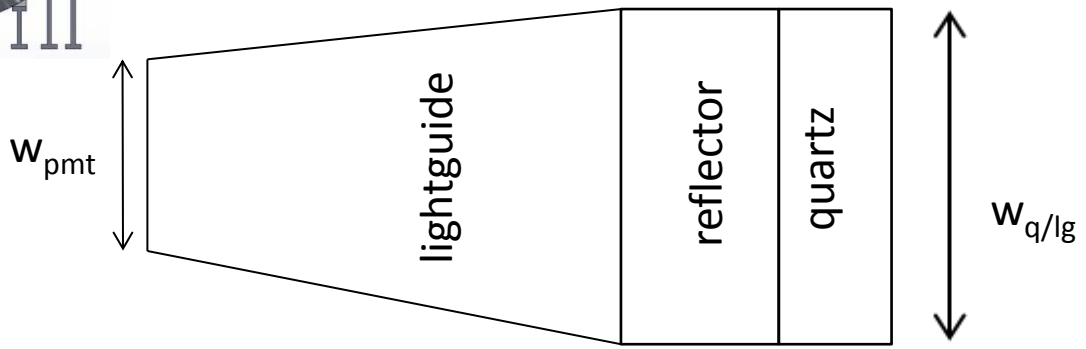
Horizontal axis perpendicular to beam axis



Front View

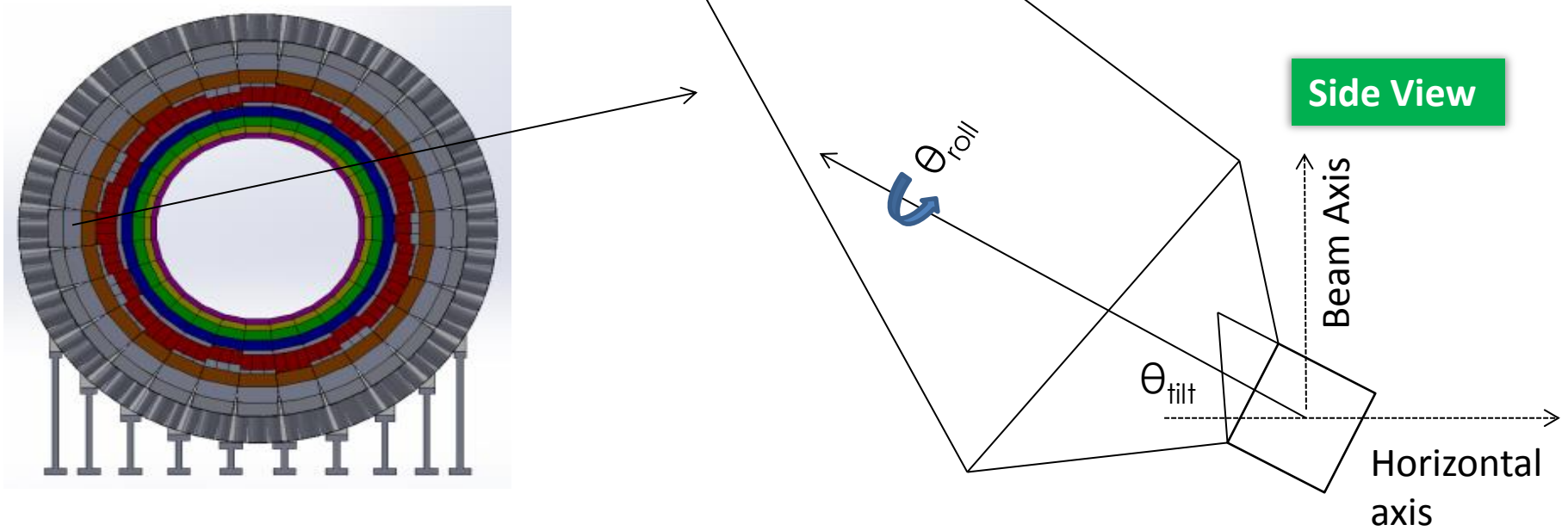
Vertical axis perpendicular to beam axis

Horizontal axis perpendicular to beam axis



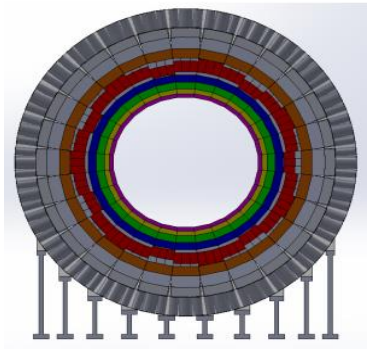
Single Detector Position Parameters

- Cartesian coordinates
- Tilt Angle of detector along beam axis
- Rotation angle about detector body axis
- Azimuthal Rotation Angle (Into and Out of Page in Side View)

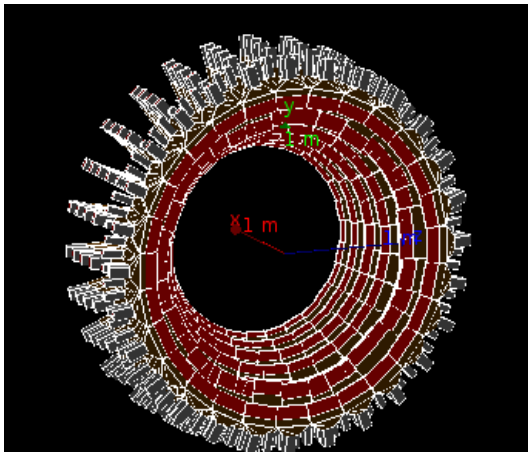


Parametrisation Interface

cadp.csv → cadGeneratorV1.pl → equations.txt (CAD)
parameter.csv
detectorMotherP.csv



gdmlGeneratorV1.pl → detector.gdml
solids.xml



CAD Generator

- Parametrization at ring level.
- Each row represents a ring and each column represents a parameter.
- cadp.csv: 1) Ring Index 2) Radial Position of Ring 3) Length of Quartz 4) Overlap Parameter (0=No azimuthal overlap, 1= Maximum azimuthal overlap) 5) Thickness of Quartz 6) Quartz Tilt Angle 7) Roll About Body Axis 8) Reflector Length 9) Reflector Top Opening Angle 10) Lightguide Tilt Angle wrt Quartz 11) Lightguide thickness 12) Lightguide Length 13) Length of PMT Placeholder 14) Diameter of PMT 16) Wall thickness 17) Z –position 18) Z-Stagger Position

1	710	40	0.5	10	5	90	100	15	20	75	525	3	6	3	550	570
2	755	50	0.5	10	5	90	100	15	20	75	475	3	6	3	430	440
3	817.5	75	0.5	10	5	90	100	15	20	75	400	3	6	3	300	310
4	892.5	75	0.5	10	5	90	100	15	20	75	312.5	3	6	3	170	180
5.0	1017.5	115	0.5	10	5	90	100	15	20	75	150	2	6	3	-15	15
5.1	987.5	105	0.5	10	5	90	100	15	20	75	200	2	6	3	-15	15
5.2	1030	140	0.5	10	5	90	100	15	20	75	125	2	6	3	-10	10
6	1150	100	0.5	10	5	90	50	15	20	75	75	3	6	3	-140	-130

GDML Generator

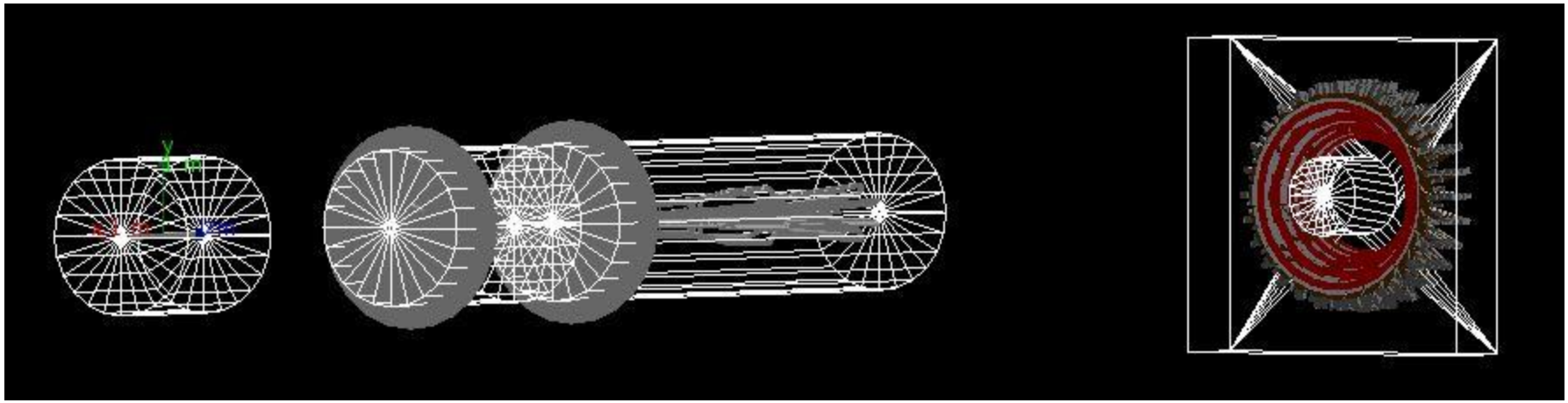
- Parametrization at individual detector level.
- Each row represents a detector and each column represents a parameter.
- parameter.csv: 1) Detector Index 2) Z-position 3) Y-position 4) X-position*(-1) 5) Quartz Thickness 6) Quartz Azimuthal Width 7) Quartz Length 8) Azimuthal Rotation Angle 9) Quartz Tilt Angle 10) Quartz Roll Angle 11) Quartz Cut Angle 12) Reflector Opening Angle 13) Reflector Length 14) LG Thickness 15) LG Azimuthal Width 16) LG Length 17) LG Tilt Angle 18) Thickness of PMT Placeholder 19) Width of PMT Placeholder 20) Length of PMT Placeholder 21) Radius of PMT 22) Wall Thickness 23) Mirror Thickness

6001	-140	0	1150	10	258.059396544876	100	0	0.0872664625997165	3.14159265358979	0.785
6002	-130	255.899074049762	1121.1670990091	10	258.059396544876	100	0.224399475256414	0.0872664625997165	3.14159265358979	0.785
6003	-140	498.966299985192	1036.11419808778	10	258.059396544876	100	0.448798950512828	0.0872664625997165	3.14159265358979	0.785
6004	-130	717.013272137543	899.106204838234	10	258.059396544876	100	0.673198425769241	0.0872664625997165	3.14159265358979	0.785
6005	-140	899.106204838234	717.013272137544	10	258.059396544876	100	0.897597901025655	0.0872664625997165	3.14159265358979	0.785

GDML Generator

- detectorMotherP.csv: 1) Thickness of Logical Container 2) Width of Logical Container 3) Length of Logical Container 4) Radius of Hollowed Out Center
- When generating ring by ring instead of total array altogether, adjust the thickness value accordingly.

1000	4000	4000	499



Example

The following steps produce detector.gdml and solids.xml file:

- perl cadGeneratorV1.pl –F cadp.csv
- Two versions of gdmlGenerator:
  - PMT Placeholder Outside LG:

    perl gdmlGeneratorV1.pl –M detectorMotherP.csv –D parameter.csv
  - PMT Placeholder Inside LG:

    perl gdmlGeneratorV2.pl –M detectorMotherP.csv –D parameter.csv

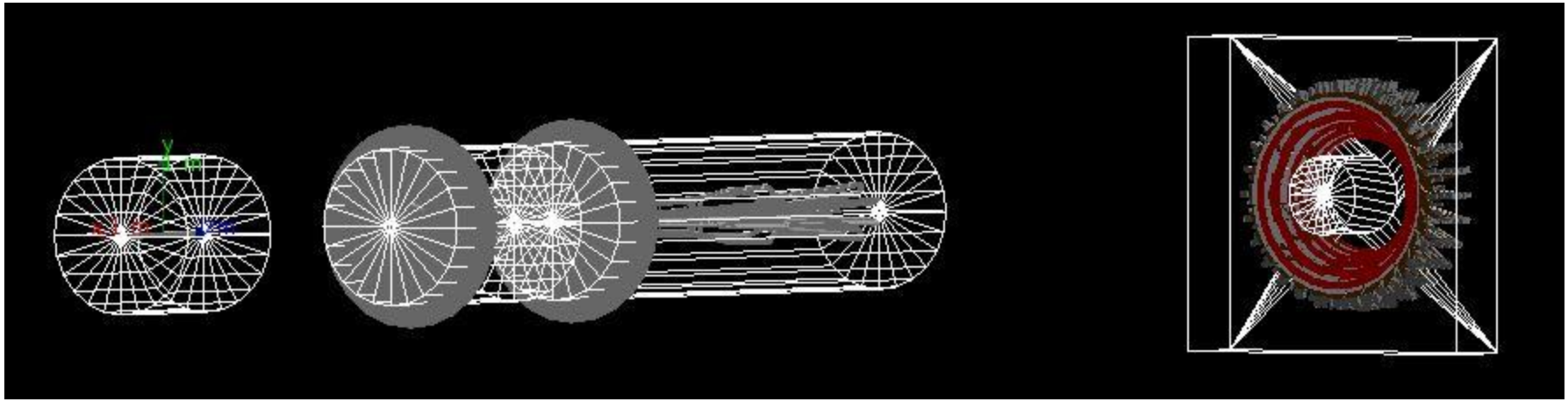
Next edit the mollerMother.gdml file:

```
<!--<physvol>
<file name="geometry_sculpt/detectorDaughter.gdml"/>
<positionref ref="detectorCenter"/>
<rotationref ref="identity"/>
</physvol>-->
  <physvol>
<file name="geometry_sculpt/detector.gdml"/>
<positionref ref="detectorCenter"/>
<rotation name="detectorRot" x="0" y="pi/2" z="0"/>
</physvol>
<physvol>
```

Example

To Load Geometry in Simulation:

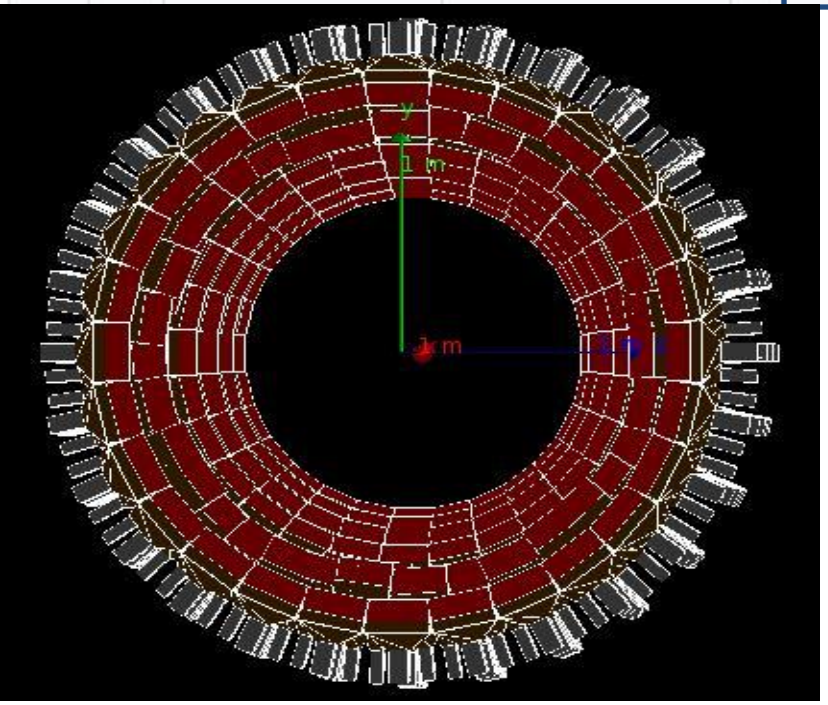
- ./remoll
- /remoll/setgeofile geometry_sculpt/mollerMother.gdml
- /vis/open OGL
- /control/execute vis/vis.mac



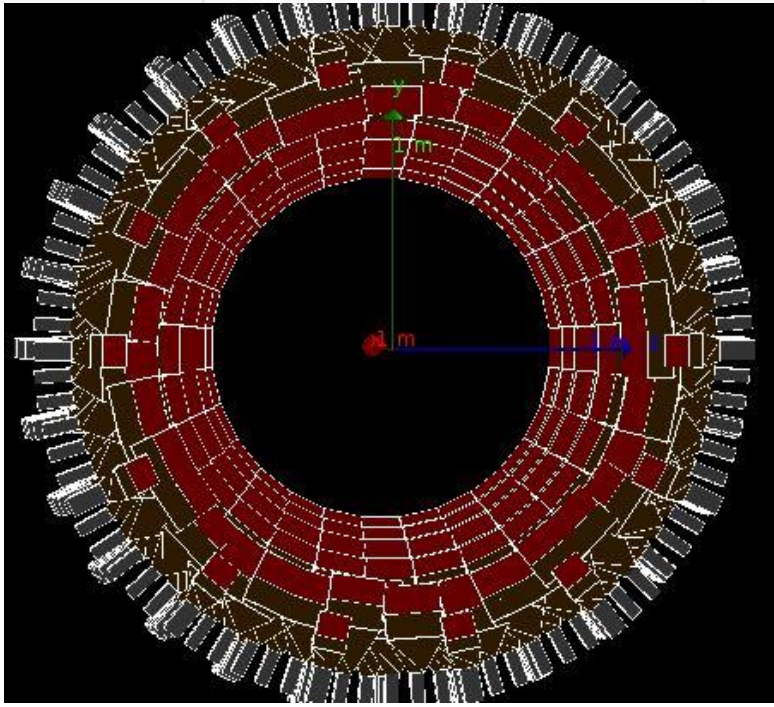
Modifying Geometry

- Suppose, we want to halve the number of detectors and halve the azimuthal width of the remaining detectors in ring 6.

6001	-140	0	1150	10	258.059396544876	100	0	0.0872664625997165	3.14159265358979	0.785
6002	-130	255.899074049762	1121.1670990091	10	258.059396544876	100	0.224399475256414	0.0872664625997165	3.14159265358979	0.78
6003	-140	498.966299985192	1036.11419808778	10	258.059396544876	100	0.448798950512828	0.0872664625997165	3.14159265358979	0.785
6004	-130	717.013272137543	899.106204838234	10	258.059396544876	100	0.673198425769241	0.0872664625997165	3.14159265358979	0.78
6005	-140	899.106204838234	717.013272137544	10	258.059396544876	100	0.897597901025655	0.0872664625997165	3.14159265358979	0.785



gdmlGenerator



Summary and Future Work

- Initial detector geometry fully parametrized. Scripts available at: https://github.com/rahmans1/geometry_test
- Future Work on Geometry Parametrization:
  1) Incorporate most up-to-date geometry.
  2) Develop analysis scripts.
- Prospective Studies:
  1) Repeat Full Backgrounds Study.
  2) Asymmetry extraction in moller ring considering Lightguide and PMT regions.
- Questions, comments, suggestions?