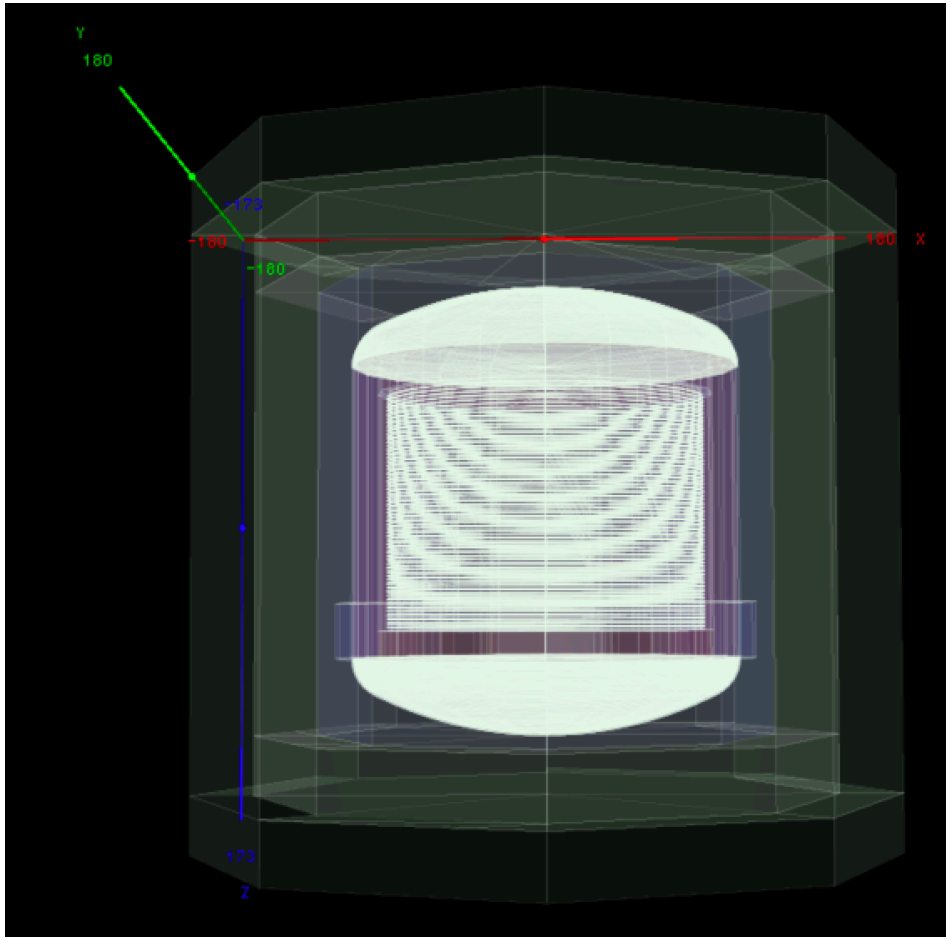
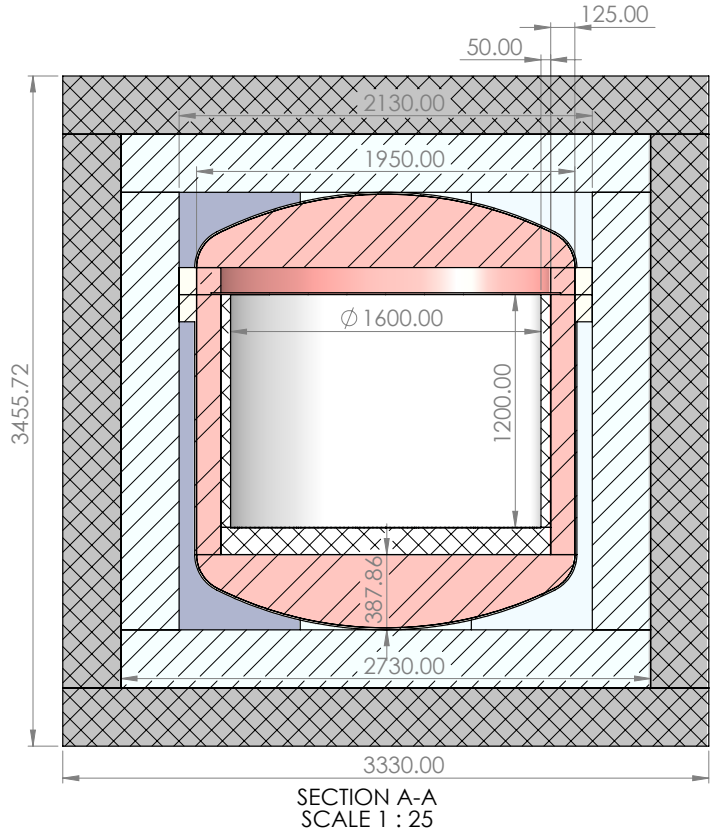
Simulation of New Detector

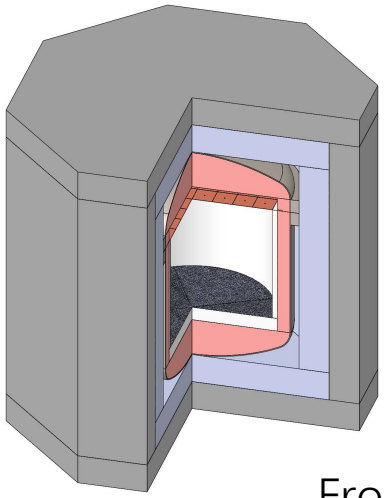
Li Tao
SYSU

Old Geometry





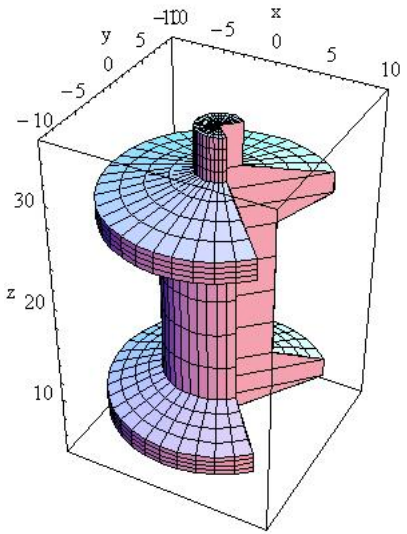
SECTION A-A
SCALE 1 : 25



From GitLab

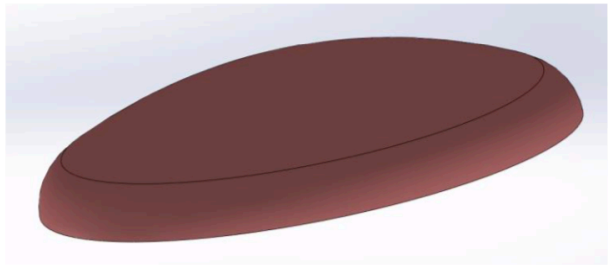
Old Geometry

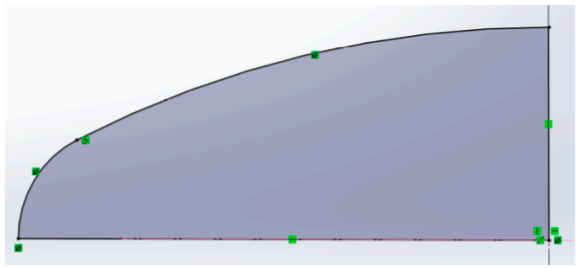
- Copper Vessel Caps



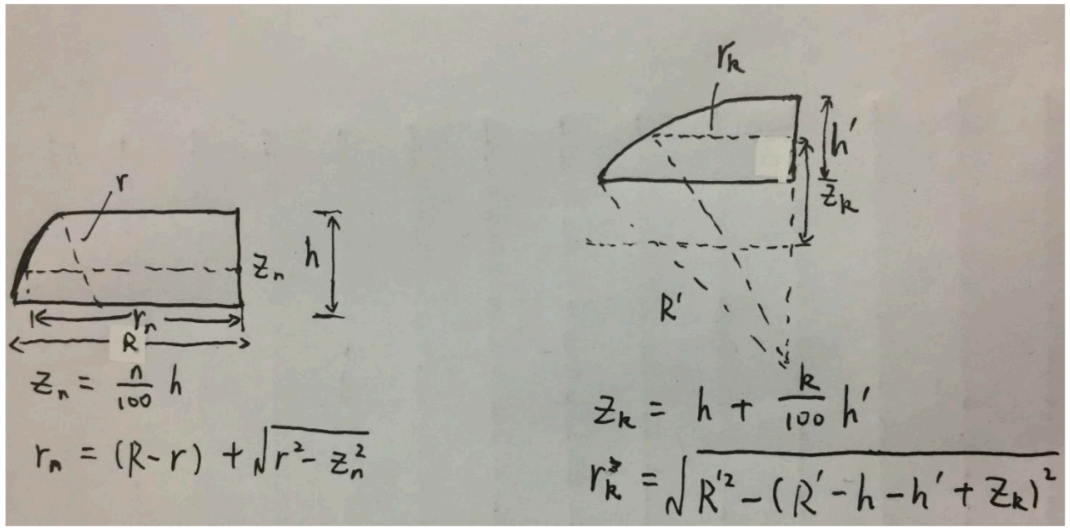
Polycons

Difficulties when writing new grometry





Revolved by a curve formed by two tangent arcs

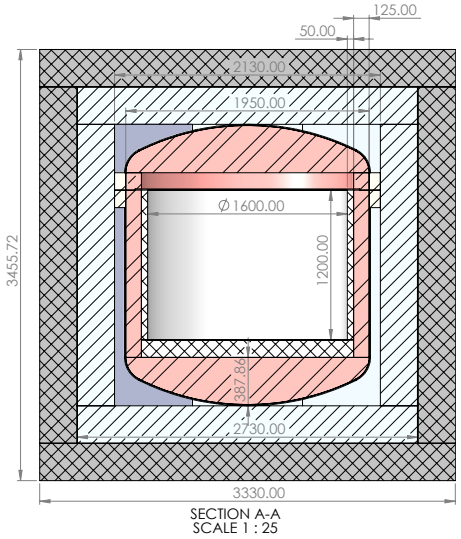


GDML can't do surface revolving, so I draw this solid by superposing polycones

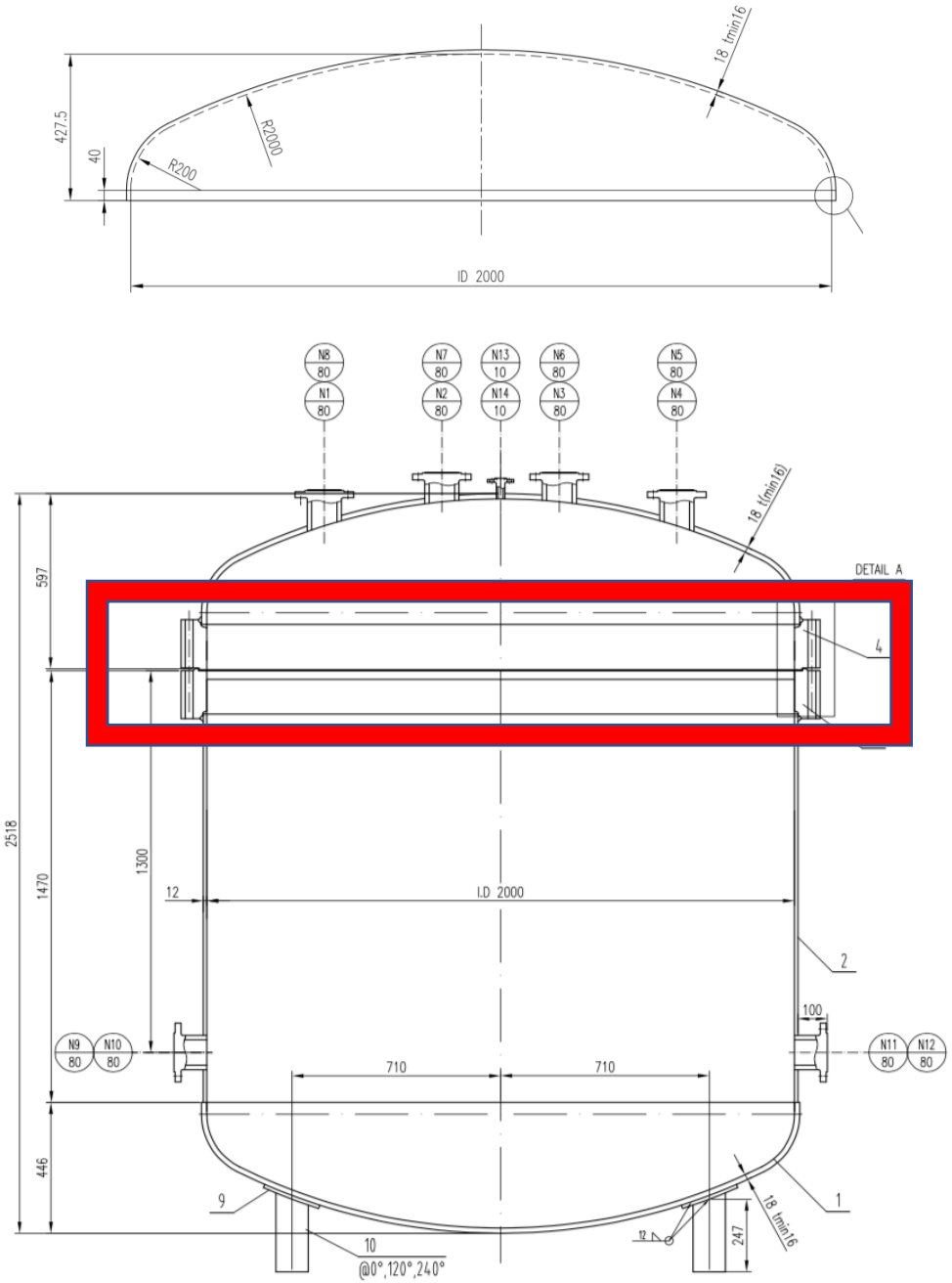
From report of Zhou Bugao

New Geometry

- Differences
  - Vessel thickness
  - Full height(more 300 mm)
  - Little change on width

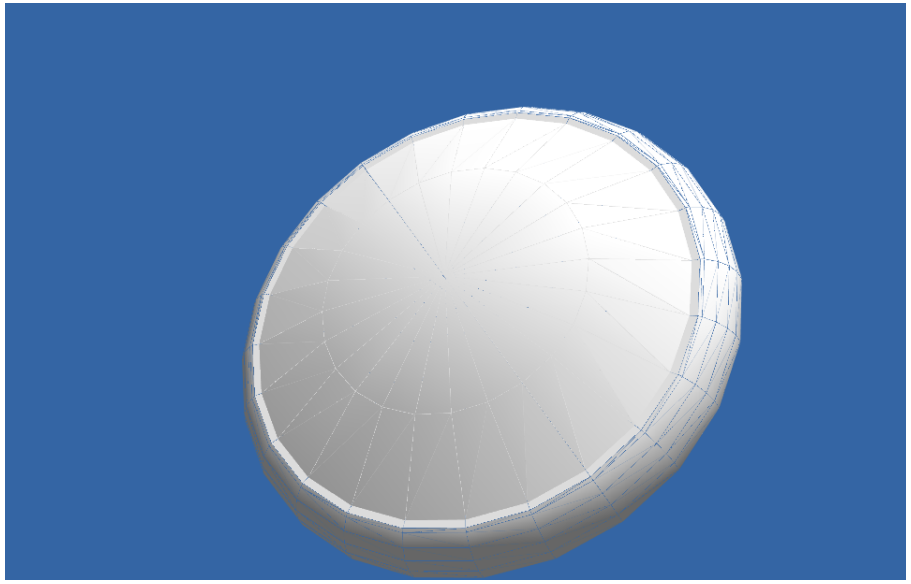


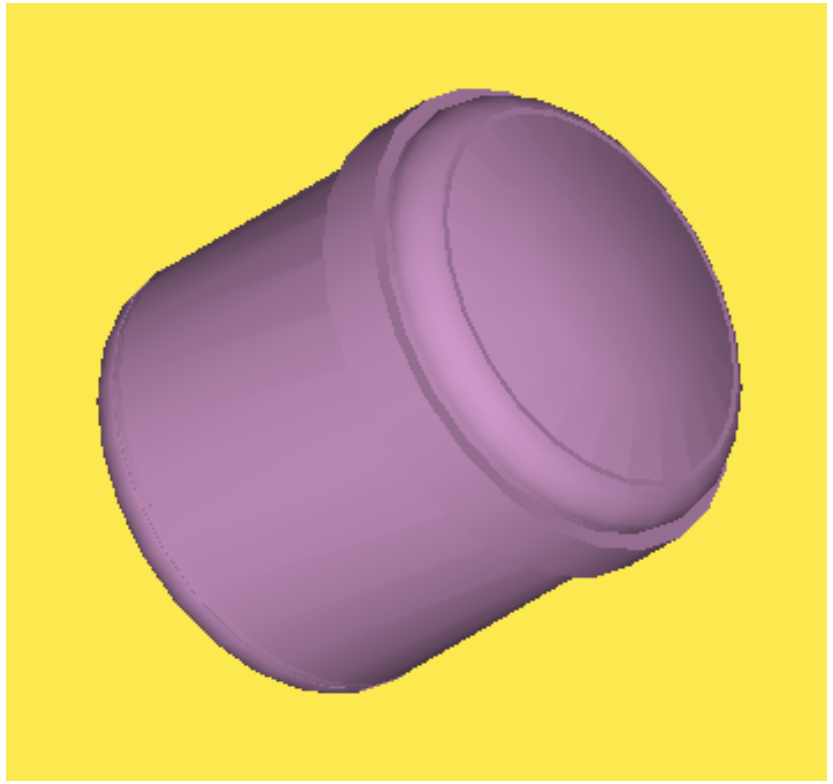
Old Geometry

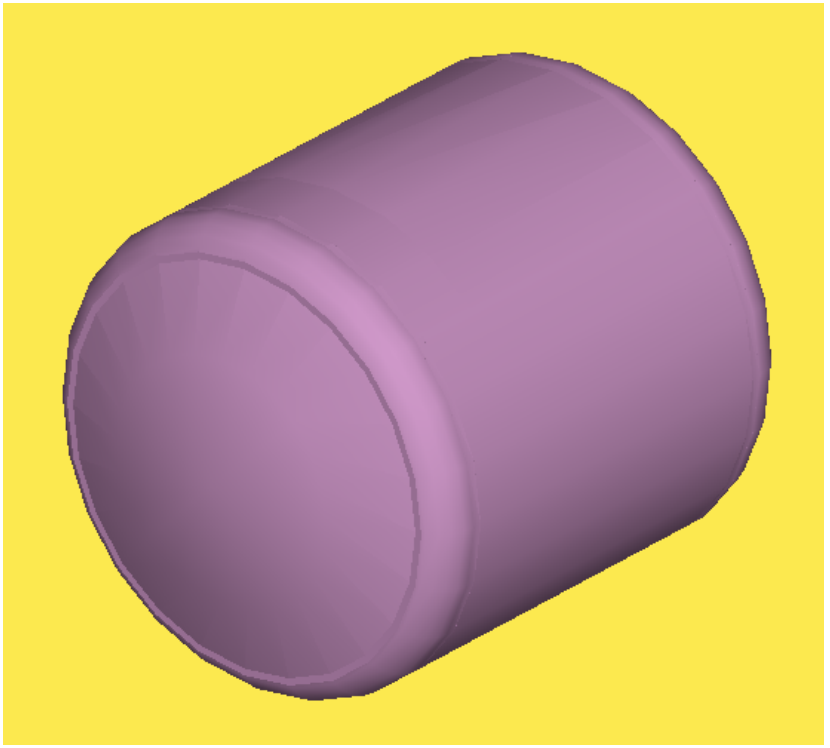


Geometry from engineering drawing

New Geometry







New Geometry

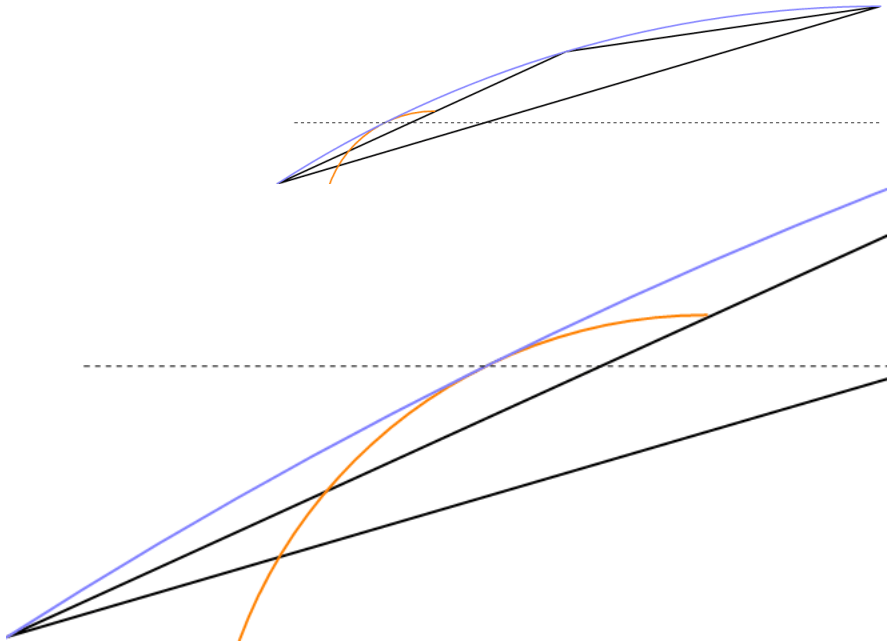
- Geant4 Visualization bias
  - Check with Mathematica & matlab
  - No overlaps

```
sqrt(200^2-x^2)+800==sqrt(2000^2-(2000-y)^2),(2000-x-y)/1800==x/200,x>0
```

```
>> eval(x)

ans =

   179.1613

>> eval(y)

ans =

   208.3872
```

```
>> eval(x+y)

ans =

   387.5485
```

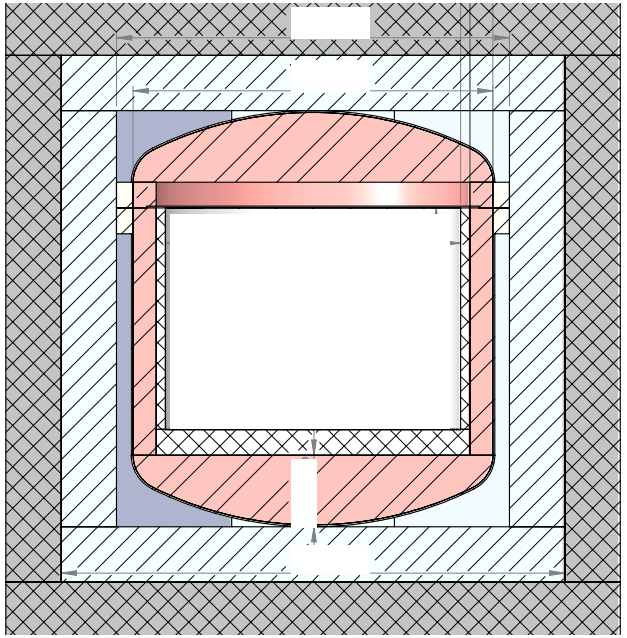
Matlab



Mathematica(by chengchen SYSU)

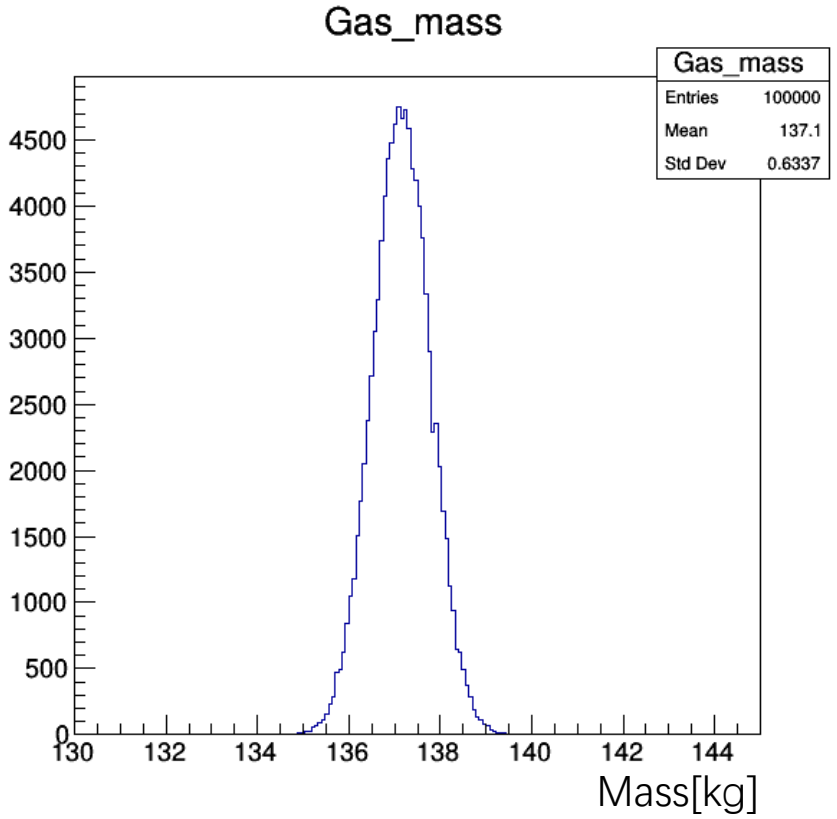
Mass

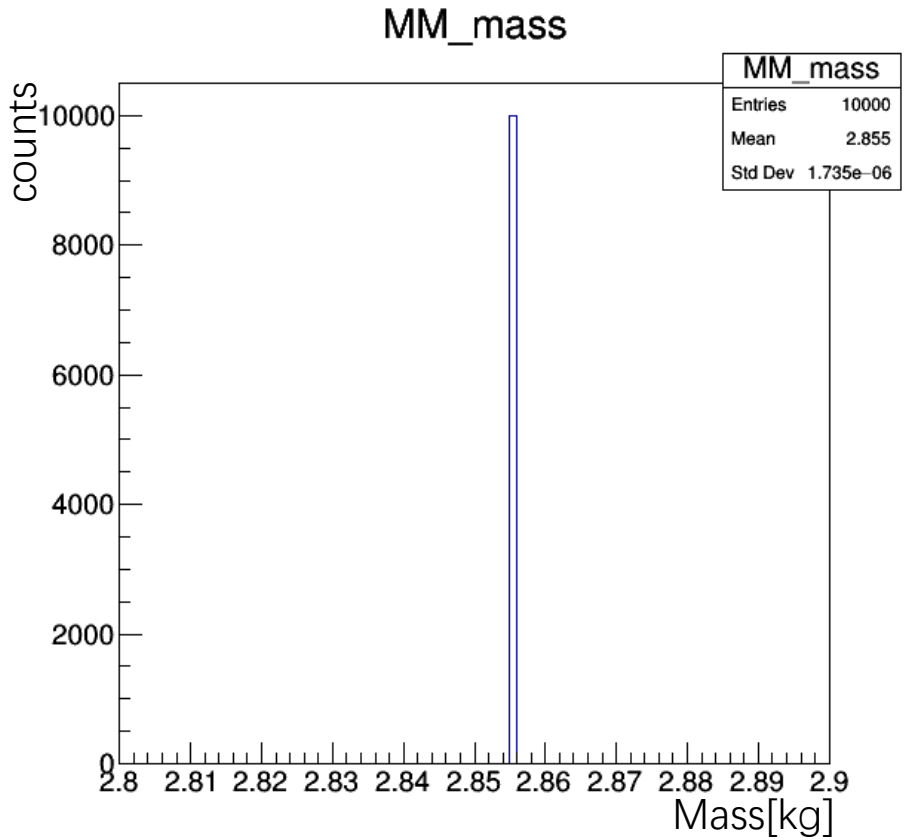
- LeadShielding
- HDPEShielding
- VesselWall
- CopperVessel
- MM
- Cathode
- Gas
- OtherXeTMAGas
- GasInBetween



Mass

- Volume size by Monte Carlo in Geant4





Mass

- an error when get mass of sensitive volume

if

```
<variable name="targetGasDensity" value="5.65884" />
```

```
<material name="Xenon_TMA" state="gas">
    <D unit="mg/cm3" value="targetGasDensity+quencherDensity" />
    <P unit="bar" value="gasPressure" />
    <T unit="K" value="gasTemperature" />
    <fraction n="quencherFraction" ref="TMA" />
    <fraction n="1-quencherFraction" ref="Xenon" />
</material>
```

REST Report

```
Gas name : Xenon_TMA
Gas temperature : 300
Gas density : 0.0568424 g/cm3
```

~137000kg

if

```
<variable name="targetGasDensity" value="0.0565884" />
```

```
<material name="Xenon_TMA" state="gas">
    <D unit="g/cm3" value="targetGasDensity+quencherDensity" />
    <P unit="bar" value="gasPressure" />
    <T unit="K" value="gasTemperature" />
    <fraction n="quencherFraction" ref="TMA" />
    <fraction n="1-quencherFraction" ref="Xenon" />
</material>
```

~137kg

Mass

- Result

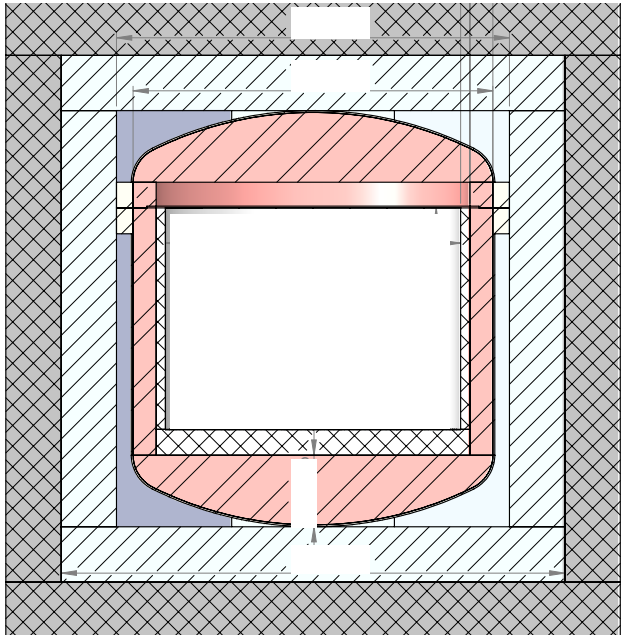
rerun code of old Geometry

Volume	Mass(kg)	Mass before(kg)	rate
HDPE Shielding	1.46E+04	13447.9539	8.19%
Lead Shielding	1.14E+05	104294.5763	8.92%
Vessel Wall	3404	2501.714152	36.07%
Copper Vessel	3.20E+04	9503.694768 （~2W）	236.40% （60%）
MM	2.855	2.855079	0.00%
Cathode	36.03	36.030298	0.00%
Gas	137.143	155.8574518	-12.01%
OtherXeTMAGas	17.58	-	-
GasInBetween	~0	2.835123046(3100/1000)	0%

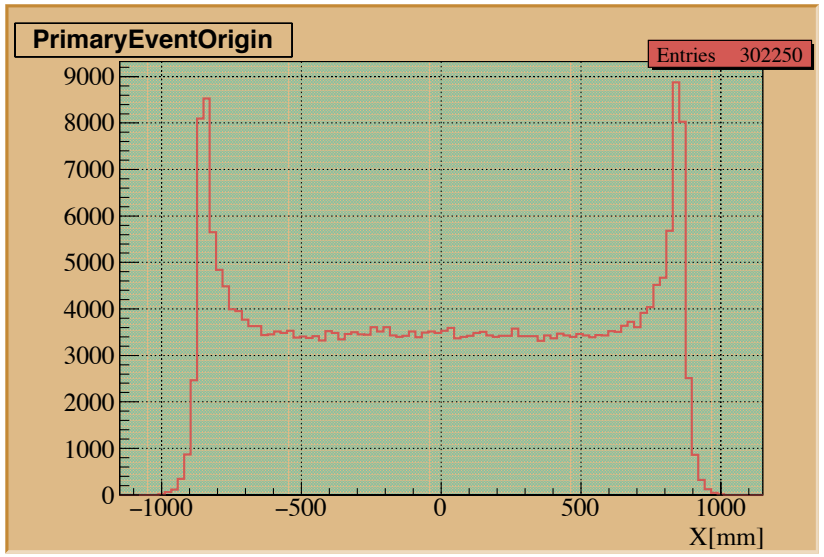
rerun code of old Geometry

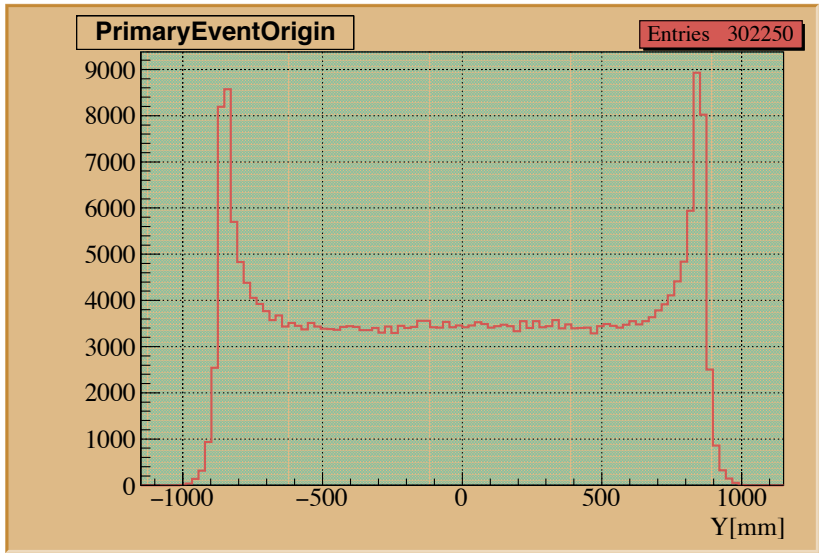
Event Rate per Year

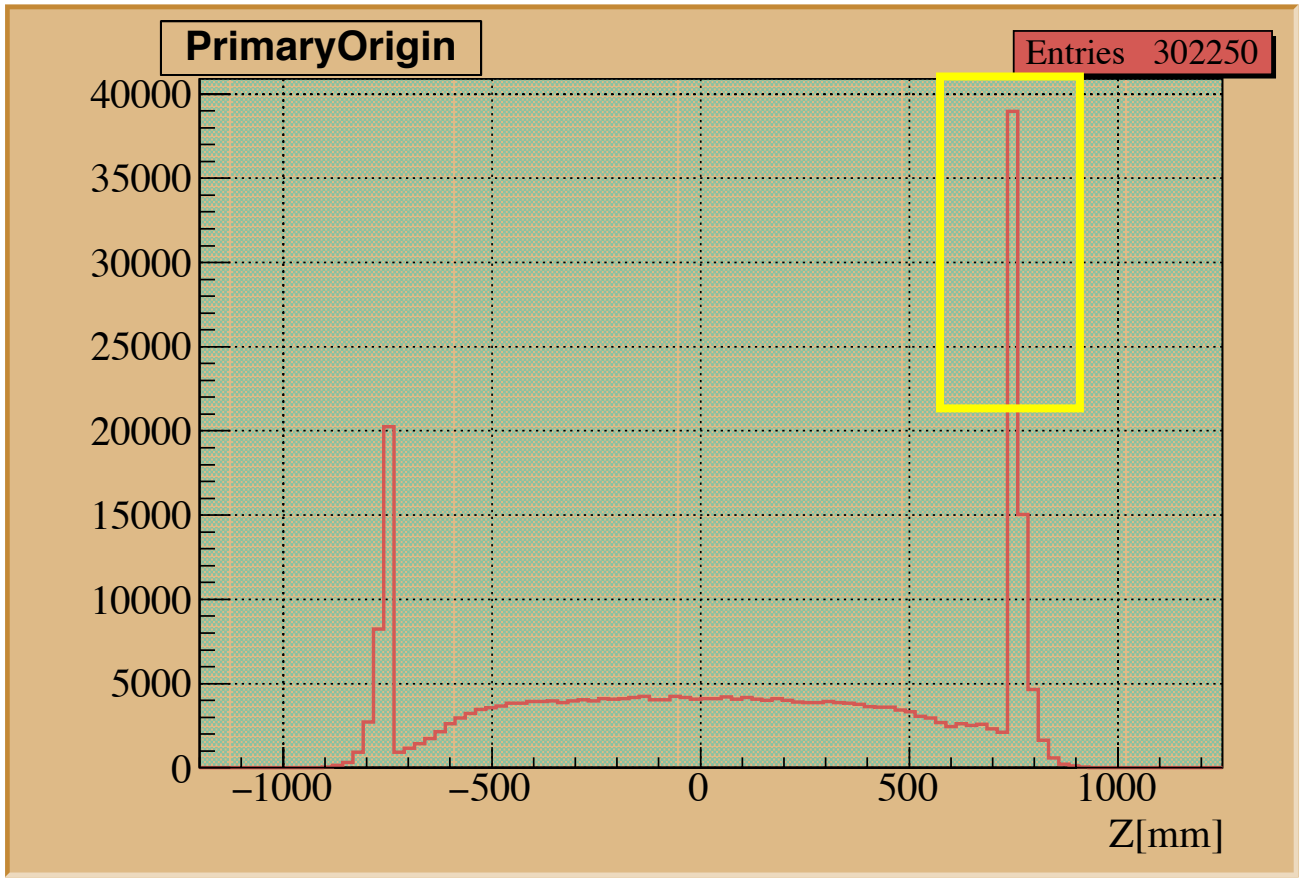
- LeadShielding
- HDPEShielding
- VesselWall
- CopperVessel
- MM
- Cathode
- Gas
- OtherXeTMAGas
- GasInBetween



CopperVessel_Th232(10 million)



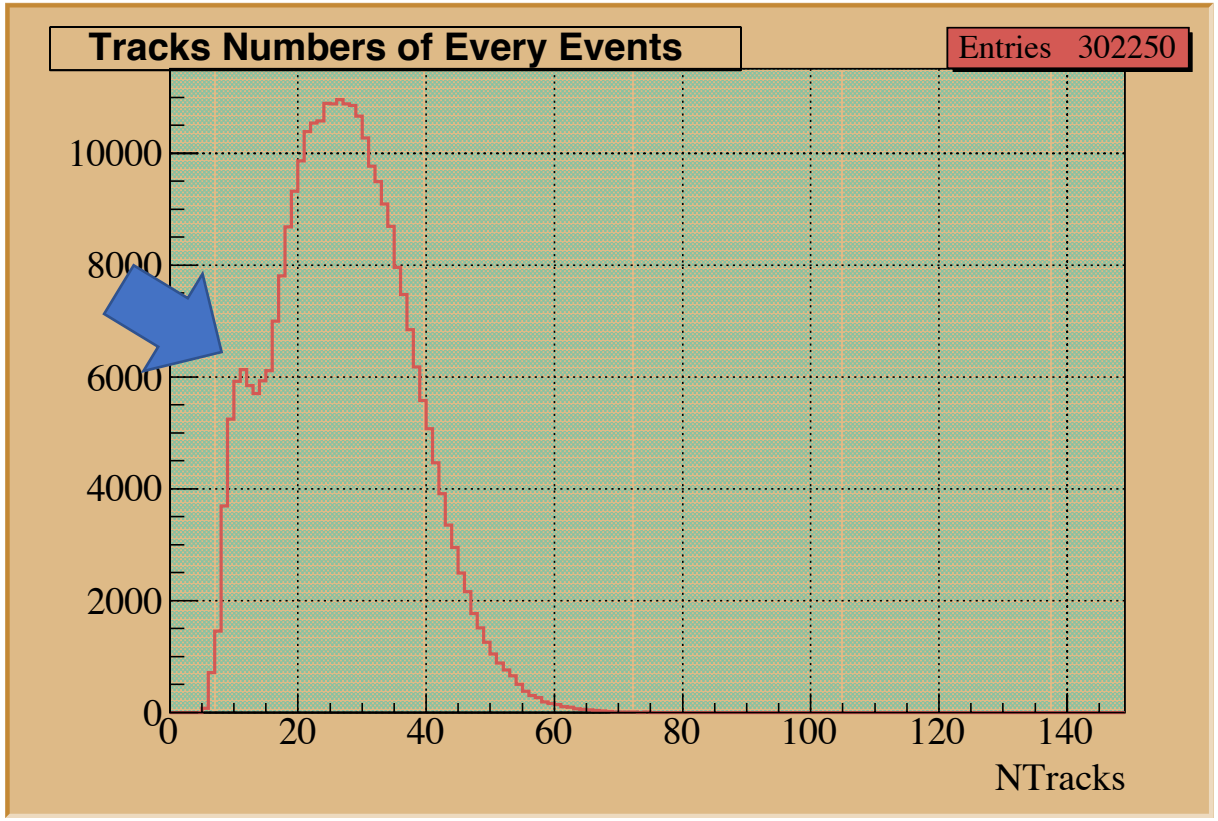




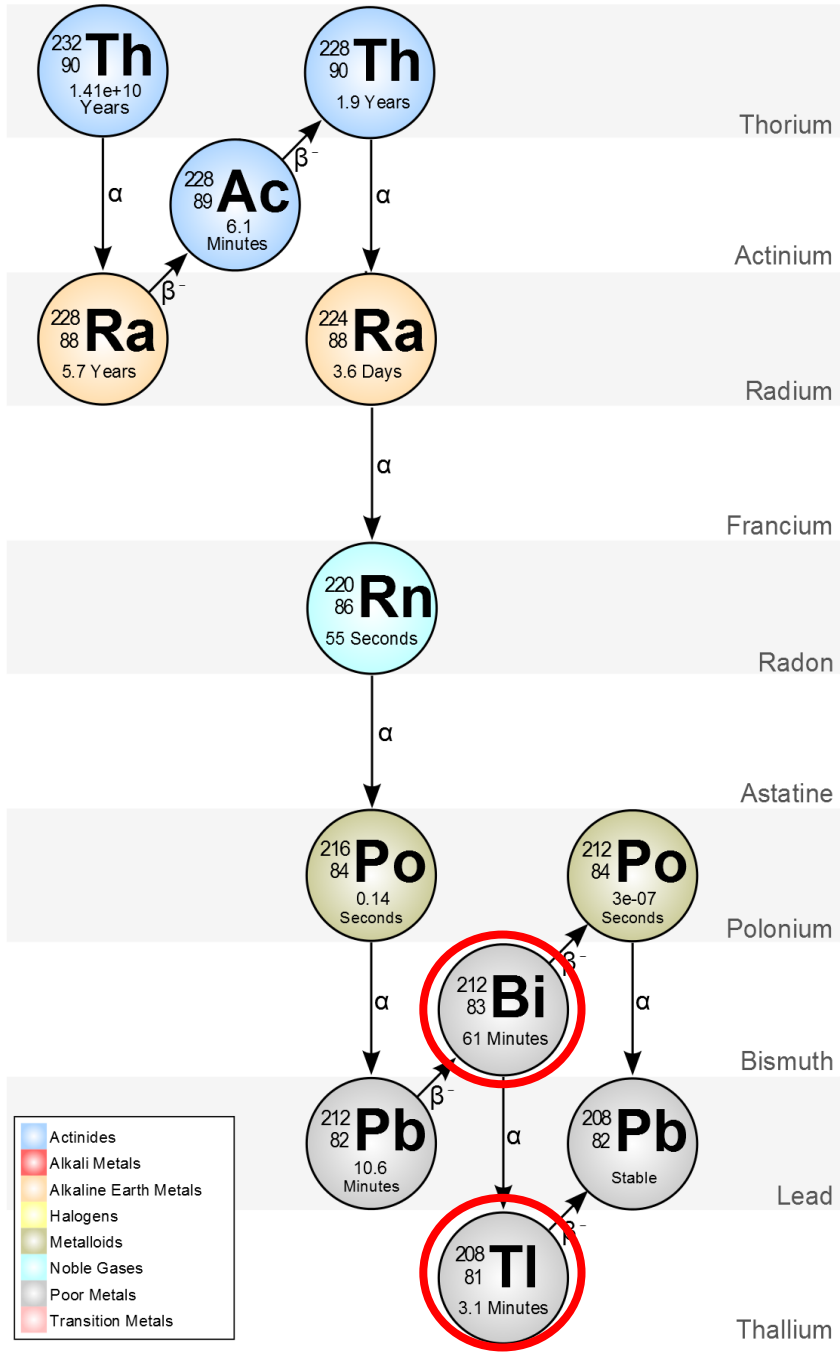
Event Primary Position Distributation

CopperVessel_Th232(10 million)

- NTracks



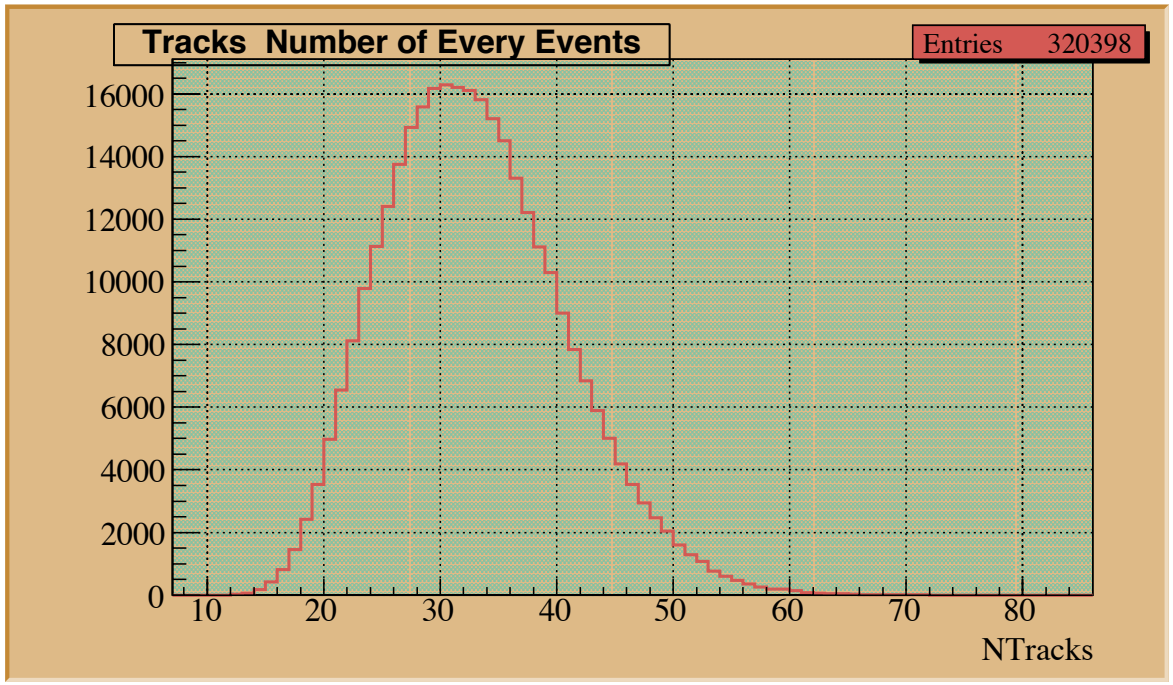
Th232



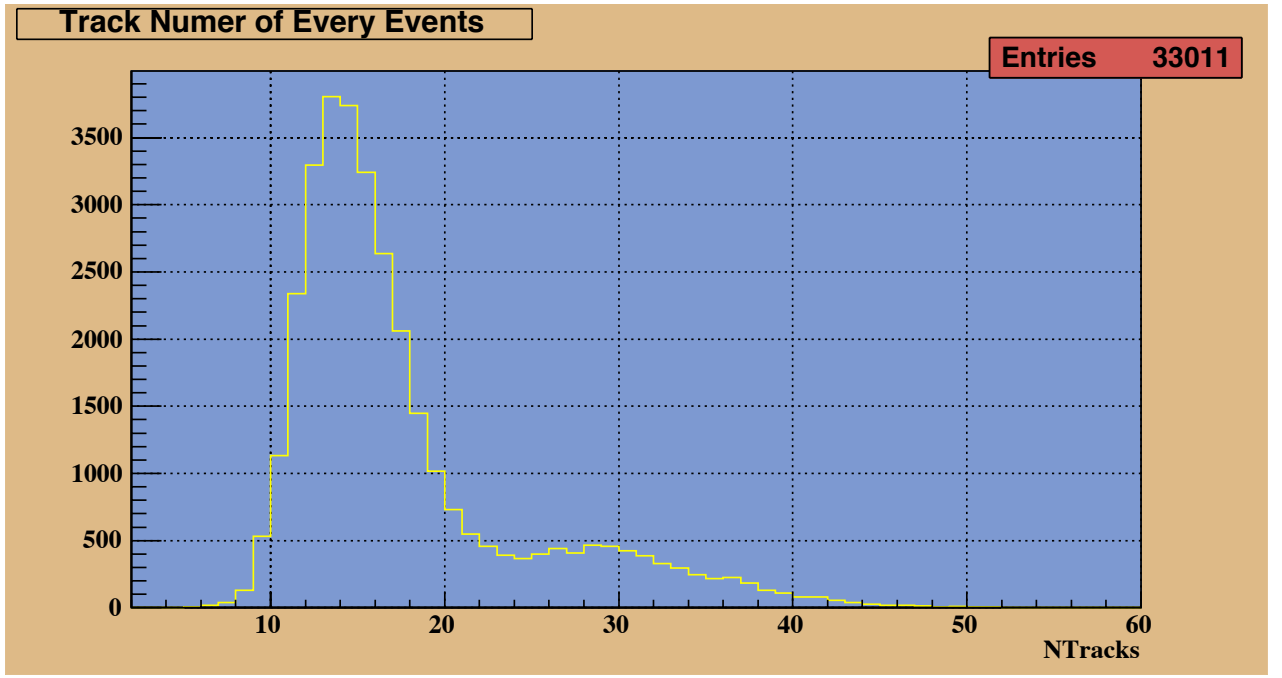
CopperVessel_Th232(10 million)

	Radiations	y(i) $(Bq\text{-}s)^{-1}$	E(i) (MeV)
Bi213	γ 1	4.29×10^{-03}	2.928×10^{-01}
Po212	γ 1	4.40×10^{-05}	7.789×10^{-01}

- NTracks



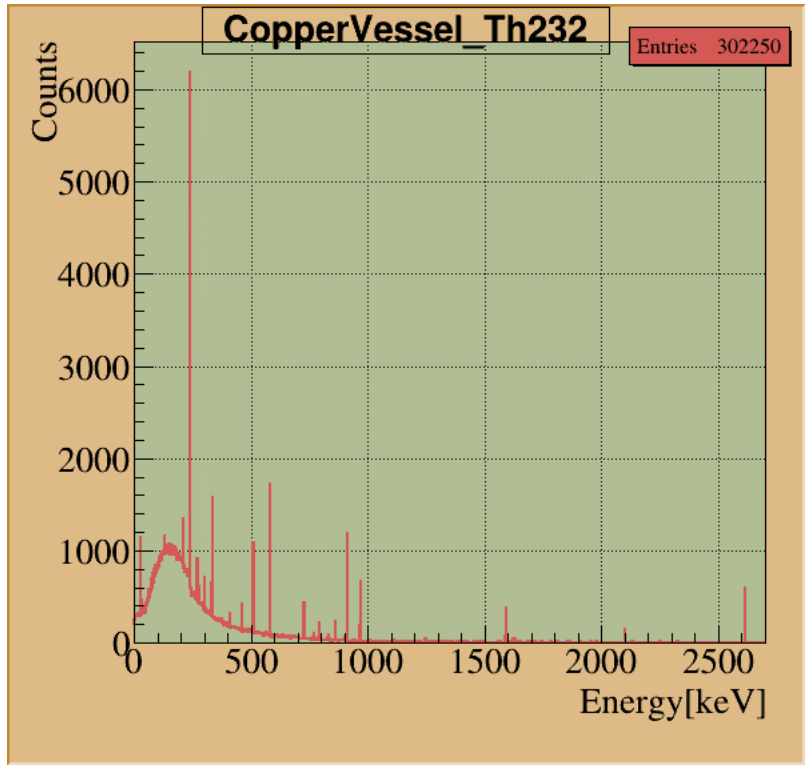
TI208

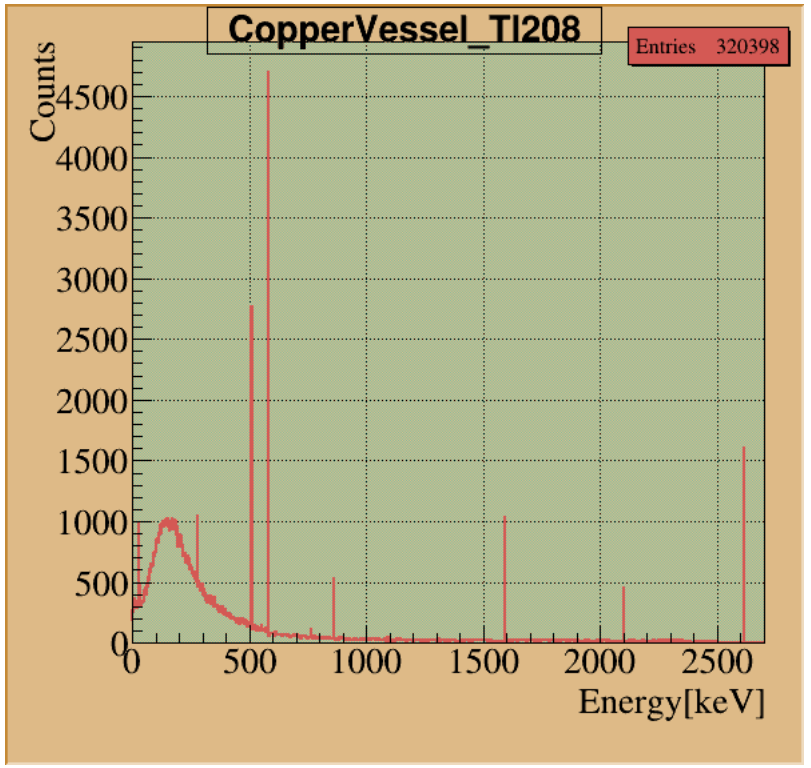


Bi213

CopperVessel_Th232(10 million)

- Energy spectrum



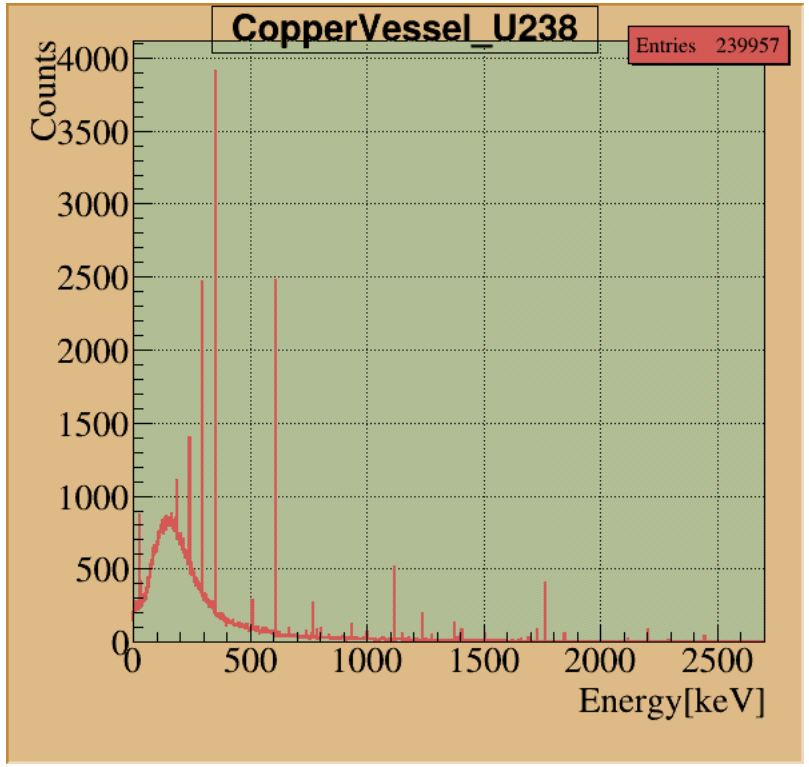


ROI Counts: 319

CopperVessel_Th232(10 million)

- Energy spectrum

Th232	rate	Per Year	U238	rate	Per Year
302250(319)	3.0225%	1.91	239957(44)	2.3996%	0.26



ROI Counts: 44

Volume	Activity(uBq/kg)	
	Th232[uBq/kg]	U238[uBq/kg]
Copper Vessel	320.00	500.00

[CDR]

$$Rate_{part} = A_0 \cdot M_{part} \cdot t \cdot S_{rate}$$

$A_0 - Radioactivity$

$M_{part} - Mass$

$t - time$

$S_{rate} - efficient\_rate$

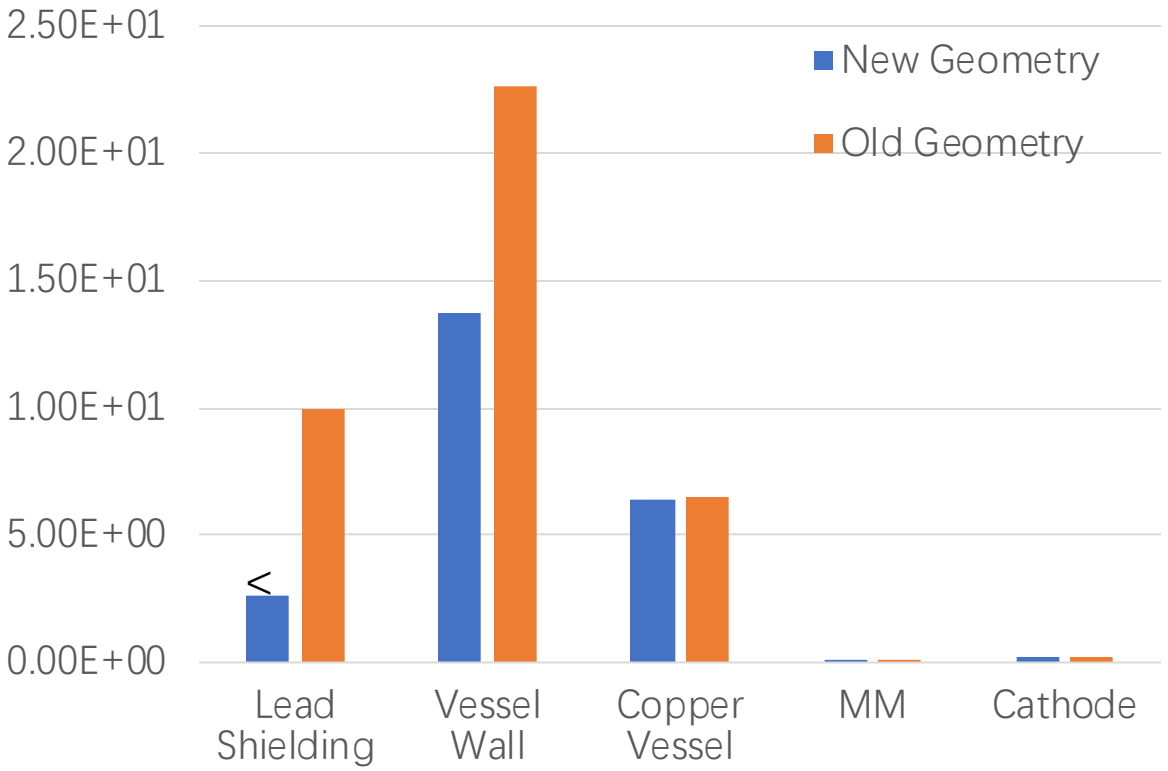
Backgroud Simulation Result

Events Counts: all counts(ROI counts)

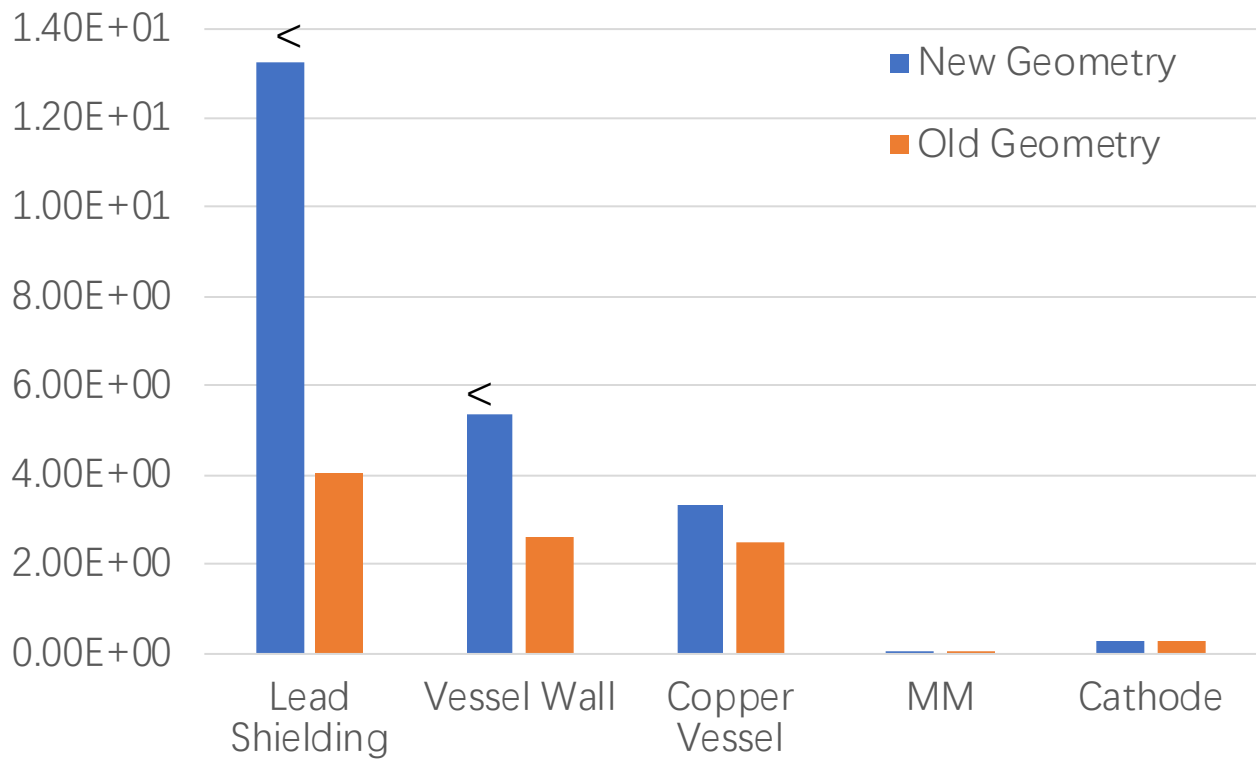
	Th232					
Volume	activity(uBq/kg) [CDR]	All Events	Events Counts	Event Rate	Counts Per Year	Past Result
HDPE Shielding	-	1.0E+08	84(0)	8.40E-07	-	-
Lead Shielding	73.00	1.0E+08	722(0)	7.22E-06	<2.62E+00	9.99E+00
Vessel Wall	320.00	1.0E+07	1597(4)	1.60E-04	1.37E+01	2.26E+01
Copper Vessel	0.20	1.0E+07	302250(319)	3.02E-02	6.43E+00	6.47E+00
MM	0.014(<45nBq/cm3)	1.0E+05	176477(196)	1.76E+00	2.47E-03	2.86E-03
Cathode	0.20	1.0E+05	96746(111)	9.67E-01	2.52E-01	2.28E-01

	U238					
Volume	activity(uBq/kg) [CDR]	All Events	Events Counts	Event Rate	Counts Per Year	Past Result
HDPE Shielding	-	1.0E+08	353(0)	3.53E-06	-	-
Lead Shielding	370.00	1.0E+08	355(0)	3.55E-06	<1.33E+01	4.04E+00
Vessel Wall	500.00	1.0E+07	905(0)	9.05E-05	<5.37E+00	2.61E+00
Copper Vessel	0.75	1.0E+07	239957(44)	2.40E-02	3.33E+00	2.50E+00
MM	0.045(<15nBq/cm3)	1.0E+05	192991(181)	1.93E+00	7.33E-03	8.50E-03
Cathode	0.75	1.0E+05	79237 (33)	7.92E-01	2.81E-01	2.97E-01

Backgroud Simulation Result



Th232



U238

Need more events

Hand Calculation to Mass

<: up limits

Biasing Volume Problems

- restG4: N biasing volumes need N+1 runs
  - No tree saved when using biasing volume
  - restG4 only has N runs
  - Entries even less when using biasing volume. ?

```
    <biasing value="off" type="virtualBox">
      <biasingVolume particle="gamma" size="2000mm" position="(0,0,0)mm" factor="20" energyRange="(24
00,15000)keV"/>
      <biasingVolume particle="gamma" size="2200mm" position="(0,0,0)mm" factor="20" energyRange="(24
00,15000)keV"/>
      <biasingVolume particle="gamma" size="2400mm" position="(0,0,0)mm" factor="40" energyRange="(24
00,15000)keV"/>
      <biasingVolume particle="gamma" size="2600mm" position="(0,0,0)mm" factor="60" energyRange="(24
00,15000)keV"/>
    </biasing>
```

restG4

Biasing Volume Problems

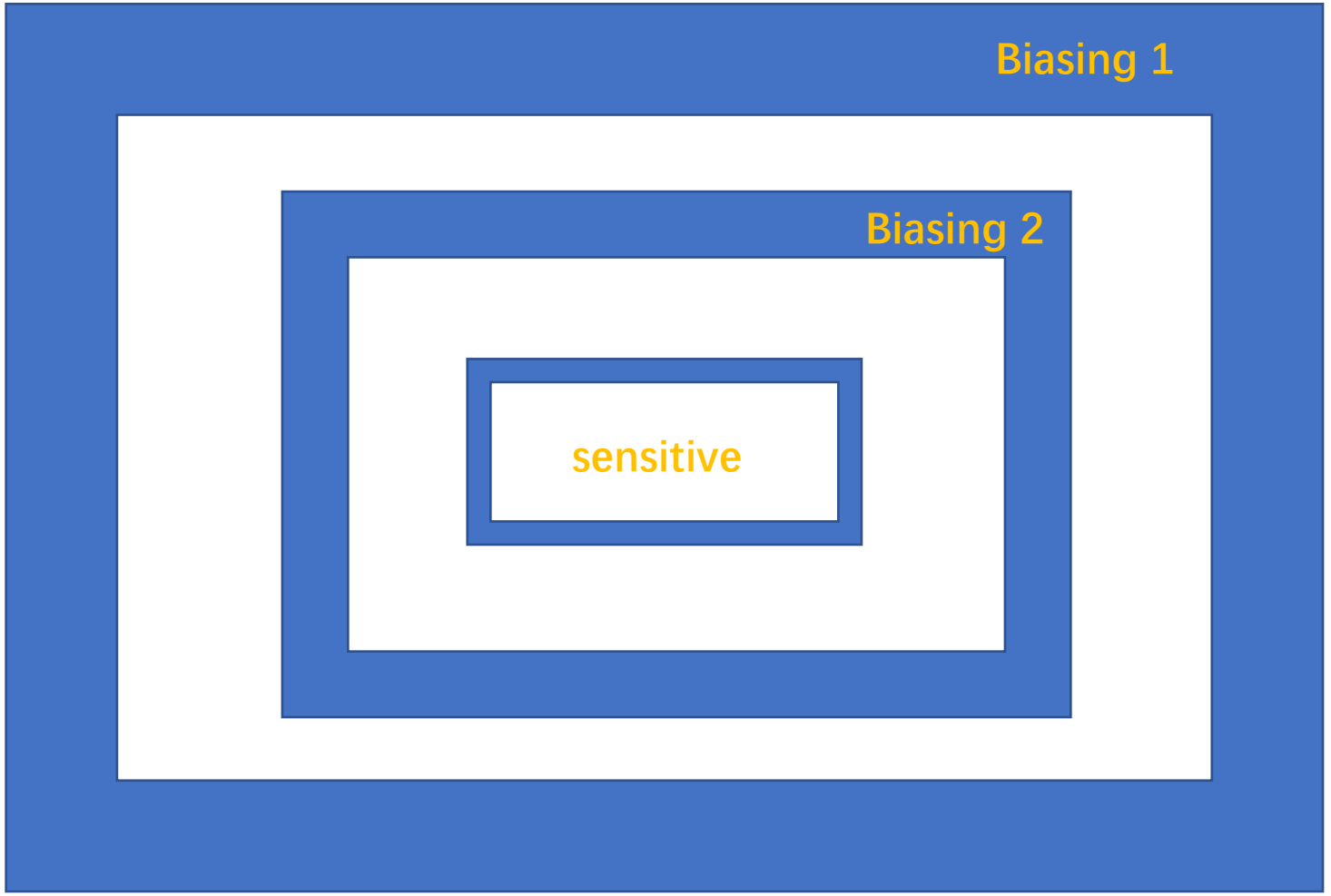
- 2 Biasing Volume

1st: gamma –biasing 1

2nd: gamma –biasing 2

3rd: gamma –sensitive

need 3 times BeamOn



TODO

- Add bolts in Geometry（by Chengchen. SYSU）

- HitsToSignal
  - Add process(simulate DAQ)

- Recalculate the Mass by Geometric Size

Thank you ~