ePIC SVT detector

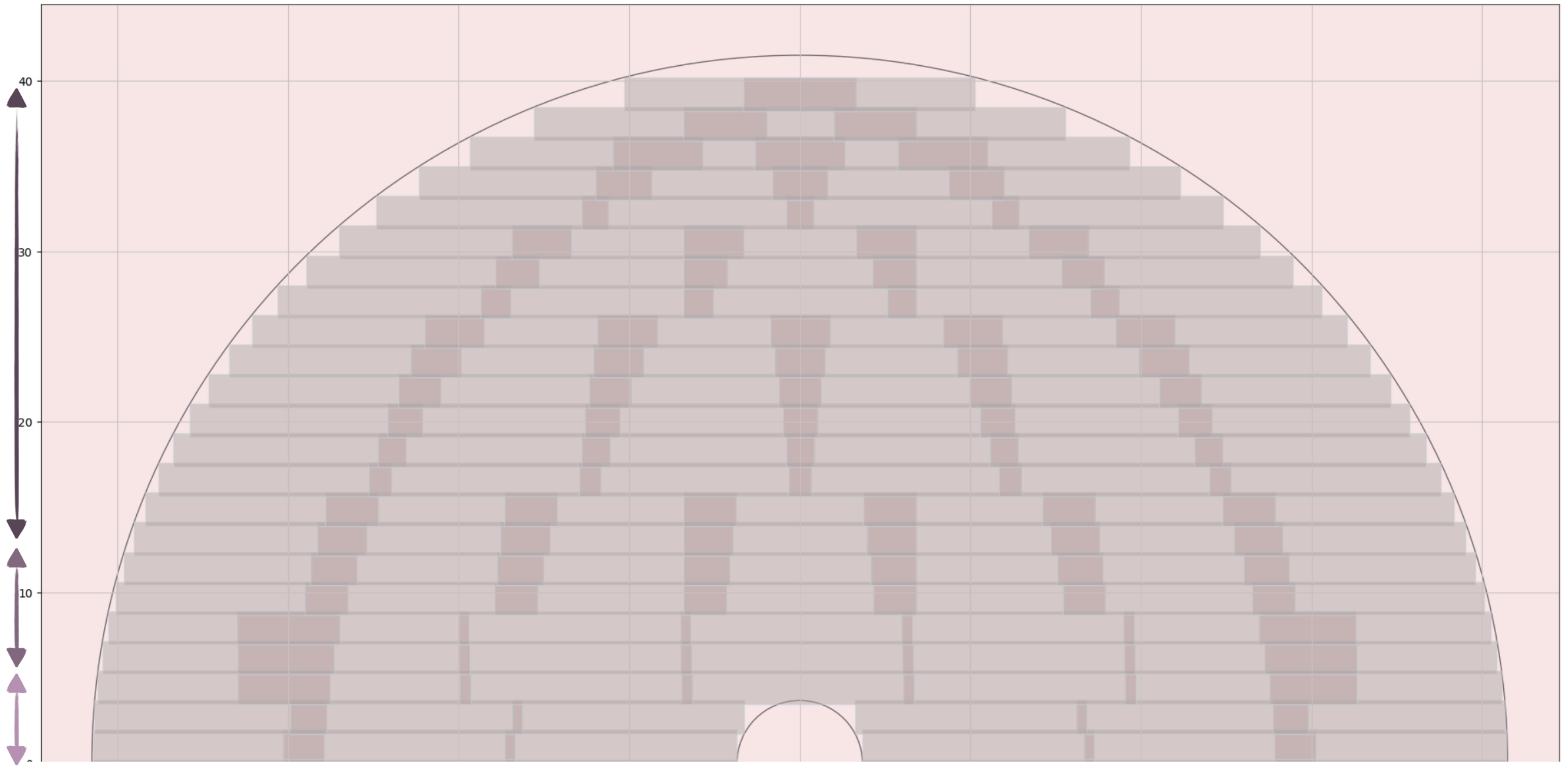
Electron & Hadron Endcaps paving

Rita Sadek and Ernst Sichtermann

EIC Meeting
03/11/2025

BERKELEY LAB

Algorithmic approach



Zone 1:

Strategy for minimum overlap in the inner region, maximum at the outer region. Vertical overlap is constant between all zones (2.175 mm)

- Inner circle:

  Symmetric filling -> cut zone in 2, x<0 and x>0.
  Filling starts at $min(\sqrt{R_{in}^2 - y^2}, \sqrt{R_{in}^2 - (y + sensor\ height)^2})$, closest possible to beam pipe, with overlap of 6 mm between each sensor to cover the readout strips. Stop filling at one sensor outside of the outer circle, last one is then pushed back in at $max(\sqrt{R_{out}^2 - y^2}, \sqrt{R_{out}^2 - (y + sensor\ height)^2})$. *Mirrored coordinates for x>0.*

- Double inner circles:

  Same logic for inner circle, difference in filling starts at:

  x<0:
  $min(\sqrt{R1_{in}^2 - y^2}, \sqrt{R1_{in}^2 - (y + sensor\ height)^2}, \sqrt{R2_{in}^2 - y^2}, \sqrt{R2_{in}^2 - (y + sensor\ height)^2})$

  x>0:
  $max(\sqrt{R1_{in}^2 - y^2}, \sqrt{R1_{in}^2 - (y + sensor\ height)^2}, \sqrt{R2_{in}^2 - y^2}, \sqrt{R2_{in}^2 - (y + sensor\ height)^2})$

  \+ Taking into account x if circle not centered around (0,0)

\+ *Filling done with both 5-RSUs and 6-RSUs sensors, best scenario (least additional overlap) is selected for paving.*

\+ *5 mm added to the inner circles to take into account bake out.*

Zone 2:

Same strategy for minimum overlap in the inner region, maximum at the outer region.

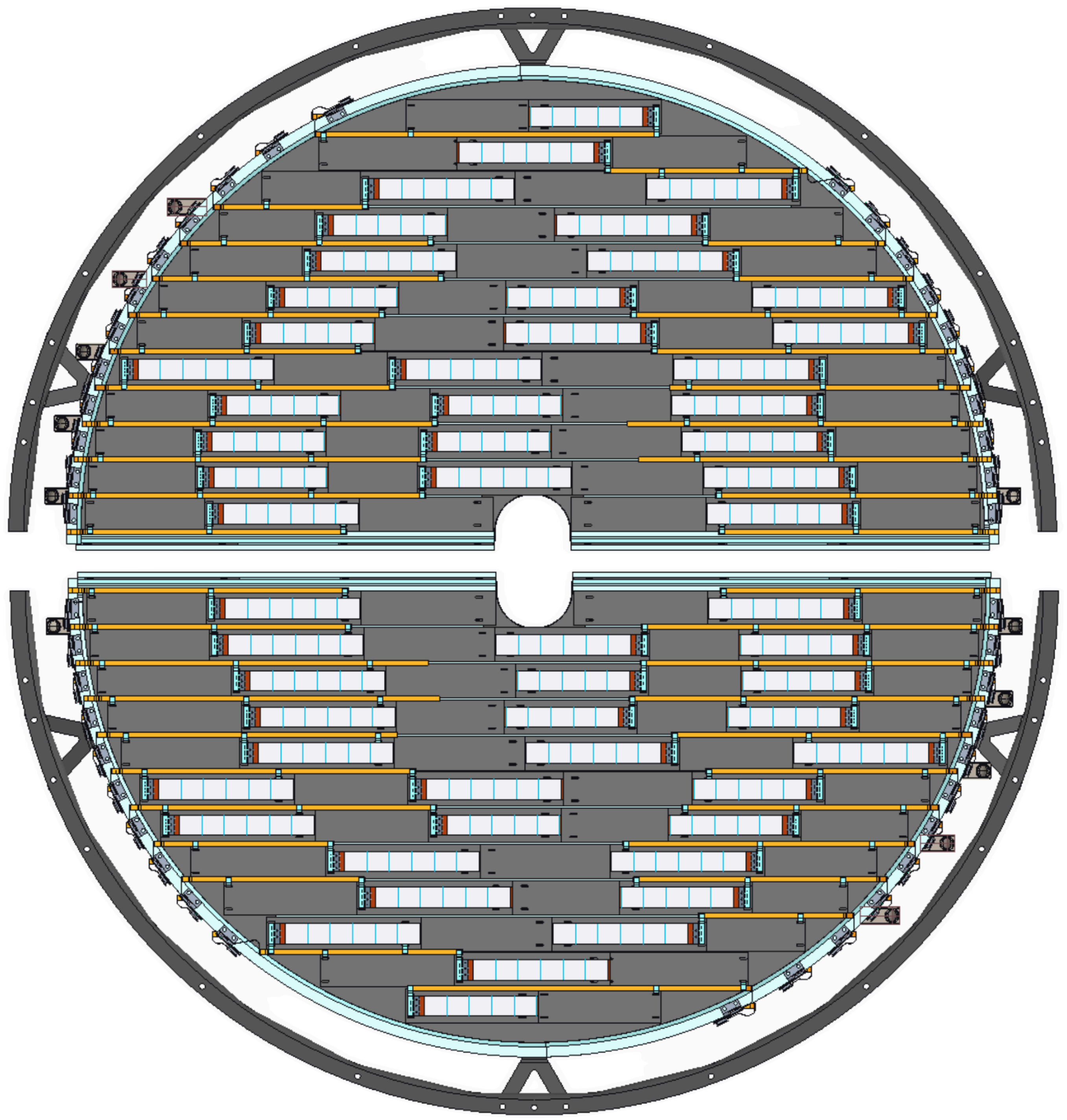
Start filling with first sensor at $max(\sqrt{R_{out}^2 - y^2}, \sqrt{R_{out}^2 - (y + sensor\ height)^2})$, with overlap of 6 mm between each sensor to cover the readout strips. Stop filling at one sensor outside of the outer circle, last one is then pushed back in at $min(\sqrt{R_{out}^2 - y^2}, \sqrt{R_{out}^2 - (y + sensor\ height)^2})$.

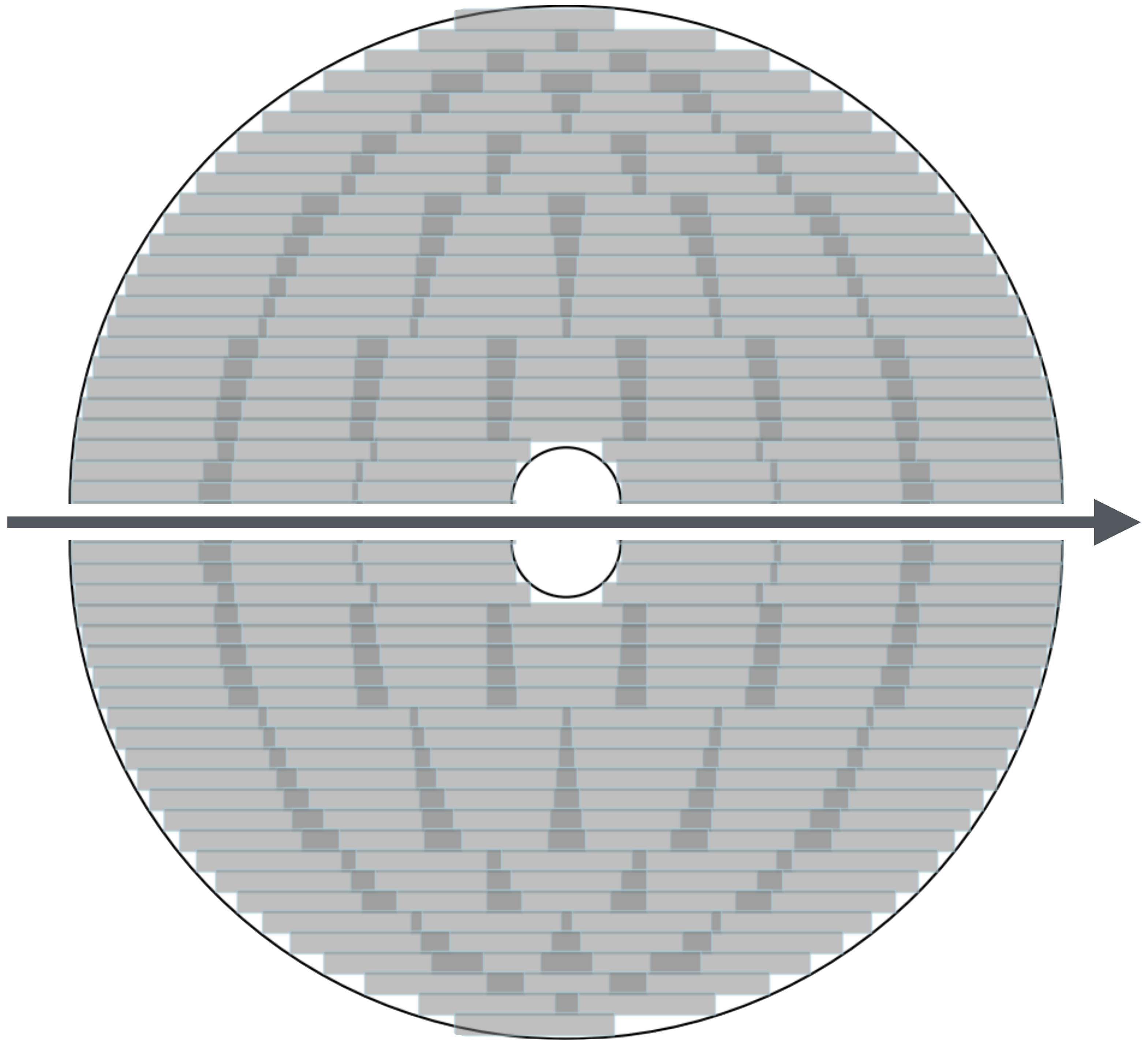
The overlap is divided by 2 and distributed on both sides.

Zone 3:

Same strategy as zone 2, difference in overlap distribution: additional overlap calculated between the first sensor outside of the outer circle, and the outer circle. Then, this additional overlap is distributed equally between all the sensors.

Disks overview





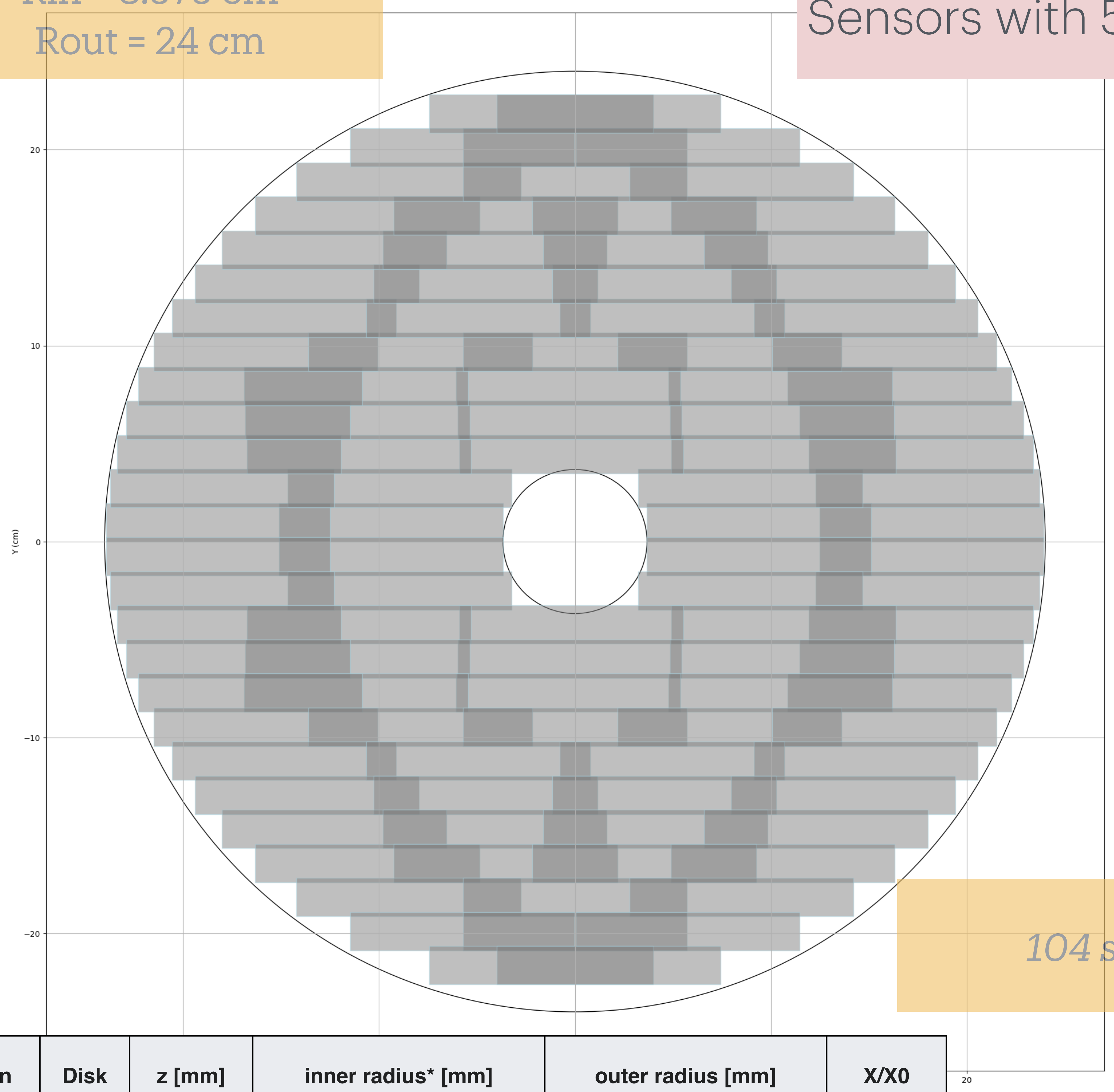
Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE	ED0	-250	36.76	240	0.24%
	ED1	-450	36.76	415	0.24%
	ED2	-650	36.76	421.4	0.24%
	ED3	-850	40	421.4	0.24%
	ED4	-1050	46.35	421.4	0.24%

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
HE	HD0	250	36.76	240	0.24%
	HD1	450	36.76	415	0.24%
	HD2	700	38.46	421.4	0.24%
	HD3	1000	53.43	421.4	0.24%
	HD4	1350	70.14	421.4	0.24%

ED0/HD0 and ED1/HD1

Rin = 3.676 cm
Rout = 24 cm

Sensors with 5 RSUs

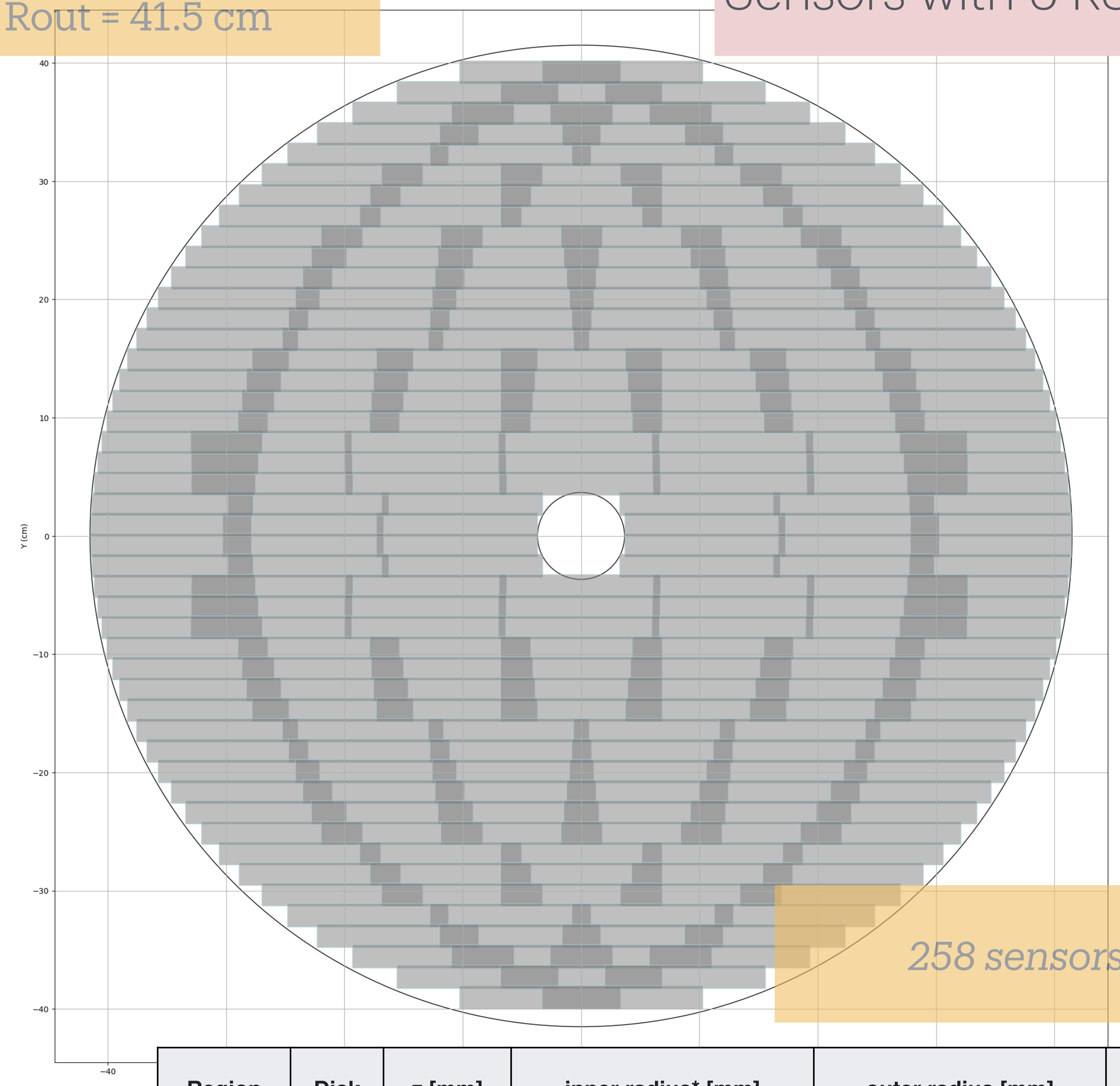


104 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE/HE	ED0/ HD0	-250	36.76	240	0.24%

Rin = 3.676 cm
Rout = 41.5 cm

Sensors with 6 RSUs



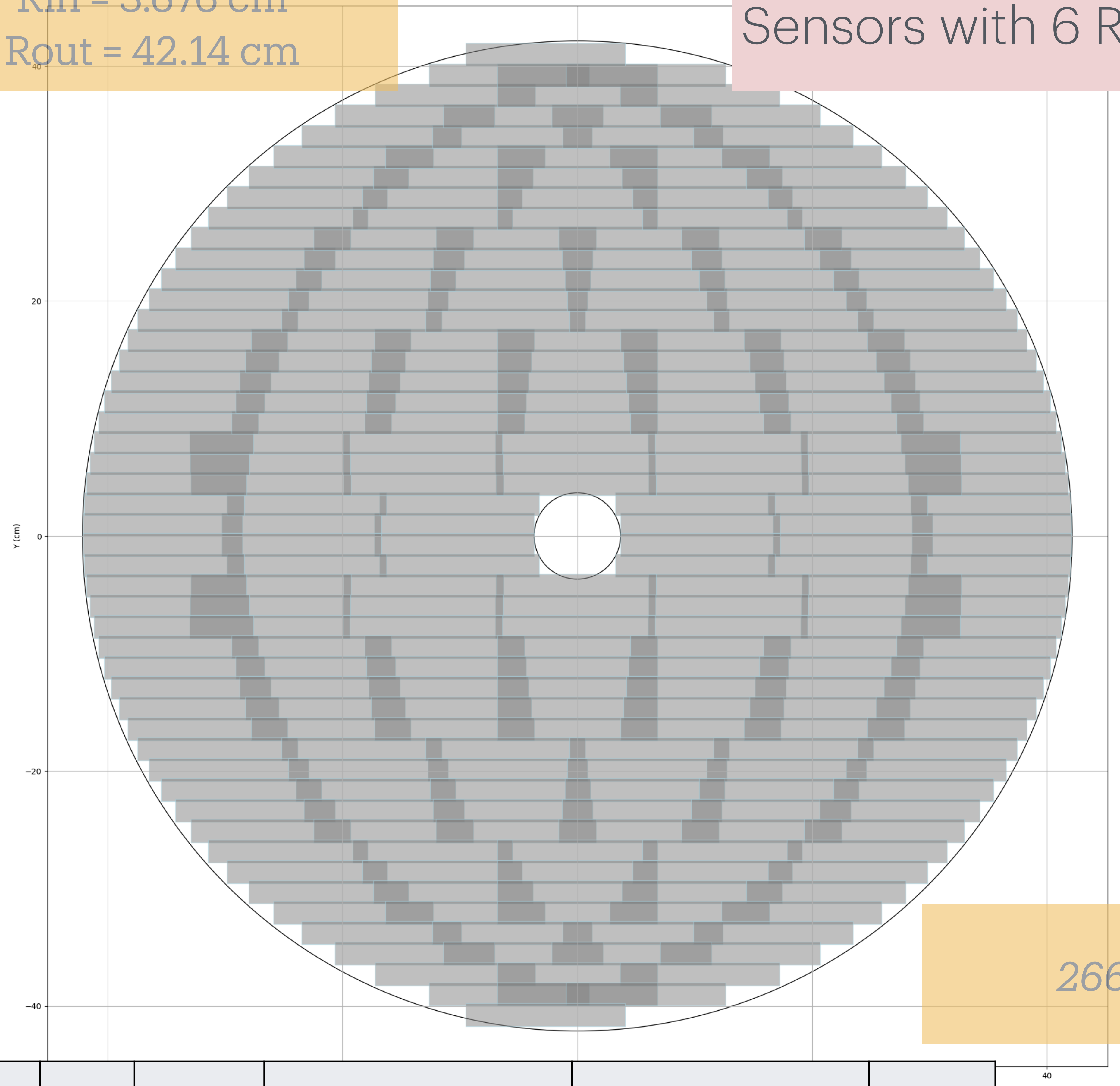
258 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE/HE	ED1/ HD1	-450	36.76	415	0.24%

ED2 and ED3

Rin = 3.676 cm
Rout = 42.14 cm

Sensors with 6 RSUs

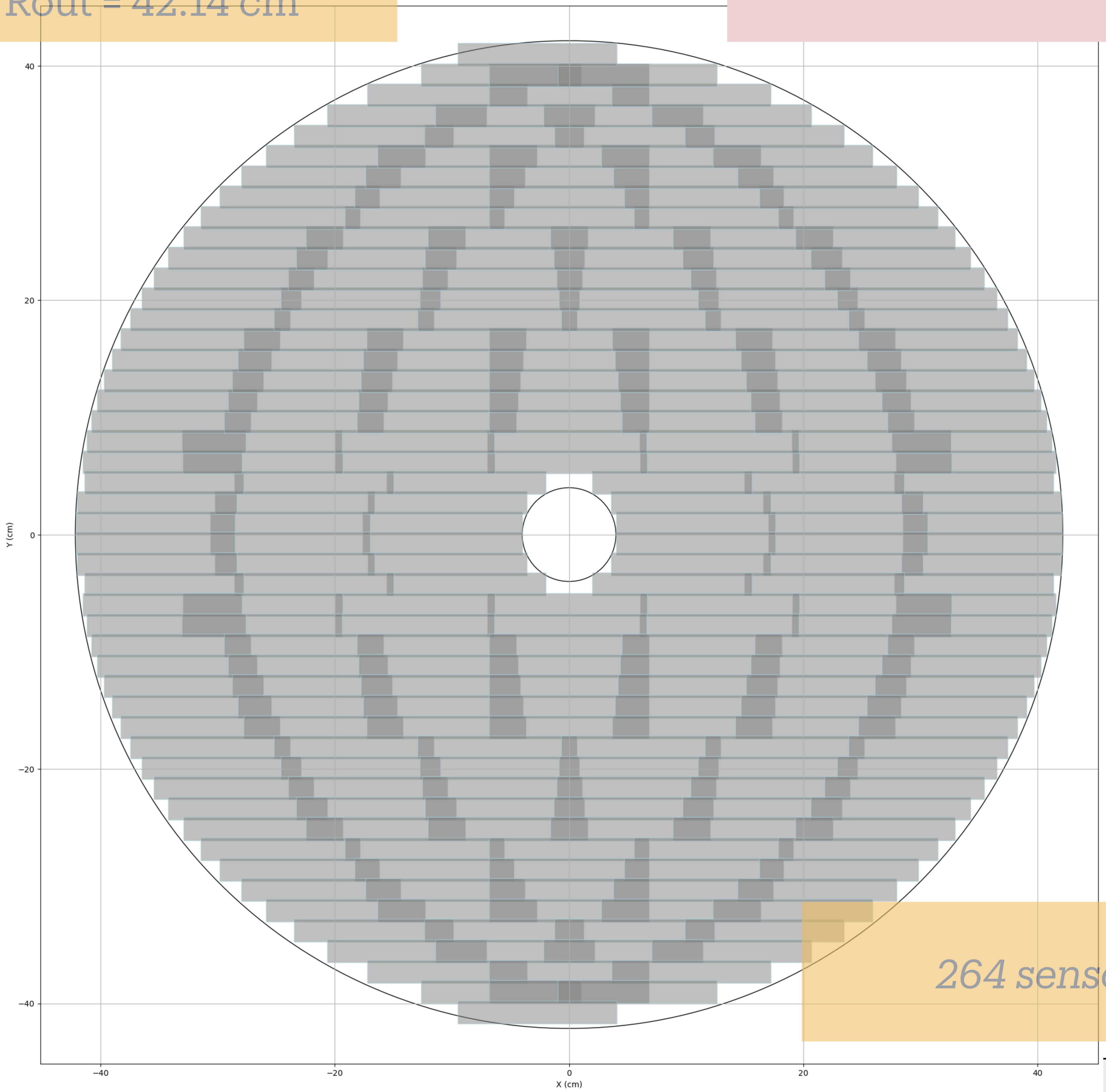


266 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE	ED2	-650	36.76	421.4	0.24%

Rin = 4 cm
Rout = 42.14 cm

Sensors with 6 RSUs



264 sensors

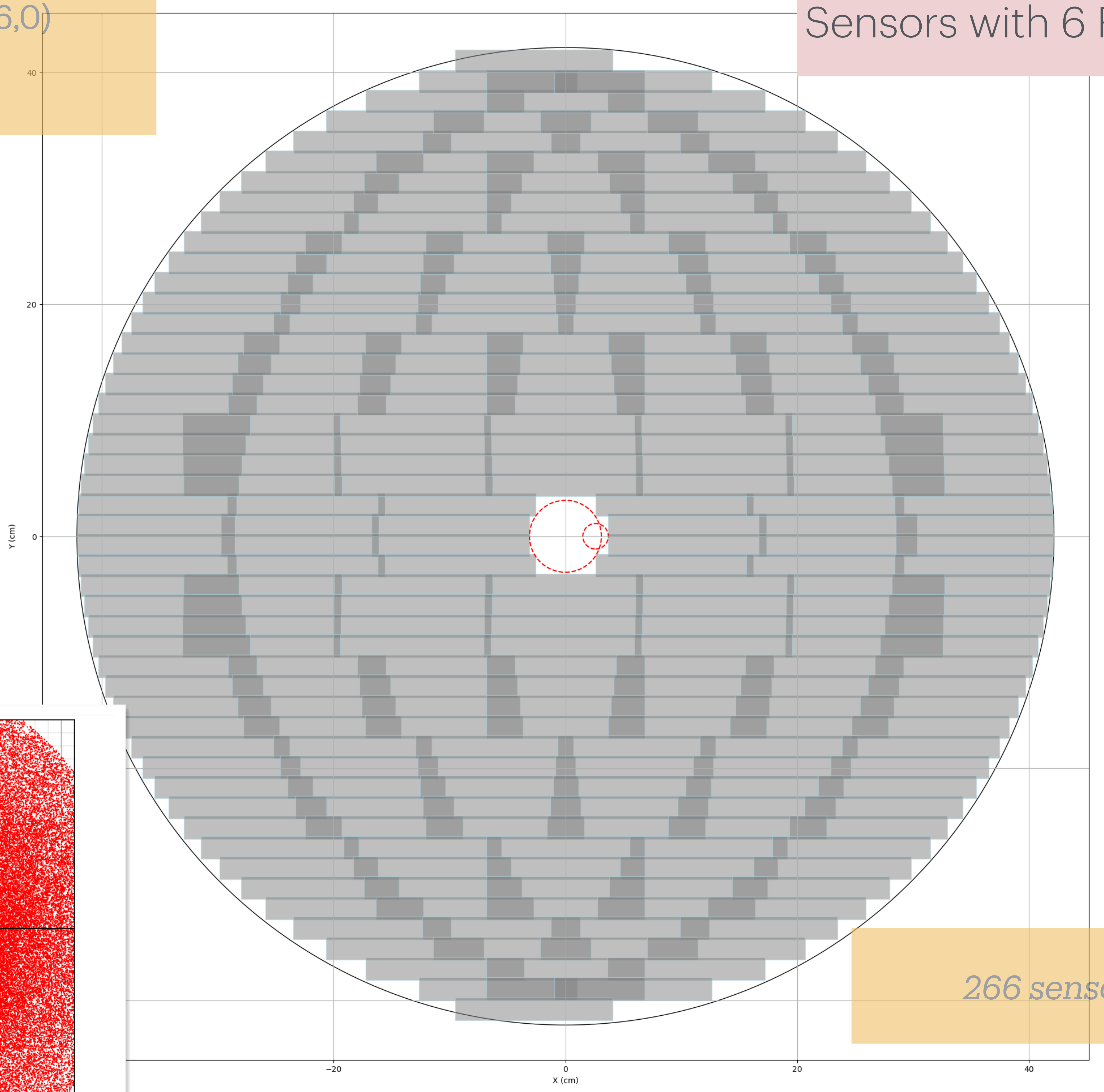
Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE	ED3	-850	40	421.4	0.24%

ED4

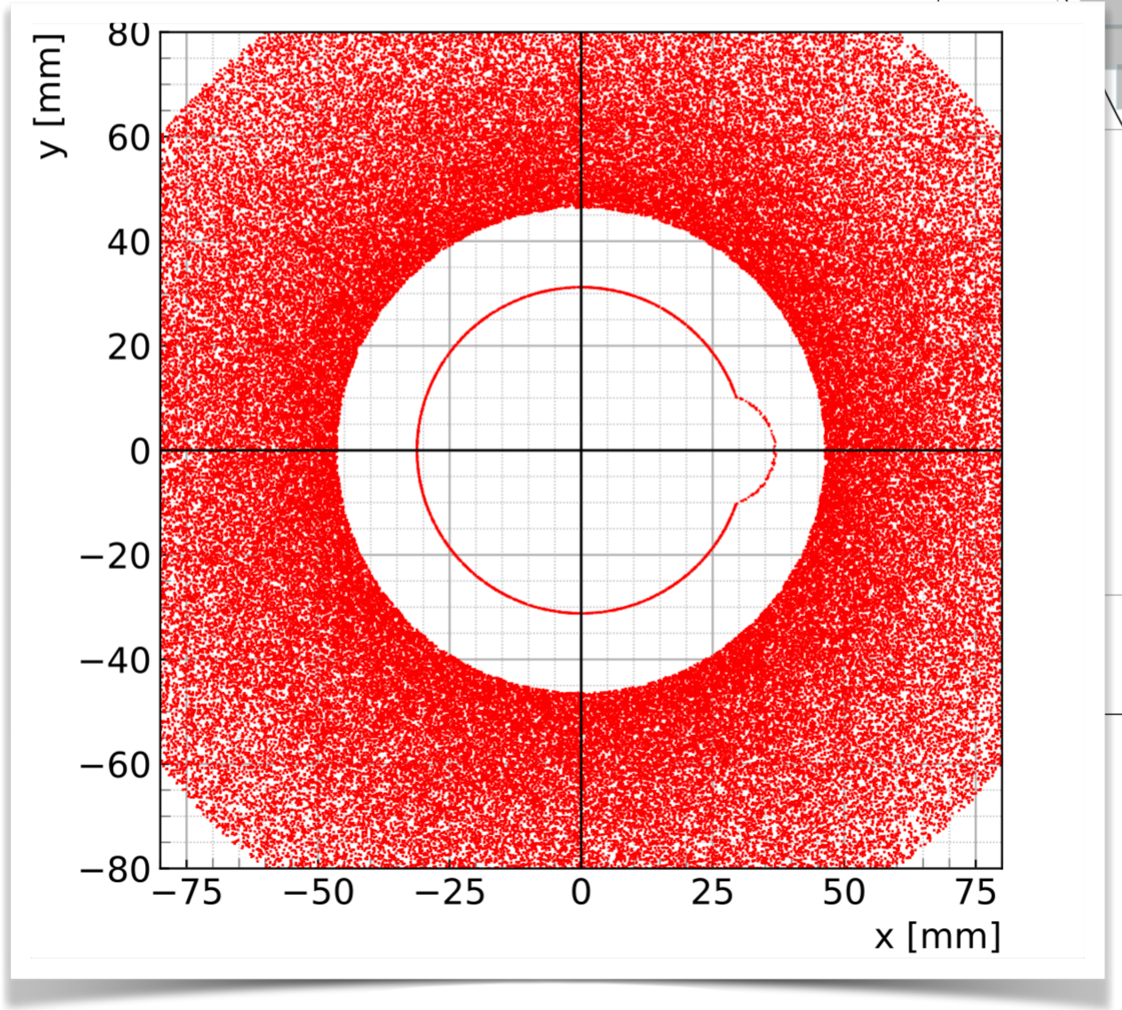
Rin1 = 3.1 cm, c1 = (0,0)
Rin 2 = 1.1 cm , c2 = (2.6,0)

Rout = 42.14 cm

Sensors with 6 RSUs



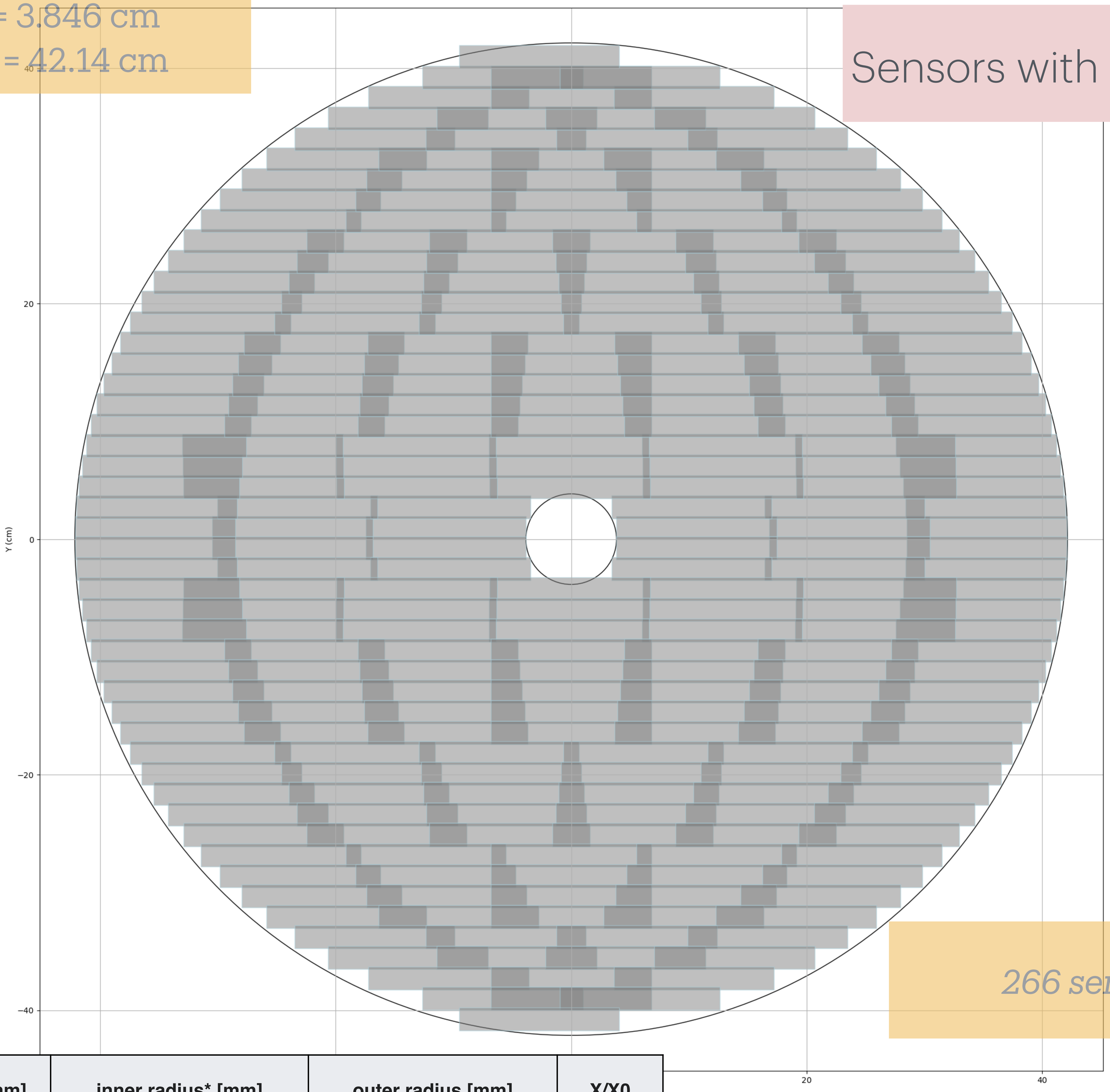
266 sensors



HD2

Rin = 3.846 cm
Rout = 42.14 cm

Sensors with 6 RSUs



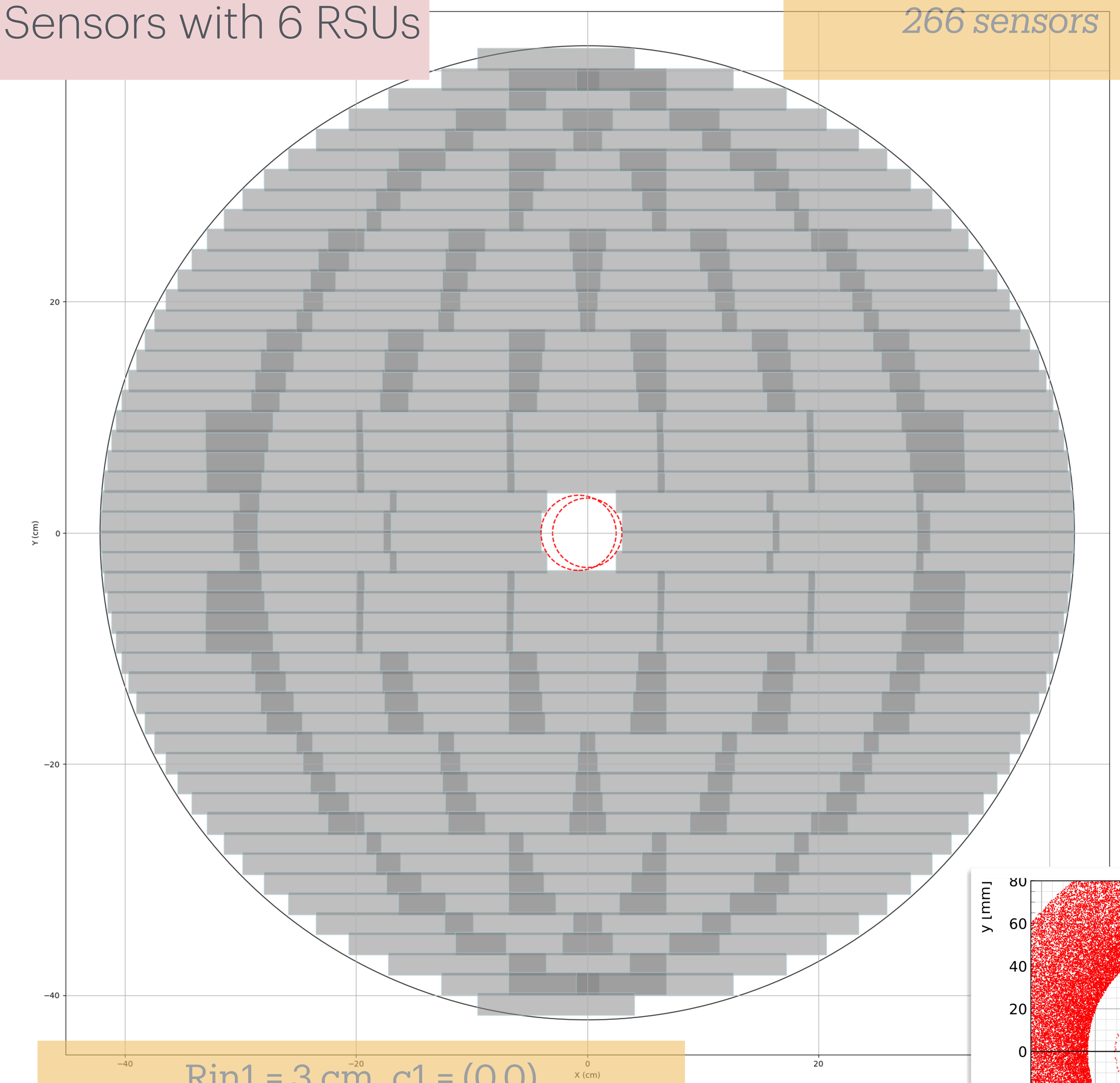
266 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
HE	HD2	700	38.46	421.4	0.24%

HD3 and HD4

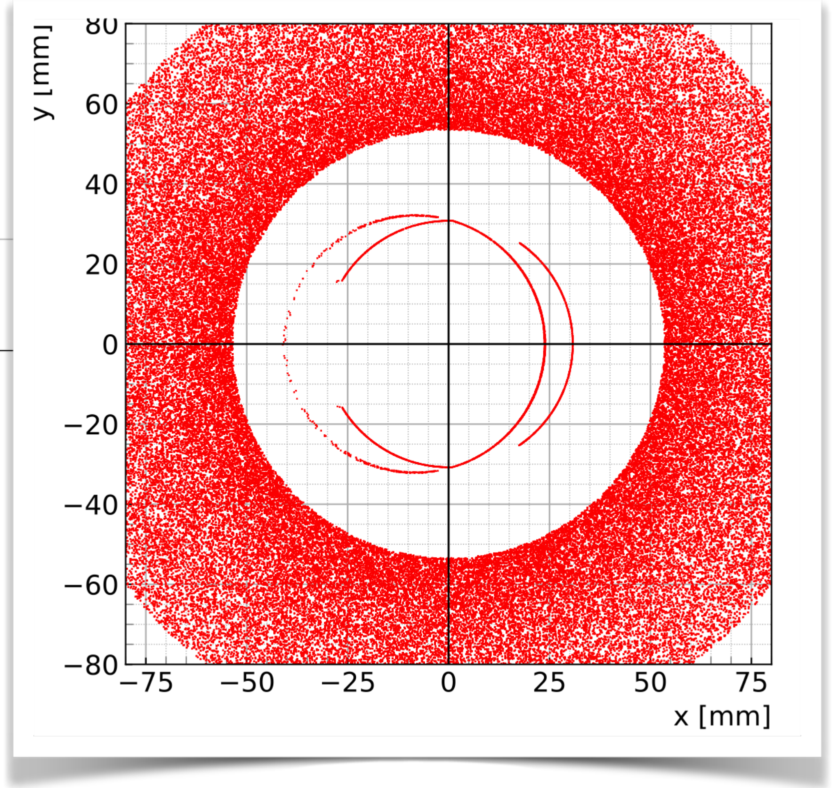
Sensors with 6 RSUs

266 sensors



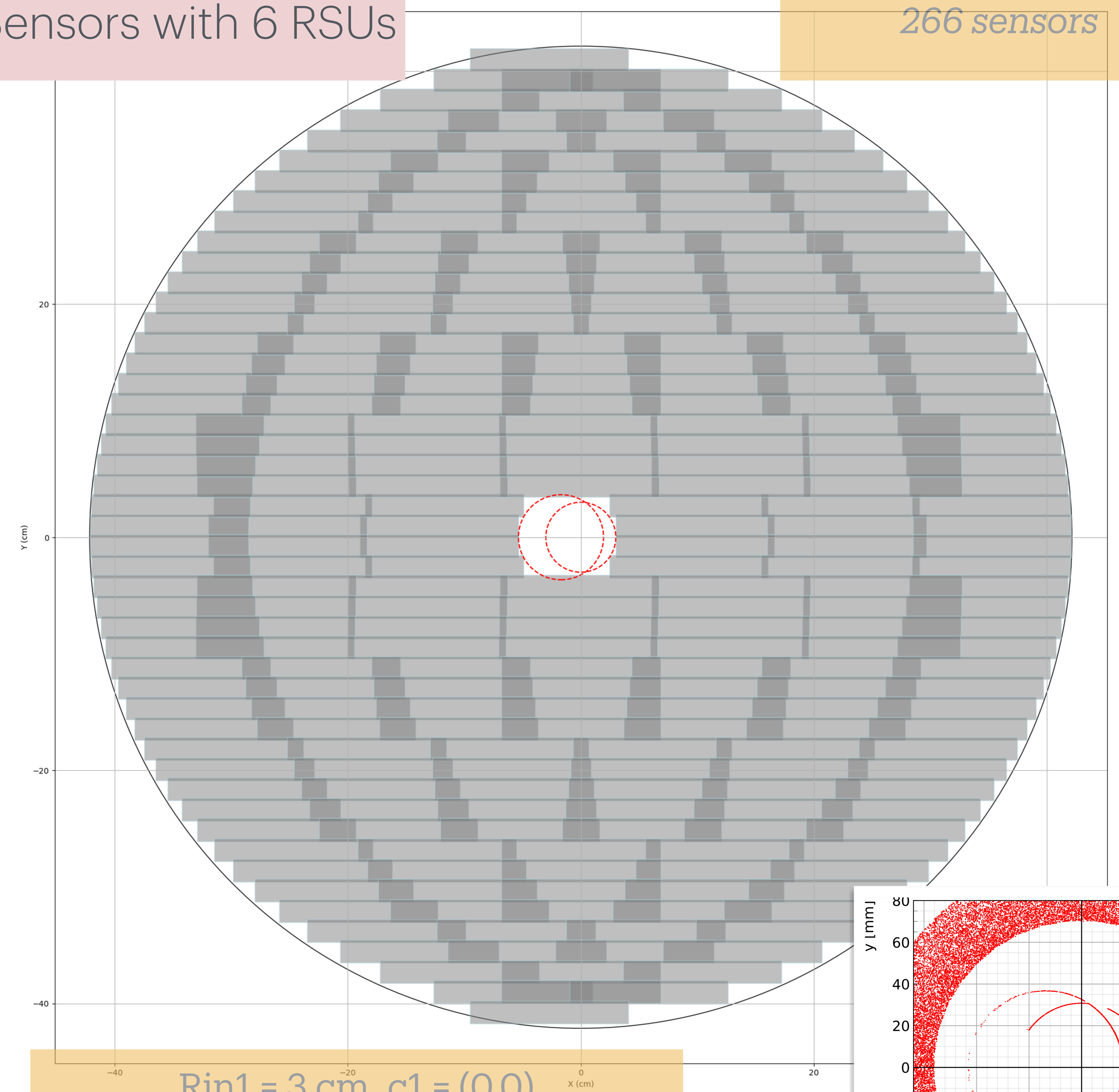
Rin1 = 3 cm, c1 = (0,0)
Rin 2 = 3.25 cm , c2 = (-0.75,0)

Rout = 42.14 cm



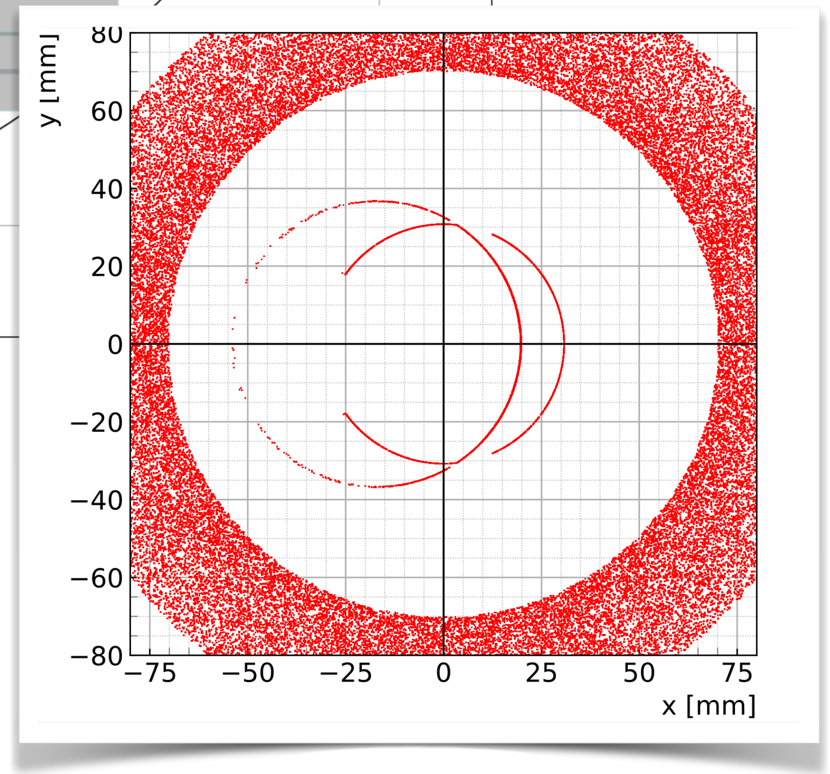
Sensors with 6 RSUs

266 sensors



Rin1 = 3 cm, c1 = (0,0)
Rin 2 = 3.65 cm , c2 = (-1.7,0)

Rout = 42.14 cm



Corrugated core

- At least three relevant dimensions; pitch, height, and angle — others include length, thickness, ...
- The sensor has a width w (= 19.564 mm for MOSAIX and EIC-LAS),
- p and w (times two) are not necessarily equal, although they are coupled,
- p = 34.77 mm; h = 6 mm; θ = 45° in preceding slides,

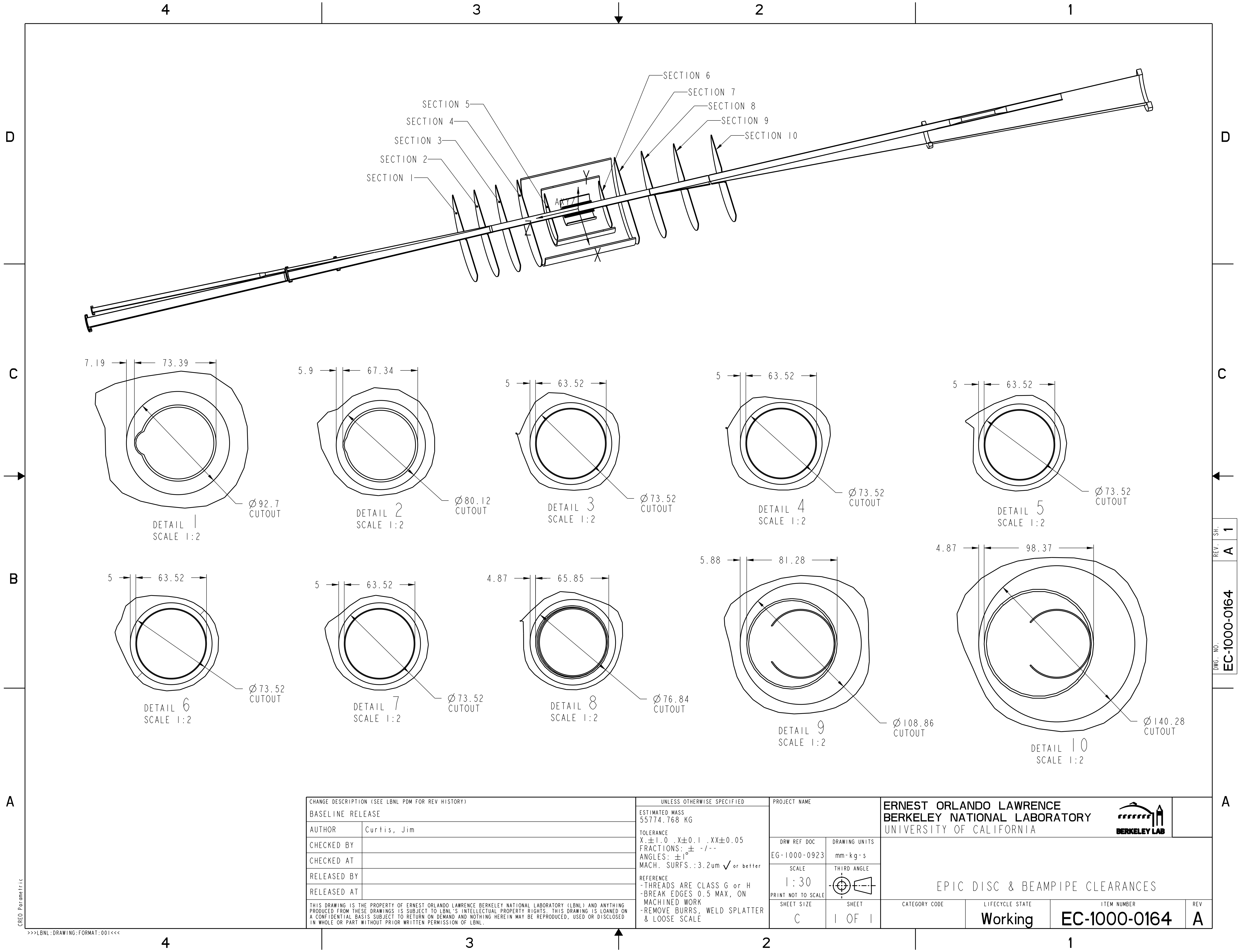
Corrugated core

- Four arrangements of sensor — inward/outward facing; front/back face — allow for overlaps,
- The sensor has a total width w (= 19.564 mm for MOSAIX and EIC-LAS),
- 0.525 mm is insensitive on both sides of MOSAIX, which puts a floor on o ($o > 0.525$ mm),
- $p = 34.77$ mm implies that $o > 0.525$ mm is satisfied ($o = 2.179$ mm), but is also a “historical choice”,
- Reasonable ranges for h and θ are ~4 mm < h < ~6 mm and $30^{\circ} < \theta < 60^{\circ}$

Corrugated core

- Tracks and an angle in combination with the finite disk thickness can escape detection,
- This is a larger effect than that from inactive areas, since the incident track angles can be 45^{o}
- Need to ensure acceptance for tracks originating from primary and (nearby) secondary vertices,
- Accounting for this effect by shifting the sensor Is preferred over increasing o (/ channel count),

Beam pipe opening



- p and w are coupled to tiling around the beampipe,
- Even number of sensor rows in the preceding slides to clear the bermpipe is not a hard requirement,

- Aside, CAD and MC need to be cross-checked.

Closing comments

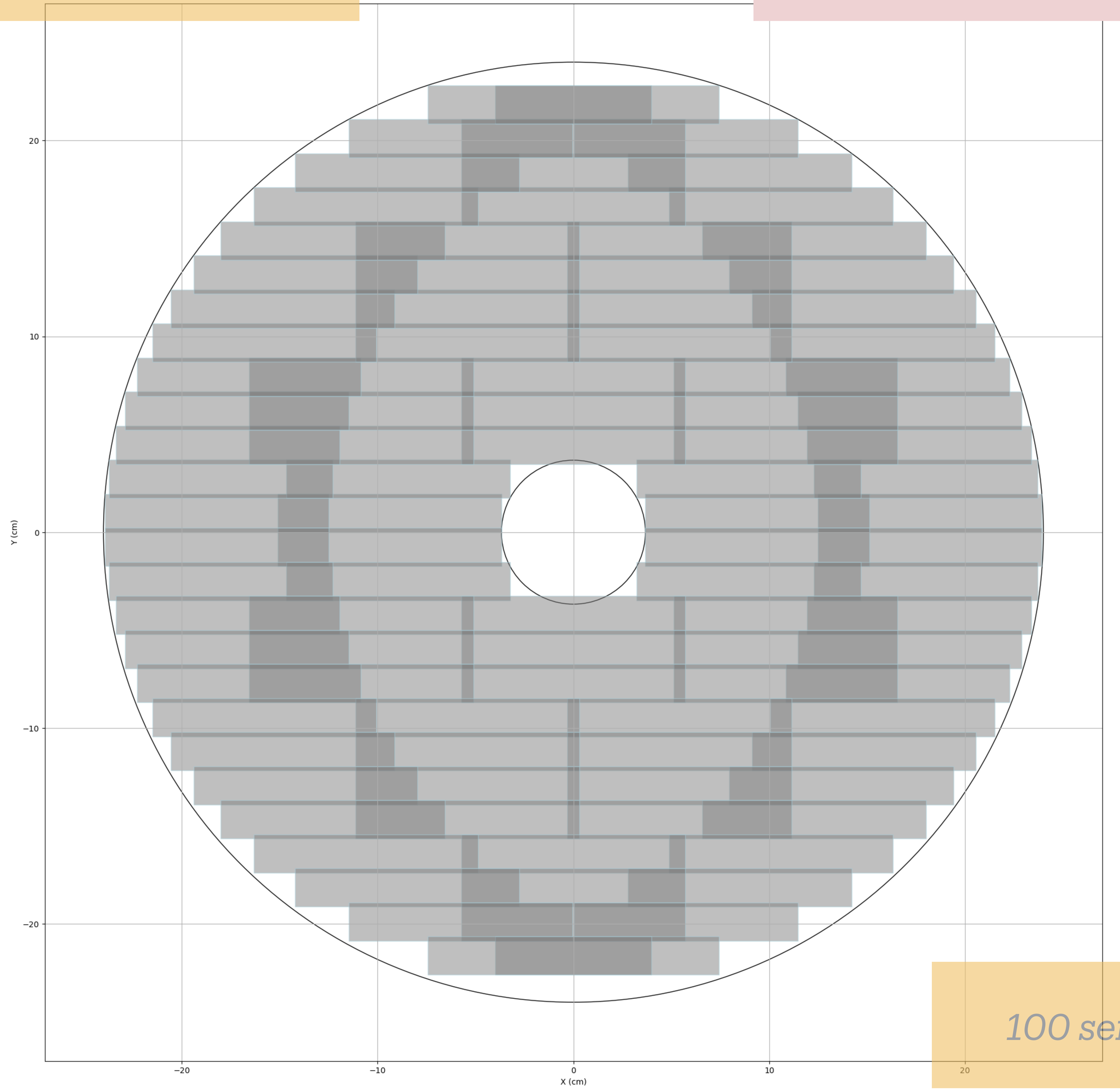
- There are multiple ways to tile a disk,
- We have chosen to tile in rows; prior studies included e.g. a crucifix and herringbone configurations
- EIC-LAS is limited to two variants with 5 or 6 RSUs,
- Disks can make use of either or both variants,
- Rows within disks should best use one variant (efficiency of the serial powering chains),
- Tiling strategy that minimizes overlap along the length of the sensor in the inner region ensures that the distance between Left EndCaps is constant in the inner region; this presents a significant simplification of the electrical interfaces (FPCs)
- This tiling strategy accommodates overlap at the outermost EIC-LAS; *if* the FPC Interface Board can be designed to accept an FPC for the innermost sensors and a separate FPC for the outermost sensor, we can likely simplify the FPC design for the innermost sensors,
- We are wrapping up the remaining loose ends; the trade-offs between p, o, and bermpipe clearances being most relevant.

Discussion time!

New paving - zone 2 extended, zone 3 removed

Rin = 3.676 cm
Rout = 24 cm

Sensors with 5 RSUs

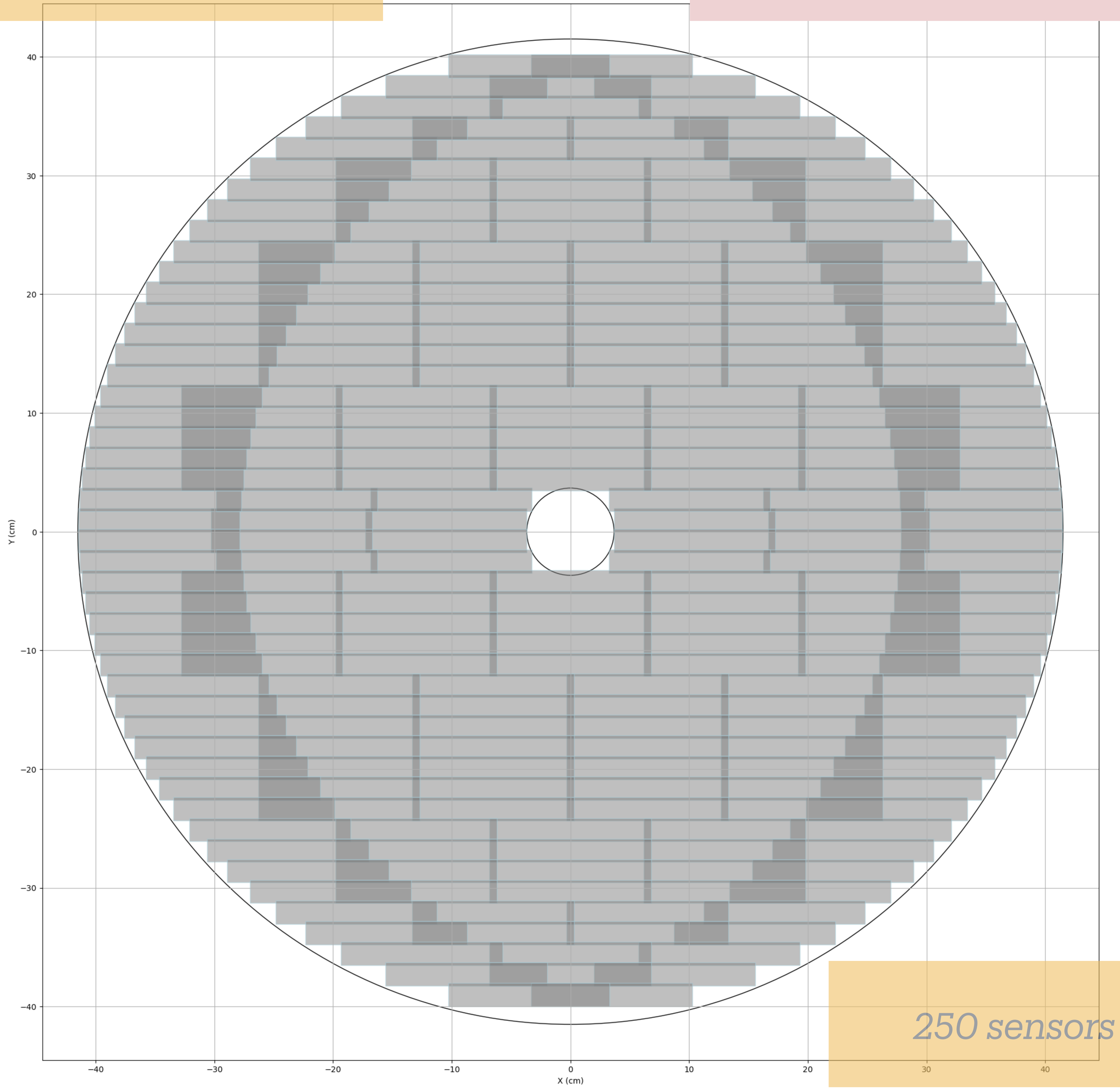


100 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE/HE	ED0/ HD0	-250	36.76	240	0.24%

Rin = 3.676 cm
Rout = 41.5 cm

Sensors with 6 RSUs



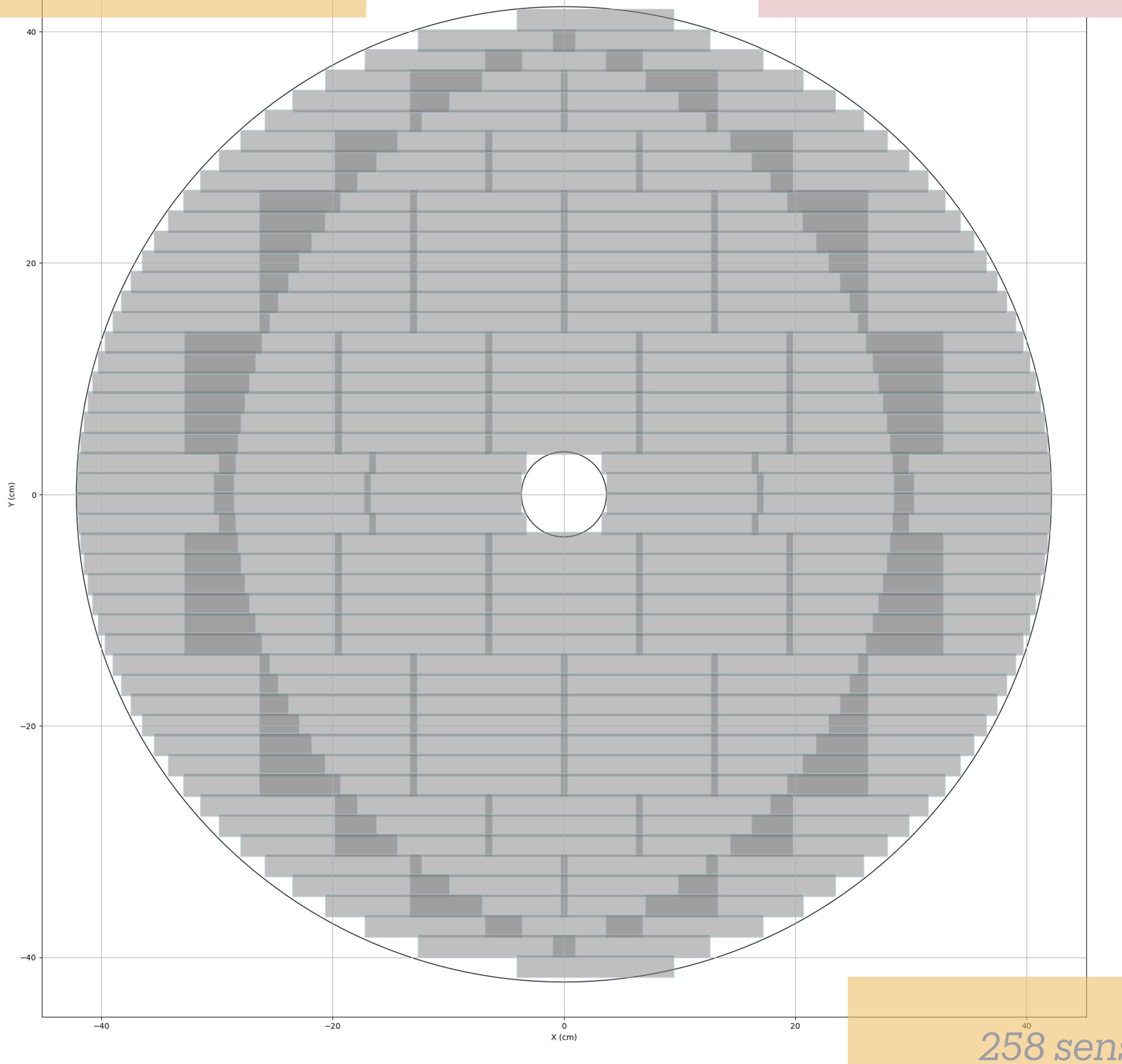
250 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE/HE	ED1/ HD1	-450	36.76	415	0.24%

ED2 and ED3

Rin = 3.676 cm
Rout = 42.14 cm

Sensors with 6 RSUs

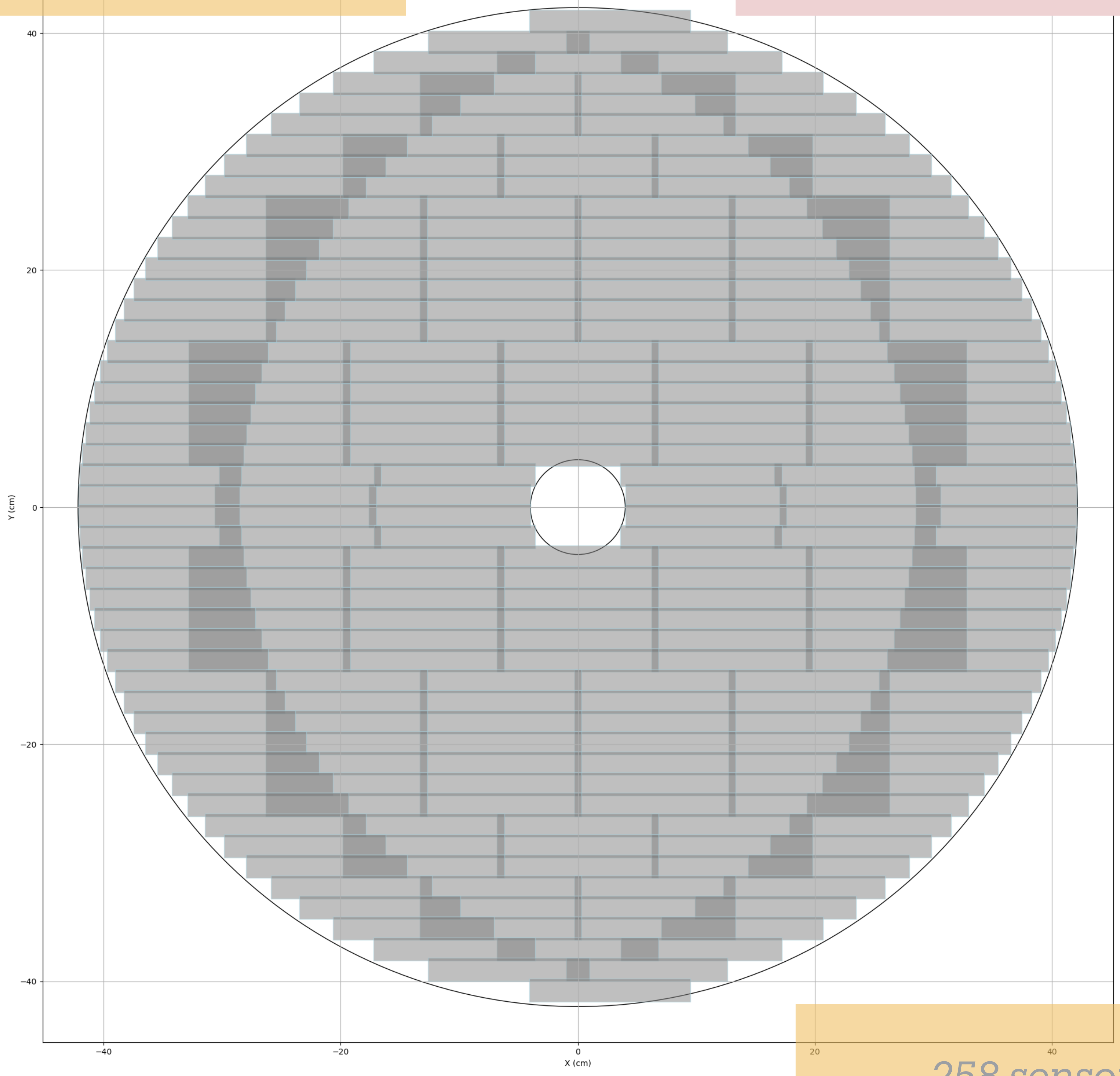


258 sensors

Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE	ED2	-650	36.76	421.4	0.24%

Rin = 4 cm
Rout = 42.14 cm

Sensors with 6 RSUs



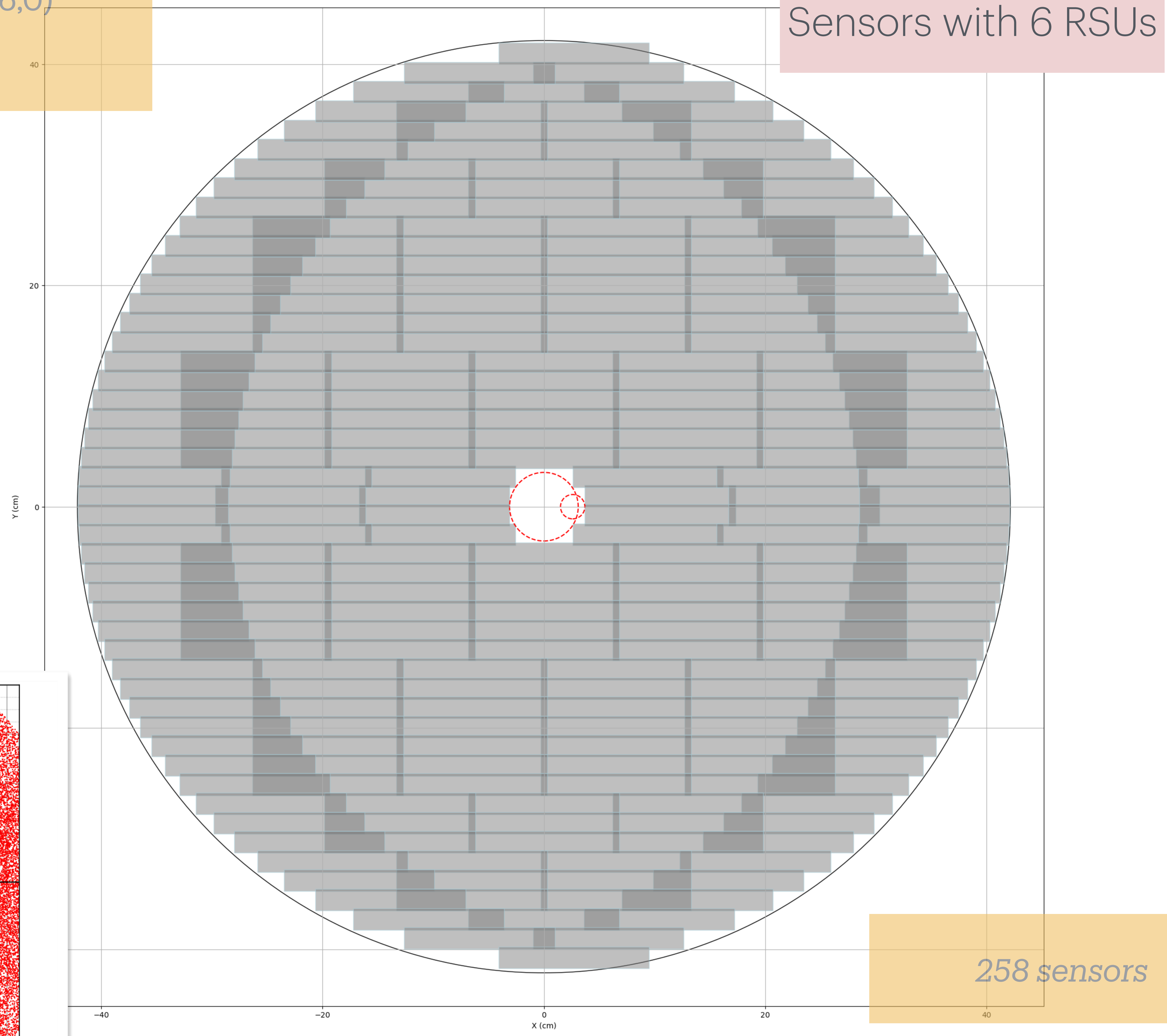
258 sensors

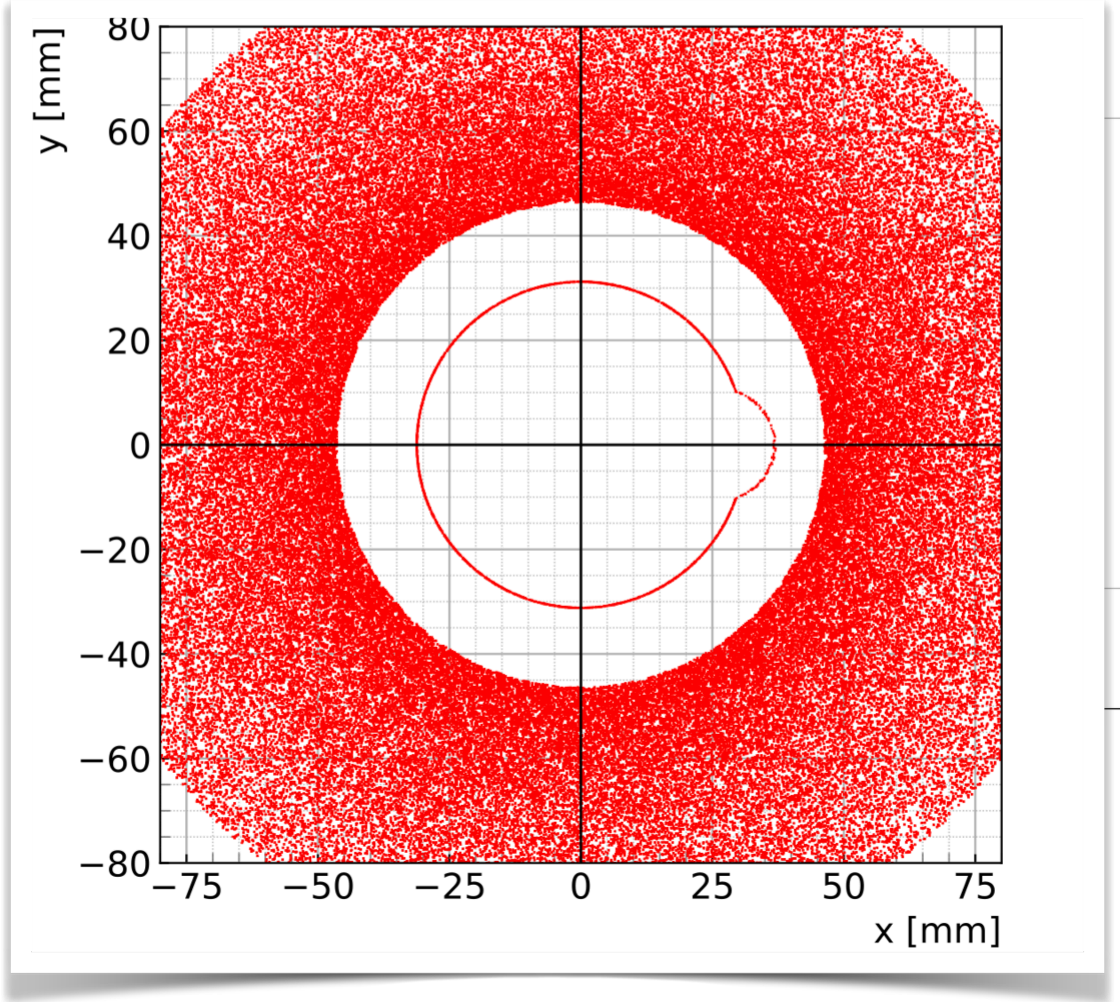
Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
EE	ED3	-850	40	421.4	0.24%

ED4

Rin1 = 3.1 cm, c1 = (0,0)
Rin 2 = 1.1 cm , c2 = (2.6,0)

Rout = 42.14 cm



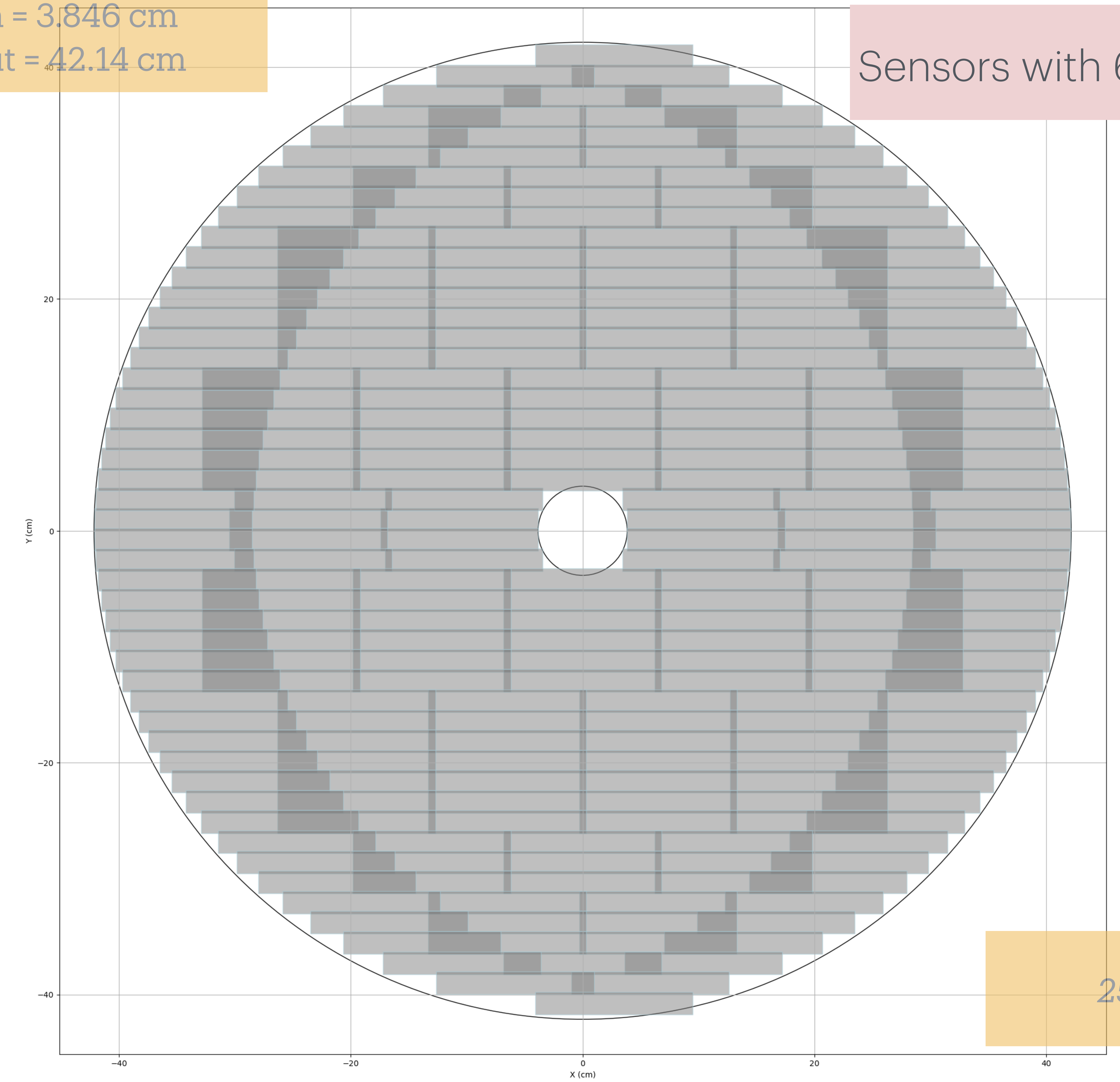


258 sensors

HD2

Rin = 3.846 cm
Rout = 42.14 cm

Sensors with 6 RSUs



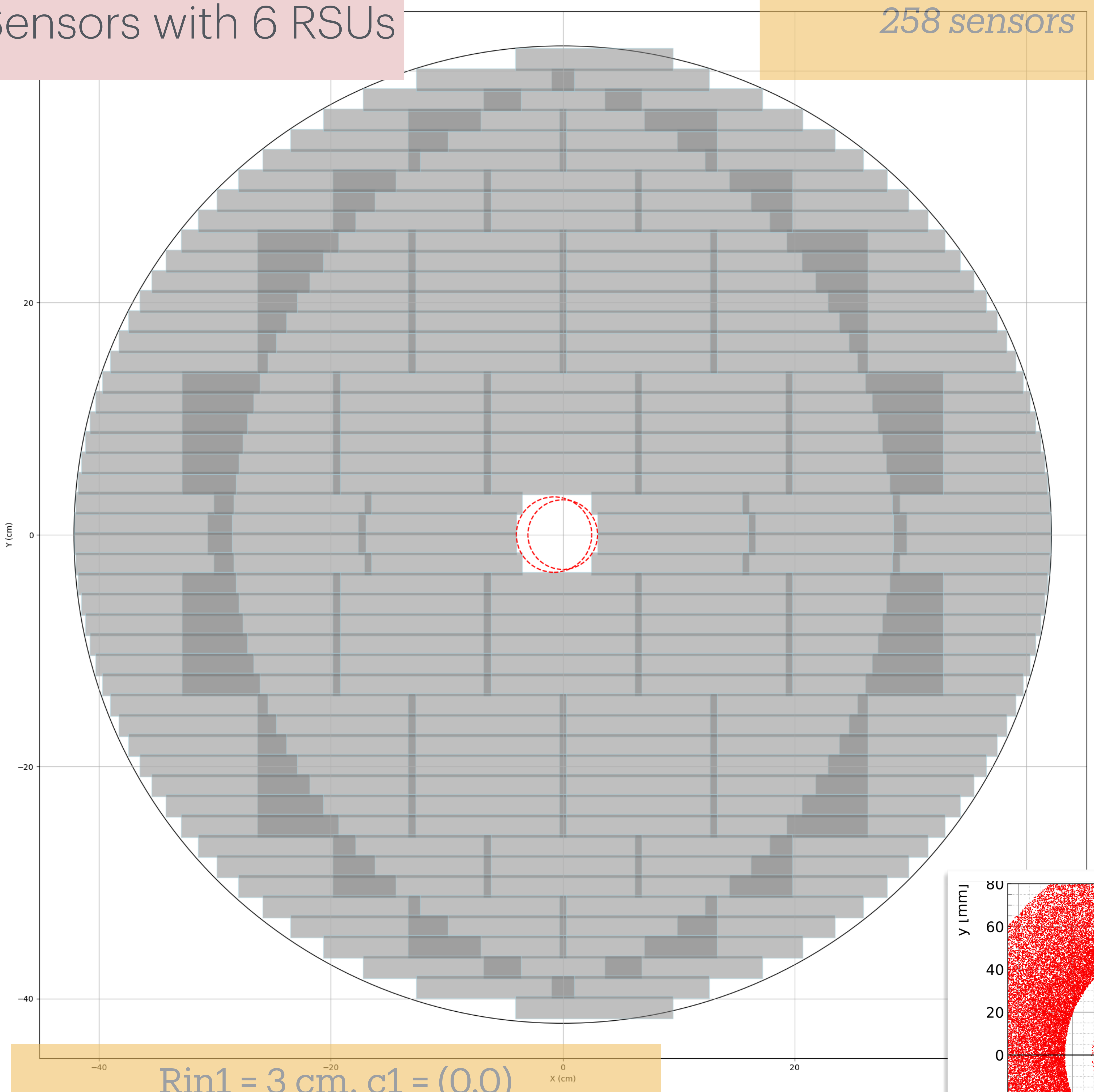
258 sensors

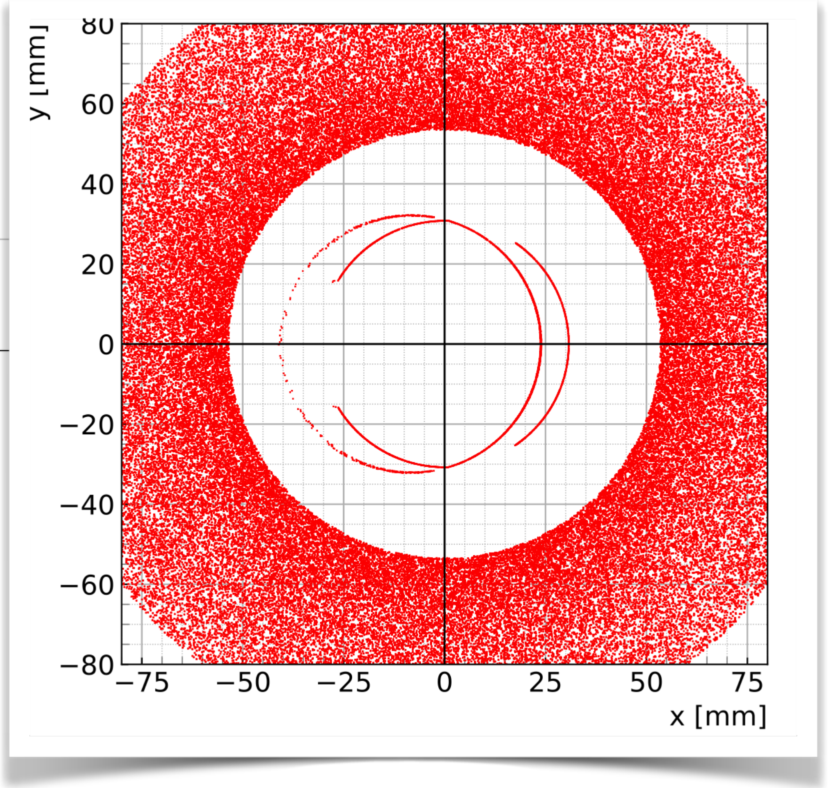
Region	Disk	z [mm]	inner radius* [mm]	outer radius [mm]	X/X0
HE	HD2	700	38.46	421.4	0.24%

HD3 and HD4

Sensors with 6 RSUs

258 sensors



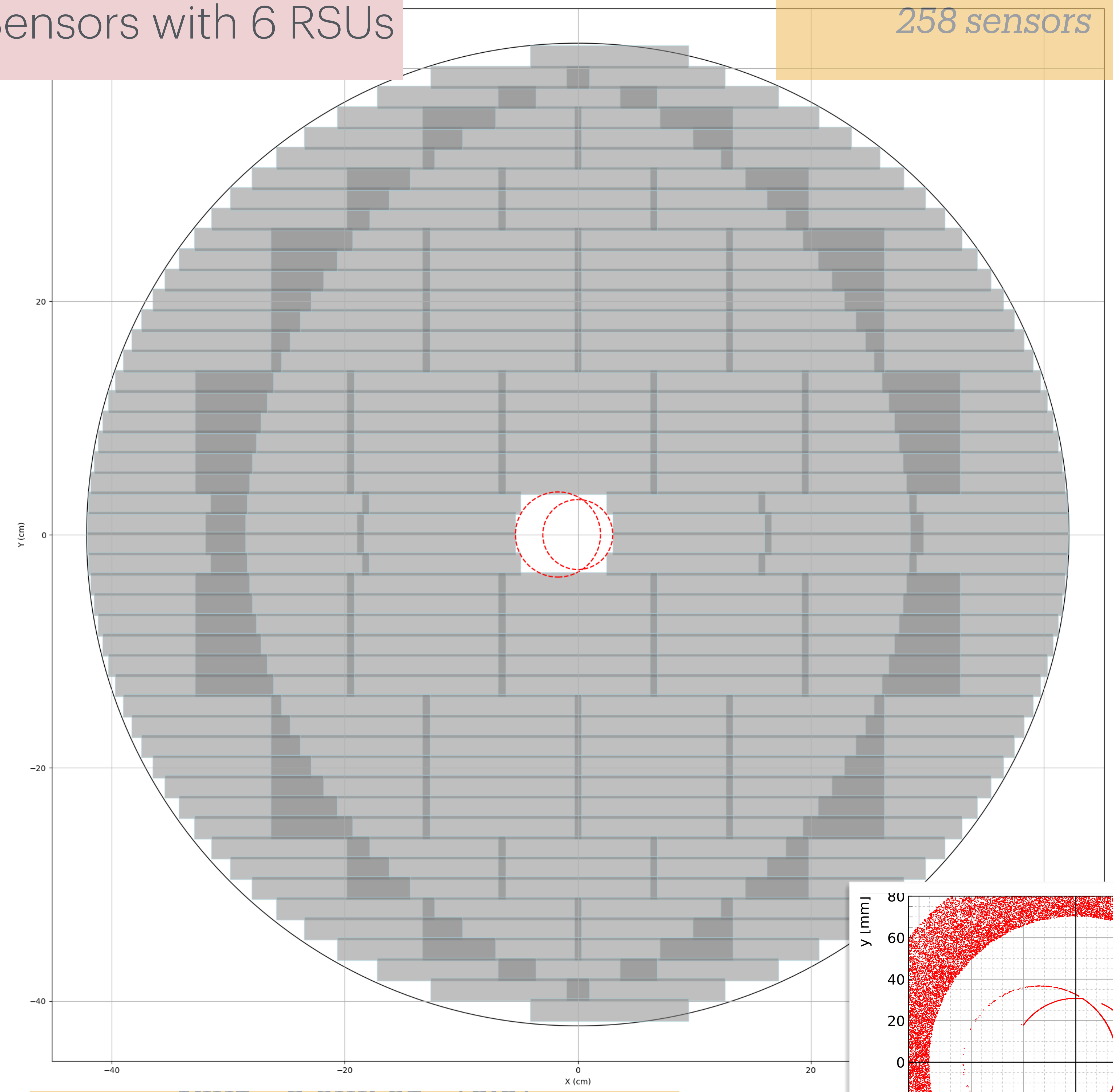


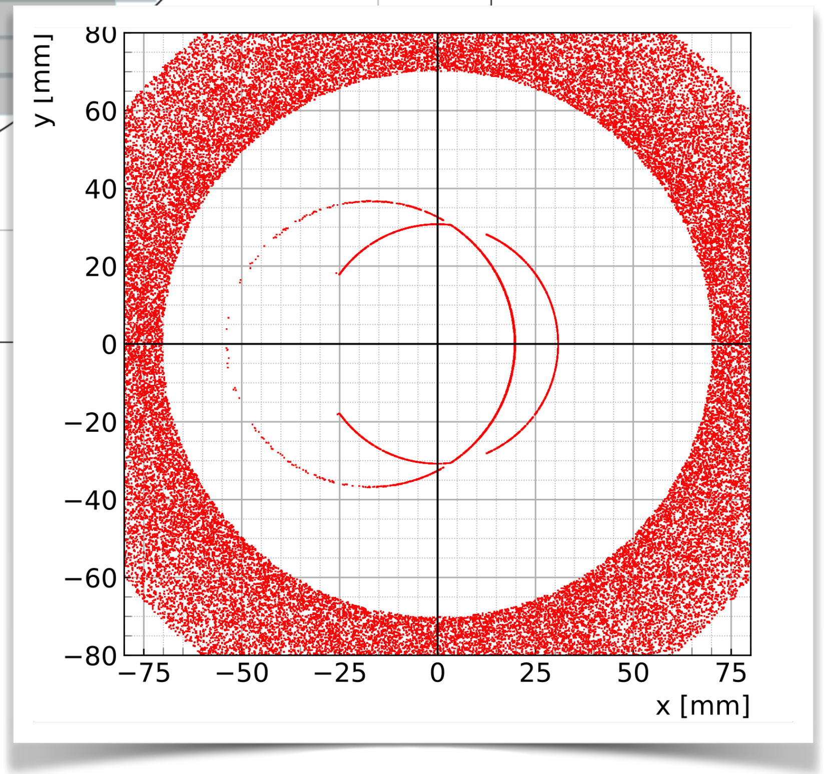
Rin1 = 3 cm, c1 = (0,0)
Rin 2 = 3.25 cm , c2 = (-0.75,0)

Rout = 42.14 cm

Sensors with 6 RSUs

258 sensors





Rin 2 = 3.65 cm , c2 = (-1.7,0)

Rout = 42.14 cm