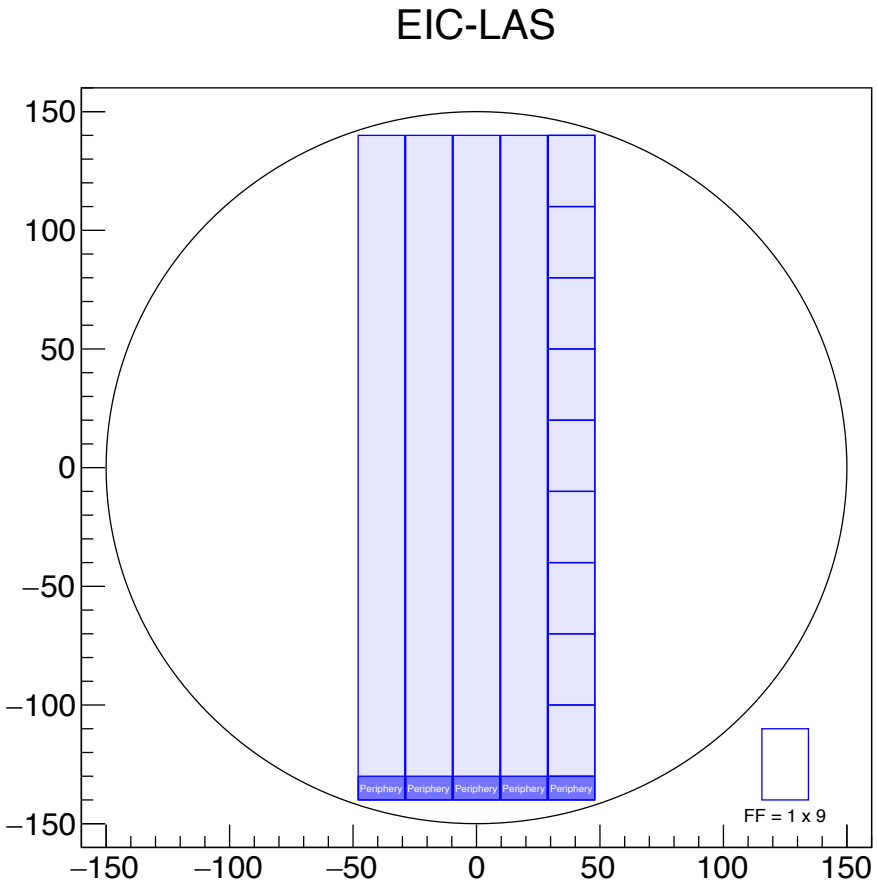
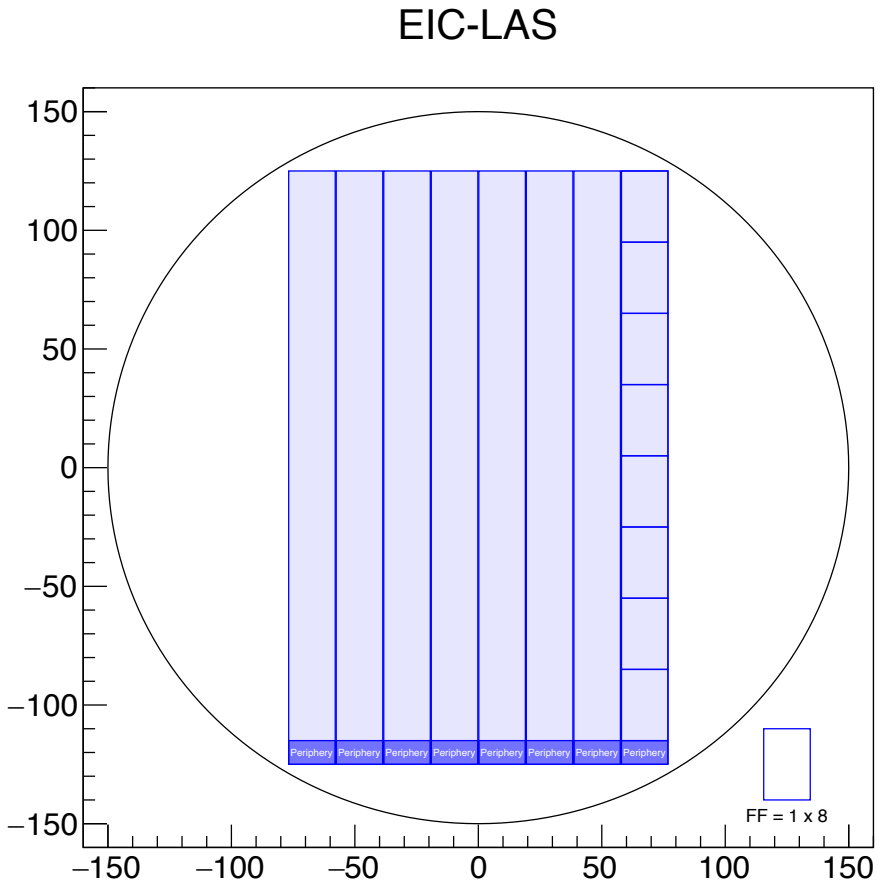
ePIC Silicon Disks

- Sensor requirements
  - Requires smaller format sensors for improved yield and tiling flexibility
  - Multiple sensor formats needed – changes to stitching plan & periphery
  - Studying optimum tiling geometry
    - Location of periphery informs design of cooling circuit
    - Layout informs material budget (e.g. sensor overlaps)
    - Both aspects needed for detailed mechanical design
    - Study will also inform cost of silicon
  - Assume 5 disks in +z and –z
    - See Ernst Sichtermann: https://indico.bnl.gov/event/16261/ from 23 June
  - Take care of the offset between the centre of the beam pipe from the nominal beam line away from the IP
  - Not a completely trivial problem, so write some code to make study easier and to explore different options
  - This is not the final word but a starting point for further discussion

EIC LAS – Wafer Usage



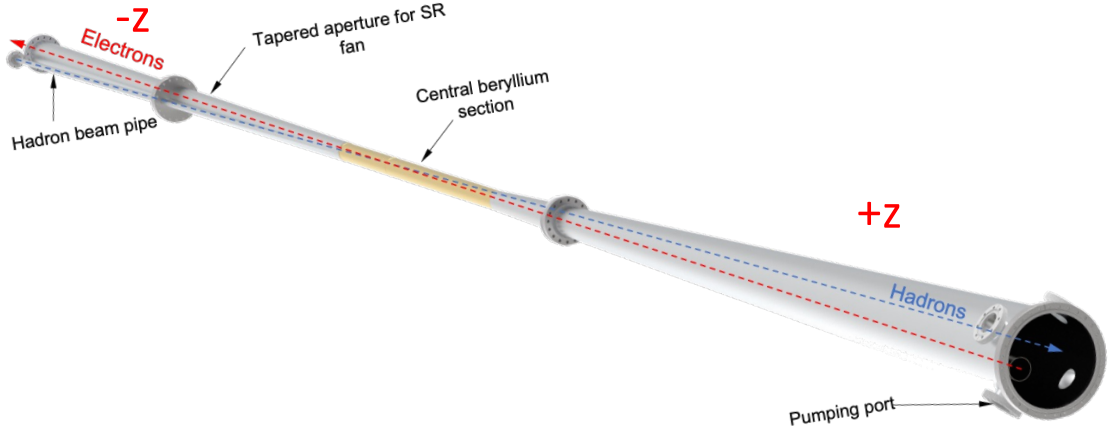
Max 5 (1 x 9) sensors per wafer
45 reticles

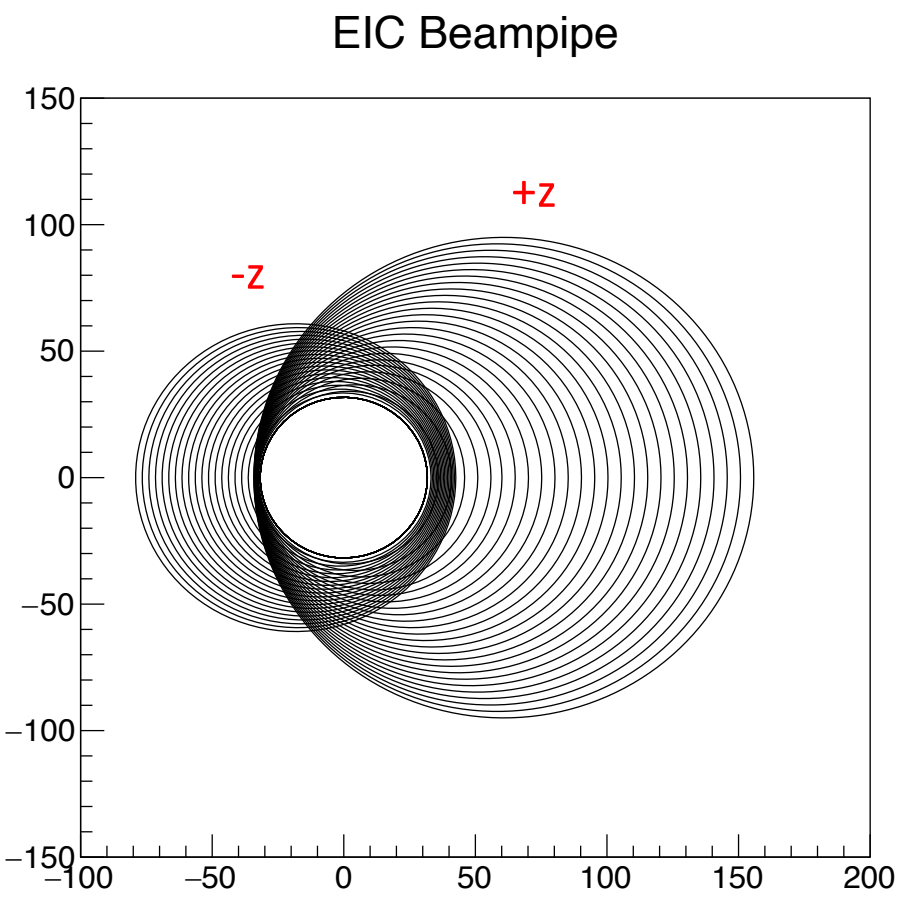


Max 8 (1 x 8) sensors per wafer
64 reticles

How many sensors of each type are needed?

Beam pipe model





Beampipe profile; 100 mm steps

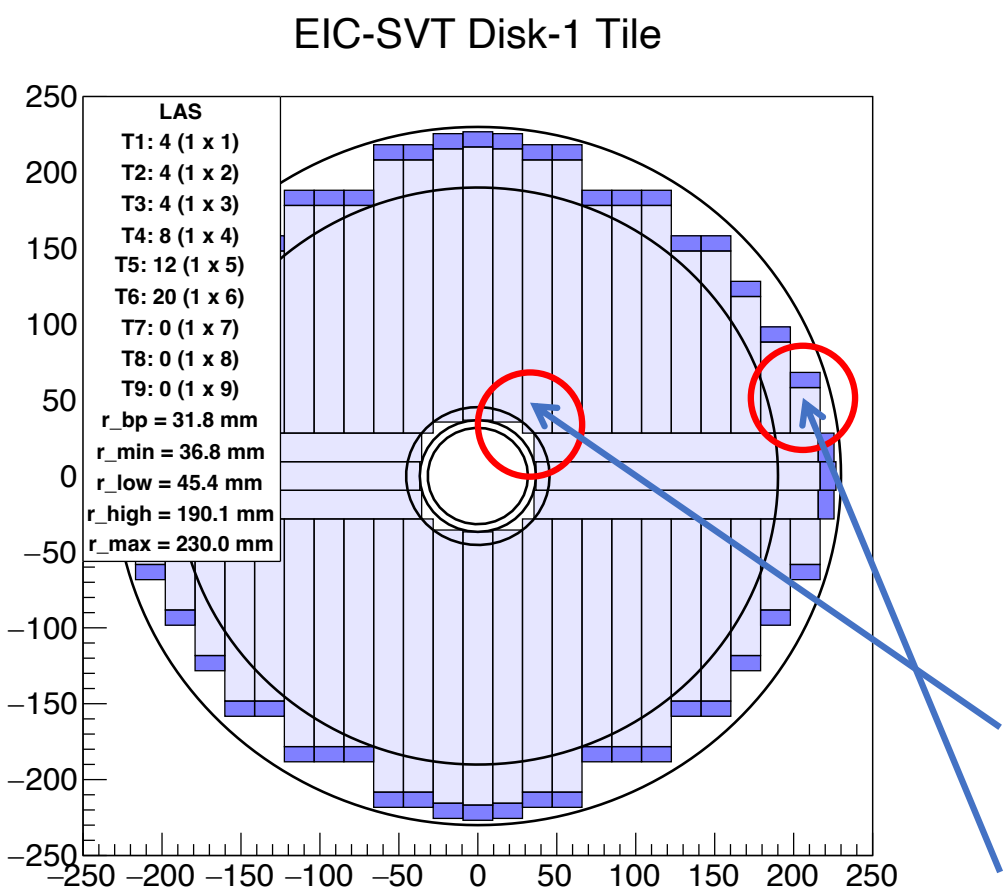
Model output

The beam pipe radius has been modelled as a function of z from the original CAD drawings

	Z - ePIC	R_bpipe	x_offset	R_inner	R_outer
5n	-1350	41.08	-5.30	46.1	430
4n	-1000	35.76	-1.81	40.8	430
3n	-700	31.76	0.00	36.8	430
2n	-450	31.76	0.00	36.8	430
1n	-250	31.76	0.00	36.8	230
1p	250	31.76	0.00	36.8	230
2p	450	31.76	0.00	36.8	430
3p	700	32.86	0.56	37.9	430
4p	1000	40.58	7.85	45.6	430
5p	1350	49.12	16.02	54.2	430

Dimensions are mm

Disk tiling algorithm



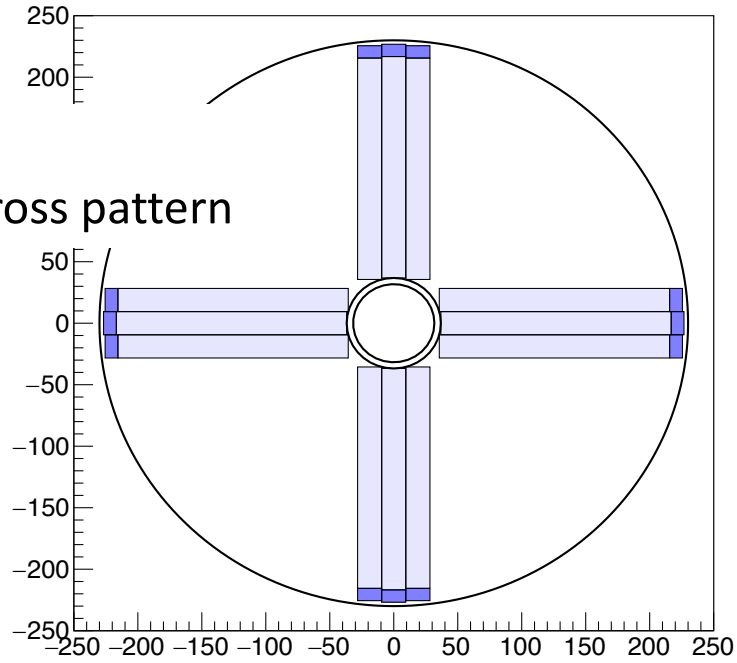
z = +/- 250 mm

Central cross = 3 sensors

The algorithm

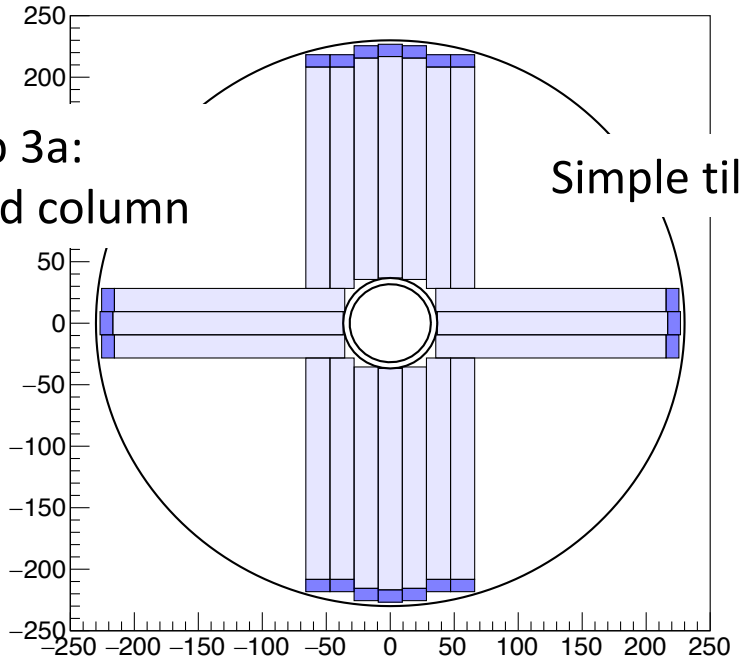
- Try to keep periphery to larger radii
- Two designs, each based on a central cross pattern smaller than the inner diameter of the disk
- Design #1 = vertical tiles (shown)
- Design #2 = herringbone pattern (alternating vertical and horizontal tiles)
- The minimum disk radius (r_min) is 5 mm larger than the beam pipe radius (r_bp) for bake out
- Sensor and periphery must be contained within the min and max radii of the disk (r_min and r_max).
- For each disk, the algorithm calculates the smallest and largest radii with full acceptance (r_low and r_high)
- The algorithm does not permit any sensor overlap
- Acceptance at small radii could be improved by allowing some sensor overlap; placing overlapping sensors on the reverse side of the disk (in progress)
- Limits on the max and min sensor length can be applied
- Study the number of sensor variants that are needed

Step 1:
Draw cross pattern

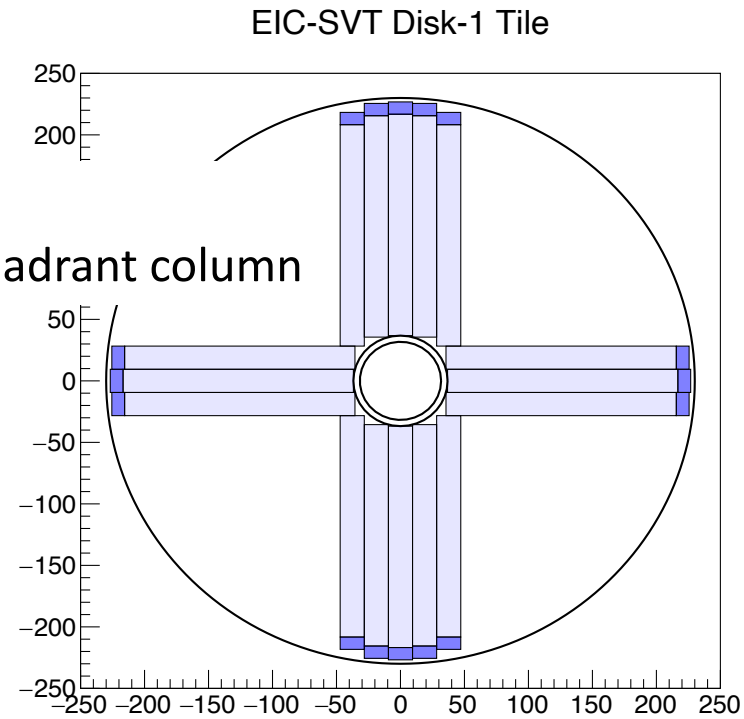


EITHER Step 3a:
Draw second column

Simple tile

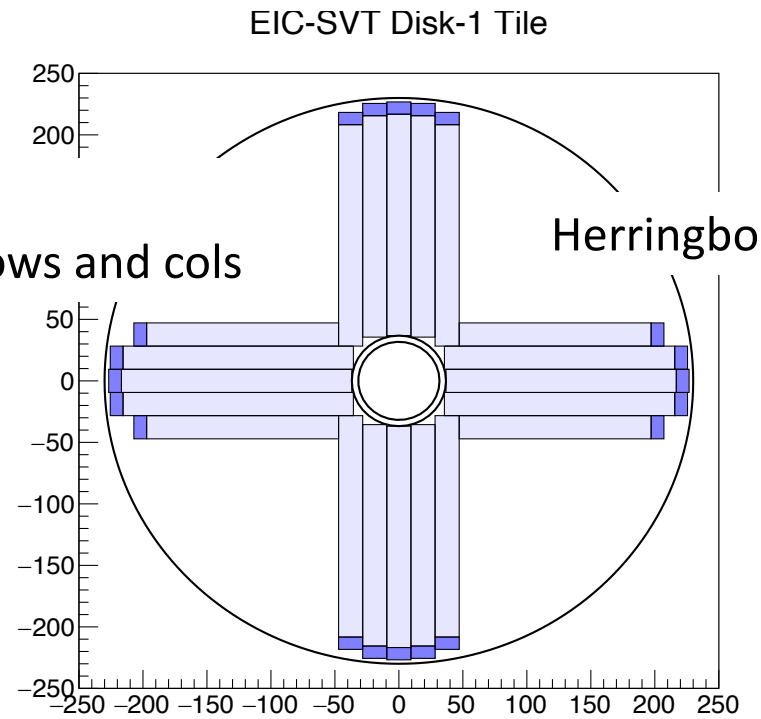


Step 2:
First quadrant column

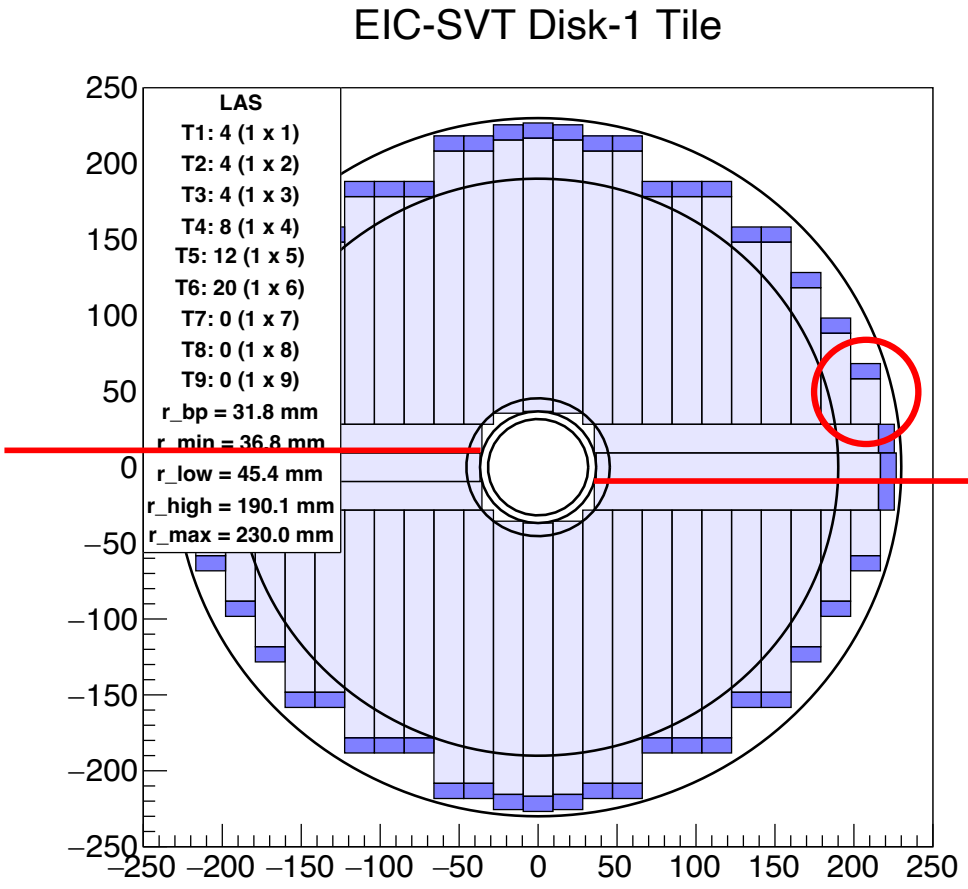


OR Step 3b:
Alternate rows and cols

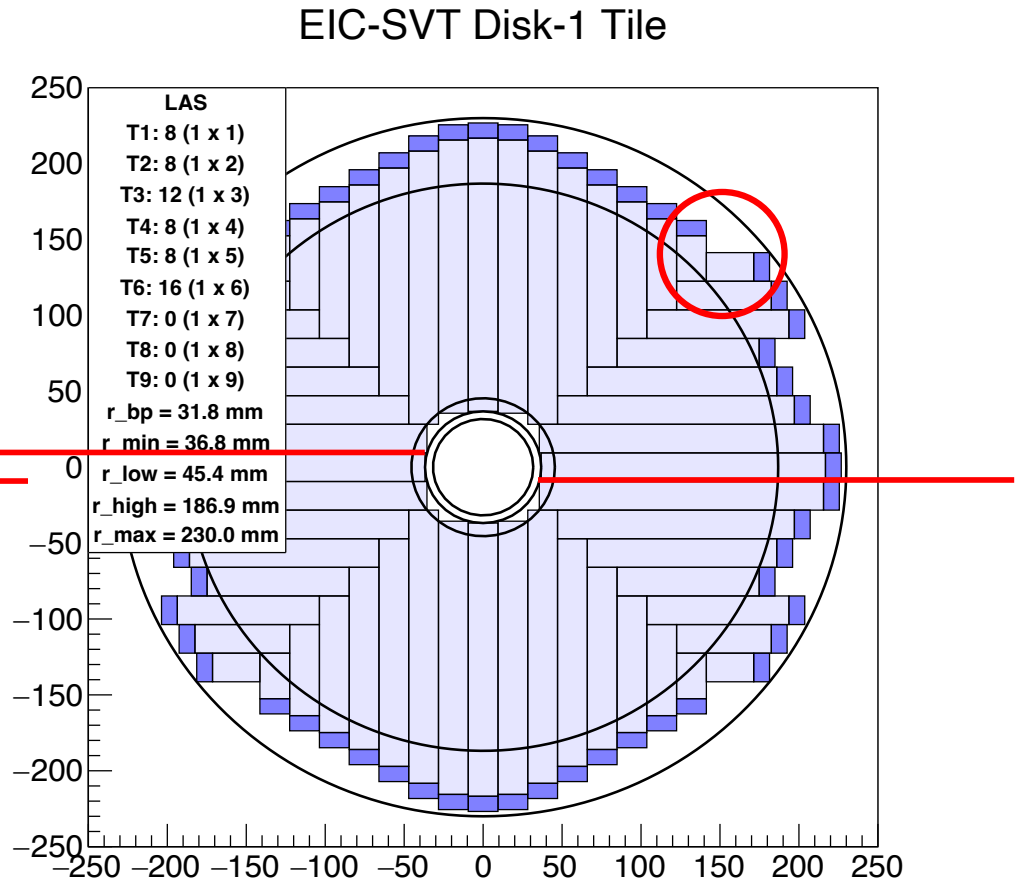
Herringbone



Disk 1

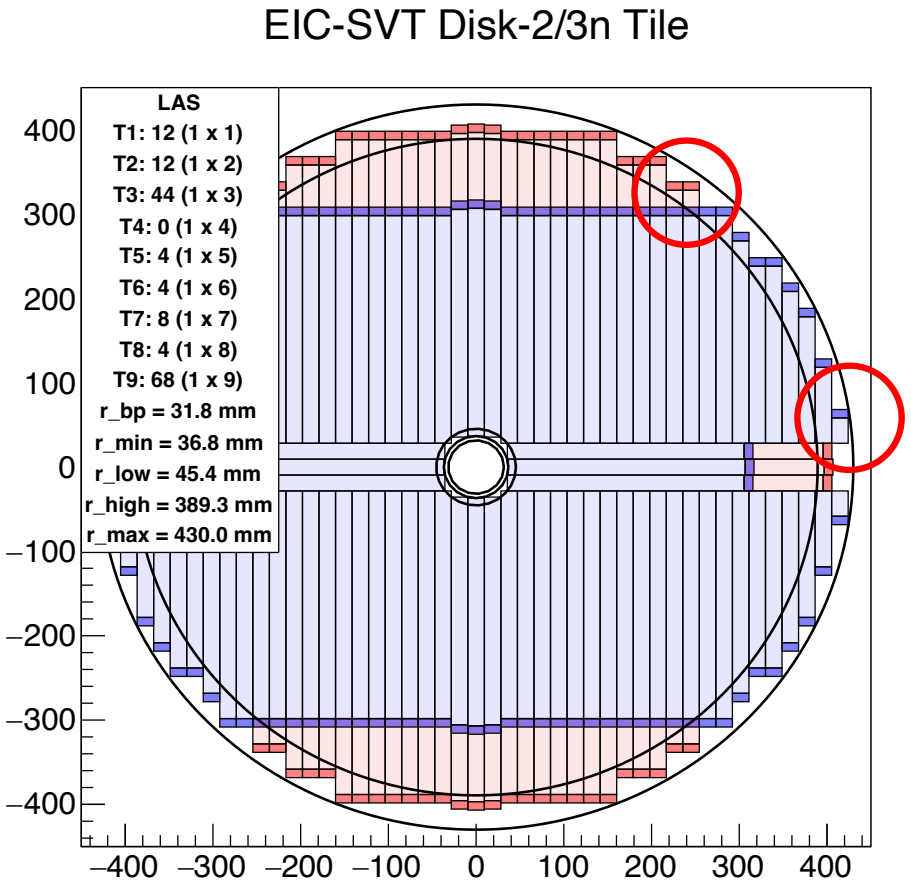


52 sensors
236 reticles

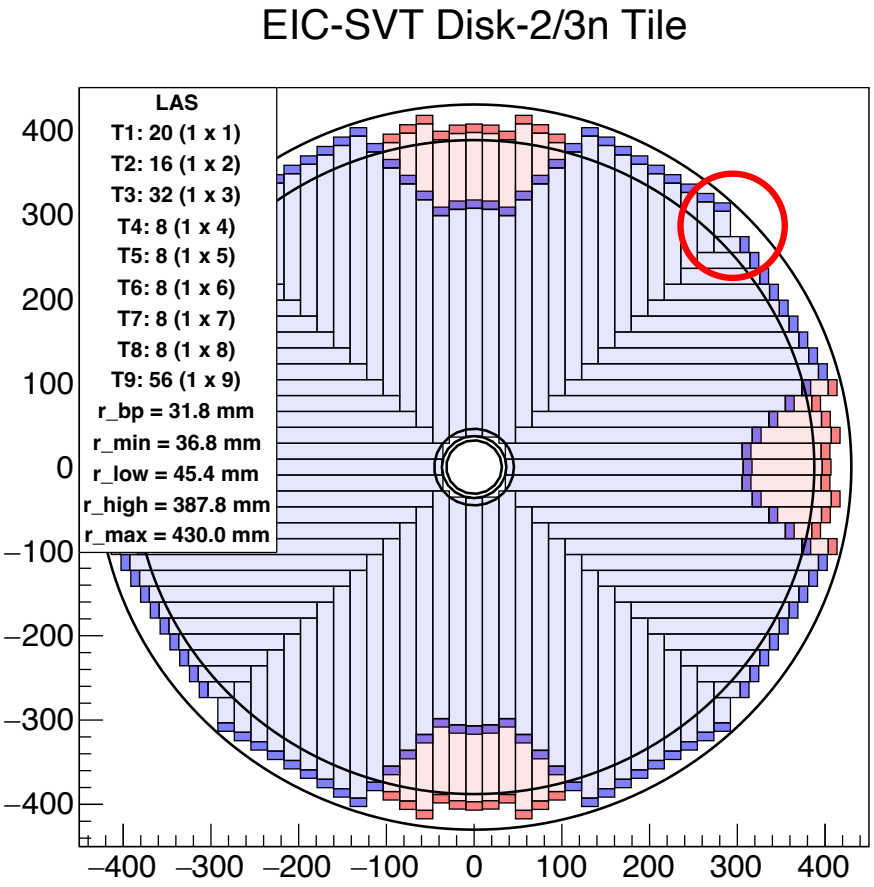


60 sensors
228 reticles

Disk 2/3n



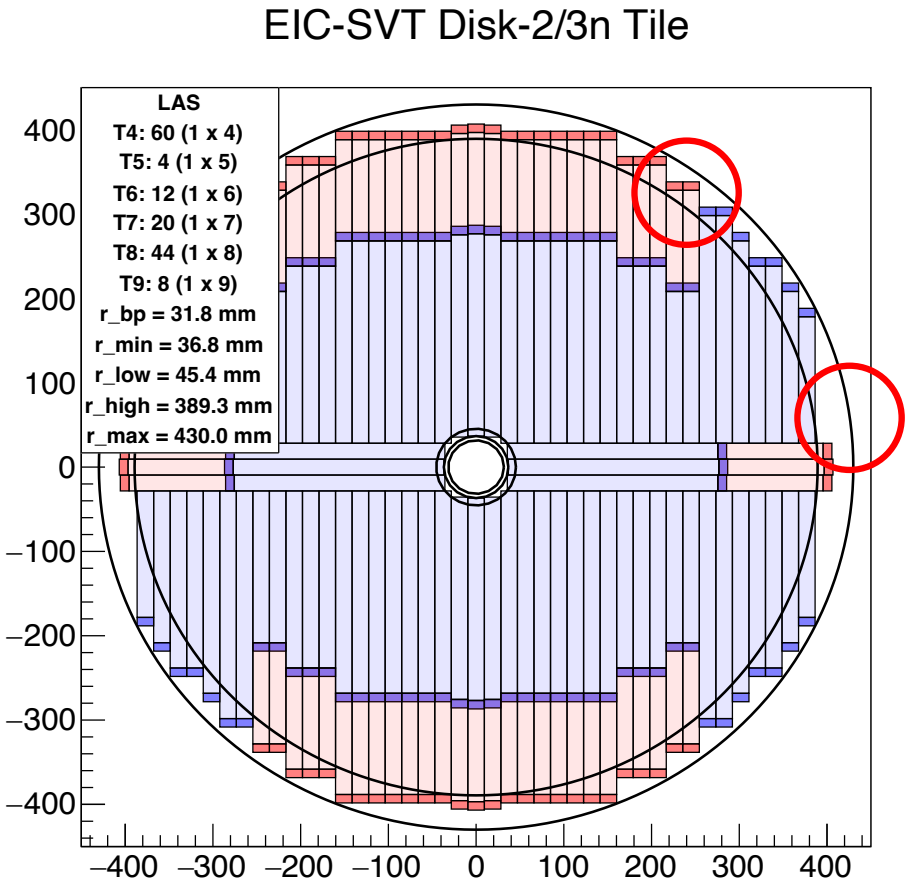
156 sensors
912 reticles



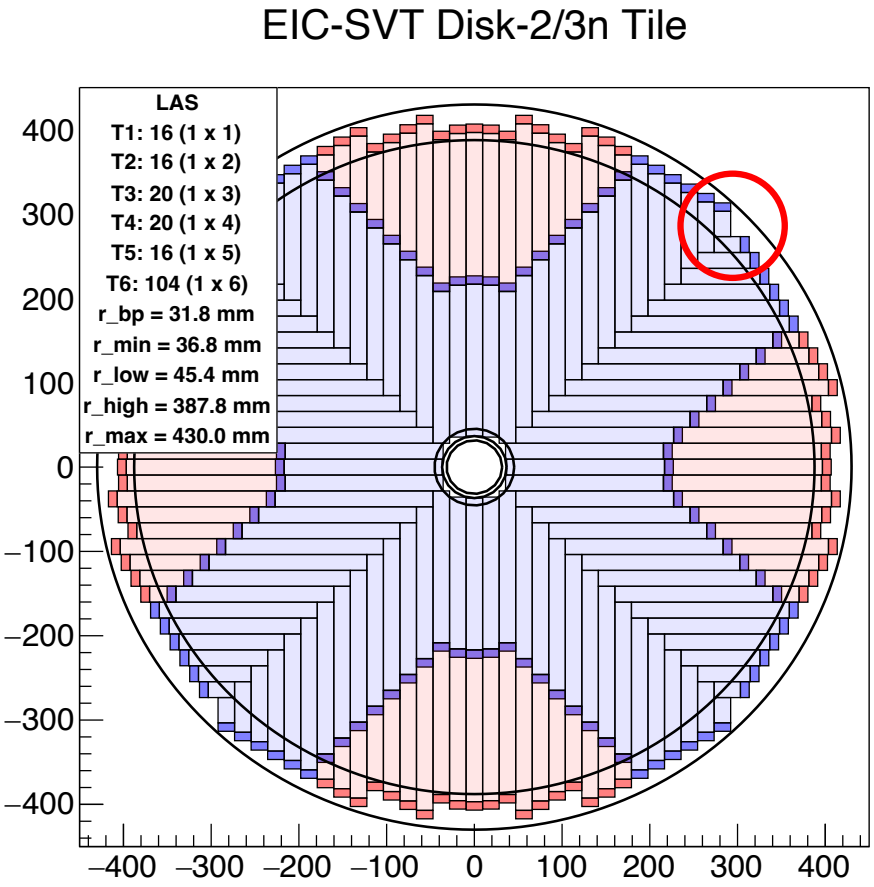
164 sensors
892 reticles

Note: Sensors in red on reverse side of disk
overlap digital periphery of inner sensors in blue

Disk 2/3n – restricting sensor size

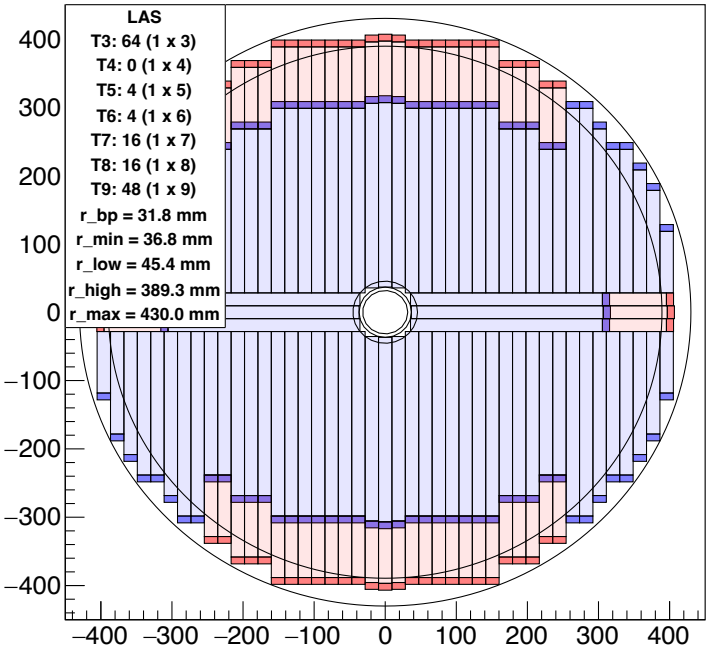


148 sensors
896 reticles
Fewer, longer sensors T4 – T9

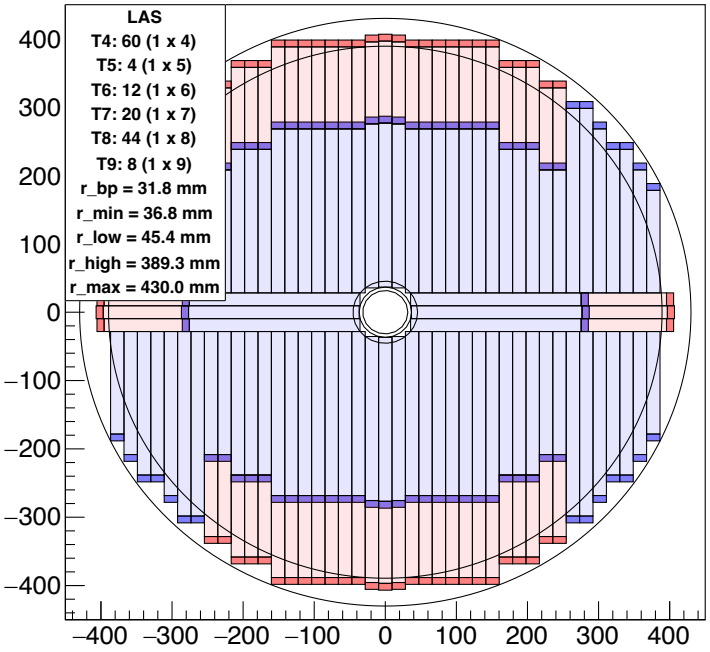


192 sensors
892 reticles
More, shorter sensors T1 – T6

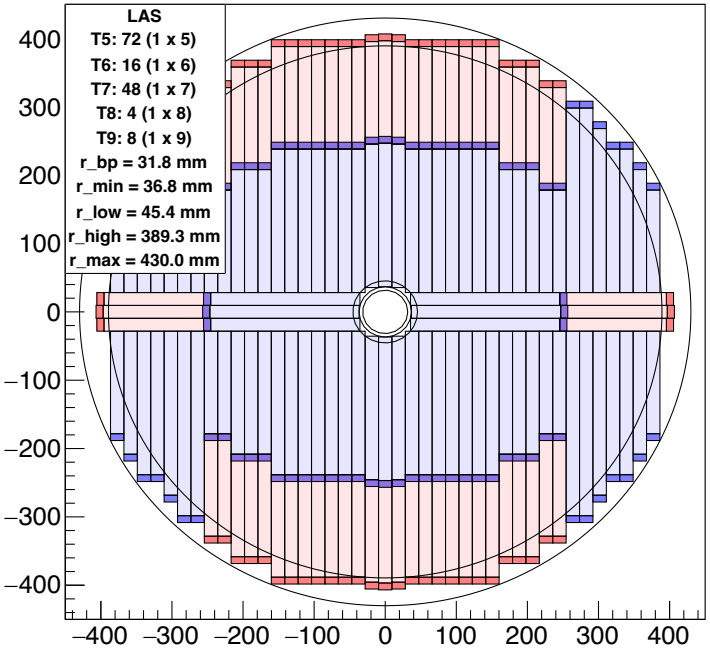
T3 – T9



T4 – T9



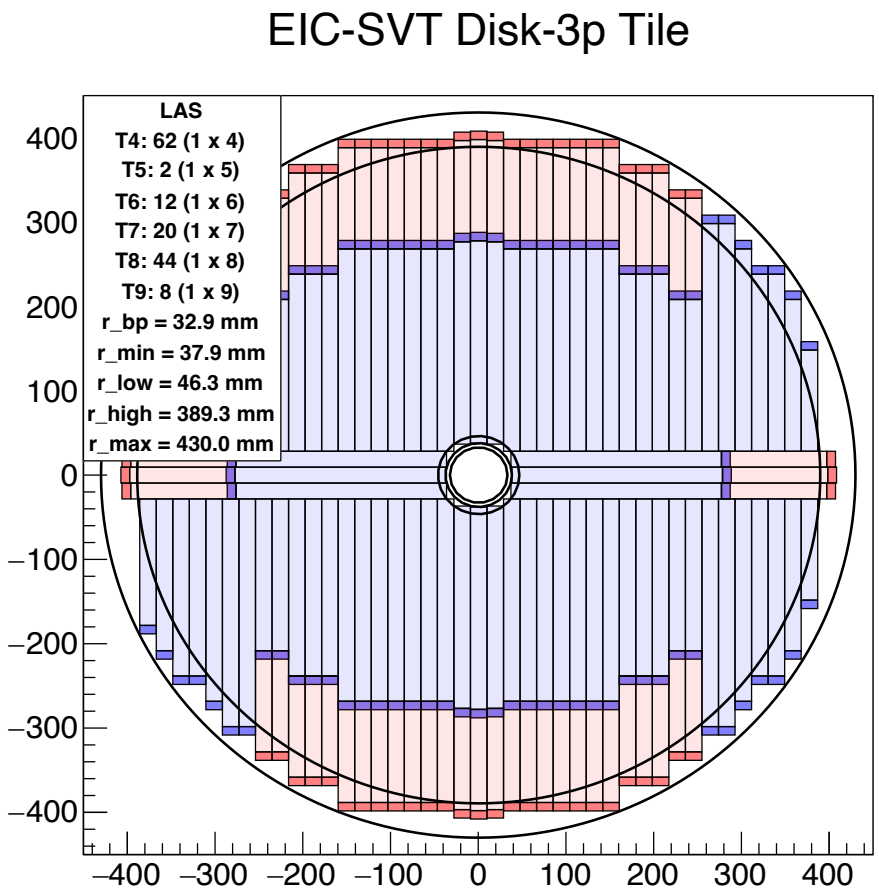
T5 – T9

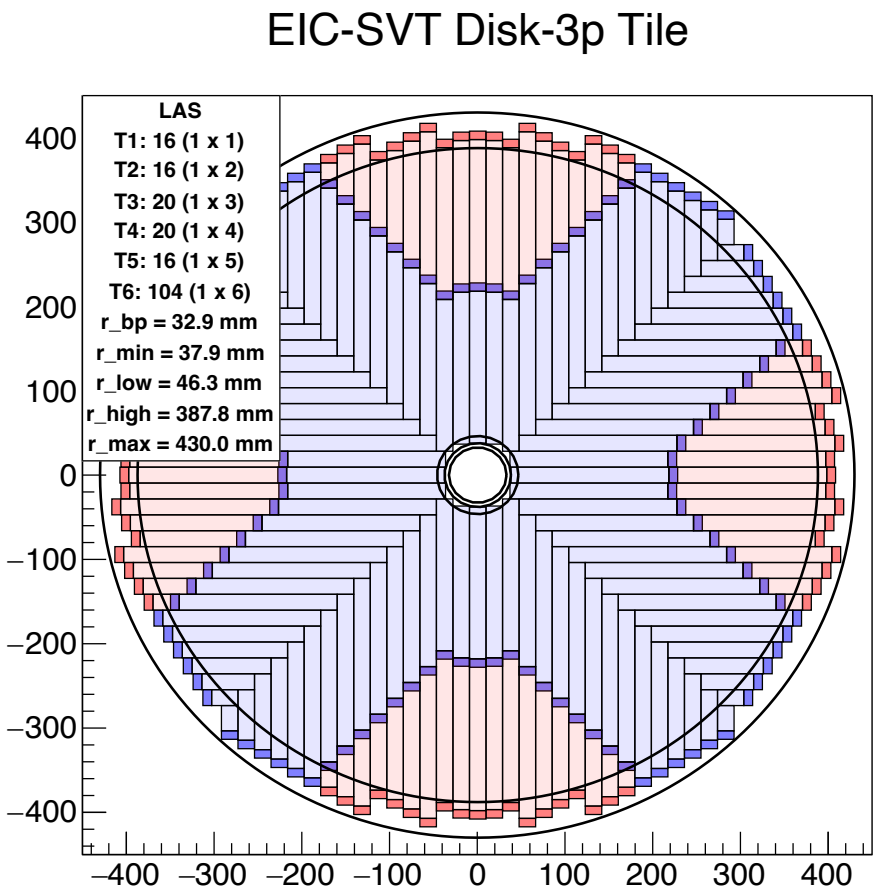


Greater prospect of reducing number of sensor types with the simple tiling design

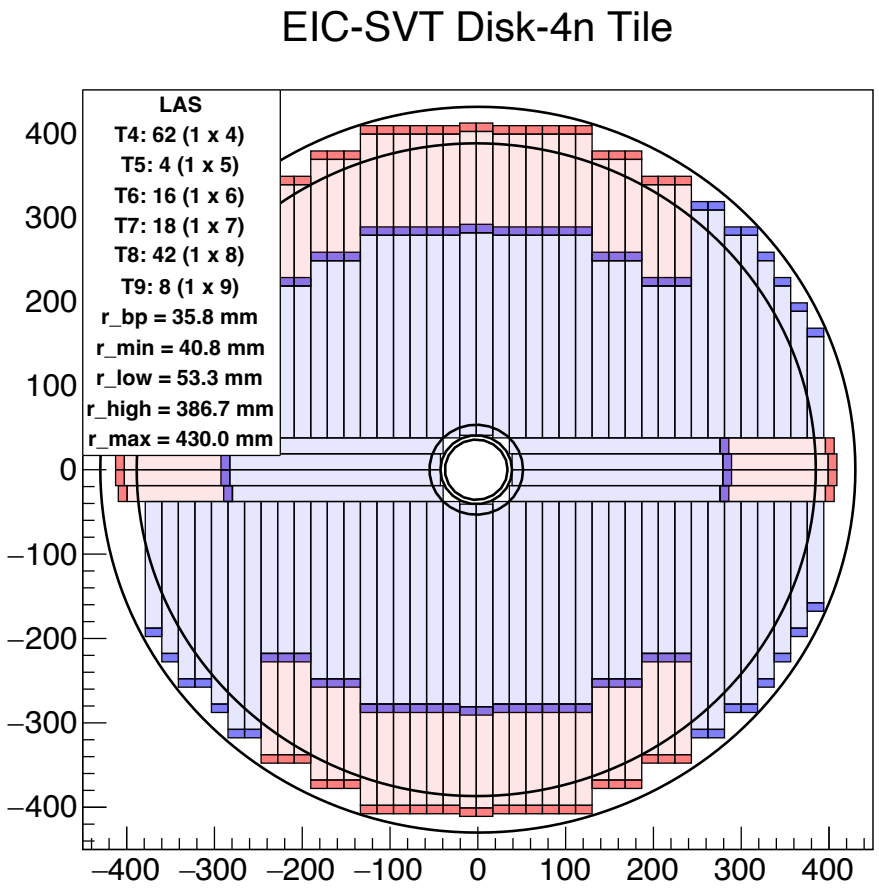
However, the reduction in sensor types pushes periphery inwards, adding material due to flex cables running over the outer sensors at larger radii

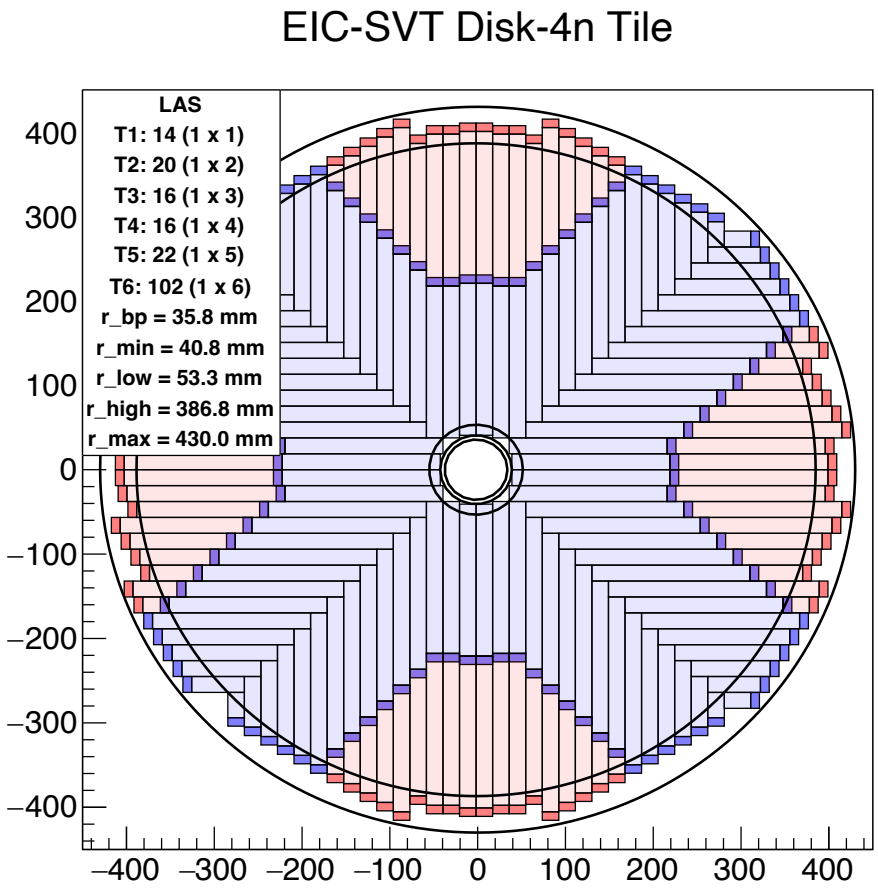
Disk 3p – restricting sensor size



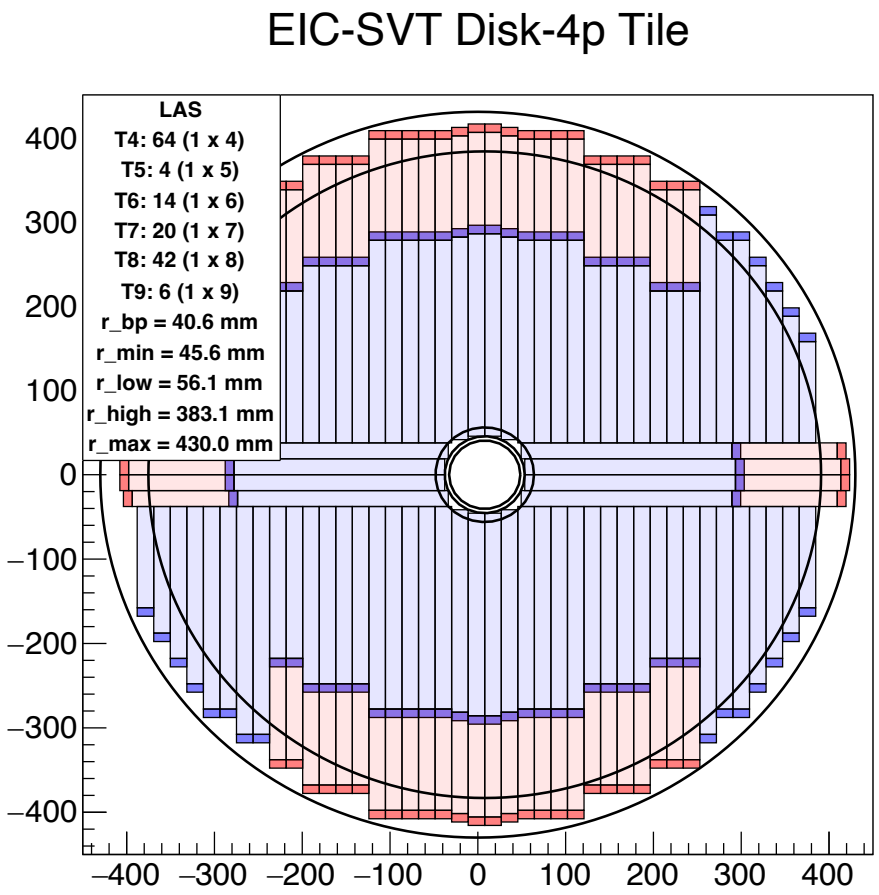


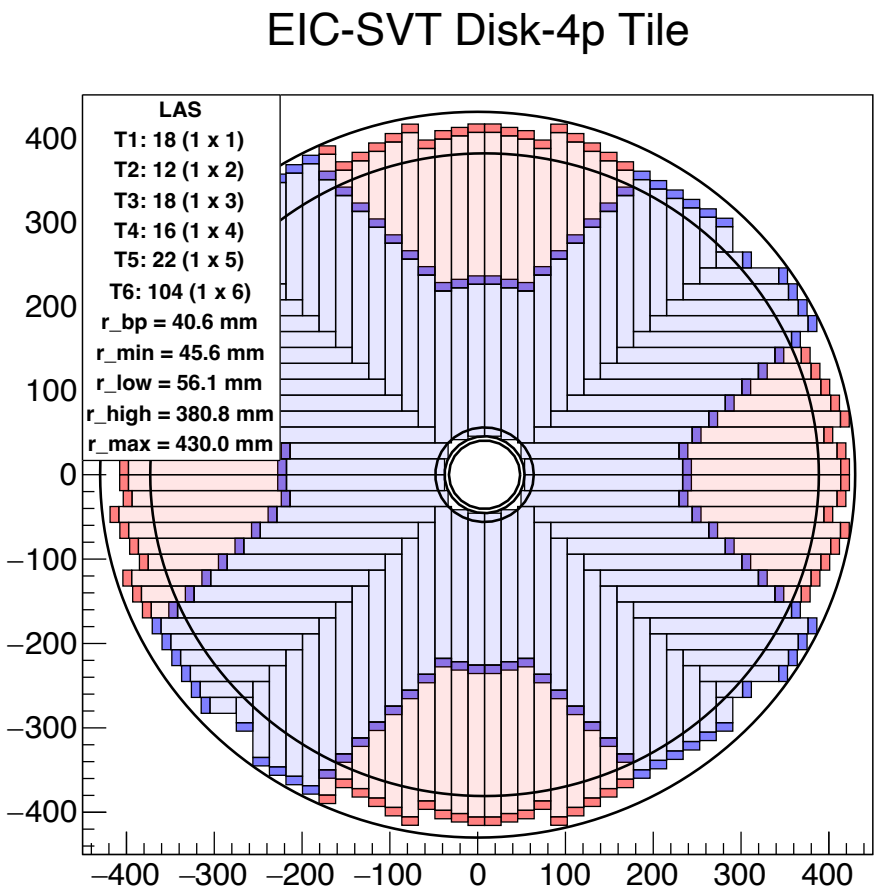
Disk 4n – restricting sensor size



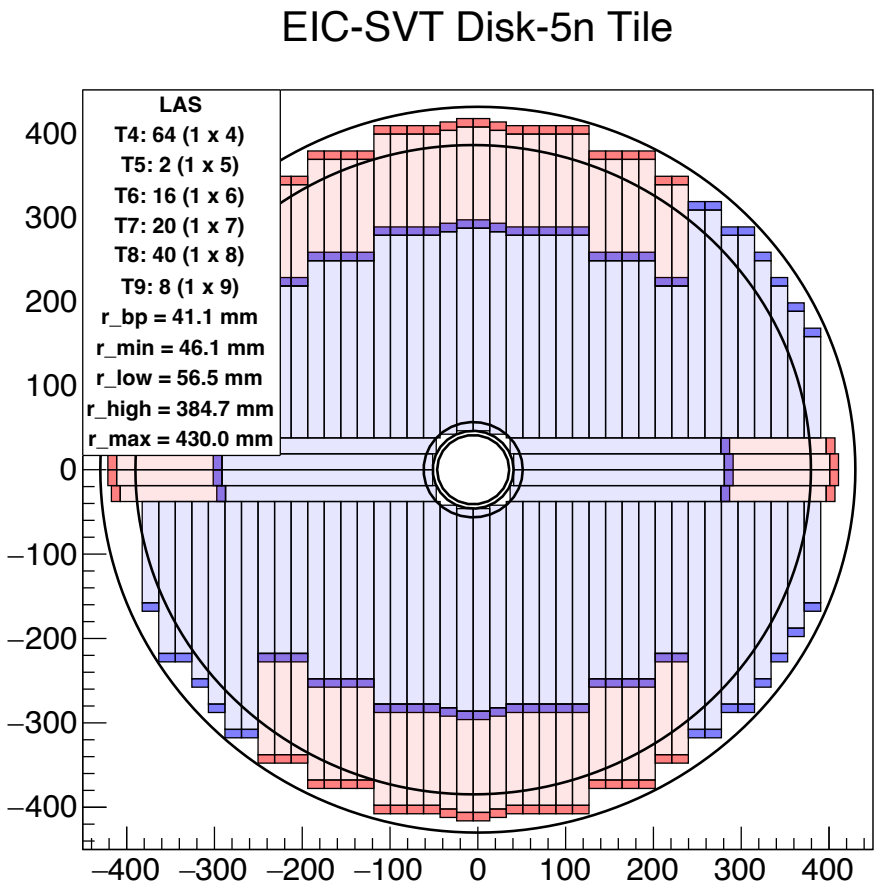


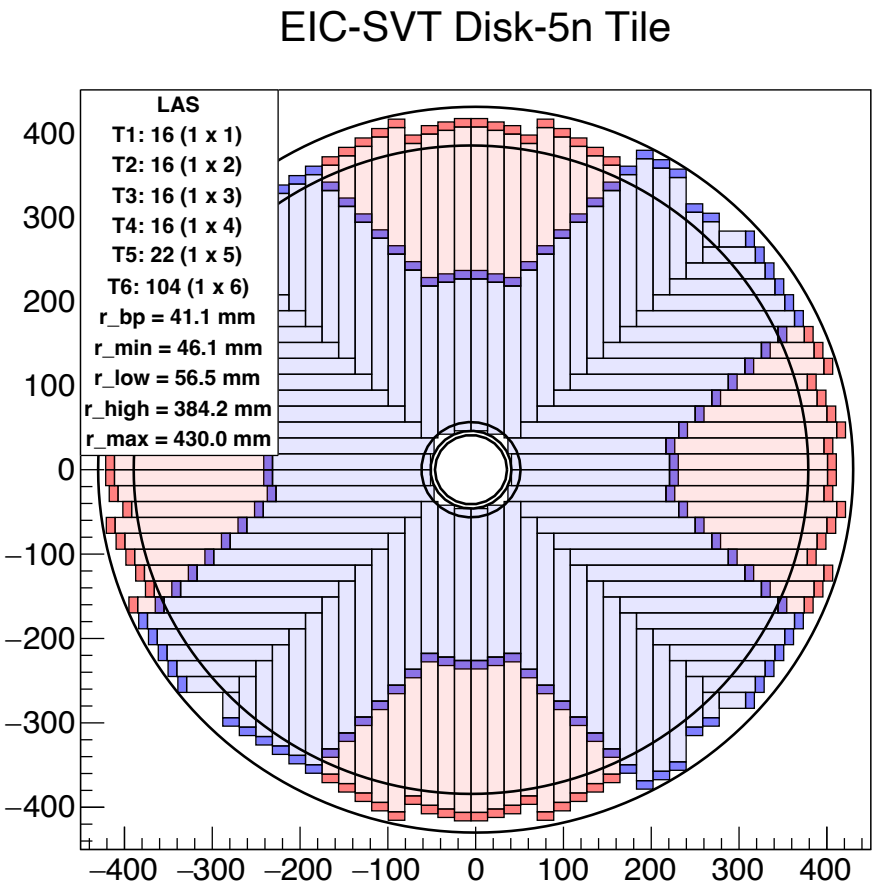
Disk 4p – restricting sensor size



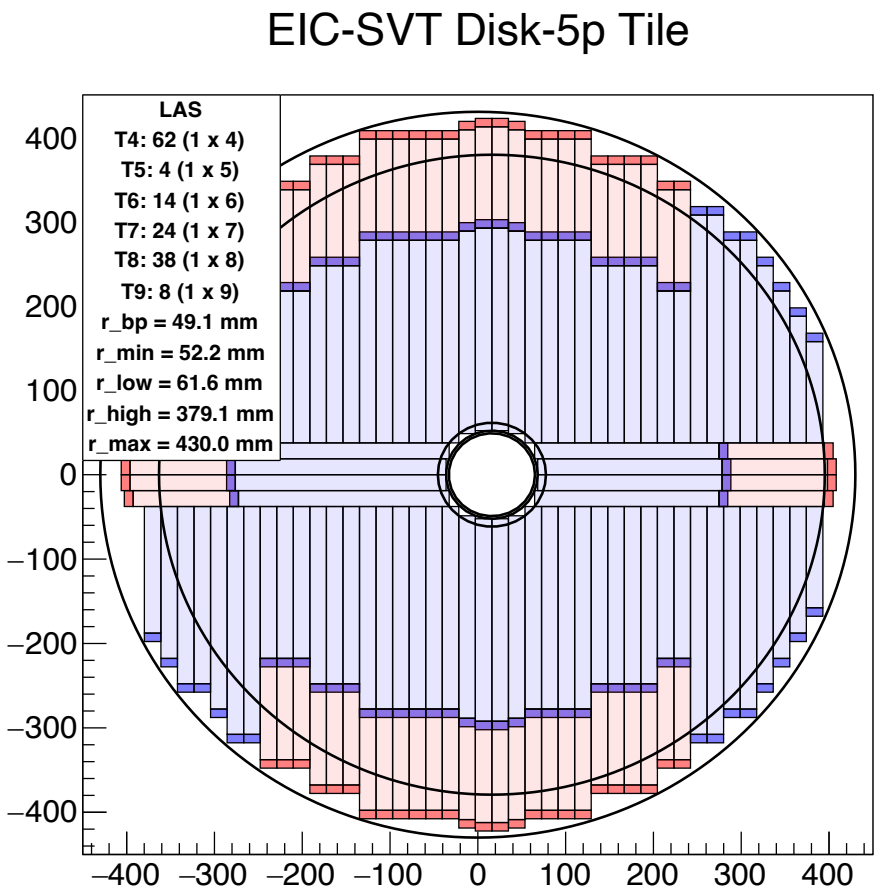


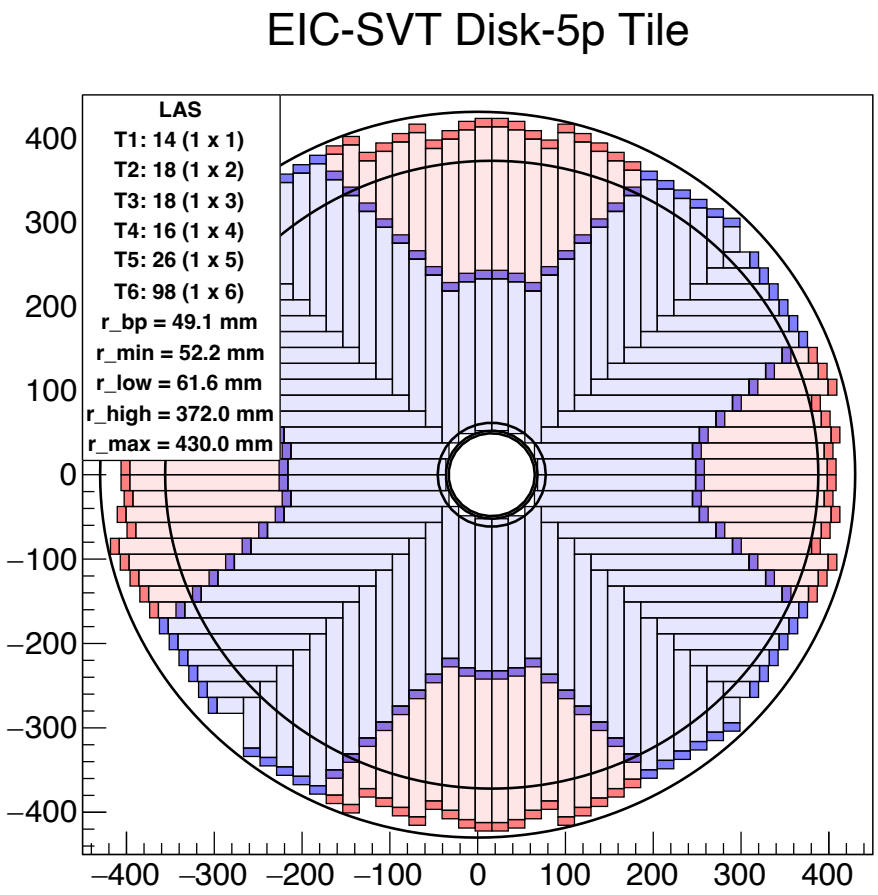
Disk 5n – restricting sensor size





Disk 5p – restricting sensor size





Conclusions

- EIC Disks
  - Multiple sensor formats needed – requiring changes to stitching plan & organisation of the digital periphery
  - Attempt to minimise the number of formats by restricting the maximum and/or minimum sensor length
  - How hard do we need to work to improve acceptance at small radii?
  - Compare acceptance (e.g. hits per track) with complete azimuthal acceptance (between r_low and r_high) with physical disk dimensions (r_min and r_max)
  - Simple tiling (most sensors lying in the same direction) requires fewer sensors and gives slightly better coverage
  - Simple tiling enables the smaller sensor variants to be eliminated and reduces the number of the longest variant. This potentially results in more efficient silicon wafer usage.