Silicon layers and disks configuration for simulations - part 2

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e-PIC Tracking WG
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Proposed ECCE Tracker – now reference for Detector 1

(ECCE proposal)

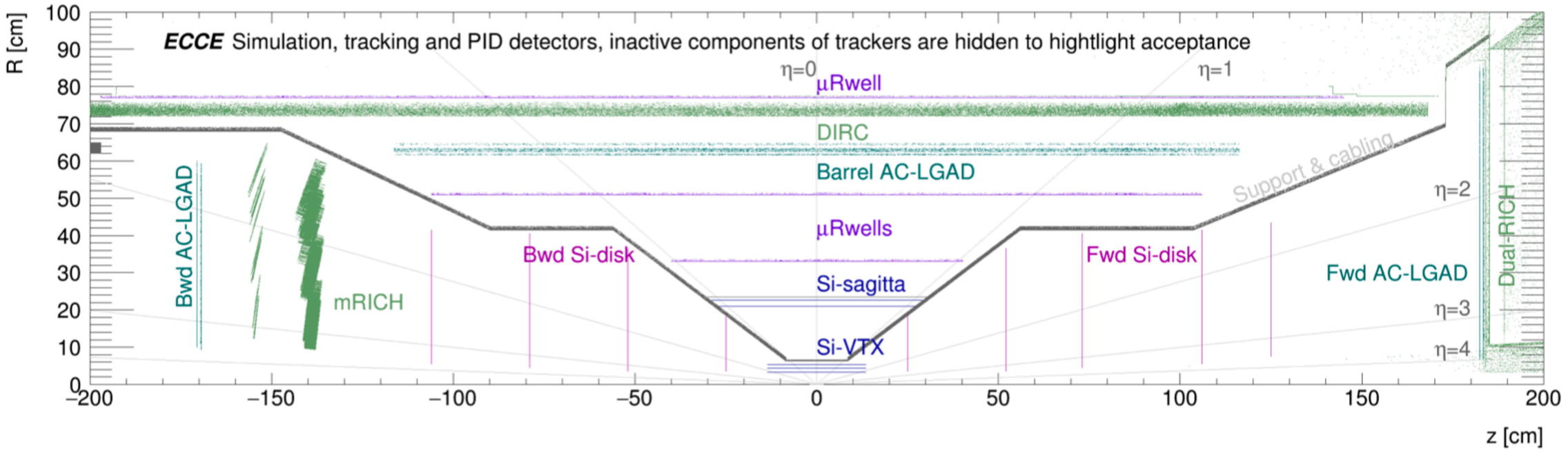


Figure 2.5: Schematic view of the ECCE tracker, including silicon, μRWELL, AC-LGAD, DIRC, mRICH and dRICH detector systems.

Transition from reference to baseline will entail, if not require, refinement / revision of the tracker configuration and layout,

The collaboration settled on a *barrel* update — past June 22 (!) — for the initial general simulation campaign,

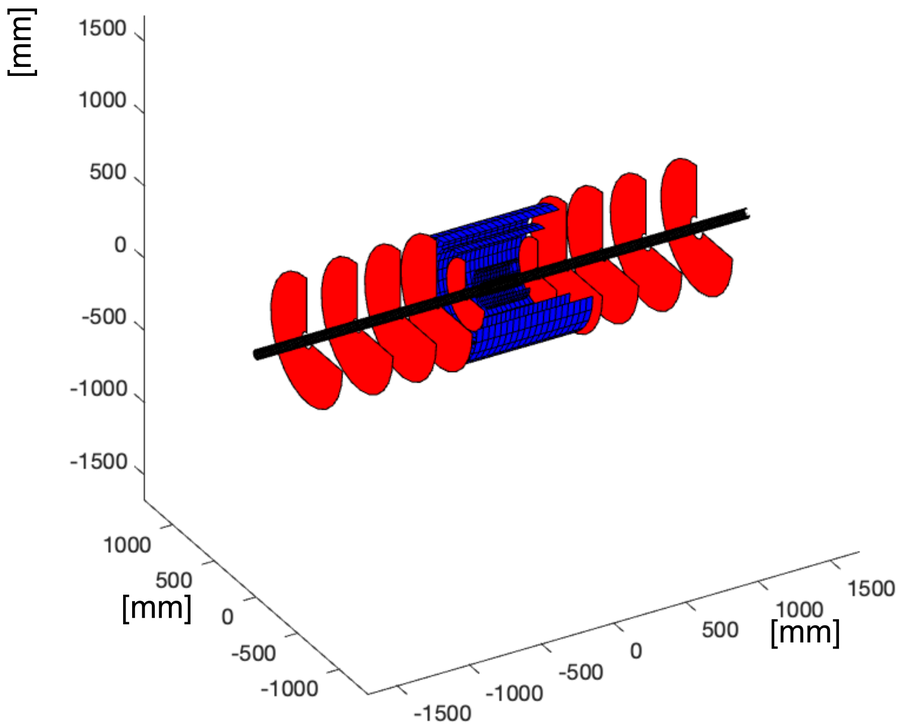
Since then, the magnet situation has improved bringing an increase in overall field to an overall ~1.7 T,

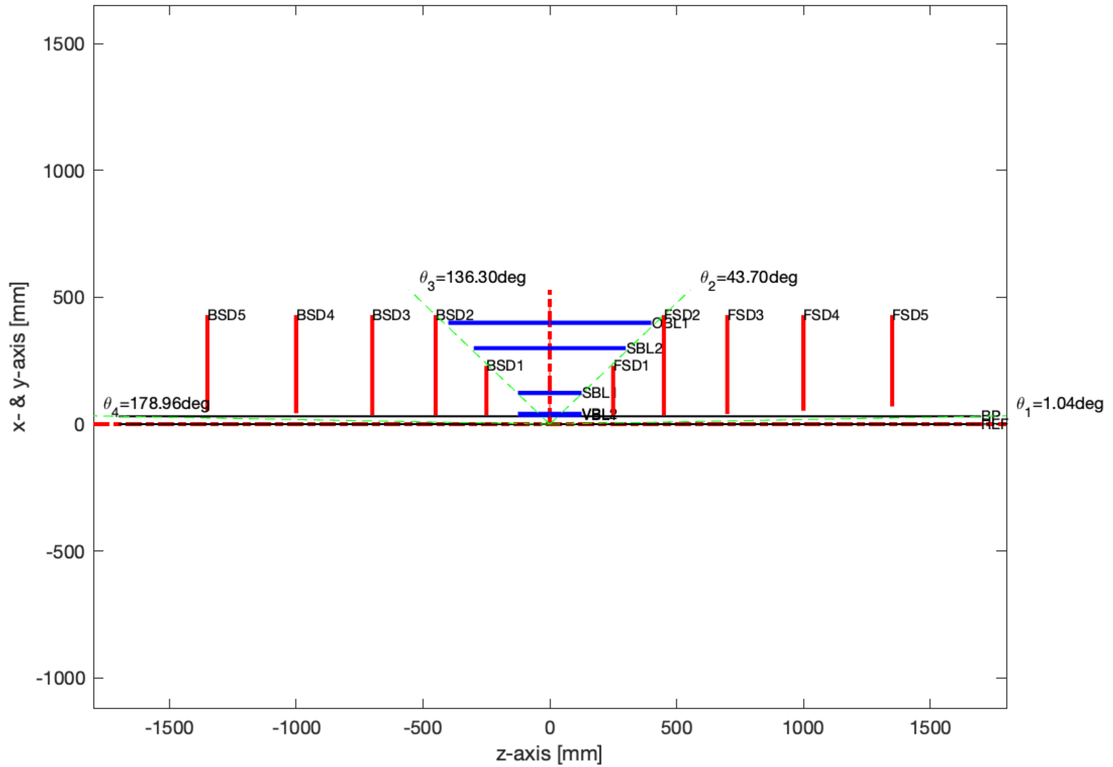
The changes to the barrel *imply* that changes are needed also to the disks. Let's make them now and, at the same time, address a few areas for improvement (in an evolutionary way). Hence, this brief reminder and proposed step forward.

Brief reminder - ∃ at least one path to recovering YR mid-rapidity performance in 1.7 T with ePIC

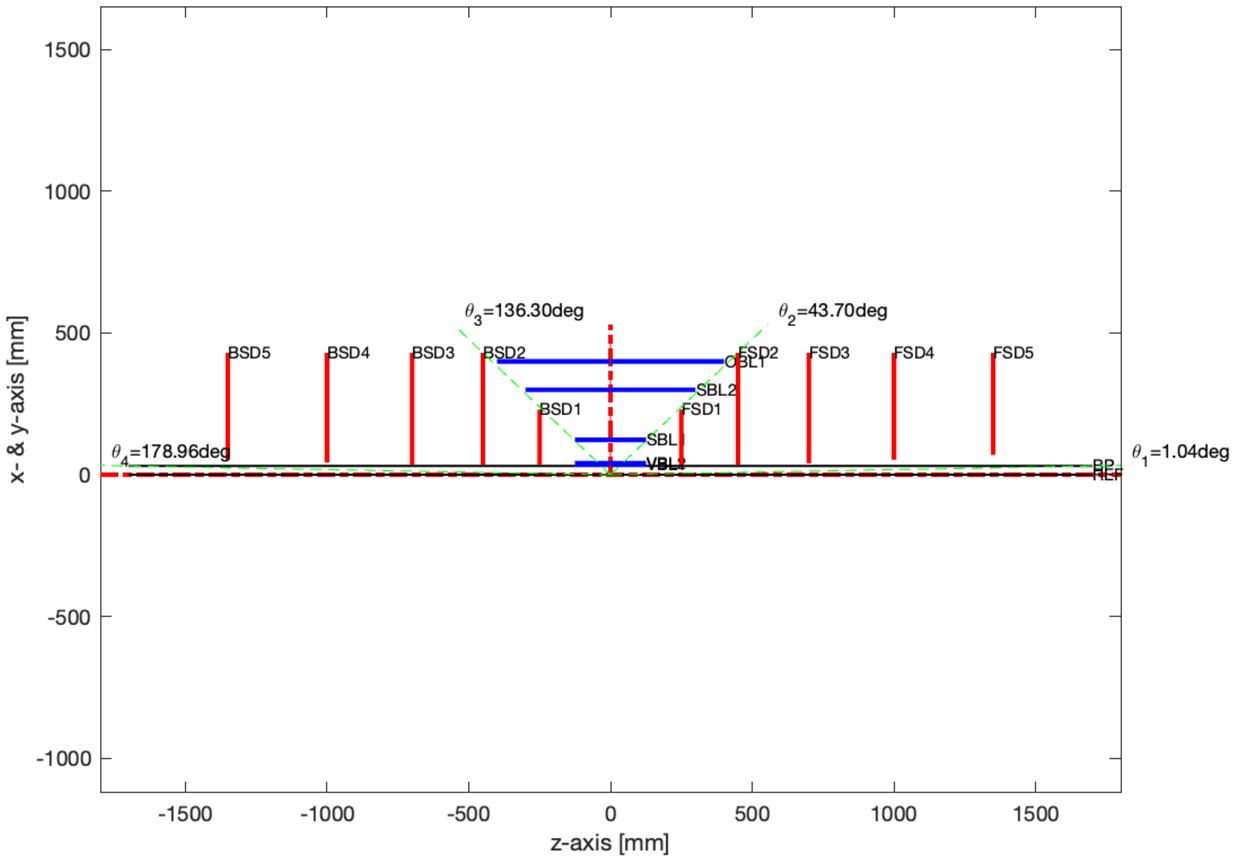
Approach / logic:

- Consider increasing the radius of the outermost vertexing layer while preserving its length of approximately 27 cm; the starting point is the r_{vtx} = 36, 48, 60 mm configuration discussed by Stephen earlier in this meeting - the goal is to have it contribute more/better to the momentum measurement,
- Replace the two sagitta layers with a more conventional stave-based design of one layer two half-lengths of $X/X_0 \sim 0.25\%$ (or less, if feasible) at a radius of approximately r ~ 0.2 m, and optimize this radius,
- Complement with a large-radius, $r_{out} \sim 0.4$ m, conventional stave-based design, with an overall length of about 0.8 m — this radius follows from the basic considerations (and YR requirements) presented earlier.
- Inner cone angle of ~45°, at least for now — c.f. Rey Cruz-Torres's studies https://indico.bnl.gov/event/12595/
  - **Note:** this cone is (or should be) projective to the nominal interaction point (at until more detailed studies inform otherwise),
- Constrain to be consistent with wafer size and anticipated reticle size





This path to recovering YR mid-rapidity performance in 1.7 T with ePIC



Barrel:

- ~45^{o} degree projective cone,
- Outermost barrel layer at r = 420 mm, l = 840 mm,
- Single “conventional” sagitta layer with r = 270 mm, l = 540mm, X/X_0 ~ 0.25%,
- Outer (third) vertex barrel layer with increased radius to r = 120 mm while preserving l = 270 mm and X/X_0 ~ 0.05%,
- Two inner vertex barrel layers with r = 36, 48 mm and l = 270 mm and X/X_0 ~ 0.05% per layer,

Disks:

- Suggest |z| = 250, 450, 700, 1000, 1350* mm,
- r_{out} = 430 mm at |z| > 430 mm, ~230 mm at |z| = 250 mm
- X/X_0 ~ 0.24% per disk,
- r_{in} ~ 5mm away from beam pipe,
- Outer support / service cylinders for 450 < |z| < 1350* mm

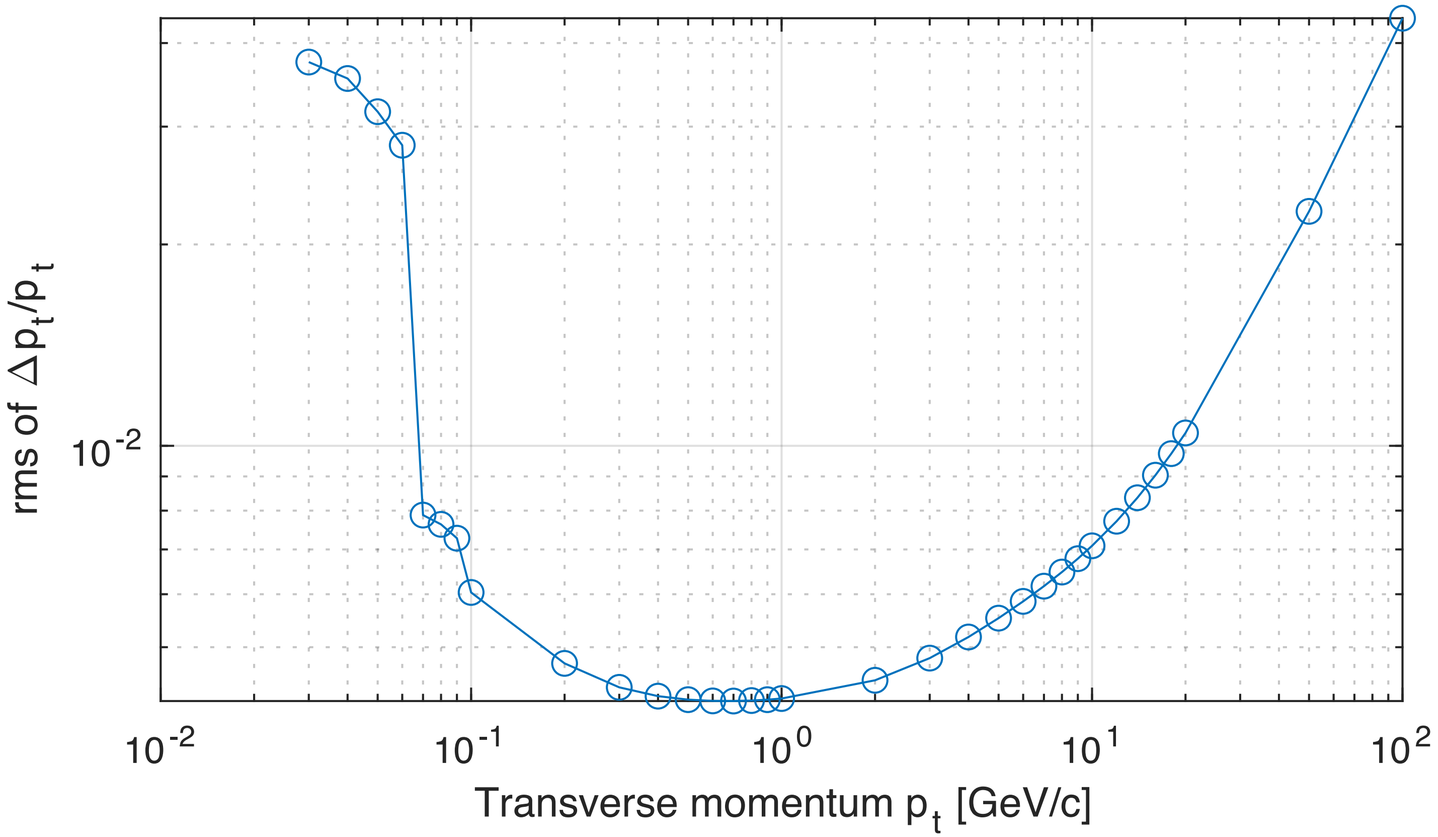
* 1350mm will “butt up” right to the mRICH volume according to the menagerie / geometry DB; GD/I considerations may reduce this, e.g. to 1300 mm, but my suggestion is to request this — otherwise empty (!) — space now.

Yes, there are other aspects, many of which require further study and further optimizations — a straightforward example would be z-extent / a 6th disk in the hadron-direction.

Material on the essential service cylinders is being worked out. This is, in my opinion, absolutely essential to incorporate soon and optimize — especially further routing.

Backup / additional slides

Fast simulation of mid-rapidity low-momentum



Mid-rapidity single charged-pion tracks over a wider kinematic range than we will encounter,

Particle mass matters at low(-est) p_T,

Simulation has multiple scattering, though not energy “loss” (or showering),

It also has digitization and Kalman filter (truth) reconstruction,

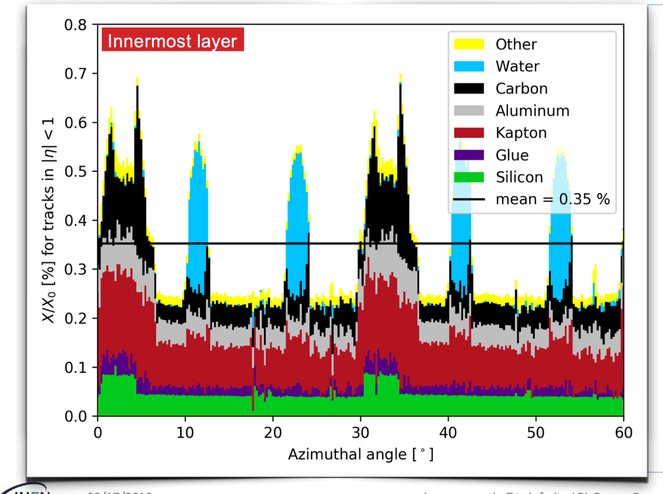
Consider this close to geometrical acceptance, if you wish,

Some of the thresholds so far from other studies are higher and are, likely, in parts algorithmic.

Note added after the mtg. on the material estimate for the outer sagitta layer

- $X/X_0 \sim 0.25\%$ for the sagitta layer in the studies to revise the barrel reference is *not* some “random” number
- Existing ALICE ITS2 innermost vertex layers have a sensitive length of 270 mm and $X/X_0 \sim 0.35\%$, c.f TDR.
- Borrowing from an excellent seminar talk by Giacomo Contin on R&D from the existing ITS2 to ITS3.

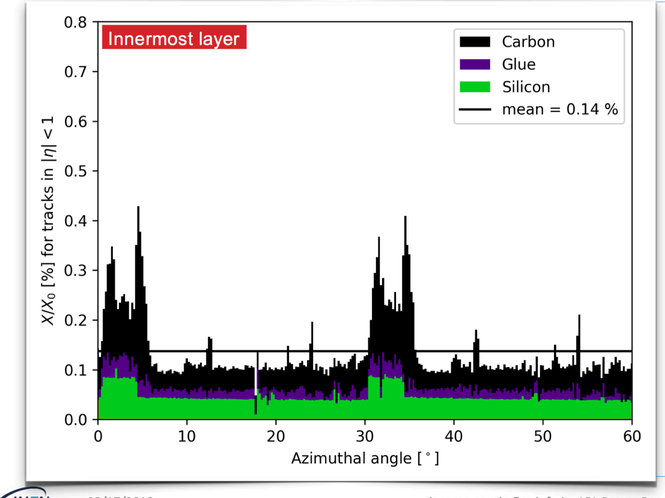
Material budget



- Observations:
  - Si makes only 1/7-th of total material budget
  - Non-uniformity due to support, cooling & overlaps

ITS2

Material budget



- Observations:
  - Si makes only 1/7-th of total material budget
  - Non-uniformity due to support, cooling & overlaps
- Removal of water cooling:
  - If **power consumption < 20 mW/cm²**
- Removal of the circuit board for power & data:
  - If **integrated on chip**

Steps towards ITS3

- Removal of cooling by water, in view of the lower power consumption of the ITS3 sensor, would already result in ~0.31%
- Sensor yield considerations may make it impractical to *fully* forego circuit board for power and data beyond ITS3 scale (area),
- Foregoing *all* mechanical support would likewise be imaginary — combined, these thus bracket the range to 0.14% to < 0.35%
- $X/X_0 \sim 0.25\%$ is instead consistent with by Leo Greiner’s estimates for the YR (ITS2 and ITS3 informed, and consistent with disks).