LBNL

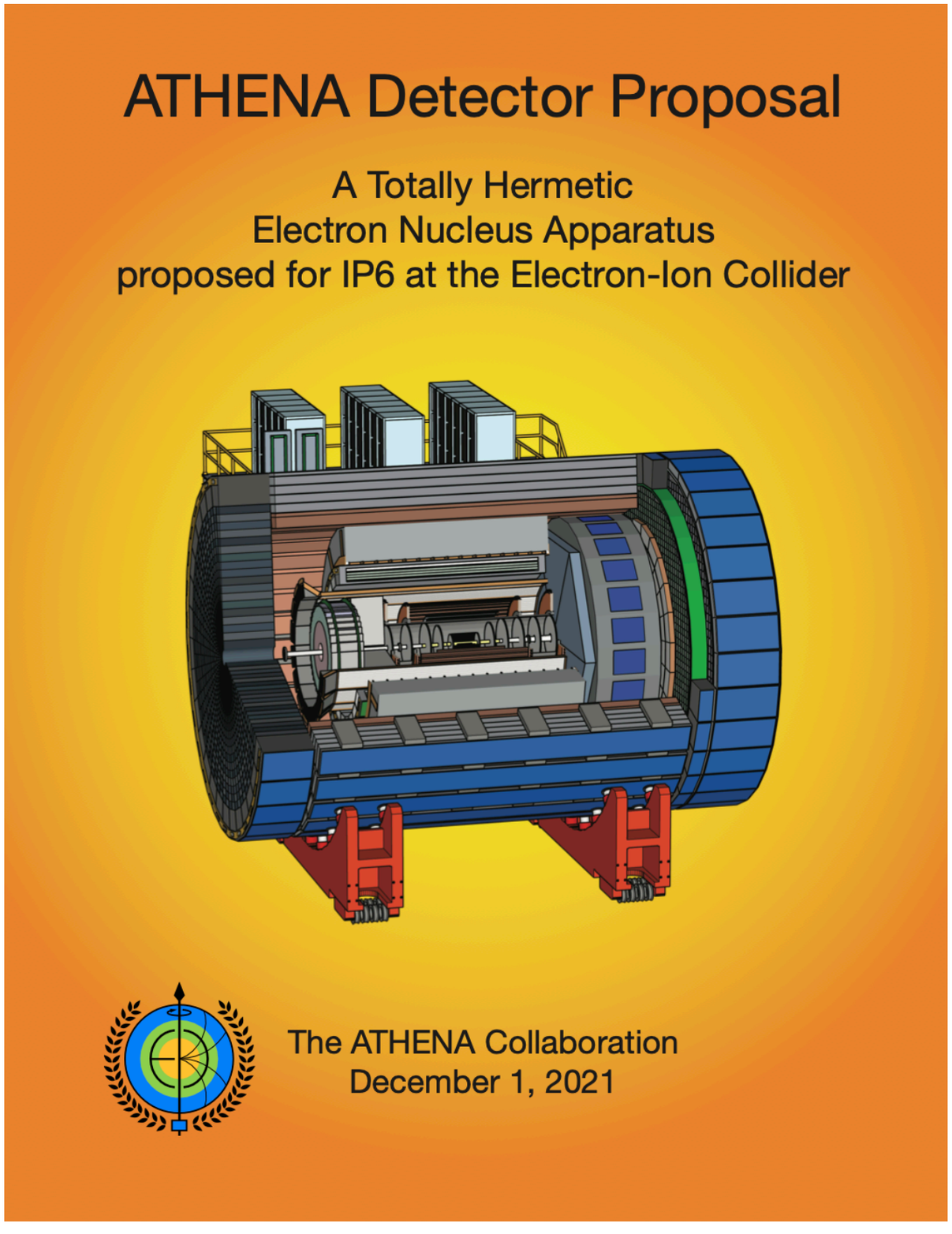
Ernst Sichtermann

EIC California Consortium Meeting
Host: UC Davis - July 18, 2022

While we have met regularly, our most recent meeting of this kind was a while ago (October 2020 if I am not mistaken).

What has happened since? A lot, actually…

“The Elephant”



LBNL stepped up as a group, perhaps even more so than during the Yellow Report,

Several very nice physics-studies were published during this period,

The proposal, stripped from costing etc, is actually accepted for publication in JINST (open access, arXiv posting will follow shortly),

The DPAP decision did not go ATHENA’s way.

The project adopted the DPAP recommendation(s).

Detector-2, if any, is “further out.”

LBNL has joined the detector-1 collaboration.

People:

John Arrington — detector-1 forward WG co-convener,

James Symons — costing committee ATHENA proposal,

Sooraj Radhakrishnan
Yuanjing Yi
Wenqing Fan
Xin Dong
} extensive Heavy-Flavor studies,

Nikki Apadula
Shujie Li,
Beatrice Liang-Gilman,
Emma Yeats,
Others…
} Project R&D, Si consortium

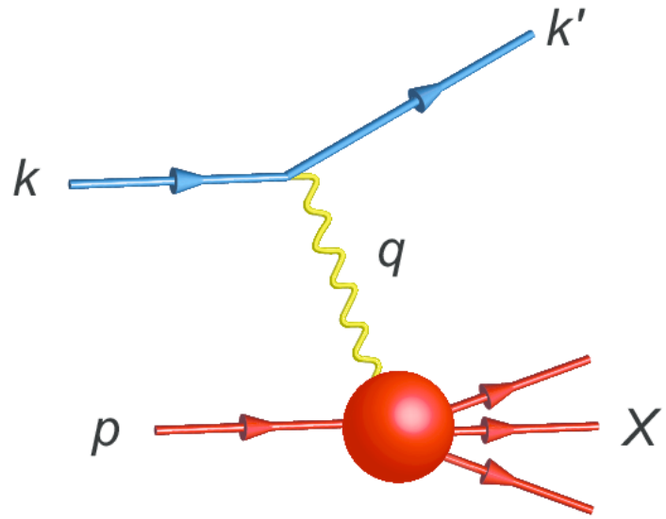
Continued strong UCB ties; e.g. Rey Cruz-Torres, Yue Shi Lai

The usual suspects: Barbara Jacak, Spencer Klein, Feng Yuan, E.S.

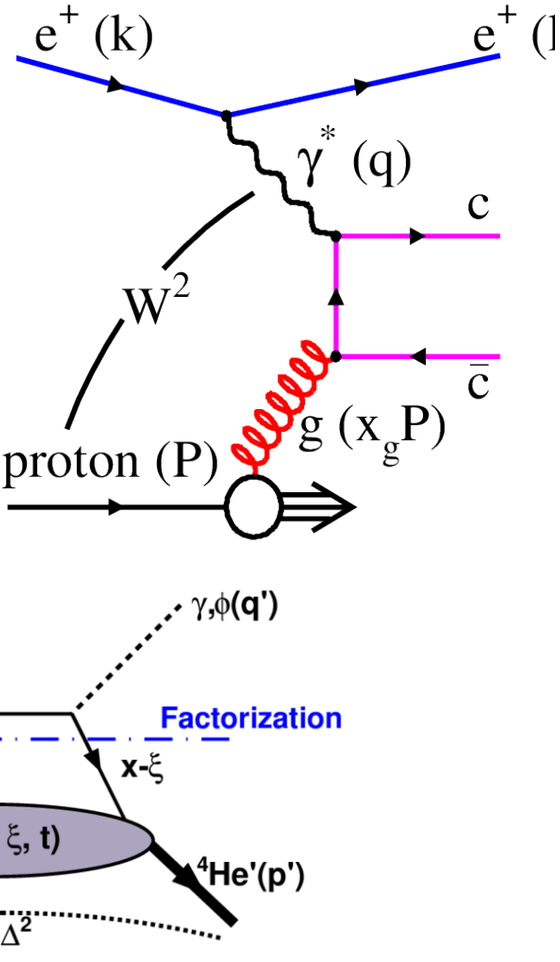
Nuclear Physics Interests:

By probe:

- Scattered electron



- Current jets



- Heavy Quark production

- Exclusive vector meson production

A range of physics topics, really — several covered in later talks,

“Shout out to Grace Gamire and all undergraduate students

Tracking:

Space is at a premium at the EIC and the baseline general purpose detector(s) will need to be: compact, tightly integrated, low-mass, high resolution, and large acceptance — challenges are even stronger in BaBar 1.4T field,

Silicon consortium aims to develop a well-integrated and large-acceptance EIC vertexing and tracking detector concept, based on Monolithic Active Pixel Sensors (MAPS) at the 65 nm node,

Sensor R&D aims to leverage ALICE-ITS3 and to fork off for EIC,
many areas of (physics-driven) commonality,
65nm technology,
10μm pixel-size turns out fortuitous with large-r EIC beam pipe

Continued and renewed simulations towards physics-optimized conceptual layout,

Attention to services and supports, constructibility;
integration e.g. with RICH + large-*z* GEM

Continued strong case for compact “more-silicon” tracking solution,

Continued desire to work across California Consortium in a concerted way.

Backup

Proposed ECCE Tracker – now reference for Detector 1

(ECCE proposal)

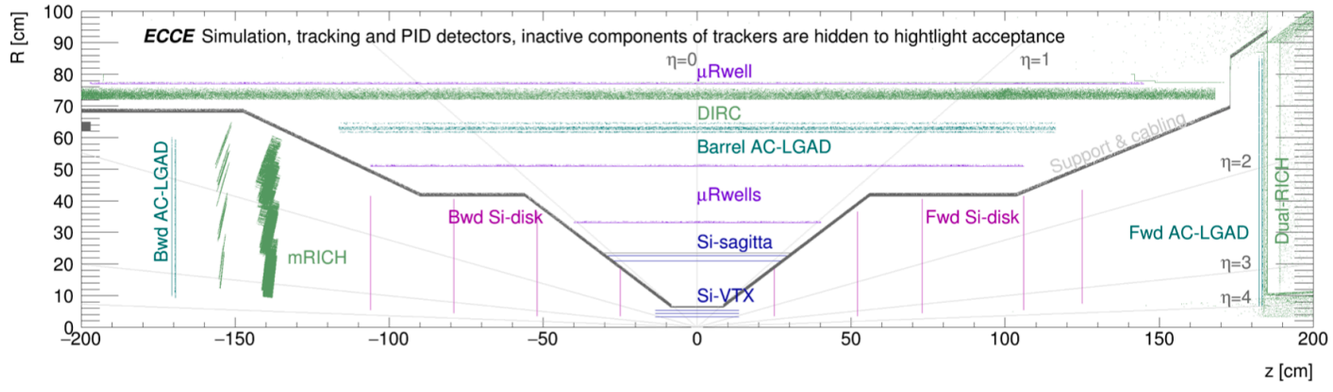


Figure 2.5: Schematic view of the ECCE tracker, including silicon, μRWELL, AC-LGAD, DIRC, mRICH and dRICH detector systems.

Points of discussion most will have heard:

- Material budget for sagitta layers,
- Resolutions or μRwells, AC-LGADs,

Not the main topics I want to pursue here and now.

Let's instead simply agree:

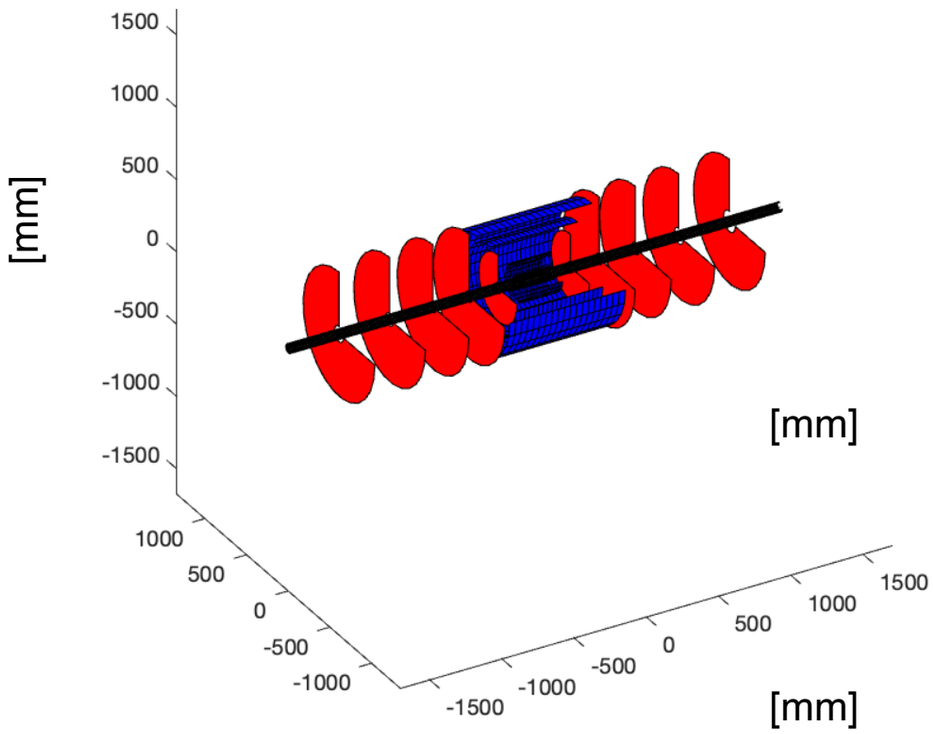
MAPS point resolution is about an order of magnitude better than for μRwells or AC-LGAD,
that is, it is far from obvious that having two closely spaced groups of MAPS layers results in optimal resolutions,

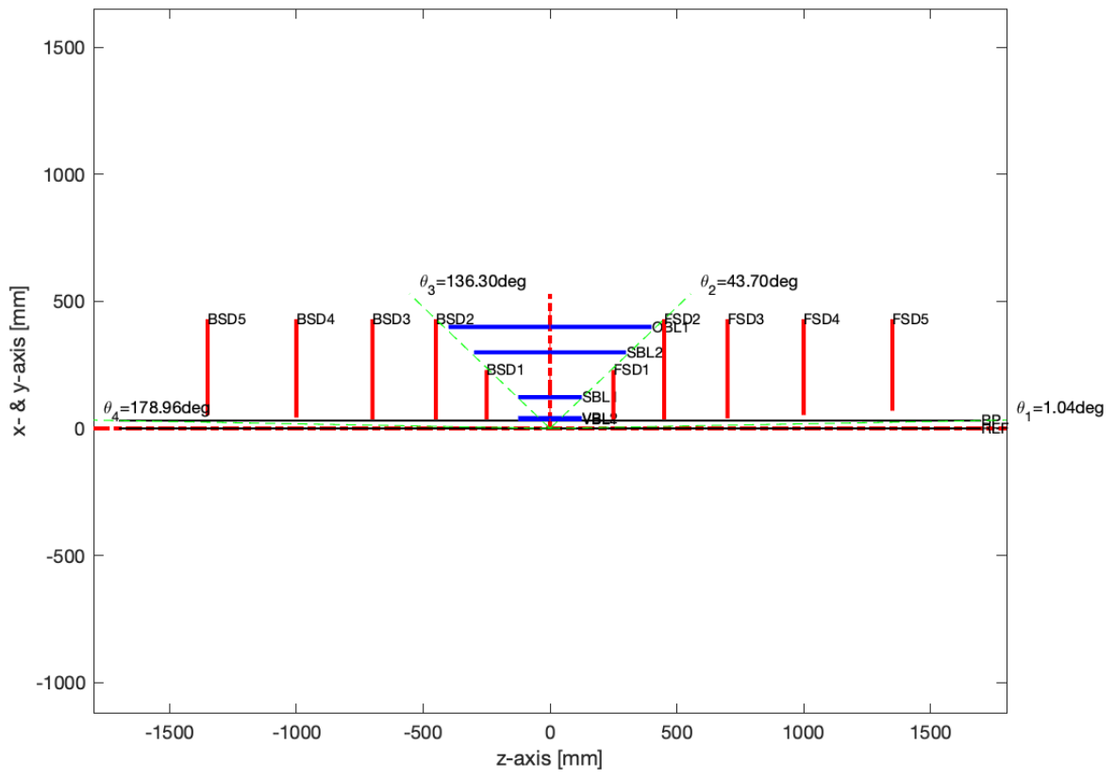
The radiation length in (dry, atmospheric) air is about 300 m;
that is, 15 cm of air corresponds to $X/X_0 \sim 0.05\%$
if the material in the sagitta layers is all important, then *also* consider e.g. helium

My main question here will be about resolutions, in particular those at mid-rapidity; is there a viable re-configuration of the five MAPS barrel layers in the reference design that could bring detector-1 to YR performance at mid-central rapidities?

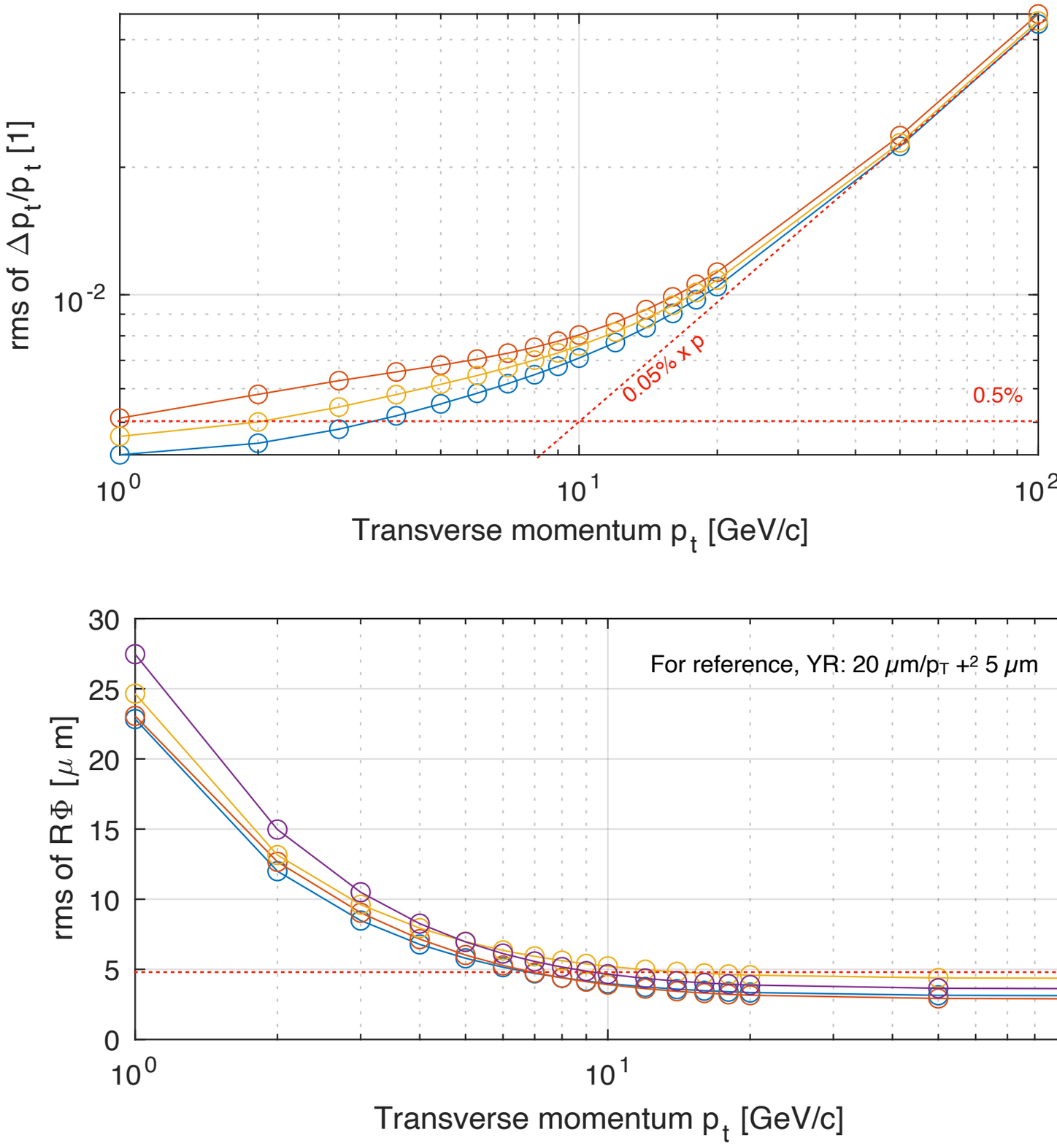
Is the YR mid-rapidity performance recoverable in 1.4T?

- Inner cone angle of ~45^{o}, at least for now — c.f. Rey Cruz-Torres's studies https://indico.bnl.gov/event/12595/
- 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 ~ 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} ~ 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.





YR mid-rapidity performance in 1.4T



Single pion tracks, exactly vertical,

- Blue curve is the (outer) r_{vtx} = 120 mm and r_{sag} = 270 mm from the previous slide,
- Yellow has an outer r_{vtx} = 96 mm and r_{sag} = 240 mm,
- Red has an outer r_{vtx} = 60 mm and r_{sag} = 240 mm,

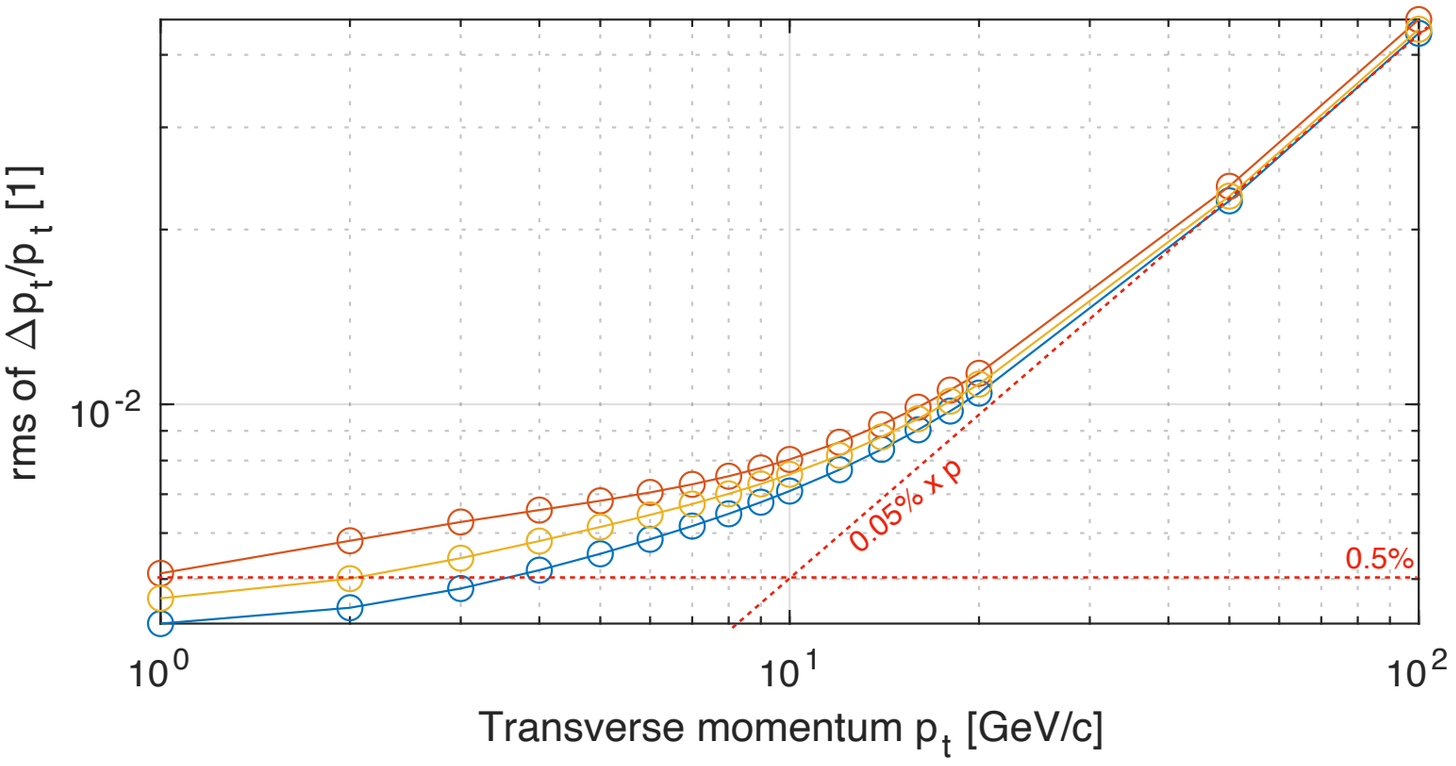
The different r_{sag} come from optimization, factoring in an assumed 30 mm reticle size,

The blue curve meets the YR requirements well within the all-silicon tracker silicon area with seemingly reasonable extensions of ongoing R&D plans/efforts.

There is likely to exist at least one path towards recovering YR mid-rapidity performance.

YR mid-rapidity performance in 1.4T

There is at least one path towards recovering YR mid-rapidity performance with five MAPS layers within r ~ 0.4 m, while preserving most of the rest of the reference design (track *finding* etc.)



Basically, “spread out” the five MAPS layers.

Key steps:

- ITS2 derived outer sagitta layer with ITS3 derived sensor, $X/X_0 \sim 0.25\%$,
- Complement with a ~conventional outer barrel layer with r ~ 0.4 m using ITS3 derived sensor,
- Drive out the outermost ITS3 derived vertex layer, preferably to $r_{vtx} \sim 120$mm while preserving its length,
- Obviously requires additional R&D, but not “blue sky” development,
- Likewise, construction/cost seem likely to be more of an evolution rather than revolution.

Fun4all simulations of this configuration have started; anticipate reasonable consistency (pric
experience and see Rey’s talk),

As said, additional work will be needed on the disk arrays and services — not for today.