Planning for TDR effort — Tracking

Ernst Sichtermann (LBNL)

Of course, with input from many:

- Francesco Bossu (Saclay)
- Xin Dong (LBNL)
- Kondo Gnanvo (JLab)
- Laura Gonella (Birmingham)
- Shujie Li (LBNL)
- Matt Posik (Temple)
- …

Errors are obviously my own

The Request

Dear DSLs,

Following what has already been communicated at the ePIC collaboration meeting (Jan 9-13, 2024), the DSLs are requested to prepare a TDR plan for their subsystem for calendar year 2024, including:

- The lab/testbeam/prototyping needed;
- The further progress needed for the reconstruction software;
- The verification of the implementation of the detector and detector response in simulation and validation using information from lab/testbeam exercises or from literature;
- The studies required to demonstrate the detector performance;
- The required engineering design;
- The needed resources to achieve 60% (CD-2) and 90% (CD-3) design completion;
- The plan should include the time required to draft the text for the pre-TDR (CD-2) and TDR (CD-3).

The plan should present the activities required month by month in order to allow progress to be monitored. The ultimate goal of this exercise should be 90% design completion consistent with the requirements of the TDR and CD-3, indicatively by the end of 2024. We recognize that the available time is limited. Therefore, please make an educated selection of the most essential studies doable within the available time.

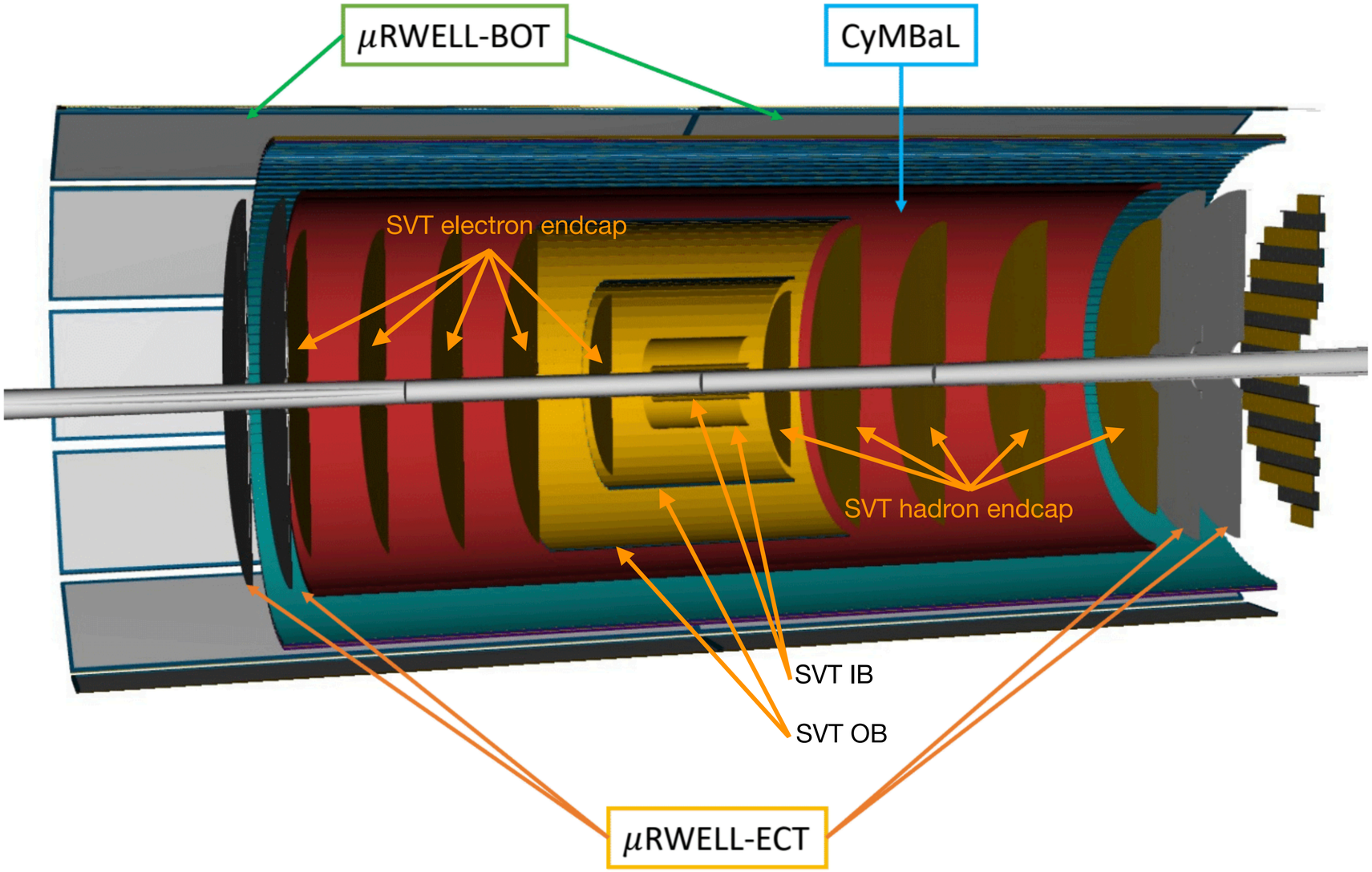
We understand that a planning exercise like this will identify shortcoming in workforce and resources. Those shortcomings should be clearly identified so everyone is aware and we can work together to address them.

The plans will be presented at dedicated CC WG meetings, to be organized by the CC WG conveners over the next few weeks. The CC WG conveners will be asked to report on the status of the planning at the TIC meeting on Monday Feb. 19.

Thank you,

Silvia, John, Oskar, Matt, Prakhar

Preliminaries



Preliminaries

January 2024 ePIC Collaboration Meeting:

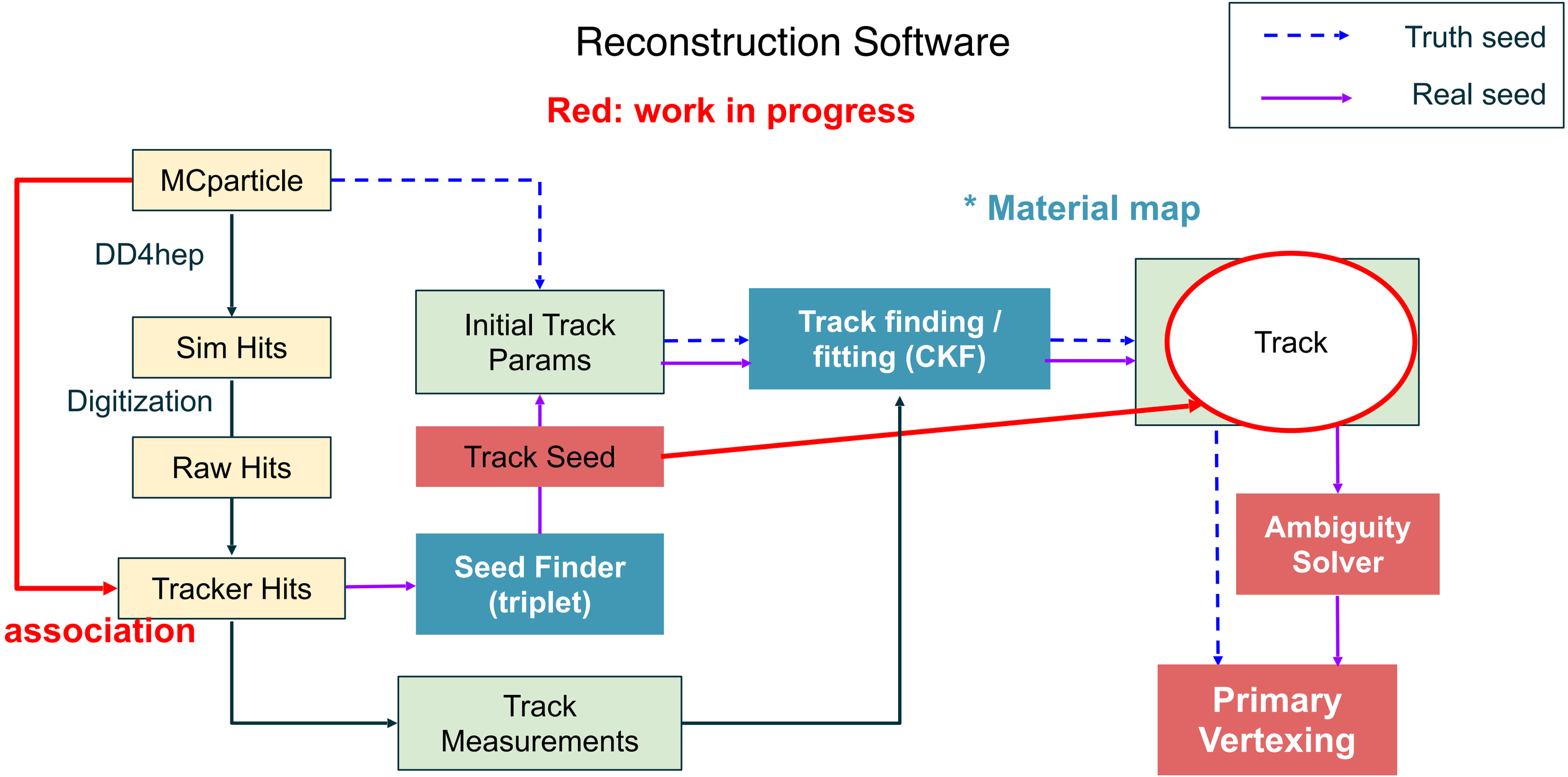
- SVT workfest at the January 2024 collaboration meeting served all of its intended purposes,
- Tracking workfest served some of its intended purposes, but fell short e.g. in advancing the detector descriptions then and there,
- AC-LGAD workfest (Time-of-Flight subsystem) — factored out from what follows,
- Incorporation of the BEMC innermost imaging layer in tracking was/is in need of a volunteer.

Regular follow-up since the Collaboration meeting:

- SVT general meetings, work-package coordination meetings, sensor designers' meetings — c.f. https://indico.bnl.gov/category/496/,
- MPGD general meetings, simulation meetings, uRWELL meetings, CyMBaL meetings — c.f. https://indico.bnl.gov/category/497/,
- Weekly track reconstruction meeting — c.f. https://indico.bnl.gov/category/463/, and bi-weekly vertexing meetings,
- Weekly joint track reconstruction, vertexing, and tracking working group meetings going forward — c.f. https://indico.bnl.gov/category/404/,

Today is certainly too soon to expect a worked-out response to the request.

Reconstruction Software

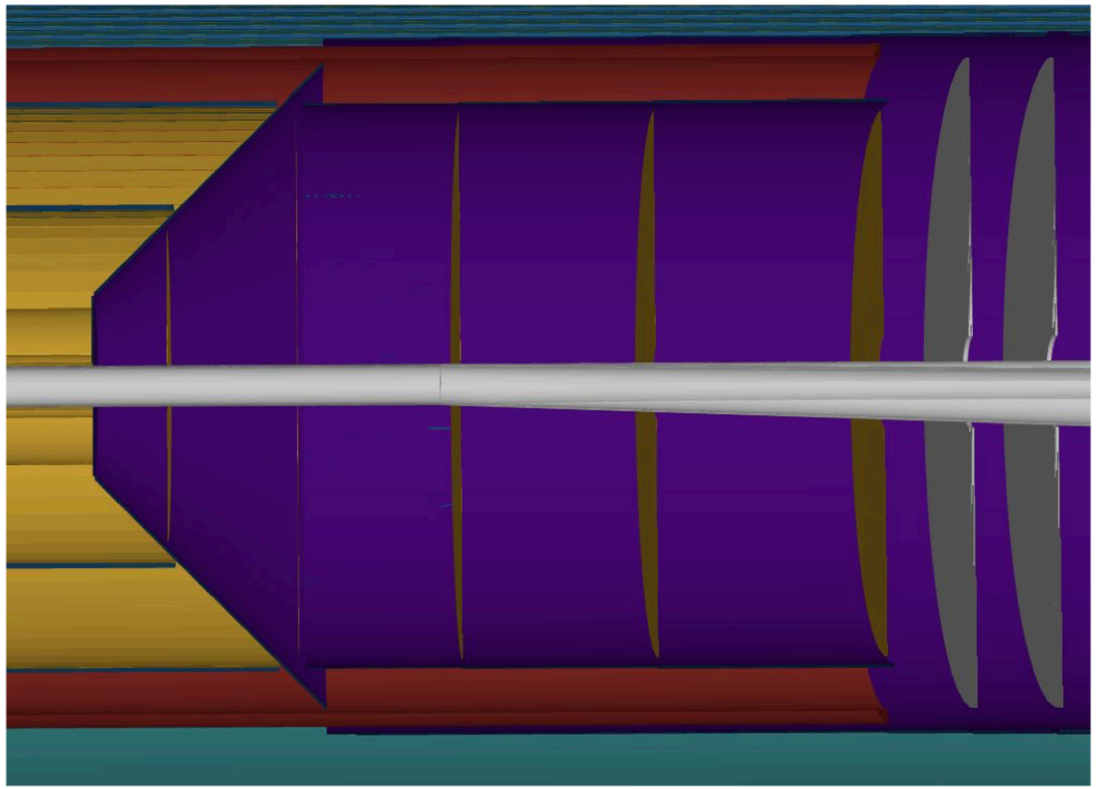


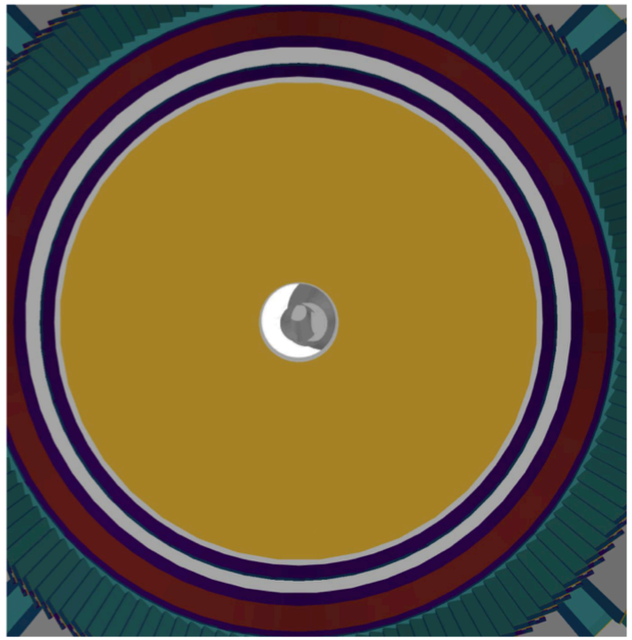
That is, there is quite some work before simulations will be able to demonstrate necessity and sufficiency (!) or inform design trade-offs,
Significant work also remains for the detector descriptions; for acceptance vs. engineering design, as well as for response, supports and services,
Groups in the SVT and MPGD DSC have identified/increased workforce; shortages remain and e.g. BEMC imaging layer is not currently covered.

Detector Description — Example I

Disks

Now: use larger centered hole to accommodate beampipe fan-out

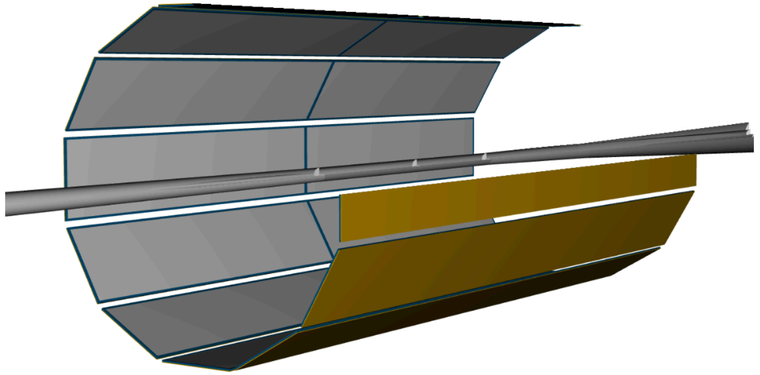


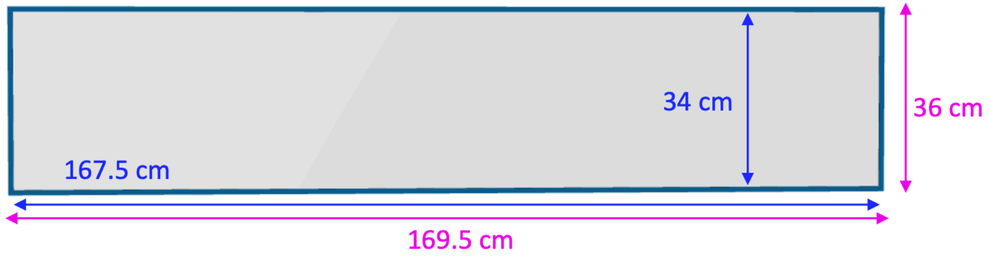


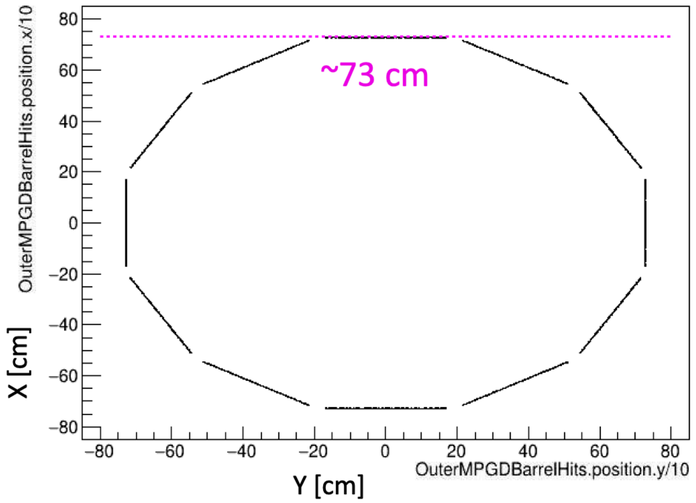
Shujie Li — c.f. https://indico.bnl.gov/event/21559/

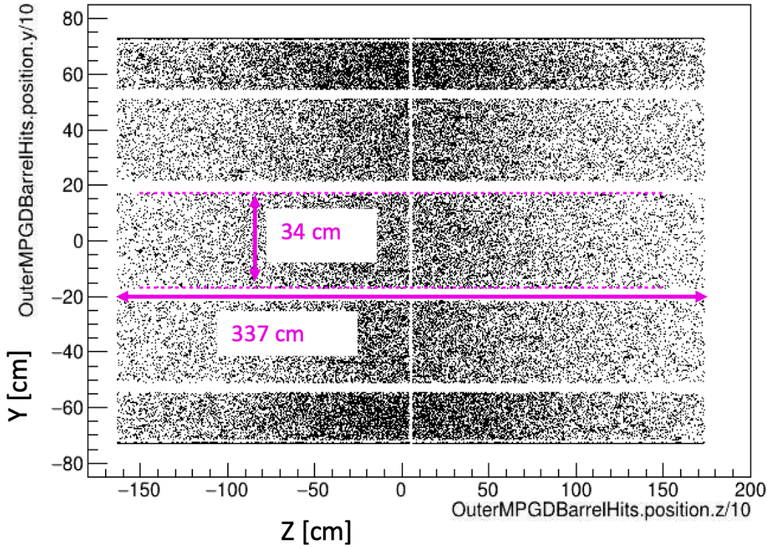
Detector Description — Example II

μRWELL-BOT Geometry (ePIC Crater Lake 24.2.0)









Courtesy Matt Posik

Detector Description — Example III

MPGD Routing: All MPGD

	Avg X0	Al Thickness (cm)
(BE1 + BE2 + IB1 + IB2 + OB1) z < -167.5	0.09557857	0.850362537
(BE1 + BE2 + IB1 + IB2) -167.5 < z < -120	0.064545617	0.57426235
(BE1 + IB1 +IB2) -120 < z < -110	0.049796311	0.443037781
(IB1 +IB2) -110 < z < -105	0.035047006	0.311813212
(IB2) -105 < z < -48.75	0.017523503	0.155906606
() -48.75 < z < 48.75	0	
(IB3) 48.75 < z < 53.75	0.017523503	0.155906606
(IB3 + IB4) 53.75 < z < 135	0.035047006	0.311813212
(IB3 + IB4+IB5) 135 < z < 148	0.052570509	0.467719818
(IB3 +IB4 +IB5 + FE1) 148 < z < 161	0.067319814	0.598944387
(IB3 +IB4 +IB5 + FE1 +FE2) 161 < z < 174	0.082069119	0.730168956
(IB3 +IB4 +IB5 + FE1 +FE2 + OB2) 174 < z	0.113102073	1.006269143

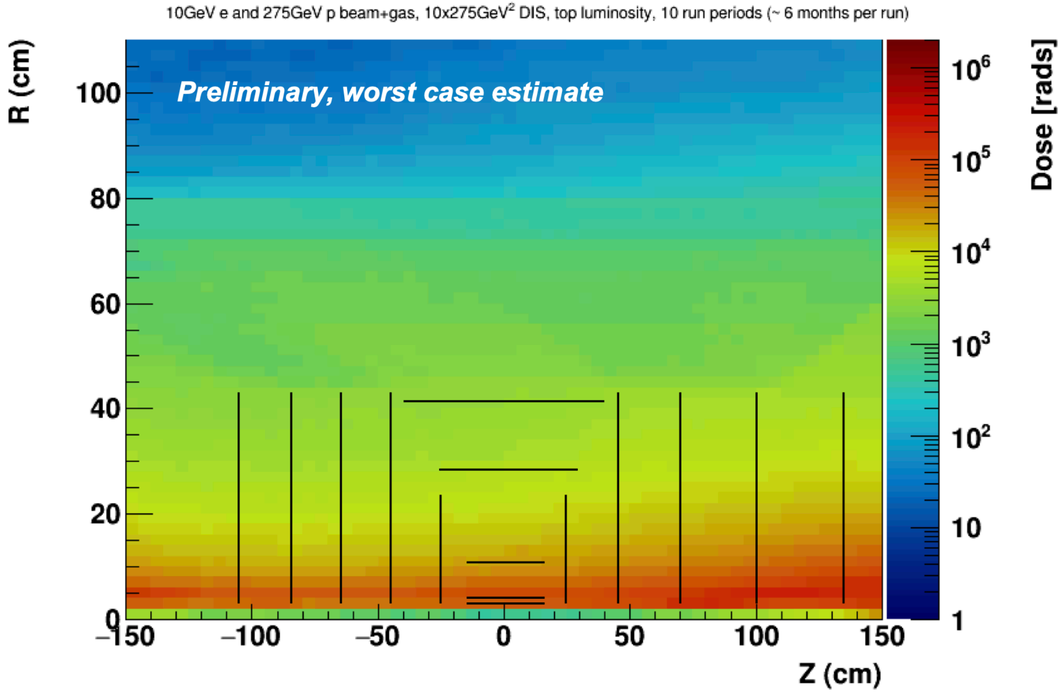
Courtesy Matt Posik

Towards TDR

Multiple approaches:

- Tracking workfest examined an existing TDR and sought input on figures — will see follow-up in joint Thursday meetings
  - For example, initial radiation dose estimates are available:

Laura Gonella — c.f. https://indico.bnl.gov/event/20473/sessions/6736/#20240109



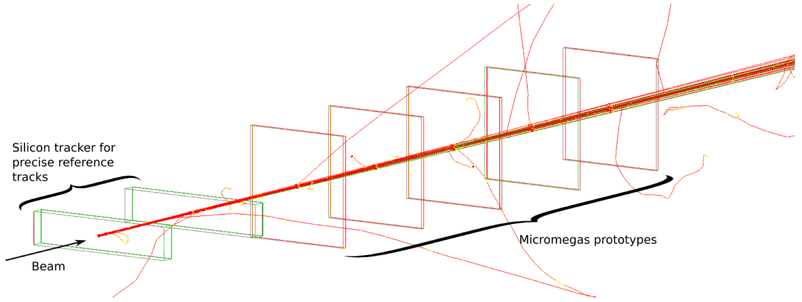
and can be refined upon. Likewise, rates and occupancies.

- MPGDs benefit from ongoing test-beam efforts,
- SVT is organized in work packages and has a WBS through TDR; evolving sensor timeline presents some complexity.

Towards TDR — CyMBaL

Beam test at MAMI

- In June 2023, beam test on a 880MeV electron beam at MAMI in Mainz.
- We tested prototypes with different variations of readout patterns and resistive patterns.



Francesco Bossu — c.f. https://indico.bnl.gov/event/21172/

Outlook

- D1 with 1mm strips or smaller is a good starting point to meet ePIC requirements. But the strip to inter-strip ratio needs to be carefully chosen.
- The pad-like design with a full resistive layer has the most even sharing between the two directions.
- Need for more data taking with muons to avoid msc and to complete testing.
- More prototypes are in construction to test more resistive layer designs.

Towards TDR — ECT

To do List

- Understand the Mechanical envelope available for uRwell endcaps - Seung joon
- Define the detector active area and final segmentation – try to start with semi-circles
- Servings & Cooling - Seung Joon, Electronic cables: Irakli Damien (Saclay)
- Geometrical Constraints on SALSA FEB?
- Read-out system definition
- Gap-size definition (with or without GEM foil)
- Material budget assessment (with/without GEM pre-amplifier)
- Detector geometry simulation Mariangela & Matt
- Detector response simulation Mariangela+ Roma group + Matt
- On-Line Calibration -> Alignment -> SVT/Tracking->TIC: survey/photogrammetry plans – targets to be installed?
- Stability against magnetic field forces (2 Tesla) (carbon fiber support)
- Mounting procedure and related constraints ?

Annalisa D'Angelo— c.f. https://indico.bnl.gov/event/21172/

(Tomorrow's engineering meeting on Inner Detector Support Structures and Cooling aims to advance several of these and other items.)

Towards TDR — SVT

WP1: Sensor design (Iain Sedgwick, TBD/TBA)

- Define ancillary chip specs, design, submit
- Continue partnership with ALICE-ITS3 and understand design
- Pending access to DB, initial work on EIC-LAS (RSU and data MUX)

WP2: Sensor testing (Lukas Tomasek, Gian Michele Innocenti)

- Test ancillary chip if available
- Progress testing of ER1

WP3: Electrical interfaces (Marcello Borri, TBD)

- Prototype and data speed on maximum length FPC (~ 30 - 40 cm)
- Progress overall design optimization

WP4: Layers and Disks (Domenico Elia, Georg Viehhauser, Nicole Apadula)

- Conceptual design of layers and disks, including mechanics, cooling, readout, powering, until the electrical/optical interface
- Choice of cooling
- Thermo-Mechanical prototypes of IB, OB, disks
- Support structure within the subsystem how to keep everything together

Overall approach:

Work towards a fully developed detector concept

Demonstrate the various SVT technologies, as far as possible

People identified here are work package coordinators; many areas to engage

New collaborators welcome!

Towards TDR — SVT

WP5: Readout and power (Jo Schambach, James Glover)

- Data: Define scheme all the way from VTRX+ at end of stave/disks to FELIX, including possible board half way for further data aggregation
- Slow control/clock: Define protocol for multiplexed transmission to staves/disks (in close collaboration with WP1)
- Test of readout components, readout boards concept

WP6 (Andy Jung, Eric Anderssen)

- Definition of services: cables for power, fibers for signals, cooling, other… (in close collaboration with the project, WP5, DAQ group)
- Definition of SVT support (in close collaboration with WP4)
- Definition of global support and integration sequence (in close collaboration with the project)
- Envelope model

Several Work Packages not covered here

General

- Refine radiation and hit rate estimates
- Detailed detector geometry implementation and simulations
- Organizational aspects,
  - Institute roles etc
  - Schedule
  - Cost
  - Risk
  - …
- Assembly, installation, and maintenance

Overall approach:

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Towards TDR — today's snapshot

Tracking / MPGD DSC / SVT DSC

- Current approach is a combination of defining an outline guided by a set of necessary and sufficient tracking figures,
- Work towards a worked-out detector concept,
- Demonstration of technologies, where possible
- Note, however, that e.g. ITS3 ER2 is scheduled for submission in October 2024 and delivery in March 2025, so that functional verification will be beyond our current planning date(s),
- Plan is for success, so far; branch points will need attention not too long from now.

Questions and comments (over-)heard in discussions that may warrant broader discussion:

- How is 60% or 90% design completion defined / assessed in practice? (DOE O 413.3B appendix C-4 "design maturity")
- Are we preparing for CD-2 or CD-2/3?
- Time and effort estimates currently seem to map better onto quarters than onto months.

To be continued (a failure to plan is, of course, a plan for failure).