ePIC MPGD Simulation Status and pre-TRD Discussion

ePIC Collaboration Meeting Leigh University
July 26th 2024

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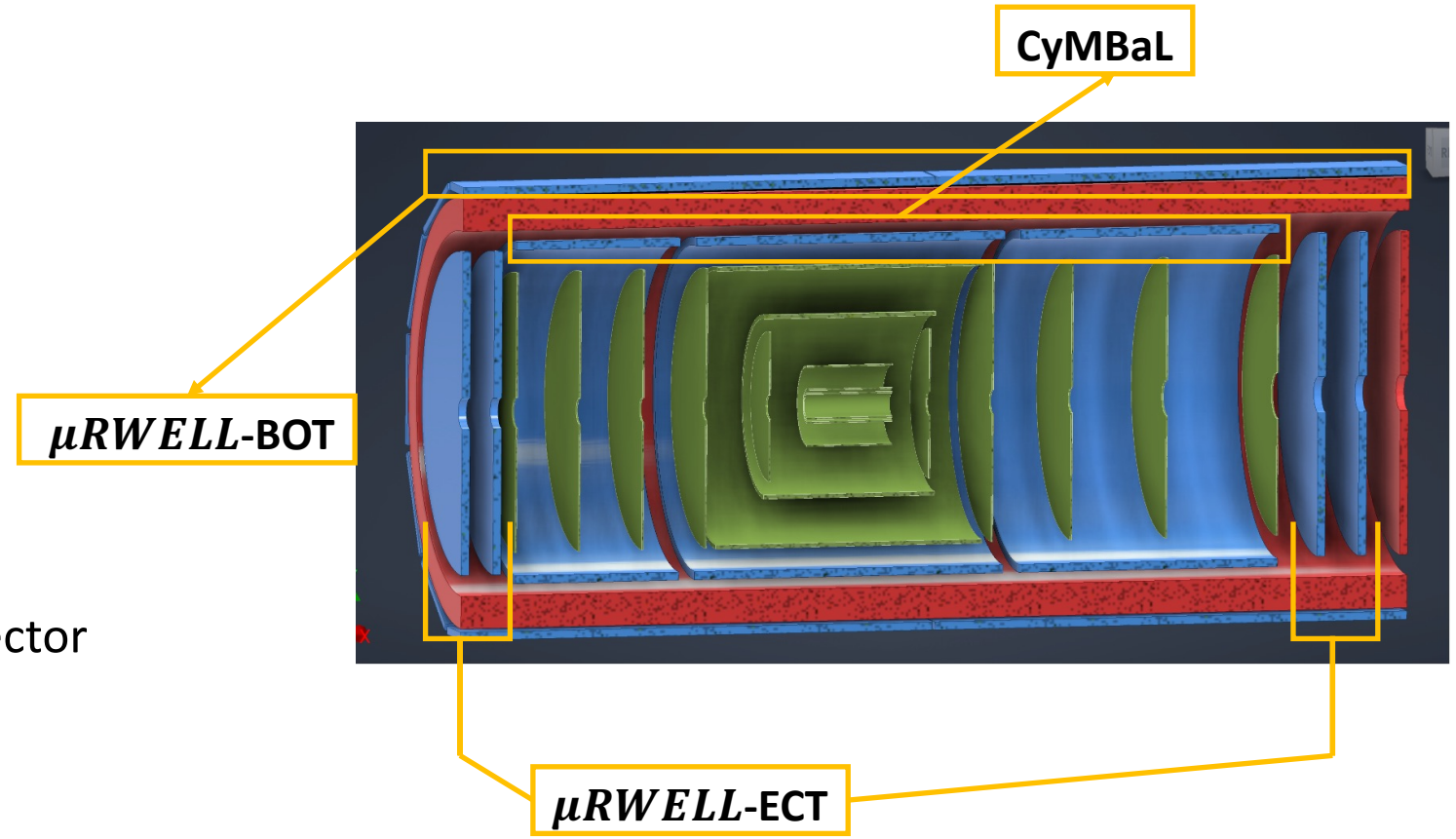
Francesco Bossu (CEA Saclay)

Simulation Task Overview

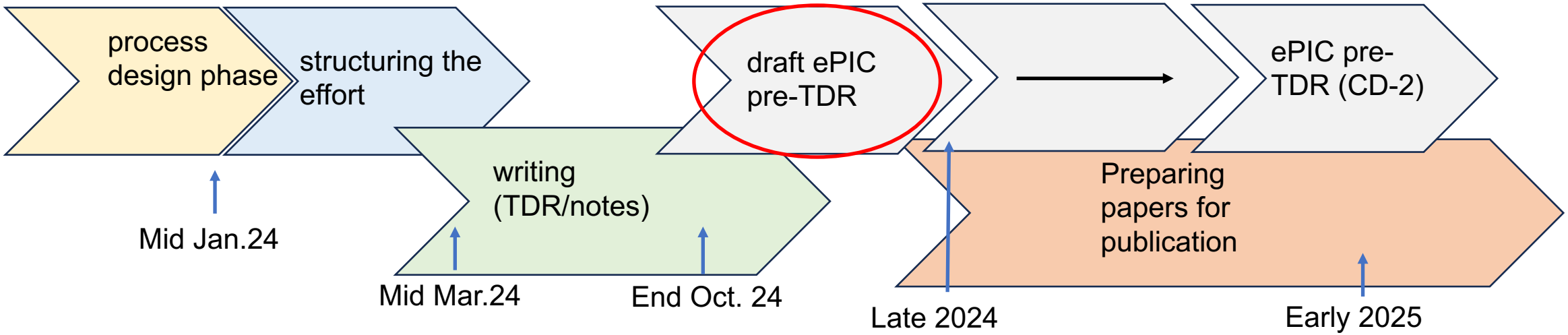
- ❑ Timeline
- ❑ Simulation Status
  - Geometry and segmentation
  - Detector response
- ❑ Simulation Studies
  - Angular resolutions at PID detector
  - Impact on pattern recognition
- ❑ pre-TDR



Simulation progress and studies discussed at MPGD DSC-Simulation Meetings: https://indico.bnl.gov/category/497/

Timeline

- Timelines shown in previous TIC meetings have the main pre-TDR drafting period extending to the **end of October** with the full ePIC contribution draft ready by around the **end of 2024**
  - Campaign used with pre-TDR ~Oct (my assumption)
  - S&C will continue software development throughout pre-TDR



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  - Uses $x - y$ pixelized segmentation
- $\mu RWELL$-ECT
  - Efforts taken over by **Mariangela, Lucilla, and INFN Roma group**
  - Implementing: disk segmentation, frame implementation, proper inner disk hole
  - Uses $x - z$ pixelized segmentation

MPGD Simulation Status Summary

- Overall Status
  - All detectors
    - have reasonable overall material budgets
    - Implement pixelated sensors with fixed spatial resolutions
  - CyMBaL (soon) and $\mu RWELL$-BOT are segmented and have frames
  - $\mu RWELL$-ECT simple geometry, e.g. no geometry segmentation or frames implemented
- Needed/Missing
  - Replacing pixelated sensors with strips
    - May require modification to space point reconstruction algorithm, e.g. pixel (2D) → strips (2x 1D)
  - Performance dependance on track angle
  - Electronics noise

Reco Status | Tracking

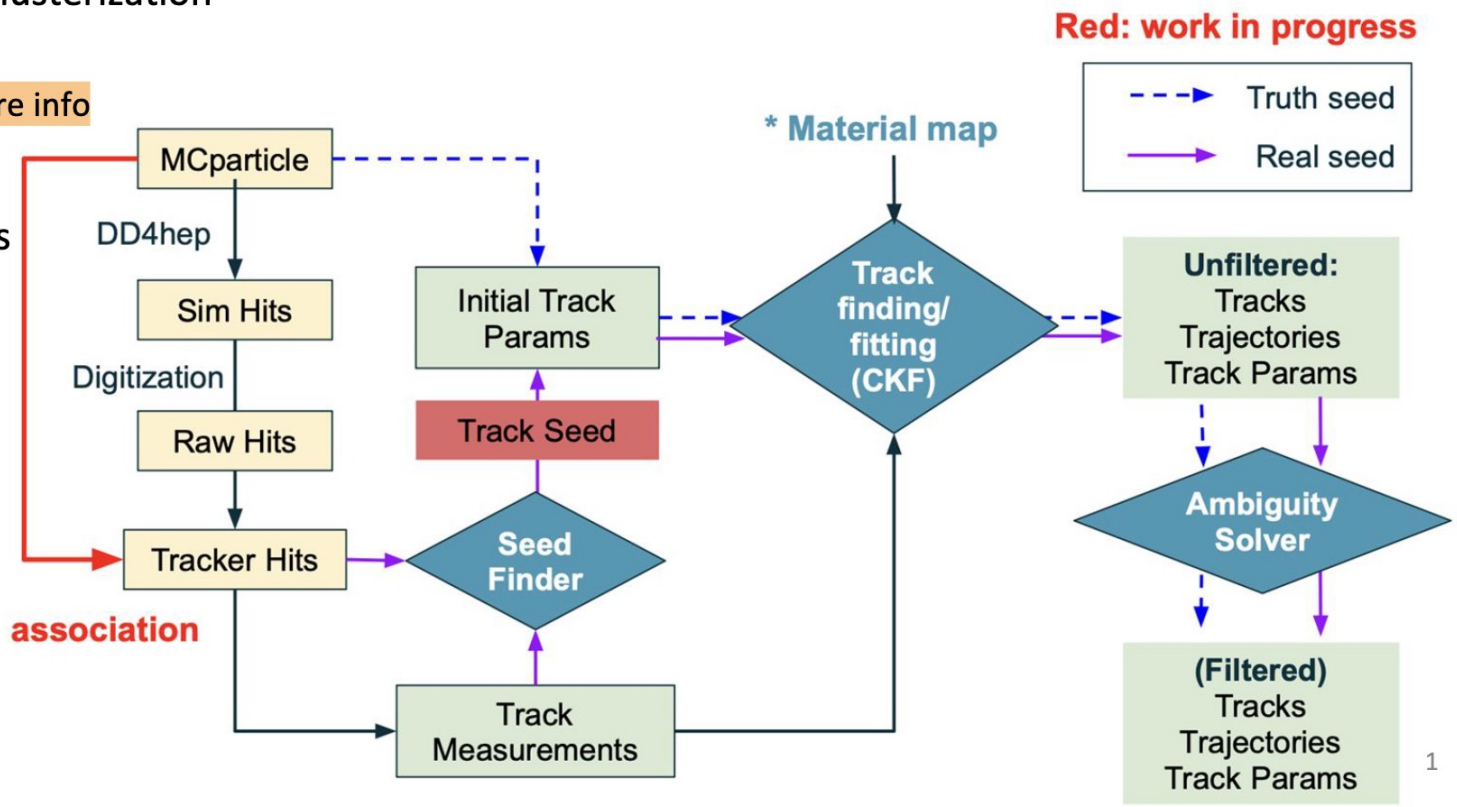
- **Overall Status**
  - Basic workflow in place
  - **What's in place?**
    - tracking finding/fitting with space points
    - realistic seeding and ambiguity resolution
  - **What's missing?**
    - Charge sharing and hits clusterization
    - Timing info

*see Barak's talk in general meeting for more info

- **Near Term Goals:**
  - Understand tracking behaviors with hit-track and seed-track associations
  - Optimize algorithm performance
- **Longer Term Goals:**
  - Tracking with time frame
  - Noise and clustering

- **Workflow Inputs/Outputs:**
  - **Input:** **RecHits from silicon tracker, MPGD, TOF, B0*
  - **Output:** *CentralCKF(Seeded)Trajectories(Unfiltered)*
    Tracks
    TrackParameters

Seed finder Can find multiple triplets from one track
CKF allow track candidates split in track finding from one initial guess
⇒ use ambiguity solver to **filter** duplicates

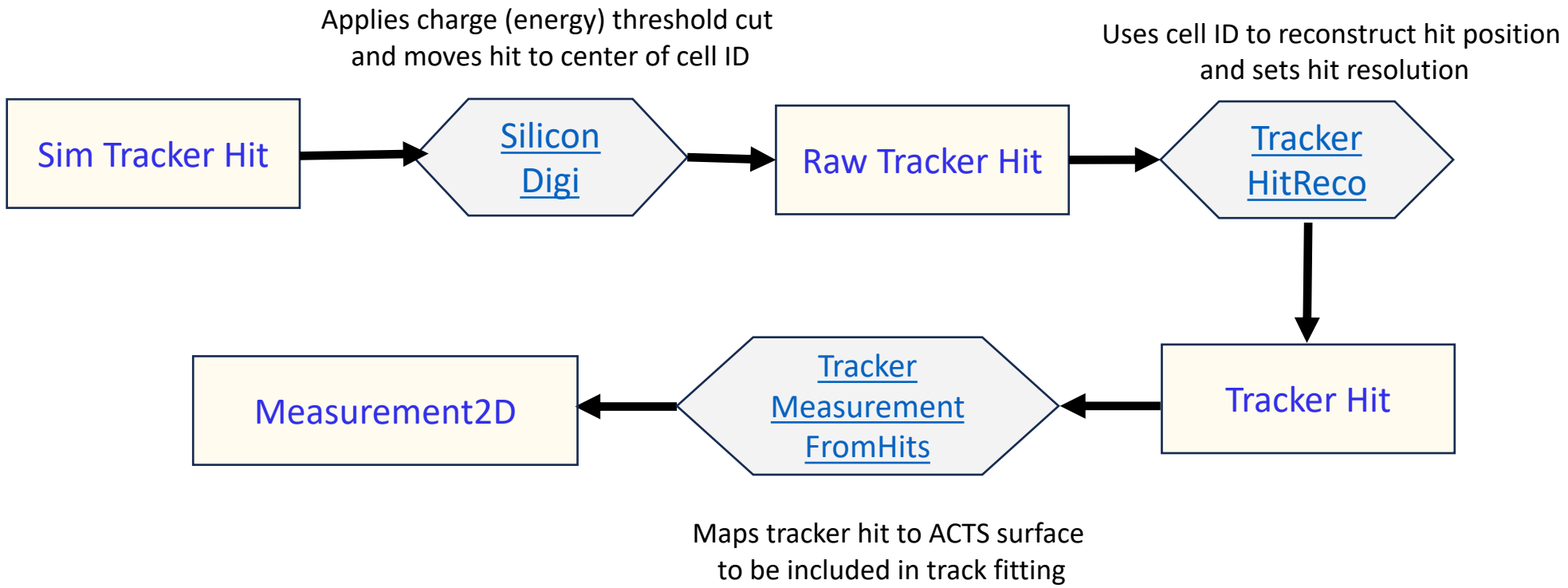


Shujie Li, Berkeley Lab

ePIC Simulation Workflow

❑ Github Repos

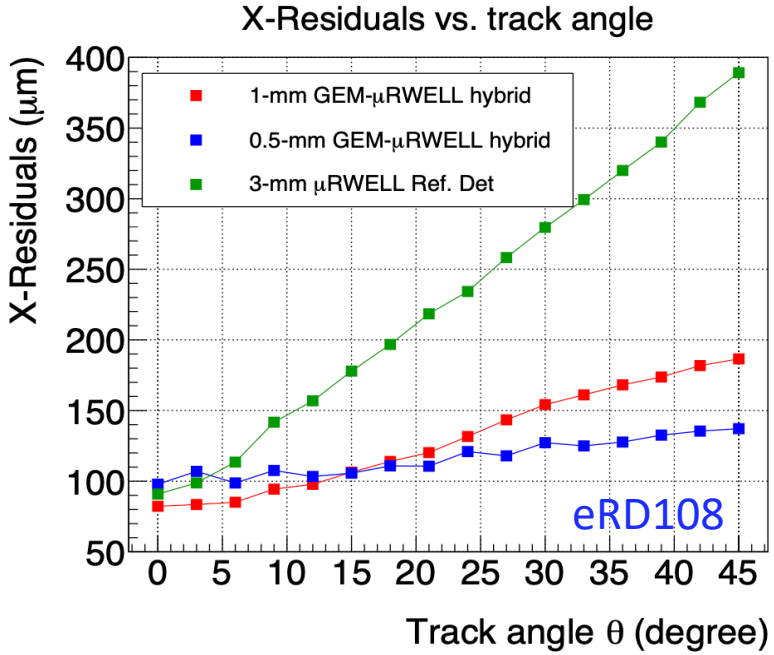
- Geometry: epic
- Digitization/Reconstruction: EICrecon

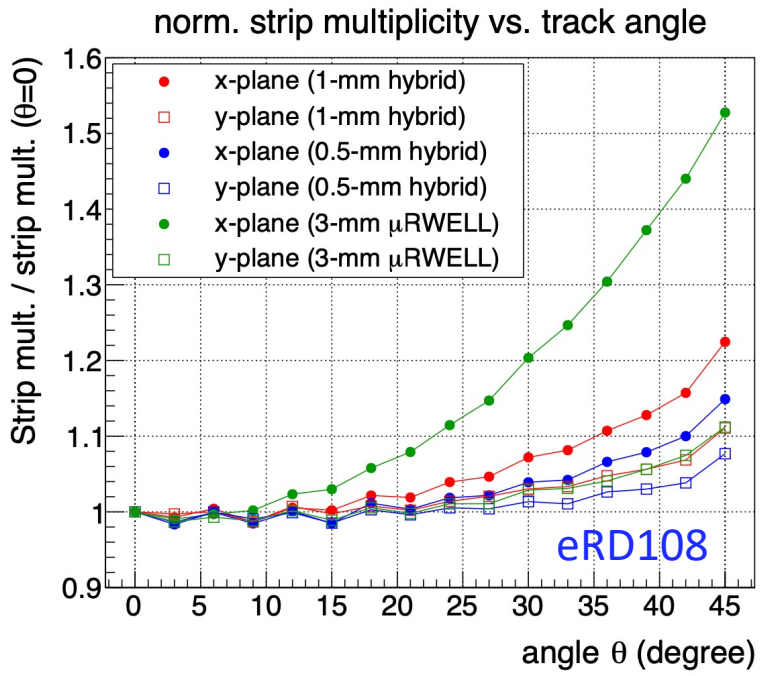


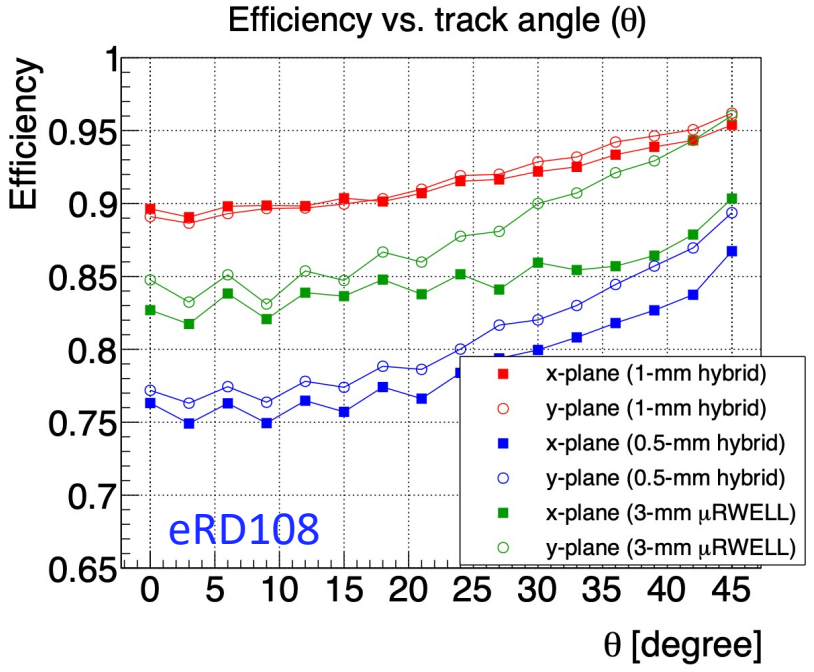
Detector Response

- Realistic detector response to be implemented via test beam data
- Questions:
  - How and where to implement test beam results into simulation framework and workflow?

Test Beam Results







Simulation Studies

- Angular resolutions at PID (hpDIRC) – (**Matt, Shyam**)
  - Study nearly completed and studied the impact of
    - Material and MPGD spatial resolution -- completed
    - Tracklets formed from MPGDs + AC-LGADs -- completed
    - Final checks -- ongoing
    - Impact of BIC – ongoing
- MPGD impact on pattern recognition – not started, (**no one assigned to task**)
  - Complete study needs background embedded environment with simulation time frames to assess sensitivity to spatial and timing resolution
  - Use only background embedded simulation data to get an initial impact on spatial resolution
- Occupancy -- not started, (**no one assigned to task**)
- Radiation dose – (**Sourav**)

Pre-TDR Structure

8.3.3.2 The MPGD trackers

Requirements

Requirements from physics: Add text here.

Requirements from Radiation Hardness: Add text here.

Requirements from Data Rates: Add text here.

Justification

Device concept and technological choice: Add text here.

Subsystem description:

- General device description: Add text here.
- Sensors: Add text here.
- FEE: Add text here.
- Other components: Add text here.

Requirements from Data Rates: Add text here.

Implementation

Services: Add text here.

Subsystem mechanics and integration: Add text here.

Calibration, alignment and monitoring: Add text here.

Status and remaining design effort:

- R&D effort: Add text here.
- E&D status and outlook: Add text here.
- Other activity needed for the design completion: Add text here.
- Status of maturity of the subsystem: Add text here.

Environmental, Safety and Health (ES&H) aspects and Quality Assessment (QA planning): Add text here.

Construction and assembly planning: Add text here.

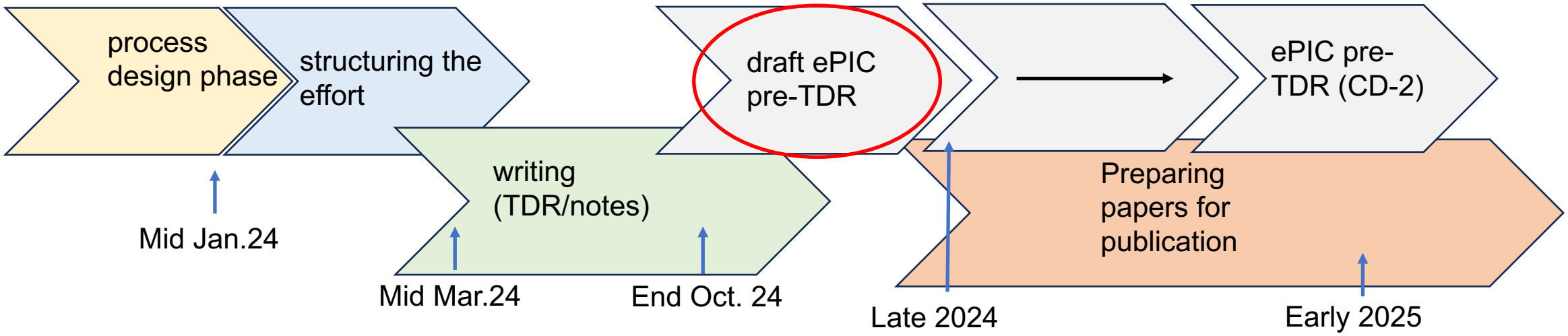
Collaborators and their role, resources and workforce: Add text here.

Risks and mitigation strategy: Add text here.

Additional Material Add text here.

General Writing Strategy

- ❑ Pre-TDR page limited to ~15 pages/subdetector.
- ❑ Additional details will need to appear in appendices
- ❑ Pre-TDR edit privileges limited (e.g. to DSLs)
- ❑ Create private overleaf to allow all MPGD contributors to edit document
  - Clone pre-TDR structure



General Plots Needed

- Associated MPGD requirements
  - Aid in achieving angular resolution into hpDIRC
  - Providing additional hit points for track reconstruction
  - Provide fast timing resolution (~10ns) to separate events from adjacent bunches

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- Detector performance plots
  1. Number of tracker hits vs. eta vs. pT
  2. MPGD hit occupancy – can use signal + background files
  3. MPGD radiation dose
  4. Detector acceptance (vs. eta, momentum)
  5. Detector material: 2D (theta, phi), 1D (eta)
  6. Test beam results
  7. MPGD performance within embedded backgrounds (and time frames)
  8. Residuals and hit distributions