Responses to Elke’s email Sept 20

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On behalf of the eRD108 Consortium / DSC Gaseous Trackers

Meeting with Project and Collaboration leaders - 09/28/2023

1. What R&D needs still to be finalized to show that the Standard µRWell (as discussed on slide 5 of Kondo's TIC presentation, leftmost column) provides an option for an MPGD tracker for ePIC even if the hit resolution is inadequate. We would also like to see a time estimate needed to complete this R&D.

❖ Standard µRWELL with simple 2D strip readout (1 mm pitch / no capacitive-sharing)

- Large area µRWELL modules: Main R&D challenges ➔ Satisfy all the constrains from ePIC
  - Small allocated envelop for the Barrel Outer Tracker 2.5 cm volume
  - Minimize material thickness (~1% X_0) and service and cables requirements
  - Time resolution ~ 10 – 20 ns
- Simple 2D strip readout ➔ No capacitive sharing because we are not targeting good spatial resolution
  - No need for high performance low channel count readout ➔ its is an overkill because the spatial resolution is dominated by the drift gap
  - 1-mm strip pitch ➔ ~ 300 µm [1/sqrt (12)] poor nominal resolution but uniform over a broad track angle range

1. What R&D needs still to be finalized to show that the Standard µRWell (as discussed on slide 5 of Kondo's TIC presentation, leftmost column) provides an option for an MPGD tracker for ePIC even if the hit resolution is inadequate. We would also like to see a time estimate needed to complete this R&D.

- Time estimate to complete R&D: here R&D means large area µRWELL prototypes for barrel Outer Tracker modules and End Cap disk ➔ Answer is ~2 to 2.5 years and
  - ~6 months to finalize the design
  - ~12 months for procurement / fabrication and delivery of the detector parts (mostly from CERN)
  - ~3 months assembly and characterization in participating institutions
  - ~6 months test in beam and analyzing and finalizing
- Opinion within eRD108
  - Strongly expressed opinion by several members within eRD108 is that this not a good option for ePIC gaseous trackers
  - The simulation is in our opinion not ready to provide the input needed to validate such choice for the trackers
  - eRD108 will rally behind the decision by the project and collaboration leaders & build the best detector possible for ePIC
  - But there is very little enthusiasm for the members to work on "poor performance" detector subsystem for ePIC

2. What additional R&D is needed to make a thin-gap µRWell (as discussed on slide 5 of Kondo's TIC presentation, 2nd column from the left) an option for an MPGD tracker for ePIC. We want also would like to see a time estimate needed to complete the R&D for a full-size thin-gap µRWell prototype. Again, we note that this should assume the availability of heavy noble gases and the gas should be chose to optimize the stability of the detector.

- Thin Gap µRWELL **with capacitive-sharing** 2D strip readout (~1 mm pitch)
  - Large area µRWELL modules: Same R&D challenges as for standard µRWELL +
    - Better control of 1-mm drift gap uniformity add a little bit to the challenge
    - Single amplification even with Xe ➔ limited detector efficiency (< 90%)
    - Time resolution < 10 ns
  - Capacitive-sharing 2D strip readout ➔ trying to achieve good spatial resolution over a wide track angle range
    - 1-mm strip pitch ➔ nominal resolution < 100 µm
    - Average resolution over angular range ~ 150 µm ➔ targeted performance

2. What additional R&D is needed to make a thin-gap µRWell (as discussed on slide 5 of Kondo's TIC presentation, 2nd column from the left) an option for an MPGD tracker for ePIC. We want also would like to see a time estimate needed to complete the R&D for a full-size thin-gap µRWell prototype. Again, we note that this should assume the availability of heavy noble gases and the gas should be chose to optimize the stability of the detector.

- Time estimate to complete R&D: similar timeline for R&D to standard µRWELL ➔ Answer is ~2 to 2.5 years and
  - Additional complication ➔ heavy gas cost and availability (during R&D phase) Xe non available
    - 8k$ small Kr-bottle last 8h during June 2023 small thin gap prototypes beam test at Fermilab
    - R&D would be delayed by the heavy gas ➔ then everything depends on how we define completing the R&D effort
- Opinion within eRD108
  - We have some reservation regarding single amplification thin gap even with heavy gas
  - Pushing the gain from the µRWELL device to reach a good level S/N for time and position resolution performance will very likely lead to operating the detectors at their stability limit
  - There won't be any degree of freedom regarding the operating HV of the detectors
  - This might not be way to approach a detector subsystem that will be installed in a collider experiment

In parallel to developing the requested information about remaining R&D, Matt Posik's simulation studies should be pursued because they will guide how small the μRWell gap needs to be, i.e., maybe can one live with a drift gap of 2mm instead of 1mm.

2-mm "thin gap" μRWELL does not make much sense in the context we are talking to

- It is basically the worse both worlds
- In fact, ideally we would like to go below 1 mm is this is technically feasible