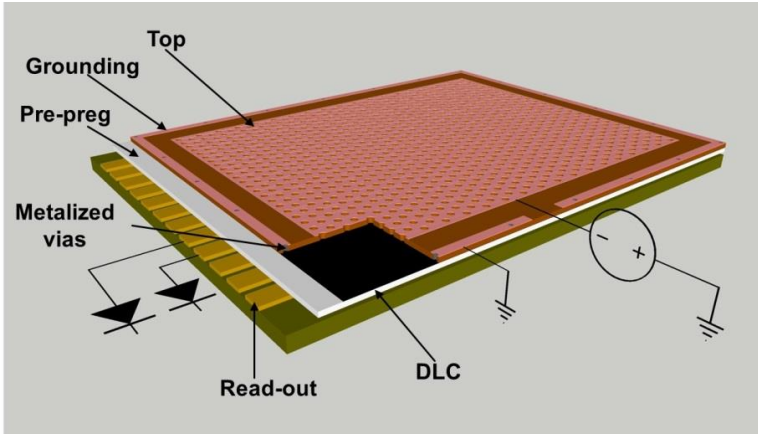
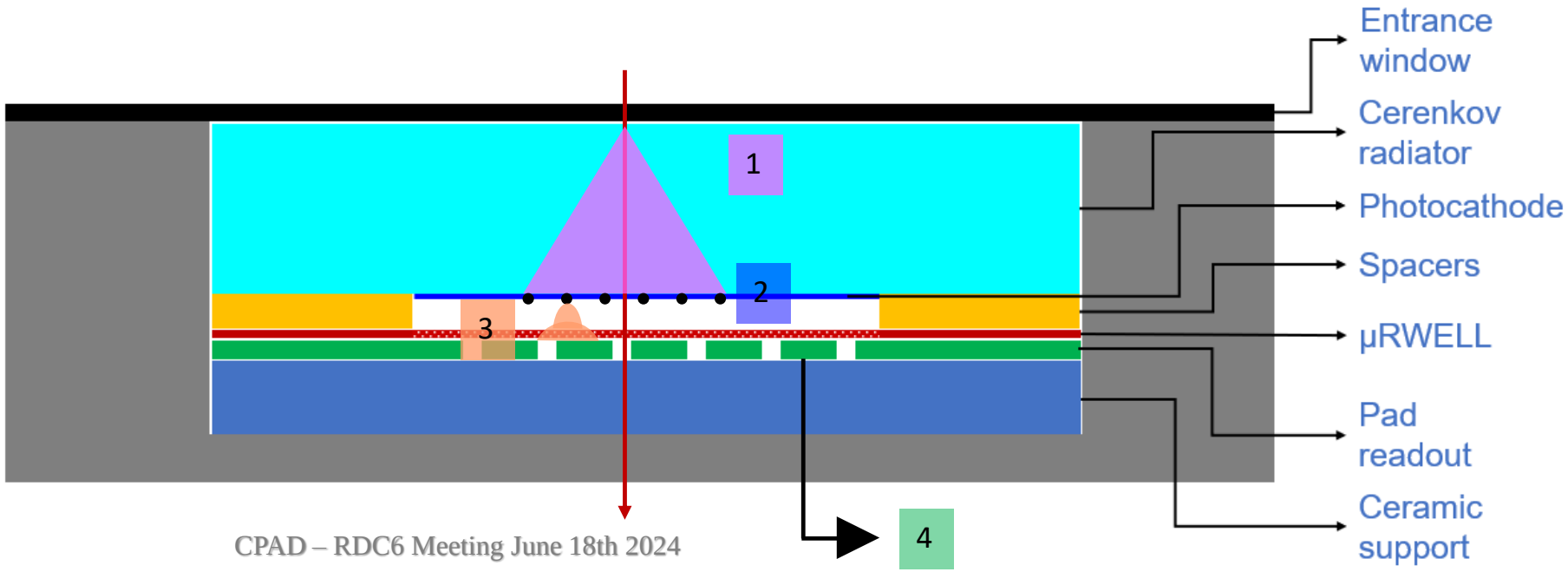
Basic concept of Fast timing µRWELL-PICOSEC detector

Concept of µRWELL-PICOSEC: Fast timing based on µRWELL technology ➔ tens of ps

1. Cherenkov photons: relativistic charged particle creates Cerenkov (prompt) photons ➔ timing.
2. Photoelectrons: convert Cerenkov photons into electrons created at the same z position ➔ timing
3. Pre-amplification: Pre-amplification of electrons 100 to 200 µm gas in high drift field (~20 kV/cm)
4. Amplification : second amplification in µRWELL gain structure ➔ high electric field (>40 kV/cm)
5. Electronic Signal: Arrival of the amplified electrons to the anode creates a signal.



1. Cerenkov photons in radiator
2. Photoelectrons in photocathode
3. Pre-amplification in 200 µm gas
3. uRWELL amplification
4. Collection of electronic signal



μRWELL-PICOSEC: Application in HEP/NP instrumentation

Timing detector for relativistic charged particles:

- Cerenkov radiator crystal transparent in VUV region
- High quantum efficiency (QE) photocathode in VUV medium ~ 7 photoelectrons for 3 mm MgF2
- Goal for timing resolution (~25 ps)

Applications:

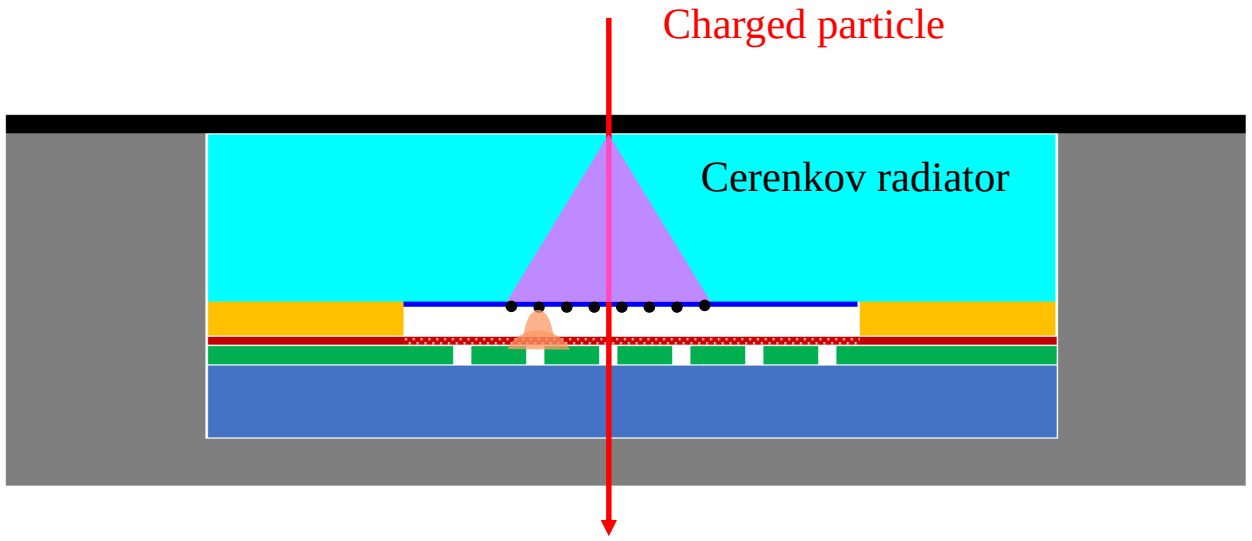
- **Time of Flight detector**
- **T0 detector**

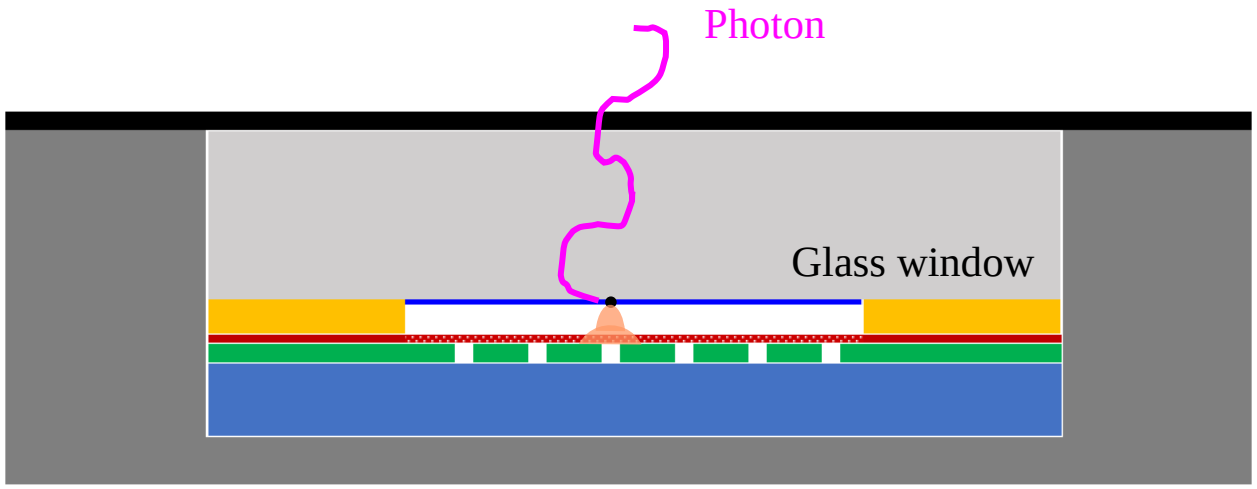
Single photon photodetector:

- High quantum efficiency (QE) photocathode in (VUV) medium which is most radiated by any radiator medium
- Window transparent to Cerenkov radiation
- High gain for single photon timing goal of ~50 ps

Applications:

- **Photosensor for RICH detectors**
- **T0 tagger at neutrino detector (liquid Ar scintillator light)**





Development of µRWELL-PICOSEC detector

Background & Rationale:

- Develop precise and fast timing cost effective gaseous detectors for particle physics and medical application.
- high-rate capability, stable in strong B-field, radiation hard, large-area, low-cost Properties such as stability, radiation hardness, large area, segmented readout are highly desirable for such timing detectors.
- Development of picosecond detector based on µRWELL technology has the potential to satisfy such requirements.

Investigate alternative radiator and photocathode materials.

- Explore alternative and more robust photocathode materials to Cesium Iodide (CsI).
- Investigate ideas of focusing optic devices integrated with radiator for precise position measurement in addition to timing.

Integrated multi-channel µRWELL-PICOSEC readout electronics readout and DAQ system.

- Lab bench precision measurement of the timing performances of µrPICOSEC prototypes.
- Development of readout and DAQ system for 100-pads channels for µrPICOSEC prototypes.

Application in Future NP and HEP Experiments:

- Cutting edge technology for high-luminosity / high energy upgrades at Jefferson Lab.
- Alternative technology to AC-LGADs and LAPPDs for future collider experiments such as EIC second detector of ePIC detector upgrade
- Explore medical imaging application such as TOF-PET based on µRWELL-PICOSEC technologies