Remaining R&D Milestones

## eRD102 (dRICH)

Validate production readiness as matched with photosensors, readout electronics, and integrated cooling, including validation by prototypes that the EIC requirements can be met

FY25: Real scale prototype completion & performance assessment. [March 2025]

Projected to be completed this FY. Per 2024 Detector R&D Day: working on reproducibility and improvements. Multiple validations completed and component QA has been set up. Demos completed (aerogel, mirrors, etc.). Completion of integrated cooling (and thermal treatments) is last step.

## eRD103 (hpDIRC)

Validate production readiness of a new high-performance DIRC detector by DIRC bar characterization, and vertical-slice prototype cosmic and beam tests including a realistic readout box. [June 2025]

Done. First DIRC bar characterization complete. Cosmic ray telescope exists. Ingredients exist for characterization and cosmics/beam tests with readout box. Intent can be completed with one sensor, but sensor for comparative test has been delayed, No showstoppers.

## eRD104 (Service Reduction)

Develop powering scheme based on serial powering to mitigate service space needs of DC-DC scheme. [December 2023].

Done. Initial powering schemes developed per 2024 Detector R&D Day.

Evaluate radiation tolerant FPGAs and high-speed fiber optic transmission option with beam test. Complete prototype multiplexing firmware. [December 2024]

 TBD

## eRD106 (Fwd EM Cal)

Done. R&D to validate production readiness is complete.

## eRD107 (Fwd H Cal)

Validate production readiness by machining and characterization of tiles, prototype module production, integration of final readout, and common beam test with EM calorimeter prototype. [June 2025]

Done. Beam tests in September/October 2023 and May 2024 at CERN/PS. Validation for 4-8 full 8M modules and H2GCROC in August 2024. {Note: common beam tests with EMCal in front was treated as optional}.

## eRD108 (MPGDs)

Complete beam test validation of cylindrical RWELL with prototype [September 2023]

Done. Complete with small-size prototypes. As part of PED effort we make a full-scale engineering test article as mechanical stability is the largest operational issue.

Complete validation of use of light-weight cylindrical Micromegas with 2D readout patterns as derived from the earlier used cylindrical technology [December 2024]

Capacitive versus zigzag readout. Per 2024 Detector R&D Day: Full scale prototype with 2D readout will be ready late this CY (2024) to finalize design choice.

## eRD109 (ASIC/FEE)

Develop a streaming readout solution for the EIC calorimeters with SiPMs and the associated PCBs and cabling infrastructure. Decide between options using COTS devices or directly starting from existing ASICs. [September 2025]

Done. Per 2024 Detector R&D Day: Decision is made for COTS (forward and backward EM calorimeter) as baseline versus ASICs as alternate. COTS specifications complete in FY24, with engineering test article planned as supported by PED. For ASICs/H2GCROC evaluation ongoing, LFHCAL tests at CERN May 2024. Further H2GCROC development done as in-kind by OMEGA/IN2P3 group to create CALOROC that is compatible with streaming. CALOROC1 is FY24/FY25, CALOROC ready for construction FY26.

Develop a streaming readout solution specific to the Ring-Imaging Cherenkov (RICH) particle identification detectors with SiPMs. This may require a modification of an existing ASIC design. [December 2025]

Done. Per 2024 Detector R&D Day: ALCOR is chose to provide this ASIC. The ALCOR development is done as in-kind by INFN. ALCORv2 32 pixel 8 x 4 in FY24, ALCORv3 64 pixel 8 x 8 in FY25, ALCORv4 ready for construction in FY26.

Develop a streaming readout solution specific to particle identification detectors with LAPPDs and/or MCPMTs. This requires a novel ASIC in 130 nm CMOS technology that meets the requirements set by EIC providing a precise time measurement with a TDC combined with an Analog Digital Converter (ADC) for the amplitude measurement. [December 2026]

Done. Per 2024 Detector R&D Day: Can tentatively use FCFD or EICROCx in smaller footprint. Baseline choice made in FY24 is FCFD. Further work carried as PED.

Develop a low-mass streaming readout solution specific to the barrel-region AC-LGAD at an EIC Detector, including design of the power delivery and readout service system. This includes a decision between redesign of existing ASICs or use of third-party ASIC solutions [September 2025].

Done. Per 2024 Detector R&D Day: Decision complete - Redesign of existing ASIC. EICROC is done as in-kind by OMEGA/IN2P3. EICROC0 exist with 4 x 4 channels, power reduction in next version. Design of EICROC1 ongoing (4 x 16 to 8 x 32 variations possible). EICROC2 with 32 x 32 in FY26. For barrel AC-LGAD (strip) use FCFD. FCFDv1 with added interfaces in FY24/FY25, synergy with FNAL/DUNE, FCFDv2 ready for construction in FY26.

Develop a streaming readout solution specific to the MPGD-based tracking detectors. This requires a modification based on previous ASIC designs to include compatibility with streaming readout, a new CMOS technology, and 64-channels. [March 2026].

Done. Per 2024 Detector R&D Day: Much work is done as in-kind by CEA/USP. 4-channel SALSA submitted April 2024. ER variations in FY24/FY25 are carried as PED.

## eRD110 (Photosensors)

Ensure applicability of SiPM readout for Ring-Imaging Cherenkov detectors. This implies validation of operation in the single photon regime, and studies of irradiation and in-situ annealing to ensure operation in a "radiation damaged and annealed" mode is possible. [September 2022]

Done. Per 2024 Detector R&D Day: complete and continuing studies driven by INFN.

Establish production readiness of a LAPPD/HRPPD-based photon-sensor readout for a Ring-Imaging Cherenkov Detector on the electron-side endcap of ePIC, including validation by prototype beam tests. [September 2024]

Obsolete. Production readiness of HRPPDs is captured as PED effort. Engineering test article of proximity-focusing Ring-Imaging Cherenkov Detector ongoing.

## eRD111 (SVT)

Report completed on barrel and disc cooling options, allowing cooling choice [December 2023]

Report is outstanding. Per 2024 Detector R&D Day: ITS3 has demonstrated air cooling is feasible for their array of vertex layers. Power estimate of EIC-LAS sensors has been refined, Baseline cooling design is air internal to the mechanical structure(s); liquid cooling in strategic places.

R&D completed for stitching of sensors [September 2024]

TBD. From 2024 Detector R&D Day: Work on MOSAIX tile circuitry with stitched backbone ongoing at BNL and MIT. Access to MOSAIX database hampers progress; needs CERN/ITS3 agreement.

## eRD112 (ToF/AC-LGAD)

Validate production readiness of the AC-LGAD detectors in the barrel region, the forward side end cap of the EIC detector, and the far-forward Roman Pot beam line detectors. This includes sensor prototypes, ASIC demonstrator, and full-scale parts tested and finalized. [September 2026]

Done, HPK sensors look promising. Have purchased 3rd version HPK sensors with FY24 funds and collaborated on CERN purchase of FBK sensors for comparison, testing ongoing in FY25. ASIC demonstrator can only be beyond CD-2 so this will be Project Engineering and Design.

## eRD113 (MAPS/ITS3/MOSAIX)

End-of-R&D Milestone: EIC vertex sensor (MOSAIX) quantification finalized [Sept. 2025]

Work related to EIC vertex sensor final engineering run (FY26) will be done as PED.

Done. ER2 tape-out at CERN expected in May/June 2025. Further MAPS/ITS3-related work is done as Project Engineering and Design activities as this is towards production-readiness sensors.

## eRD115 (Barrel EM Cal)

Characterize the integrated AstroPix and SciFi/Pb system with a mixed e/π beam and MIPs, benchmarking the response to charged pions, benchmarking the electron-pion separation capability, and testing the new generation SiPMs. [Summer 2025]

Projected to be completed this FY? Per 2024 Detector R&D Day: Recycle GlueX Baby BCal and add imaging layers. Baby BCal moved to ANL and Astropix setup prepared. Dependent on FBTF beam availability.