

The case for a 2nd detector at IR8 at the EIC

The science case for the EIC was developed and endorsed by the National Academy of Sciences (NAS). The NAS report discusses in detail the scientific questions driving the conception and design of the EIC accelerator, the large acceptance multi-purpose detector to be built by the ePIC collaboration in the 6 o'clock interaction region (IR) and a second detector that could be stationed at the 8 o'clock IR. This motivation includes fundamental questions about the origin of the proton's spin and mass, the characteristics of the "glue" that binds quarks inside of nucleons, and the nature of very dense gluon systems in nuclei.

The ePIC Detector is, by definition, designed to address the science program described in the NAS report. However, a second detector will allow for enhanced capabilities in selected sectors. Examples include a higher magnetic field for increased tracking resolution in the kinematic region crucial for exploring low-x physics, a topic that was highlighted as high discovery potential in the NAS report. The addition of a muon detector at the 2nd Detector would allow the EIC to explore heavy flavor physics via complementary decay channels while also opening doors to new channels in proton tomography and Beyond the Standard Model Physics. Finally, the implementation of a secondary focus into the beam optics of IR8 would enable a novel new program focused on the 3D partonic structure of nuclei and the phenomenology of target fragmentation by allowing for the direct detection of scattered ions in the far forward region. Besides providing these new opportunities and the reduction of systematic errors when combined with precision results from ePIC, only a second detector allows for mutual confirmation of results, a crucial component of discovery science. Two detectors will also expand the opportunities for a new generation of scientists and encourage technological development and innovation by fostering between the two collaborations a healthy and friendly competition, which provides the most fertile ground for the emergence of the best new ideas.

The timeline for a second experiment is important. The programs at IR8 would follow ePIC by several years, allowing for the timely validation of flagship measurements and the exploration of surprising new results. This delayed time frame is being used to pursue advances in detector technologies via the current EIC R&D program. In the spring of 2022 the Detector Proposal Advisory Panel, an international committee of detector experts and theorists assembled to review the detector proposals submitted for IR6, noted in their report *“There is significant support in the community and from the panel for a second general-purpose detector system to be installed in IR8 when resources are available.”* Capitalizing on this momentum the EIC Users Group (EICUG) formed the 2nd Detector and IR8 working group in the summer of 2022 and charged them with engaging the broader community to develop a unified concept for a 2nd Detector at IR8. This working group is in the process of refining the science case for a second detector and plans to engage in the DOE critical decision process within the next five years. The realization of IR8 with a secondary focus and general-purpose detector will require significant external (ie non-DOE) funding and the EICUG is actively working to engage additional national and international resources for this effort.