DIRC and high-B budget

	FY16	FY17	FY18	*Total*
Postdoc (50%)	$57k	$58k	$59k	*$174k*
Students	$16k	$16k	$16k	*$48k*
Hardware	$15k	$35k	$35k	*$85k*
Travel	$27k	$21k	$25k	*$73k*
Total	*$115k*	*$130k*	*$135k*	*$380k*

	FY16	FY17	FY18	Total
ODU	$57k	$58k	$59k	*$174k*
CUA	$8k	$8k	$8k	*$24k*
USC	$15k	$15k	$15k	*$45k*
JLab and GSI	$35k	$49k	$53k	*$137k*
Total	*$115,000*	*$130,000*	*$135,000*	*$380k*

Manpower

50% postdoc at ODU
summer students at USC and CUA for high-B tests

Hardware

FY16
$15k for LHe and minor high-B components (sensor holders, etc)

FY17
$15k for LHe and minor high-B components
$25k for radiation hard lens

FY18
$15k for LHe and minor high-B components
$20k for adding precision timing capability to high-B facility

Abstract draft

An essential requirement for the central detector of an Electron-Ion Collider (EIC) is a radially-compact subsystem providing particle identification (e/π, π/K, K/p) over a wide momentum range. To this end, the electromagnetic calorimeter needs to be complemented by one or more Cherenkov detectors. With a radial size of only a few cm, a Detector of Internally Reflected Cherenkov light (DIRC) is a very attractive option. Currently, R&D is being undertaken for several DIRC projects around the world (Belle-II, PANDA, LHCb). A future EIC DIRC can benefit from many aspects of these efforts, but it also provides its own unique set of challenges and priorities, for instance due to the in momentum distributions of the produced particles, and the impact of the readout of the DIRC bars on the detector endcap design.

The initial goal of the DIRC R&D (eRD4) undertaken as part of the Generic R&D for an EIC program was to demonstrate the feasibility of building a high-performance DIRC that would extend the momentum coverage by up to 50% beyond state-of-the-art. Through a combination of simulations and prototype studies we now consider this goal to be achieved using an approach an approach with BaBar-like boxes with narrow bars, each an advanced spherical three-layer lens, and a common, compact (30 cm long) expansion volume of fused silica. Some work is still ongoing to evaluate the performance of the final lens prototype (such as the evaluation of CERN test beam from the spring of 2015 aimed at measuring the photon yield), but we expect most of this to be completed in FY15. This was, on one hand, made possible by the high performance of the advanced three-layer spherical lens over the full range of polar angles (in terms of achieved single-photon θ_c resolution and photon yield) that was designed in FY13 and procured in FY14, and on the other by the flatness of its focal plane, which allowed us to save a substantial amount of funds by not having to build and test a new expansion volume designed specifically to match the lens properties.

An aspect of eRD4 that has greatly expanded during the course of the R&D effort (even though the total budget remained flat - in part due to contributions from the participating groups), has been the studies of component performance in the environment of an EIC detector. The flagship project was the development of the high-B sensor test facility, which was commissioned in FY14 and started taking production data in FY15. The initial results for MCP-PMTs with small pore size are intriguing, as they suggest that on one hand this type of sensor could provide a low-noise sensor solution for single-photon measurements (required for Cherenkov applications) in fields of 1-3 T, but also that the performance of the MCP-PMTs is strongly dependent on the angle with respect to the local B-field, and is significantly affected by the details of the design. The latter suggests that the effort could eventually move beyond the characterization of different sensors and, together with sensor manufacturers, develop sensors optimized for the magnetic environment of an EIC detector. As such, the high-B test facility not only provides synergies with the other PID-related activities, but also is an important resource for all EIC detector R&D. Over time the photosensor work could become an independent effort within the consortium, but for now we chose, for continuity, to keep it in the DIRC chapter.

Following the suggestions from the committee, the main goal of the DIRC R&D proposed as part of the

PID consortium proposal will now be aimed developing a specific, cost-performance optimized DIRC solution for the EIC detector(s). This will involve several steps.

In order to establish a baseline solution, we will address the radiation hardness of the high-performance DIRC already developed. The lens prototype that was developed for the optics tests used both radiation hard fused silica as well as NLAK glass. Destructive radiation tests are under way with one such lens, but for the longer term we will try to build another prototype using either PbF_2 or a radiation hard glass (the latter would somewhat reduce the photon yield due to absorption of some wavelengths). Due to the lead content, making such lenses will first require us to find an appropriate manufacturer (planned for FY16).

In addition, two other solution will be investigated. The first will focus on potential cost savings by replacing the narrow BaBar-like bars with wider plates. In this case the reduction in the number of side bounces is lower, which reduces the required tolerances of the surfaces, greatly easing manufacture. With good timing resolution (~100 ps), it now becomes possible to determine the number of side reflections and the exit location of each photon. However, in contrast to Belle II, which will rely primarily on the time information, we would like to pursue a full 3D (x, y, t) capability. To do so will require developing appropriate optics (*e.g.*, advanced cylindrical lenses) and new reconstruction algorithms (with possible synergies with the proposed RICH effort). As previously, there will be large synergies with the PANDA DIRC group. This work can start right away in FY16.

The other solution will focus on an FDIRC-like readout for BaBar-like bar boxes, using SLAC experience and synergies with the GlueX DIRC project, which aims at producing such a solution over the next three years for four of the actual BaBar boxes. Based on this work, we will also investigate the possible performance improvements by coupling the bars directly to a compact expansion volume (without the performance-reducing prisms) and by using smaller pixels. However, in order to fully benefit from the synergies with GlueX, the bulk of this work will be done in FY17 and FY18. This will also have the advantage that later on, an investigation can be made of the suitability of an FDIRC-like readout for plate radiators and a comparison made with cylindrical lenses.

We feel that this plan addresses the suggestions of the committee to continue the high-B sensor program, pursue the development of radiation hard lenses, and make a comparative cost-performance study of the different configurations possible for a specific EIC DIRC application.