

C75 Preliminary Design Review

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Charge:

The next cryomodule from CEBAF to be refurbished will be removed during the summer down this year. The present intent is that the cryomodule will be refurbished according to a plan called C75. The charge to the committee for this preliminary design review can be most easily summarized by the committee answering several questions in a formal report:

1. Are the requirements and goals for the C75 cryomodule understood, well specified, and realistic?
2. Is the preliminary design conceptually complete, and likely to lead to an operating cryomodule with the desired characteristics? Will the design be flexible enough to take full advantage of ongoing R&D?
3. Is the C75 cryomodule planned adequately and “ready to go” for refurbishing activity to commence starting toward the end of 2016? If not, should refurbishments as C50 continue until outstanding issues are resolved, or should other paths (e.g., full C100 replacement) be pursued?

Committee Response:

The need for a cost-effective CEBAF 12 GeV maintenance program is clear. The objective is to ensure that JLab can deliver reliable operation for the approved physics program, which requires both full energy and full current. Maintaining this capability requires a recycling program for CEBAF cryomodules which replaces lost linac voltage, reduces cryogenic heat load, and increases availability. In addition, Arne provided the value metric that reducing the integrated CEBAF trip rate by 5 trips/hour is equivalent to about 2.5 weeks of beam to the user in a 30 week year, corresponding to a savings of \$1.25M/year in terms of weeks of beam operations.

A cost analysis clearly favors reworking existing cryomodules over replacement with new. Unfortunately, simple continuation of the C50 effort will yield decreasing benefits as the capability of the worst-performing cryomodule is slowly increasing as a consequence of our always picking the lowest-performing cryomodule for the next C50 upgrade. With the current trend of ~34 MV integrated voltage loss per year (1.5%), the current C50 program will not sustain the needed physics availability for more than a couple of years. The proposed C75 concept provides a straightforward path resulting in incremental improvements to the reworked cavities which promises all-round better performance and return on investment. It efficiently brings to bear for CEBAF the SRF design, technique, and material improvements of the past 20 years.

The C75 concept will enable full exploitation of improvements that are independently underway to secure higher Q's and reduced field emission in newly built cryomodules and to stabilize in-tunnel performance. It also dovetails with on-going CEBAF RF system evolution, directly exploiting the LLRF and HPRF designs running the injector cryomodule, R100. The LLRF is simply a duplication of that implemented for the C100 cryomodules.

A clear rationale should be offered for why the goal of $Q_0 > 8\text{e}9$ is chosen for CEBAF, while JLab is providing cryomodules with $Q_0 > 2.7\text{e}10$ for LCLS-II.

The motivation and concept for C75 are clear and fully supported by the review committee. We recommend that the full cost of anticipated CEBAF linac maintenance requirements for the next 5 years be collected and parsed for clarity, including provision of needed spare components. This should clearly identify the incremental costs for C75 over a sustained 1/year C50 program and the projected break-even point considering the value of additional effective weeks of physics running that would result from improved availability and trip-rate reduction.

The identification of C75 R&D topics presented was mature and, if resourced, will support appropriate demonstration tests prior to the required commit date for the next cryomodule rework.

For maximum benefit, ongoing Q_0 improvement and field emission reduction R&D should be coupled as strongly as possible to the current C50-12 work, as well as to the subsequent cryomodule and on-going tunnel servicing work.

Summary responses:

1. Are the requirements and goals for the C75 cryomodule understood, well specified, and realistic?
 - **Yes**
2. Is the preliminary design conceptually complete, and likely to lead to an operating cryomodule with the desired characteristics? Will the design be flexible enough to take full advantage of ongoing R&D?
 - **Yes, if other improvement efforts (Q_0 and FE control) proceed in parallel.**
3. Is the C75 cryomodule planned adequately and “ready to go” for refurbishing activity to commence starting toward the end of 2016? If not, should refurbishments as C50 continue until outstanding issues are resolved, or should other paths (e.g., full C100 replacement) be pursued?
 - **Yes, if adequately resourced. Decision points were identified.**

Recommendations specific to the proposed C75 work:

1. A clear separation should be made between actions that are aimed at improving performance (better Q_0) in both C50 or C75 cryomodules and those that are specific to the C75 module.
2. A budget table should be produced that links expenditures to the proposed milestones in developing the C75 concept. The table should also address the out year annual expenditures, showing the planned C50 costs and the additional cost for the C75 program. The budget tables should separate procurements from JLab labor.
3. Proceed aggressively with implementation of the C75 program as paced by available budget authority.
4. Prepare an analysis of and propose a C75-based program which would provide very satisfying availability for the physics program within three years and sustain it confidently thereafter.