

Upgrade Cost Group Review of the ALICE FoCAL Project¹

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Process : The review began with an introductory meeting on November 29, 2023, at which ALICE described the FoCAL detectors, the outcomes of their R&D program, cost estimates, schedule, risks, and various special issues. Given that the ~8 M€ project cost is below the 10 M€ UCG threshold and the design is mature, detailed and based on extensive R&D, we decided that an iterative meeting was not needed. Instead, ALICE would submit the FoCAL UCG package in January with the expectation that a focus session at the Feb-March LHCC meeting would be sufficient for us to evaluate the project and make recommendations. We received the FoCAL UCG package two weeks ago and followed up with a few minor questions. At the focus session held on February 26, ALICE summarized the developments since November, making a persuasive case that the project was well understood and ready for approval.

Overview: The FoCAL project consists of two independent forward calorimeters, FoCAL E and FoCAL H, to cover the pseudo-rapidity range $3.2 < \eta < 5.8$. The electromagnetic calorimeter FoCAL E consists of silicon pads (1 cm x1cm resolution) interspersed between $1-X_0$ tungsten layers, and two pixel layers with $30\mu\text{m} \times 30\mu\text{m}$ segmentation to help with π^0 recognition. FoCAL H uses copper tubes containing scintillating fibres, configured to have 10,000 1 cm x1cm readout towers. The project depends critically on readout chips designed for the CMS HGCal. Common FoCAL items include cooling, power, platform, DSS, DCS, and DAQ.

Organization, Management and Schedule: It was clear that ALICE took the review seriously and did its best to profit from the exercise. The project is well organized with strong leadership, management, and technical personnel. The schedule and cost estimates are credible, supported by highly detailed WBS, Gantt and milestone charts. Positions appear to be largely filled down to levels 2 and 3, importantly with actual identified people holding appropriate skills. Risks are identified and quantified, with reasonable mitigation plans, including responses to various developments in the Ukraine.

The beryllium beam pipe presents a special risk. The traditional vendor no longer accepts orders and no other commercial vendors have come forward, forcing CERN to do this delicate job. ALICE is not alone, as ATLAS also depends on CERN for their beampipe.

Cost Situation: The estimated cost of 8 M€ has been stable since November and is less than that at the time of the LOI. The estimate is almost entirely based on actual vendor quotations, as is demonstrated by the extraordinarily secure cost-weighted average Quality Factor of 1.3. The funding situation, though greatly improved from what it was in November, remains a concern because 32% of the required funds are not yet in hand. In mitigation ALICE has been able to reallocate sufficient resources to keep on schedule for at least a year, in expectation that their remaining funding requests will be approved. Furthermore, there are feasible descoping and phasing scenarios that allow parts of the installation to take place during the YETS following LS3.

¹ [CERN-LHCC-2024-004 ; ALICE-TDR-022](#)

To elaborate:

- Sufficient funding is now available to join the ~358 k€ of joint chip procurements with CMS, a step essential for FOCAL to stay on schedule.
- However, US funding is still not in place.
 - Fortunately, ALICE is able to reallocate available resources to mitigate a near-term lack of US funding and prevent delays, as long as the money is approved in a year or so.
 - There are reasonable prospects for 1.5 M in-kind contribution from India.
- Though not complete, the money matrix shows reasonable coverage as far as it goes.

Conclusion: We recommend approval of the FOCAL TDR to the RB and RRB to allow the project to begin and resources to become available.