

# U.S. ATLAS HL-LHC Upgrade Project

## NSF Annual MREFC Director's Review

*15 - 16 June 2021*

Committee:

Ed Blucher (Chair), Tulika Bose, John Carlstrom,  
Cathy Lavelle, Ted Liu, Lucas Taylor, Paul Tipton

# 1. Completion of Final Design

- a. Review FDR panel recommendations and comment on whether they have been satisfactorily addressed.

## Comments:

- Yes, it appears that all technical FDR (and NSF EVMS Verification Review) recommendations have been addressed satisfactorily.
- Several Education and Public Outreach recommendations have not yet been implemented because of COVID. EPO activities are restarting now, and will be reviewed in the context of the Operations Plan renewal in July 2021. The results of this Operations Plan review should be part of the August MREFC presentation.

## Recommendations

- None

# 1. Completion of Final Design (cont.)

- b. Have pre-construction technical activities that were separately funded by NSF through the ATLAS operations program been satisfactorily completed?

## Comments:

- Most pre-MREFC activities have been completed; a few remain (5 milestones under HTT and 2 under Global Trigger) but are expected to be completed by the NSF MREFC review in August. These should be closely monitored.

## Recommendations

- None

## 2. Project Management

- a. Implementation of PEP, project controls and financial reporting, including sub awardee oversight. *Examine the current version of the PEP, representative change control actions, and recent EVMS Reports and advise NSF on their use as effective management tools.*

### Comments:

- The current PEP clearly outlines the organization, roles/responsibilities and management processes implemented to manage and control the project performance.
- Scope is clearly delineated in the WBS by funding agency and tracked appropriately.
- The resource loaded schedule (RLS) appears well developed, and is logically linked with critical path activities identified for each L2 WBS.
- The project team measures performance against the RLS, which is maintained through baseline change control and updated monthly using earned value processes.
- The project applies variance analysis thresholds to ensure timely reporting of variances.
- The Cost Estimating Plan should be reviewed and updated to incorporate the latest guidance.e.g. “All material and travel resources are entered in FY17 dollars”.

## 2. Project Management

### Comments (continued):

- The practice of implementing baseline changes to replan work planned in the past is inconsistent with the EIA Standard 748 for EVMS and should not be continued. The COVID BCP 1033 is cited as an example where work was planned in July 2020 and rescheduled to start in Jan 2021. This BCP was approved and implemented in December 2020. The project cited an NSF guidance document for re-baselining COVID-impacted work as the authorization to replan work in the past, but this guidance specifically states that work planned in the past should not change performance indicators in the past. The result of this BCP is a re-statement of the BCWS which modified the performance metrics. This practice is inconsistent with the NSF guidance and the EVM System Description at BNL. The project did have discussions with NSF on implementing this change.

### Recommendations

- Implement proactive reviewing of “look ahead schedules” for work scheduled 3-6 months in the future that cannot be performed as planned, and replan this work through the formal change control process, ensuring EVMS compliance.

## 2. Project Management

### b. Financial tracking of COVID and non-CoVID costs & cumulative COVID costs-to-date.

#### Comments:

- In the Overview and Cost and Schedule talks address the items in the review charge more explicitly to better present the big picture (e.g. total cost with and without Covid).
- The cost reporting of actual costs and accruals seems to be working well. In the accounting systems, Covid and non-Covid costs are not distinguished. Once the actuals and accruals are collected, the fraction of costs attributable to Covid are estimated. This approach is reasonable.
- The Covid actual costs (\$1.67M to date) and COVID BCPs (\$1.33M to date) need to be more clearly communicated, especially given that the COVID BCPs were retroactive. There is some residual overlap (possible double-counting) of these actuals and the BCPs that needs to be resolved.
- The presentation of Covid cost impacts should be clearly presented as two components:
  - **Historical Covid costs**, which should only include past Covid actual costs and accruals.
  - **Future Covid costs**, which is the sum of BCPs that add future Covid costs to the baseline plus the cost impacts of the Covid scenarios (or a single CL from the three scenarios).

## 2. Project Management

- b. Financial tracking of COVID and non-CoVID costs & cumulative COVID costs-to-date.

### Recommendations

- The presentation of costs needs to be more clearly articulated, for example as a summary table showing:
  - **Costs not including Covid** (e.g. at 90% CL) = Direct + Indirect + Escalation + Estimate Uncertainty + non-Covid Risk Contingency
  - **Costs including Covid** (e.g. at 90% CL) = Non-Covid costs + Covid Actuals/Accruals + Covid BCPs + Covid Scenarios

## 2. Project Management

- c. Risk management process, including completeness of current projections of risk and potential mitigation costs and the adequacy of the contingency budget and schedule to mitigate future non-COVID risks. *Advise NSF on the completeness of the risk register in identifying currently foreseen non-COVID related threats and opportunities with appropriate probabilities and estimated cost and schedule.*

### Comments:

- Risks are reviewed quarterly, and risk actions are reported monthly to NSF.
- The risk register was recently reviewed and updated; most changes were modest (e.g. updated risk expiration dates to reflect COVID delays).



## 2. Project Management

### Comments (continued):

- Project summary talks could usefully show high-level risk summaries, such as:
  - Top 10 cost risks (e.g. tornado plot of average risk cost)
  - Top 10 schedule risks (e.g. delay per risk to critical path)
  - Total project cost probability distribution function, with 70% and 90% CLs
  - Project finish date and project float, with 70% and 90% CLs
- The risk analysis MC that aggregates all risks was been updated but only the cost contingency numbers were shown. The schedule risk MC results should also be shown.

### Recommendations

- Include in the presentations in August summaries of the main results (see comments) and results of the non-COVID schedule risk analysis, such as risk-adjusted float to the ATLAS need by dates (e.g. at 90% C.L.) for all L2 deliverables.

## 2. Project Management

- d. *Adherence to the QA/QC processes presented at the FDR. Advise NSF on whether it is being implemented as intended.*

### Comments:

- Project management listed documentation that showed they have addressed FDR recommendations on QA/QC processes.
- The project summary talks could more thoroughly respond to this specific charge item. A brief summary of the QA/QC processes that are in place and being followed would be helpful.
- Since the International ATLAS QA/QC process is part of the project QA/QC plan, it would be helpful for reviewers to see a series of slides, one for each WBS 6.4, 6.5, 6.6, and 6.8, that summarizes all International ATLAS reviews since the NSF FDR, giving review outcomes and recommendations. Alternatively these could be in each of the technical progress presentations.

## 2. Project Management

- d. Adherence to the QA/QC processes presented at the FDR. *Advise NSF on whether it is being implemented as intended.*

### Recommendations

- None

### 3. Plans for FY 2022

- a. Examine and comment on COVID impact modelling and assessment by the project of forecast COVID-related cost and schedule impacts. Advise on the realism of assumptions and the credibility of the models used, and the completeness (base on current understanding) of additional schedule and budget needs. Advise on the timing for when additional NSF funds to offset pandemic impacts are likely to be needed within the project.

#### Comments:

- The Covid modeling methodology, initially developed by Fermilab, applies Covid inefficiencies to activities in the P6 schedule to model Covid lockdowns, safe-working in Labs, and teleworking. This methodology is conceptually sound.
- The Covid working efficiencies applied to future scenarios are informed by project performance to date (albeit with large intrinsic uncertainties). This is a solid approach, although the teleworking efficiency of 70% seems low compared to other similar projects.
- The Covid High (worst case) scenario assumes a 15% Covid increase in vendor costs, based on management judgment following discussions with vendors (with varying degrees of openness). The project is encouraged to refine this estimate based on more detailed assessment of specific purchases, and to continue monitoring potential vendor cost increases due to Covid.

### 3. Plans for FY 2022

#### Comments (continued):

- The project has stated that there are “significant impacts on vendor lead times”. These effects have not been modeled in the Covid risk scenario analysis. They should be included.
- The COVID High scenario does not consider the possibility of a lockdown due to a major resurgence of a new virus variant. The project should consider including such a lockdown.
- The COVID scenario analysis is based on scaling from an old (July 2020) analysis. It should be updated to use the current project schedule and Covid scenarios calendars in P6.
- A single COVID schedule scenario impact (14 months) and a single marching army cost ( $\$1,162\text{k} = 14 \text{ months} * \$83\text{k} / \text{month}$ ) is assumed in all three COVID scenarios. The analysis needs allow for different delays and different burn rate costs of each scenario.
- Covid risk delays from vendors, or for deliverables to the US from partners, should be included the Covid risk assessment (perhaps not on the timescale of the August review). The proposed approach of adding new risks for handover milestones is reasonable.

# 3. Plans for FY 2022

## Recommendations:

- Update the COVID risk modeling to address the deficiencies described in the comments
- Present a clear summary of the COVID cost impacts, including:
  - **COVID actual costs/accruals in the past** (labor inefficiencies, extra PPE, etc.)
  - **Costs of COVID schedule variances** (escalation, marching army costs)
  - **COVID BCPs that add resources in the future** (inefficiencies, escalation, marching army)
  - **COVID scenario analyses** (direct impacts, escalation, marching army costs) e.g. at 90% CL
  - **COVID impacts on vendors, partner delays, amplification of non-COVID risks**
- Present results of the schedule risk analysis with and without Covid. For example, for each US-ATLAS final L2 deliverable, show the milestone dates for:
  - 1) L2 deliverable complete — baseline early finish, no risks
  - 2) L2 deliverable complete — late finish, including risk (e.g. at 90% CL)
  - 3) L2 deliverable complete — late finish, including risk, for each of Covid L/M/H scenarios
  - 4) L2 deliverable — iATLAS need by date
  - 5) L2 float values (months) between need by dates and (non-Covid and Covid) late finish dates

### 3. Plans for FY 2022

- b. Examine and comment on the realism of plans for the coming project year (10/1/21 - 9/30/22) based on current understanding of COVID pandemic impacts and mitigation strategies, and lessons learned from the first year of construction.

#### Comments:

- In the previous year, the management team has clearly learned a great deal about how to guide this project through a global pandemic. They demonstrated a clear commitment to using the project metrics to pinpoint problem areas. The management team is making a good effort to keep the metrics meaningful and predictive, while also teasing out COVID from non-COVID effects.
- The project management team indicated that their working efficiencies are slowly increasing as the institutes learn how to work with Covid restrictions
- There is ongoing concern about vendor delays and vendor cost increases.
- The project summary talks could more thoroughly respond to this specific charge item. While there is more uncertainty about meeting milestones due to the impact of COVID, a succinct, reasonable statement of what are the most likely outcomes in the next FY for each WBS would help the reviewers address this question.

## 3. Plans for FY 2022

- c. Examine and forecast risk-adjusted expenditure and obligation profile (including pandemic-related risks) for the coming fiscal year and advise on the adequacy of its substantiation. Make recommendations for modification, if appropriate.

### Comments:

- The funding and cost profiles were presented and the cost profile has been revised to account for some of the COVID impacts through two BCPs that impacted on past performance.
- The Covid risks and scenario analysis results were not fully included in the cost profiles and should be taken into account.
- The project did not present the associated obligations profile and the documentation provided to reviewers included an obligations profile that was below the cost profile in some fiscal years.

### Recommendations

- In the presentations show funding, obligations and cost profiles that depicts the current planning where obligations are reflective of all potential costs (base cost plus escalation) for labor and material. The effects of the COVID scenarios should be shown.



## 3. Plans for FY 2022

- d. Do the materials presented by the project provide adequate substantiation for re-baselining within the next 6-12 months? If not, what criteria must be satisfied as a precondition for conducting a re-baselining review that would confidently bound estimates for additional schedule and budget based on current understanding?

### Comments:

- No, current information is not sufficient to assess when a re-baselining is possible. The risk analysis was not yet complete -- notably the schedule risk analysis -- and the Covid scenarios are not yet fully updated (see previous comments).
- Lab access has improved but there are still significant uncertainties in vendor lead times and costs
- Rebaselining the project not only requires stability for the US project, but also for vendors and international collaborators, including CERN.

### Recommendations

- For the August review, the project should present a high level roadmap towards re-baselining, including required pre-conditions, such as: status of the pandemic, working efficiencies of US ATLAS institutes, expected vendor costs and delays, and the status of the iATLAS and CERN schedules

## 4. Technical Progress

- a. Comment on the adequacy of progress and planning across all Level 3 WBS elements, considering COVID-19 uncertainties. Identify non-COVID-related impediments to technical progress and comment on the adequacy of plans and efforts exerted by ATLAS to mitigate their impacts.

### Comments:

- Technical progress has been made across WBS areas, for example radiation testing of the LAr ADC in 2020 and early 2021 which allowed successful ADC PDR in Dec 2020 (with now well advanced design for COLUTAv4).
- Good technical progress occurred despite COVID inefficiencies and restrictions (e.g. lack of access to irradiation facilities). With the limited time of this one day review, it was not possible to adequately assess the progress in all areas in sufficient detail.
- **LAr:** ongoing commissioning for Run 3 led to labor availability issues for backend electronics work, which was addressed by strengthening the team working on firmware and integration. Availability of some components (part of global ASIC shortage) for v1.1 SRTM is a concern, as full testing of the SRTM v1.1 boards is needed to finalize v2.0 SRTM design.

## 4. Technical Progress

Comments (continued):

- **TILE Cal:** TILE Cal technical progress generally looks very good. There have been significant schedule delays since the FDR. Risk-adjusted L2 completion dates and associated float to the need-by dates should be presented at the August review.
- **Muon:** As a result of the ATLAS PDR, the design for the prototype Command Module (non-US scope, MPI) for the L0MDT changed affecting also the Service Module design (US/NSF scope). Firmware implementation is underway. Activities should be carefully monitored.
- **Muon:** sMDT production had initial failure rates of 20%. The issues are mostly understood and the failure rate is now ~5 - 10%. The project is working to further reduce the failure rate. It would be useful to define a goal (maximum allowed failure rate) for the August review.

## 4. Technical Progress

Comments (continued):

- **Trigger:** The hardware-based Track Trigger is undergoing a technology re-baseline due to the L0-only architecture decision by international ATLAS. Any of the 3 options chosen as the baseline will impact the current US ATLAS trigger project, some much more than the others. This major architectural uncertainty is not captured in the Trigger risk register. We are told that, on June 16 2021 (the day this review ends), the extended TDAQ steering group will select an option to be retained as the baseline.

Recommendations

- Since the iATLAS approval of track trigger re-baseline will happen (Oct 2021), the project should present one clear option as the baseline for the August review and capture uncertainties associated with the Track Trigger re-baseline as risks (threats and opportunities) in the risk register and risk analysis.

## 4. Technical Progress

- b. Comment on the level of engineering and scientific labor that is being applied to support Level 0 Trigger development, as evidenced by satisfactory technical progress in firmware development.

### Comments:

- From the material provided, it was not possible to respond to this review question.

### Recommendations

- For the August review, provide sufficient information in the Trigger presentations for reviewers to address Review Charge question 4(b).

# Summary

- Your clear and informative talks, and responses to our questions, were much appreciated, especially given the short duration of the review
- The HL-LHC ATLAS NSF project has made very impressive technical progress in spite of the COVID challenges
- There is still substantial future uncertainty due to COVID, in addition to the delay incurred so far. The COVID risk analysis needs more work to assess this and inform re-baselining decisions.

In addition to the specific comments and recommendations, the committee suggests:

- Presentations in the August review should more clearly address each charge question, and point to supporting materials
- Additional materials should be made available in advance to the reviewers, such as:
  - Cost Estimate BOEs, vendor quotes, .xer file of the P6 schedule, project summary schedule, project milestone listing, and critical path.