The committee thanks ATLAS for their hard work in crafting these presentations, and found them very responsive in Q&A. The committee believes ATLAS is on track for a review in April. A few items that we feel should be addressed are included in the body of this report.

Subcommittee: Management, Project Controls, Cost and Schedule

Tom LeCompte (SLAC), Raj Gutta (BNL), Victor Krabbendam (LSST) and Marco Verzocchi (FNAL)

Answers to Charge Questions:

A. Are the new baseline cost and schedule changes reasonable, well justified and documented?

   Yes. However, the ATLAS team should provide additional justification on contingency.

B. Is the risk register complete?

   Yes, although the loss of key personnel has been a challenge and based on this experience, ATLAS may wish to review these risks,

C. Are the risk adjusted cost and schedule changes reasonable and well justified?

   Yes. However, the ATLAS team should provide additional justification on contingency.

D. Is there high confidence that the remaining project scope can be accomplished within the revised budget and the revised schedule? Can it meet ATLAS need-by dates?

   Yes, although we offer a recommendation to address isolated schedule pressures.

E. Are the additional to COVID-19 impacts (from supply chain, high inflation, schedule delays, Ukraine war) that increase the TPC clearly identified and justified? This will form the basis of the additional funds requested.

   Yes. These are coupled, and "impact accounting" (was this Supply Chain or was this High Inflation?) may prove difficult.

F. How has the scope of uncosted scientific labor changed with the re-baselining, and what are the implications of these changes on the project scope, budget, schedule, and risk?

   The scope has not changed much in terms of total number of FTEs. However there have been challenges with the availability of the scientific labor due to the overlap

between the commissioning of the Phase 1 upgrades and the start of the HL-LHC work. These problems may continue as ATLAS is running now, so there are operational demands on people's time. (Note: it is difficult to answer this question in yes/no terms).

G. Are the scope contingencies and up scope opportunities credible and reasonably valued?

Yes.

H. Is the Project well managed? Is the review documentation complete?

Yes. The review documentation needs some attention - specific comments follow.

I. Evaluate the current technical status of the subsystem and the plans for the coming year- are they reasonable? Are there specific technical challenges? Do the external dependencies (if any) raise concerns?

N/A

J. Has the scientific (uncosted) labor needs/expectation changed, and if so, what are the potential impacts? Is the project utilizing a satisfactory means for managing, monitoring, and tracking uncosted labor contributions?

N/A - see the other subcommittee sections

K. Is the project adhering to best practices in systems engineering, interface management, and subaward management?

Yes.

Findings:

- The project has lost some key engineers and this has contributed in some cases to the delays that have been accumulated so far. The problem has been partially mitigated by involving more institutions in some of the developments.
- There are over 100 days of float between the scheduled completion date and the CERN need-by date.
- Addition to TPC doesn't include the positive cost variance
- Cost/ Schedule/ Risk/ Rebaseline presentation is mostly thorough and addresses many charge questions.
- EVM data from Dec-2022 Monthly status report-
    - BCWS = $23.85M

    - BCWP = $18.80M
    - ACWP = $16.80M
    - SV= -$5M; SPI=0.79
    - CV = +$2M; CPI=1.12
    - BAC = $52.42M; EAC=$50.67M
    - TPC = $75M (does not include COVID BCP costs $1.6M)
- Requesting $6.4M in base funding for direct World Event impact and $3.1M in additional contingency for added global and project schedule risk for a new Risk Adjusted TPC of $84.5M.
- The NSF is covering more than its fair share (based on PhD authors) of contributions formerly the responsibility of Russia or Belarus. The explanation given is that this is where the expertise is. To compensate, the additional M&O contribution is reduced.
- The project presently plans to reset baseline (S=P=A) upon approval of rebaseline, which means the positive Cost Variance (approx. $2M) will be part of TPC additions.

Comments (Technical):

- The project should assess whether they have adequately captured the risk of loss of key personnel and if they are taking sufficient mitigation steps.
- Consider how to justify the added $3.1M contingency given the results of the 90%CL results from the MC.
- Supply chain issues continue to affect some components needed to populate electronic boards. The uncertainty on the lead time for some components is of the order of a year or more and any delay on the procurements may significantly reduce the available schedule float. This risk can be mitigated by early procurements of these components which requires small changes in the ATLAS approval procedures.

Comments (Presentation and Documentation):

- Cost/ Schedule/ Risk/ Rebaseline presentation included elements of charge questions related to both status and rebaseline which may be overwhelming for the reviewers.
- It was possible to misunderstand some of the schedules and whether “float” referred to the critical path or the need-by date. Clarification may aid future committees’ understanding.
- Some of the content of Mike Tuts’s presentation (Project Controls and Financial Management) is probably more appropriate to the Management / Cost / Schedule

breakout instead of being in a plenary presentation, despite the fact that these slides address some of the charge questions.

- The plot in slide 19 of Mike Tuts (yearly funding needs in the original and new baseline, plus available funding) is not very clear. It would be better to show also the cumulative curves in the same plot, despite the fact that there may be drawbacks from doing this (why do you need to re-baseline now ? should we wait another year and see ?).
- The ATLAS team could help the committee in writing their report by adding flags on the slides (answer to charge XX), which sometimes appear on the slides. They probably meant to do this by having a document linked from the web page called “Charge to Review Panel with Links to Documentation” but unfortunately that points to the document from a previous review. Either solution works, and the ATLAS team should choose one and implement it consistently.
- In Mike Tuts presentation the issue of the NSF contribution to covering the missing contributions from Belarus, Russia, and JINR could cause questions, since it is obvious that US-NSF is taking responsibility for more than the share of Ph.D. authors. The reply provided to this question was very clear. The committee thinks that it would be better to have slides ready on this issue.
- In the presentations it was not always clear whether the new cost estimates were based on an update of all the basis of estimate documentation(including new quotes) or simply on the accounting for the increased inflation. This came up only during a question and answer session. Since the new baseline is based on an update of the BoE documentation, this point should be made very clearly in future reviews.
- The information on the amount of contributed work is contained only in the four L2 presentations (the Muon presentation contains this information in a format different from the three others). It would be preferable to summarize this information in one of the management presentations and have backup slides discussing the issues that have arisen with the contributed labor (and in particular the issue of missing contributed labor at institutions that receive their base grant from DOE).
- The time allocated to the L2 presentations was minimal and the presenters had to rush through their presentations. When preparing the agenda for the NSF review the ATLAS project should consider allocating more time to the L2 presentations and to Gustaaf Broojimans’s presentation.
- Opening Intro talk:
    - Hyper Inflation is mentioned – Adding words or comment to preview that this is above the Current Execution Plan(CEP) 3% and using national/global data impacts FY23/4

    - Schedule slides: consider that these are new reference but focus on summarizing changes that have delayed need dates. This can set up the second presentation and then the detailed talks from the L2
    - Forecast for Audience the general project management updates:
        - As commented during presentation: highlight any changes (if any) to high level org chart
        - PEP changes? Consider having a draft update available for Review.
        - Comment that CEP changes are procedural without cost impacts.
        - Comment on Plan for submitting the Supplemental Funding Request (SFR). Keep in mind that an SFR wants the changes while a PEP is the cumulative.
        - Consider developing a draft of the SFR before the review.
    - Consider adding a broad statement about ES&H to show attention at highest level. Can forecast the good comments in the individual talks.
    - Opening talk has Scope contingency Status, consider a high level comment about Budget contingency and Schedule pressure as forecast for next talks.
    - Emphasize the solid System Engineering (SE) approach and availability of detailed talk in breakout.
- Cost/Schedule summary talk
    - Consider how to emphasize that all BCPs (both types) follow the approved CEP
    - Slide 9 non-COVID schedule impacts – (See also other comment above) Consider how to emphasize Management attention and to forecast details addressed in later reports AND coordinate with later presentations to connect with these numbers and comments.
- Other Talks / Templates
    - Nice consistent format – shows good coordination and helps reviewers, the occasional customization is appropriate to reflect some differences in projects
    - Main Changes slide: Change “Known Risk” to “Realized Known Risk”

Recommendations:

- Before the next review, determine if S=P=A reset is in the best interest of the Project. Whatever is decided, be prepared with a crisp justification on why you made the choice you did and ensure all the talks are in alignment.

- Consider proceeding with the procurements of items with long lead times (FPGAs, other discrete components for electronic boards) at least six months prior to the corresponding ATLAS PRRs as a way to preserve the available schedule contingency.

Subcommittee: Muons and Trigger

Alexei Safonov (Texas A&M), Darin Acosta (Rice)

Answers to Charge Questions:

A. Are the new baseline cost and schedule changes reasonable, well justified and documented?

   Yes, apart from the specific comments related to Muon CSM and L0MDT where further clarifications may be needed.

B. Is the risk register complete?

   Yes

C. Are the risk adjusted cost and schedule changes reasonable and well justified?

   Yes. For the risk associated with COTs such as FPGAs, e.g. RN-06-06-05-003 add, the potential schedule impact may be underestimated as the delays may run as long as 24 months (the risk quotes 12 months as “high”). The realized risk for personnel loss for GEP algorithm firmware was included in BCP 1057b.

D. Is there high confidence that the remaining project scope can be accomplished within the revised budget and the revised schedule? Can it meet ATLAS need-by dates?

   Yes, apart from the clarifications with the sMDT and L0MDT that have been noted. The delay from the loss of GEP algorithm firmware personnel was accounted for, and is not on the critical path.

E. Are the additional to COVID-19 impacts (from supply chain, high inflation, schedule delays, Ukraine war) that increase the TPC clearly identified and justified? This will form the basis of the additional funds requested.

   Yes. For the CSM, if the decision is made to purchase the voltage regulator components at a higher price, the TPC may need to be adjusted. Trigger does not have a supply-chain impact for its deliverables.

F. How has the scope of uncosted scientific labor changed with the rebaselining, and what are the implications of these changes on the project scope, budget, schedule, and risk?

   Not much, the changes to the uncosted scientific labor scope are essentially negligible.

G. Are the scope contingencies and up scope opportunities credible and reasonably valued?

   Yes.

H. Is the Project well managed? Is the review documentation complete?

   Yes and Yes. Given potential schedule risks, the Muon management team should continue putting high emphasis on timely and pro-active risk mitigation (particularly, for schedule).

I. Evaluate the current technical status of the subsystem and the plans for the coming year- are they reasonable? Are there specific technical challenges? Do the external dependencies (if any) raise concerns?

   For the Muon project, the answer is in general yes. For the CSM dependence on the commercial components, which may have an unknown delivery time, the project should consider addressing the issue with priority. The L0MDT, the design changes recommended and implemented in 2021 have impacted the schedule, but are expected to streamline the design and were worth making from technical perspective.

   The progress and plans for the optical plant (WBS 6.8.1) are reasonable. Progress and plans for the GEP framework firmware for (WBS 6.8.3) also are reasonable. Progress was somewhat hindered recently for the GEP algorithm firmware of 6.8.3 due to the unfortunate loss of personnel, for which replacement hiring is in progress. No concerns on external dependencies.

J. Has the scientific (uncosted) labor needs/expectation changed, and if so, what are the potential impacts? Is the project utilizing a satisfactory means for managing, monitoring, and tracking uncosted labor contributions?

   No, changes to scientific labor are very minimal.

K. Is the project adhering to best practices in systems engineering, interface management, and subaward management?

   Yes

Muon Findings:

- sMDT chamber production and assembly work (WBS 6.6.1) has been ongoing with a significant fraction of the assembly already completed.
- The TDC ASIC sub-project is at the stage of full evaluation of the pre-series packaged chips with good preliminary results. Assuming the chip is approved, remaining production steps only require packaging of the chips (wafers for full production are on hand)
- The CSM board has a complete and validated design. However, in the preceding years the sub-project accumulated a large (538 days) delay, a significant fraction of which is due to a commercial part that had an undetermined availability and remains in limited supply. The float to need-by-date is 178 working days.
- The L0MDT sub-project (WBS 6.6.4) is responsible for the design and production of the “service module” of the L0MDT ATCA blade, the “command module” (the second part of L0MDT containing the FPGA) design is a responsibility of a international partner, with US being responsible for 50% of the production. The sub-project has seen a significant increase in labor cost ($1.5M, roughly doubling earlier estimates), partially associated with the loss of key personnel.

Muon Comments:

- Given the project’s stage of approaching production, readiness in terms of the QC planning should receive stronger emphasis (including making links to the documentation such as QC testing manuals or procedures available to the reviewers)
- The sMDT sub-project has few dependencies, a well defined plan for completing the deliverable, and the float to the need-by date is reasonable.
- The TDC sub-project’s good preliminary testing results for the ASIC, modest changes and good results for the previous ASIC prototype, and a clear plan to completion that shows few dependencies. The risk of delays appears low.
- The CSM sub-project: without urgently addressing the problem with the commercial part availability (that is either unavailable or in limited supply or available elsewhere at higher cost), the project runs a sizable risk of missing the need-by-date. Since this specific ATLAS need-by date is connected with the chamber installation planning, the impact of failing the need-by dates can be significant. A good use of contingency could be to advance this purchase to mitigate this risk, as additional wait time will also add to the standing army costs in addition to schedule risk.
- The L0MDT project dependence on the delivery of the FPGA, which have not been ordered yet, can become worrisome if the project waits for too long, as

these FPGAs can require as much as 1-2 years delivery time, which is sufficient to wipe out all of the remaining float.
- For the L0MDT sub-project, it was difficult for the committee to understand the sources of the large labor cost increase in detail and whether an analysis of the causes for such increase and potentially a re-assessment if the resources allocated/available to this task would be warranted to complete the work on time.

Muon Recommendations:

- No recommendations for the sMDT or TDC ASIC sub-projects.
- The project should consider the possibility to either update the CSM design with parts that are currently available on the market and are radiation hard or urgently secure the parts that the design critically depends on (a specific voltage regulator) to mitigate the risk of not meeting the ATLAS deadline. The project should reach a decision by the next annual review, and should be prepared for discussing the progress at the rebaselining review.
- The L0MDT project should consider advancing orders for the FPGA as in the management recommendations, and review if any other parts can have significant delivery times to mitigate schedule risks before the re-baselining review to ensure the potential risk exposure is correctly captured in the risk register.
- For the re-baselining review, the L0MDT sub-project should clearly explain the changes that led to the large labor cost increase for re-baselining. Further, a clear case should be made that these additions are sufficient to complete the project on time, and are not indicative of potential lingering problems with insufficient labor resources.

Trigger Findings:

- The optical plant for WBS 6.8.1 is similar in functionality to that used for the Phase-1 upgrade, even reduced in fibers in/out.
- A scope opportunity may become realized for WBS 6.8.1 by simplifying the FOX++ optical plant with cables
- The deliverables for the firmware releases of WBS 6.8.3 are understood and documented
- The architecture of the framework firmware for the GEP is well advanced, taking into account the needs of multiple algorithms to be incorporated within resource and timing constraints.
- GEP algorithm firmware feeds into the framework deliverable through integration milestones, and are generally not on the critical path.

- The interplay of the scientific labor with the project labor is well understood and efficient. For example algorithm work and initial firmware development is done by scientific labor, and is then handed over to engineers for firmware development.
- There are BCPs for WBS 6.8.2 and 6.8.3 for COVID-19 inefficiencies, lab closure, hiring freezes. WBS 6.8.1 and 6.8.3 do not have exposure to supply chain effects.
- The project realized the risk for the “loss of key personnel in firmware effort” on WBS 6.8.3 in the last year with the departure of 3 engineers. The cost and schedule impact was accounted for in BCP 1057b. One position has been hired with a start date next month, the other two are still to be filled. The project tapped expertise from other institutes (SMU, Stanford) as well as made use of scientific labor to continue progress.
- Regular meetings will be held to monitor the technical progress on the firmware development and integration for WBS 6.8.3
- Scope contingencies and opportunities are clearly delineated

Trigger Comments:

- The project team is commended for its efforts to carry-on tasks after the loss of firmware person-power for WBS 6.8.3 with additional engineering effort and scientific labor, and pivoting to increase the documentation on the algorithms, interfaces, etc. to aid future personnel.

Trigger Recommendations:

- The project should continue its efforts to replace the lost GEP engineering labor for algorithm firmware, and ensure their efficient ramp-up once hired as well as closely monitor the technical progress. Review the situation by the next annual review.

Subcommittee: Calorimeters

Sarah Eno (Maryland) Ted Liu (FNAL)

LAr overall comments:

Overall the project is in good shape, with great progress made. In particular, the v4 ADC is going to be the final version (without the need for v5), and this is very impressive. The risk registers for the remaining active risks are rather complete covering a wide range of potential known risks, with a few major risks to be retired soon. The schedule appears to be tight in the coming year for the system integration testing to fully validate FEB2 and sRTM design in order to pass the FDR review next May, especially due to potential delay in the availability of LASP (final hardware and firmware). However, the FEB2 system validation does not require LASP while sRTM does. The team is very experienced in the system integration testing (has worked closely with the DoE/BNL team in the past). A practical way to mitigate potential supply chain delays is to pre-order the potentially difficult-to-get parts and a plan is being developed, indeed this may be the only way to ensure successful completion. Much of the discussions during the breakout session were about how to improve the slides/presentations to better answer the charge questions for the actual review this April.

Recommendation: none, keep up the good work!

Charge questions and answers:

a. Are the new baseline cost and schedule changes reasonable, well justified and documented?

- yes

b. Is the risk register complete?

- yes

c. Are the risk adjusted cost and schedule changes reasonable and well justified?

- yes

d. Is there high confidence that the remaining project scope can be accomplished within the revised budget and the revised schedule? Can it meet ATLAS need-by dates?

- Yes, however there are few concerns below.
- increased number of sRTM still a cost risk due to potential further de-densification of LASP by partner CPPM. Note that this is captured in the Risk Register.
- The system integration test (under DoE scope) is challenging, especially with the potential (un)availability of the final version of LASP, and the results are required for the FDR in May 2024. The FEB2 system testing does not depend on the LASP, only the sRTM depends on the LASP.

e. Are the additional to COVID-19 impacts (from supply chain, high inflation, schedule delays, Ukraine war) that increase the TPC clearly identified and justified? This will form the basis of the additional funds requested.

- Yes. A practical way to mitigate potential supply chain delays is to pre-order the potentially difficult-to-get parts and a plan is being developed, indeed this may be the only way to ensure successful completion (See also the relevant comment made by the management subcommittee on this issue).

f. How has the scope of uncosted scientific labor changed with the rebaselining, and what are the implications of these changes on the project scope, budget, schedule, and risk?

- Not much, only 3 FTEs involved, very moderate

g. Are the scope contingencies and upscope opportunities credible and reasonably valued?

- yes, good job with LSB2.

h. Is the Project well managed? Is the review documentation complete?

- yes

i. Evaluate the current technical status of the subsystem and the plans for the coming year – are they reasonable? Are there specific technical challenges? Do the external dependencies (if any) raise concerns?

- dependency on LASP but captured in risk registers
- dependence on INFN radiation tolerant powering. solvable but not yet solved, but solutions are known to exist, particularly one by CERN
- dependence on system integration testing and the schedule appears to be tight. FEB2 system testing does not require the LASP, sRTM system testing requires LASP.

j. Has the scientific (uncosted) labor needs/expectation changed, and if so, what are the potential impacts? Is the project utilizing a satisfactory means for managing, monitoring, and tracking uncosted labor contributions?

- Not much. The uncosted scientific labor involved is rather moderate.

k. Is the project adhering to best practices in systems engineering, interface management, and subaward management?

- yes

Tile: Overall comments

Overall the project is well advanced and in great shape. All subprojects have passed FDR, with the Main Board and ELMB-motherboard have even passed the PRR and production is well underway with sufficient float. The project should revisit the risk registers to see if additional risks are needed for the production, such as radiation testing of active components and potential single point of failure with the assembler for the main board. Much of the discussions during the breakout session were about how to improve the slides/presentations to better answer the charge questions.

Recommendation: none, keep up the good work!

Charge questions and answers:

a. Are the new baseline cost and schedule changes reasonable, well justified and documented?

- yes

b. Is the risk register complete?

- Suggest to revisit the risk registers and see if additional known risks should be added, for example, the risk for radiation test failures on active components in the future.

c. Are the risk adjusted cost and schedule changes reasonable and well justified?

- see comment above for b.

d. Is there high confidence that the remaining project scope can be accomplished within the revised budget and the revised schedule? Can it meet ATLAS need-by dates?

- yes

e. Are the additional to COVID-19 impacts (from supply chain, high inflation, schedule delays, Ukraine war) that increase the TPC clearly identified and justified? This will form the basis of the additional funds requested.

- yes

f. How has the scope of uncosted scientific labor changed with the rebaselining, and what are the implications of these changes on the project scope, budget, schedule, and risk?

- Uncosted scientific labor not needed for production work

g. Are the scope contingencies and upscope opportunities credible and reasonably valued?

- no more scope contingencies and upscope opportunities

h. Is the Project well managed? Is the review documentation complete?

- The project is well managed and has passed all the important reviews

i. Evaluate the current technical status of the subsystem and the plans for the coming year – are they reasonable? Are there specific technical challenges? Do the external dependencies (if any) raise concerns?

- Yes. There is a solution for the radiation failure of the isolation amps, however, as another possible solution, suggest also look into military grade isolation amps (for 6.5.4).

j. Has the scientific (uncosted) labor needs/expectation changed, and if so, what are the potential impacts? Is the project utilizing a satisfactory means for managing, monitoring, and tracking uncosted labor contributions?

- scientific labor not needed for completion of production

k. Is the project adhering to best practices in systems engineering, interface management, and subaward management?

- Yes, and they are proactively working out solutions for potential NIU management org chart change needs