**Update on the ARIEL project scope and timeline and their impact on the science program**

**November 2016**

**Postponing the 50 MeV e-Linac upgrade and the 500 kW photo-converter**

The current e-Linac with its three accelerating cavities (1 in the Injector Cryo-Module (ICM), 2 in the Accelerator Cryo-Module 1 (AMC1)) is performing better than originally planned, allowing us to reach up to 35 MeV electron beams (instead of the original 25 MeV) with 100kW beam power. Due to the levelling off of the fission cross-section above 35 MeV and the limitation of current target technology to 100kW, there is only a factor 1.2 gain in isotope production yields when going from 35 to 50 MeV.

In addition, the implementation of 500 kW electron beam power with current target technologies would require us to split the electron beam and distribute it to several connected fission targets and also to move the fission targets further away from the photo-converter. Our analysis shows that this would gain at best a factor of two in fission rate, much less than the factor of 5 increase one might have naively expected, going from 100kW to 500kW.

While we will continue to pursue the R&D efforts to push target and converter technologies for a future upgrade we do not want to hold up the design and construction efforts for the ARIEL targets by such an R&D effort. Therefore we are postponing the implementation of 50MeV electron beam energy and the 500kW converter/target to a later stage.

**Changes to the timeline for Science Milestones**

While the basic phased structure of the project remains, the detailed planning that has been carried out during the last year has changed the timeline for important milestones of the project.

First, the delay by more than a year to secure the final provincial contributions to the ARIEL-II CFI project has directly affected the completion time.

Second, recent advances in the ARIEL target design have led to a new design concept, which was reviewed and endorsed by an international external expert committee and presented at the ARIEL Science Workshop in July 2016. This new design, which is based on the ISOLDE model, is significantly more capable and versatile than the original proposal, which was based on the ISAC model. The new solution will allow for a faster exchange of targets, yielding a number of critical benefits, including more reliable operation, reduced operating cost, greater beam availability, and increased science output. However, the design is new to TRIUMF and more complex, which results in a later completion date for the ARIEL targets.

Overall the ARIEL-II CFI project will be a 6 year project starting at the end of 2016 which will be completed by the end of 2022 with the start of RIB extraction from the ARIEL proton target.

At the same time we aim to enhance the ISAC capabilities and reliability. Therefore we have made a deliberate effort to bring the CANREB charge breeder online as early as possible to deliver high mass beams from ISAC via the EBIS charge breeder in support of the accelerated beam program at ISAC.

**Current ARIEL science milestones**

The ARIEL-II project team has invested significant effort into detailing the schedule within the available schedule and manpower. In particular for Phase 1 of the project the schedule is now very well understood. Phase 1 is also the predominant part of the project since it includes the new target module design, the remote handling infrastructure, the target hall shielding, the hot-cell infrastructure, as well as the design, prototyping, and partial construction of the RIB transport system. In addition to detailing the schedule we have also carried out a Monte Carlo analysis of the schedule and based on this analysis we expect to achieve the following milestones with high confidence. These dates result from a rigorous application of best practices for project management, which is critical to carry out responsible planning and to manage expectations.

| **Science enabling milestone** | **Month/Year** |
|---|---|
| First EEC approved experiments with high-mass accelerated beams from ISAC utilizing the CANREB/ARIEL EBIS charge breeder | 10/2020 |
| First EEC approved beta-NMR experiments with photo-produced $^{8}$Li | 03/2022 |
| First EEC approved experiments with photo-fission RIBs from the e-Linac | 06/2022 |
| First EEC approved experiments with RIBs from ARIEL Proton target | 03/2023 |

While these milestones are consistent with the on-time delivery of the CFI deliverables for the CANREB and ARIEL-II CFI projects, these dates for science delivery are substantially later than originally projected and we understand that they are disappointing to many of you and they are to us as well. Therefore we want to work with the user community to explore all possibilities to accelerate the current schedule and we are starting to analyze the impact of various mitigating measures. Some of these potential mitigations might impact the science delivery of the current program, for example by extending shutdown periods. At the same time we are investing substantial efforts to improve performance and reliability of the ISAC target modules, which would improve the utilization of ISAC during potentially shorter running periods.

We are looking forward to consulting with the user community on the details and the impact of the most promising measures in early 2017.

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