29th September 2023

Delay on:	**D3.1 Common cold box delivered**
Delivery Date in Annex 1:	M30 (30th September 2023)
Expected Delivery Date:	30.06.2024

Experience with existing state-of-the-art cold boxes and cold box R&D

In the last two years (M6-M30) existing cold boxes have been used by CERN and other AIDAInnova collaborating institutes to gain valuable experience on cold box performance and operations. In particular, the ACONITE telescope coldbox, which is installed permanently inside the SPS beam area H6A at CERN, has been extensively used, primarily by silicon sensor R&D communities working on detector designs in their final prototyping stages, for final construction by 2028; including the ATLAS Inner Tracker pixel, ATLAS Inner tracker strips, ATLAS high granularity timing detector and the CMS Phase II Tracker pixel detectors. A lot of operational experience has been gained, and lessons learnt will be incorporated into the new design, namely:

- cool down with an external liquid cooling circuit and a heat exchanger is quite slow which has an impact on the usable beam time and significant cooling capacity gets lost
- operating with silicon oil in a hydraulically open circuit leads to water contamination which causes first performance loss (viscosity increase) and then failure (clogging) requiring regular cleaning and replacement of thermal transfer fluid (time and person power intensive; silicon oil is expensive)
- alternative thermal transfer liquid ethanol currently used which has viscosity and price advantages but requires safety derogation due to flammability
- in order to avoid water contamination a chiller bath flushing with nitrogen was installed
- in order to achieve a lower temperature a more powerful chiller was employed; second chiller used to pre-cool the nitrogen used for flushing the cold box; for some high power/deep temperature applications driven by the needs of ATLAS Inner Tracker pixel the second chiller was exploited to drive an additional direct cooling

Using these measures the operational reliability was improved significantly operating for weeks and months without further intervention on the cooling system which is important due to the small time windows available for intervention and very limited person power. Furthermore, the lower achievable temperature threshold was decreased by more than 20°C below -60°C allowing measurements crucial for the ATLAS Inner Tracker pixel qualification program. This gives valuable input to the specification of the next generation cold box.

The delay in the new cold box design was primarily driven by complying with the person power test beam needs of the ATLAS Inner Tracker pixel program, which has been in a crucial final prototyping phase, requiring input to reviews to finalise the design and transition from final prototyping to now the recent successful start of the construction process. Work on

the current setup for HL-LHC did not allow the investment of work into a new setup; at the same time freezing the design was difficult due to the accumulation of new knowledge regarding the possible technical solutions.

Plans for finalising the AIDAInnova cold box

In collaboration with AIDAInnova lead institute CERN, an engineer from IJCLab, experienced in cooling developments leading a team - Aboud Falou - has drafted a preliminary design based on agreed specifications by CERN. Discussions are ongoing to finalise the design based on incorporating all lessons learnt from the existing cold box and the design should be frozen by M31. The next steps are procurement of parts (M32-M36) and the construction and commissioning (M37-M38). Procurement will be under the responsibility of Andre Rummler at CERN and construction by Aboud Falou who will be based at CERN from M32 as a project associate to maximise the efficiency of the collaborative work. Commissioning will be the responsibility of Andre Rummler at CERN.