

An update on the MG detector for the CSPEC instrument

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On behalf of MG.CSPEC team and the ESS Detector Group

MG test at the LET instrument at ISIS

Since after the leak issue with the MG detector vessel was encountered prior to the beamtime at LET back in November 2020, the centre focus had been to fix the issue to get the detector ready to use in vacuum for the nearest possible testing opportunity at the LET instrument.

Considering the importance of the MG detector performance test at LET for the MG.CSPEC project, the MG.CSPEC steering board committee (SBC) had agreed during a meeting on the 8th December 2020 to proceed with the two potential fix solutions in parallel. These are:

- Solution 1: Manufacture a brand-new vessel for the LET test.
- Solution 2: Refurbish the current vessel by employing a new seal design.

Solution 1: Manufacture a brand-new vessel made for the LET test:

The full MG.CSPEC detector array consists of 6 shorter detector modules around the beam-dump as shown in Figure 1. These detector modules are part of a future upgrade of the CSPEC instrument and are not envisioned for CSPEC detector day 1 operation.

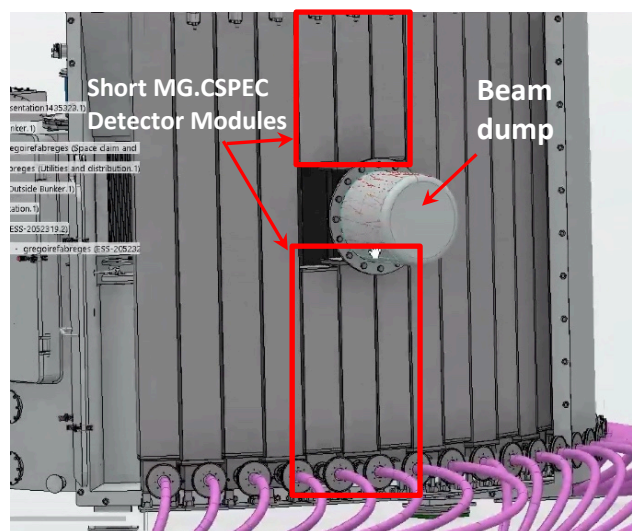


Figure 1: MG.CSPEC detectors around the CSPEC beam dump

We decided to take this opportunity to manufacture the new vessel to the same design specification of the MG detector modules around the beam-dump. The design drawings, modified version of the MG.300, were ready by the end of December 2020 and were forwarded to a company called CECOM Snc, located near Rome in Italy, for fabrication

straight after. It is the same company that had previously manufactured the 4m long MG.300 vessel back in April 2020.

The MG.CSPEC-BD vessels are 30 (w) x 30 (d) x 170 (l) cm³ (including the 20cm in height electronics box at the bottom). The volume of the main vessel is separated from the electronics compartment by an interface plate. During the operation of the detector the electronics box that houses the VMM readout cards will be maintained at atmospheric pressure while the vessel volume is filled with 0.5 to 1 bar of Arg/CO₂ gas. An O-ring seal solution is employed at all interface points.

The new vessel was received at ESS on 16.03.21. Inspection was carried out following day before it was vacuum and leak tested. The vessel reached a vacuum level of 4.17×10^{-8} mbar within 1 hour of pumping down, a level that would qualify the vessel to use inside the LET tank. A leak testing and qualifying procedure for MG.CSPEC vessels are currently being formalised in a collaboration with the vacuum group.



Figure 2 Fabrication of the MG.CSPEC-BD0 at CECOM. Photo taken first week of March 2021



Figure 3 MG.CSPEC-BDO as it arrived at Utgard (top left). Vacuum reading after 1 hour of pumping down (top right). Alessio Laloni setting up the vessel for the vacuum test (bottom)

Solution 2: Refurbish the current vessel by employing a new seal design:

It was clear that the vessel leak issue was originating from failing rubber gaskets on 3 different locations, one at the bottom lid and two at the electronic box. The electronic compartment had also an excessive welding job done on multiple corners, these are all potential leak areas. Our first intention was to remove all of the old rubber gaskets and substitute them with an O-ring seal solution. With that, we decided to cut off the vessel's old bottom flange all together and weld a new extension that has a machined O-ring groove. The entire old electronics compartment was ditched, the replacement was made of a single block of aluminium as illustrated in Figure 4 below. The refurbishment was made by Wallins Mekaniska workshop, located in Eslöv. The refurbished vessel was ready on Friday 5.02.2021.

A vacuum and a leak test were performed the following week. After 3 days of pumping down the vacuum reached a level of 2.5×10^{-7} mbar. The pump was then switched off while observing the vacuum level for 5 hours, no loss of the vacuum was noted during that period. The measured leak rate was found to be 4.4×10^{-7} mbar.l/s, which together with the vacuum test result, would qualify the refurbished vessel to use inside the LET tank.

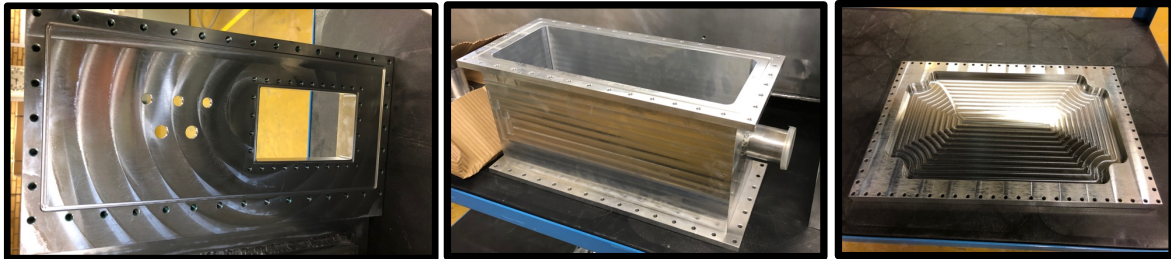


Figure 4 Refurbished MG vessel. O-ring seal solution was employed at all interfaces points

Beamtime:

Due to the planned long maintenance shutdown after the coming run cycle, there had been a higher than usual user demand to utilise the beamtime at the LET instrument and therefore, no time was made available for detector testing. Nevertheless, ESS will make a request for reconsideration for a beamtime in the first run cycle after the shutdown, estimated to take place around Spring 2022.

Procurements for MG.CSPEC

Ultra-pure Aluminium

56kg free sample (from a previously discarded batch due to higher actinide presence than specified in the tender Quality Assurance requirements) has arrived at Utgard on 01.04.2021. This sample will be used to assess the mechanical quality and rigidity of the new alloy through a dummy production run cycle. Initial checks conducted on the same day were very positive, the aluminium sheets are well machined, well cleaned, no visible scratches or fingerprints and each aluminium sheet was separated by thin piece of paper. The measured dimensions all fell comfortably within the specified tolerances.

A rigorous quality control procedure is in place and for that, 15 sheets will be used in a dummy production run:

- Carves MG.CSPEC specific blades by a company called HPetch near Stockholm.
- Blades are then coated with natural B₄C at the ESS coating facility in Linkoping.
- Grids are then assembled at Utgard workshop in Lund.

The sheets have already arrived at HPetch on 08.04.21. The whole process may take up to 30 days before it is completed. Delivery of the ultra-pure aluminium first batch of 500kg is on hold until the QA investigations are fully performed.

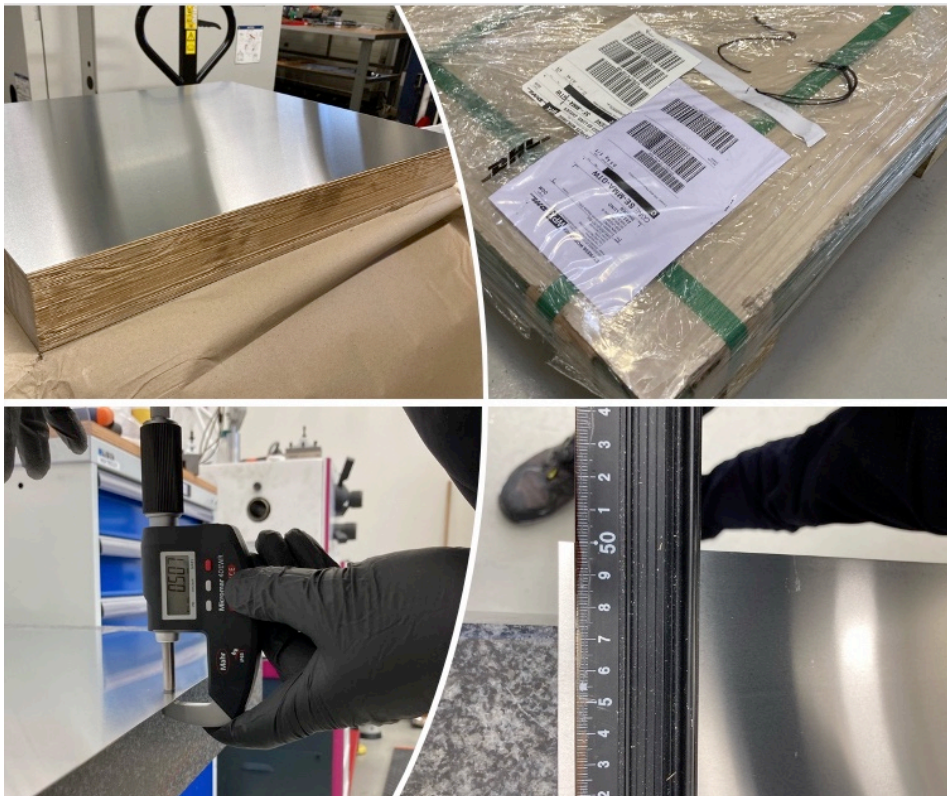


Figure 5 Radio-pure aluminium sheets to be used in the dummy production run

B₄C powder:

Second and final batch of 25kg (50kg in total) has arrived at Linköping on 25.03.21, that is enough B₄C powder for all of CSPEC and TREX detectors. 5kg from the first batch has already been sent to RHP technology for QA. The powder will eventually be used to manufacture B₄C targets once the framework agreement is finalised.



Figure 6 Second and final batch of B₄C powder had arrived at ESS coating facility in Linköping