S4 and S5 Calibration & Characterisation Mechanical Work Package Descriptions

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Classification:	**Commercial in Confidence**

Prepared by:	**Elise Allthorpe-Mullis**
Checked by:	**Lauren Von Dran**

CHANGE RECORD

Issue	Date	Change
0.1	14/05/2018	First Draft
1.0		First Release
2.0	18/06/2018	Update following review
3.0	25/06/2018	Dates updated following review

Contents

SCOPE

This document describes the work required to support the activities related to the S4 and S5 UVNS instruments.

For the S4 UVN program, we are only required to provide the STC-2 facility suitably modified in line with the S4 UVN requirements. No Mechanical Ground Support Equipment or Optical Ground Support Equipment is required.

For the S5 UVNS program we are required to provide the STC-1 facility for the STM test campaign, and the STC-3 facility (identical to STC-2) for the EM test campaign. Both facilities must be suitably modified in line with the S5 UVNS requirements. The changes required for the EM campaign in STC-3 are in line with those required for S4 UVN testing in STC-2, so the designs can be directly applied from S4 UVN. Unlike S4 UVN, we are required to provide Mechanical Ground Support Equipment, which is being provided by our sub-contractor APCO (Switzerland). Therefore, we will have to review their design and data packages for compliance with requirements.

In the Background section, we have described the STC-1, STC-2 and STC-3 facilities and then detailed the additional work required to make the facilities suitable for the S4 UVN and S5 UVNS calibrations.

Solid models to understand the scope and effort required to carry out the work defined in the work packages are listed on page 6 Applicable and Reference Documents.

Applicable and Reference Documentation

Bid No.	Title	Document Number	Issue	Issue Date
AD04b	Requirement Specification for S5MGSE	GS5.RS.ASG.UVNS.00036	4	27/06/2016
AD04	C&C Facility Requirements Specification	GS5-SP-ADSO-UNVS-1000113913	3	05/08/2017
AD4a	MGSE-C&C Test MGSE Requirements Specification	GS5-SP-ADSO-UVNS-1000111569	3	07/08/2017
AD02	Specific SOW for C&C Test Facility	GS5-SOW-ADSO-UVNS-1000112442	2	05/07/2016
RD01	Definitions Acronyms Abbreviations	GS5_LI_ASG_UVNS_00001	3	28/05/2014
RD02	Acronyms and Abbreviations	S5-LI-RAL-UVNS-0002	2	13/01/2017
RD03	Drawing example KE-0291-127-A	KE-0291-127-A	A	03/02/2018
RD04	SHE Booklet Contractors RAL	-	-	-
RD05	STP model example KE-0264-470-A	KE-0264-470-A	A	01/03/2018

1 Background

1.1 STC-1, STC-2 and STC-3

STFC's RAL Space will perform the Calibration and Characterisation (C&C) within the R25 building and the new R100 building. The C&C will be performed in three Space Test Chambers (STC-1, STC-2 or STC-3). STC-1 is located in the R25 building. STC-2 and STC-3 are located in the new R100 building.

1.1.1 STC-1 Test suite

The STC-1 Test Suite comprises of a large vacuum chamber, cleanrooms and customer facilities. The STC-1 Suite has a layout which has been replicated throughout newer facilities due to its success, it consists of a vacuum chamber with doors either end that open into cleanrooms (Figure 1).

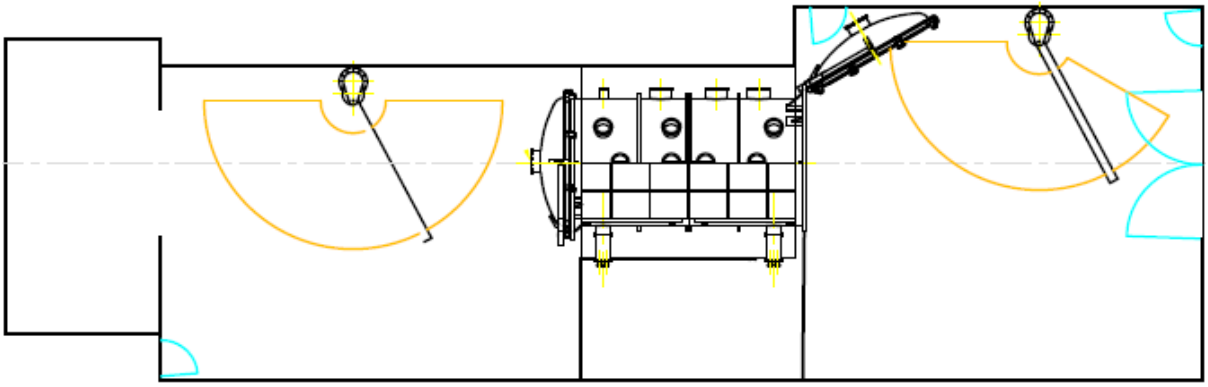

Figure 1: STC-1 test suite layout

At the side of the chamber, linking the two cleanrooms is an additional cleanroom that provides access to the chamber feedthrough ports. Associated with the suite is a small customer office and a shared change room for each cleanroom.

The cleanrooms at each end of the chamber are ISO Class 6 and there is an area adjacent to each opening door of the chamber that is ISO Class 5. The cleanroom complex is temperature and humidity controlled. Within the cleanrooms at each end of the chamber there is a 1000kg jib crane.

The STC-1 vessel, shown in Figure 2, has the following properties:

- 3m diameter and 5.5m length
- Temperature range -180°C +100°C (in 12 separate control zones)

- Vacuum rating 10^{-} 7 mBar, payload & temperature dependant
- Electrical Ground Support Equipment (EGSE) access areas
- Dry pumping system throughout, 60,000l/s high vacuum capacity
- Molecular contamination control through cold trap if required
- Residual Gas Analysis (200amu)
- TQCM available

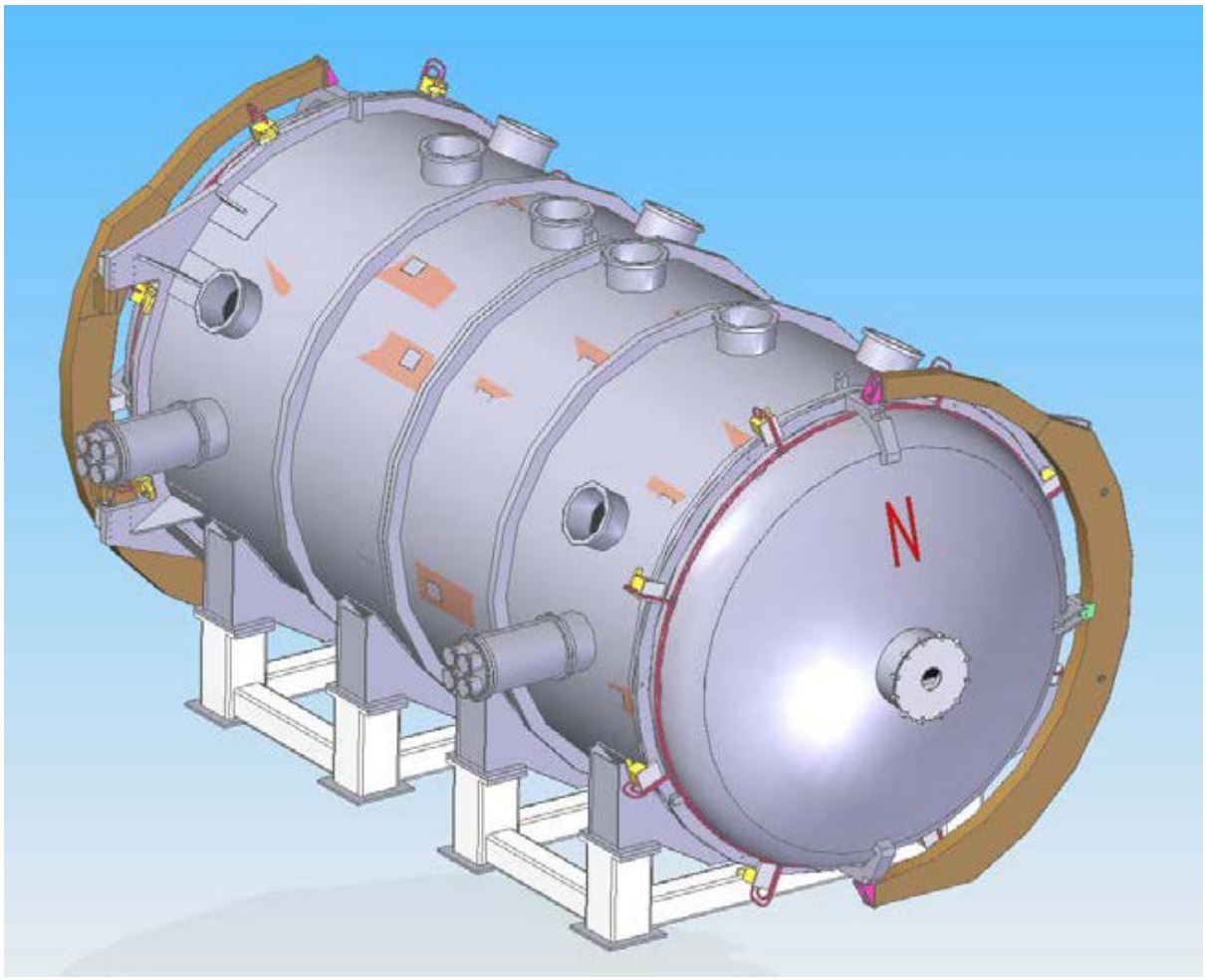

Figure 2: STC-1 test suite chamber

1.1.2 STC-2 and STC-3 Test Suites

STC-2 and STC-3 vessels have a 5m diameter and 6m length with a shroud envelope exceeding 4.7m diameter (see Figure 3). They both have similar vacuum performance characteristics to RAL's STC-1 test suite.

Figure 3: STC-3 vacuum chamber during installation

Both STC-2 and STC-3 are situated within an ISO Class 6 cleanroom complex with local ISO Class 5 areas, designed with the calibration of optical instruments in mind. This includes: provision of a dedicated 'Black' OGSE space, separate from the main cleanroom; dedicated EGSE space adjacent to the chamber to minimise harness lengths; and a spacious cleanroom with dedicated cranage and change facilities for the sole use of the STC-2 and STC-3 facility occupants (see Figure 4).

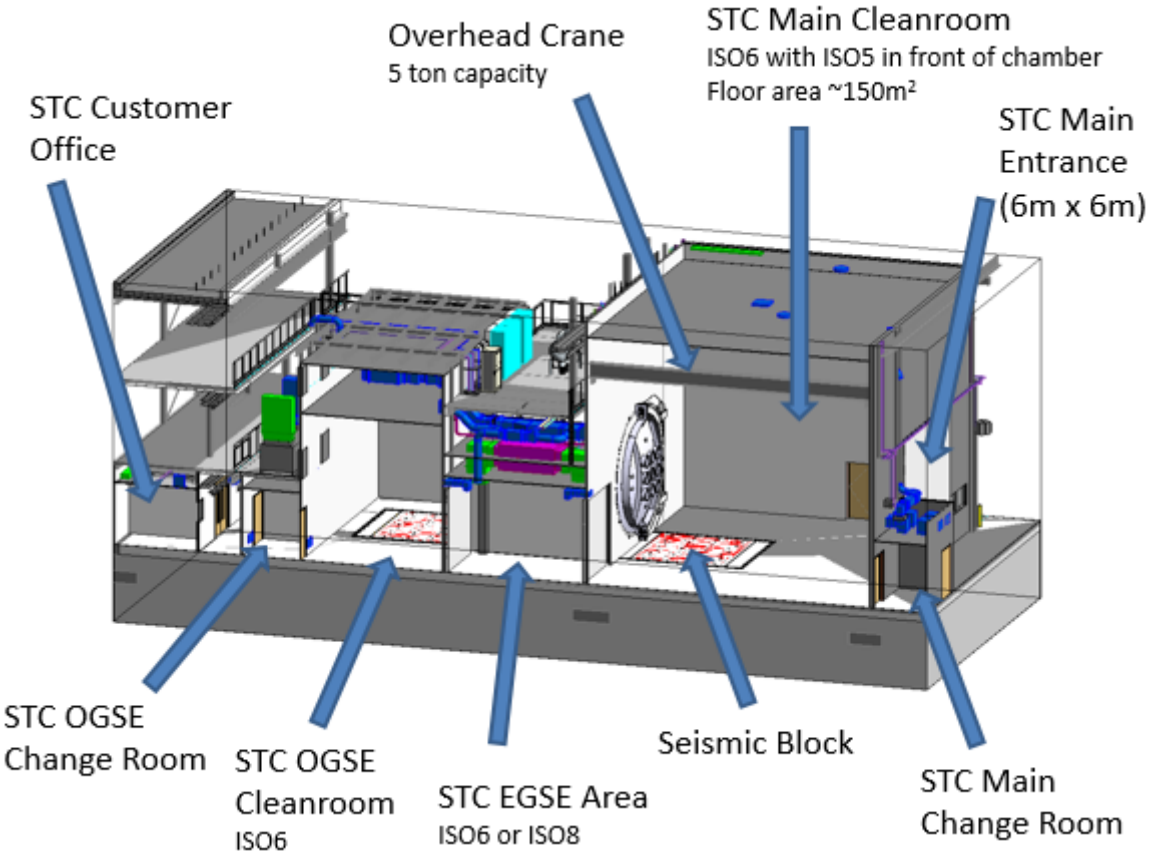

Figure 4: Section through STC-2 Test Suite indicating key features

1.2 TVAC Chamber rails

The STC chambers use a rail-based system for payload support (see Figure 5). The C&C Test MGSE will interface with the test facility via Quiet Rails and Noisy Rails. STC-2 and STC-3 have project specific rails, whereas STC-1 had rails built in during chamber build. In STC-3, the quiet rails are stainless steel I Beam Sections which interface with the test facility seismic block. For thermal reasons, the Quiet Rails will be enclosed in MLI and have heaters attached. The noisy rails are stainless steel C Sections which interface with the test facility.

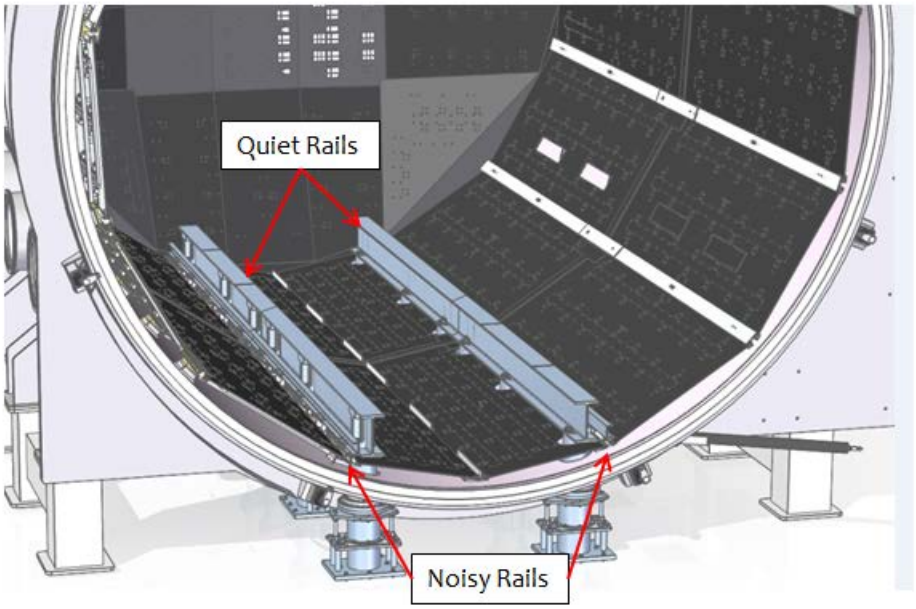

Figure 5: STC-3 Chamber Quiet and Noisy Rails

The quiet rails are mounted on a vibration isolation system in the form of an air isolated 300T seismic block that connects OGSE stations at either end of the chamber with the rails inside the chamber itself. This minimises the impact of any chamber-borne or building-generated vibration sources on the item-under-test or its associated test equipment. There are very stringent requirements with regard to micro-vibration. This has led to the MGSE for both S4 and S5 being split into two components; one mounted on the quiet rails and one mounted on the noisy rails. This will ensure that micro-vibration will be kept to a minimum.

1.3 Cleanroom Trolleys

Dedicated cleanroom trolleys will be used in order to load the C&C test MGSE into the TVAC Chamber (see Figure 6). The rails on the Cleanroom trolleys are designed to be the same as those within the TVAC Chamber.

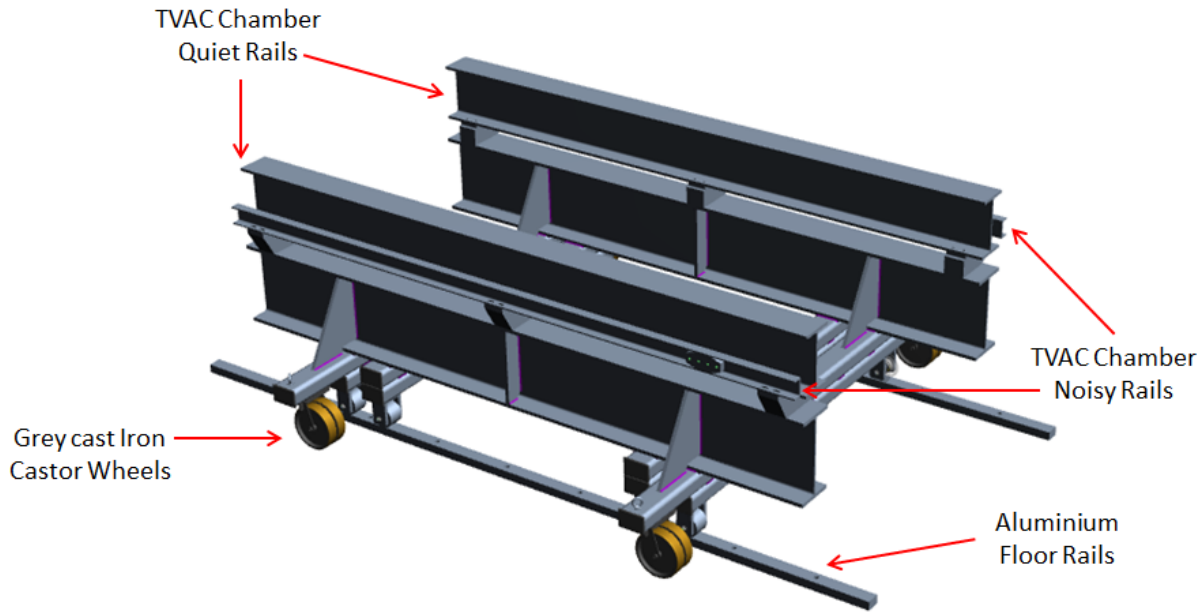

Figure 6: Cleanroom Trolley

In order to load the Instrument under test and its associated MGSE into STC-1, STC-2 or STC-3, a trolley with the same rails is used to align with the chamber rails. This will ensure that equipment can be integrated on the trolley outside the cleanroom and then easily moved inside the chamber. Design and manufacture has been achieved (see Figure 7).

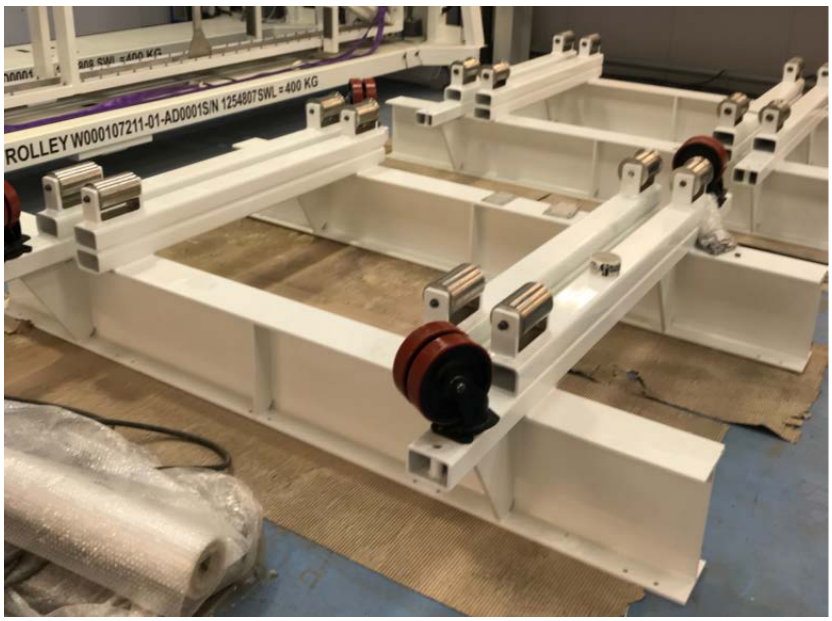

Figure 7: Cleanroom Trolley manufactured

1.4 S4 MGSE on STC-2 /3 rails

For S4 UVN we have provided a cart onto which the customer installs the instrument and its associated MGSE.

1.5 S5 MGSE on STC-2 /3 rails

For S5 UVNS we are required to provide the entire MGSE onto which the instrument is mounted. Two sets of MGSE have been manufactured for S5, one for the STM test campaign in STC-1, and another for the EM test campaign in STC-2/3.

1.5.1 MGSE on STC-1 rails

The S5 MGSE for the STC-1 chamber has been manufactured. A drawing of the STC-1 cart is shown in Figure 8.

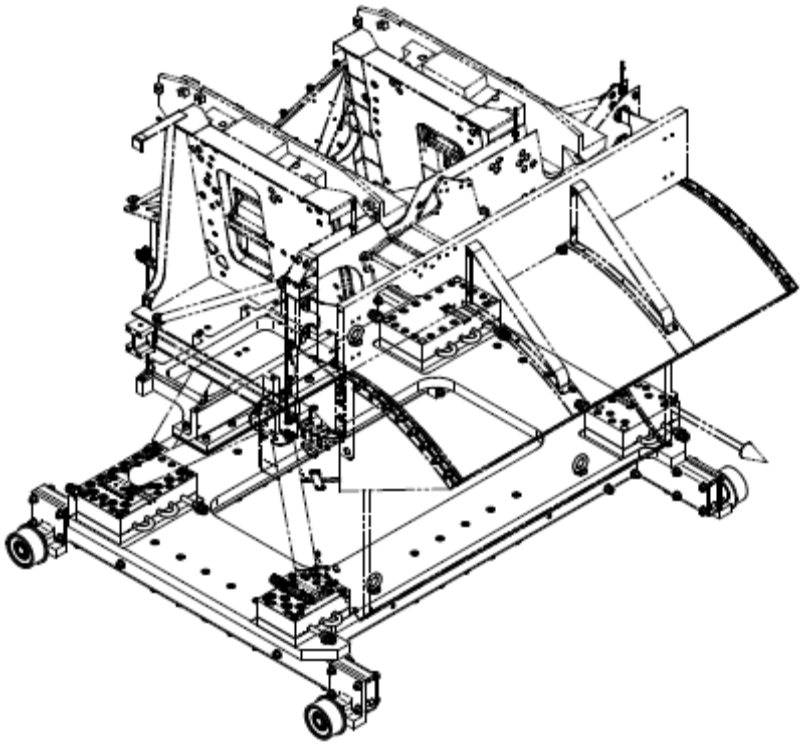

Figure 8: Drawing of cart assembly for STC-1 chamber

1.5.2 MGSE on STC-2 /3 rails

The S5 MGSE for the STC-2/3 chamber has been manufactured by our main subcontractor. Figure 9 shows the S5 MGSE mounted on the cleanroom trolleys.

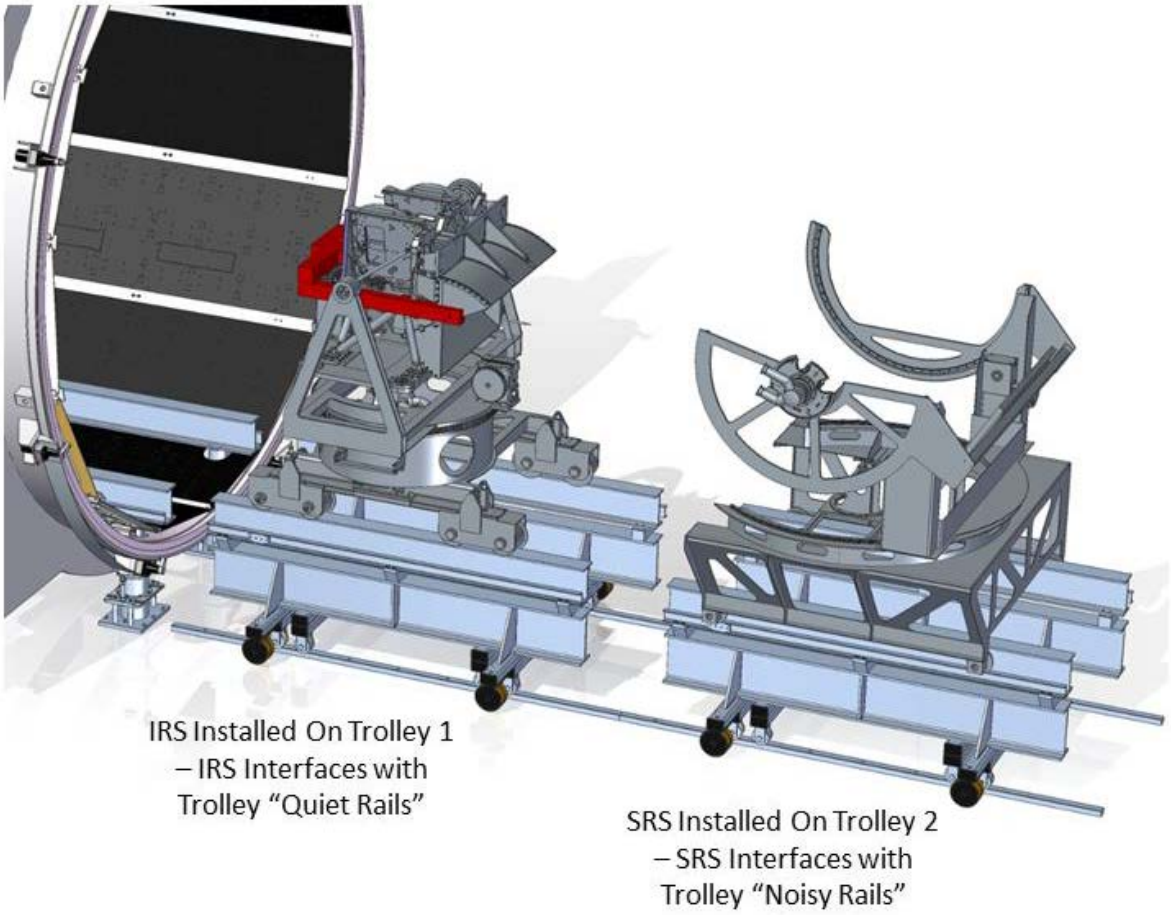

Figure 9: S5 IRS and SRS Installed on Cleanroom Trolleys

1.6 Windows, Flange, Baffles and Shutters

Figure 10 provides an overview of the window flange design. The designs for the S4 and S5 windows are essentially the same. However, the size and positioning of the window within the flanges varies from flange to flange. The outline shown is for the Optical window positioning, but the concept is true for the Alignment windows also.

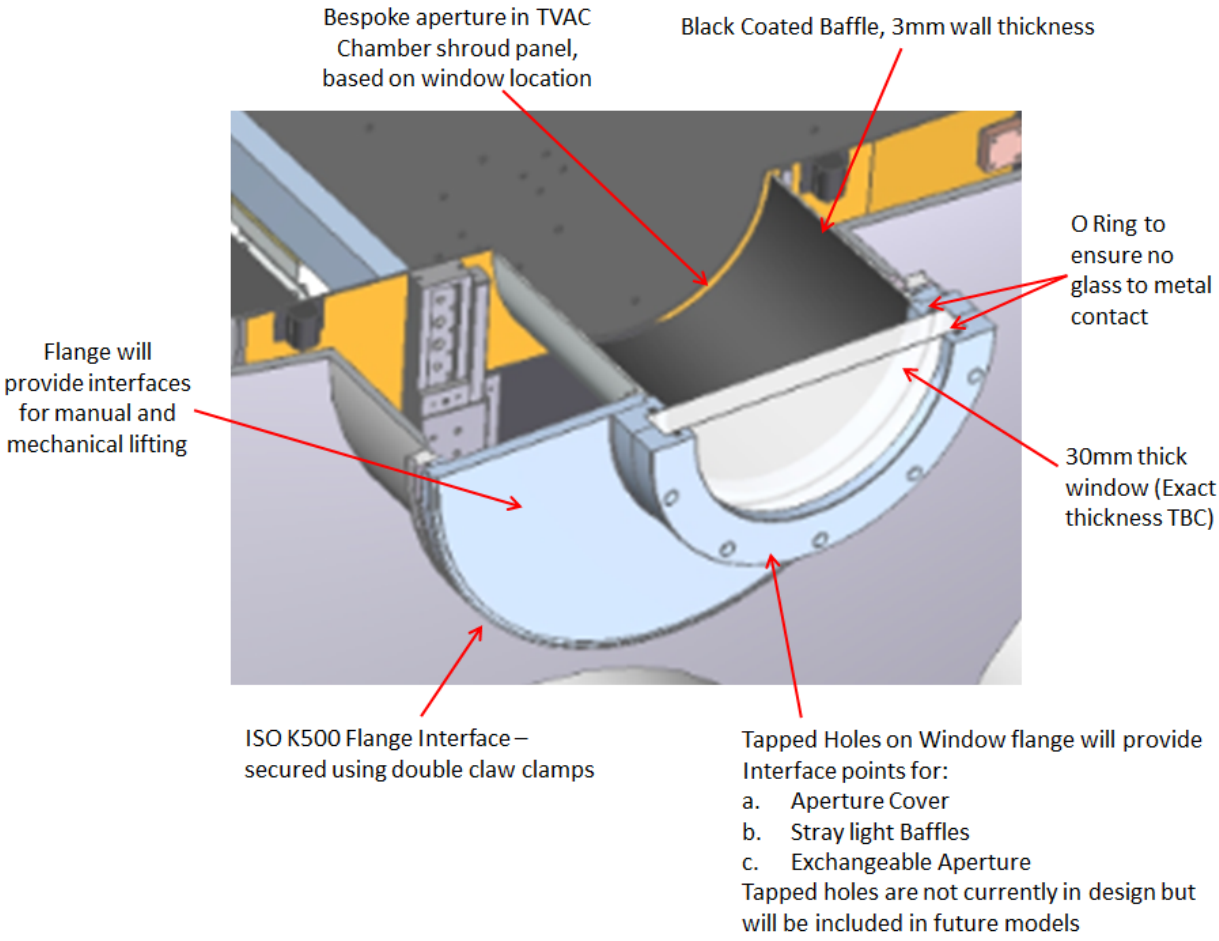

Figure 10: Overview of the window flange design

1.6.1 S5 Window Flange Design

All Optical and Alignment windows will be 30mm thick in order to provide a Safety Factor of 10. Both optical windows will be manufactured from Infrasil 302, and both alignment windows will be manufactured from BBAR Coated DUV Grade Fused Silica. Apart from a change in material, and a difference in the positioning of the window within the flange, the design philosophy is the same for all windows.

Previous design work showed that there was a clash between the window diameter and the internal baffle. Therefore design rework will be needed for the hardware in order to remove the clash.

1.6.2 Window Flanges

The Optical and Alignment window flanges will be manufactured from stainless steel and will interface with the TVAC Chamber via a standard ISO500 interface. The non-optical surfaces of the flange will be black coated.

All flanges will be individually part marked with handles for manual lifting and "eyes" for hoisting. The flanges will interface with the TVAC Chamber via double claw clamps. O Rings will be used to ensure that there is no metal to glass contact at the window to flange interface. The window flange will provide an interface for an exchangeable aperture and external baffles.

The window flanges are based on the diameter of the window, and since this is not yet known, design of the flanges will follow on from the accepted window diameter.

1.6.3 Internal Baffles

These are internal, black painted, baffles with 3mm wall thickness and will provide a thermal coupling between the window and the TVAC chamber. Whilst the baffle design philosophy is common, each baffle will be unique due to unique angles in the TVAC chamber door and side.

1.6.4 External Baffles

External, black painted, stray light baffles will be installed. These baffles will interface with the window aperture and will be removable.

1.6.5 Shutters

All four window shutter systems within the STC-2/3 TVAC Chambers will use the same parts, in order to aid installation and the facility spares philosophy.
There will be no active heating or cooling on the shutters in the form of LN2/heaters; however copper straps will be installed in order to conductively couple the shutters to the thermal shroud.

Due to extensive design rework of the shroud panels, it is possible that rework of the shutters is foreseen in order to accommodate the new interfaces at the shroud panels (see section 1.7.1).

1.7 Bespoke Shroud Panels

The door shroud is more complex than usual due to the requirement to minimise the spacing between the instrument and the optical windows of the chamber (~250mm). This requirement results in a multi-faceted shroud design.

Both S4 and S5 have bespoke door shroud panels and observation side shroud panels. Due to the fact that S4 and S5 utilise different apertures, the shroud panels are different. Aside from the apertures, they are generically the same.

The design and manufacture of STC-2 and STC-3 shroud panels had previously been carried out, however recently failed their thermal cycle tests. Therefore a complete rework of design is needed based on decisions agreed internally at RAL. Figure 11 and Figure 12 show the old design of the shroud panels.

1.7.1 S5 door shroud panels - rework

Figure 11 provides an outline of the S5 shroud panel design. The S5 test set up requires the use of three apertures on the OGSE facing TVAC Chamber door. Therefore, the shroud panel will be bespoke for S5 both in terms of mechanical and thermal design. The diagram below provides an overview of the STC3 OGSE room shroud design.

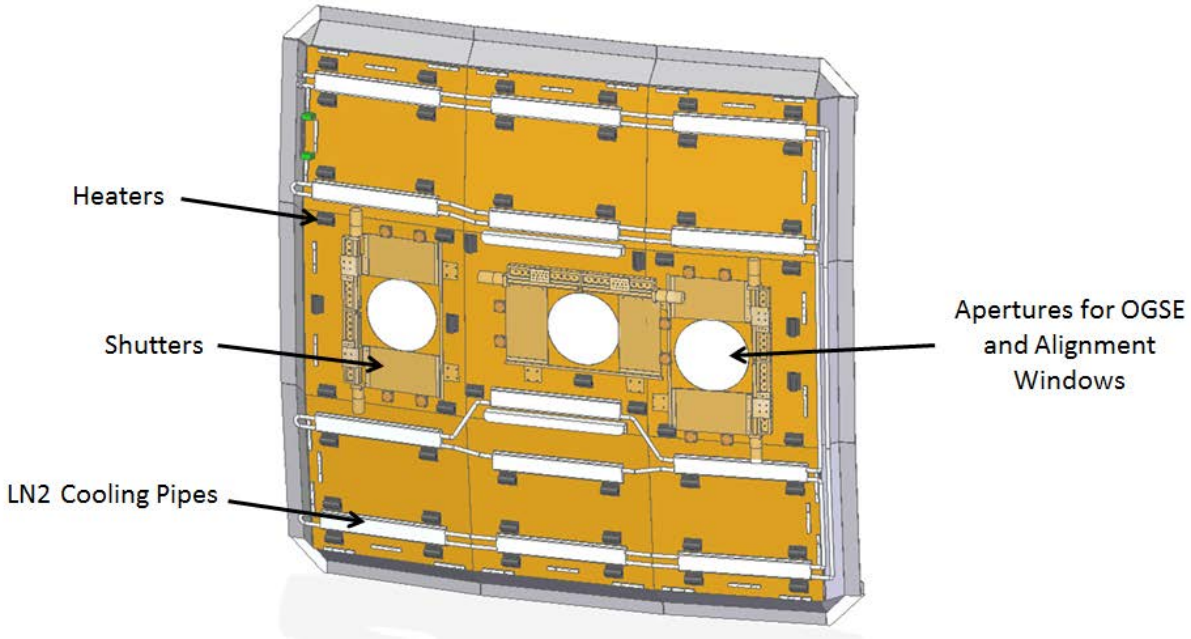

Figure 11: S5 OGSE Room Door Shroud Design

Thermal straps will provide a conductive coupling from the shutters to the shroud panel. Heater and LN2 layout has been optimised in order to provide the best possible control in the space available. However, due to the position of the apertures there will be regions of the shroud where no heaters or LN2 are locally applied.

1.7.2 Alignment Window Shrouds - rework

S4 and S5 require the use of apertures on the Service side of the TVAC Chamber for alignment purposes. As such these shroud panels will also be bespoke both in terms of mechanical and thermal design.

Figure 12 shows the S5 observation window shroud design in the service area. Heater and LN2 layout has been optimised in order to provide the best possible control in the space available. Thermal straps will provide a conductive coupling from the shutters to the shroud panel.

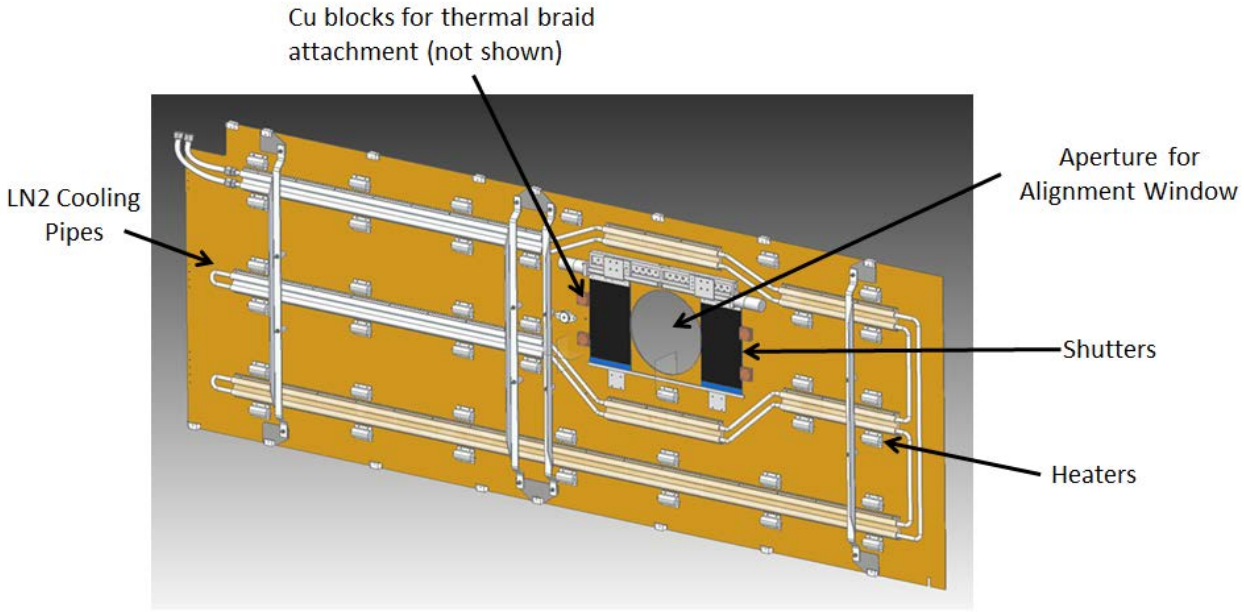

Figure 12: Service Area Alignment Window Shroud Panel Design

1.7.3 Cold Black Target Shroud

A dedicated Black Plate will be provided for all test campaigns taking place in STC2/3. This plate will be cooled with Gaulden or LN2 and mounted onto the TVAC chamber by a bracket, interfacing with the OGSE room Door panel shroud. The black plate will be effectively a shroud panel therefore will be based on the TVAC shroud panel redesign.

1.8 S5 Warm Stage Heat Pipe (HPC) Cooling

For S5 we are required to provide HPC Cooling via Galden cooled plate, mechanically fastened to the S5 Instrument Heat Pipe Clamp (see Figure 13). The thermal concept is based on a copper tube press fitted into a slot machined in an Aluminium Alloy base plate.

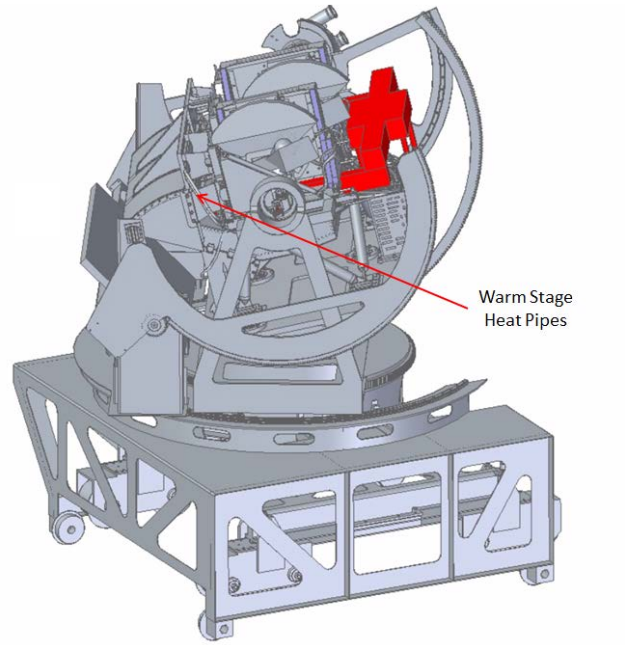

Figure 13: Warm Stage Heat Pipe

It is foreseen that 8 fasteners will be removed from the Instrument Heat Pipe Clamp and used as an interface to the RAL HPC Cooling MGSE (as shown in Figure 14).

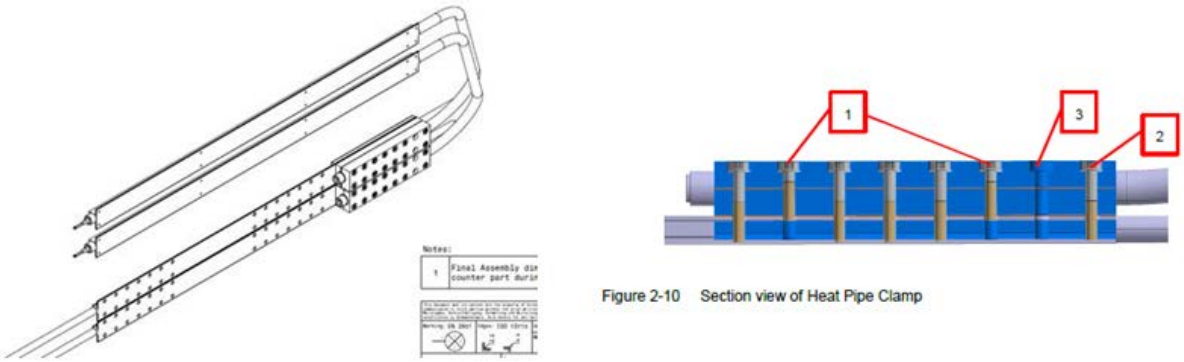

Figure 14: Foreseen Interface for RAL HPC MGSE

The micro vibrations induced due to the HPC cooling will be monitored and assessed during the S5 EM test campaign.

Drawings for the HPC MGSE are to be updated, and mechanical support during manufacture and incoming inspection will be required.

1.9 Pipework

During the S5 test campaign pipework will be needed from the chamber to the HPC, Cold Trap, Cold Black Target and the Cold Radiator Shroud (CRAS). This is to transport LN2 and Gaulden fluids for cooling.

1.9.1 Cold trap pipework

Pipework will run from the chamber to the Cold Trap, this pipework will come from the two flanges on the chamber (see Figure 15).

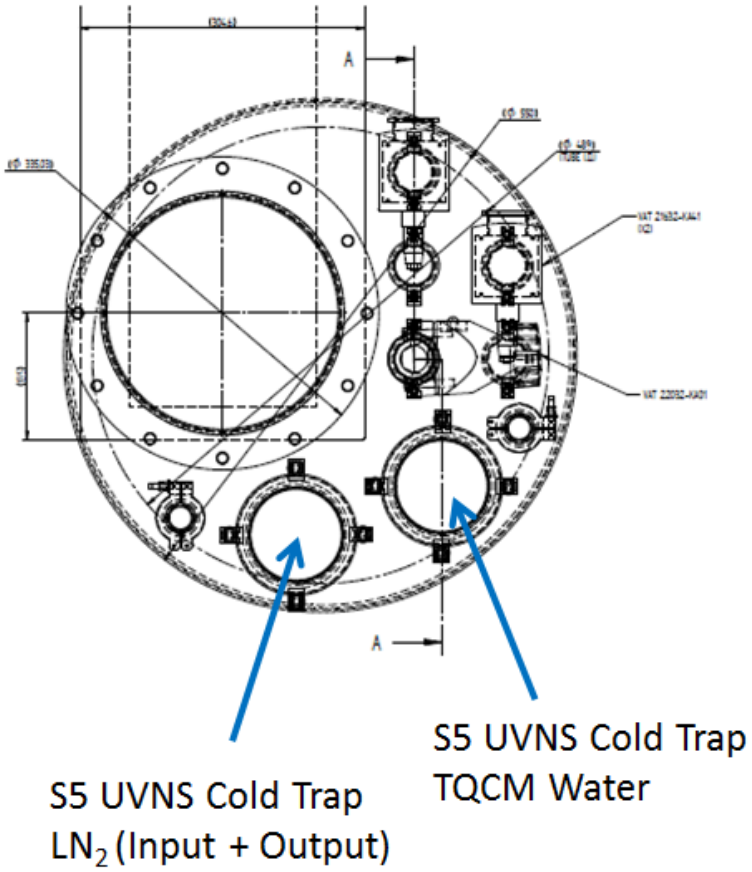

Figure 15: Pipework flange interface points for S5 test activities

One set of pipework will run to the Cold Trap, and the other to the Cold Trap CQCM. Another CQCM will be located near the door and pipework will run to this from a flange on the chamber.

1.9.2 S5 MGSE pipework routing (CRAS and HPC)

Pipework will run from a flange on the chamber to the MGSE interface. The MGSE is supplied by our sub contractor APCO.

1.9.3 Review APCO pipework

Pipework will run within the MGSE supplied by our sub-contractor. This pipework will need to be reviewed.

1.9.4 Cold black target pipework

Pipework will run from a flange on the chamber to the cold black target. The location of the cold black target is shown in Figure 16.

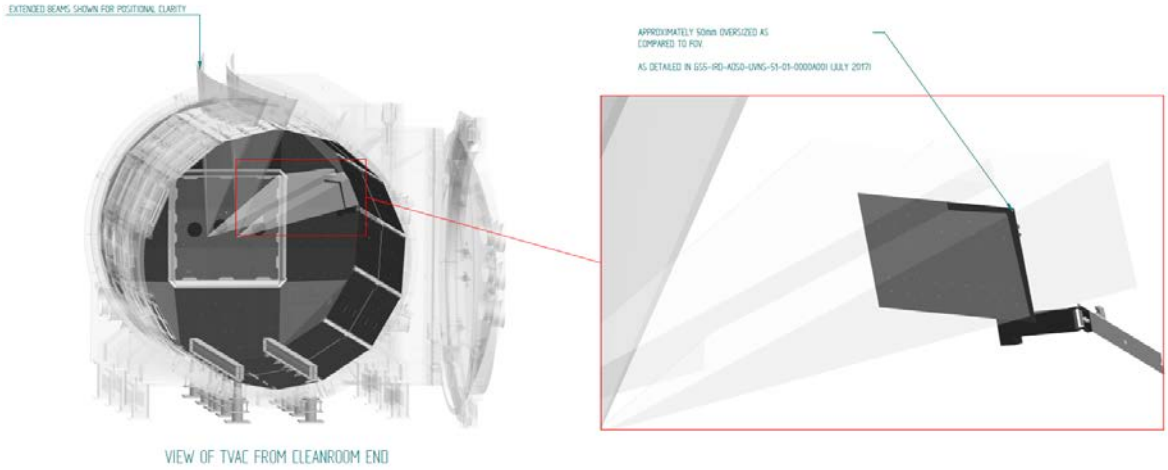

Figure 16: View of chamber from cleanroom, with location of cold black target indicated

1.10 Harness

Harness routing will be designed so as to respect the range of movements of the TRS (APCO MGSE).

In order to ensure that the harness will not impede the movement of the MGSE or become trapped, it is planned to suspend the harness from the TVAC chamber "ceiling" mounting points. This is a common approach within the RAL Space Test Facility.

Figure 17 demonstrates how this concept was used on a previous programme. Suspending the harness also limits the conductive heat transfer to adjacent surfaces. In order to limit the radiative heat transfer all harness will be wrapped in MLI.

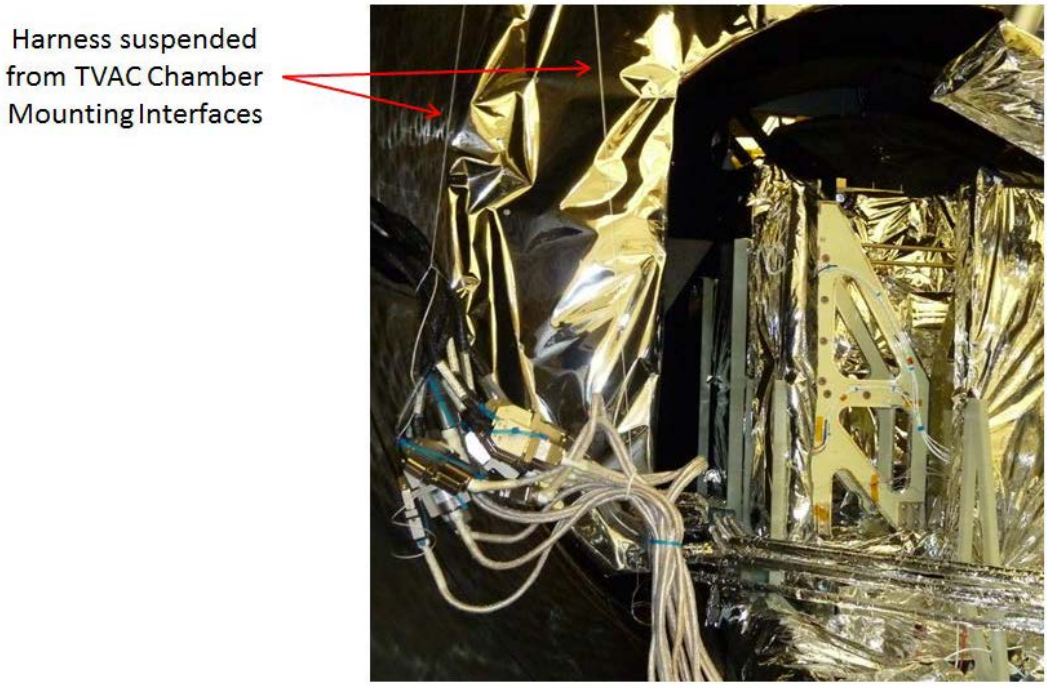

Figure 17: Harness Suspended within TVAC Chamber

It will be possible to perform tests along the test harness where it exits the TVAC Chamber via dedicated feedthroughs into the EGSE Room.
With respect to the Instrument harness interface, RAL assume the following:

- The S5 UVNS Instrument harness will be delivered with savers
- No flight grade connectors are required (neither at instrument IF nor EGSE IF)
- The harness routing and Feedthrough definition does not need to accommodate the separation of instrument and MGSE signals, nor separate High Power signals to different flanges

The S5 harness has been designed and manufactured for STM test in STC-1. The harness involved for this work package is relevant to only S5 EM test in STC2/3.

1.11 STC-2/3 Scaffolding

Some ground support equipment arriving with the customer for EM test is above working height level. The design and manufacture of scaffolding in STC2/3 is therefore needed in

order to accommodate employees working at height. Dimensions have been provided by the customer in order to begin design work.

Work Package Description

2 WP 12-2ADV S4 /S5 facility mechanical design activities up to S5 EM testing

Project:	S-4/5 UVN Calibration & Characterisation Test Facility			**WP Ref:**	12-2ADV
Phase:	1			**Sheet No.**	1 of 1
WP Title:	TVAC Chamber Mods Definition & Design			**Date:**	23-05-18
Contractor	TBD				
Start date	22/08/2018	**Start event**	Kick-off		
End date	31/05/2019	**End event**	STC2/3 Facility Test readiness review		
WP manager	Brian Maddison				

2.1 Objective(s)

- Completion of modifications to STC-2 facility required to support S4 UVN test campaigns
- Completion of modifications to STC-1 and STC-3 facilities required to support S5 UVN test campaigns
- APCO MGSE delivery 1 compliant with requirements.

2.2 Inputs

- Mechanical solid models for STC-1, STC-2 and STC-3
- Mechanical solid models for S4 and S5
- ICD's for S4 and S5
- Customer requirements documentation
- Metrology for S5 MGSE cart

2.3 Tasks

All mechanical design work to be carried out using Solid Edge ST10.
All structural analysis of solid edge assemblies to be carried out using ANSYS V18.
Mechanical design drawings to be delivered in PDF format.

Meetings (See note 1)

1) Attendance at weekly meeting via web-ex for S4 and S5
2) Attendance at RAL for monthly meetings for S4 and S5
3) Attendance at RAL in support of all project reviews for S4 and S5
4) Attendance at APCO for Factory Acceptance Testing of S5 APCO MGSE delivery 1

Assembly Integration and Test support (See note 2)

5) Support at RAL for S5 Test Facility AIT in the integration of the MGSE items for which the contractor has been responsible for the design
6) Support at RAL for S5 APCO MGSE delivery incoming inspection with respect to confirming interface control document compliance
7) Support at RAL for S5 APCO MGSE delivery AIT with regards to addressing any mechanical issues that arise during integration

Successful completion of Procurement packs for the following:-

End stop bracket drawings

Shutter drawings

Internal baffle design and drawings

External baffle design and drawings

HP Cold Plate drawings

Cold black target shroud panel redesign

OGSE room door shroud panel redesign

Alignment window door shroud panel redesign

STM test set up model (Location of IF points as per ADS request)

Completion of the procurement pack will involve production of drawings, derived

from the solid model, which can be used to manufacture components.

S4 Shroud panels redesign (See note 3)

8) Produce procurement pack against which the S4 shroud panels can be procured. - including mandatory inspection points during fabrication process. Completion of the procurement pack will involve production of drawings, derived from the solid model, which can be used to manufacture components.
9) Meet with the company selected to do this work ensuring they understand the manufacturing process, if applicable.
10) Attend and oversee mandatory inspection points during fabrication process, if applicable.
11) Attend and oversee incoming inspection at RAL
12) Produce incoming inspection report

S5 Shroud panels redesign (See note 4)

13) Cold black target shroud panel redesign
14) OGSE room door shroud panel redesign
15) Alignment window door shroud panel redesign
16) Meet with the company selected to do this work ensuring they understand the manufacturing process, if applicable.
17) Attend and oversee mandatory inspection points during fabrication process, if applicable
18) Attend and oversee incoming inspection at RAL
19) Produce incoming inspection report

S5 Trolleys (See note 5)

1) Attend and oversee incoming inspection at RAL
2) Produce incoming inspection report

Shutters redesign (see note 6)

3) S4 and S5 shutter shims
4) Shutter redesign based on shroud panel redesign

S5 Scaffolding (See note 7)

5) Deign and support for S5 scaffolding design

Pipework (See note 8)

6) S5 MGSE pipework routing. (Both LN2 and Galden), scope dependant on scope of APCO work.
7) Review of APCO pipework routing
8) S5 HPC pipework routing
9) S5 Cold Trap pipework routing

S4 Cleanroom trolley (see note 9)

10) S4 cleanroom trolley design

S4 Patch panel rework (See note 10)

11) Design rework for S4 patch panel

S5 Windows and baffles (See note 11)

12) Detailed redesign of OGSE window flanges
13) Detailed redesign of observation window flanges
14) Detailed redesign of internal baffles for OGSE windows and observation windows
15) Detailed redesign of external baffles for OGSE windows.
16) Produce procurement pack against which the windows and baffles can be procured. - including mandatory inspection points during fabrication process.
17) Meet with the company selected to do this work ensuring they understand the manufacturing process, if applicable.
18) Attend and oversee mandatory inspection points during fabrication process, if applicable
19) Attend and oversee incoming inspection at RAL
20) Produce incoming inspection report.

MOC panel mounting brackets design (see note 12)

21) S4 require the design and manufacture of MOC panel mounting brackets.

Cable harness (See note 13)

22) Review of APCO MGSE proposed harness routing.

23) Define cable lengths and routing and method of support for S5 for EM test.

Room drawings (see note 14)

1) STC-3 OGSE room drawing
2) STC-3 EGSE room drawing

2.4 Outputs

Meetings

1) Attendance at weekly meeting via web-ex for S4 and S5
2) Attendance at RAL for monthly meetings for S4 and S5
3) Attendance at RAL in support of all project reviews for S4 and S5
4) Attendance at APCO for Factory Acceptance Testing of S5 APCO MGSE delivery 1

AIT

1) Support at RAL for S5 Test Facility AIT in the integration of the MGSE items for which the contractor has been responsible for the design
2) Support at RAL for S5 APCO MGSE delivery incoming inspection with respect to confirming interface control document compliance
3) Support at RAL for S5 APCO MGSE delivery AIT with regards to addressing any mechanical issues that arise during integration

S4 Shroud panels

5) S4 shroud panels inspection report showing compliance with requirements

S5 Shroud panels

6) S5 shroud panels inspection report showing compliance with requirements

S5 Trolleys

7) S5 trolleys incoming inspection report showing compliance with requirements

Pipework

8) S4 and S5 pipework in place (LN2 and Galden)
9) Review of APCO MGSE pipework

S5 Windows and baffles

10) S5 windows and baffles that meet requirements.

Cable harness

11) Cable harness definition that meets requirements for length and MGSE rotation for S5

Room drawings

12) STC-3 OGSE room drawing

13) STC-3 EGSE room drawing

14) S4 ICD

15) S5 ICD

2.5 WP 11-2ADV Notes

Note 1

RAL monthly meetings will require attendance at RAL for two days. One day for meeting and one day for follow up discussions / clarifications.
APCO factory acceptance testing will take place at APCO premises in Switzerland and take place over a 3 day period.

Note 2

Support at RAL for S5 Test Facility AIT will be required over a 10 day period for STM test campaign.
Support at RAL for S5 APCO MGSE delivery 1 incoming inspection AIT will be required over a 2 day period
Support at RAL for S5 APCO MGSE delivery 1 AIT will be required over a 10 day period
Support at RAL for S5 Test Facility AIT will be required over a 10 day period for EM test campaign.

The price per day for on site support is required in case a CCN is required in the event that problems are encountered and the AIT period extends beyond planned time.

Note 3

The detailed redesign of the S4 shroud panels is required.

Note 4

The detailed redesign of the S4 shroud panels is required.

Note 5

S5 trolleys detailed design has been completed. Therefore support is only required upon incoming inspection.

Note 6

Shutters have been originally designed and manufactured however redesign/modification may be needed once shroud panel design has been finalised.

Note 7

Design can be based on S4 scaffolding design but modified to suit S5 requirements.

Note 8

Pipework in the facility for LN2 and galden shall be via flexible pipes. The lengths will need to be defined and a method devised for supporting them such that vibration coupling to the quiet rail is eliminated in all bar the S5 warm stage heat pipe case. Therefore, the proposed mount shall minimise vibration coupling to the quiet rails.
Review and acceptance of APCO proposed MGSE pipework routing.

Note 9

Design and drawings of S4 cleanroom trolley required.

Note 10

Design has been done for the S4 patch panel, however design rework is required.

Note 11

Detailed design has been done for S5 OGSE windows and observation windows. However, the proposed design found a clash with the window diameter and flanges. Therefore rework is needed which will in turn have an impact on the internal and external baffle design.

Note 12

Design may be common with previous projects due to heritage. Design to be modified in order to be compliant with S4 requirements.

Note 13

There are stringent limits to the cable lengths which will require serious consideration as to routing and choice of chamber flange in order to meet the length requirements. In addition supports for cables must be defined such that the coupling of vibration noise via cables to the quiet rail is kept to a minimum.

Note 14

Room drawings to be provided in PDF format.

3 Milestones

The following Table shows Work Package WP 12-2ADV broken down in Milestones. Each milestone has a set of activities which need to be successfully completed in order to proceed to the next milestone. The duration, delivery date as well as the payment percentage amount is also shown.

Milestone	Task Description	Duration (weeks)	Due T0+ (weeks)	Delivery Date	Amount (%)
0	**Attendance at RAL for 2 day Kick off meeting**	0	0	22/08/2018	0
1	**Successful completion of Procurement packs for the following:-**	10	12	14/11/2018	30
	End stop bracket drawings				
	Shutter drawings				
	Internal baffle design and drawings				
	External baffle design and drawings				
	HP Cold Plate drawings				
	Cold black target shroud panel redesign				
	OGSE room door shroud panel redesign				
	Alignment window door shroud panel redesign				
	STM test set up model				
	Successful support of the following:-				
	STM test campaign				
2	**Successful completion of Procurement packs for the following:-**	4	16	12/12/2018	10

	S4 and S5 shutter shims				
	Cold Black target assembly with LN2 routing				
	STC-3 OGSE room drawing				
	STC-3 EGSE room drawing				
	Successful completion of the following:-				
3	S4 ICD Update with latest Airbus definitions	7	23	30/01/2019	20
	S5 ICD updates including latest APCO geometry (with harness)				
	Successful completion of the following:-				
	S5 (MGSE) Pipework routing (scope dependant on scope of APCO work)				
	Review of APCO pipework routing				
	S5 HPC Pipework routing				
4	S5 Cold Trap Pipework routing	8	33	10/04/2019	25
	S5 Window and flange redesign				
	Support for STC-3 scaffolding for build				
	Successful attendance of the following:-				
	Attendance for Mechanical Support at RAL for APCO MGSE Delivery 1				
	Successful completion of the following:-				
	S5 (MGSE) harness routing (scope dependant on scope of APCO work)				
	Review of APCO harness routing				
5	S4 rework design of patch panels	4	37	08/05/2019	10
	S4 cleanroom trolley design				
	MOC panel mounting brackets design				

6	**Successful support of the following:-** EM test campaign Incoming inspections of EM hardware	3	40	29/05/2018	5
				Total:	100