



**SPIRE - 300mK PSW-PFM filter stack**

**End Item Data Package (EIDP)**

**SPIRE - 300mK PSW-PFM filter stack**

SPIRE Ref.: SPIRE-UCF-DOC-002183

Cardiff Ref.: HSO-CDF-EIDP-062 Issue 1.0

15 June 2004

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# Change Record

Issue	Section	Date	Changes
1.0		15 <sup>th</sup> June 2004	First Issue after DRB approval

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## SECTION 01 - Shipping Documents

Labelling on box:-

# Instructions to FedEx – Important!

At LAX, please handover to:-

PackAir Airfreight INC.,  
5510 West 104 St.,  
Los Angeles CA90045  
USA

Power of Attorney - Roger Bachar  
Telephone (310) 342 6051



**Figure 1 PSW PFM filter stack prior to shipping to JPL**

## SECTION 02 - Transportation, Packing, Handling & Integration Procedures

**This package contains flight hardware.  
To be opened only by authorised SPIRE personnel in clean room conditions.**

Do not touch filter surface.

Handle only by Aluminium frame.

To be integrated to SPIRE flight model PMW BDA according to JPL procedure.

Hand over to JPL Cognisant Engineer – Mark Weilert

Mark Weilert  
M/S 79-24  
Jet Propulsion Laboratory  
4800 Oak Grove Dr.  
Pasadena Ca 91109-8099

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## SECTION 03 - Certificate of Conformance

<i>Cardiff University Astronomy Instrumentation Group hereby certifies that the following equipment,</i>		
Spacecraft / Project:	<b>Herschel</b>	
Instrument:	<b>SPIRE</b>	
Model:	<b>PFM</b>	
Subsystem:	<b>300mK PSW filter stack</b>	
Serial No:	<b>FILT-PFM-250</b>	
<i>As described in this End Item Data Package:</i> <b>HSO-CDF-EIDP-062</b>		
<i>Complies with the requirements set out in:</i> <b>SPIRE-RAL-PRJ-000034</b>		
<b><i>Responsible Authority</i></b>		<b><i>Signature</i></b>
Cardiff Filter Management	Prof P.A.R.Ade	
	Dr C.E.Tucker	
Cardiff Product Assurance	Dr I.Walker	
Cardiff SPIRE Management	Dr P.Hargrave	



## SECTION 04 - Qualification Status List

Test	Status	Applicable document / Test reference	Test Institute
	<b>PFM-PSW - FILT-PFM-250</b>		
Spectral behaviour - Near-band transmission	Tested at component and assembly level. Compliant.	HSO-CDF-SP-002-2.2 See historical record for test references	UWC
Spectral behaviour - out-of-band blocking, at $\lambda < 15\mu\text{m}$	Open test. Off-cuts to be tested once facility commissioned	HSO-CDF-SP-002-2.2 See historical record for test references	UWC
Dimension and tolerances to specification	Compliant	HSO-CDF-ICD-012-3.0	UWC
Filter flatness	Not applicable for this assembly	HSO-CDF-ICD-012-3.0	UWC
Inspection for surface defects	Passed		UWC
Mass	Compliant	HSO-CDF-ICD-012-3.0	
Thermal cycling (5 cycles 300K-77K-300K)	Passed	See historical record for test references	UWC
Cold vibration	Not tested at unit level, but qualified in SPIRE CQM cold vibration campaign	MSSL-Technote-SPIRE-26 SPIRE-RAL-REP-002007	MSSL/RAL – Cold vibration RAL – Post vibration inspection
Environmental condition - Vacuum $3 \times 10^{-1} \text{mBar}$	Passed	See historical record for test references	UWC
Differential pressure (a pumping-out rate of 10mB/sec)	Passed	See historical record for test references	UWC
Pre-bake out (not exceeding 80°C)	Passed		UWC
Outgassing	Test not performed. All materials used within ESA / NASA specifications		
Cleanliness checks, by visual inspection.	Passed		UWC
Degradation due to high energy radiation.	Not tested. Heritage from previous space missions (ISO, Cassini)		

## Compliance Matrix

The PSW filter stack comprises the PFIL4S and PFIL5S components, which have been bonded together to minimise fringing between these components. PFIL4S is a higher frequency blocking filter, and the exact position of the edge is not important (see HSO-CDF-RFW-063). The edge position of PFIL4S has been selected to provide optimal overall stack transmission, taking into account all other preceding components in the PSW filter channel. The edge is defined by PFIL5S.

Name	Location	Temp.	Filter type	Component Edges			Bonded stack edges cm-1	Comments	Thickness (mm) HSO-CDF-ICD-012 Issue 3.0		Bonded stack assembly Actual thickness (mm)
				Trans.	Required	Actual			Component	Assembly	
					cm-1	cm-1					
PFIL4S	Over SW array	300 mK	Low-pass edge Blocker	90%	47.5	54.1		Blocker. Edge out of spec. - see HSO-CDF-RFW-063	0.236 ± 0.05	5.48±0.10	5.55
				50%	50.0	57.8					
				10%	52.5	54.1					
PFIL5S	Over SW array	300 mK	Low-pass edge definer	90%	45.6	46.3	43.8	PSW edge definer. Component meets spec.	0.246 ± 0.05	5.48±0.10	5.55
				50%	48.0	47.9	47.5				
				10%	50.4	49.4	48.8				

# SECTION 05 - Top Level Drawings (Inc. Family Tree)

## TOP LEVEL DRAWING LIST

Drawing No.	Title
FILT-CQM/PFM-200-03.001	300mK Filter Assembly

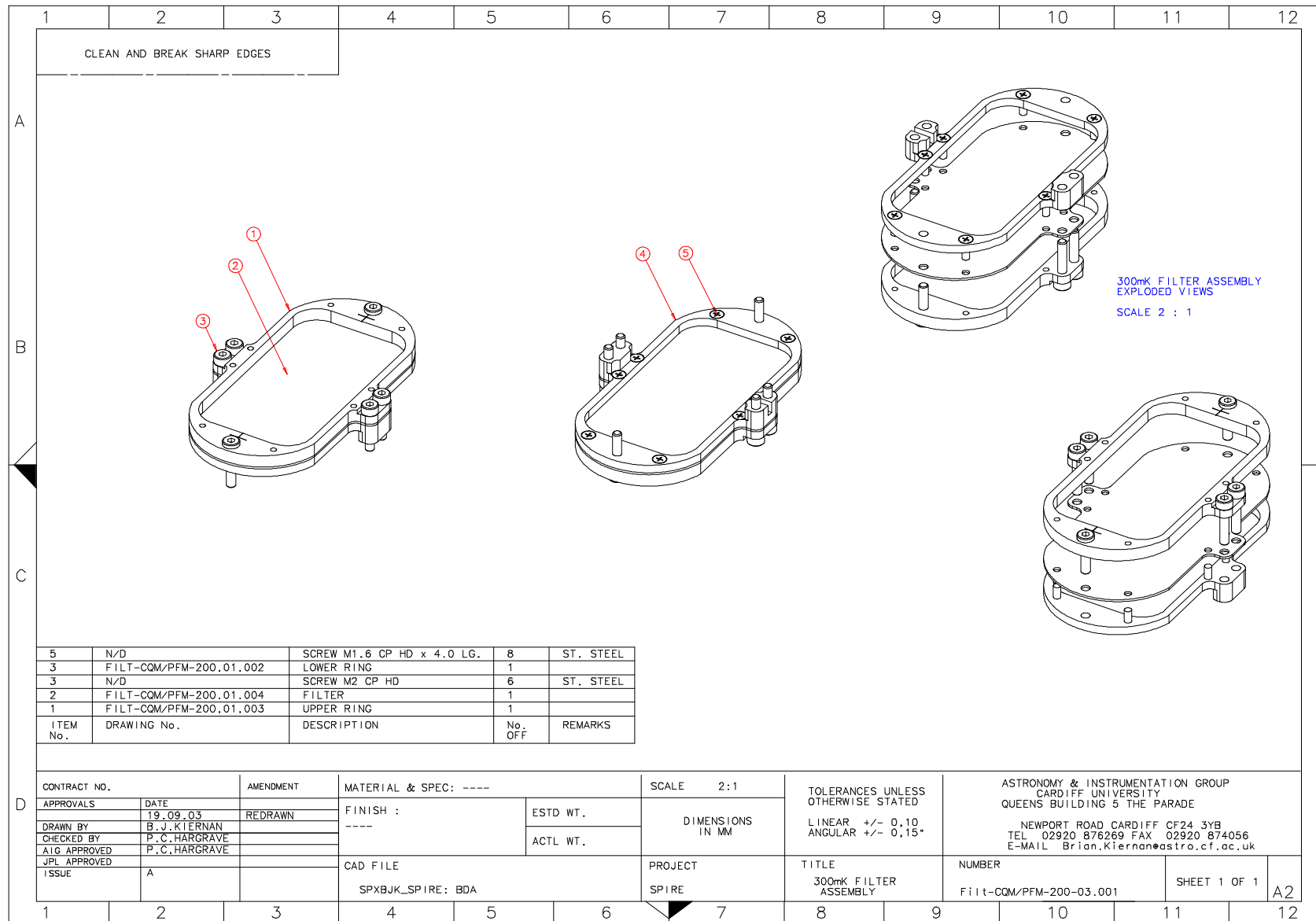


Figure 2 300mK filter stack assembly

# SECTION 06 - Interface Drawings

## INTERFACE DRAWING LIST

Drawing No.	Title
FILT-CQM/PFM-200	300mK Filter ICD

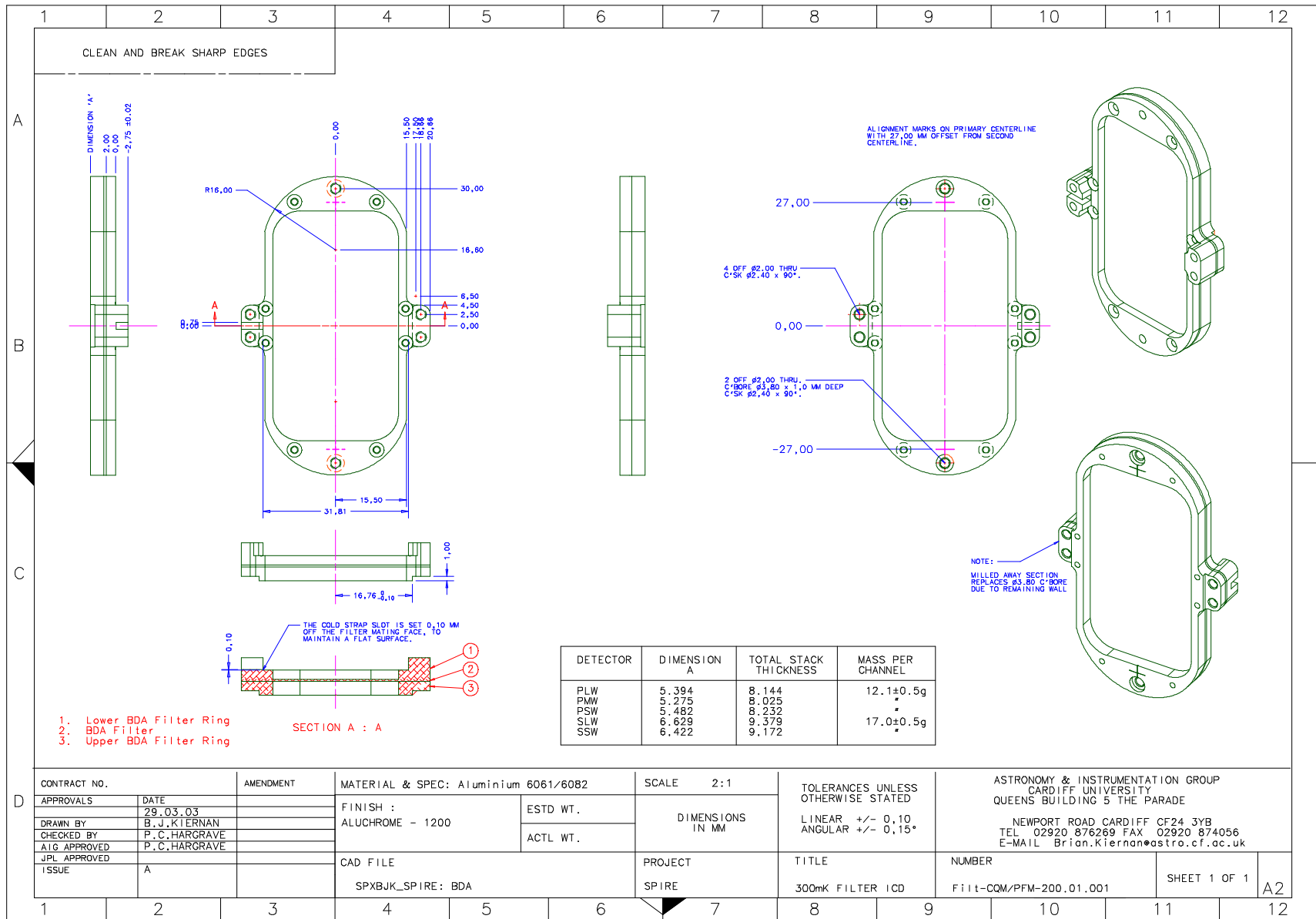


Figure 3 Interface drawing for 300mK filters

## SECTION 07 - Functional, Block & Mechanical Drawings

Component drawings are given in this section.

### ***FUNCTIONAL & BLOCK DRAWING LIST***

Drawing No.	Title

### ***MECHANICAL COMPONENT DRAWING LIST***

Drawing No.	Title
FILT-CQM/PFM-200-01-004	300mK Filter
FILT-CQM/PFM-200-01-003	300mK Filter Upper Ring
FILT-CQM/PFM-200-01-002	300mK Filter Lower Ring

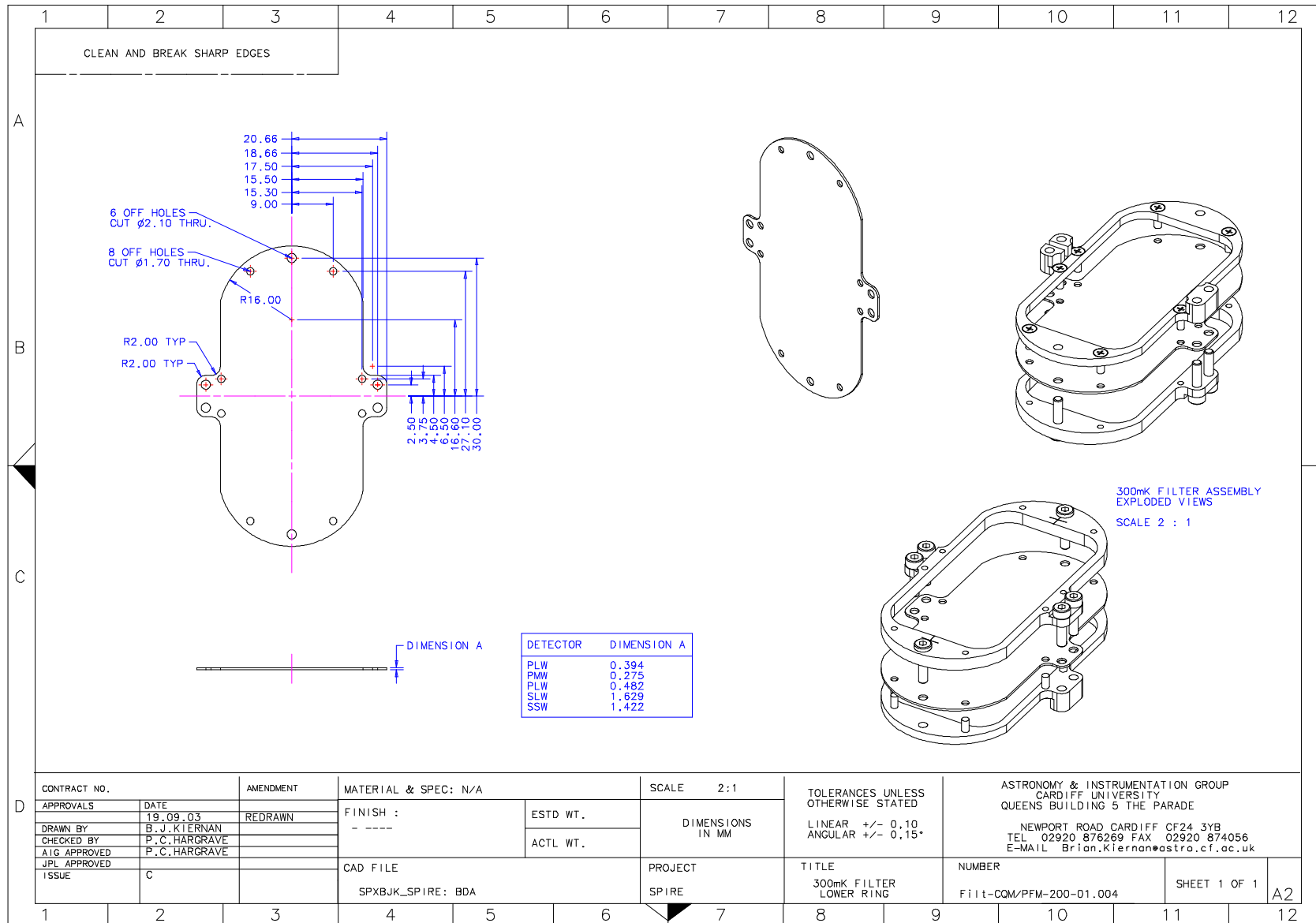


Figure 4 300mK Filter



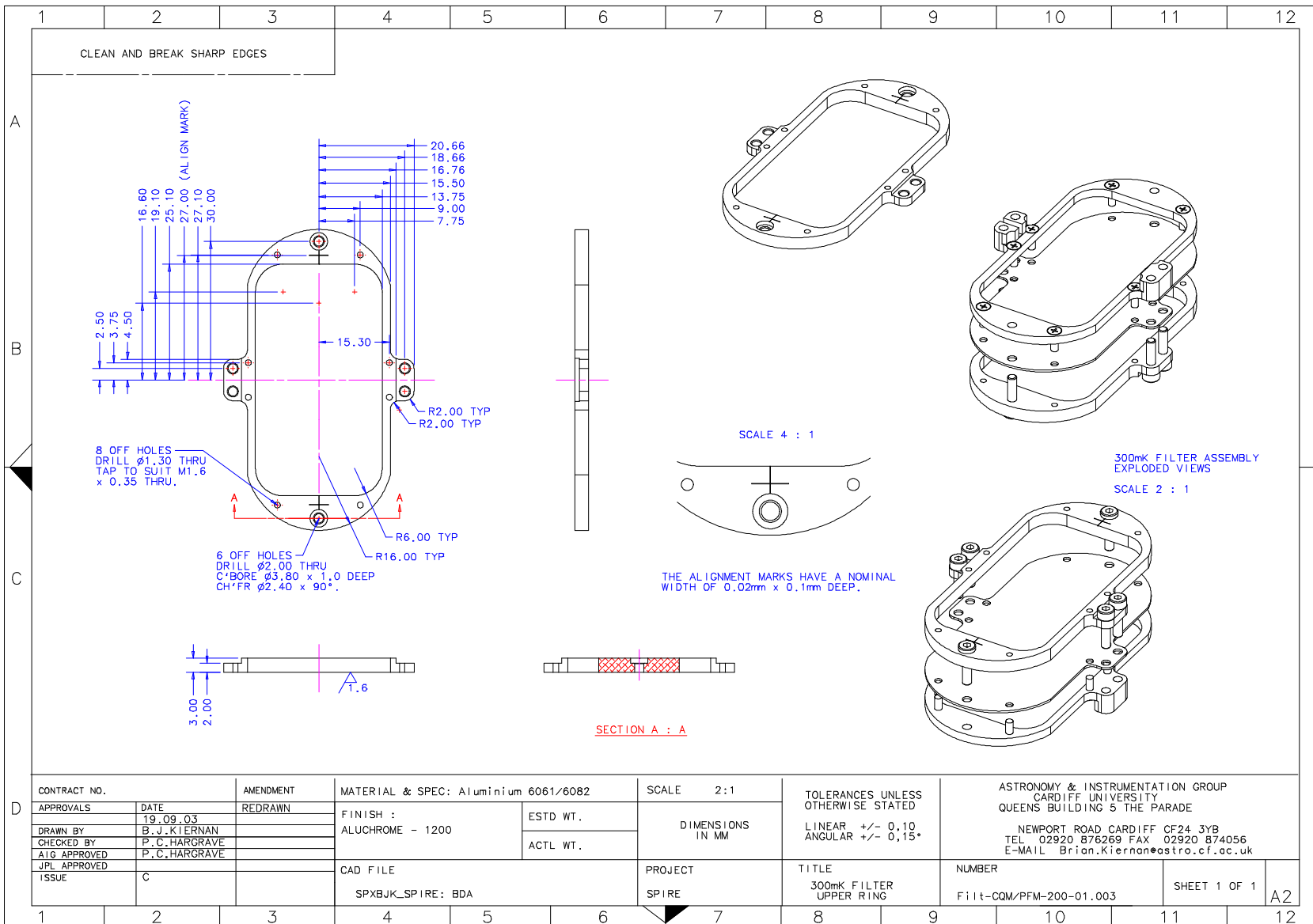


Figure 5 300mK Filter Upper Ring

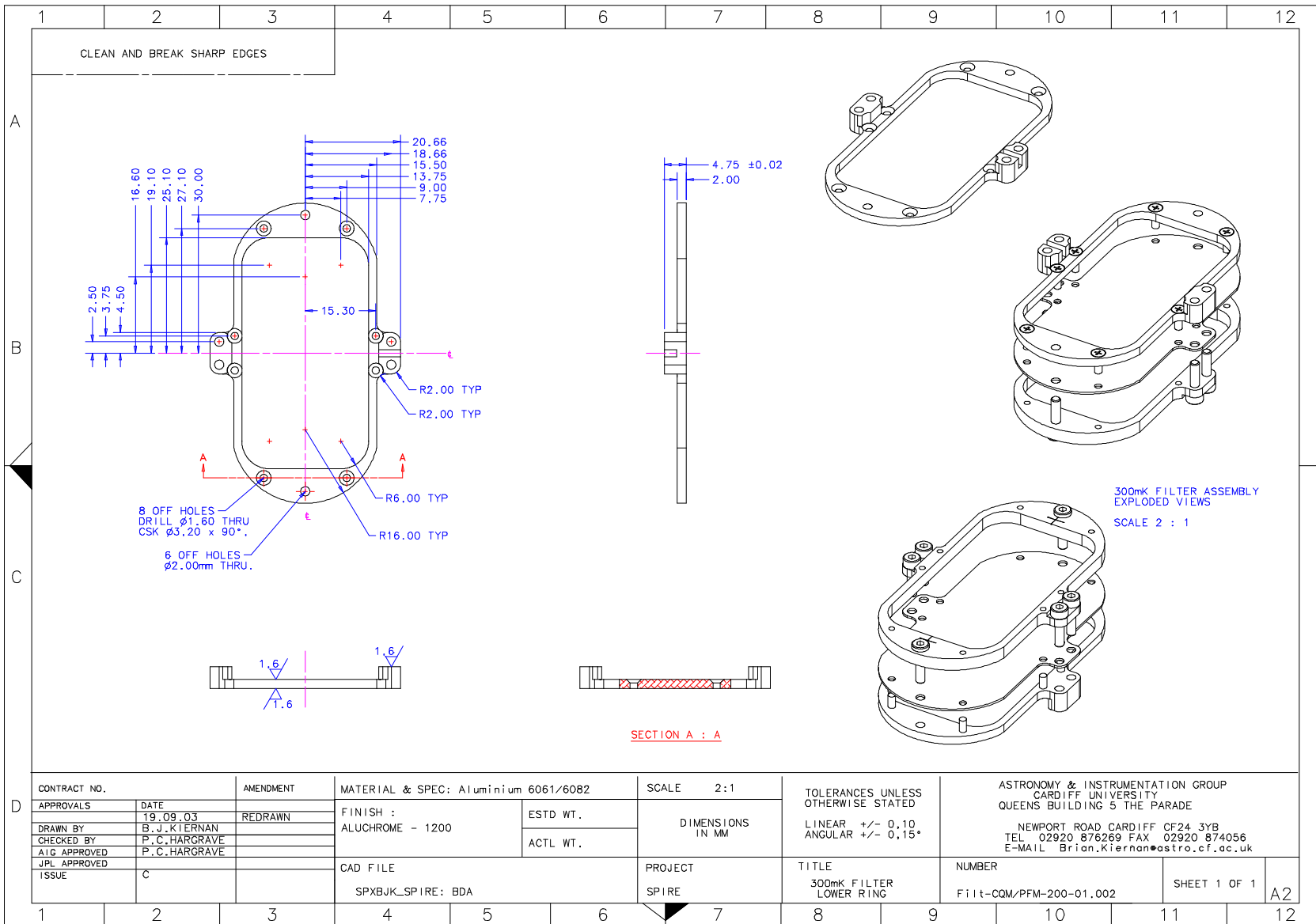


Figure 6 300mK Filter Lower Ring

## SECTION 09 - As Built Configuration Items Status List

Item	Reference	Location	Notes
Filter drawings and manufacturing files		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_documents\Filters\Drawings\300MK-filter-CQM-PFM.doc	
Material certificates of conformance		Available at Cardiff for inspection	
FILT-PFM-250 Spectroscopic test data PSW-PFM assembly		\\Darkstar\Astroworld\Projects\SPIRE\Cardiff_workpackages\Configured_documents\Issued\Data\FILT-PFM-250_PSW_assembly_210504.xls	

Part number	Description	Details
<b>FILT-PFM-250</b>	<b>PFM PSW FILTER ASSEMBLY</b>	
FILT-PFM-251	PSW PFM lower filter ring	Aluminium-6082 – Aluchrom 1200 coated
FILT-PFM-252	PSW-PFM upper filter ring	Aluminium-6082 – Aluchrom 1200 coated
FILT-PFM-253	PFIL4S – PFM – W859 filter	57.8 cm <sup>-1</sup> LPE blocking filter
FILT-PFM-254	PFIL5S – PFM – W857 filter	47.9 cm <sup>-1</sup> LPE blocking filter

## SECTION 11 - List of Waivers

HSO-CDF-RFW-063	SPIRE PFM Blocking Filters RFW	
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## SECTION 12 - Copies of Waivers

## SECTION 13 - Operations Manual

## SECTION 14 - Historical Record

The following table contains *brief* historical details of the manufacture, assembly and testing of the PFM 300mK PSW filter assembly, including the levels of environmental cleanliness.

A *full* historical record of every stage of manufacture for each individual grid integral to the final mounted filter is traceable at UWC, in both hard copy log-book format and on a Microsoft Access database.

### PSW PFM filter stack

Date	Action	UWC Test reference
24/05/02	Upper and lower filter clamp rings manufactured – Cardiff MEC. Ref. Q/1731.1	
16/3/04	Filter W857 manufactured in class 1000 clean room	
18/3/04	Filter W857 spectroscopically tested in the range 15-140cm-1	T0289r10
19/3/04	Filter W857 spectroscopically tested in the range 5-40cm-1	T0288r10
18/3/04	Filter W859 manufactured in class 1000 clean room	
19/3/04	Filter W859 spectroscopically tested in the range 15-140cm-1	
19/3/04	Filter W859 spectroscopically tested in the range 5-40cm-1	T0288r28
14/5/04	Filters W857 and W859 bonded together	
17/5/04	Bonded filters W857 and W859 spectroscopically tested in the range 15-140cm-1	T0325r10
17/5/04	Bonded filters W857 and W859 cut to PSW drawing.	
17/5/04	Bonded filters W857 and W859 thermally shocked 5 times between 300K and 77K	THERM 0187
17/5/04	PFM-PSW spectroscopically tested in the range 10-145cm-1 at three locations over area	T0325r10, T0325r13, T0325r16,
19/5/04	Bonded filters W857 and W859 spectroscopically tested in the range 20-650cm-1	T0328r4
19/5/04	Filters mounted as SPIRE_PFM_PSW filter stack	
19/5/04	SPIRE_PFM_PSW spectroscopically tested in the range 15-140cm-1	T0328r10
19/5/04	SPIRE_PFM_PSW thermally cycled 300K-77K-300K 3 times	THERM 0188
19/5/04	SPIRE_PFM_PSW spectroscopically tested in the range 15-140cm-1	T0328r13
19/5/04	SPIRE_PFM_PSW spectroscopically tested in the range 5-40cm-1	T0329r9
20/05/04	PFM-PSW baked for 17hrs at 350K	

21/05/04	PFM-PSW stack final clean, 12Hr bake-out	
24/5/04	PFM PSW 300mK stack DRB meeting	HSO-MOM-064
15/06/04	PFM-PSW shipped to JPL	

**SECTION 15 - Logbook / Diary of Events**

Not provided – available from subsystem provider upon request.

**SECTION 16 - Operating Time / Cycle Record**

## SECTION 20 - Calibration Data Record

The recommended total stack transmission for the PSW channel to be used for calibration purposes is indicated in this section, with traces shown for the ranges 0-650cm<sup>-1</sup>, 0-140cm<sup>-1</sup>, and 0-70cm<sup>-1</sup>.

These are the measured transmission spectra prior to final cleaning and packing.

The raw data is stored in the file \\Darkstar\Astroworld\Projects\SPIRE\Cardiff\_workpackages\Configured\_documents\Issued\Data\FILT-PFM-250\_PSW\_assembly\_210504.xls (Microsoft Excel workbook). This file is available from Cardiff, and is under configuration control on Livelink (managed by RAL).

Calibration data for all SPIRE flight model filters may be found in the file

\\Darkstar\Astroworld\Projects\SPIRE\Cardiff\_workpackages\Configured\_documents\Issued\Data\PFM-filters-summary.xls



PFM PSW Stack Transmission (0-650cm-1)

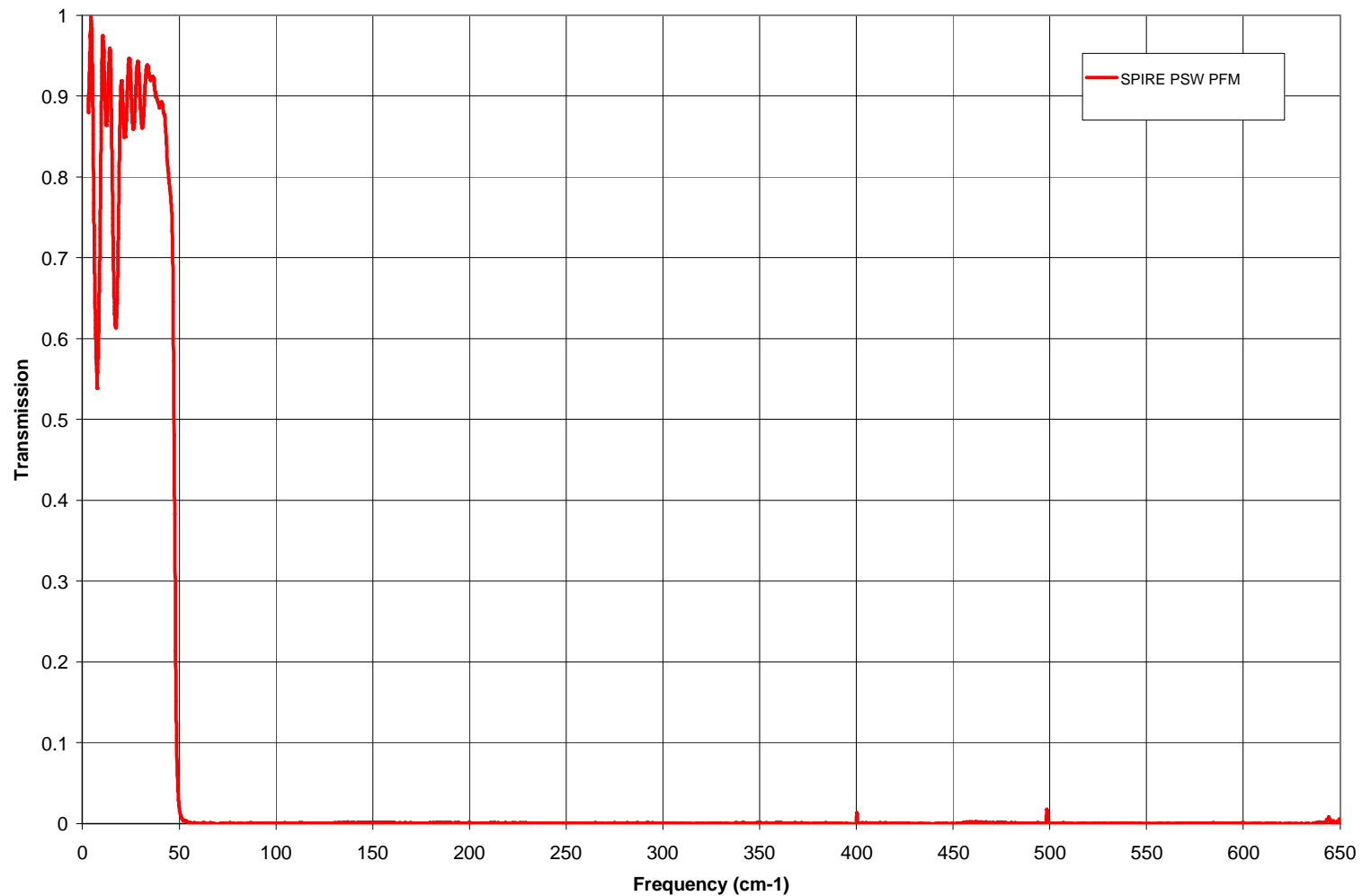


Figure 7 Spectroscopic data for PFM-PSW stack

PFM PSW Stack Transmission (0-140cm-1)

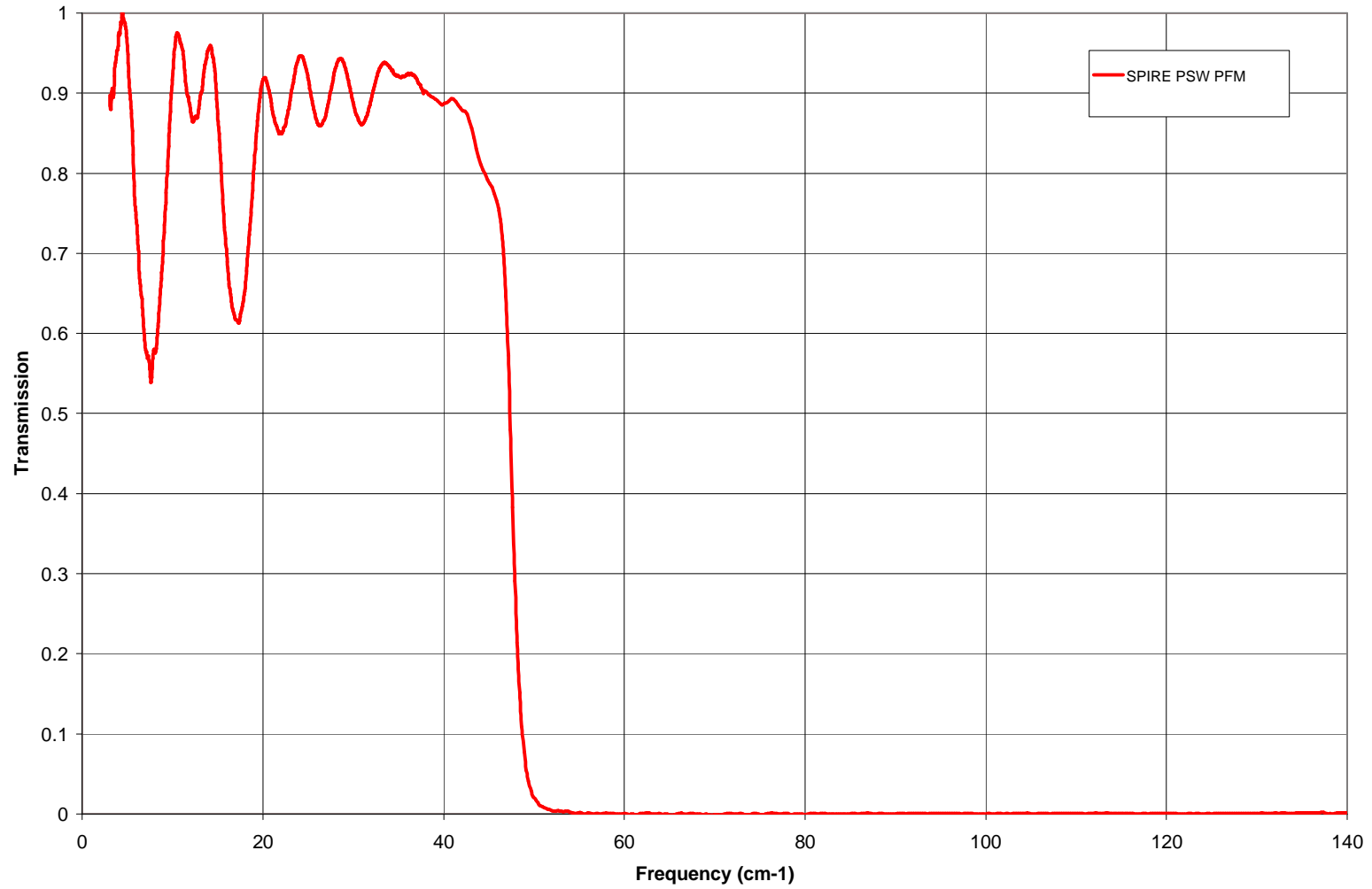
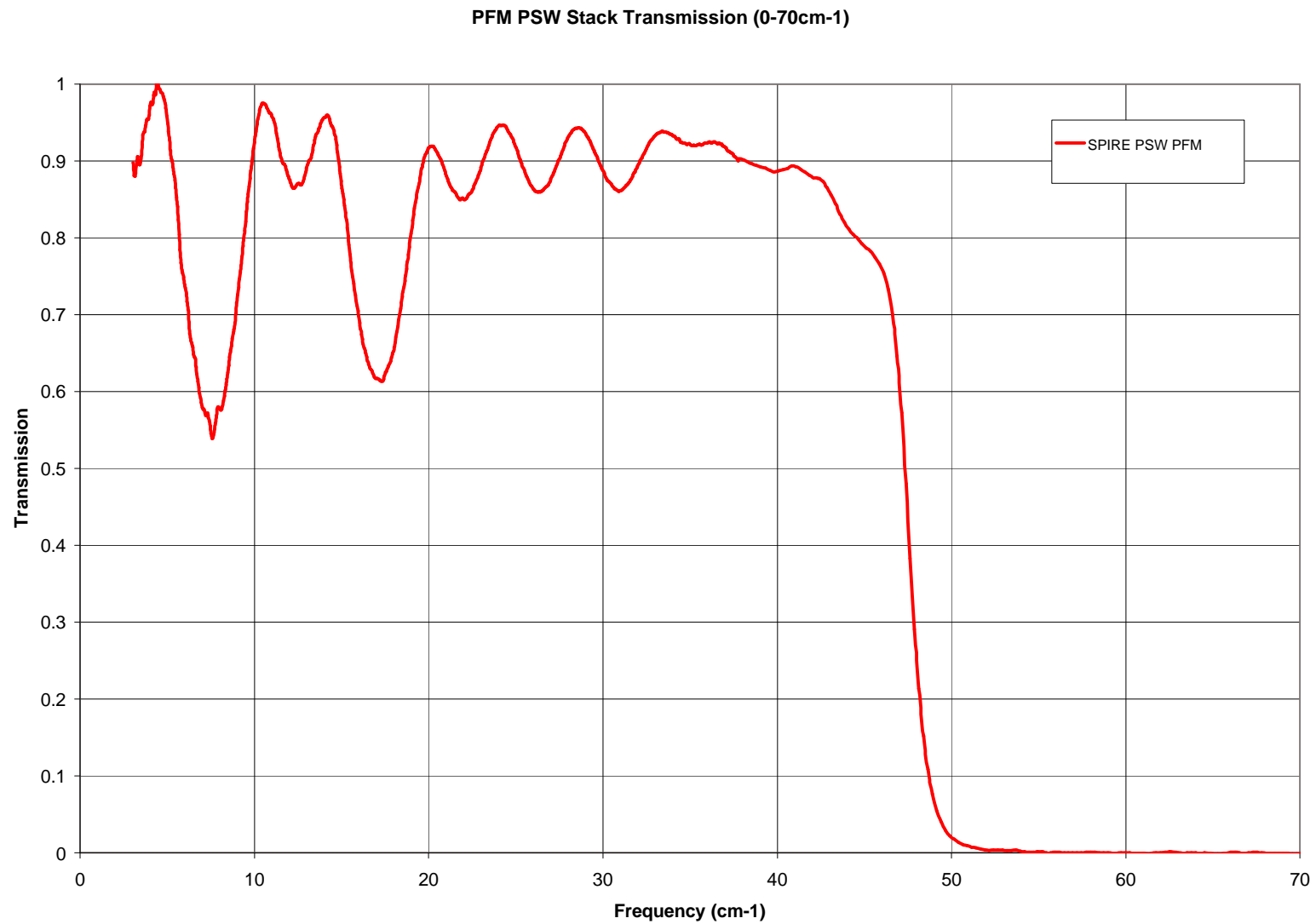
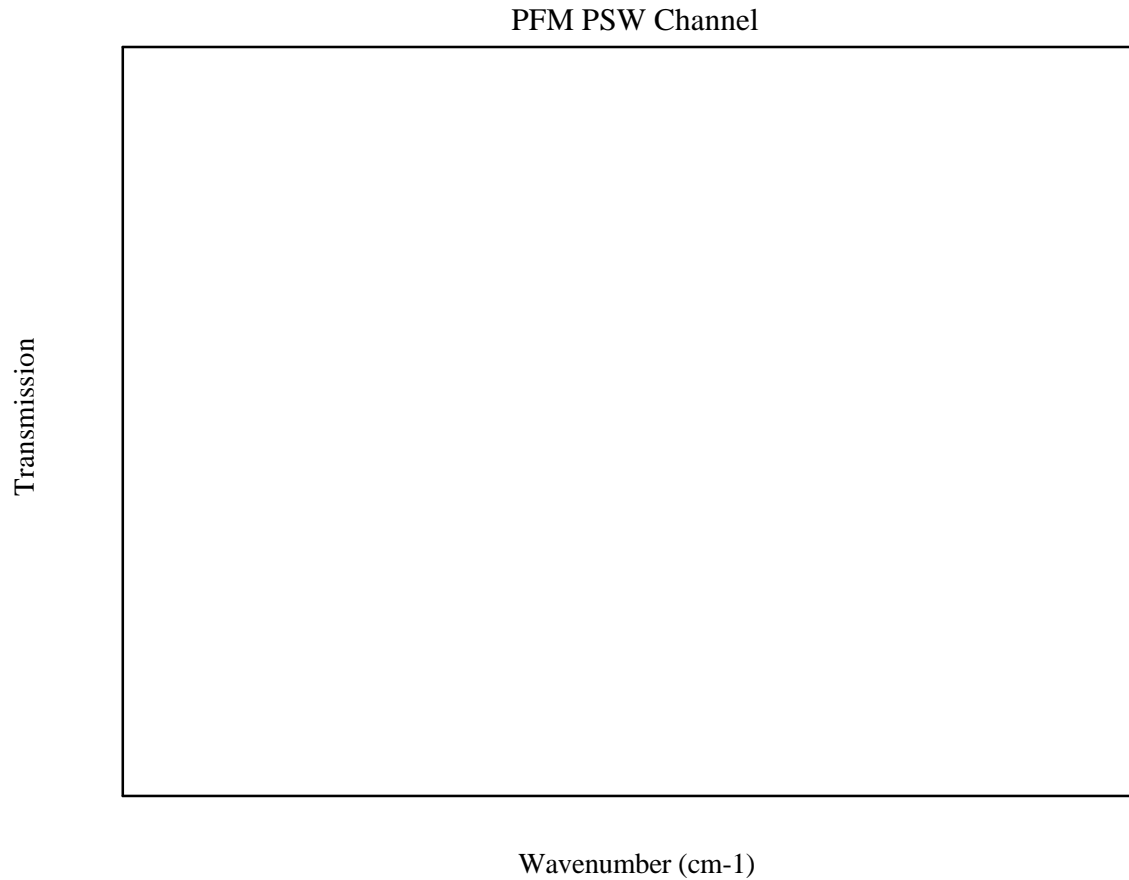


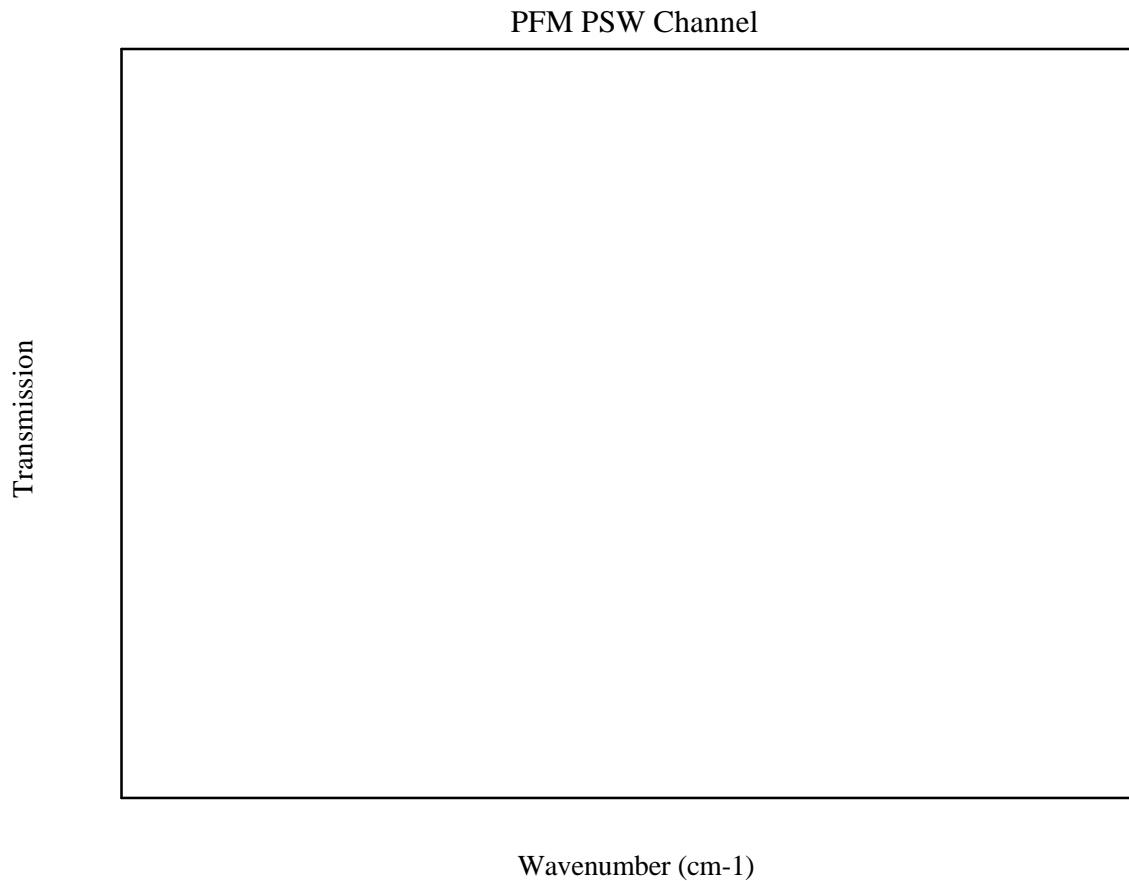
Figure 8 Spectroscopic data for PFM-PSW stack



**Figure 9 Spectroscopic data for PFM-PSW stack**



**Figure 10** Calculated total PFM PSW channel transmission. These data are calculated from the measured profiles of all flight model filters in the PSW channel.



**Figure 11** Calculated PSW PFM total channel transmission, showing level of rejection attained out to  $600\text{ cm}^{-1}$ .

## **SECTION 21 - Temporary Installation Record**

## **SECTION 22 - Open Work / Deferred Work / Open Tests**

Off-cuts of the filter material will be measured below 15µm using the Bomen spectrometer, once this facility is fully commissioned.

## **SECTION 23 - List of Non-Conformance Reports**

None

## **SECTION 24 - Copies of Non-Conformance Reports**

## SECTION 25 - Test Reports

The filter module (PSW assembly and sub-units) underwent the following series of qualification tests:-

- a) Post-manufacture spectroscopic measurements – 5-40cm<sup>-1</sup> and 15-140cm<sup>-1</sup> of PFIL4S and PFIL5S
- b) Post-bonding spectroscopic measurements – 5-40cm<sup>-1</sup> and 15-140cm<sup>-1</sup> of PFIL4S and PFIL5S
- c) Cutting of PFM and FS filter stacks from same bonded pair substrate.
- d) Thermal shocks of the filter material. This consisted of five cycles of:-
  - Plunge filter material at room temperature into bath of liquid nitrogen and leave for 2 minutes
  - Remove filter material from LN<sub>2</sub> and place in oven at 320K for 10 minutes
- e) Visual inspection
- f) Spectroscopic measurements of mounted assembly at three points over the filter area – 10-145cm<sup>-1</sup> range
  - Uniformity checks:-
    - The filter assembly was checked for uniformity at three points along the filters long axis - at the centre of the filter, and at two points along the long axis, 16mm either side of the central point.
    - The FTS geometric beam footprint was approximately 7mm diameter.
- g) Spectroscopic measurements of bonded filter material – 20-650cm<sup>-1</sup> range
- h) Cleaning and mounting in clamp
- i) Spectroscopic measurements in the range 15-140cm<sup>-1</sup>
- j) PFM-PSW assembled stack thermally cycled 300K-77K-300K (3 times)
- k) Spectroscopic measurements - 15-140cm<sup>-1</sup> range
- l) Spectroscopic measurements - 5-40cm<sup>-1</sup> range
- m) PFM-PSW stack vacuum baked for 17Hrs at 350K
- n) Visual inspection under microscope

### ***Spectroscopic tests – index***

Spectroscopic tests were carried out according to standard UWC FTS procedures. Refer to historical record for index.

### PFM PFIL4s and PFIL5S Transmission

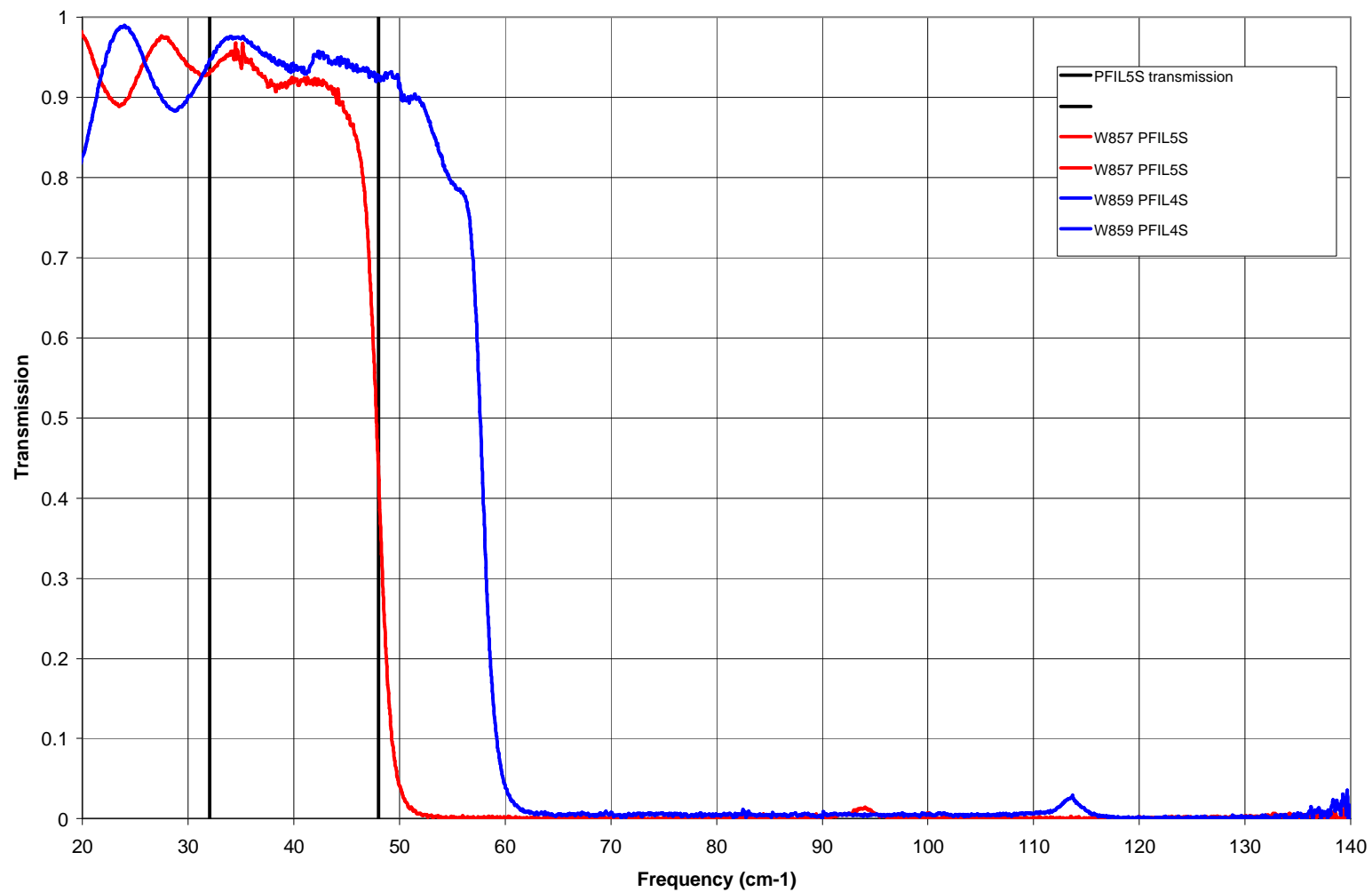
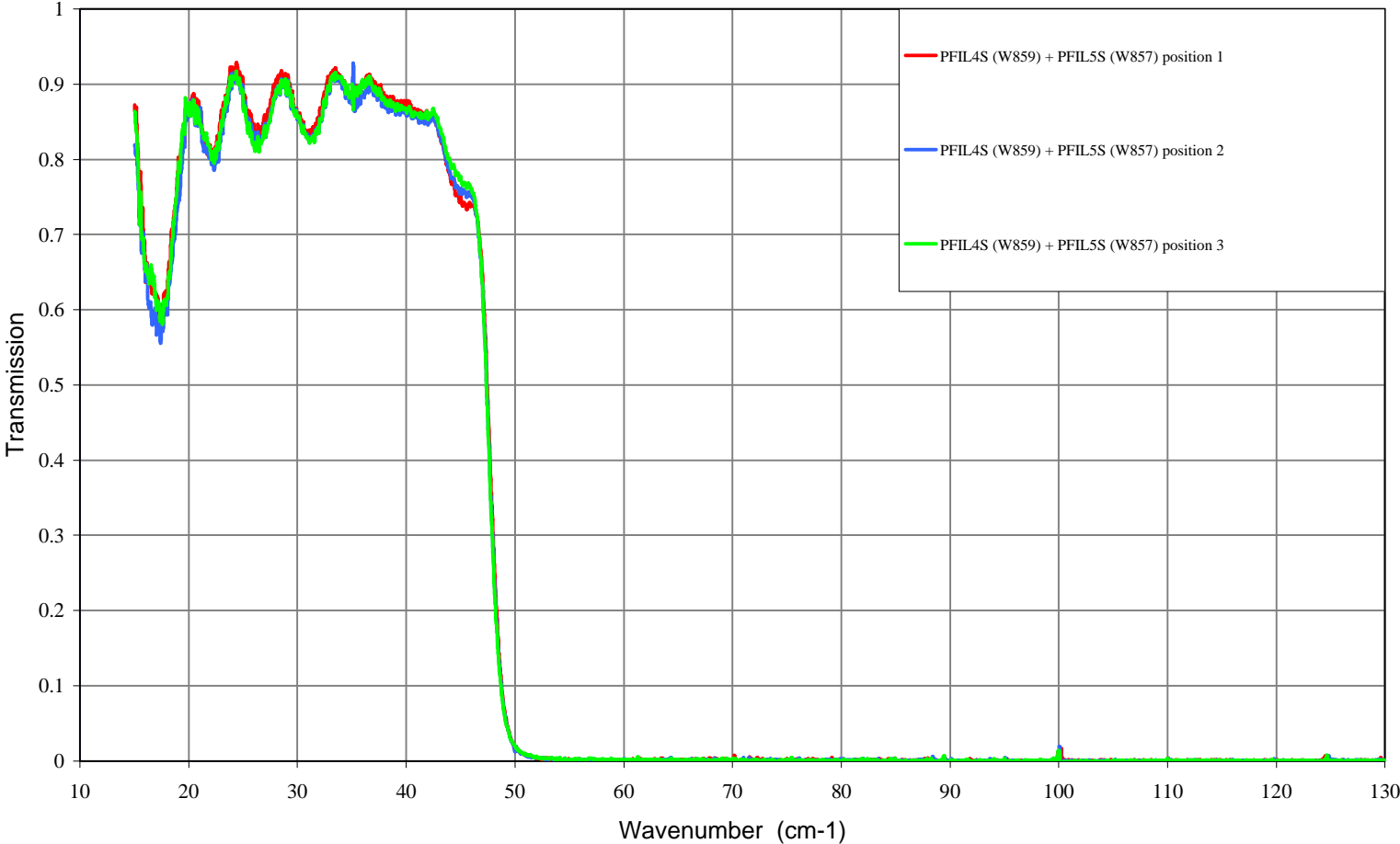


Figure 12 PFM PFIL4S and PFIL5S transmission, prior to bonding and cutting.



**Bonded filter stack (PFIL4S & PFIL5S) - Uniformity post cutting & thermal shocks**



**Figure 13 Bonded filter stack - uniformity post-cutting and 5 thermal shock cycles**

### FILT-PFM-250 PFM PSW stack post-mounting & thermal cycling

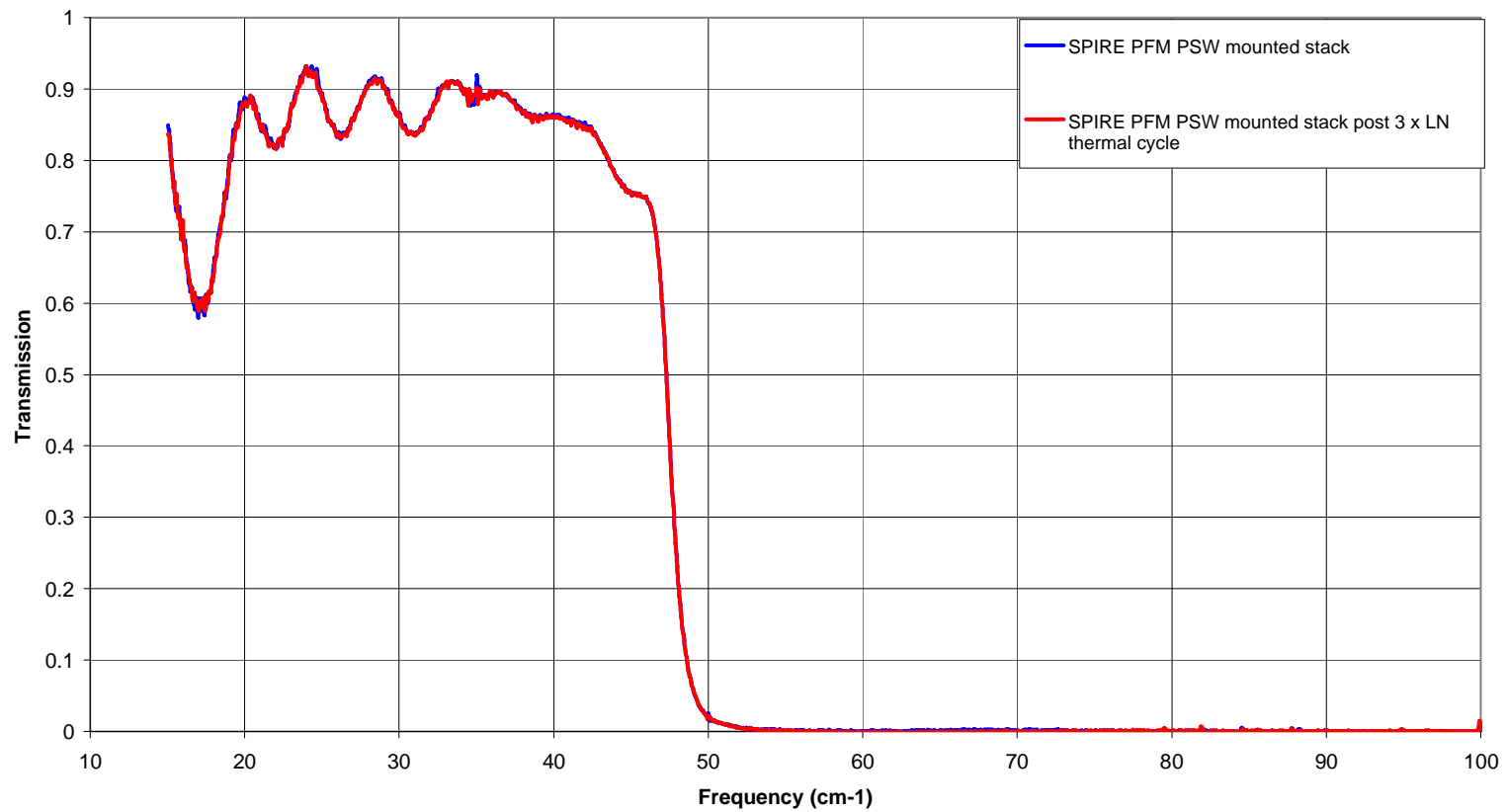


Figure 14 Final PFM PSW 300mK filter assembly, post-mounting, before and after thermal cycles

## SECTION 27 - Reference List of EIDP's

### Associated

<u>Title</u> (Listed in alphabetical order)	<u>ID</u> (Serial No.)	<u>Acronym</u>	<u>Document No.</u>	<u>Issue</u>	<u>Date</u>
PSW BDA PFM EIDP					

### Lower Level

<u>Title</u> (Listed in alphabetical order)	<u>ID</u> (Serial No.)	<u>Acronym</u>	<u>Document No.</u>	<u>Issue</u>	<u>Date</u>

## SECTION 28 - Mass Records

Assembly	Final measured mass
FILT-PFM-250 – PFM PSW assembly	8.785g

## SECTION 29 - Cleanliness Statement

The manufacture of these filter elements took place within a class 1000 clean-room, following the procedures laid out in the UWC document, “UWC Filter Fabrication Procedures.doc”. Although filter testing took place within a standard laboratory environment, the mounted filters were subsequently cleaned (using acetone and a de-ionised air-gun), in a class 100 laminar flow cabinet, prior to packaging.

Date	Statement	Signature/Signatory
21st May 2004	This item has been cleaned following the procedures laid out in the UWC document, “UWC Filter Fabrication Procedures.doc”	CT

## SECTION 30 - Other Useful Information

## SECTION 31 - DPL/DML

Refer to the Cardiff SPIRE filters Declared Materials & Parts list (HSO-CDF-LI-018) and the filters Declared Processes List (HSO-CDF-LI-021).

## SECTION 32 – List of Appendices/Attachments

<u>Appendix #</u>	<u>Title</u> (Listed in alphabetical order)	<u>Document No.</u>	<u>Issue</u>	<u>Date</u>	<u>Notes</u>