

<b>PTR MoM</b>	<b>Date:</b> 19-April-2005	<b>NUMBER</b>	<b>SPIRE-RAL-MoM- 002408</b>
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**Subject: PFM1 Cold Verification – Post Test Review**

- AGENDA:**
1. Equipment Description
  2. Design vs. Build Reconciliation
  3. Mandatory Inspection Points (MIP) References & Closure
  4. Review of Actions from Test Readiness Review (TRR) & any Previous Meetings
  5. Non-Conformances / open Items & Actions
  6. Test Procedure & Changes since TRR
  7. Request for Waiver (RFW)
  8. Hardware Inspection
  9. Preliminary Summary of Test Results
    - Overview of test campaign
    - Test facility status
    - Functional Tests
    - Instrument Operations
    - Performance Tests
  10. Any Other relevant Business

**Conclusion**

Main objectives of the PFM1 cold tests were carried out. Full analysis of test data to be performed.

**Meeting Participants**

**RAL:** Dave Smith, Bruce Swinyard, Tanya Lim, Doug Griffin, Sunil Sidher, Samuel Ronayette, Eric Clark, Asier Aramburu

**IC** Davide Rizzo

**Cardiff:** Pete Hargrave, Tim Waskett, Adam Woodcraft, Matt Griffin (part time)

<b>Written By:</b> Dave Smith	<b>Chaired By:</b> Dave Smith
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**DISTRIBUTION**  
Participants + Eric Sawyer, Ken King, Dave Clements(IC), Carsten Schamberg(ESTEC), Didier Ferrand (LAM)

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<b>Equipment Description</b>	
<b>Spacecraft / Project</b>	Herschel / SPIRE
<b>Instrument / Model</b>	PFM 1
<b>Sub System / Serial No.</b>	N/A
<b>As Built Status</b> <i>List of all items /Parts</i>	SPIRE-RAL-DOC-002326 Issue 2.1

<b>Test Documentation</b>	
<b>Type of Test</b>	Cold Functional and Performance test
<b>AIV Facility Test No.</b>	N/A
<b>Location &amp; Date(s) of Testing</b>	SPIRE Calibration Facility 18-Feb-2005 to 15-Apr-2005
<b>Applicable Test Specification</b> (Document No. & Issue)	Test Plan SPIRE-RAL-DOC-2055 issue 1
<b>Applicable Test Procedure</b> (Document No. & Issue)	SPIRE-RAL-PRC-02223 issue 1.0 (formally released at start of test)
<b>AIV Facility Test Plan</b> (if applicable?)	NA
<b>TRR MoM</b>	SPIRE-RAL-MoM-002306 phase 3

<b>NCRs, Waivers, Open Work</b>	
<b>NCR's</b>	See continuation sheets and appendix 1
<b>Waivers</b>	None
<b>Open Work</b>	All open work from TRR closed.
<b>Inspection Points</b>	KIP final inspection of FPU, 17/1/05 MIP before closing tank, final TRR 27/1/05 Inspection of FPU to be performed (KIP)

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**CONTINUATION SHEET****Review of Actions:**

AI-002306-1 - Pete Hargrave to review the test procedure for PCAL and SCAL, warm functional test – not done.

**NCRS**

See attachment 1 – NCR spreadsheet

**NCRs raised before Test**

92.2 N/A for this test

100 open, remedial action taken

101 open, remedial action taken

102 open – no effect on test

103 open - no effect on test

104 open – flight spare unit swapped in – original unit returned

105 open - simultaneous generation BSM & SMEC packets – A update to EEPROM on MCU has been prepared.

106 open - electrical short between FPU and cryostat due to incorrect harness wiring – used as is, did not have significant effect on testing – analysis of noise tests to be done

**NCRs raised during test**

107 open – dynamic range of SCU thermometers not matched to flight thermometers – fix to SCAL temperature channels to allow tests to continue

108 open – Automatic shutdown of LIAs – to be discussed

109 closed – N/A for this test.

**Preliminary Summary of Test Results****Overview of test campaign**

Presentation by Dave Smith – Attachment 2

Staffing

Cryostat operations – OK

Instrument operations – Worked well with Tim and Davide supporting Sunil and Asier

Test directors – Bruce/Tanya – need 3<sup>rd</sup> person to direct tests – could have Locke, Marc or Pete

Cold tests at ASTRIUM in July

AVM tests in Alenia

**Test Facility Status**

No major problems occurred but some issues need to be resolved before next test campaign.

Some failing thermometers – caused by poor wiring quality – to be investigated.

Thermometer calibrations at instrument I/F – new thermometers needed?

Cold blackbody – cannot get to 4K – may need a further NIR filter – NCR-113

Air leak – possible location identified – propose to seal suspect joint with stycast – NCR114

Pump controller shutting down - NCR-085

Vacuum gauge head failed during pump-down – NCR 111

Laser gas – faulty regulator – NCR 112 - should be checked before each test campaign

Could not command TFTS from SCOS – NCR115 – to be investigated before next test campaign.

Calibration curves in SCOS did not match actual thermometers – need to match to serial no.

For PFM2 – QM2 does not have redundant side – hence could read redundant thermometers via lakeshore unit – to be investigated

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## Functional Tests & Operations

Presentation by Sunil

**Action #1** : Safe switch on procedure needs document number - Bruce

**Action #2:** Test reports for functional tests to be given individual document numbers - Sunil

Problems occurred with simultaneous generation of SMEC and BSM data – an update to the MCU EEPROMs has been generated by Didier

Sequence follows master test procedure – comments added – some changes to be made for PFM2

Power bench needs resetting when MCU is switched on – NCR has been raised – should not be an issue for PFM2 as PSU will be used.

Missing SMEC parameters from HK report – temporary fix implemented

BSM – oscillations in chop and jiggle axes – possibly caused by missing capacitors on QM1 board – NCR-116

JFETs turned on without having to use heaters

PCAL and SCAL tests – plots show resistances as expected

PCAL & SCAL temp vs. current plots – test ok although could be simplified with fewer power steps – e.g. low and high

SMEC scans – show expected behaviour

AMV2 DPU did not work with DRCU – separate investigation being conducted

Problems encountered –

LIA shutdown

**Action #3:** Provide a log of power cycles of JFETs – DS

Anomalous HK parameters for LIA-P and LIA-S at specific bias/sample frequencies – NCR-117 to be raised.

Inability to put SMEC into closed loop at first attempt following SMEC switch on – under investigation

Separate commands are needed to switch on MCU, spectrometer and photometer LIAs – NCR-118

It is easy to send an unknown command to the DRCU – NCR-119

SPR to be raised on TM ingestion in HCSS – can grow to 42,000 – should be investigated before PFM2

QLA frequently 'hangs' – possibly due to amount of memory – should be resolved for PFM2

Should have more people trained in QLA

Lessons to be learned

Avoid unnecessary changes to instrument configuration

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Warm electronics need to be protected – NOTE configuration will be different for next tests  
Need point of contact for contingency – i.e. difficult to contact

Test scripts need to be rationalised – old test scripts need to be moved off  
Some effort is needed to write up test sequences as scripts to avoid manual commanding  
Fault recognition document – need secure folder containing key documents

**Action # 4:** Compile hard copy folder of critical documents – incl. list of documents , summary sheet – SS/DS

Need a printer  
Label plugs

#### Successes

Experience gained from CQM tests enabled problems to be anticipated and solved  
Sufficient human resources to conduct tests without stress on test team  
Most tests successfully performed  
Future tests could be conducted

#### Plans for future

Test specifications to be updated  
Creation of HCSS scripts for BSM and SMEC tests  
Tests with AVM  
FPU simulator needs updating  
Update data ICD  
New version of the OBS which supports autonomy functions

#### **SMEC & BSM Operations**

Presentation by Asier

Need written procedures from Didier to tune PID settings  
Need to analyse SMEC data to understand relationship between power, temperature, settings

#### **Performance Testing**

Tanya

#### **Data Test Log, Data Download Status**

Excel spreadsheet – to be made available on web site  
Log complete up to 473 lines – should be complete by end of next week  
Includes functional tests and operator procedures  
Data have been downloaded for early tests – remaining will be extracted ASAP

Times in UTC – some discrepancy between actual test times and times recorded in word logs

Additional information for web site pdf'd daily logs, TC history

Web address -> [http://scott1.bnsc.rl.ac.uk:8080/hcss/test\\_area/index.htm](http://scott1.bnsc.rl.ac.uk:8080/hcss/test_area/index.htm)

#### **Test Plan**

Most tests in plan completed with the following exceptions:

- DNC-S noise test with tel sim background
- DLA-S Beam attenuation using laser
- CPF-S PCAL loaded frequency characterisation
- CPN PCAL Flash while nulling
- OBL/L-S Beam scan using hot BB – type 1 (one was done but not intended)
- OPI-S Pupil scan using HBB – (done with laser)
- SRN – room temp nulling – done but failed due to high background
- SFL – Fringe contrast step and look
- SML – Mirror carriage characterisation step and look

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OBS – OOB radiation using SMEC

Issues

- Need for separate settings for each array
- Need to search for optimum operating frequency
- Settings for VMs to be better documented – folder in Q drive – should be in HCSS
- Unable to do jiggle tests
- Variable background for BSM tests – most likely due to loading from window
- More work on pupil scanning – may need test without using actuators - TS not really designed for this test

Changes for next tests

- Change noise tests to pickup at each bias
- Need better SCAL warm up procedure
- Internal filtering – possibly need more

IDL toolkit – pass tools through Tanya to put on website

**Beam Scans**

- Preliminary plots presented by Samuel
- For further investigation – look at how beam width varies with wavelength – at least on nominal pixel
- Peak up maps – measured pixel positions to be compared with optical model

**Detector performance**

- Bruce presented preliminary results
- Measured spectral resolution is as predicted

**Plan for data analysis**

**Action # 5:** Tanya to formalise plan for data processing – who does what and when.

**Date of Next Test Campaign**

Nominally end of June – Eric to update Schedule

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**Summary of Actions**

**Action #1 :** Safe switch on procedure needs document number - Bruce

**Action #2:** Test reports for functional tests to be given individual document numbers – Sunil

**Action #3:** Provide a log of power cycles of JFETs – DS

**Action # 4:** Compile hard copy folder of critical documents – incl. list of documents , summary sheet – SS/DS

**Action # 5:** Tanya to formalise plan for data processing – who does what and when.



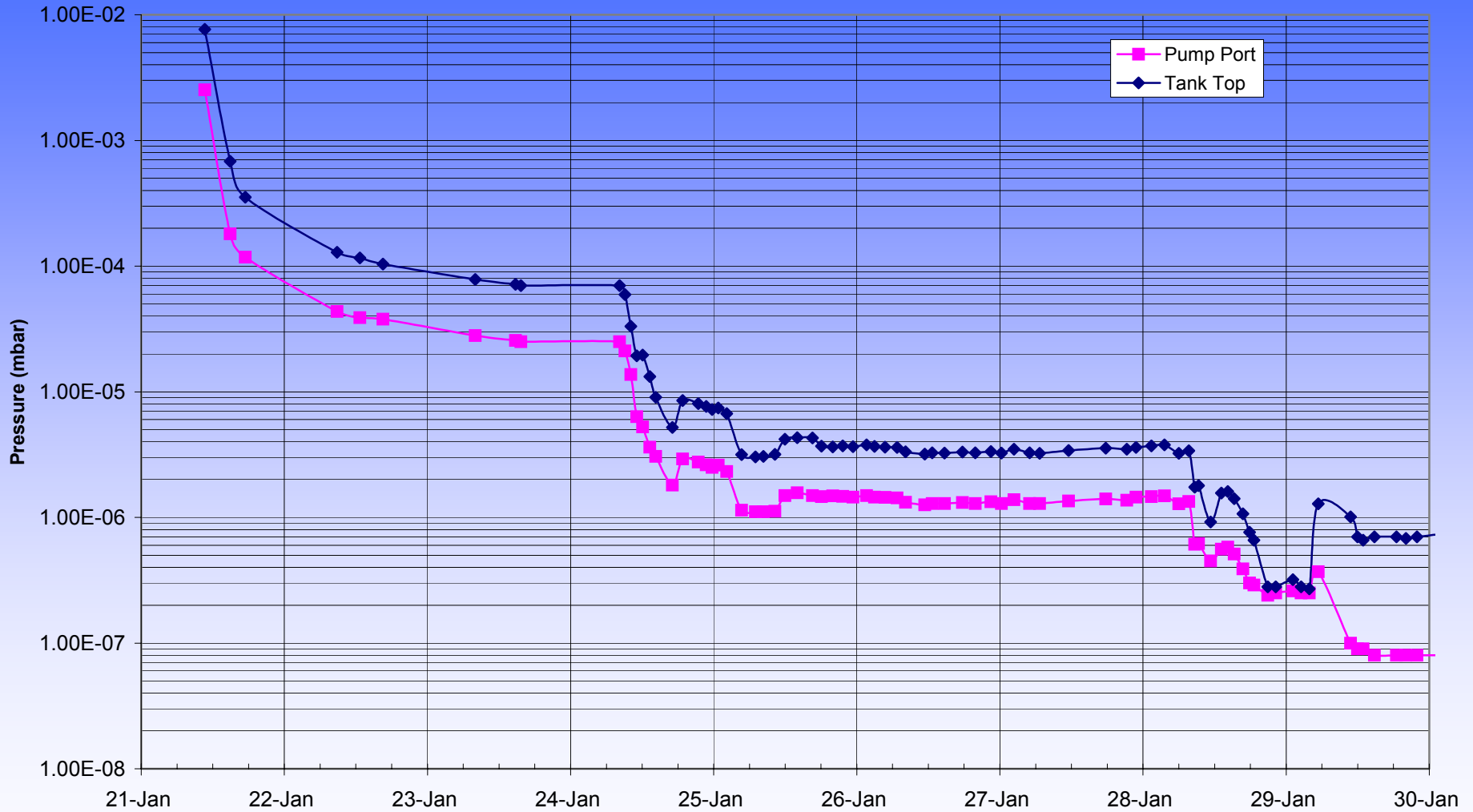
# SPIRE PFM1 – Test History



# Test History (1)

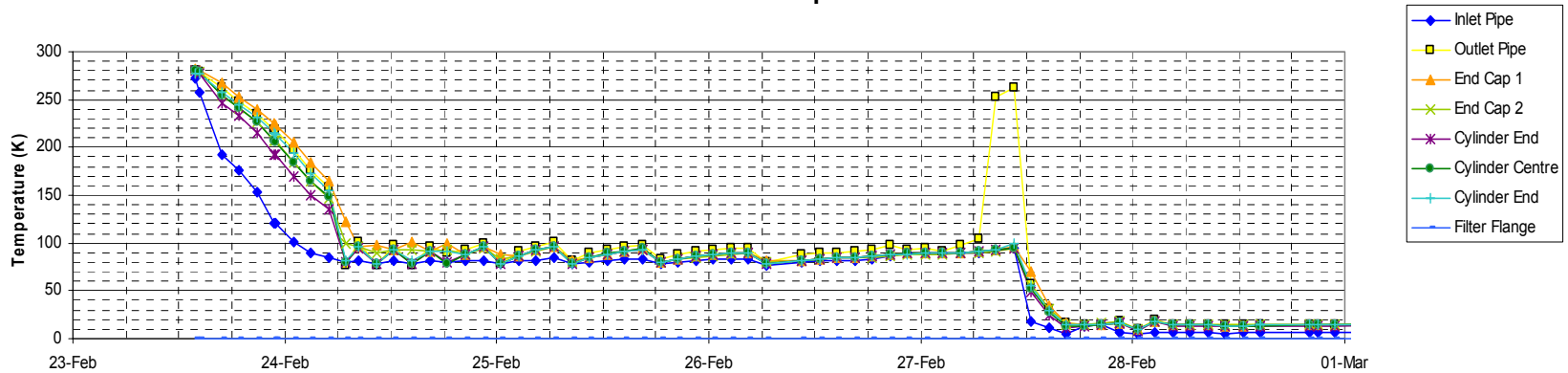
- 18-Feb-05 TRR Held  
FPU In cryostat
- 19-Feb-05 Pump Down Started
- 21-Feb-05 Pump down halted due to fault with vac gauge  
Gauge head replaced  
Pump down restarted 17:00
- 22-Feb-05 Short Functional Test performed
- 23-Feb-05 Cooldown Started
- 25-Feb-05 Cool functional test performed
- 27-Feb-05 Started transferring liquid helium
- 28-Jan-04 FPU at 4K

# Pump-Down

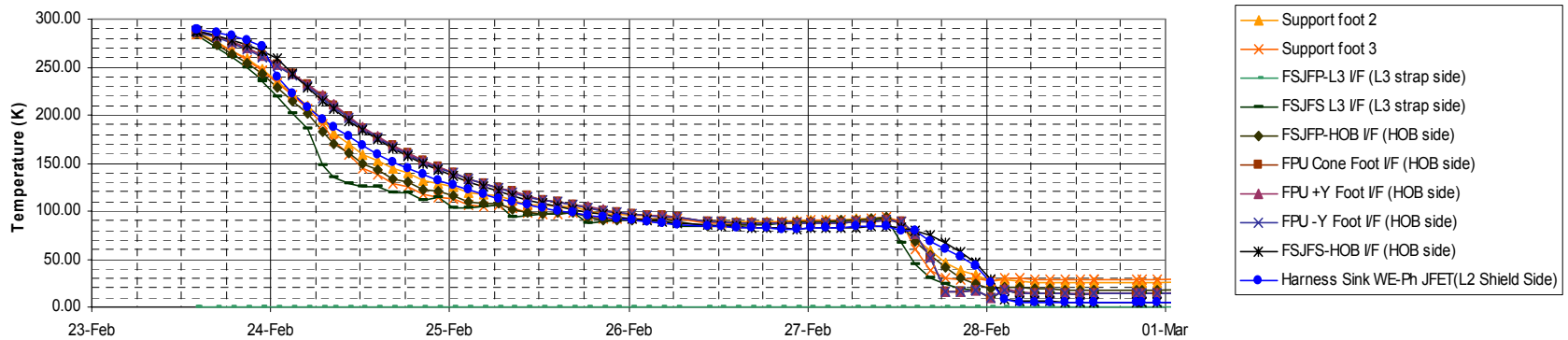


# Cooldown (1)

## Shield Temperatures

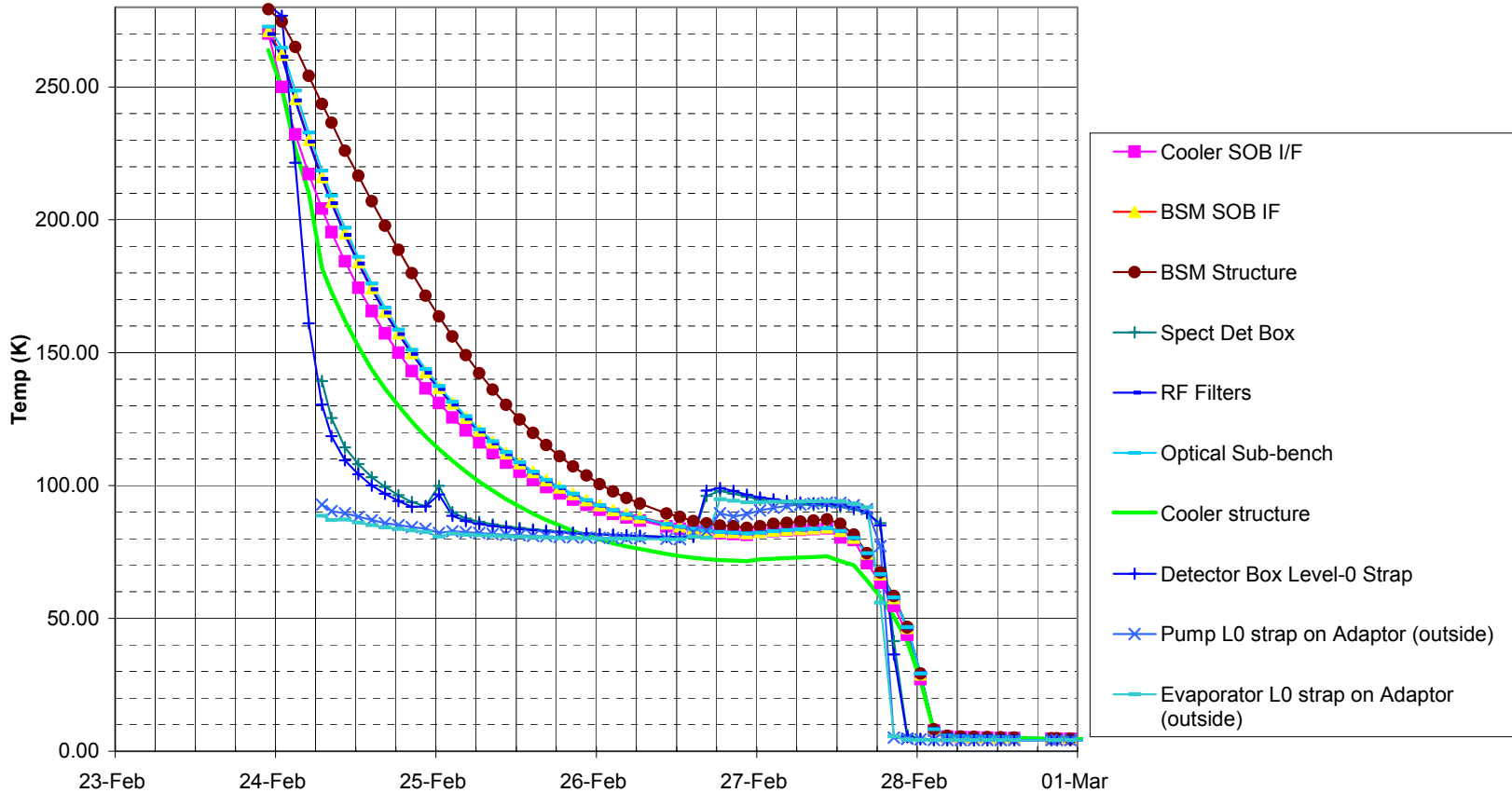


## HOB Temperatures



# Cooldown (2)

## FPU Cooldown



# Cryogen Use

- Liquid Nitrogen
  - 450 litres for cooldown of LN2 shield
  - <100 litres per day for topping up
  - <200 litres for precooling He Vessels
- Liquid Helium
  - < 750 litres for cooldown
  - 4500 litres used while cold
    - Average 115 litres per day

# Test History (2)

- 28-Feb-05 Cold functional tests started
- 01-Mar-05 MCU Tests started
- 03-Mar-05 Tuned SMEC PID settings  
Cooled L0 temperatures to 1.7K  
1st Cooler recycle
- 04-Mar-05 Detectors on  
Performed dark Load Curves  
Noise Tests

# Test History (3)

- 07-Mar-05  
Cooler ran out after >84 hours  
Tests with AVM2 DPU  
MCU Troubleshooting  
Attempted Thermal test on cooler pump heater  
Cooler recycled
- 08-Mar-05  
Reconfigured with AVM1 DPU  
EEPROMS replaced in MCU to fix noise problem  
Tuned BSM PID settings  
First scans with SMEC on CBB
- 09-Mar-05  
SMEC scans with laser  
SCAL 2% tests

# Test History (4)

- 10-Mar-05 SCAL 4% tests  
LIAs automatically shut down
- 11-23 Mar-05 Troubleshooting of LIA shutdown
- 24-Mar-05 Detectors back on after JPL go ahead  
Bias frequency tests  
CBB nulling with SCAL
- 25-28 Mar-05 Easter break – FPU maintained at 4K
- 28-Mar-05 Cryostat back at operating temperatures  
Cooler recycled



# Test History (5)

- 29-Mar-05      Beam scans with BSM
- 30-Mar-05      PCAL flash  
BSM chop test
- 31-Mar-05      PTC Tests
- 01-Apr-05      PTC Tests  
Beam scans
- 04-Apr-05      Upgrade to SCU  
Tests with SCAL at 80K  
Recycled cooler
- 05-Apr-05      Tests with laser at 232 $\mu$ m  
SMEC scans for SSW  
Nulling with SCAL-4% at 80K

# Test History (6)

- 06-Apr-05 Tests with laser at 232 $\mu$ m  
Beam scans  
Chopper frequency tests  
Polarisation  
Pupil scans
- 07-Apr-05 Tests with laser lines at 309.5 $\mu$ m and 302.3 $\mu$ m  
SMEC scans on SSW and SLW  
Beam scans performed on SSW and SLW  
Cooler recycled
- 08-Apr-05 Load curves at different CBB temperatures  
SMEC scans with laser (530 $\mu$ m)  
PFM nodding test  
Performance tests concluded
- 09-14 Apr-05 Warm Up
- 11-Apr-05 Functional test of warm electronics performed
- 15-Apr-05 FPU at Ambient

# Problems/Anomalies

- Vacuum gauge head failed during pump-down - NCR-???
- MCU HK acquisition interference on BSM and SMEC control – NCR-???
- Limited range of SCU DC thermometer resistance measurement – NCR-107
- Possible error in calibration of SCU AC thermometry at high resistance values -
- LIA shutdown – NCR-108
- Turbo-pump shutdown – NCR-085
- Laser gas – faulty regulator

## Role of Functional Tests

- **To check for basic functionality and integrity of the instrument subsystems.**
- **To be performed on different models (AVM, CQM, PFM and FS) of the instrument during ground testing.**
- **To be performed in flight during checkout phase and following instrument and spacecraft contingencies (TBC).**
- **They are not intended to be used for calibrating or performance testing the instrument.**

## Functional Test Definitions

**All tests are defined in the SPIRE Functional Test Specification document, SPIRE-RAL-DOC-001652 (Issue 1.3 draft, 20<sup>th</sup> Dec 2004) with principal inputs coming from:**

- **DRCU/DPU ICD, Sap-SPIRE-Cca-076-02, Issue 1.0, 14<sup>th</sup> Feb 2003**
- **MCU/DCU Command List ICD and User Manual, LAM/ELE/SPI/011011, Issue 4.0, 30<sup>th</sup> Sept. 2004**
- **SPIRE Data ICD, SPIRE-RAL-PRJ-001078, Issue 2.0, 15<sup>th</sup> Nov. 2004**

### **Additional reference documents:**

- **Safe switch on of DCU and connection of JFETs, SPIRE-RAL-NOT-???, Issue 1.0, 22<sup>nd</sup> Feb. 2005**
- **JFET switch on procedures for PFM1, SPIRE-RAL-NOT-002285, Issue 1.2, 25<sup>th</sup> Jan 2005**
- **MCU QM1 and SMECm CQM test procedure at room temperature, LAM.PJT.SPI.PRC.041020\_01 Issue 1, Rev 0, 20<sup>th</sup> Oct 2004**
- **SPIRE OBS User Manual, SPIRE-IFS-PRJ-001391, Issue 1.1, 29<sup>th</sup> Dec 2004**

## **SPIRE EGSE Setup**

**For the functional tests the SPIRE EGSE was set up and integration tested with the following key components:**

- CDMS Simulator version 2.5**
- SCOS 2000 2.3e P5 + TOPE**
- DPU with OBS version 2.0.A installed**
- HCSS v0.2.4 (Build # 572), including EGSE router and gateway**
- QLA v2.2.1**
- Packet Display Test Tool**

## Preconditions for Tests

- **The Telemetry Ingestion component of the HCSS was running so that all telecommands and telemetry data was stored inside the Versant database of the HCSS.**
- **Power to the DCU and the SCU was switched on.**
- **The OBS was running and generating nominal & critical HK telemetry packets.**
- **QLA was running and the Jython script for the appropriate functional test executing and awaiting test telemetry.**
- **Functional tests were *generally* performed in the order outlined in the PFM1 Cold Test – Master Procedure (SPIRE-RAL-PRC-002223, Issue 1.0).**

## Warm Functional Tests during PFM1 test campaign - I

Date	Instrument State	Tests Performed & <b>Principal Anomalies</b>
31 <sup>st</sup> Jan 2005-2 <sup>nd</sup> Feb 2005	Cryoharness integrated to warm and cold units. FPU outside cryostat.	SCU – 0.1 mA bias current applied to PCAL, SCAL2 & SCAL4 DCU – but JFETs not switched on MCU – <b>Current limiter needs resetting on Power Bench following switch on</b> BSM – Chop and Jiggle axes step tests SMEC – First attempt to switch on and initialise ( <b>Missing SMEC parameters from HK report – SPR on the Data ICD</b> ). <b>Temporary fix to HK implemented</b>
15-16 <sup>th</sup> Feb 2005	Cryoharness re-integration following fix to the SMEC grounding short problem. Redundant harness for the BSM jiggle axis? <b>SMEC orientation had changed from last time</b> FPU still outside cryostat.	SCU - 0.1 mA bias current applied to PCAL, SCAL2 & SCAL4 DCU – but JFETs not switched on MCU – <b>Current limiter needs resetting on Power Bench following switch on</b> BSM – Chop and Jiggle axes step tests SMEC – Switch on and initialise <b>(Spikes in SMEC science parameters)</b>

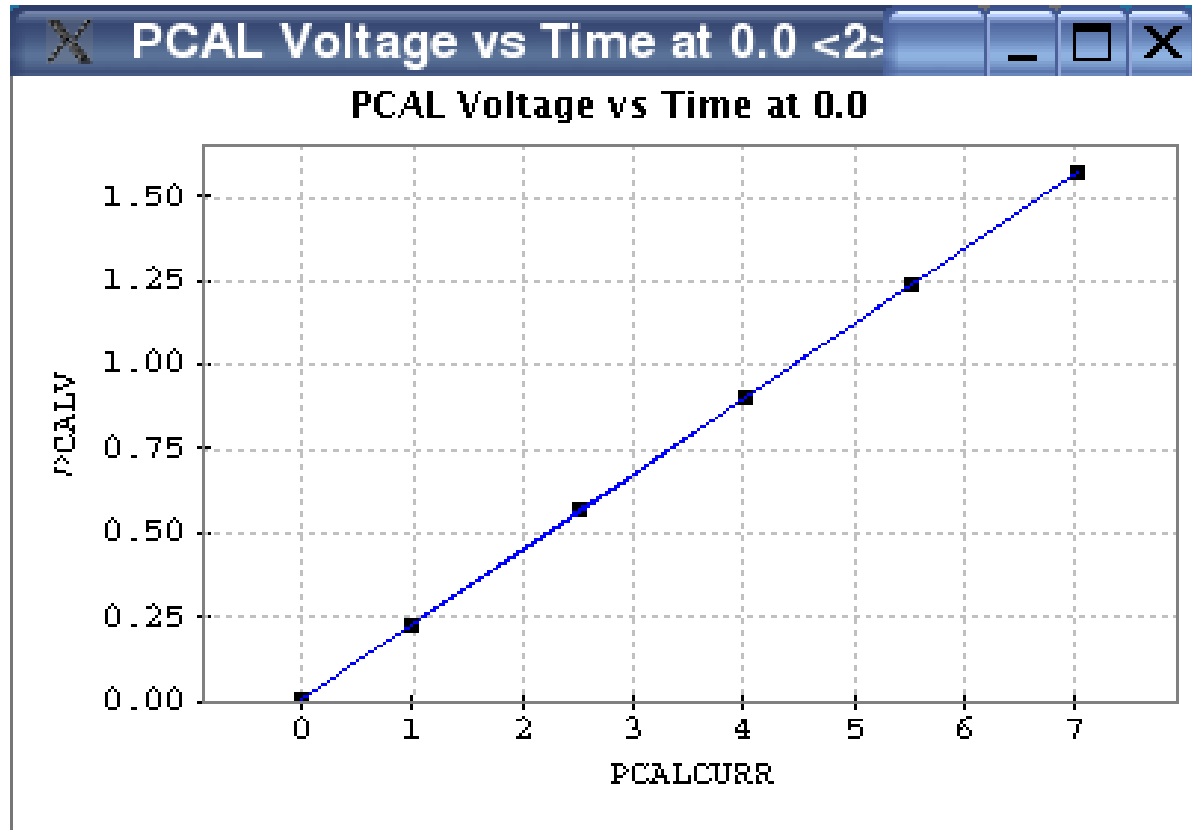


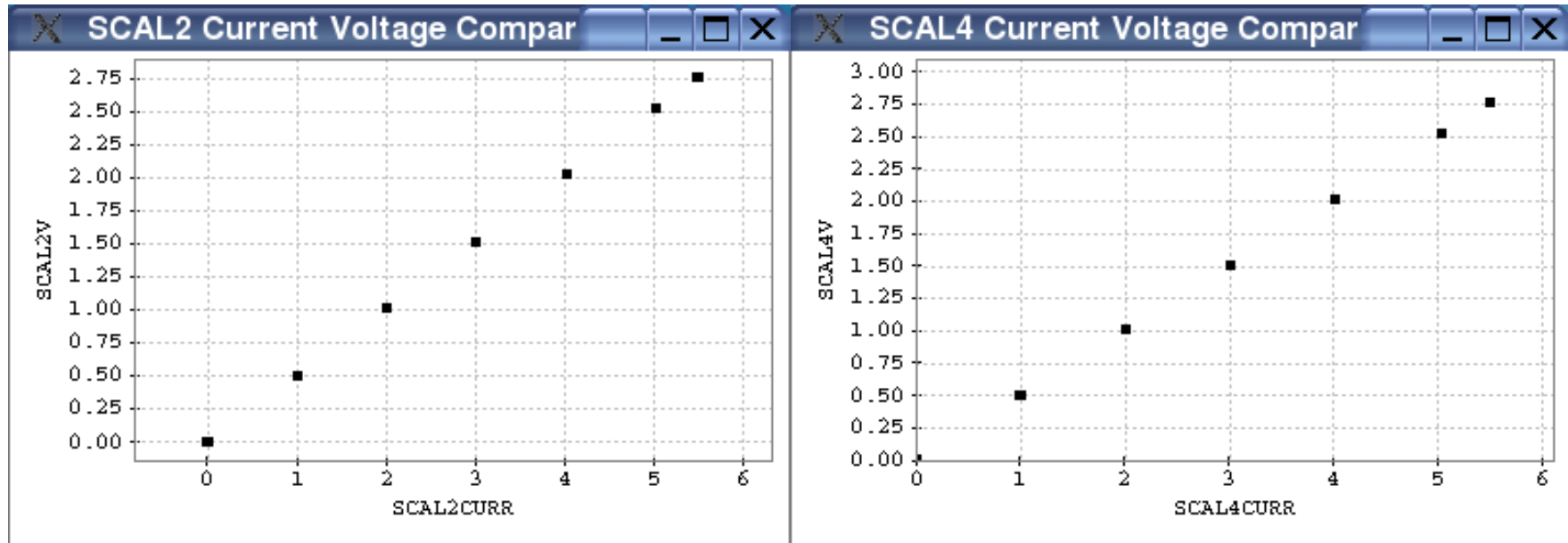
## Warm Functional Tests during PFM1 Test Campaign - II

Date	Instrument State	Tests Performed & <b>Principal Anomalies</b>
22 <sup>nd</sup> Feb 2005	FPU inside cryostat. Following pump down. Pump port pressure: $2.63 \times 10^{-5}$ mbar	SCU - 0.1 mA bias current applied to PCAL, SCAL2 & SCAL4 DCU – but JFETs not switched on MCU – <b>Current limiter needs resetting on Power Bench following switch on</b> BSM – Chop and Jiggle axes step tests SMEC – switch on, initialisation and step tests
25 <sup>th</sup> Feb 2005	FPU inside cryostat. Temperature ~ 80K	SCU - 0.1 mA bias current applied to PCAL, SCAL2 & SCAL4 DCU – but JFETs not switched on MCU – <b>Current limiter needs resetting on Power Bench following switch on</b> BSM – Chop and Jiggle axes step tests SMEC – switch on, initialisation and step tests

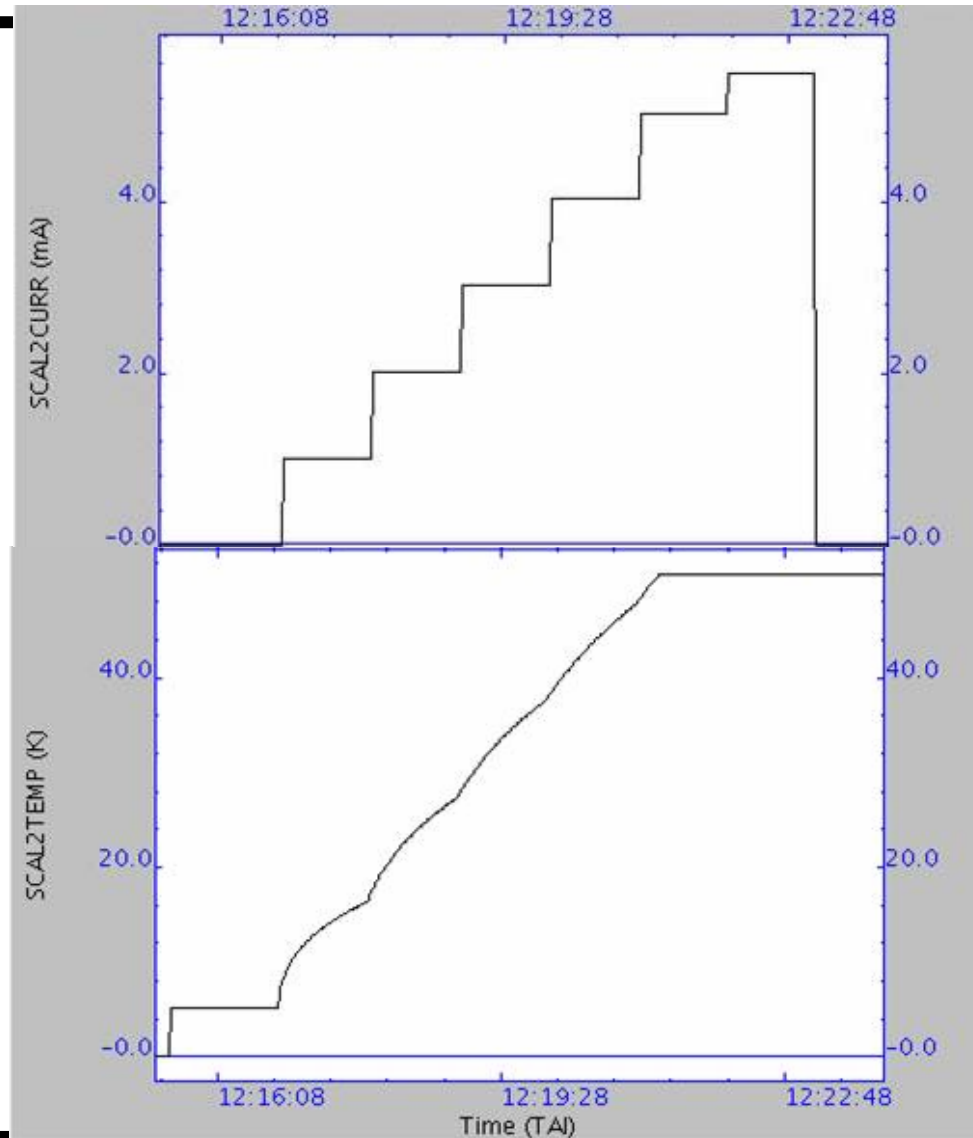
## Cold Functional Tests during PFM1 Test Campaign - I

Date	Instrument State	Tests Performed & <b>Principal Anomalies</b>
28 <sup>th</sup> Feb – 3 <sup>rd</sup> Mar 2005	SUBKTEMP ~ 3.24 K	SCU - including PCAL, SCAL2 & SCAL4 characterisation tests ( <b>SCAL2 and SCAL4 temperatures went out of range at high bias currents</b> ) DCU – but JFETs not switched on MCU – <b>Current limiter needs resetting on Power Bench following switch on</b> BSM - Chop and Jiggle axes step tests ( <b>Large oscillations in the chop and jiggle axes motor currents and voltages</b> ) SMEC – Set up of PID values and performed SMEC Scan Functional Test – <b>SCR on the Data ICD for changes to SMEC science frame</b> Cooler recycled for the first time
4 <sup>th</sup> Mar 2005	SUBKTEMP < 300 mK	JFET switch on procedure for PFM1 executed <b>Conclusion: Not necessary to switch on JFET heater</b>

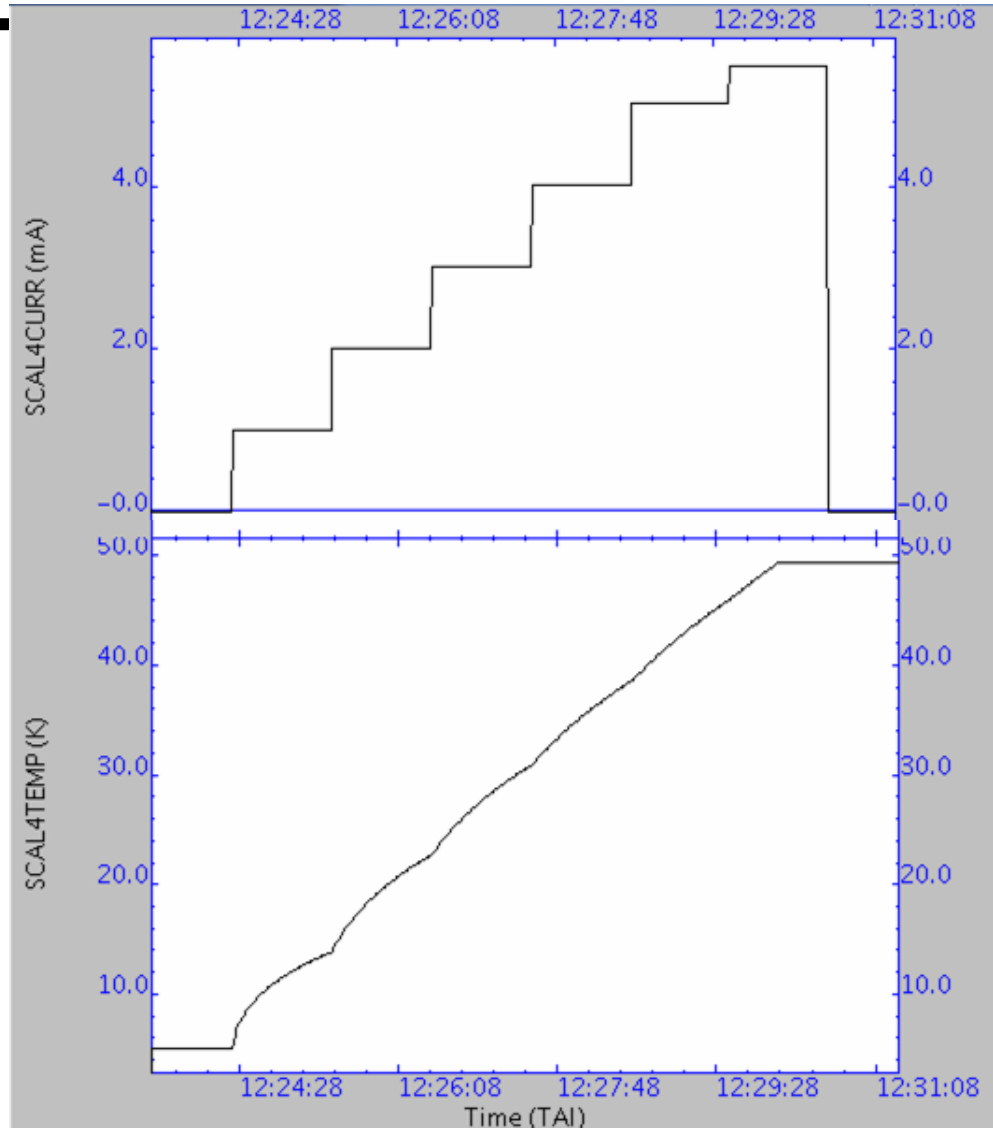




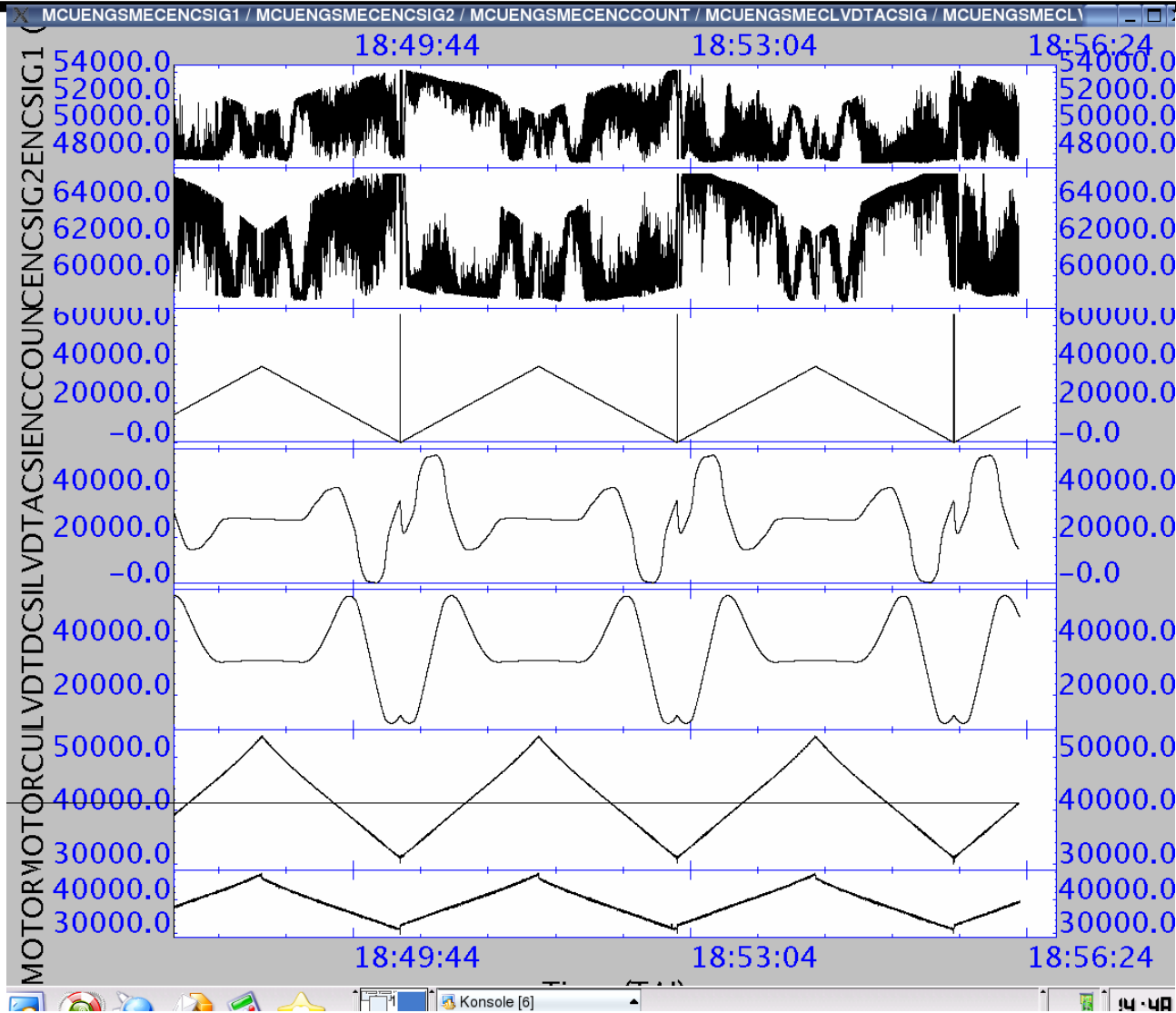
# SPIRE PFM1 Functional Test Report



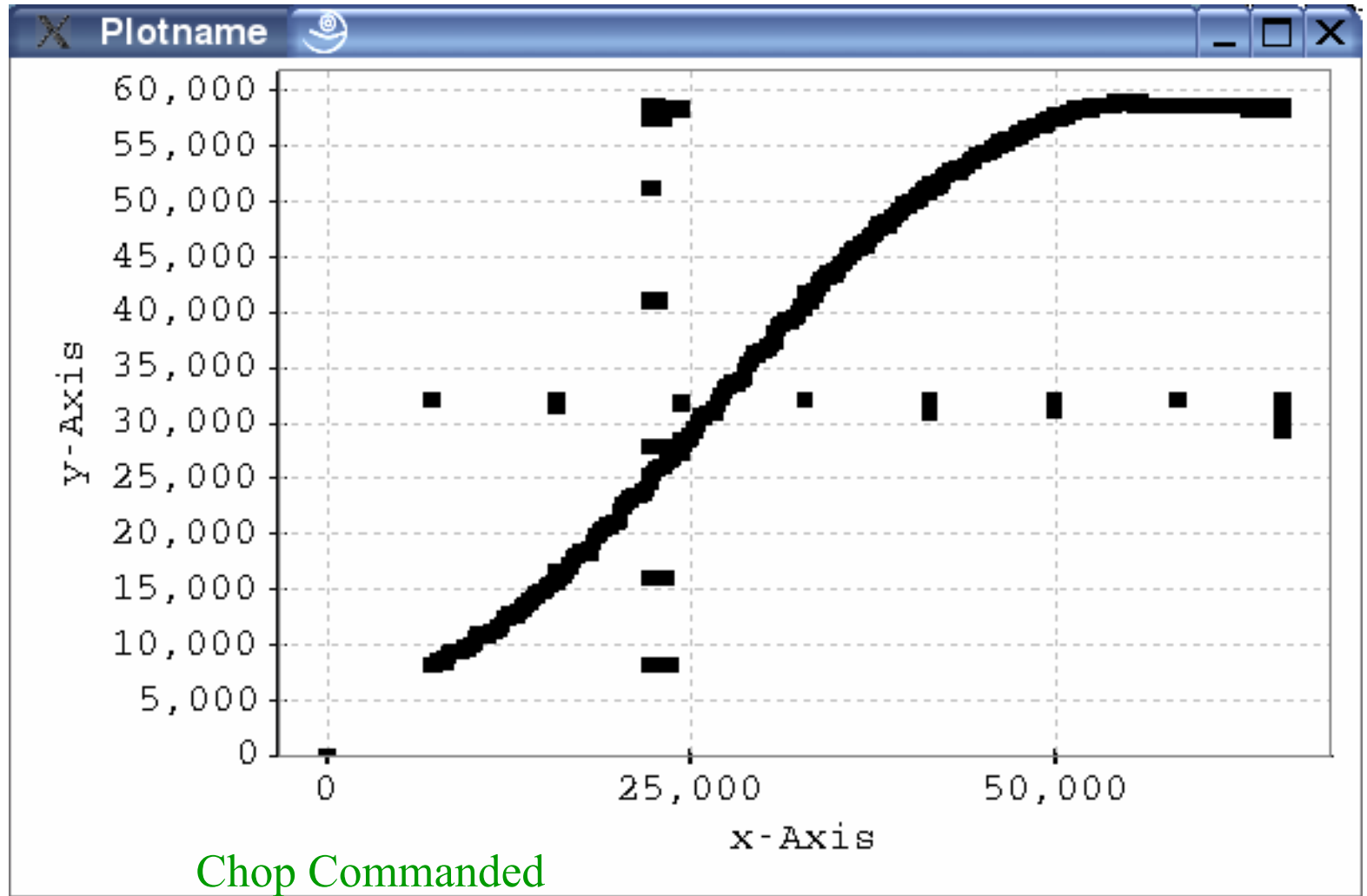
# SPIRE PFM1 Functional Test Report



# SPIRE PFM1 Functional Test Report



Chop Sensor  
Signal



Chop Commanded  
Position





Jiggle Sensor  
Signal

Jiggle Commanded  
Position

## Cold Functional Tests during PFM1 Test Campaign - II

Date	Instrument State	Tests/Activities Performed & <b>Principal Anomalies</b>
7 <sup>th</sup> Mar 2005	SUBKTEMP < 300 mK	<b>AVM2 DPU connected to the WE in place of the AVM1 DPU</b>
8 <sup>th</sup> Mar 2005	SUBKTEMP < 300 mK	Reverted back to AVM1 DPU PID tuning for Chop & Jiggle axes
10 <sup>th</sup> Mar 2005	SUBKTEMP < 300 mK	<b>LIA switch off problems</b> <b>MS Word problems in keeping Test Logs</b>
4 <sup>th</sup> April 2005	SUBKTEMP ~ 1.8 K	Resistors for SCAL2 and SCAL4 replaced on SCU board for nulling tests with the CBB

## Warm Functional Tests after Warm Up

Date	Instrument State	Tests Performed & <b>Principal Anomalies</b>
11 <sup>th</sup> April 2005	Test on the stand alone Warm Electronics in the Control Room, without an MCU.	<b>DCU</b> <b>SCU</b>

## Problems Encountered - I

- **Spontaneous switching off of the LIAs – appears to be related to the LIA temperatures.**
- **Anomalous HK parameter values for the LIA-P and LIA-S temperatures and voltages at specific bias and sampling frequencies. An NCR needs to be raised - but is it on OBS or DRCU?**
- **Inability to put the SMEC into closed loop at first attempt following SMEC switch on and initialisation. Subsequent attempts are invariably successful. Under investigation by Asier with Didier at LAM.**
- **It is critical to have separate DRCU commands to switch on the MCU, Spectrometer and Photometer LIAs. The potential for accidentally switching on or switching off a subsystem is enormous, despite safeguards in scripts. Raise an NCR?**
- **It is quite easy to send an unknown command to the DRCU. The DCU, MCU or SCU should reject a command which is not listed in the ICD. Or is it an OBS task to reject such commands?**

## Problems Encountered - II

- **The time on the CDMS Simulator drifts by ~ 30 seconds in 24 hours. SPR already open but needs addressing with high priority.**
- **TFCS cryostat temperature sensors were changed before the campaign which caused confusion during monitoring with SCOS.**

## SCOS Problems during Tests

- **SCOS 2000 History File Archive (HFA) was found to be ingesting science TM as well as HK and Event Reports. This problem became apparent just in time and the EGSE gateway was reconfigured to prevent serious consequences.**
- **A fundamental limitation of the HFA under SCOS 2.3eP5 is that it can grow to a maximum of before a new HFA needs to be set up. The archive splitting tool only works under SCOS 3.1, which is still awaiting the addition of EGSE extensions at ESTEC.**
- **Occasionally some of the SCOS and EGSE tasks, such as Telecommand History, TOPE and PDSTC, disappear without warning. Usually they can be restarted but can cause delays during testing.**

## HCSS Problems

- **The CUS lacked functionality to return the size of a calibration table stored inside the HCSS database. A workaround using TCL was developed but it required the table to be present on the SCOS machine.**

**An SCR has been raised on the CUS.**

- **Size of the TM ingestion store queue needed to be monitored regularly. It grew to a maximum of ~ 42,000 items while Spectrometer bolometer array and SMEC science data were being generated at 53 and 250 Hz respectively during a beam scan observation. The PFM1 database was safeguarded against loss of data and/or corruption by the stopping of non-essential data generation. **An SPR needs to be raised – on TM ingestion or Versant DB?****

## QLA Problems

- **QLA scripts for some functional tests need to be refined to provide a more clear Pass/Fail criteria. Specific examples include**
  - Comparison of SCU parameter values in HK and science frames
  - Comparison of latest DCU, MCU and SCU test patterns with previous test patterns
  - Comparison of BSM parameter values in HK and science frames
- **QLA frequently hangs, leading to much confusion about the status of tests and data generation – interim solution was put in place during testing but needs further investigation.**
- **More people need to be fully trained in running QLA.**



## Lessons Learned

- **Never change the configuration of the instrument during testing unless absolutely necessary to continue with the tests, otherwise more free parameters are introduced into an already complex system. The problems with the AVM2 DPU will be investigated with SPIRE AVM.**
- **SPIRE Warm Electronics (WE) power bench continued to cause problems at switch on of the LIAs or the MCU. The protection screen in front of trolley was a source of hindrance to the test team.**
- **Lack of space in the Cryo Lab leaves no margin for error. Potential for accidental switch on or switch off of critical test equipment cannot be overlooked.**
- **To avoid long delays during a test campaign a point-of contact must be established at each participating institute for the reporting of subsystem problems which need urgent attention.**

## Successes

- **Experience gained from CQM campaigns allowed us to anticipate and solve potential problems.**
- **In this campaign we had enough human resources to conduct the tests without the test team suffering from fatigue.**
- **Most tests were successfully performed.**
- **Future campaigns could in principle be conducted with a subset of the PFM1 test team.**

## Plans for the Future

- **The Functional Test Specification needs to be updated**
- **Creation of HCSS scripts for the BSM and SMEC tests**
- **Tests with the AVM to commence**
- **Plans for the FPU simulator?**
- **Update Data ICD**
- **New version of the OBS which supports Autonomy Functions**

## Contents

### Test Log, Data Download Status

### Test Plan

- DETECTOR TESTS
- PCAL TESTS
- OPTICAL TESTS
- BSM CHARACTERISATION
- SPECTROMETER SPECIFIC TESTS
- SCAL TESTS

### Data Analysis Responsibilities

## Test Log/Website Status

- Baseline log complete up to April 5<sup>th</sup>
  - *Without last day 473 lines on the spreadsheet (about 450 tests logged)*
- Website a few days behind
- Aiming to complete baseline log either this week or next week
- Final log may take more time
- Data so far downloaded for early tests and priority cases only
- Remaining data ASAP but may take a few weeks

## Longer Term

- Tidy up logs from previous campaigns
- Would like to add other data e.g. from beam monitor
- What about Word logs and uplink logs?

## DETECTOR TESTS

1. DNA-S Noise Test with Lowest Possible Background ✓
  - *Done at 160Hz, 70Hz, 106Hz (5 mins)*
  - *Overnight noise for three nights*
2. DNC-S Noise Test with Telescope Representative Background ✗
  - *Not done but room data and CBB data can be used*
3. DAB-S Dark Load Curves ✓
  - *Done at 70 Hz and 160 Hz*
  - *Shorter version introduced and done following cooler recycles*
  - *Did load curves with LED on and off*
4. DAL-S Optical Load Curves ✓
  - *Done at 70 Hz, 7.5 K, 10 K, 15 K*
  - *Done at 160 Hz, 7.5 K*
5. DRB/L-S Time Response With The Hot Black Body or Laser ✓
  - *Done for two pixels SSW D1,D3*
6. DLA-S Beam Attenuation Using The Laser ✗

## PCAL TESTS

1. CPT-S PCAL Dark Frequency Characterisation ✓
  - *Done internally only*
2. CPF-S PCAL Loaded Frequency Characterisation ✗
  - *Not Done*
3. CPN Flash While Nulling ✗
  - *Not Done*
4. CPS-S PCAL Standard Flash ✓
  - *Done at least 4 times*
5. *Added Test to flash PCAL at various SMEC positions* ✓
  - *Done*

## SCAL TESTS

1. CSC Spectrometer Calibrator Load Curves ✓
  - *Done separately for SCAL 2 and SCAL 4*
  - *SCAL 2 – 0.22, 0.45, 0.70 mA*
  - *SCAL4 – 0.22, 0.75 mA*
2. CSL SMEC Low Resolution Scan With SCAL On ✓
  - *Done – LR scans for SCAL2, HR for SCAL4, LR while heating up*
3. CSS Scanning the SMEC While SCAL is Cooling ✗
  - *Not Done but used CSL as an alternative test*



## OPTICAL TESTS

1. Focus Test ✓
  - *Done both using 'X' raster and '+' raster, on central pixels*
2. PKB/L-S Peak-Up Using T/S With The Hot Blackbody or Laser ✓
  - *SLW pixels, A1,A3,B2,B3,C1,C2,C3,C4,C5,D2,D3,E1*
  - *SSW pixels, B3,C2,D4,E2*
3. PKI-S - Peak-Up Using The BSM With The Hot Blackbody or Laser ✓
  - *Not done as a jiggle map as intended*
4. OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 1 ✗
  - *Not done but not intended*
5. OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 2 ✓
  - *Done*
6. OSB/L-S Beam Scan Using The T/S With The Hot Blackbody or Laser – Type 3 ✓
  - *Done only as part of focus test on D4*

## OPTICAL TESTS (Continued)

1. OPI-S Pupil Scan Using Hot Black Body **X**
  - *Not done with BB used laser*
2. OPI-S Manual pupil scan using Laser  $\checkmark$ 
  - *Done*
3. OPI-S Pupil Scan using actuators  $\checkmark$ 
  - *Done but failed*
4. OBL-S Out of Band Rejection Using OOB Laser Lines  $\checkmark$ 
  - *Done*
5. DPB-S Polarisation With The Black Body or Laser  $\checkmark$ 
  - *Done SSW D1, D4*

## BSM CHARACTERISATION

1. BSM-S BSM Characterisation ✓
  - *Done by stepping chopped blackbody signal*
  - *Also moved between two pixels using external chopper*
2. BCT-S BSM Chop Throw ✓
  - *Done between all chop axis pixels, both arrays, not done off axis*
3. OPB-S Beam Scan Using The BSM ✓
  - *Done for SLW C3*
4. Operations Test – Simulated Nodding ✓

## SPECTROMETER SPECIFIC TESTS

1. SSC Spectral Scan With Cold Black Body Un-nulled ✓
  - *Done*
2. OBP Balancing of Ports (Nulling Test) ✓
  - *Done*
3. SRN Room Temperature Nulling
  - *Done but Failed*
4. SFC Fringe Contrast and Spectral Response While Scanning ✓
  - *Done for SLW C3, B2, SSW*
5. SFL Fringe Contrast and Spectral Response Step and Look ✗
  - *Not Done*
6. SMC Mirror Carriage Characterisation While Scanning ✓
  - *Done*
7. SML Mirror Carriage Characterisation Step and Look ✗
  - *Not Done*
8. OBS Out of Band Radiation Using the SMEC ✗
  - *Not Done*

## Summary I

- Not Done
  - *Beam Attenuation*
  - *PCAL loaded frequency characterisation, PCAL while nulling*
  - *Step and look tests*
  - *Some tests only partially done e.g. SCAL tests, optical tests open ended*
- New tests
  - *Flashing PCAL at different SMEC positions*
  - *Shorter version of dark load curve for after cooler recycle*
- Changes
  - *BSM tests pretty much defined as we went along – as expected*

## Summary - II

- Issues

- *Need for separate array detector settings not communicated effectively*
- *Half SSW detectors very noisy – needed to search for best operating frequency – impacted test scripts*
- *Settings for VMs need to be better documented*
- *Unable to do jiggle tests*
- *Very variable background for BSM tests*
- *More work needed on pupil test?*

- Changes for next tests

- *Change noise tests to pickup at each bias*
- *Need better SCAL warm up procedure*
- *Internal filtering – Room nulling, BSM background*

## Data Analysis

### Detector Data

*Noise Tests – Tanya*

*Load Curves – Adam, Bruce, Bernhard*

*Time Response – Sarah (as beam attenuation not done)*

Calibrator Data *All Data – Cardiff (overlap with the load curves)*

### Optical Data

*Focus, Peakups, T/S Beam Scans – Samuel (Tanya) and Mark*

*Polarisation, OOB – Sarah or Imperial*

### BSM Data

*Performance Tests – Tanya*

*Simulated Nodding – Imperial*

Spectrometer Tests *All Data – Leithbridge, LAM, Bruce*

# PFM1 MECHANISMS OVERVIEW

- BSM operation:
- Major issues:
  - Zero target position different from zero current position. (optical misalignment?)
  - Is the conversion between ADC sensor value and position in the sky dependant on the gain of the electronics used? (probably yes)
  - Discrepancy between initial PID parameter tuning and “real” performance. (slow response).
  - PID parameters had to be retuned when chopping between pixels was performed.



# PFM1 MECHANISMS OVERVIEW

More major issues:

- Are the PID parameters dependent on the electronics?
- Is the BSM “square test pattern” different from a real chopping between pixels?
- If not, why did we have to change the close loop settings.

# PFM1 MECHANISMS OVERVIEW

For next test campaign:

- Need to understand better the PID parameter tuning process.

# PFM1 MECHANISMS OVERVIEW

- SMECm operation:
- Major issues:
  - SMEC initialisation procedure failure.
  - Is this a software problem or a mechanical problem?
  - Need to revise switch on and switch off procedures.
  - Need a repeatable reliable sequence for initialisation ,completely automatic and “blind”.

# PFM1 MECHANISMS OVERVIEW

## More major issues:

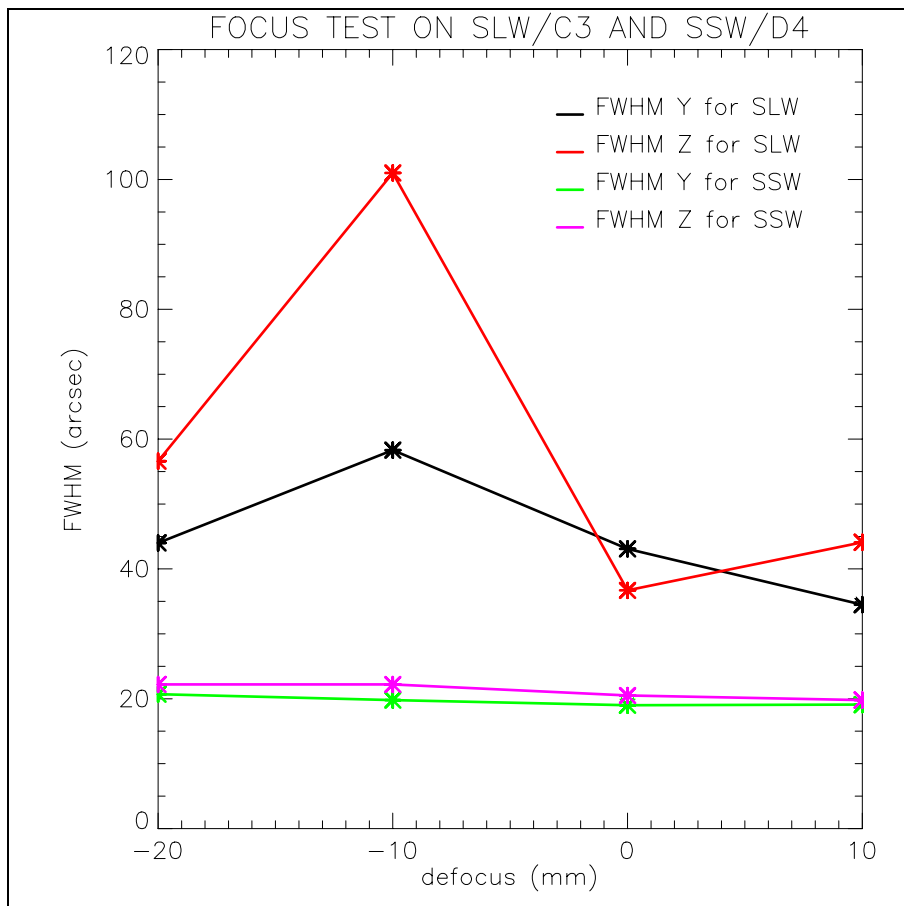
- If the encoder sine signals levels are strongly dependent on the thermal situation ,how can we overcome this?

# PFM1 MECHANISMS OVERVIEW

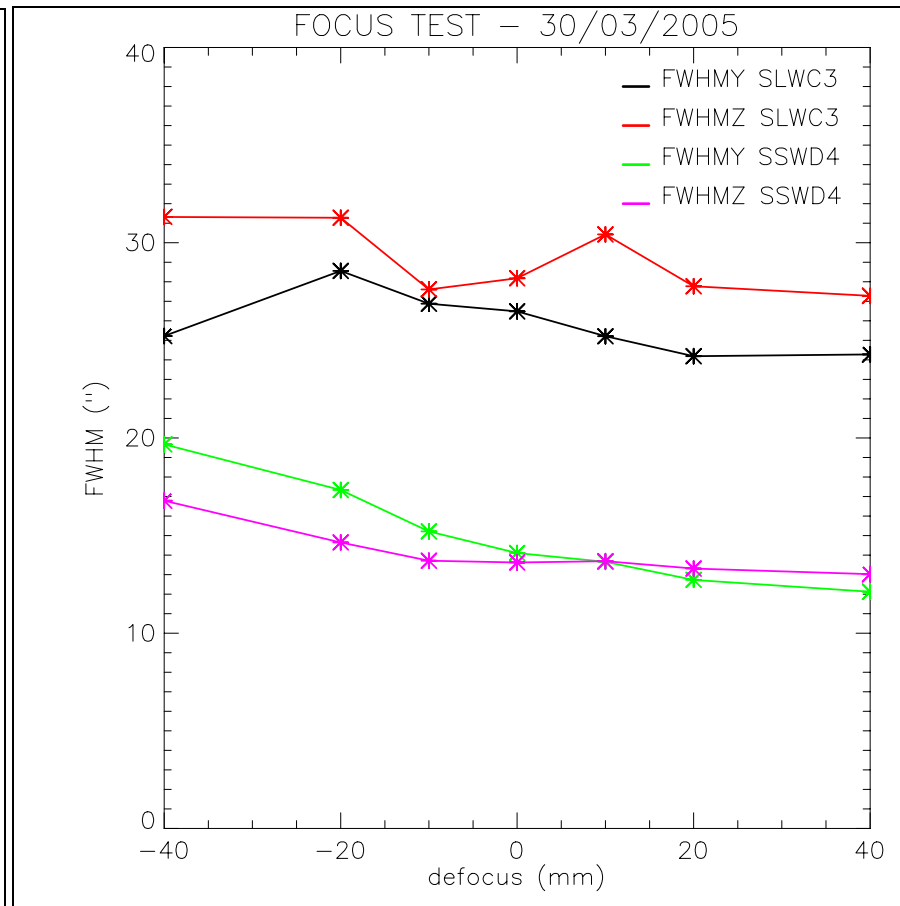
- For next test campaign:
  - Improved initialisation procedure.

# PFM1 MECHANISMS OVERVIEW

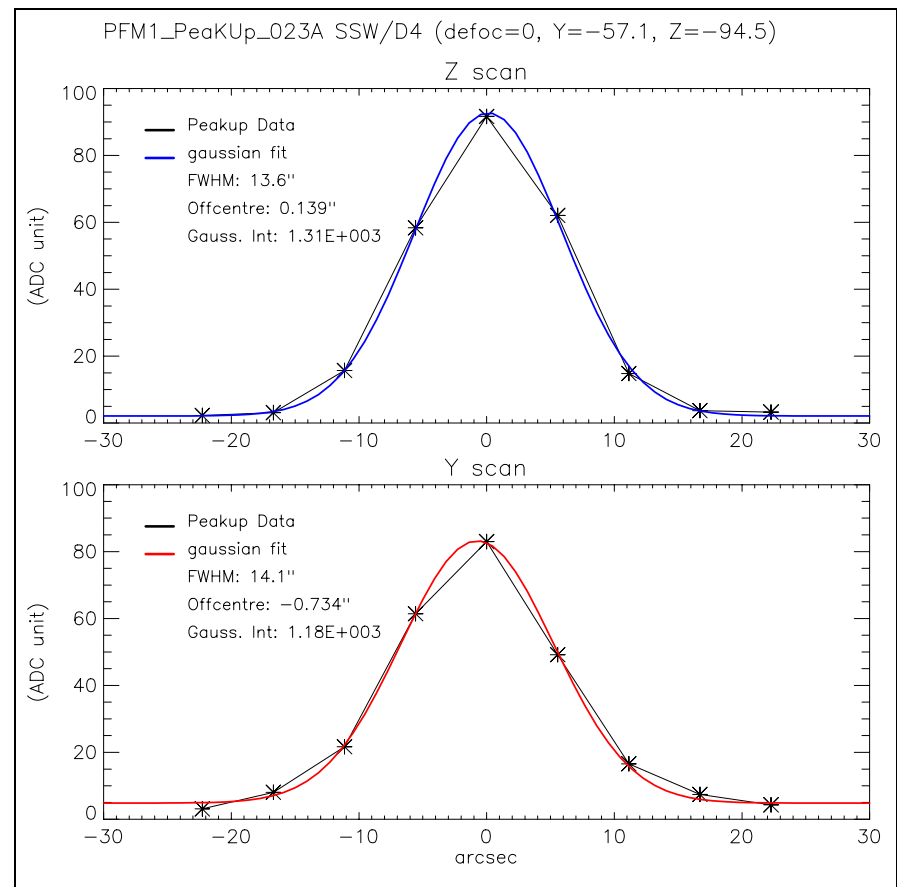
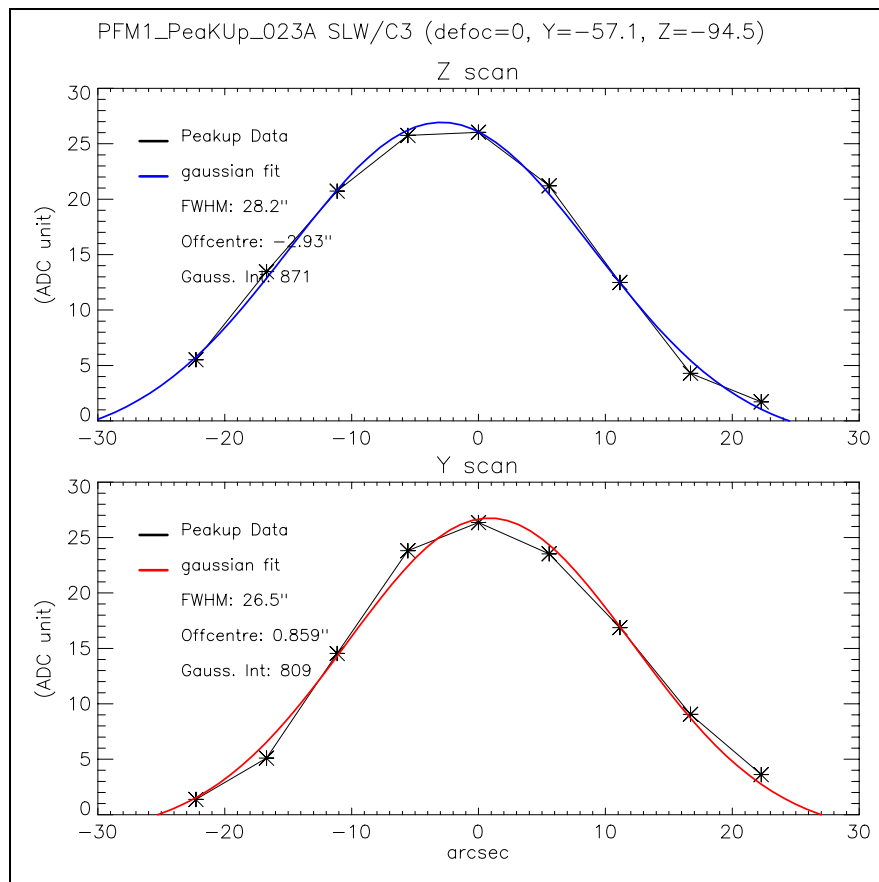
- General remarks:
  - The functional check procedures need to be revised by the relevant people.  
for example BSM open loop step setting was only done properly after Didier was at RAL.
  - No one had taken a look at the functional test document to verify for the real utility of some of the functional tests.



from peak up along Y and Z axis

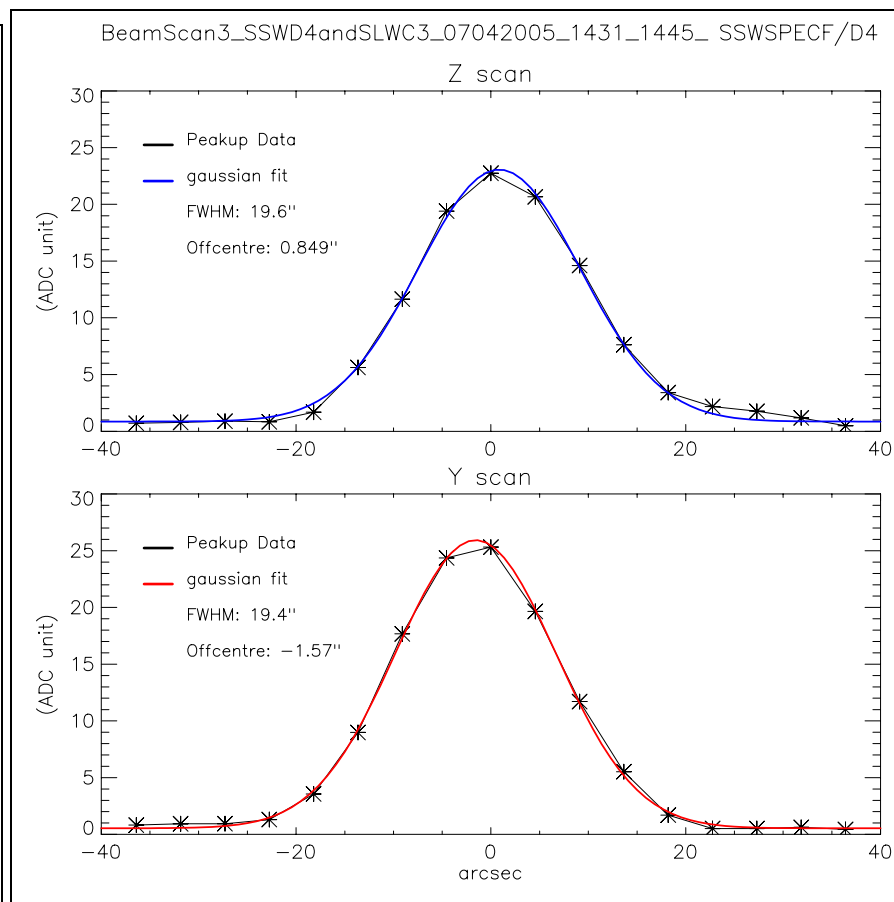
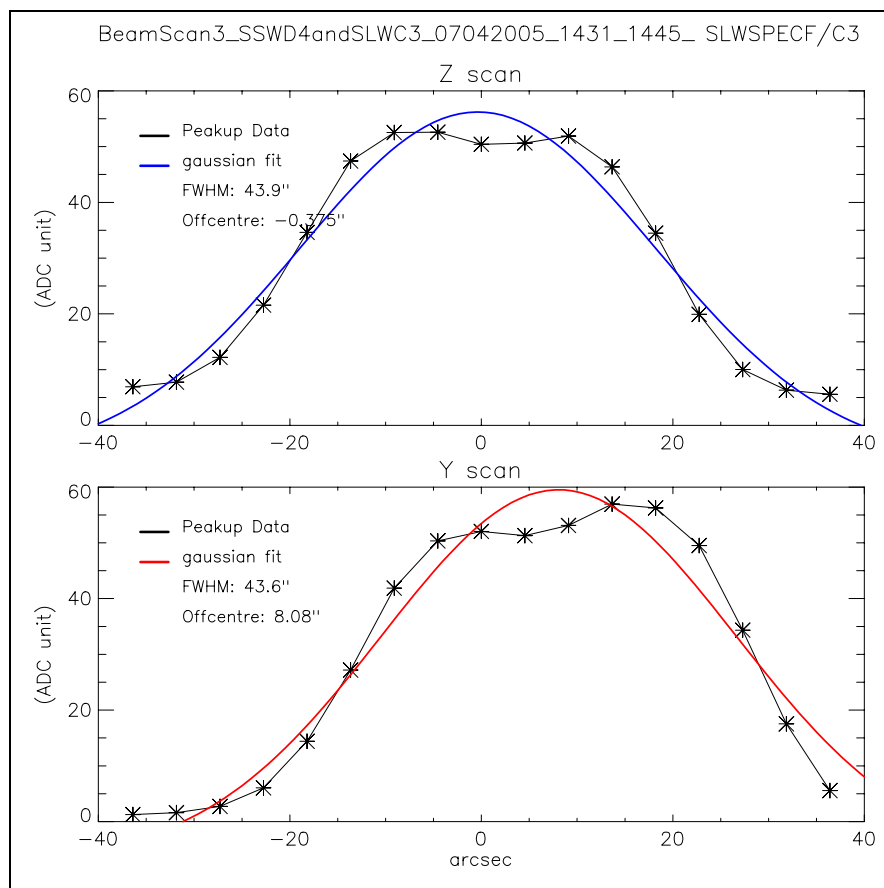


from peak up at 45deg / Y and Z axis



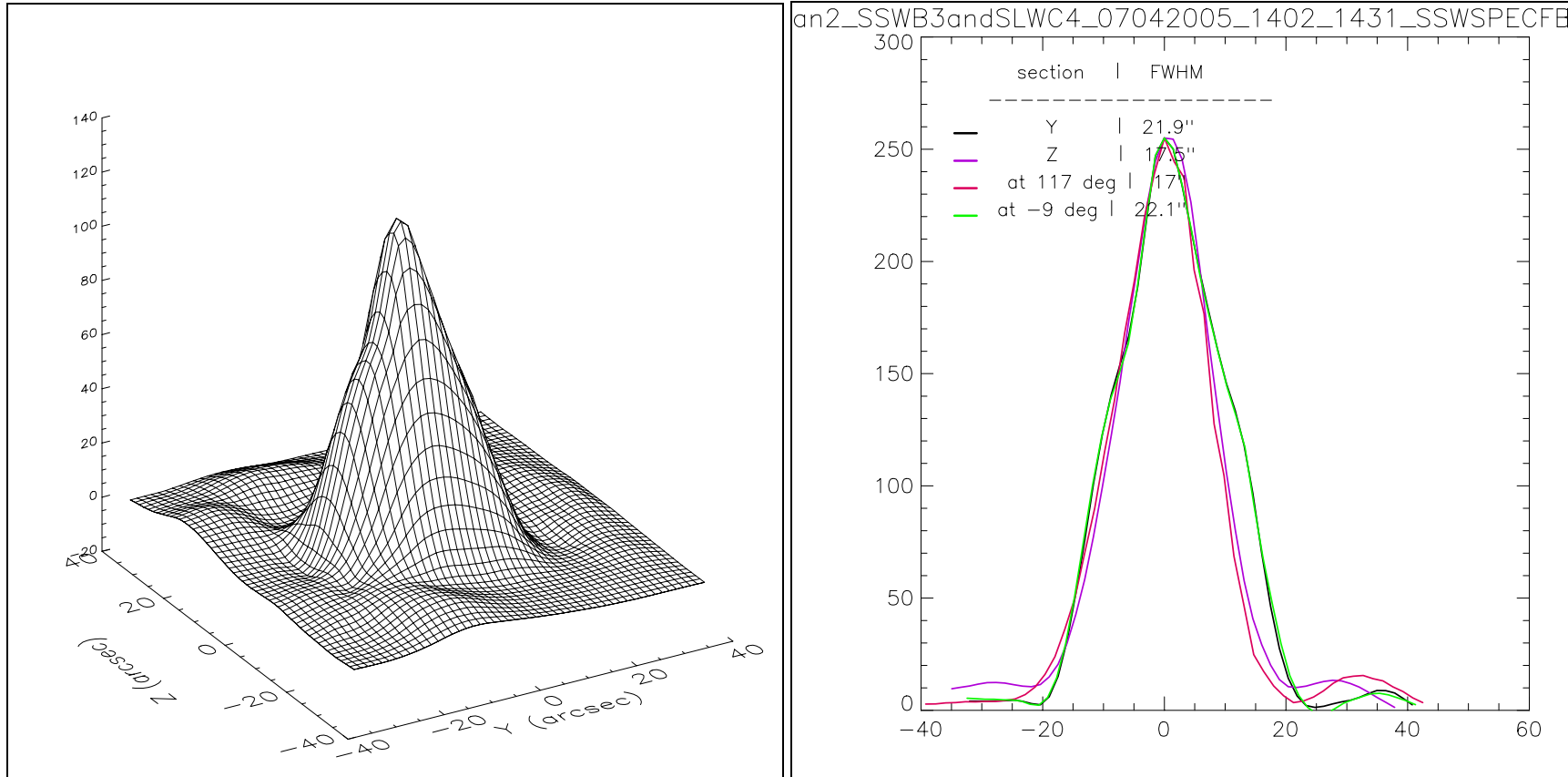
peak up at 45 deg with HBB



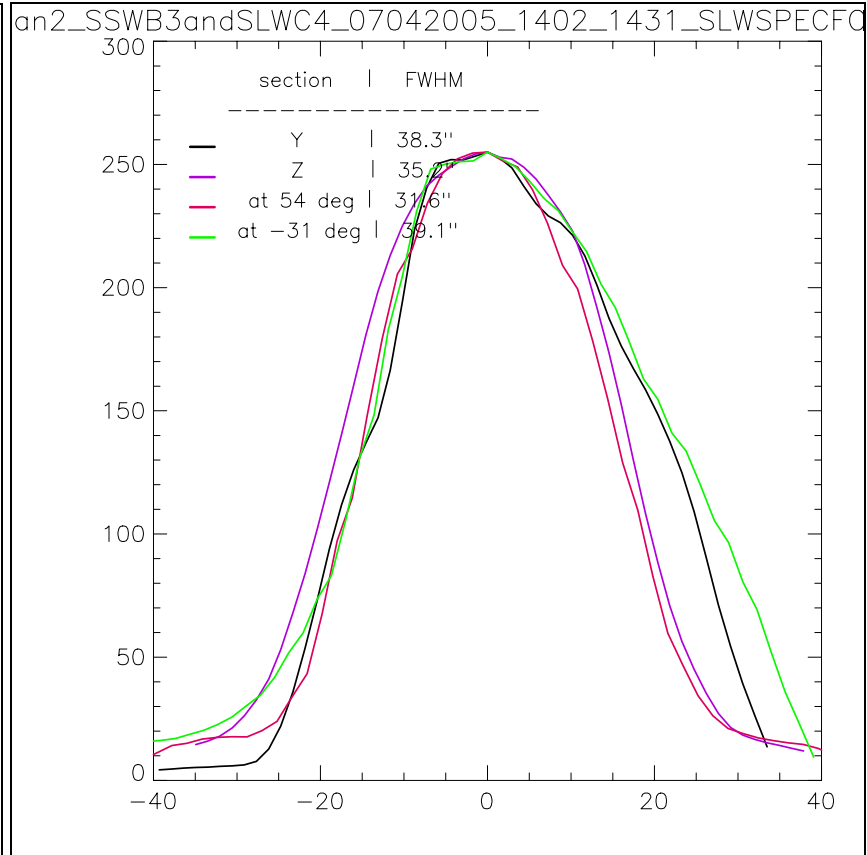
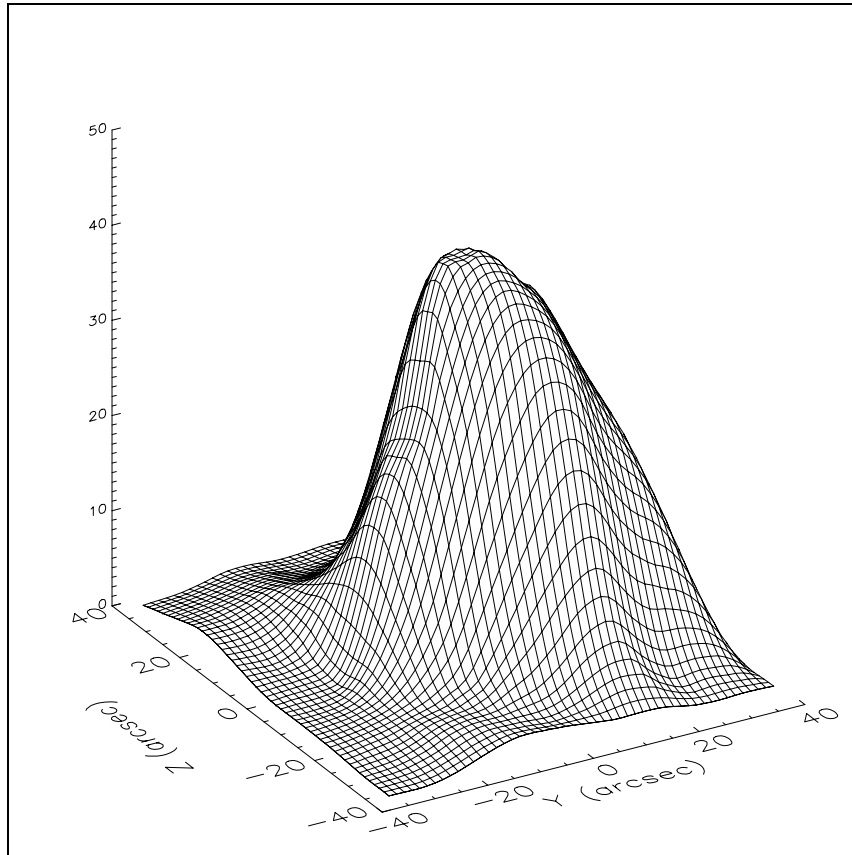


peak up with LASER – 302 $\mu$ m + 309 $\mu$ m

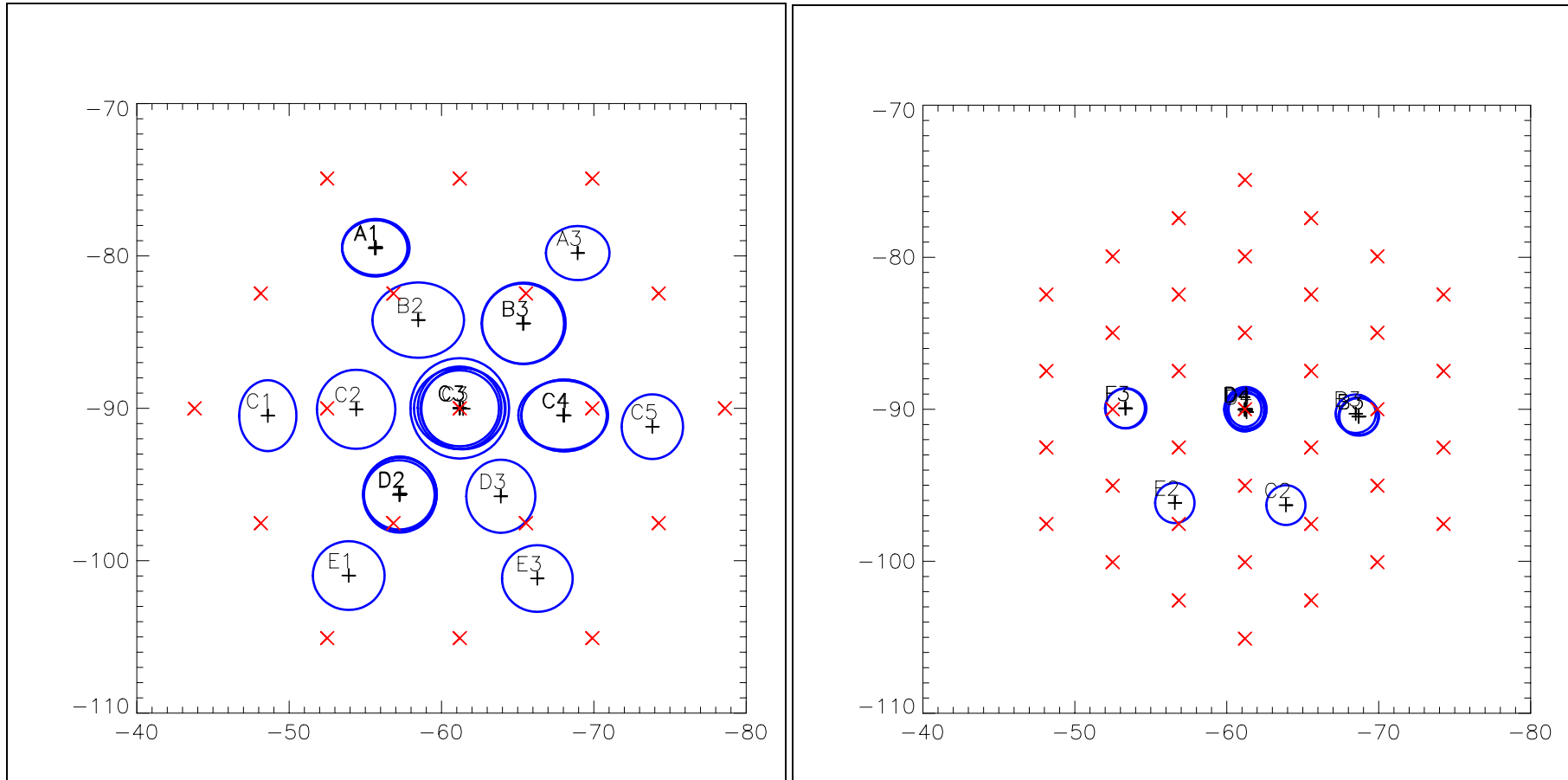
beam scan SSW/B3 – 302 $\mu$ m



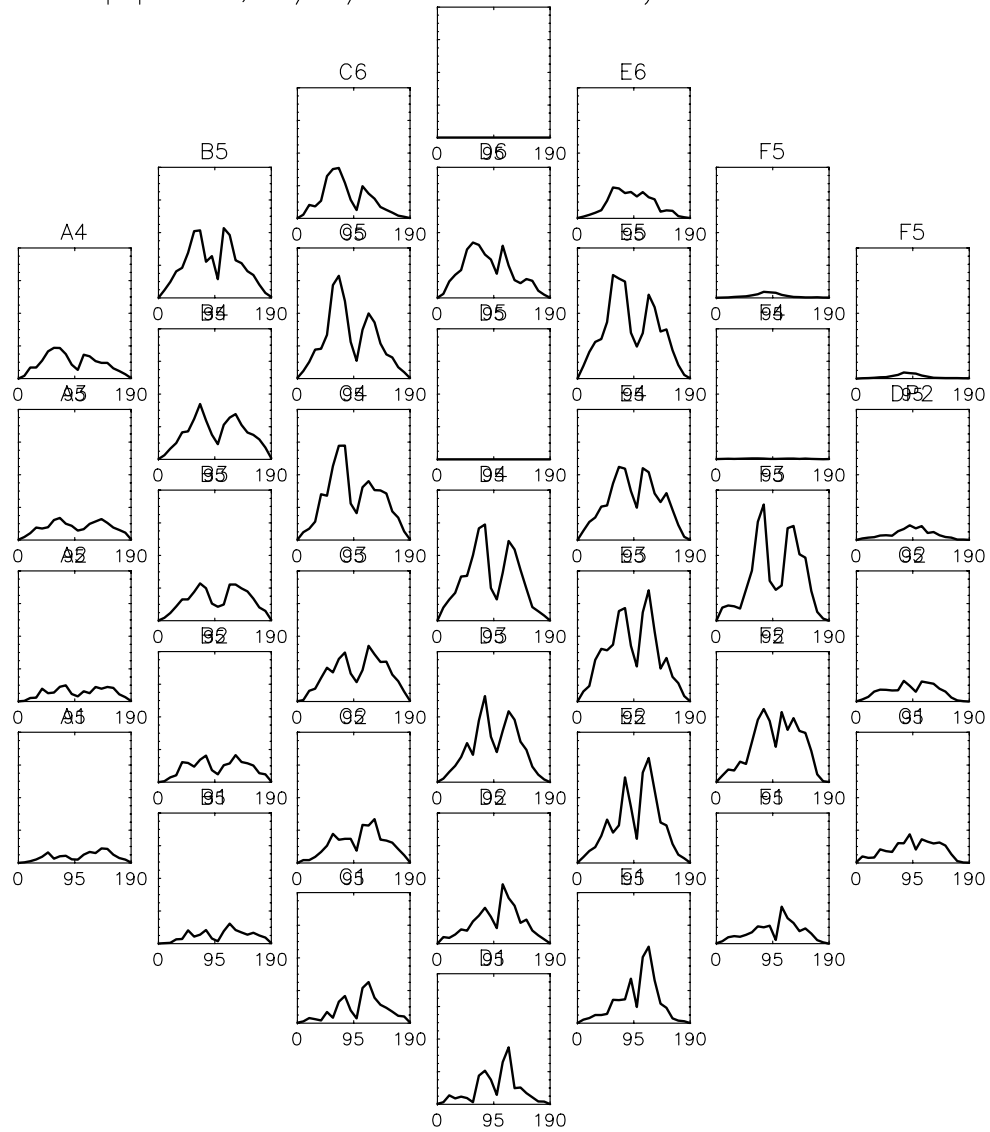
Beam scan SLW/C4 – 302 $\mu$ m



Pixel centres

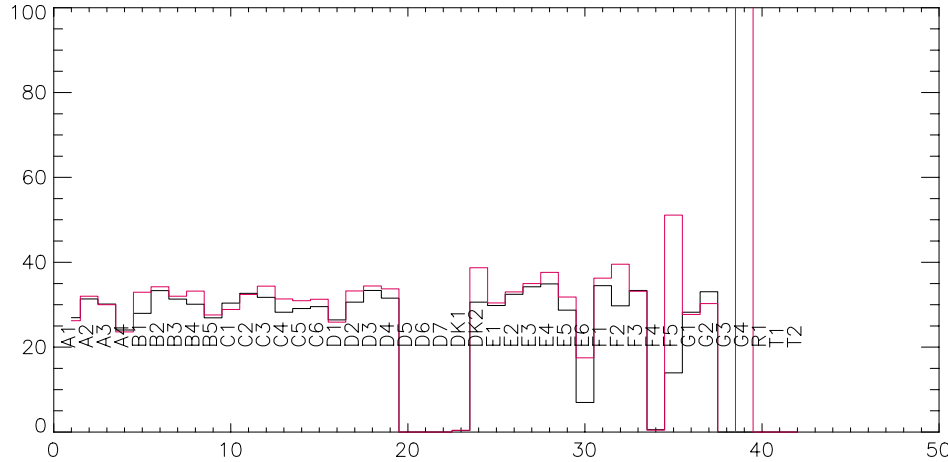


SSW (Manual pupil scan, 06/04/2005 19:16 - 19:34)



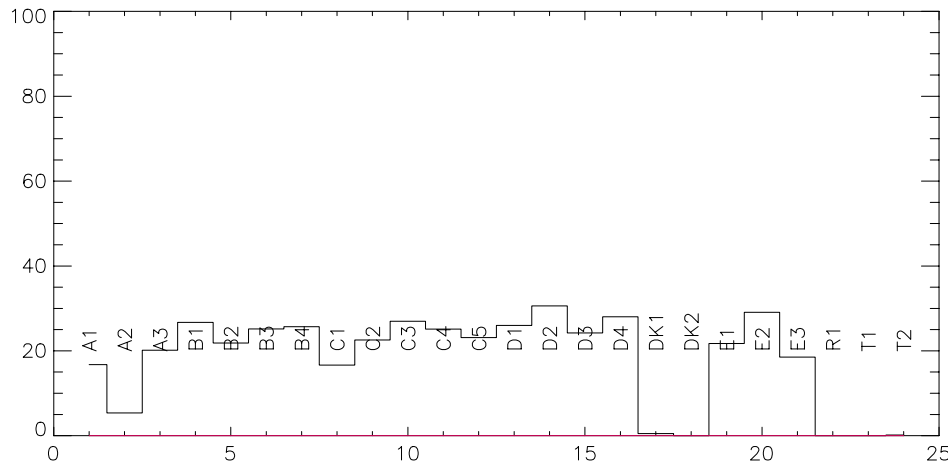
Pupil Scans with laser – pointing at SSW D4

# Background power looking into room (pW) from loadcurves

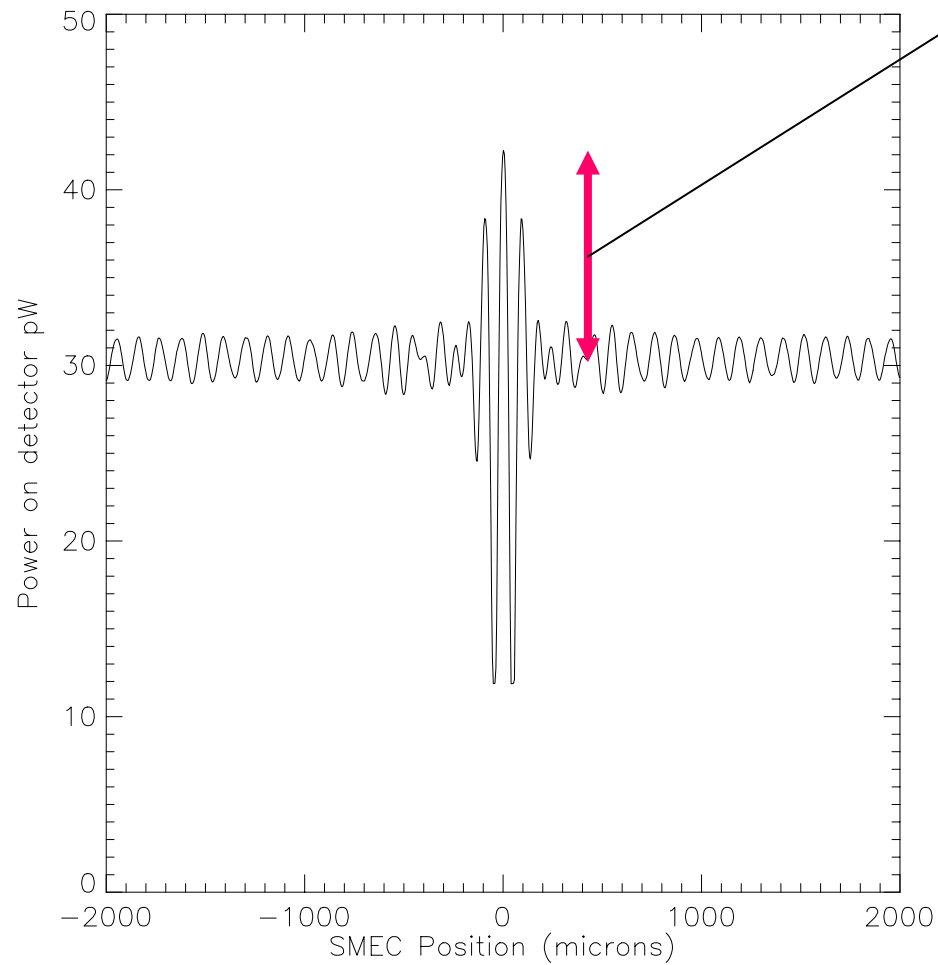


Note swapped pixels:

DP2 is in the G3 position  
F5 is in the G4 position  
F4 is definitely a dark pixel  
F4 and F5 positions show no response.  
D5, D6 and D7 don't seem to work very well

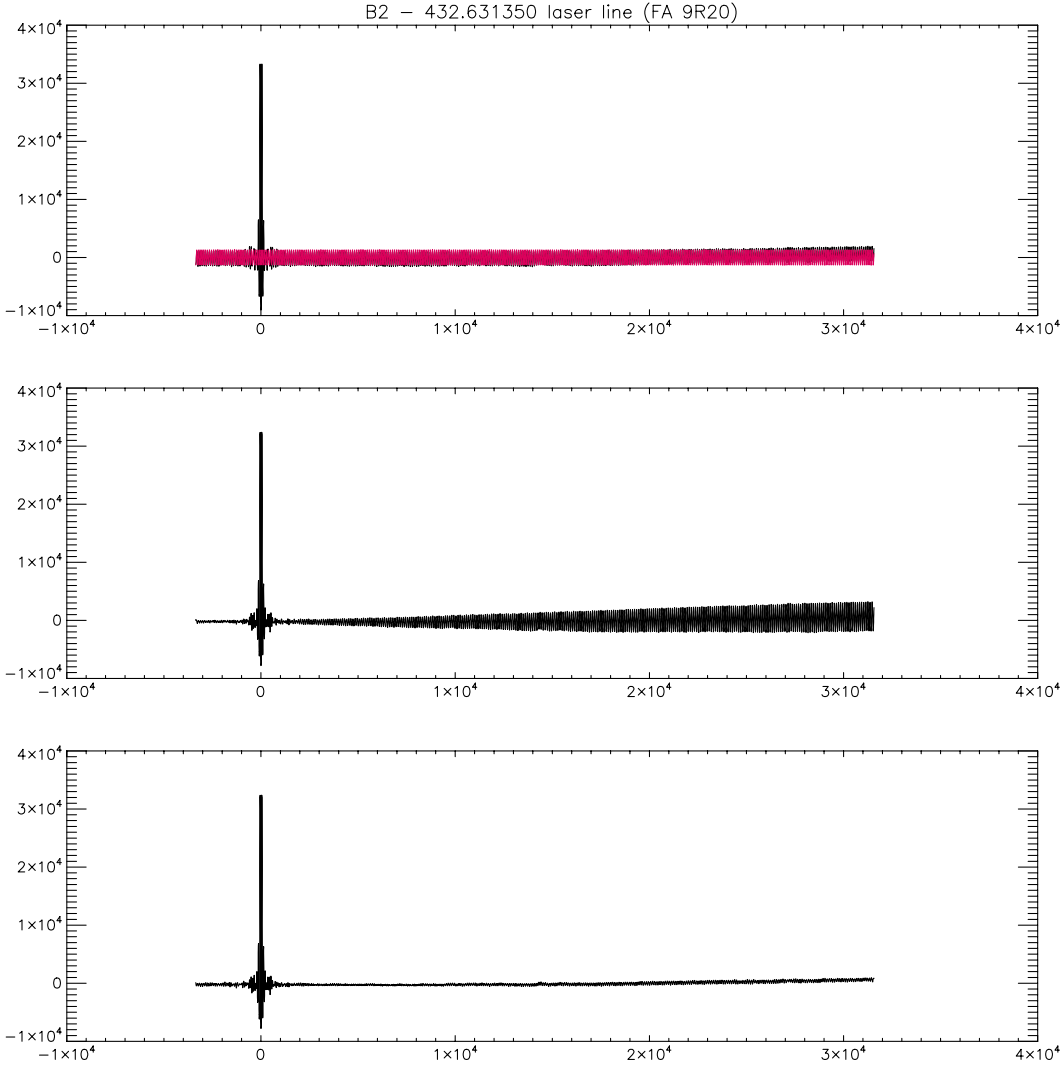


# Interferogram with laser on SLW



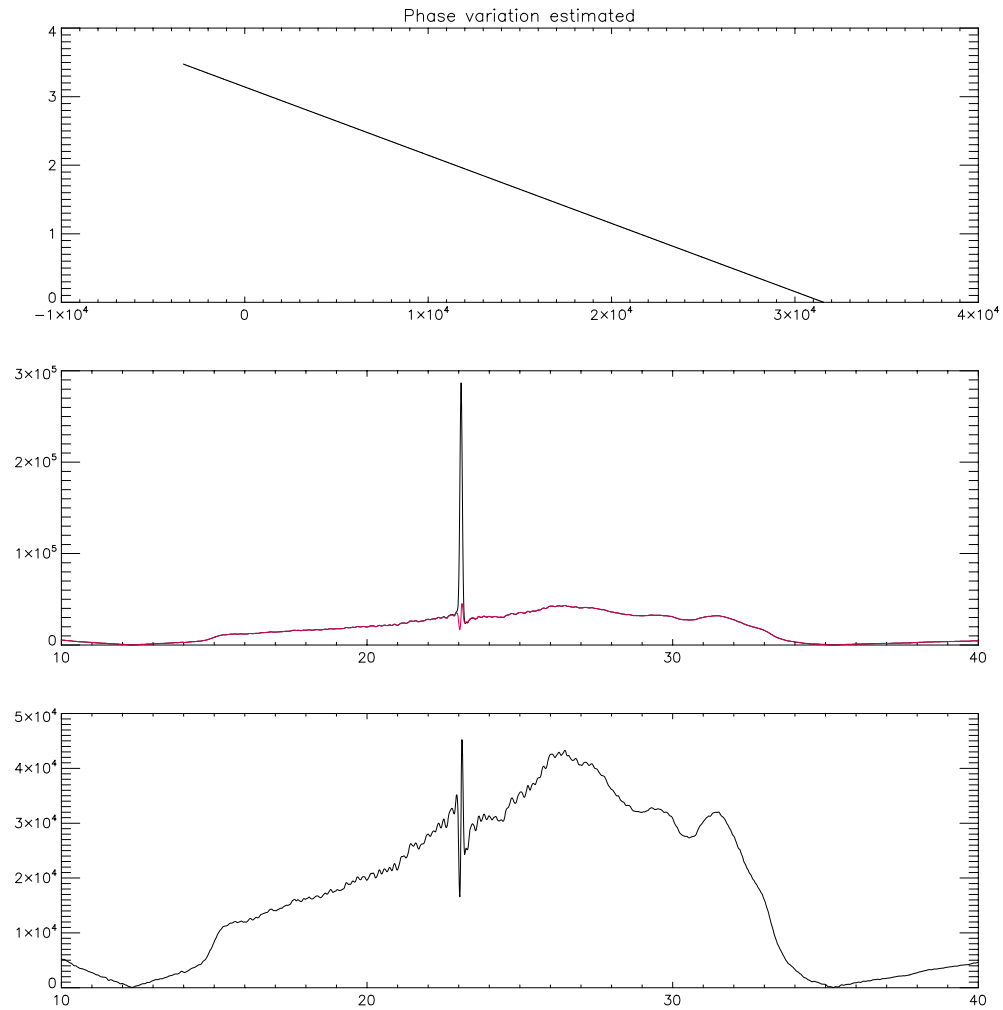
Half the optical  
power  
~10-11 pW →

# Interferogram with laser on SLW – fitting cosine for 432.631 micron

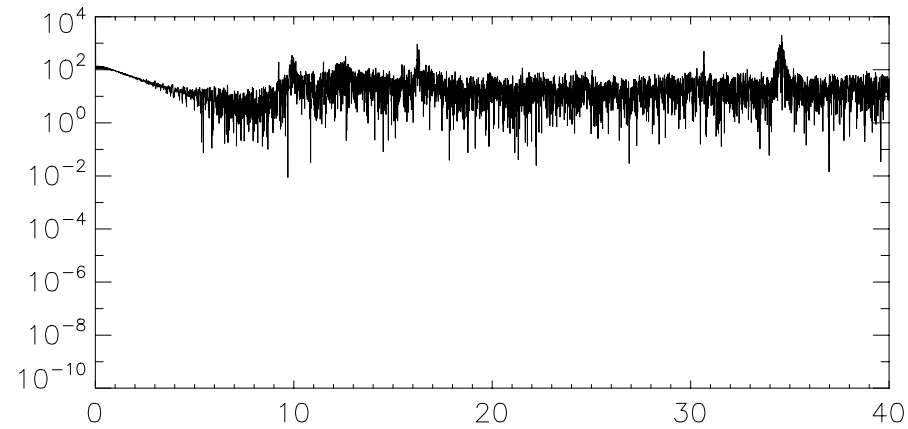
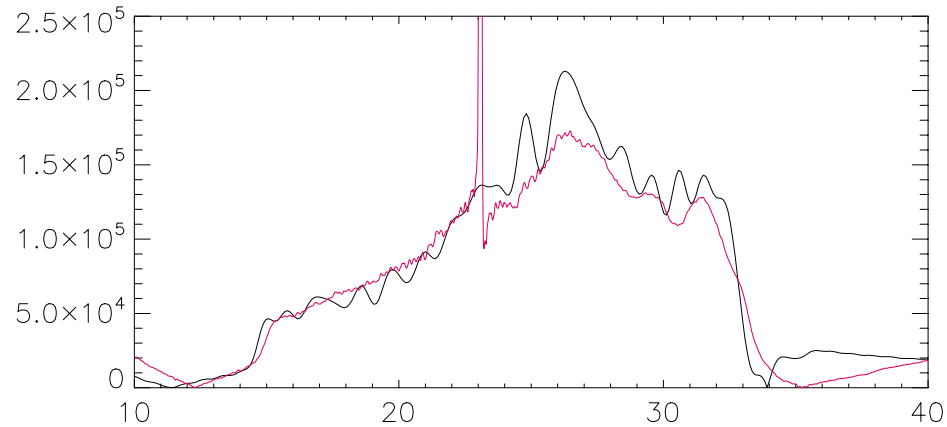




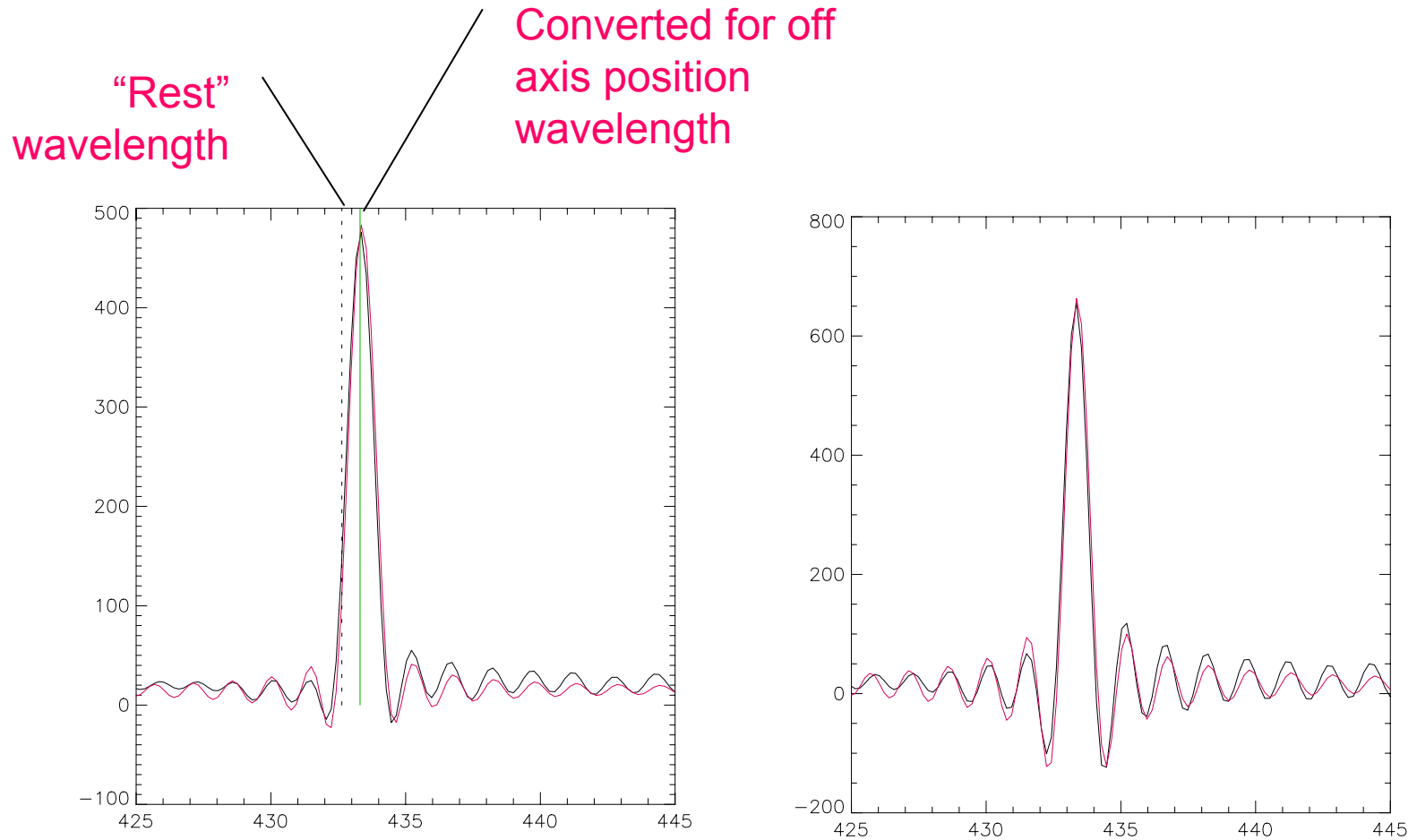
# Phase variation linear with OPD – subtracted cosine in spectral space



# B2 with line compared to C3 without – and position error spectrum



# Line in spectral domain with and without apodisation



# Resolution

- The recovered line profile with no apodisation – the FWHM is about 0.89 mm giving a resolving power of  $R \sim 483$ .
- The scan length from ZPD was about 3.2 cm giving an expected resolution of  $1.22/(2.0 \times 3.2 \times 4.0) = 0.0476 \text{ cm}^{-1}$  – or  $R \sim 485$  at this wavelength.
- Seems to be some phasing problem across base of line pedestal not even either side of line – needs further investigation.
- Spectrometer seems to be working for “high” resolution despite the horrible microvibration environment and possible ghosting.
- Next jobs – look at other pixels; look at other wavelengths; look more closely at phase errors versus SMEC position.

# SLW C3 on the room

