UK Astronomy Technology Centre	Herschel SPIRE	**Herschel SPIRE Beam Steering Mirror Model 'DM-2' Vibration Report** **v 0.1**	Ref: ATC: SPI-BSM-REP-005 Date : 21 May 2003 Author: DMcN

Herschel SPIRE Beam Steering Mirror Model 'DM-2' Vibration Report

Author : David McNeill
Date: 21 May 2003
Version: 0.1

Document Prepared By:	**David McNeill**		
Document Released By:	**Phil Parr-Burman**	**Signature and Date:**	

HERSCHEL SPIRE BEAM STEERING MIRROR MODEL 'DM-2' VIBRATION REPORT

v 0.1

DISTRIBUTION LIST :

SPIRE-Project	Eric Sawyer	
	Eric Clark	✓
	Dave Kelsh	
	Doug Griffin	✓
UK ATC	Colin Cunningham	
	Gillian Wright	✓
	Ian Pain	
	Tom Baillie	
	Tully Peacocke	
	Brian Stobie	✓
	David McNeill	✓
	Ken Wilson	
	Tom Paul	
	Ian Laidlaw	
	Gary Rae	
	Derek Ives	
	Ian Bryson	
	Phil Parr-Burman	✓
LAM	Dominique Pouliquen	

* indicates master copy

VERSION CONTROL

Date	Index	Remarks
21 May 2003	0.1	Creation of the document

Contents

1 APPLICABLE DOCUMENTS

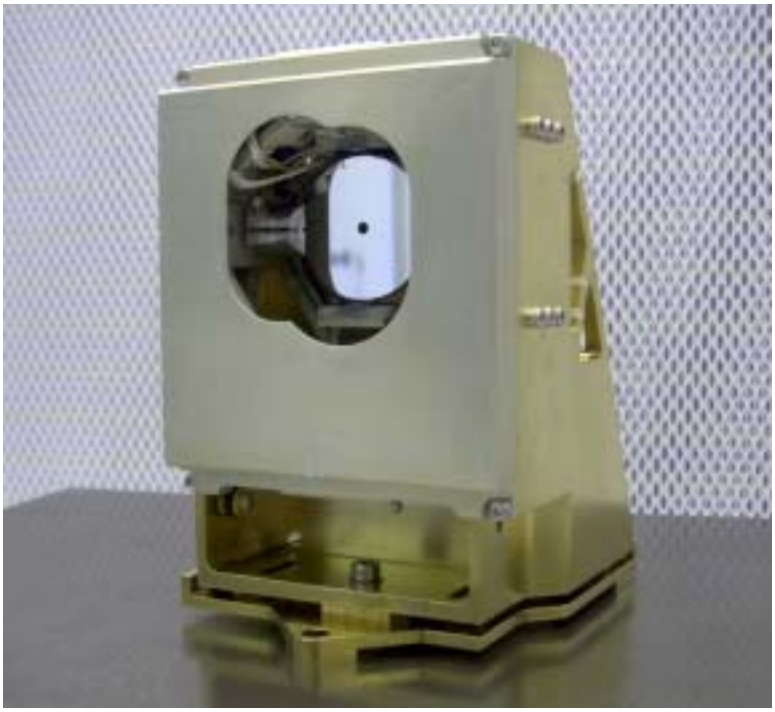
Applicable documents are project specific and may be assumed to apply fully to the BSM, unless stated otherwise

Ref	Title	Author	Reference	Ver	Date
AD 1	Spire Beam Steering Mirror Subsystem Test Plan		SPIRE-ATC-PRJ-000736		
AD 2	Spire Beam Steering Mirror Subsystem Specification Document		Ref: SPIRE-ATC-PRJ-460	3.6	
AD 3					
AD 4					

2 UK ATC SPIRE BSM MODEL 'DM-2' VIBRATION REPORT

2.1 Introduction

This report shows that the Spire Beam Steering Mirror Development Model # 2 (Assembly Drawing Number SPIRE-BSM-023-001) has been vibration tested to the required level to prove the design, components and assembly fit for flight model. It outlines details of this vibration test and accompanying checks performed showing condition of the model.



The Beam Steering Mirror, Model DM-2 (Assembly Drawing Number SPIRE-BSM-023-001)

2.2 Before Vibration-Test Checks.

Before the test, the BSM was checked at 5K to ensure it operated properly, with positive results. Position of components also checked before vibration, to check any movement in parts more susceptible to shifts on shaking.

2.3 Vibration Test

Full details of the Vibration Test are in Appendix 1. The BSM was cold-shaken to the required Qualification Levels (See also AD2).

2.4 After Vibration-Test Checks.

The BSM has been checked after the vibration test. Results are in Appendix 2.

2.5 Conclusion.

After being subject to Qualification Level Vibration, the checks show that The SPIRE BSM DM-2 unit has successfully passed the vibration test.

3 APPENDICES

3.1 Appendix 1: RAL Vibration Report: "AIV-2003-008-VIB"

3.2 Appendix 2: Post-vibration check of DM-2: "UK ATC Inspection Record: BSM M-2 (After Cold-Shake at RAL)"

SST DEPARTMENT

VIBRATION TEST FACILITY

REPORT REF: AIV-2003-008-VIB

HERSCHEL : BSM AND 300mK COMPONENTS

RUTHERFORD APPLETON LABORATORY
Vibration Facility
Chilton, Didcot,
Oxfordshire OX11 OQX

Tel: 44 (0) 1235 446617

CONTENTS

1) TEST ITEM DESCRIPTION

The test items consisted of :-

- BSM
- BSM Flex Pivot Up-screen Rigs
- Calibrators (P-Cal)
- Calibrators (S-Cal)
- 300mK Support
- 300mK Stray-light Baffle
- “Black” Paint Sample

Testing would be carried out on the head of the shaker within the Cryostat.

2) TEST SPECIFICATION

The BSM, P-Cal, S-Cal and the Black Paint samples were to be tested to Qualification levels. As the Qualification levels for the 300 mK Components are higher than the other components; these items were tested to mechanically characterize the difference in the structural response between ambient and cryogenic temperatures. The BSM Flex Pivot Up-screen rig were used to make evident any defects in the construction of the pivots intended for use in the BSM Proto-Flight Model.

Initially all testing would be carried out within the Cryostat housing but at atmospheric pressure and ambient temperature. (BSM, P-CAL, S-CAL and 300mK support only) All tests would then be repeated at cold temperatures (All items). Testing would be carried out in the Y-axis only (BSM Flex Pivot Up-screen Rigs were orientated to allow all axes to be tested).

The voltage from the Chop and Jiggle axes of the BSM were monitored during all tests. The signal was read out with a DC amplifier with a gain of 2. The signals were then captured with a 16-bit Data Acquisition Card.

SINE SURVEY TEST

One sweep @ 0.5g from 5 Hz to 2000 Hz at 2 octaves per minute.

SINE SWEEP

FREQUENCY (Hz)	TEST LEVEL
5 – 24.8	20mm pk-pk
24.8 - 100	25g

One sweep at 2 octaves per minute.

RANDOM

Y AXIS

FREQUENCY (Hz)	TEST LEVEL
20 - 100	+3 dB/oct
100 - 400	0.117 g^2 / Hz
400 - 2000	-12 dB/oct

Overall Test Level = 7.5 g rms. for 60 Seconds ambient /120 seconds cold.

3) ACCELEROMETER CALIBRATION STATUS

SINGLE AXIS - ENDEVCO 2272 & B&K 4393

SERIAL NUMBER	CALIBRATION PC/g	Date	SIGNAL CONDITIONER
A26A	12.25	07/11/02	ENDEVCO 2275A
YG32	13.68	07/11/02	
YA81	12.50	07/11/02	
1434586	3.0	N/A	

NOTE

Due to the temperature effects, a reduction of 10% in the sensitivity values was used during all cold testing.

See test summary for details on S/N 1434586

SINGLE AXIS - ENDEVCO 7250A-10

SERIAL NUMBER	CALIBRATION mV/g	Date	SIGNAL CONDITIONER
CN05	10.58	05/03/02	DYTRAN MODEL E4121 SERIAL No. 227
CN10	10.00	05/03/02	

Signal Conditioner: Dytran model E4121 Serial No. 227
Calibrated on**:** 20 February 2002

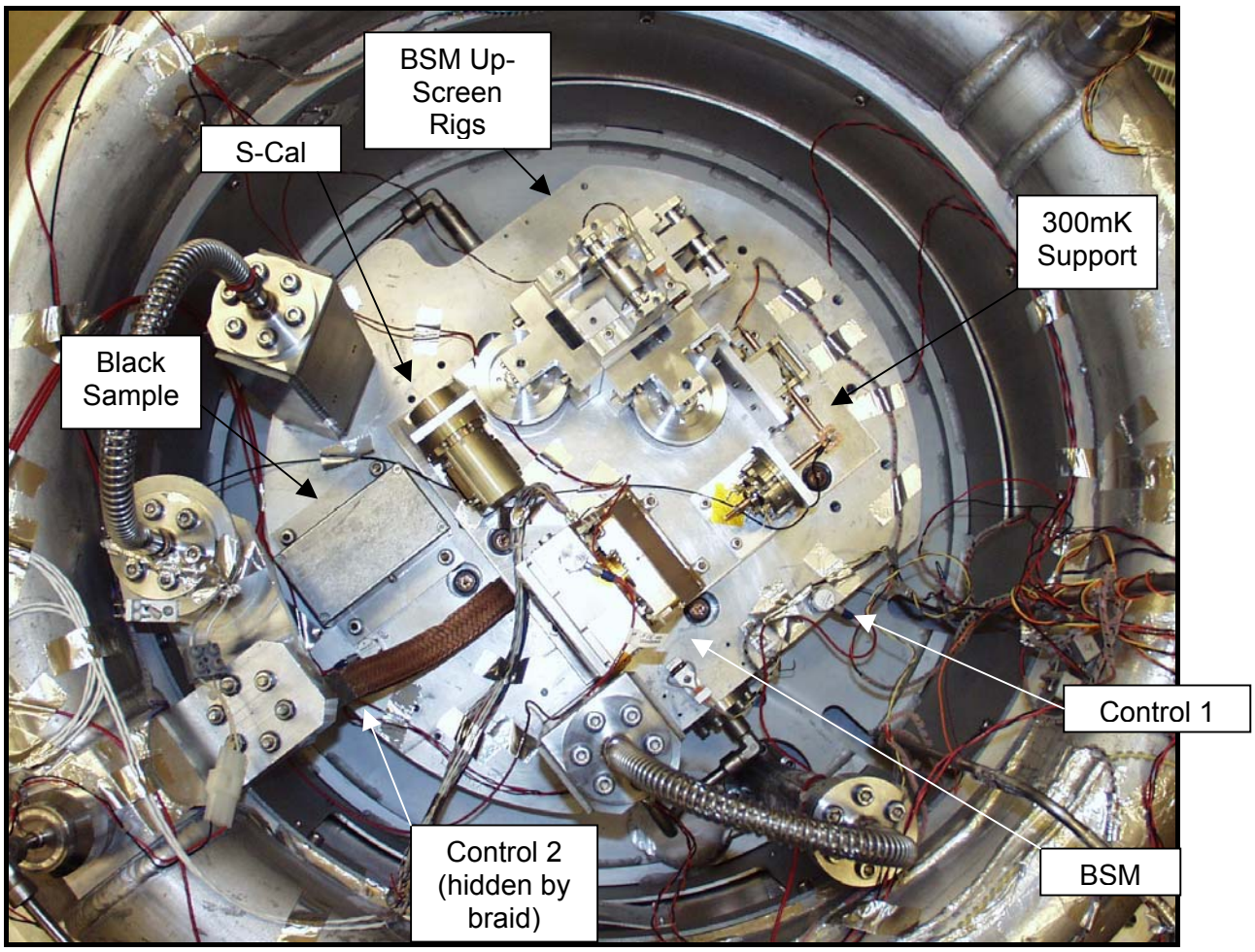
Signal Conditioner: Endevco 2275A
Calibrated on**:** September 2002

4) CLEANLINESS

Approved cleanroom gloves to be worn when handling the test items.

5) FIXTURE DETAILS

Y AXIS FIXTURE CONFIGURATION



A view of the test items mounted on their vibration fixture. The control strategy implemented involved taking the average response from the two accelerometers attached to the fixture as shown above.

6) TEST SUMMARY

Test Dates: 03 February 2003 to 06 February 2003

Observers: Doug Griffin and Facility Staff

Organisation **:** RAL

CHANNEL ALLOCATION:

CONTROL:-

Channel No.	Accelerometer Type/Serial No.	Testing Axis	Mounting Position
1	Endevco YA81	**Y**	Fixture
2	Endevco A26A	**Y**	Fixture

MONITORING:-

Channel No.	Accelerometer Type/Serial No.	Testing Axis	Mounting Position
3	Endevco YG32	**Y**	BSM
4	B&K 1434586	**Y**	300mK Busbar
5	Endevco CN05	**Z**	BSM
6	Endevco CN10	**X**	BSM

NOTE

Accelerometer B&K 1434586 was an uncalibrated unit, which was not specified to have a working temperature range at the low temperatures it would be subjected too. As such the data collected should only be viewed as an indication of frequency response. The amplitude data has no relevance.
Accelerometers connected to channels 5 & 6 were only attached during the initial warm testing at atmospheric conditions.

ACTION	DATE	TIME
Pumpdown Started	04/02/03	22:00
Cooldown Started	05/02/03	03:00
Cold Vib. Testing	05/02/03	18:15
Start Warm Up	05/02/03	19:00
Ambient Testing	06/02/03	10:00
Test Item Removed	06/02/03	13:00

ACCELEROMETER TEST PLOTS

ATMOSPHERIC/AMBIENT TEST CONDITIONS 04/02/03

VIBRATION TESTS in the Y-axis

RUN 00005 SINE SURVEY *FIG 1 a,b*

RUN 00001 SINE SWEEP *FIG 2 a,b*

RUN 00001 RANDOM *FIG 3 a,b (1 minute duration)*

RUN 00006 SINE SURVEY *FIG 4 a,b*

COLD TEST CONDITIONS 05/02/03

VIBRATION TESTS in the Y-axis

RUN 00007 SINE SURVEY *FIG 5 a,b*

RUN 00002 SINE SWEEP *FIG 6 a,b*

RUN 00008 SINE SURVEY *FIG 7 a,b*

RUN 00002 RANDOM *FIG 8 a,b (2 minute duration)*

RUN 00009 SINE SURVEY *FIG 9 a,b*

VACUUM/AMBIENT TEST CONDITIONS 06/02/03

VIBRATION TESTS in the Y-axis

RUN 000011SINE SURVEY *FIG 10 a,b*

7) CONCLUSION

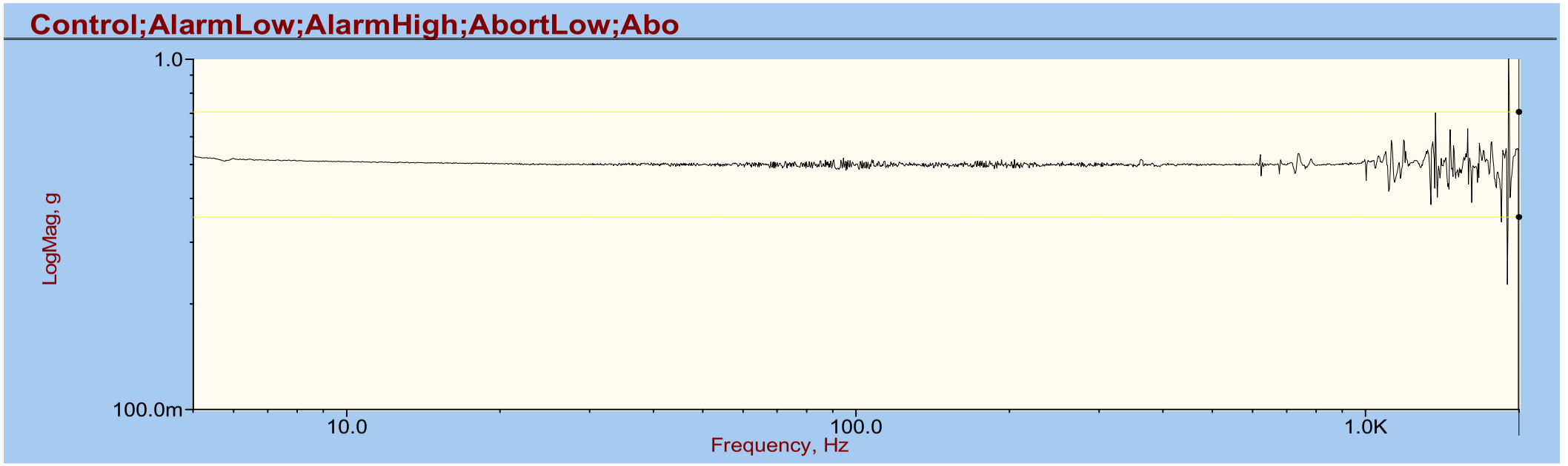
The test items were subjected to the Qualification levels of vibration. On inspection, post testing, the Kevlar cord exhibited no signs of wear.

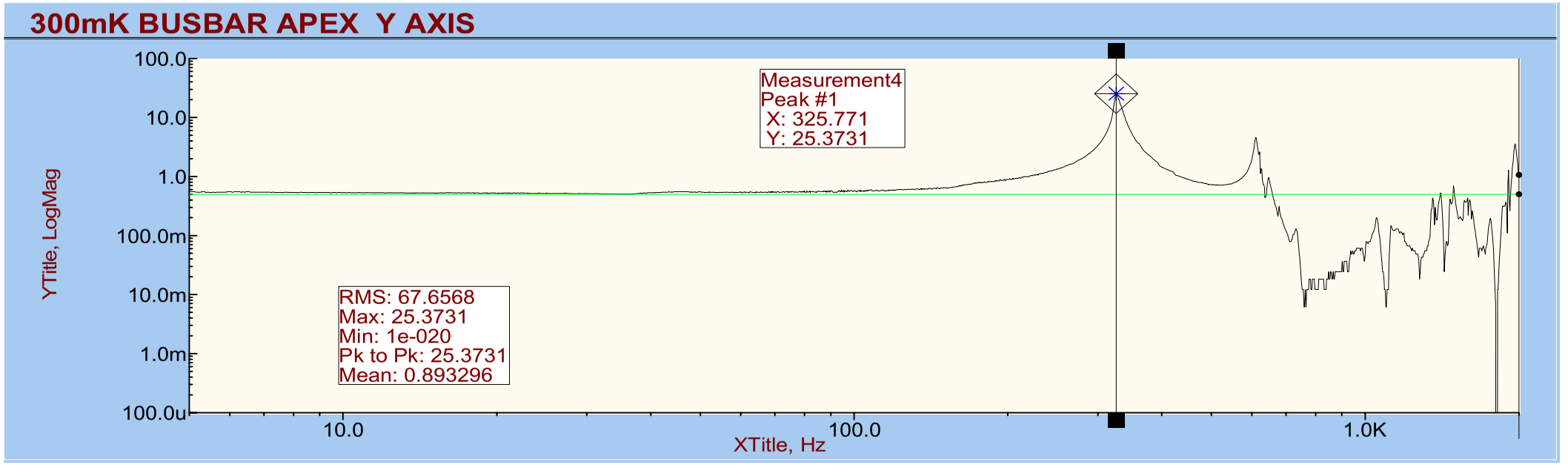
No instrumentation was present on the S-Cal unit. Visual observation of the response of the unit during warm vibration testing indicated no significant resonance. Visual inspection after the testing indicated that the unit had not been damaged. The performance of S-Cal will be measured after the test campaign to confirm that no damage was caused by the test.

FACILITY OPERATOR: -

FACILITY MANAGER:-

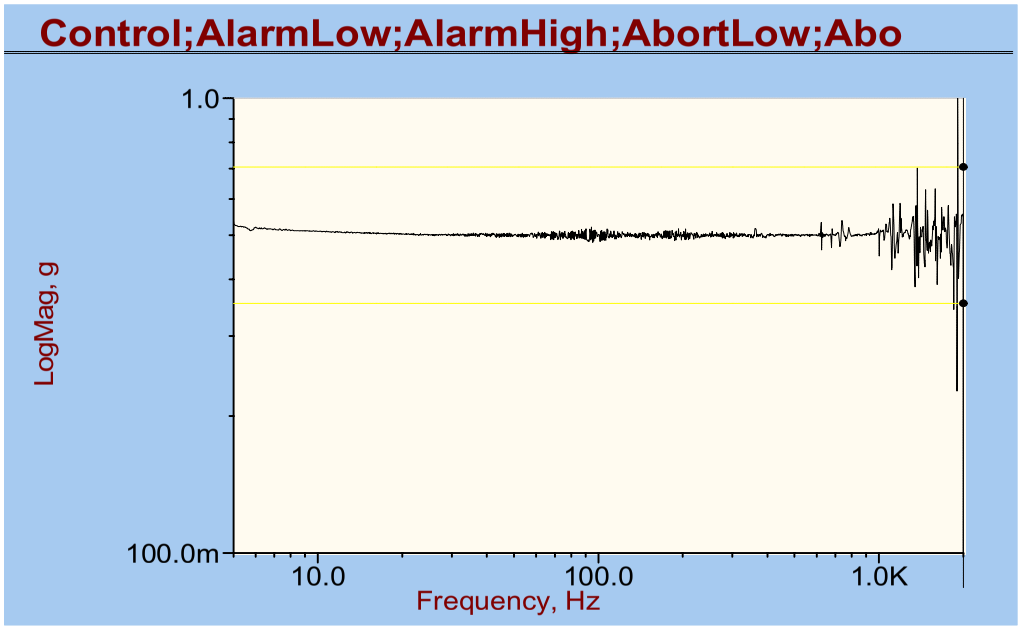
ANNEX:A ACCELEROMETER PLOTS

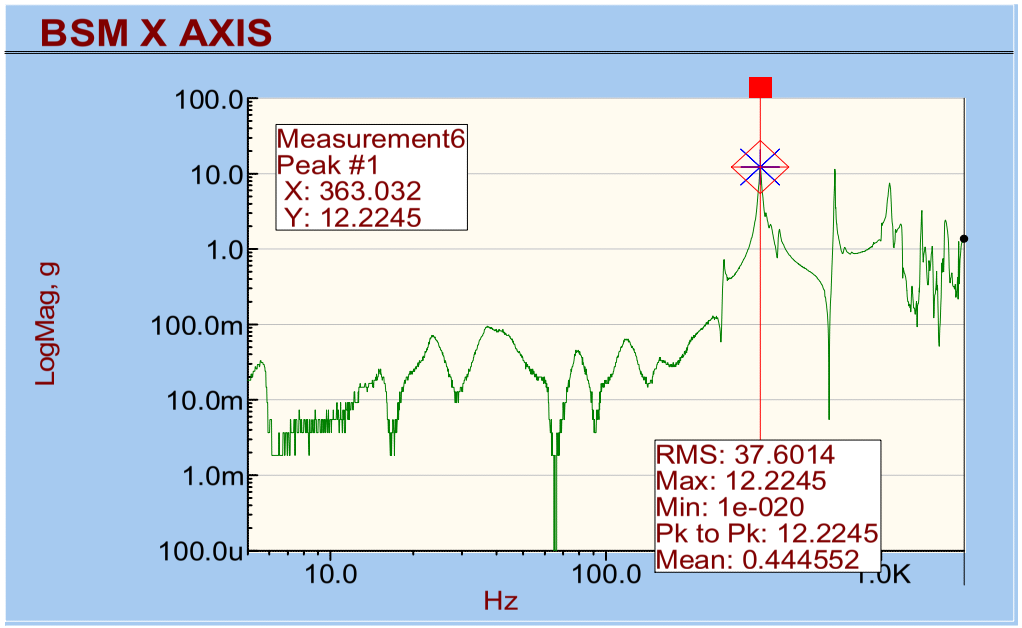


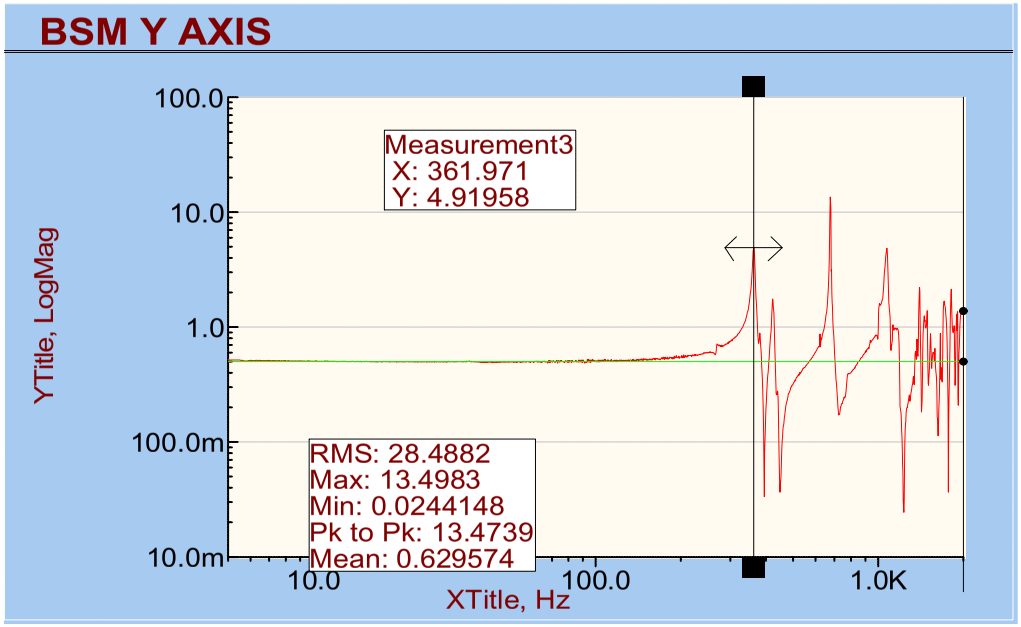


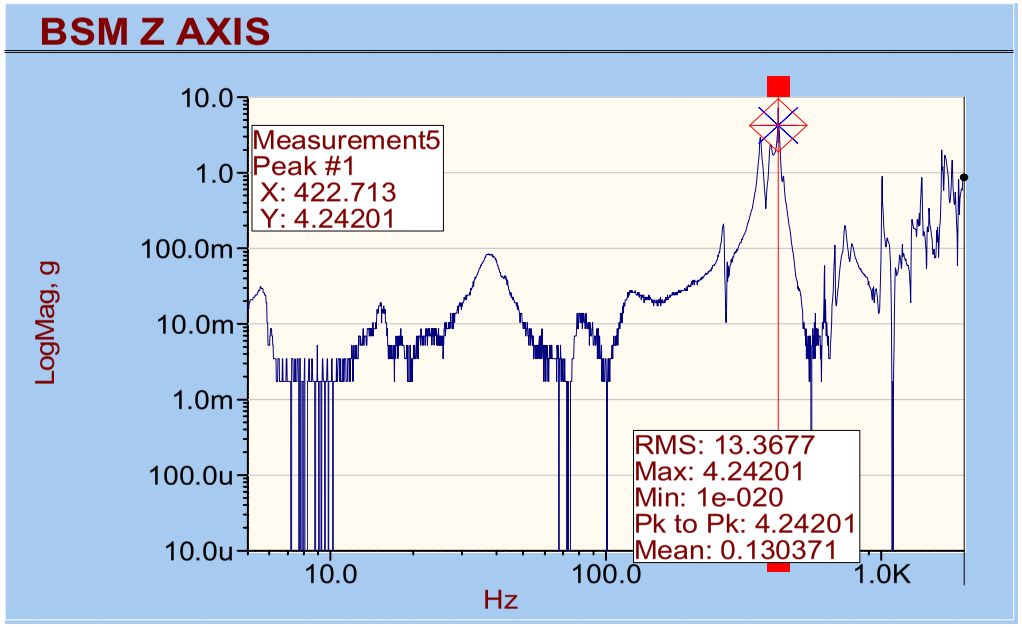
BSM AND 300mK COMPONENTS SINE SURVEY AMBIENT/ATMOSPHERIC TESTING
RUN 00005
Y AXIS
19:23:25 04/02/2003

Fig 1a



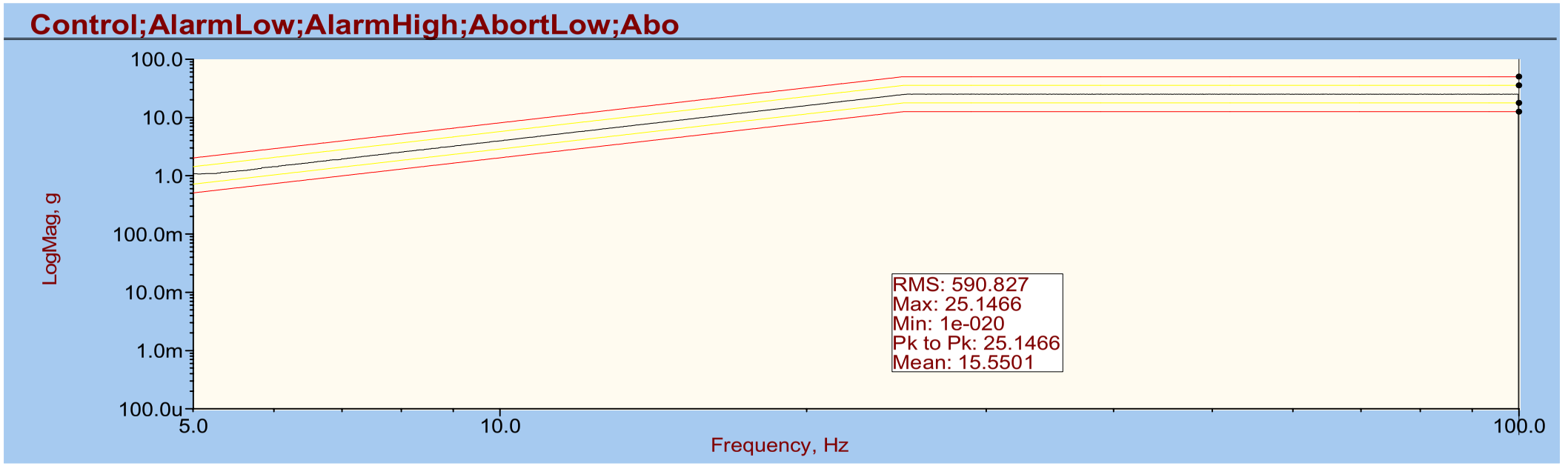


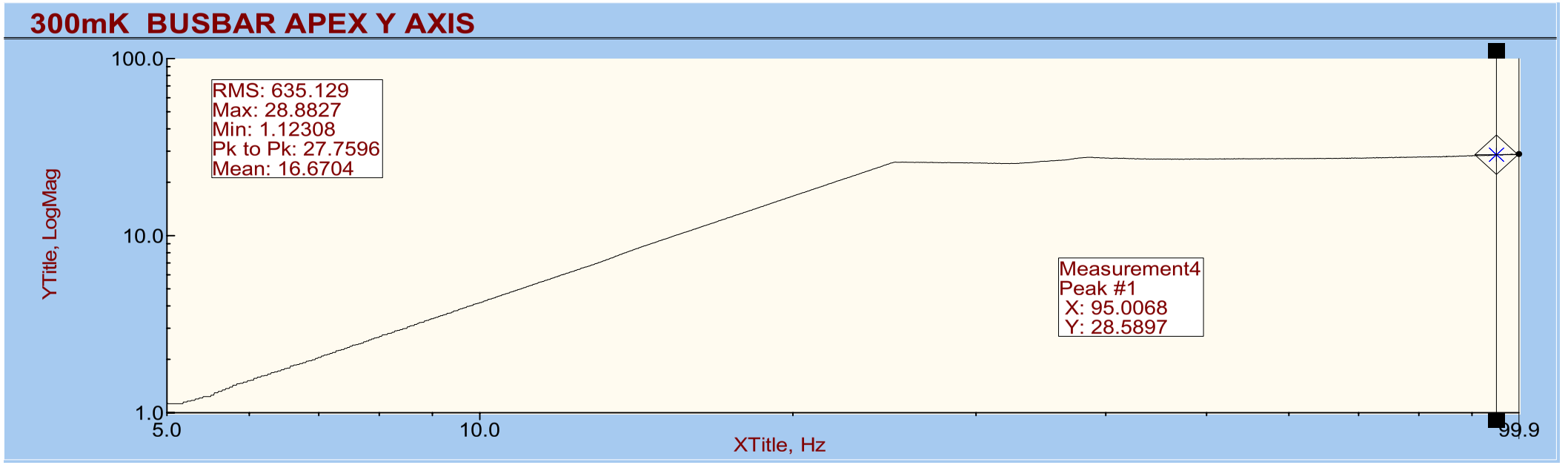




BSM AND 300mK COMPONENTS SINE SURVEY AMBIENT/ATMOSPHERIC TESTING
RUN 00005
Y AXIS
19:23:25 04/02/2003

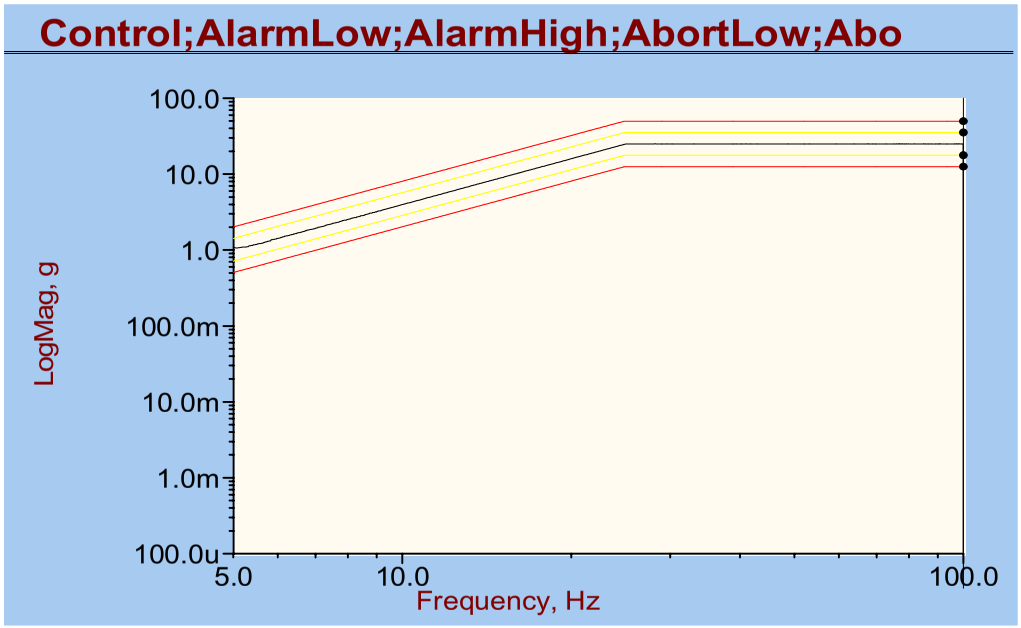
Fig 1b

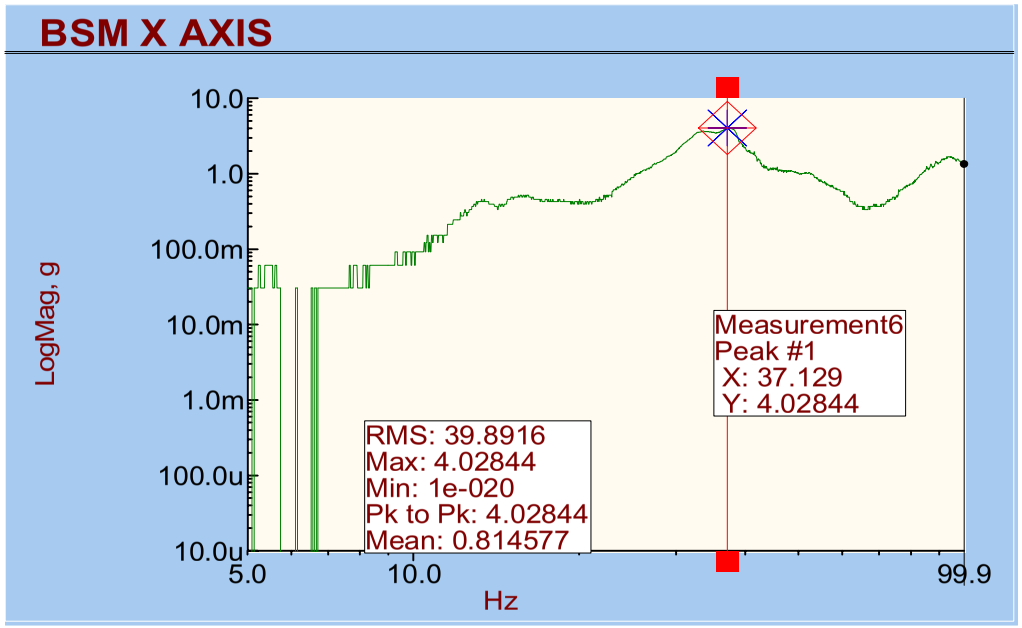


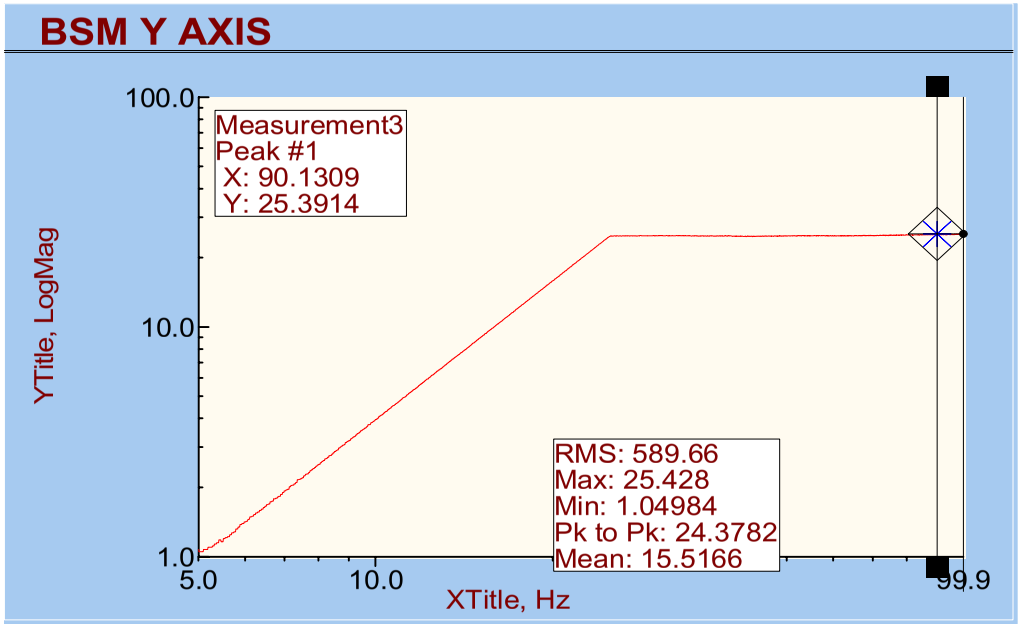


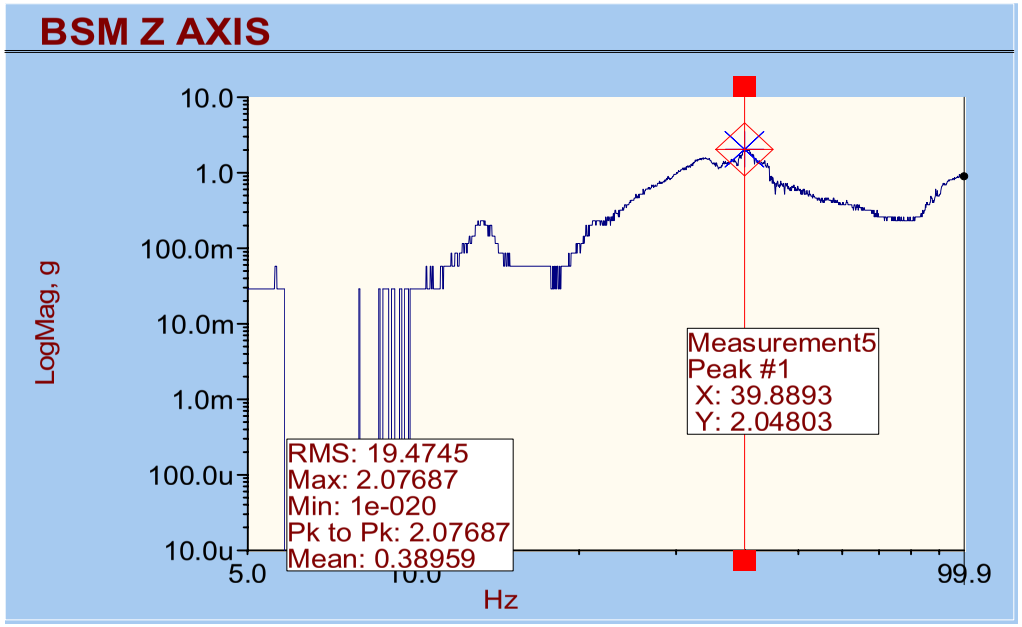
BSM AND 300mK COMPONENTS SINE SWEEP AMBIENT/ATMOSPHERIC TESTING
RUN 00001
Y AXIS
19:36:42 04/02/2003

Fig 2a



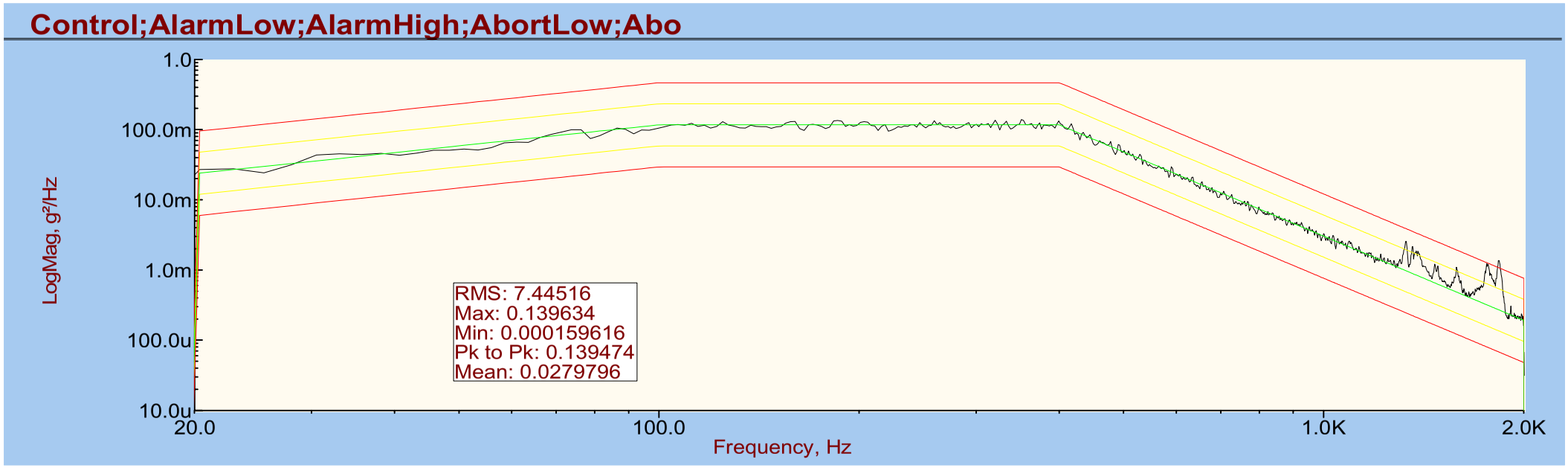


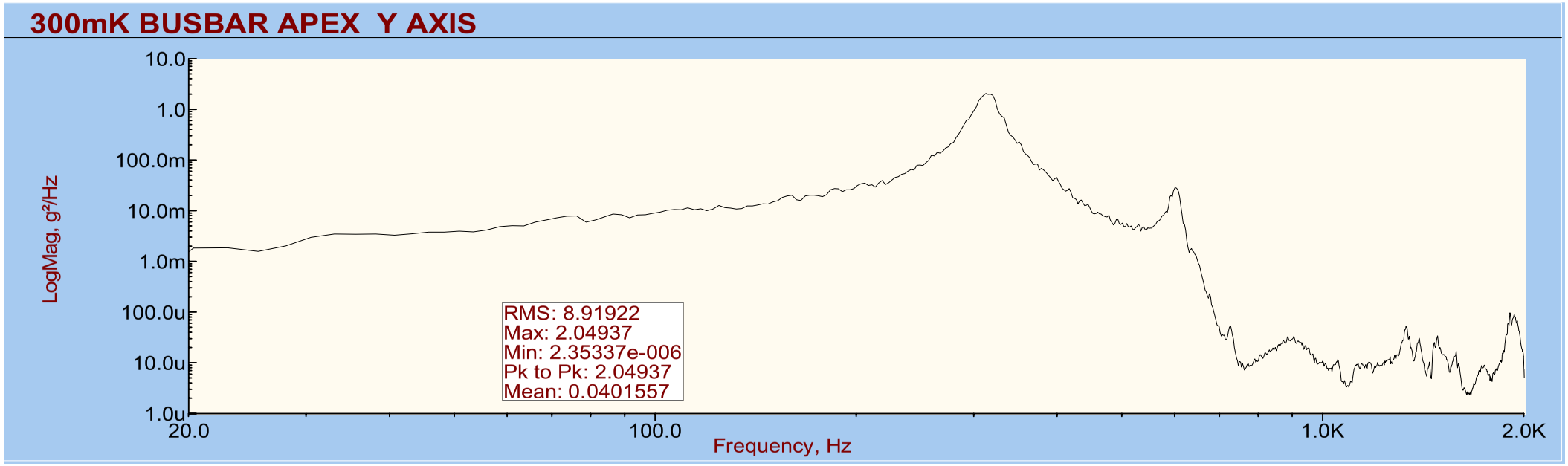




BSM AND 300mK COMPONENTS SINE SWEEP AMBIENT/ATMOSPHERIC TESTING
RUN 00001
Y AXIS
19:36:42 04/02/2003

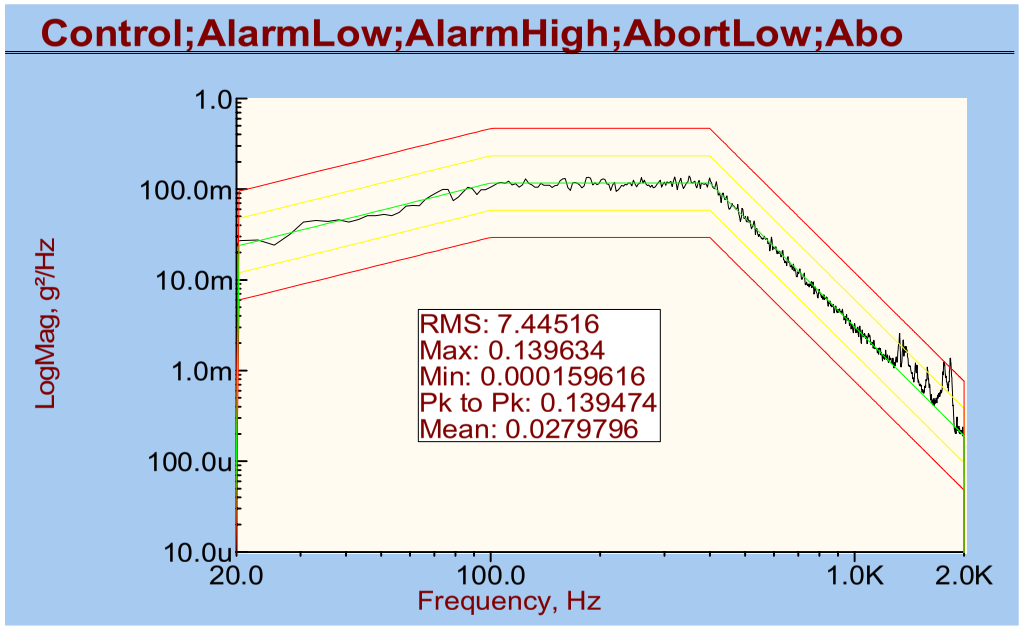
Fig 2b

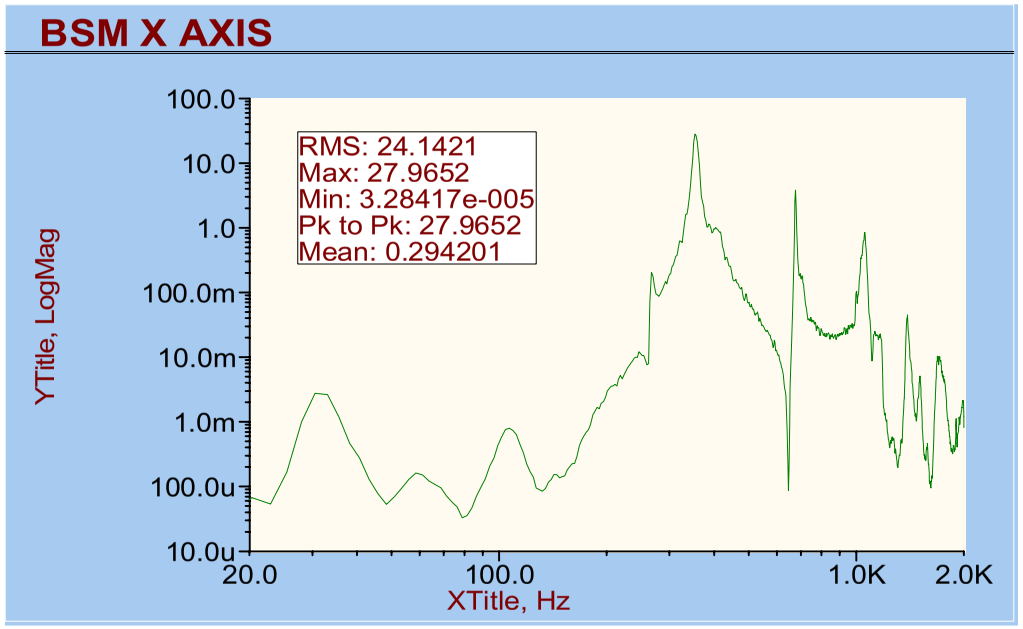


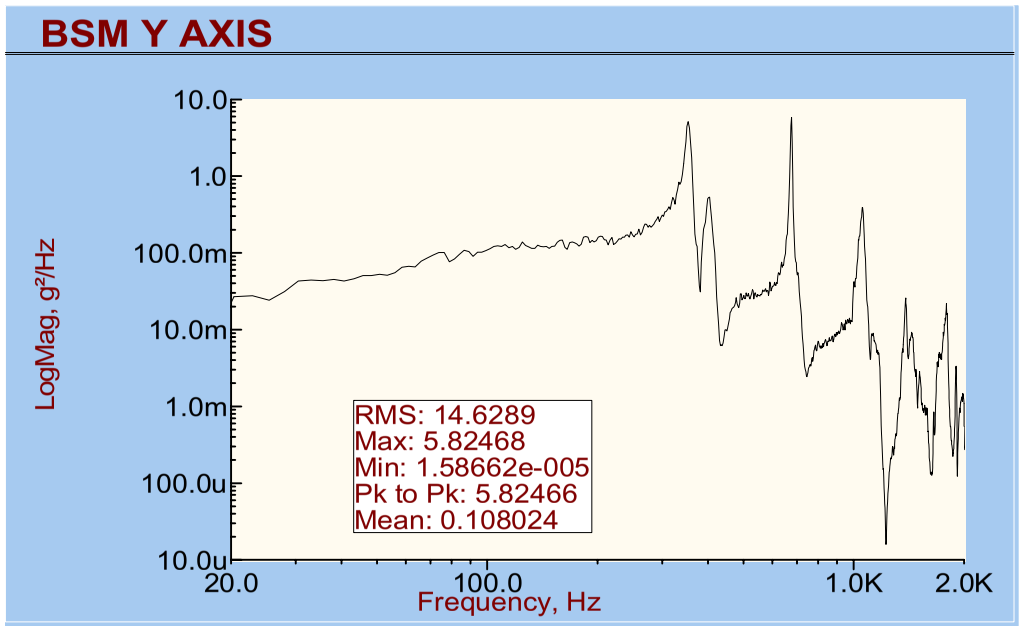


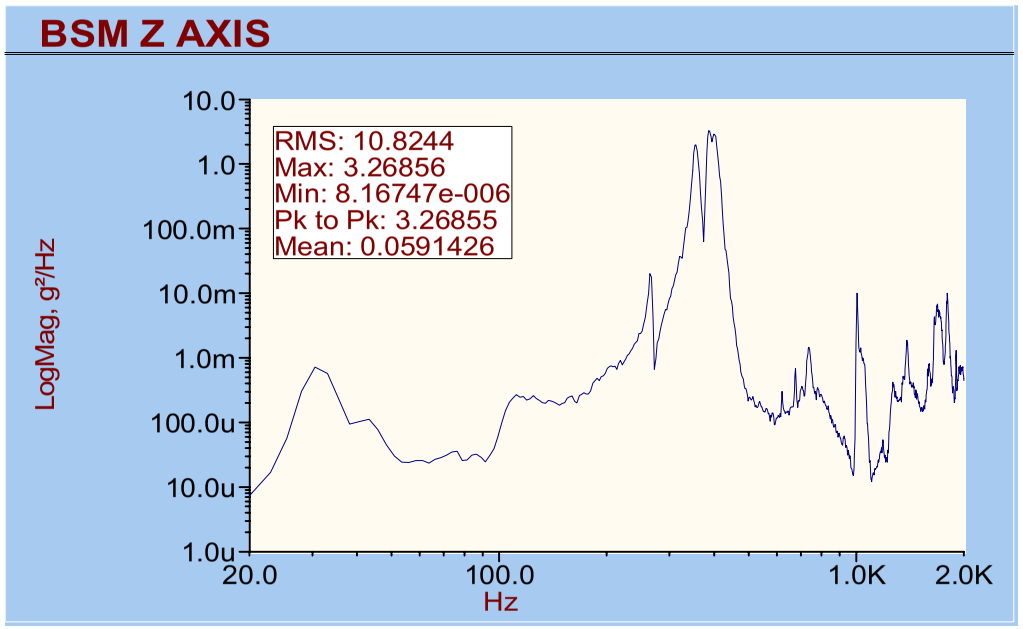
BSM AND 300mK COMPONENTS RANDOM AMBIENT/ATMOSPHERIC TESTING
RUN 00001
Y AXIS
19:50:47 04/02/2003

Fig 3a



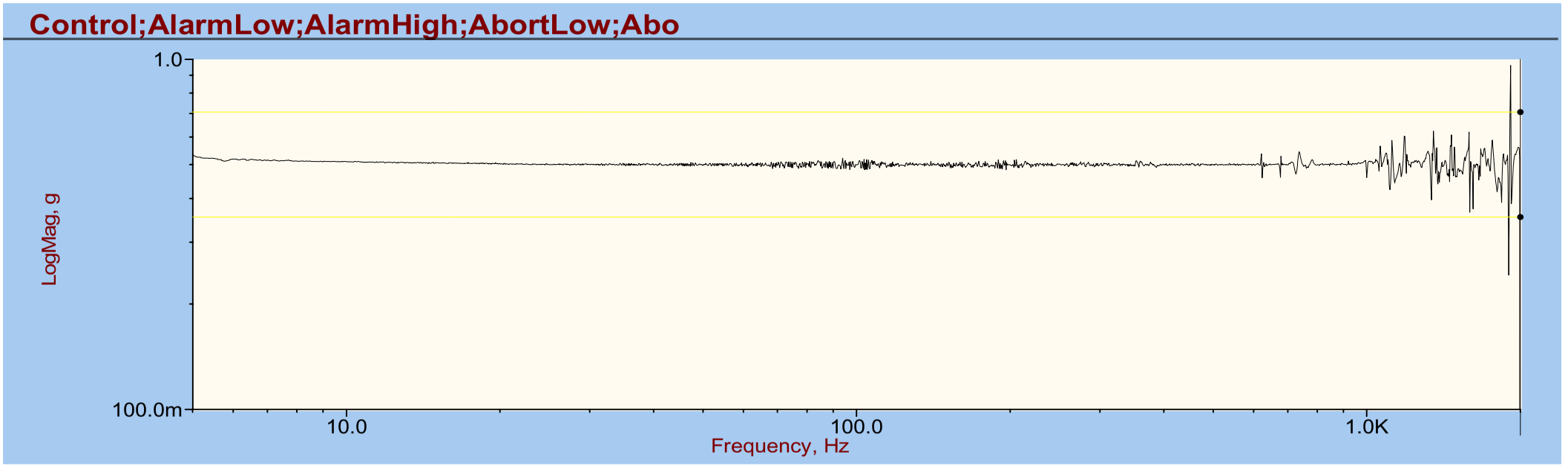


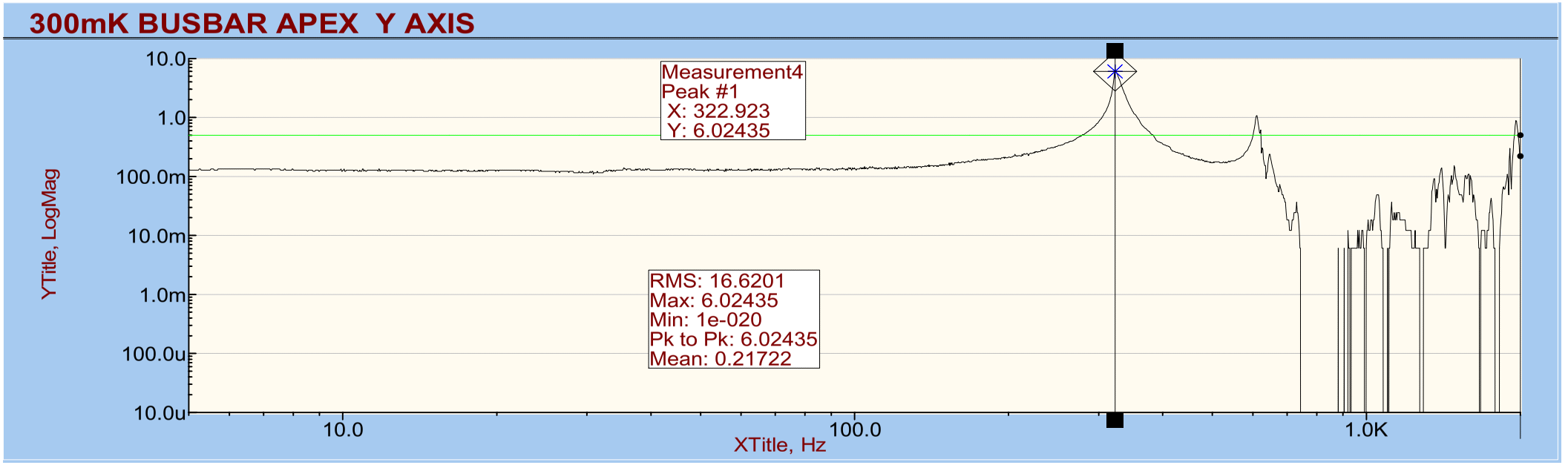




BSM AND 300mK COMPONENTS RANDOM AMBIENT/ATMOSPHERIC TESTING
RUN 00001
Y AXIS
19:50:47 04/02/2003

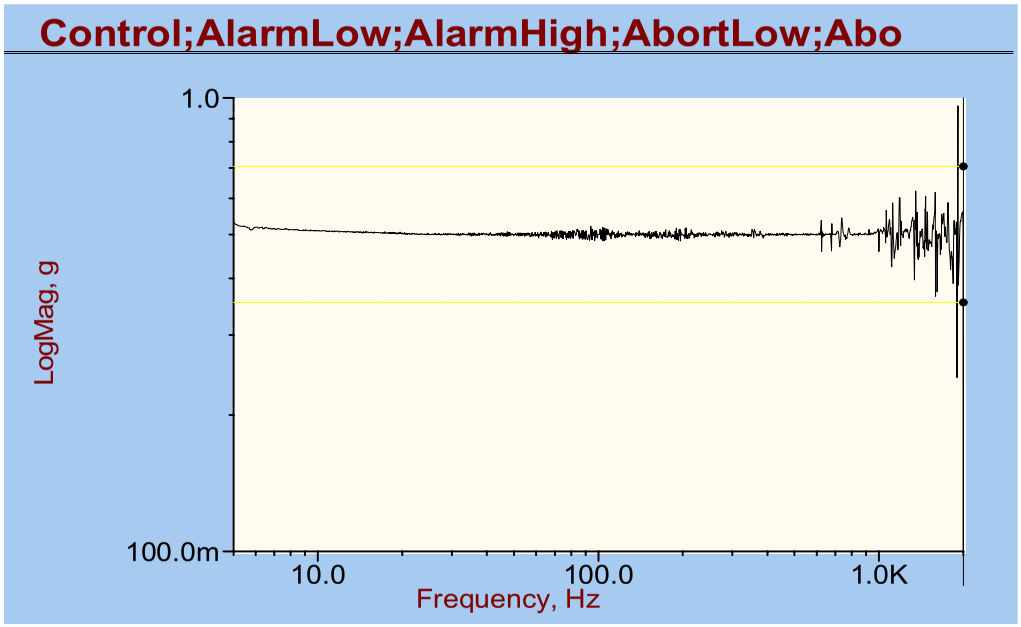
Fig 3b

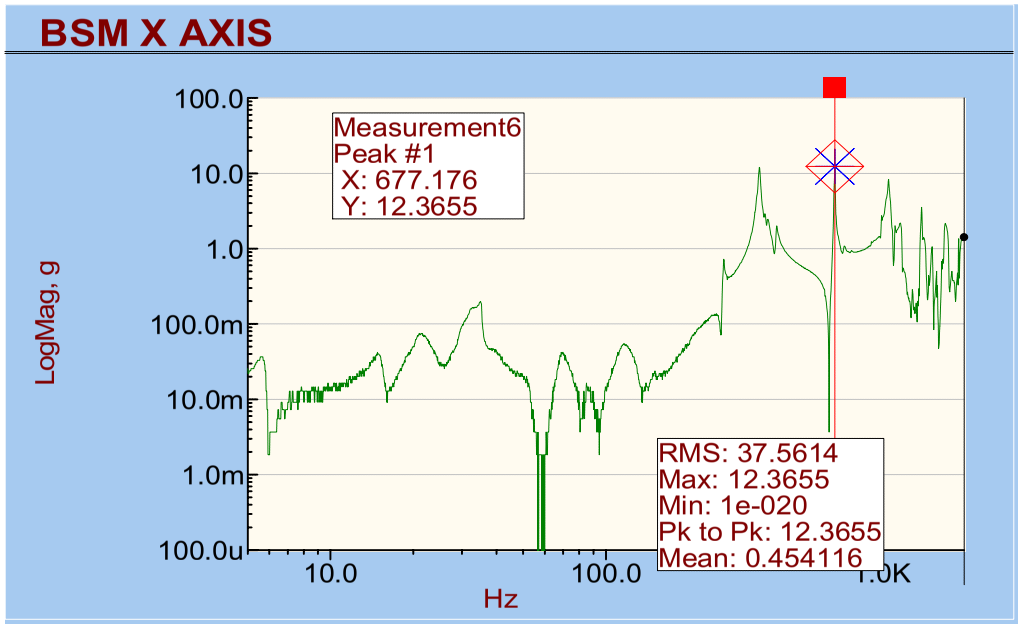


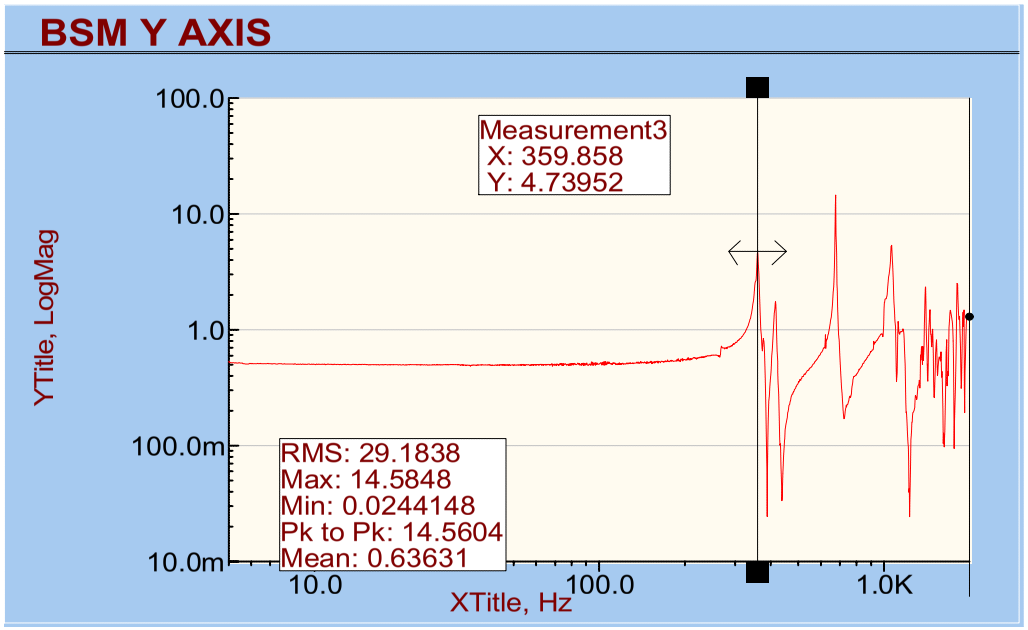


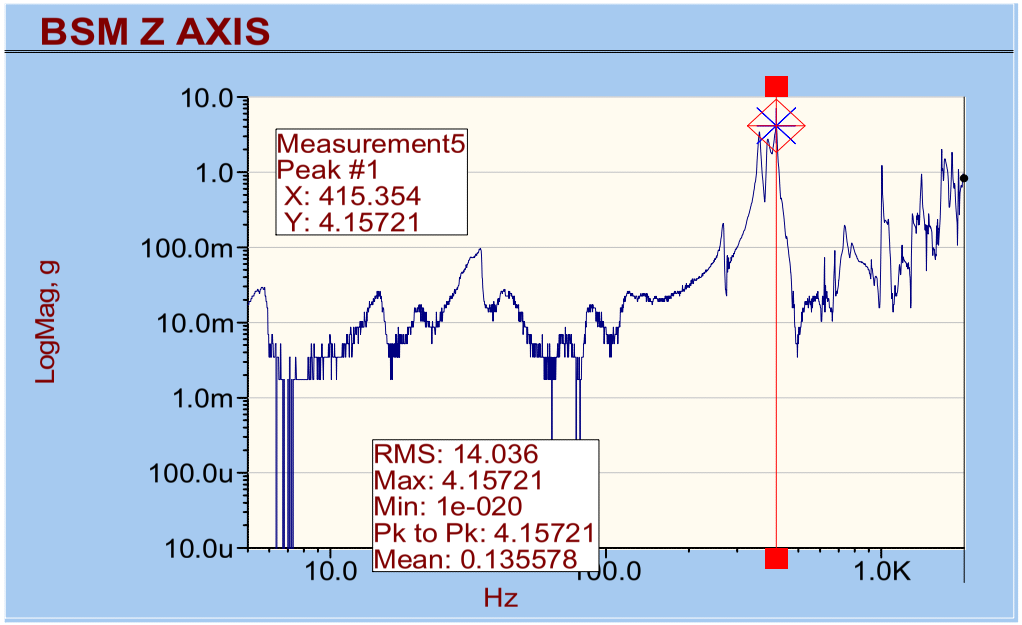
BSM AND 300mK COMPONENTS POST RANDOM SINE SURVEY AMBIENT/ATMOSPHERIC TESTING
RUN 00006
Y AXIS
19:55:48 04/02/2003

Fig 4a



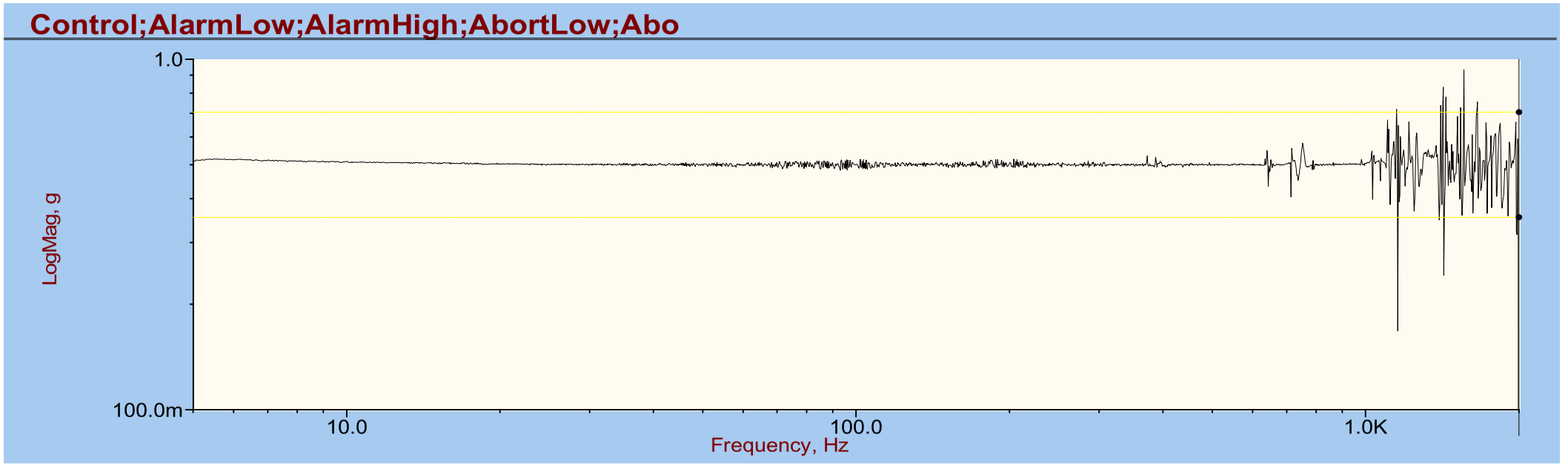


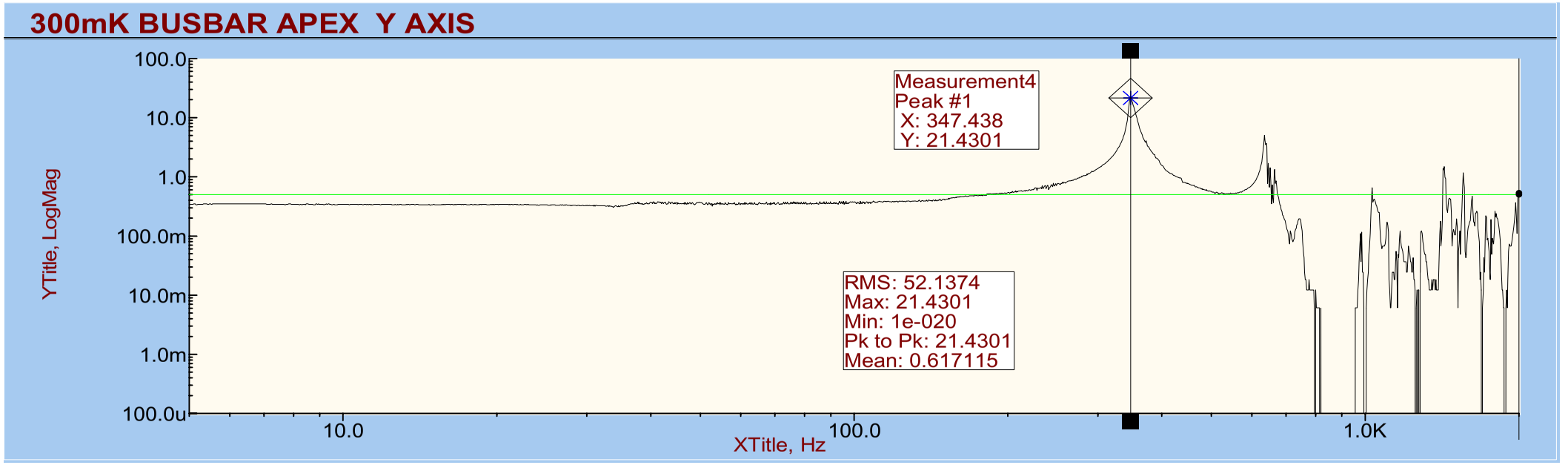




BSM AND 300mK COMPONENTS POST RANDOM SINE SURVEY AMBIENT/ATMOSPHERIC TESTING
RUN 00006
Y AXIS
19:55:48 04/02/2003

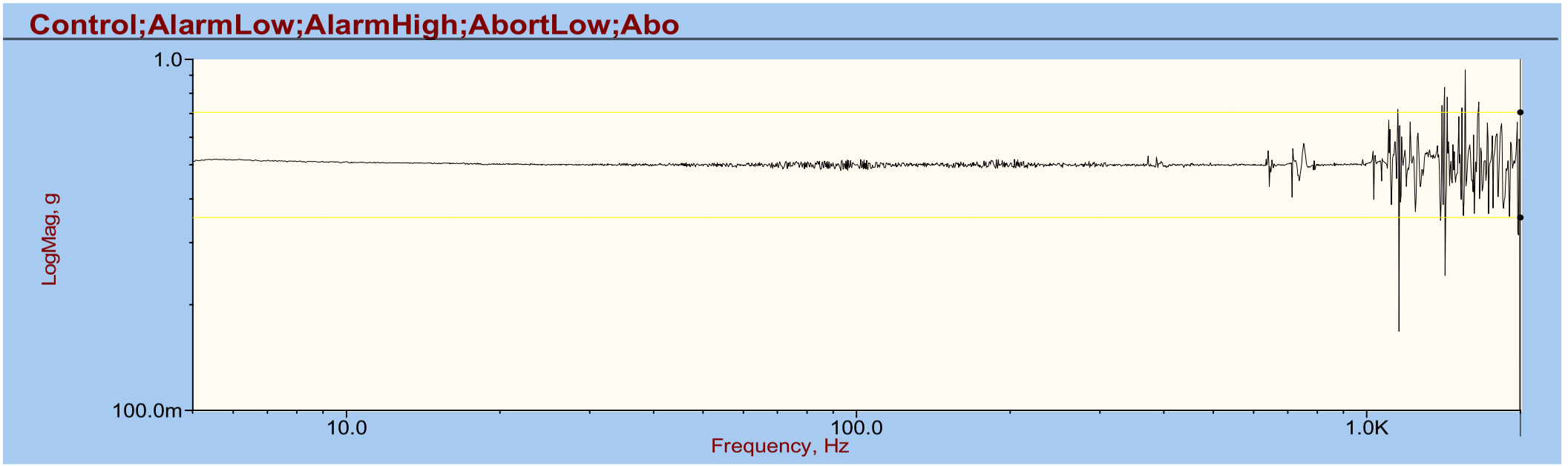
Fig 4b

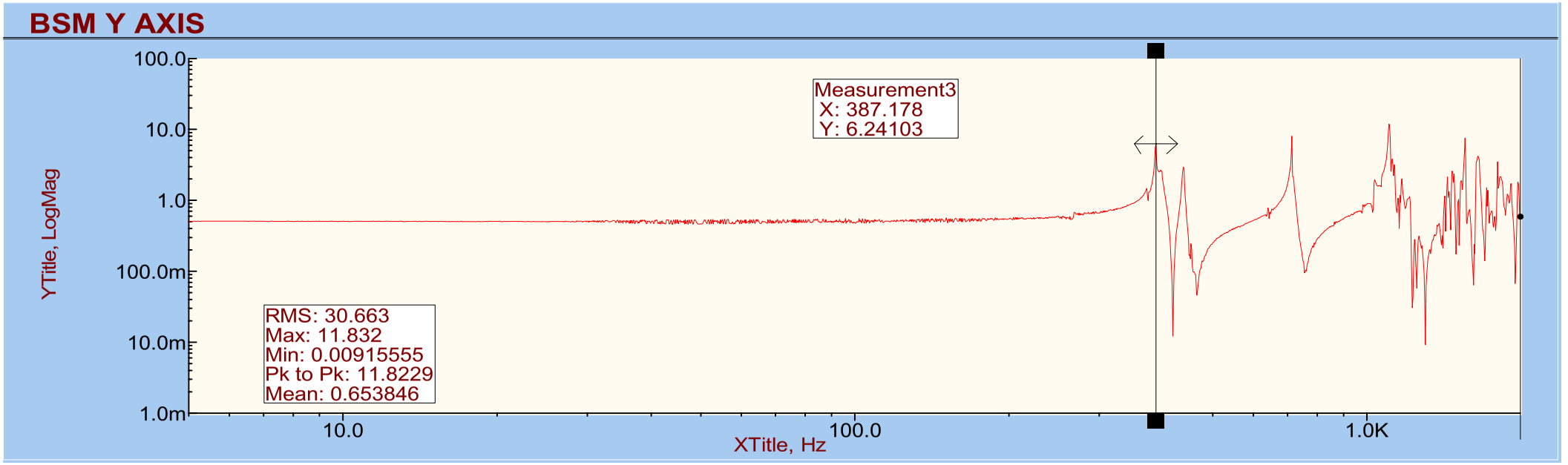




BSM AND 300mK COMPONENTS SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00007
Y AXIS
17:30:47 05/02/2003

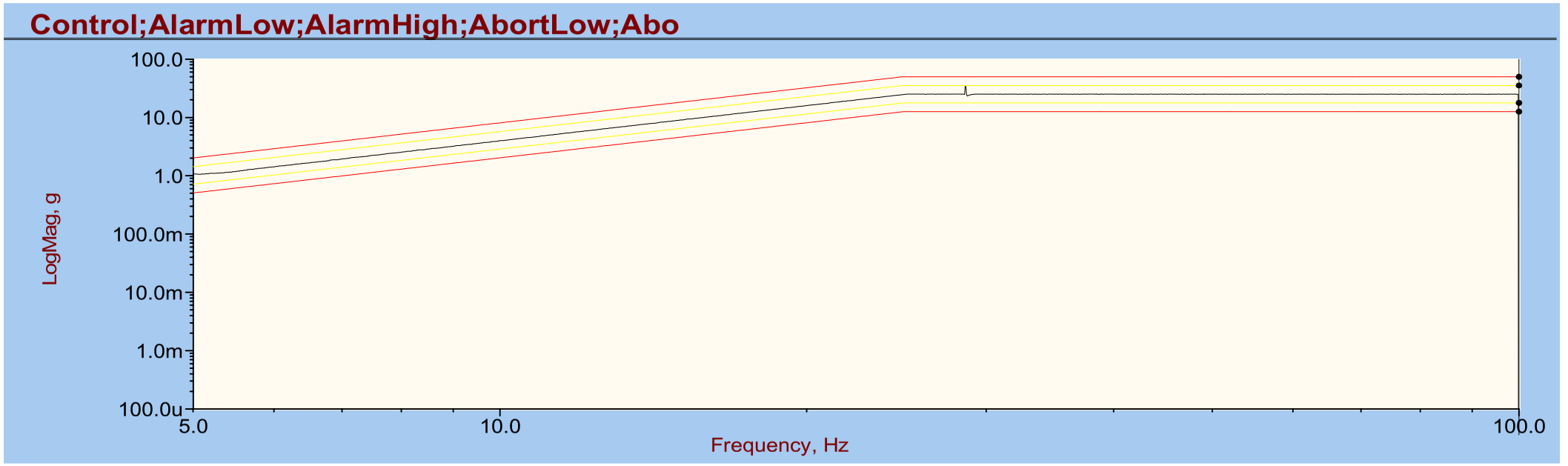
Fig 5a

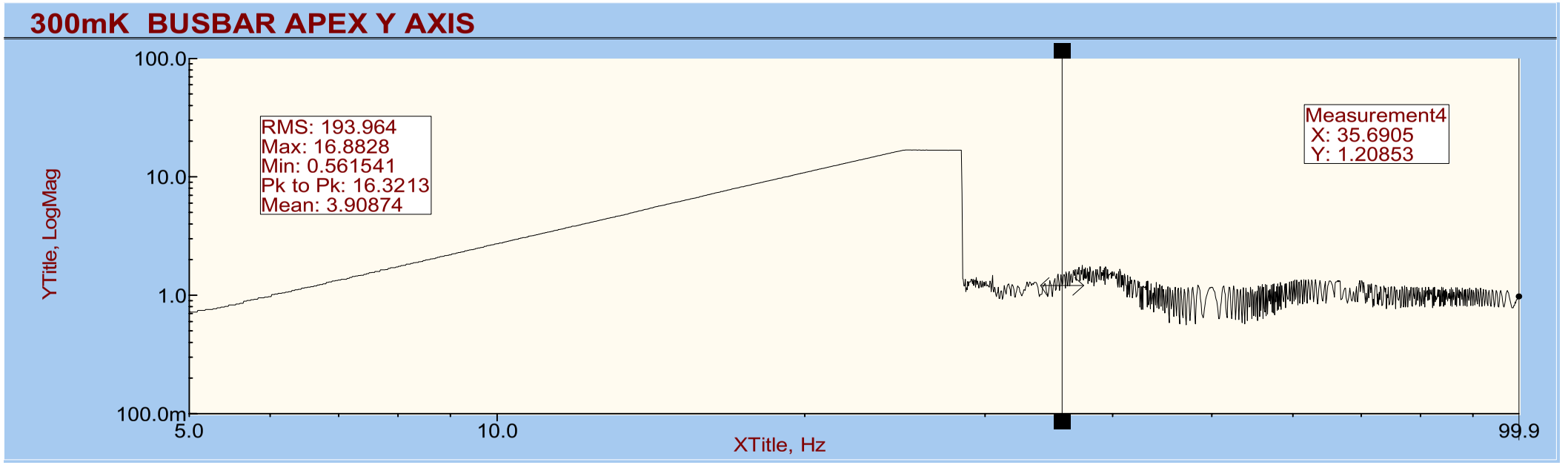




BSM AND 300mK COMPONENTS SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00007
Y AXIS
17:30:47 05/02/2003

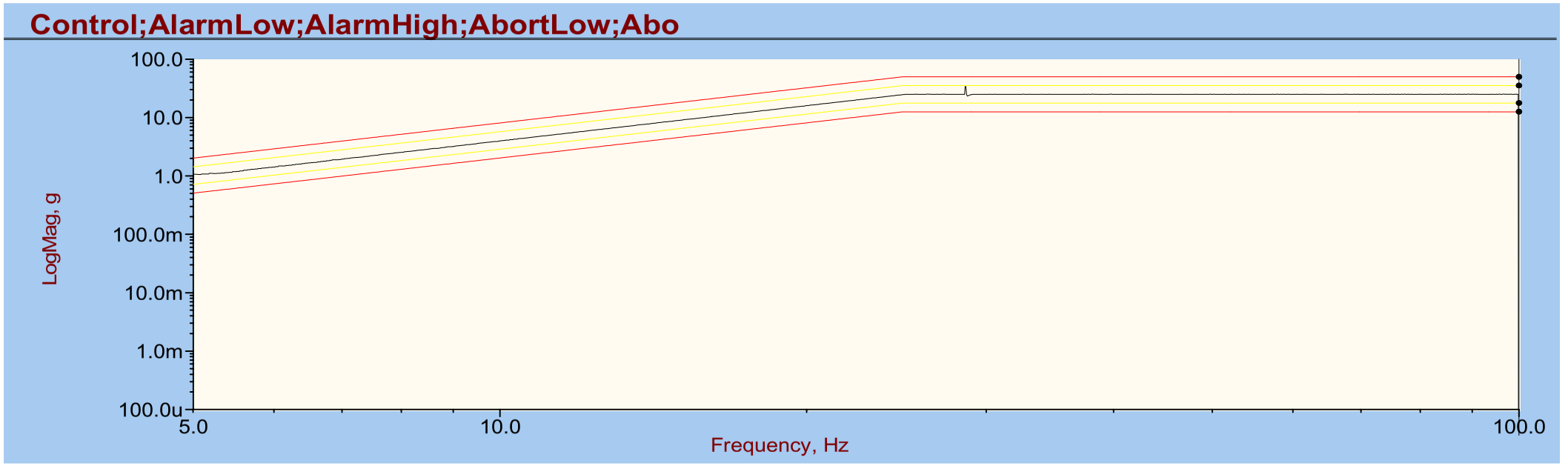
Fig 5b

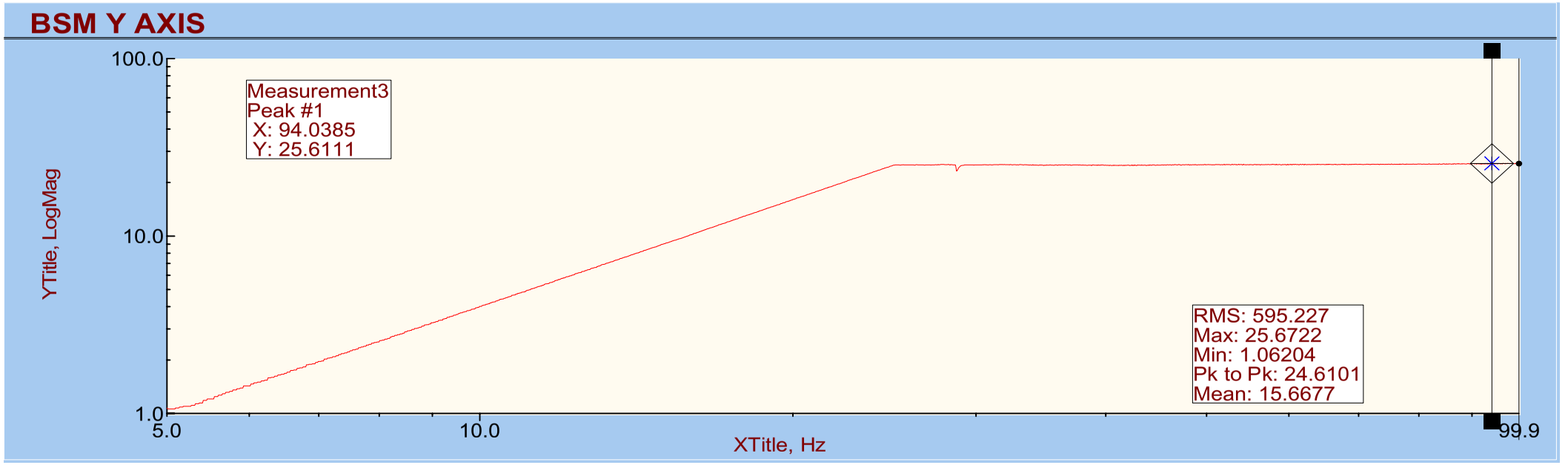




BSM AND 300mK COMPONENTS SINE SWEEP TEST MASS AT 10 KELVIN
RUN 00002
Y AXIS
17:41:29 05/02/2003

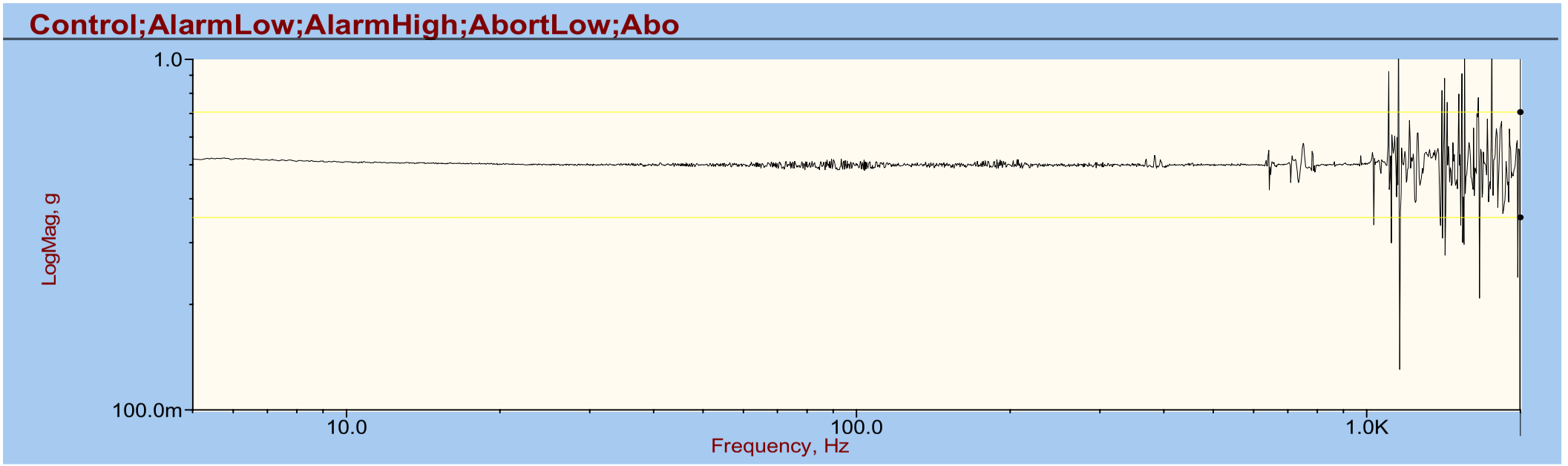
Fig 6a

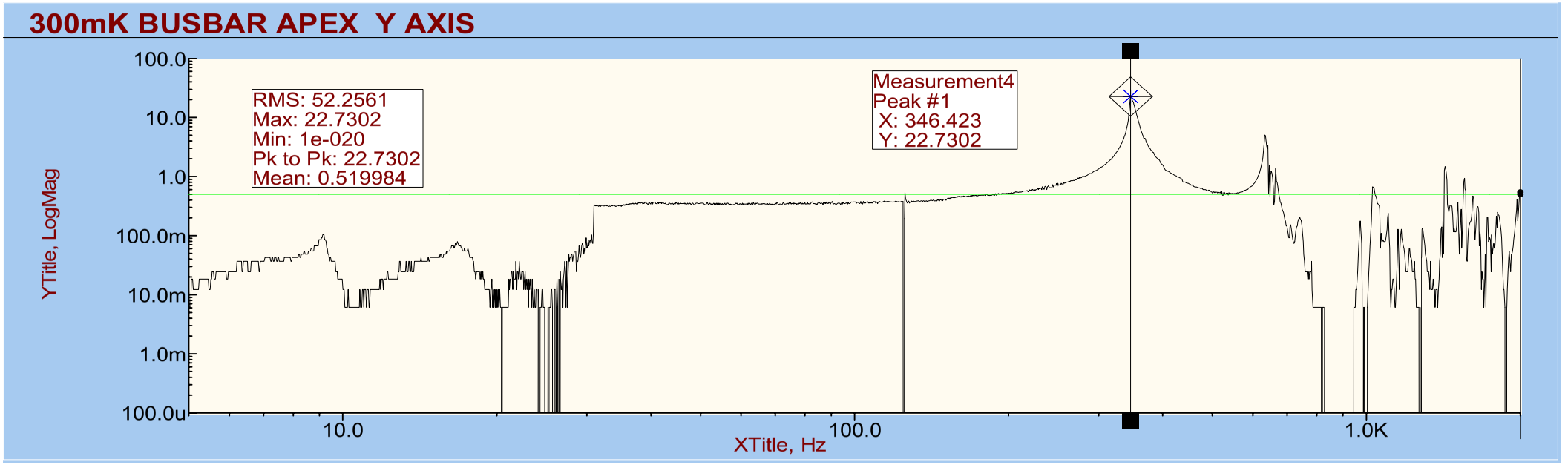




BSM AND 300mK COMPONENTS SINE SWEEP TEST MASS AT 10 KELVIN
RUN 00002
Y AXIS
17:41:29 05/02/2003

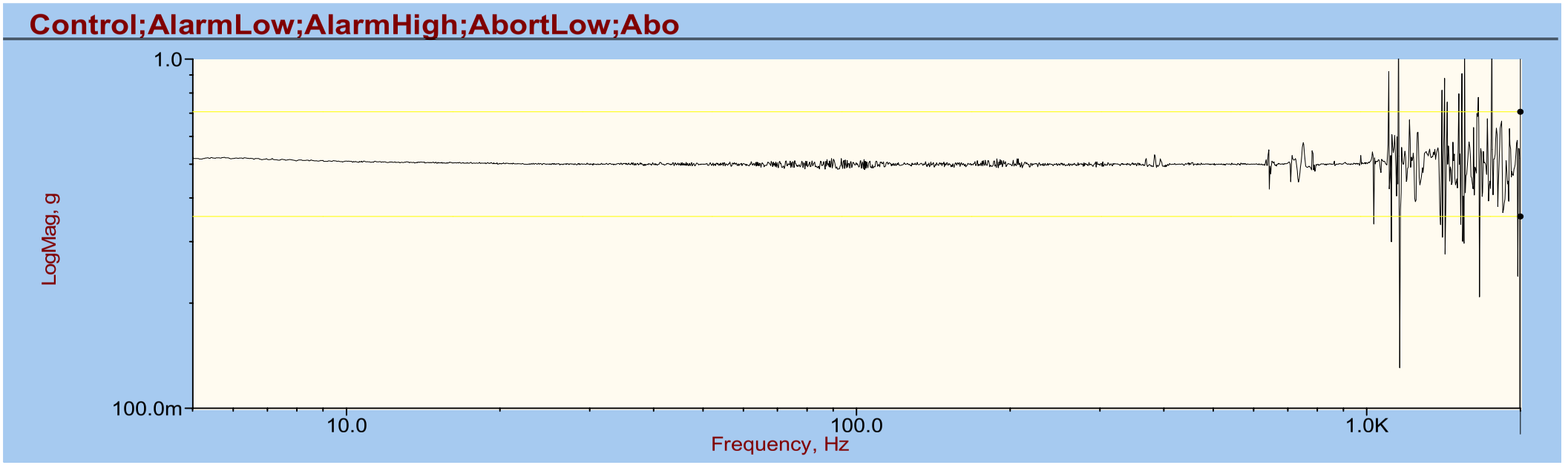
Fig 6b

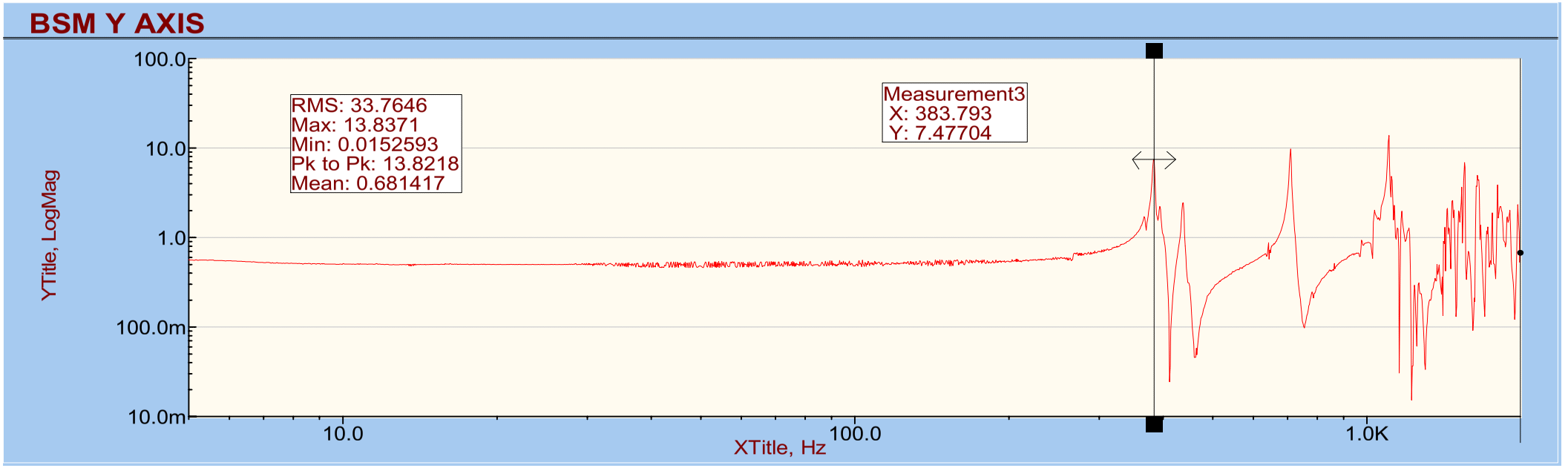




BSM AND 300mK COMPONENTS POST SINE SWEEP SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00008
Y AXIS
17:48:26 05/02/2003

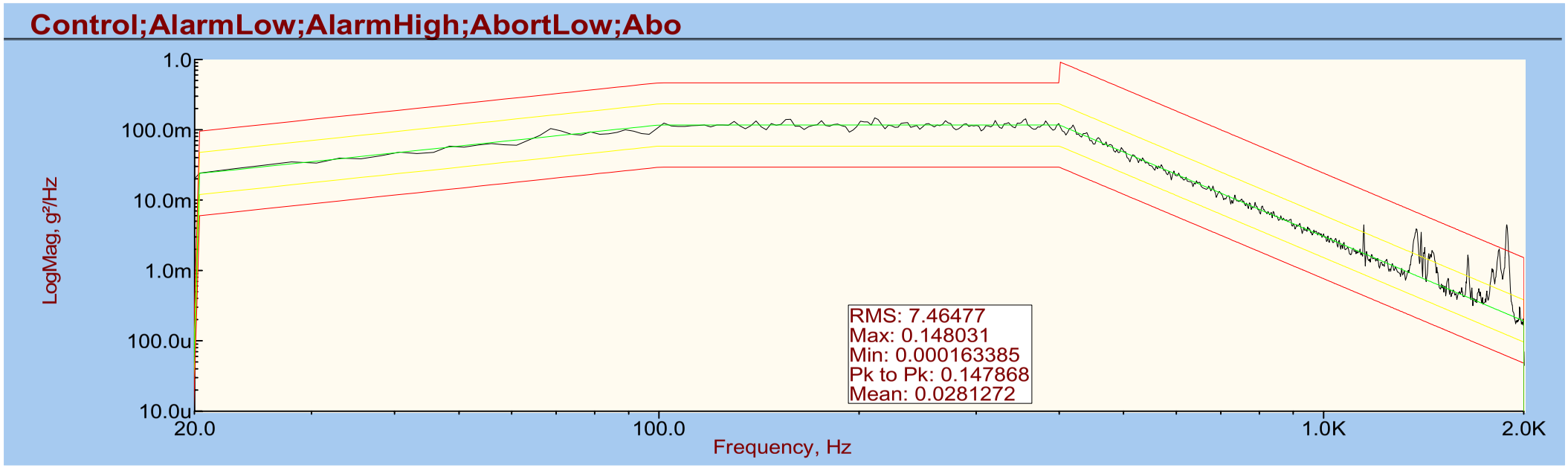
Fig 7a

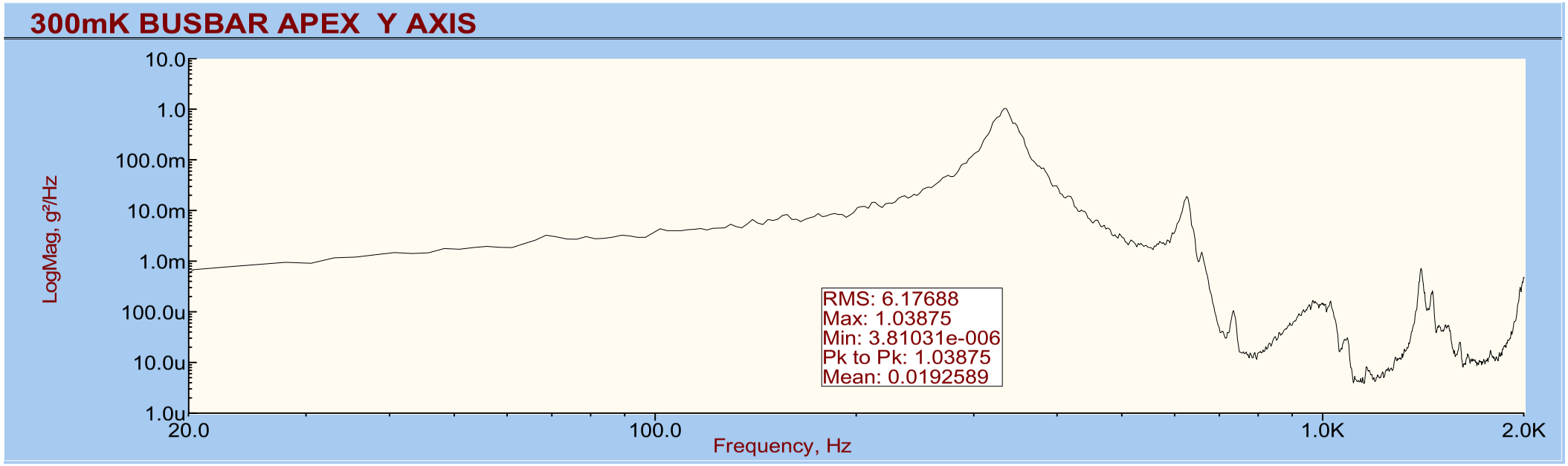




BSM AND 300mK COMPONENTS POST SINE SWEEP SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00008
Y AXIS
17:48:26 05/02/2003

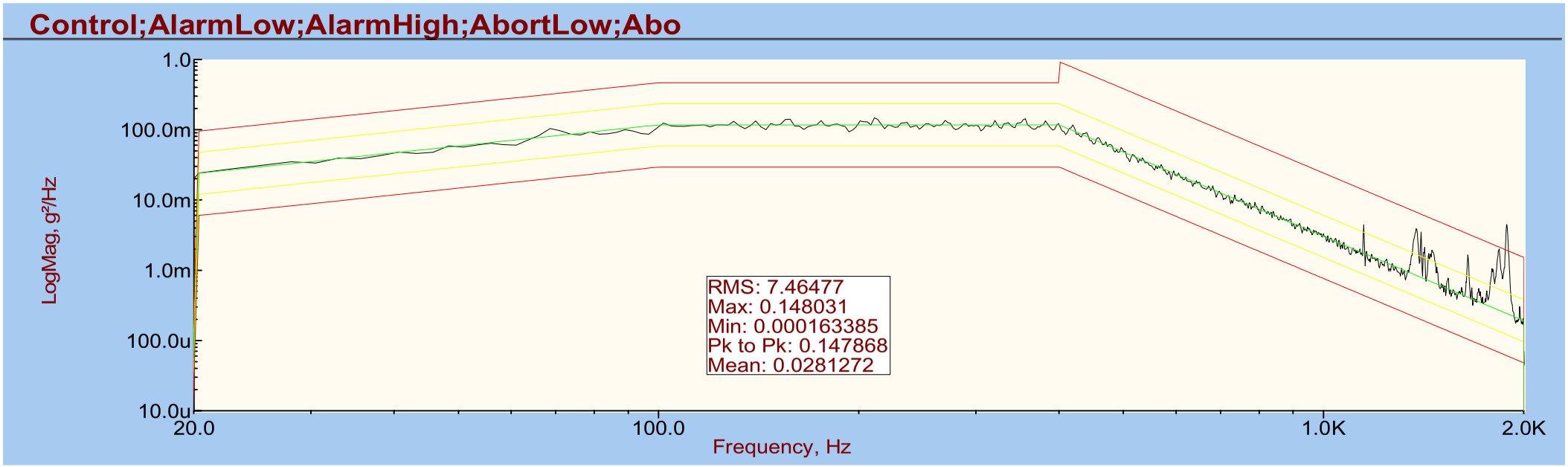
Fig 7b

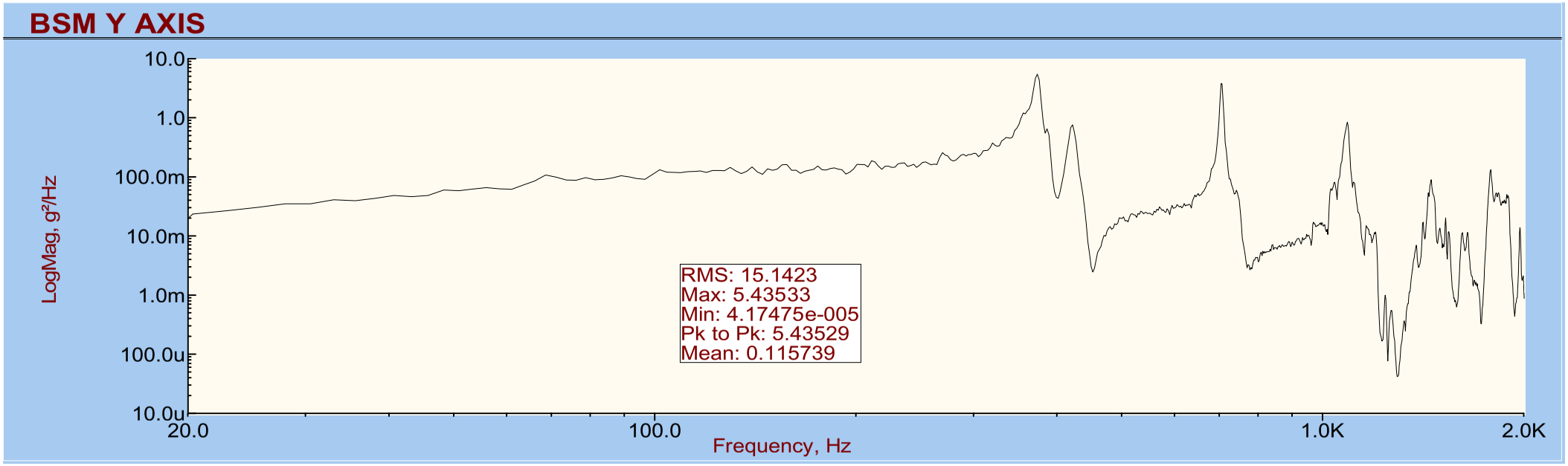




BSM AND 300mK COMPONENTS RANDOM TEST MASS AT 10 KELVIN
RUN 00002
Y AXIS
17:59:07 05/02/2003

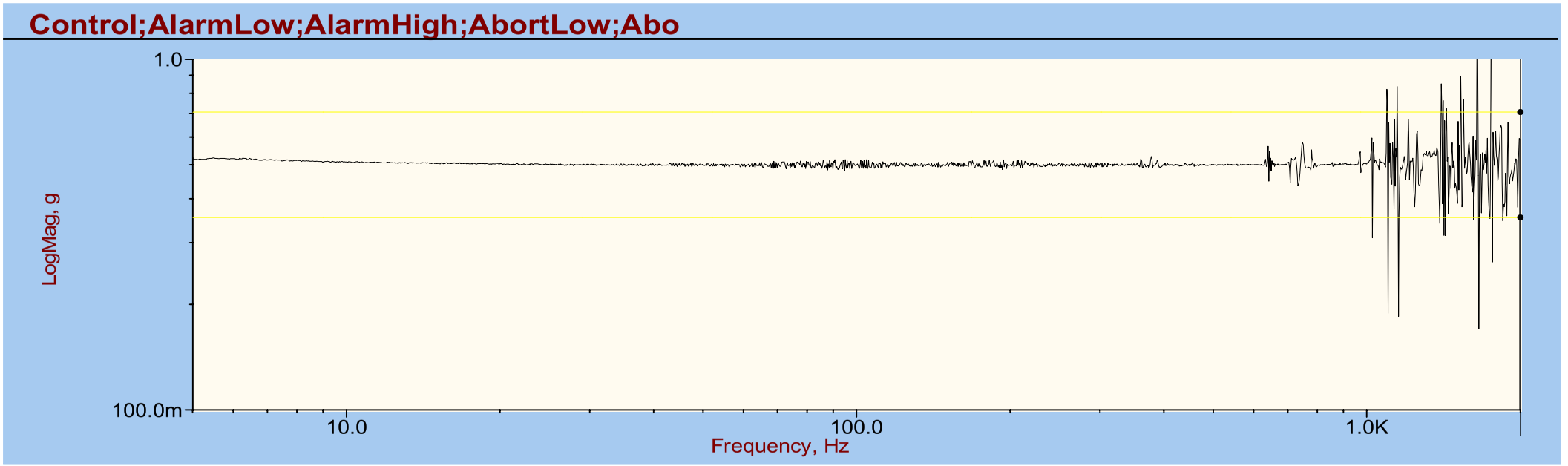
Fig 8a

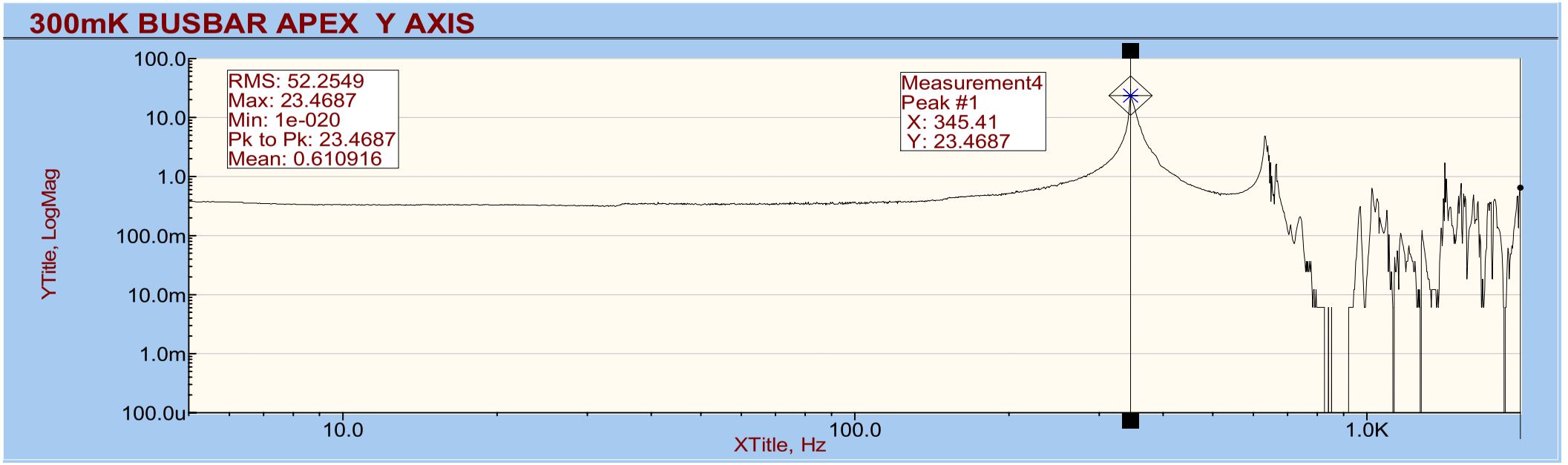




BSM AND 300mK COMPONENTS RANDOM TEST MASS AT 10 KELVIN
RUN 00002
Y AXIS
17:59:07 05/02/2003

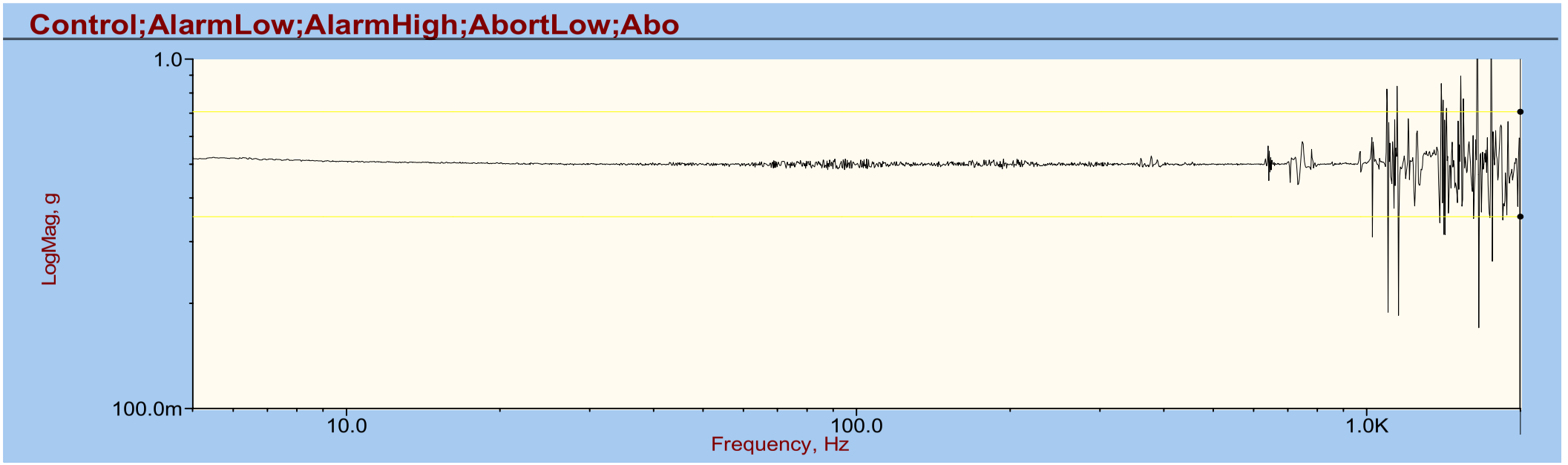
Fig 8b

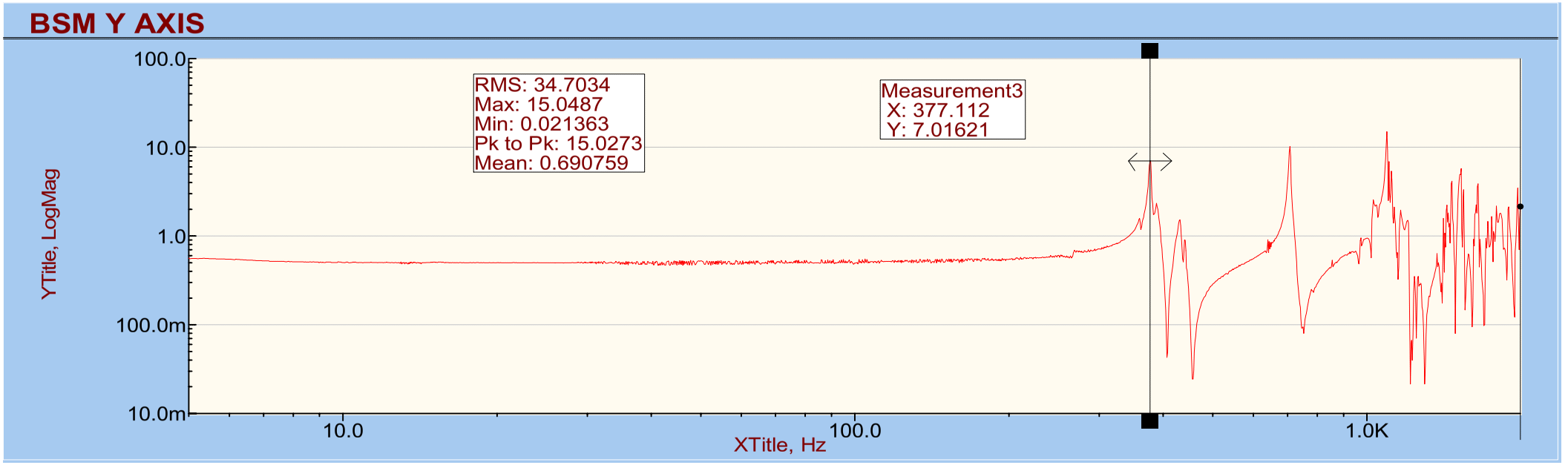




BSM AND 300mK COMPONENTS POST RANDOM SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00009
Y AXIS
18:03:49 05/02/2003

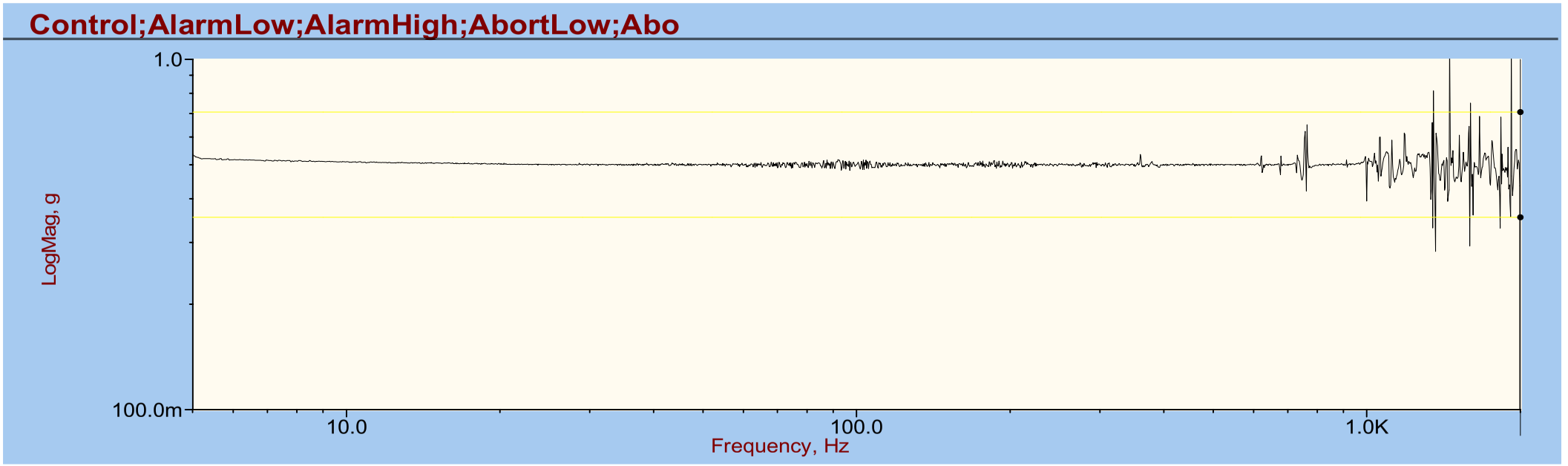
Fig 9a

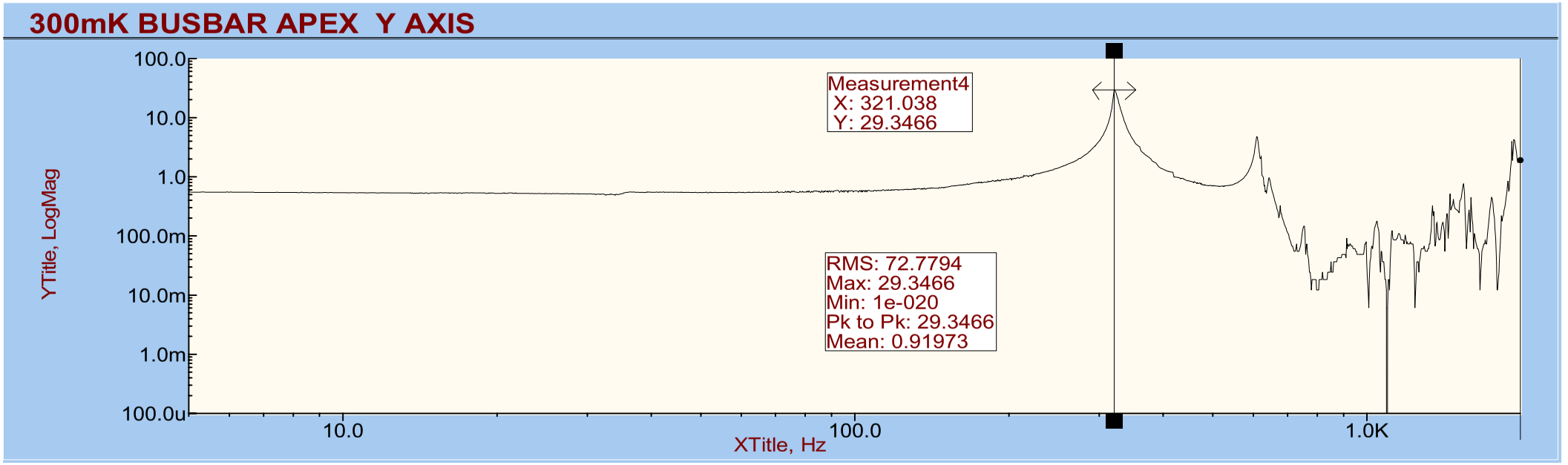




BSM AND 300mK COMPONENTS POST RANDOM SINE SURVEY TEST MASS AT 10 KELVIN
RUN 00009
Y AXIS
18:03:49 05/02/2003

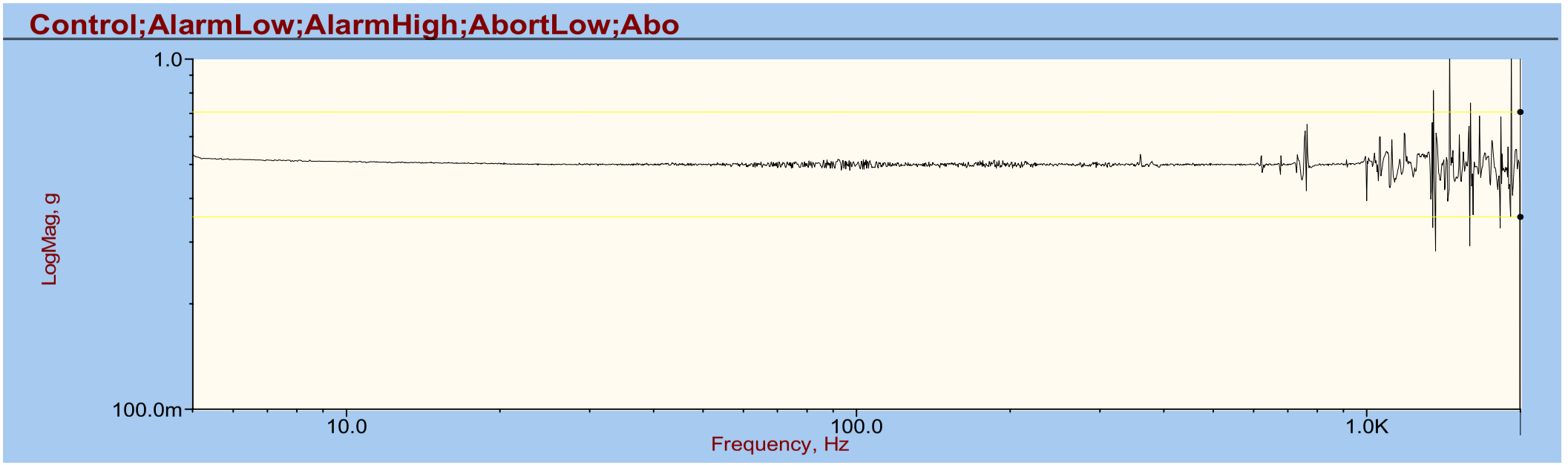
Fig 9b

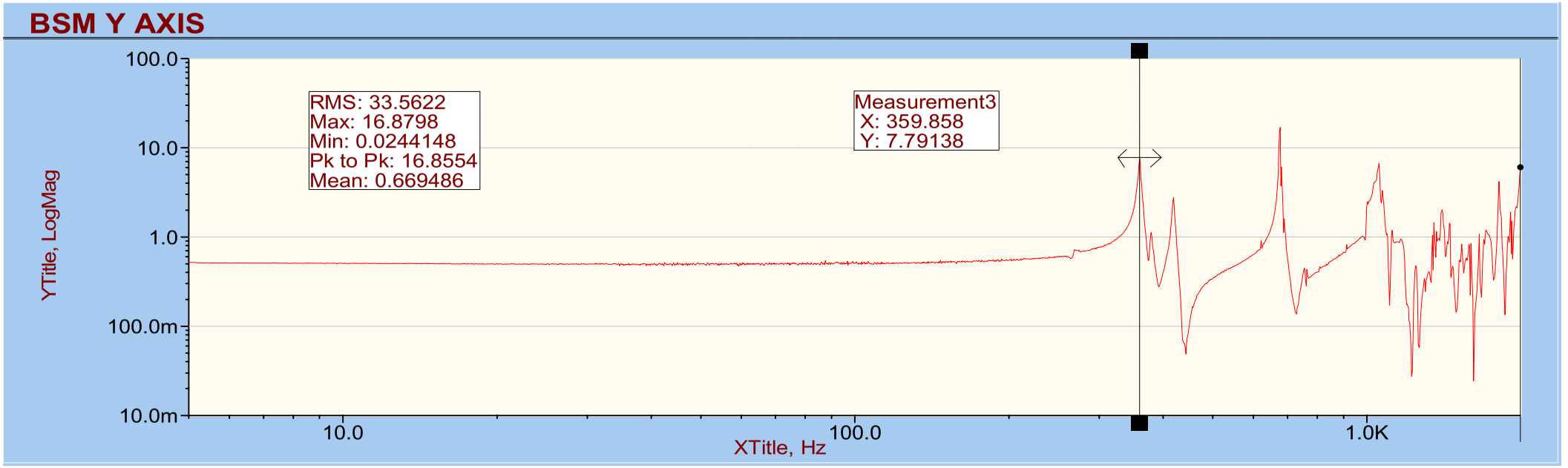




BSM AND 300mK COMPONENTS SINE SURVEY TEST MASS UNDER VACUUM AT AMBIENT
RUN 000011
Y AXIS
09:55:58 06/02/2003

Fig 10a

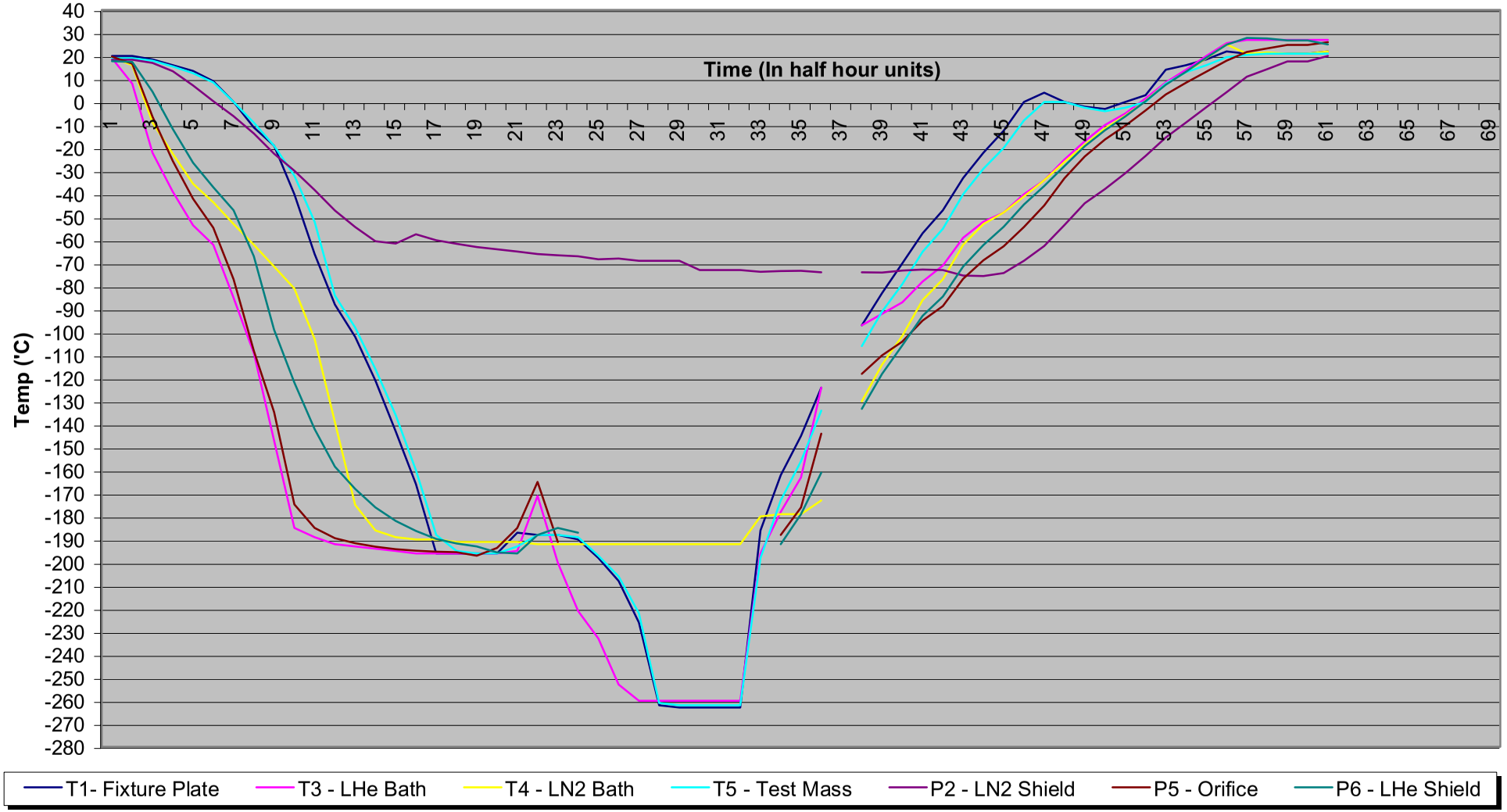




BSM AND 300mK COMPONENTS SINE SURVEY TEST MASS UNDER VACUUM AT AMBIENT
RUN 000011
Y AXIS
09:55:58 06/02/2003

Fig 10b

BSM 300mK Components Cooldown/Warmup Data



UK Astronomy Technology Centre

SPIRE Project

INSPECTION Record

PART Description: BSM DM-2 (After Cold-shake at RAL) 14/02/03

DWG No..... version .....

Source

ATC Workshop ☐ Free issue ☐ Bought in ☐

Work Ref Number..... From..... PO Number .....

Details .....

.....

Summary of checks performed

Quantity Count ☐ .....OK .... Short .....Defective

Material: ☐ Finish: ☐ Dimensions ☐ Mass: ..... Serial # Marking: ☐

Conformance Certificate: ☐ Cleanliness Certificate ☐ Other ☐

NOTES (continue on additional sheets, or marked on manufacture drawings as required)

SUGGESTED CHANGES

.....

.....

.....

.....

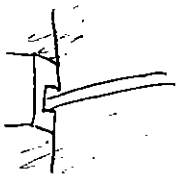
Raised NCR ☐ Number ..... Raised CTD ☐ Number .....

INSPECTOR Ian Lain, with David M'Neill recording. DATE 14/02/03

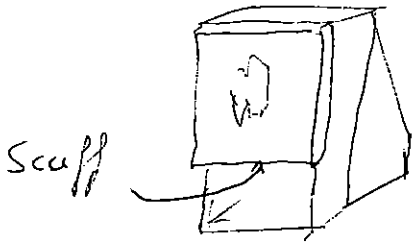
Check of DM-2

* Minor scuffing of interface shoe bolt hole-faces where it was tightened down to the bench at RAL.

* Flexitape clamp - pins visible on upper clamp.
* Flexitape looks as though it is rubbing on side on the way out of the clamp.
(Was same when we sent it)



* bottom right-angle of baffle scuffed where ~~stiffen~~ heat-leaf scuffed it on bolting to cryostat at ATC.



Removing baffle. (Loosening Torques)

Top left	180 N.mm
Bottom left	190 N.mm
Top right	110 N.mm
Bottom right	240 N.mm.

* Magnetic debris on bottom chop sensor - bridging gap. (May have been there before we sent it down)

Removing EMC Sheild (Rear).
(Loosening torques).

bot. left	220 N.mm
top left	220 N.mm
bot right	220 N.mm
Top right	200 N.mm.

A few bits of debris in EMC Cavity (Al?)

D.H. McNeill

Check of DM-2 (Cont'd)

Plastic P-Clips !??! in EMC Cavity.

Feed-thro into EMC Cavity for lower left jiggle Motor (#00441) : wires are against sharp edge on hole. (Could cut into wire).

Cernox Thermometer wire not taped down with capton tape (as photos of 'before' shake indicate).

Key Measurements:

Bottom gap between jiggle frame and pivot clamp : 0.7 mm
0.75 will not go.

Top gap " " : 0.4 mm
0.5 will not go.

LHS of chop axis (between jiggle sensor and actuator) : 015 mm (tight).

Chop sensor spacing top : 0.15 mm goes
0.2 goes. (tight).

bottom : 0.15 mm.

---

* hole, or tear in bottom chop motor wire heat-shrink. This is where the wire goes through the hole in the back-wall of the structure.

Check Shows no unacceptable wear and no movement of components.

Unit still operates perfectly well under power.