ALCATEL
SPACE

HERSCHEL / PLANCK

Planck satellite CQM Acoustic test report
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ENREGISTREMENT DES EVOLUTIONS / *CHANGE RECORDS*

ISSUE	**DATE**	**§ : DESCRIPTION DES EVOLUTIONS** ***§ : CHANGE RECORD***	**REDACTEUR** ***AUTHOR***

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1. INTRODUCTION

The Planck CQM acoustic tests have been performed from 14/10/2004 to 22/10/2004 in Cannes Alcatel facilities. One of the main objective of this test was to inject realistic random loads on the HFI structure. During previous sub-system campaigns HFI FPU STMs, the critical part of HFI had been identified as the struts between 4K and 1.6K stages, which have been instrumented with strain gauges for this test. However, the HFI STM was not completely flight representative, and especially did not contain the Air Liquide cooler (see ch. 8.1).

This test sequence (called CQMA"2") followed a first test sequence performed in August 2004 in the same facilities, which had been stopped after one unique run at –15dB, due to an obvious weakness identified on the LFI FPU MTD links, not compatible with the levels to be passed on higher level runs. It had then been decided to improve accordingly the LFI FPU MTD design.

The CQMA test sequence described in this report includes this new LFI FPU design. The other configuration differences for this second sequence wrt the first sequence is the presence of PR and SR, whereas CSAG dummies had been used for the first sequence (see RD 1 and RD 2).
The first sequence results (-15dB run) are available at Alcatel test facilities. They are not part of this report, since better information, in a more realistic configuration, is given with the second sequence. However, a description of the outcome of this first sequence in given in minute H-P-ASP-MN-5262.

Despite remaining concerns on FPU links, which have been carefully checked thanks to the use of strain gauges on LFI FPU struts, a – 6dB run (140.5 dB overall) has been passed successfully on the structure.

2. REFERENCE DOCUMENT

Ref.	*No.*	*Issue/date*	*Title*
RD 1	H-P-3-ASP-TS-0728	Iss. 1	Planck satellite CQM acoustic test specification
RD 2	H-P-3-ASP-TS-0728	Iss. 3	Planck satellite CQM acoustic test specification
RD 3	TR-PHED-400320-AIRL	26/04/2004	FPS vibrations test report
RD 4	SCI-PT-IIDA-04624	Iss. 3.3	Herschel/Planck interface document
RD 5	TR-PHCBB-400138-IAS	Iss. 1	Vibration test report on Bellow and support on the PR panel
RD 6	TN-PH242-400081-IAS	Iss. 1	Specification on acoustic levels for the HFI FPU
RD 7	Draft AN-PH243-XXXX-IAS	08/12/2003	Mechanical coupled study on HFI and LFI FPU
RD 8	AN-PHEC-400296-AIRL	07/04/2004	DCP/PPLM sub-system structural analysis report
RD 9	PL-LFI-LAB-RP-021	18/06/2004	RAA mechanical analysis

3. TEST CONFIGURATION

The test configuration and instrumentation is described in document RD 2. Main items are recalled hereafter :

The Planck CQM Acoustic (CQMA) test model is composed of 2 main parts :

- The PPLM (cryo-structure+telescope) QM model, delivered by ALCATEL (sub-contracted to CSAG)
- The SVM dummy not "thermally" equipped, delivered by ALCATEL (sub-contracted to APCO). The VIS lower ring is closed by a dedicated tool plate. The sub-platform central hole is closed by an SLI.

The PPLM QM model is equipped with the following equipment :

- CQM PACE on +Y side delivered by JPL
- Primary reflector QM delivered by Astrium
- Secondary reflector QM delivered by Astrium
- LFI FPU MTD delivered by ALCATEL (sub-contracted to LABEN), which is structurally flight representative at that time (STM) – updated links design was then implemented wrt July 2004 delivery
- HFI FPU mechanical model delivered by HFI/ESA

Simple mass dummies are manufactured by ALCATEL for the following parts :

- PACE for -Y side : MD on V-grooves and FPU
- Upper WG support structure : MD on PR panel
- Pipes 0.1K and 4K : MD on V-grooves and lower beam
- Bellow : MD on PR panel
- JFET : MD on PR panel (with I/F blades)
- BEU and PAU boxes : MD on sub-platform

The figure hereafter recalls the test configuration and the microphones position :

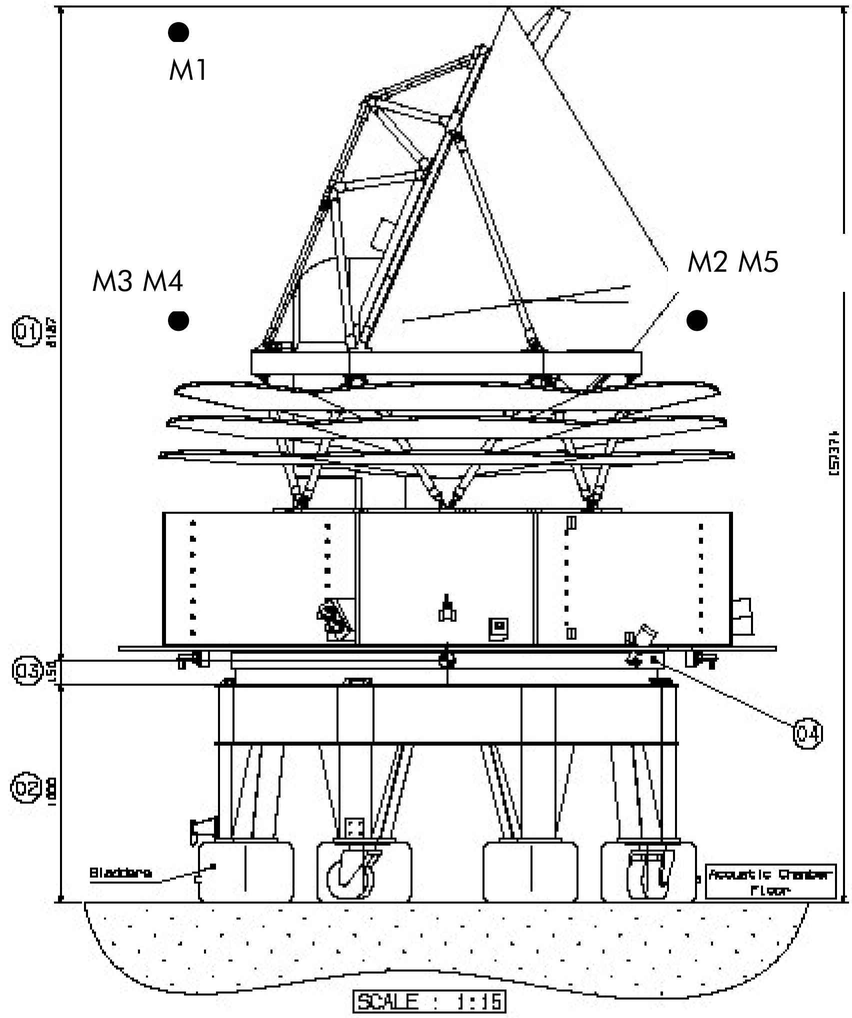


Figure 1 : acoustic test configuration – microphones position

4. LFI FPU LINKS LOADS RECOVERY

Following the LFI FPU MTD delivery in July 2004, and the CQMA test first sequence in August 2004, it has become obvious that the LFI FPU links were under-sized and would not support specified acoustic loads (see H-P-ASP-MN-5269). As a consequence, it has been decided :

- to improve the LFI FPU STM links design (see H-P-ASP-MN-5323, H-P-3-ASP-TR-0830)
- to implement strain gauges on LFI FPU struts in order to assess during the test the loads for the 4 types of links between main frame and PR interface (see RD 2)

The way these strain gauges have been used during the test is described hereafter.

4.1 LFI FPU links loads calculation methodology

All critical links have been verified thanks to the strain gauges data, using the following formula :

4.1.1 Sketch of the strut

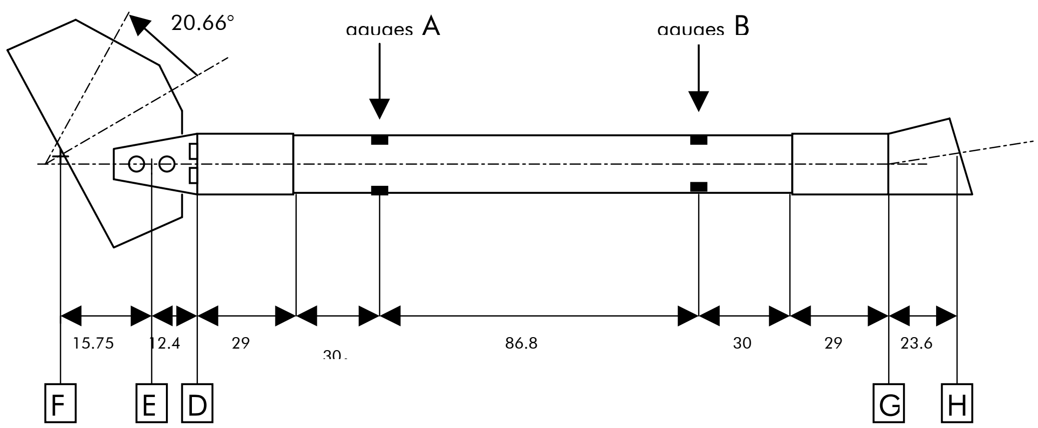


Figure 2 : strain gauges location

4.1.2 Axial force in the strut

Hypothesis: thickness << tube diameter
1.75 mm << 31.75 mm

$$F_a = E.\pi.D.e.\varepsilon \qquad \text{(Eq. 1)}$$

with

F_a = axial force
E = Young modulus
D = beam diameter
E = beam thickness
ε = strain gauge measurement (average of the 2 strain gauges measurements)

4.1.3 Bending moment in the strut

Hypothesis are the same as for the axial force

$$M_b = E.S.\frac{R}{2}\Delta\varepsilon \qquad \text{(Eq. 2)}$$

with

Mb = bending moment
E = Young modulus
S = working section of the beam = 2.π.R.e
R = radius of the beam
$\Delta\varepsilon$ = difference between the measurement of the two gauges of the same section = $\varepsilon_2 - \varepsilon_1$

4.1.4 Calculation of the shear force in the strut

Hypothesis: linear variation of the bending moment along the strut x axis

The bending moment is measured with the gauges at two different locations.

$$F_{shear\ A} = \left(\frac{\partial M_b}{\partial x}\right)_A \qquad \text{(Eq. 3)}$$

with

$F_{shear\ A}$ = shear force in the beam

$$F_{shear\ A} = \frac{M_{b\,A} - M_{b\,B}}{x_A - x_B} \qquad \text{(Eq. 4)}$$

With the previous assumptions, we have a constant shear force in the whole beam. The axial force is also constant in the beam.

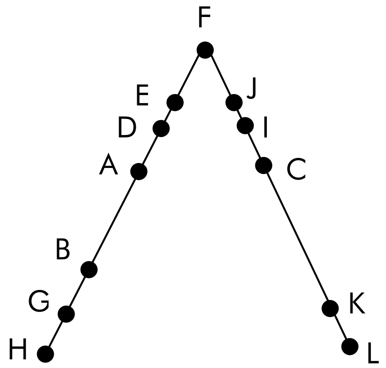
4.1.5 Calculation of the bending moment at a different location (point D for instance)

$$M_D = M_A + (x_D - x_A).F_{shear\ A} \qquad \text{(Eq. 5)}$$

4.1.6 Calculation of the shear force in the second strut

$$F_{shear\ C} = F_{shear\ A}.\frac{M_{b\,C}}{M_{b\,A}} \qquad \text{(Eq. 6)}$$

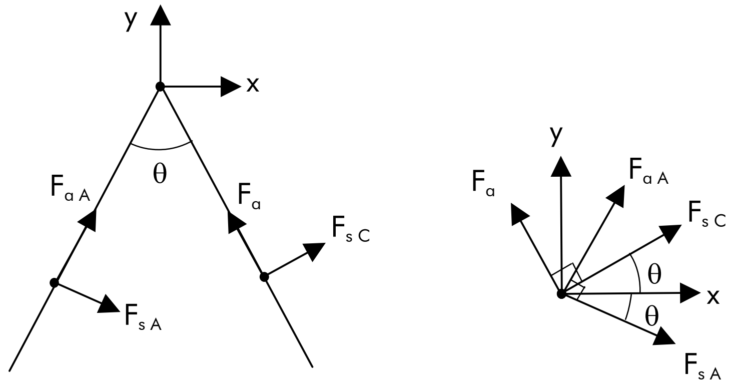
4.1.7 Sketch with the locations of the struts links



Detailed locations of the links are shown at Fig. 1.
Gauges are at the location: A, B and C.
D, G, I and K are links of the same type: brackets/strut (D-type link).
E and J are identical links: bracket/bracket (E-type link).
F is a unique link.
H and L are identical links: bracket/panel (H-type link).

4.1.8 Calculation of the shear force and tension in the screws of link F

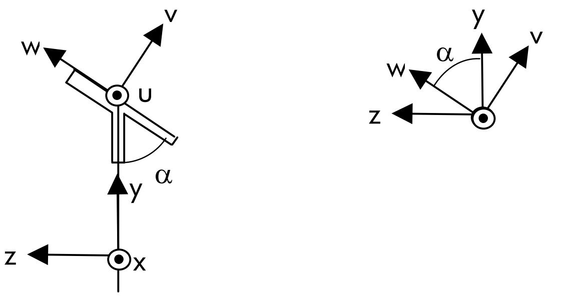
This requires the sum of the contribution of the 2 struts and projection of the force components in different coordinates systems.



$F_x = \sin\theta.(F_{a A} – F_{a C}) + \cos\theta.(F_{s A} + F_{s C})$

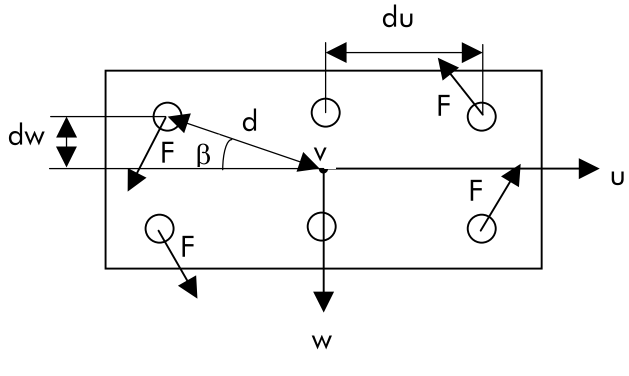
$F_y = \cos\theta.(F_{a A} + F_{a C}) + \sin\theta.(-F_{s A} + F_{s C})$

The second step is to project Fx, Fy and Mz is the local coordinates system of the bracket shown on the following sketch.



$F_v = \sin\alpha.F_y$
$F_w = \cos\alpha.F_y$
$M_v = -\cos\alpha.M_z$
$M_w = \sin\alpha.M_z$

The locations of the 6 screws on the bracket is shown below together with the hypothesis for the force distribution between the screws.



$D_{UW} = sqrt(d_U^2 + d_W^2)$

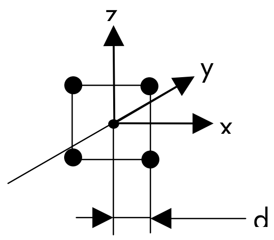
$cos\beta = d_U/d_{UW}$
$sin\beta = d_W/d_{UW}$
$M_V = 4.d_{UW}.F_{Sm}$
$F_{Sm} = M_V /(4.d_{UW})$

$F_{shear\ U} = |F_U|/6 + cos\beta.|F_{Sm}|$
$F_{shear\ W} = |F_W|/6 + sin\beta.|F_{Sm}|$

$$\mathbf{F_{shear} = sqrt(F^2_{shear\ U} + F^2_{shear\ W})}$$
$$\mathbf{F_{tension} = F_V/6 \pm M_W/(4.d_U)}$$

4.1.9 Calculation of the shear force and tension in the screws of the links type D (D, I, G and K)

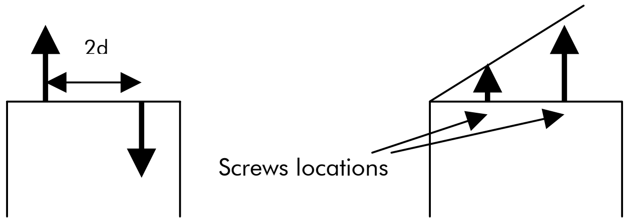
The local coordinates system is the same than the one of the strut. No projections are needed.



$$\mathbf{F_{tension} = F_{axial} /4 \pm M_Z/(4.d)}$$
$$\mathbf{F_{shear} = Fx/4}$$

Link bonding take in plane loads

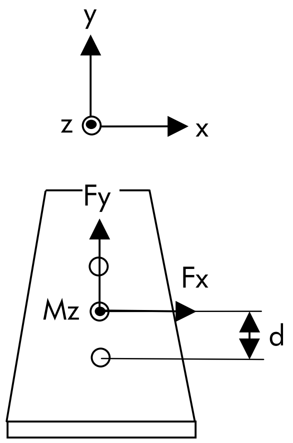
The results presented in annex 4 and 5 take into account this formula. However, during tests, calculation has been made with less conservative formula for F tension coming form moment Mz, in order to have a more realistic assessment (indeed, in case of gapping, rotation point cannot be at the centre of the link) :



Mz distribution in Dynawork formula

Mz distribution in re-assessed formula

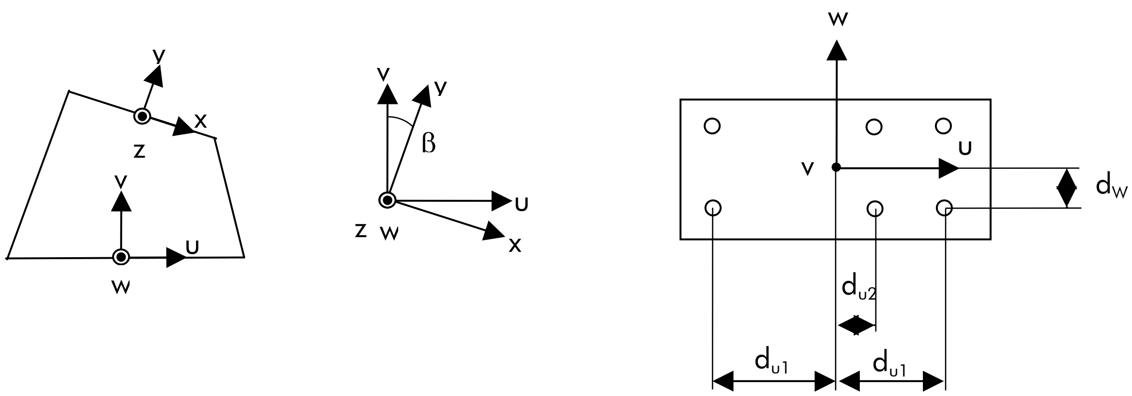
4.1.10 Calculation of the shear force and tension in the screws of the links type E (E and J)



$$\mathbf{F_{Xm} = F_X/2 \pm M_Z/(2.d)}$$
$$\mathbf{F_{Ym}=F_Y/2}$$
$$\mathbf{F_{shear} = sqrt(F^2_{Xm} + F^2_{Ym})}$$

4.1.11 Calculation of the shear force and tension in the screws of the links type H (H and L)

Next sketch shows the base bracket and its local coordinates system.



$M_W = 4.d_{U1}.F_1 + 2.d_{U2}.F_2$

Hypothesis: $F_2 = F_1.d_{U2}/d_{U1}$

$F_1 = M_W.d_{U1}/(4.d^2_{U1} + 2.d^2_{U2})$

$$\mathbf{F_{tension} = F_V/6 \pm M_W.d_{U1}/(4.d^2_{U1} + 2.d^2_{U2})}$$
$$\mathbf{F_{shear} = F_U/6}$$

4.2 LFI FPU strain gauge data post-processing

The only way to derive realistic loads from the strain gauge data for an acoustic test, is to use time dependent files and make the calculations described in previous chapter with these files (indeed, using directly RMS values form the strain gauges means making calculation on non simultaneous and un-signed levels). Then a PSD is computed for each load, as well as the corresponding RMS value, which in final is used for the loading check.

This is a non usual procedure which has necessitated to develop a specific program, using the Dynaworks software. The corresponding script is given in annex 6.

The results are finally given as RMS values tables for each type of link (see annex 4 and 5).

5. TEST SEQUENCE

Following table describes the CQMA2 test sequence:

Designation (date)	Level - duration
TBNA1 (19/08/04) (Sequence aborted)	*-15dB – 30s*
TBNA2 (14/10/04)	-12dB – 30s
BNA3 (15/10/04)	-8dB – 30s
TBNA4 (15/10/04)	-12dB – 30s
TBNA5 (21/10/04)	-12dB –30s
NIA6 (21/10/04)	-6dB – 2min
TBNA7 (22/10/04)	-12dB – 30s

Table 1: TEST SEQUENCE

Due to the risks identified on the LFI FPU links, intermediate very low level runs (-12dB) have been added in order to have a secured step by step procedure.

6. DATA AVAILABILITY

All data (acoustic levels, PSDs, time dependent files for LFI strain gauges, RMS values) are stored at Alcatel test facilities. PSDs are available as universal files.

Main data are presented in Annex 1 to 3, and annex 9 : RMS values tables for runs TBNA4, BNA3, NIA6, as well as the PSD plots for the NIA6 –6dB run.

7. CQMA2 TEST RESULTS

The reference test qualification levels (146 dB overall) are recalled in the following table :

Qualification level test		
OCTAVE BAND CENTRE FREQUENCY (Hz)	**QUALIFICATION LEVEL (dB) Ref.: 0 dB = 2.10^{-5} Pa**	**TEST TOLERANCE (dB)**
31.5	132	-2, +4
63	134	-1, +3
125	139	-1, +3
250	143	-1, +3
500	138	-1, +3
1000	132	-1, +3
2000	128	-1, +3
integrated level	146	-1, +3
Test duration :	2 min	

Table 2: ACOUSTIC LEVELS

All the runs are commented in the following chapters, with also an instrumentation status for each run.

7.1 TBNA2 (-12dB, 30s)

The following acoustic levels have been passed, within tolerances (except at high frequencies, which is acceptable for low level runs) :

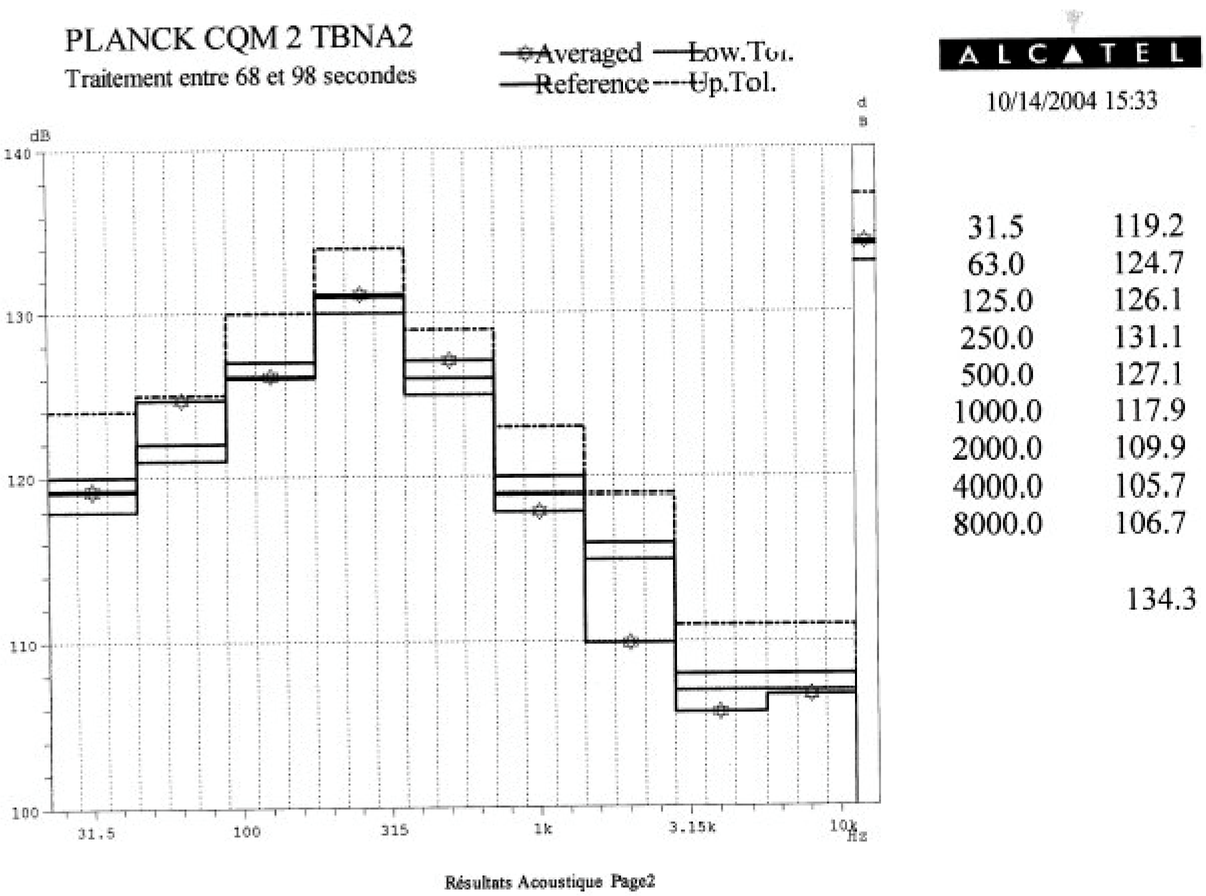


Figure 3 : TBNA2 acoustic levels

The outcome of this run is described in minutes H-P-ASP-MN-5472. Main issues are listed below :

- High frequency peak (between 1500Hz and 2000Hz) appears on LFI strain gauges, which is not physical and is due to test facilities. As a consequence, only the 0-1100Hz band shall be considered for the RMS values calculation, for all the runs.

- Failure of accelerometers GVA30Z, GVC75Z, BF103P, PR201Y, PR203P, and of strain gauges B31, SGLFI55, SGA1, SGA2, SGB3, SGB4 (problem has then been fixed for the 4 last ones).

- Identification of LFI most critical link : link D on bibod 3, as expected from analyses (see TRR presentation H-P-ASP-MN-5451), due to high bending moment : 9.8 Nm calculated from LFI strain gauges. Therefore, LFI FPU design appears to be the driver for the upper levels runs. Note that QS analyses along X RDP on the simplified FPU FEM delivered by LABEN to Alcatel show bending moment on this link which is the same order of magnitude of the one calculated with the strain gauges.

- HFI strain gauges data check by IAS show by extrapolation possibility to go up to about –5 dBs without endangering critical HFI struts.

7.2 BNA3 (-8dB, 30s)

The following acoustic levels have been passed, within tolerances (except for the 2000Hz frequency band, which is acceptable) :

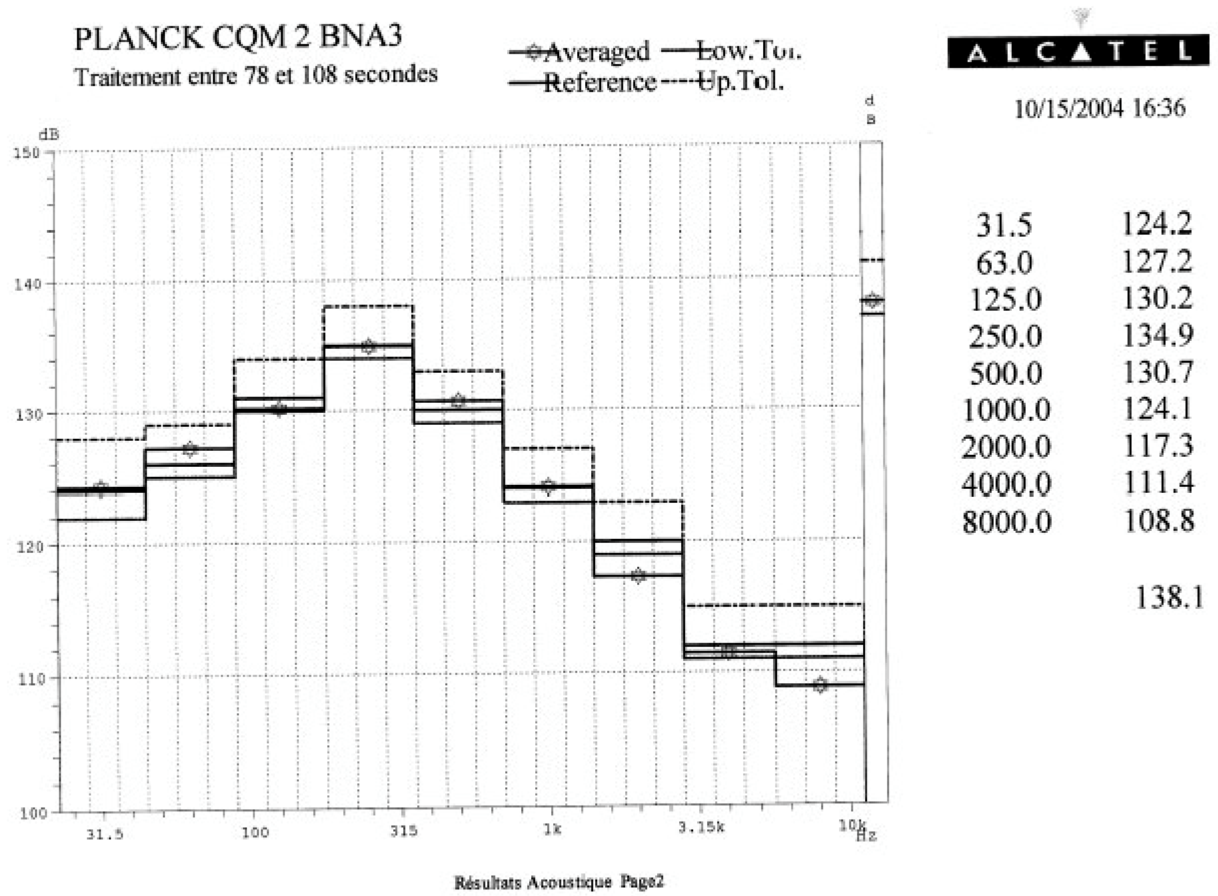


Figure 4 : BNA3 acoustic levels

Note that tuning in the 63Hz band has been done in order to reduce the acoustic level in this octave (which was at the upper tolerance for the TBNA2), where the highest loads on the FPU occur. So, in order to check linearity of levels evolution between –12dB and –8dB runs, TBNA4 should be considered.

The outcome of the – 8dB run is described in minutes H-P-ASP-MN-5483. Main issues are listed below :

- Bending moment (14.1Nm 3 sigma) on LFI critical link (D on bipod 3) extracted from the strain gauges, leads to a calculated out of plane load on the screws slightly higher (1416N 3 sigma) than the minimum guarantied tension characterised at Alcatel (1365N – type B value). This means that going to higher levels may mean entering a gapping domain on this link, which is risky because not predictable.

- IAS checks on HFI strain gauges allow to go safely to –6dB from HFI point of view

- Comparison of –8dB (TBNA4) and –12dB (BNA3) runs shows almost linear evolution of levels, as shown in H-P-ASP-MN-5483

- Instrumentation status : failure of accelerometers GVA30Z, GVA36R, GVA37T, GVC75Z, GVC86Z, BF103P, PR201Y, and of strain gauges B31, SG24

7.3 TBNA4 (-12dB, 30s) (control run)

The following acoustic levels have been passed, within tolerances (except for the high frequency bands, which is acceptable for low level runs) :

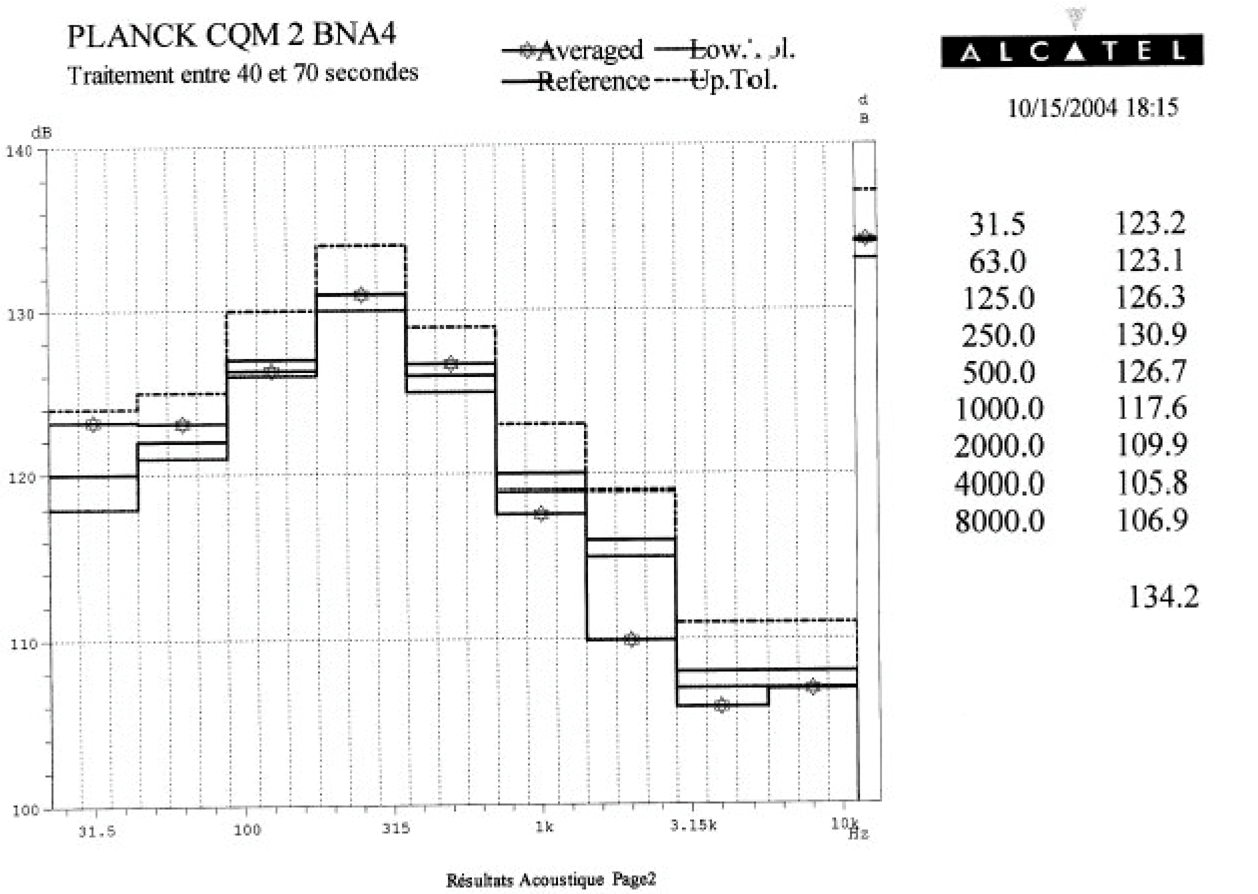


Figure 5 : TBNA4 acoustic levels

- Wrong matching for PSDs of SVM15R, SVM16T and SVM17Z between TBNA2 and TBNA4 leads to an inspection on the SVM dummy, which shows that the PACE bracket on the SVM cone has been wrongly screwed (wrong torque), which is fixed for the next runs.

- Control very low levels comparison between TBNA2 and TBNA4 shows no structural failure. Failing accelerometers GVA36R, GVA37T, SG24, GVC86Z for the BNA3, re-work for the TBNA4.

- Decision by ESA and Alcatel to go to a –6dB run, acknowledging the risks on the LFI FPU (see H-P-ASP-MN-5502)

7.4 TBNA5 (-12dB, 30s)

The TBNA5 run has been passed as a verification run because of the 6 days delay between the – 8dB and the –6dB runs.

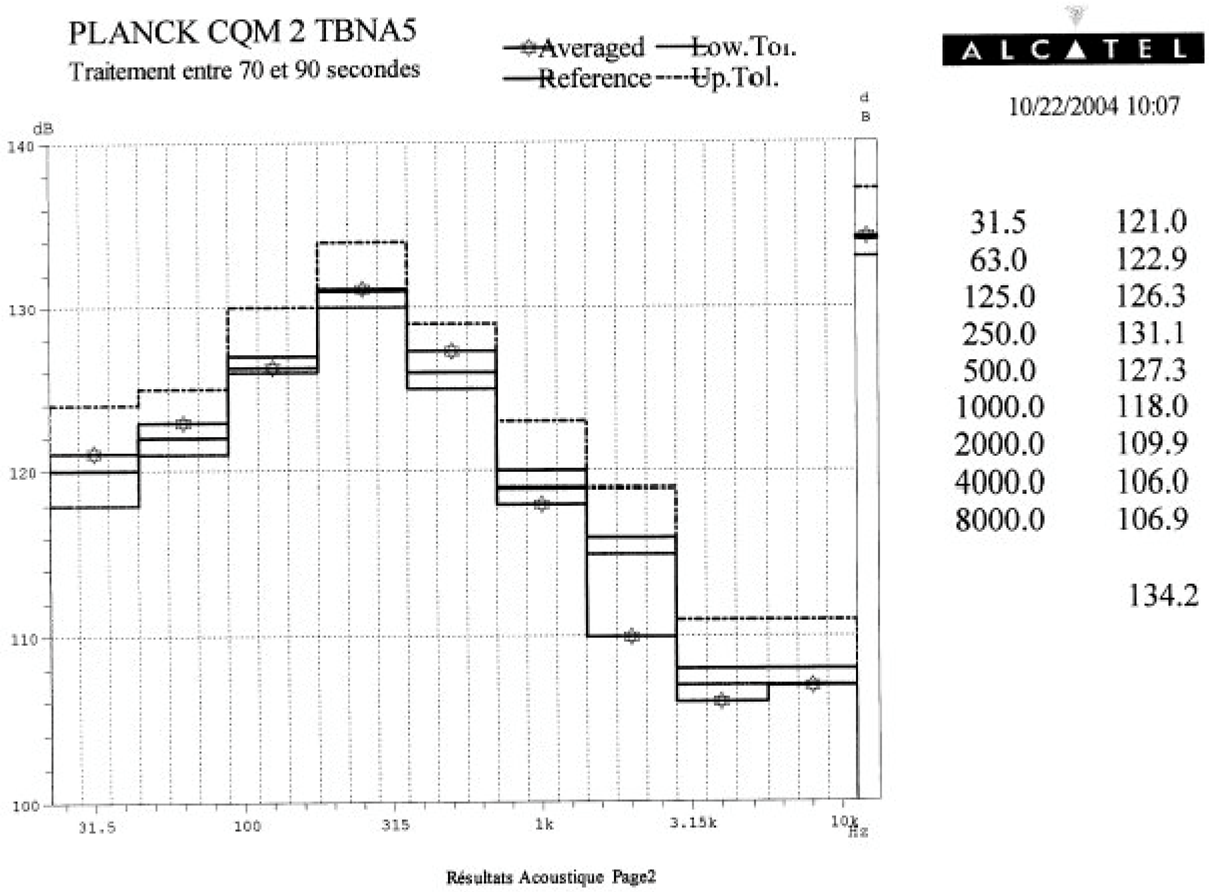


Figure 6 : TBNA5 acoustic levels

Matching is good with TBNA4 and no problem is identified concerning structural integrity.

Instrumentation status is the following for TBNA5 : failure of BF103, B31, SGLFI55, GVA30Z, PR201Y, GVA36R, GVA37T, B62, B72, GVC86Z, SG43.
SG43 failure is not an issue since opposed to it, at the same location, is the SG44 which gives good matching. Also, strain gauges B6-2 and B7-2 give strange results (peaks at same frequency but change of amplitude), which is test facilities related and is fixed for the following runs.
By comparison between TBNA5 and TBNA2, it is checked that the PACE support on SVM dummy has been properly attached, since good matching is observed for SVM15R, SVM16T and SVM17Z.

7.5 NIA6 (-6dB, 2min)

The following acoustic levels have been passed for the NIA6, within tolerances

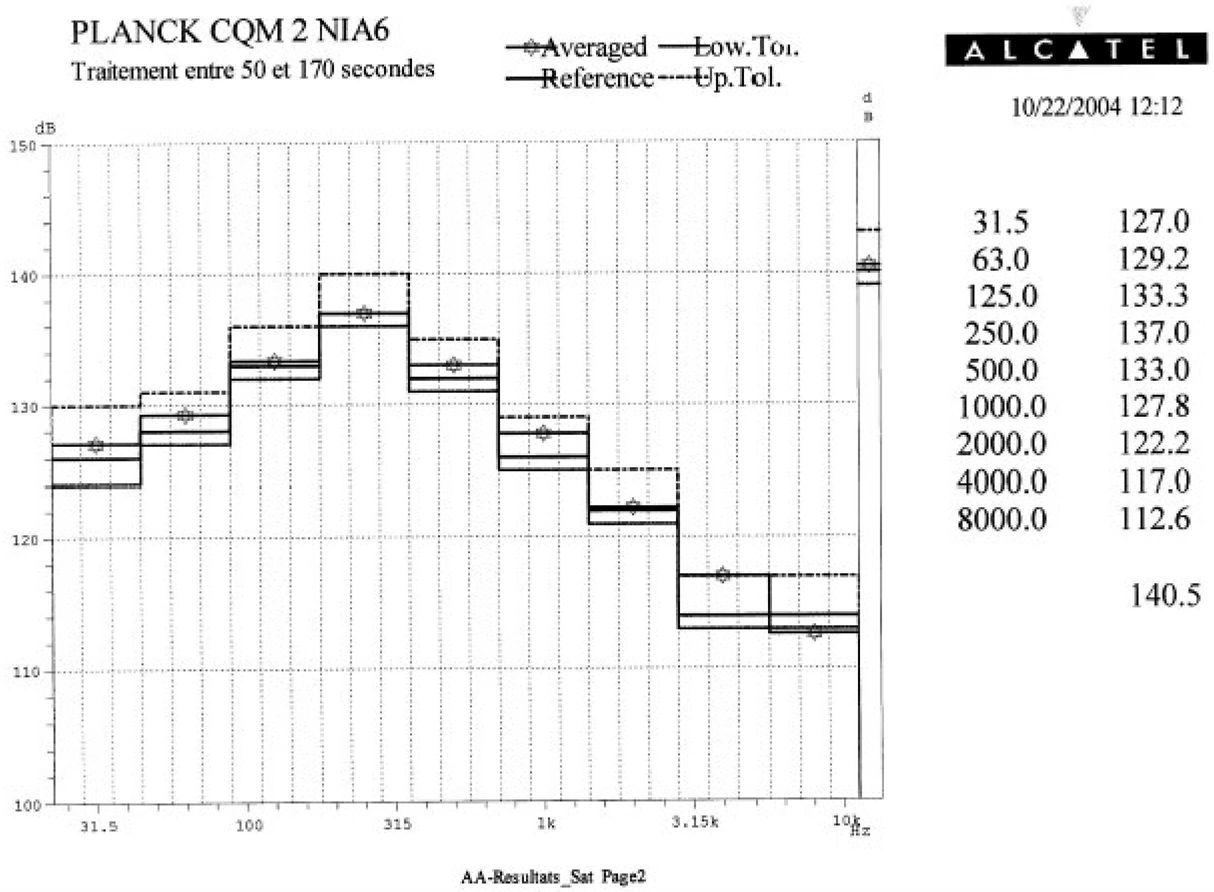


Figure 7 : NIA6 acoustic levels

The outcome of this run is described below :

- correct level passed on HFI in the critical frequency range (peaks at 195Hz and 225Hz). Indeed, strain gauge data evolution for the HFI is almost linear between –8dB and –6dB runs, and peaks are at same frequencies.

- non linear evolution of the 78Hz peak of the LFI FPU between –8dB and –6dB runs (see figure 8) : this effect concerns the FPU and areas next to the FPU I/F (such as the lower beam), for the X RDP direction. Acoustic levels have been checked more accurately, using 3rd of octaves, and no decrease of acoustic level around 78Hz has been identified between –8dB and –6dB runs (see 80Hz band on figures 9 and 10). As a consequence, the most plausible explanation is a beginning of gapping on link D under –6dB loading, which was assessed as possible for this run anyway according to BNA3 strain gauges data. This is confirmed by the fact that non linear evolution is observed on bipods 2 and 3, which are concerned by the gapping, and not on bipod 1, for which no gapping risk is identified. As a consequence, it is likely that part of the out of plane loads generated by the bending moment due to the X RDP motion of the FPU, passed through the link bonding for bipods 2 and 3, which can account for a higher damping on this mode.

- Status on instrumentation is the same as for TBNA5, except for SG24 (not working, but opposite side SG23 is working so it is not a concern), B62 and B72 (both working), SGLFI55 (working).

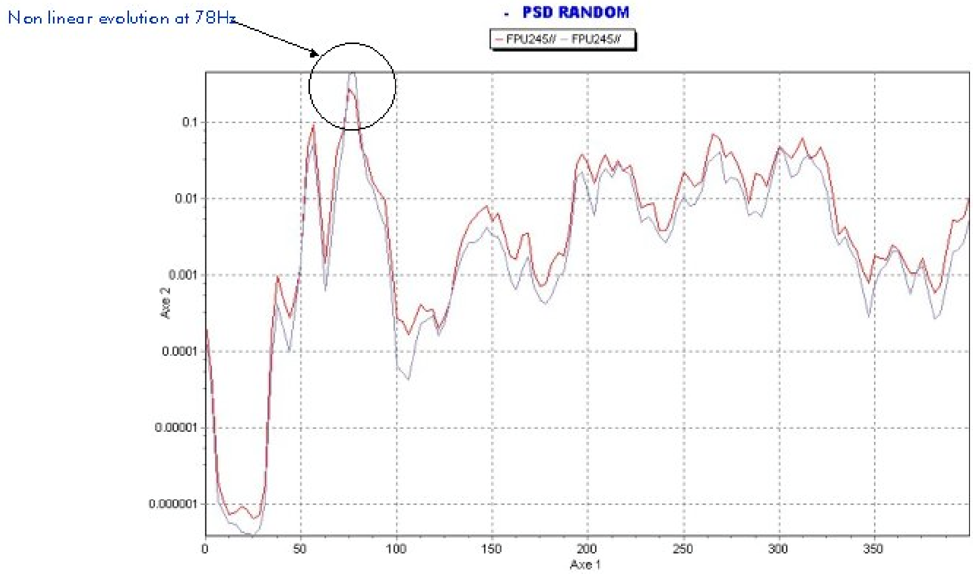


Figure 8 : FPU response comparison between BNA3 and NIA6

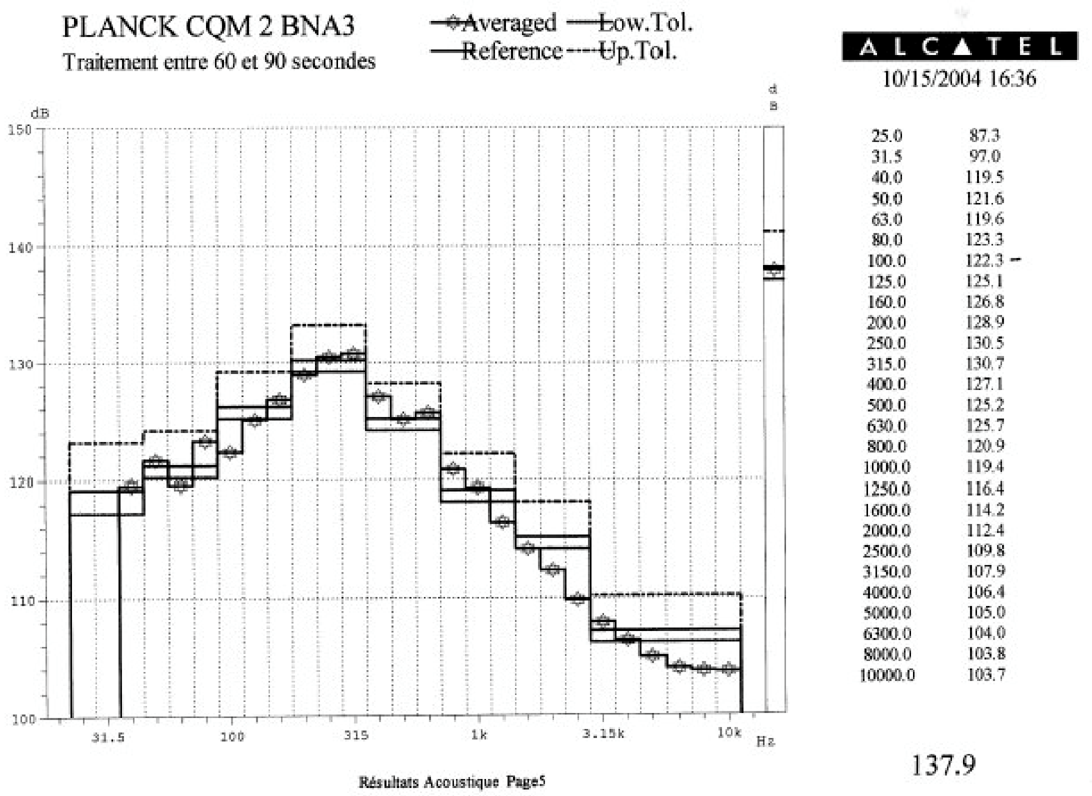


Figure 9 : BNA3 acoustic levels – third of octaves

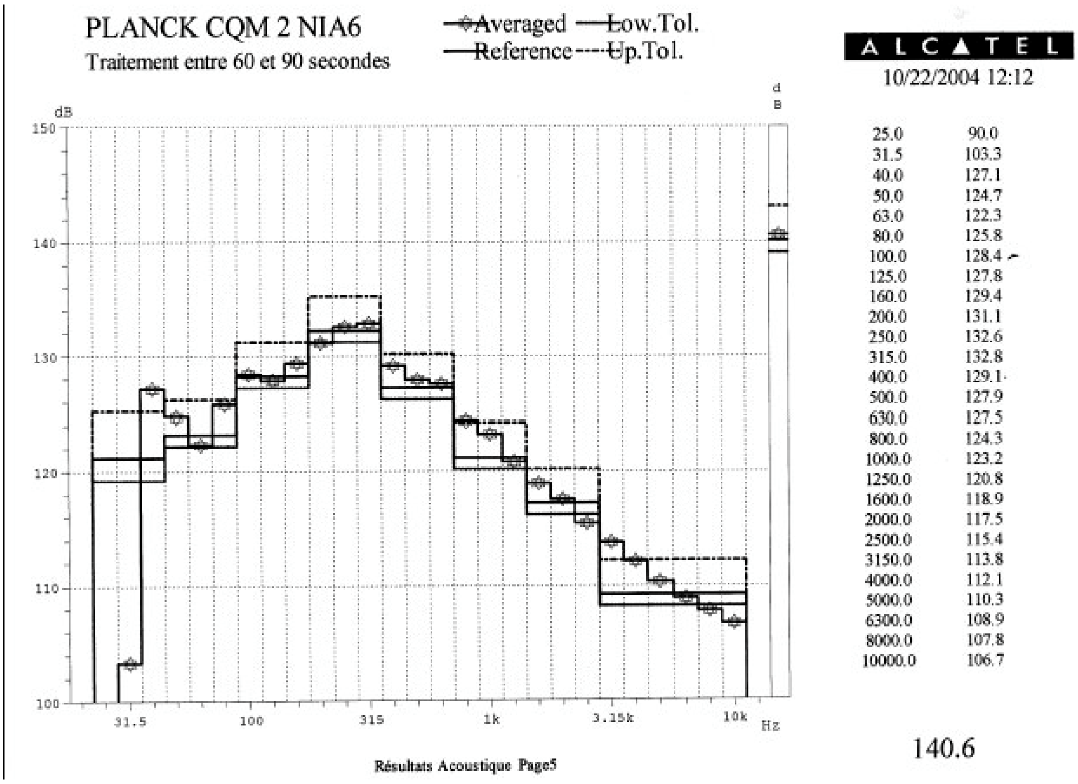


Figure 10 : NIA2 acoustic levels – third of octaves

7.6 TBNA7 (-12dB, 30s) control very low level run

The following acoustic levels have been passed for the TBNA7, very comparable to TBNA5.

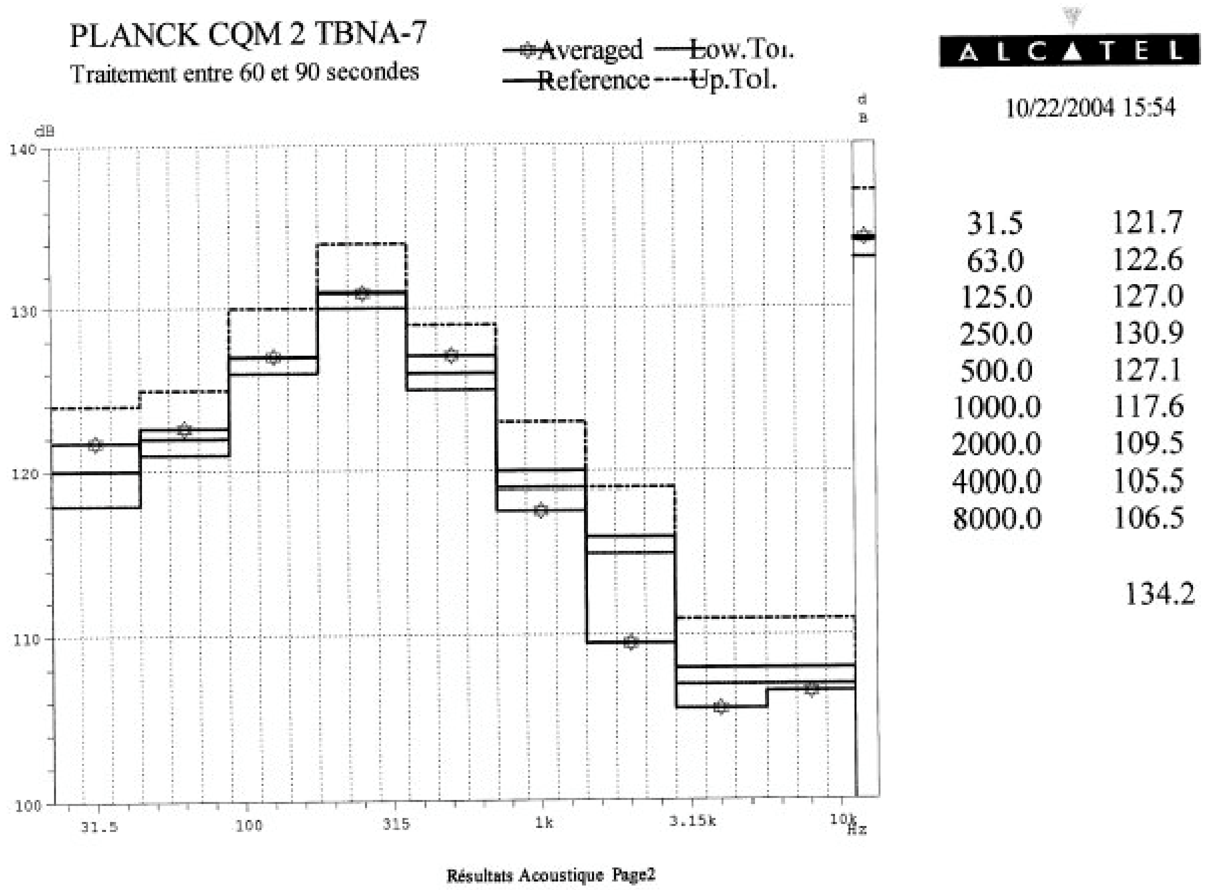


Figure 11 : TBNA7 acoustic levels

Good matching is observed between TBNA5 and TBNA7 PSDs, with the following status on instrumentation : with respect to NIA6, the only changes are the following : SR209 is not working ; SGLFI55 gives a wrong signal, as it has been the case for every TBN. Also, SGLFI64 and SGLFI73 show small amplitude difference, while there is no frequency shift. But the opposite strain gauges (SGLFI63 and SGLFI71) show good matching, which indicates that the difference is coming from the strain gauge itself. In any case good matching is observed for all LFI accelerometers, which indicates that nothing has broken on the LFI links : gapping effect was not strong enough to reach failure of the link.

As a consequence, it is concluded that the –6dB run has been passed successfully on all the structure without degradation.

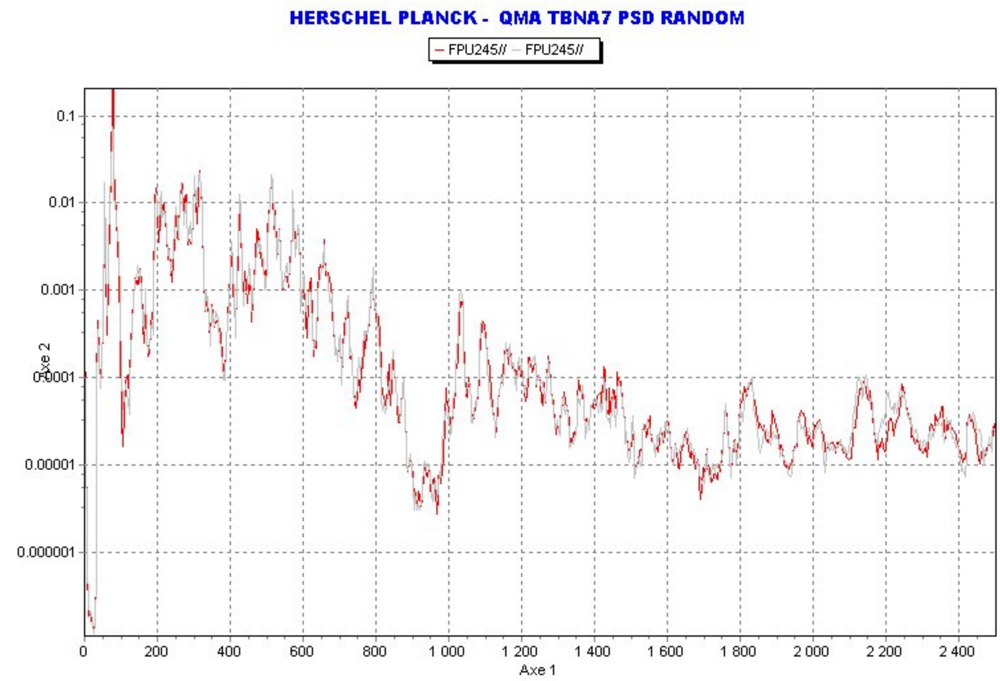


Figure 12 : TBNA5 and TBNA7 comparison – LFI FPU X

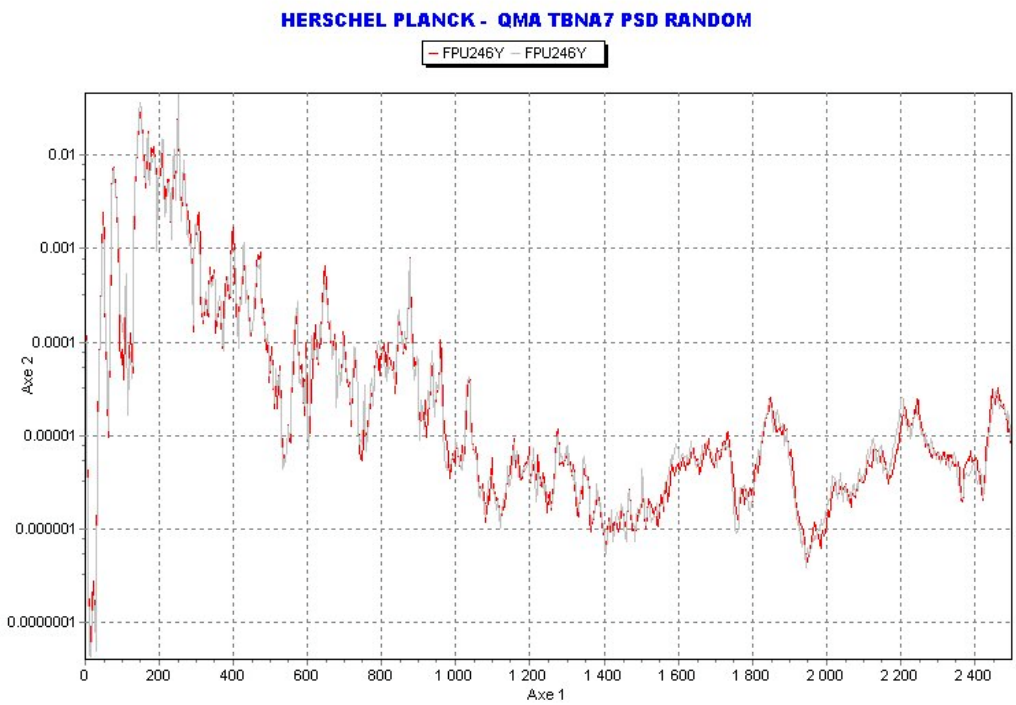


Figure 13 : TBNA5 and TBNA7 comparison – LFI FPU Y

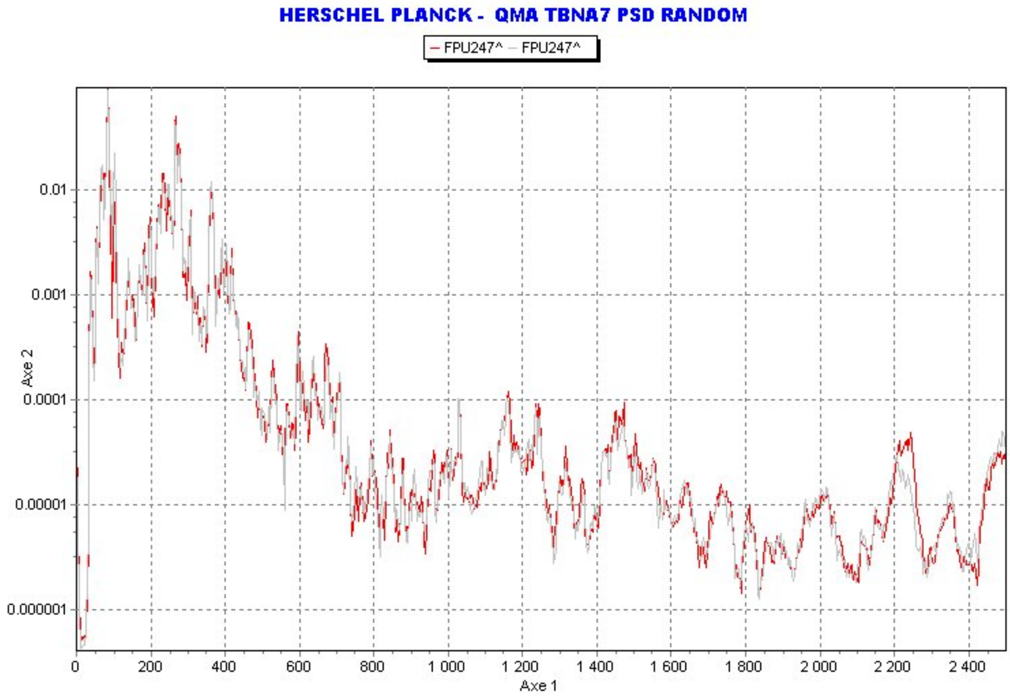


Figure 14 : TBNA5 and TBNA7 comparison – LFI FPU Z

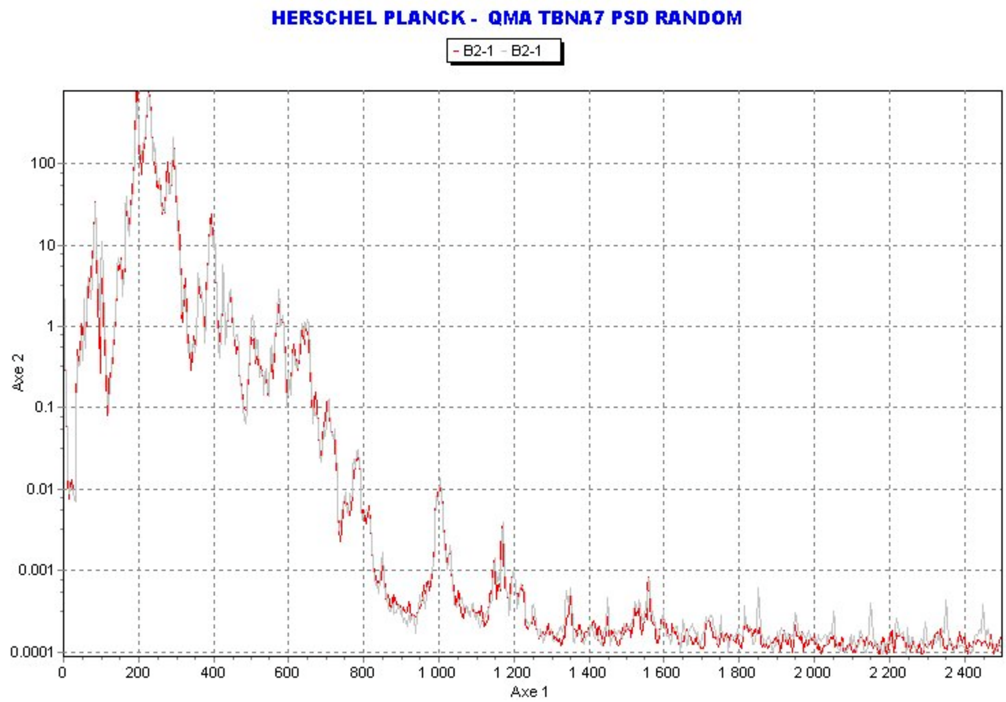


Figure 15 : TBNA5 and TBNA7 comparison – HFI strain gauge (most loaded one)

8. STATUS ON PPLM EQUIPMENT QUALIFICATION

This chapter gives a picture of what can be said, from Alcatel point of view, concerning the PPLM equipment acoustic / random environment, as well as their mechanical qualification status for acoustic / random.
PPLM primary structure has been checked as normal work using dedicated accelerometers at same locations as for CSAG sub-system telescope and cryo-structure tests. However, it has already been qualified by applying full qualification acoustic levels on both sub-structures, during telescope and cryo-structure QM tests.

Note : the comparison between instrument interface levels during test, and instrument random spec, takes into account the "–3dB rule " on the PSDs peaks, that is to say the peaks values are divided by 2 before making the comparison (same way spec have been derived from ASTRYD PSDs).

8.1 HFI FPU

IAS has been present during all the CQMA campaign, or available by phone, in order to check the stress levels seen on the HFI critical struts between 4K and 1.6K stages.

Qualification status of HFI, taking into account CQMA test results, is still expected from IAS.

Especially, it shall be taken into account in this status the fact that the HFI FPU STM was not completely flight representative, the main difference with the flight configuration being the absence of the Air Liquide cooler.

What can be said, from Alcatel point of view, is that a maximum micro-strain of 295.3 µm/m RMS has been passed on the 4K/1.6K struts which were the critical parts on the HFI FPU STM. According to RD 6, the maximum allowable micro-strain is 333 µm/m, such a ratio of 1.12 with –6dB results, which corresponds to 1.0 dB margin (keeping safety factor).
The artificial increase of damping at 78Hz due to LFI FPU links (see NIA6 run description above) is not an issue for HFI qualification, since levels are seen by HFI as quasi-static acceleration at this frequency, for which HFI has already been qualified at sub-system level (38g X, 40g Y, 37g Z, seen at CoG during FPS campaign – see RD 3 – much higher than CQMA test levels).

So, in theory, it could have been passed –5dB (taking into account the 1.0 dB margin) as a maximum on the HFI FPU, with the HFI STM configuration. However, the difference with the flight configuration induces frequency shifts of the modes loading the critical struts, as shown in IAS email sent on 19/07/2004 : in lateral along X RDP, the transfer functions between LFI I/F and 0.1K stage, measured during HFI STM and FPS sub-system tests, show that the peaks at 196Hz, 222Hz and 309Hz are shifted down to 188-196Hz (double peak), 213Hz and 261Hz for the FPS (flight representative) model. Also, amplitude of the transfer functions are different (higher on the first mode for the FPS). See figure 16 (these transfer functions are similar for 1.6K stage, as shown in RD 3).
As a consequence, there is a possibility that HFI in flight configuration may have seen more than 295.3 µm/m, which is difficult to assess precisely : according to the test data and the transfer functions comparison, the tendency seems to be that the strain gauge PSD first high peak would be higher in amplitude, and the second one lower.
Given this uncertainty, Alcatel recommend to ask for a level reduction of at least –6 dB, TBC by IAS/ESA who should give their opinion on the struts stresses with a flight configuration HFI FPU, having a better knowledge of their instrument and of the accelerometers information in the 2 configurations. This level

reduction should be applied at least in the 250Hz octave, and in the 125Hz octave, taking into account the frequency shift with the FPU in flight configuration, once mounted on satellite (with the current data, transfer functions comparison shows that we are close to the 125Hz / 250Hz octaves frontier).

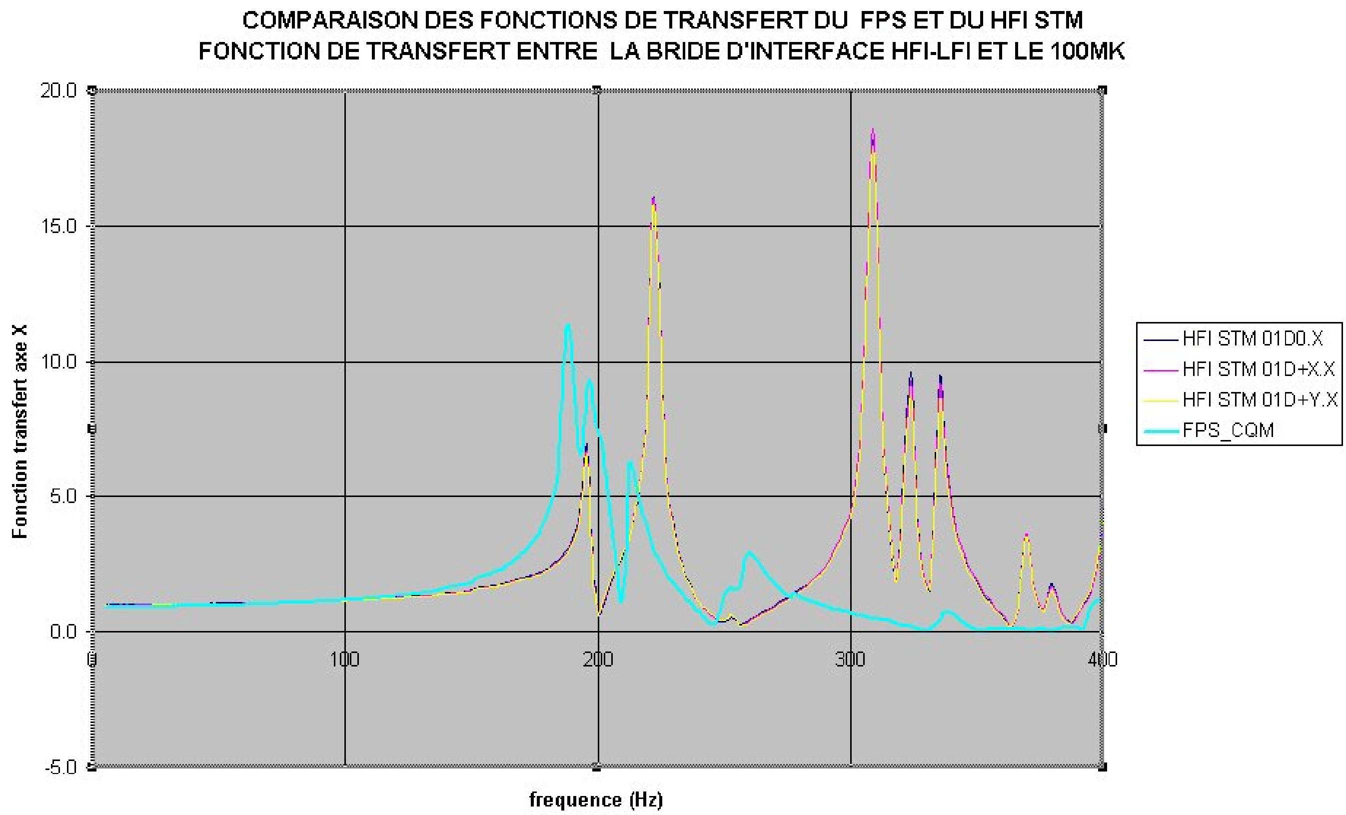


Figure 16 : transfer functions comparison between HFI STM and FPS models (IAS test data)

Concerning the absence of the Air Liquide cooler (0.1K stage) during CQMA tests, Alcatel have already expressed their concern (see fax H-P-ASP-LT-5235 dated 04/08/2004) on the random levels passed during FPS test campaigns (see RD 3), not at all compatible with LFI/HFI interface levels computed by IAS (see RD 7), nor with CQMA test data at this interface. This topic has been discussed with IAS during Week 4 / 2005 and will lead to supplementary analyses taking into account the sub-system and CQMA tests data, in order to :

- Assess the levels that would have seen the Air Liquide cooler if it had been mounted on HFI during CQMA tests.

- Re-assess the FPS qualification approach accordingly, taking into account remaining margins in Air Liquide analyses.

Concerning the second point, it can already be stated that very deep notches during FPS sub-system tests (down to 10*E-5 g2/Hz) were driven by a no breaking risk approach for the CQM, with a criteria of not going higher than about 3 gRMS on the 0.1K stage. This criterion looks severe, since it has been passed more than 30g on the FPU CoG during the QS tests (see RD 3).

According to the outcome of these analyses, there is a non negligible probability that the Air Liquide cooler becomes the most critical item for the HFI under random loads, which may lead to even further level reduction request than –6dB in the 250Hz band.

8.2 JFET

JFET was represented by a mass dummy, with interface blades to be more representative, and is not qualified by this test.
Mechanical environment at JFET I/F has been derived from accelerometers PRP120, PRP121, PRP122, PRP126. JFET spec (see RD 4) covers –6dB run levels (factor of more than 4 for in plane and out of plane spec, in line with ASTRYD analyses results).

8.3 Bellow

The bellow was represented by mass dummies. Random environment is not sizing for the bellow, which has its main modes below 100Hz. However a bellow sample has been tested by IAS with the JFET random qualification spec (see IAS report RD 5).
Mechanical environment at Bellow I/F has been derived from accelerometers PRP122, PRP141, PRP120, PRP121. JFET spec covers –6dB run levels for both in plane (factor of more than 6) and out of plane (minimum factor of 1.2 on 200Hz peak on PRP141). Situation should even improve with the real hardware, since the Bellow is a highly damped structure.

8.4 LFI FPU

The LFI FPU STM design is not any more flight representative, so it is not qualified by this test. The new LFI FPU (flight model) has been, in the meantime, tested successfully by LABEN (sine and random) at sub-system level (test report is still expected).

Mechanical environment at FPU I/F has been derived from accelerometers PRP128, PRP129, PRP130, PRP131, PRP132, PRP133, PRP134.
FPU spec (see RD 4) covers –6dB run levels for both in plane and out of plane (by a factor higher than 2, except for high frequency peak at 460Hz, just covered).

8.5 LFI wave guide and wave guide upper support structure

Wave guide upper support structure was represented by mass dummies, and is not qualified by this test.
Mechanical environment at FPU I/F has been derived from accelerometers PRP123, PRP124, PRP125, PRP127, PRP141. WGSS spec covers –6dB run levels, except at 210Hz and 260Hz out of plane, where the need is 0.56g2/Hz, for a spec at 0.2g2/Hz. This should be acceptable for the WGSS which have main modes at low frequency (below 100Hz), and is being checked with LABEN for the wave guides (not expected to be critical because first modes are rather around 100Hz according to RD 9, ch. 5.10).

8.6 PACE

JPL was present during CQMA first sequence in August (-15 dB run) in order to check the PACE behaviour under acoustic loads.

According to the –15dB run results from PACE strain gauges, JPL has stated that the PACE could sustain qualification (146 dB) level with still positive margin for both pipe and blades supports, by extrapolating linearly, which is conservative. JPL statement is part of the minutes H-P-ASP-MN-5262.
Moreover PACE strain gauges have been verified for CQMA2 campaign, confirming JPL statement : PACE has seen –6dB, and could have seen 146dB with still positive MoS at strain gauges locations.

For information, at the PACE I/F on the V-grooves, levels are in the same range as CSAG tests, and as ASTRYD analyses.

8.7 0.1K and 4K pipes

0.1K and 4K pipes were not mounted for CQMA tests, and have been represented by mass dummies (see doc. RD 2). However, levels have been checked at their interface with PPLM structure.

Mechanical environment at 0.1K and 4K pipes I/F has been derived from accelerometers :
- GVA32, GVA33, GVB52, GVB53, GVC72, GVC73, GVA34, GVA35, GVA54, GVA55, GVC74, GVC75, for V-grooves I/F
- FR165, FR166, FR167, FR168 for frame I/F
- LB180, LB181, LB182, LB183 for lower beam I/F

Unexpected high levels were observed at frame, and mainly lower beam I/F, with peaks much higher than ASTRYD predictions, and sometimes, at a lesser extent, higher than peaks observed during CSAG acoustic test campaign on telescope QM.
Concerning the differences with ASTRYD prediction, it seems that ASTRYD is more reliable for large surfaces random levels (surfaces directly excited by acoustic sound pressure such as V-grooves). Especially, it was not possible to extract levels on the lower beam, from ASTRYD computation, because the lower beam was not represented by surface elements in the FEM. Moreover, ASTRYD analysis has been performed up to 350Hz, which is the usual range where highest random loads are seen. Higher levels peaks are seen during test, but are expected not to be critical because almost all the effective mass of the pipe participates to lower frequency modes.

Concerning the difference of levels seen on frame and lower beam wrt CSAG tests (up to a factor of 4 on certain peaks, but lower levels in other frequency ranges), they are likely to be due to the different configurations : presence of mass dummies not present on the telescope QM (which, for instance, creates a bending mode of the flange on the lower beam not present for CSAG tests), and random levels injected to the frame and the lower beam by the V-grooves acoustic response, via the cryo-struts (V-grooves were not present in the telescope QM test).

However, these levels must be considered with caution because :

- presence of real pipes should improve damping and I/F stiffness
- presence of harness on the satellite flight model will increase damping (harness will also be present around pipe)
- accelerometer on lower beam flange is on top of mass dummy, which may over-assess the in plane levels, due to the height between pipe I/F and dummy top (dummy rotation effect).

In any case, in order to have a good opinion on the risk induced by these high I/F levels, it has been asked to IAS and Air Liquide to check the integrity of the 0.1K pipe under updated random levels derived from CQMA test. These levels, directly extracted from –6dB run, have been provided only when not covered by current pipe spec, and are defined as follows :

Telescope in plane over-spec :
0.55g2/Hz between 200Hz and 265Hz, instead of 0.35g2/Hz (lower beam flange)
5.5g2/Hz between 265Hz and 340Hz, instead of 0.35g2/Hz (lower beam flange)
2.1g2/Hz between 340Hz and 390Hz (lower beam flange)
8.5g2/Hz between 390Hz and 460Hz (lower beam flange)
1.5g2/Hz at 595Hz (lower beam flange)

Telescope out of plane over-spec :
0.26g2/Hz between 100Hz and 180Hz, instead of 0.2g2/Hz (frame)
0.4g2/Hz between 220Hz and 260Hz, instead of 0.35g2/Hz (lower beam flange)
3.5g2/Hz between 260Hz and 350Hz, instead of 0.35g2/Hz (frame and lower beam flange)
0.5g2/Hz at 360Hz (frame), 435Hz (lower beam triangle) and 595Hz (lower beam flange)

V-grooves over-spec :
Only slight exceeds are observed with the -6dB run :
0.37g2/Hz in plane at 625Hz (high frequency, probably not critical)
4.8g2/Hz at 150Hz, 5.6g2/Hz at 224Hz out of plane (small exceeds wrt 4g2/hz spec) and 5.5g2/Hz at 450Hz out of plane (high frequency)

Air liquide has already made analyses presenting quite comfortable MoS with the current spec (see RD 8). It has been proposed to IAS / Air Liquide to extract stress PSDs from these analyses, not available at that stage. With these data, it will be possible to see if pipe modes are in the critical frequency ranges, and to extrapolate stress levels and corresponding MoS if necessary.

Concerning 4K pipe, no analyses results are available for the moment, but these analyses are on-going. It has been agreed that IAS would also ask for PSDs to RAL, in the frame of these analyses, in order to make similar checks for 4K.

These 2 requests should be formalised by IAS during Week 5 / 2005.

8.8 PR and SR

PR and SR have already been qualified under qualification acoustic loads (Ariane 5 qualification spectrum). Test reports are not available at Alcatel yet, but some data have been provided by Astrium for CQMA tests, as RMS values (see annex 8 and 9). These values compare very well with the CQMA test values (RMS values extrapolated to qual are very close to PR and SR sub-system tests values), so PR and SR are not critical for acoustic.

9. CONCLUSION

Despite remaining concerns on the LFI FPU STM design, a –6dB run, with a 2min duration, has been passed successfully on the Planck CQMA model, which has been agreed as the objective to be passed on the FPU HFI STM for this test campaign.

From Alcatel point of view, the only acoustic level reduction clearly identified at this stage is –6dB in the 250Hz and 125Hz bands, due to the HFI 4K-1.6K stages struts. This request could even be stronger, according to the analyses to be performed by IAS / Air Liquide concerning the Air Liquide cooler and clamping mechanism (0.1K stage) not present during test, and could concern other octaves (see ch. 8.1). In any case, since CQMA2 test is the only test successfully qualifying the 4K-1.6K struts, Alcatel propose a –6dB reduction for all the spectrum.

PACE has also seen –6dB loads, and could see qualification loads (146 dB) with still positive MoS, according to JPL.

PR and SR have seen the same kind of loads as for the sub-system tests (scaled to –6 dB), and as such do not seem influenced by the satellite configuration. As a consequence PR and SR are not critical for acoustic loads and may have seen qualification loads.

Other instrument random environment have been checked with dedicated accelerometers (instrument being represented by mass dummies) :

JFET I/F see levels compatible with ASTRYD analyses and corresponding spec (when scaled to qualification loads), and as such is not critical.

Bellow design is not critical under random environment (low frequency modes), and –6dB run levels are covered by levels passed in sub-system tests.

LFI FPU random environment under –6dB loads is covered by spec by more than a factor of 2, except for one high frequency peak at 460Hz (just covered).

Upper wave guide support structure and wave guides random environment under –6dB loads are covered by spec, except for 2 peaks at 210Hz and 260Hz, not covered by a factor of 2, which will be checked with LABEN (not expected to be critical).

Concerning 0.1K and 4K pipe I/F, for the –6dB run, they already see levels quite higher than qualification random spec on frame and, most of all, on lower beam, but with a conservative configuration wrt flight (see ch. 8.7).
Impact on concerned instrument is being checked and should also concern mainly 250Hz octave.

These comparisons have been done directly using the –6dB run results, that is to say the current approach is to identify potential problems for a –6dB acoustic loading on all octaves. Remaining issues after this check concern HFI (Air Liquide cooler), wave guides (not expected to be critical), 0.1K and 4K pipes. All these issues are being checked with instrument.

In case it is necessary to consider level reduction octave by octave, a more detailed check should then be made, but will necessitate first to have received answers from instrument concerning over-specs, as detailed in ch. 8.

10. ANNEXES

ANNEX 1

RMS values TBNA4 (range : 5-1000Hz)

RAPPORT D'ANALYSE
Fichier : tbna4.pch Sub 11
Plage de frequence : [5.00 , 1000.00 Hz]

	Valeur RMS
SUB1//	0.48
SUB2Y	0.93
SUB3^	0.53
SUB4//	0.82
SUB5Y	0.72
SUB6^	1.30
SUB7^	0.44
SVM15R*	2.57
SVM16T*	1.48
SVM17Z*	1.31
SVM18^	1.30
SVM19^	14.54
SVM20^	7.22
SVM21^	11.86
GVA30Z	34.00
GVA31Z	24.20
GVA32R*	2.44
GVA33T*	2.38
GVA34Z*	9.74
GVA35Z*	10.62
GVA36R*	2.10
GVA37T*	1.69
GVA38Z*	9.37
GVA39Z*	9.99
GVA40Z	26.43
GVB50Z	23.29
GVB51Z	24.64
GVB52R*	3.15
GVB53T*	2.64
GVB54Z*	15.62
GVB55Z*	18.54
GVB56R*	2.01
GVB57T*	1.87
GVB58Z*	7.55
GVB59Z*	9.66
GVC70Z	23.96
GVC71Z	25.78
GVC72R*	3.09
GVC73T*	2.95
GVC74Z*	8.01
GVC75Z*	6.84
GVC76R*	2.19
GVC77T*	1.97
GVC78Z*	8.94
GVC79R*	2.23
GVC80T*	1.84
GVC81Z*	6.62
GVC82R*	1.99
GVC83T*	1.38
GVC84Z*	10.91
GVC85Z*	8.07
GVC86Z	26.20
BF100^	22.73
BF101^	25.84
BF102^	18.18
BF103^	0.26
BF104^	22.24
BF105^	16.28

PRP120//*	1.05
PRP121Y*	0.93
PRP122^*	2.33
PRP123//*	1.57
PRP124Y*	1.21
PRP125^*	3.45
PRP126^*	2.09
PRP127^*	1.93
PRP128//*	1.27
PRP129Y*	1.00
PRP130^*	1.96
PRP131//*	2.23
PRP132Y*	1.13
PRP133^*	2.23
PRP134^	1.95
PRP135//	1.15
PRP136Y	2.14
PRP137^	3.24
PRP138//	1.47
PRP139Y	1.17
PRP140^	3.20
PRP141^*	3.06
SRP150//	2.99
SRP151Y	2.12
SRP152^	2.30
SRP153//	3.59
SRP154Y	2.34
SRP155^	2.45
FR165R*	4.32
FR166T*	1.88
FR167Z*	5.80
FR168^	6.10
LB180//	10.26
LB181Y	9.95
LB182^*	7.96
LB183^*	5.47
PR200//	1.49
PR201Y	0.01
PR202^	2.04
PR203^	6.67
PR204^	5.31
PR205^	5.98
SR206//	1.63
SR207Y	1.07
SR208^	1.57
SR209	1.94
SR210	4.48
FPU220//*	1.76
FPU221Y*	1.31
FPU222^*	1.72
FPU223//*	2.40
FPU224Y*	1.43
FPU225^*	1.51
FPU226^	1.43
FPU230//	3.48
FPU231Y	2.67
FPU232^	3.86
FPU233//	2.96
FPU234Y	2.77
FPU235^	1.79
FPU236//	1.93
FPU237//	1.71
FPU238Y	1.73
FPU239//	2.34
FPU240Y	1.89
FPU241^	1.74
FPU242//	2.14
FPU243Y	1.47
FPU244^	1.76
FPU245//	1.79

FPU246Y	1.28
FPU247^	1.43
FPU248//	2.02
FPU249Y	1.60
FPU250^	2.08
B1-1	147.10
B1-2	121.63
B2-1	160.65
B2-2	118.92
B3-1	0.00
B3-2	114.98
B5-1	146.23
B5-2	135.29
B6-1	143.98
B6-2	121.83
B7-1	130.40
B7-2	110.43
SG01	44.45
SG02	18.36
SG11	43.59
SG12	39.73
SG21	40.12
SG22	24.06
SG23	177.52
SG24	182.79
SG34	217.66
SG41	32.24
SG42	98.61
SG43	19.66
SG44	18.84
SG35	44.12
SG36	51.13
SGVA1	27.79
SGVA2	32.85
SGVB3	22.64
SGVB4	25.08
SGLFI51	18.12
SGLFI52	23.56
SGLFI53	21.43
SGLFI54	14.14
SGLFI55	135.02
SGLFI56	16.29
SGLFI61	13.41
SGLFI62	38.67
SGLFI63	30.41
SGLFI64	19.72
SGLFI65	39.89
SGLFI66	14.30
SGLFI71	15.12
SGLFI72	43.82
SGLFI73	30.97
SGLFI74	21.97
SGLFI75	29.57
SGLFI76	20.32

ANNEX 2

RMS values BNA3 (range : 5-1000Hz)

RAPPORT D'ANALYSE
Fichier : bna3.pch Sub 11
Plage de frequence : [5 , 1000.00 Hz]

	Valeur RMS
SUB1//	0.75
SUB2Y	1.46
SUB3^	0.87
SUB4//	1.30
SUB5Y	1.07
SUB6^	1.96
SUB7^	0.72
SVM15R*	5.26
SVM16T*	1.58
SVM17Z*	2.42
SVM18^	1.98
SVM19^	21.65
SVM20^	11.13
SVM21^	18.97
GVA30Z	52.93
GVA31Z	36.72
GVA32R*	3.79
GVA33T*	3.70
GVA34Z*	15.45
GVA35Z*	15.96
GVA36R*	3.30
GVA37T*	2.61
GVA38Z*	14.28
GVA39Z*	15.77
GVA40Z	39.26
GVB50Z	36.98
GVB51Z	38.63
GVB52R*	4.89
GVB53T*	4.26
GVB54Z*	23.51
GVB55Z*	28.84
GVB56R*	3.13
GVB57T*	2.96
GVB58Z*	11.63
GVB59Z*	14.80
GVC70Z	36.97
GVC71Z	40.14
GVC72R*	4.65
GVC73T*	4.56
GVC74Z*	12.05
GVC75Z*	10.92
GVC76R*	3.37
GVC77T*	3.07
GVC78Z*	13.76
GVC79R*	3.45
GVC80T*	2.85
GVC81Z*	9.88
GVC82R*	3.09
GVC83T*	2.22
GVC84Z*	17.48
GVC85Z*	12.11
GVC86Z	39.21
BF100^	36.21
BF101^	39.35
BF102^	26.99
BF103^	0.30
BF104^	35.43
BF105^	25.62

PRP120//*	1.63
PRP121Y*	1.47
PRP122^*	3.63
PRP123//*	2.48
PRP124Y*	1.97
PRP125^*	5.45
PRP126^*	3.28
PRP127^*	3.04
PRP128//*	1.93
PRP129Y*	1.57
PRP130^*	3.11
PRP131//*	3.53
PRP132Y*	1.81
PRP133^*	3.48
PRP134^	3.06
PRP135//	1.87
PRP136Y	3.42
PRP137^	5.15
PRP138//	2.28
PRP139Y	1.88
PRP140^	5.36
PRP141^*	4.71
SRP150//	4.43
SRP151Y	3.41
SRP152^	3.65
SRP153//	5.46
SRP154Y	3.80
SRP155^	3.98
FR165R*	7.06
FR166T*	3.06
FR167Z*	9.55
FR168^	9.59
LB180//	16.33
LB181Y	15.72
LB182^*	12.53
LB183^*	8.78
PR200//	2.17
PR201Y	0.00
PR202^	3.09
PR203^	10.19
PR204^	8.24
PR205^	9.06
SR206//	2.76
SR207Y	1.68
SR208^	2.50
SR209	3.14
SR210	7.02
FPU220//*	2.77
FPU221Y*	2.01
FPU222^*	2.57
FPU223//*	3.81
FPU224Y*	2.23
FPU225^*	2.34
FPU226^	2.18
FPU230//	5.28
FPU231Y	4.03
FPU232^	5.99
FPU233//	4.49
FPU234Y	4.18
FPU235^	2.74
FPU236//	3.09
FPU237//	2.70
FPU238Y	2.68
FPU239//	3.69
FPU240Y	2.90
FPU241^	2.59
FPU242//	3.40
FPU243Y	2.30
FPU244^	2.73
FPU245//	2.85

FPU246Y	2.01
FPU247^	2.21
FPU248//	3.16
FPU249Y	2.51
FPU250^	3.06
B1-1	223.54
B1-2	185.62
B2-1	237.53
B2-2	175.35
B3-1	2.23
B3-2	174.88
B5-1	223.44
B5-2	206.84
B6-1	224.08
B6-2	187.28
B7-1	203.35
B7-2	165.85
SG01	117.15
SG02	75.84
SG11	60.47
SG12	57.89
SG21	57.84
SG22	34.54
SG23	252.75
SG24	265.21
SG34	310.81
SG41	49.79
SG42	144.80
SG43	30.73
SG44	31.20
SG35	65.11
SG36	75.65
SGVA1	37.99
SGVA2	44.42
SGVB3	31.98
SGVB4	36.84
SGLFI51	26.64
SGLFI52	36.91
SGLFI53	33.35
SGLFI54	20.83
SGLFI55	34.77
SGLFI56	24.97
SGLFI61	19.15
SGLFI62	61.67
SGLFI63	47.85
SGLFI64	28.69
SGLFI65	62.47
SGLFI66	22.16
SGLFI71	20.52
SGLFI72	70.04
SGLFI73	49.69
SGLFI74	33.71
SGLFI75	47.07
SGLFI76	31.53

ANNEX 3

RMS values NIA6 (range : 5-1000Hz)

RAPPORT D'ANALYSE
Fichier : nia6.pch Sub 11
Plage de frequence : [5 , 1000.00 Hz]

	Valeur RMS
SUB1//	0.93
SUB2Y	1.82
SUB3^	1.15
SUB4//	1.67
SUB5Y	1.36
SUB6^	2.92
SUB7^	1.00
SVM15R*	9.39
SVM16T*	3.17
SVM17Z*	3.55
SVM18^	3.23
SVM19^	27.29
SVM20^	14.81
SVM21^	24.03
GVA30Z	77.68
GVA31Z	46.10
GVA32R*	5.03
GVA33T*	4.91
GVA34Z*	19.52
GVA35Z*	21.61
GVA36R*	1.42
GVA37T*	3.86
GVA38Z*	18.85
GVA39Z*	20.30
GVA40Z	49.44
GVB50Z	47.04
GVB51Z	50.36
GVB52R*	6.43
GVB53T*	5.42
GVB54Z*	29.67
GVB55Z*	36.72
GVB56R*	4.15
GVB57T*	3.76
GVB58Z*	15.01
GVB59Z*	19.35
GVC70Z	47.25
GVC71Z	51.44
GVC72R*	6.09
GVC73T*	5.90
GVC74Z*	15.97
GVC75Z*	17.26
GVC76R*	4.38
GVC77T*	3.96
GVC78Z*	17.82
GVC79R*	4.31
GVC80T*	3.70
GVC81Z*	12.91
GVC82R*	4.05
GVC83T*	3.02
GVC84Z*	22.47
GVC85Z*	16.38
GVC86Z	63.42
BF100^	45.83
BF101^	52.09
BF102^	33.77
BF103^	0.44
BF104^	44.43
BF105^	32.06

PRP120//*	2.09
PRP121Y*	1.89
PRP122^*	4.60
PRP123//*	3.12
PRP124Y*	2.55
PRP125^*	6.66
PRP126^*	4.27
PRP127^*	3.94
PRP128//*	2.43
PRP129Y*	2.02
PRP130^*	4.13
PRP131//*	4.65
PRP132Y*	2.33
PRP133^*	4.29
PRP134^	3.85
PRP135//	2.42
PRP136Y	4.43
PRP137^	6.44
PRP138//	2.93
PRP139Y	2.43
PRP140^	6.66
PRP141^*	6.04
SRP150//	5.63
SRP151Y	4.34
SRP152^	4.67
SRP153//	6.89
SRP154Y	4.86
SRP155^	5.12
FR165R*	8.76
FR166T*	3.64
FR167Z*	12.37
FR168^	12.31
LB180//	20.93
LB181Y	20.93
LB182^*	16.32
LB183^*	11.83
PR200//	3.41
PR201Y	0.01
PR202^	3.92
PR203^	12.26
PR204^	10.06
PR205^	11.26
SR206//	3.52
SR207Y	2.96
SR208^	3.10
SR209	3.93
SR210	8.77
FPU220//*	3.03
FPU221Y*	2.71
FPU222^*	3.26
FPU223//*	4.60
FPU224Y*	2.89
FPU225^*	3.10
FPU226^	2.88
FPU230//	6.31
FPU231Y	4.82
FPU232^	7.49
FPU233//	5.36
FPU234Y	4.86
FPU235^	3.49
FPU236//	3.33
FPU237//	3.21
FPU238Y	3.42
FPU239//	4.46
FPU240Y	3.77
FPU241^	3.32
FPU242//	4.02
FPU243Y	2.96
FPU244^	3.60
FPU245//	3.25

FPU246Y	2.62
FPU247^	2.84
FPU248//	3.35
FPU249Y	3.19
FPU250^	4.11
B1-1	274.07
B1-2	230.22
B2-1	295.29
B2-2	219.24
B3-1	2.34
B3-2	212.58
B5-1	258.31
B5-2	241.02
B6-1	269.66
B6-2	228.41
B7-1	250.48
B7-2	201.99
SG01	106.65
SG02	52.64
SG11	77.54
SG12	71.37
SG21	71.81
SG22	40.78
SG23	362.81
SG24	4512.80
SG34	401.88
SG41	70.91
SG42	203.24
SG43	44.61
SG44	55.45
SG35	79.24
SG36	95.90
SGVA1	45.62
SGVA2	51.43
SGVB3	45.41
SGVB4	55.00
SGLFI51	32.90
SGLFI52	45.92
SGLFI53	43.03
SGLFI54	23.91
SGLFI55	42.22
SGLFI56	31.17
SGLFI61	22.62
SGLFI62	64.11
SGLFI63	46.65
SGLFI64	49.27
SGLFI65	65.04
SGLFI66	28.59
SGLFI71	23.40
SGLFI72	81.34
SGLFI73	37.59
SGLFI74	30.03
SGLFI75	49.76
SGLFI76	34.37

ANNEX 4

Loads on FPU links – BNA3 (RMS values – range : 0-1100Hz)

Bipode no 1	
Component	**RMS**
DSP_Fs_D_bp1	14.9
DSP_Ft_D_bp1	323.5
DSP_Fy_D_bp1	390.3
DSP_Fx_D_bp1	59.8
DSP_Mz_D_bp1	7.7
DSP_Fs_E_bp1	777.3
DSP_Fx_E_bp1	59.8
DSP_Fy_E_bp1	390.3
DSP_Mz_E_bp1	8.4
DSP_Fs_F_bp1	196.9
DSP_Ft_F_bp1	187.5
DSP_Fu_F_bp1	295.4
DSP_Fv_F_bp1	380.9
DSP_Fw_F_bp1	269.7
DSP_Mv_F_bp1	10.6
DSP_Mw_F_bp1	14.9
DSP_Fs_G_bp1	14.9
DSP_Ft_G_bp1	253.4
DSP_Fy_G_bp1	390.3
DSP_Fx_G_bp1	59.8
DSP_Mz_G_bp1	5.1
DSP_Fs_H_bp1	29.3
DSP_Ft_H_bp1	144.6
DSP_Fu_H_bp1	175.8
DSP_Fv_H_bp1	353.5
DSP_Mw_H_bp1	6.4
DSP_Fs_I_bp1	14.9
DSP_Ft_I_bp1	311.7
DSP_Fy_I_bp1	374.7
DSP_Fx_I_bp1	59.8
DSP_Mz_I_bp1	7.5
DSP_Fs_J_bp1	748.6
DSP_Fx_J_bp1	59.8
DSP_Fy_J_bp1	374.7
DSP_Mz_J_bp1	8.2
DSP_Fs_K_bp1	14.9
DSP_Ft_K_bp1	262.8
DSP_Fy_K_bp1	374.7
DSP_Fx_K_bp1	59.8
DSP_Mz_K_bp1	5.8
DSP_Fs_L_bp1	19.0
DSP_Ft_L_bp1	153.0
DSP_Fu_L_bp1	114.2
DSP_Fv_L_bp1	361.8
DSP_Mw_L_bp1	7.1

Bipode no 2	
Component	**RMS**
DSP_Fs_D_bp2	26.1
DSP_Ft_D_bp2	562.5
DSP_Fy_D_bp2	542.8
DSP_Fx_D_bp2	104.5
DSP_Mz_D_bp2	12.7
DSP_Fs_E_bp2	1118.5
DSP_Fx_E_bp2	104.5
DSP_Fy_E_bp2	542.8
DSP_Mz_E_bp2	14.0
DSP_Fs_F_bp2	288.7
DSP_Ft_F_bp2	302.1
DSP_Fu_F_bp2	547.8
DSP_Fv_F_bp2	289.1
DSP_Fw_F_bp2	204.7
DSP_Mv_F_bp2	18.0
DSP_Mw_F_bp2	25.5
DSP_Fs_G_bp2	26.1
DSP_Ft_G_bp2	433.1
DSP_Fy_G_bp2	542.8
DSP_Fx_G_bp2	104.5
DSP_Mz_G_bp2	9.0
DSP_Mz_K_bp2	9.3
DSP_Fs_H_bp2	46.8
DSP_Ft_H_bp2	247.9
DSP_Fu_H_bp2	280.9
DSP_Fv_H_bp2	476.0
DSP_Mw_H_bp2	11.4
DSP_Fs_I_bp2	26.1
DSP_Ft_I_bp2	563.2
DSP_Fy_I_bp2	560.9
DSP_Fx_I_bp2	104.5
DSP_Mz_I_bp2	12.8
DSP_Fs_J_bp2	1066.1
DSP_Fx_J_bp2	104.5
DSP_Fy_J_bp2	560.9
DSP_Mz_J_bp2	14.0
DSP_Fs_K_bp2	26.1
DSP_Ft_K_bp2	436.0
DSP_Fy_K_bp2	560.9
DSP_Fx_K_bp2	104.5
DSP_Fs_L_bp2	22.1
DSP_Ft_L_bp2	260.4
DSP_Fu_L_bp2	132.6
DSP_Fv_L_bp2	555.0
DSP_Mw_L_bp2	11.7

Bipode no 3	
Component	**RMS**
DSP_Fs_D_bp3	27.6
DSP_Ft_D_bp3	627.6
DSP_Fy_D_bp3	612.7
DSP_Fx_D_bp3	110.4
DSP_Mz_D_bp3	14.1
DSP_Fs_E_bp3	1161.5
DSP_Fx_E_bp3	110.4
DSP_Fy_E_bp3	612.7
DSP_Mz_E_bp3	15.4
DSP_Fs_F_bp3	275.6
DSP_Ft_F_bp3	289.5
DSP_Fu_F_bp3	590.9
DSP_Fv_F_bp3	309.3
DSP_Fw_F_bp3	219.0
DSP_Mv_F_bp3	16.9
DSP_Mw_F_bp3	23.9
DSP_Fs_G_bp3	27.6
DSP_Ft_G_bp3	445.3
DSP_Fy_G_bp3	612.7
DSP_Fx_G_bp3	110.4
DSP_Mz_G_bp3	8.8
DSP_Mz_K_bp3	13.8
DSP_Fs_H_bp3	52.0
DSP_Ft_H_bp3	258.5
DSP_Fu_H_bp3	312.1
DSP_Fv_H_bp3	538.7
DSP_Mw_H_bp3	11.3
DSP_Fs_I_bp3	27.6
DSP_Ft_I_bp3	442.6
DSP_Fy_I_bp3	569.8
DSP_Fx_I_bp3	110.4
DSP_Mz_I_bp3	9.1
DSP_Fs_J_bp3	879.9
DSP_Fx_J_bp3	110.4
DSP_Fy_J_bp3	569.8
DSP_Mz_J_bp3	10.5
DSP_Fs_K_bp3	27.6
DSP_Ft_K_bp3	608.7
DSP_Fy_K_bp3	569.8
DSP_Fx_K_bp3	110.4
DSP_Fs_L_bp3	20.4
DSP_Ft_L_bp3	342.5
DSP_Fu_L_bp3	122.6
DSP_Fv_L_bp3	567.3
DSP_Mw_L_bp3	16.4

ANNEX 5

Loads on FPU links – NIA6 (RMS values – range : 0-1100Hz)

Bipode no 1		Bipode no 2		Bipode no 3	
Component	**RMS**	**Component**	**RMS**	**Component**	**RMS**
DSP_Fs_D_bp1	18.6851	DSP_Fs_D_bp2	47.1509	DSP_Fs_D_bp3	50.2276
DSP_Ft_D_bp1	405.28	DSP_Ft_D_bp2	733.87	DSP_Ft_D_bp3	849.43
DSP_Fy_D_bp1	502.635	DSP_Fy_D_bp2	441.628	DSP_Fy_D_bp3	472.976
DSP_Fx_D_bp1	74.7404	DSP_Fx_D_bp2	188.604	DSP_Fx_D_bp3	200.91
DSP_Mz_D_bp1	9.52466	DSP_Mz_D_bp2	18.5218	DSP_Mz_D_bp3	21.6404
DSP_Fs_E_bp1	864.32	DSP_Fs_E_bp2	1412.93	DSP_Fs_E_bp3	1565.12
DSP_Fx_E_bp1	74.7404	DSP_Fx_E_bp2	188.604	DSP_Fx_E_bp3	200.91
DSP_Fy_E_bp1	502.635	DSP_Fy_E_bp2	441.628	DSP_Fy_E_bp3	472.976
DSP_Mz_E_bp1	10.4225	DSP_Mz_E_bp2	20.8216	DSP_Mz_E_bp3	24.116
DSP_Fs_F_bp1	215.021	DSP_Fs_F_bp2	384.814	DSP_Fs_F_bp3	390.802
DSP_Ft_F_bp1	231.731	DSP_Ft_F_bp2	468.364	DSP_Ft_F_bp3	478.6
DSP_Fu_F_bp1	254.814	DSP_Fu_F_bp2	662.224	DSP_Fu_F_bp3	724.371
DSP_Fv_F_bp1	616.218	DSP_Fv_F_bp2	387.272	DSP_Fv_F_bp3	381.941
DSP_Fw_F_bp1	436.307	DSP_Fw_F_bp2	274.204	DSP_Fw_F_bp3	270.43
DSP_Mv_F_bp1	11.225	DSP_Mv_F_bp2	27.4066	DSP_Mv_F_bp3	27.5627
DSP_Mw_F_bp1	15.8537	DSP_Mw_F_bp2	38.7078	DSP_Mw_F_bp3	38.9282
DSP_Fs_G_bp1	18.6851	DSP_Fs_G_bp2	47.1509	DSP_Fs_G_bp3	50.2276
DSP_Ft_G_bp1	336.681	DSP_Ft_G_bp2	802.739	DSP_Ft_G_bp3	787.068
DSP_Fy_G_bp1	502.635	DSP_Fy_G_bp2	441.628	DSP_Fy_G_bp3	472.976
DSP_Fx_G_bp1	74.7404	DSP_Fx_G_bp2	188.604	DSP_Fx_G_bp3	200.91
DSP_Mz_G_bp1	6.58955	DSP_Mz_G_bp2	20.7589	DSP_Mz_G_bp3	19.822
DSP_Fs_H_bp1	38.0547	DSP_Fs_H_bp2	52.0213	DSP_Fs_H_bp3	56.3647
DSP_Ft_H_bp1	191.089	DSP_Ft_H_bp2	432.77	DSP_Ft_H_bp3	432.199
DSP_Fu_H_bp1	228.328	DSP_Fu_H_bp2	312.128	DSP_Fu_H_bp3	338.188
DSP_Fv_H_bp1	453.976	DSP_Fv_H_bp2	364.942	DSP_Fv_H_bp3	386.911
DSP_Mw_H_bp1	8.25121	DSP_Mw_H_bp2	25.1555	DSP_Mw_H_bp3	24.5316
DSP_Fs_I_bp1	18.6851	DSP_Fs_I_bp2	47.1509	DSP_Fs_I_bp3	50.2276
DSP_Ft_I_bp1	259.743	DSP_Ft_I_bp2	769.356	DSP_Ft_I_bp3	659.266
DSP_Fy_I_bp1	375.994	DSP_Fy_I_bp2	639.351	DSP_Fy_I_bp3	656.269
DSP_Fx_I_bp1	74.7404	DSP_Fx_I_bp2	188.604	DSP_Fx_I_bp3	200.91
DSP_Mz_I_bp1	6.94719	DSP_Mz_I_bp2	18.5589	DSP_Mz_I_bp3	14.8977
DSP_Fs_J_bp1	769.682	DSP_Fs_J_bp2	1405.35	DSP_Fx_J_bp3	200.91
DSP_Fx_J_bp1	74.7404	DSP_Fx_J_bp2	188.604	DSP_Fy_J_bp3	656.269
DSP_Fy_J_bp1	375.994	DSP_Fy_J_bp2	639.351	DSP_Mz_J_bp3	17.3625
DSP_Mz_J_bp1	7.59324	DSP_Mz_J_bp2	20.85	DSP_Fs_J_bp3	1224.34
DSP_Fs_K_bp1	18.6851	DSP_Fs_K_bp2	47.1509	DSP_Fs_K_bp3	50.2276
DSP_Ft_K_bp1	433.787	DSP_Ft_K_bp2	836.079	DSP_Ft_K_bp3	1065.93
DSP_Fy_K_bp1	375.994	DSP_Fy_K_bp2	639.351	DSP_Fy_K_bp3	656.269
DSP_Fx_K_bp1	74.7404	DSP_Fx_K_bp2	188.604	DSP_Fx_K_bp3	200.91
DSP_Mz_K_bp1	11.8996	DSP_Mz_K_bp2	20.8675	DSP_Mz_K_bp3	26.5359
DSP_Fs_L_bp1	25.8587	DSP_Fs_L_bp2	27.1207	DSP_Fs_L_bp3	20.1705
DSP_Ft_L_bp1	220.501	DSP_Ft_L_bp2	475.436	DSP_Ft_L_bp3	588.945
DSP_Fu_L_bp1	155.152	DSP_Fu_L_bp2	162.724	DSP_Fu_L_bp3	121.023
DSP_Fv_L_bp1	350.55	DSP_Fv_L_bp2	646.422	DSP_Fv_L_bp3	675.579
DSP_Mw_L_bp1	13.508	DSP_Mw_L_bp2	25.2523	DSP_Mw_L_bp3	31.2618

ANNEX 6

Dynaworks script for LFI FPU links loads recovery

```
#==================================================
=================================
#
#                   Essais vibrations aléatoires PLANCK
#
#
#Calcul des torseurs d'efforts aux IF des bipodes.
#Calcul des DSP des efforts et des valeurs RMS.
#
#
#
# Gilles Carte, BE SYSTEM (2004).
# Denis Rébuffat, ALCATEL (2004).
#==================================================
=================================
.begin

torseur_jauges()

#==================================================
=================================
#
#==================================================
=================================

prefix = "./Macros_PLANCK/"

nom_macro = prefix//"choix_essai"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"load_or_create_tab"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"registre_defaut"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"setlabel_gc"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"view2d_gc1"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"view2d_gc2"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"view2d_gc3"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"liaison_f"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"liaison_type_e"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"liaison_type_d_mod"
loadmacrofile(nom_macro, ADD)

nom_macro = prefix//"liaison_type_h"
loadmacrofile(nom_macro, ADD)

#==================================================
=================================
# Initialisations
#
# n_def  = registre par défaut (initialisation à 0 ou 1)
# n_jg   = registre de la liste des jauges
# nj0    = la 1ère jauge est stockée à nj0+1 (les autres suivent)
#==================================================
=================================

debug = 0                          Chargement des macros

classe_rep   = "Temporel"
classe_essai = "Essai"

n_def   = 2
n_jg    = 3
n_screw = 4
n_tors  = 5

nj0   = 10

n_fa  = 20
n_fb  = 21
n_fs  = 22
n_ft  = 23
n_mt  = 24
n_ma  = 25
n_mb  = 26
n_mc  = 27
n_fta = 28
n_fna = 29
n_ftc = 30
n_fnc = 31
n_tmp = 32

#==================================================
=================================
```

```
# Création du tableau de synthèse pour les vis
#=================================================================================

nb_synt=0

r(n_screw) = create_array( "Réponse", "Link", STRING, 27)

addcolumn(r(n_screw), AFTER, 1, "Bipode"      , INTEGER)
addcolumn(r(n_screw), AFTER, 2, "F_shear"     , FLOAT)
addcolumn(r(n_screw), AFTER, 3, "spec_shear"  , FLOAT)
addcolumn(r(n_screw), AFTER, 4, "SM_shear"    , FLOAT)
addcolumn(r(n_screw), AFTER, 5, "F_tension"   , FLOAT)
addcolumn(r(n_screw), AFTER, 6, "spec_tension", FLOAT)
addcolumn(r(n_screw), AFTER, 7, "SM_tension"  , FLOAT)

#=================================================================================
# Caractéristiques géométriques des bipodes
#=================================================================================

f1=1100.
f2=3200.

pii = 3.141592

# Rayon, épaisseur et module d'Young du matériau du tube
rayon   = 31.75e-3/2.
ep      =  1.75e-3
young   = 87.00e+9
section = 2.0*pii*rayon*ep

# Distances entre jauges et aux points d'IF
d_ab = 86.80e-3
d_ad = 59.00e-3
d_ae = 71.40e-3
d_af = 87.15e-3
d_bg = 59.00e-3
d_bh = 82.60e-3

d_ci = d_ad
d_cj = d_ae
d_cf = d_af
d_ck = d_ab + d_bg
d_cl = d_ab + d_bh

# Angle ferrure côté sommet, angle au sommet et angle ferrure base
alpha  = 54.7
theta  = 41.4
theta2 = theta/2.0
beta   = theta2

# Conversion des angles en radians
alpha  = pii*alpha/180.
beta   = pii*beta /180.
theta2 = pii*theta2/180.

#=================================================================================
#
#=================================================================================

ichoix = 1
liste = dbselect(WORK, classe_essai)

choix_essai(liste, ichoix)

idessai = getlabel(liste(ichoix), "IdEssai")
essai   = getlabel(liste(ichoix), "Essai")
date    = getlabel(liste(ichoix), "DateEssai")
niv_exc = getlabel(liste(ichoix), "Niveau")

#=================================================================================
#
#=================================================================================

unite_def=menu("Unité des déformations", "m", "cm", "mm", "micron", 4)

if (unite_def=="cm") then
  coeff_def=1.e-2
elseif (unite_def=="mm") then
  coeff_def=1.e-3
elseif (unite_def=="micron") then
  coeff_def=1.e-6
endif

#=================================================================================
#
#=================================================================================

registre_defaut(n_def, classe_rep, idessai)
```

```
#==================================================
================================
# Choix des paramètres de la fonction GXX
#==================================================
================================

nb_pts  = menu("Nombre de points par segments", "128", "256", "512", "1024", 2)
fenetre = menu("Choix de la fenêtre", "RECTANG", "HANNING", "HAMMING", "PARZEN",
"BLACKMAN", "LAPLACE", 2)

nb_pts=atoi(nb_pts)

#==================================================
================================
# Boucle sur les trois bipodes
#==================================================
================================

n_bipod = 1

#message_win("Attention: démarrage au bipode 3")

while(n_bipod <= 3)

text_bipod=sprintf("Bipode no %d: ",n_bipod)

#==================================================
================================
#
#==================================================
================================

nom_tab   = sprintf("jauges_bipode_%d", n_bipod)
nom_macro = nom_tab

load_or_create_tab(prefix, n_jg, nom_tab, nom_macro, 0)

#==================================================
================================
#
#==================================================
================================

nj    = nj0
nb_jg = nbx(r(n_jg))

k=1
kmax=nb_jg
while(k<=kmax)

  nom = r(n_jg)."jauge"(k)

  crit1="Fonction == \"Temporel\""
  crit2=sprintf("PointMesure == \"%s\"",nom)
  crit3=sprintf("IdEssai == %d",idessai)

  crit=sprintf("%s et %s et %s",crit1,crit2,crit3)

  liste=dbselect(WORK,classe_rep,crit)
  n_select=dbnbselect(liste)

# Si la jauge est introuvable
  if (n_select<=0) then
     text="Jauge "//nom//" introuvable...\nMise à zéro."
     message_win(text)
     nj+=1
     r(nj)=r(n_def)

# S'il y a plus d'une jauge répondant au critère dans la BD
  elseif (n_select>=2) then
     text=sprintf("%d jauges satisfont le critère\nChoix de la dernière\n",n_select)
     message_win(text)
     nj+=1
     r(nj)=dbreadselected(liste,n_select)

# S'il y a une et une seule jauge répondant au critère dans la BD
  elseif (n_select==1) then       Récupération de la liste des jauges
     nj+=1
     r(nj)=dbreadselected(liste,1)
  endif

# Ajustement par rapport aux unités
  r(nj)*=coeff_def

# Incrémentation du compteur de boucle
  k+=1

endwhile                              Chargement des jauges, type temporel

#==================================================
================================
# Combinaison des jauges pour calcul des efforts résultants
# n_fa = effort normal en A
# n_ma = moment de flexion en A
# n_fb, n_mb, n_fnc, n_mc idem qu'en A mais en B, C, D, E et F
# n_fta effort tranchant dans la barre AB
# n_fna effort normal    dans la barre AB
```

```
#====================================================
==================================

# Point A
nj1 = nj0 + 1
nj2 = nj0 + 2
r(n_fa) =       young*section*0.5*(r(nj2) + r(nj1))
r(n_ma) = rayon*young*section*0.5*(r(nj2) - r(nj1))

# Point B
nj1 = nj0 + 3
nj2 = nj0 + 4
r(n_fb) =       young*section*0.5*(r(nj2) + r(nj1))
r(n_mb) = rayon*young*section*0.5*(r(nj2) - r(nj1))

# Point C
nj1 = nj0 + 5
nj2 = nj0 + 6
r(n_fnc) =       young*section*0.5*(r(nj2) + r(nj1))
r(n_mc ) = rayon*young*section*0.5*(r(nj2) - r(nj1))

# Effort tranchant (dérivée du moment)
r(n_fta) = (r(n_ma) - r(n_mb))/d_ab

# Effort normal (moyenne entre A et B)
r(n_fna) = 0.5*(r(n_fa)+r(n_fb))

#====================================================
==================================
# Comparaison des moments en A et C pour estimation effort tranchant en C
#====================================================
==================================

X_AXIS=LIN
Y_AXIS=LIN

setlabel(r(n_ma),"PointMesure", "Moment de flexion en A")
setlabel(r(n_mc),"PointMesure", "Moment de flexion en C")
vue = text_bipod//"comparaison des moments de flexion en A et C"

r(n_tmp)=abs(r(n_mc))

view2d(r(n_ma), r(n_tmp), vue, 0, 0, 700, 500)

rep = prompt("Comparaison satisfaisante ?")

if (rep == 1) then
  r(n_ftc) = r(n_fta)
else
  r(n_ftc) = r(n_fta)*r(n_mc)/r(n_ma)
endif

close2d(vue)

CURVE2D_CAPTION="\Essai.Essai\" \"PointMesure\" \"Type\" \"RMS\""
CURVE2D_CAPTION_SYNONIMS="\"Essai\" \"PointMesure\" \"Type\" \"RMS\""

#====================================================
==================================
# Torseur en F et calcul efforts vis semelle ferrure sommet
#====================================================
==================================

liaison_f()

#====================================================
==================================
# Torseurs en E et J: calcul efforts vis équerres - ferrure sommet
#====================================================
==================================

liaison_type_e(n_fna, n_fta, n_ma, d_ae, "E")
liaison_type_e(n_fnc, n_ftc, n_mc, d_cj, "J")

#====================================================
==================================
# Torseurs en D, G, I et K: calcul efforts vis équerres - embout tube
#====================================================
==================================

liaison_type_d(n_fna, n_fta, n_ma,  d_ad, "D")
liaison_type_d(n_fna, n_fta, n_mb, -d_bg, "G")
liaison_type_d(n_fnc, n_ftc, n_mc,  d_ci, "I")
liaison_type_d(n_fnc, n_ftc, n_mc, -d_ck, "K")

#====================================================
==================================
# Torseurs en H et L: calcul efforts vis semelle ferrure base
#====================================================
==================================

liaison_type_h(n_fna, n_fta, n_mb, -d_bh, "H")
liaison_type_h(n_fnc, n_ftc, n_mc, -d_cl, "L")

n_bipod += 1
endwhile

# Fin de la boucle sur les bipodes
```

```
#=================================================
===============================
# Affichage et sauvegarde du tableau de synthèse pour les vis
#=================================================
===============================

setlabel(r(n_screw),"Commentaire","Tableau synthèse efforts RMS dans les vis")
setlabel(r(n_screw),"PointMesure","tab_RMS_screw")
setlabel(r(n_screw),"Fonction","synthese")
setlabel(r(n_screw),"IdEssai",idessai)

edit(r(n_screw))

message_win("Penses à imprimer le tableau\nde synthèse pour les vis !\n")

dbwrite(r(n_screw),WORK,"Réponse")

#=================================================
===============================
# Construction, affichage et sauvegarde du tableau de synthèse pour les vis
#=================================================
===============================

crit1 = sprintf("IdEssai == %d", idessai)
crit2 = "Fonction == \"postrait\""
crit  = crit1//" et "//crit2
liste = dbselect(WORK, "DSP", crit)

n_select = dbnbselect(liste)

if (n_select > 0) then

# Création du tableau de synthèse pour les torseurs
  r(n_tors) = create_array( "Réponse", "Component", STRING, n_select)

  AddColumn(r(n_tors), AFTER, 1, "IdEssai", INTEGER)
  AddColumn(r(n_tors), AFTER, 2, "RMS"    , FLOAT  )


  k=1
  while(k<=n_select)
    nom  = getlabel(liste(k),"PointMesure")
    rms1 = getlabel(liste(k),"RMS")
    r(n_tors)."Component"(k)=nom
    r(n_tors)."IdEssai"(k)=idessai
    r(n_tors)."RMS"(k)=rms1
    k+=1
  endwhile

  setlabel(r(n_tors),"Commentaire","Tableau synthèse des composantes RMS des torseurs")
  setlabel(r(n_tors),"PointMesure","tab_RMS_torseur")
  setlabel(r(n_tors),"Fonction","synthese")
  setlabel(r(n_tors),"IdEssai",idessai)

  edit(r(n_tors))

  message_win("Penses à imprimer le tableau\nde synthèse des torseurs !\n")

  dbwrite(r(n_tors),WORK,"Réponse")
endif

#=================================================
===============================
# Fin de la macro
#=================================================
===============================

text1="Tableaux de synthèse des efforts RMS dans les vis\n"
text2="et des composantes RMS des torseurs sauvegardés\n"
text3="dans la BD...ça peut servir, s'pas ?\n\n"
text4="Fin de la macro...ciao !\n"
text=text1//text2//text3//text4
message_win(text)

.end
```

```
#----------------------------------------------------------------------------
#
# Calculs des éléments de la liaison type F
#
# - torseur au point F
#- tension et cisaillement des vis de la liaison
#- DSP et valeurs RMS
#- marges de sécurité
#
# Gilles CARTE, BE SYSTEM (2004)
#----------------------------------------------------------------------------

.begin
liaison_f()

# Initialisation
n_fx   = 60
n_fy   = 61
n_fu   = 62
n_fv   = 63
n_fw   = 64
n_mv   = 65
n_mw   = 66
dsp_fs = 67
dsp_ft = 68
dsp_fu = 69
dsp_fv = 70
dsp_fw = 71
dsp_mu = 72
dsp_mv = 73
dsp_mw = 74
n_fx1  = 75
n_fx2  = 76
n_fy1  = 77
n_fy2  = 78
n_fs1  = 79
n_fs2  = 80
n_fs3  = 81
n_fs4  = 82
n_fs   = 83
n_ft1  = 84
n_ft2  = 85
n_ft   = 86
dsp_fs = 87
dsp_fs1= 88
dsp_fs2= 89
dsp_fs3= 90
dsp_fs4= 91
dsp_ft = 92
        dsp_ft1= 93
        dsp_ft2= 94

        # Valeurs limites RMS à 3 sigmas des efforts dans les vis
        spec_fs = 2500./3.
        spec_ft = 2000./3.

        # Calcul du cisaillement dans les vis (plan (u,w))
        # Hypothèse: les 2 vis centrales ne reprennent aucun cisaillement
        d_u = 21.50e-3
        d_w =  9.73e-3
        d_uw =sqrt(d_u*d_u+d_w*d_w)

        # Projection sur la médiatrice du bipode et sa normale (point F)
        # Axe Y = médiatrice, axe X = normale à droite à Y dans le plan du bipode
        # Theta2 = demi angle au sommet du bipode

        r(n_fx) = sin(theta2)*(r(n_fna)-r(n_fnc)) + cos(theta2)*( r(n_fta)+r(n_ftc))
        r(n_fy) = cos(theta2)*(r(n_fna)+r(n_fnc)) + sin(theta2)*(-r(n_fta)+r(n_ftc))

        # Projection sur la semelle de la ferrure et sa normale (point F)

        r(n_fu) = r(n_fx)
        r(n_fv) = sin(alpha)*r(n_fy)
        r(n_fw) = cos(alpha)*r(n_fy)

        # Calcul du moment en F (moment en A + C + contribution efforts tranchants)

        r(n_mt) = r(n_ma) + d_af*r(n_fta) + r(n_mc) + d_cf*r(n_ftc)

        # Projection du moment sur les axes v et w

        r(n_mv) = -cos(alpha)*r(n_mt)
        r(n_mw) =  sin(alpha)*r(n_mt)

        cosg=d_u/d_uw
        sing=d_w/d_uw

        r(n_fx1) = r(n_fu)/6. + sing*r(n_mv)/(4.*d_uw)
        r(n_fx2) = r(n_fu)/6. - sing*r(n_mv)/(4.*d_uw)
        r(n_fy1) = r(n_fw)/6. + cosg*r(n_mv)/(4.*d_uw)
        r(n_fy2) = r(n_fw)/6. - cosg*r(n_mv)/(4.*d_uw)

        r(n_fs1) = sqrt(r(n_fx1)*r(n_fx1)+r(n_fy1)*r(n_fy1))
        r(n_fs2) = sqrt(r(n_fx1)*r(n_fx1)+r(n_fy2)*r(n_fy2))
        r(n_fs3) = sqrt(r(n_fx2)*r(n_fx2)+r(n_fy1)*r(n_fy1))
        r(n_fs4) = sqrt(r(n_fx2)*r(n_fx2)+r(n_fy2)*r(n_fy2))

        # Calcul de la traction dans les vis
```

```
# Hypothèse: les deux vis centrales ne reprennent aucun effort dû au moment

r(n_ft1) = r(n_fv)/6. + r(n_mw)/(4.*d_u)
r(n_ft2) = r(n_fv)/6. - r(n_mw)/(4.*d_u)

# DSP traction
command="r(dsp_ft1) = gxx(r(n_ft1), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_ft2) = gxx(r(n_ft2), "//fenetre//", nb_pts, 0.05)"
exec(command)

# DSP cisaillement
command="r(dsp_fs1) = gxx(r(n_fs1), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fs2) = gxx(r(n_fs2), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fs3) = gxx(r(n_fs3), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fs4) = gxx(r(n_fs4), "//fenetre//", nb_pts, 0.05)"
exec(command)

# Troncature des DSP
cut(r(dsp_ft1),X,f1,f2)
rms1=psdrmsval(r(dsp_ft1))
setlabel(r(dsp_ft1),"RMS",rms1)
rms_ft1=rms1

cut(r(dsp_ft2),X,f1,f2)
rms1=psdrmsval(r(dsp_ft2))
setlabel(r(dsp_ft2),"RMS",rms1)
rms_ft2=rms1

# Recherche du max de la tension
rms_ft = rms_ft1
r(dsp_ft)=r(dsp_ft1)
if (rms_ft2 >= rms_ft) then
   rms_ft    = rms_ft2
   r(dsp_ft) = r(dsp_ft2)
endif

# Troncature des DSP cisaillement
cut(r(dsp_fs1),X,f1,f2)
rms1=psdrmsval(r(dsp_fs1))
setlabel(r(dsp_fs1),"RMS",rms1)
rms_fs1=rms1

cut(r(dsp_fs2),X,f1,f2)
rms1=psdrmsval(r(dsp_fs2))
setlabel(r(dsp_fs2),"RMS",rms1)
rms_fs2=rms1

cut(r(dsp_fs3),X,f1,f2)
rms1=psdrmsval(r(dsp_fs3))
setlabel(r(dsp_fs3),"RMS",rms1)
rms_fs3=rms1

cut(r(dsp_fs4),X,f1,f2)
rms1=psdrmsval(r(dsp_fs4))
setlabel(r(dsp_fs4),"RMS",rms1)
rms_fs4=rms1

# Recherche du max du cisaillement
rms_fs    = rms_fs1
r(dsp_fs) = r(dsp_fs1)

if (rms_fs2 >= rms_fs) then
   rms_fs    = rms_fs2
   r(dsp_fs) = r(dsp_fs2)
endif

if (rms_fs3 >= rms_fs) then
   rms_fs    = rms_fs3
   r(dsp_fs) = r(dsp_fs3)
endif

if (rms_fs4 >= rms_fs) then
   rms_fs    = rms_fs4
   r(dsp_fs) = r(dsp_fs4)
endif

# Marges de sécurité
SM_fs = 100.*(spec_fs/rms_fs - 1.)
SM_ft = 100.*(spec_ft/rms_ft - 1.)

# Tableau de synthèse
nb_synt+=1
r(n_screw)."Link"        (nb_synt) = "F"
r(n_screw)."Bipode"      (nb_synt) = n_bipod
r(n_screw)."F_shear"     (nb_synt) = rms_fs
r(n_screw)."spec_shear"  (nb_synt) = spec_fs
r(n_screw)."SM_shear"    (nb_synt) = SM_fs
r(n_screw)."F_tension"   (nb_synt) = rms_ft
r(n_screw)."spec_tension"(nb_synt) = spec_ft
r(n_screw)."SM_tension"  (nb_synt) = SM_ft

# Affectation des LABEL
setlabel_gc(dsp_fs,"DSP cisailt vis liaison F","DSP_Fs_F","postrait",n_bipod,idessai)
setlabel_gc(dsp_ft,"DSP tension vis liaison F","DSP_Ft_F","postrait",n_bipod,idessai)
```

```
# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fs ),WORK,"DSP")
dbwrite(r(dsp_ft ),WORK,"DSP")

# Message d'infos
text0 = "Link F\nRMS values and spec.\n\n"
text1 = sprintf("Fs=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_fs,spec_fs,SM_fs)
text2 = sprintf("Ft=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_ft,spec_ft,SM_ft)
text=text0//text1//text2

if (debug == 1) then
  message_win(text)
endif

#=================================================
================================
# DSP des composantes du torseur local
#=================================================
================================

command="r(dsp_fu) = gxx(r(n_fu), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fv) = gxx(r(n_fv), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fw) = gxx(r(n_fw), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_mv) = gxx(r(n_mv), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_mw) = gxx(r(n_mw), "//fenetre//", nb_pts, 0.05)"
exec(command)

cut(r(dsp_fu),X,f1,f2)
rms1=psdrmsval(r(dsp_fu))
setlabel(r(dsp_fu),"RMS",rms1)

cut(r(dsp_fv),X,f1,f2)
rms1=psdrmsval(r(dsp_fv))
setlabel(r(dsp_fv),"RMS",rms1)

cut(r(dsp_fw),X,f1,f2)
rms1=psdrmsval(r(dsp_fw))
setlabel(r(dsp_fw),"RMS",rms1)

cut(r(dsp_mv),X,f1,f2)
rms1=psdrmsval(r(dsp_mv))
setlabel(r(dsp_mv),"RMS",rms1)

cut(r(dsp_mw),X,f1,f2)
rms1=psdrmsval(r(dsp_mw))
setlabel(r(dsp_mw),"RMS",rms1)

# Affectation des LABEL
setlabel_gc(dsp_fu,"DSP Fu plan torseur F","DSP_Fu_F","postrait",n_bipod,idessai)
setlabel_gc(dsp_fv,"DSP Fv perp torseur F","DSP_Fv_F","postrait",n_bipod,idessai)
setlabel_gc(dsp_fw,"DSP Fw plan torseur F","DSP_Fw_F","postrait",n_bipod,idessai)
setlabel_gc(dsp_mv,"DSP Mv perp torseur F","DSP_Mv_F","postrait",n_bipod,idessai)
setlabel_gc(dsp_mw,"DSP Mw plan torseur F","DSP_Mw_F","postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fu ),WORK,"DSP")
dbwrite(r(dsp_fv ),WORK,"DSP")
dbwrite(r(dsp_fw ),WORK,"DSP")
dbwrite(r(dsp_mv ),WORK,"DSP")
dbwrite(r(dsp_mw ),WORK,"DSP")

.end
```

```
#---------------------------------------------------------------------------
#
# Calculs des éléments de la liaison type D
#
# - torseur au point D
#- tension et cisaillement des vis de la liaison
#- DSP et valeurs RMS
#- marges de sécurité
#
# Gilles CARTE, BE SYSTEM (2004)
#---------------------------------------------------------------------------

.begin

liaison_type_d(n1, n2, n3, dist, nom)

# Initialisation no des registres
nfn=n1
nft=n2
nm =n3

n_mt    = 80
n_ft1   = 81
n_ft2   = 82
dsp_ft  = 83
dsp_ft1 = 84
dsp_ft2 = 85
dsp_fs  = 86
dsp_fn  = 87
dsp_mt  = 88

# Distance entre les vis
d_x=7.20e-3

# Valeurs cisaillement RMS seuil à 3 sigma
spec_fs = 2555./3.
spec_ft = 1366./3.

# Moment en D ou G (ou I ou K) suivant la barre considérée
r(n_mt) = r(nm) + dist*r(nft)

# Cisaillement dû à l'effort tranchant uniquement réparti entre 4 vis
r(n_fs)=r(nft)/4.

# Tensions dues à l'effort normal et au moment Mz répartie entre 4 vis
r(n_ft1)=r(nfn)/4. + r(n_mt)/(4.*d_x)
r(n_ft2)=r(nfn)/4. - r(n_mt)/(4.*d_x)

# DSP cisaillement
    command="r(dsp_fs) = gxx(r(n_fs), "//fenetre//", nb_pts, 0.05)"
    exec(command)

    # DSP tension
    command="r(dsp_ft1) = gxx(r(n_ft1), "//fenetre//", nb_pts, 0.05)"
    exec(command)
    command="r(dsp_ft2) = gxx(r(n_ft2), "//fenetre//", nb_pts, 0.05)"
    exec(command)

    # Troncature ft1
    cut(r(dsp_ft1),X,f1,f2)
    rms1=psdrmsval(r(dsp_ft1))
    setlabel(r(dsp_ft1),"RMS",rms1)
    rms_ft1=rms1

    # Troncature ft2
    cut(r(dsp_ft2),X,f1,f2)
    rms1=psdrmsval(r(dsp_ft2))
    setlabel(r(dsp_ft2),"RMS",rms1)
    rms_ft2=rms1

    # Recherche du max entre ft1 et ft2
    rms_ft = rms_ft1
    r(dsp_ft)=r(dsp_ft1)
    if (rms_ft2 >= rms_ft) then
       rms_ft    = rms_ft2
       r(dsp_ft) = r(dsp_ft2)
    endif

    # Troncature fs
    cut(r(dsp_fs),X,f1,f2)
    rms1=psdrmsval(r(dsp_fs))
    setlabel(r(dsp_fs),"RMS",rms1)
    rms_fs=rms1

    # Marges de sécurité
    SM_fs = 100.*(spec_fs/rms_fs - 1.)
    SM_ft = 100.*(spec_ft/rms_ft - 1.)

    # Tableau de synthèse
    nb_synt+=1
    r(n_screw)."Link"        (nb_synt) = nom
    r(n_screw)."Bipode"      (nb_synt) = n_bipod
    r(n_screw)."F_shear"     (nb_synt) = rms_fs
    r(n_screw)."spec_shear"  (nb_synt) = spec_fs
    r(n_screw)."SM_shear"    (nb_synt) = SM_fs
    r(n_screw)."F_tension"   (nb_synt) = rms_ft
    r(n_screw)."spec_tension"(nb_synt) = spec_ft
    r(n_screw)."SM_tension"  (nb_synt) = SM_ft
```

```
# Affectation des LABEL
comment = "DSP cisailt vis liaison "//nom
nom_pt  = "DSP_Fs_"//nom
setlabel_gc(dsp_fs,comment,nom_pt,"postrait",n_bipod,idessai)

comment = "DSP tension vis liaison "//nom
nom_pt  = "DSP_Ft_"//nom
setlabel_gc(dsp_ft,comment,nom_pt,"postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fs),WORK,"DSP")
dbwrite(r(dsp_ft),WORK,"DSP")

# Message d'infos
text0 = sprintf("Link %s\nRMS values and spec.\n\n", nom)
text1 = sprintf("Fs=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_fs,spec_fs,SM_fs)
text2 = sprintf("Ft=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_ft,spec_ft,SM_ft)
text=text0//text1//text2

if (debug == 1) then
   message_win(text)
endif

#==================================================
================================
# DSP des composantes du torseur local
#==================================================
================================

# Calcul des DSP
command="r(dsp_fn) = gxx(r(nfn), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_ft) = gxx(r(nft), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_mt) = gxx(r(n_mt), "//fenetre//", nb_pts, 0.05)"
exec(command)

# Troncature des DSP
cut(r(dsp_fn),X,f1,f2)
rms1=psdrmsval(r(dsp_fn))
setlabel(r(dsp_fn),"RMS",rms1)
rms_fax=rms1

cut(r(dsp_ft),X,f1,f2)
rms1=psdrmsval(r(dsp_ft))
setlabel(r(dsp_ft),"RMS",rms1)
rms_flat=rms1

cut(r(dsp_mt),X,f1,f2)
rms1=psdrmsval(r(dsp_mt))
setlabel(r(dsp_mt),"RMS",rms1)
rms_mt=rms1

# Affectation des LABEL
cm1="DSP Fy perp torseur "//nom
cm2="DSP Fx plan torseur "//nom
cm3="DSP Mz perp torseur "//nom

pm1="DSP_Fy_"//nom
pm2="DSP_Fx_"//nom
pm3="DSP_Mz_"//nom

setlabel_gc(dsp_fn,cm1,pm1,"postrait",n_bipod,idessai)
setlabel_gc(dsp_ft,cm2,pm2,"postrait",n_bipod,idessai)
setlabel_gc(dsp_mt,cm3,pm3,"postrait",n_bipod,idessai)

# Sauvegarde des DSP du torseur dans la BD
dbwrite(r(dsp_fn),WORK,"DSP")
dbwrite(r(dsp_ft),WORK,"DSP")
dbwrite(r(dsp_mt),WORK,"DSP")

.end
```

```
#---------------------------------------------------------------------------
#
# Calculs des éléments de la liaison type E
#
# - torseur au point E
#- tension et cisaillement des vis de la liaison
#- DSP et valeurs RMS
#- marges de sécurité
#
# Gilles CARTE, BE SYSTEM (2004)
#---------------------------------------------------------------------------

.begin

liaison_type_e(n1, n2, n3, dist, nom)

nfn=n1
nft=n2
nm =n3

n_mt    = 78
n_fy    = 79
n_fx1   = 80
n_fx2   = 81
n_fs1   = 82
n_fs2   = 83
dsp_fs  = 84
dsp_fs1 = 85
dsp_fs2 = 86
dsp_fu  = 87
dsp_fv  = 88
dsp_mu  = 89

# Aucune composante du torseur n'entraîne d'effort de tension
# Valeurs cisaillement RMS seuil à 3 sigma
spec_fs = 6475./3.

# Distance entre les vis
d_axe=9.e-3

# Moment en E (ou J) suivant la barre considérée
r(n_mt) = r(nm) + dist*r(nft)

# Cisaillement dû aux efforts normal et tranchant et au moment de flexion
r(n_fx1) = r(nft)/2. + r(n_mt)/(2.*d_axe)
r(n_fx2) = r(nft)/2. - r(n_mt)/(2.*d_axe)
r(n_fy ) = r(nfn)/2.
r(n_fs1) = sqrt(r(n_fx1)*r(n_fx1) + r(n_fy)*r(n_fy))
r(n_fs2) = sqrt(r(n_fx2)*r(n_fx2) + r(n_fy)*r(n_fy))

# DSP cisaillement
command="r(dsp_fs1) = gxx(r(n_fs1), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fs2) = gxx(r(n_fs2), "//fenetre//", nb_pts, 0.05)"
exec(command)

# Troncature des signaux pourris
cut(r(dsp_fs1),X,f1,f2)
rms1=psdrmsval(r(dsp_fs1))
setlabel(r(dsp_fs1),"RMS",rms1)
rms_fs1=rms1

cut(r(dsp_fs2),X,f1,f2)
rms1=psdrmsval(r(dsp_fs2))
setlabel(r(dsp_fs2),"RMS",rms1)
rms_fs2=rms1

# Recherche du max entre fs1 et fs2
rms_fs = rms_fs1
r(dsp_fs)=r(dsp_fs1)
if (rms_fs2 >= rms_fs) then
   rms_fs    = rms_fs2
   r(dsp_fs) = r(dsp_fs2)
endif

# Marges de sécurité
SM_fs = 100.*(spec_fs/rms_fs - 1.)

# Tableau de synthèse
nb_synt+=1
r(n_screw)."Link"        (nb_synt) = nom
r(n_screw)."Bipode"      (nb_synt) = n_bipod
r(n_screw)."F_shear"     (nb_synt) = rms_fs
r(n_screw)."spec_shear"  (nb_synt) = spec_fs
r(n_screw)."SM_shear"    (nb_synt) = SM_fs
r(n_screw)."F_tension"   (nb_synt) = 0.
r(n_screw)."spec_tension"(nb_synt) = 0.
r(n_screw)."SM_tension"  (nb_synt) = 0.

# Affectation des LABEL
comment = "DSP cisailt vis liaison "//nom
nom_pt  = "DSP_Fs_"//nom
setlabel_gc(dsp_fs,comment,nom_pt,"postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fs),WORK,"DSP")

# Message d'infos
```

```
text0 = sprintf("Link %s\nRMS values and spec.\n\n", nom)
text1 = sprintf("Fs=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_fs,spec_fs,SM_fs)
text=text0//text1

if (debug == 1) then
   message_win(text)
endif

#==================================================
=================================
# DSP des composantes du torseur local
#==================================================
=================================

# Calcul des DSP
command="r(dsp_fu) = gxx(r(nft), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fv) = gxx(r(nfn), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_mu) = gxx(r(n_mt), "//fenetre//", nb_pts, 0.05)"
exec(command)

cut(r(dsp_fu),X,f1,f2)
rms1=psdrmsval(r(dsp_fu))
setlabel(r(dsp_fu),"RMS",rms1)

cut(r(dsp_fv),X,f1,f2)
rms1=psdrmsval(r(dsp_fv))
setlabel(r(dsp_fv),"RMS",rms1)

cut(r(dsp_mu),X,f1,f2)
rms1=psdrmsval(r(dsp_mu))
setlabel(r(dsp_mu),"RMS",rms1)

# Affectation des LABEL
cm1="DSP Fx plan torseur "//nom
cm2="DSP Fy plan torseur "//nom
cm3="DSP Mz perp torseur "//nom

pm1="DSP_Fx_"//nom
pm2="DSP_Fy_"//nom
pm3="DSP_Mz_"//nom

setlabel_gc(dsp_fu,cm1,pm1,"postrait",n_bipod,idessai)
setlabel_gc(dsp_fv,cm2,pm2,"postrait",n_bipod,idessai)
setlabel_gc(dsp_mu,cm3,pm3,"postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fu ),WORK,"DSP")
dbwrite(r(dsp_fv ),WORK,"DSP")
dbwrite(r(dsp_mu ),WORK,"DSP")

.end
```

```
#---------------------------------------------------------------------------
#
# Calculs des éléments de la liaison type H
#
# - torseur au point H
#- tension et cisaillement des vis de la liaison
#- DSP et valeurs RMS
#- marges de sécurité
#
# Gilles CARTE, BE SYSTEM (2004)
#---------------------------------------------------------------------------

.begin

liaison_type_h(n1, n2, n3, dist, nom)

nfn=n1
nft=n2
nm =n3

n_mt    = 60
n_fu    = 61
n_fv    = 62
n_fs    = 63
n_ft1   = 64
n_ft2   = 65
n_ft    = 66
dsp_fs  = 67
dsp_ft1 = 68
dsp_ft2 = 69
dsp_ft  = 70
dsp_fu  = 71
dsp_fv  = 72
dsp_mw  = 73

# Valeurs cisaillement RMS seuil à 3 sigma
spec_rms_fs = 2537./3.
spec_rms_ft = 1366./3.

# Distance entre les vis
d_u1=14.89e-3
d_u2= 5.89e-3
d_w = 7.00e-3

# Moment en D ou G (ou I ou K) suivant la barre considérée
r(n_mt) = r(nm) + dist*r(nft)

# Projection des efforts dans le repère local (u,v,w) de la semelle
# beta = angle d'inclinaison de la semelle (cf plan MEC 700101040)
# beta est défini dans "torseur_jauges_mod"
# Le moment est inchangé (axes z et w confondus)

r(n_fu) =  cos(beta)*r(nft) + sin(beta)*r(nfn)
r(n_fv) = -sin(beta)*r(nft) + cos(beta)*r(nfn)

# Cisaillement dû à l'effort Fu uniquement réparti entre les 6 vis
r(n_fs)=r(n_fu)/6.

# Tension due à l'effort normal et au moment Mz réparti entre 6 vis
r(n_ft1)=r(n_fv)/6. + r(n_mt)*d_u1/(4.*d_u1*d_u1+2.*d_u2*d_u2)
r(n_ft2)=r(n_fv)/6. - r(n_mt)*d_u1/(4.*d_u1*d_u1+2.*d_u2*d_u2)

# DSP cisaillement
command="r(dsp_fs) = gxx(r(n_fs), "//fenetre//", nb_pts, 0.05)"
exec(command)

# DSP tension
command="r(dsp_ft1) = gxx(r(n_ft1), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_ft2) = gxx(r(n_ft2), "//fenetre//", nb_pts, 0.05)"
exec(command)

# Troncature des DSP de la tension
cut(r(dsp_ft1),X,f1,f2)
rms1=psdrmsval(r(dsp_ft1))
setlabel(r(dsp_ft1),"RMS",rms1)
rms_ft1=rms1

cut(r(dsp_ft2),X,f1,f2)
rms1=psdrmsval(r(dsp_ft2))
setlabel(r(dsp_ft2),"RMS",rms1)
rms_ft2=rms1

# Recherche du max de la tension
rms_ft = rms_ft1
r(dsp_ft)=r(dsp_ft1)
if (rms_ft2 >= rms_ft) then
   rms_ft    = rms_ft2
   r(dsp_ft) = r(dsp_ft2)
endif

# Troncature de la DSP du cisaillement
cut(r(dsp_fs),X,f1,f2)
rms1=psdrmsval(r(dsp_fs))
setlabel(r(dsp_fs),"RMS",rms1)
rms_fs=rms1

# Marges de sécurité
```

```
SM_fs = 100.*(spec_fs/rms_fs - 1.)
SM_ft = 100.*(spec_ft/rms_ft - 1.)

# Tableau de synthèse
nb_synt+=1
r(n_screw)."Link"         (nb_synt) = nom
r(n_screw)."Bipode"       (nb_synt) = n_bipod
r(n_screw)."F_shear"      (nb_synt) = rms_fs
r(n_screw)."spec_shear"   (nb_synt) = spec_fs
r(n_screw)."SM_shear"     (nb_synt) = SM_fs
r(n_screw)."F_tension"    (nb_synt) = rms_ft
r(n_screw)."spec_tension"(nb_synt) = spec_ft
r(n_screw)."SM_tension"   (nb_synt) = SM_ft

# Affectation des LABEL
comment = "DSP cisailt vis liaison "//nom
nom_pt  = "DSP_Fs_"//nom
setlabel_gc(dsp_fs,comment,nom_pt,"postrait",n_bipod,idessai)

comment = "DSP tension vis liaison "//nom
nom_pt  = "DSP_Ft_"//nom
setlabel_gc(dsp_ft,comment,nom_pt,"postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fs),WORK,"DSP")
dbwrite(r(dsp_ft),WORK,"DSP")

# Message d'infos
text0 = sprintf("Link %s\nRMS values and spec.\n\n", nom)
text1 = sprintf("Fs=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_fs,spec_fs,SM_fs)
text2 = sprintf("Ft=%7.2f N (spec=%7.2f N, SM=%6.1f %)\n",rms_ft,spec_ft,SM_ft)
text=text0//text1//text2

if (debug == 1) then
  message_win(text)
endif

#==================================================
==================================
# DSP des composantes du torseur local
#==================================================
==================================

# Calcul des DSP
command="r(dsp_fu) = gxx(r(n_fu), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_fv) = gxx(r(n_fv), "//fenetre//", nb_pts, 0.05)"
exec(command)
command="r(dsp_mw) = gxx(r(n_mt), "//fenetre//", nb_pts, 0.05)"
exec(command)

cut(r(dsp_fu),X,f1,f2)
rms1=psdrmsval(r(dsp_fu))
setlabel(r(dsp_fu),"RMS",rms1)
rms_fu=rms1

cut(r(dsp_fv),X,f1,f2)
rms1=psdrmsval(r(dsp_fv))
setlabel(r(dsp_fv),"RMS",rms1)
rms_fv=rms1

cut(r(dsp_mw),X,f1,f2)
rms1=psdrmsval(r(dsp_mw))
setlabel(r(dsp_mw),"RMS",rms1)
rms_mw=rms1

# Affectation des LABEL
cm1="DSP Fu plan torseur "//nom
cm2="DSP Fv perp torseur "//nom
cm3="DSP Mw plan torseur "//nom

pm1="DSP_Fu_"//nom
pm2="DSP_Fv_"//nom
pm3="DSP_Mw_"//nom

setlabel_gc(dsp_fu,cm1,pm1,"postrait",n_bipod,idessai)
setlabel_gc(dsp_fv,cm2,pm2,"postrait",n_bipod,idessai)
setlabel_gc(dsp_mw,cm3,pm3,"postrait",n_bipod,idessai)

# Sauvegarde des DSP dans la BD
dbwrite(r(dsp_fu ),WORK,"DSP")
dbwrite(r(dsp_fv ),WORK,"DSP")
dbwrite(r(dsp_mw ),WORK,"DSP")

.end
```

```
#setlabel

.begin

setlabel_gc(nn1,commentaire,pointmesure,fonction,nn2,idessai)

n=nn1
comment =sprintf("Bipode %d : %s", nn2, commentaire)
ptmesure=sprintf("%s_bp%d", pointmesure, nn2)

setlabel(r(n),"UnitéValeurs", "N2/Hz")
setlabel(r(n),"UnitéValeurs", "N2/Hz")
setlabel(r(n),"Commentaire" , comment )
setlabel(r(n),"PointMesure" , ptmesure)
setlabel(r(n),"Fonction"    , fonction)
setlabel(r(n),"IdEssai"     , idessai )

.end
```

ANNEX 7

Astrium data for PR subsystem acoustic test

Acoustic test of PLANCK Primary reflector QM

Location and Channel Allocation of Accelerometers

The location of the accelerometers and a detailed description is defined in Fig. 9 1, Fig. 9 2 and in Tab. 9 1. For easy definition of the accelerometer locations the angle φ was introduced (see Fig. 9 1). For simple alignment of the accelerometer directions local coordinate systems were defined, which all have the z-axis normal to the back face surface and the x-axis pointing to the reflector center (see Fig. 9 1).

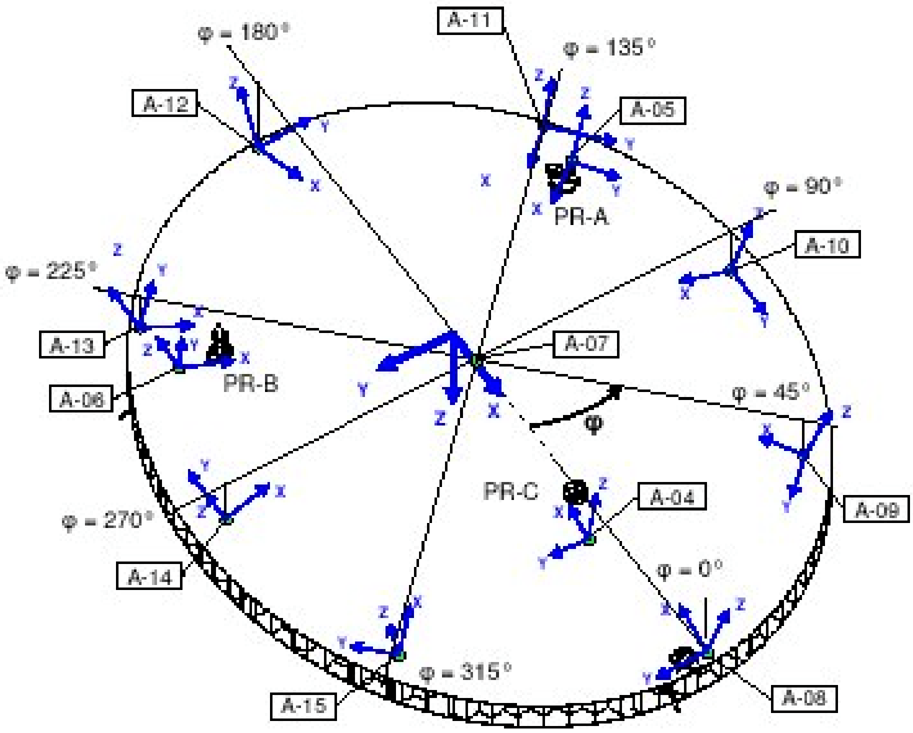


Fig. 9 1: Locations and local coordinate systems of accelerometers on the reflector

Channel No.	No.	Name	Coord Sys	Dir.	Position	φ [deg]	g RMS	max psd g^2/Hz
1	A-01	A-MBC	Global	X	mounting bracket for FR-C	0		
2				Y				
3				Z				
4	A-02	A-MBA	Global	X	mounting bracket for FR-A	120		
5				Y				
6				Z				
7	A-03	A-MBB	Global	X	mounting bracket for FR-B	240		
8				Y				
9				Z				
10	A-04	A-BPRC	Local	X	back face close to FR-C	0		
11				Y				
12				Z				
13	A-05	A-BPRA	Local	X	back face close to FR-A	120		
14				Y				
15				Z				
16	A-06	A-BPRB	Local	X	back face close to FR-B	240		
17				Y				
18				Z				
19	A-07	A-BC	Global	X	back face center			
20				Y				
21				Z				
22	A-08	A-BE000	Local	Y	back face close to edge	0		
23				Z			24.4	12
24	A-09	A-BE045	Local	Y	back face close to edge	45		
25				Z			17.6	4.5
26	A-10	A-BE090	Local	Y	back face close to edge	90		
27				Z			20.8	10
28	A-11	A-BE135	Local	Y	back face close to edge	135		
29				Z			16.8	2.3
30	A-12	A-BE180	Local	Y	back face close to edge	180		
31				Z			26.8	20
32	A-13	A-BE225	Local	Y	back face close to edge	225		
33				Z			15.8	2.3
34	A-14	A-BE270	Local	Y	back face close to edge	270		
35				Z			20.0	10.0
36	A-15	A-BE315	Local	Y	back face close to edge	315		
37				Z			17.0	4.3

Tab. 9 1: Channel allocation, locations and maximum seen test levels of accelerometers (channels with highest accelerations marked blue)

ANNEX 8

Astrium data for SR subsystem acoustic test

Acoustic test of PLANCK Secondary reflector QM

Location and Channel Allocation of Accelerometers

The location of the accelerometers and a detailed description is defined in Fig. 9 1, Fig. 9 2 and in Tab. 9 1. For easy definition of the accelerometer locations the angle φ was introduced (see Fig. 9 1). For simple alignment of the accelerometer directions local coordinate systems were defined, which all have the z-axis normal to the back face surface and the x-axis pointing to the reflector center (see Fig. 9 1).

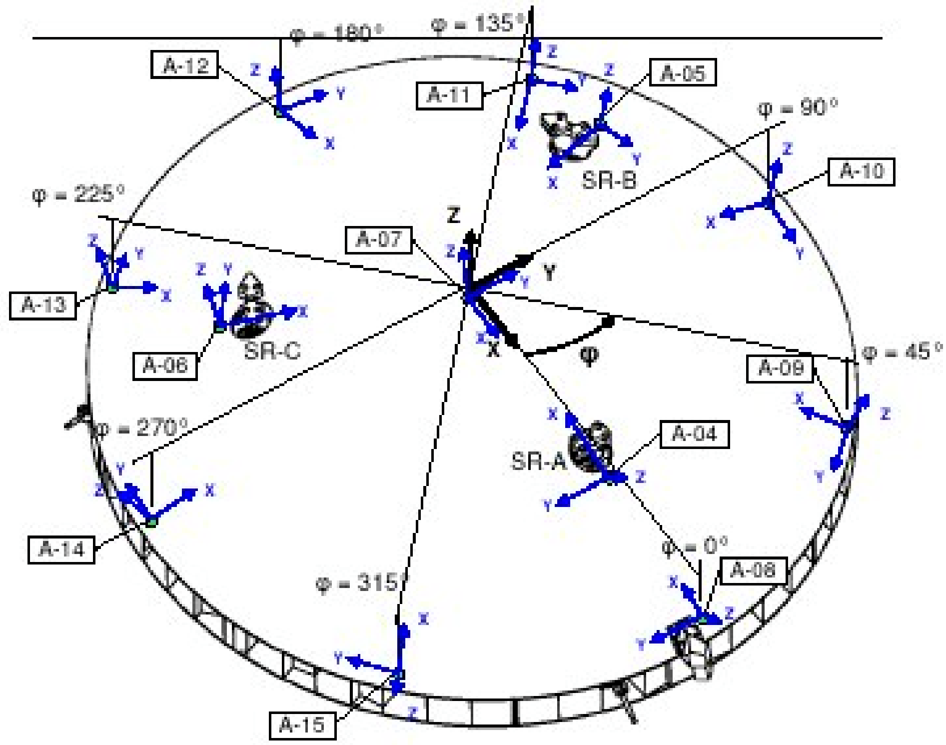


Fig. 9 1: **Locations and local coordinate systems of accelerometers on the reflector backside**

Channel No.	No.	Name	Coord Sys	Dir.	Position	φ (deg)	g RMS	max psd g^2/Hz
1	A-01	A-MBA	Global	X	mounting bracket for SR-A	0		
2				Y				
3				Z				
4	A-02	A-MBB	Global	X	mounting bracket for SR-B	120		
5				Y				
6				Z				
7	A-03	A-MBC	Global	X	mounting bracket for SR-C	240		
8				Y				
9				Z				
10	A-04	A-BSRA	Local	X	back face close to SR-A	0		
11				Y				
12				Z				
13	A-05	A-BSRB	Local	X	back face close to SR-B	120		
14				Y				
15				Z				
16	A-06	A-BSRC	Local	X	back face close to SR-C	240		
17				Y				
18				Z				
19	A-07	A-BC	Global	X	back face center			
20				Y				
21				Z				
22	A-08	A-BE000	Local	Y	back face close to edge	0		
23				Z			15.5	2.5
24	A-09	A-BE045	Local	Y	back face close to edge	45		
25				Z			19.8	11.0
26	A-10	A-BE090	Local	Y	back face close to edge	90		
27				Z			15.8	4.1
28	A-11	A-BE135	Local	Y	back face close to edge	135		
29				Z			16.0	2.5
30	A-12	A-BE180	Local	Y	back face close to edge	180		
31				Z			17.0	5.0
32	A-13	A-BE225	Local	Y	back face close to edge	225		
33				Z			16.3	2.2
34	A-14	A-BE270	Local	Y	back face close to edge	270		
35				Z			15.2	3.3
36	A-15	A-BE315	Local	Y	back face close to edge	315		
37				Z			17.8	6.0

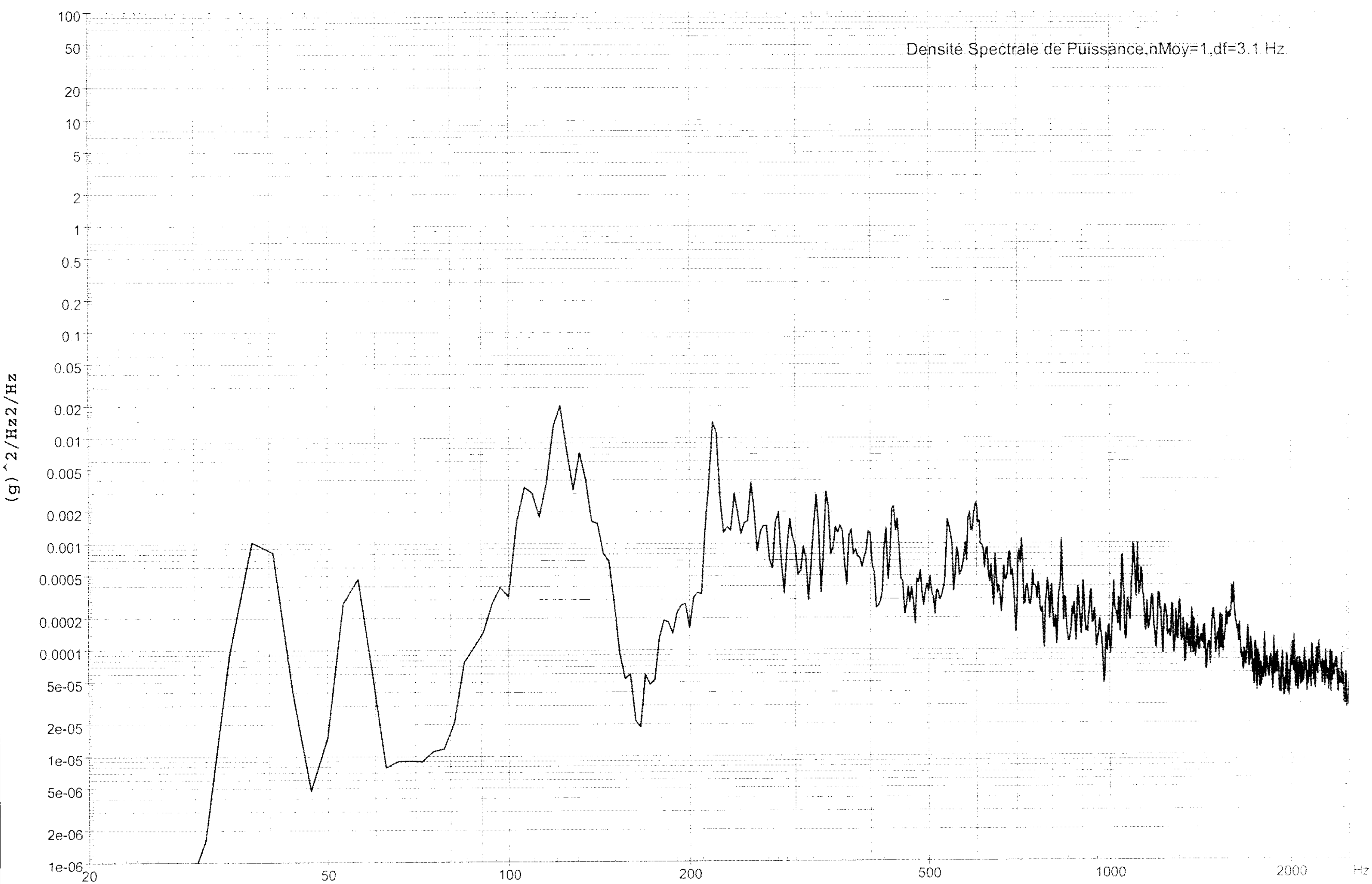
Tab. 9 1: Channel allocation, locations and maximum seen test levels of accelerometers (channels with highest accelerations marked blue)

ANNEX 9

NIA6 PSD plots

ALCATEL SPACE

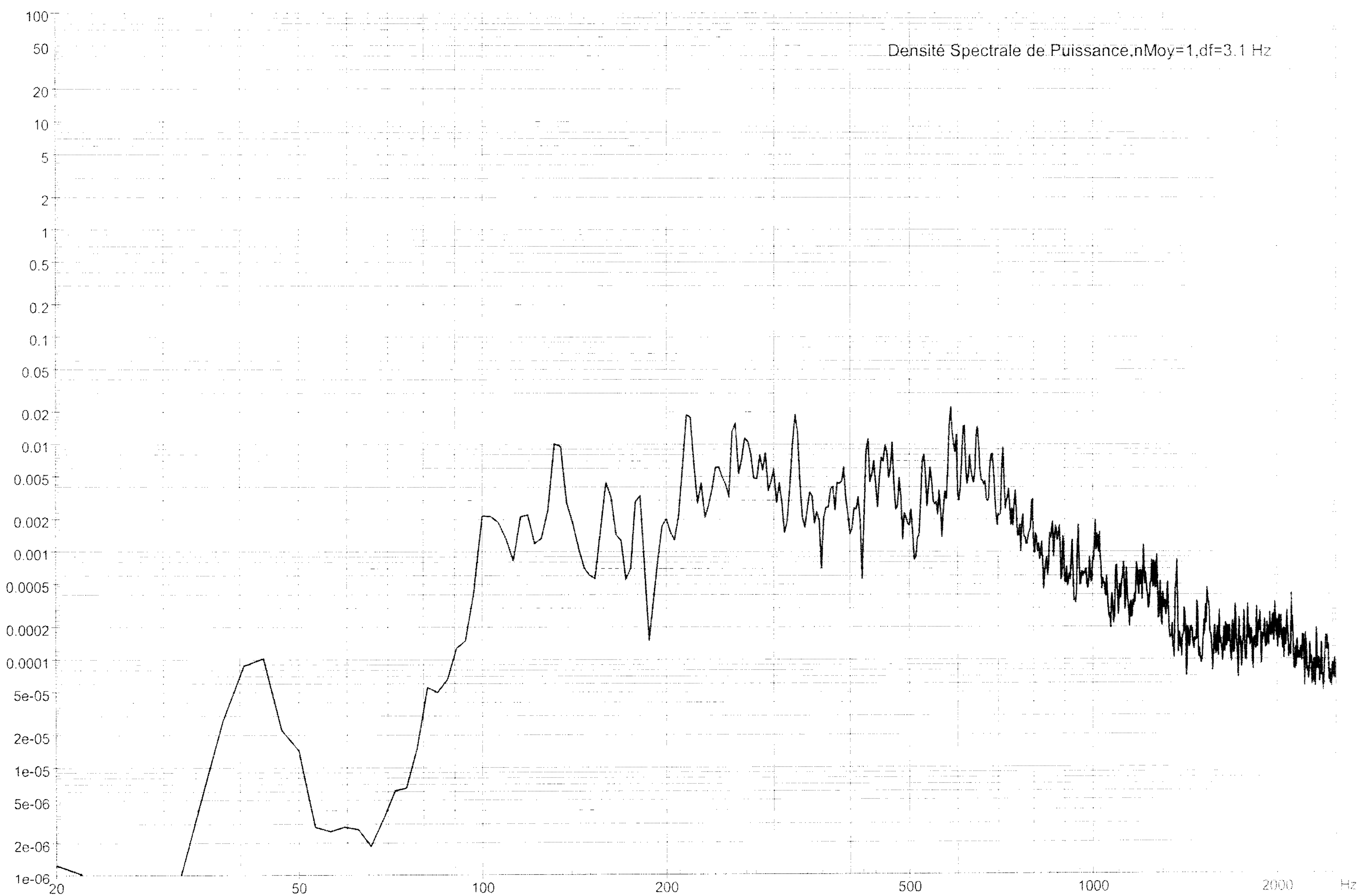
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 13: SUB1// - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

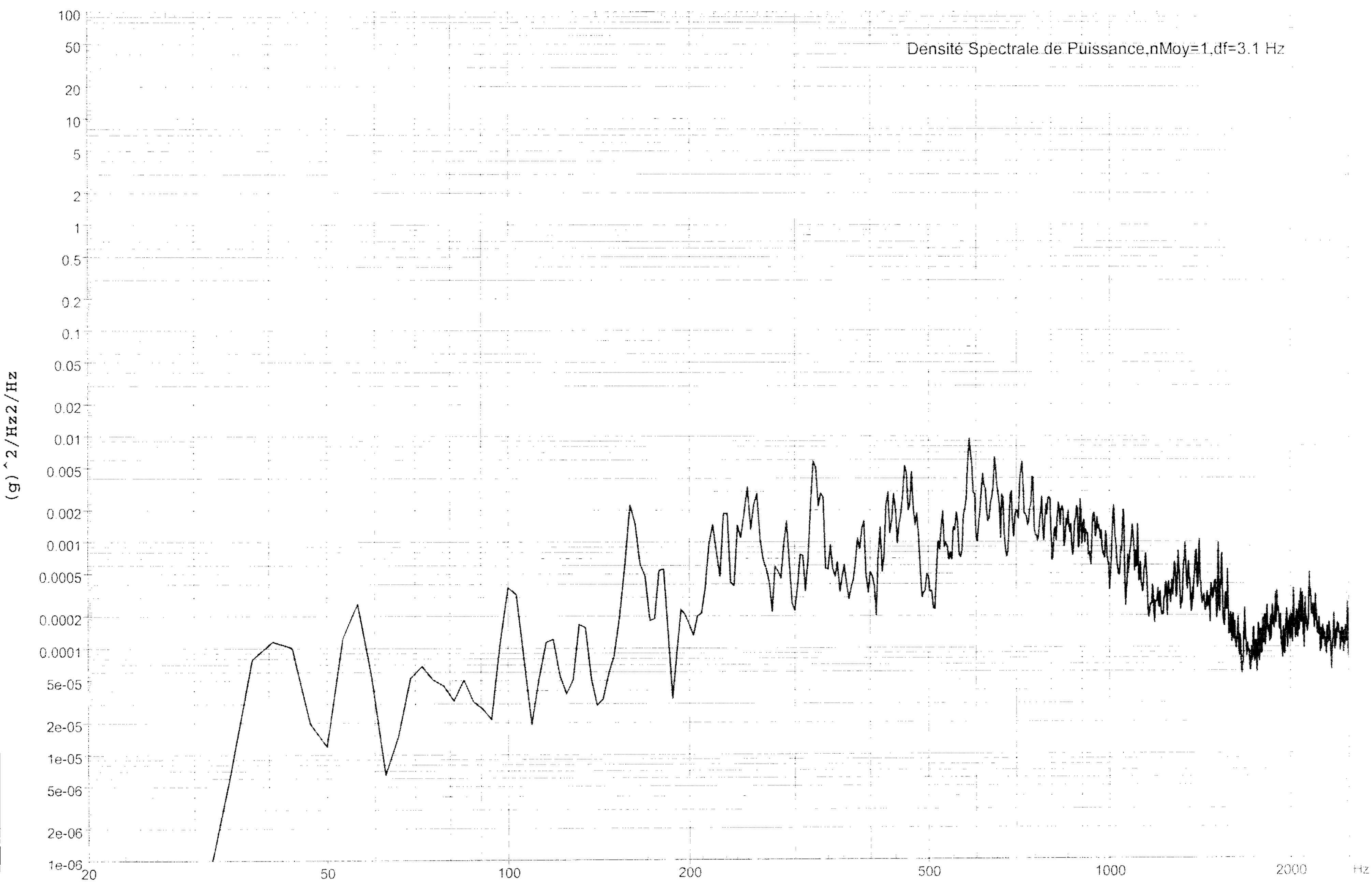
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 14: SUB2Y - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

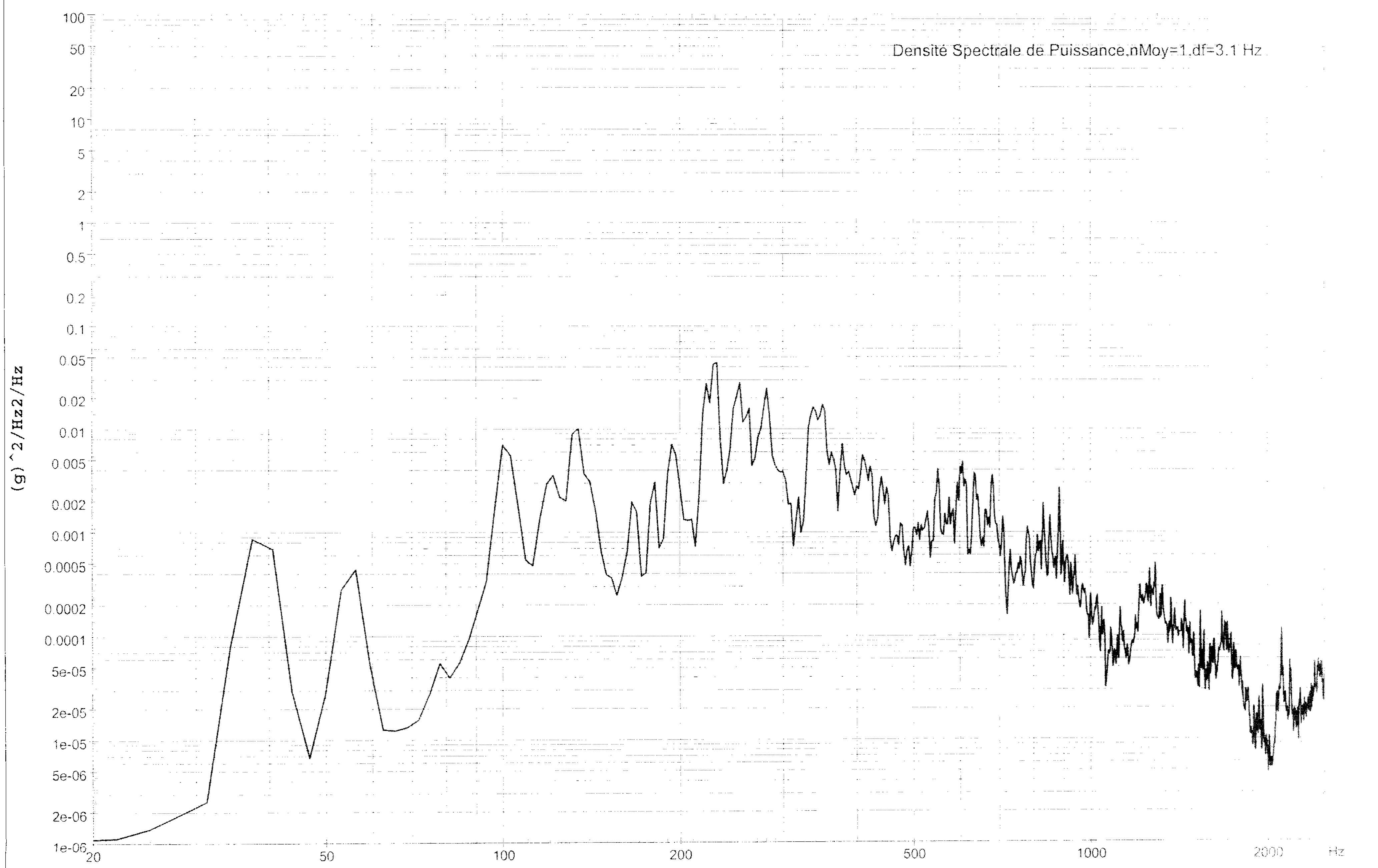
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 15: SUB3^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

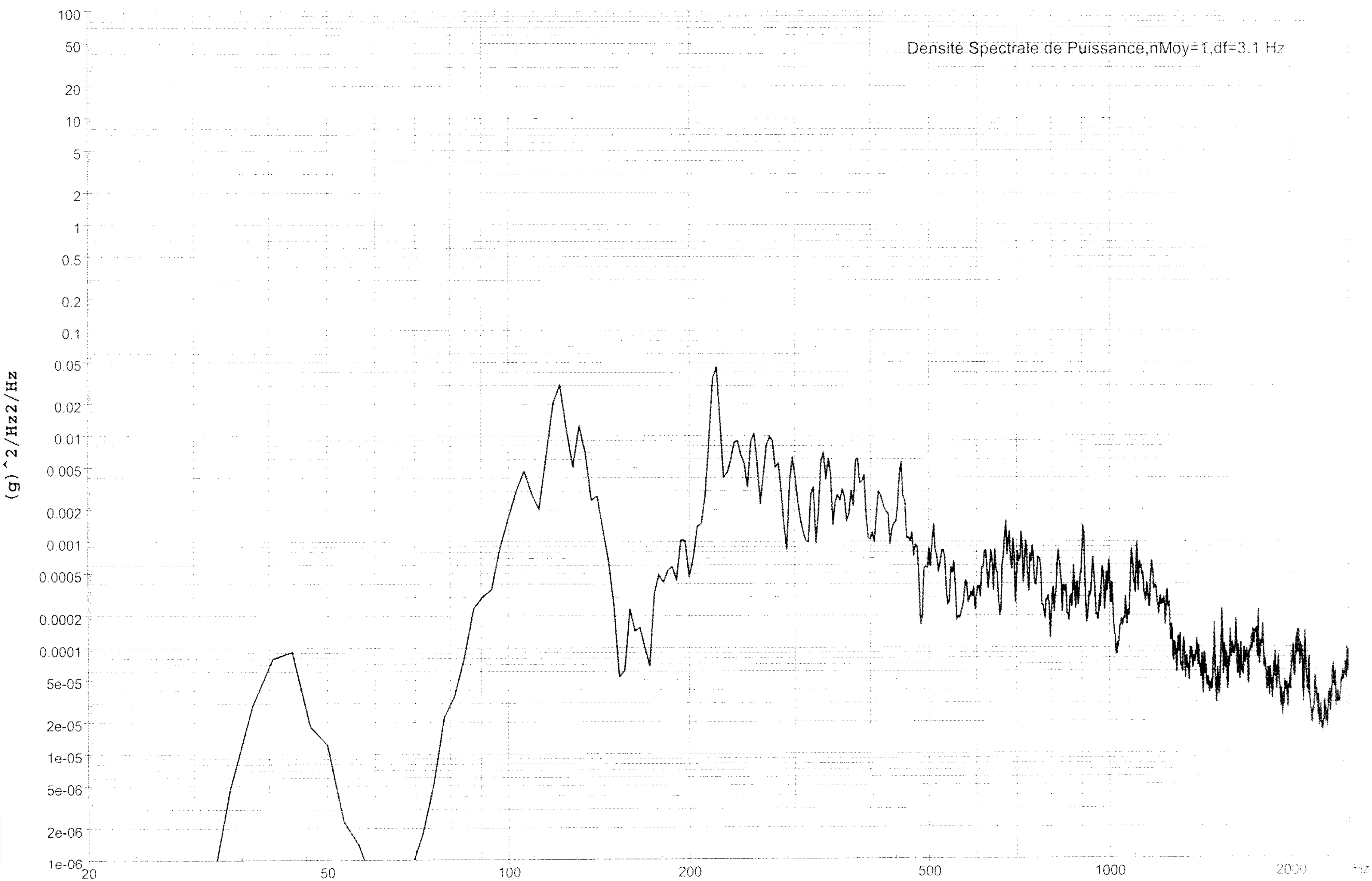
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 16: SUB4// - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

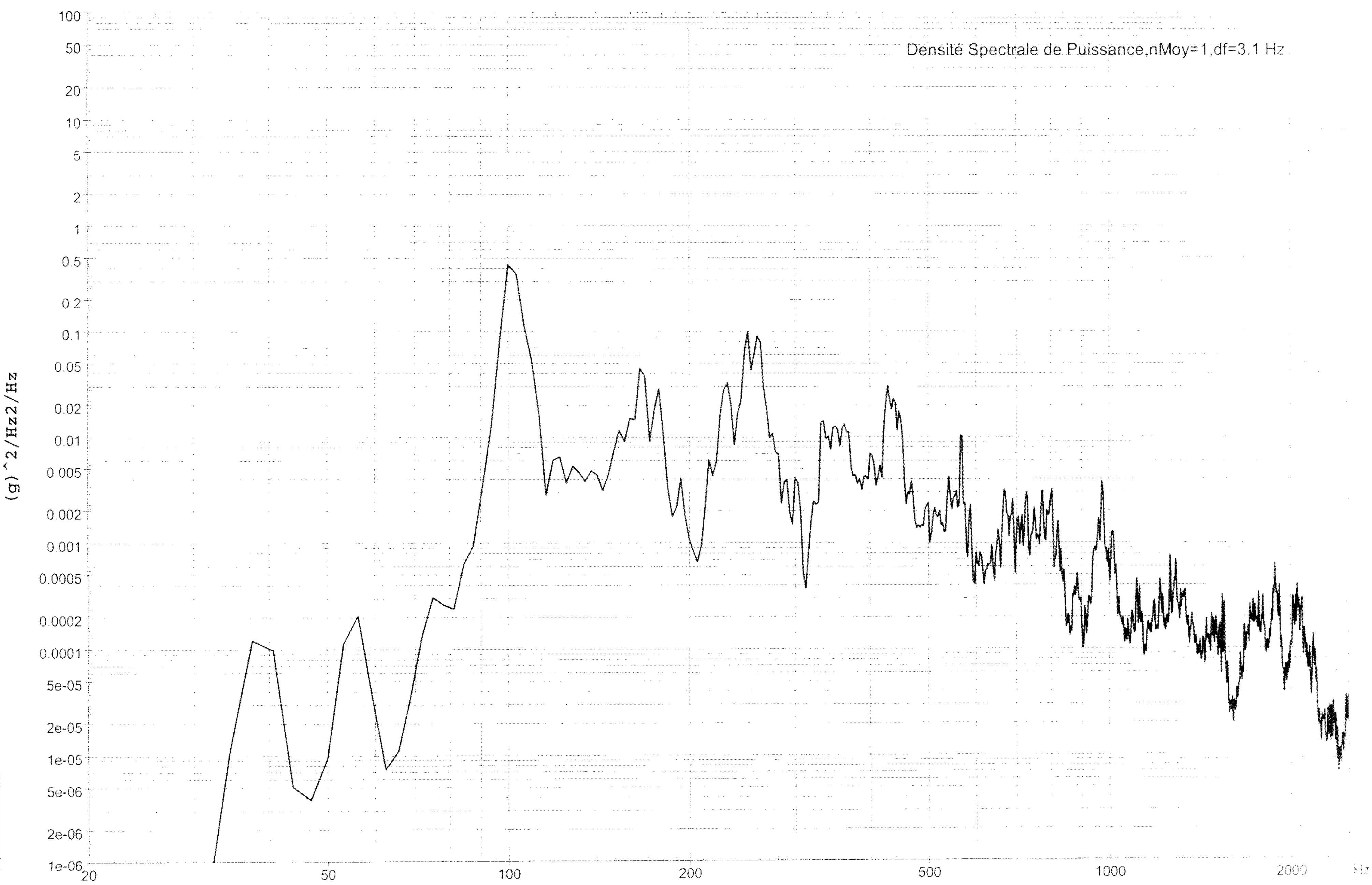
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 17: SUB5Y - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

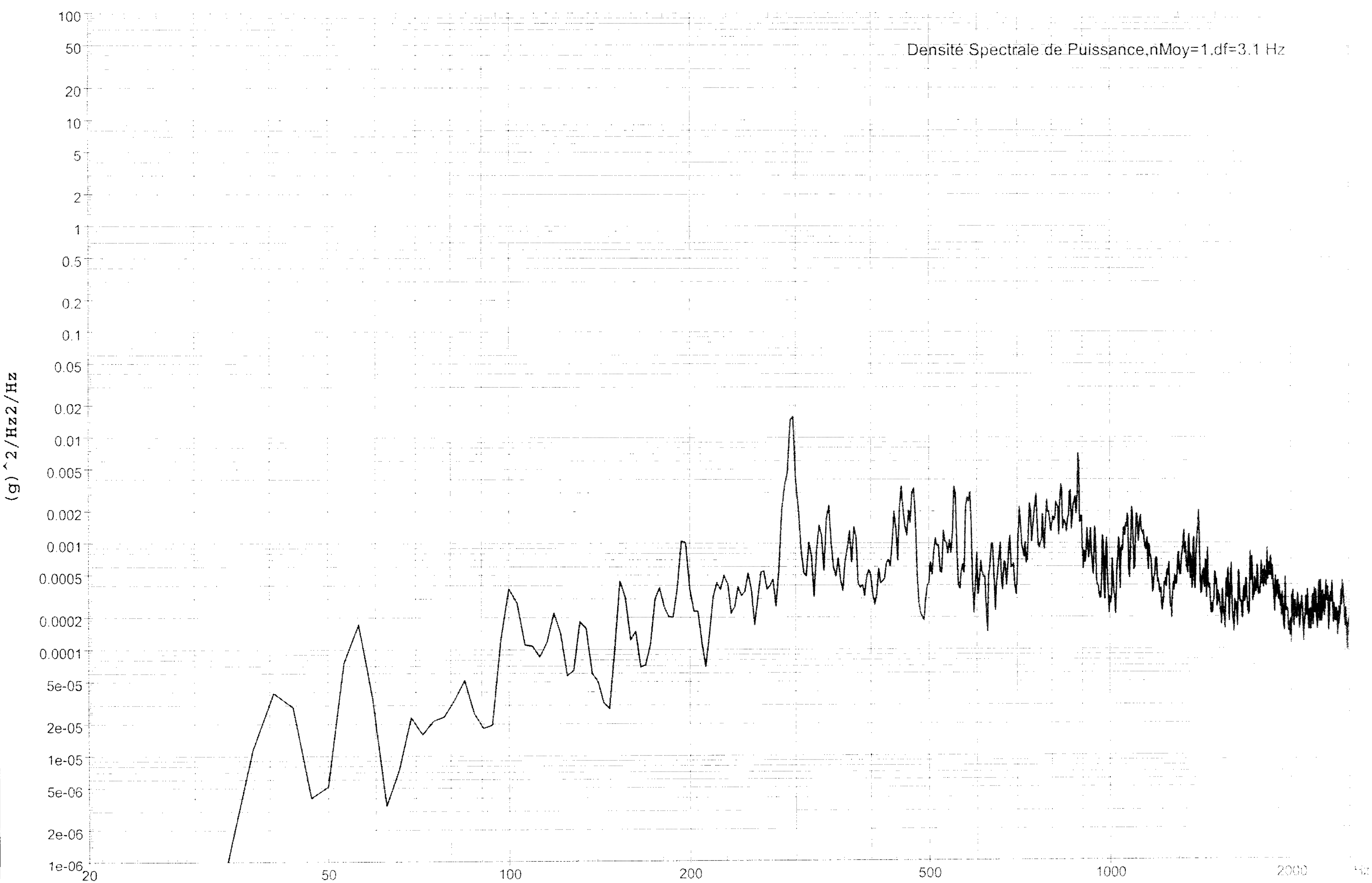
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 18: SUB6^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

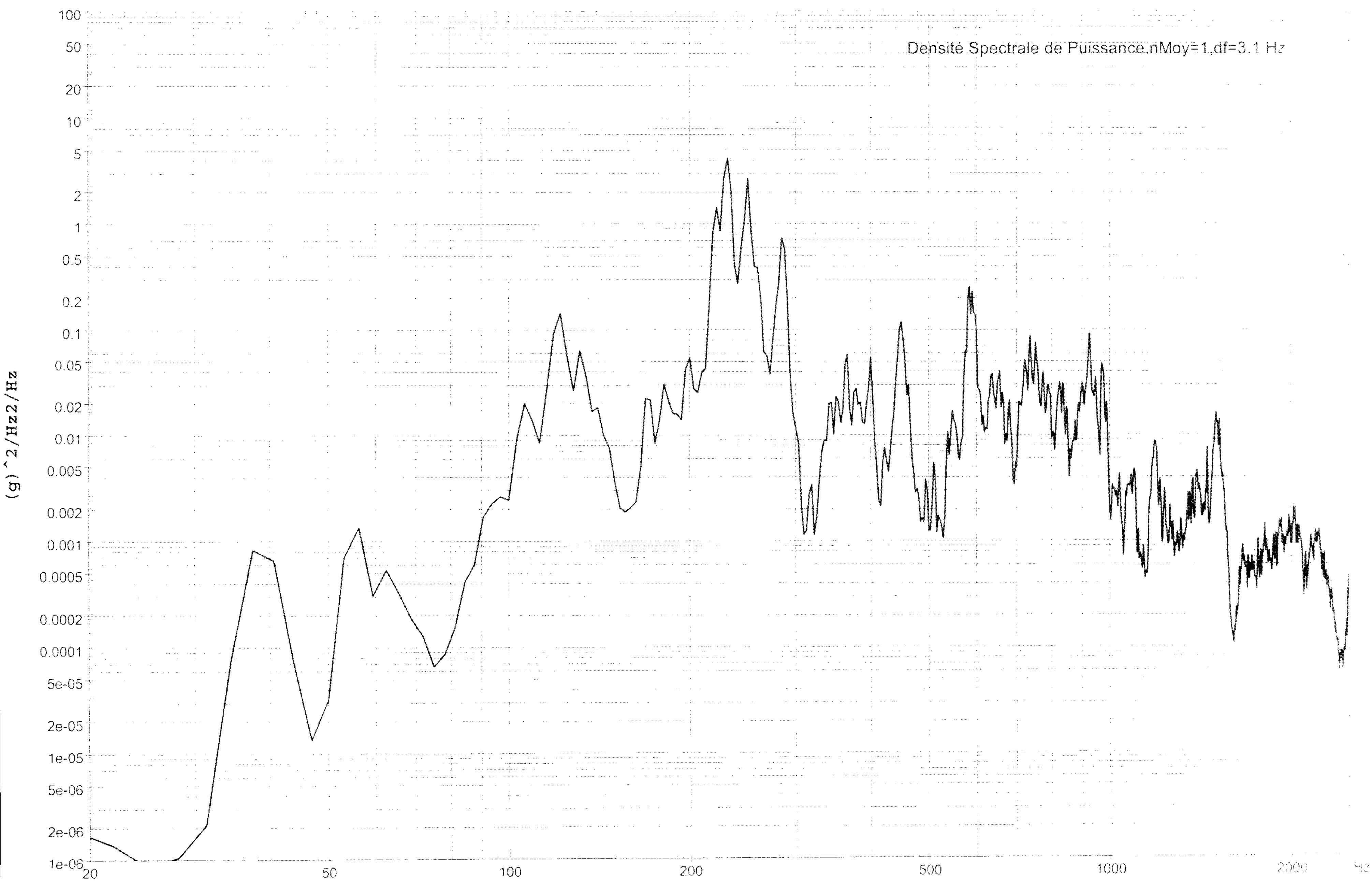
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 19: SUB7^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

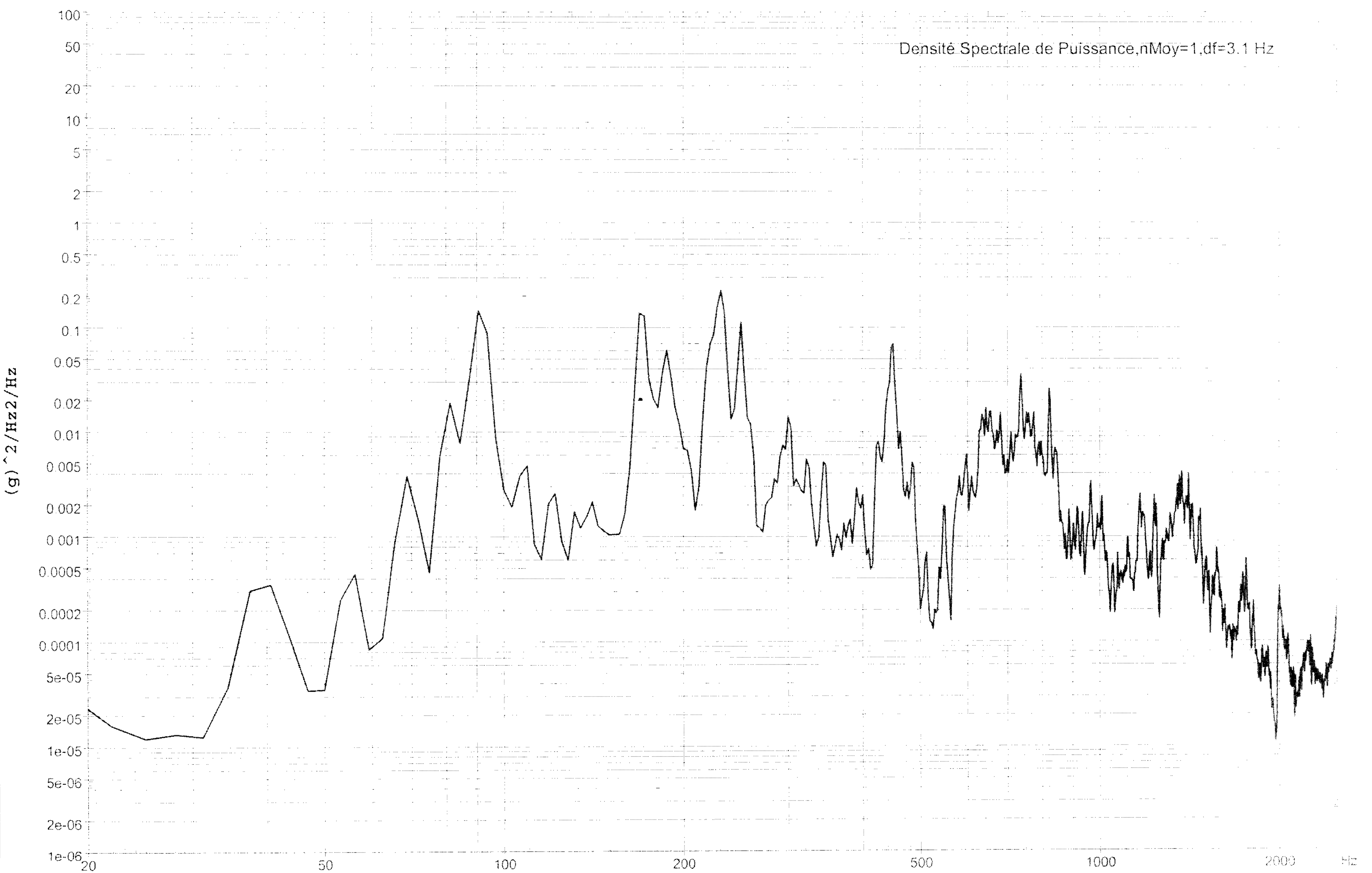
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 20: SVM15R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

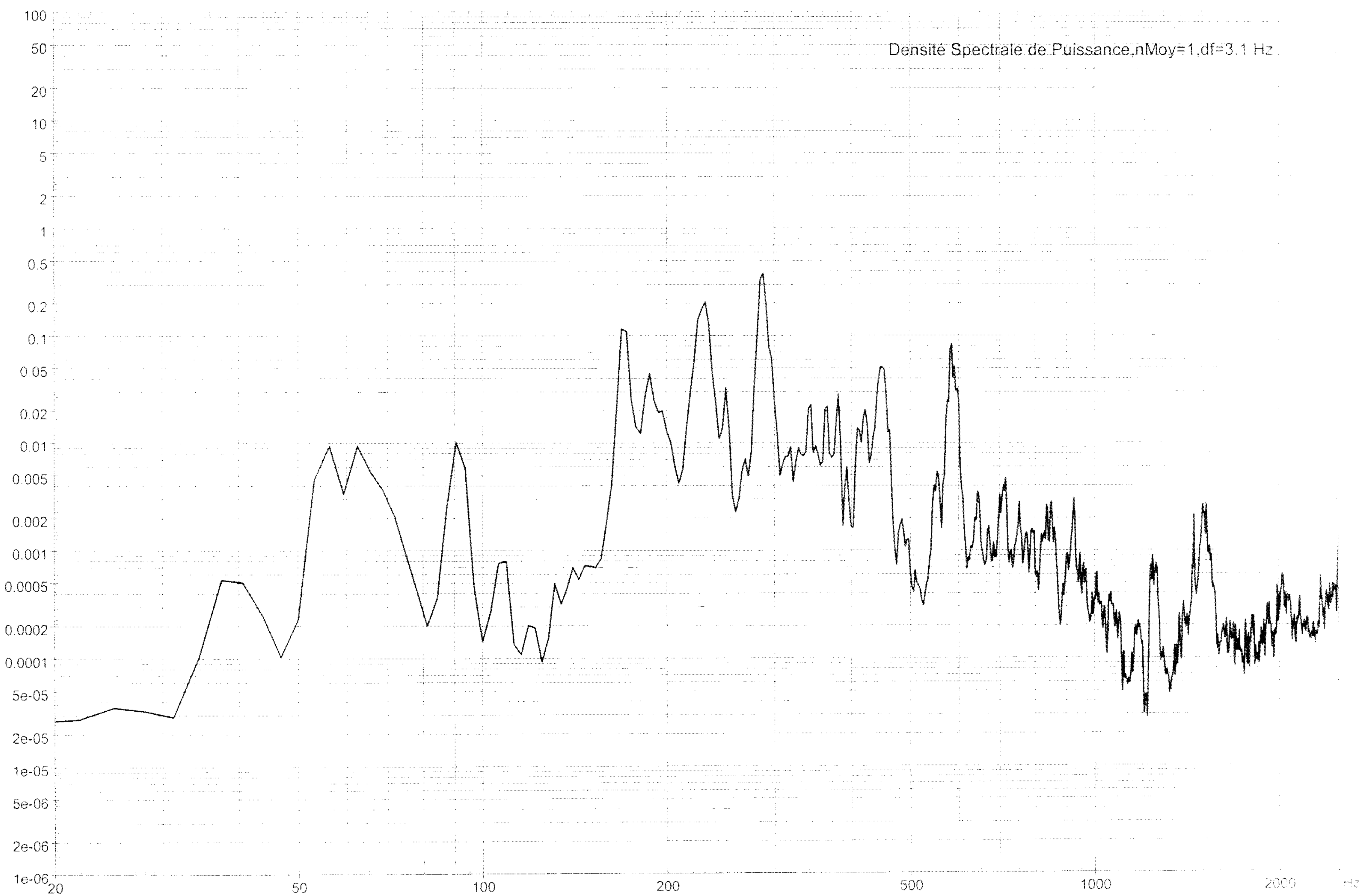
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 21: SVM16T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

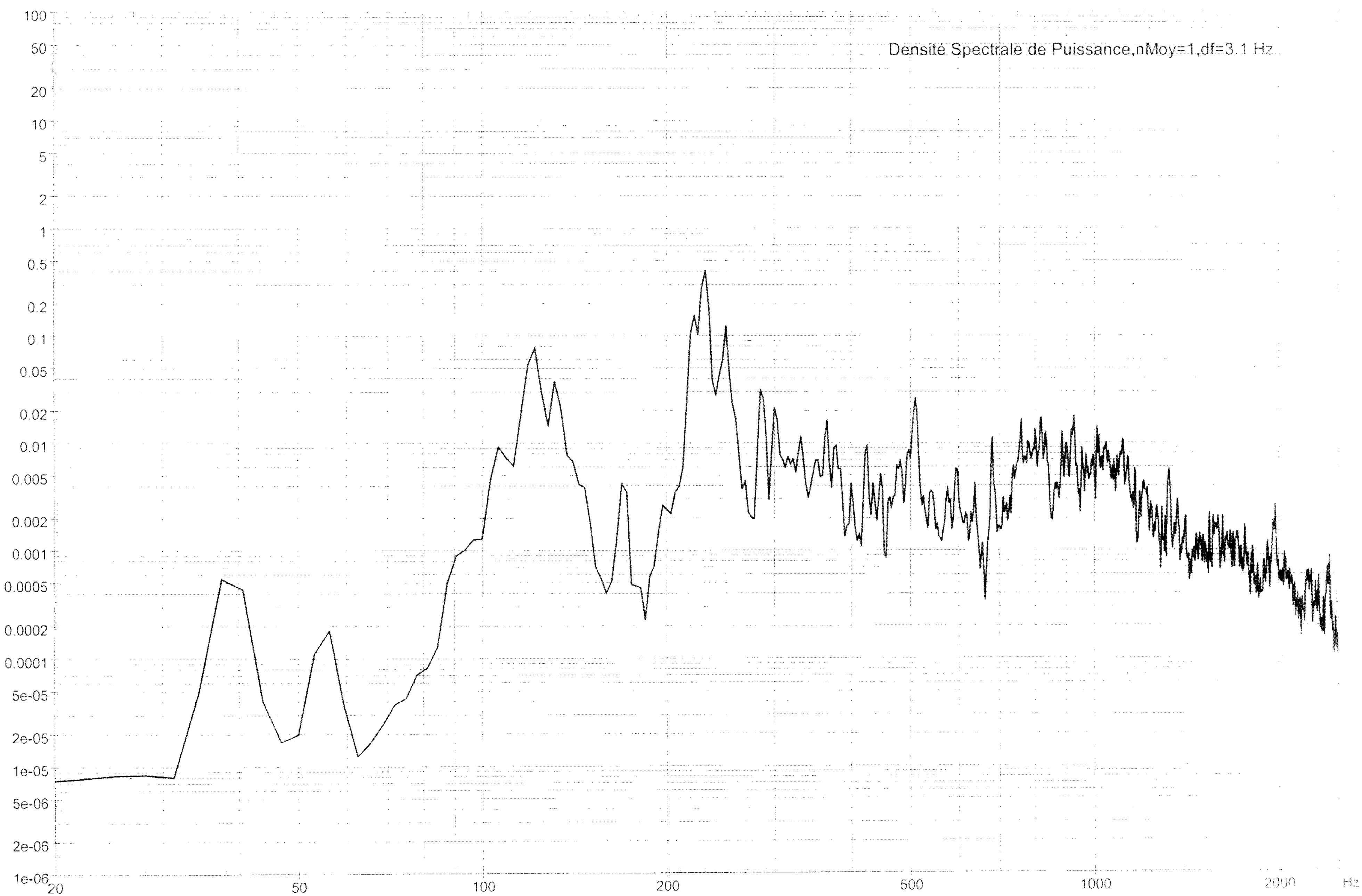
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 22: SVM17Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

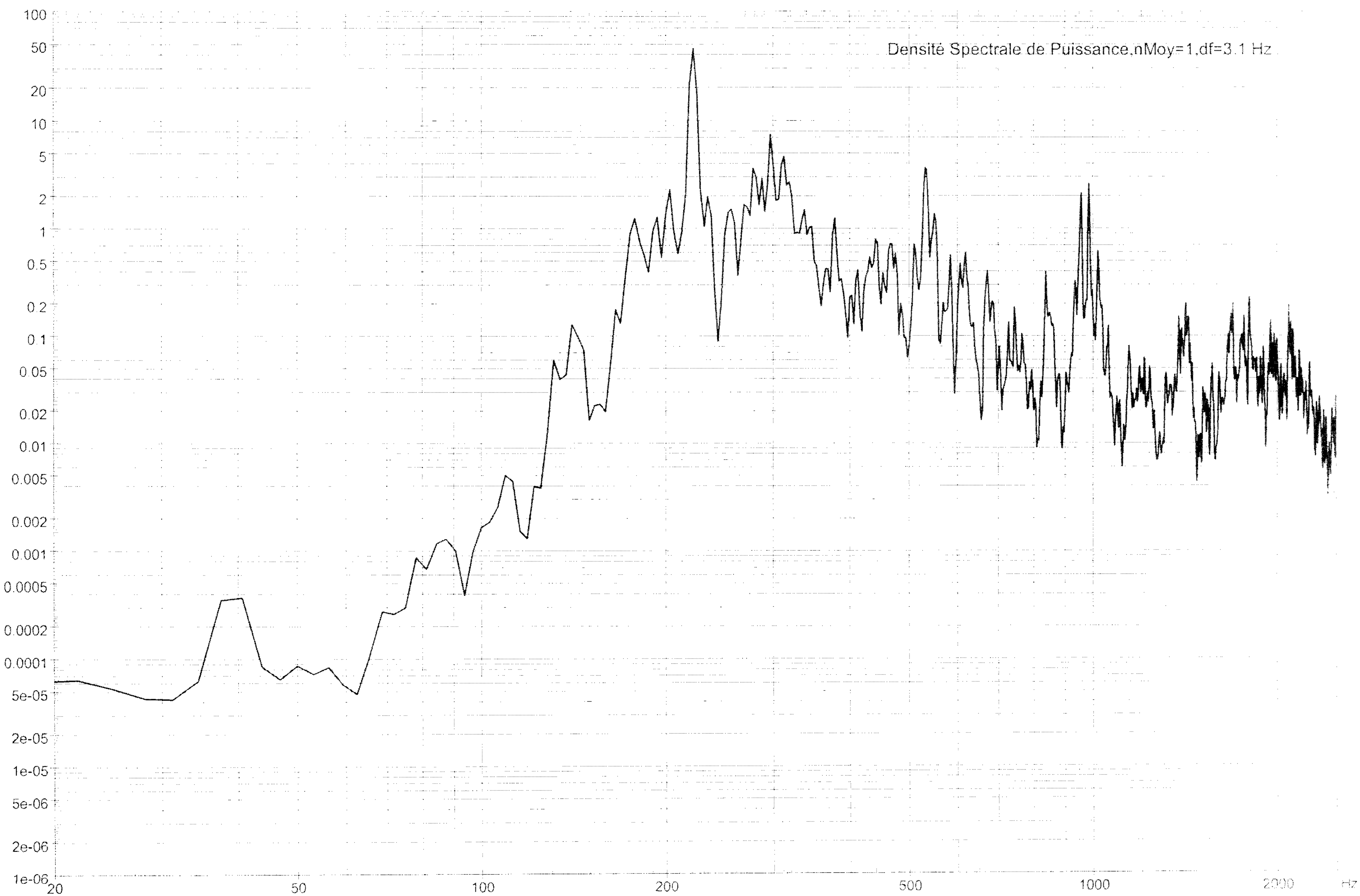
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 23: SVM18^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

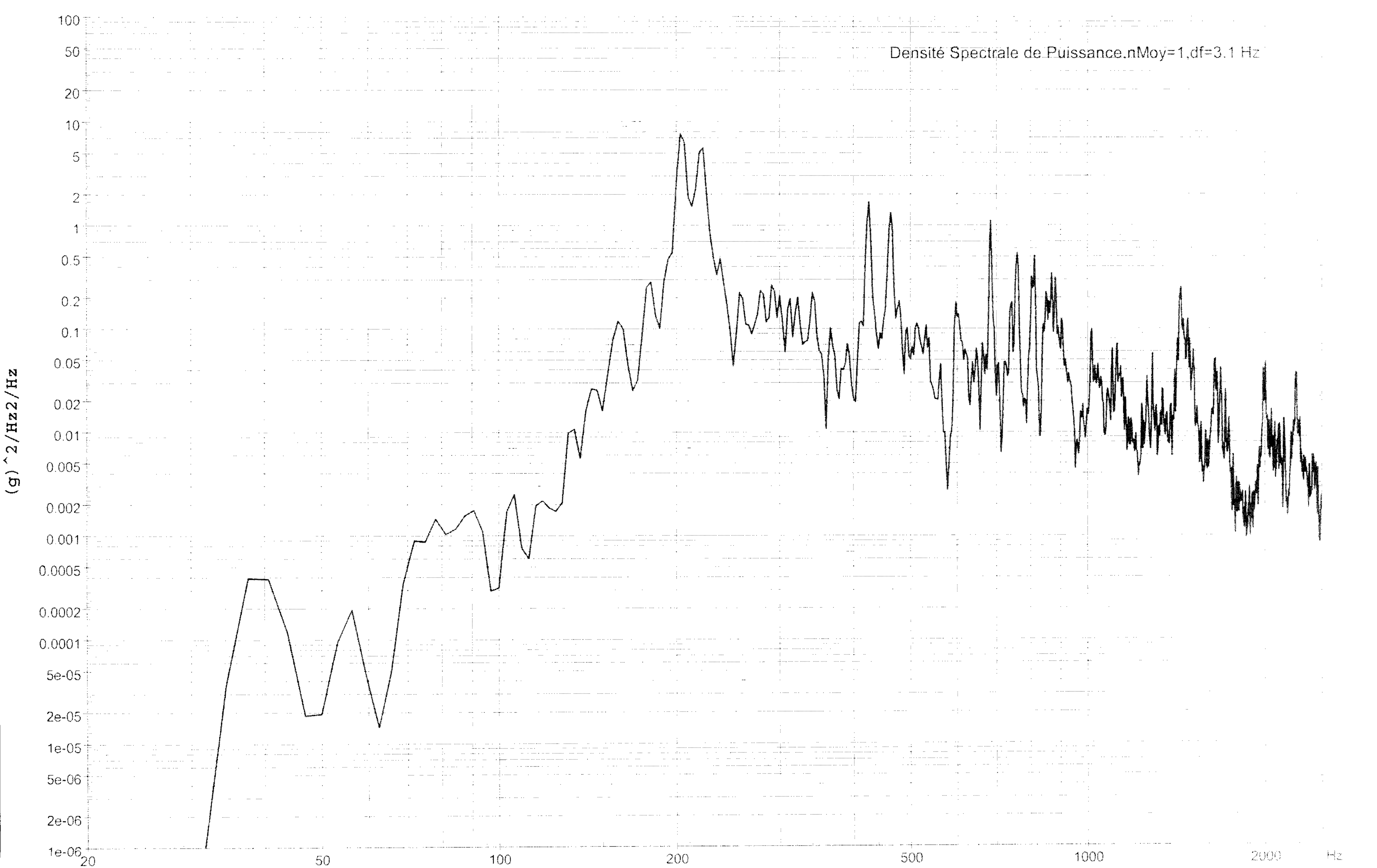
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 24: SVM19^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

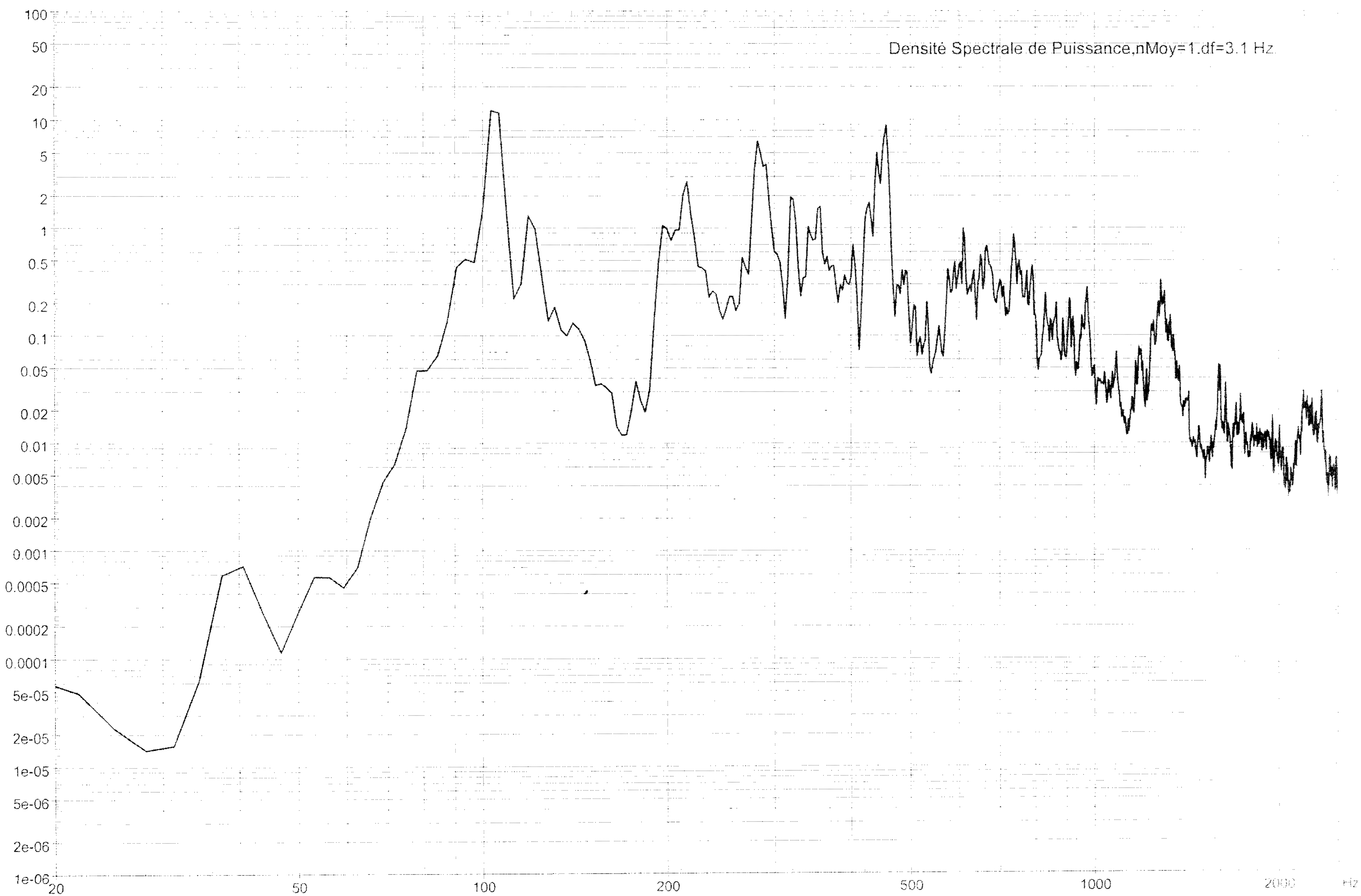
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 25: SVM20^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

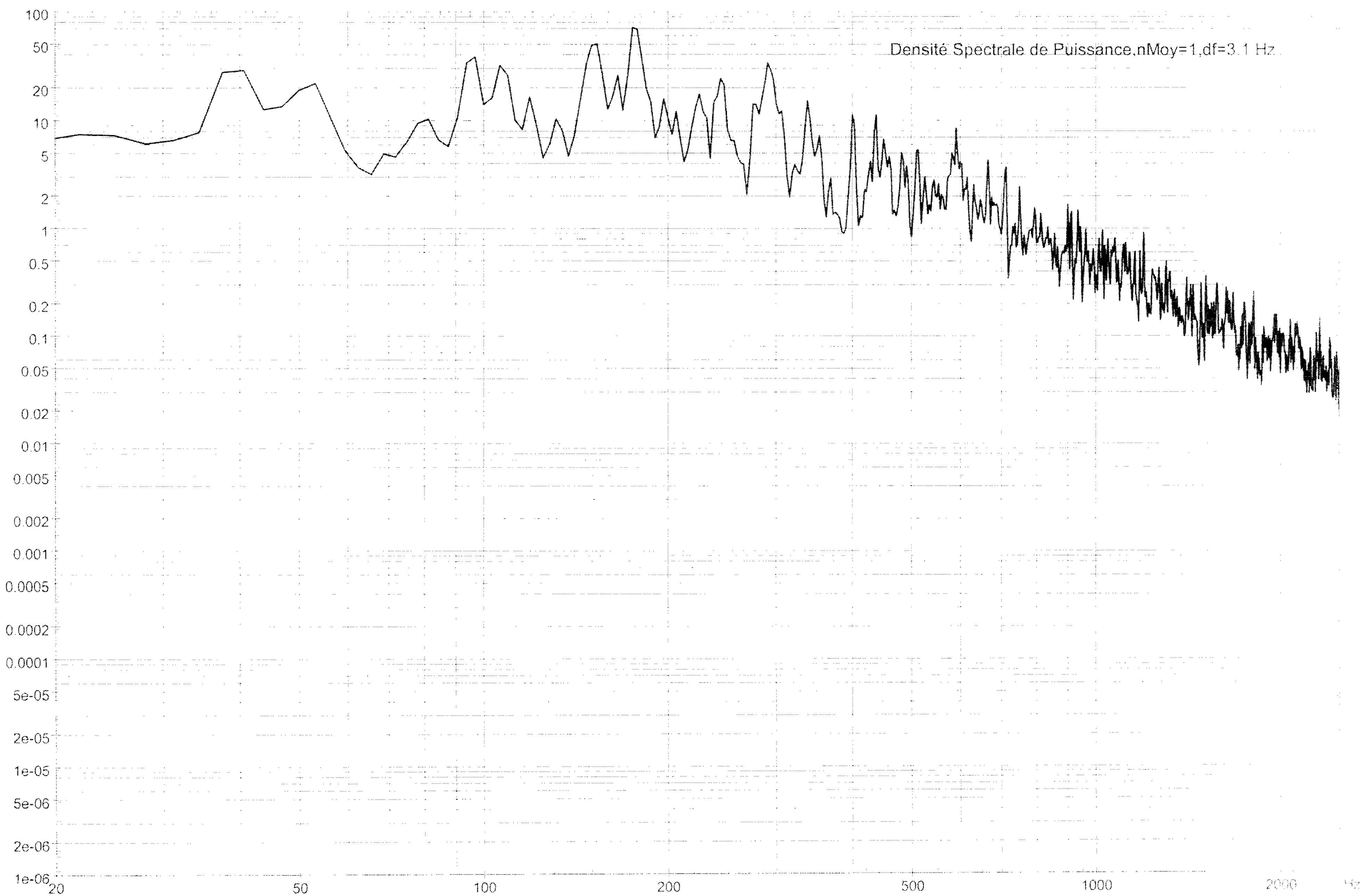
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 26: SVM21^ - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

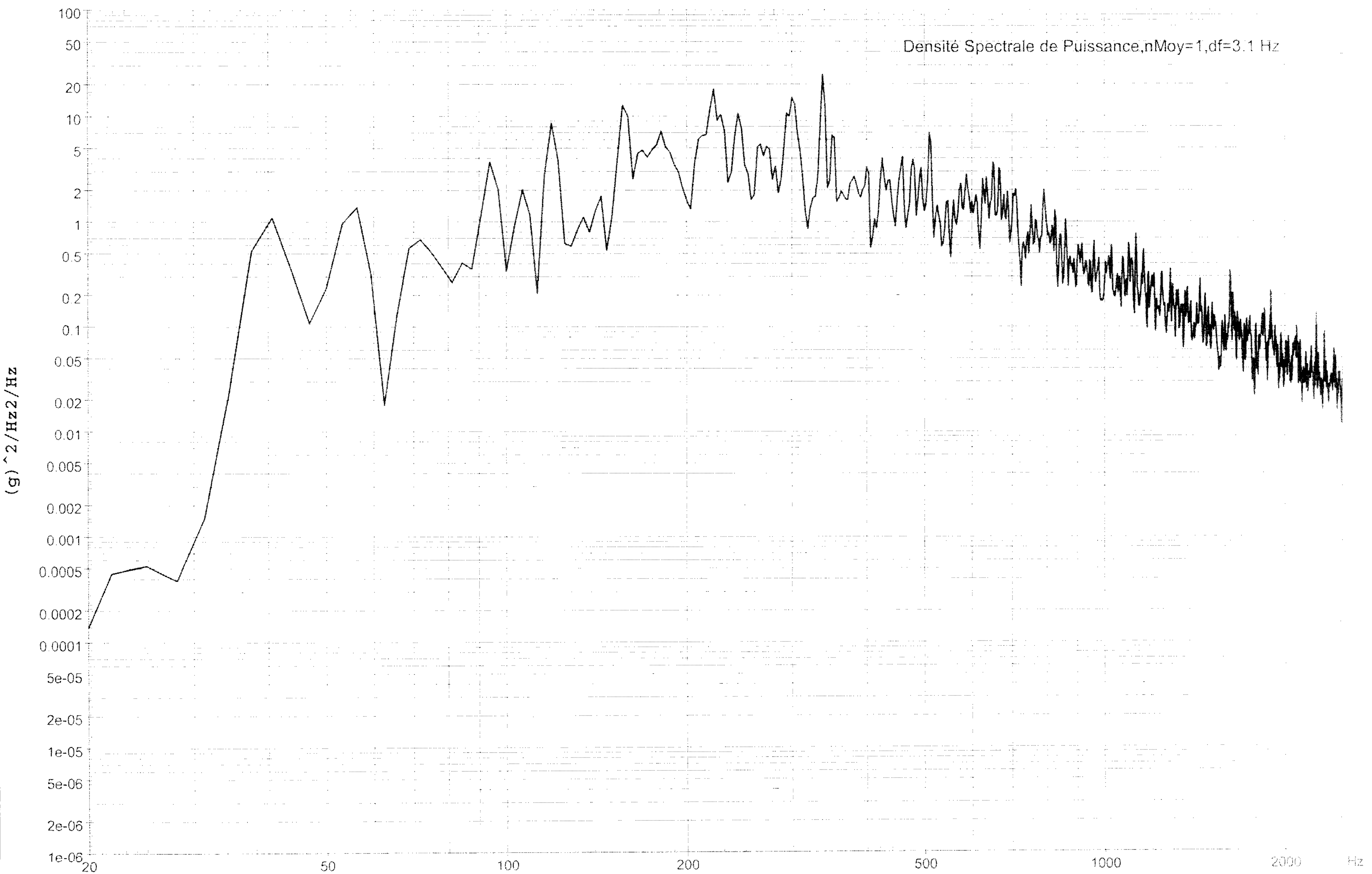
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 27: GVA30Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

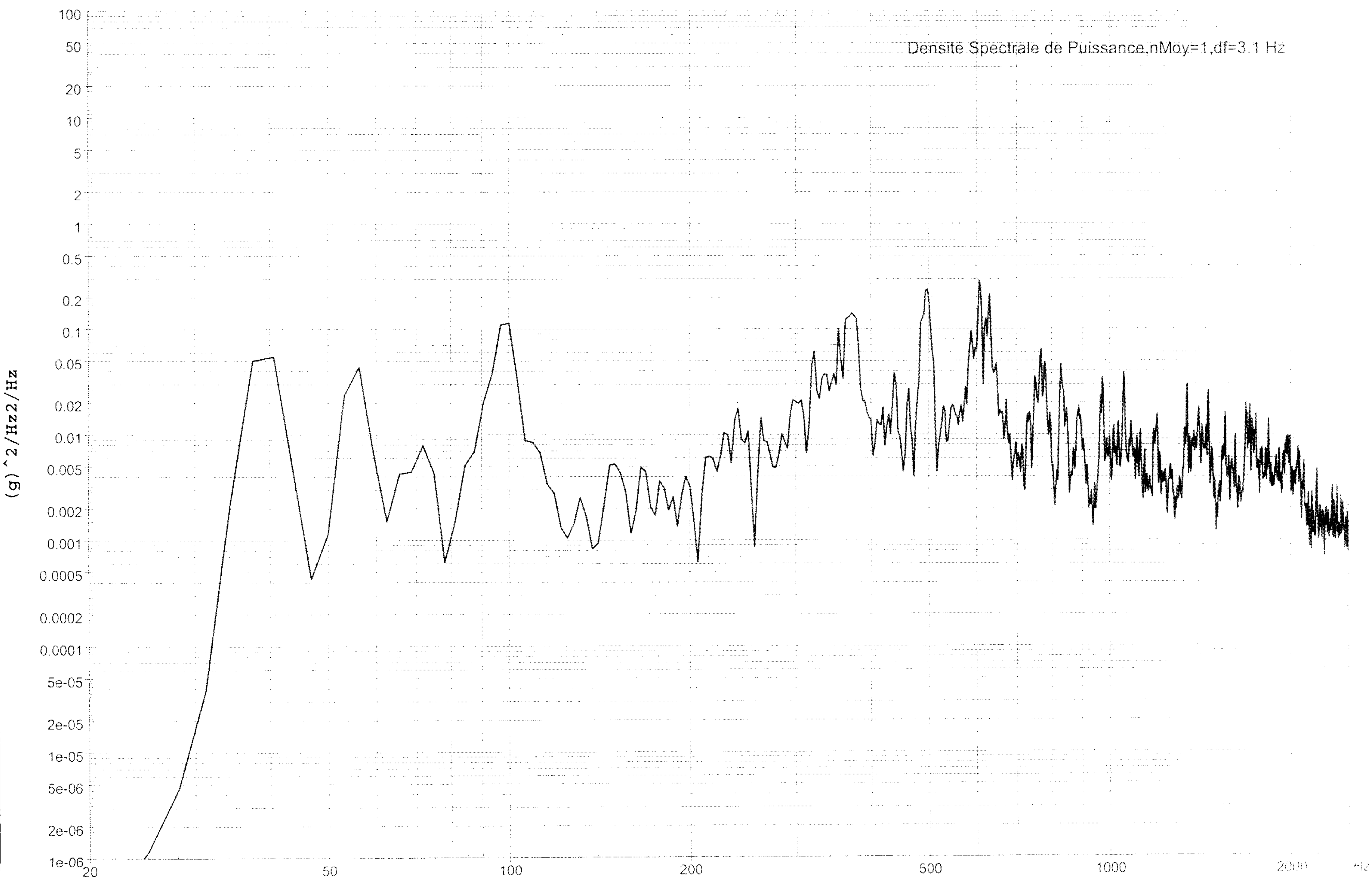
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 28: GVA31Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

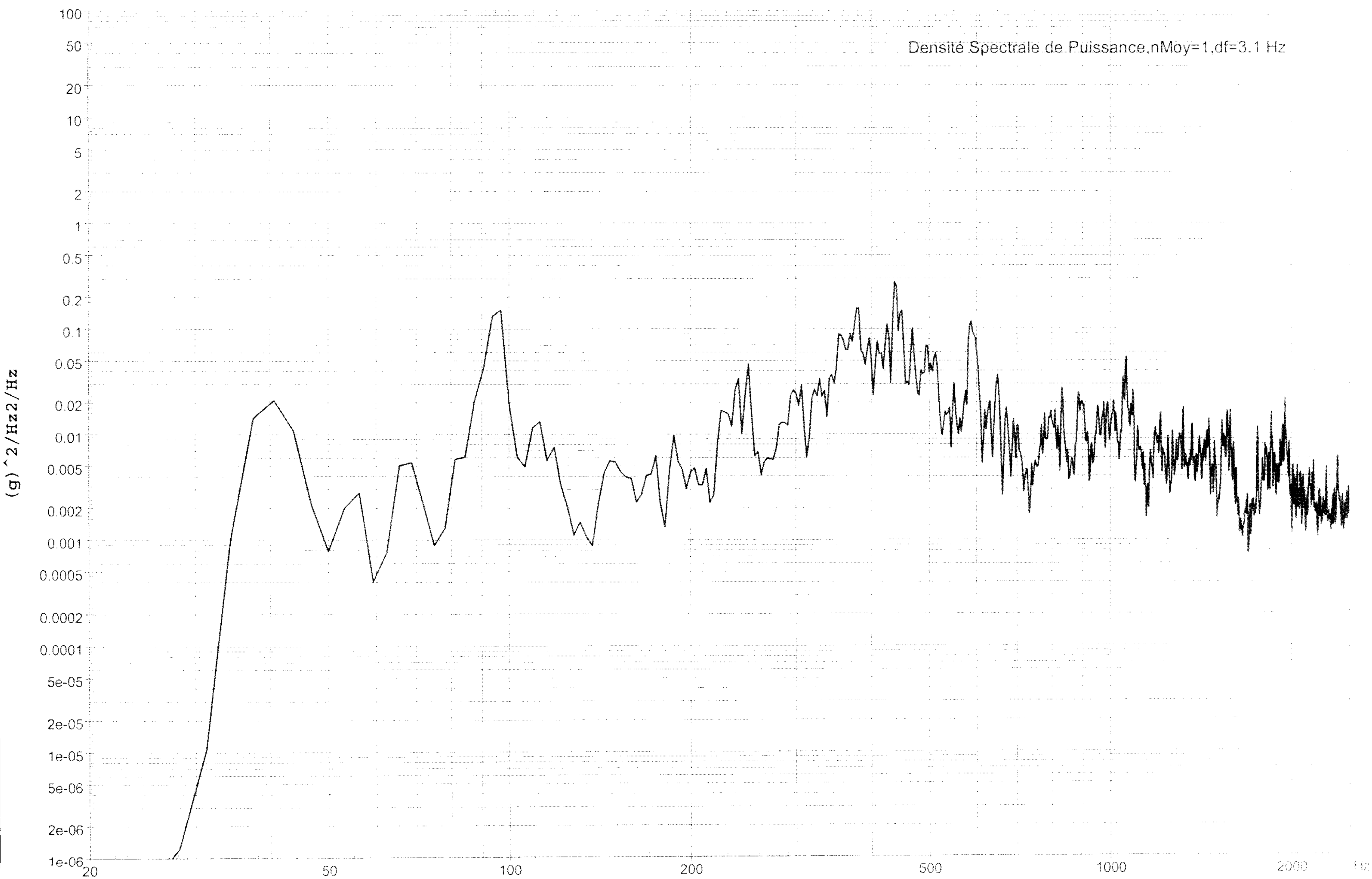
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 29: GVA32R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

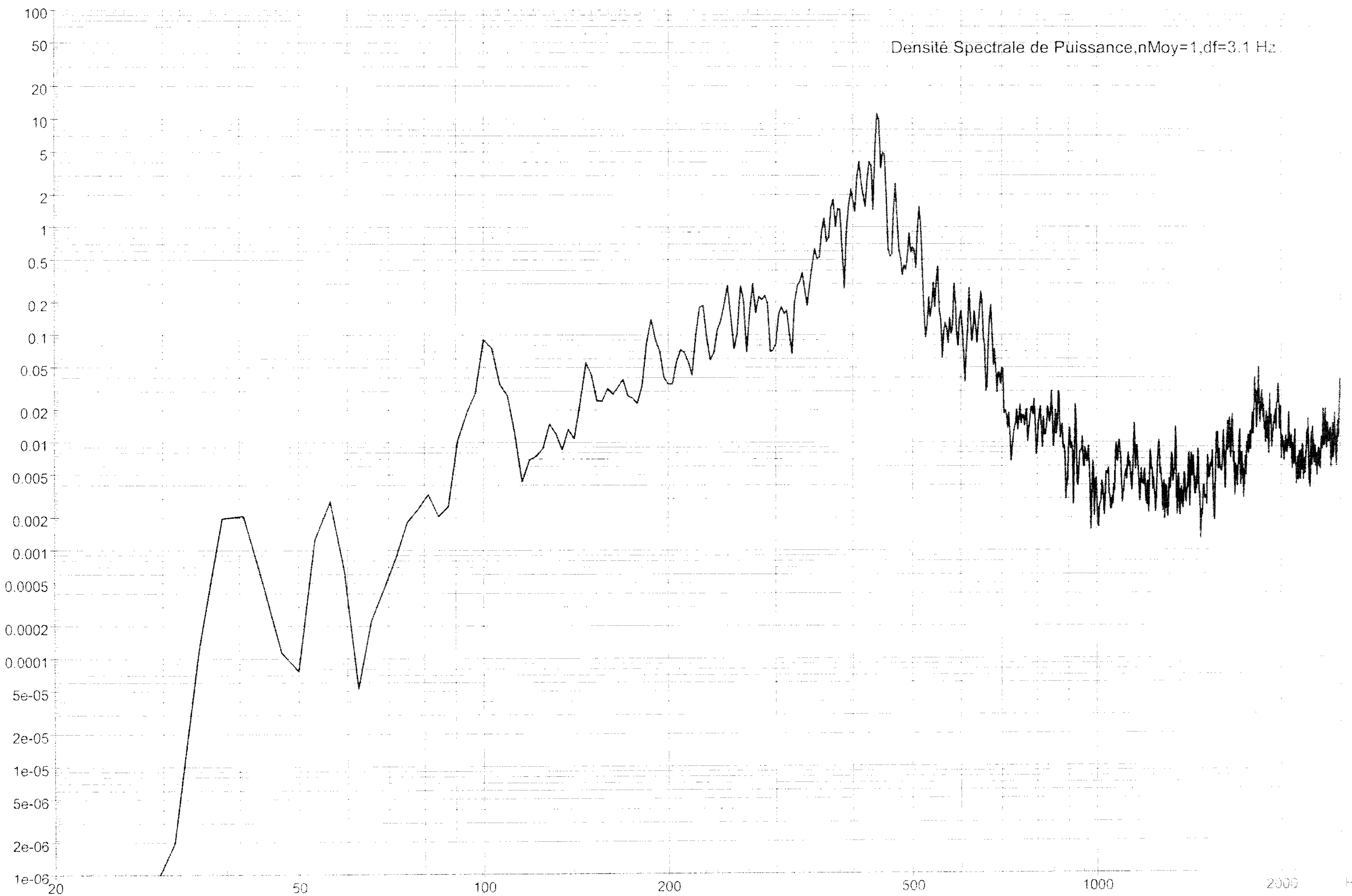
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 30: GVA33T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

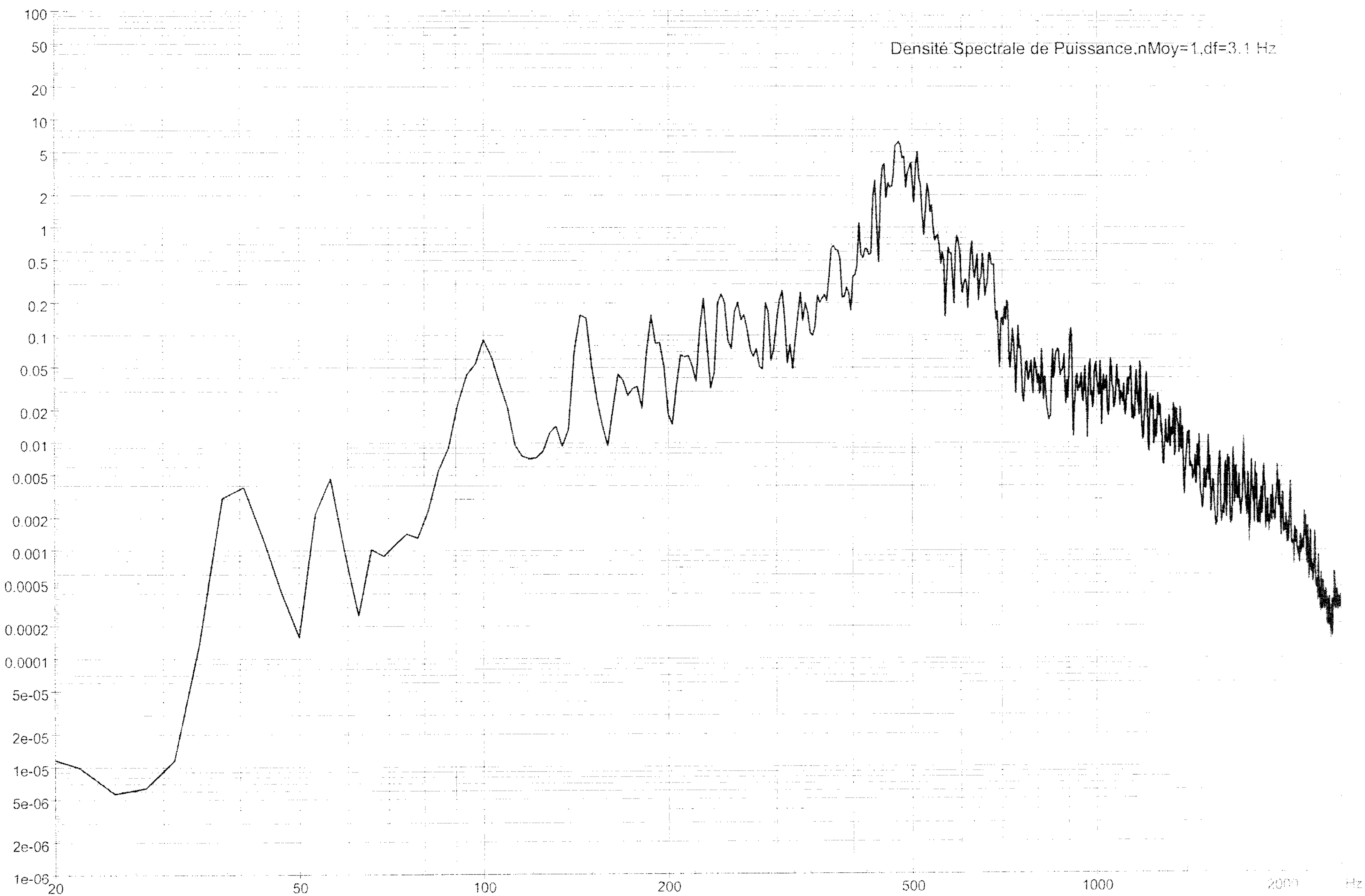
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



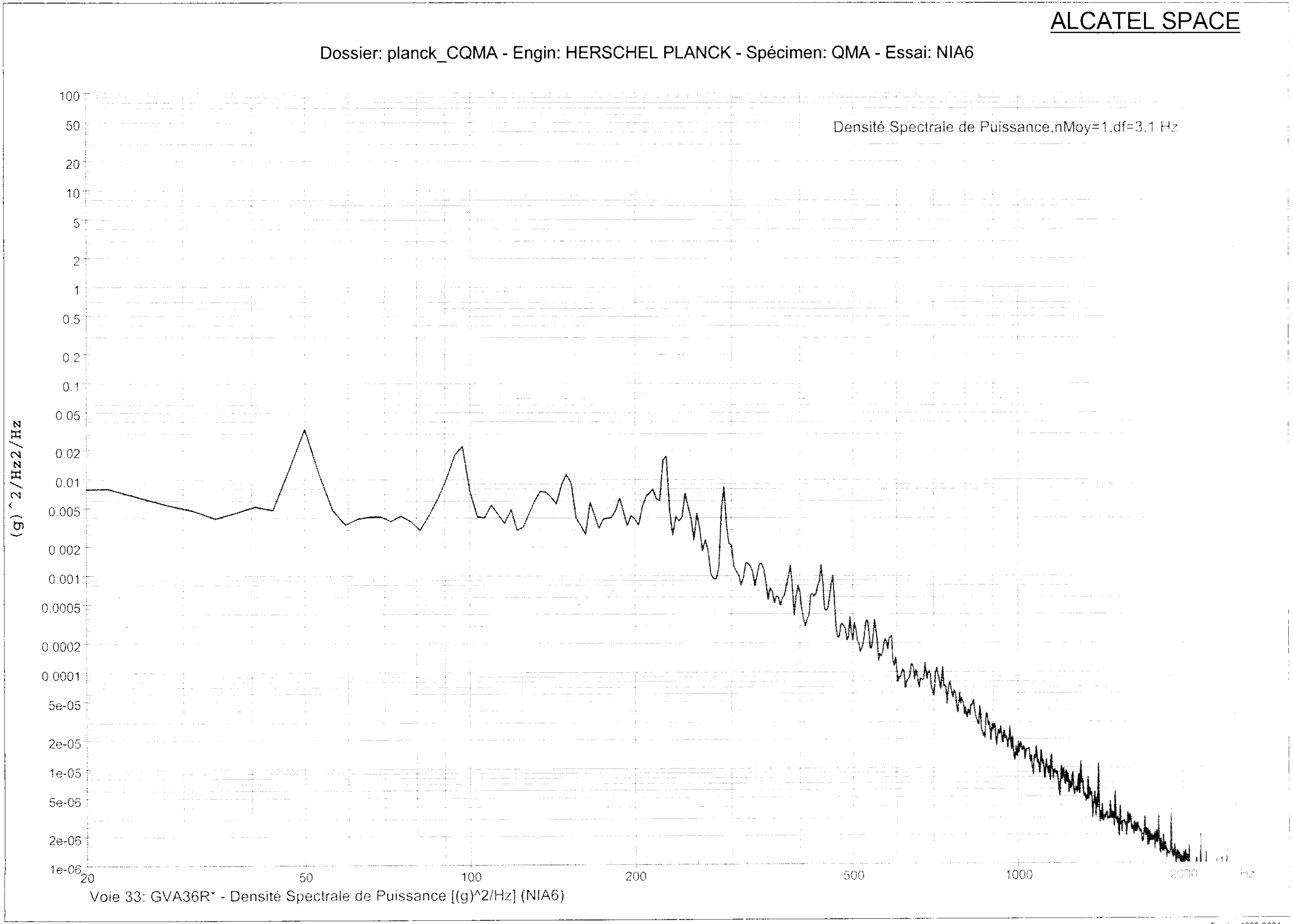
Voie 31: GVA34Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

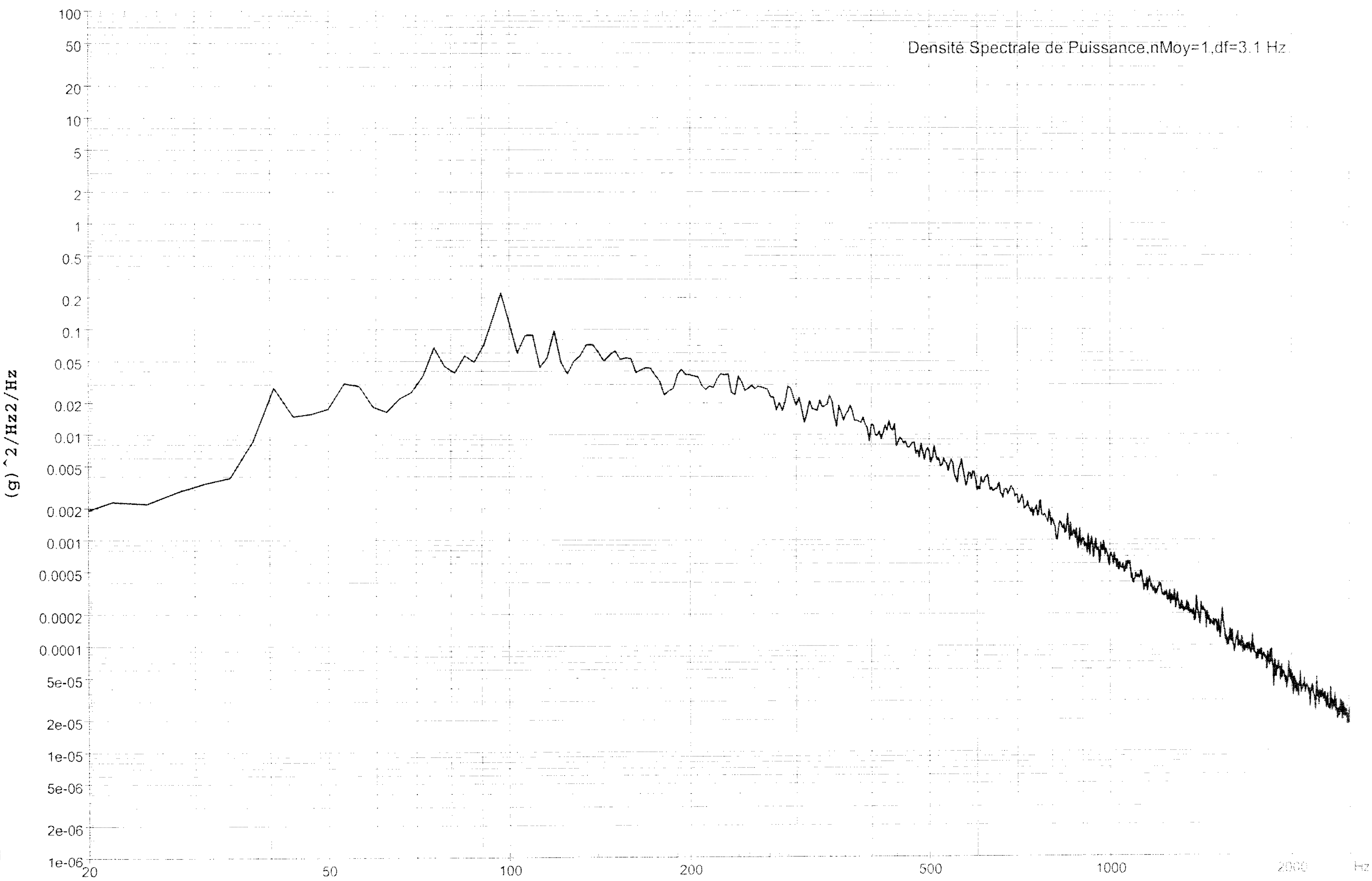


Voie 32: GVA35Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)


ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 33: GVA36R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

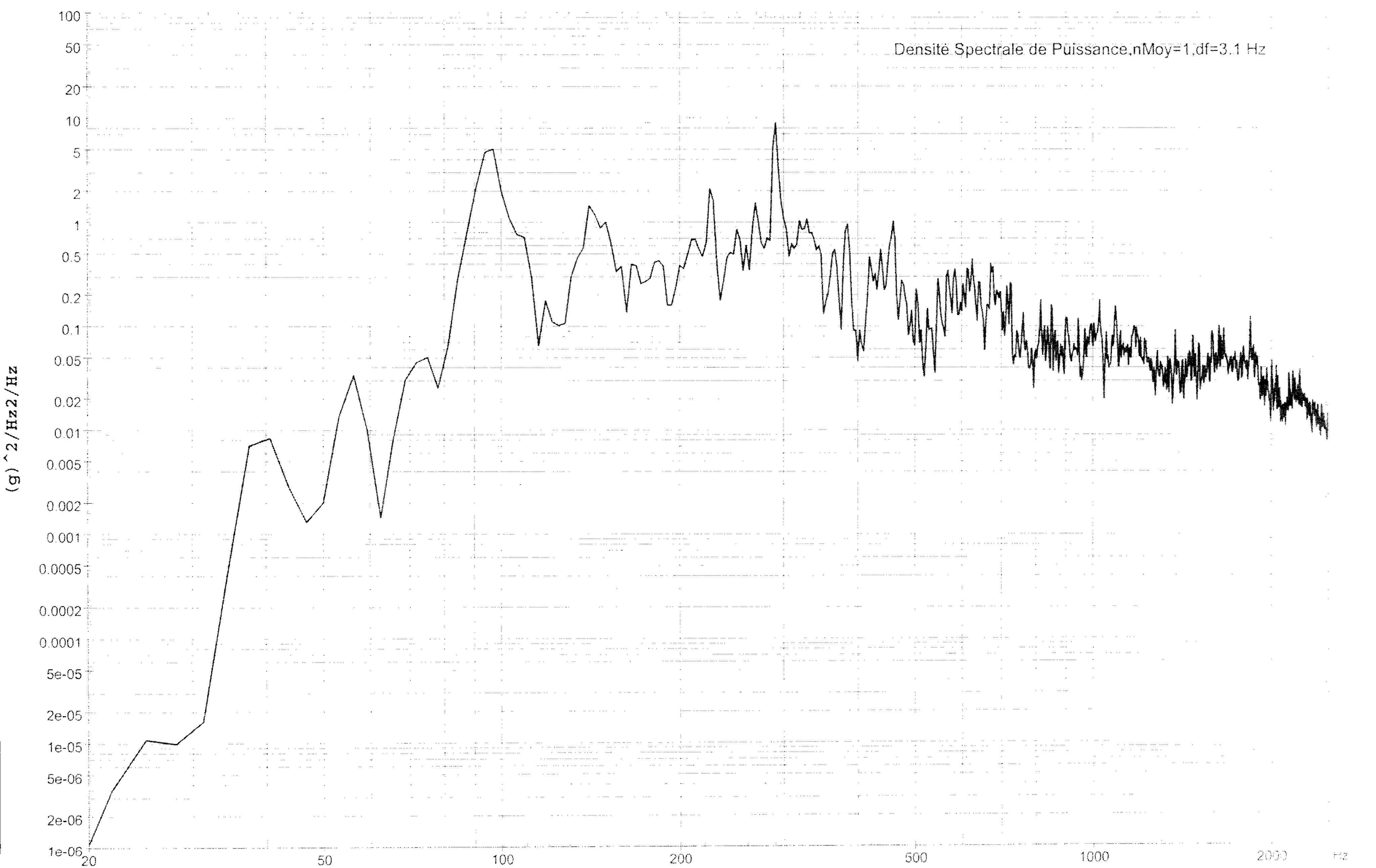
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 34: GVA37T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

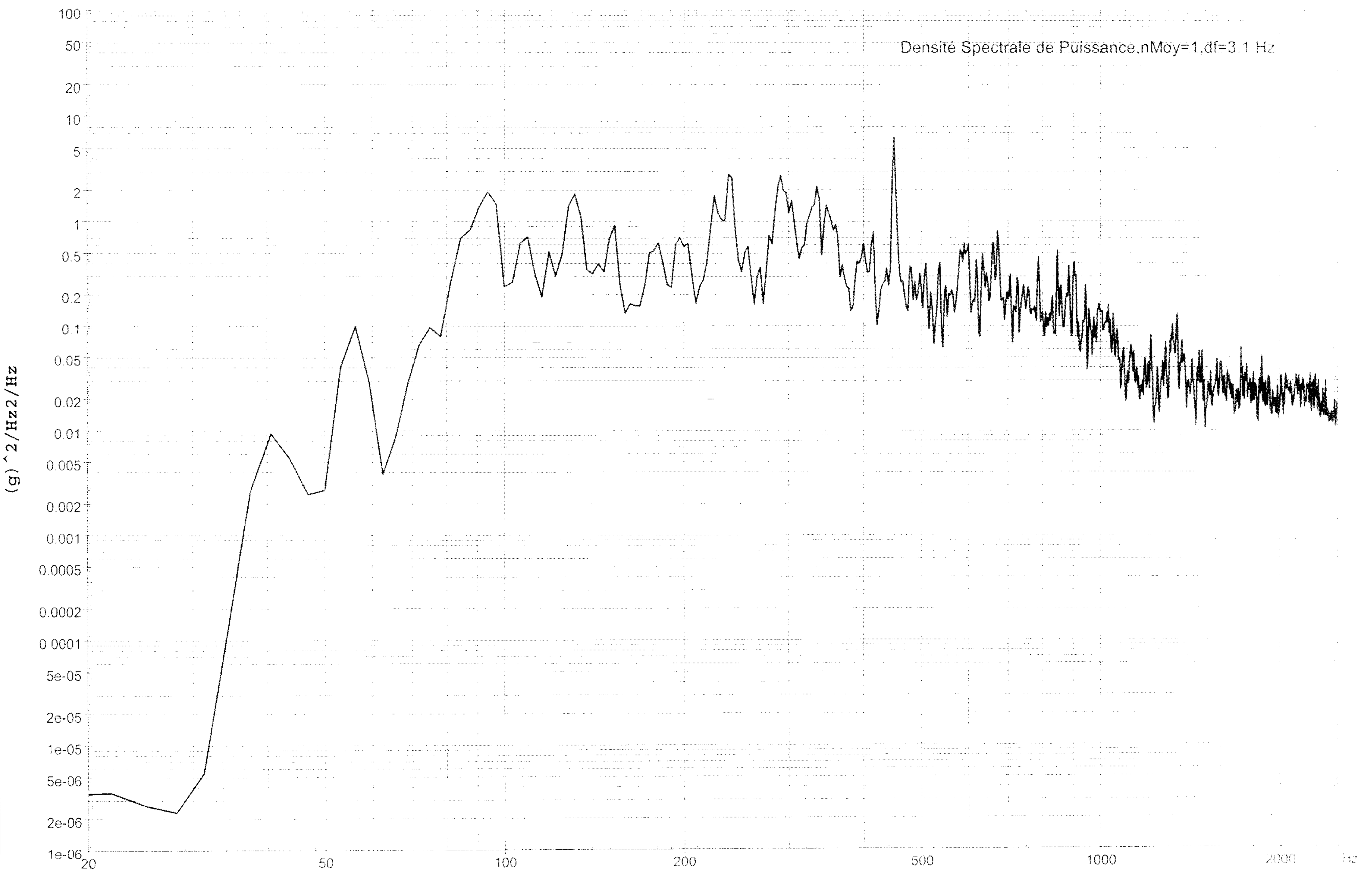
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



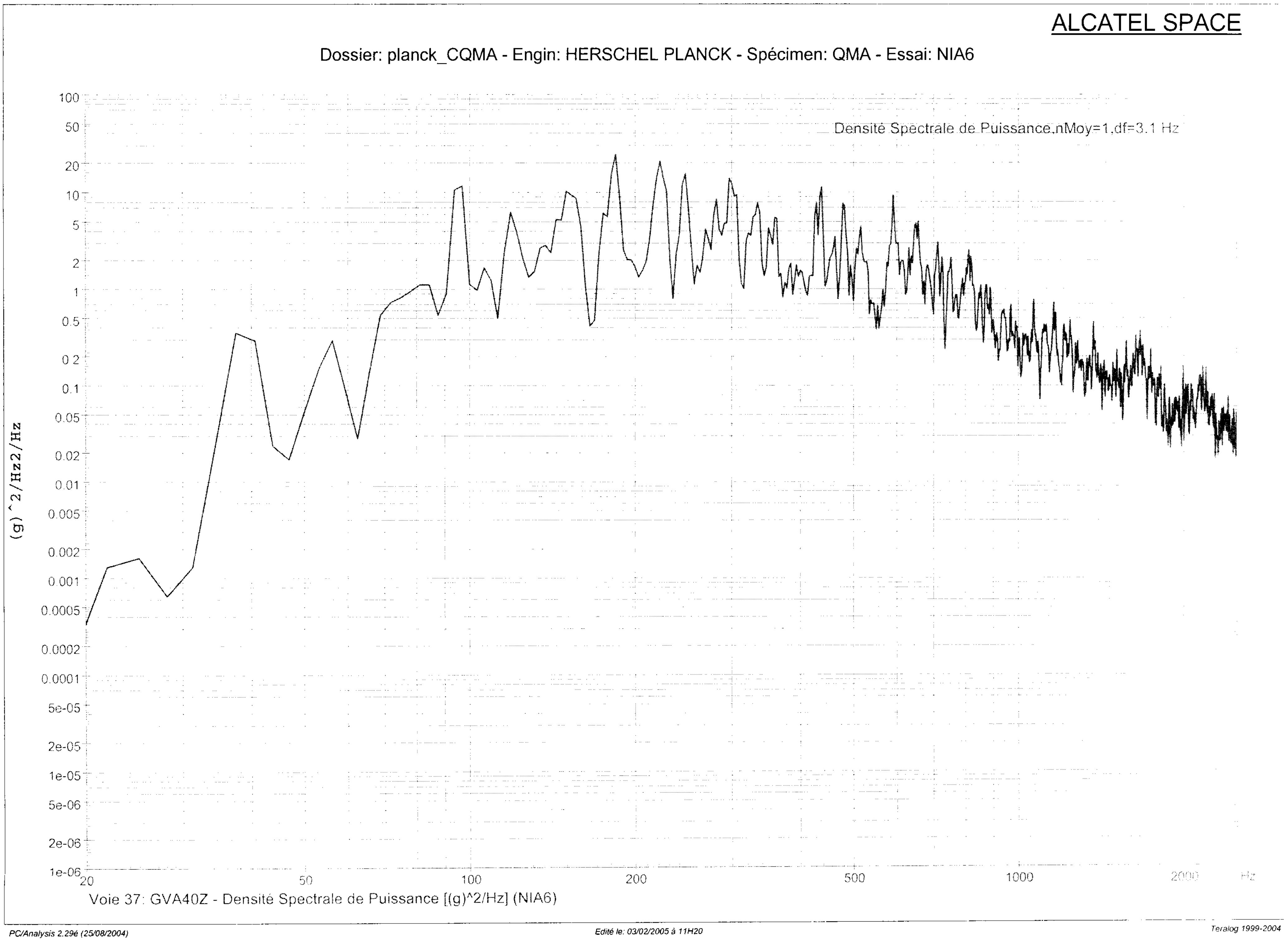
Voie 35: GVA38Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



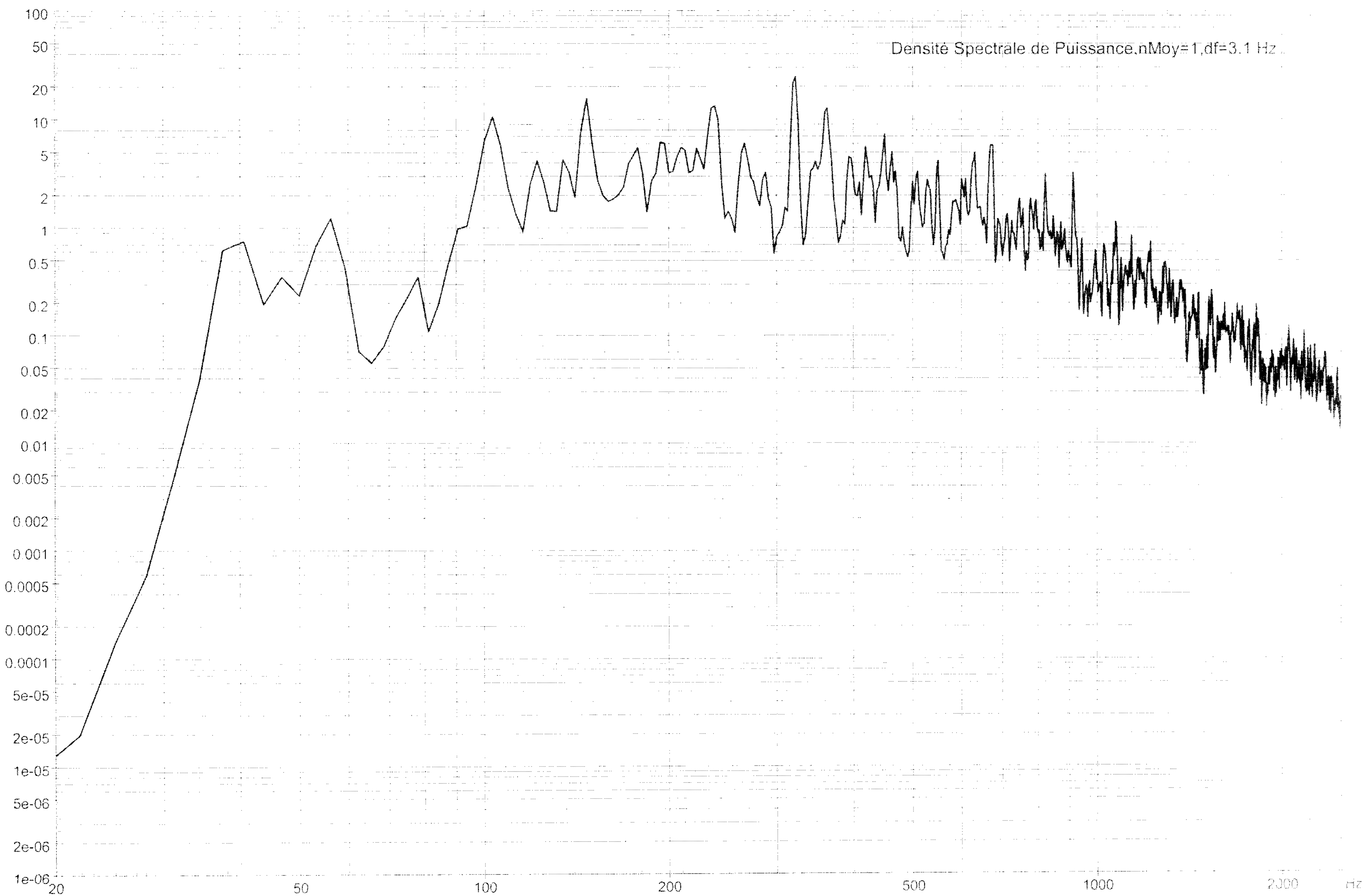
Voie 36: GVA39Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)



ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 37: GVA40Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)
PC/Analysis 2.29é (25/08/2004)
Edité le: 03/02/2005 à 11H20
Teralog 1999-2004

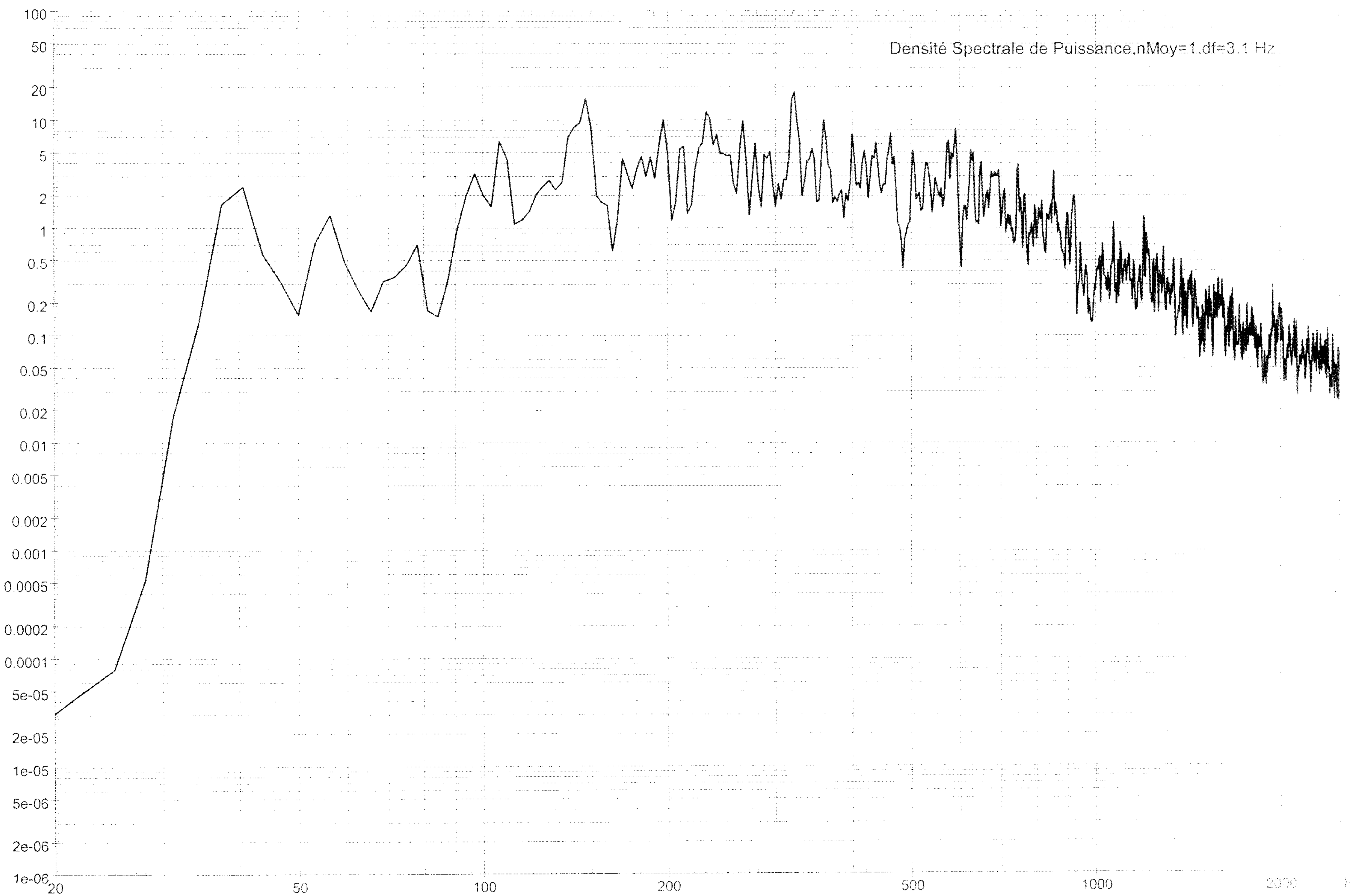
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 38: GVB50Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

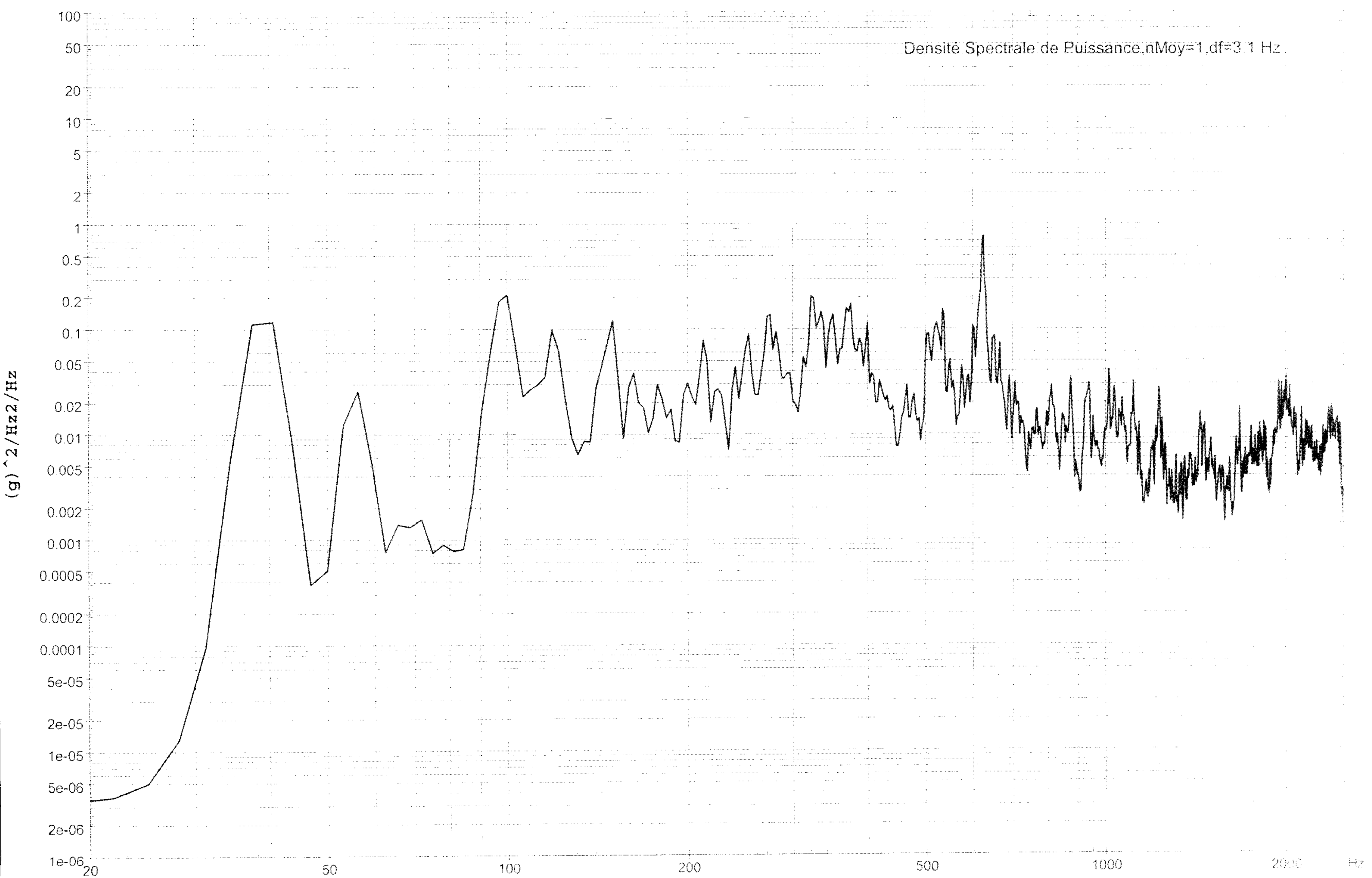
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 39: GVB51Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

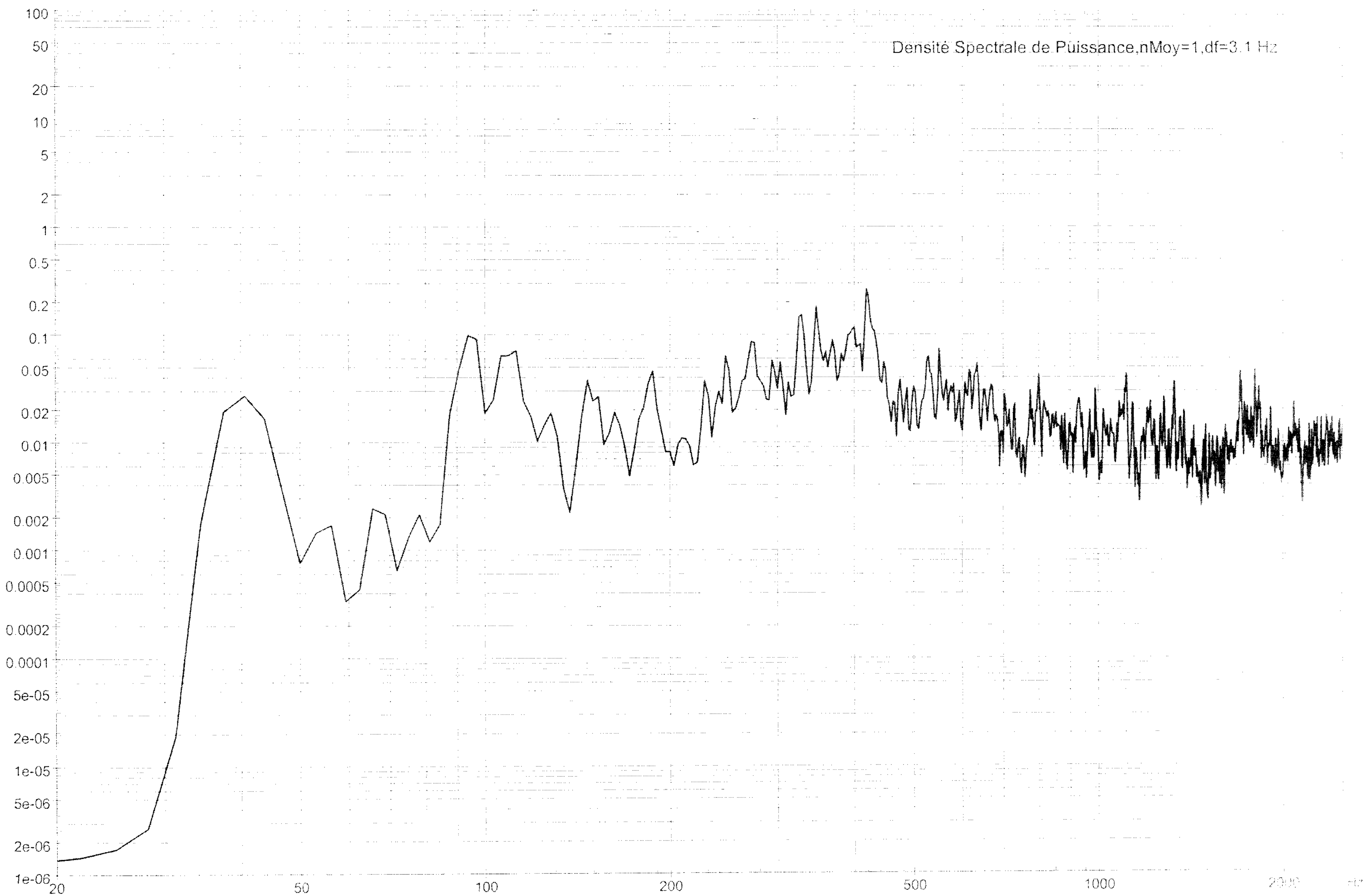
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 40: GVB52R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

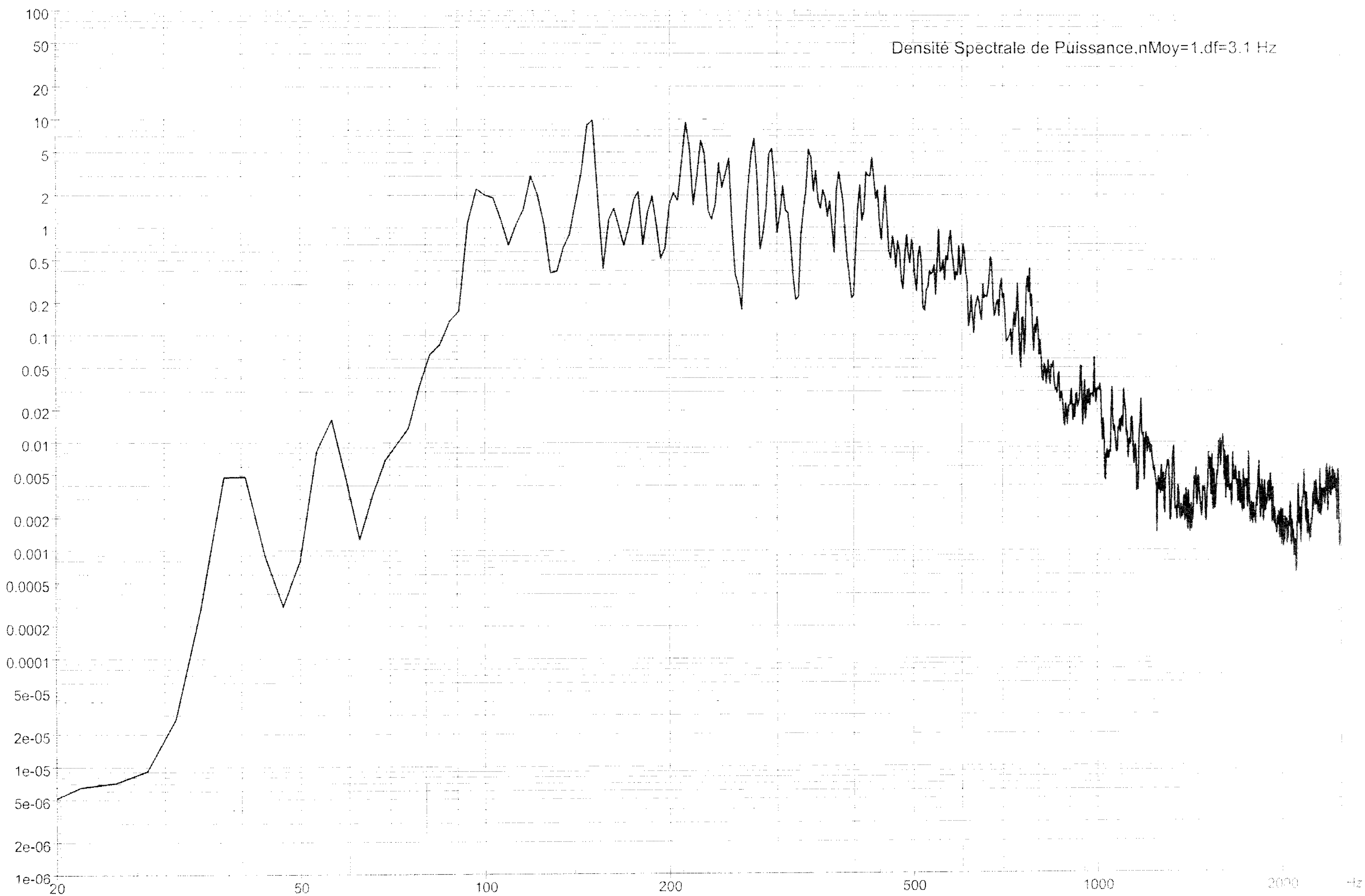
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



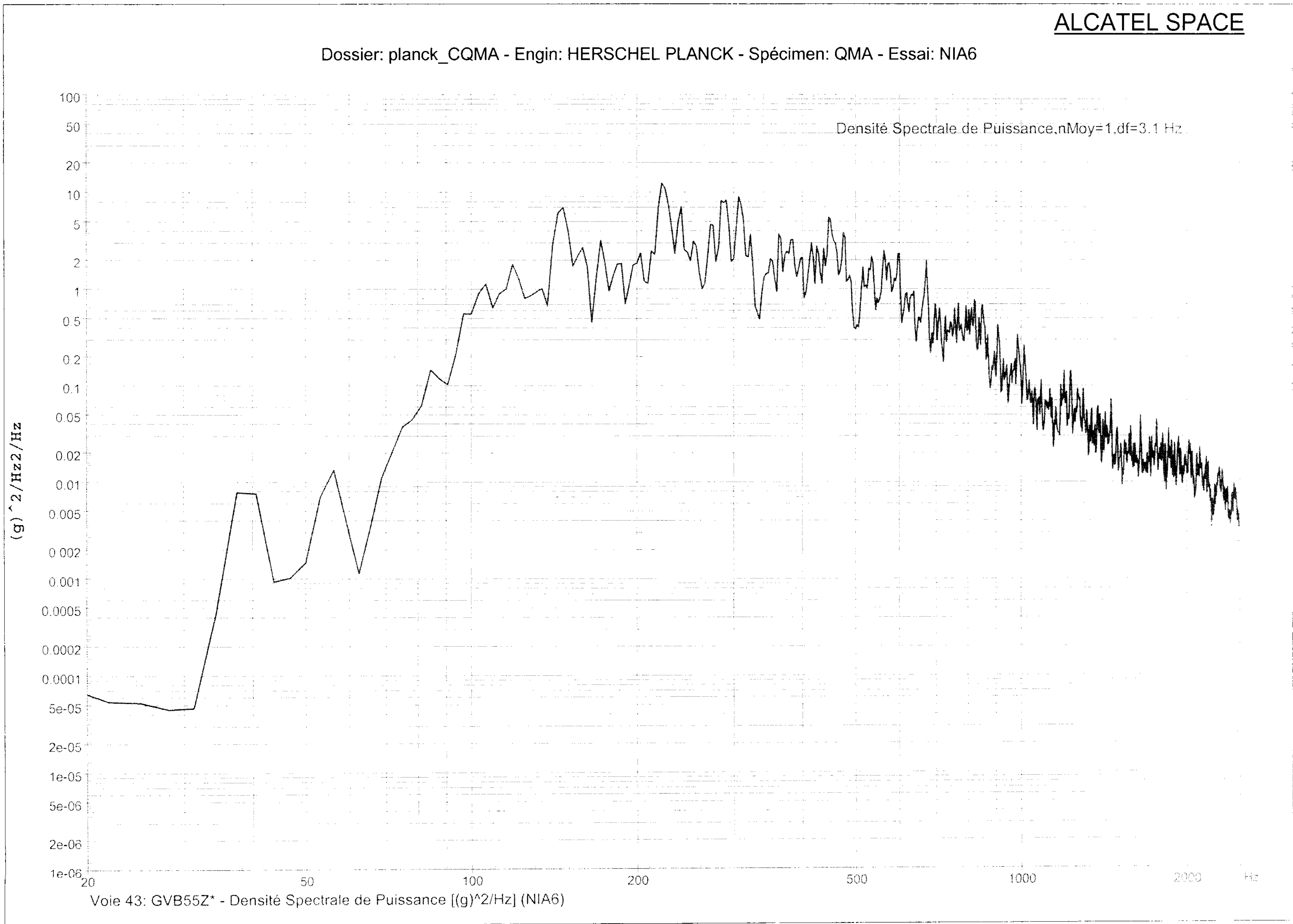
Voie 41: GVB53T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

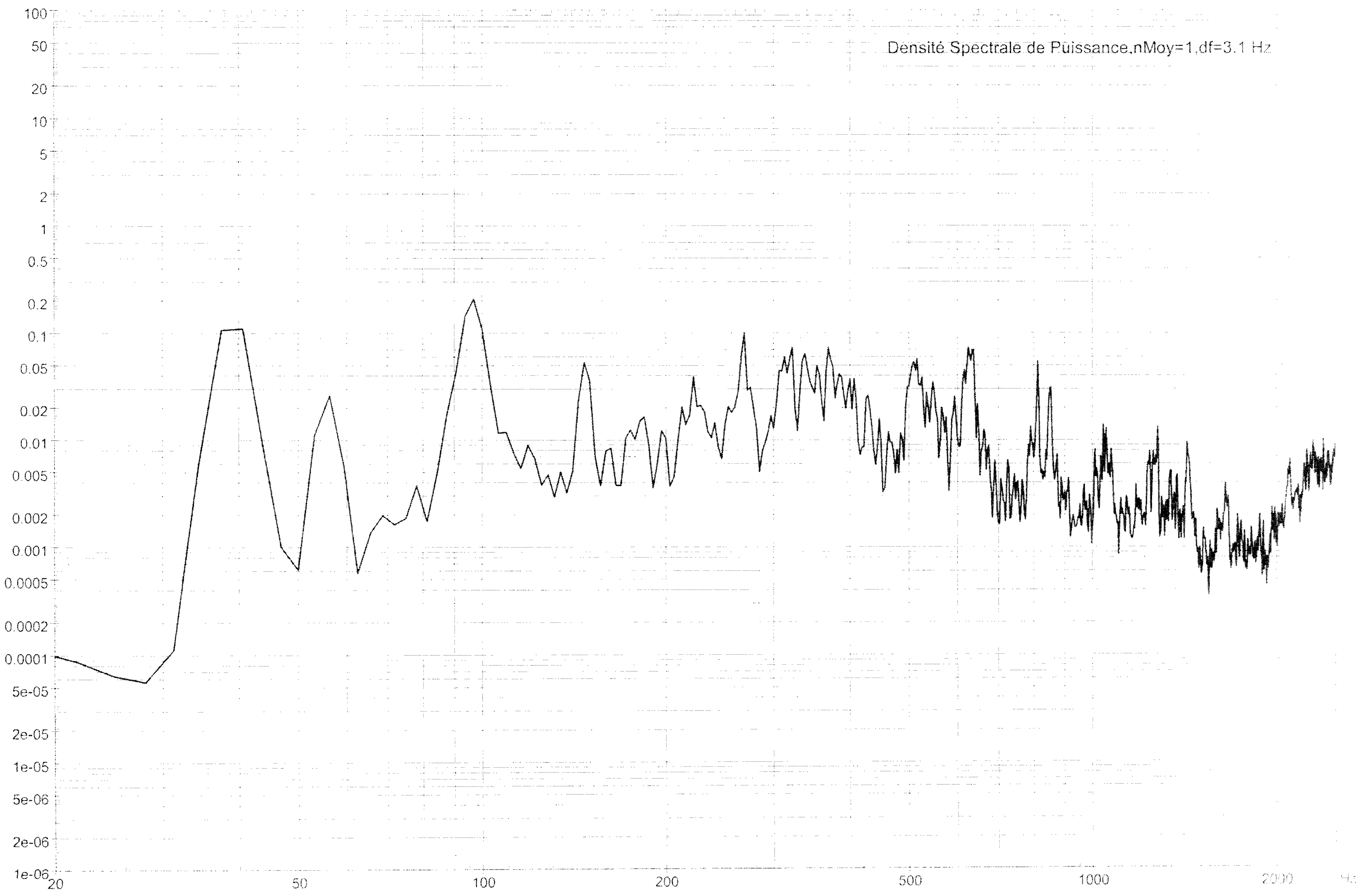


Voie 42: GVB54Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)


ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 43: GVB55Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

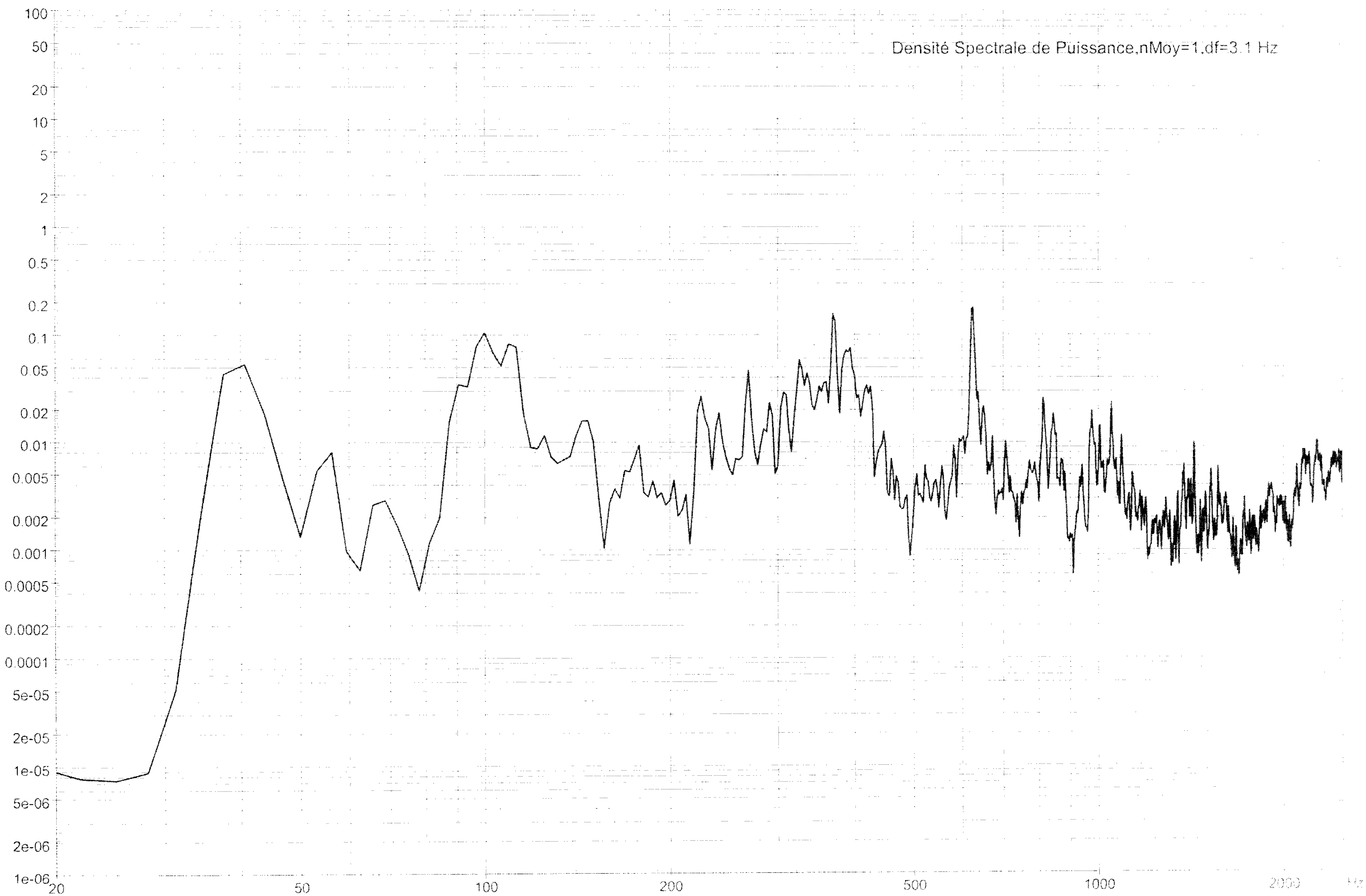
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 44: GVB56R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

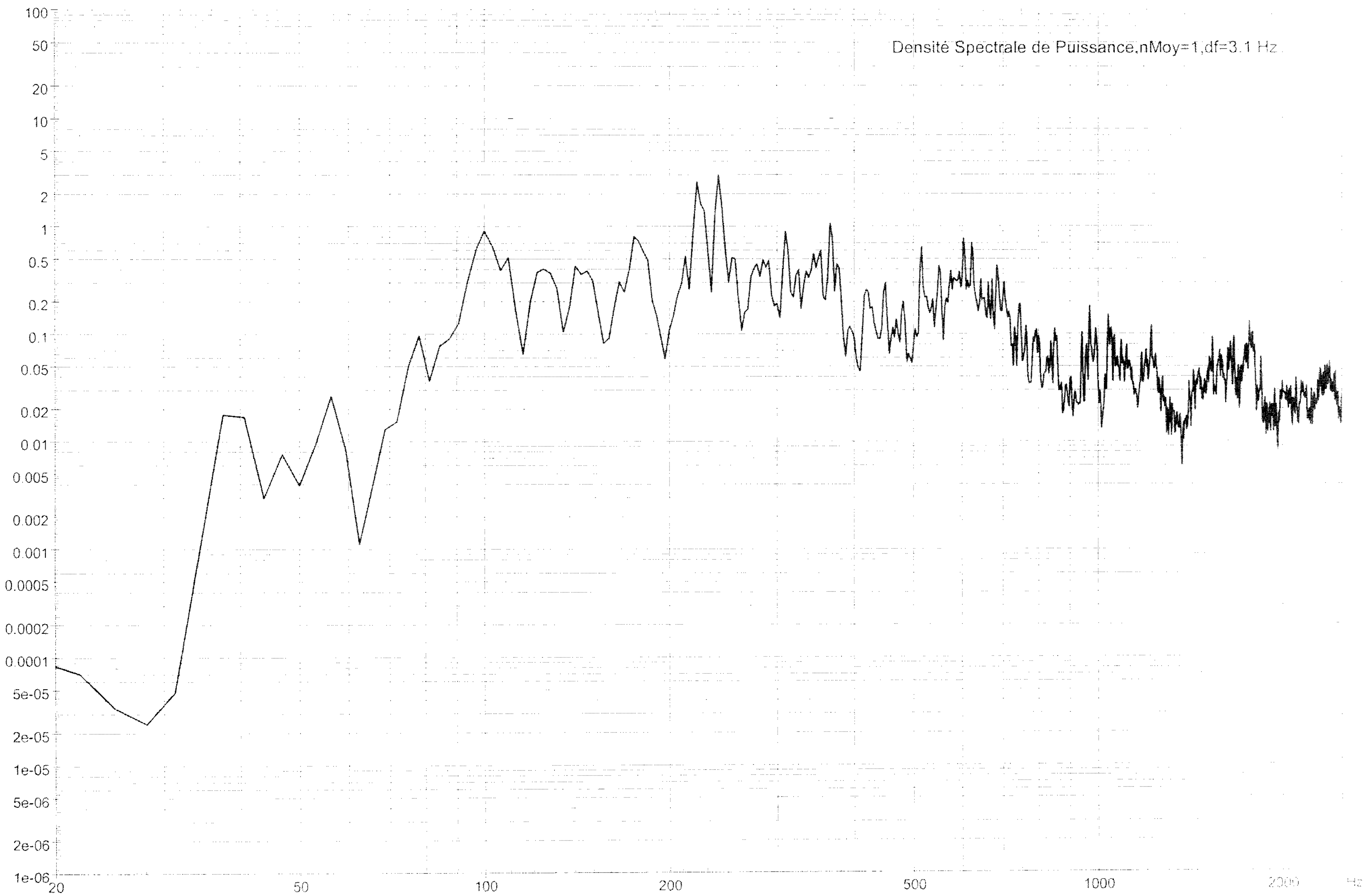
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



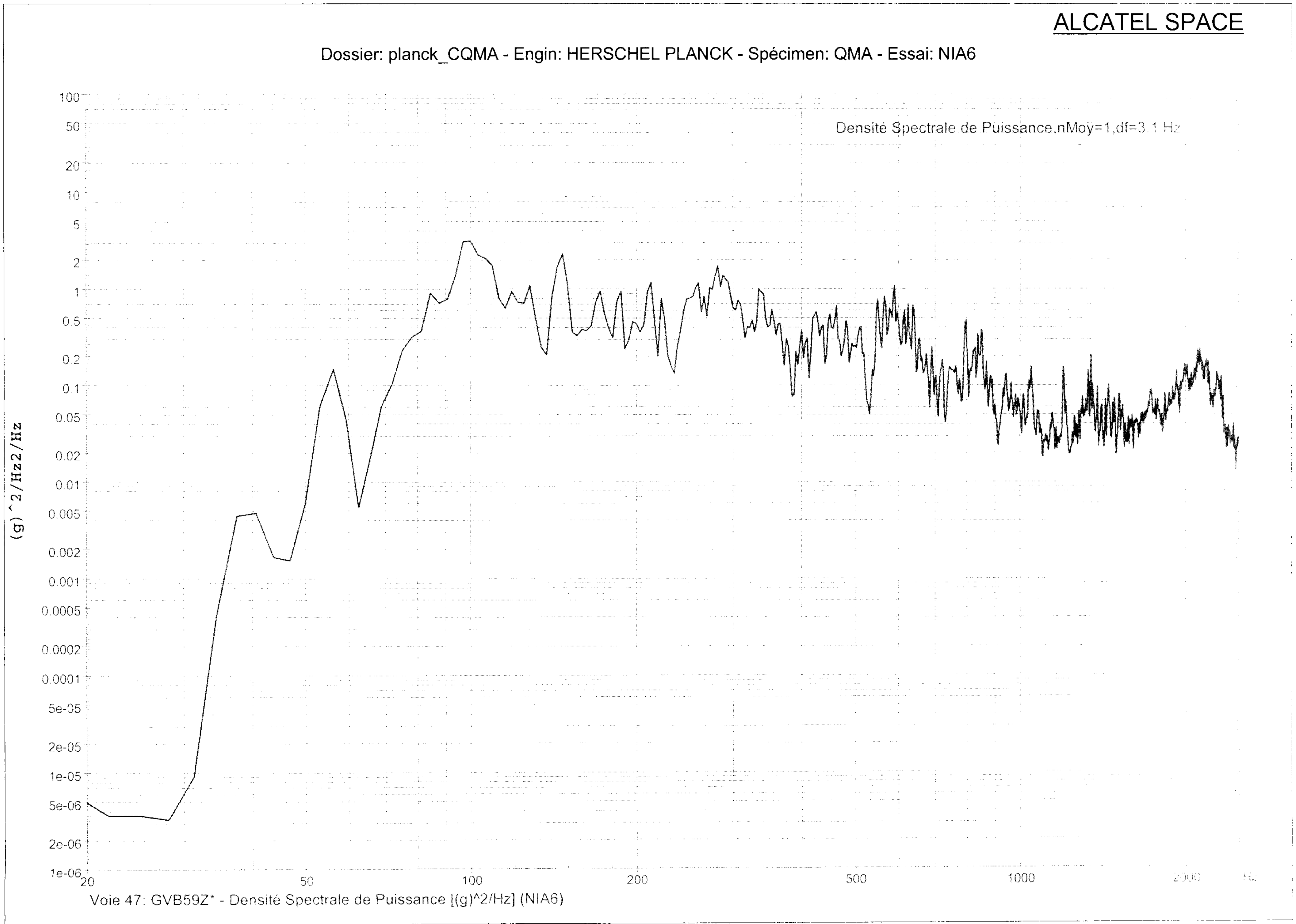
Voie 45: GVB57T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

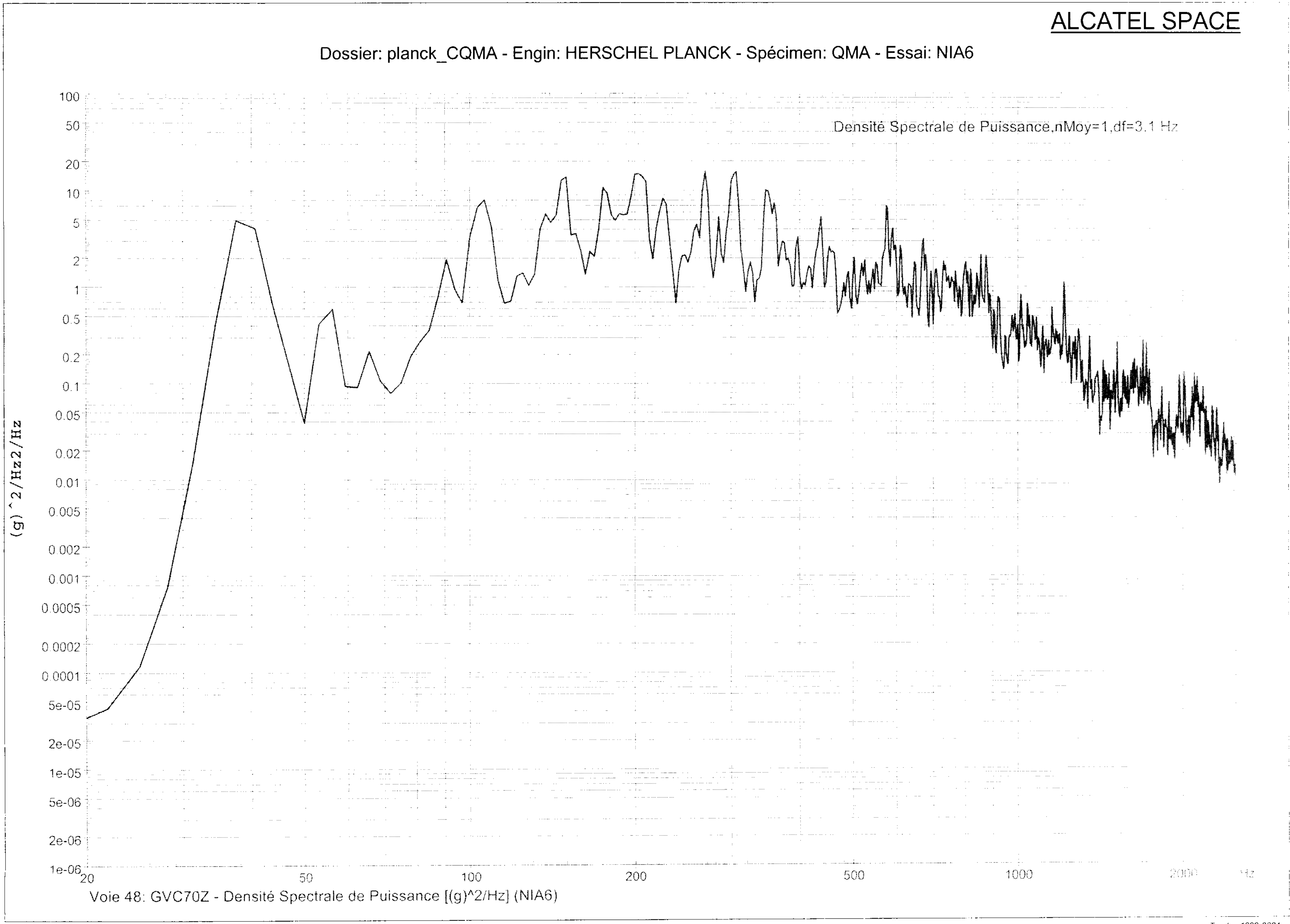
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 46: GVB58Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

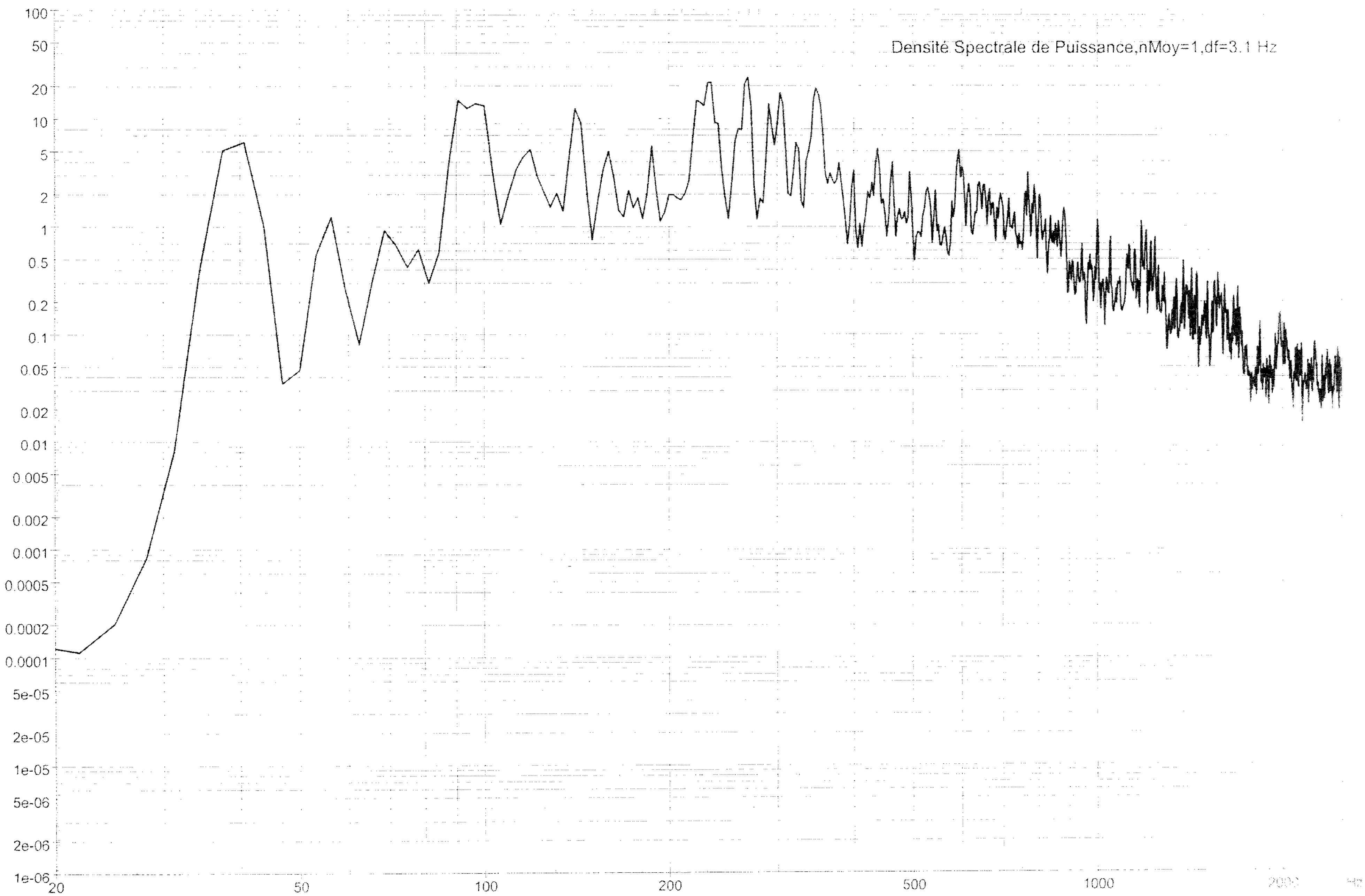

ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 47: GVB59Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)



PC/Analysis 2.29é (25/08/2004) Edité le: 03/02/2005 à 11H20 Teralog 1999-2004

ALCATEL SPACE

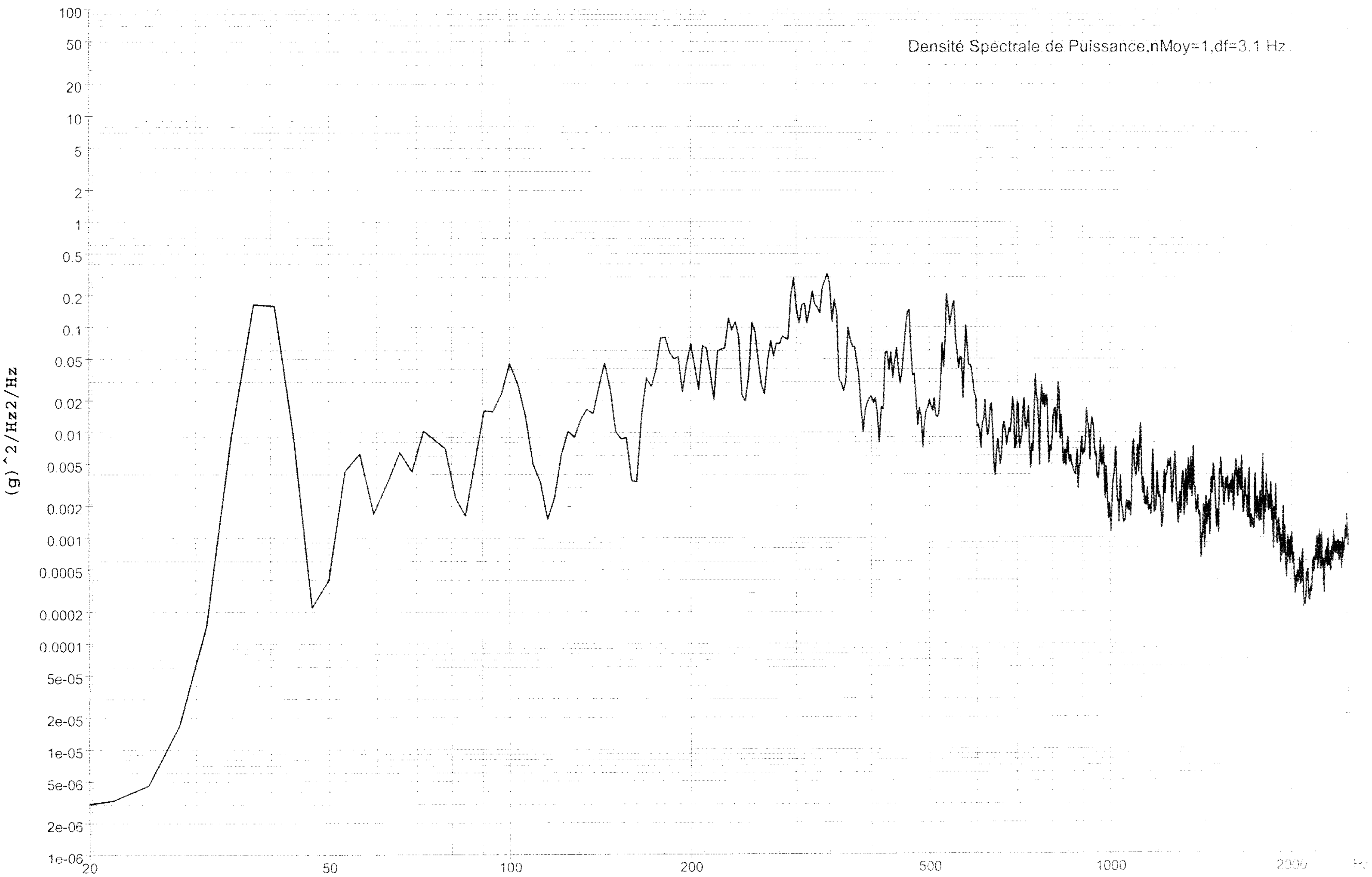
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 49: GVC71Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

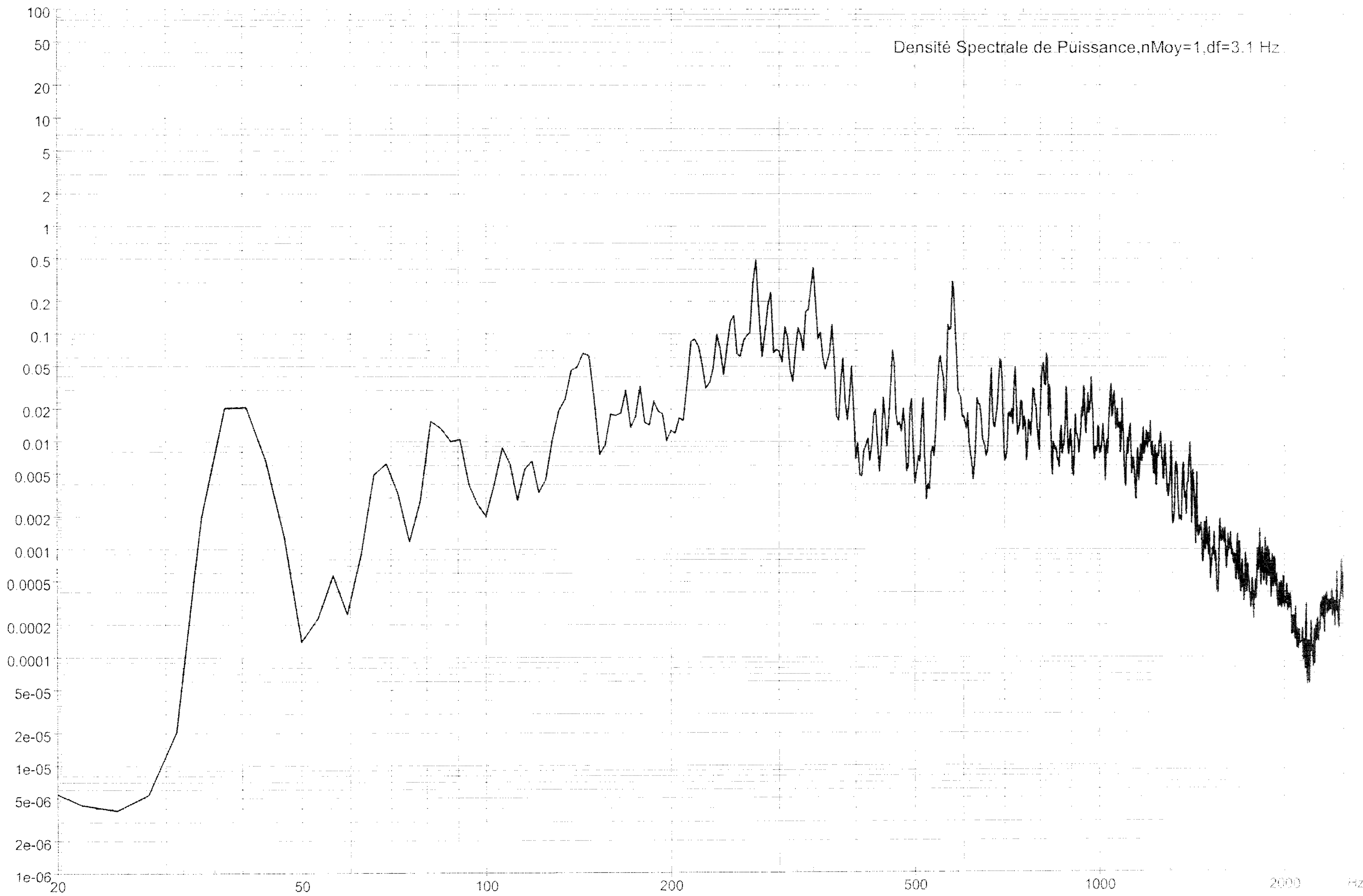
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 50: GVC72R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

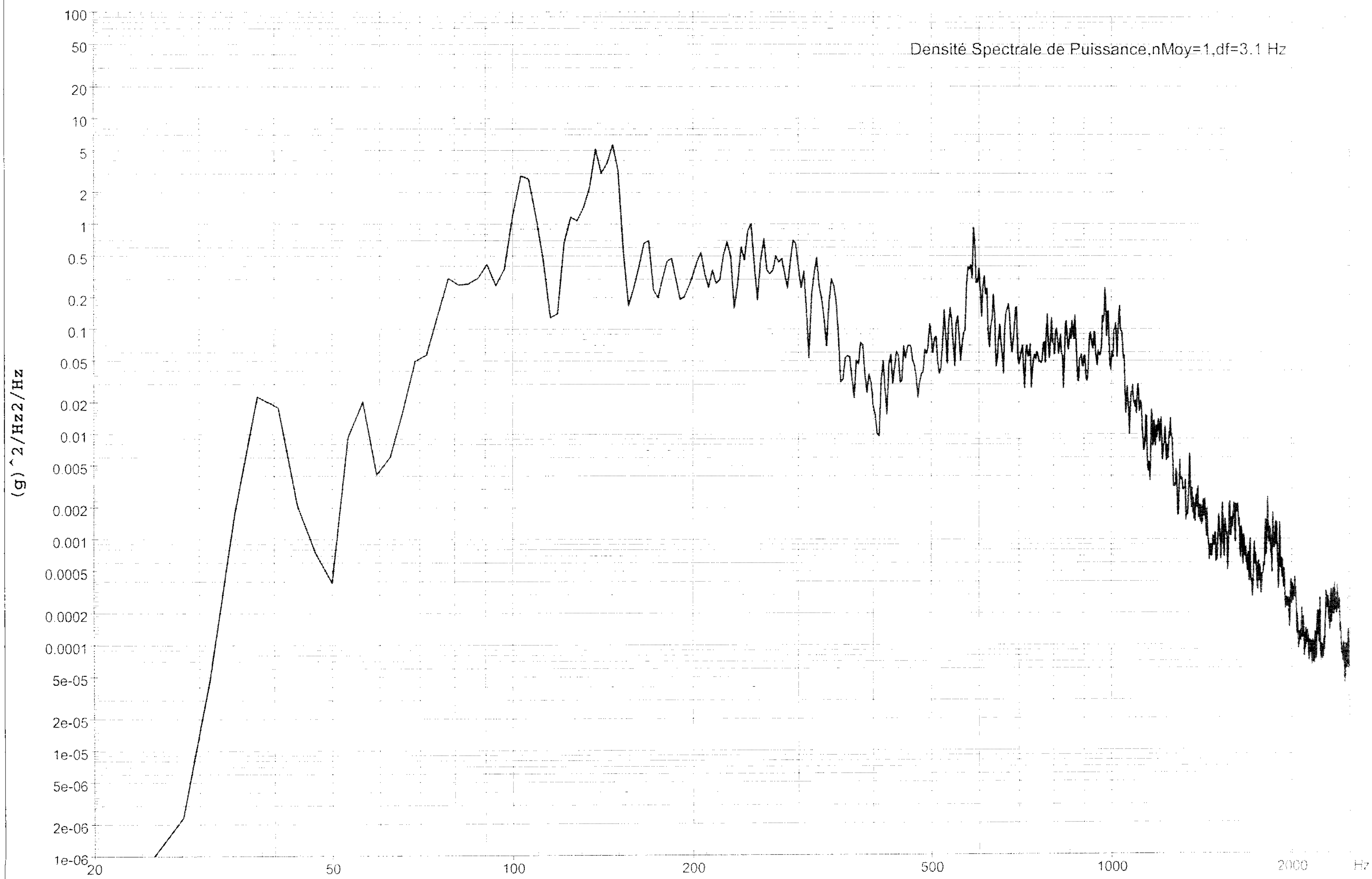
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



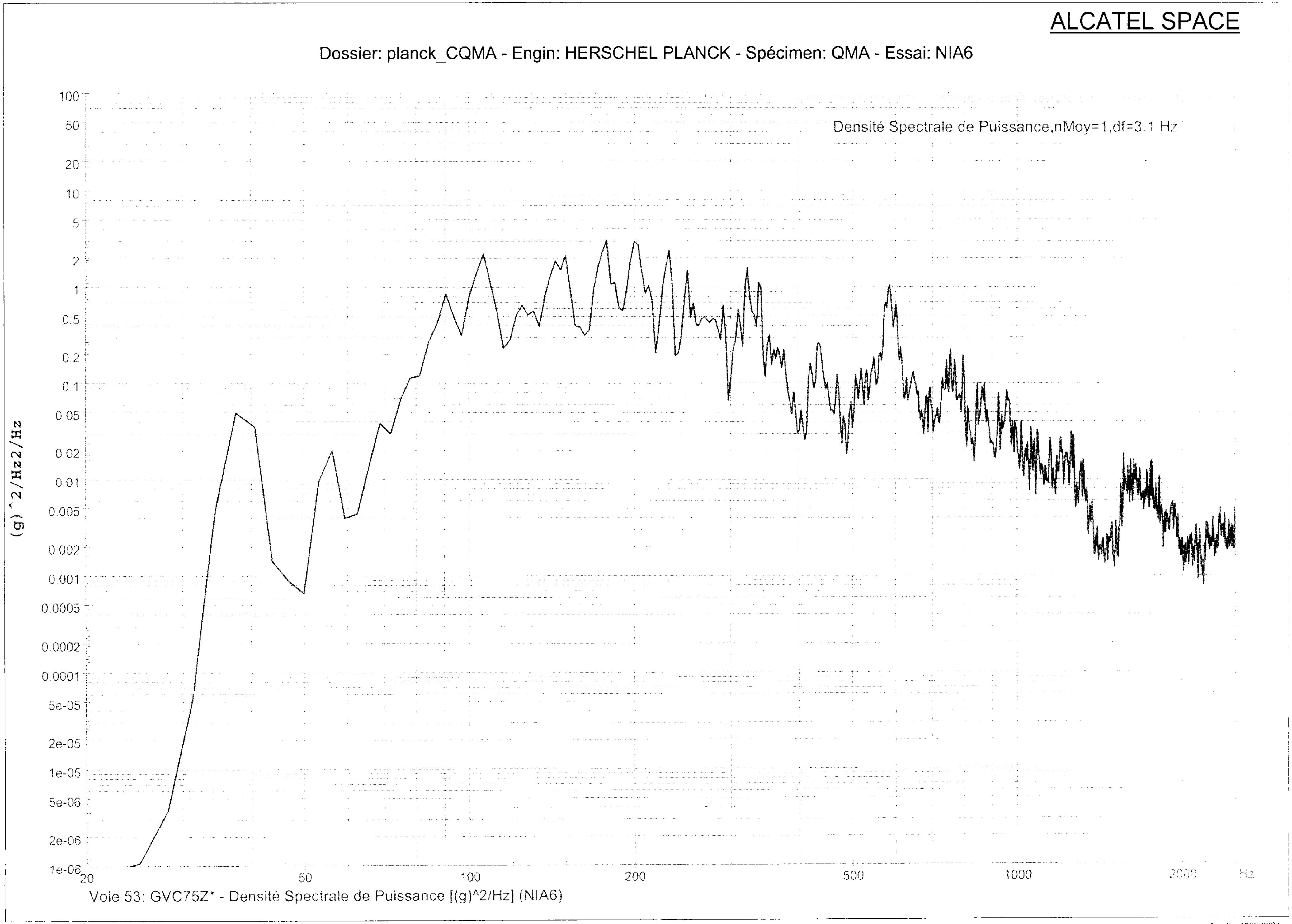
Voie 51: GVC73T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



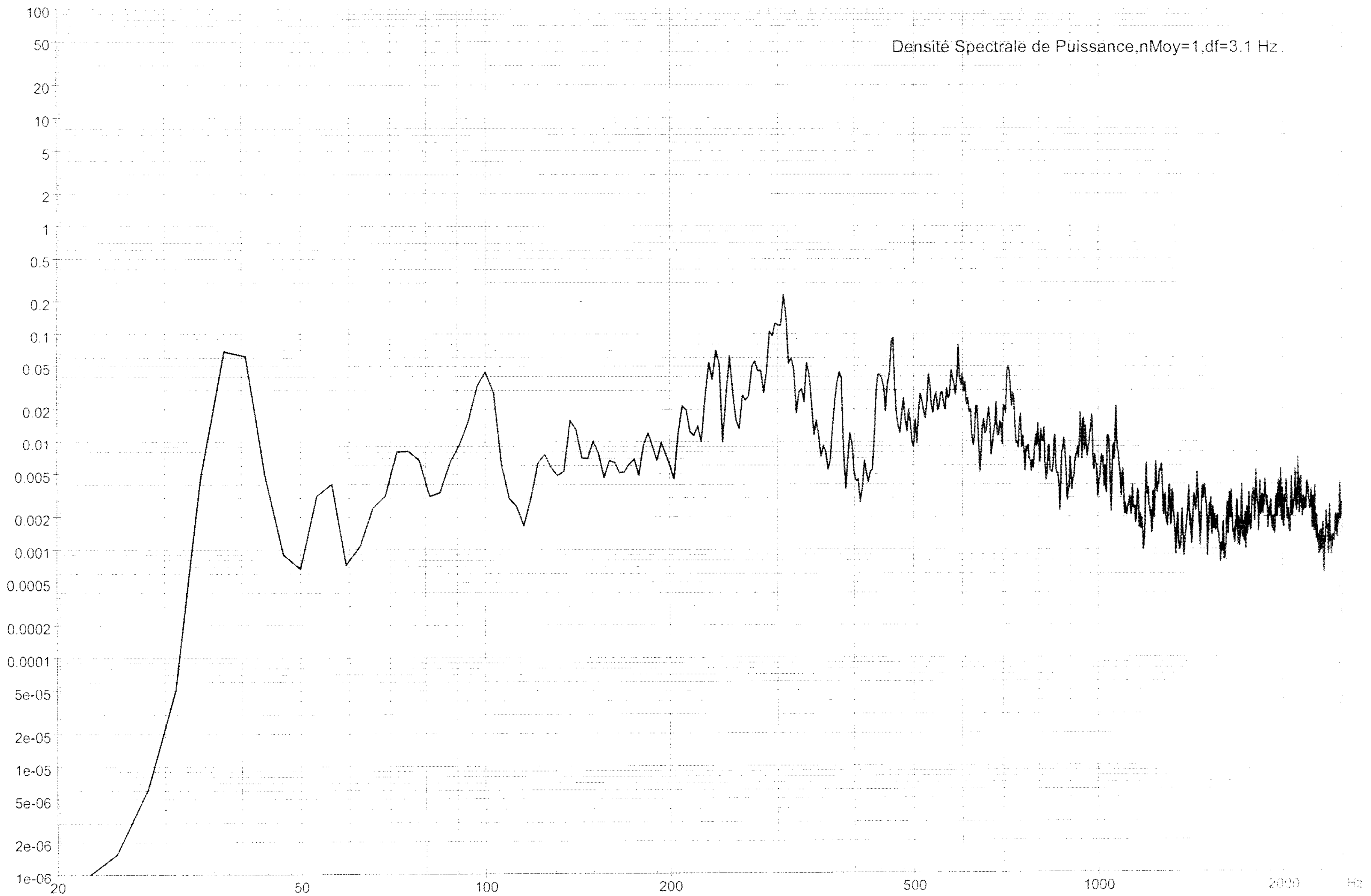
Voie 52: GVC74Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)



ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 53: GVC75Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

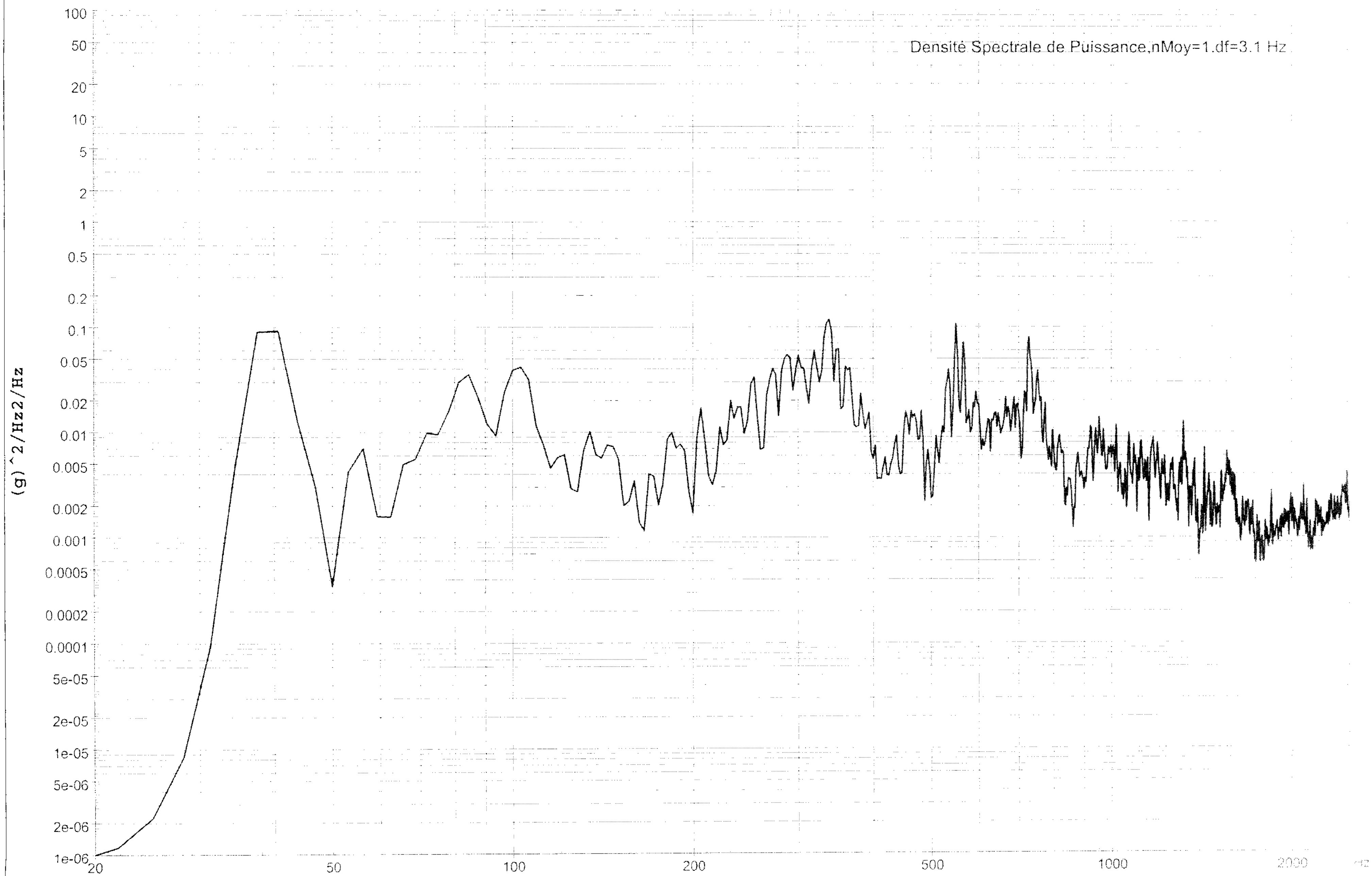
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 54: GVC76R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

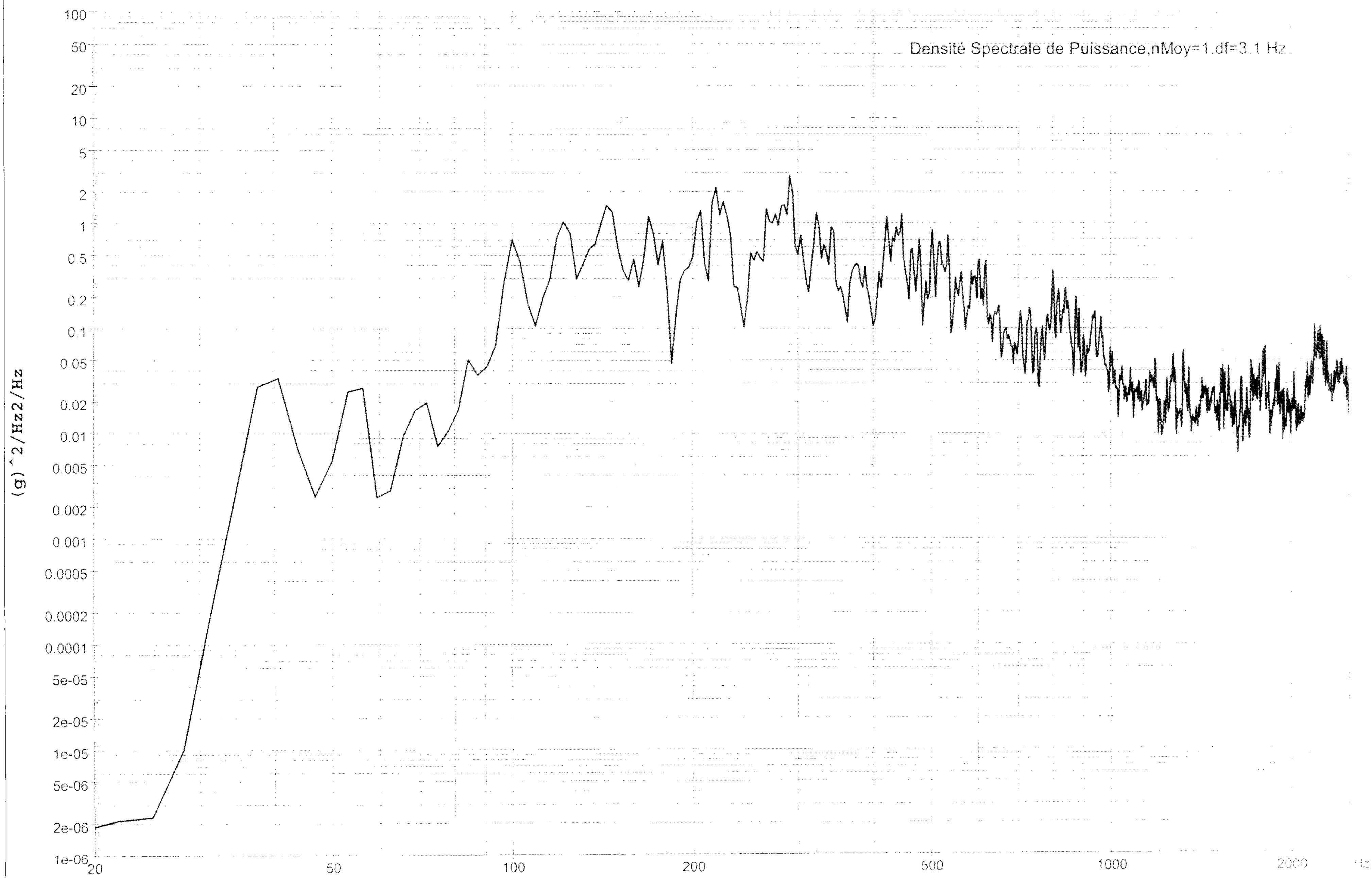
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 55: GVC77T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 56: GVC78Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

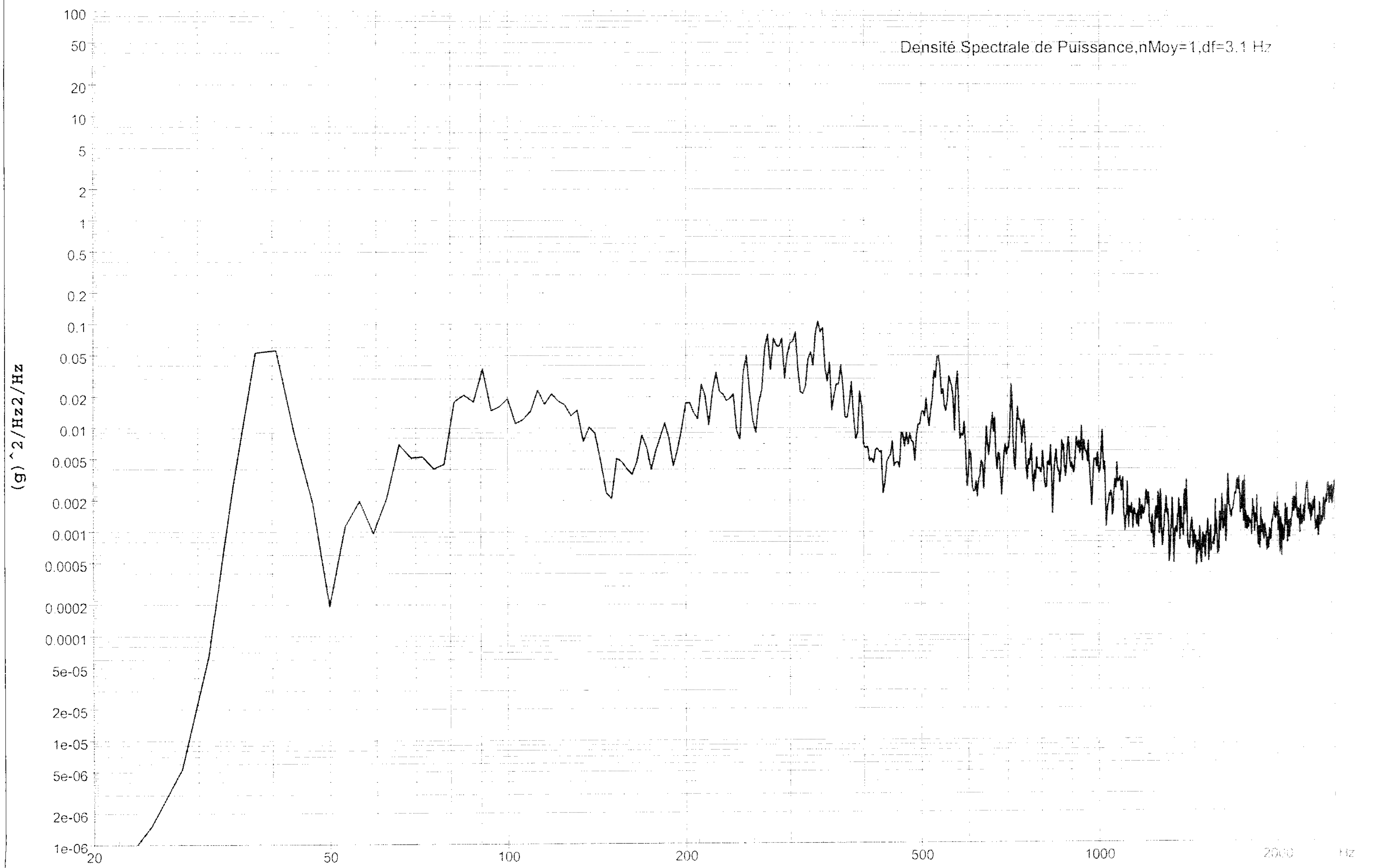
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

Voie 57: GVC79R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

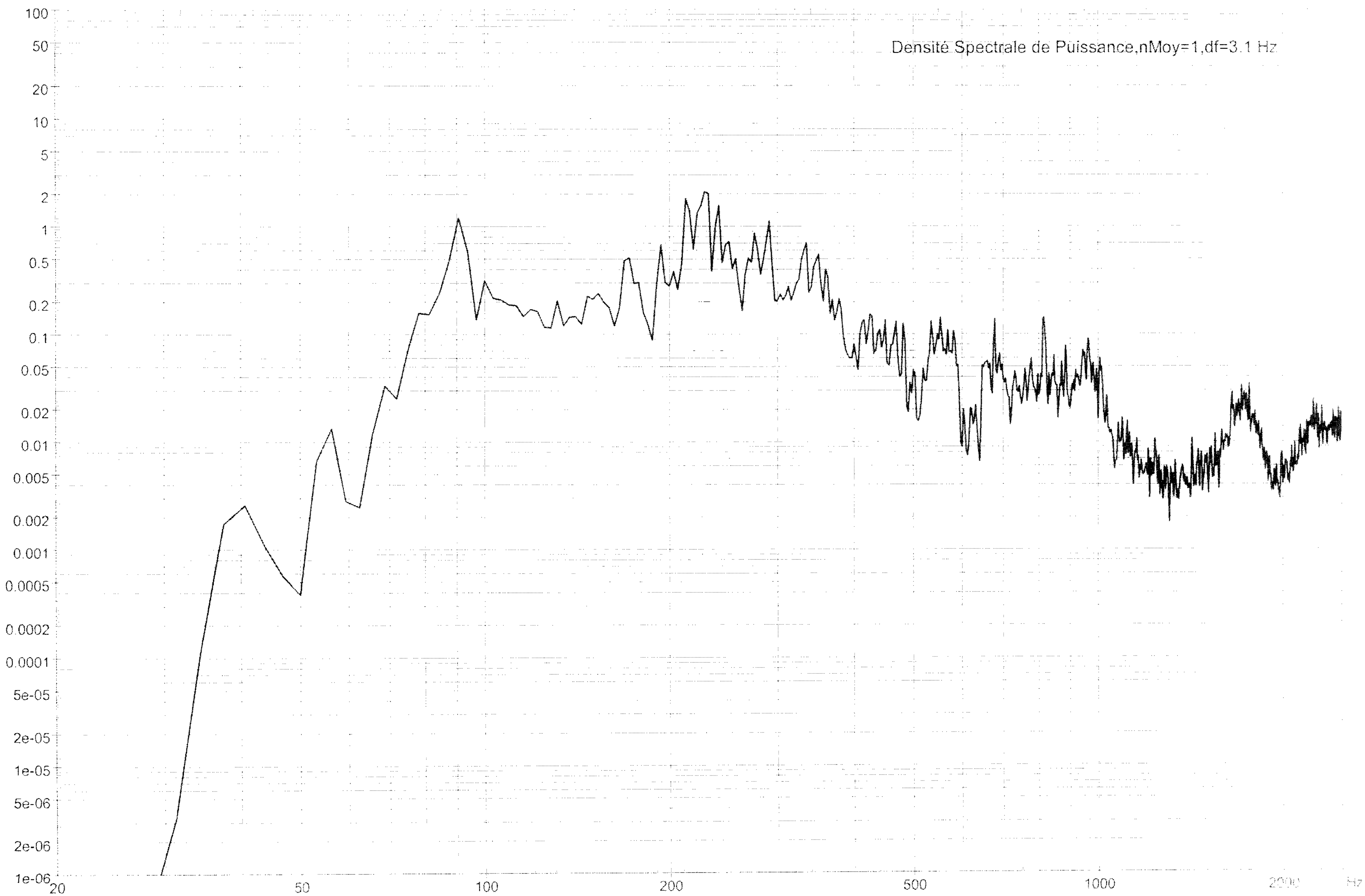
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



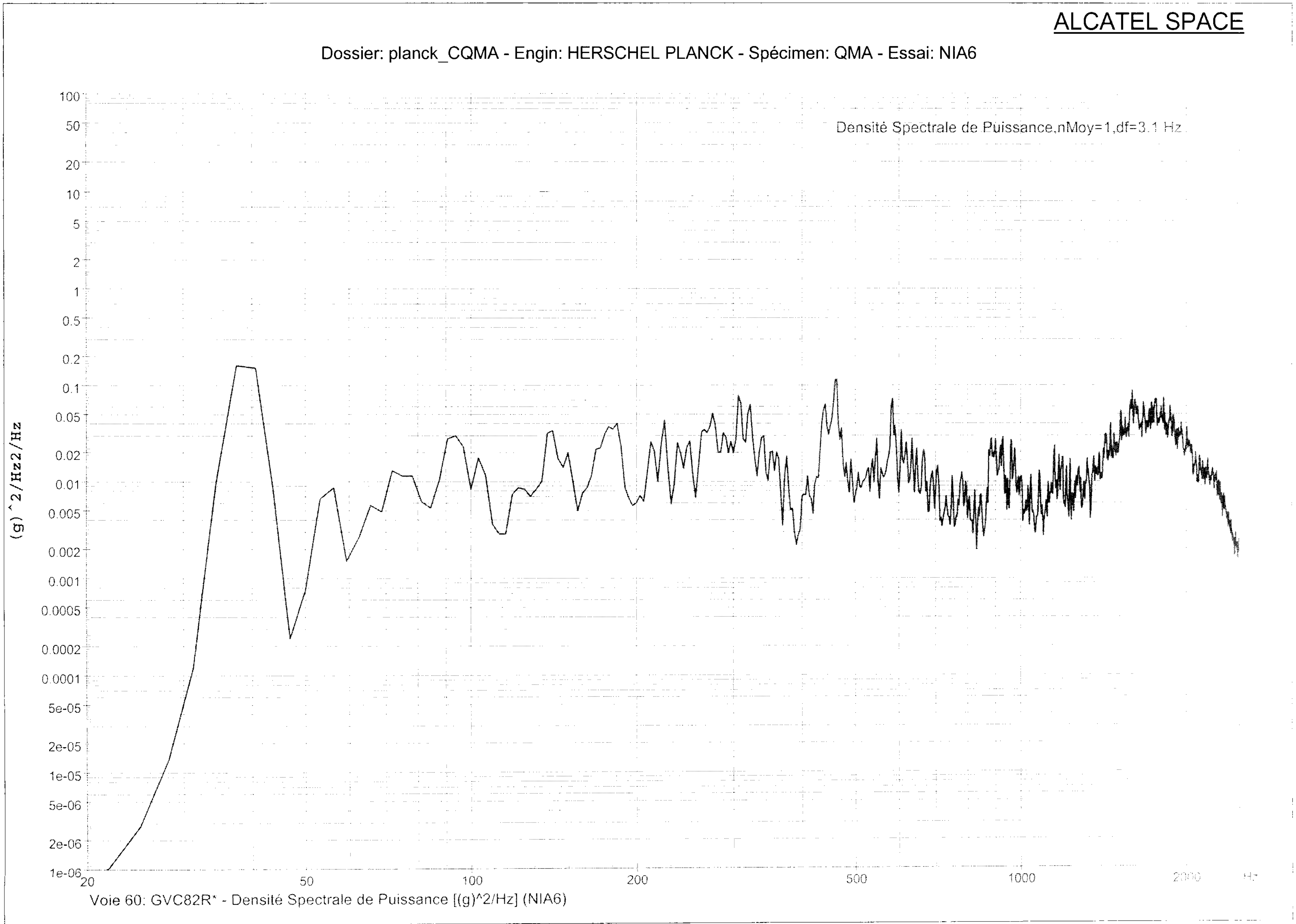
Voie 58: GVC80T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

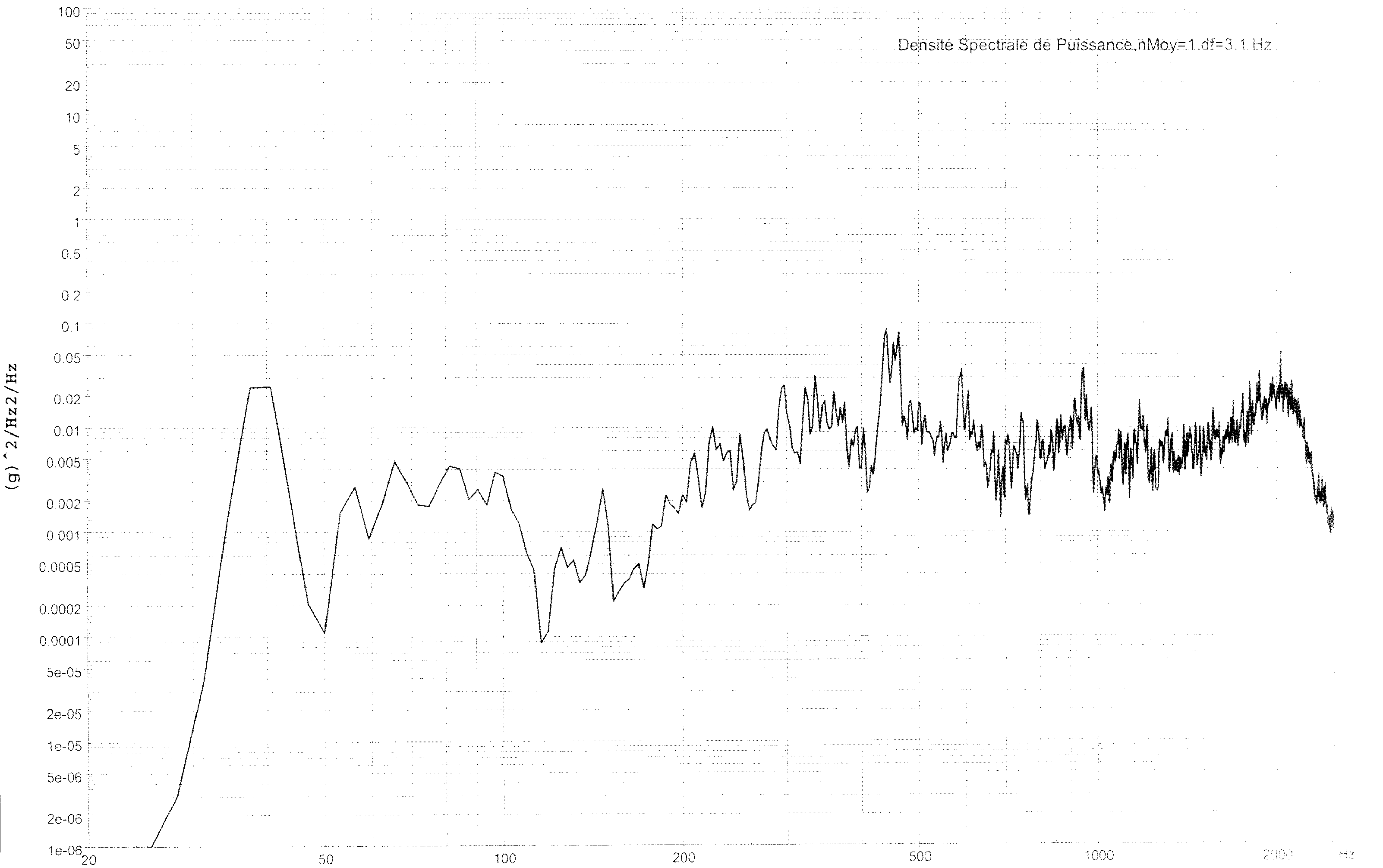


Voie 59: GVC81Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

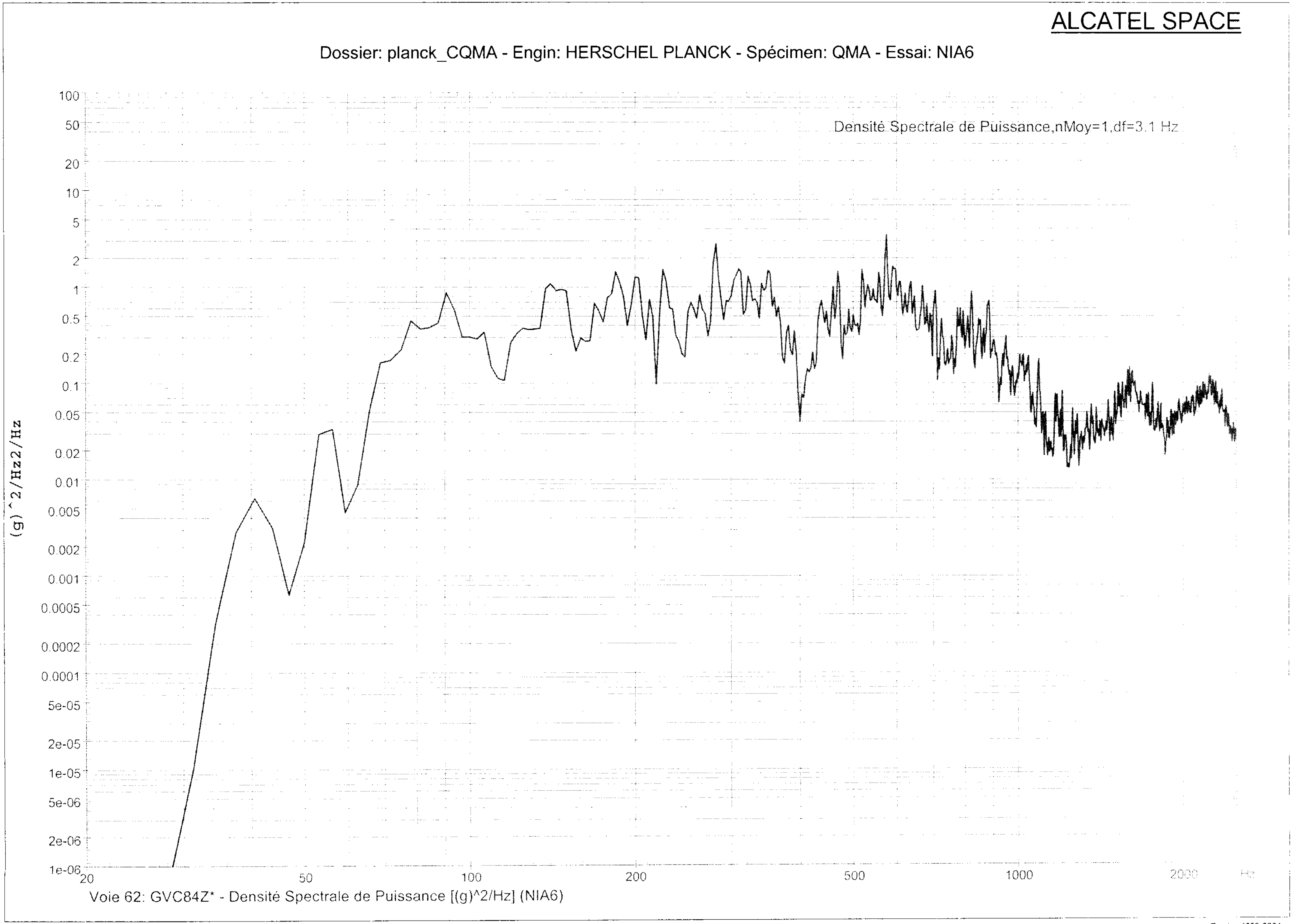

ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
Densité Spectrale de Puissance,nMoy=1,df=3.1 Hz
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
Voie 60: GVC82R* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

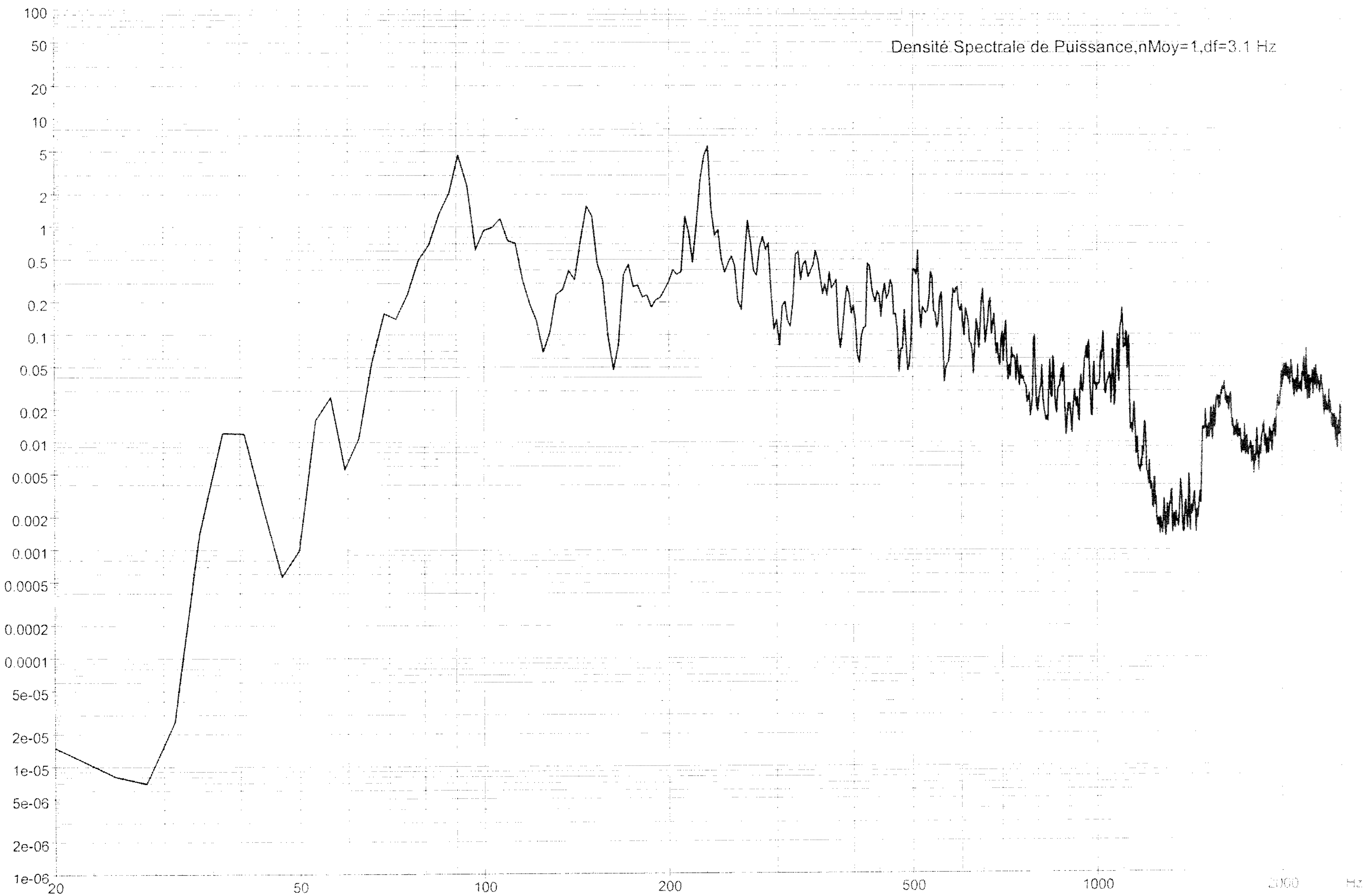


Voie 61: GVC83T* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)



PC/Analysis 2.29é (25/08/2004) Edité le: 03/02/2005 à 11H30 Teralog 1999-2004

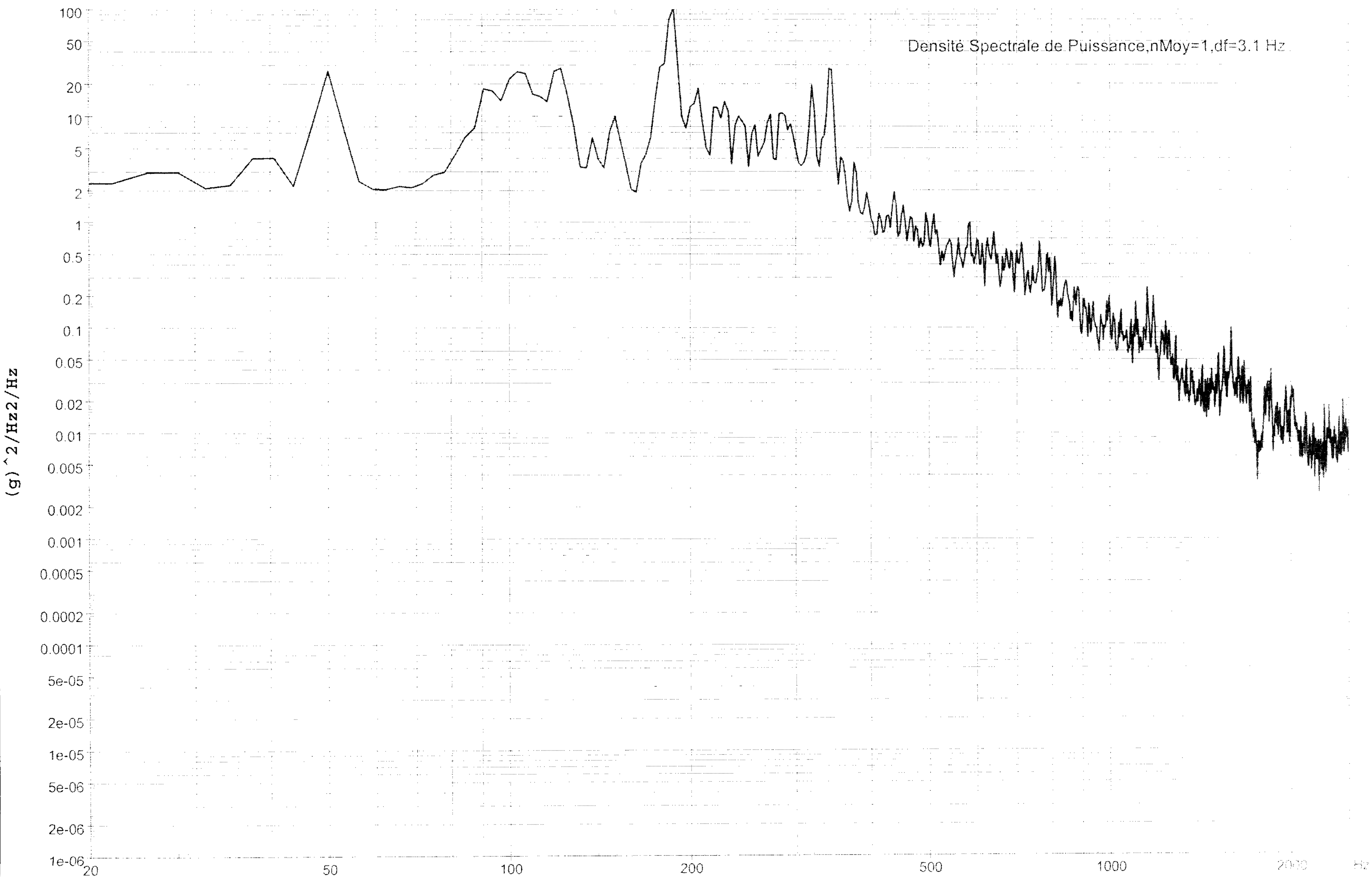
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 63: GVC85Z* - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

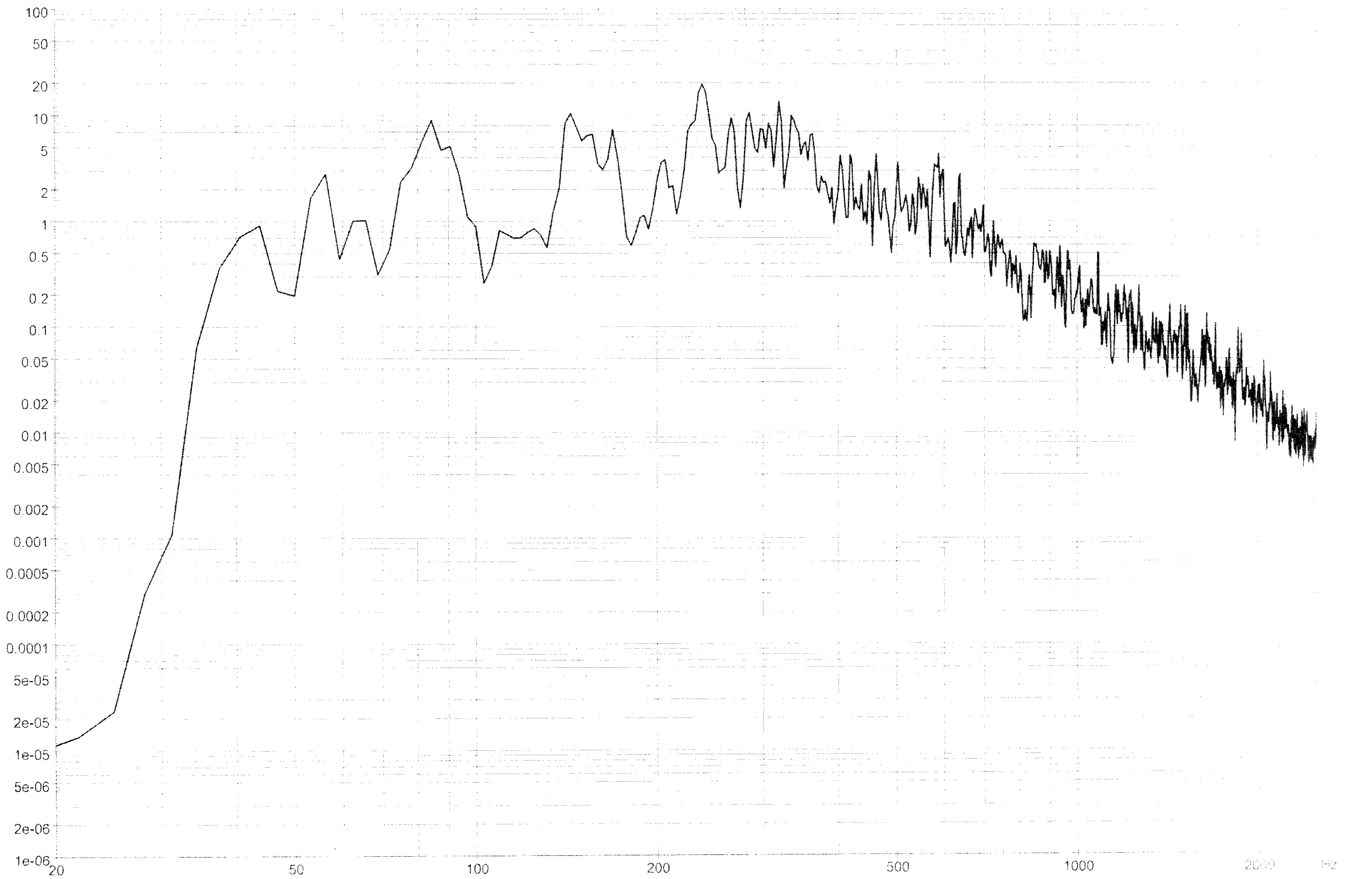
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



Voie 64: GVC86Z - Densité Spectrale de Puissance [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



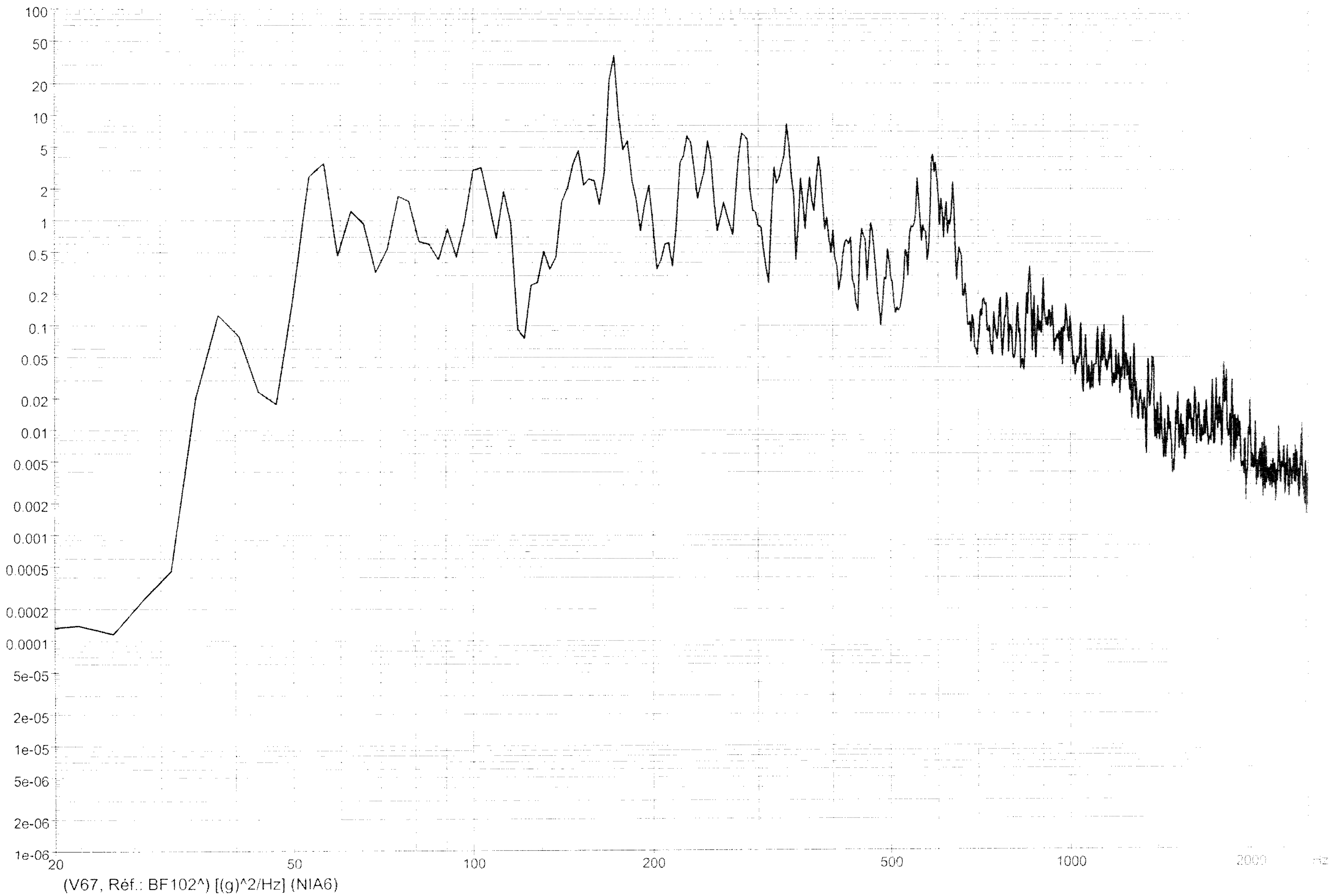
(V65, Réf.: BF100^) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

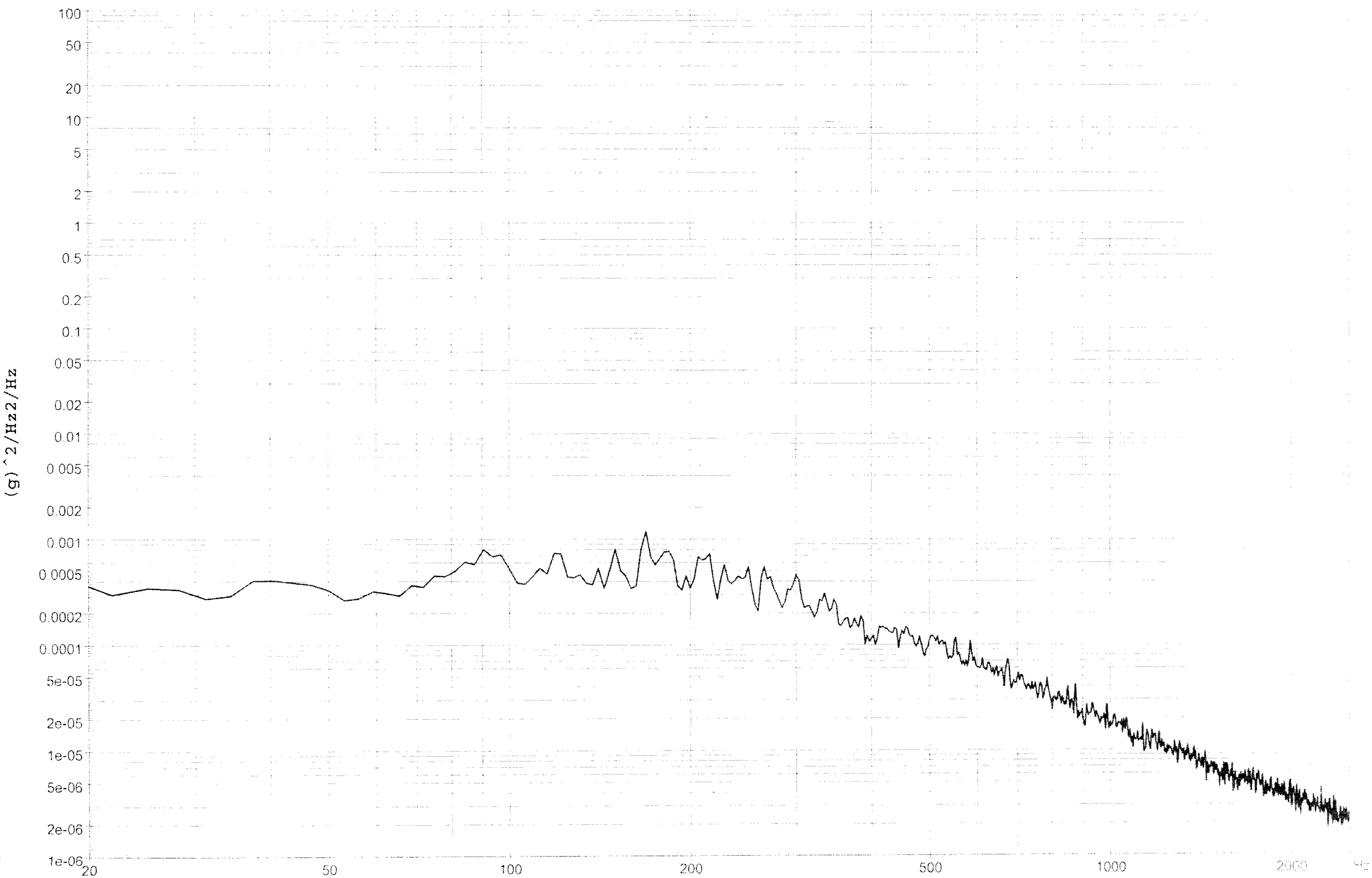
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

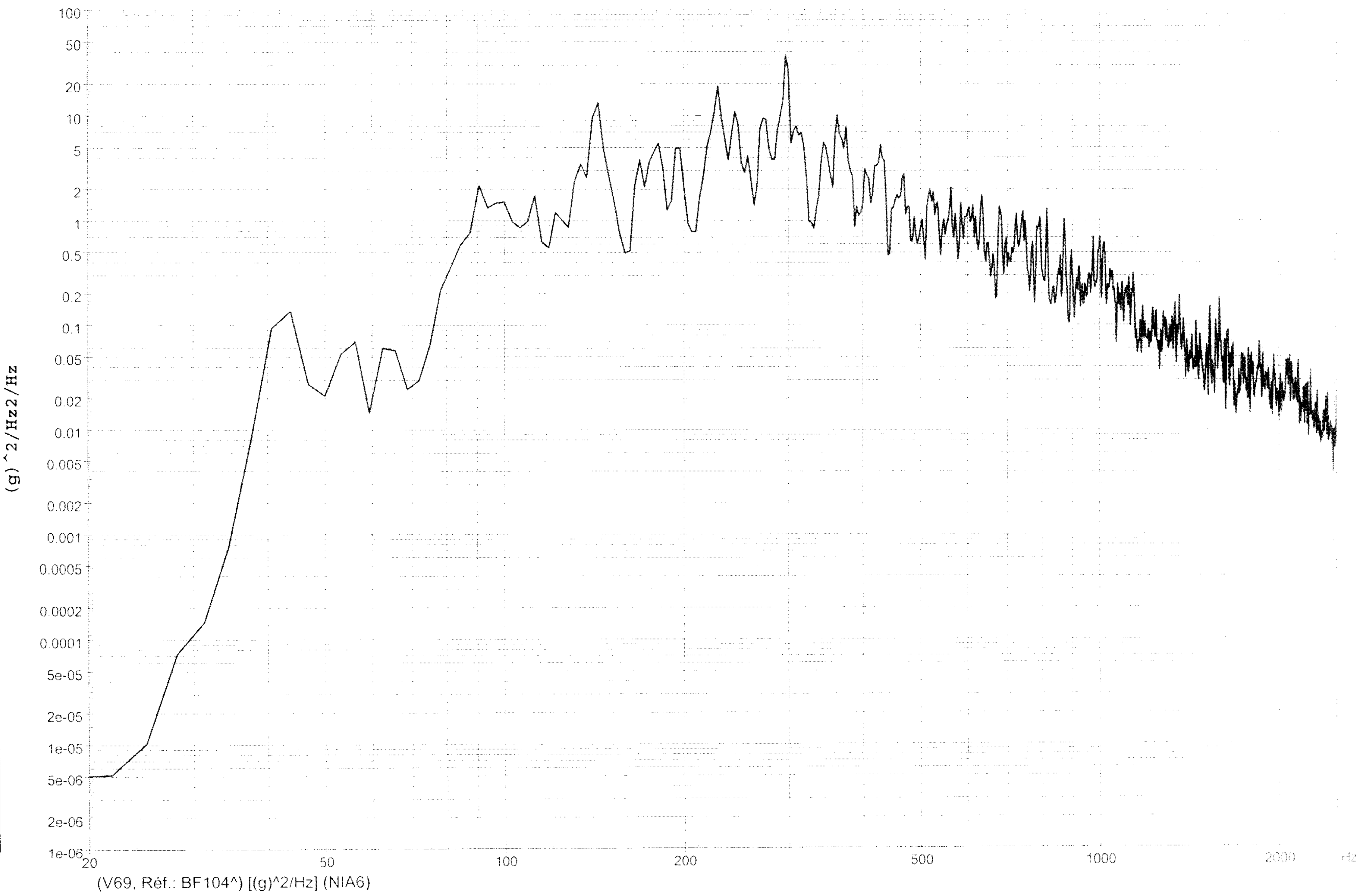
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

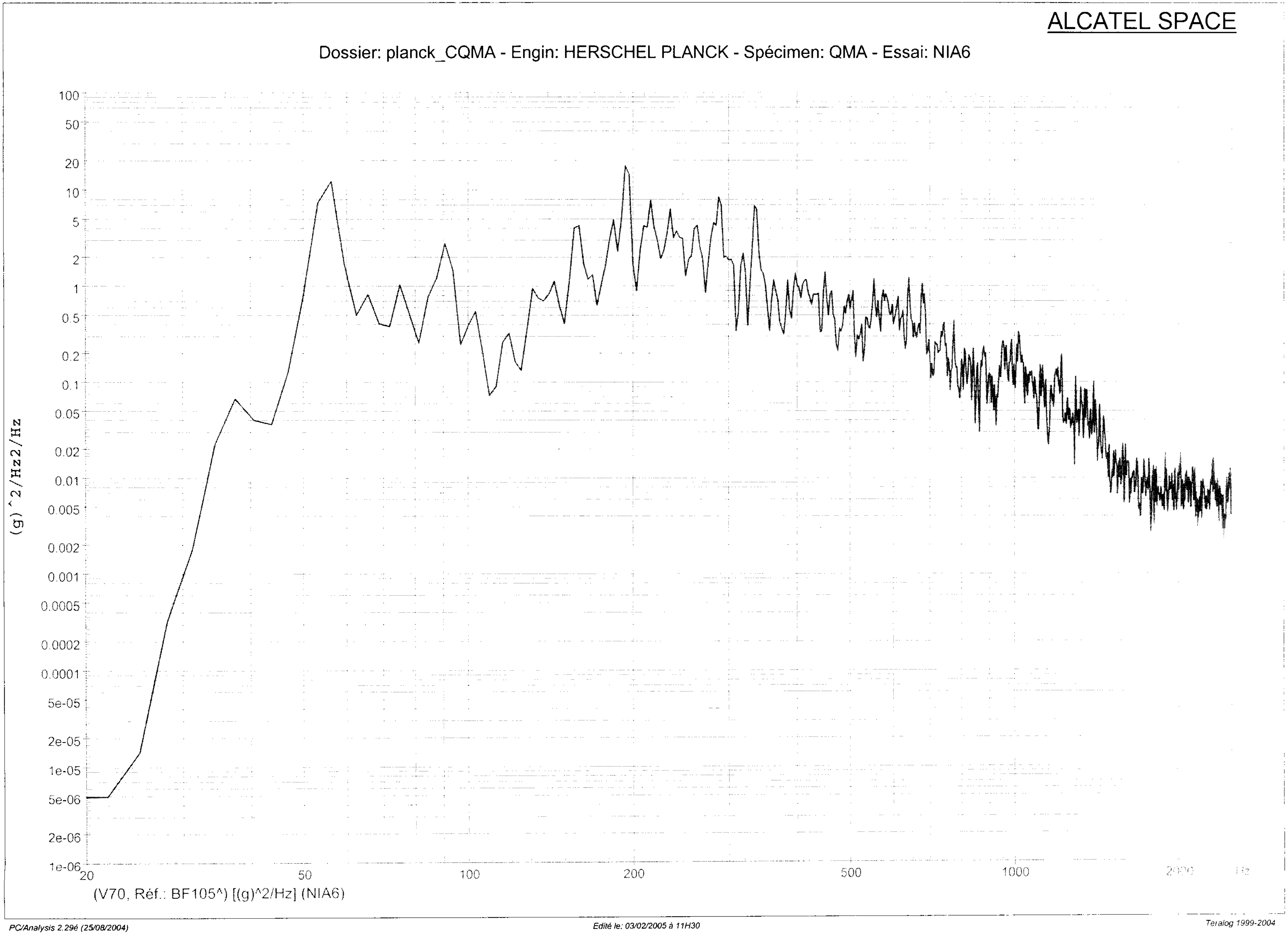


(V68, Réf.: BF103^) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

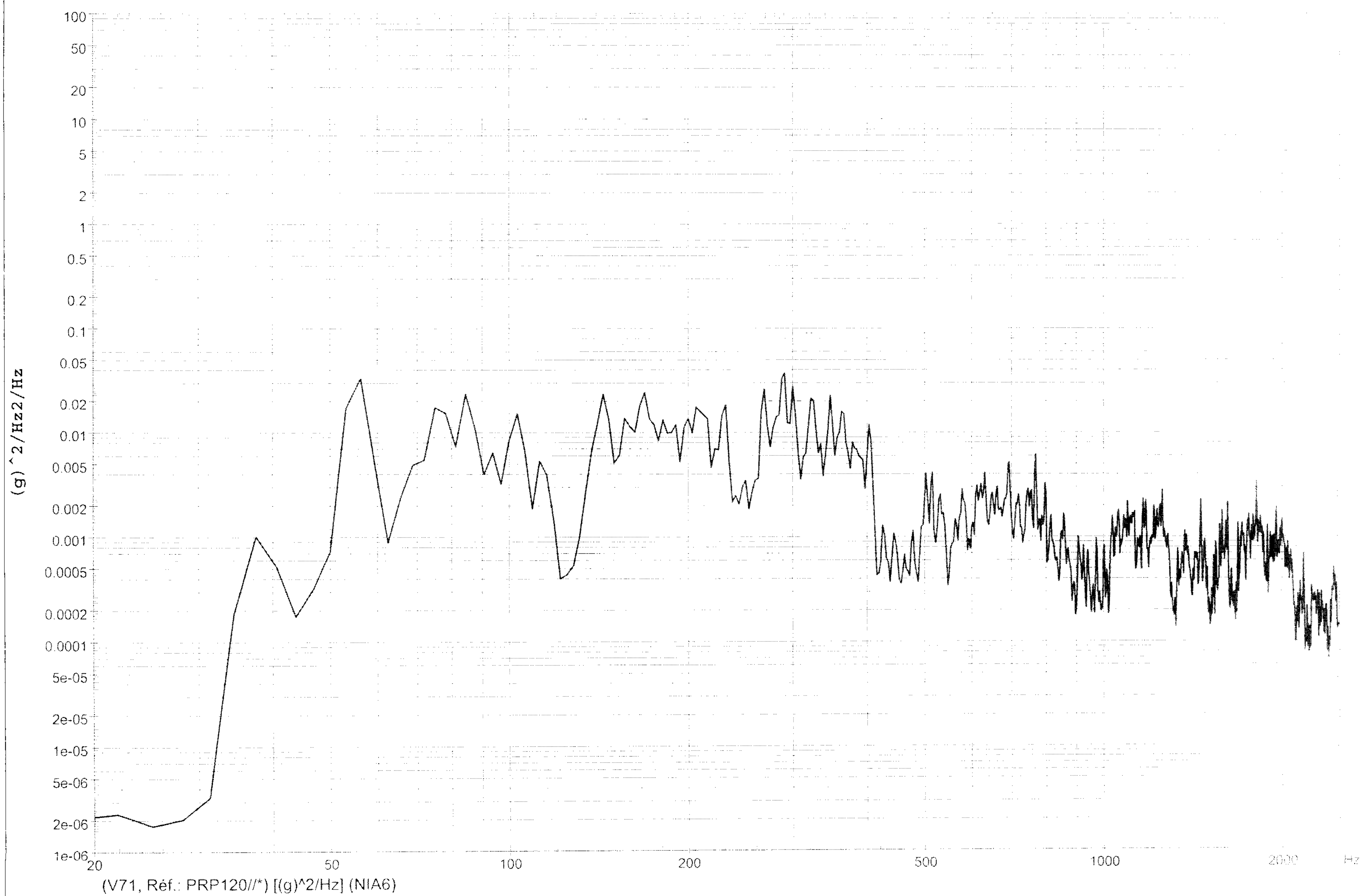
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6




ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
(V70, Réf.: BF105^) [(g)^2/Hz] (NIA6)
PC/Analysis 2.29é (25/08/2004)
Edité le: 03/02/2005 à 11H30
Teralog 1999-2004

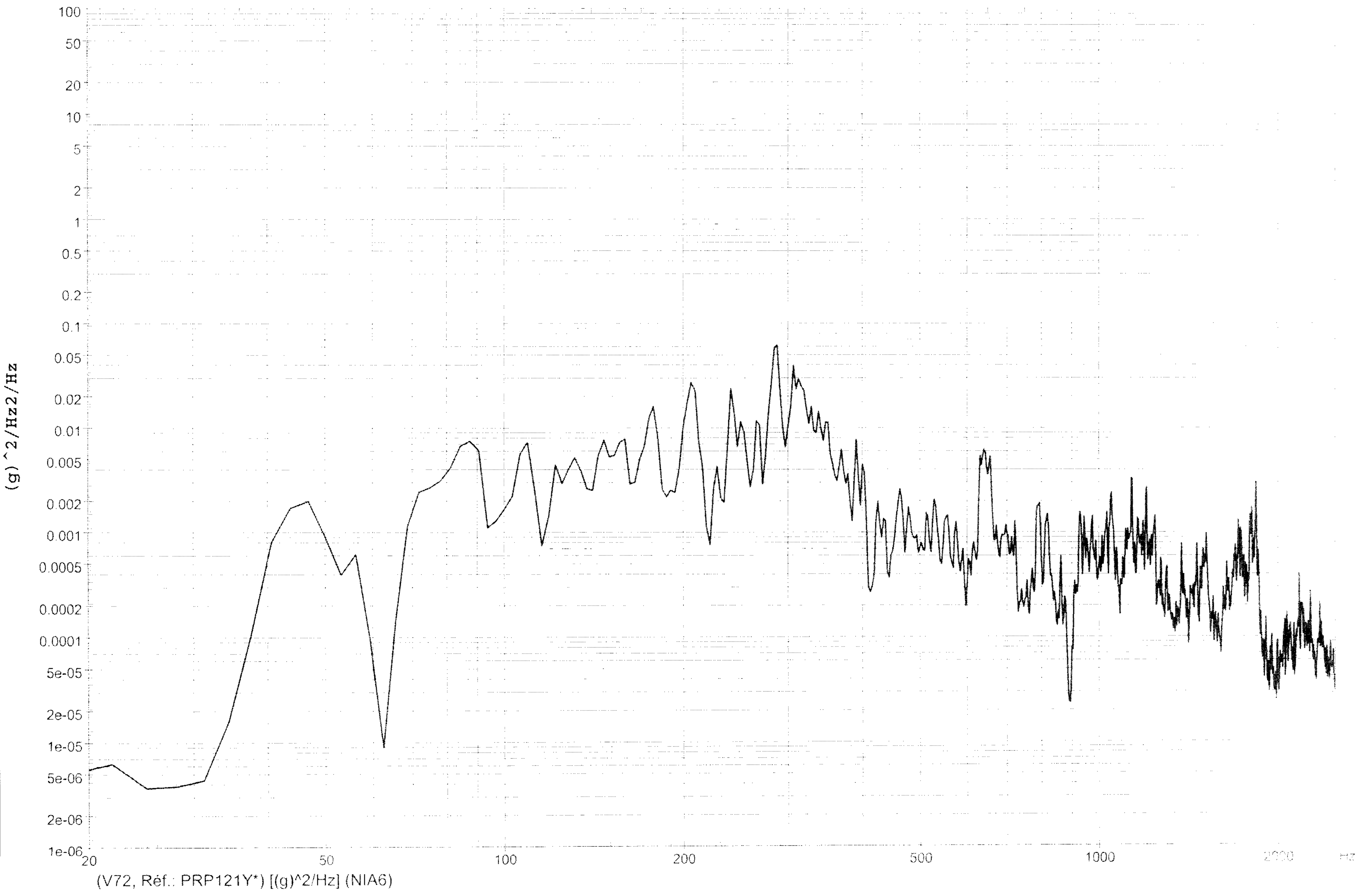
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



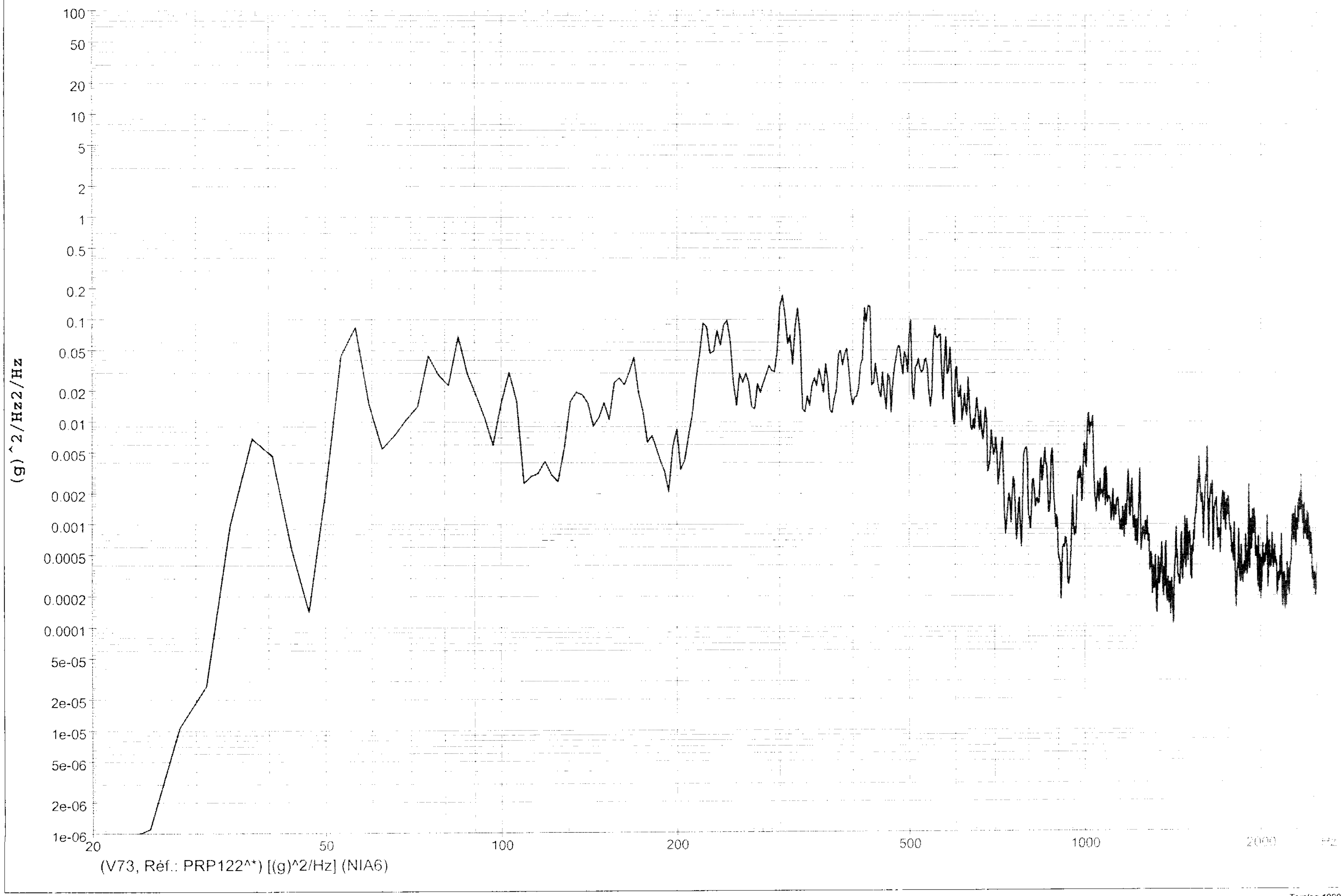
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



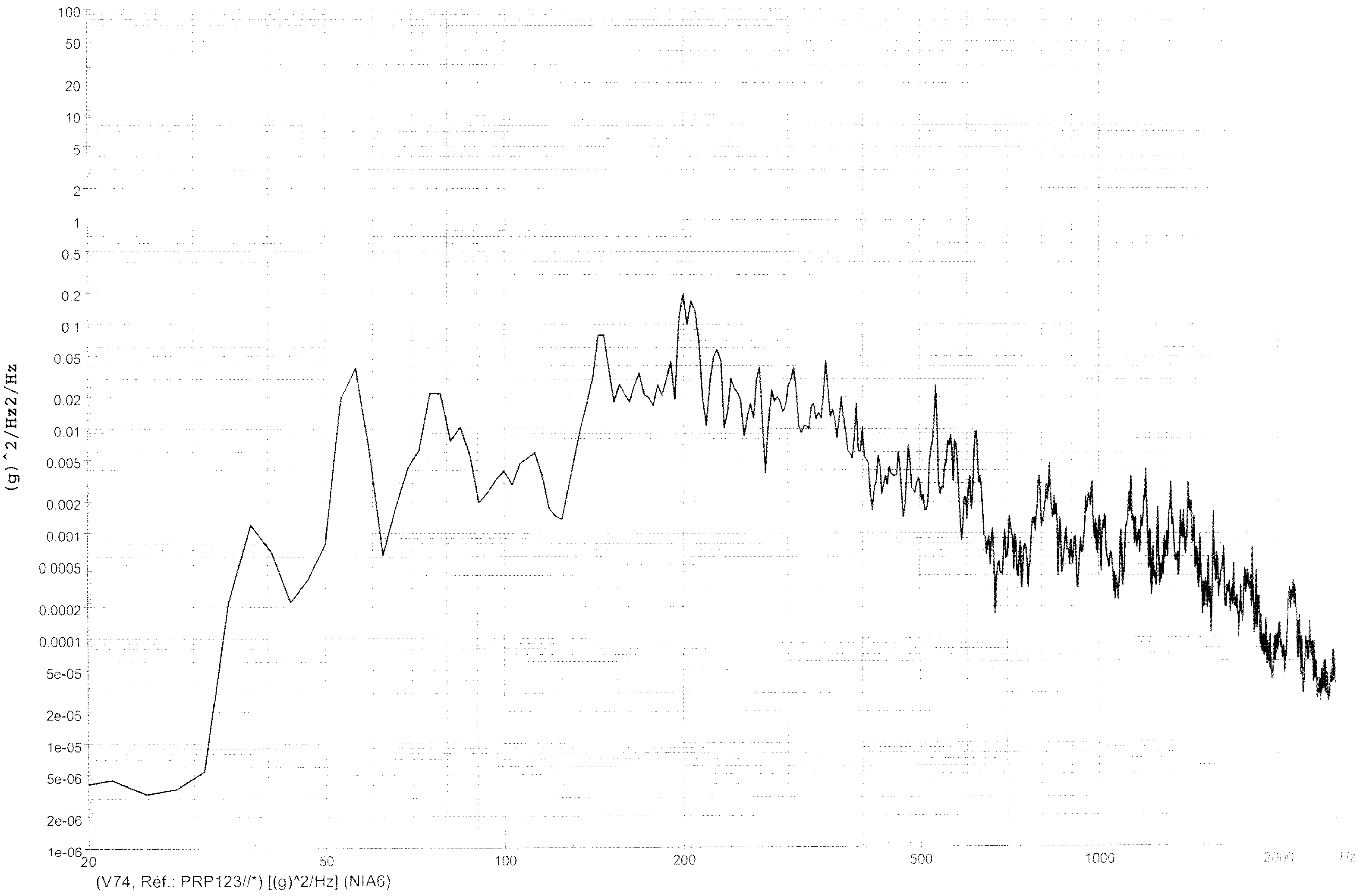
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

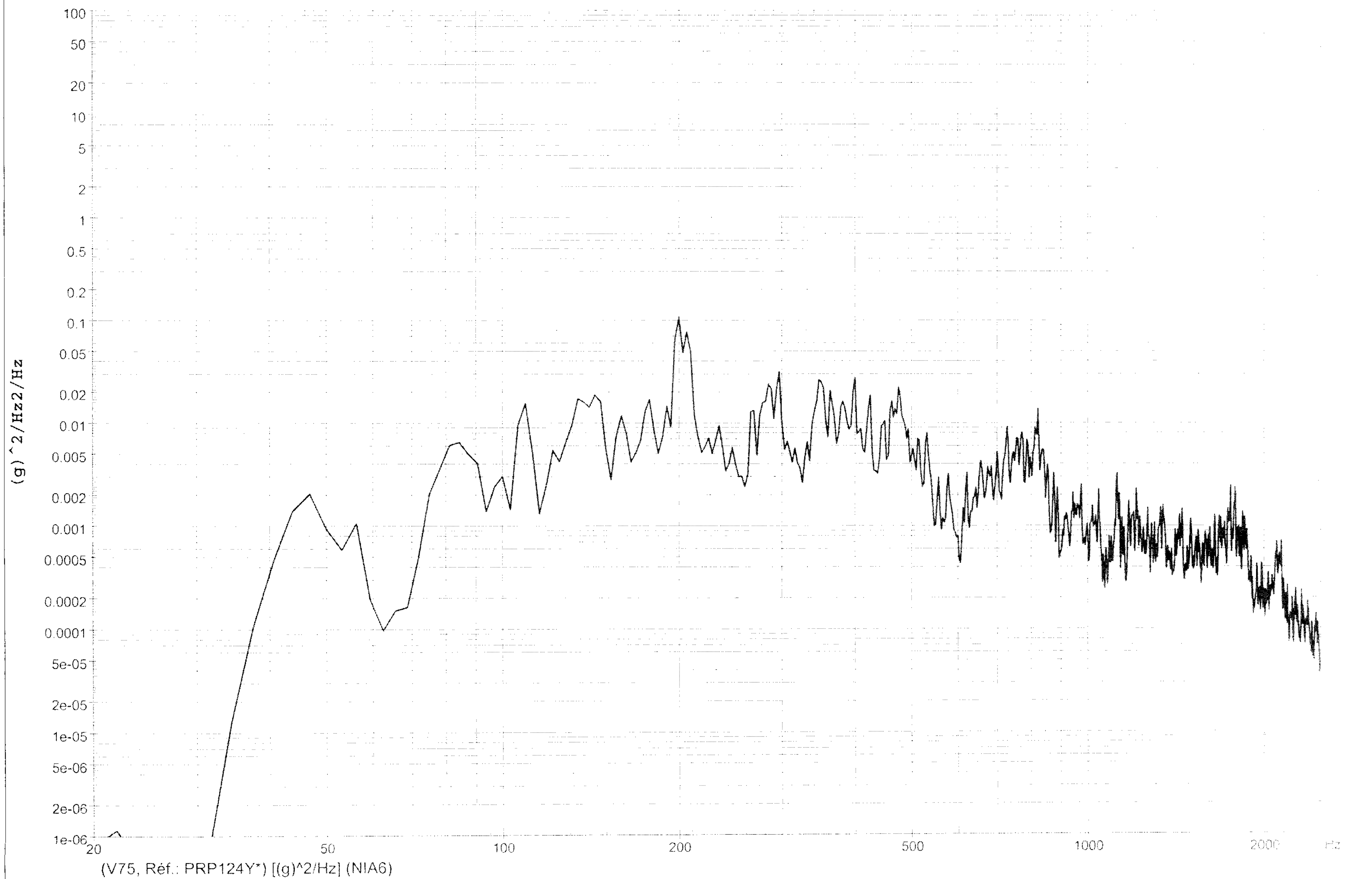


ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

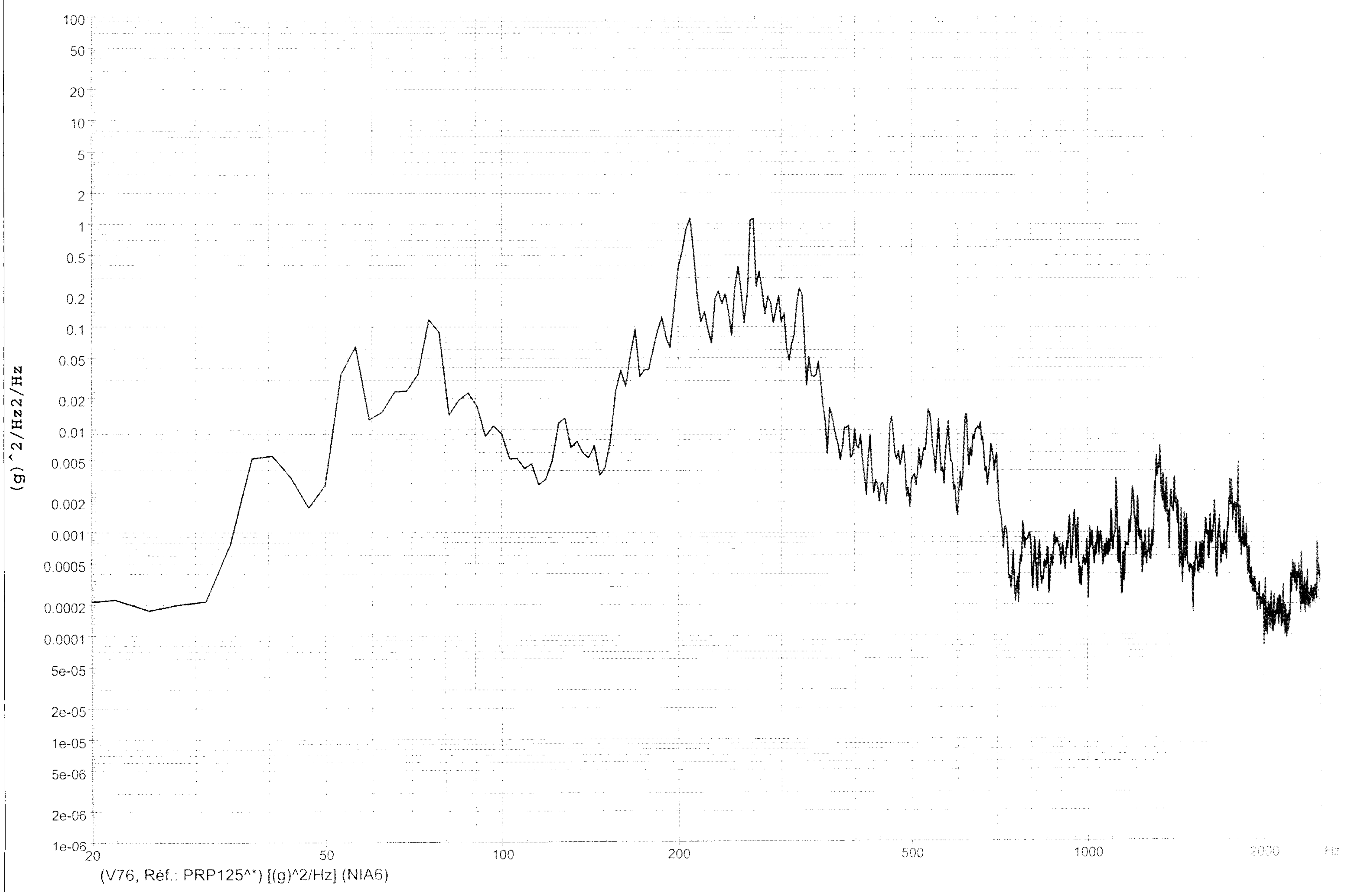


Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



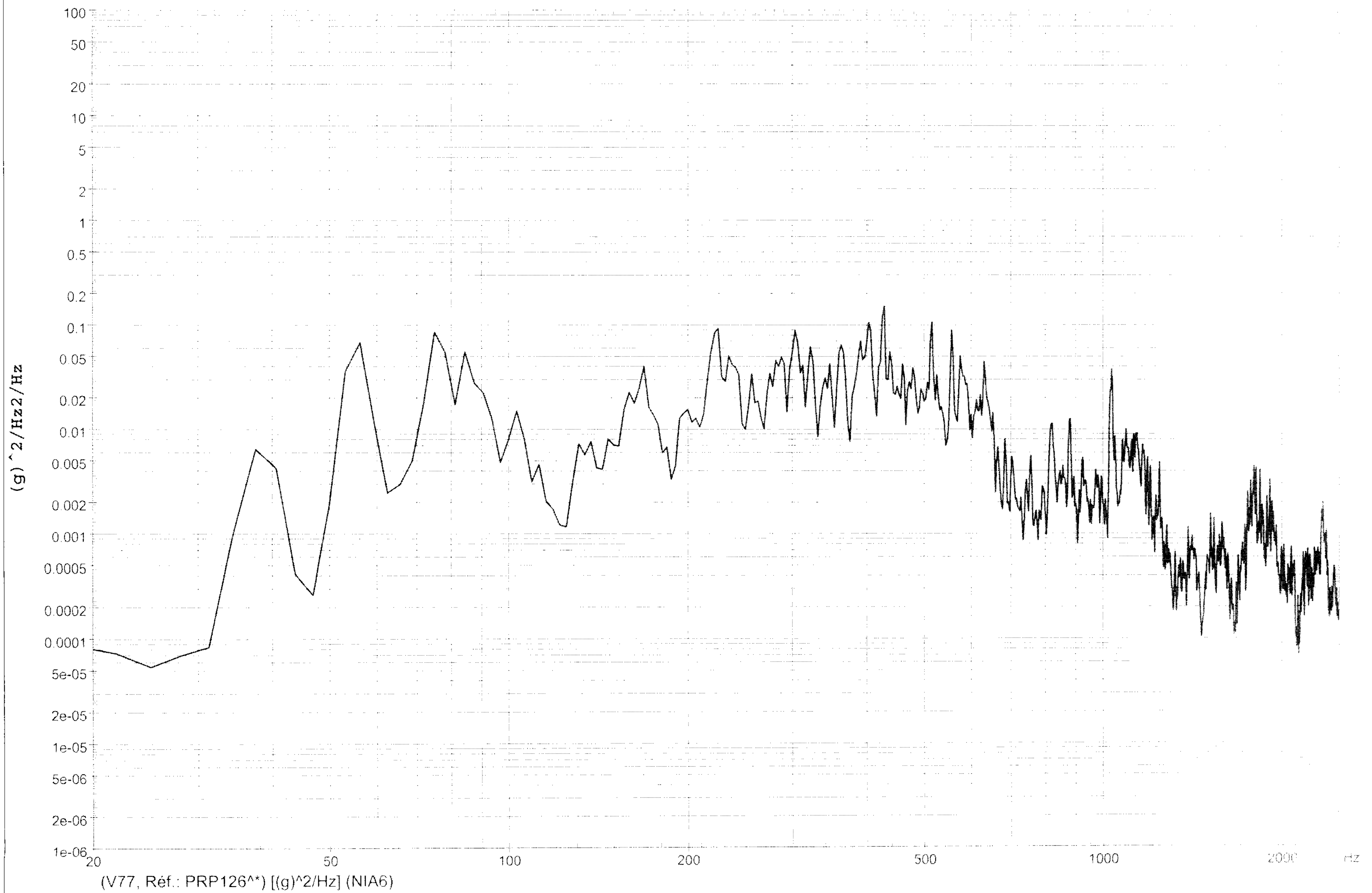
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



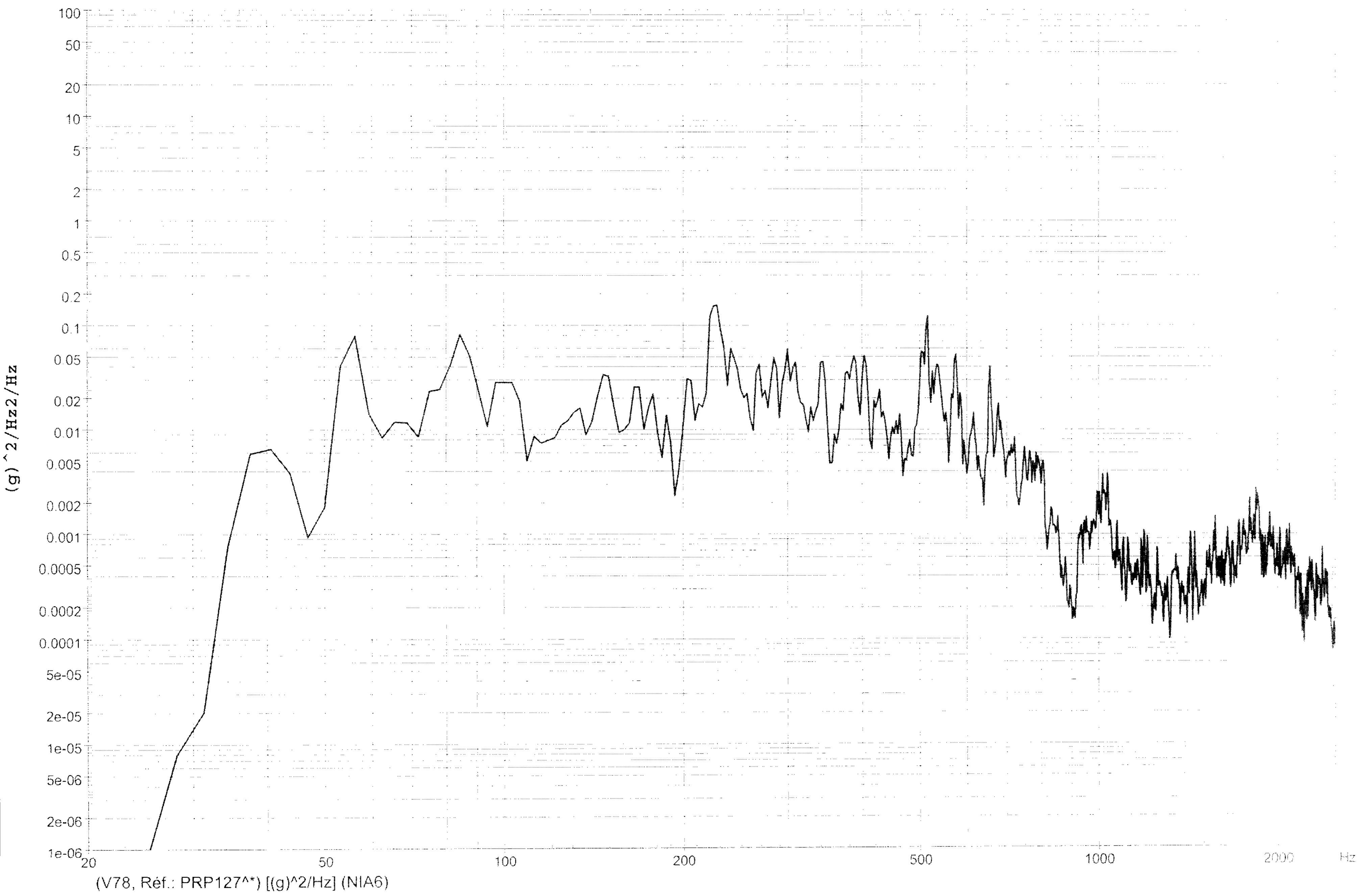
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



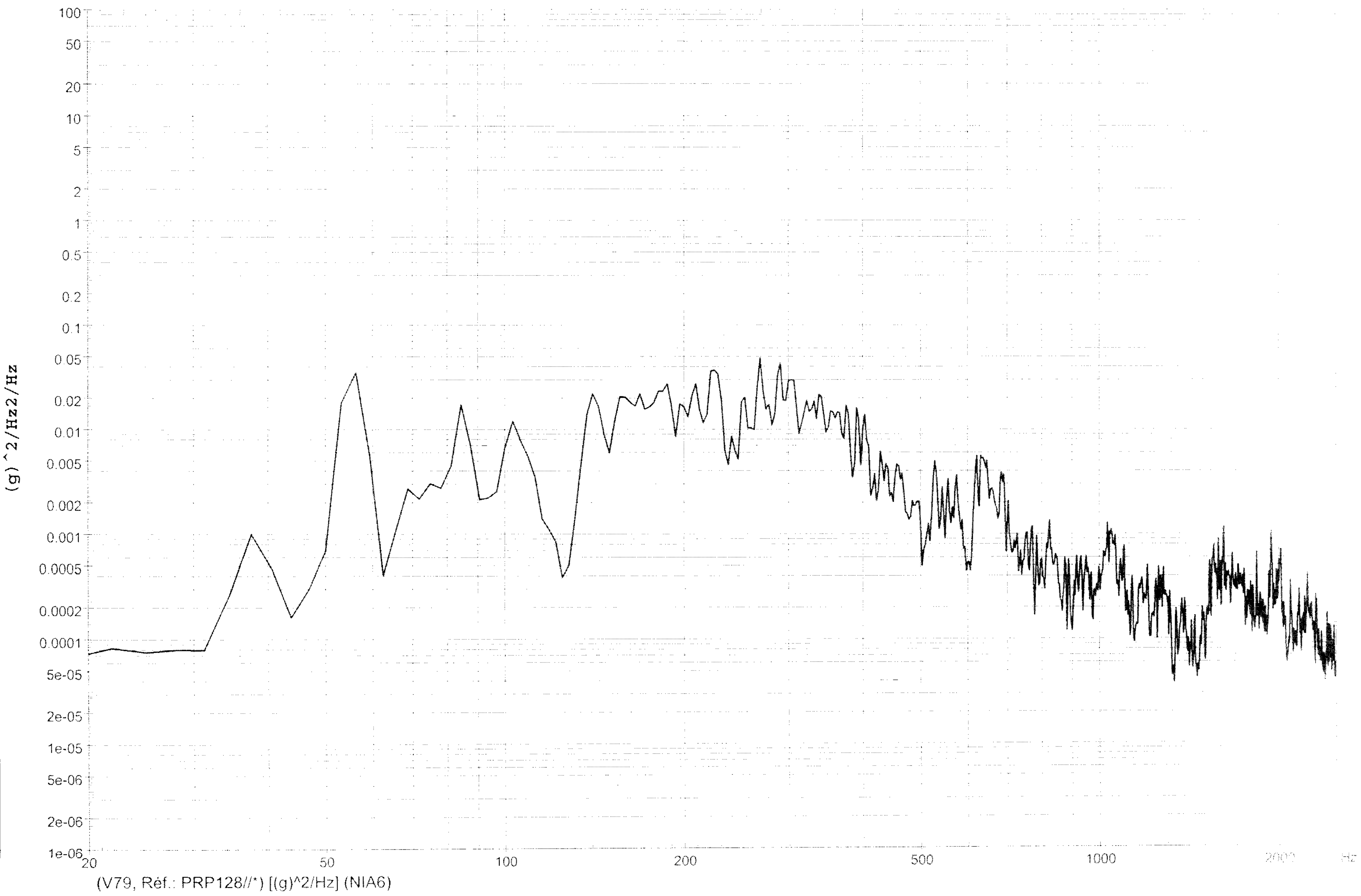
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



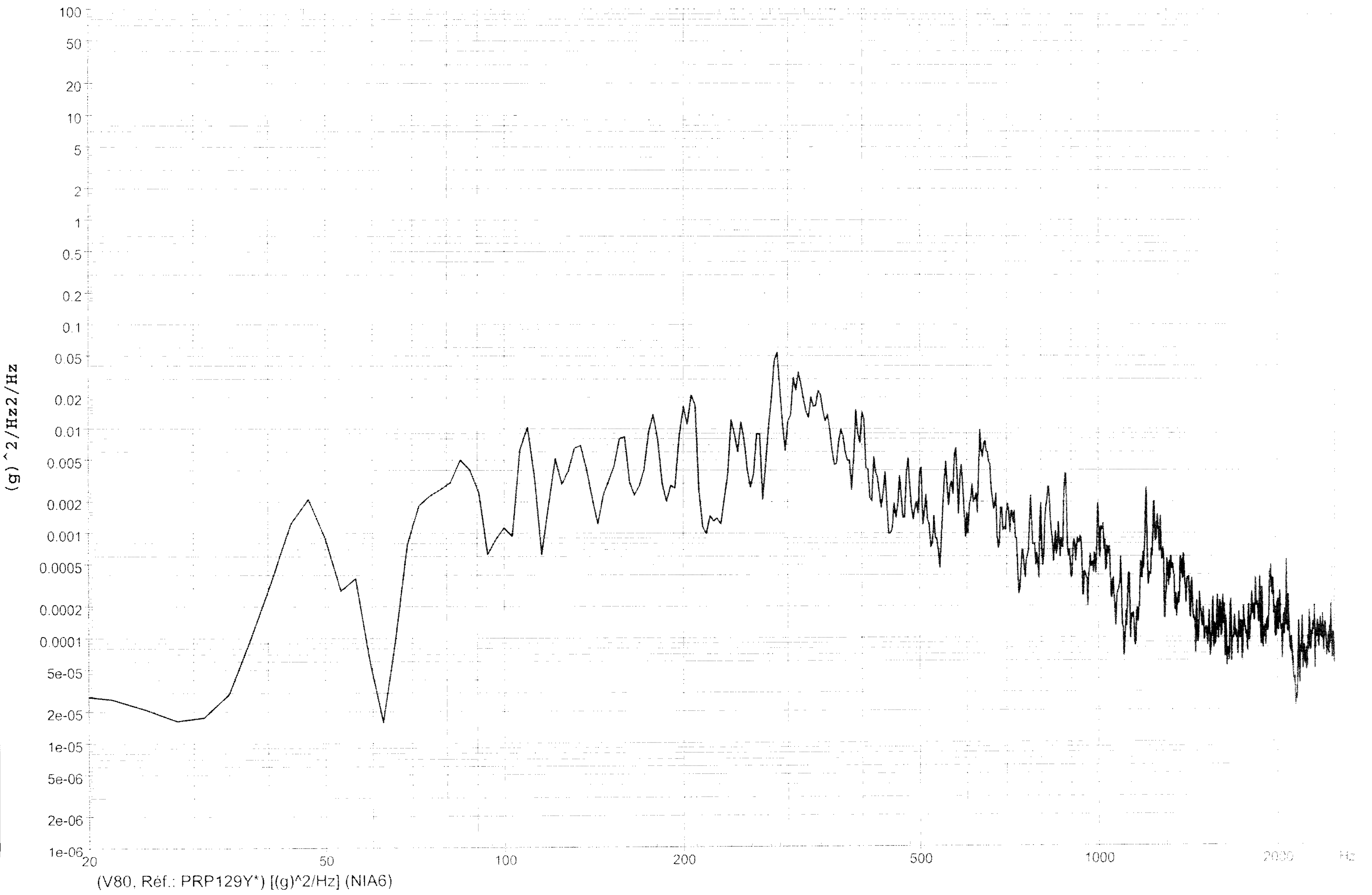
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



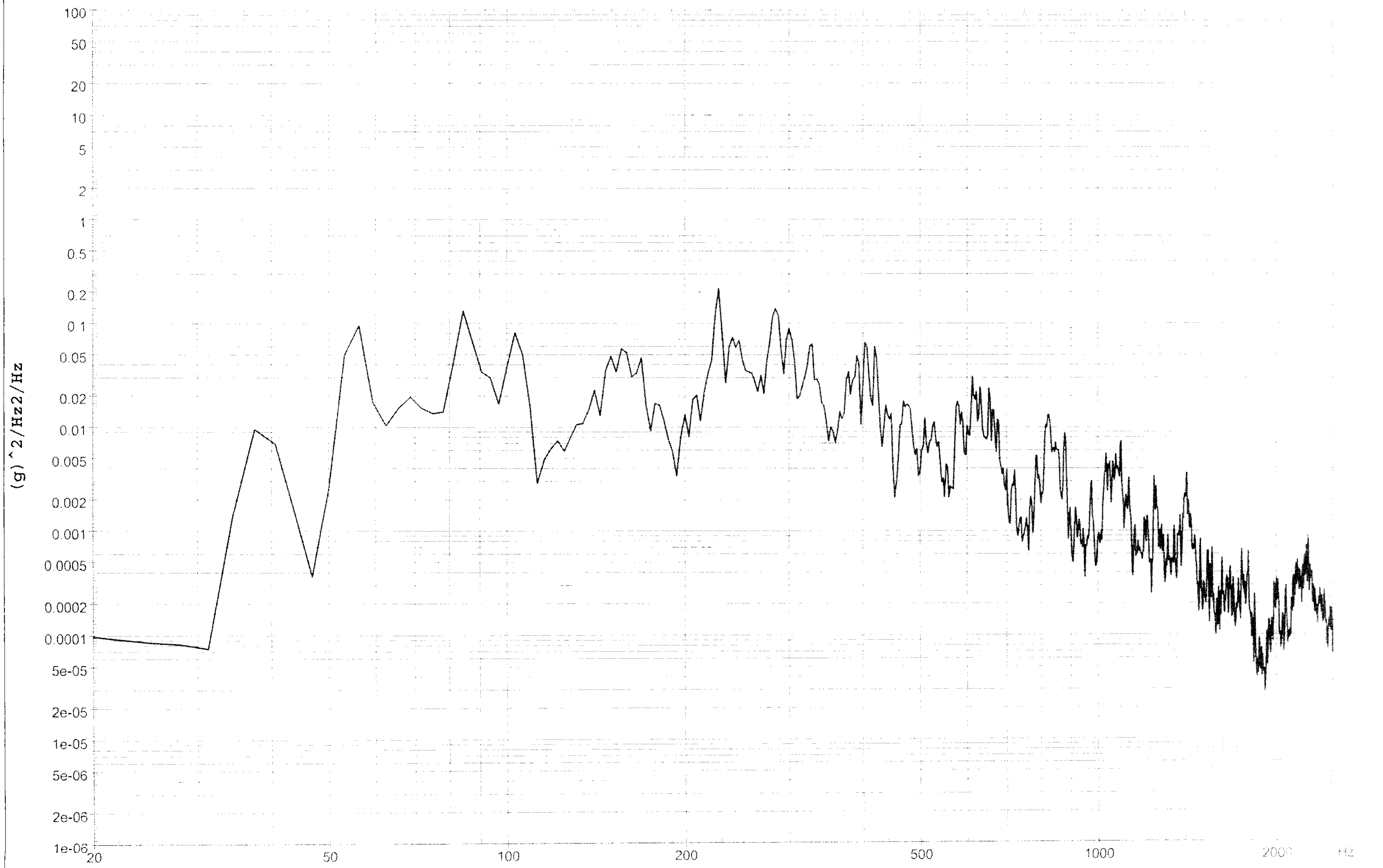
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

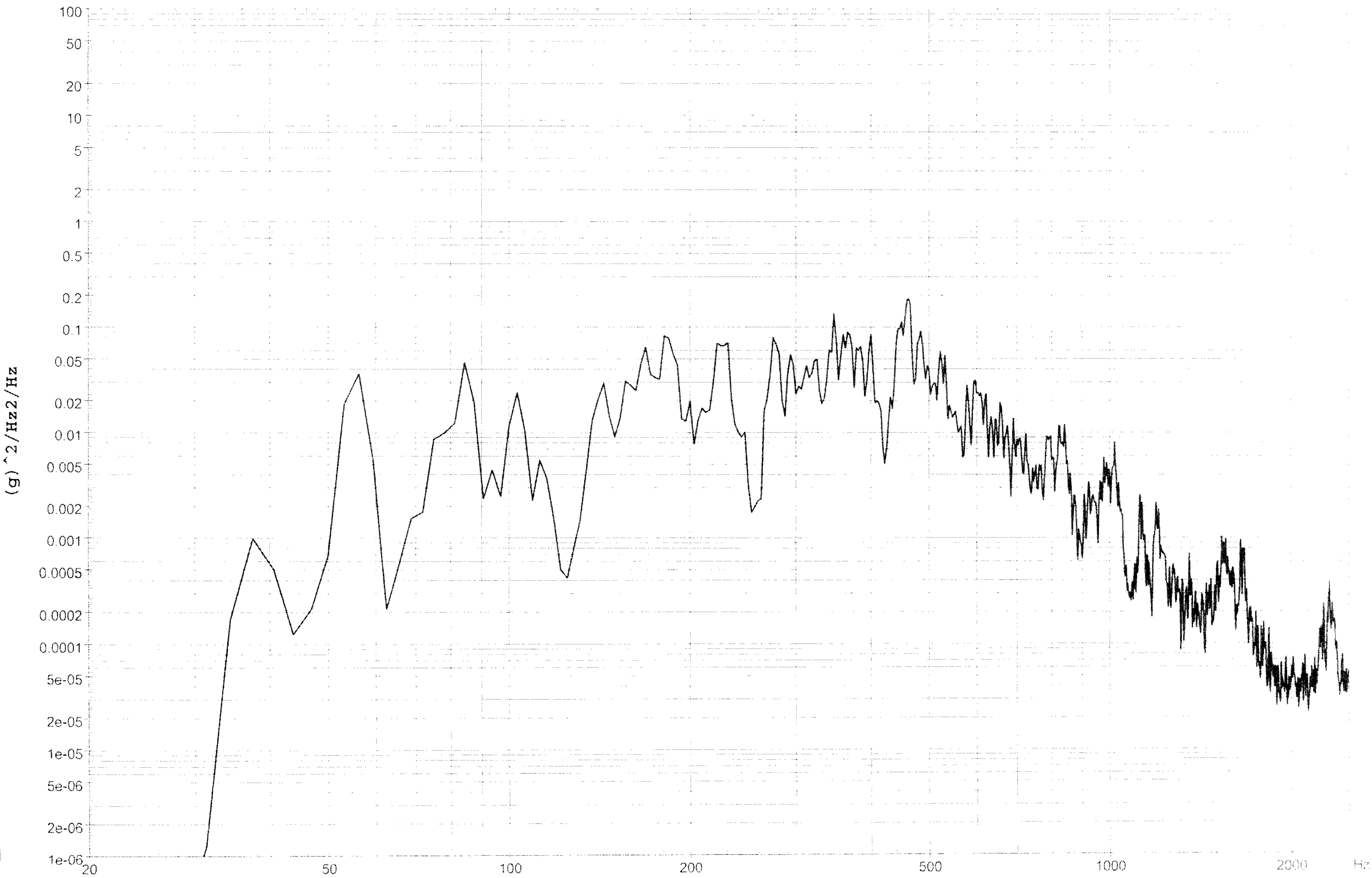
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V81, Réf.: PRP130^*) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

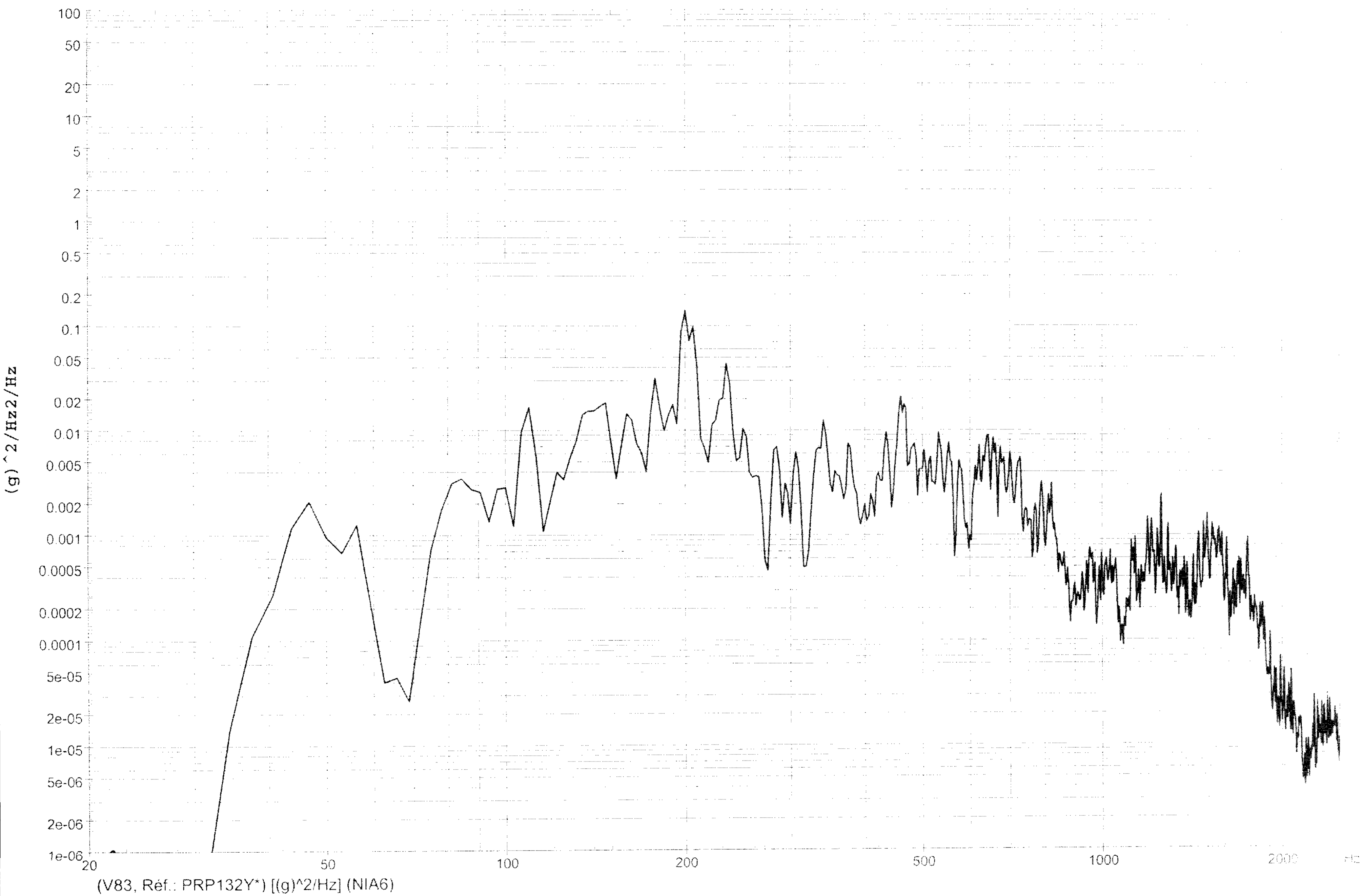
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

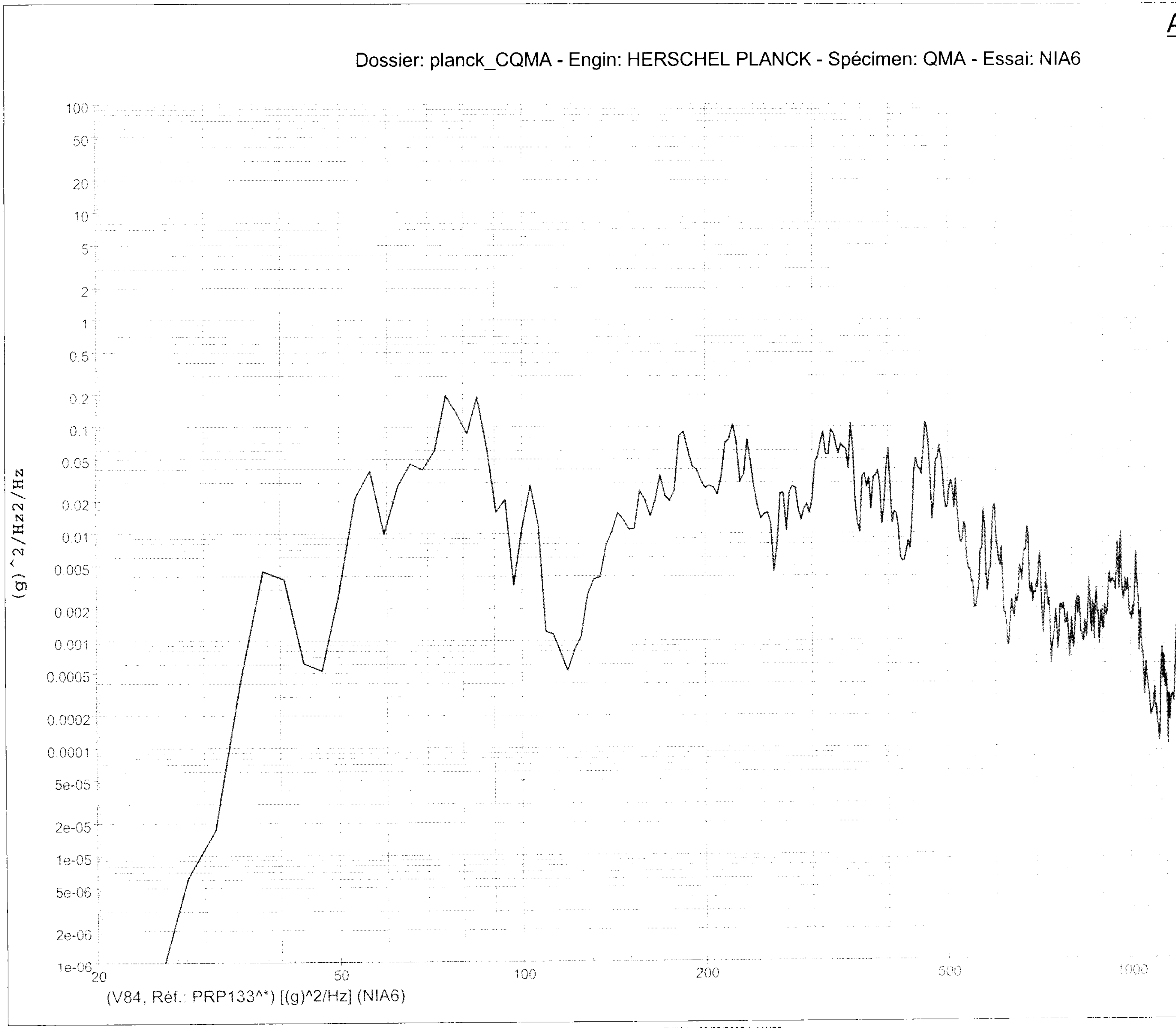


(V82, Réf.: PRP131//*) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

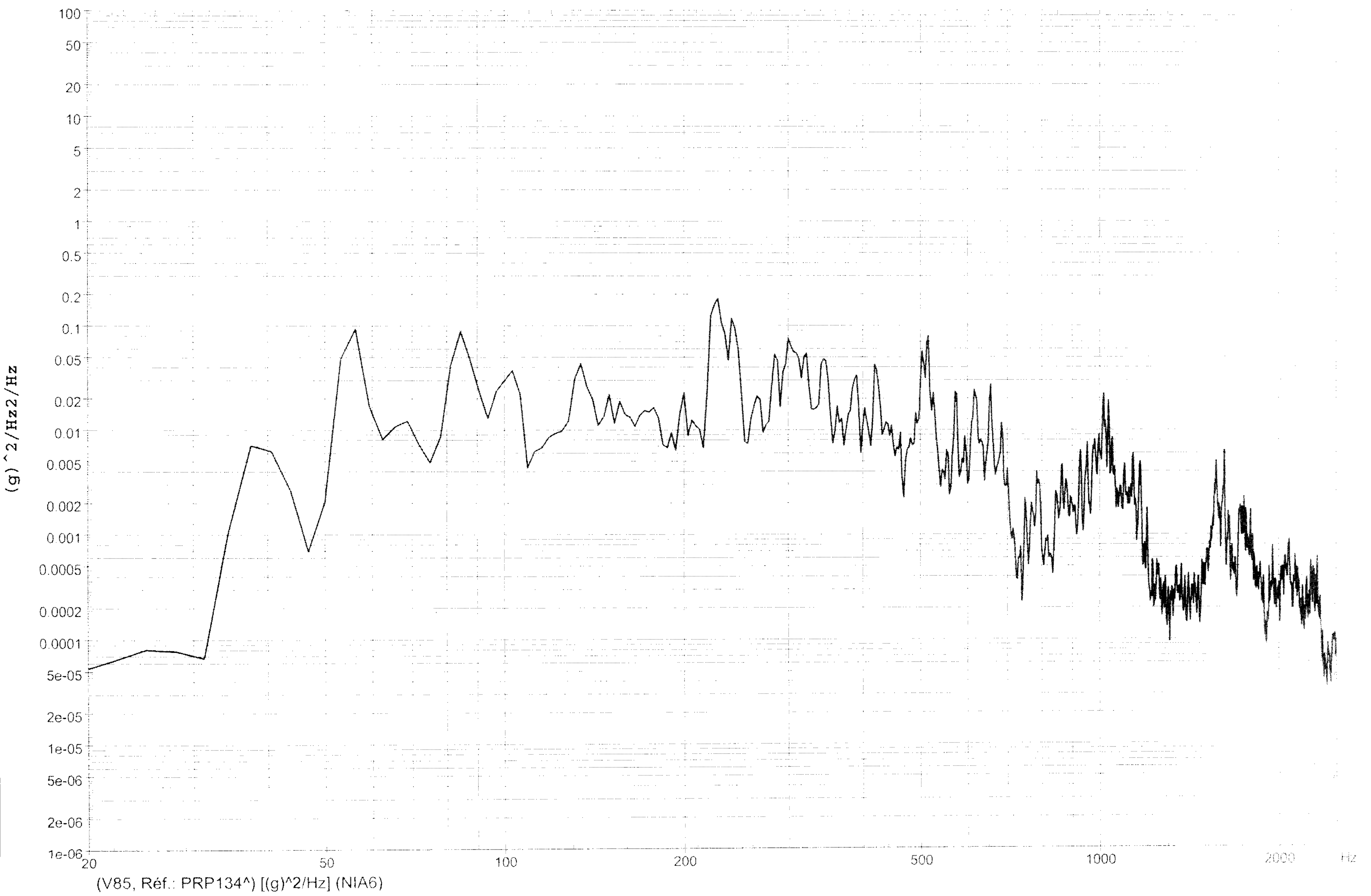
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6




Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
(V84, Réf.: PRP133^*) [(g)^2/Hz] (NIA6)

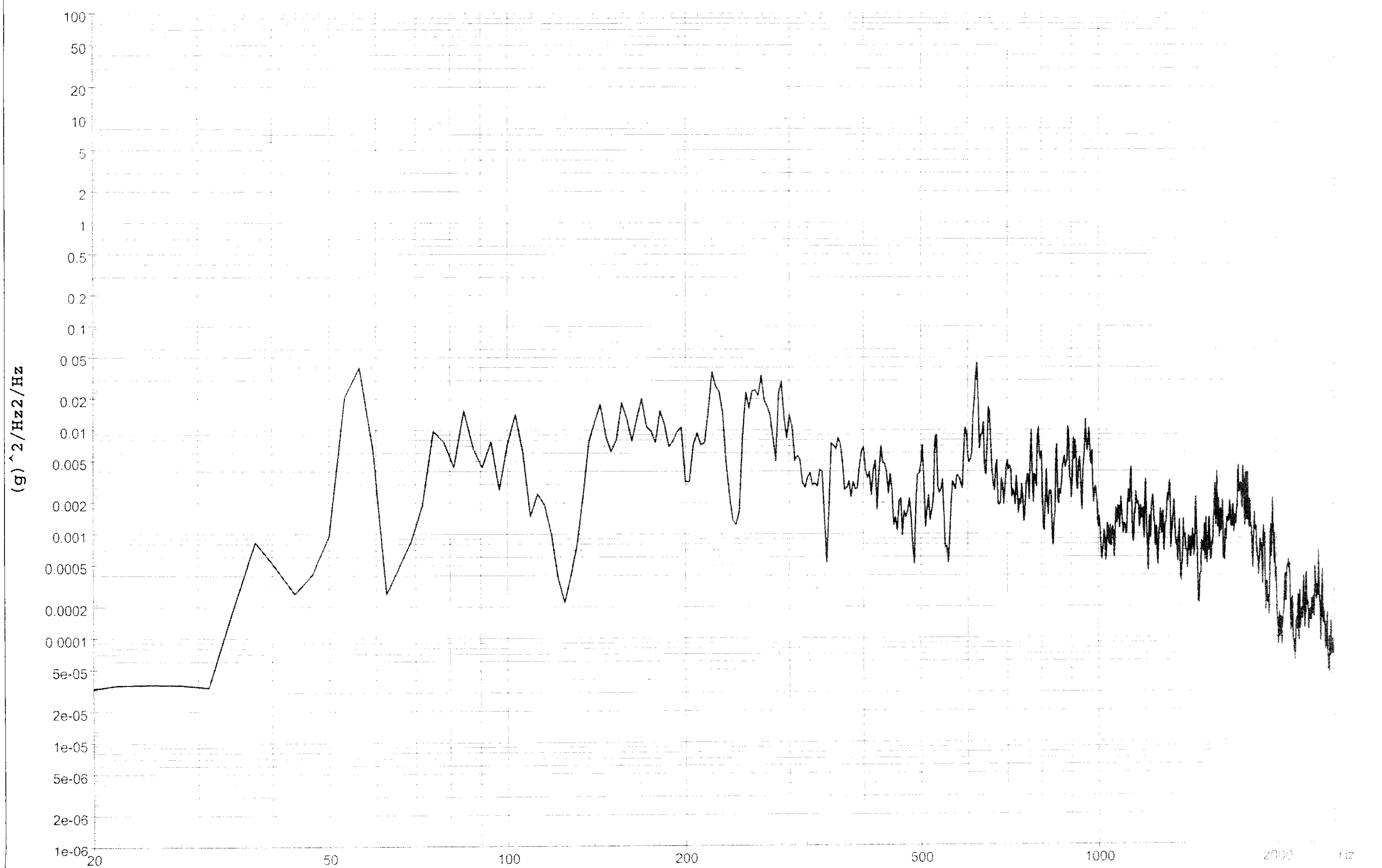
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

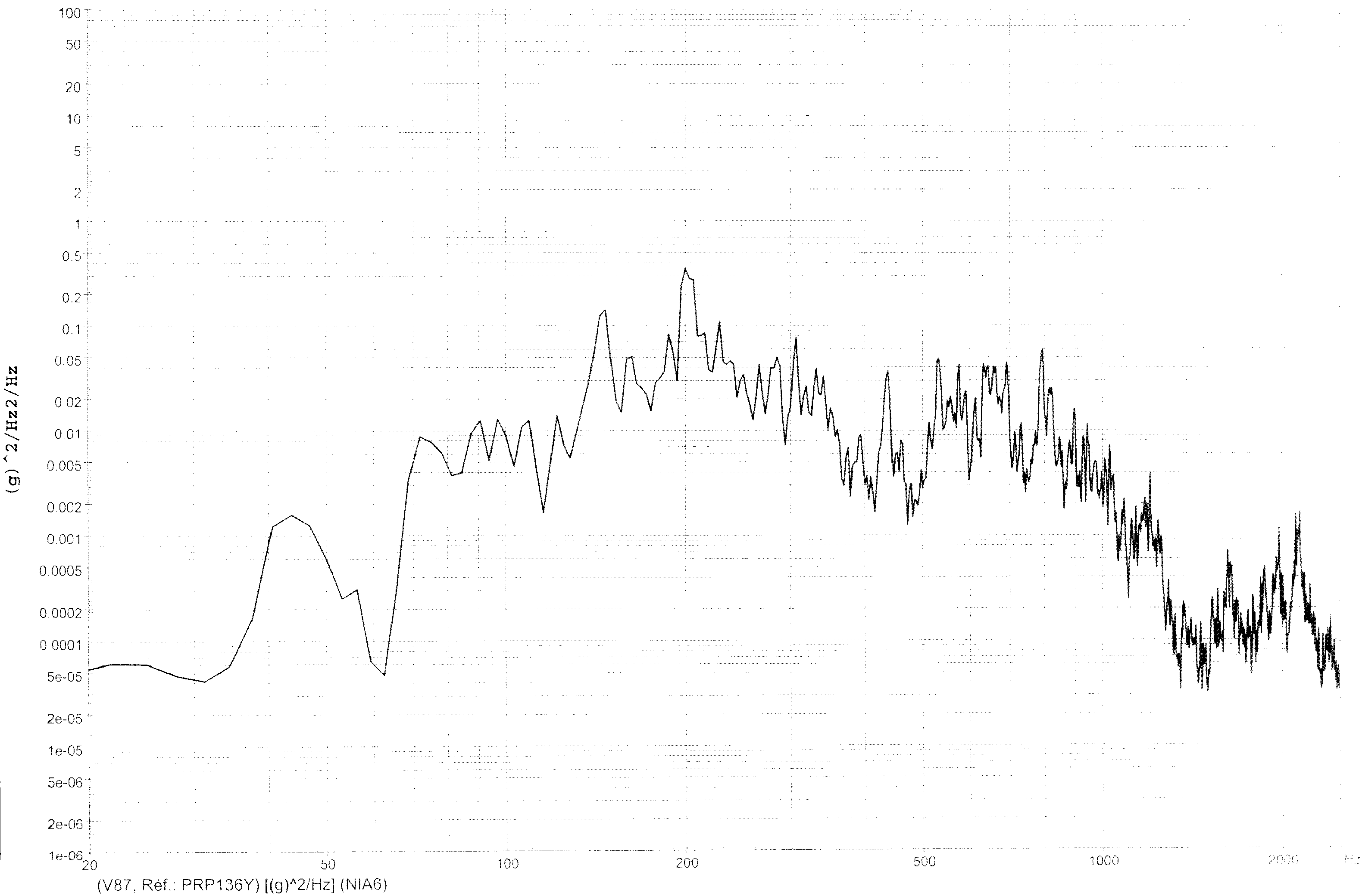
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V86, Réf.: PRP135//) [(g)^2/Hz] (NIA6)

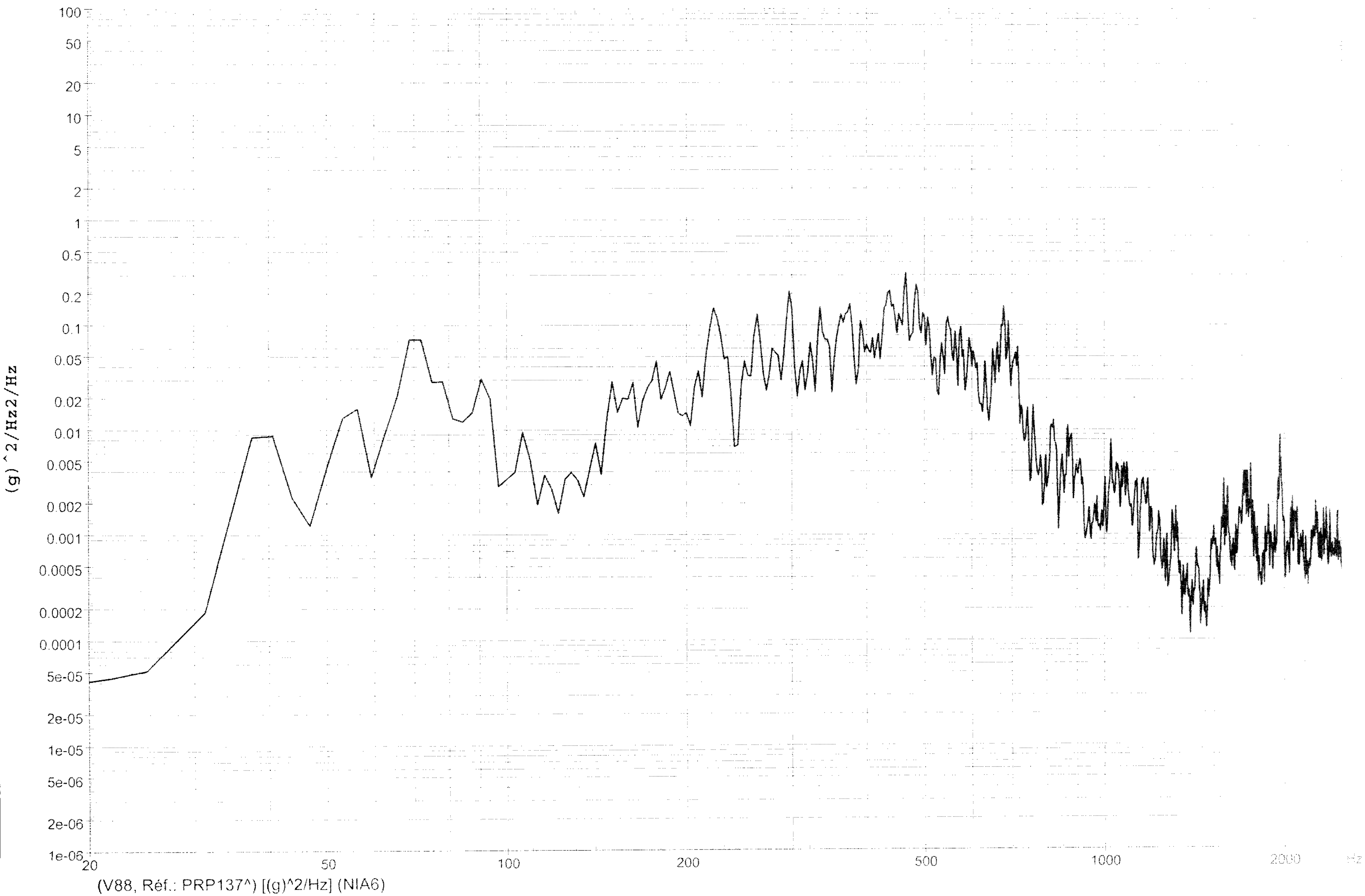
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



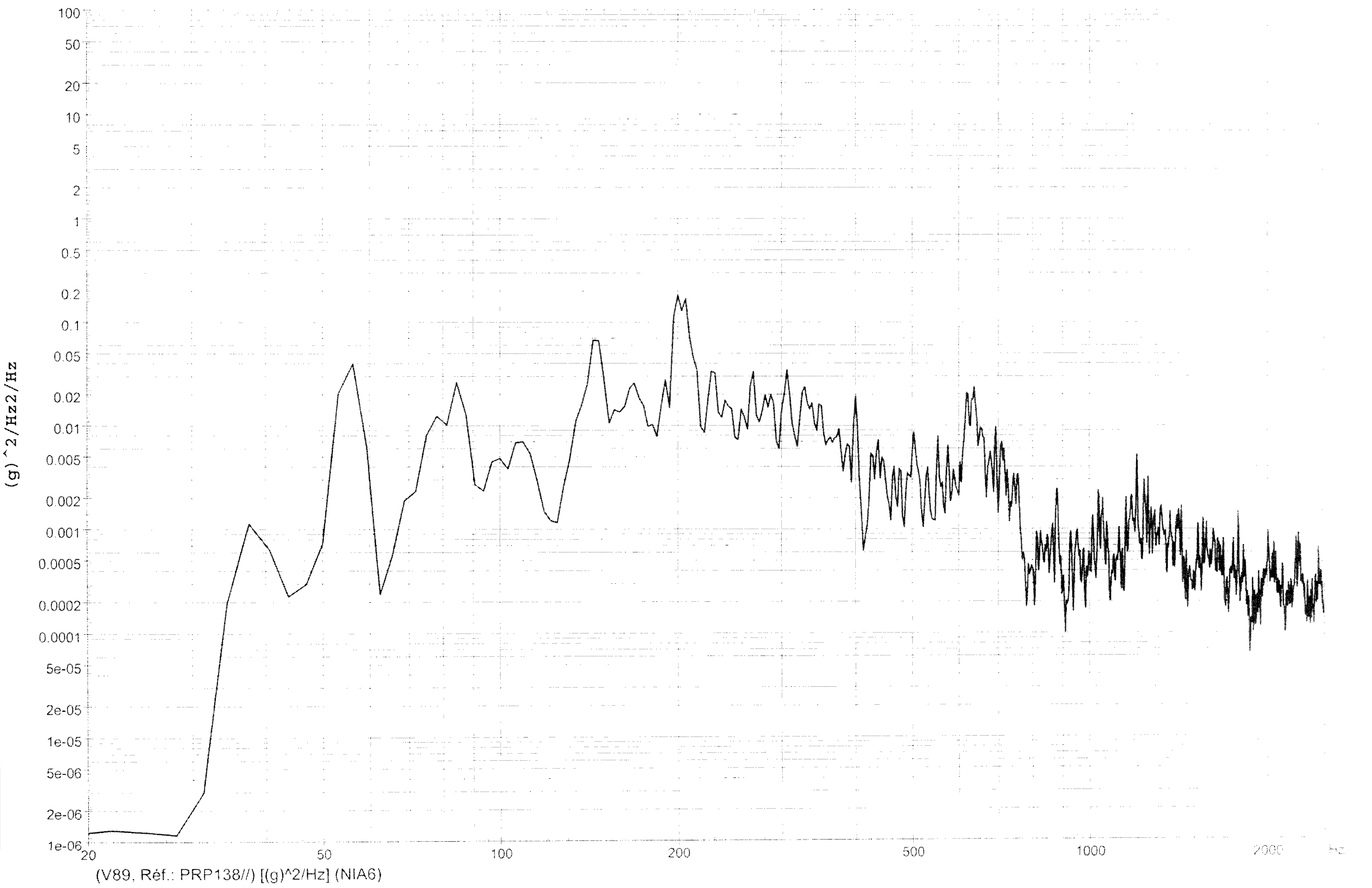
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



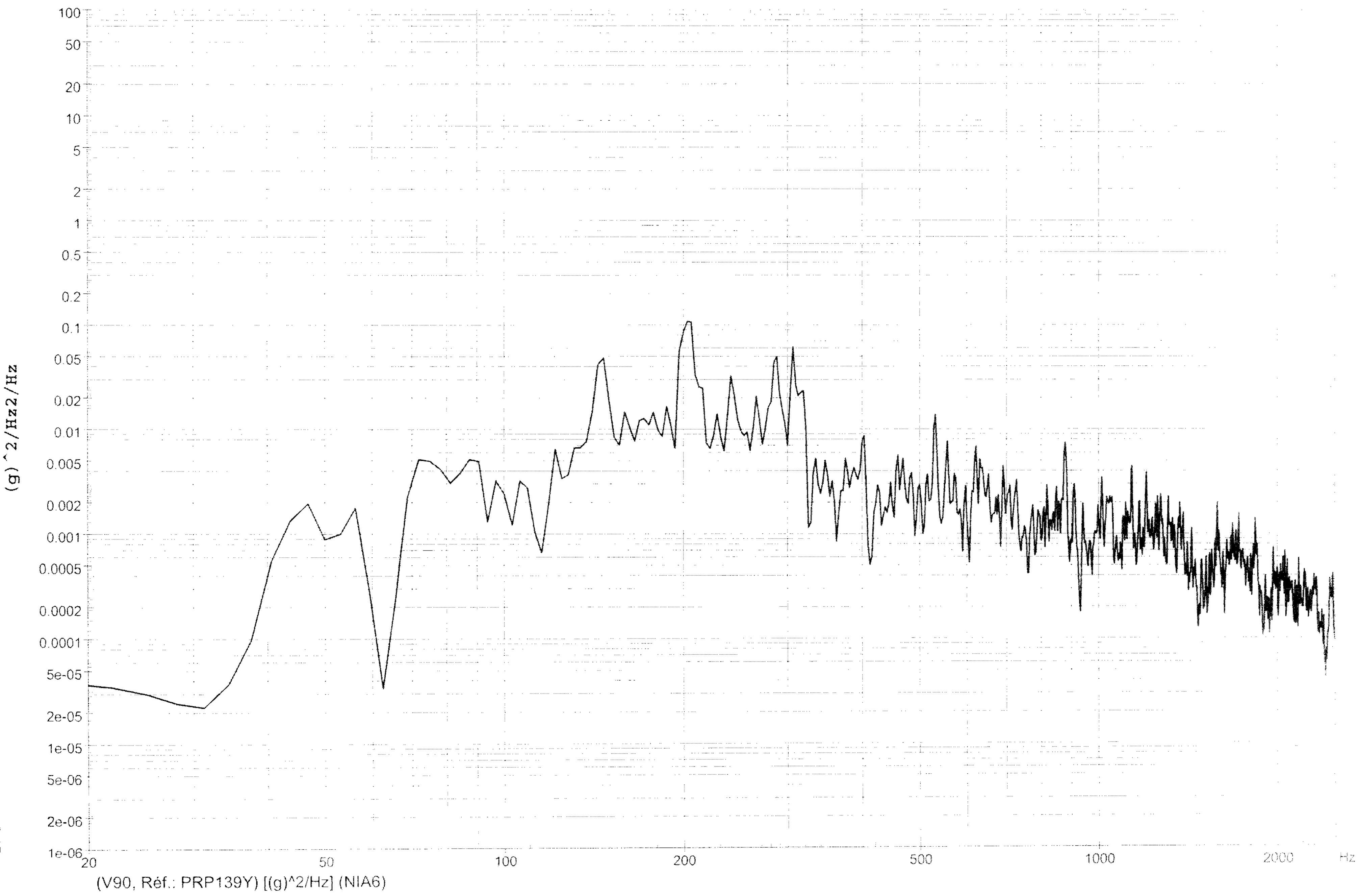
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



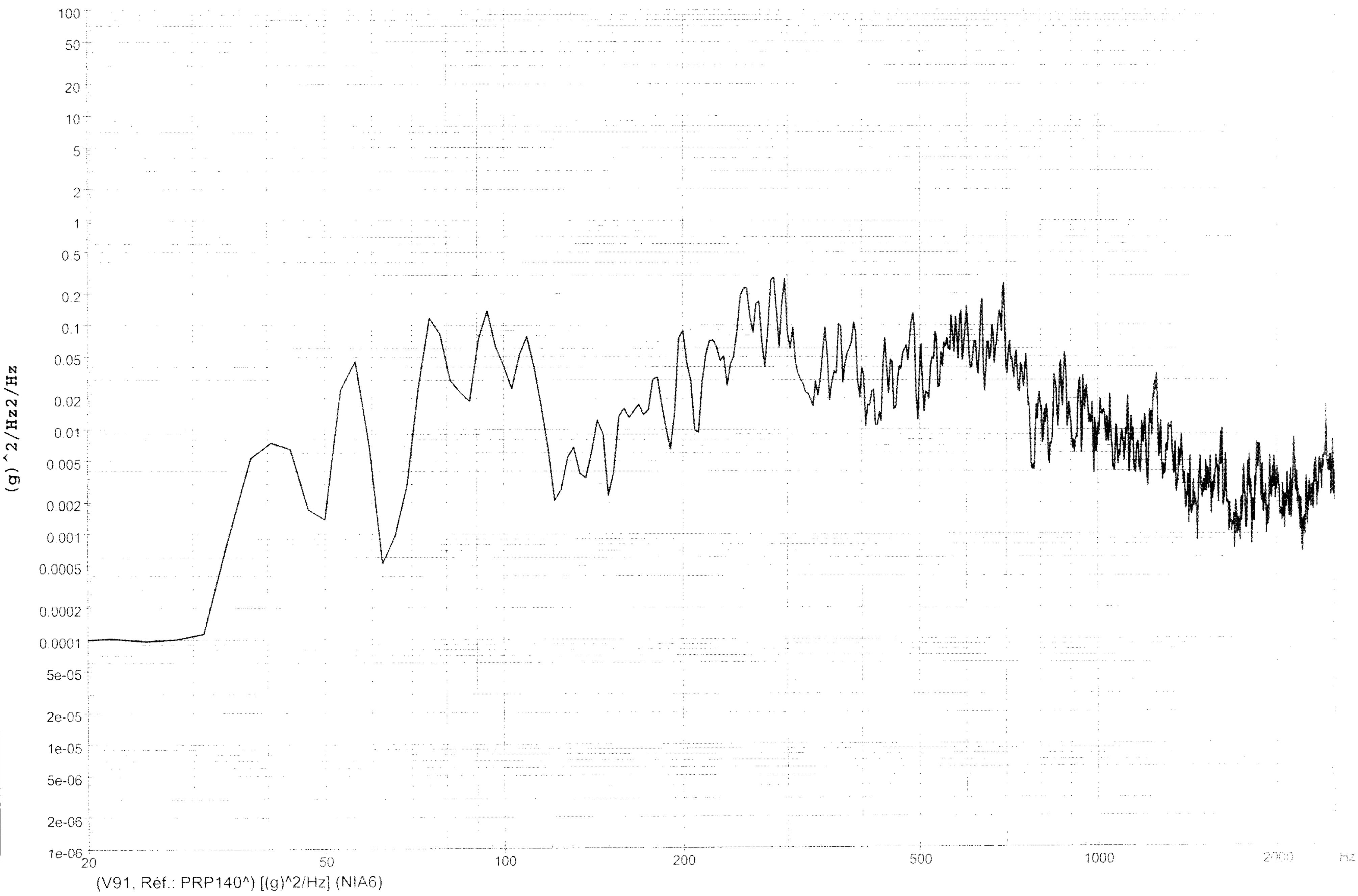
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



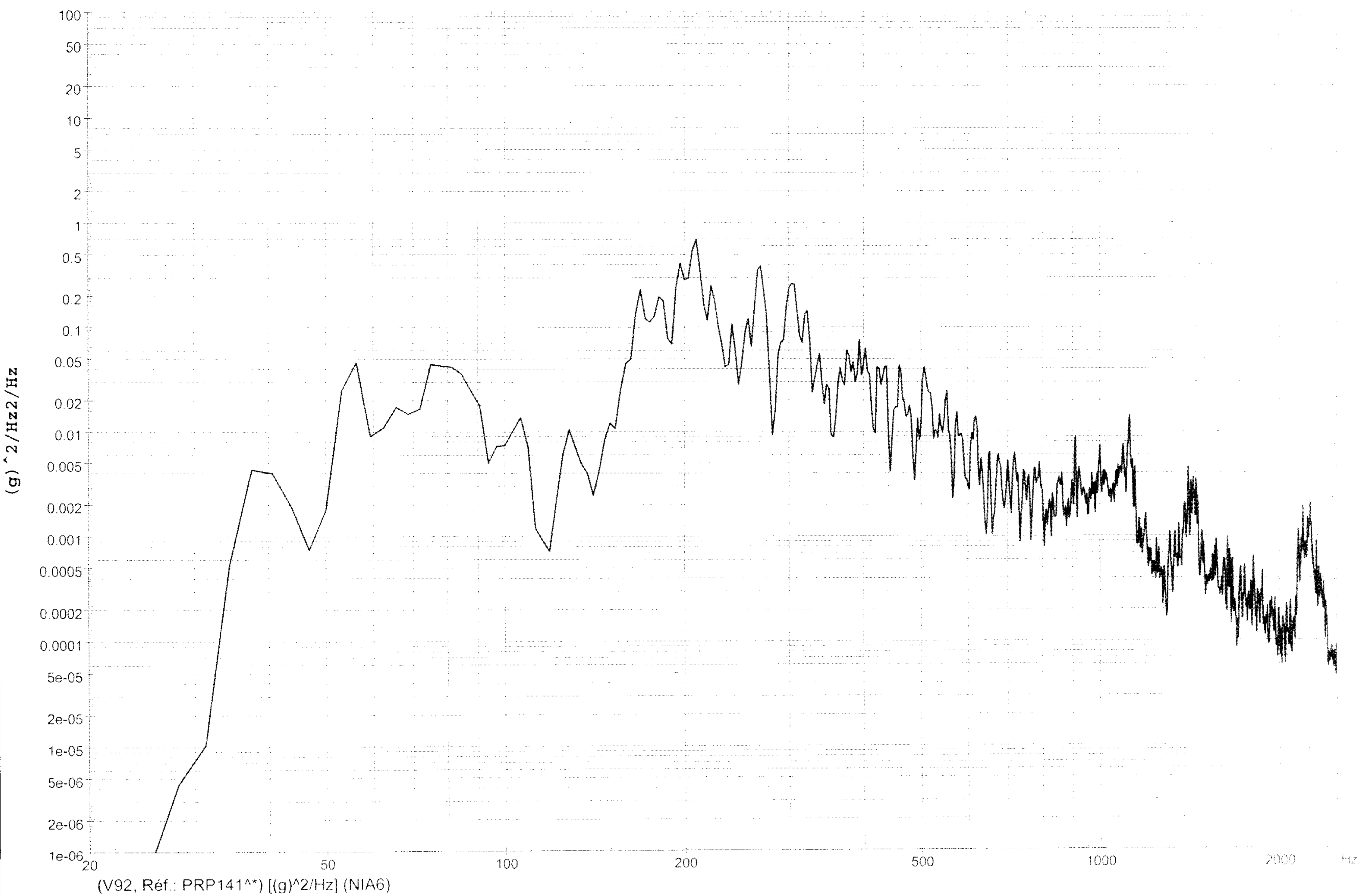
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



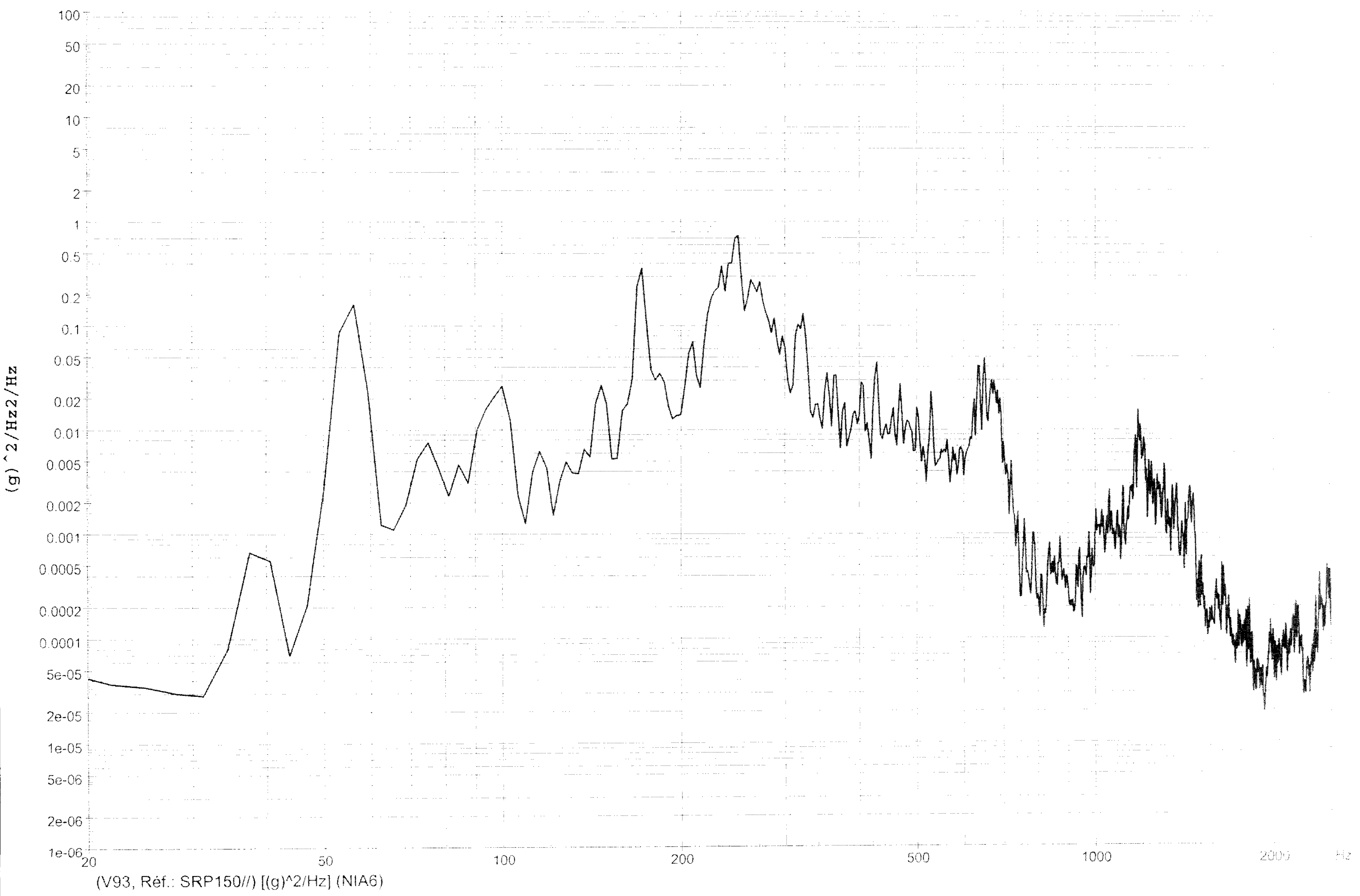
ALCATEL SPACE

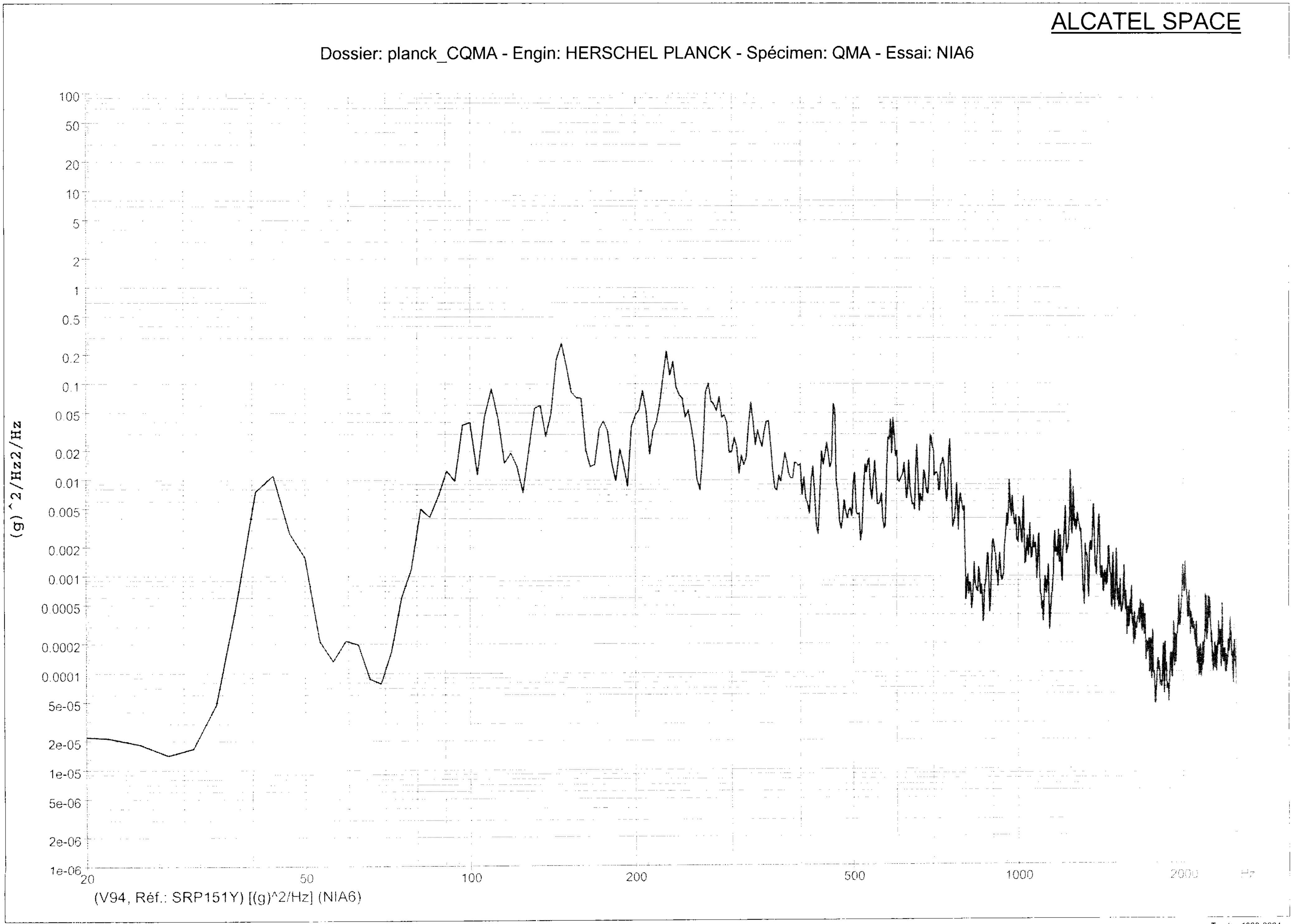
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

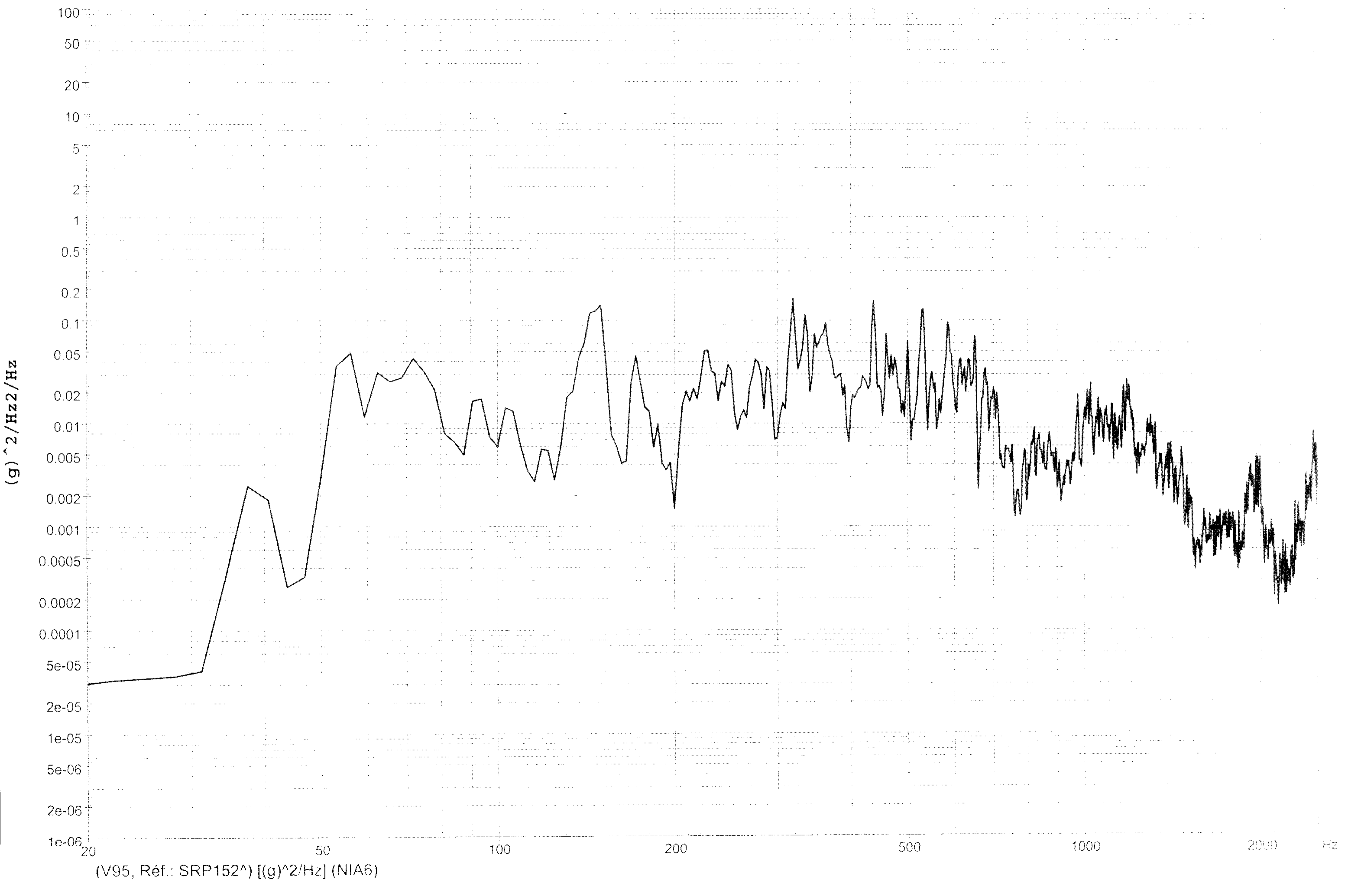
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6




ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
(V94, Réf.: SRP151Y) [(g)^2/Hz] (NIA6)
PC/Analysis 2.29é (25/08/2004)
Edité le: 03/02/2005 à 11H30
Teralog 1999-2004

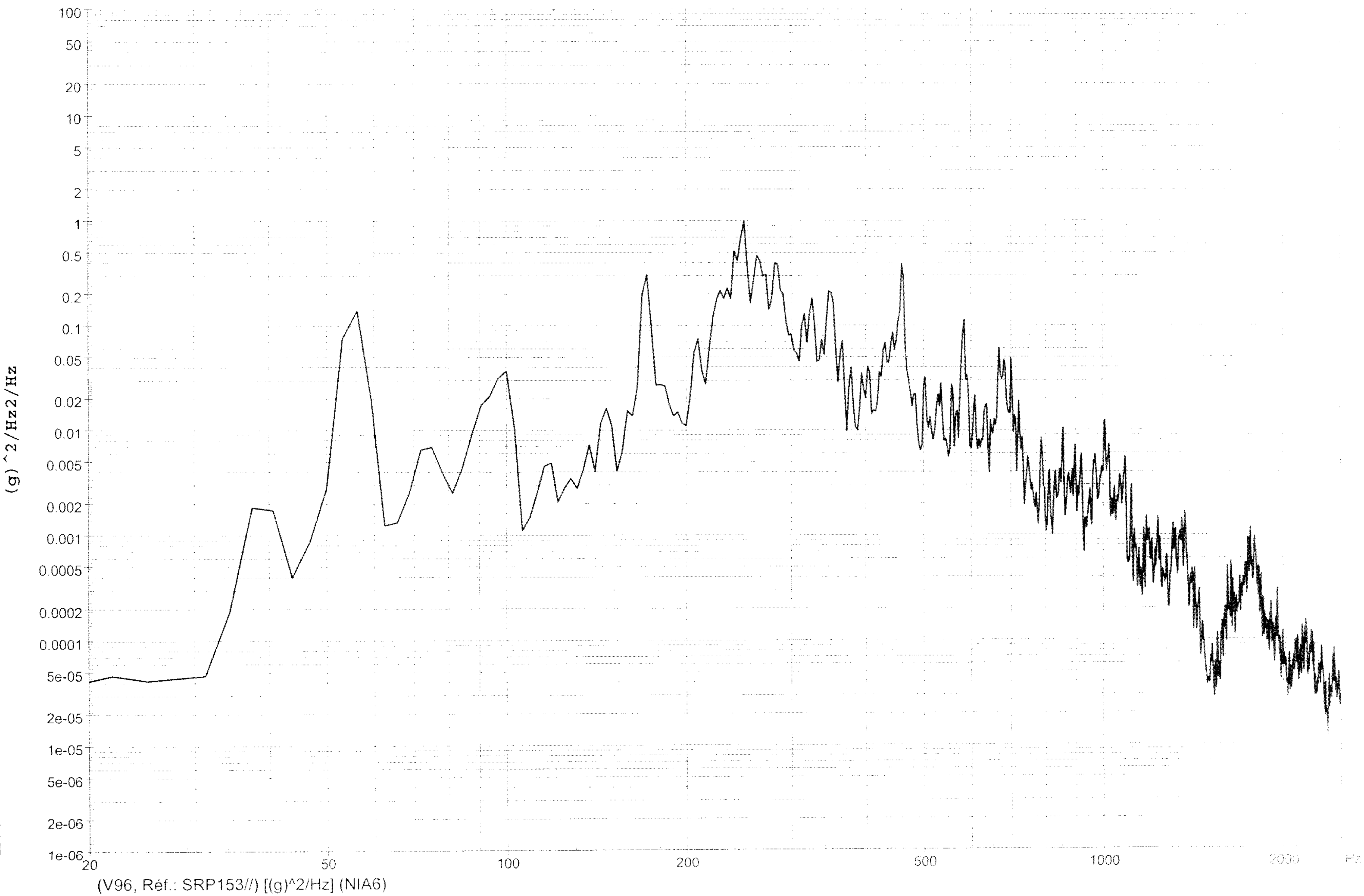
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



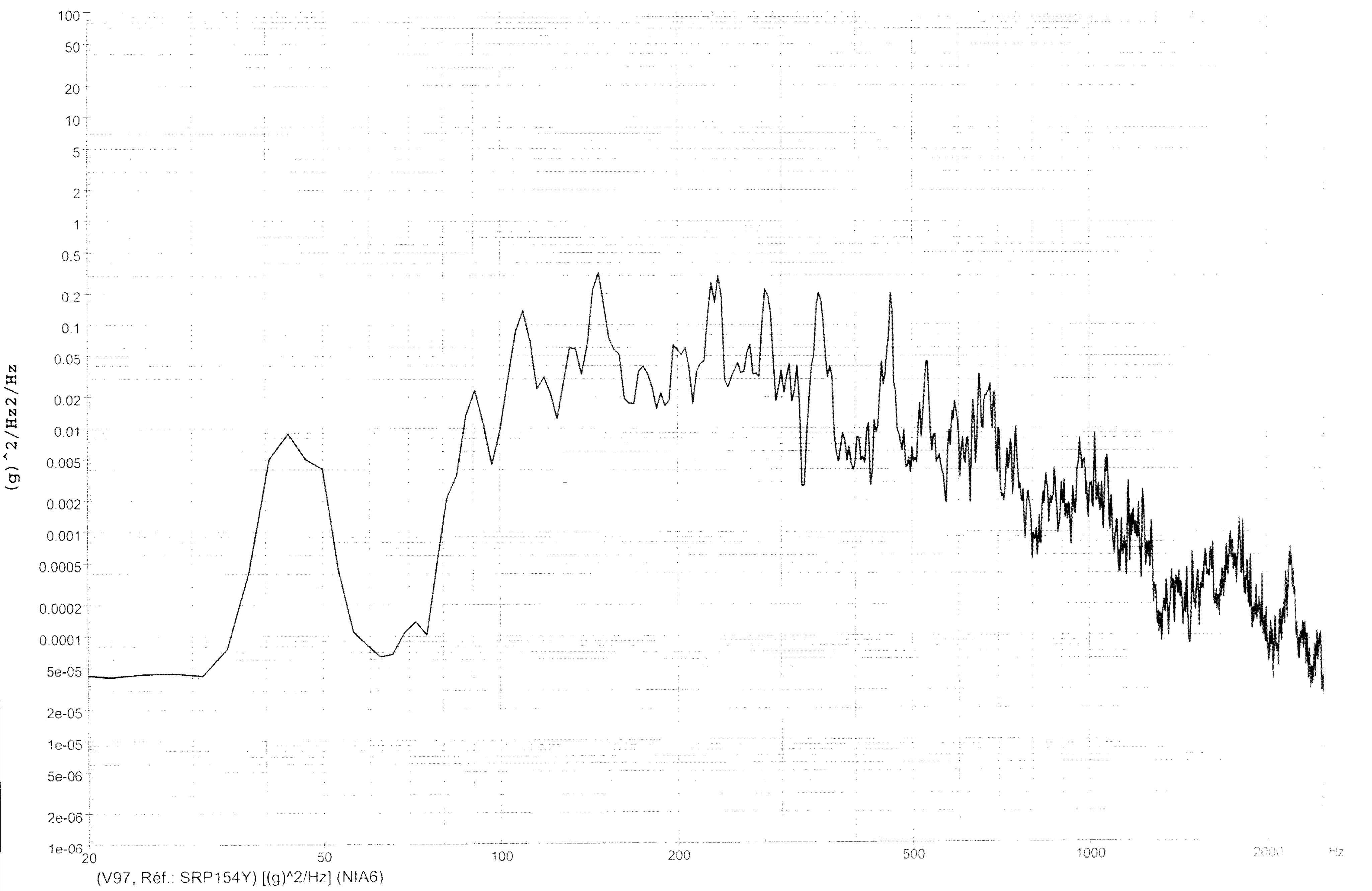
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



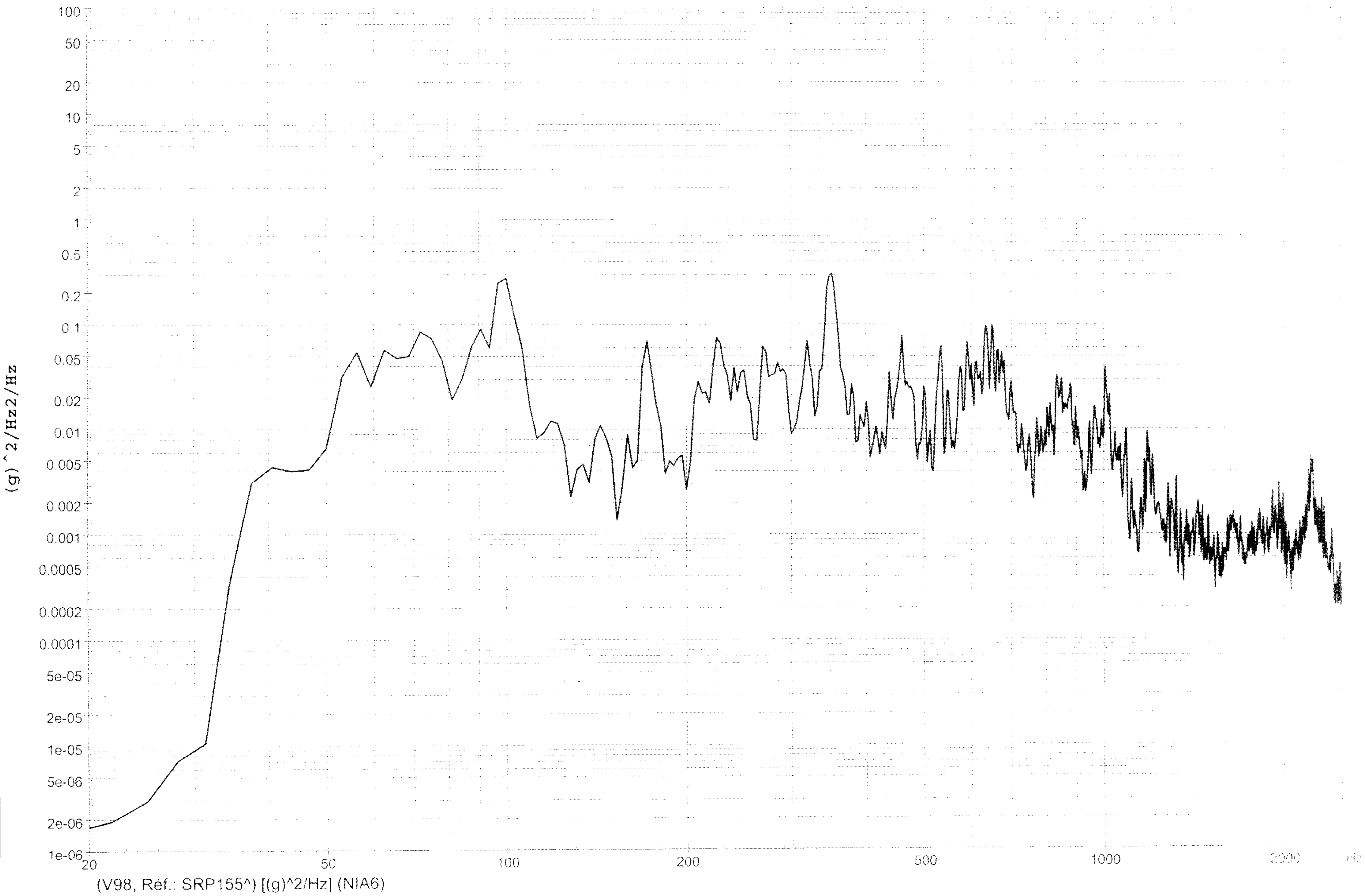
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



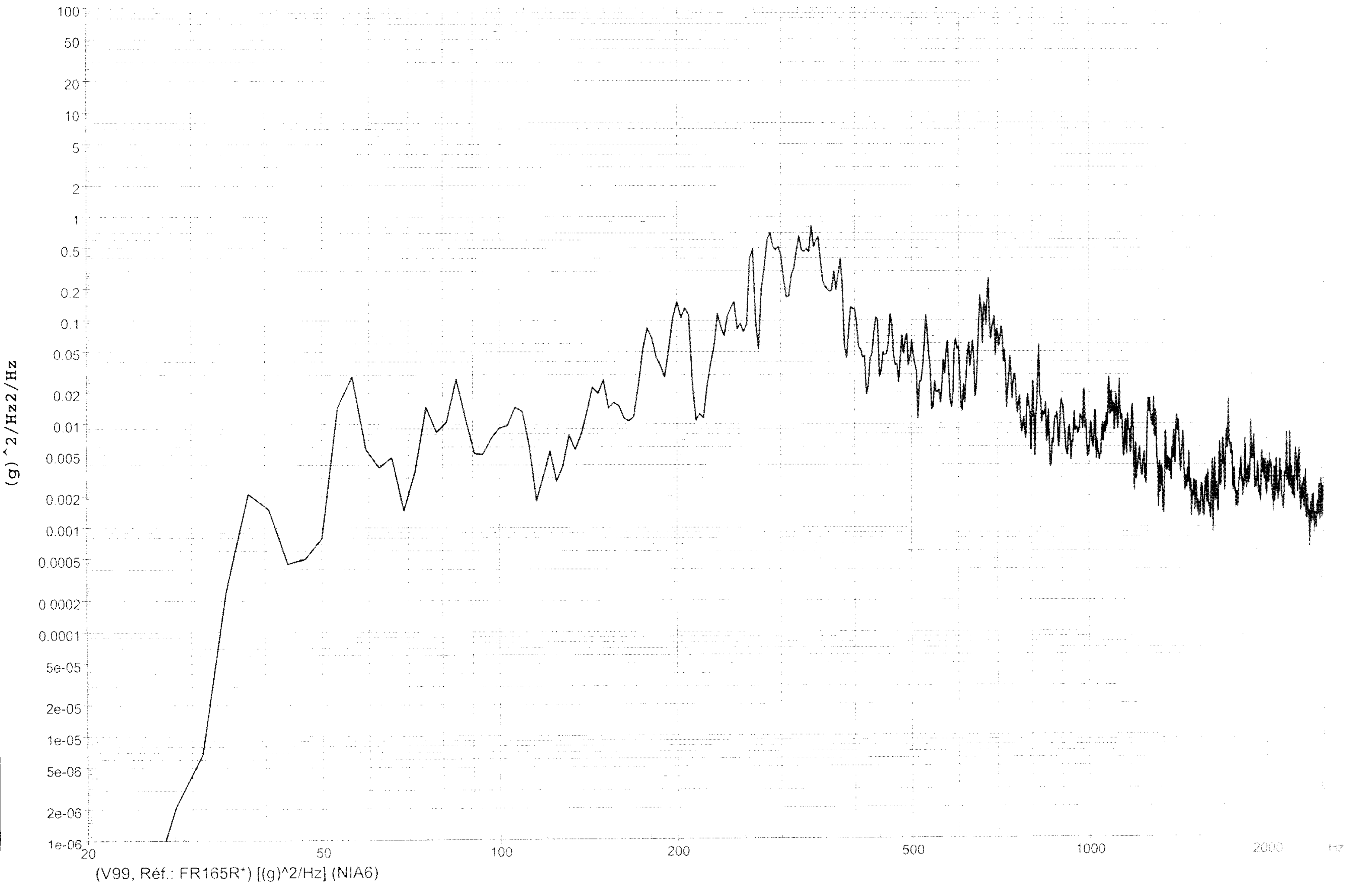
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

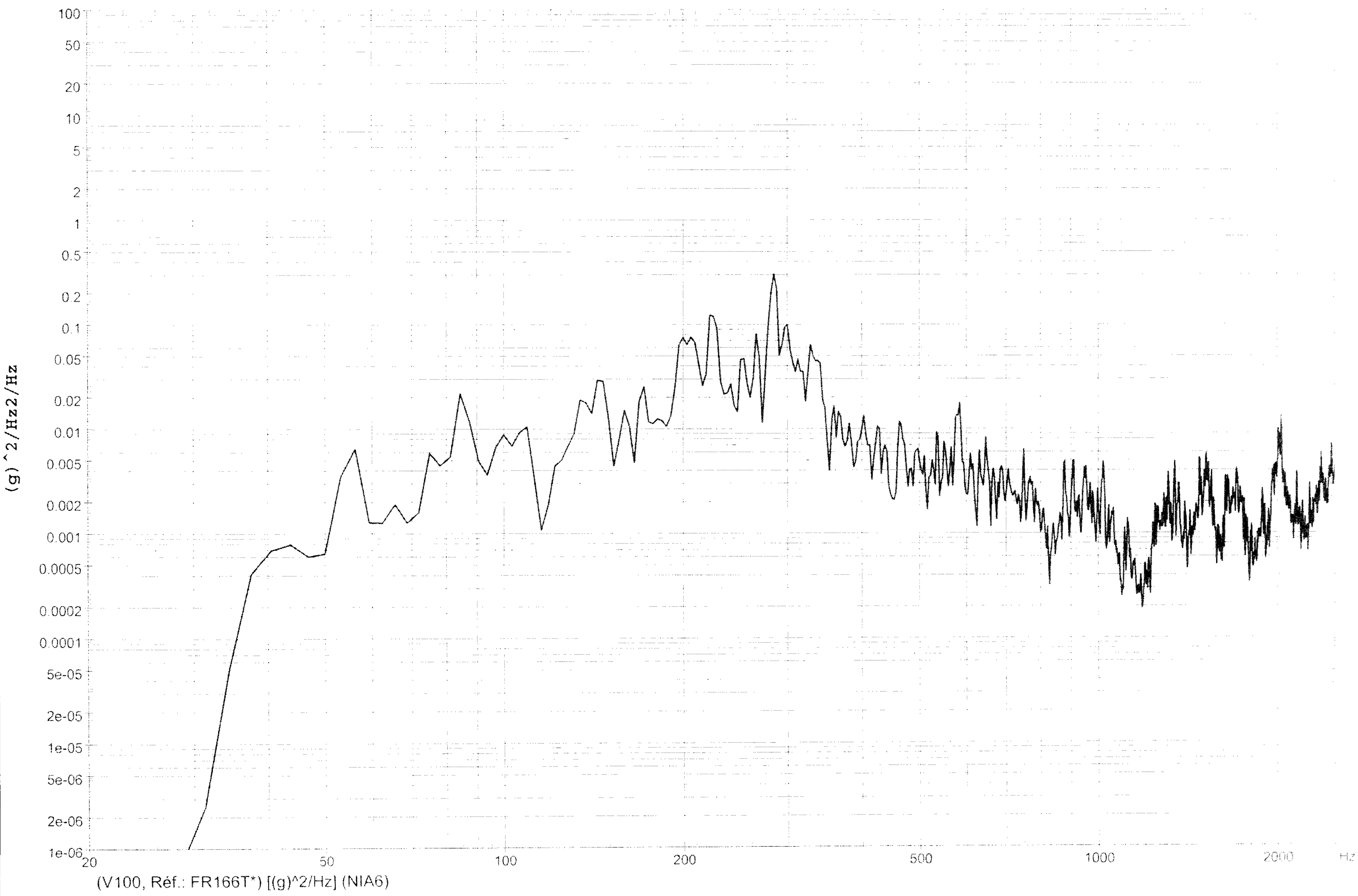


ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

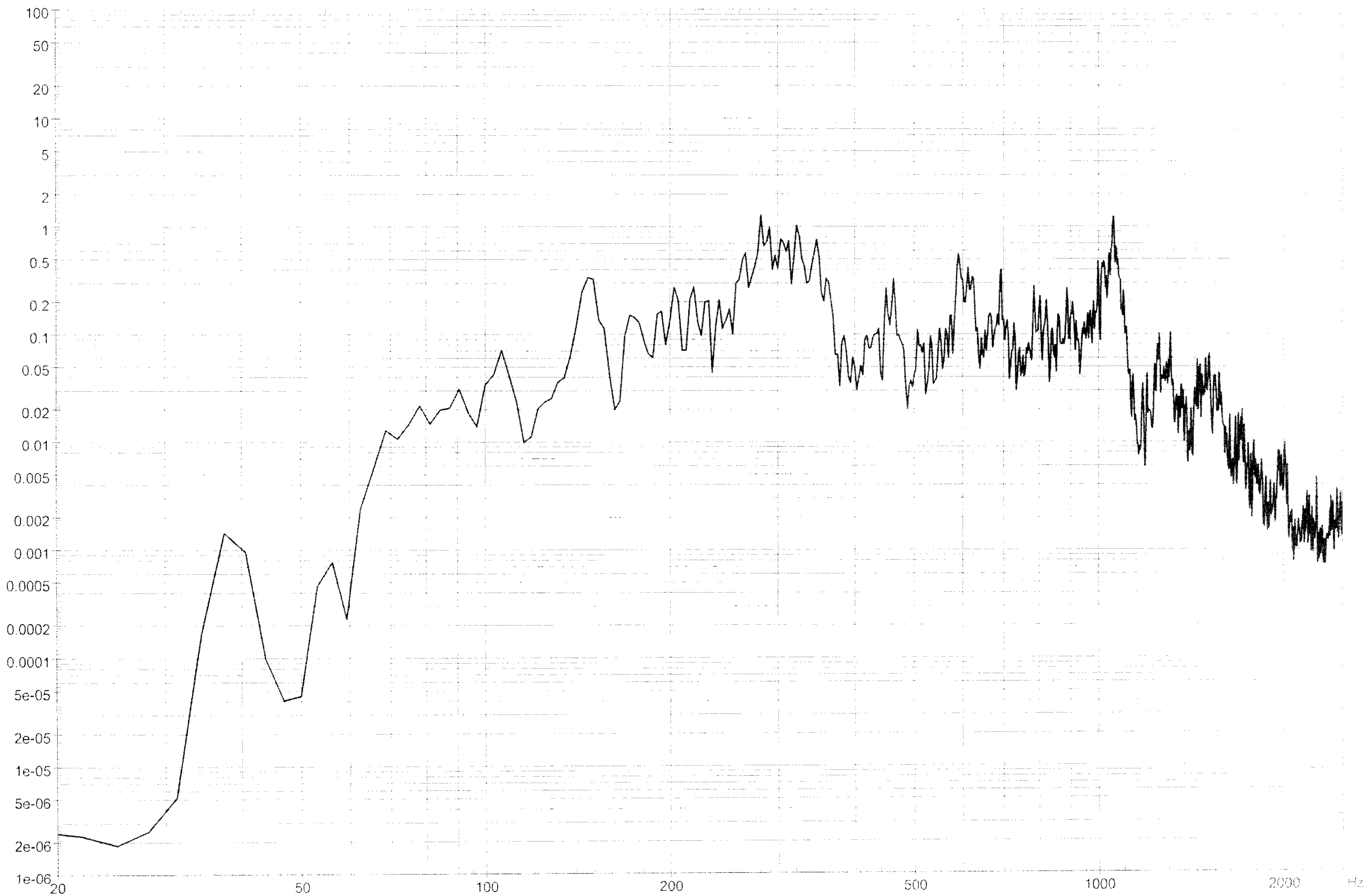


Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

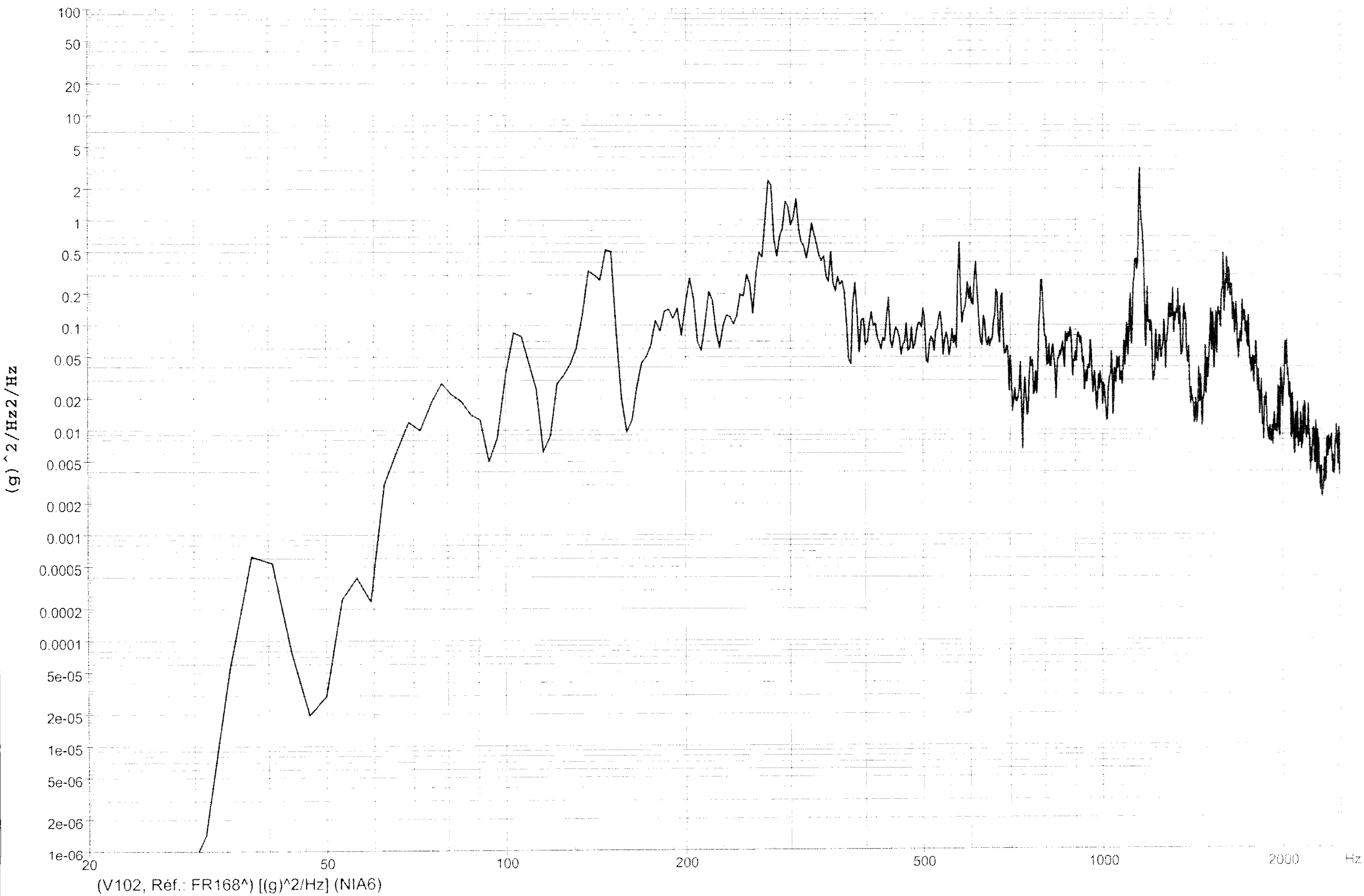
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V101, Réf.: FR167Z*) [(g)^2/Hz] (NIA6)

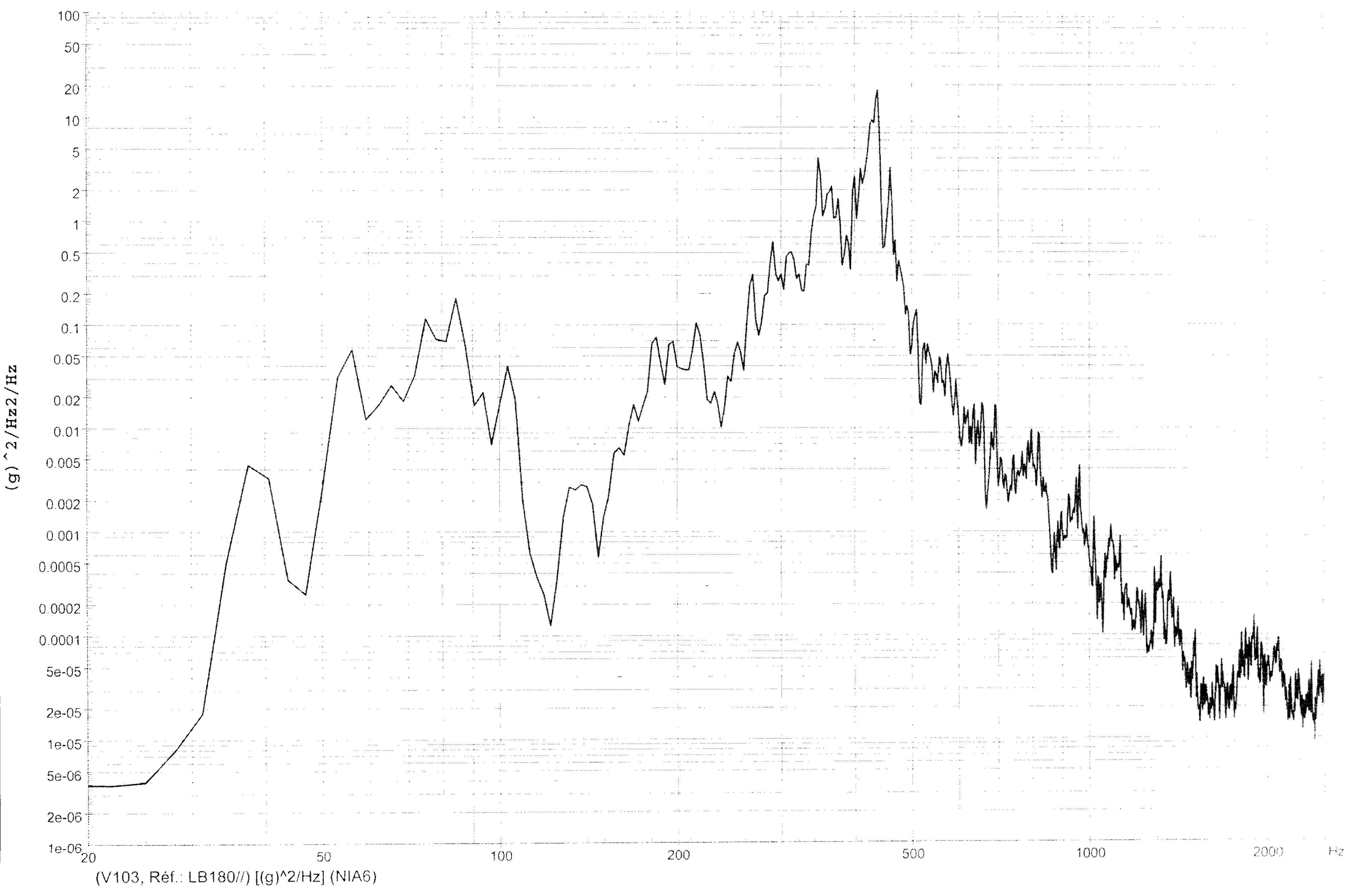
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



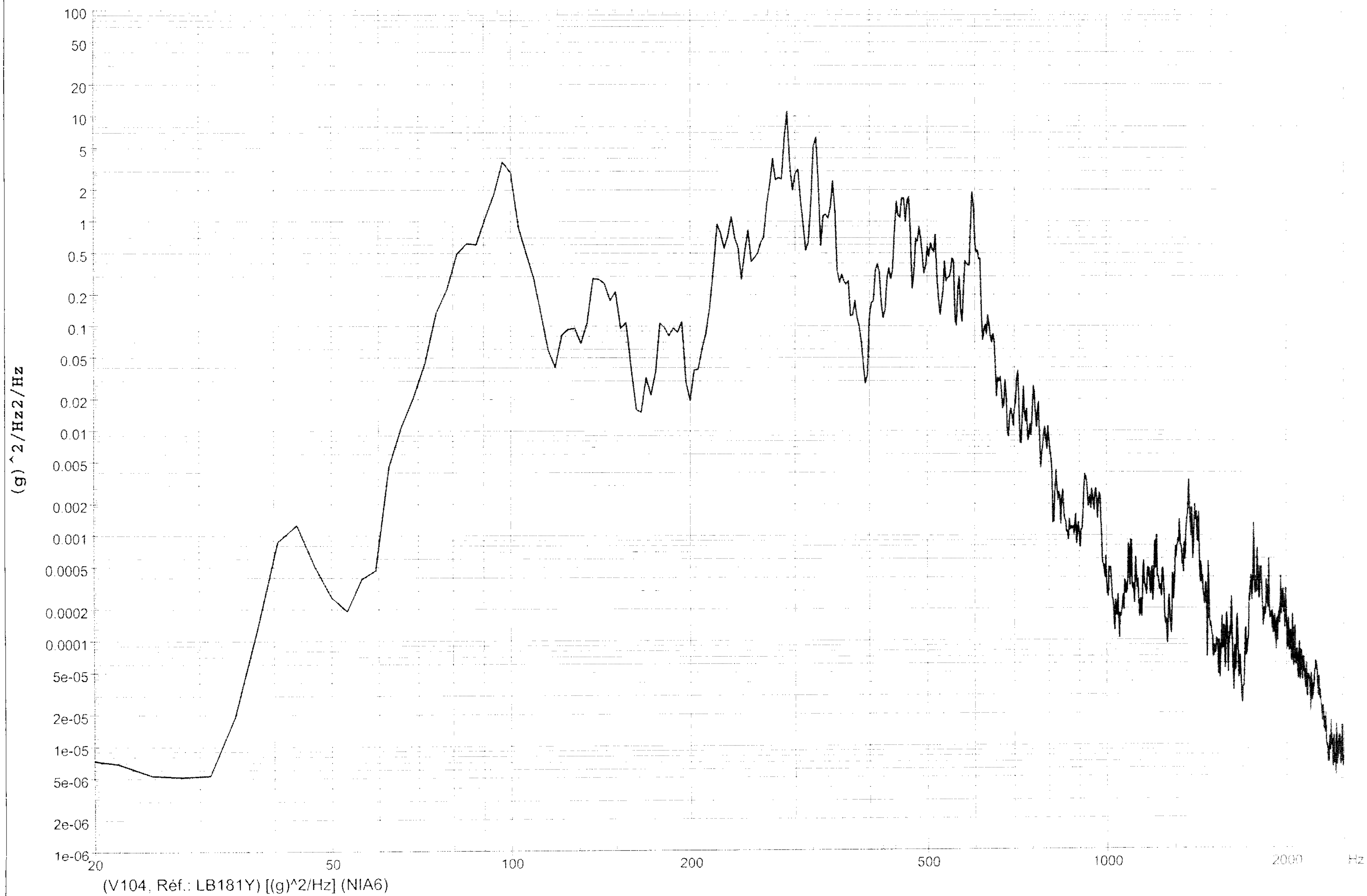
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



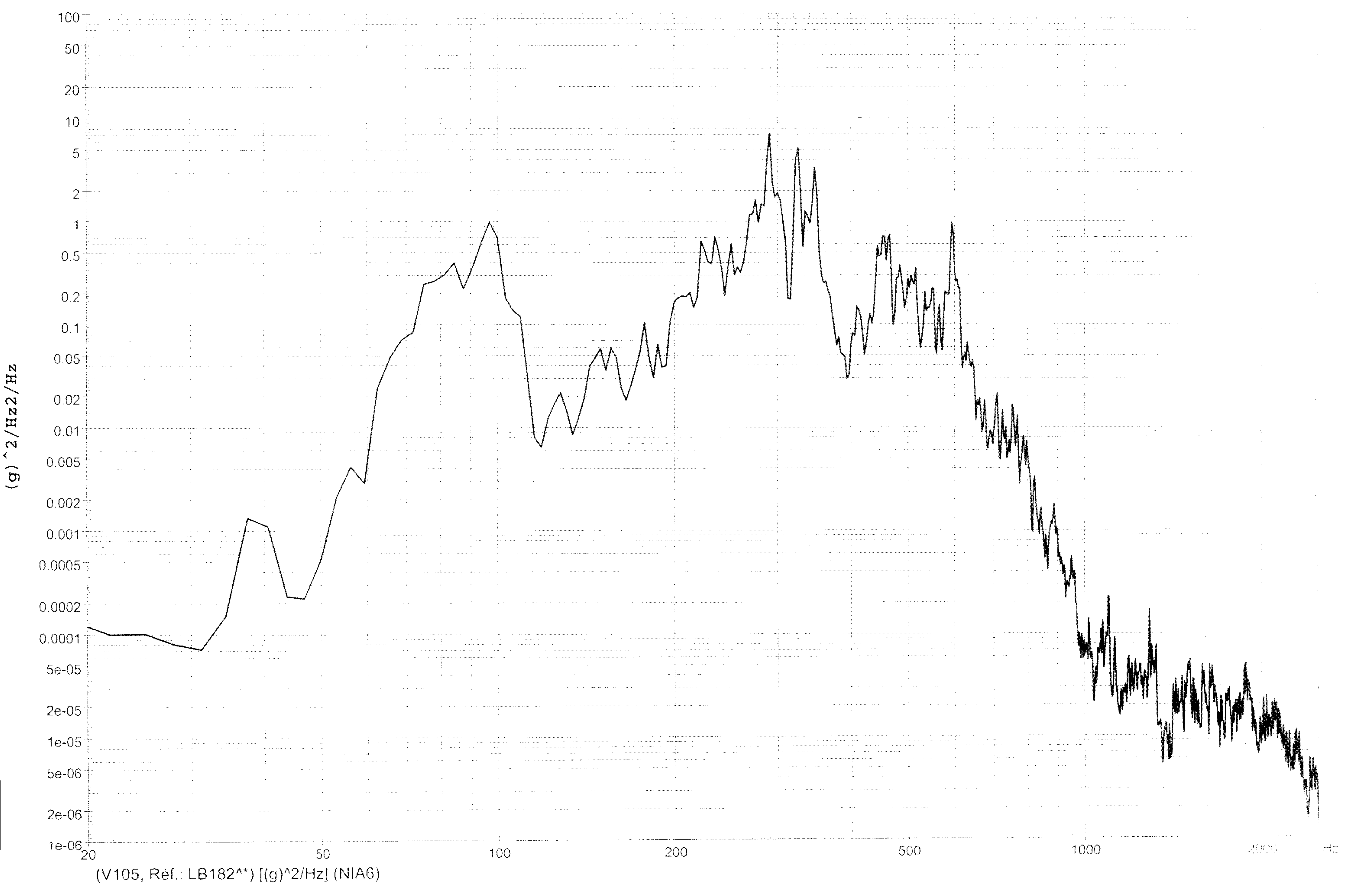
ALCATEL SPACE

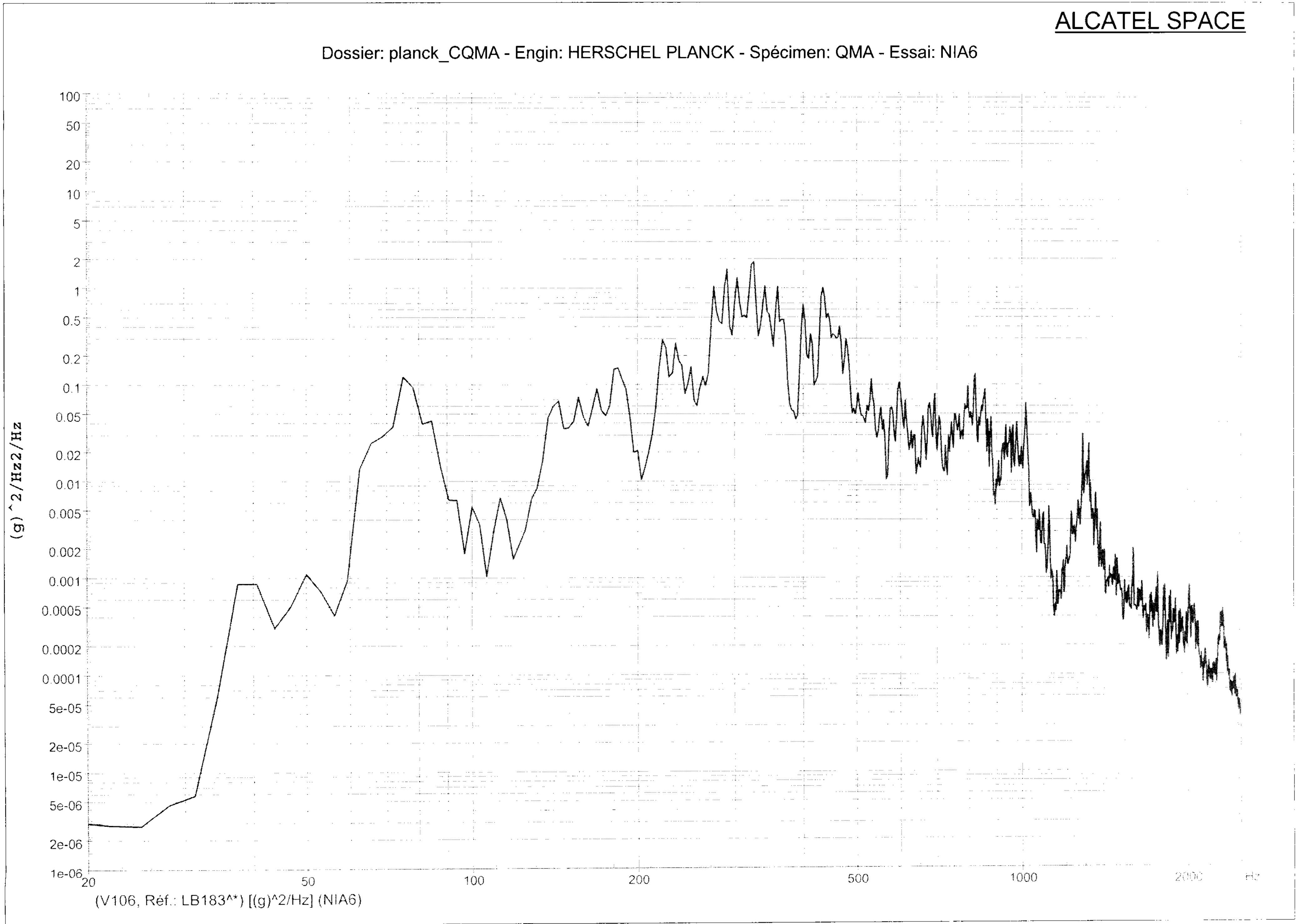
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6




ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(g)^2/Hz2/Hz
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
(V106, Réf.: LB183^*) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

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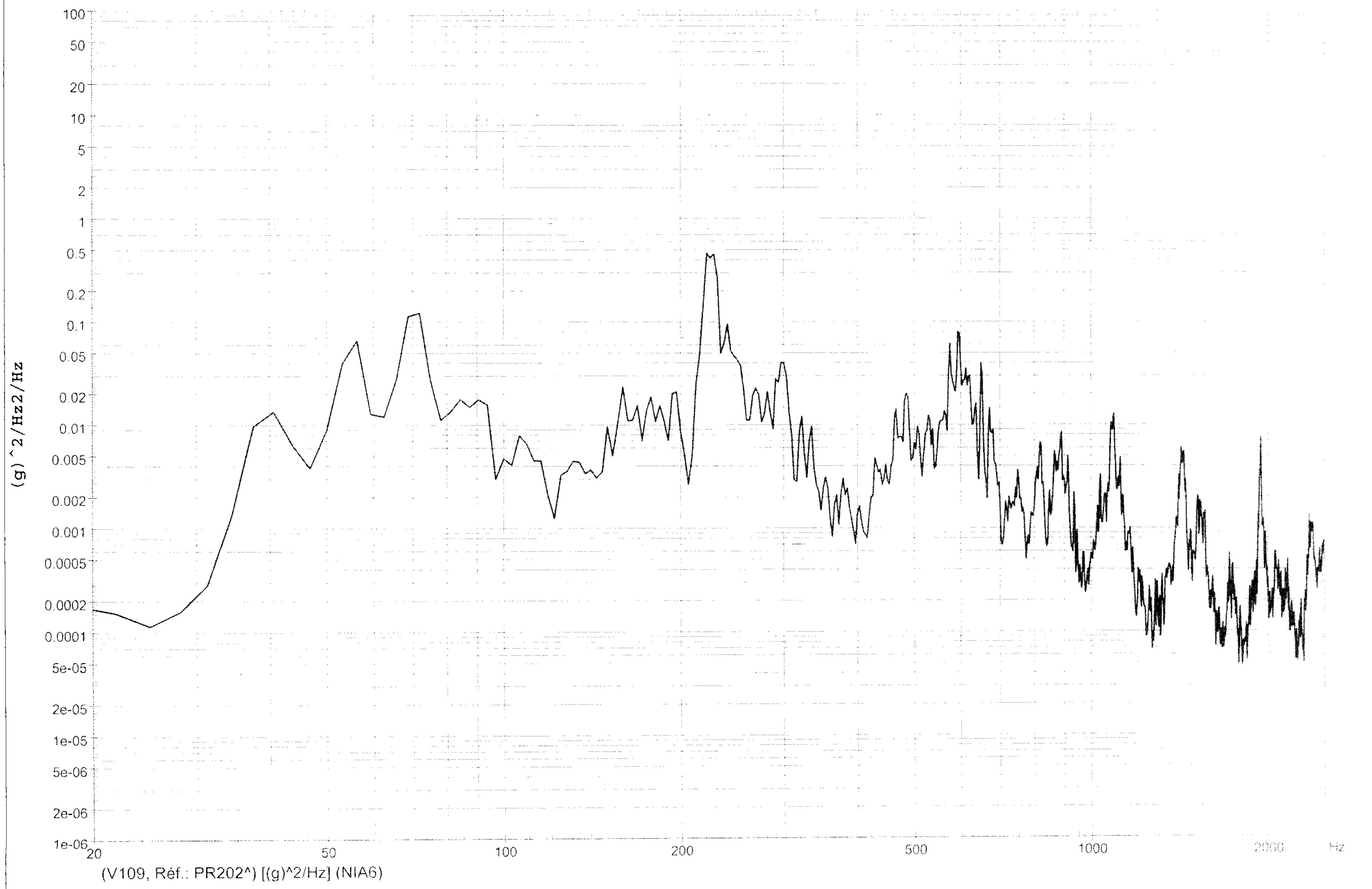

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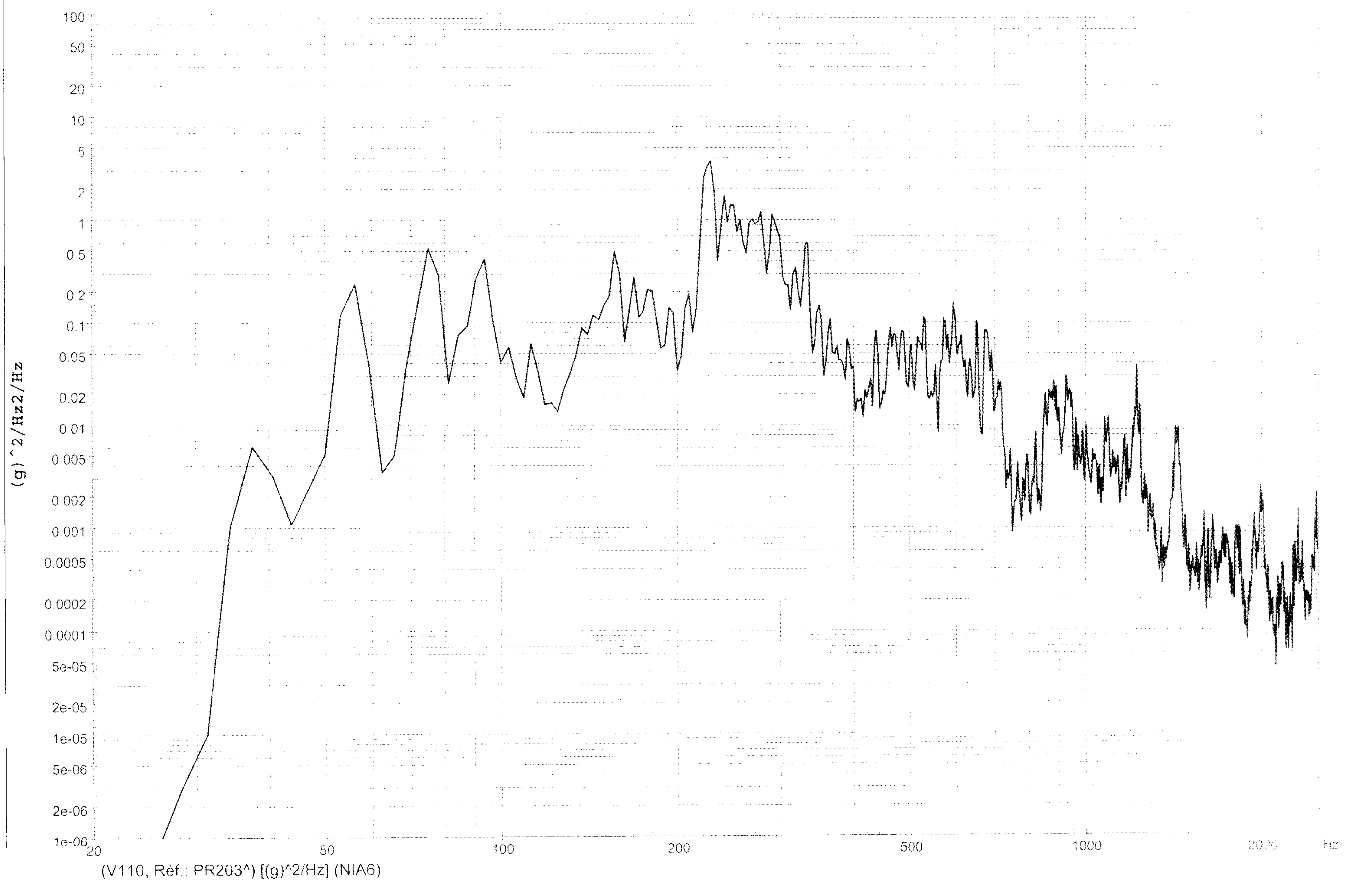

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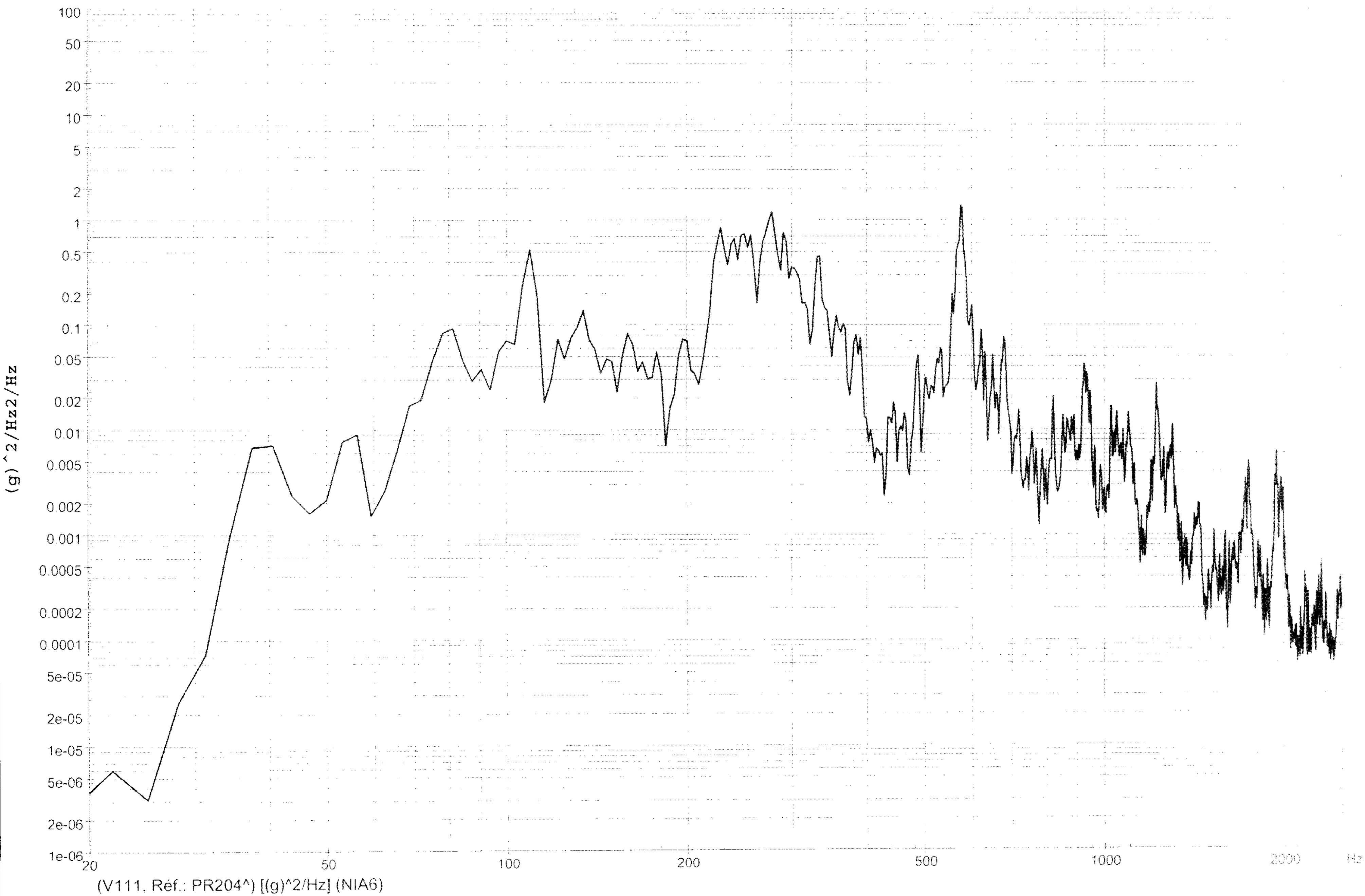

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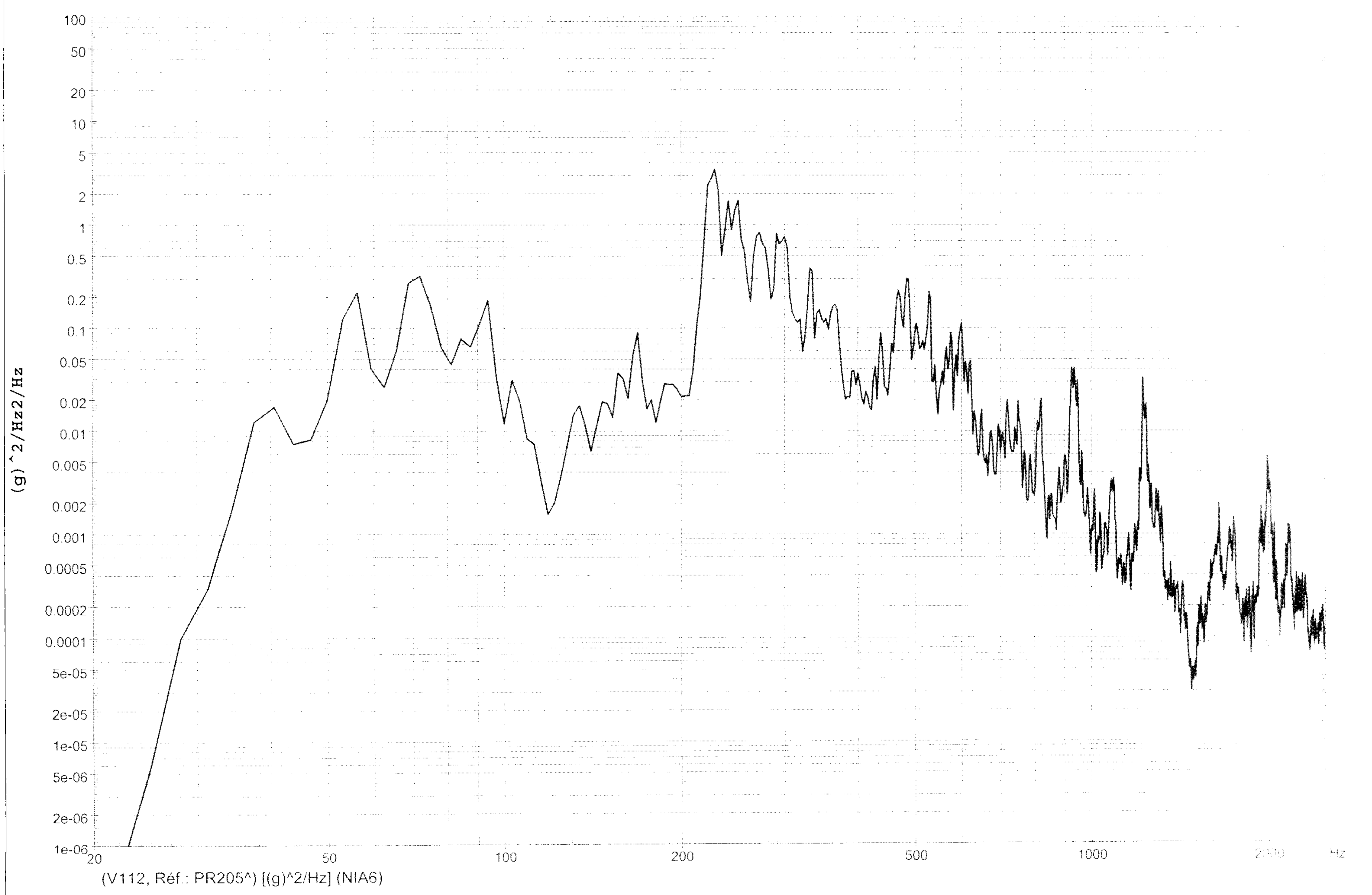

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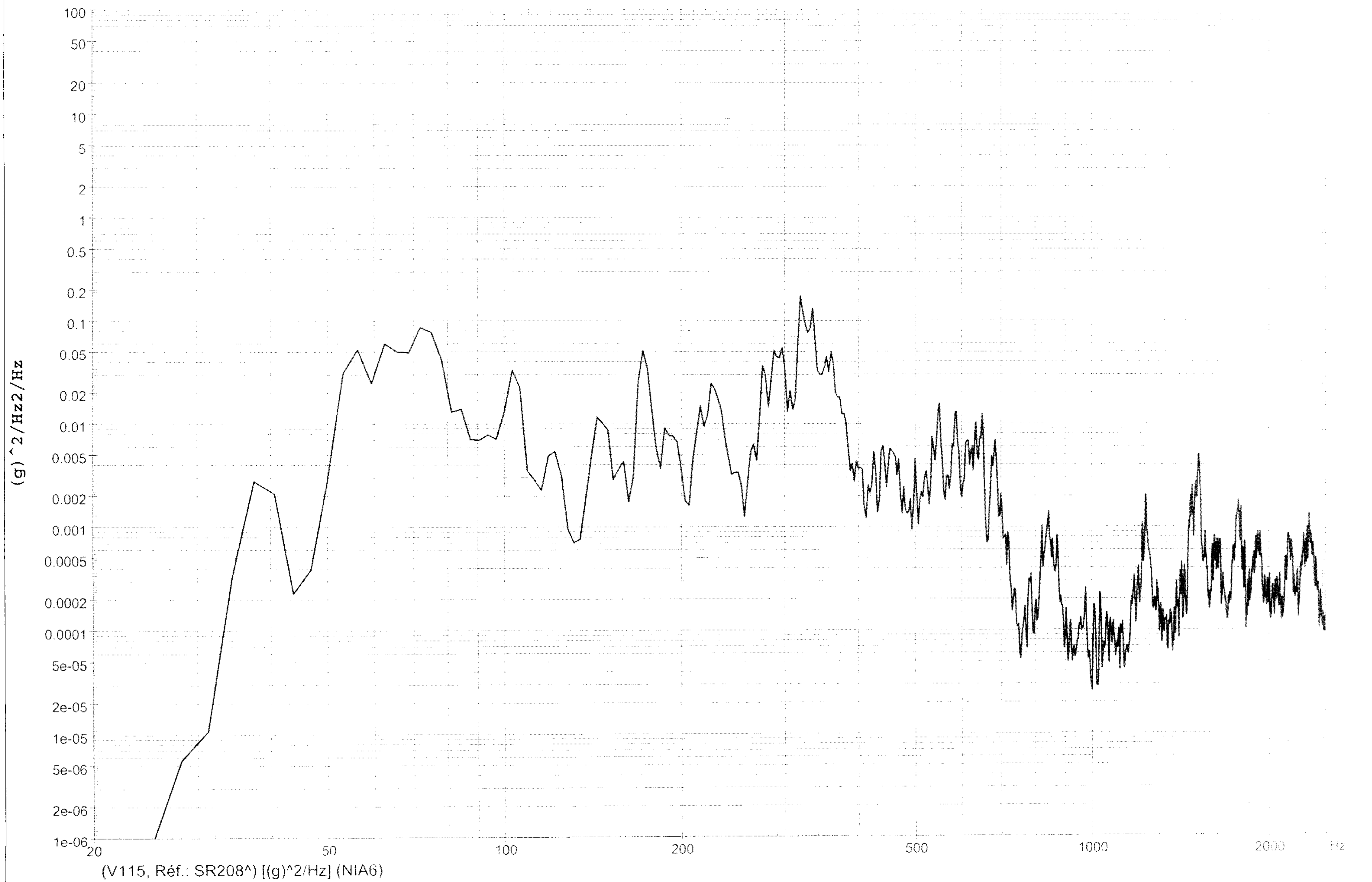

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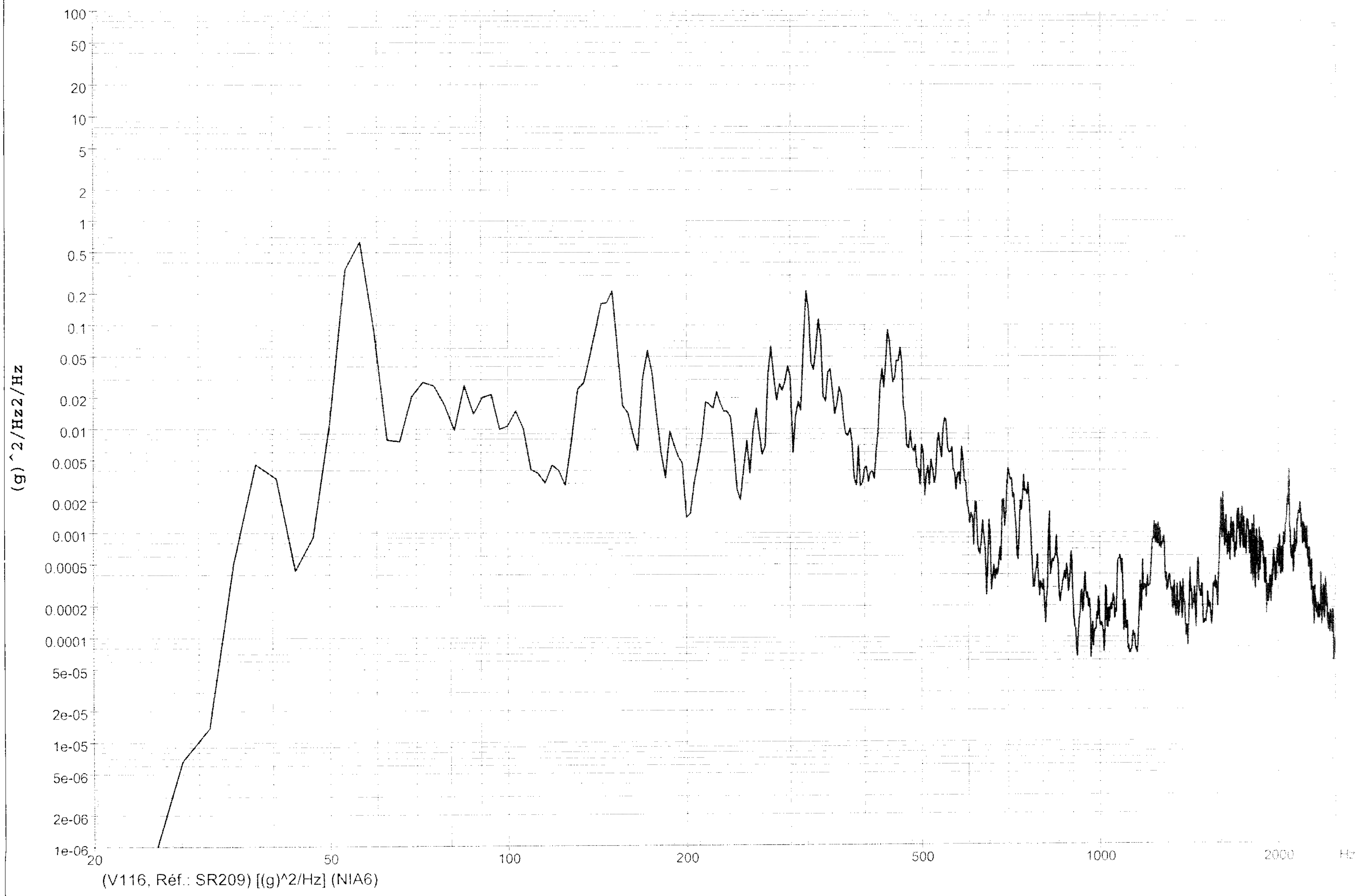

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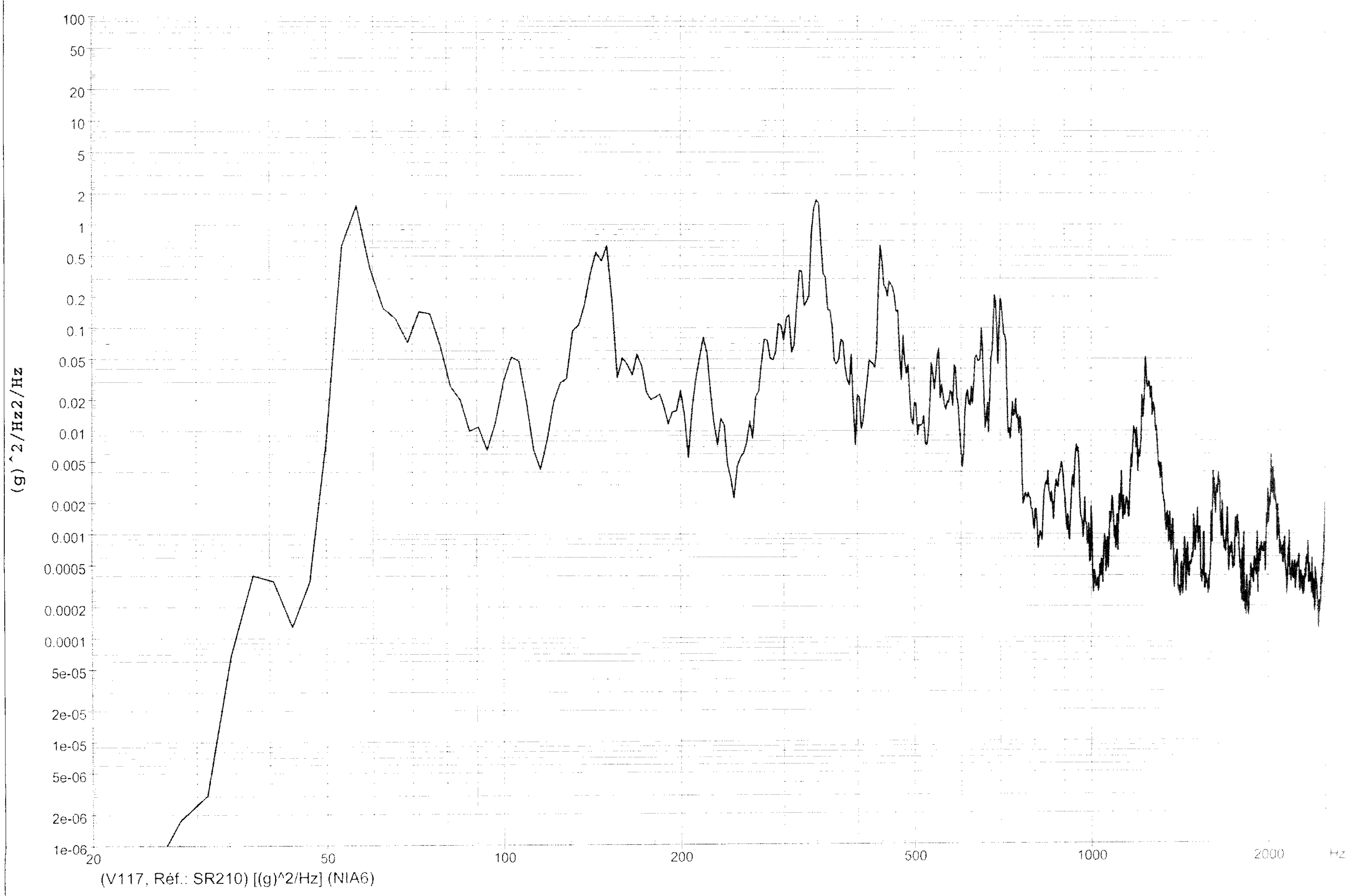

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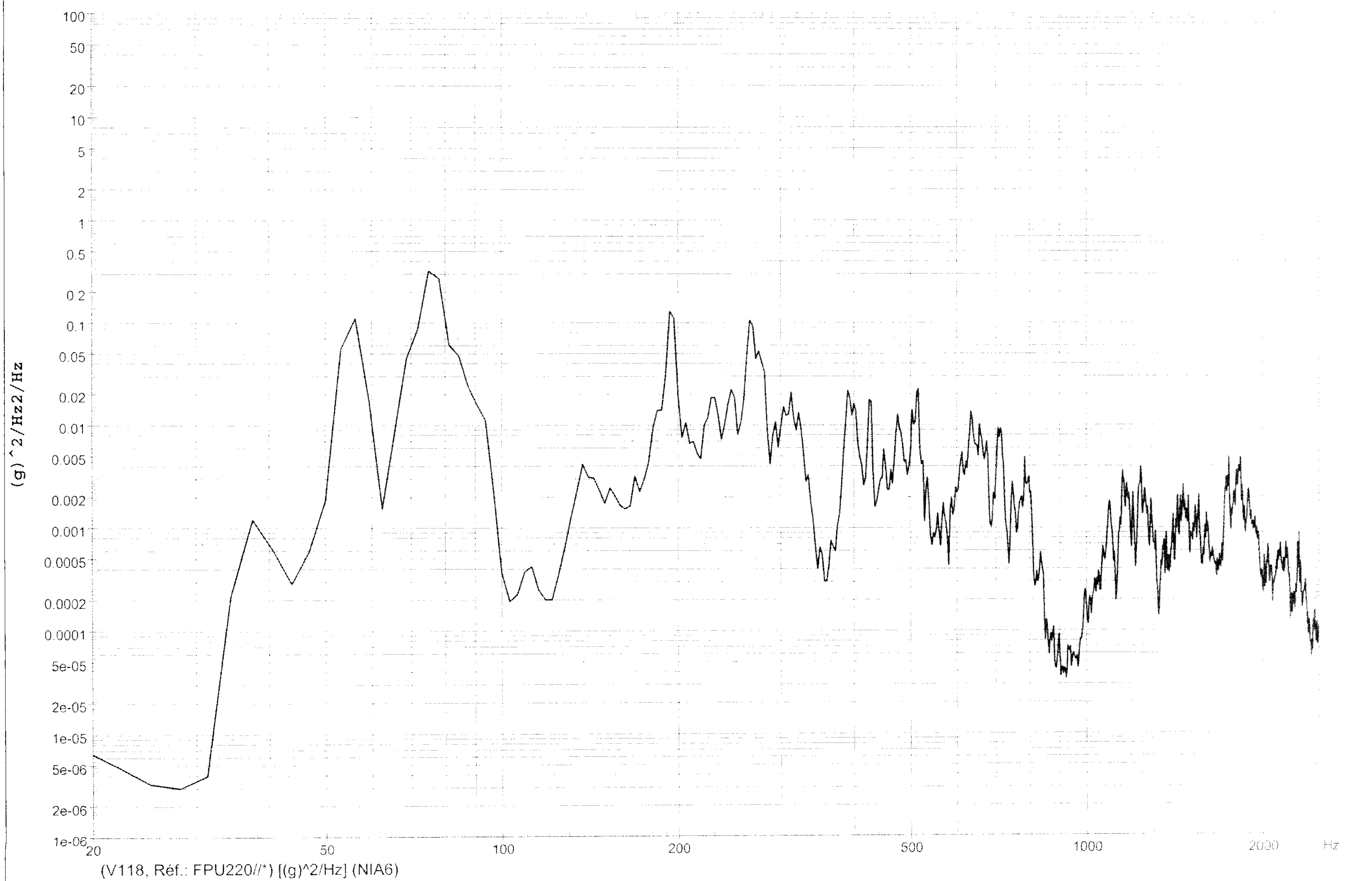

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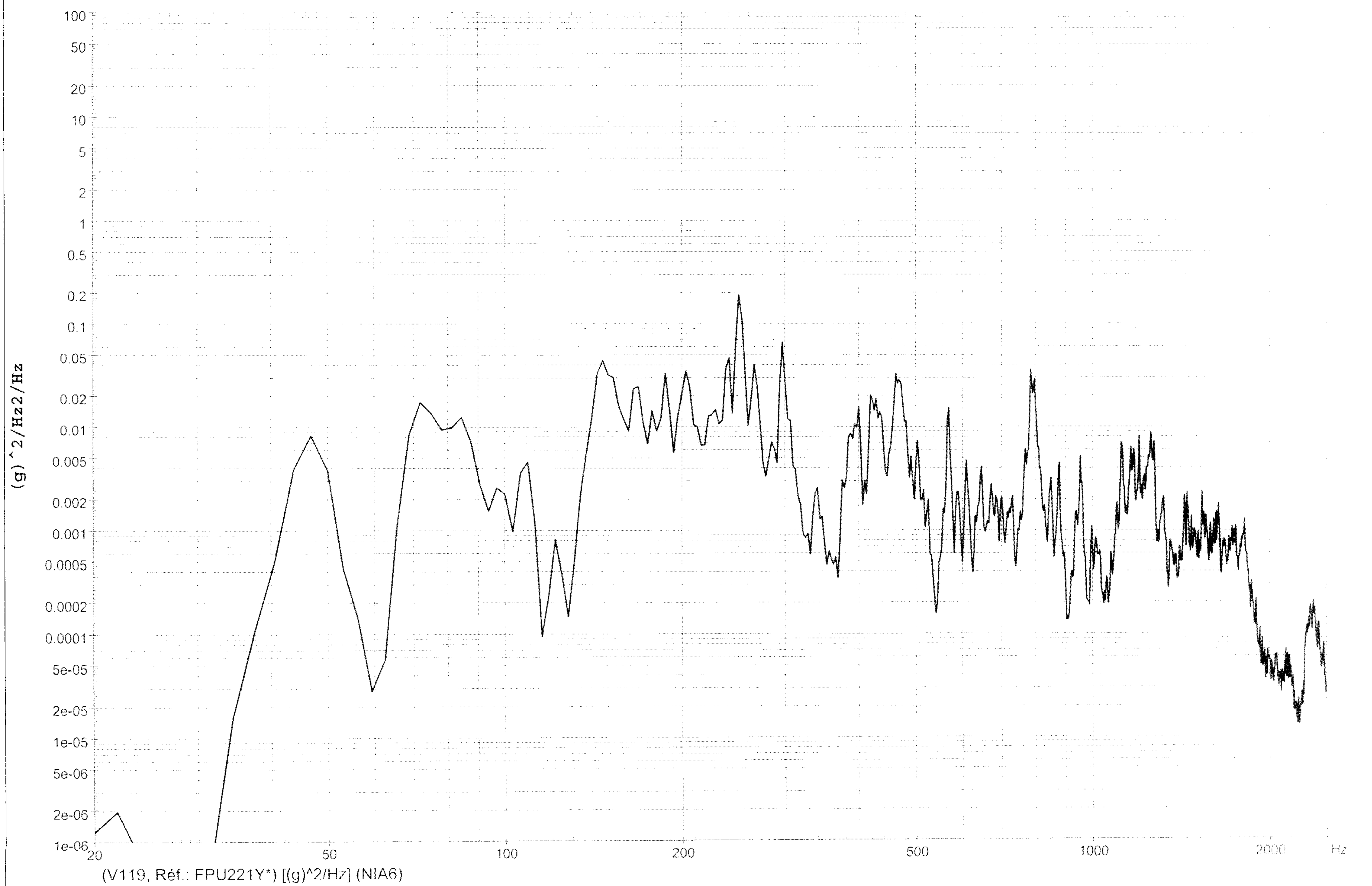

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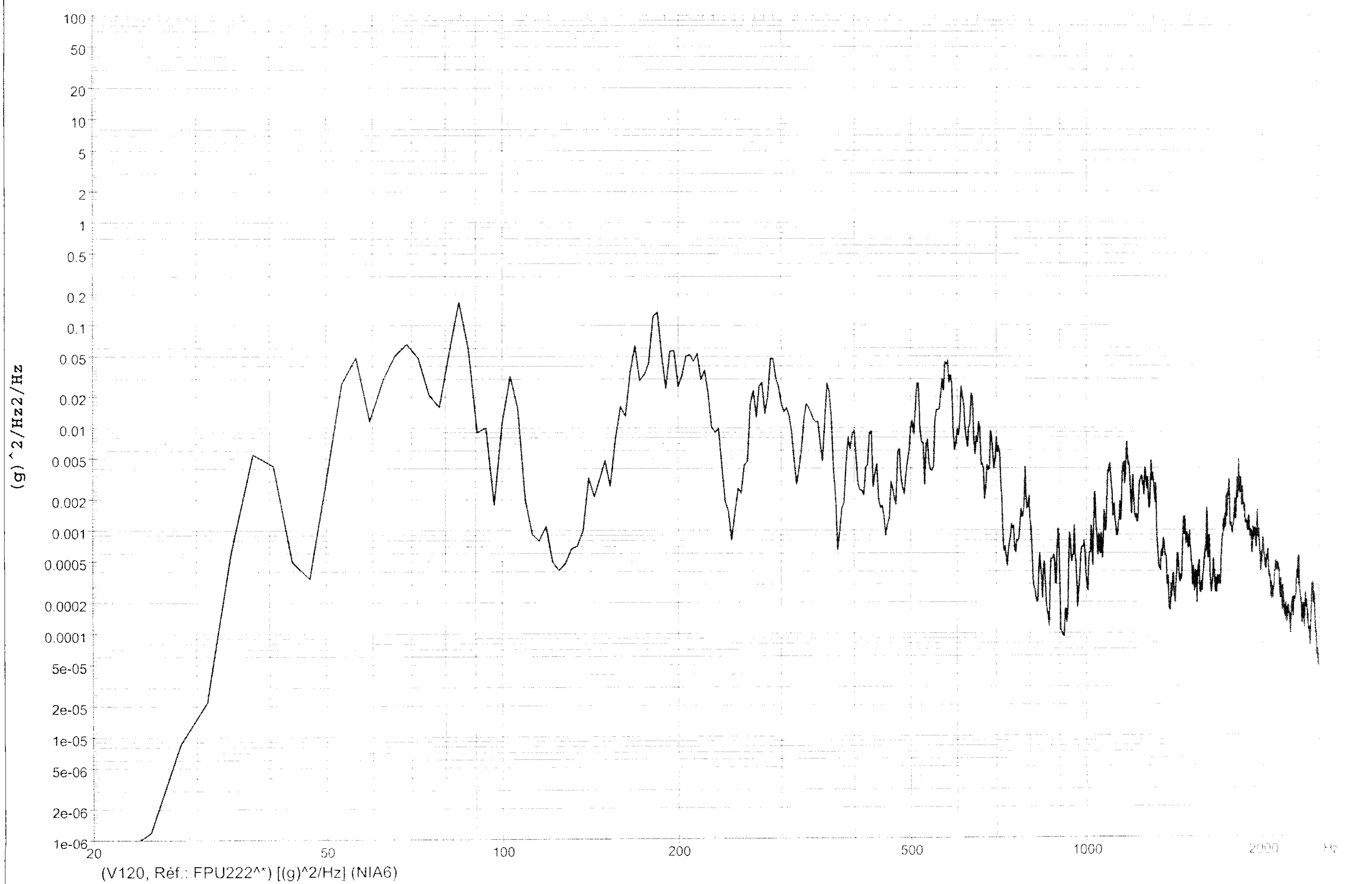

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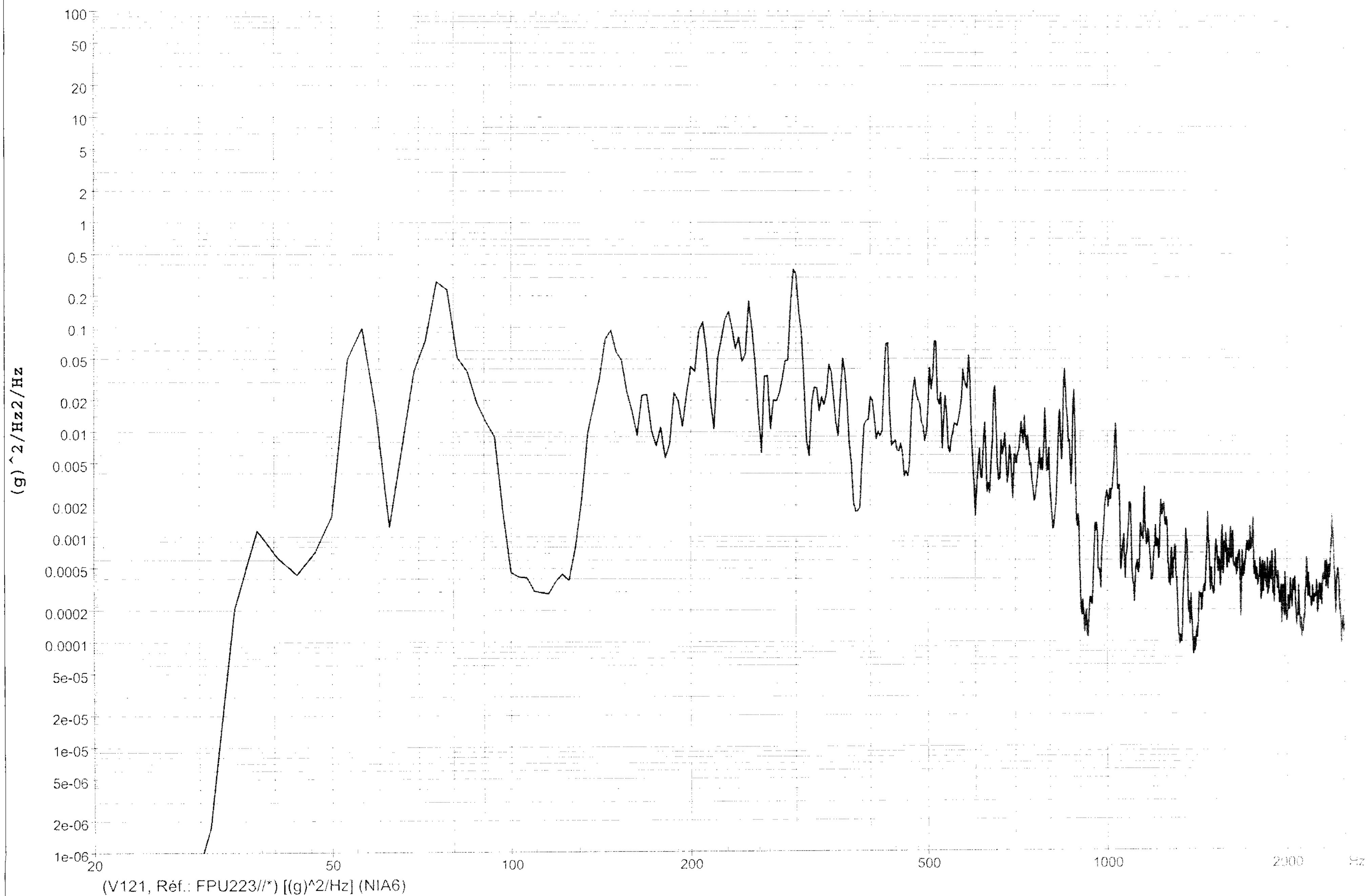

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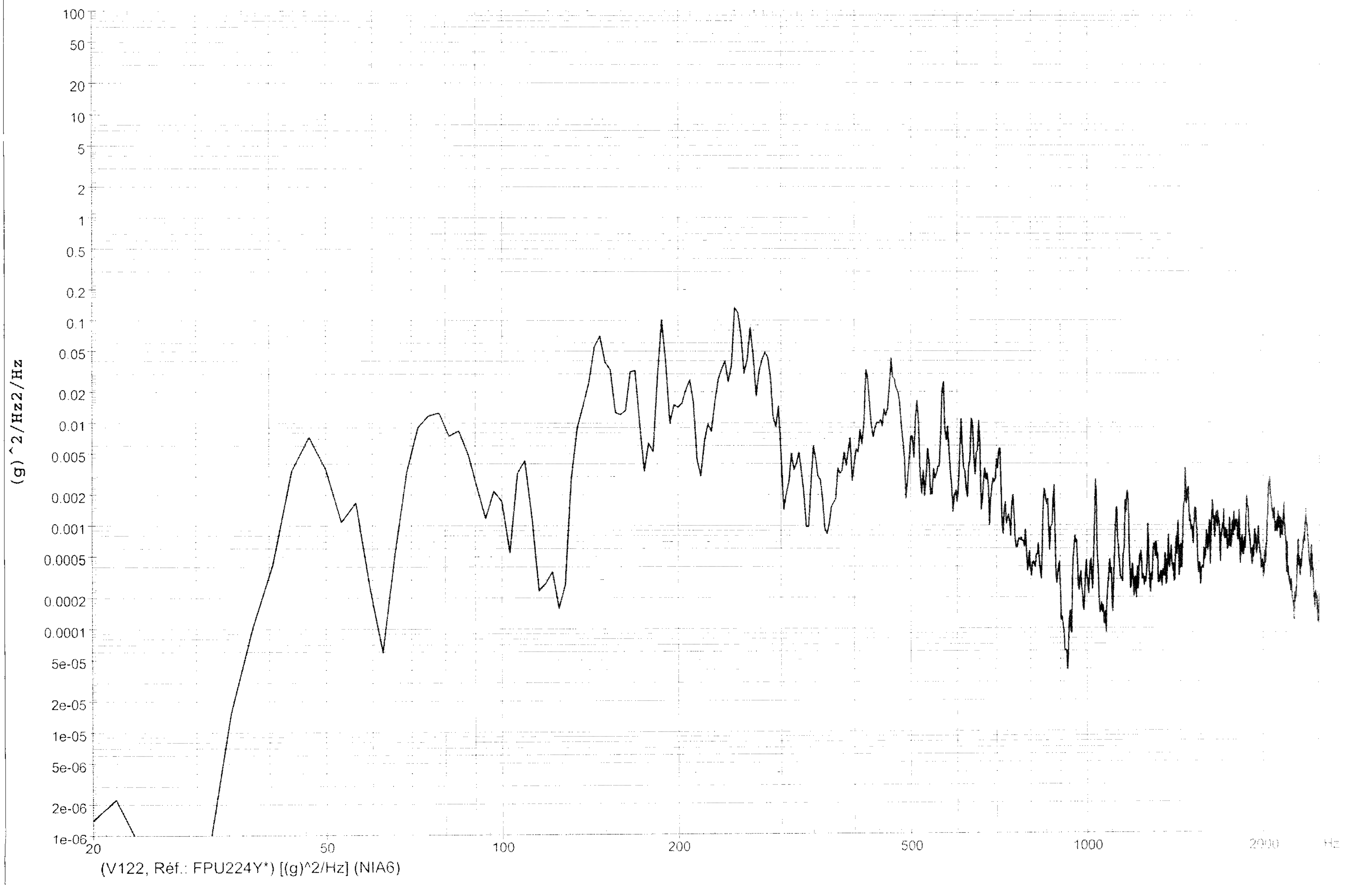

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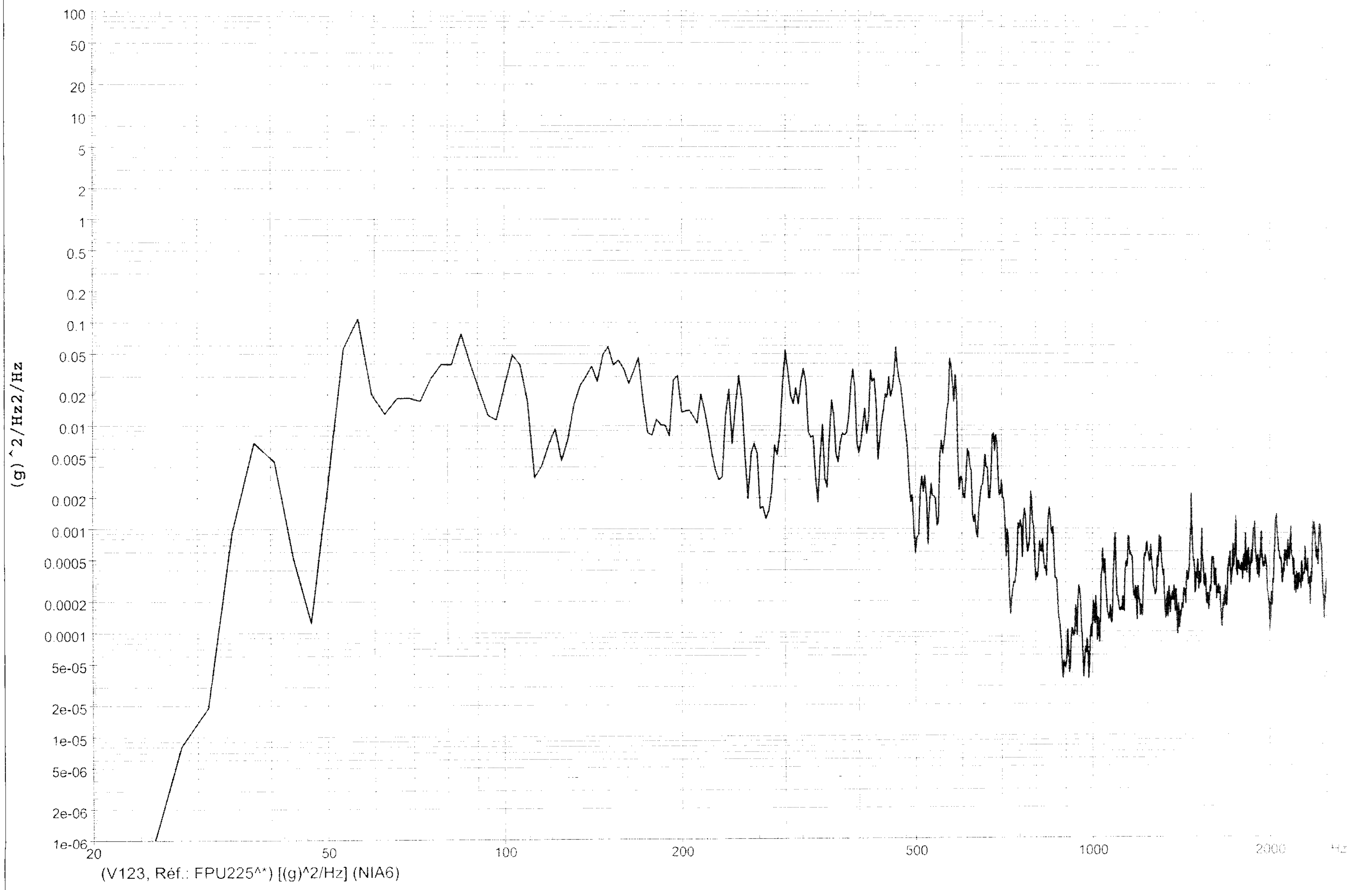

ALCATEL SPACE

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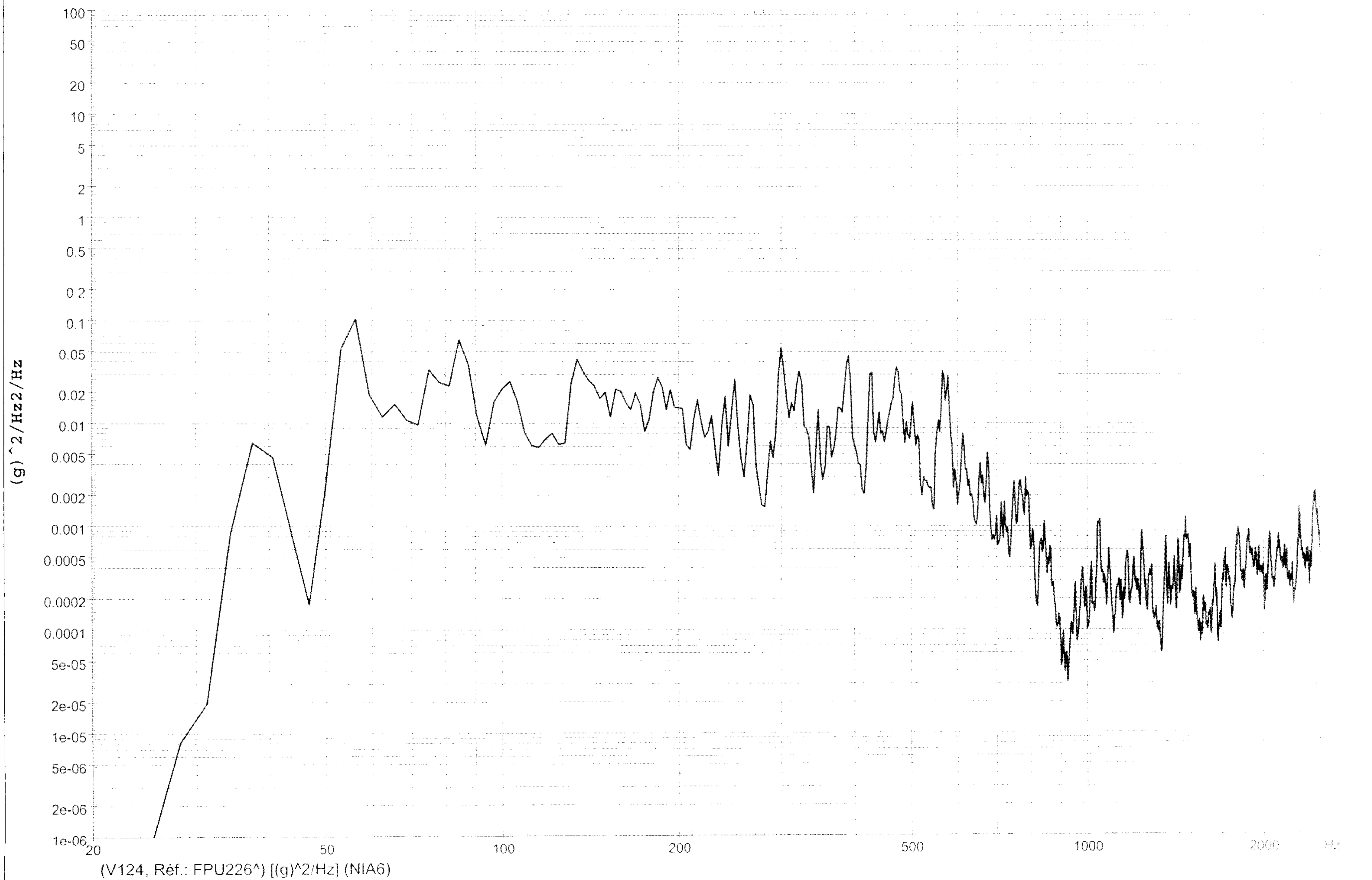

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Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

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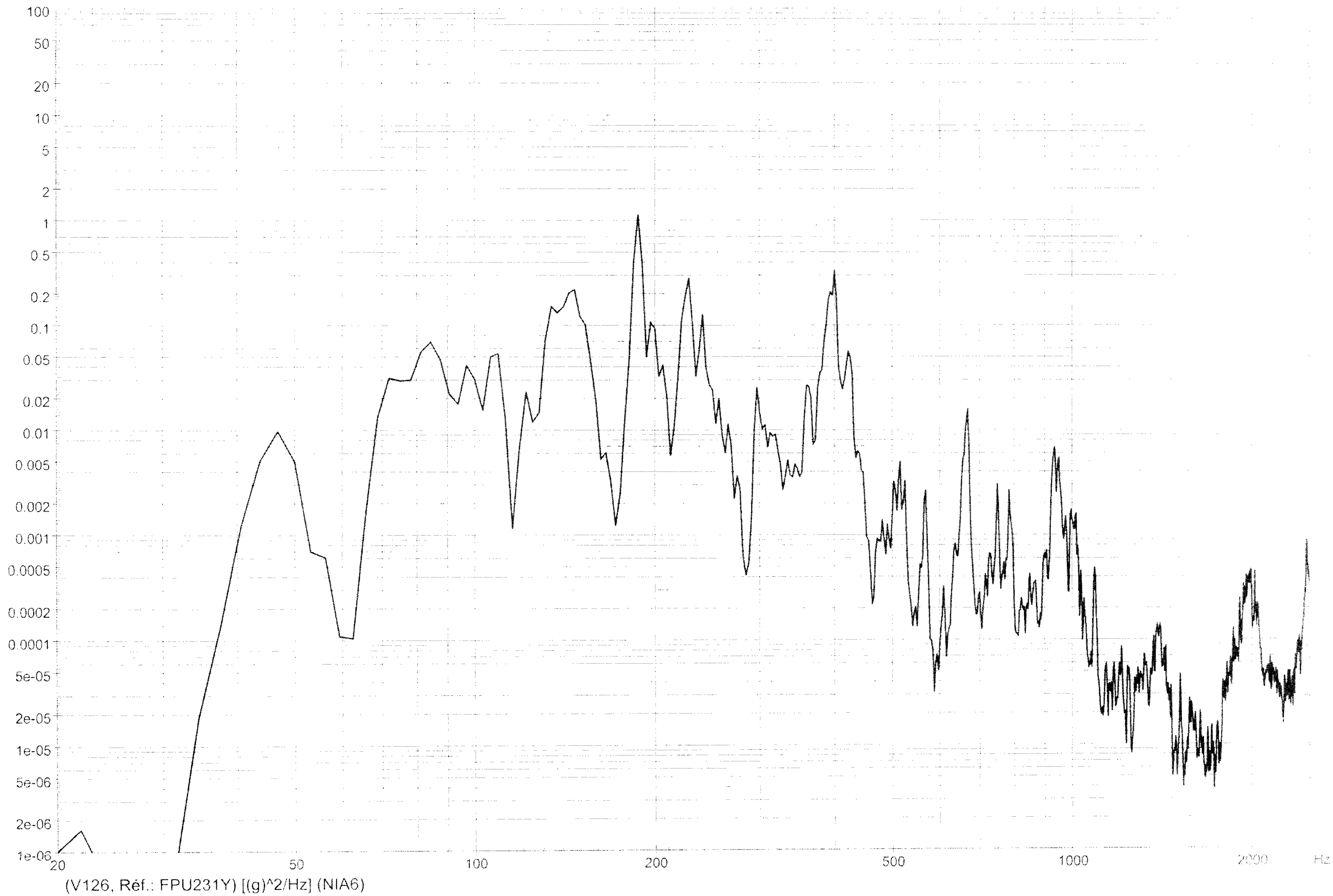

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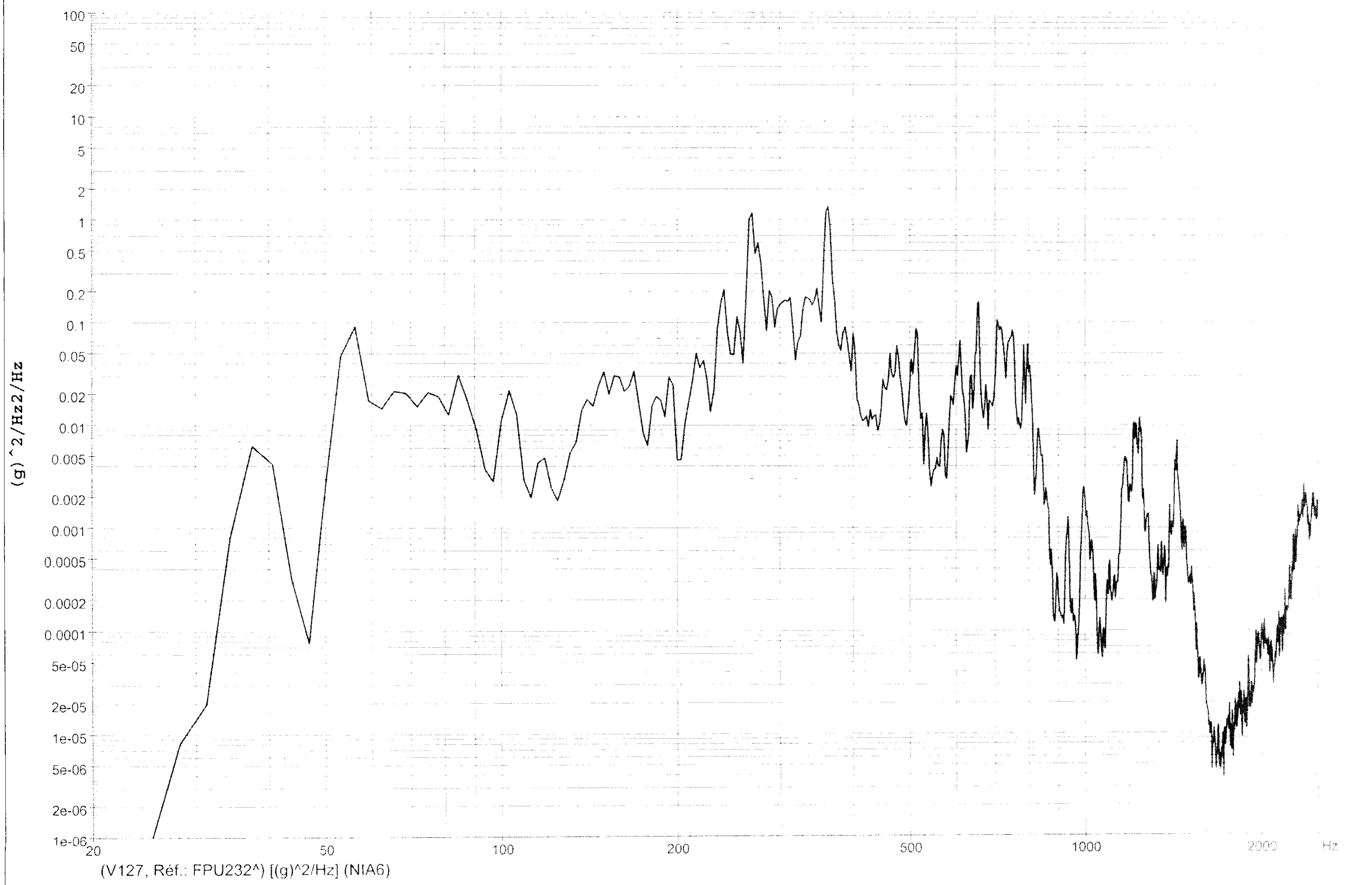

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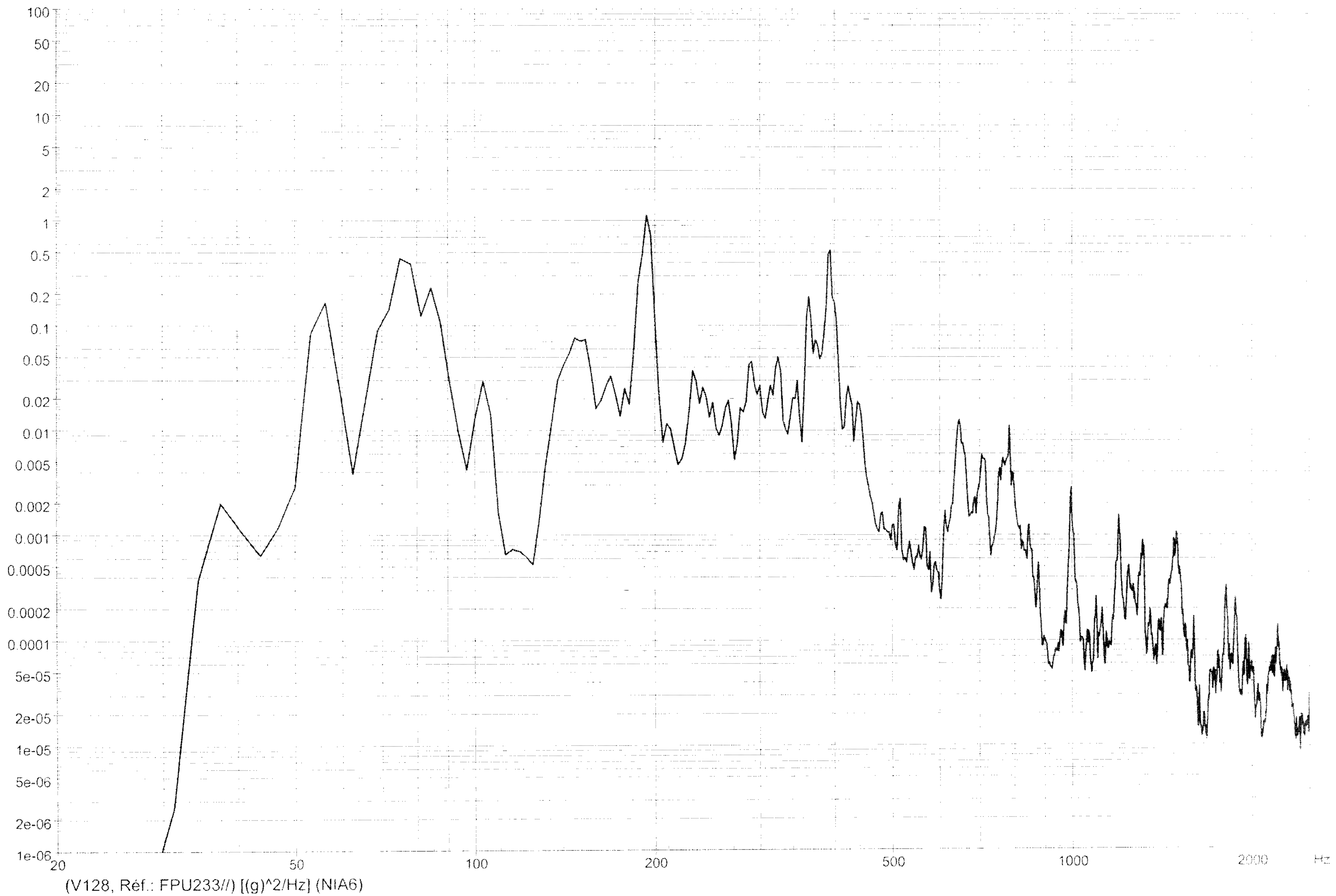

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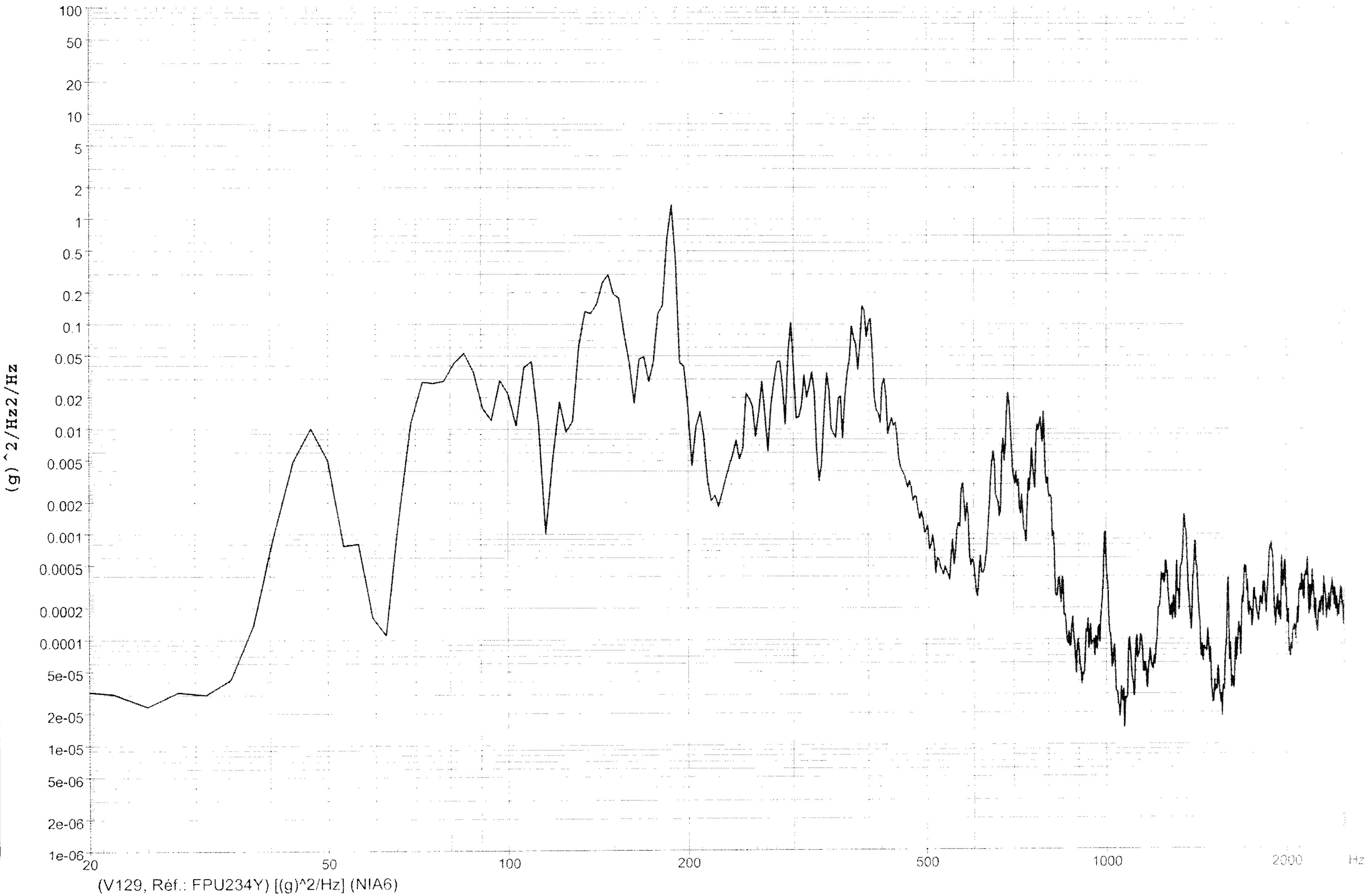
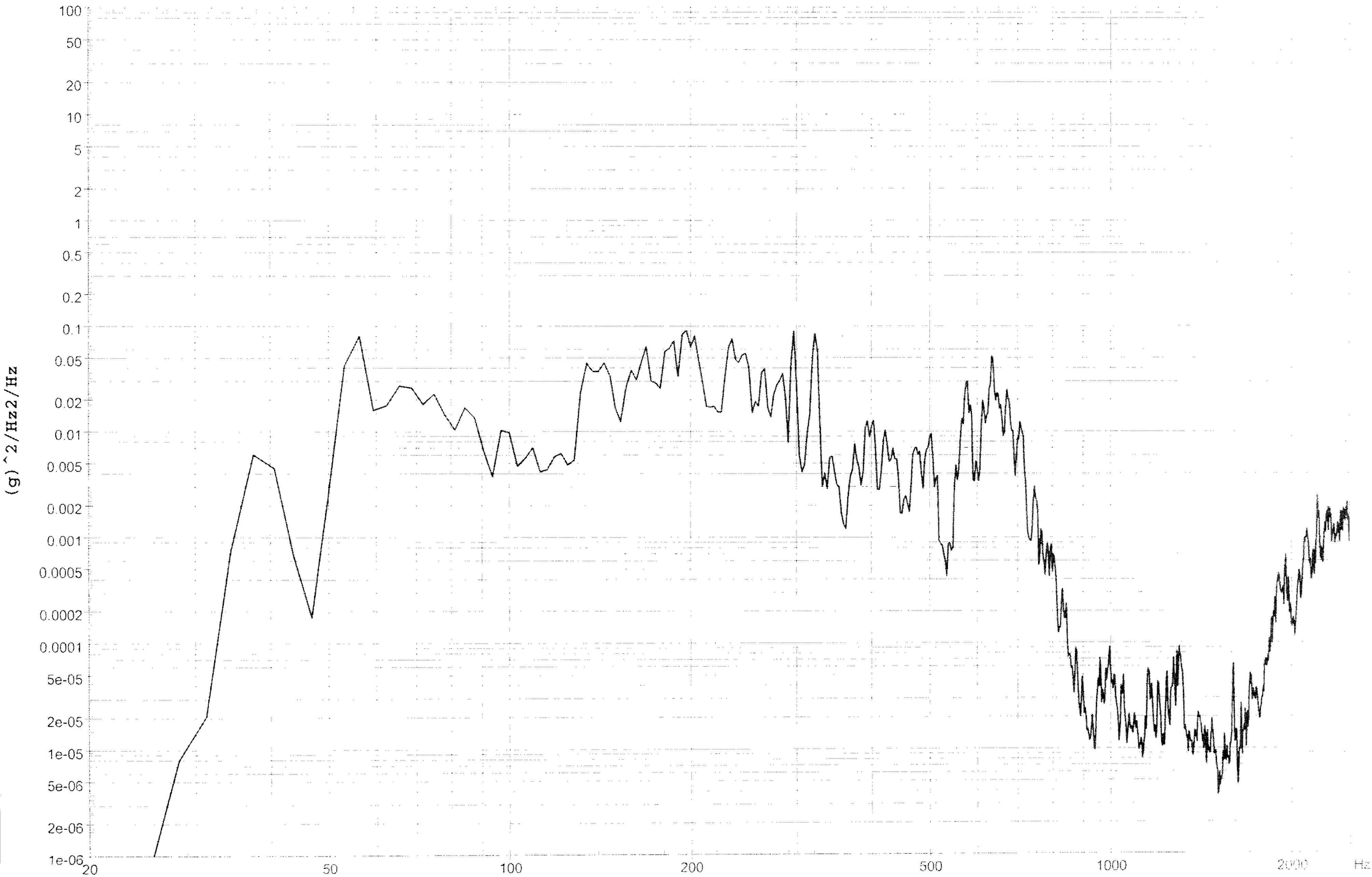
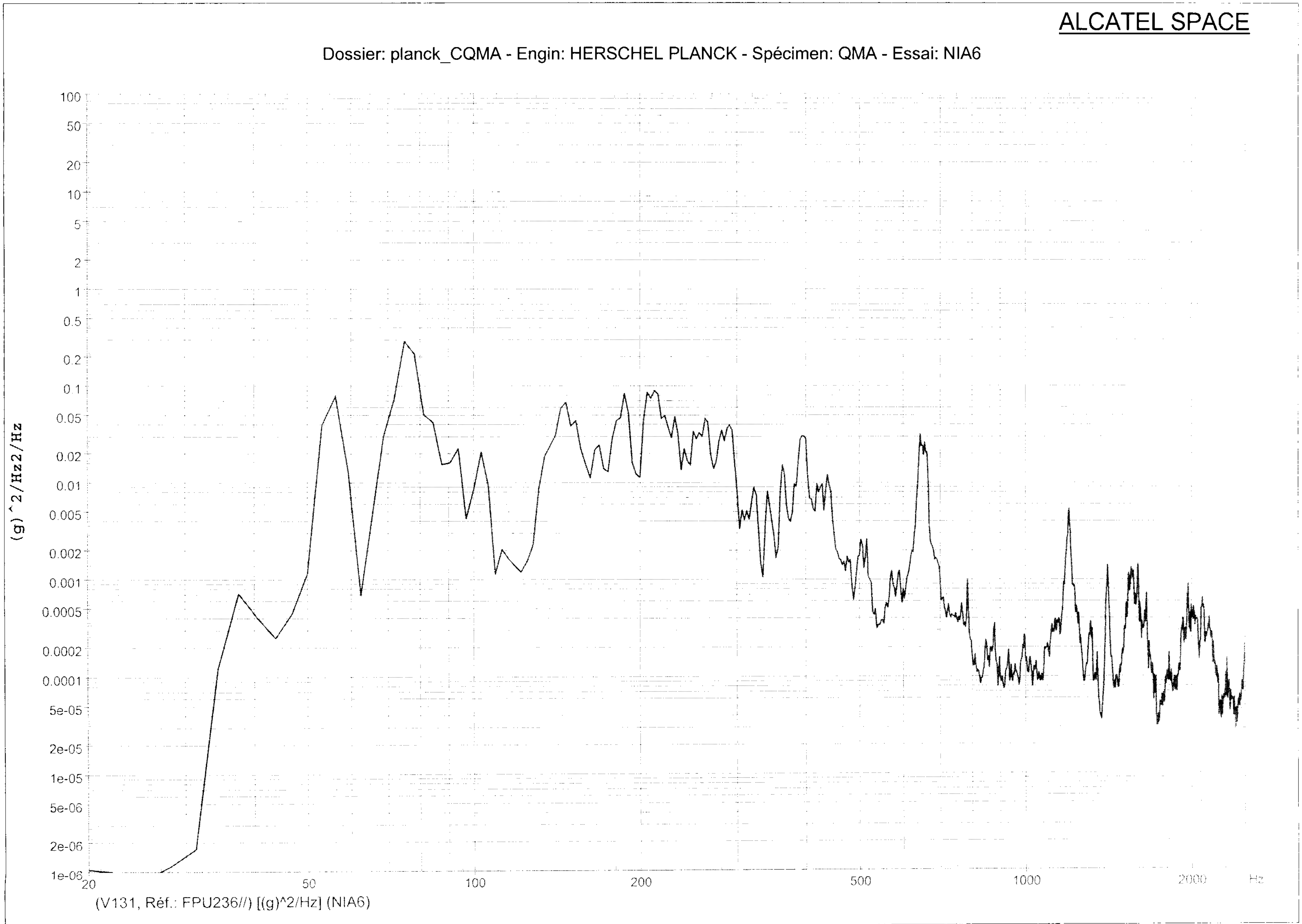


ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V130, Réf.: FPU235^) [(g)^2/Hz] (NIA6)



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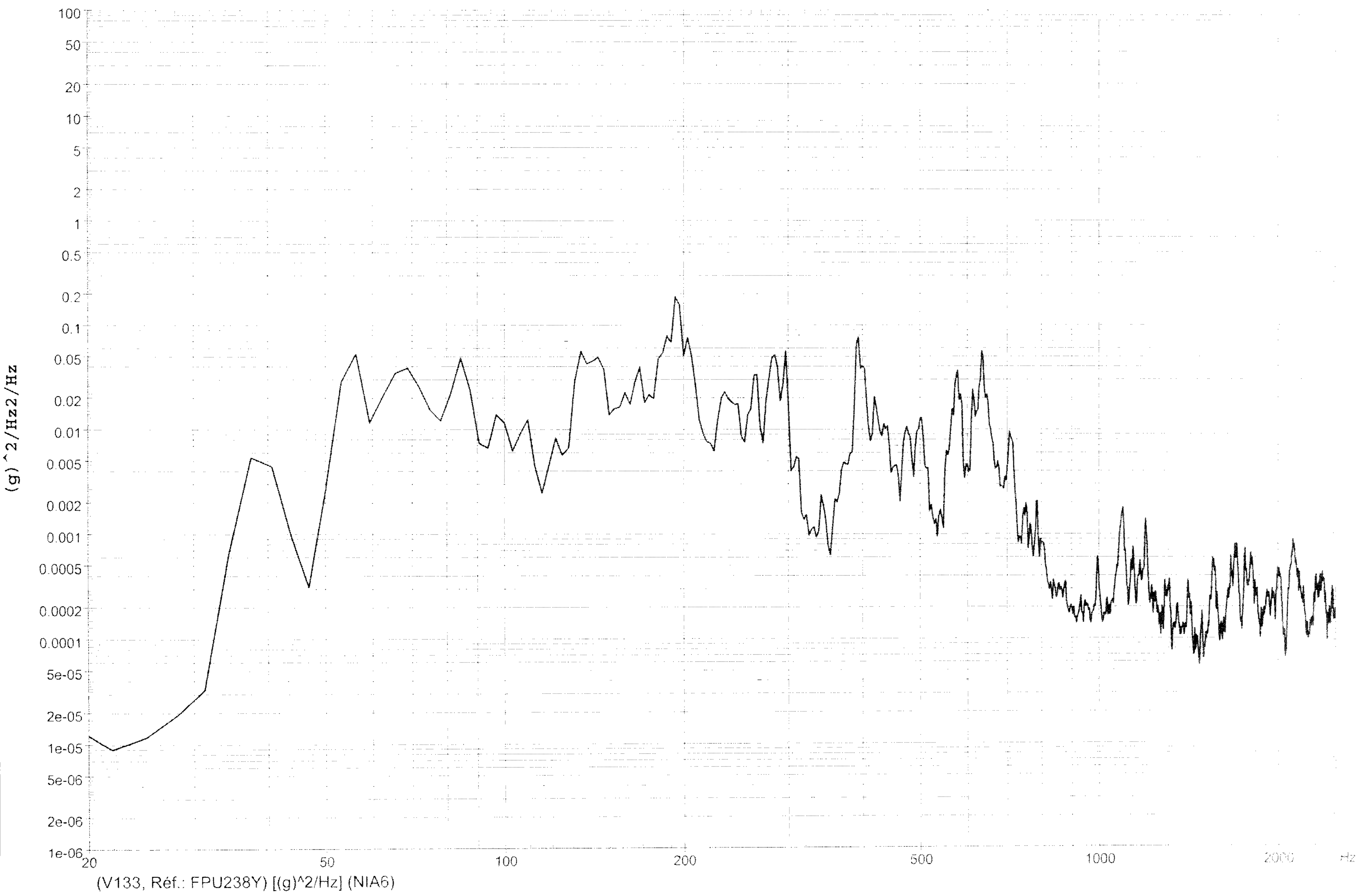

ALCATEL SPACE

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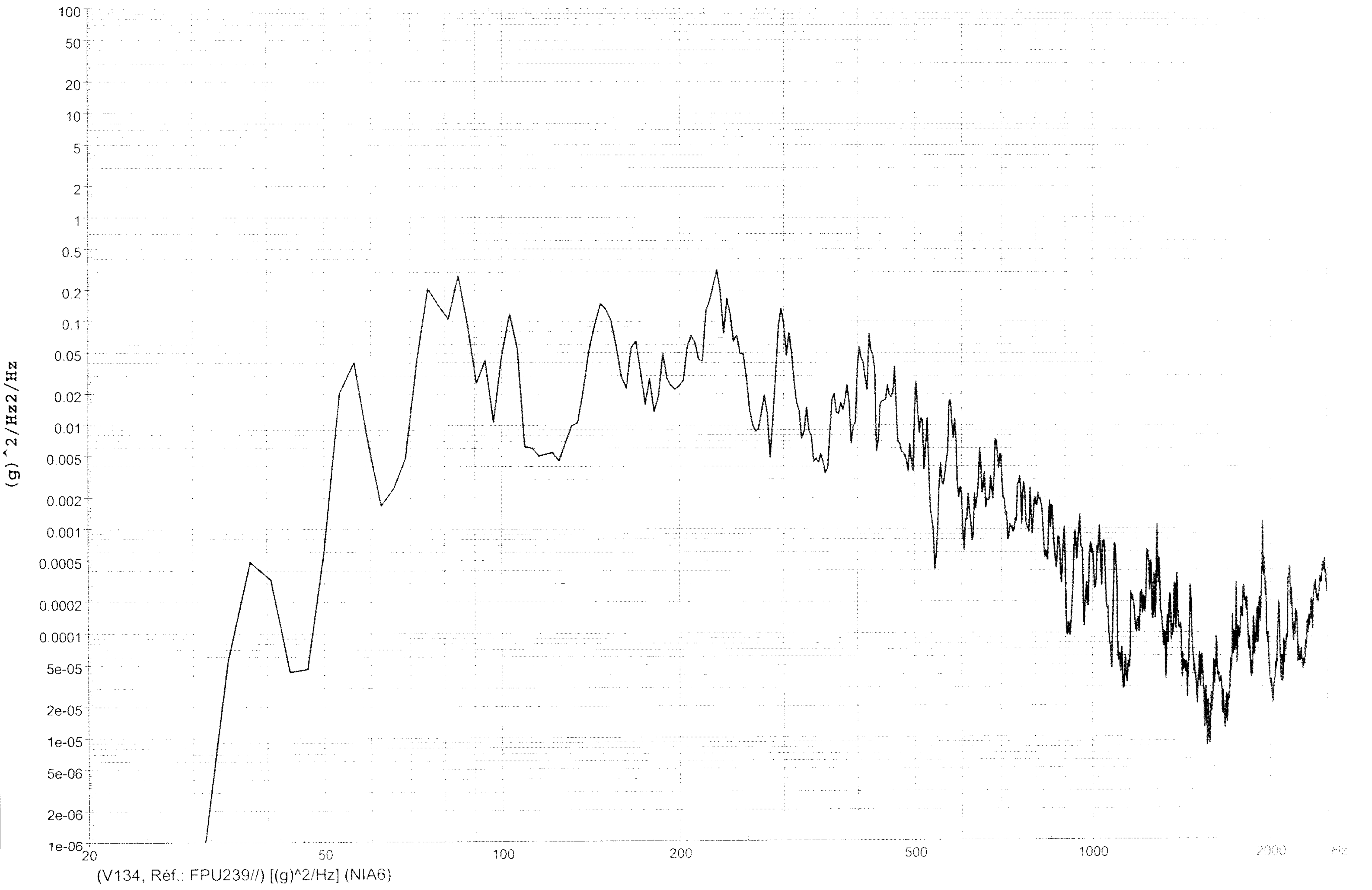

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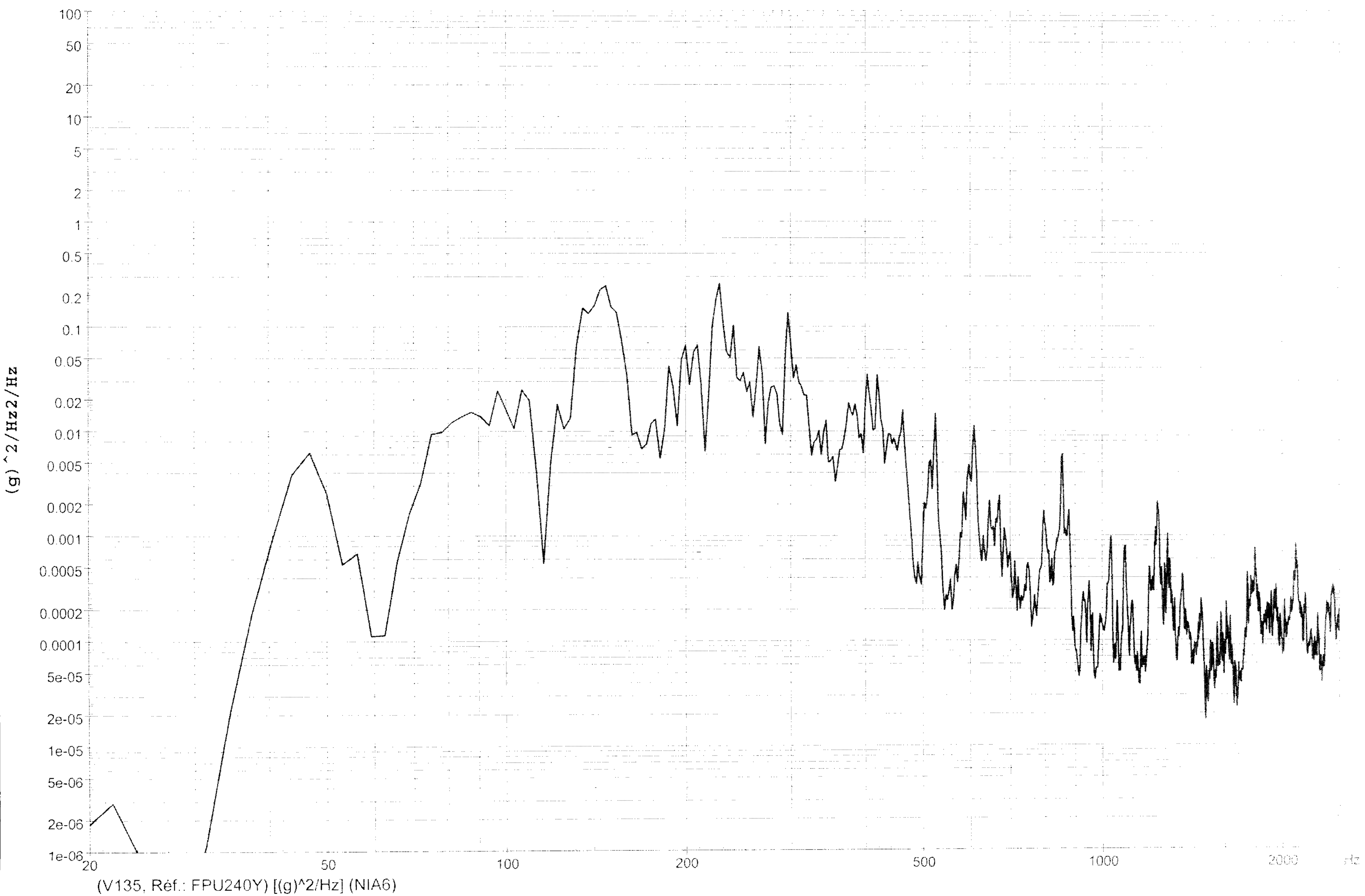

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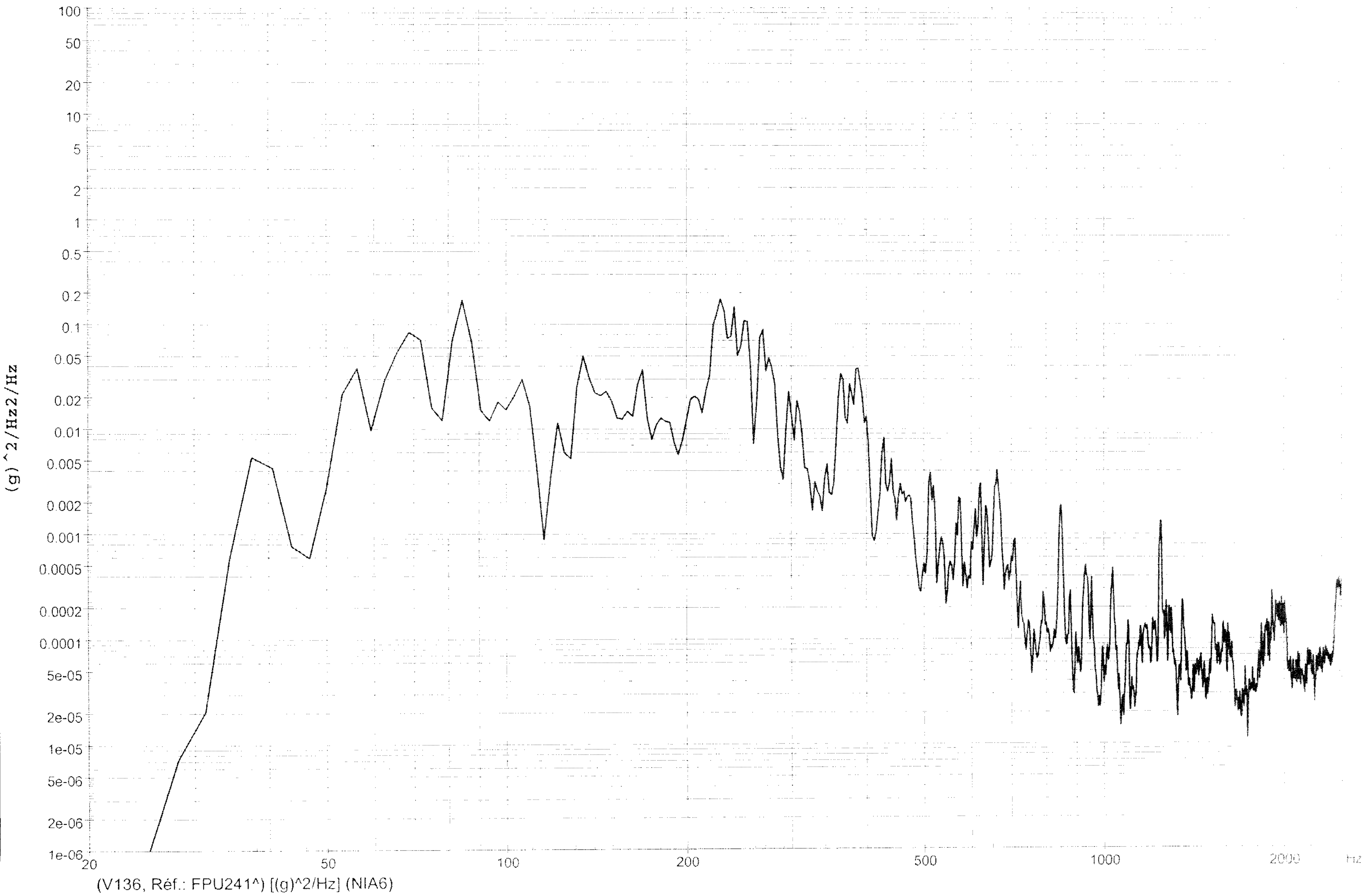

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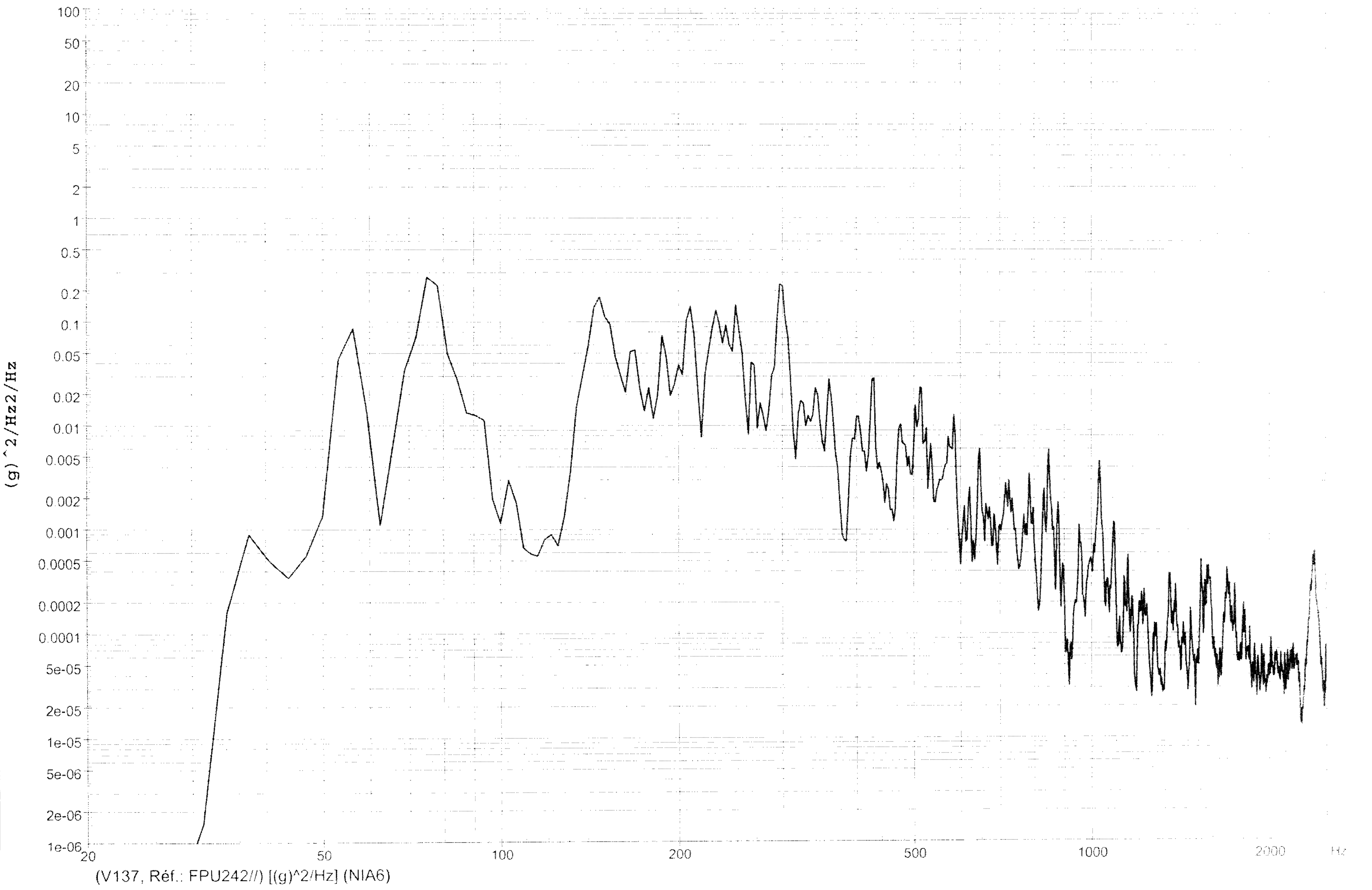
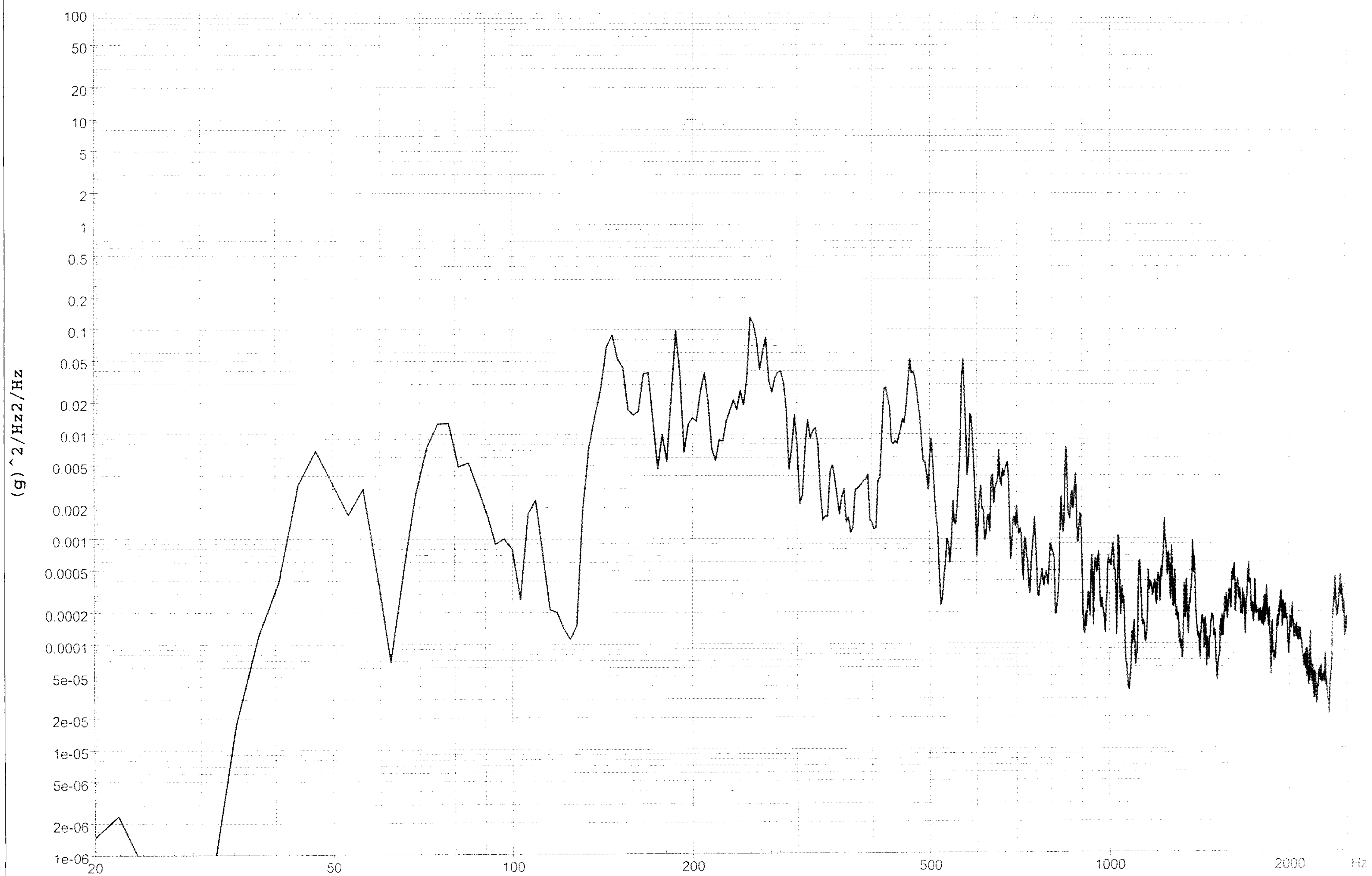
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

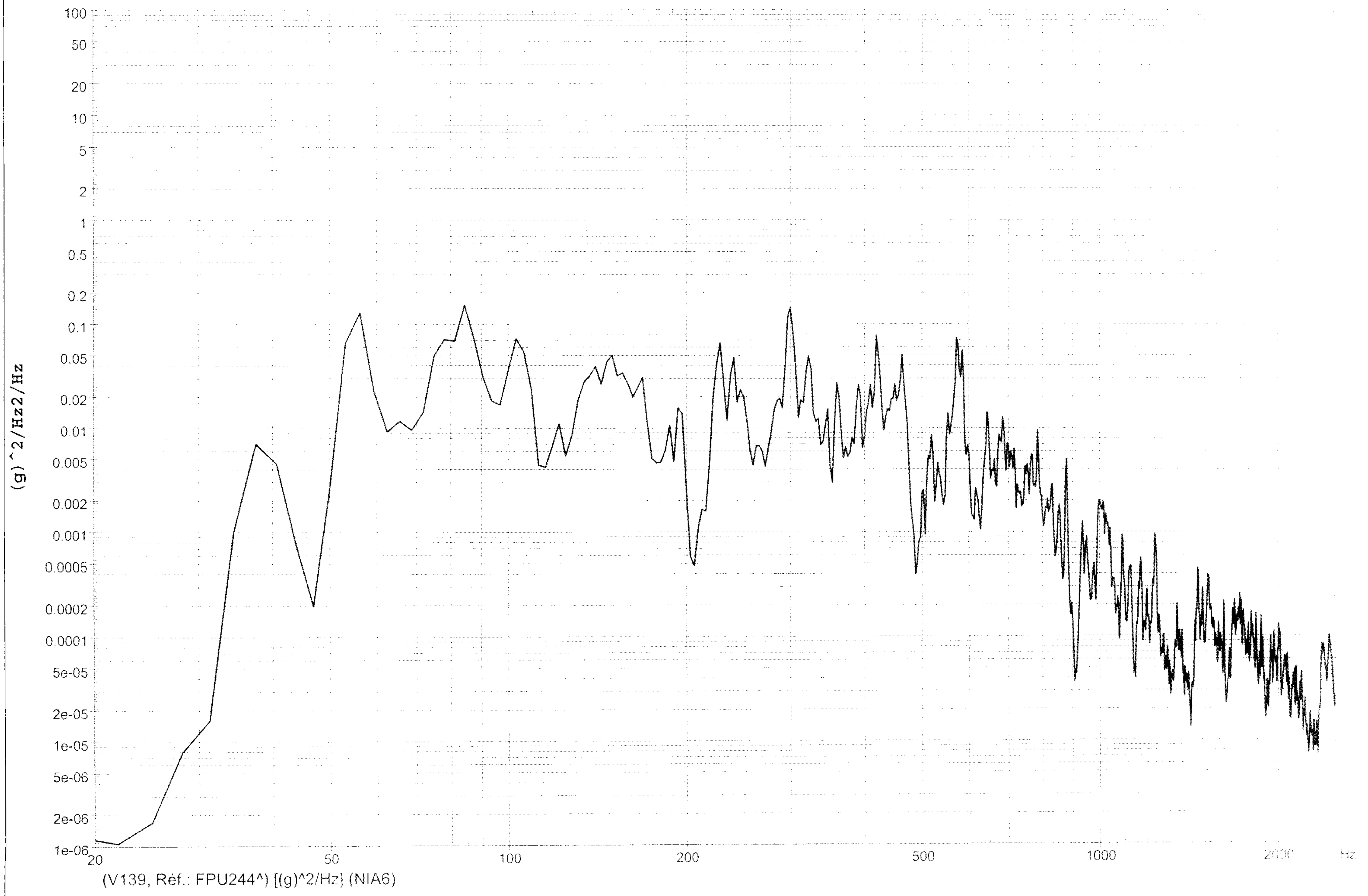
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V138, Réf.: FPU243Y) [(g)^2/Hz] (NIA6)

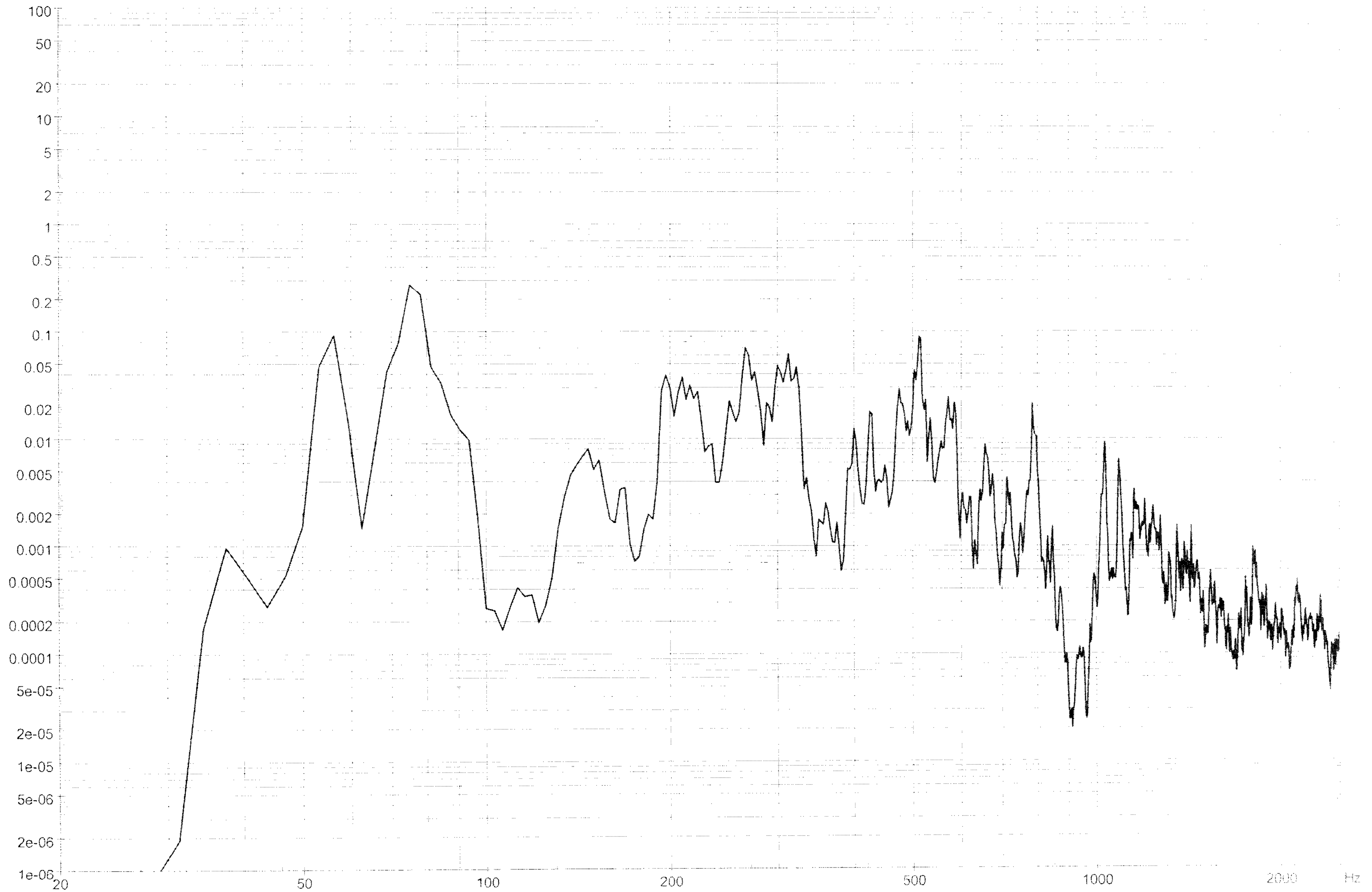
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

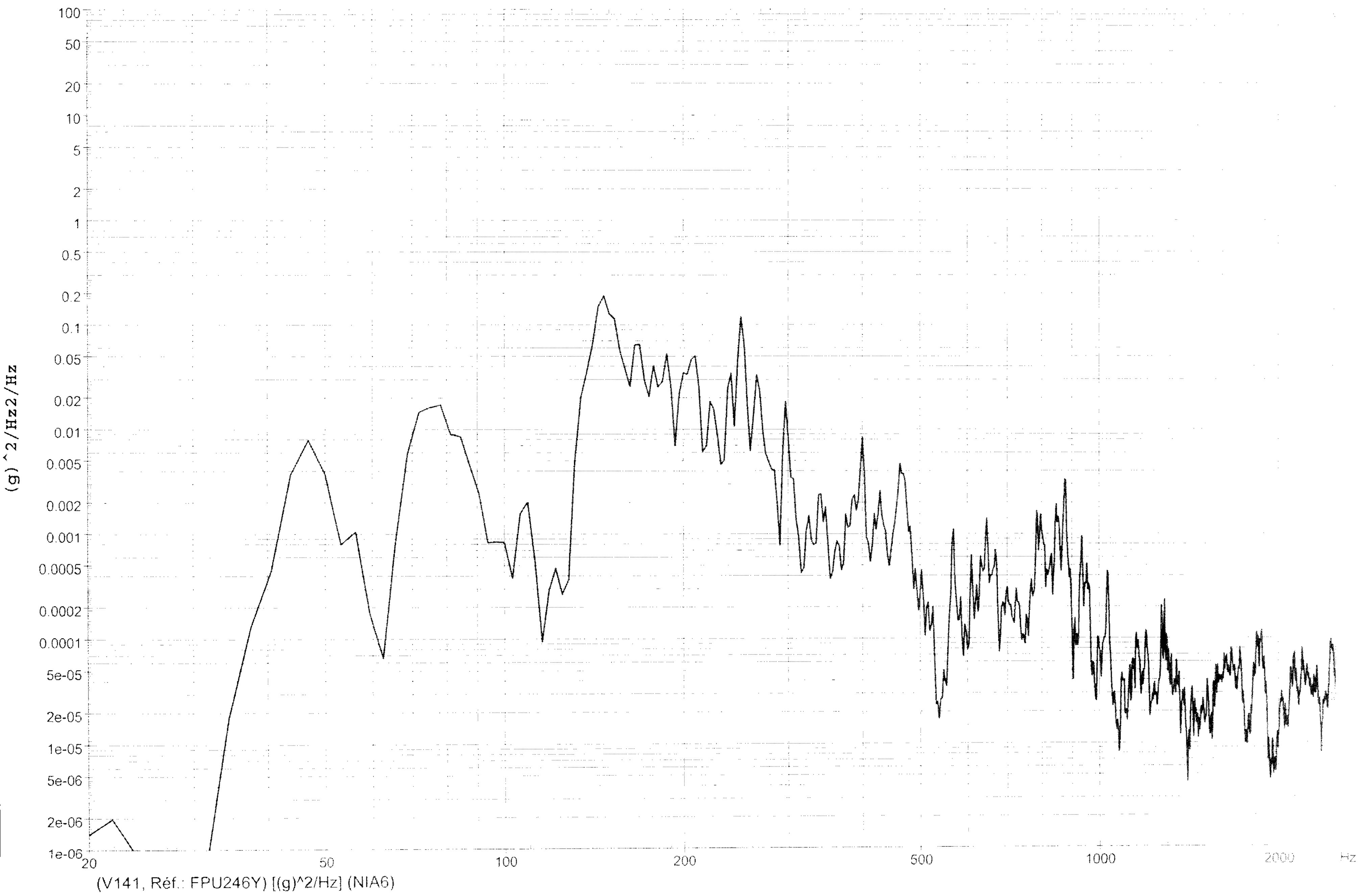
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V140, Réf.: FPU245//) [(g)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



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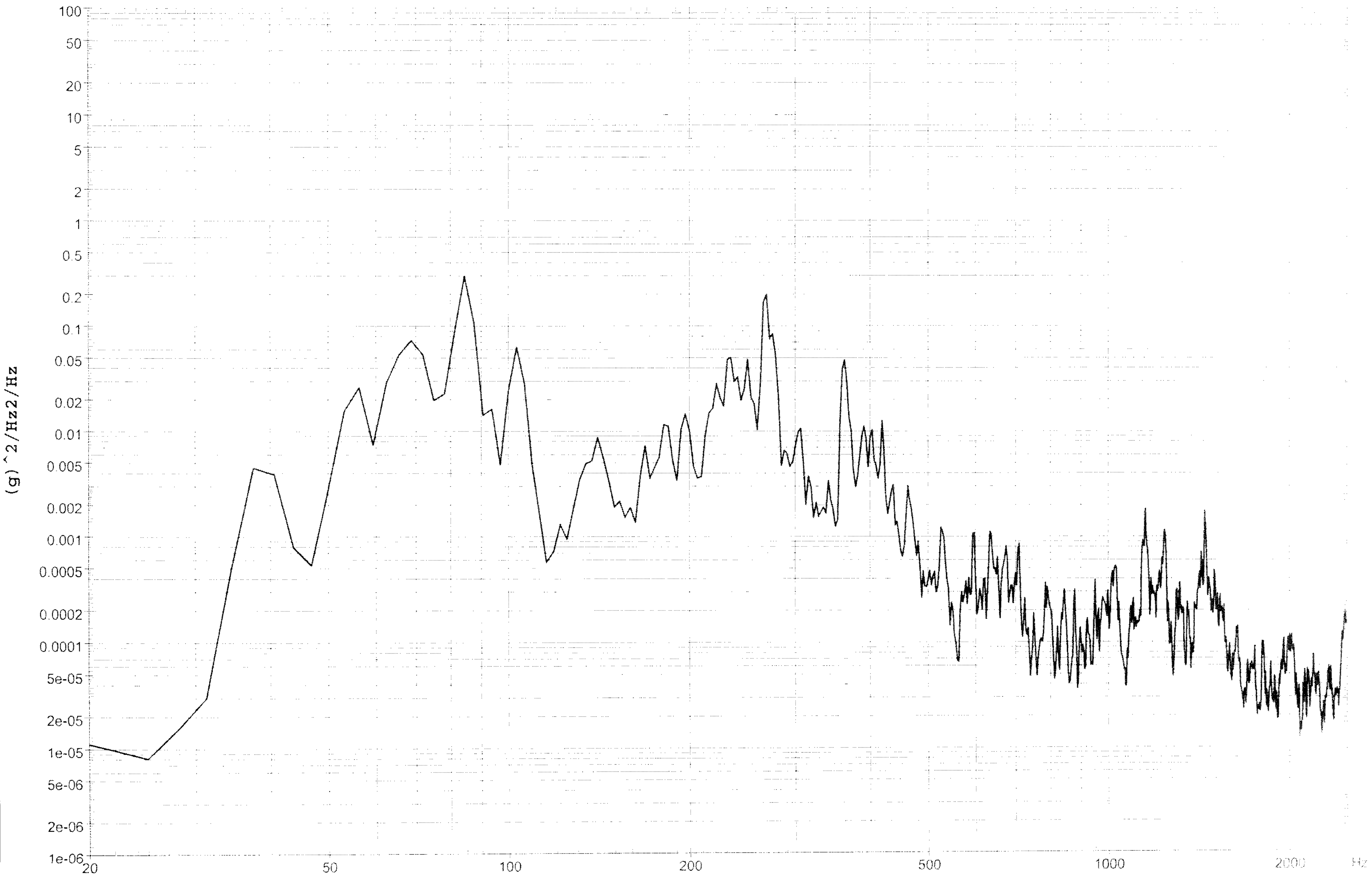
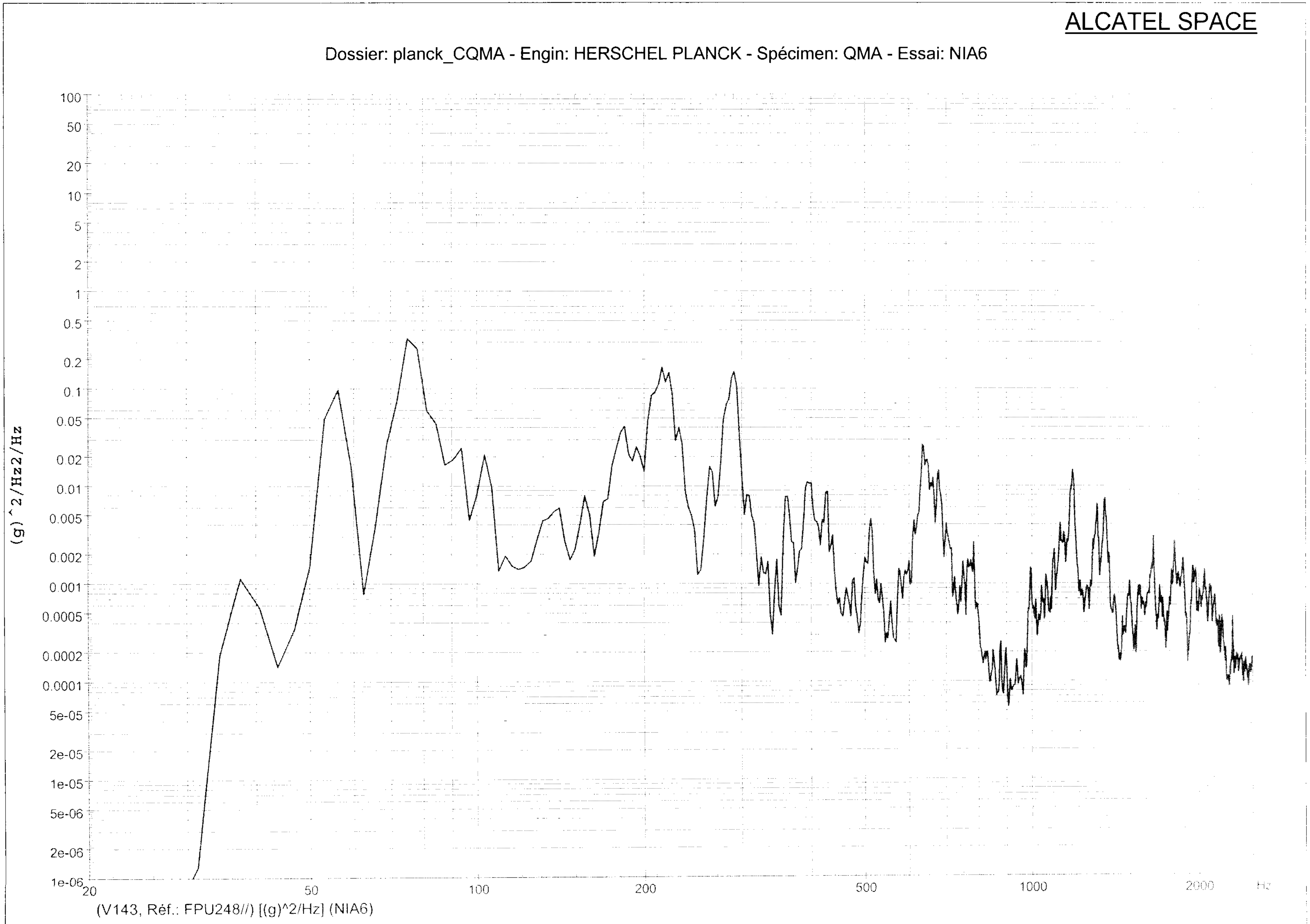


(V142, Réf.: FPU247^) [(g)^2/Hz] (NIA6)



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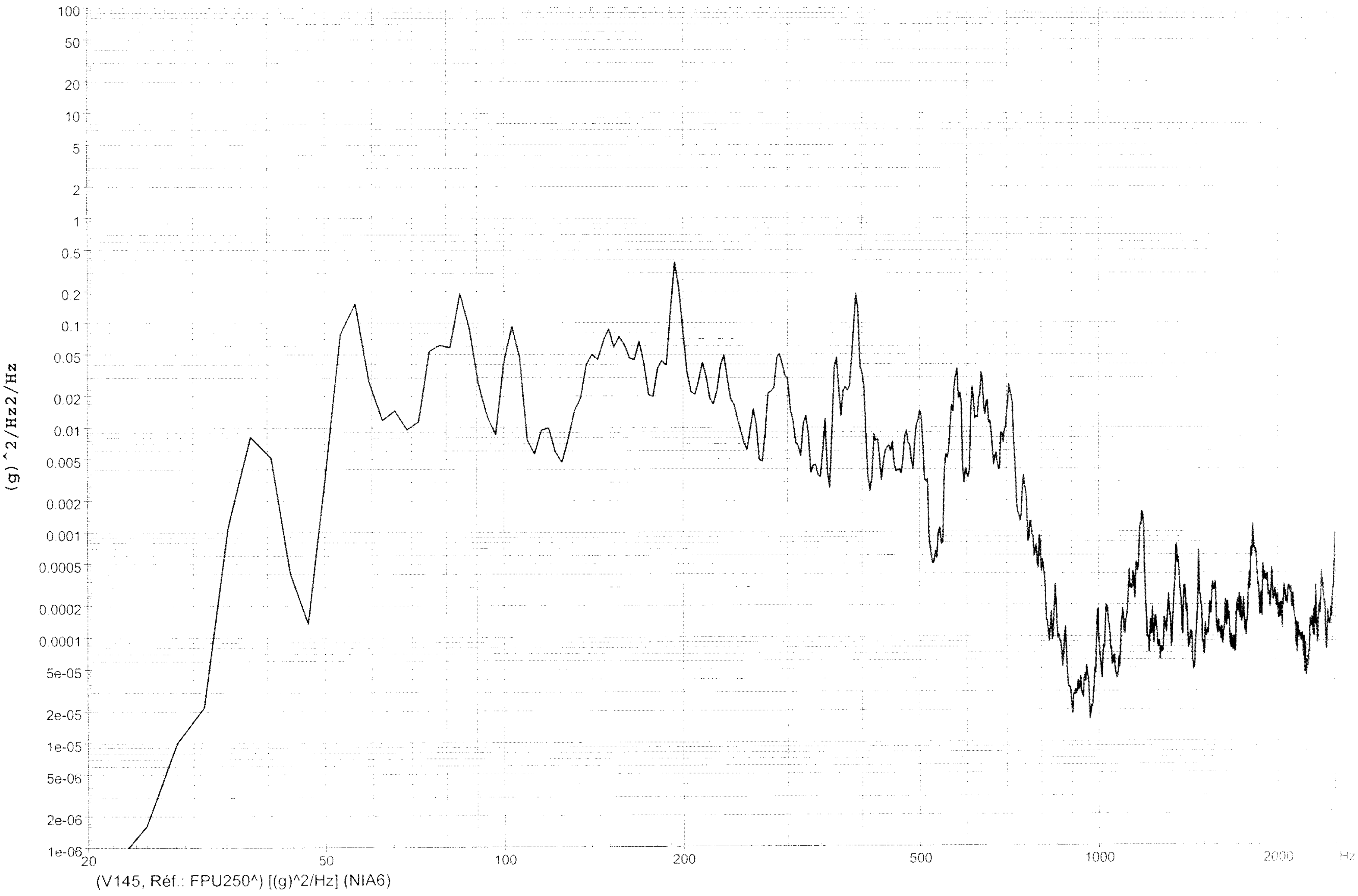

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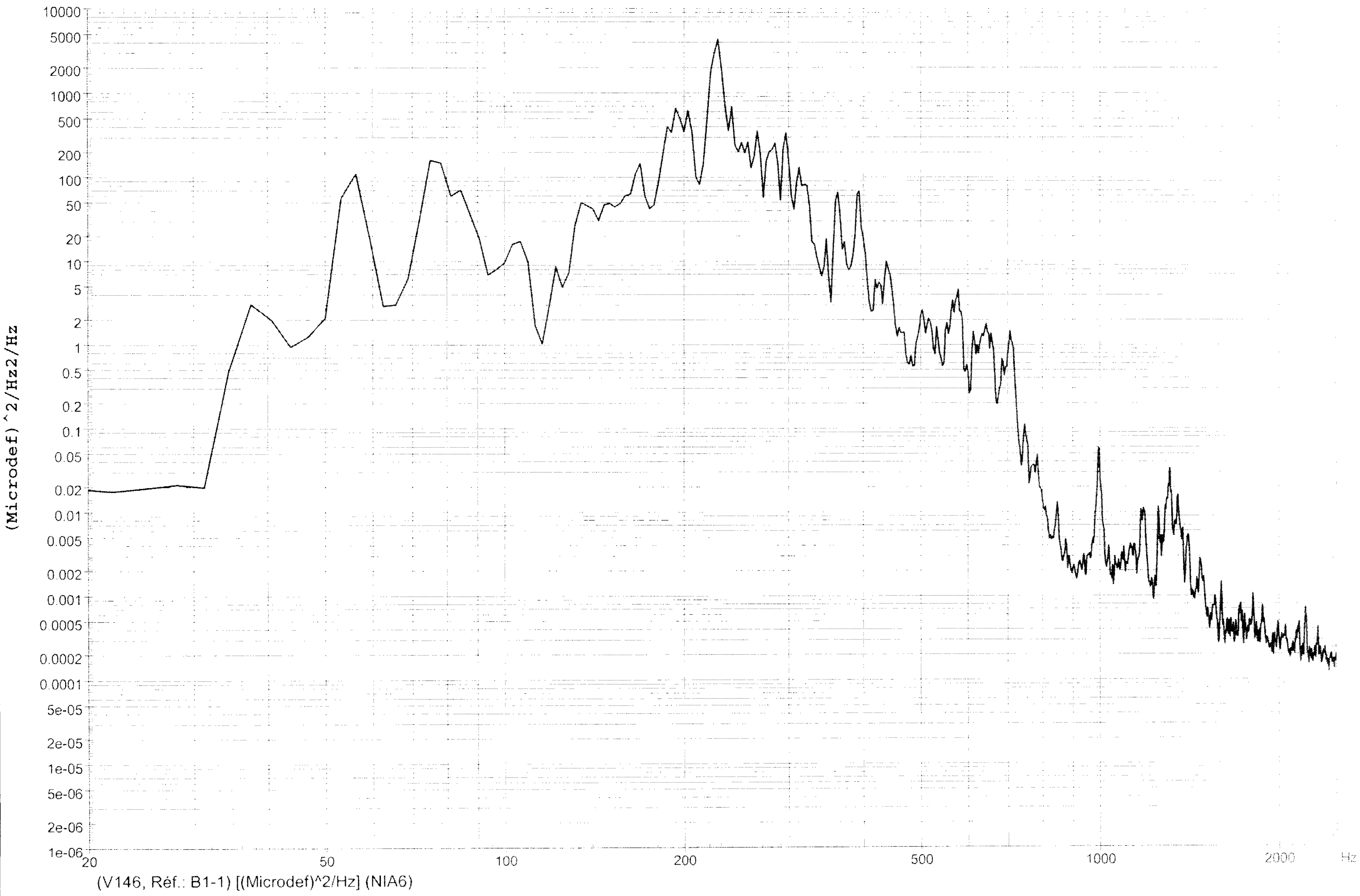


ALCATEL SPACE

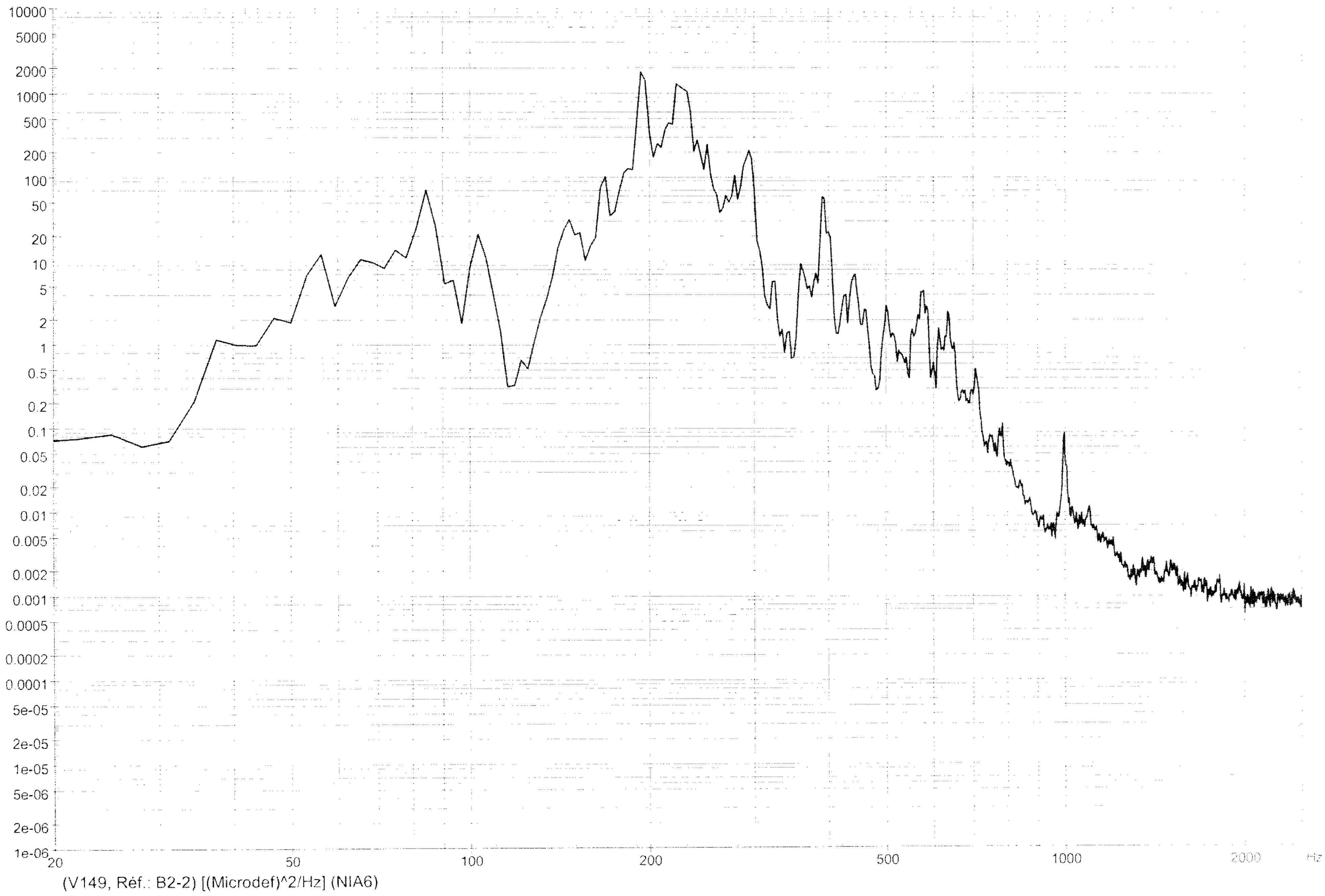
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

(V147, Réf.: B1-2) [(Microdef)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

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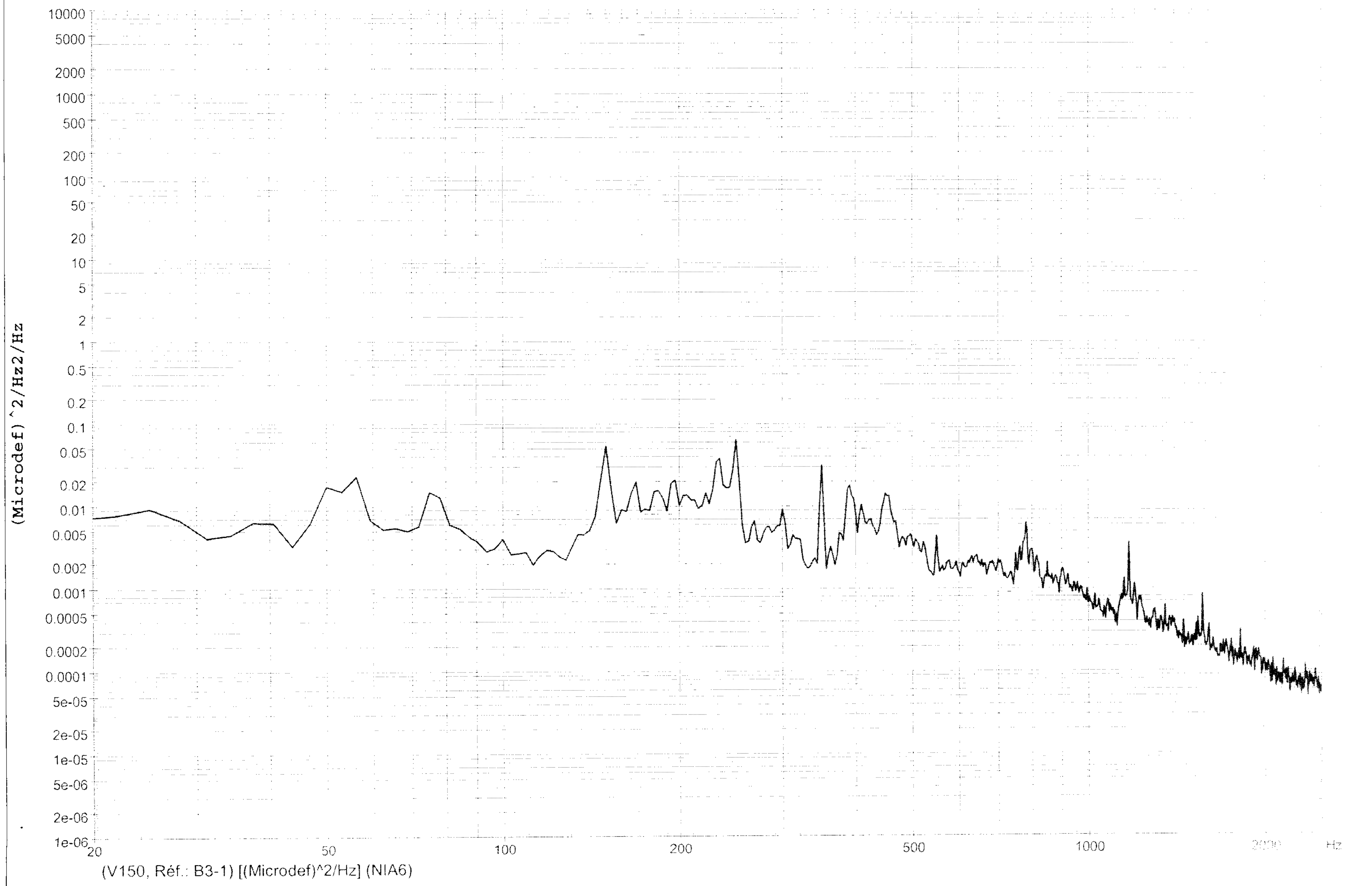

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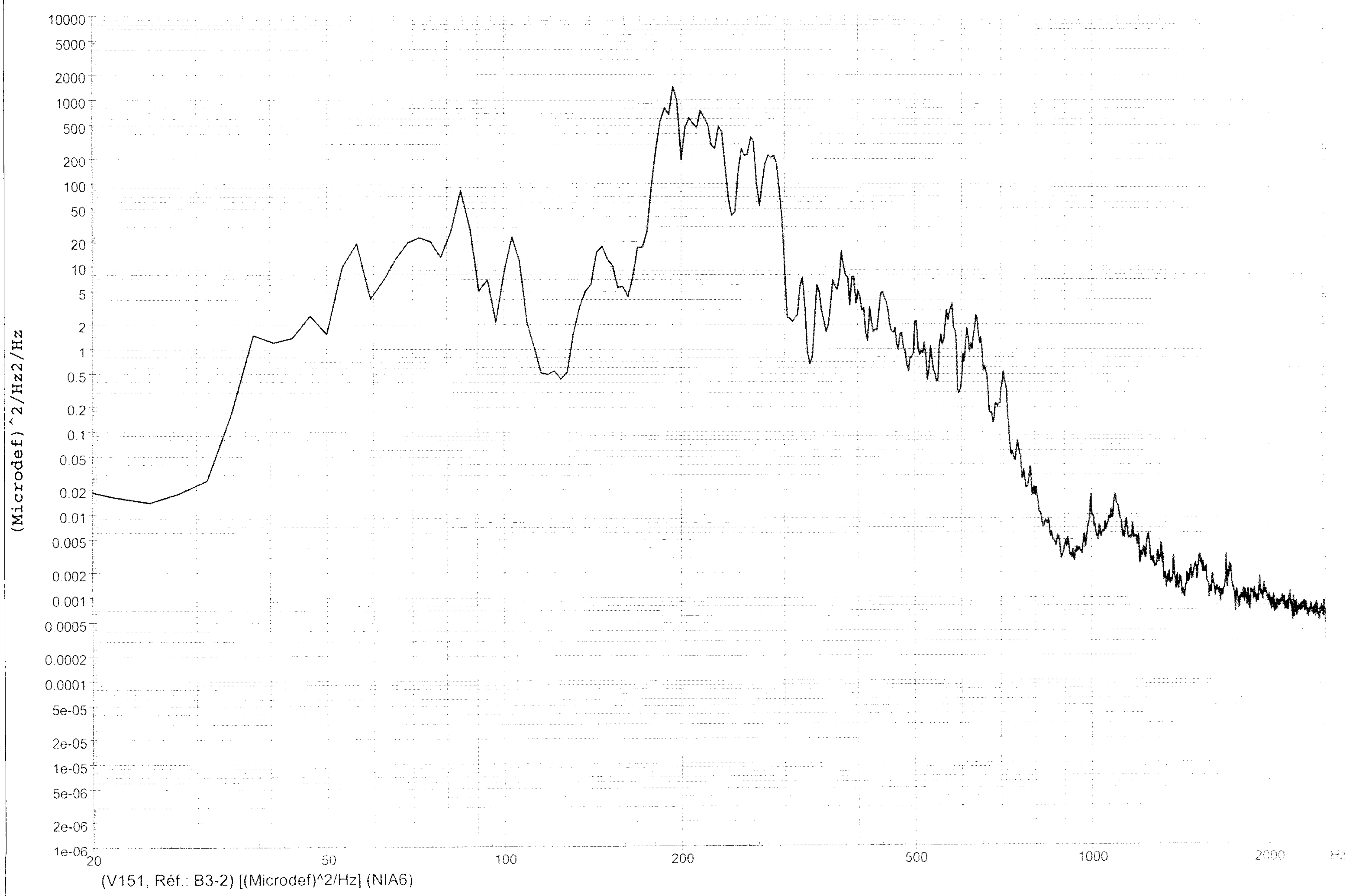

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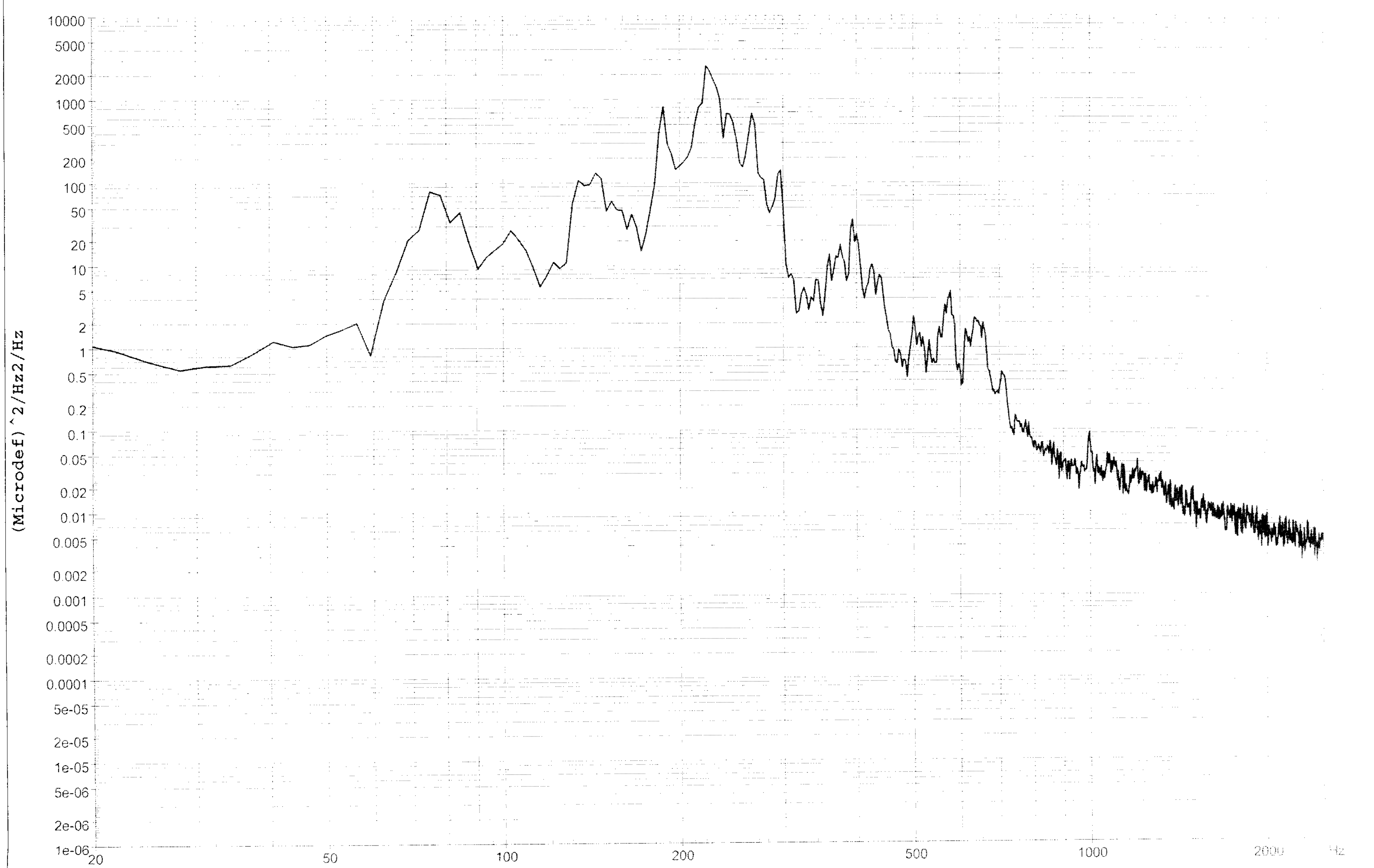


(V152, Réf.: B5-1) [(Microdef)^2/Hz] (NIA6)

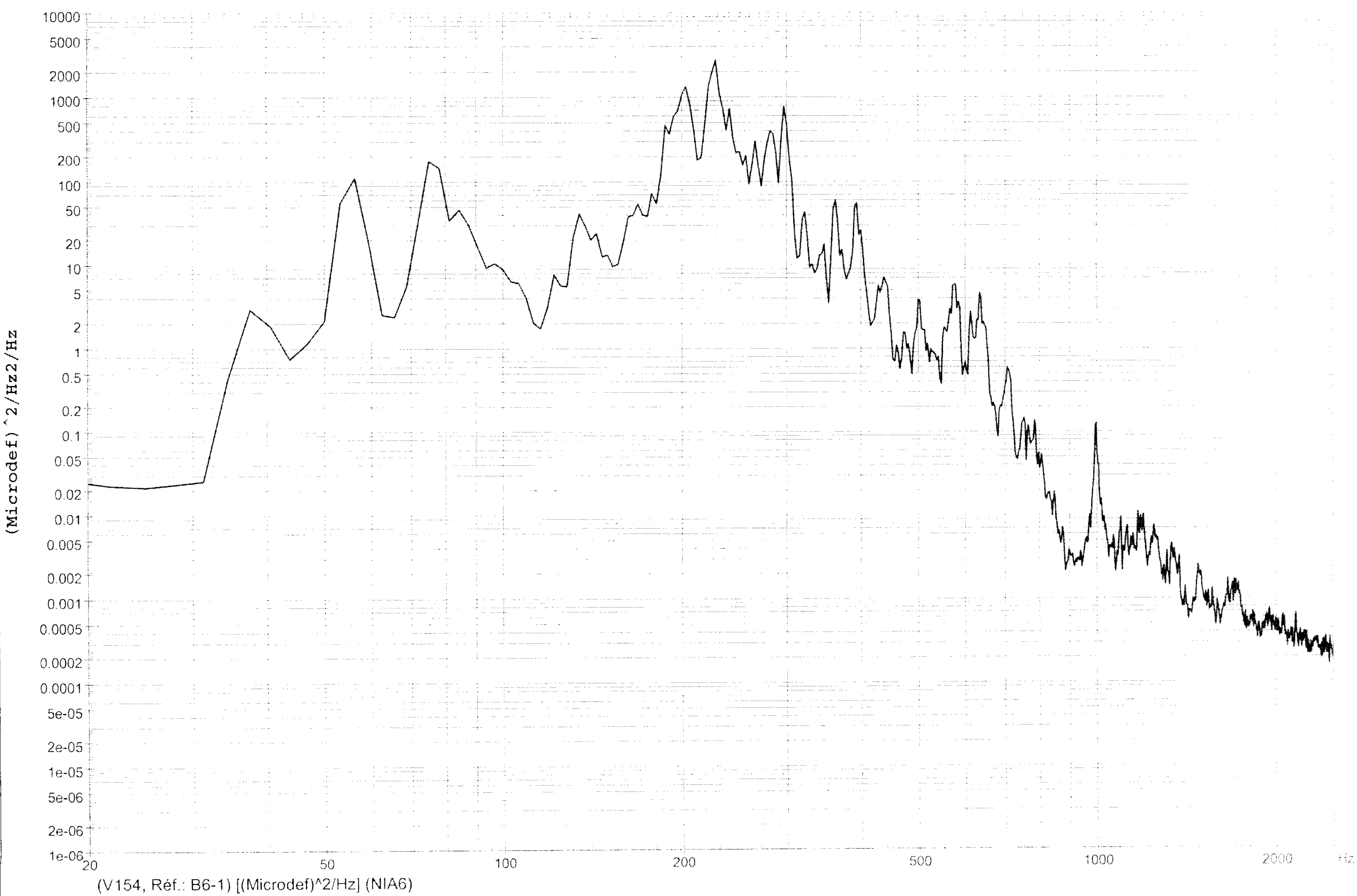
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

(V153, Réf.: B5-2) [(Microdef)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

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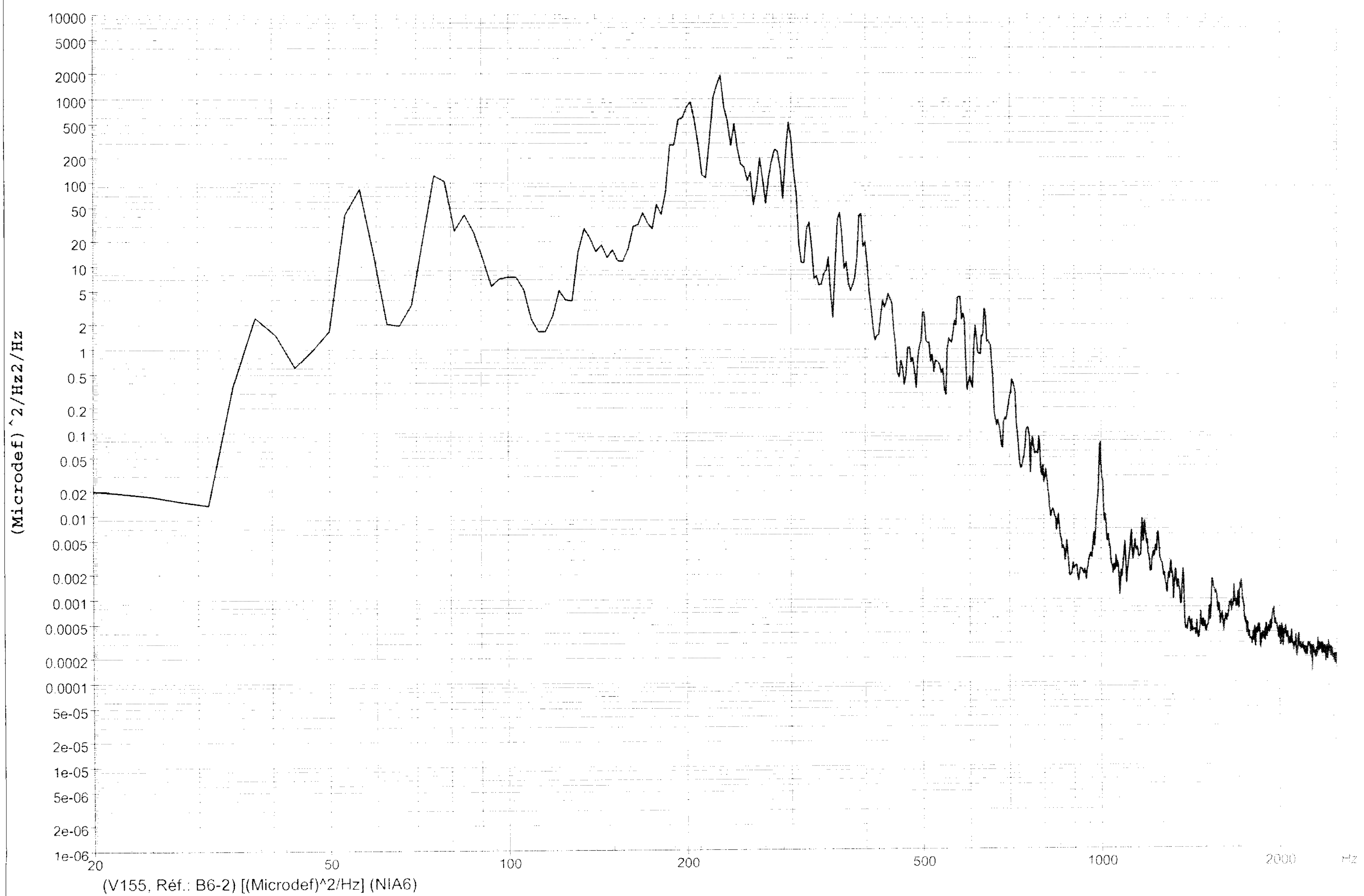

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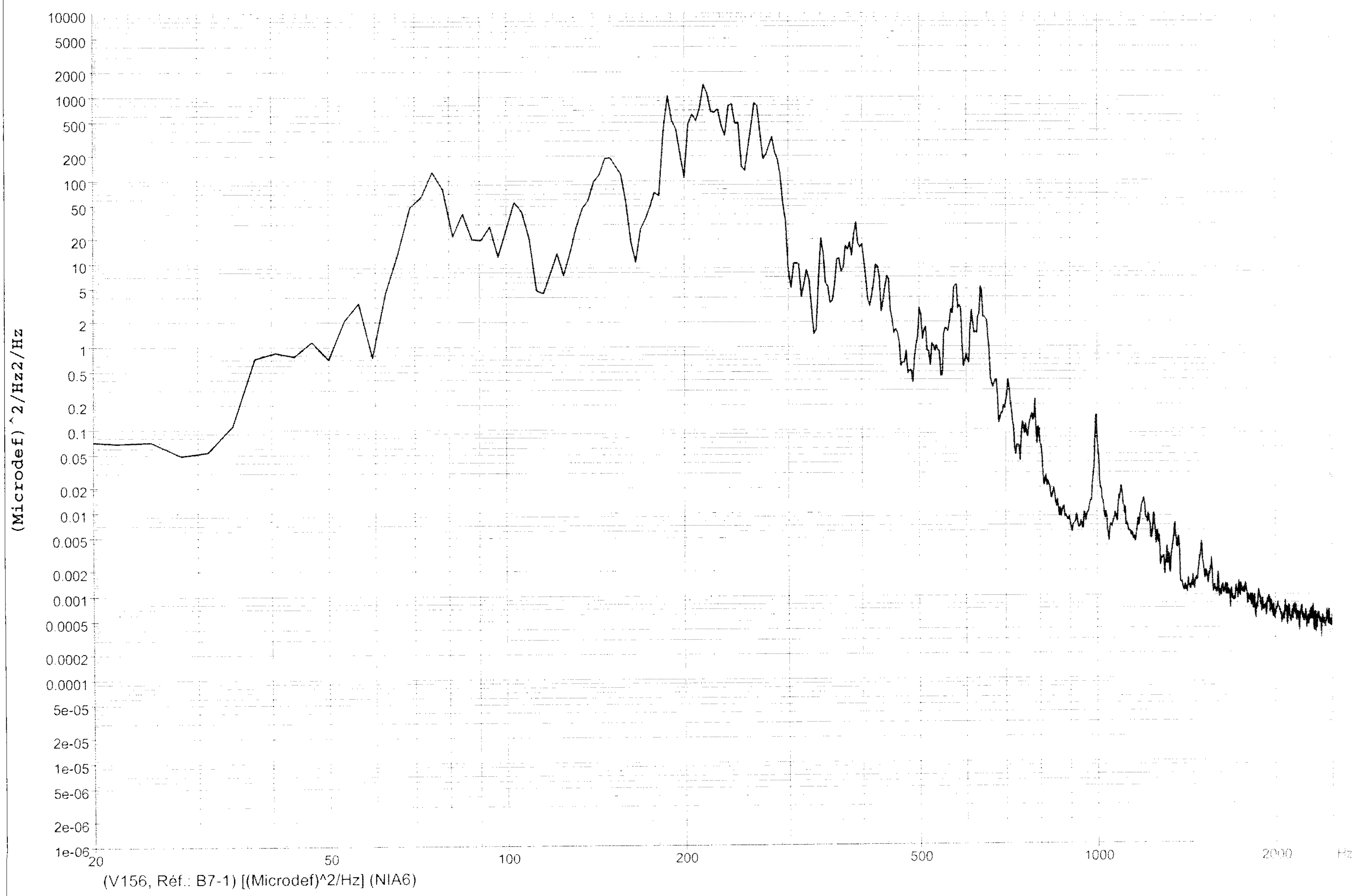
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



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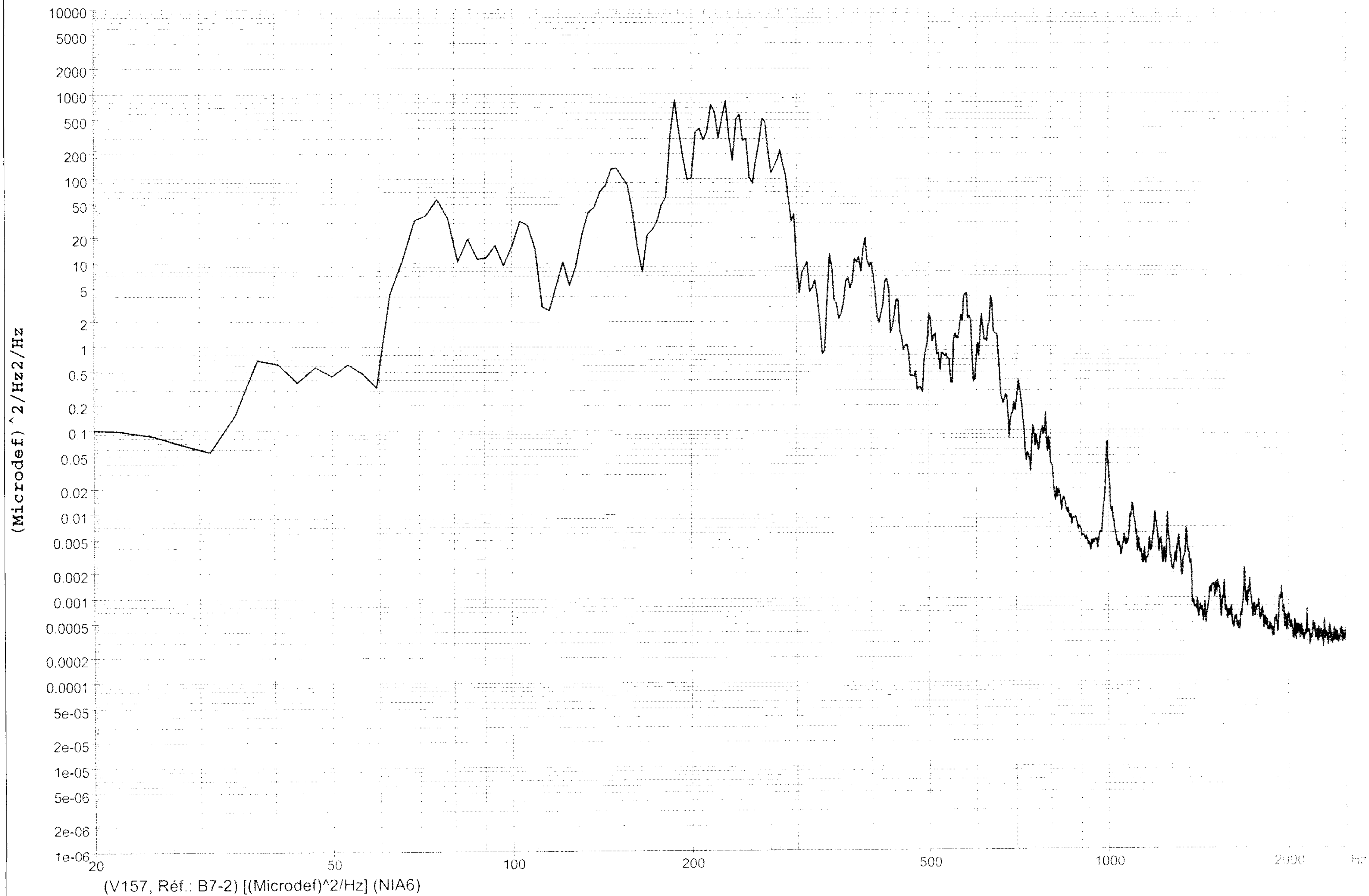

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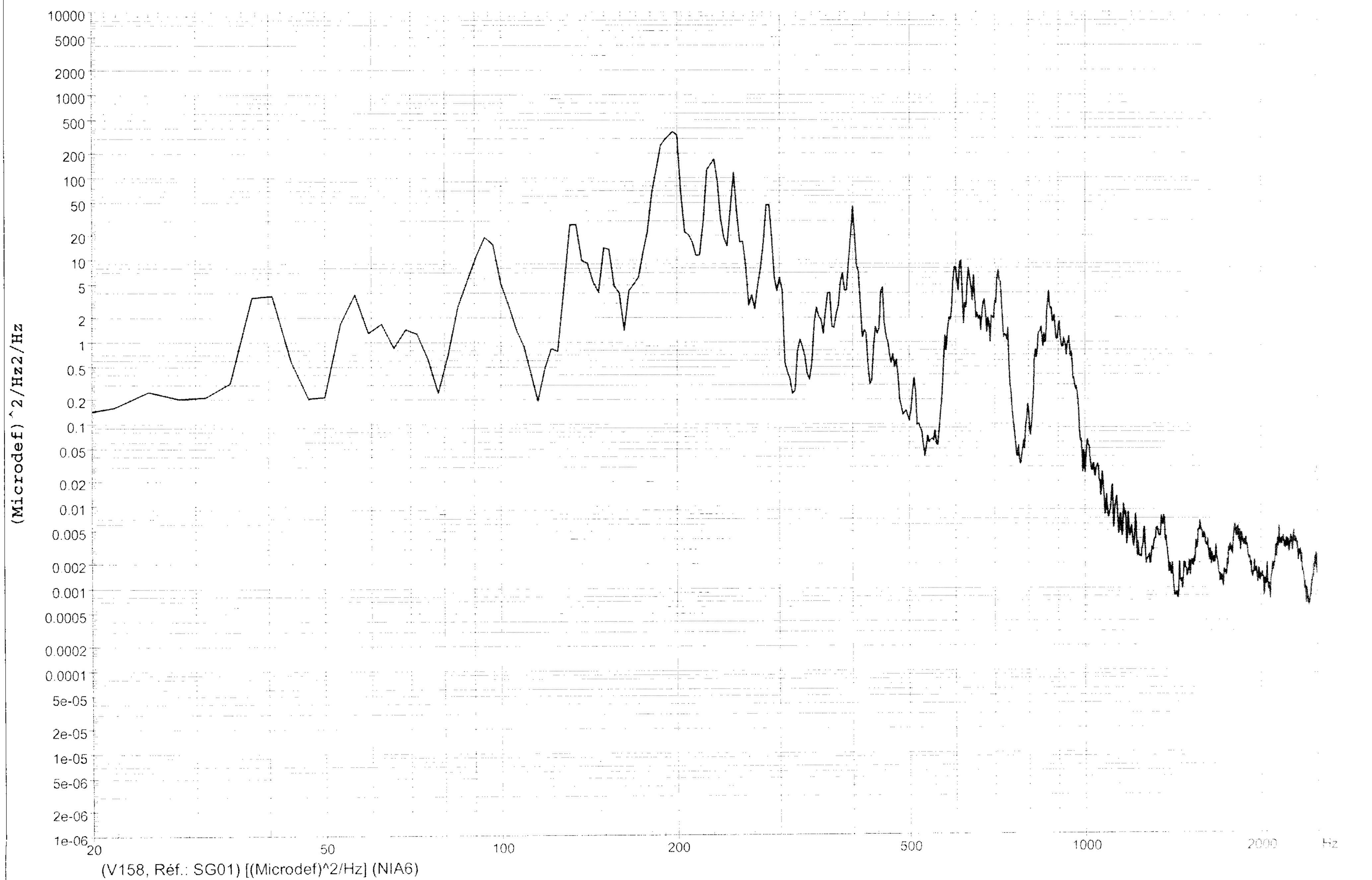

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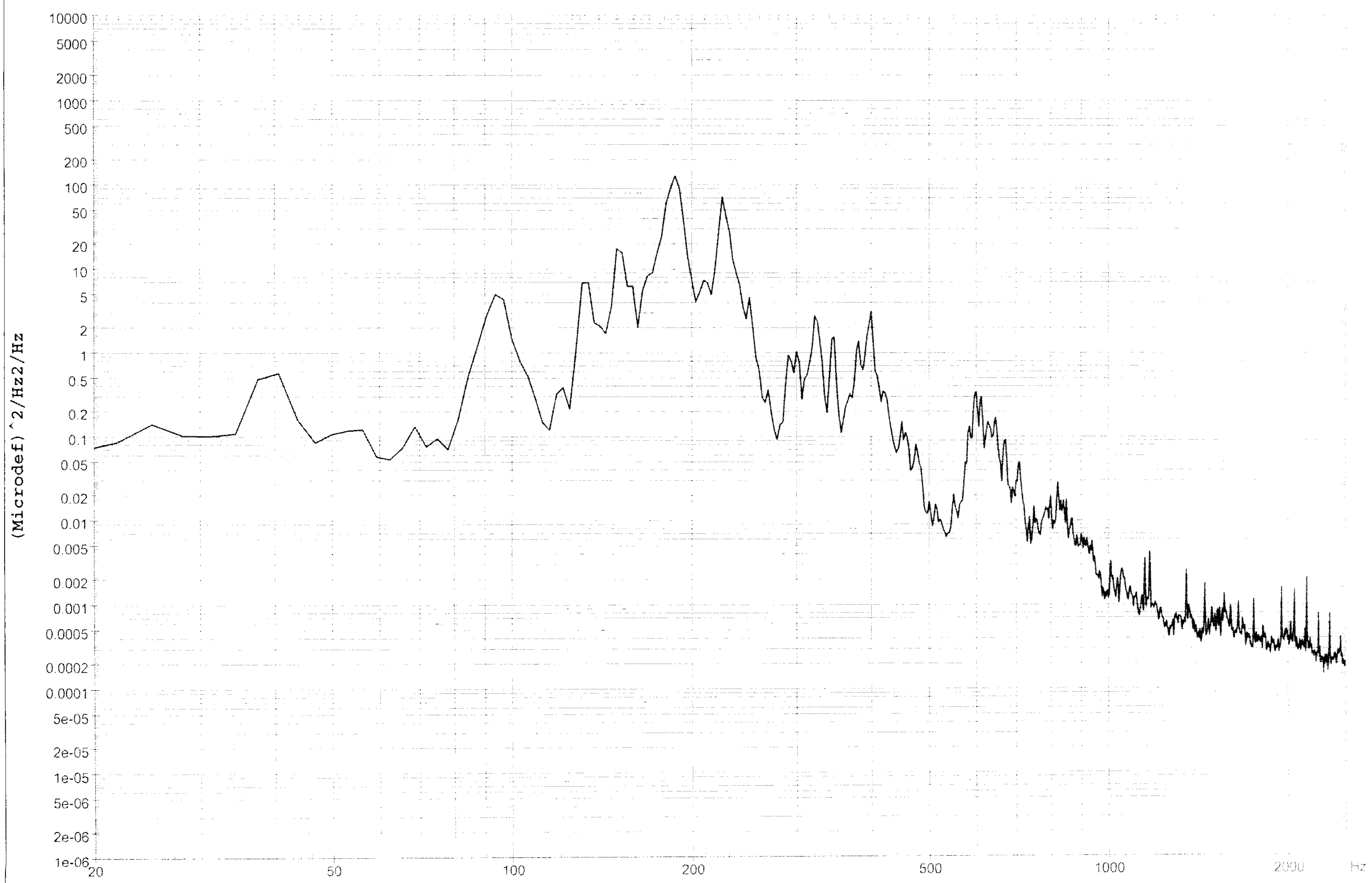
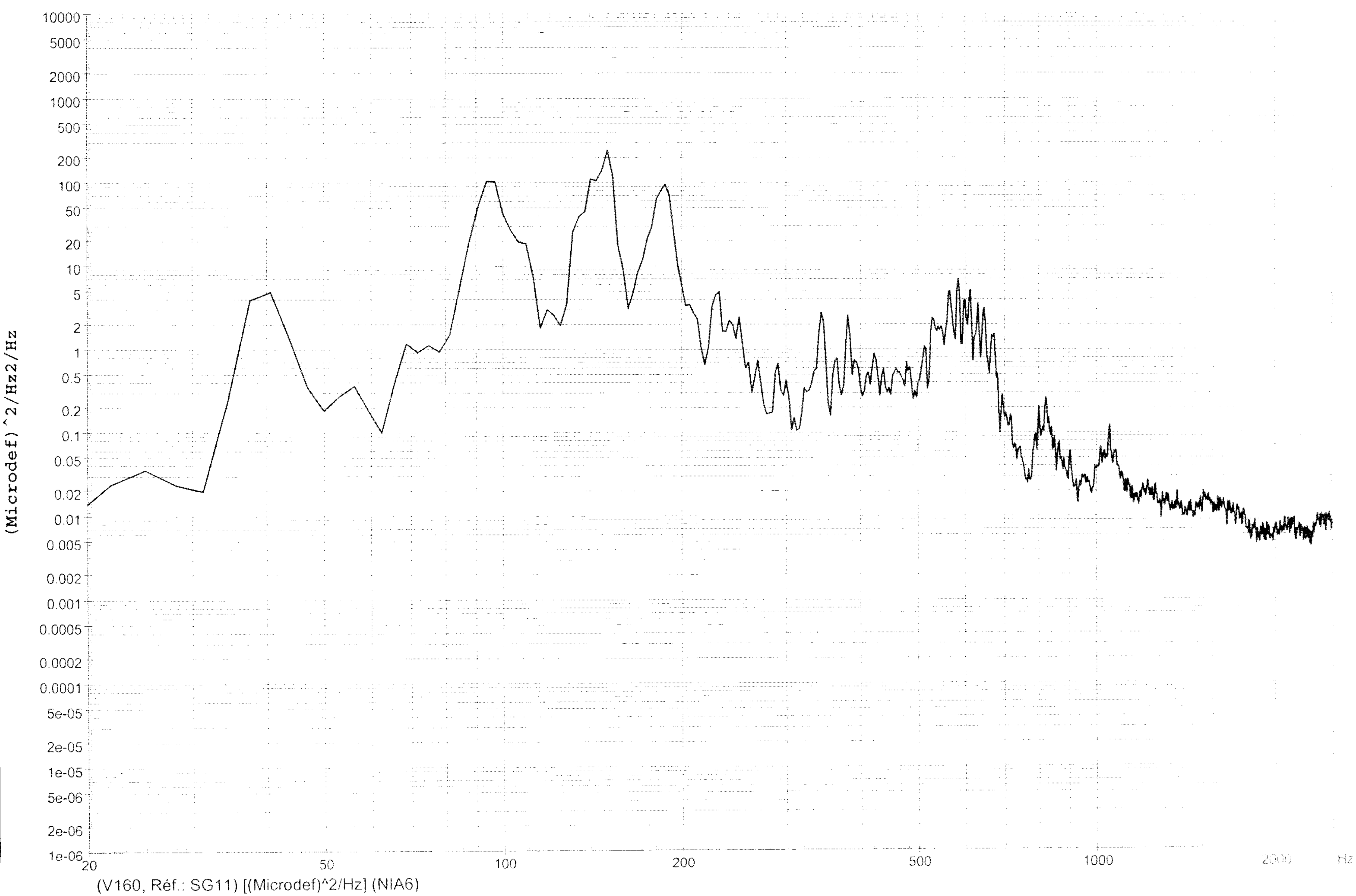
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V159, Réf.: SG02) [(Microdef)^2/Hz] (NIA6)

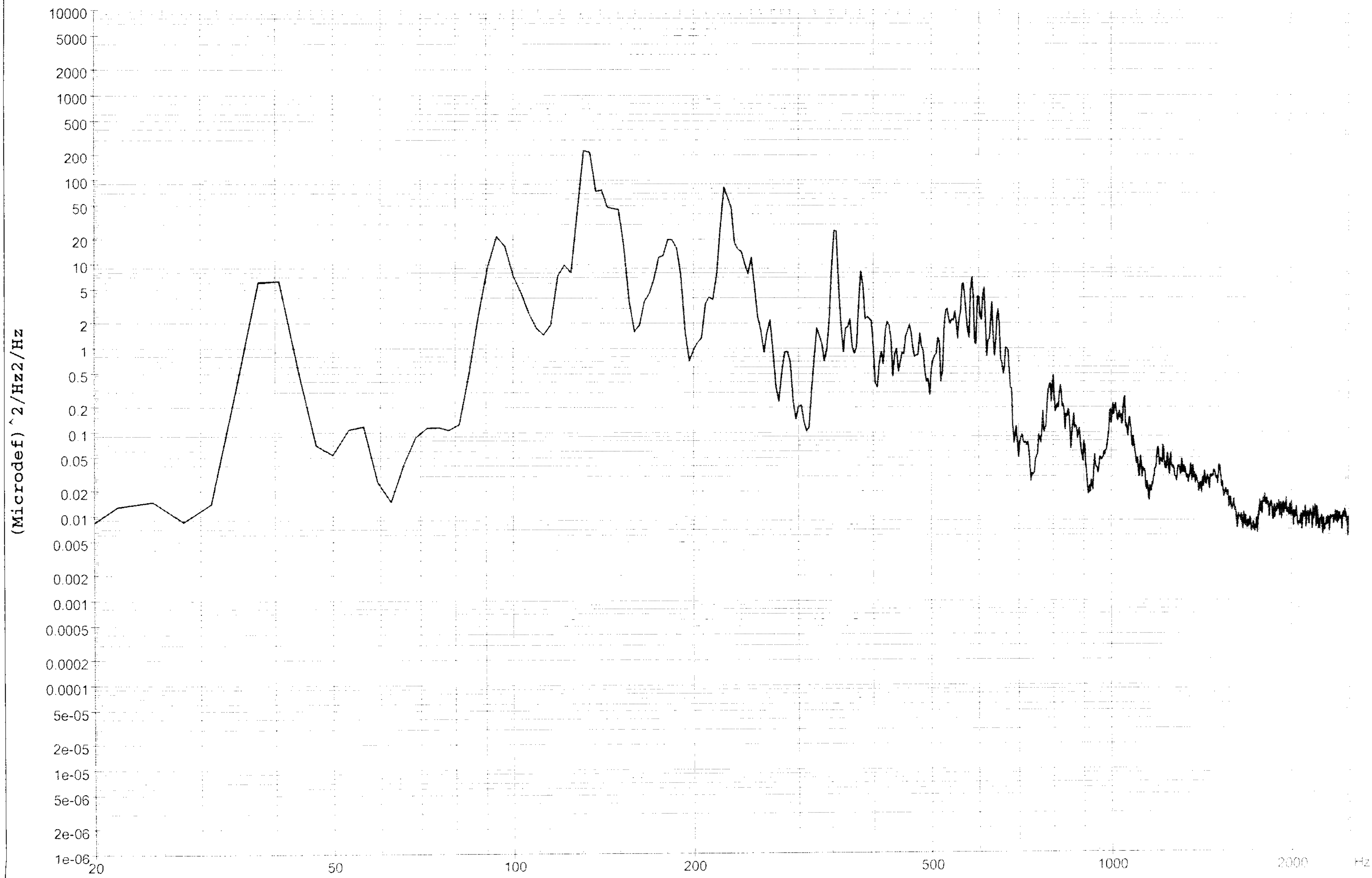
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



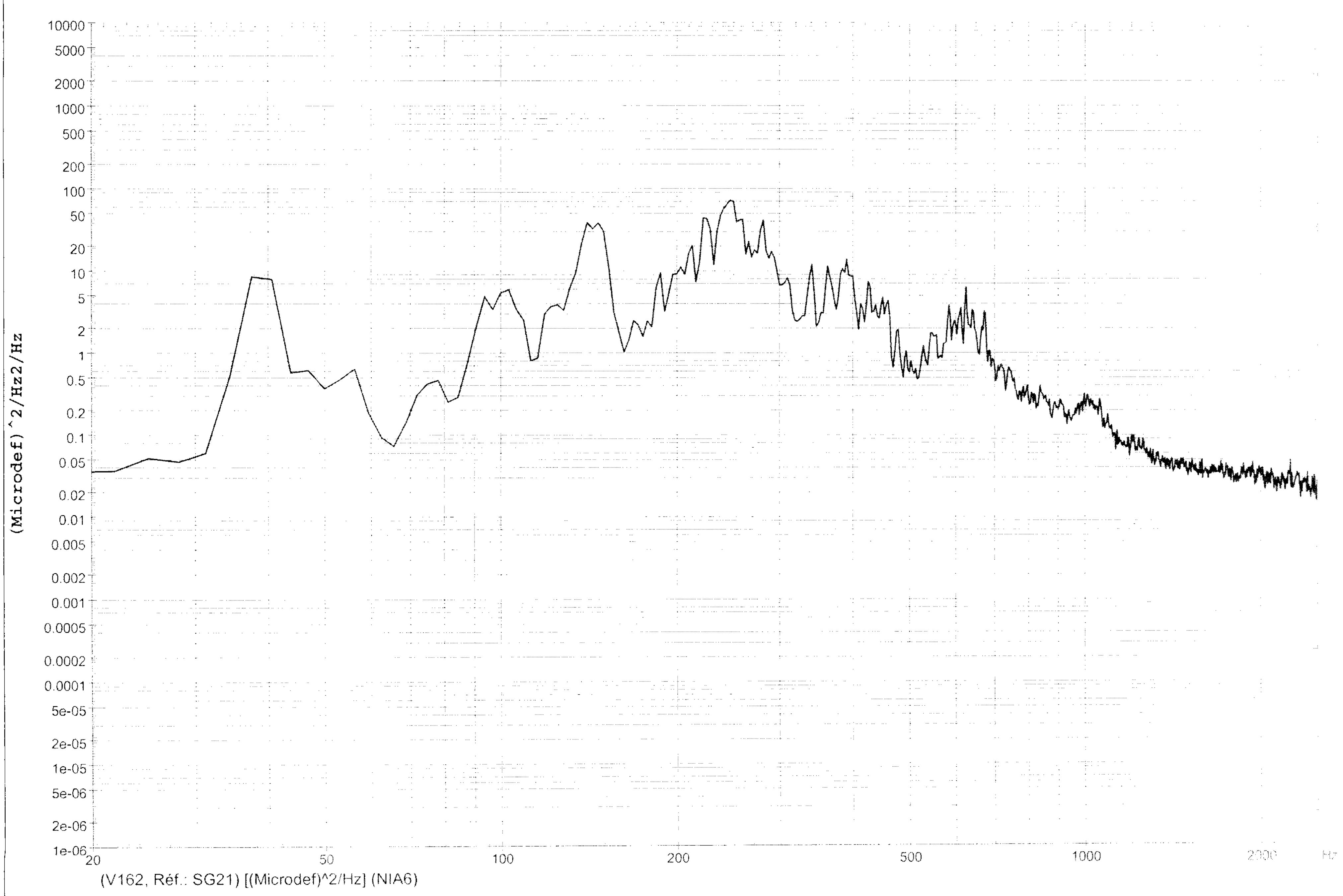
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



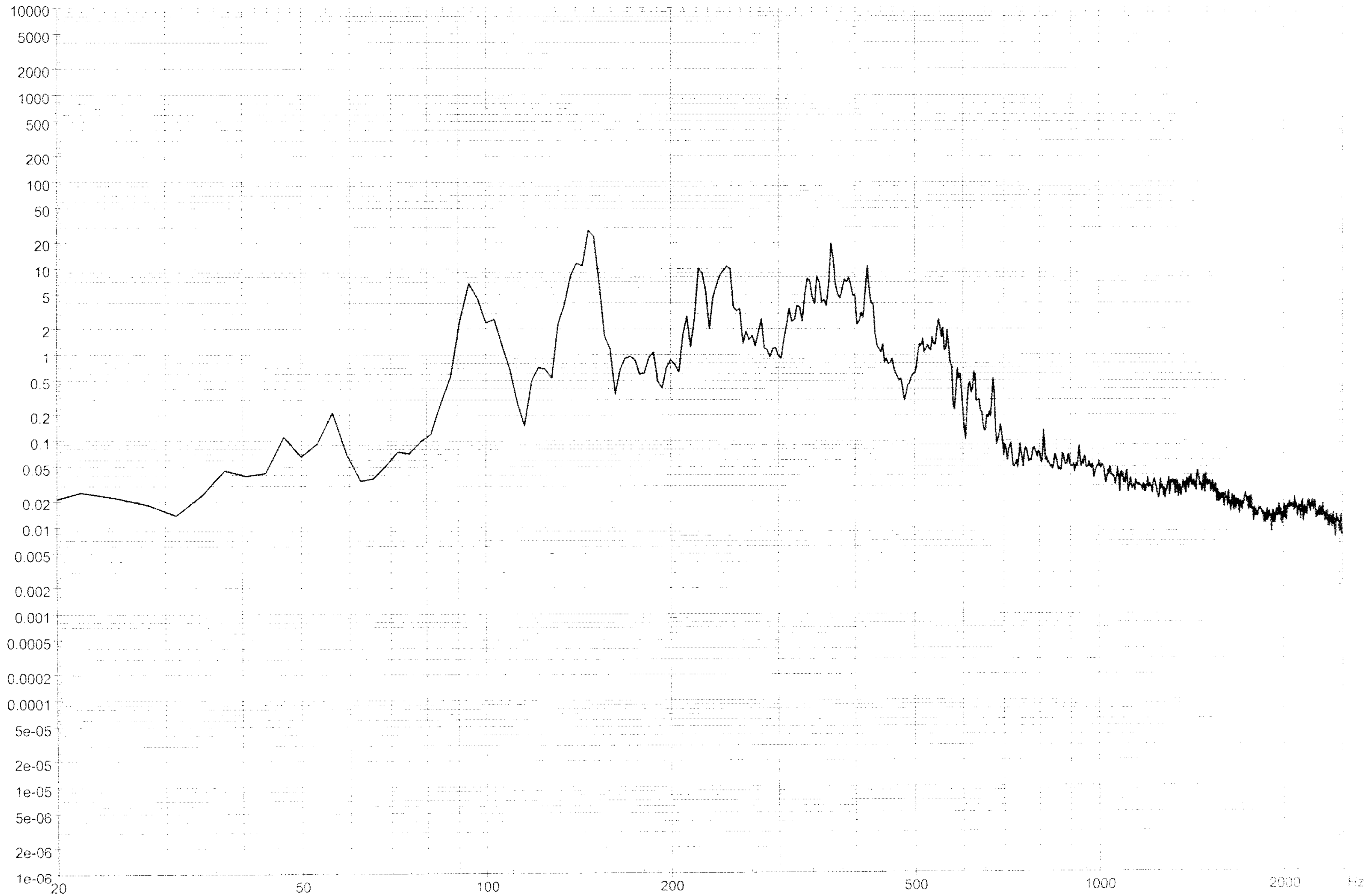
(V161, Réf.: SG12) [(Microdef)^2/Hz] (NIA6)

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

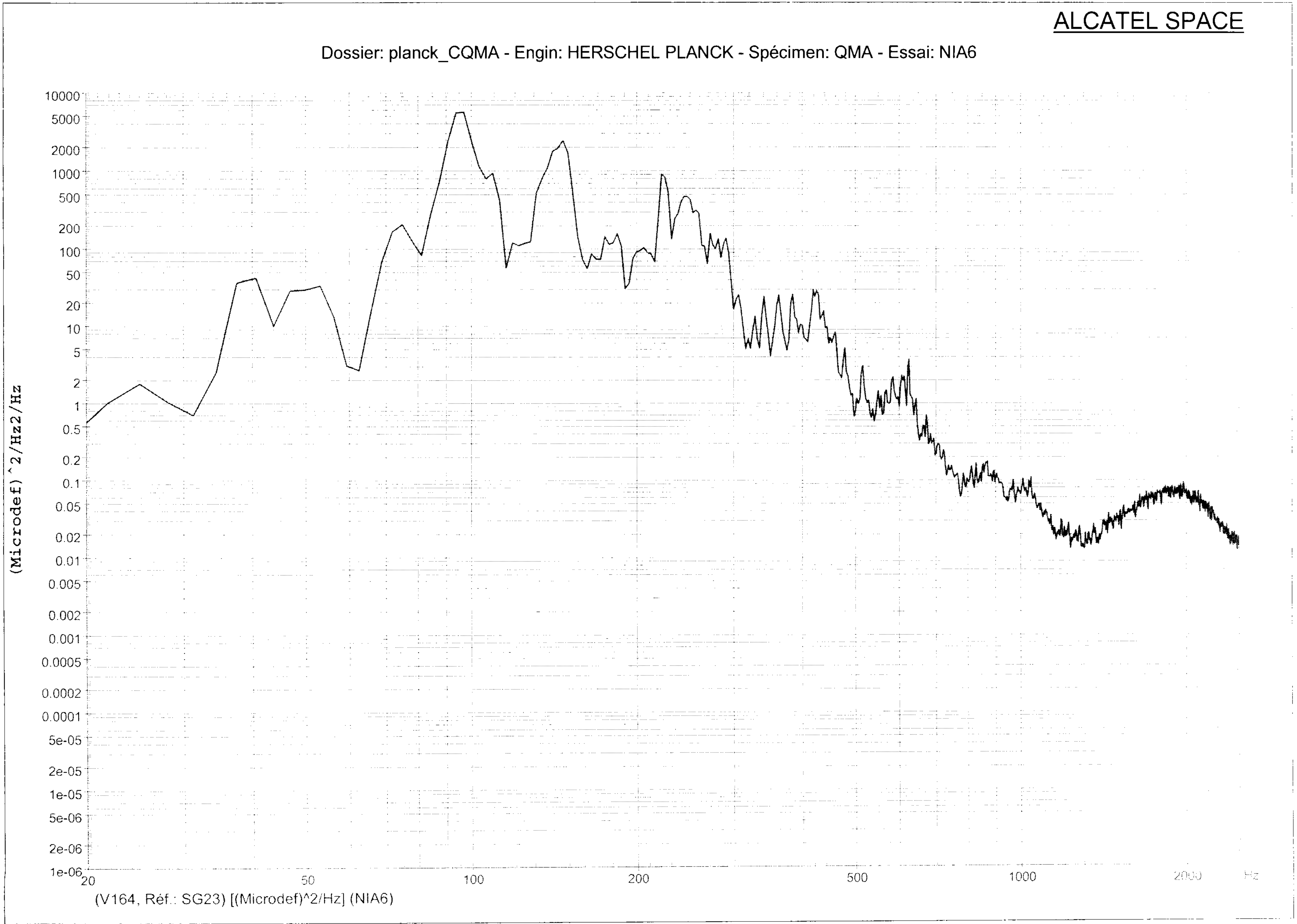


ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

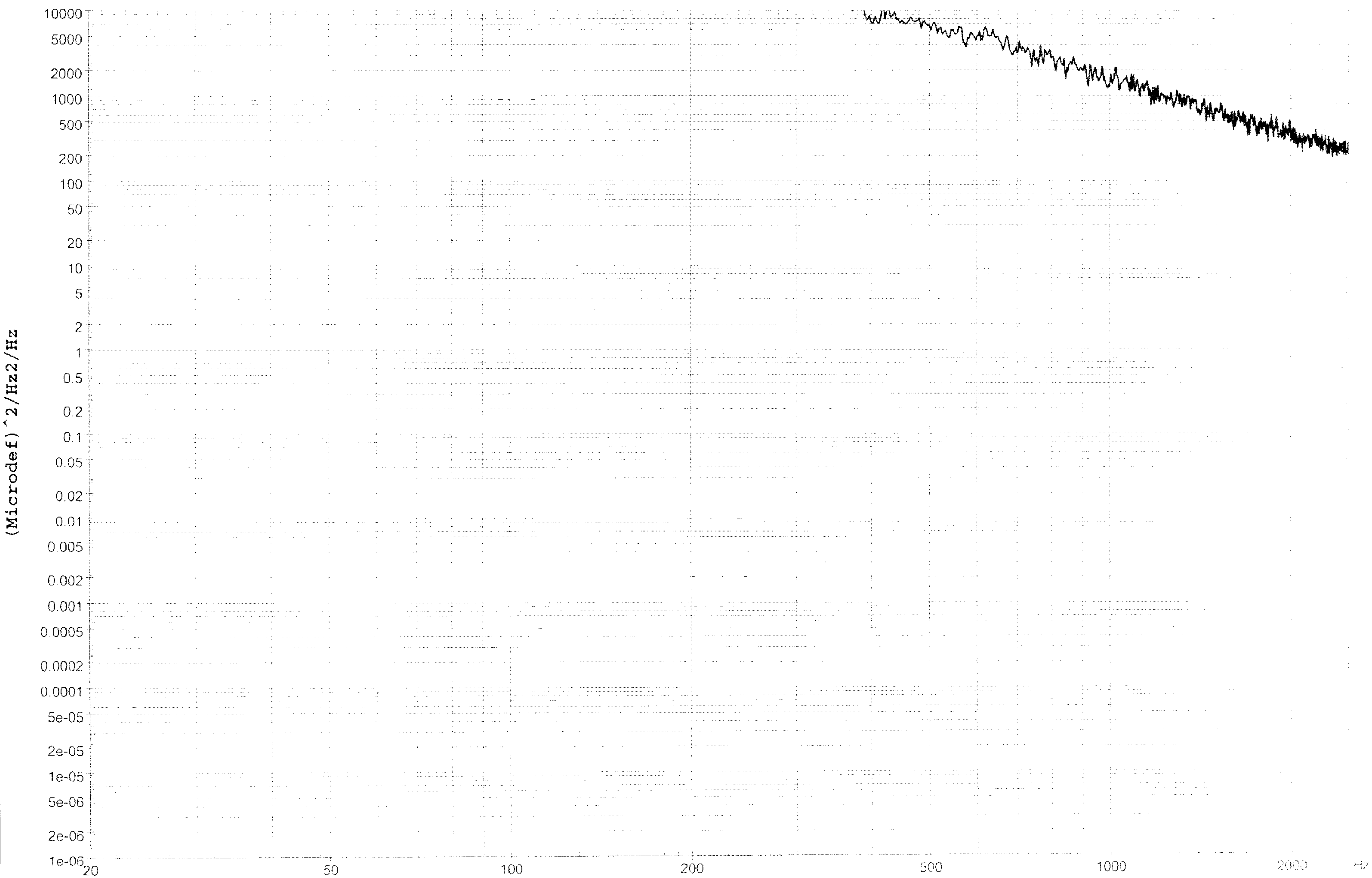


(V163, Réf.: SG22) [(Microdef)^2/Hz] (NIA6)


ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(Microdef)^2/Hz2/Hz
10000
5000
2000
1000
500
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
(V164, Réf.: SG23) [(Microdef)^2/Hz] (NIA6)

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V165, Réf.: SG24) [(Microdef)^2/Hz] (NIA6)

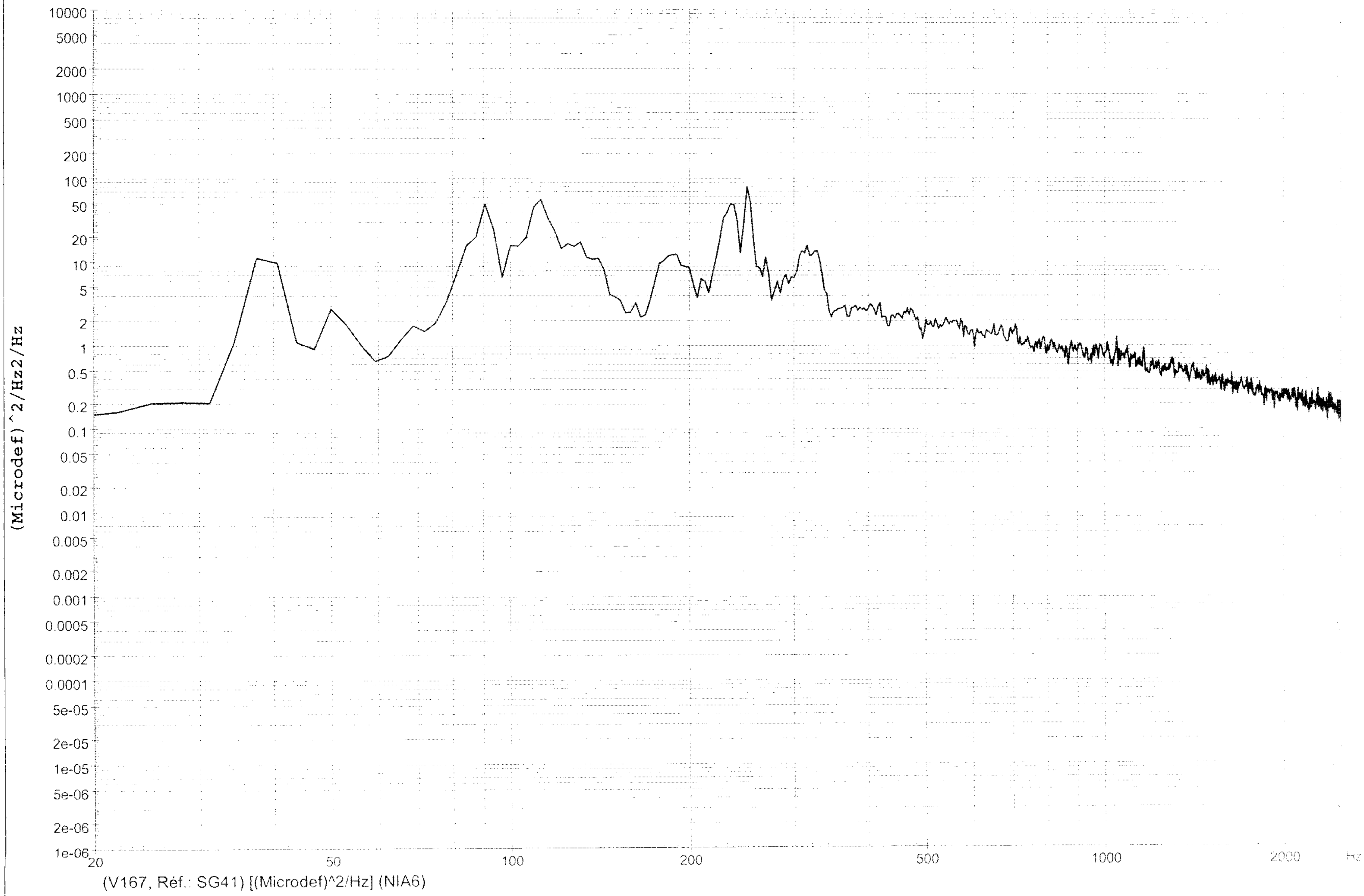
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

(V166, Réf.: SG34) [(Microdef)^2/Hz] (NIA6)

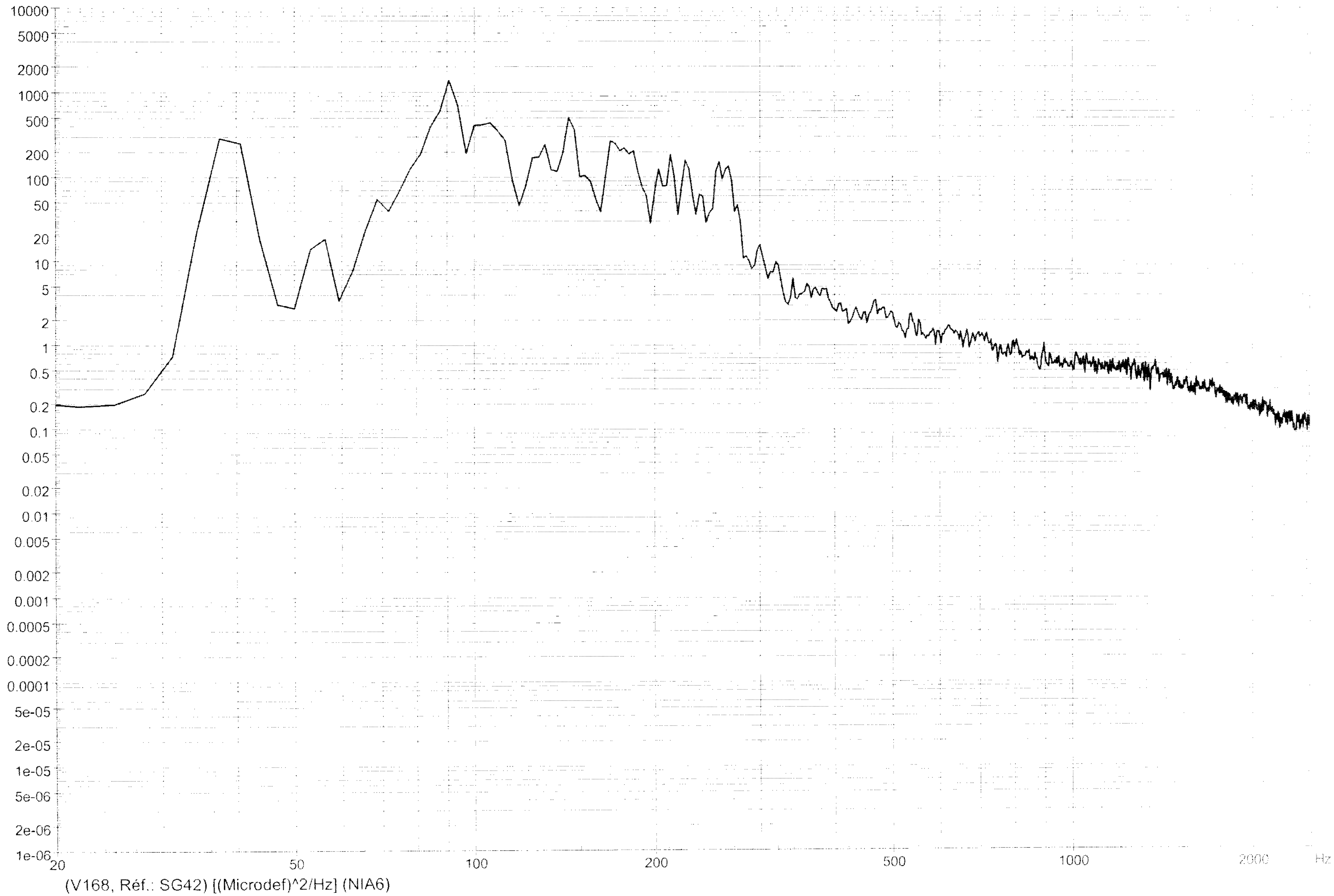
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



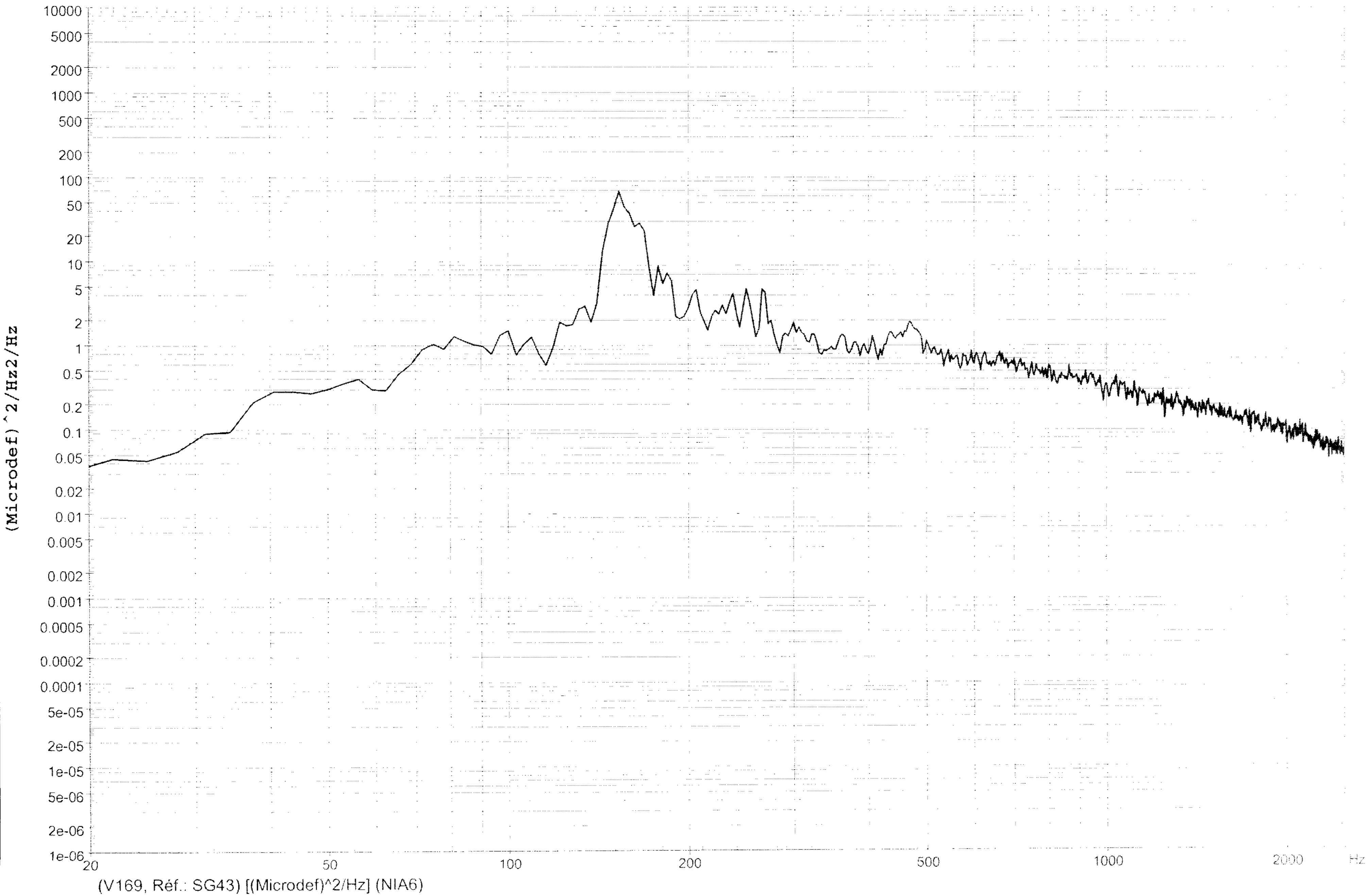
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



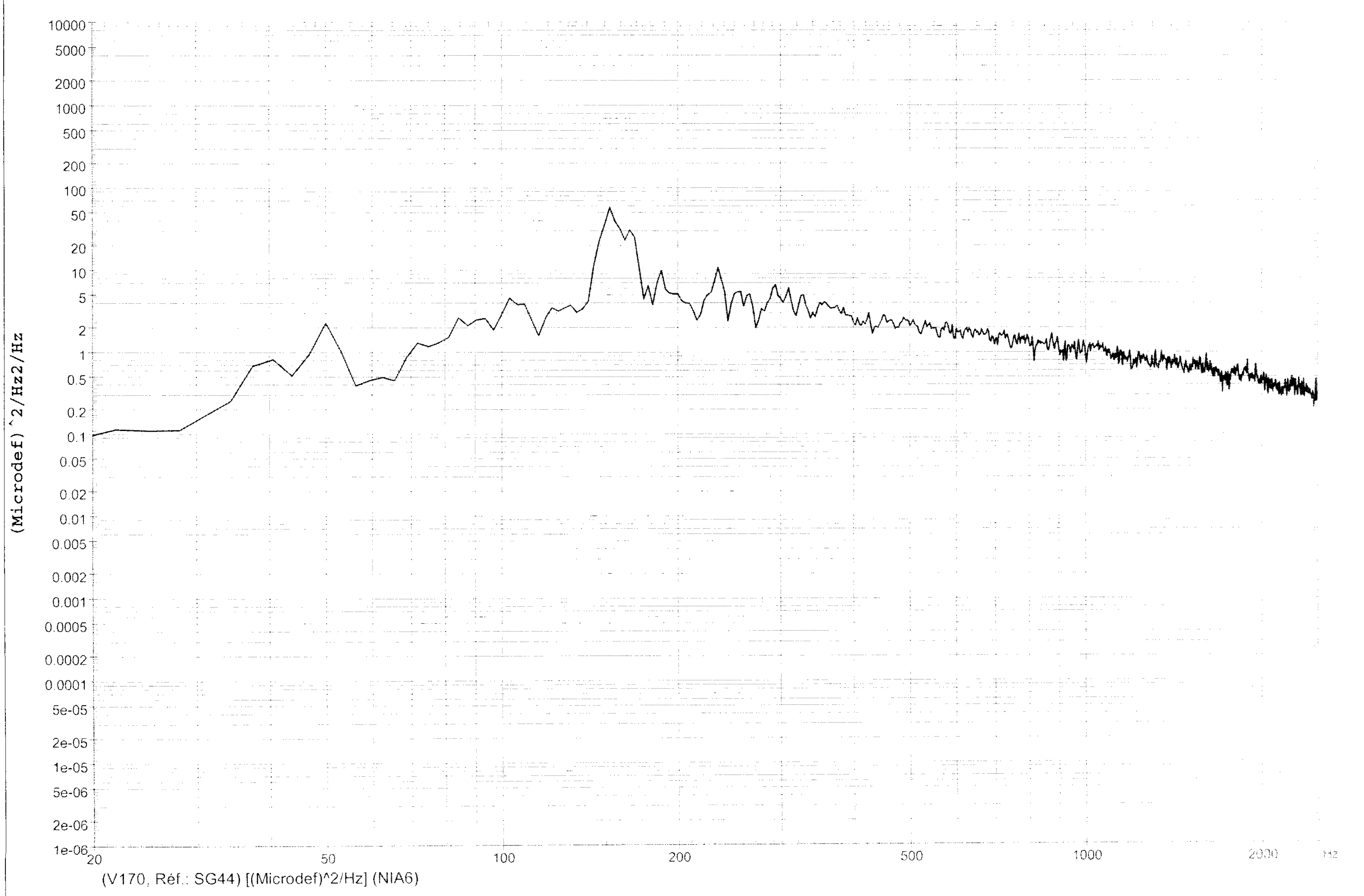
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

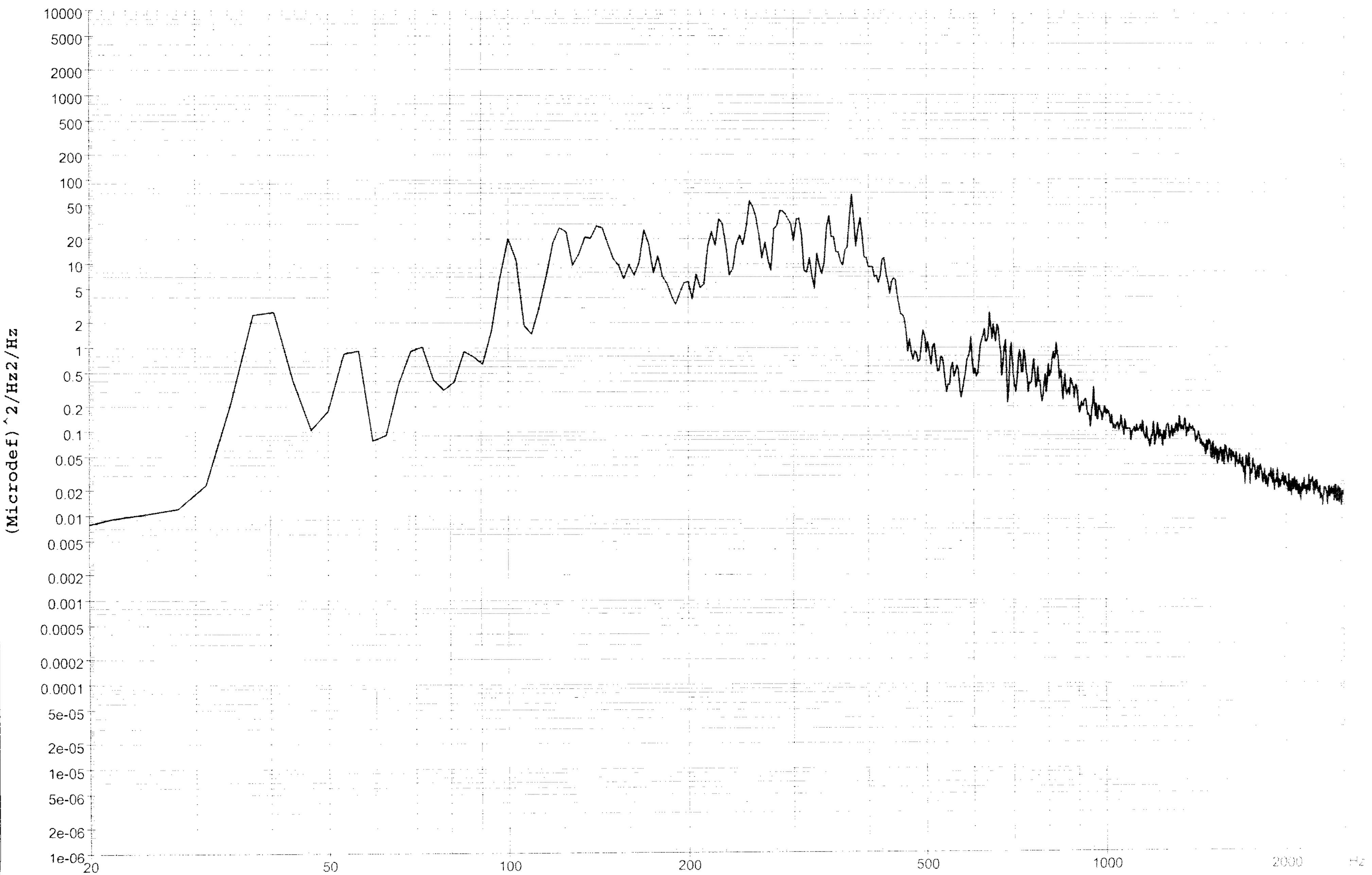


ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



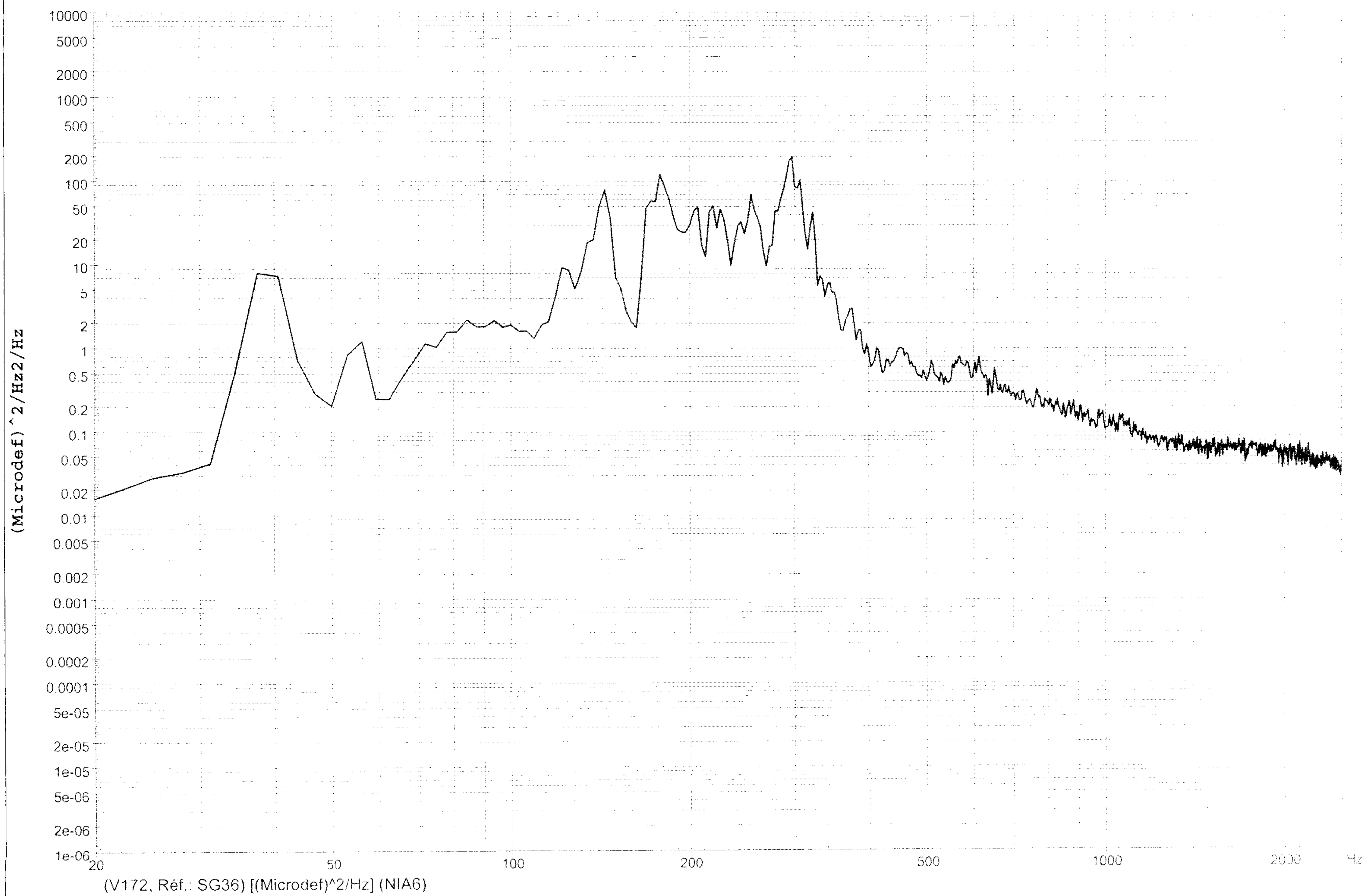
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V171, Réf.: SG35) [(Microdef)^2/Hz] (NIA6)

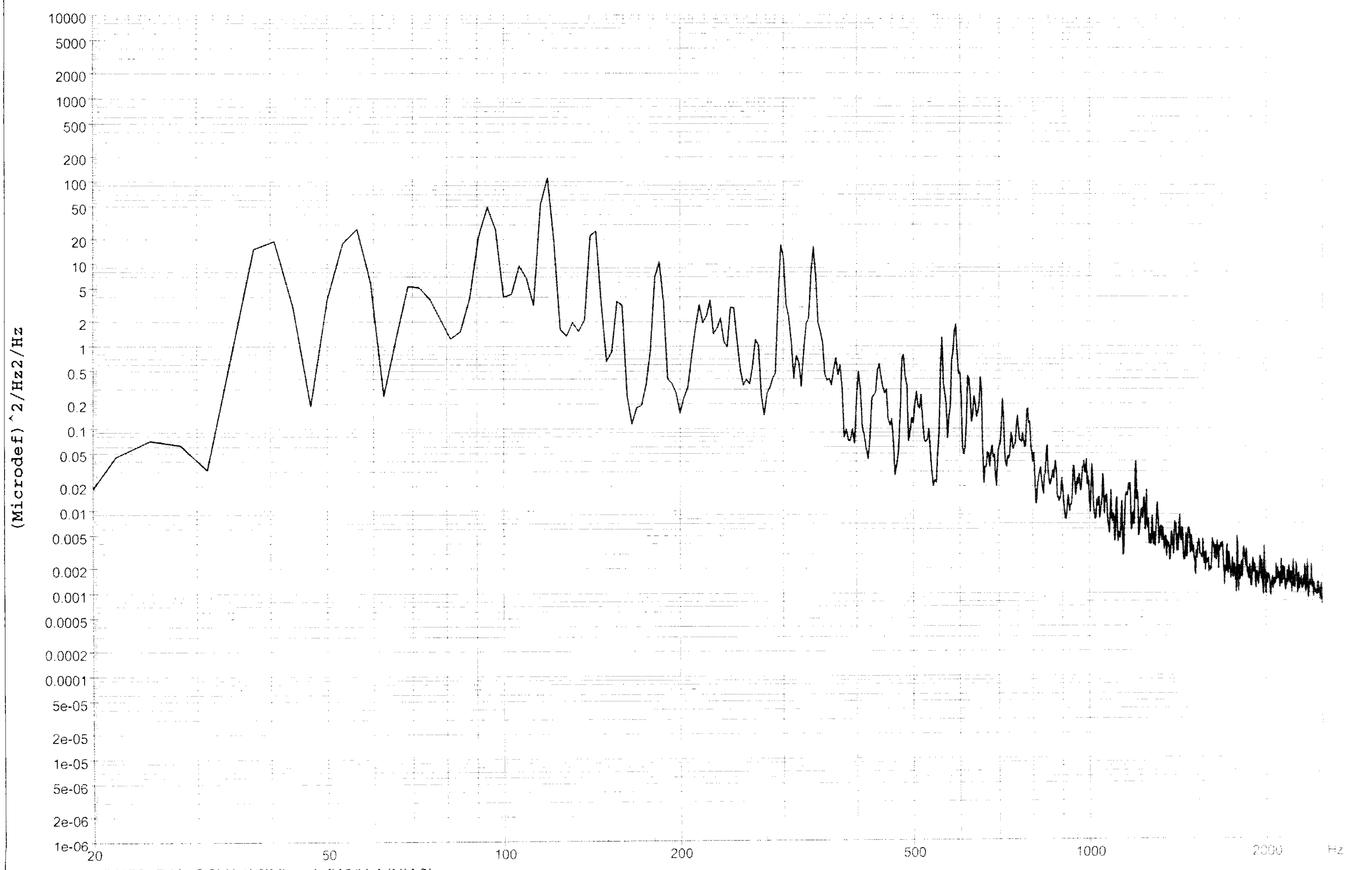
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

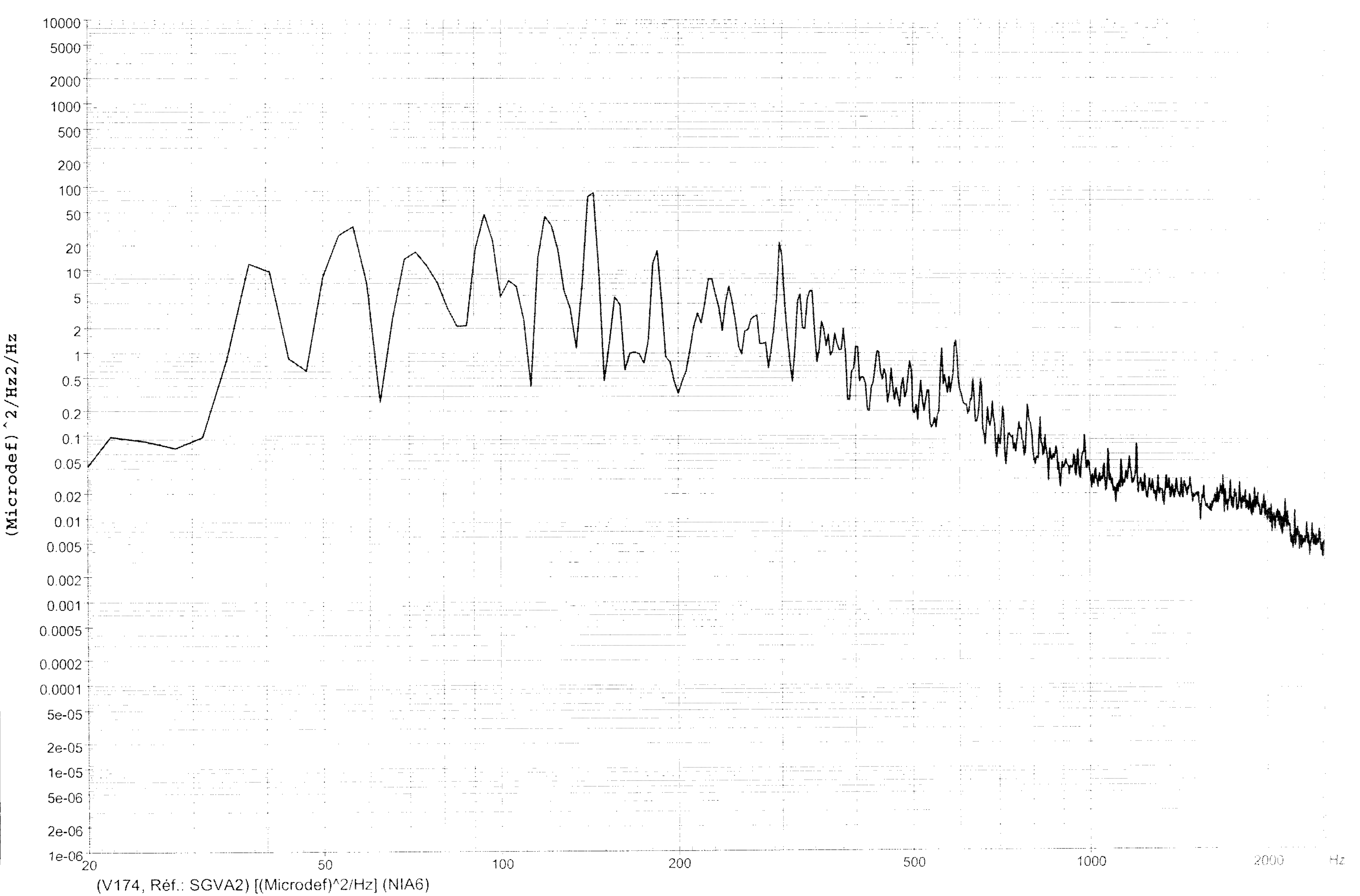
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V173, Réf.: SGVA1) [(Microdef)^2/Hz] (NIA6)

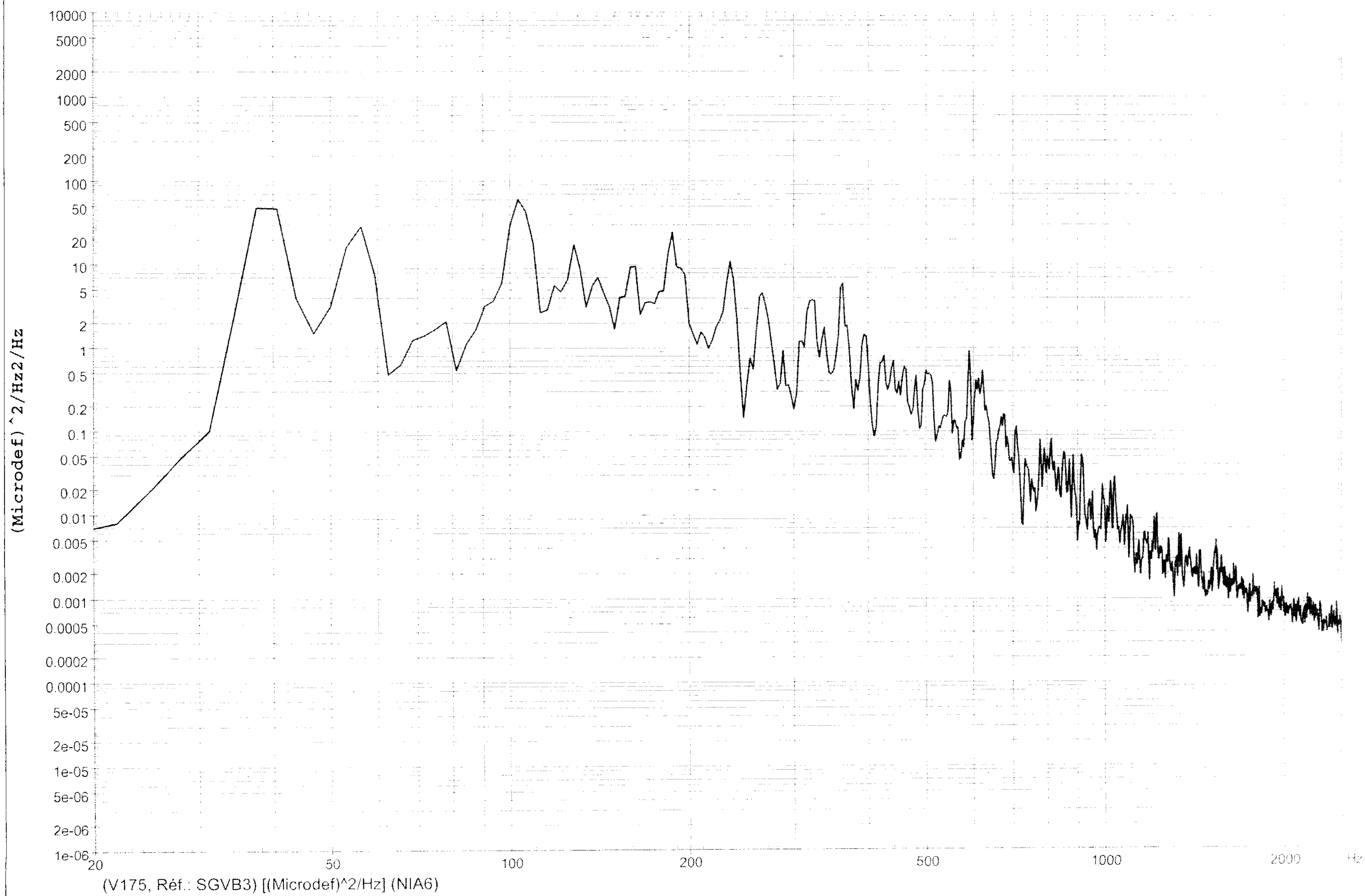
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



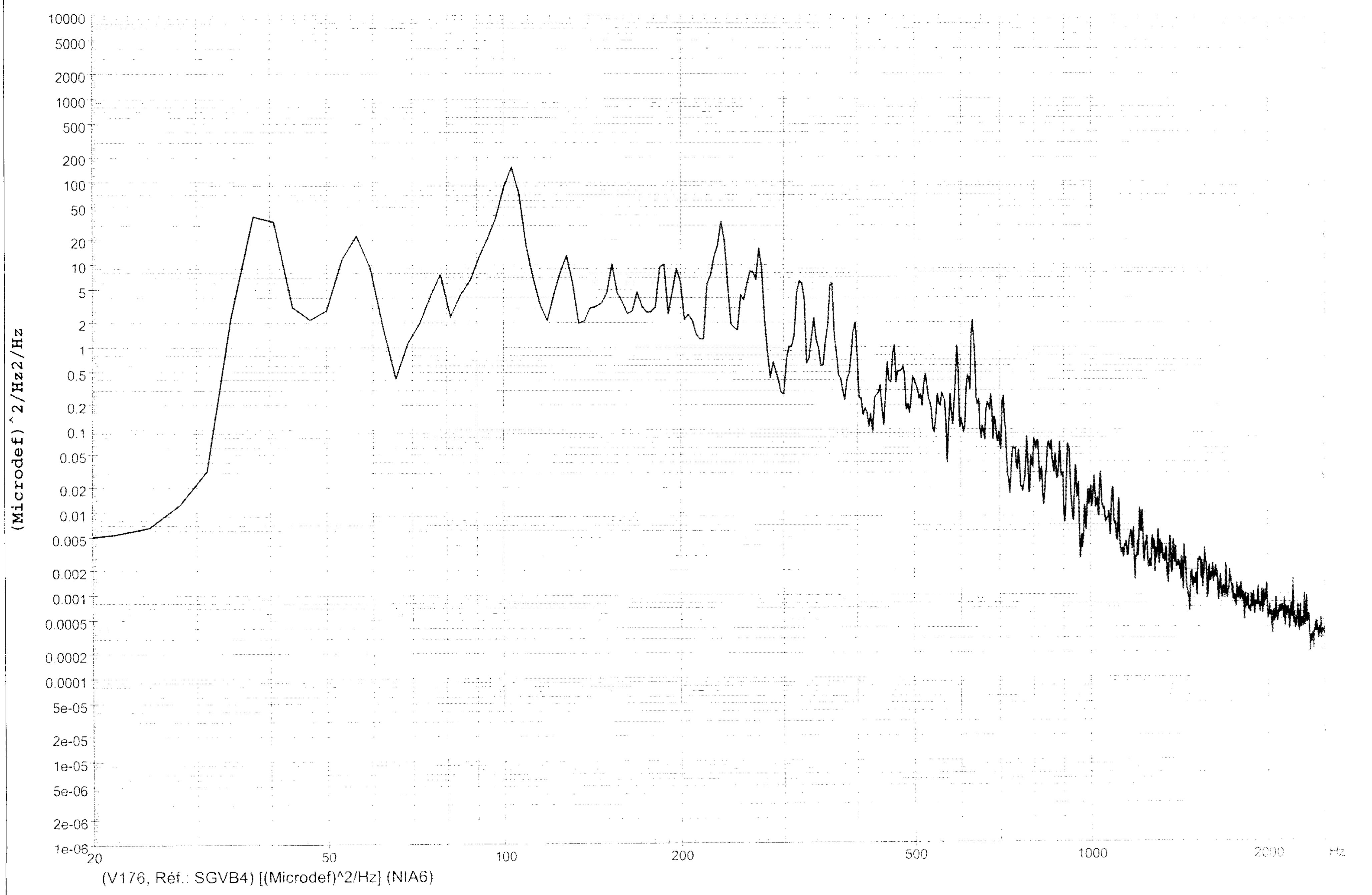
ALCATEL SPACE

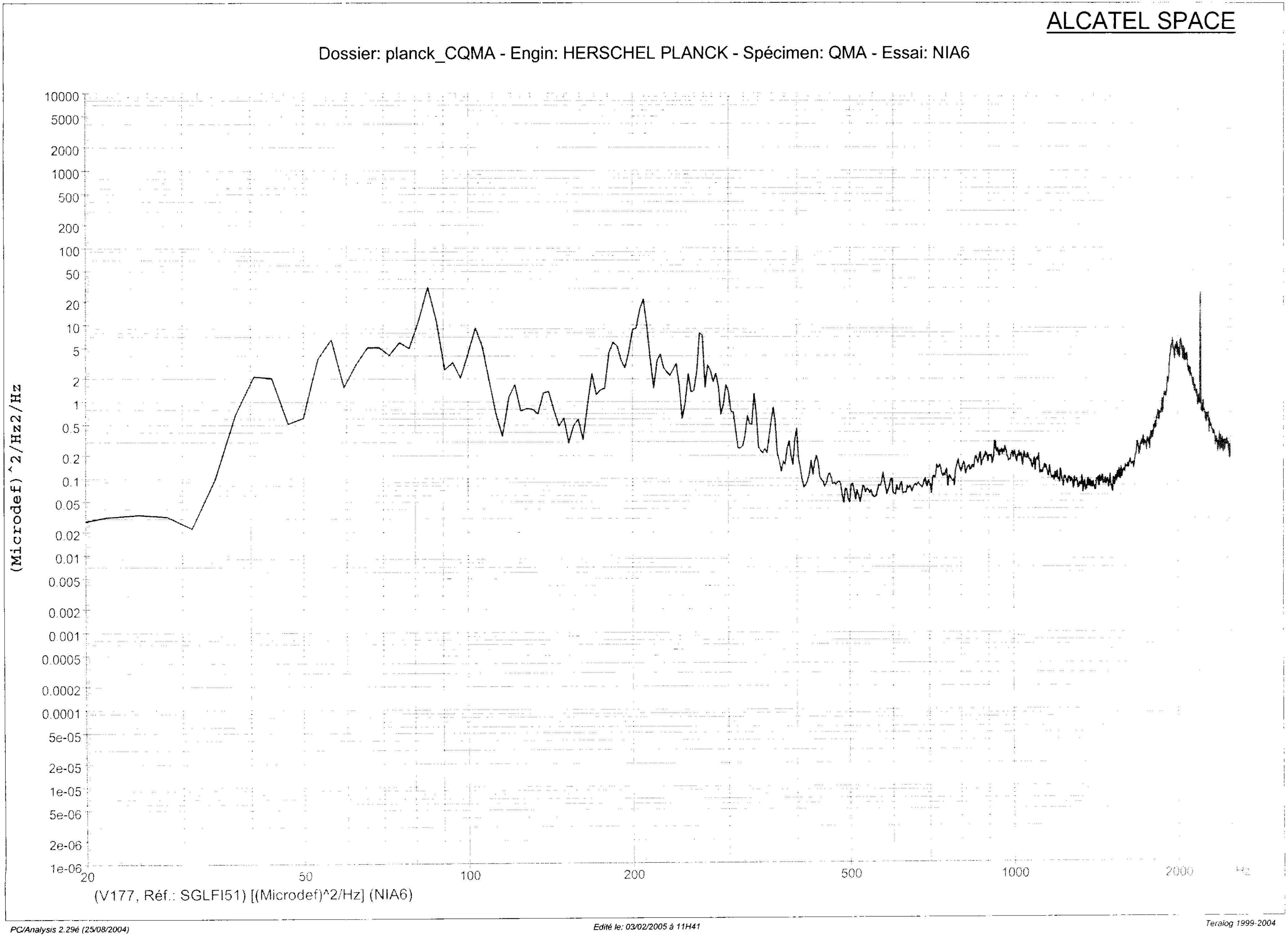
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

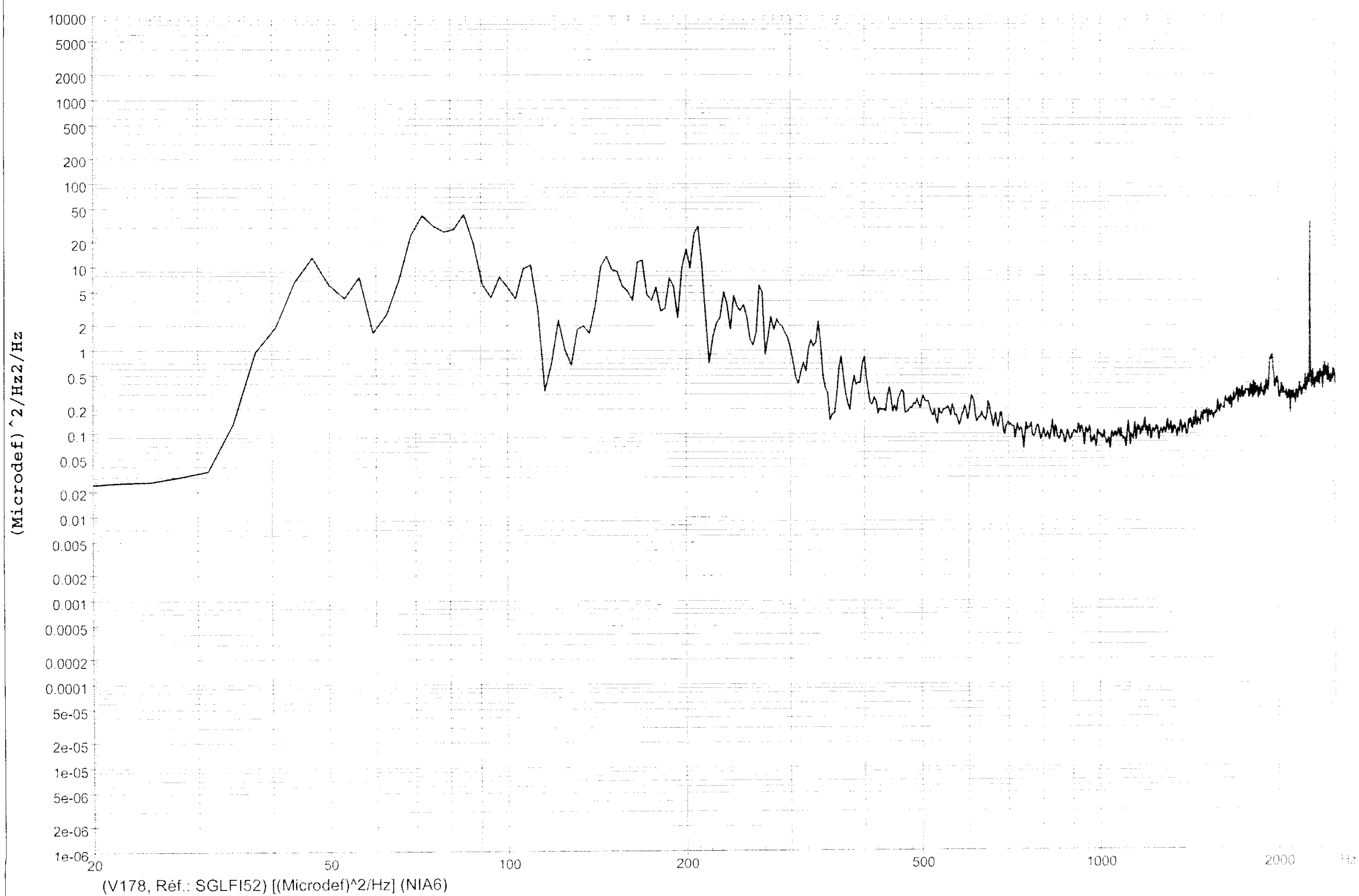
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6




ALCATEL SPACE
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6
(Microdef)^2/Hz2/Hz
10000
5000
2000
1000
500
200
100
50
20
10
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
0.0005
0.0002
0.0001
5e-05
2e-05
1e-05
5e-06
2e-06
1e-06
20
50
100
200
500
1000
2000
Hz
(V177, Réf.: SGLFI51) [(Microdef)^2/Hz] (NIA6)
PC/Analysis 2.29é (25/08/2004)
Edité le: 03/02/2005 à 11H41
Teralog 1999-2004

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



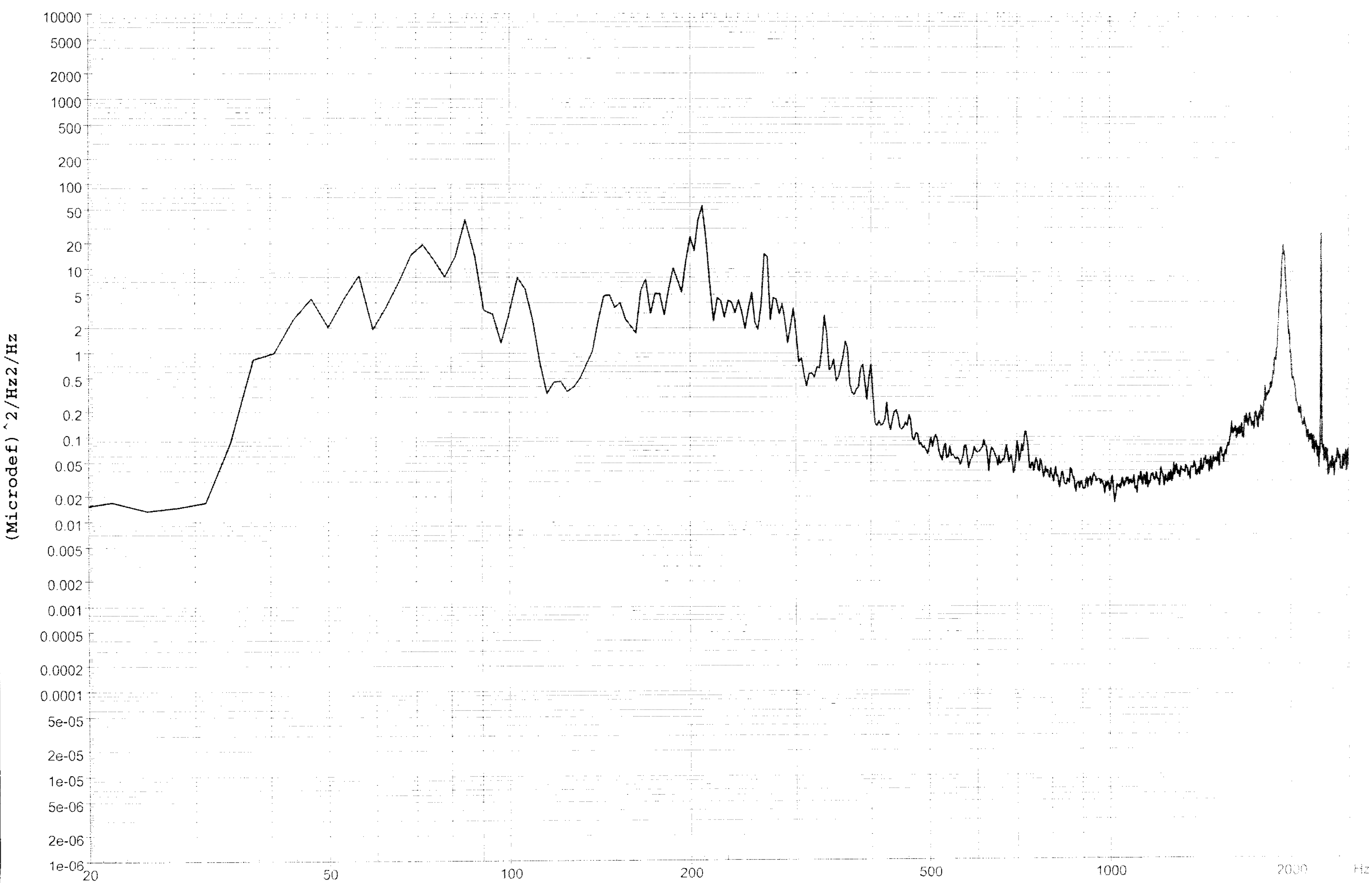
PC/Analysis 2.29é (25/08/2004)

Edité le: 03/02/2005 à 11H41

Teralog 1999-2004

ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6

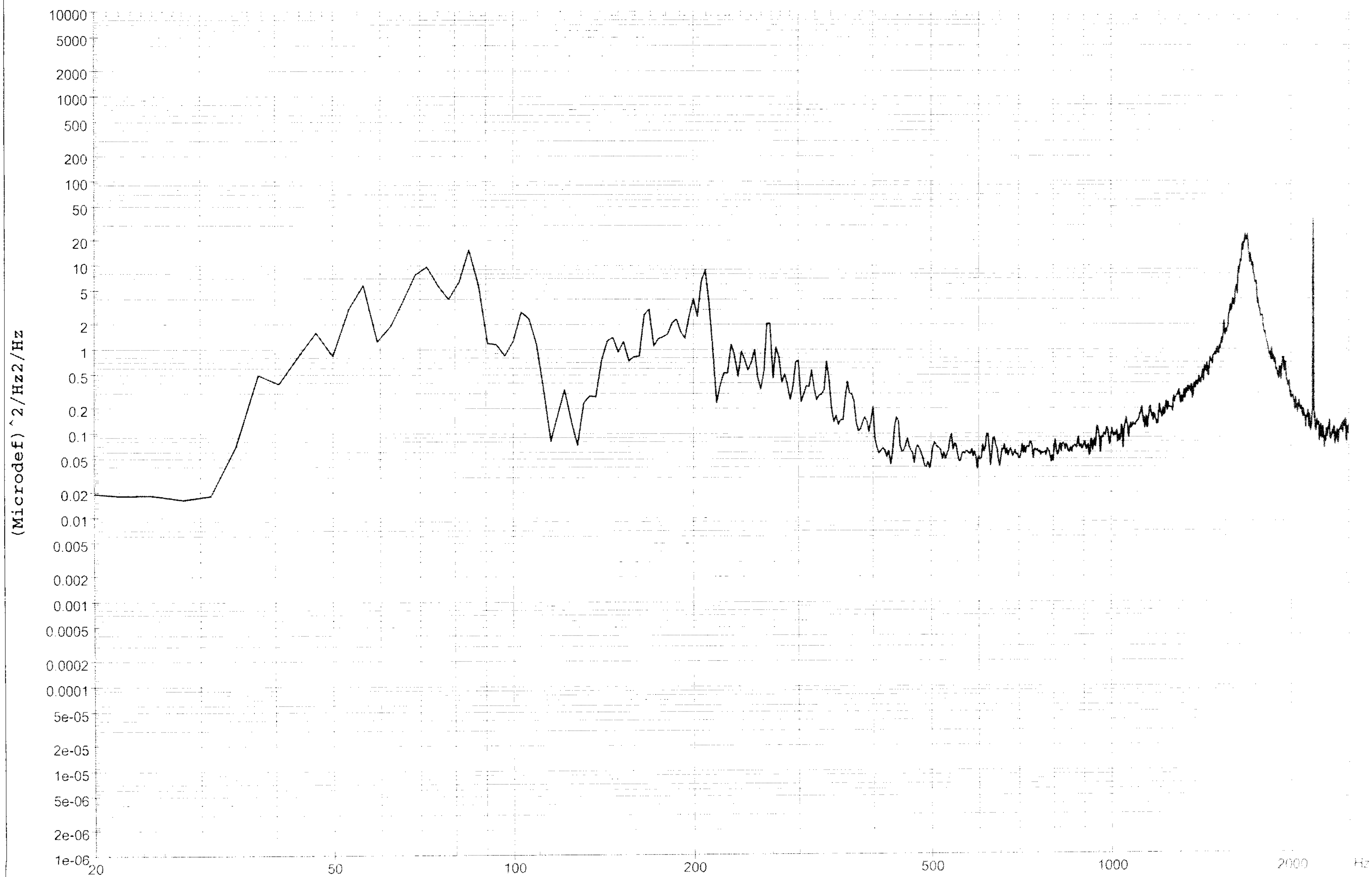


(V179, Réf.: SGLFI53) [(Microdef)^2/Hz] (NIA6)

PC/Analysis 2.29é (25/08/2004) Edité le: 03/02/2005 à 11H41 Teralog 1999-2004

ALCATEL SPACE

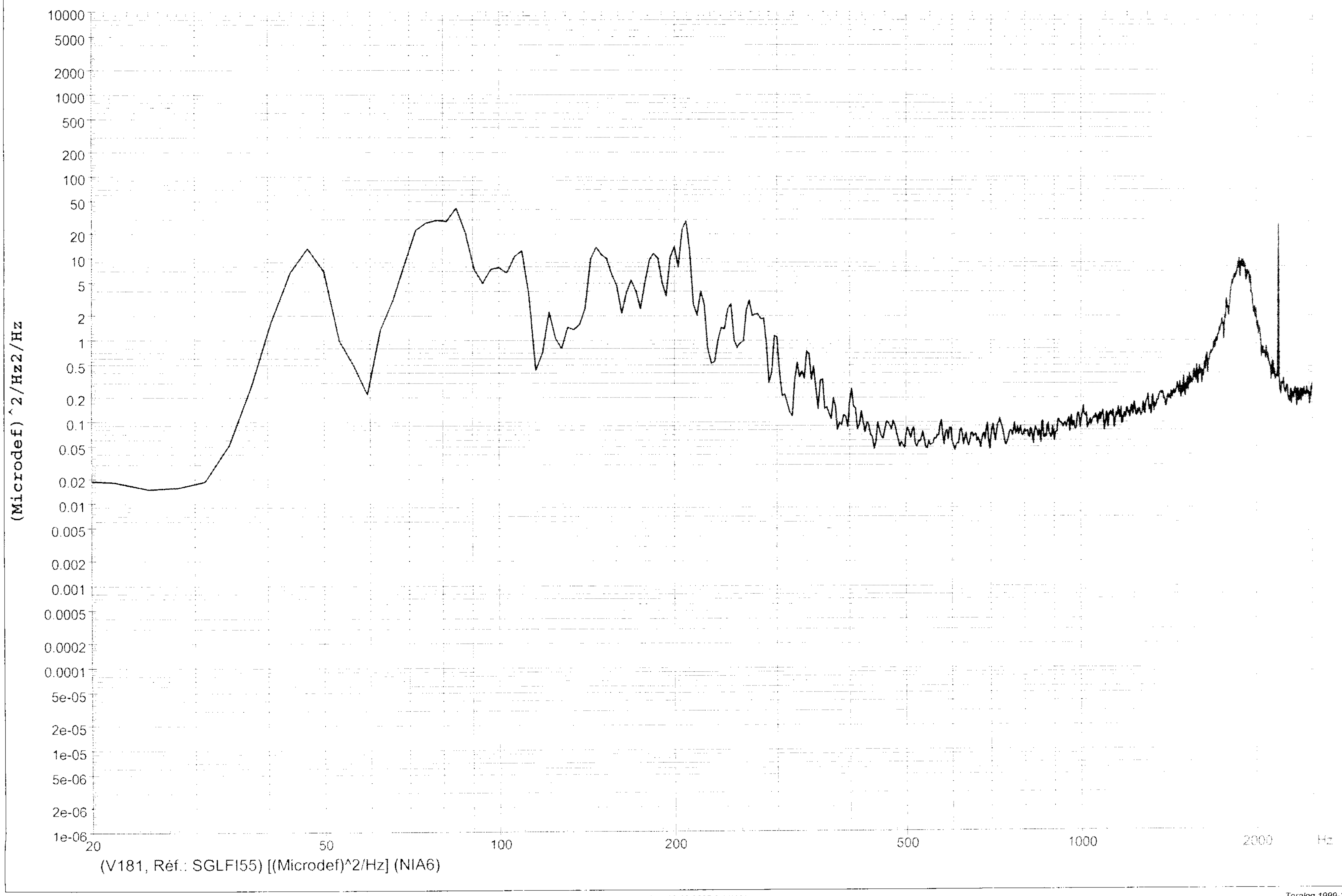
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V180, Réf.: SGLFI54) [(Microdef)^2/Hz] (NIA6)

ALCATEL SPACE

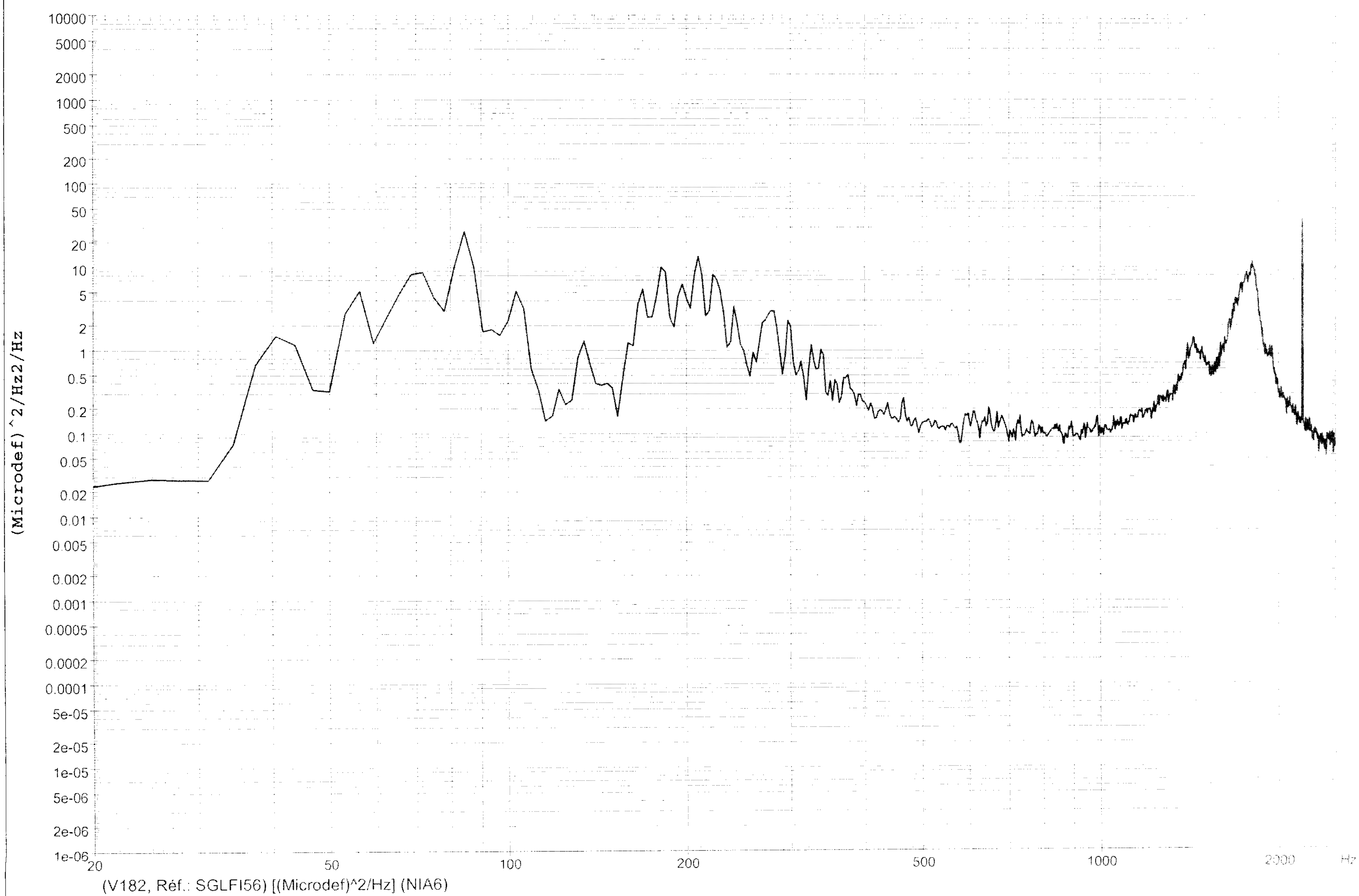
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



PC/Analysis 2.29é (25/08/2004) Edité le: 03/02/2005 à 11H41 Teralog 1999-2004

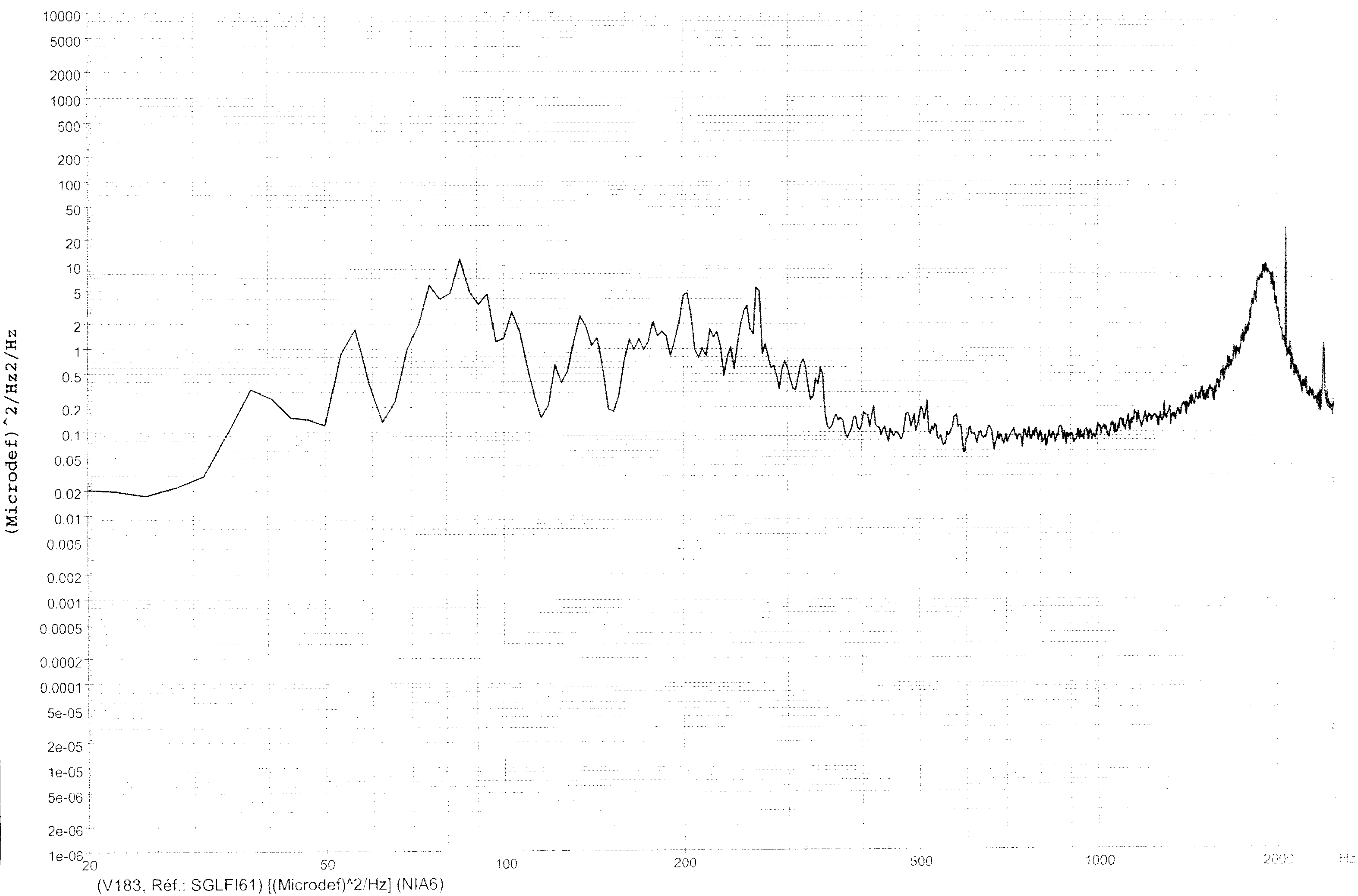
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



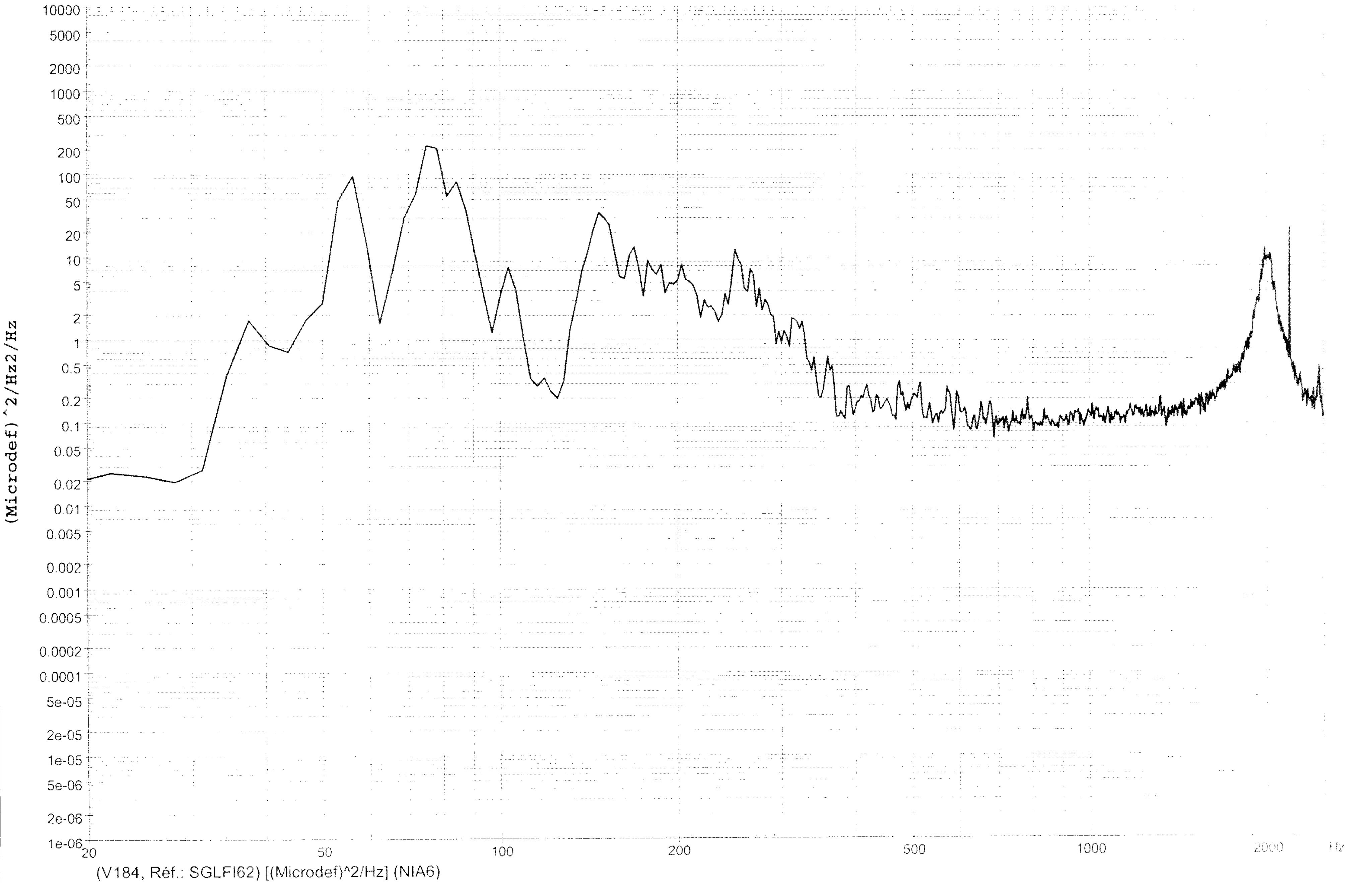
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



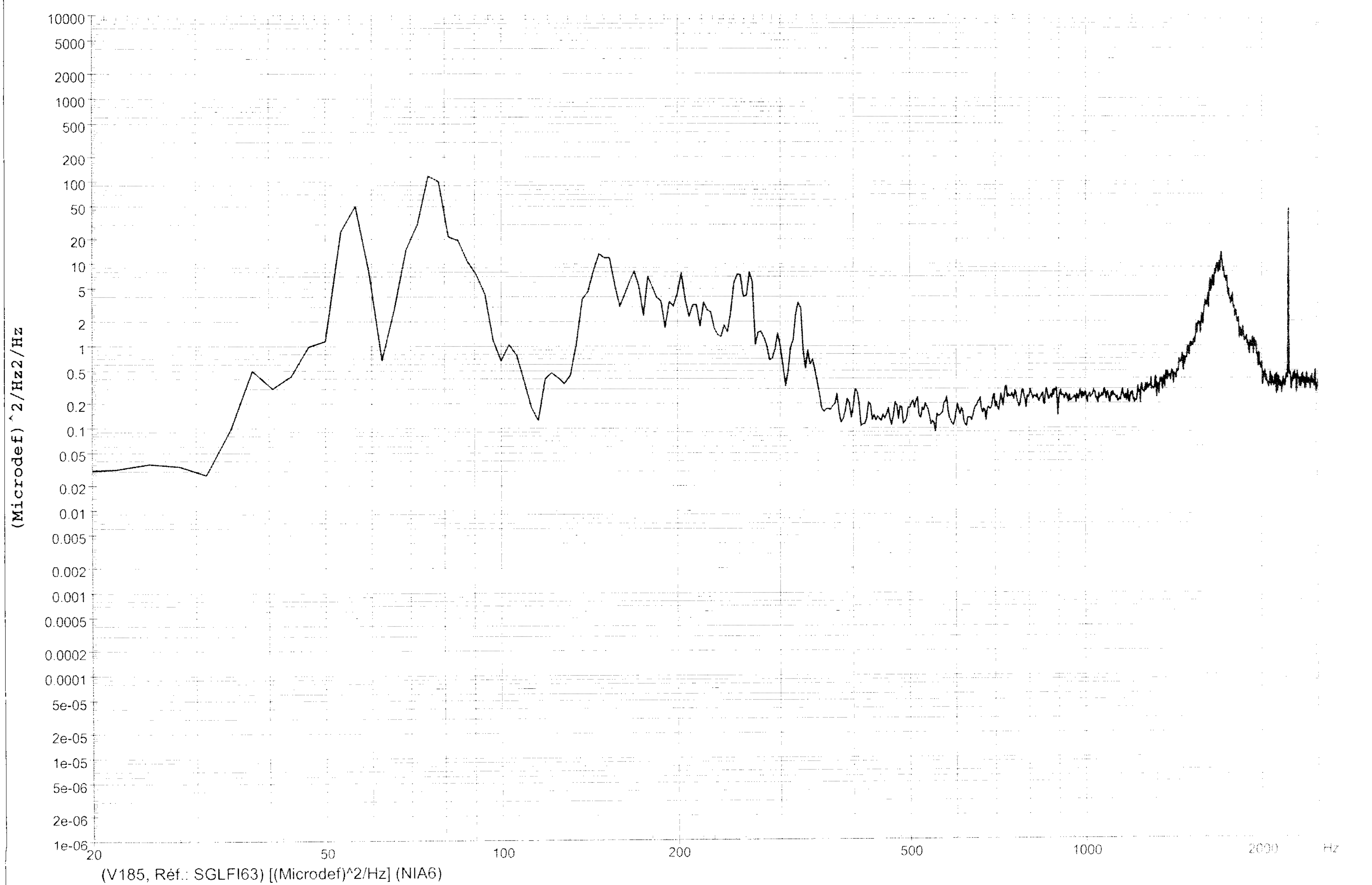
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



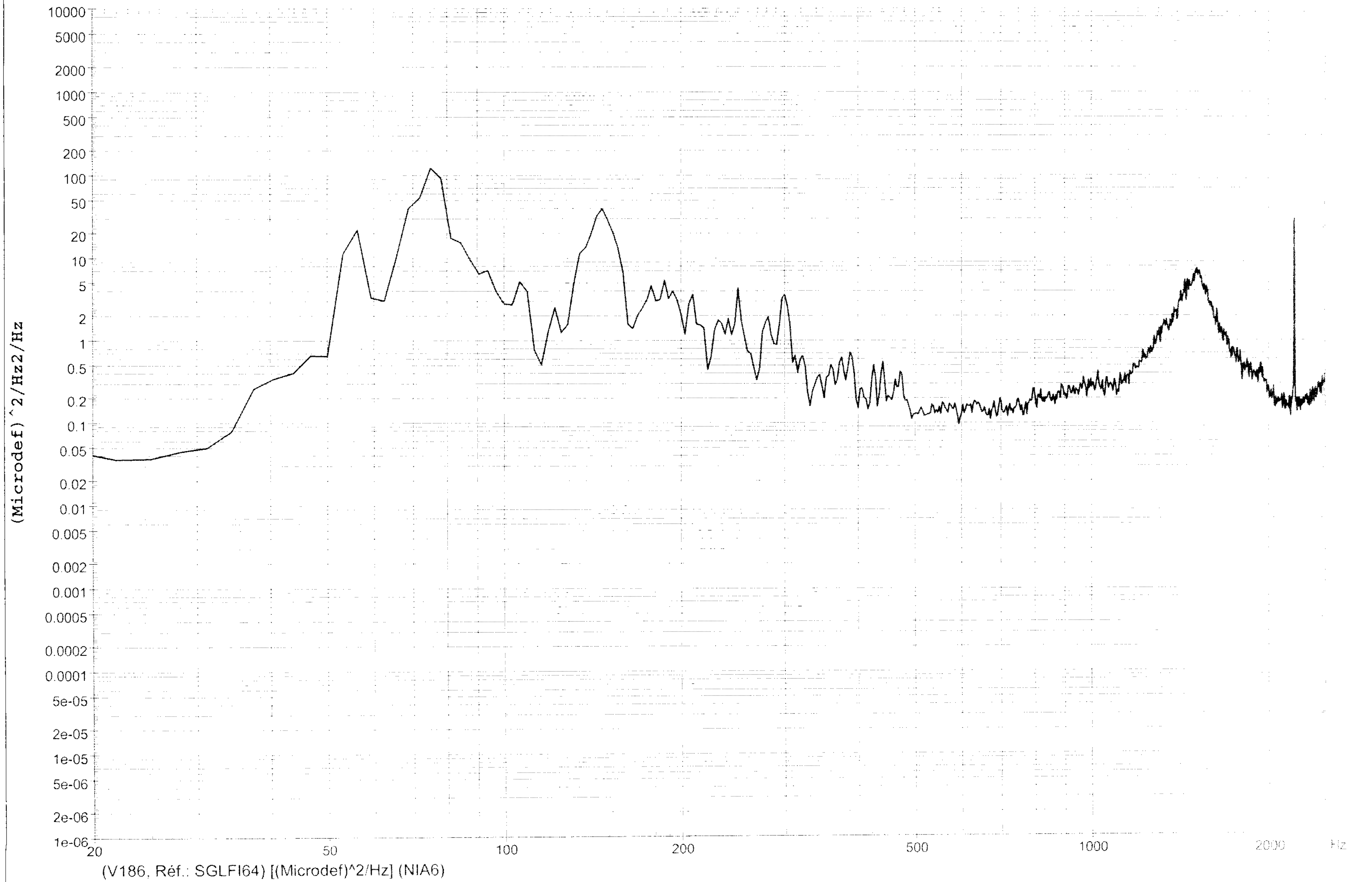
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



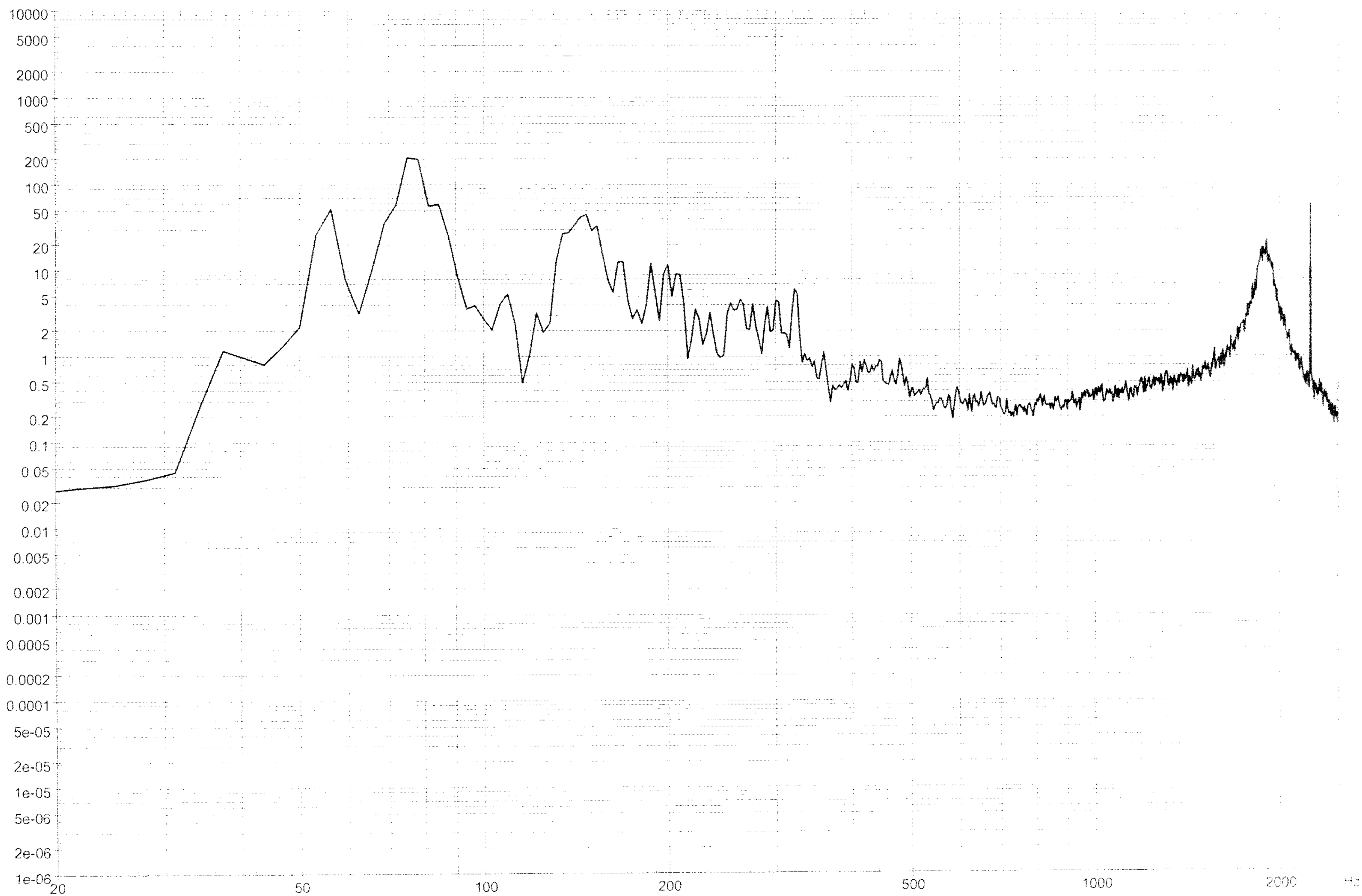
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



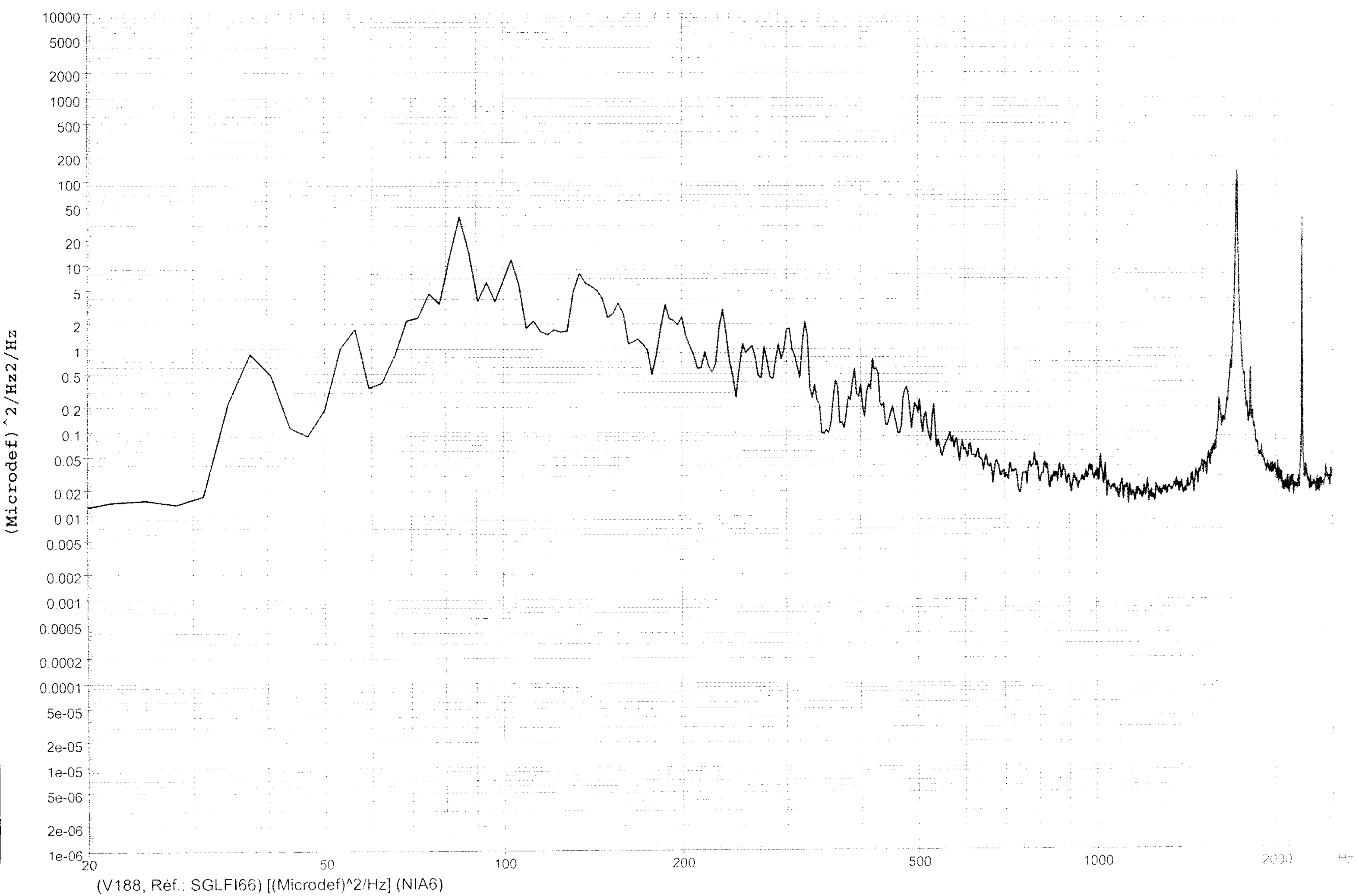
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



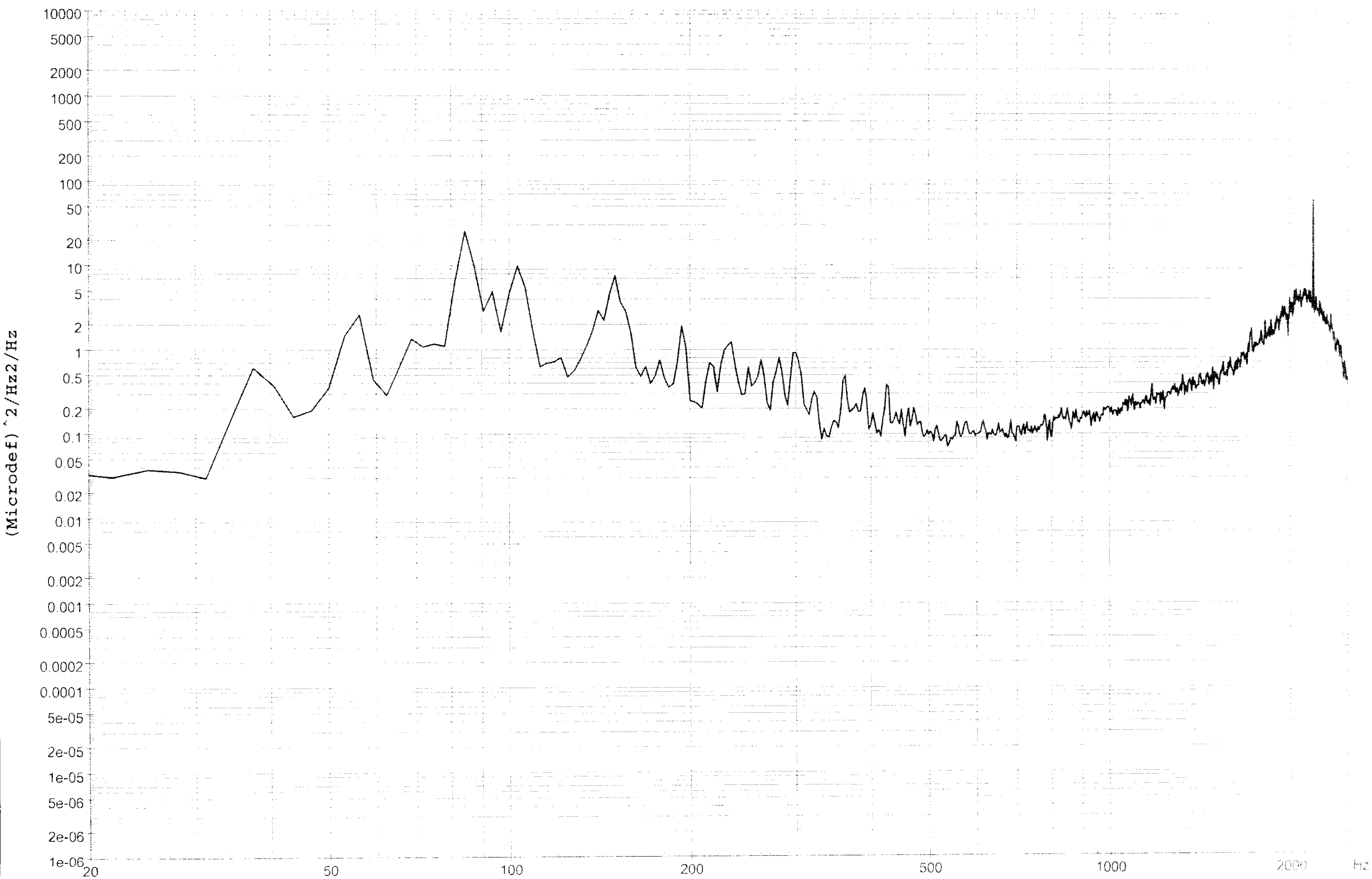
(V187, Réf.: SGLFI65) [(Microdef)^2/Hz] (NIA6)

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



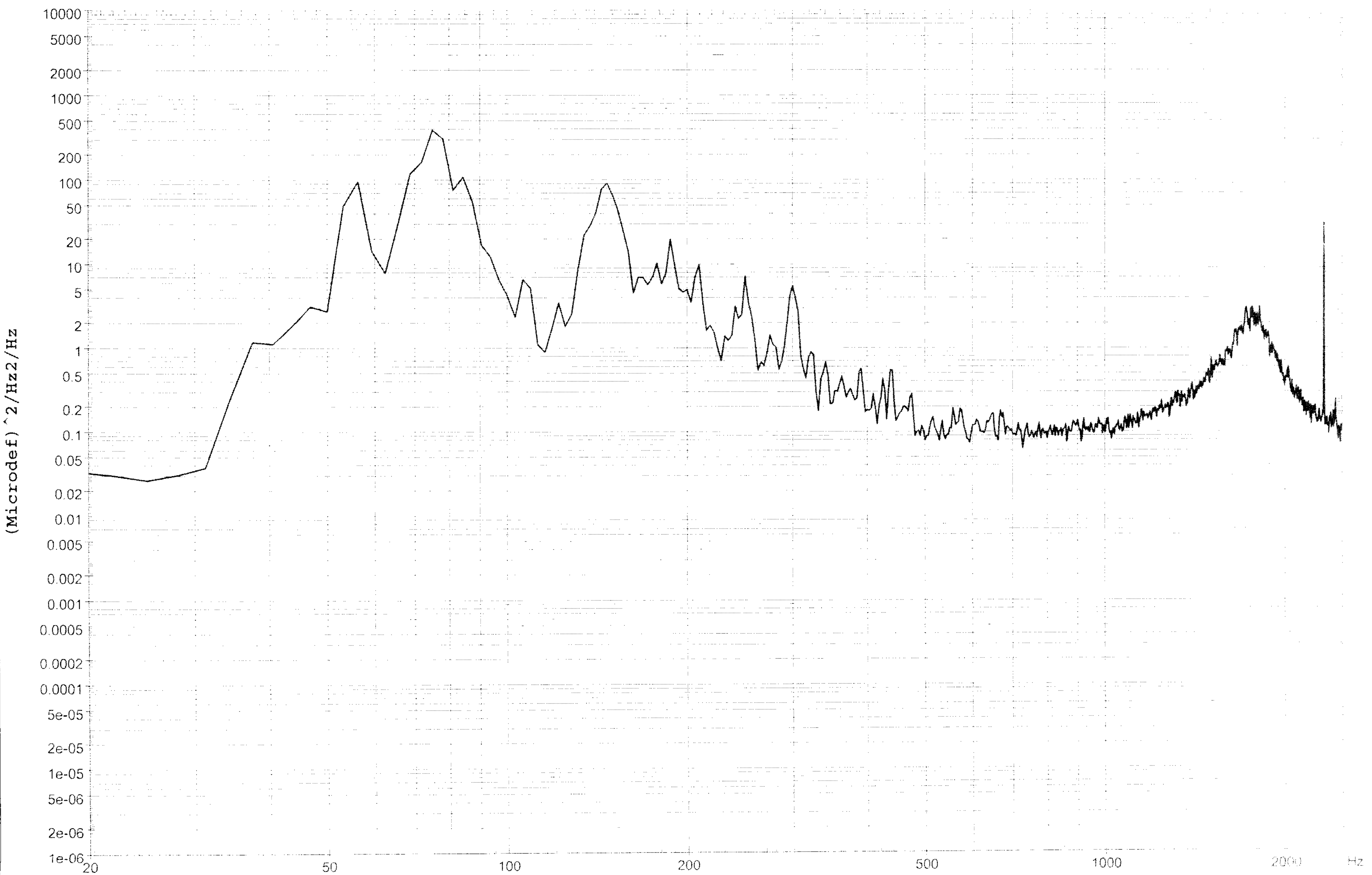
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V189, Réf.: SGLFI71) [(Microdef)^2/Hz] (NIA6)

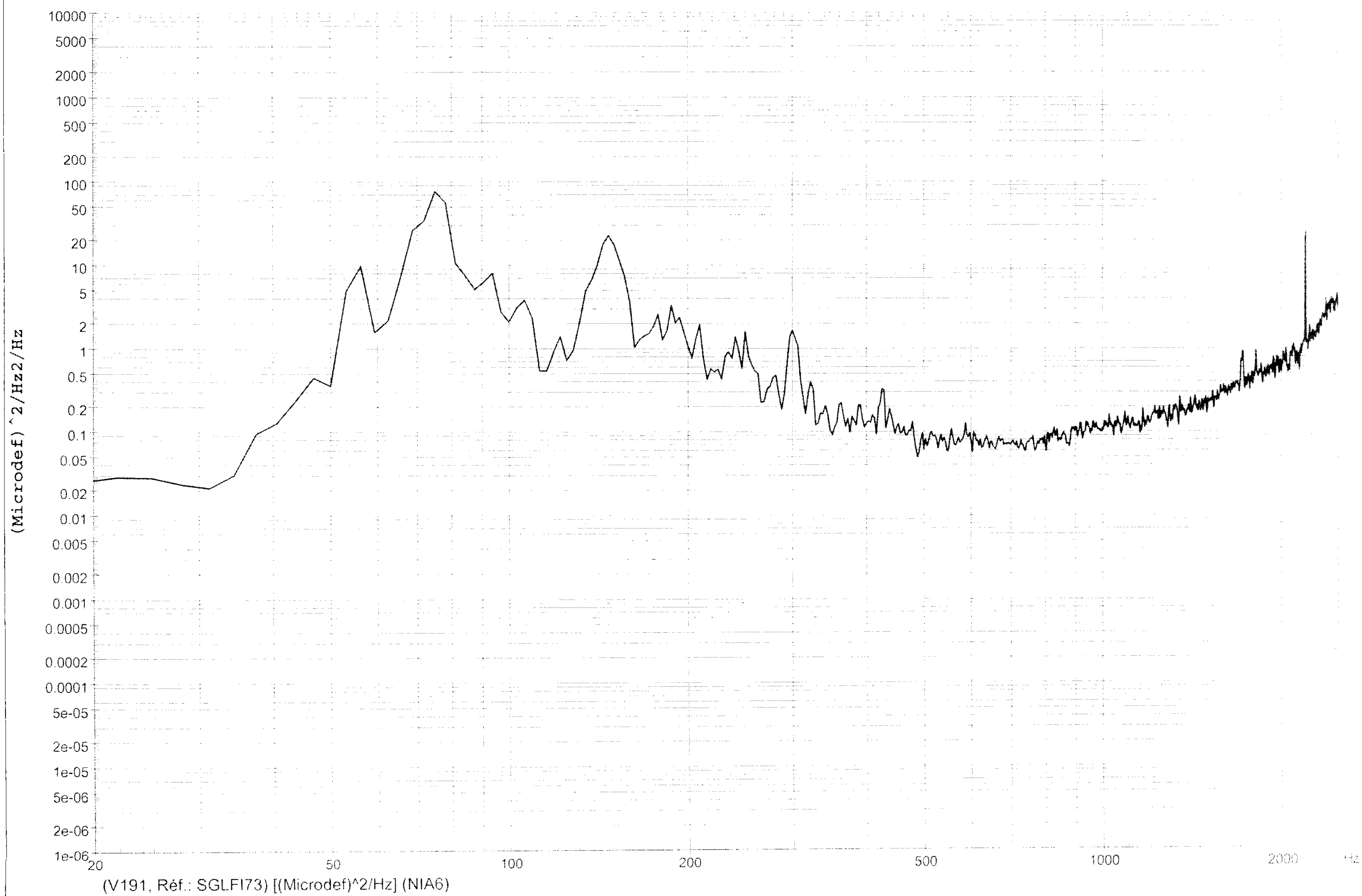
Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



(V190, Réf.: SGLFI72) [(Microdef)^2/Hz] (NIA6)

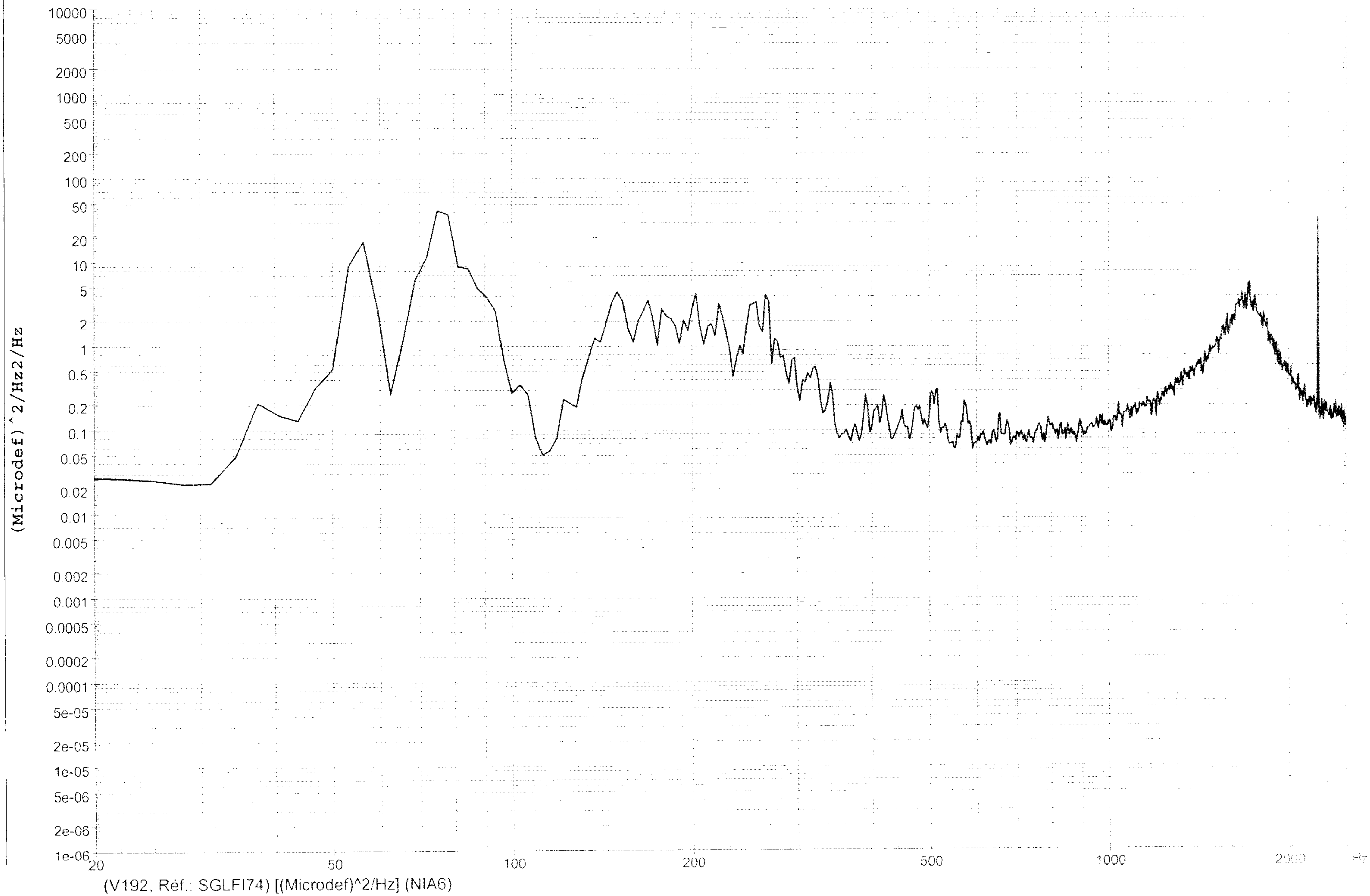
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



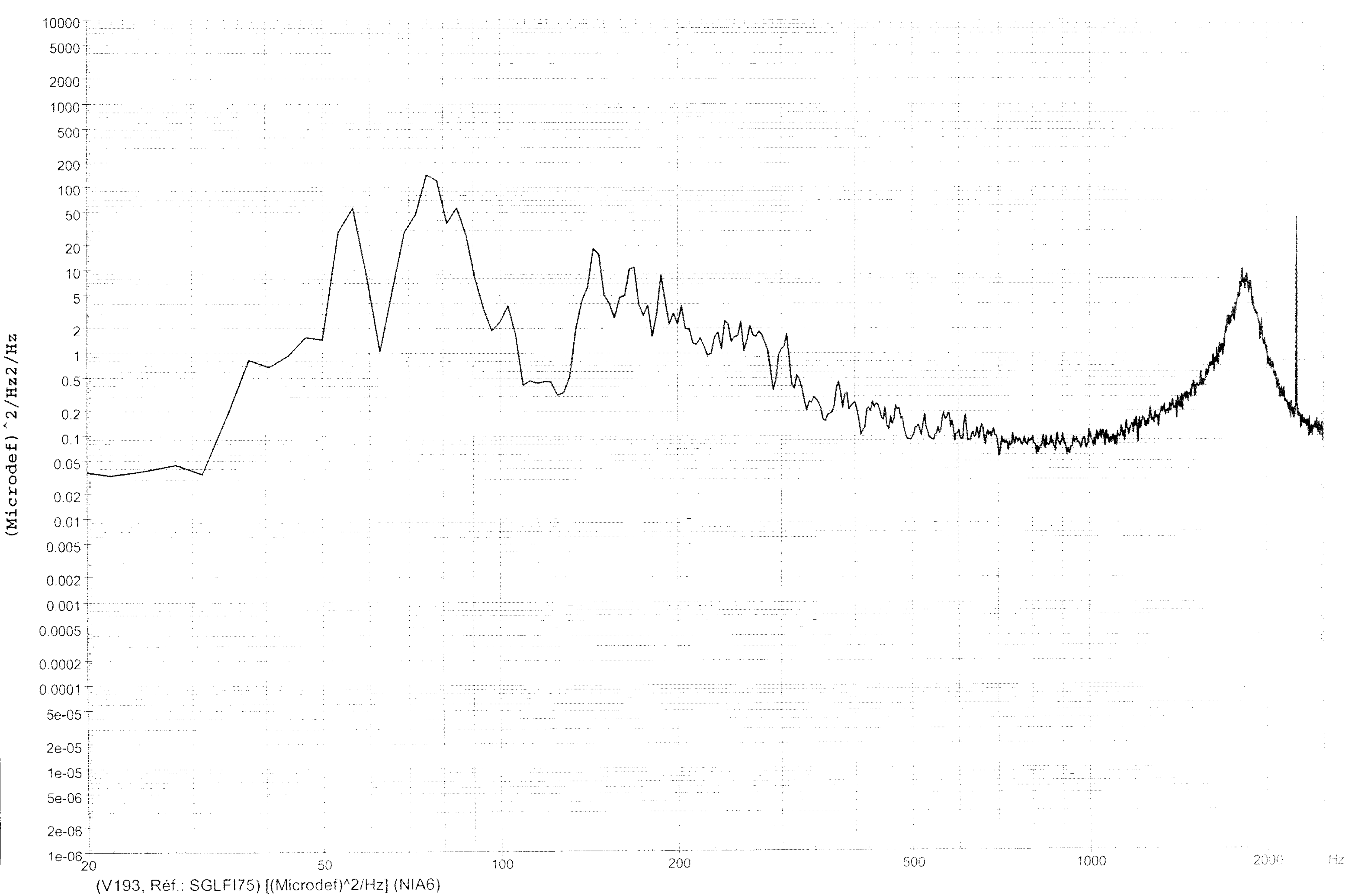
ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6



ALCATEL SPACE

Dossier: planck_CQMA - Engin: HERSCHEL PLANCK - Spécimen: QMA - Essai: NIA6