AUCOTEAM
INGENIEURGESELLSCHAFT FÜR AUTOMATISIERUNGS- UND COMPUTERTECHNIK mbH BERLIN

Test lab

CERTIFICATE of QUALITY TEST

Deutscher Akkreditierungs Rat
DAP-PL-3439.00

according to DIN 55 350 – 18 – 4.3.4

Test report-No. 5559 / 06

Client	**Spectra-Physics GmbH** Ruhlsdorfer Str. 95 14532 Stahnsdorf
Equipment under test	**Laser Head** **Controller** manufacturing date March 2006
Purpose	***Test of the climatic resistance and of the dynamic-mechanical robustness according to the standards as well as to the demands of the client***
Test program	***Temperature Cycling Test - test Nb*** ***Heat and Humidity Storage Test - test Cab*** ***Drop Test - test Ed*** ***Vibration Test - test Fc*** ***Shock Test - test Ea***
Test period	March 17th to March 24th 2006
Realization / results	see page 2 to 8
Test result	**The tests were realized according to the standards and to the demands of the client.** **After the Temperature Cycling Test, the operability of the Laser Head "B" was not ensured.** **After the Heat and Humidity Storage Test, the operability of the Laser Head was not ensured.** **During the drop test, accelerations partly > 30 g were measured.** **After the Vibration Test and the Shock Tests, the operability of the specimens was ensured.** **The tests that were not passed will be repeated after changing the construction of the Laser Head.**

Dipl.-Ing. R. Lein
Head of test lab / test manager
Berlin, April 6th 2006

AUCOTEAM GmbH Berlin QUALITÄTSPRÜFUNG

Dipl.-Ing. M. Rode
Test engineer

1 Purpose

Test of the climatic resistance and of the dynamic-mechanical robustness under defined environmental conditions according to the standards and to the demands of the client.

2 Equipment under test (EUT)

Laser Head	packed and unpacked	
Controller	packed and unpacked	
specimen-No.	Laser Head A, B (packed), Controller PS (packed)	(tests Nb)
	Controller SN C10014-ENG, Laser Head SN C50017-ENG, empty housing of Laser Head, 2 cables	(tests Cab)
	Laser Head SN C50018-ENG, Controller SN C10014-ENG	(tests Fc and Ea)
	Laser Head, Controller, 2 cables in package	(test Ed)
manufacturing date	March 2006	
delivery date of the EUT	March 16th 2006	
return date of the EUT	March 24th 2006	

3 Basics

3.1 Demands of the client

3.2 Used standards

IEC 60068-1:1988 + **Corr.** 1988 + **A1**:1992 **DIN EN 60068-1**, issue: 1995-03
"Environmental testing - part 1: general and guidance"

IEC 60068-2-6:1995 + **Corr.** 1995 **DIN EN 60068-2-6**, issue1996-05
"Environmental testing Part 2 - test Fc: vibration, sinusoidal"

IEC 60068-2-14:1984 + **A1**:1986 **DIN EN 60068-2-14**, issue: 2000-08
"Environmental testing - part 2: test N: temperature change"

IEC 60068-2-27:1987 **DIN EN 60068-2-27**, issue: 1995-03
"Environmental testing - part 2: test Ea: shock"

IEC 60068-2-32:1975 + **A1**:1982 + **A2**:1990 **DIN EN 60068-2-32**, issue:1995-03
"Environmental testing - part 2: test Ed: free fall"

IEC 60068-2-47:1999 **DIN EN 60068-2-47**, issue: 2000-08
"Environmental testing - part 2-47: test methods – mounting of components, equipment and other articles for vibration, impact and similar dynamic tests"

IEC 60068-2-78 / 2001 **DIN EN 60068- 2-78**, issue: 2002-09
"Environmental testing - part 2-78: test Cab: damp heat, steady state"

ASTM D 5276 - 98
"Standard Test Method for Drop Test of Load Containers by Free Fall"

ASTM D 3580 - 95 (Reapproved 2004)
"Standard Test Methods for Vibration (Vertical Linear Motion) Test of Products"

ASTM D 999 - 01
"Standard Test Methods for Vibration Testing of Shipping Containers"

ASTM D 3332 - 99 (Reapproved 2004)
"Mechanical-Shock Fragility of Products, Using Stock Machines"

4 Test program

4.1 Temperature Cycling Test
Temperature change, slow – test Nb
according to IEC 60068-2-14

specimen-No.	A, B and PS
EUTnot operating	
lower test temperature	-20 °C
upper test temperature	+50 °C
temperature change gradient	5 K/min
dwell time at -20 °C	3 h
dwell time at +50 °C	3 h
cycle duration	ca. 6,5 h
number of cycles	10
test duration	ca. 3 d

Visual inspection
Before and after the test, the specimens shall be examined visually.

Functional test
Before and after the test, a functional test of the specimens shall be performed by the client.

Failure criteria
- mechanical and/or thermal damages
- no function or functional failure

4.2 Heat and Humidity Storage Test
Damp heat, steady state – test Cab
according to IEC 60068-2-78

specimen-No.	Controller SN C10014-ENG, Laser Head SN C50017-ENG, empty housing of Laser Head, 2 cables
EUTnot operating	
test temperature	+40 °C
relative humidity	85 % r.H.
test duration	96 h (4 d)

Remark
The humidity inside the empty housing shall be logged.

Visual inspection
Before and after the test, the specimens shall be examined visually.

Functional test
Before and after the test, a functional test of the specimens shall be performed by the client.

Failure criteria
- mechanical and/or thermal damages
- no function or functional failure
- high humidity inside the empty housing

4.3 Drop Test

Free fall – test Ed

according to IEC 60068-2-32 and ASTM D 5276 - 98

specimens	Laser Head, Controller, 2 cables in package
EUT	not operating
falling height	1 m
underlay	concrete floor
test parameters	1 fall on each side, edge, corner
max. permissible acceleration on EUT	30 g (measured at the Laser Head)

Visual inspection

Before and after the test, the specimens shall be examined visually for any mechanical damages.

Functional test

Before and after the test, a functional test of the specimens shall be performed by the client.

Failure criteria

- max. permissible acceleration on EUT =< 30 g
- mechanical damages that could lead to a partly or total functional failure
- no function or functional failure

4.4 Vibration Test

Vibration, sinusoidal – test Fc

according to IEC 60068-2-64, ASTM D 3580 - 95 and ASTM D999 - 01

specimens	Laser Head SN C50018-ENG, Controller SN C10014-ENG, 2 cables
EUT	not operating
Test A	specimens in package
Test B	Laser Head and Controller not in package
frequency range	3 Hz – 300 Hz – 3 Hz
acceleration	0,5 g (4,905 m/s²)
frequency change	1 octave/min
number of axes	3 (X, Y, Z)
test duration	2 sweeps in X-, Y- and Z-axis

Remark

The specimens shall be checked for any resonance points. Afterwards, the specimens shall be tested in every resonance point for 15 min.

Visual inspection

Before and after the test, the specimens shall be examined visually for any mechanical damages.

Functional test

Before and after the test, a functional test of the specimens shall be performed by the client.

Failure criteria

- mechanical damages
- no function or functional failure

4.5 Shock Test

Mechanical Shock – test Ea

according to IEC 60068-2-27and ASTM D 3332

specimens	Laser Head SN C50018-ENG, Controller SN C10014-ENG
EUT	not operating
pulse shape	rectangle

Test #1

acceleration	10 g
pulse duration	18 ms
number of axes	1 (Z-axis, 2 directions)
number of shocks	1 shocks per direction
number of shocks total	2 shocks

Test #2

acceleration	20 g
pulse duration	18 ms
number of axes	1 (Z-axis, 2 directions)
number of shocks	1 shocks per direction
number of shocks total	2 shocks

Test #3

acceleration	$35_{-10\%}$ g
pulse duration	$18_{-10\%}$ ms
number of axes	1 (Z-axis, 2 directions)
number of shocks	1 shocks per direction
number of shocks total	2 shocks

Visual inspection

Before and after the test, the specimens shall be examined visually for any mechanical damages.

Functional test

Before and after the test, a functional test of the specimens shall be performed by the client.

Failure criteria

- mechanical damages
- no function or functional failure

5 Realization

The environmental tests were carried out one by one according to the program of testing methods (complex 4.1 to 4.5), according to the standards and to the demands of the client.

Remark (Drop Test)
The procedure for identifying the members (faces, edges, and corners) of the rectangular containers (big and small one) was as follows (see Fig. A1). One end of the box is facing the manufacturer's joint, where applicable, on the observer's right, the top of the box is designated as 1, the right side as 2, the bottom as 3, the left side as 4, the near end as 5, and the far end as 6. The edges are identified by the numbers of two faces that form that edge; for example, 1 2 identifies the edge formed by the top and the right side. The corners are identified by the three faces that meet to form that corner; for example, 1 2 6 identifies the corner at which the top, right side, and far end
meet (see Fig. A2).

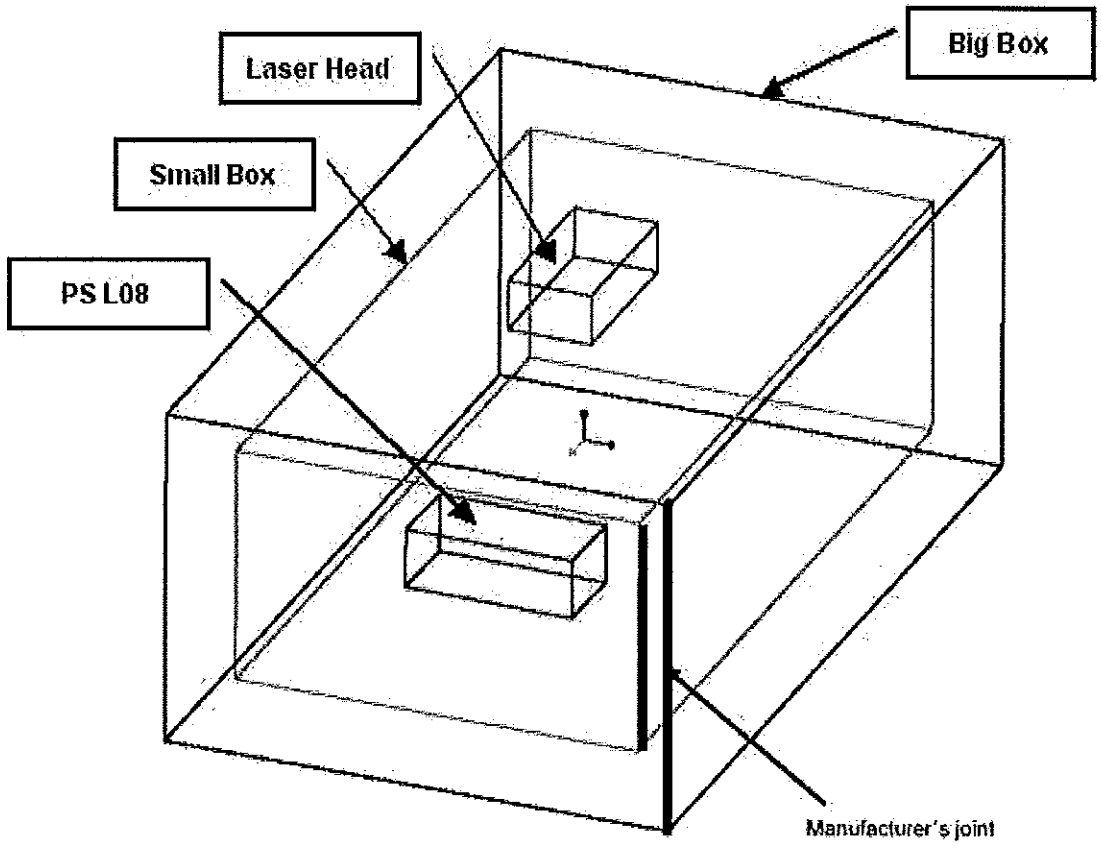


Fig. A1

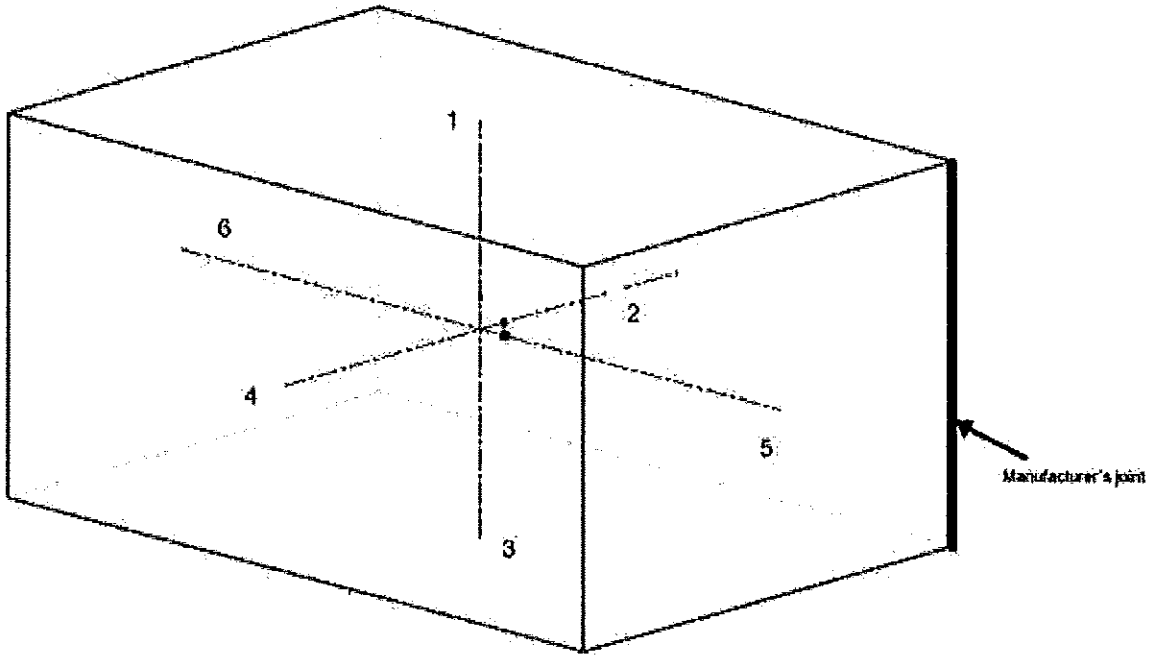


Fig. A2

Measuring and test facilities

name	type	serial-No.	producer	Calibrated till	remarks
data logger	MA 2290-8	H03120430G	Ahlborn	21.07.2006	temp. / humidity measuring
temperature / humidity sensor	FH A646-R	05050092	Ahlborn	24.01.2008	temp. / humidity measuring
climatic test chamber 6	KPK 630.V	010/89	Feutron	22.06.2006	test Cab
temperature test chamber 10	TPK 600	096/01	Feutron	26.09.2006	test Nb
vibration test facility	TV 57315/LS-11K	157/02	Tira	02.06.2006	test Fc and Ea
acceleration sensor	752-500	12858	Endevco	09.09.2006	control sensor - test Fc
acceleration sensor	353B18	102393	PCB	18.07.2007	control sensor - test Fc
acceleration sensor	353B33	90977	PCB	23.01.2008	measurement K3 - test Fc (K3 - at the Controller)
acceleration sensor	353B34	86256	PCB	18.02.2007	measurement K4 - test Fc (K4 - at the Laser Head)
acceleration sensor	353B03	41543	PCB	17.03.2006	control sensor - test Ea
acceleration sensor	8778A500	2012472	Kistler	23.01.2008	measurement K3 - test Ea
acceleration sensor	352C22	61919	PCB	11.08.2007	measurement K4 - test Ea
provided by the client:					
notebook with test software					functional test
several interface cables					functional test

Climatic protocols see appendix 1

Drop test, vibration and shock protocols see appendix 2

Pictures see appendix 3

6 Results

6.1 Climatic tests

After the

- Temperature Cycling Test ***- test Nb***

no mechanical or thermal damages of the specimens A and PS were determined.
The operability of these specimens was ensured.

Remark
Specimen B showed mechanical damages (broken soldered points and broken PCB).
The operability of these specimens was not ensured.

After the

- Heat and Humidity Storage Test ***- test Cab***

the controller and the cables showed no mechanical, thermal or any other corrosive damages.
The operability of the controller was ensured.

Remark
The operability of the Laser Head was not ensured because of the high humidity inside.
The measured level of humidity inside the empty housing was about 75 % r.h.

6.2 Dynamic-mechanical tests

During

- Drop Test ***- test Ed***

the following max. accelerations were measured at the specimen (3D acceleration sensor at the Laser Head):

2006/03/23		**Max. acceleration [g] (absolute)**			
time	**geometry**	**X**	**Y**	**Z**	**vector**
11:18	1	6	7	14	14
11:25	3	4	12	25	28
11:32	4	4	**64**	4	**64**
11:40	2	4	25	3	25
11:48	5	28	7	6	28
11:51	6	**42**	7	3	**42**
11:56	26	20	14	2	25
12:38	46	6	14	28	28
12:46	15	1	2	1	2
12:49	53	21	6	9	23
12:54	45	1	3	1	3
12:58	52	15	15	4	19
13:05	12	5	28	25	**36**
13:08	14	1	4	1	5
13:13	34	7	11	14	17
13:19	32	3	19	10	21
13:22	436	11	12	8	17
13:27	345	11	11	6	15
13:32	352	0	14	9	19
13:37	326	10	12	6	17
13:47	145	1	3	1	4
14:00	146	0	4	1	3
14:04	612	8	26	25	**35**
14:17	512	13	6	9	14

After the drop test, no external damages of the specimens like cracks, breaks, distortions or any other mechanical damages were determined.

After the Drop Test, the operability of the specimens was ensured.

After

- Vibration Test (incl. resonance dwell) ***- test Fc***

no external damages of the specimens like cracks, breaks or distortions were determined.

Resonance points / points with increased acceleration were detected. The dwell test was done.

The operability of the specimens was ensured.

After

- Shock Test** (Test #1)* ***- test Ea
- Shock Test** (Test #2)* ***- test Ea
- Shock Test** (Test #3)* ***- test Ea

no external damages of the specimens like cracks, breaks, distortions or any other mechanical damages of the specimens were determined.

The operability of the specimens was ensured.

The further evaluation will be done by the client.

The tests were realized according to the standards and to the demands of the client.

After the Temperature Cycling Test, the operability of the Laser Head "B" was not ensured.

After the Heat and Humidity Storage Test, the operability of the Laser Head was not ensured.

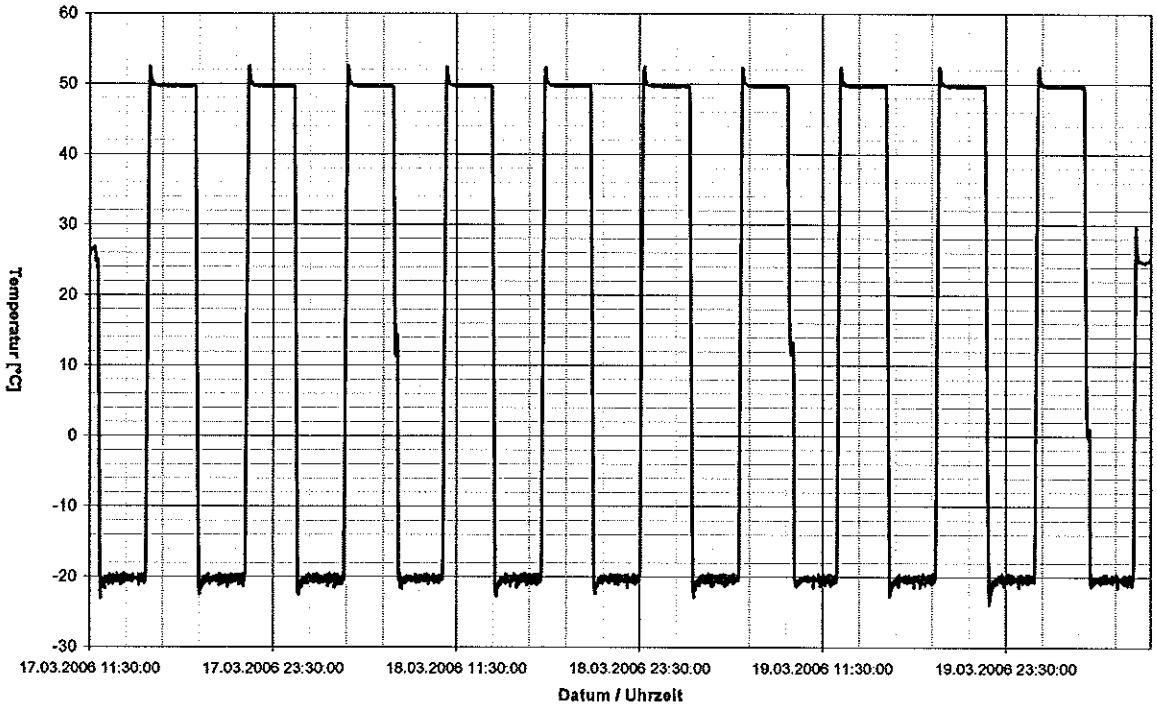
During the drop test, accelerations partly > 30 g were measured.

After the Vibration Test and the Shock Tests, the operability of the specimens was ensured.

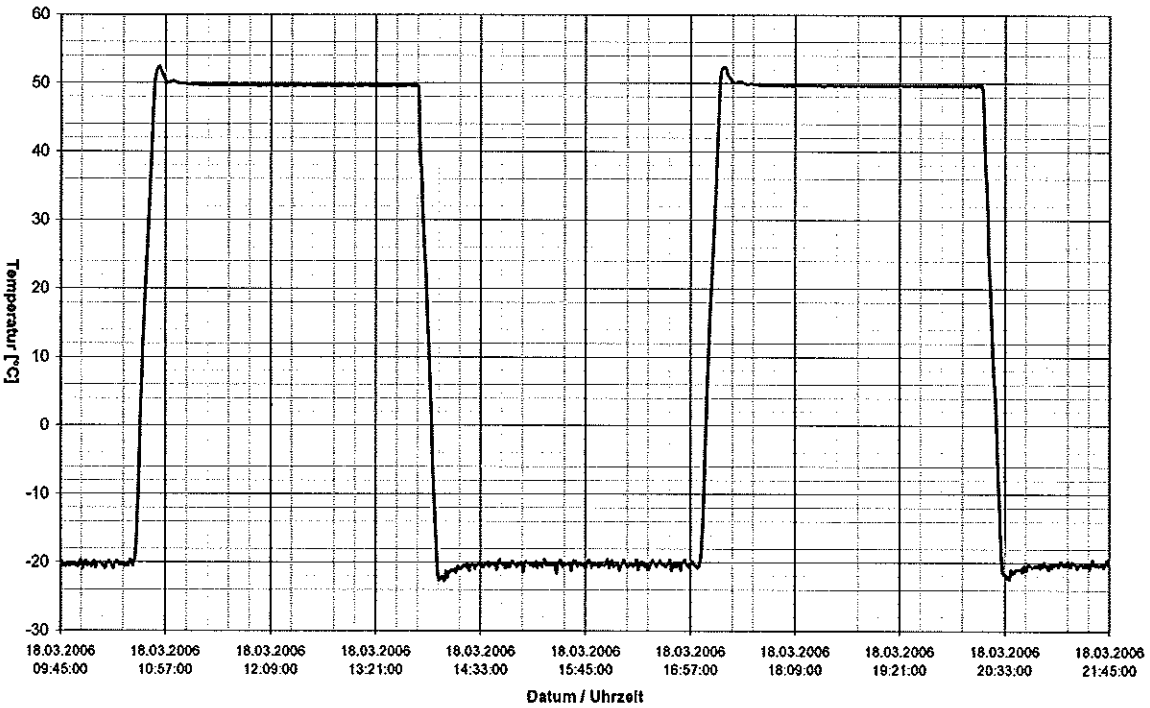
The tests that were not passed will be repeated after changing the construction of the Laser Head.

This test report-No. 5559 / 06 includes 10 pages and appendix 1 to 3.

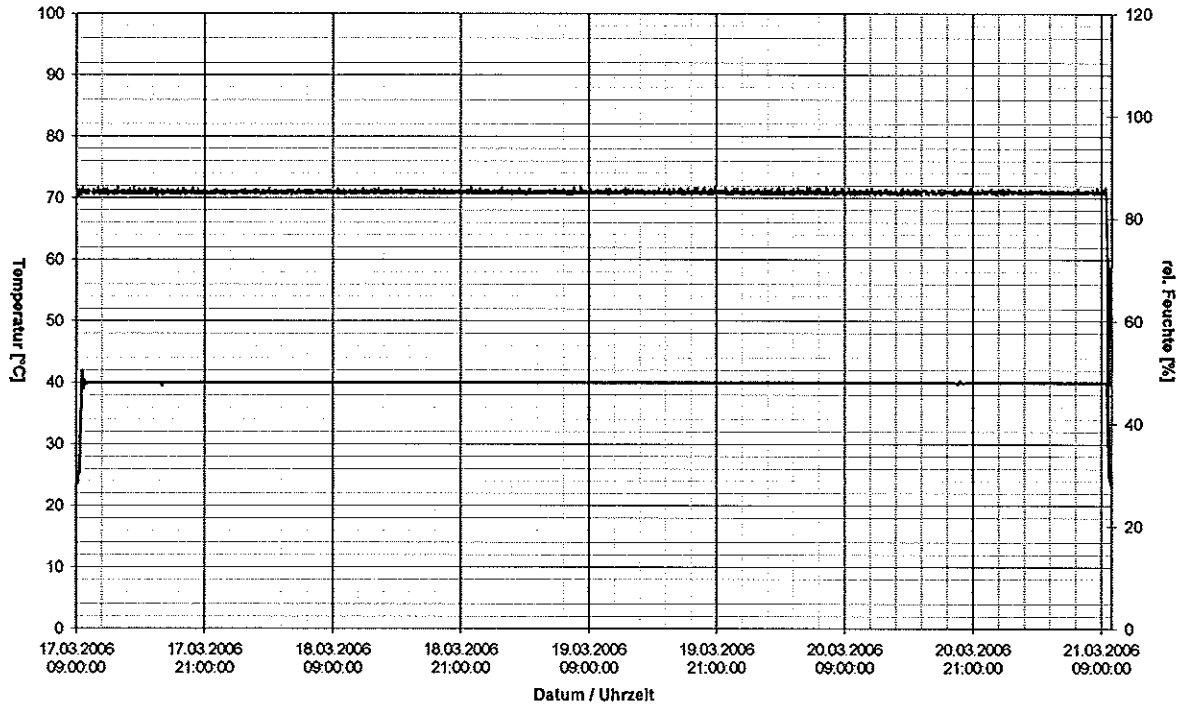
appendix 1 – climatic protocols
appendix 2 – drop test, vibration and shock protocols
appendix 3 – pictures



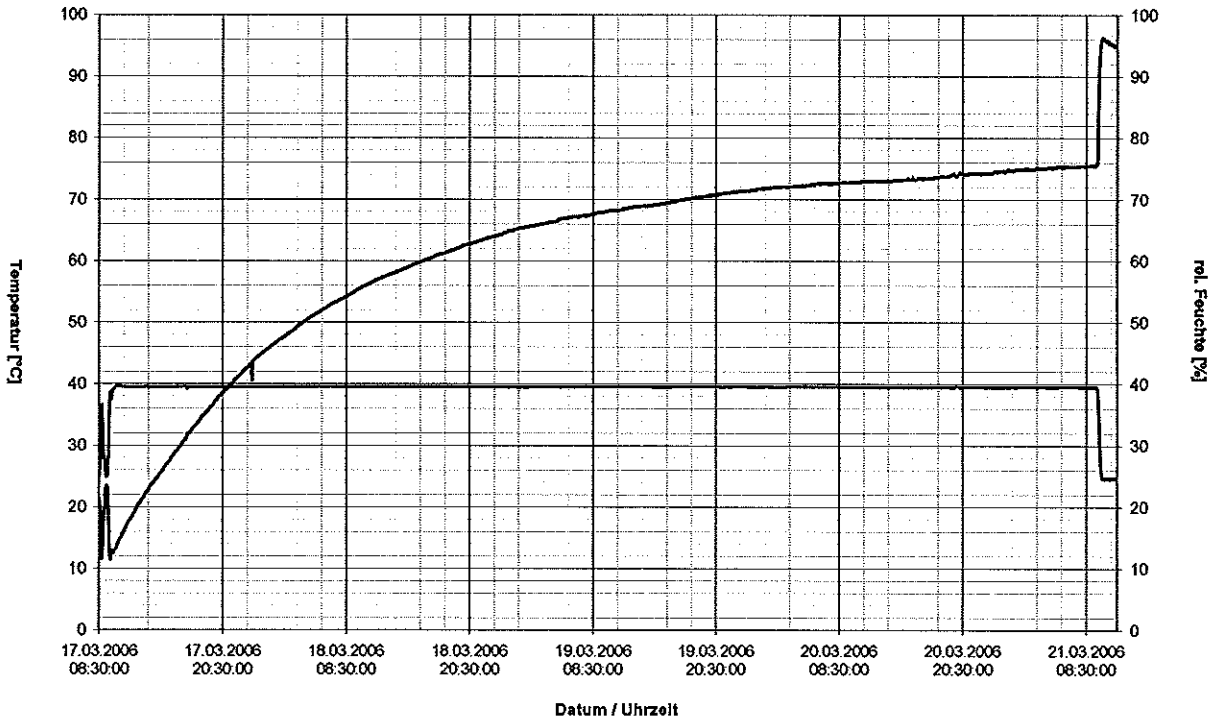
Temperature behavior in the temperature test chamber TPK 10 – test Nb (-20°C/+50°C, 10 cycles)



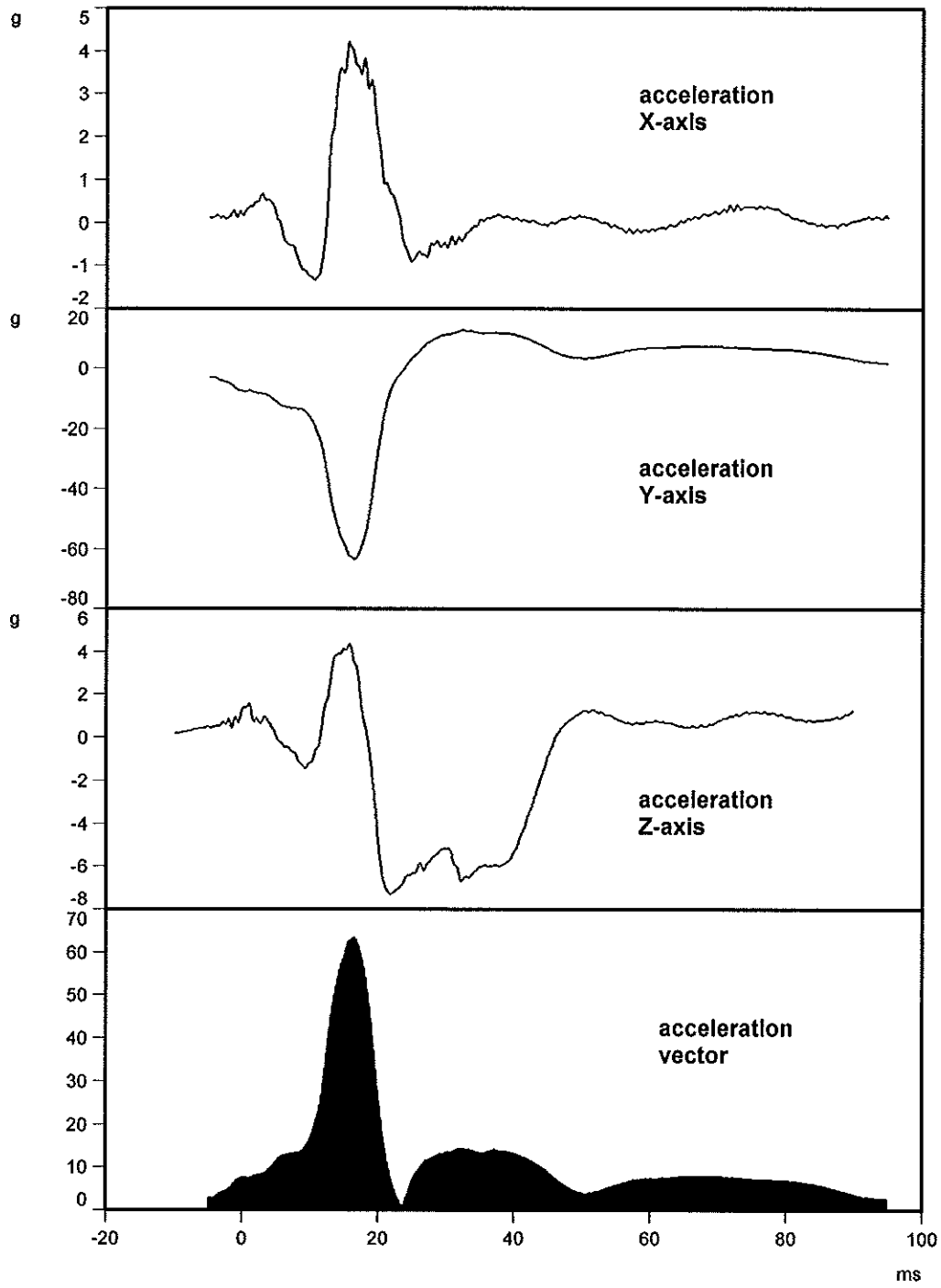
Temperature behavior in the temperature test chamber TPK 10 – test Nb (-20°C/+50°C, 2 cycles)



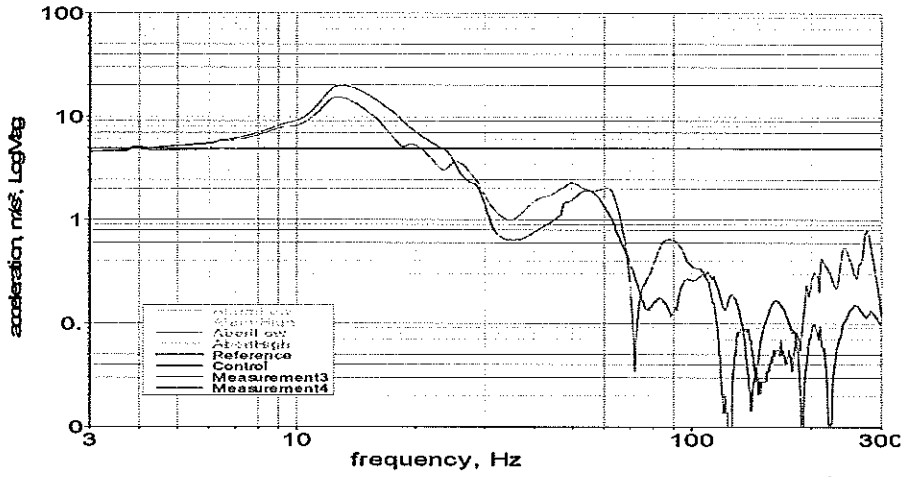
Climatic behavior in the climatic test chamber TPK 6 – test Cab (+40°C / 85 % r.F., 4 d)



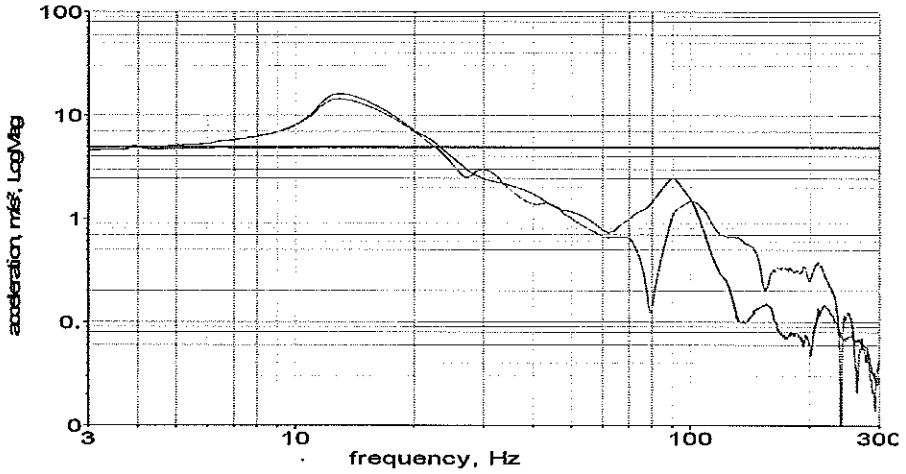
Climatic behavior inside the empty housing during test Cab (+40°C / 85 % r.F., 4 d)



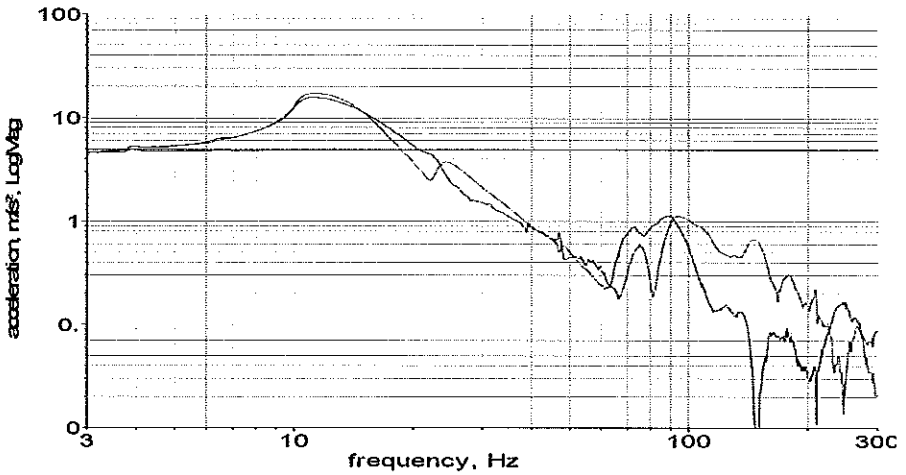
Maximally measured acceleration during Drop Test on side 4



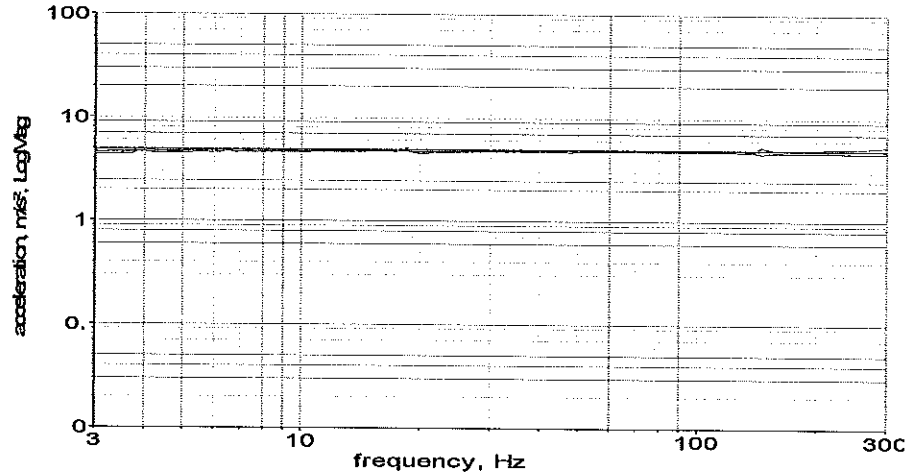
Vibration Test, Z-axis, specimens in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)



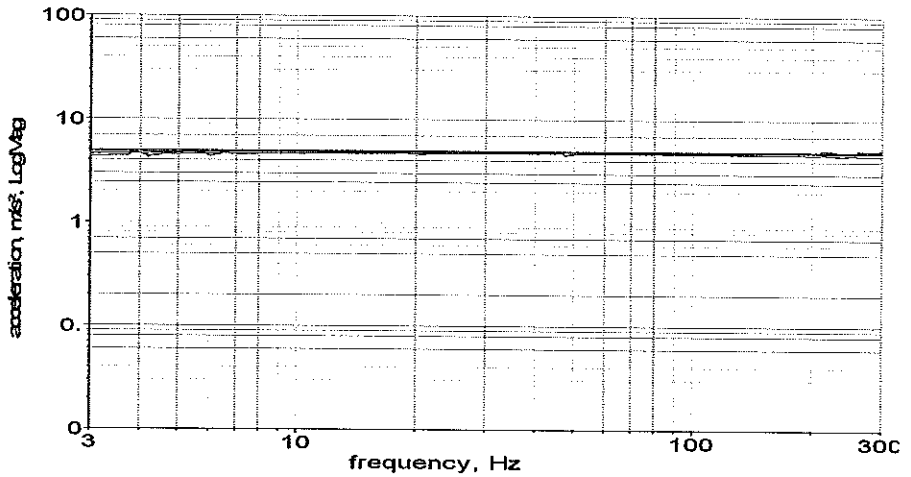
Vibration Test, Laser Head in X-axis, Controller in Y-axis, specimens in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)



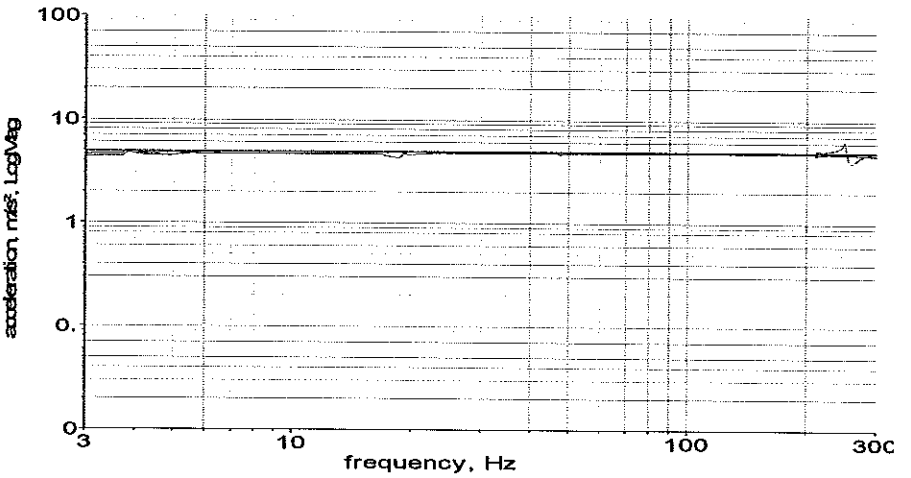
Vibration Test, Laser Head in Y-axis, Controller in X-axis, specimens in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)



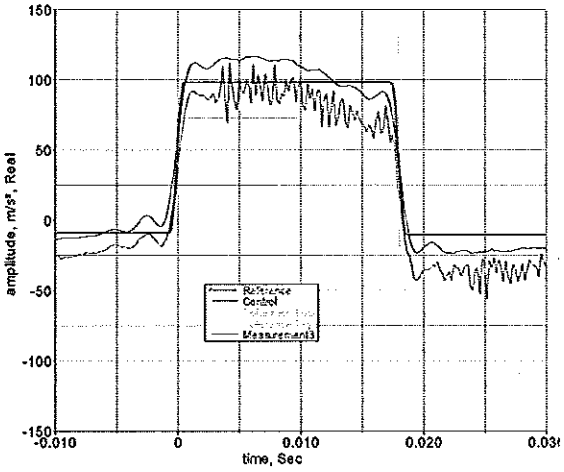
Vibration Test, X-axis, specimens not in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)

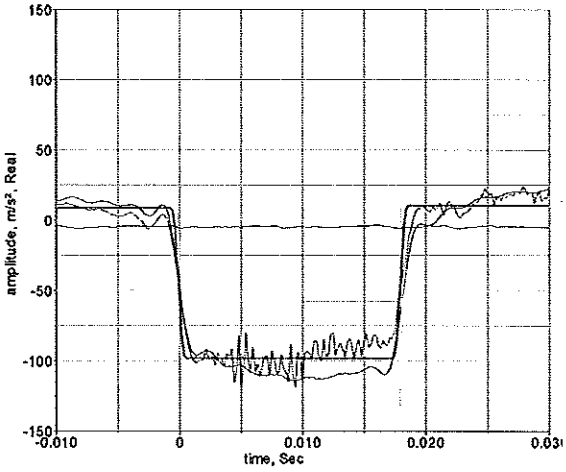


Vibration Test, Y-axis, specimens not in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)

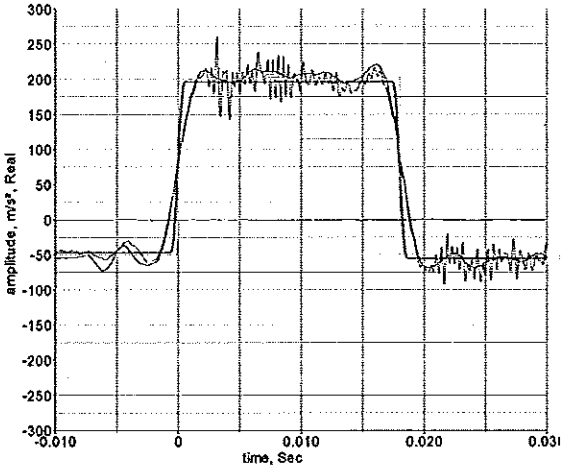


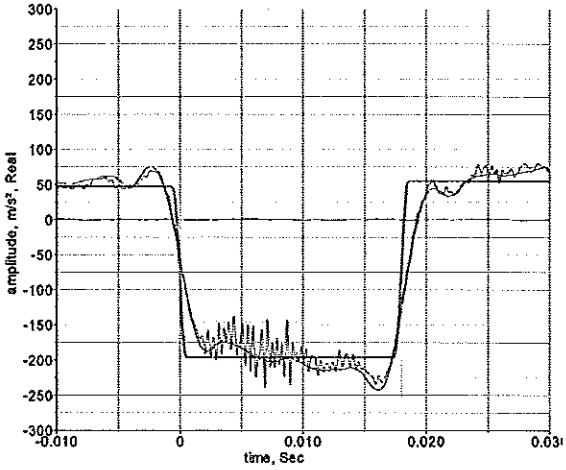
Vibration Test, Z-axis, specimens not in package, 3 - 300 - 3 Hz, 4,905 m/s² (0,5 g)



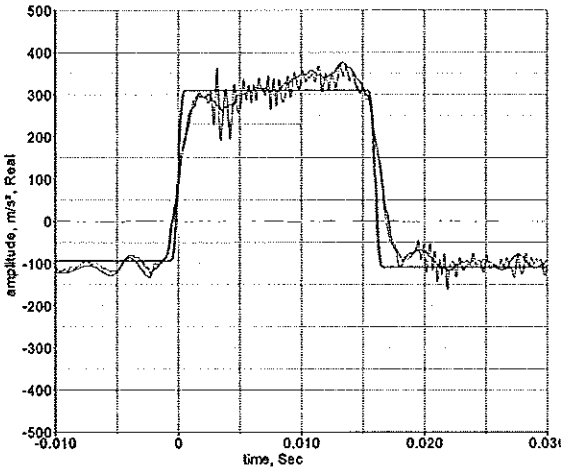


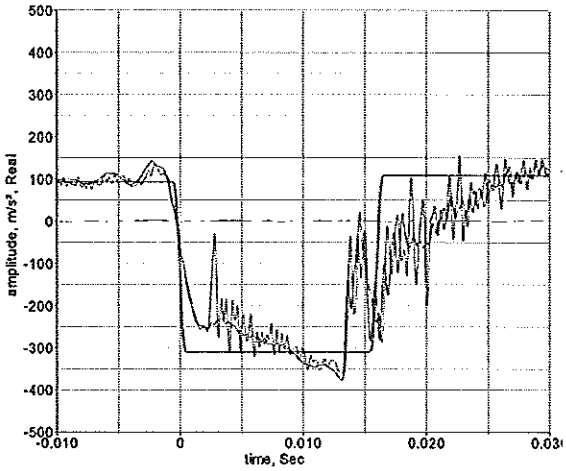
Shock, Z-axis, 10 g, 18 ms





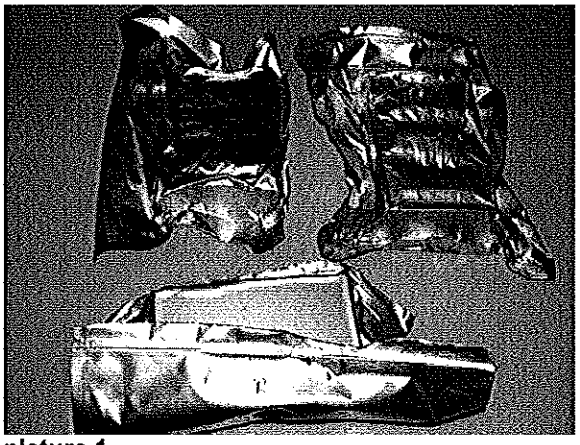
Shock, Z-axis, 20 g, 18 ms





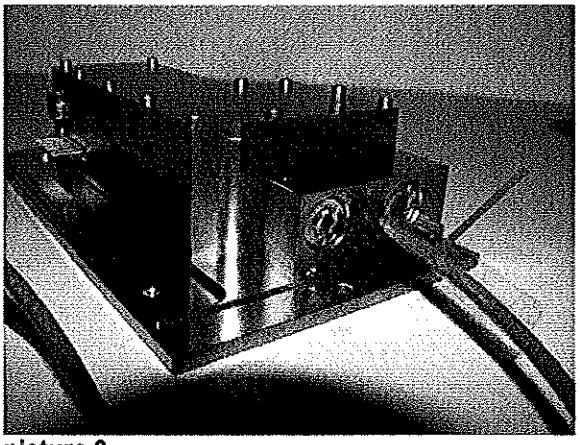
Shock, Z-axis, 35.$_{10\%}$ g, 18.$_{10\%}$ ms.

Pictures

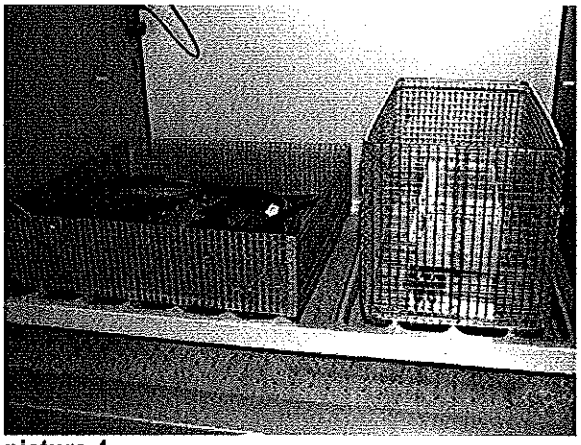


picture 1
Laser Heads A and B
Controller PS
delivery status

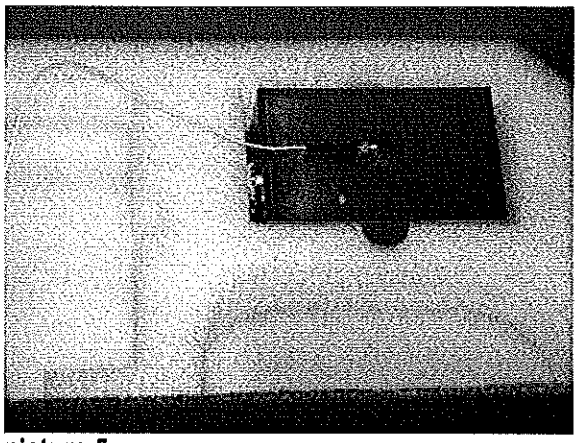
picture 2
Laser Heads A and B and Controller PS
in temperature test chamber 10
during test - Nb (-20°C/+50°C)



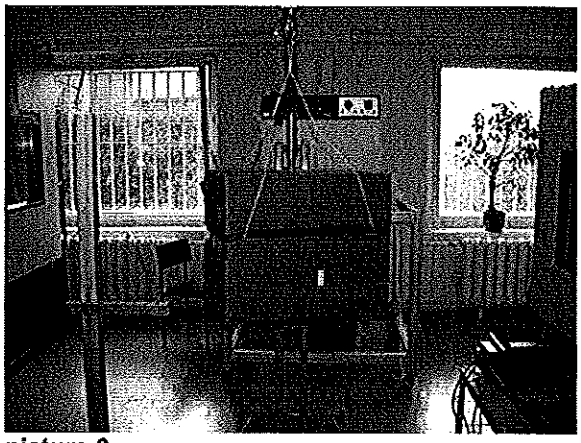
picture 3
empty housing
with humidity sensor inside (arrow)
before test - Cab (+40°C / 85% r.h.)



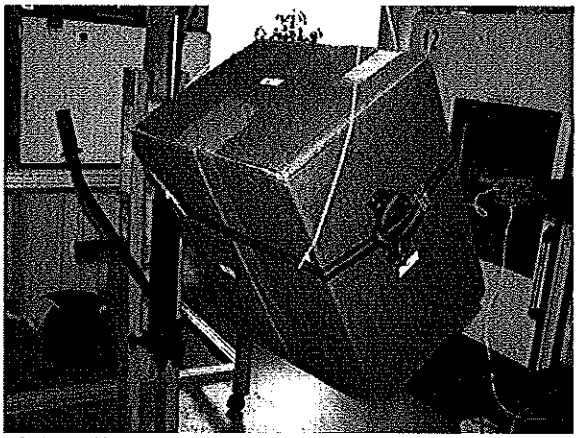
picture 4
specimens in test baskets
in climatic test chamber 6
during test - Cab (+40°C / 85% r.h.)



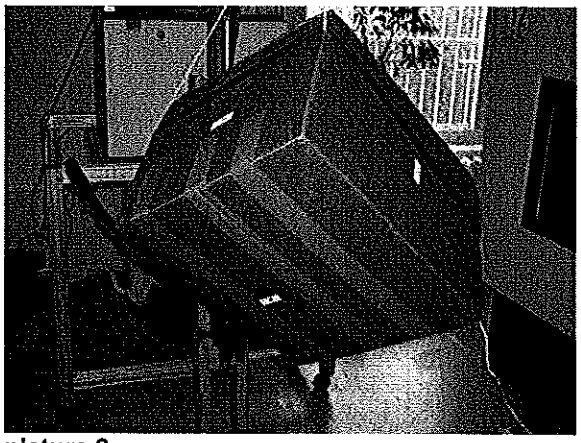
picture 5
Laser Head in package
with 3D acceleration sensor (arrow)
before Drop Test



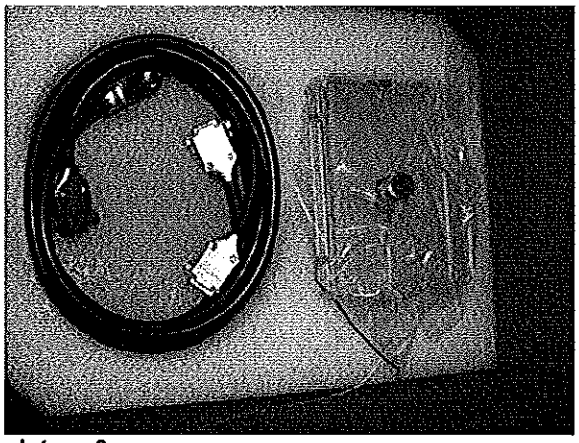
picture 6
Specimens in package
hanging on crane
during Drop Test on side 4



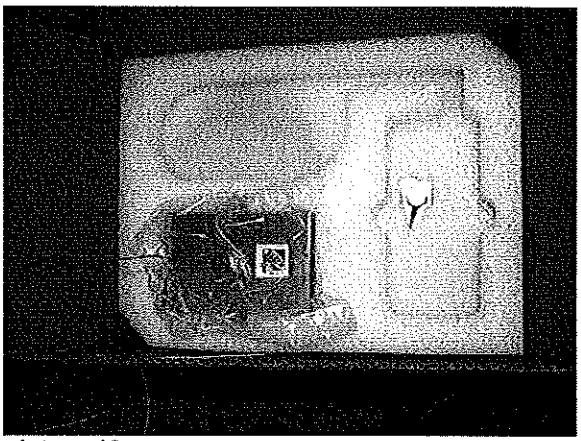
picture 7
Specimens in package
on crane
during Drop Test on edge 3-5



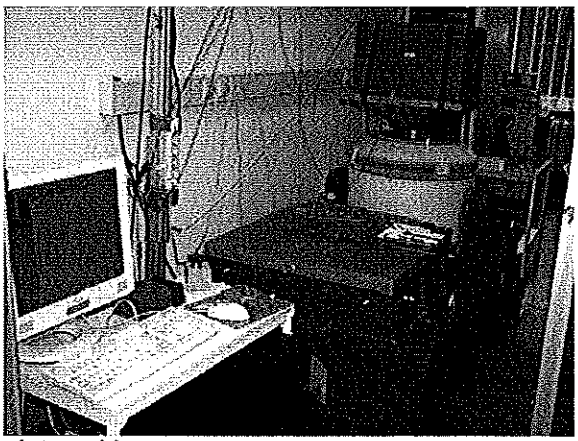
picture 8
TMC-Tuner Module – specimen No. 0032
top
during Drop Test on corner 1-5-4



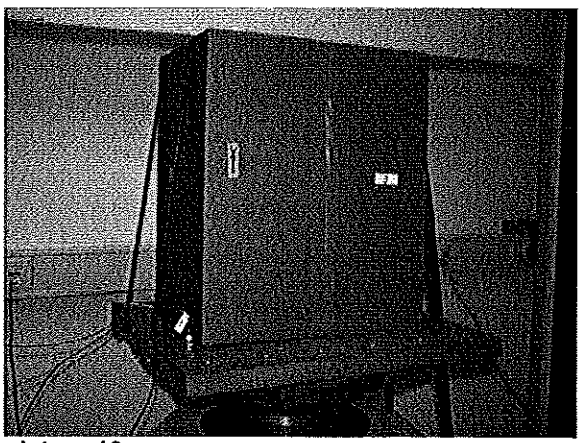
picture 9
Controller in package
with acceleration sensor
before test Fc in Z-axis



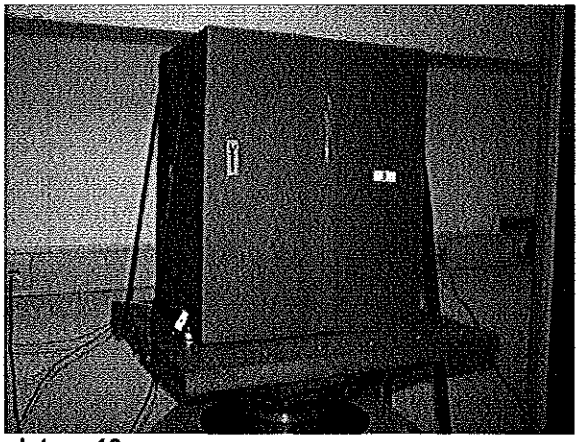
picture 10
Laser Head in package
with acceleration sensor
before test Fc in Z-axis



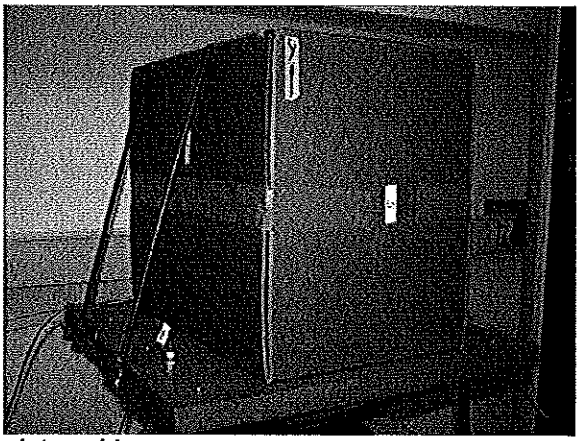
picture 11
Specimens in package
on the vibration test facility TiraVib
during test Fc in Z-axis



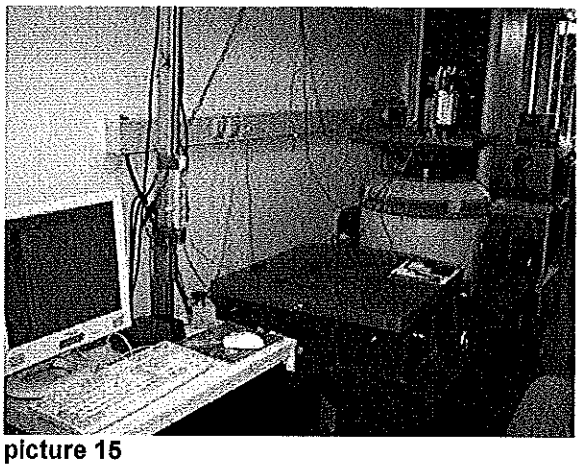
picture 12
Specimens in package
with accelerations sensors
during test Fc in Z-axis



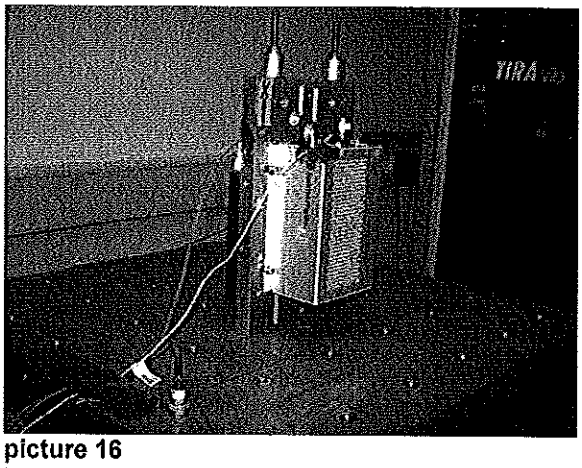
picture 13
Specimens in package
with accelerations sensors
during test Fc in X-axis



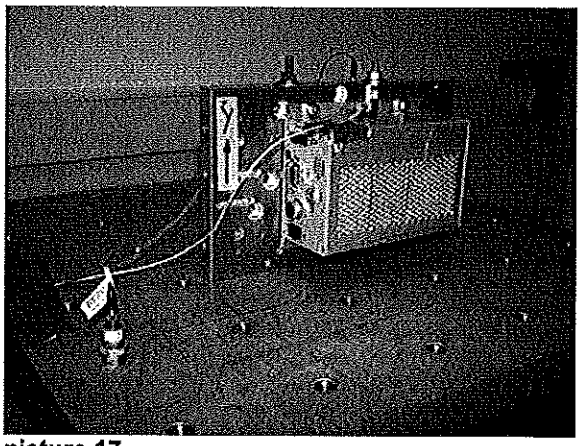
picture 14
Test setup with notebook, DC-controller, DMM
with accelerations sensors
during test Fc in Y-axis



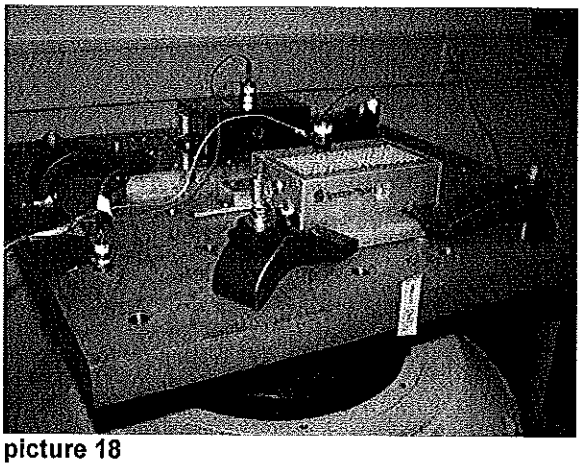
picture 15
Laser Head and Controller
on the vibration test facility TiraVib
during test Fc in X-axis



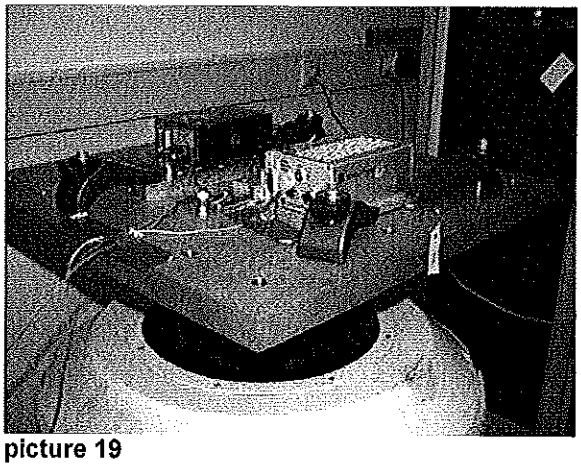
picture 16
Laser Head and Controller
with accelerations sensors
during test Fc in X-axis



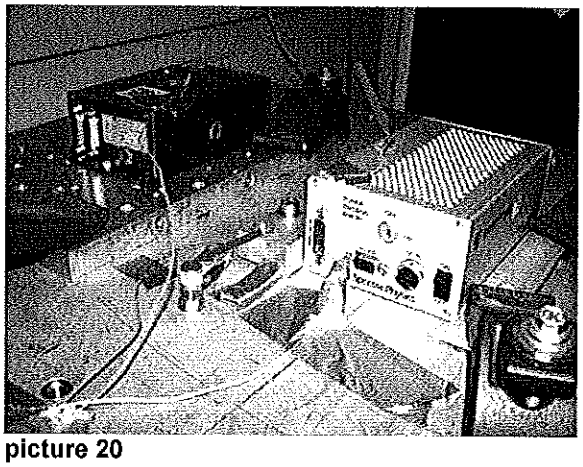
picture 17
Laser Head and Controller
with accelerations sensors
during test Fc in Y-axis



picture 18
Laser Head and Controller
with accelerations sensors
during test Fc in Z-axis



picture 19
Laser Head and Controller
on the shock table
during shock tests in Z- and Zi-axis



picture 20
Laser Head and Controller
with accelerations sensors (arrows)
during shock tests in Z- and Zi-axis