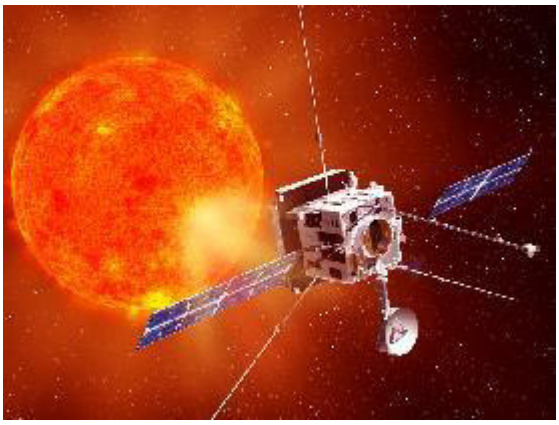

SOLAR ORBITER ENERGETIC PARTICLE DETECTOR

MLI Standoff Bonding Qualification Test Report

Note: The report includes 9 Annexes A, B, C, D, E, F, G, H and I.

Document ID: SO-EPD-KIE-TR-0050

Issue: 1

Revision: 0

Date: 2018-07-20

Written	Checked	Approved configuration control	Approved QA	Approved Experiment Manager	Approved Principal Investigator
M.L.Richards W.Boogaerts	A.Ravanbakhsh	C.Martin	W.Boogaerts M.L.Richards	C.Martin	R. Wimmer-Schweingruber
Signature and date	Signature and date	Signature and date	Signature and date	Signature and date	Signature and date

File: SO-EPD-KIE-TR-0050_iss1_rev0_MLI_StandoffBondingTest_Report.docx

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The following list indicates the individuals and agencies in receipt of review copies of the present document:

Agency / Organization	Name & Title	Contact information
SRG-UAH	Javier Rodriquez-Pacheco EPD-Principal Investigator	javier.pacheco@uah.es
SRG-UAH	Manuel Prieto, EPD Project Manager	manuel.prieto@uah.es
SRG-UAH	Teresa Isabel Varela Jeraldo EPD Configuration Control Responsible	teresa.varela@uah.es
CAU	Michael Richards Walter Boogaerts EPD Kiel PA/QA	mlr@richards-consulting.eu WBoogaerts@gmx.net
CAU	EPD-Solar Orbiter Kiel Team	solo_kiel@physik.uni-kiel.de

CHANGE RECORD

Issue	Revision	Date	Modified by	Section / Paragraph modified	Change implemented
1	0	2018-07-20	W.Boogaerts M.L.Richards A.Ravanbakhsh	All	First draft

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Purpose

This Report is an overview of gluing and testing the glued Parts for the Qualification workmanship at CAU/Kiel.

1.2 Scope

This Report comprises test coupon manufacture and inspection, workmanship test, TVAC cycling and rupture test. Testing in pull and shear is performed on representative sample and interface types.

All of the activities during the test has been performed based on the *MLI Standoff Bonding Qualification Test Procedure* "SO-EPD-KIE-TR-0055".

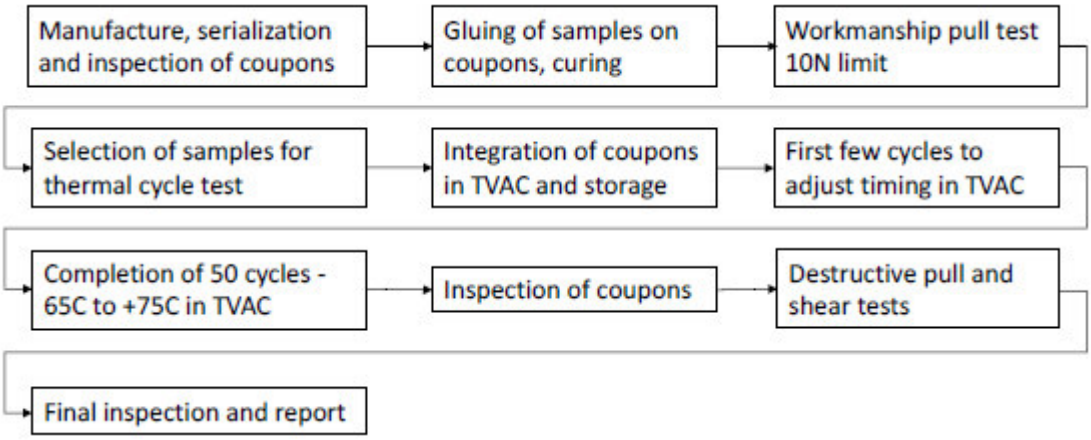


Figure 1 Test flow diagram

Note to Figure 1:

Inspection of Glue for Cracks under microscope.

Instead of destructive test, maxiumum 20 N pull and shear testing after visual inspection as was agreed during the TRR.

1.3 **Acronyms and Abbreviations**

CIDL	Configuration Item Data List
CIL	Critical Item List
DCL	Declared Components List
DML	Declared Materials List
DMPL	Declared Mechanical Parts List
DPL	Declared Processes List
EICD	Experiment I/F Control Document
EPD	Energetic Particles Detector
EPT	Electron, Proton Telescope
FM	Flight Model
HET	High Energy Telescope
MOC	Molecular Contamination
NA	Not Applicable / No applicable
NR	Normative Requirement
PA	Product Assurance
PAC	Particulate Contamination
QA	Quality Assurance
RfA	Request for Acceptance
RfD	Request for Deviation

2 REFERENCE DOCUMENTS

2.1 Applicable Documents

ID.	Title	Reference	Iss./Rev.	Date
AD-01	Standoff Rupture Test Outline	Email Kristin Wirth		2017-06-23
AD-02	Use of EPO-TEK H20E and Scotch Weld B/A Grey	SO-EPD-KIE-RA-0002		2017-06-01
AD-03	Summary NRB#3, SOL.SC.ASTR.NCR/00700	Email Andrew Ewbank		2017-05-30
AD-04	EPT-HET & STEP FM/FS Application Procedure of 3M Scotch Weld 2216 B/A	SO-EPD-KIE-PR-0027	1 / 0	2015-11-26
AD-05	EPT-HET PQM MLI Stand-off Bond-strength Test-Report	SO-EPD-KIE-TR-0044	1 / 1	2017-07-07
AD-06	MLI standoff bonding EPT-HET and STEP instruments	SO-EPD-KIE-PR-0045	1 / 1	2015-03-01
AD-07	EPT-HET PQM MLI Stand-off Bond Strength Test Plan and Procedure	SO-EPD-KIE-TP-0060	1 / 1	2017-06-22
AD-08	MLI Standoff Rupture Test Re-Plan	Email Kristin Wirth		2017-12-11
AD-09	EPD Instrument MLI standoff bond integrity check - test specification	SOL-SP-ADSS-1000264089	1	
AD-10	MLI Standoff Bonding Qualification Test Procedure	SO-EPD-KIE-TR-0055	1 / 2	2018-02-15

Table 1 Applicable documents

2.2 Normative documents

ID.	Title	Reference	Iss. / Rev.	Date
ND-01	Space engineering: Adhesive bonding handbook	ECSS-E-HB-32-21A	A	2011-03-20
ND-02	3M Scotch Weld Epoxy Adhesive 2216 Technical data		C	2009-Dec
ND-03	Space product assurance: Thermal testing for the evaluation of space materials, processes, mechanical parts and assemblies	ECSS-Q-ST-70-04	C	2008-11-15

Table 2 Normative documents

3 TEST COUPONS

For further Information see AD-10.

Coupon	Code	Sample type	Serial numbers
1		A-10	1, …, 10
2		A-10	11, …, 20
3		B-100	21, …, 30
4		B-100	31, …, 40
5		B-40	41, …, 50
6		B-40	51, …, 60
7		A-10-c	61, …, 70
8		A-10-c	71, …, 80
9		B-150-b	81, …, 90
10		B-150-b	91, …, 100
11		A-10-r	101, …, 110
12		B-100-r	111, …, 120
13		B-40-r	121, …, 130
14		A-10-cr	131, …, 140
15		B-150-br	141, …, 150

Table 3 Coupon definition

3.1 Description Testing Facility

For further Information see AD-10.

4 DOCUMENTATION AND QA

This report provides the as-run reports of inspection results and rupture data. Photos will be provided separately in the Annexes. TVAC temperature and pressure recordings are attached to the Annexes. Comments such as deviations from procedure are noted in the as-run procedure QA participation was at inspections, pull and shear tests. Failed bonds will be cause for an NCR.

5 Overview of performed Testing with References to as-run – Reports

Overview of Testing for Gluing Qualification for EPD-EPT-HET/STEP at CAU/Kiel										W. Boogaerts/ A. Ravanbakhsh
Sample type	Serial numbers	Gluing date	As run report	10Nm Report	TV-Cycling Report	Check for Cracks under Microscope Report	20Nm Report	Rupture Report	Pull/ Shear	Remarks
A-10	1, …, 10	11.6.18	Gluing_Report_ A-10.docx Annex A	28 – 29.06.2018 Qualification-10N-before_TVAC.docx Annex E	3 -16.7.2018 TVAC_50_Cycling.docx Annex F	17.7.2018 Check of Cracks after TVAC.docx Annex G	17.7.2018 Qualification-20N-after_TVAC.docx Annex H	19.7.2018 Rupture_Testing.docx Annex I	Pull	
A-10	11,…, 20	11.6.18							Shear	
B-100	21,…, 30	18.6.18	Gluing_Report_ B-100.docx Annex B						Pull	
B-100	31,…, 40	18.6.18							Shear	
B-40	41,…, 50	21.6.18	Gluing_Report_ B-40.docx Annex C						Pull	
B-40	51,…, 60	21.6.18							Shear	
A-10-c	61,…, 70	12.6.18	Gluing_Report_ B-150-b_and_A-10-c.docx Annex D						Pull	
A-10-c	71,…, 80	12.6.18							Shear	
B-150-b (1)	81,…, 85	12.6.18							Pull	
B-150-b (2)	86,., 90	12.6.18							Pull	
B-150-b (1)	91,…, 95	12.6.18							Shear	
B-150-b (2)	96,…, 100	12.6.18							Shear	
A-10-r	101,…,110	11.6.18	Same as A-10	N/A	N/A	N/A	N/A	N/A	Ref.	
B-100-r	111,…,120	18.6.18	Same as B-100						Ref.	
B-40-r	121,…,130	21.6.18	Same as B-40						Ref.	
A-10-cr	131,…,140	12.6.18	Same as A-10-c						Ref.	
B-150-br (1)	141,…,145	12.6.18	Same as B-150						Ref.	
B-150-br (2)	145,…,150	12.6.18	Same as B-150						Ref.	

6 SUMMARY AND CONCLUSIONS

The qualification test of maximum 20N pull and shear was successful for all of the 100 samples. (See Annex H).

- Workmanship Pull and Shear-Testing 10 N- Limit Testing after Glue-Curing of 7 Days (See Annex E)
- 50 cycles inside TVAC (See Annex F)
- Inspection of Glue for cracks under Microscope after TVAC (see Annex G)
- 20 N Pull and Shear Testing after Visual Inspection (See Annex H)

In addition to the qualification, a rupture test attempt has been done on two samples of each type of metal-to-metal (B-100, B-40, B-150-b) up to 200 N without rupture. (See Annex I)

- Also, an additional rupture attempt was made to the limit of force gauge, 400N, on two samples in order to see whether the bonding can be ruptured. Unfortunately, the set up jig failed at about 360 N but the bonding did not fail!

The conclusion is that the testing was very successful.

Annex A

Christian-Albrechts-Universität zu Kiel	**Gluing Report with Scotchweld®2216 B/A** **A-10 and A-10-r**	Appendix to Reference: SO-EPD-KIE-TR- 0050_iss1_rev0 Date: 11/06/2016 Page: 1 of 2

1	**Description**	**Information**	**Remarks**
Information	Components to glue	**A-10 1-10 Pull** **A-10 11-20 Shear** **A-10-r 101-105 Pull** **106-110 Shear**	**Acc. to** **SO-EPD-KIE_TP-0061_1_1**
	Sample-Number	**A-10**	
	Time / Date / Facility	**14:30-15:30 / 11.06.18 / Clean Room CAU**	
	Cleanliness Level / Temperature / Humidity	**ISO-8 / 18°C / 45 %**	
2	**Material**	**Description**	
Used Material	Hardener w. Batch-Nr. and Expiration Date	**Part A: 2216 B/A Gray - Base / White** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	**Acc. to** **SO-EPD-KIE-PR-0045_1_0** **SO-EPD-KIE-PR-0027_1_0**
	Glue w. Batch-Nr. and Expiration Date	**Part B: 2216 B/A Gray - Accelerator / Gray** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	
	Used Solvent(s)	**IPA**	
	Cleaning tool(s)	**Wipes**	
3	**Description**	**Information**	
Mixing-Protocol	**Part A** acc. to Datasheet	**3,5 gr.** (by Weight: **7** parts) (**min. 2,8** gr.)	
	Part B acc. to Datasheet	**2,5 gr.** (by Weight: **5** parts) (**min. 2,0** gr.)	
	Mixing done by	**Hand** ~~Mixing Cartridge~~	
	Potting Time	**90 Min. from 14:30**	

4		**Processing Steps**		**OK**	**n. OK**
Adhesive Protocol	1	Cleaning of the Surfaces by Isopropanol and Cleanroom wipes		x	
	2	Roughen the bonding surface with Fiberglass Pen/ Brass Pen		N/A	
	3	Cleaning of the Surfaces by Vakuum Cleaner and Aceton with Cleanroom wipes		N/A	
	4	Cleaning of the Surfaces by tbd		N/A	
	5	Mixing the Components acc. to **3**		x	
	6	Check Air-Outgassing of the mixed glue.	Gun with **100 %** Power until air-bubbling stopped in mixed glue. Gun with **30%** for Surface with Glue	x	
	7	Apply the adhesive manually ~~or with a dispenser~~		x	
	8	Creating the adhesive samples acc. to **1**		x	
	9	~~Curing of the adhesive acc. to Datasheet Time **240 Min** Temperature: **66ºC**~~		N/A	
		Other Curing Settings acc. to Datasheet: Time:**7 Days** ; Temperature: **20 ºC**		x	
	10	Bake Out if necessary	Time:_____Min. ;Temperature:_____ºC	N/A	

5	Work OK		Remarks

General	Deviation affecting the quality of the components	**Y/N**	NCR-Ref.:

Performed by:	**QA-Check:**	**Pictures and Remarks**
Name: Ali Ravanbakhsh	Name: Walter Boogaerts	attached

Pictures

Cleaning of Stand Off's with IPA

Cleaning Stripes

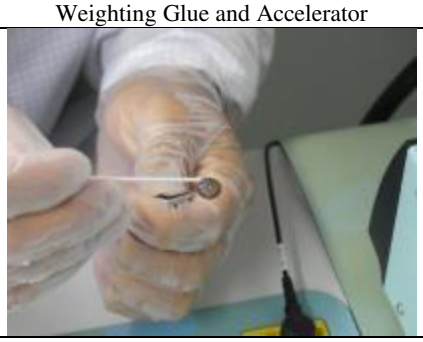
Scotch-Weld 2216 B/A

Special Spoons for adding Glue to Surface

Weighting Glue and Accelerator

Mixing Glue and Accelerator

Removing Air Bubbles by Hot Air



Adding mixed glue to Surface StandOff

Removing Air Bubbles from Surface

Placing StandOff on Stripe

A-10 Overview with Gluing Sample and description

Gluing Sample

Annex B

Christian-Albrechts-Universität zu Kiel	**Gluing Report with Scotchweld®2216 B/A** **for B-100_B-100-r**	Appendix to Reference: SO-EPD-KIE-TR- 0050_iss1_rev0 Date: 18/06/2016 Page: 1 of 2

1	**Description**	**Information**	**Remarks**
Information	Components to glue	**B-100 21- 40** **B-100-r 111-118 (119 – 120 missing)**	**Acc. to** **SO-EPD-KIE_TP-0061_1_1**
	Sample-Number	**B-100_ B-100-r**	
	Time / Date / Facility	**14:40-15:42 / 18.06.18 / Clean Room CAU**	
	Cleanliness Level / Temperature / Humidity	**ISO-8 / 18°C / 45 %**	
2	**Material**	**Description**	
Used Material	Hardener w. Batch-Nr. and Expiration Date	**Part A: 2216 B/A Gray - Base / White** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	**Acc. to** **SO-EPD-KIE-PR-0045_1_0** **SO-EPD-KIE-PR-0027_1_0**
	Glue w. Batch-Nr. and Expiration Date	**Part B: 2216 B/A Gray - Accelerator / Gray** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	
	Used Solvent(s)	**IPA**	
	Cleaning tool(s)	**Wipes**	
3	**Description**	**Information**	
Mixing-Protocol	**Part A** acc. to Datasheet	**3,5 gr.** (by Weight: **7** parts) (**min. 2,8** gr.)	
	Part B acc. to Datasheet	**2,5 gr.** (by Weight: **5** parts) (**min. 2,0** gr.)	
	Mixing done by	**Hand** ~~Mixing Cartridge~~	
	Potting Time	**90 Min. from 14:40**	

4	**Processing Steps**		**OK**	**n. OK**
Adhesive Protocol	1	Cleaning of the Surfaces by Isopropanol and Cleanroom wipes	x	
	2	Roughen the bonding surface with Fiberglass Pen/ Brass Pen	N/A	
	3	Cleaning of the Surfaces by Vakuum Cleaner and Aceton with Cleanroom wipes	N/A	
	4	Cleaning of the Surfaces by tbd	N/A	
	5	Mixing the Components acc. to **3**	x	
	6	Check Air-Outgassing of the mixed glue. — Gun with **100 %** Power until air-bubbling stopped in mixed glue. Gun with **30%** Power for Surface with Glue	x	
	7	Apply the adhesive manually ~~or with a dispenser~~	x	
	8	Creating the adhesive samples acc. to **1**	x	
	9	~~Curing of the adhesive acc. to Datasheet Time **240 Min** Temperature: **66°C**~~	N/A	
		Other Curing Settings acc. to Datasheet: Time:**7 Days** ; Temperature: **20 °C**	x	
	10	Bake Out if necessary Time:_____Min. ;Temperature:_____°C	N/A	

5	Work OK		Remarks

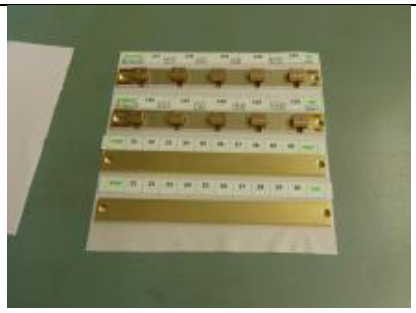
General	Deviation affecting the quality of the components	**Y/N**	NCR-Ref.:

Performed by:	**QA-Check:**	**Pictures** attached **Remarks**
Name: Ali Ravanbakhsh	Name: Walter Boogaerts	**B-100-r 111-118** added to Stripes for B-150-br (1 and 2)

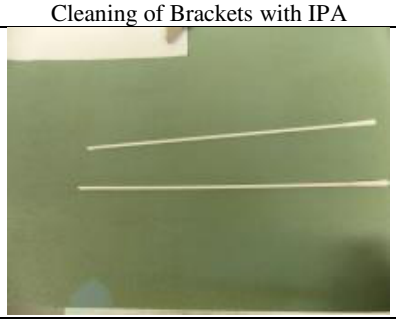
Pictures

Cleaning of Brackets with IPA

Cleaning Stripes



Overview Stripes before adding B-100-r



Special Spoons for adding Glue to Surface

Weighting Glue and Accelerator

Mixing Glue and Accelerator

Removing Air Bubbles by Hot Air

Adding mixed glue to Surface Bracket

Removing Air Bubbles from Surface

Placing Bracket on Stripe

B-100 and B-100-r (added to B-150-br) Overview with Gluing Sample and description

Gluing Sample for B-100 and B-100-r

Annex C

Christian-Albrechts-Universität zu Kiel	**Gluing Report with Scotchweld®2216 B/A** **B-40 41 – 50 / 51 – 60** **B-40-r 121 - 129**	Appendix to Reference: SO-EPD-KIE-TR- 0050_iss1_rev0 Date: 21/06/2016 Page: 1 of 2

1	**Description**	**Information**	**Remarks**
Information	Components to glue	**B-40 41 – 50 / 51 – 60** **B-40-r 121 – 129 (no room for 130!)**	**Acc. to** **SO-EPD-KIE_TP-0061_1_1**
	Sample-Number	**B-40_B-40-r**	
	Time / Date / Facility	**14:15-15:25 / 21.06.18 / Clean Room CAU**	
	Cleanliness Level / Temperature / Humidity	**ISO-8 / 18°C / 45 %**	
2	**Material**	**Description**	
Used Material	Hardener w. Batch-Nr. and Expiration Date	**Part A: 2216 B/A Gray - Base / White** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	**Acc. to** **SO-EPD-KIE-PR-0045_1_0** **SO-EPD-KIE-PR-0027_1_0**
	Glue w. Batch-Nr. and Expiration Date	**Part B: 2216 B/A Gray - Accelerator / Gray** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	
	Used Solvent(s)	**IPA**	
	Cleaning tool(s)	**Wipes**	
3	**Description**	**Information**	
Mixing-Protocol	**Part A** acc. to Datasheet	**3,5 gr.** (by Weight: **7** parts) (**min. 2,8** gr.)	
	Part B acc. to Datasheet	**2,5 gr.** (by Weight: **5** parts) (**min. 2,0** gr.)	
	Mixing done by	**Hand** / ~~Mixing Cartridge~~	
	Potting Time	**90 Min. from 14:15**	

4		**Processing Steps**		**OK**	**n. OK**
Adhesive Protocol	1	Cleaning of the Surfaces by Isopropanol and Cleanroom wipes		x	
	2	Roughen the bonding surface with Fiberglass Pen/ Brass Pen		N/A	
	3	Cleaning of the Surfaces by Vakuum Cleaner and Aceton with Cleanroom wipes		N/A	
	4	Cleaning of the Surfaces by tbd		N/A	
	5	Mixing the Components acc. to **3**		x	
	6	Check Air-Outgassing of the mixed glue.	Gun with **100 %** Power until air-bubbling stopped. Gun with **30%** for Surface Stand Offs	x	
	7	Apply the adhesive manually ~~or with a dispenser~~		x	
	8	Creating the adhesive samples acc. to **1**		x	
	9	~~Curing of the adhesive acc. to Datasheet Time **240 Min** Temperature: **66°C**~~		N/A	
		Other Curing Settings acc. to Datasheet: Time:**7 Days** ; Temperature: **20 °C**		x	
	10	Bake Out if necessary Time:_____Min. ;Temperature:_____°C		N/A	

5	Work OK		Remarks
General	Deviation affecting the quality of the components	**Y/N**	NCR-Ref.:

Performed by:	**QA-Check:**	**Remarks**
Name: Ali Ravanbakhsh	Name: Walter Boogaerts	**Only Bonding Surfaces are Iridised!** **Pictures** attached

Pictures

Cleaning of Parts with IPA

Cleaning Stripes

Overview Parts before Gluing

Special Spoons for adding Glue to Surface

Weighting Glue and Accelerator

Mixing Glue and Accelerator

Removing Air Bubbles by Hot Air

Adding mixed glue to Surface

Removing Air Bubbles from Surface

Placing on Stripe

B-40 Overview with Gluing Sample and description

Gluing Sample

Annex D

Christian-Albrechts-Universität zu Kiel	**Gluing Report with Scotchweld®2216 B/A** **for B150-b / B150-br / A-10-c (cr)**	Appendix to Reference: SO-EPD-KIE-TR- 0050_iss1_rev0 Date: 12/06/2016 Page: 1 of 2

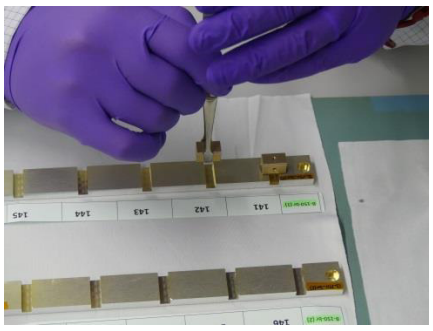
1	**Description**	**Information**	**Remarks**
Information	Components to glue	**B150 – br 141 - 150** **A-10-c 61 – 70** **A-10-c 71 – 80** **B-150-b 81 - 100**	**Acc. to** **SO-EPD-KIE_TP-0061_1_1**
	Sample-Number	**B150-b and B150-br and A-10-c**	
	Time / Date / Facility	**12:00-13:26 / 12.06.18 / Clean Room CAU**	
	Cleanliness Level / Temperature / Humidity	**ISO-8 / 18°C / 45 %**	
2	**Material**	**Description**	
Used Material	Hardener w. Batch-Nr. and Expiration Date	**Part A: 2216 B/A Gray - Base / White** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	**Acc. to** **SO-EPD-KIE-PR-0045_1_0** **SO-EPD-KIE-PR-0027_1_0**
	Glue w. Batch-Nr. and Expiration Date	**Part B: 2216 B/A Gray - Accelerator / Gray** **Batch: 8176-8179** **Exp. Date: 19/1/2019**	
	Used Solvent(s)	**IPA**	
	Cleaning tool(s)	**Wipes**	
3	**Description**	**Information**	
Mixing-Protocol	**Part A** acc. to Datasheet	**3,5 gr.** (by Weight: **7** parts) (**min. 2,8** gr.)	
	Part B acc. to Datasheet	**2,5 gr.** (by Weight: **5** parts) (**min. 2,0** gr.)	
	Mixing done by	**Hand** ~~Mixing Cartridge~~	
	Potting Time	**90 Min. from 12:00**	

4	**Processing Steps**		**OK**	**n. OK**
Adhesive Protocol	1	Cleaning of the Surfaces by Isopropanol and Cleanroom wipes	x	
	2	Roughen the bonding surface with Fiberglass Pen/ Brass Pen	N/A	
	3	Cleaning of the Surfaces by Vakuum Cleaner and Aceton with Cleanroom wipes	N/A	
	4	Cleaning of the Surfaces by tbd	N/A	
	5	Mixing the Components acc. to **3**	x	
	6	Check Air-Outgassing of the mixed glue. — Gun with **100 %** Power until air-bubbling stopped in mixed glue. Gun with **30%** Power for Surface with Glue	x	
	7	Apply the adhesive manually ~~or with a dispenser~~	x	
	8	Creating the adhesive samples acc. to **1**	x	
	9	~~Curing of the adhesive acc. to Datasheet Time **240 Min** Temperature: **66ºC**~~	N/A	
		Other Curing Settings acc. to Datasheet: Time:**7 Days** ; Temperature: **20 ºC**	x	
	10	Bake Out if necessary Time:_____Min. ;Temperature:_____ºC	N/A	

5	Work OK		Remarks
General	Deviation affecting the quality of the components	**Y/N**	NCR-Ref.:

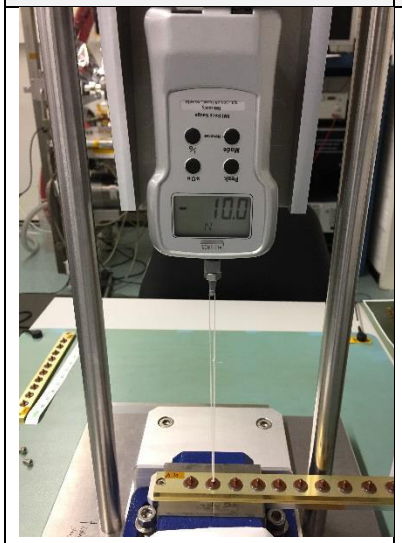
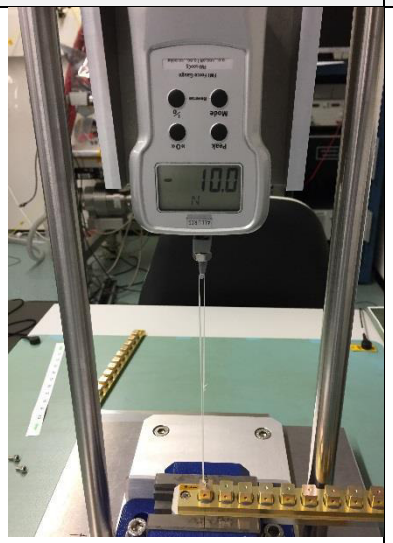
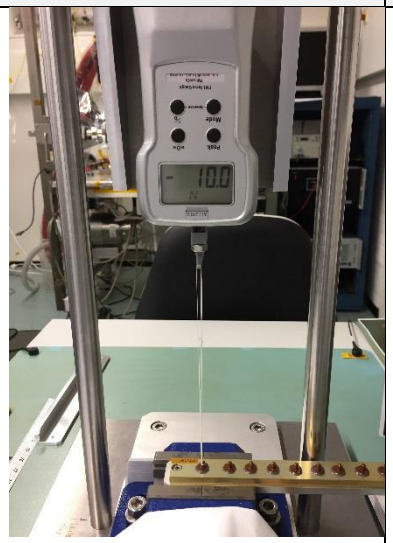
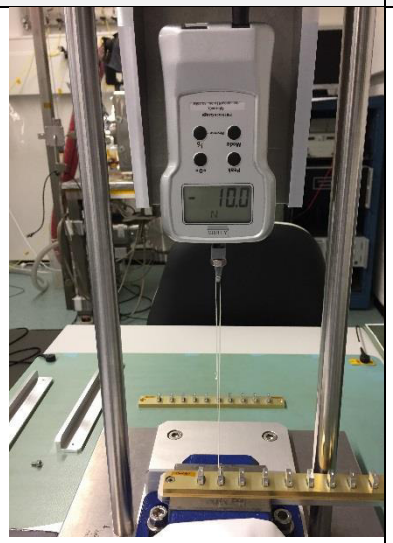
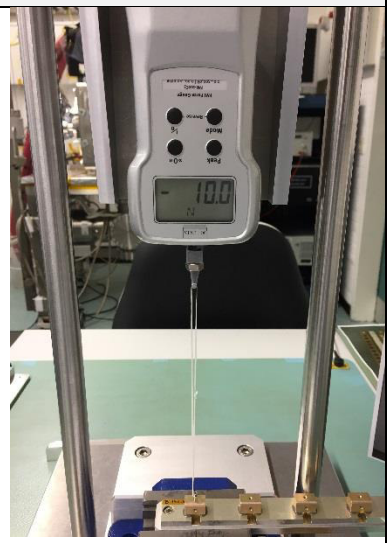
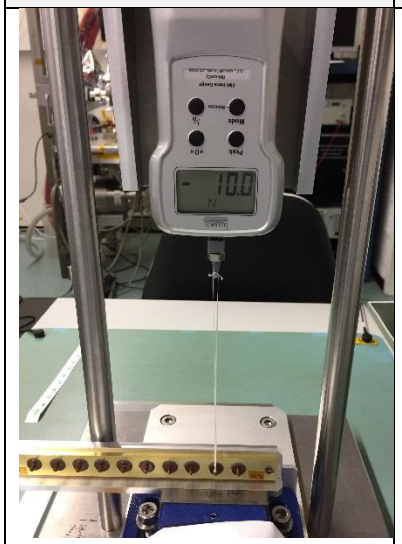
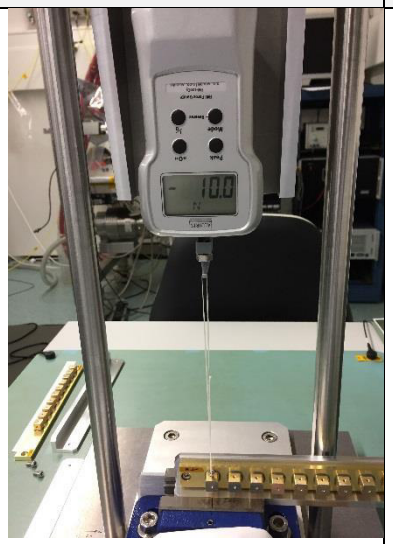
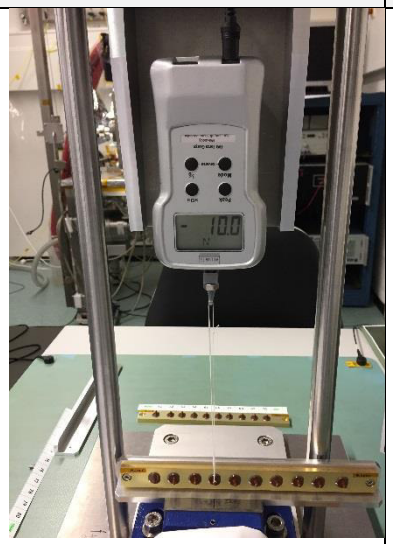
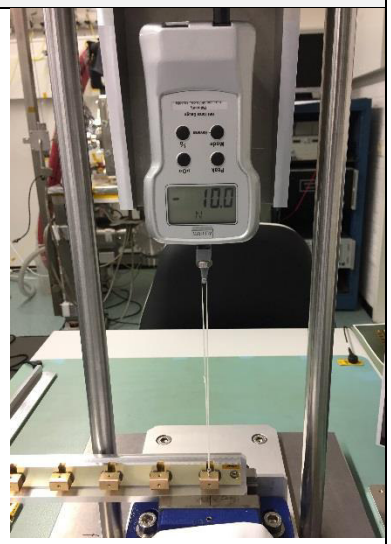
Performed by:	**QA-Check:**	**Pictures and Remarks**
Name: Ali Ravanbakhsh	Name: Walter Boogaerts	attached

Pictures

		
Cleaning of Brackets with IPA	Cleaning Stripes with IPA	Scotch-Weld 2216 B/A
		
Special Spoons for adding Glue to Surface	Weighting Glue and Accelerator	Mixing Glue and Accelerator
		
Removing Air Bubbles by Hot Air	Adding mixed glue to Surface Brackets	Removing Air Bubbles from Surface
		
Placing Bracket on Stripe	B150-b and B150-br Overview with Gluing Sample and description	Gluing Sample

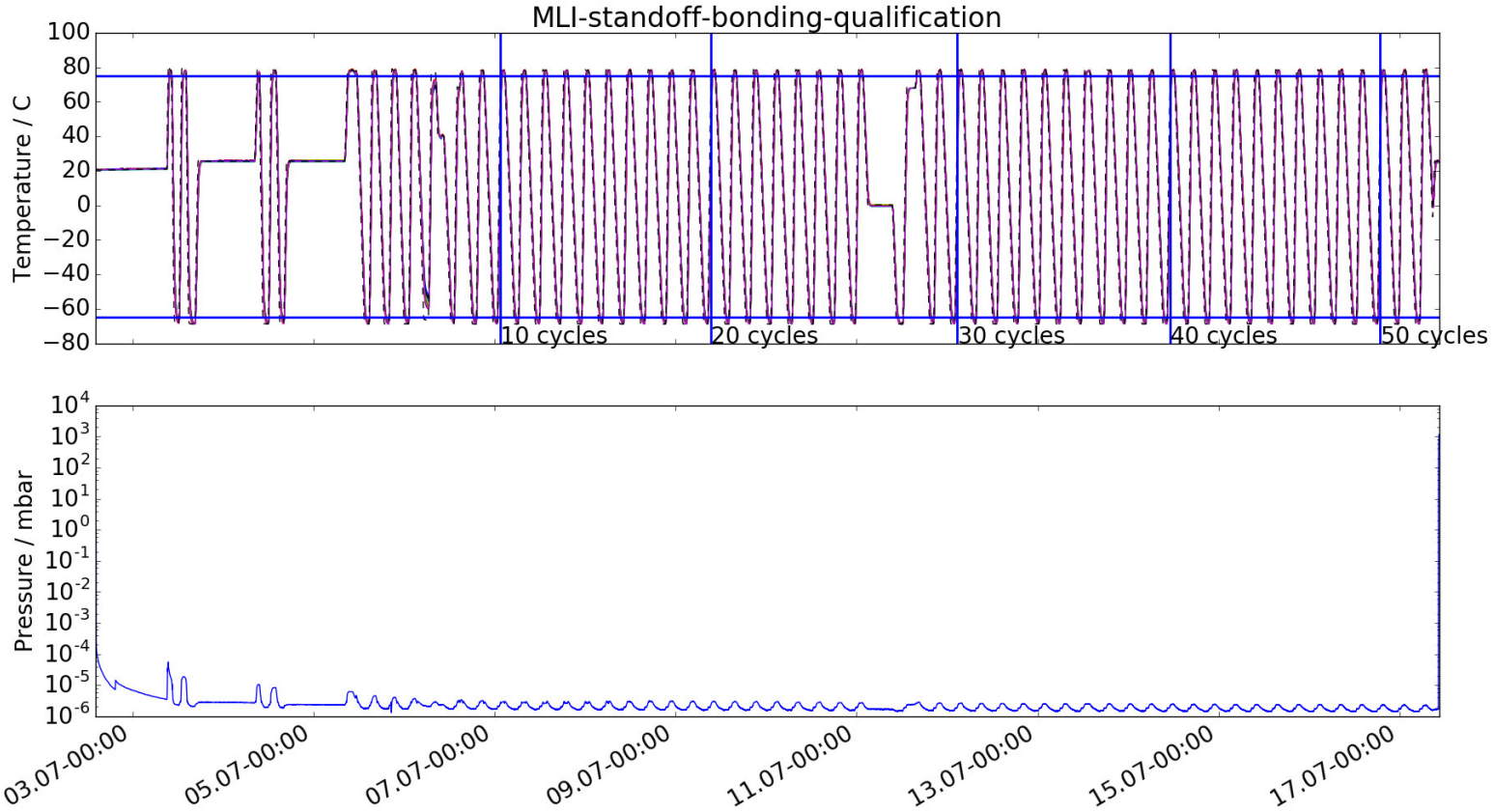
Annex E

MLI Stand Off's Bonding QualificationTest										Performed by
Workmanship Test before TVAC / 10 N during 10 Sec.										Ali Ravanbakhsh / Lars Seimetz
28.6.2018				29.6.2018						Remarks
A-10	Pull	B-100	Pull	B-40	Pull	A-10-c	Pull	B-150	Pull	
1	√	21	√	41	√	61	√	81	√	
2	√	22	√	42	√	62	√	82	√	
3	√	23	√	43	√	63	√	83	√	
4	√	24	√	44	√	64	√	84	√	
5	√	25	√	45	√	65	√	85	√	
6	√	26	√	46	√	66	√	86	√	
7	√	27	√	47	√	67	√	87	√	
8	√	28	√	48	√	68	√	88	√	
9	√	29	√	49	√	69	√	89	√	
10	√	30	√	50	√	70	√	90	√	
A-10	Shear	B-100	Shear	B-40	Shear	A-10-c	Shear	B-150	Shear	
11	√	31	√	51	√	71	√	91	√	
12	√	32	√	52	√	72	√	92	√	
13	√	33	√	53	√	73	√	93	√	
14	√	34	√	54	√	74	√	94	√	
15	√	35	√	55	√	75	√	95	√	
16	√	36	√	56	√	76	√	96	√	
17	√	37	√	57	√	77	√	97	√	
18	√	38	√	58	√	78	√	98	√	
19	√	39	√	59	√	79	√	99	√	
20	√	40	√	60	√	80	√	100	√	

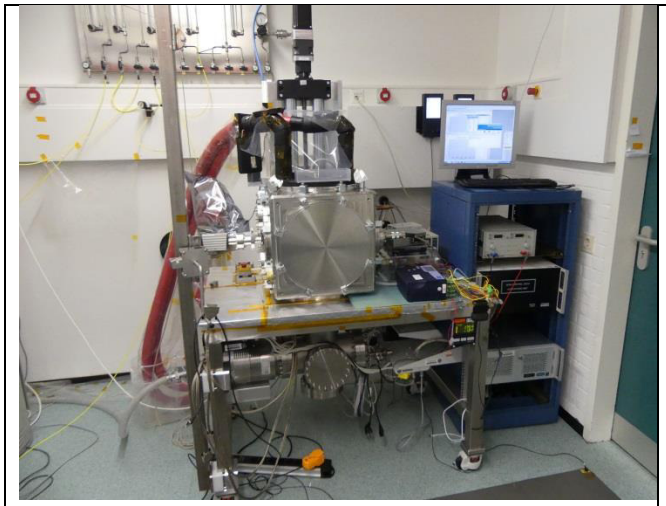
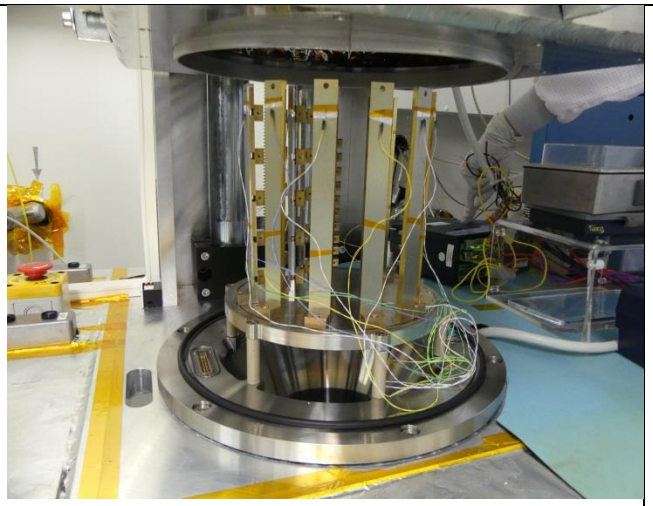
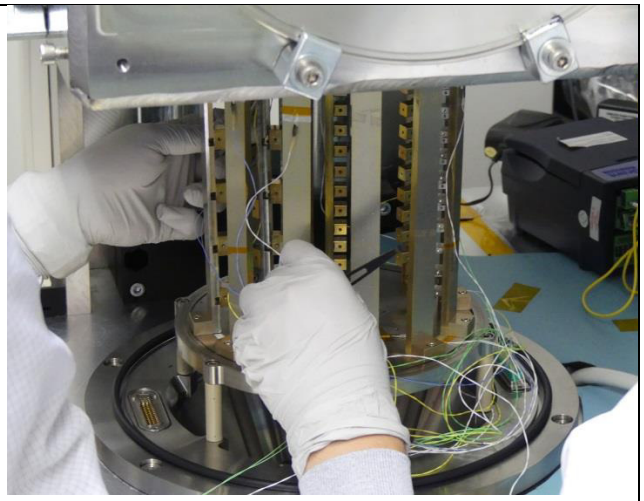
A-10 [1-20]	B -100 [21-40]	B-40 [41-60]	A-10-c [61-80]	B-150 [81-100]
Pull [1-10]	**Pull [21-30]**	**Pull [41-50]**	**Pull [61-70]**	**Pull [81-90]**
				
Shear [11-20]	**Shear [31-40]**	**Shear [51-60]**	**Shear [71-80]**	**Shear [91-100]**
				

Annex F

MLI Stand Off's Bonding QualificationTest	
Overview Cycling TVAC	**Performed by** **Ali Ravanbakhsh / Walter Boogaerts / Mahesh Yedla / Robert Elftmann**
3 - 16.7.2018	**Remarks**



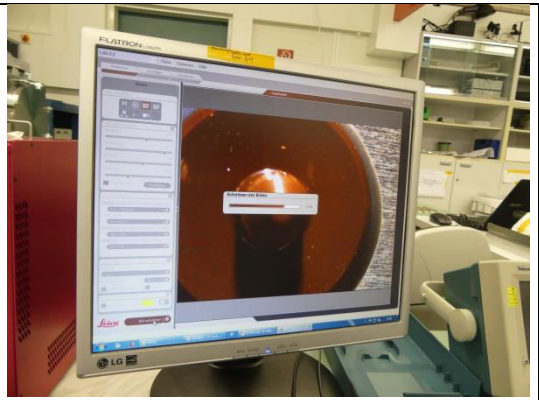
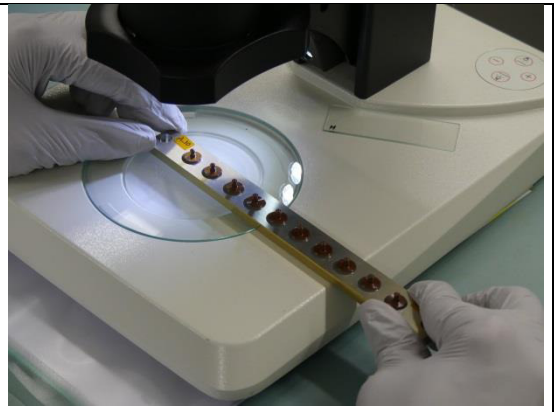
Pictures

		
TVAC-Facility	Overview integrated Parts after opening the TV-Chamber	Deintegration of Parts for further Testing

Annex G

MLI Stand Off's Bonding QualificationTest										
Visual Check of Cracks after TVAC						**Performed by** **Ali Ravanbakhsh / Walter Boogaerts / Mahesh Yedla / Robert Elftmann**				
17.7.2018										**Remarks**
A-10	**Pull**	**B-100**	**Pull**	**B-40**	**Pull**	**A-10-c**	**Pull**	**B-150**	**Pull**	
1	√	**21**	√	**41**	√	**61**	√	**81**	√	
2	√	**22**	√	**42**	√	**62**	√	**82**	√	
3	√	**23**	√	**43**	√	**63**	√	**83**	√	
4	√	**24**	√	**44**	√	**64**	√	**84**	√	
5	√	**25**	√	**45**	√	**65**	√	**85**	√	
6	√	**26**	√	**46**	√	**66**	√	**86**	√	
7	√	**27**	√	**47**	√	**67**	√	**87**	√	
8	√	**28**	√	**48**	√	**68**	√	**88**	√	
9	√	**29**	√	**49**	√	**69**	√	**89**	√	
10	√	**30**	√	**50**	√	**70**	√	**90**	√	
A-10	**Shear**	**B-100**	**Shear**	**B-40**	**Shear**	**A-10-c**	**Shear**	**B-150**	**Shear**	
11	√	**31**	√	**51**	√	**71**	√	**91**	√	
12	√	**32**	√	**52**	√	**72**	√	**92**	√	
13	√	**33**	√	**53**	√	**73**	√	**93**	√	
14	√	**34**	√	**54**	√	**74**	√	**94**	√	
15	√	**35**	√	**55**	√	**75**	√	**95**	√	
16	√	**36**	√	**56**	√	**76**	√	**96**	√	
17	√	**37**	√	**57**	√	**77**	√	**97**	√	
18	√	**38**	√	**58**	√	**78**	√	**98**	√	
19	√	**39**	√	**59**	√	**79**	√	**99**	√	
20	√	**40**	√	**60**	√	**80**	√	**100**	√	

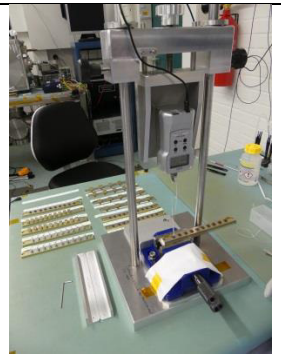
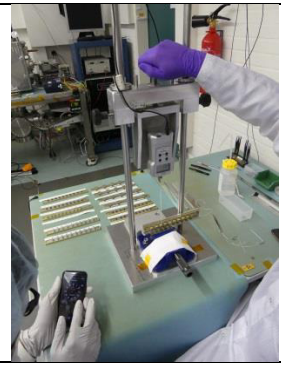
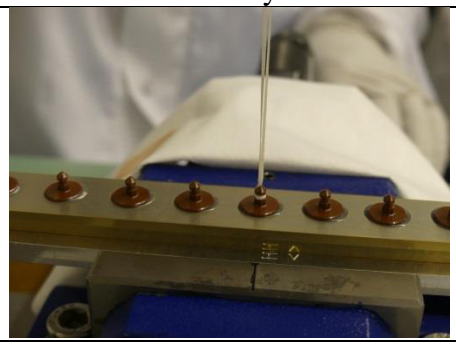
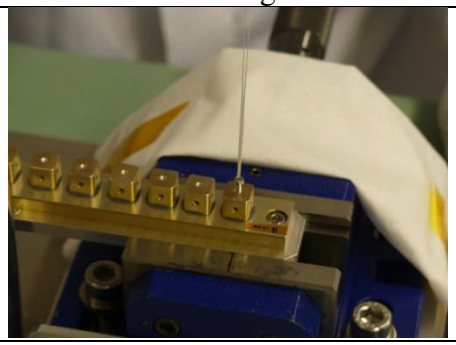
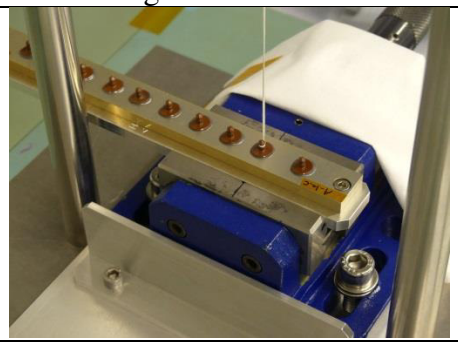
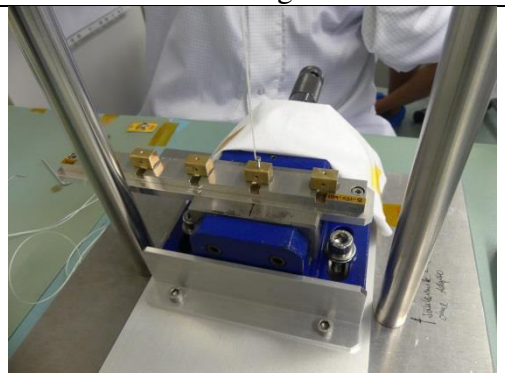
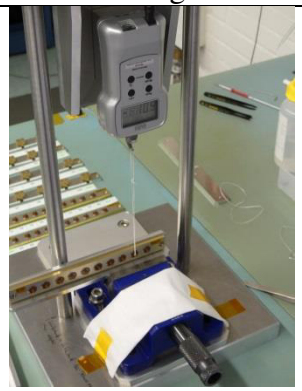
Pictures

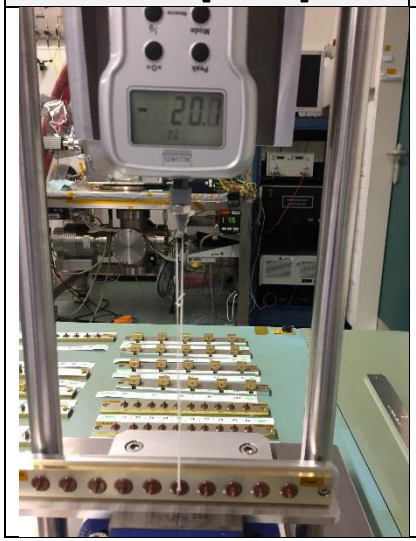
			
Overview Facility	Microscope Leica S8APO	Screen with Microscope S/W	Checking of A-10 Gluing

Annex H

MLI Stand Off's Bonding QualificationTest										
Workmanship Test after TVAC / 20 N during 10 Sec.							**Performed by** Ali Ravanbakhsh / Walter Boogaerts Mahesh Yedla			
17.7.2018										Remarks
A-10	**Pull**	**B-100**	**Pull**	**B-40**	**Pull**	**A-10-c**	**Pull**	**B-150**	**Pull**	
1	√	**21**	√	**41**	√	**61**	√	**81**	√	
2	√	**22**	√	**42**	√	**62**	√	**82**	√	
3	√	**23**	√	**43**	√	**63**	√	**83**	√	
4	√	**24**	√	**44**	√	**64**	√	**84**	√	
5	√	**25**	√	**45**	√	**65**	√	**85**	√	
6	√	**26**	√	**46**	√	**66**	√	**86**	√	
7	√	**27**	√	**47**	√	**67**	√	**87**	√	
8	√	**28**	√	**48**	√	**68**	√	**88**	√	
9	√	**29**	√	**49**	√	**69**	√	**89**	√	
10	√	**30**	√	**50**	√	**70**	√	**90**	√	
A-10	**Shear**	**B-100**	**Shear**	**B-40**	**Shear**	**A-10-c**	**Shear**	**B-150**	**Shear**	
11	√	**31**	√	**51**	√	**71**	√	**91**	√	
12	√	**32**	√	**52**	√	**72**	√	**92**	√	
13	√	**33**	√	**53**	√	**73**	√	**93**	√	
14	√	**34**	√	**54**	√	**74**	√	**94**	√	
15	√	**35**	√	**55**	√	**75**	√	**95**	√	
16	√	**36**	√	**56**	√	**76**	√	**96**	√	
17	√	**37**	√	**57**	√	**77**	√	**97**	√	
18	√	**38**	√	**58**	√	**78**	√	**98**	√	
19	√	**39**	√	**59**	√	**79**	√	**99**	√	
20	√	**40**	√	**60**	√	**80**	√	**100**	√	

Pictures

		
Facility	Testing	Testing and Time Control
		
Pull Testing A-10	Pull Testing B-100	Pull Testing A-10-c
		
Pull Testing B-150-b	Shear Testing A-10	Shear Testing B-40

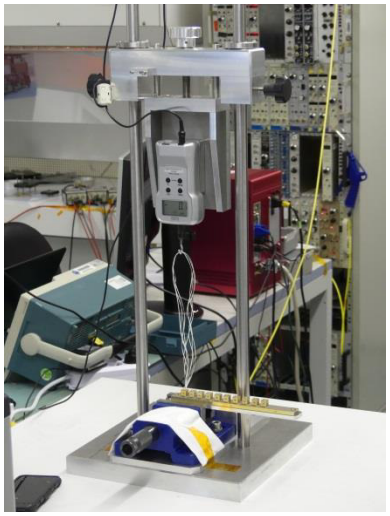
A-10 [1-20]	B -100 [21-40]	B-40 [41-60]	A-10-c [61-80]	B-150 [81-100]
Pull [1-10]	Pull [21-30]	Pull [41-50]	Pull [61-70]	Pull [81-90]
				
Shear [11-20]	Shear [31-40]	Shear [51-60]	Shear [71-80]	Shear [91-100]
				

Annex I

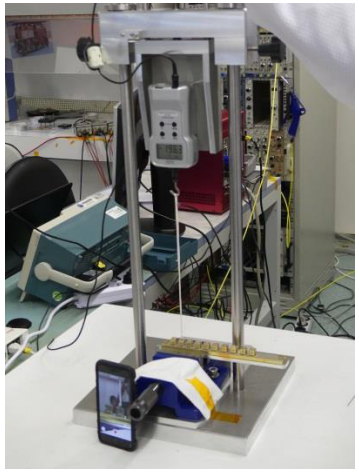
MLI Stand Off's Bonding QualificationTest										
Rupture Testing after TVAC							Performed by Ali Ravanbakhsh / Walter Boogaerts Mahesh Yedla			
19.7.2018										Remarks
A-10	Pull	B-100	Pull	B-40	Pull	A-10-c	Pull	B-150	Pull	
1	√	21	①	41	⑤	61		81	⑨	
2		22	②	42	⑥	62		82	⑩	
3		23		43	⑬	63		83		
4		24		44	⑭	64		84		
5		25		45		65		85		
6		26		46		66		86		
7		27		47		67		87		
8		28		48		68		88		
9		29		49		69		89		
10		30		50		70		90		
A-10	Shear	B-100	Shear	B-40	Shear	A-10-c	Shear	B-150	Shear	
11		31	③	51	⑦	71		91		
12		32	④	52	⑧	72		92		
13		33		53		73		93		
14		34		54		74		94		
15		35		55		75		95		
16		36		56		76		96	⑪	
17		37		57		77		97	⑫	
18		38		58		78		98		
19		39		59		79		99		
20		40		60		80		100		

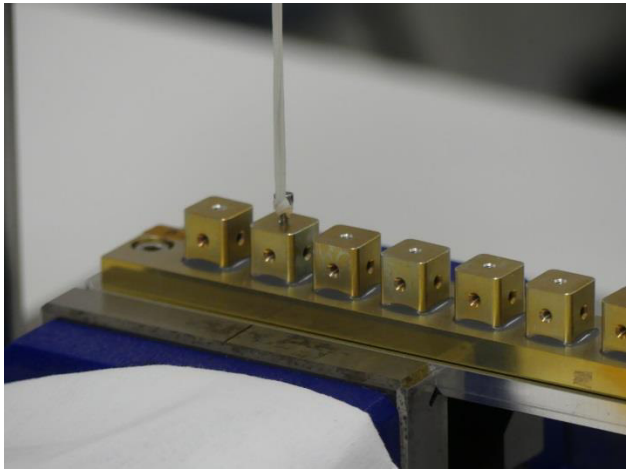
Remarks

① **B-100 number 21 Pull Tested until 200 N. No damages!**

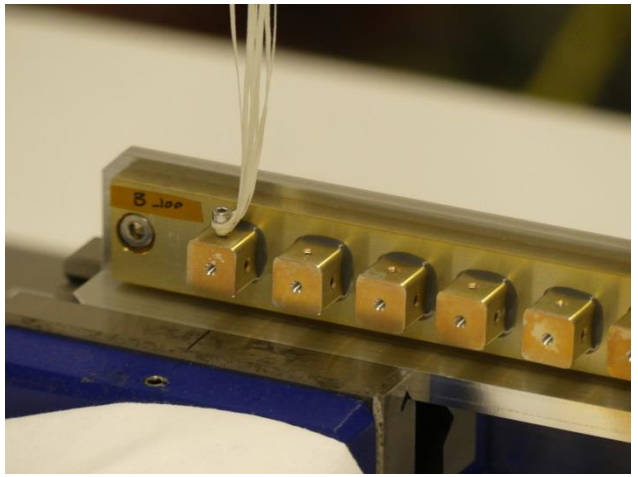


② **B-100 number 22 Pull Tested until 200 N. No damages!**

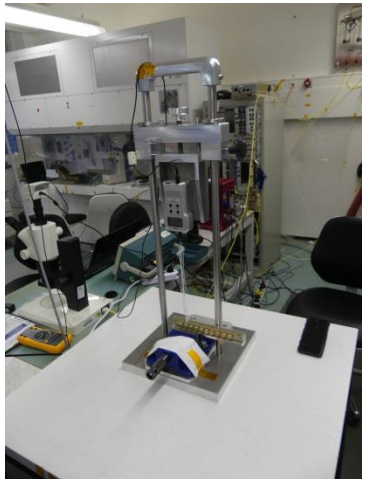


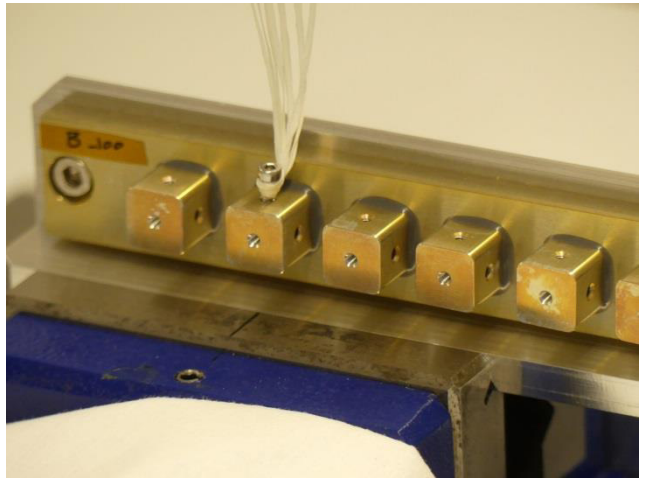


③ **B-100 number 31 Shear Tested until 200 N. No damages!**

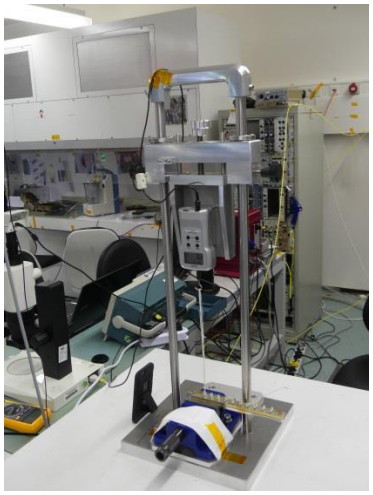


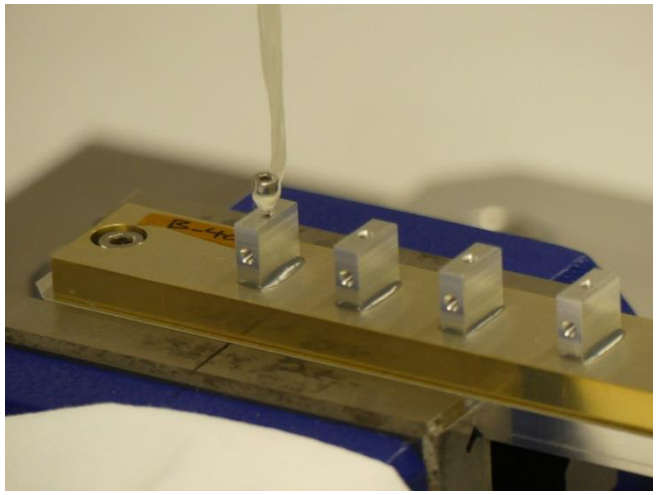
④ **B-100 number 32 Shear Tested until 200 N. No damages!**



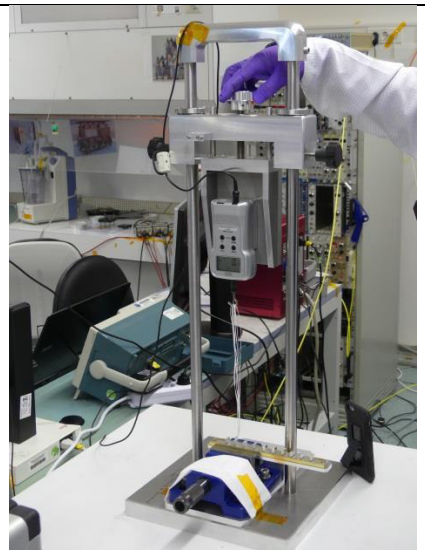


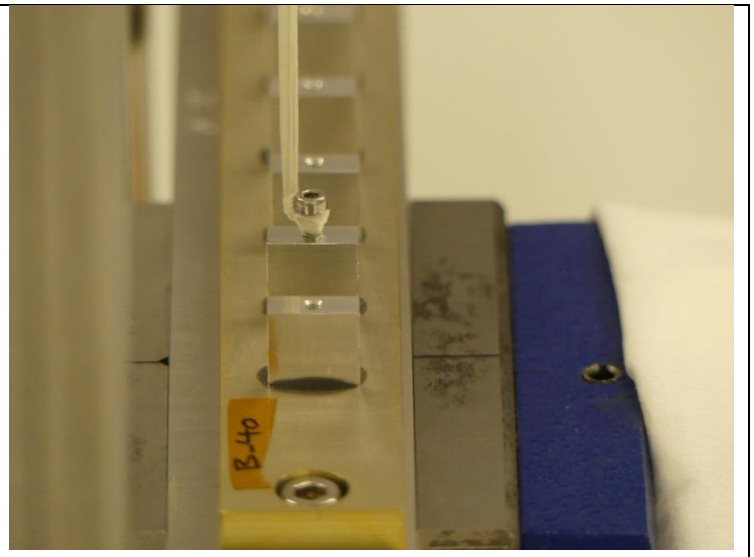
⑤ B-40 number 41 Pull Tested until 200 N. No damages!



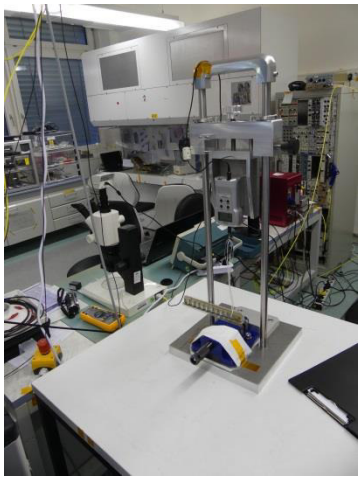


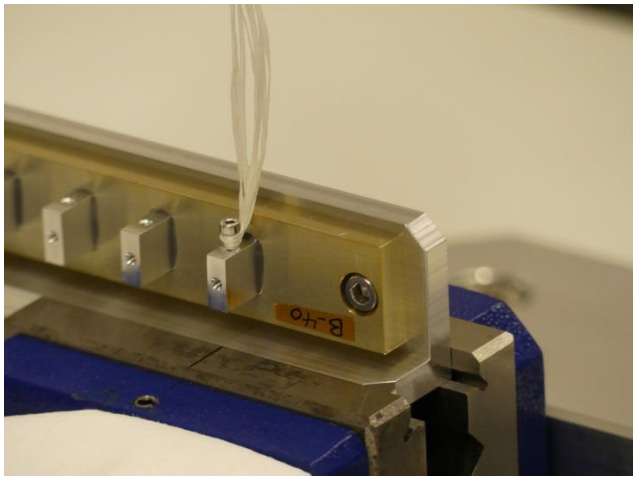
⑥B-40 number 42 Pull Tested until 230 N. No damages!



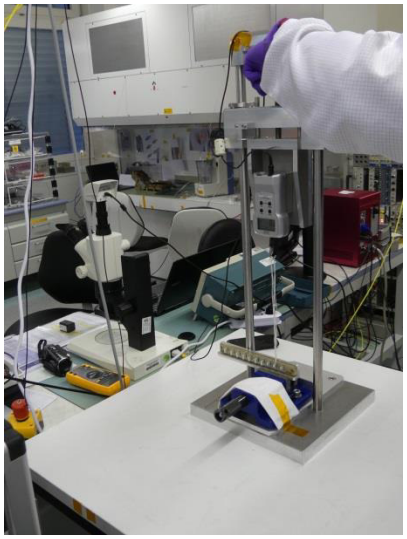


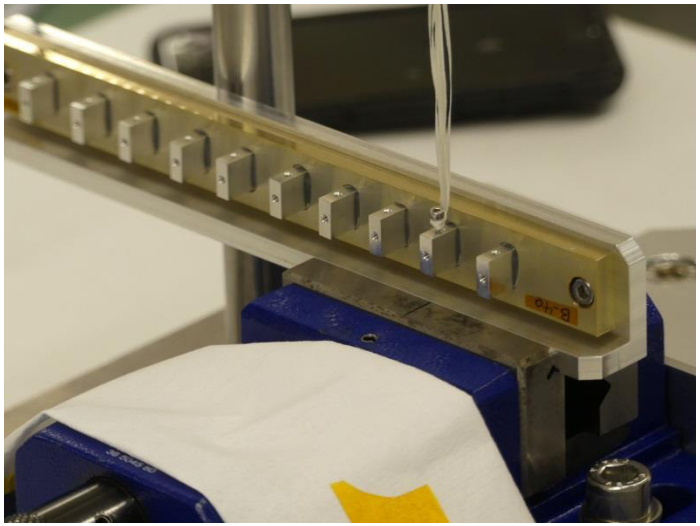
⑦ **B-40 number 51 Shear Tested until 200 N. No damages!**



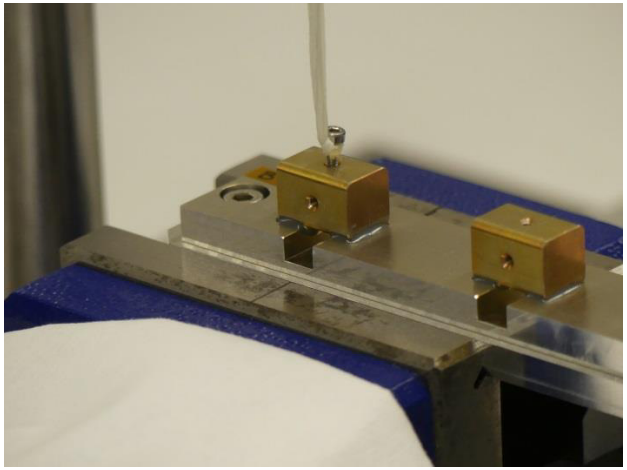


⑧ **B-40 number 52 Shear Tested until 200 N. No damages!**

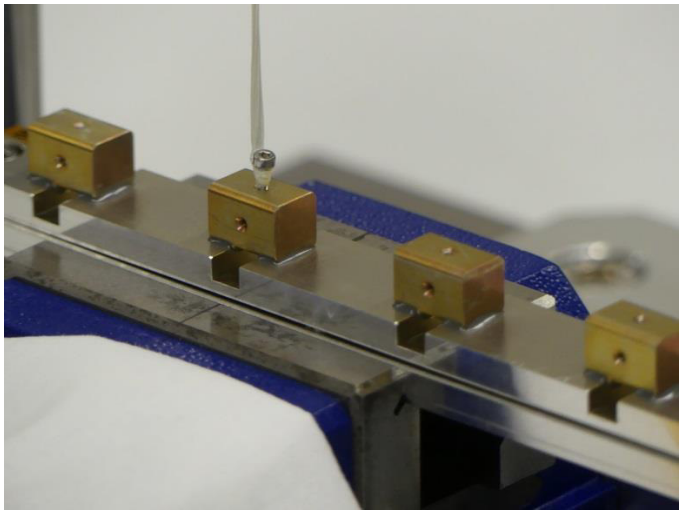




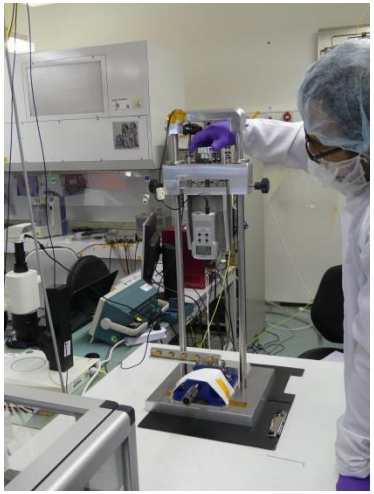
⑨ **B-150 number 81 pull Tested until 200 N. No damages!**

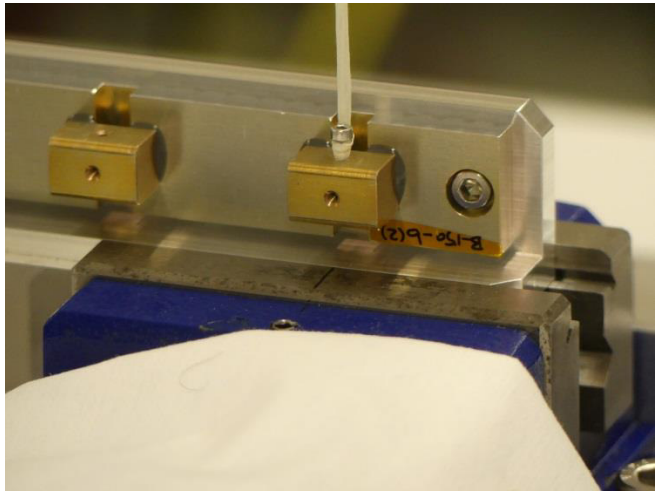


⑩ **B-150 number 82 pull Tested until 200 N. No damages!**

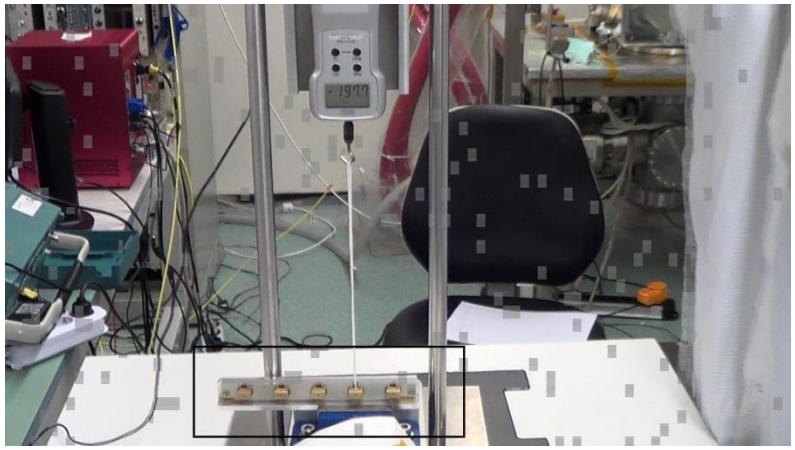


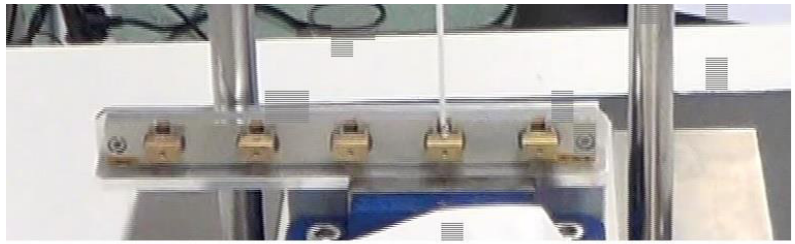
⑪ **B-150 number 96 shear Tested until 200 N. No damages!**



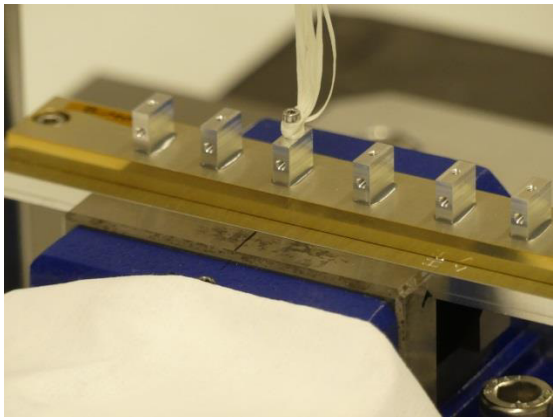


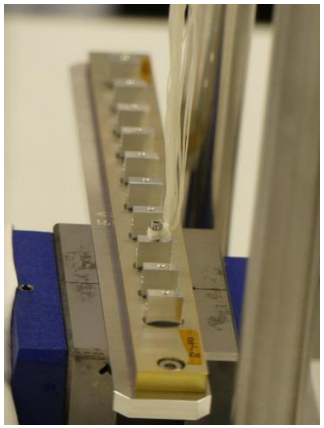
⑫ **B-150 number 97 shear Tested until 200 N. No damages!**

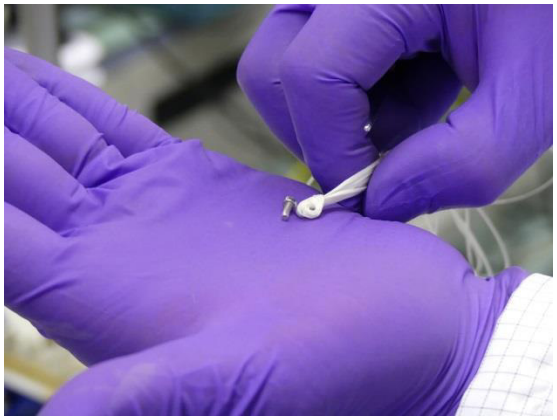




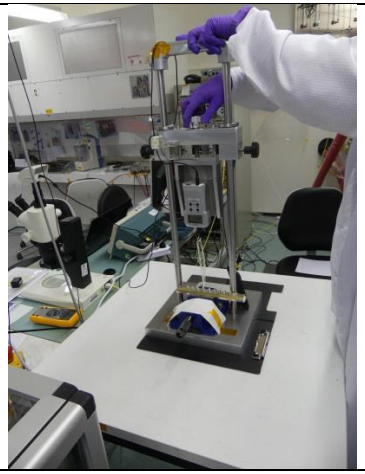
⑬ **B-40 number 43 pull Testing for 400 N. Lacings Cord 16 Layers!! To 360 N. Support Slit out of Holder. Screw bended. Photo. Change the screw and test next (B-40 Number 44) for Pull**

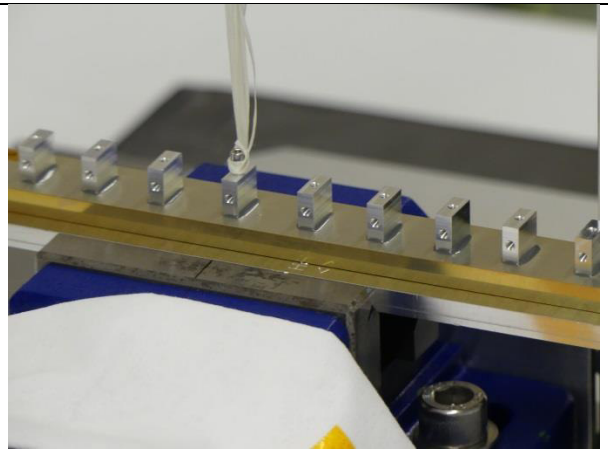


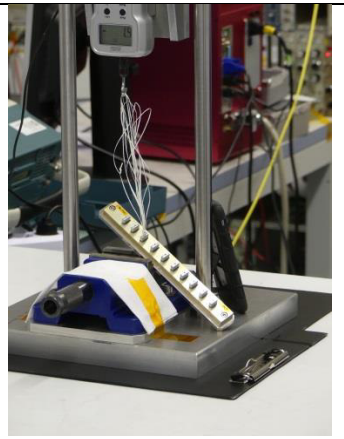




⑭ **B-40 Number 44 Pull. Next try to break. So new screw, same lacing tape. More force to Support Slit.**







Lacing Tape broken at 360 N. Again screw bended.