Prüfbericht-Nr.: *Test report no.*:	**DE244T5B 001**	**Auftrags-Nr.:** *Order no.*:	30010 1977	Seite 1 von 19 *Page 1 of 19*
Kunden-Referenz-Nr.: *Client reference no.*:	2062211	**Auftragsdatum:** *Order date:*	2024-03-27	
Auftraggeber: *Client*:	Aiko Energy Netherlands B.V. (for add. information see page 3)			
Prüfgegenstand: *Test item*:	Photovoltaik Module			
Bezeichnung / Typ-Nr.: *Identification / Type no.*:	AIKO-A455-MAH54Mb (representative for AIKO-Axxx-MAH54M -family)			
Auftrags-Inhalt: *Order content*:	Hail impact test with the aim of recommendation/classification for VFK "Hagelregister"			
Prüfgrundlage: *Test specification*:	according to / following VKF - Prüfbestimmung *** "Nr. 25 "Photovoltaik Module" - Version 1.03 (01/11/2016) *following IEC 61215-2 "Terrestrialphotovoltaik modules - Design qualification and type approval - Part 2: Test procedures*			

Wareneingangsdatum: *Date of sample receipt*:	2024-04-10
Prüfmuster-Nr.: *Test sample no:*	see "List of test samples"
Prüfzeitraum: *Testing period*:	2024-04-30 – 2024-05-13
Ort der Prüfung: *Place of testing*:	Am Grauen Stein, 51105 Köln, Cologne
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland Solar GmbH
Prüfergebnis*: *Test result**:	Siehe Sonstiges / See Other

geprüft von: *tested by:*	X Signiert von: Juergen Sommer	**genehmigt von:** *authorized by*:	X Signiert von: Ulrich Fritzsch
Datum: *Date:*	2024-05-22	**Ausstellungsdatum:** *Issue date:*	2024-05-22
Stellung / Position:	Sachverständige(r)/Expert	**Stellung** / Position:	Sachverständige(r)/Expert

Sonstiges / *Other*:

*** VKF (Vereinigung Kantonaler Feuerversicherungen) /// Additional test specifications:
- Prüfbestimmung Nr 00a – Allgemeiner Teil A - Version 1.03 (01/03/2018)
- Prüfbestimmung Nr 00b – Allgemeiner Teil B - Version 1.01 (01/12/2018)
- Beschlusssammlung HSR – formal - Version 23 (30.08.2022)
- Beschlusssammlung HSR - technisch - Version 19 (13/09/2018)

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* *Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Anmerkungen
Remarks

A

Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.
Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.

The equipment used durinag the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.
Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.

B

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C

Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben.
Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.

*Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.*
Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.

D

Die Entscheidungsregel für Konformitätserklärungen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC GC8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird.

The decision rule for statements of conformity in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance to ILAC GC8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report.

E

Wenn auf dem Bericht kein Akkreditierungshinweis aufgebracht ist, wurde der Bericht nicht im akkreditierten Bereich erstellt und ist folglich auch nicht vom EA MLA abgedeckt. Unabhängig davon wurde der Bericht auf Basis der allgemeinen Regeln der ISO/IEC 17000er Reihe erstellt. Mit "#" gekennzeichnete Prüfungen sind nicht Bestandteil der Akkreditierung D-PL-22040-01-00.

If there is no accreditation notice on the report, the report has not been produced in the accredited area and is consequently not covered by the EA MLA. Regardless of this, the report has been prepared based on the general rules of the ISO/IEC 17000 series. Tests marked with "#" are not covered by the accreditation D-PL-22040-01-00.

F

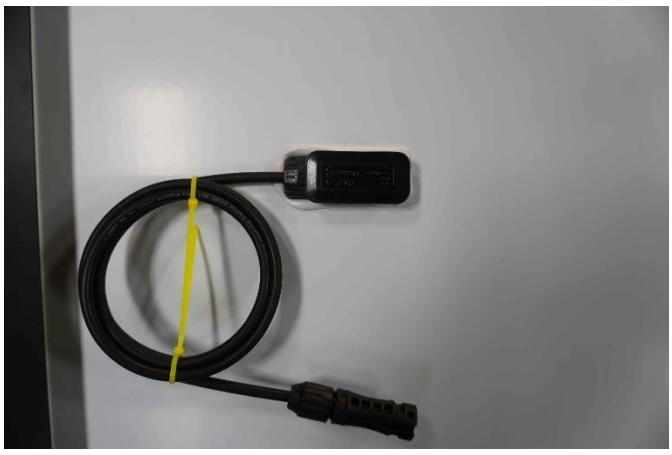
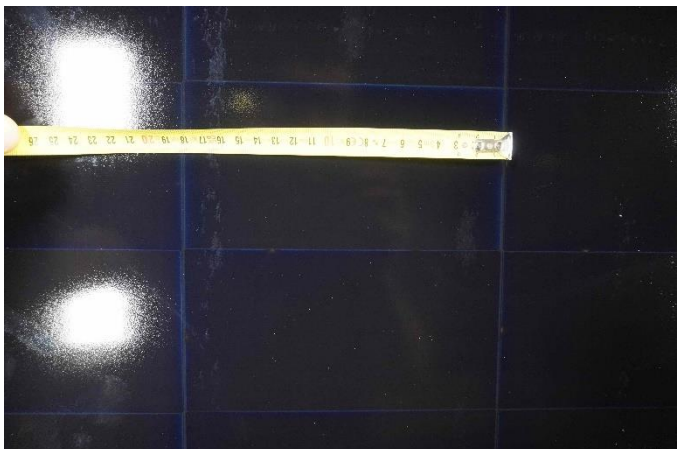
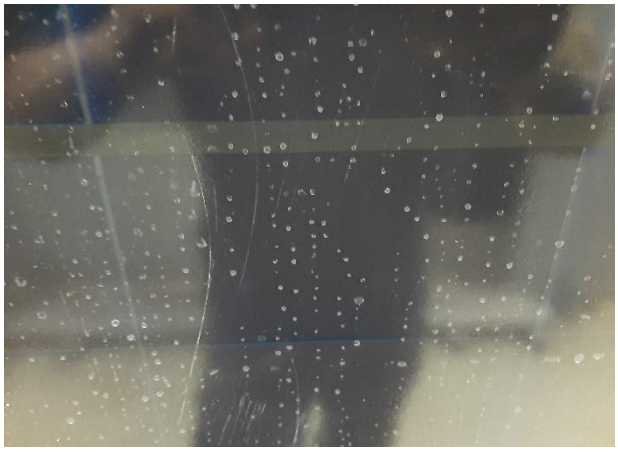
Revision History

Revision	*Date*	*Nature of changes*	*Page*
-	2024-05-22	Original issue	

Produktbeschreibung
Product description

1	**Auftraggeber** *Client*	Aiko Energy Netherlands B.V. Hofplein 20 3032 AC Rotterdam Netherlands
2	**Produktdetails** *Product details*	**Allgemeine Informationen ;** General Information
		Brand name: Aiko
		Type name: AIKO-A455-MAH54Mb
		Product category: PV-module
		Year of production: ---
		Power class [W]: 455
		Cell technology: Mono
		Cell dimension (l / w) [mm]: 182 / 91 (half cut)
		No. of cells: 108
		Max. system voltage [V]: 1500
		Thickness of glazing [mm]: 3.2 (front)
		Glazing (front): Hardened, low-reflection white glass
		Frame material: Aluminium
		Frame thickness [mm]: 30
		Dimensionen ; Dimension
		Dimension (l / w / h) [mm]: 1757 / 1134 / 30
		Gross area [m²]: 1.992
3	**Technische Dokumentation** *Technical documentation*	for detailed constructional data see *Test Report* CN22WKH5 010 *and Annexes* *issued by TÜV Rheinland* *Technical Datasheet "Neostar2P_188-AIKO-A-MAH54Mw 450-490W"* *Technical Datasheet "Neostar2P_188-AIKO-A-MAH54Mb 445-485W"* *issued by Aiko*
4	**Hersteller** *Manufacturer*	Zhuhai Fushan Aiko Solar Technology Co., Ltd. No.681, Fuguo Road, Doumen District, Zhuhai 519175 Guangdong China
5	**Sonstiges** *Other*	- The tested module type might be also available in different powerclasses. - Further the result is aplicable to additional types; for more details see "*General remarks*" - Mounting: Asymetric (across mounting holes / 178 & 329 mm from corner)
6	**Prüfmusterbereit-stellung**: *Test sample obtaining*	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☒ others: randomly chosen from existing test batch

Produktbeschreibung
Product description

Sample - Front (example)	Sample - Back (example)
	
Example of junction box	Example of cells
	
Example of junction box	Example of cells
	

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**Result summary table**

Test	Date [DD Month YYYY]		Summary of main test results	—
	Initial (1st)	Final (2nd)		
Insulation test	02 May 2024	07 May 2024	No visual defects	P
Wet leakage current test	02 May 2024	07 May 2024	No visual defects	P
Performance at STC	02 May 2024	08 May 2024	No visual defects	P
Electroluminescence images	02 May 2024	08 May 2024	No visual defects	P
Impact resistance	06 May 2024		HW4 with 40 mm ice balls passed	P
Final inspection	13 May 2024		see *Final evaluation*	P

Supplementary information:

- All results are related to the tested sample
- According to test procedure the tested PV module is **recommended** to be **classified in HW4**
- No pre-exposure necessary; no relevant plastic parts

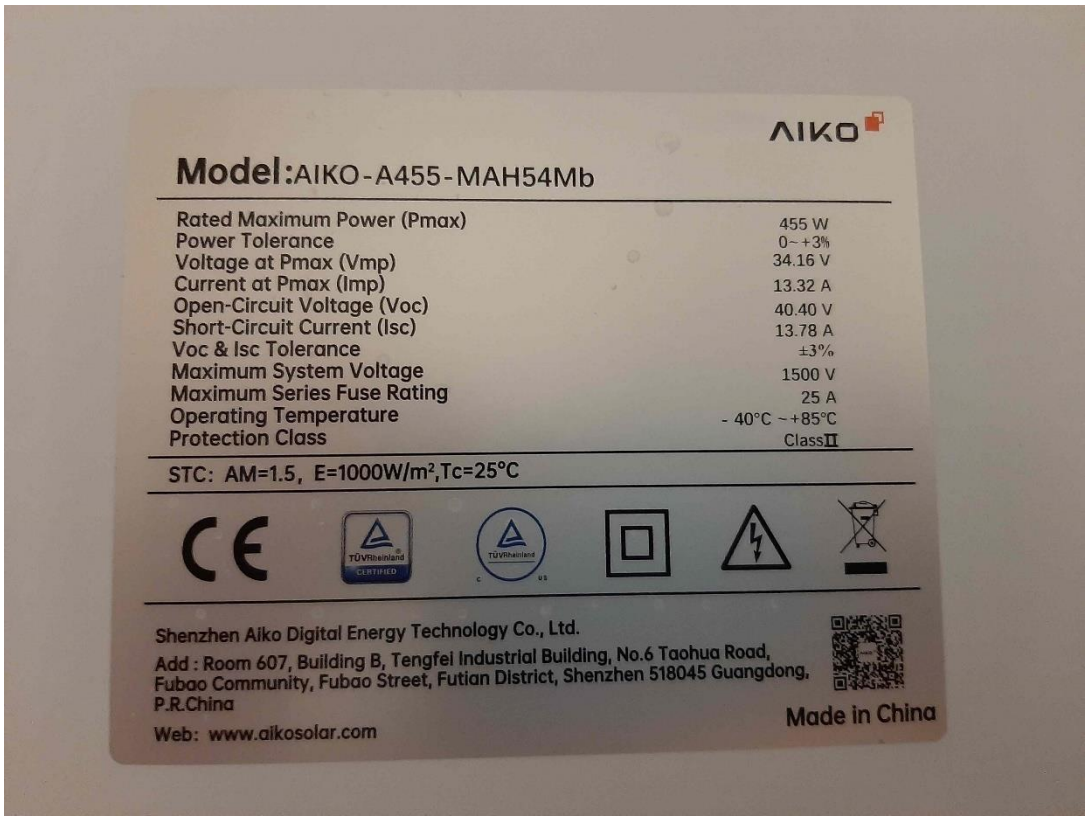
	Final evaluation (recommendation of testing laboratory)

In four-eyes principle; by	J. Sommer	U. Fritzsche	—
The acceptance of recommendation and final classification is part of FER (Fachkommision Elementarschutzregister)			
Properties of component		Evaluation of hail withstand	
Water tightness		- - -	
Visual nature / look		HW4	
Mechanics		HW4	
Transmittance		- - -	
Opacity		- - -	

Supplementary information: -

Prüfbericht-Nr.: DE244T5B **001**
Test report no.:

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Visual inspection (Initial)**		
Test date [YYYY-MM-DD]	2024-04-30		—
Sample No.	Nature and position of initial findings		
HV2024000798	No relevant visual defects		P
HV2024000799	No relevant visual defects		P
Supplementary information: -			
Type plate (example)			



-	**List of test samples**		
Sample No.	Sample S/N	Remarks / constructional characteristics	—
HV2024000798	Z012312E535002875	-	
HV2024000799	Z012312E535002845	Spare	

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**Maximum power determination (STC)**

General; for all following measurements								
Module temperature [°C]				corrected to 25				—
Irradiance [W/m²]				1000				
Initial / Final*								
Test date [YYYY-MM-DD]				2024-05-02 and *2024-05-08				
Sample No.	P_{max} [W]	V_{mpp} [V]	I_{mpp} [A]	V_{oc} [V]	I_{sc} [A]	FF [%]	Degradation [%]	
HV2024000798	446.6	34.45	12.97	40.07	13.88	80.3	-	P
	449.3	34.69	12.95	40.31	13.85	80.5	(-)	P
Supplementary information: -								

-	**Insulation test (ISO)**

General; for all following measurements						
Maximum system voltage [V_{DC}]			1500			—
High voltage applied [V_{DC}]	1st		3000			
	2nd		8000			
Insulation resistance measured at [V_{DC}]			1000			
Initial / Final*						
Test date [YYYY-MM-DD]			2024-05-02 and *2024-05-07			
Sample No.	Measured	Area	Result*	Dielectric breakdown		
	[GΩ]	[m²]	[GΩ × m²]	Yes (description)	No	
HV2024000798	1.0	1.99	2.0	-	x	P
	1.0	1.99	2.0	-	x	P

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

-	**Wet leakage current test (WL)**				
General; for all following measurements					—
Insulation resistance measured at [V_{DC}]		1000			
Solution resistivity [Ω cm]		< 3.500			
Solution temperature [°C]		22 ± 3			
Initial / Final*					
Test date [YYYY-MM-DD]		2024-05-02 and *2024-05-07			
Sample No.	Measured	Area	Result		
	[MΩ]	[m²]	[MΩ × m²]		
HV2024000798	1000	1.99	1990		P
	1000	1.99	1990		P

-	**Electroluminescence images (EL)** Analysis of electroluminescence images (see also *Annex : Additional information*)			
Initial / Final*				—
Test date [YYYY-MM-DD]		2024-05-02 and *2024-05-08		
Sample No.	Reverse current applied [A]	Attributes		
HV2024000798	5	No conspicuousness/findings		
	5	No conspicuousness/findings		
Supplementary information: Estimated analysis without guarantee				

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Impact resistance test (general)**		

Test date [YYYY-MM-DD] Day code	2024-05-06[a]
Sample-No. ID code	HV2024000798[798]
Method used for impact resistance	Nr. 25 "Photovoltaik Module
Surface conditioning	none
Sample tilt angle [° from horizontal]	90
Direction of shoot [°]	0 (horizontal)
Impact angle [° from sample surface]	90
Distance (sample to center of v_0-meas.) [mm]	500 to 700
Ice ball production [week of the year]	9 (hermetically sealed)
Storage temperature of ice ball [°C]	-20
Ambient conditions (mean) [°C and % RH]	[a]23.4 and 41.3
Diameter of ice ball [mm]	40
Weight of ice ball (mean) [g]	30.0
Velocity of ice ball (mean) [m/s]	27.5
Impact energy (at least) [J]	11.1

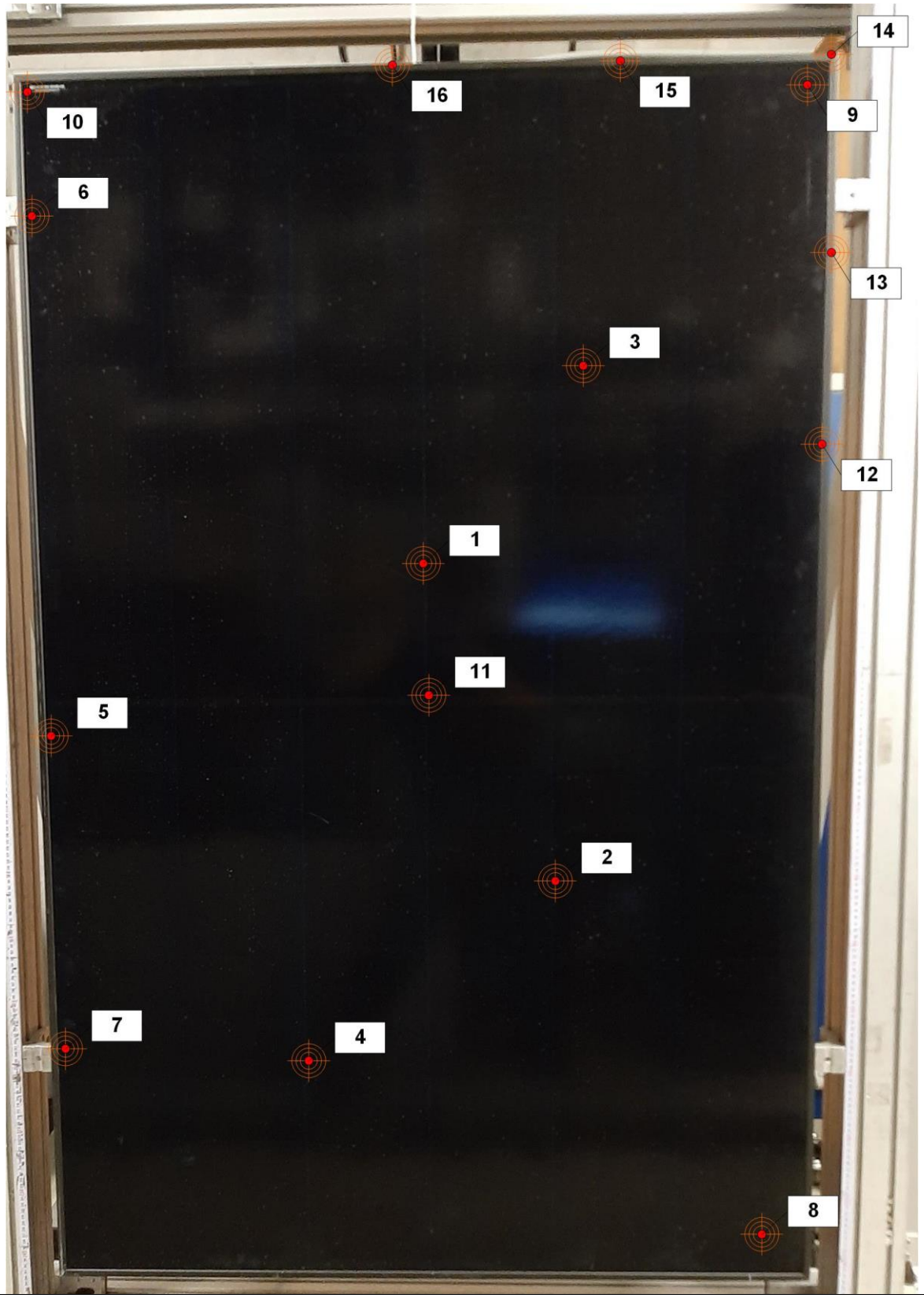
Example of Test Set-up

Mounting elements

Supplementary information:

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

Overview of impact positions



Supplementary information: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

- **Impact resistance test – Result table**

Sample ID	Impact information					Mass of ball [g]	Velocity of ball [m/s]	Impact energy [J]	—
	Day	No.	Location & description (cells from left bottom [x/y])		IEC***				
	After initial control measurements (Ice ball diameter = 40 mm)								
798	a	1	3/11 – 4/12	Over edges of circuit	3	28.87	27.90	*11.24*	P
		2	4/6 – 5/7	Over edges of circuit	4	29.17	28.21	*11.61*	P
		3	5/13 – 5/14	Near interconnects	5	29.02	27.89	*11.29*	P
		4	2/3 – 2/4	Near interconnects	6	28.94	28.01	*11.35*	P
		5	1/9	Edge of module window	2	29.06	28.23	*11.58*	P
		6	1/17	Near mounting position	7	28.95	28.10	*11.43*	P
		7	1/2	Near mounting position	8	28.75	28.45	*11.64*	P
		8	6/1 (75 mm)	Far away from other impacts	9	28.78	28.37	*11.58*	P
		9	4/9 – 5/10	Over the junction box	11	28.69	28.22	*11.42*	P
		10	6/18	Far away from other impacts	10	28.72	28.10	*11.34*	P
		11	1/18 (20 mm)	Corner of module window	1	29.09	28.33	*11.67*	P
		12	600 mm from left top	Vertical frame	-	29.10	28.47	*11.79*	P
		13	250 mm from left top	Vertical frame	-	29.00	28.22	*11.55*	P
		14	right bottom	Tip of frame	-	28.75	27.96	*11.24*	P
		15	250 mm from left top	Horizontal frame	-	28.67	27.85	*11.12*	P
		16	600 mm from left top	Horizontal frame	-	28.81	28.06	*11.34*	P
	Change to final measurement and inspection								—

Supplementary information: *value to low (not valid); **value to high (not valid); ***location acc. to IEC-standard

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Final inspection (general)**		
Test date [YYYY-MM-DD]		2024-05-13	—
Sample-No.	Potential problem	Evaluation*/**	
		HW4	
HV2024000798	Technical problems	HW 4 **passed**; with 40 mm Slight cracks visible under use of electroluminescence NO power degradation detectable*	P
	Visual problems (distance; > 5 m)	HW 4 **passed**; with 40 mm NO cracks visible ; NO dents visible	P
	Visual problems (near; < 0.5 m)	HW 4 **passed**; with 40 mm NO cracks visible ; NO dents visible	-
NOTE	Individual additional remarks: All results are related to the tested samples. * referred to measuring uncertainty **see also *Final evaluation* and *Annex : Additional information*		—
Supplementary information: -			

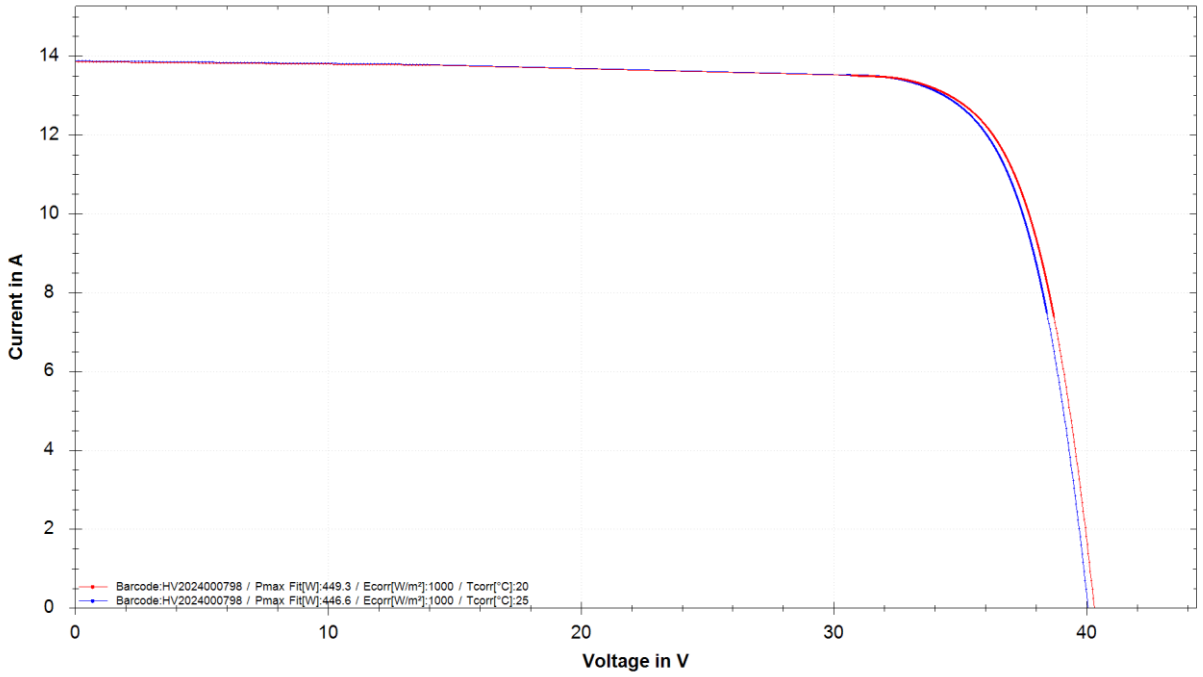
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**General remarks and subblementary information**		
	Measuring uncertainties		
	All results only refer to the test samples that were subjected to testing. The extended total measuring uncertainty is: u (k=2) ≤ ± 2.5 %		—

Related test reports / certificates / documents		
The construction of the tested samples is documented in the relevant report valid in conjunction with the IEC certificate.		
Document no.	Certificate no.	
Test report CN22WKH5 010 *incl. Annexes* *issued by TÜV Rheinland*	PV 50614580	—
Technical Datasheet "Neostar2P_188-AIKO-A-MAH54Mw 450-490W" *Technical Datasheet "Neostar2P_188-AIKO-A-MAH54Mb 445-485W"* *(2404 v1.4)* *issued by Aiko*		

Others - The result of the tested sample is also equivalent to:	
Main Types	
• **AIKO-Axxx-MAH54Mb** ○ power classes 445 - 485 W (108 cells) ○ cells (mono / half-cut) ○ frame color (black or silver) ○ backsheet color (inner layer) (black ; only) ○ backsheet color (outer layer) (black or white) ○ encapsulation color (transparent ; only) ○ frame thickness (30 mm ; only) ○ maximum system voltage (1500 V_{DC} ; only)	• **AIKO-Axxx-MAH54Mw** ○ power classes 450 - 490 W (108 cells) ○ cells (mono / half-cut) ○ frame color (black or silver) ○ backsheet color (white ; only) ○ encapsulation color (transparent + white ; only) ○ frame thickness (30 mm ; only) ○ maximum system voltage (1500 V_{DC} ; only) ○
The recommendation ***"HW4"*** **is aplicable to the various power ranges** of above listed main types and endings.	

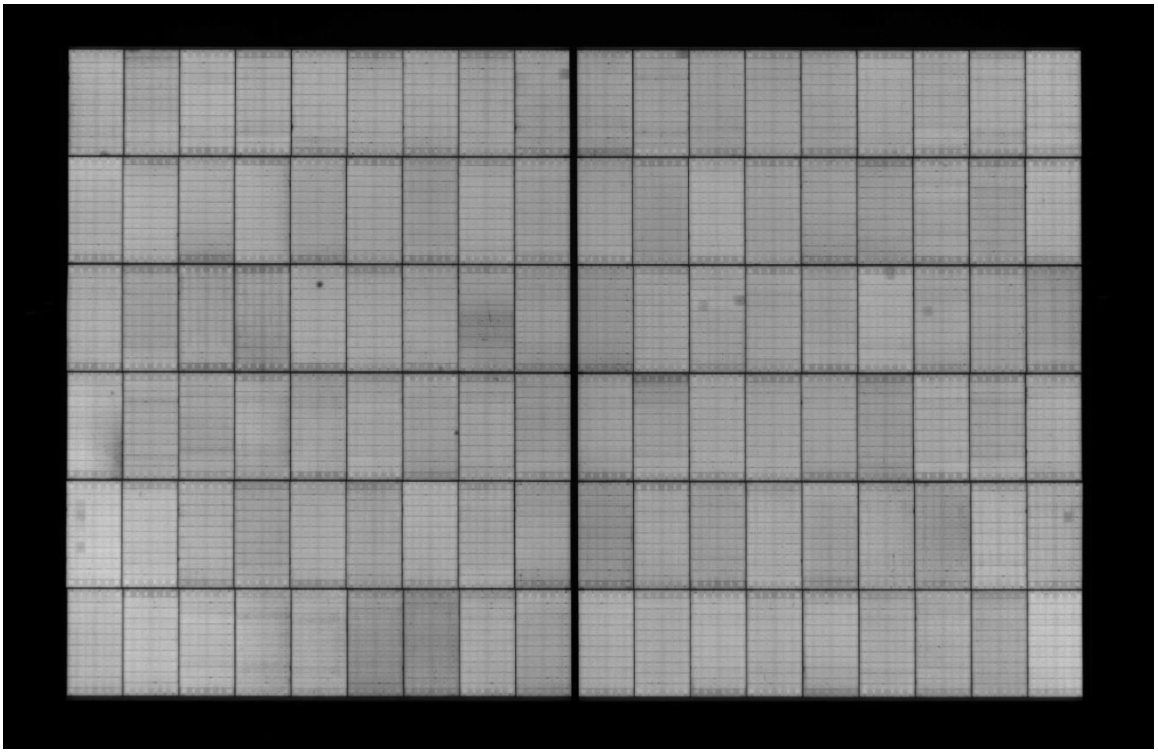
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

IV-curve *initial* vs. *final for 40 mm Hail Impact*



Electroluminescence image - *for 40 mm Hail Impact*

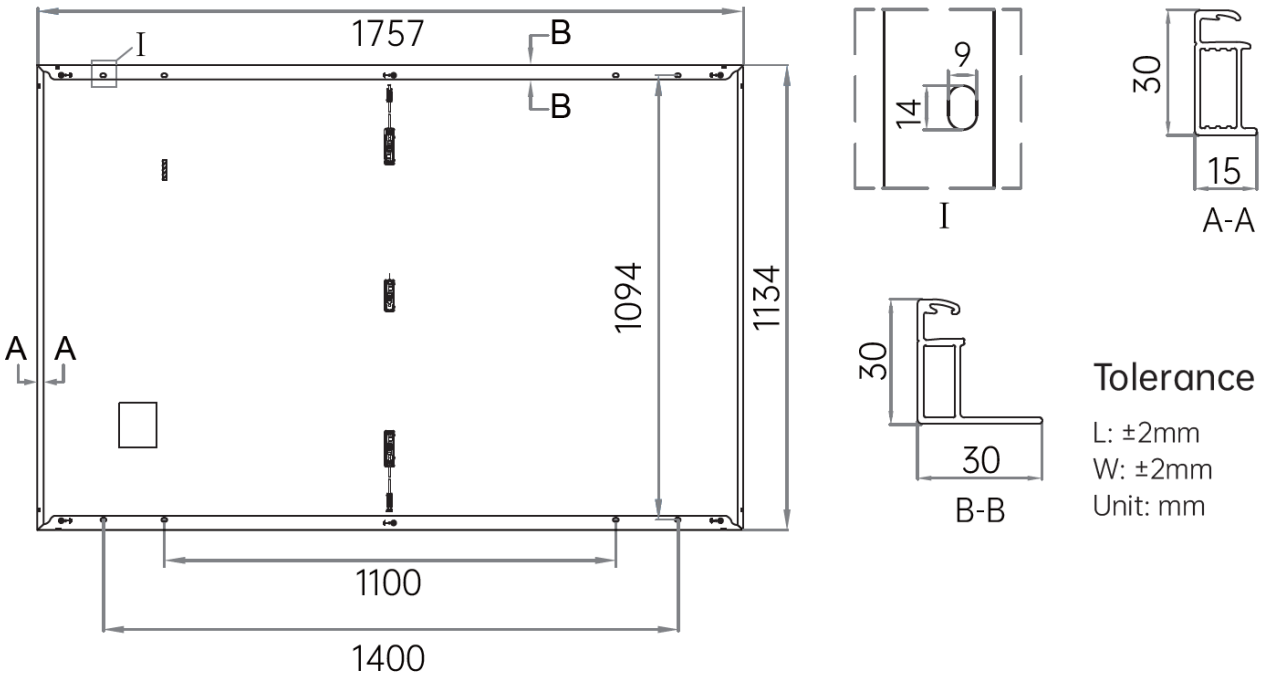
final



Supplementary information: -

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional information**		

Frame - Extract of drawing



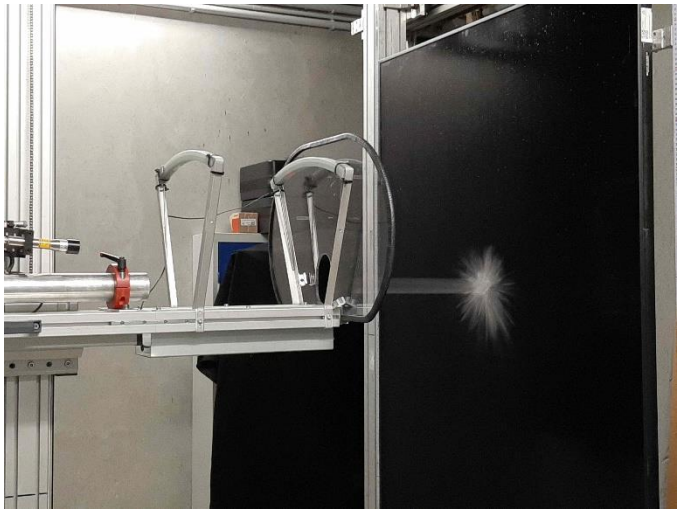
Supplementary information: -

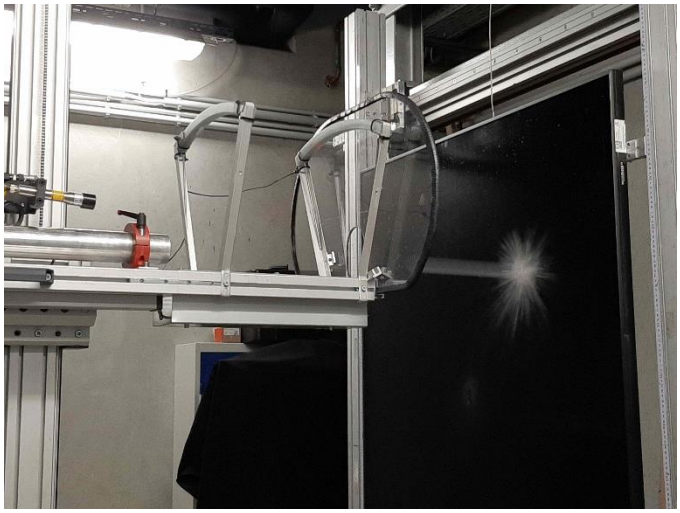
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

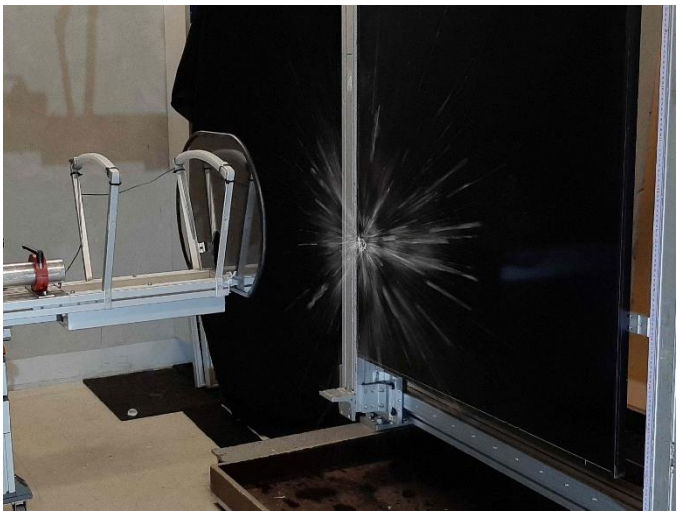
Test Set-up (example)

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

Example of Impacts on Module (40 mm)

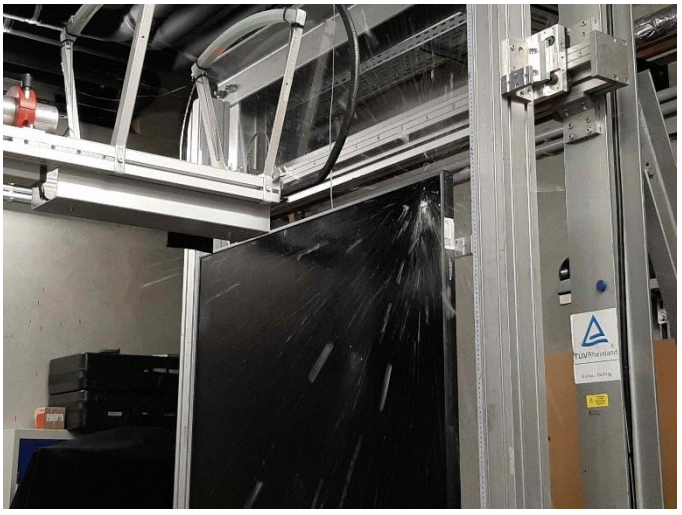


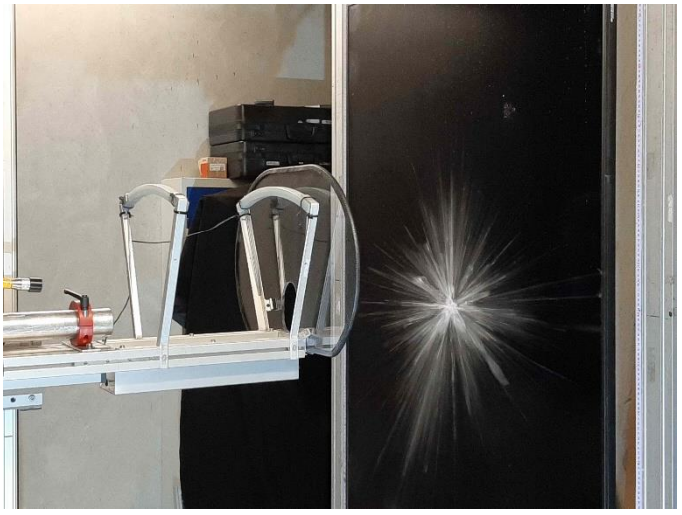


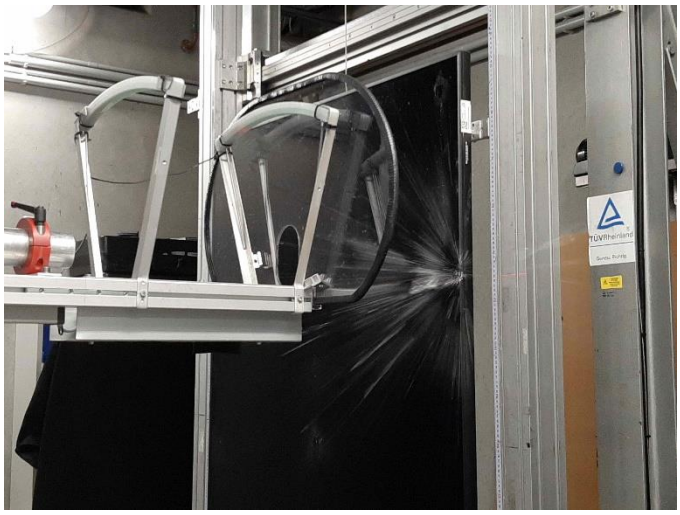
Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*
-	**Annex: Additional photo documentation**		

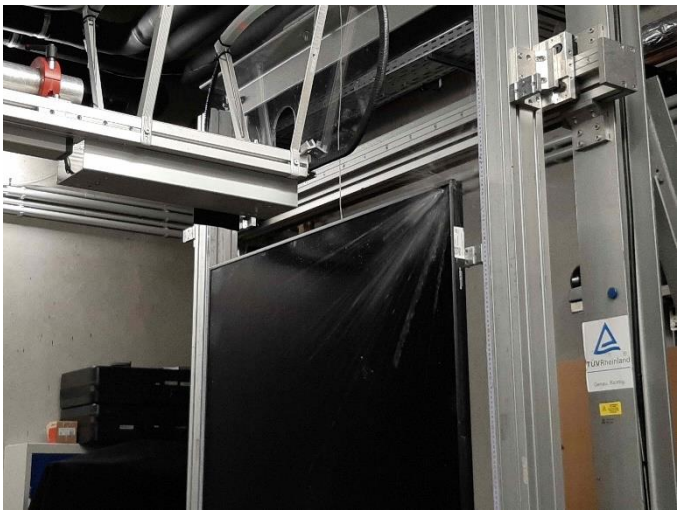
Example of Impacts on Module (40 mm)





Example of Impacts on Frame (40 mm)





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