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US-11230 NEW YORK

Att. Peter Bloom

REPORT ISSUED BY THE RESEARCH ASSOCIATION OF THE TEXTILE
INDUSTRY, AITEX

Nº 2020EP2751

The test was carried out at Polígono Industrial Fuente del Jarro. C/ Ciudad de Gibraltar, 5; 46988 – Paterna (Valencia); which property is shared at 50% between research institutes AITEX and ITE.

APPLICANT

TIGERWORKWEAR LTD

Date of reception 05/10/2020

Date Test Starting: 06/10/2020
Ending: 04/11/2020

IDENTIFICATION AND DESCRIPTION OF SAMPLES

REFERENCES

Fabric RQMC220

According to information supplied by the customer:

Fabric reference: RQMC220

Composition and percentage: 60%MODACRYLIC,40% COTTON

Color: NAVY BLUE

Weight: 220 gsm or 6.5 oz/yd²

Fabric structure: INTERLOCK FABRIC

Manufacturer: TIGERWORKWEAR LTD

TESTS CARRIED OUT

- MASS PER UNIT AREA.
- PRE-TREATMENT FOR DOMESTIC WASHING AND DRYING PROCEDURES FOR TEXTILE TESTING.
- ELECTRIC ARC EXPOSURE TEST: DETERMINATION OF THE ARC RATING (ATPV OR EBT50) OF FLAME RESISTANT MATERIALS FOR CLOTHING.

PHOTOGRAPHY



Reference ⁽¹⁾
Fabric RQMC220

RESULTS/RESULTADOS

MASS PER UNIT AREA

Standard

ASTM D3776/3776M-09a (R2017) Option C

Conditioning date

14/10/2020

Test date

16/10/2020

Atmosphere for conditioning testing

Temperature (21±1) °C

Relative humidity

(65±2) %

Type of fabric

Knitting fabric

State of the specimens

Original

Previous treatment

Null

Reference

Fabric RQMC220

Mass per unit area (oz/yd ²)	Mass per unit area (g/m ²)	Mass per unit area (oz/yd)	Mass per unit area (g/m)
6,89	233,43	1,51	46,69

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RESULTS/RESULTADOS

PRE-TREATMENT FOR DOMESTIC WASHING AND DRYING PROCEDURES FOR TEXTILE TESTING

Standard

AATCC 135:2018

Standard deviation

Reference

Sample 1 Fabric RQMC220

Washing machine

13373I12

Washing cycles

3

Washing procedure

IV

Dryer machine

Whirlpool 13098I12

Drying procedure

Aiii

Washing powder

AATCC 1993 WOB

Start and finish date

14/10/2020 - 15/10/2020

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RESULTS/RESULTADOS

MASS PER UNIT AREA

Standard

ASTM D3776/3776M-09a (R2017) Option C

Conditioning date

15/10/2020

Test date

16/10/2020

Atmosphere for conditioning testing

Temperature (21±1) °C

Relative humidity

(65±2) %

Type of fabric

Knitting fabric

State of the specimens

Washed

Previous treatment

3 washing cycles, according to standard AATCC 135:2018, washed procedure 3/IV/Aiii

Reference

Fabric RQMC220

Mass per unit area (oz/yd ²)	Mass per unit area (g/m ²)	Mass per unit area (oz/yd)	Mass per unit area (g/m)
7,77	263,52	1,70	52,70

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RESULTS/RESULTADOS

ELECTRIC ARC EXPOSURE TEST: DETERMINATION OF THE ARC RATING (ATPV OR E_{BT50}) OF FLAME RESISTANT MATERIALS FOR CLOTHING

Standard

ASTM F1959/F1959M-14e1

Test results

The test program includes minimum of twenty individual panel arc trials.

The following test data was recorded for each trial:

Arc exposure electrical conditions: arc trial number, RMS arc current, peak arc current, arc voltage, arc duration, energy dissipated in arc, plots of arc current and arc voltage.

Temperature rise response from two monitor sensors for each panel in each trial, plot of average responses from two monitor sensors.

Pictures after arc exposure.

Video

Essential test data and test results are presented in the following pages as follows:

Arc rating: ATPV or E_{BT50} or both and plots of the burn injury probability (ATPV) or break open probability (E_{BT50}) or both versus E_i.

Heat attenuation factor (HAF) and plot of HAF on E_i.

Test specimen description and order of layer.

Distance from an arc center line to the panel surface.

Subjective evaluation.

Pictures after arc exposure.

Ignition probability value (if determined during testing).

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Test conditions	
Date test.	02/11/2020
Arc current	(8 ± 1) kA
Stainless steel electrodes, gap of the electrodes	(300 ± 5) mm
Distance between the electrodes and sample	(300 ± 5) mm
Fuse wire	0.5 mm
Number of samples tested	21
Starting and ending pre-treatment date	14/10/2020 - 15/10/2020
Starting and ending conditioning date	30/10/2020 - 02/11/2020
Conditioning	24 h; 21 ± 1°C, 65 ± 2 % Hr.

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Reference Fabric RQMC220

Sample description according to the information supplied by the customer

Navy blue knitted fabric style RQMC220, 60%MODACRYLIC,40% COTTON, 220 g/m²,
manufacturer TIGERWORKWEAR LTD.

Pre-treatment

3 washing cycles at 49°C, according to standard AATCC TM135-2018, method 3IV and type Aiii drying

Sample weight

As received: 233 g/m²

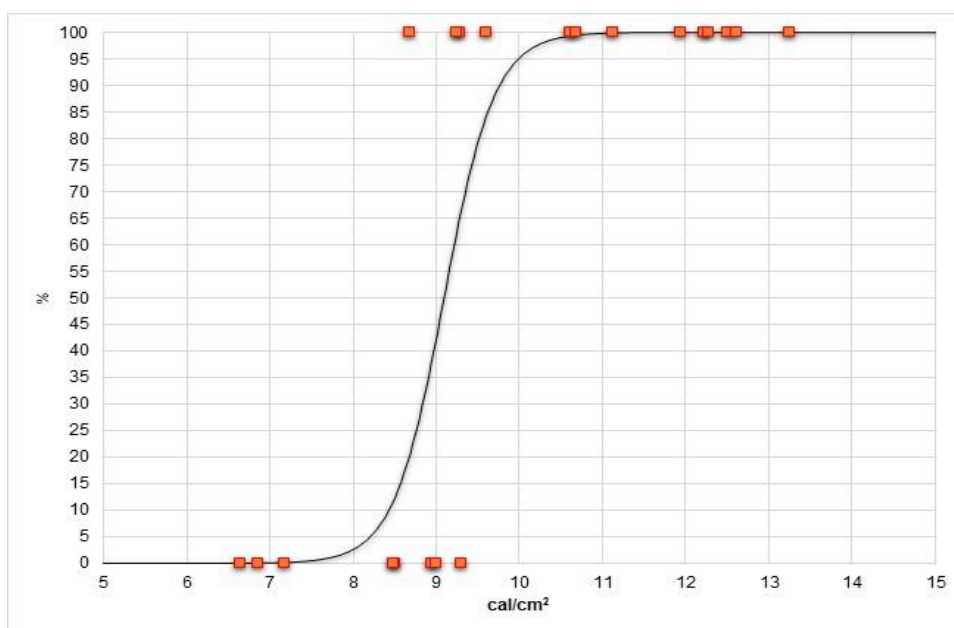
After wash: 264 g/m²

Deviation from the standard

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Determination of ATPV, 50% of Probability of 2nd degree burn

ATPV | 9,1 cal/cm²



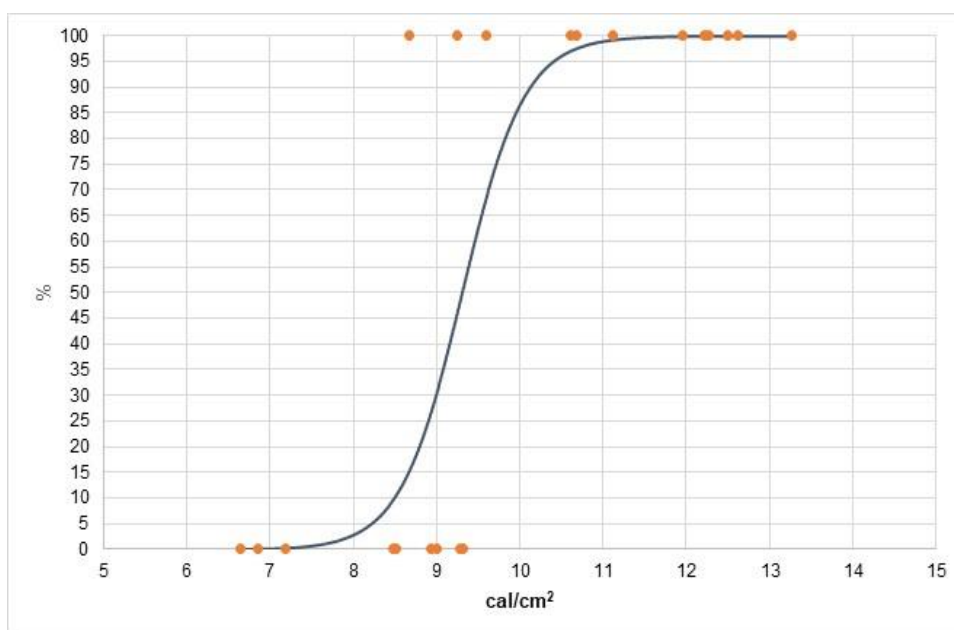
Probability %	5	10	20	30	40	50	60	70	80	95
E _i cal/cm ²	8,2	8,4	8,7	8,8	9,0	9,1	9,2	9,4	9,5	10,0

ATPV points above	10
ATPV points 20%	11
ATPV points below	5
ATPV points mix zone	6

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Determination of E_{BT50} , 50% of Probability broken

E_{BT50} 9,3 cal/cm²



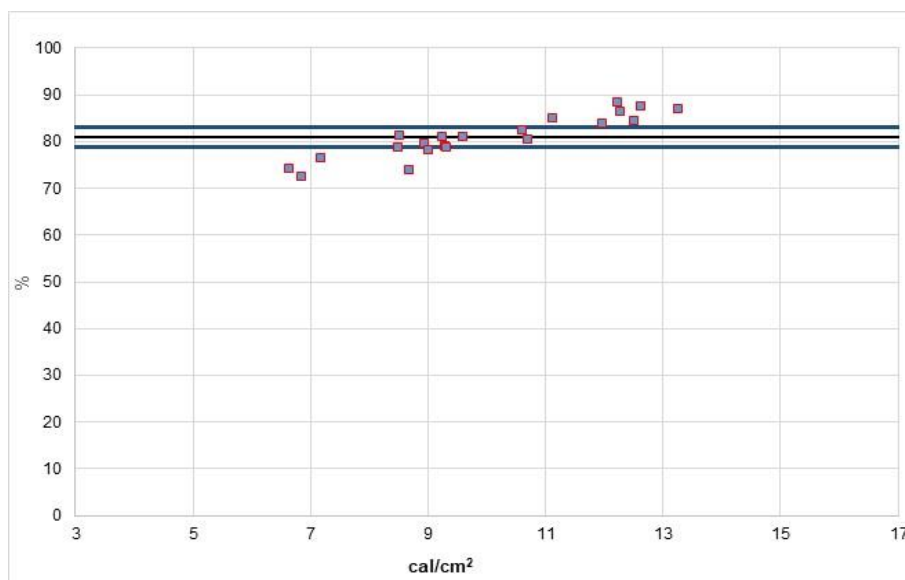
Probability %	5	10	20	30	40	50	60	70	80	95
E_i cal/cm ²	8,2	8,5	8,8	9,0	9,2	9,3	9,5	9,6	9,8	10,4

E_{BT50} points above	10
E_{BT50} points 20%	12
E_{BT50} points below	5
Points mix zone	6

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Determination of HAF, confidence Intervals 95%

HAF	81,0 %
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% HAF value :	81,0
Upper Confidence Level %:	83,1
Lower Confidence Level %:	79,0
Points above:	7
Points below:	7
Points between:	7
Total Points:	21

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Summary of measured energy and subjective evaluation:

Test	Time (ms)	Cycles 50Hz	Ei cal/cm ²	SCD cal/cm ²	HAF %	Burn	Break Open
1-A	173,8	8,69	8,9	-0,06	79,7	N	N
1-B	173,8	8,69	9,3	0,04	79,1	Y	N
1-C	173,8	8,69	9,2	0,36	81,0	Y	Y
2-A	132,8	6,64	8,5	-0,28	81,4	N	N
2-B	132,8	6,64	6,8	-0,07	72,6	N	N
2-C	132,8	6,64	6,6	-0,32	74,4	N	N
3-A	152,6	7,63	10,6	0,25	82,5	Y	Y
3-B	152,6	7,63	7,2	-0,32	76,4	N	N
3-C	152,6	7,63	8,5	-0,26	78,9	N	N
4-A	213,8	10,69	12,2	0,01	88,4	Y	Y
4-B	213,8	10,69	11,1	0,42	84,9	Y	Y
4-C	213,8	10,69	12,5	0,47	84,4	Y	Y
5-A	173,6	8,68	12,6	0,3	87,6	Y	Y
5-B	173,6	8,68	8,7	0,42	74,0	Y	Y
5-C	173,6	8,68	9,0	-0,15	78,2	N	N
6-A	192,8	9,64	12,3	0,27	86,4	Y	Y
6-B	192,8	9,64	9,3	-0,05	78,9	N	N
6-C	192,8	9,64	9,6	0,16	81,2	Y	Y
7-A	203,2	10,16	13,3	0,19	87,0	Y	Y
7-B	203,2	10,16	12,0	0,44	83,9	Y	Y
7-C	203,2	10,16	10,7	0,01	80,6	Y	Y

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Summary of measured energy and subjective evaluation:

Test	After flame (s)	Ablation	Melting	Dripping	Charring	Embrittlement
1-A	0	N	N	N	Y	Y
1-B	0	N	N	N	Y	Y
1-C	0	Y	N	N	Y	Y
2-A	0	N	N	N	Y	Y
2-B	0	N	N	N	Y	Y
2-C	0	N	N	N	Y	Y
3-A	0	Y	N	N	Y	Y
3-B	0	N	N	N	Y	Y
3-C	0	N	N	N	Y	Y
4-A	0	Y	N	N	Y	Y
4-B	0	Y	N	N	Y	Y
4-C	0	Y	N	N	Y	Y
5-A	0	Y	N	N	Y	Y
5-B	0	Y	N	N	Y	Y
5-C	0	N	N	N	Y	Y
6-A	0	Y	N	N	Y	Y
6-B	0	N	N	N	Y	Y
6-C	0	Y	N	N	Y	Y
7-A	0	Y	N	N	Y	Y
7-B	0	Y	N	N	Y	Y
7-C	0	Y	N	N	Y	Y

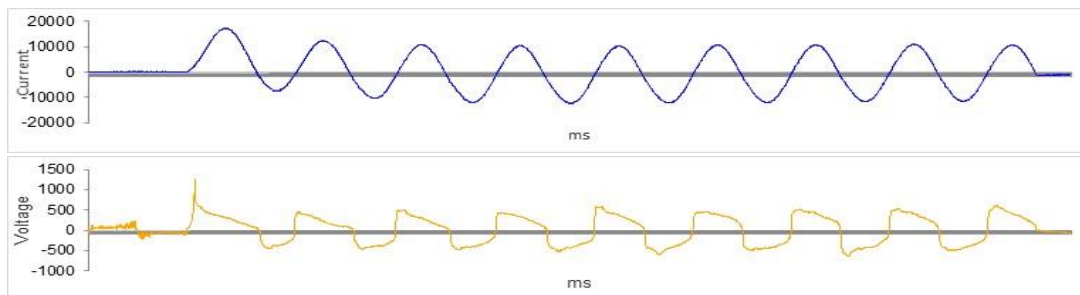
Y Yes N No

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Electrical current and response sensor response:

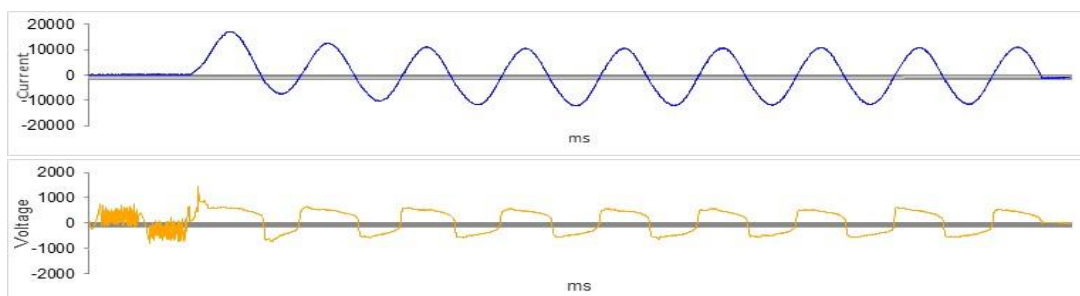
Calibration shot

INITIAL CALIBRATION



Ei Panel A	9,6 cal/cm ²	Ei Panel B	7,4 cal/cm ²	Ei Panel C	7,9 cal/cm ²
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FINAL CALIBRATION



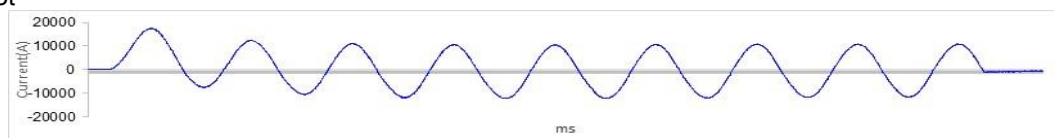
Ei Panel A	10,2 cal/cm ²	Ei Panel B	8,4 cal/cm ²	Ei Panel C	8,1 cal/cm ²
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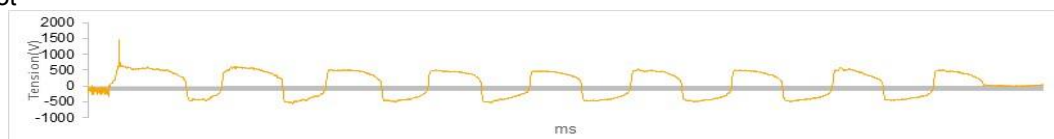
Electrical current and response sensor response:

Shot 1

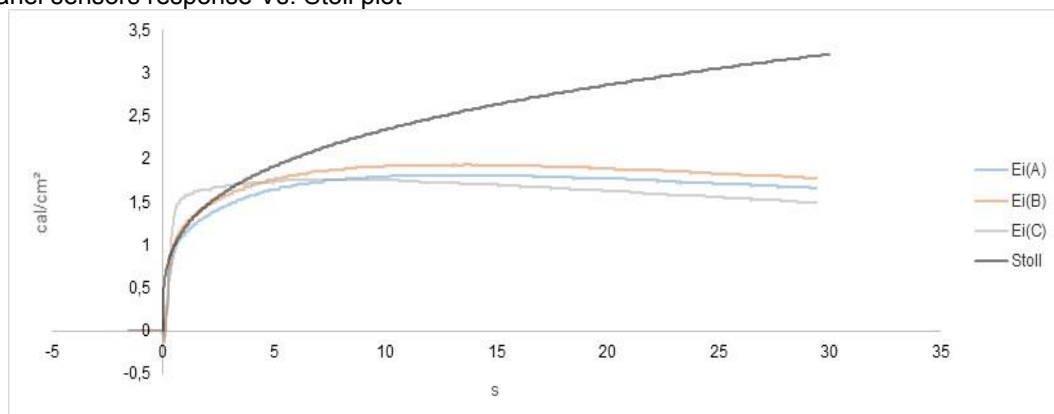
Current Plot



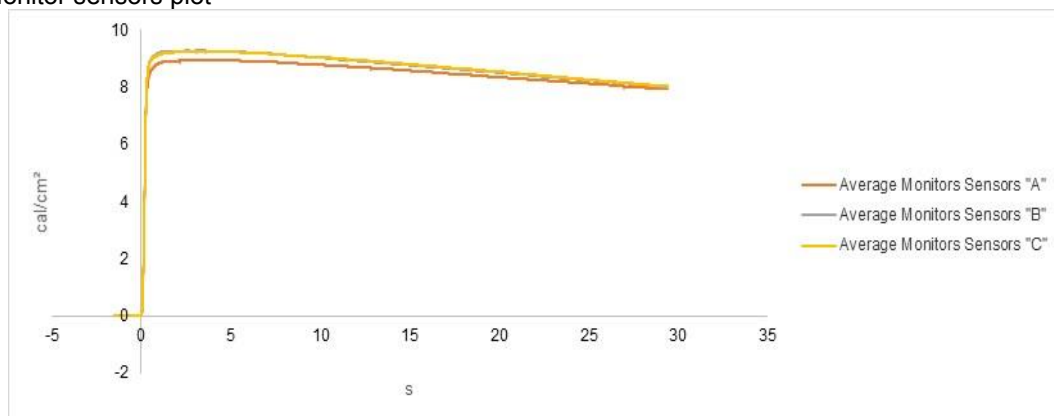
Voltage Plot



Average panel sensors response Vs. Stoll plot



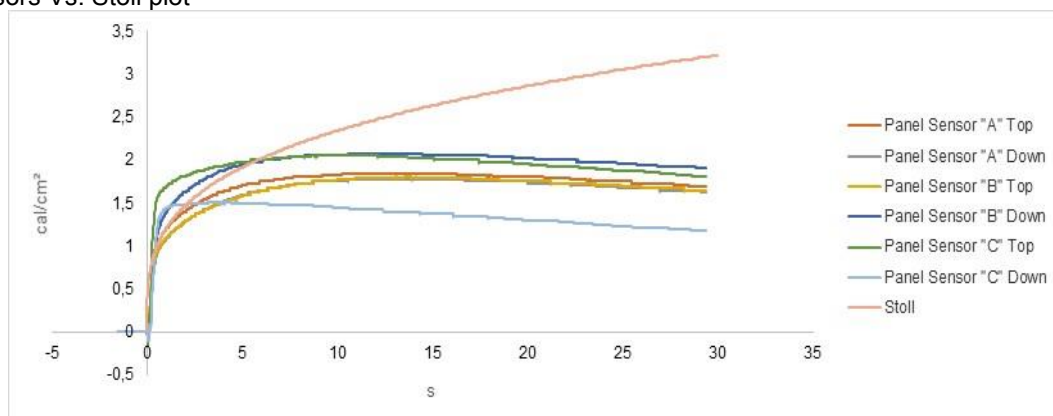
Average monitor sensors plot



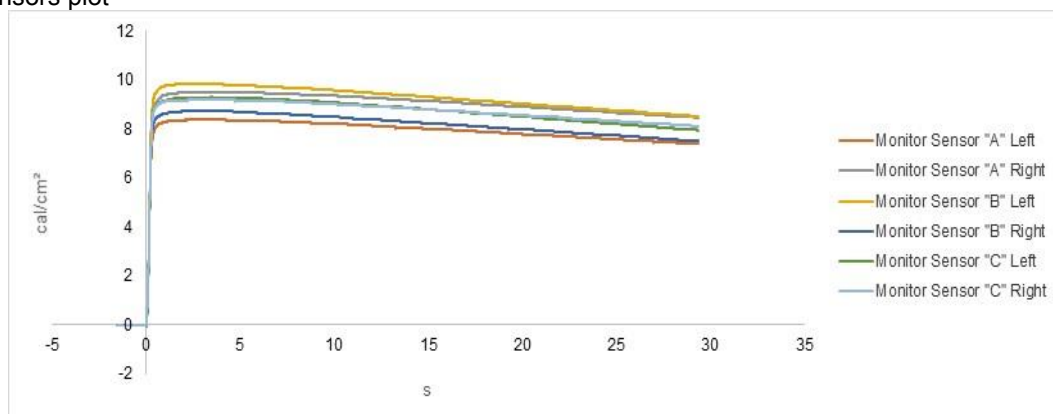
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Electrical current and response sensor response:
Shot 1

Panel sensors Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,2	Current Peak (kA)	17,6	Arc Voltage (V)	1449,0
Duration (cycles nº)	8,7	Duration (ms)	173,8	Arc Energy (kJ)	541,2
Arc Voltage (kJ)	419,5				

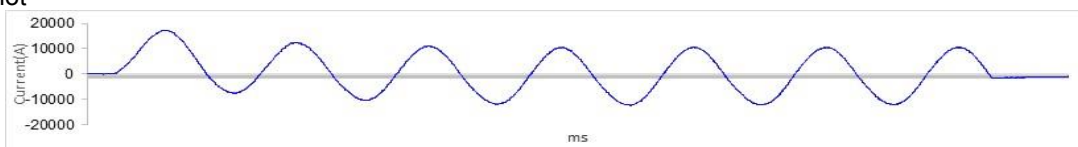
sensor response	PANEL A	PANEL B	PANEL C
Ei	8,94 cal/cm ²	9,28 cal/cm ²	9,24 cal/cm ²
SCD	-0,06 cal/cm ²	0,04 cal/cm ²	0,36 cal/cm ²
HAF	79,72 %	79,11 %	80,96 %

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Electrical current and response sensor response:

Shot 2

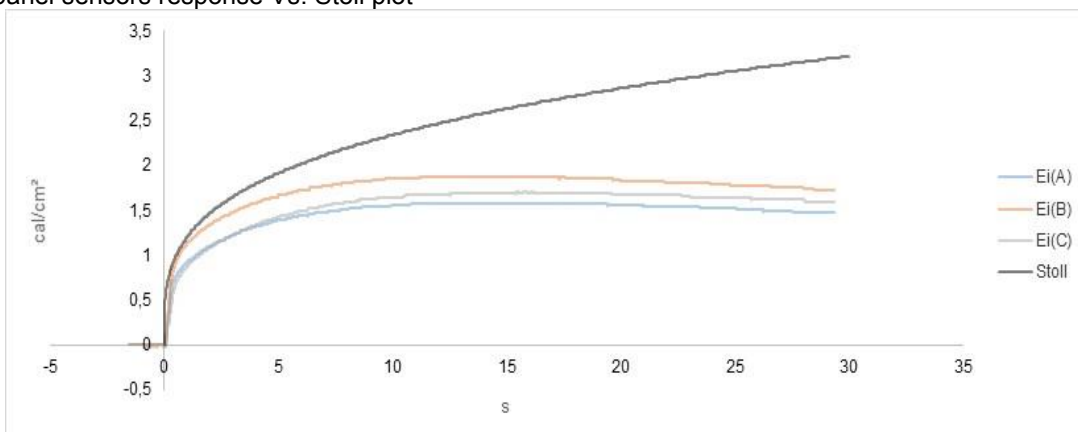
Current Plot



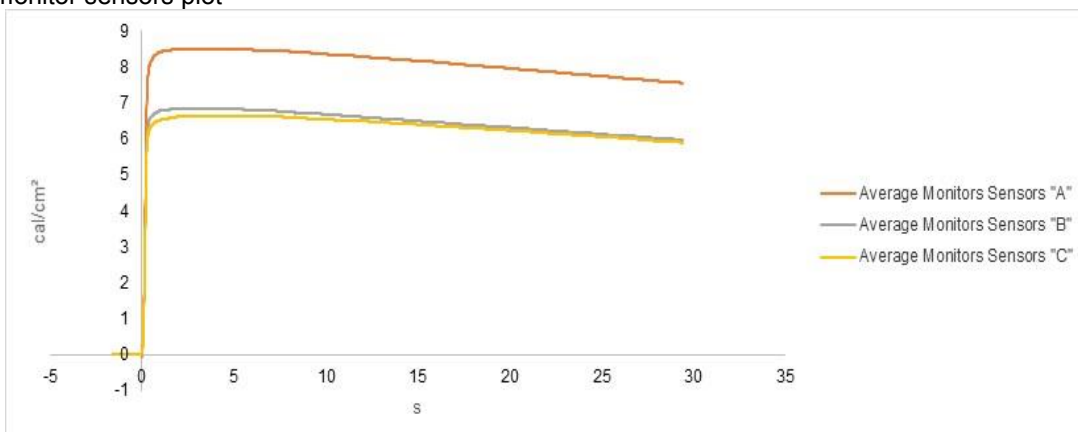
Voltage Plot



Average panel sensors response Vs. Stoll plot



Average monitor sensors plot

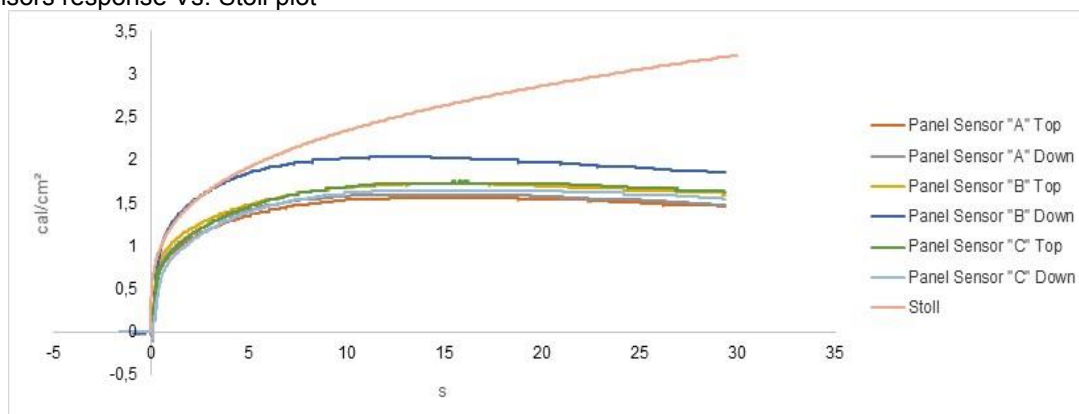


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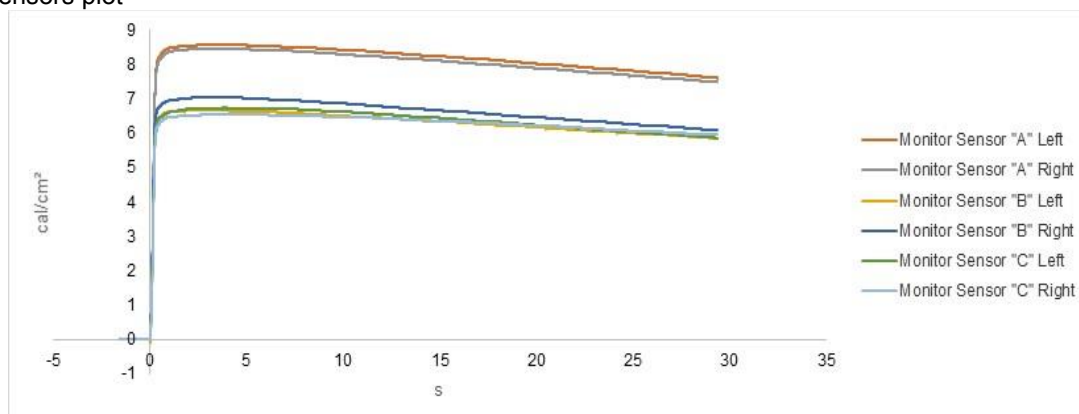
Electrical current and response sensor response:

Shot 2

Panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,2	Current Peak (kA)	17,3	Arc Voltage (V)	1410,0
Duration (cycles nº)	6,6	Duration (ms)	132,8	Arc Energy (kJ)	409,7
Arc Voltage (kJ)	418,7				

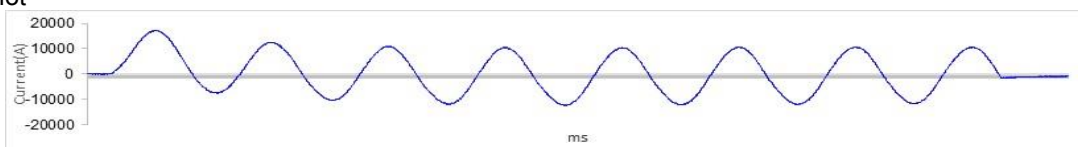
sensor response	PANEL A	PANEL B	PANEL C
Ei	8,51 cal/cm ²	6,85 cal/cm ²	6,64 cal/cm ²
SCD	-0,28 cal/cm ²	-0,07 cal/cm ²	-0,32 cal/cm ²
HAF	81,41 %	72,56 %	74,39 %

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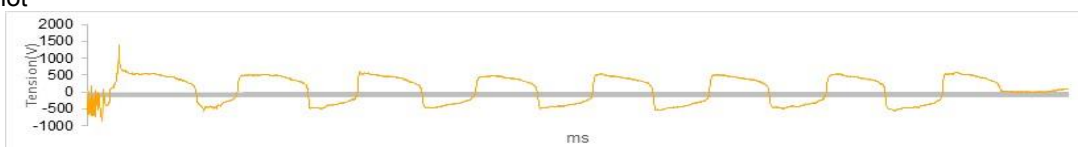
Electrical current and response sensor response:

Shot 3

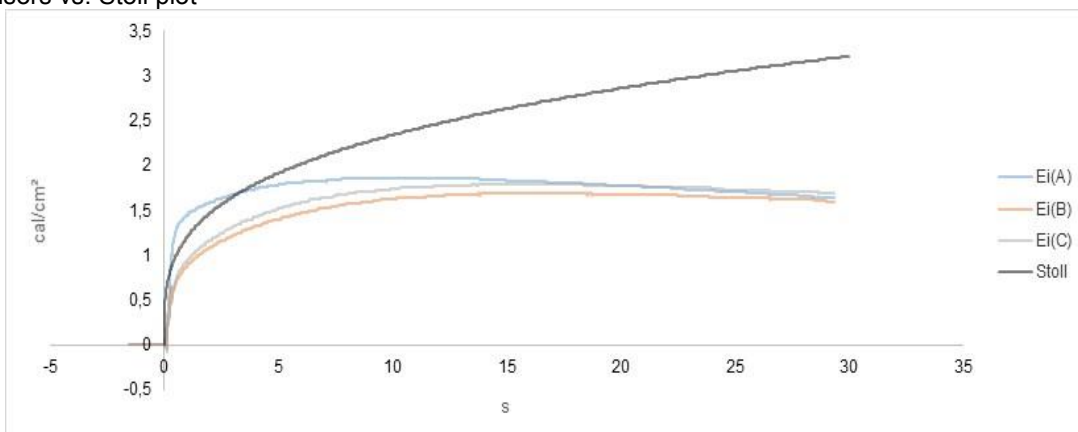
Current Plot



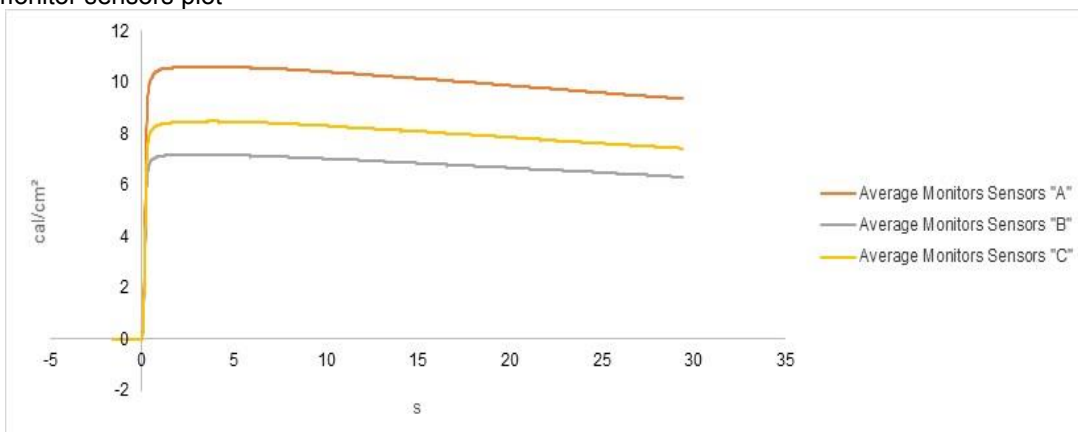
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot

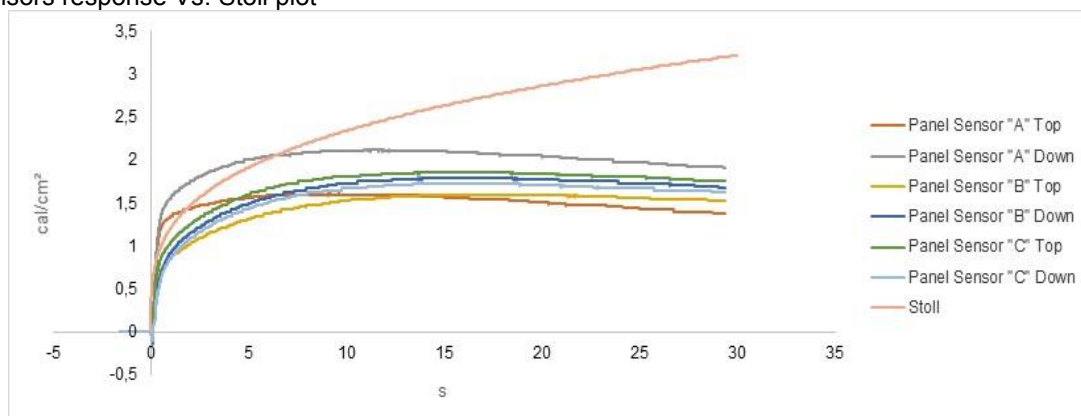


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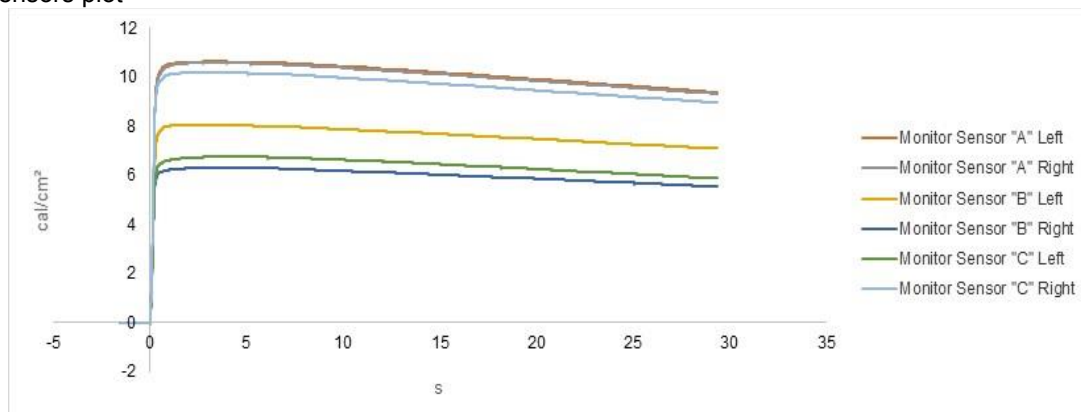
Electrical current and response sensor response:

Shot 3

Panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,2	Current Peak (kA)	17,3	Arc Voltage (V)	1392,0
Duration (cycles nº)	7,6	Duration (ms)	152,7	Arc Energy (kJ)	466,0
Arc Voltage (kJ)	416,7				

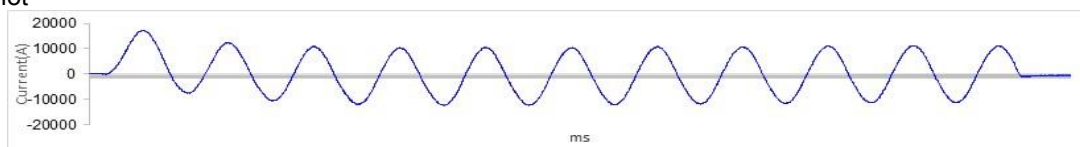
sensor response	PANEL A	PANEL B	PANEL C
Ei	10,61 cal/cm²	7,18 cal/cm²	8,48 cal/cm²
SCD	0,25 cal/cm²	-0,32 cal/cm²	-0,26 cal/cm²
HAF	82,48 %	76,42 %	78,93 %

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Electrical current and response sensor response:

Shot 4

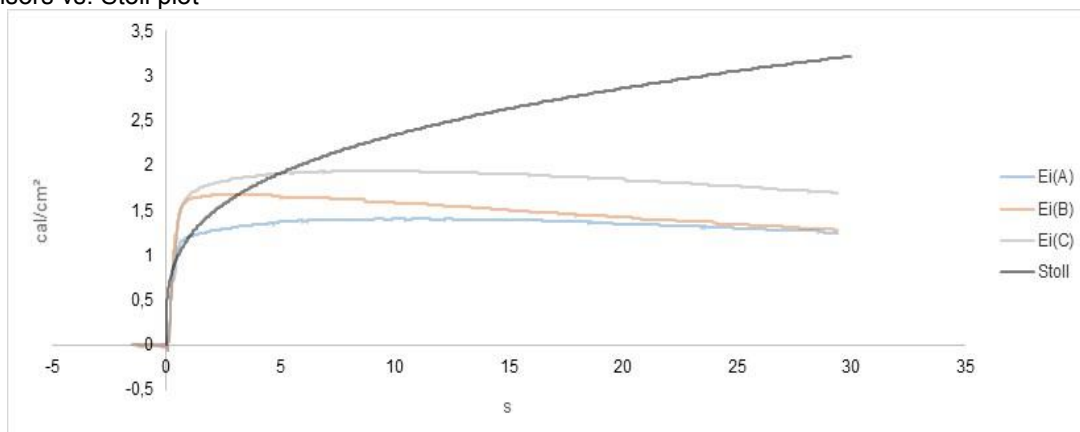
Current Plot



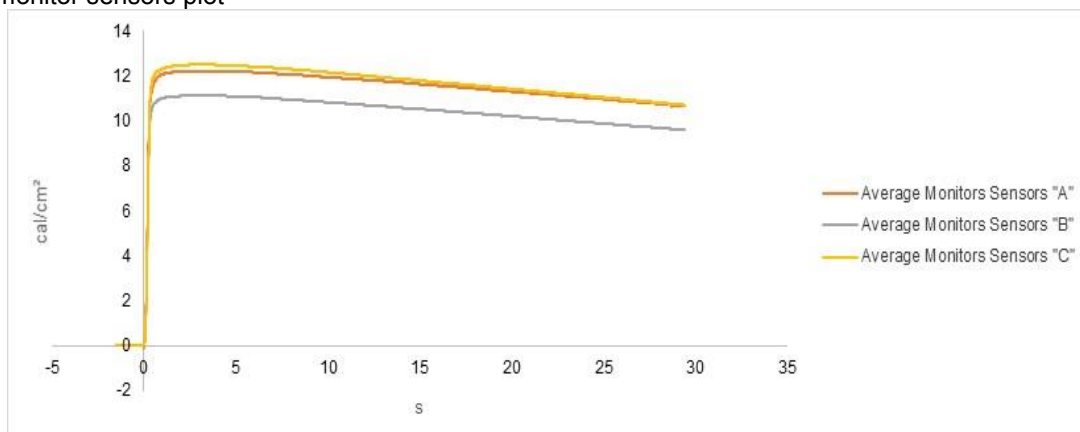
Voltage Plot



Panel sensors vs. Stoll plot



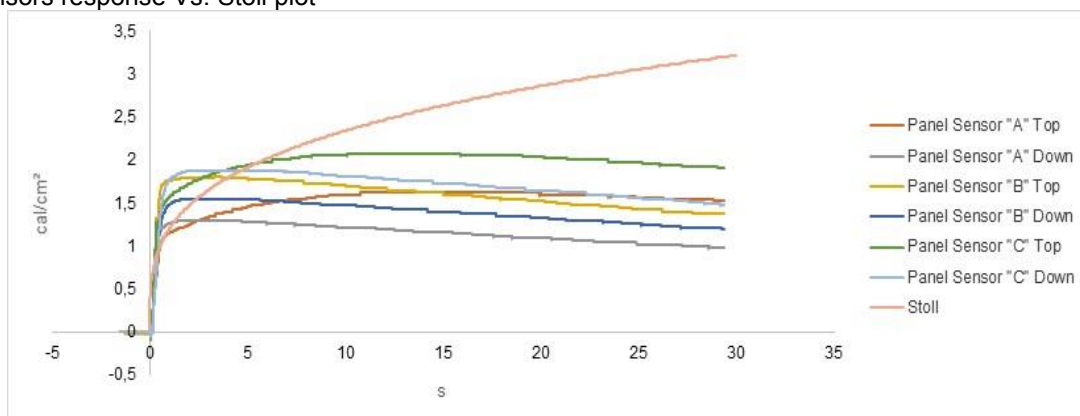
Average monitor sensors plot



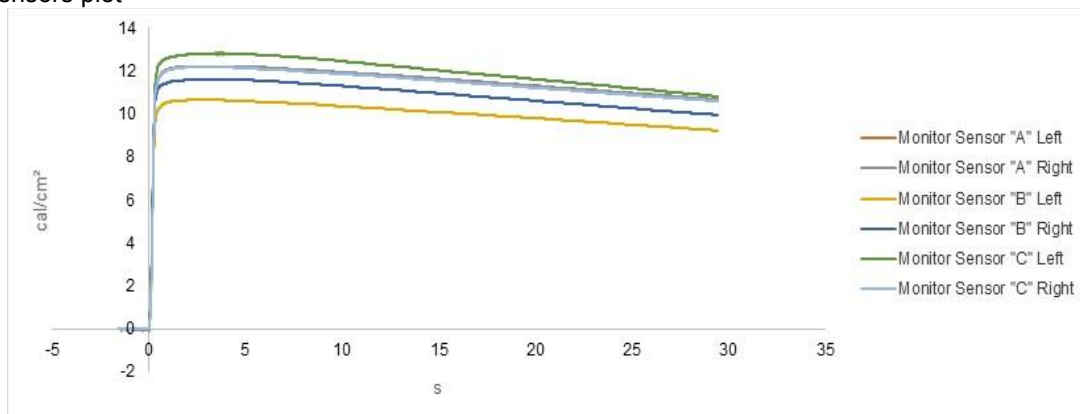
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Electrical current and response sensor response:
Shot 4

Panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,1	Current Peak (kA)	17,3	Arc Voltage (V)	1485,0
Duration (cycles nº)	10,7	Duration (ms)	213,8	Arc Energy (kJ)	630,9
Arc Voltage (kJ)	401,0				

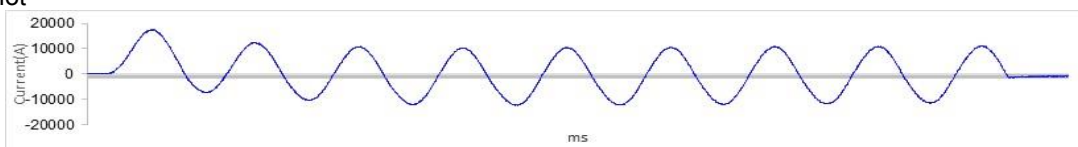
sensor response	PANEL A	PANEL B	PANEL C
Ei	12,22 cal/cm²	11,12 cal/cm²	12,50 cal/cm²
SCD	0,01 cal/cm²	0,42 cal/cm²	0,47 cal/cm²
HAF	88,44 %	84,94 %	84,45 %

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Electrical current and response sensor response:

Shot 5

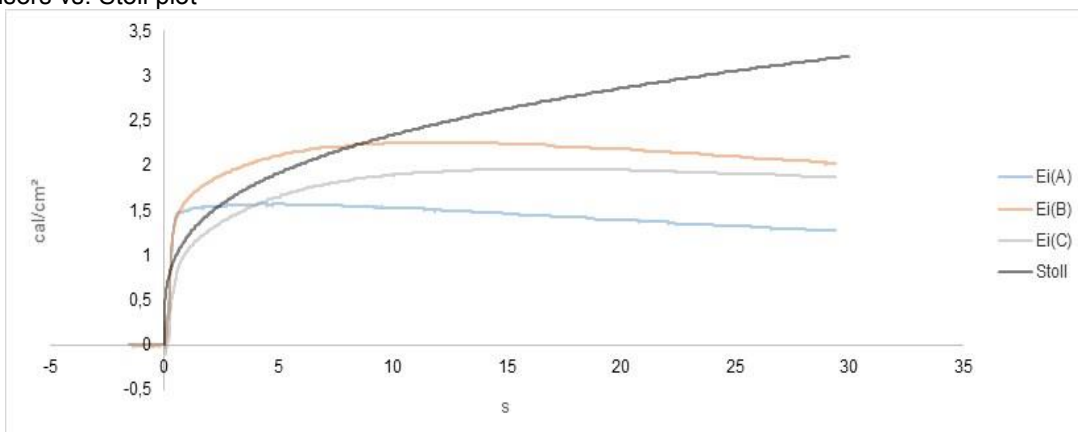
Current Plot



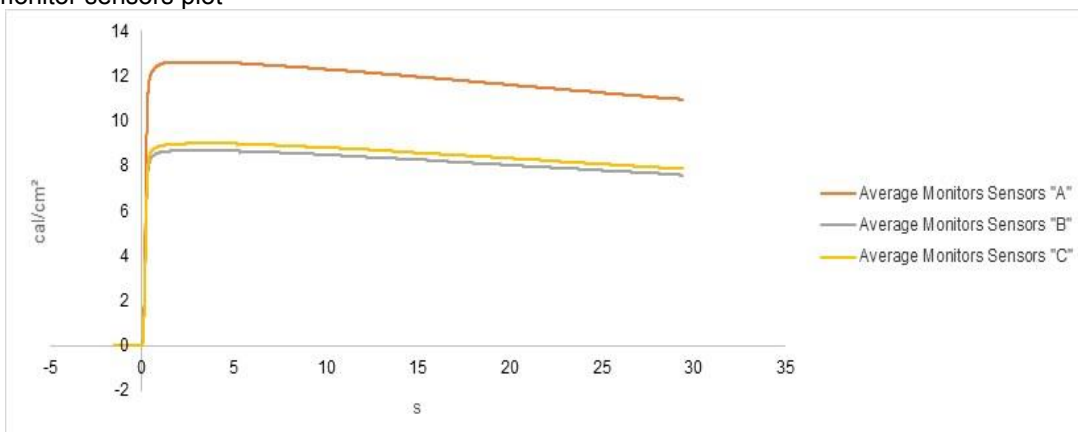
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot

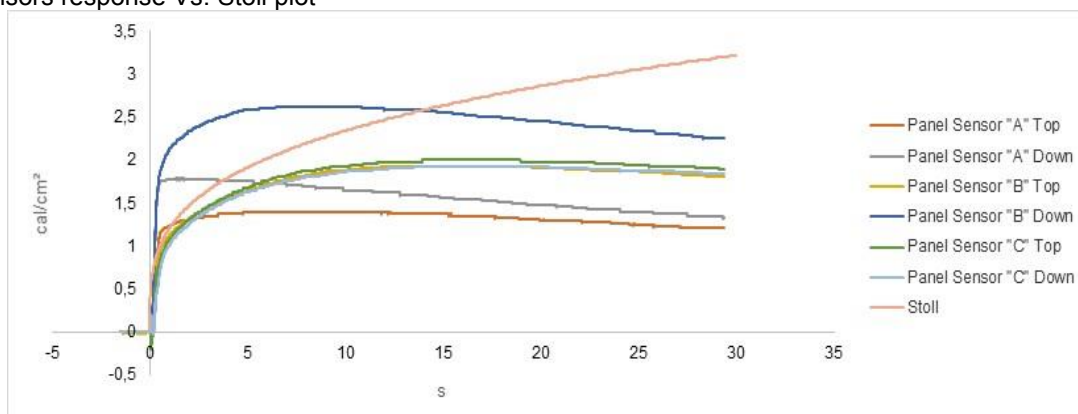


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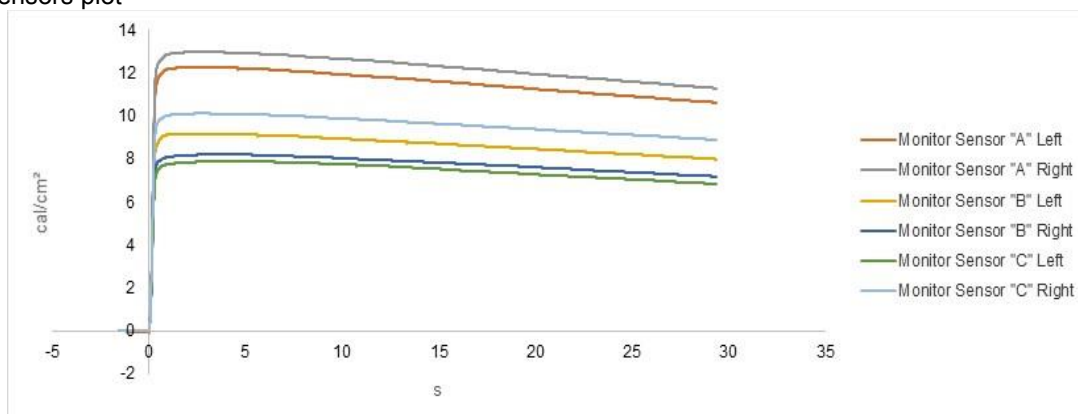
Electrical current and response sensor response:

Shot 5

Panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,1	Current Peak (kA)	17,6	Arc Voltage (V)	1464,0
Duration (cycles nº)	8,7	Duration (ms)	173,7	Arc Energy (kJ)	540,2
Arc Voltage (kJ)	423,9				

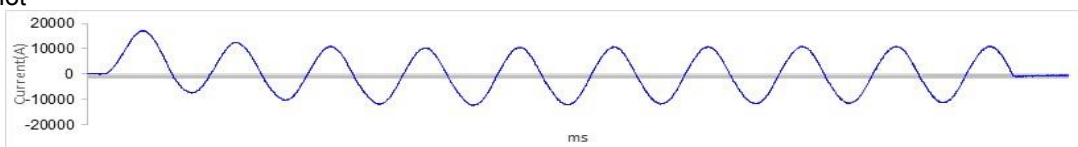
sensor response	PANEL A	PANEL B	PANEL C
Ei	12,62 cal/cm ²	8,68 cal/cm ²	9,00 cal/cm ²
SCD	0,30 cal/cm ²	0,42 cal/cm ²	-0,15 cal/cm ²
HAF	87,56 %	73,96 %	78,18 %

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Electrical current and response sensor response:

Shot 6

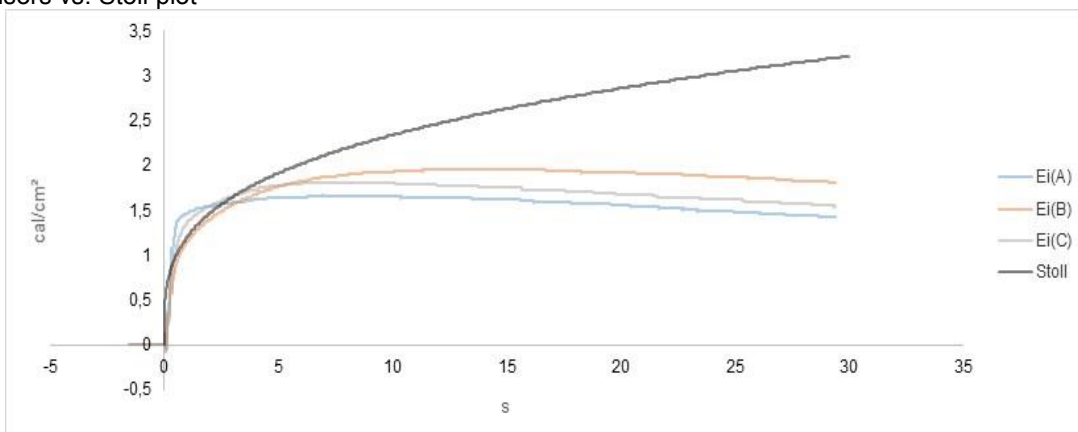
Current Plot



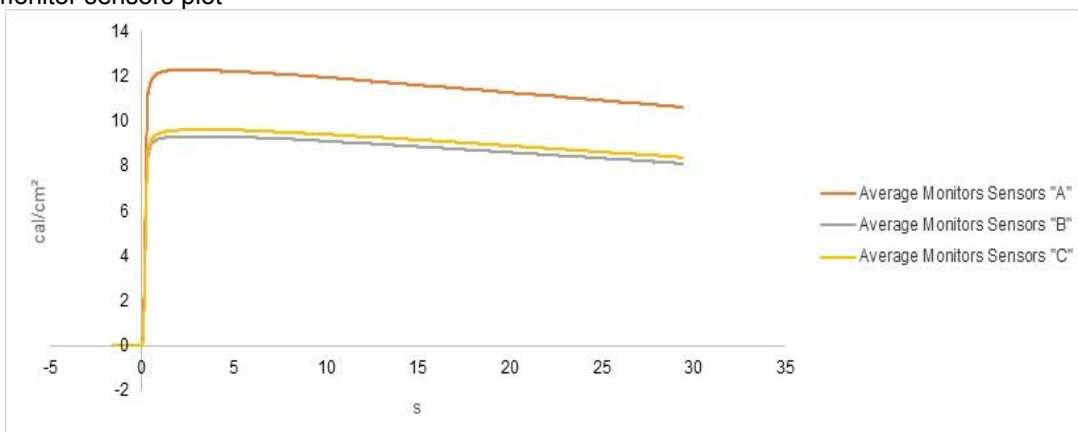
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot

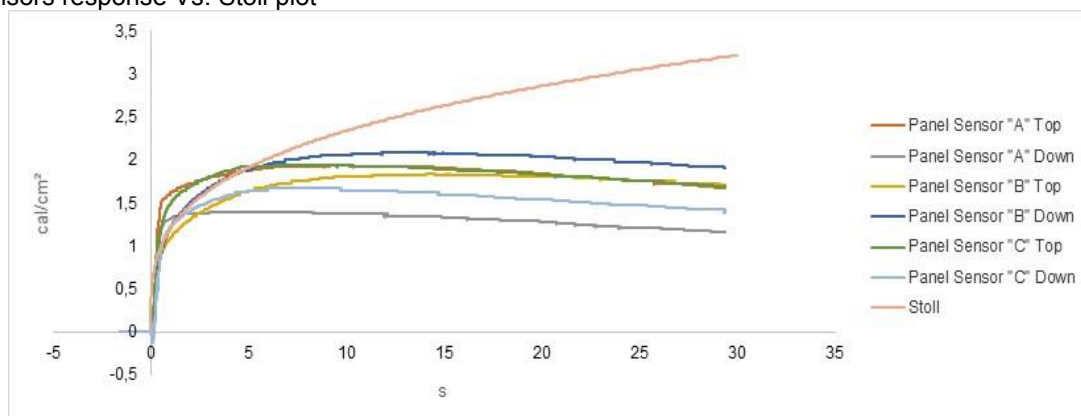


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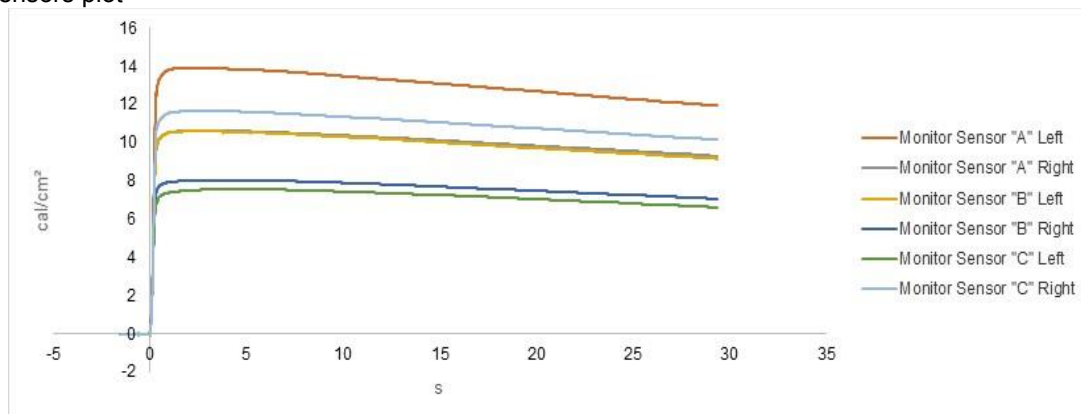
Electrical current and response sensor response:

Shot 6

Panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,1	Current Peak (kA)	17,1	Arc Voltage (V)	1446,0
Duration (cycles nº)	9,6	Duration (ms)	192,8	Arc Energy (kJ)	545,7
Arc Voltage (kJ)	390,0				

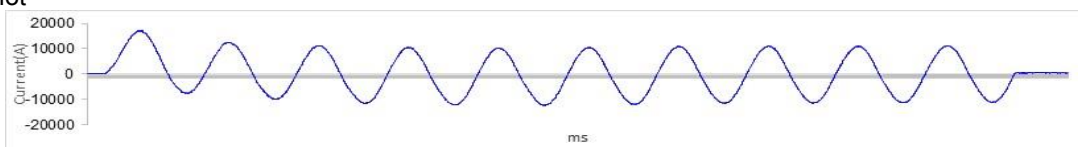
Sensor response	PANEL A	PANEL B	PANEL C
Ei	12,27 cal/cm ²	9,31 cal/cm ²	9,60 cal/cm ²
SCD	0,27 cal/cm ²	-0,05 cal/cm ²	0,16 cal/cm ²
HAF	86,41 %	78,89 %	81,19 %

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Electrical current and response sensor response:

Shot 7

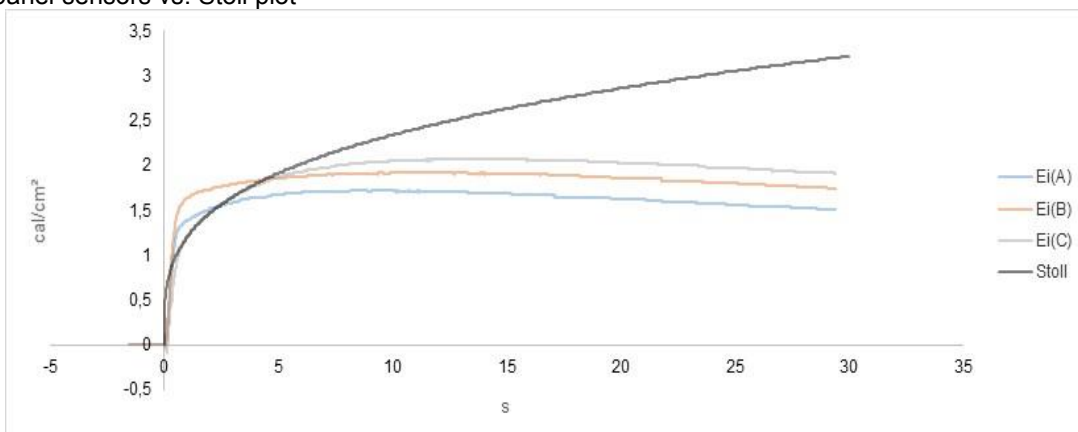
Current Plot



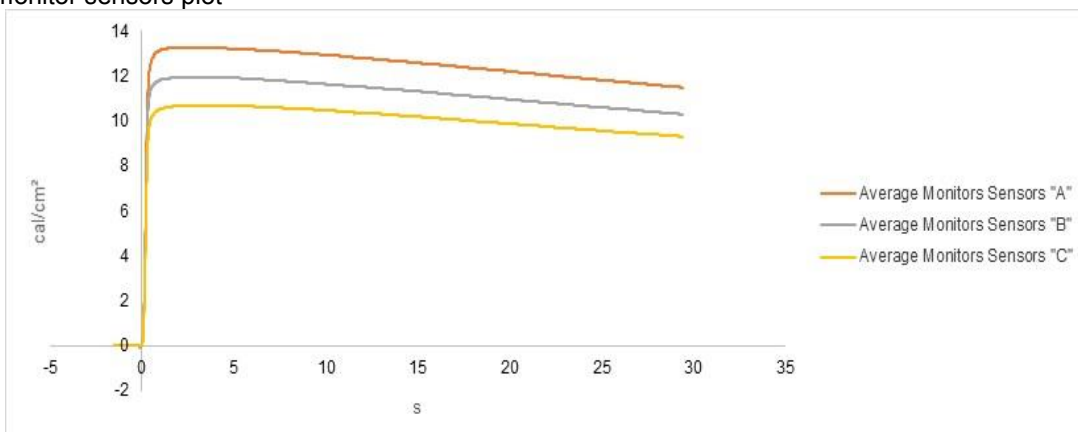
Voltage Plot



Average panel sensors vs. Stoll plot



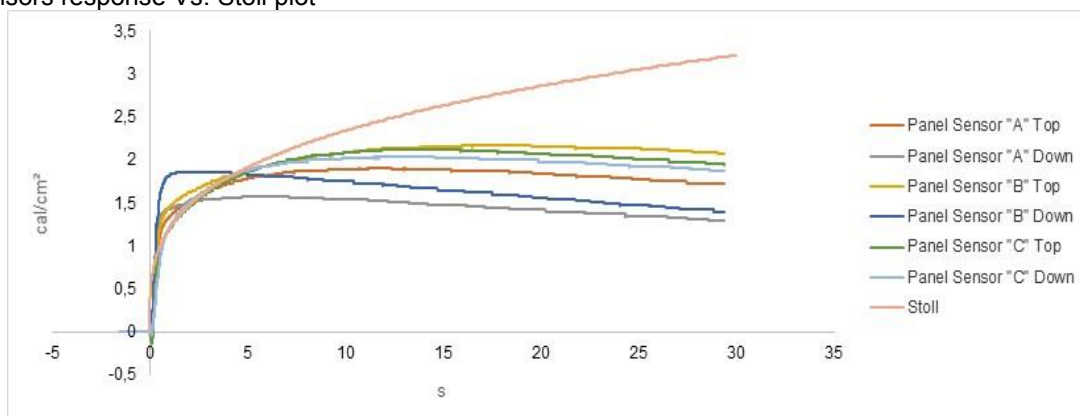
Average monitor sensors plot



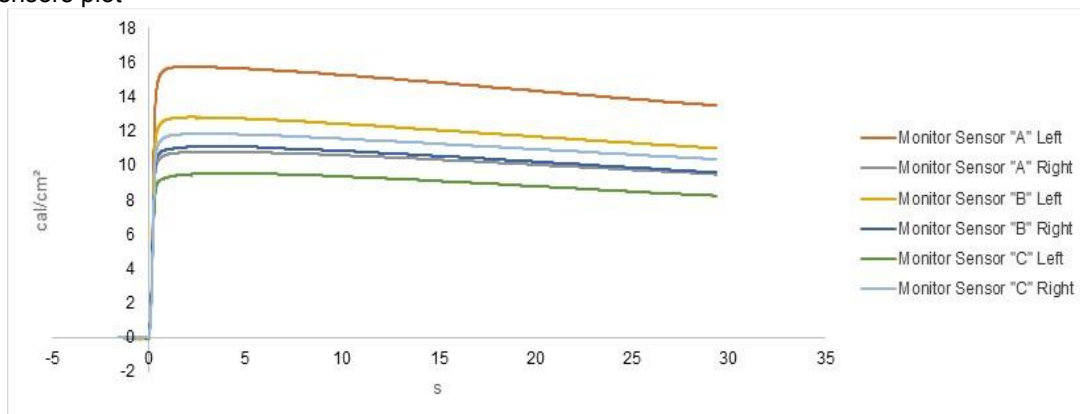
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Electrical current and response sensor response:
Shot 7

Panel sensors response Vs. Stoll plot



Monitor sensors plot

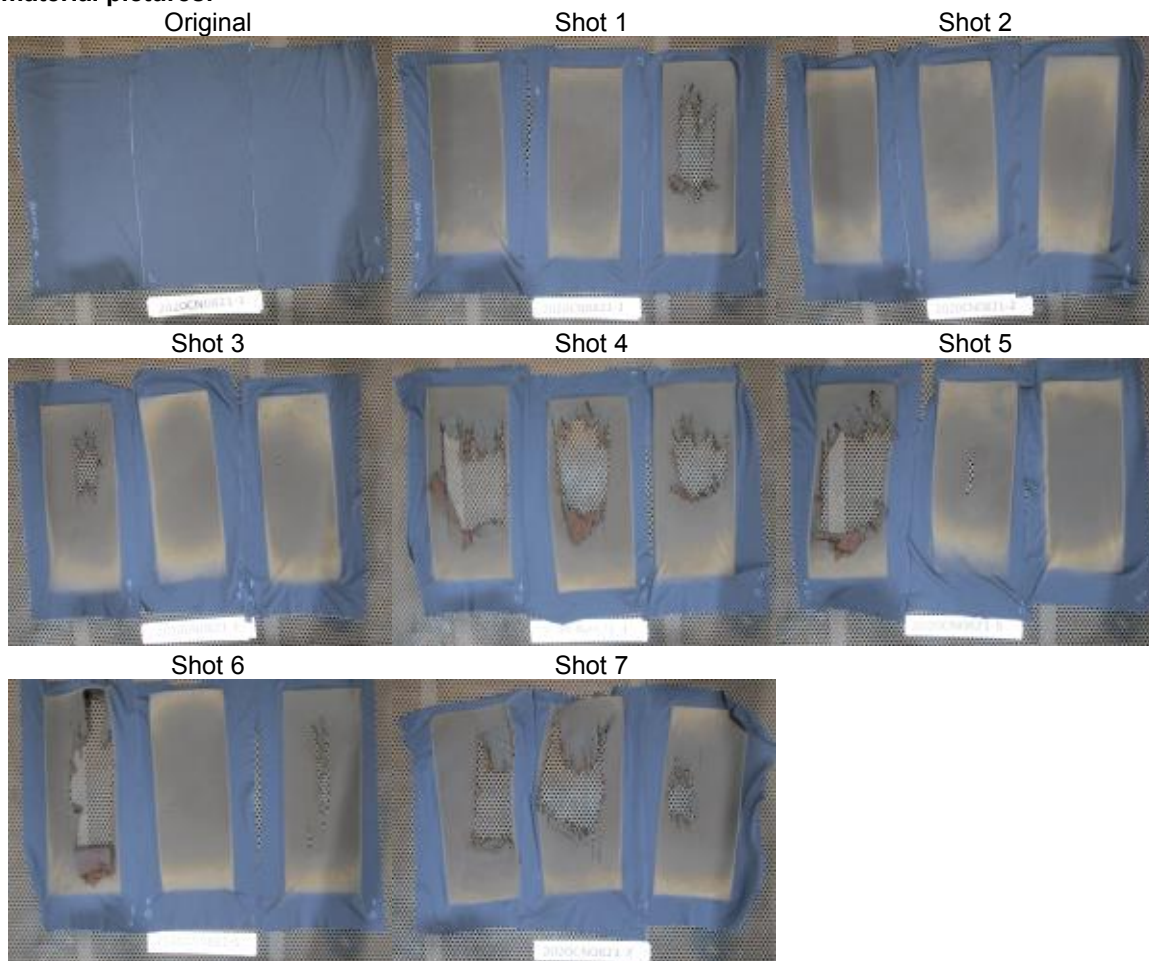


Current Total RMS (kA)	8,0	Current Peak (kA)	17,1	Arc Voltage (V)	1449,0
Duration (cycles nº)	10,2	Duration (ms)	203,2	Arc Energy (kJ)	646,6
Arc Voltage (kJ)	433,2				

sensor response	PANEL A	PANEL B	PANEL C
Ei	13,26 cal/cm²	11,95 cal/cm²	10,69 cal/cm²
SCD	0,19 cal/cm²	0,44 cal/cm²	0,01 cal/cm²
HAF	87,03 %	83,89 %	80,58 %

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Tested material pictures:



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Summary of results:

ATPV	9,1 cal/cm ²
E_{BT50}	9,3 cal/cm ²
HAF	81,0 %

FABRIC TESTED ACCORDING TO THE STANDARD ASTM F1959/F1959M-14e1

ARC RATING (ATPV)

9,1 cal/cm²

*According to ASTM F1506-18 and ASTM F1959/F1959M-14e1, arc rating values below 10 cal/cm² shall be reported to the nearest 0.1 cal/cm², and arc rating values above 10 cal/cm² shall be reported to the nearest 1 cal/cm².

Arc Flash PPE category according to standard NFPA70E Edition 2018 Table 130.7 (C) (16) - Personal Protective Equipment (PPE)

PPE Category	Minimum Arc Rating (cal/cm²)
1	4
2	8
3	25
4	40

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Lucia Martinez
Head of PPE and Ballistics department



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