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FLAMESAFE MAXISOFT LTD
ROYAL ROAD
TOMBEAU BAY
MAURITIUS

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

Nº 2018CN0189

The test was carried out at :High Current Laboratory located 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

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ITE
INSTITUTO TECNOLÓGICO DE LA ENERGÍA

Applicant

FLAMESAFE MAXISOFT LTD

Date of reception 14/05/2018

Data test Starting : 14/05/2018
Ending: 17/05/2018

Identification of samples

- "Fabric WKS-350"

According to information supplied by the customer:

Fabric reference: WKS-350
Composition: Modacrylic Cotton
Fabric structure: Single Fleece
Color: Navy
Weight: 350 g or 10.3 oz/yd2

Test Carried out

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

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

Standard
AATCC TM135:2015

Standard deviation

Reference
Sample 1 Fabric WKS-350

Washing machine
13373I12

Washing cycles
3

Washing procedure
IV

Dryer machine
Whirlpool 13098I12

Drying procedure
Aiii

Washing powder
AATCC 1993 WOB

Start and finish data test
14/05/2018 - 15/05/2018

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

Standard

ASTM F1959/F1959M-14

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 Ei.

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

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.	17/05/2018
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	14/05/2018 - 15/05/2018
Starting and ending conditioning date	16/05/2018 - 17/05/2018
Conditioning	24 h; 21 ± 1ºC, 65 ± 2 % Hr.

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Reference Fabric WKS-350

Sample description according to the information supplied by the customer

Navy knitted fabric style WKS-350, Modacrylic Cotton, 350 g/m².

Pre-treatment

3 washing cycles at 49ºC, according to standard AATCC TM135-2015, method IV and type Aiii drying.

Washed sample weight before test

388,26 g/m²

Deviation from the standard

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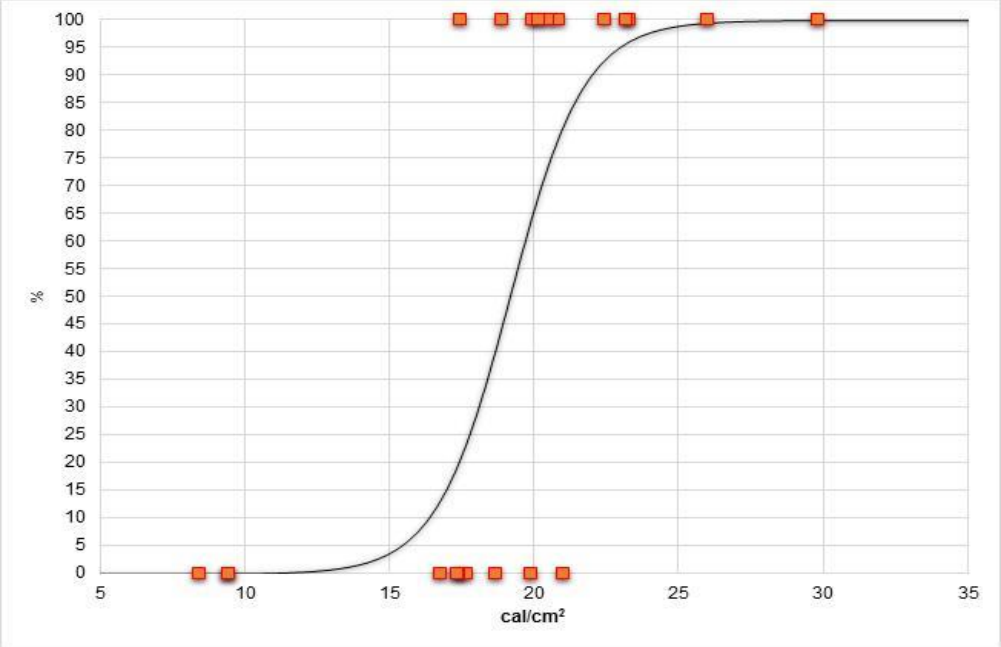
Determination of ATPV, 50% of Probability of 2nd degree burn

ATPV	19,1 cal/cm^2



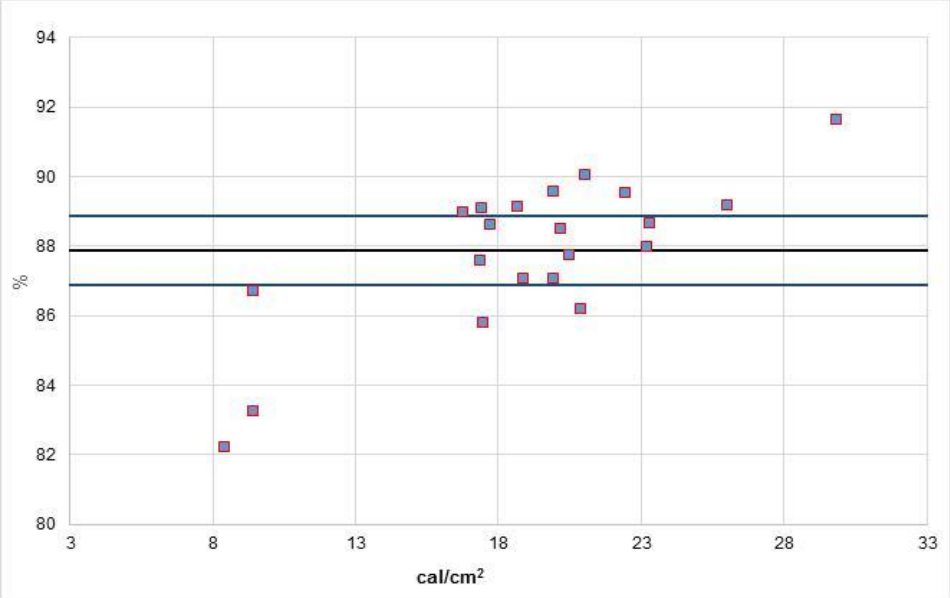
Probability %	5	10	20	30	40	50	60	70	80	95
E_i cal/cm^2	15,3	16,3	17,4	18,0	18,6	19,1	19,7	20,2	20,9	22,9

ATPV points above	5
ATPV points 20%	14
ATPV points below	6
ATPV points mix zone	10

>>>

Determination of HAF, confidence Intervals 95%

HAF	87,9 %



% HAF value :	87,9
Upper Confidence Level %:	88,9
Lower Confidence Level %:	86,9
Points above:	8
Points below:	5
Points between:	8
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	163,6	8,18	9,4	-0,39	83,3	N	N
1-B	163,6	8,18	8,4	-0,47	82,3	N	N
1-C	163,6	8,18	9,4	-0,56	86,7	N	N
2-A	403,6	20,18	23,3	0,3	88,7	Y	N
2-B	403,6	20,18	20,8	0,57	86,2	Y	N
2-C	403,6	20,18	21,0	-0,05	90,1	N	N
3-A	503,8	25,19	29,8	0,78	91,7	Y	Y
3-B	503,8	25,19	26,0	0,6	89,2	Y	Y
3-C	503,8	25,19	22,4	0,03	89,6	Y	N
4-A	363,2	18,16	23,2	0,56	88,0	Y	N
4-B	363,2	18,16	18,8	0,17	87,1	Y	N
4-C	363,2	18,16	16,7	-0,2	89,0	N	N
5-A	343,8	17,19	18,6	-0,19	89,2	N	N
5-B	343,8	17,19	19,9	0,3	87,1	Y	N
5-C	343,8	17,19	17,6	-0,04	88,6	N	N
6-A	343,2	17,16	20,5	0,25	87,8	Y	N
6-B	343,2	17,16	17,4	0,18	85,8	Y	N
6-C	343,2	17,16	17,4	-0,22	89,1	N	N
7-A	353,2	17,66	20,1	0,06	88,6	Y	N
7-B	353,2	17,66	17,3	-0,13	87,6	N	N
7-C	353,2	17,66	19,9	0	89,6	N	N

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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	N	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	Y	N	N	Y	Y
3-C	0	N	N	N	Y	Y
4-A	0	N	N	N	Y	Y
4-B	0	N	N	N	Y	Y
4-C	0	N	N	N	Y	Y
5-A	0	N	N	N	Y	Y
5-B	0	N	N	N	Y	Y
5-C	0	N	N	N	Y	Y
6-A	0	N	N	N	Y	Y
6-B	0	N	N	N	Y	Y
6-C	0	N	N	N	Y	Y
7-A	0	N	N	N	Y	Y
7-B	0	N	N	N	Y	Y
7-C	0	N	N	N	Y	Y

Y Yes N No

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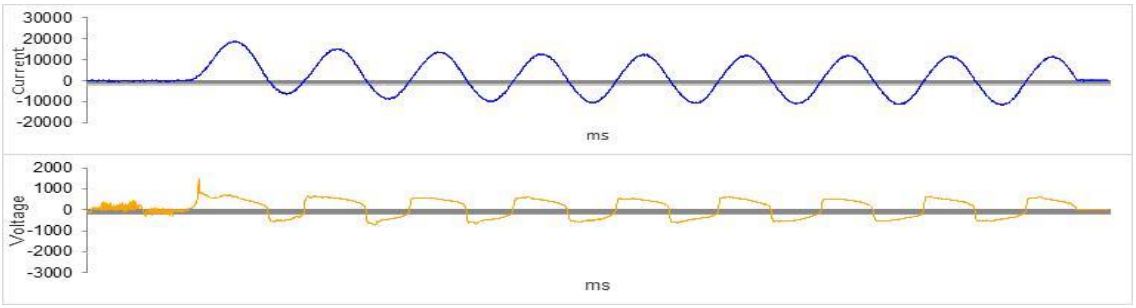
Electrical current and response sensor response:

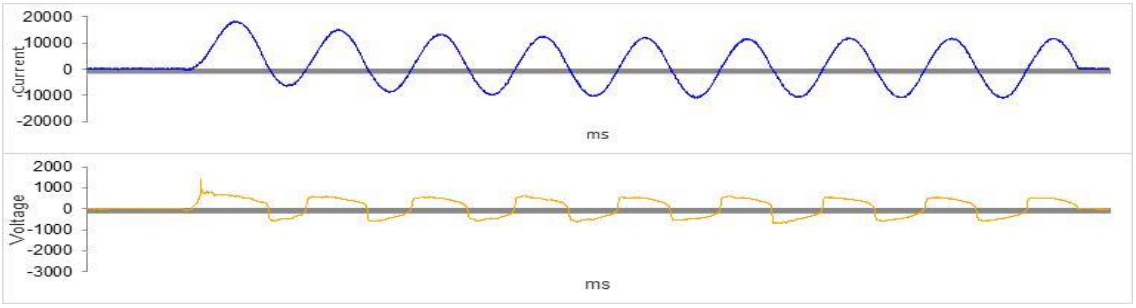
Calibration shot

INITIAL CALIBRATION



Ei Panel A	7,0 cal/cm^2	**Ei Panel B**	6,8 cal/cm^2	**Ei Panel C**	7,1 cal/cm^2

FINAL CALIBRATION



Ei Panel A	8,7 cal/cm^2	**Ei Panel B**	9,1 cal/cm^2	**Ei Panel C**	7,5 cal/cm^2

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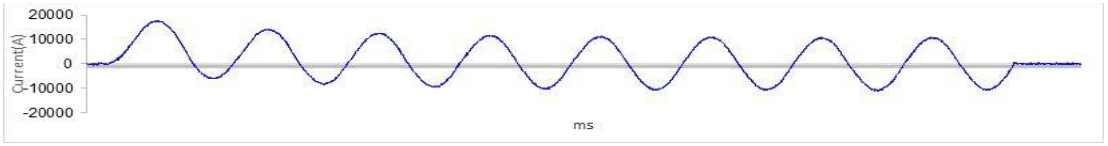
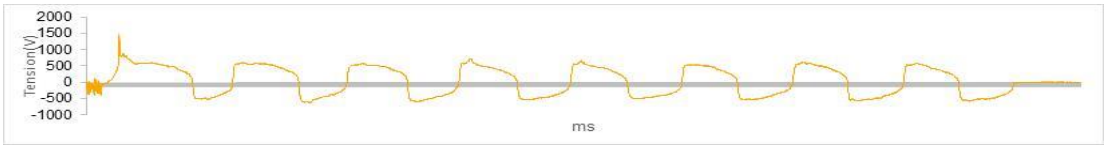
Electrical current and response sensor response:

Shot 1

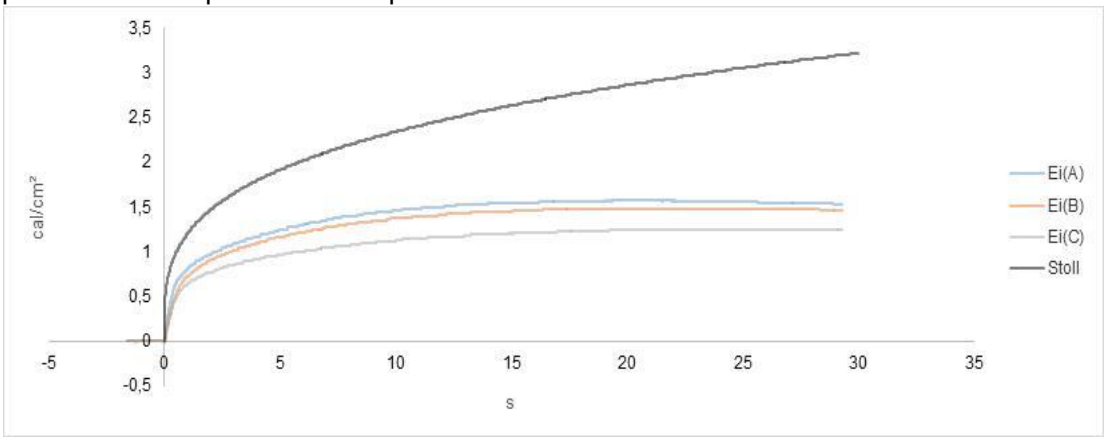
Current Plot



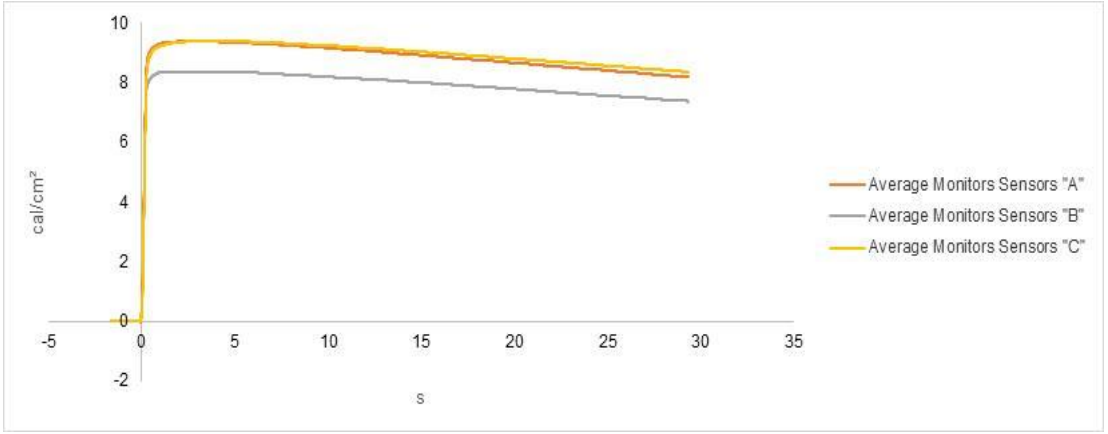
Voltage Plot



Average panel sensors response Vs. Stoll plot



Average monitor sensors plot



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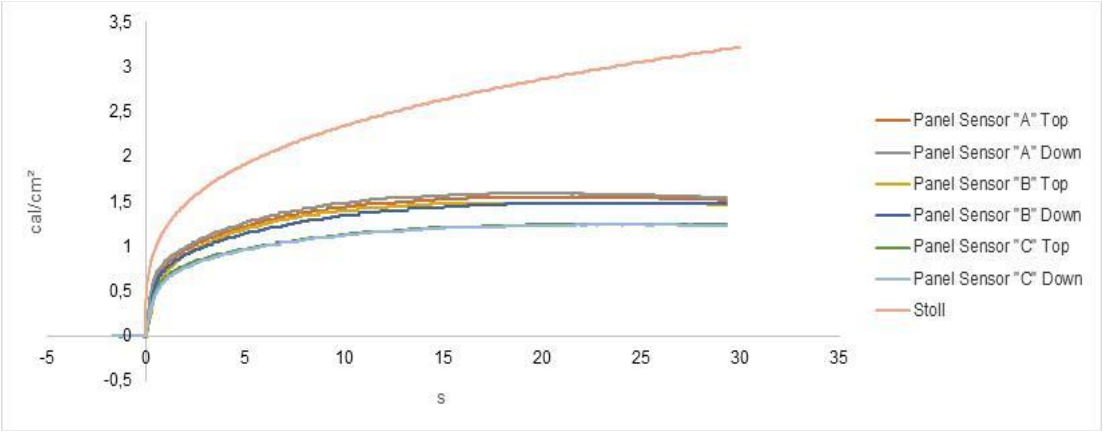
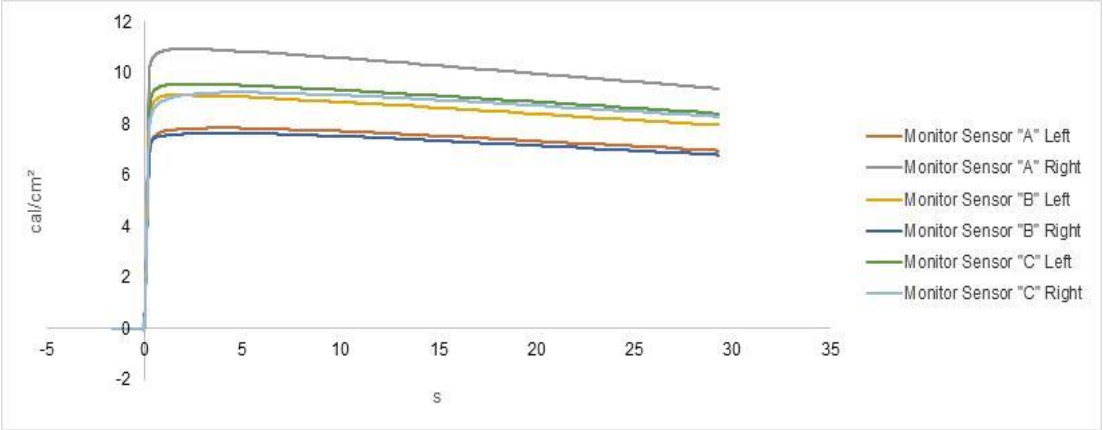
Electrical current and response sensor response:

Shot 1

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	17,8	**Arc Voltage (V)**	1476,0
Duration (cycles nº)	8,2	**Duration (ms)**	163,6	**Arc Energy (kJ)**	533,6
Arc Voltage (kJ)	457,9				

sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	9,38 cal/cm^2	8,37 cal/cm^2	9,39 cal/cm^2
SCD	-0,39 cal/cm^2	-0,47 cal/cm^2	-0,56 cal/cm^2
HAF	83,27 %	82,27 %	86,73 %

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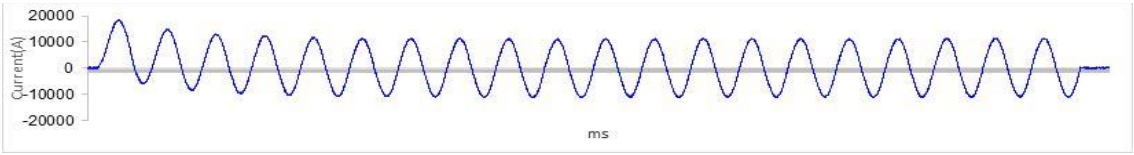
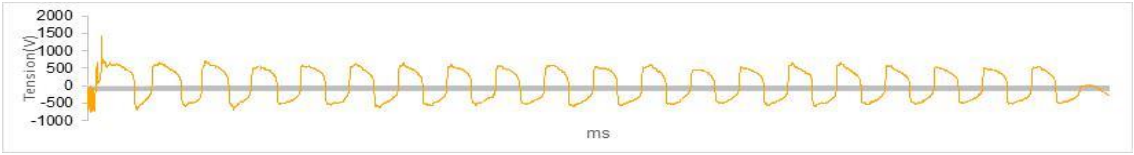
Electrical current and response sensor response:

Shot 2

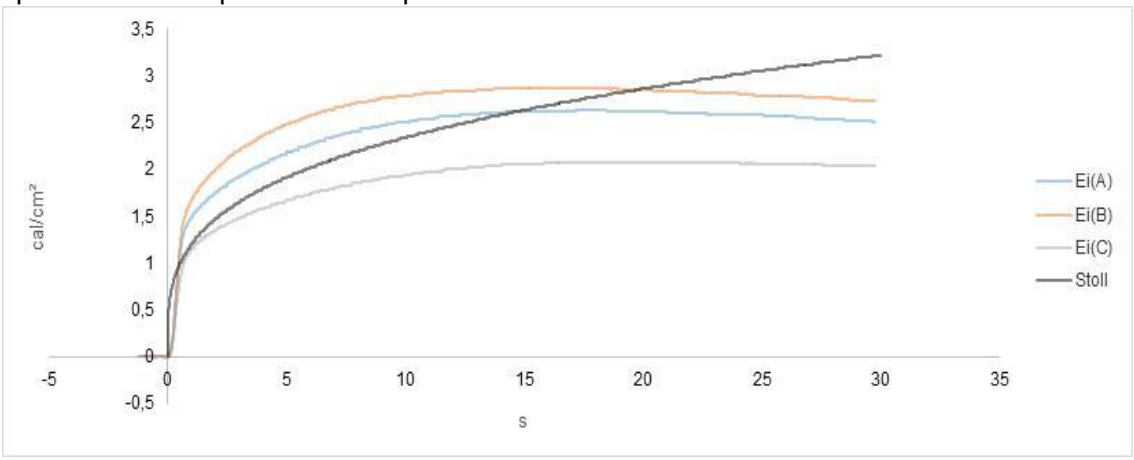
Current Plot



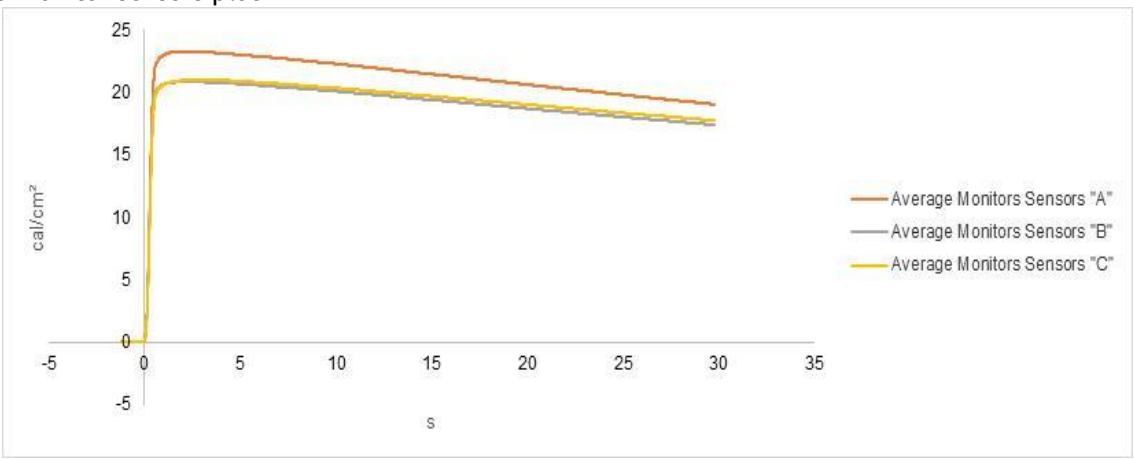
Voltage Plot



Average panel sensors response Vs. Stoll plot



Average monitor sensors plot



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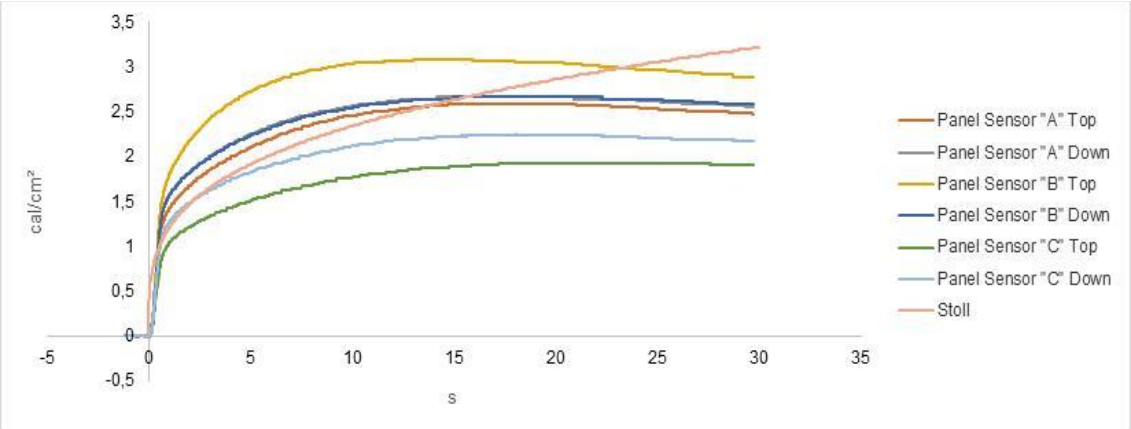
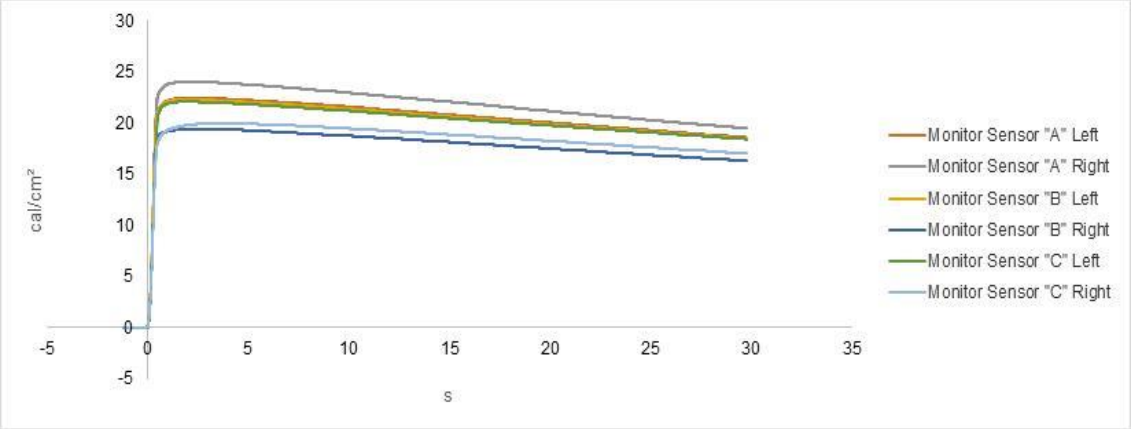
Electrical current and response sensor response:

Shot 2

Average panel sensors response Vs. Stoll plot



Average monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	18,3	**Arc Voltage (V)**	1428,0
Duration (cycles nº)	20,2	**Duration (ms)**	403,6	**Arc Energy (kJ)**	1313,4
Arc Voltage (kJ)	448,8				

sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	23,26 cal/cm^2	20,83 cal/cm^2	21,00 cal/cm^2
SCD	0,30 cal/cm^2	0,57 cal/cm^2	-0,05 cal/cm^2
HAF	88,69 %	86,24 %	90,08 %

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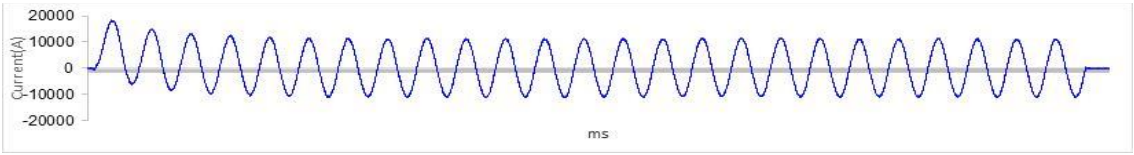
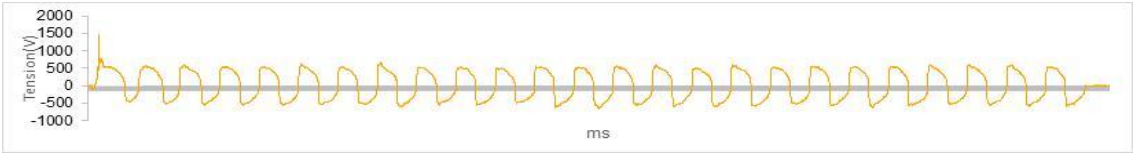
Electrical current and response sensor response:

Shot 3

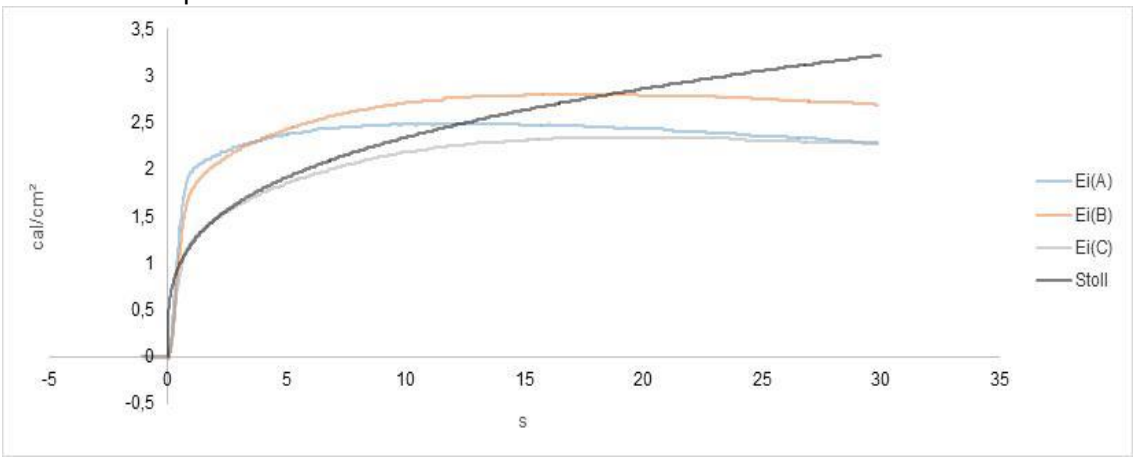
Current Plot



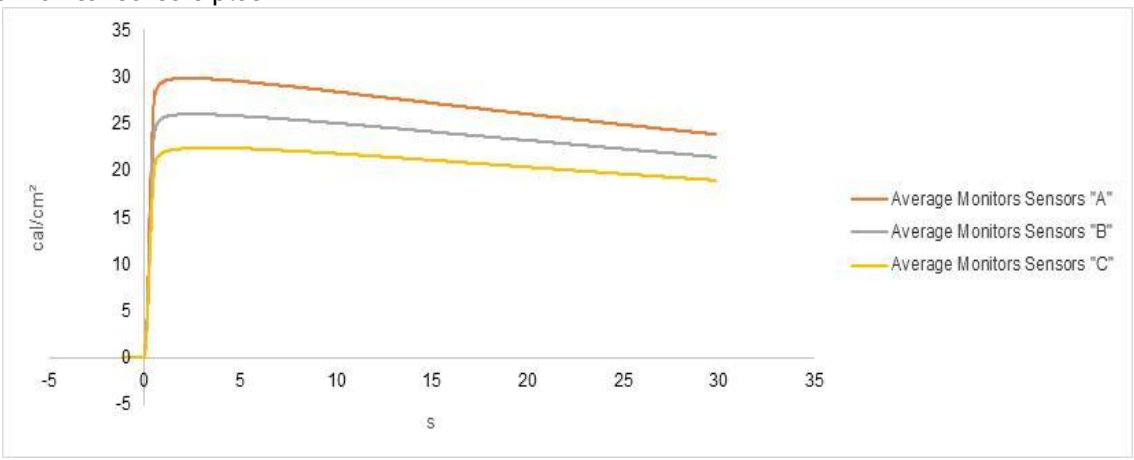
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot



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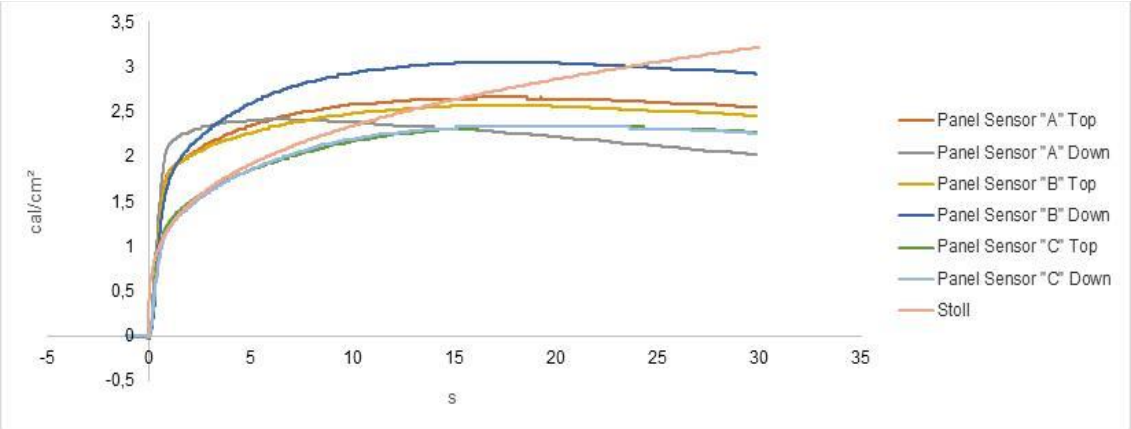
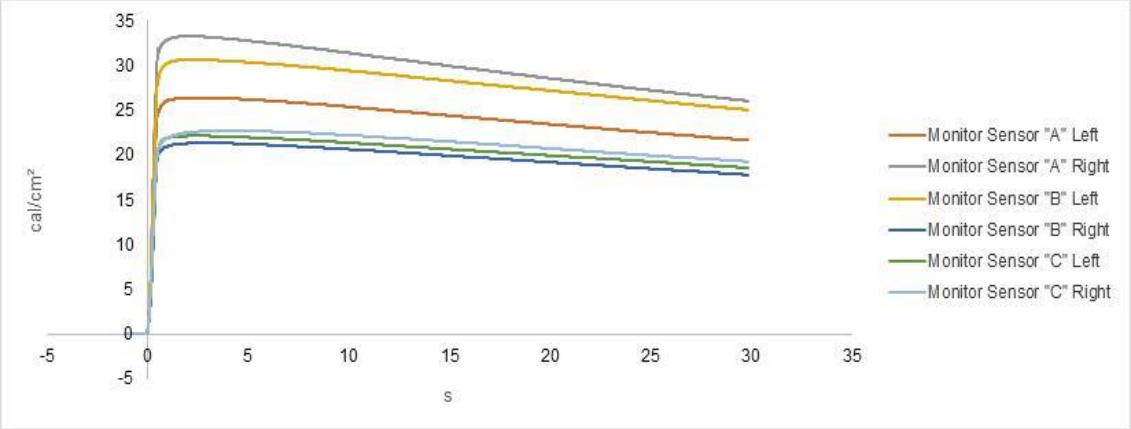
Electrical current and response sensor response:

Shot 3

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	18,3	**Arc Voltage (V)**	1470,0
Duration (cycles nº)	25,2	**Duration (ms)**	503,7	**Arc Energy (kJ)**	1591,8
Arc Voltage (kJ)	438,8				

sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	29,82 cal/cm^2	25,98 cal/cm^2	22,42 cal/cm^2
SCD	0,78 cal/cm^2	0,60 cal/cm^2	0,03 cal/cm^2
HAF	91,67 %	89,22 %	89,56 %

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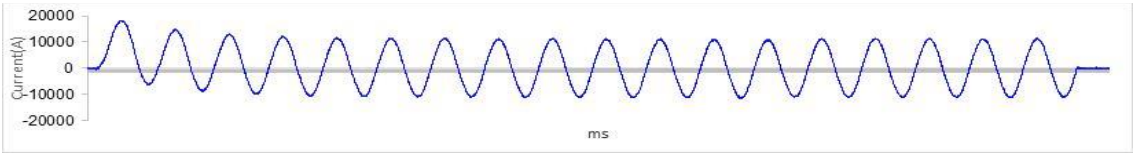
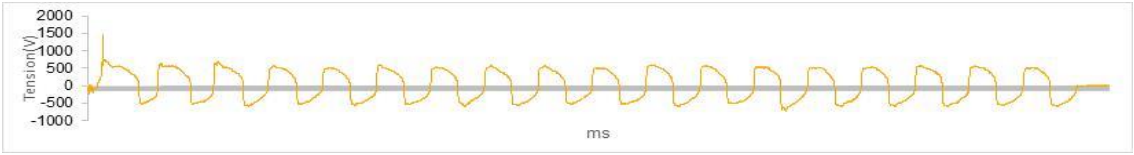
Electrical current and response sensor response:

Shot 4

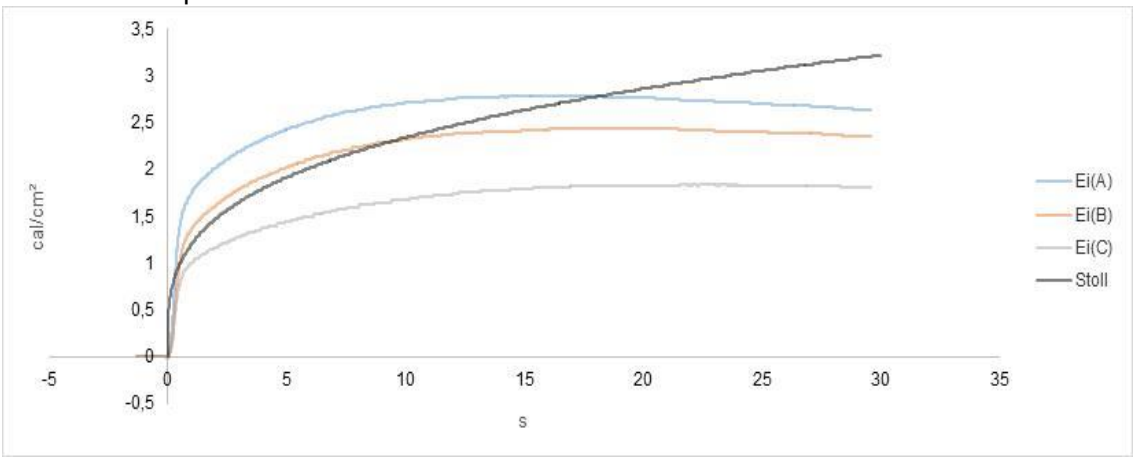
Current Plot



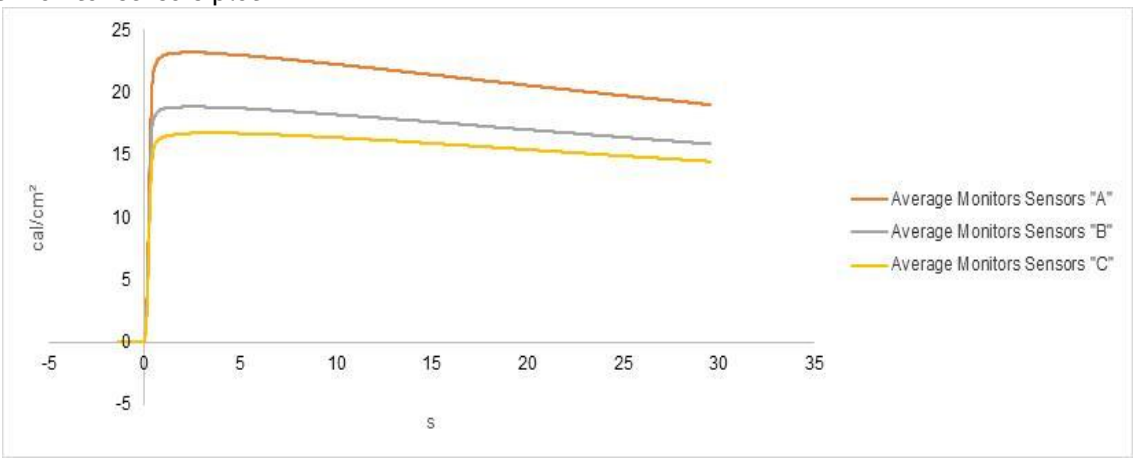
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot



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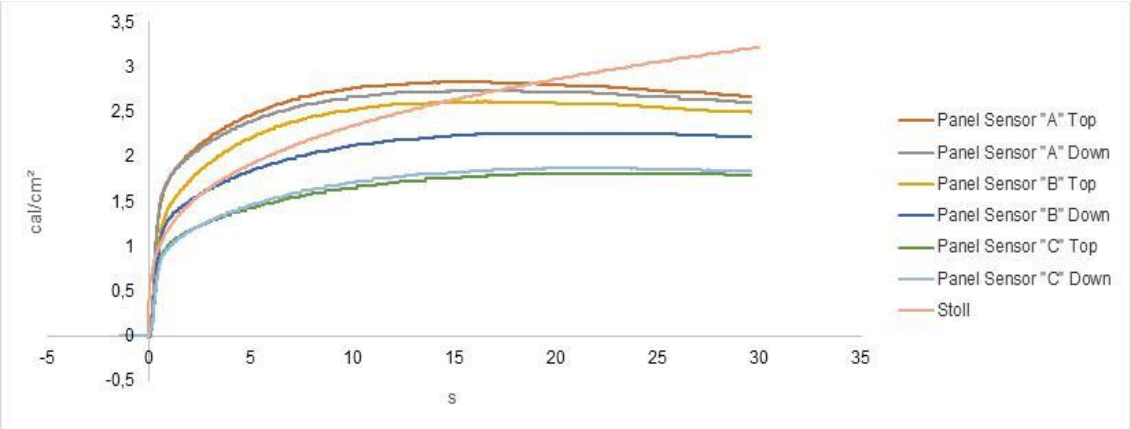
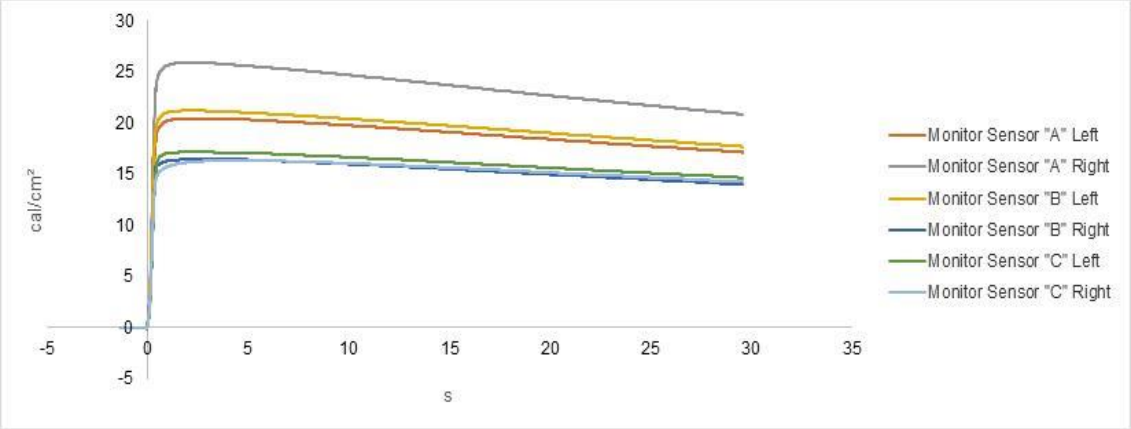
Electrical current and response sensor response:

Shot 4

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	18,2	**Arc Voltage (V)**	1452,0
Duration (cycles nº)	18,2	**Duration (ms)**	363,2	**Arc Energy (kJ)**	1170,3
Arc Voltage (kJ)	444,6				

sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	23,18 cal/cm^2	18,84 cal/cm^2	16,74 cal/cm^2
SCD	0,56 cal/cm^2	0,17 cal/cm^2	-0,20 cal/cm^2
HAF	88,00 %	87,09 %	89,01 %

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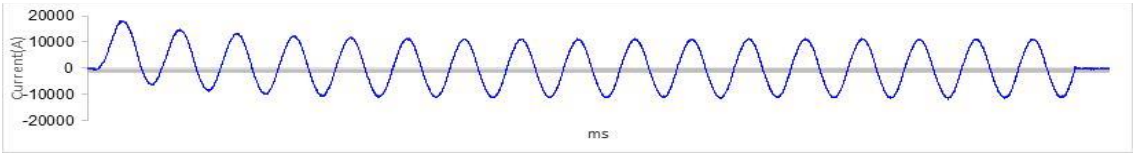
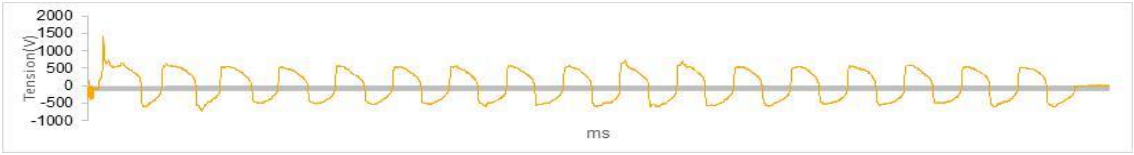
Electrical current and response sensor response:

Shot 5

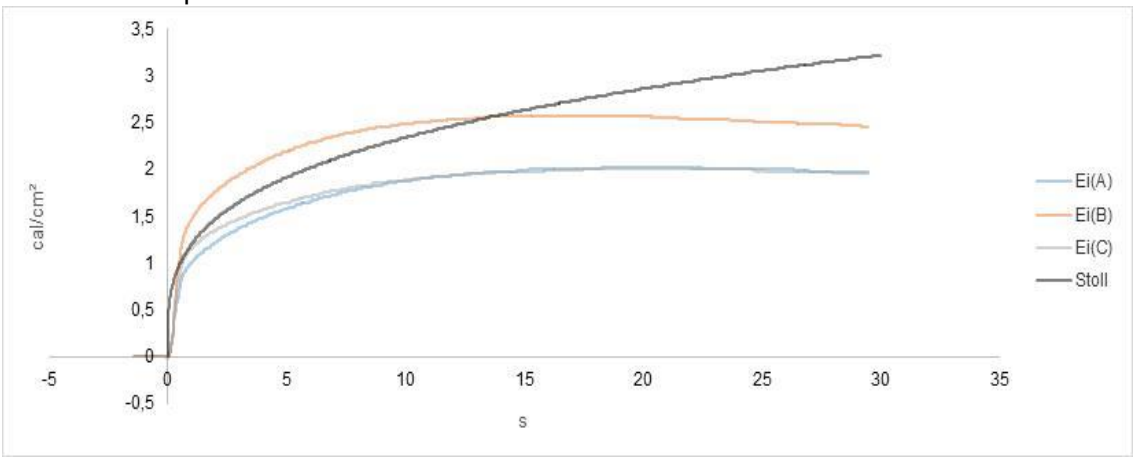
Current Plot



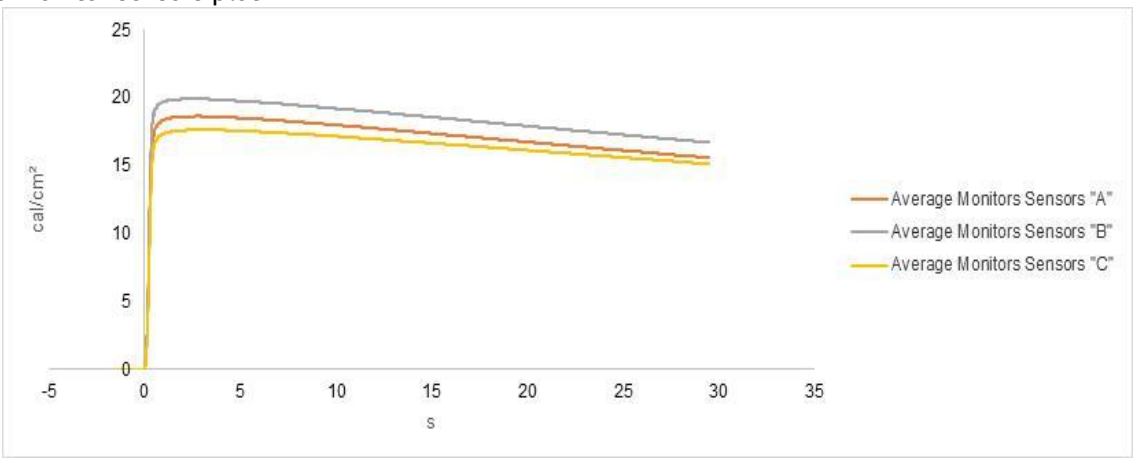
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot



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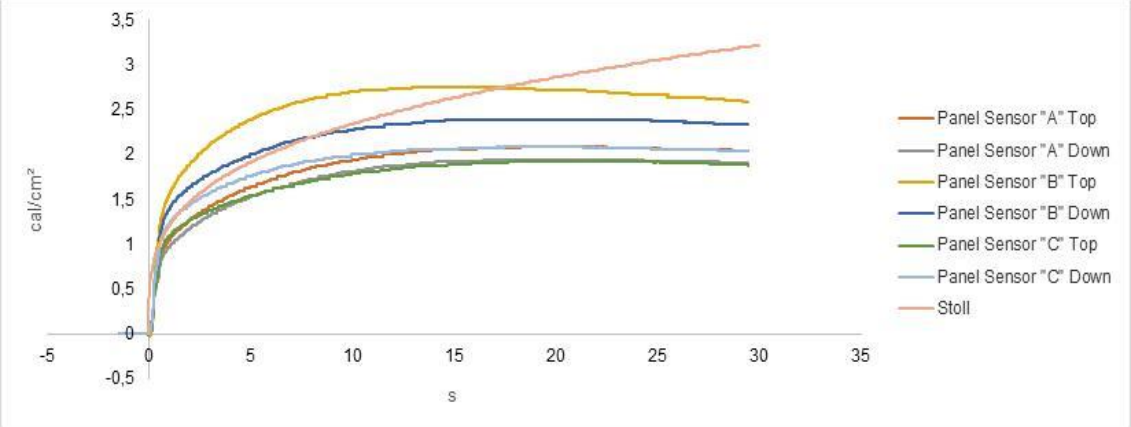
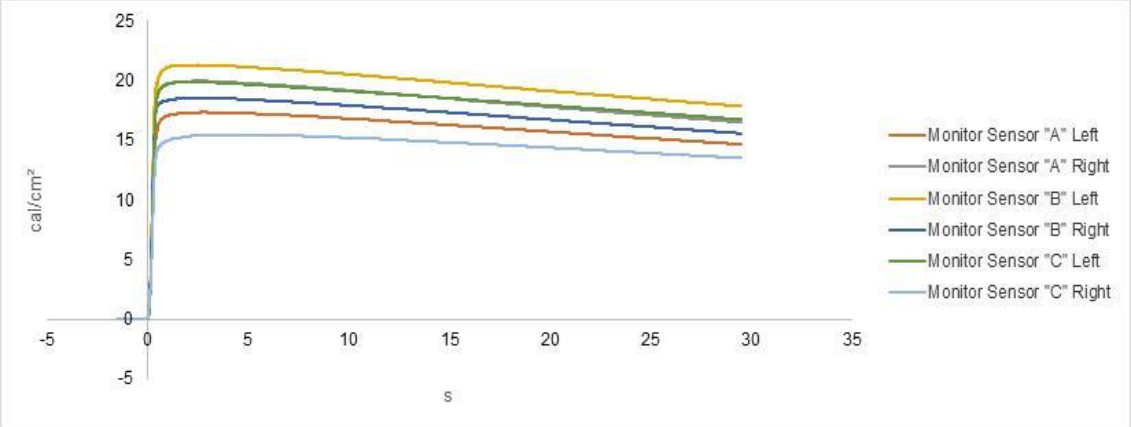
Electrical current and response sensor response:

Shot 5

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,1	**Current Peak (kA)**	18,2	**Arc Voltage (V)**	1431,0
Duration (cycles nº)	17,2	**Duration (ms)**	343,8	**Arc Energy (kJ)**	1110,2
Arc Voltage (kJ)	445,6				

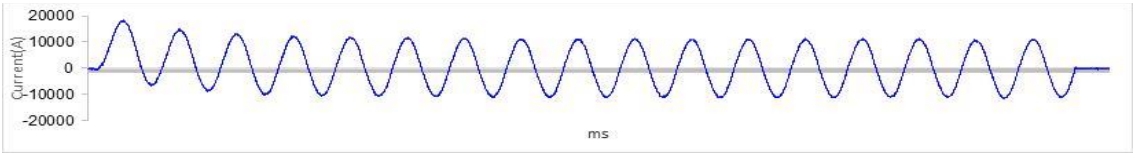
sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	18,64 cal/cm^2	19,91 cal/cm^2	17,65 cal/cm^2
SCD	-0,19 cal/cm^2	0,30 cal/cm^2	-0,04 cal/cm^2
HAF	89,18 %	87,09 %	88,65 %

>>>

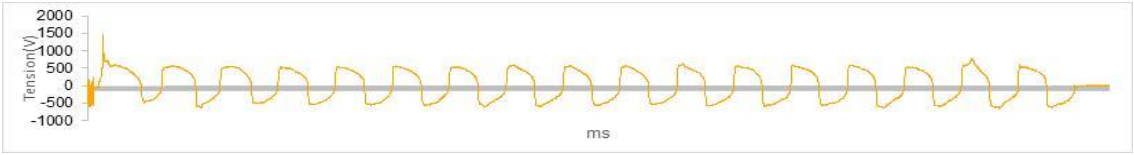
Electrical current and response sensor response:

Shot 6

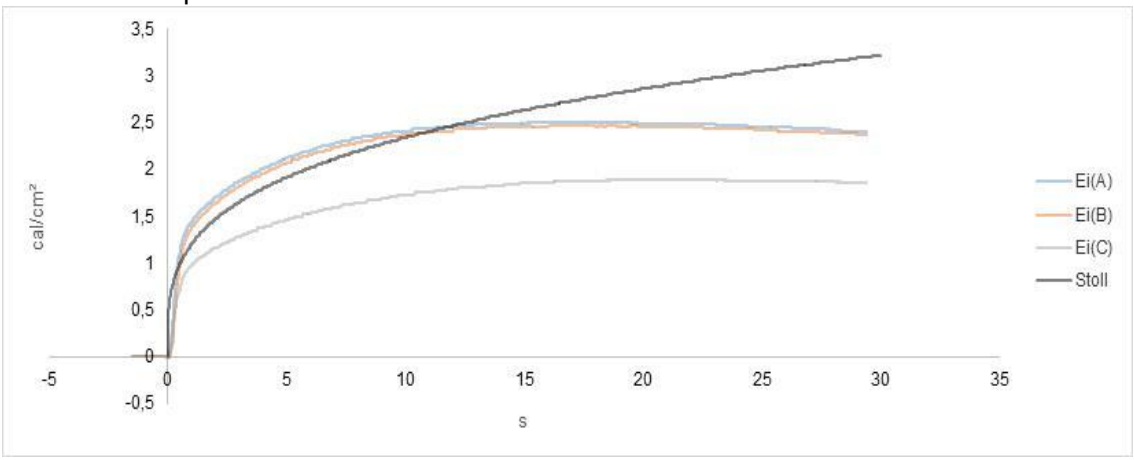
Current Plot



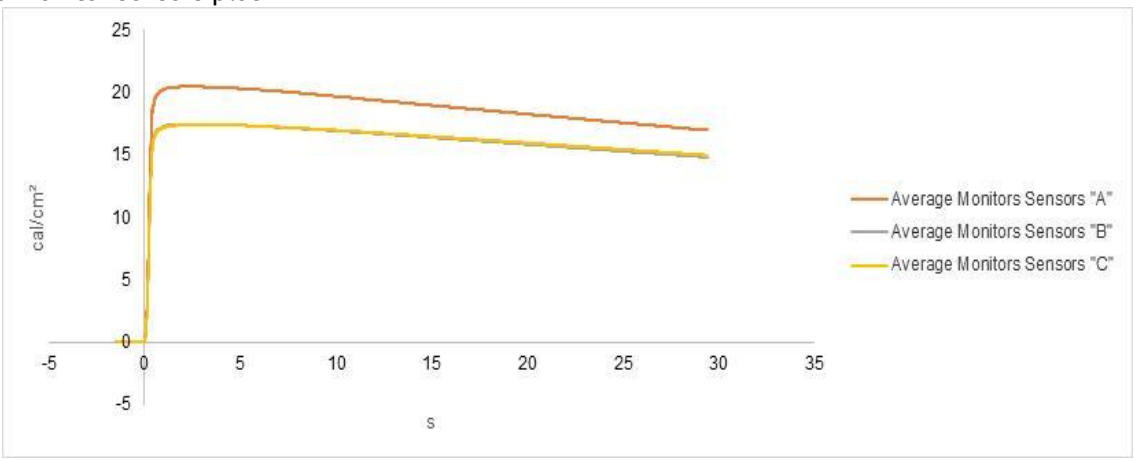
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot

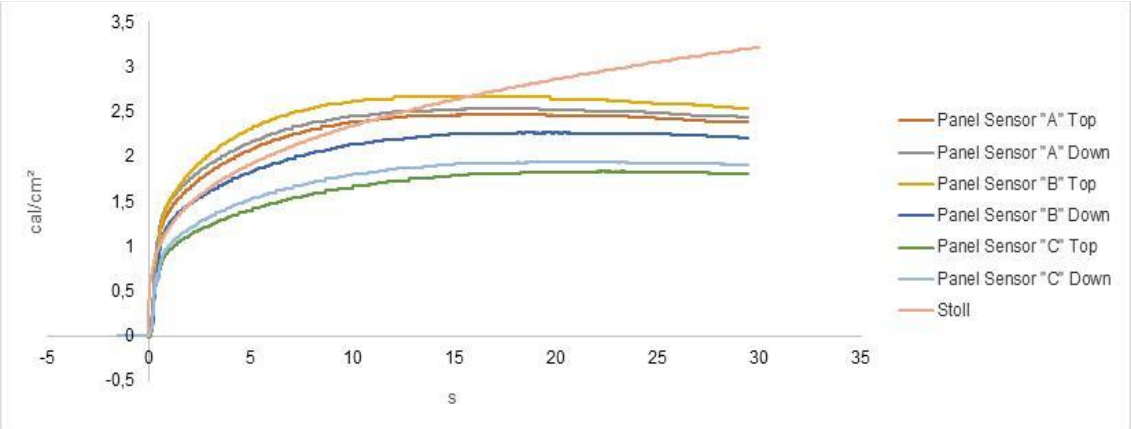


>>>

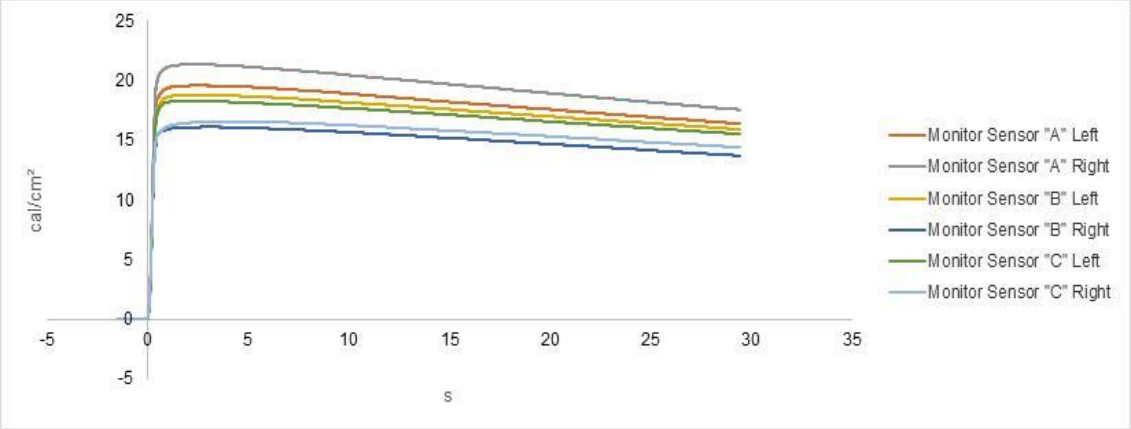
Electrical current and response sensor response:

Shot 6

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	18,3	**Arc Voltage (V)**	1476,0
Duration (cycles nº)	17,2	**Duration (ms)**	343,3	**Arc Energy (kJ)**	1125,3
Arc Voltage (kJ)	452,4				

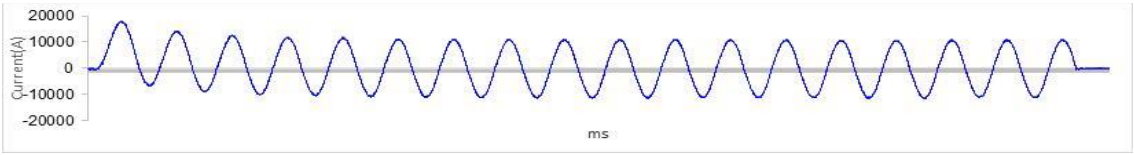
Sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	20,46 cal/cm^2	17,44 cal/cm^2	17,39 cal/cm^2
SCD	0,25 cal/cm^2	0,18 cal/cm^2	-0,22 cal/cm^2
HAF	87,76 %	85,83 %	89,12 %

>>>

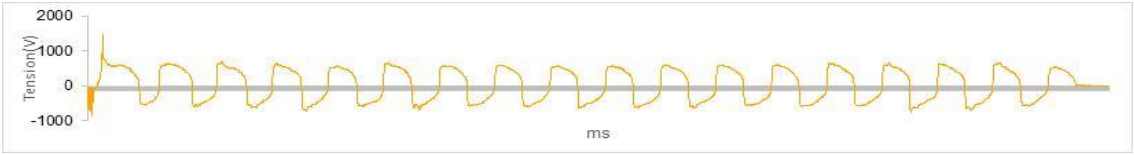
Electrical current and response sensor response:

Shot 7

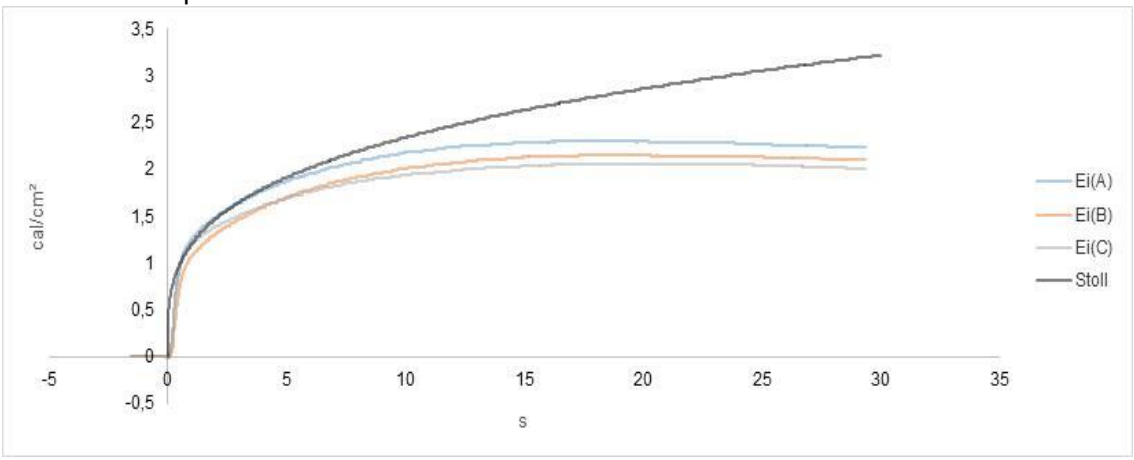
Current Plot



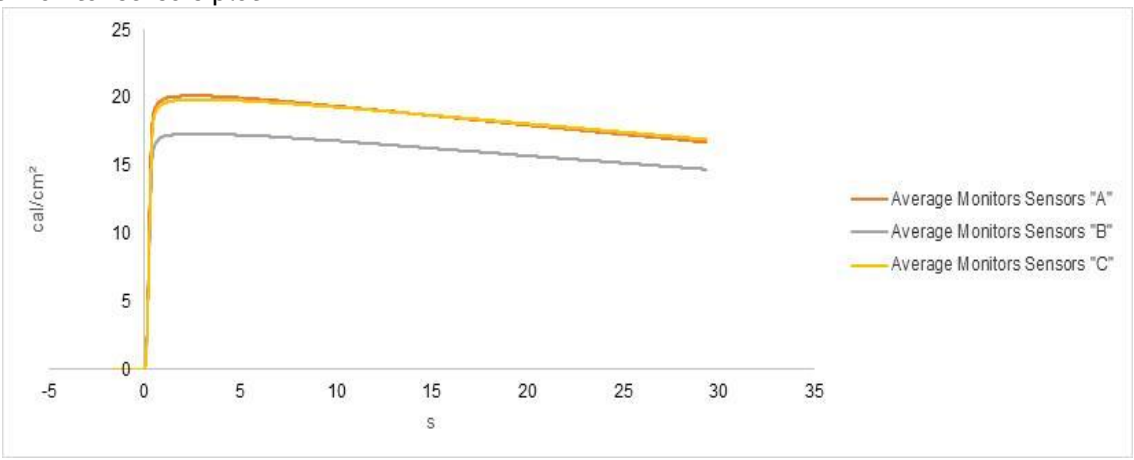
Voltage Plot



Panel sensors vs. Stoll plot



Average monitor sensors plot

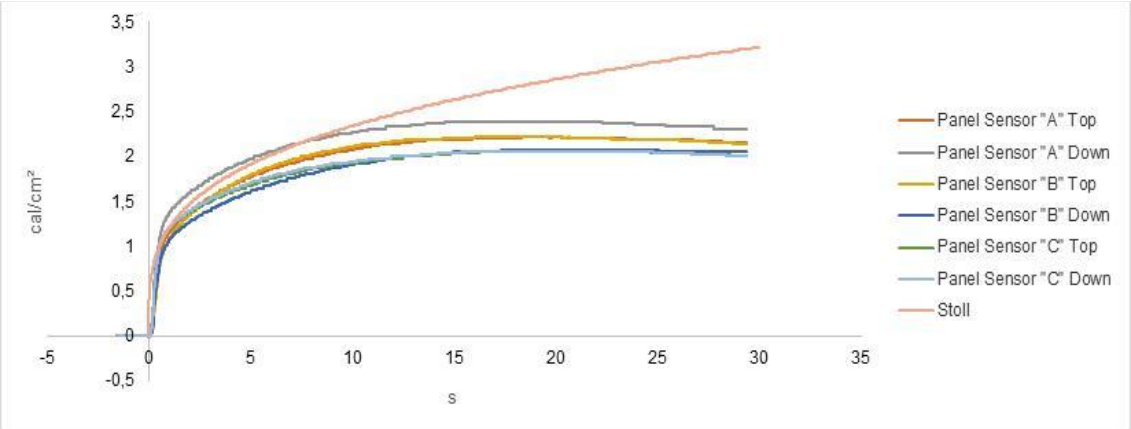


>>>

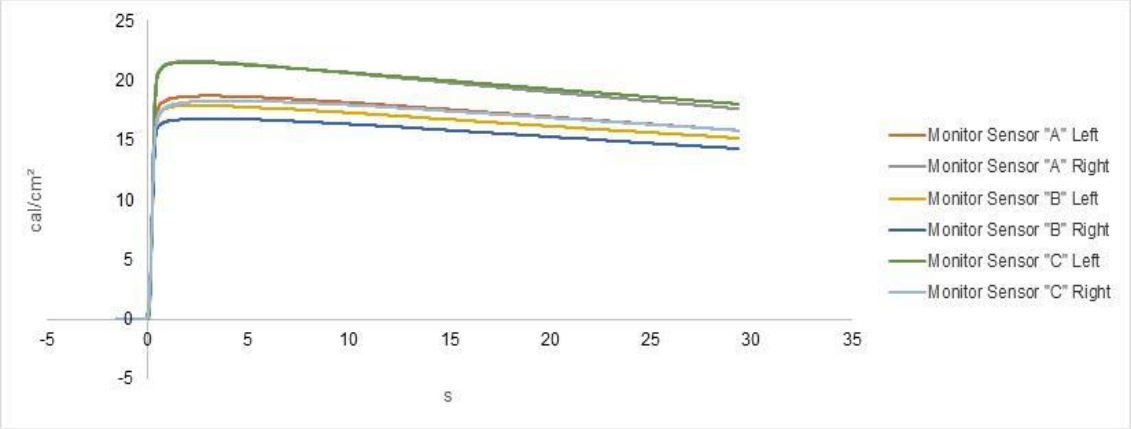
Electrical current and response sensor response:

Shot 7

Average panel sensors response Vs. Stoll plot



Monitor sensors plot



Current Total RMS (kA)	8,0	**Current Peak (kA)**	17,9	**Arc Voltage (V)**	1503,0
Duration (cycles nº)	17,7	**Duration (ms)**	353,3	**Arc Energy (kJ)**	1212,2
Arc Voltage (kJ)	478,9				

sensor response	**PANEL A**	**PANEL B**	**PANEL C**
Ei	20,14 cal/cm^2	17,34 cal/cm^2	19,89 cal/cm^2
SCD	0,06 cal/cm^2	-0,13 cal/cm^2	0,00 cal/cm^2
HAF	88,55 %	87,61 %	89,62 %

>>>

Tested material pictures:

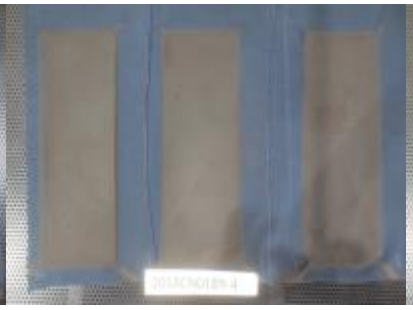
Original

Shot 1

Shot 2

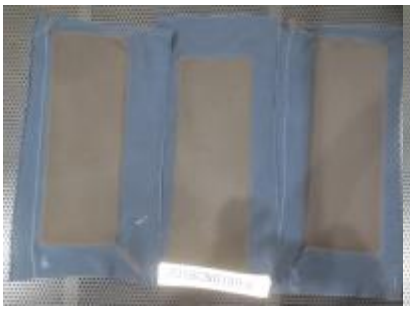
Shot 3

Shot 4



Shot 5

Shot 6



Shot 7

>>>

Summary of results:

ATPV	19,1 cal/cm^2
HAF	87,9 %

FABRIC TESTED ACCORDING TO THE STANDARD ASTM F1959/F1959M-14
ARC RATING
19,0 cal/cm^2

>>>

*According to ASTM F1506-15 y ASTM F1959/F1959M-14, arc rating values below 10 cal/cm^2 shall be reported to the nearest 0.1 cal/cm^2, and arc rating values above 10 cal/cm^2 shall be reported to the nearest 1 cal/cm^2.

Arc Flash PPE category according to standard NFPA70E Edition 2015 Table 130.7 (C) (16) - Personal Protective Equipment (PPE)

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

///

Lucia Martinez
Head of PPE and Ballistics department

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Laboratories:

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