

# **Electrostatic Discharge Tests of Solar Array Coupons With Different String-to-String Gaps without RTV Adhesive Grout**

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# Background

High power generation on satellites



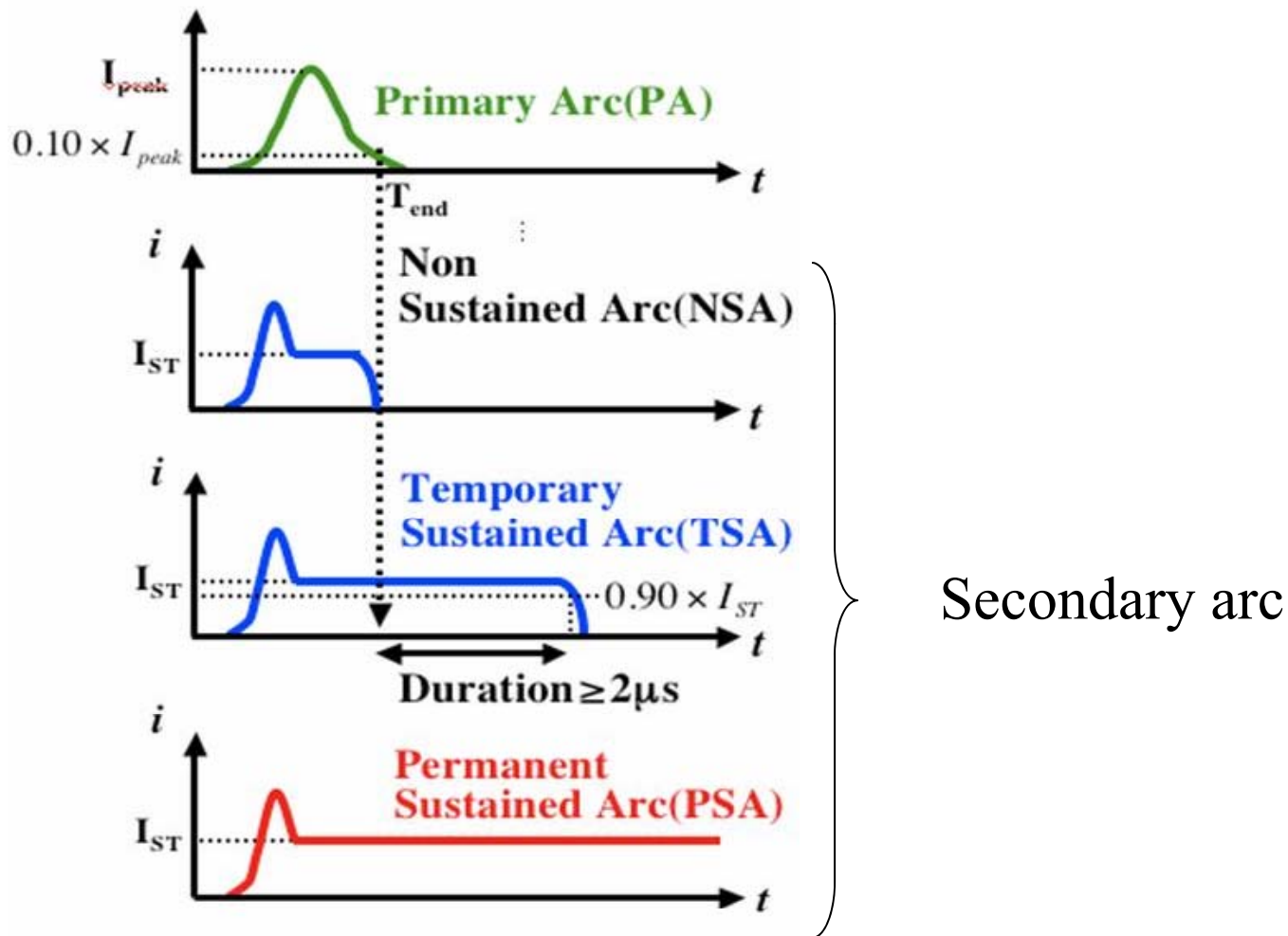
Sustained arc



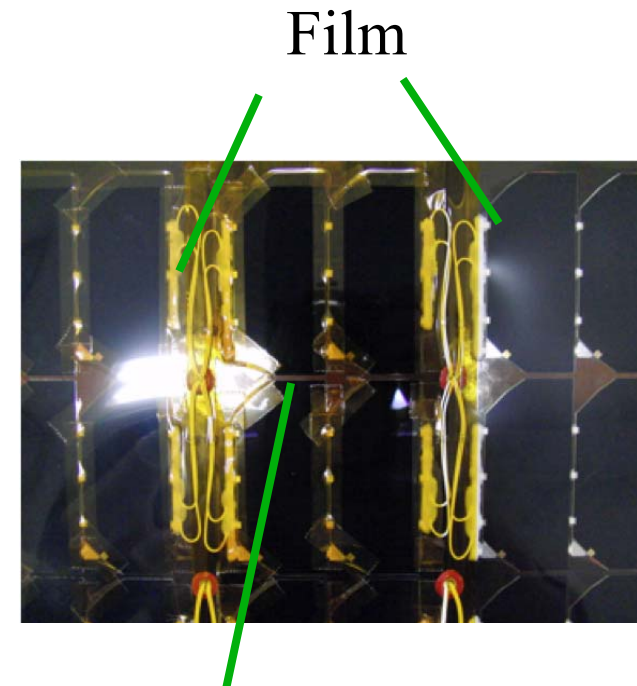
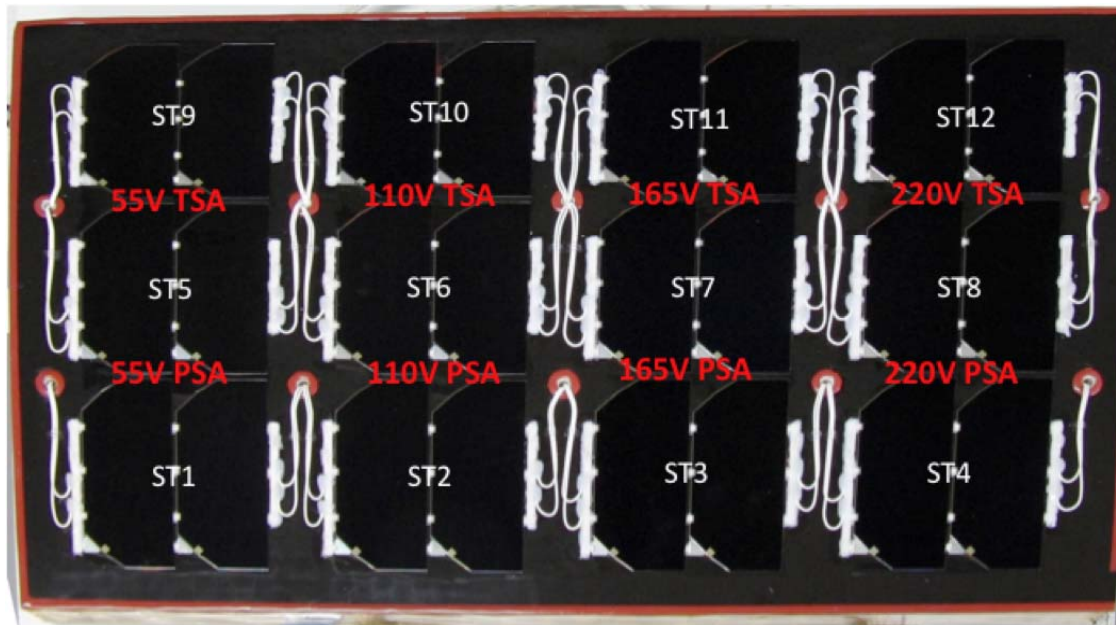
Power loss

- Purpose
  - Identify the design limit of solar panel design without using grouting technique
    - gap length, voltage, current

# Definition of secondary arc



# Test coupon



4 coupons

Test gap

Gap length: 1mm, 2mm, 3mm, 4mm (not used)

# Test condition: TSA



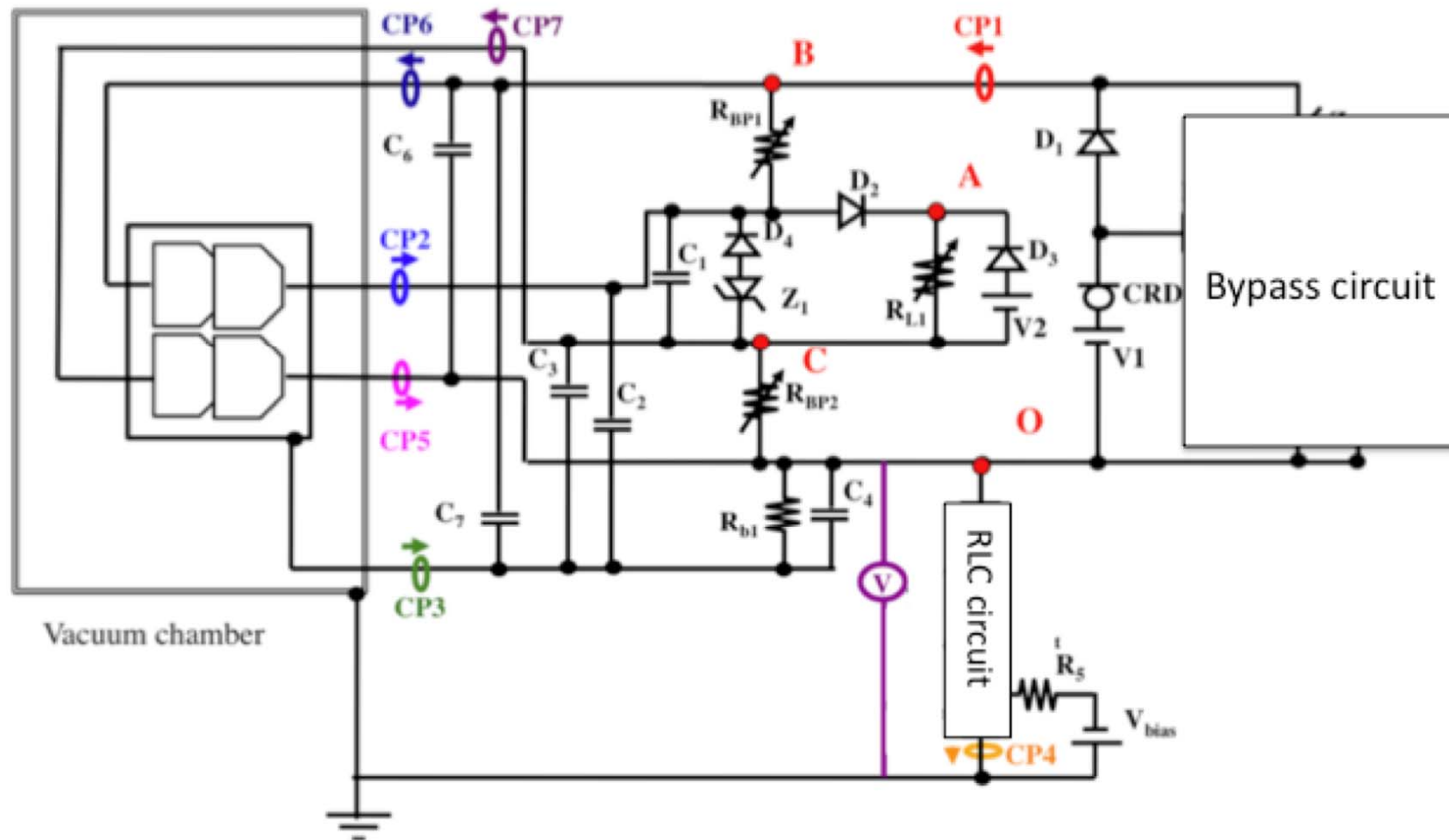
TSA threshold test		Voltage, V			
		55	110	165	220
Current, A	0.55	1	7	13	19
	1.10	2	8	14	20
	1.65	3	9	15	21
String under test		ST9 – ST5	ST10 – ST6	ST11 – ST7	ST12 – ST8

# Test condition: PSA



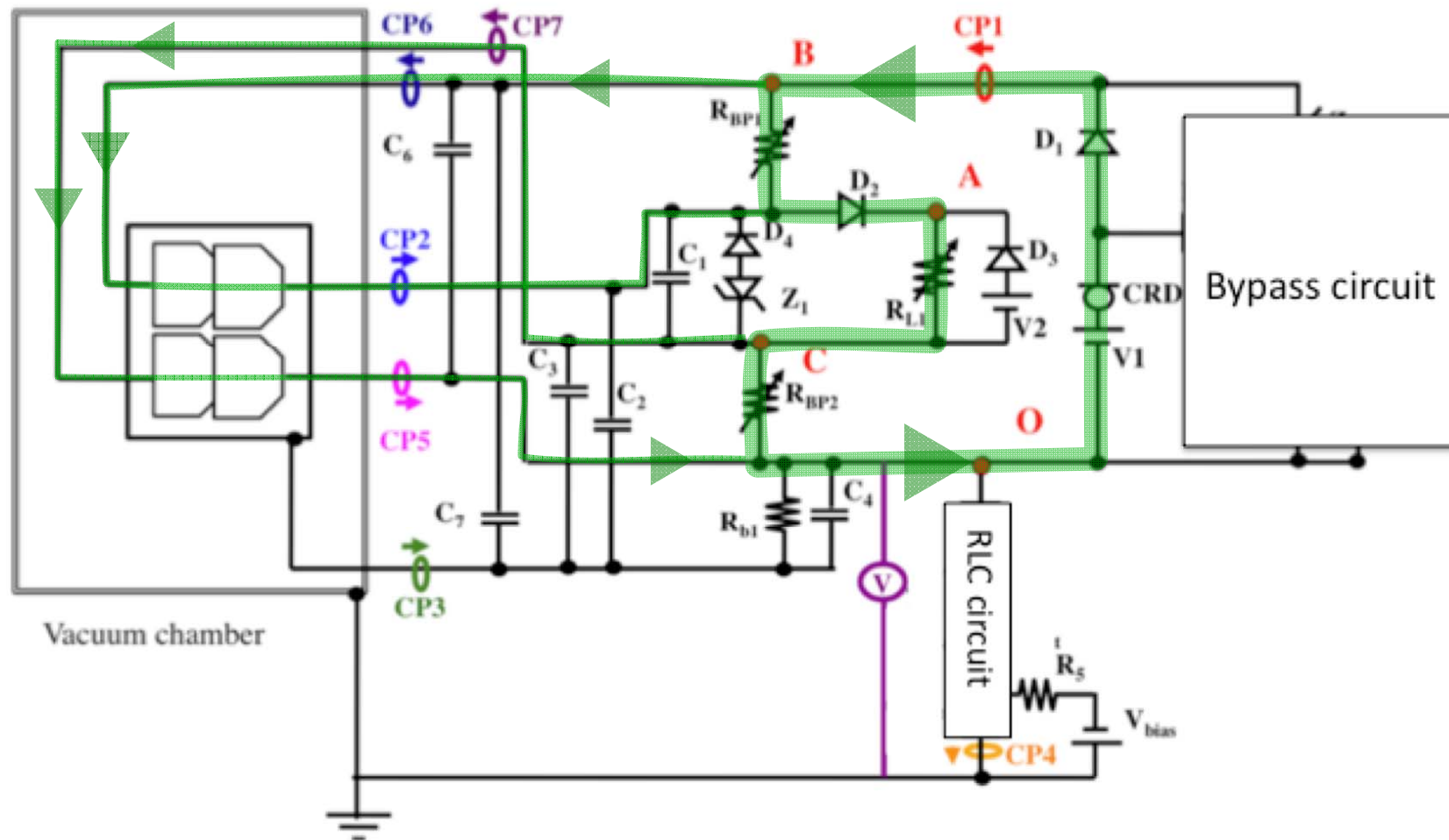
PSA threshold test		Voltage, V			
		55	110	165	220
Current, A	0.55	4	10	16	22
	1.10	5	11	17	23
	1.65	6	12	18	24
String under test		ST5 – ST1	ST6 – ST2	ST7 – ST3	ST8 – ST4

# Test schematic





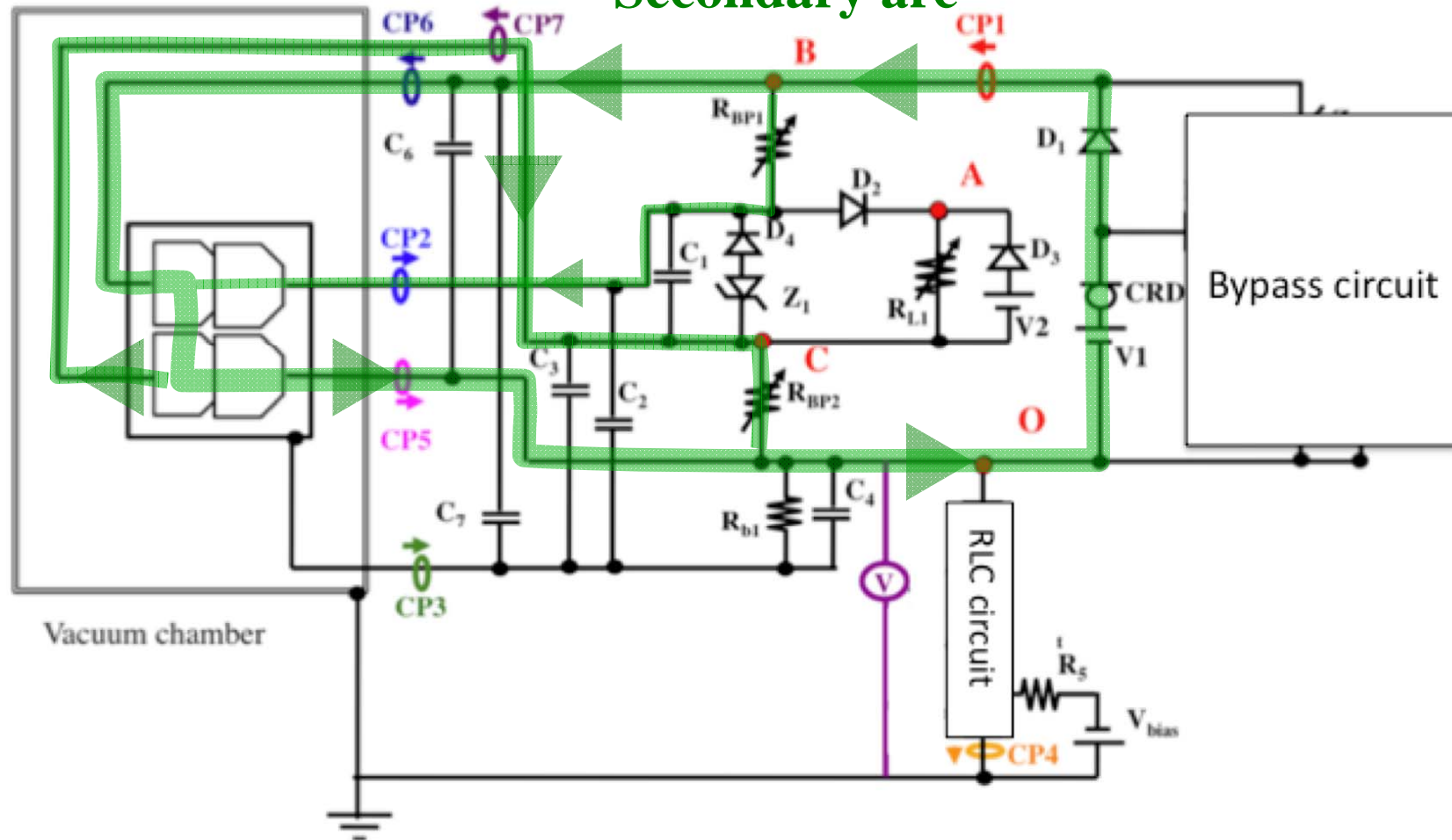
# Test schematic



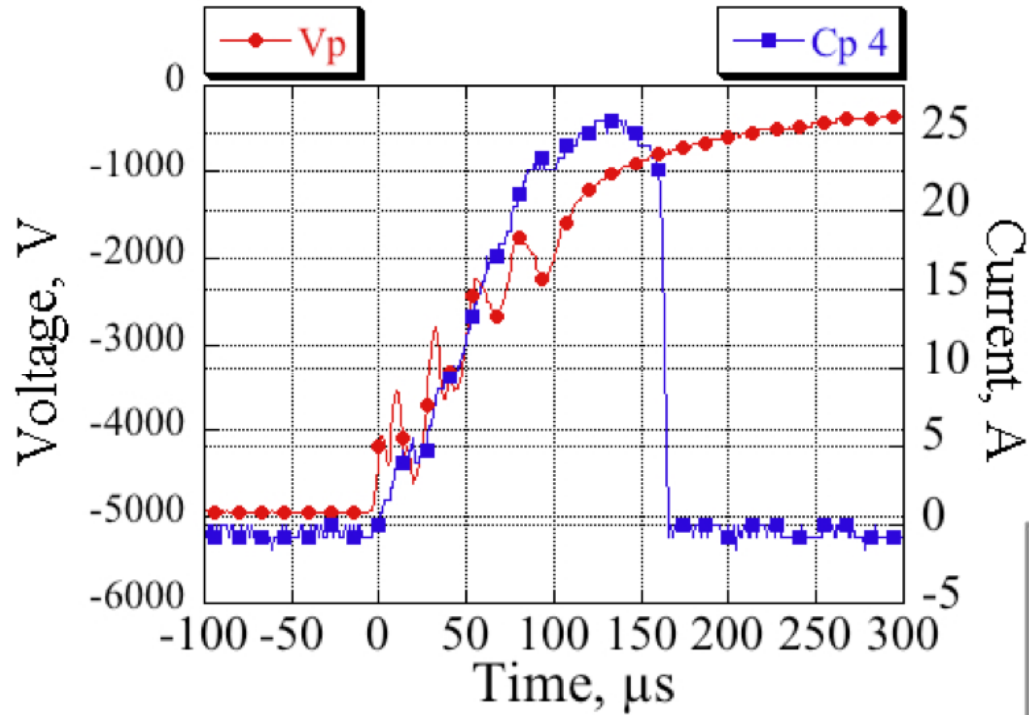


# Test schematic

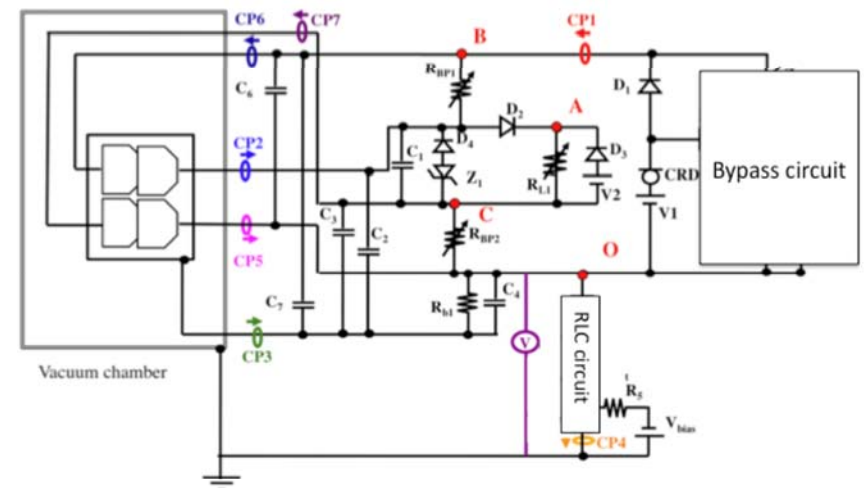
## Secondary arc



# PA



55V 0.55A  
gap length: 3mm





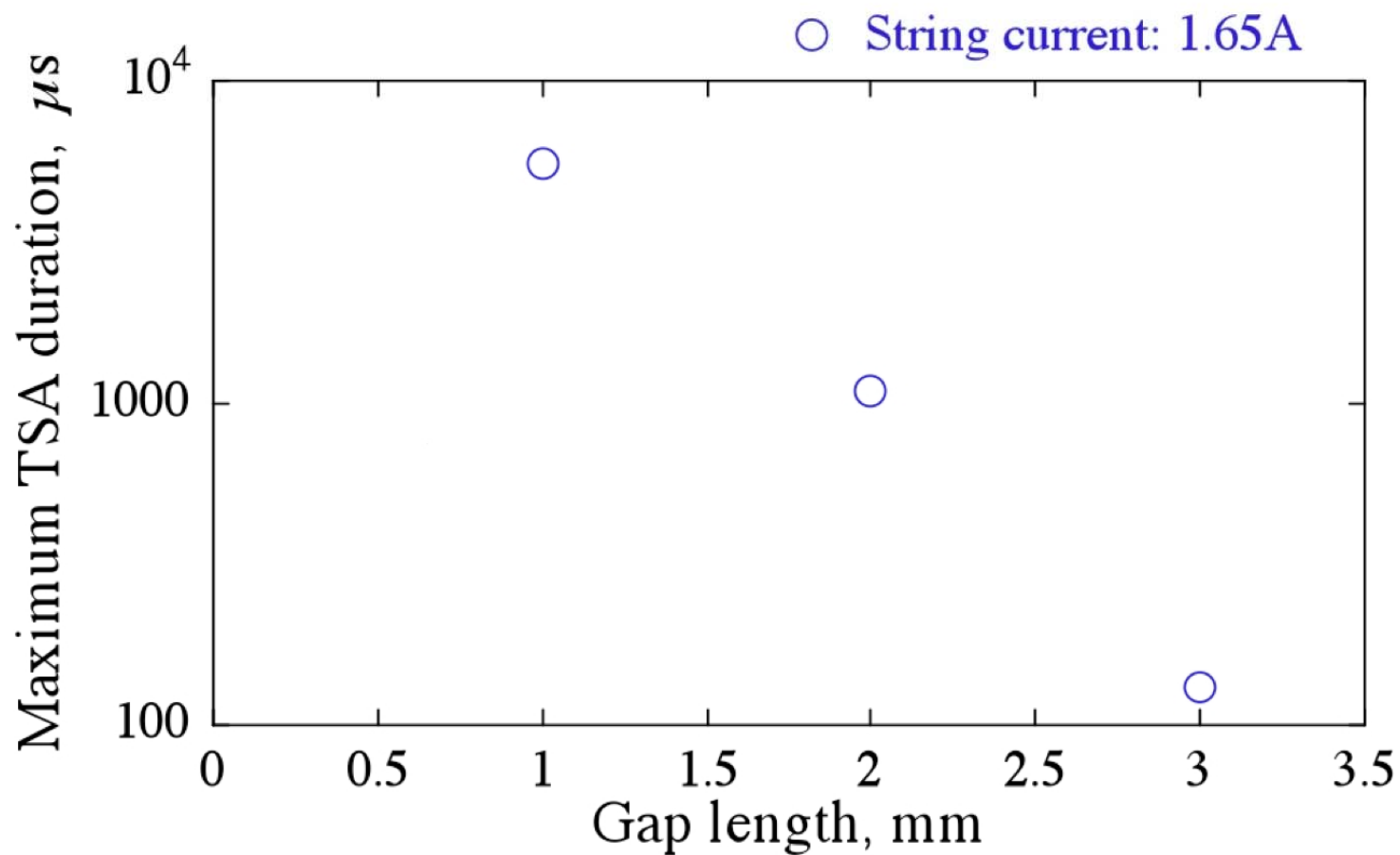


# Test result

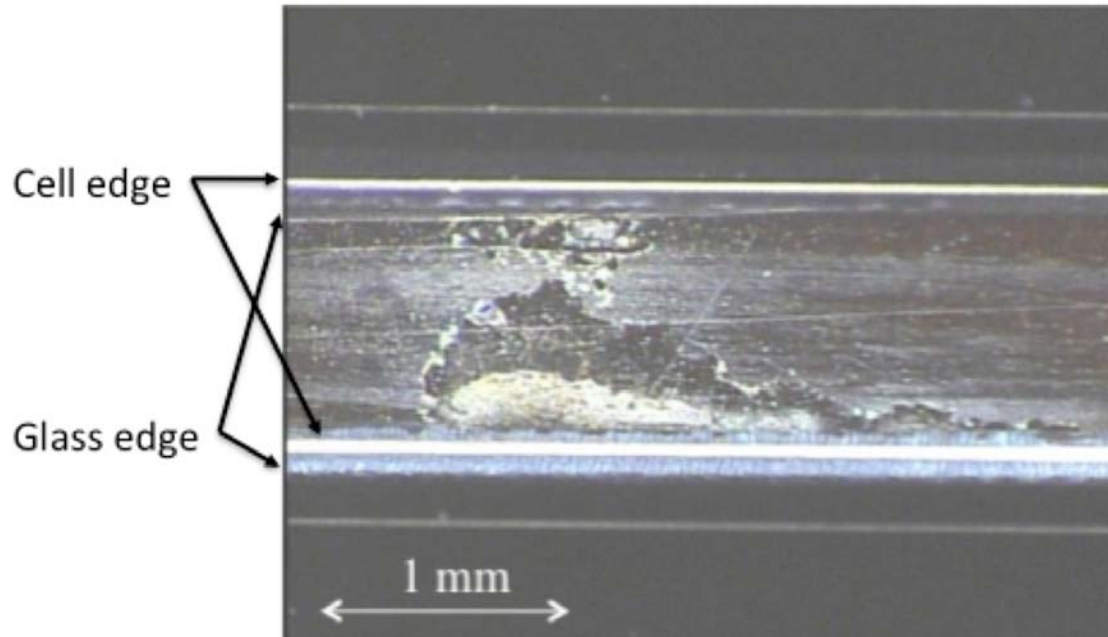
Gap length mm	String current, A	String voltage, V			
		55	110	150	220
1	0.55	NSA	NSA	NSA	NSA
1	1.10	TSA	NSA	TSA	TSA
1	1.65	TSA	TSA	TSA	TSA
2	0.55	NSA	NSA	NSA	NSA
2	1.10	NSA	NSA	NSA	NSA
2	1.65	TSA	TSA	TSA	TSA
3	0.55	NSA	NSA	NSA	NSA
3	1.10	NSA	NSA	NSA	NSA
3	1.65	NSA	TSA	NSA	TSA

No PSA occurred up to 1.65A

# TSA duration



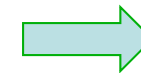
# Resistance drop in gap



110V 1.65A

8 discharges

Total arc duration: 15ms



**1.3MΩ**



# Resistance drop in gap

Gap length: 1mm

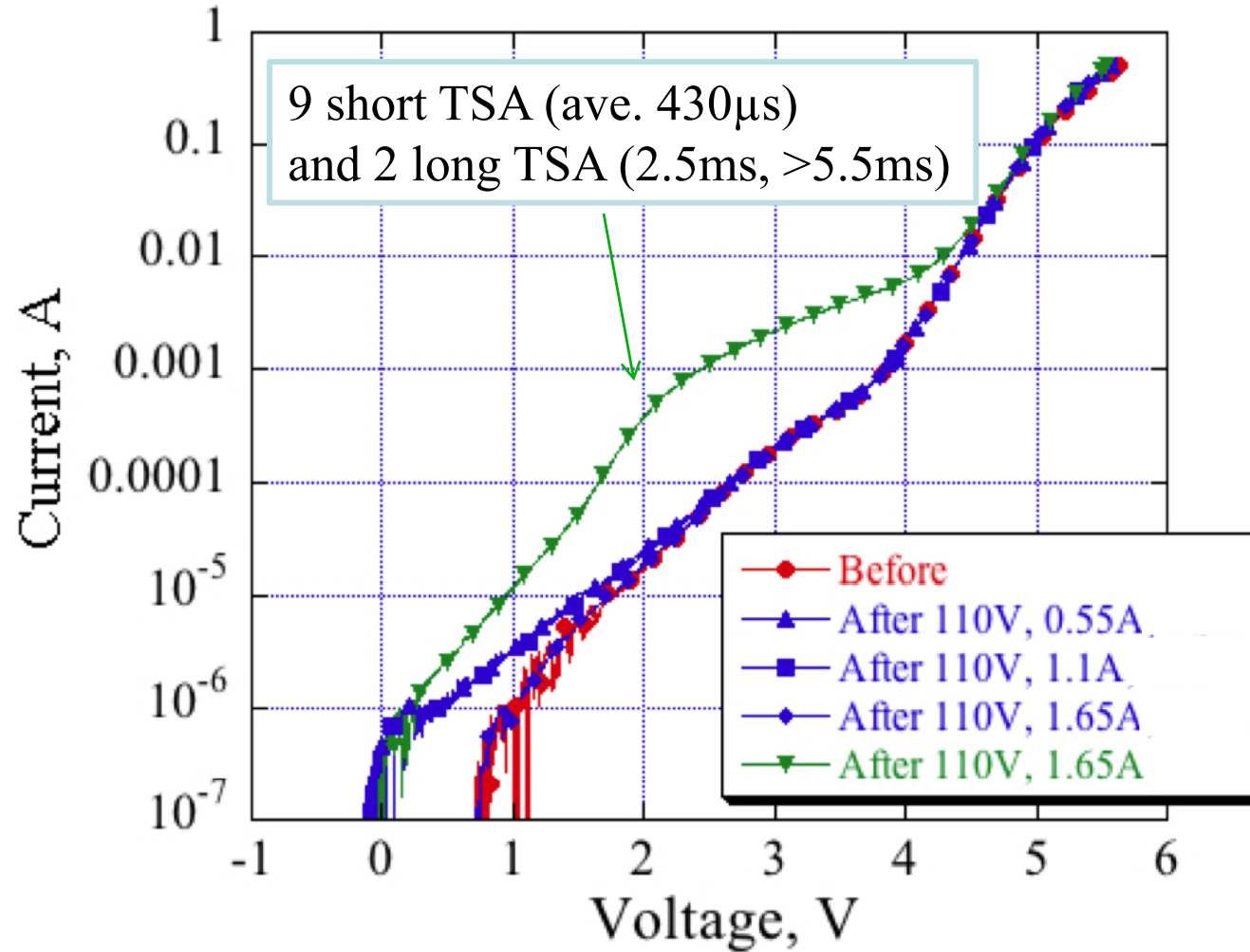
String (hot-rtn)	String voltage (V)	String current (A)	Number of arcs	Cumulative duration of TSA+NSA ( $\mu$ s)	Resistance between strings ( $M\Omega$ )	Resistance between cell and ground, ( $M\Omega$ )
5-1	55	1.1	11	1515	4.5	O.R.
5-1	55	1.65	15	7842	0.8	O.R.
6-2	110	1.65	10	2696	28	O.R.
6-2	110	1.65	8	14564	1.3	O.R.
7-3	150	1.1	20	3182	3.1	O.R.
7-3	150	1.65	20	11859	1.3	O.R.

# Resistance drop in gap

Gap length: 2mm

String (hot-rtn)	String voltage (V)	String current (A)	Number of arcs	Cumulative duration of TSA+NSA ( $\mu$ s)	Resistance between strings (M $\Omega$ )	Resistance between cell and ground, (M $\Omega$ )
5-1	55	1.65	35	3814	O.R.	O.R.
5-1	55	1.65	15	2090	O.R.	O.R.
5-1	55	1.65	3	427	O.R.	O.R.
6-2	110	1.65	10	1711	O.R.	O.R.
6-2	110	1.65	10	1608	O.R.	O.R.
7-3	150	1.65	10	1485	O.R.	O.R.
7-3	150	1.65	10	2539	O.R.	O.R.
8-4	220	1.65	10	1721	1.9	O.R.
8-4	220	1.65	10	1607	1.9	O.R.

# Cell degradation



- Long duration TSA degraded the cell
- Anode cell was degraded

## Summary

- Secondary arc threshold testing was performed on the solar array coupons without grouting
- No PSA occurred up to 1.65A
- The secondary arc duration decreased with increasing in gap length
- The long duration secondary arc degraded the cell