2010/ 9/ 22
11th Spacecraft Charging Technology Conference
New Mexico, USA

Propagation Area and Speed of Flashover Discharge on Large Solar Array Panels in a Simulated Space Plasma Environment

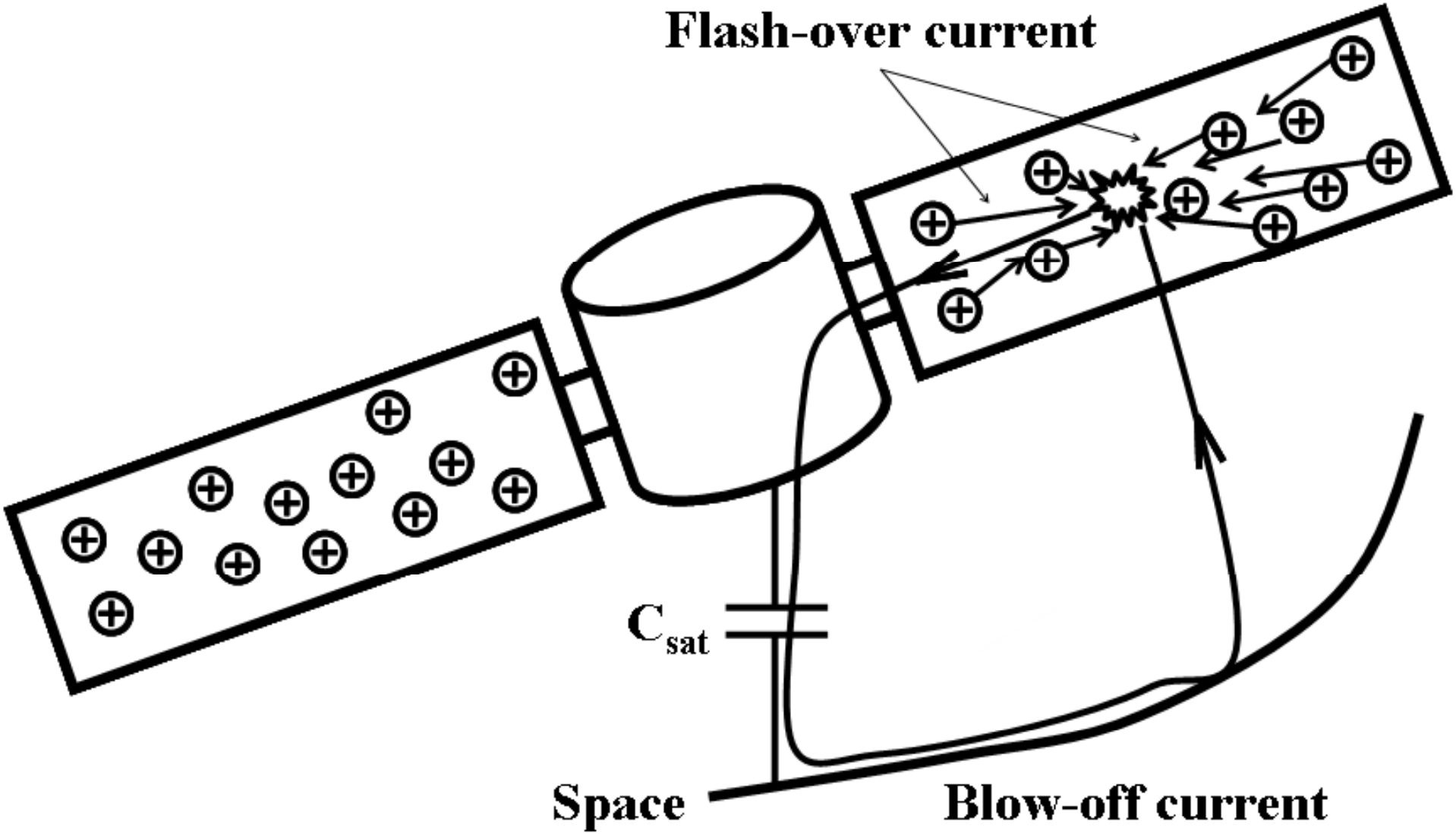
T, Okumura. M, Imaizumi, K, Nitta. M, Takahashi
Japan Aerospace Exploration Agency
T, Suzuki. K, Toyoda
Kyushu Institute of Technology

No2

Background

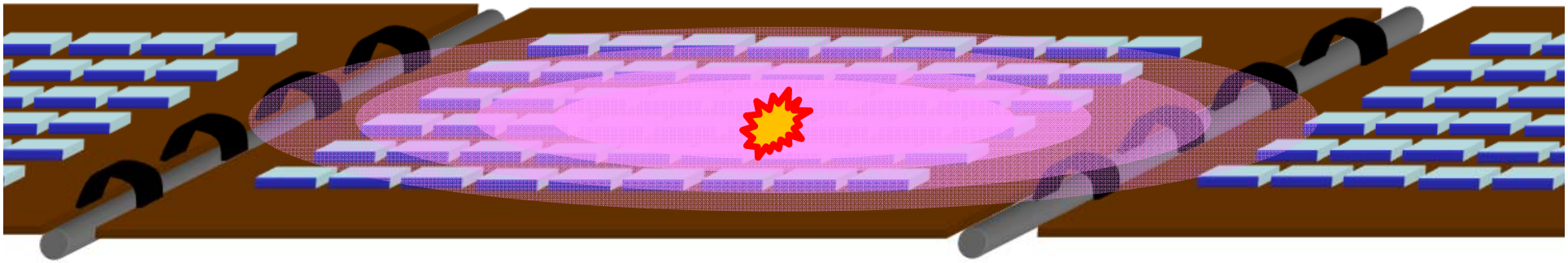
No3

Primary discharge on solar array

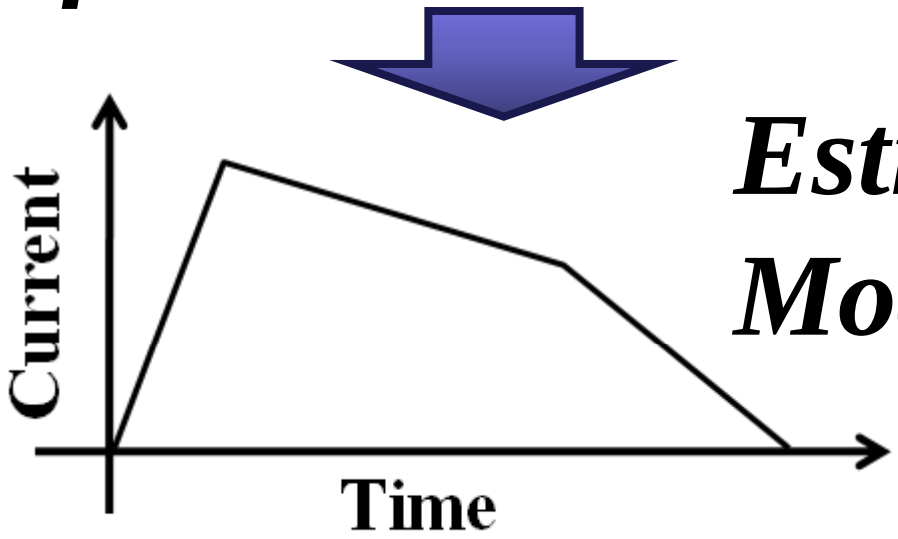


Purpose of our research

What is the characteristics…?



How fast? ***How far?***



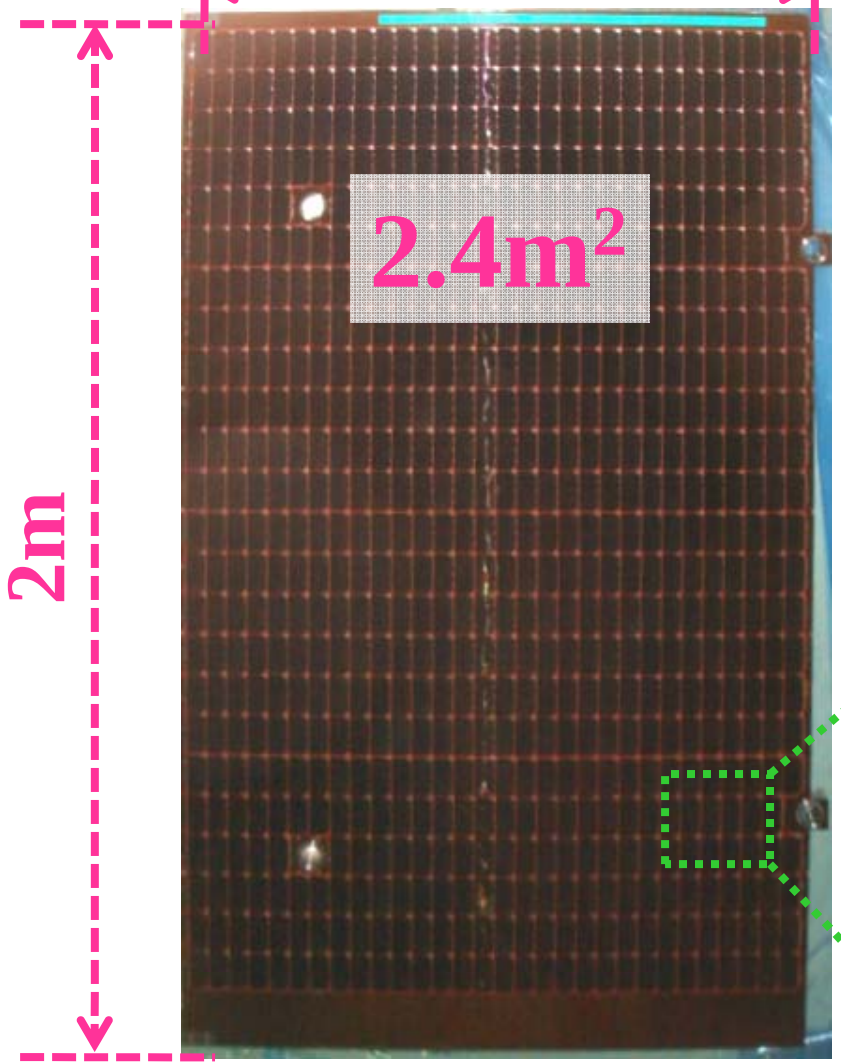
Estimation Model

No5

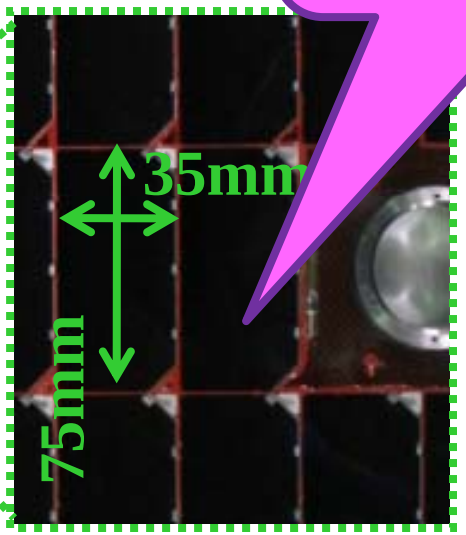
Experiment

No6

Solar array panel



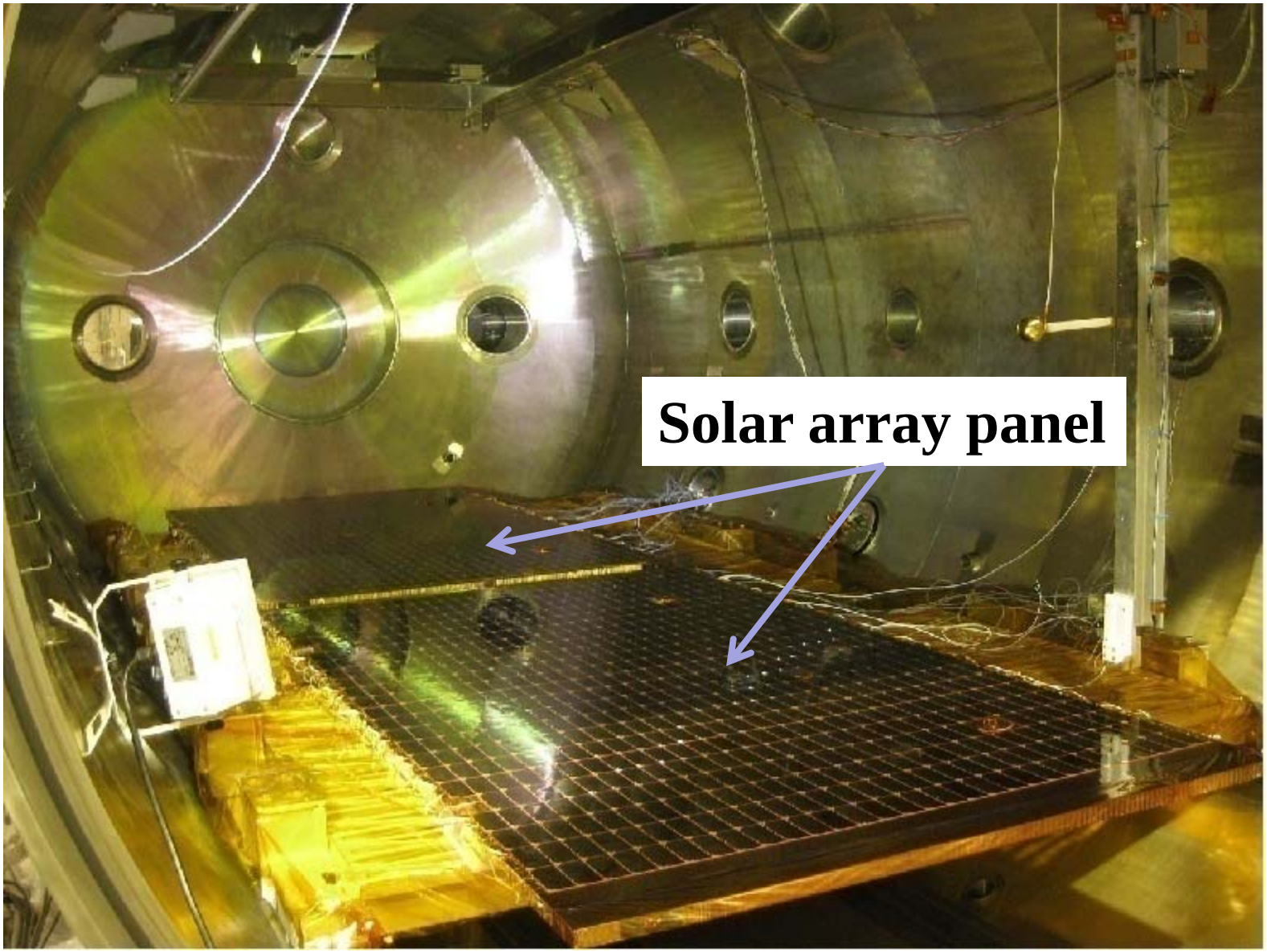
× 2 = 4.8m²



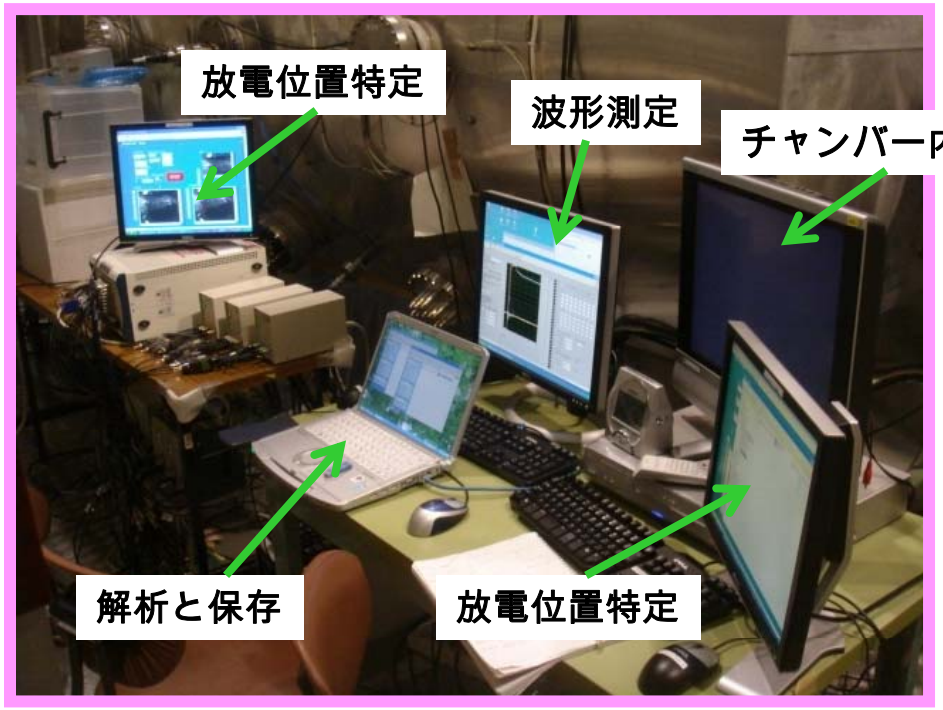
MJ cell
CG =100μm

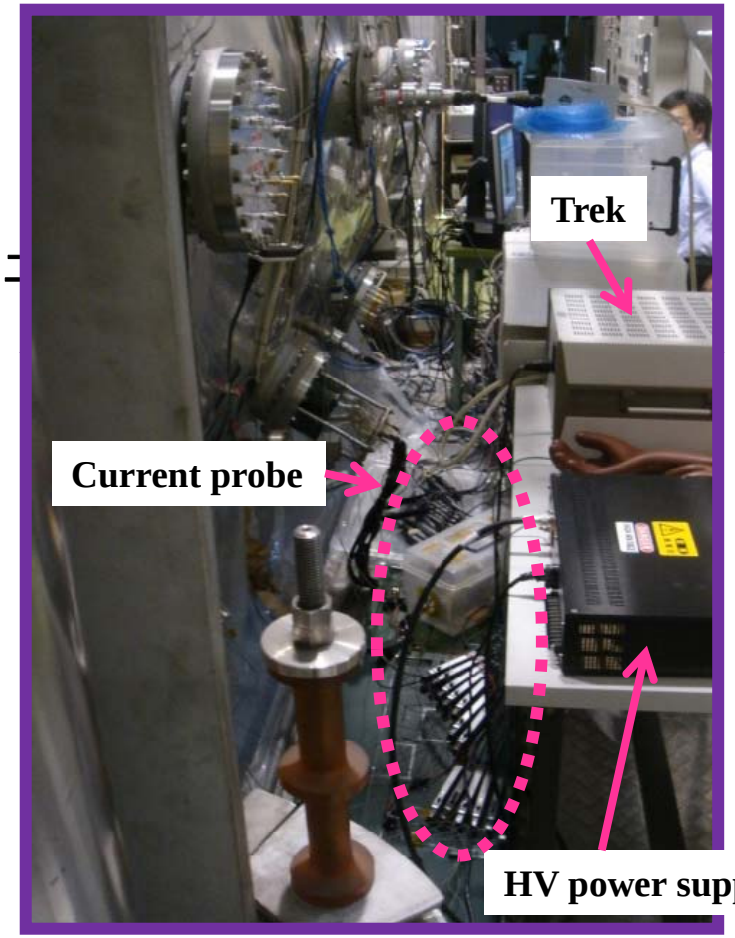
No7

Vacuum chamber

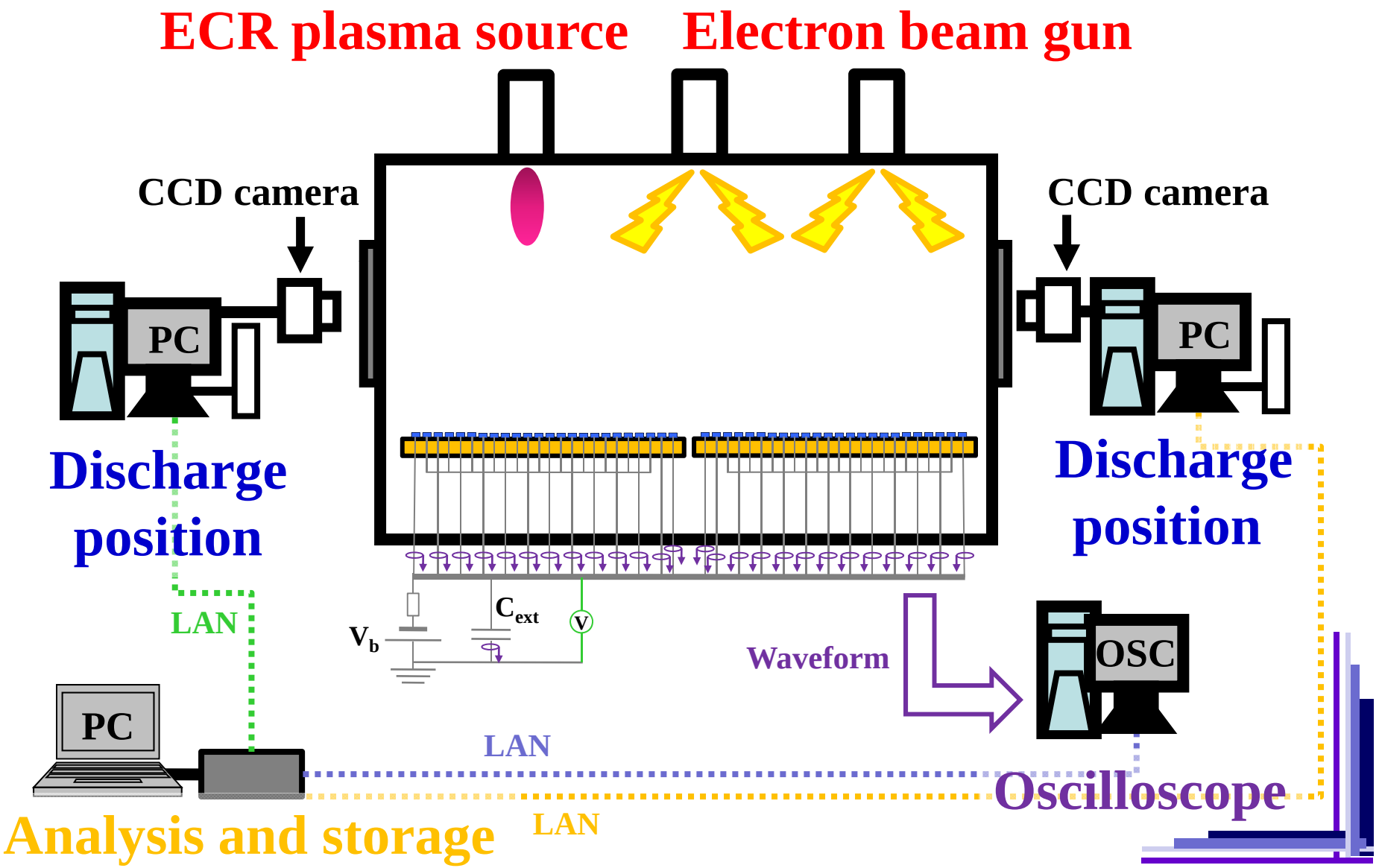


試験の様子

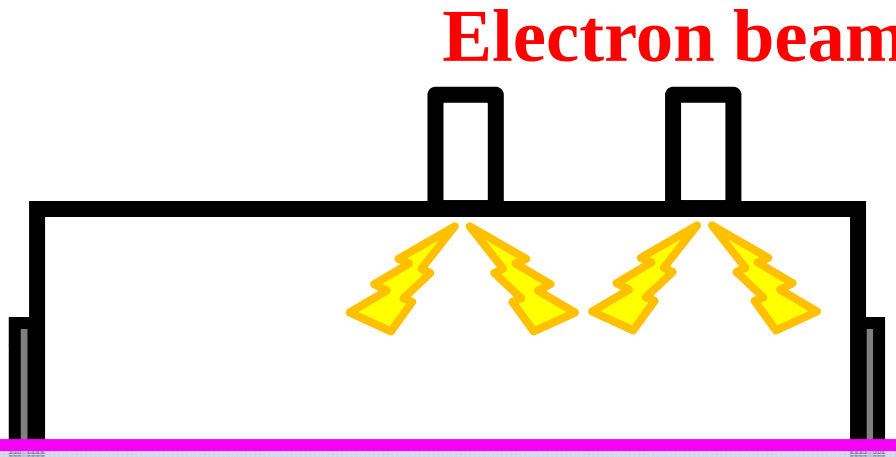

放電位置特定
波形測定
チャンバー内モニ
解析と保存
放電位置特定


Trek
Current probe
HV power supply

Experiment system



GEO test



E_b: 6~7keV, I_e: 10μA/m^2

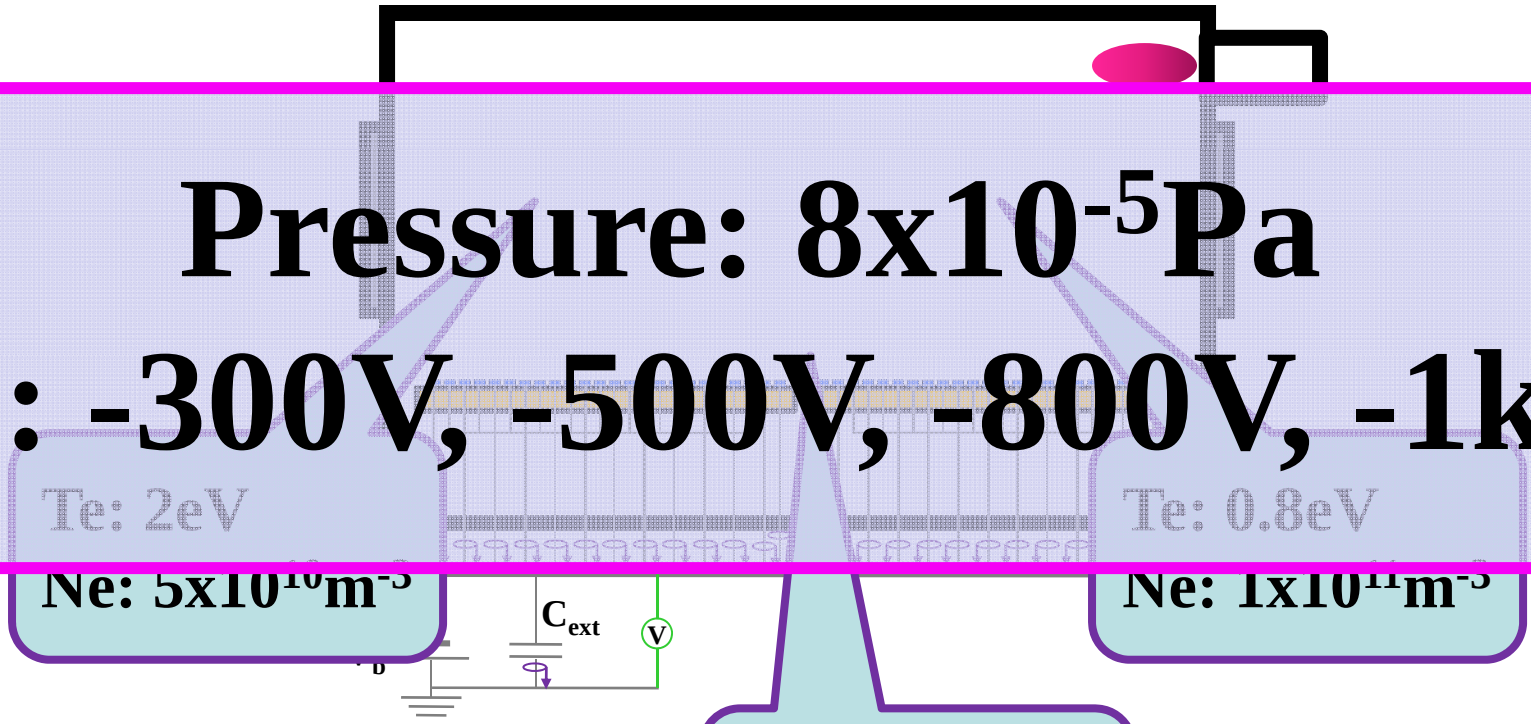
Pressure: 5x10^{-5}Pa

LEO test

ECR plasma source

Pressure: 8×10^{-5}Pa

V_b: -300V, -500V, -800V, -1kV

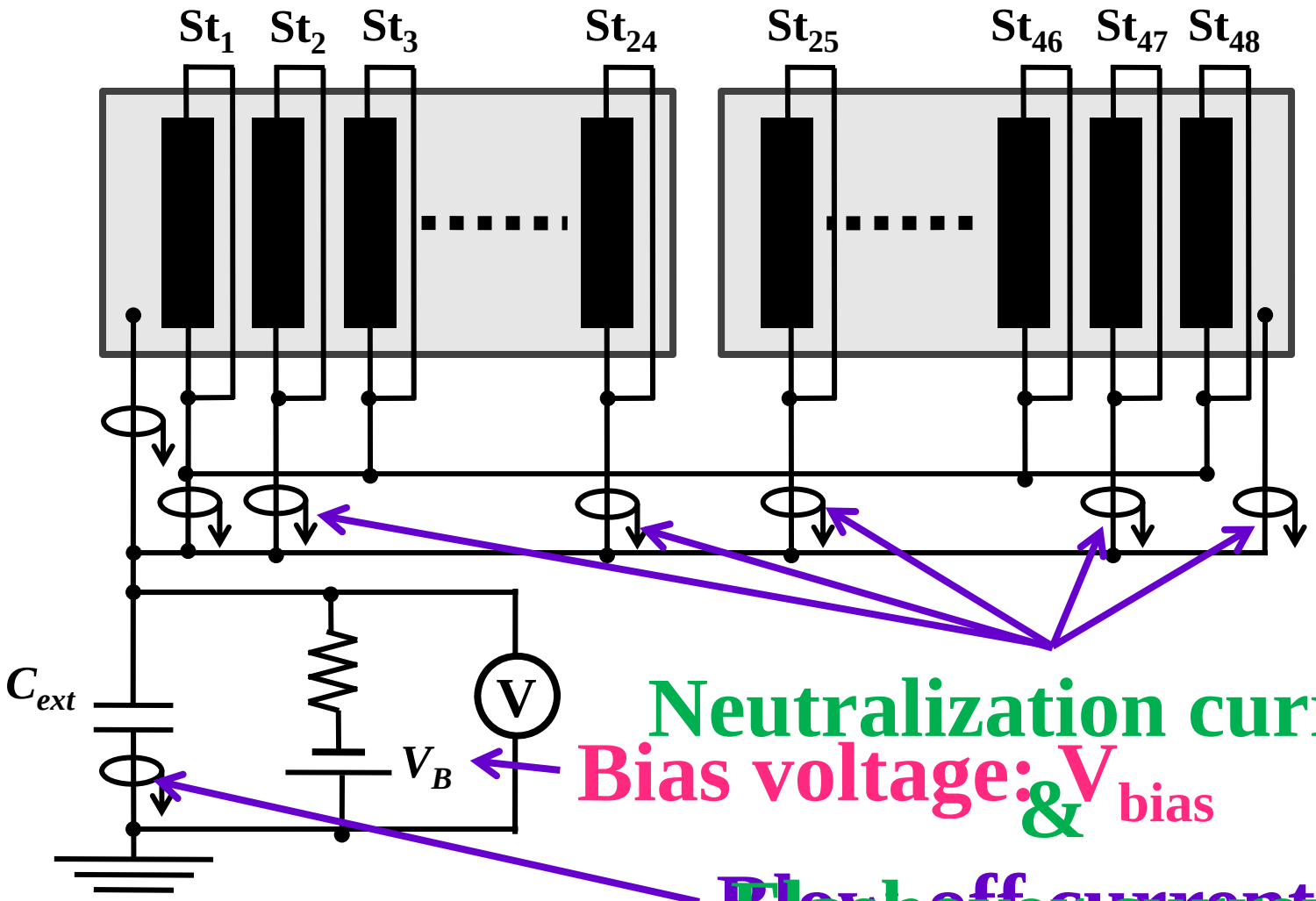


Te: 0.6eV
Ne: 1×10^{11}m^{-3}

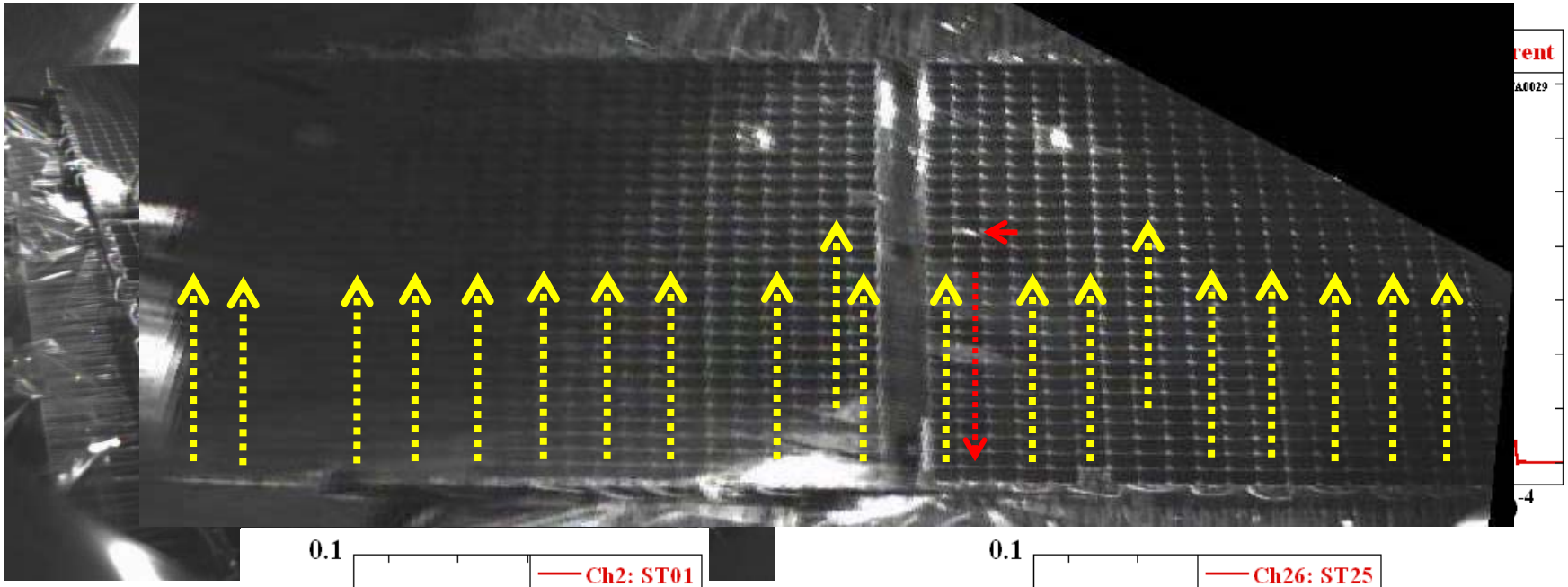
Propagation length

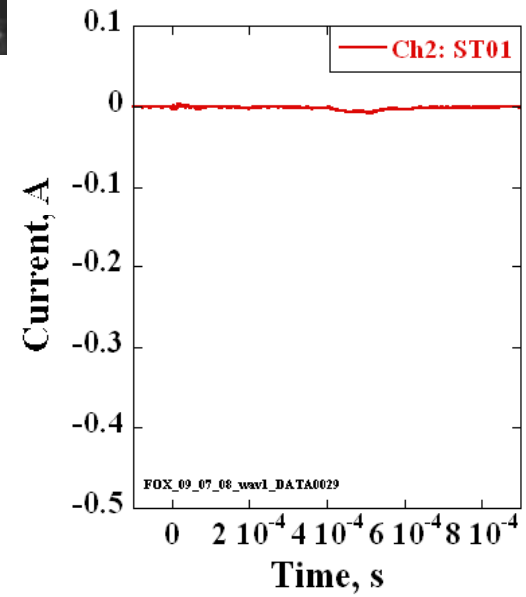
Experiment technique and result

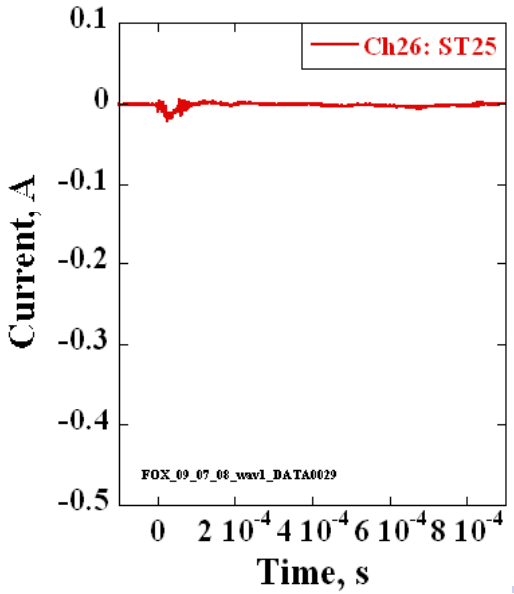
Discharge circuit



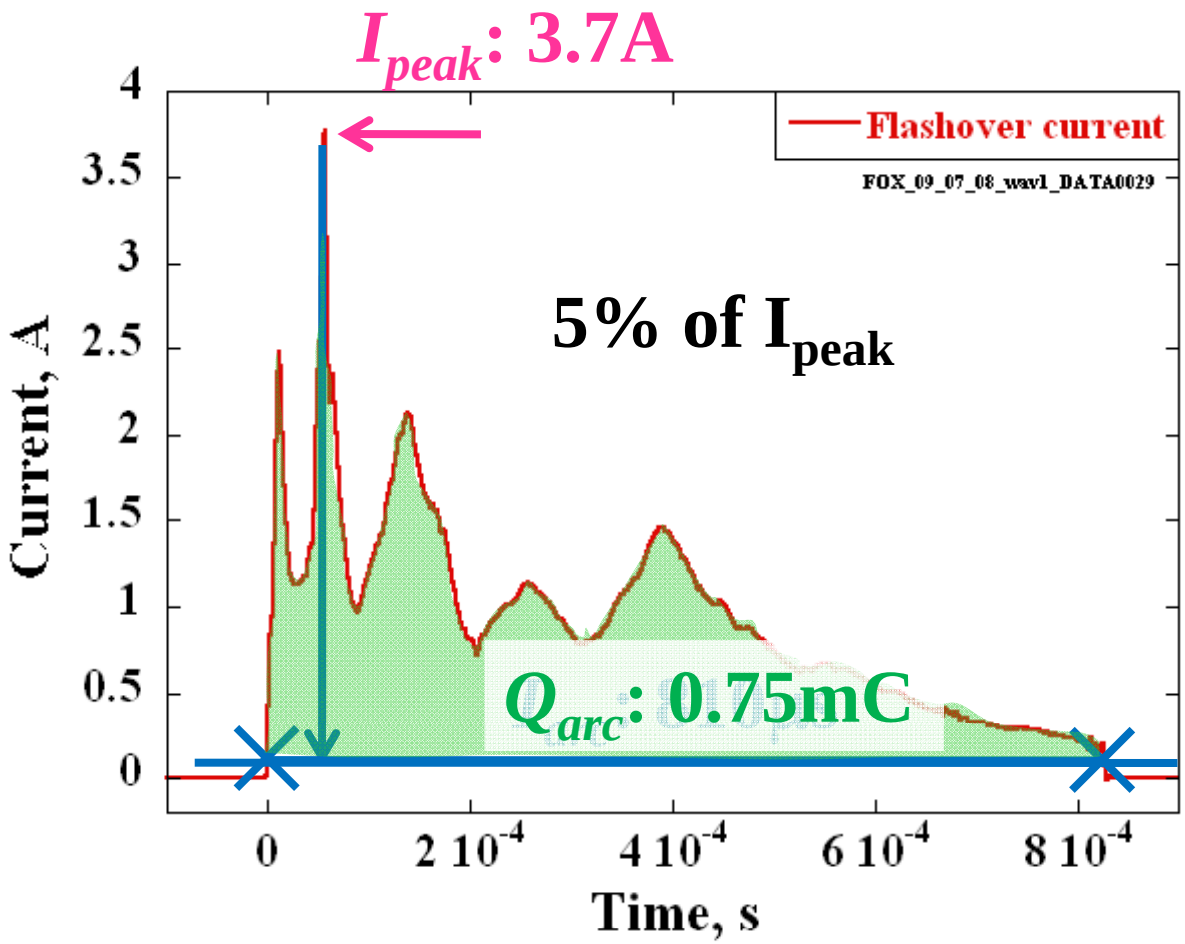
No14 **How did we measure the propagation length??**



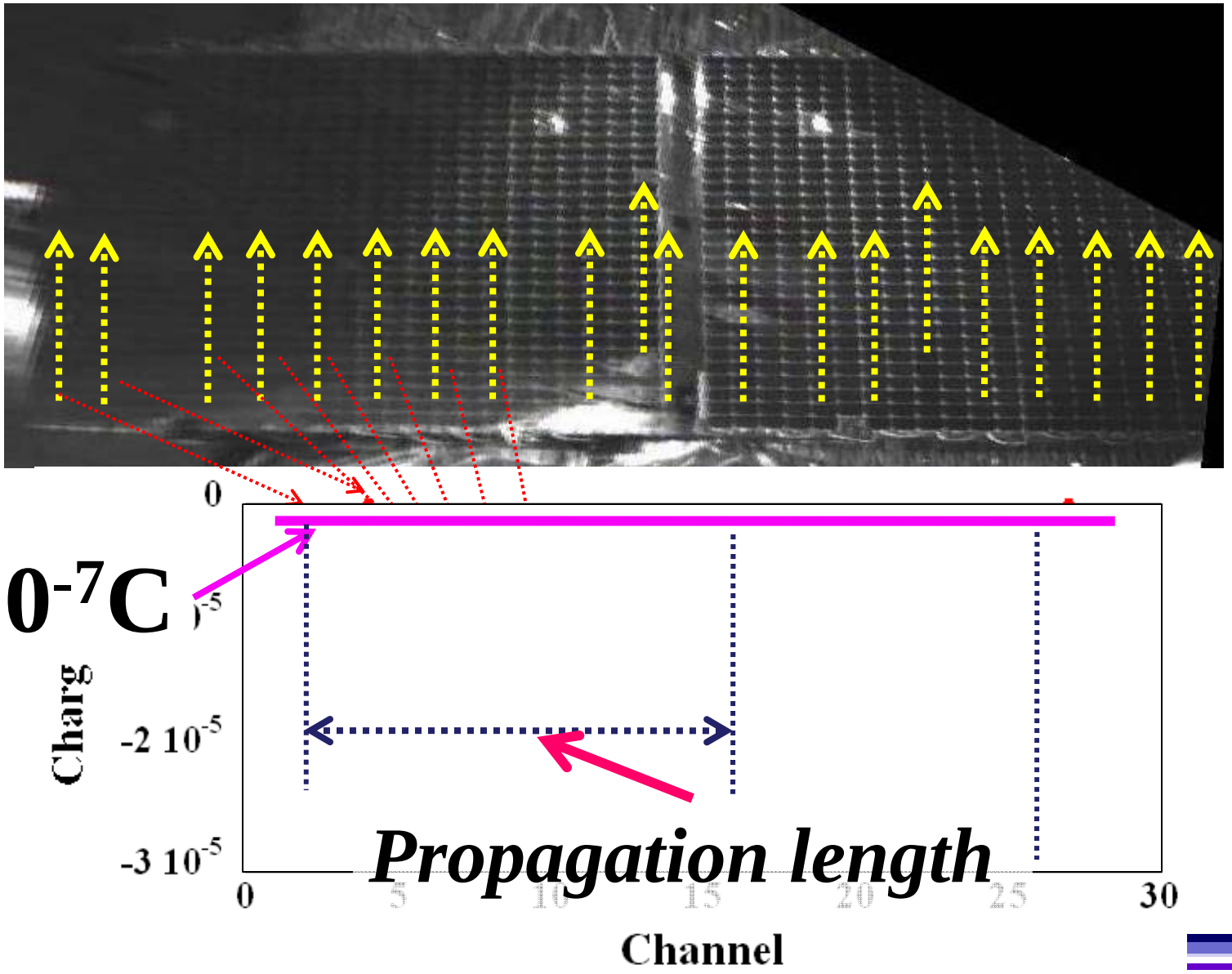




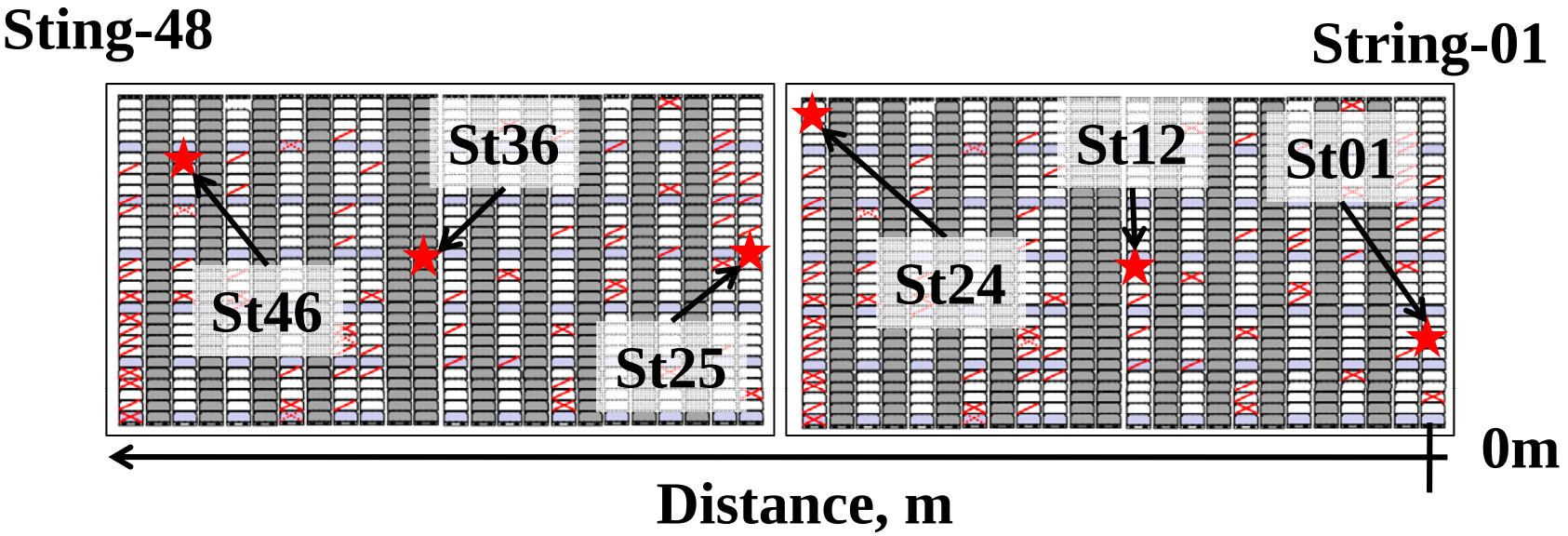
Discharge parameter

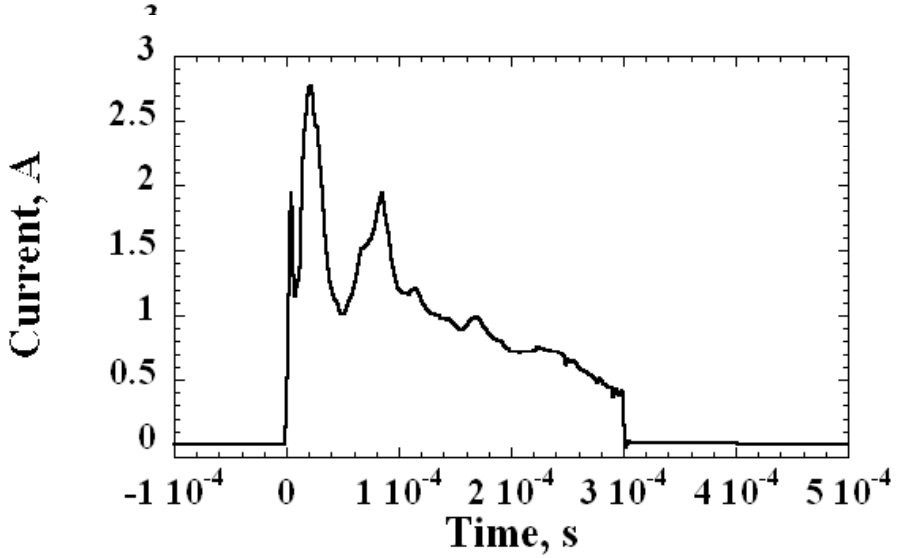


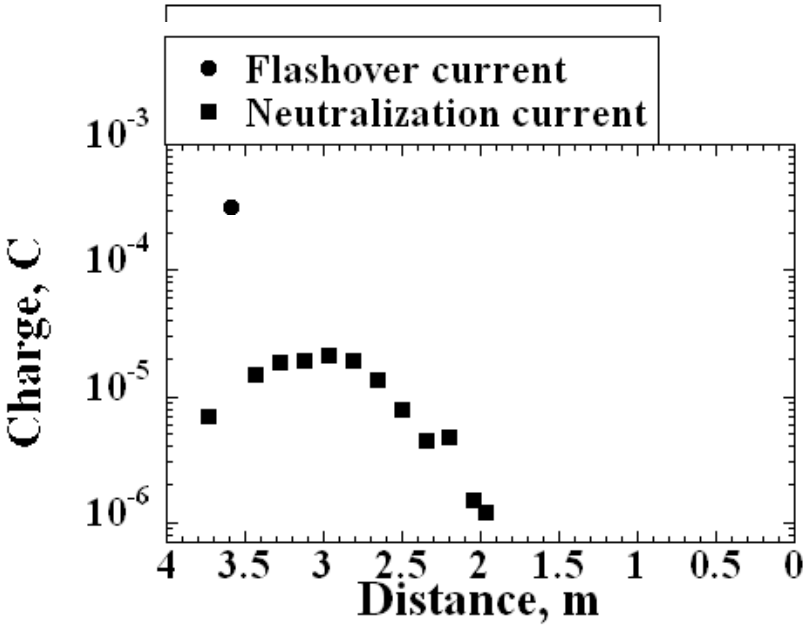
Definition of propagation length



No17 Waveform analysis in GEO environment

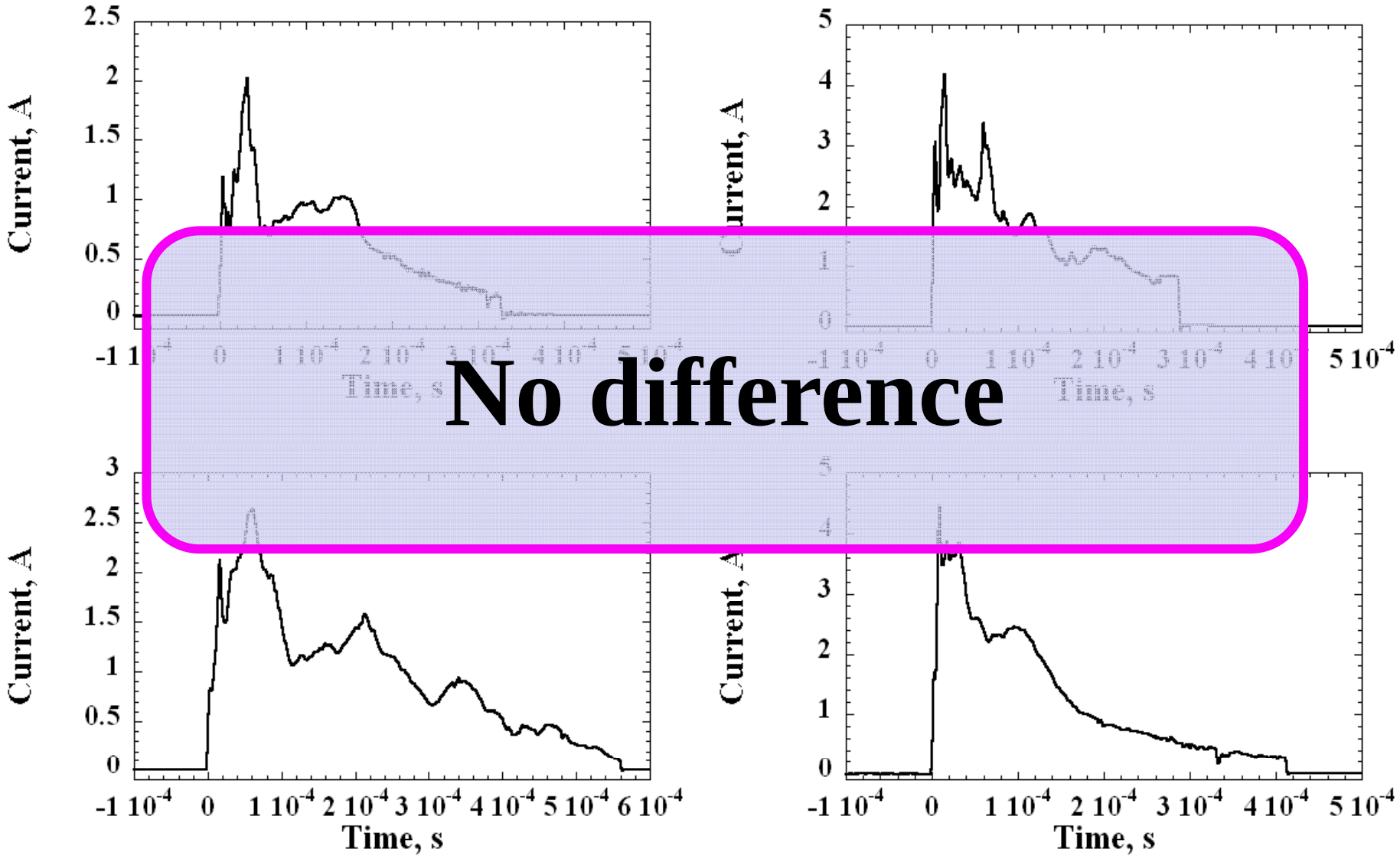






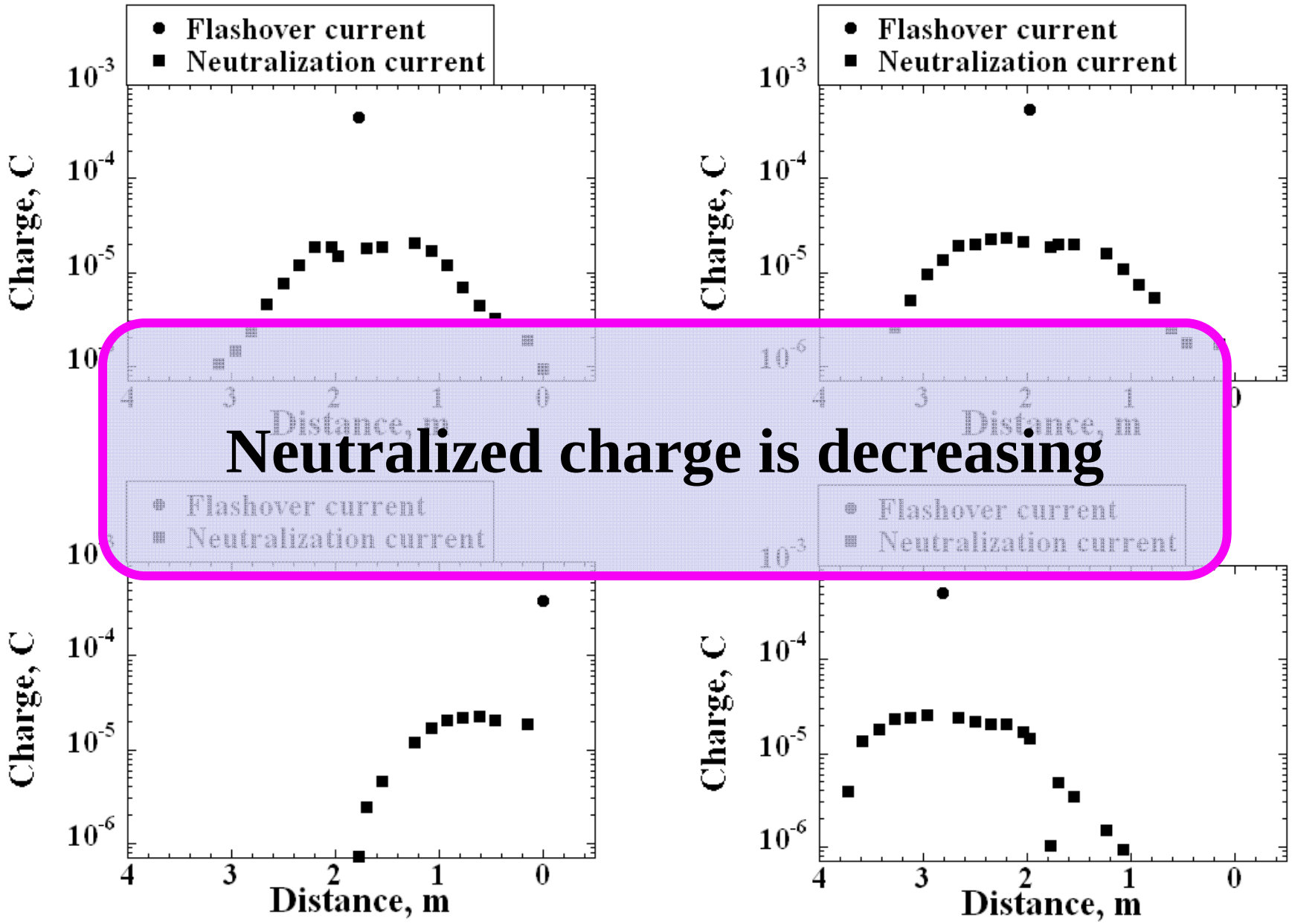
No18

Flashover current waveform



No19

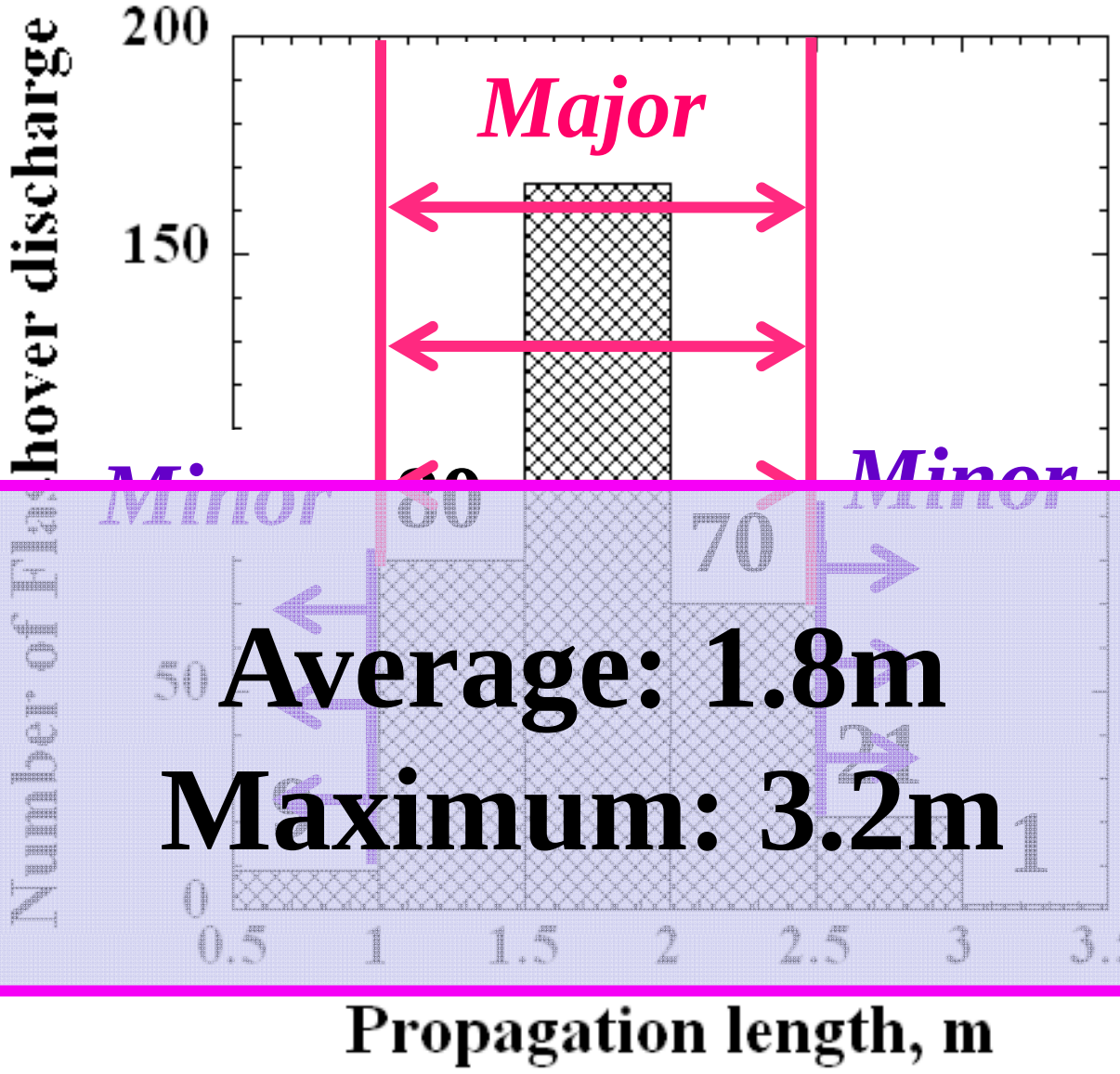
Distribution of neutralized charge



Neutralized charge is decreasing

No20

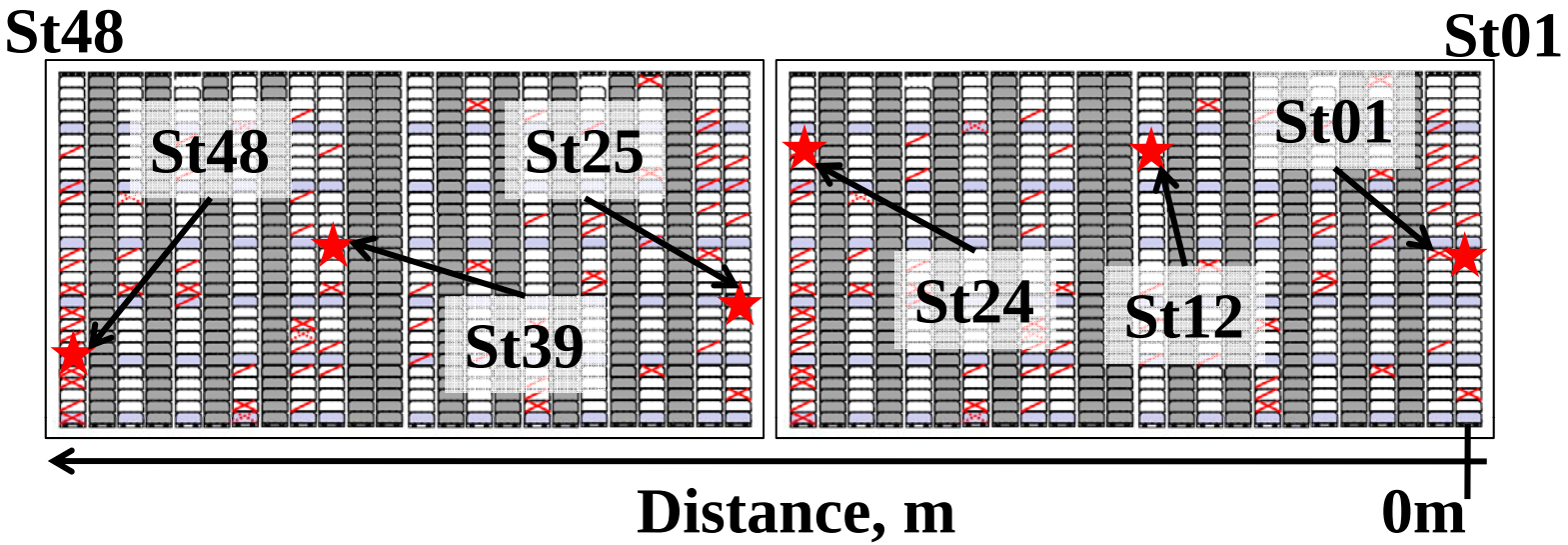
Propagation length in GEO

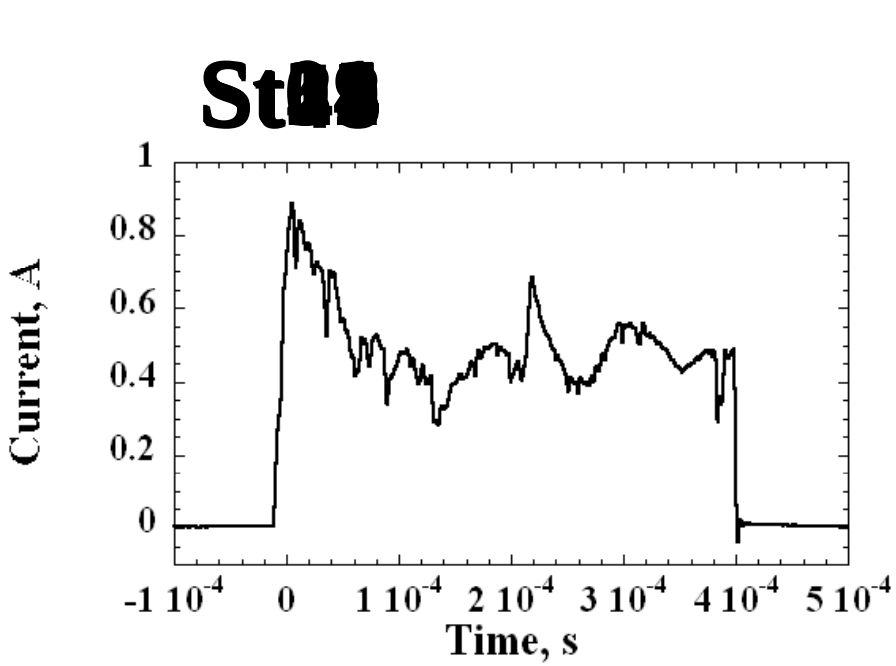


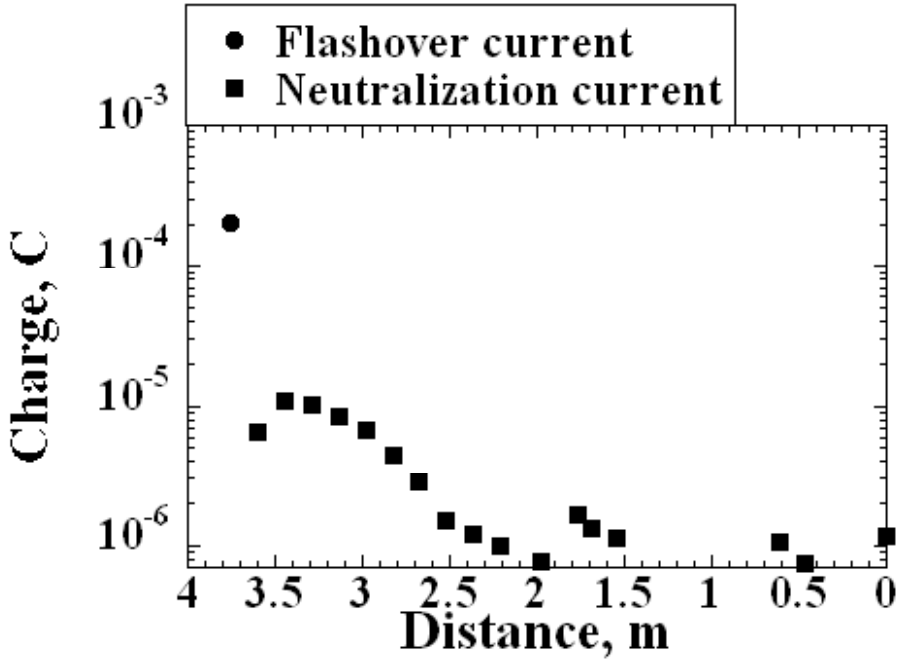
Average: 1.8m

Maximum: 3.2m

No21 **Waveform analysis in LEO environment**

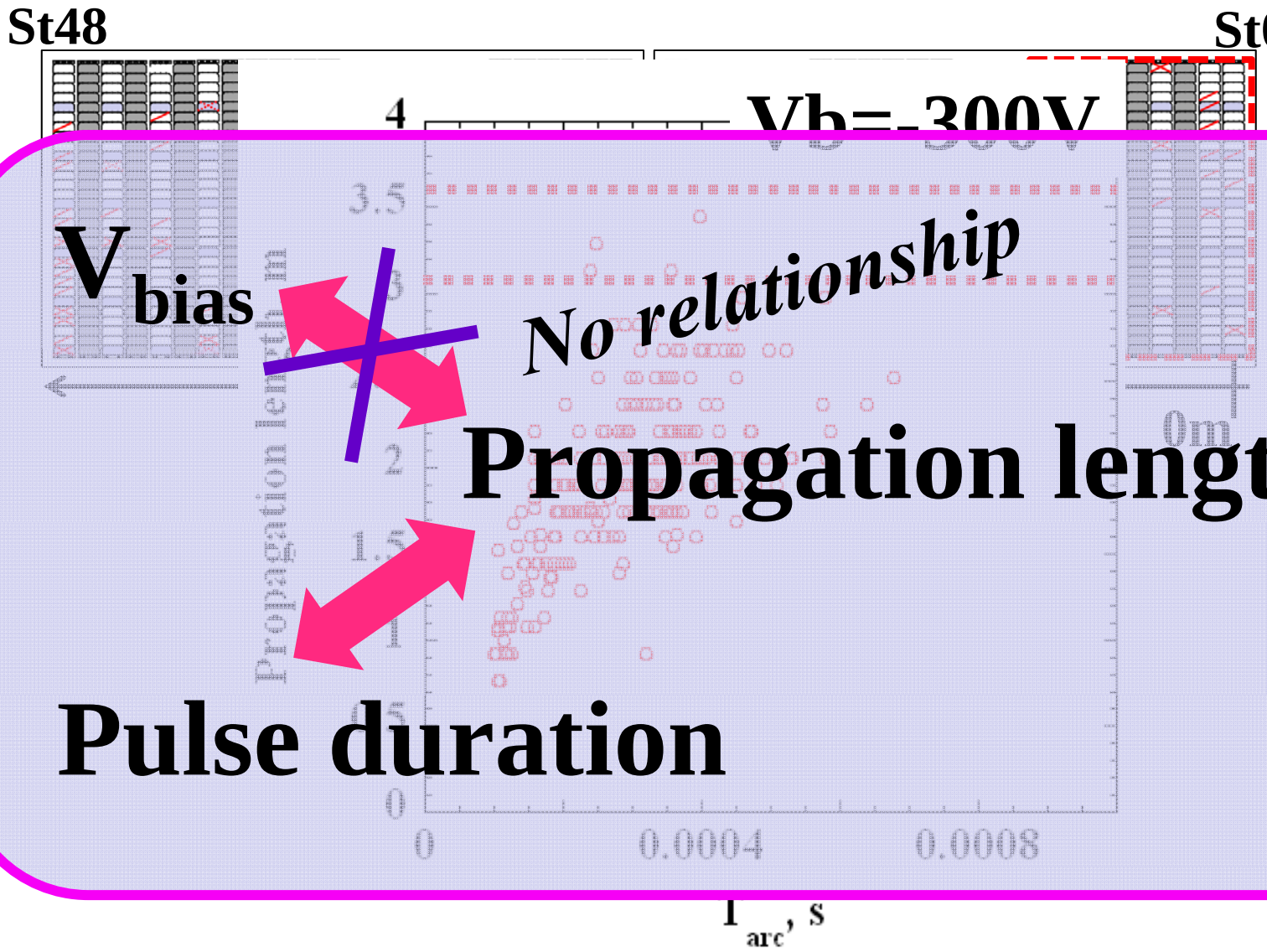






No22

Propagation length in LEO



V_{bias} *No relationship*

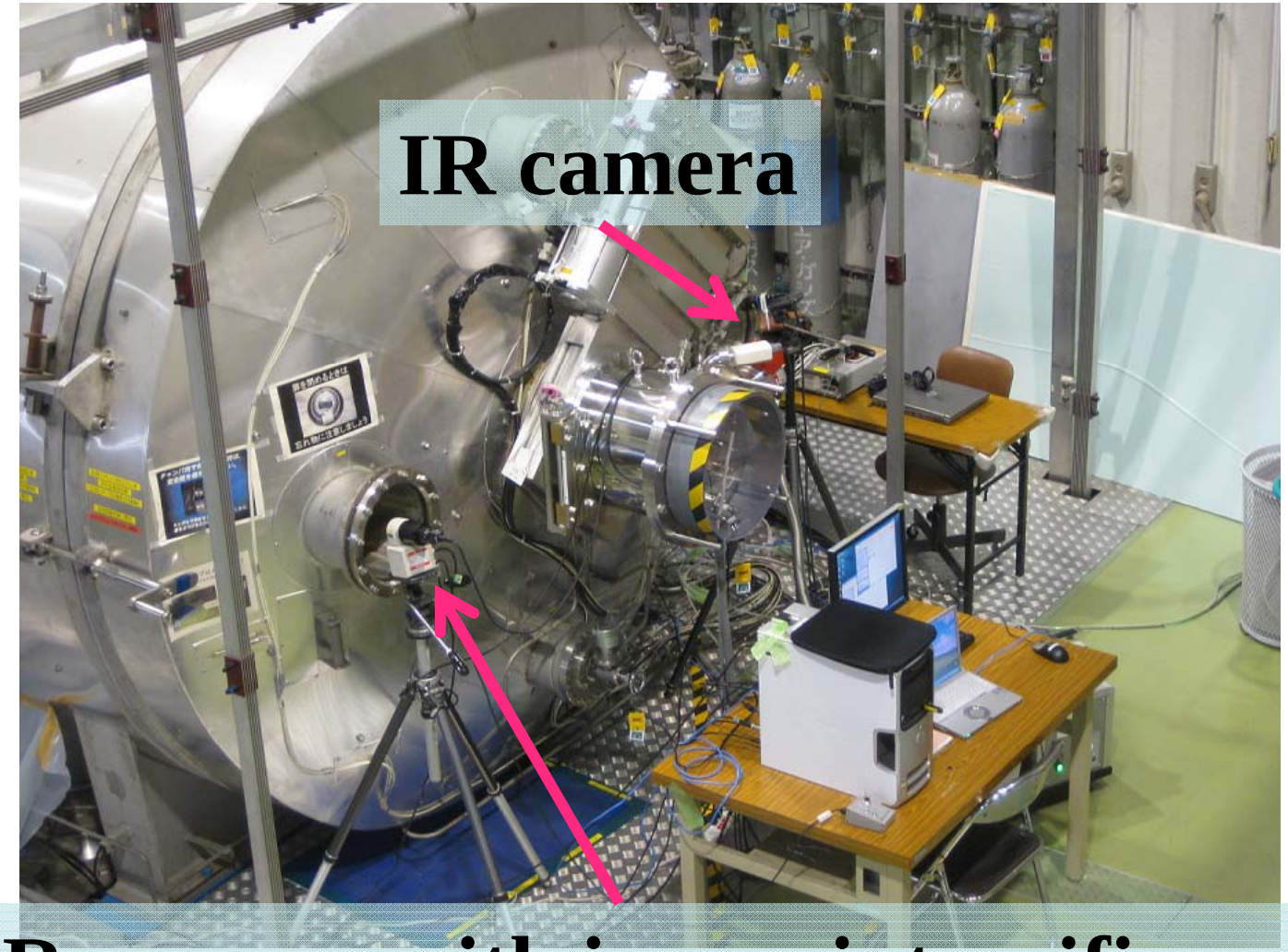
Propagation length

Pulse duration

Propagation speed

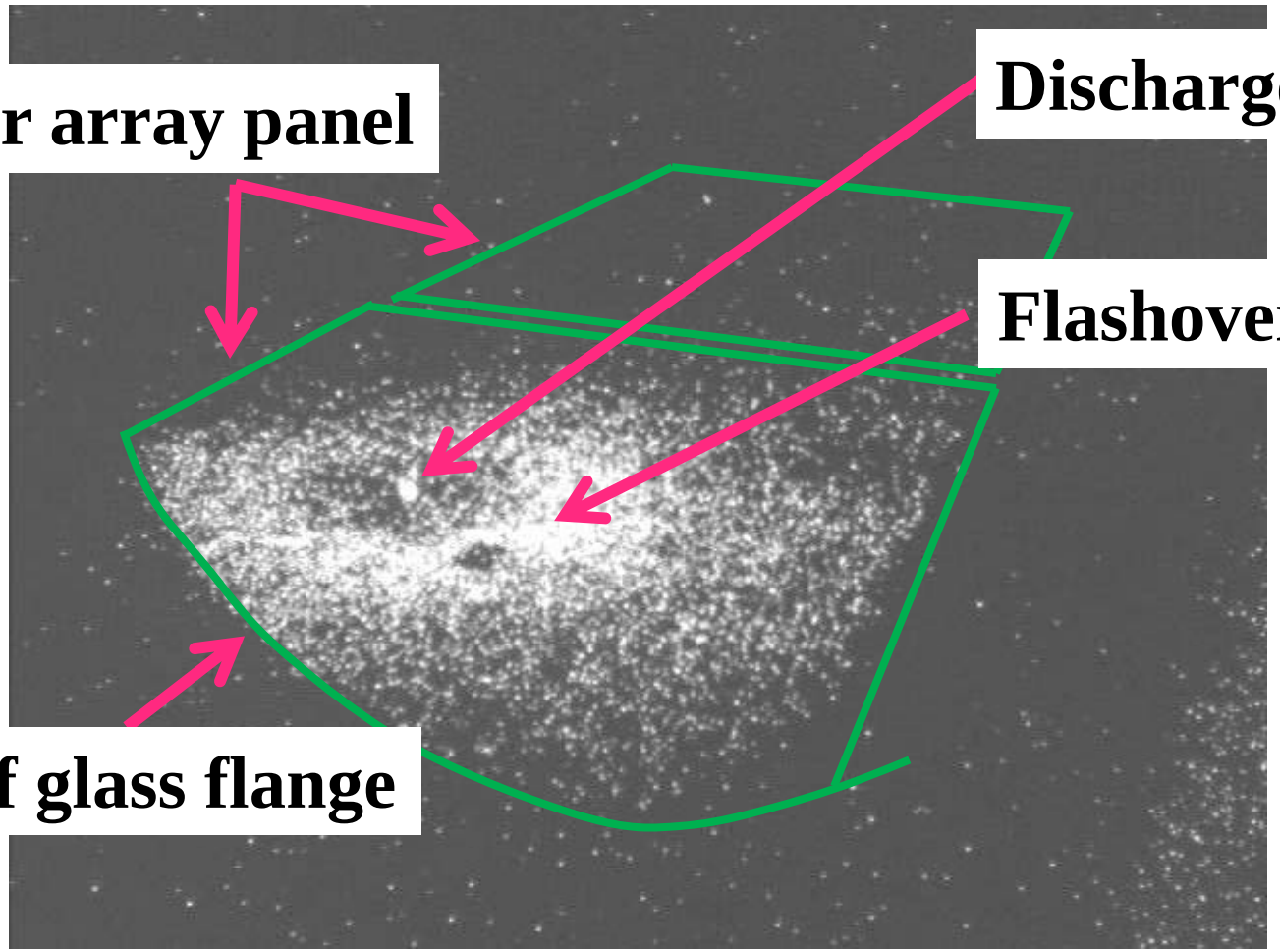
Experiment technique and result

How did we measure the speed??

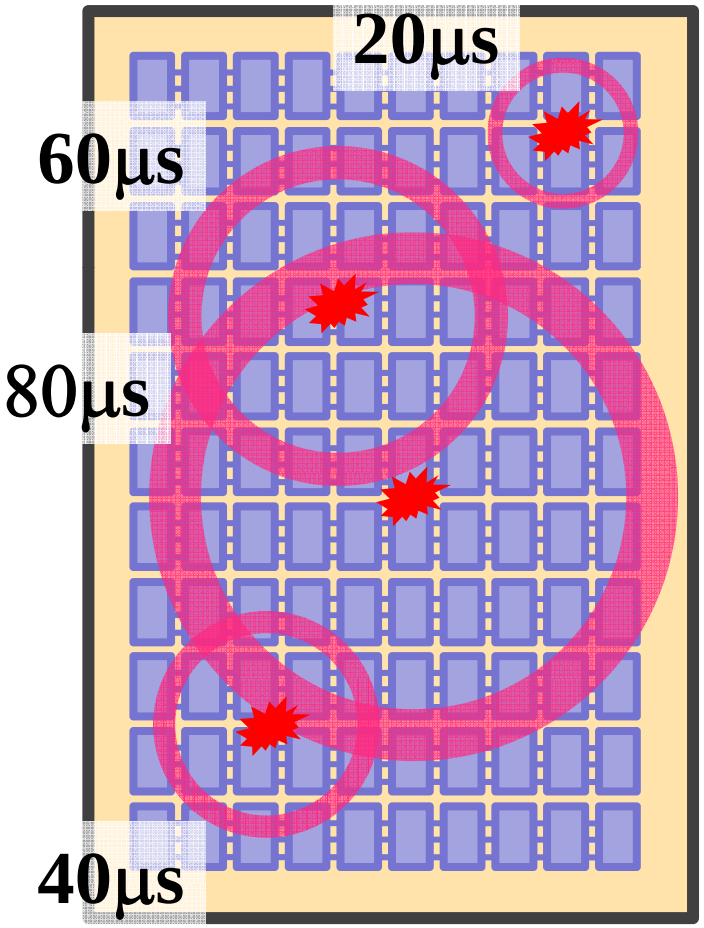


IR camera with image intensifier

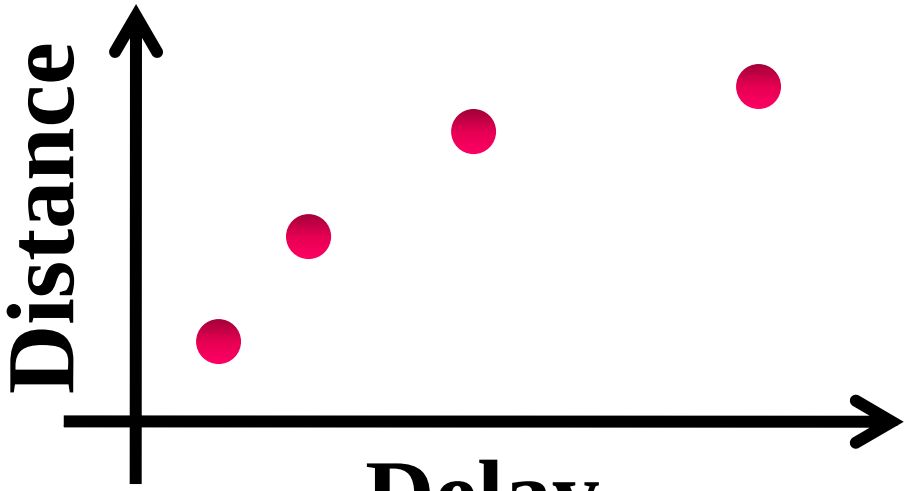
How does it work??



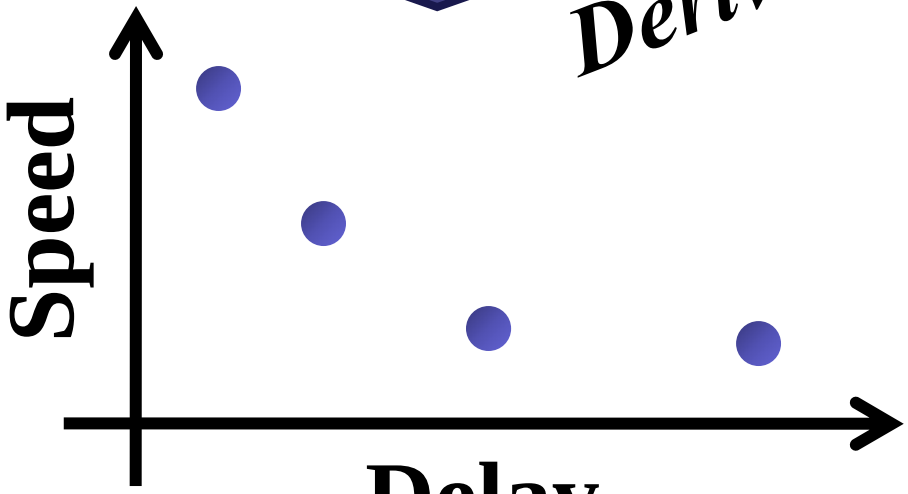
No26



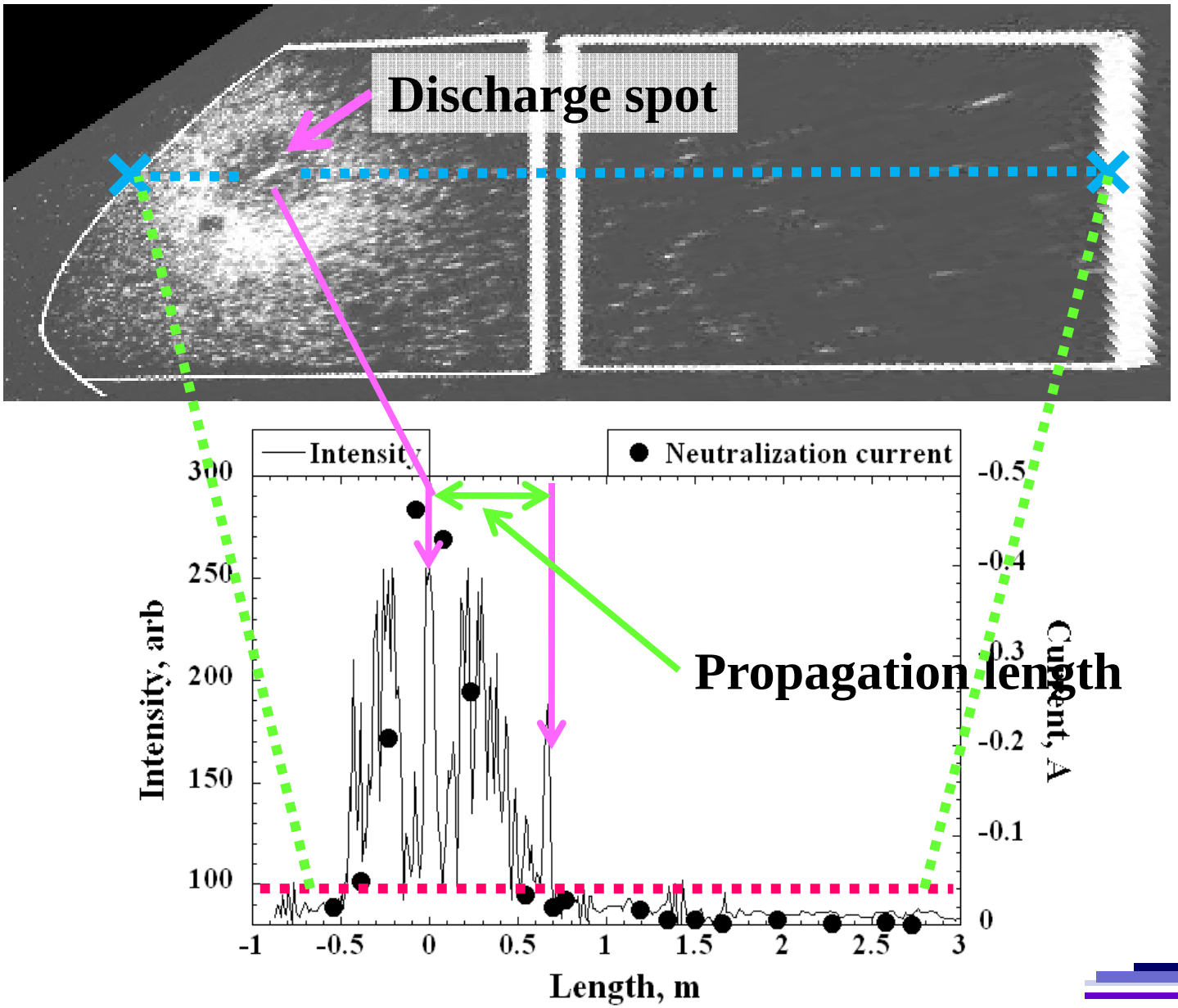
How to calculate??



Derivative

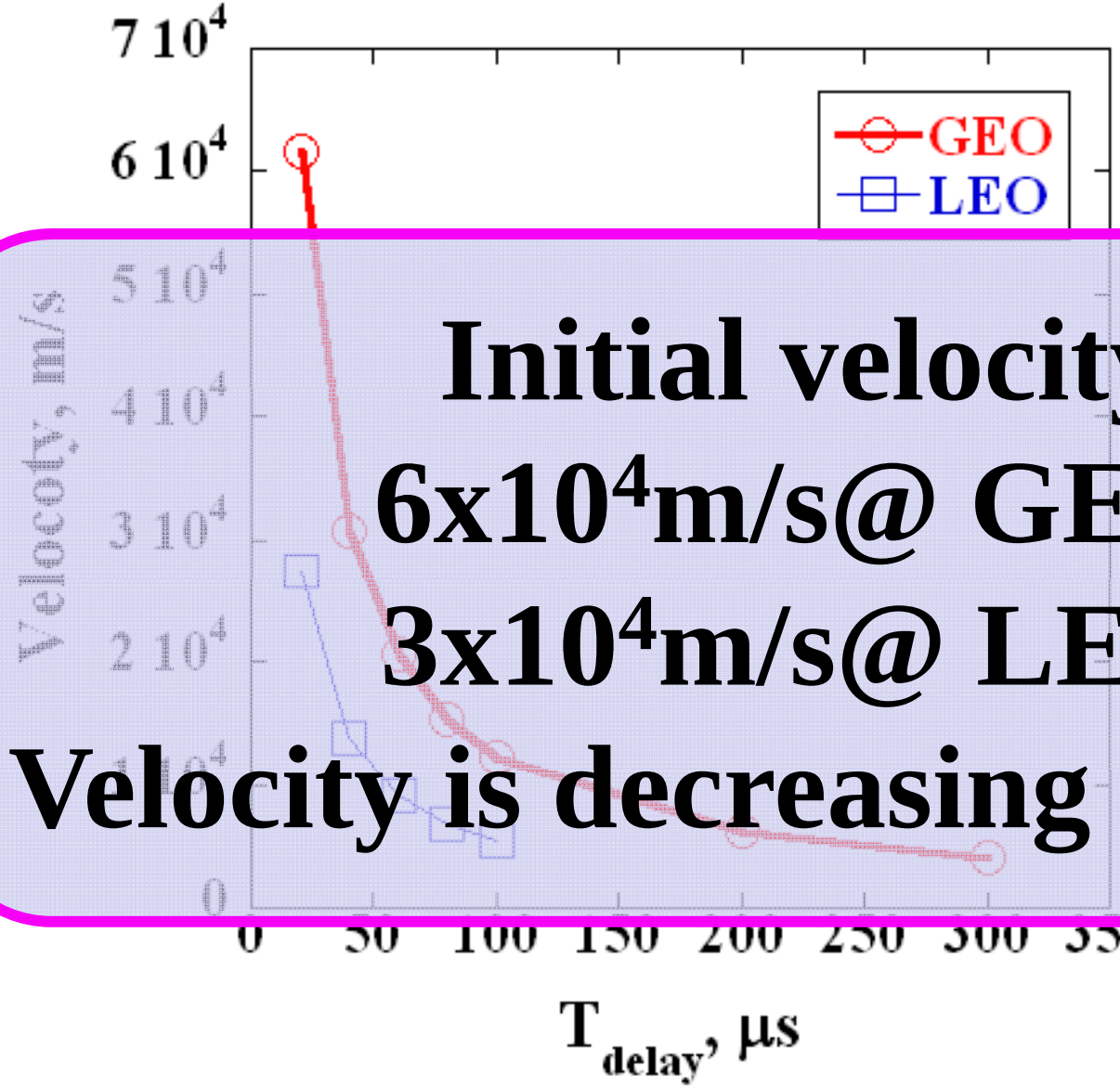


Example of analysis



No28

Propagation speed



Initial velocity

$6x10^4$m/s@ GEO

$3x10^4$m/s@ LEO

Velocity is decreasing with time

Summary

		GEO	LEO
Propagation length	Average	1.8m	2.0m
	Maximum	3.2m	3.8m
	Neutralization distribution	Decreasing with distance	
Velocity	Initial velocity	$6x10^4$m/s	$3x10^4$m/s
	Decelerate?	Yes	

Future work

- Effect of C_{ext} on the characteristics of flashover discharge
- Physical model to understand the characteristics of flashover discharge
- Numerical model to estimate the flashover current
- Discharge current monitor on a satellite

Thank you for your attention

空へ挑み、宇宙を拓く

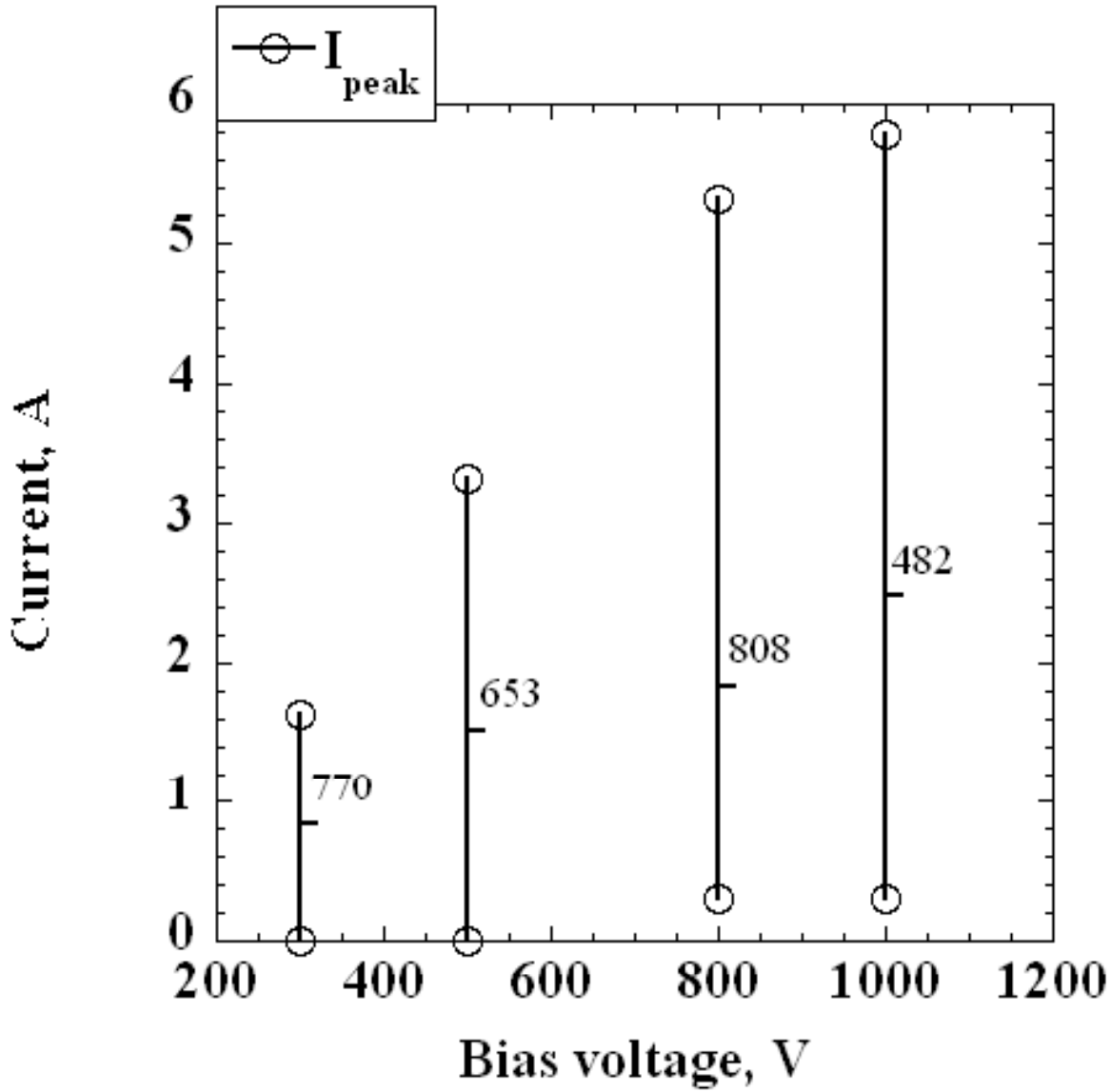
JAXA
宇宙航空研究開発機構
Japan Aerospace Exploration Agency

La SEINE

Appendix

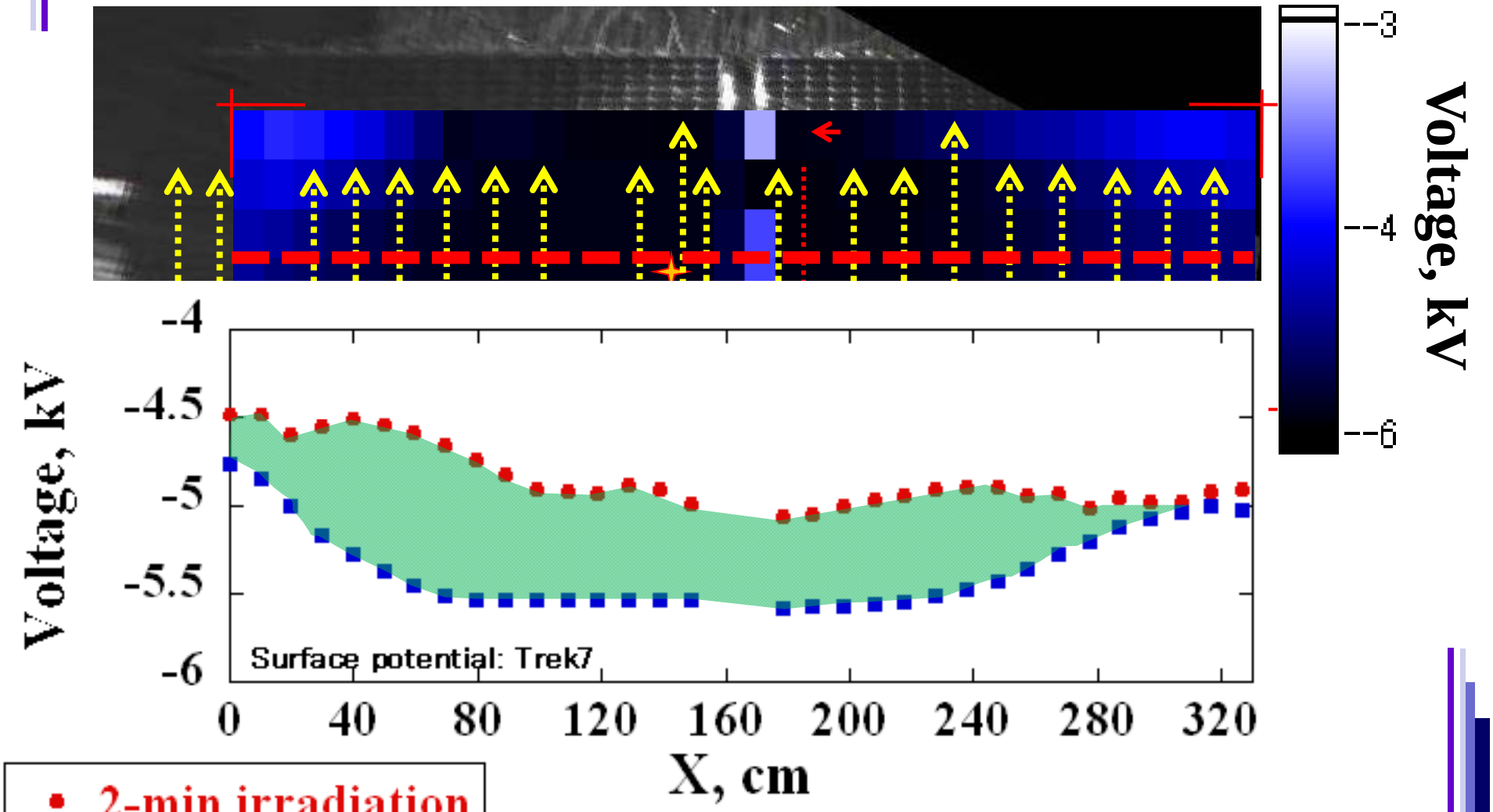
No33

V_{bias} VS Peak current

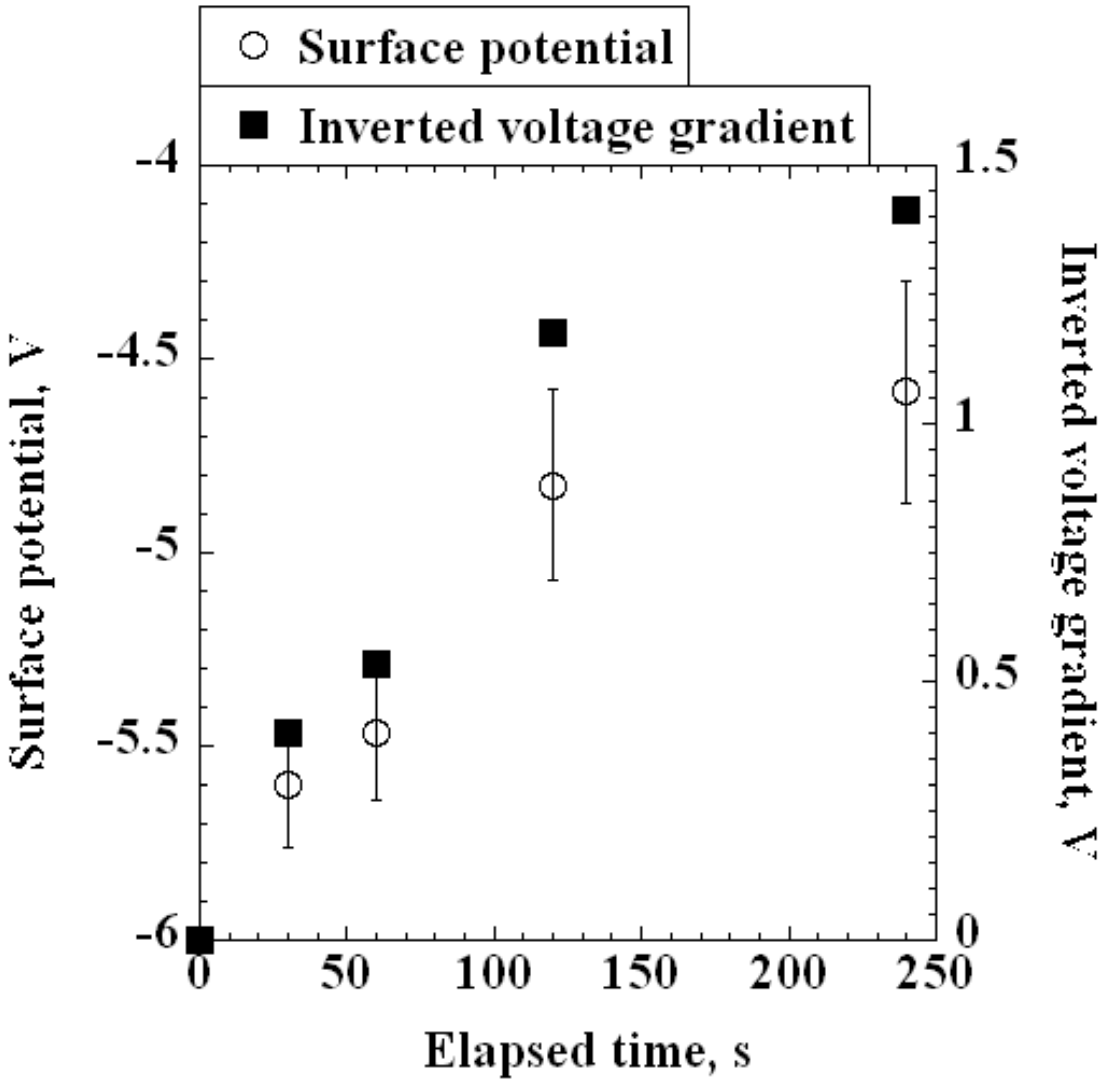


No34

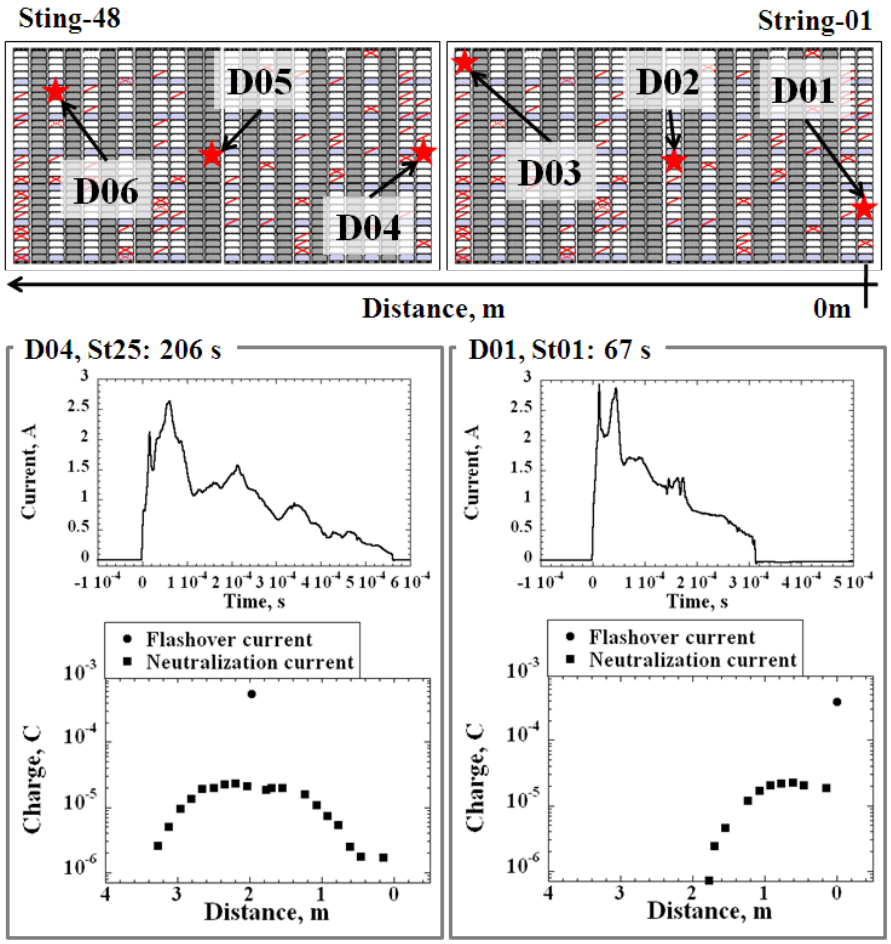
Surface potential distribution



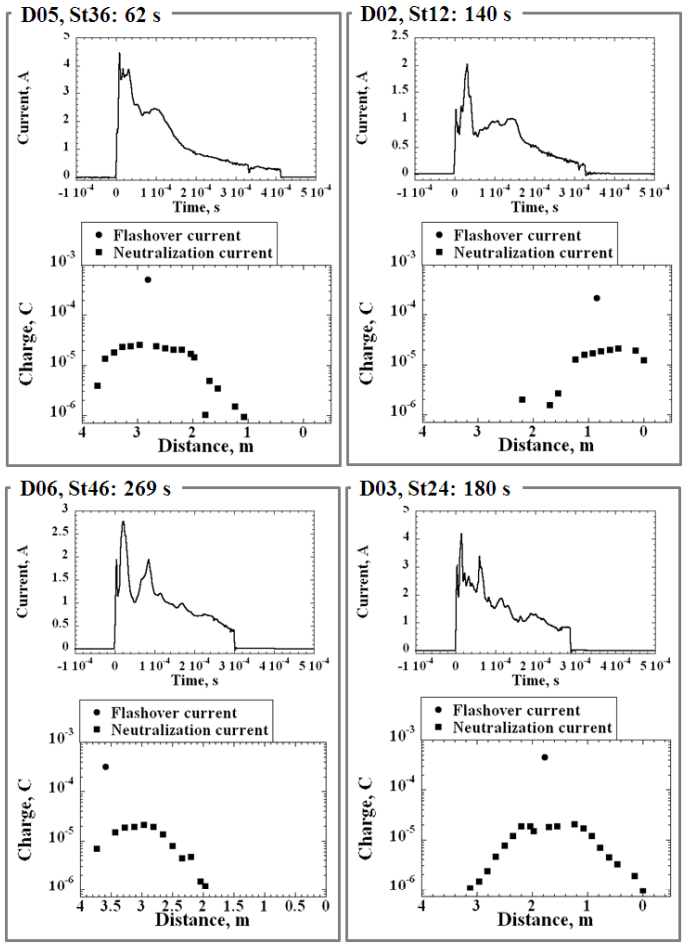
Surface potential profile



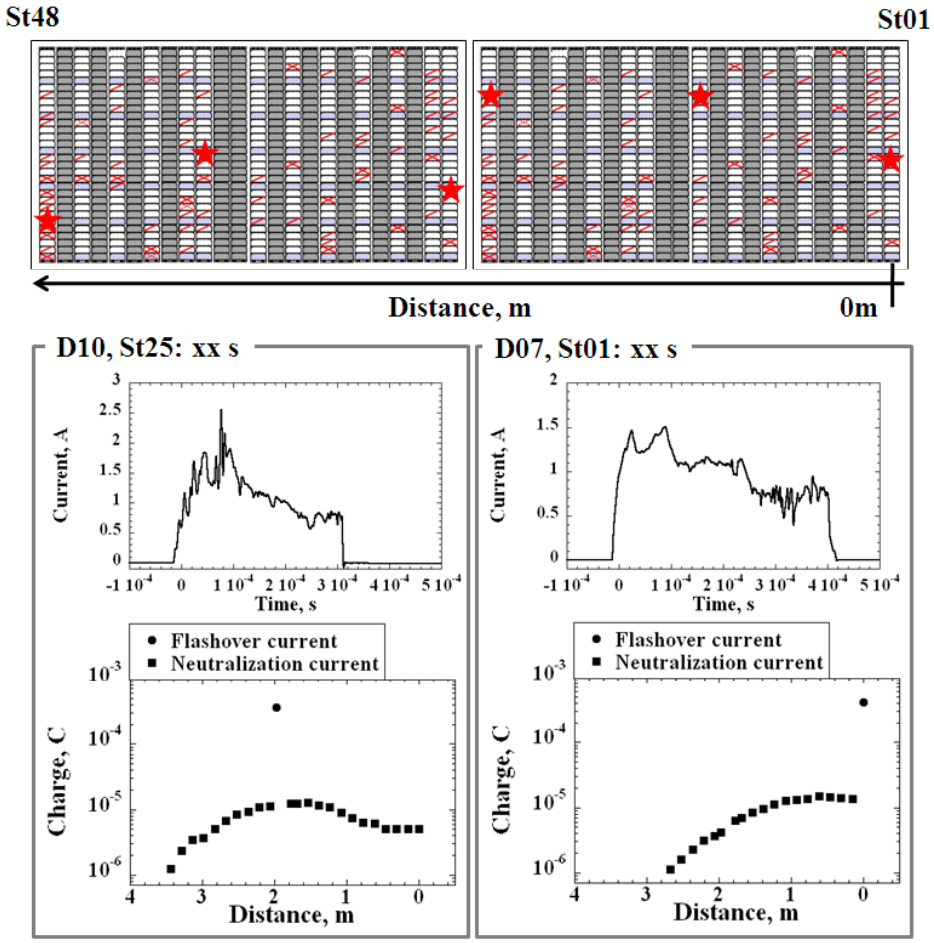
No36


Sting-48
String-01
D05
D06
D04
D02
D01
D03
Distance, m
0m
D04, St25: 206 s
D01, St01: 67 s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m

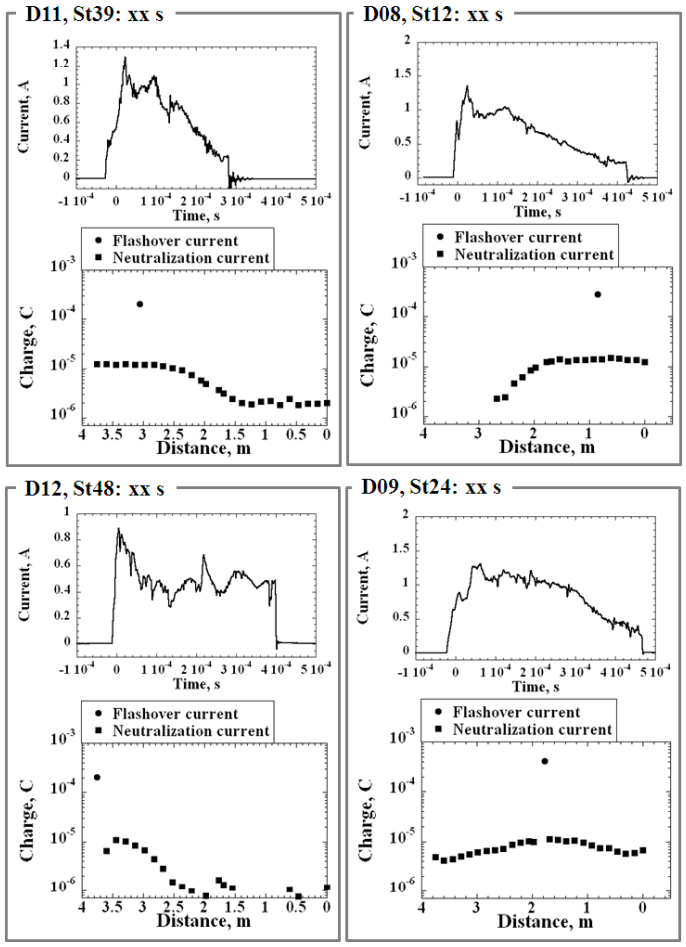
No37


D05, St36: 62 s
D02, St12: 140 s
D06, St46: 269 s
D03, St24: 180 s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m

No38


St48
St01
Distance, m
0m
D10, St25: xx s
D07, St01: xx s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m

No39


D11, St39: xx s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m
D08, St12: xx s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m
D12, St48: xx s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m
D09, St24: xx s
Current, A
Time, s
Flashover current
Neutralization current
Charge, C
Distance, m