

IRRADIATION TESTS FOR LVPS AT UPPSALA

October 24-28 2005

B.Allongue (PH / ESS)

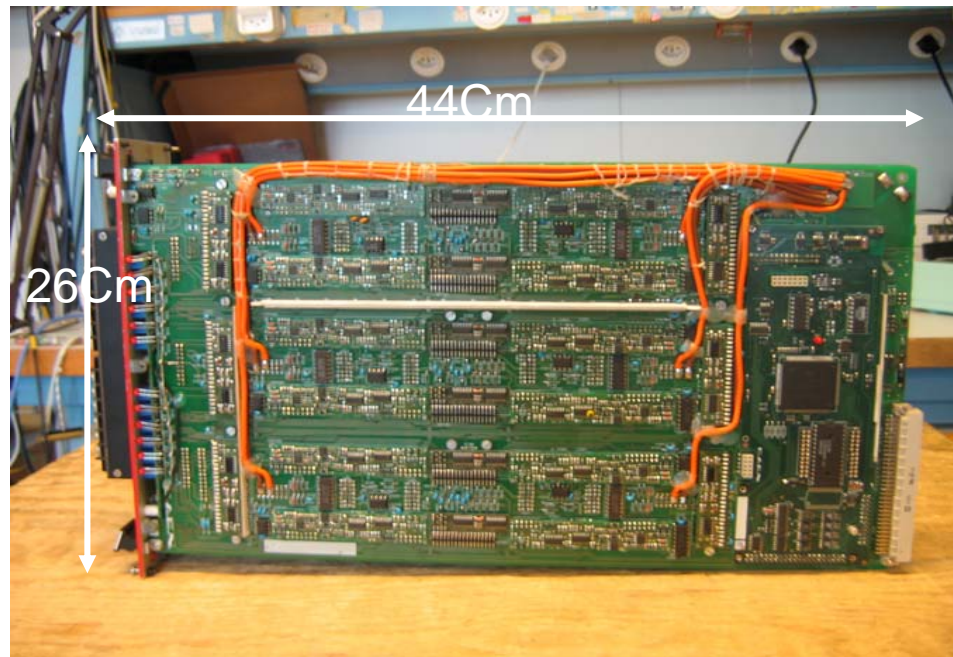
F.Anghinolfi (PH / MIC)

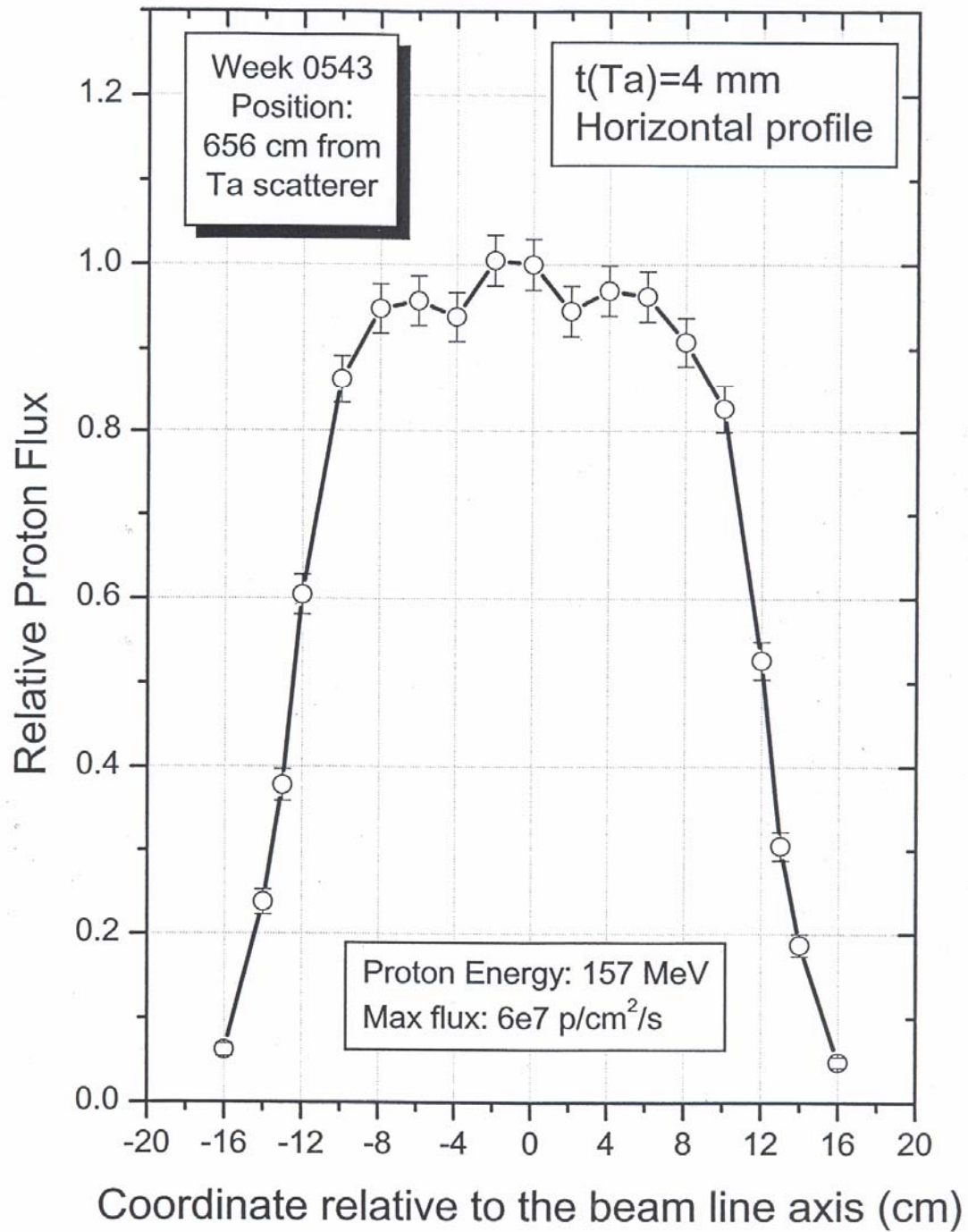
P.Fontaine (PH / ESS)

- Why Uppsala ?
- Specifications
- Samples tested
- Test set-up
- Test results
- Conclusion

Why Uppsala?

- Need a beam to irradiate large power modules.





Why Uppsala? Cont.

- The facility is called TSL:
The Svedberg Laboratory.
- Located in the University of Uppsala.

Specifications

- Specification “A”
 - Total Ionising Dose
 - 140 Gy over 10 years
 - Neutrons
 - 10^{12} 1MeV equivalent neutrons/cm² over 10 years
 - Protons
 - $2 \cdot 10^{11}$ >20MeV protons/cm² over 10 years
- Specification “B”
 - Radiation is present at a level below 4 Gy and 10^{11} 1 MeV equivalent neutrons/cm² over 10 years, of which approximately 10% are above 20MeV

Samples tested

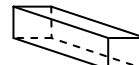
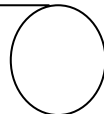
- Wiener Maraton:
 - 12 channels 2-8V / 50A / 300W (Air cooled, no magnetic shielding).
 - 2 channels extracted for test.
- CAEN Easy:
 - A3009: 12 channels 2-8V / 9A / 45W.
 - A3025: 4 channels 2-8V / 25A / 150W.
 - A3016: 6 channels 2-8V / 16A / 90W.
 - A3486: 2 channels 48V / 40A / 2000W (1 channel tested).

Test set up

- Wiener Maraton:
 - AC/DC/PFC located in the hostile area but behind shielding.
 - Control and Monitoring boards located in the counting room.
 - Power modules located within the beam.
- CAEN Easy:
 - SY2527 located in the counting room for control and monitoring.
 - Power modules located within the beam.

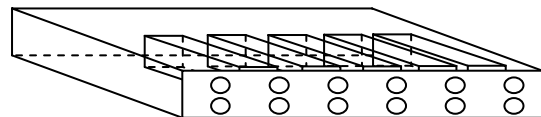
Hostile area

Beam



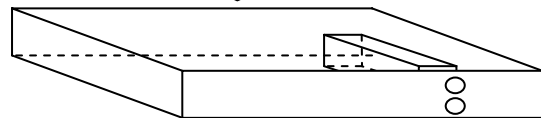
Power modules

Concrete blocks



385VDC

Power modules chassis



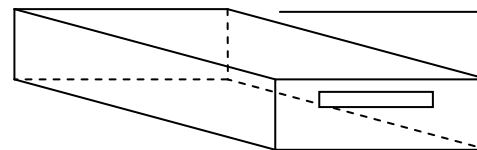
AC input

PFC chassis

Monitoring and control

Monitoring and control

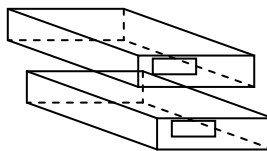
Power



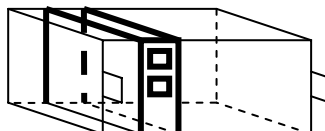
Electronic load

Patch Panel

Control room



DVM MUX



VME crate + Control and monitoring board

Voltage and current measurements

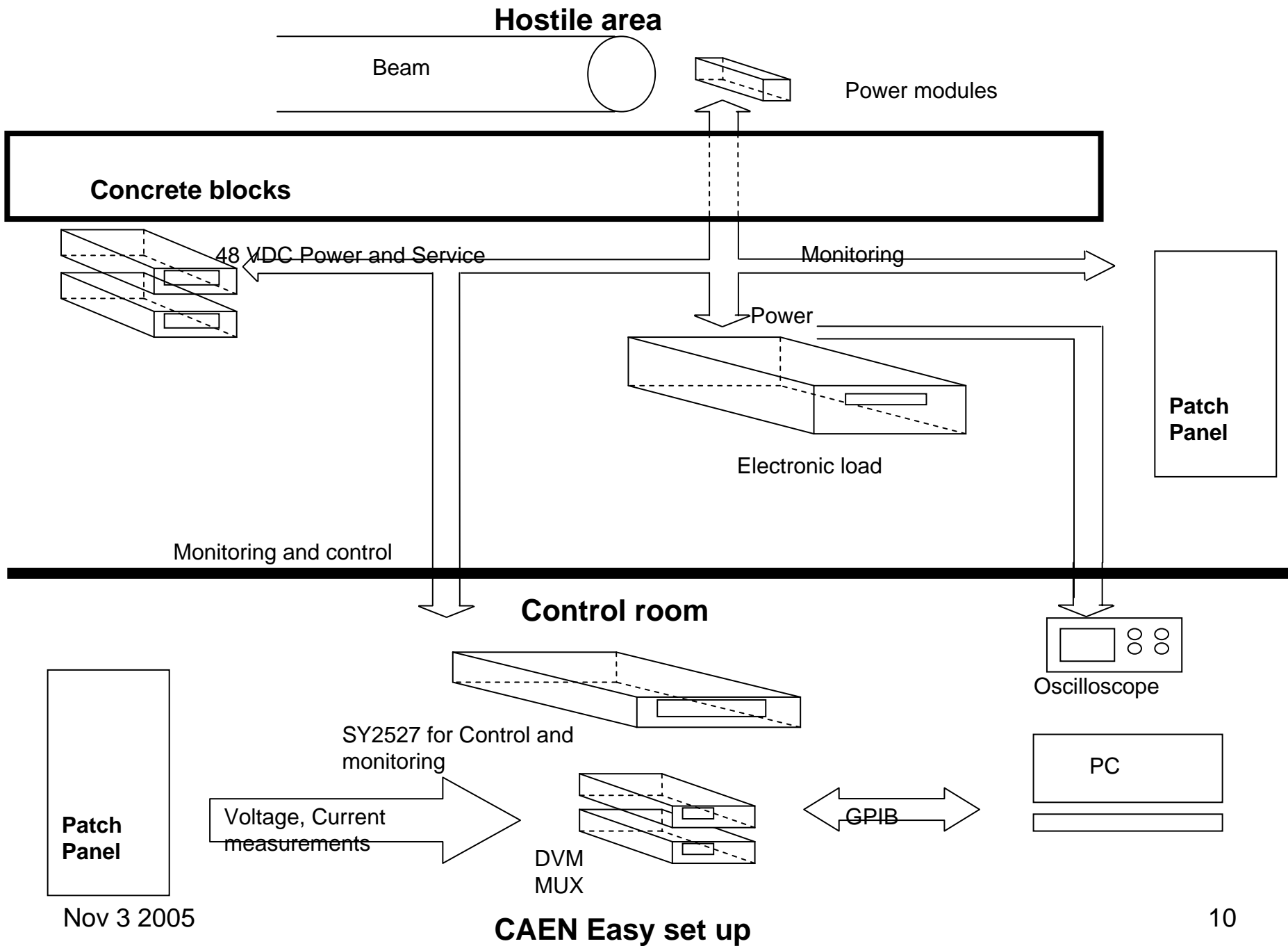
Control and monitoring

GPIB

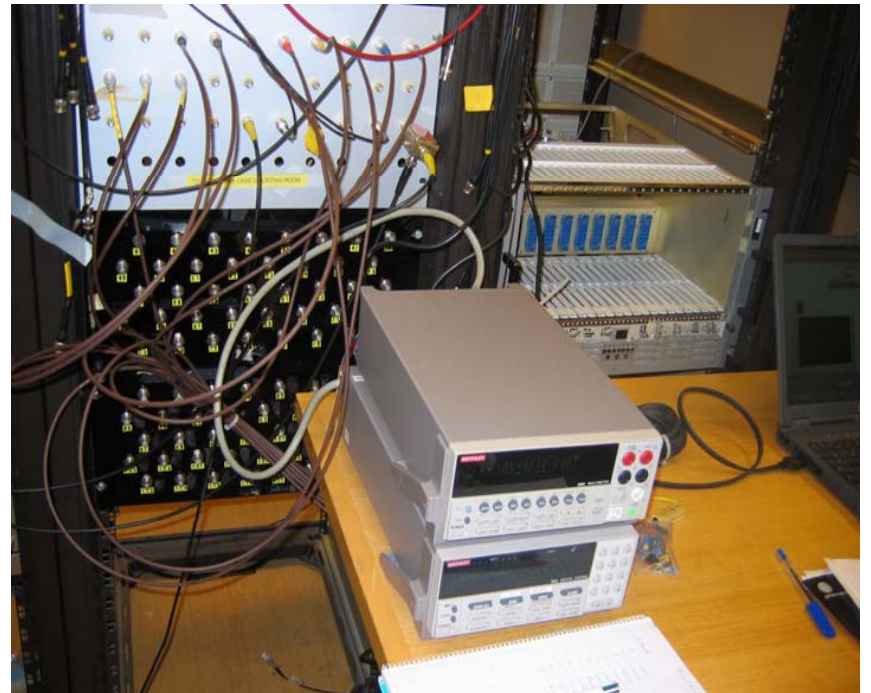
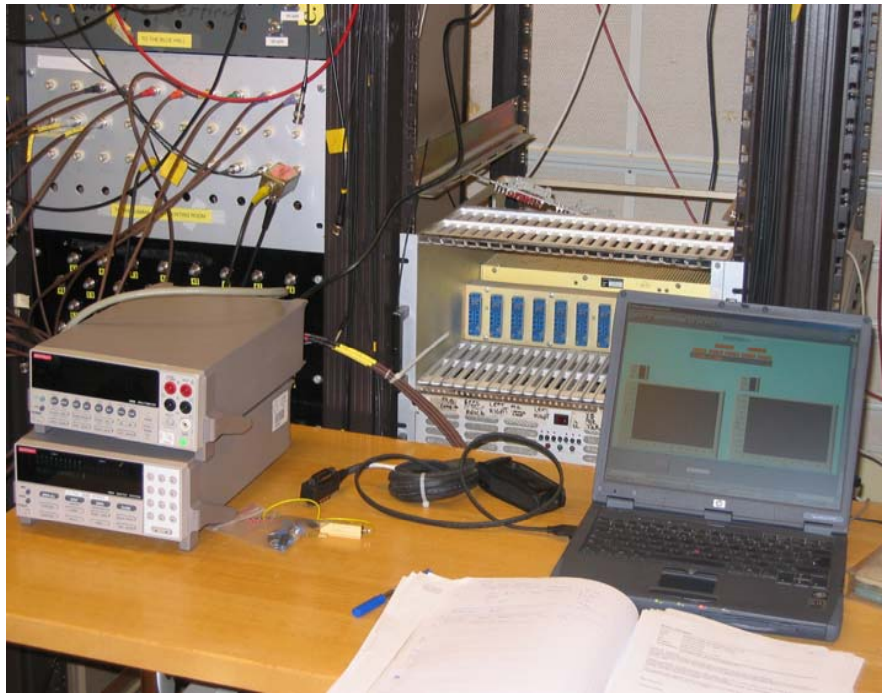
USB

Oscilloscope

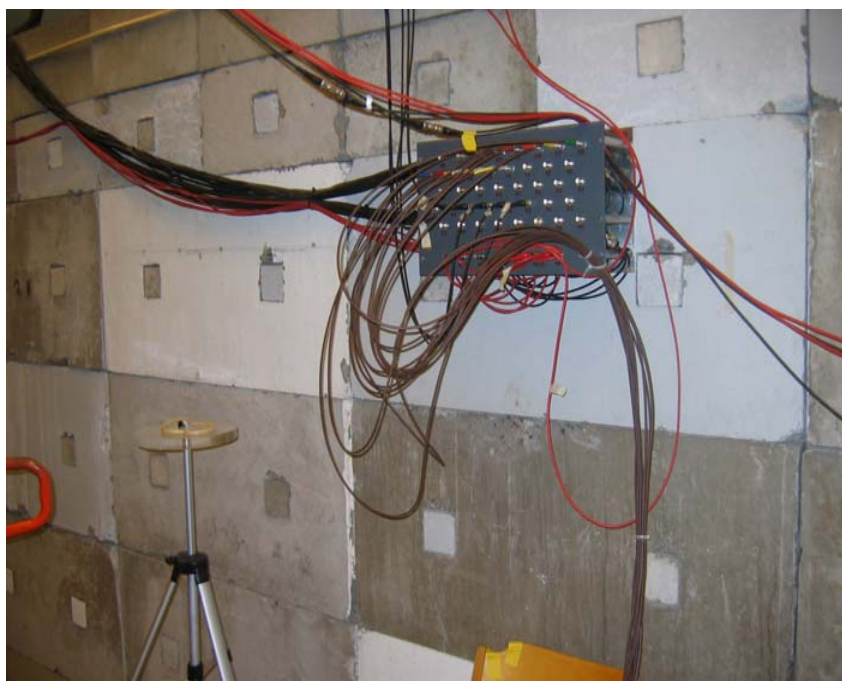
PC



Control room



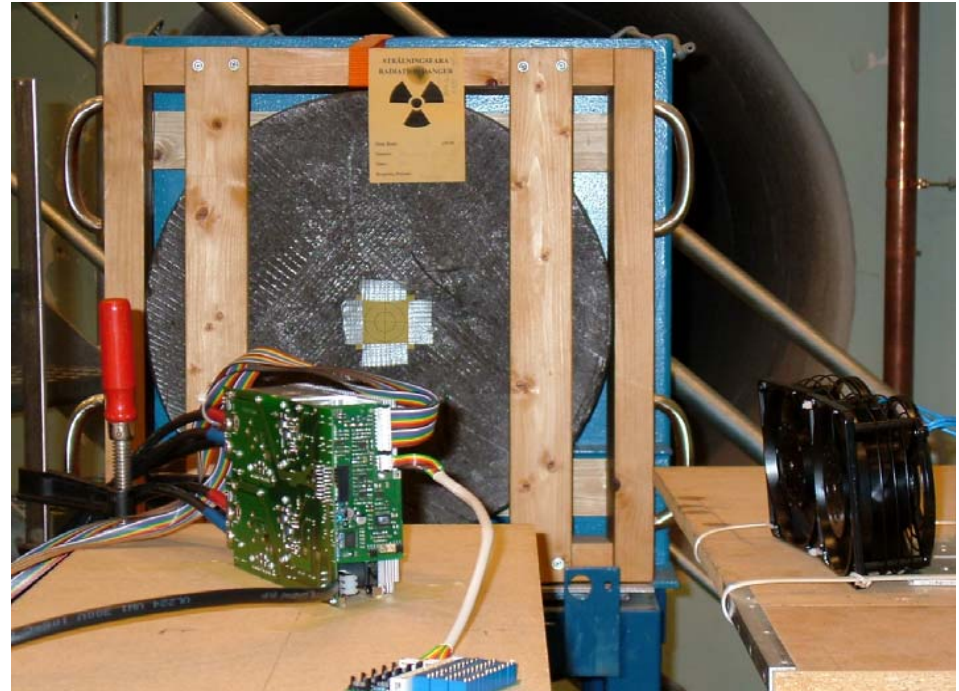
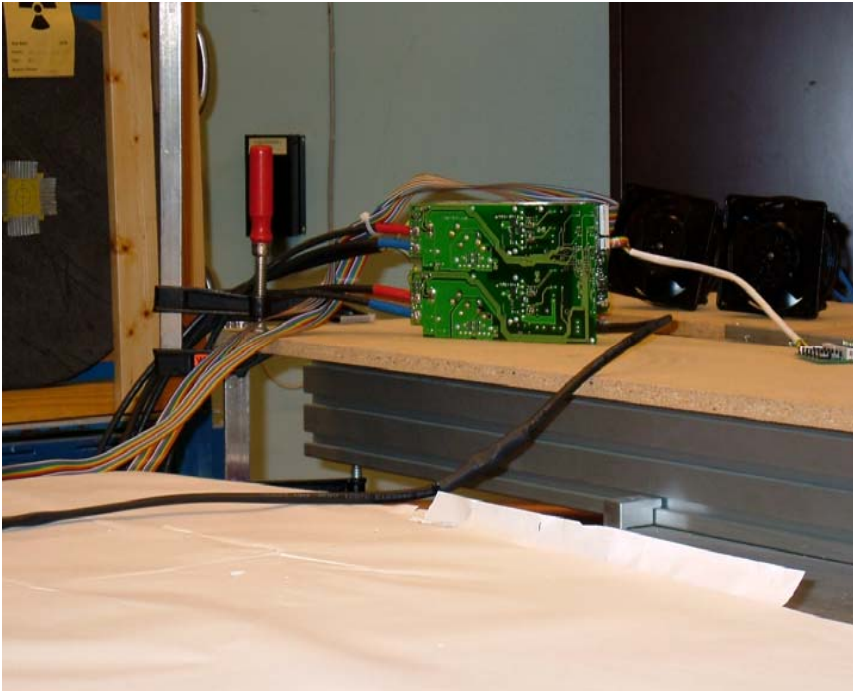
Hostile area



Tests results

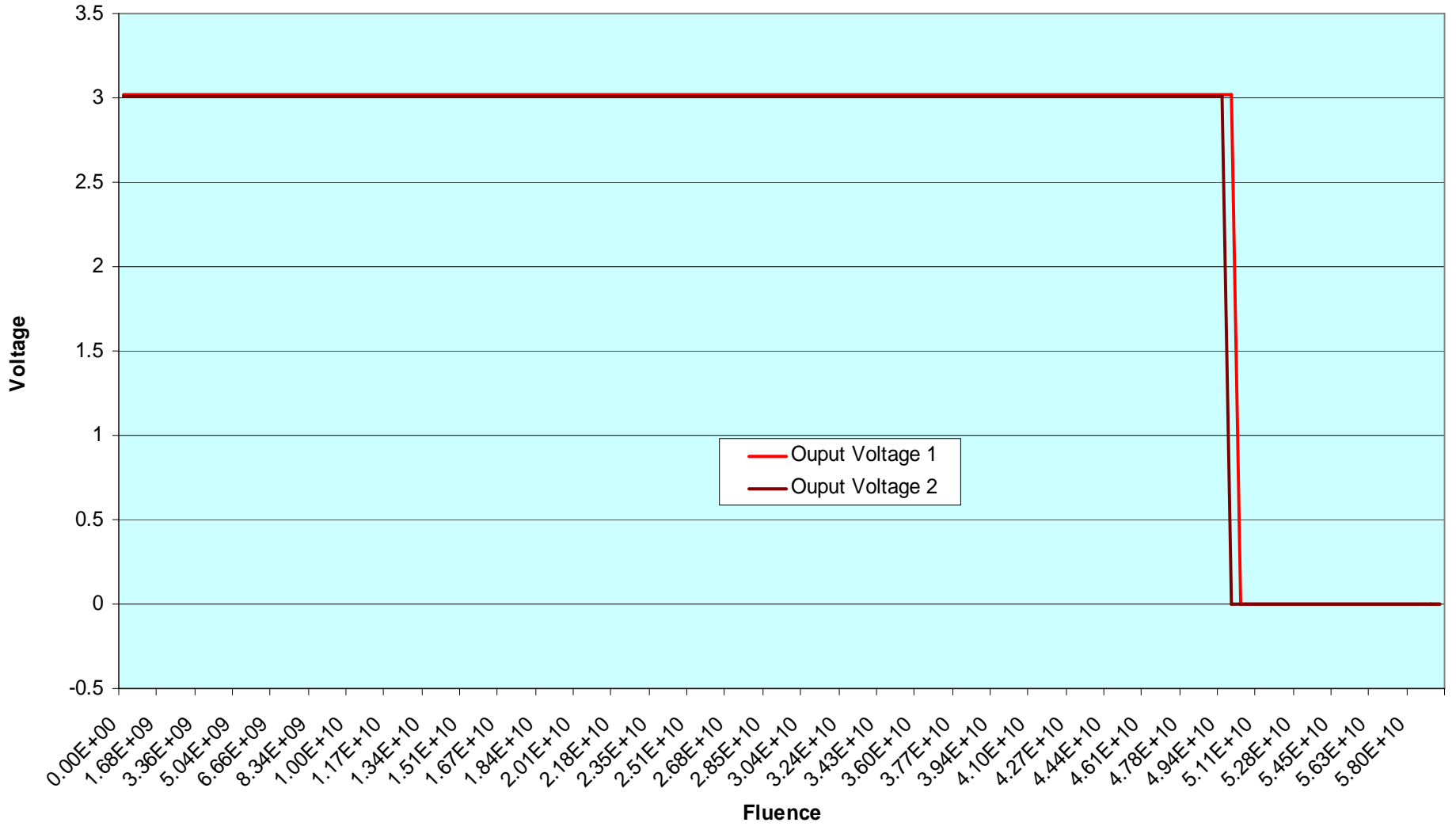
- Wiener Maraton:



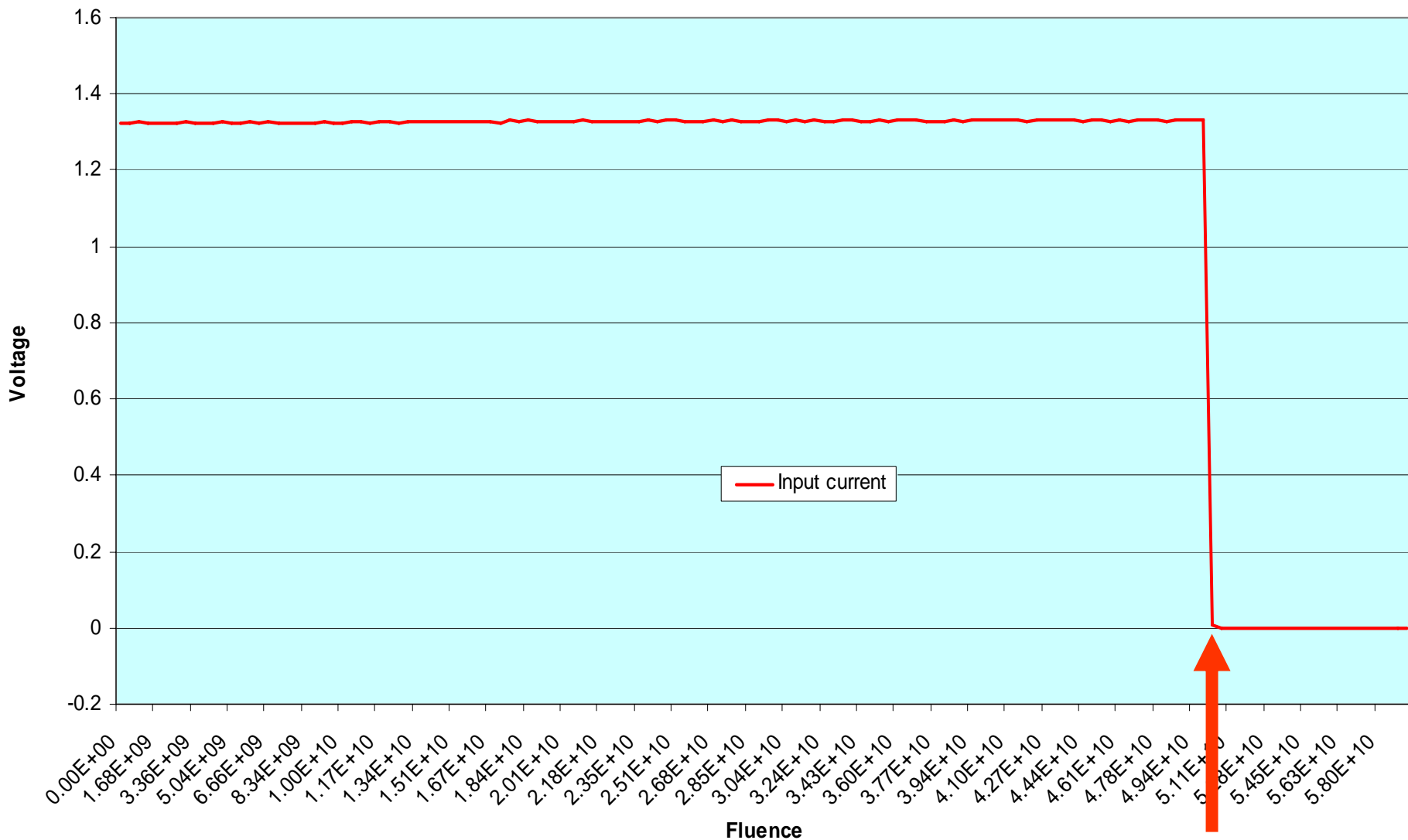


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Wiener Maraton Output voltage



Wiener Maraton DC Input current



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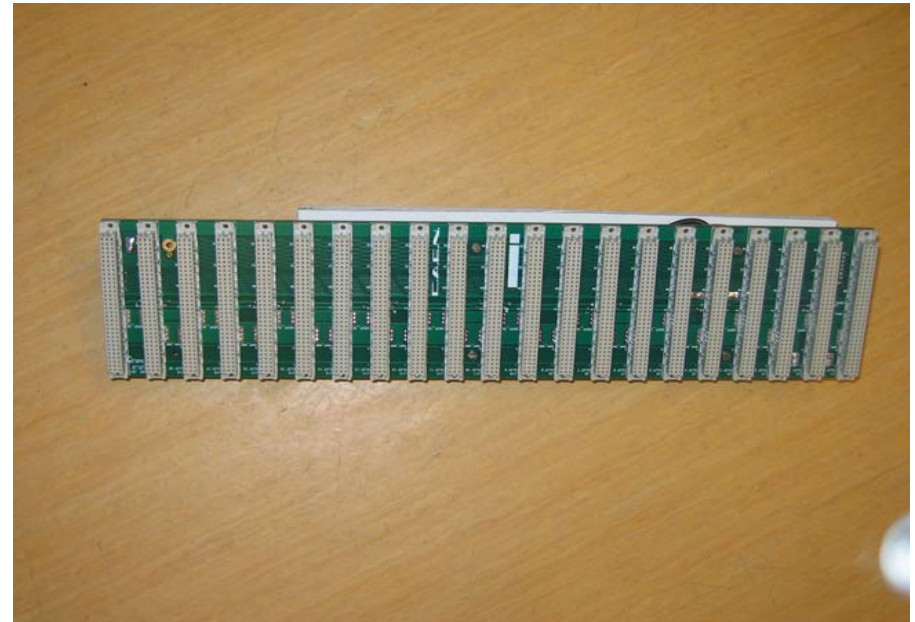
5.03 10¹⁰ p/cm²

Tests results cont.

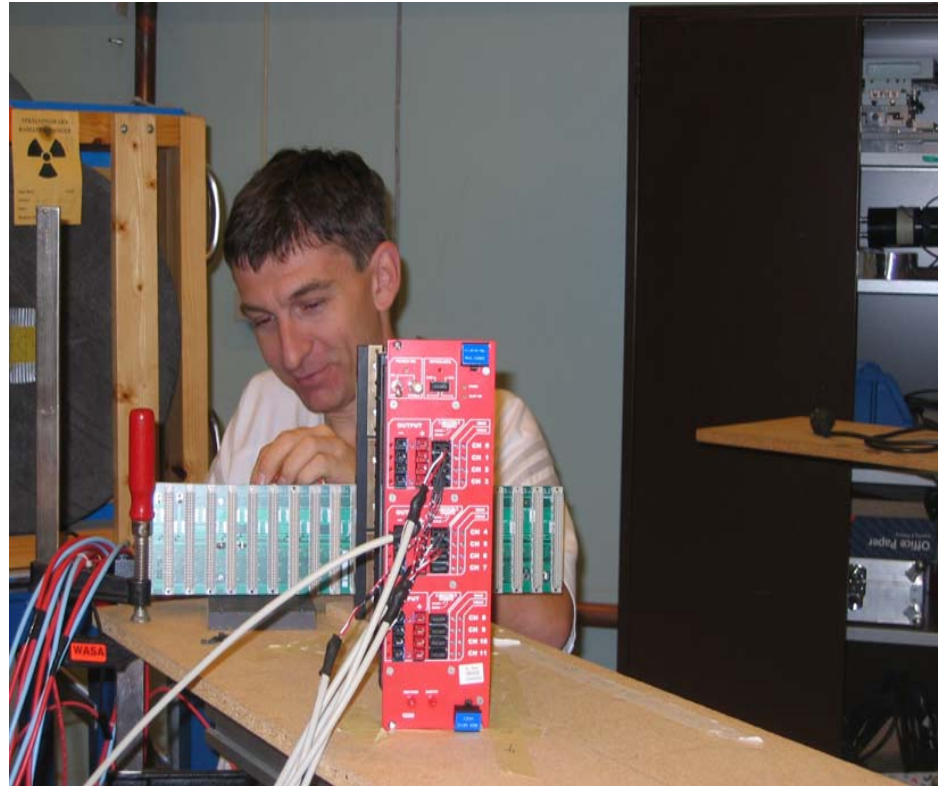
- At $5 \cdot 10^{10}$ p/cm² the fuses of the electrical distribution blew.
- Strong suspicion that the PFC module, although located behind concrete blocks failed because of radiation environment.

Tests results cont.

- CAEN Easy:



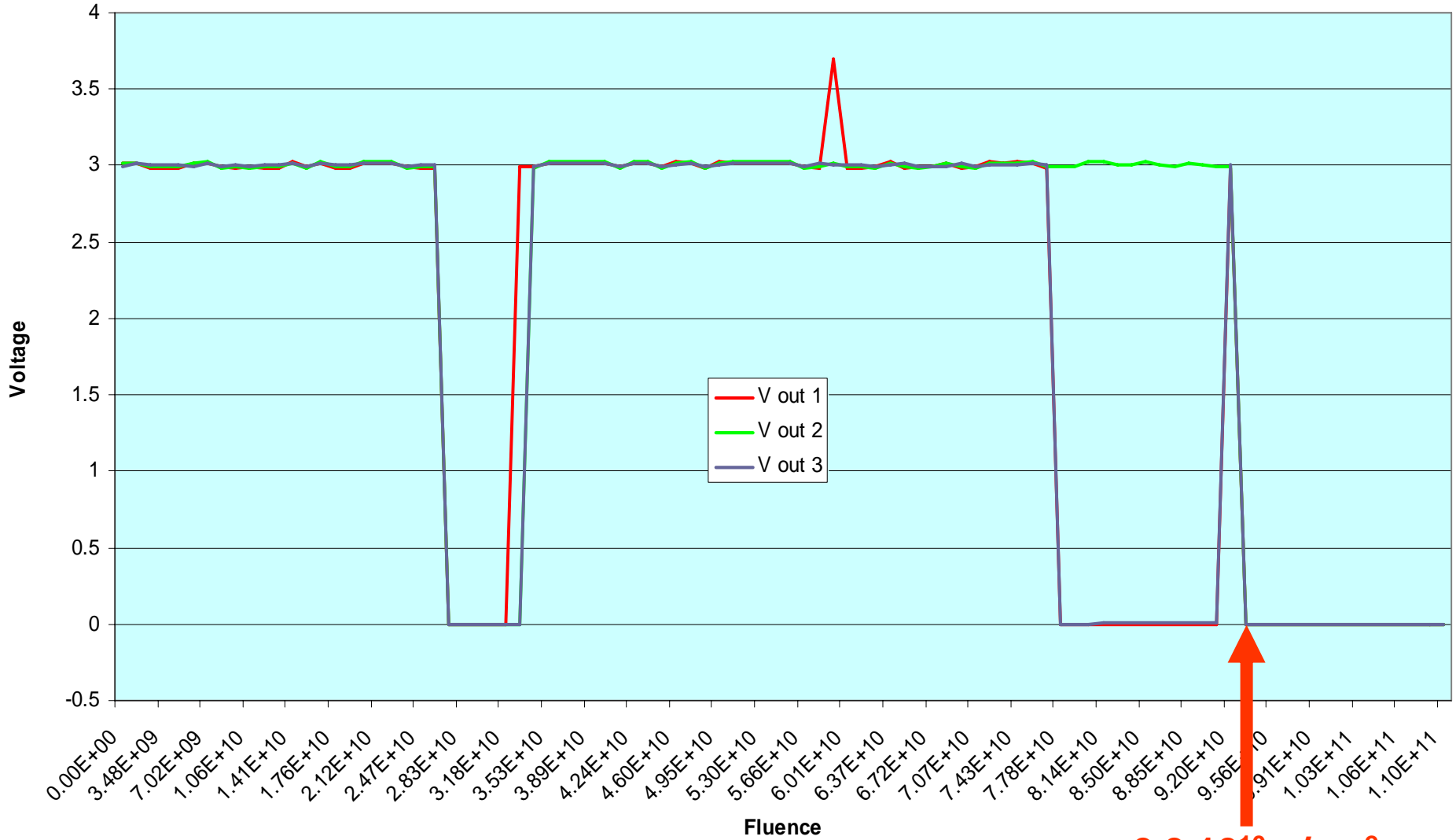
Backplane to replace Easy crate



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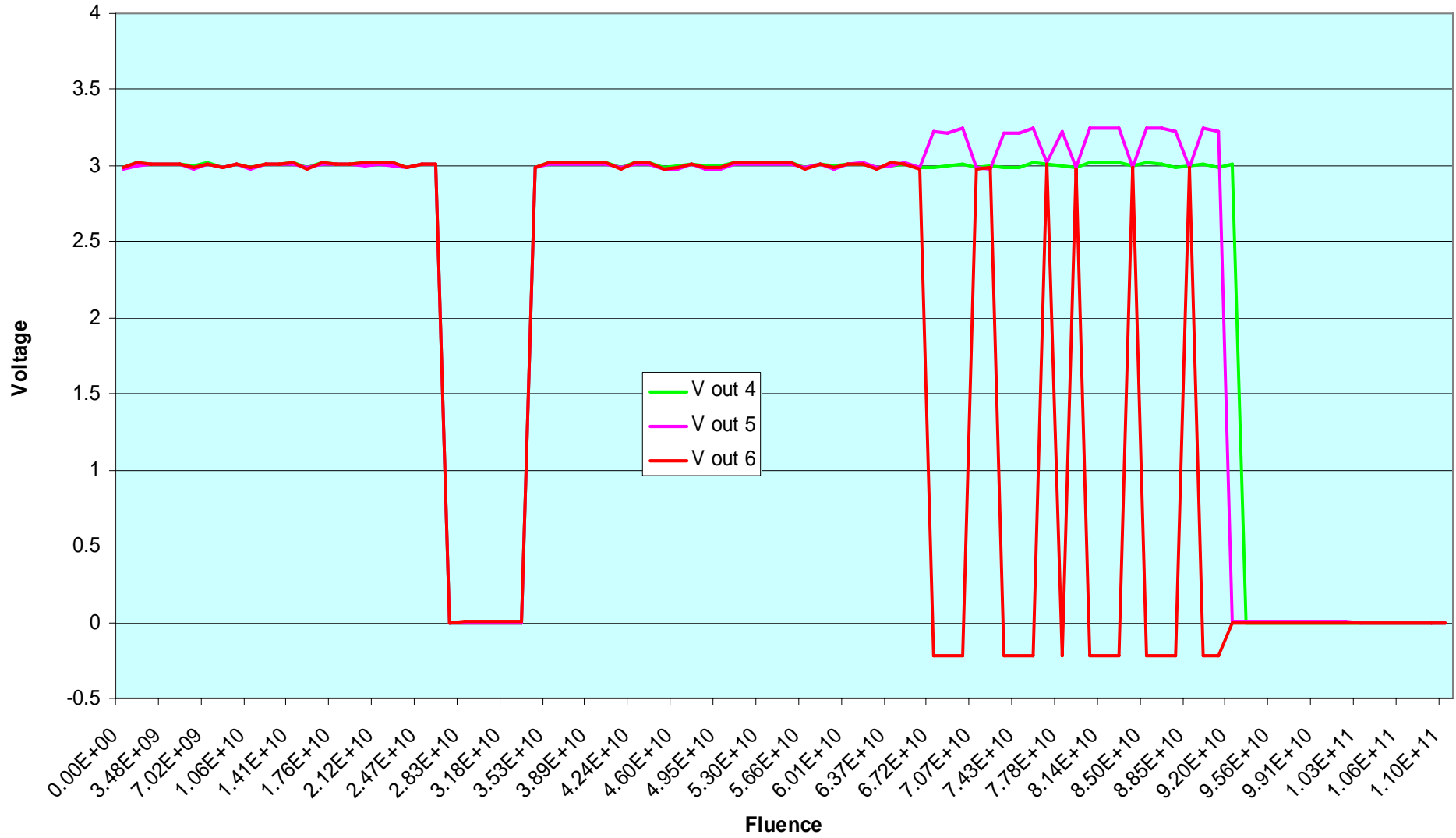
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Caen A3009 Output voltage

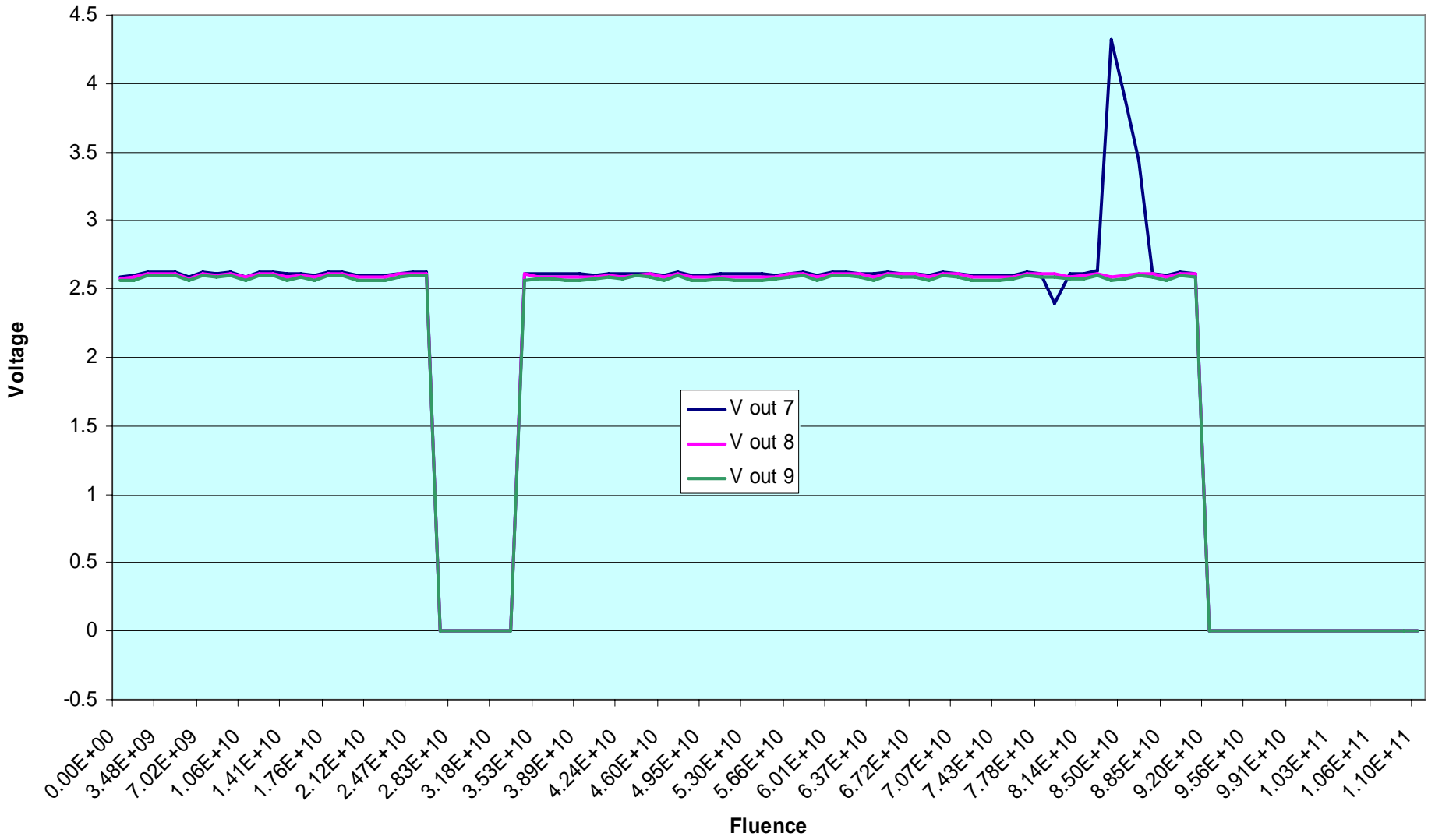


9.3 10¹⁰ p/cm²

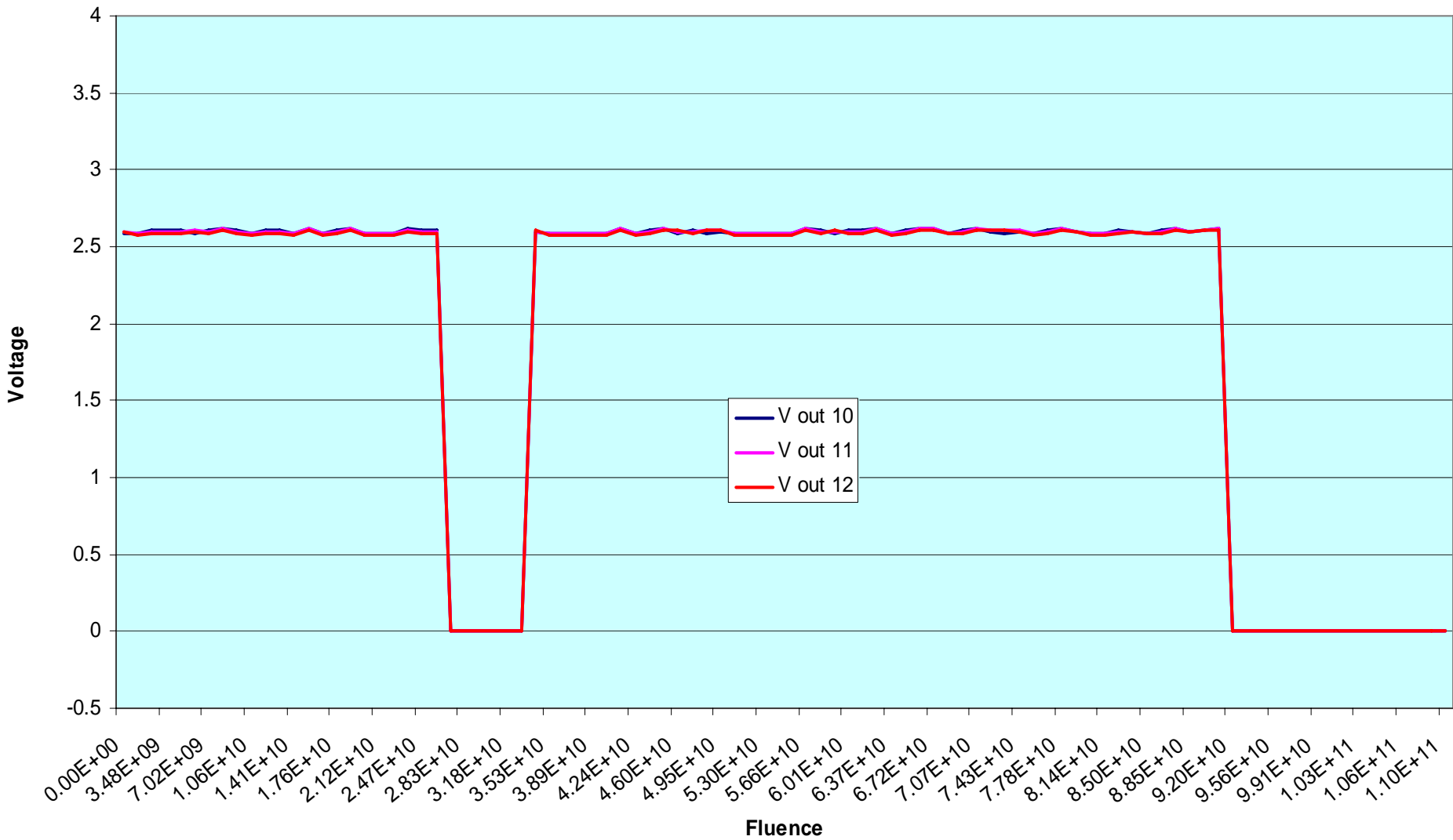
Caen A3009 Output voltage



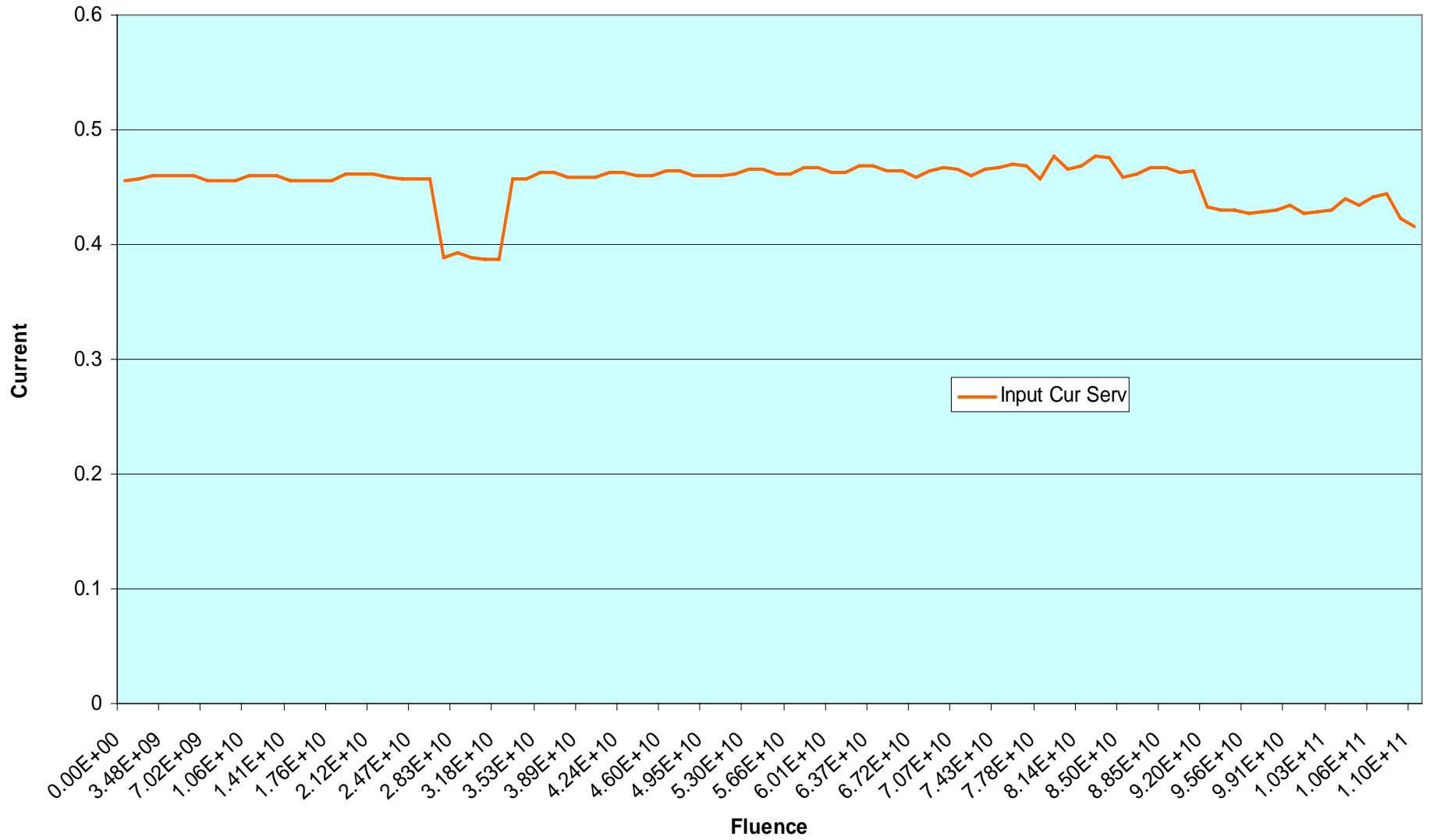
Caen A3009 Output voltage



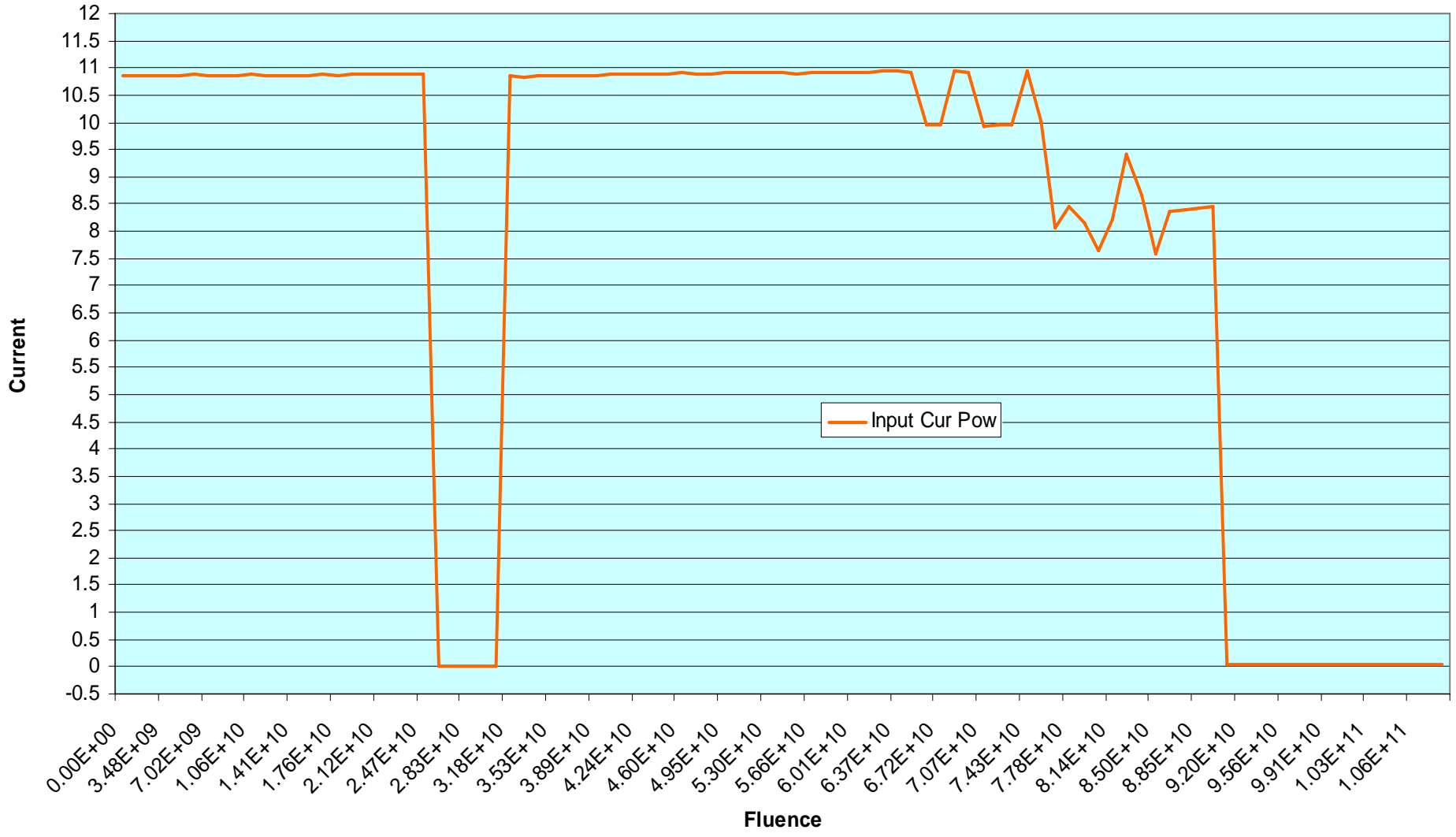
Caen A3009 Output voltage



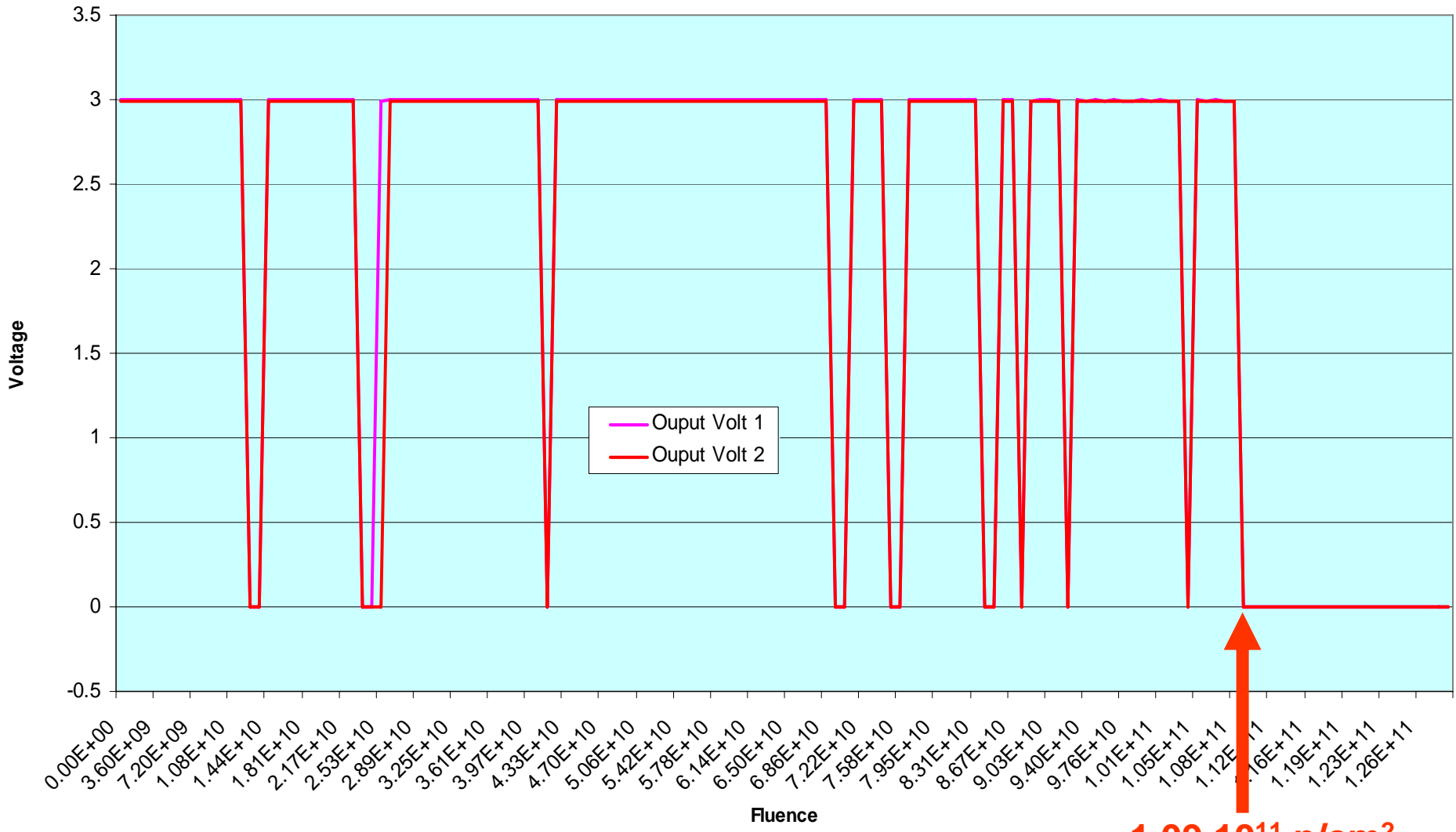
Caen A3009 Input Current Service



Caen A3009 Input current power

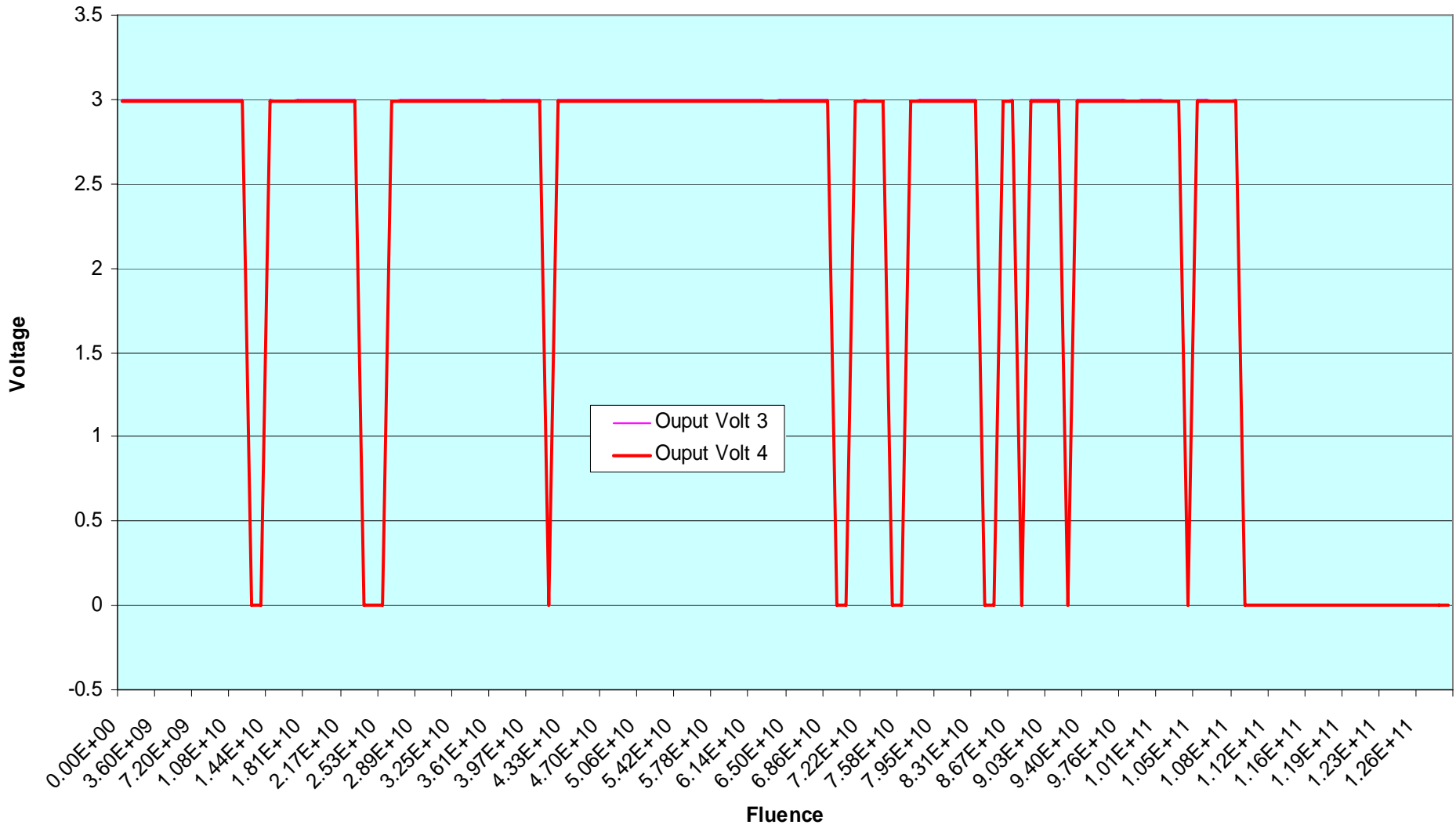


CAEN A3025 Output voltage

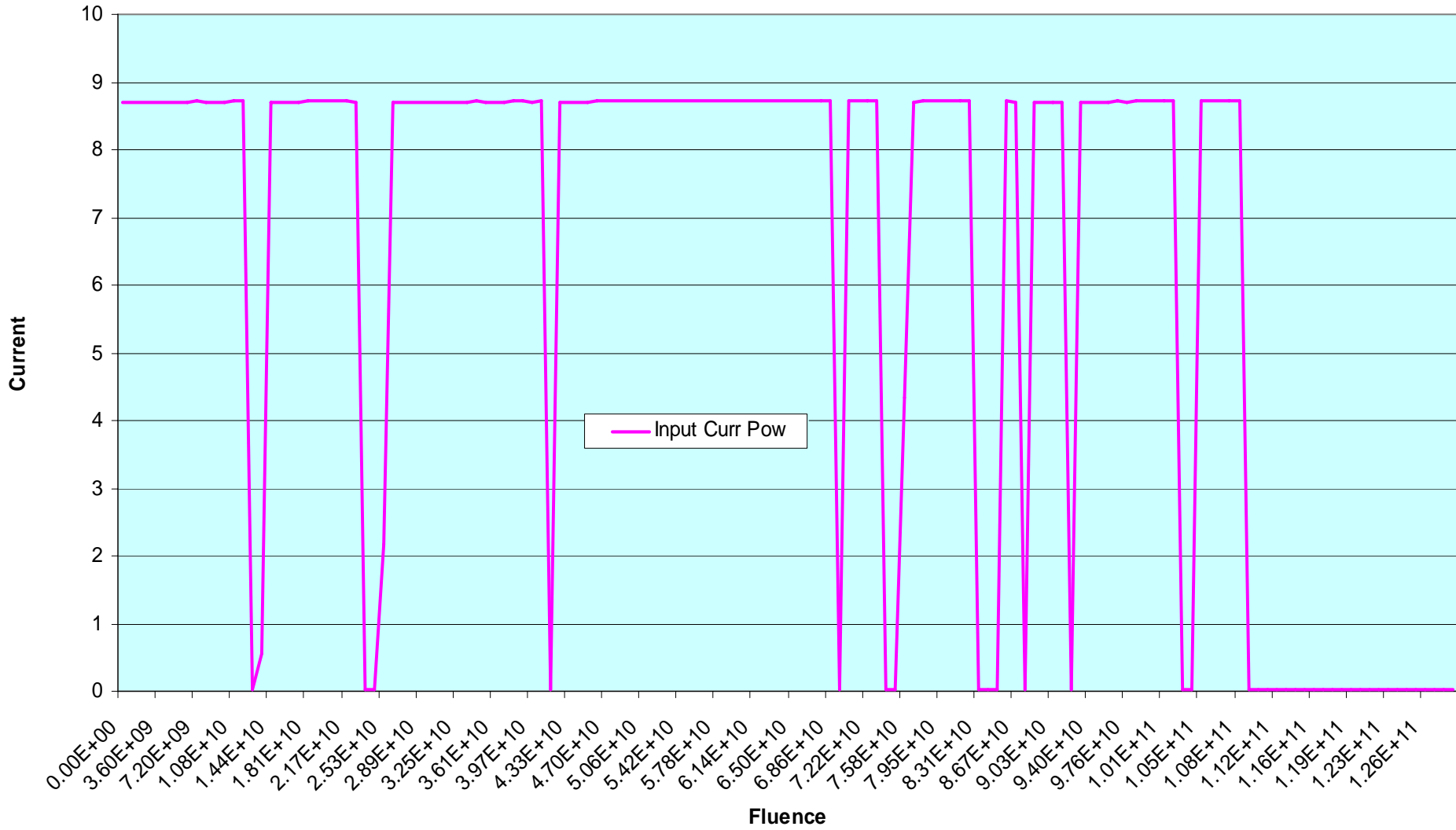


1.09 10¹¹ p/cm²

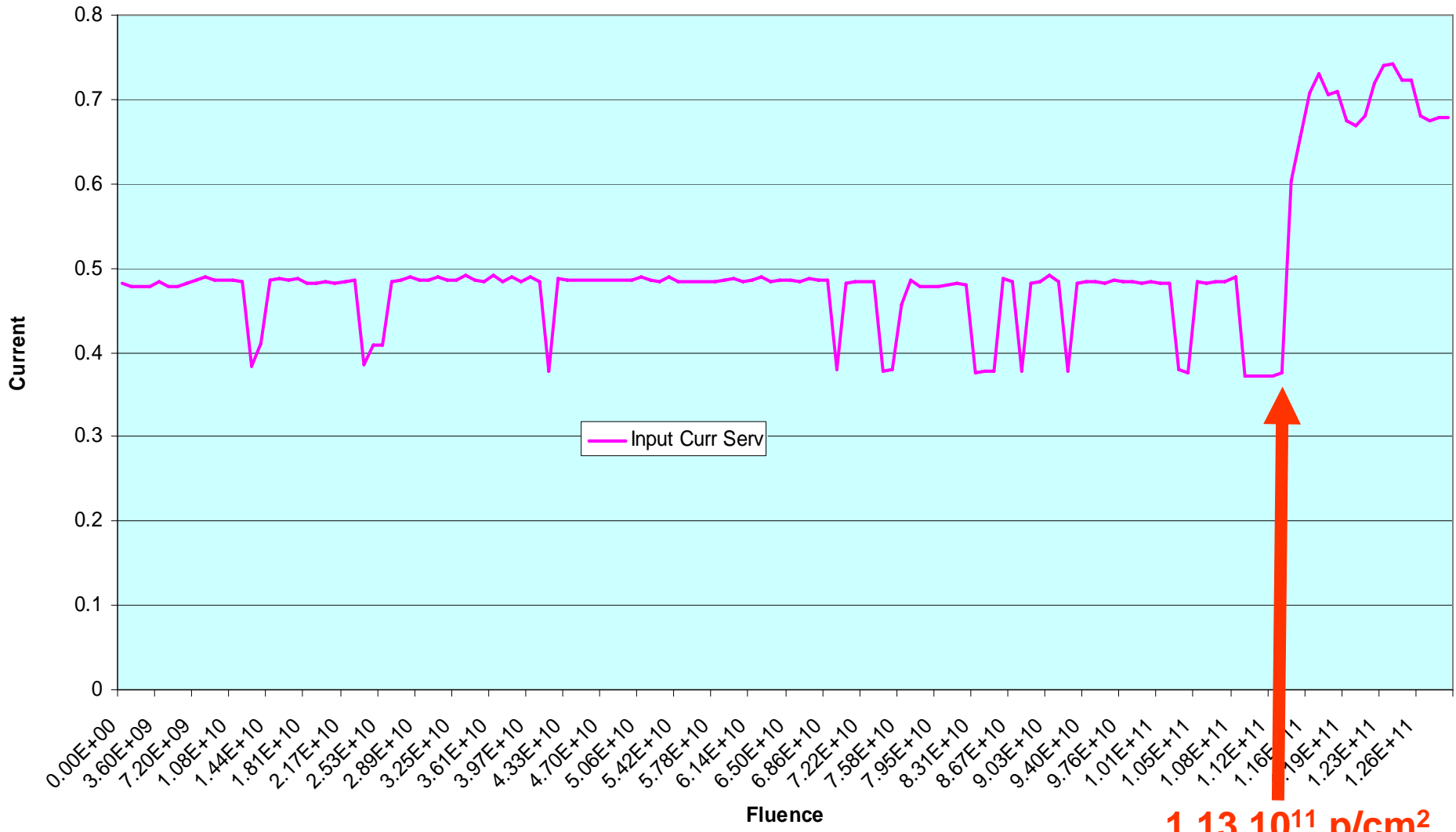
CAEN A3025 Ouput voltage



CAEN A3025 Input Current Power



CAEN A3025 Input Current Service



1.13 10¹¹ p/cm²

A 3486

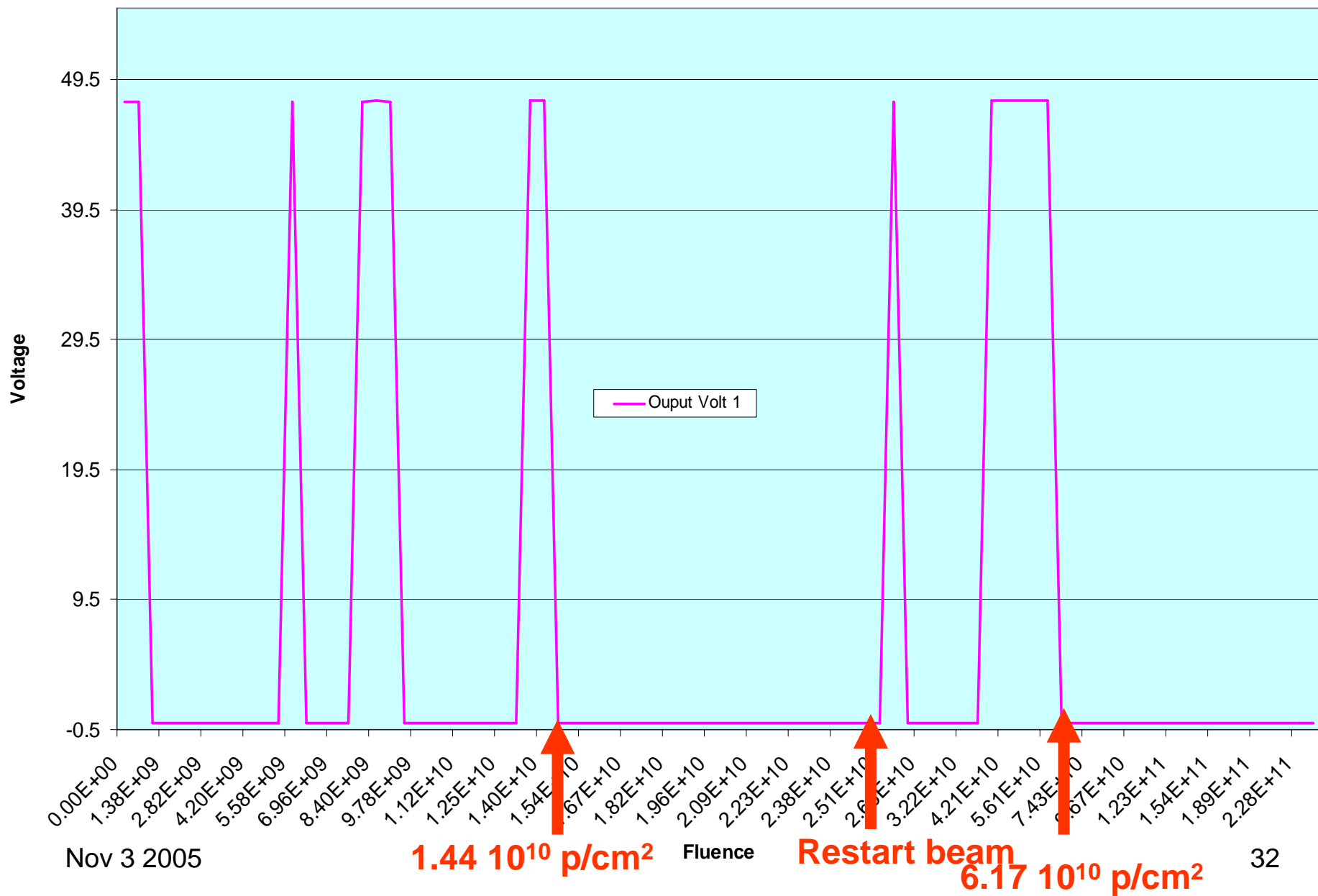


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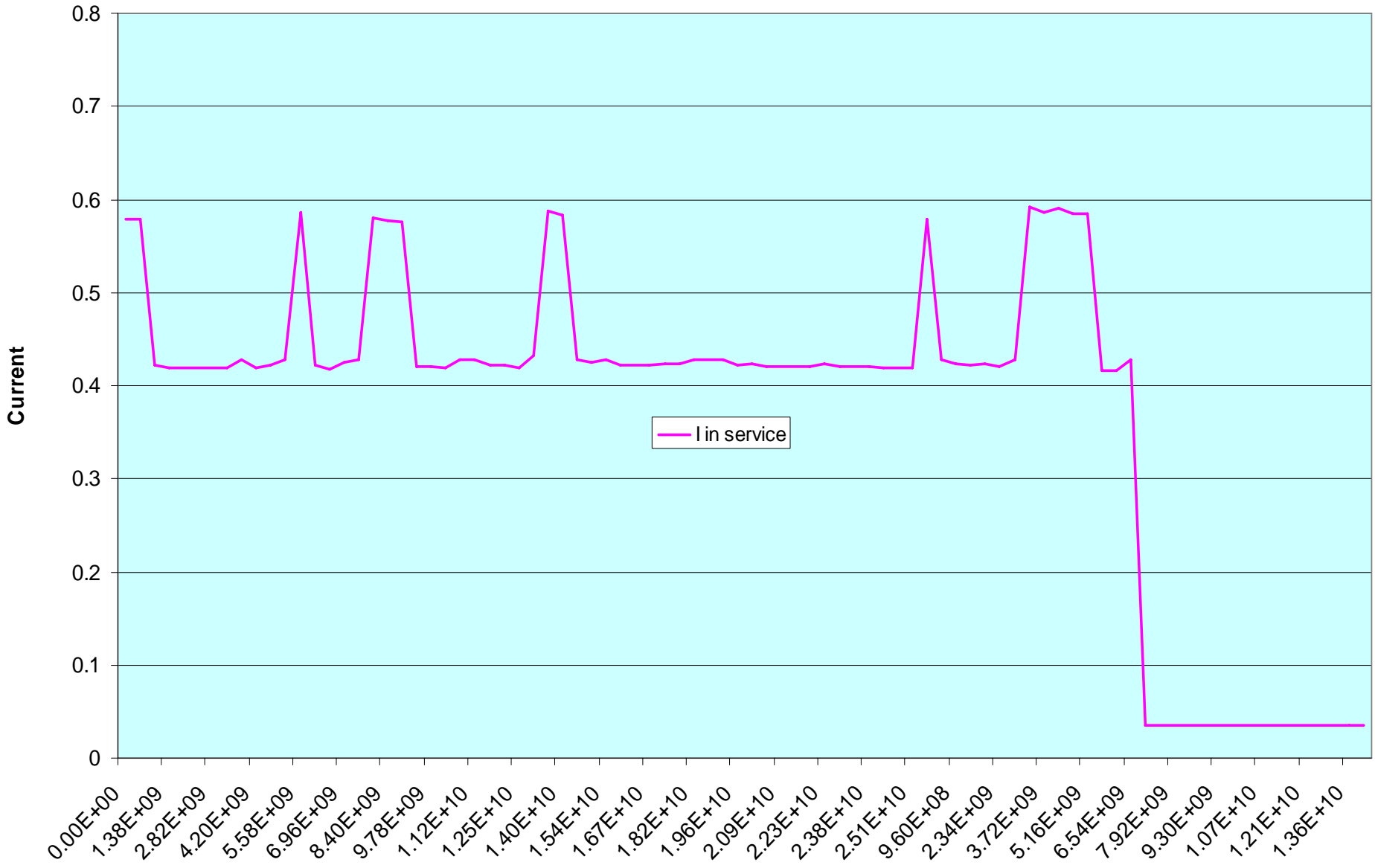
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- Test in 2 parts:
 - First part up to $2.5 \cdot 10^{10}$ p.cm².
 - Stop proton beam for therapy.
 - Restart proton beam.

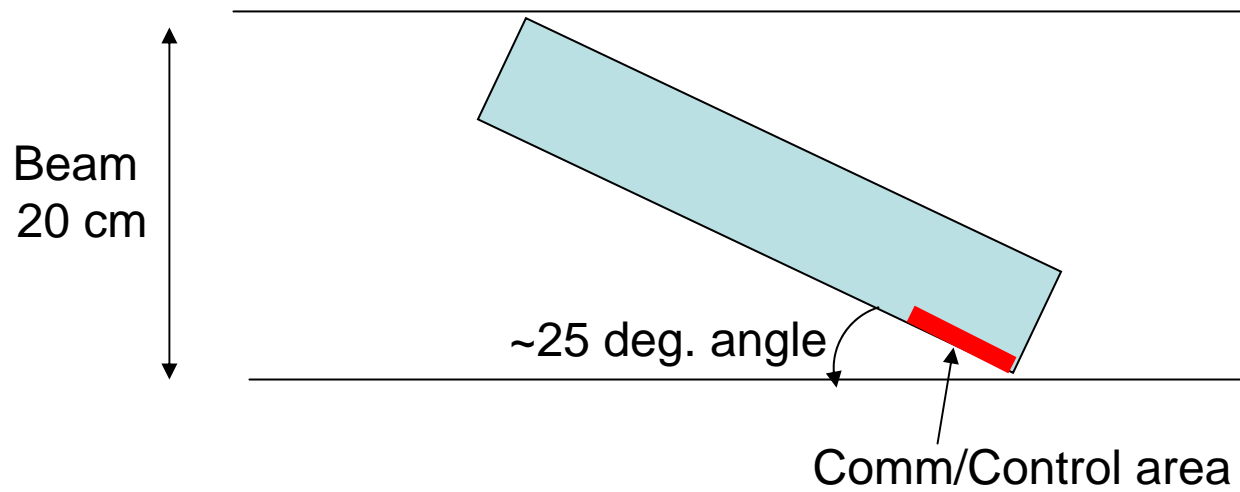
CAEN A3486 Output voltage



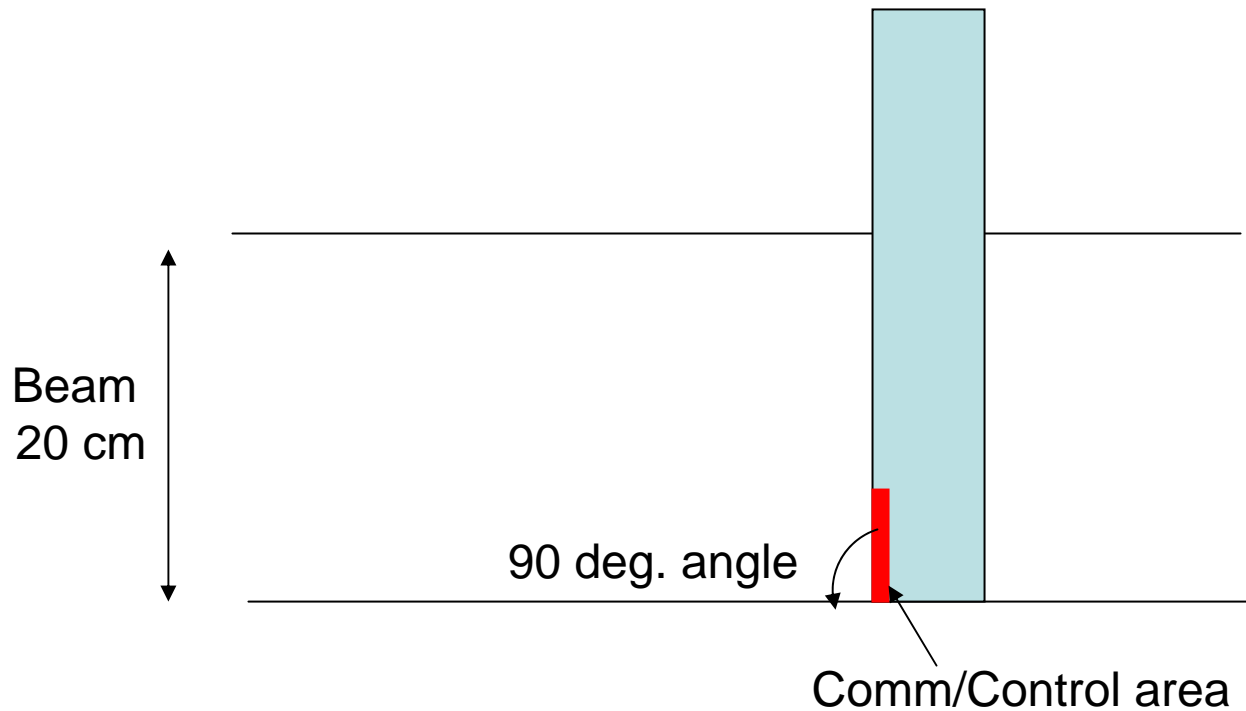
CAEN A3486 Input current service



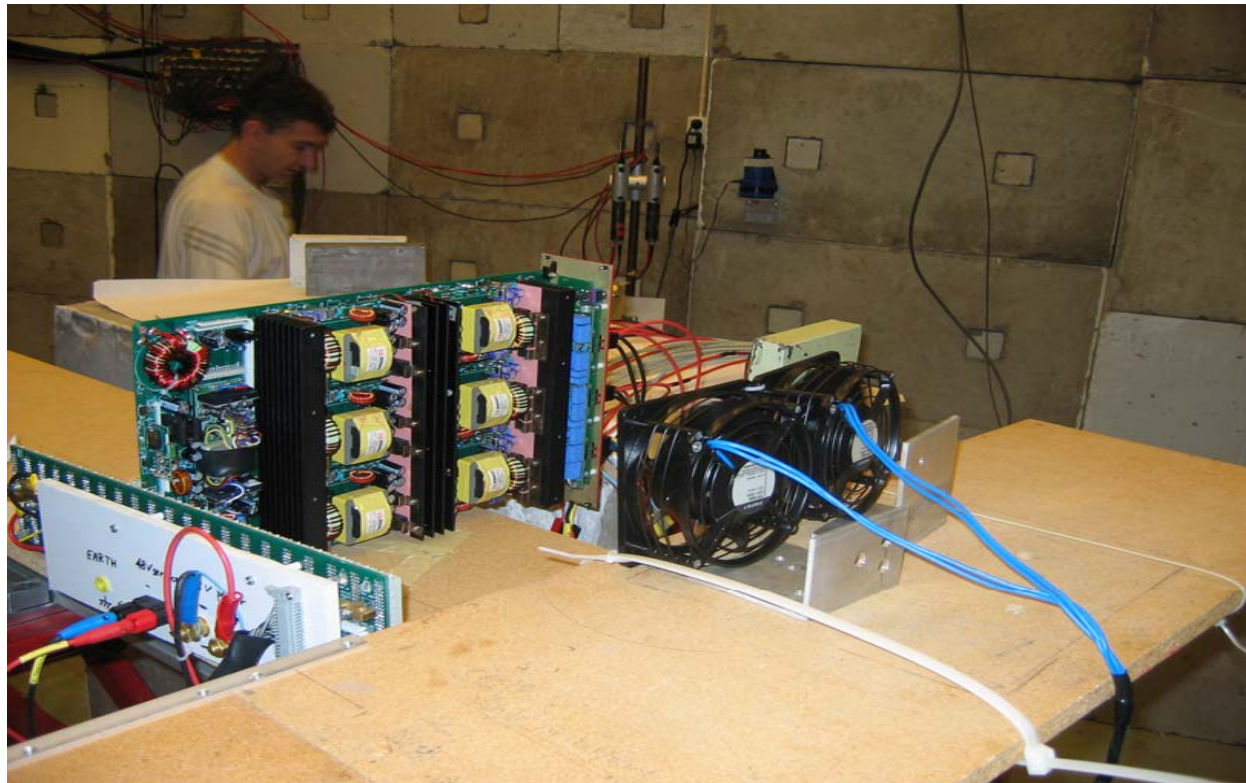
Irradiation Condition for 3009/3025



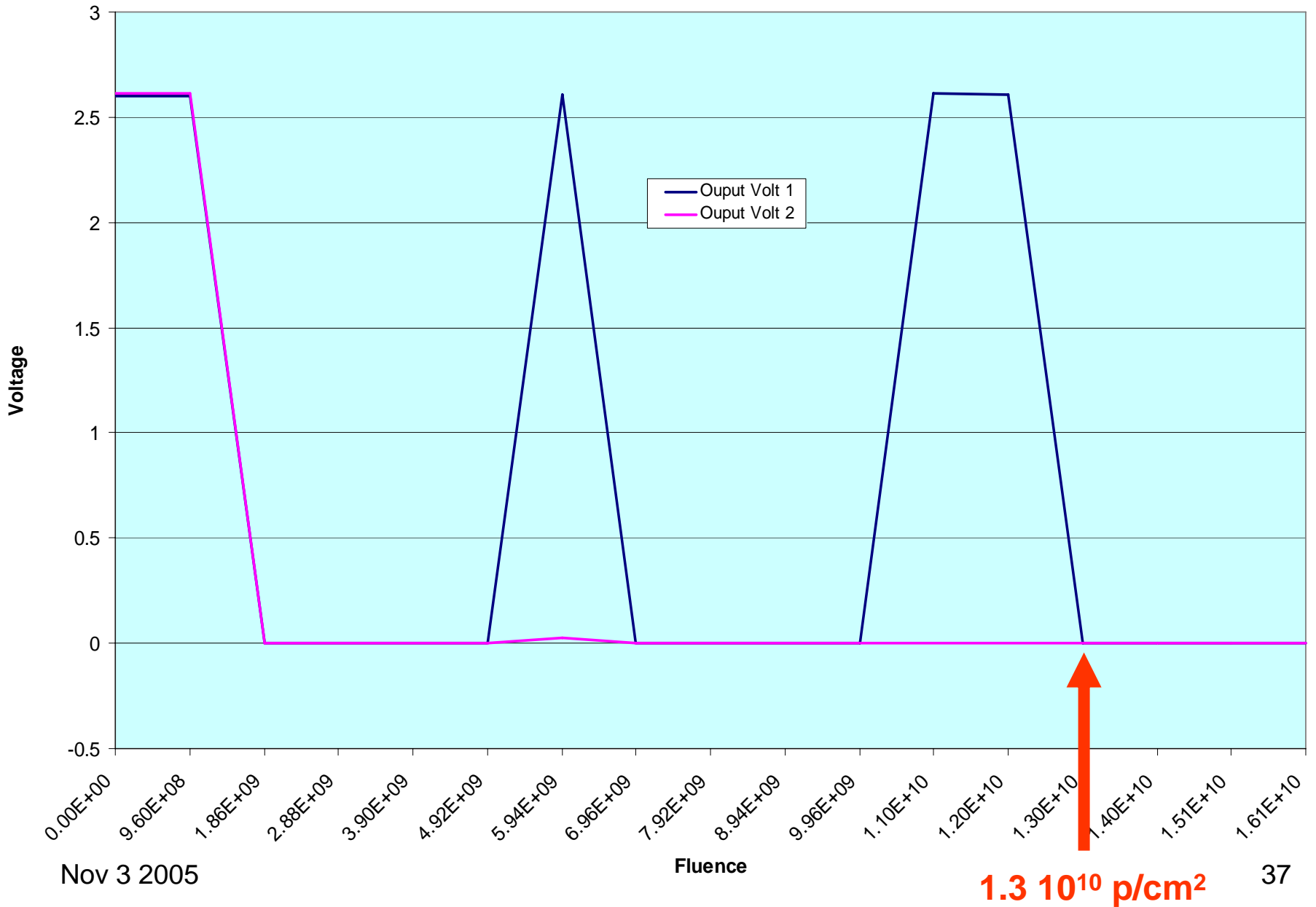
Irradiation Condition for 3016/3486



A3016



CAEN A3016 Output Voltage



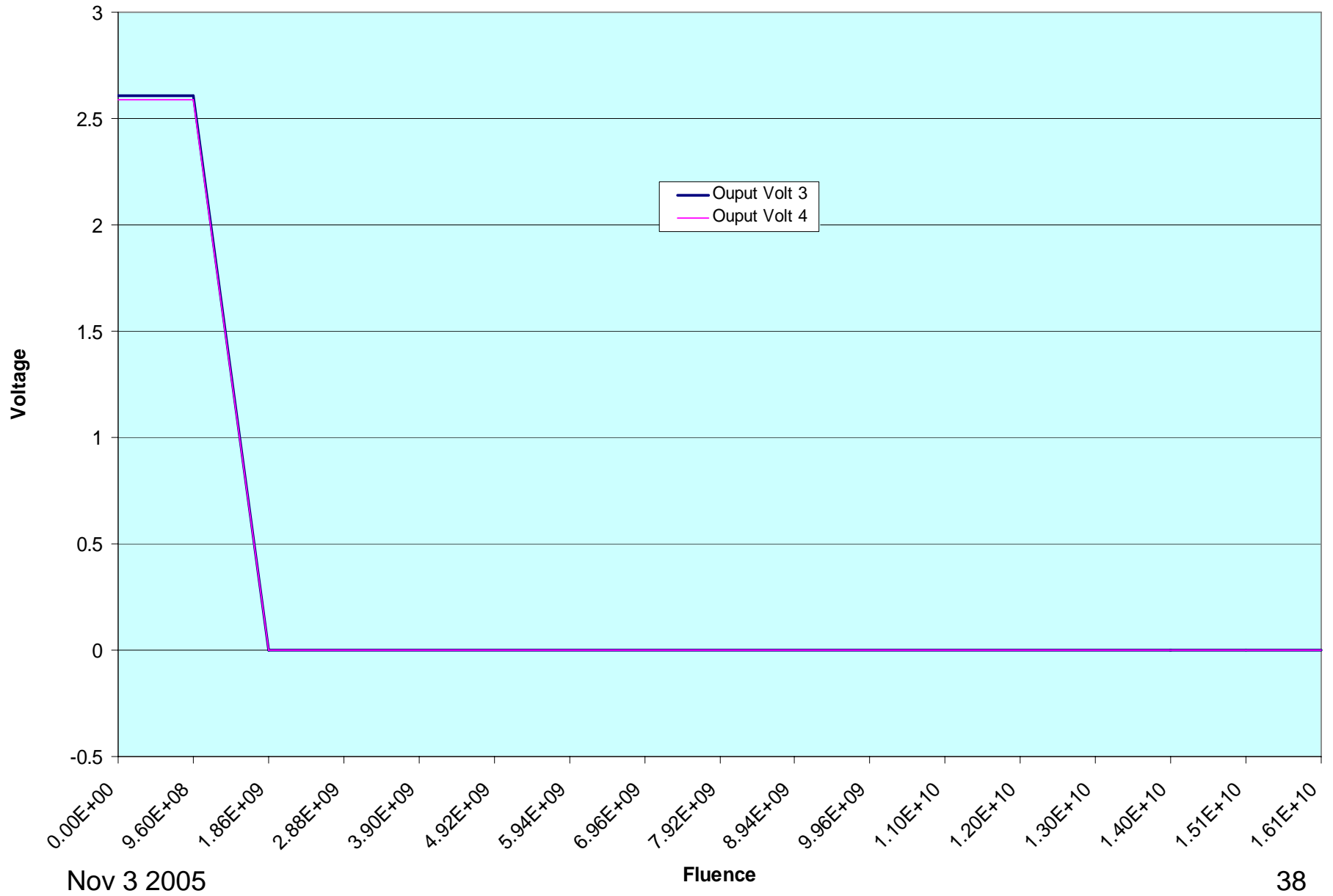
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Fluence

1.3×10^{10} p/cm²

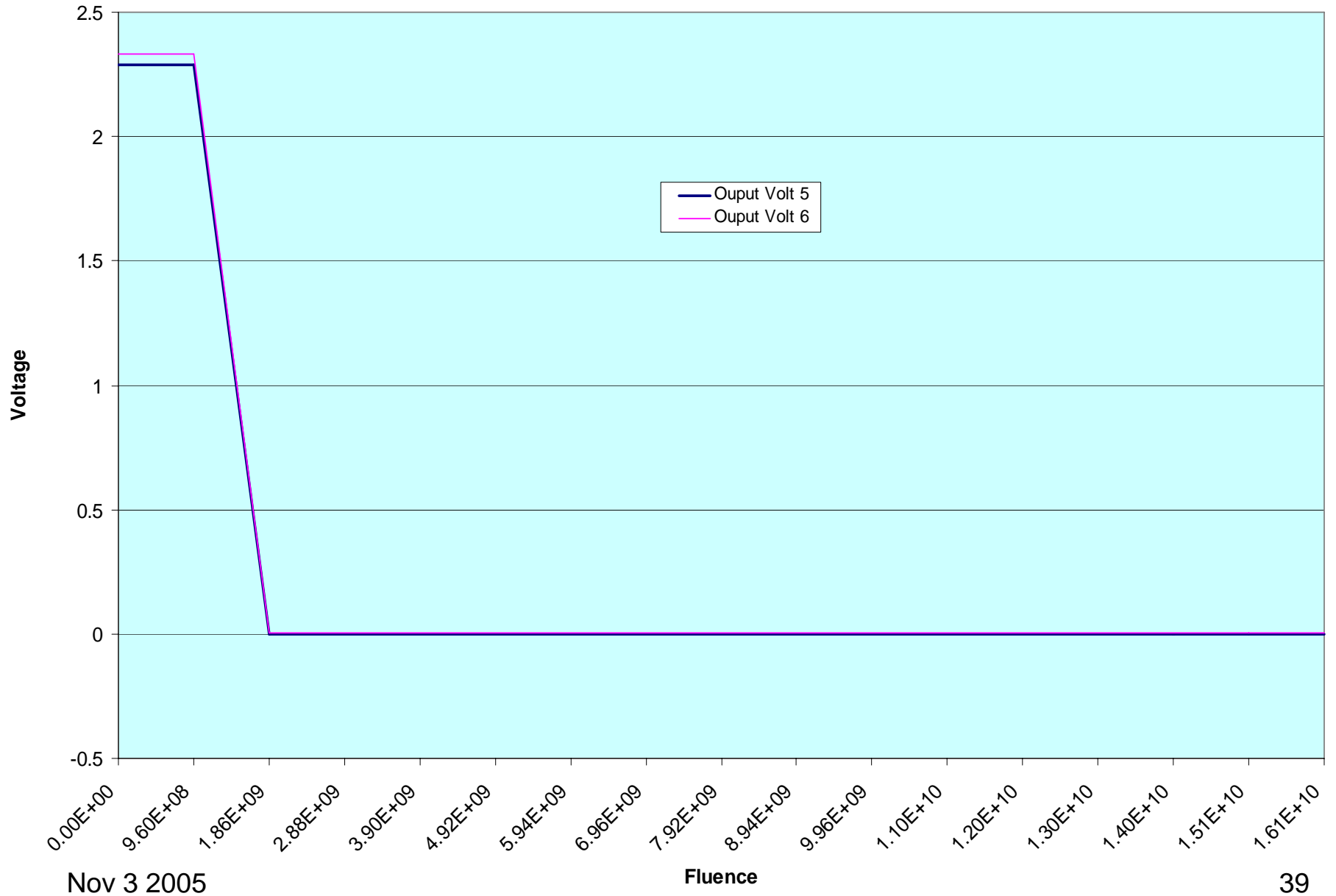
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CAEN A3016 Output Voltage



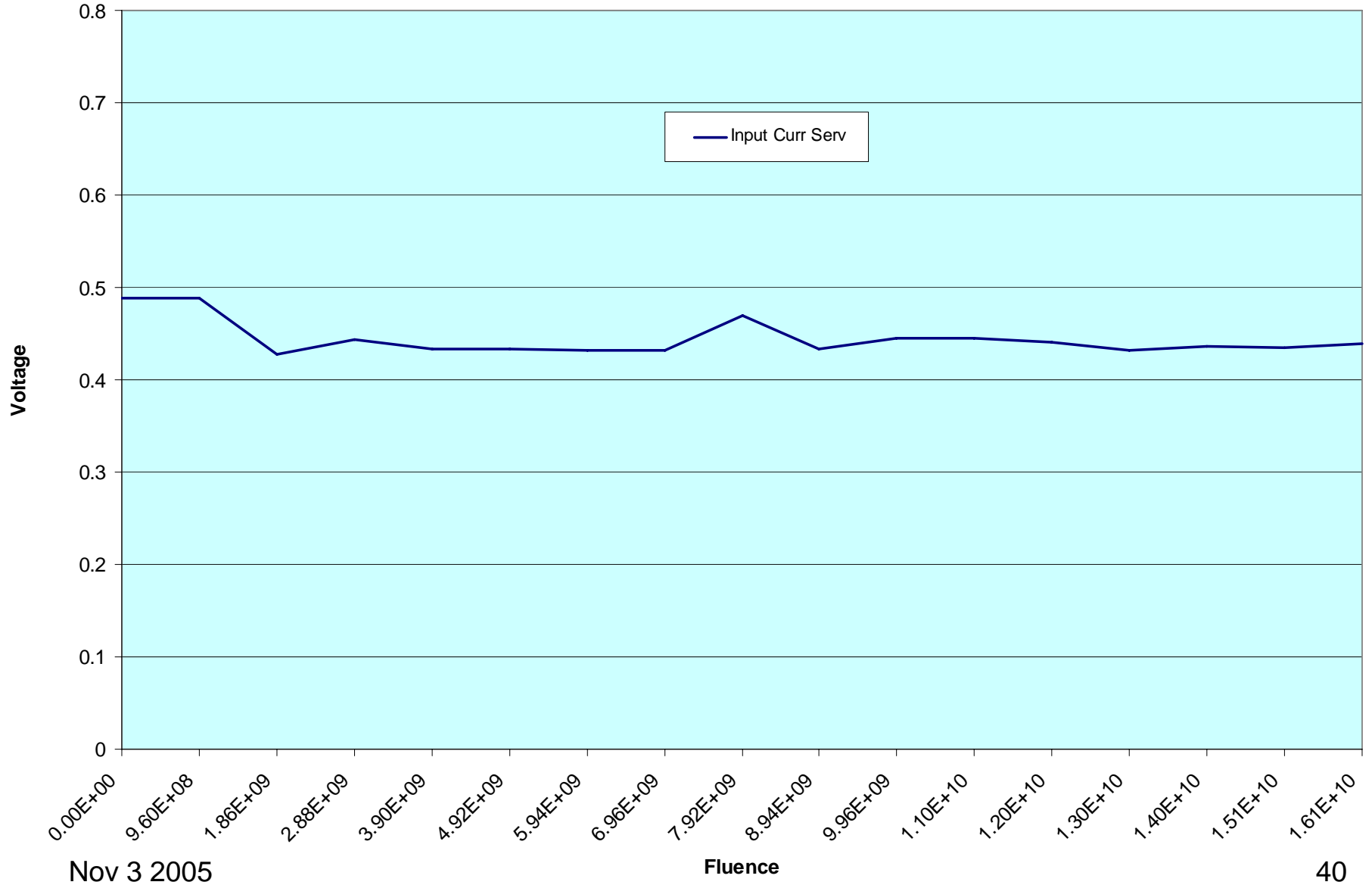
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CAEN A3016 Output Voltage

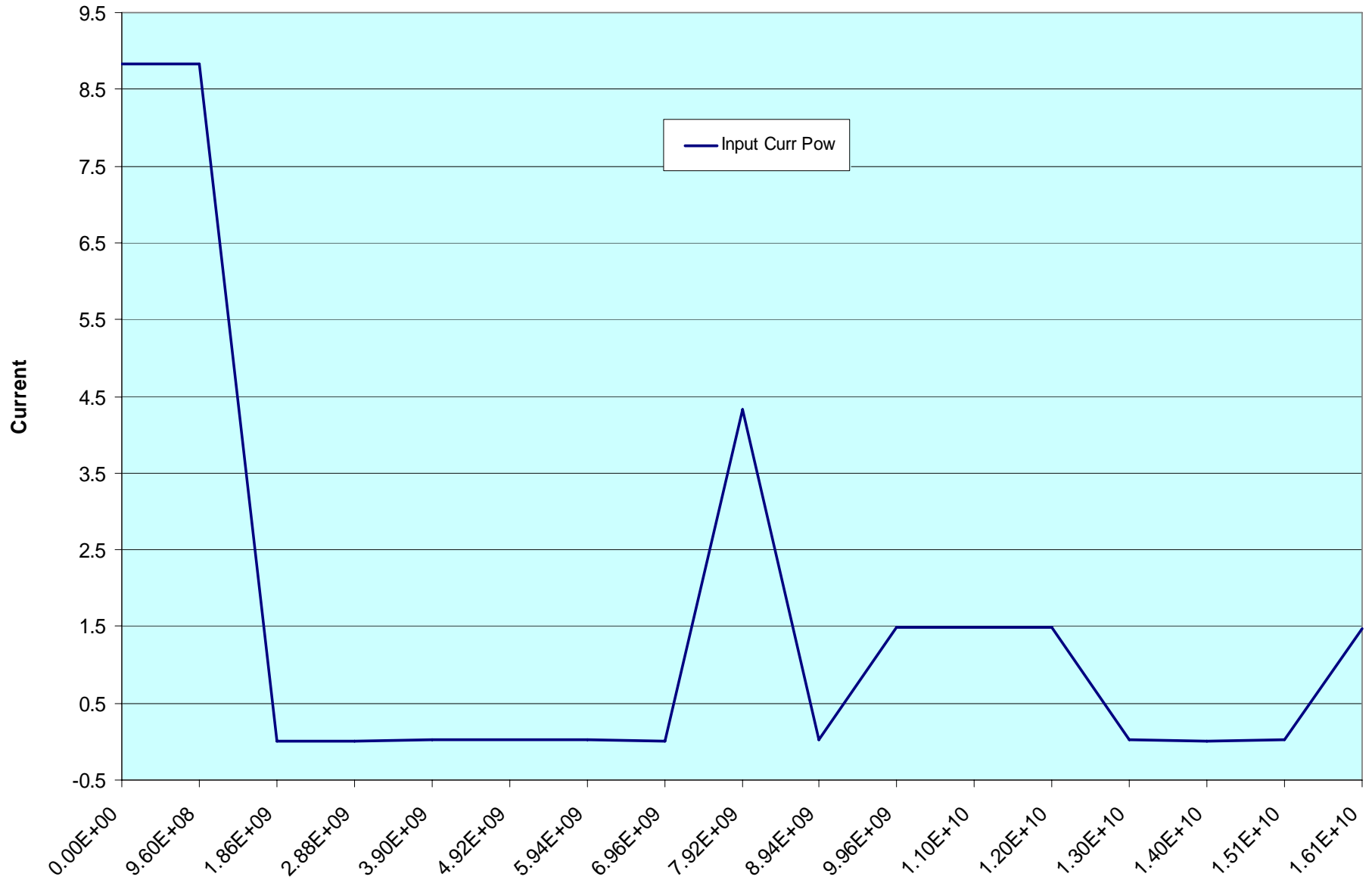


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CAEN A3016 Input Current Service



CAEN A3016 Input Current Power



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Fluence

	First drop	Permanent loss
A3009	$2.6 \cdot 10^{10} \text{ p/cm}^2$	$9.3 \cdot 10^{10} \text{ p/cm}^2$
A3025	$1.17 \cdot 10^{10} \text{ p/cm}^2$	$1.09 \cdot 10^{11} \text{ p/cm}^2$
A3486	$4 \cdot 10^8 \text{ p/cm}^2$	$1.44 \cdot 10^{10} \text{ p/cm}^2$
		Proton beam stopped for therapy (40mn) ==> recovering time ==> restart
A3016	$9.6 \cdot 10^8 \text{ p/cm}^2$	$6.17 \cdot 10^{10} \text{ p/cm}^2$ $1.3 \cdot 10^{10} \text{ p/cm}^2$

Conclusion

- Tests so far are inconclusive.
- Additional proton tests at PSI.
 - To reach specified fluence of $2 \cdot 10^{11}$ p/cm² and 140 Gy.
 - PSI allows early access.
- Neutron tests at Prospero as foreseen.