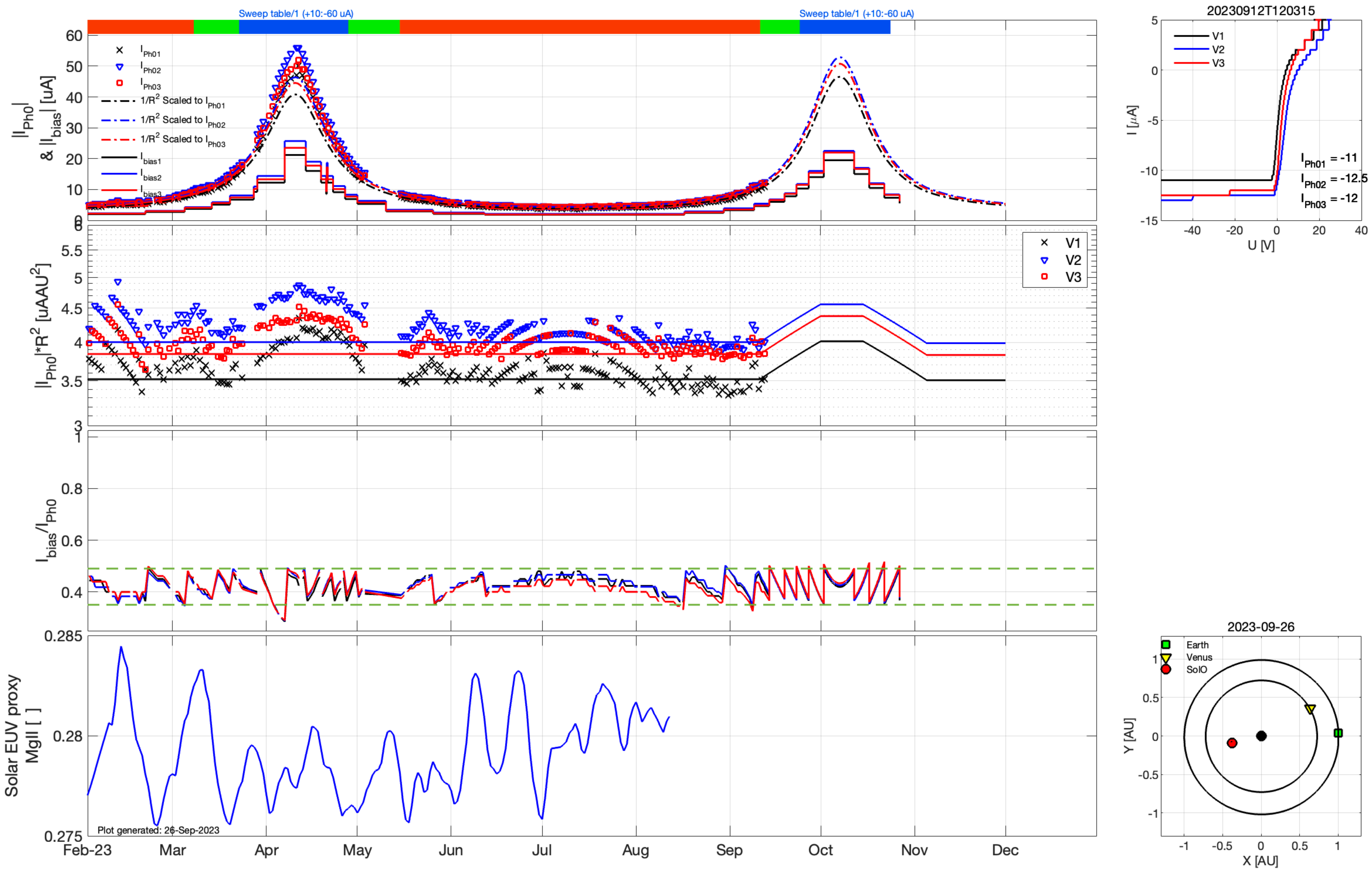
BIAS Status

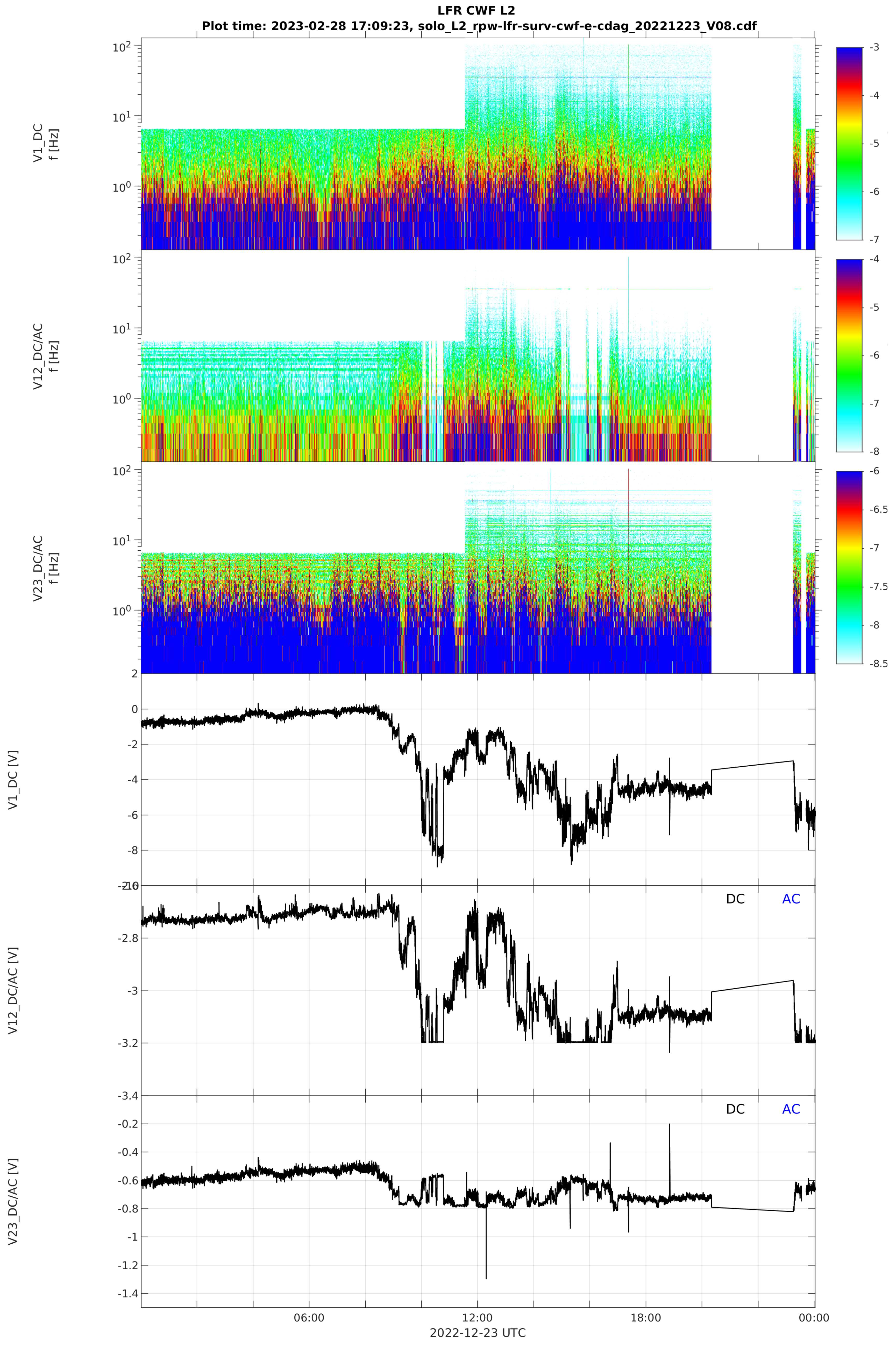
RPW Consortium meeting

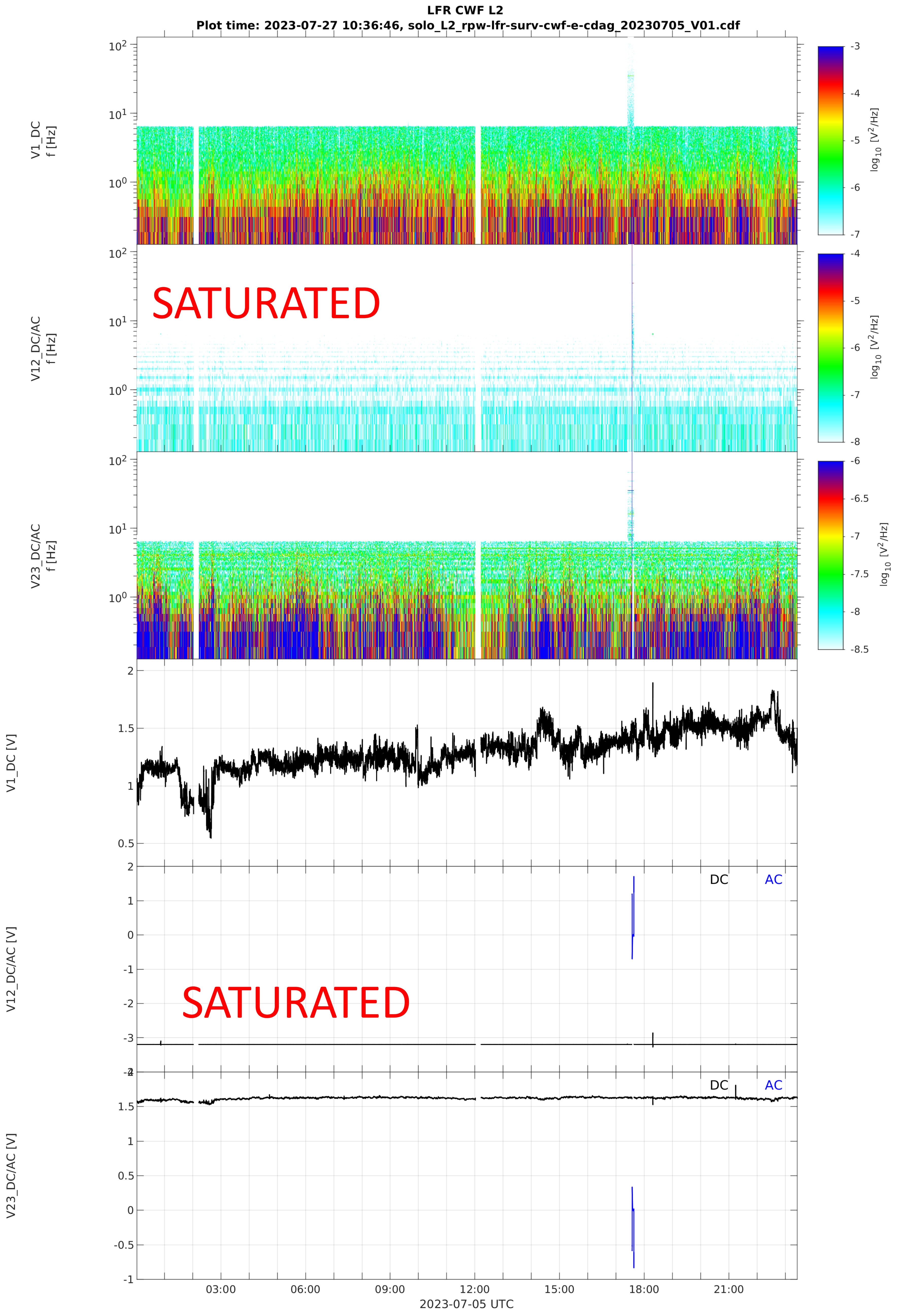
Yuri Khotyaintsev, 2023-10-03

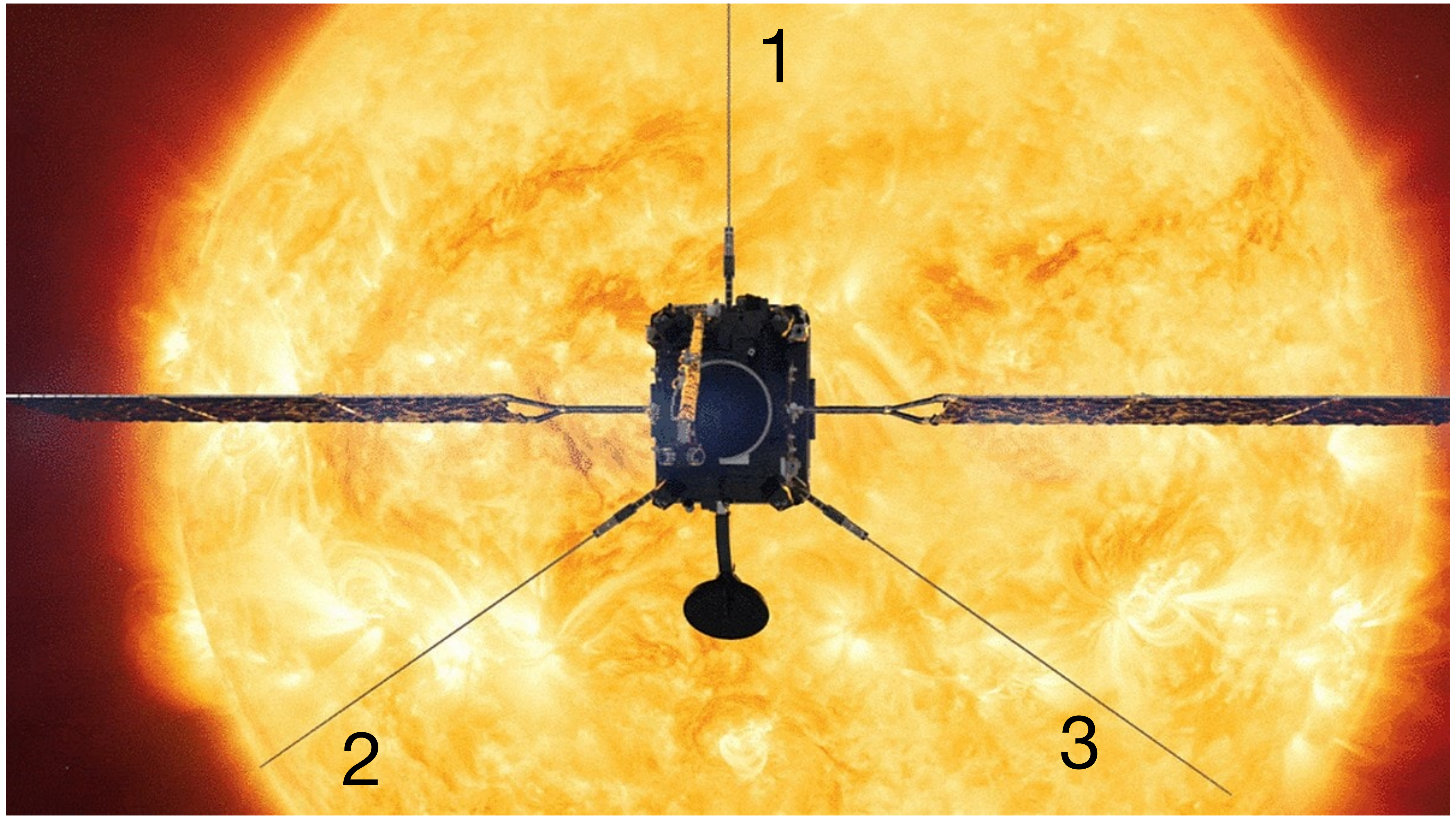


Sweep table/1 (+10:-60 uA)
Sweep table/1 (+10:-60 uA)
$|I_{Ph0}|$ & $|I_{bias}|$ [uA]
I_{Ph01}
I_{Ph02}
I_{Ph03}
$1/R^2$ Scaled to I_{Ph01}
$1/R^2$ Scaled to I_{Ph02}
$1/R^2$ Scaled to I_{Ph03}
I_{bias1}
I_{bias2}
I_{bias3}
$|I_{Ph0}|*R^2$ [uAAU^2]
V1
V2
V3
I_{bias}/I_{Ph0}
Solar EUV proxy MgII [ ]
Plot generated: 26-Sep-2023
Feb-23
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
20230912T120315
I [μA]
U [V]
I_{Ph01} = -11
I_{Ph02} = -12.5
I_{Ph03} = -12
2023-09-26
Earth
Venus
SolO
X [AU]
Y [AU]

Saturation


LFR CWF L2
Plot time: 2023-02-28 17:09:23, solo_L2_rpw-lfr-surv-cwf-e-cdag_20221223_V08.cdf
V1_DC f [Hz]
V12_DC/AC f [Hz]
V23_DC/AC f [Hz]
V1_DC [V]
V12_DC/AC [V]
V23_DC/AC [V]
DC
AC
2022-12-23 UTC


LFR CWF L2
Plot time: 2023-07-27 10:36:46, solo_L2_rpw-lfr-surv-cwf-e-cdag_20230705_V01.cdf
SATURATED
SATURATED
V1_DC f [Hz]
V12_DC/AC f [Hz]
V23_DC/AC f [Hz]
V1_DC [V]
V12_DC/AC [V]
V23_DC/AC [V]
DC
AC
2023-07-05 UTC



The signals we normally measure:

V1_DC

V12_DC (V1-V2)

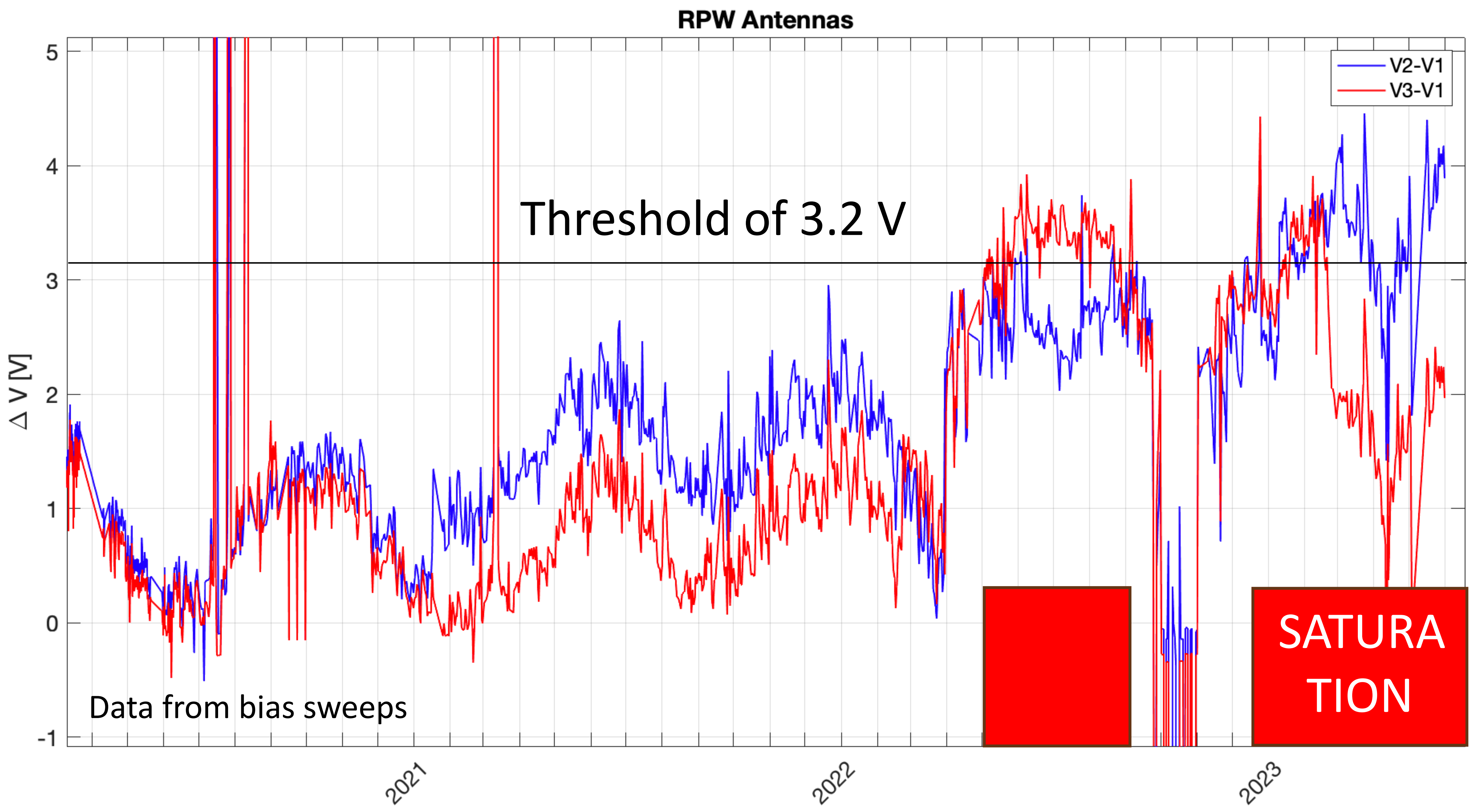
V23_DC (V2-V3)

V2 & V3 are then computed from the diffs.

The analogue diffs are limited to +/-3.2 V

- corresponds to E-field of ~500 mV/m,
- Solar wind VxB ~5 mV/m

Evolution of saturation

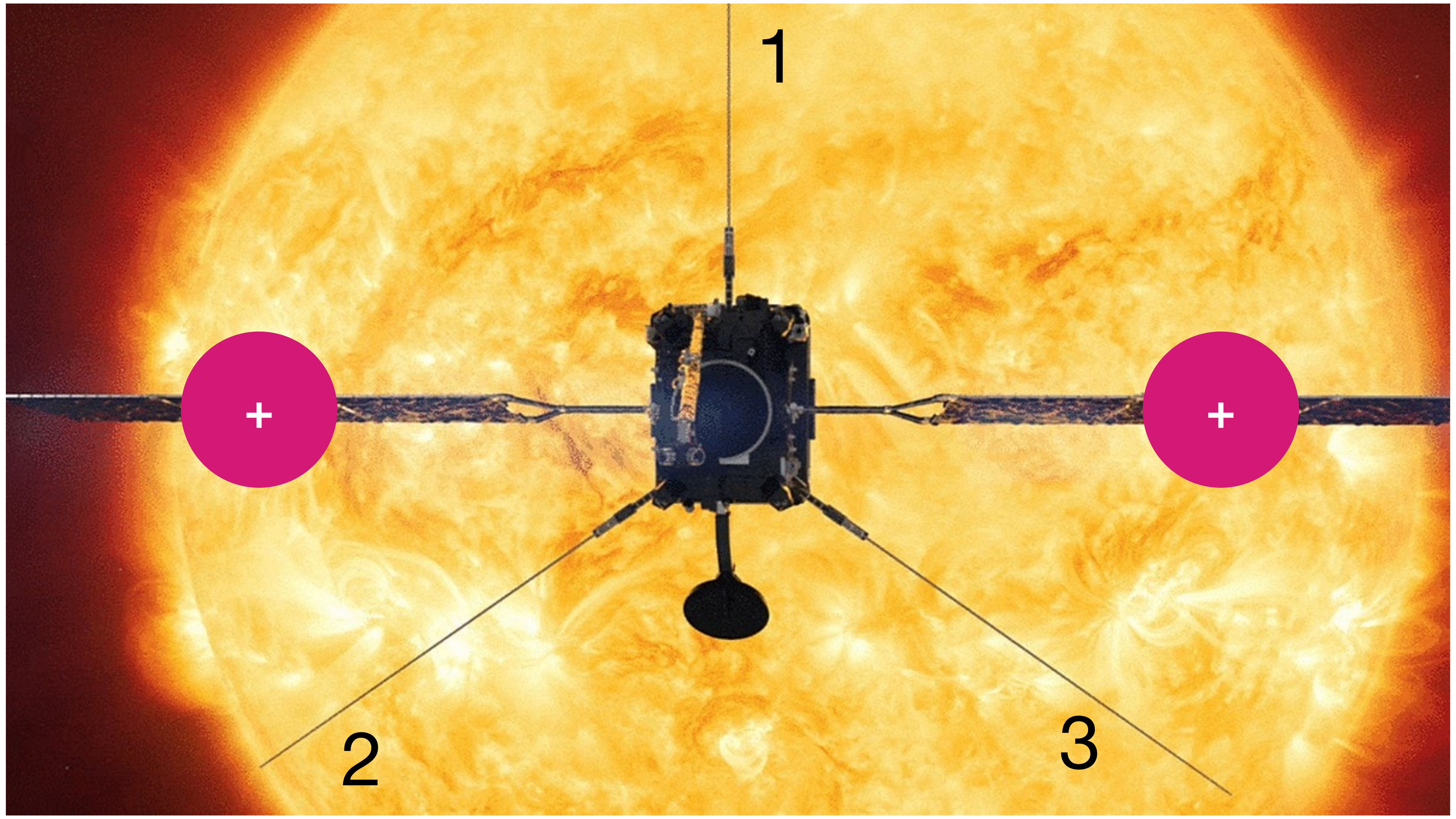


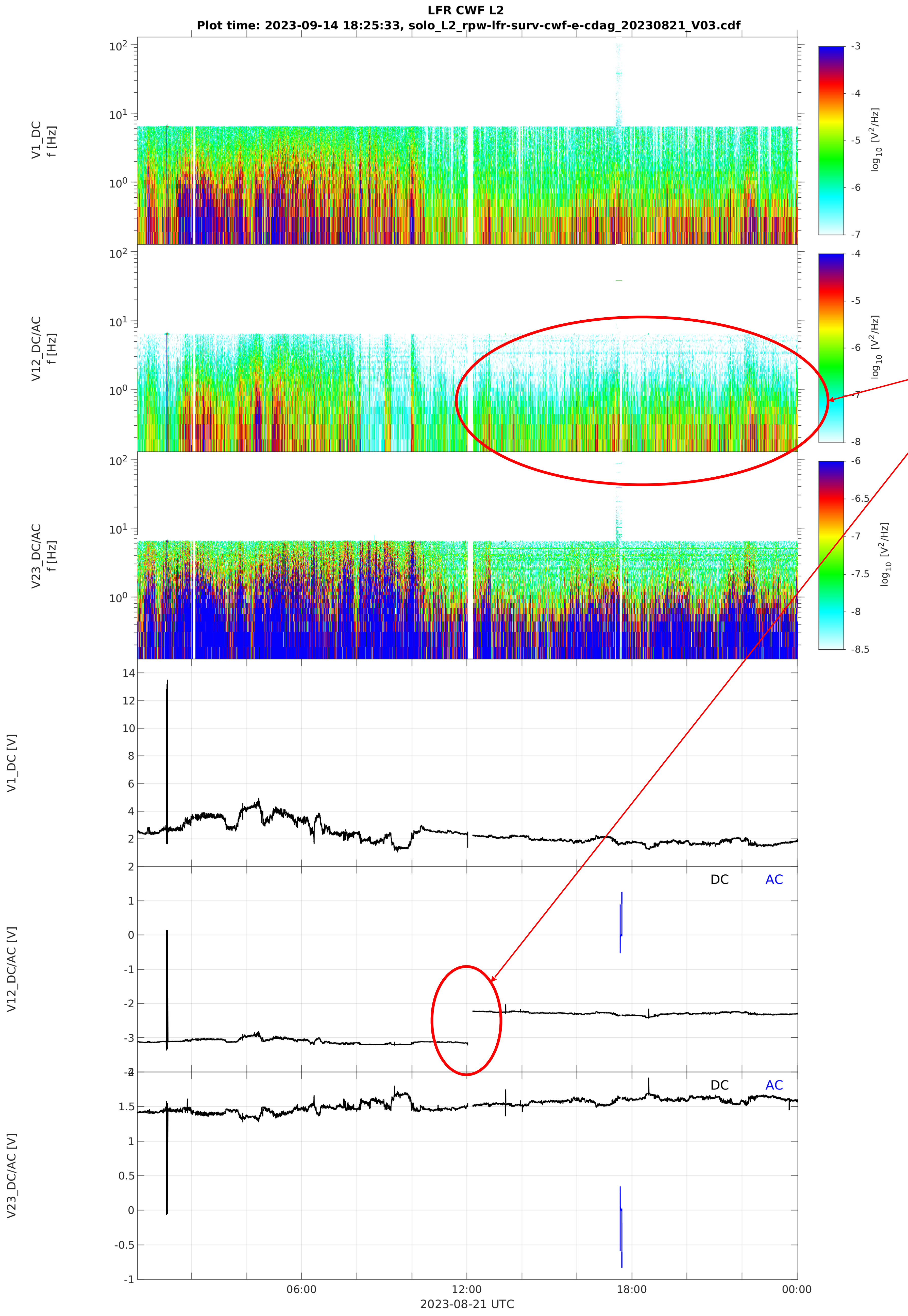
V12 was increasing over time and started to exceed 3.2 V in December 2022, leading to saturation of the DC E-field measurement. This implies that only the V23 component is available. Spacecraft potential and density can be computed from V1.

As a workaround, V12 was replaced by V13 on August 21, 2023.
However, even V13 exceeded the saturation threshold in 2022 and early 2023, so we can reencounter the saturation.

The cause

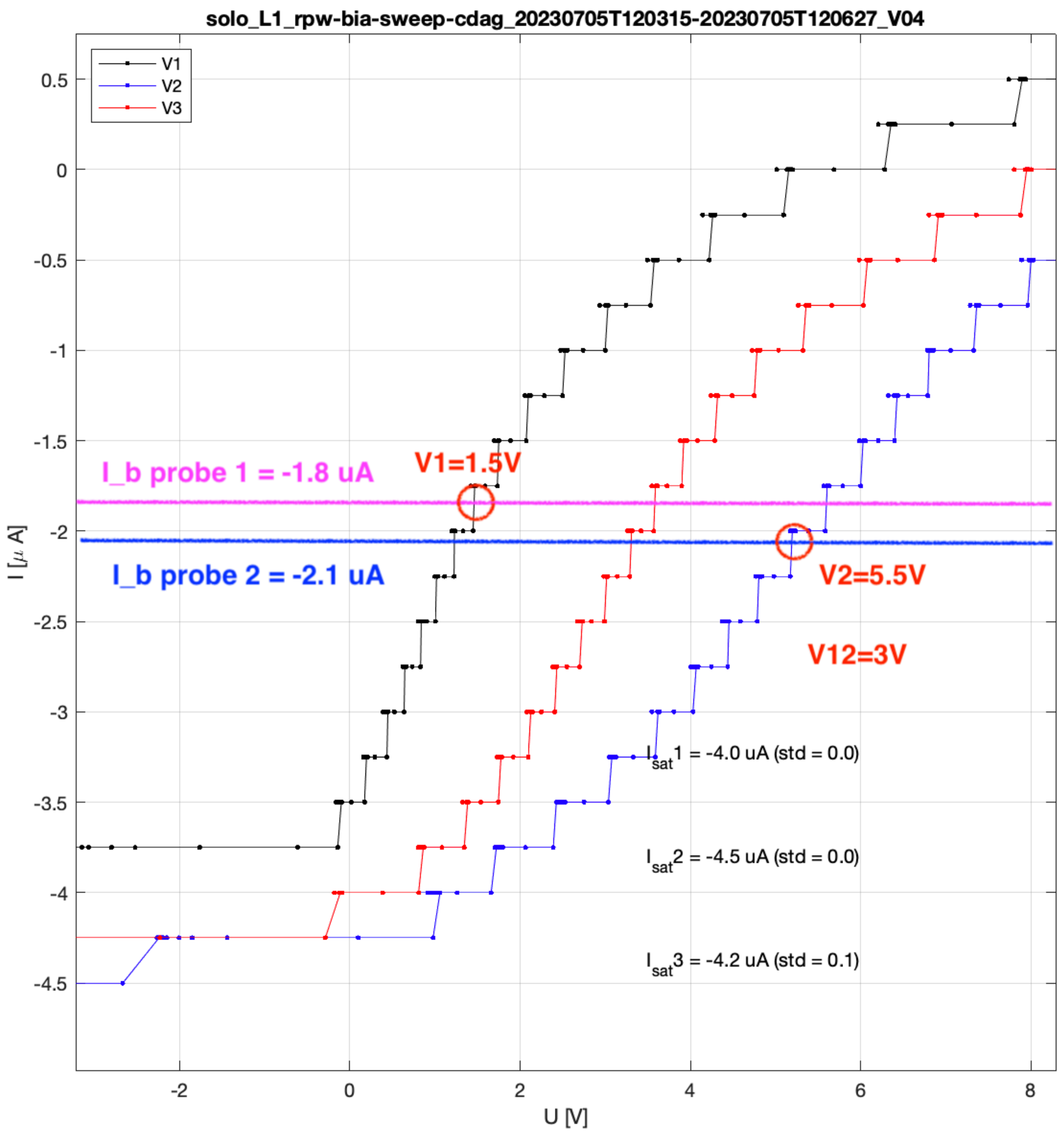
- Micrometeorites hit the solar panels
- This blows fuses and parts of the panel become disconnected from the SC ground
- Non-grounded areas charge up
- Antennas 2 & 3 are close to the panels and see these charges





Workaround

Change from V12 to V13. Data is good after this.



Saturation

- Things already done
  - Switched to V13 instead of V12
  - Used V1 only to produce SCPOT
  - Implemented monitoring of saturation
- Things to be done
  - Develop a flag to mark the saturation in the EFIELD data.
  - Switch processing to use V1 and recalibrate/reprocess everything.
  - **Be ready to switch back to V12**
  - **Be ready to switch to V1, V2, V3** (calibration mode 0) - procedure from commissioning needs to be resurrected.

	BIAS output signals					
MODE	**BIAS_1**	**BIAS_2**	**BIAS_3**	**BIAS_4**	**BIAS_5**	**Operation**
0	V1_DC	V12_DC*	V23_DC	V12_AC*	V23_AC	Standard operation
1	V2_DC	V3_DC	V23_DC	~~V12_AC*~~	V23_AC	probe 1 fails
2	V1_DC	V3_DC	V13_DC*	V13_AC*	~~V23_AC~~	probe 2 fails
3	V1_DC	V2_DC	V12_DC*	V12_AC*	~~V23_AC~~	probe 3 fails
4	V1_DC	V2_DC	V3_DC	V12_AC*	V23_AC	Calibration mode 0
5	2.5V Ref	2.5V Ref	2.5V Ref	V12_AC*	V23_AC	Calibration mode 1
6	GND	GND	GND	V12_AC*	V23_AC	Calibration mode 2
7	GND	GND	GND	V12_AC*	V23_AC	Calibration mode 2

where * denotes the ability to switch from V12_AC and V12_DC, to V13_AC and V13_DC, using the latchin relay, in the case of failure of probe 2. It is not possible to have a combination of V12 and V13 signals in the same mode.

Table 4 LFR/TDS BIAS unit output signals.

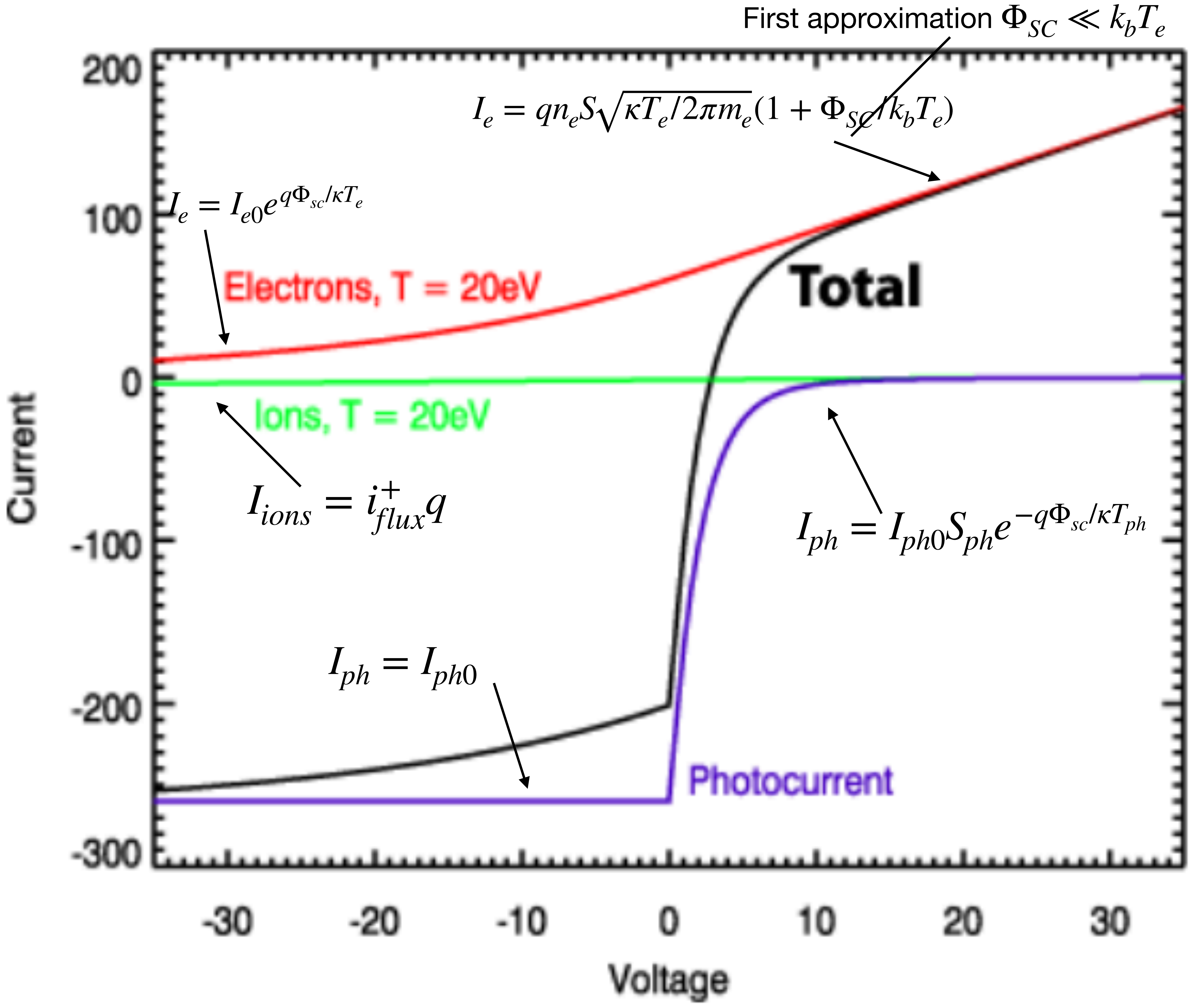
Status of datasets

- Density
  - Delivered up to 2022-11-25
  - Implemented a flag for high density (>100 cc)
  - Considering changing the ScPot to use V1 only.
  - Developing a new calibration approach (lead by Jordi Boldu)
- E-Field
  - Data in SOAR until Dec 1, 2022.
  - Preliminary cal until end of May 2023.

DC E-field


Excellent
OK
Not OK
Discrete events
Bias changes
d23 [V]
k23
d123 [V]
R [AU]
k123
B [nT] LL
V [km/s] LL
2021
2022
2023

New density cal

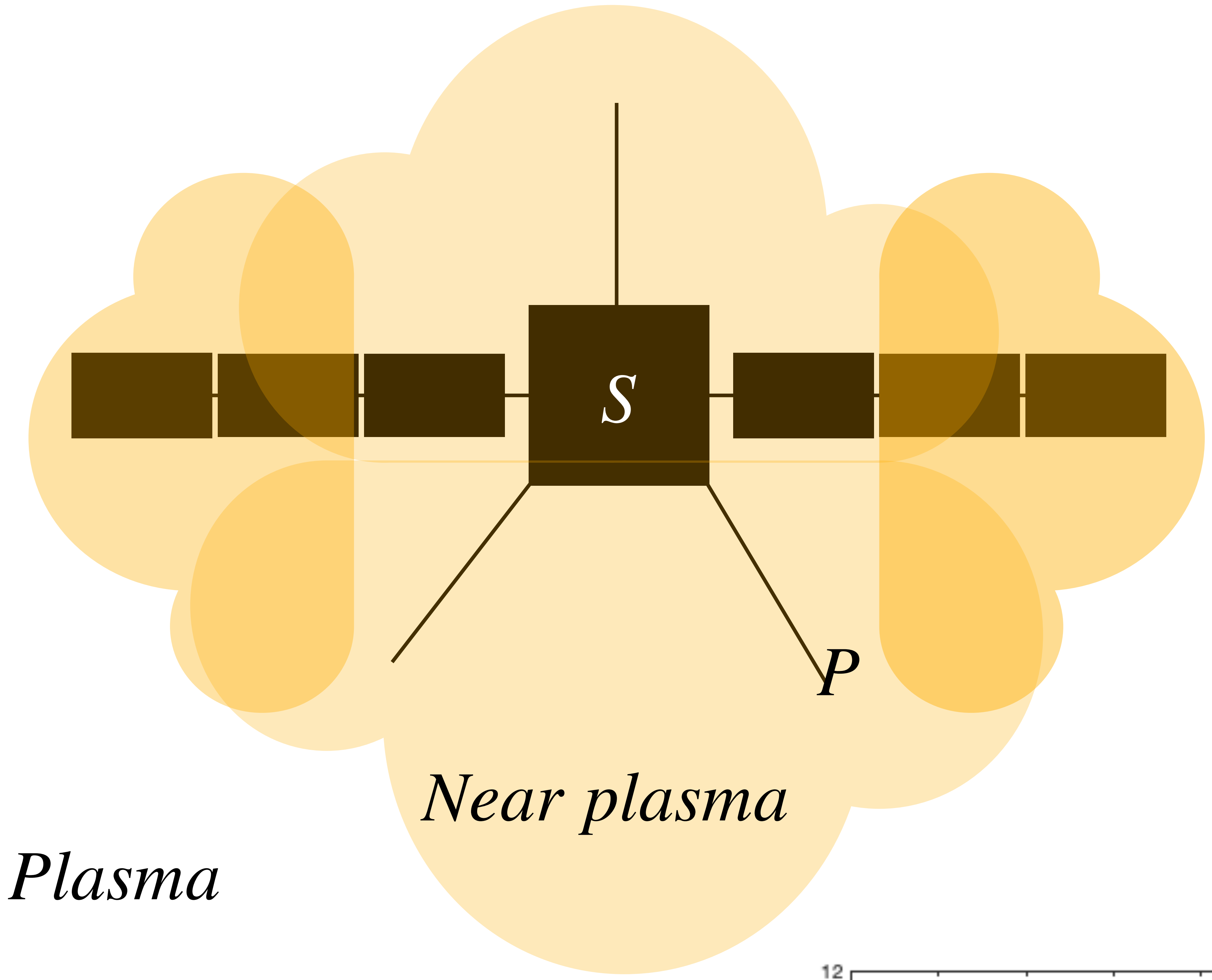


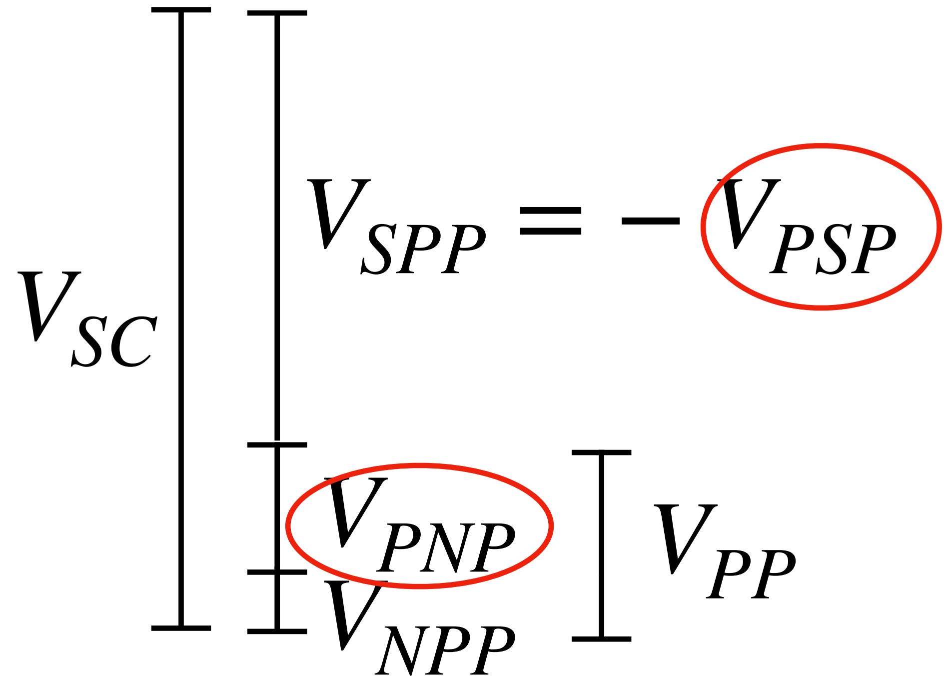
$\Phi_{SC} \geq 0, I_{ph} \approx I_e$

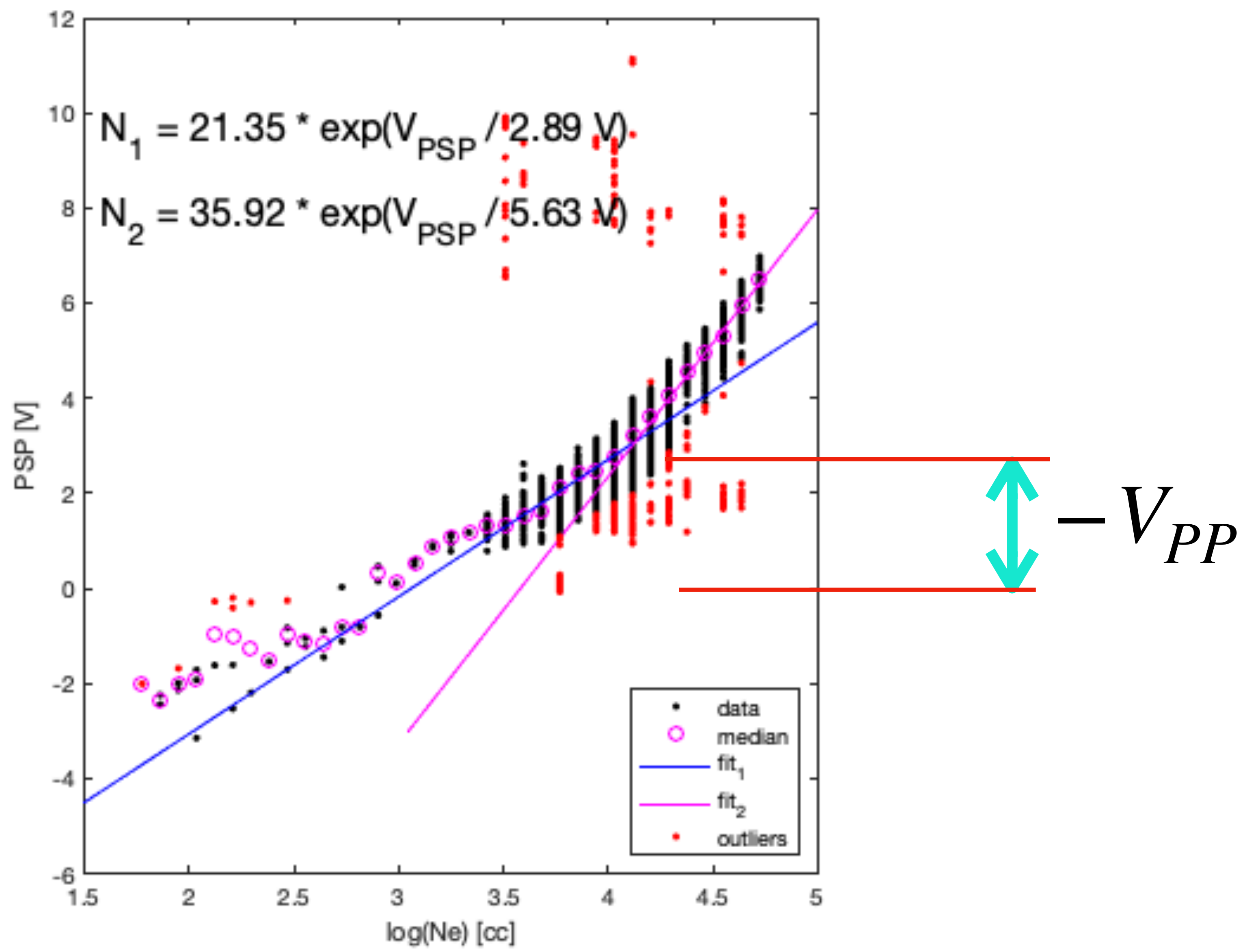
$$n_e = \frac{I_{ph0} S_{ph}}{qS\sqrt{\kappa T_e/(2\pi m_e)}} e^{-q\Phi_{sc}/\kappa T_{ph}}$$

$\Phi_{SC} < 0, I_{ph} + I_i \approx I_e$

$$n_e = \frac{(I_{ions} + I_{ph0}) S_{ph}}{qS\sqrt{\kappa T_e/(2\pi m_e)}} e^{-q\Phi_{sc}/\kappa T_e}$$







$$n_e = n_0 e^{-\Phi_{sc}/\beta^{\pm}}$$

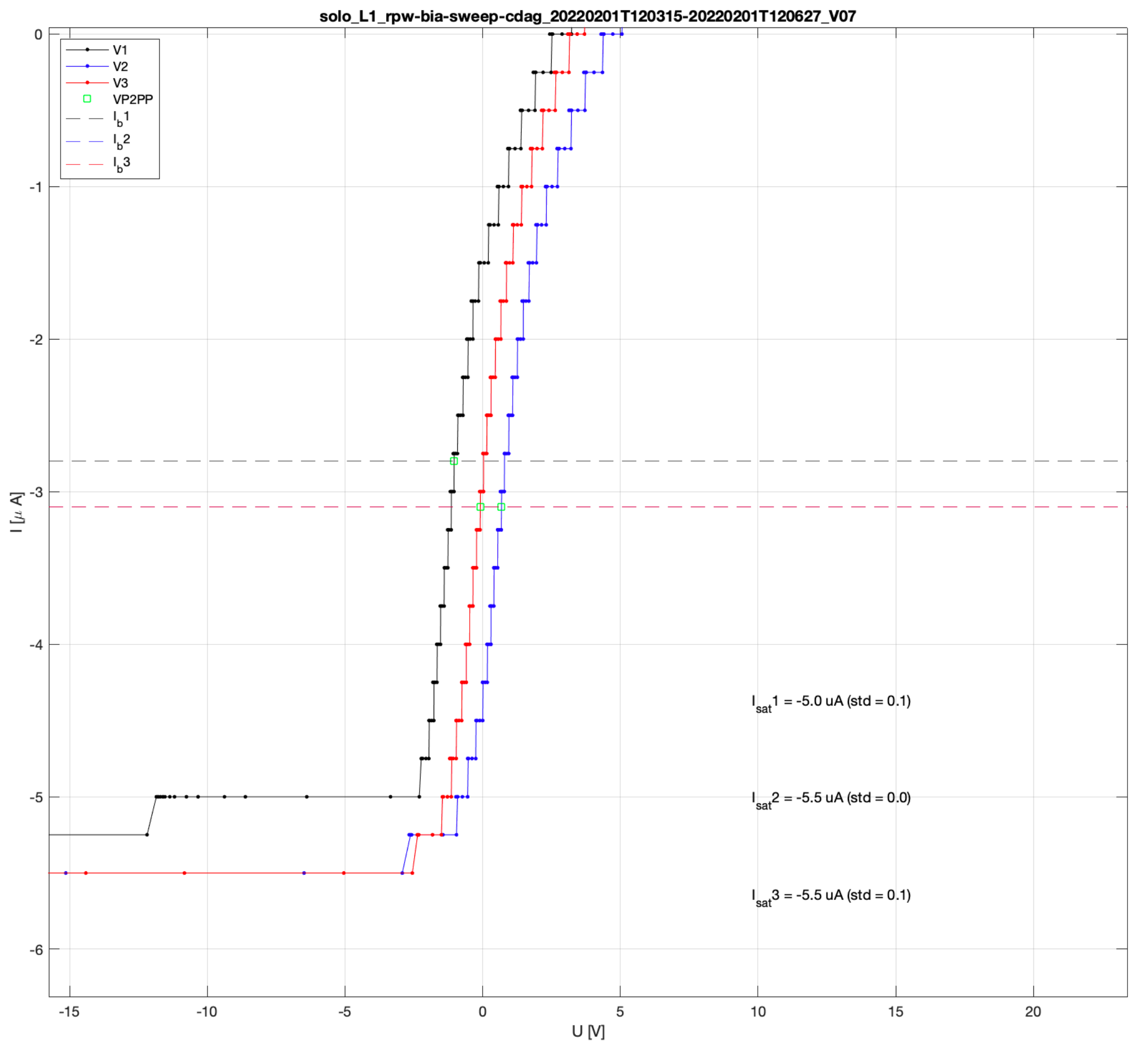
We have different expressions for ne depending on the sign of the s/c potential. i.e at $\Phi_{sc} = 0$

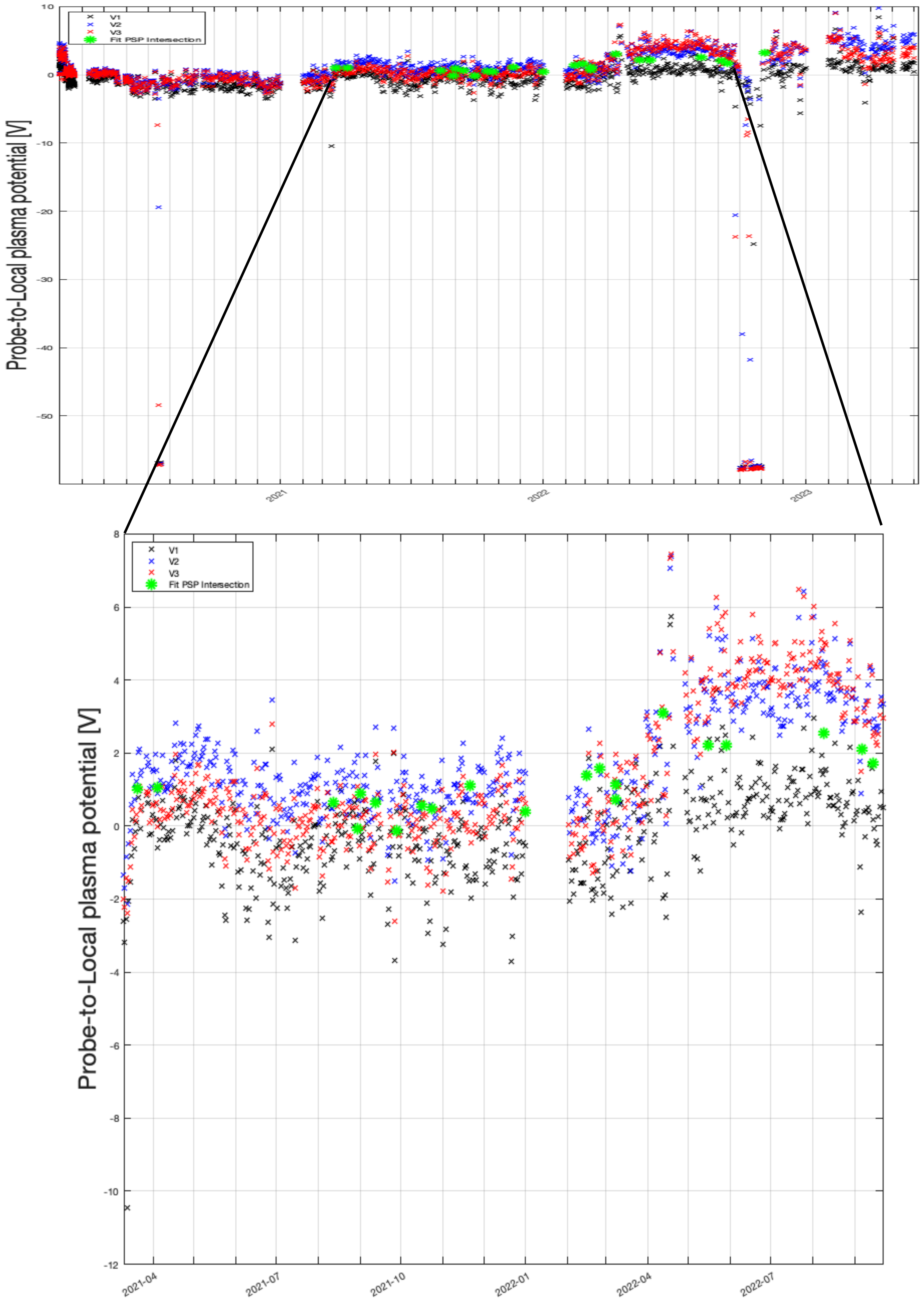
$$\Phi_{sc} = -\Phi_{PSP} + \Phi_{PP}$$

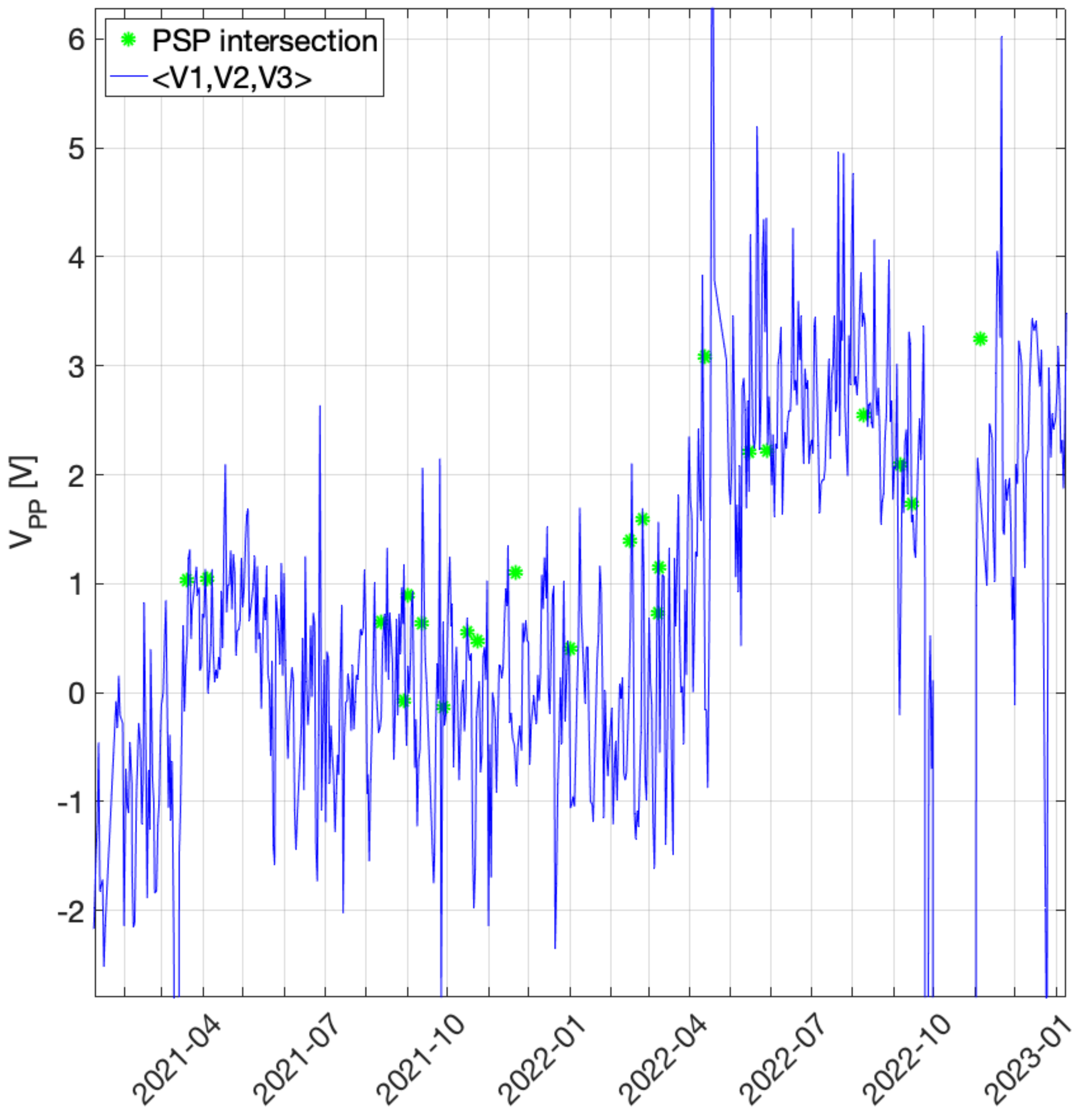
$$n_e = n_0 e^{(\Phi_{psp} - \Phi_{pp})/\beta}$$

$$ln(n_e) = ln(n_0) + \frac{\Phi_{PSP}}{\beta} - \frac{\Phi_{PP}}{\beta}$$

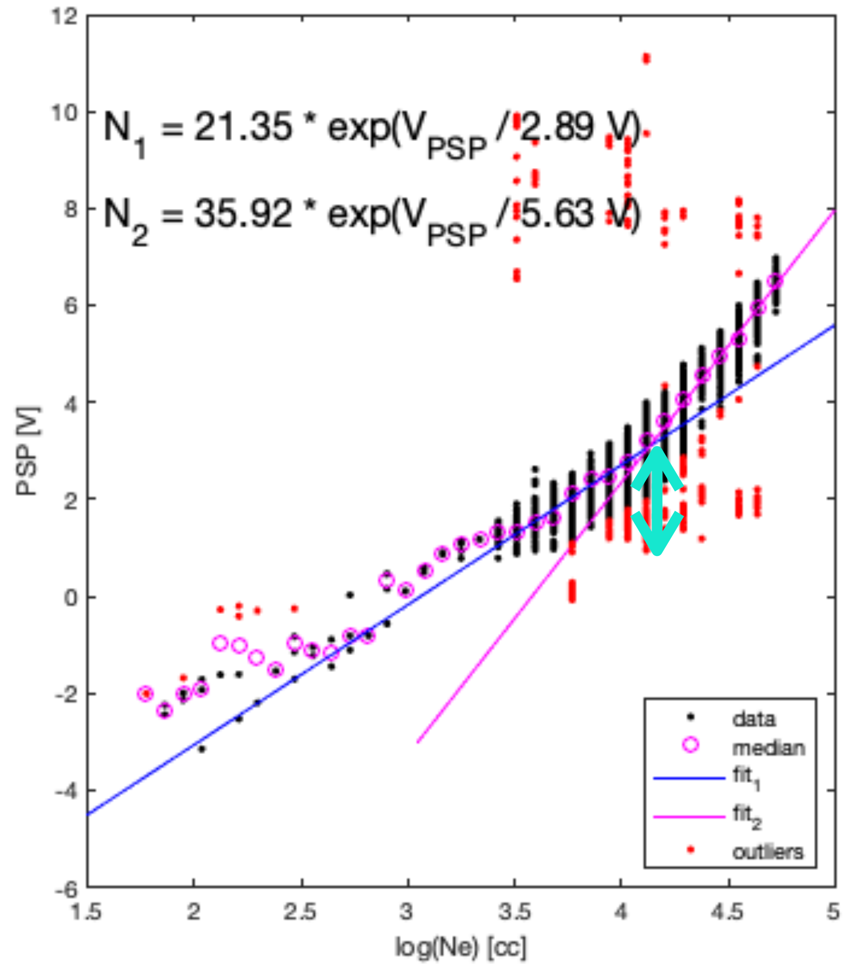
- VPP, the potential at the bias current.







- PSP intersection: s/c potential value where the two fits intersect.



- We start needing 2 fits around the time where PSP = Vpp, i.e. Vsc started being close to 0.