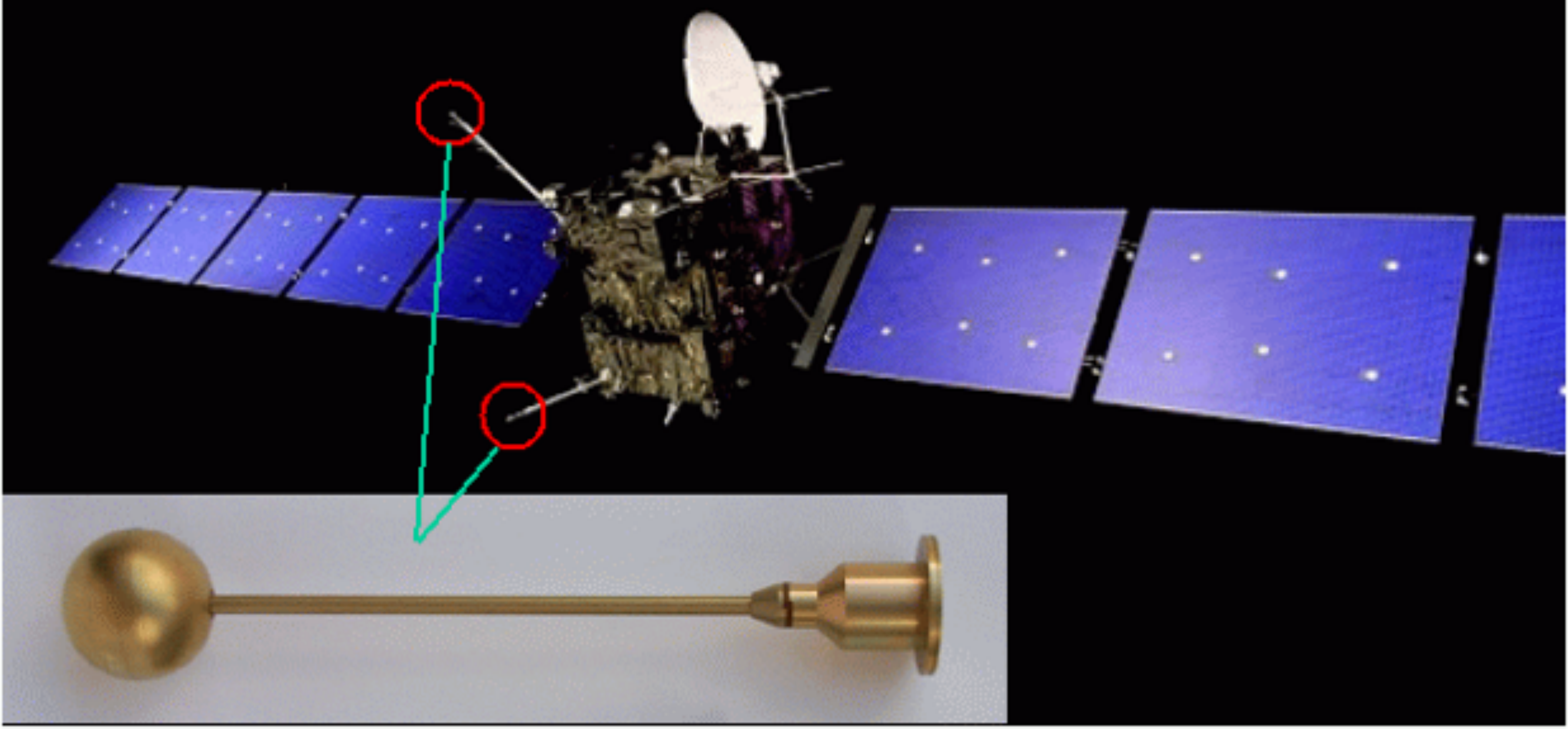
RPCLAP Review

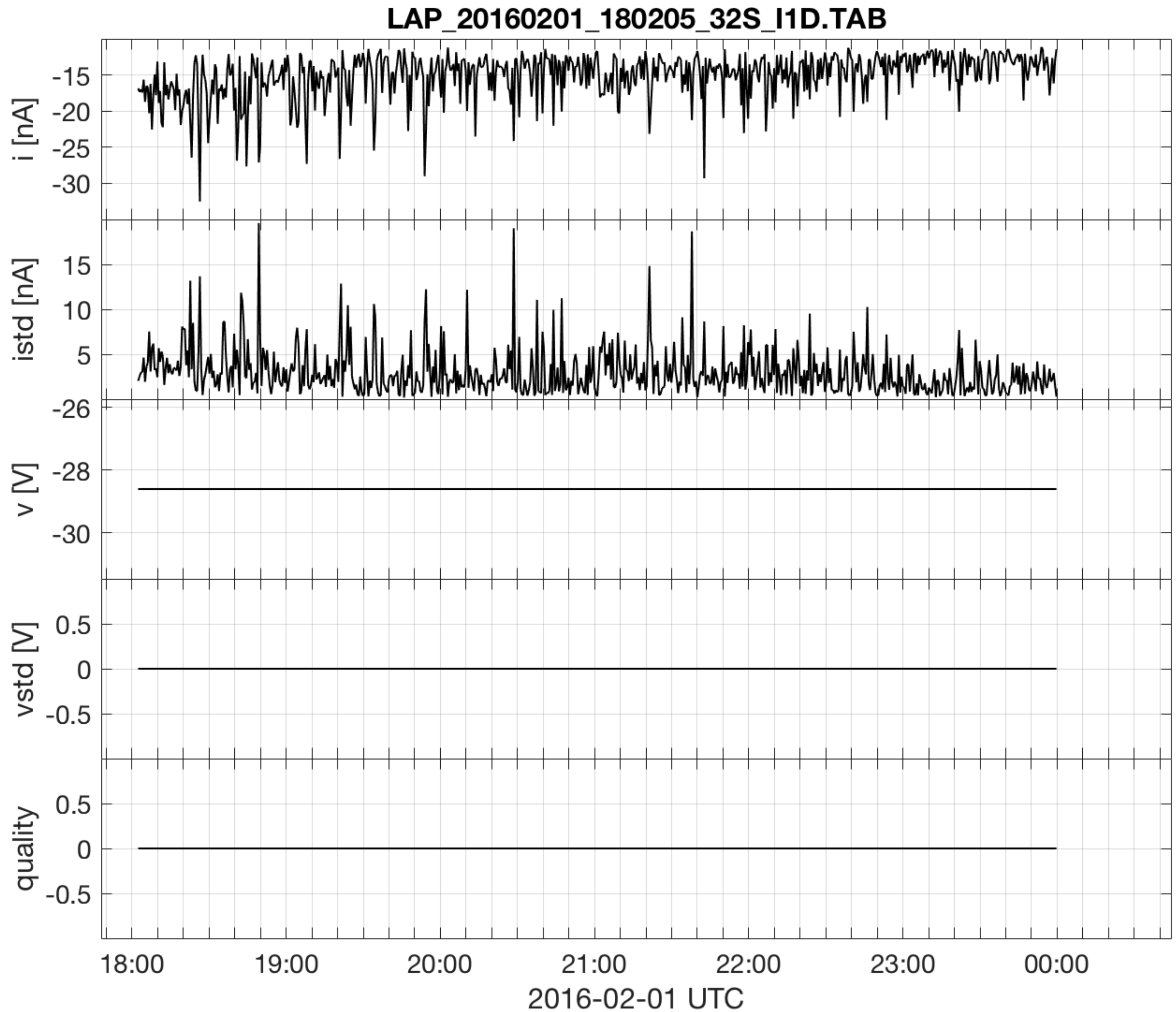
Yuri Khotyaintsev

ESAC, 2018-10-09

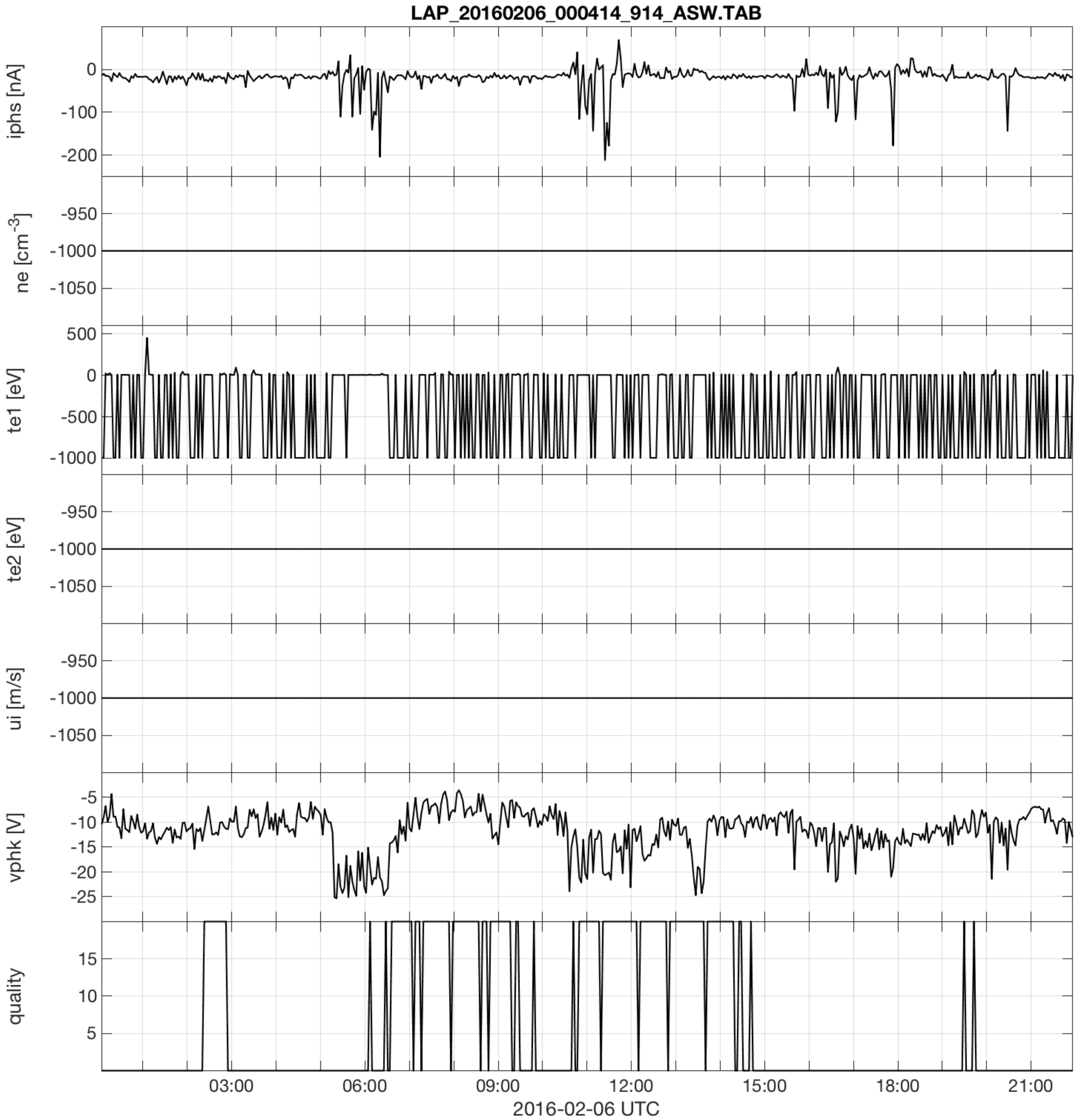
Langmuir probe instrument (LAP)



Data example: 32S



Data example: ASW

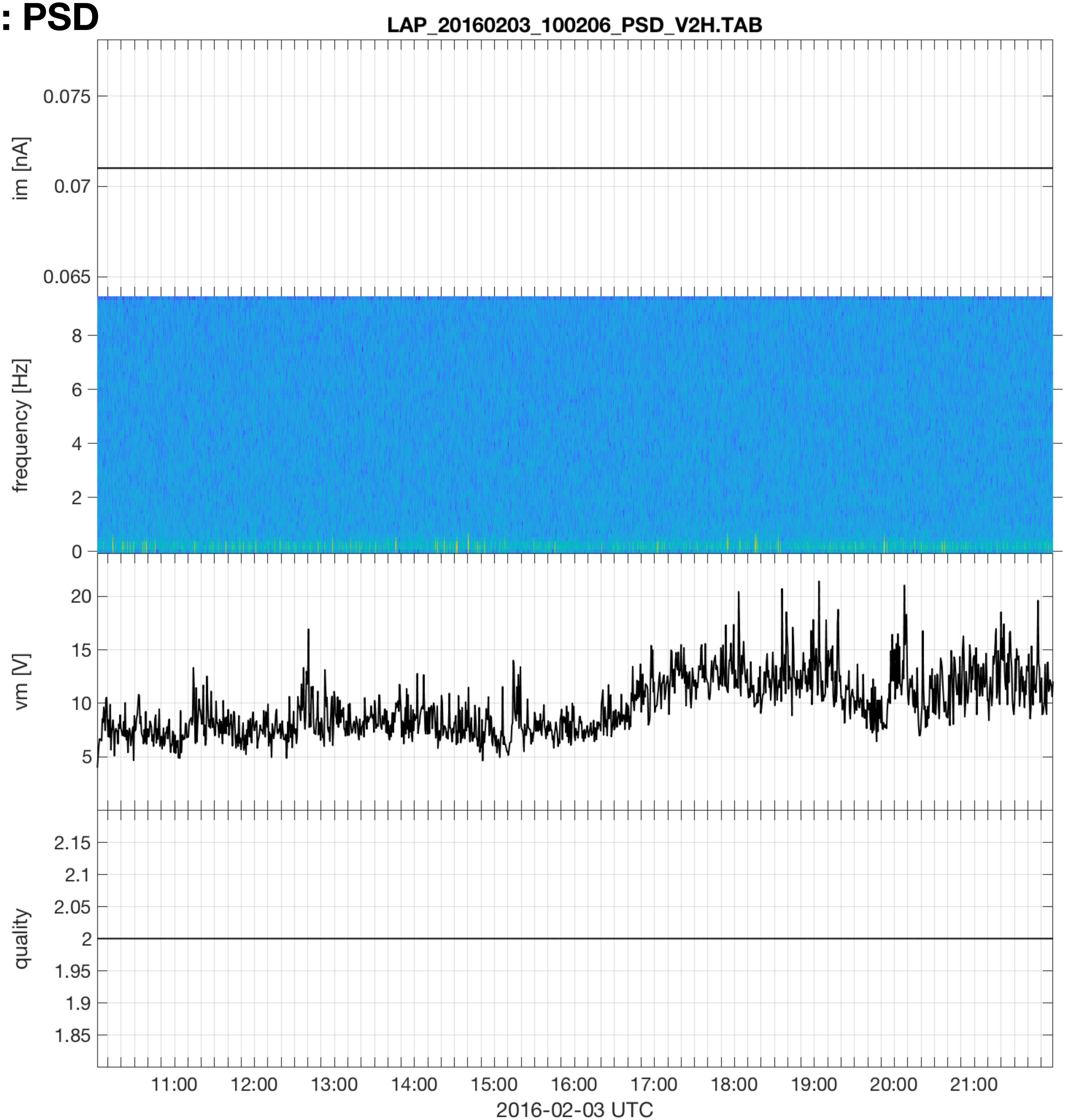


Placeholder?

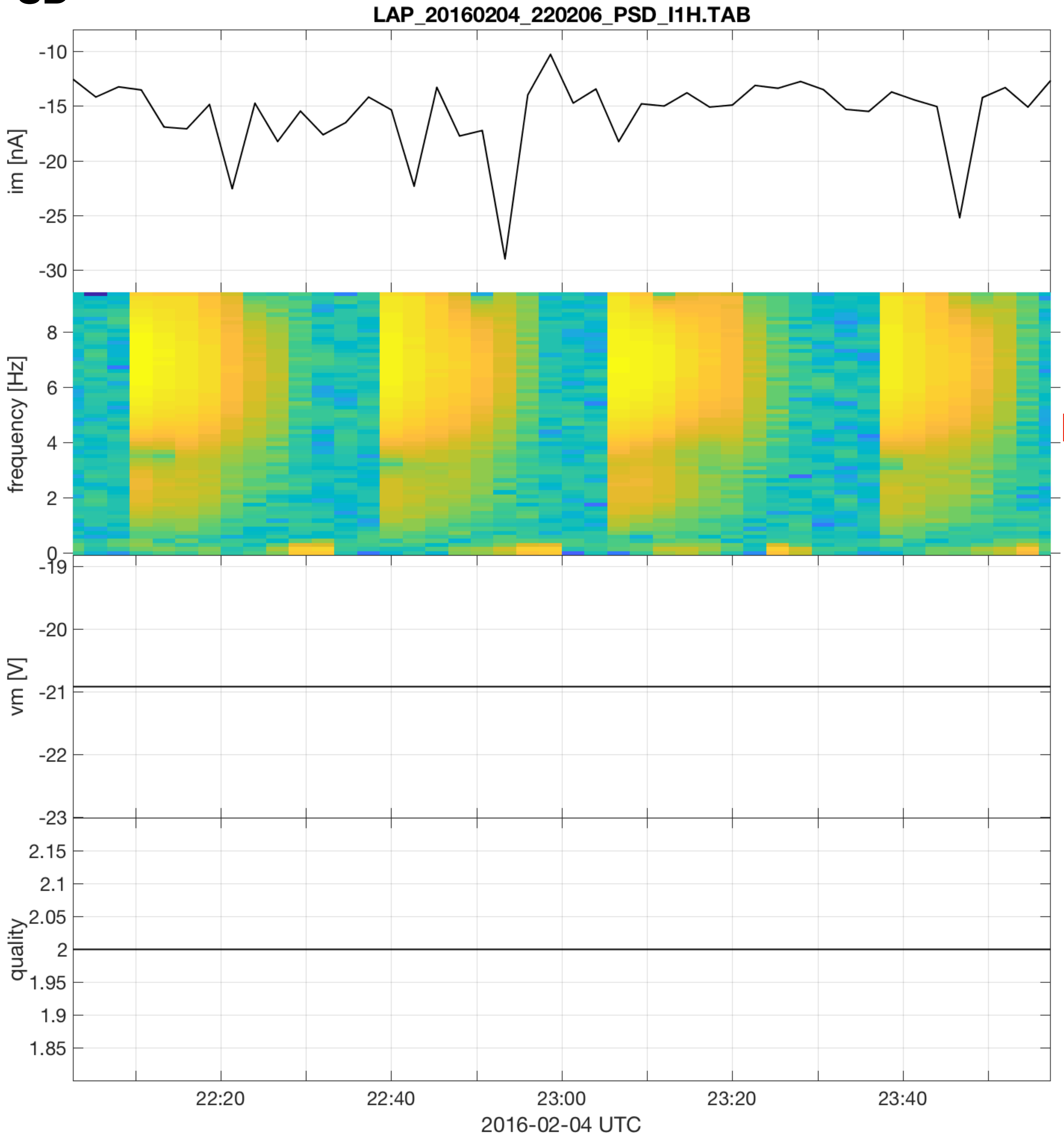
Placeholder?

Placeholder?

Data example: PSD



Data example: PSD



Interference??

Product summary

- Downsampled time series,1 sample/32 s - OK
- Photosaturation current,1 sample/60 minutes - OK
- Spacecraft potential proxy - why proxy?
- Analysed Sweep parameters (ASW) - some quantities are placeholders?
- Plasma density - see RID
- Spectral products (PDS) - scientific value is unclear to me
- Electric field?

RPCLAP-EU-YK-001: Unclear product name - plasma density

- Analysed Sweep parameters (ASW) : **Electron density**

- **Plasma density**, based on fix-bias density mode samples

Section 2.1

- High-level physical parameters derived from lower-level data:
  - Photosaturation current
  - Spacecraft potential
  - Electron density
  - Plasma density
  - Electron temperature
  - Ion bulk flow speed

RPCLAP-EU-YK-001: Unclear product name - plasma density

- Both MIP and LAP measure the **Electron density**
- **Plasma density = electron density** based quasi-neutrality assumption
- Suggestion: rename **plasma density-> electron density** (also for MIP)

2.2.8 Plasma Density

The best full time resolution plasma density product is considered to be the MIP-LAP cross-calibrated density delivered with the MIP archive. In that product, the LAP probe current and proble voltage have been calibrated to plasma density using MIP values.

However, MIP data are not always available for calibration. During such periods, we instead provide a LAP probe current calibrated to plasma density using the electron density as determined from the sweep (Section 2.2.7). One single linear transformation is used for every operations block, corresponding to one value for every data file.

Standard quality flags are applied (Section 3.2.2). Various algorithms for the quality value are still under evaluation, and the value currently assigned is 1.0.

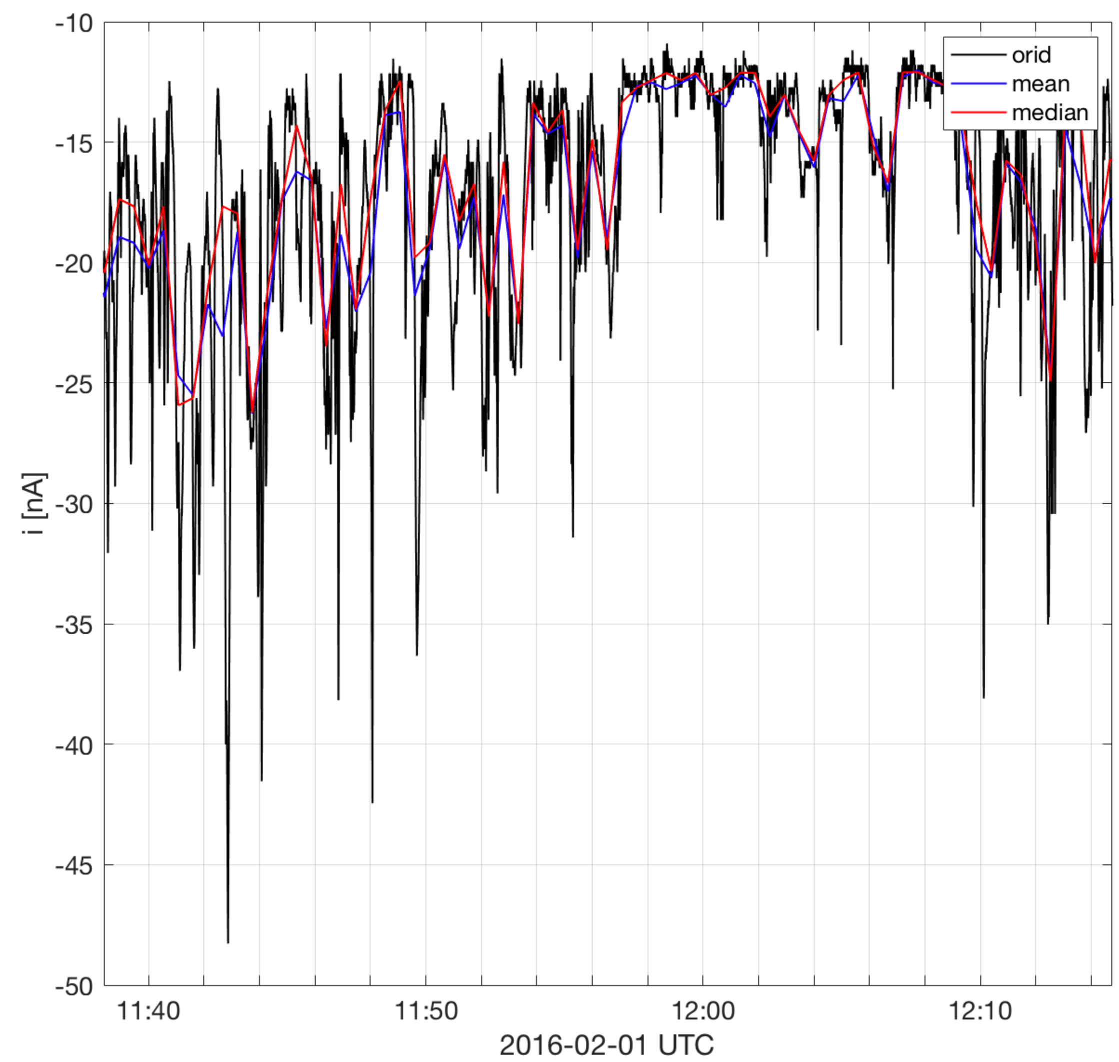
2.2.9

where $\mathrm{A_p}$ is the cross-sectional area of the probe, n_i is the ion number density, m_i is the ion mass, q_i is the ion charge and E_i is the effective energy of the incoming ions, dependent on thermal and flow velocity. By performing a linear least-squared-distance fit of this region to get an estimate of the slope, and using the simultaneous RPCMIP electron density, assuming quasi-neutrality and an effective ion mass of 19 a.m.u., we can estimate the effective energy of the ion. Taking $E_i = 0.5 m_i v_i^2$, we obtain an effective ion bulk velocity. This is performed for every sweep on LAP1, if there is a simultaneous MIP density estimate. The quality value of this output depends on the MIP input quality value, and the LAP analysis performance.

RPCLAP-EU-YK-002: use median instead of mean for downsampling data

- If the spikes are not a physical variation **median** will produce a smoother downsampled dataset

- But, if the spikes are real, it is more appropriate to use **mean**



RPCLAP-EU-YK-003: unclear documentation

2.2.3 Photoelectron knee potential

An automated routine analyses every LAP1 voltage sweep (i.e. when the current is measured for a range of voltages) to find characteristic regions in the sweep. The spacecraft potential is estimated from a "knee" in the sweep from a sunlit probe arising from the fact that all photoelectrons escape a probe when it is negative with respect to its surroundings, but not at higher voltages. This knee ($\boldsymbol{V_{ph}}$) therefore marks the point where the potential between the probe and the surrounding plasma is 0 V, and can be found by locating a local maximum in d^2I/dV^2 [RD10]. The algorithm does this by filtering/smoothing the data, which may reduce the accuracy and introduce artifacts in individual analyzed result, but provides a sufficiently stable estimate during the entire mission. The filtering is especially important in tenuous plasmas where currents are close to the instrument resolution level, and during disturbances from other sources.

With the sign convention we use, the photoelectron knee is a direct proxy for the spacecraft potential, $\boldsymbol{V_{SC}}$, between the spacecraft and the plasma [RD8]. Corrections to $\boldsymbol{V_{ph}}$ for obtaining a better value of $\boldsymbol{V_{SC}}$ are studied in RD7 and RD8. To avoid confusion, no such corrections have been attempted on these data.

Standard quality flags are provided for the sweep as a whole (Section 3.2.2). Each individual parameter, including this one, also has a quality value assigned. Various algorithms for this are still under evaluation, and the value currently given is 1.0.

??

RPCLAP-EU-YK-003: unclear documentation

$$\mathrm{A_p} q_i n_i \sqrt{\frac{E_i}{m_i}} \times \frac{eV_p}{E_i} \,,$$

where $\mathrm{A_p}$ is the cross-sectional area of the probe, n_i is the ion number density, m_i is the ion mass, q_i is the ion charge and E_i is the effective energy of the incoming ions, dependent on thermal and flow velocity. By performing a linear least-squared-distance fit of this region to get an estimate of the slope, and using the simultaneous RPCMIP electron density, assuming quasi-neutrality and an effective ion mass of 19 a.m.u., we can estimate the effective energy of the ion. Taking $E_i = 0.5 m_i v_i^2$, we obtain an effective ion bulk velocity. This is performed for every sweep on LAP1, if there is a simultaneous MIP density estimate. The quality value of this output depends on the MIP input quality value, and the LAP analysis performance.

2.2.10 *Electron Temperature, Method 1*

The nomenclature of "Electron Temperature" (T_e) is to be understood as the characteristic energy of the Maxwellian distribution approximation of the bulk cometary or interplanetary plasma. When the Langmuir probe absolute potential ($\boldsymbol{V_p}$) between the probe and a plasma at infinity is below 0 V, the electron current I_e to the probe is governed by a retarding exponential

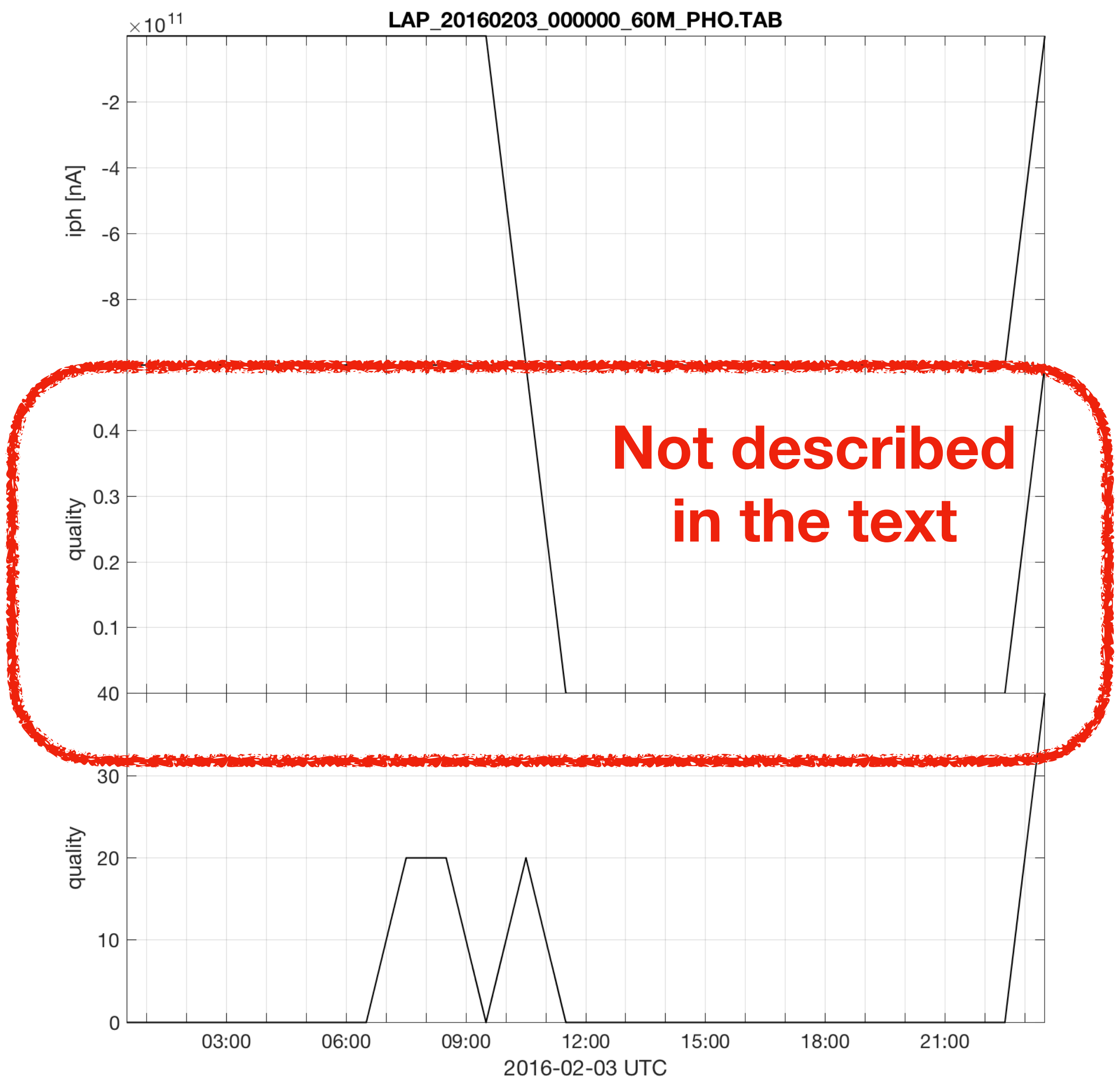
$$\exp\left(\frac{eV_p}{k_B T_e}\right) ,$$

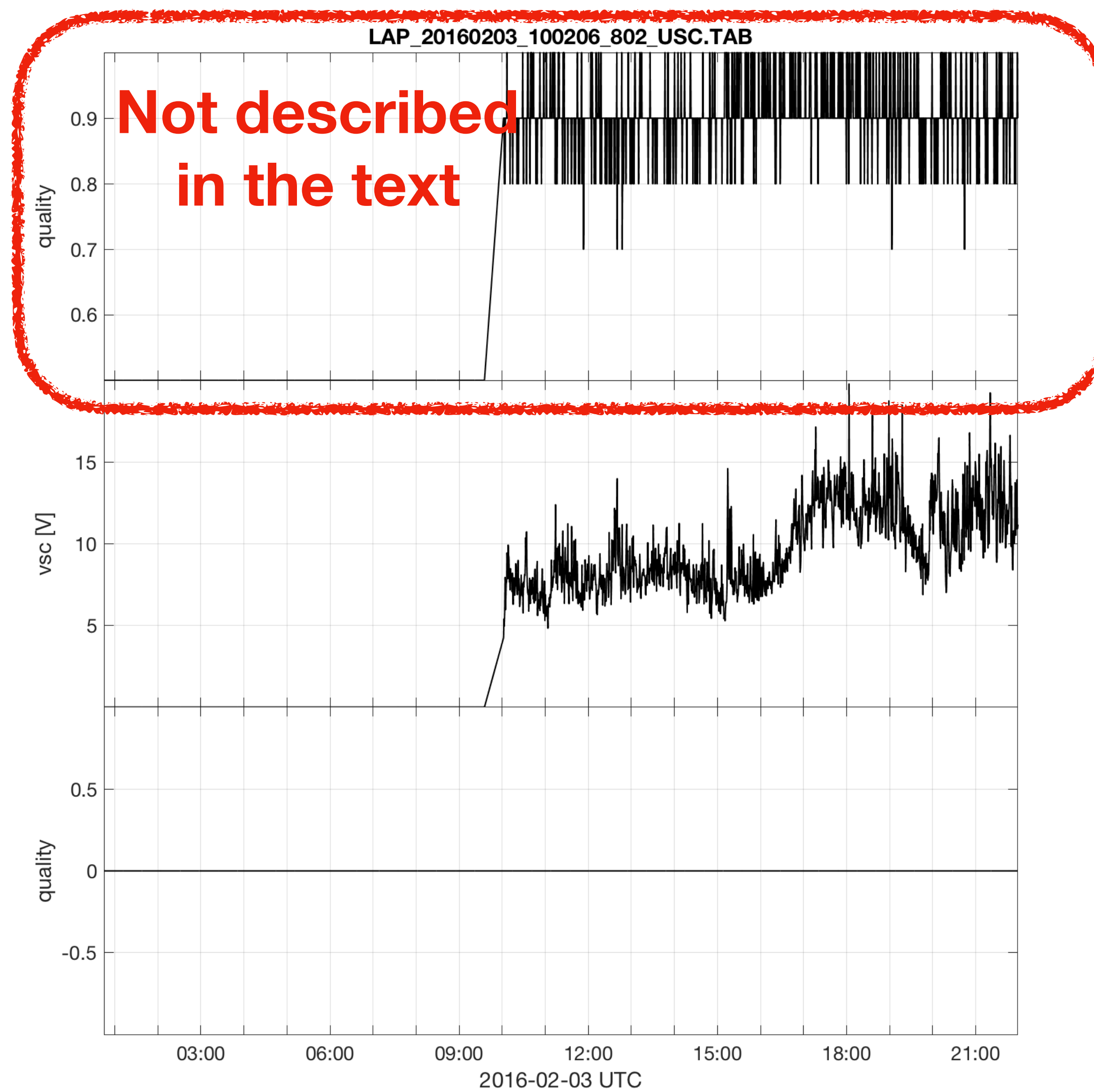
I_e ~ exp(eV_p/…)

where e is the fundamental charge of an electron and k_B is Boltzmann's constant [RD9]. By identifying and removing other currents such as ion current and secondaries, we select a region of retarding electron current and perform a fit to identify T_e. The ion current is identified with a linear fit in this region and if the probe is sunlit, the region of the retarding electron current fit is further constrained to a region below $\boldsymbol{V_{ph}}$ where the photoelectron current can be assumed to behave only as an offset, and is removed by identifying this offset.

2.2.11 *Electron Temperature, Method 2*

RPCLAP-EU-YK-003: unclear documentation





RPCLAP-EU-YK-003: unclear documentation

Analysed Sweep parameters (ASW) and RPCMIP data (for cross-calibrated data)	1	UTC time	**LAP_** *CCYYMMDD_hhmmss_iii* **_ASW**
	1	OBT time	
	1	Electron density; cm^{-3}	
	1	Quality value	
	1	Photosaturation current, method 2; A	

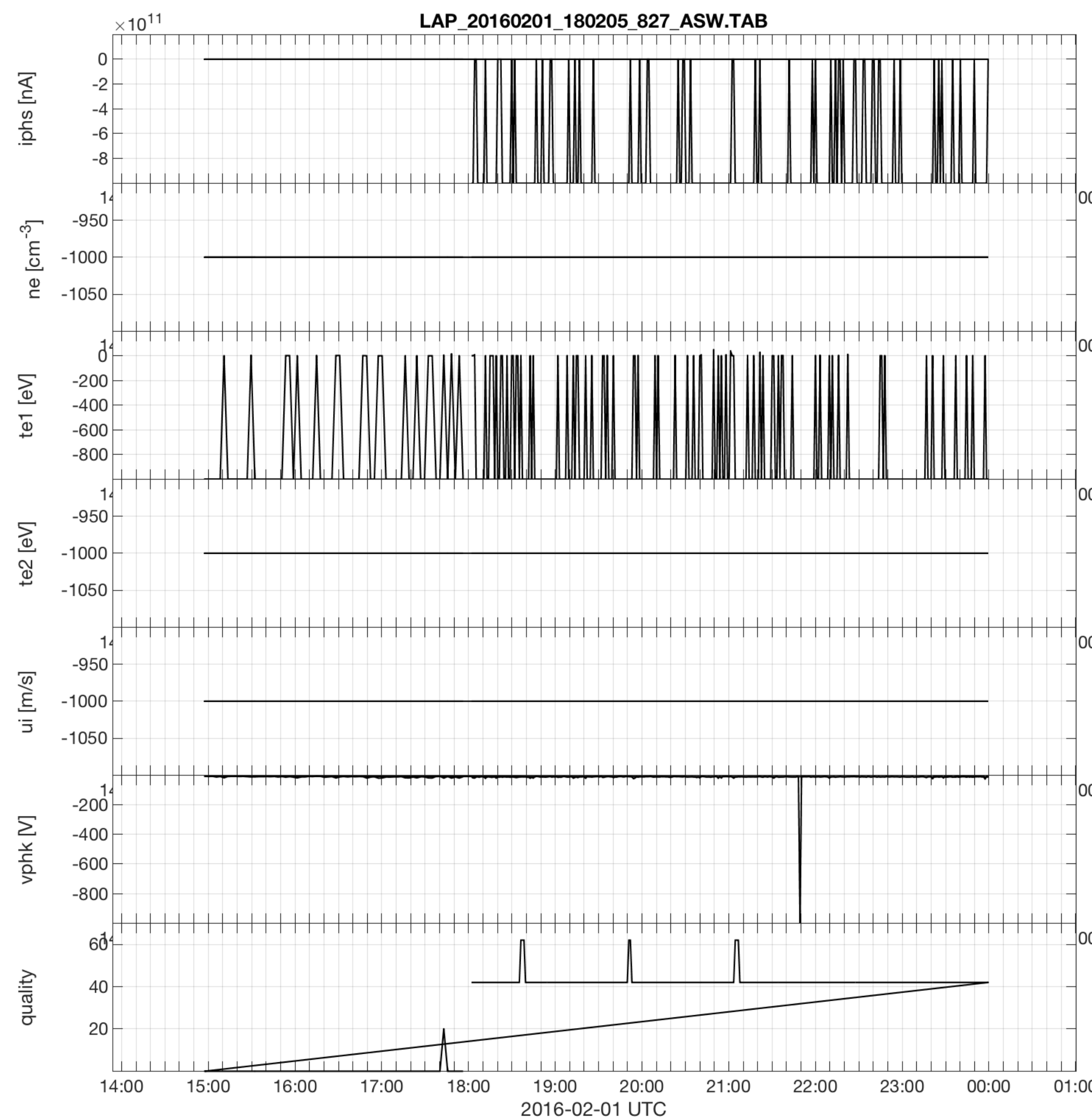
UTC/OBC times must be start/stop pairs

RPCLAP-EU-YK-004: missing data

- **USC** missing for some days
- **NPL** missing completely

RPCLAP-EU-YK-005: errors in ASW product

- wrong time order in some files (i.e. LAP_20160201_180205_827_ASW.TAB),
- data from wrong day (e.g. LAP_20160202_000000_827_ASW.TAB)
- some quantities are alway constant (fill?) values, e.g. Ne, Te2



RPCLAP-EU-YK-006: Quality parameters not implemented (DERIVED)

- Apart from PHO & USC, all products have a placeholder for quality.

END