DWE Health Report

This document provides a summary report on the performance of the DWE Ultra-Stable Oscillators (USOs) during the Huygens mission.
The original intention of DWE was to measure the carrier frequency of the Huygens channel A signal aboard Cassini. Tracking the signal with Earth based telescopes was planned as a secondary alternative for redundancy and to seperate the two horizontal Huygens velocity components. It was, however, not clear a-priori that the signal would be strong enough at Earth to provide a useful ground-based data set. Unfortunately, the sequence to be executed by Cassini during the Huygens mission did not contain the command to switch on the receiver USO (RUSO). The reason for this fatal flaw has been investigated by a joint ESA/NASA task force and can be summarized by insufficient communication between NASA, responsible for the development of this sequence, and ESA, responsible for testing and verifying this sequence. As a consequence of the incorrect sequence, the receiver channel A did not have a reference frequency and could thus not lock on the channel A signal from Huygens. This behavior is displayed in Figs. 1 and 2. These figures show link parameters of the Probe Support Equipment (PSA) aboard Cassini, as well as the measured carrier frequency (f_R, panel 1) and the received signal level (AGC, panel 4). The carrier lock status of cannel A (Fig. 1, 6th panel) remained at 0 (not locked), whereas for channel B (Fig. 2), all relevant link parameters switched to 1 (locked) at t_0.
Nevertheless, the transmitter USO (TUSO) operated nominally, as can be seen in Fig. 3. This figure shows again the received channel A carrier frequency (f_R) and the received signal level (AGC). Panels 3-6 show the RUSO relevant parameters, obtained from the PSA aboard Cassini. It can be seen that the RUSO was selected (panel 5), but not powered (panel 6), leading to the loss of channel A. If it had not been selected either, the radio system would have automatically selected the backup chrystal oscillator instead. As this oscillator has an accuracy not sufficient for DWE, the Cassini-based DWE would have been lost too, but at least the data from other experiments would have been rescued.
The TUSO relevant parameters are plotted in panels 7-14 of Fig. 3. Some of these were transmitted via channel A only and are thus lost (no data in the corresponding panels). Others were transmitted via channel B only (solid lines), or via channel A (lost) and redundantly via channel B (dashed lines). In particular, the TUSO lock status (panel 13) indicates that the TUSO was permanently locked internally and thus provided a stable signal frequency throughout the entire descent. The TUSO was powered via two independent lines, the so called nominal line (panels 9 and 10) and the redundant line (panels 11 and 12). The nominal line cannot be evaluated, but the redundant line shows the expected behavior. Also, the internal TUSO temperatures (panel 7) are as expected (almost identical to the temperatures observed e.g. during in-flight checkouts). The temperature of the TUSO box (panel 8), measured by a thermistor next to the TUSO box, has an initial value of 32.5°C. During the descent, it decreased to 22.5°C, and after impact, it decreased further to 17.5°C. This behavior is in agreement with the expectations, although the absence of thermal equilibrium makes it difficult to estimate the accuracy of this measurement.

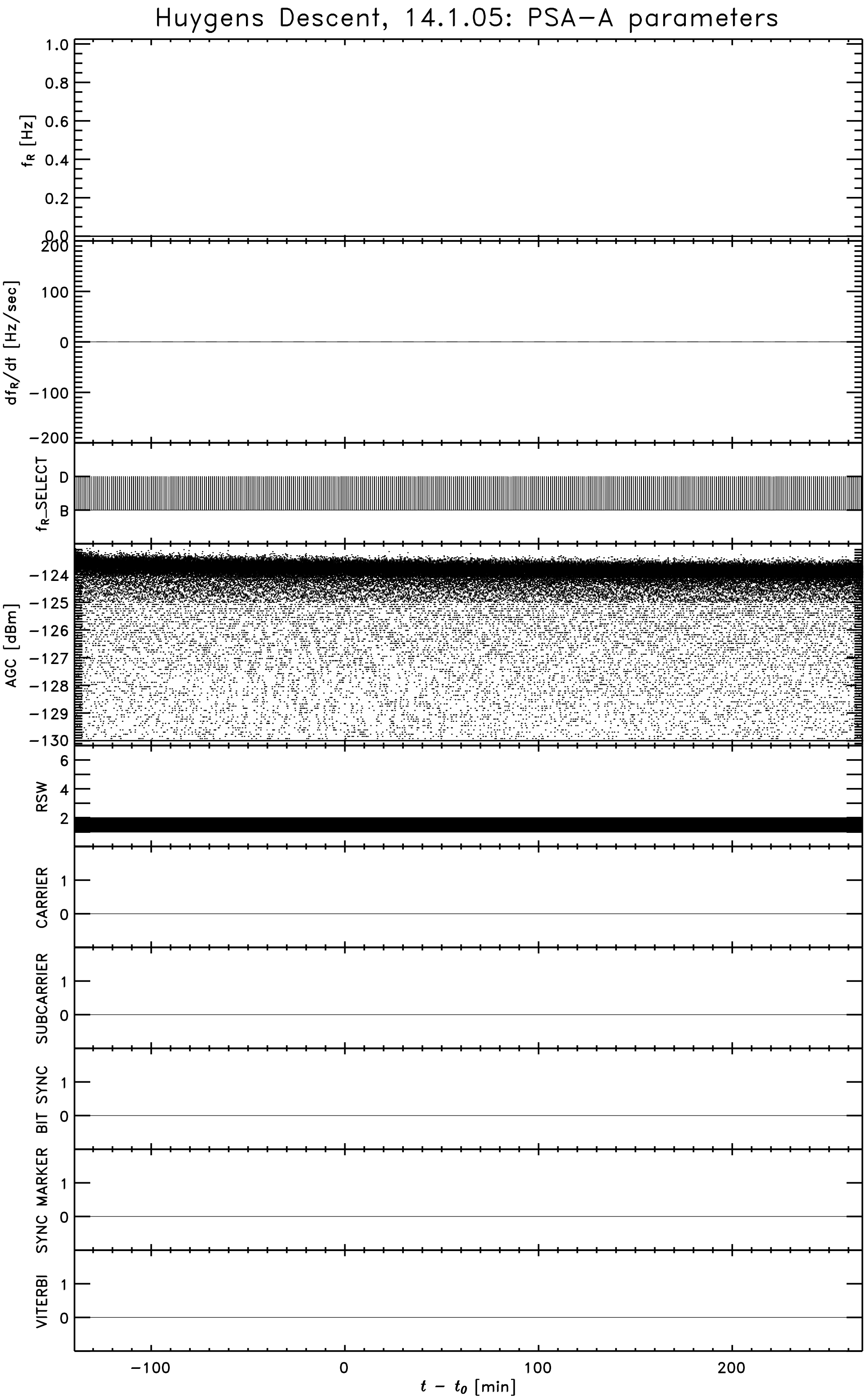

Figure 1: Link parameters for channel A

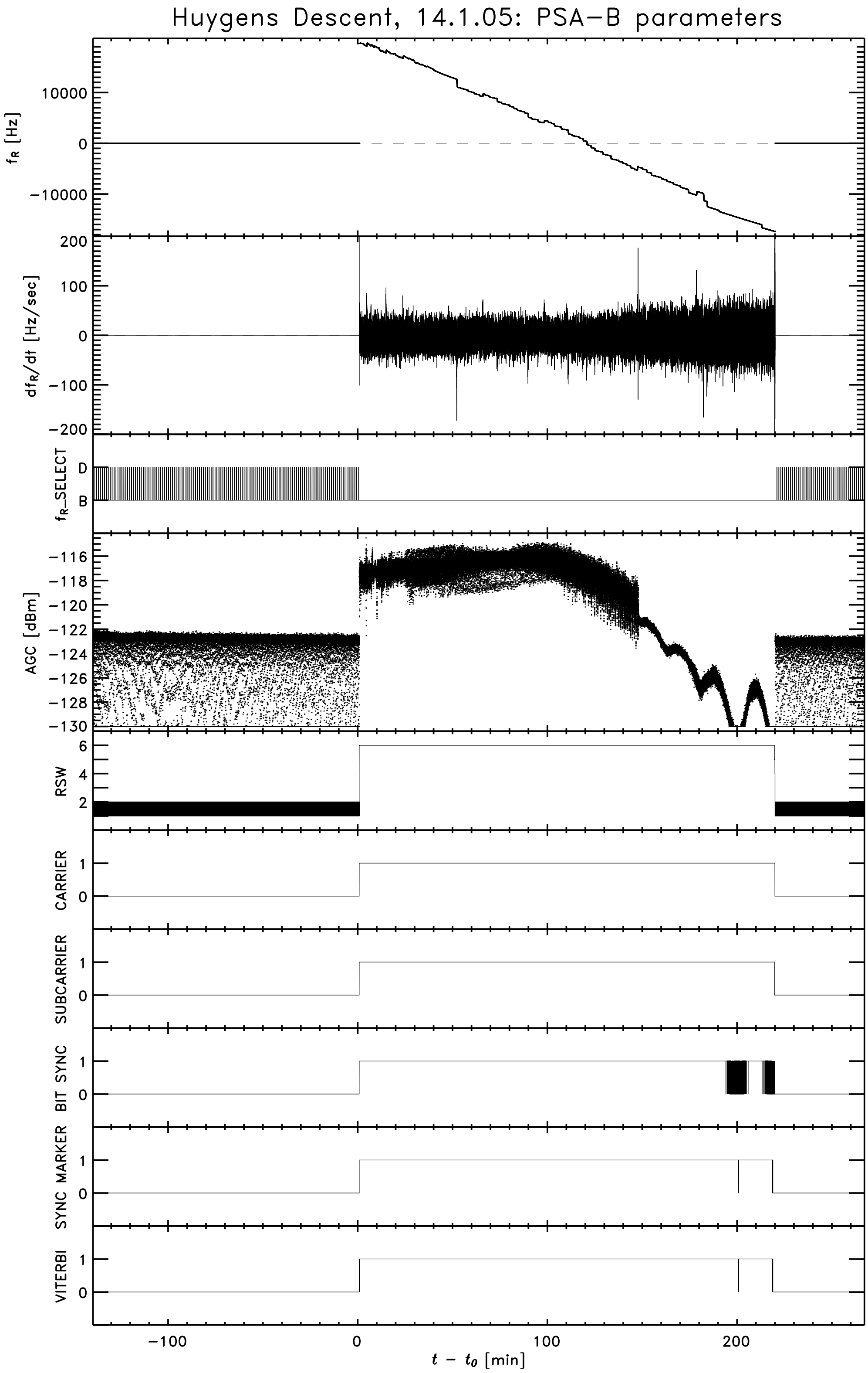

Figure 2: Link parameters for channel B

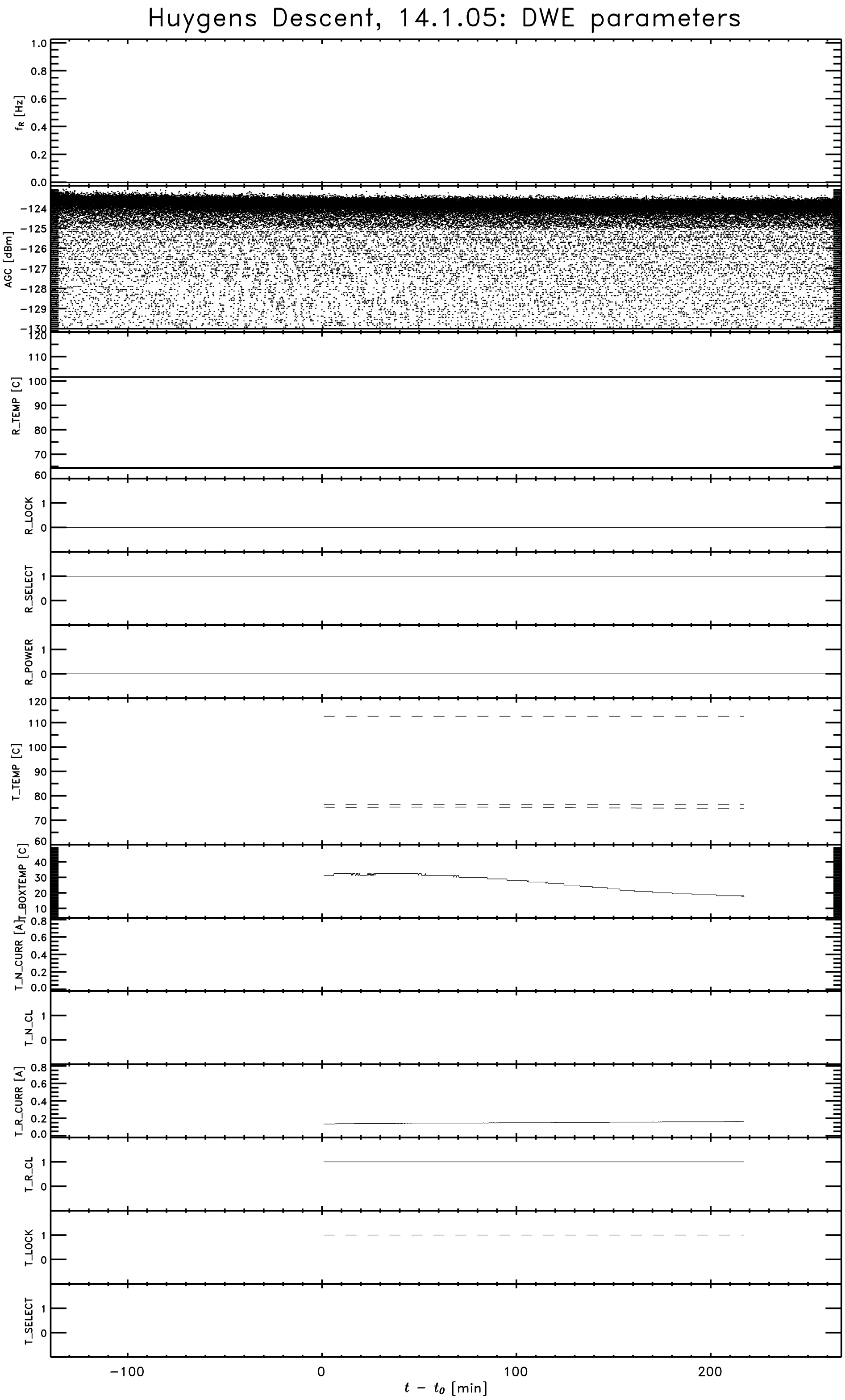

Figure 3: USO performance parameters