1. INTRODUCTION

Water is a limited resource on the International Space Station (ISS). Orbiting crew members need to recycle water however possible, and this includes (gulp) recycling their own urine. The Urine Processor Assembly (UPA) provides the vital equipment for urine processing on the ISS. It extracts water from urine via vacuum distillation. This water is combined with recaptured water from the crew cabin heat exchanger and undergoes further treatment in the Water Processor Assembly (WPA) and ultimately becomes crew drinking water as part of the potable water system for the space station. The UPA is complex hardware operating in a harsh environment. It can sometimes need special attention, for example the following information was reported on GMT 2019-01-16:

Urine Processor Assembly (UPA) Belt Slippage – Overnight UPA was commanded to Operate and towards the end of the initial Distillation Assembly (DA) spin up, the DA speed dropped significantly and did not recover. UPA briefly made it to Normal before going to Shutdown. A Pressure Control and Pump Assembly (PCPA) pumpdown was performed to bring pressure below 24 mmHg, and this successfully sent UPA back to Operate.

Urine Processor Assembly (UPA) Sensor Disagreement - After UPA completed a process cycle down to 2%, a few error codes were received shortly after UPA transitioned to Standby. This resulted in UPA transitioning to Shutdown and a flag set for Node 3 UPA Pretreated Urine Bus Unavailable. This condition was a transient, so the Urine Bus Unavailable Flag was cleared, and UPA was returned back to Standby, thereby clearing the error codes. This incident will be investigated by a team on the ground.

A handbook document that previously described routine operations of the UPA from the vibratory acceleration environment perspective – see this link for some interesting details.

2. QUALIFY

Figure 1 on page 2 is a color spectrogram computed from Space Acceleration Measurement System (SAMS) sensor 121f08 measurements made in the Columbus module (COL) during the overnight period mentioned in the Introduction section. The horizontal, white arrow annotation on Figure 1 points to just before the start of the 3.6 Hz narrowband signature associated with UPA ops, starting at about GMT 03:37. The smaller, red arrow attempts to point out, at about GMT 05:46, when either the crew awoke prematurely causing some broadband occlusion of the clean narrowband UPA signature or when the UPA started operating differently or the start of something completely different and perhaps unrelated. For now, it is unclear from these vibratory measurements alone which was the case.

For more of a complete picture, Figure 2 through Figure 4 on page 3 through 5 are spectrograms for SAMS sensors in the US LAB, US LAB and JEM, respectively.

3. QUANTIFY

Figure 5 on page 6 shows acceleration interval Root-Mean-Square (RMS) values versus time. These RMS values correspond to a tight frequency band around the UPA narrowband spectral peak. The frequency band ranges from 3.5 to 3.7 Hz and the RMS values were computed from SAMS sensor 121f05 measurements made in the JEM during the same span as the spectrogram of Figure 4. The upward, magenta arrow shows the start time for the narrowband UPA spectral signature at about 3.6 Hz. Before the UPA started, the baseline RMS value was about 1.5 μg_{RMS} and this value stepped up to just about 2.5 μg_{RMS} starting at GMT 03:37. This is shown along with other SAMS sensors in Table 1 below, where the UPA starts at about GMT 2019-01-16 / 03:37.

Table 1. Interval acceleration RMS step when UPA starts for 4 SAMS sensors.

Sensor	Before UPA (μg_{RMS})	During UPA (μg_{RMS})	Location
121f03	2	2.75	LAB1O1 (ER2)
121f04	2	3.25	LAB1P2 (ER7)
121f05	1.5	2.5	JPM1F1 (ER5)
121f08	1.25	1.4	COL1A3 (EPM)

4. CONCLUSION

The RMS results presented here show that the two SAMS sensors in the US LAB and one in the JEM tend to experience higher RMS values while the UPA ops are active relative to that registered by the SAMS sensor in the Columbus module. It was not evident from the analysis done here (yet) what impact the UPA belt slippage had on the vibratory environment.

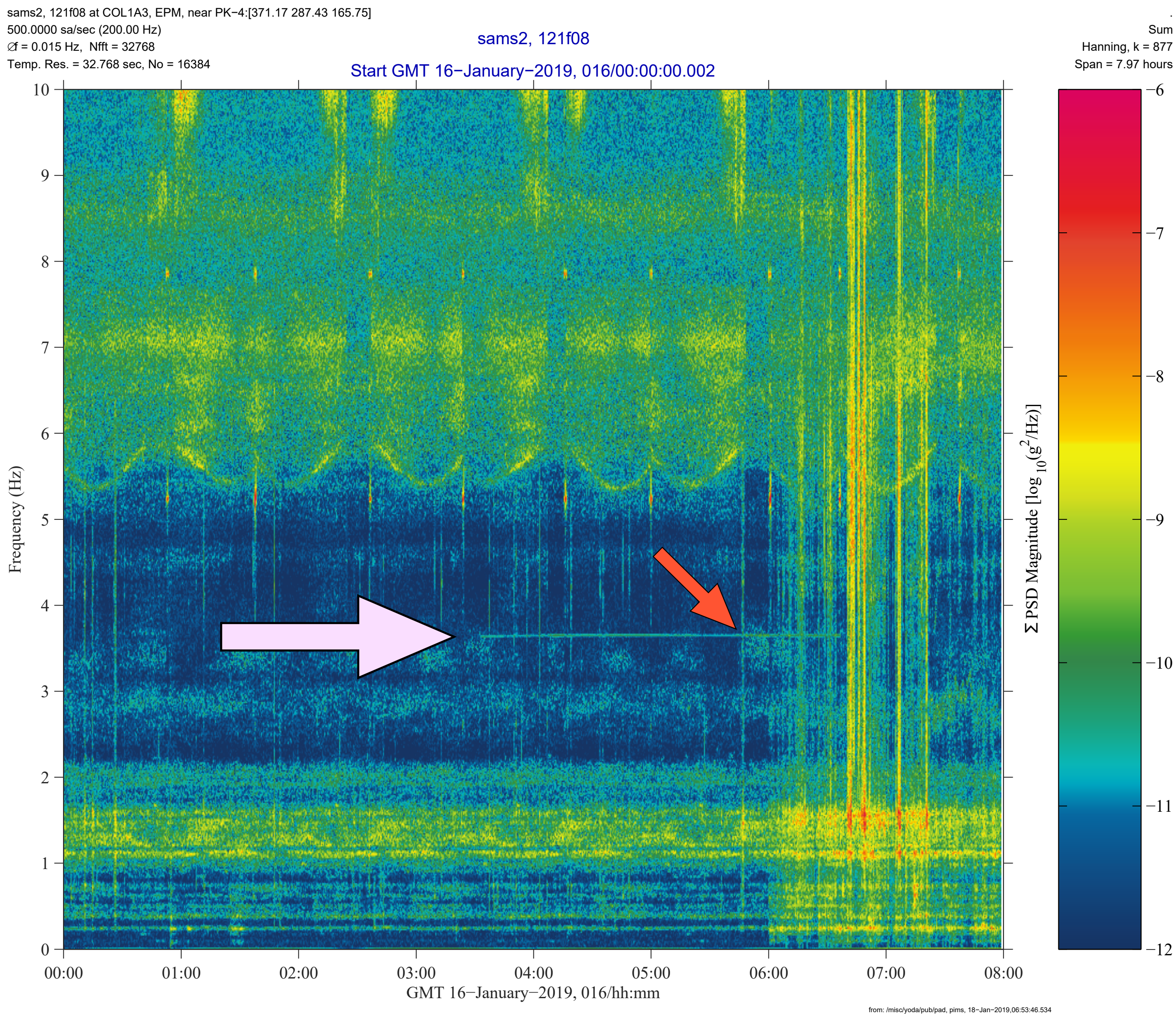

Fig. 1: Spectrogram showing UPA signature near 3.6 Hz via SAMS sensor (121f08) in COL.

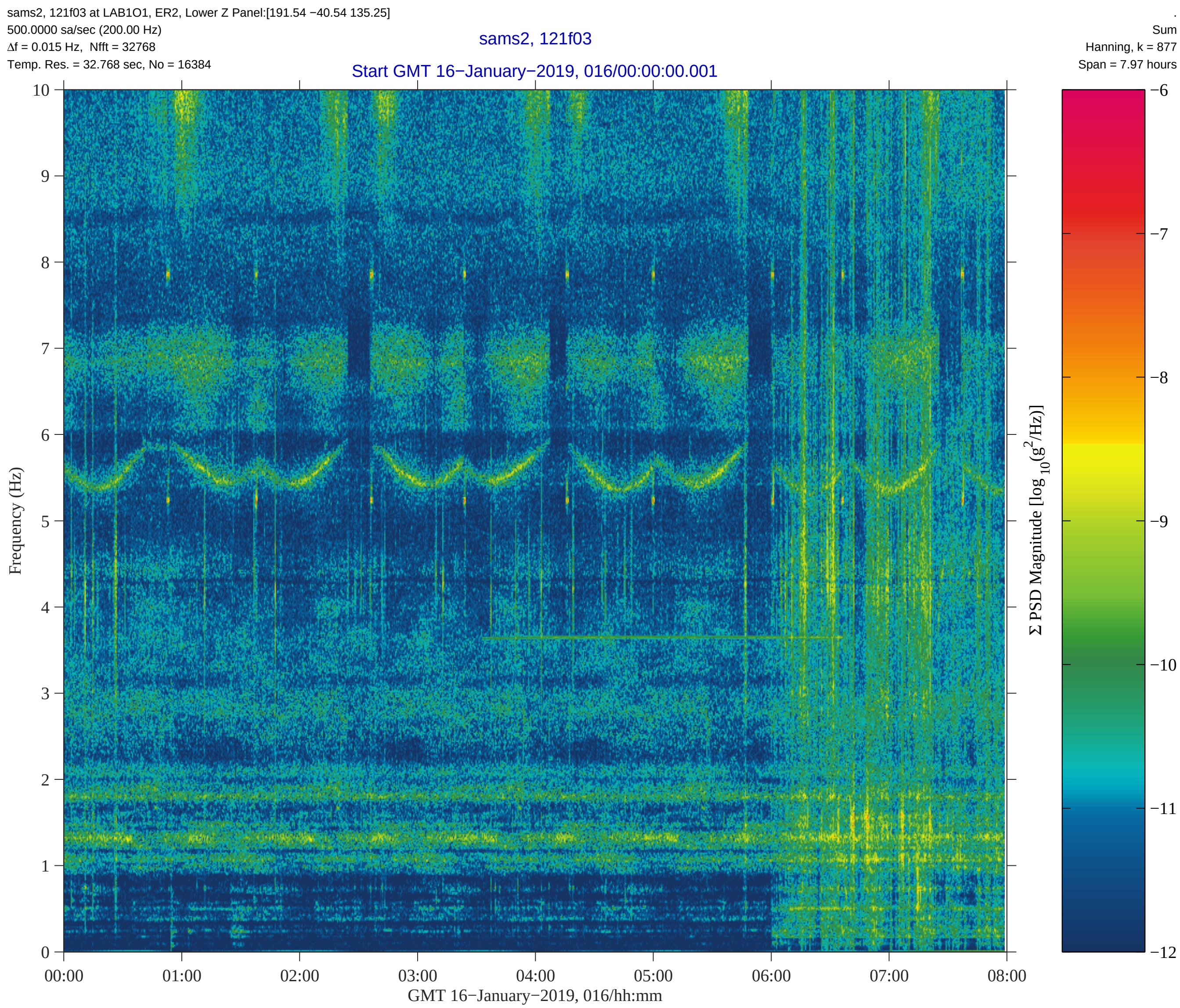

Fig. 2: Spectrogram showing UPA signature near 3.6 Hz via SAMS sensor (121f03) in LAB.

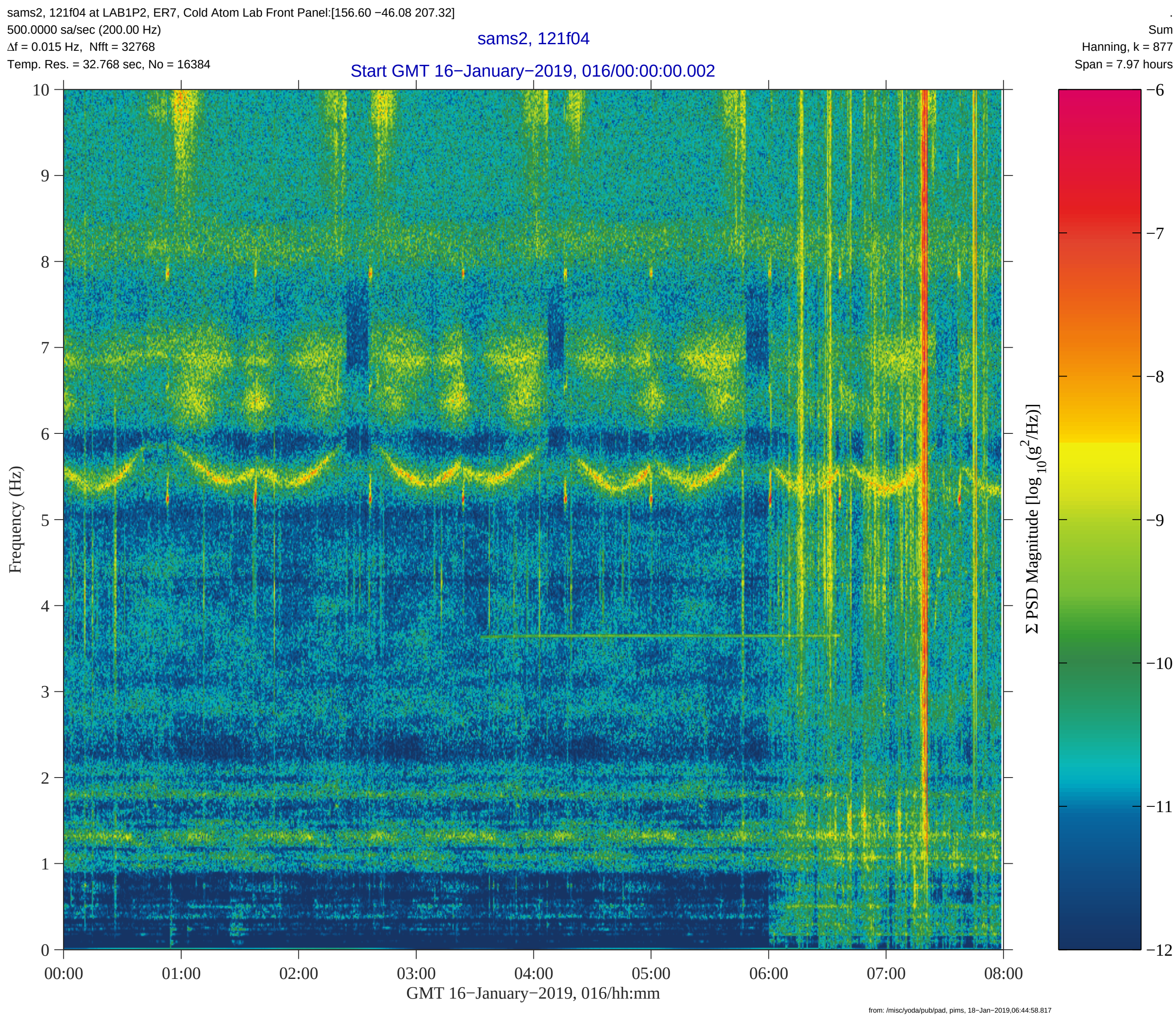

Fig. 3: Spectrogram showing UPA signature near 3.6 Hz via SAMS sensor (121f04) in LAB.

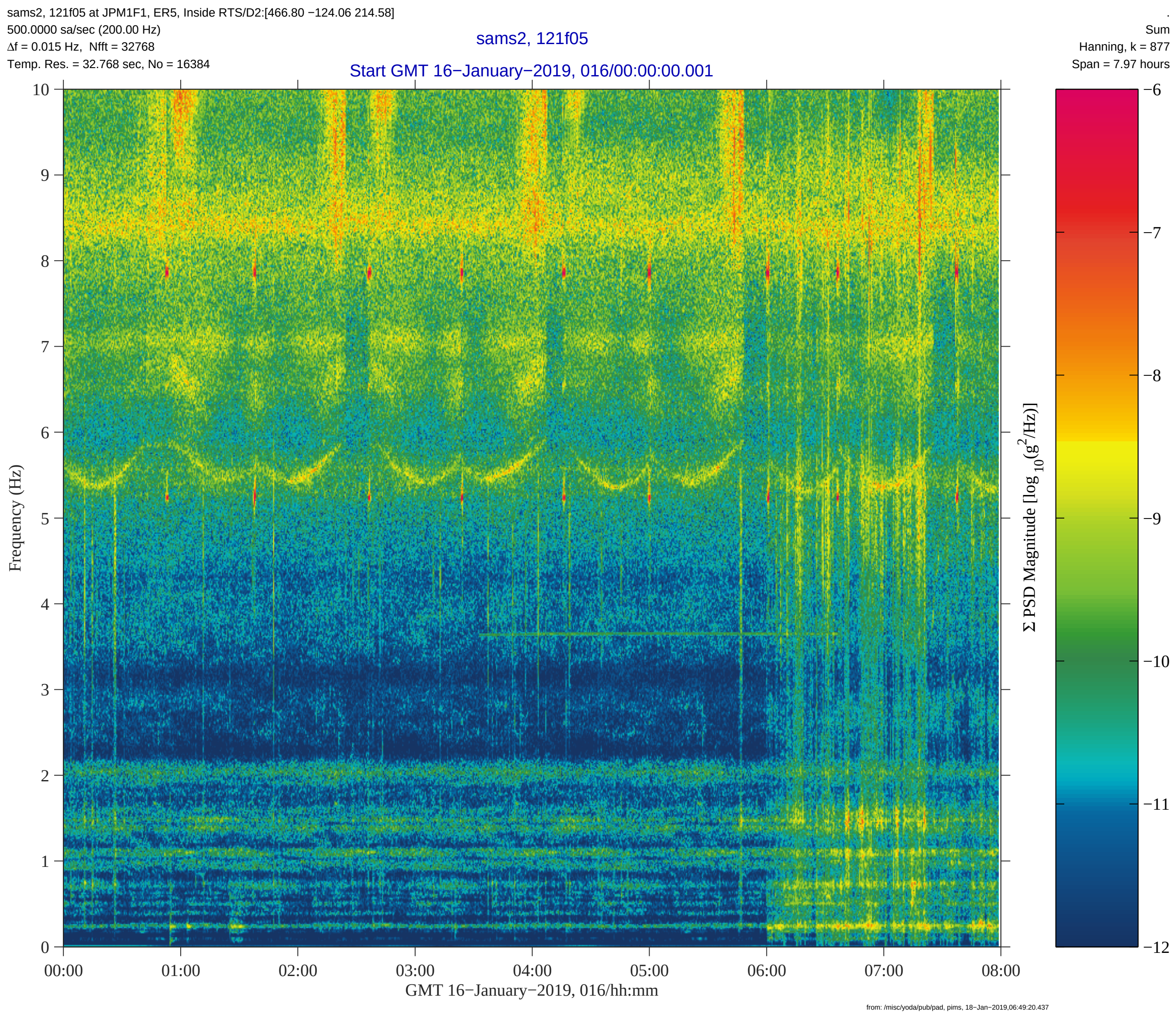

Fig. 4: Spectrogram showing UPA signature near 3.6 Hz via SAMS sensor (121f05) in JEM.

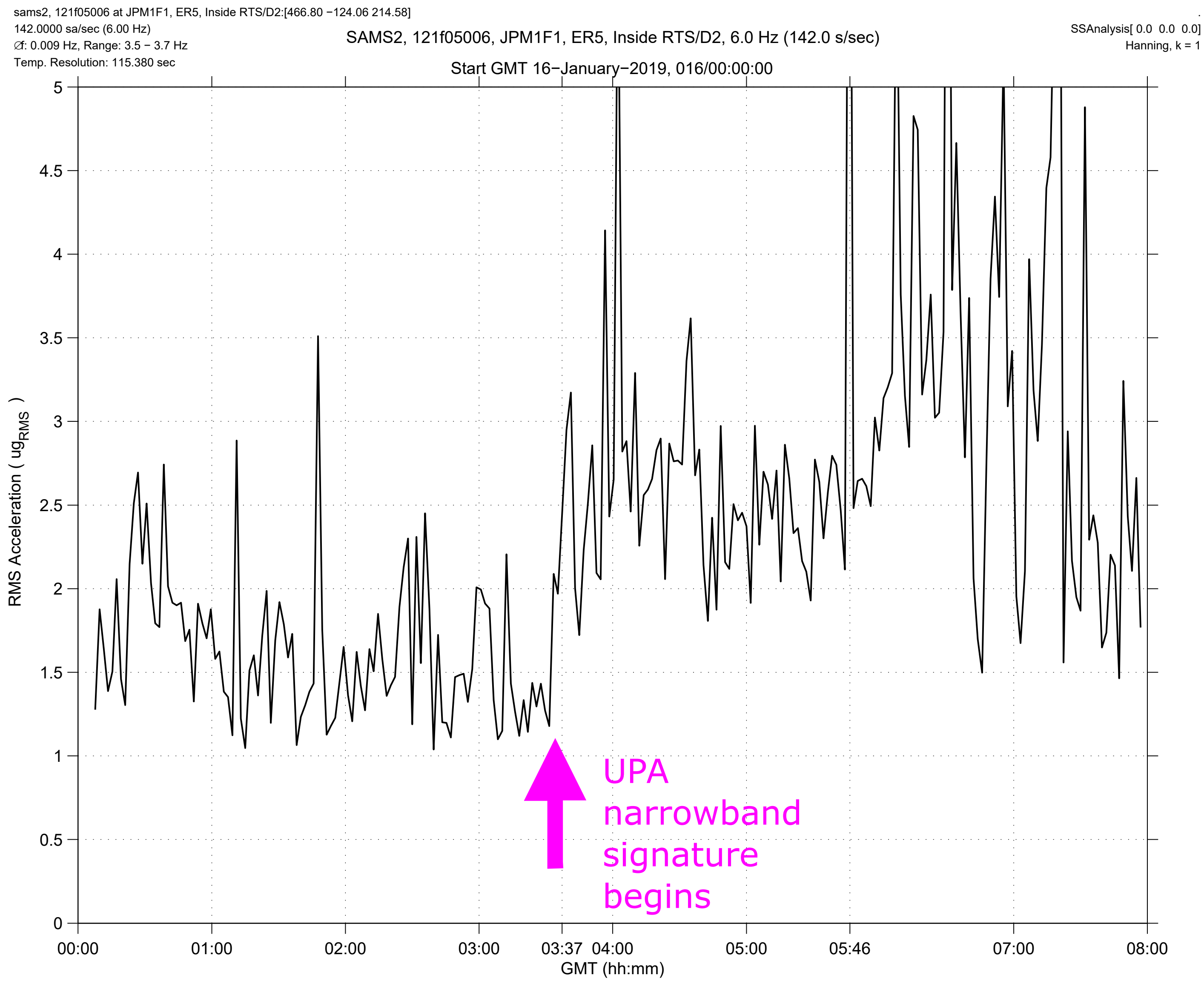

Fig. 5: Interval RMS (3.5<f<3.7 Hz) showing UPA contribution via SAMS sensor (121f05) in JEM.

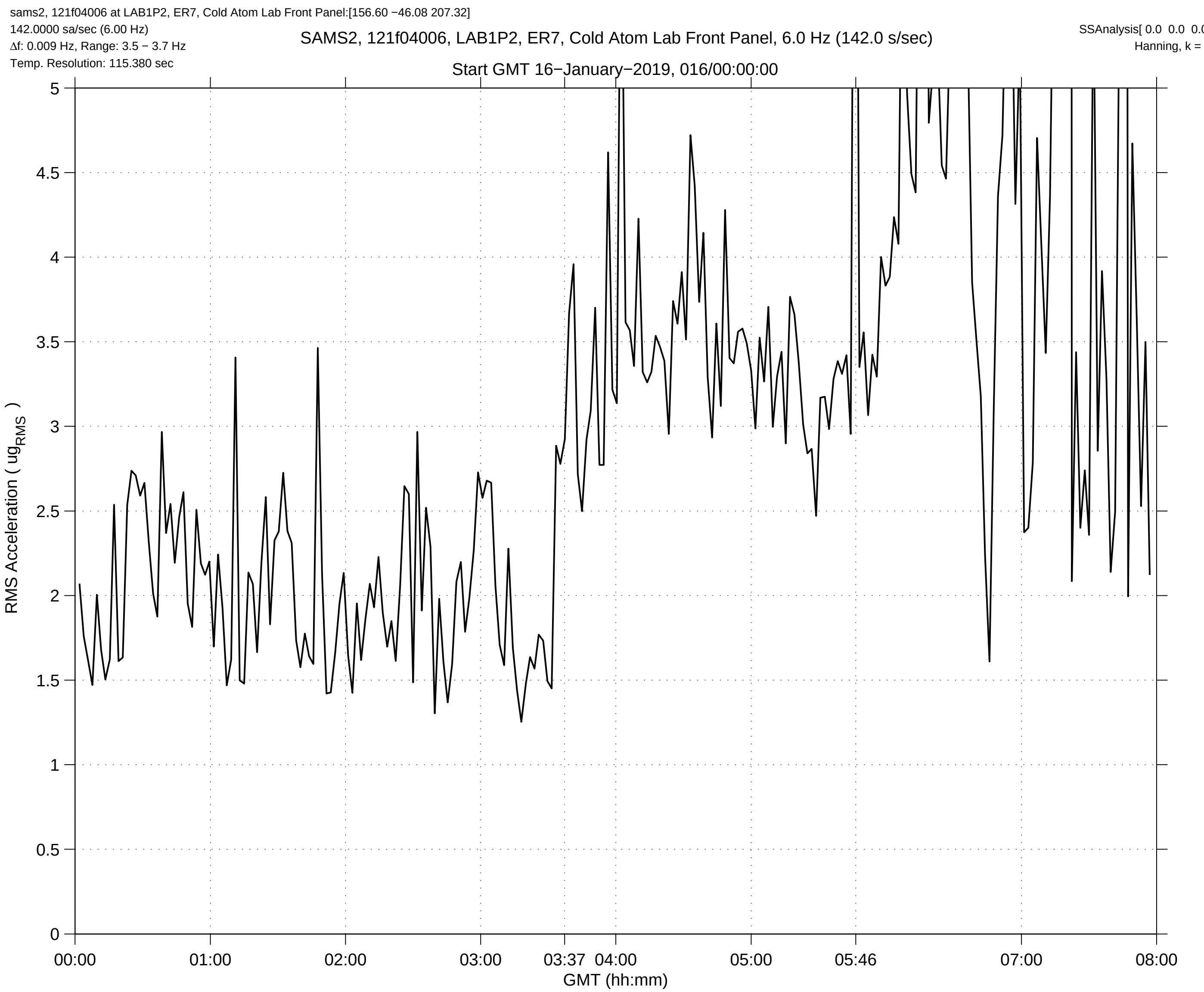

Fig. 6: Interval RMS (3.5<f<3.7 Hz) showing UPA contribution via SAMS sensor (121f04) in LAB.

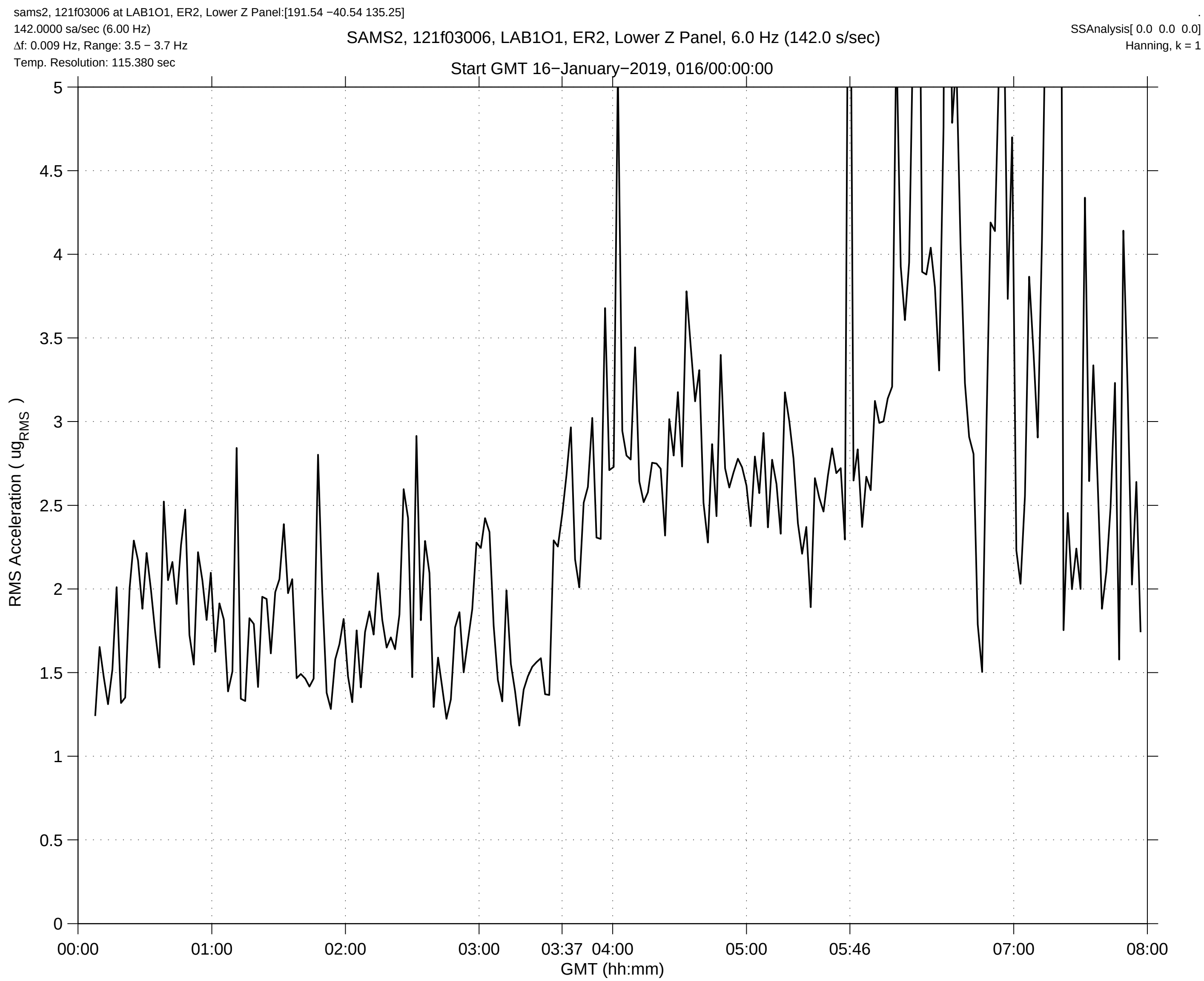

Fig. 7: Interval RMS (3.5<f<3.7 Hz) showing UPA contribution via SAMS sensor (121f03) in LAB.

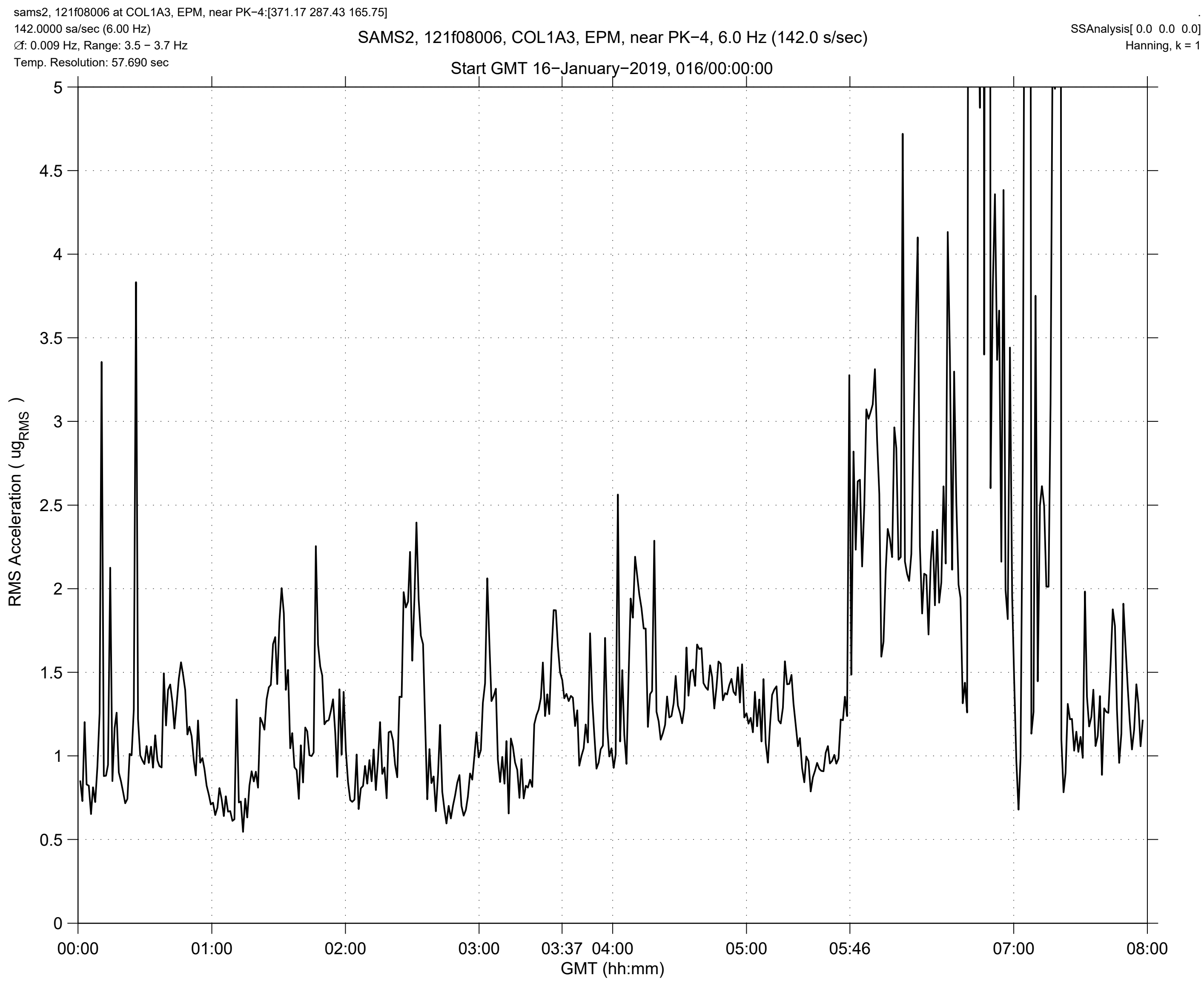

Fig. 8: Interval RMS (3.5<f<3.7 Hz) showing UPA contribution via SAMS sensor (121f08) in COL.