1. KEY POINTS

This document is a follow-up to the "Dragon Dockings" document (see link in the Introduction section below). Here, we use similar plotting conventions and low-frequency emphasis, but focus here on the key points associated with "Service Module, Aft Port" **Progress 93P docking** event on **GMT 2025-09-13**.

- **Why the 6 Hz View** As in the Dragon docking document, we emphasize *6 Hz low-pass filtered* acceleration to suppress localized higher-frequency content and isolate the global, low-frequency structural response most characteristic of a docking disturbance.

- **Primary Onset ("First Bump")** In the data set used to generate the included plots, the most prominent onset consistent with docking occurs near **2025-09-13 17:24 GMT** and is strongest along the *+X* **axis** (SSA body axes). Makes sense since the Progress approaches from and docks to the aft end of the Service Module. The as-flown timeline shows Progress 93P *"Docking at 17:27:21"* whereas SAMS measures this "first bump" at 17:23:38, about 4 minutes earlier. It is unclear (to me) if this is intended to allow or account for settling of relative motion between the 2 vehicles or otherwise.

- **Docking Signature Characteristics** The event appears as a short, highly-directional impulsive onset followed a few seconds later by a second (oppositely-directed impulse), then by low-frequency, 0.17 Hz structural response that decays over several minutes, consistent with global ISS structural excitation. The initial acceleration impulse along the +X axis, aligns with the physical geometry shown in the artist rendering – Figure 1 (page 3). Per the Space Station Analysis (SSA) coordinate system, the +X axis defines the forward flight direction. Because the Progress 93P vehicle docked at the *Service Module, Aft Port*, the docking force was applied to the "rear" of the station, driving the global structure forward along the longitudinal axis. This results in the "first bump" manifesting as a positive X-axis impulsive onset, followed by a characteristic 0.17 Hz structural ring-down as the largest structures of the ISS dissipate the sudden stimulus energy. Longitudinal alignment is visually confirmed during final approach phase as captured in Figure 2, which shows the Progress Kurs navigation overlay. The pilot or automated system aligns the gold crosshairs (Progress camera view) with the docking target (affixed to the Service Module). Once centered, the vehicle maintains a constant velocity until the capture mechanism engages.

2. INTRODUCTION

This short document is a follow-up to the "Dragon Dockings" document, which can be downloaded from this link: four Dragon dockings.

Here, we apply the same low-frequency-focused view to characterize the **Progress 93P docking** event on **GMT 2025-09-13**, using SAMS acceleration measurements and the same conventions for identifying the earliest clear global-response onset ("first bump").

Figure 1 (page 3) is an annotated artist rendering that identifies the location of where the Progress 93P vehicle docked with respect to context of the rest of the ISS and the SSA coordinate system.

The data plot figures included in this document were generated for two SAMS sensor heads located in the US LAB (121f03 at LAB1O1, and es20 at LAB1S2). The first data plot figure provides a time-frequency overview; the latter two provide short, per-axis acceleration versus time around the event to illustrate onset directionality and low-frequency ring-down behavior.

3. QUALIFY

Figure 3 provides a structural-mode regime spectrogram view below 2 Hz, which is of keen interest for docking disturbances. The visually dominant feature is the short-duration onset ("first bump") followed by excited/elevated 0.17 Hz ringout, which decays with time.

Because the ISS is a distributed structure, response details vary with sensor location; however, the low-frequency docking signature is expected to remain globally observable, with the most prominent axis depending on docking geometry and location.

4. QUANTIFY

Figures 4 and 5 provide short, per-axis acceleration versus time views centered on the event. These plots are intended to make the onset directionality and subsequent decay in the structural regime clearly discernible.

For this Progress 93P docking case, the "first bump" is expected and observed predominantly along the +X axis in the SSA convention, consistent with the qualitative directionality expectation used when screening for the event.

5. CONCLUSION

In the included spectrogram and time-series views (for 2 US LAB sensor heads), the Progress docking event manifests with a clearly impulsive onset ("first bump") followed by a second bump about 3.3 seconds later followed by decaying low-frequency (0.17 Hz) response. For this case, the most prominent onset is observed along the +X axis as the Progress docks to the aft end of the ISS. This low-frequency perspective remains the most interpretable view for vehicle-level structural response and for users needing a conservative disturbance-onset marker.

Table 1. Progress 93P Docking Event Summary Metrics

Metric	Observation
Docking Event Date	2025-09-13
Docking Port	Service Module, Aft Port
Primary Accel Axis	+X (SSA body axes)
As-Flown Timeline	17:27:21 GMT
SAMS Measured 1st Bump	17:23:38 GMT
SAMS Measured 2nd Bump	~3.3 seconds after 1st bump
Ring-down Frequency	0.17 Hz
Low-Pass Cutoff Frequency	6 Hz

6. SPECULATION ON DOCKING-PORT CAPTURE DYNAMICS

The detailed mechanics and compliance of the Service Module aft docking system are not known to this author, so the interpretation below is provided as plausible speculation only.

SAMS indicates a second impulsive feature approximately ~3.3 seconds after the initial contact signature, and in the opposite direction. One possible explanation is mechanical play ("slop") and/or compliance in the capture mechanism: the initial contact drives motion into one side of the capture interface, then the relative motion is taken up across the available clearance and the stack responds by contacting the opposing side. Under this interpretation, the apparent "rebound" is not a free-flight separation; it is a direction reversal associated with taking up backlash/clearance within the capture mechanism as it transitions toward a more constrained configuration.

The as-flown timeline notes "docking" approximately 4 minutes after the first SAMS bump. A plausible interpretation is that the timeline docking time corresponds to a later operational milestone (e.g., completion of capture/hard-mate or a post-capture stabilization step) rather than the earliest structural-contact onset. The intervening minutes could therefore reflect an intentional settling period to reduce residual relative motion between the two vehicles before proceeding to subsequent post-docking activities.
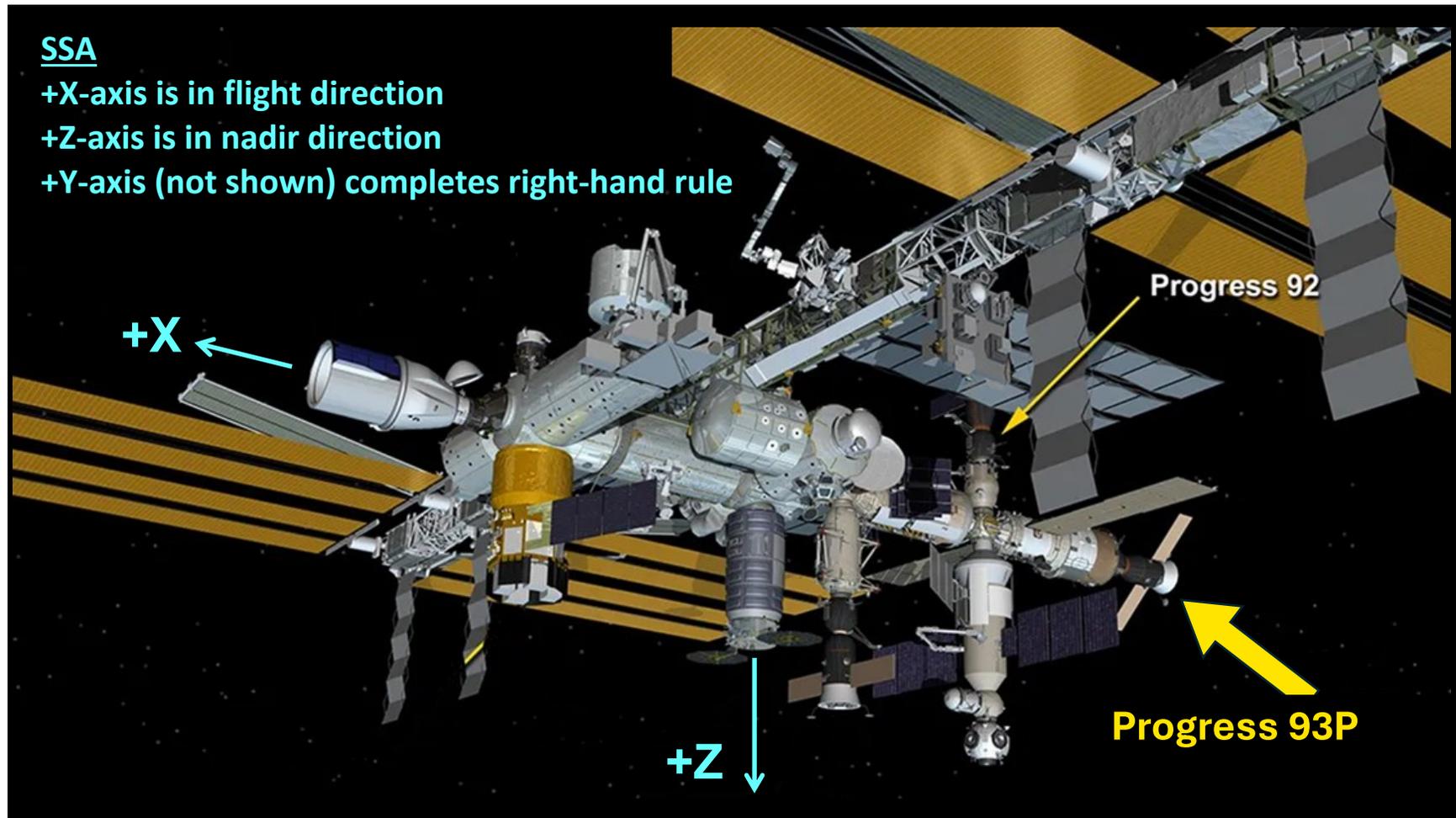
Fig. 1: Progress 93P Shown Already Docked at Service Module Aft Port and in Context of Space Station Analysis (SSA) Coordinates.
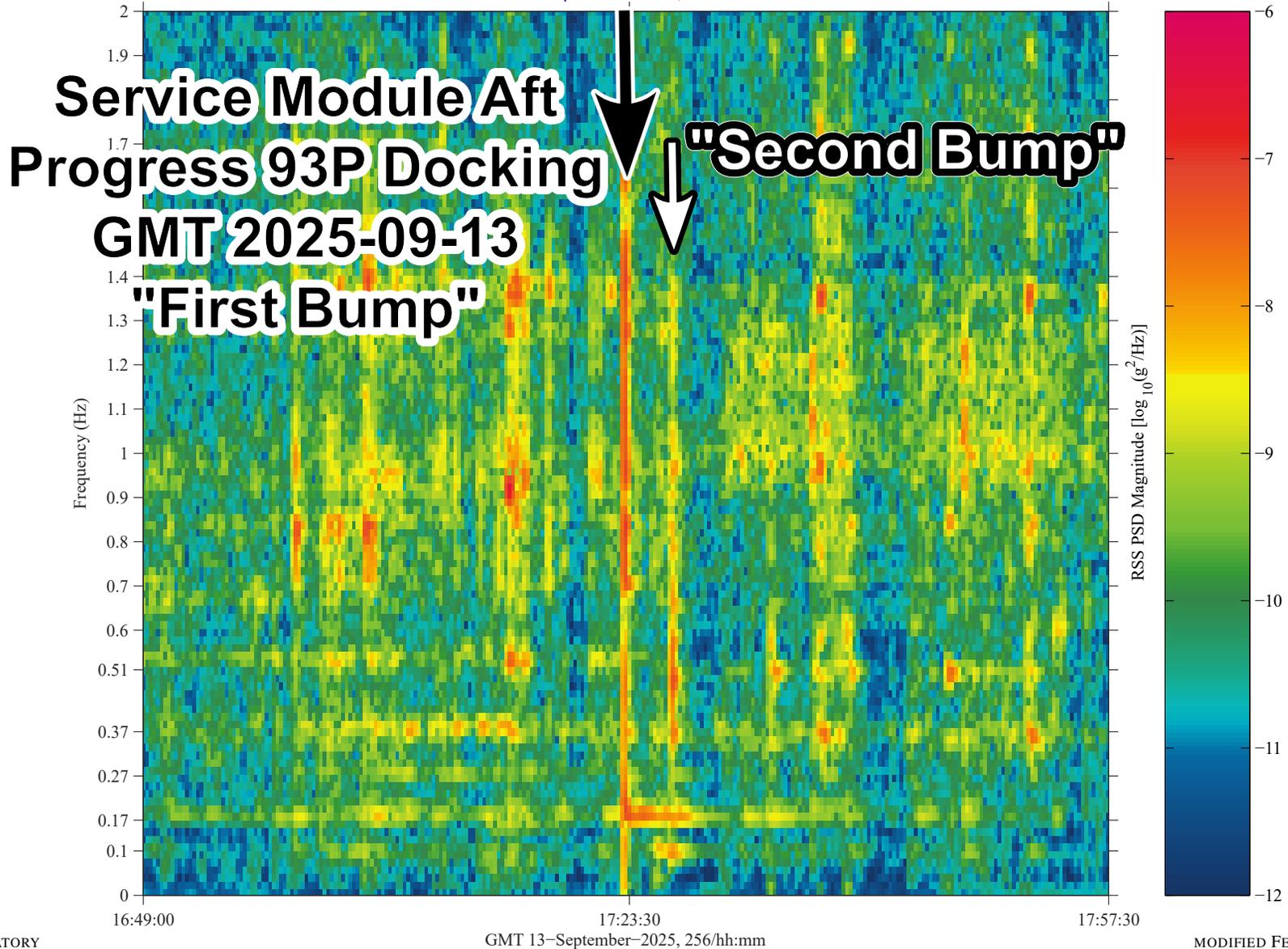
Fig. 2: Screenshot of YouTube Video Showing Progress 93P Approaching the ISS on GMT 2025-09-13.

Fig. 3: Progress 93P Docking: 2 Hz, 8.5-Minute Spectrogram (structural-mode regime), SAMS Sensor 121f03, GMT 2025-09-13.
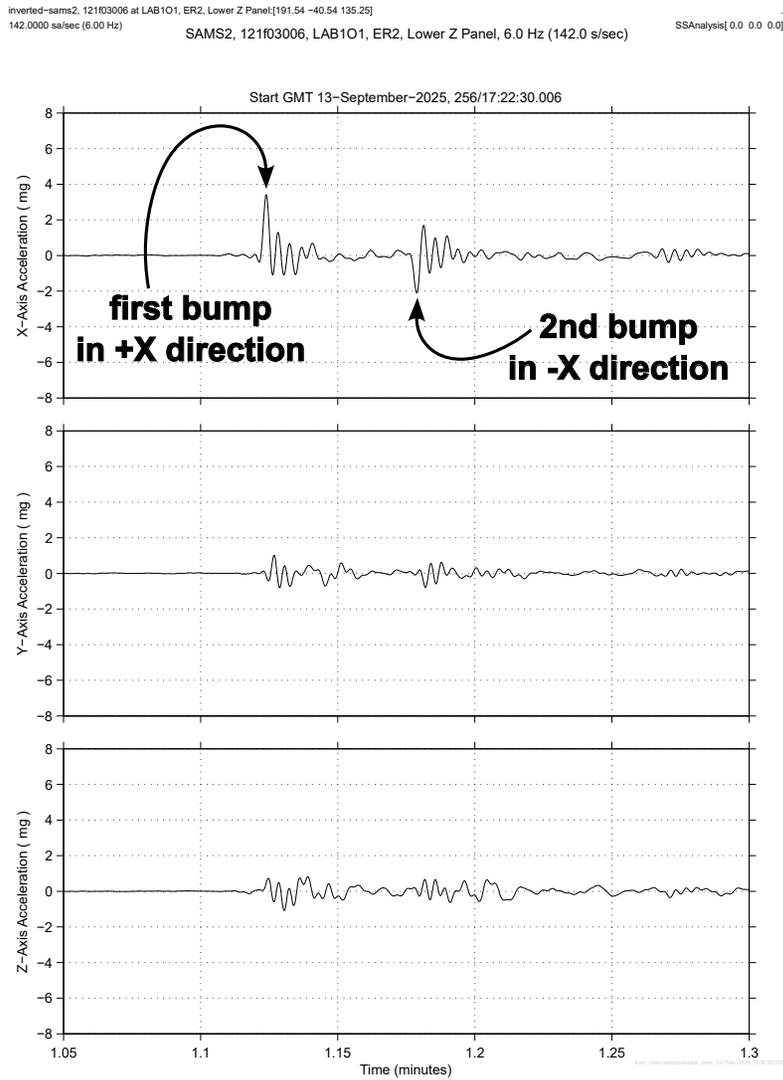
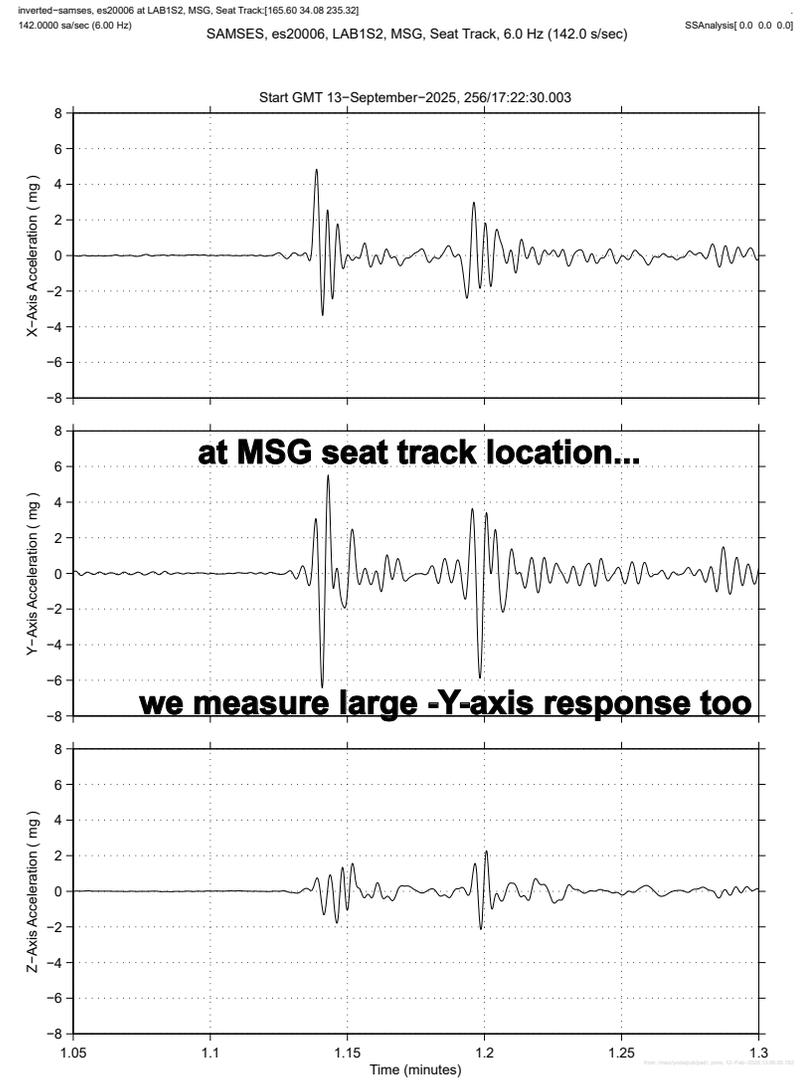Fig. 4: ~15-Second, 6 Hz $a_{xyz}(t)$ via SAMS 121f03 Sensor at LAB1O1 (ER2).

Fig. 5: ~15-Second, 6 Hz $a_{xyz}(t)$ via SAMS es20 Sensor at LAB1S2 (MSG).