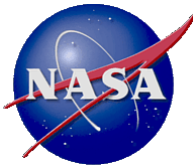


NASA WG3 MMOD Protection Summary

37th Interagency Space Debris Coordination Committee (IADC)
6-10 May 2019

NASA JSC-XI/Eric L. Christiansen
NASA JSC (JETS)/Jim Hyde
NASA JSC (JETS/UTEP)/Josh Miller

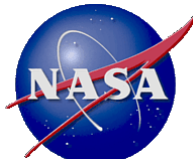
Summary of Meteoroid and Orbital Debris (MMOD) Protection Activities



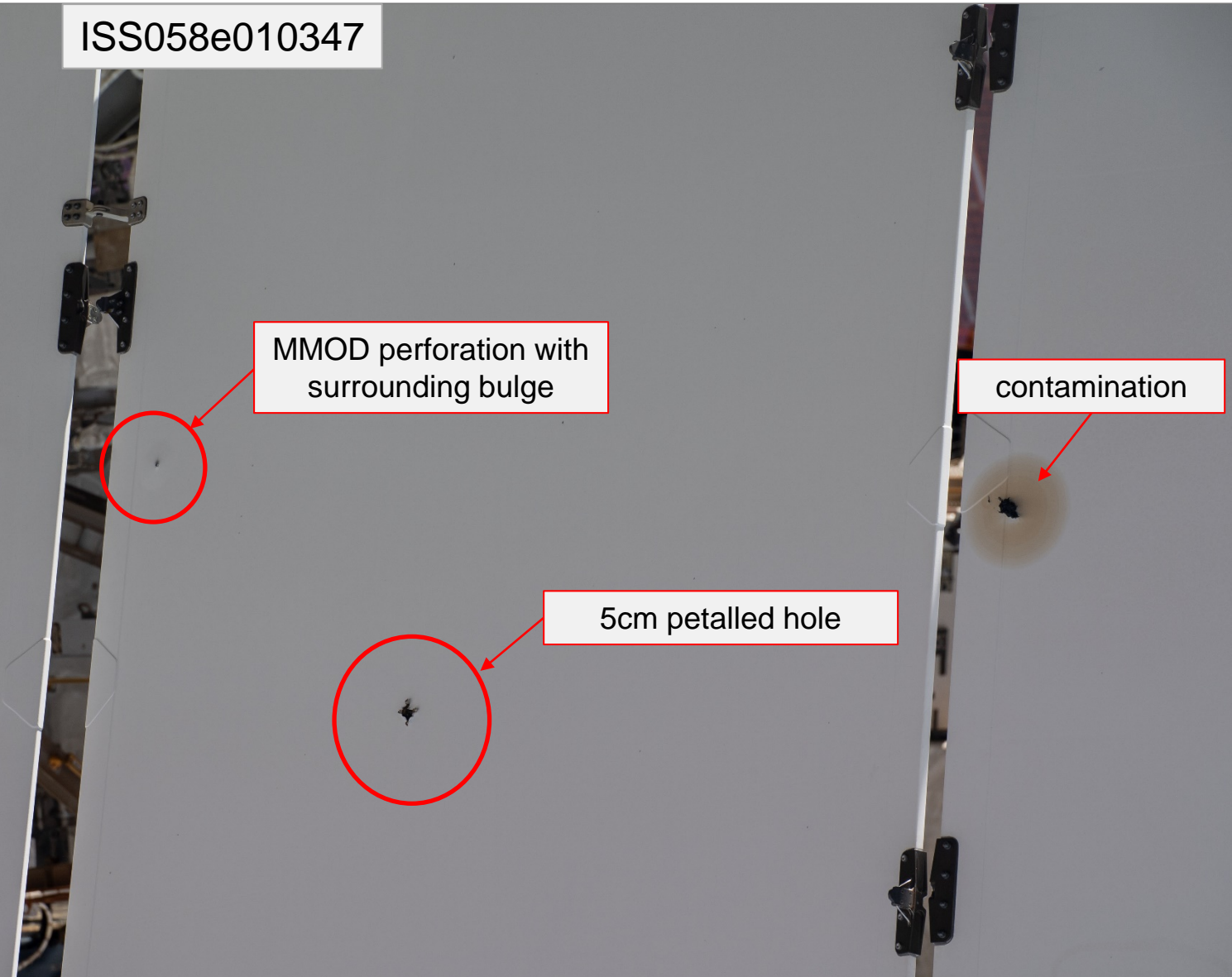
- **Multipurpose Crew Vehicle (Orion), Commercial Crew & Resupply Vehicles:**
 - Completed MMOD test, evaluation & requirements verification of SpaceX and Boeing commercial crew vehicles
 - Significant changes made to both vehicles to meet MMOD requirements
 - Working with Sierra Nevada Corporation to incorporate adequate MMOD protection on their ISS resupply vehicle
 - Performed post-flight MMOD damage inspections of SpaceX Dragon cargo vehicle after ISS resupply missions (SpX-14 through SpX-16 missions)
 - Testing for Orion: European Service Module mass reduction
 - Analyzing alternative Orion mission trajectories to reduce risk to the upper stage & overall vehicle stack while in Earth orbit
 - Testing composite overwound pressure vessels (COPVs) with the NASA Engineering and Safety Center (NESC): Leak and Rupture criteria
- **International Space Station (ISS):**
 - Identified MMOD damage in on-orbit photos of ISS hardware & visiting vehicles
- **Provided literature on WG3 share for AI 36.1 Shape Effects Study**

Space Station Radiator Panel

observed February 2019



ISS058e010347

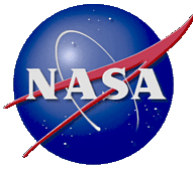


MMOD perforation with
surrounding bulge

contamination

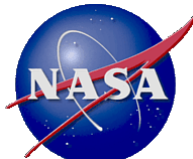
5cm petalled hole

Space Station Radiator Panel



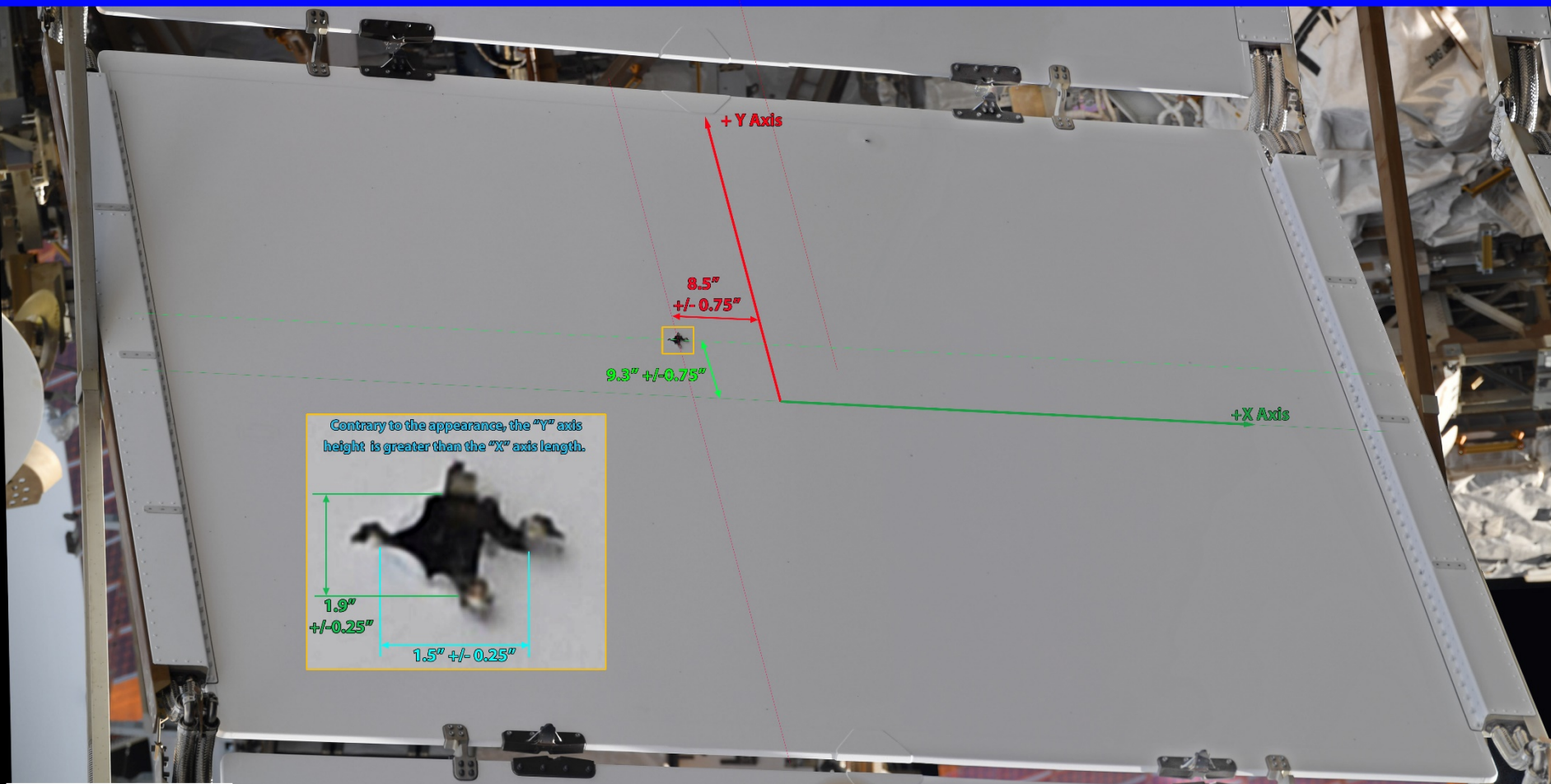
Grease Ball

Space Station Radiator Panel



Measurement of Exit Hole of MMOD Strike on S1-2 HRS Radiator, Panel 4 Single Camera Analysis of Image iss058e0103444, 447 and 450

by D. Liddle, Feb, 13, 2019 Rev 1.0, JSC Image Science and Analysis Group /XI4



Contrary to the appearance, the "Y" axis height is greater than the "X" axis length.

1.9" +/- 0.25"
1.5" +/- 0.25"

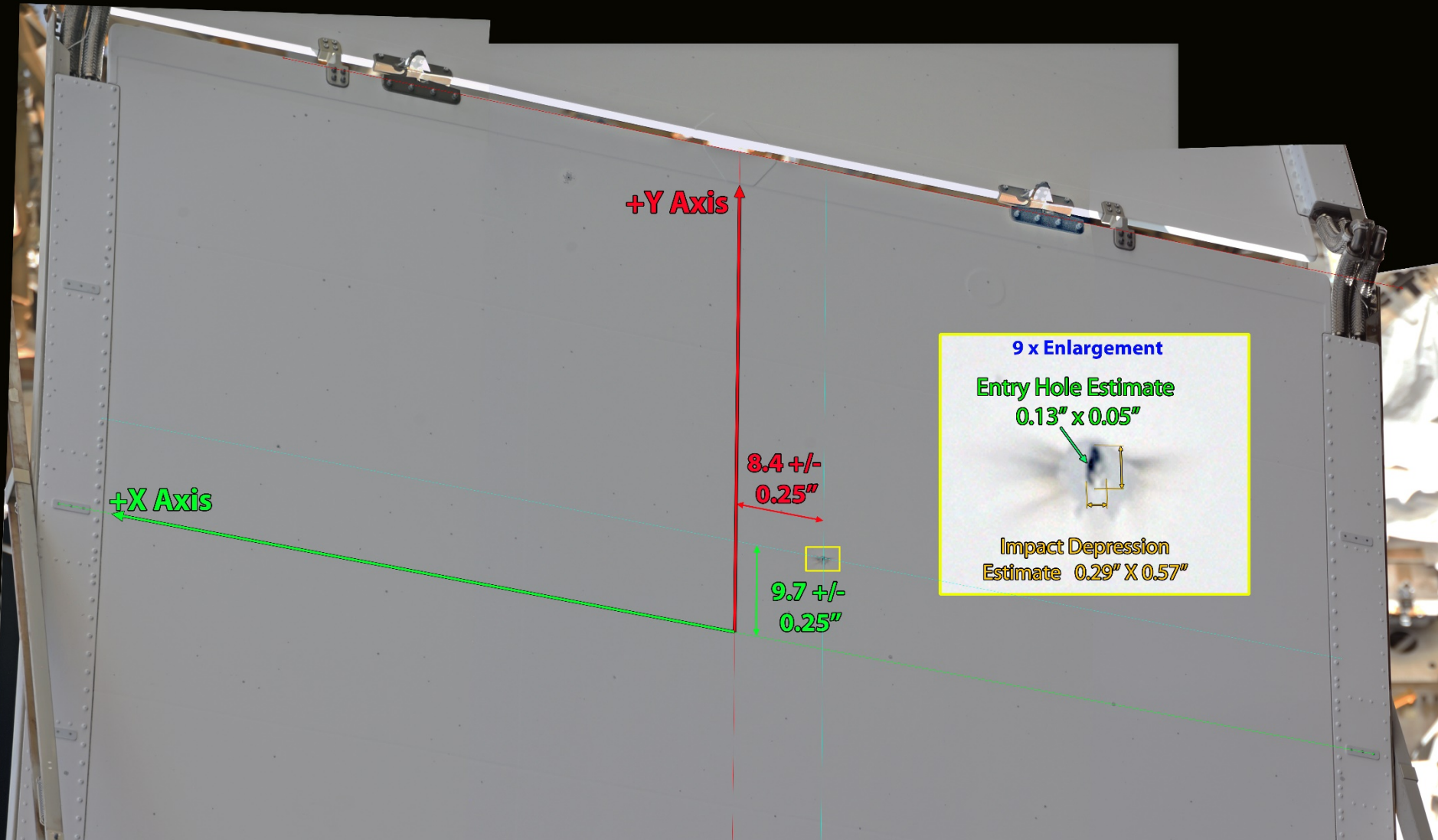


Space Station Radiator Panel

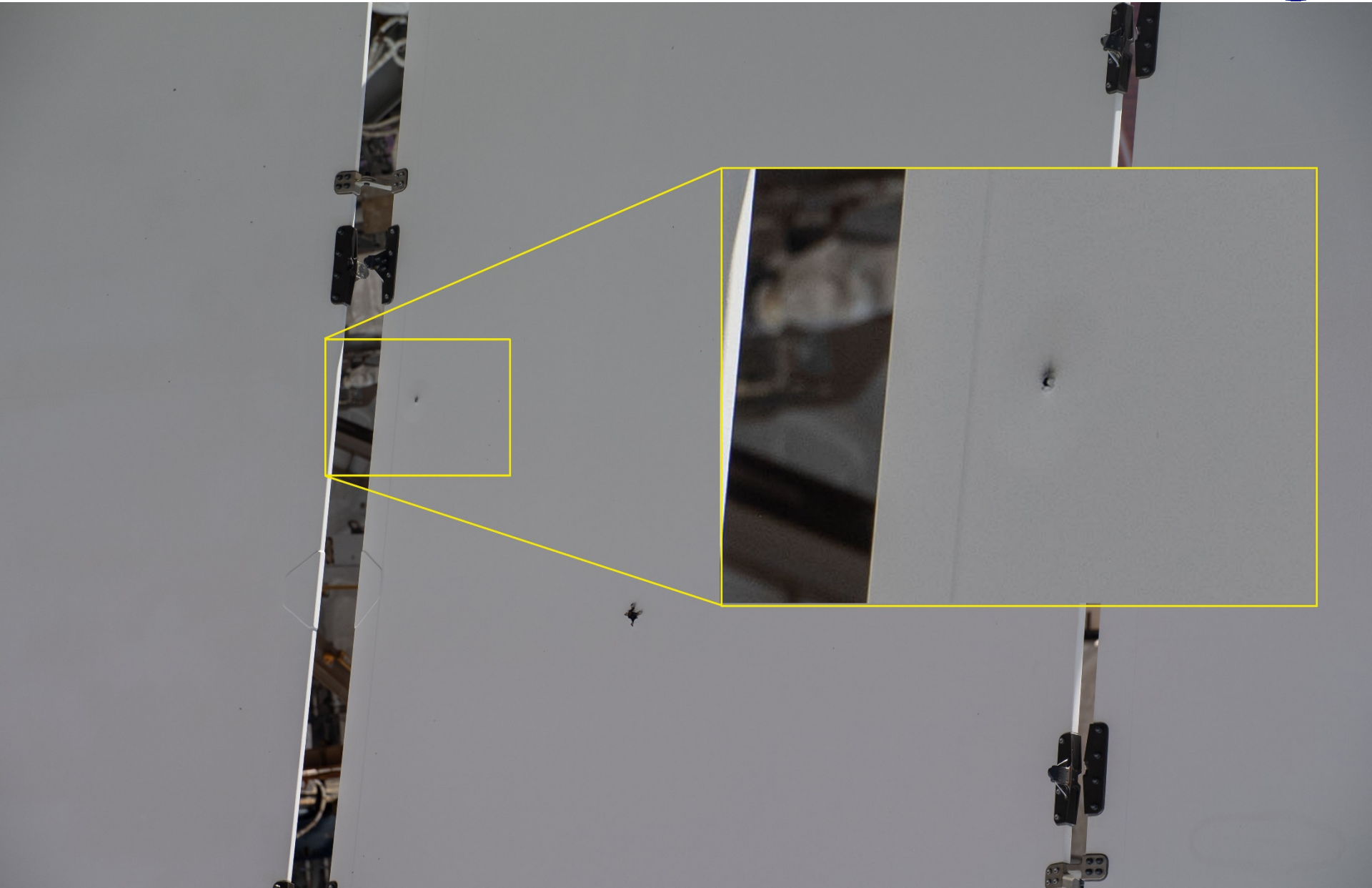
Measurement of Entrance Hole of MMOD Strike on S1-2 HRS Radiator, Panel 4

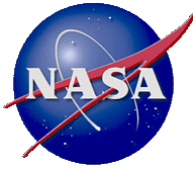
Single Camera Analysis of Image ISS057e057629, 632 and 635

By D. Liddle, March 19, 2019, Rev 1.0, JSC - Image Science and Analysis Group /XI4



Space Station Radiator Panel





Backup Charts

ISS *Bumper* finite element model

after addition of MLM, Russian Node, Science Power Module, and Bigelow Expandable
Activity Module (BEAM), and after PMM relocation

