External High Definition Camera (EHDC) Capabilities

ISIW-2017

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EHDC Capabilities

- Background information (ISIW2014): https://www.nasa.gov/sites/default/files/files/V_Studer-External_High_Definition_Camera.pdf
- Status –
  - As of January 2016, two cameras have been installed (locations CP8 and CP9) and a third is also onboard the ISS, awaiting installation. Speculation is that it will be located at CP3.
  - A fourth unit is expected to be launched (TBD date)
  - Imagery collected to date shows expected significant improvement in resolution over the co-located standard definition video cameras.
- Imaging portion consists of a Nikon D4 with a 600mm lens
  - Estimated pixel scale at 100' range for maximum zoom (600 mm): 0.37 mm
  - Degradations associated with demosaicking, suboptimal focusing, and other factors will give poorer actual resolution.

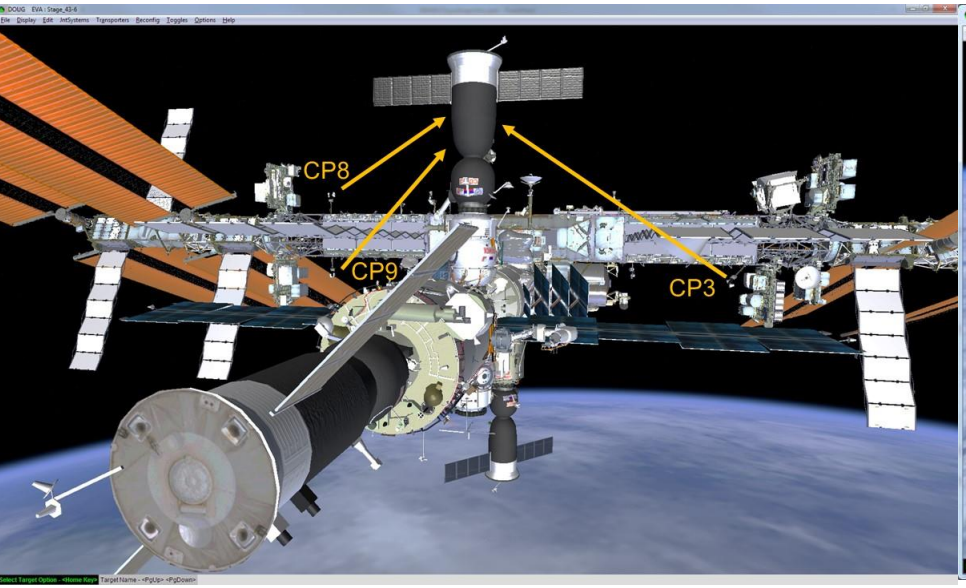
EHDC View Paths to Crewed Visiting Vehicles (VV)

Good:

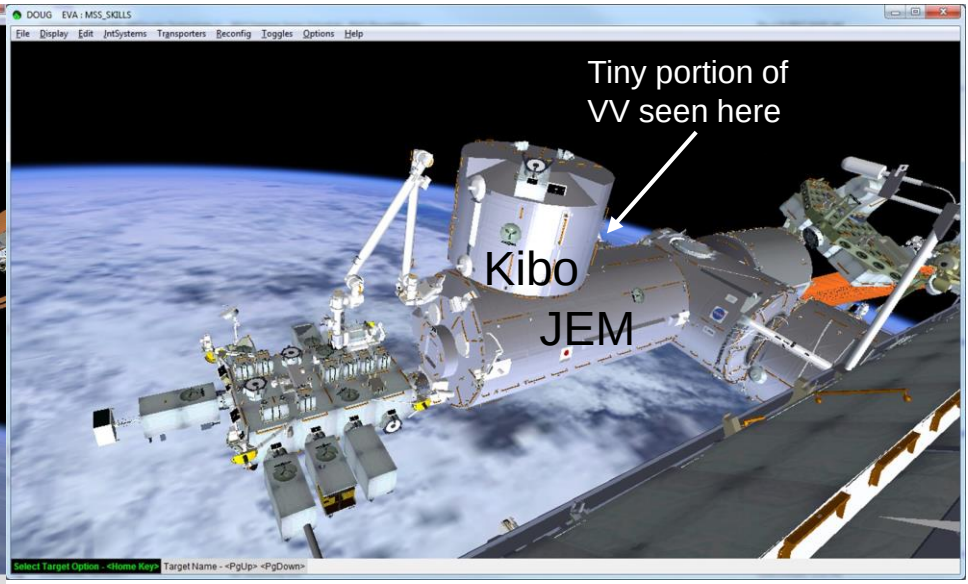
- VV at Node 2 zenith (N2Z), except for velocity-vector facing surface*
- VV at MRM1, MRM2 and MLM (starboard-forward, port-forward)*

Poor:

- VV at Node 2 forward (N2F). Almost completely occluded by JEM (w.r.t. CP9), Kibo (w.r.t. CP8), Columbus (w.r.t. CP3), and the truss (w.r.t. CP13).



CP3,8,9 based views are good for zenith- (& nadir)-docked Soyuz

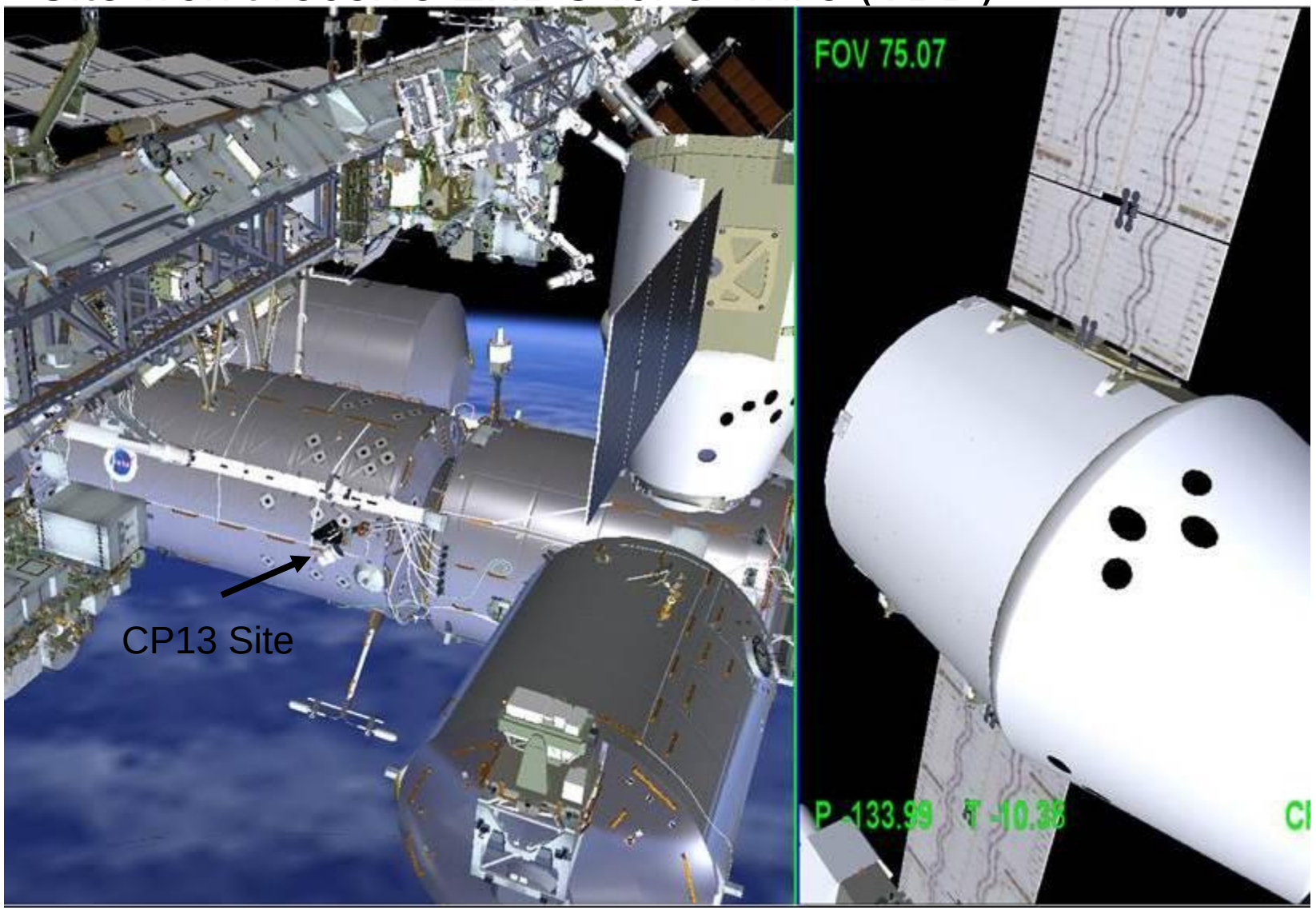


Kibo essentially blocks CP8-based view of N2F-docked VV

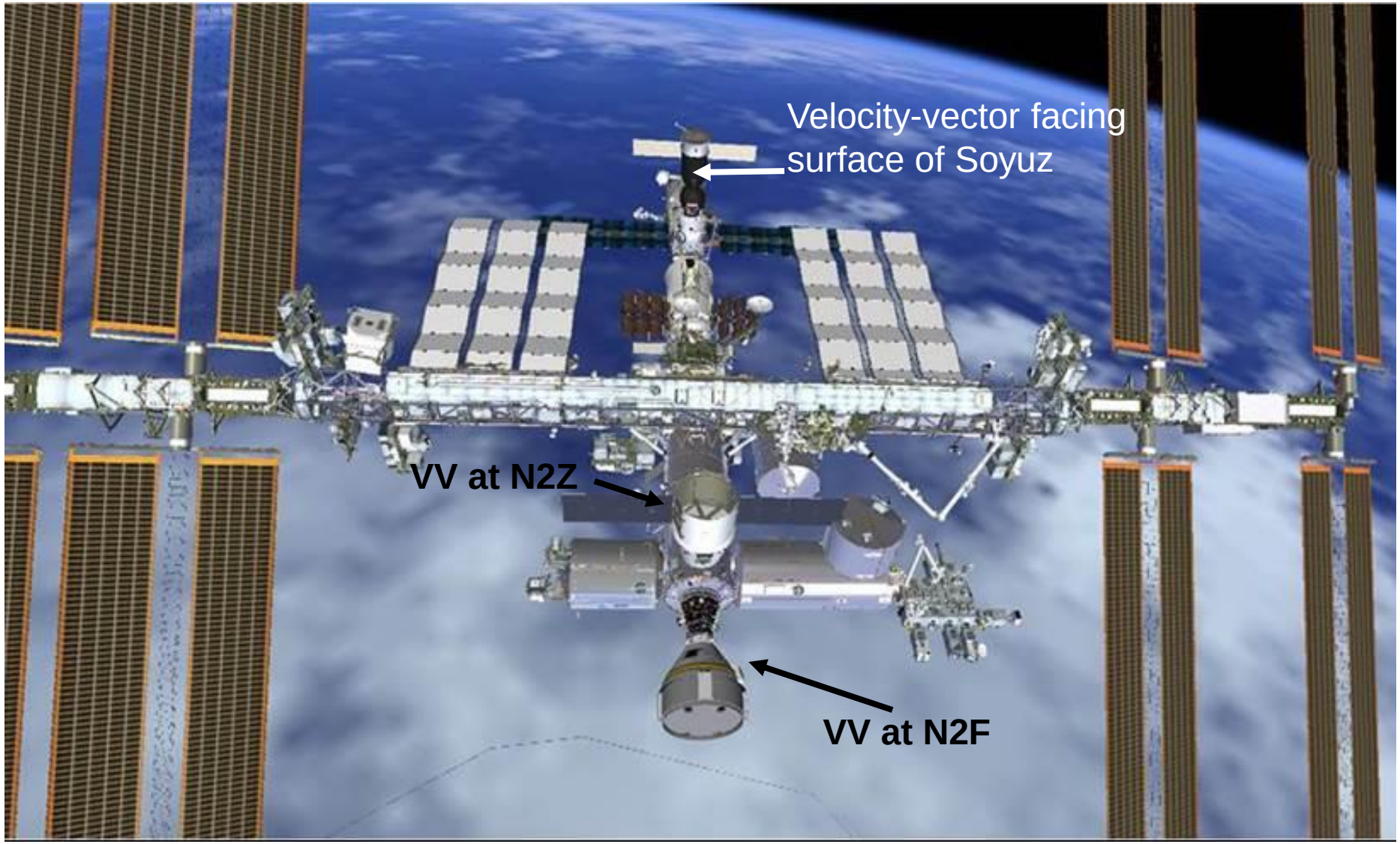
*ISS reference frame

CP13 Location and Sample View (Graphical)

- Site won't receive EHDC for a while (TBD).

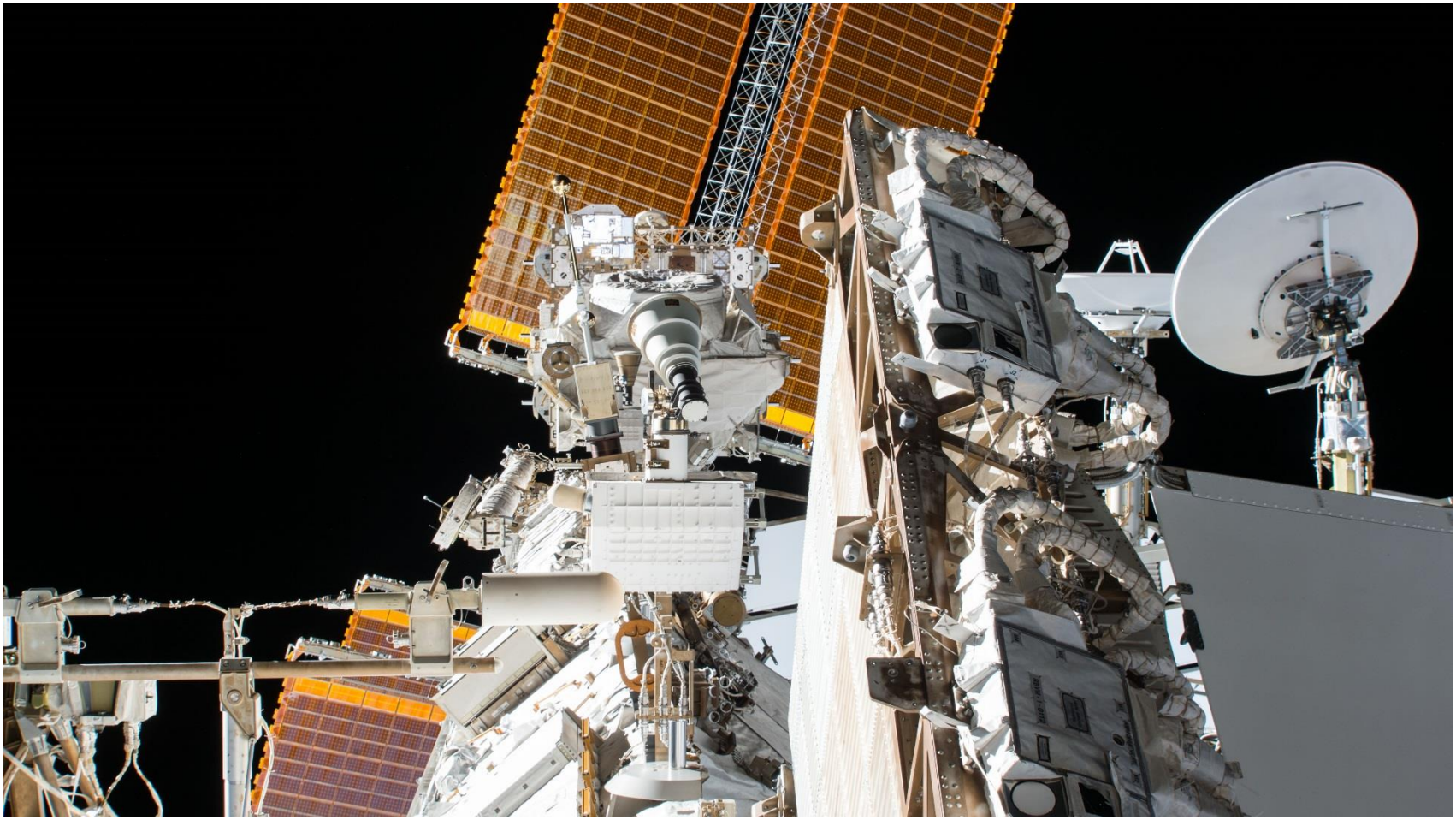


Visiting Vehicles docked at Node 2 Forward (N2F) and Node 2 Zenith (N2Z)



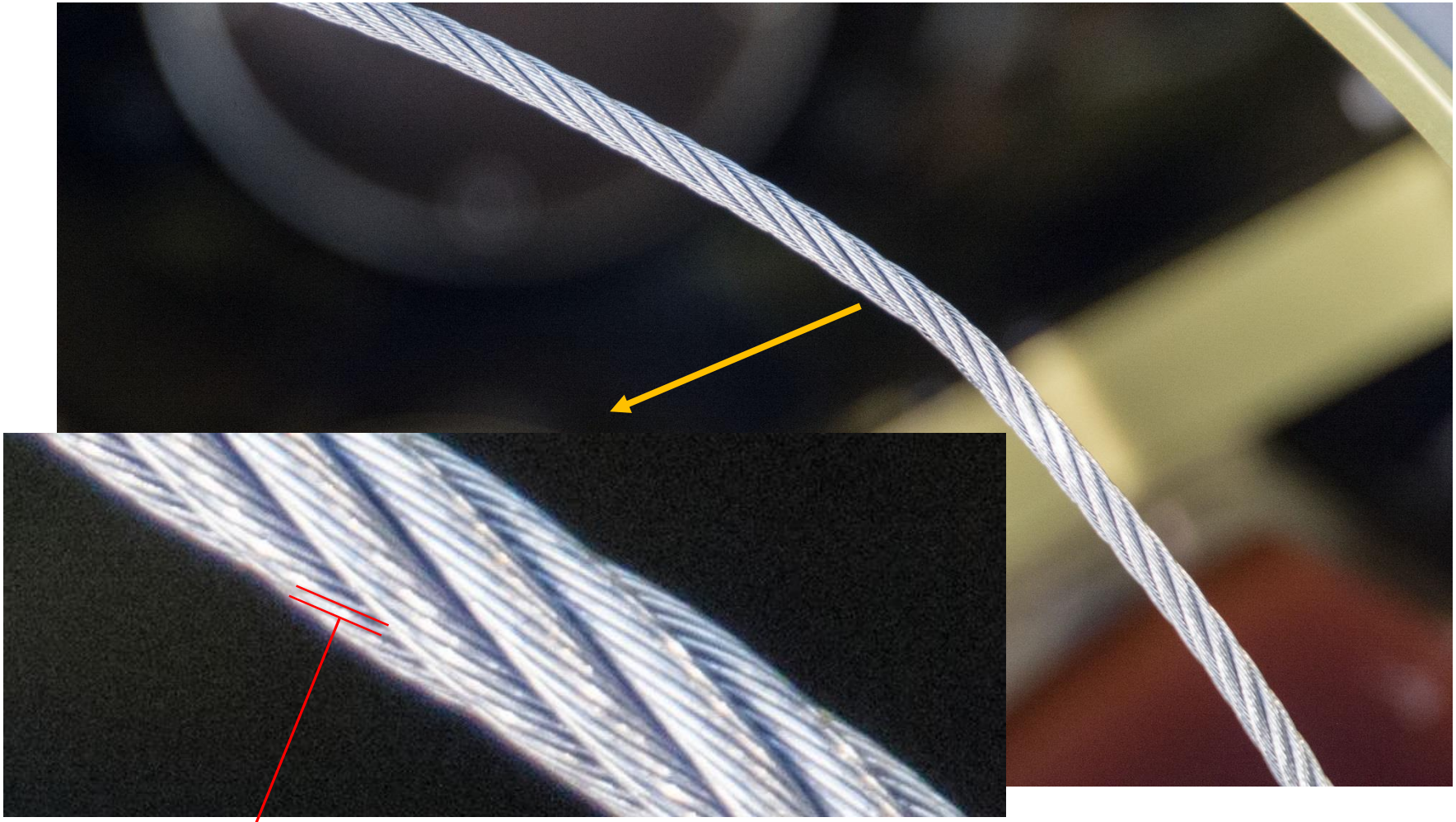
ISS modules block CP3, 8, 9 views of these VV, and the truss blocks CP13 views of N2F

Recent EHDC Capture



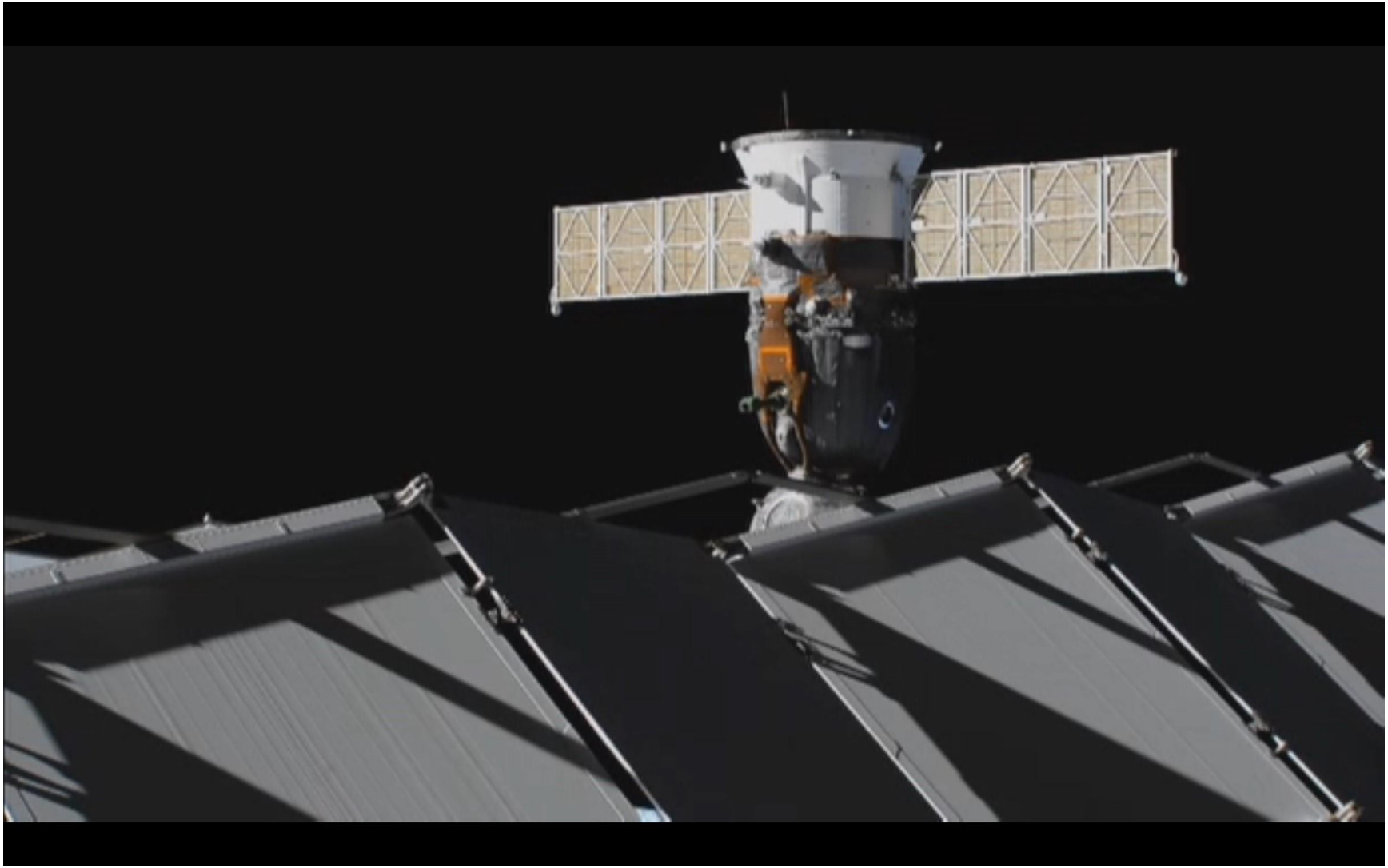
CP8-based view, looking starboard along truss

Recent EHDC Capture



SSRMS End-effector Snare Cable – stakeholders looking for signs of wear. Here, the camera use is more like that of a microscope. Each cable strand is about 0.01” in diameter.

Recent EHDC Capture

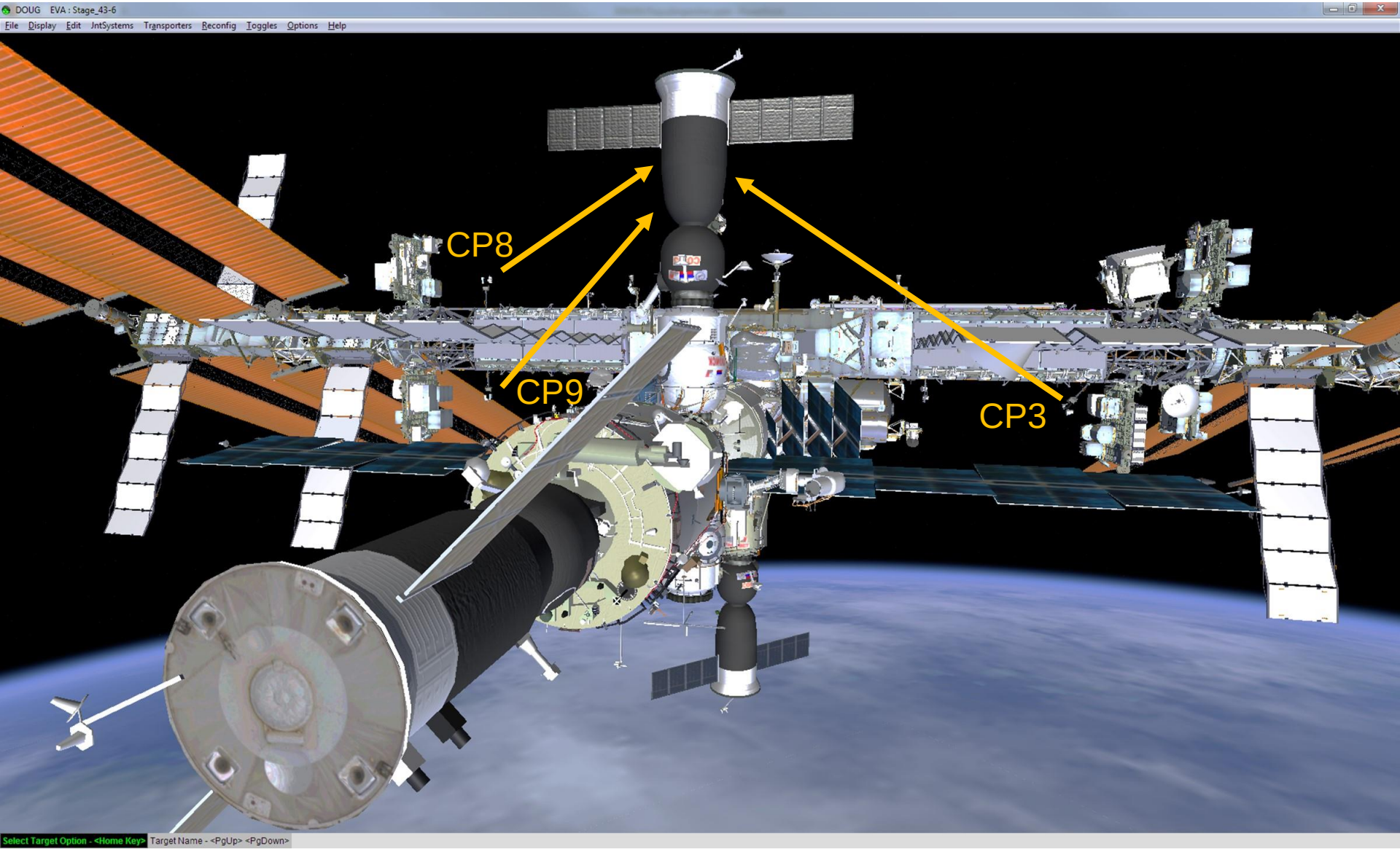


Pointing Test (not full zoom or optimized focus): CP8-based view of Soyuz at MRM2. (Not all camera pointing directions are known yet to yield adequate WiFi signals)

Section 2

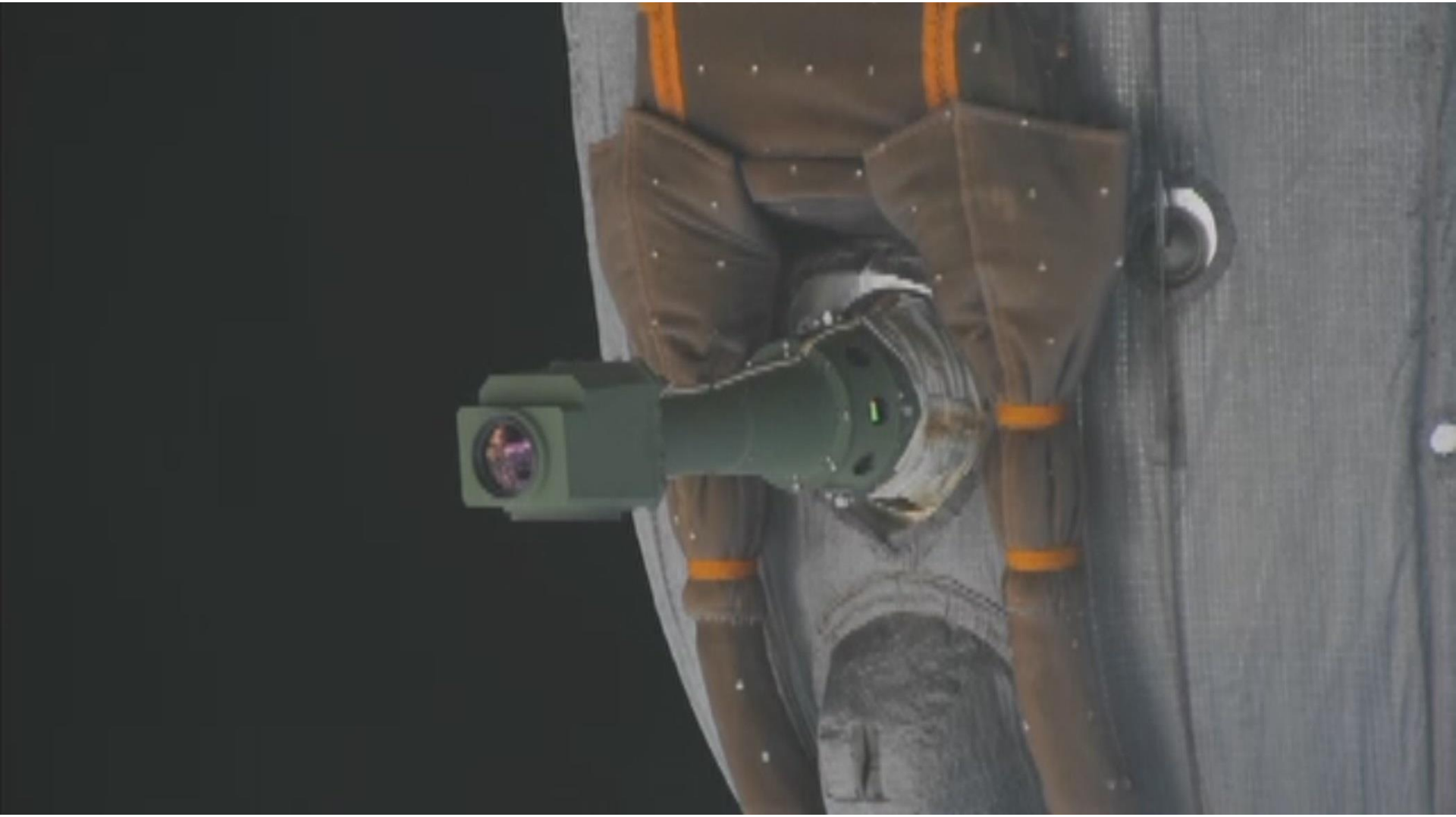
EHDC-BASED SOYUZ INSPECTION

Zenith-docked Soyuz Observed from 3 Fixed Camera Positions



EHDC Video Frame*

(from 720p video at full optical zoom, but not full digital zoom)**



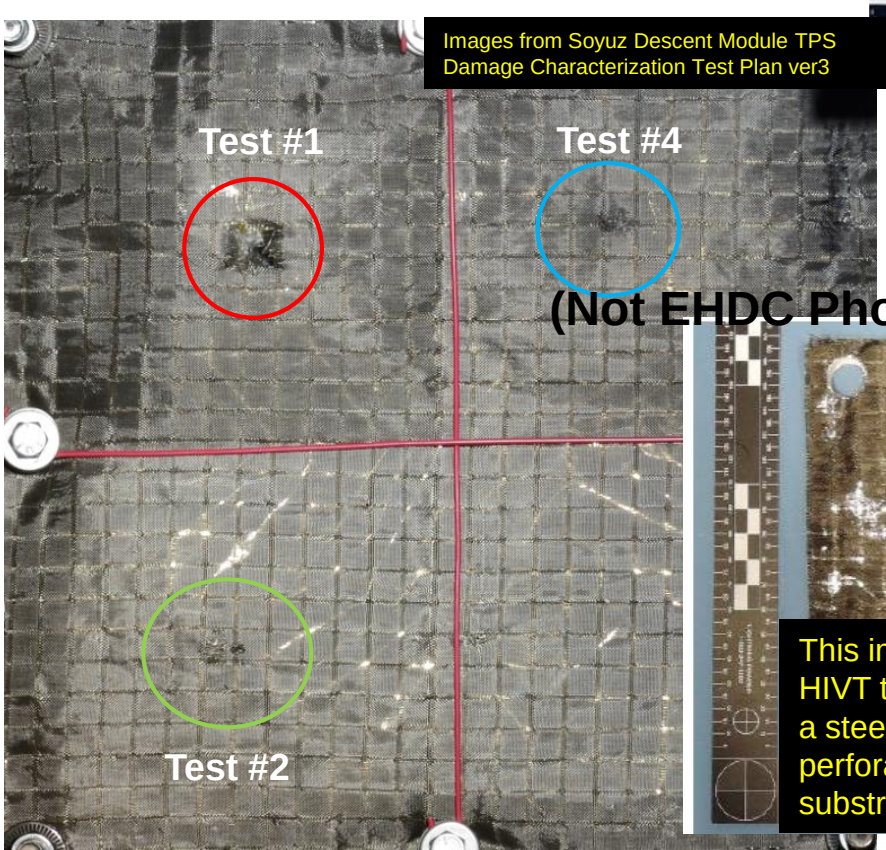
*CP8 EHDC to Soyuz at MRM-2 (zenith-docked Soyuz)

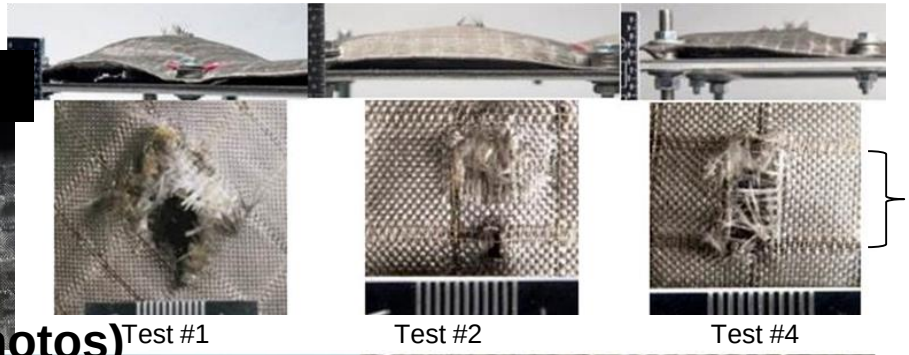
**See ground-based image (2 slides later) of Soyuz multilayer insulation (MLI), that is, the blanket material, for anticipated best resolution.

Inspection Reporting Criteria

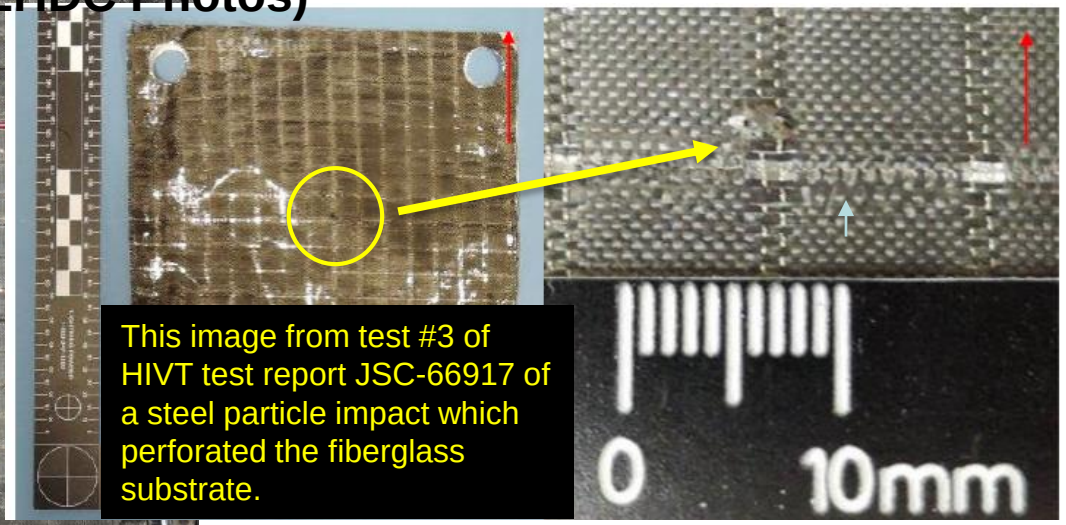
Use this slide as an identification and scale guide for the immediately following slides, which show Test #1, #2, and #4 damage as imaged from flight-like camera/lens combination

- Regions of interest (ROI) are observations of potential configuration anomalies or something different in the appearance on the Soyuz MLI blanket that could be micrometeoroid/orbital debris (MMOD) damage.
- The expectation for the appearance of MMOD damage is based upon hypervelocity impact tests on a sample of Soyuz MLI blanket as shown in photos below.
  - The goal is to positively confirm or clear an observation as an MMOD strike by acquiring imagery with resolution sufficient to resolve fibers or weaving pattern in and around the suspect sites.
- Analysts review imagery for changes in contrast or color and report ROI which may be more than a stain or shadow and have a dimension larger than about 3mm (assumed minimum critical damage size).



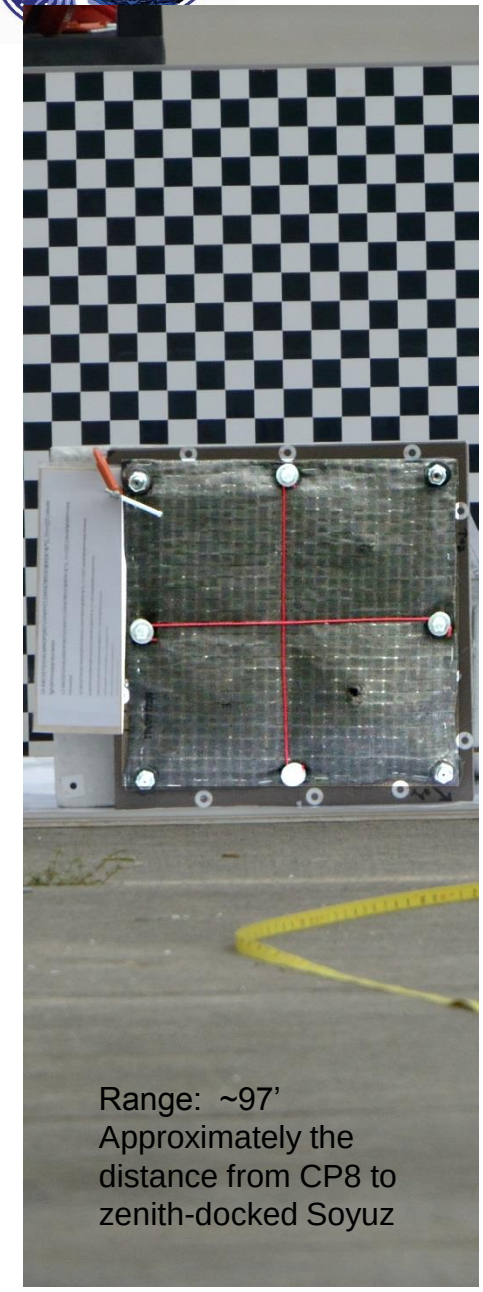


(Not EHDC Photos)

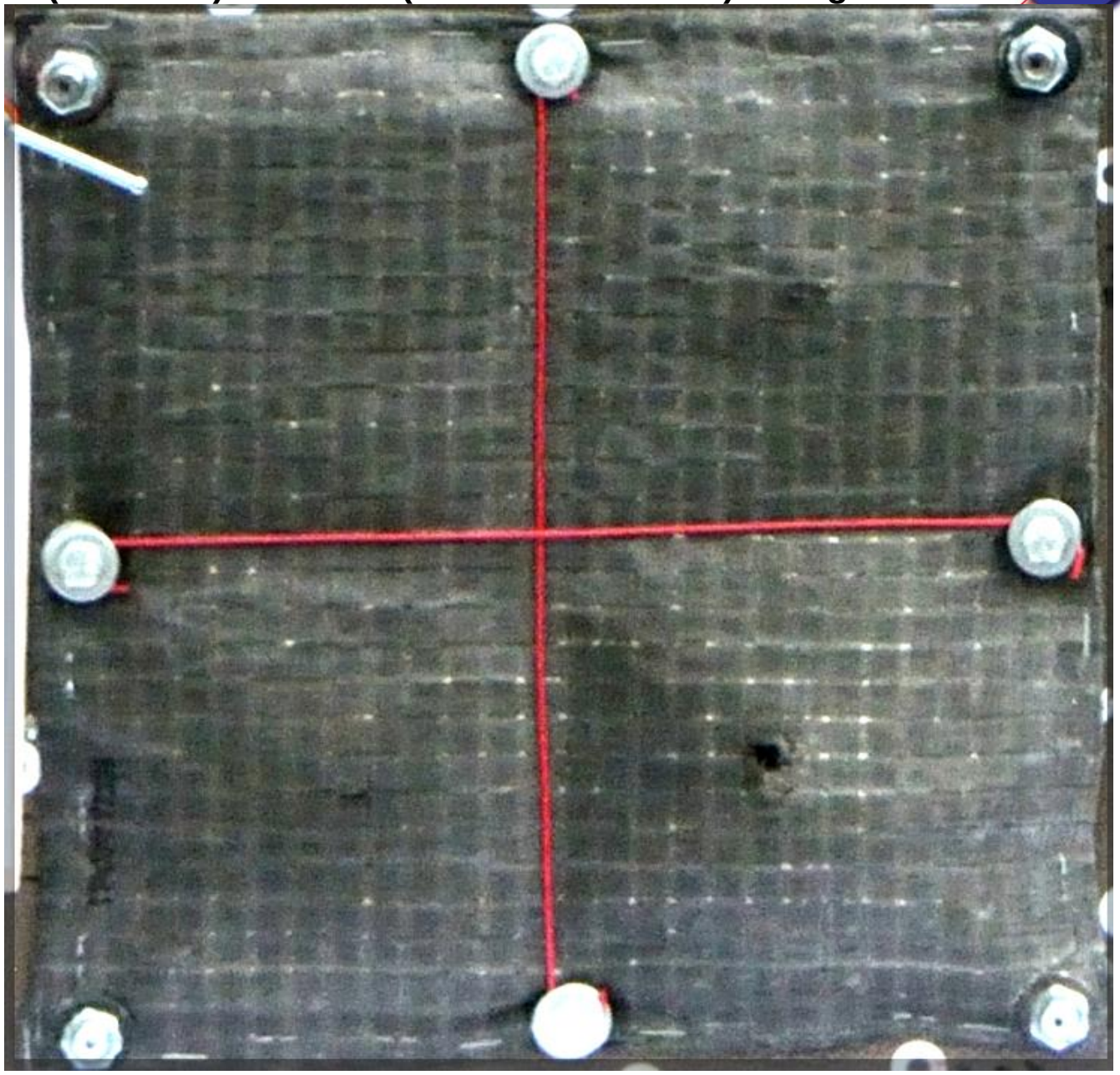


Ground Study: Soyuz MLI Damage Detectability

Same camera (Nikon D4) and Lens (zoomed to 600mm) as flight unit



Range: ~97'
Approximately the distance from CP8 to zenith-docked Soyuz



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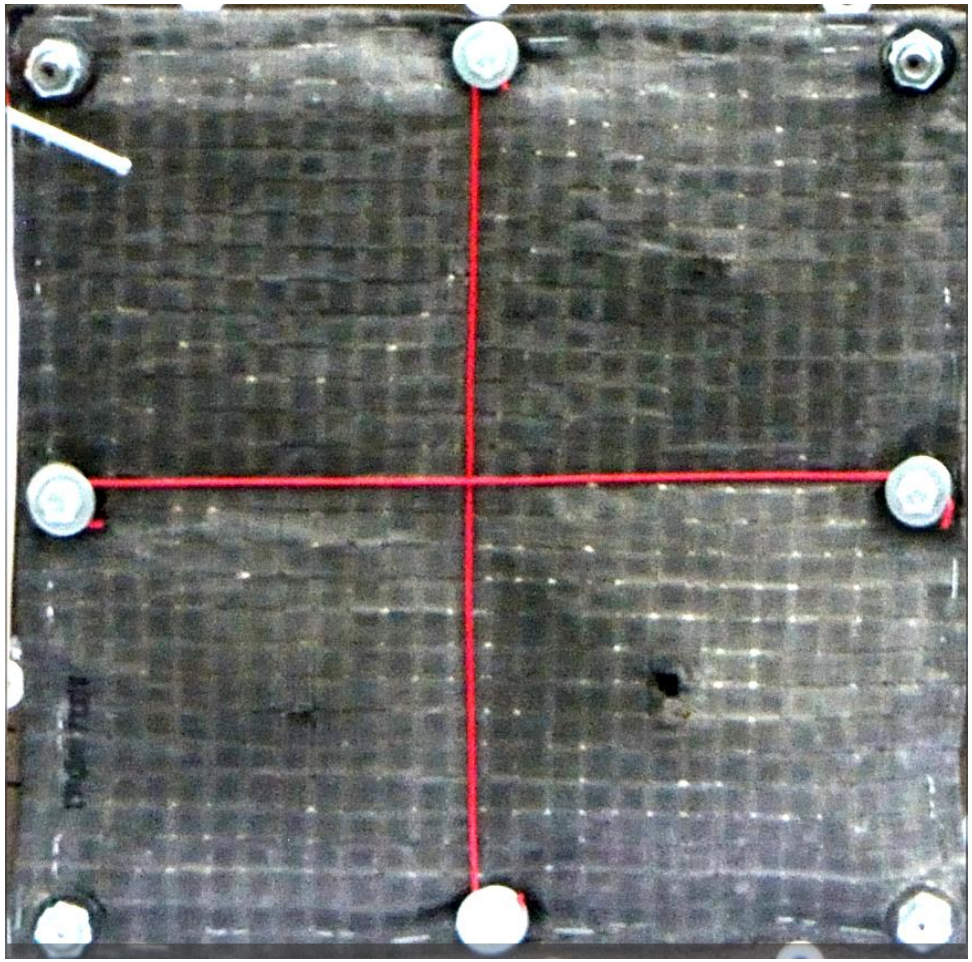
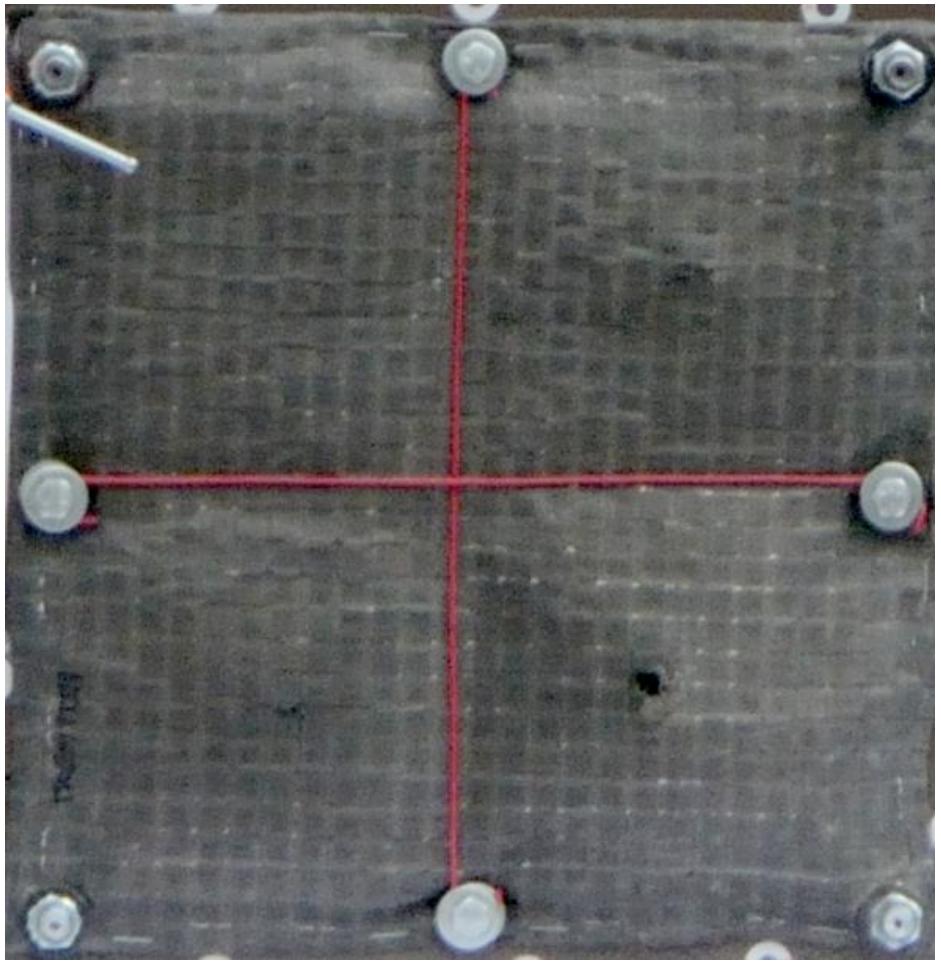


Range: ~78’
Approximately the distance from CP9 to nadir- (MRM-1) docked Soyuz
Note that the regular weaving pattern within the 1cm x 1cm cells cannot be resolved



Range: ~116’
Approximately the distance from CP9 to nadir (MLM)-docked Soyuz (future configuration)

Comments w.r.t. EHDC-based Soyuz Inspection

- Critical damage likely detectable, except for very small steel-projectile strikes
- No EHDC-Soyuz distance is small enough for resolution of the regular weaving pattern. Only the coarser stitching at the 1 cm cell boundaries can be resolved.
- Best approach is to conduct an image survey on a newly arrived Soyuz and compare photos to inspection ones taken close to the time of departure (~ 5.5 months later).
  - Blink comparisons between before/after images are an excellent way to detect subtle changes.
- Downloading full-resolution still frames is currently very demanding on existing WiFi link
  - Approximately 2 full-res stills can be downlinked before ISS-ground LOS. Thus a full-resolution still survey of the velocity-vector portion of a Soyuz is not currently time efficient.

Anticipated EHDC Updates

- Likely next EHDC, already on-board ISS, is CP3.
- Plans are in work to transfer firmware to ISS onboard server to allow continued operation during ISS-ground loss of signal (LOS), and storage of images on ISS server.
- Plans are in work to convert EHDCs to wired units to eliminate camera-ISS LOS issues associated with pointing. The units will then additionally serve as wireless access points (WAPs) for other systems.