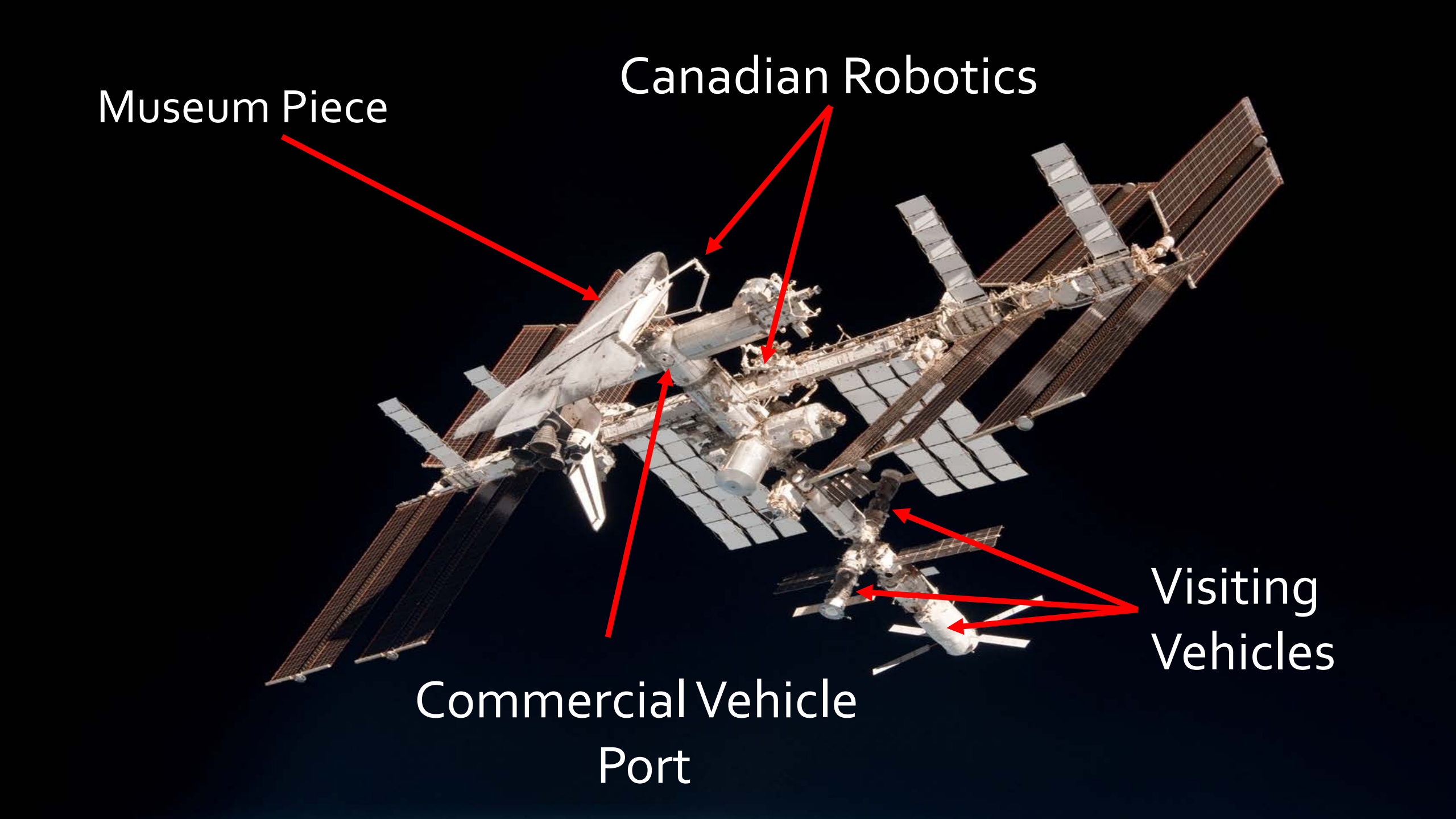
Human Robotic Interaction for Space

DR. ELLIOTT COLESHILL

Seneca

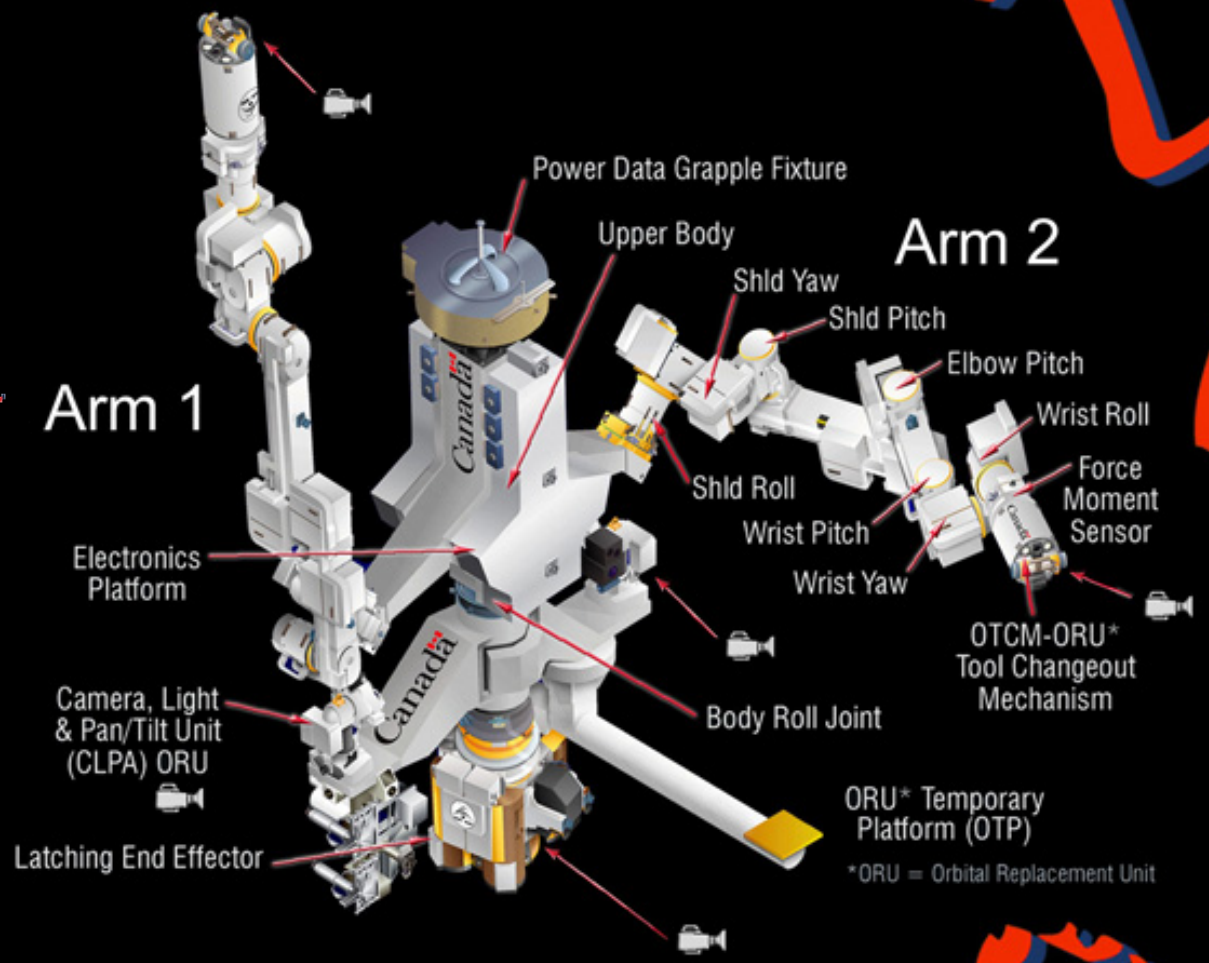
International Space Station


Museum Piece
Canadian Robotics
Visiting Vehicles
Commercial Vehicle Port

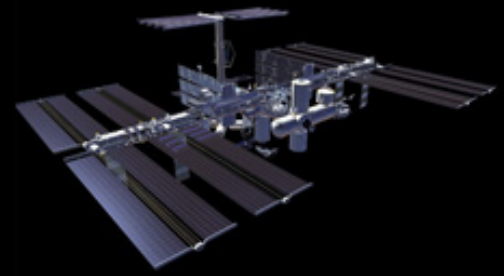
The Hardware

CANADIAN SPACE AGENCY MOBILE SERVICING SYSTEM

Canadarm2



Dextre



CSA ASC

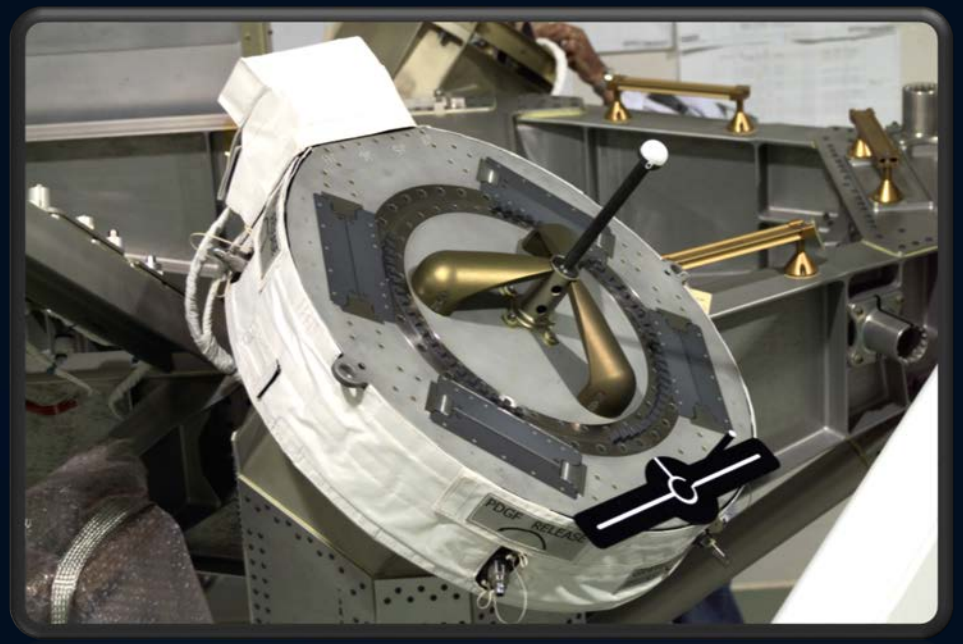
Canadian Space Agency | Agence spatiale canadienne

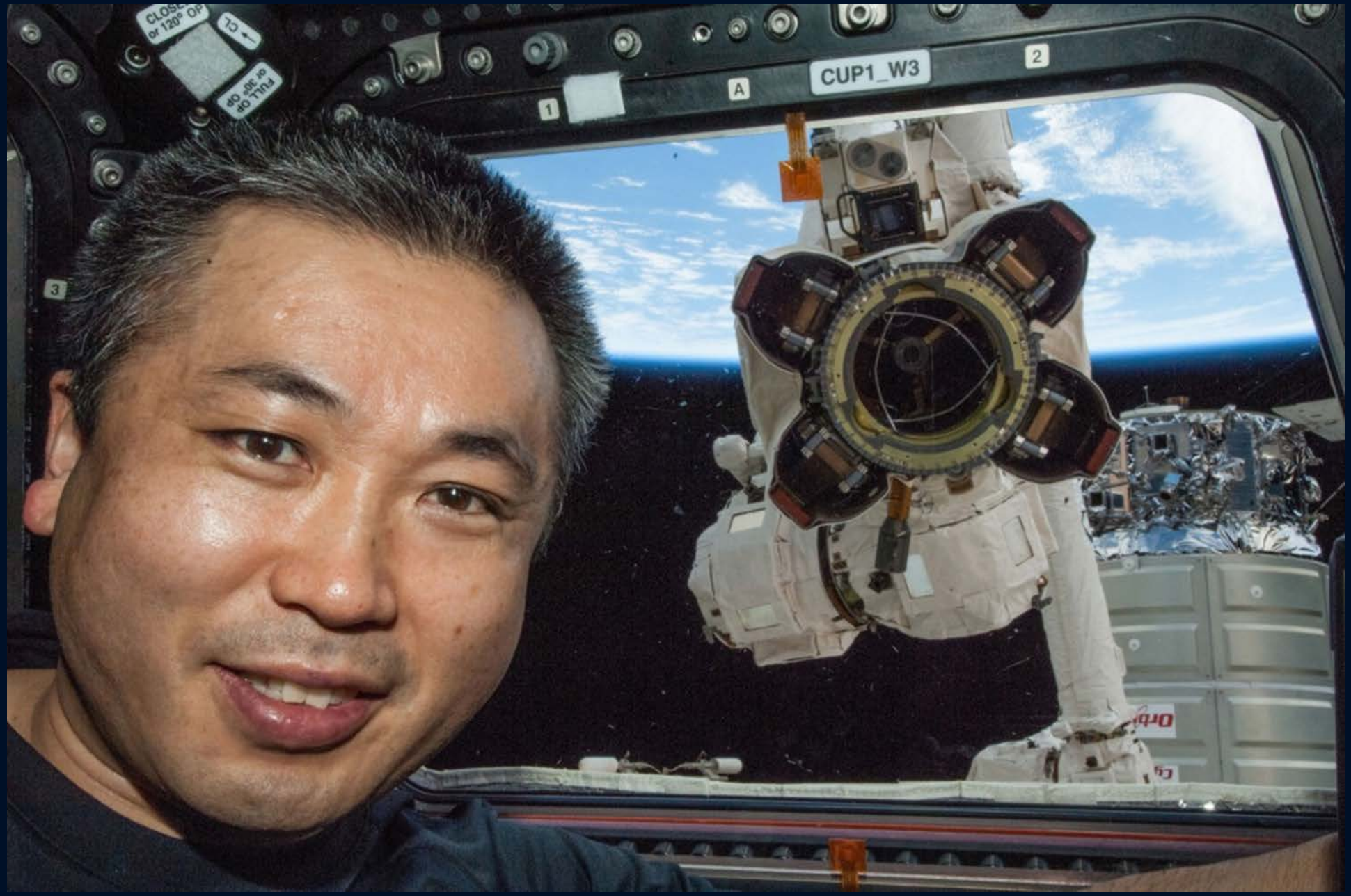
MDA

Canadarm2

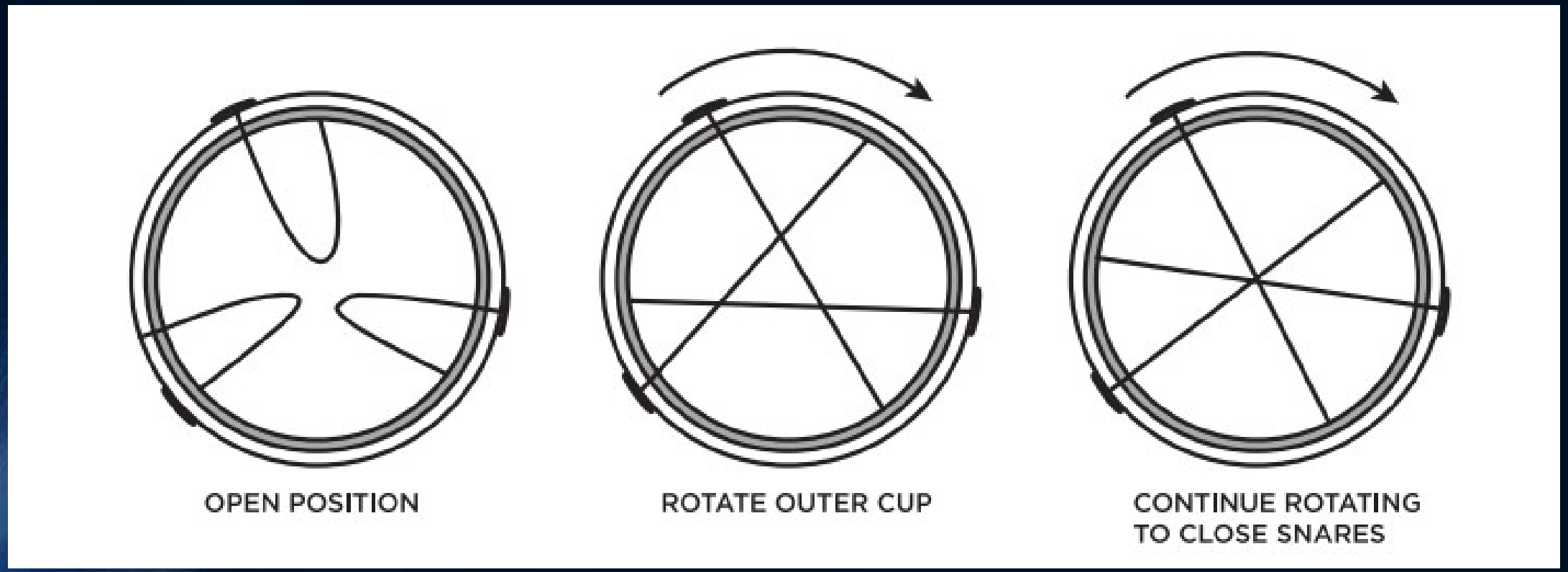
END EFFECTOR

POWER DATA GRAPPLE FIXTURE




CUP1_W3

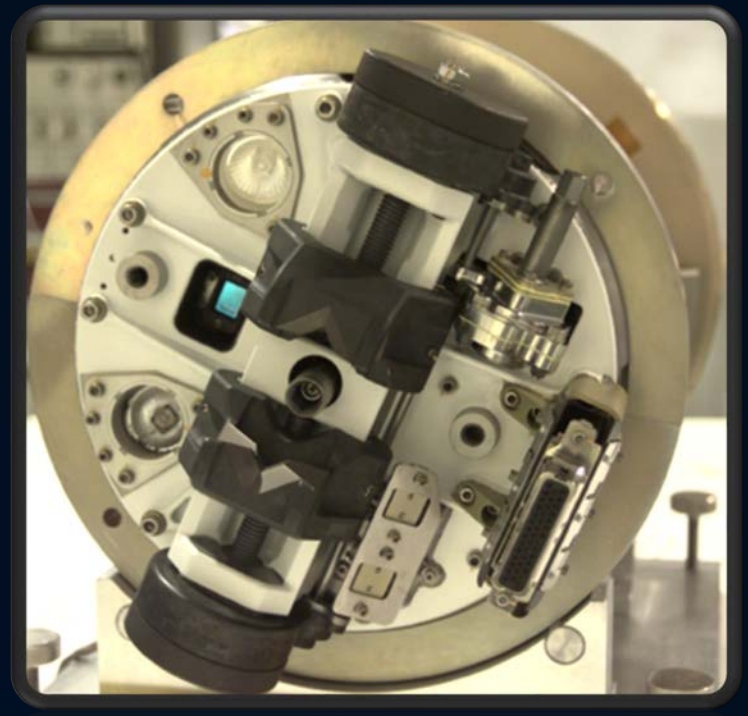
Snare Operation



Dextre

MICRO-FIXTURE

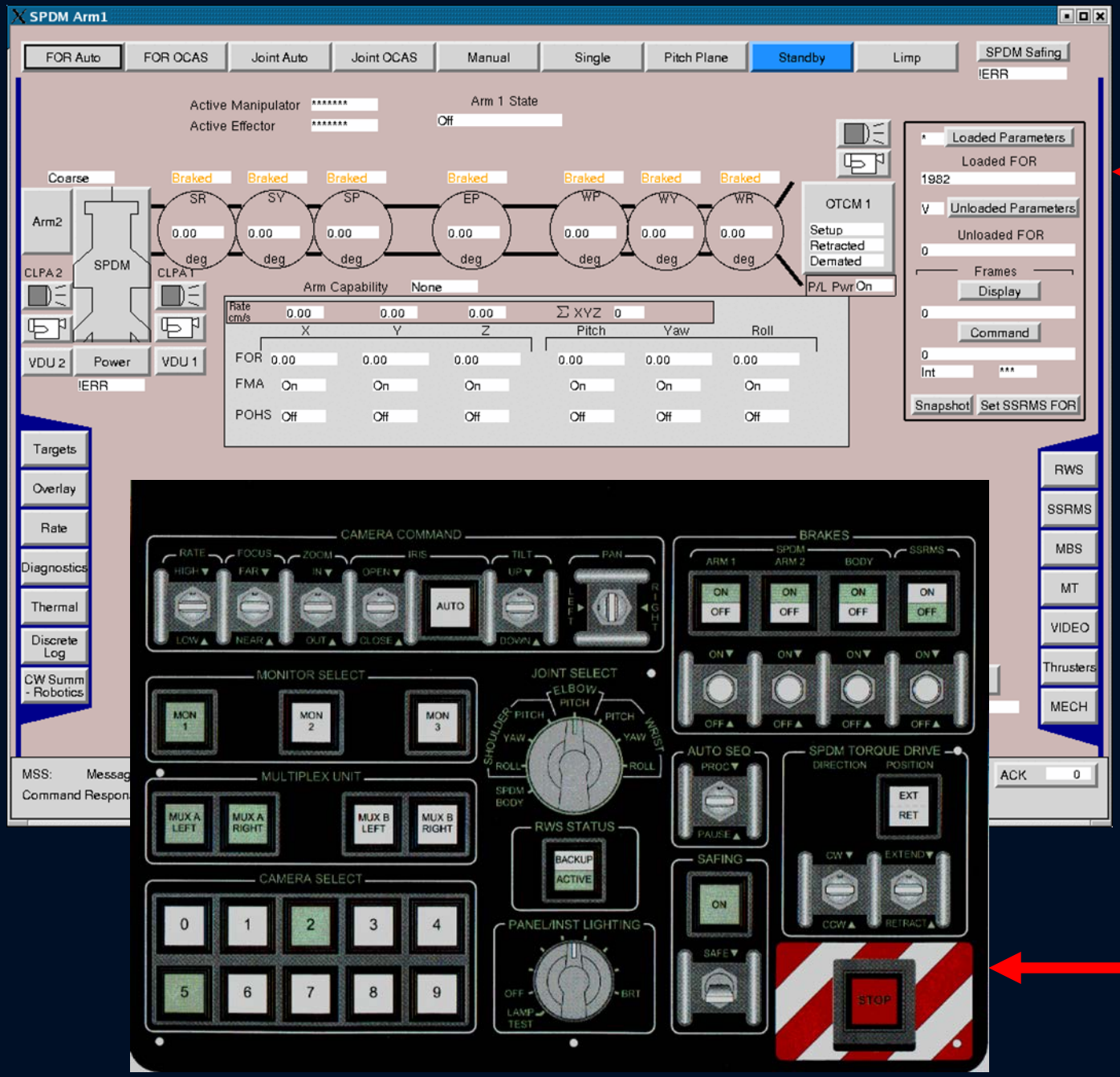
ORBITAL TOOL CHANGEOUT MECHANISM



Robotic Workstation

One in US Lab

One in Cupola

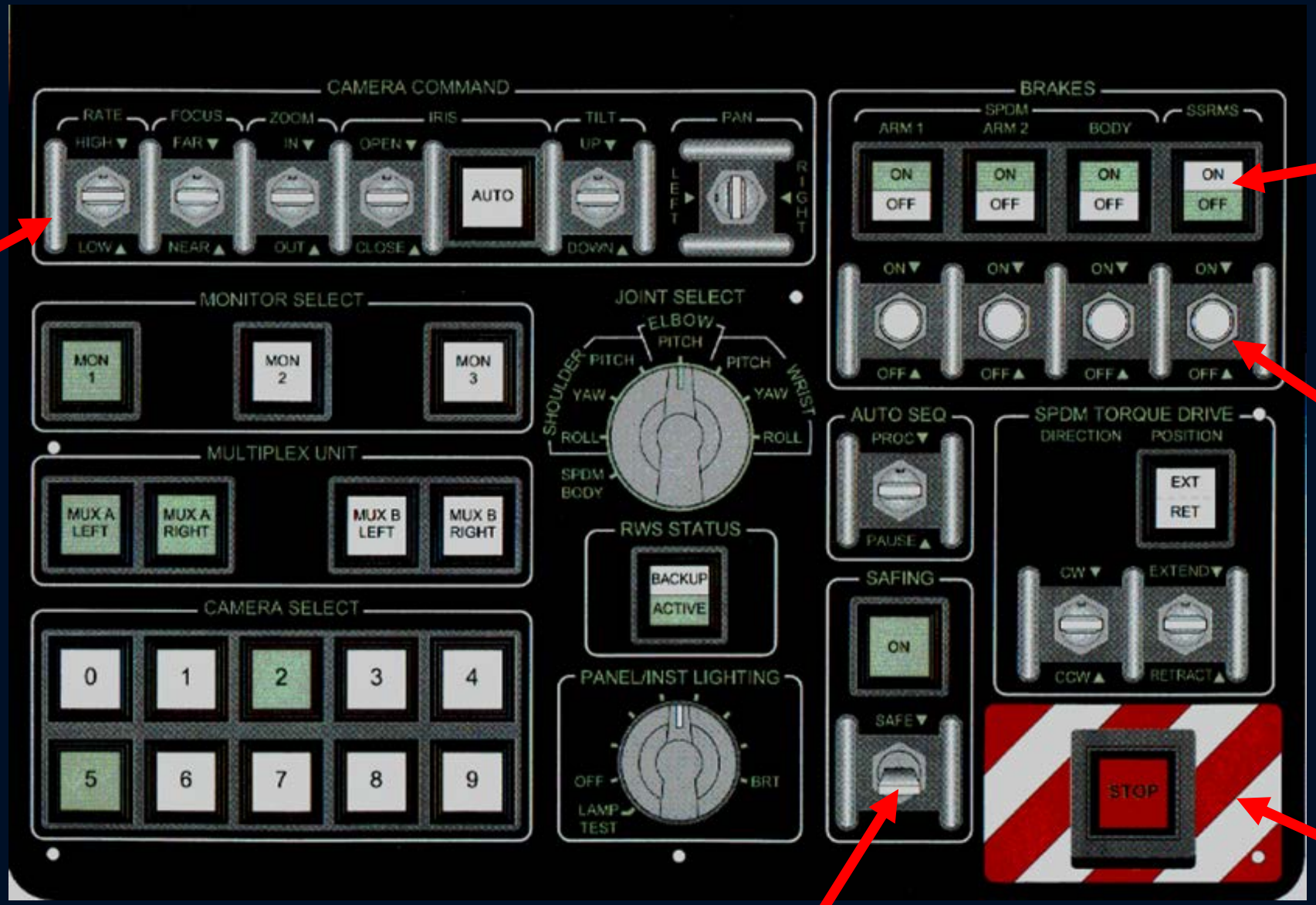


Software

Hardware

One Manipulator Per Page for Safety

IBM Thinkpad
Linux Based
(RT Extensions)
HTML



Bump Bars

Status Lamps

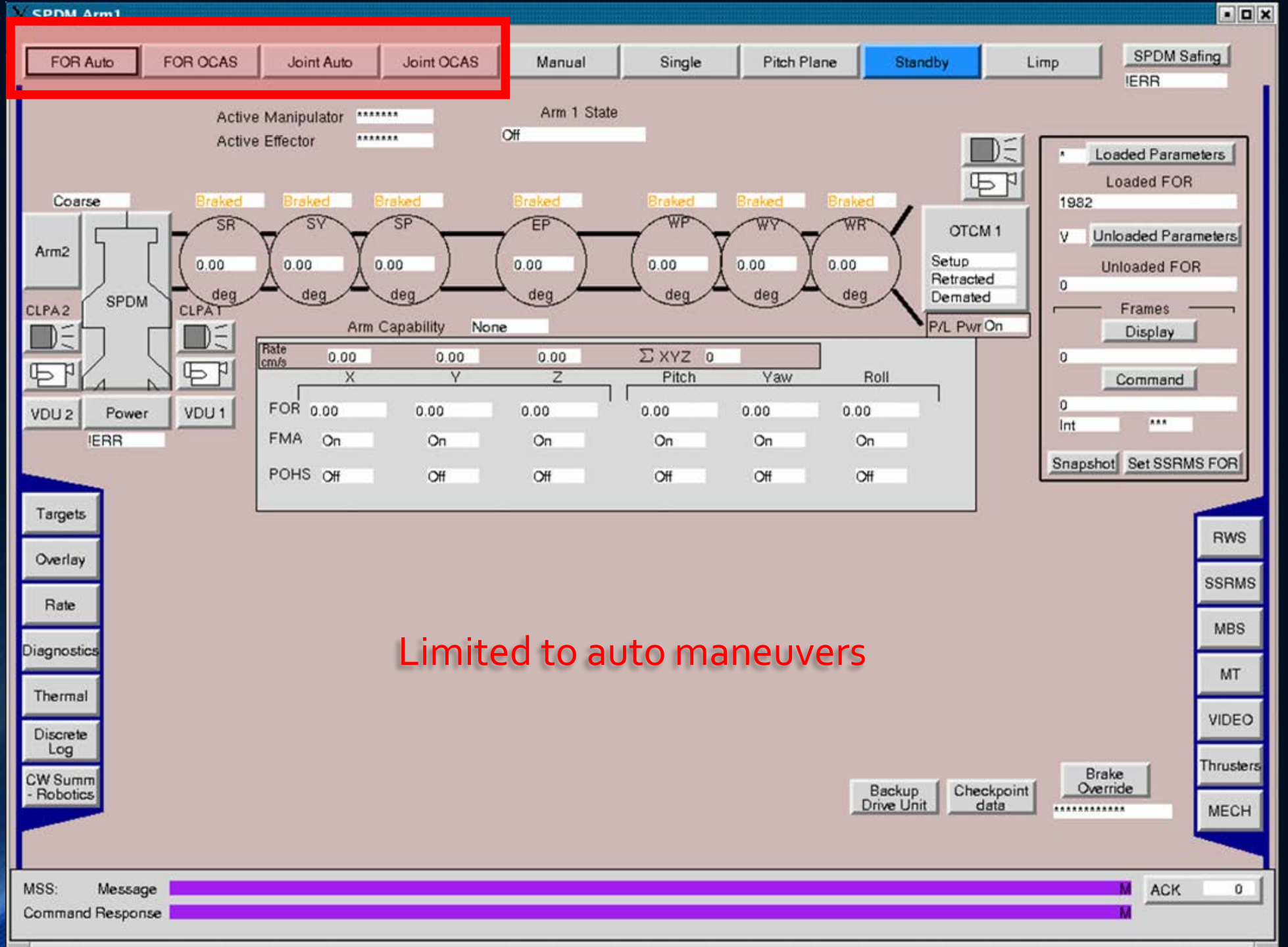
Pull Toggle Switches

Safing

Emergency Stop

Video of ISS Crew Operating the Arm


ATLAS


SPDM Arm1
FOR Auto
FOR OCAS
Joint Auto
Joint OCAS
Manual
Single
Pitch Plane
Standby
Limp
SPDM Safing
!ERR
Active Manipulator
Active Effector
Arm 1 State
Off
Loaded Parameters
Loaded FOR
1982
Unloaded Parameters
Unloaded FOR
Frames
Display
Command
Int
Snapshot
Set SSRMS FOR
Coarse
Braked
SR
SY
SP
EP
WP
WY
WR
0.00
deg
Arm2
SPDM
CLPA 2
CLPA 1
VDU 2
Power
VDU 1
!ERR
OTCM 1
Setup
Retracted
Demated
P/L Pwr On
Arm Capability
None
Rate cm/s
Σ XYZ
X
Y
Z
Pitch
Yaw
Roll
FOR
FMA
POHS
On
Off
Targets
Overlay
Rate
Diagnostics
Thermal
Discrete Log
CW Summ - Robotics
RWS
SSRMS
MBS
MT
VIDEO
Thrusters
MECH
Backup Drive Unit
Checkpoint data
Brake Override
MSS:
Message
Command Response
ACK
Limited to auto maneuvers

Video 1/3 SPDM Performing Operations using Ground Control

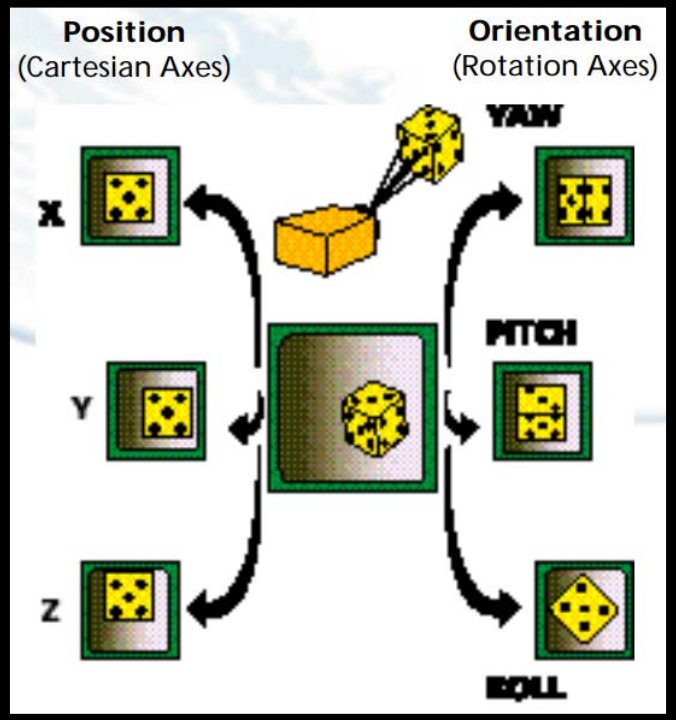
Video 2/3 SPDM Performing Operations using Ground Control

Video 3/3 SPDM Performing Operations using Ground Control

Machine Vision

CRITICAL TO SPACE TELE-OPERATED ROBOTICS

Canadian Space Vision System

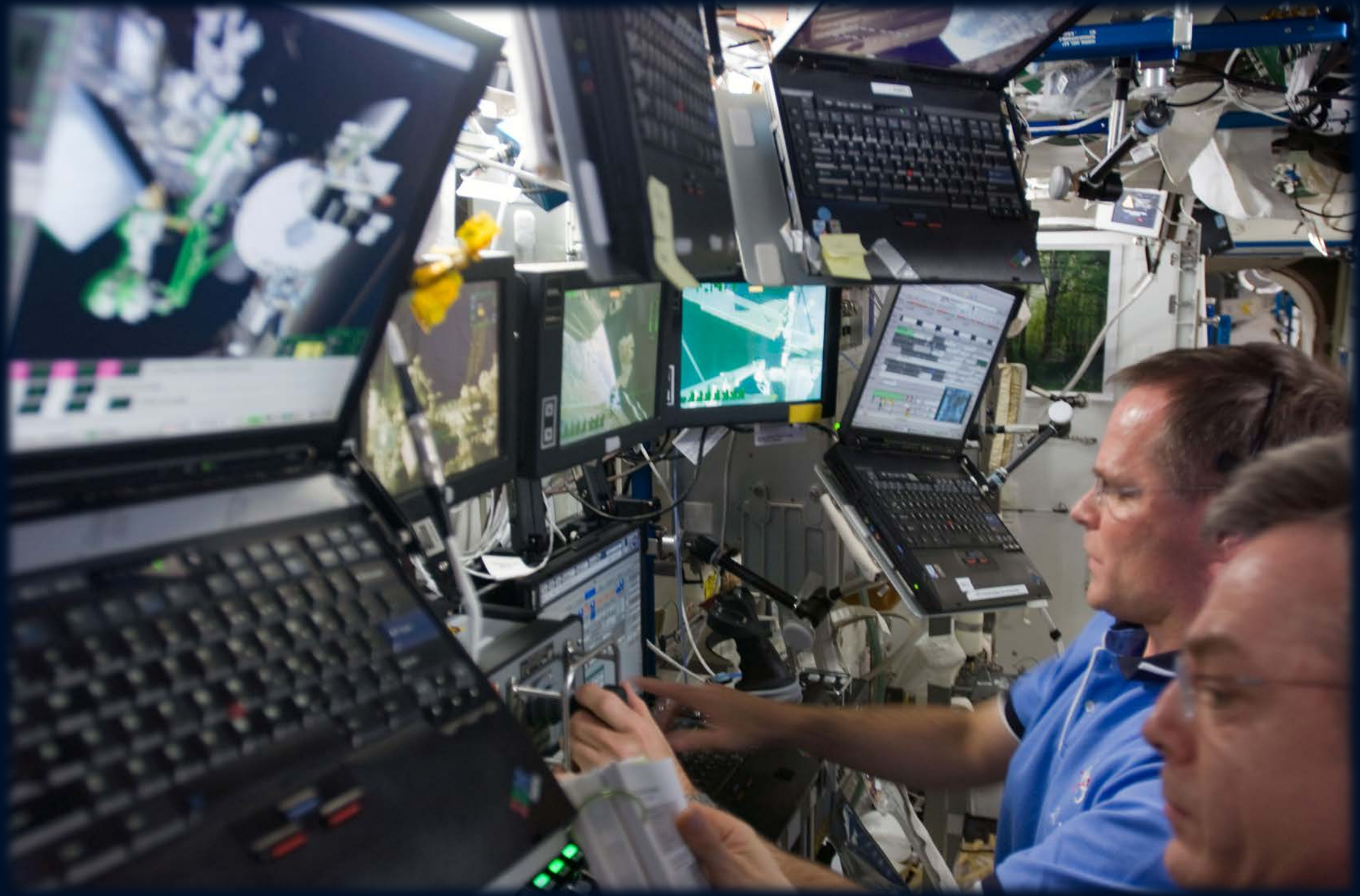


MSS Cameras

Many cameras located all over Space Station – Along Central Truss, Modules, etc…


R CAM
L CAM
S BAND


LAB1P5

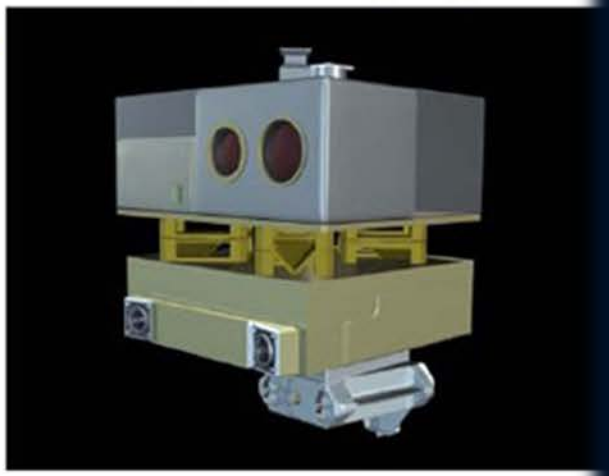


The Concept - DDVS

The Dextre-Deployable Vision Sensor (DDVS) is a surface inspection tool concept for the ISS, using IR, HD and LiDAR.

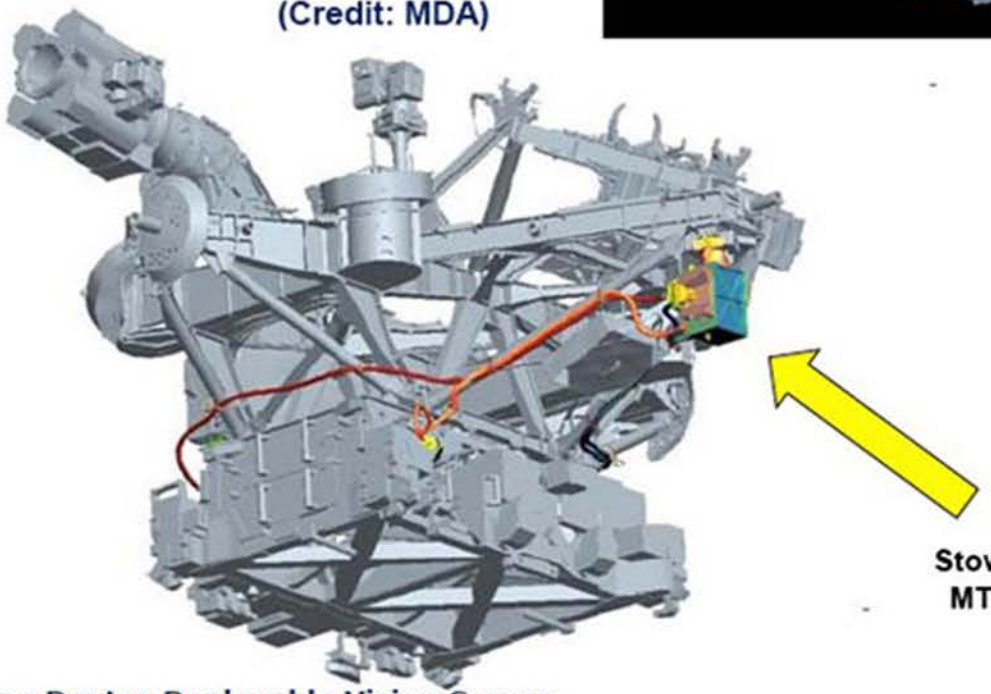
- Launch 2018 pressurized, deploy through JEM airlock (will comply to volume)
- Install and stow on MTRA
- Dextre tool with ops support from CSA
- Requires use of Station WiFi, downlink to ground support station

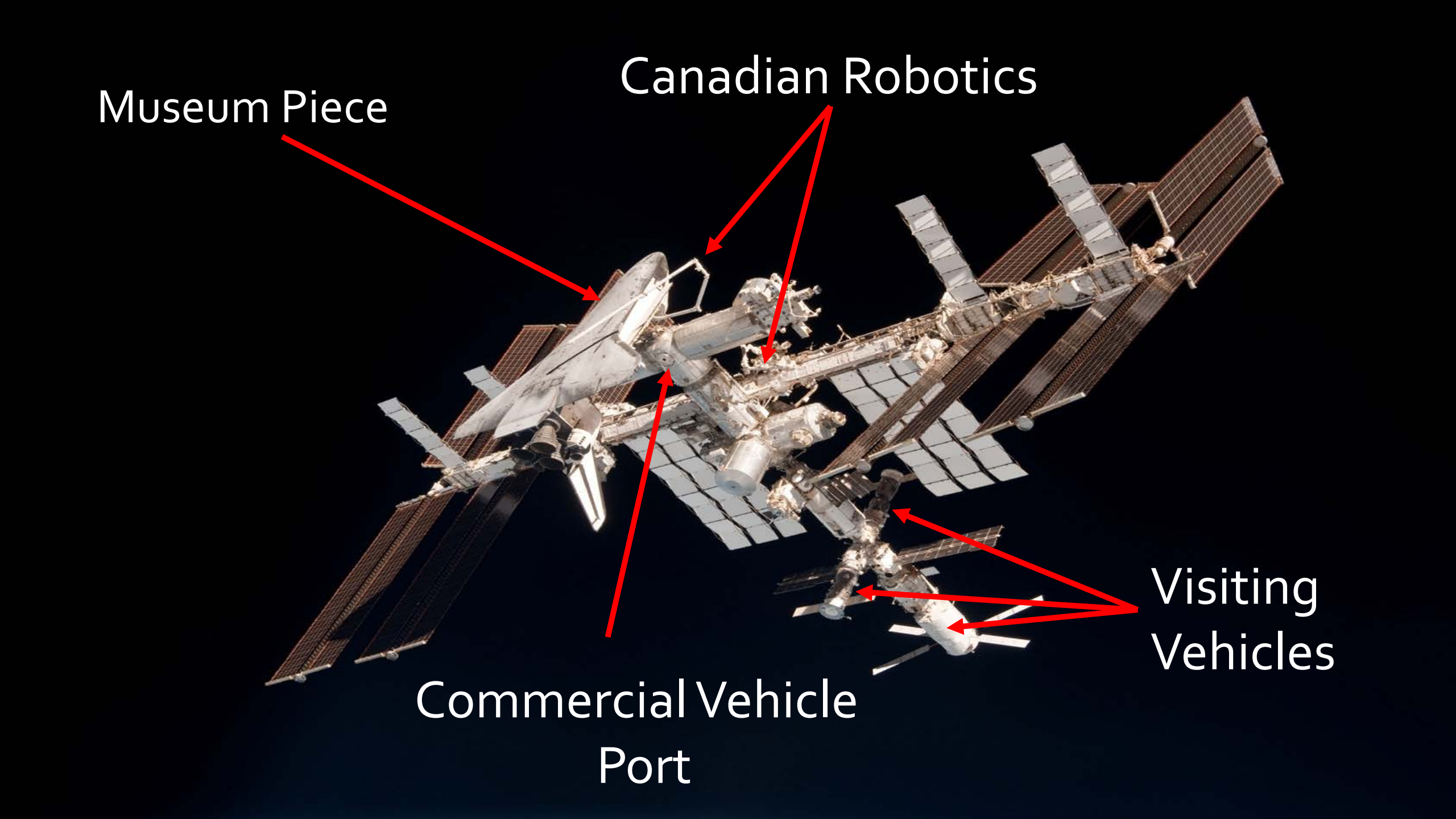
Tool Concept (Artist image only)



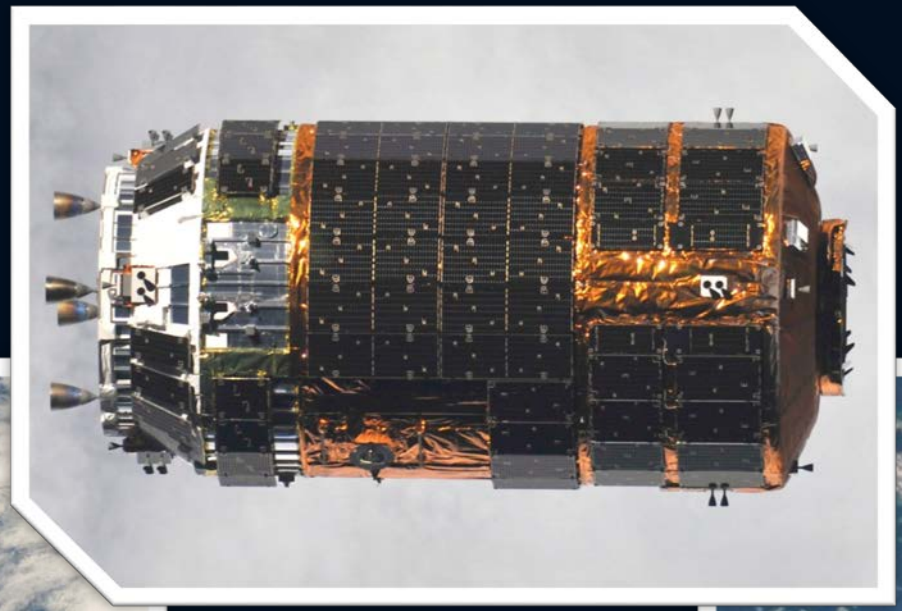
(Credit: MDA)

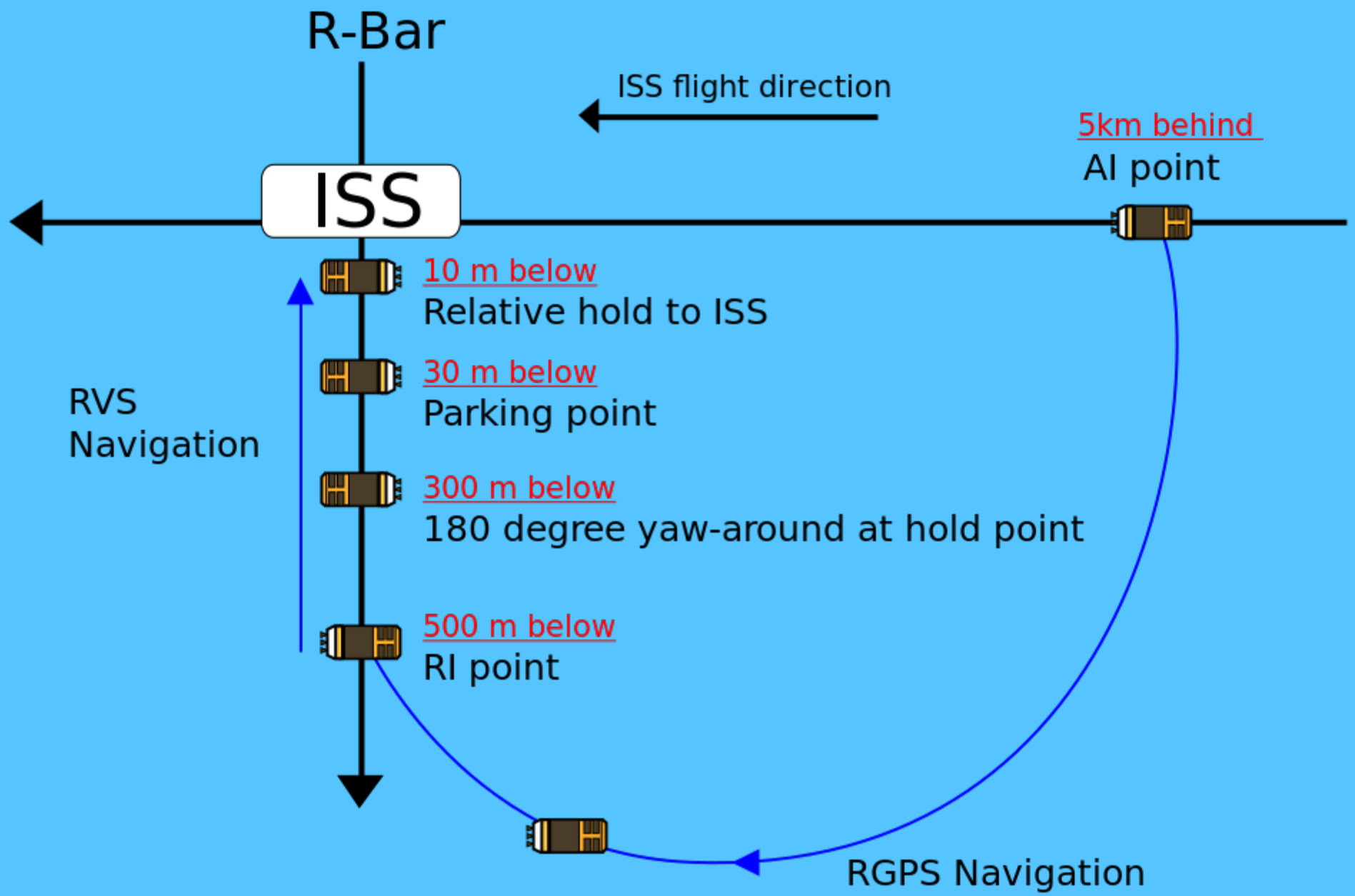
(Credit: MDA)

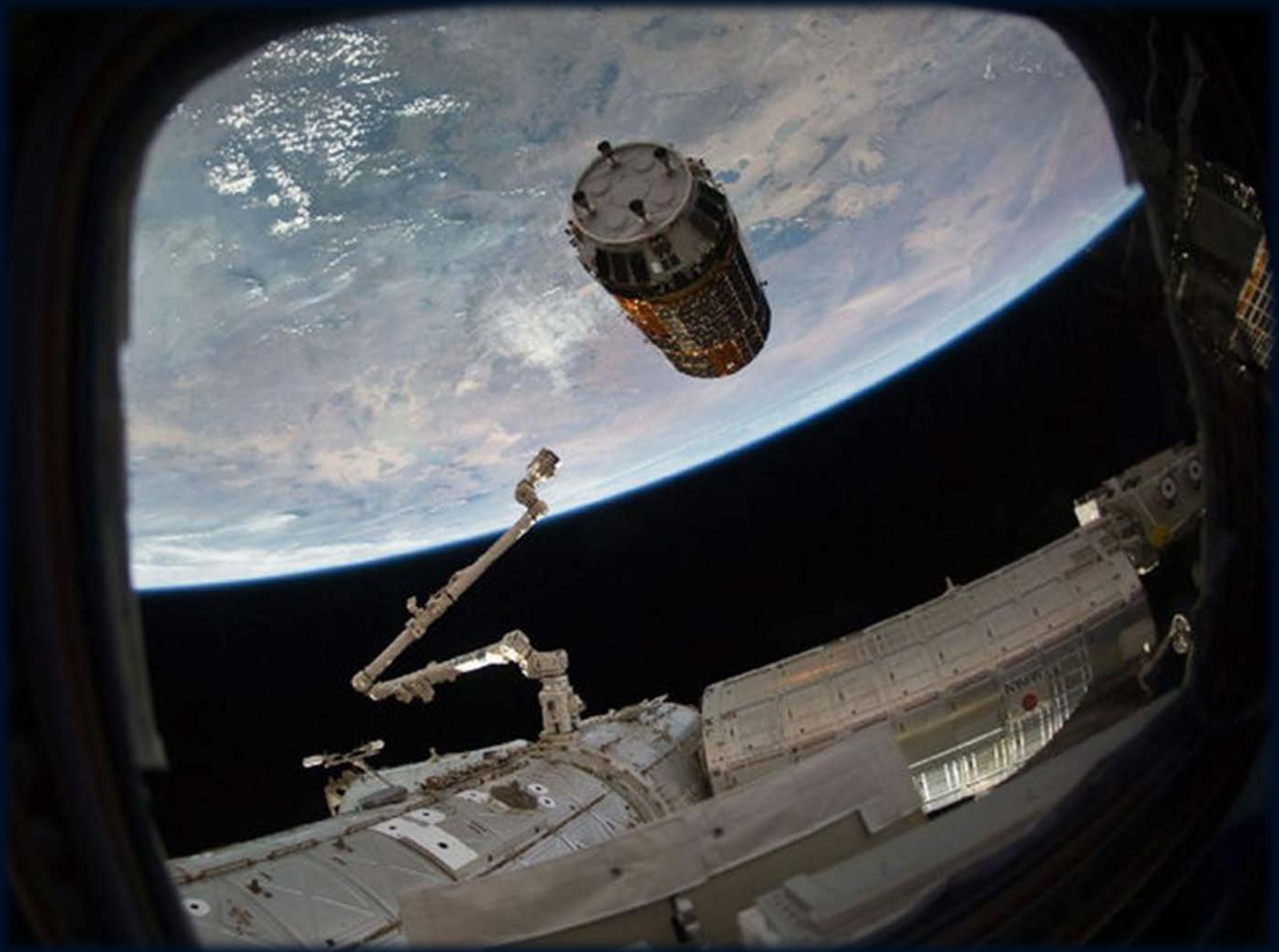



Museum Piece
Canadian Robotics
Visiting Vehicles
Commercial Vehicle Port

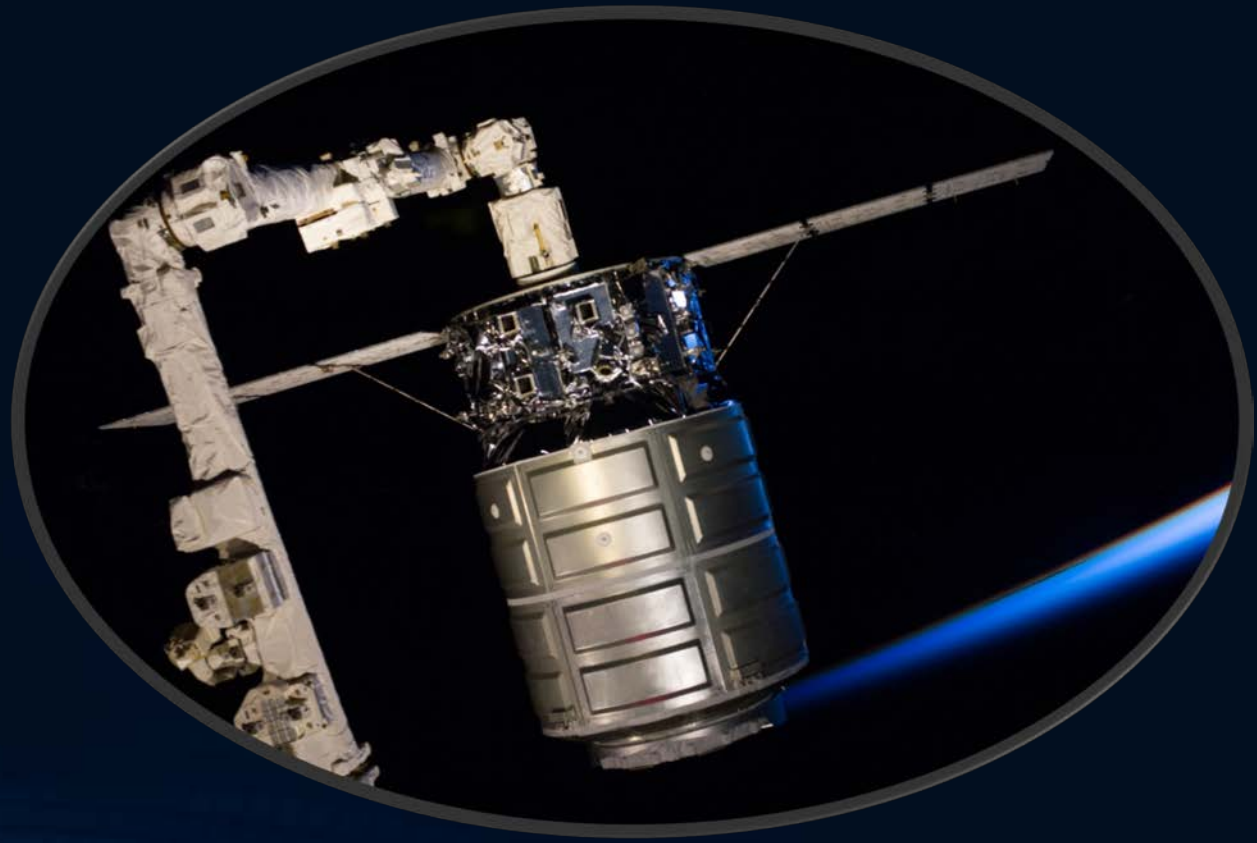
Visiting Vehicles
Free-Flyer Capture




R-Bar
ISS flight direction
ISS
5km behind
AI point
10 m below
Relative hold to ISS
30 m below
Parking point
RVS
Navigation
300 m below
180 degree yaw-around at hold point
500 m below
RI point
RGPS Navigation

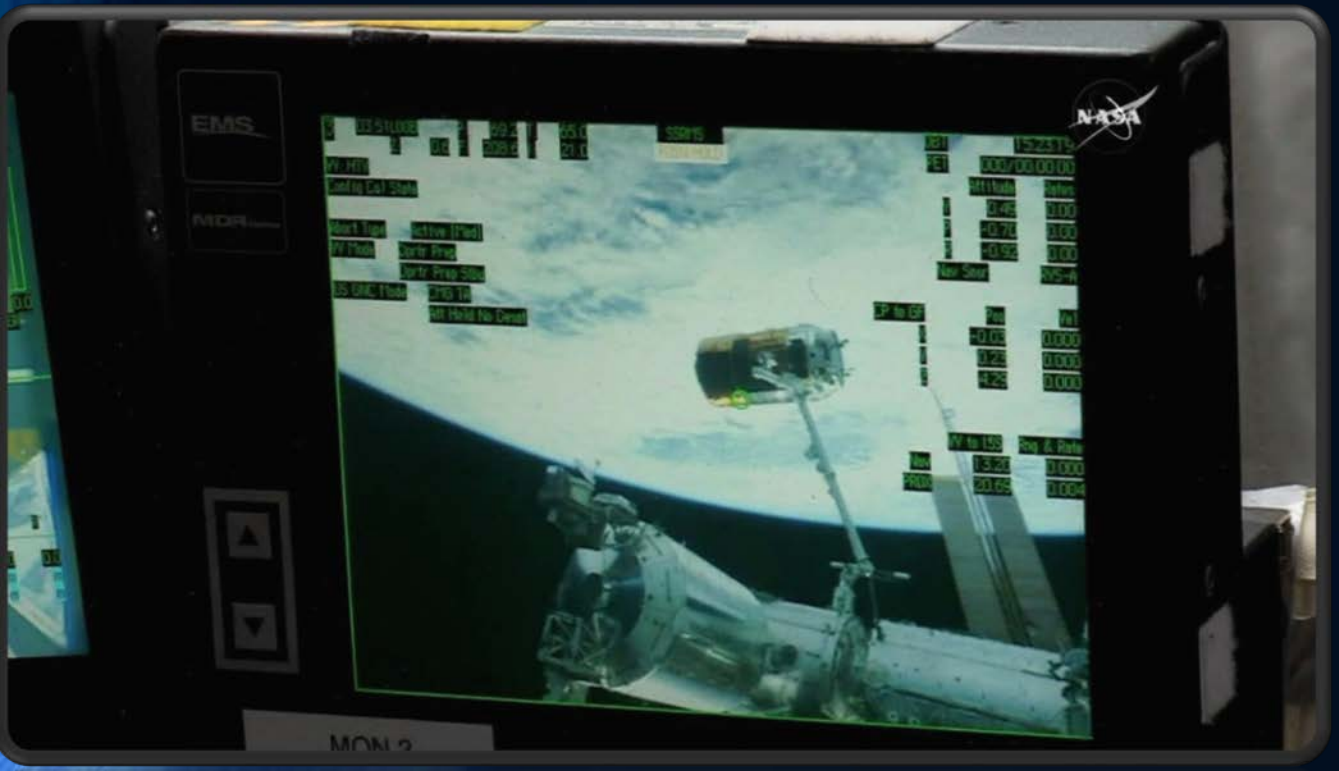


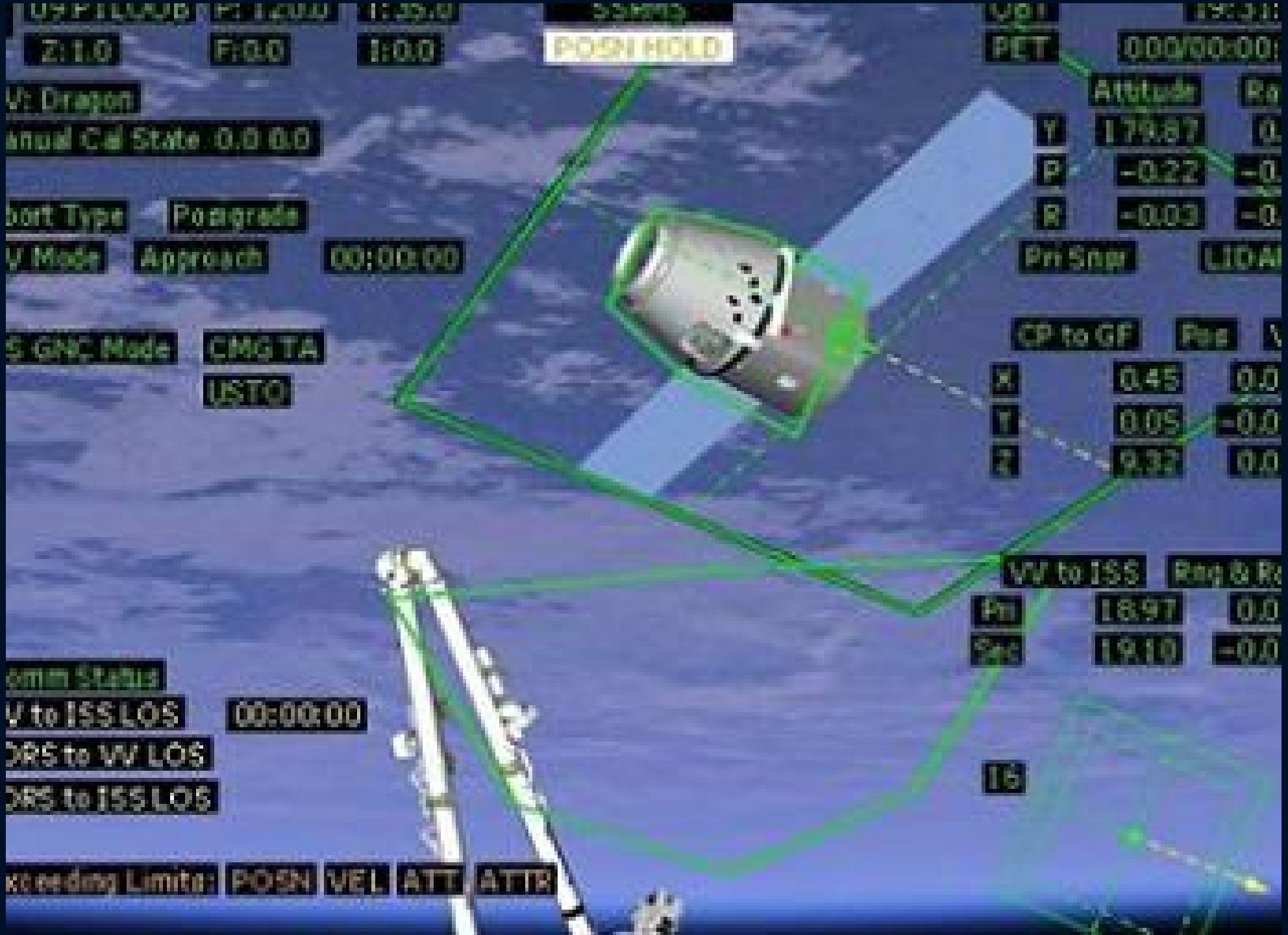
Free Flyer Capture




CUP1 W4
CUP1 W3
CUP1 W2
EMS
MDR
STOP
PCS 1010

Free Flyer Capture Overlays




Z:1.0
F:8.0
I:0.0
PDRN HOLD
PET
Attitude
Y
179.87
P
-0.22
R
-0.03
PriSnpr
CP to GF
0.45
0.05
VV to ISS
18.97
19.10
16
Approach
00:00:00
CMG TA
USTO
00:00:00
VV to ISS LOS
VV LOS
ISS LOS
PDSN
VEL
ATT
ATTR


03 STLOOB P: 75.3 T: 64.2
Z: 0.6 F: 203.4 I: 1.0
SSRMS
GET
PET 000/00:00:
V: HTV
Config Cal State
Attitude
Y -0.04
P 0.09
R -0.07
Nav Snsr
RVS
Abort Type Active [Med]
V Mode CP Hold
CP SK
S GNC Mode CMG TA
USTO
CP to GF Pos
X -0.20
Y 0.19
Z 0.29
VV to ISS Rng & Re
Nav 9.20
PROX 12.46
omm Status
DRS to VV LOS

Time-lapse Video of SpaceX Dragon Capture

Thank You

Dr. Elliott Coleshill

Seneca