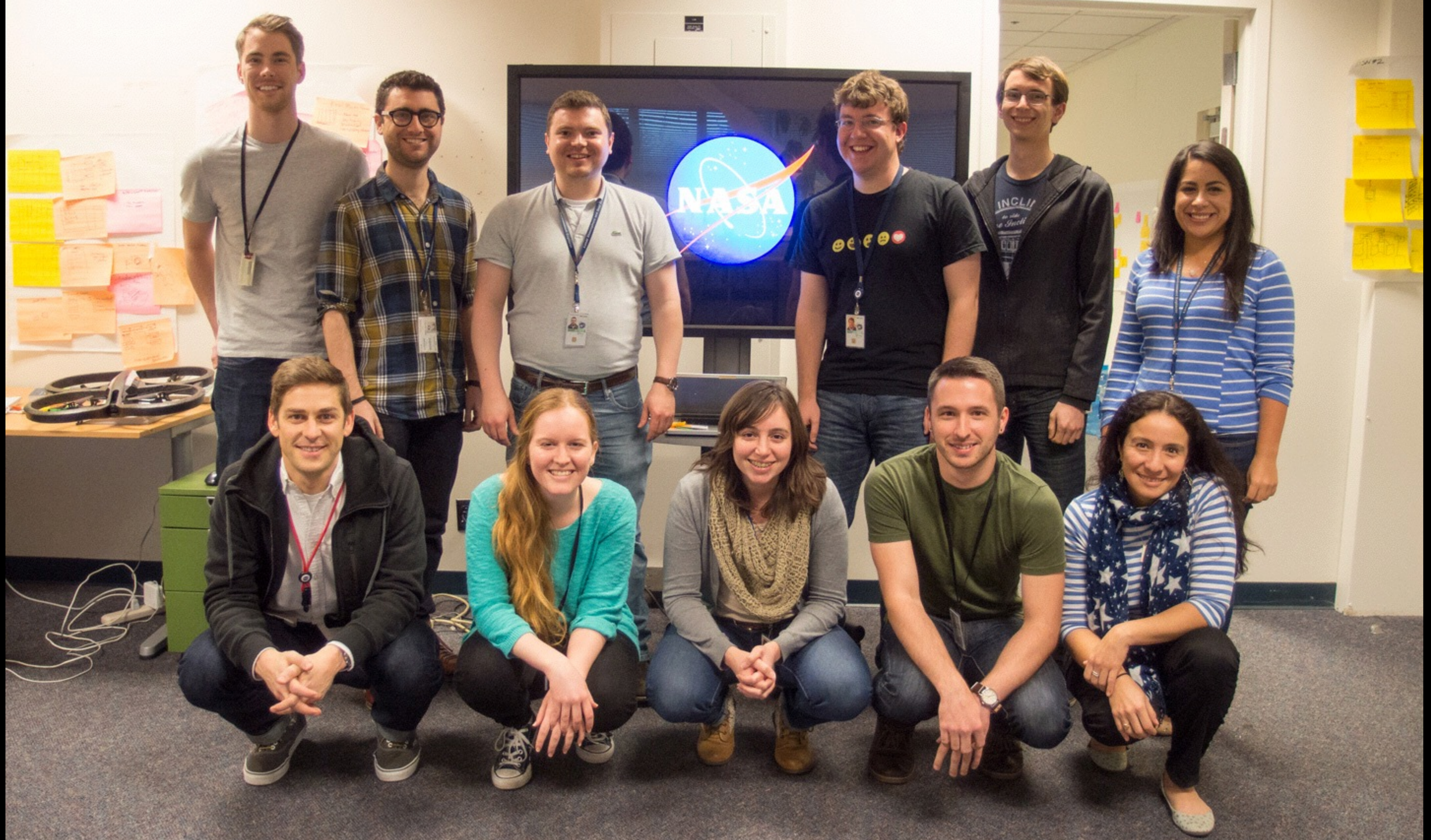
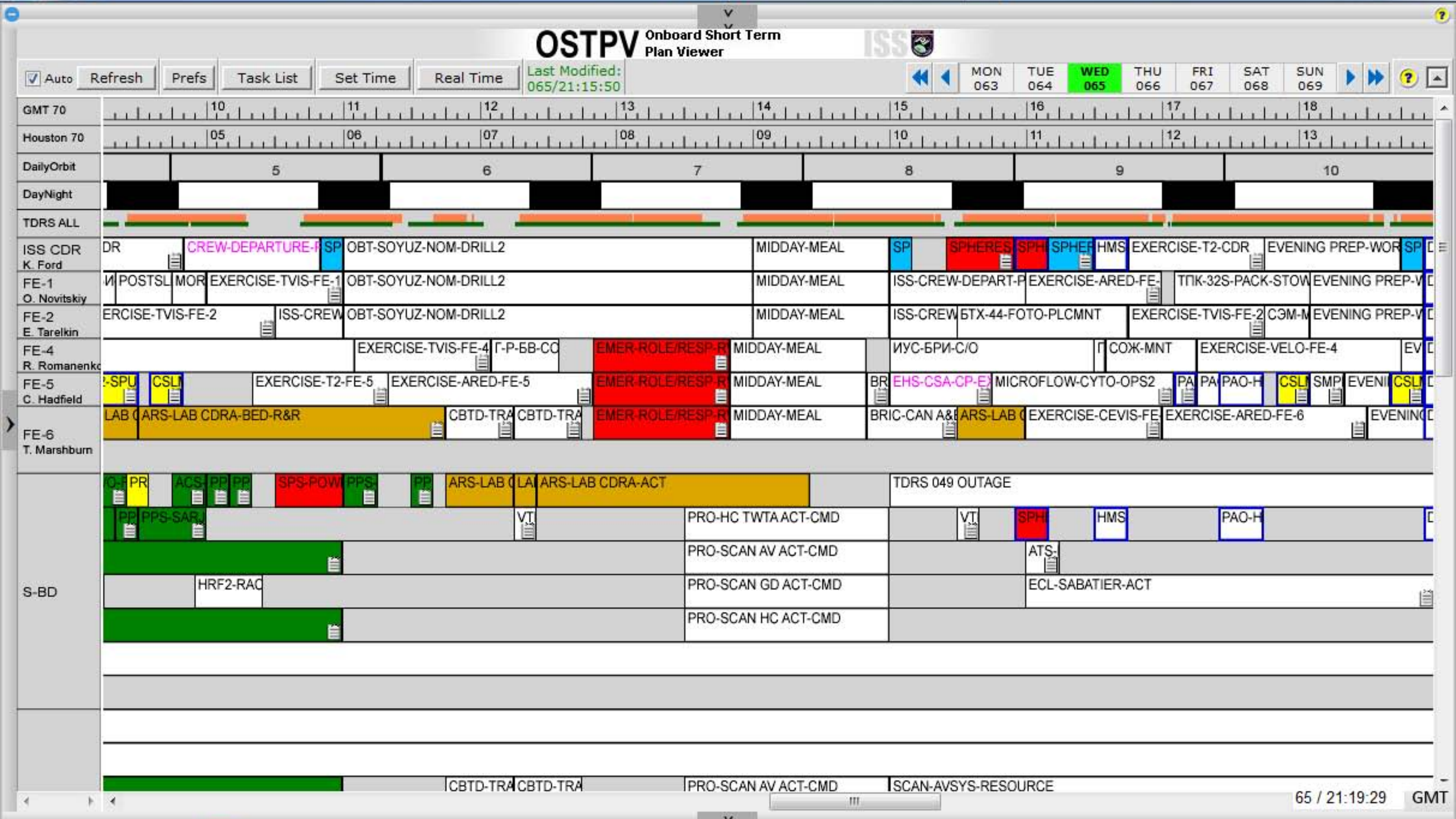
DESIGNING INTERFACES FOR ASTRONAUT AUTONOMY IN SPACE

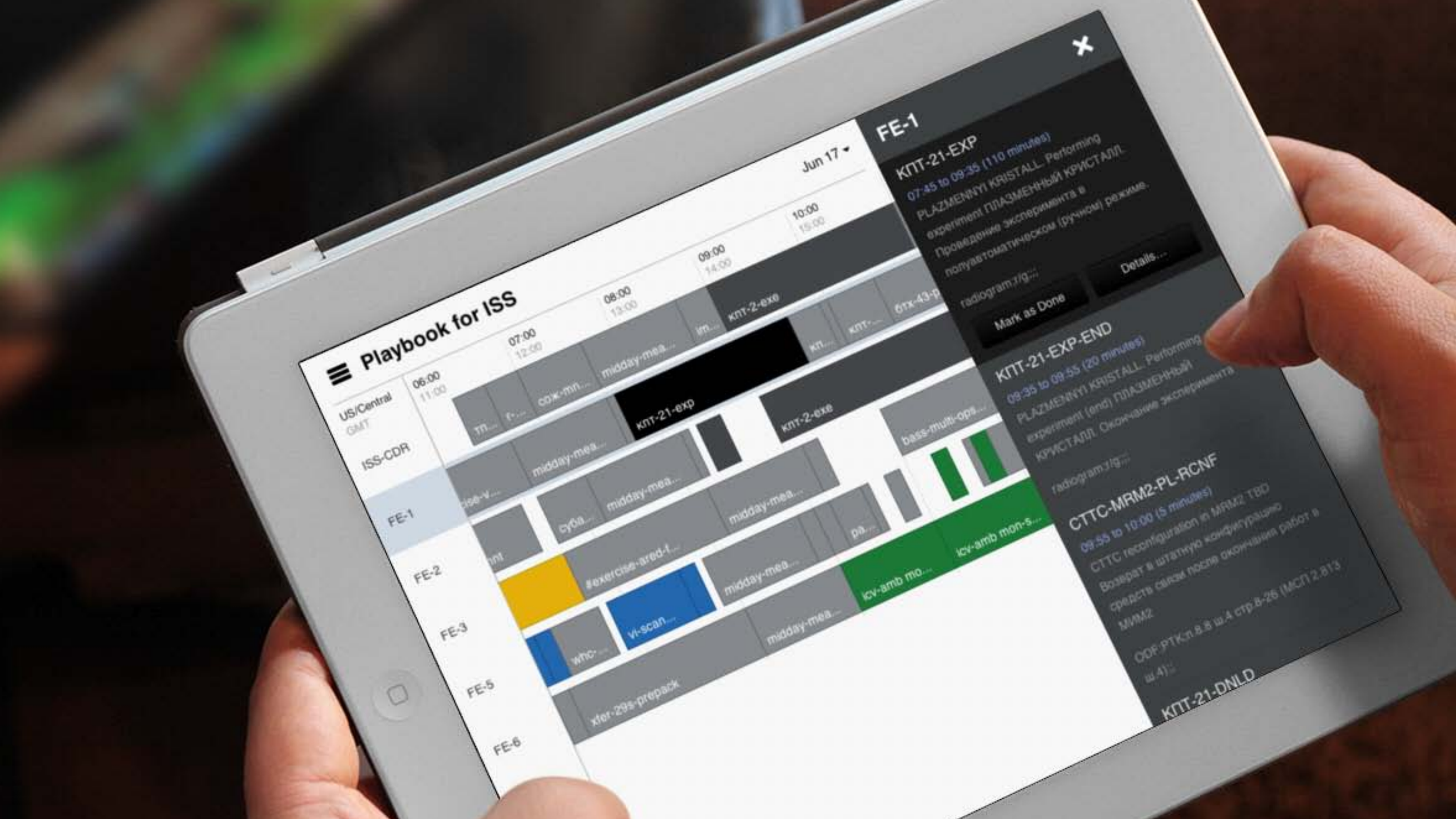
Steve Hillenius, NASA
@hillenius


NASA

(Star Trek Generations)


OSTPV
Onboard Short Term
Plan Viewer
Auto
Refresh
Prefs
Task List
Set Time
Real Time
Last Modified:
065/21:15:50
MON 063
TUE 064
WED 065
THU 066
FRI 067
SAT 068
SUN 069
GMT 70
Houston 70
DailyOrbit
DayNight
TDRS ALL
ISS CDR
K. Ford
FE-1
O. Novitskiy
FE-2
E. Tarelkin
FE-4
R. Romanenko
FE-5
C. Hadfield
FE-6
T. Marshburn
S-BD
CREW-DEPARTURE-P
OBT-SOYUZ-NOM-DRILL2
MIDDAY-MEAL
EXERCISE-T2-CDR
EVENING PREP-WOR
POSTSL
EXERCISE-TVIS-FE-1
ISS-CREW-DEPART-P
EXERCISE-ARED-FE-
ТПК-32S-PACK-STOW
EVENING PREP-W
ERCISE-TVIS-FE-2
ISS-CREW
БТХ-44-FOTO-PLCMNT
EXERCISE-TVIS-FE-2
EVENING PREP-W
EXERCISE-TVIS-FE-4
ИУС-БРИ-С/О
СОЖ-МНТ
EXERCISE-VELO-FE-4
CSLI
EXERCISE-T2-FE-5
EXERCISE-ARED-FE-5
EHS-CSA-CP-E
MICROFLOW-CYTO-OPS2
PAO-H
SMP
EVENI
ARS-LAB CDRA-BED-R&R
CBTD-TRA
BRIC-CAN A&
ARS-LAB
EXERCISE-CEVIS-FE
EXERCISE-ARED-FE-6
EVENIN
PR
ACS-
PPS-
SPS-POW
ARS-LAB
ARS-LAB CDRA-ACT
TDRS 049 OUTAGE
PPS-SARJ
VI
PRO-HC TWTA ACT-CMD
SPH
HMS
PAO-H
PRO-SCAN AV ACT-CMD
ATS-
HRF2-RAC
PRO-SCAN GD ACT-CMD
ECL-SABATIER-ACT
PRO-SCAN HC ACT-CMD
CBTD-TRA
PRO-SCAN AV ACT-CMD
SCAN-AVSYS-RESOURCE
65 / 21:19:29
GMT


APEX
PLATO
SCORE
ETHOS
SPARTAN
THOR
FLIGHT DIRECTOR
CAPCOM
TOPO
BME


Playbook for ISS
Jun 17
06:00
07:00
08:00
09:00
10:00
US/Central
GMT
ISS-CDR
FE-1
FE-2
FE-3
FE-5
FE-6
кпт-21-exp
кпт-2-exe
midday-mea...
xfer-29s-prepack
FE-1
КПТ-21-EXP
07:45 to 09:35 (110 minutes)
PLAZMENNYI KRISTALL. Performing experiment ПЛАЗМЕННЫЙ КРИСТАЛЛ. Проведение эксперимента в полуавтоматическом (ручном) режиме.
radiogram:r/g:...
Mark as Done
Details...
КПТ-21-EXP-END
09:35 to 09:55 (20 minutes)
PLAZMENNYI KRISTALL. Performing experiment (end) ПЛАЗМЕННЫЙ КРИСТАЛЛ. Окончание эксперимента
radiogram:r/g:...
CTTC-MRM2-PL-RCNF
09:55 to 10:00 (5 minutes)
CTTC reconfiguration in MRM2. ТВО Возврат в штатную конфигурацию средств связи после окончания работ в МРМ2
ODF:РТК-п.8.8 ш.4 стр.8-26 (МСП 2.813 ш.4)...
КПТ-21-DNLD

crew autonomy: allowing astronauts to make decisions on their own, with limited input from mission control

crew autonomy: allowing astronauts to make decisions on their own, without input from mission control

Why is it important?

- Astronauts want more autonomy
- Increased situational awareness
- Increased efficiency
- Future deep space missions

It can take anywhere from 8 to 48 minutes for roundtrip communication between Earth and Mars.


Mission Control Center
SPARTAN
ISO
PAO
OPS PLANNER
FLIGHT DIRECTOR
APCOM
TOPO
BME
SURGEON
POSN 4288
POSN 4278


STBD
TO NOD


MISSION CONTROL CENTER
SPARTAN
ISS
PAO
OPS PLANNER
FLIGHT DIRECTOR
APCOM
TOPO
BME
SURGEON
POSN 4288
POSN 4278

science experiments
maintenance
education/public outreach

mission planning
power planning
positioning and control
of the station
support for the crew

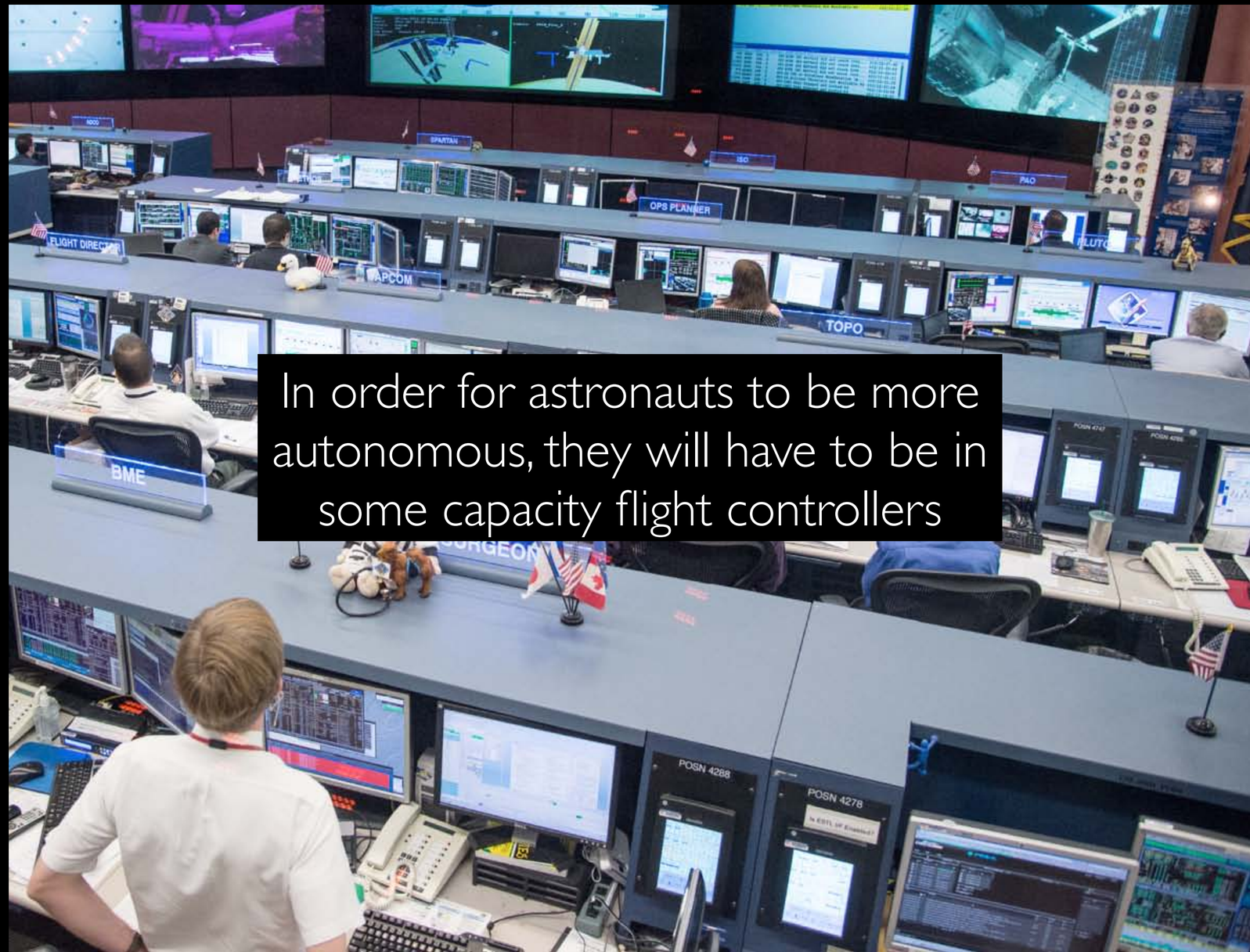
plus tons of other really **important** things!

6 astronauts

100s of flight controllers

6 astronauts

100s of flight controllers



In order for astronauts to be more autonomous, they will have to be in some capacity flight controllers

How do you design a tool that
allows astronauts to plan and
control their own missions?

---

*How do you design a tool that lets an
astronaut take on the roles of
hundreds of people?*

Design Constraints

Balance
Walk up and use
Mobile
Empowering
Efficient and Effortless
Advise, not enforce
Communication Time Delay Tolerant

GMT 12/13/07 (347): 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

MET Day 004: 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 005/00

FD06

Group	Crew	Activities
STS-123	CDR GORIE	SLEEP; POST SLEEP; PMC A/G; POST SLEEP; IMU; POST SLEEP; INH BT / PAD; CWC; CINIT; EXERCISE; CTWECRM; P/TV07 EVA OPS; CWC / INIT; MEAL; CTWECRM; CXWFCER; P/TV07 EVA OPS
	PLT JOHNSON [M1]	SLEEP; SLEEP SALOG; POST SLEEP; IOLLUM / OFF; MCIU*; SSRMS EVA 2 S/U; SSRMS SUP PORT
	MS1 BEHNKEN	SLEEP; POST SLEEP; A/L REP; HYG BRK/ HATCH CLS; CAMPOUT EVA PREP; 14.7 rep; EVA 2 (07:00); IVA SUP PORT; SPDM ASSEMBLY
	MS2 FOREMAN [EV2]	SLEEP; POST SLEEP; HYG BRK/ PREBREATHE; 10.2 DPRS; CAMPOUT EVA PREP; EMU PURGE; EMU PREBREATHE; C_LK DPRS; DPS; EGRS; SETUP; SPDM ARM2 STOW; SPDM ARM1 STOW; SPDM ARM INSTALL; SPDM COVER REMOVAL; *
	MS3 DOI	SLEEP; POST SLEEP; FAN 1; RACK FRONT STOW RMVL; RACK KBAR; P/TV 07 S/U; MRLN; PHOTO; MEAL; RK DMS1 ROT/RCNFG; RK EPS1 ROT/RCNFG; EXERCISE; RK WS ROT/RCNFG
	MS4 LINNEHAN [EV1]	SLEEP; POST SLEEP; HYG BRK/ PREBREATHE; A/L REP; 10.2 DPRS; CAMPOUT EVA PREP; EMU PURGE; EMU PREBREATHE; C_LK DPRS; DPS; EGRS; SETUP; SPDM ARM2 STOW; SPDM ARM1 STOW; SPDM ARM INSTALL; SPDM COVER REMOVAL; @
DN	FE-2 EYHARTS	SLEEP (8.5); POST SLEEP; PREP WORK; DPC; H/O; MRLN; MVRILD; TVIS; MRLN SAMP STOW; MEAL; MRLN; TVIS
EXP	ISS CDR WHITSON	SLEEP (8.5); ♦; POST SLEEP; HYG BRK/ HATCH CLS; CAMPOUT EVA PREP; 14.7 rep; BSA*; RED; MEAL; RK DMS1 ROT/RCNFG; RK EPS1 ROT/RCNFG; TVIS; ®
	FE-1 MALENCHENKO	SLEEP (8.5); POST SLEEP; PREP WORK; DPC; PMC; TVIS; EXERCISE CEVIS; MEAL; COX MNT; IMS; RAM INSTL; RK WS ROT/RCNFG
UP	FE-2 EXP16 REISMAN [M2]	SLEEP (8.5); POST SLEEP; PREP WORK; DPC; H/O; FAN 1; RACK FRONT STOW RMVL; SSRMS EVA 2 S/U; EXER; H/O; SSRMS SPDM SUP PORT

STS	
DAY/NIGHT	
ORBIT	72, 73, 74, 75, 76, 77, 78, 79, 80
TDRS	W -171; E -46; Z -275
ORB ATT	BIAS -XLV -ZVV

NOTES: ♦HAM P/DN; *FILTER CK; *TERM; ♦SORTIE CL; @SORTIE CL; ®PRE SLEEP-

OBJECTIVE:
Perform first stage capture following translation of U.S. Lab into ready-to-latch position for berthing to Node 1 Forward Active Common Berthing Mechanism (ACBM).
CBM capture latches are driven from initial position of 200° (fully deployed) to approximately 186°.

LOCATION:
Node 1/AFD EPCS

DURATION:
5 minutes

REFERENCED PROCEDURE(S):
LAB INSTALL (FDF: PDRS OPS, NOMINAL LAB OPS)

NOTE

1. Step titles followed by the notation "(AOS/M)" indicate that AOS during the execution of that step is mandatory. If currently LOS or expecting LOS prior to completion of an AOS/M step, wait for the next AOS to perform step.
2. For any off-nominal steps or any attention symbols that appear, refer to {NODE 1 CBM MATE MALFUNCTION} (SODF: ASSY MAL: MALFUNCTION: CBM).
3. Step 1 is nominally performed with the SRMS in Position Hold mode.
4. Capture sequence may be initiated with three of four RTLs closed. In this case, the latch associated with the open RTL must be masked.

1. READY-TO-LATCH INDICATORS (RTLs) CLOSED VERIFICATION

√Step 7 of LAB INSTALL complete (FDF: PDRS OPS, NOMINAL LAB OPS)

PCS Node 1: S&M
Node 1:S&M

sel Forward CBM

Node 1 Forward CBM Display
'Functional CBM Representation (External View)'

√RTL indications (four) – green

****

If RTL X (where X = 1, 2, 3, 4) is gray after repeated attempts to gain ready to latch indication

√**MCC** for go

sel Latch X

Capture Latch X Details

sel Commands

Latch_X_Cmds

cmd Mask Latch X **Execute**

Node 1 Forward CBM Display
'Functional CBM Representation (External View)'

√Latch X – Ø

****

2. FIRST STAGE CAPTURE PERFORMANCE (AOS/M)

CAUTION

To prevent damage to active CBM (ACBM), free drift (DAP: FREE for shuttle control or thruster inhibit for SM control) is required from initiation of CBM capture latch operation until a minimum of eight alternating bolts (every other bolt) have completed the ABolts command. SRMS shall remain grappled to U.S. Lab until such time.

A6U √DAP: FREE

PCS Node 1 Forward CBM Display
'Commands by Task'

sel Mate

Node 1 Fwd CBM Mate
'Capture Passive CBM'

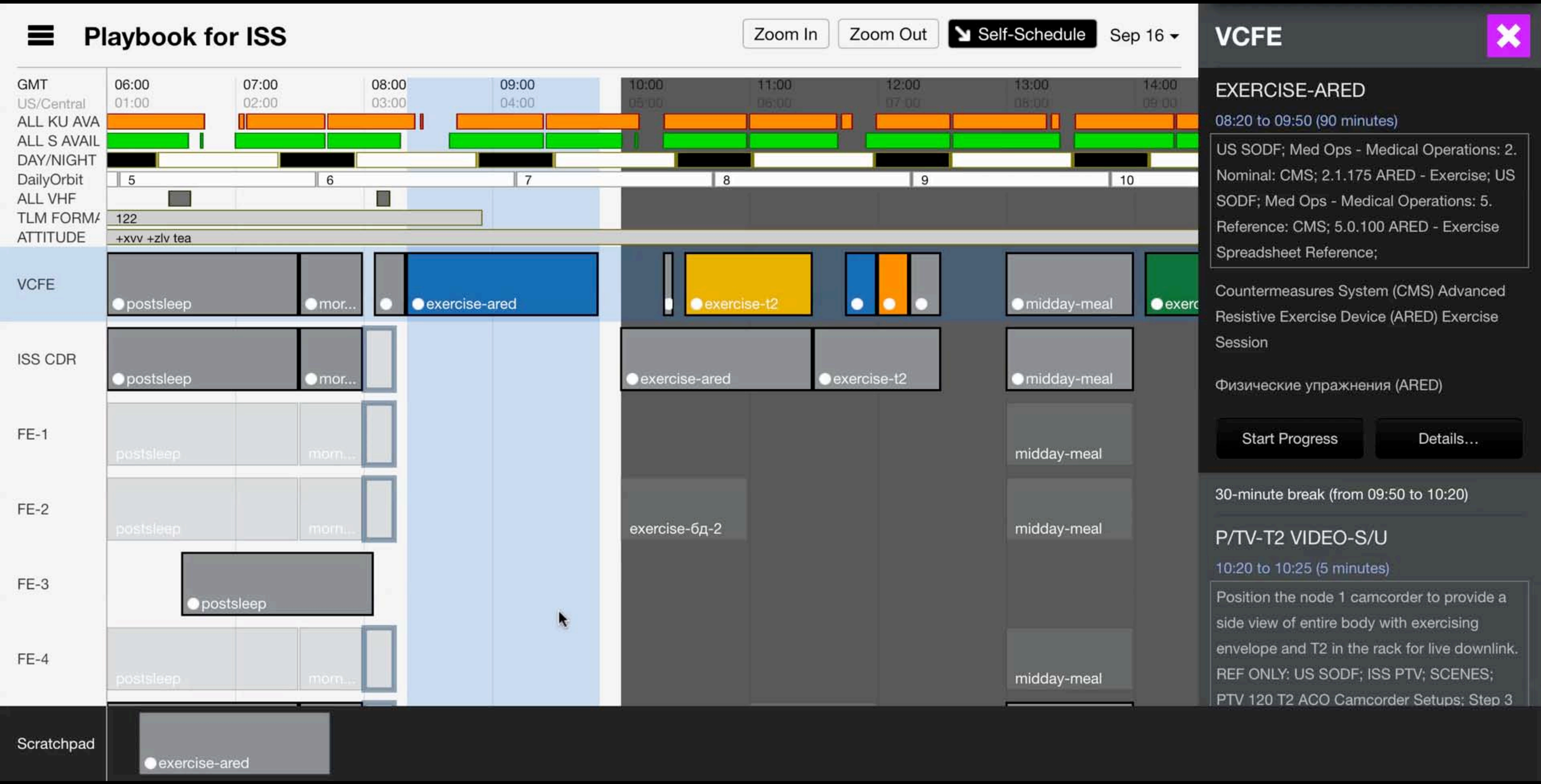
cmd Capture First Stage **Execute**

'Confirmation Request'

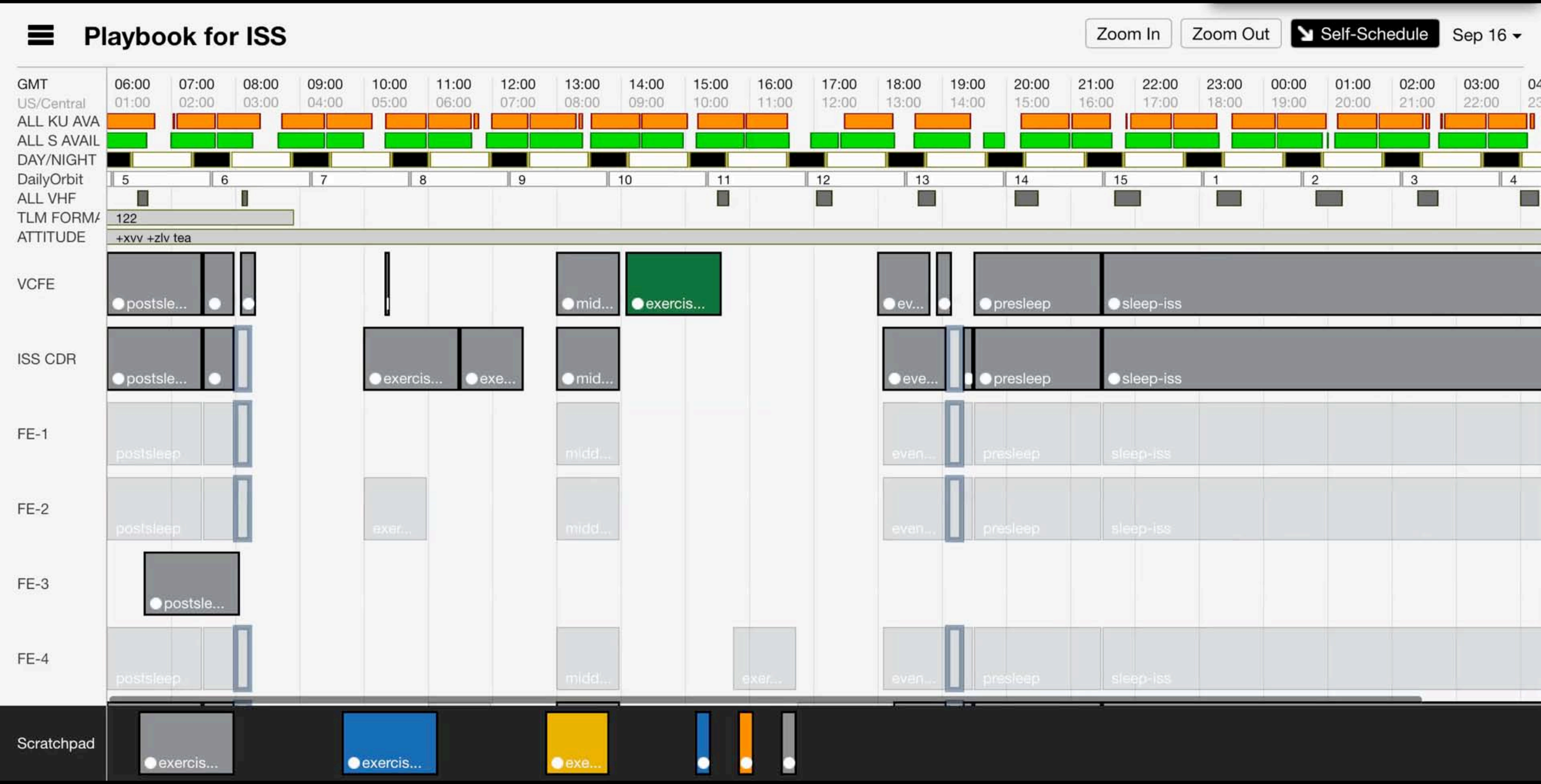
√Override Capture Command?

cmd Yes **Execute**
(Command requires approximately 15 seconds.)


Playbook for NEEMO 19
Self-Schedule
FE-1 (Andy)
Daily Ratings Survey
17:00
18:00
19:00
20:00
21:00
pre-sleep activities
Start Progress
Meal

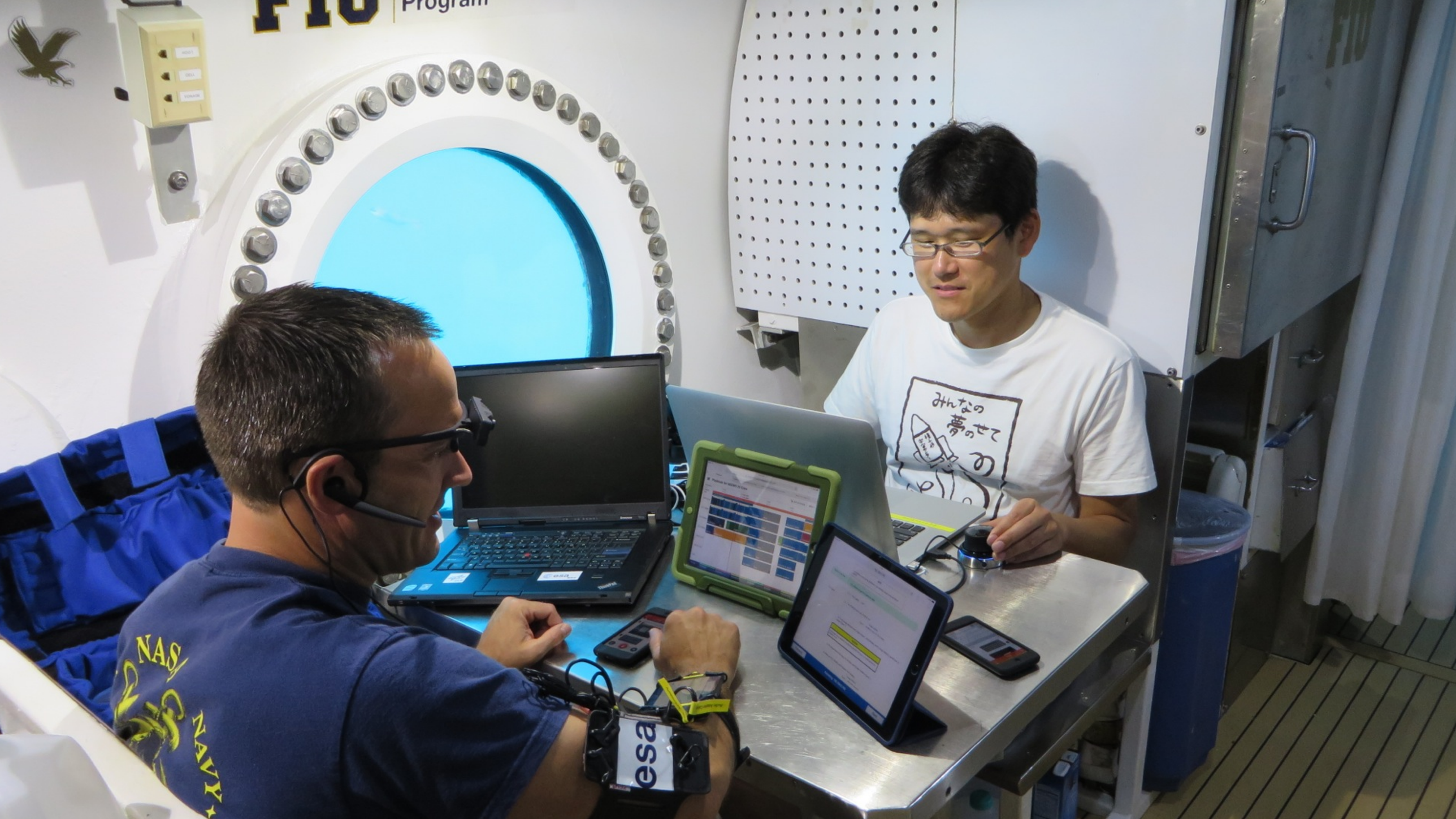

Playbook for ISS
Zoom In
Zoom Out
Self-Schedule
Sep 16
GMT
US/Central
06:00
01:00
07:00
02:00
08:00
03:00
09:00
04:00
10:00
11:00
12:00
13:00
14:00
ALL KU AVA
ALL S AVAIL
DAY/NIGHT
DailyOrbit
5
6
7
8
9
10
ALL VHF
TLM FORMA
122
ATTITUDE
+xvv +zlv tea
VCFE
postsleep
mor...
exercise-ared
exercise-t2
midday-meal
ISS CDR
FE-1
FE-2
exercise-бд-2
FE-3
FE-4
Scratchpad
VCFE
EXERCISE-ARED
08:20 to 09:50 (90 minutes)
US SODF; Med Ops - Medical Operations: 2. Nominal: CMS; 2.1.175 ARED - Exercise; US SODF; Med Ops - Medical Operations: 5. Reference: CMS; 5.0.100 ARED - Exercise Spreadsheet Reference;
Countermeasures System (CMS) Advanced Resistive Exercise Device (ARED) Exercise Session
Физические упражнения (ARED)
Start Progress
Details...
30-minute break (from 09:50 to 10:20)
P/TV-T2 VIDEO-S/U
10:20 to 10:25 (5 minutes)
Position the node 1 camcorder to provide a side view of entire body with exercising envelope and T2 in the rack for live downlink. REF ONLY: US SODF; ISS PTV; SCENES; PTV 120 T2 ACO Camcorder Setups; Step 3

(Rebecca Boyd)


Playbook for ISS
Zoom In
Zoom Out
Self-Schedule
Sep 16
GMT
US/Central
06:00 01:00
07:00 02:00
08:00 03:00
09:00 04:00
10:00 05:00
11:00 06:00
12:00 07:00
13:00 08:00
14:00 09:00
15:00 10:00
16:00 11:00
17:00 12:00
18:00 13:00
19:00 14:00
20:00 15:00
21:00 16:00
22:00 17:00
23:00 18:00
00:00 19:00
01:00 20:00
02:00 21:00
03:00 22:00
ALL KU AVA
ALL S AVAIL
DAY/NIGHT
DailyOrbit
5 6 7 8 9 10 11 12 13 14 15 1 2 3 4
ALL VHF
TLM FORM
122
ATTITUDE
+xvv +zlv tea
VCFE
postsle... mid... exercis... ev... presleep sleep-iss
ISS CDR
postsle... exercis... exe... mid... eve... presleep sleep-iss
FE-1
postsleep midd... even... presleep sleep-iss
FE-2
postsleep exer... midd... even... presleep sleep-iss
FE-3
postsle...
FE-4
postsleep midd... exer... even... presleep sleep-iss
Scratchpad
exercis... exercis... exe...


HYDROLINX
FIU
FIU
DELL


Zoom In
Zoom Out
Self-Schedule
Playbook for NEEMO 20


FIU
Program
みんなの
夢のせて
NAS
NAVY

Playbook for NEEMO 19

+ Add Note

Copy MD7 17:07:41. We'll be waiting!

Add Photo, Video, or Files

Add Note

17:09:19
MD7

Potted up yesterday:
- Skin-B Kit
- HEADS-UP laptop
- MobiPV kit
- 3 complete GGlass (with chargers and earbuds)
- Surface Sampling Kit

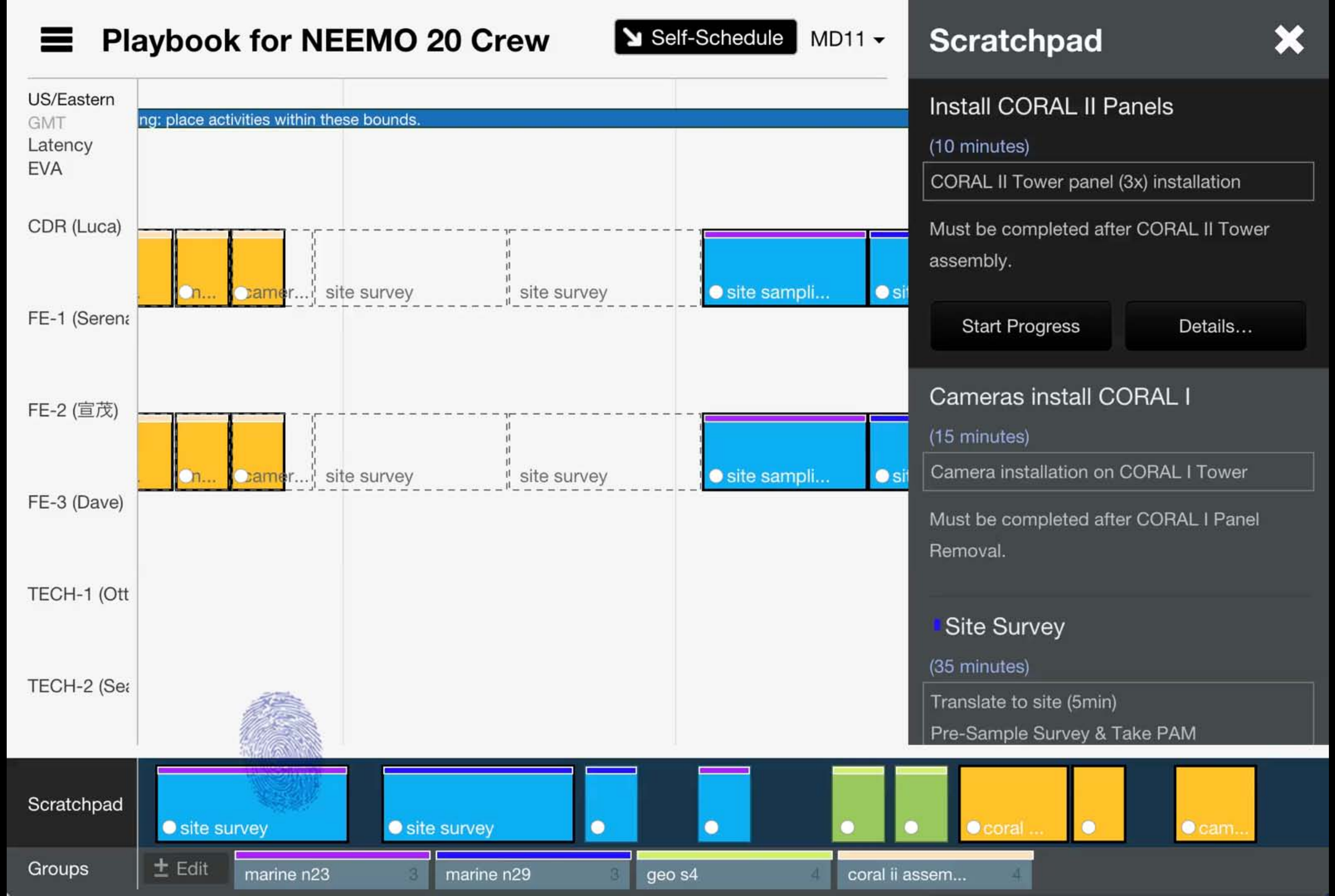
The rest of the hardware is packed in Aquarius and will follow us in the potting up today.

01:14 UNTIL DELIVERY · EARLIEST RESPONSE 17:19:19

17:07:41
MD7

Good morning NEEMO MCC! Or are we just speaking to an empty room because everyone is on call for a well deserved morning off? All is well and everyone is well at 7ft and ascending!

DELIVERED · EARLIEST RESPONSE 17:17:41


Playbook for NEEMO 20 Crew
Self-Schedule
MD11
US/Eastern
GMT
Latency
EVA
ng: place activities within these bounds.
CDR (Luca)
FE-1 (Seren
FE-2 (宣茂)
FE-3 (Dave)
TECH-1 (Ott
TECH-2 (Se
site survey
site survey
site sampli...
Scratchpad
Install CORAL II Panels
(10 minutes)
CORAL II Tower panel (3x) installation
Must be completed after CORAL II Tower assembly.
Start Progress
Details…
Cameras install CORAL I
(15 minutes)
Camera installation on CORAL I Tower
Must be completed after CORAL I Panel Removal.
Site Survey
(35 minutes)
Translate to site (5min)
Pre-Sample Survey & Take PAM
Scratchpad
site survey
site survey
coral ...
cam...
Groups
Edit
marine n23
marine n29
geo s4
coral ii assem...


4
3

DESIGNING INTERFACES FOR ASTRONAUT AUTONOMY IN SPACE

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