Development of Flight Research Experiment Complements

Suzanne McCollum

Outline

- What is ISSMP?
- How to get started
- Why does it take so long?
- What are some of the unique challenges of designing flight experiments?

What is ISSMP?

HRP Control Board

Science Management Panel

Human Research Program

Manager – *William Paloski, Ph.D.*
Deputy Manager – *Barbara J. Corbin*
Chief Scientist– *Craig E. Kundrot, Ph.D., Acting*
Program Clinician – *Cedric H. Senter, M.D.*

HRP International Science Office

Chief – *John B. Charles, Ph.D.*

HRP Science Management Office

Manager – *Michelle Perchonok, Ph.D.*

Human Research Program Integration

Manager – *Katherine Daues*
Deputy Manager – *Roberto Galvez*
Education & Outreach– *Charles Lloyd, PharmD*

ISS Medical Projects

Manager – *S. McCollum*

Scientist –
C. Sams, Ph.D.
Deputy Scientist –
R. Pietrzyk

Space Radiation

Manager –
J. Uri

Scientist – TBD

Human Health Countermeasures

Manager. –
D. Baumann

Scientist -
P. Norsk Ph.D.

Exploration Medical Capability

Manager –
T. McGrath

Scientist –
S. Watkins, M.D., Ph.D.

Behavioral Health & Performance

Manager –
L. Bollweg

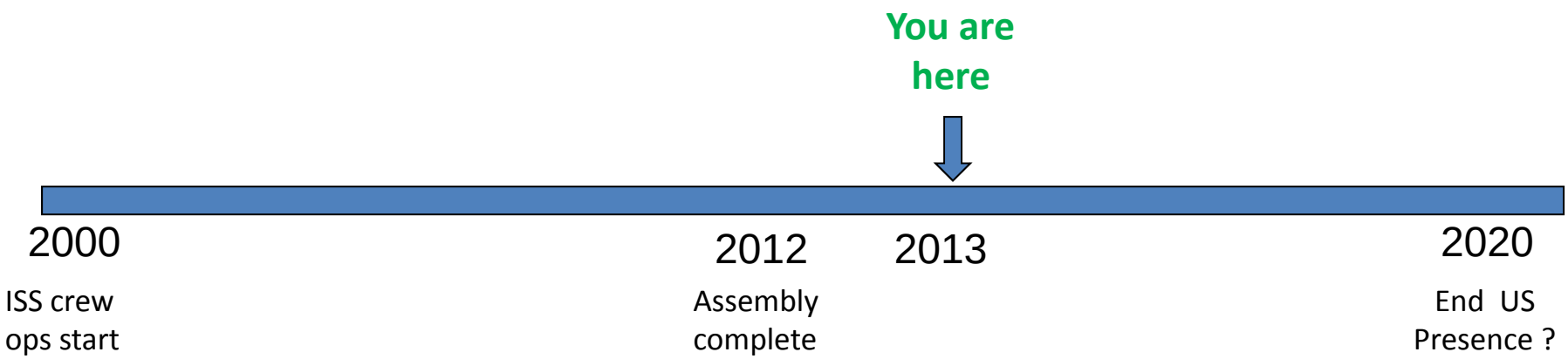
Scientist –
L. Leveton, Ph.D.

Space Human Factors & Habitability

Acting Manager –
M. Perchonok, Ph.D.

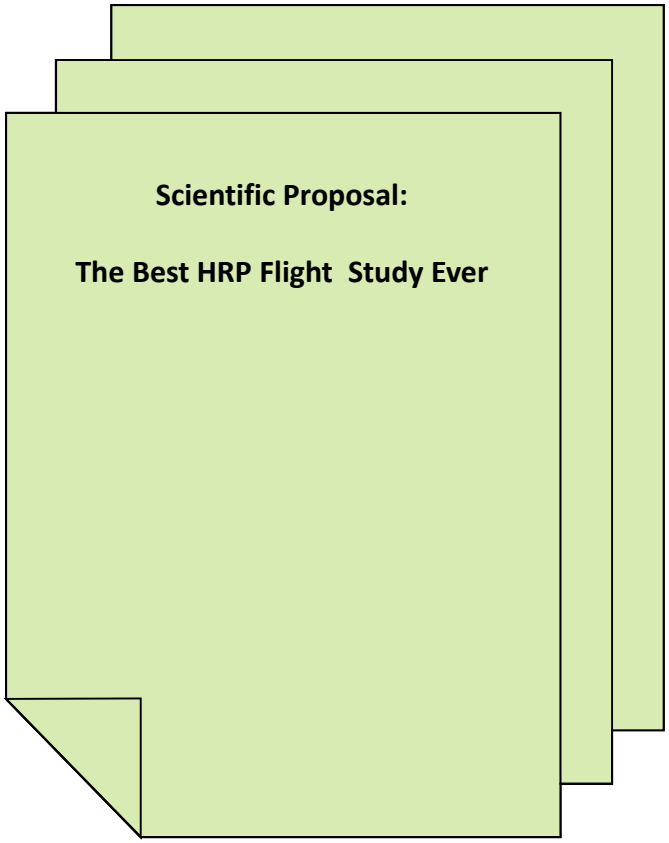
Scientist –
T. Sullivan, Ph.D.

Why is ISSMP needed?



- ISS represents the ONLY opportunity to mitigate risks for the long duration transit phase of Exploration class missions
- ISS is a limited resource
- At assembly complete, remaining time is too short to complete HRP objectives without maximal use of assets
- Aggressive strategies are needed to close knowledge gaps and mitigate risks during the remaining life of ISS

How to Get Started



How to Get Started: Sponsorship

For more information on research sponsorship and funding, see:
http://www.nasa.gov/mission_pages/station/research/funding_information.html

How to Get Started: HRP Process

HRP "select for flight" process requires:

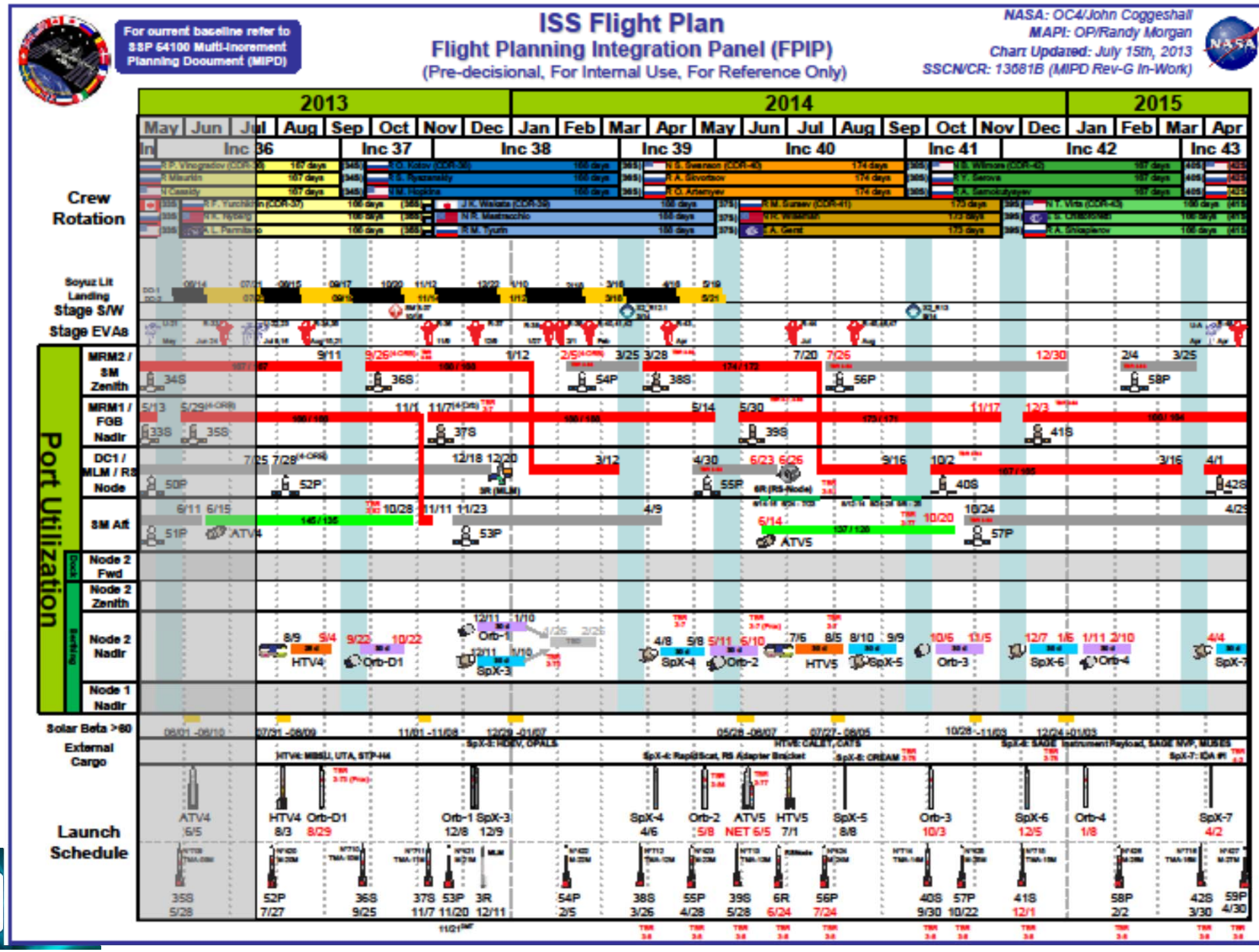
- HRP research Element sponsor
  - Is it relevant to HRP?
- Merit review
  - Is it scientifically sound?
- Institutional Review Board Approval
  - Will the crew subject be treated in an ethical, safe, and equitable manner?
- Feasibility Assessment
  - Can it be executed in-flight within available resources?

How to Get Started

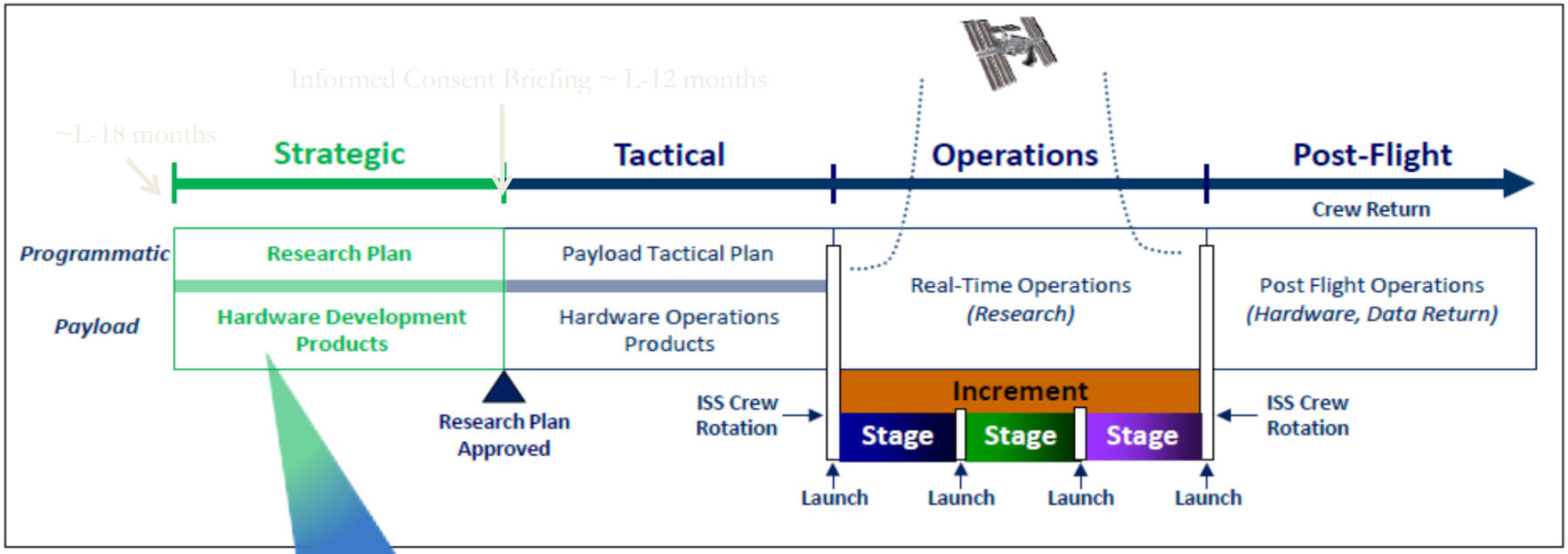
- Once selected for flight, ISSMP has the authority to include experiments in complements of research submitted to the ISS Program.
- That doesn't mean you can fly on the next Increment!

WHY NOT?

Why Does it Take So Long?


For current baseline refer to SSP 64100 Multi-Increment Planning Document (MIPD)
ISS Flight Plan
Flight Planning Integration Panel (FPIP)
(Pre-decisional, For Internal Use, For Reference Only)
NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan
Chart Updated: July 15th, 2013
SSCN/CR: 13681B (MIPD Rev-G In-Work)
2013
2014
2015
May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr
Inc 36 Inc 37 Inc 38 Inc 39 Inc 40 Inc 41 Inc 42 Inc 43
Crew Rotation
Soyuz Lit
Landing
Stage S/W
Stage EVAs
Port Utilization
MRM2 / SM Zenith
MRM1 / FGB Nadir
DC1 / MLM / RS Node
SM Aft
Node 2 Fwd
Node 2 Zenith
Node 2 Nadir
Node 1 Nadir
Solar Beta >60
External Cargo
Launch Schedule
HTV4 Orb-D1 Orb-1 SpX-3 SpX-4 Orb-2 ATV5 HTV5 SpX-5 Orb-3 SpX-6 Orb-4 SpX-7
8/3 8/29 12/8 12/9 4/6 5/8 NET 6/5 7/1 8/8 10/3 12/5 1/8 4/2
52P 7/27 36S 9/25 37S 11/7 53P 11/20 3R 12/11 54P 2/5 38S 3/26 55P 4/28 39S 5/28 6R 6/24 56P 7/24 40S 9/30 57P 10/22 41S 12/1 58P 2/2 42S 3/30 59P 4/30

ISS Strategic Planning



Payload Developer Inputs

WHO:	Points of Contact
WHAT:	Requirements Definition
WHEN:	Operations Plan
WHERE:	Launch and On-Orbit Requirements
WHY:	Investigation Objectives

ISS Strategic Planning

- OZ/Research Planning Working Group (RPWG) collects flight resource requirements at around L-15 months from all NASA and IP agency sponsors to develop an Increment Research Plan:
  - Research summary/description
  - Crew Time – pre, in, postflight
  - Upmass/Downmass (what we need to fly/return on which flight)
  - Cold stowage
  - Power, data, photo/TV
- ISSMP submits requirements for all planned HRP research
  - Experiments must be selected for flight by HRP and have well defined requirements at the start of the strategic planning phase.
  - If an experiment requires a lot of definition work to define requirements, or if new hardware is required, it can take even longer to be ready for inclusion in Increment planning.

ISS Strategic Planning

- During the Strategic Planning phase, ISSMP works with International Partners (CSA, ESA and JAXA) to integrate all proposed human research for a given Increment into “complement scenarios”.
  - Complement scenarios represent a potential combination of experiments whose requirements can be implemented in the first week postflight
  - This integration work is required during this phase because the before JSC IRB and HRMRB must approve the complement scenarios having the crewmember sign consent forms
  - ISSMP develops complement scenarios based on experiment requirements and constraints, which are then reviewed and discussed with the IP’s, approved by OZ, and then submitted to the IRB for approval
  - Increment 39/40 Strategic Planning identified 9 potential complement scenarios

Increment 41/42 Complement Scenarios

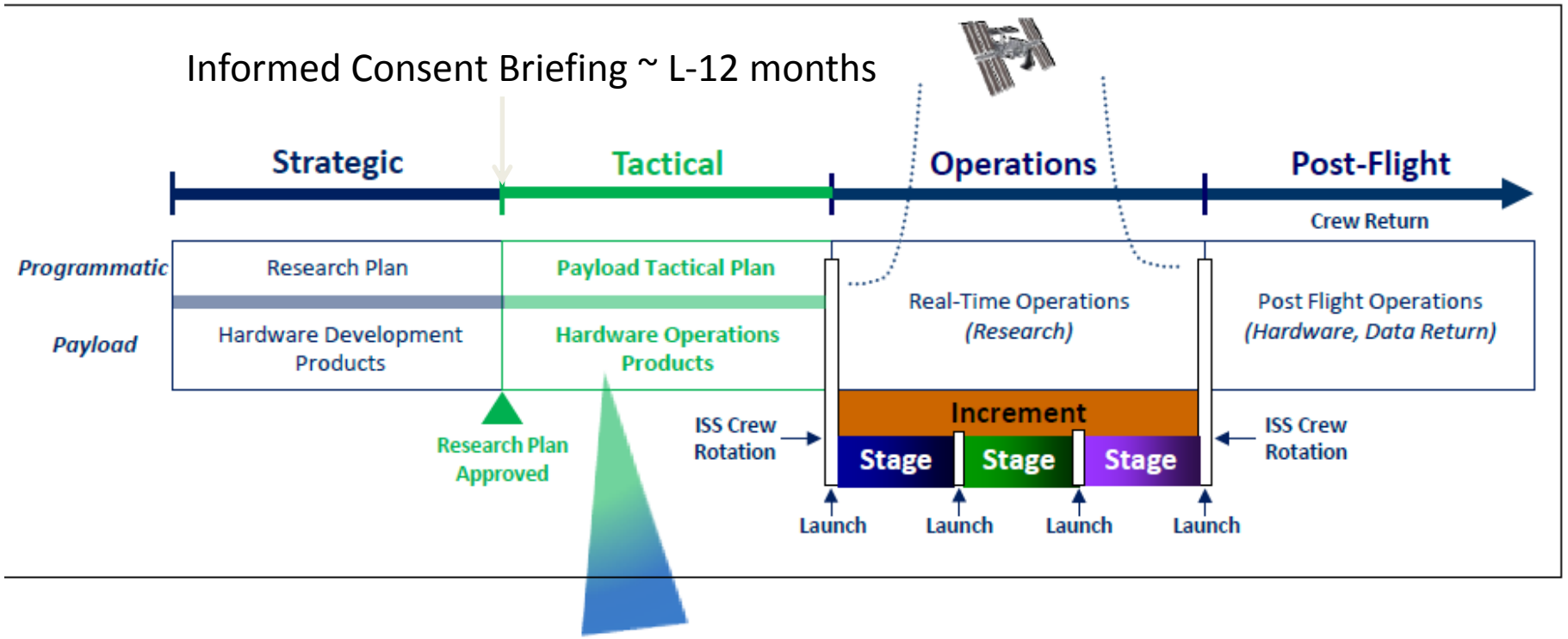
ALL EXPERIMENTS	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring	Airway Monitoring
Astro Palate (Food Acc)	Astro Palate	Astro Palate	Astro Palate	Astro Palate	Astro Palate	Astro Palate	Astro Palate	Astro Palate	Astro Palate
Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs	Bio Rhythms-48hrs
Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile	Biochemical Profile
Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control	Bispho Control
Blind & Imagined (SLINK)	Blind & Imagined	Blind & Imagined		Blind & Imagined					
Body Measures	Body Measures	Body Measures	Body Measures	Body Measures	Body Measures	Body Measures	Body Measures	Body Measures	Body Measures
Bone/Muscle Check (Chk Saliva)		Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check	Bone/Muscle Check
BP Reg	BP Reg	BP Reg	BP Reg	BP Reg	BP Reg	BP Reg	BP Reg	BP Reg	BP Reg
Cardio Ox	Cardio Ox	Cardio Ox		Cardio Ox		Cardio Ox			Cardio Ox
Cartilage	Cartilage	Cartilage		Cartilage	Cartilage			Cartilage	
Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm	Circadian Rthm
Cognition	Cognition	Cognition	Cognition	Cognition	Cognition	Cognition	Cognition	Cognition	Cognition
Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy	Energy
IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing	IVA Clothing
IVD			IVD			IVD	IVD		IVD
Journals	Journals	Journals	Journals	Journals	Journals	Journals	Journals	Journals	Journals
Manual Control	Manual Control	Manual Control			Manual Control		Manual Control		
Microbiome	Microbiome	Microbiome		Microbiome	Microbiome	Microbiome		Microbiome	Microbiome
Muscle Biopsy		Muscle Biopsy	Muscle Biopsy	Muscle Biopsy	Muscle Biopsy				
NeuroMapping			NeuroMapping		NeuroMapping			NeuroMapping	
Ocular Health	Ocular Health	Ocular Health	Ocular Health		Ocular Health	Ocular Health	Ocular Health	Ocular Health	Ocular Health
Orthostatic Tolerance		Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance	Orthostatic Tolerance
Repository	Repository	Repository	Repository	Repository	Repository	Repository	Repository	Repository	Repository
Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers	Salivary Markers
Skin B	Skin B	Skin B	Skin B	Skin B	Skin B	Skin B	Skin B	Skin B	Skin B
Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches	Space Headaches
Sprint	Sprint						Sprint (no biopsy)	Sprint	Sprint
Synergy	Synergy	Synergy	Synergy	Synergy	Synergy	Synergy	Synergy	Synergy	Synergy
V-C Reflex		V-C Reflex				V-C Reflex			
Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring	Wearable Monitoring

Why does it take so long?

Informed Consent Briefing process:

- Crewmembers are given informed consent briefings on all experiments per a target participation matrix. They are NOT shown the complement scenarios or asked to choose one.
- Crewmembers complete an interest survey to indicate level of interest in participation for each study they are pitched. These surveys are used to determine the “best fit” complement scenario for each crewmember.
- Proposed crew complements are reviewed with IP’s and OZ before obtaining signed consent forms from crewmembers. Actual crew participation can be any subset of a complement scenario (each represents a maximum number of studies that will fit together).

ISS Tactical Planning



Payload Developer Inputs

- Changes to Baselined Research Plan
- Training Products and Procedures
- Safety Review Packages
- Hardware Verification Data
- Software Verification Data

Why does it take so long?
You are not alone!

Increment 35/36 Research Plan - On-Orbit Investigations

Human Research

Bone & Muscle Physiology
Spinal Ultrasound

Cardiovascular & Respiratory Systems
Integrated Cardiovascular
Ocular Health (HTV4)
Vessel Imaging
BP Reg, Vascular

Human Behavior & Performance
Journals
Reaction Self Test
Circadian Rhythms (35S)

Neurological & Vestibular Systems
Reversible Figures
Space Headaches (35S)
SKIN-B (34S)

Integrated Physiology & Nutrition
Microbiome (52P, 35S)
Nutrition, ProK, Repository
ENERGY (SpX-2, ATV4, HTV4)
Biological Rhythms 48h (HTV4)

Key:
NASA
CSA
ESA
JAXA

Biology and Biotechnology

Microbiology
Viable

Cellular Biology
~~Cell Bio Tech Demo (SpX2) (3961)*~~
~~<Cell Mechanosensing>~~
Space Pup (HTV4)
Stem Cells (SpX2)

Animal Biology
AQH Microscope
~~<MEDAKA OSTEOCLAST>~~
MEDAKA OSTEOCLAST 2

Macro Crystal Growth
JAXA PCG

Plant Biology
Seedling Growth (SpX2)
Resist Tubule (HTV4)
Aniso Tubule (HTV4)

Passive Env. Control Sys.
~~BRIC-17~~ (SpX2) (3961)*

Physical Sciences

Fluid Physics
CFE-2
CCF
CVB-2 (ATV4)
DECLIC-HTI-R (ATV4)
FASES (ATV4)
SODI-DCMIX (52P)
Dynamic Surf (ATV4, HTV4)
Ice Crystal 2 (HTV-4)
Marangoni EXP
Marangoni UVP

Combustion Science
FLEX-2
ICE-GA (HTV4)
BASS

Material Science
SpaceDRUMS
CSLM-3 (SpX-2)
MSL Batch 2a-2 (ATV4)
Alloy Semiconductor
Hicari

Complex Fluids
BCAT-3,-4,-6
DECLIC-ALI
BCAT-C1
ACE-1 (ATV4, SpX2)

Technology Demonstration

Air, Water, Surface Monitoring
Amine Swingbed
DIAPASON (HTV4)
UBNT

Robotics & Imaging
3DA1 Camcorder
HET Smartphone
Robonaut

Radiation Measurement
REM
DOSIS-3D (34S)
TRITEL (33S)
Radi-N2
Area PADLES 10

Avionics & Software
SNFM

Commercial
SPHERES Interact

Communication & Navigation
Surface Telerobotics
I-STAR

Picosatellites
SPHERES-RINGS (HTV4)
SPHERES-VERTIGO (3961)*

Characterizing Expt H/W
~~<Microflow (SpX2)>~~

Spacecraft & Orbital Envt
HiMassSEE
<IBALL>

Deployables
JSSOD-Cubesats (HTV4)
Ardusat-1/WarriorSat-1 (HTV4) (3946)*
TechEdSat-3P (HTV4) (3955)*

Educational Activities

Educational Demos
EPO Demos
ISS Ham Radio
EPO Parmitano
~~<EPO-10>~~

Student Expts
EarthKAM
Nanoracks Modules-19, 20, 21, 22 (SpX2)
Module-9 (35S) (3953)*
Windows on Earth (3961)*
Tomatosphere-III

Cultural Activities
Comm & Outreach
Asian Seed 2013 (HTV4)
JAXA Commercial (HTV4)

Competitions
SPHERES Zero Robotics

Earth & Space Science

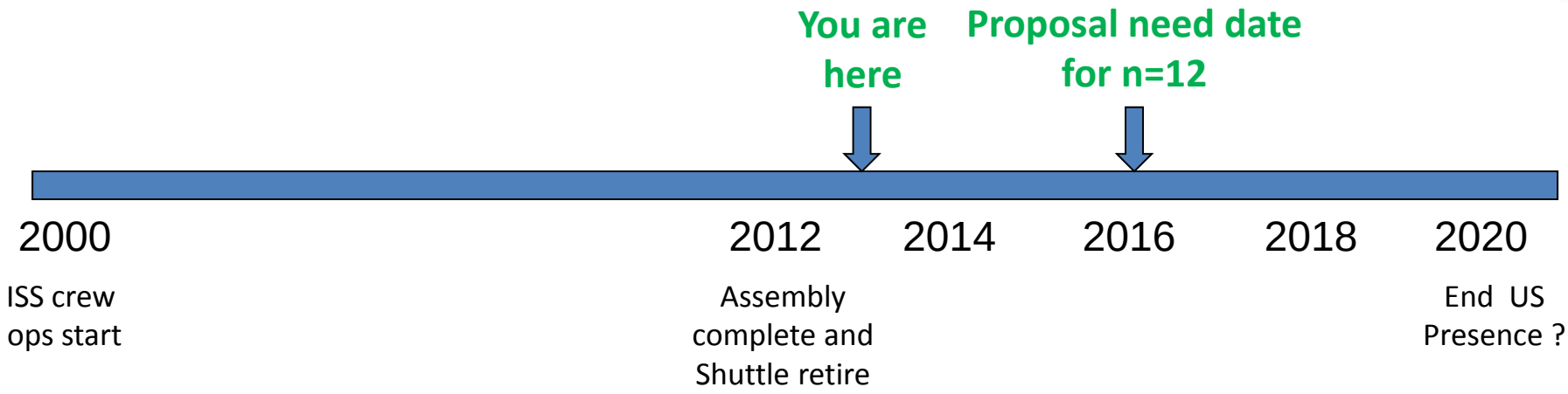
Earth Remote Sensing
CEO
I-SERV

<Pending CEF> *Open CEF

Why does it take so long?

- Summary:
  - There is a lot of research being conducted on ISS!
  - Careful planning is crucial to ensure the success of all planned operations on ISS
  - Unique challenges/constraints of human research require additional integration and planning
  - New research CAN be added later in the flow, but ONLY if it can be accommodated in the baseline plan

Why does it take so long?



- There is not much time left to complete human research investigations on ISS.
  - Assuming 4 subjects agree to participate per year (out of 6), it will take 3 years to complete in-flight operations for a study with an n=12
  - Factoring in 18 months for planning, this means an *approved* proposal would be required no later than the spring of 2016 in order to support the first subject launching in the fall of 2017
  - Additional time needs to be factored in for proposal solicitation/writing and merit review

Strategies for Design/Selection of Flight Experiments

Strategies for Design/Selection of Flight Experiments

- Consider the following when designing and soliciting flight research:
  - How will the study inform future research?
  - How important is the timeline for getting results – are the results critical in the path to risk reduction?
  - How critical is this study compared to the rest of your flight portfolio?
  - Is flight research required to answer this question?
- Large, complex studies will take longer to get ready for flight and get results. Simple experiments requiring fewer flight resources will obtain results faster
- ISSMP is here to help explain flight resource limitations and assist in designing experiments that are implementable

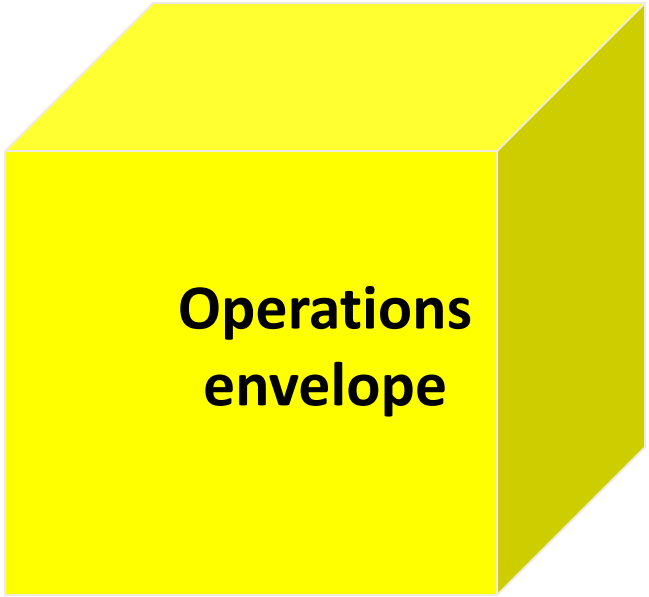
Strategies for Design/Selection of Flight Experiments

Operational Flight Constraints

Restricted flight ops

Crew time: preflt, in-flt, postflt

Power



Ku coverage

Sample storage and stability

Hardware access/failures

Data/comm availability

Weight and volume

Expt Complexity

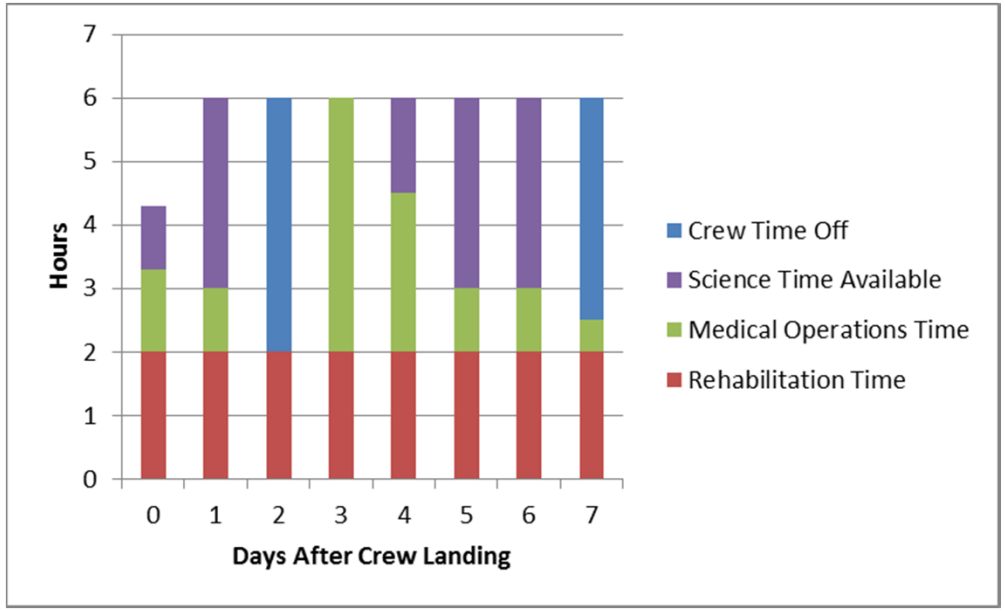
Strategies for Design/Selection of Flight Experiments

- Preflight Baseline Data Collection (BDC) and Training
  - Crew training flow is very full and leaves limited openings for BDC
    - Ops training is in multiple locations with extensive travel required
      - US
      - Russia
      - Europe
      - Japan
  - All US systems and NASA payload training and BDC has to be scheduled when they are at JSC
  - Constrains the ability to train for science and perform preflight testing

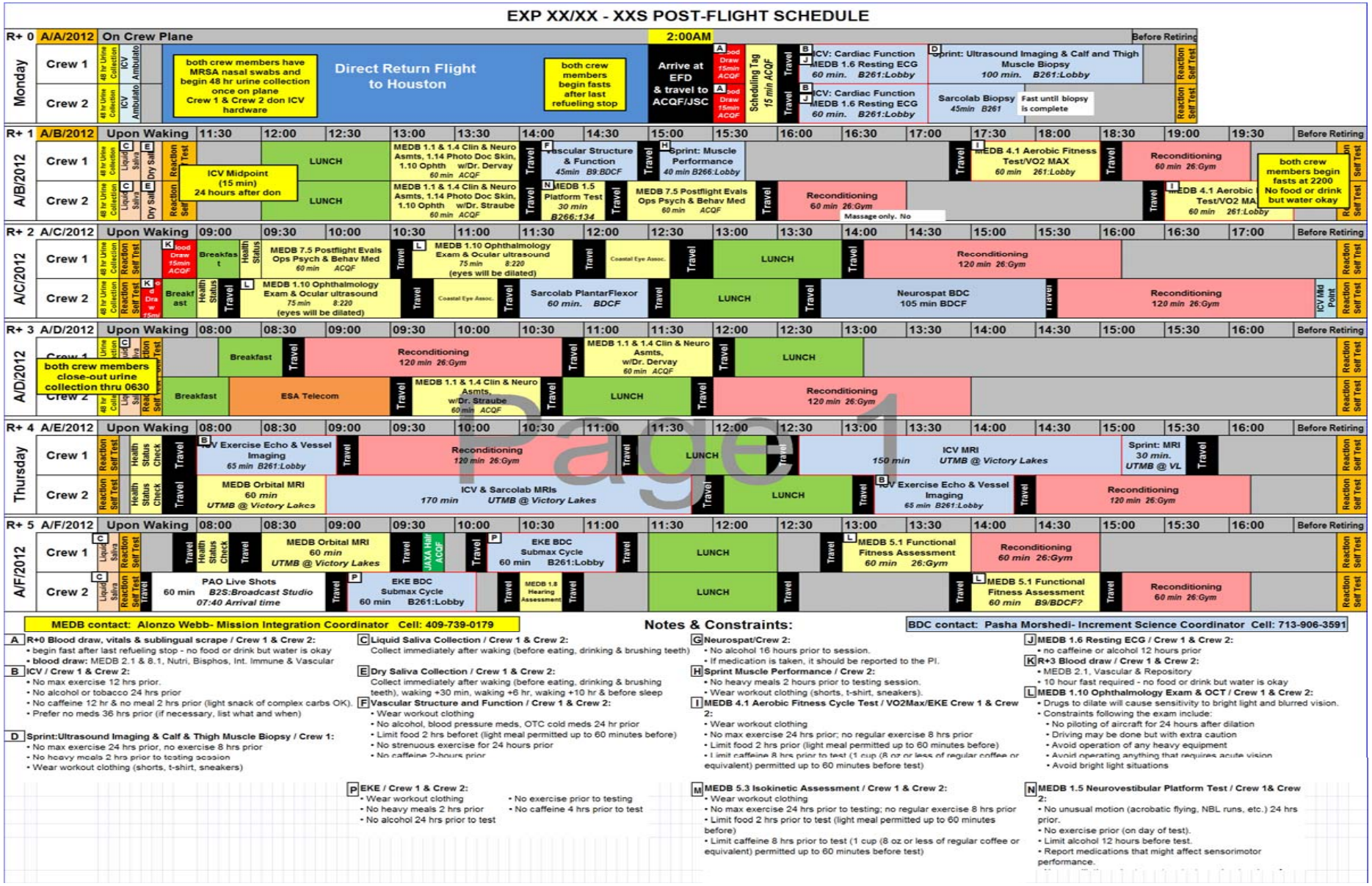
Strategies for Design/Selection of Flight Experiments

– Postflight BDC:

- All crew rotations are now on Soyuz until commercial crew capability comes on line
- USOS crew will nominally depart landing site within hours of landing and return directly to JSC
- Only limited testing possible on R+0 (typically “non-active” sessions) due to recovery ops
- Time on one day can be greater than 6 hours if “overage” is given back the next day
- Unique schedule is developed for each crewmember based on their complement of research



Example of Postflight Crew Schedule



Strategies for Design/Selection of Flight Experiments

- Why are these constraints so limiting?
  - Priority task to rehab the crew from the flight and return them to safe terrestrial function
  - Crews may look good at any point but may be generally fatigued and vulnerable to injury
  - Crew may have significant circadian disruption
  - Large number of experiments can overwhelm available time and crewmember resources
  - Frequent testing can bias test results

Strategies for Design/Selection of Flight Experiments

- In-flight crew time:
  - ISS Program is strongly emphasizing the need to maximize the utilization of ISS with providing as much time as possible for payload operations. Goal is for an average of 35 hours per week
  - This is good news for investigators, but in-flight crew time is still a limited resource.
    - The total amount of time is not always the problem, it depends on the requirements
    - Building in flexibility and decreasing the complexity of in-flight sessions goes a long way to ensuring success
    - Understanding how long each activity takes is a key part of the planning process

Conclusion

- Flying human life sciences experiments in space is challenging
  - ISSMP is here to help HRP investigators!
  - Requires adequate time to plan and integrate with other research on ISS
  - Requires investigators to be flexible and sensitive to unique constraints of spaceflight.
  - Keeping studies simple will yield results sooner