

An Introduction to Aerospace Medicine at NASA

Ronak V. Shah, DO, MBA, MPH
Medical Director of Clinical Services
NASA Johnson Space Center

12.10.2018

The NY Minute

- NY/NJ native
- Internal medicine
- Aerospace medicine
- Research
- Operational support
- Medical Director

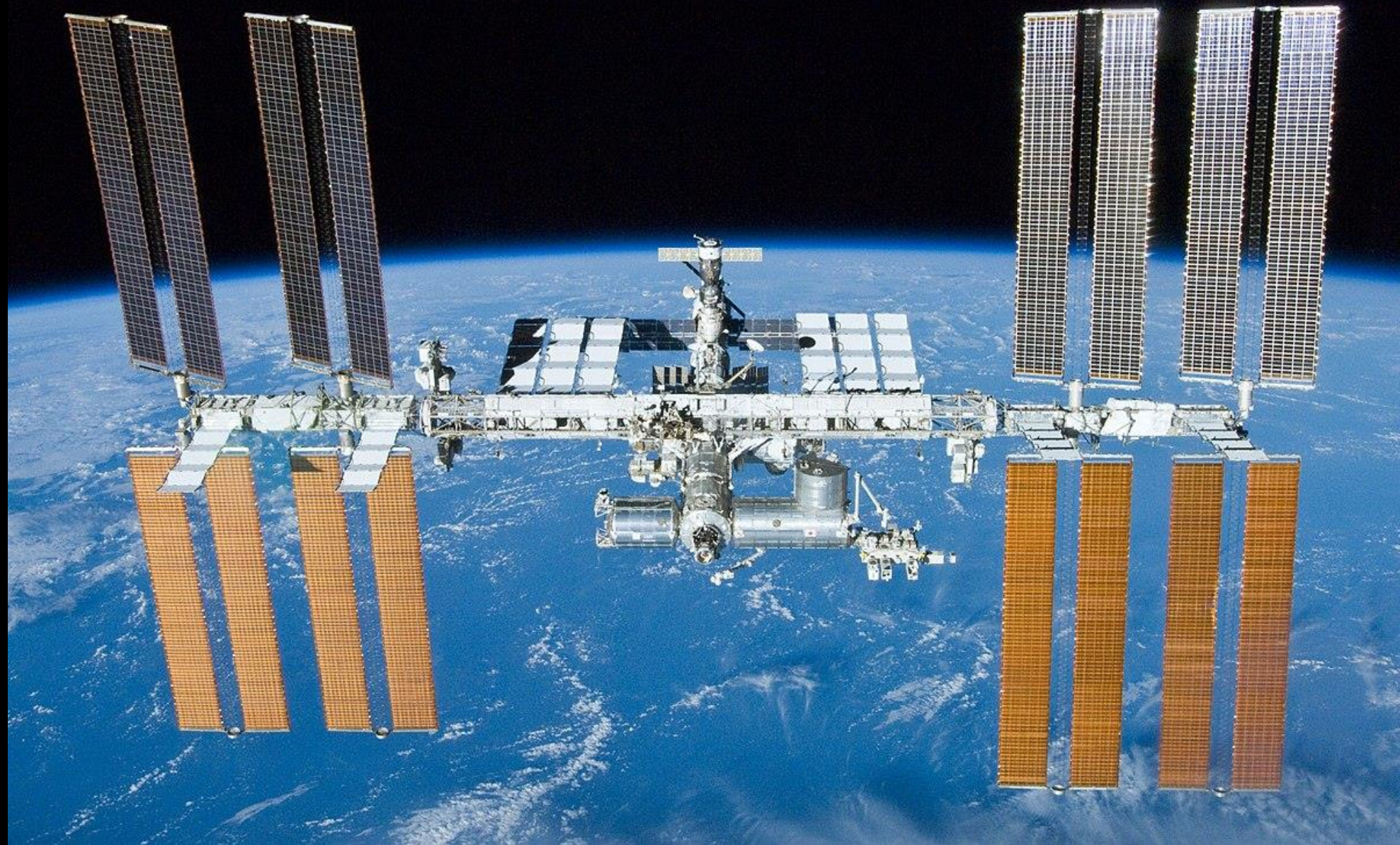
What is Aerospace Medicine?

- TRADITIONAL MEDICINE

Abnormal physiology in a normal environment

- AEROSPACE MEDICINE

Normal physiology in an abnormal environment



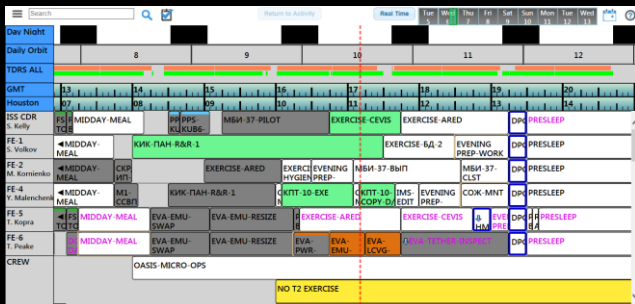
Hazards of Spaceflight



Space Environment



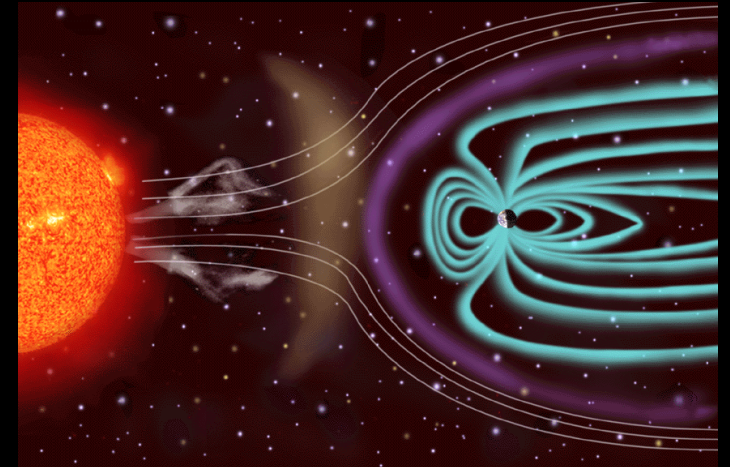
Spacecraft Environment



Spaceflight Mission

Space Radiation

- Three main sources
 - GCR ****biggest threat to deep space missions****
 - Trapped Radiation
 - Solar particle events
- Exposure based on orbital altitude/inclination, duration, and solar activity
- Shielding from Earth's atmosphere is roughly equivalent to 10 m of water



Radiation Dose Ranges

	Typical Dose (rem)
Round-trip NY to London / Chest x-ray (1 film)	0.01
Natural background radiation per year	0.3
CT scan	3-10
Typical mission dose on ISS	10-15
Estimated dose for 3-yr Mars mission	100-150
Atomic bomb survivors	Up to 400
Human LD ₅₀ , no medical intervention	350-550
Human LD ₅₀ , with medical intervention	500-1000

ISS Radiation Shielding

Well Shielded

- Node 2 USOS Crew Quarters
- Service Module, aft of treadmill



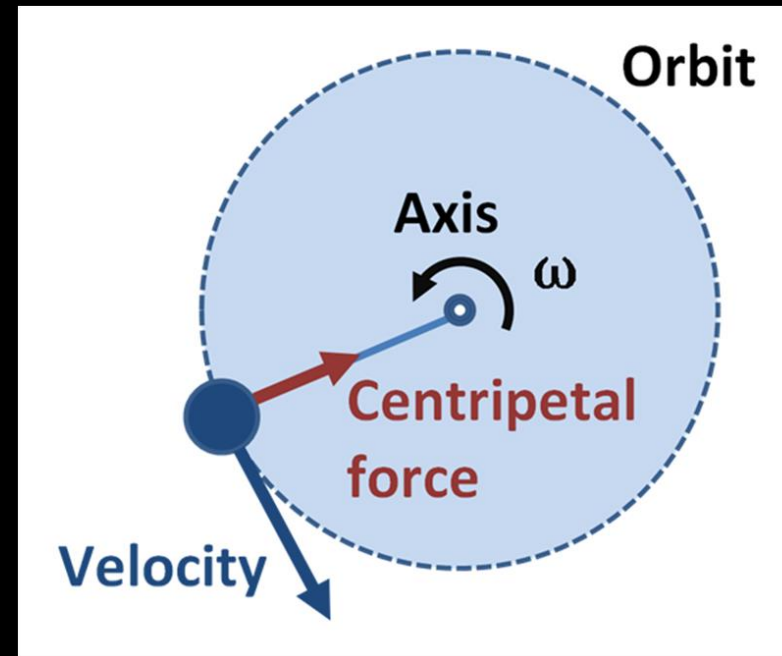
Not Well Shielded

- Lab Window
- Cupola
- Airlocks
- Service Module, fore of treadmill (Russian crew quarters)



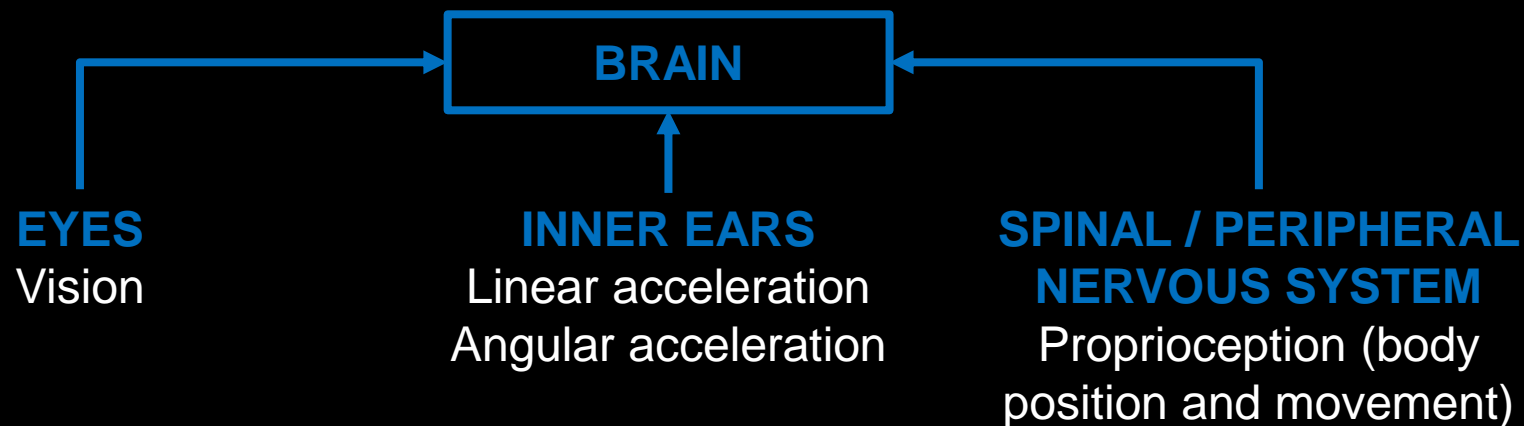
Quick Foray into Orbital Mechanics

- ISS doesn't "escape gravity"
- Microgravity aboard the ISS a result of freefall
- The station is constantly falling 'over the horizon'



Neurovestibular Physiology

- Sense of orientation
- Balance / posture
- Pursuit tracking / maintaining gaze
- Smooth movement





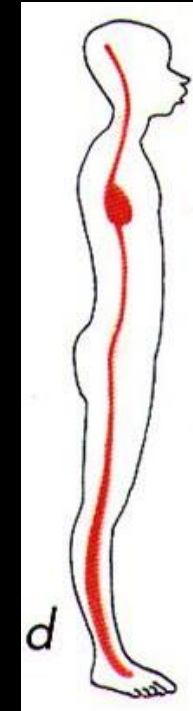
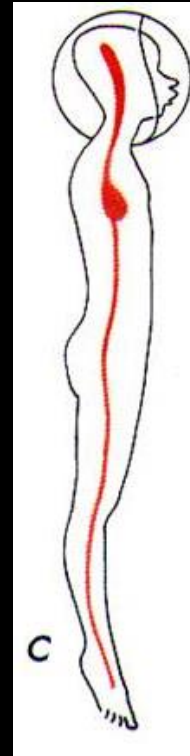
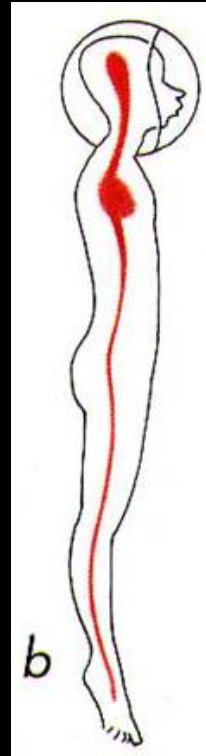
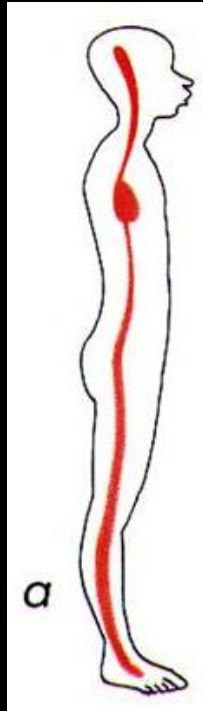
ISS002E5497 2001/04/05 08:29:03

Space Motion Sickness



Photo NASA

Fluid Shifts During Spaceflight



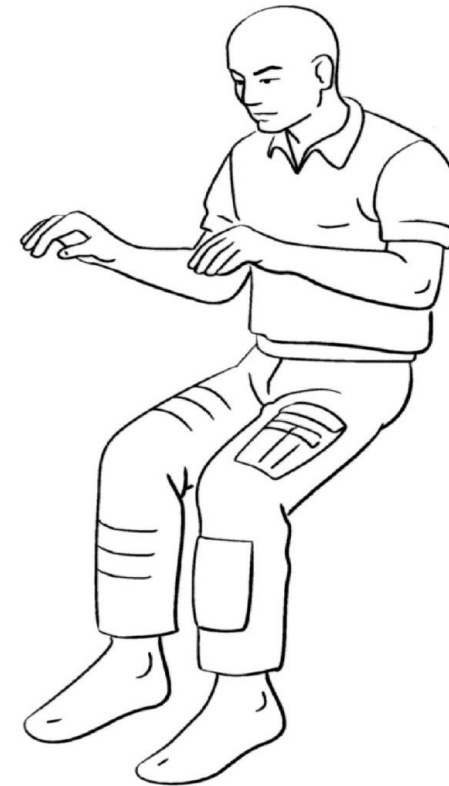
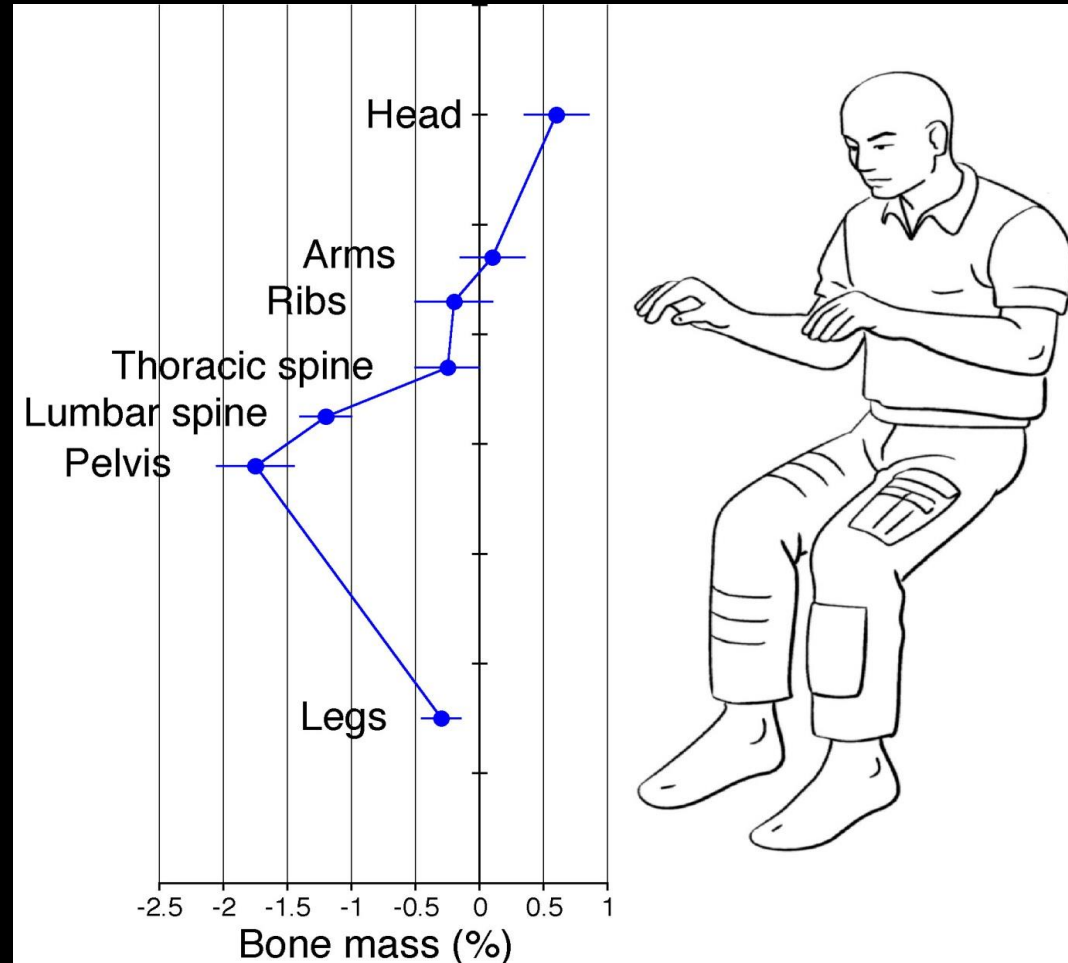
An Example of Fluid Shift



Shortly after reaching orbit:

- Leg volume decreases by ~ 1 L per leg
- Forehead tissue thickness increases by $\sim 7\%$ compared to preflight supine control

Bone Loss During Spaceflight



Post-flight changes in bone density compared to preflight

Potential Problems Secondary to Bone Loss

Altered calcium metabolism



Kidney stones



Fractures

Reduced emergency egress capability



In-Flight Exercise Countermeasures

2.5 hours of exercise scheduled daily

T2
(Treadmill 2)



CEVIS
(Cycle Ergometer with
Vibration Isolation &
Stabilization)



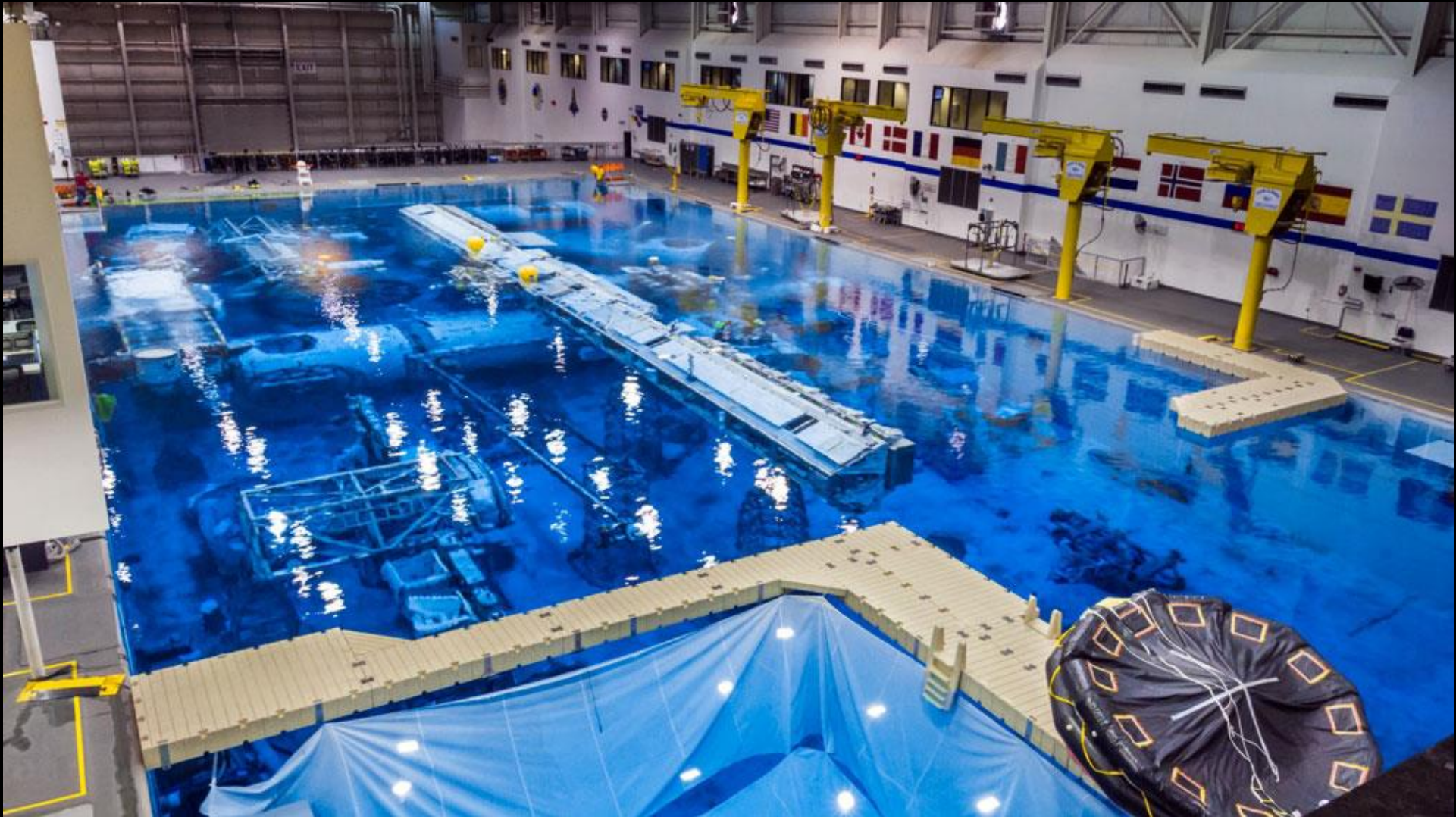
ARED
(Advanced Resistive
Exercise Device)



Neurovestibular	✓		
Cardiovascular	✓	✓	
Musculoskeletal	✓	✓	✓



NBL Training









T38 Training







Launch Landing Ops





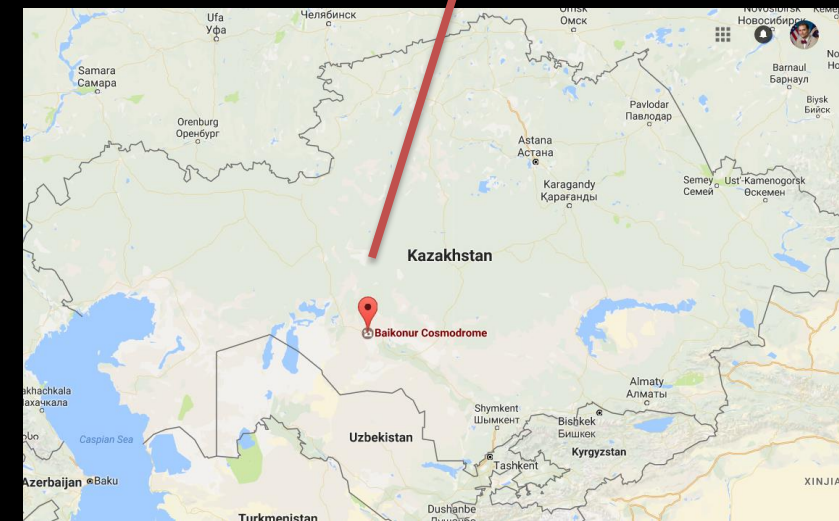
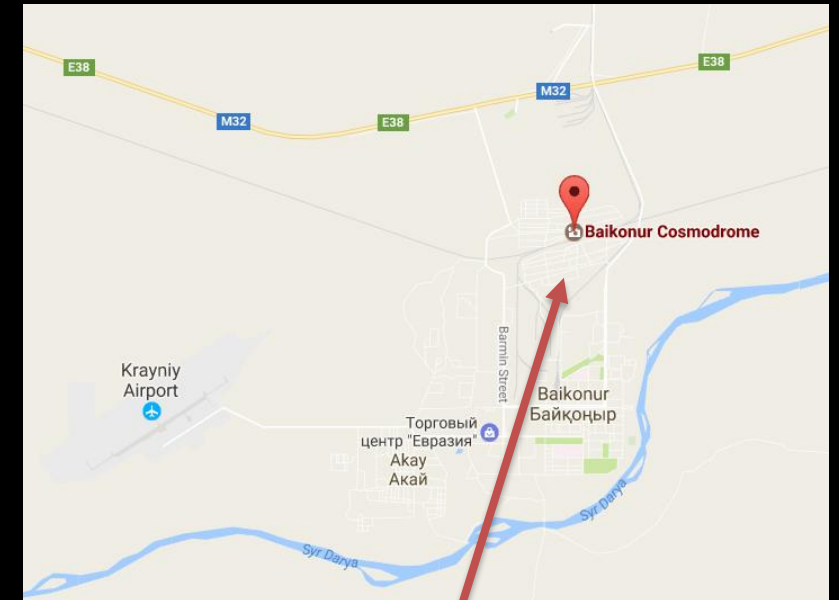




Launch and Landing of Russian Soyuz – Medical Support for US and Partner Astronauts



- Launch – Baikanour
 - USOS 1 Crew Surgeon, 1 Deputy Crew Surgeon, 1 Russian Based US Physician
 - IP – 1 IP Surgeon
- Landing – Kazakhstan
 - USOS 1 Crew Surgeon, 1 Deputy Crew Surgeon, 1 Russian Based US physician
 - IP – 1 IP Surgeon
 - Direct Return Doctor





Launch and Landing of Russian Soyuz – Medical Support for US and Partner Astronauts





Launch and Landing of Russian Soyuz – Medical Support for US and Partner Astronauts



- **Launch - Capabilities**

- Trauma Kit
- Launch specific supplement
- Local facilities
- Russia based US doctor for coordination

- **Landing – Capabilities**

- Trauma Kit
- Ultrasound, Vscan, fluid warmer, vein finder, iStat
- Landing specific supplement
- Local facilities
- Russia based US doctor for coordination

Launch/Landing Medical Pack



April 2016

Trauma Pack

Emerg Meds Pocket

EpiPen	1
Diphenhydramine 50mg IM/IV	2
Prednisone 20mg PO	3
Nitroglycerin Sublingual Tablets	25
Albuterol HFA	1
Syringe 3cc	2
Needle 20-22G 1.5"	2
Epinephrine 1:10,000 injectable	3



Trauma Pack

I.V. Pouch

IV Setups (Smartsite Infusion Set)	2
IV pressure Infuser	1
NS 0.9% 1 Liter	2
Tourniquet disposable	2
Gauze 2x2	4
Tegaderm medium	3
Gloves	4
Alcohol pad	8
18G Needle 1 1/2"	2
Syringe 10cc	2
IV Cap/microclave	3
Tape 1/2 in clear (Durapore)	1
18G catheter	3
22G catheter	3
Chux Pad (May be in Gutter)	1

*Note: 1L may be moved to outside IV Molle supplement for ease of access, available upon request in Star City. Supplement carries 1L plus IV start kit (not pictured)



Landing Supplement Pack

Upper Mesh Pouch	
Mist fan	1
Heat Pack/Cold Pack (as required)	2
Towel in Ziplock	1
Wet wipe - Antibacterial Pack	2
Lower Mesh Pouch	
Emesis bag	4
Nitrile Gloves Large	4
Ziplock bags quart size	2
Ziplock bags gallon size	2
Tissue Pack	1
Plastic Insert #1	
Phenergan IM 25mg/1ml vial	2
20-22G needle 1.5"	3
Syringe 3ml	2
Alcohol Prep Wipes	10
Plastic Insert #2	
Ondansetron 4mg SL ODT (Zofran)	8
Meclizine 25mg PO	6
Calcium Carbonate 500mg Tabs	20
Plastic Insert #3	
Tylenol 500mg PO	10
Ibuprofen 200mg PO	20
Artificial Tears	1
Afrin nasal spray	1
Plastic Insert #4	
Straw	2
Ear plugs - pair	10
Plastic Insert #5	
Foley Catheter 16Fr	1
10cc syringe	1
Lidocaine Jelly 2% 30ml tube	1
Providone-Iodine Swabsticks	2
Back Plastic Pouch	
Face Mask	5
Foley Leg Bag (Bard Dispoz-A-Bag)	1
Sterile Gloves	1



Launch Supplement Pack

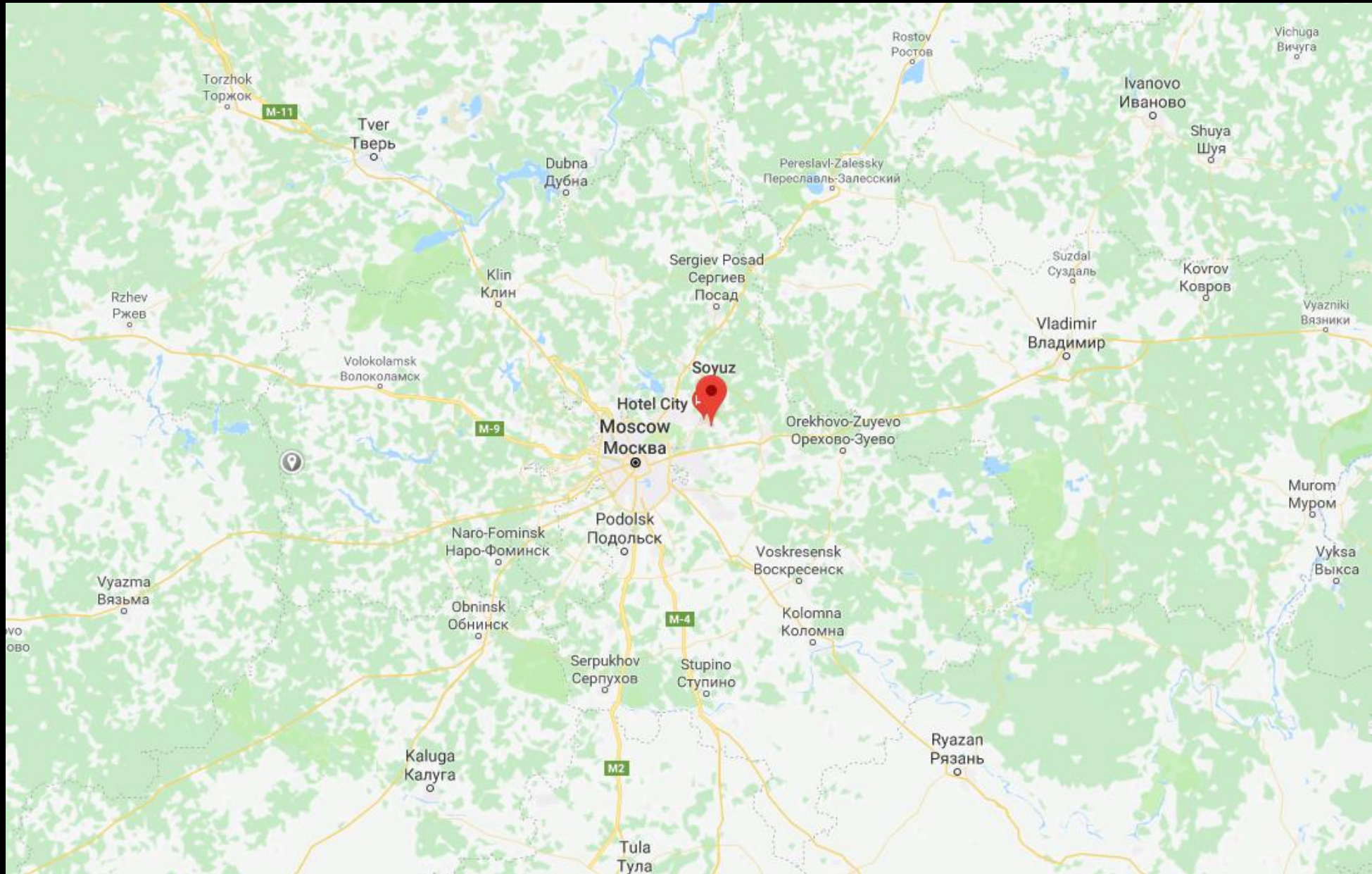
Upper Mesh Pouch	
Wet Wipe Pack - antibacterial	2
Gloves nitrile large	8
Afrin nasal spray	2
Digital thermometer + sheathes(#7)	1
Band aids	10
Bacitracin Packets	5
Fleets Enema	2
Lower Mesh Pouch	
Tape 1" cloth	1
Coban 2" roll	1
Ziplock bag quart	5
Tissue Pack	2
Plastic Insert #1	
Ibuprofen 200mg PO	20
Aspirin 325mg PO	10
Tylenol 500mg PO	10
Plastic Insert #2	
Ambien 10mg PO	10
Sonata 10mg PO	10
Omeprazole 20mg	10
Calcium Carbonate 500mg Tabs	20
Loperamide 2mg PO	10
Loratadine 10mg PO	10
Plastic Insert #3	
Olopatadine (Patanol) Opth	1
Ciprofloxacin opth 0.3% 1 bottle 5ml	1
Clotrimazole (Lotrimin) cream 0.42oz	1
Fluocinonide 0.05% cream 15 gram	1
Throat Lozenges	8
Artificial Tears 15ml bottle	2



Plastic Insert #4	
Fluconazole 150mg PO	1
Clindamycin 300mg PO	10
Tinidazole 500mg PO	4
Doxycycline 150mg PO	14
Ciprofloxacin 500mg PO	14
Tamiflu 75mg PO - Packet of #10	3
Valtrex 500mg	8
Plastic Insert #5	
Phenergan 50mg IM	2
Ondansetron 4mg SL ODT	6
Ceftriaxone 1mg IV	2
Sterile Water for Injection	2
Meclizine 25mg PO	6
Back Plastic Pouch	
Nasal packing	1
Nasal Saline 45ml bottle	1
Tongue depressor	2
Qtips	2
Packets for pills	10
Emesis Bags	2
Ear plugs	2
Chapstick	2
Ziplock bag quart	5
Dental crown replacement kit	1
IM Injection Kit	
Syringe 3ml	2
Needle 20G 1.5"	2
Acohol Prep Pads	4

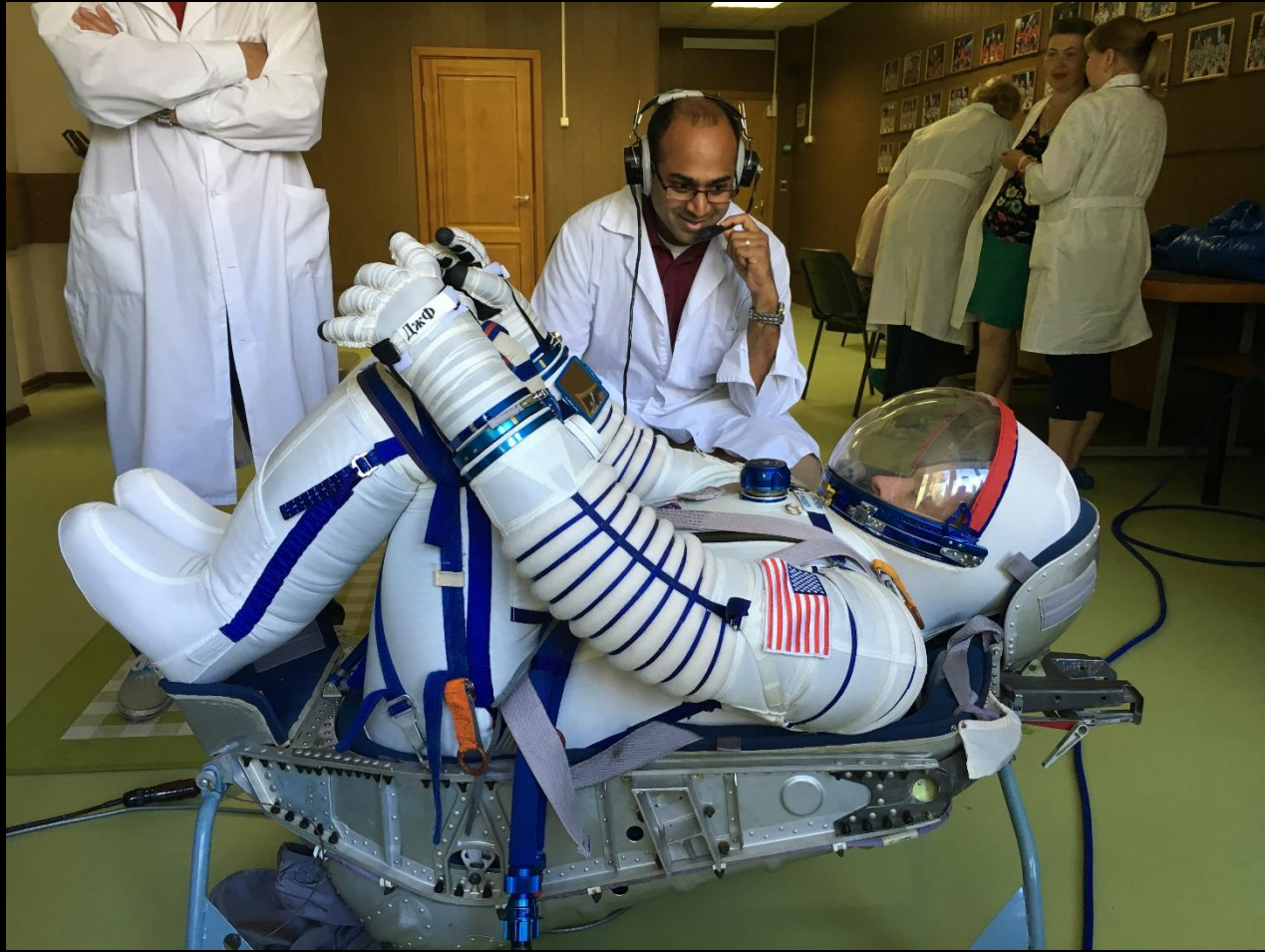
Star City





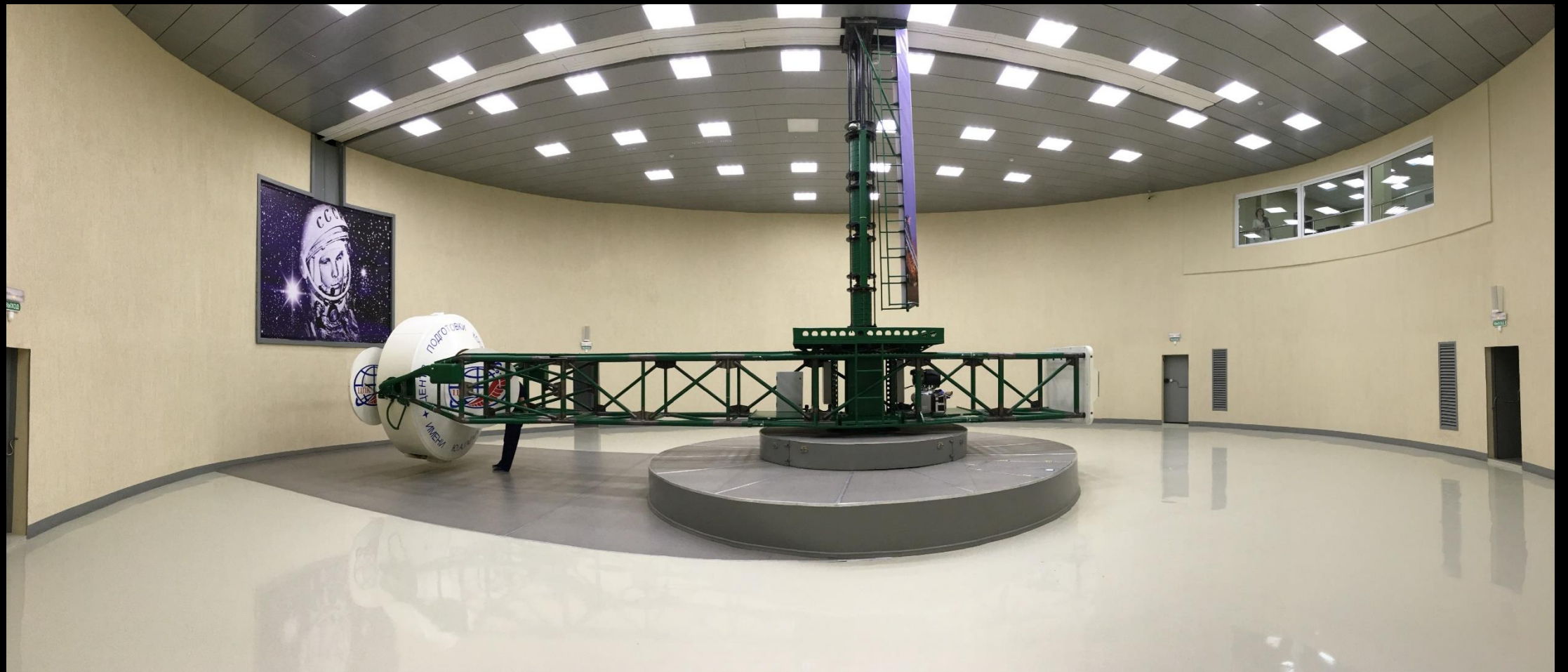


















Thank you

ronak.v.shah@nasa.gov

Topics

- Hazards of spaceflight
- Physiological changes in flight
- Crew training (CMO)
- Crew training NBL, hyperbaric/hypobaric medicine
- T-38 CRM – best realtime training.
- Ground support Houston - Preflight, Inflight, Postflight
- Ground support Zvozdny Gorodok (Star City), Russia
- Launch and Landing Operations, Kazakhstan
- LSAH program, the long game