

Quantification of In-flight Physical Changes: Anthropometry and Neutral Body Posture (Body Measures)

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Objective

Gather preliminary data to understand the magnitude and variability of microgravity changes on the body shape and size.

Background

An understanding of how the body changes in microgravity is necessary to ensure optimal crew performance, fit, and comfort in space to prevent suit fit and vehicle/habitat design issues.

Previous studies aboard Skylab and Space Shuttle Missions have provided limited data. Skylab (N=3) showed stature increased by up to 3%, which drove requirements to allow for such growth (MSIS-STD-3000, 1985). Spinal Elongation (N=29) exhibited an increase in seated height by up to 6% and an increase in stature by up to 3%, leading to requirement updates with new standards.

Methods

Subjects

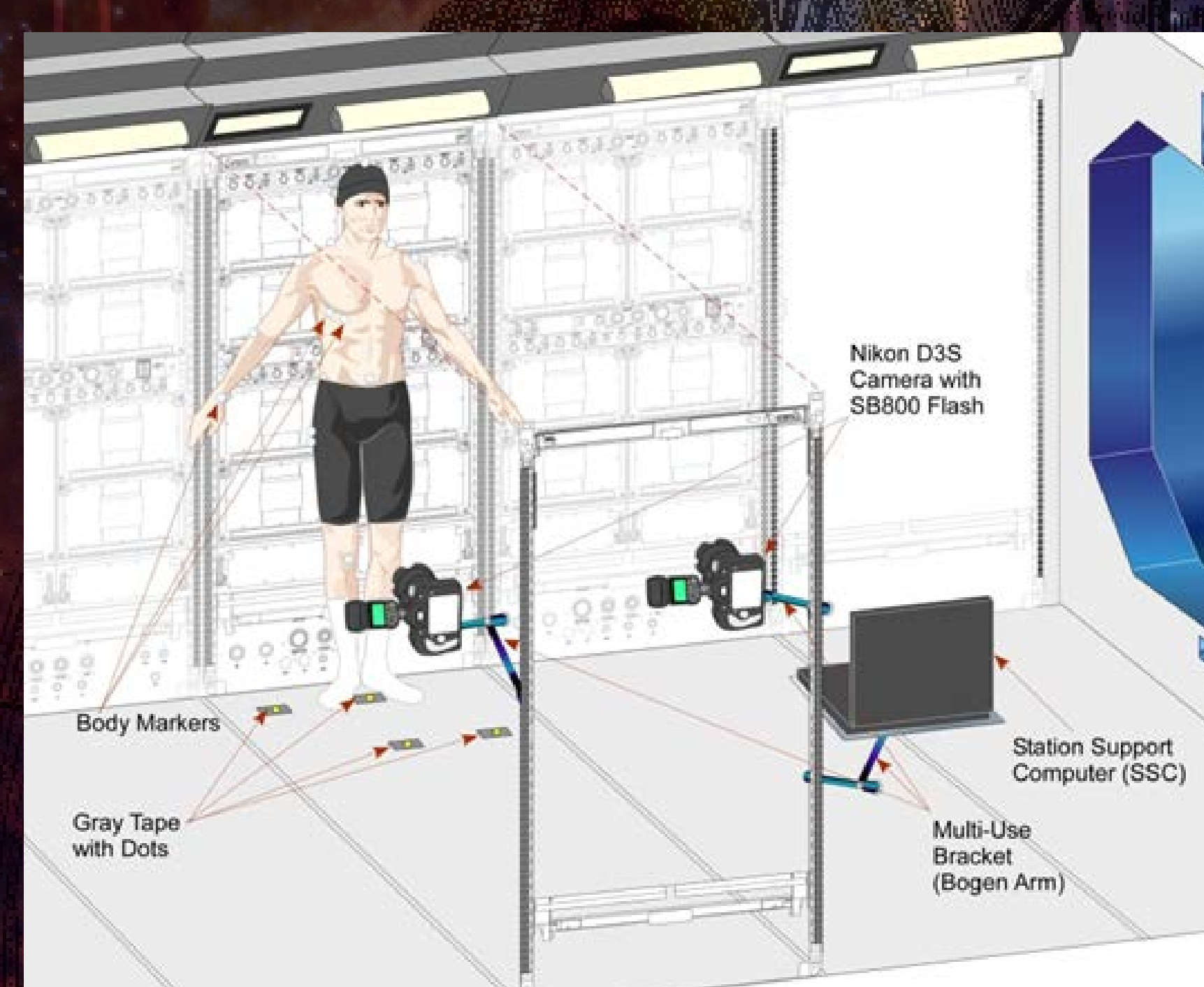
- 9 USOS (7 males, 2 females) (originally planned for 12)
- ISS experience: First time fliers to experienced ISS fliers with multiple prior missions

Data Collection Sessions

- Preflight (1)
- In-flight: FD15, 45*, 80, 105*, 135*, R-15 (*reserve sessions)
- Postflight: R+20

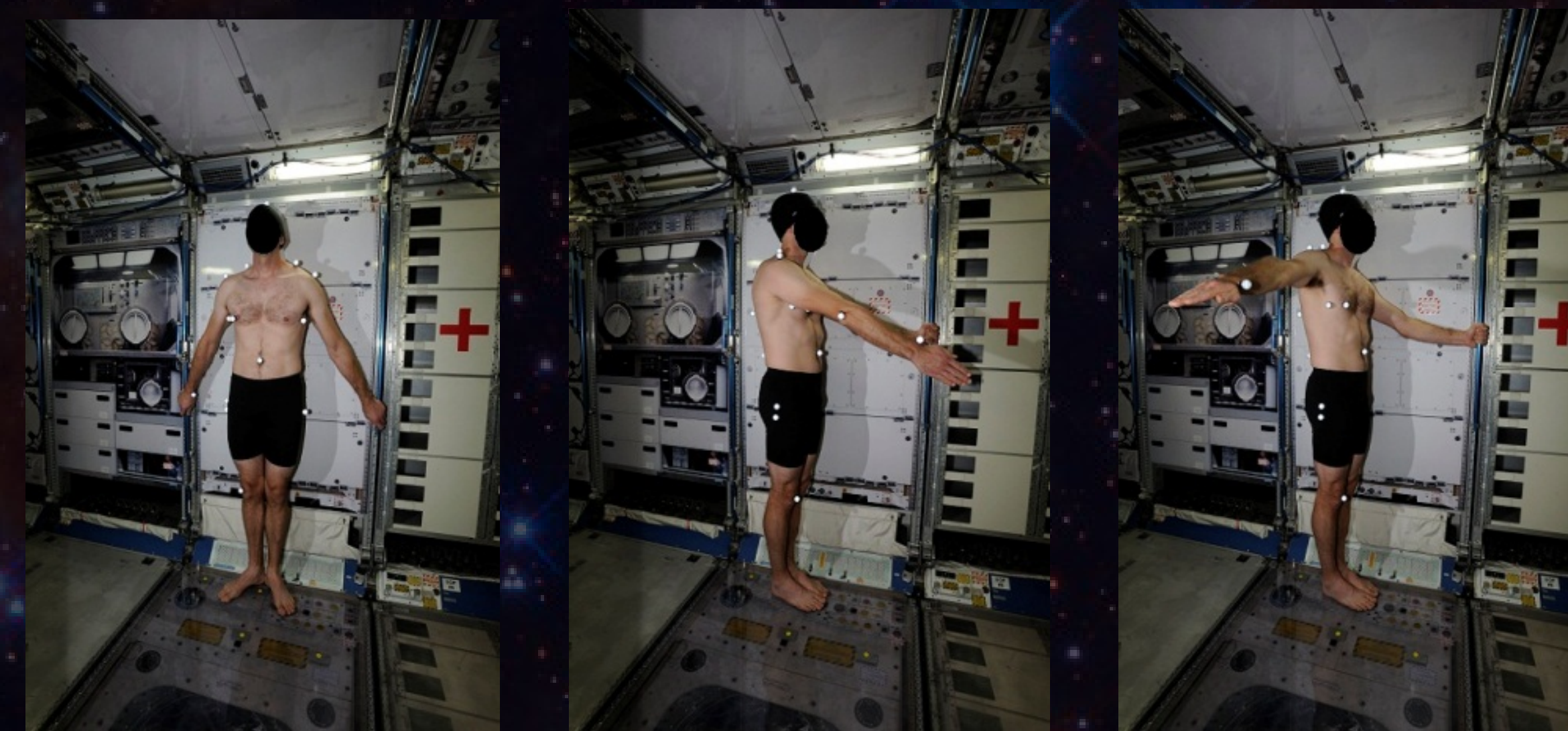
Equipment and Materials

- Tape measure, 3D photogrammetry using 2 digital cameras (ground and in-flight)
- Anthropometer, 3D whole body laser scanner (ground only)



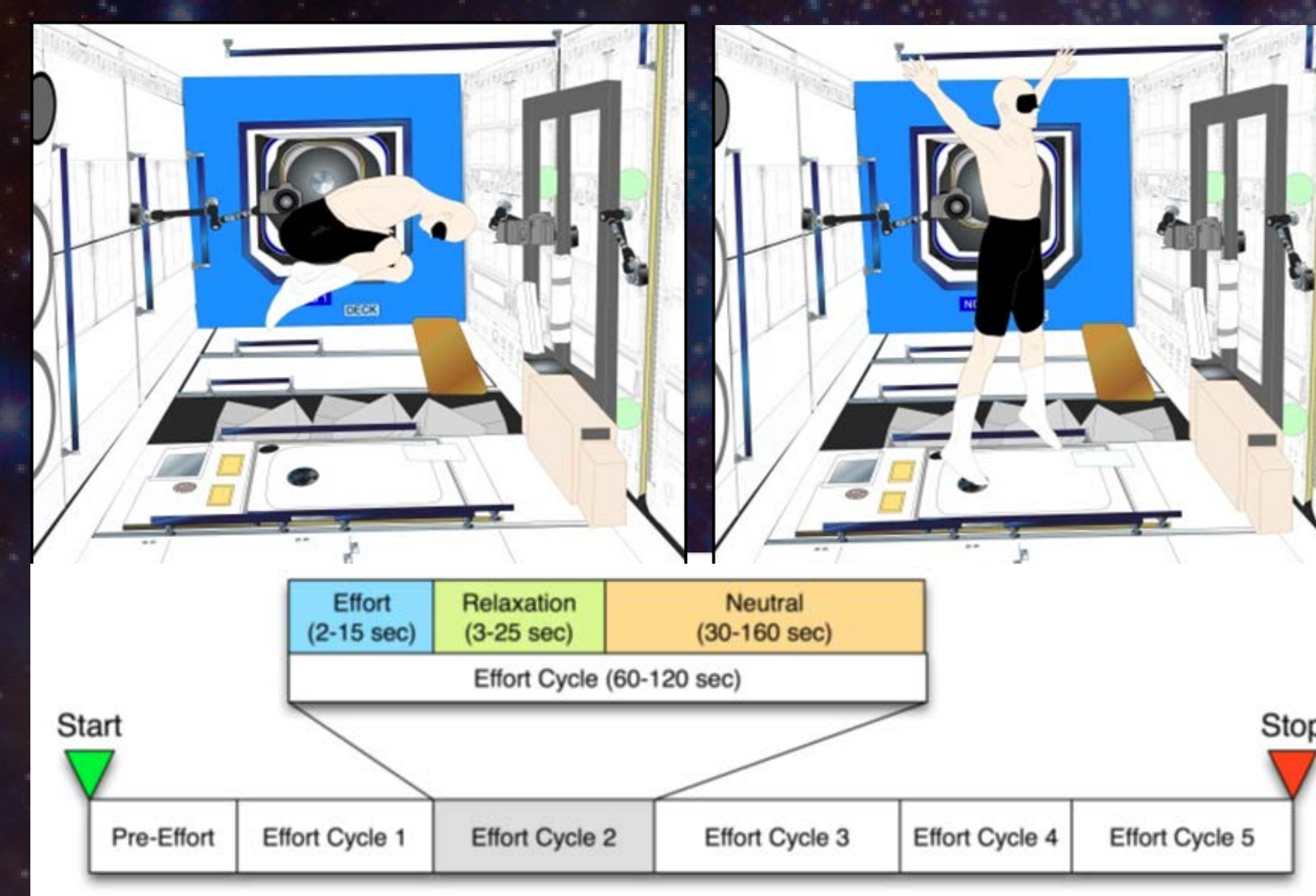
Activity 1: Anthropometric Measurements

- Collect two photographs per posture for three specific postures in front of ISS rack
- Measurements
 - Heights: Stature, Acromion, Mid-Shoulder, Knee, Hip, Crotch
 - Breadths: Biacromial, Hip, Chest
 - Depths: Chest, Waist
 - Lengths: Upper Arm, Lower Arm
 - Circumferences: Chest, Waist, Hip, Bicep Flexed, Thigh, Calf

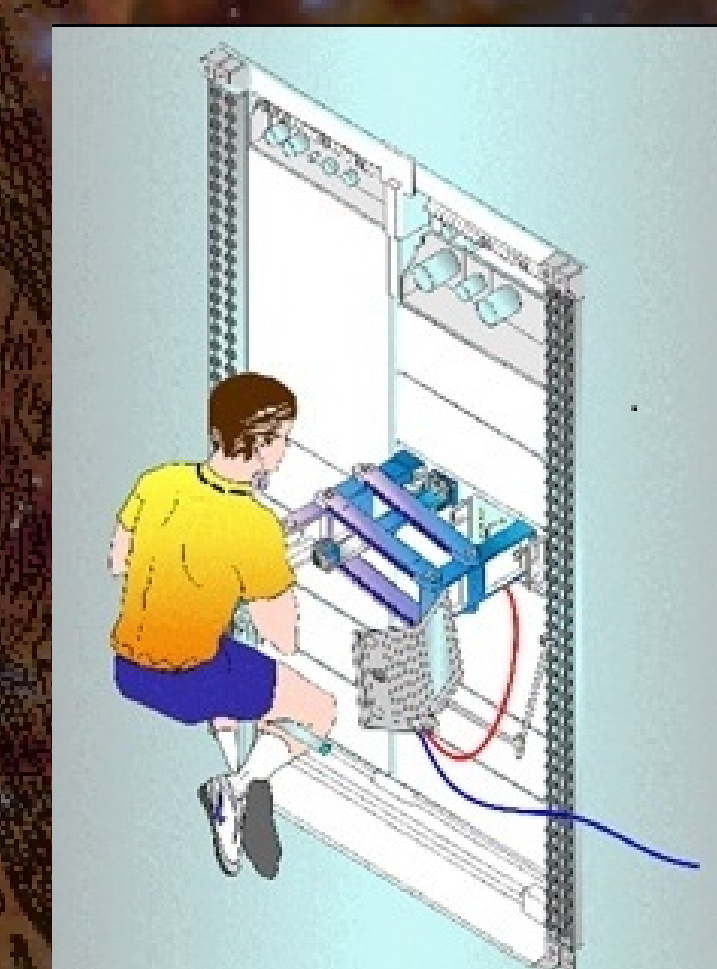


Activity 2: Neutral Body Posture

- Collect video to determine posture and joint angles (in-flight only)
- Consists of performing 2 phases; an effort phase (stretch/crouch) and relaxed phase
- Sequence is repeated 10 times/session, altering and randomizing the effort phase posture



Activity 3: Body Mass Measurement



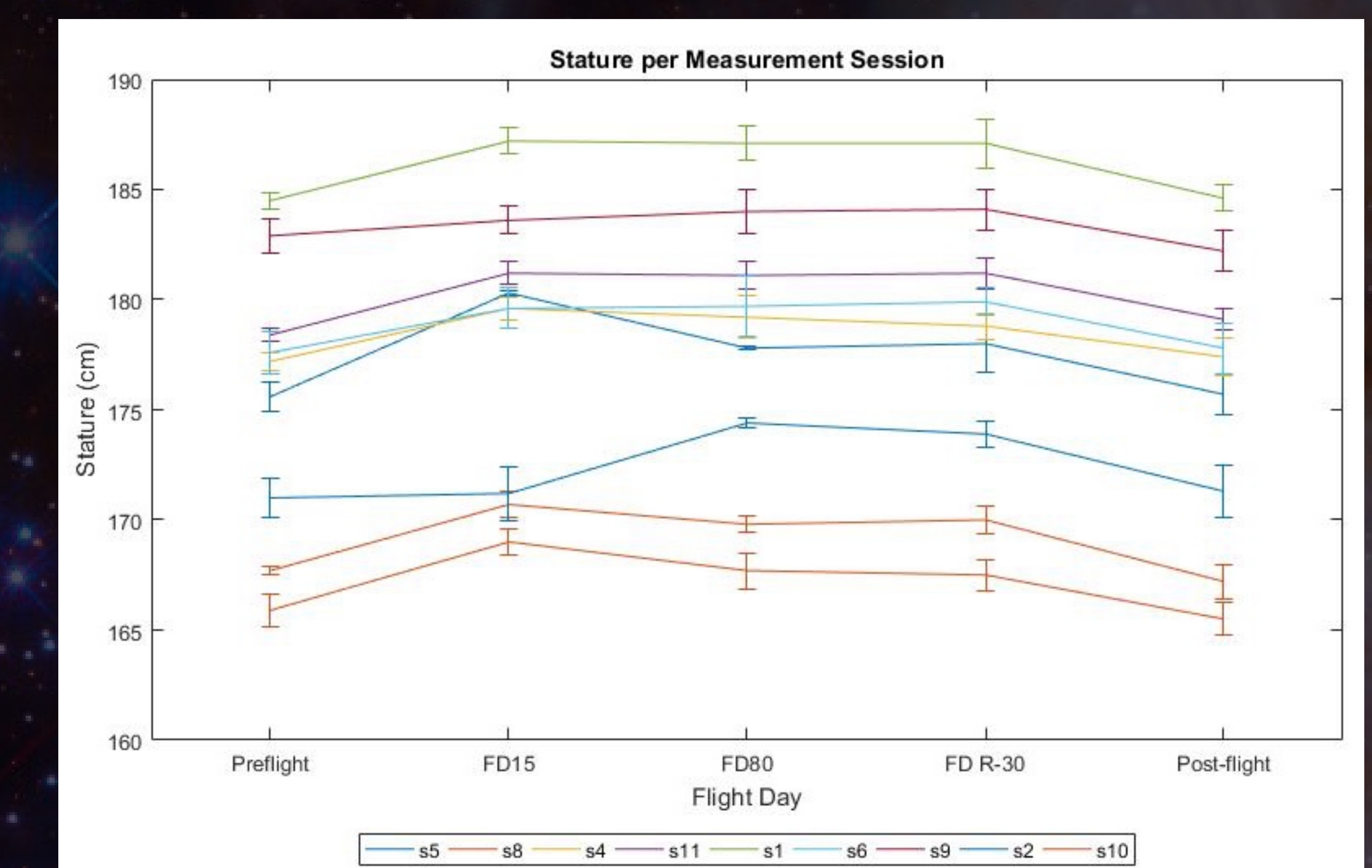
SLAMMD Body Mass Measurement

Results

Body Measurements

- Stature: similar to historical data, biphasic growth, quick increase in height then plateau
- Calf circumference: decreasing trend for all subjects
- Bicep circumference flex: no significant change

Observed measurement inconsistencies can be attributed to variations in marker placement, body posture, and incorrect camera settings.

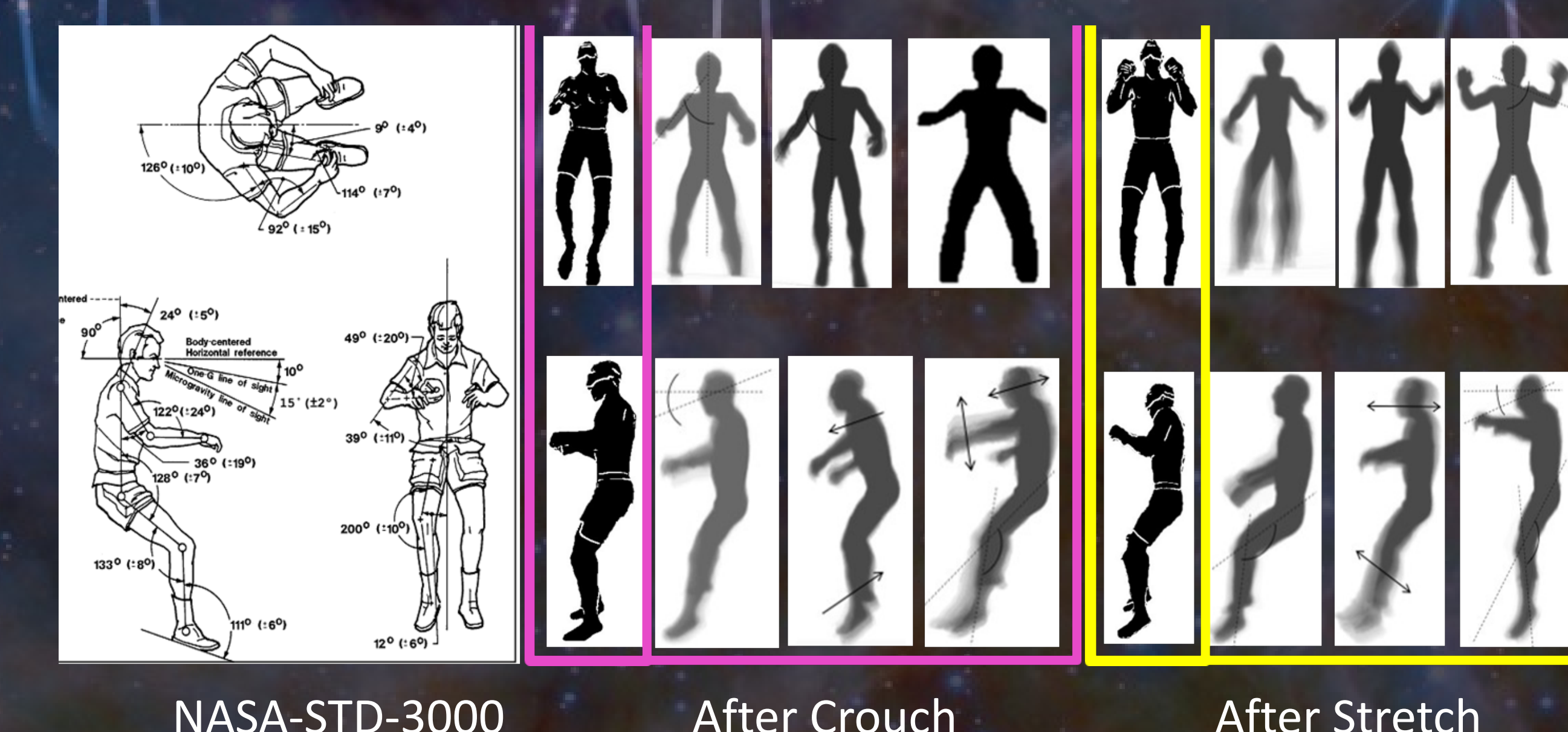


EVA Critical Measurements

- Stature: 3% max growth during first 15 mission days
- Crotch height: varied due to location of measurement, subjects self marked location
- Mid-shoulder height: varied due to arm angle (holding on to handrails)

Neutral Body Posture

- Goal is to evaluate posture and joint angles while in a "neutral" posture
- Evaluate intra and intersubject variations compared to NASA-STD-3000 posture
- Preliminary results
 - Crouch: Hands at or below NASA-STD-3000 posture
 - Stretch: Hands are generally in a higher position than NASA-STD-3000 posture
- Data analysis is currently in progress



NASA-STD-3000

After Crouch

After Stretch