



# Glenn Research Center Human Research Program

<http://spaceflightsystems.grc.nasa.gov/Advanced/HumanResearch/>

August 23, 2010

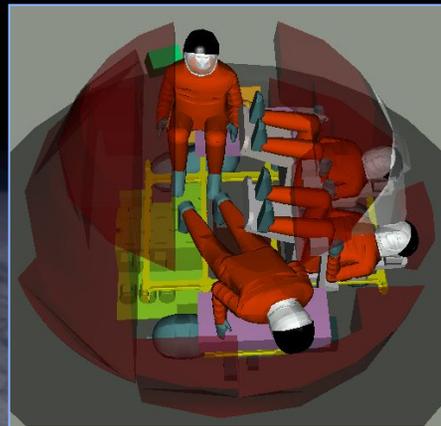


# Human Research Program

- The Human Research Program (HRP) formulated in October 2005
- Program Plan Approved in May 2006, authorizing advancement into implementation
- Program goals
  - Perform research necessary to understand and reduce spaceflight human health and performance risks in support of exploration
  - Enable development of human spaceflight medical and human performance standards
  - Develop and validate technologies that serve to reduce medical risks associated with human spaceflight



*Clay Anderson centrifuges Nutrition blood samples during Increment 15*



*Seat layout for contingency EVA*



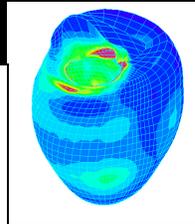
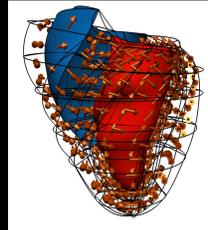
*Example of a study on the effects of center of gravity on performance*



# GRC Human Research Program



Exercise Prototype Device



Digital Astronaut Heart Model



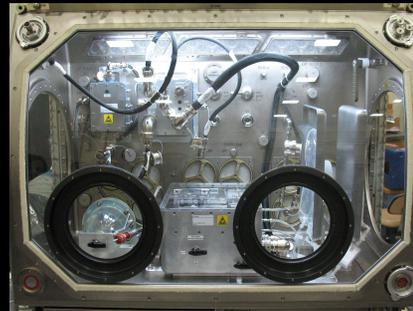
Center for Space Medicine Flight Harness



Enhanced Zero-G Locomotion Simulator



Lunar Health Monitor



IVGEN in MSG



PUMA Headgear



NASA-NIH developed Dynamic Light Scattering (DLS) Device



BioWATCH



IMM: Fracture Risk

## Exploration Medical Capability:

- Quantify risk of inability to adequately treat
- Develop technologies to quantify state of health
- Develop treatment technologies

## Exercise Countermeasures:

- Develop requirements for effective and reliable exercise hardware
- Validate candidate exercise hardware technologies
- Focus on crew health maintenance

## Digital Astronaut:

- Quantify space normal anatomy and physiology
- Interpret data
- Guide research to mitigate risk

Lumbar Spine

Proximal Femur



# Exploration Medical Capability

Exploration Medical Capabilities effort at GRC includes the following tasks:

- **IntraVenous fluid GENERation** for exploration (IVGEN): Produce USP grade 0.9% normal saline from in situ resources
- **Reusable Medical Lab Devices**: Lab on a chip that can be reused on-orbit
- **Injectable Medications**: Deliver IM pharmaceuticals through the space suit when cabin temperature and pressure are low
- **Imaging Integration**: Identify and insure readiness of imaging technologies for diagnosis and treatment
- **Oxygen Concentrators**: Fire risk assessment and device development
- **Integrated Medical Model (IMM)**: Predicts risk associated with exploration missions





# GRC Exercise Countermeasures Project



- **Flight Harness Station Development Test Objective (SDTO)** – Center for Space Medicine (CSM) harness flight development / TVIS harness on-orbit comfort evaluation
- **Advanced Exercise Concepts** - Identify, design, build prototypes, and evaluate Exploration exercise device concepts for Lunar Outpost. Delivered cycle ergometer that met requirements for the Lunar Electric Rover (LER) for evaluation at Desert RATS
- **Ground Based Research** for investigations performed in the Exercise Countermeasures Lab (ECL) on the enhanced Zero-g Locomotion Simulator (eZLS) – lunar-g and Martian-g capable
- **National Space Biomedical Research Institute (NSBRI) Research Study** - Collaborative Study with University of Washington “Monitoring Bone Health Using Daily Load Stimulus During Lunar Missions”



Harness SDTO on International Space Station



Cycle Ergometer



Aerobic/Resistive Gas Spring Device

Lunar Electric Rover Crew Exercise Devices



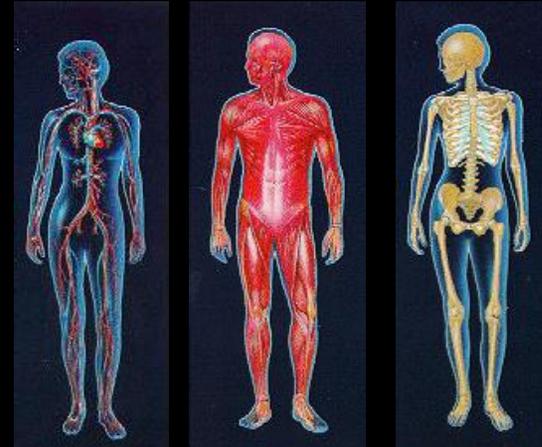
Lunar Gravity Simulation in ECL



# Computational Modeling in support of HRP

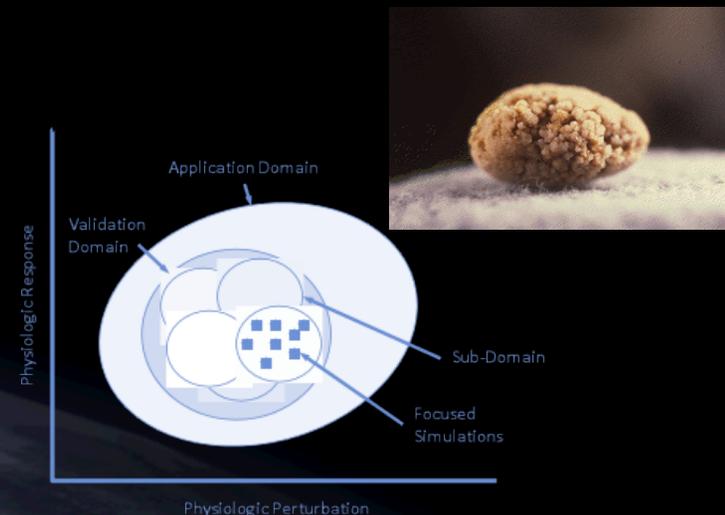
## Capabilities in deterministic physiological modeling

- Computational approaches to simulate human physiological systems
  - Heart Function
  - Cardiovascular disease formation
  - Neuro-vestibular function
  - Muscle function
  - Bone turnover and formation



## Continually advancing methods to estimate the changes induced by space flight

- Pre and Post flight motor unit recruitment
- Effects of bone unloading on turnover
- Renal Stone (crystal) growth
- Neuro-vestibular deconditioning
- Effective change in heart shape due to unloading

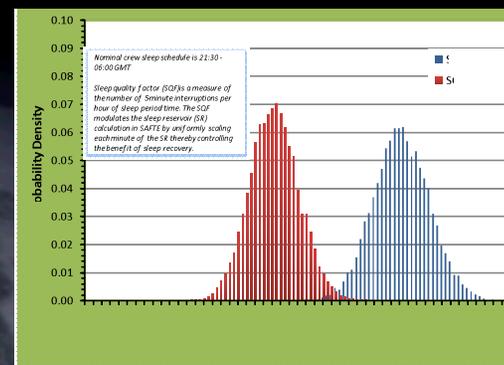
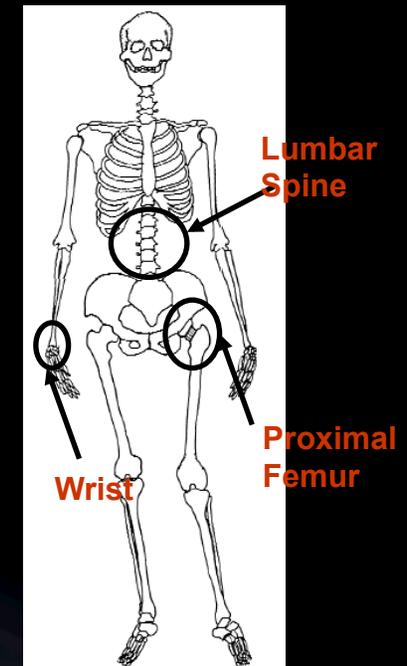
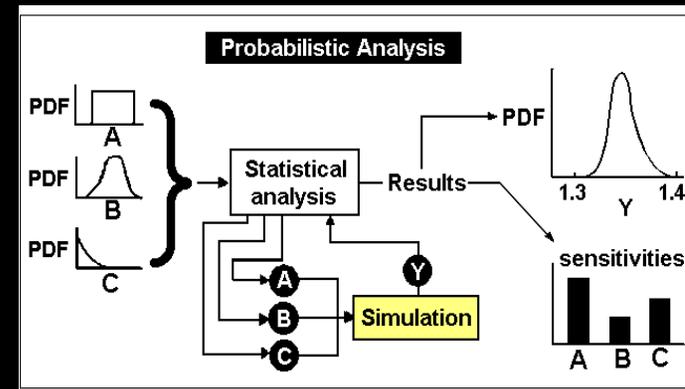




# Probabilistic Modeling Of Medical Event Scenarios

## In Support Of The Integrated Medical Model

- Probabilistic modeling expertise supporting risk activities
  - IMM, HSRB, HRP-PRA
- Successful Modeling Efforts
  - Bone fracture at susceptible locations
  - Sleep disturbance requiring intervention
  - Renal stone frequency
- Plans for several other models including other injury scenarios
  - Chest, abdominal and head injury
  - Anaphylaxis, Angina, Seizure
    - Bayesian updating





# Strategic Partnerships



## **Cleveland Clinic Center for Space Medicine**

- Promote interdisciplinary research that will exploit the unique skills, capabilities, and facilities of CCF and NASA GRC in support of long-duration spaceflight

## • **John Glenn Biomedical Engineering Consortium**

- Case Western Reserve University, Cleveland Clinic Foundation, University Hospitals of Cleveland, the National Center for Space Exploration Research perform interdisciplinary research leveraging GRC expertise in fluid physics and sensor technology to mitigate critical risks to crew health, safety, and performance.

## • **Case Western Reserve University/University Hospitals**

- Leveraging expertise in the Case Biomedical Engineering Department and the University Hospitals Center for Clinical Research and Technology in the areas of physiological systems, clinical research, and patient care.

## • **Wright Patterson Air Force Research Laboratory - Human Effectiveness Directorate**

- Leveraging the consolidation of all aerospace medicine and human research activities at WPAFB in response to the BRAC directive. Collaborative effort in the area of circadian rhythm upset and sleep deprivation

## • **BioEnterprise**

- Tech watch and collaborative efforts to further development and commercialize life-science-related technologies in Northeast Ohio.

## • **Human Performance Consortium**

- Exploring collaborative opportunities with regional organizations interested in the field of human performance - Case Western, Kent State, Cleveland State, the Cleveland Clinic/ Lerner Research Institute, Orbital Research, University Hospitals