

2<sup>nd</sup> Human Suborbital Science Program  
Life Sciences and Medical Research  
Workshop

# Results

May 2009

Sponsored by **NASA and USRA** (Universities Space Research Association)

# Emerging Commercial Suborbital Science

- Suborbital vehicles under development by emerging commercial companies offer new potential capabilities:
  - High flight rates, with rapid-turnaround and fly-on-demand, allow intensive
  - Support for both unmanned payloads and human-tended experiments
  - Lower cost than many existing research methods
  - Research fields include: earth science, heliophysics, planetary sciences, astronomy, microgravity physical sciences, life sciences, aeromedical, and aeronautics
  - Affordable platform for risk reduction, flight qualification, and raising hardware TRLs
  - Hands-on experience for students and postdocs to build and fly low-cost experiments
- Initial test flights expected in 2010 timeframe

# Workshop Objectives

- Two-way conversation between vehicle developers and scientists:
  - Scientists: what unique science do these vehicles enable?
  - Vehicle developers: how can we best tailor our spacecraft and ground processes to meet scientific needs?
- 1<sup>st</sup> Workshop in Dec 2008, San Francisco
  - Held in conjunction with American Geophysical Union AGU Fall Meeting
  - Focus on earth science, heliophysics, and planetary sciences
- 2<sup>nd</sup> Workshop in May 2009, Los Angeles
  - Held in conjunction with Aerospace Medical Association Annual Meeting
  - Focus on life sciences and aerospace medical research

# Workshop Program (May 2009)

- **NASA Commercial Suborbital Science Program Office**
  - Col. Yvonne Cagle, MD, Suborbital Science Program Manager
- **Service providers**
  - Armadillo Aerospace, Blue Origin, Masten Space, XCOR, NASTAR Center, Garvey Spacecraft, Virgin Galactic
- **Scientists**
  - Dr. Adrian LeBlanc, Universities Space Research Assoc.
  - Dr. Erika Wagner, MIT Bioastronautics
  - Dr. Jon Charles, NASA Program Scientist, Johnson Space Center
- **Breakout Sessions**
  - A pair of 45-minute breakout sessions allowed for brainstorming and discussion in small groups



# Human Physiological

**Capability:** Take advantage of low-cost access to 3-5 minutes of weightlessness, including transitions to and from high-g's

## **Research ideas:**

- In-situ monitoring throughout flight of numerous parameters:
  - Heart rate (ECG and/or "pulse-meter")
  - Cardiac stroke volume (impedance plethysmography)
  - Arterial blood pressure (non-invasive, finger: finapres/portapres, wrist)
  - Oxygen saturation (pulse oximeter)
  - Regional blood volume (impedance plethysmography)
  - "Brain waves" (EEG)
  - Eye movements (EOG)
  - Spacecraft reference data
- Early response characterization:
  - Neurovestibular and sensorimotor responses
  - Oculomotor control and perceptual disturbances
  - Motion sickness onset
  - Fluid shift
  - Thoracic impedance
- Evaluate pre-screening methodology & pharmaceutical countermeasures

## **Desirements:**

- Unobtrusive personal physiological data recording system
- Low profile receiver/recorder
- Real-time telemetry

# Large Population Medical Research

**Capability:** Take advantage of potentially large number of spaceflight participants with varying medical histories

## **Research ideas:**

- Participants opt in to help build large database
- Compare varying levels of fitness:
  - Smoking
  - Alcohol
  - Stress & behavior
  - BMI
  - High blood cholesterol
  - High blood pressure
  - Physical inactivity
- Compare other covariates:
  - Age, gender, race
  - Flight experience
  - Various medical conditions
- Effects of medications
- Comparison of vehicle trajectories:  $+g_x$  vs.  $+g_z$  ascent/descent body vectors
- Study cumulative effects of repeated exposures (crew)

## **Desirements:**

- Standardized central database
- Cross-industry agreement between providers, NASA, and research community

# Other Biological & Life Sciences

**Capability:** Take advantage of early access to samples, frequent re-flight of experiments, and new payload possibilities, including large equipment not suitable for existing platforms

## **Research Ideas:**

- Experiment types currently unfeasible
  - Primates
  - Free-flying birds, insects
  - Radiation sources
  - Test alternative cabin conditions (temp, pressure, atmospheric composition)
  - Fertilization & early development
- Osteoclastogenesis triggered through proteins with short half-life
- Lung deposition of particulates
- Acute cellular responses
- Gene expression
- RNA sampling
- Immune response testing
- Transitions between various g-loading, “push-pull” effects from repeated exposures

## **Desirements:**

- Standardized experiment racks
- Power, data recording, telemetry
- Containment of hazards

# Additional Enabled Activities

**Capability:** Take advantage of low-cost compared to existing ISS life sciences research, as well as exciting, high-profile nature of flights

## **Ideas:**

- Astronaut Training
  - Spatial awareness
  - Emergency procedures
  - Medical procedures
  - Countermeasures
- Technology test and risk reduction
  - Low cost flight qualification
  - Iterative approach to experiment design
- Education and Outreach
  - Student-built experiments
  - Participatory activities, streaming video
  - Hands-on training opportunities for small experiment hardware
  - Flights of teachers to space
  - Leverage private sector outreach expertise