New Shepard Suborbital Vehicle for Research Missions

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Next-Generation Suborbital Researchers Conference
Boulder, CO
February 18, 2010

Our Purpose

- **Company Purpose: Space Launch**
  - **Blue Origin is developing vehicles and technologies to help enable human space transportation**

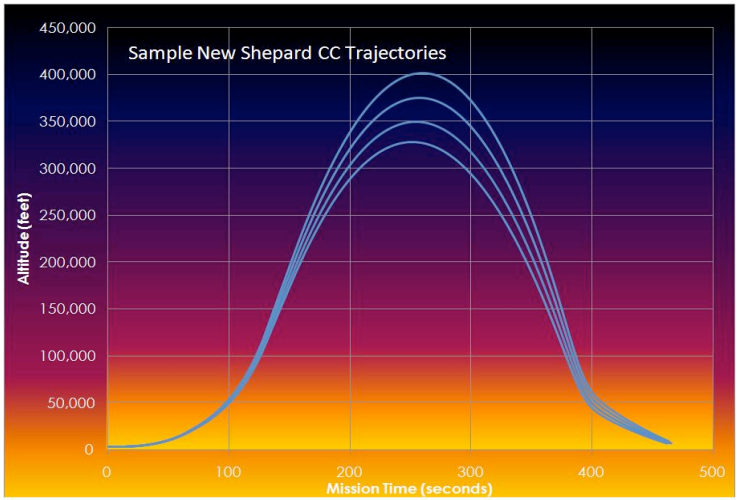
- **Our focus is on:**
  - **Reusable launch vehicle systems**
  - **Safety systems and human factors**
  - **Frequent launch operations**

Locations

- **Kent, WA (Seattle area)**
- **Culberson County, TX**
  - All flight test vehicles fabrication, assembly and initial ground testing at our own dedicated launch site in West Texas desert (the only privately-owned dedicated launch site in the USA)
  - 244,000 ft2 facility

New Shepard Vehicle

- **Designed to safely and routinely carry 3 or more astronauts to above 325,000 ft.**
- **Propulsion Module**
  - **Vertical take-off, vertical powered landing booster stage**
  - **Nearly vertical trajectory**
  - **Fully reusable and optimized for rapid turnaround with small ground crew**
- **Crew Capsule**
  - **Fault tolerant design for safety-critical functions**
  - **Crew escape capability**
  - **Separates from the Propulsion Module and lands separately under parachutes**
  - **Fully reusable and optimized for rapid turnaround with small ground crew**
- **Flight testing of prototype vehicles began in 2006**



New Shepard Research Capabilities

- **Blue Origin is developing a modular Cabin Payload System (CPS) with standard mechanical and electrical interfaces and data services for experiments**
  - **CPS Racks can be switched out in place of seats in crew cabin**
  - **Blue Origin also plans to accommodate customers who want to bring their own racks**

Experiment Accommodation	Services Provided
Crew/Payload Capacity	3 or more astronauts or CPS racks
Experiment Mass	120 kg per position (including CPS rack weight)
Windows	One per crew position
Power	28 VDC provided
In-Flight Communications	Voice and telemetry for experiment monitoring and control
Video	Cameras provided for experiment use
Data Interfaces	Analog I/O, Digital I/O, RS-232, Ethernet Data recording onto onboard solid-state drives
Control Software	Blue Origin developed GUI for scripting experiment control
Microgravity Levels	< 0.001 g for approximately 3 minutes
Pointing Accuracy	±5° per axis during coast
Turning Capability	Yes

New Shepard Research Applications

BLUE ORIGIN

Types of Investigations	Example Applications
Remote Sensing	Atmospheric science Earth observations
In-Situ Science	Atmospheric sampling Magnetospheric measurements
In-Cabin Science	Physiology Gravitational biology Microgravity physics
Instrument Test / Demonstrations	Gain flight experience Raise TRL levels

Phase 1 Flight Demonstration Program

- **Blue Origin has selected three research payloads from experienced scientists to fly on the *New Shepard* suborbital vehicle as part of Phase 1 of a Research Flight Demonstration Program**
  - **Serves as a pathfinder to help develop *New Shepard* experiment accommodations and integration process while accomplishing real science**

- **Program Status**
  - **RFP issued in June 2009, proposals due in July 2009**
  - **Winning proposals selected in September 2009**
  - **Payload User's Guide issued to experiment teams**
  - **Selected teams currently designing and fabricating their experiments**
  - **Blue Origin currently building and testing prototype Cabin Payload System hardware and software**

Selected Payloads (1 of 3)

- ***Three-Dimensional Critical Wetting Experiment in Microgravity***

  - Principal Investigator: Steven Collicott, Purdue University

  - Research Goal: Dr. Collicott plans to use the *New Shepard* vehicle's microgravity environment to probe capillary fluid movement in three dimensions. Various types of devices rely on wicking fluid, or capillary fluid physics, including spaceflight life-support and fuel systems, and, for applications operated in ordinary Earth gravity, small fuel cells and miniature sensors and instrumentation for health sciences. However, capillary action can be difficult to study in Earth laboratories, and mathematical models of the critical wetting that takes place in these devices are based largely on two-dimensional data. Dr. Collicott plans to measure wetting in three dimensions in the *New Shepard* vehicle's zero-gravity environment. These measurements can then be used to create three-dimensional mathematical models of wetting that can be used in a variety of applications.

Selected Payloads (2 of 3)

- ***Microgravity Experiment on Dust Environments in Astrophysics (MEDEA)***

  - Principal Investigator: Joshua Colwell, University of Central Florida
  - Co-PI: Dan Durda, Southwest Research Institute
  - Co-PI: Jürgen Blum, Institut für Geophysik und extraterrestrische Physik Technische Universität Braunschweig

  - Research Goal: Dr. Colwell and his team plan to use the *New Shepard* microgravity environment to study early formation of planets, focusing on the behavior and interaction of dust particles and regolith material. These observations will help fill in some of the gaps in knowledge of the early stages in the formation of solar systems, when clouds of loose dust aggregate into protoplanetary bodies. The microgravity environment aboard the *New Shepard* vehicle allows the team to study multiple collisions among free-flying dust particles at slow speeds. These collisions are impossible to perform in Earth laboratories due to the overwhelming effect of gravity.

Selected Payloads (3 of 3)

- ***Effective Interfacial Tension Induced Convection (EITIC)***

  - Principal Investigator: John Pojman, Louisiana State University
  - Co-PI: Patrick Bunton, William Jewell College

  - Research Goal: Dr. Pojman and Dr. Bunton are investigating how miscible fluids, i.e., fluids that dissolve completely in each other, such as honey and water; can act like immiscible fluids, such as oil and water. The researchers plan to use the *New Shepard* vehicle's microgravity environment to observe fluid flow caused by a temperature variation at the boundary between two miscible fluids.