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# Q-PACE: The CubeSat Particle Aggregation and Collision Experiment

**Joshua Colwell** (1,2), Julie Brisset (2), Adrienne Dove (1), and Stephanie Jarmak (1) and the Q-PACE team.
(1) Department of Physics, University of Central Florida, Orlando FL 32816, USA, (josh@ucf.edu) (2) Florida Space Institute, University of Central Florida, Orlando FL 32816

## Abstract

Q-PACE is a long duration microgravity experiment housed in a 3U CubeSat planned for launch to low Earth orbit. The experiment is designed to observe tens of thousands of collisions at speeds below 10 cm/s between particles ranging in size from 10 micron silicon spheres to chondrules and cm-size quartz spheres. Collisions occur in a backlit chamber and are recorded by a video camera. Video data is compressed onboard the spacecraft before downlinking to Earth. Two reservoirs of particles, one containing meteoritic chondrules and one containing aggregates of 10-micron silicon spheres can be opened to deliver their particles into the main collision chamber in later phases of the mission. Initially collisions take place between cm-size and 2-mm-diameter particles. The speed of the initial collisions is determined by a system of shakers that cause the test cell walls to collide with the particles at speeds of up to 10 cm/s. The dust aggregates will be disaggregated in the final phase of the experiment to allow dust to coat the larger particles to study the effects of a thin coating on collisional outcomes. Video records the collisional damping which may lead to formation of large aggregates at speeds of 1 mm/s, based on a preliminary experiment that flew on the International Space Station. The results of Q-PACE will be a database of collisional outcomes at low-velocity for different particle types and including both monomers and aggregates with applications to collisional evolution in the early protoplanetary disk as well as in planetary ring systems. We present the design, operation, and experiment plan for Q-PACE.

## Experiment

Figure 1 shows a top-down view of the Experiment Test Cell (ETC) in which the collision experiments take place. A single experiment run will take only a few minutes before collisions completely damp the particle velocities.

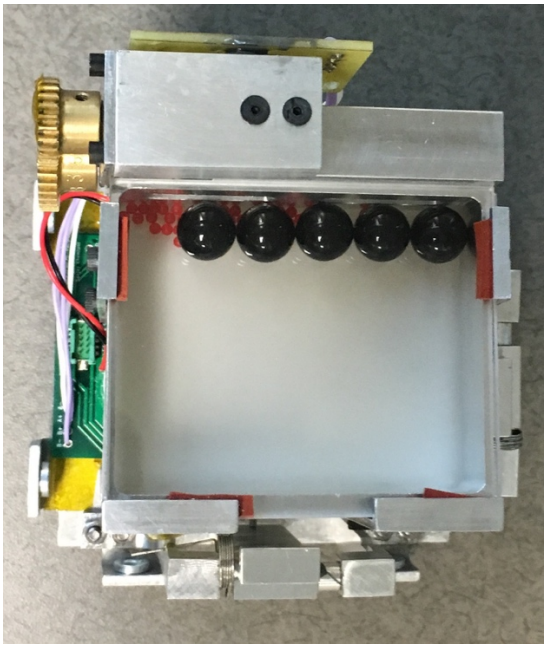

Figure 1: The Q-PACE Experiment Test Cell. At the top is a motorized mechanism to release two additional populations of small particles into the main test chamber in later stages of the mission.

## Mission

Figure 2 shows the spacecraft. Q-PACE is expected to be operational in orbit for at least 3 years. Downlink times will be the rate limiting step and are anticipated to take 2-3 weeks per experiment run. Results from Q-PACE will be used to identify the probabilistic distribution of coefficients of restitution based on collision speed and particle type for modeling early stages of planetesimal formation and planetary ring evolution.

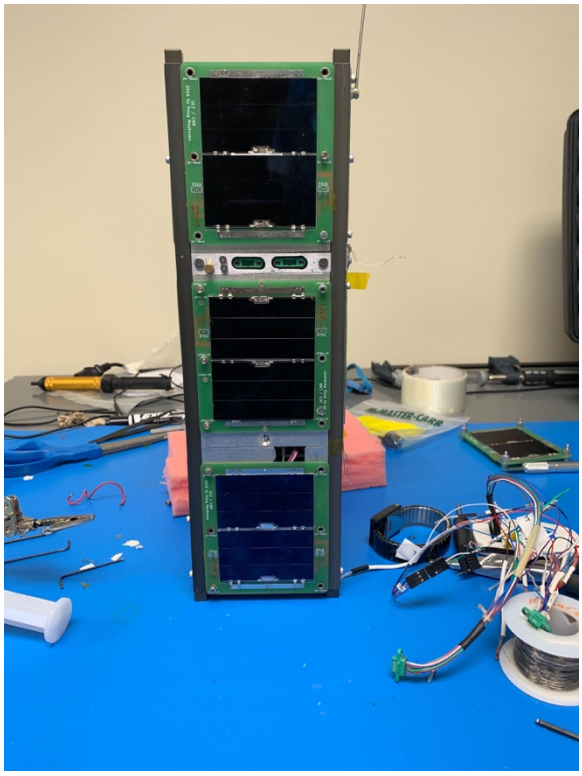

Figure 2: The assembled Q-PACE 3U CubeSat.

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