

Objective: Develop a solar array design for the CubeSat family of space craft. The design adheres to the following requirements:
1) Must have the ability to orient Solar Panels towards the Sun to maximize solar power generation; **2)** Must within the space of a 3U CubeSat for launch; **3)** The movement must use no power or computation internal to the CubeSat

CubeSat Background

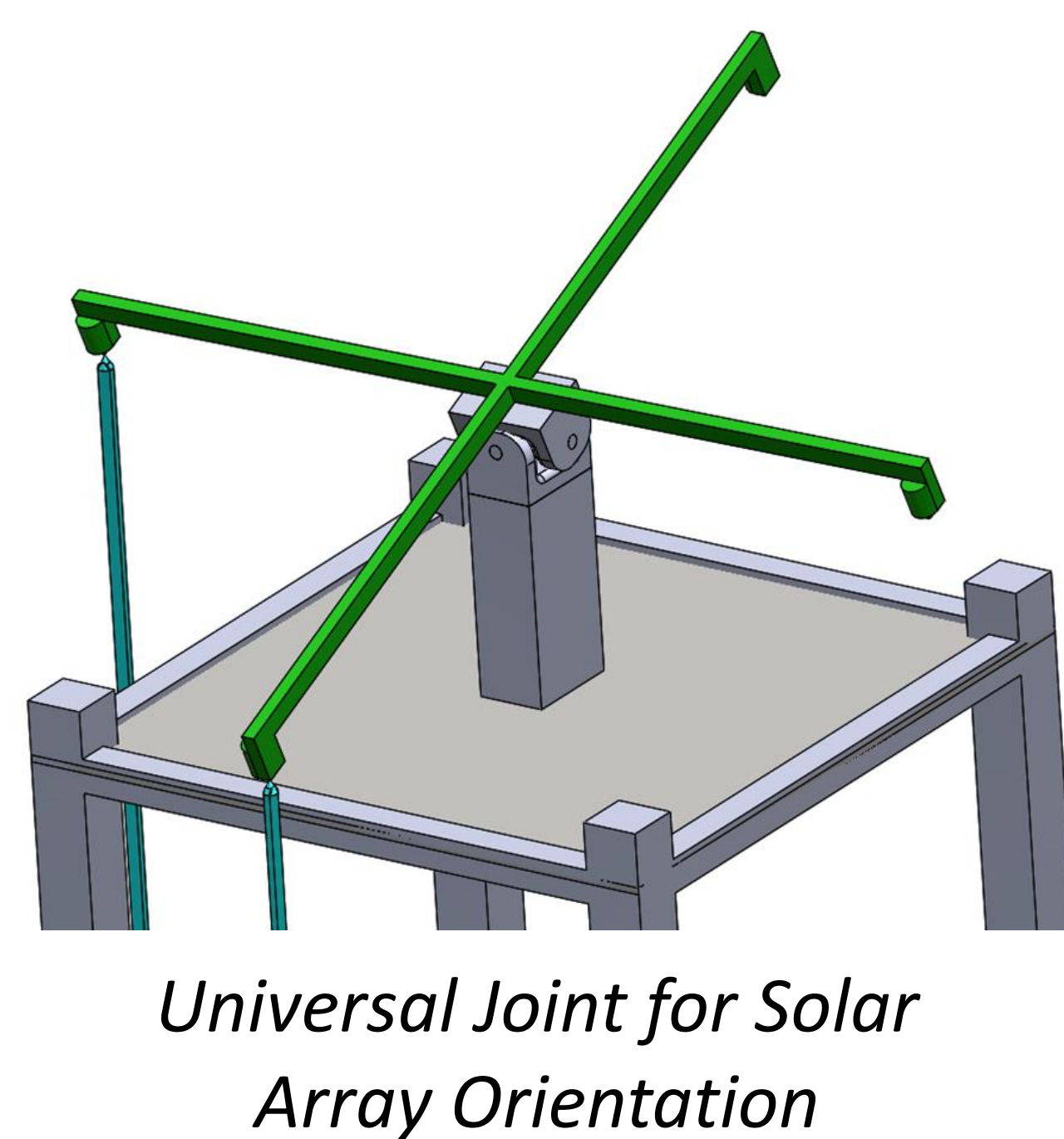
- Design originated in late 1990's
- Small satellites built up from individual units
- 1 unit = 10cm x 10cm x 10cm cube
- CubeSats make space more accessible to small institutions
- Causing a revolution in Space, Defense, and Conservation Research



Photograph of San Francisco, CA taken from a CubeSat and 3 Unit CubeSat (Courtesy of Planet Labs Inc., San Francisco, CA)

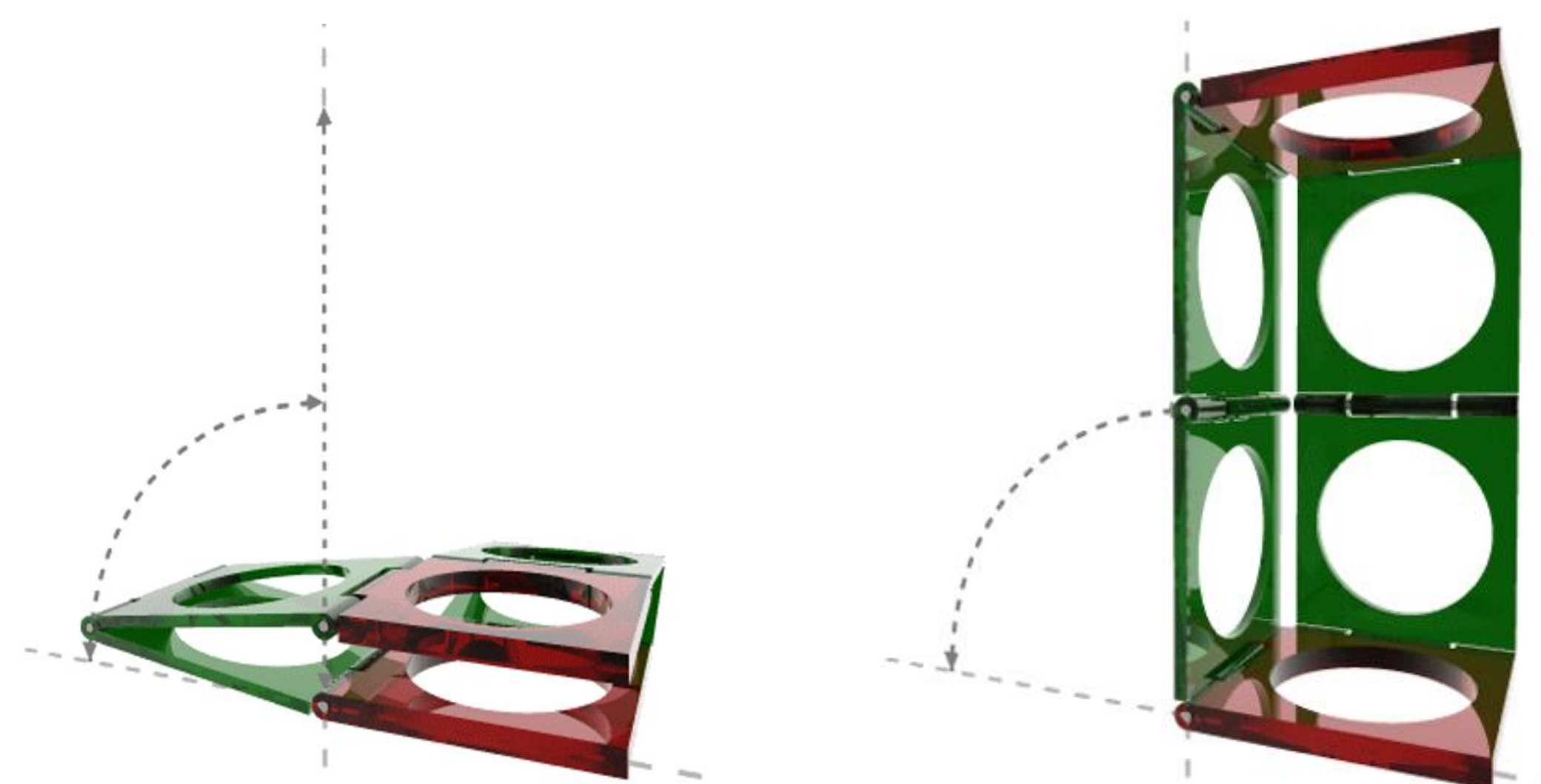
Design Philosophy

- Use a Universal Joint to allow for full range spatial pointing
- Use smart materials as prismatic actuators to control position



Creating Clearance

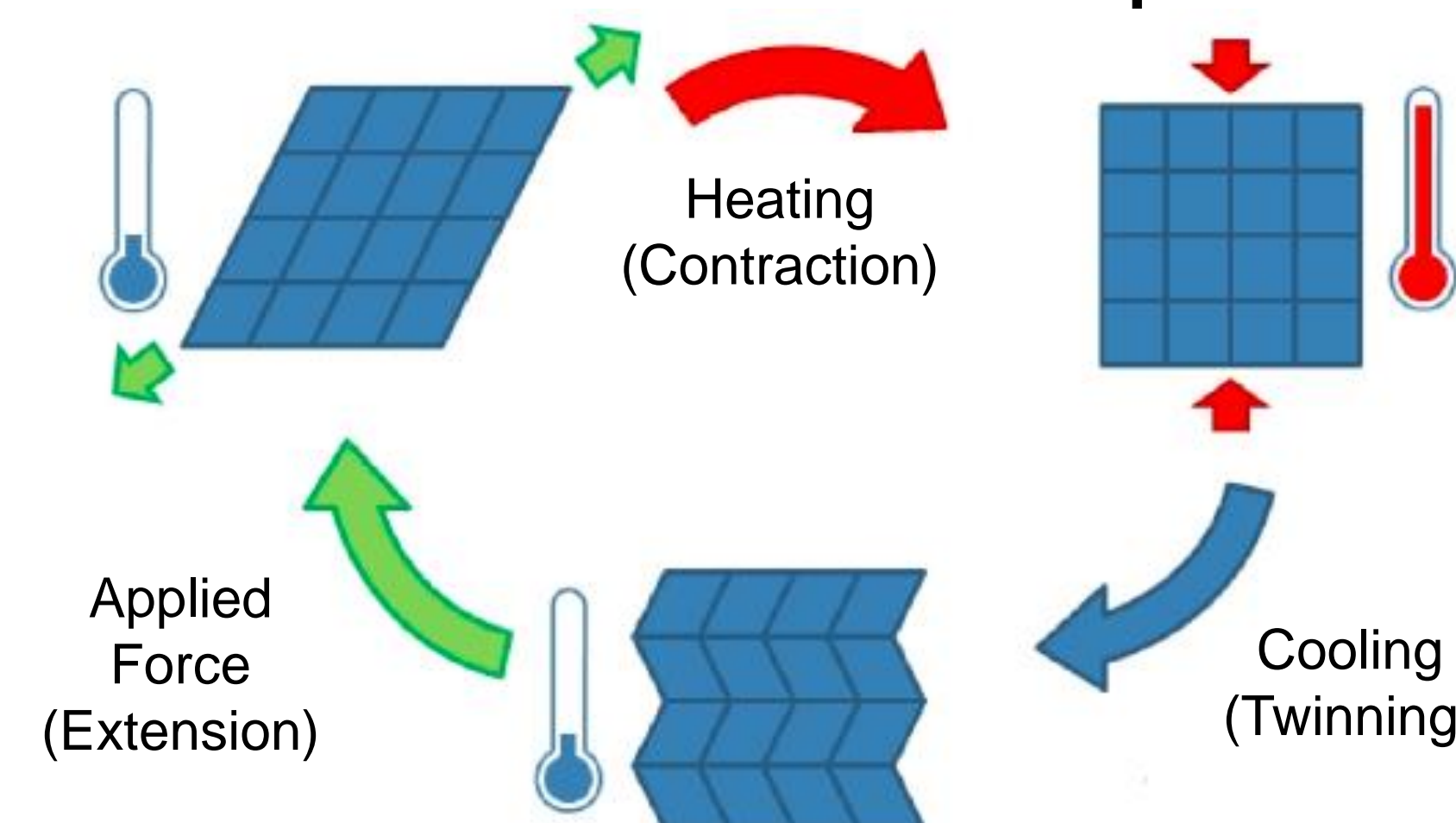
- Universal Joint movement requires separation from the CubeSat Chassis
- Solution: Sarrus Linkage
- Straight-line Mechanism developed in the 1850's
- Spatial 6-Revolute Joint Mechanism



Sarrus Linkage Collapsed (Left) and Deployed (Right)
Image Source: "Sarrus linkage," Wikipedia, 28-Feb-2018, [Online]. Available: https://en.wikipedia.org/wiki/Sarrus_linkage. [Accessed: 09-Apr-2018].

Nitinol Material

- Shape Memory Alloy, phase dependent on temperature
- Temperature can be reached by passing an electric current through the nitinol
- Common Actuator in Aerospace applications



Nitinol Phase Transformation

Image Source: J. P. Swensen and A. M. Dollar, "Optimization of Parallel Spring Antagonists for Nitinol Shape Memory Alloy Actuators," in IEEE International Conference on Robotics & Automation (ICRA), Hong Kong, China, 2014.

Actuation Design

- Pass electric current through Nitinol Springs
- Electric current from auxiliary solar panels
- 4 Nitinol Springs, acting as antagonistic pair

Deployment Procedure

