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SPOAC and Hinge Integrated MSAC: Non-holonomic Attitude Control Systems for Spacecraft

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Conventional Attitude Control Systems (ACS)

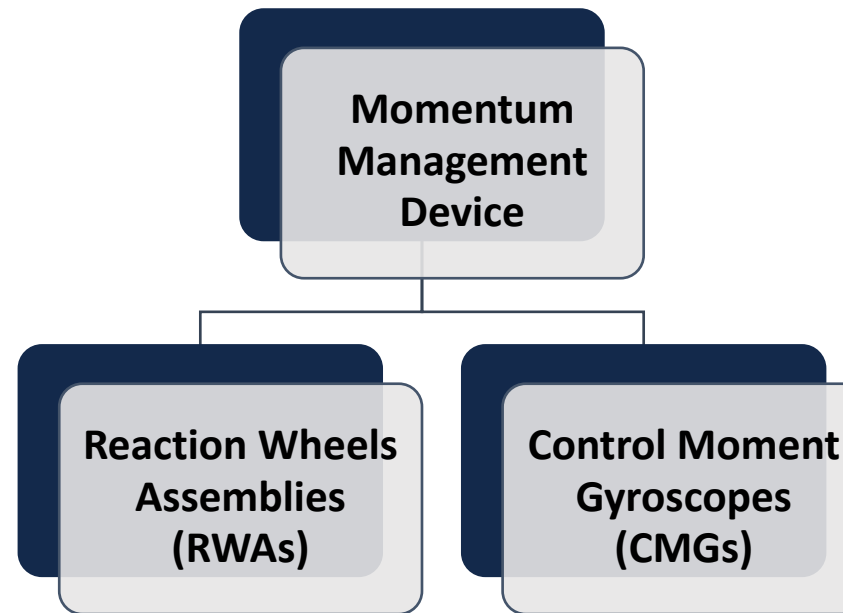
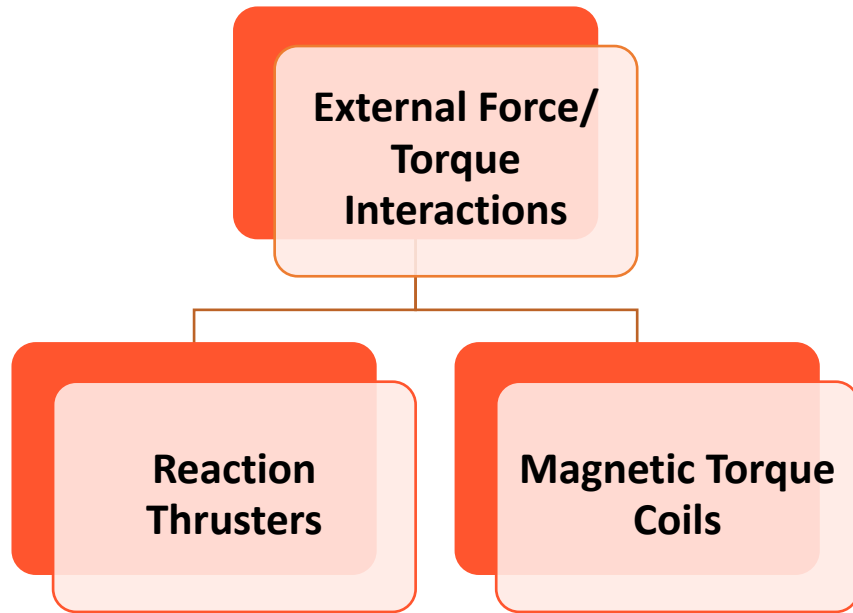


Image credit: NASA

Inherent Operational Limitations:

- Finite fuel sources
- Range of the Earth's magnetic field

Drawbacks:

- Significant amount of vibration →
- Coupled with passive vibration isolation systems →
- Increased mass, volume, and budget

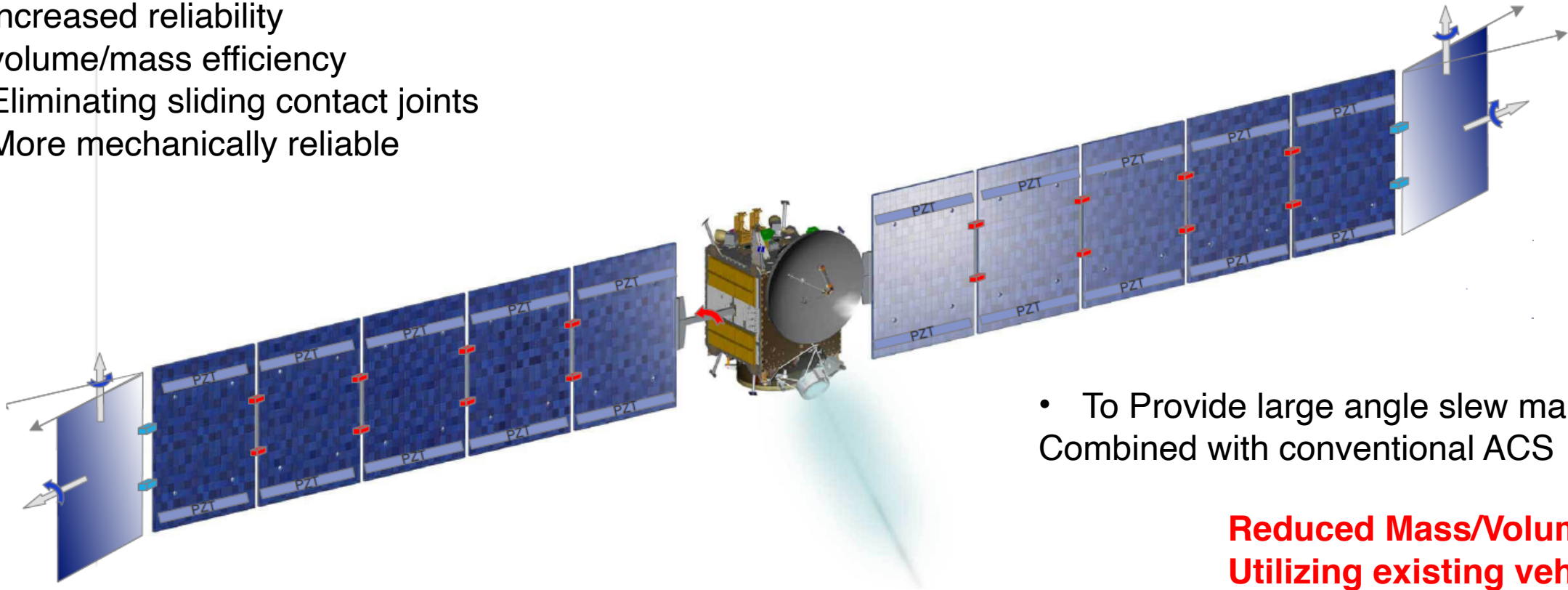
Benefits:

- Unconstrained to fuel, and space-environment

Strain-Actuated Solar Arrays (SASA)



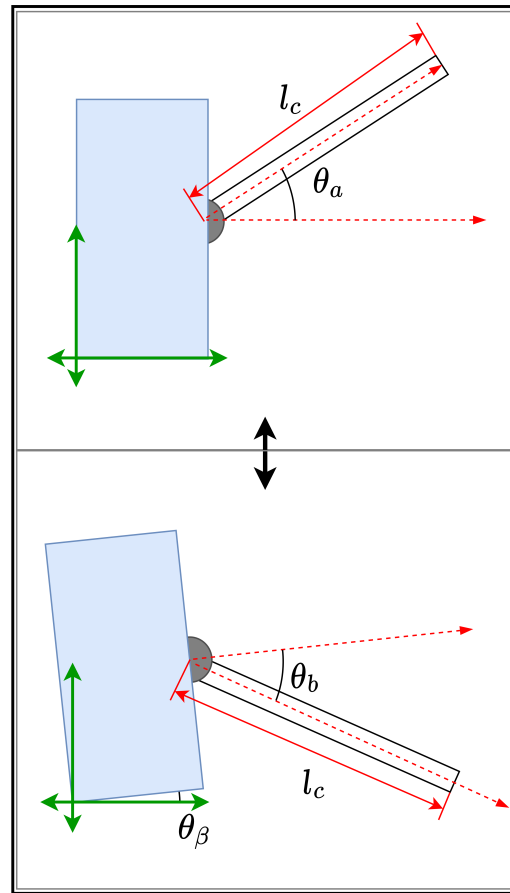
- active jitter reductions
- **small** angle slew maneuvers
- increased reliability
- volume/mass efficiency
- Eliminating sliding contact joints
- More mechanically reliable



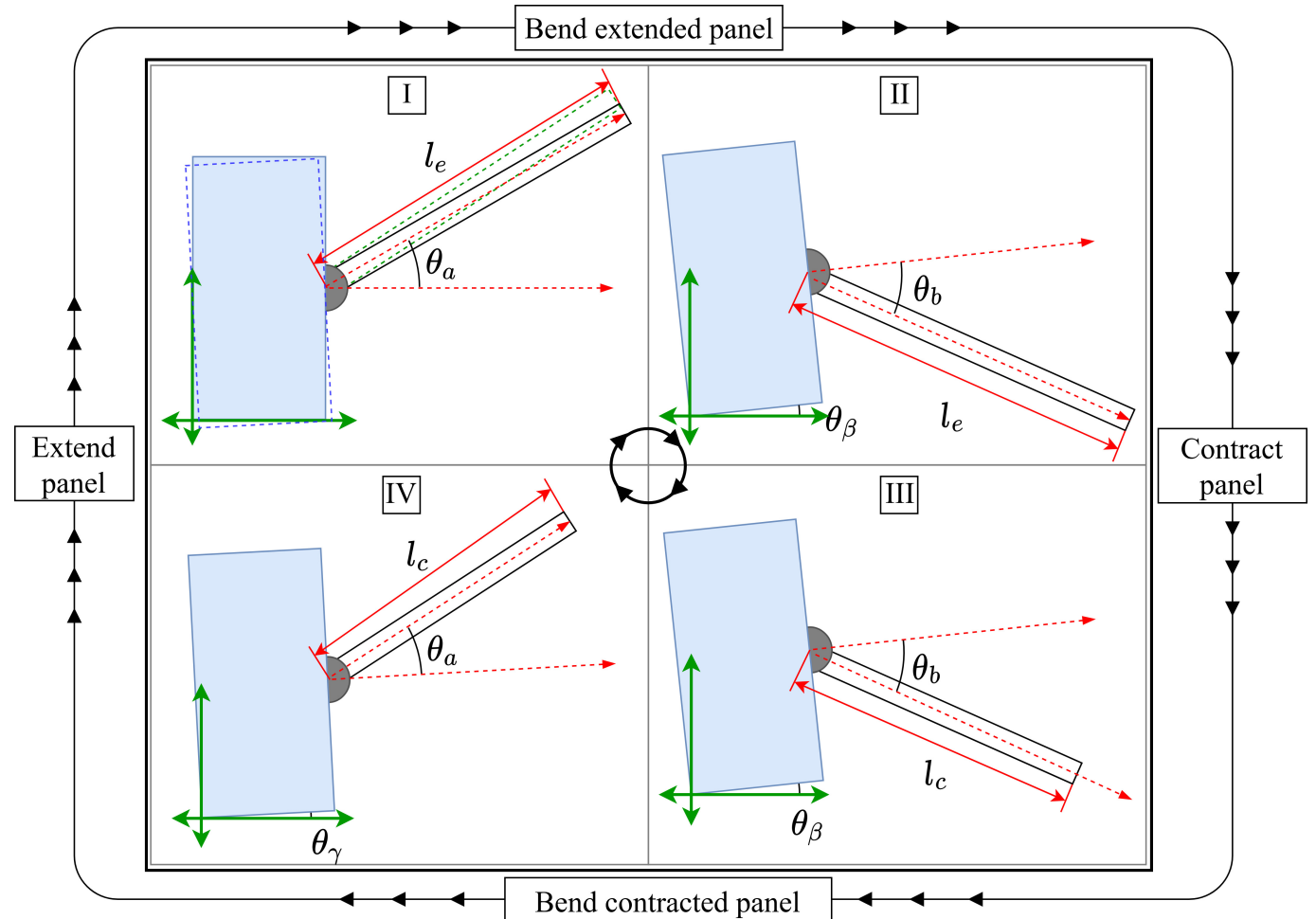
- To Provide large angle slew maneuvers:
Combined with conventional ACS

**Reduced Mass/Volume
Utilizing existing vehicle
mass (deployable panels)**

Multifunctional Structures for Attitude Control (MSAC)



SASA



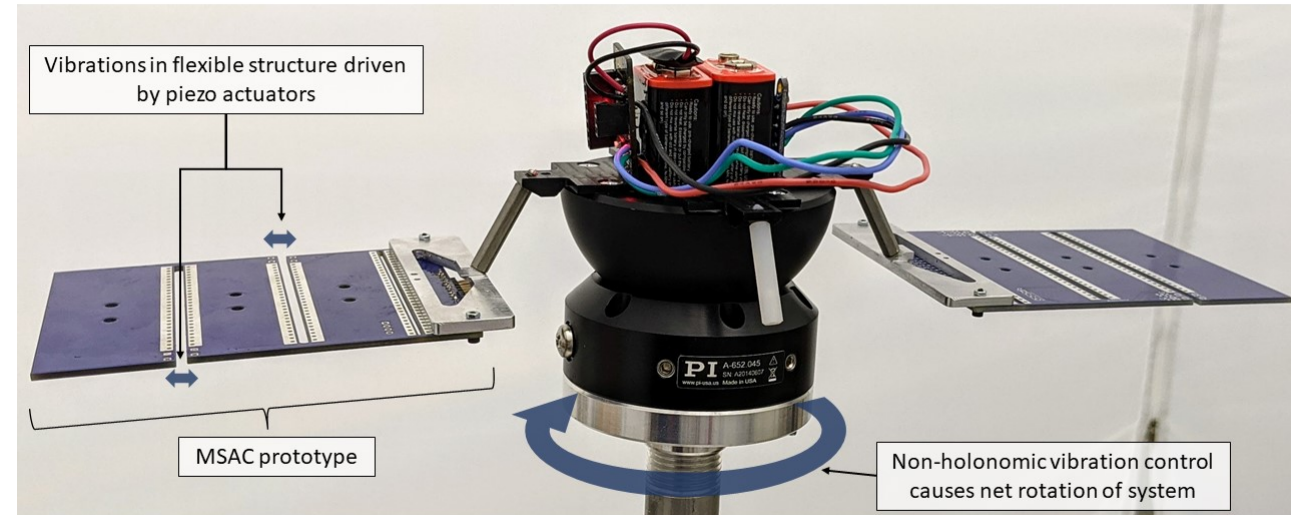
MSAC

Multifunctional Structures for Attitude Control (MSAC)

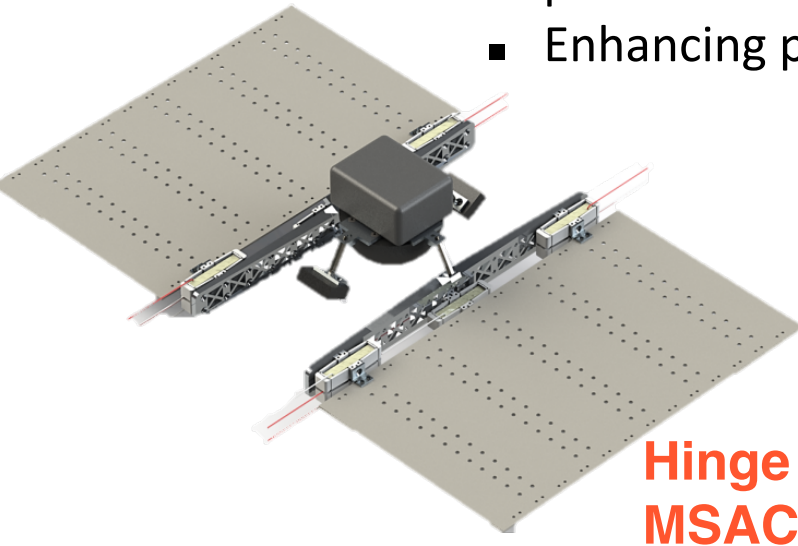


- active noise cancellation
- **large** angle slewing
- precise phase-aligned cyclic motions in deployable panels
- non-holonomic control trajectories
- desirable resonance modes
- precise frequencies and phases
- reduced system mass, volume, power consumption, and cost
- Enhancing pointing performance

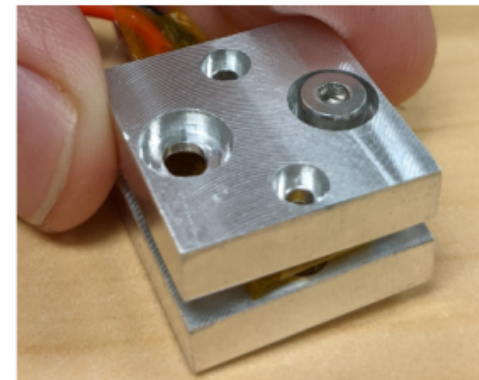
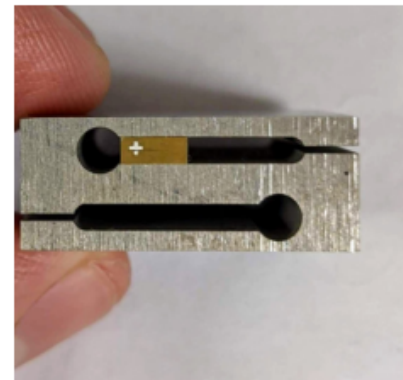
Panel Integrated MSAC



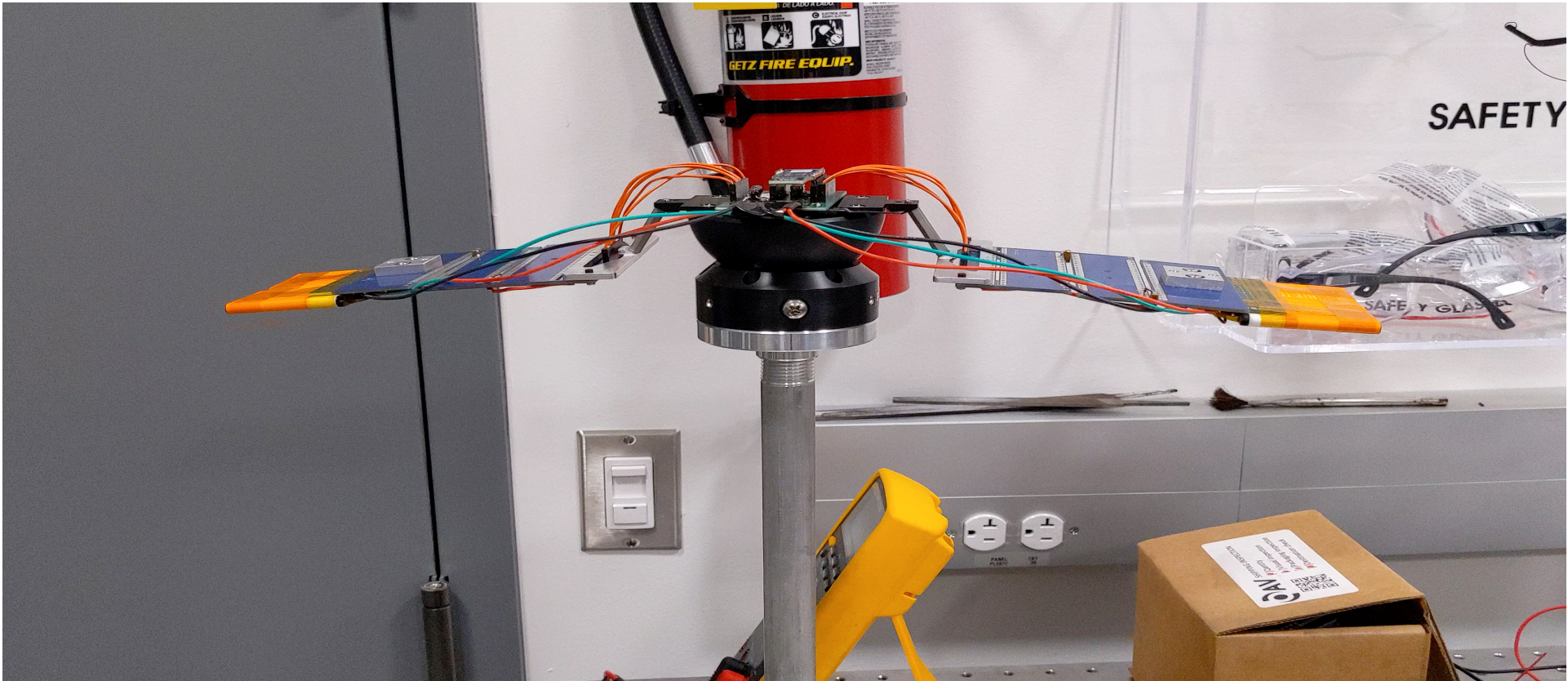
Cilia-MSAC



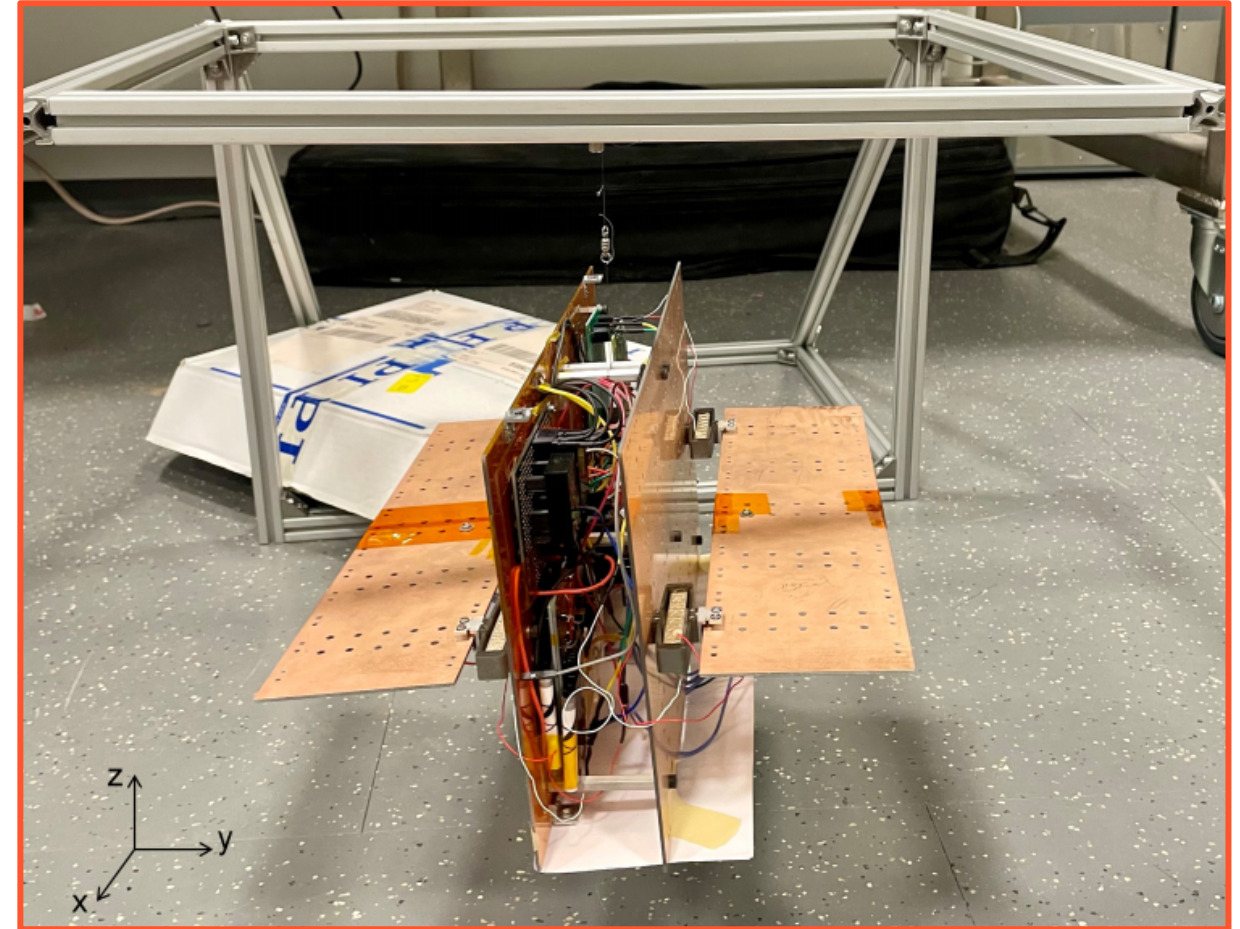
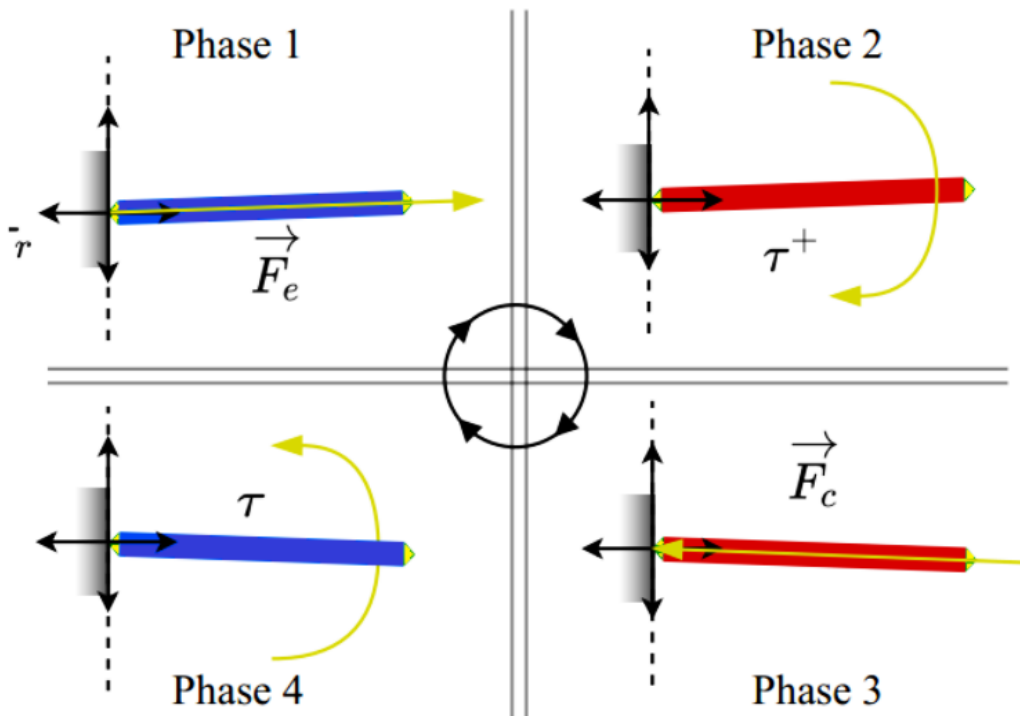
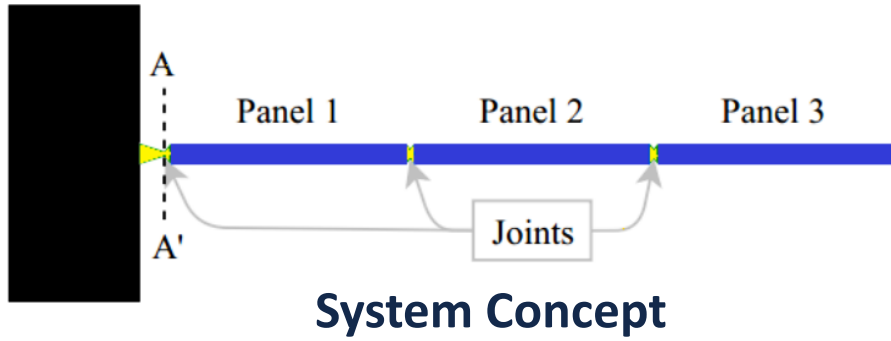
Hinge Integrated MSAC



Multifunctional Structures for Attitude Control (MSAC)

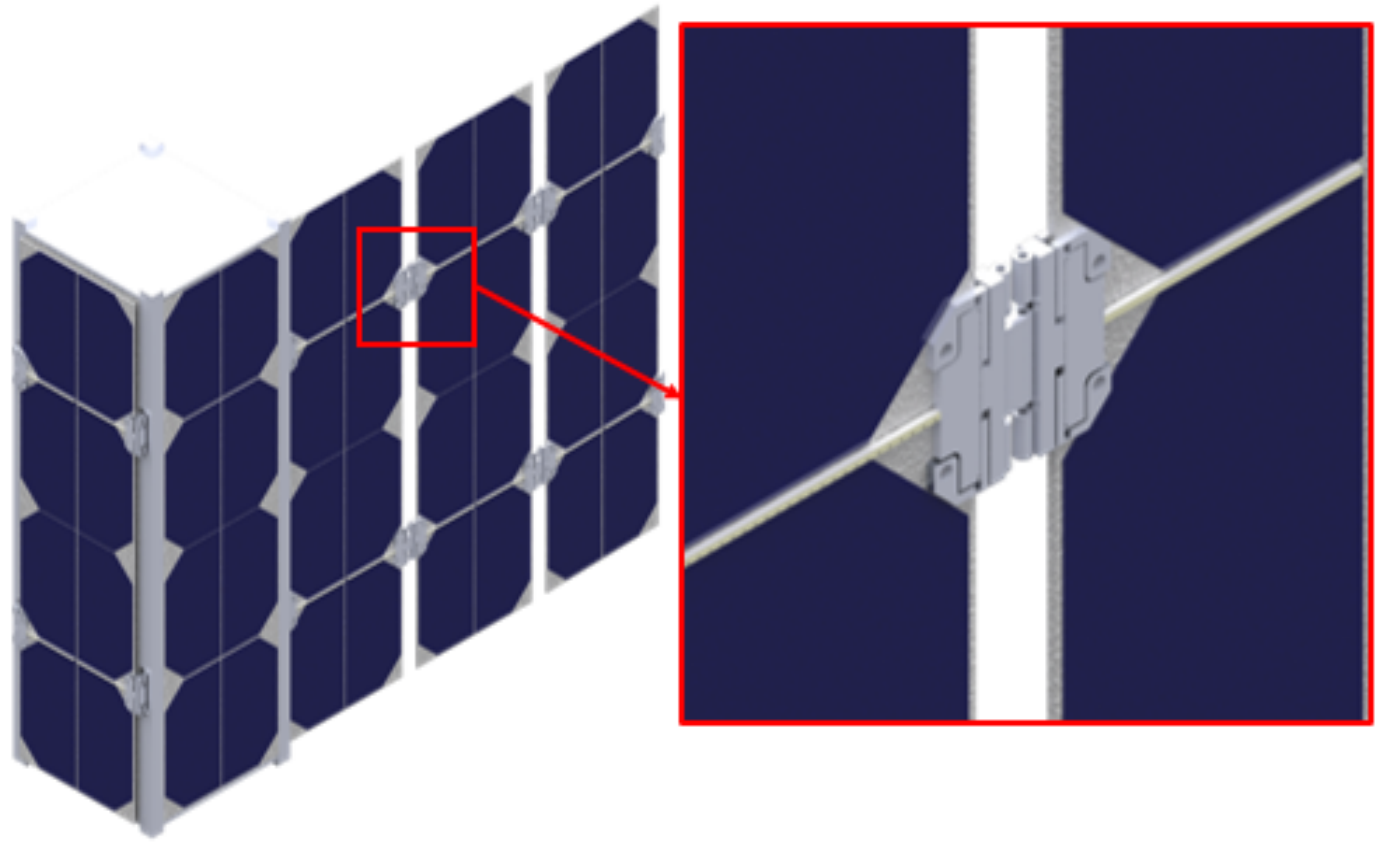
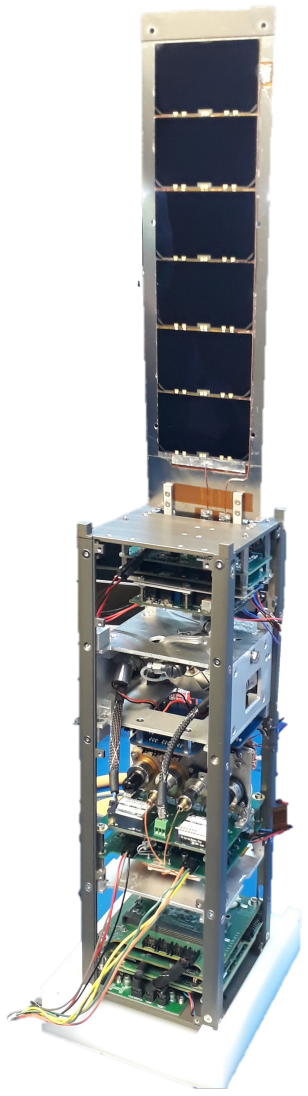


Hinge Integrated MSAC



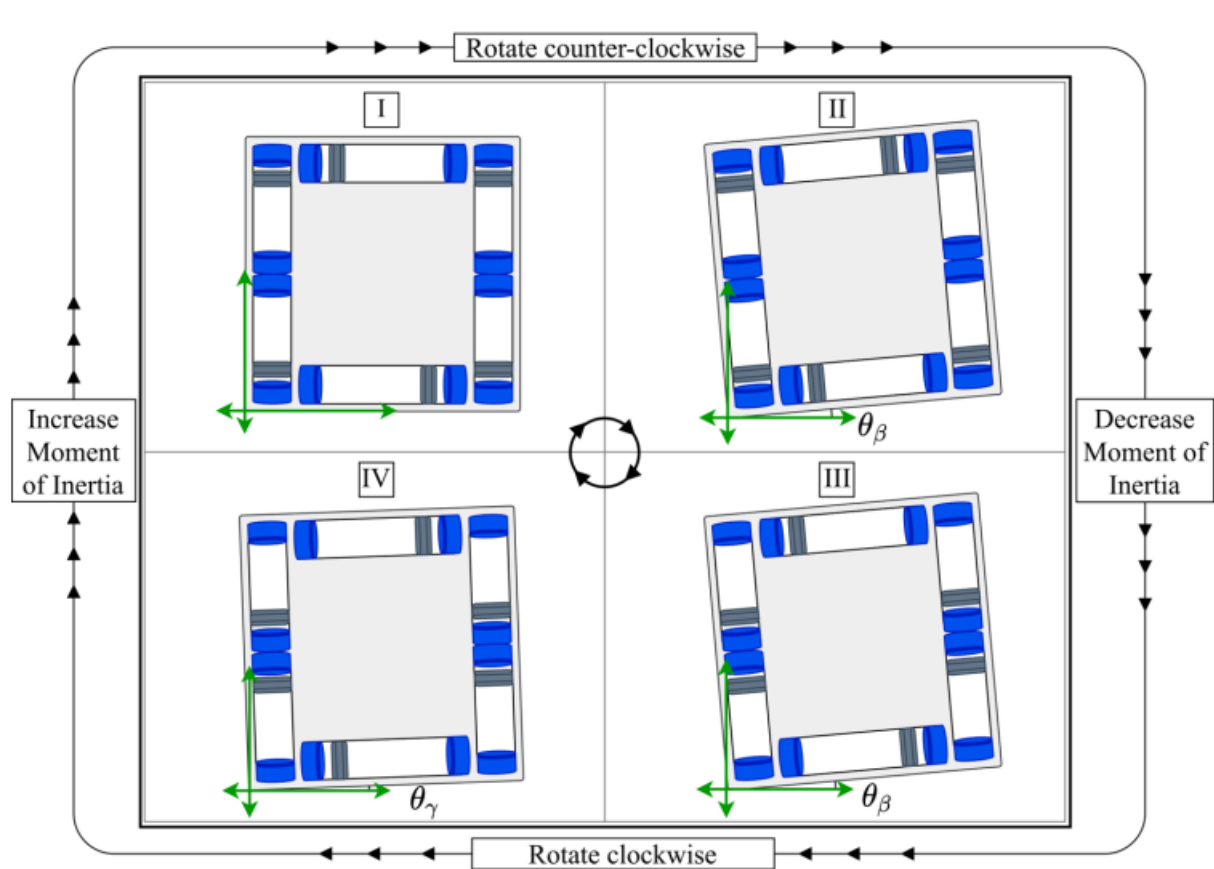
Experimental Setup

Hinge Integrated MSAC

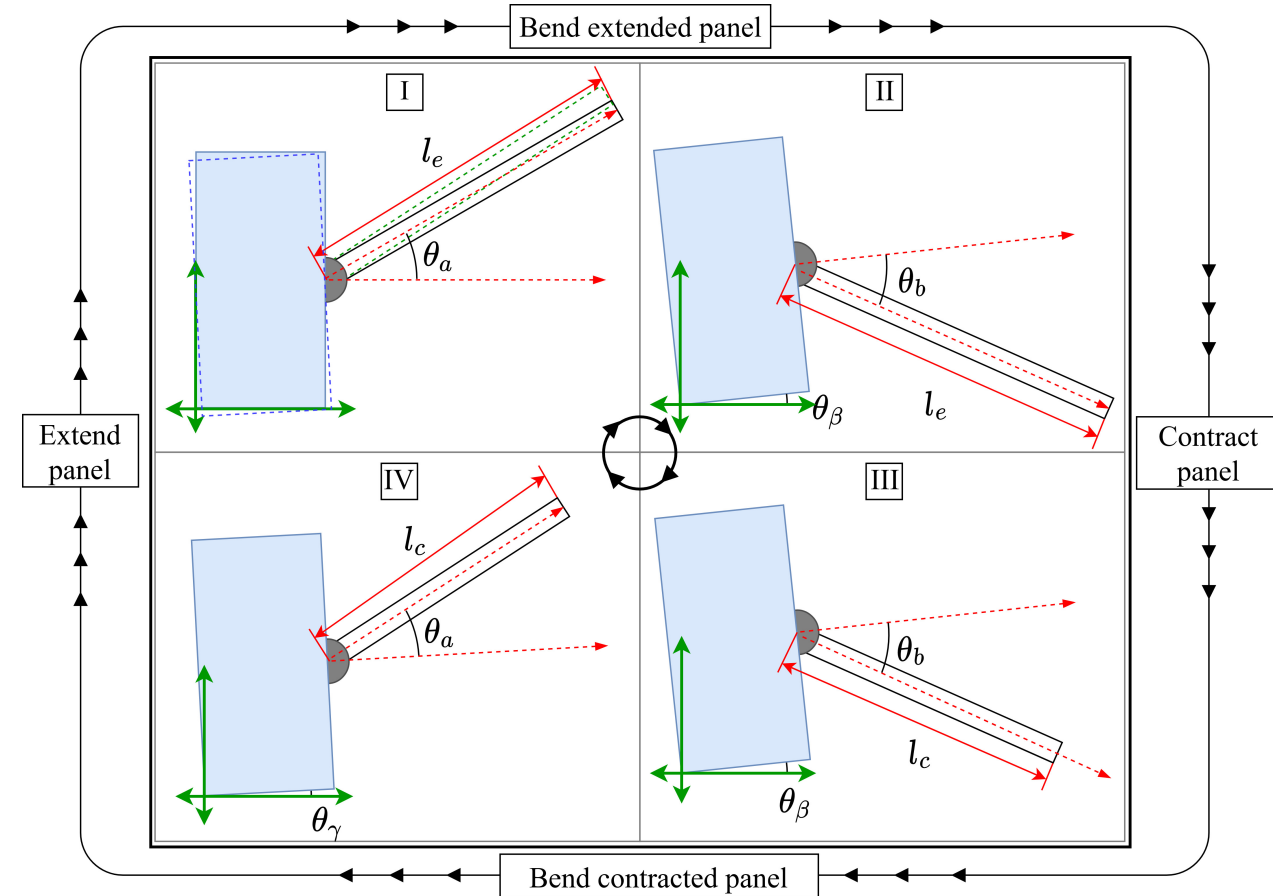


Real Setup

Suspended Phased Oscillators for Attitude Control (SPOAC) Concept

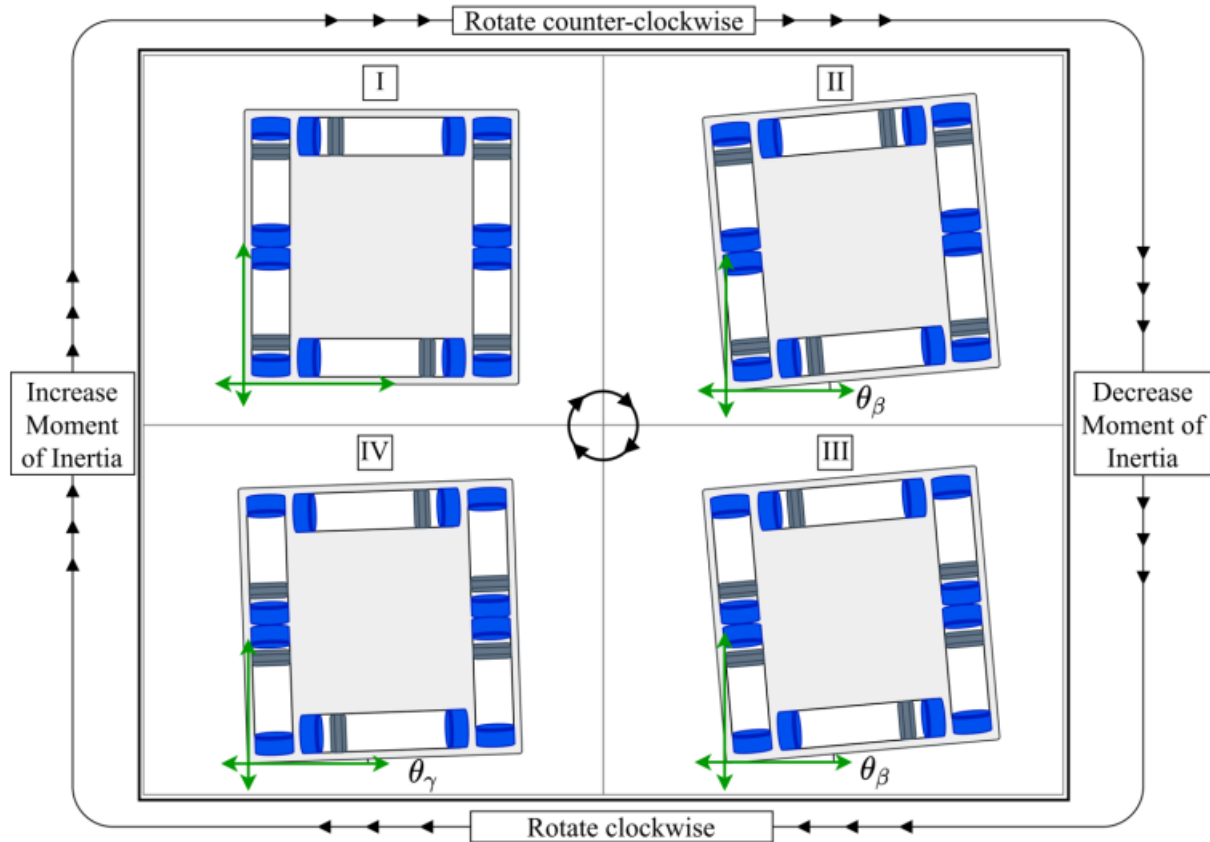


Four-phase SPOAC system cycle

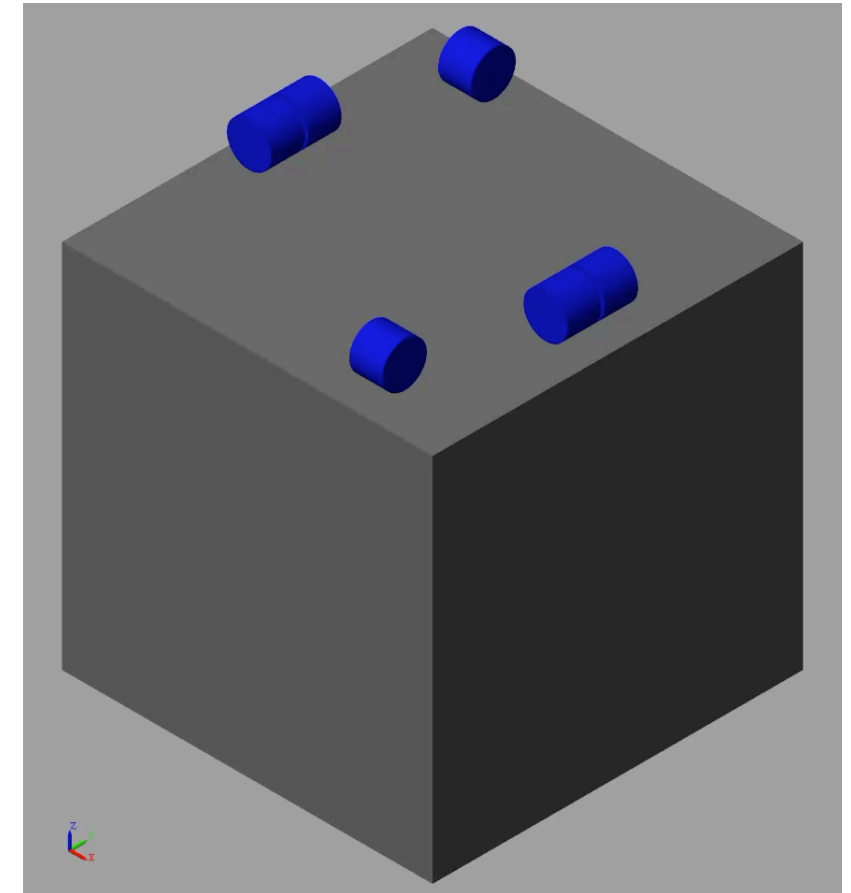


Four-phase MSAC system cycle

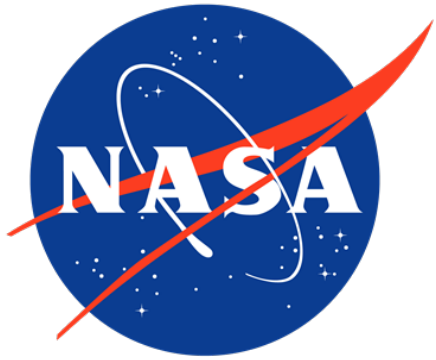
Suspended Phased Oscillators for Attitude Control (SPOAC) Concept



Four-phase SPOAC system cycle



Simplified SPOAC system design



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A Simple Trajectory

