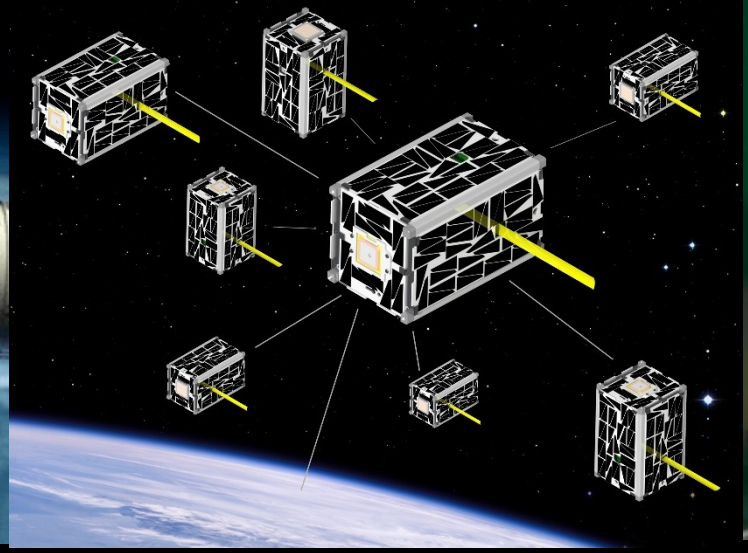

On the Feasibility of Quantum Docking for Cubesats

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Outline

- Introduction and Motivation
- Related Work
- Objectives
- Challenges
- ConOps
- Flux Pinning
- Methodology
- Conclusion and Future Work

Introduction and Motivation – Quantum Docking

- CubeSat launches are increasing at an exponential rate
- On-Orbit assemblies of CubeSats
- Flux-pinning provides very high mechanical stiffness
- No voltage or power are required
- No plumes ejected

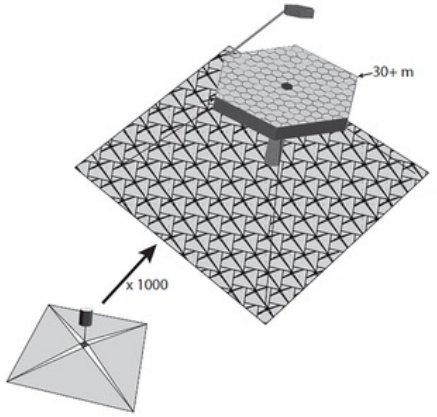


Figure 1: Graphic depiction of Modular Active Self-Assembling Space Telescope Swarms from NASA **(Credit: D. Savranasky)**

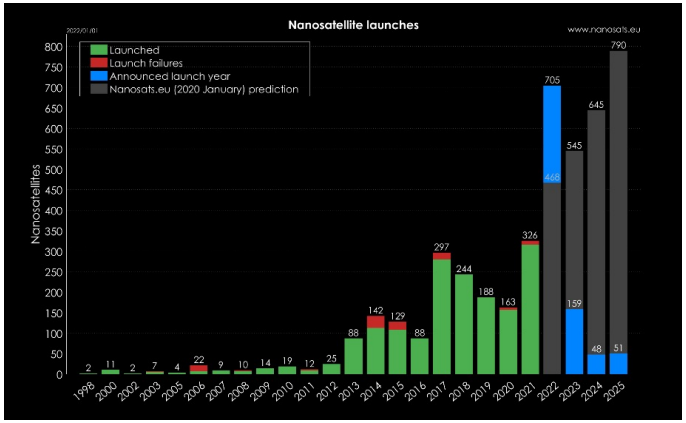


Figure 2: CubeSats lunched history and future prediction **(Credit: Nanosat.eu)**

Related Work

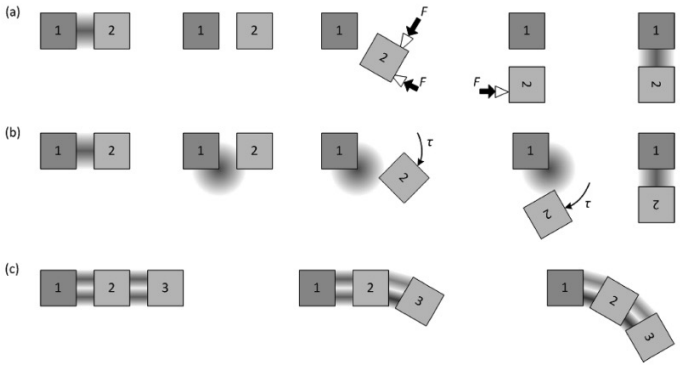


Figure 3: Example configurations **(Shoer & Peck, 2009)**

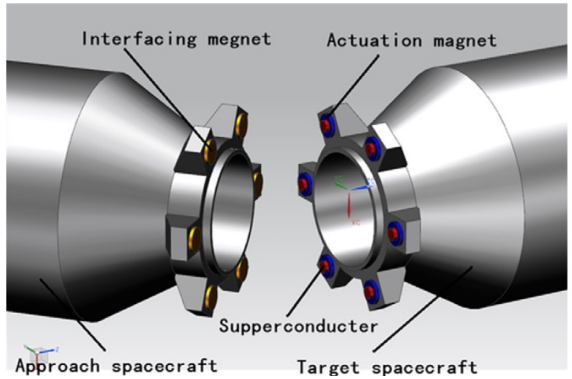


Figure 4: A non-contacting spacecraft docking configuration using superconducting interface modules **(Yang et al., 2012)**

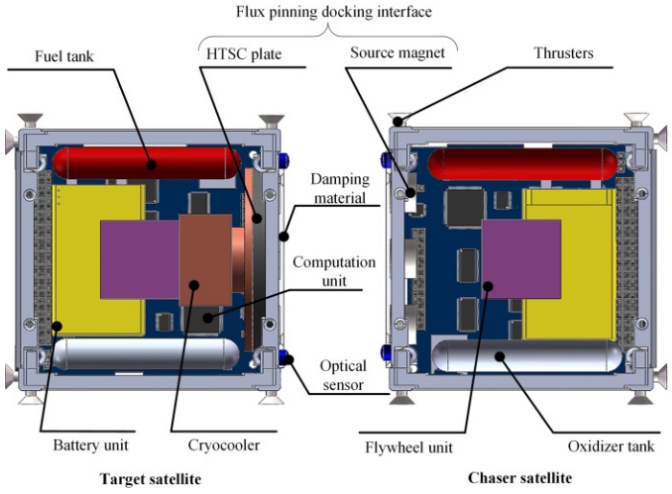


Figure 5: The configuration of FPDI on two satellites **(Yang et al., 2018)**

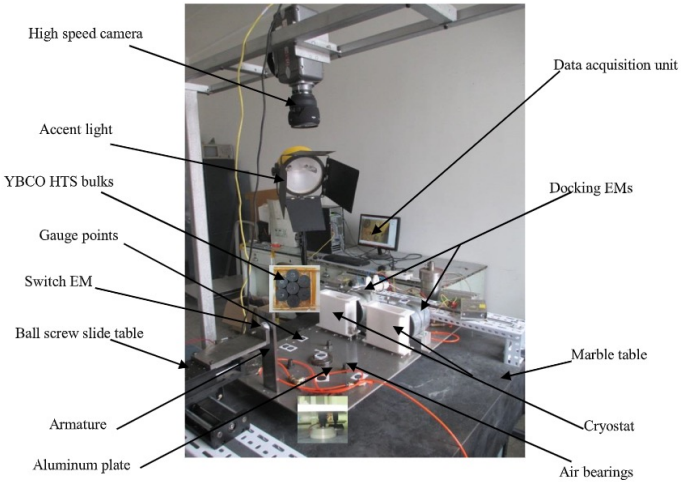
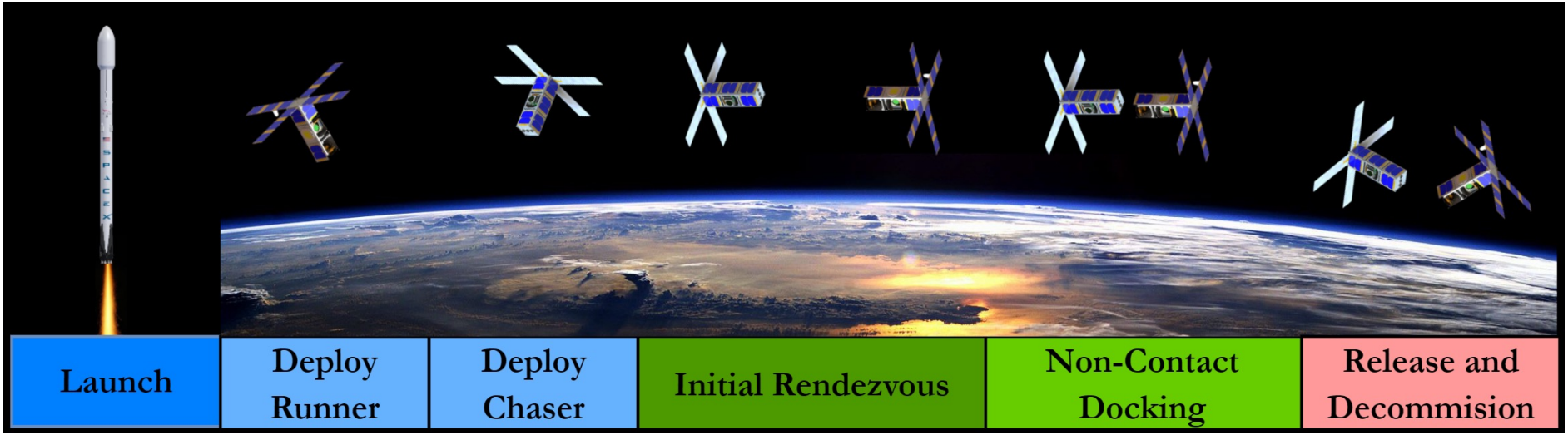


Figure 6: Simulated Docking Experimental Platform (SDEP) (3DOF) **(Zhang et al., 2019)**

Objectives

- Need algorithms to manage morphing
- Rendezvous, Dock, Release of two or more 3U CubeSats in Low Earth Orbit (LEO)
- Limit Electromagnetic Interferences (EMI) within spacecrafts



Challenges

- **Electromagnetic Interference (EMI)**
- **Flux-Pinning Docked Interfaces (FPDI) takes more time to reach equilibrium state**
- **Actuation – Need to cool down the superconductor to very low temperatures (50 – 80 K)**

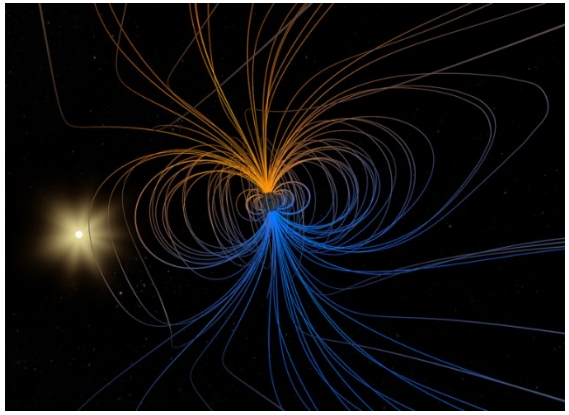


Figure 7: Earth's gravitational field **(Sadiku, 1989)**

Figure 8: Egg Cryptoconservation in N_2

Concept of Operations

Flux Pinning

- What are the physics that enable quantum locking?
- How does the "pinning" happen?

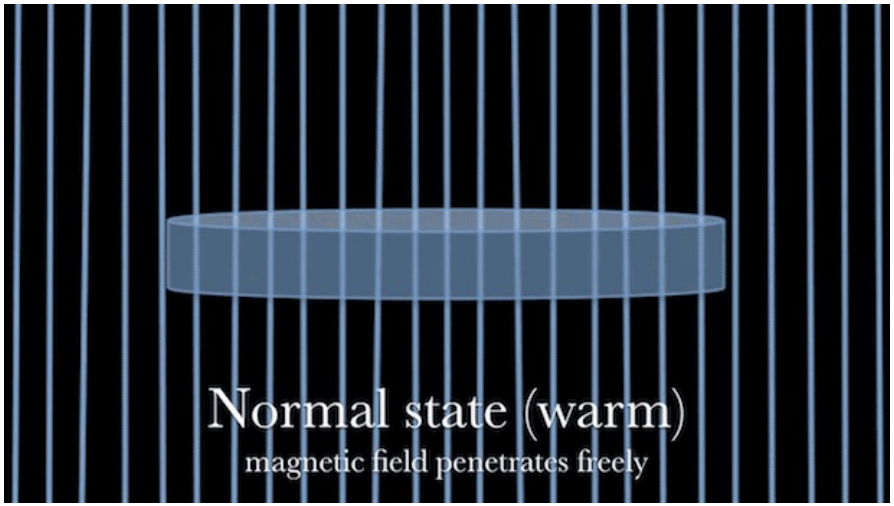
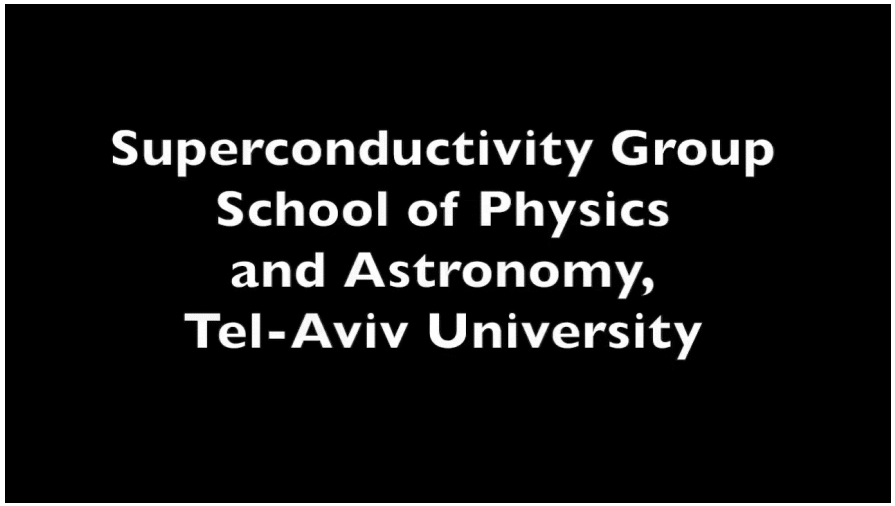


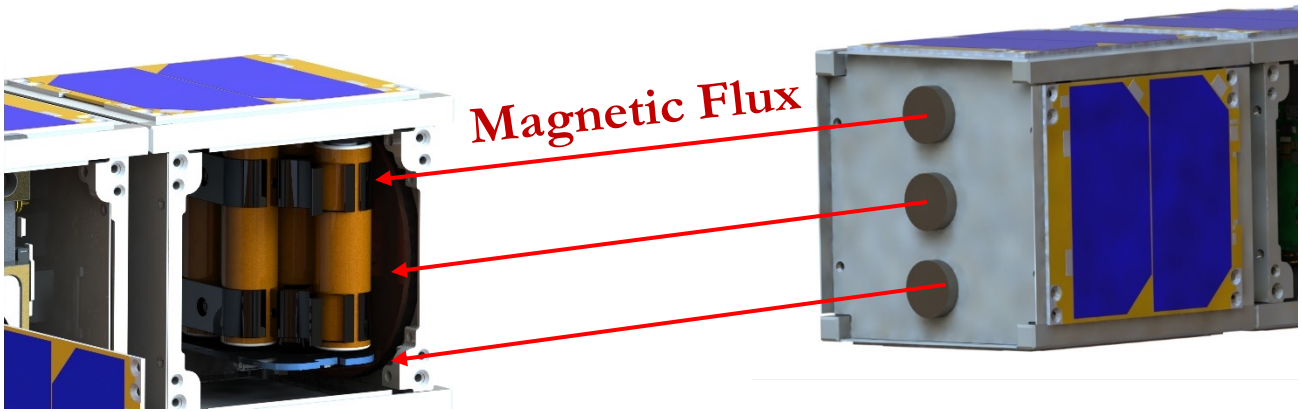
Figure 9: Stages of Flux-Pinning



Magnetic levitation demo **(Credits: Tel-Aviv University, 2011)**

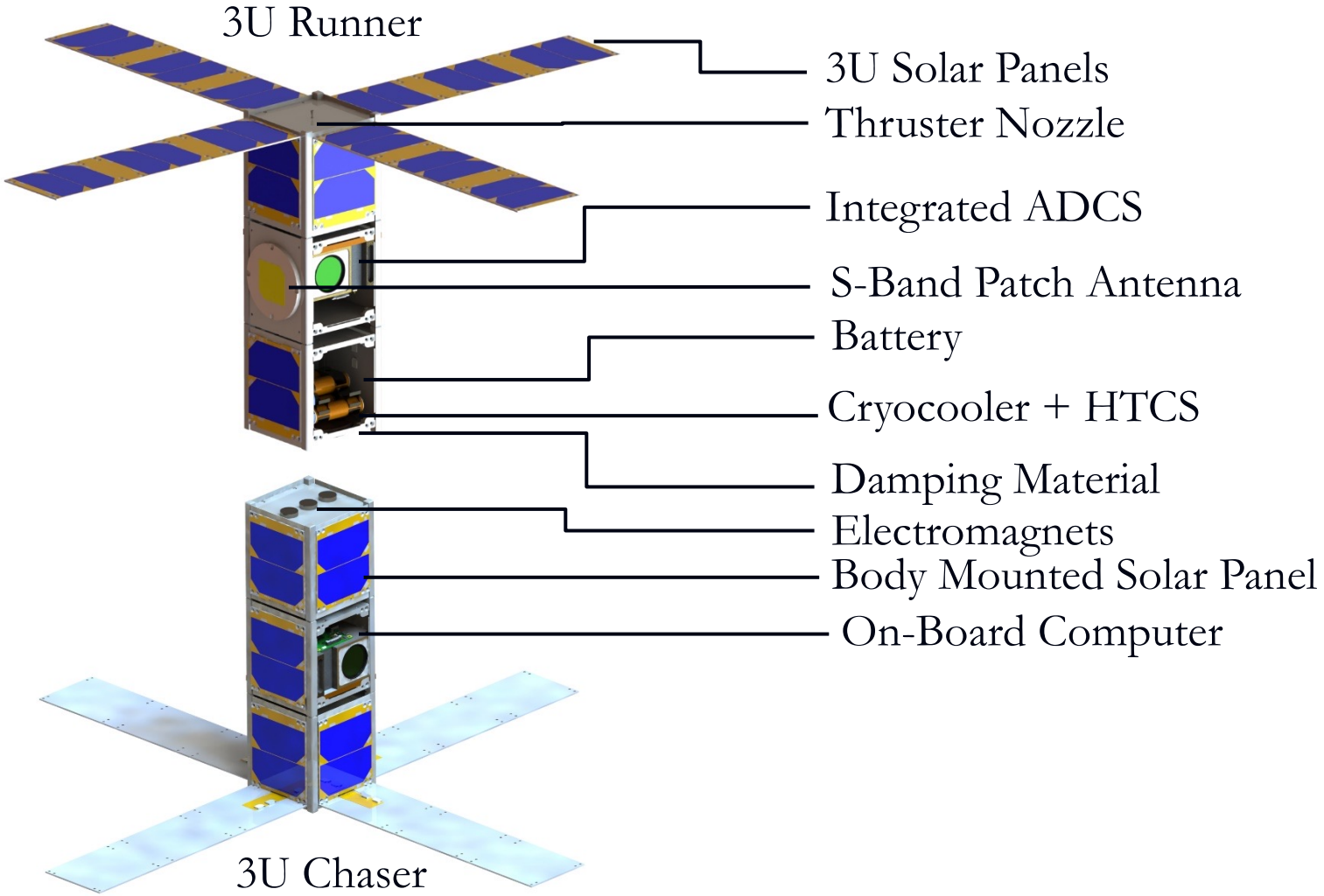
Methodology

- Perform initial rendezvous with “lighting cues”
- HTSC is cooled below its critical temperature (N_2 or cryocooler)
- EM controls interaction between chaser and runner



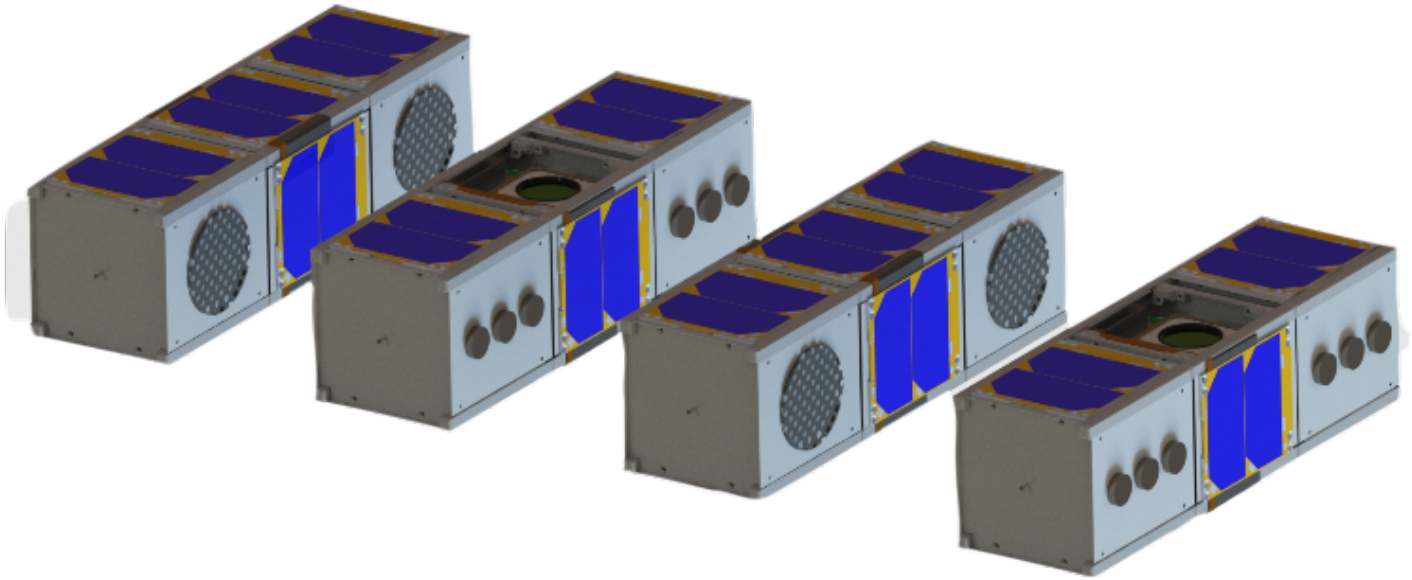
Runner Chaser

Methodology



Conclusion & Future Work

- Early-stage development for sizing, system design
- Flux-pinning can lead to new levels of non-contact interactions between spacecrafts
- Vast range of applications possible – lunar ark storage?



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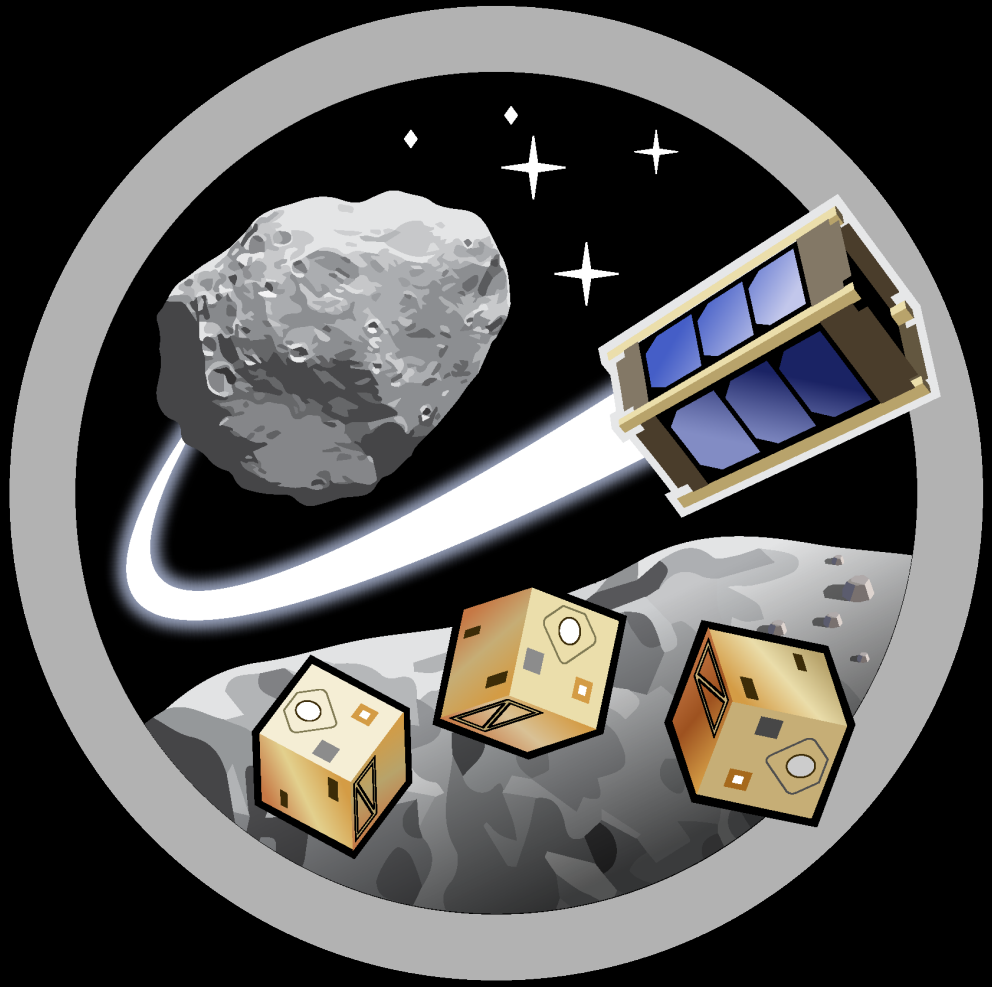

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