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COEP Satellite Initiative



Solar Panel Deployment Mechanism for a Solar Sailing Nanosatellite

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Introduction



- Current Mission Objectives:
 1. To demonstrate the concept of orbit maneuvering using solar sails.
 2. Characterization of charged particle environment with position.
- Necessity of Solar Panels Deployment Mechanism:
 1. Solar sails prevent the sunlight reaching the satellite faces behind it.
 2. Maximum three faces can be facing the sun.
 3. This limits the number of solar cells facing the sun thus limiting the power generation.
 4. Volume constraints in the launch vehicle demands for foldable panels.



Research Questions and literature review



- Currently available mechanisms:
 1. Provide only deployment with no locking.
 2. Provide deployment with active locking (more power consumption).
- The mechanism presented uses passive means for deployment as well as locking.
- The mechanism uses power only for the initiation of the deployment.

Present Mechanism

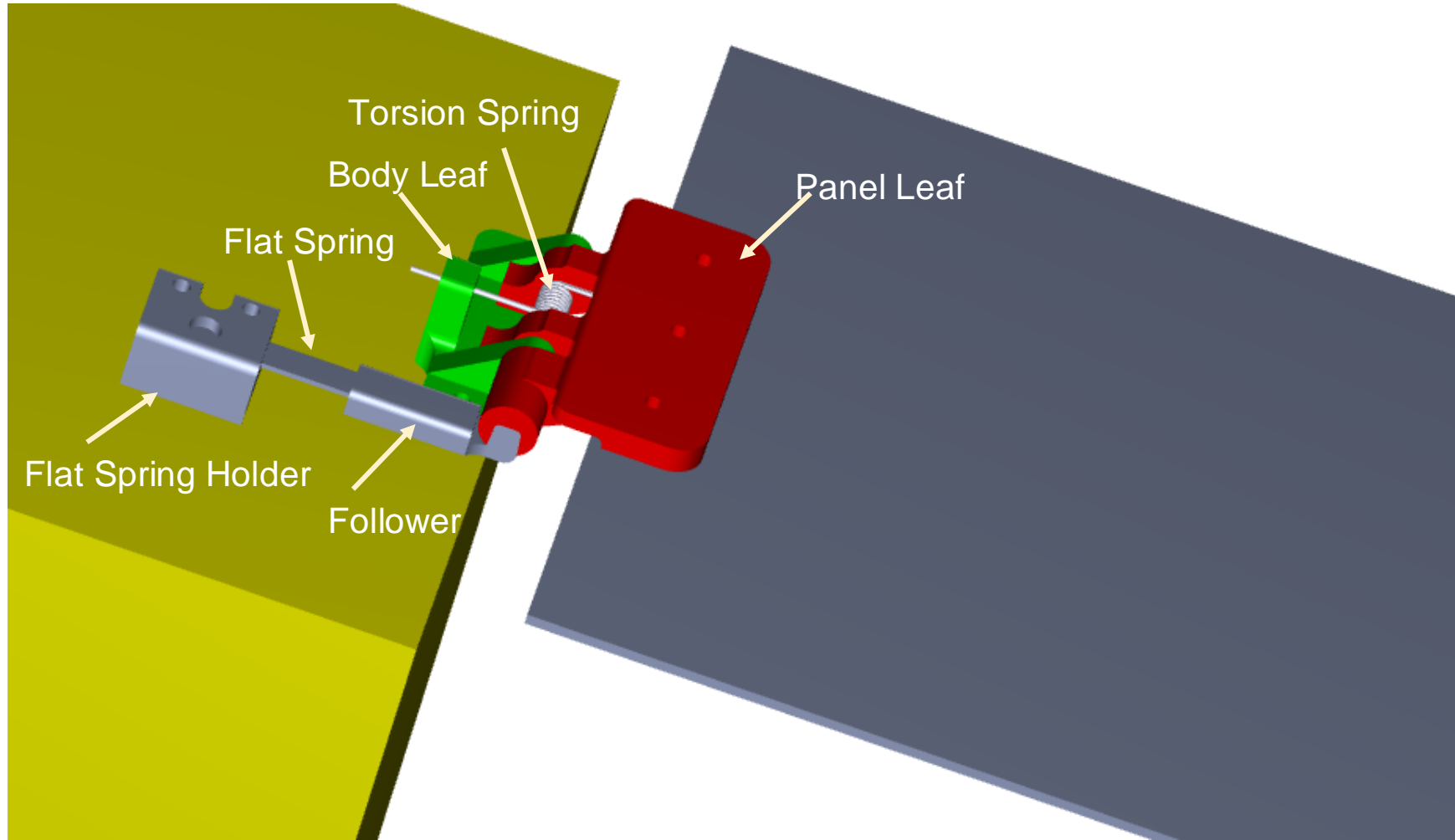


Fig.1 Creo of the Mechanism

Parts of the current SPD mechanism

Hinge Assembly:

Body Leaf

Panel Leaf

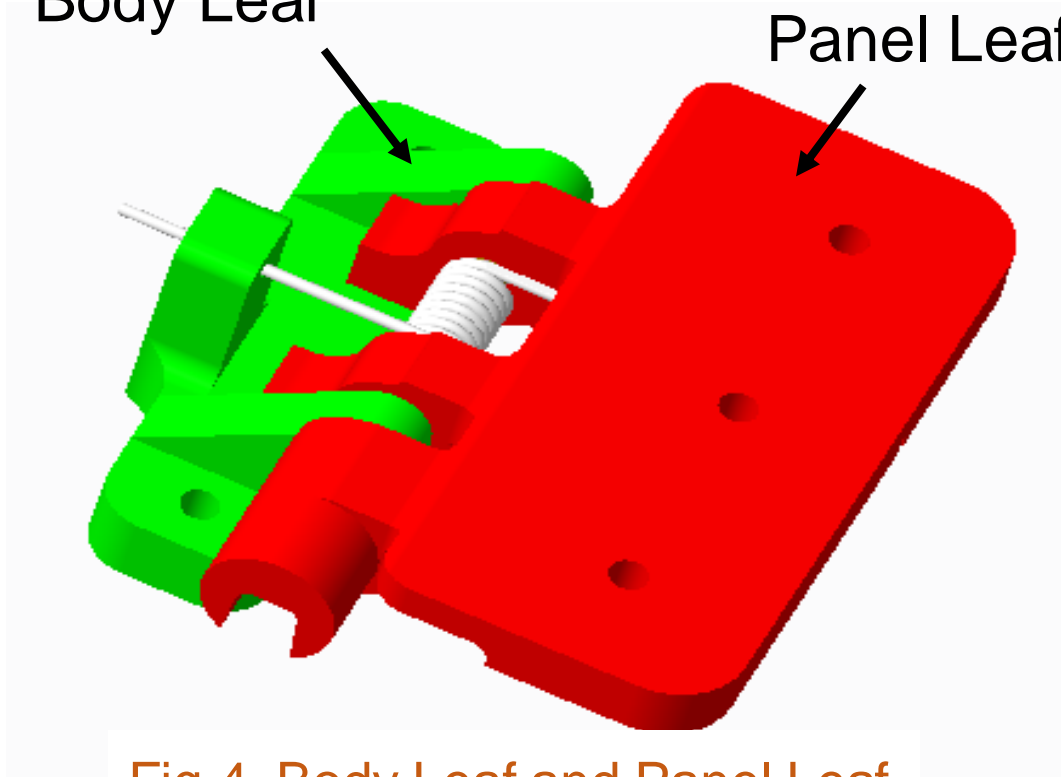


Fig.4. Body Leaf and Panel Leaf

Pin

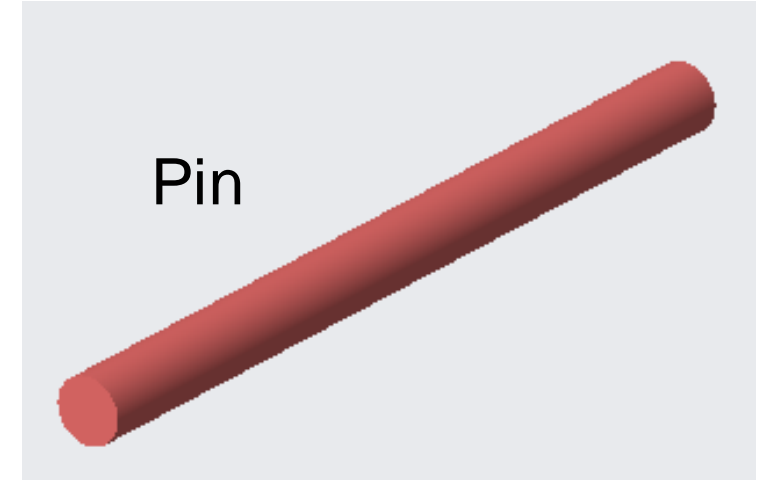
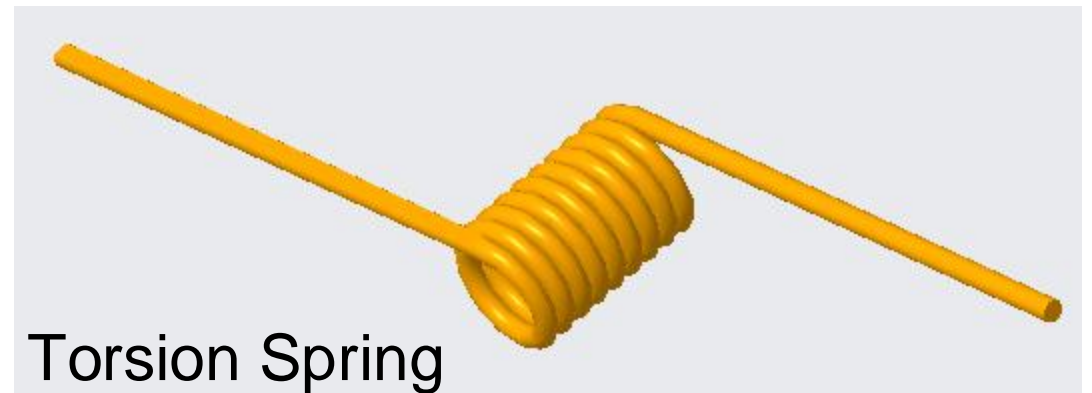


Fig.5. Pin



Torsion Spring

Fig.6. Torsion Spring

Parts of the current SPD mechanism

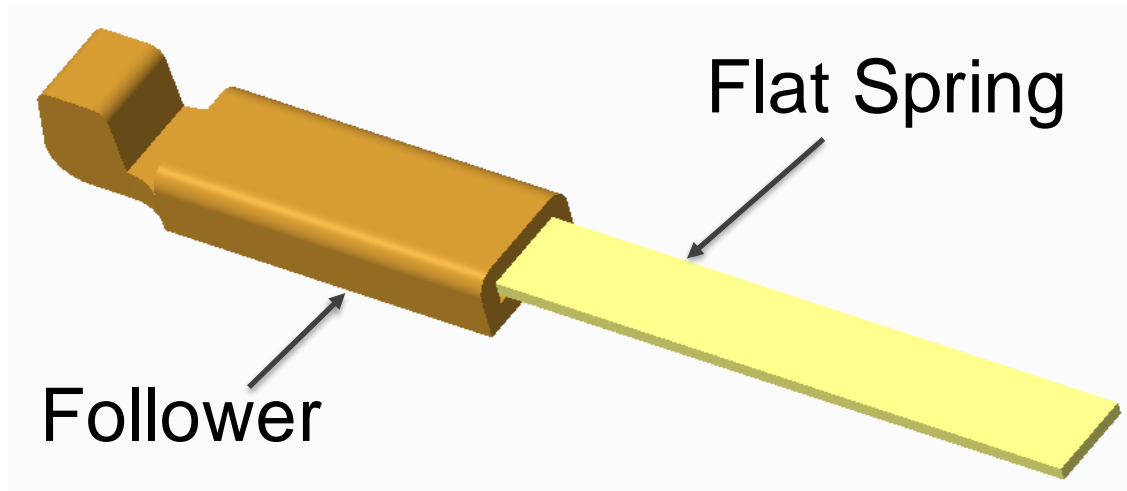


Fig.7. Flat Spring and Follower Assembly

Flat spring holder

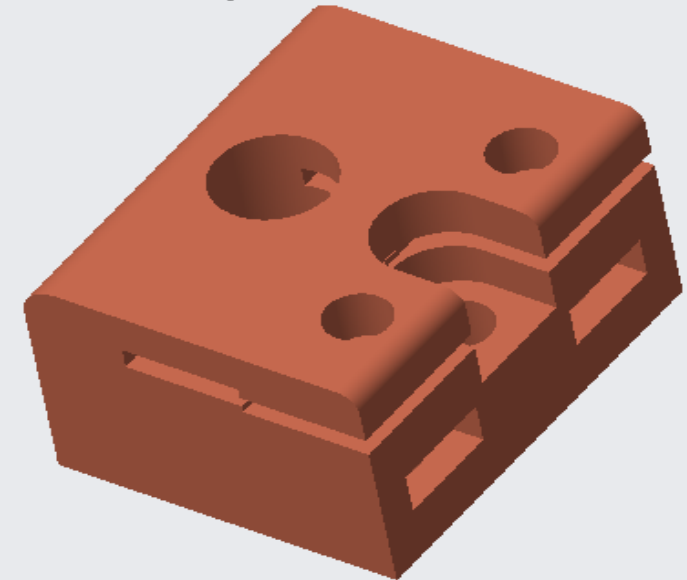


Fig.8. Flat Spring Holder

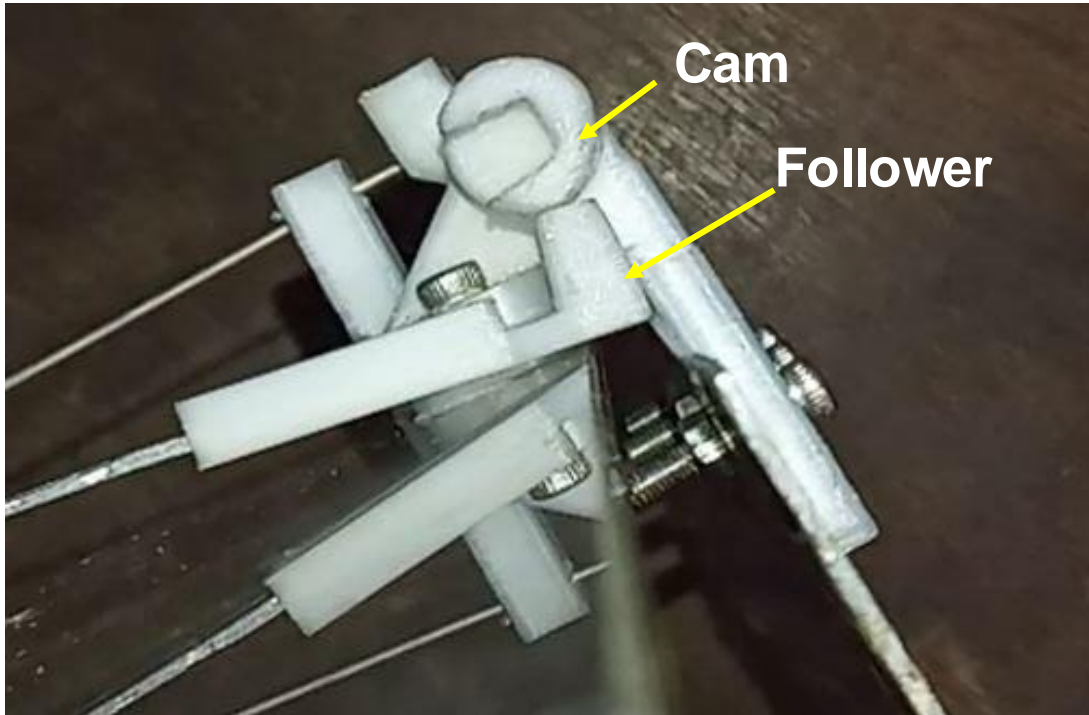


Fig.2. Mechanism in undeployed position

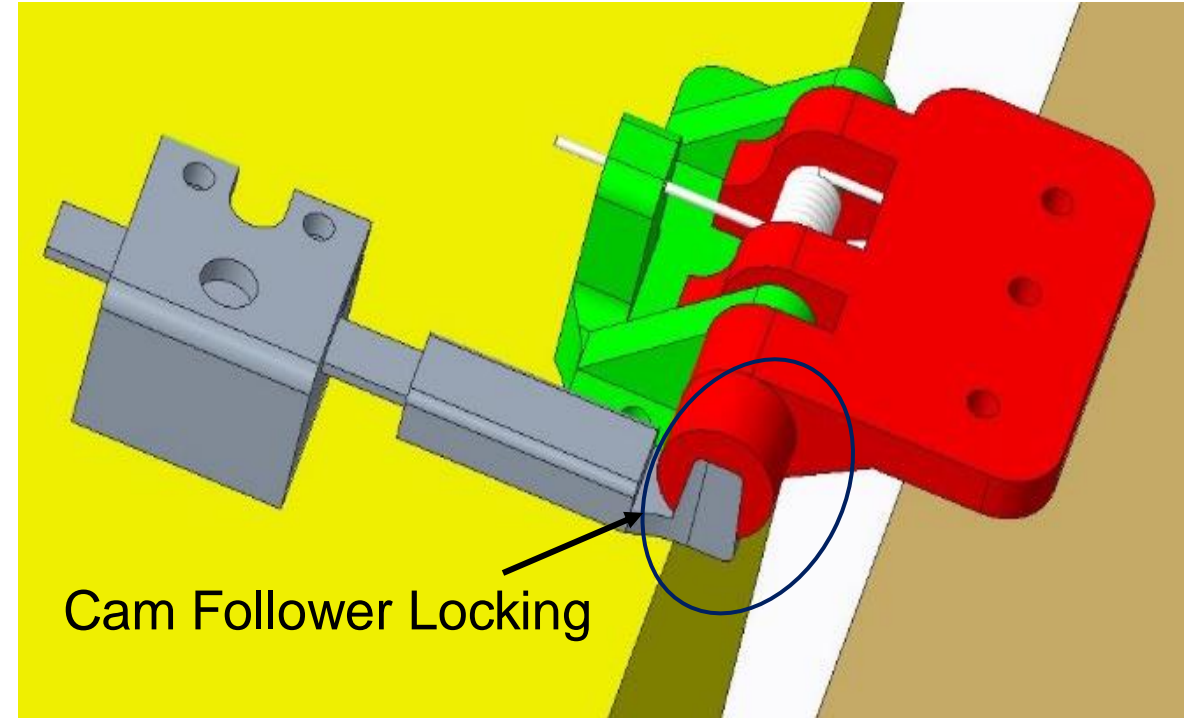


Fig.3. Mechanism in deployed and locked state



Torsion spring specifications:

- Torque needed for smooth deployment= **135 N-mm**

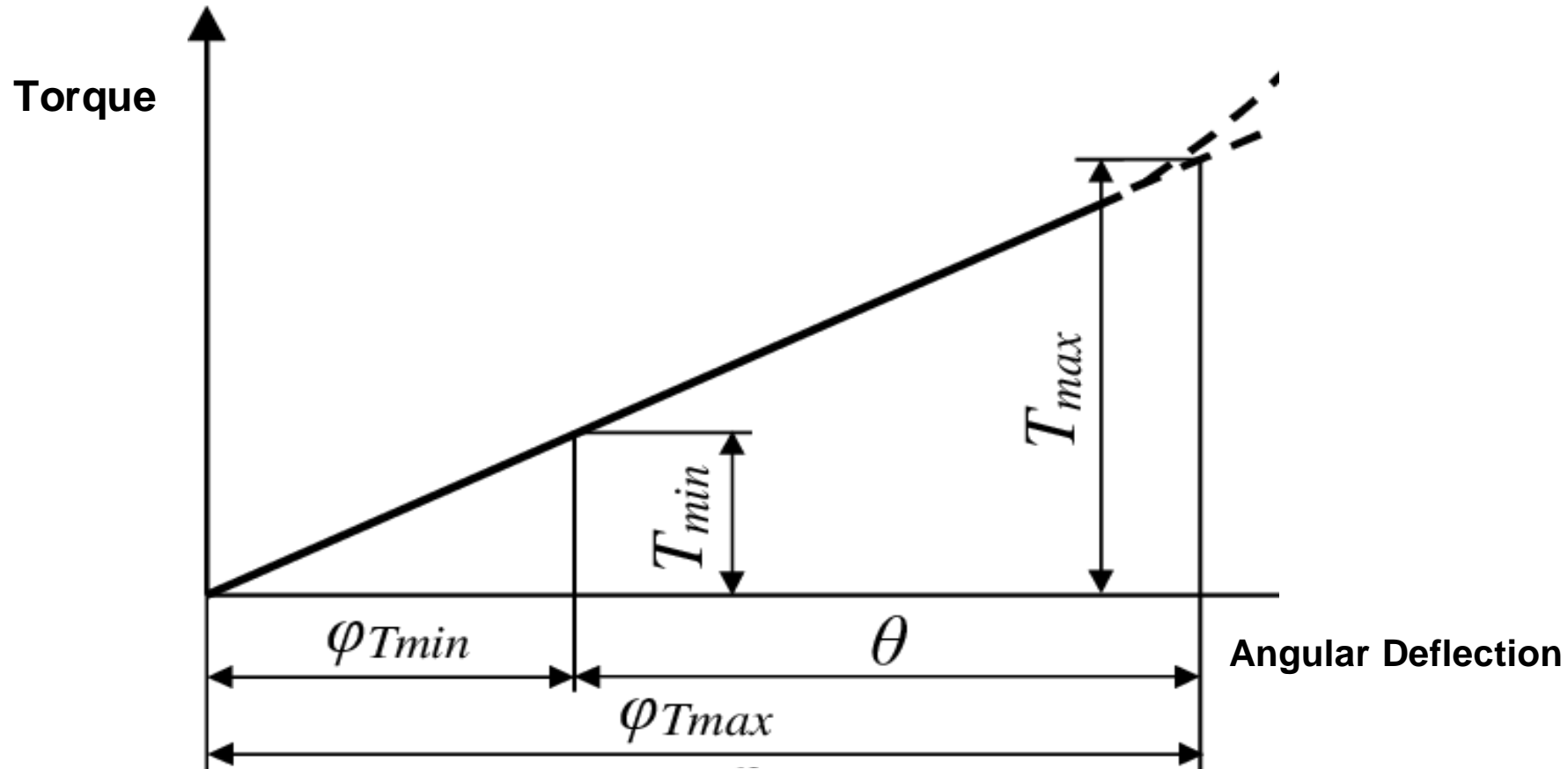


Fig.9. Torque vs. Deflection



Cam-Follower Locking:

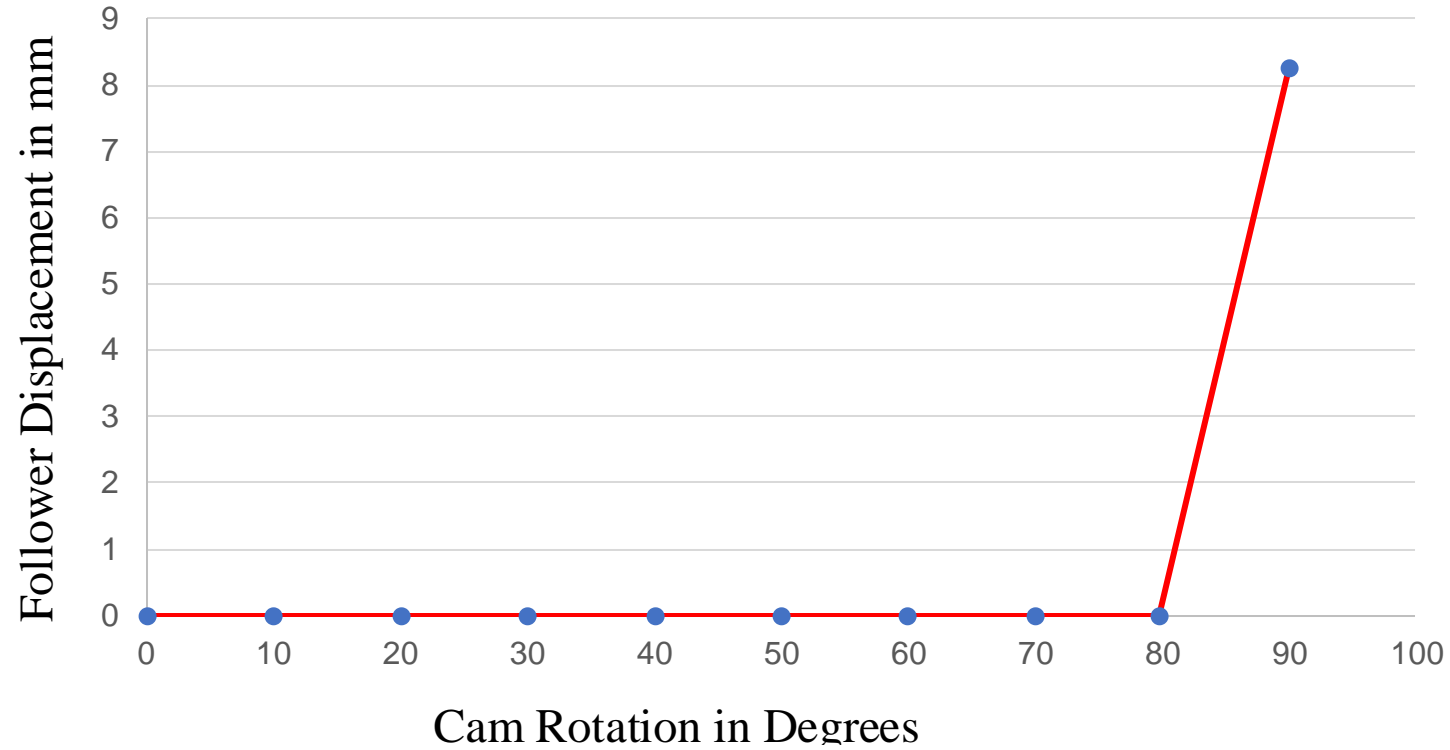


Fig.11. Follower displacement vs. Cam Rotation



Component details of SPD mechanism

- The parts of the mechanism have been made from ABS plastic using 3D printing.
- The maximum allowable deflection of the follower owing to height constraints of the satellite is around 8 mm to 9 mm. Flat spring is made of CFRP.
- Design of the torsion spring was carried out considering the space constraints.
- The material chosen for the torsion spring is stainless steel.



Conclusions

- The value of torque required for smooth deployment has been found to be 135 Nmm and has been verified experimentally.
- The stiffness of the torsion spring required for this purpose is thus 1.5 Nmm/degree .
- The maximum value of the locking force the system can provide is $40 \text{ N to } 50 \text{ N}$ and has been limited due to the space constraints on the upper face of the satellite.
- As the flat spring is made of composite (CFRP) and is under a constant deflection which might lead to the stress relaxation; but the extent to which stress relaxation will take place has to be explored before considering this as the limitation of the mechanism