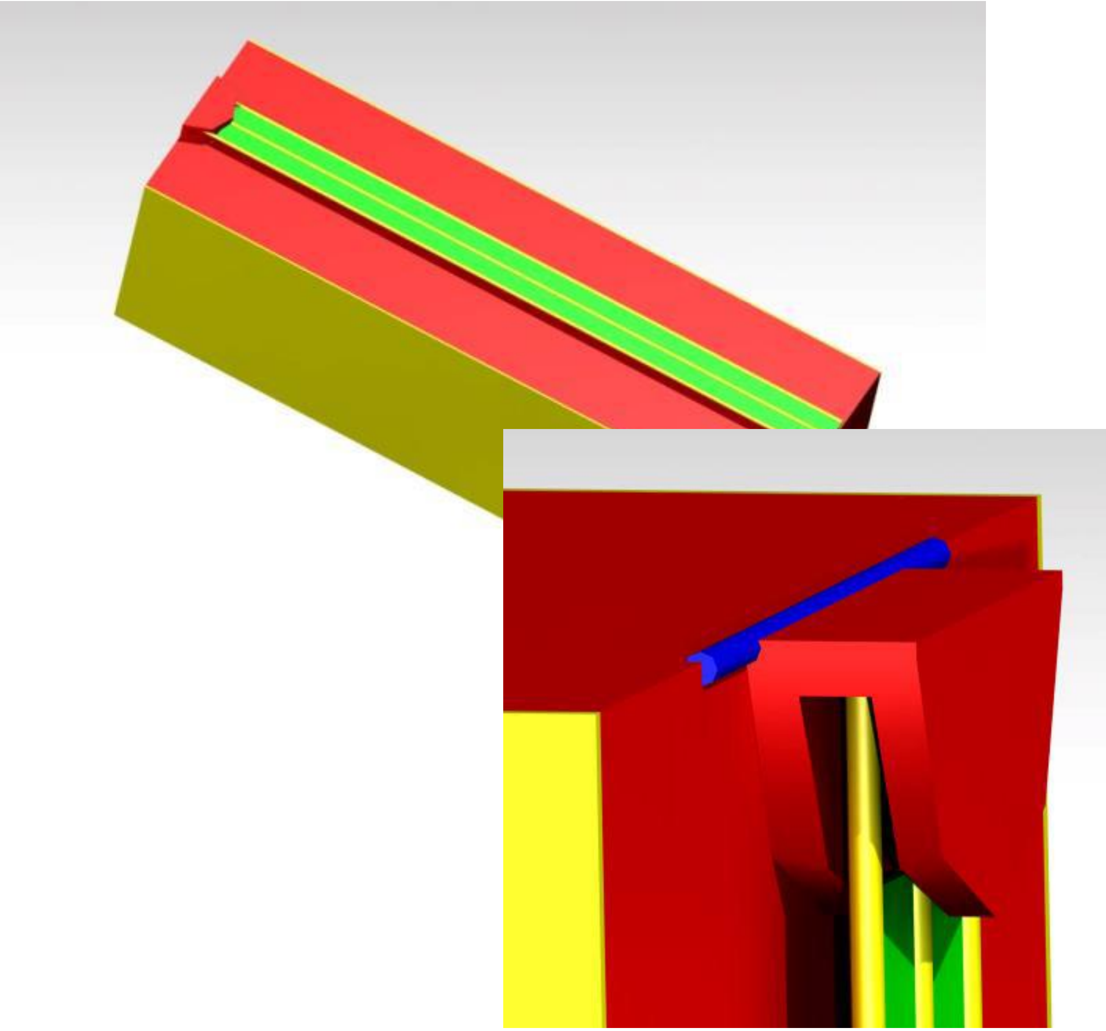
Space Fan: A Mechanical De-Orbiting Device System for Satellites

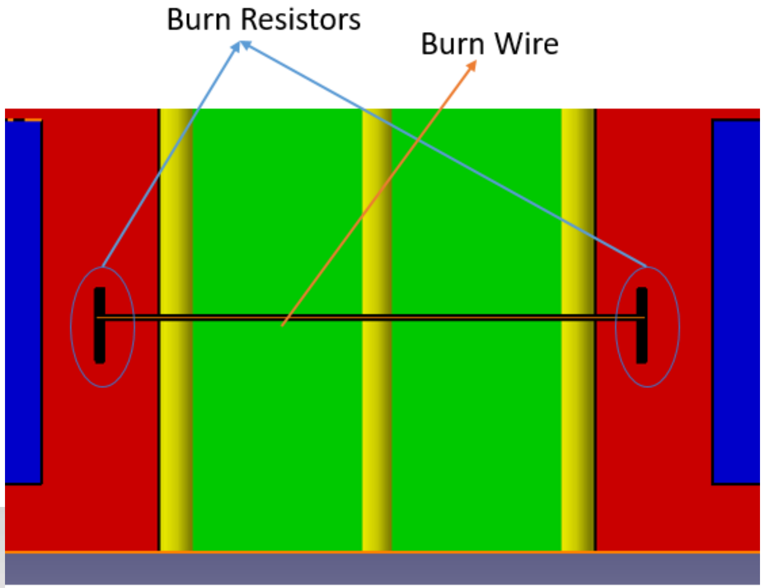
Mehmet Şevket Uludağ
Boğaç Karabulut

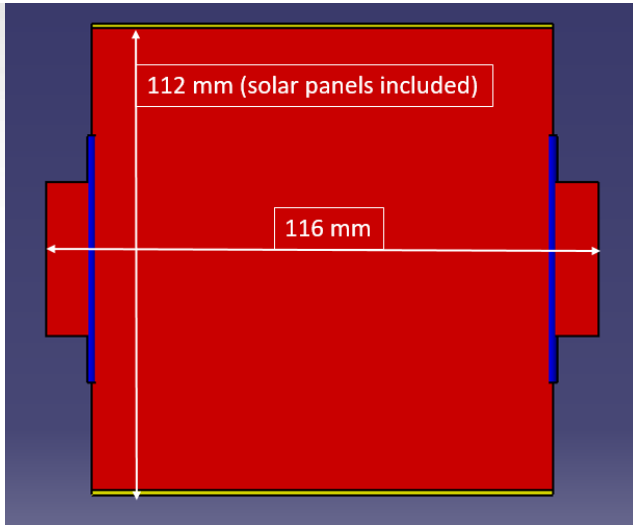
Istanbul Technical University

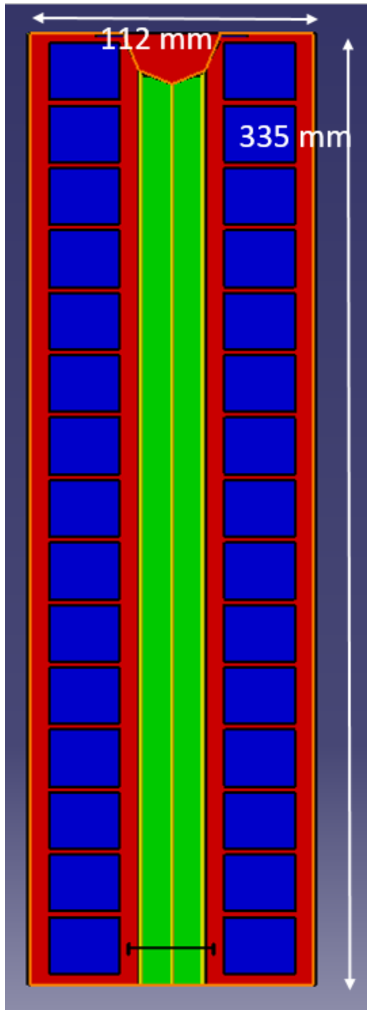
Soner Baloğlu
Barış Altun
Aeronautics and Space Technologies Institute

First Iteration

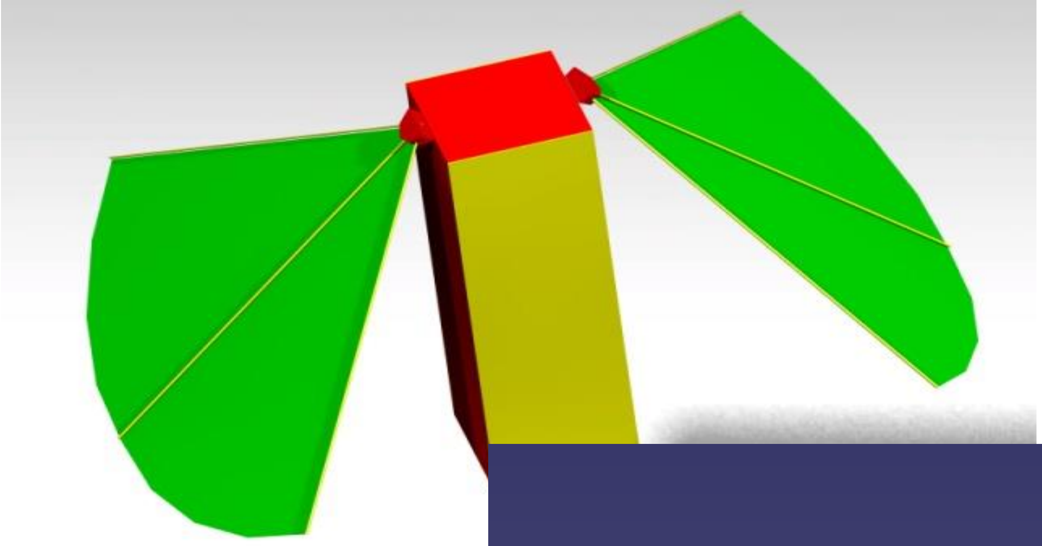


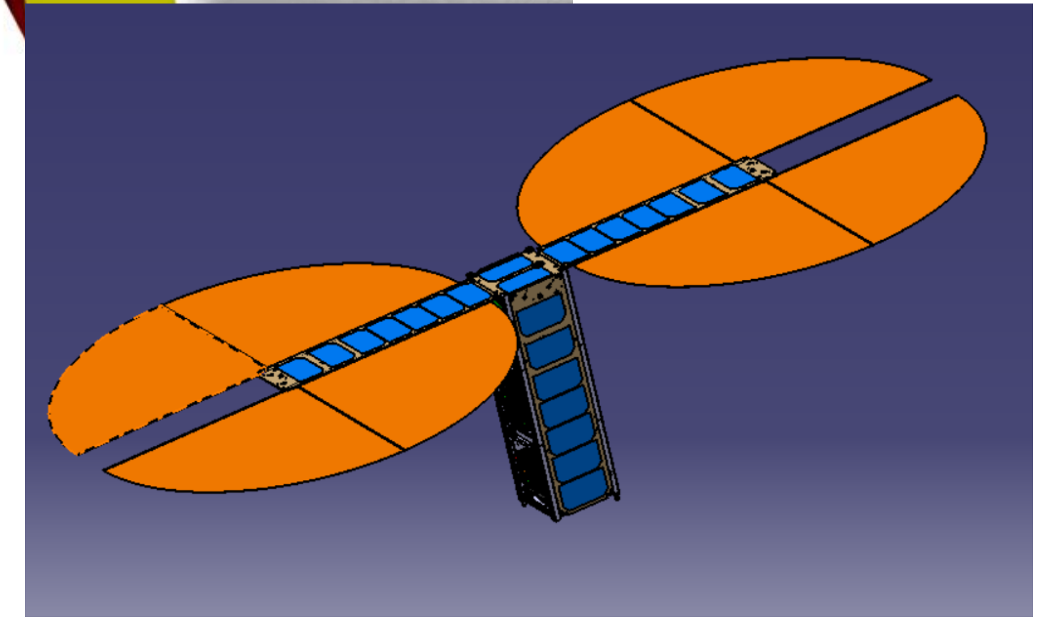






First Iteration



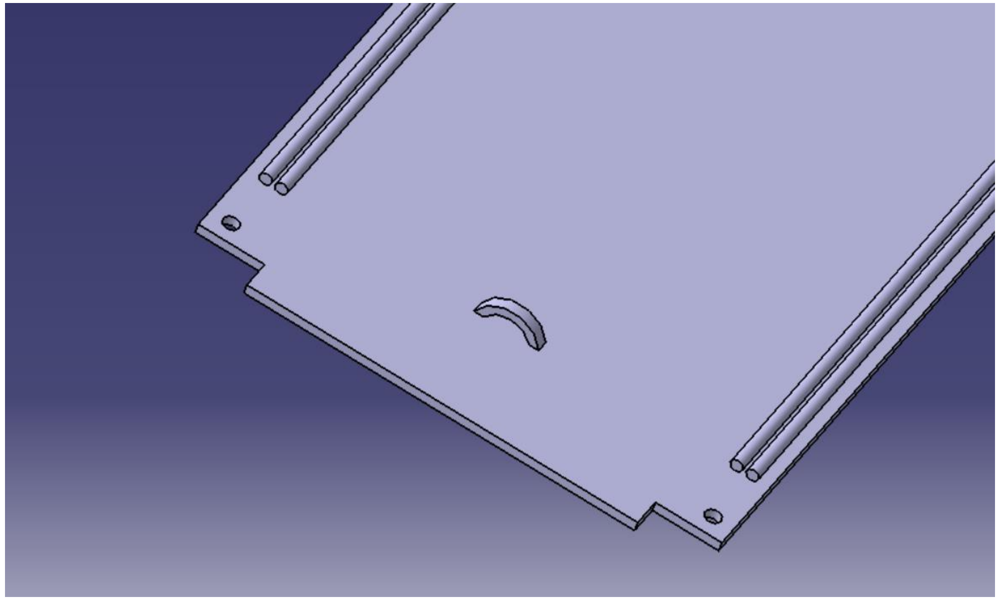


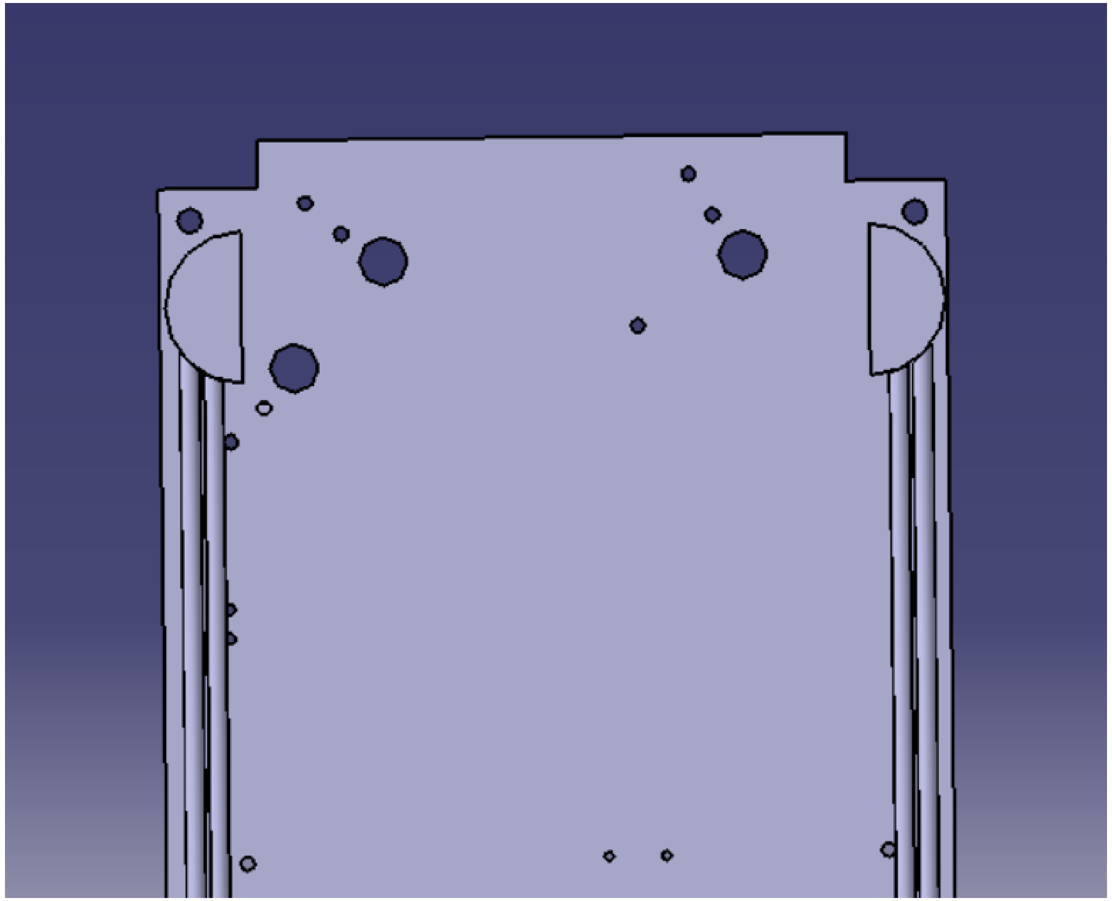
First Iteration performance Values
Area : 0,345 m^2
Satellite life time 560 days

New Design
Area : 0,6285 m^2
Satellite Lifetime : 504 days
Advantage : more solar psnels

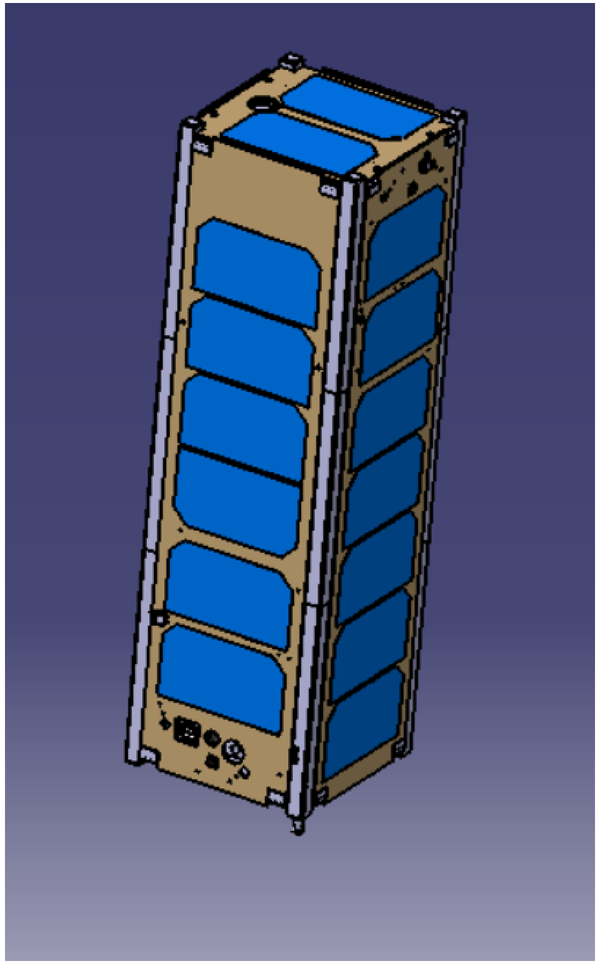
Deployment Mechanism

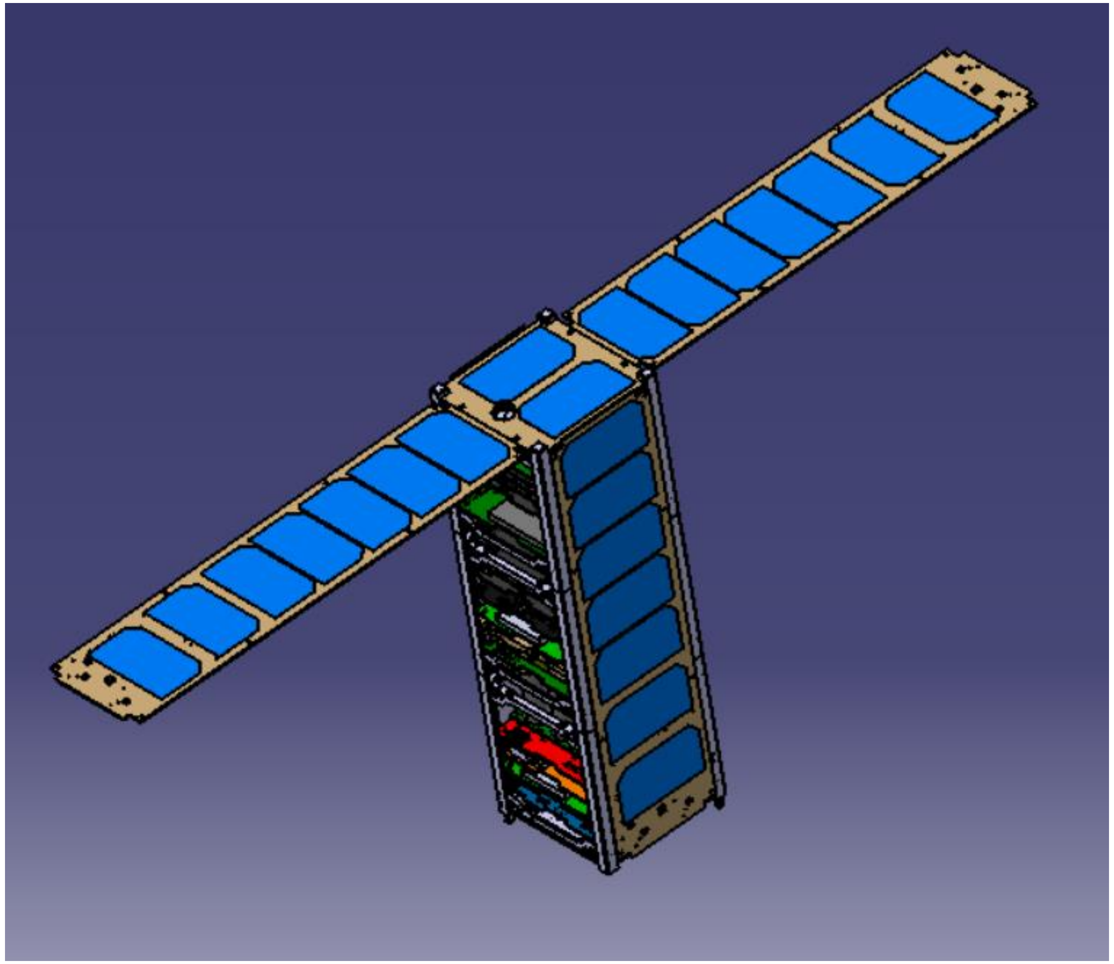
- Interface PCB
- Opening Contorl Switch
- Multiple springs
- 10 ohm, 5 V for 30 seconds, less then 50mW, 75 Joule



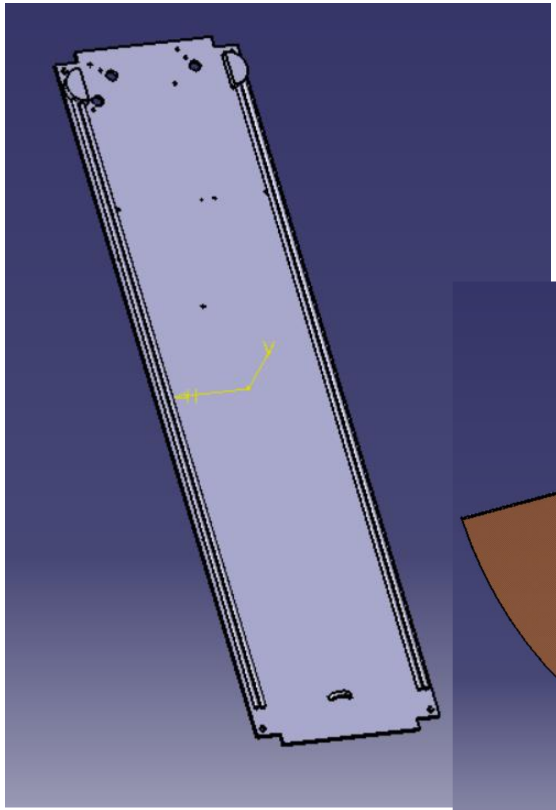


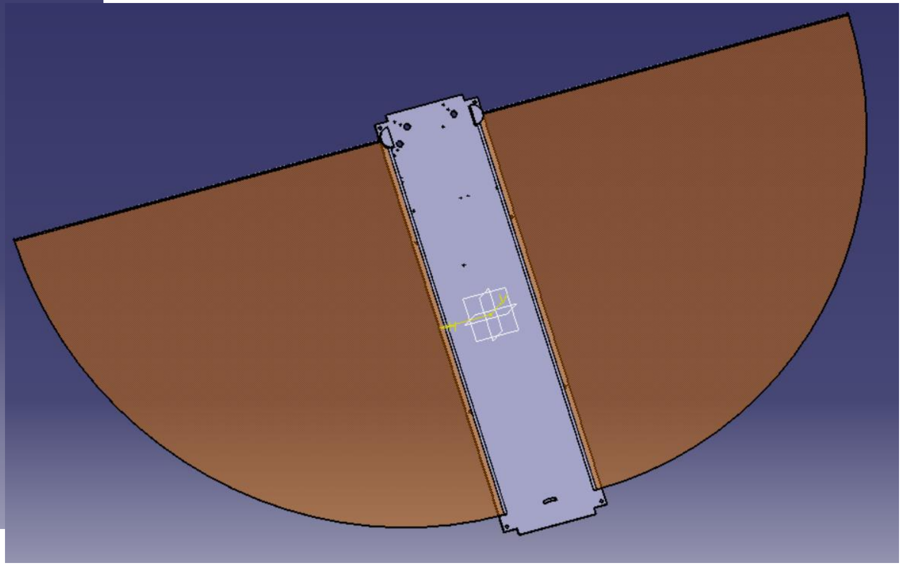
Opening Squence

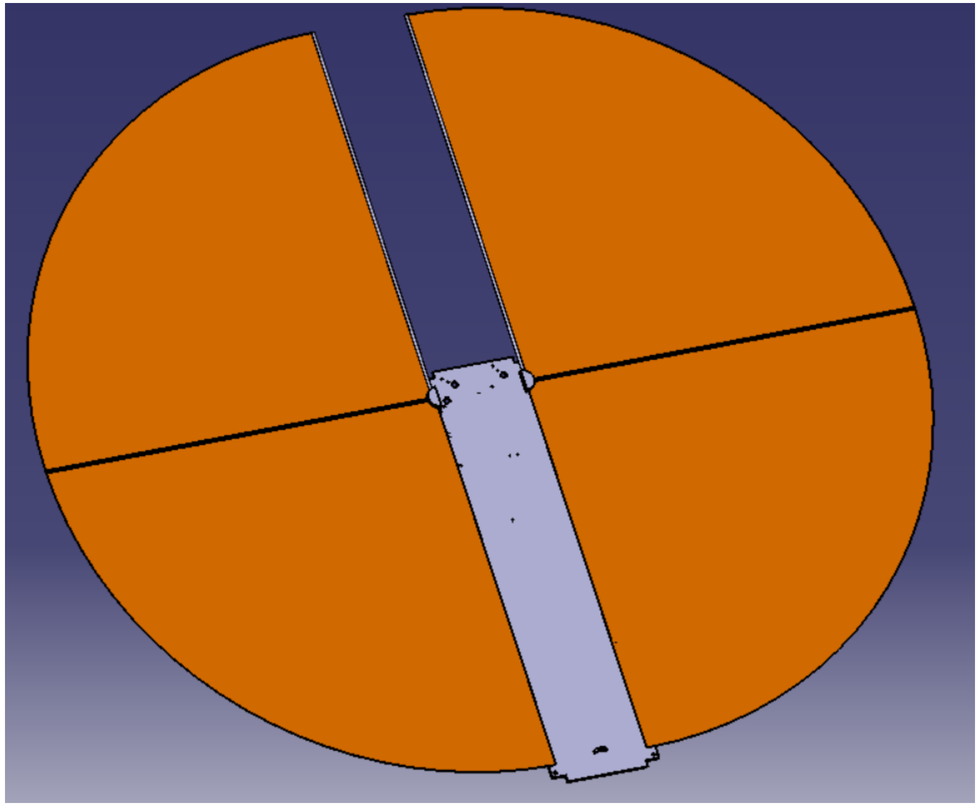




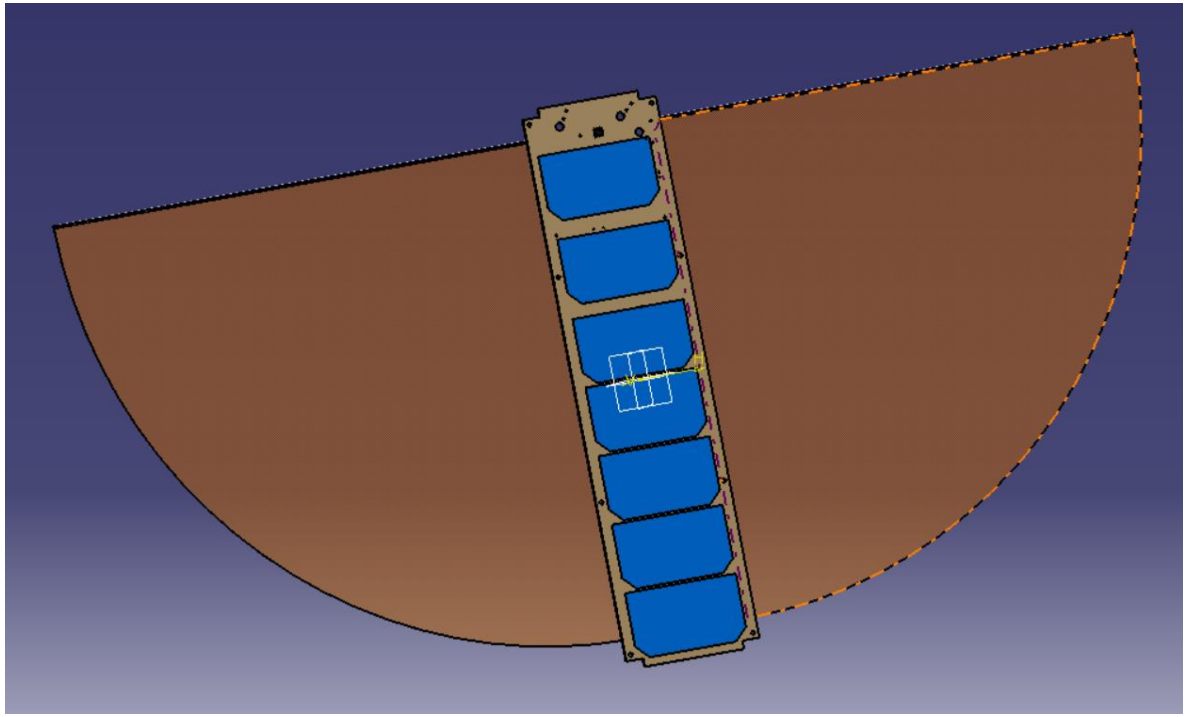
Opening Squence

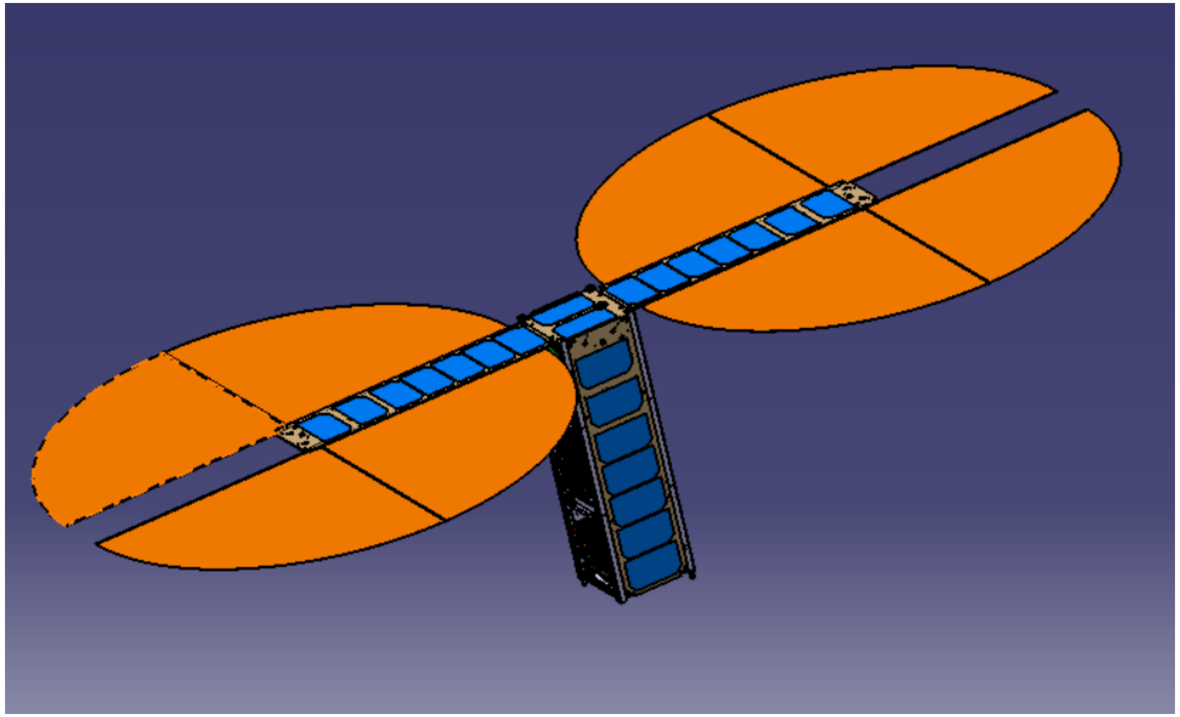






Opening Squence

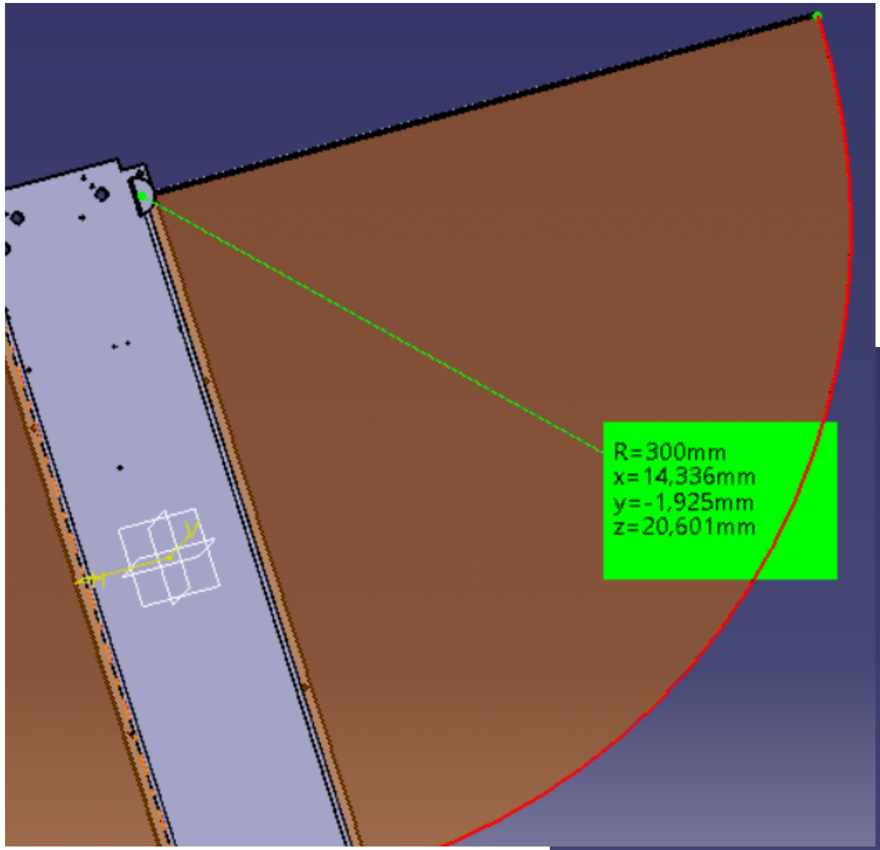


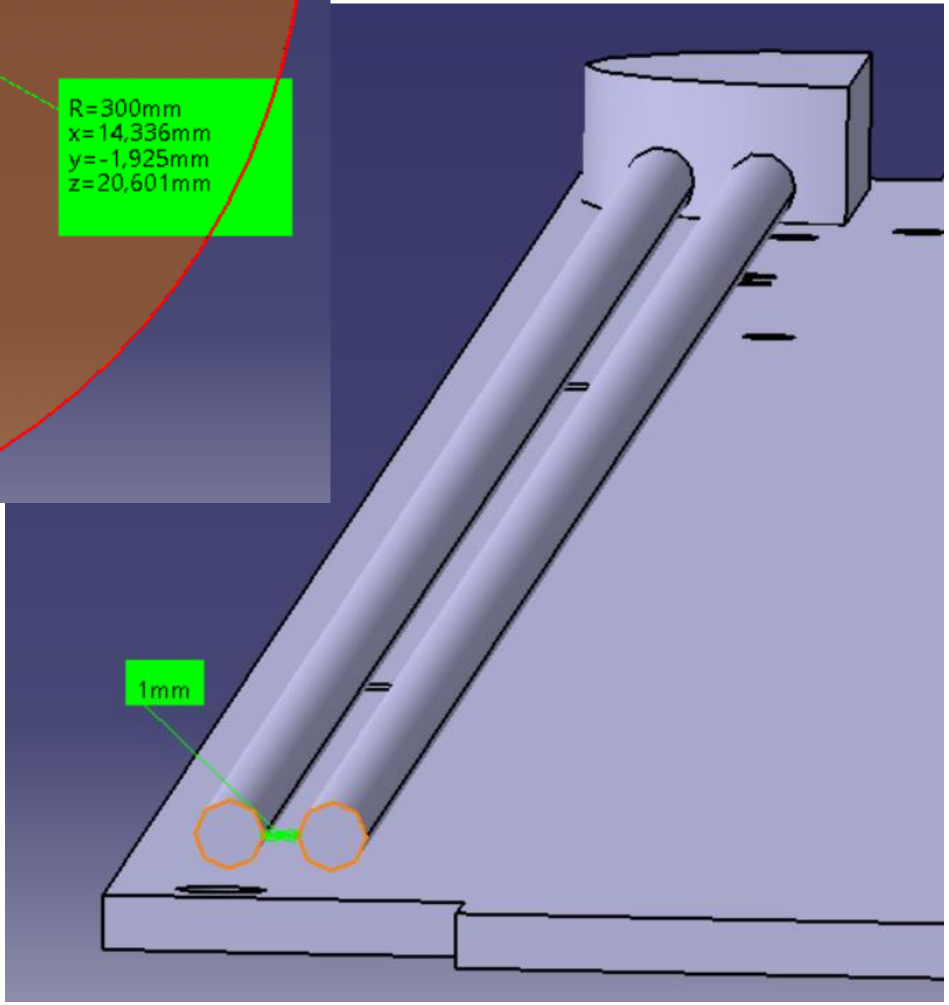


Folding of Sail

- Thickness of the kapton is 0.125 mm *
- Folding like hand fans

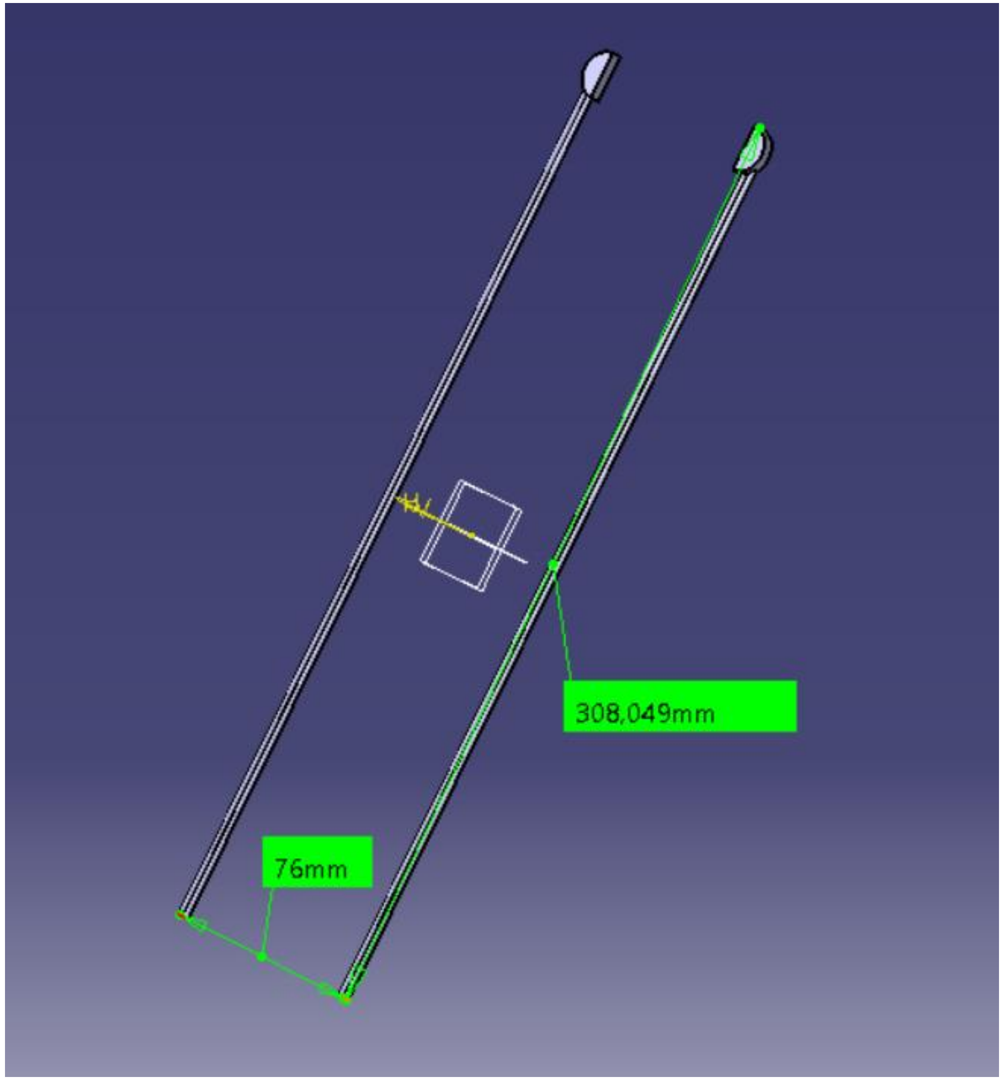
Radius	Circumference	Height of Folding	Folding Number	Total Folding Thickness
300	94,25	1,8	47,12	0,58

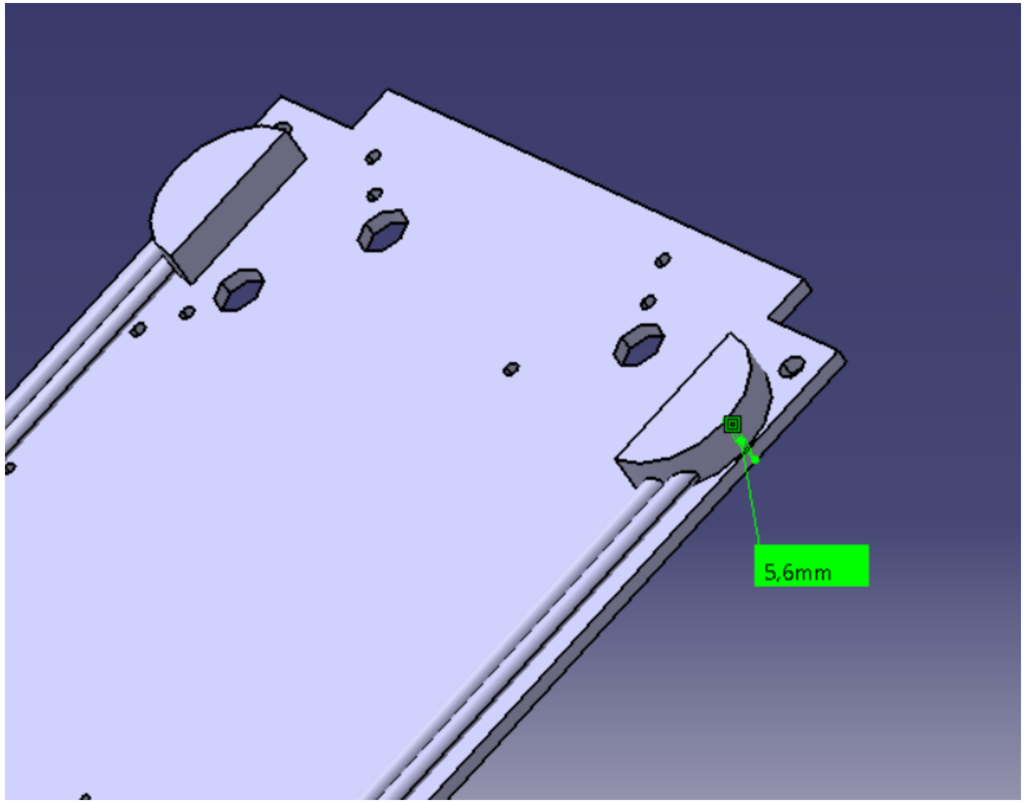




*http://www.dupont.com/content/dam/dupont/products-and-services/membranes-and-films/polyimde-films/documents/DEC-Kapton-general-specs.pdf

Mechanical Properities

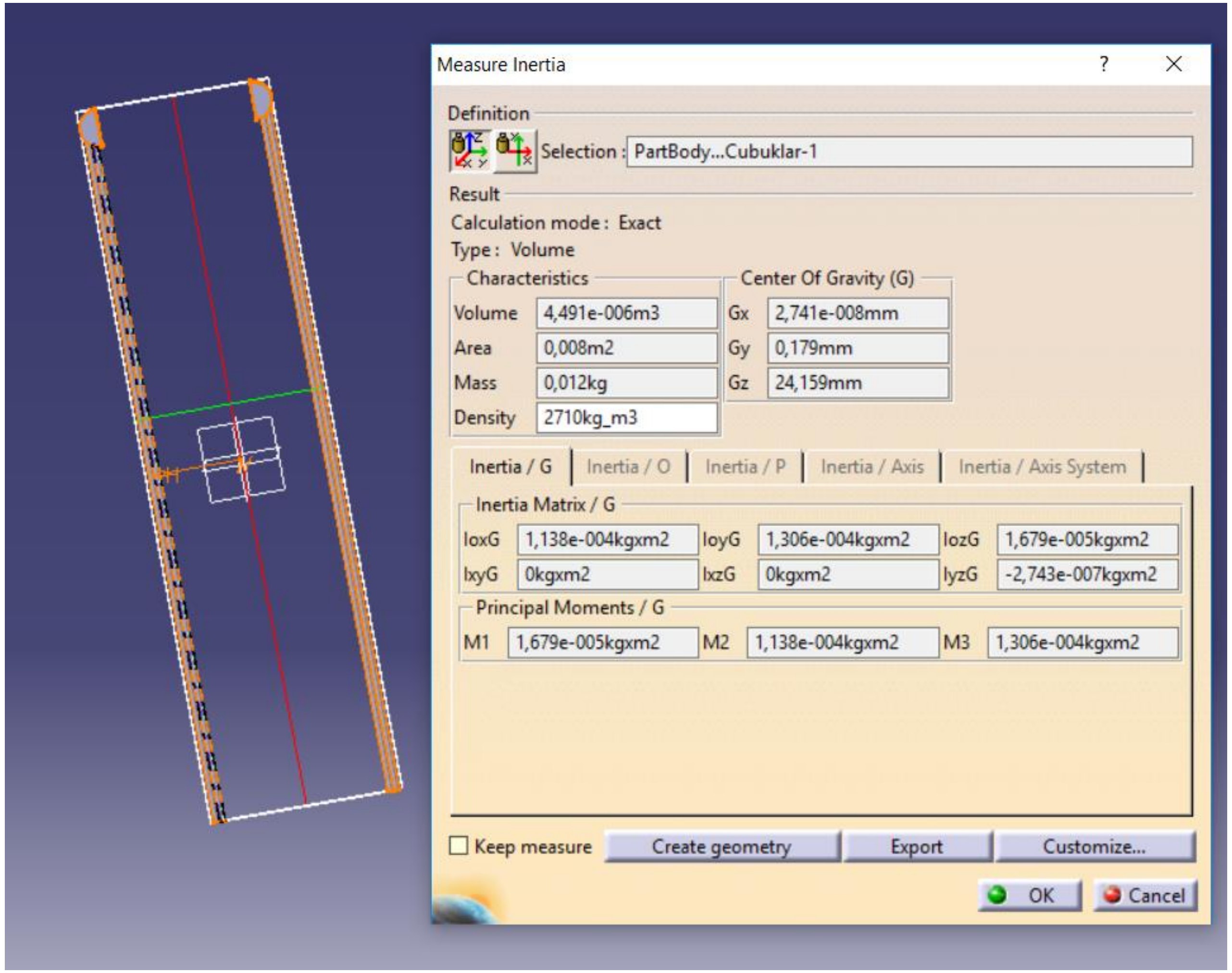




Mechanical Properities

- 12 grams for opening rots
- 10 grams for springs
- 8 grams Resistor + Kapton + Melting Wire

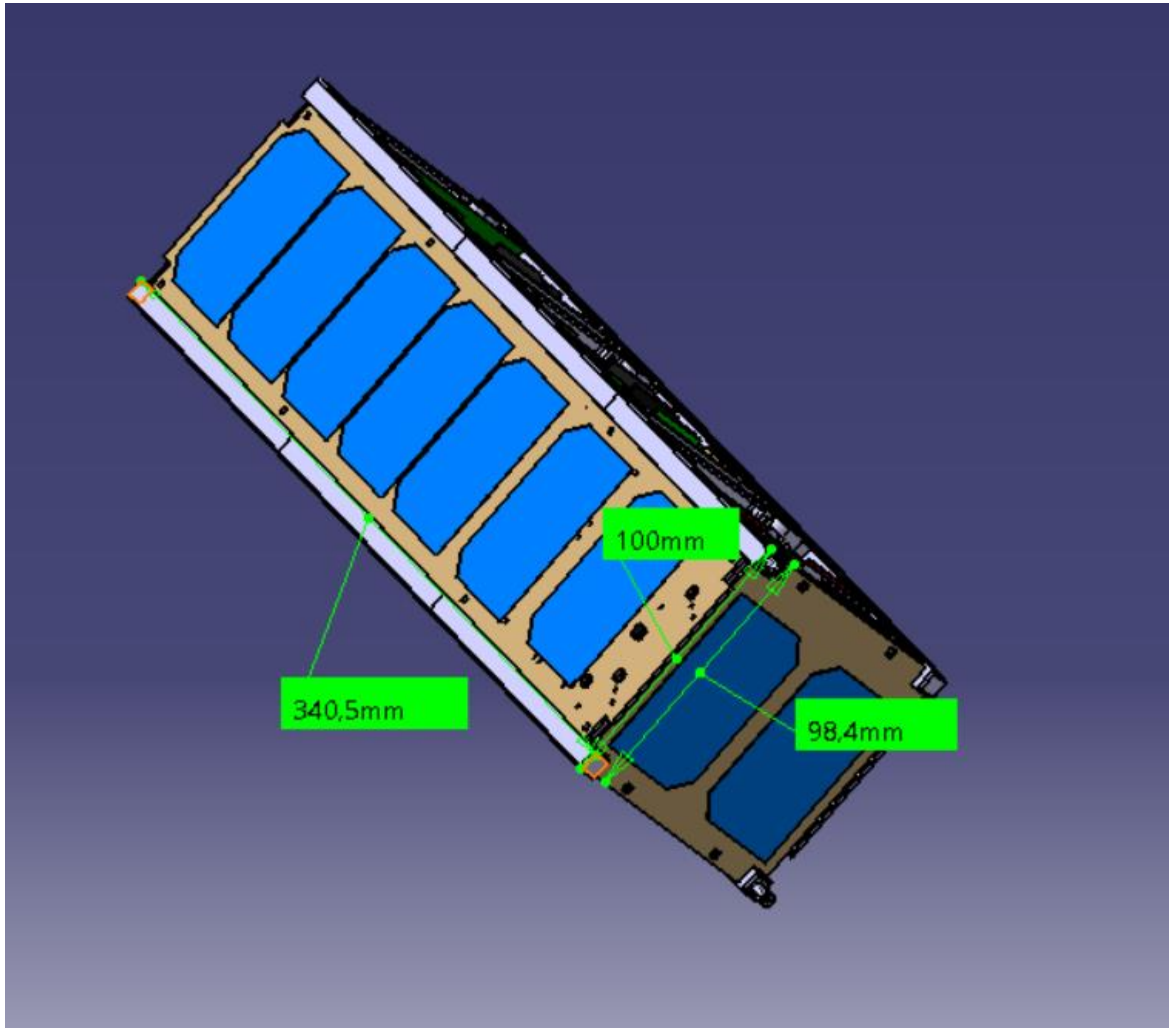
- Total Mass = 60 gr
- Cost 500 – 1000 $



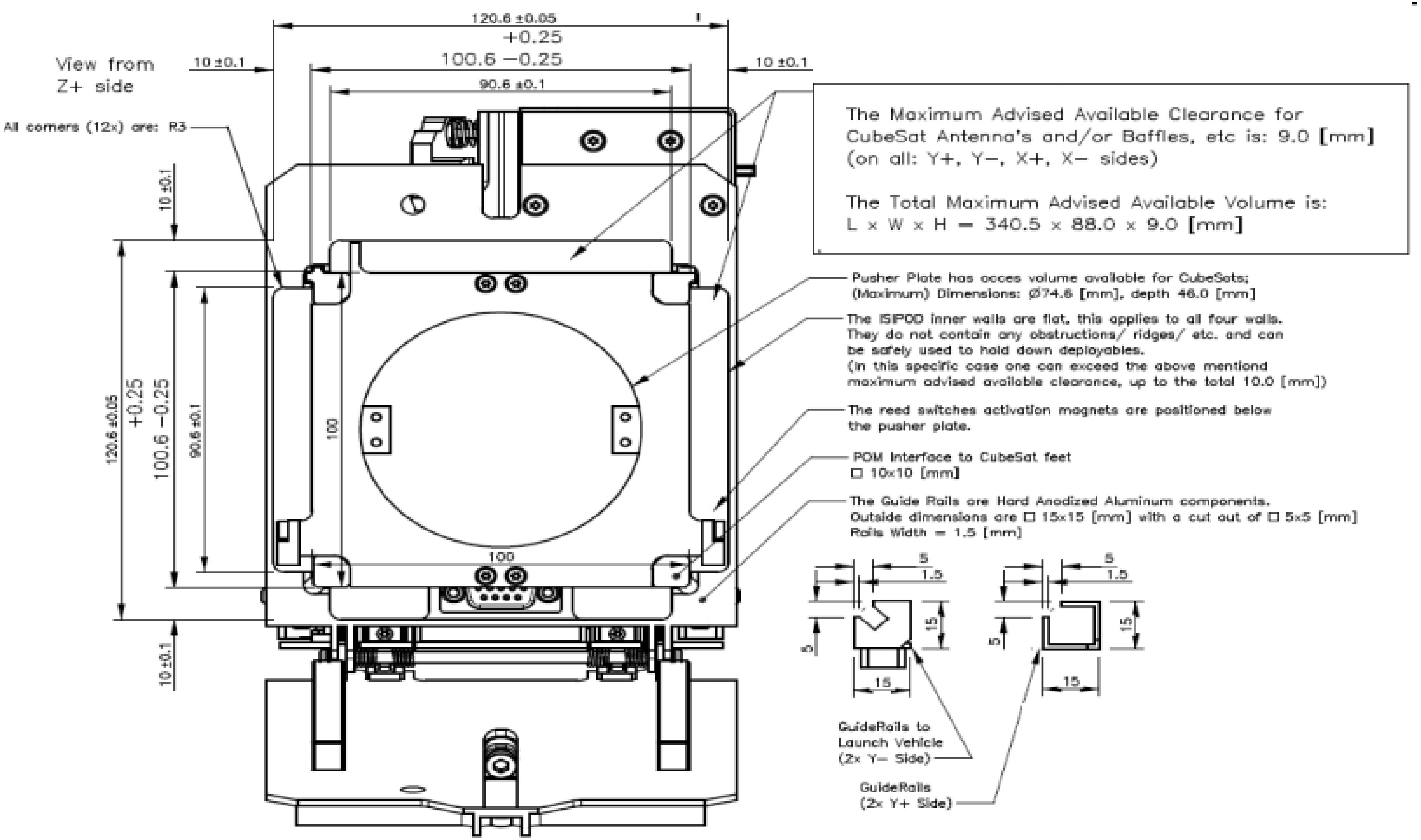
Mechanical Properities

- 98,4 mm Structure
- 5.6 mm Panel + Opening Mechanism Thickness (one side)

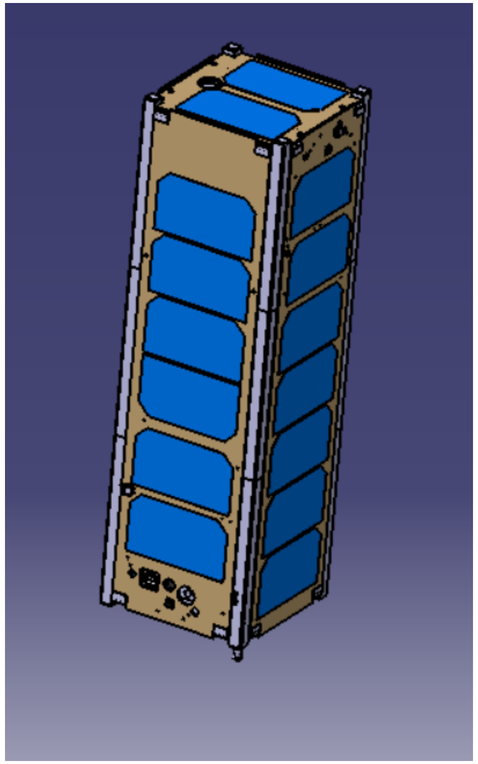
- Allowble space is 9.5 mm from sturcture to outwards



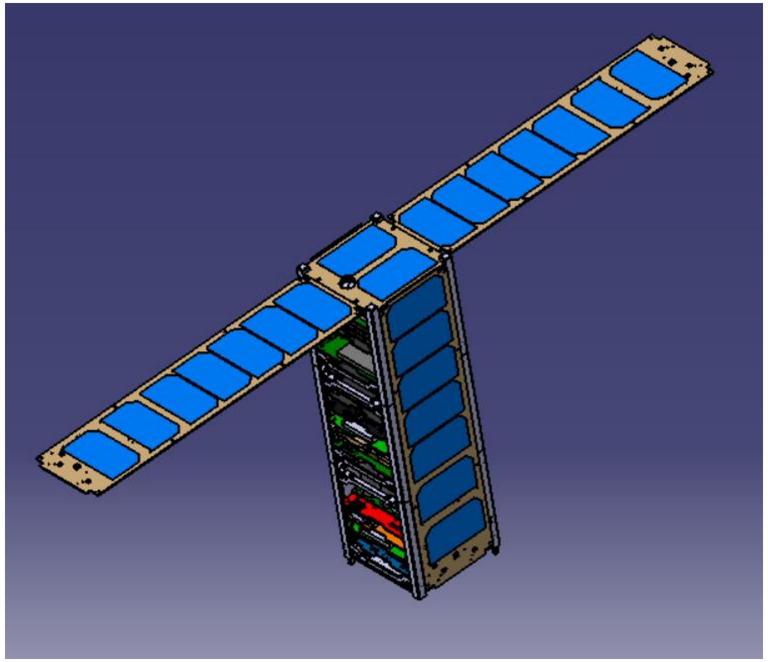
ISIPOD CubeSat Deployer



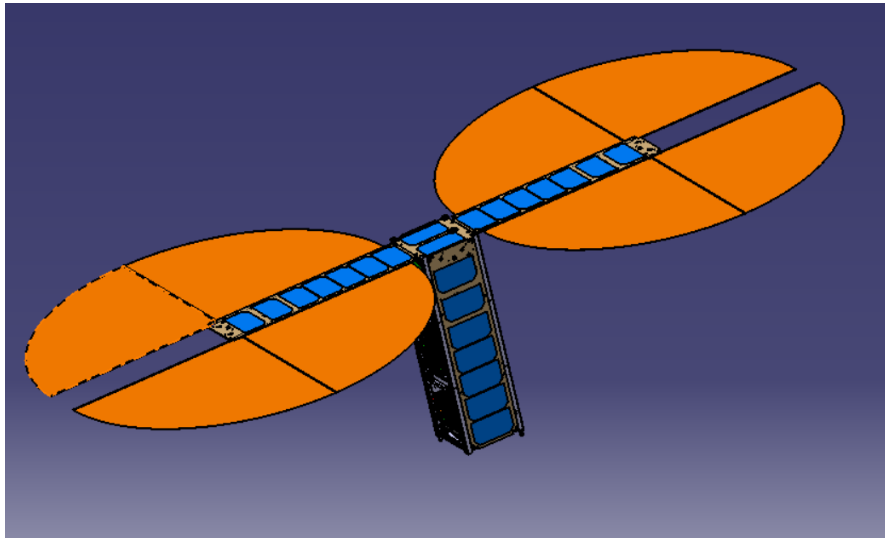
Analysis Configurations



Case A



Case C



Case D

Analysis Results

	Case A	Case B	Case C	Case D	Case E
CubeSat Mass [kg]	4	4	4	4	4
Drag Area [m^2]	0.01	0,03	0.0633	0,6285	0,5627
Altitude [km]	552	552	552	552	552
Start time for DDS	21 Oct 2018	21 Oct 2018	21 Oct 2018	21 Oct 2018	21 Oct 2018
Attitude Control	3 axis	Random	3 axis	3 axis	Pas. Aero. Stab.
De-orbit Date		3 Agu 2023	27 Jul 2021	7.Mar.20	16 Apr 2021
Flight Time	+30 years	1748	1011	504	513

Passive Aerodynamic Stabilization

Design helps passive aerodynamic stabilization.
Its possible to stabilize the satellite with about 15 degree pointing error at each axis with passive aerodynamic stabilization*

Regions of Influence	Altitude Range	Environmental Effects
Region I	Below 300 km	Aerodynamic torques dominate angular motion
Region II	300-650 km	Aerodynamic and Gravitational torques are comparable
Region III	650-1000 km	Aerodynamic, Gravitational and Solar torques are comparable
Region IV	Above 1000 km	Solar and Gravitational torques dominate angular motions

*An Attitude Control System for ZA-AeroSat subject to significant Aerodynamics Disturbances *Willem H. Steyn, Mike Alec Kearney*

Advantages

- Simplicity
- Cheap
- Not wasting space
- Applicable with COTS launch pods

Disvantages

- Deployment mechanism spring*
- Solar panel deployment mechanism is needed $$$

*%2 change in modlues loss for each 55 degree change

Space Vehicle Mechanisms: Elements of Successful Design

Page:148

Thank You For Your Attention