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TAL TECH

Ferromagnetism issues in Materials for Nano-Satellite Components

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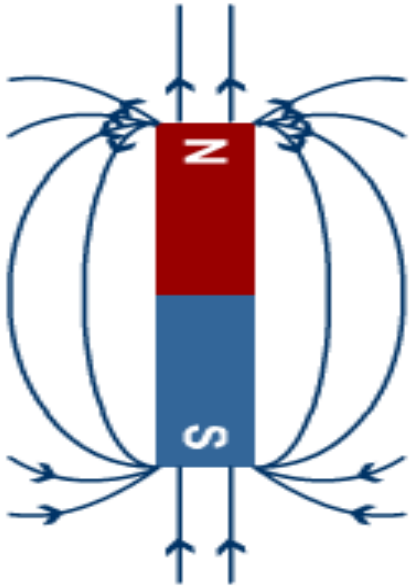
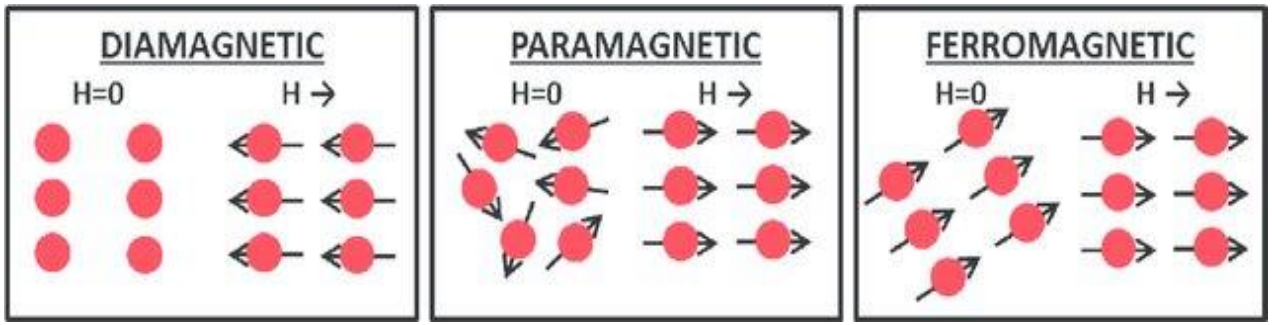
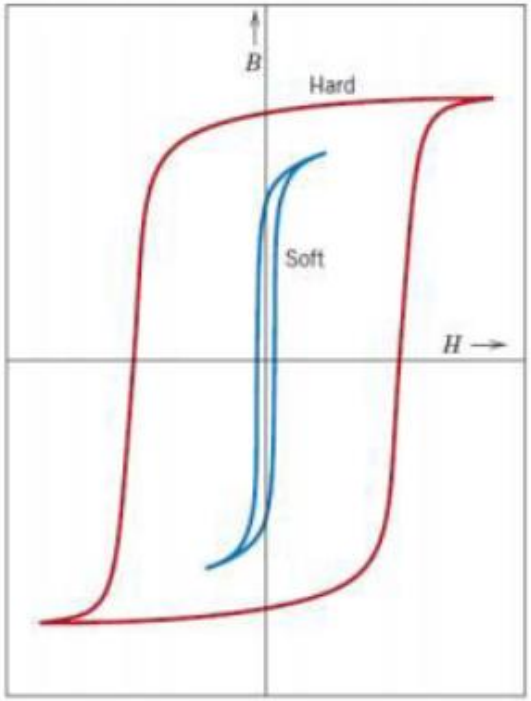
Magnetism

Magnetism *is a class of physical phenomena that are mediated by magnetic fields. Electric currents and the magnetic moments of elementary particles give rise to a magnetic field, which acts on other currents and magnetic moments.*



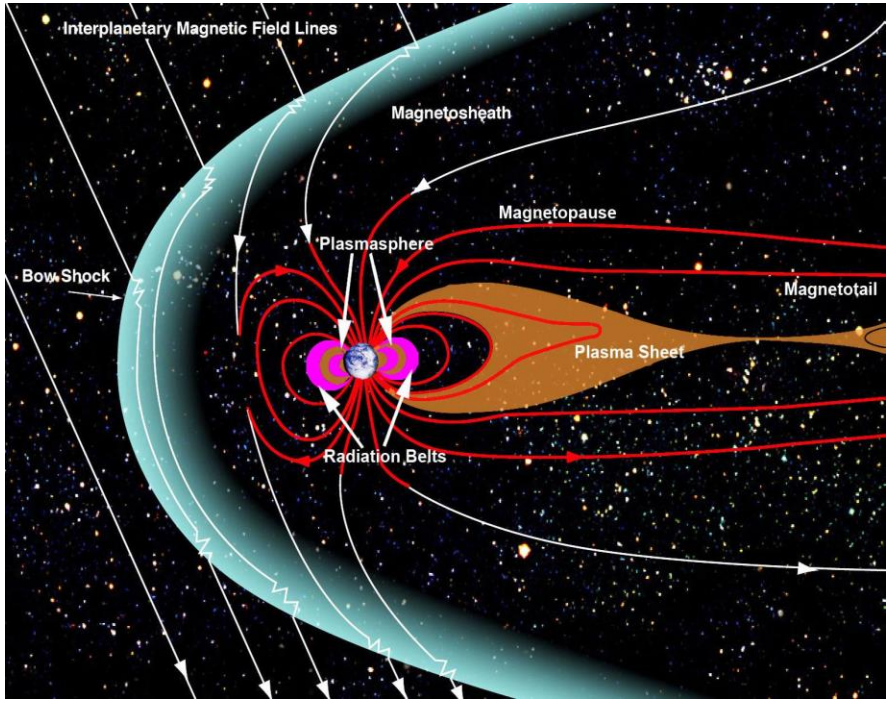
Magnets


DIAMAGNETIC
H=0
H →
PARAMAGNETIC
H=0
H →
FERROMAGNETIC
H=0
H →

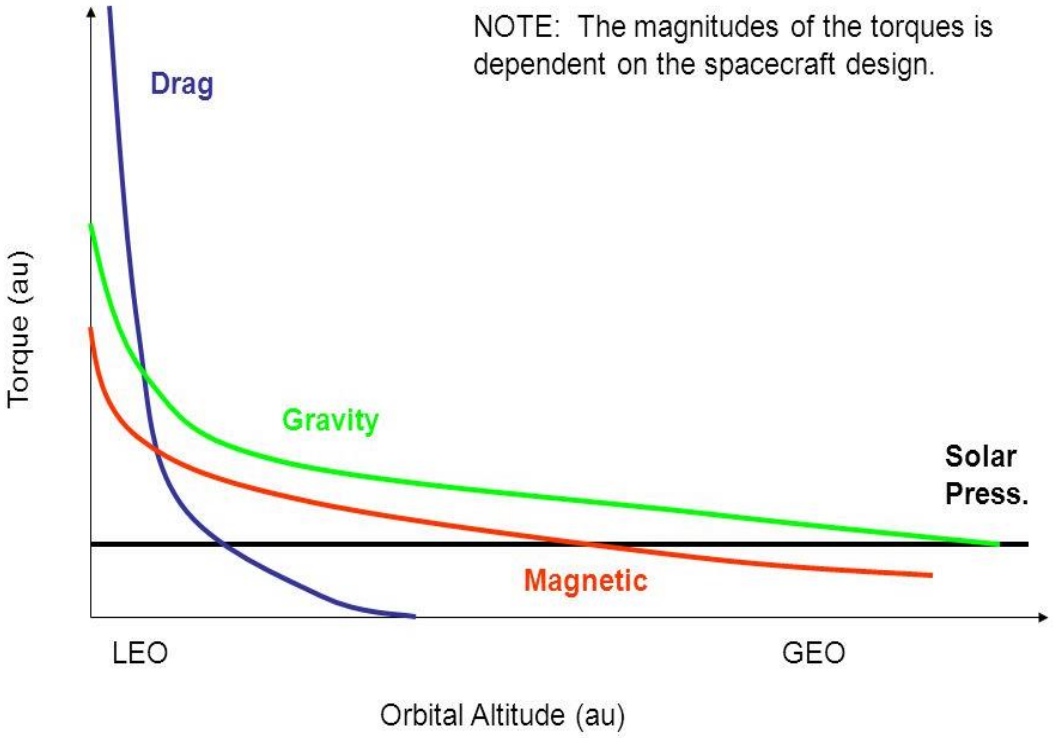

B
Hard
Soft
H →

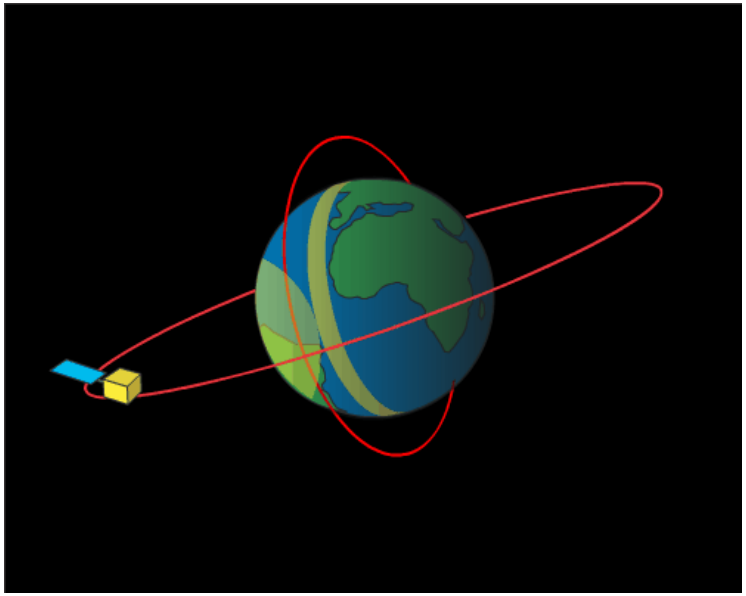
Magnetism in Space

Earth Orbit	Magnetic Field Strength (B)
Low Earth Orbit (160-2000 Km)	3x 10^{-4} - 6x10^{-4} Tesla
Medium Earth Orbit (2000-35786 km)	-
Geo Statioanry Orbit (<=36000 Km)	30-120 nano Tesla



External Disturbance Torques on Satellite





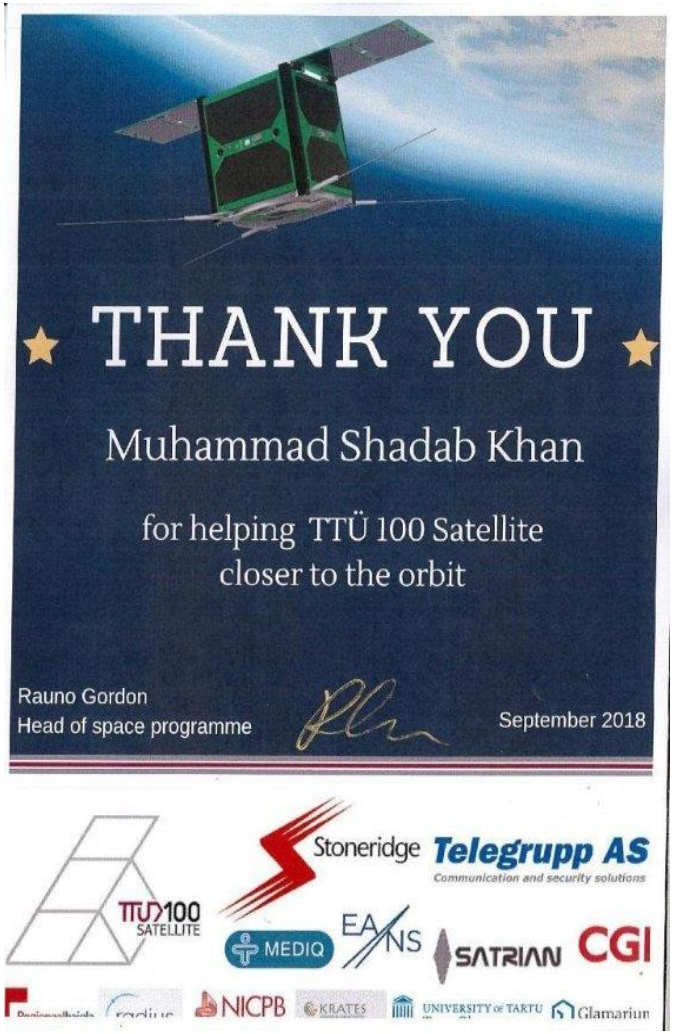
ESTCUBE-1 Results

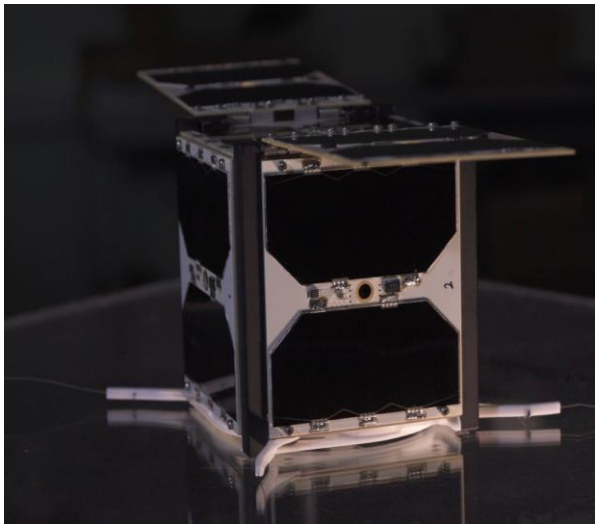
- ESTCUBE-1 Satellite from Estonia
- In-Flight results showed Un-stability of the CubeSat

- Primary reason was found to be due to use of Ferromagnetic Substances (Screw/Battery Cover)

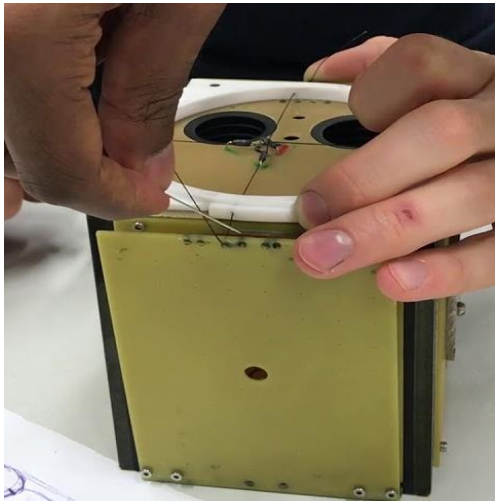
- ESTCUBE team decided to use Non magnetic Ti6Al4V Fasteners/Screws for ESTCUBE-2 Satellite

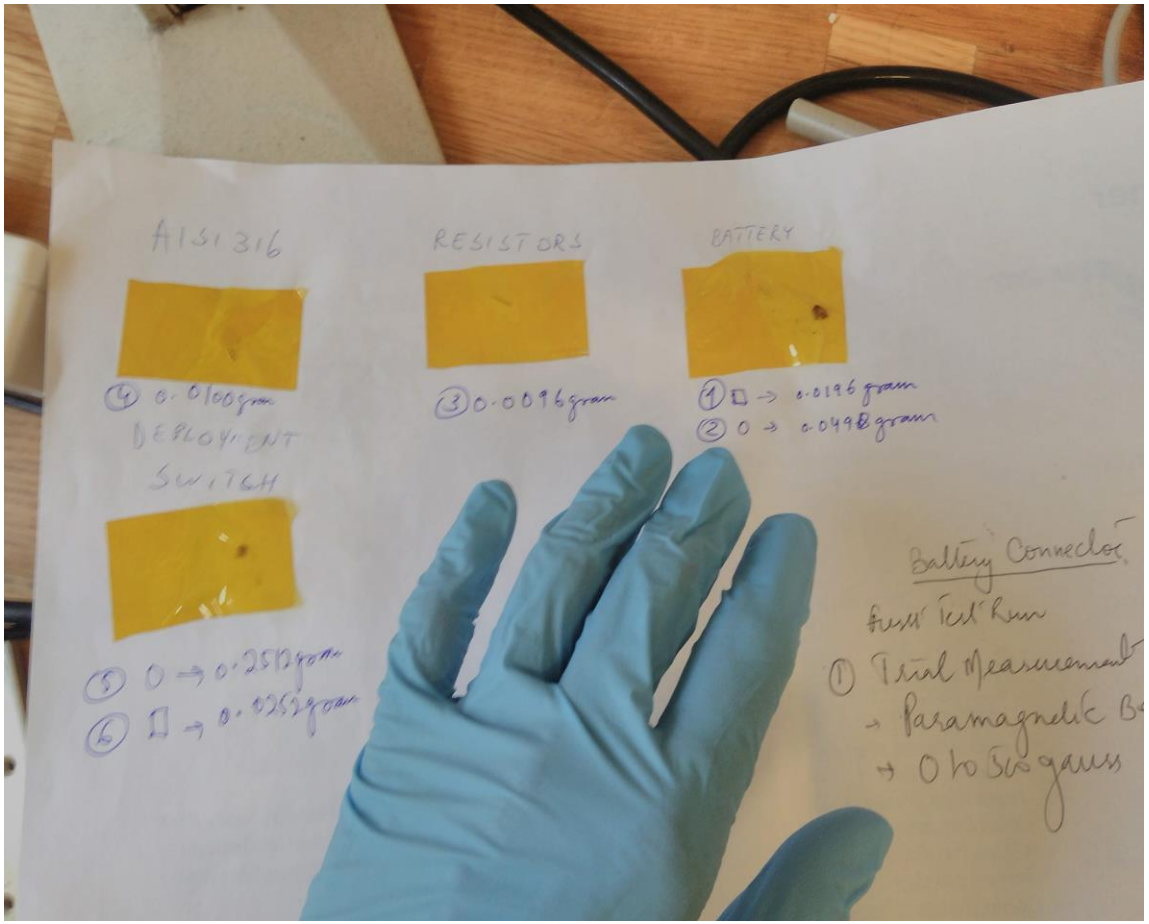
TTU100 CubeSat Project





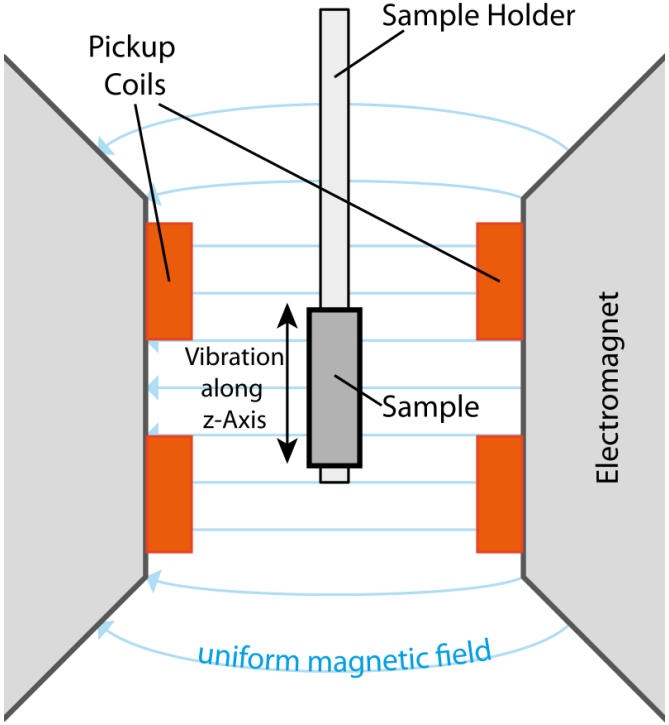
Sample Test using VSM



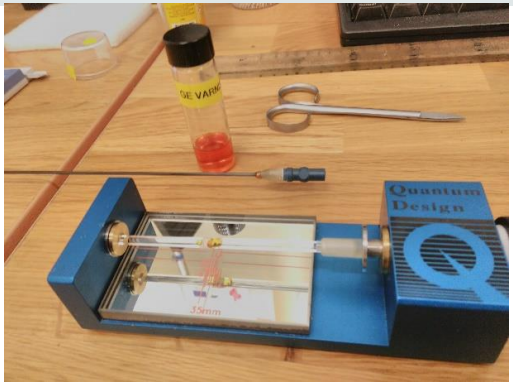


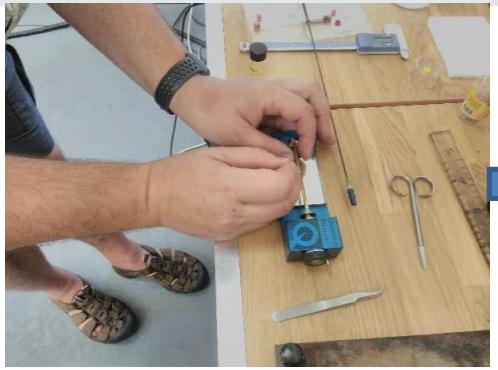
Magnetic Measurement Devices

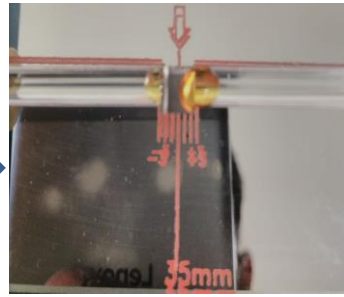
VSM (vibrating sample magnetometer)

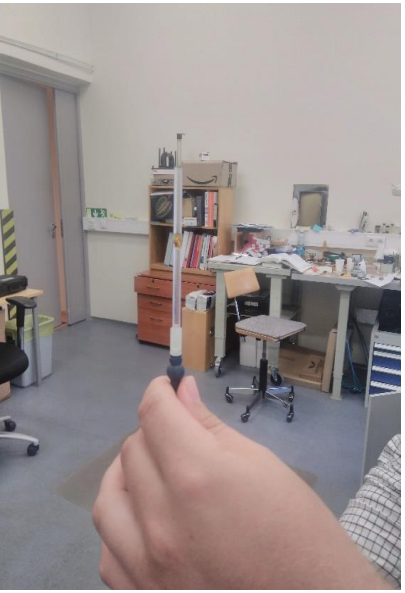


Test Set-Up Procedure









Analysis of Results

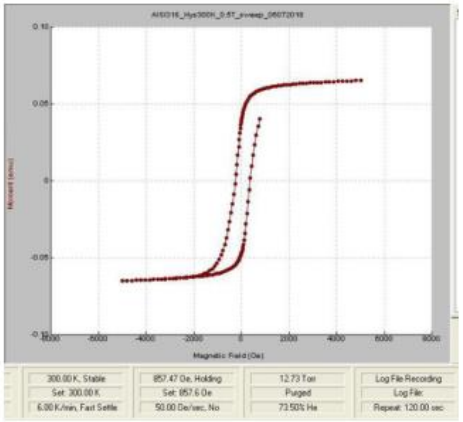


Fig. 10 AIS 316

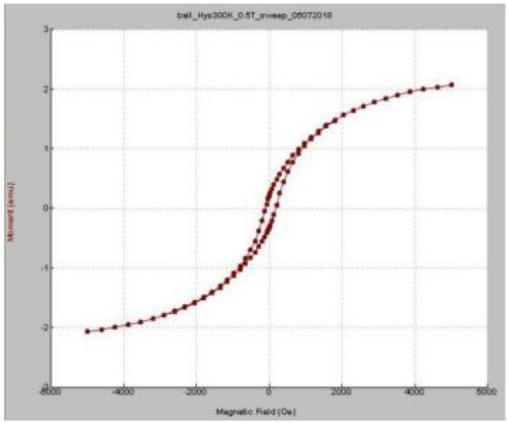


Fig.11 Switch Ball

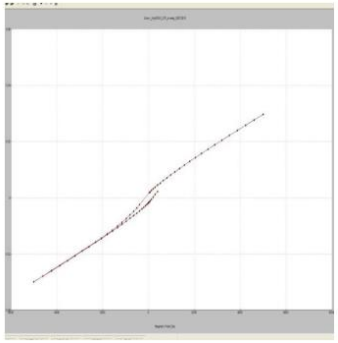


Fig.14 Screw

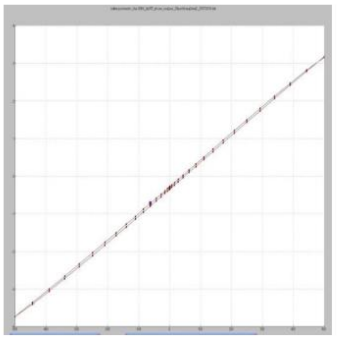


Fig.15 Battery Connector

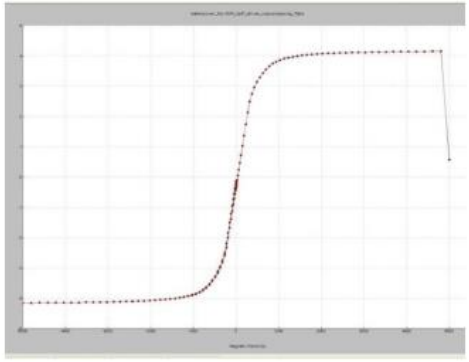


Fig. 12 Battery Cover

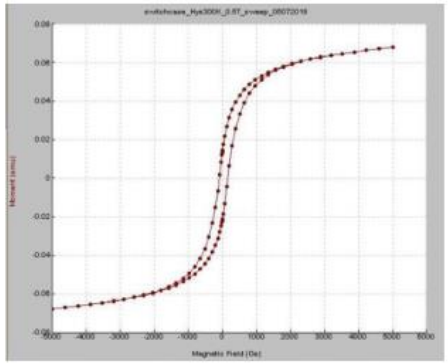


Fig.13 Switch Case

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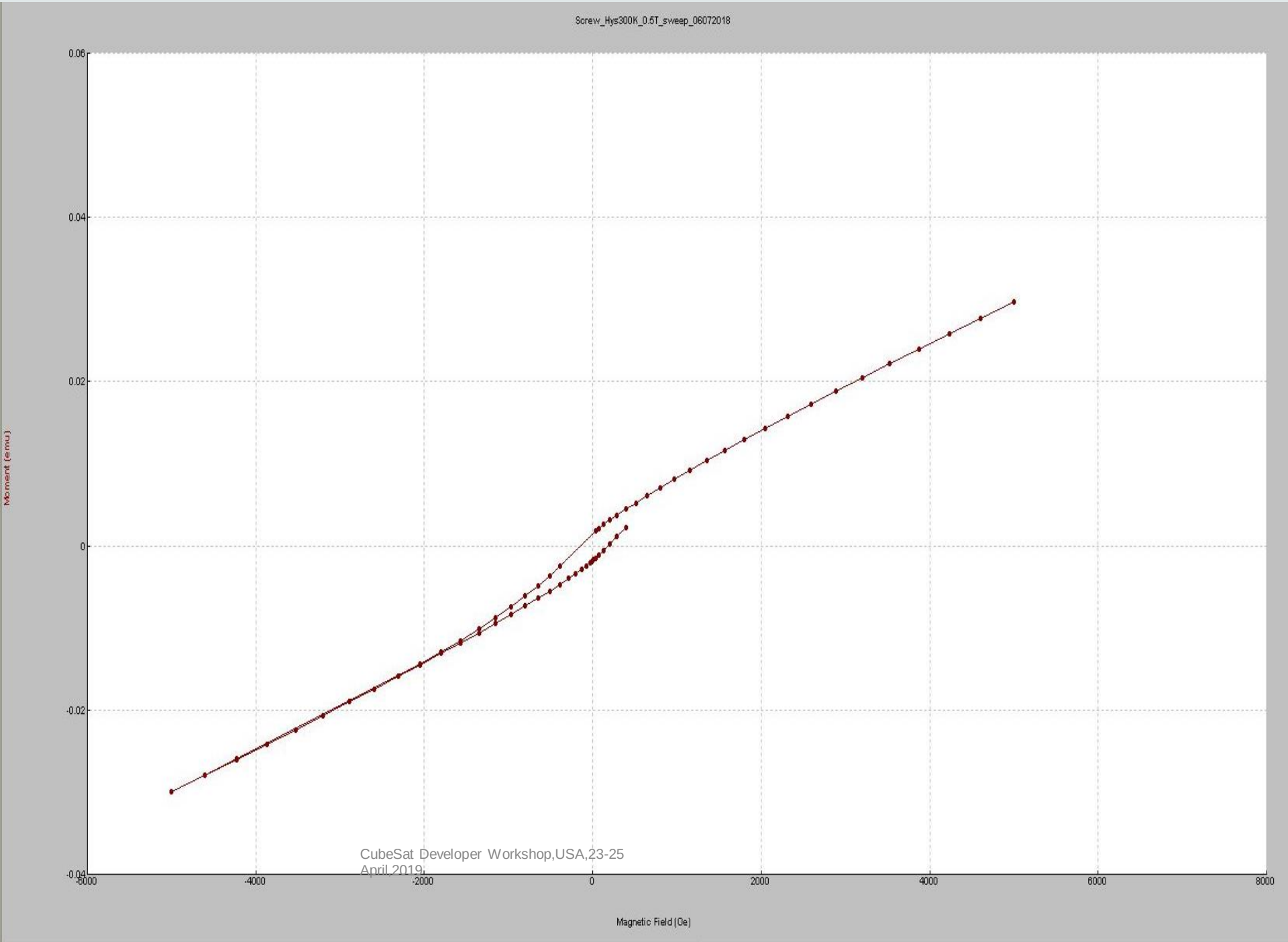
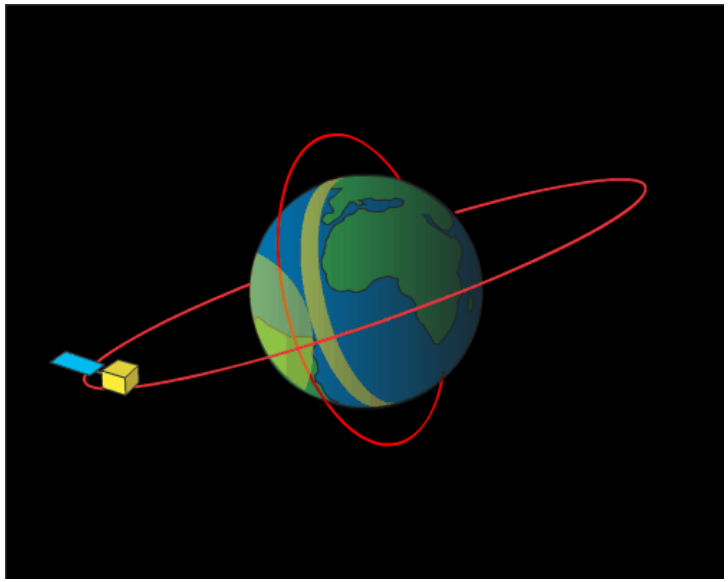

Screw_Hys300K_0.5T_sweep_06072018
0.06
0.04
0.02
0
-0.02
-0.04
Moment (emu)
-8000
-4000
-2000
0
2000
4000
6000
8000
Magnetic Field (Oe)

Result Intrepretation in Space Environment

FerroMagnetic Screw

- **Ferromagnetic Specimen induces Torque**
  τ= Mx B
  M= Magnetic Moment
  B= Magnetic field Strength
- **Torque affects Spin Stabilisation of the Satellite**
- **Resulting into the Satellite not stabilised/ Oriented Correctly towards Earth**
- **Earth Imaging Satellites affected maximum due to Unstability**



Conclusion

- **VSM is a good tool to Measure Magnetic moment for Materials, suitable for both weakly and strongly magnetic substances**
- **Magnetic substances disturbs the stabilization of the Spacecraft**
- **External Unwanted Torque must be avoided to keep the Spacecraft Stabilized**
- **Replacement of the Magnetic Substance with Non Magnetic Substance**
- **Development of New Materials/Manufacturing Processes**

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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Smart Materials and Adaptive Structures (9)

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NEW MATERIALS AND MANUFACTURING PROCESSES FOR NANO-SATELLITE COMPONENTS

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“ It is only with the Heart that one can see rightly; what is essential is invisible to the eye ”

- Antoine de Saint-Exupéry