Smart Nanosatellite Attitude Propagator (SNAP 2.0)

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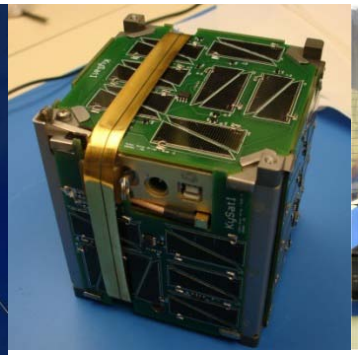
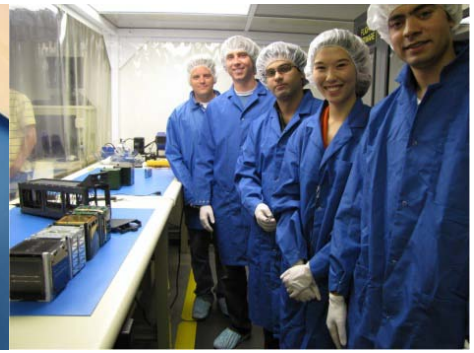
Kentucky Space Missions




New NanoRacks/CubeLab Standard on the ISS, July 2010

First Student Built Satellites to be Launched by NASA (ELaNa/Glory) February 23rd, 2011

Balloon-1, July 2008

Garvey P-12A

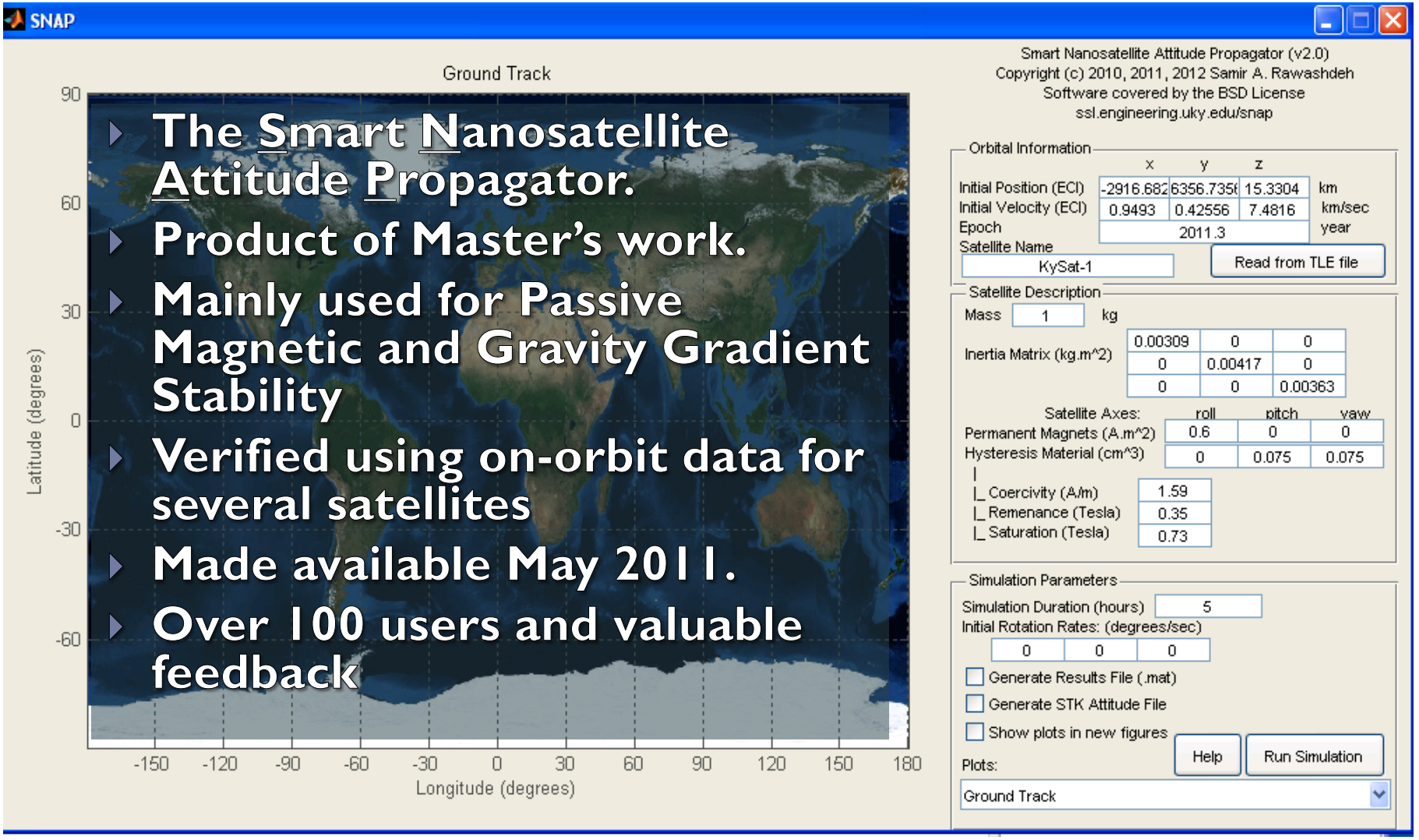
First CubeSats Ejected into Sub-Orbital Space, March 2010

First Flight, Composite Super Loki, December 2007

Presentation Overview

- What is SNAP? (an attitude propagator)
- How it works
- Example: Passive Magnetic Stability
- Status since release
- What's new this Summer?
- Capabilities and moving forward.
- How to get a copy

What is SNAP?


SNAP
Ground Track
Latitude (degrees)
Longitude (degrees)
90
60
30
0
-30
-60
-150
-120
-90
-60
-30
0
30
60
90
120
150
180
The Smart Nanosatellite Attitude Propagator.
Product of Master's work.
Mainly used for Passive Magnetic and Gravity Gradient Stability
Verified using on-orbit data for several satellites
Made available May 2011.
Over 100 users and valuable feedback
Smart Nanosatellite Attitude Propagator (v2.0)
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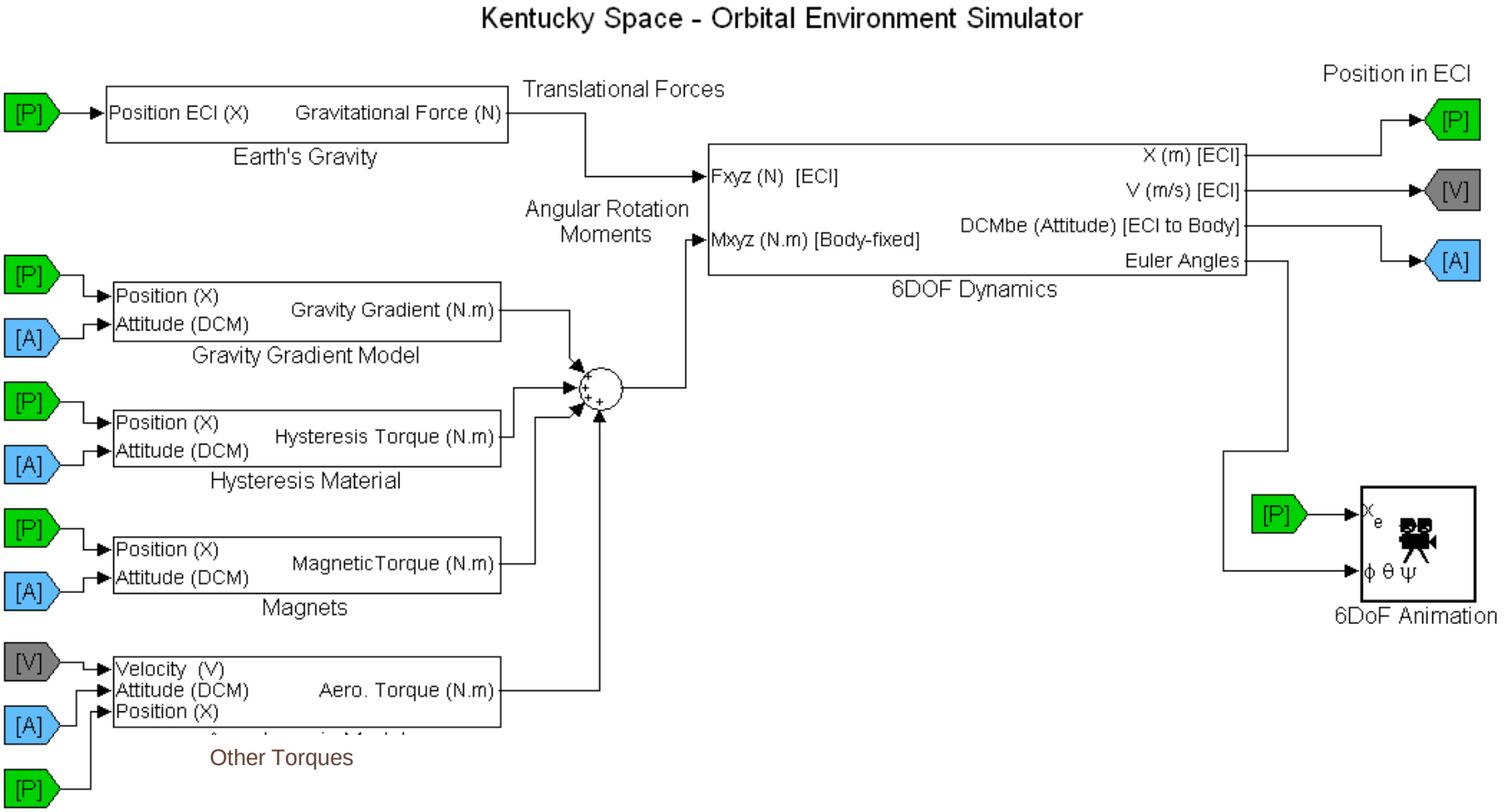
ssl.engineering.uky.edu/snap
Orbital Information
x
y
z
Initial Position (ECI)
-2916.682
6356.735
15.3304
km
Initial Velocity (ECI)
0.9493
0.42556
7.4816
km/sec
Epoch
2011.3
year
Satellite Name
KySat-1
Read from TLE file
Satellite Description
Mass
1
kg
Inertia Matrix (kg.m^2)
0.00309
0
0
0
0.00417
0
0
0
0.00363
Satellite Axes:
roll
pitch
yaw
Permanent Magnets (A.m^2)
0.6
0
0
Hysteresis Material (cm^3)
0
0.075
0.075
|_ Coercivity (A/m)
1.59
|_ Remenance (Tesla)
0.35
|_ Saturation (Tesla)
0.73
Simulation Parameters
Simulation Duration (hours)
5
Initial Rotation Rates: (degrees/sec)
0
0
0
Generate Results File (.mat)
Generate STK Attitude File
Show plots in new figures
Plots:
Help
Run Simulation
Ground Track

How SNAP works

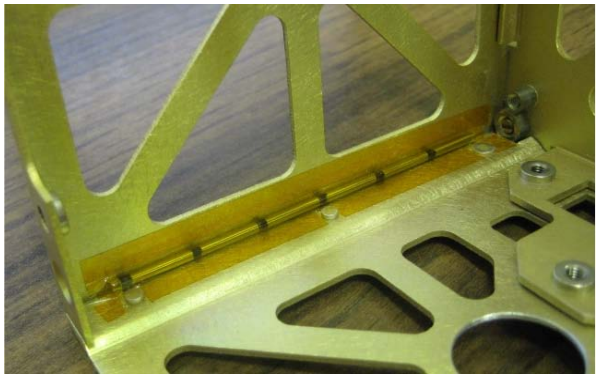


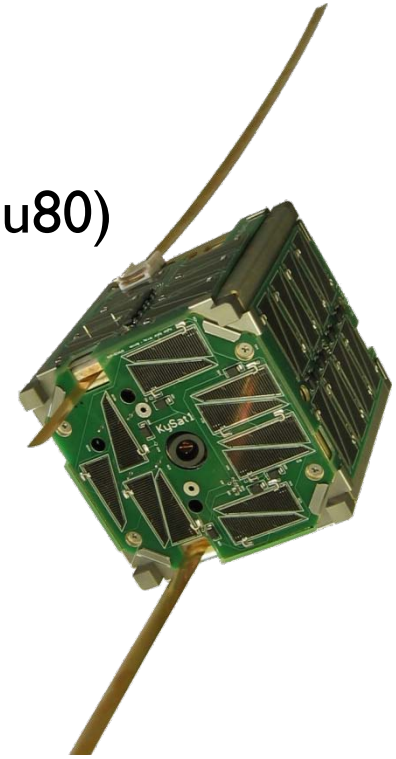
Capability

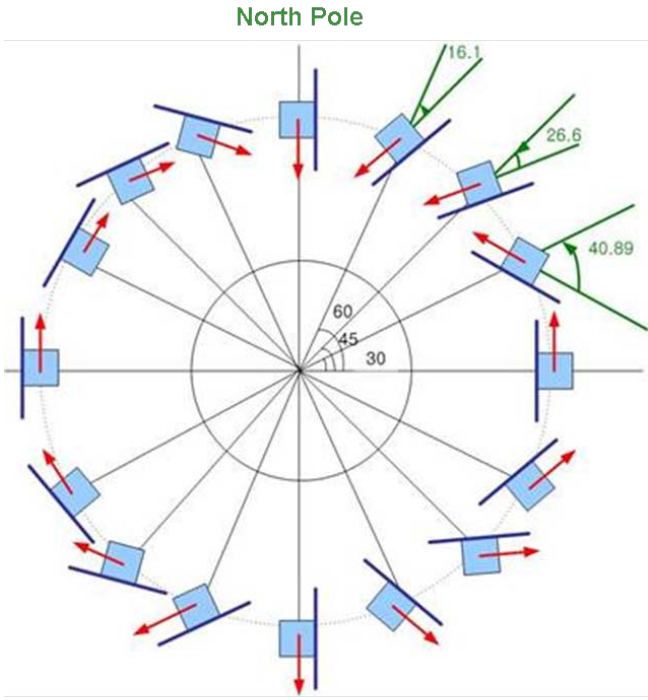
- Adjustable Spacecraft Description and Orbit
  - Inertia Matrix
  - Magnets and Hysteresis Material
  - Orbital Elements
- Simulate Effect of Orbital Environment on Satellite Attitude
- Response Plots
  - Satellite attitude relative to nadir, magnetic field, velocity vector
  - Angular rates
  - Individual environmental torques
- Export to MATLAB
- Export to STK

Passive Magnetic Stability

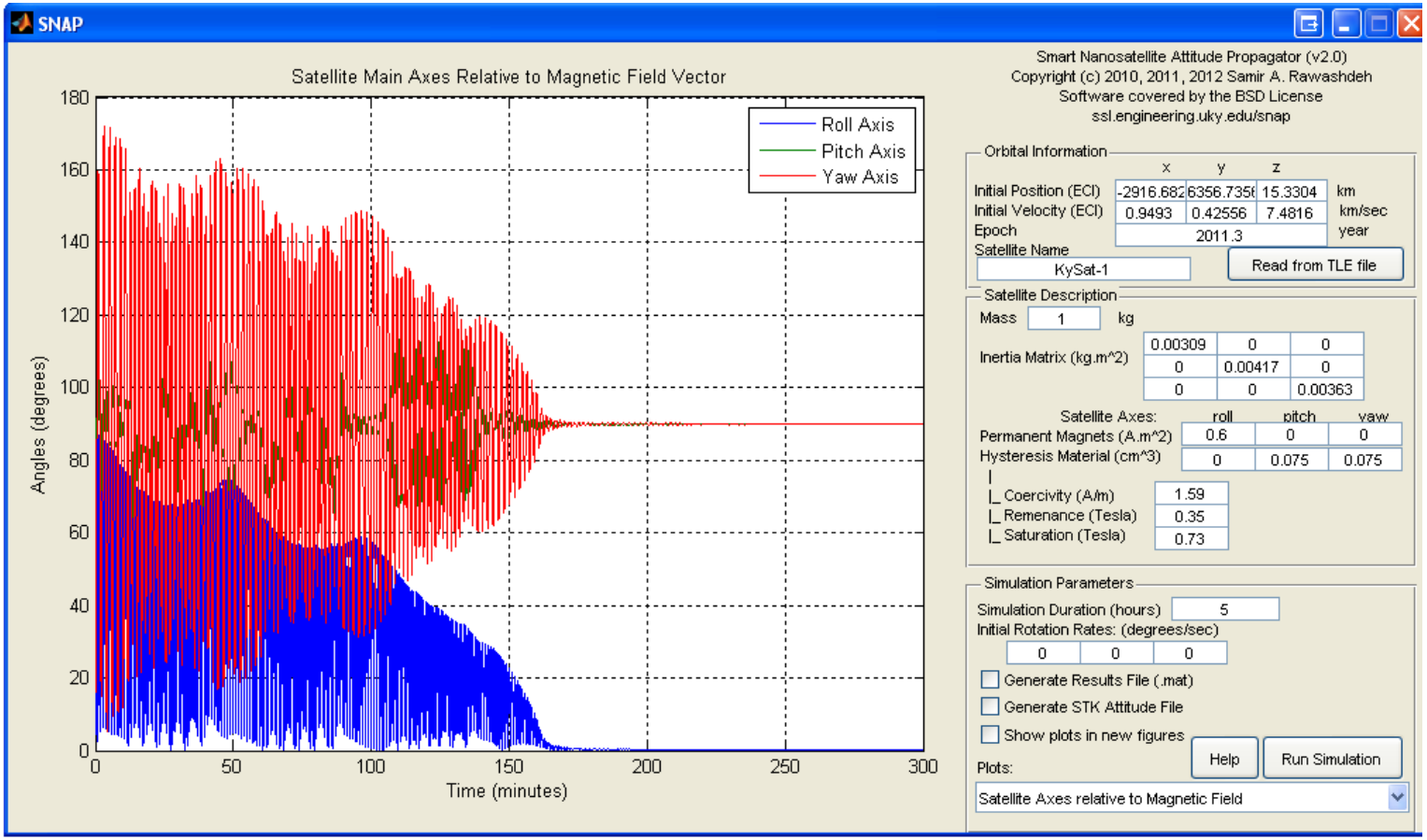
- Implemented on KySat-1
- Polar Orbit
- Align with Magnetic Field
  - Permanent Magnets
- Dampen Motion
  - Hysteresis Material (HyMu80)







Attitude Response

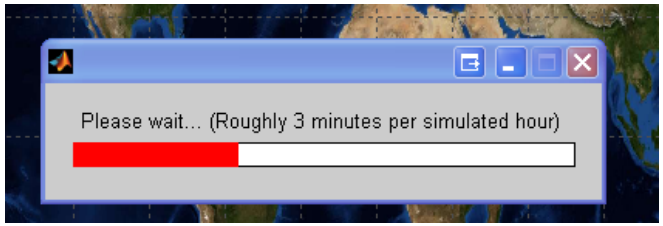


KySat-1: Animation

Play Video

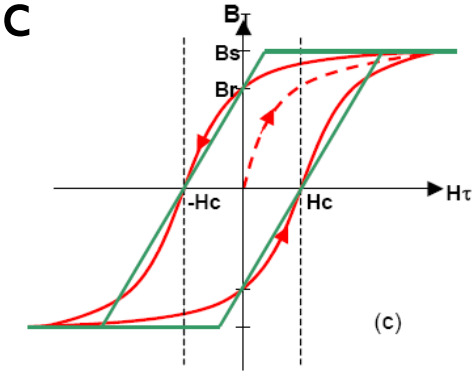
What's new in SNAP 2.0?

- It's slower… but more accurate (shortened time-step)

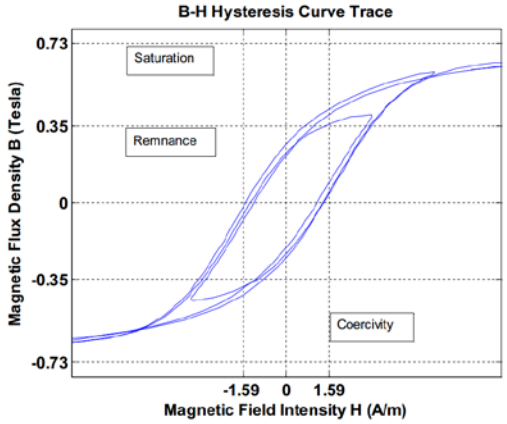


- Higher fidelity Magnetic Hysteresis Model

Old approximation



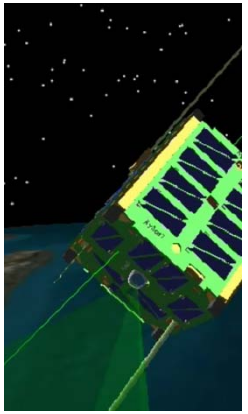
New continuous model



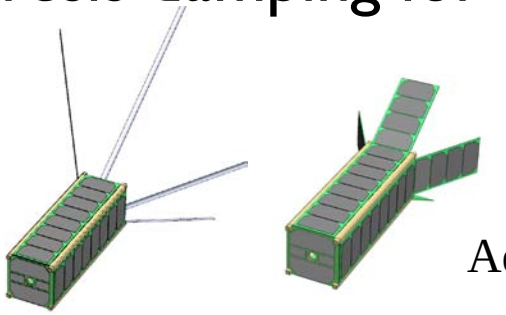
- *Flexibility for additions and Improvements.*

Potential

- Power generation profiling
- Aerodynamic Stabilization with Magnetic Hysteresis damping for ISS altitudes

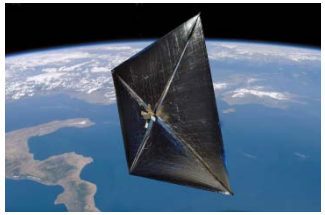


KySat-1 Illumination



Aerostable Concepts, UKY

- Model solar pressure for solar sailing

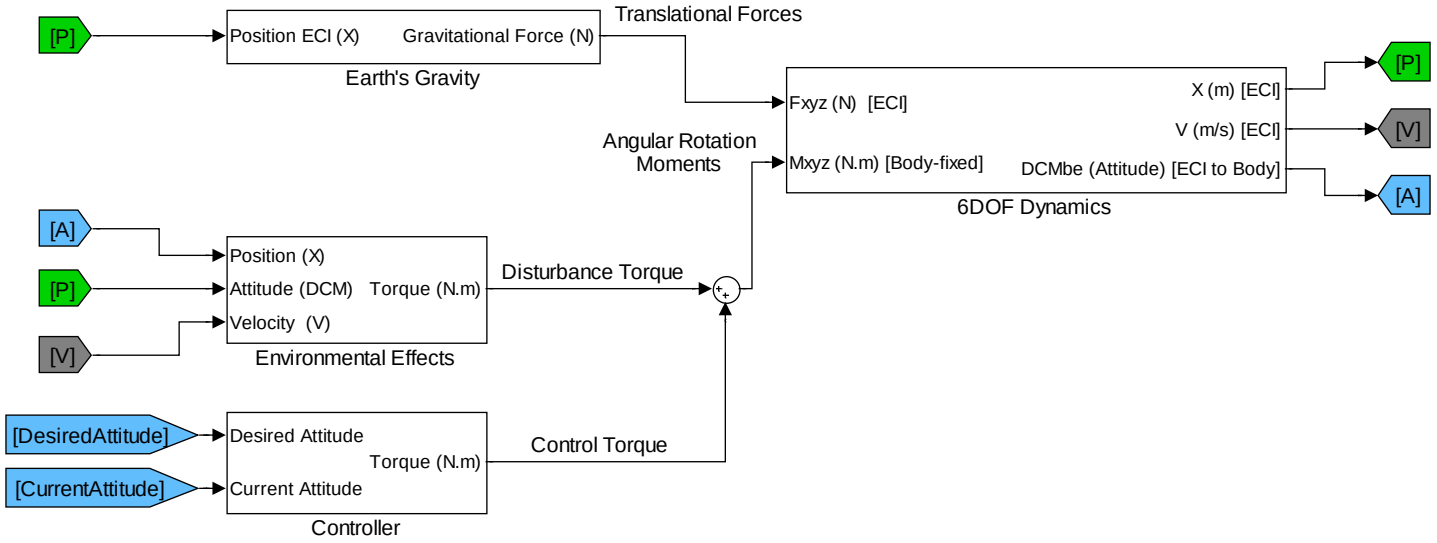


Nanosail-D, NASA

- Reaction wheels, torque coils, momentum wheels.

Active Attitude Control

- Compare desired attitude with actual attitude
- Study attitude control system effectiveness against disturbance torques
- Tune control algorithms.
- Quantify slew rates and tracking accuracy.



Conclusion

- Download SNAP
  - http://ssl.engineering.uky.edu/snap/
  - (Or just Google "CubeSat SNAP")

- New user forum for questions and file exchange
- Share models you create

- Advanced capabilities beyond SNAP are available at UKY

Thank You

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