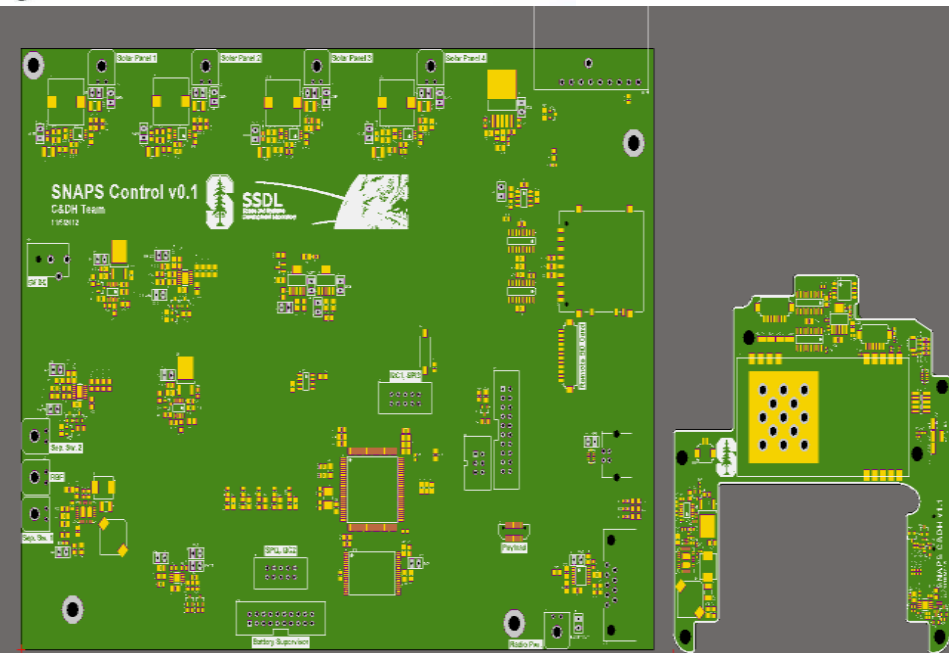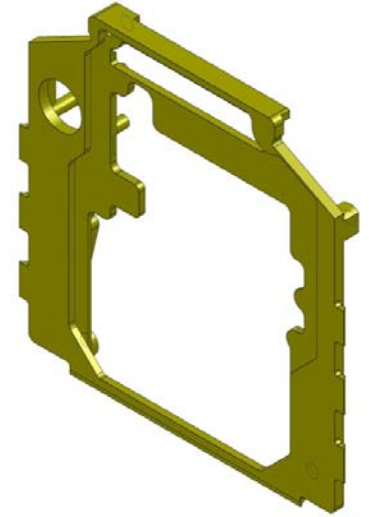# SNAPS – A Novel Imaging Nanosatellite

Andrew E. Kalman <aek@stanford.edu>

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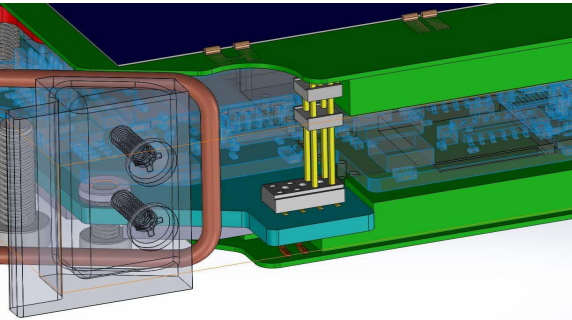
SNAPS Requirements

- 16-bit or better MCU

- MCU with FPU

- No deployables, including UHF antenna (i.e., be a good neighbor)

- Compatible with 3U Planetary Systems Canisterized Satellite Dispenser (CSD)

- Structure must be 3D-printable

- Can accommodate some sort of payload, e.g. a camera

- Public domain design

- Result: *1/4U-size nanosatellite (25mm thick)*

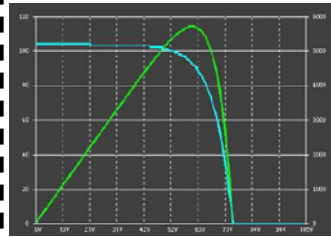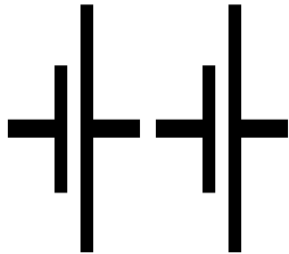- SNAPS: Stanford Nano Picture Satellite

6U CSD w/6U payload

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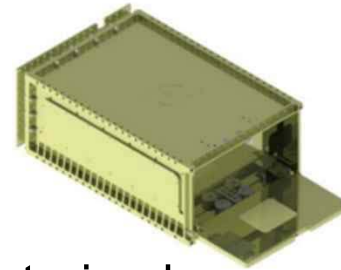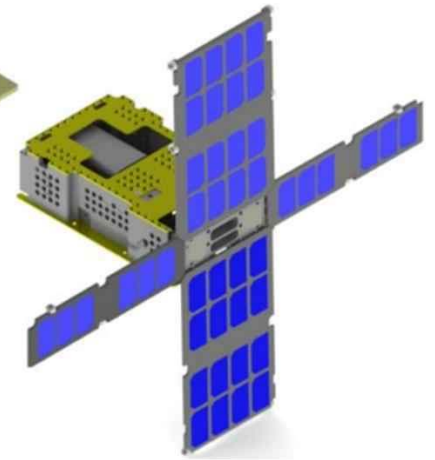
SNAPS Architecture

2 x 2W

Spectrolab UTJ

~95%

MPPT Board

~20Wh

Battery Supervisor Board

ARM MCU

0 - ~300mW

300mW (1mW sleep)

Dual-Port Interface
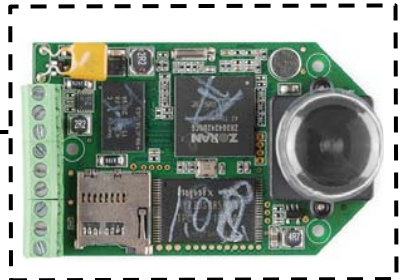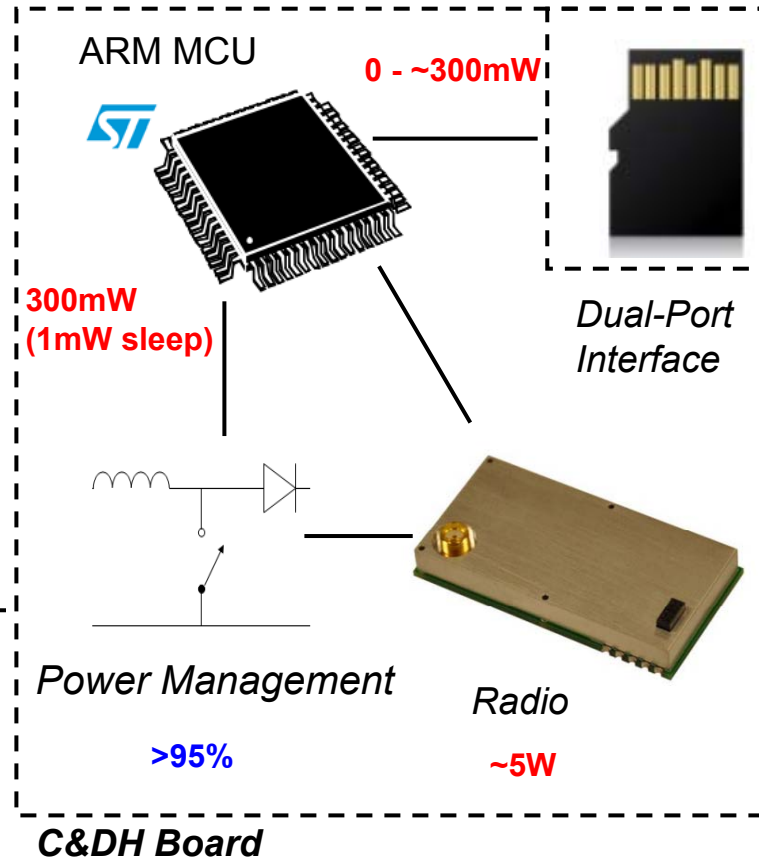
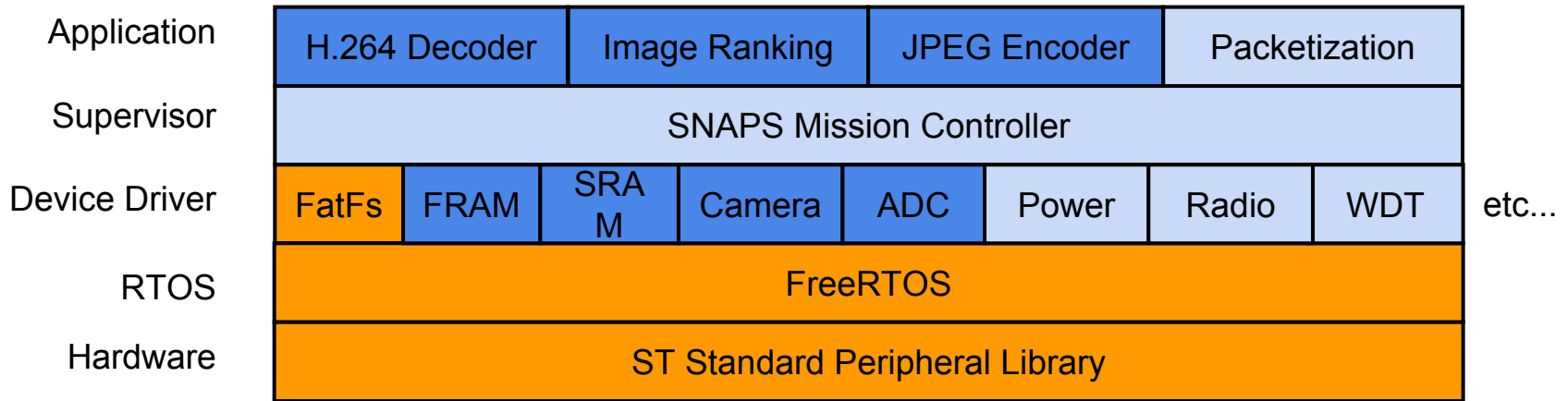*HackHD 1080p Camera (H.264 video stream)*

~5.5W

Power Management

>95%

Radio

~5W

C&DH Board

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SNAPS C&DH Board

- Microcontroller
  - STM32F407 microcontroller
    - 1MB Flash, 192K SRAM, up to 168MHz
    - DSP, FPU, SPI, I2C, UART, FSMC, ADC
    - Firmware in C/C++ with IAR Embedded Workbench for ARM
    - USB communication for debug and programming
- Memory
  - 4MB SRAM, 2Mb FRAM
  - SD (dual-port interface allows MCU or Camera access)
- Radio: Lithium-1 (UHF half-duplex)
- Interfaces to Solar Cell PCBs
- Interface to Battery Supervisor, with:
  - Two Li-Ion 18650 cells + protection circuitry
  - RBF & Separation switches
 - USB 3 connector for access port comms & power

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SNAPS C&DH Software

Application	H.264 Decoder	Image Ranking	JPEG Encoder	Packetization
Supervisor	SNAPS Mission Controller			

Device Driver	FatFs	FRAM	SRAM	Camera	ADC	Power	Radio	WDT	etc...

RTOS	FreeRTOS
Hardware	ST Standard Peripheral Library

■ Library
■ Custom (complete)
□ Custom (in progress)

All SNAPS embedded software is written in C using the IAR EWARM toolchain.
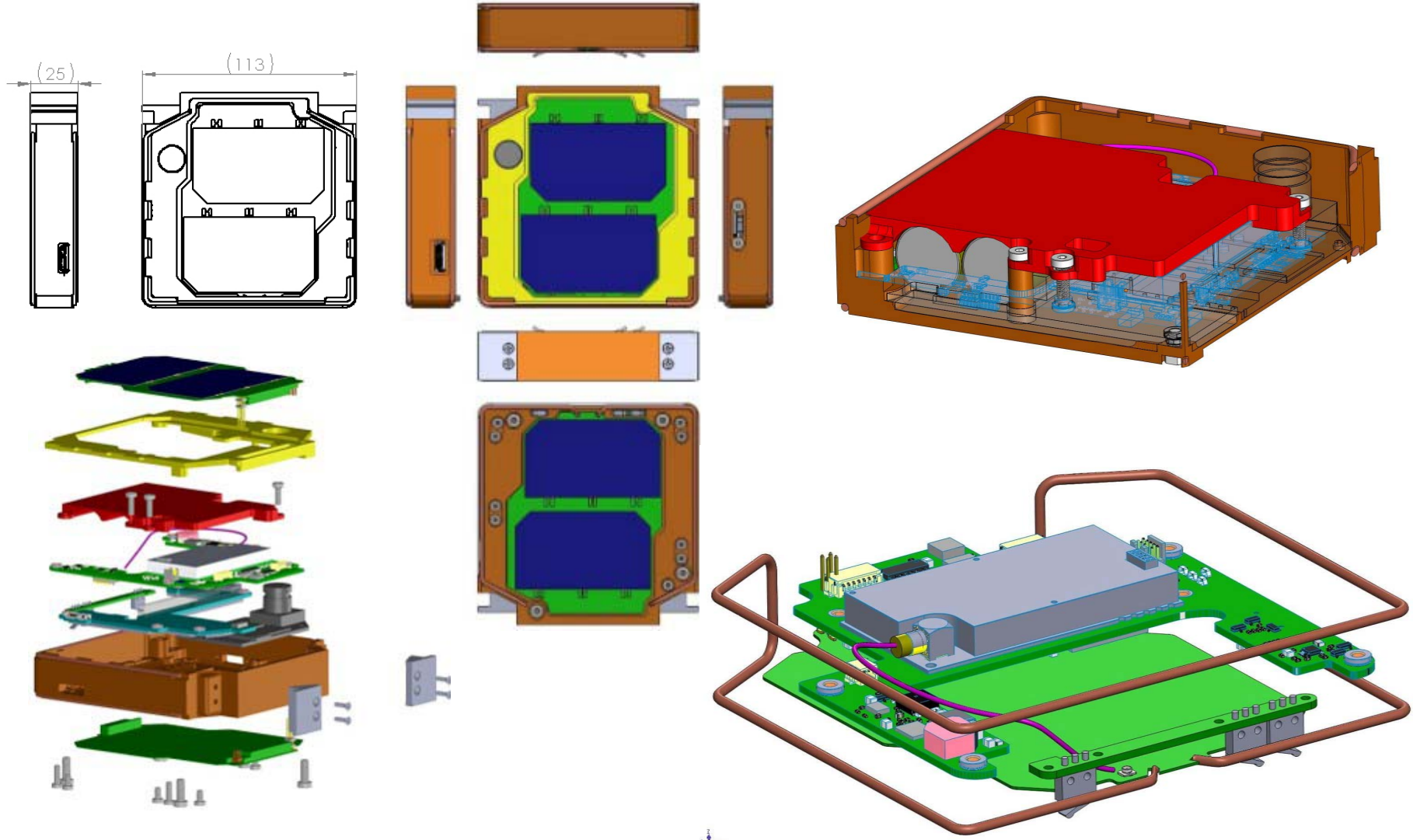
SNAPS C&DH Development
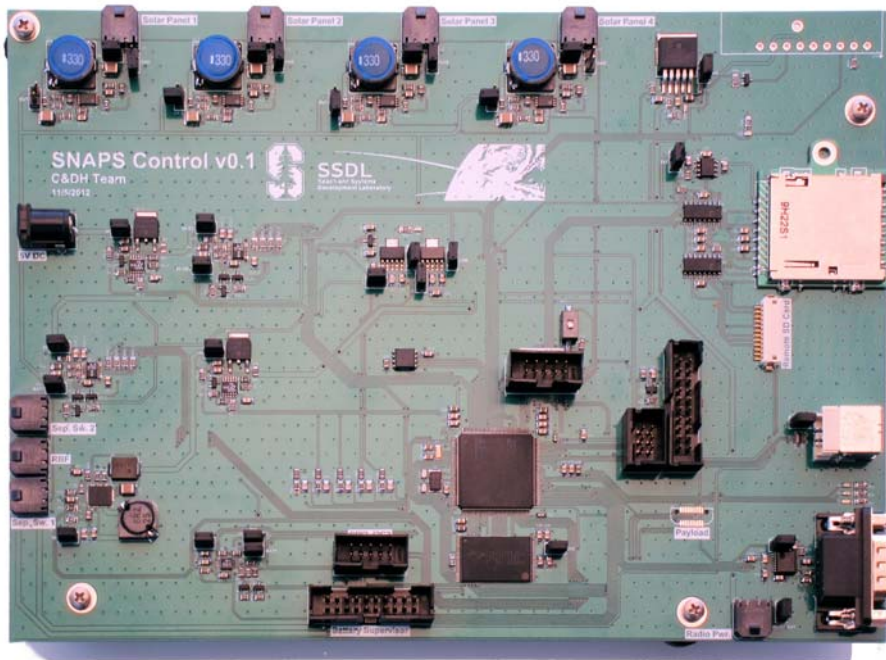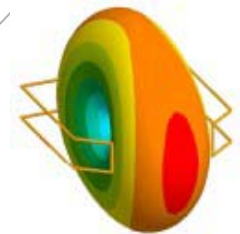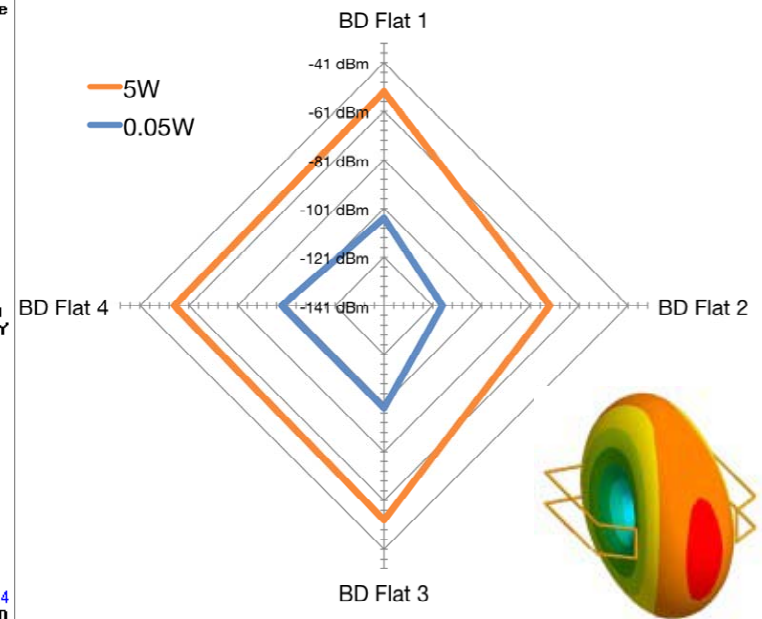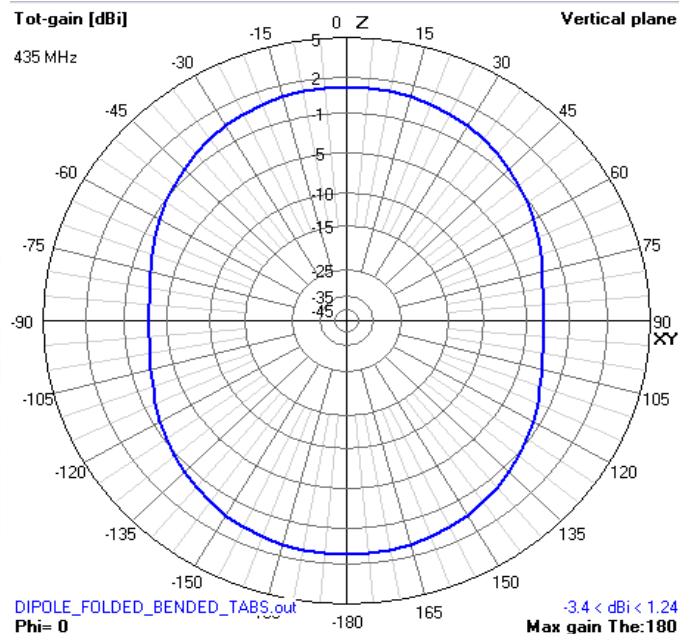

v0.1 (Development Mule)
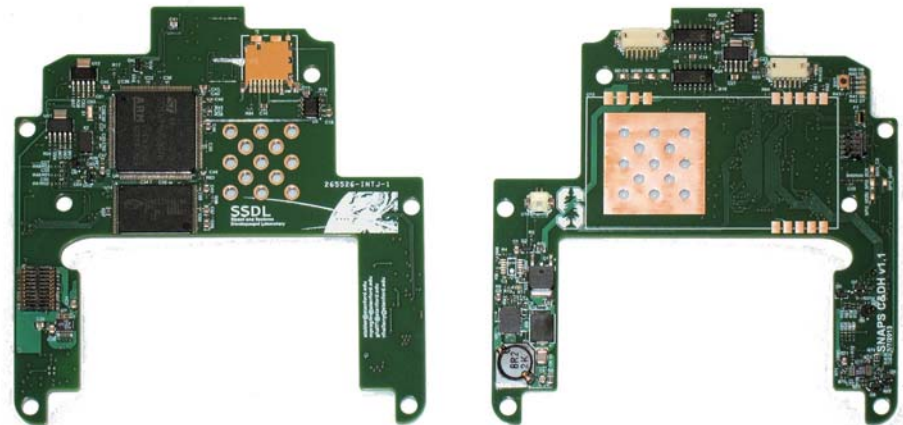
v1.1 (1st flight units?)

SNAPS Structure

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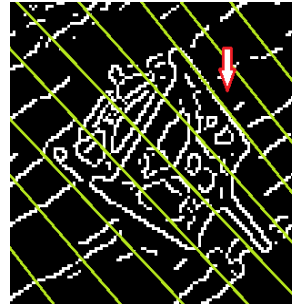# SNAPS Bodipole™ Antenna

SNAPS Ground Station

SNAPS Image Processing

Still image captured
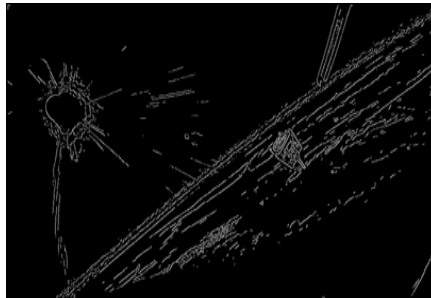from H.264 stream

Proximity
Filter

Corner
detection
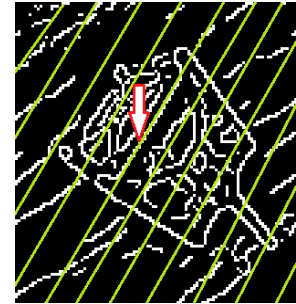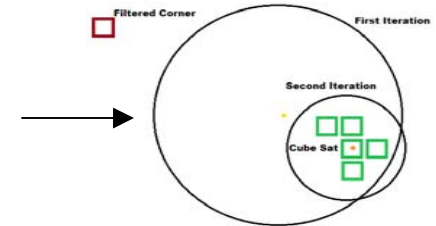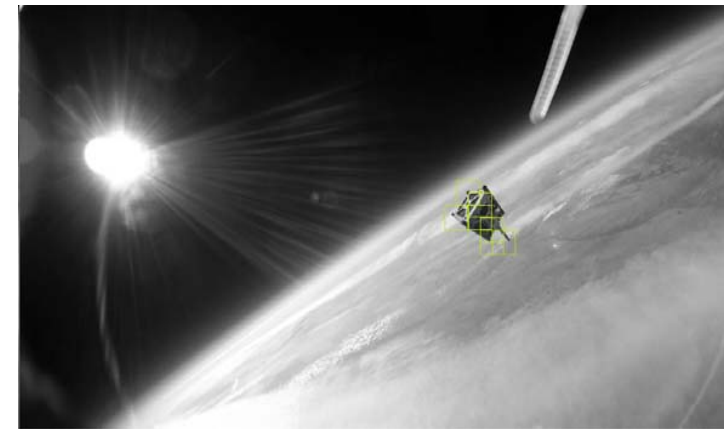
CubeSat detected!

RGB to greyscale,
resize, smooth,
edge detection

CubeSat isolation
via thresholding
and histograms

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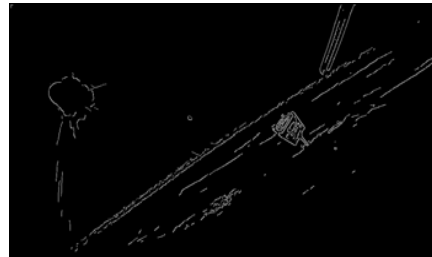
SNAPS Further Work

- Documentation & website
- Hardware
    - Assembly & testing of C&DH board
    - Full mechanical integration w/3D-printed parts
    - First build of final structure (printed or machined)
    - Balun for Bodipole antenna
    - Final passive magstab config
- Software
    - Radio integration
    - CarpComm (beacon) and ??? (data) support, GS integration
    - Power management strategies
    - Image Capture & Processing
- Licensing
- Testing, Testing, Testing!

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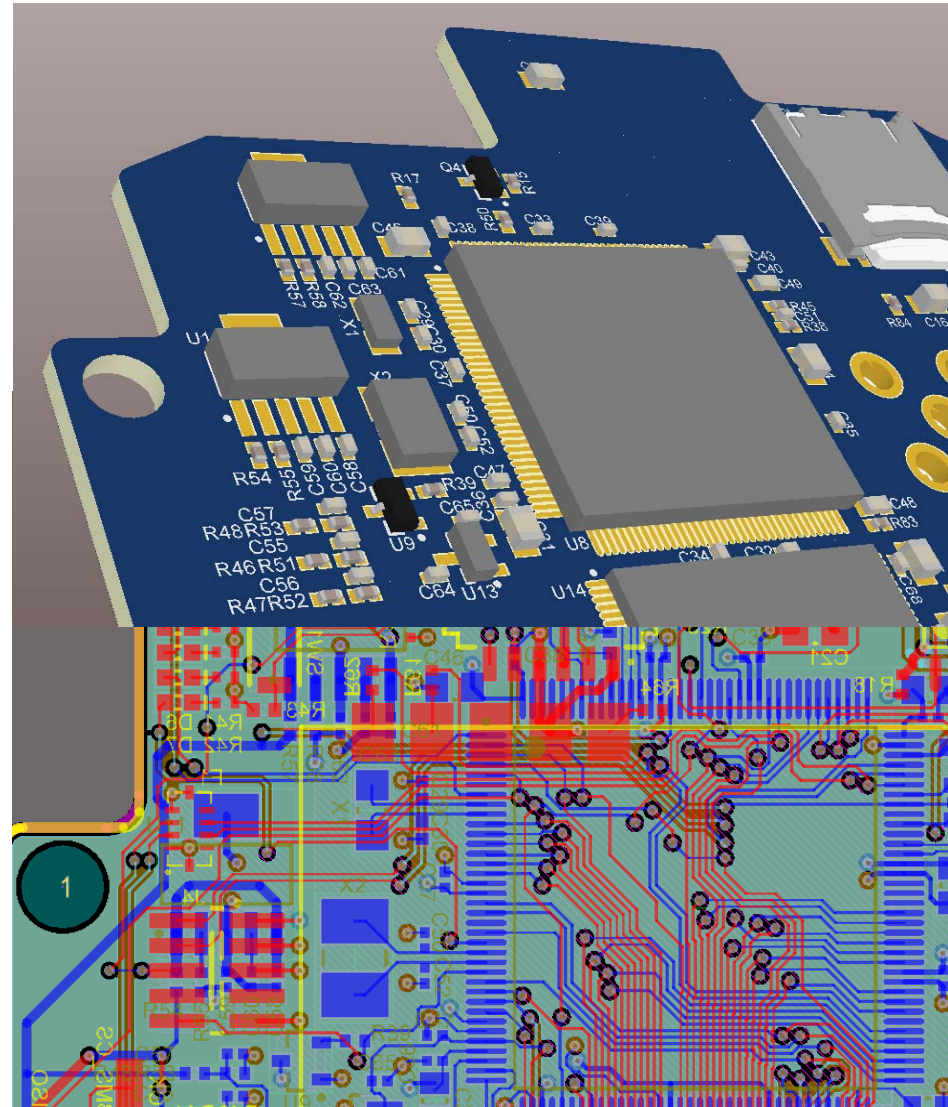
SNAPS Team Members

Alisha Babbitt, Rob Blount, John Cast, Evan Clark, David Gerson, Kaz Gunning, Rahul Gupta-Iwasaki, Greg Hall, Nathan Hall-Snyder, Theresa Johnson, Niels Joubert, Jason Kang, Vaibhav Kumar, Brian Mahlstedt, Andrew Nuttall, Max Praglin, Manu Sharma, Abishek Sheshadri, Steven Shepard, Adrian Spanu, Ben Stabler, Ana Tarano, Nathan Tardiff, Ben Todd, Mengze Yu, Andreas Zoellner

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