FLIGHT READINESS REVIEW

Windward Community College
University of Hawaii
2009-2010

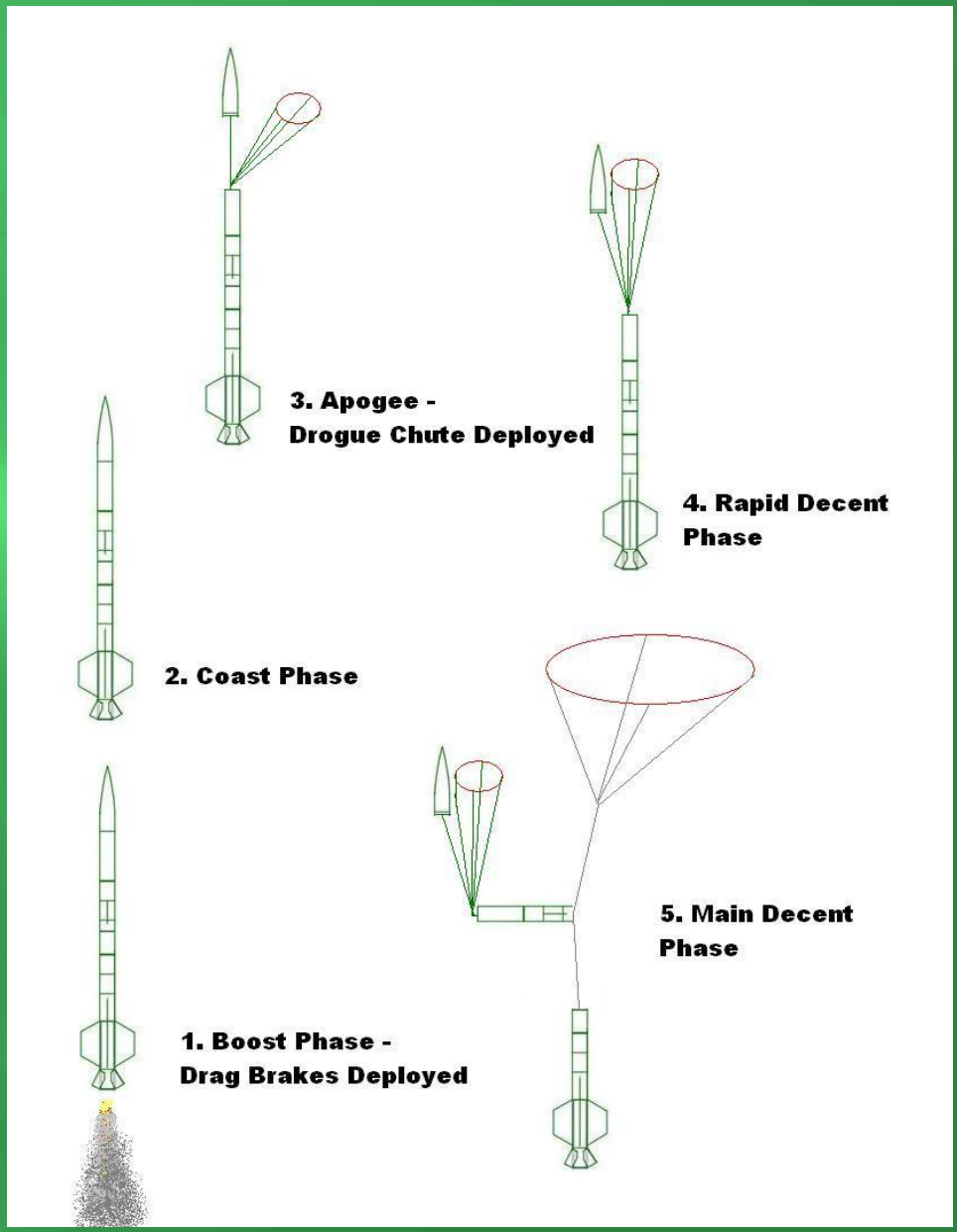
PROJECT: LEO HANO

Design Criteria

- Build a Rocket to be launched to an altitude of 5280 ft. (1 mile)
- Rocket must carry a scientific payload
- Rocket must return safely

Flight Profile

1. Boost Phase
2. Coast Phase
3. Apogee
   - Drogue Deployed
   - Drogue size: 36”
4. Rapid Decent Phase
   - 60 ft/sec
5. Main Deployment
   - Main Size: 96”
   - ~20 ft/sec

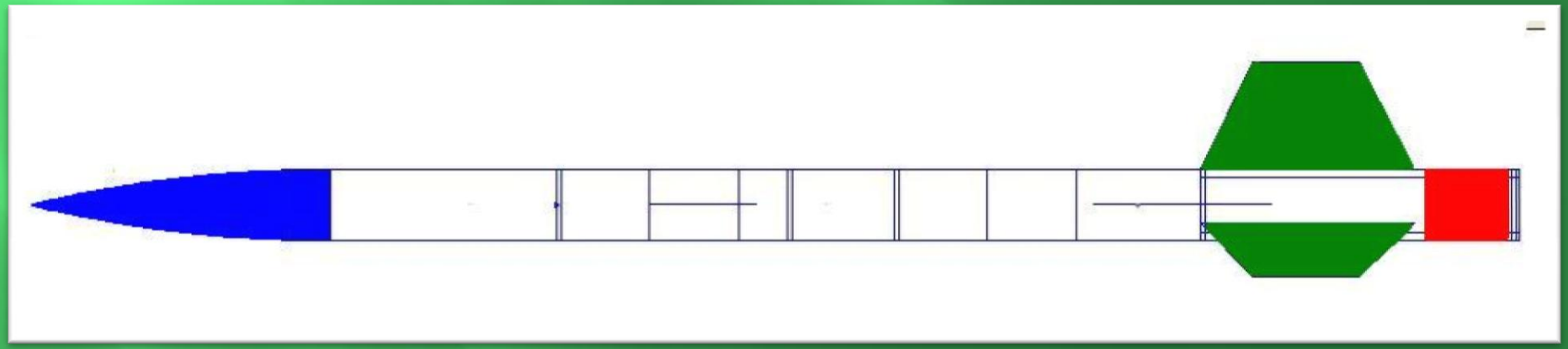


Rocket Design Details

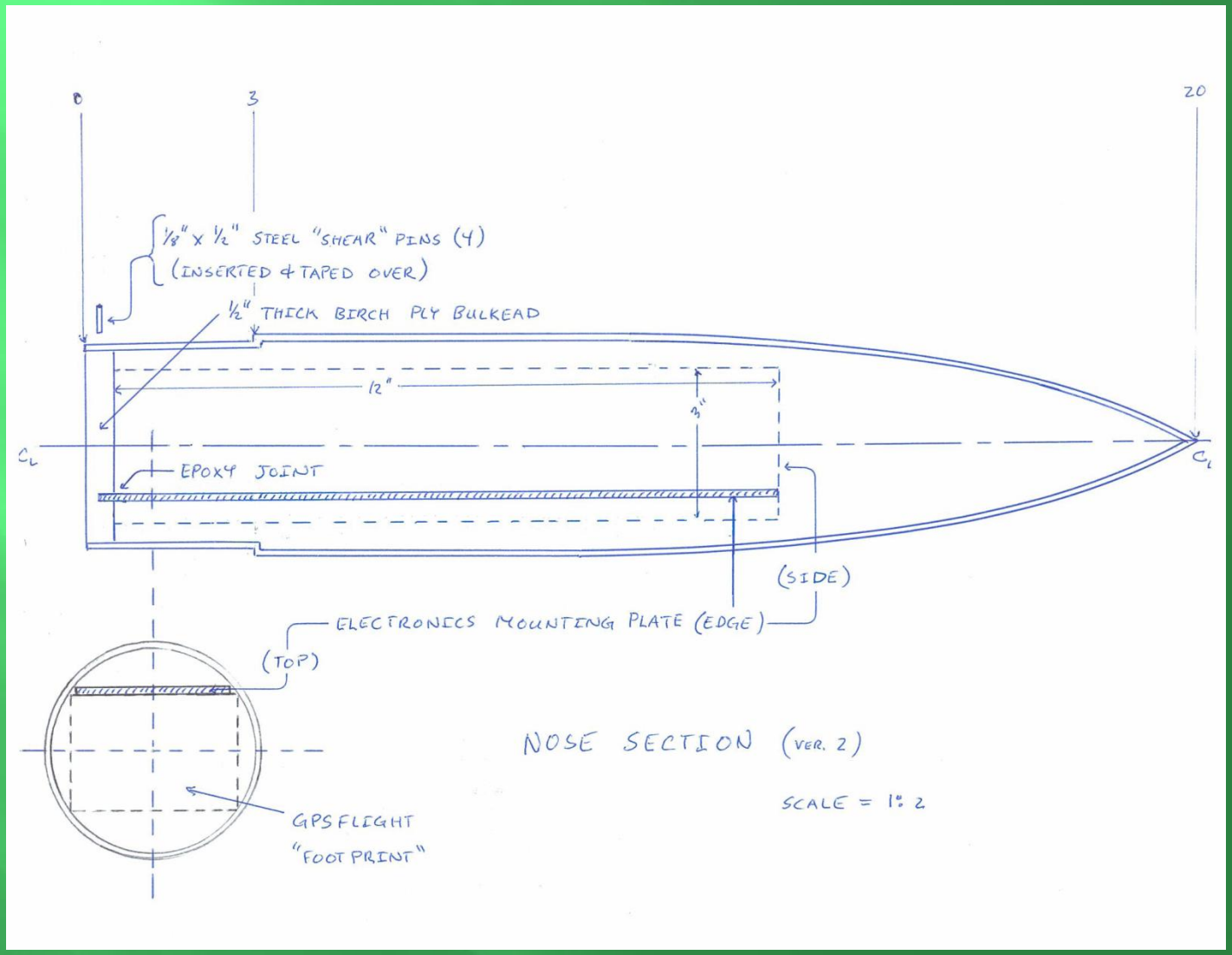
- Length: 86”
- Diameter: 4”
- Weight: 20 lbs., unloaded
- Weight: ~25 lbs., on the pad
- Materials: G10 Fiberglass
- Recovery: Dual Deployment, electronic
- Propulsion: 75mm Aerotech K560W

Characteristics

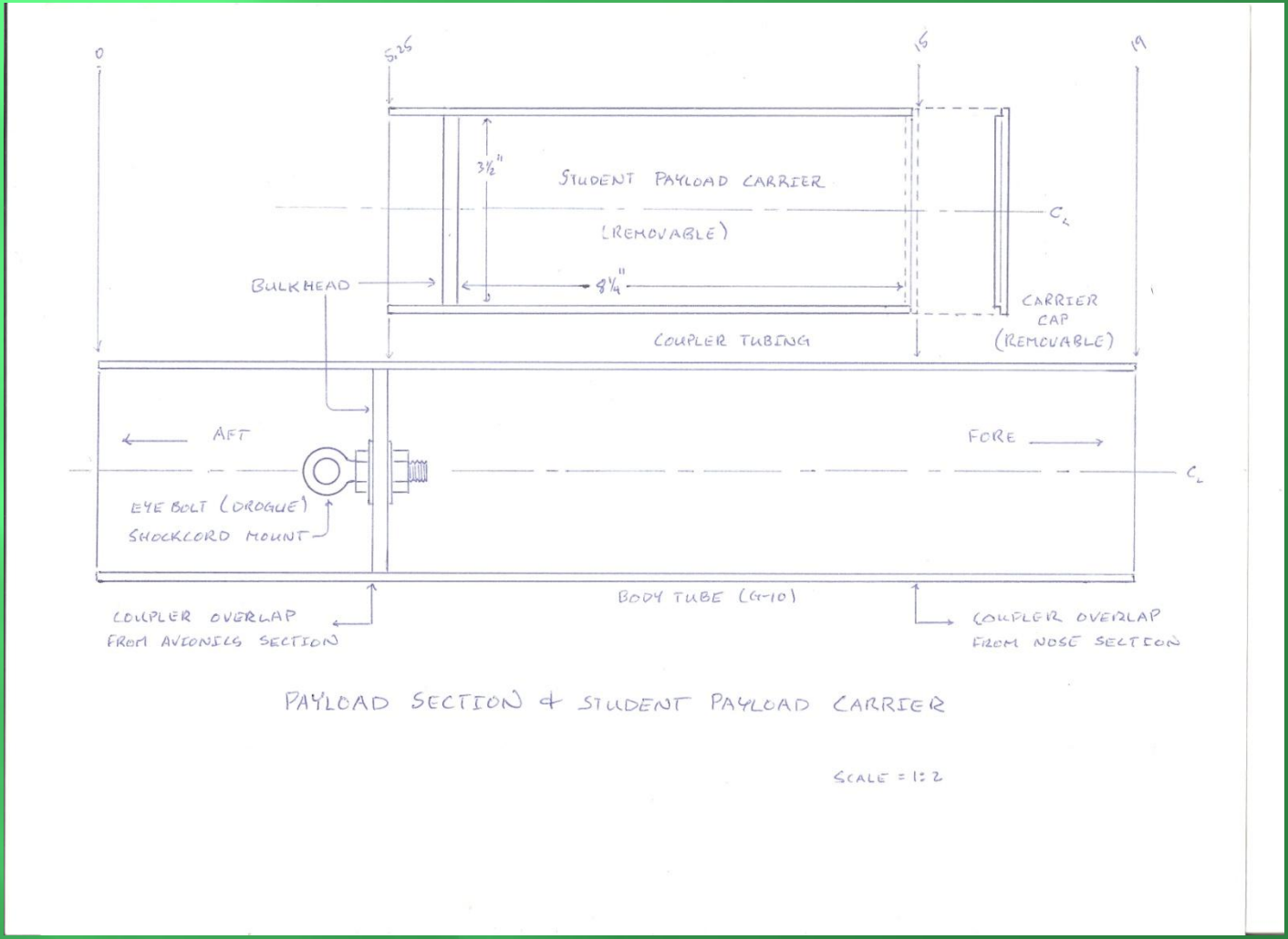
- Electronics in nose cone
- Drag shoe system
- Three fin design



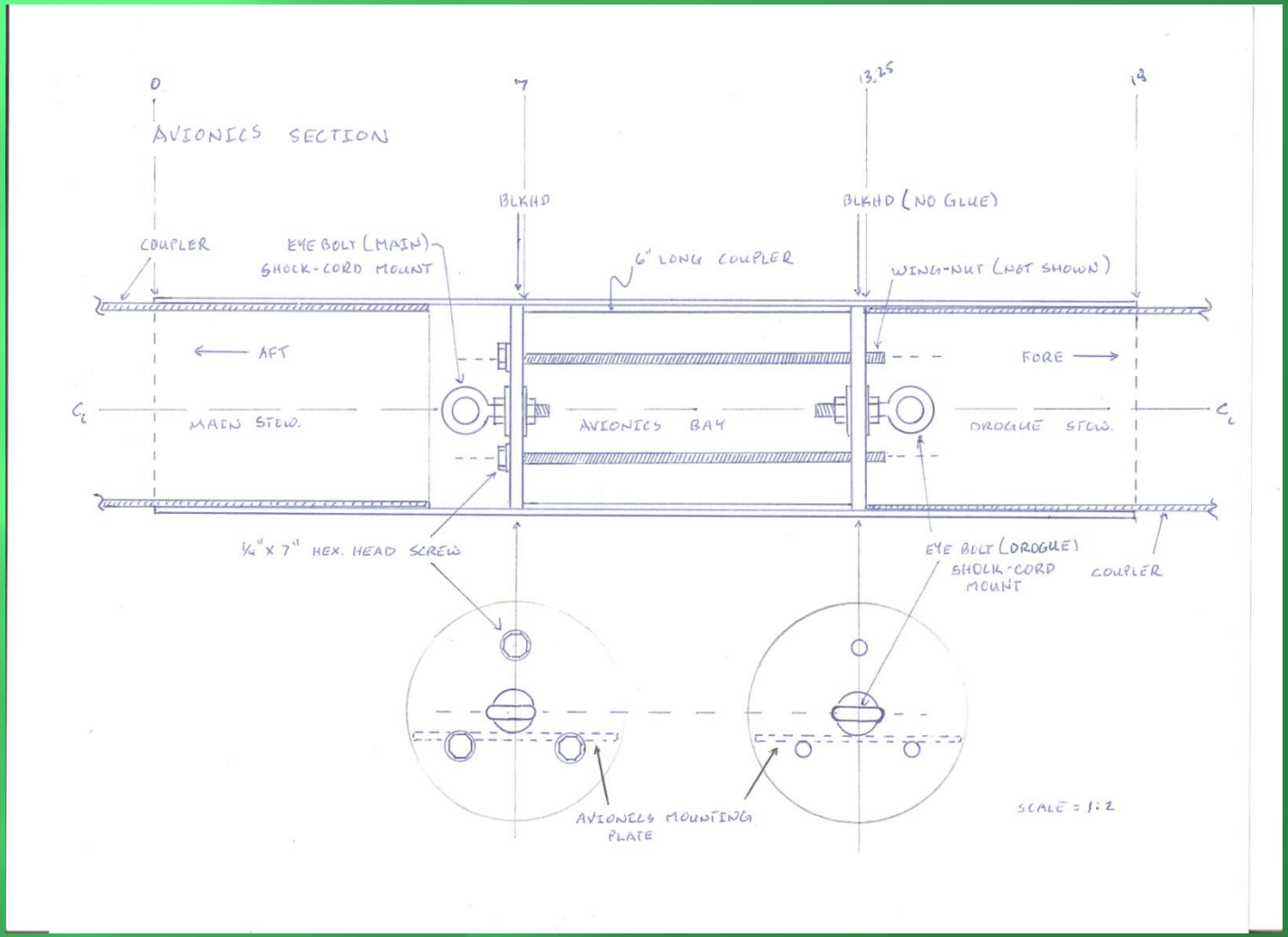
Nosecone Detail



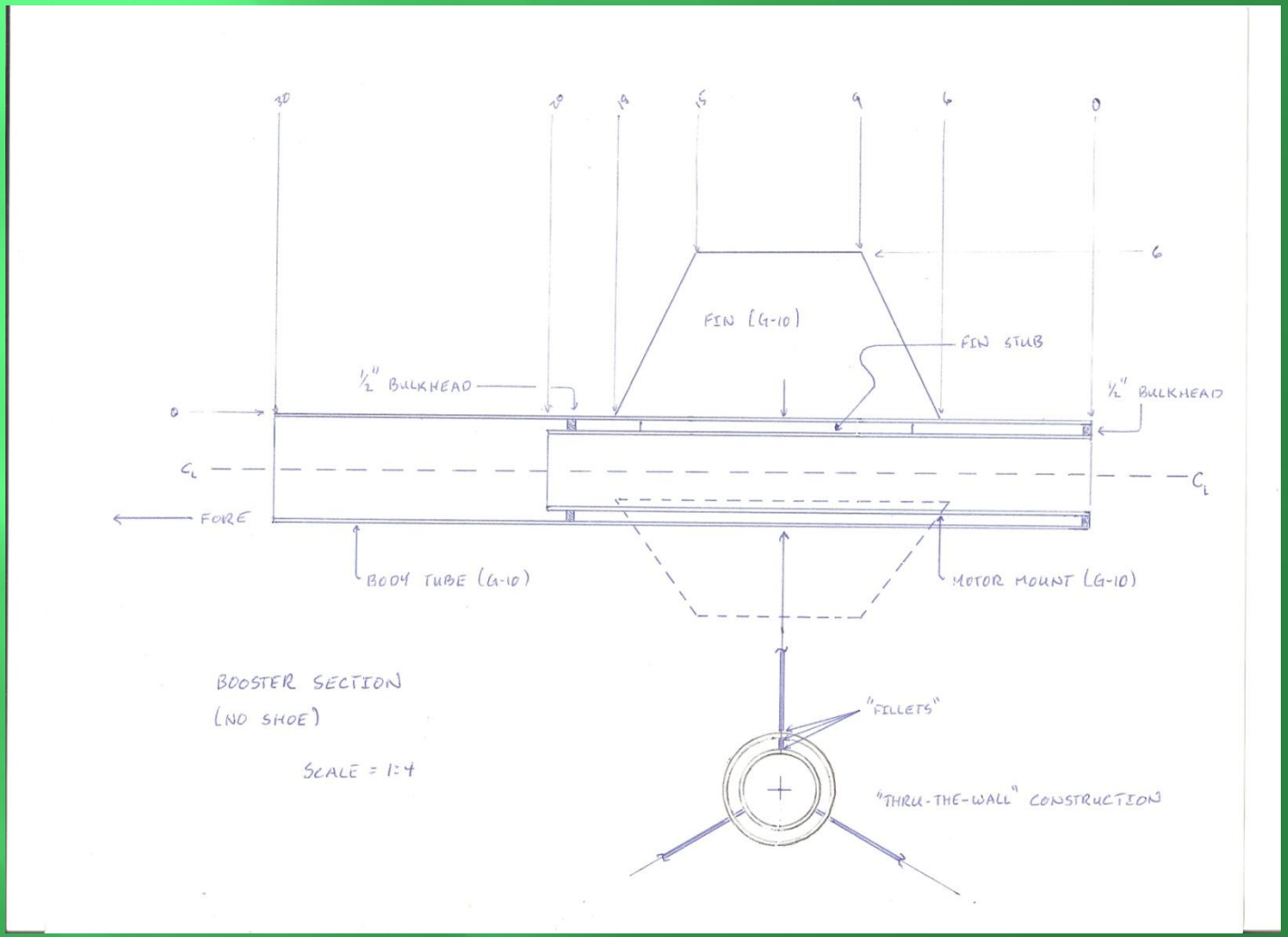
Payload Detail



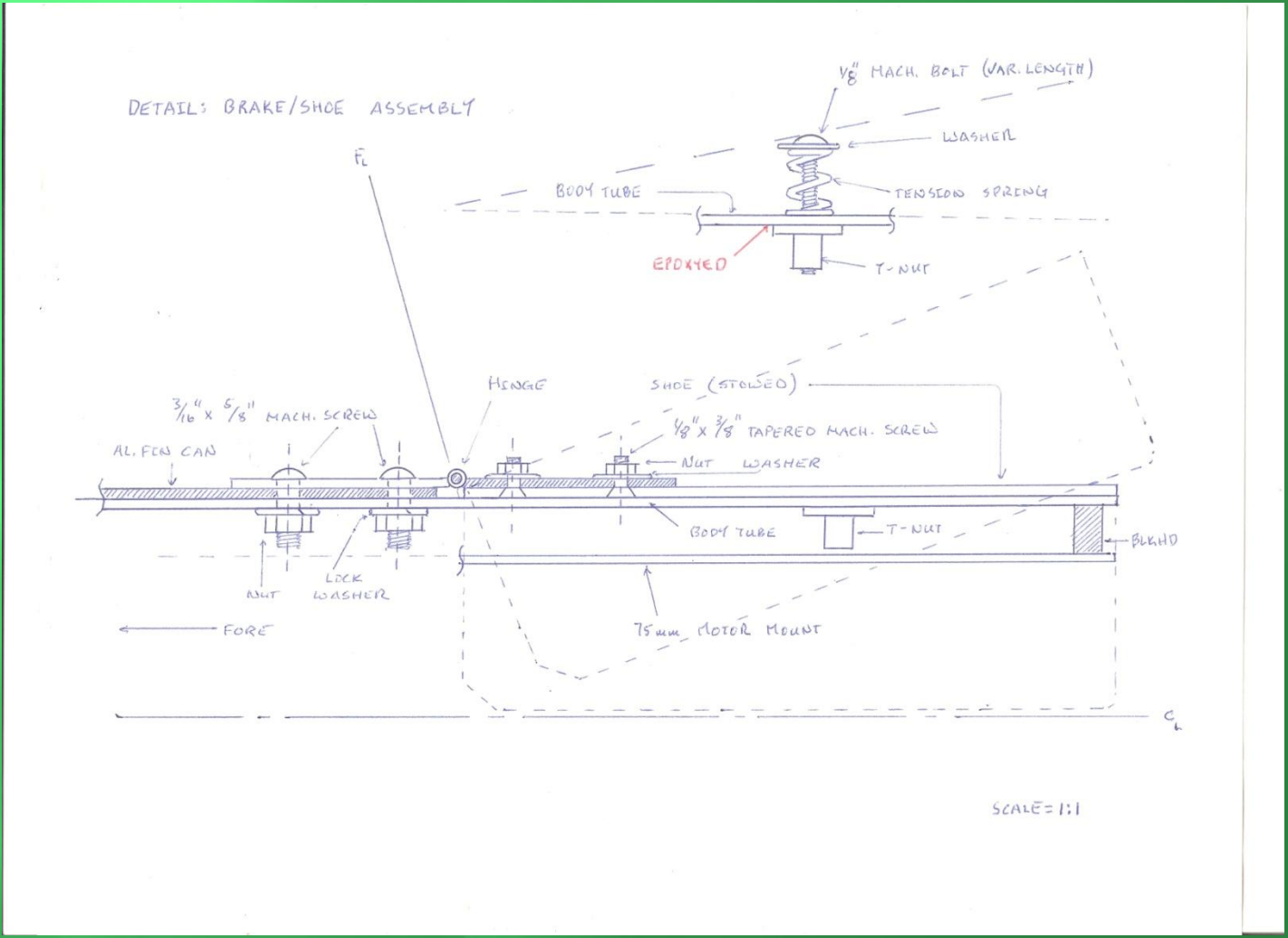
Avionics Detail



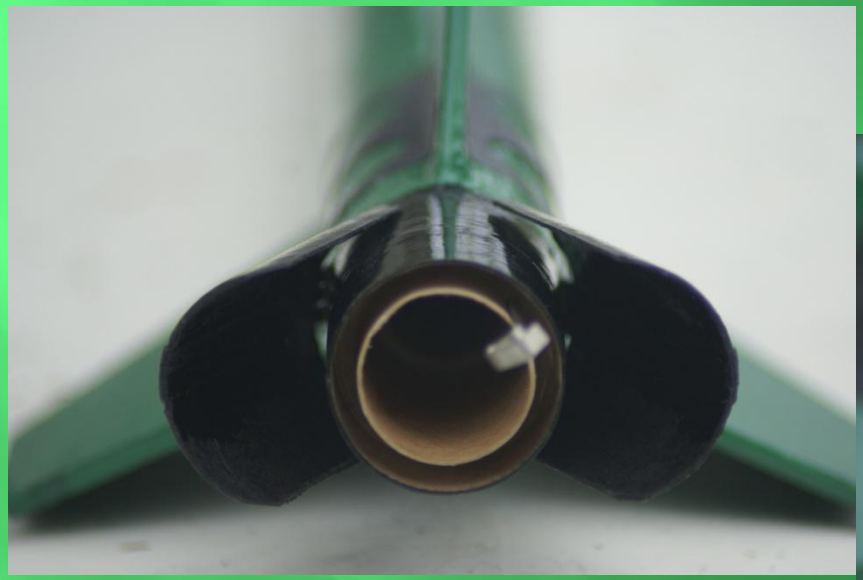
Booster Detail



Drag Shoe Detail



3/8 Scale Drag Shoe



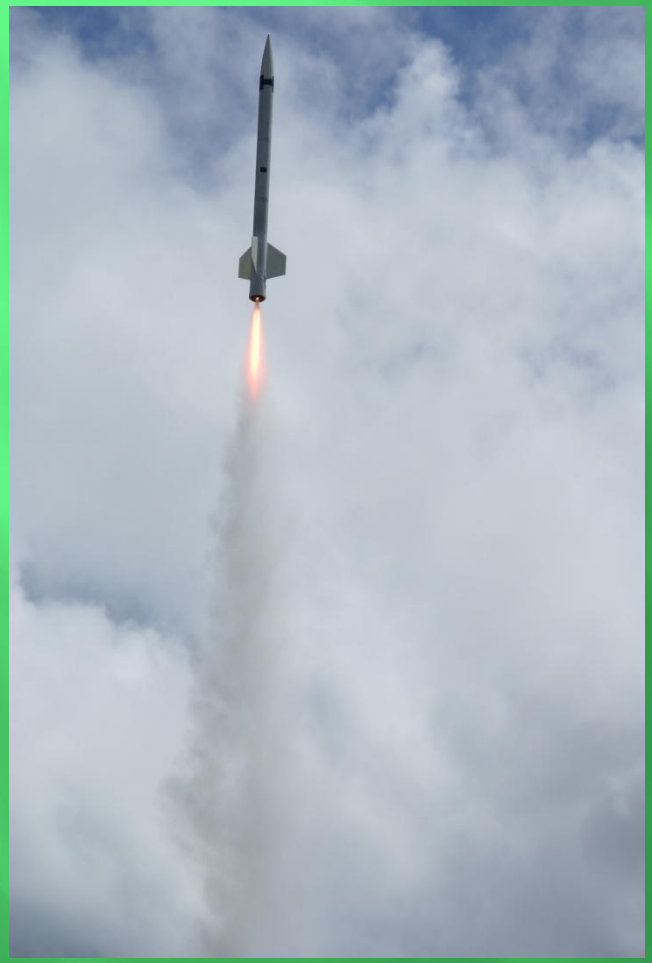
Flight Testing

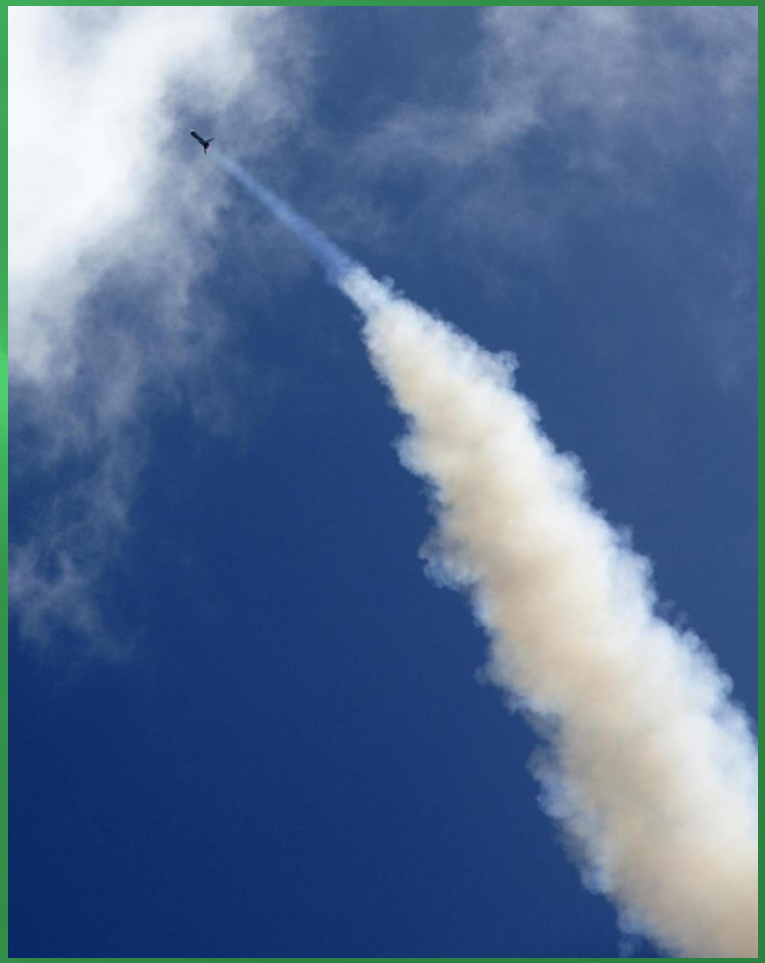
Full Scale

Deployment Testing

Deployment test video link:
http://www.youtube.com/user/hrapozo#g/c/C63EC3A5EC384256

Full Scale Testing

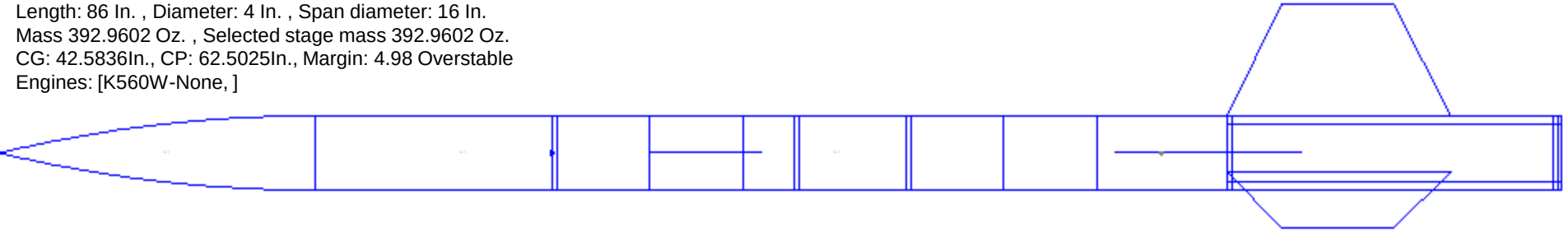




Test launch video:
http://www.youtube.com/user/hrapozo?feature=mhw4#p/c/2876F744B00AF01E/0/lENAOq6s7q0

RockSim Data

Leo Hano rocket
Length: 86 In. , Diameter: 4 In. , Span diameter: 16 In.
Mass 392.9602 Oz. , Selected stage mass 392.9602 Oz.
CG: 42.5836In., CP: 62.5025In., Margin: 4.98 Overstable
Engines: [K560W-None,]



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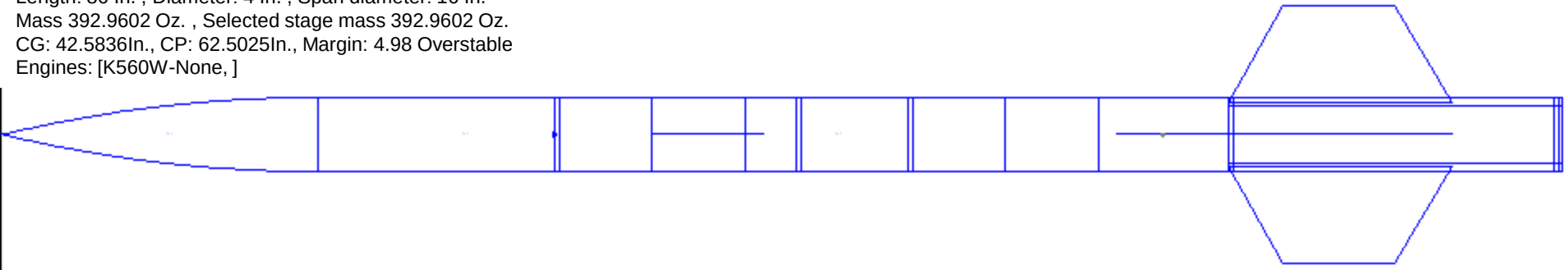


RockSim Results

Simulation control parameters

- Flight resolution: 800.000000 samples/second
- Descent resolution: 1.000000 samples/second
- Method: Explicit Euler
- End the simulation when the rocket reaches the ground.

Launch conditions

- Altitude: 0.00000 Ft.
- Relative humidity: 50.000 %
- Temperature: 59.000 Deg. F
- Pressure: 29.9139 In.

Wind speed model: Calm (0-2 MPH)

- Low wind speed: 0.0000 MPH
- High wind speed: 2.0000 MPH

Wind turbulence: Fairly constant speed (0.01)

- Frequency: 0.010000 rad/second

- Wind starts at altitude: 0.00000 Ft.
- Launch guide angle: 0.000 Deg.
- Latitude: 0.000 Degrees

Launch guide length: 144.00 in.
Velocity at launch guide departure: 62.6080 ft/s
Launch guide was cleared at : 0.389 sec

RockSim Results

Max data values:

- Maximum acceleration:Vertical (y): 369.942 Ft./s/sHorizontal (x): 2.679 Ft./s/sMagnitude: 370.000 Ft./s/s
- Maximum velocity:Vertical (y): 1409.3348 ft/s, Horizontal (x): 2.9333 ft/s, Magnitude: 1409.4989 ft/s
- Maximum range from launch site: 427.87809 Ft.
- Maximum altitude: 18714.96241 Ft.

Recovery system data

- P: Drogue Deployed at : 32.499 Seconds
- Velocity at deployment: 11.6554 ft/s
- Altitude at deployment: 18714.96240 Ft.
- Range at deployment: -427.87809 Ft.
- P: Main chute Deployed at : 267.926 Seconds
- Velocity at deployment: 68.1610 ft/s
- Altitude at deployment: 499.99519 Ft.
- Range at deployment: 110.94046 Ft.

Time data

- Time to burnout: 5.861 Sec.
- Time to apogee: 32.499 Sec.
- Optimal ejection delay: 26.637 Sec.

Landing data

- Successful landing
- Time to landing: 279.839 Sec.
- Range at landing: 120.95958
- Velocity at landing: Vertical: -40.6380 ft/s , Horizontal: 0.7629 ft/s , Magnitude: 40.6452 ft/s

Recovery Details

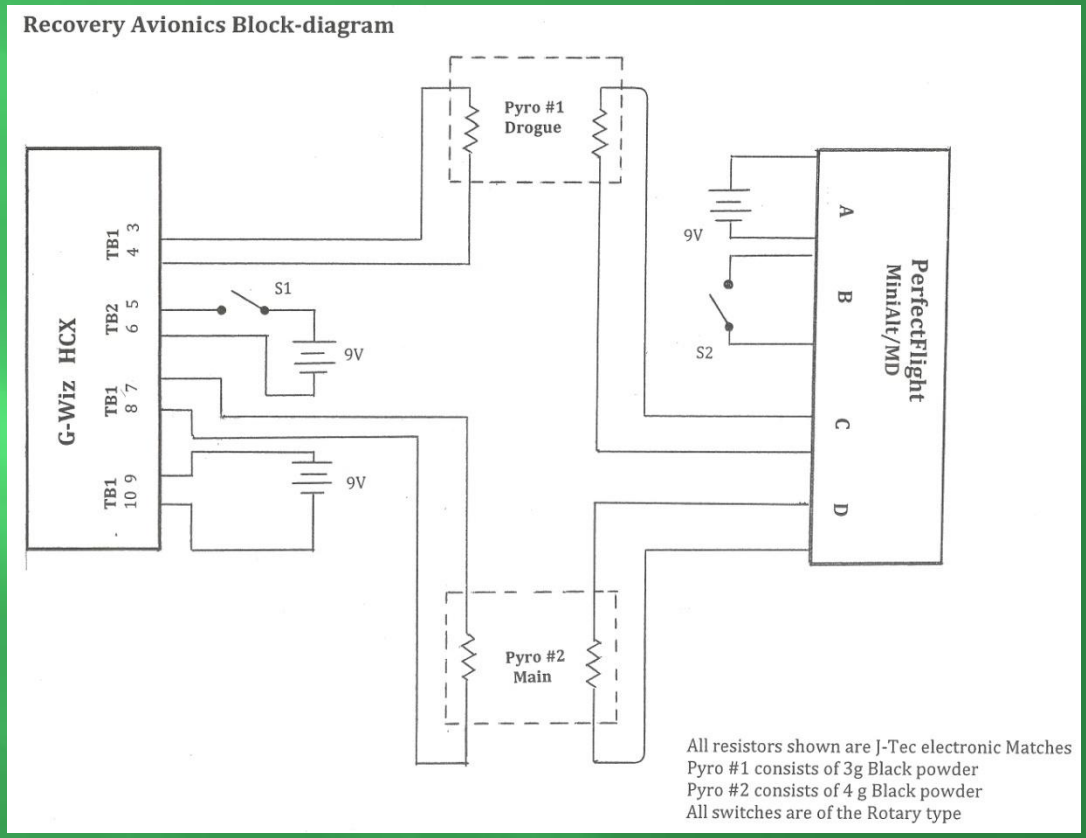
Dual Deployment

Primary Controller:
G-Wiz HCX Flight Computer, Dual 9V Lithium batteries

Auxiliary Controller:
Perfect Flight MAWD, 9v Lithium

Drogue Chute: 36”
Deployed at Apogee

Main Chute: 96”
Deployed at 500’



Drogue Decent rate: 60ft/sec
Drogue Charge: 3g Black Powder

Main Decent rate: ~20ft/sec
Main Charge: 4g Black Powder

LEO HANO PAYLOAD

Rockets that can be used

- Leo Hano – Windward Community College (WCC)'s USLI project. Uses a J to K class motor. Need to be flown on big fields.
- Caliber ISP – Uses a G to I class motor. Need to be flown on big fields.
- Executioner – Uses a D to E class motor. Can be flown at the monthly launches held at WCC.
- Omega – Uses a C to E class motor but is able to loft a Sparrow unit on a D motor with no problem and can be flown on the monthly launches held at WCC.

Phases of construction

- **Phase I – Unit is built on a commercially available development board. At this stage you just have to worry about controller code development and device hookups.**
- **Phase II – Unit is built on a breadboard. At this stage you need to worry about power supply and communication issues. It is possible to fly a Phase II unit in a rocket but not recommend in the long run.**
- **Phase III – Unit is built on a circuit board, this is what flies in a rocket.**

Mynah Bird 2

- Original electronic payload to be flown on the Windward Community College's Leo Hano project.
- Mynah Bird 2 was designed to measure air temperature, air pressure and acceleration during a rocket flight.
- Delays were encountered in device protocols, work site issues and the need of G class motor rocket to flight test Mynah Bird 2.
- Will continue to work on this project at a later date.

What to do instead

- Instead of lofting one big electronic project, loft 2 to 3 smaller independent electronic projects.
- Each smaller project can be lofted on a C to E class motor rocket for flight testing.
- Use either existing projects or do a new one that can rapidly be built using available parts.

List of projects to be lofted in the Leo Hano

- Sparrow1 – air temperature
- Sparrow10 – acceleration
- Sparrow12 – acceleration

Mission of Sparrow1

- Measure the air temperature of the payload bay at one second interval.
- Store this data in an external EEPROM.
- When the mission is over and Sparrow1 has been retrieved, it will then be hooked up to a computer's serial port. The data from the EEPROM will be displayed and captured to a file on the computer for later processing.

Sparrow1 Data Limits

- Uses a 24LC256 EEPROM that has a capacity of 32K bytes of storage
- 4 bytes per sample
- 1 sample per second
- 8192 samples
- Should be able to record 136 minutes worth of data

Status of Sparrow1

- Originally started in the Spring of 2008
- The project has logged 3 flights using 2 different units.
- The latest unit was last flown in December 2008 and still exist.
- Will need to make a new unit since the current unit doesn't fit into the Omega payload bay.

Mission of Sparrow10

- Measure the X, Y and Z acceleration at one second interval
- Store this data in the controller's EEPROM.
- When the mission is over and Sparrow10 has been retrieved, it will then be hooked up to a computer's serial port. The data from the EEPROM will be displayed and captured to a file on the computer for later processing.

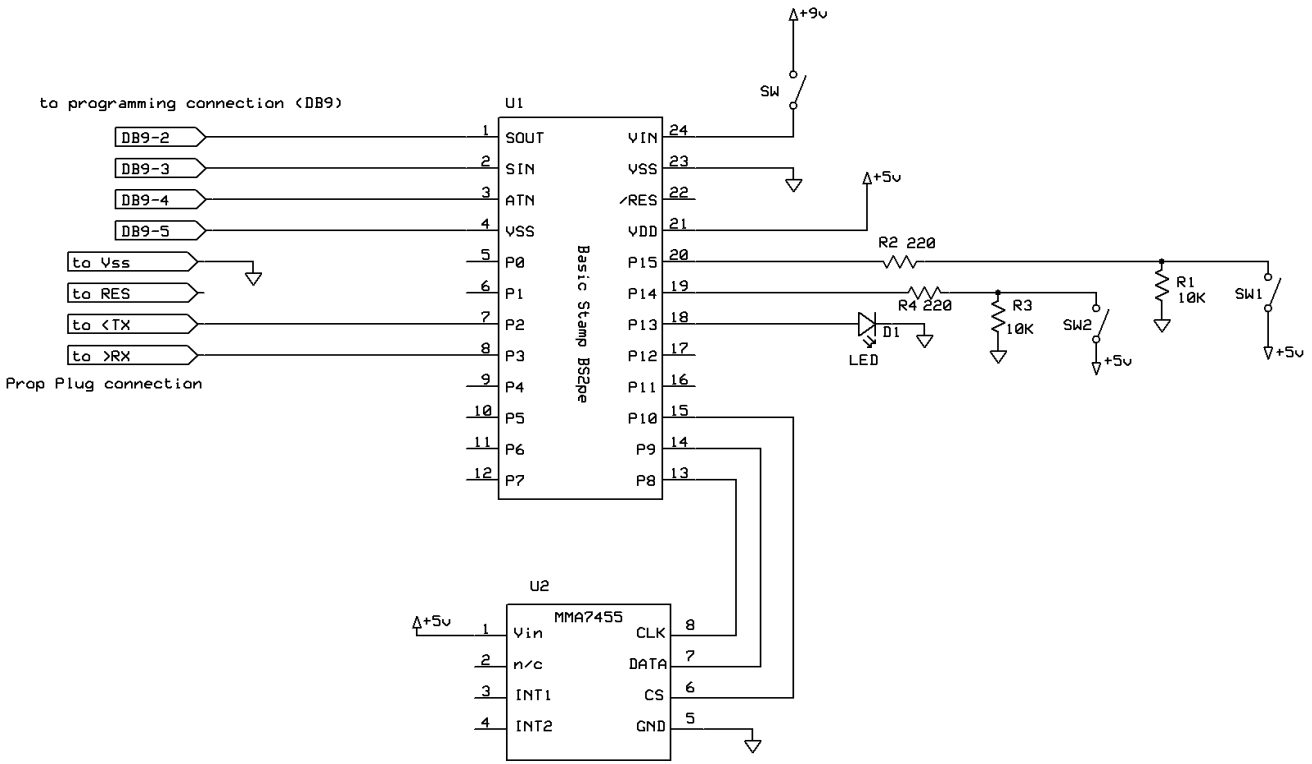
Sparrow10 Data Limits

- The Basic Stamp 2pe controller has 16K bytes of EEPROM, organized as eight 2K byte data segments.
- 3 bytes per sample.
- 1 sample per second.
- 660 samples per segment for a total of 5280 samples.
- 11 minutes per segment for a total of 88 minutes.

Status of Sparrow10

- Been working on this project since February 2010.
- Unit #1 – Phase I – completed 02/22/10
- Unit #2 – Phase II – completed 03/05/10, used on the Leo Hano deployment test and has flown 3 times on an Omega rocket.
- Unit #3 – Phase II – completed 03/12/10 flown on the Leo Hano rocket once.
- Unit #4 – Phase III – not started yet, parts are on order and need to work on the circuit board.

Circuit diagram of Sparrow10



Honolulu Community College		
Sparrow10 - unit #3		
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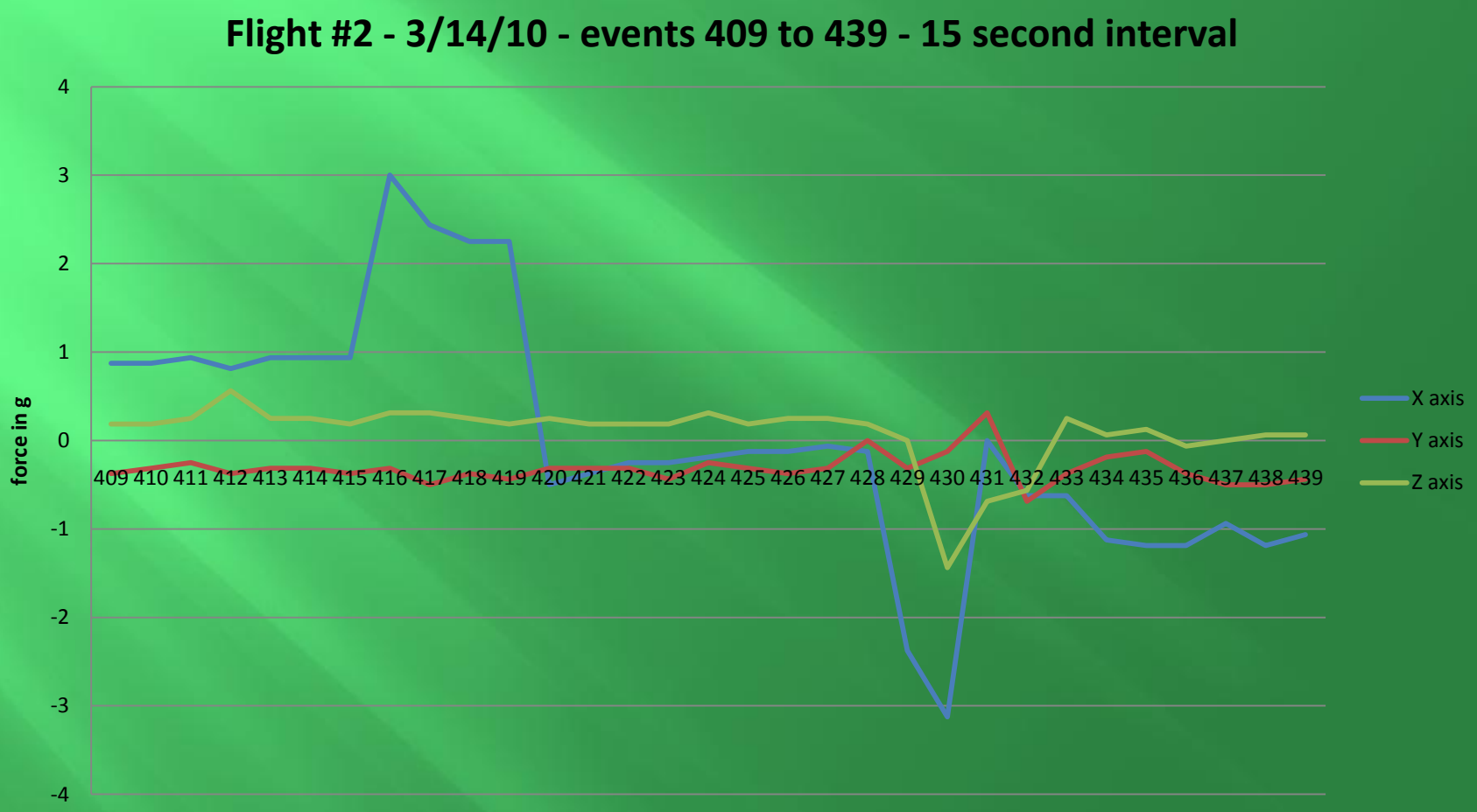
Sparrow10 – unit #2

Carried on board an Omega 24e rocket using a D12-5 motor. The photo on the right is from flight #2 on March 14, 2010 at the Kaneohe Marine Base.

Flight #	Date	Rocket	Engine	# of samples
1	3/14/10	Omega 24e	D12-5	464
2	3/14/10	Omega 24e	D12-5	662
3	3/14/10	Omega 24e	D12-5	936

Omega on D12-5 – ½ second sample rate

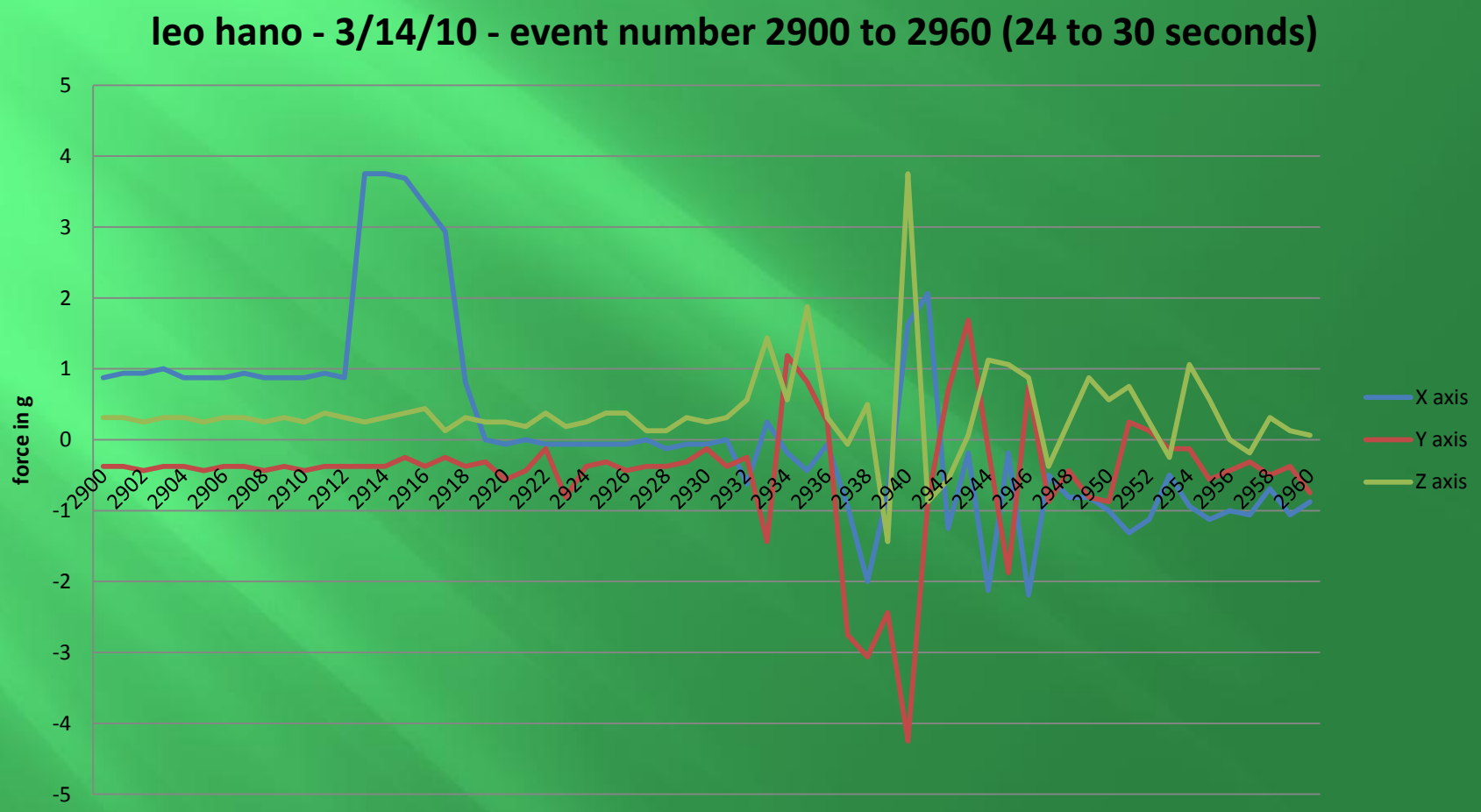


Sparrow10 – unit #3

Photo on the right is from the Leo Hano rocket on March 14, 2010.

Flight #	Date	Rocket	Engine	# of samples
1	3/14/10	Leo Hano	J315R	5280

Leo Hano on J315R – ½ second sample rate



Mission of Sparrow12

- Measure the X, Y and Z acceleration between 2 to 5 samples per second.
- Store this data in an external EEPROM.
- When the mission is over and Sparrow12 has been retrieved, it will then be hooked up to a computer's serial port. The data from the EEPROM will be displayed and captured to a file on the computer for later processing.

Sparrow12 Data Limits

- Plan to use a 24LC512 EEPROM that can hold 64K bytes of storage.
- 3 bytes per sample
- 21840 samples
  - 364 minutes – 1 sample/second
  - 182 minutes – 2 samples/second
  - 121 minutes – 3 samples/second
  - 91 minutes – 4 samples/second
  - 72 minutes – 5 samples/second

Status of Sparrow12

- Still in the planning stages.
- The parts that were meant for Mynah Bird 2 will be used for Sparrow12.
- The controller code is roughly the same as Sparrow10 but with the additional external EEPROM and a faster controller.

PAU