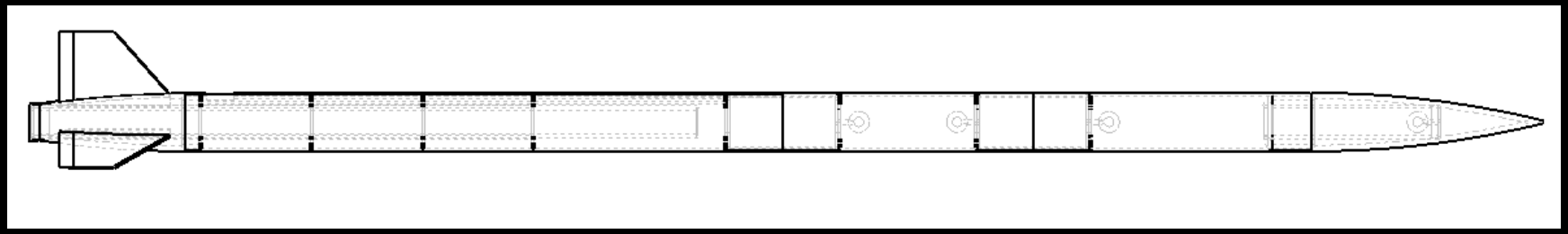
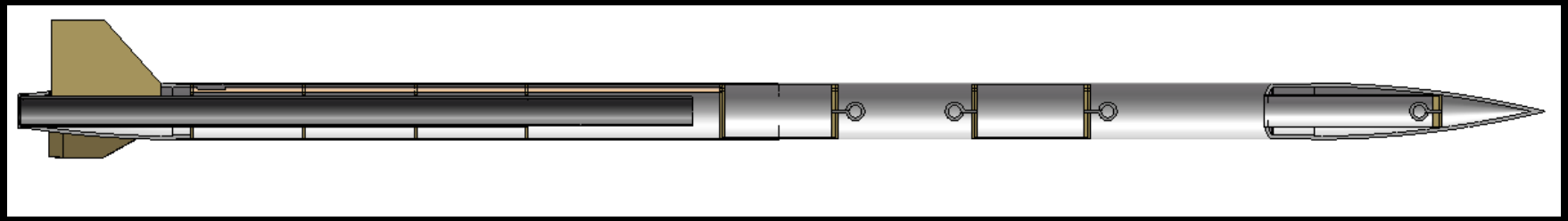
Harding University Flying Bison 2009 FRR Presentation

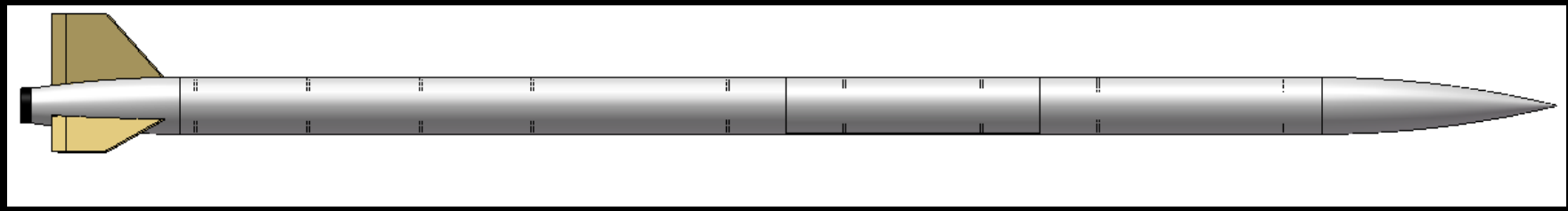
Vital Statistics

Size:	3.9” ID, ~4.0” OD, 9.5’ Full Length
Motor Choice:	K-265 Contrail Rockets Hybrid, 54mm
Recovery System:	Drogue - 24” Classic II Sky Angle
	Main - 60” Classic II Sky Angle
	Electric Match Ejection Charges
Rail Size:	> 8 feet
No. of Fins:	3

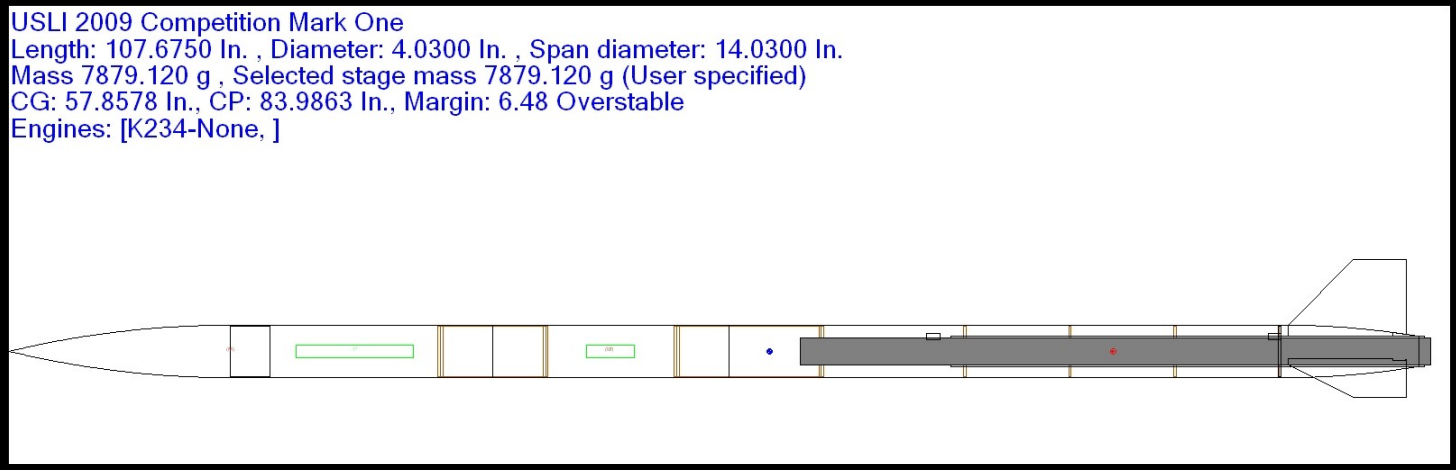
Overall Rocket Design







Rocket Flight Stability

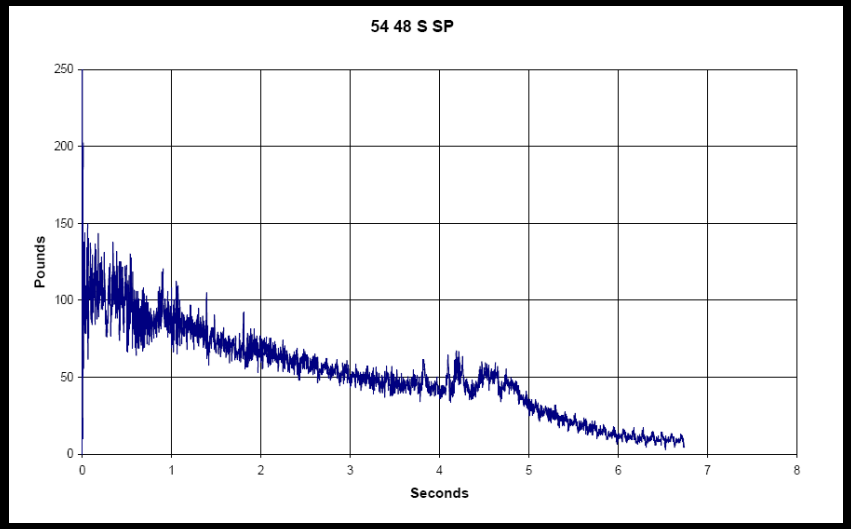


- CP: 83.99” from nose of vehicle
- CG: 57.86” from nose of vehicle
- Vehicle is overstable by a margin of 6.48 body calibers.

Thrust to Weight Ratio

- The ratio of the average thrust of the K-265SP hybrid rocket motor to the weight of the vehicle is 4.72.

Thrust to Weight Ratio



- The weight of the vehicle was determined from the actual weight of all components, including the scientific payload.

Rail Exit Velocity

- The rail length required for this vehicle is 8’ or greater.
- According to simulations, the velocity upon departure from an 8’ launch guide is 53.54 ft/s.
- According to simulations, the launch guide will be cleared 0.335 seconds from ignition.

Parachute Size and Descent Rates

- Main Parachute:
  - 60” Classic II Sky Angle Parachute
  - Descent Rate: 16.2 ft/s
  - Cd: 1.890
  - Shroud Line Length: 60”
- Drogue Parachute:
  - 24” Classic II Sky Angle Parachute
  - Descent Rate: 50.4 ft/s
  - Cd: 1.160
  - Shroud Line Length: 24”

Test Plans and Procedures

- A test flight of the launch vehicle did occur on March 15th, with a subscale motor to keep the rocket beneath the ceiling of the Memphis NAR club.
- The motor used was a J-265SP, and the maximum altitude reached was 2047 feet.

Test Plans and Procedures

- All data acquisition, telemetry, and GPS subsystems have been tested.
- An on-board power regulator has constructed to meet the power requirements of all of the electronics.

Test Plans and Procedures

- Several of our team members have completed their Level Two certification flights.
- These flight have provided additional testing of our avionics subsystems *in situ*.
- These test flights have all employed hybrid rocket motors, which has provided opportunity for testing our support system.

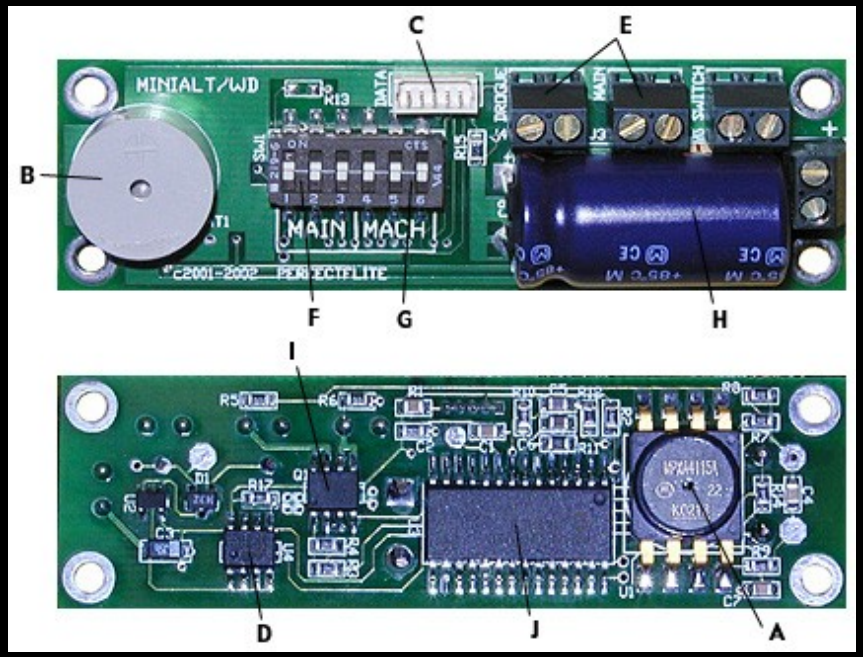
Scale Model Test Flight

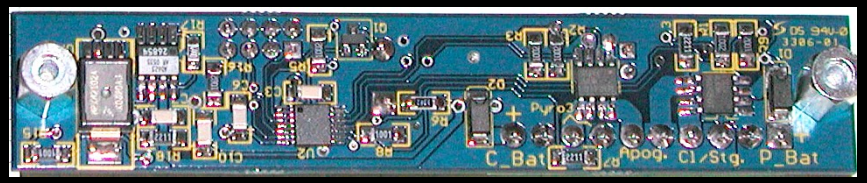
- Two separate scale models of the competition rocket have been flown, constructed from similar materials and of similar dimensions.
- Both flights were complete successes, and provided proof of concept of the competition vehicle as well as necessary experience in the preparation of a high-powered rocket for the team.

Dual Deployment Avionics Test

- The avionics systems, redundant PerfectFlite MAWD and G-Wiz LCX systems, have been tested and shown to successfully deploy the drogue and main parachutes at the desired altitudes.
- Both systems have passed all self and bench tests, firing both the drogue and main parachute separation charges.
- These two avionics subsystems will be used for redundant recovery system deployment, for safety purposes.

Dual Deployment Avionics Test





Ejection Charge Amount Test

- Both ground testing and flight testing of the ejection charges has confirmed that 3 grams of FFFG black powder provides complete separation and deployment of both the drogue and main parachutes.

Payload Integration Feasibility

- The REMSPEC has been designed to fit in a 3.8” x 10” cylinder so the instrument may be fit into a coupler tube section.
- A piece of aluminum tubing will be run through small holes in the centering rings alongside the motor mount tube, to give the fiber optic cable access to the exhaust plume.
- The data acquisition and telemetry subsystems will be housed in a similar, adjacent cylinder custom-cut to hold all components in proper orientation.
- Both sections of the payload will simply be slid in to the airframe and fixed with six nylon bolts, as part of a coupler section.

Science Payload

- ***R***ocket ***EM***ission ***SPEC***trometer, **REMSPEC**
- Measures emission spectrum of the exhaust plume of our hybrid rocket
- Spectral range of 280 nm through 1000 nm
- Measured at a rate of five times per second starting at ignition and continuing through burnout (approximately four seconds).

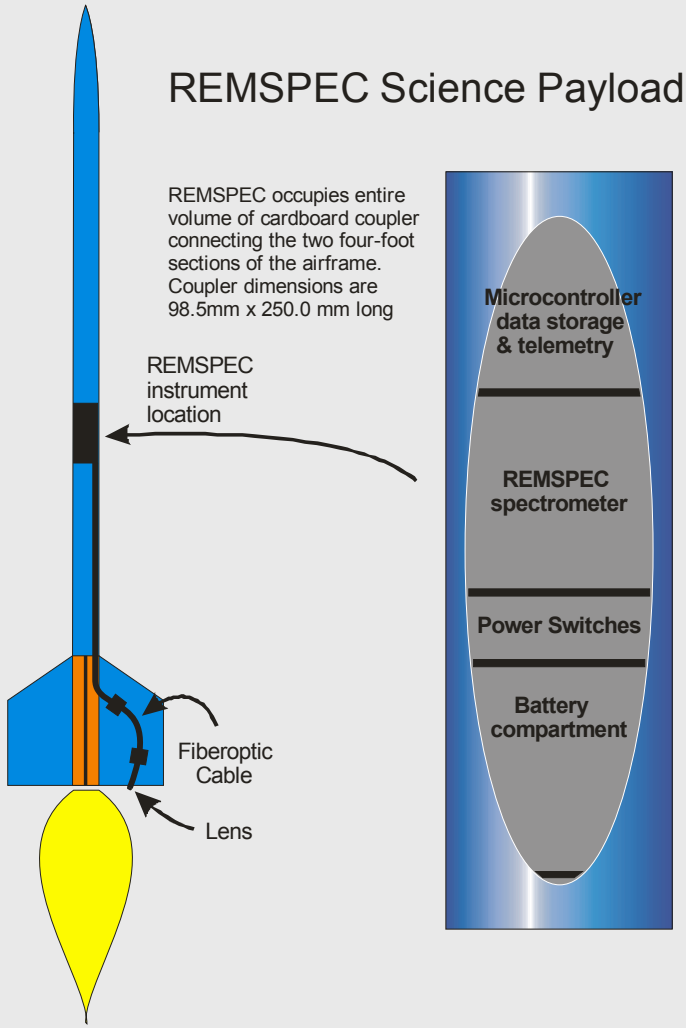
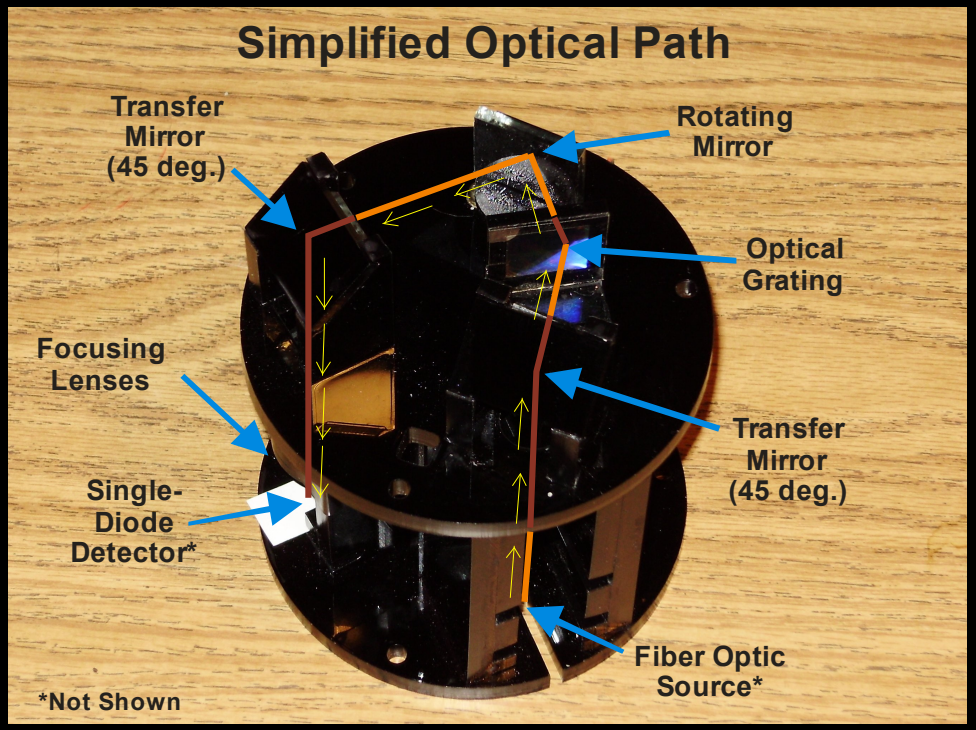


Figure 4.1 Schematic showing REMSPEC location and fiber optic cable placement.

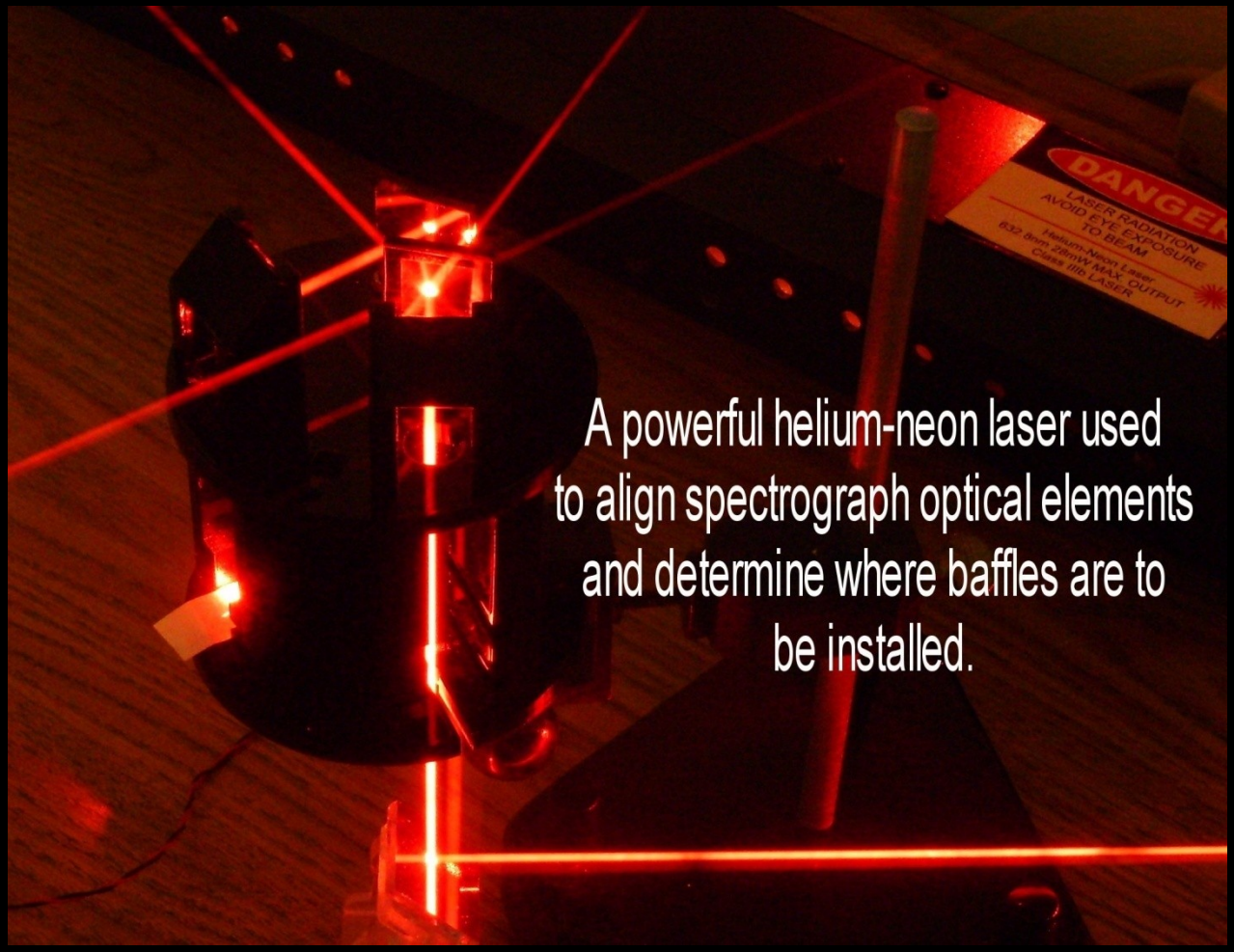
Figure 4.2 Schematic of coupler tube showing arrangement of sub systems.



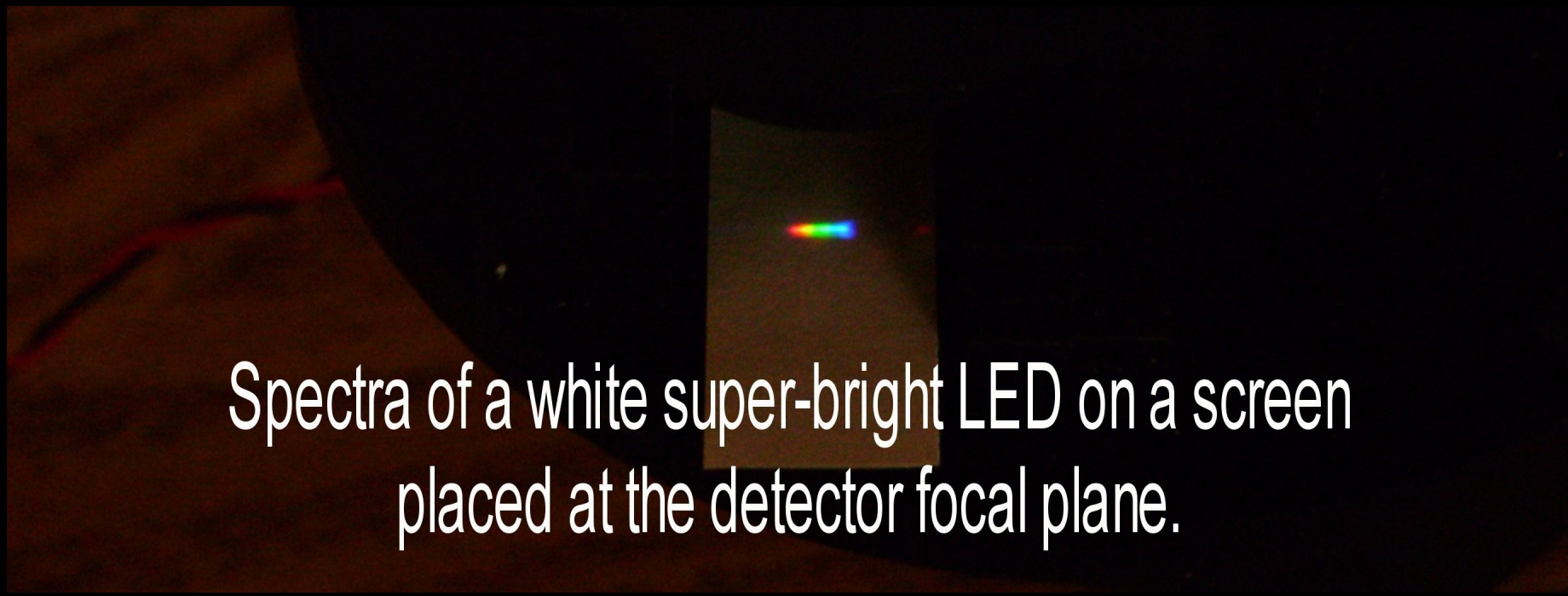
REMSPEC

Showing folded light path which allows maximum light path length while minimizing construction volume.

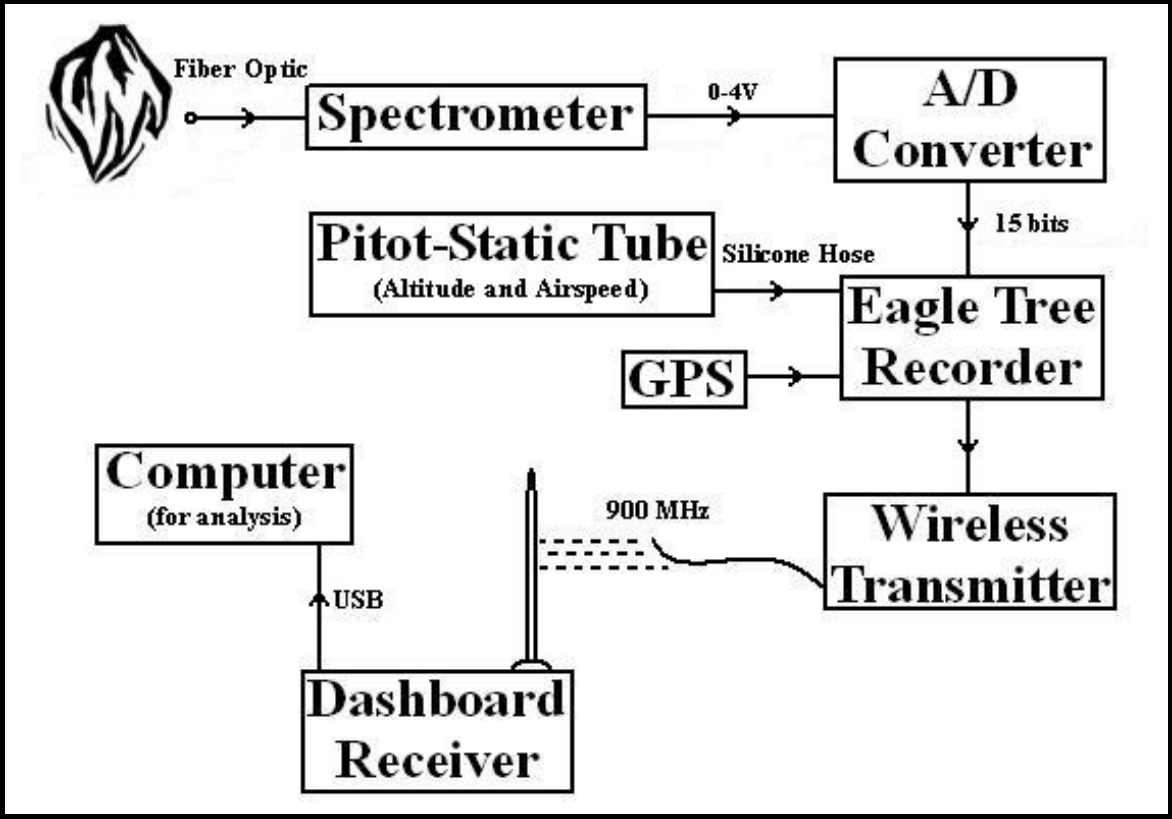
REMSPEC Alignment



Test Spectrum of LED



Microcontroller



SeaGull HP High Powered Rocketry Package

- Wireless Telemetry Transmitter, 900 Mhz, 200 mW
- Dashboard Receiver
- Flight Data Recorder
- Two – 15 bit A/D digital recorders
- GPS
- SMA Dashboard Antenna
- Pitot Tube for altitude and velocity

What Do We Expect to Find in Exhaust Plume?

Table 1. Common Species Found in Emission Spectra of Flames

Species		Type of Transition	
OH	263 nm – 289 nm	$A \rightarrow X$	OH and CH spectra overlap in this region
OH	306 nm – 324 nm		$A \rightarrow X$
CH	415 nm – 440 nm		$A \rightarrow X$
CH	386 nm – 404 nm		$B \rightarrow X$
C_2	460 nm – 560 nm		$d \rightarrow a$
O_2	759 nm – 770 nm		$b \rightarrow X$
H_2O	606 nm – 758 nm		3rd overtone vibrational stretch
H_2O	778 nm – 861 nm		3rd overtone vibrational stretch
H_2O	9400 nm – 9700 nm		3rd overtone vibrational stretch
Metals	350 nm – 700 nm		metal impurities at distinct, known wavelengths

Budget

Item	Amount
Rocket Airframe	300.00
Parachutes and Safety Harness	100.00
Construction Hardware and Consumables	200.00
Perfect Flight MAWD	100.00
Materials for Science Payload	600.00
Contrail Rocketry Hybrid Motor System and Reloads	500.00
Nitrous Oxide, Motor Fuel Grains, Launch Consumables	300.00
NAR Level 1 and Level 2 Licensure	200.00
Outreach	100.00
Travel to Competition Launch at Space Flight Center (10 Travelers)	2600.00
Total Estimated Expense	5000.0

Outreach

- 3rd Grade Class at Westside Elementary
- Civil Air Patrol Cadet Program
- Newspaper Articles
- Local Radio Interviews

Acknowledgement

- Departments of Chemistry, Engineering and Physics
- Arkansas Space Grant Consortium
- Arkansas/NASA Workforce Development