



**Designing Intelligent
Rockets**



Introduction

The Portland State Aerospace Society

Started in 1997 because undergraduate electrical engineering labs don't blow up.

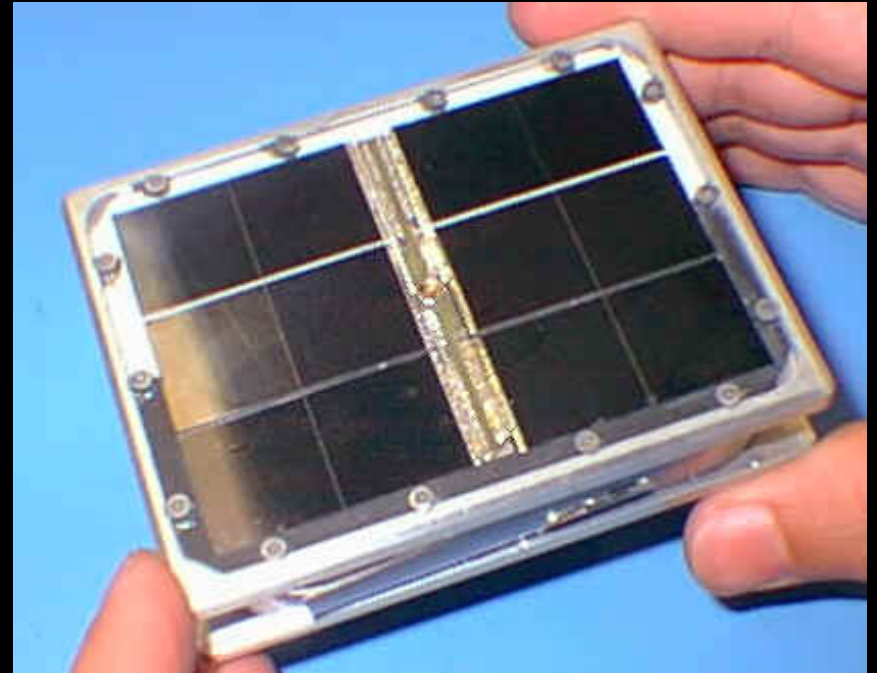
Consists of :

- Undergraduate and graduate students
- Community members

The Portland State Aerospace Society

- The PSAS
“vision statement”:

**Put a nanosatellite
into orbit.**



What do you need to get there?

1. A really, really big rocket

- Done: amateurs have already gone well past 100 km

2. A lot of money and lawyers

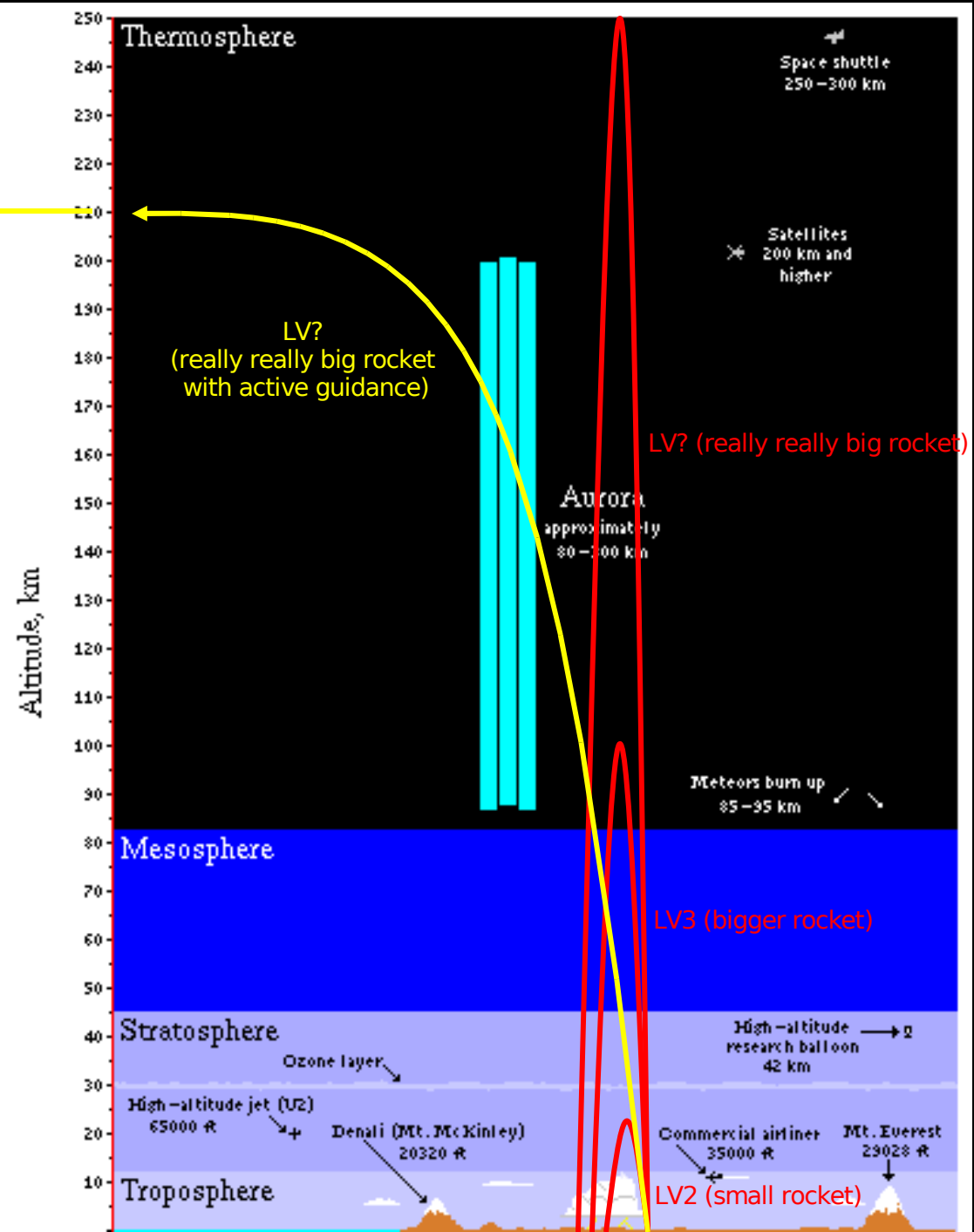
- Anyone have a spare \$1 million (or so)?

3. Active guidance

- Can't just go up, need to follow a trajectory into orbit
- Commercial guidance systems cost > \$250,000
- No amateur group has ever done active guidance (because it's really, really, really hard to do)

Going Up: SubOrbital & Orbital Rockets In Context

7.6m/s = 17,000mph = Mach 10



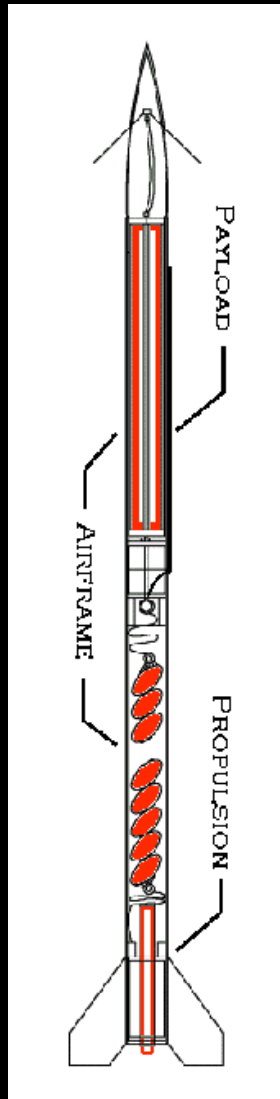


Launch Vehicle 0: Starting Small

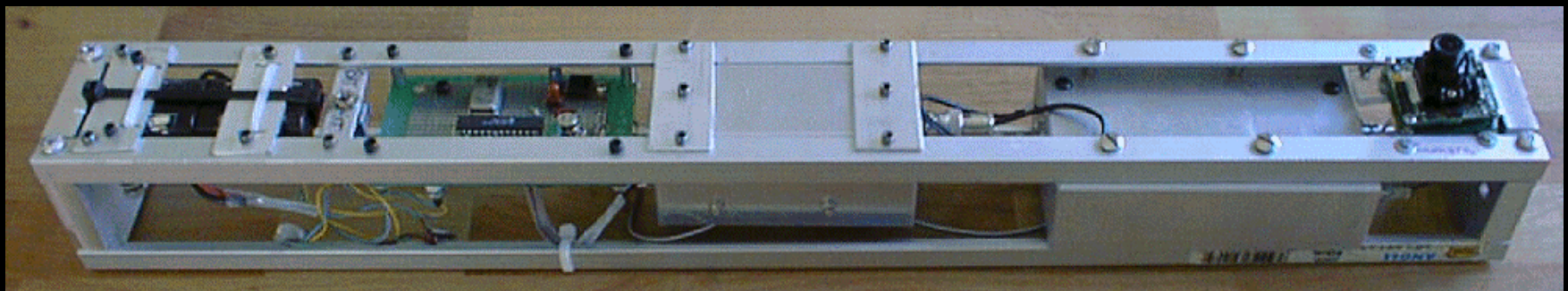
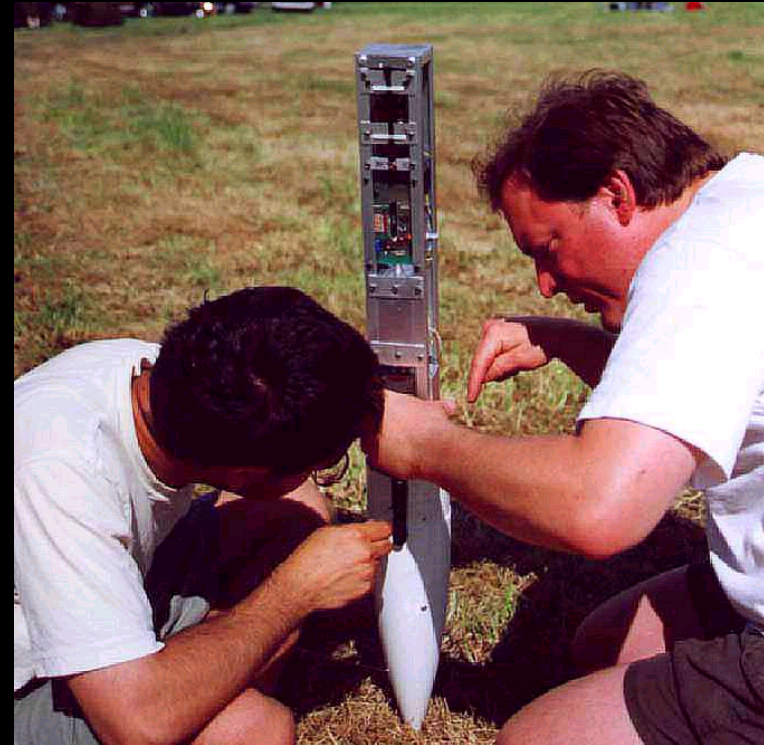
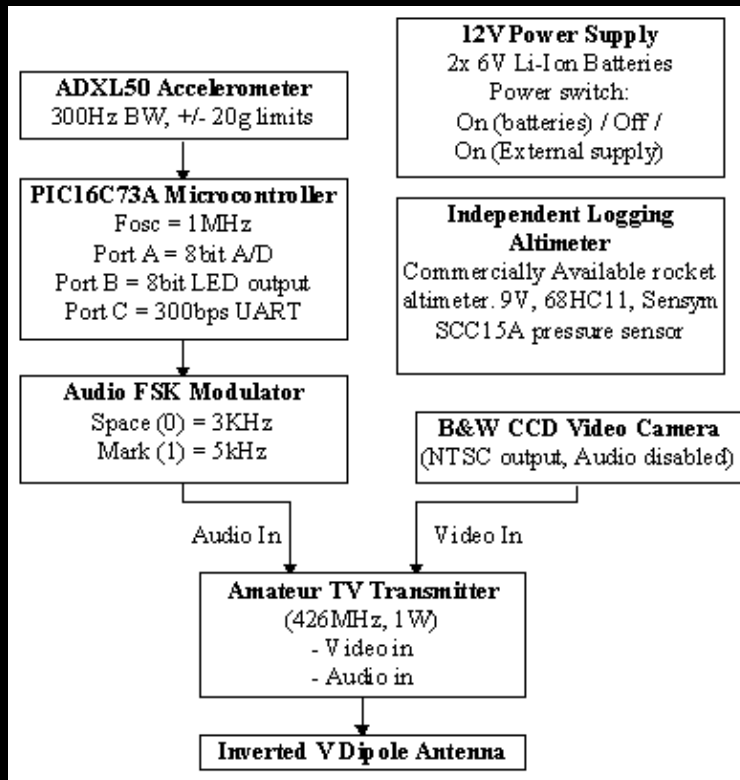
Launch Vehicle No. 0 - LV0

- **First Flight -- June 6th, 1998**
- **Objectives:**
 - **PSAS' "first attempt" at amateur rocketry**
 - **Prove an amateur television / telemetry system**
- **Apogee: 300m (1,000ft)**

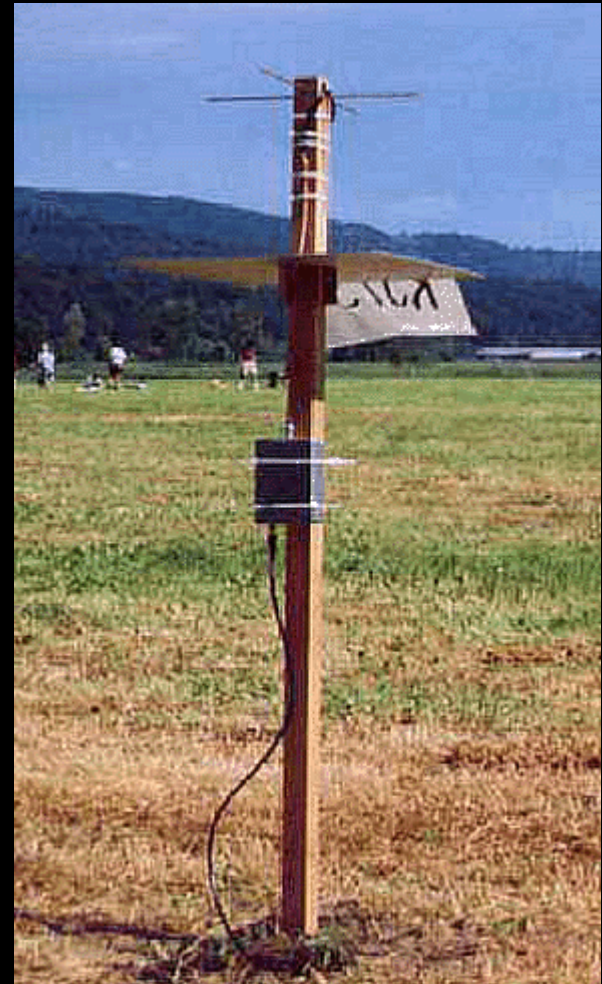
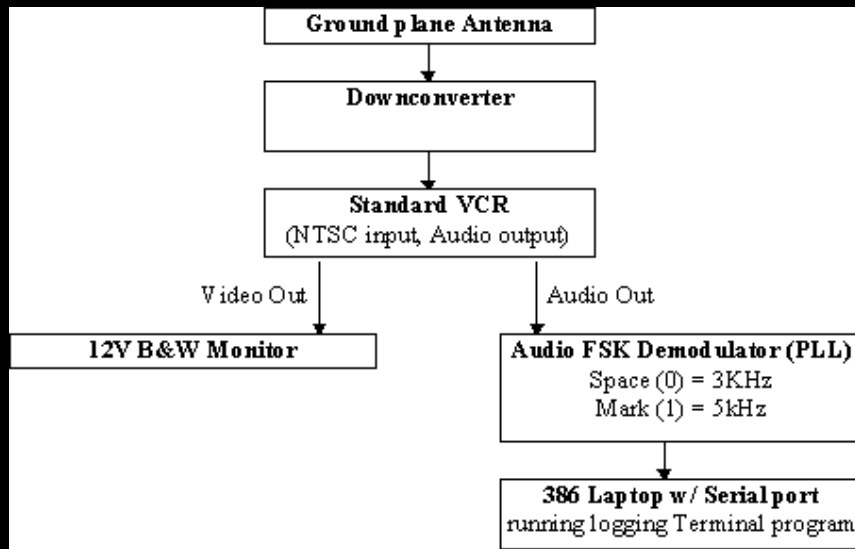
LV0 - Airframe



LV0 - Avionics



LV0 - Ground Support





**Launch Vehicle 1:
Getting Closer**

Launch Vehicle No. 1/1b - LV1/1b

- **First Flight -- April 11, 1999**
- **Second Flight -- October 7, 2000**
- **Objectives:**
 - Proof of concept of **airframe design**
 - Proof of concept of **inertial measurement unit**
 - Proof of concept of **RF communications system**
- **Apogee: 3.6km (12,000 ft)**

LV1 - Ground Support - Launch Tower



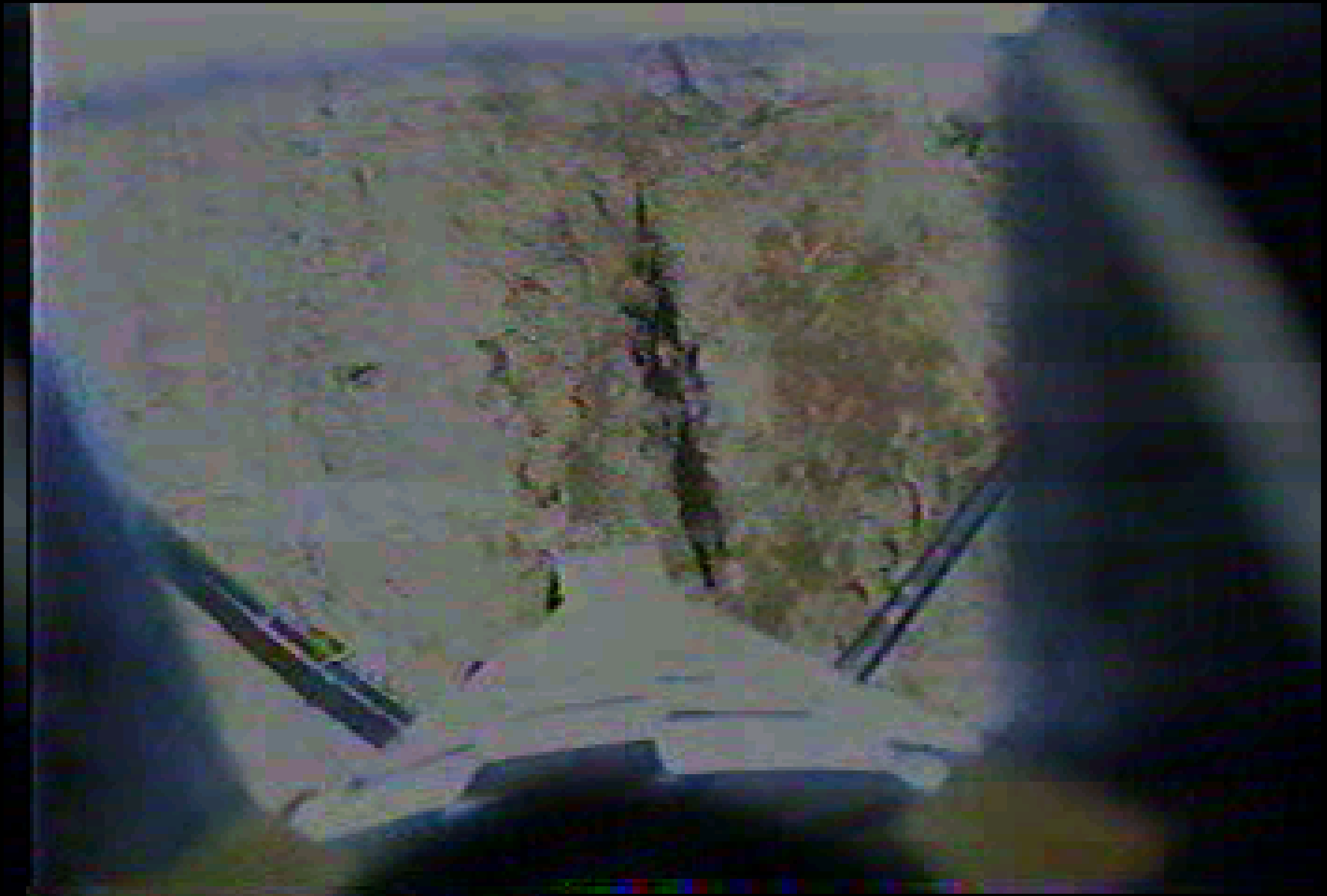
LV1 - Ground Support - Camp



LV1 - 04/11/99 Ground Video



LV1 - 04/11/99 Onboard Video



LV1 - Flight Profile

- **Liftoff wieght:** 43 lbs
- **Max altitude:** 11,436 ft
- **Max Mach No:** Mach 0.85
- **Max velocity:** 650 mph
- **Max acceleration:** 7.08 g
- **Max deceleration:** -2.84 g
- **Coast time:** 20.4 sec





Launch Vehicle 2.1

Launch Vehicle No. 2.1 - LV2.1

- **First Flight -- September 22, 2002**
- **Second Flight -- September 21, 2003**
- **Objectives:**
 - **Modular, adaptable airframe design**
 - **Modular avionics system**
 - **High speed bi-directional communications system**
- **Apogee: (18,000 ft)**

LV2.1 - Ground Systems



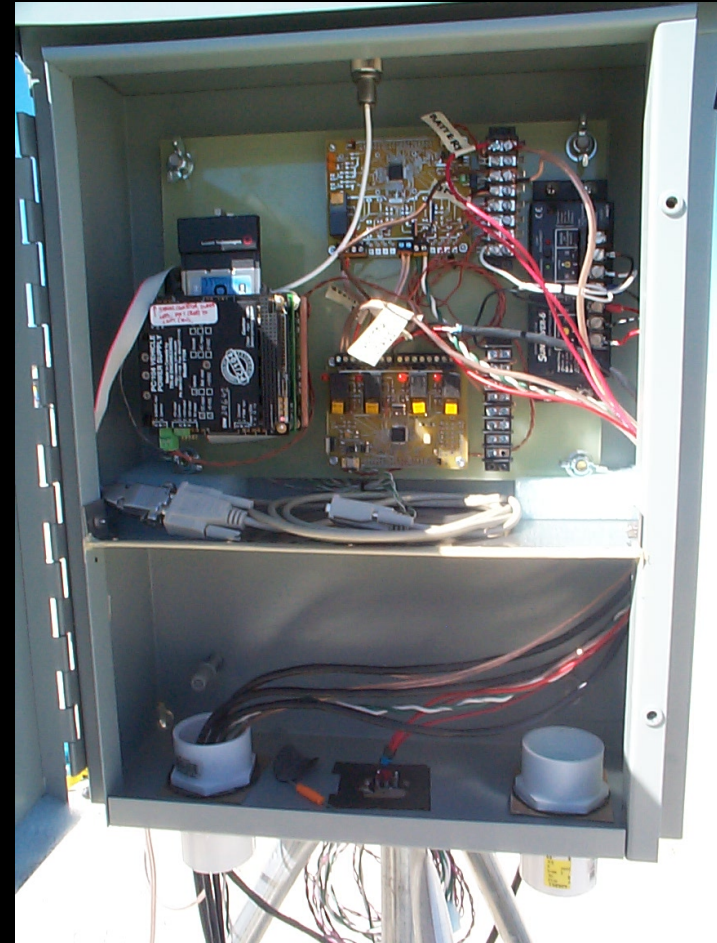
LV2.1 - Ground Systems

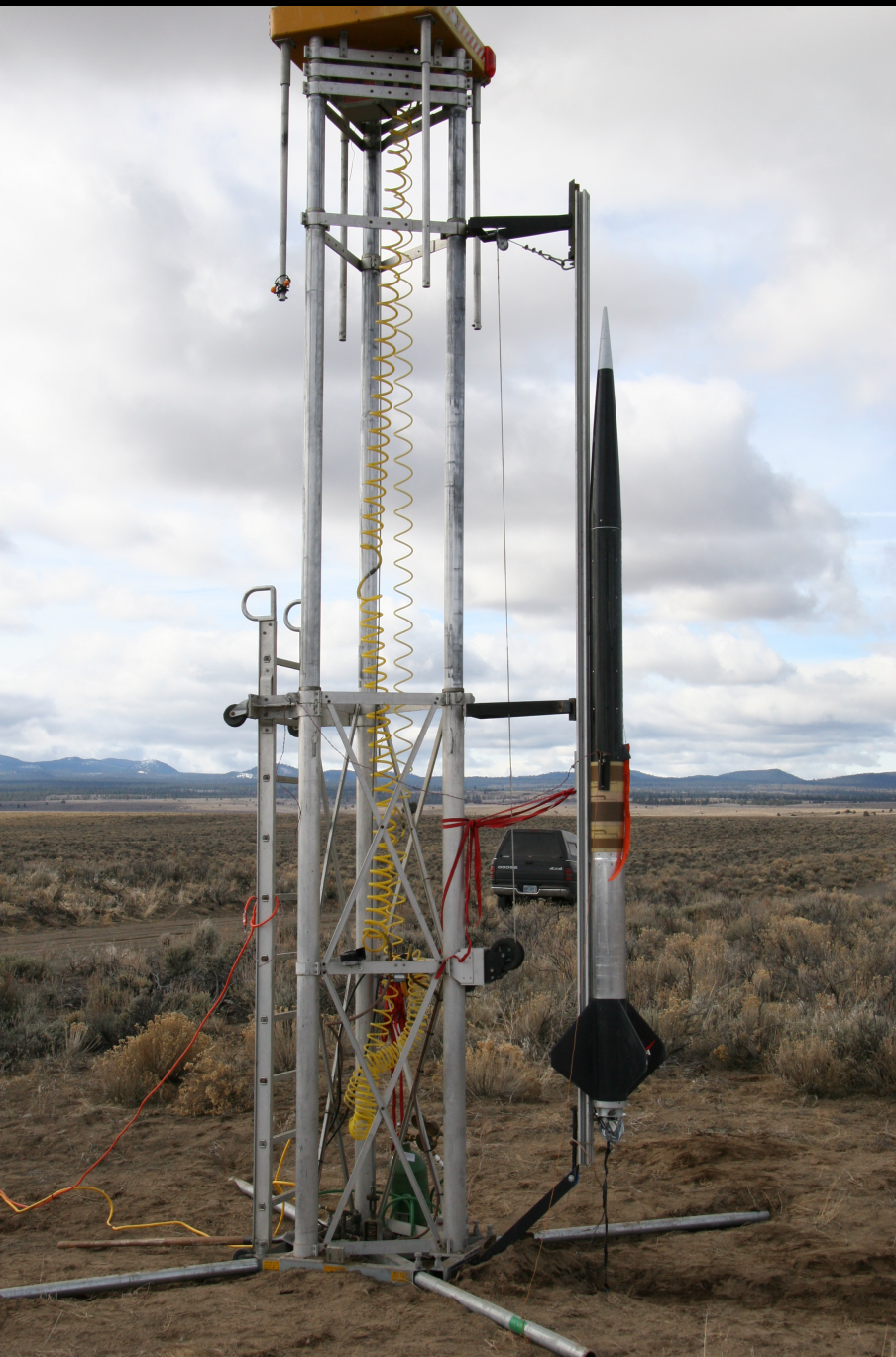


LV2.1 - Ground Systems



LV2.1 - Ground Systems





LV2.1
Ready for Flight

LV2.1 Flight

- **September 22, 2002**
in the Black Rock Desert,
Nevada
- **Max altitude:** **18,848ft**
- **Max mach No.:** **1.3**
- **Max velocity:** **921mph**
- **Max acceleration:** **12.55g**





Launch Vehicle 2.2

Launch Vehicle No. 2.2

- **First Flight -- August 20th, 2005**
- **Objectives:**
 - **Prove open-source software**
 - **Use 802.11 Telemetry System**
- **Apogee: (18,805 ft)**

LV2.2: Brothers, Oregon

8/20/2005



LV2.2: Brothers, Oregon

8/20/2005



LV2.2: Brothers, Oregon

8/20/2005



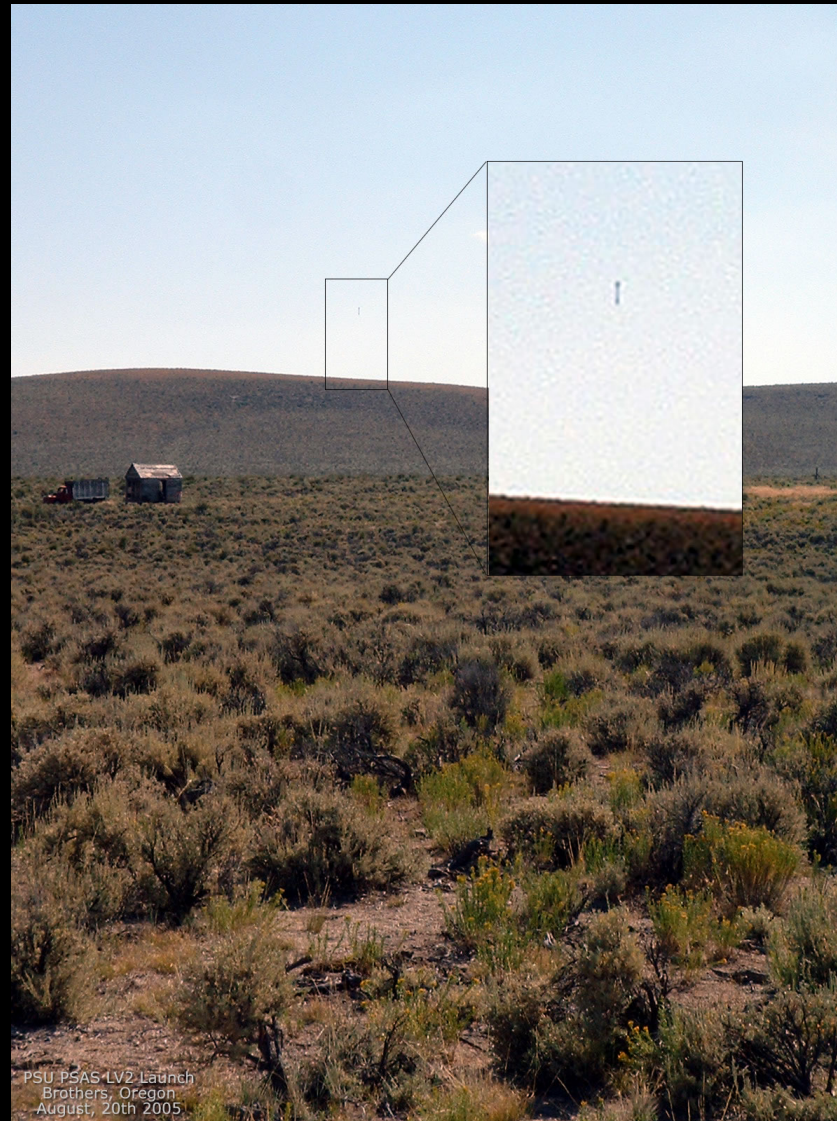
LV2.2: Brothers, Oregon

8/20/2005



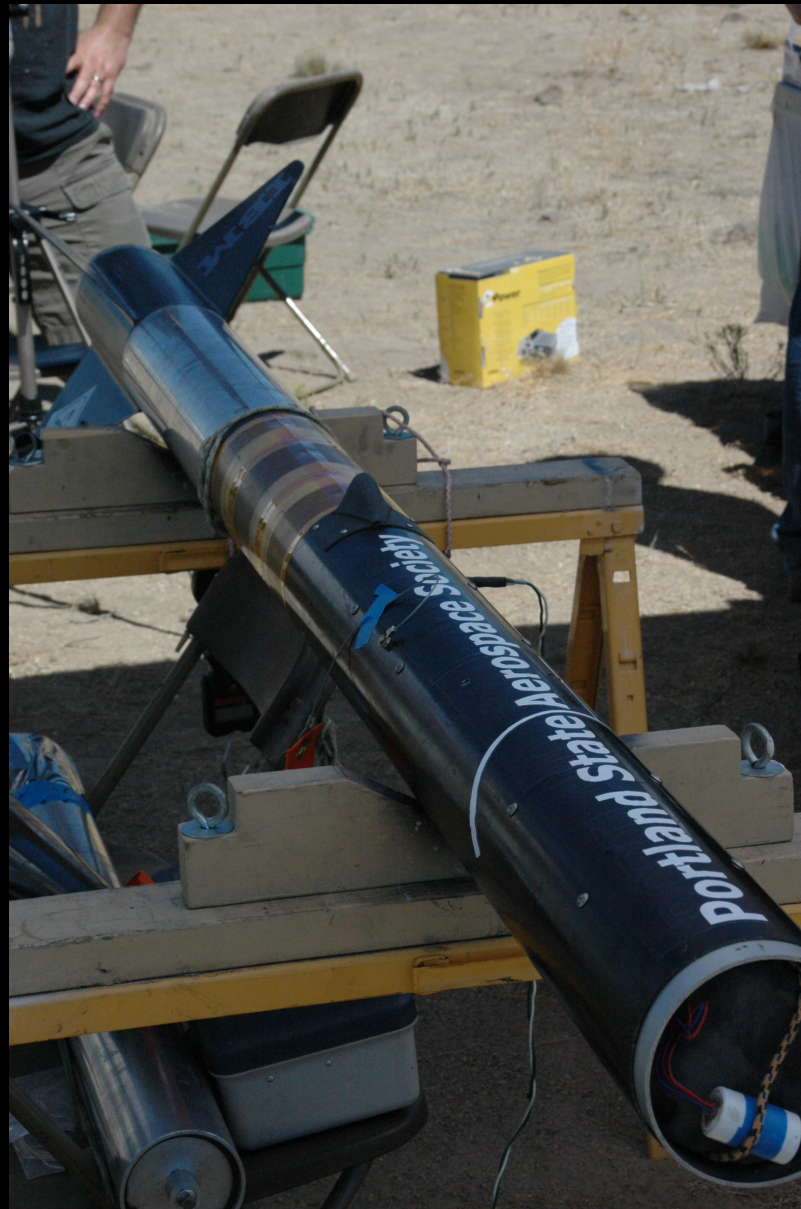
LV2.2: Brothers, Oregon

8/20/2005



PSU PSAS LV2 Launch
Brothers, Oregon
August, 20th 2005

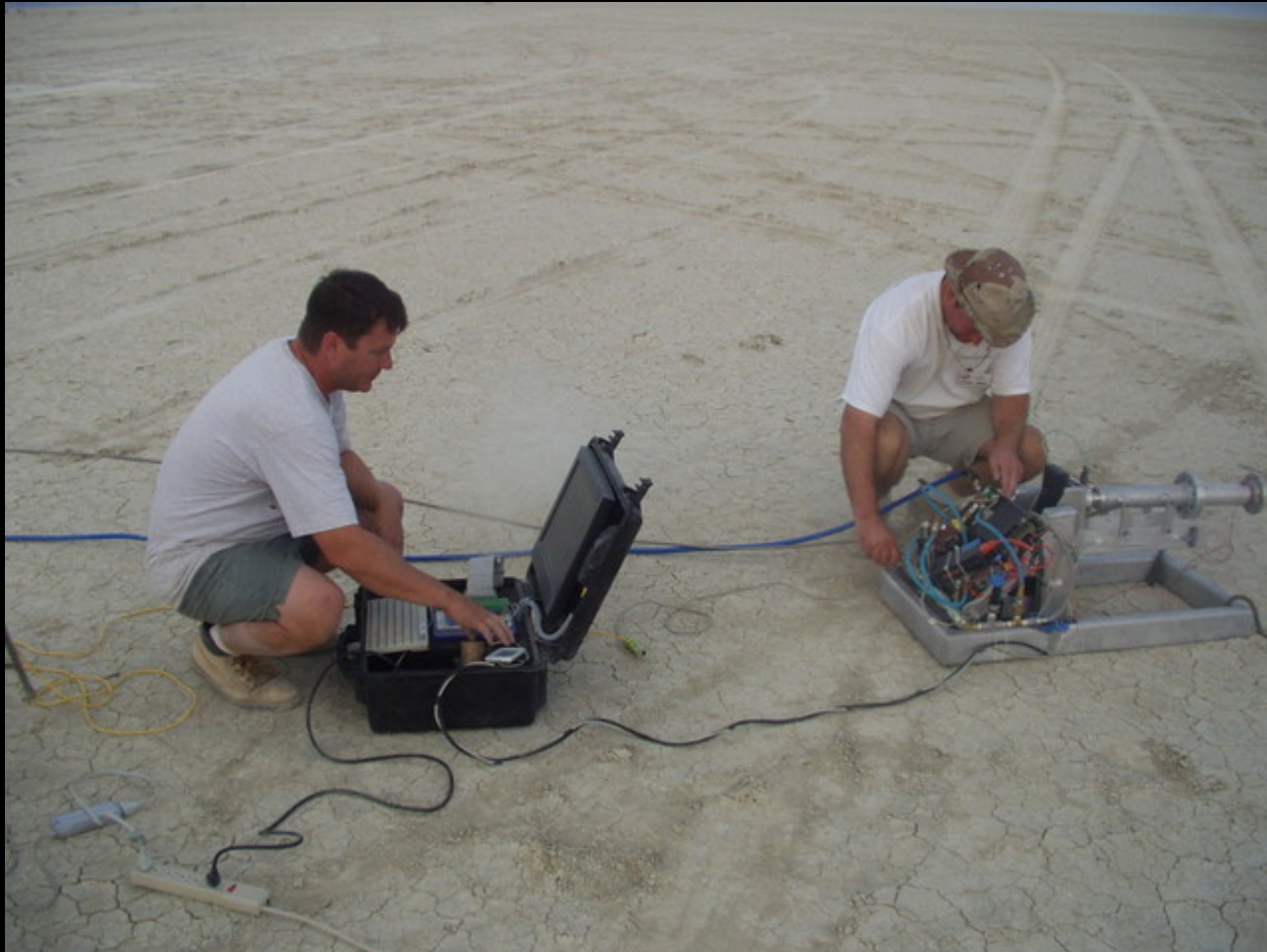
LV2: Brothers, Oregon 8/20/2005





Current Projects

Next Generation Hybrid Motor



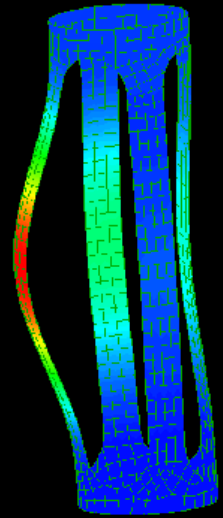
Next Generation Hybrid Motor

Why develop a hybrid motor?

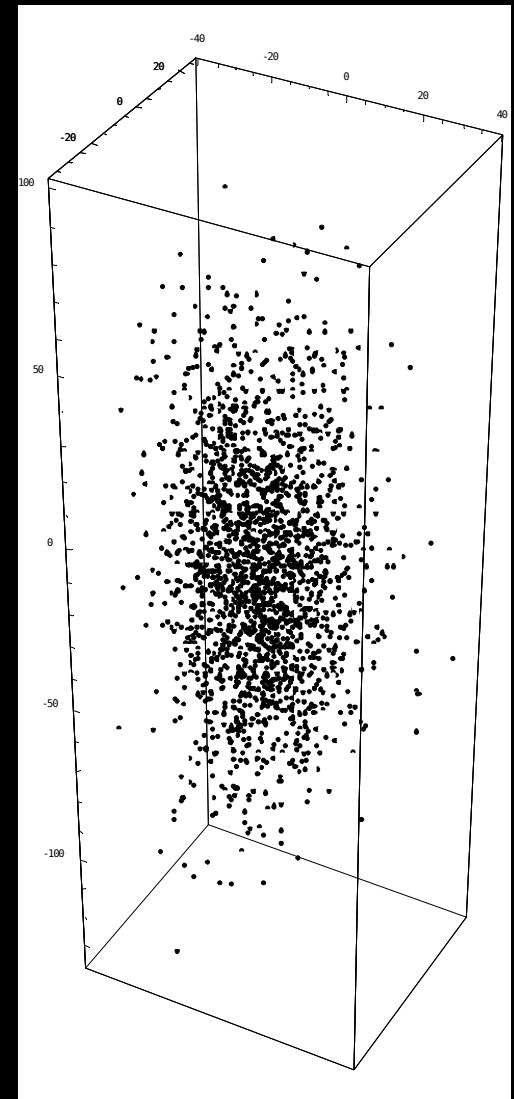
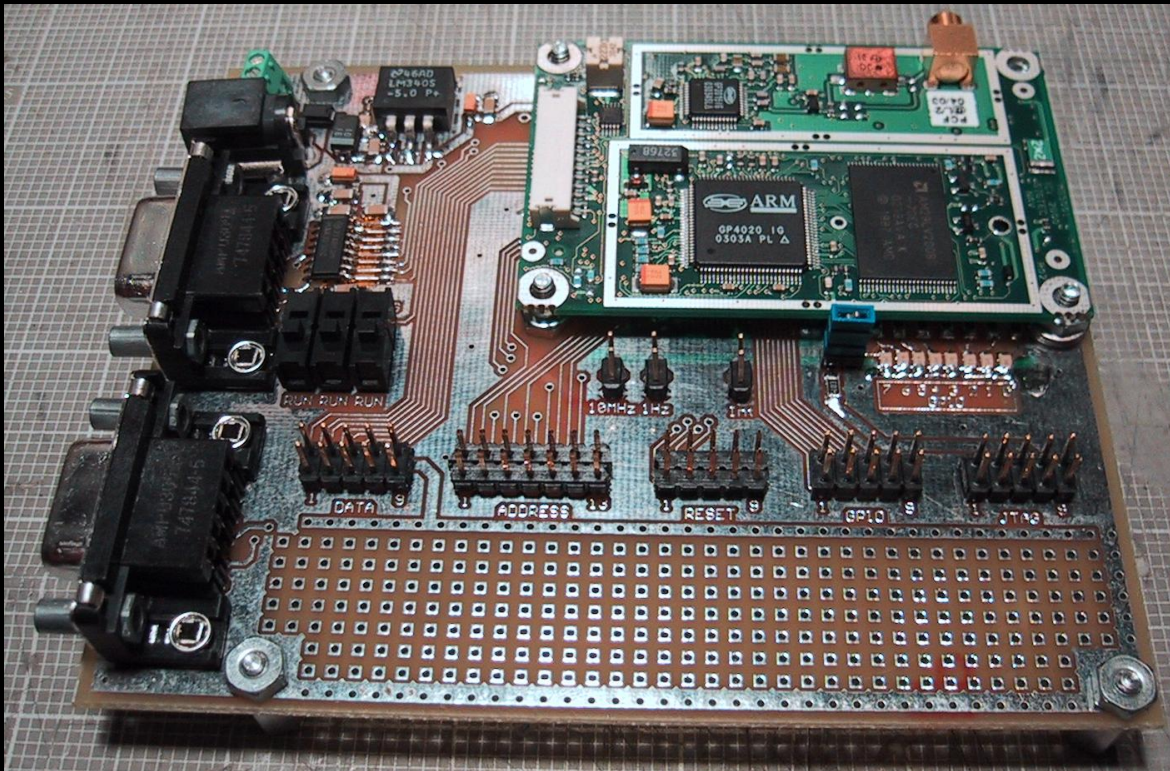
- **Safe:**
 - presents less of an explosion hazard than solid or bi-propellant motors.
- **Controllable:**
 - Hybrids can be shut down and restarted (as well as throttled).
- **Easy to Manufacture:**
 - Parfin wax can be bought at any craft store
- **Environmentally Friendly**

New Airframe

- LV2.2 was totalled in 2005
- Mechanical Engineering students (and any students who can weld) are needed



GPL-GPS: Open Source GPS Receiver

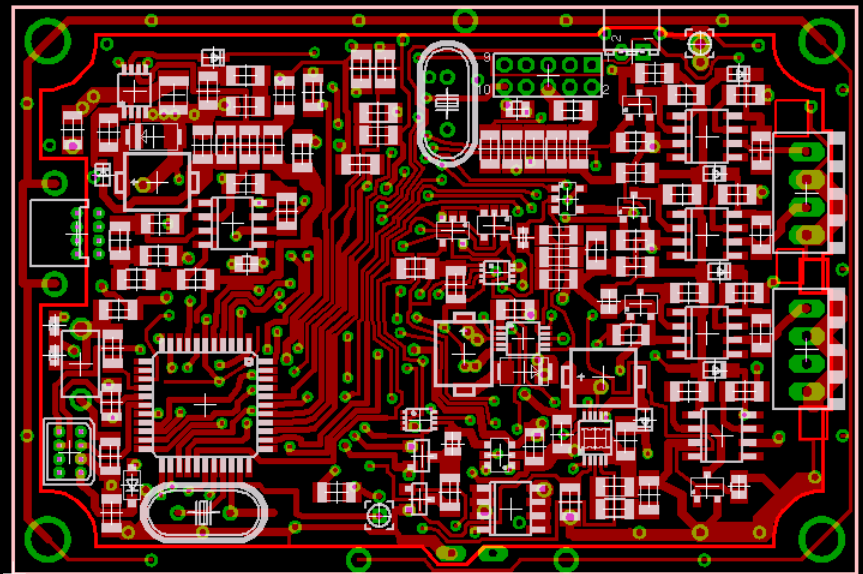


GPL-GPS: Open Source GPS Receiver

- **Commercial, off-the-shelf GPS boards**
 - Inexpensive hardware (< \$150)
 - Software limits on acceleration, velocity and altitude
 - Closed source; licenses typically > \$20,000
- **Solution: GPL-GPS**
 - GPL licensed firmware for GPS receivers
 - Uses the eCos 2.0 open source RTOS
 - First fix: May 2, 2005

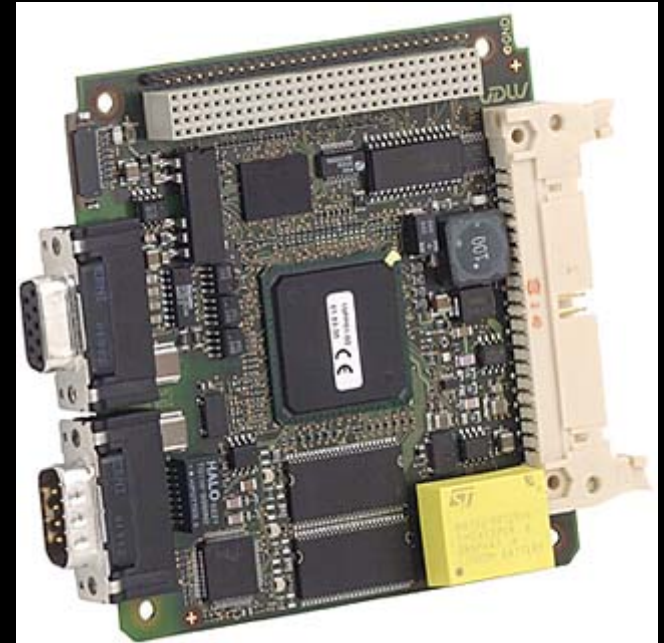
USB Avionics Nodes

- **Rocket uses USB instead of CAN**
- **Sensor electronics ("nodes") need to be redesigned**
- **Nodes will need**
 - schematics
 - board layouts
 - firmware



IBM “Linux on POWER” Grant

- **Flight Computer moving from x86 to POWER**
- **We need help bringing up Linux 2.6**
- **Flight software needs to be redesigned**





Join the Dark Side!
(in three easy steps)

Step 1:
Figure Out What You're
Interested In

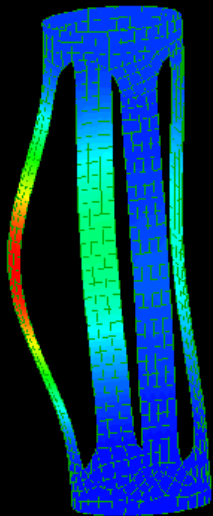


Figure Out What You're Interested In: Airframe?

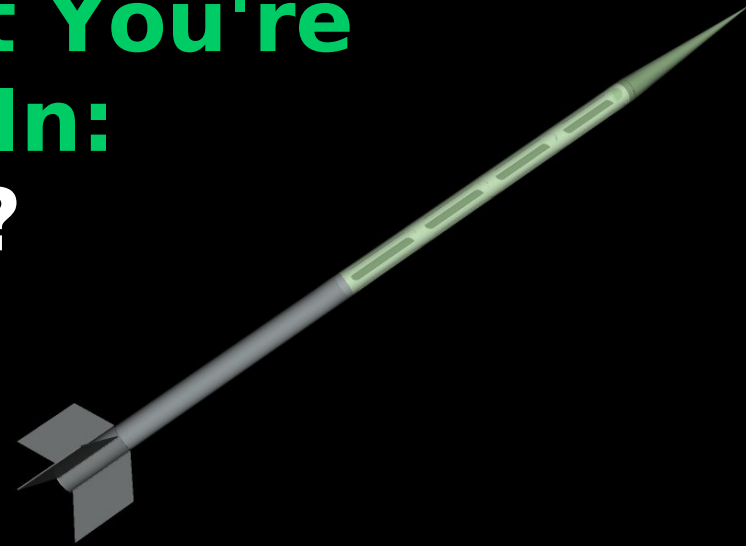


Figure Out What You're Interested In: Avionics?

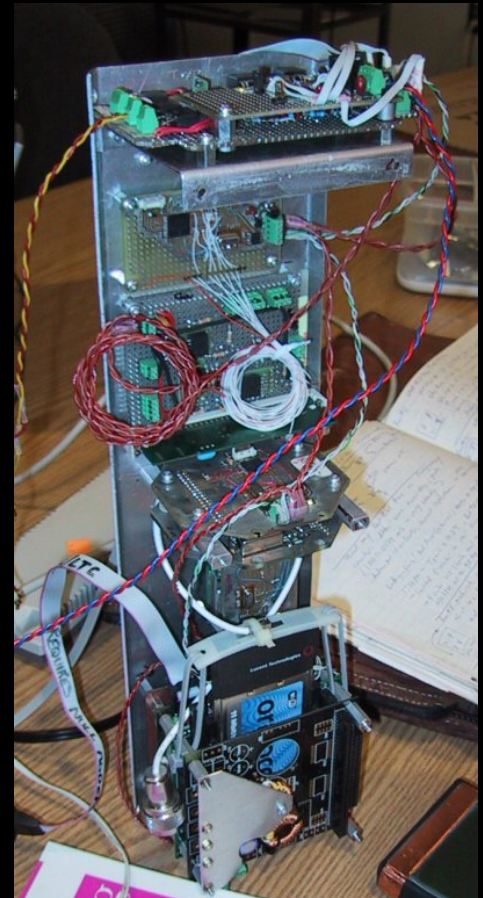
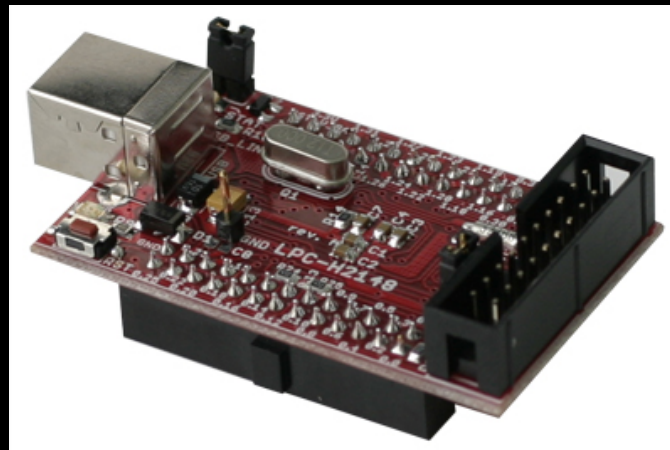
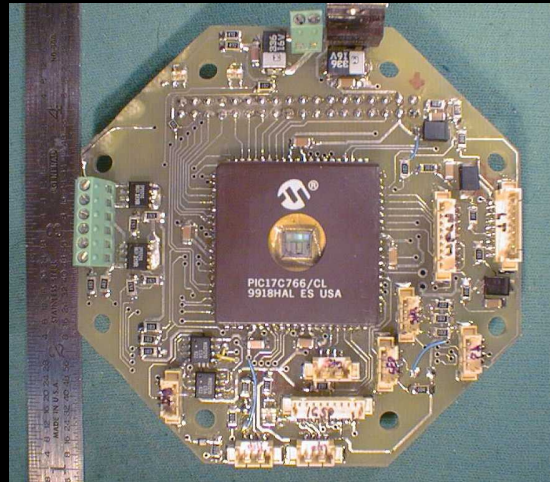


Figure Out What You're Interested In: Communications?

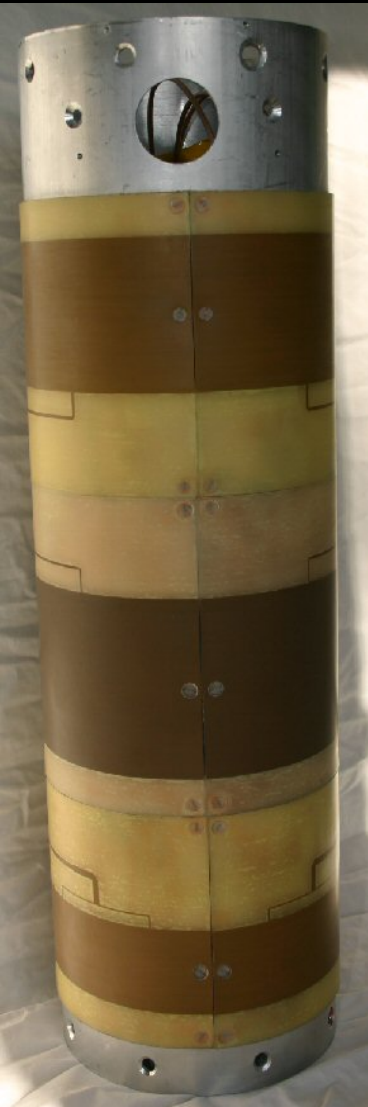
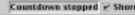



Figure Out What You're Interested In: Propulsion?



Software?



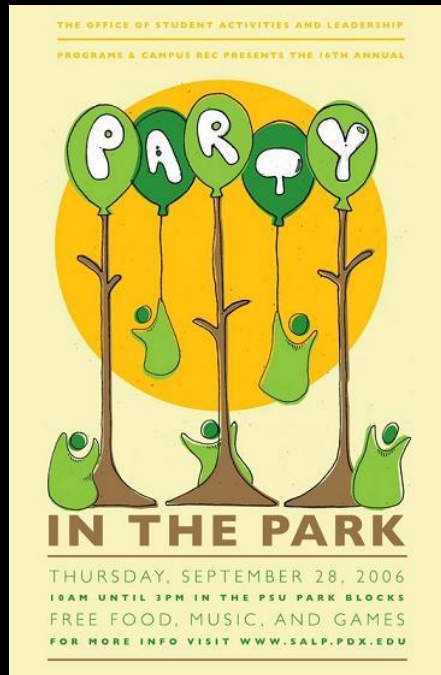
East 1

Deploy Dragsel

Figure Out What You're Interested In: Logistics?



Figure Out What You're Interested In: Student Club Work?



**Portland State
Aerospace
Society**

Find out more about
PSU's amateur
rocketry club!

Introductory Meeting
Wednesday,
August 2nd, 6-7pm
Fourth Avenue Building,
Room 155

<http://psas.pdx.edu>

The poster features a black and white illustration of a rocket launch. A rocket is shown ascending from a launch pad, with a large plume of smoke and fire at the base. The rocket has a long, thin body and a pointed nose cone. The launch pad is a tall, dark structure with a horizontal arm extending from the side.



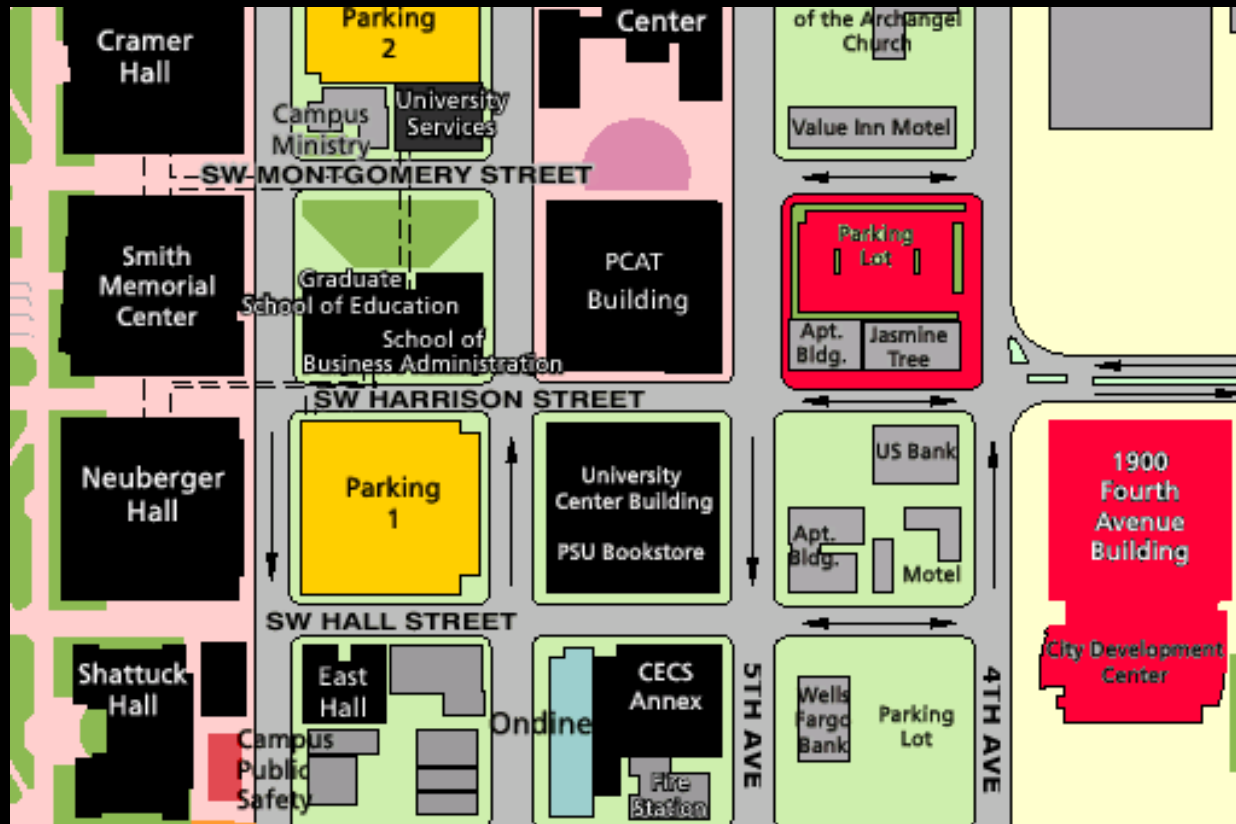
**Figure Out What You're
Interested In:
Just want to watch a launch?**



Step 2: Attend a Meeting

Attend a Meeting

- **PSAS meets every Wednesday**
 - 7pm
 - Fourth Avenue Building, Room 155



Attend a Meeting

- **Ask questions (and ask again if you're confused)**
- **Ask about projects**
- **Get setup with a wiki account**
- **Most importantly:**

ATTEND A SECOND MEETING

Step 3:
Find the website
and
Join a mailing list

Website and Mailing Lists

- **Website:**

<http://psas.pdx.edu>

- **Mailing lists are linked from the main page:**

- psas-airframe
- psas-avionics
- psas-comm -- communications team
- psas-propulsion
- psas-psu-liaison -- student club work
- psas-software
- psas-uncertainty

Website and Mailing Lists

- If you just want to know when the next launch is:
 - Look at the schedule page
 - <http://psas.pdx.edu/Schedule>
 - Subscribe to **psas-announce**

Portland State Aerospace Society

- **Thanks! Questions?**
- **Email: info@psas.pdx.edu**
- **Further information: <http://psas.pdx.edu/>**
- **Next meeting:
<http://schedule.psas.pdx.edu/>**