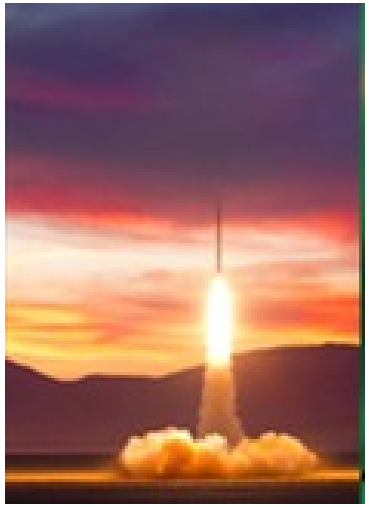
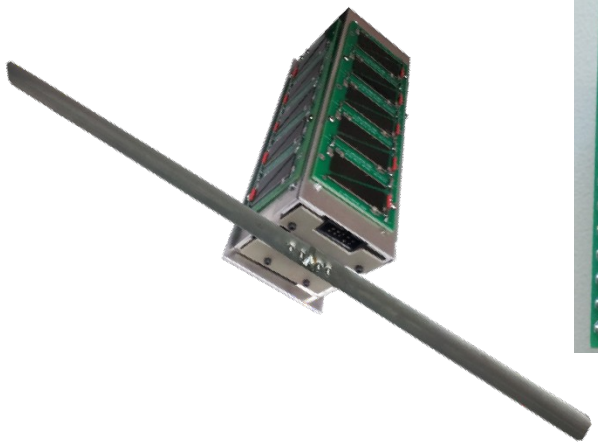
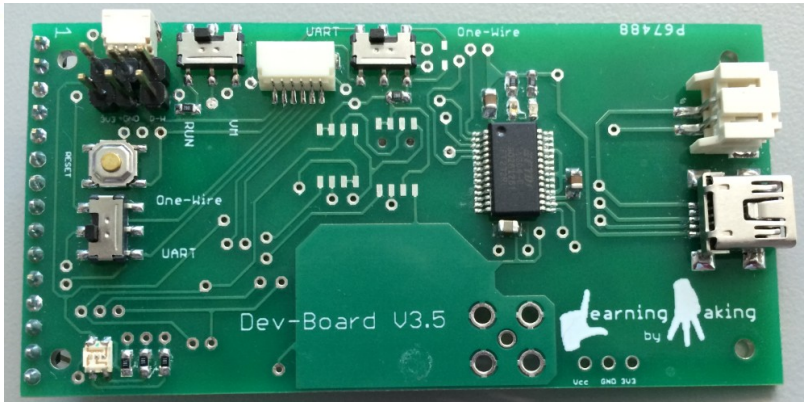
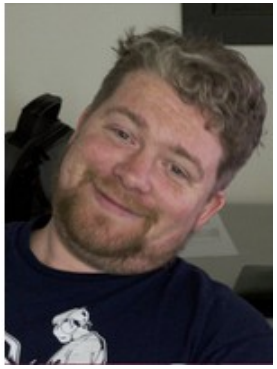







# *Rockets, Satellites and More!*

rof. Lynn Cominsky
ducation and Public Outreach
onoma State University

Kevin John
Instructional Technology

Dr. Kevin McLin
GTN Director

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Education Support Scientist

Alyssa Afa'ese
Student Assistant – SEE

Juanita Tenorio
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Scientific Illustrator

Laura Chase
Project Support Coordinator

David McCall
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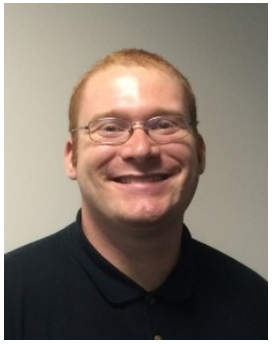


Hunter Mills
Support Staff

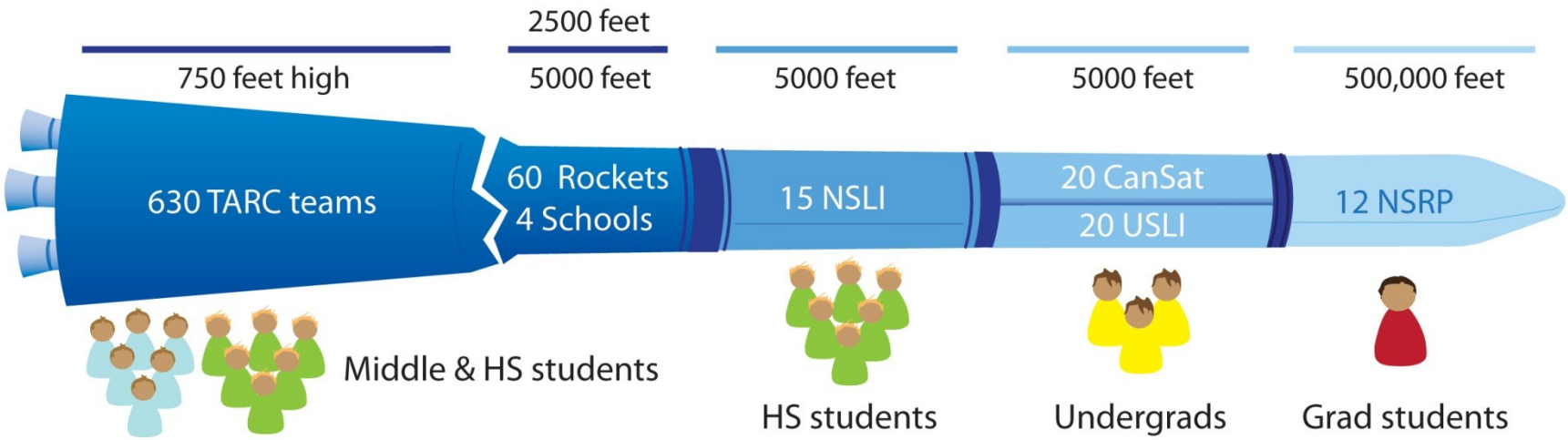
Amandeep Gill
Student Assistant – Physic

Our mission is to develop exciting formal and informal educational materials to inspire students in grades 5-14 to pursue STEM careers, to train teachers nation-wide in the classroom use of these materials, and to enhance science literacy for the general public.

# What do we do?

- We support several different NASA high-energy astrophysics missions
- We develop curriculum for middle ⎵ college students and train teachers
- We run a robotic telescope at Pepperwood
- In the past we have also worked on PBS Nova and planetarium shows, interactive web games, weekly webcomics and more
- We build experiments and launch them!

# STEM Pipeline for rocketry



# Team America Rocketry Challenge

- About 7000 students nationwide
- Model rockets that usually loft eggs to 500-750 feet and return them

The Coeur D'Alene (Idaho) High School team loading their model on the pad.
Photo by Glenn Feveryear.


The Geekette Team from Lake Braddock Secondary School (Virginia).
Photo by AIA.

# Model vs. High Power Rocketry

- Motors are rated by thrust in Newton-seconds
- Each letter is a factor of 2 more thrust
- Model rockets are ¼ A to G  (160 N-s, max)
- HP rocketry is H and above
  - Level 1 is H and I (640 N-s max)
  - Level 2 is J and K (2560 N-s max)
- I am a Level 2 flyer (so is Kevin J.)

# Meet the S4 partners

- **Association of Experimental Rocketry of the Pacific (AeroPac) –** the Northern CA/Nevada chapter of the Tripoli Rocketry Association
  - Tony Alcocer – President
  - Ken Biba – Education Director
- **Endeavour Institute** – Balloon Fests
  - Steve Kliewer, Director
- We also partner with a few other rocket clubs: **LUNAR** (Livermore Unit of NAR) and **ROC** (Rocketry Organization of California) for launches

s4.sonoma.edu

# High Powered Rocketry and YOU

**Certification Process:**

**Level 1** – Build, fly and recover an airframe on an L1 motor

**Level 2** – Build, fly and recover an airframe on an L2 motor and pass a written test

**Level 3** - Build, fly and recover an airframe on an L3 motor using electronics

**NAR Clubs:**

**Kansas:**

- Kansas City Association of Rocketry (KCAR)
- De Soto High School Rocketry Club (DHS Rocketry Club)
- Kansas Organization for Space Modeling

**Oklahoma:**

- Piedmont Area Rocketry Club (PARC)
- Red River Rocketeers (RRRS)

**Tripoli Clubs in Kansas:** Tripoli Kansas, Tripoli Mo-Kan
**In Oklahoma:** Tripoli Oklahoma, Tripoli Tulsa

# World’s Best Launch Site

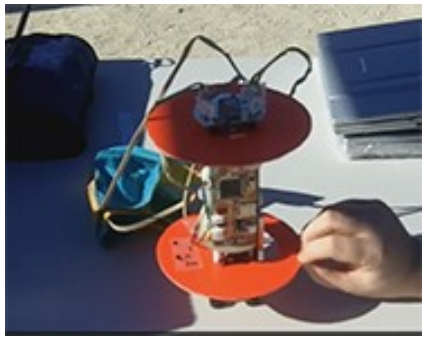
AeroPAC: Black Rock Playa (200,000 ft limit)

# ARLISS as the inspiration for S4

- AeroPac and Bob Twiggs started A Rocket Launch for International Student Satellites (ARLISS) over 10 years ago
- University students from across the globe come to the Black Rock playa to launch payloads which are ejected from the rockets
- Mostly students from Japan, but also Korea, India, Turkey, and a few from the USA

# ARLISS

A Rocket Launch for International Student Satellites

- Collaboration between engineering students and amateur rocket flyers
- Various payload designs flown over the years include come-back rovers and scientific instruments
- Black Rock Desert simulates harsh alien environments

# Tethered Balloons

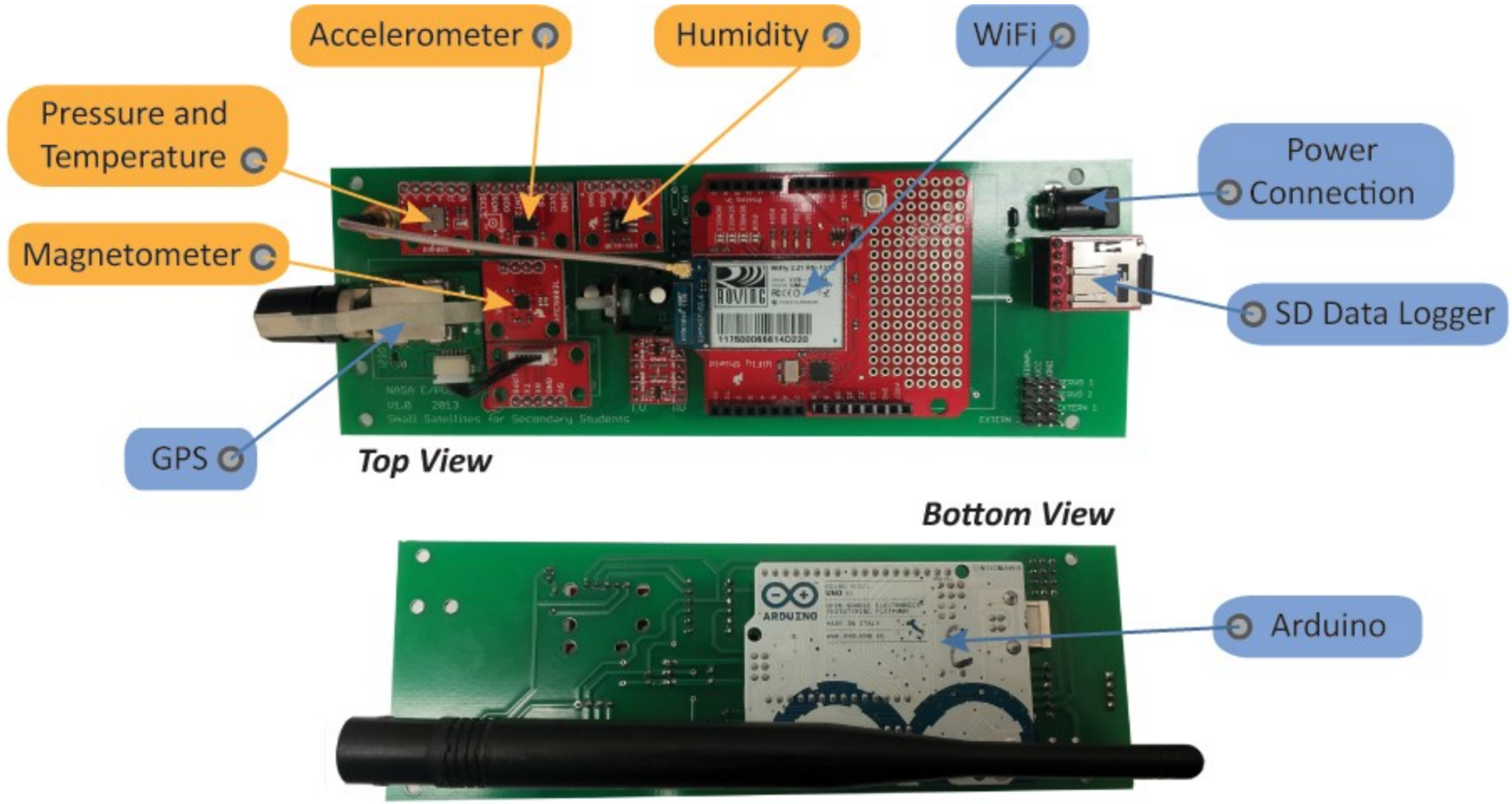
- Doesn’t require certification or complicated FAA clearance
- Less expensive
- Doesn’t require advanced equipment for telemetry
- Less constraints on payload size and weight
- Can be flown tethered to 1,000 feet or untethered
- Greater control over altitude
- Much longer time series for data

# Balloonfest 2013

Tobin James Cellars, Paso Robles, Ca


- For the past 3 years, the SSU team has been learning how to fly rockets and balloons, while designing the S4 flight electronics and software
- We have designed a “flight board” which includes base components and optional sensors and have written an educator guide with background information, instructions and additional resources.
- Last summer, we trained a group of teachers to build these payloads and launched them at Lucerne dry lakebed in Southern California
- This year, the teachers are building S4 payloads with their middle & high-school students and flying them on rockets or tethered balloons

# S4 Payload


Accelerometer
Humidity
WiFi
Pressure and Temperature
Power Connection
Magnetometer
SD Data Logger
GPS
Top View
Bottom View
Arduino

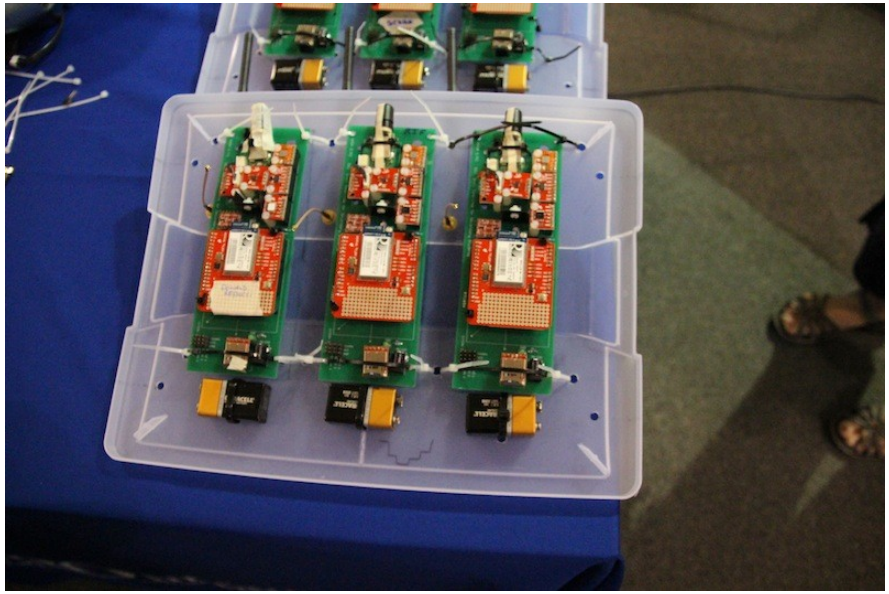
# 4 Teacher Training – July 2013
# Aero Institute, Palmdale Ca

- 18 educators from a diverse set of schools and other teaching organizations
- Week long course
- Built, tested and flew a prototype payload
- Helped us refine our educational materials and the payload itself
- Included talks from our partners and mentors


The first two days were spent learning the basics of electronics and soldering which were then put to use in constructing the flight board.

Beth Hill, Lawrence Jones Middle School

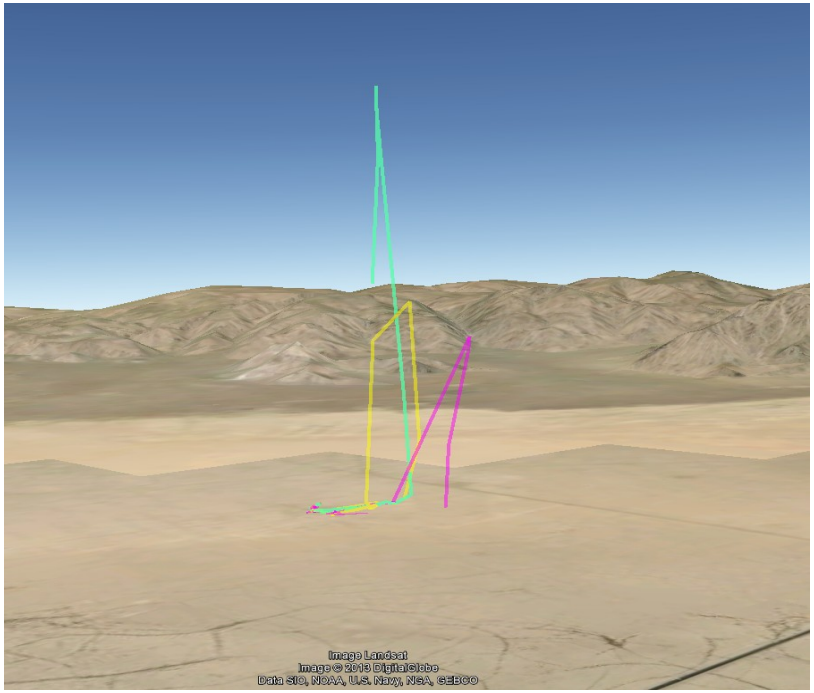
Once the flight board was finished the educators were introduced to programming in Arduino’s Processing language. They were then able to upload the programs to the payload after which they installed the sensors onto the flight board and finalized the payload.



On Thursday the educators took their payloads out to a local high school’s fields. They readied their payloads for tethered helium balloon flights, three-to-a-gondola, as dark storm clouds were approaching.

Once a helium balloon was filled and tethered the winds really kicked up and it began to rain. With the weather too chaotic to fly helium balloons, the educators took their payloads around the high school on foot in order to get

Donald Repucci, Morro Bay




On Saturday the training was shifted to the Lucerne dry lake bed about 70 miles east of Palmdale. There, the payloads were flown on 3 and 4 inch diameter rockets to altitudes as high as 1828.1m (6000 feet) with on-site routers taking live data of each launch.

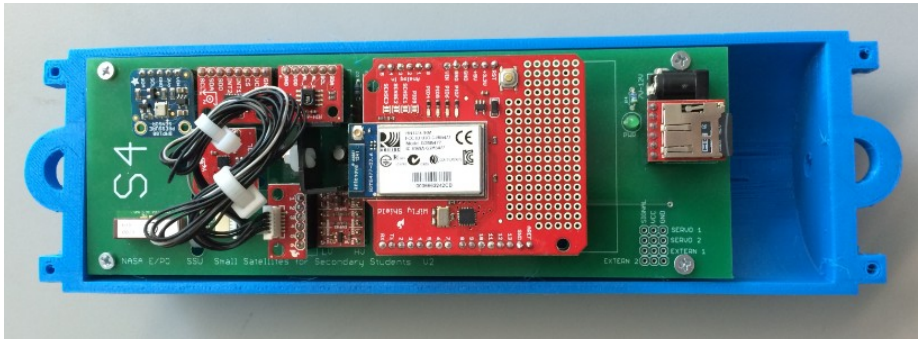
The bottom figure shows our three highest flight paths, as

# Everything thing went *perfectly…*

Nose cone from “lawn dart” rocket

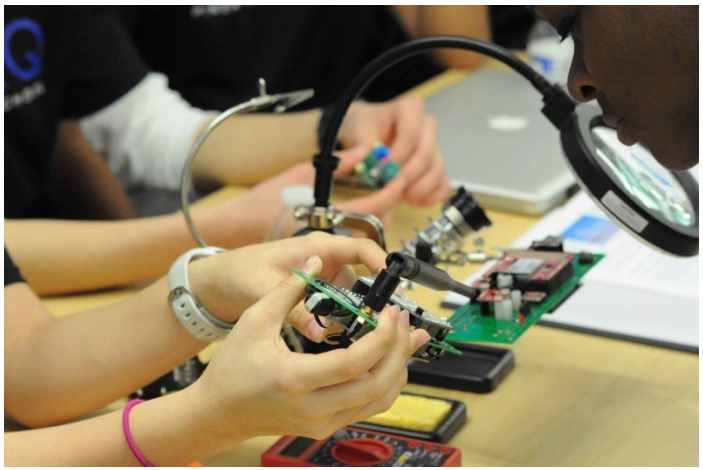

…right up until the last flight

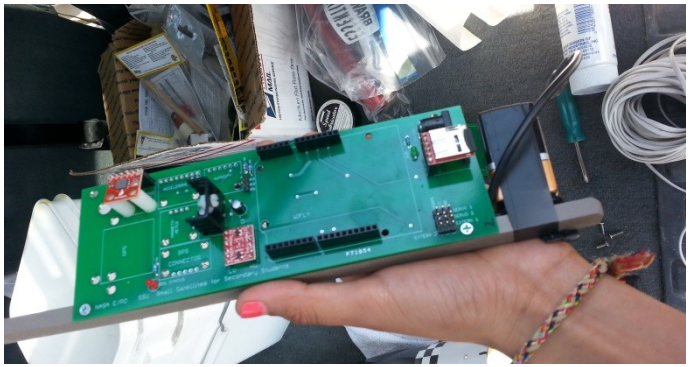
# This year at Black Rock

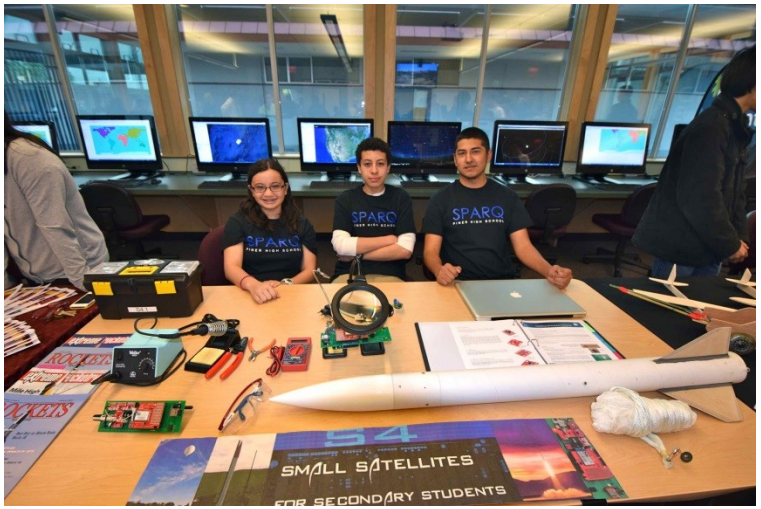



S4 payload tests in 3D printed canister with ARLISS-K rocket to 8100 feet AGL

# S4 in 2014
# Student Payloads

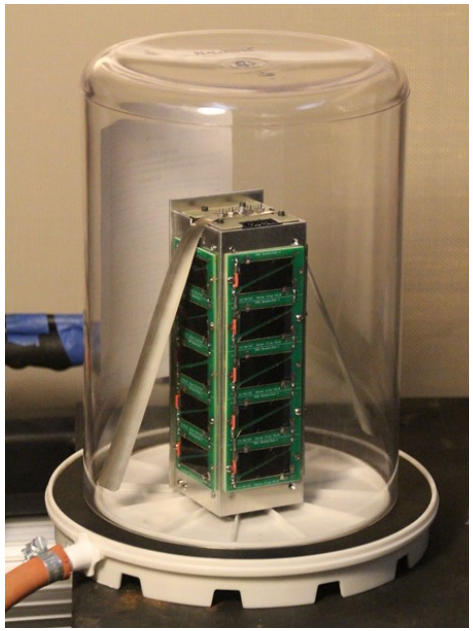






# SU students build and launch PocketQube – Nov 2013

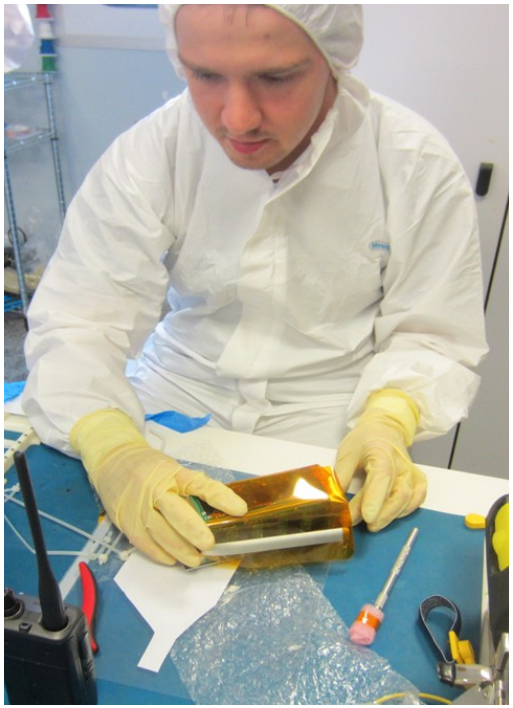
- SSU student Kevin Zack designed the S4 board
- He then started working on the PocketQube project
- PocketQubes are smaller than traditional CubeSats
- Our “3P” satellite was 15 x 5 x 5 cm & weighed about 0.5 kg
- It was launched from Unisat-5, an Italian

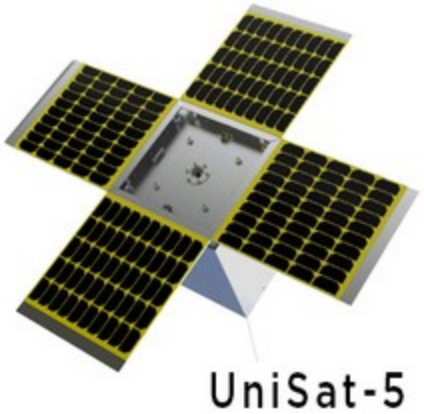


SSU Vacuum testing

- Collaboration between SSU and Morehead State University
- SSU provided the electronics
- MSU provided the solar panels, structure and integration with

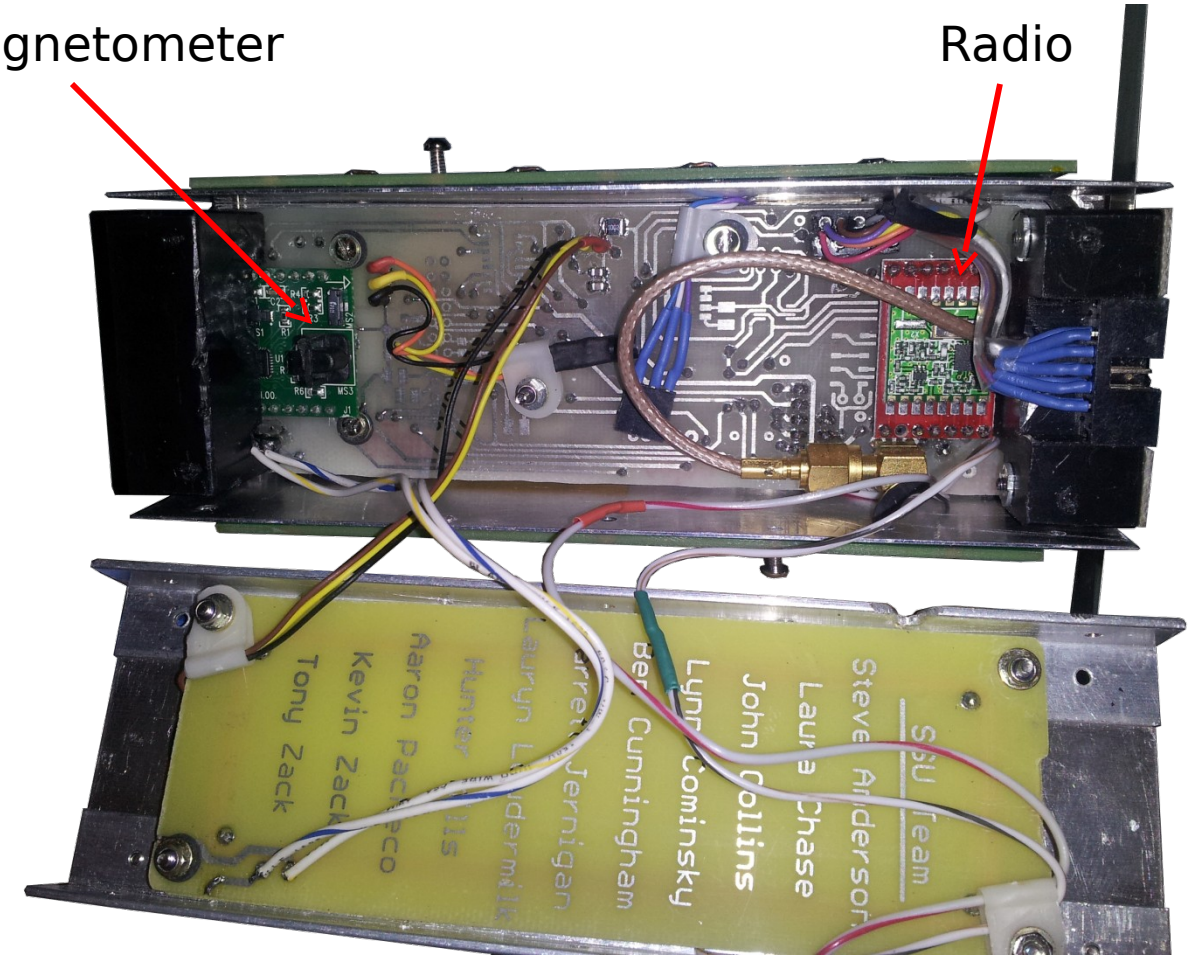
Sean McNeil (MSU) integrating with Unisat-5 in Italy





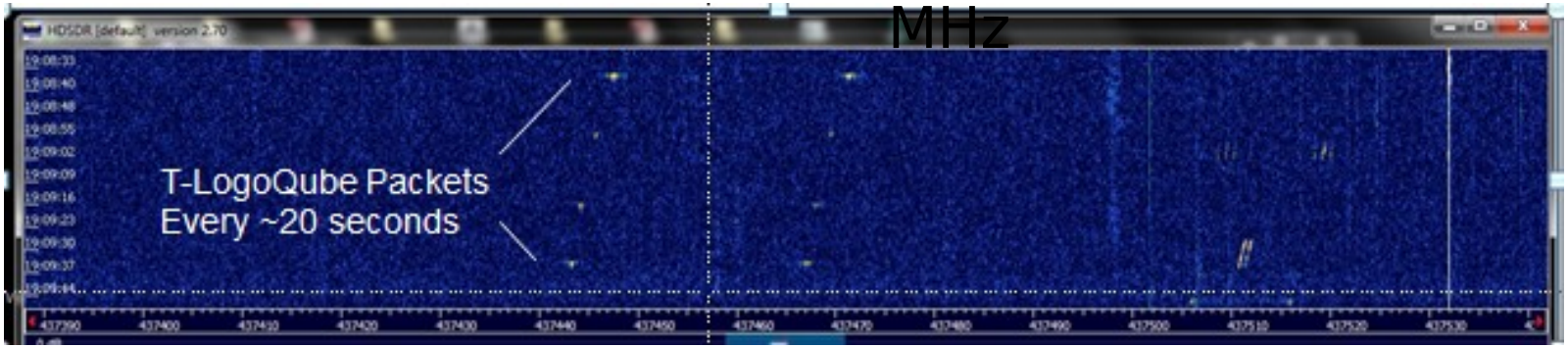

UniSat-5 launched several CubeSats and PocketQubes

# Inside T-LogoQube



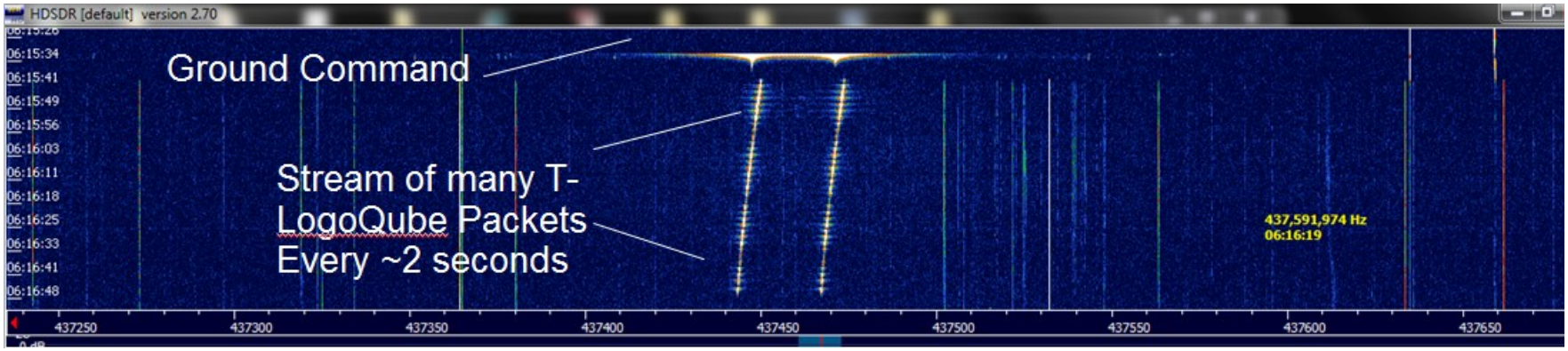
T-LogoQube team with Yagi antenna at the Little H-bar Ranch: L to R – Hunter Mills, Ben Cunningham, Kevin Zack, Steve Anderson, Aaron Pacheco, Garrett Jernigan and Lynn Cominsky

First packets detected using the Yagi antenna at 437.465 +- 0.012 MHz



# Commanding T-LogoQube

- Logo commands telling T-LogoQube to dump data during a pass over the Yagi antenna at the Little H-bar Ranch in Petaluma




Time

Frequenc y

TLQ lasted for two months and then fell victim to radiation due to its polar orbit

# Next SSU CubeSats

TRL-6:  Will be flying x-ray detector to raise the TRL to 6. It is a 1u-CubeSat to be launched from ISS in spring-summer 2015.

A3Sat: All female team of SSU students who are building a “flat-sat” to be tested in a high-altitude balloon flight. Then eventually we will try to arrange for a

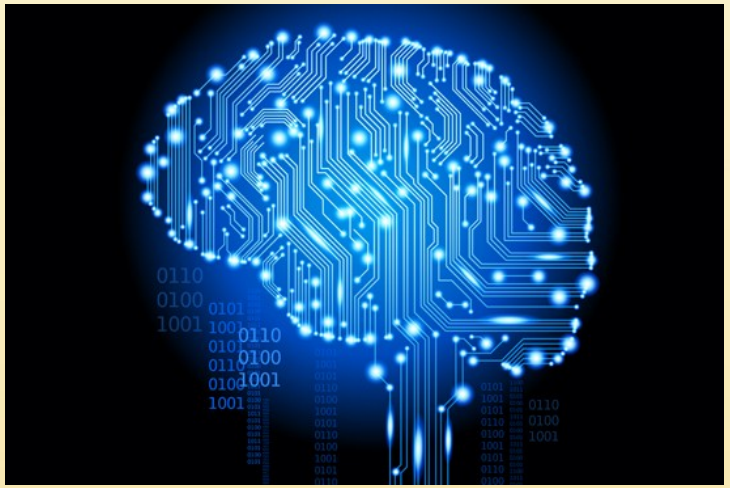
Alyssa, LRC, Anna, Aman, Carolyn Peruta

# What is Learning by Making?

- One of only 18 Investing in Innovation (i3) development projects awarded in 2013 by the U.S. Department of Education
- Five-year program to develop engaging, hands on, project-based learning that integrates science and mathematics
- Two new elective STEM courses:
  - Environmental Science/Biology
  - Chemistry/Physics

# Innovations

- Use of computational thinking to focus on real world problem solving
- Solutions are constructed by teachers and students working together

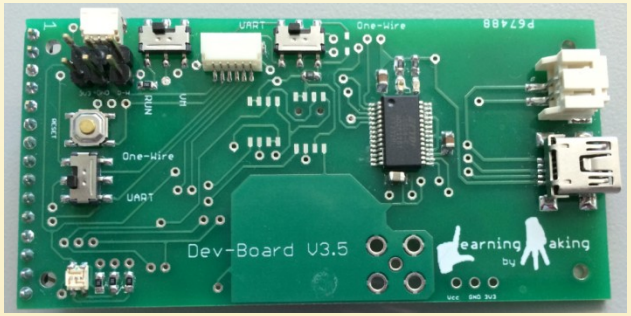


- Use of Logo programming language – overcomes barrier to learning how to code
- Sensor based experiments that are networked
- Simulations and modeling

# Our goals

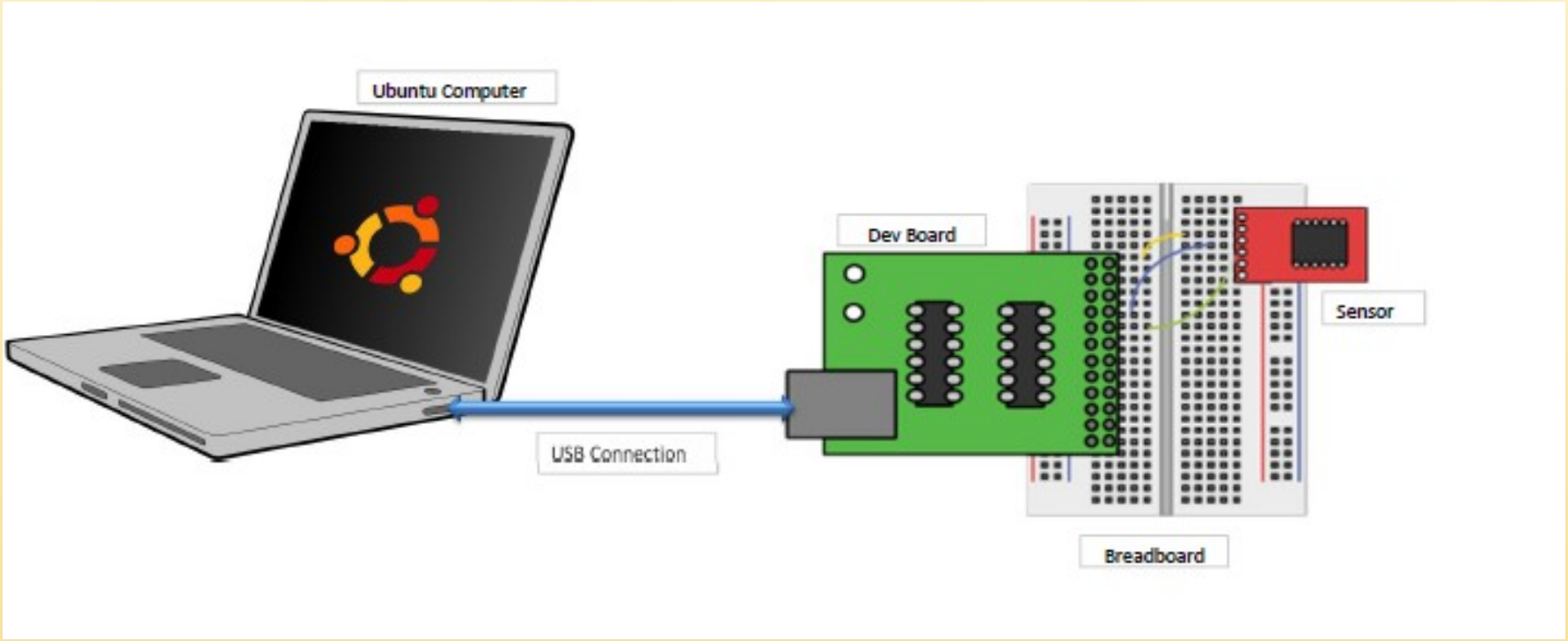
- Develop two year-long integrated high school STEM courses that will be accepted as elective credit for university eligibility in California
- Train at least half of the science and mathematics teachers in our partner schools to successfully deliver the curriculum
- Improve math and science proficiency by 15% for students enrolled in the new courses.

# First year overview

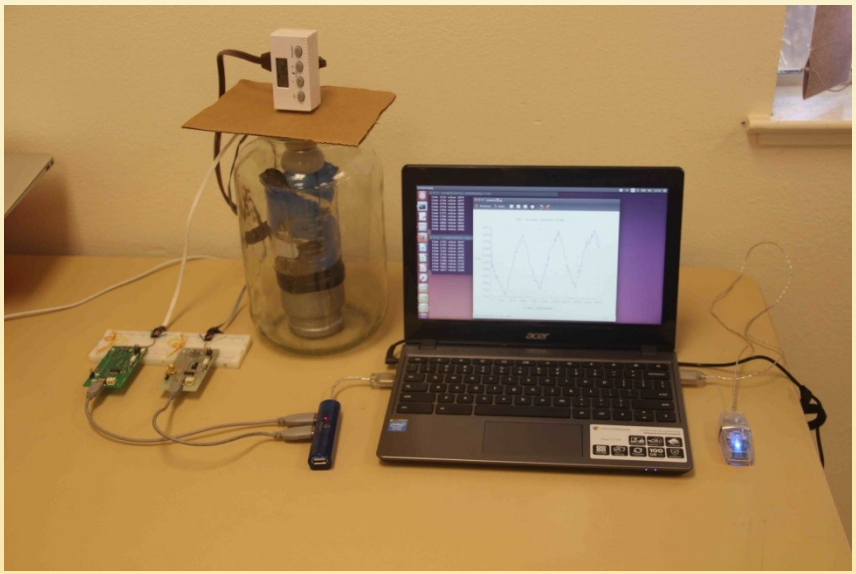


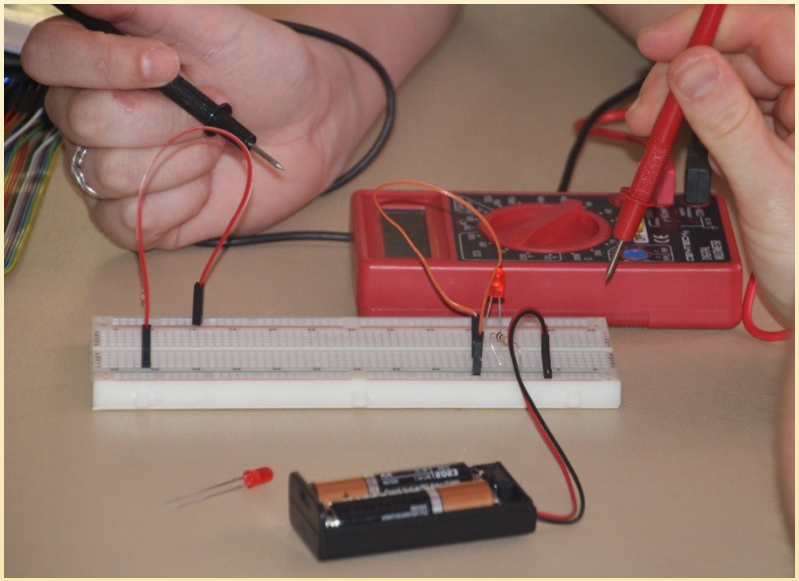

- SSU is writing a Logo manual and building hardware platform prototype
- Initial design of Environmental Science and Biology experiments and sensor selection and tests
- Many visits with teachers to understand needs, infrastructure and how to successfully implement these ideas at the schools
- Set up web-based infrastructure to allow real time communications with teachers

# Prototype experiment



# 2014 Summer Institute






# Connecting with AAPT-AOK

- Anyone want to build an S4 payload? We will send you the board (for free!). Information on parts/WiFi software available at http://s4.sonoma.edu
- *Stay tuned for news about future CubeSat launches*
- University students can build radio antenna systems and listen to CubeSats – ask me how if you are interested
- *Learning by Making HS curriculum won't be available for the public for at least two years. Sorry!*
- We have many other NASA-funded programs that I could not discuss tonight.
  - Especially "Big Ideas in Cosmology" online/hybrid college curriculum for GE

To see all our projects: