Nurturing Success

CubeSat Developers' Workshop
San Luis Obispo,CA
April 25th, 2009

CAL POLY

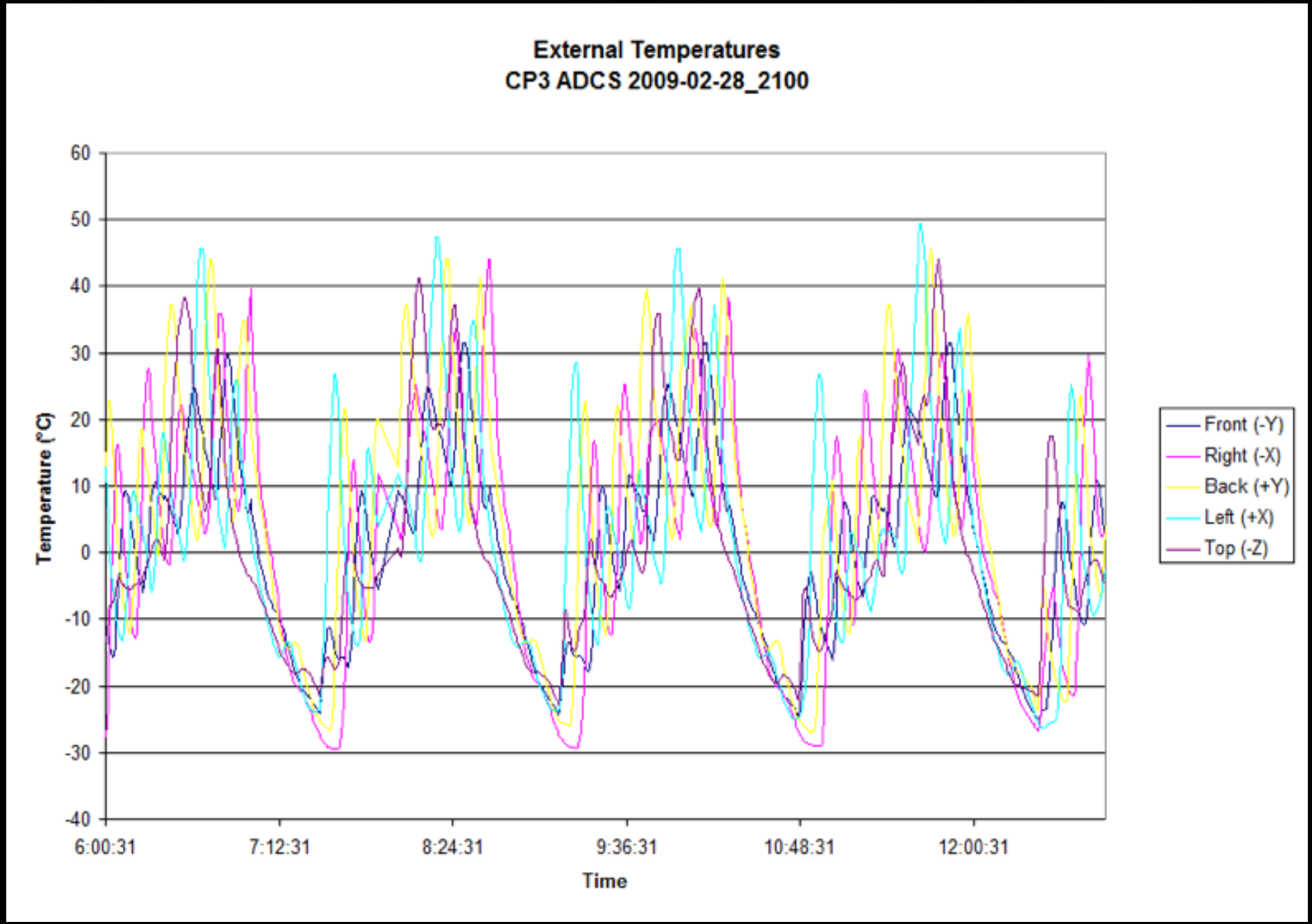
PolySat

- Objective: Engineering Education
- Objective: Provide a reliable bus system to allow for flight qualification of a wide variety of small sensors and attitude control devices.

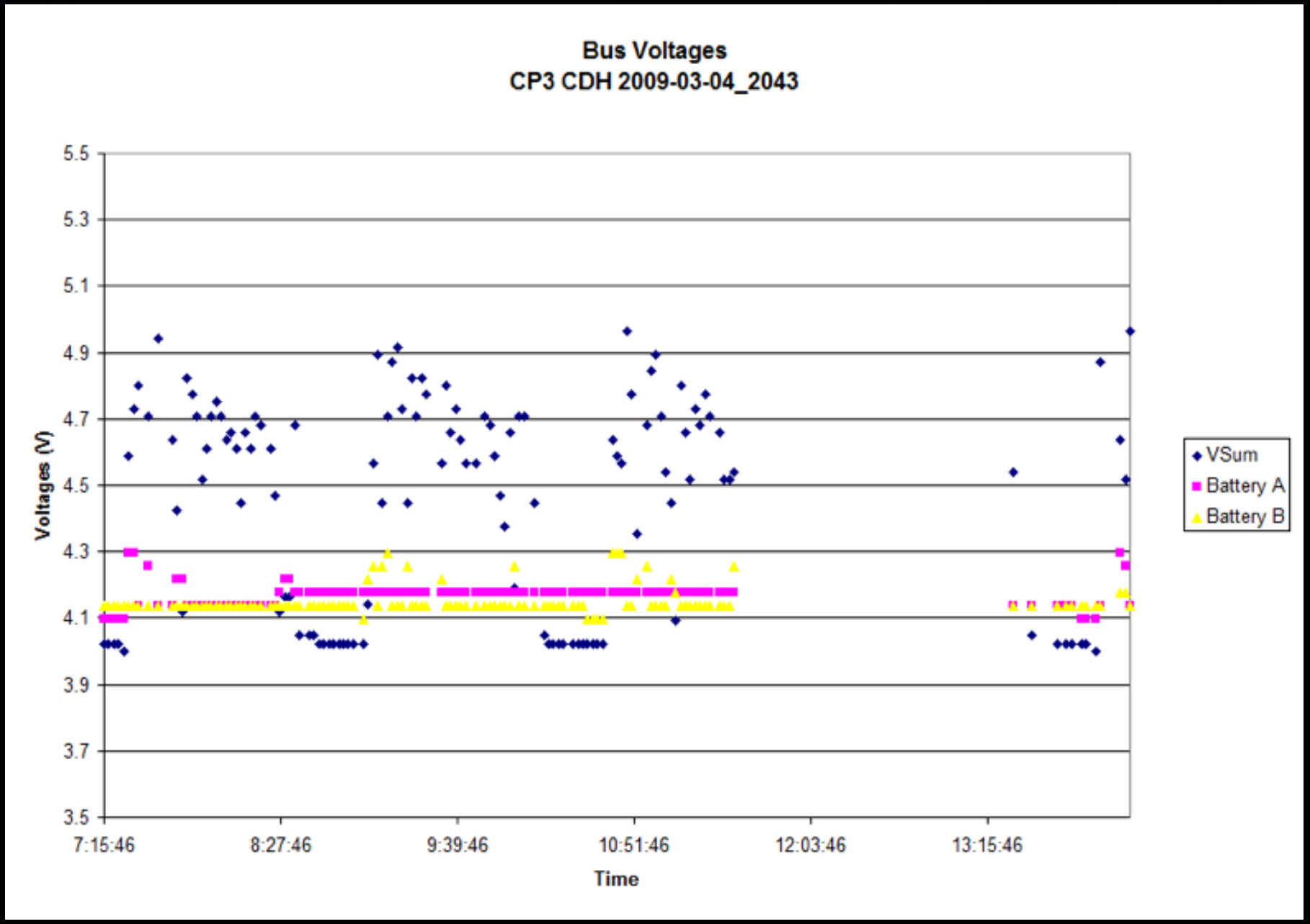
History: PolySat LV Integrations

	Mission	Status	Success?
CP1	Build a CubeSat from COTS parts. Test Magnetorquers and 3rd party Sun Sensor.	Dnepr1 LV Failure	**YES!** The CP1 team paved the way for CP2.
CP2	Test bed for custom structure, EPS, and CDH.	Dnepr1 LV Failure	**YES!** The CP2 team built a capable team to tackle CP3
CP3	Attitude Determination experiments from suite of sensors. Custom bus characterization. Imagers.	Dnepr 2 LV placed in orbit. Still operational after 2 years!	**YES!** Uplink issues discovered--an area of research for newer members. Power system working nominally
CP4	Re-fly of CP2.	Dnepr 2 LV placed in orbit. Brain-dead. Can only access basic house-keeping data. EPS working nominally after 2 years!	**YES!** Perfect example of responsive space. Build lots and keep them in the clean room!
CP6	CP3 re-fly with improved comms (LNA, and filter on receive), bus software, and an additional NRL Payload	Integrated to Minataur Rocket, launching out of Wallops hopefully within May.	**YES!** Major contributions to bus improvements made by new generation members. New respect for documentation.

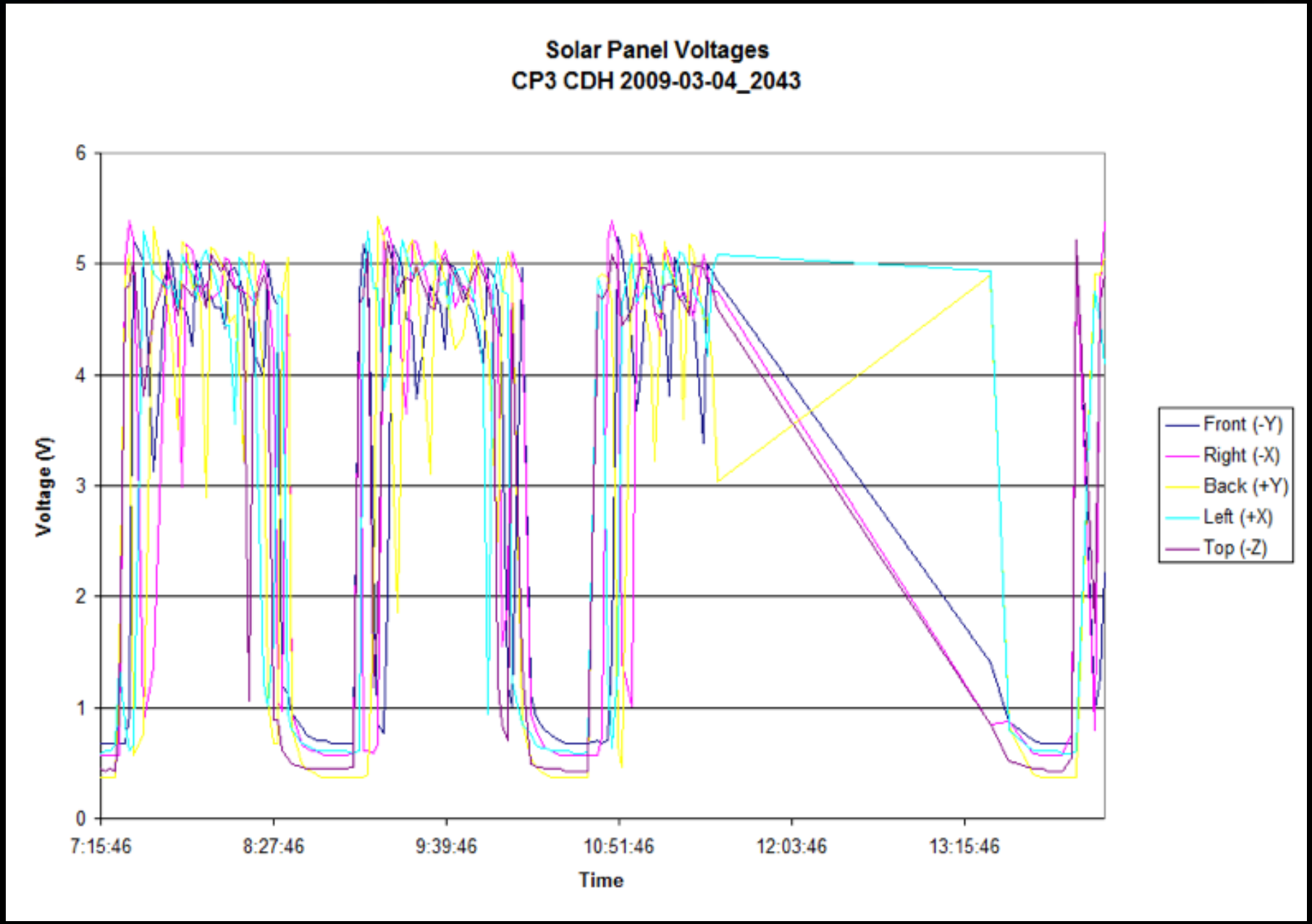
Recent CP3 External Temps



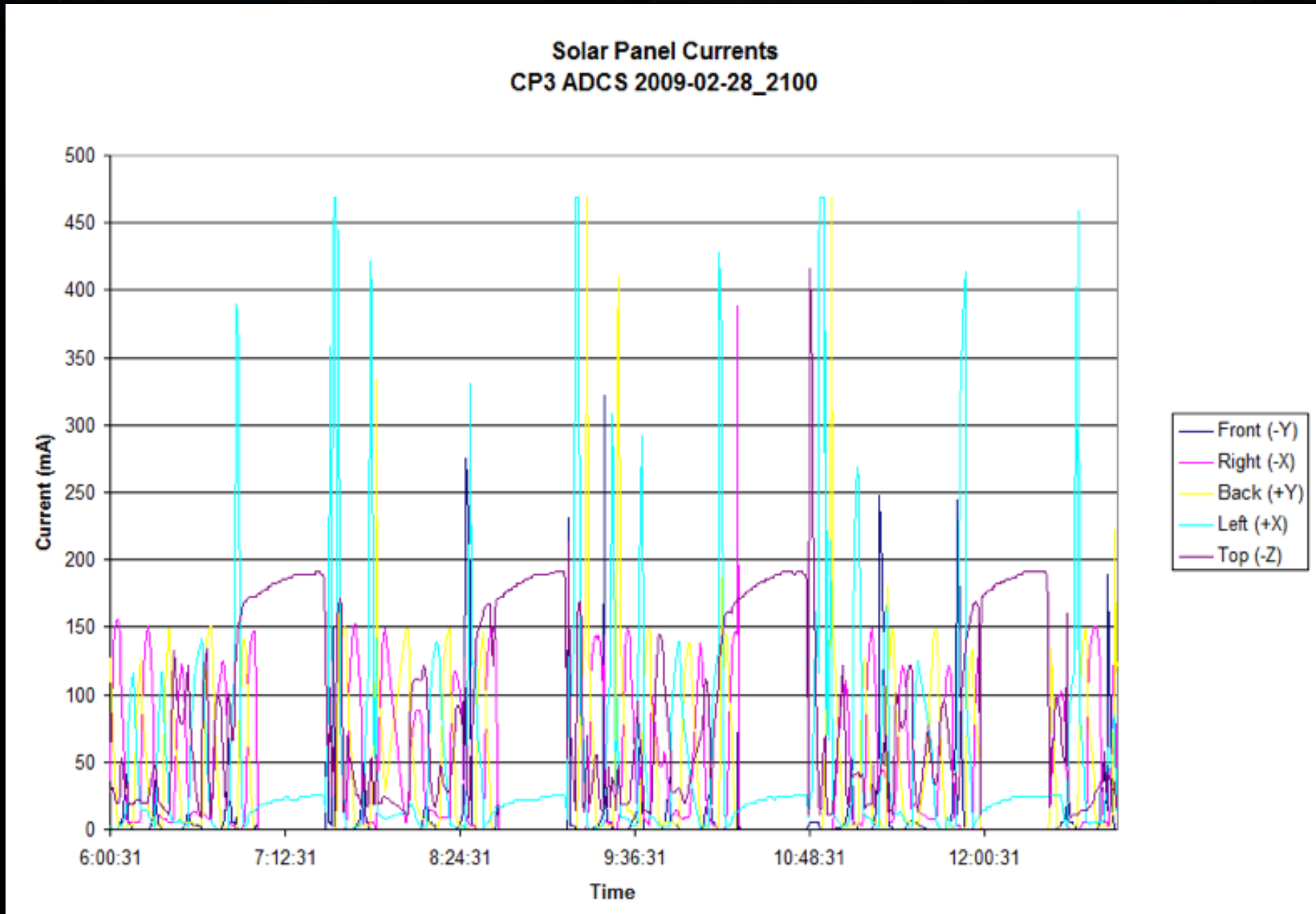
Recent CP3 Bus Voltages



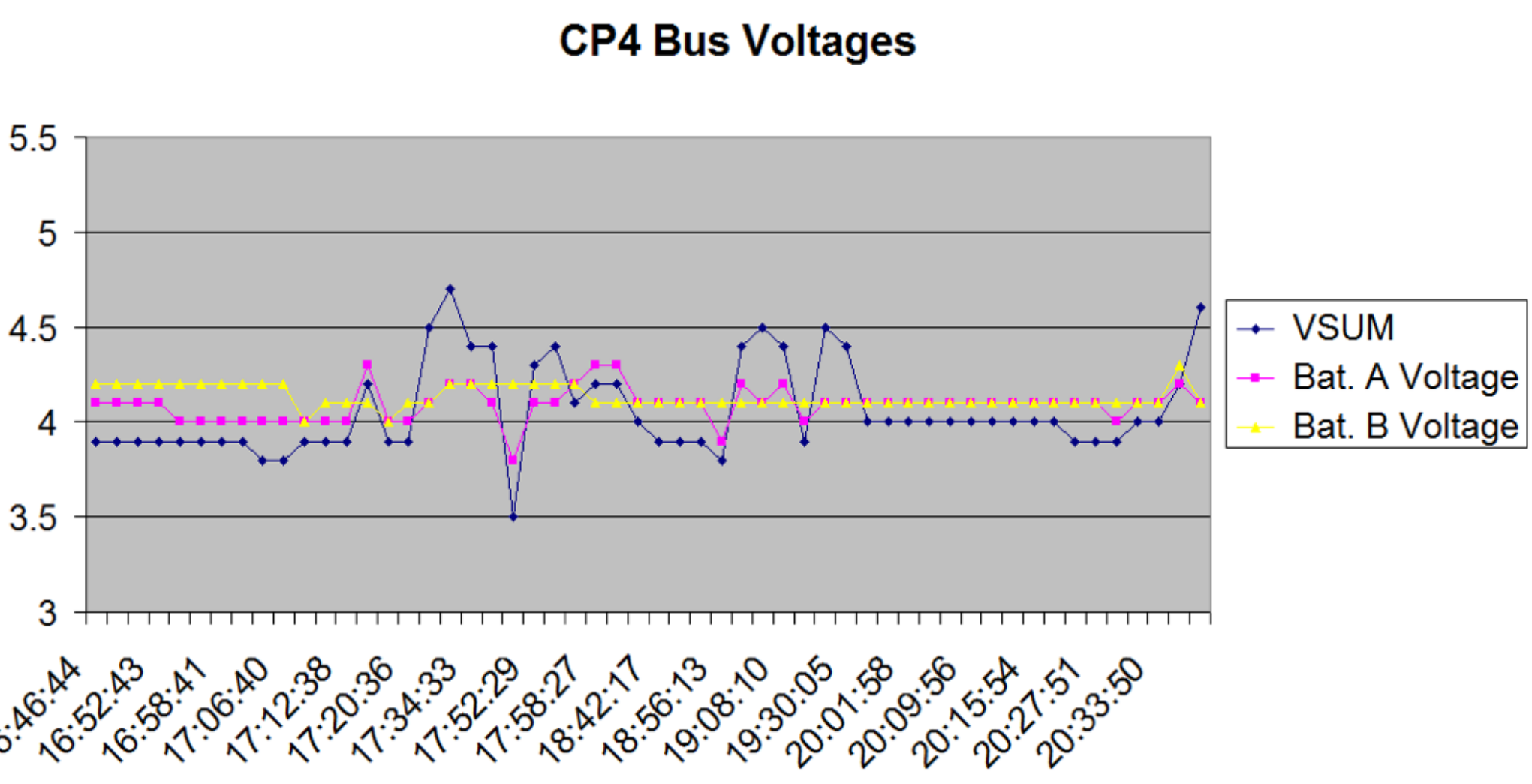
Recent CP3 Panel Voltages



Recent CP3 Solar Panel Currents



CP4 Bus Voltages



CP6

- Bus Improvements:
  - Low Noise Amplifier and Filter on Receive line
  - Software stability

- Naval Research Laboratories Payload
  - Electron emitter and collection experiment
  - Two collectors, one emitter
  - Precursor to full electro-dynamic tether experiment

NRL Payload Fit Check

Current Developments

	Mission	Status	Success?
CP5	Deployable for increased de-orbit rate.	New members since CP6 developing deployable structure and release mechanism. Proof of concept prototyping.	**YES!** Continued progress on an entirely custom system by newer recruits.
CP7	Received grant to design vibration dampener experiment into the CubeSat testbed.	Currently developing modified test bed for Zero-Gravity flight. Entirely controlled by current bus design, but constructed for Zero-G flight.	**YES!** The payload designer and CP7 project manager is a 3rd year EE. (John Abel) Get to experience a Vomit Commit flight.
CPX	That's what the workshop is for--we're always looking ahead.	Active	**YES!** A CubeSat program spanning several generations of students, and gaining momentum.

Zero-Gravity Test Bed

University CubeSat Program Challenges

- Programs often dependent on small, dedicated groups of students.
  - Satellite design cycle is emotionally draining for students.
  - Some programs get caught with the simultaneous transition to a new team with a new mission.
  - Disconnects in flow of knowledge (wiki can help!)
- Having faced these challenges, what did we learn?

Laundry List of Lessons Learned

- Recruit during all phases of the design cycle (critical investment!)
  - Bring them up to speed! Study sessions and board population and testing are educational.
  - Team leads need to recruit a multidisciplinary team.
- Always look beyond the current project.
  - Teams should want to finish the current project to move onto the next one.
  - Don’t let the program leave with the team.

Lesson’s Learned Cont...1

- Many large challenges can be broken into smaller, manageable tasks.
  - CubeSat development isn’t exactly rocket science...that’s the point!
  - Graduate students can learn from High School students. (component research and characterization.
    - Some Jr. High’s and High School teach technology and engineering courses.
    - Support STEM education. Visit K-12 classrooms focused on project based learning.

Lessons Learned Cont.…2

- Recruit younger students, and don’t let go.
  - Younger CubeSat developers have more time to get caught up.
  - Nimble fingers and eyes like a hawk--a requirement for SM Soldering.
  - Gently force a Master’s degree. Gently.
- Local K-12 outreach counts as recruitment!
  - Make CubeSat’s ubiquitous in your area.
  - Get High School students applying to

Lesson Learned Cont...3

- GPA of a student is not always indicative of engineering passion or ability.
- Industry and Student relationships can be mutually beneficial.
- Designing you're own hardware provides a far deeper understanding of the satellite, and is an incredible learning tool.
  - For university students, much success found in "failures".
  - Platform for aggressive creativity

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CP EPS Availability

- Cal Poly would like to offer up our simple, 1U EPS / Side Panel design to the community.
  - 2 year proven flight heritage
  - Ideal for relatively simple missions
- Details of deliverables and interfaces TBD
- Price also TBD, but will reflect our cheap labor and inability to provide real support.

EPS Overview

- Two 3.7V Lithium-Ion Batteries in parallel.
  - 3.4AH capacity with proper-protection
  - Unregulated Battery/Solar Cell Supply
  - Three DC/DC converters to step down Unregulated power to desired voltage.
  - Capable of recovery from battery cut-off due to low power.
- I2C for component communication amongst Power Board, Side Panels, and the chosen CDH.

Thanks!

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