DESIGNING, SIMULATING, AND TESTING THE POWER SUBSYSTEM FOR RAPID

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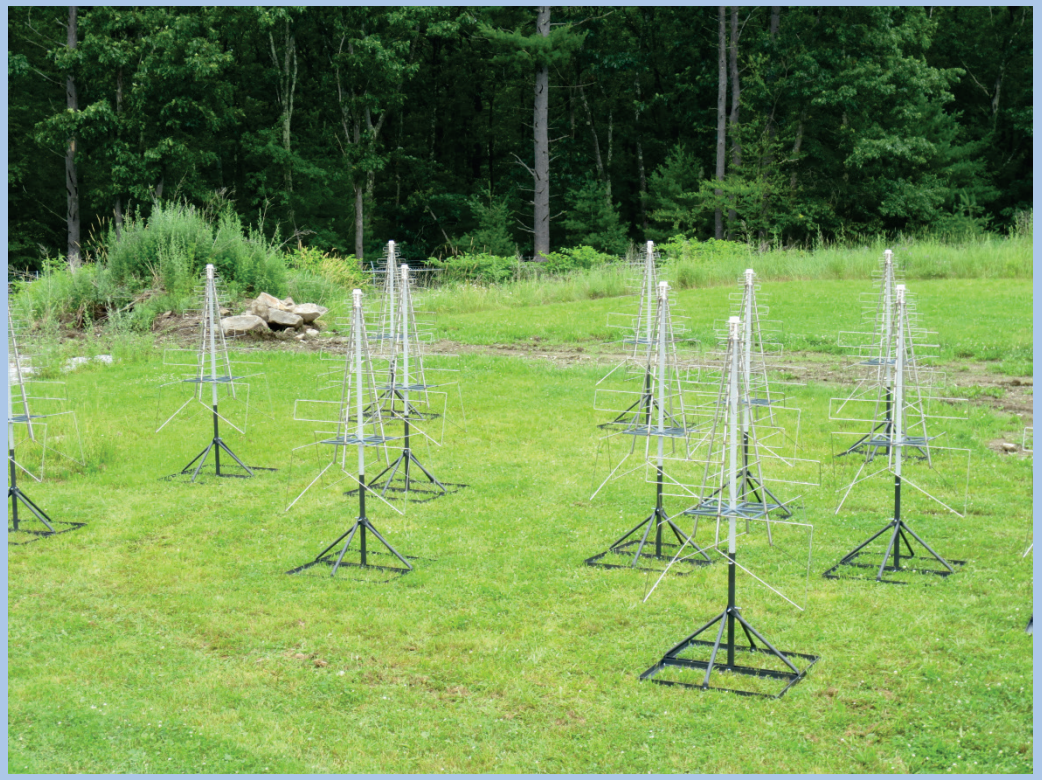
OUTLINE

- Introduction to RAPID
- 3 Power Subsystem Components
  - Solar Panel
  - Battery
  - Charge Controller
- Python Power Model Simulation
  - Demonstration
- Test Bed
- Summary

RAPID

Radio Array of Portable Interferometric Detectors

- Portable field units for conducting radio interferometry



Consists of:

- Antenna
- LNA
- Atomic clock
- FPGA
- Storage unit
- Power subsystem

RAPID

Advantages:

- Independent
- Reconfigurable
- Transportable to ideal location for observations
- Large number of baselines
- Wide field
- Wide frequency range

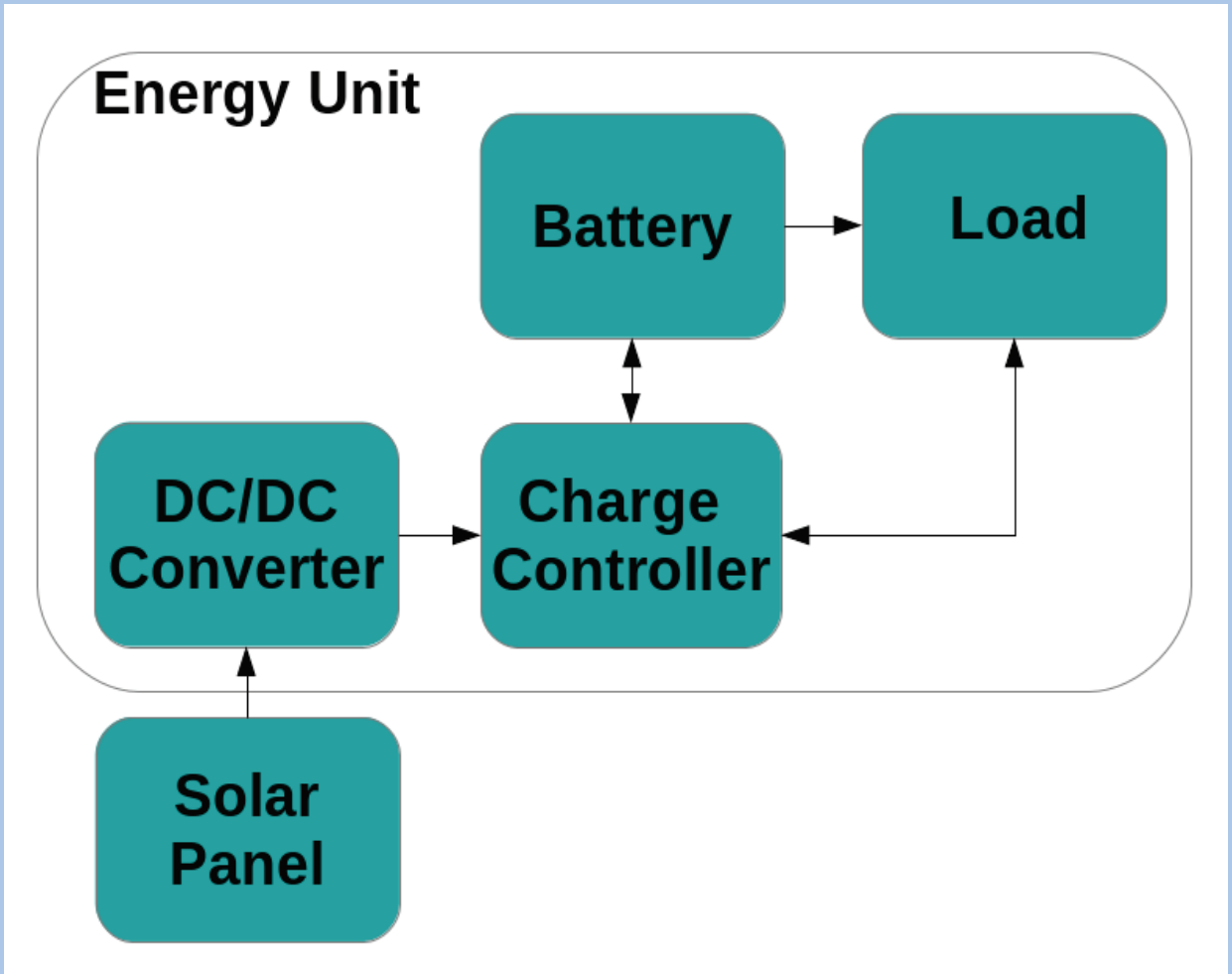
- In order to produce large numbers of antennas, hardware must be efficient, reasonably sized, cost effective, shippable, etc…

To maximize portability, each unit must contain an easily transportable power supply

POWER SUBSYSTEM

Contains:

- Photovoltaic Panel
- DC/DC Converter
- Battery
- Charge Controller

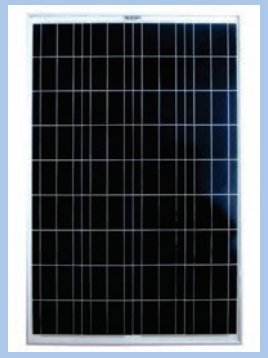


PHOTOVOLTAIC PANEL

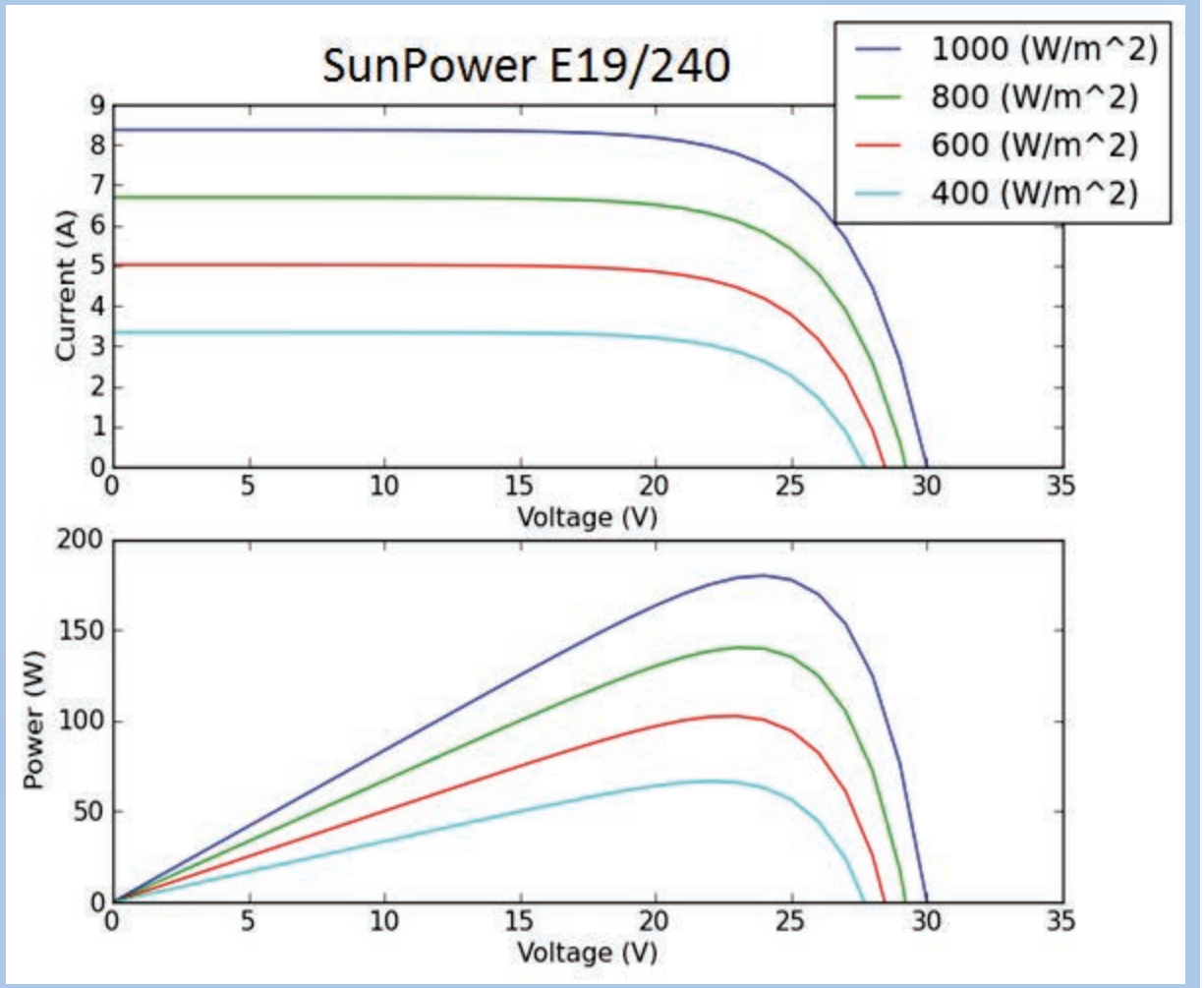
Considerations:

- Efficiency
- Size/Weight
- Cost

SunPower E19



Grape Solar

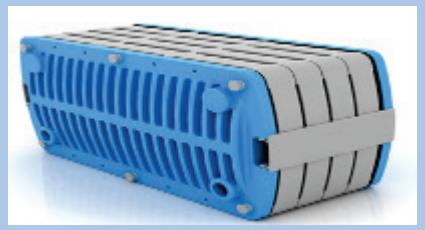


BATTERY

3 Types of Batteries:

- Lead Acid

- NiMH



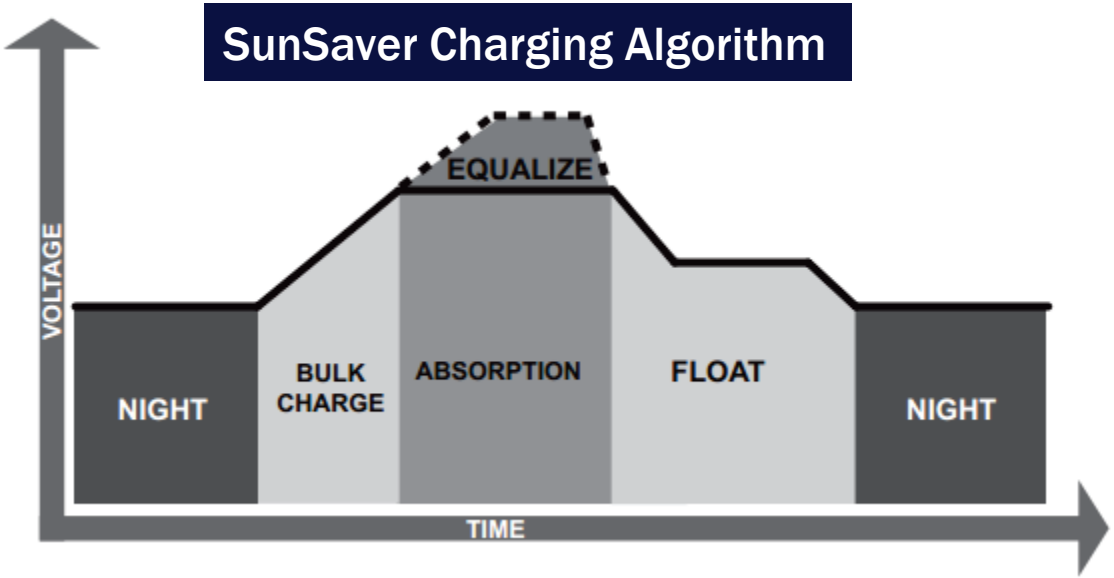
- Lithium Ion

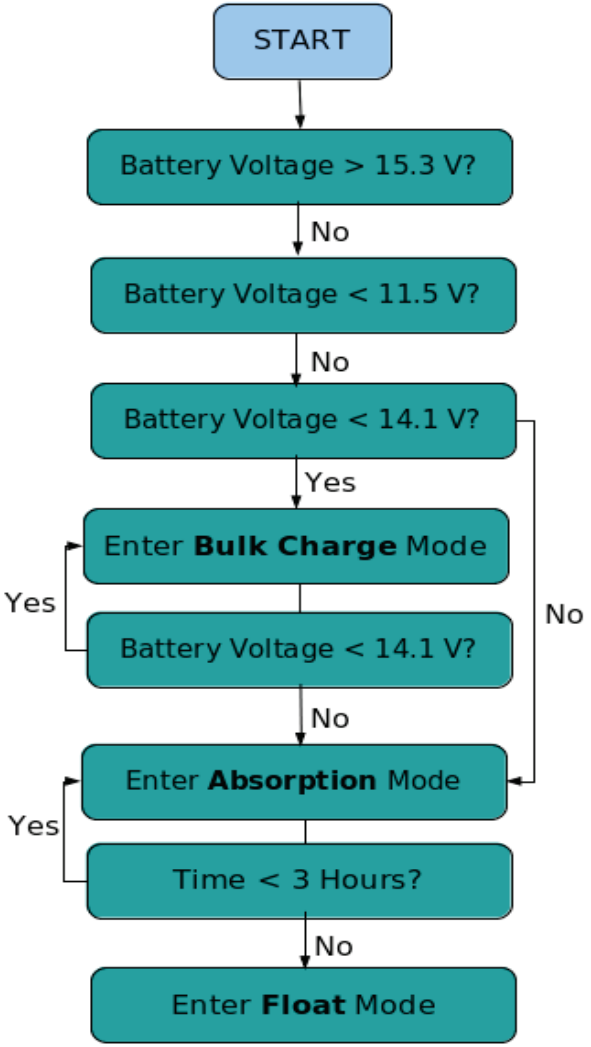
Selected for RAPID

CHARGE CONTROLLER

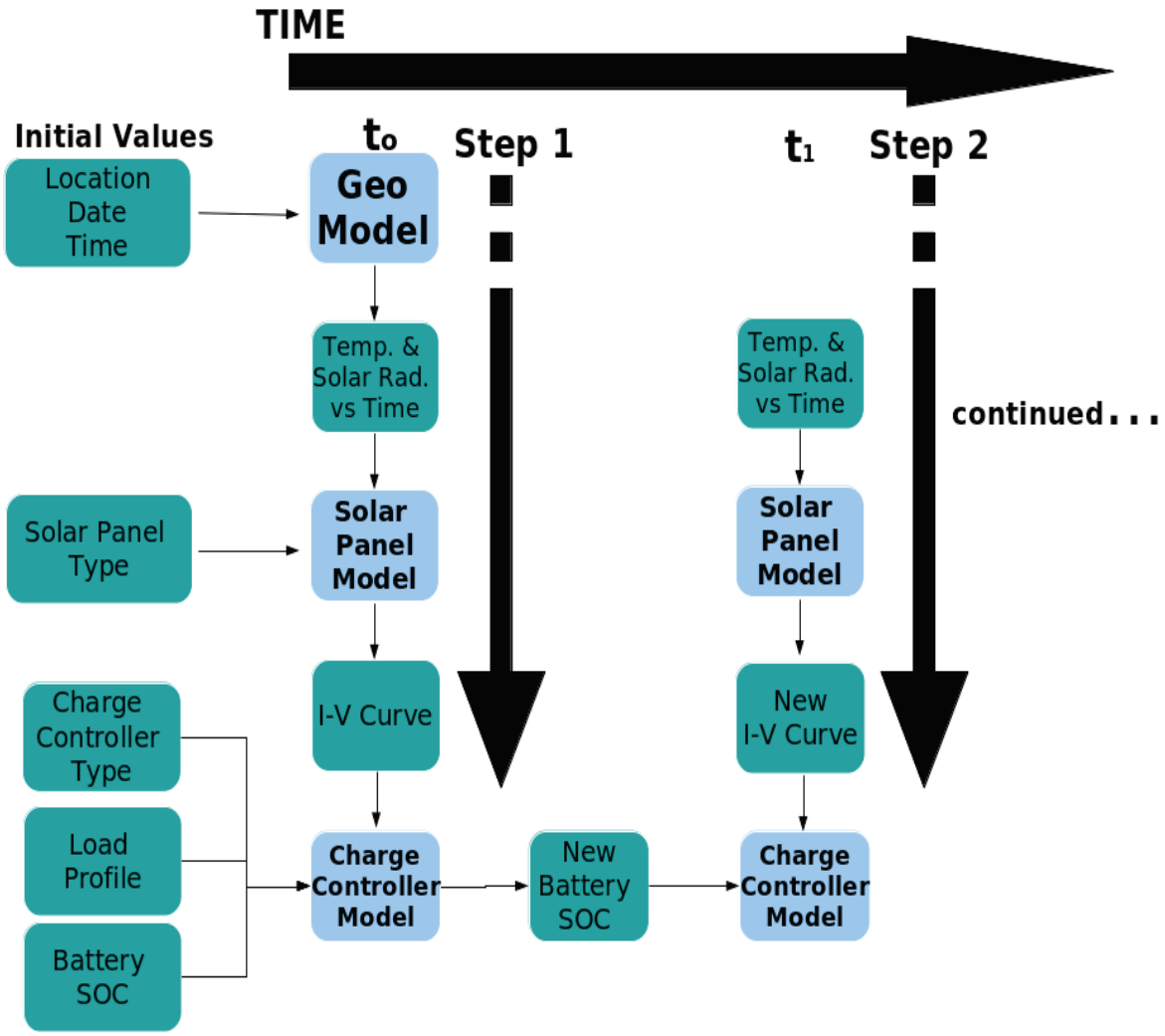
- Morningstar's SunSaver PV System Controller

SunSaver Charging Algorithm





POWER MODEL



- Python simulation
- Uses discrete time steps
- Easily configurable for different load profiles, solar panels, and geographic locations

DEMONSTRATION

Load Profile:

5 hour experiment

On 30 min, off 30 min

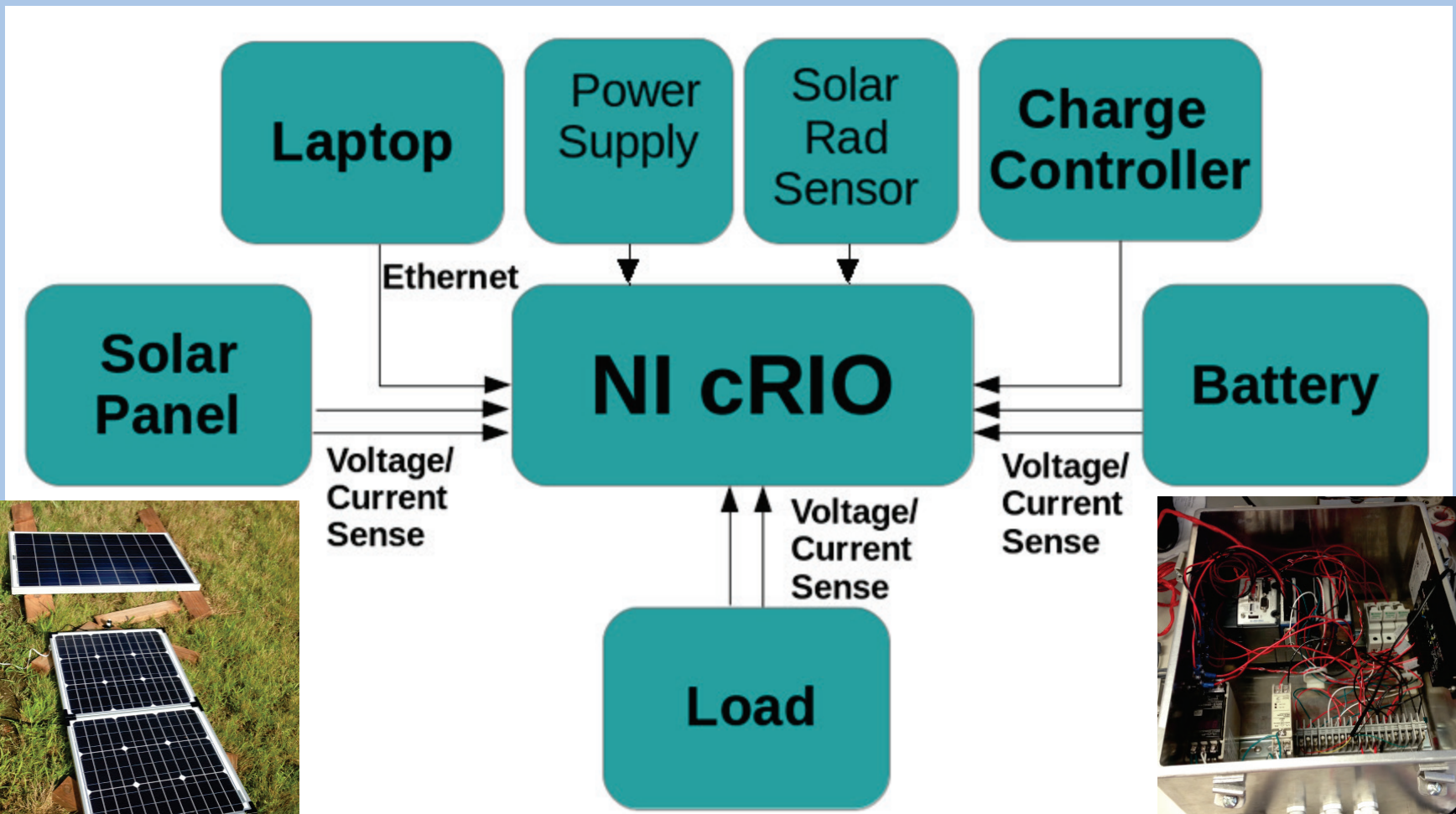
[400,400,300,300,300] W/m^2

[25,25,25,25,25] ^oC

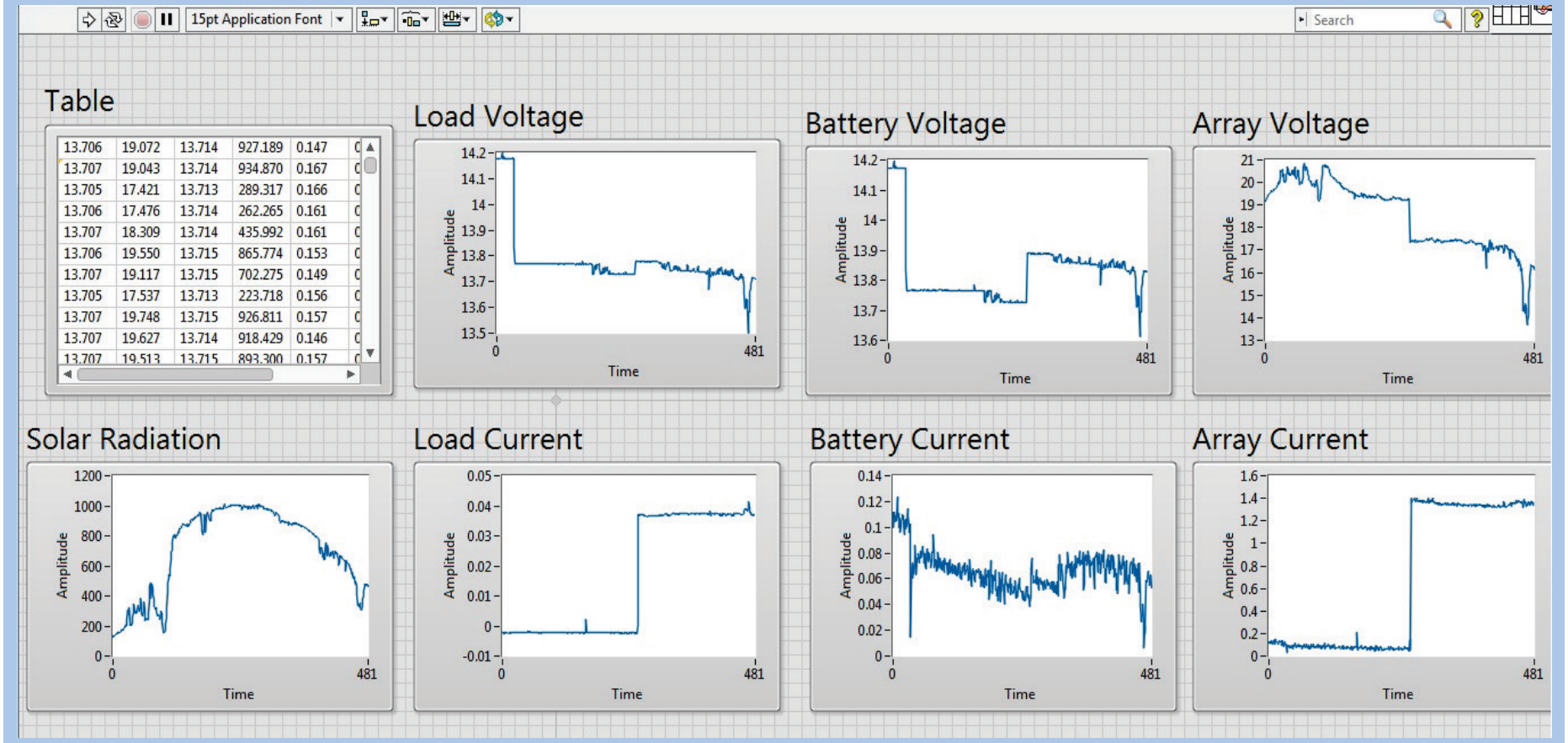
SOC = 13.5 A-hrs

V_{Bat} = 13.2 V

POWER SYSTEM TESTING



DATA EXAMPLE



SUMMARY

- Important to get an idea of how the power system will perform before deploying the antennas
- Utilize the python simulation as well as the test bed to get a sense of how feasible an experiment is
- Better understand the solar panel and battery capacity needed to run RAPID
- The model will continue to be developed as more variables become known

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- Colin Lonsdale
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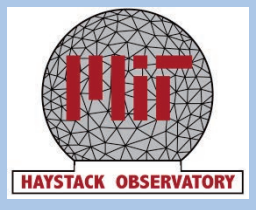

THANK YOU

Questions?

REFERENCES

- U. Boke, "*A simple model of photovoltaic module electric characteristics*," in Proc. Eur. Conf. Power Electron. Appl., Sep. 2007, pp. 1–8.
- Eric P. Usher and Michael M. D. Ross. Recommended Practices for Charge Controllers, Report IEA PVPS T3-05: 1998, CANMET Energy Diversification Research Laboratory, Natural Resources Canada, Varennes, Québec, August 1998.