



Advanced Energy Storage System for Thermal Engines



AUVSI Annual Review

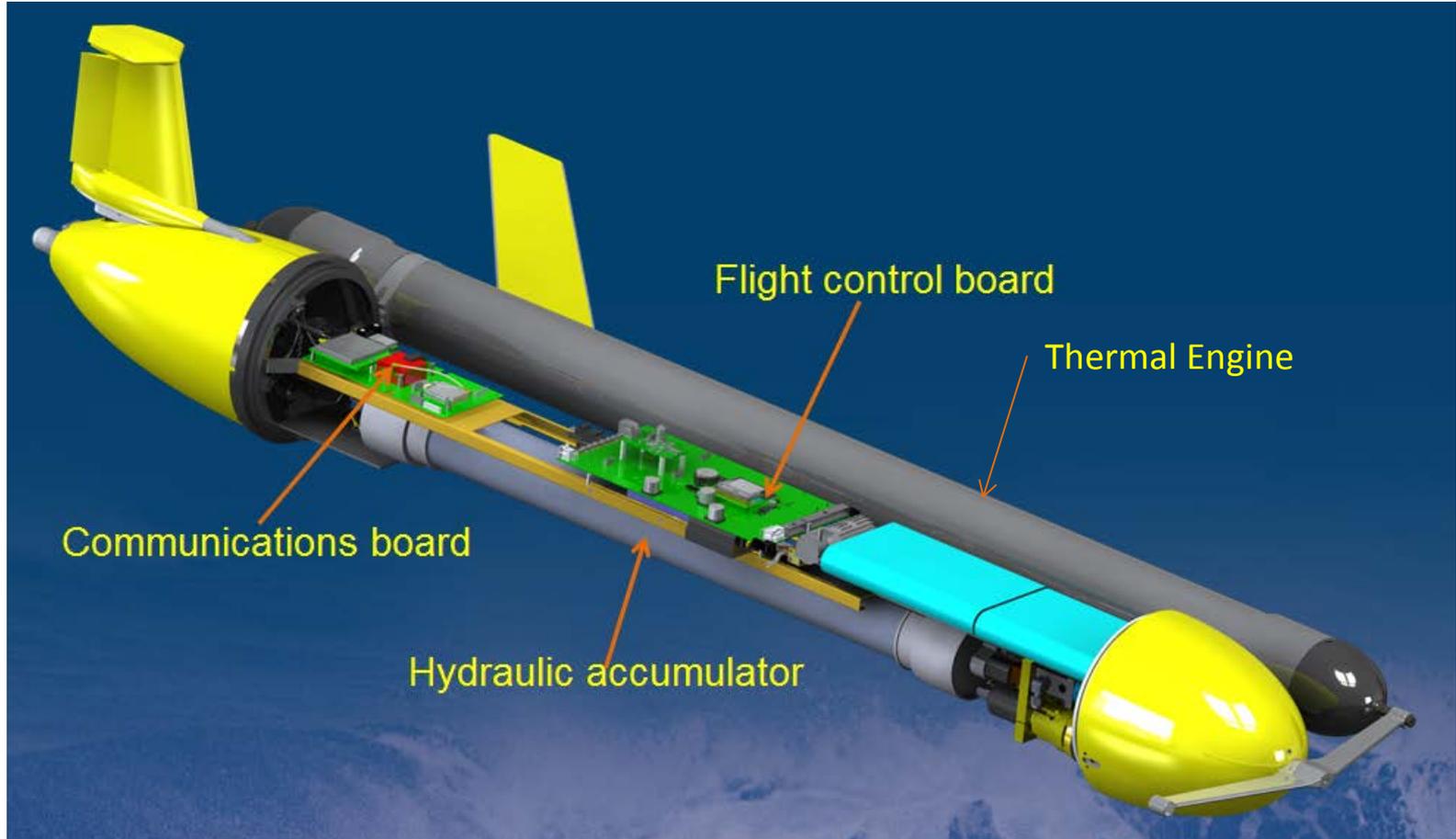
PI: Terry Huntsberger
Mechanical: Jack A. Jones
Electrical: Thomas Valdez



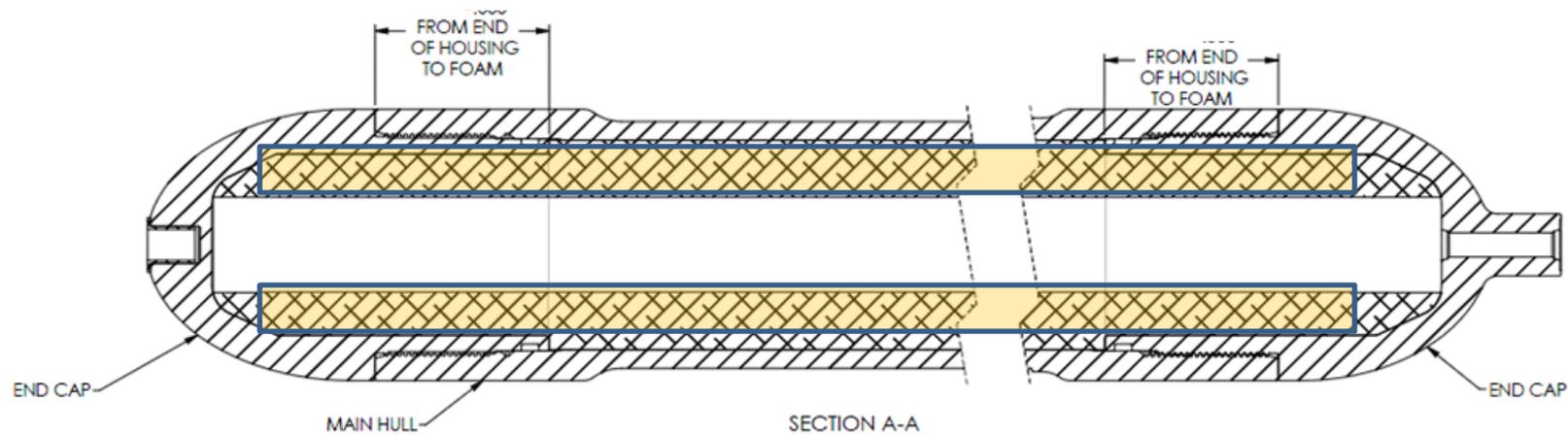
Program Manager: Rob Stirbl
Jet Propulsion Laboratory
California Institute of Technology

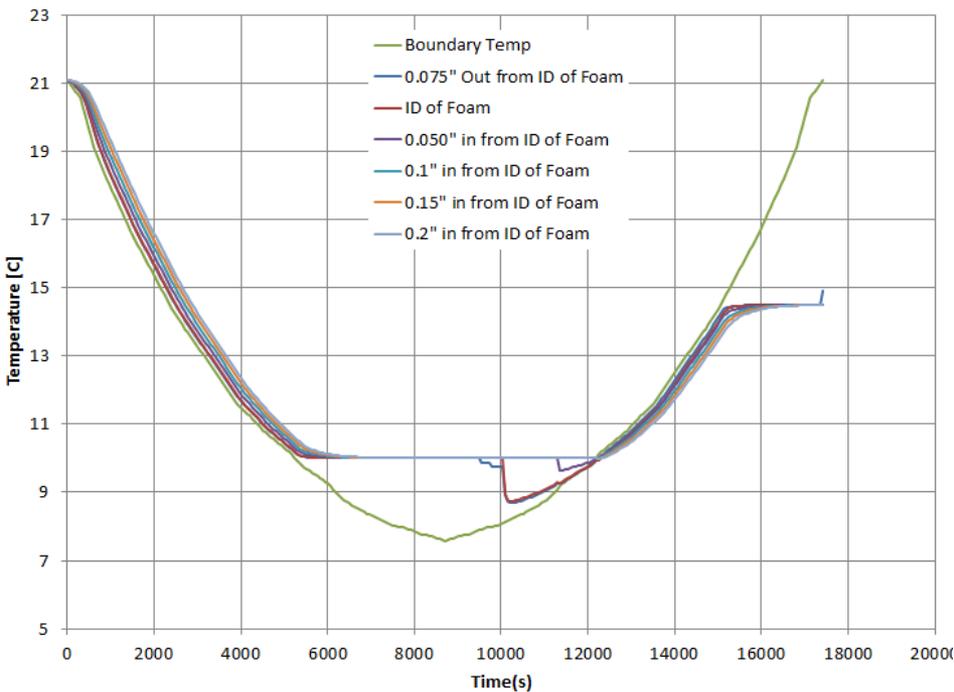
January 31, 2013

Slocum-TREC Primary Components

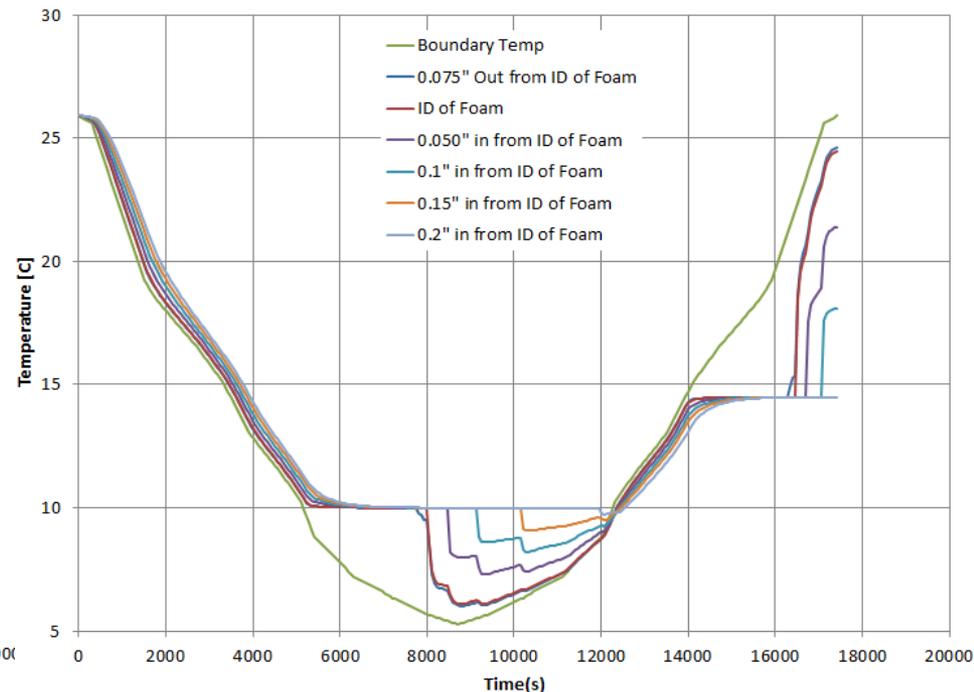


Thermal Engine with Aluminum Foam



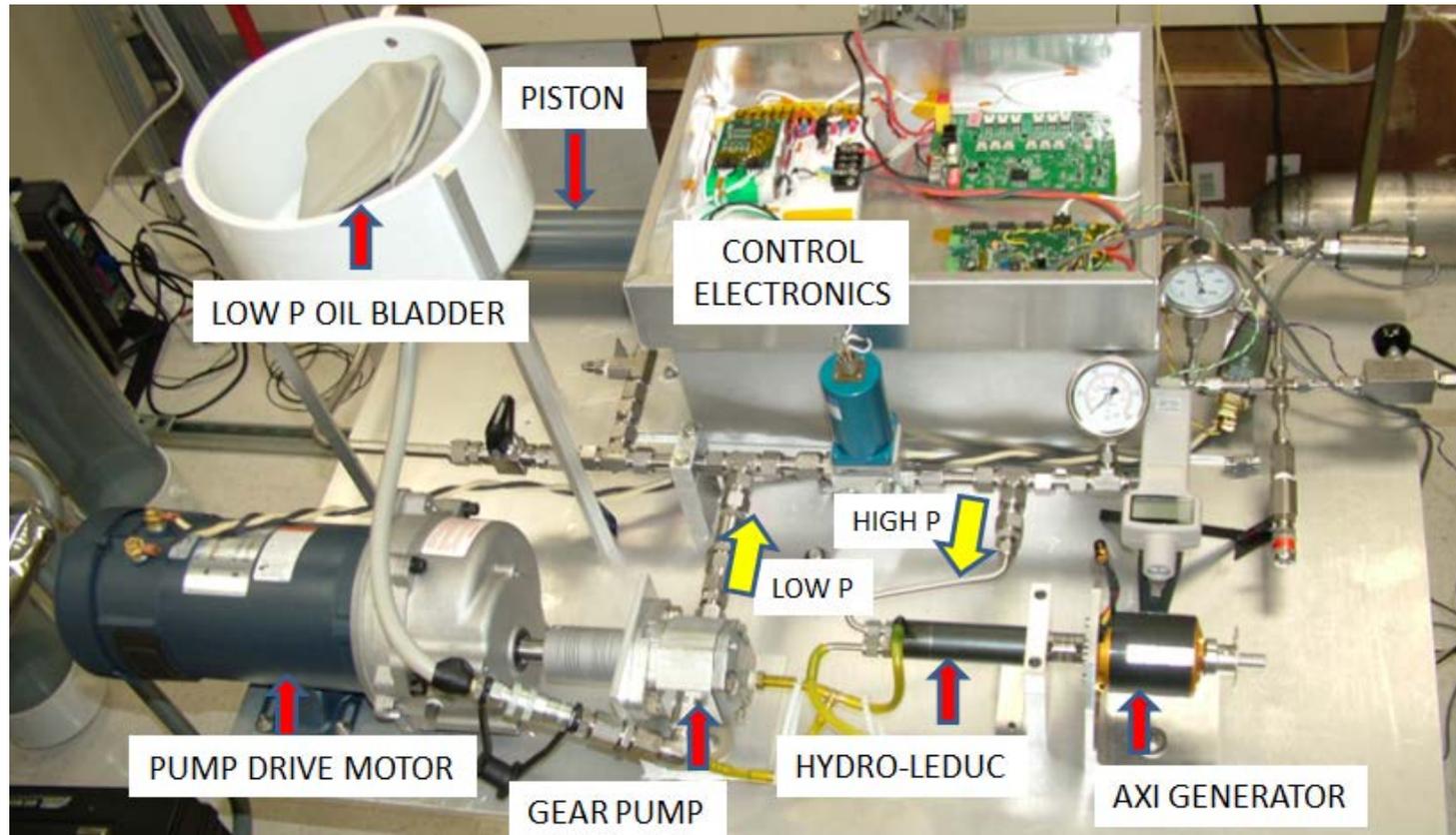


Canary Islands

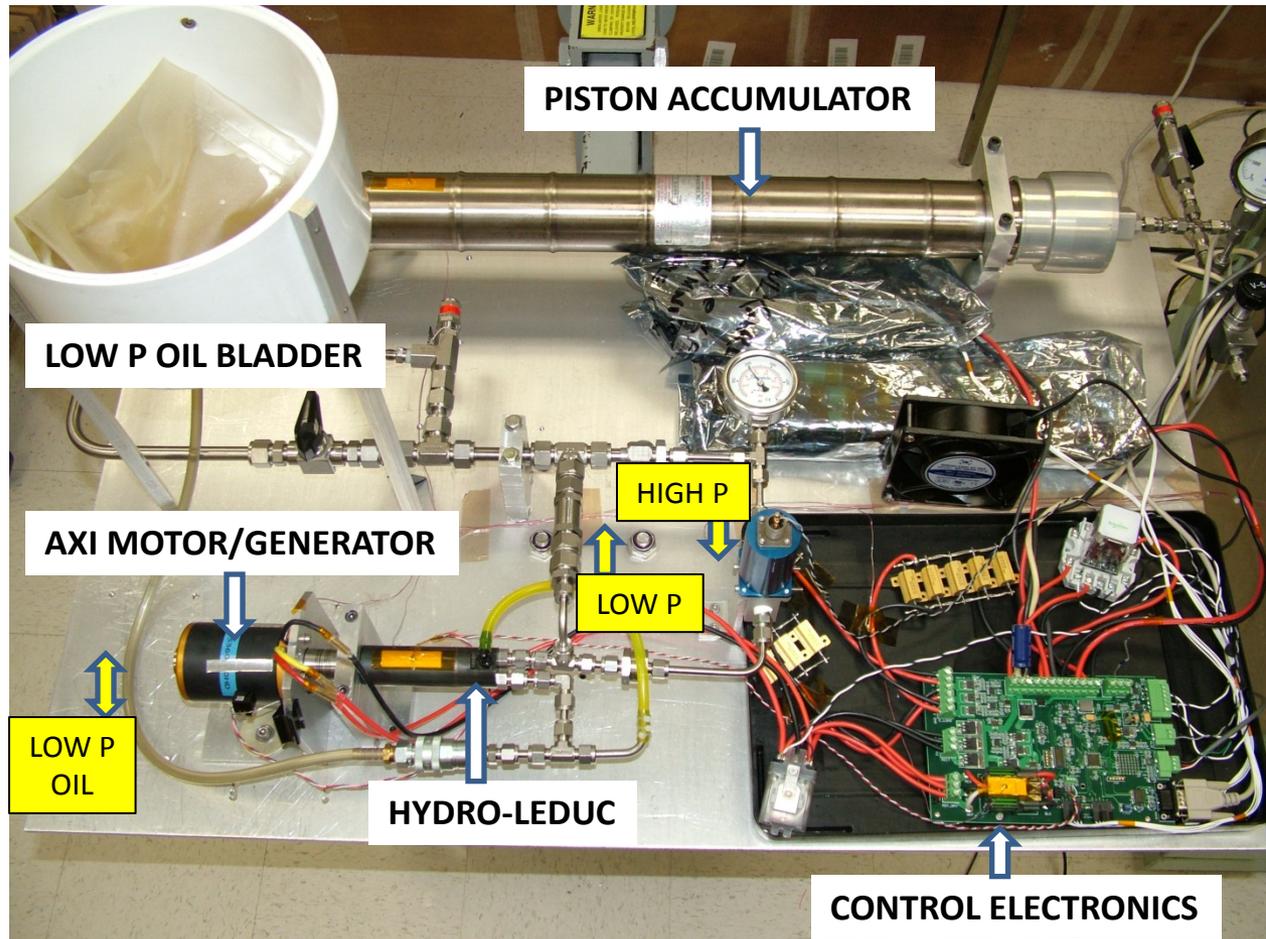


St Thomas

Transient thermal analyses have shown that the Slocum-TREC thermal engine PCM will fully melt during dives near St. Thomas and Hawaii, but it will only partially melt for dives near the Canary Islands off of northern Africa. Operation at San Diego, even in summer, is even more marginal. Melting occurs at 14.6 °C (200 bar), and freezing occurs at 10 °C (1 bar).

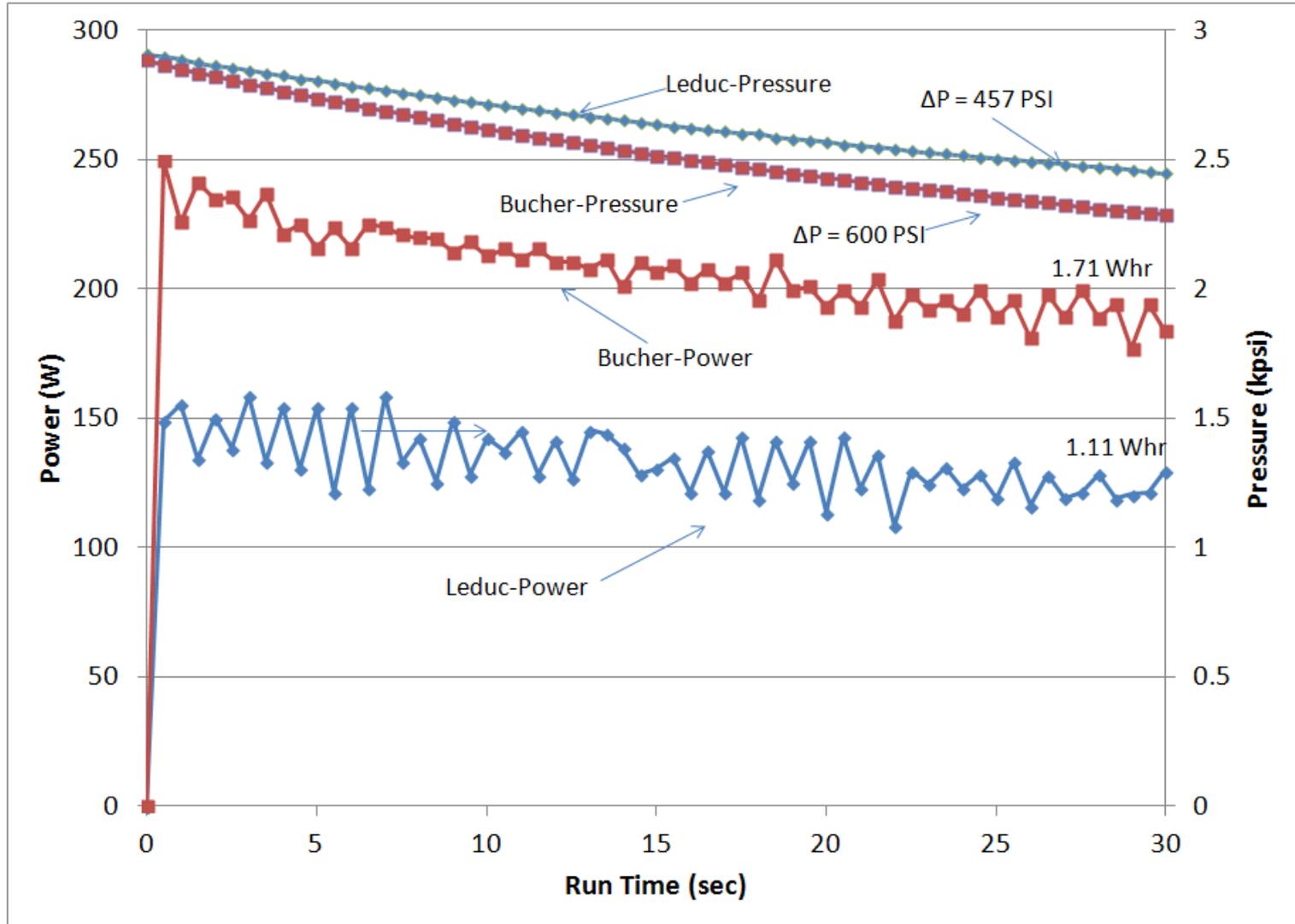


The piston accumulator has been cycled over 100 times with a nitrogen gas leakage of less than 5 cc. Further accelerated endurance testing is underway.



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Genset Testing





Increased Operating Efficiency over SOLO-TREC



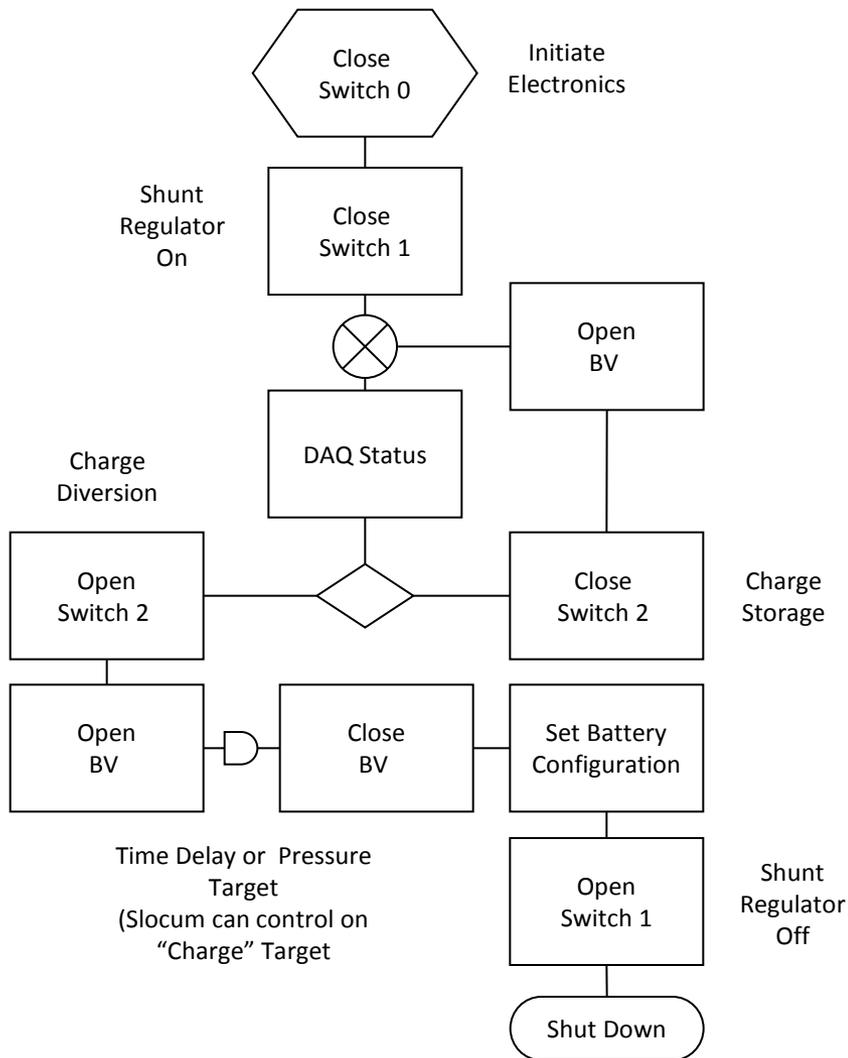
Genset	Low complexity motor control electronics	Ripple-free Charge	$\eta > 60\%$	$I < 15\text{ A}$	Charge time > 20 seconds	COTS	Durability
Hydro-Leduc-Maxon RE65-24V	X	X	62.7*				
Hydro-Leduc-AXI 5345			51.1**				
Hydro-Leduc-AXI 5360			59.7	X	X		
Bucher-AXI 5360			69.8			X	X
Bucher-Maxon RE65-36V	X	X	65.2	X	X	X	X

* Tested with reverse protection diode

** 67% efficiency measured at TWR, which used a lower viscosity oil and 12V charge

The baseline chosen for the Thermal Gliders, to be deployed in 2013, is the Hydro-Leduc pump/motor in combination with the AXI-5360 motor generator (60% efficiency). By comparison the SOLO-TREC combination using a Marzocchi hydraulic pump with a Maxon motor, yielded an electromechanical efficiency of 45%.

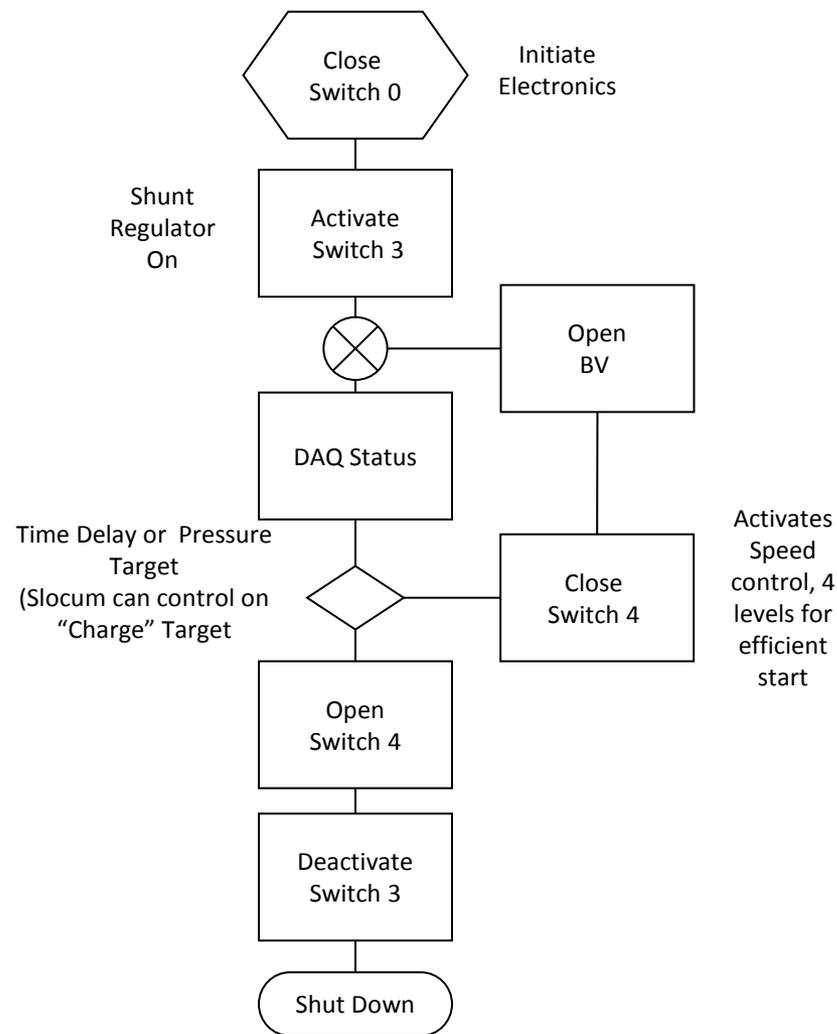
Charge Control Logic Outline



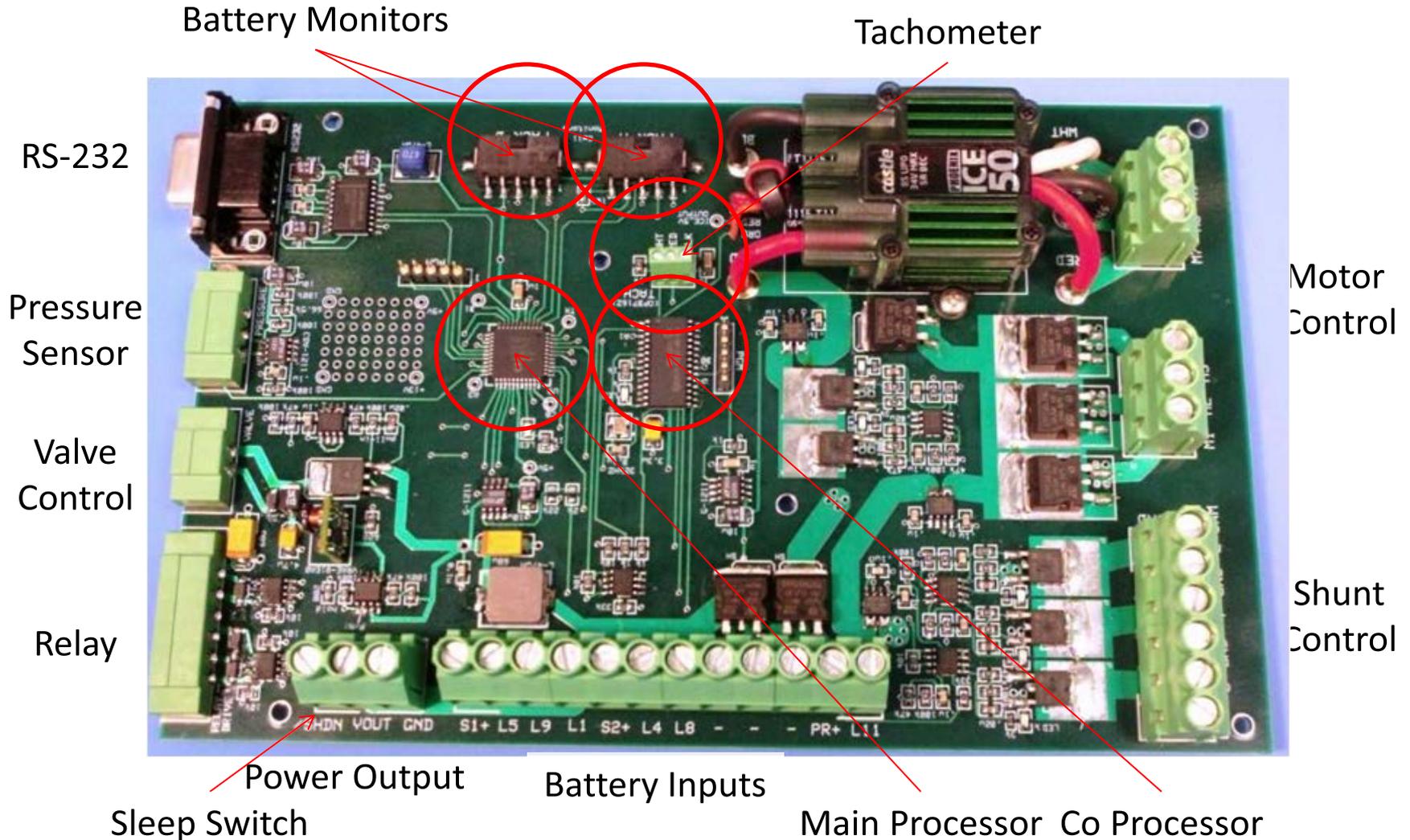
- Electronics to be initiated approximately 5 seconds prior to pressure discharge
- Electronics can be shut down at anytime, software shutdown preferred
- DAQ Status (1 Hz)
 - Charge Pressure
 - Cell voltages
 - Alternator Current
 - Diversion Load Current
- Ball Valve (BV) closed when either electric motor voltage drops to pre-set value (~10.0 Volts) or the minimum pressure is reached

Pump Control Logic Outline

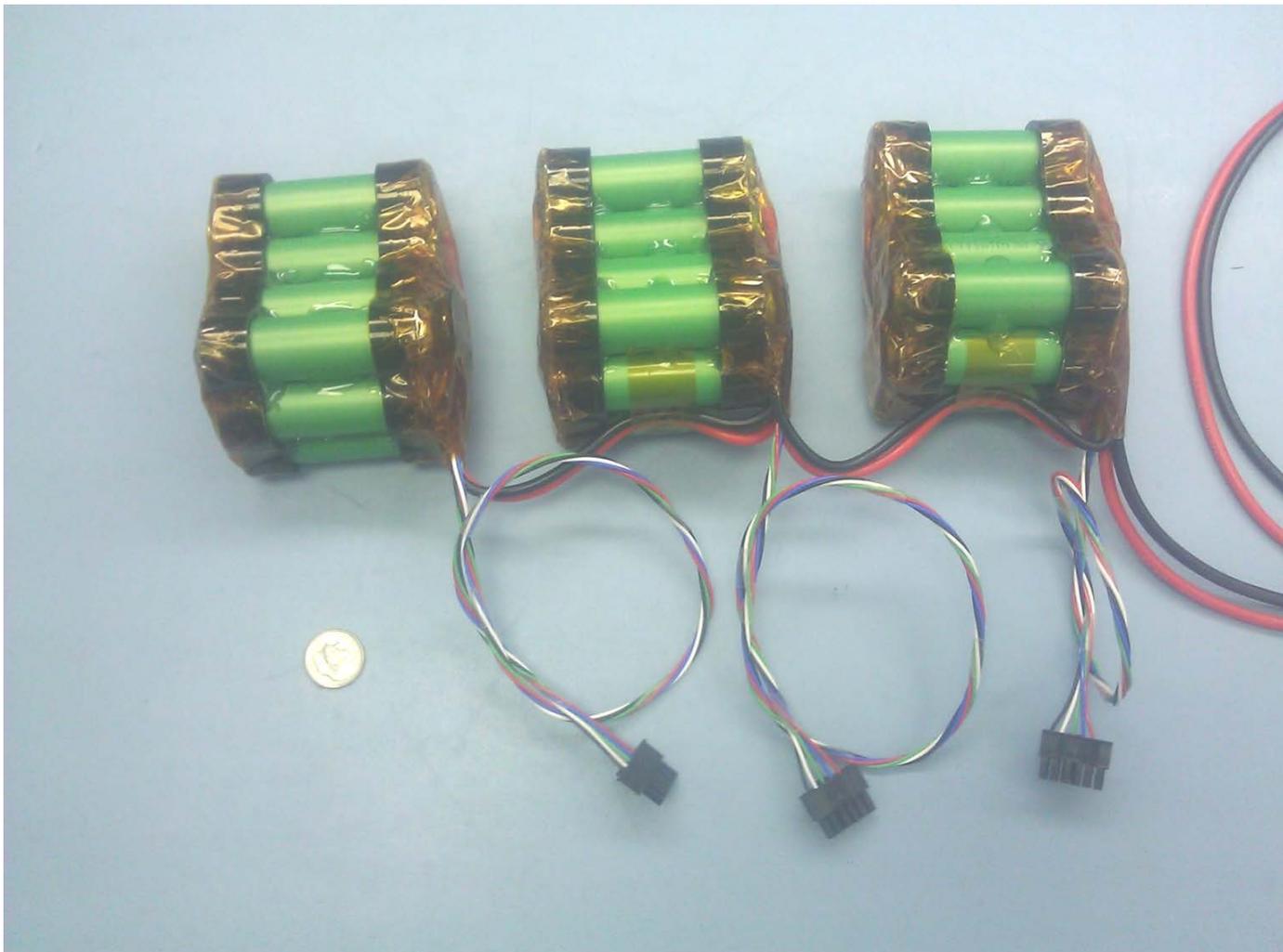
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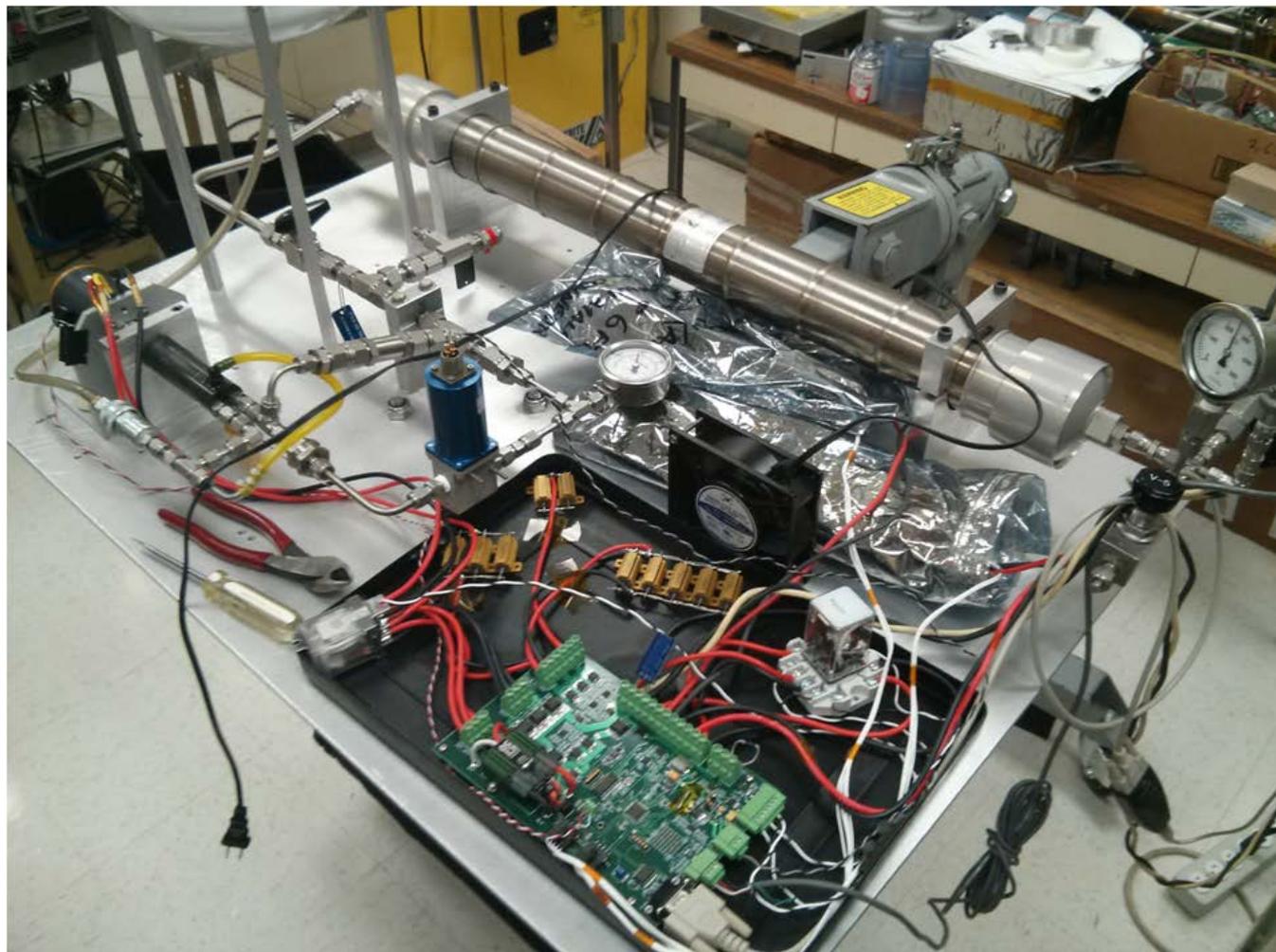
Energy Storage Subsystem: Mother Board



Energy Storage: Battery



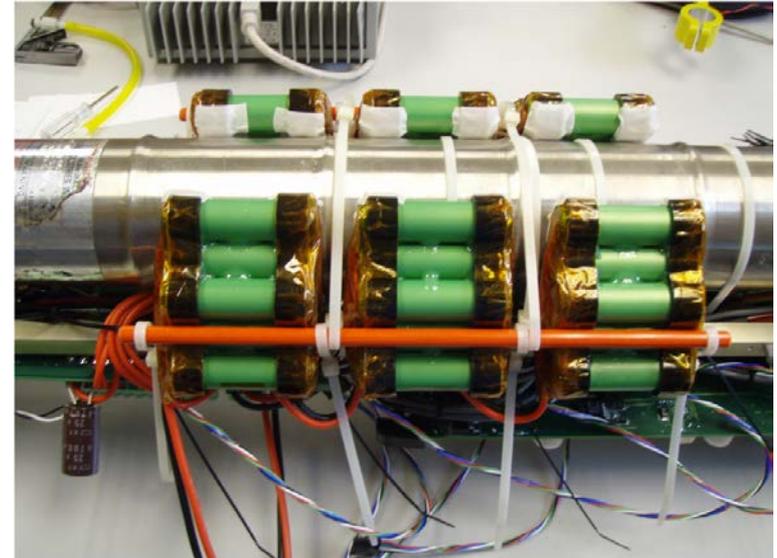
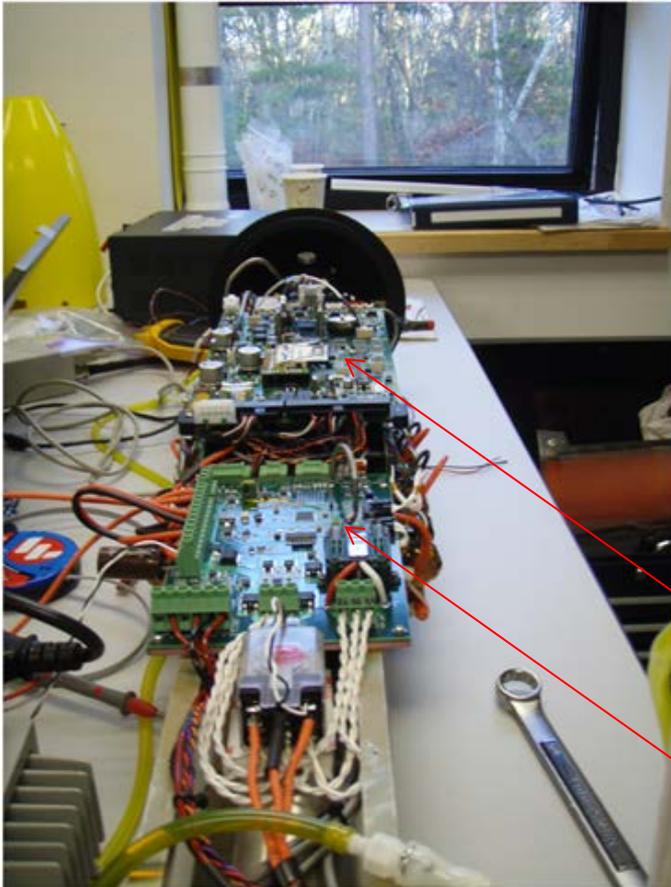
Slocum-TREC Simulator



Electronics Delivery: Electronics Integration

Control Electronics

Batteries

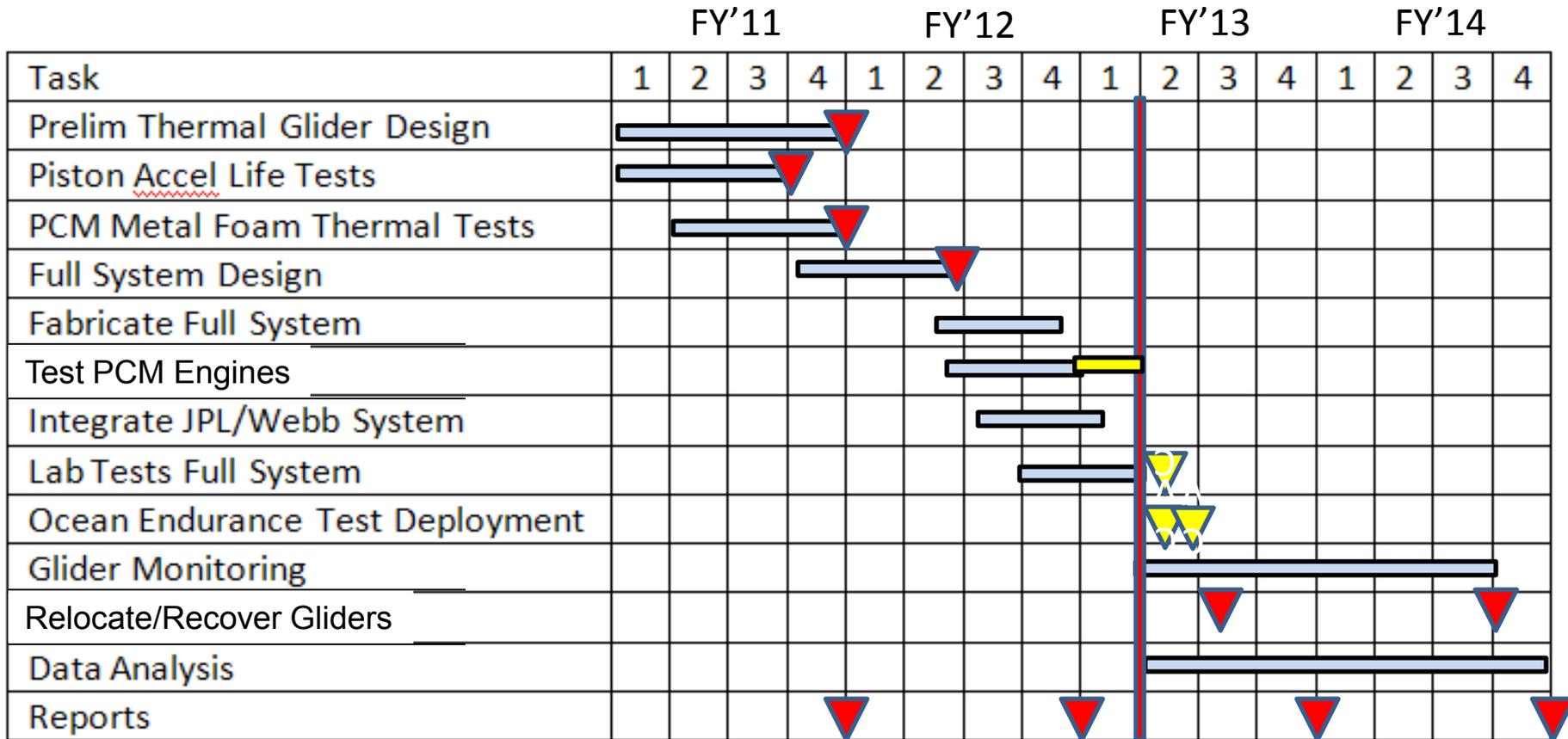


Slocum Controller (TWR)

Energy Storage System
Control Electronics (JPL)



Slocum-TREC Schedule



Major Milestones on Schedule



Major Milestones Delayed Approximately 2 Months