PACE 2012

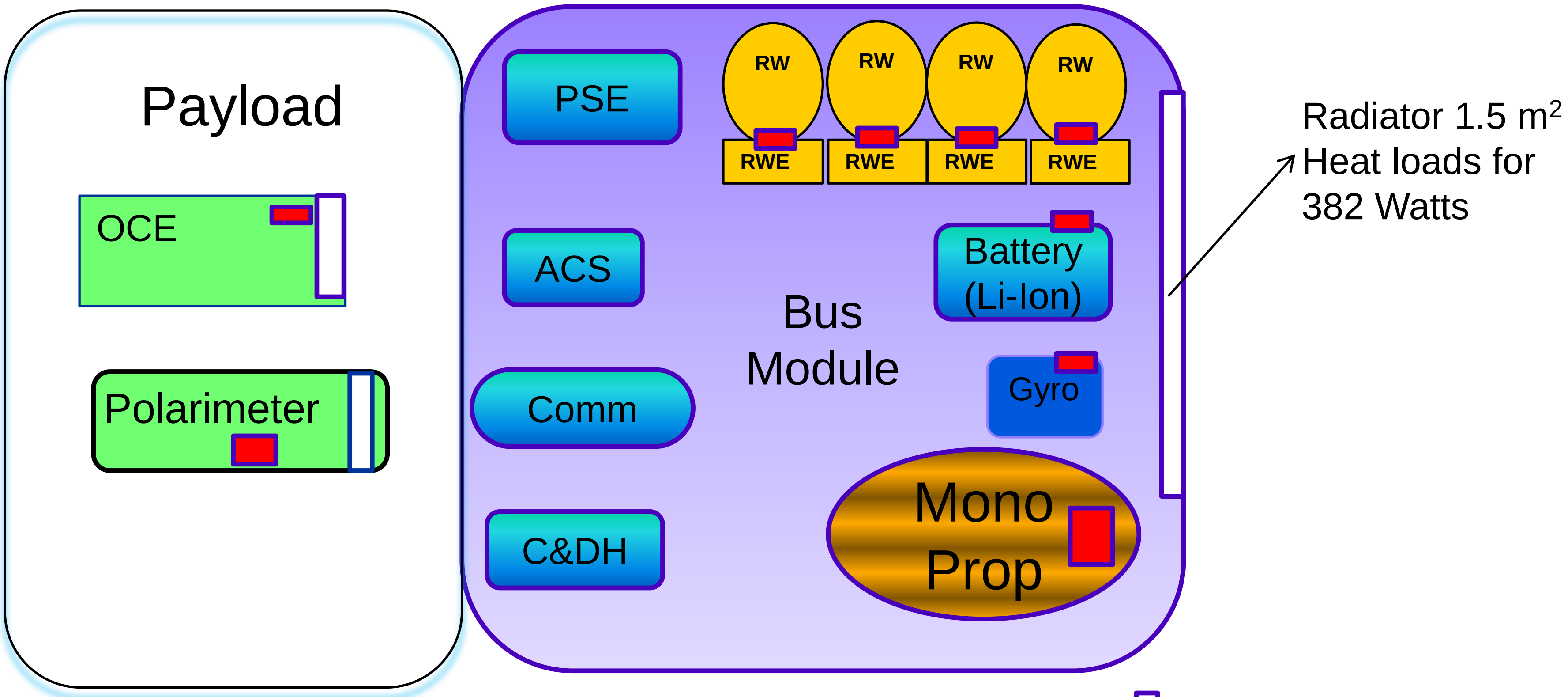
Thermal Systems

14 – 18 May, 2012

Thermal System Overview

- Thermal Control Design System for Spacecraft Bus
  - Active heater control via mechanical thermostats
  - Passive S/C Radiators for spacecraft components
  - Instruments isolated from spacecraft bus
- Internal Surface Coatings of bus – high emittance surfaces (Aeroglaze Z306 Black Paint)
- Backside of arrays – painted white, high emittance
- External MLI layer insulated on spacecraft bus
  - Outer layer GBK
  - 15 layers MLI make-up
- Kapton film heaters mounted on panels near box baseplates
- Thermostatically controlled heaters
- Flight thermistors for telemetry of temperatures
- Cho-therm interface material used for box to panel interface (electrically and thermally conductive) except for Battery (Nusil interface).
- Heater System (operational and survival)
  - Redundant heaters
  - Two Thermostats in series
  - Thermostatically controlled heaters

PACE TCS Block Diagram

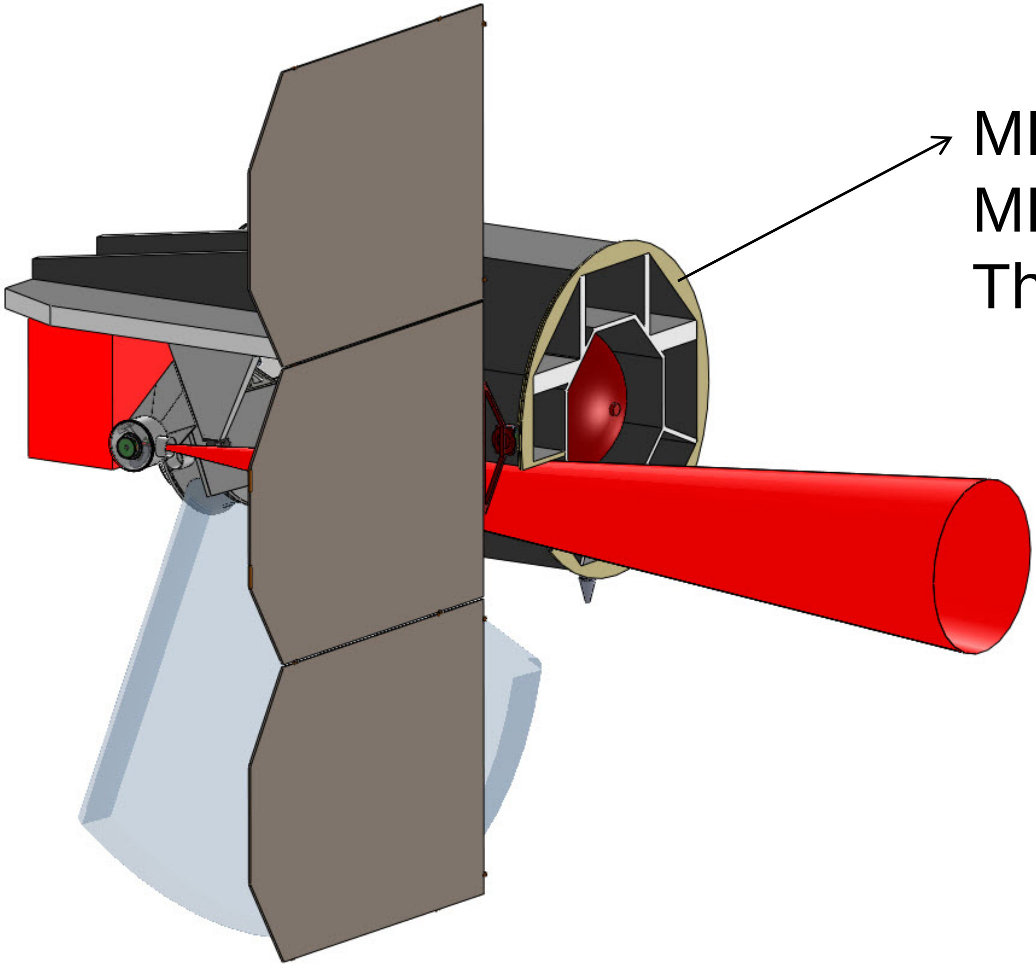


Heater control (thermostatically controlled)
Provide Survival Power to Instrument Payload, Prop System

Radiators on bays
External surface

Thermostatically controlled survival Heaters, enabled by PSE

PACE Observatory



MLI closeout and
MLI on tank, passive
Thermal system

Thermal Temperature Requirements

- S/C Components
  - Electronics
    - -10°C to +40°C operational and -20°C to +50°C survival
      - Avionics, comm system
- Solar Array Temperature

  - Operational -100°C to +100°C
- Omni Antennas

  - Operational -40°C to +70°C
- Li-Ion Battery Temperatures

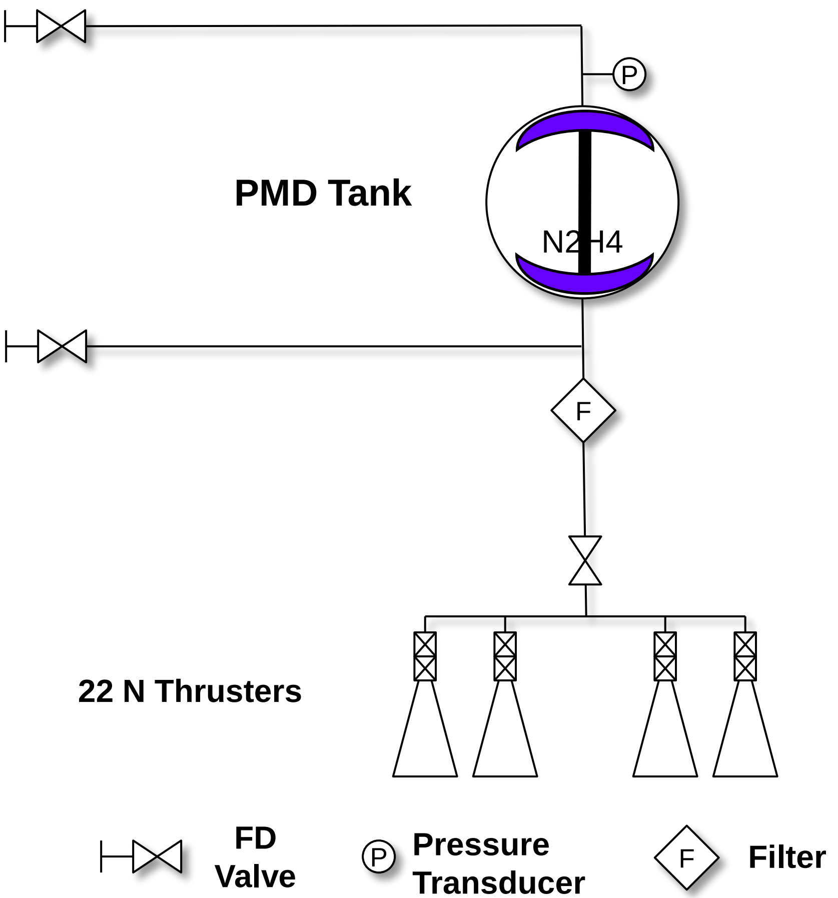
  - Operational 0°C to +10°C (for this Study)
- Chemical Propulsion System

  +10°C to 40°C

Heater Circuits Summary

Components	Primary	Redundant
Li-Ion Battery	1	1
22 N Thrusters (4)	4	4
Tank 1 (zones)	4	4
Fuel Lines (zones)	8	8
S/A Drive	1	1
Star Tracker 1	1	1
Star Tracker 2	1	1
RWs, RWEs	4	4
Gyros	1	1
OCE	1	1
Polarimeter	1	1

Propulsion Subsystem Thermal Control



- **Tanks mounted on deck within s/c bus**
- **Isolated from structure with Ultrem isolators.**
- **External MLI Bus GBK on sides for Propulsion module insulation. (18 layers) or bias material to reduce heater power needed.**
- **Tanks MLI (Inside VDA MLI inside bus). low ε surface to minimize radiation.**
- **Heaters mounted to tanks and fuel lines for thermal control.**
  - Thermostatically controlled
  - Controlled by servicing bus
- **Thermistors mounted to PM components.**
- **Monitored by C&DH in Bus.**

Spacecraft Total Heater Power

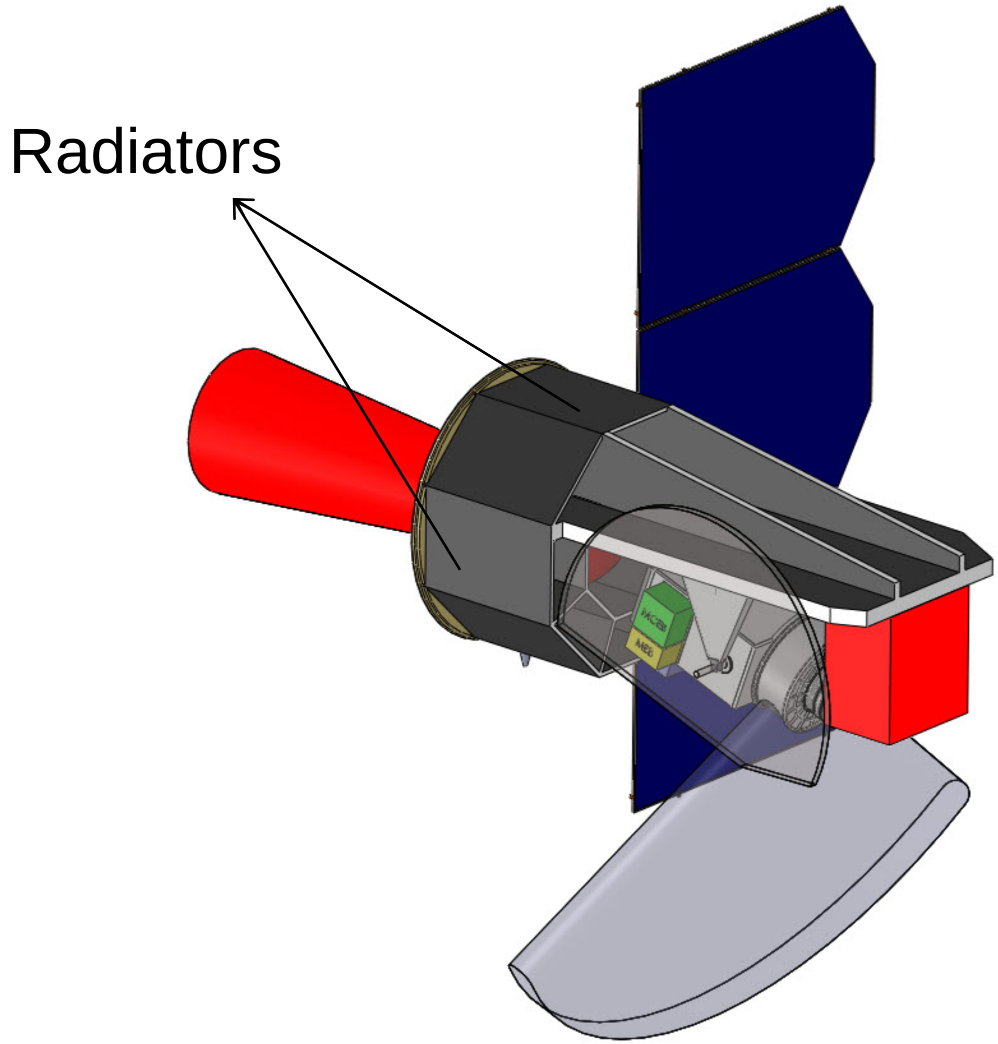
Component	Watts
Propulsion	42.0
Star trackers (2)	10 (survival)
Li-Ion Battery	10*
	62.0

* Operational Heaters

Propulsion System Heater Power

Component	Watts
22 N thrusters (4)	14.0
Tanks (2)	20
Exterior fuel lines	8
Total	42.0

Spacecraft Radiator Locations



Issues / Potential Risks / Future work

Issues – None

Risks:

- Instrument's radiators have no dependency on spacecraft so they can be tested for design at the Instrument level test

Future work:

- Box locations inside bus to place radiators

Backup Material

Acronym List

- **MLI:** **Multi-layer insulation**
- **TCS:** **Thermal control system**
- **BOL:** **Beginning of Life**