

# Managing Thermal Requirements of a CubeSat System

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Team Miles, NASA CubeQuest Challenge



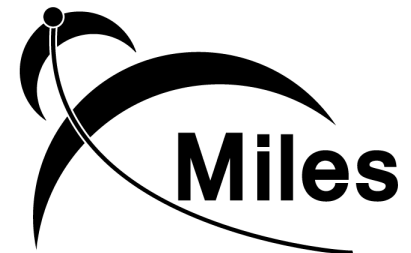
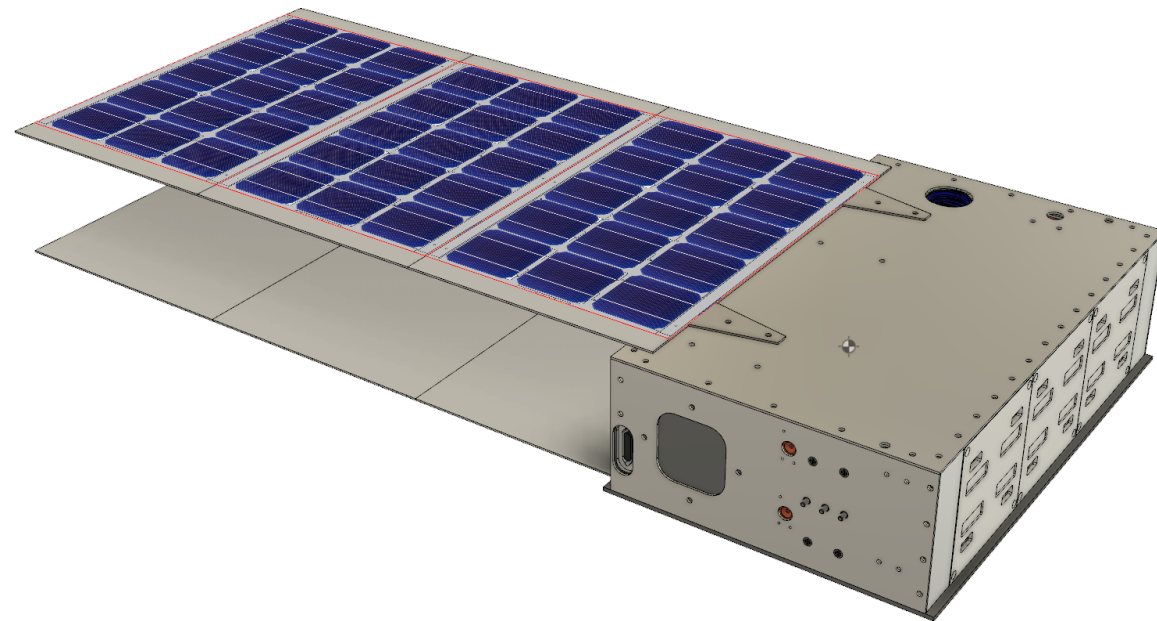
# The circumstances/limitations:

- 6U
- 14 kg
- 200 days
- Deployed 412,000 km from Earth
- Final distance from the Sun: 1.3 Au
- Expected temperature range: 40°C to 3°C



# Factors affecting craft's thermal environment:

- Orientation to the sun
- Solar panels
- Power consumption
- Energy loss



# Systems requiring thermal consideration

1. Communication
2. Power
3. Control
4. Propulsion



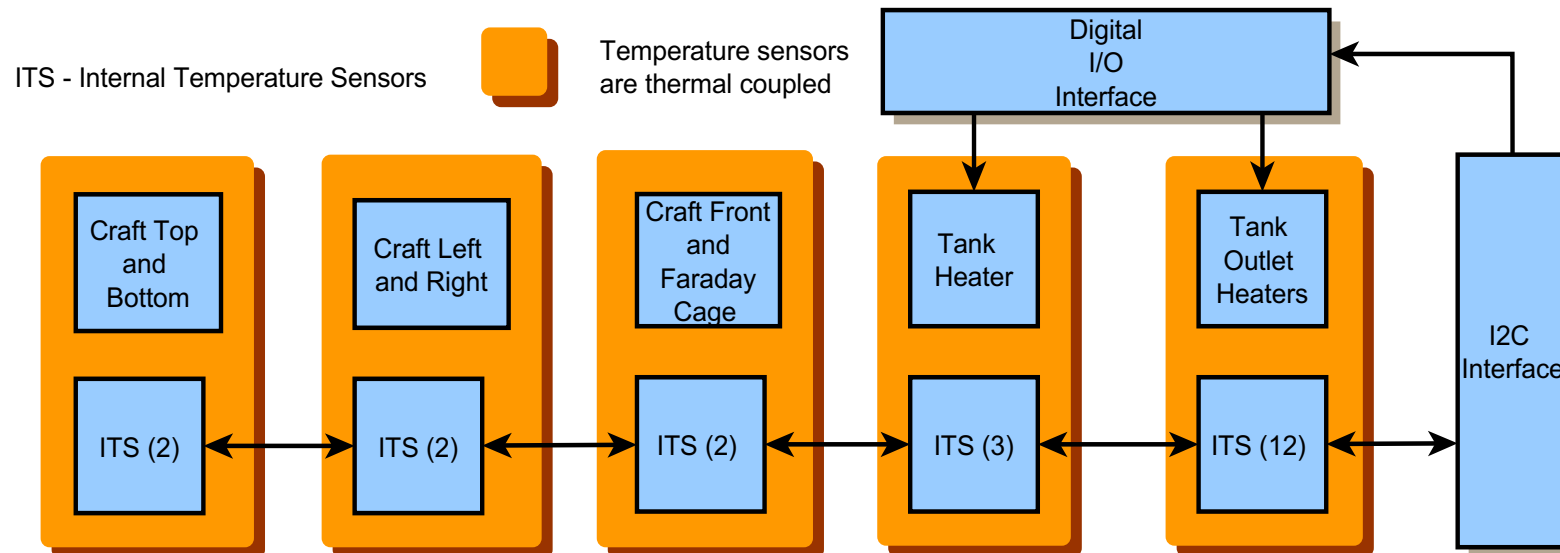
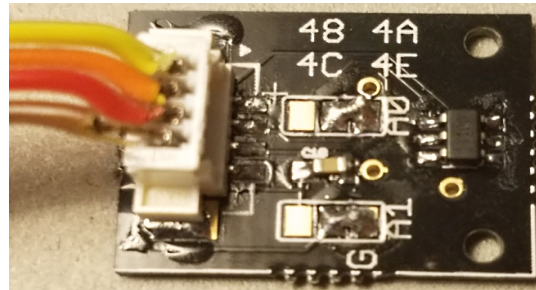
# Methods to manage thermal conditions

- Sensing
- Heating
- Materials/Structure
- Behavior



# Sensing

- ITS
- Thermistors
- Temperature sensors



# Heating

- Film heaters



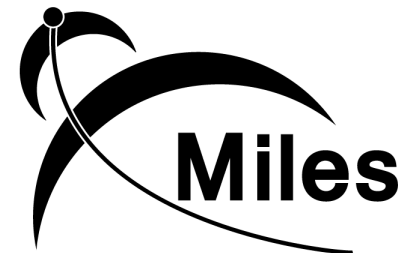
**Operating Temperature:** -200 to 200°C (-328 to 392°F) for heaters without pressure sensitive adhesive (PSA).

Maximum operating temperature for heaters with pressure sensitive adhesive is 120°C (248°F)

**Maximum Thickness:** 0.010" except at lead wire exit

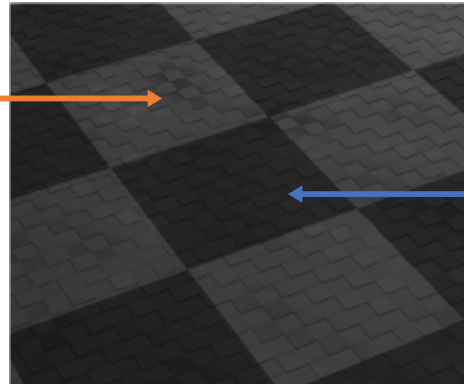
**Wattage:** 2.5, 5 or 10 W/in<sup>2</sup>

**Dielectric Strength:** 1250 Vac



# Materials/Structure

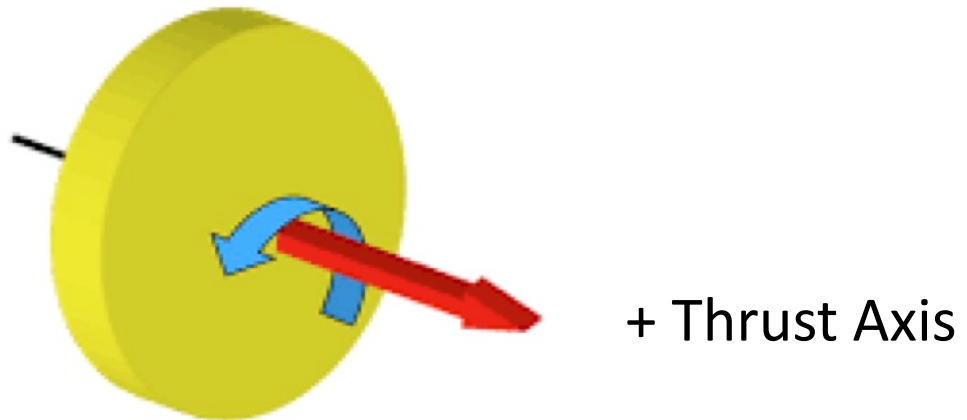
- 7075-T7351 Aluminum hull
- Thermal coatings on hull: 3 different layers





# Behavior

- “BBQ” roll



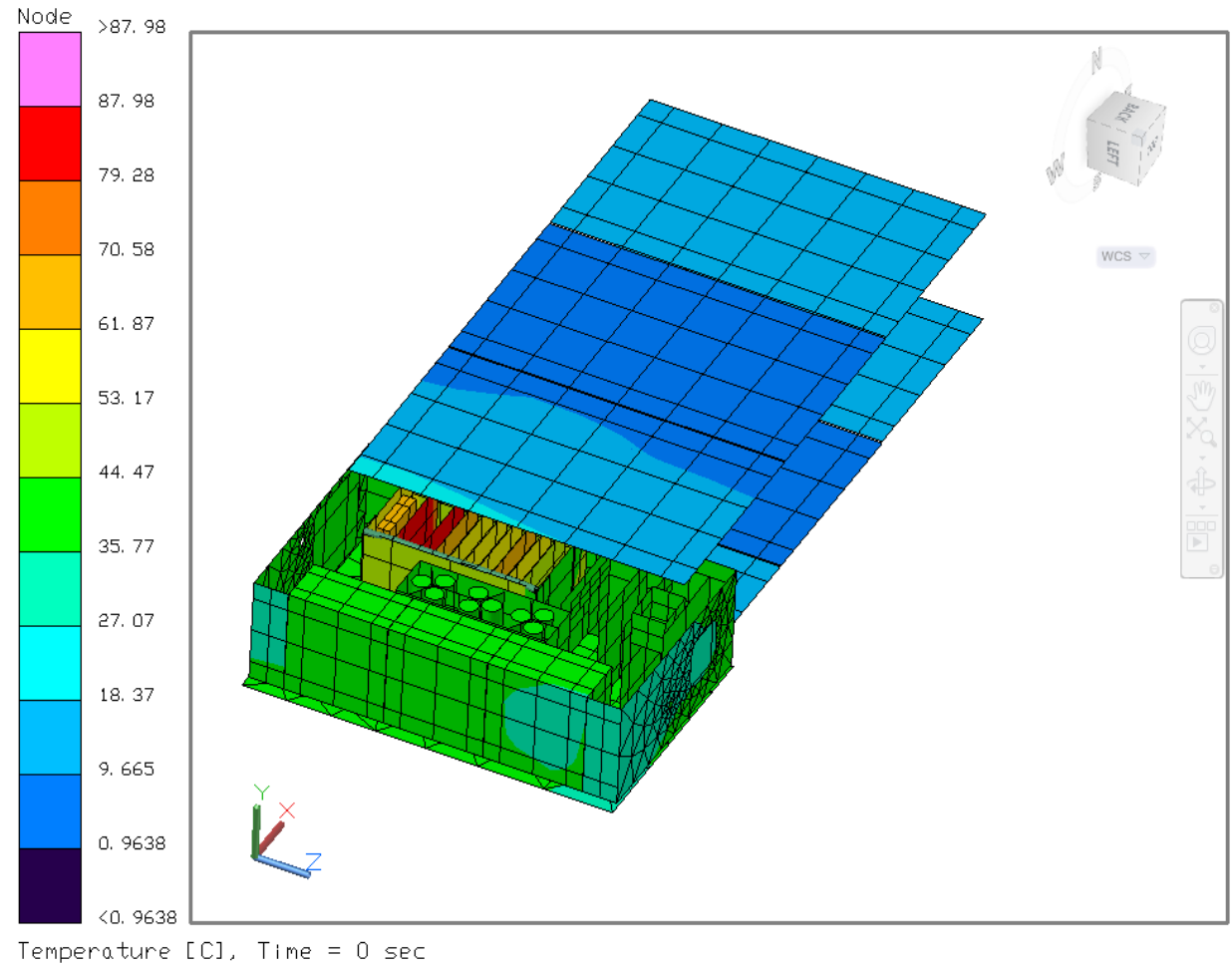
# Thermal properties of external materials:

Material	Absorptivity	Emissivity
Z306	0.955	0.89
Solkote	0.94	0.49
Al panel net	0.9475	0.69
Solar panel substrate	0.90	0.90
Solar cell	0.92	0.85



# Thermal FEA simulation:

Location	Avg. Temp (°C)
Solar Array	11
C&DH Boards	66
Batteries	42
Tank	38
Star Trackers	41
Radio	82
Amplifier	63

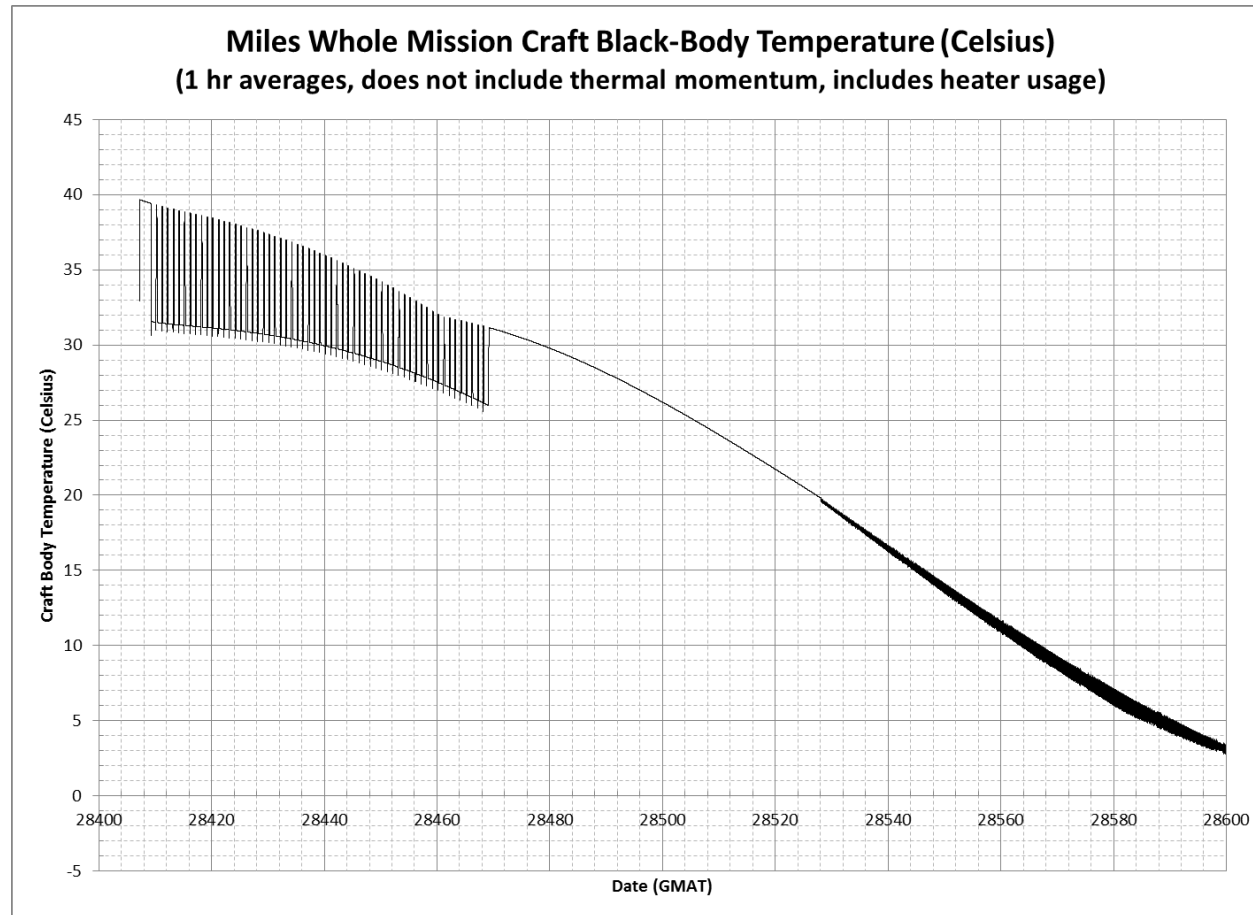


# Operational modes & Power usage

Mode	Gross Electrical Usage	Non-thermal Energy Leaving Craft	Net Thermal Energy
Radio receive, no thruster	10.848W	0W	10.848W
Transmit, no thruster	31.248W	5W	26.248W
No radio, Thrusting	27.5W	10.77W	16.73W

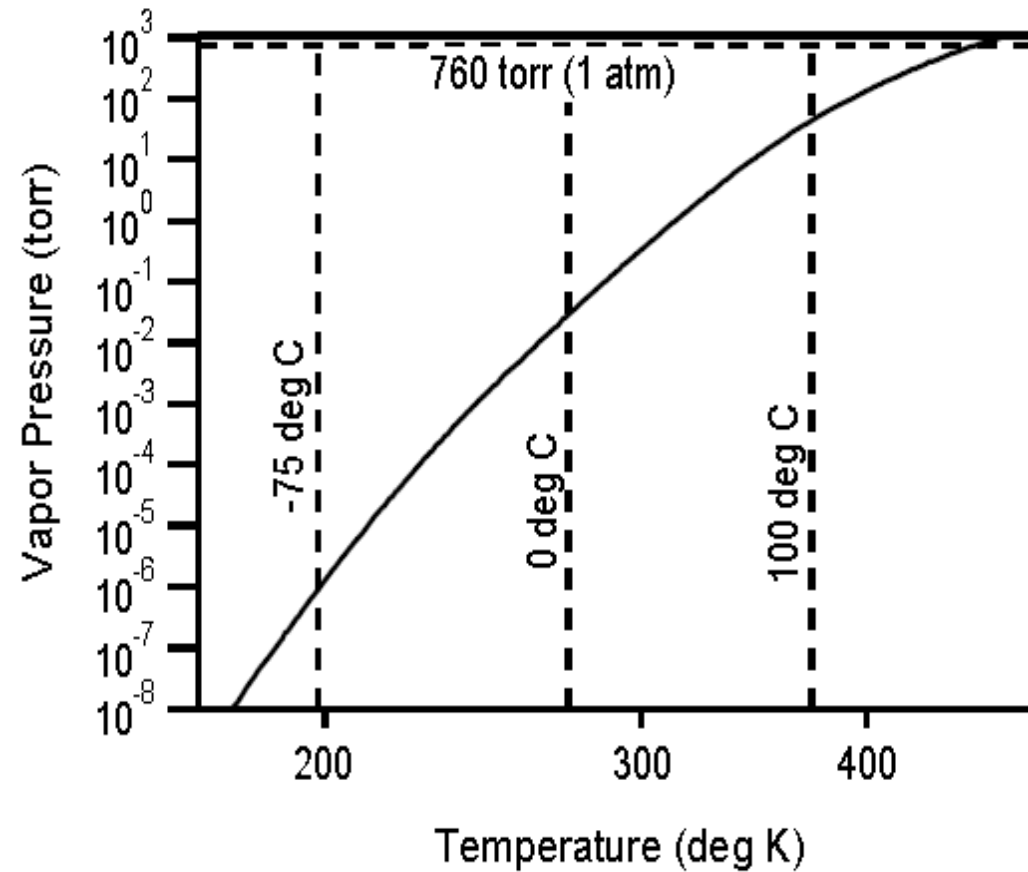


# Power usage during mission



# Thermal regulation of I<sub>2</sub>

Vapor pressure curve for I<sub>2</sub>



# Mass of thermal system

THERMAL	Qty	Mass (g)		Total (g)
Flat film heater Faraday cage (3x13cm)	1	14.5	14.5	
Temperature Sensor Boards	6	1.61	9.66	
Thermal Coating	1	29	29	53.16
(Thermal Control Panels (sq.cm.))	(12000)	(0.01)	(120)	(173.16)

# Contact information:

Team Miles: <https://miles-space.com>

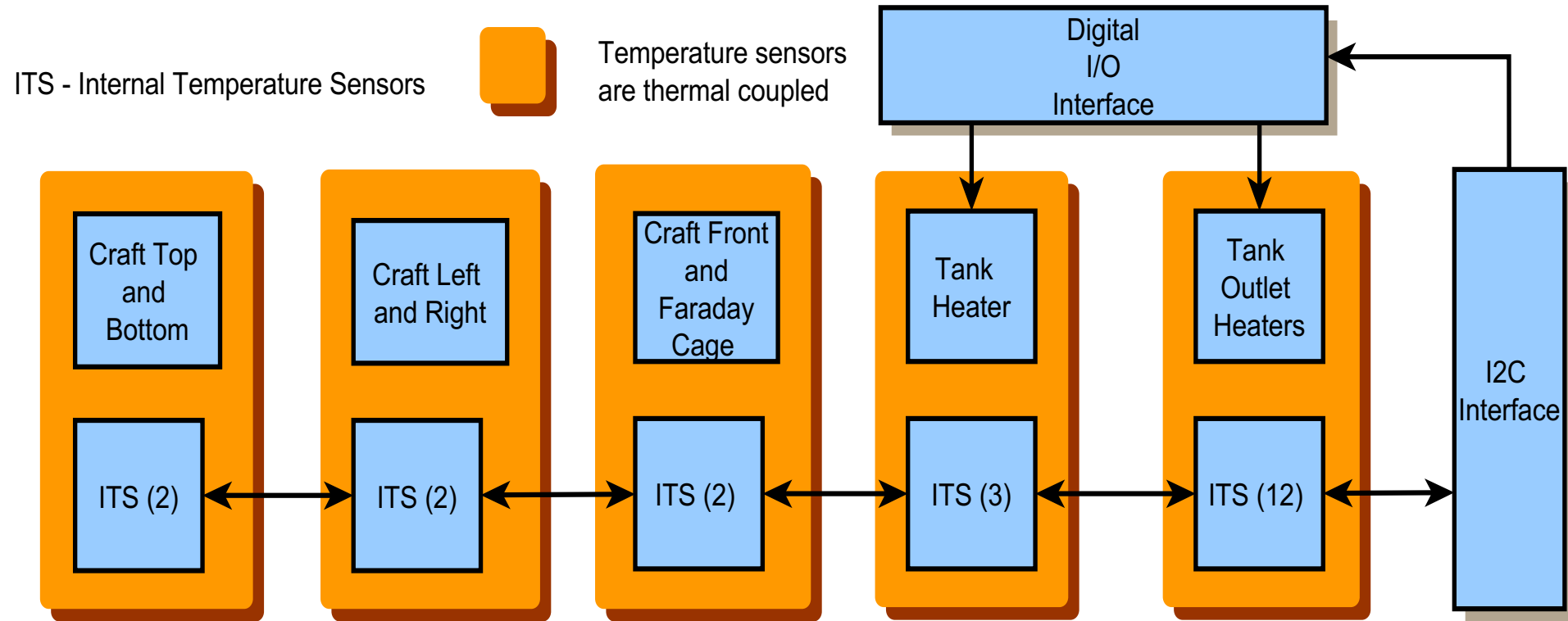
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# Thermal System



# Keeping thermal conditions under control:

- Temperature sensors
- Thin-film heaters
- Thermal coatings

