Industry Survey of Small Satellite Deployable Radiator Technology

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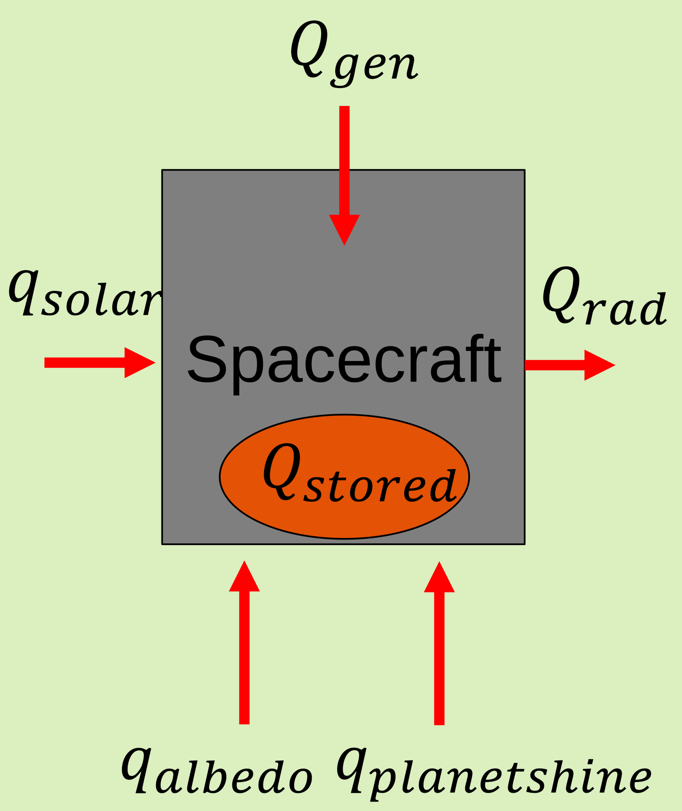
1. Survey Background



The space industry is moving toward small satellites with more capability. With increased capability comes the need to dissipate additional heat. As form factors decrease in size deployable radiators provide a viable solution. A survey of 11 different technologies was conducted and performance metrics compared.

$$q_{solar} + q_{albedo} + q_{planetshine} + Q_{gen} = Q_{stored} + A_{rad}\varepsilon\sigma(T_{rad}^4 - T_{sink}^4)$$

Environmental heat loads remain the same.

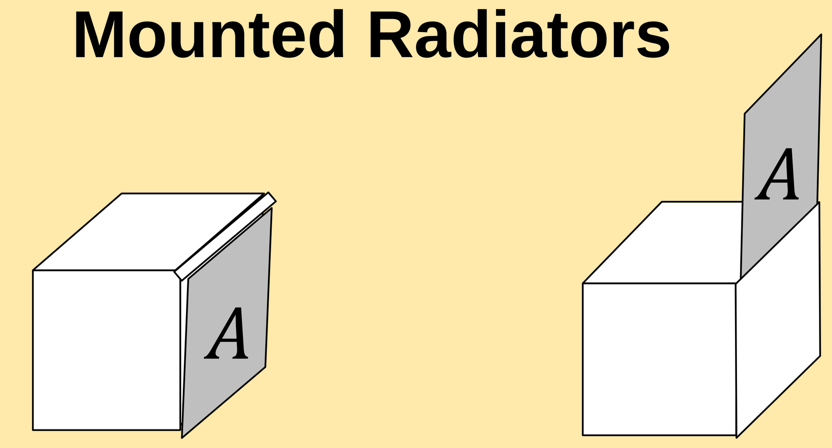
Internal heat generation increases

Stored energy remains similar

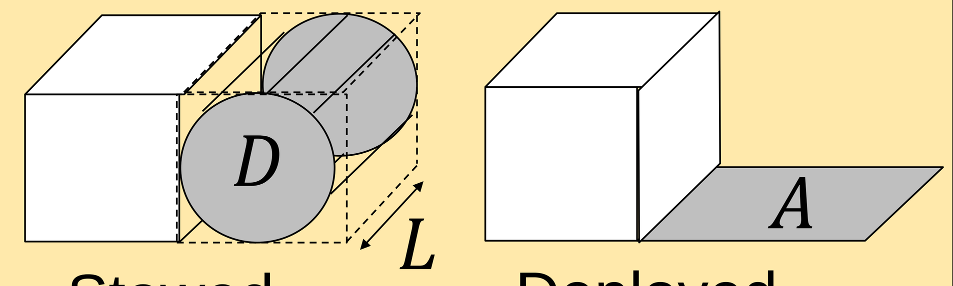
Therefore, for a fixed radiator temperature the radiator area must increase

2. Technology Approaches

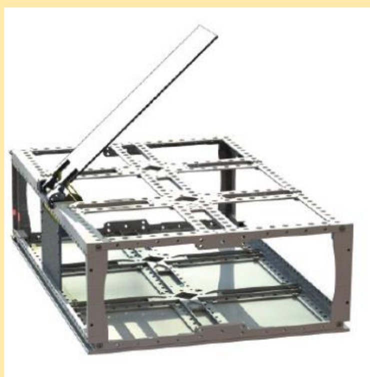
Deployable Panel Mounted Radiators



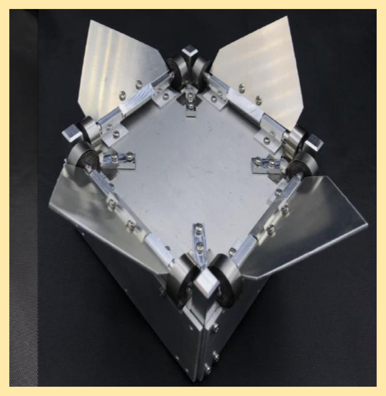
Cylindrically Stowed Deployable Radiators



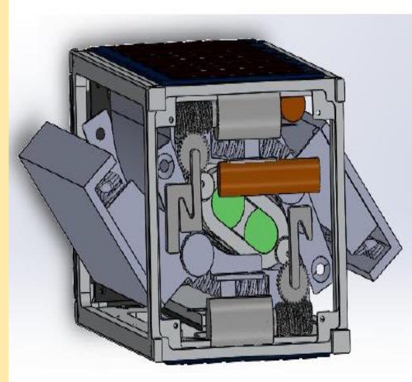
Red Wire



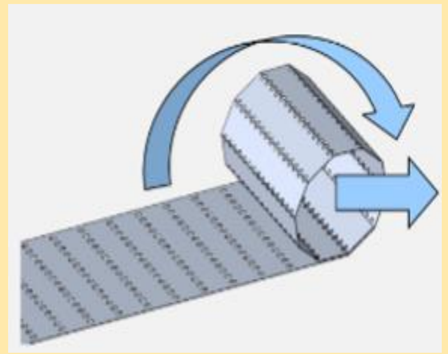
BYU



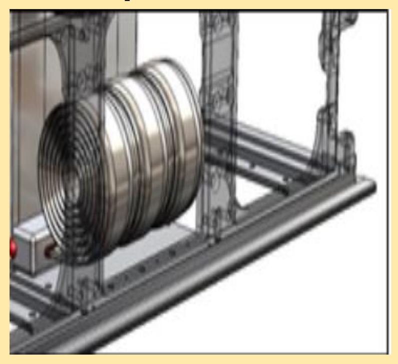
Cal Poly



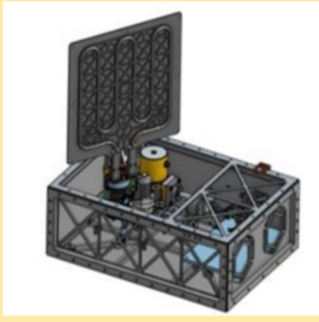
ThermAvant Inc



Pumpkin/YSPM

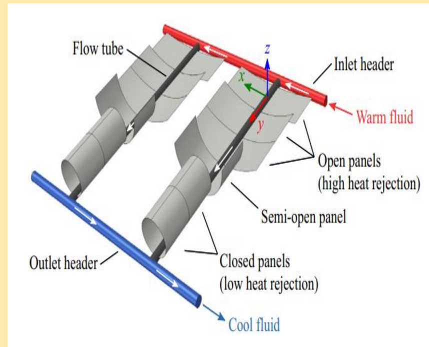


TMT inc.



Utah State

Texas A&M

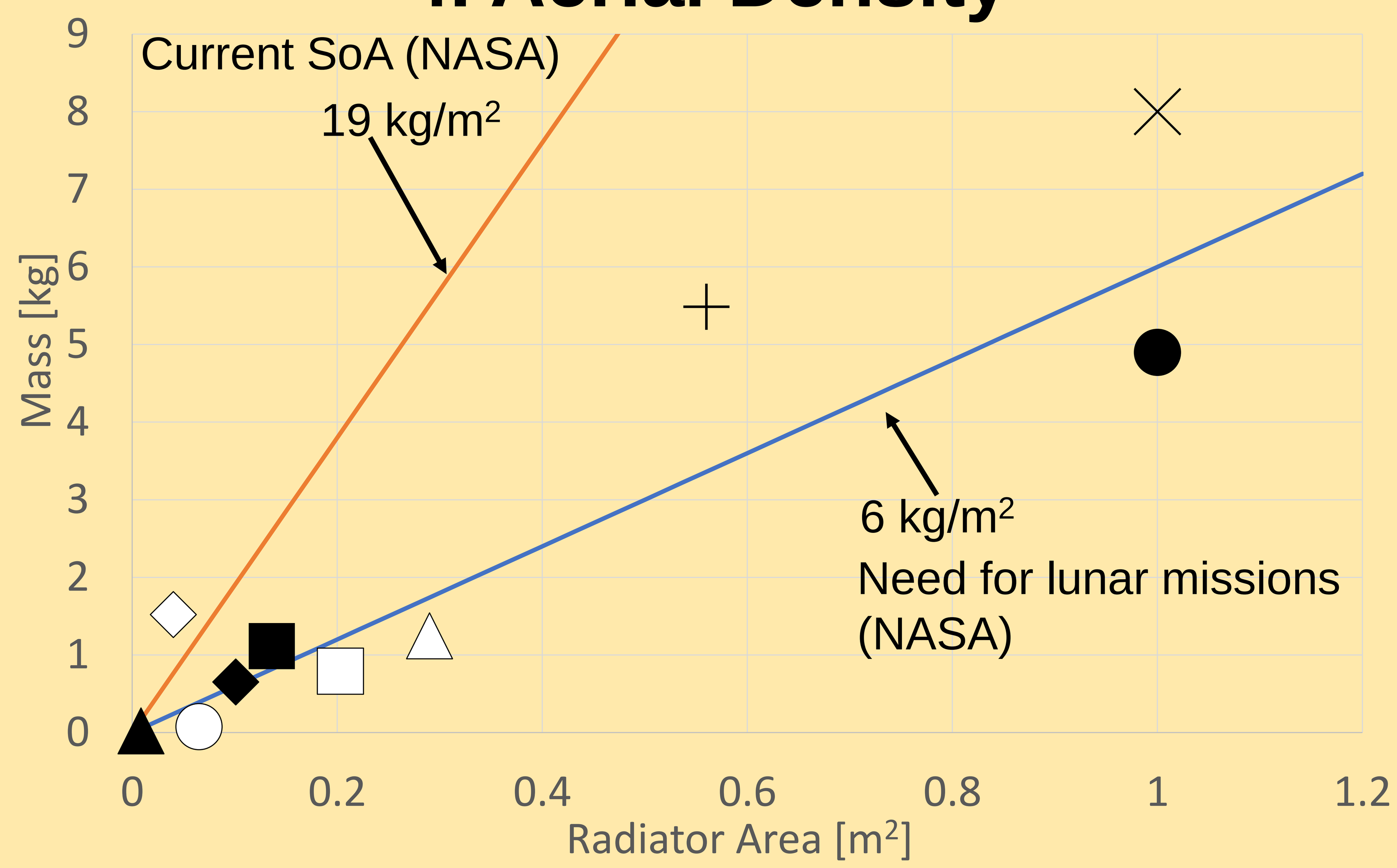


3. Performance Matrix and Trends

- TRL advancement needed
- Available radiator areas up to $1m^2$
- Radiating power target ~100W
- Temperature ranges are application or fluid specific
- Deployed Area/Stowed volume ratio largest for panel/hinge type radiators
- Multiple options for customers

	Max TRL	Radiator Area [m^2]	Radiating Power [W]	Operating Temperature [°C]	Deployed Area/Stowed Volume [m^{-1}]
Redwire Space: Q-Rad ●	5	0.04 to 1	100 to 300	-196 to 150	242
Thermal Management Technologies ×	6	.10 to 1	100	- 20 to 60	32
ThermAvant: Unspooling □	4	0.34	1500	Up to 105	109
ThermAvant: Local Plastic Deformation ■	4	0.136	140	Up to 80	398
JPL/Cal Poly: AMDROHP ◆	2/3	0.069	50	Up to 65	32
BYU: Triangular Fin ▲	4	0.0085	35 (30% DC in LEO)	-50 to 90	234
BYU: Radial Fin ▲	4	0.0085	30 (20% DC in LEO)	-50 to 90	266
Utah State University: Active Thermal Architecture ◇	6/7	0.04	60 (6U), 150 (16U)	-20 to 100	20
JAXA: Re-Deployable Radiator △	4	0.29	100	0 to 30	79
NASA/Texas A&M: SMA Morphing Radiator ○	4	0.0065	10	30 to 120	98
Pumpkin/YSPM: Rollout Deployable Radiator +	2	0.56	330	-70 to 50	124

4. Aerial Density



5. Summary

- Observing industry need for deployable radiators corresponding to increased capability in small satellites
- Available technologies show promise in several performance metrics and require TRL investment and flight opportunities
- Many of the surveyed technologies utilize two phase heat transfer to enhance heat rejection. Cylindrically stowed configurations can provide larger areas but require large stowed volumes