NASA SBIR 2004 Phase I Solicitation

E1.07 Thermal Control for Instruments

Lead Center: GSFC

Participating Center(s): ARC, JPL, MSFC

Future instruments and platforms for NASA's Earth Science Enterprises will require increasingly sophisticated thermal control technology.

1. Instrument optical alignment needs, lasers, and detectors require tight temperature control, often to better than +/- 1°C.

2. Heat flux levels from lasers and other high power devices are increasing, with some projected to go as high as 100 W/cm².

3. Cryogenic applications are becoming more common. Large, distributed structures, such as mirrors and antennae, will require creative techniques to integrate thermal control functions and minimize weight.

4. The push for miniaturization also drives the need for new thermal technologies towards the micro-electromechanical system (MEMS) level.

5. The drive towards ‘off-the-shelf’ commercial spacecraft, and reconfigurable spacecraft presents engineering challenges for instruments, which must become more self-sufficient.

Innovative proposals for thermal control technologies are sought in the following areas:

- Miniatrurized heat transport devices, especially those suitable for cooling small sensors, devices, and electronics.
- Highly reliable, miniaturized Loop Heat Pipes and Capillary Pumped Loops that allow multiple heat load sources and multiple sinks.
- Advanced thermoelectric coolers capable of providing cooling at ambient and cryogenic temperatures.
- Inexpensive passive radiative coolers for low Earth orbit.
• Technologies for cooling very high flux (>100 W/cm²) heat sources, including spray and jet impingement cooling.

• Advanced thermal control coatings, such as variable emittance surfaces and coatings with a high emissivity at ambient and cryogenic temperatures.

• High conductivity materials to:
  - Minimize temperature gradients, especially for optical benches and structures,
  - Provide jitter isolation links between cryocoolers and sensors, and
  - Provide high efficiency light-weight radiators.

• Advanced analytical techniques for thermal modeling, focusing on techniques that can be easily integrated into existing codes.

• Thermal control systems that actively maintain optical alignment for very large structures at both ambient and cryogenic temperatures.

• Single and two-phase pumped fluid loop systems, which accommodate multiple heat sources and sinks.

• Long life, lightweight pumps for single and two-phase fluid loop systems.

• Efficient, lightweight vapor compression systems for cooling up to 2 kW.