Future instruments for NASA's Science Mission Directorate will require increasingly sophisticated thermal control
technology. Innovative proposals for thermal control technologies are sought in the following areas:

- Instrument Optical alignment needs, lasers, and detectors that require tight temperature control, often to
  better than +/- 1°C. Some new missions, such as LISA and TPF, require methods of temperature
  measurement and control to micro-Kelvin levels.

- Heat flux levels from lasers and other high power devices are increasing with some projected to go as high
  as 100 W/cm². They will require thermal technologies such as spray and jet impingement cooling. Also, high
  conductivity, vacuum compatible interface materials will be needed to minimize thermal losses across
  make/break interfaces.

- Future missions will utilize large, distributed structures such as mirrors and detector arrays at both ambient
  and cryogenic temperatures. These missions will require creative techniques to integrate thermal control
  functions and minimize weight. Some anticipated technology needs include: advanced thermoelectric
  coolers capable of providing cooling at ambient and cryogenic temperatures, high conductivity structural
  materials to minimize temperature gradients and provide high efficiency lightweight radiators, and advanced
  thermal control coatings such as variable emittance surfaces and coatings with a high emissivity at ambient
  and cryogenic temperatures.

- The push for miniaturization also drives the need for new thermal technologies towards the MEMS level.
  Miniaturized heat transport devices, especially those suitable for cooling small sensors, devices, and
  electronics, include miniaturized mechanical pumps, Loop Heat Pipes (LHPs), and Capillary Pumped Loops
  (CPLs) which allow multiple heat load sources and multiple sinks.

- The drive towards robotic missions and reconfigurable spacecraft presents engineering challenges for
  science instruments, which must become more self-sufficient. Some of the technology needs are:

  - Advanced analytical techniques for thermal modeling focusing on techniques that can be easily
    integrated into existing codes, emphasizing inclusion of LHPs, CPLs, and mechanically pumped
    system models;
- Single and two-phase mechanically pumped fluid loop systems, which accommodate multiple heat sources and sinks, and long life, lightweight pumps for these systems; and

- Efficient, lightweight vapor compression systems for cooling up to 2 KW.