Cryogenic cooling systems often serve as enabling technologies for detectors and sensors flown on scientific instruments as well as advanced telescopes and observatories. As such, technological improvements to cryogenic systems (as well as components) further advance the mission goals of NASA through enabling performance (and ultimately science gathering) capabilities of flight detectors and sensors. Presently, there are six potential investment areas that NASA is seeking to expand state of the art capabilities in for possible use on future programs such as IXO (http://ixo.gsfc.nasa.gov/), Safir (http://safir.jpl.nasa.gov/), Spirit and Specs, Planetary and Europa science missions (Jupiter Europa Orbiter (JEO), Jupiter Ganymede Orbiter (JGO), Titan Saturn System mission (TSSM)). The topic areas are as follows:

### Extremely Low Vibration Cooling Systems

Examples of such systems include joule thomson coolers, pulse tube coolers and turbo brayton cycles. Desired cooling capabilities sought are on the order of 40 mW at 4K or 1W at 50K. Present state of the art capabilities display

### Advanced Magnetic Cooler Components

Continuous ADRs can operate at 50 mK or lower, with heat sinks up to 5 K. Refrigerators with larger operating temperature range (lower cold temperature, higher heat sink temperature), having lower mass, lower (or zero) fringing magnetic fields, and/or more efficient operation are sought. In addition, technologies that improve system performance (e.g., HTS leads) are also sought. Examples of specific components include:

- Low current superconducting magnets
- Active/Passive magnetic shielding (3-4 Tesla magnets)
- Single or polycrystalline magnetocaloric materials (3)
- Superconducting leads (10K - 90K) capable of 10 amp operation with 1 mW conduction
- 10 mK scale thermometry.
Continuous Flow Distributed Cooling Systems

Distributed cooling provides increased lifetime of cryogen fluids for applications on both the ground and spaceborne platforms. This has impacts on payload mass and volume for flight systems which translate into costs (either on the ground, during launch or in flight). Cooling systems that provide continuous distributed flow are a cost effective alternative to present techniques/methodologies. Cooling systems that can be used with large loads and/or deployable structures are presently being sought after.

Heat Switches

More robust heat switches (e.g., operating ranges and conductance performance) are currently needed that are easy to operate and applicable to spaceflight activities. Performance capabilities include heat switches for operating ranges 5 or greater, low off conductance and simple manufacturing/operational capability.

Highly Efficient Magnetic and Dilution Cooling Technologies

These systems are currently limited to continuous ADR performance capabilities. Alternative technologies that provide sub-Kelvin cooling are sought.

Low Input Power/Low Temperature Cooling Systems

Cooling systems providing cooling capacities upwards of 0.3W at 35K with heat rejection capability to temperature sinks as low as 150K are of interest. Presently there are no cooling systems operating at this heat rejection temperature. Input powers should be limited to no greater than 20W.