NASA astrophysics missions currently under development, such as the Herschel and Planck, (http://science.hq.nasa.gov/missions/phase.html) have been enabled by improvements in detectors. Beyond 2007, advances are expected in detectors, readout electronics, and other technologies, particularly those enabling polarimetry and large format imaging arrays for the visible, near IR, IR and far IR/submm and spectroscopy with unprecedented sensitivity. These advances may enable future mission concepts such as the Single Aperture Far Infrared (SAFIR) Observatory (http://safir.jpl.nasa.gov/index.shtml), SPICA (http://www.ir.isas.ac.jp/SPICA/), CMBPOL, and SNAP (http://snap.lbl.gov). Space science sensor and detector technology innovations are sought in the following areas:

Future space-based observatories in the 10 - 40 micron spectral regime will be passively cooled to about 30 K. They will make use of large, sensitive detector arrays with low-power dissipation array readout electronics. Improvements in sensitivity, stability, array size, and power consumption are sought. In particular, novel doping approaches to extend wavelength response, lower dark current and readout noise, novel energy discrimination approaches, and low noise superconducting electronics are applicable areas. Future space observatories in the 40 micron to 1 mm spectral regime will be cooled to even lower temperatures, frequently < 10 K, greatly reducing background noise from the telescope. In order to take advantage of this potentially huge gain in sensitivity, improved far infrared/submillimeter detector arrays are required. The goal is to provide noise equivalent power as low as $10^{-20}$ W Hz$^{-1/2}$ over most of the spectral range in a 10,000 pixel detector array with low-power dissipation array readout electronics. The ideal detector element would count individual photons and provide some energy discrimination. For detailed line mapping (e.g., C$^+$ at 158 micron), heterodyne receiver arrays are desirable, operating in the same frequency range near the quantum limit.

In addition to technologies specific to the astrophysics missions previously mentioned, the following cross-cutting technologies are also of interest:

- Large (4 meter), lightweight, deployable antennas for frequencies between 180 to 660 GHz. Reflectors for such antennas with surface densities of 10 kg/m$^2$ or less.
- Broadband (> 2 GHz, 4 GHz preferred), modest resolution (10 MHz), low power (< 5 watt) digital spectrometers for submillimeter spectroscopy. This may include enabling technologies such as:
  - Efficient FPGA firmware for spectral analysis including polyphase filterbanks;
  - High speed, low power, space qualifiable digitizers with analog bandwidths of > 5 GHz and preferably up to 18 GHz, sample rates > 5 Gs/s, 4 to 6 bit resolution, and simple interface to present FPGAs;
  - Hardware (ex. ASICs) for low power implementation of digital signal processing.
- Broad bandwidth, low power, flight qualifiable spectrometers. Band of interest is 6 to 18 GHz or higher with ~200 MHz resolution.
- Reliable, tunable, spurious free, and flight qualifiable local oscillators for SIS mixers covering 190 to 270 GHz and 600 to 660 GHz.
- Broadband cryogenic isolators covering 6 to 18 GHz.

While focused technology and instrument developments are progressing for missions in the development phases such as the Space Interferometry Mission (SIM) and the James Webb Space Telescope (JWST), ambitious mission concepts are being pursued for future opportunities to address cosmology questions, galactic/stellar astrophysics and extrasolar planet finding quests. Innovative concepts that will significantly advance the state of the art in sensitivity, spectral coverage, array format, power dissipation, and other instrument critical parameters are sought. Also solicited are proposals that address key improvements in current techniques and devices in terms of performance, reliability and technology maturity. In such efforts, the proposer must demonstrate expertise and capability with respect to the existing technique/device/process/system. Optical/electronic devices that enhance or complement the detector function in an instrument are also of interest. Examples are micro shutter arrays to select objects across a focal plane for spectroscopy, timing and analog to digital converters for large focal plane instruments. The optical and near-IR requirements include giga pixel arrays, exceptionally stable sensitivity and precision calibration.

### Spectral Coverage / Function | Technology | Parameters to Push
--- | --- | ---
0.1 um - 1.0 um | Improving silicon response in UV and NIR, smart pixel arrays, solar blind response detector arrays, energy resolving calorimeter arrays | Sensitivity, array format size, high purity silicon processes
1.0 um - 4.0 um | New sensor materials, Large format cryogenic readout multiplexers, Large format (>1kx1k) array hybridization techniques | Sensitivity, array format size
4.0 um - 40 um | Low power cryo operated multiplexers, new sensor materials (e.g., novel dopants for extrinsic Si detectors) | Sensitivity, array format size (~megapixels)
40 um - 200 um | Monolithic focal plane arrays (BIB technologies, new sensor materials) | Sensitivity, array format size (~megapixels)
200 um - 1000 um | Photometric imaging arrays, spectroscopy arrays, THz coherent receiver arrays (mixers, sources, precision packaging) | Photometric imaging arrays (NEP~1e-18 W/Hz^{0.5}, 10,000 pixels); Spectroscopic arrays (NEP~1e-20 W/Hz^{0.5}, 1,000 pixels)

### Supporting Device Categories

| Spectral Coverage / Function | Technology | Parameters to Push |
--- | --- | ---
mm wave | MMIC packaging | Cost, cryo operation |
<table>
<thead>
<tr>
<th>Digital spectrometer (back-end for coherent receivers)</th>
<th>Autocorrelation spectrometers, high resolution FFT spectrometers</th>
<th>15 GHz or greater bandwidth (autocorrelation), 2 GHz or greater bandwidth (FFT &gt;32K points); low power, compact configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutter arrays for multi-object spectrographs</td>
<td>Micro-electromechanical shutter arrays or new technologies to do the same thing better</td>
<td>Reliability, low off state scatter or leakage, cryo operability</td>
</tr>
<tr>
<td>Infrared optical filters</td>
<td>Thin film or other technologies to realize ~1&quot; aperture filters</td>
<td>High out of band rejection, well defined passbands (especially in 4-40um), cryo operation</td>
</tr>
<tr>
<td>Array hybridizing techniques</td>
<td>New, high yield bump bonding techniques</td>
<td>Yield, format size</td>
</tr>
</tbody>
</table>