Prioritized Technology: Low Intensity/Low Temperature Solar Power

Technical Goal

- Develop advanced solar power technologies to meet the needs of next decadal solar system exploration missions
  - Outer Planet Missions: Develop high efficiency solar cells and low mass solar arrays to operate in low intensity and low temperature (LILT) environments.
  - Small Body/Asteroid Missions: Develop high voltage (> 300V), high power (> 50 kW) low mass (> 250 W/kg at 1 AU) solar arrays for future solar electric propulsion missions including LILT environments.
- The goal is to develop new cell technology and solar array components to enable missions to orbit Jupiter and its inner moons including Europa and Io
  - Improve solar cell conversion efficiency, & eliminate need for screening
  - Improve radiation resistance
  - Solar array concentrator elements which improve specific power and mitigate LILT conditions
- Enable solar powered spacecraft for Saturn
- Specific objectives to be demonstrated are:
  - > 40% efficient solar cells at LILT
  - > 8 W/kg array specific power at 5 AU
  - Extended lifetime in high radiation environment near Jupiter

Mission Applications

- Increases range of missions that can be solar powered versus radioisotope power systems
  - Enable solar powered spacecraft to 10 AU distances include Saturn and its moons
  - Increase power for and enable long duration Jupiter (4% irradiance, -140 C) and Saturn (1% irradiance, -165 C) orbital missions
- Reduce the power system mass and and volume of the electric propulsion missions to small bodies, asteroids and outer planets
  - Change of cell from SOA triple junction to next generation inverted metamorphic multi-junction (IMM) on Europa Clipper would result in >20% cell mass reduction and 2% efficiency improvement
  - Gains in efficiency and reductions in mass are destination specific, but may also be applicable to 1 AU missions.
- Concentrator concepts to reduce mass may have benefits for solar array protection from radiation in Earth polar orbits and near Jupiter.

Technical Status

<table>
<thead>
<tr>
<th>Solar Cells</th>
<th>Efficiency (%)</th>
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<tbody>
<tr>
<td>SOA Triple Junction Solar Cell</td>
<td>~ 30 @ 25 C</td>
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<tr>
<td>~ 33 @ -140 C</td>
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<table>
<thead>
<tr>
<th>Solar Arrays</th>
<th>Specific Power (W/kg) @ 1AU, BOL</th>
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<tbody>
<tr>
<td>Rigid Panel: 60-80</td>
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<tr>
<td>Flexible Fold Out : 100</td>
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- STMD GCD Extreme Environments Solar Power (EESP) program addressing improved performance near Jupiter. Radiation degradation key issue for this environment. SMD supported Base Program of EESP
- Prior Solar Array Structures (SAS) program demonstrated flexible fold/roll out array concepts
- Current cell & array technology reaching practical efficiency & wing size limits.
  - SOA cell technology requires pre-screening due to possible performance degradation under LILT conditions
- Rigid panel solar array specific power and stowed volume limit growth
- Inverted Metamorphic Multi-junction (IMM) solar cell technology may show improved performance in LILT environments compared to SOA technology

Development Cost and Schedule

5/26/17