0.31 Astronomical Units (AU) – the average Earth to sun distance – was launched on December 10, 1974 and Helios B, which reached 0.29 AU, was launched on January 15, 1976. These spacecraft used ordinary silicon cells that were modified for high-intensity use and had second surface mirrors to cool the array. The remainder of their technology was very similar to what is used on standard arrays. In addition to these missions, the upcoming MESSENGER Discovery mission is planned for travel to 0.31 AU. Its solar array design is already under development.

The current solar array technology can meet the needs of MESSENGER or other spacecraft that approach the sun to about 0.3 AU, but with reduced performance and increased risk compared to other applications. Further progress is required in both cell and array development for closer encounters to the sun. The common feature to the high-temperature and high-intensity solar arrays that have operated thus far is the replacement of a significant fraction of the solar cells by optical solar reflectors (OSRs). These are mirrors that help control the array temperature near the sun at the cost of reduced power at larger distances.

The MESSENGER design also off-points the array as the spacecraft nears the sun to keep the array below 130°C. The array is designed to tolerate pointing at the sun for a maximum of 1 h (probably much longer). However, it will be unable to function under this extreme condition (i.e. 260°C).

The US Air Force and BMDO also developed some high-temperature arrays in the late 1980s. The Survivable COncentrating Photovoltaic Array (SCOPA) and SUrvivable PowER System (SUPER) were designed to be capable of surviving laser attack. These were concentrator arrays that directed the incident laser light away from the solar cells. Although the laser light would not impinge directly, the arrays' temperature would increase dramatically and thus the arrays needed to withstand several hundred degrees Celsius.

The high-temperature survivability of SCOPA and SUPER was achieved through changes to the contact metallization and through the use of diffusion barriers in the GaAs cells used. Both Tecstar and Spectrolab developed the cells in conjunction with this effort. Other smaller companies such as Astropower, Kopin, and Spire have also worked on developing high-temperature cells. GaAs cells reaching an AM0 efficiency of 18% were produced that degraded less than 10% under one-sun after annealing in vacuum for 15 min at 550°C. Concentrator cells were produced that survived repeated 7-min excursions to 600°C. These same cells exhibited only 10% loss with exposure to 700°C. NASA is also currently funding an effort to develop wide band gap solar cells for high-temperature/high-intensity environments. Cells using materials such as SiC, GaN, and AlGaInP are being developed [52]. These cells may also benefit from high-emissivity selective coatings that will limit the unusable IR entering the solar cells and reduce their steady-state temperature.

10.5.7 Electrostatically Clean Arrays

There is an entire class of proposed missions designed to study the Sun–Earth Connection (SEC). These spacecraft typically measure the fields and particles associated with the solar wind. This requires that arrays be developed that do not distort the local environment