A Roadmap for the Rapid Deployment of Space-Based Fission Reactors

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Abstract. There has been little progress in the development of a deployable fission reactor for space power applications in the United States since the first and only launch of such a system, the SNAP-10A, in April of 1965. Technical and programmatic risks in the development of a reliable and efficient power conversion system, the adverse effects of radiation in the vicinity of other spacecraft, and the need to develop enhanced safety mechanisms, etc. have deterred rapid deployment in the past. Yet, the potential benefits to be gained from the use of nuclear fission reactors, particularly its application to electric propulsion systems for interplanetary missions, remain compelling. Nuclear electric propulsion (NEP) systems would provide high delta-V capabilities (no need for gravity assists), independent of solar flux, while at the same time providing long duration, high-power operations. Preliminary results from recent studies indicate that the time is ripe for a major thrust in the development of NEP and other fission reactor-based space power systems and applications. Studies at JPL currently include an NEP orbiter mission to Neptune/Triton, an NEP interplanetary transport system for multiple Mars/Venus sample return missions, as well as multiple studies for the application of fission power to Mars surface missions. A longer-term strategy for nuclear systems use in space is developed for this study, particularly for deep space missions. The studies suggest that nuclear systems could be central to the establishment of a robust interplanetary infrastructure including transportation (propulsion) and power systems for driving communications and in-situ resource development, paving the way for human expansion beyond Earth orbit. These nuclear systems could also lead to a new era of space science by employing high power instruments, which could lead to myriad of new discoveries. In this study, a rapid deployment strategy is developed based on the assertion that the technical requirements for developing and deploying a fission reactor in space are relatively simple to meet and that the enabling of new science applications (e.g., active radiometry, laser oblation, etc.) would quickly provide the science returns on the initial investment. The development of a highly beneficial "fast track" mission concept would provide the proof of concept for a much larger scale development of nuclear systems in space. This "fast track" mission could form the basis for an accelerated roadmap for NEP systems and other space fission reactor applications which, if adopted, would enable the start of a new era of solar system exploration characterized by safe, deep space, high power and/or mass payloads, long duration capabilities, and soon after, human travel to Mars and beyond.