Session Summary: Opening Plenary
Monday, February 7, 2011

The NETS-2011 Opening Plenary welcomed a highly distinguished panel of speakers to discuss historical space nuclear programs, current programs (and currently desired programs), and how to make these more successful in light of budget constraints, public perception, politics, and policy. The distinguished panelists and their topics of discussion included:

Historical Perspectives on Space Nuclear Power and Propulsion
***H. Finger**, retired, formerly held several key positions within AEC and NASA*

Potential Mission Applications for Space Nuclear Systems
***J. Casani** , NASA Jet Propulsion Laboratory, Special Assistant to the Director*

Current NASA Interest in Space Nuclear Power and Propulsion
***J. Adams**, Deputy Director, Planetary Science Division, NASA Headquarters*

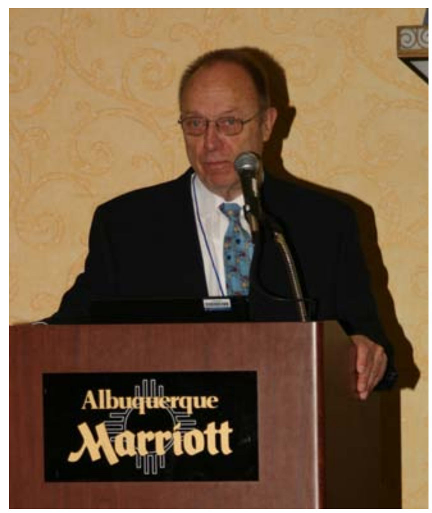
Radioisotope Power Systems: The Quiet Technology
***R. Lange**, U.S. DOE, Deputy Assistant Secretary for Business and Technical Support*

Viable Development Strategies for Space Fission Power and Propulsion
(oral presentation only; no presentation file available)
***M. Griffin**, former NASA Administrator and King-McDonald Eminent Scholar for Mechanical and Aerospace Engineering at the University of Alabama in Huntsville*

Opening Plenary Panelists

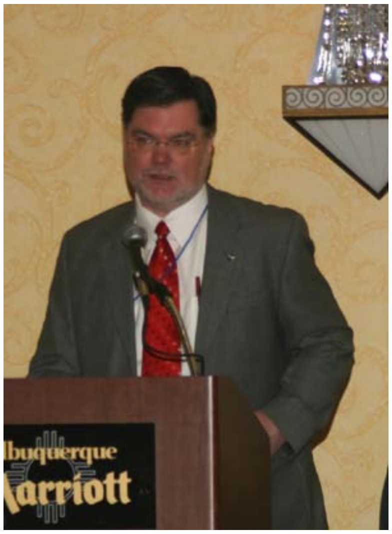
Mr. Harry Finger's opening presentation outlined successful developments in nuclear rocket propulsion in the 1960's, such that by 1970 detailed planning for human exploration of Mars had become possible. That development was cut short, but Mr. Finger believes that collaborative meetings such as NETS-2011 will serve as a stimulus to move forward in those areas. The current limited economic conditions restricts our [U.S.] ability "…to continue to lead in the development and execution of major space exploration activities." There is a legacy of contributions that space science, which is enabled by advanced power systems, has provided to society. However, at this point in time, the lack of a clear mission leads to the lack of focused research and development programs. Mr. Finger expressed "…serious concerns about the course of our space and also aeronautics activities and our resulting international standing in these areas." We developed and demonstrated that nuclear rocket propulsion systems could move us forward to substantial deep space missions starting in 1970. Mr. Finger urges the space nuclear community to "get back on the proven technology development we did 50 years ago and advance it further with updated technology to build a truly versatile, secure space exploration capability to maintain and grow our leadership." *More details are included in Mr. Finger's speaker notes.*

Dr. John Casani of the NASA Jet Propulsion Laboratory discussed potential and current mission applications for space nuclear systems. Dr. Casani pointed out that we have a "catch-22" of sorts regarding the time required to develop systems versus time to plan a mission. Missions can come and go much faster than we can develop the corresponding propulsion technology. To break out of this catch-22 we need either a technology funder with a vision for the future, or a high priority mission that "would take longer to incubate than the space nuclear power system it would need." There have been several "great space visionaries" that have played a major role in nuclear and space systems development and exploration. This list includes Sean O'Keefe, who was at NASA's helm during the last major wave for space nuclear power with Project Prometheus in the 2004-2005 timeframe. Mr. O'Keefe had a vision and a mission, so what happened? O'Keefe's successor, Dr. Mike Griffin, found that electric propulsion was not yet advanced enough for the planned Jovian mission and funding was redirected to the Constellation Program. Constellation was later abandoned, as it was found to be "unexecutable" given the Administration's funding constraints. So, how do we overcome these seemingly endless problems for space nuclear systems? Space nuclear power and propulsion systems require major investment, and have a difficult time surviving changes in the Administration and Congress. To provide some insurance of a sustainable program, sufficient money must be invested early on to provide technology development results before system engineering and requirements development are complete – if enough investment has been made, a program becomes harder to cancel and funding may become more sustainable. A significant amount of work has been done in space nuclear systems, both using radioisotopes and fission. We can build on previous work to provide power and propulsion systems for truly advanced missions. Dr. Casani ended his remarks by noting that Mr. O'Keefe had it right: "The next major step in space exploration is going to require Space Nuclear Power."



Honorary General Chair Dr. John Casani speaks at the Plenary.

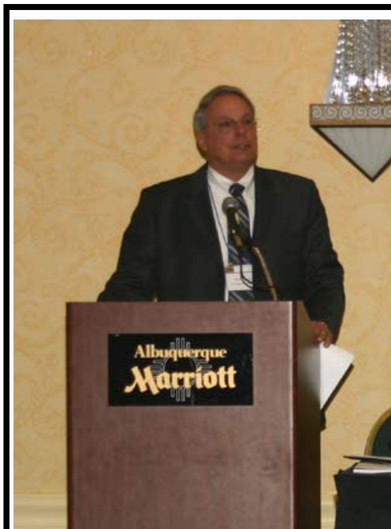
Mr. Jim Adams of NASA Headquarters opened his presentation by commenting that we need nuclear power to accomplish solar system exploration. However, much work remains to be



Jim Adams, NASA HQ, fields questions following his talk.

done. Radioisotope power systems have provided a wealth of data over the last 50 years of space exploration (June 2011 marks the 50th anniversary of the use of radioisotope power systems in space; the Transit IV-A, launched in June 1961, was the first satellite powered by a nuclear battery). The radioisotope-powered Cassini spacecraft, launched in 1997, is expected to provide data from Saturn through 2017. The Mars Science Lab, powered by the multi-mission radioisotope thermoelectric generator (MMRTG) will be launched in November 2011. Reactor-based power systems can provide even more power for ambitious science missions, but we have work to do to develop the balance of plant and to overcome the issues related to the required cost outlay to develop the power system. The "holy grail" of space travel is a permanent human presence in the solar system, but humans "can't live like robots." Humans require sufficient power to live in space – and nuclear options can provide that power. "Don't lose your vision for advanced systems!"

Mr. Robert Lange of DOE presented developments in radioisotope power generation, a critical power source for exploration of the solar system. Radioisotope power systems (RPS) have a long legacy. For all prior missions, *RPS have continued to operate far beyond their design life*. Many of these missions, such as the Cassini mission to Saturn (launched 1997) and New Horizons to Pluto (launched 2006) could not be done without nuclear power. However, 1988 marked the last domestic production of plutonium-238, the fuel of choice for RPS. Although other isotopes have been considered and could be used, they do not offer as many advantages as ^{238}Pu. Mr. Lange offered a few suggestions to ensure continued use of mission-enabling radioisotope systems. First, infrastructure is expensive, but it is important that we keep facilities operation and staffed with trained personnel even though we may only launch an RPS a few times a decade. Second, we need to reestablish domestic production of ^{238}Pu to ensure that we have the necessary fuel available to support missions beyond the 2020 timeframe (see notes from the Panel Session on ^{238}Pu Supply and Production for more discussion on this topic). Radioisotope-powered missions have "changed our understanding of the solar system." We need to expand our use of RPS and other space nuclear power systems (i.e. fission) to continue to learn more and increase our understanding about our solar system.



Bob Lange, DOE, talks about radioisotope power systems.

Dr. Michael Griffin, former NASA Administrator, concluded the opening plenary by presenting viable development strategies for space fission power and propulsion. Several speakers had previously noted that "the days of Apollo are over." Dr. Griffin clarified that we *do* have an Apollo-era checkbook, but we lack the Apollo-era focus in which technology development was performed along parallel paths rather than in series. If we look at the NASA budget over the past 15 years and compare it to the 15 years of the Apollo program (1959-1974), we see that current-day funding exceeds that of the Apollo-era. The last 10 years of funding exceeded that of the 10 years of the lunar Apollo program (1969-1979). So, why haven't we been as successful? We have not experienced a lack of funding, but a lack of *vision* over time. Shifts in funding allocation have undermined recent programs, such as Constellation. We need to establish a *viable development strategy*. Programs must be finished, and they need to have a demonstrated need. Historical evidence indicates that missions drive the technology; technology does not drive missions. There is a high barrier to entry for space nuclear power systems – budget, technology, policy, public image, development time, etc. However, flying a manned mission to Mars without nuclear power is like crossing the oceans in a sailing ship -- "…we *need* to go to nuclear like the early explorers needed steamships." The key question, of course, is how we go about doing this. Dr. Griffin suggested that nuclear power and propulsion be linked to a stable, long term, public program. The technology requires *stable* funding and support, as it takes time to develop complex systems. This support should be *long term*, on the order of a decade or more. It should be supported by a *public* program, vice the private sector, as it has high risk, and the payoff is over a long period of time. A private enterprise requires a market and a reasonable rate of return and payback time, and nuclear power and propulsion systems will take a bit longer for the investment to pay off. Dr. Griffin noted, "Some things are important for society to do that do not look good on a balance sheet – space nuclear power and propulsion is one of these."

Honorary General Chair Harry Finger chats with Dr. Mike Griffin following the Opening Plenary.