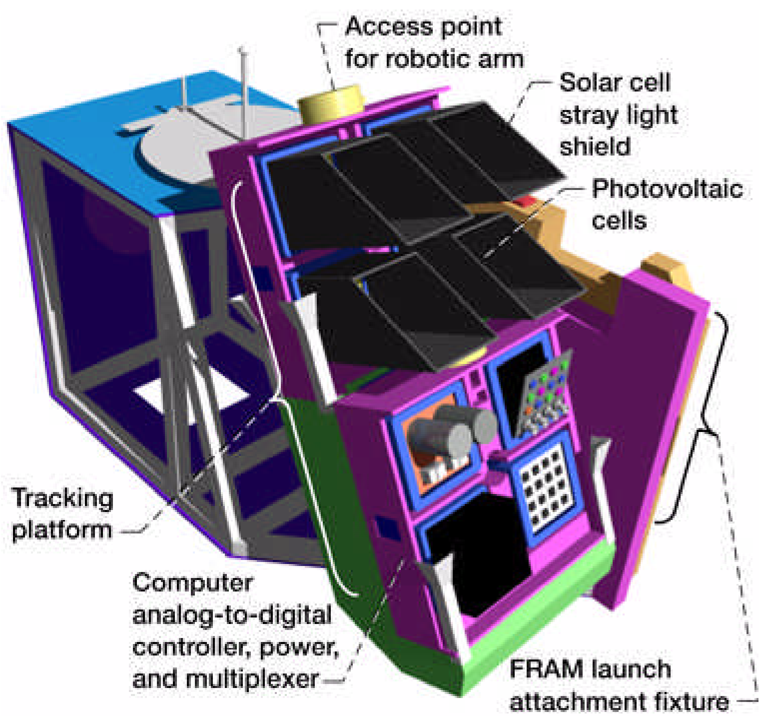
Photovoltaic Engineering Testbed Designed for Calibrating Photovoltaic Devices in Space

Accurate prediction of the performance of solar arrays in space requires that the cells be tested in comparison with a space-flown standard. Recognizing that improvements in future solar cell technology will require an ever-increasing fidelity of standards, the Photovoltaics and Space Environment Branch at the NASA Glenn Research Center, in collaboration with the Ohio Aerospace Institute, designed a prototype facility to allow routine calibration, measurement, and qualification of solar cells on the International Space Station, and then the return of the cells to Earth for laboratory use. For solar cell testing, the Photovoltaic Engineering Testbed (PET) site provides a true air-mass-zero (AM0) solar spectrum. This allows solar cells to be accurately calibrated using the full spectrum of the Sun.

Although intended for the testing and calibration of solar cells, PET could also provide a platform for conducting active experiments in a low Earth environment for either long or short durations and could provide a rapid path for the delivery and return of those experiments. Other payloads can be accommodated at sites on PET that provide a field of view in the ram, zenith, or nadir directions, to conduct active experiments in space or to operate Earth-observing instruments.



Photovoltaic Engineering Testbed (PET) facility.

Illustration showing facility with access point for robotic arm; solar cell stray light shield; photovoltaic cells; tracking platform; computer analog-to-digital controller, power, and multiplexer; and FRAM launch attachment fixture.

The PET facility, shown in this illustration, is designed to be located on the Japanese Experiment Module Exposed Facility (JEM-EF) of the International Space Station. PET includes an articulating platform, which provides viewing angles normal to the Sun when beta angles are between 0° and 20°. This normal-incidence Sun-viewing opportunity occurs approximately 5 days during each month.

The PET facility consists of a primary carrier structure, a Beta-Angle Tracking-Platform, command and data handling systems, interface avionics, a site for Earth-viewing instruments, and two robotically removable trays (both of which accommodate four carriers for solar cells or carriers for other devices).

The on-orbit replaceable units are both mounted on the Beta Tracking Platform. The solar cell carriers, called multicell carriers, provide for the mounting and testing of photovoltaic cells. Optionally, other devices can be flown, such as materials or electrical, mechanical, or optical systems that require testing in a low-Earth-orbit environment. Each carrier is a self-contained element with individual interfaces for power, data, command, and mounting.

Prototype test hardware for a multicell carrier has been fabricated (as shown in the photograph). The design shown has mounting locations for twenty-eight 2- by 2-cm photovoltaic cells. The carrier includes a motorized shutter, which is typically not opened until just prior to the on-orbit test. The tracking platform also has a fixed backwards tilt of 25°, which keeps the field-of-view of the solar cells above the Earth's horizon.

Prototype multicell carrier.

Each multicell carrier contains an embedded central processor and analog-to-digital converters, power and signal conditioning, and a solar-cell voltage and load-switching controller. Utilizing custom data-acquisition electronics, the system can autonomously measure and store individual solar cell temperatures and I-V curve measurements. Several weeks of test data can be stored in nonvolatile memory. Facility instrumentation will consist of a cavity radiometer and Sun position sensors to verify the incident solar flux and orientation.

A significant capability of the PET Facility is the ability to routinely replace the carriers and trays on-orbit. Carriers will be transported to and from orbit as pressurized cargo. Carriers that have completed their mission will be placed into a protective container for return to Earth as pressurized cargo. After the completed carrier is removed, the on-orbit replaceable units will be equipped with new carriers and returned to their externally mounted location on the PET facility. This cycle will be repeated to calibrate and measure new samples as often as required by the users.

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Glenn contacts: Dr. Geoffrey A. Landis, 216-433-2238, Geoffrey.A.Landis@grc.nasa.gov; and Dr. Sheila G. Bailey, 216-433-2228, Sheila.G.Bailey@grc.nasa.gov

OAI contacts: Phillip P. Jenkins, 216-433-2233, Phillip.P.Jenkins@grc.nasa.gov; and J. Andrew Sexton, 440-962-3066, John.A.Sexton@grc.nasa.gov
Author: Dr. Geoffrey A. Landis
Headquarters program office: OSF, OHSF
Programs/Projects: Human Spaceflight