sensor and static pressure probes have been applied in a variety of field programs and can be adapted for use in different planetary atmospheres.

References: [1] Bedard A. J. Jr. and Ramsey C. (1988) *J. Appl. Meteor., 22,* 911–918. [2] Nishiyama R. T. and Bedard A. J. Jr. (1991) *Rev. Sci. Inst., 62,* 2143–2204.

DESIGN OF A PARTICLE BEAM SATELLITE SYSTEM FOR LUNAR PROSPECTING. D. H. Berwald and P. Nordin, Grumman Aerospace and Electronics, Bethpage NY 11714, USA.

One potential use for neutral particle beam (NPB) technology is as an active orbital probe to investigate the composition of selected locations on the lunar surface. Because the beam is narrow and can be precisely directed, the NPB probe offers possibilities for high-resolution experiments that cannot be accomplished using passive techniques. Rather, the combination of both passive and active techniques can be used to provide both full-coverage mapping (passively) at low resolution (tens of kilometers) and high-resolution information for discrete locations of special interest.

A preliminary study of NPB applicability for this dual-use application was recently conducted by Grumman and its subcontractors, McDonnell Douglas and SAIC. This study was completed in February 1993 [1]. A novel feature was that consideration of the use of a Russian launch vehicle (e.g., the Proton) and other Russian space hardware and capabilities was encouraged. This paper describes the lunar prospector system design. Toepfer et al. [2] discuss issues and opportunities involving lunar scientific experimentation using an NPB.

The NPB lunar prospector utilizes a modified design of the Far Field Optics Experiment (FOX) [3]. Like the Earth-orbiting FOX, the core capability of the NPB lunar prospector will be a pulsed RF LINAC that produces a 5-MeV proton beam that is projected to the target with a 30-μr beam divergence and a 10-μr beam-pointing accuracy. Upon striking the lunar surface, the proton beam will excite characteristic radiation (e.g., X-rays) that can be sensed by one or more detectors on the NPB platform or on a separate detector satellite.

Two principal design variants have emerged. The first, a non-nuclear design, utilizes a Proton fourth stage for transfer to lunar orbit. The electric power source is solar and the NPB satellite performs its experimental program while orbiting about 50 km above the lunar surface. When the NPB satellite passes over its target, the beam is activated and the experiment is performed. A key issue for this configuration is the design mass margin that can be achieved within the capabilities of the Proton fourth stage.

The second design variant is powered by a Topaz 3 nuclear reactor (40 KWe). Efficient but low-thrust electric propulsion (e.g., SPT-200 or larger) is used for orbital transfer. The payload delivered to lunar orbit is much larger, but a second spacecraft will be required to provide adequate separation of the nuclear reactor and the detector. A high-low configuration is employed. The detector and NPB orbit at altitudes of 25–50 km and 1980 km respectively. The issues for the second design are technology availability, reliability, and cost.

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References: [1] Grumman Aerospace (1993) *Final Report, NPBSE Special Study Task* 4. [2] Toepfer A. J. et al. (1993), this volume. [3] Grumman Aerospace (1992) *Final Report, NPBSE Basic Contract Task 1.*

LASER-INDUCED BREAKDOWN SPECTROSCOPY INSTRUMENT FOR ELEMENTAL ANALYSIS OF PLANETARY SURFACES. J. Blacic[1], D. Pettit[1], D. Cremers[2], and N. Roessler[3], [1]Geology and Geochemistry Group, Los Alamos National Laboratory, Los Alamos NM 87545, USA, [2]Photochemistry and Photophysics Group, Los Alamos National Laboratory, Los Alamos NM 87545, USA, [3]McDonnell Douglas Electronics Systems Co., St. Louis MO 63166, USA.

TABLE 1. Systems analysis summary for LIBS instrument.

Systems:	Diode-Pumped, Nd-YAG Laser System*			Spectrometer System‡		Optical System	Support System¶		Total Instrument§	
Maximum Analytical Range (m)	Optical Energy (mJ)	Average Electrical Power*(W)	Mass† (kg)	Mass (kg)	Power (W)	Mass (kg)	Mass (kg)	Power (W)	Mass (kg)	Power (W)
20–40	180	0.3	0.7	2.0	3.2	0.3	0.5	0.4	3.5	3.9
50–100	320	0.6	4.8	2.0	3.2	0.5	0.8	0.6	8.1	4.4
100–500	1000	1.5	16	2.0	3.2	0.8	1.8	0.8	20.6	5.5

*Assumes 10-ns pulse and 0.1-Hz repetition rate (McDonnell Douglas Electronic Systems Co.).
† Includes power conditioning and storage.
‡ Includes spectrograph, intensified CCD detector, thermoelectric cooler, and electronics.
¶ Includes structure, motors, and misc. hardware.
§ No power generation or communications allowance.