THE CLEMENTINE INSTRUMENT COMPLEMENT; Paul G. Lucey, Planetary Geosciences, University of Hawaii at Manoa, Honolulu HI 96822

The recent successes of the Galileo SSI imaging experiment at the Moon and Gaspra show the utility of multispectral imaging of planetary objects. "Clementine" is the planetary community's "code name" for the SDIO (Space Defense Initiative Organization) mission to the Moon and the asteroid Geographos. This mission is designed as a long term stressing test on sensors and space systems developed for SDIO. In the course of this test Clementine will obtain science data using a varied and powerful array of remote sensing instruments which were developed by or for Lawrence Livermore National Laboratory in Livermore, California. Clementine carries five cameras, one for navigation and four for science experiments. In addition, a laser ranger is included which will serve as a laser altimeter. The Clementine cameras cover a wider range of spatial resolutions and wavelength range than did Galileo and are almost ideally suited to mapping of mafic rock types as are present on the Moon and expected at Geographos. The technical characteristics of the Clementine cameras are listed in the following tables.

Table 1. Camera Characteristics

CAMERA NAME	ARRAY TYPE	ARRAY DIMENSIONS	ANGULAR EXTENT OF A PIXEL	RESOLUTION @ 500 KM MAPPING ORBIT
LIDAR	intensified Thompson CCD	288x384	20μrad	20 meters
UV-VIS	Thompson CCD	288x384	255μrad	125 meters
Near-IR	Amber InSb array	256x256	350μrad	175 meters
LWIR	Rockwell HgCdTe	128x128	143μrad	70 meters

Table 2. LIDAR camera filters

Center	415 nm	560 nm	650 nm	750 nm	broadband (400-750 nm)
Bandpass (FWHM)	40 nm	50 nm	50 nm	50 nm	350 nm

Table 3. UV-Vis camera filters *

Center	340 nm	415 nm	750 nm	900 nm	950 nm	1.00 μm	broadband (400-750nm)
Bandpass (FWHM)	60 nm	40 nm	10 nm	20 nm	30 nm	30 nm	350 nm

* If the broadband filter is determined not to be required for navigation, all 6 science filters will fly, else one will be dropped.

Table 4. Near-IR camera filters

Center	1.1 μm	1.25 μm	1.50 μm	2.0 μm	2.6 μm	2.78 μm
Bandpass (FWHM)	60 nm	60 nm	60 nm	60 nm	60 nm	30 nm

The LWIR camera is broadband only, covering 8 to 10.5 μm.

Calibration of the cameras will occur at the sensor calibration laboratory at LLNL. In flight calibrations using standard stars and other standards should improve the stated accuracies. SNR's include the following noise sources: shot noise, calibration error, digitization noise, readout noise, and frame transfer noise (where applicable). The achieved SNR's are a balance between detector saturation and acceptable image smear. The "worst" case uses the longest possible integration times.

Table 5. Camera calibration and design SNR

CAMERA NAME	RELATIVE CALIBRATION	ABSOLUTE CALIBRATION	BEST CASE SNR (70% ALBEDO, 0° PHASE)	WORST CASE SNR (5% ALBEDO, 85° PHASE)
LIDAR	1%	20%	41	13
UV-VIS	1%	15%	87	25
Near-IR	1%	30%	97	11
LWIR	1%	30%	954 (300K, emissivity = 0.3)	