THE MESSENGER 2007 VENUS FLYBY: PEEKING THROUGH ATMOSPHERIC WINDOWS WITH MASCS, MDIS, AND VENUS EXPRESS' VIRTIS. Noam R. Izenberg[1], Jörn Helbert[2], Louise M. Prockter[1], James V. McAdams[1], Sean C. Solomon[3], William E. McClintock[4], and Nils Müller[2]. [1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, noam.izenberg@jhuapl.edu; [2]Institute for Planetary Research, DLR, Rutherfordstrasse 2, D-12489 Berlin, Germany; [3]Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, DC 20015; [4]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80303.

Introduction. The MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) spacecraft, launched on 3 August 2004 as part of NASA's Discovery Program, will be the first spacecraft to orbit Mercury [1]. En route to Mercury, MESSENGER flew by Venus on 24 October 2006 and will do so a second time on 5 June 2007 [2]. The first flyby, with a closest approach of 2987 km, took place during solar conjunction, and no science observations were undertaken. The second Venus flyby will have a closest approach of 300 km, currently targeted to be over 12°S, 165°E, near the boundary between the lowland plains of Rusalka Planitia and the rifted uplands of Aphrodite Terra. Late trajectory refinements may cause modest changes in the closest approach time and target location.

Observational Strategy at Venus. The full complement of MESSENGER's instruments [3] will be directed at Venus [2]. The flyby presents several unique opportunities: a range of scientific observations of the Venus atmosphere, planetary environment, and surface [4]; an important practice for the upcoming Mercury flybys, the first of which occurs seven months later; and the chance to conduct collaborative and complimentary observations with the European Space Agency's Venus Express (VEX) mission.

MDIS. The Mercury Dual Imaging System (MDIS) consists of wide-angle and narrow-angle imagers mounted on a pivot platform that enables the instrument to point in a different direction from the spacecraft boresight. The MDIS narrow-angle camera (NAC) is monochromatic with a 1.5° field of view, while the wide-angle camera (WAC) has a 10.5° field of view and a set of 11 color filters (plus one broad-band filter) ranging from 415 nm to 1020 nm.

During the Venus flyby (Fig. 1), MDIS will image the dayside and nightside in visible through near-infrared filters, and color and higher-resolution monochrome mosaics will be made of both the approaching and departing hemispheres.

MASCS. The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) consists of an UltraViolet and Visible Spectrometer (UVVS) and a Visible and InfraRed Spectrograph (VIRS). The UVVS atmospheric slit has 1° x 0.04° field of view and an overall wavelength range of 115-600 nm in 0.6-nm steps. The VIRS component has a 0.023° circular field of view. Its VISible (300-1050 nm) and Near InfraRed (850-1450 nm) detectors have spectral resolutions of 5 nm (as low as 2.3 nm if spectral channels are not binned).

During the Venus flyby (Fig. 1), UVVS will make profiles of atmospheric species on the dayside and nightside as well as observations of the exospheric tail on departure. VIRS will observe the planet near closest approach to sense cloud chemical properties and near-infrared returns from the surface on the night-side.

VIRTIS. The Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) is the VEX instrument most complementary to MDIS and MASCS for atmosphere and surface observations at Venus. VIRTIS is a dual instrument with two telescopes: VIRTIS-M is an imaging spectrometer working in the visible (VIRTIS-M-vis from 300 to 1000 nm) and in the infrared (VIRTIS-M-IR from 1000 to 5000 nm), and VIRTIS-H is a high-resolution infrared spectrometer (2000 to 5000 nm). The primary function of VIRTIS is the study of the three-dimensional dynamics, composition and temporal variation of the Venus atmosphere [5].

VIRTIS is also able to study the Venus surface and surface-atmosphere interaction and to search for the thermal signature of active volcanism. Starting with the first data following orbit insertion the M-IR channel of VIRTIS has been systematically mapping the surface of Venus through the atmospheric windows located at 1020, 1100, and 1180 nm [6]. The VIRTIS team has developed a data a processing pipeline for the extraction of surface data from the received signal [7]. To remove the effect of cloud contrast the routine uses two additional "cloud windows" at 1270 and 1310 nm.

Synergies among MDIS, MASCS, and VIRTIS. The data obtained by MASCS and MDIS during the MESSENGER flyby of Venus are in many ways complementary to the data currently being obtained by VIRTIS-M on VEX. The NIR channel of MASCS VIRS covers all "surface-related" windows observed by VIRTIS-M. While MASCS, as a point spectrometer, has a relatively limited spatial coverage, it can study the atmospheric windows at a spectral resolution approximately four times better than VIRTIS-M (Fig. 2). The higher spectral resolution will improve understanding of the effect of O_2 airglow on the 1270-nm cloud window. These data can be used to improve the data processing by VIRTIS-M. Two MDIS color filters (at 1000 and 1020 nm) cover an NIR atmospheric window also observed by VIRTIS-M (Fig. 2). With an adapted version of the VIRTIS data processing pipeline and observations of the "cloud" windows provided by VIRTIS-M these images can be compared to the maps produced by VIRTIS over the last year. In addition MDIS has a filter at 950 nm, which might allow observing through additional atmospheric window not accessible by VIRTIS-M due to exposure time limitations.

The MESSENGER flyby will permit a variety of two-spacecraft observations, including imaging and spectroscopy of the Venus clouds and detection of surface emissions. VEX's orbit will allow it to observe the region of Venus under MESSENGER's closest approach a few hours after the flyby (Fig. 3). VIRTIS will image cloud structure with its mapping component and will enable direct comparison with MDIS imaging and separation of ground and emissions in MASCS point spectra.

References. [1] S. C. Solomon *et al., Planet. Space Sci.*, **49**, 1445, 2001; [2] J. V. McAdams, *Adv. Astronaut. Sci.*, **116**, part III, 643, 2004; [3] R. E. Gold *et al., Planet. Space Sci.*, **49**, 1467, 2001; [4] S. C. Solomon *et al., LPS*, **38**, #1413; [5] G. Piccioni *et al. ESA SP-1291*, 2006; [6] J. Helbert *et al*., *BAAS*, **38**, #16.03, 2006; [7] N. Mueller *et al., Eos Trans. AGU*, **87** (52), #P42A-07.

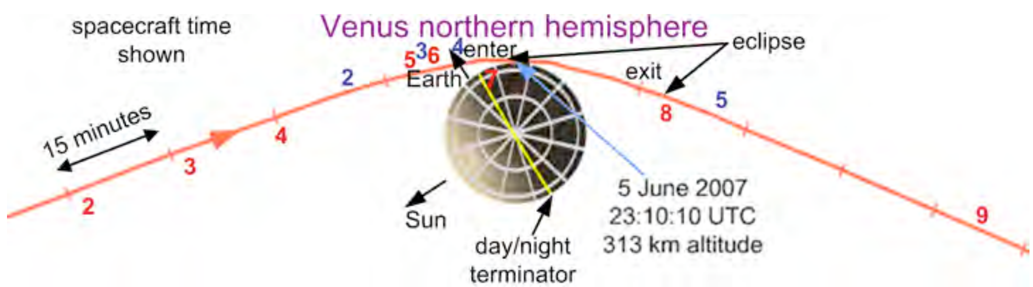

Fig. 1. MESSENGER flyby geometry with sequenced MDIS (red) and MASCS (blue) observations numbered. MDIS observations shown include calibrations (2), color and monochrome mosaics (3,4,6,8), color photometry (5,7), and a departure movie (9). MASCS observations shown include a dayside exosphere profiles (2), dayside to nightside cloud (and surface) observations (3-4), and nightside exosphere and tail observations (4-continued, 5).

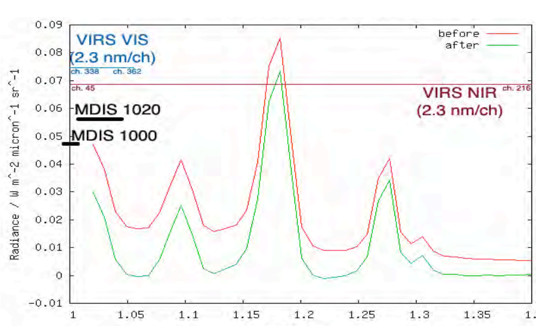

Fig. 2. VIRTIS spectrum of Venus atmosphere (before and after removal of scattered sunlight) with MASCS wavelengths and MDIS IR filters overlain.

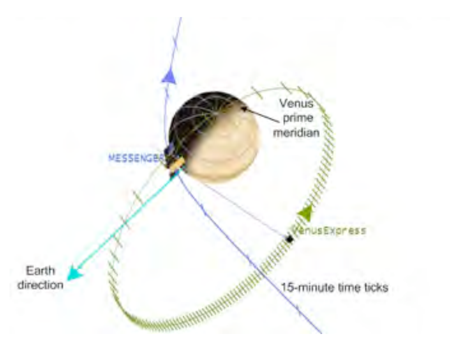

Fig. 3. MESSENGER and VEX trajectories and relative positions during MESSENGER Venus flyby 2.