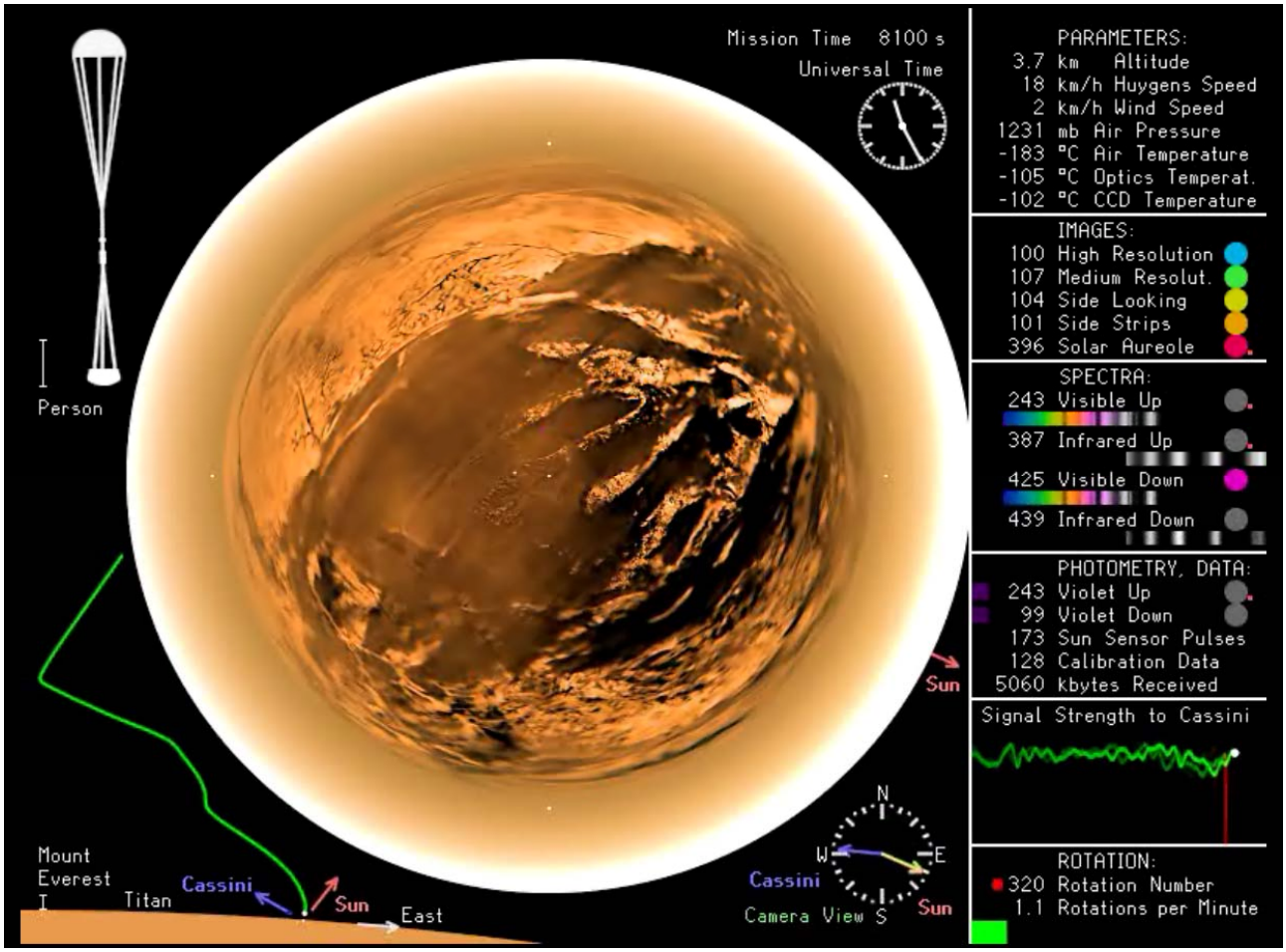

Explanation to the DISR movie
4 May 2006

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Video credits: ESA/NASA/JPL/University of Arizona.

This movie, built with data collected during ESA Huygens' mission at Titan on 14 January 2005, shows the operation of the DISR camera during its descent up to touch- down. The almost 4-hour long operation of DISR is shown in less than five minutes - 40 times the actual speed up to landing and 100 times the actual speed thereafter.

The big circle displays the view from the Huygens probe over the bottom hemisphere including part of the upper hemisphere, up to 35 º elevation above horizontal. As DISR takes more and more images, the field of view becomes more and more filled. We watch as the whole mosaic builds up. Six small white dots mark the four cardinal directions, the nadir direction (straight down), and the landing site. The red arrow on the lower right edge of the circle points to the sun. Note that the haze near the sun is much brighter than in the opposite direction.

The lower left corner displays the trajectory of Huygens viewed from the south. A scale bar indicates the size of Mount Everest for comparison. Colored arrows point to the sun and to Cassini, the mother ship of the Huygens probe, which was essential for the data transmission to earth. The zig-zag of the green trajectory is due to unexpected variations of the wind speed.

The top left corner displays a close-up view of the Huygens probe, highlighting large, unexpected parachute motions. A scale bar gives the size of an average person for comparison. Note that the magnification increases after the deployment of the smaller parachute.

To the lower right of the big circle is a compass displaying the directions to the sun and Cassini. When the DISR cover is ejected, DISR begins to work, and a green arrow shows the changing viewing direction due to the rotation of Huygens. While Huygens was designed to spin counterclockwise, it stopped and started spinning clockwise for the remainder of the descent.

To the upper right of the big circle is a clock giving Universal Time (Greenwich Mean Time, two hours earlier than Central European Summer Time) on 14 January 2005. Events during the descent are sometimes given in Mission Time in seconds displayed above, which starts with the deployment of the first parachute.

After touch down on Titan's surface, the main display changes to the view from DISR in the latest raw images (center) and combined processed images (right). In order to judge the size of the rocks, a scene from the moon at similar scale is added on the left. During the time on the surface, the apparent brightness of the medium and high resolution images changes due to changes in the exposure times.

The right side of the screen displays detailed information about parameters of DISR and Huygens. From the top, these are: altitude, speed, wind speed, air pressure (mean air pressure at Earth's sea level is near 1000 millibar), air temperature, and the temperature measured at the optics and the CCD detector of DISR.

Further down is a summary of the number of imaging exposures. DISR had four imagers, a high and a medium resolution imager, both looking down, a side looking imager operated in two different modes, full image and double strip, and a solar aureole imager looking up. The latter imager always took four images simultaneously, in the blue and in the near-infrared, and in two orthogonal polarization directions each. The timing of each exposure is shown by a white dot flashing to the left of each exposure counter. The exposed area is shown by a colored flashing area in the big circle. The direction of each exposure is also displayed on the far right by a white flashing area in the colored circles. The color corresponds to the color used in the big circle. The little dot to the right of the red circle indicates the direction to the sun.

Further down is a summary of spectroscopic exposures. DISR had two visible and two infrared spectrometers, one each looking up, and the other one looking down. The current spectra are displayed with wavelength increasing from the left to right. The overlapping spectral region between the visible and infrared spectrometers is evident. During the beginning of the descent, dark methane bands are obvious in the down-looking infrared spectrometer. As Huygens sinks to the surface, methane bands become more and more apparent in the other spectrometers. Since methane in Titan's atmosphere is concentrated near the surface, most of the variation occurs close to landing. Once on the surface, a major part of the solar spectrum, especially in the near-infrared, is blocked out by methane. In the down looking spectrometers, however, the DISR surface lamp provided illumination to probe the spectrum of Titan's surface throughout the probed spectrum (480-1600 nanometres). The down looking visible spectrometer was an imaging spectrometer, and the imaged parts of Titan are visible as pink flashes in the big circle. Many of the infrared spectroscopic exposures consisted of a series of sub-exposures accumulating signal. The direction for each sub-exposure is indicated by white flashes in the little gray circles to the right, while the white dots to the left of the exposure

counters are set to gray as long as exposures are still accumulating signal.

Further down is a summary of photometric exposures and other DISR data. DISR had up and down looking violet photometers to cover the violet and ultraviolet, complementing the spectral range of the spectrometers. Violet squares to the left of the exposure counters indicate the current recorded brightness. Right below, the red square shows the current recorded brightness of the sun in the near-infrared by the sun sensor. In the thick haze of the final part of the descent, the sensitivity of the sun sensor was insufficient to capture the fading sun. The sun sensor had triple slits to record pulses of the sun, whenever the viewing direction was toward the sun, as indicated by the green arrow of the compass passing the red arrow. The sun sensor missed several pulses when Huygens was swinging stronger than expected. On the other hand, all the other DISR components handled the swinging perfectly. Further down is a counter of calibration exposures. They were essential for accurate data analysis. Right below, the amount of DISR data transmitted is constantly updated. The limited data rate was the primary limit for data gathering of DISR. Nevertheless, due to sophisticated data compression algorithms, some 3500 exposures were successfully transmitted to earth via Cassini.

The graph further down displays the strength of the signal of Huygens received by Cassini, modulated mostly by the rotation of Huygens. From one rotation to the next, the shape of the transmission strength remained almost constant. This feature helped to pin down the rotation of Huygens for each second of the descent. As Cassini sank lower in the sky as viewed from Huygens, the transmission strength curve changed significantly. The Huygens mission ended when Cassini went below the horizon, indicated by the blue arrow on the bottom left.

The very bottom gives information about the rotation of Huygens. Rotations are counted each time the sun passes the field of view of DISR, as indicated in the compass by the green arrow passing the red one. At the beginning of each rotation, a red dot next to the rotation counter flashes, and a vertical red bar appears in the graph above. Rotation number zero is at the turn-around point from counterclockwise to clockwise rotation. The rotational rate is given below in digital form and by a green bar in analog form. During the descent on the large parachute, the rotational rate changed slowly as expected. Later on, however, on the smaller parachute, the rotational rate was unexpectedly unstable. This made the DISR data analysis more complicated, but they did not hamper any of the science results. The first results were published in Nature 438, 765-778 (2005).

Sound was added in order to increase awareness of the various events. The sound in the left speaker follows the motion of Huygens. The pitch of the tone indicates the rotational speed, similar to the sound of an engine. The type of the tone varies with the tilt of the parachute. Vibrato indicates vibration of the parachute. Little clicks indicate the clocking of the rotation counter. Larger noise corresponds to the entry of the heat shield into the atmosphere, to parachute deployments, to the heat shield release, to the jettison of the DISR cover, and to touch down.

The sound in the right speaker follows the data from DISR. The pitch of the continuous tone goes with the strength of the signal from Huygens to Cassini. The 13 different chime tones correspond to the workings of the 13 different components of DISR, in time with the flashing white dots to the left of the exposure counters. Naturally, the counters at the top and bottom get the high and low notes, respectively. All parts of DISR worked together as programmed, creating a harmony.