



## *SORCE Records the Transit of Venus*

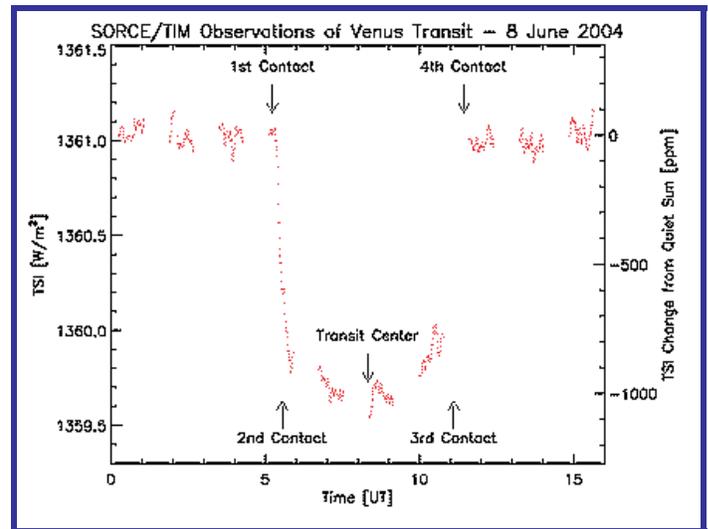
By Gary Rottman and Greg Kopp

Today, for the first time since 1882, the planet Venus came between the Earth and the Sun. The circumstances for these special transit events occur only every 122 years, and then in pairs separated by about 8 years. We will have another in 2012, but then not again until 2117 and 2125. The size of the planet Venus is about one arc minute, or about the size of a typical sunspot on the solar disk. Therefore as the planet moves across the Sun, we expect a dip in solar irradiance of about 0.1%. The *SORCE* TIM instrument routinely records the passage of sunspots with comparable dips in TSI. (The very largest sunspot groups late in October of 2003 produced a drop in TSI of more than 0.3%.) Observing the transit of Venus is well within the precision and accuracy capability of the *SORCE* TIM, and we anticipated that this astronomical event was an opportunity to test the instrument, and may provide some unique scientific data as well.

*SORCE* schedulers and scientists took advantage of the opportunity to capture this rare alignment by planning special experiments. The transit involves four contact points: first contact as the edge of Venus touches the limb of the Sun, second contact as the planet is just onto the disk of the Sun (the period between these contact points is the ingress period), third contact as the edge of Venus just reaches the other limb of the Sun, and fourth contact as Venus finally leaves the Sun (with the period between third and fourth contact referred to as the egress period). The ingress and egress times are about 20 minutes, and the total time of the transit is about six hours. Viewing from the ground was limited to the eastern part of the United States and points further east so we hope our colleagues in Europe had their own special view. From the vantage of the *SORCE* orbit, several observations of the Sun were completed during the transit.

The *SORCE* satellite was in an almost ideal position to record the transit, and we report here the first (preliminary) observations from TIM. SIM, SOLSTICE, and XPS were also placed in their most optimal observing configurations, but it will take a few more days to look for the very small signature of the transit.

The *SORCE* Total Irradiance Monitor (TIM) measured a decrease in the total solar irradiance (TSI) as Venus transited the Sun today. In agreement with our predictions, the incident sunlight dropped slightly less than 0.1%, or 1000 parts per million (ppm), during the transit. These preliminary data, which have been adjusted to 1 AU for comparison with other TSI values seen throughout the year, show a decrease from the Sun's normal TSI value of 1361 W/m<sup>2</sup> down to 1359.7 W/m<sup>2</sup>. The gaps spaced throughout the data are from times when the *SORCE* spacecraft was in the Earth's shadow and



could not view the Sun. As luck would have it, 1st through 2nd contacts (ingress) was recorded, but egress (3rd and 4th contacts) was not. Venus did not move across a diameter of the Sun, but rather across a shorter chord near the southpole. The slight curvature in TSI during transit, bright to slightly darker and then brighter, as Venus moves along the chord of the Sun is due to the fact that the Sun is not as bright near its edge, or limb, and Venus therefore blocks less radiation than it does as it moves further onto the solar disk. This is a well known effect called "limb darkening" on the Sun. The small fluctuations (about 50 ppm) in brightness on short time scales are from normal solar oscillations and can be seen both before and after the transit.

Greg Kopp has provided the TSI figure here, but we wish to acknowledge all of the *SORCE* team that make these experiments happen. Cindy Russell, Ken Griest and the other planners, Sean Ryan, Deb McCabe, Brian Boyle and the entire ops team, Chris Pankratz and all of the data processing folks, and of course all other members of our team. Data were received from the spacecraft about six hours after the event, and were processed and into Greg's hands about one hour later. Need we mention again how well the Orbital spacecraft, the instruments and the entire ground system continues to perform.

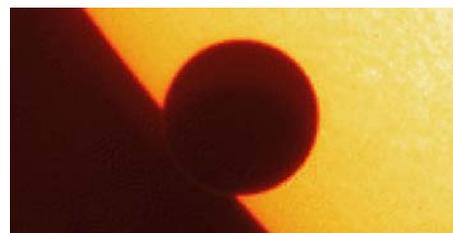


Image of Venus during ingress (5:34 UT) taken by TRACE. Venus on the eastern limb of the Sun shows a faint ring around the planet. This faint ring, with a brightness of only about 1% of the brightness of the Sun close to its edge, is a consequence of the scattering that occurs in the atmosphere of Venus, allowing some sunlight to show around the edge of the otherwise dark planetary disk.