Venus Interferometric Synthetic Aperture Radar (VISAR) for the Venus Origins Explorer. S. Hensley[1], S. Smrekar[1], M. D. Dyar[2,3], D. Perkovic[1], B. Campbell[4], Marwan Younis[5], and the VOX team, [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena CA, 91109 (shensley@jpl.nasa.gov), [2] Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ 85719, [3] Dept. of Astronomy, Mount Holyoke College, South Hadley, MA 01075, [4]Smithsonian Institution, Center for Earth and Planetary Studies, MRC 315 PO Box 37012, Washington, DC 20013, [5]German Aerospace Center (DLR), Münchener Straße 20, 82234 Weßling, Ger.

Introduction: One of the three primary science instruments for the proposed Venus Origins Explorer (VOX) mission [1] to the NASA New Frontiers Program is an X-band radar interferometer. This radar is designed to provide 1-2 order of magnitude improvements in both imaging and topographic resolution as well as make repeat pass oberservations of selected targets to look for deformation signatures from active geological processes.

Radar Overview: The Venus Interferometric Synthetic Aperture Radar (VISAR) instrument is an X-band single pass interferometer designed to generate high-resolution imagery and topography of the surface of Venus. High-resolution topography is integral to many of the proposed VOX science investigations and single pass radar interferometry is the optimal means of obtaining these measurements at Venus [2, 3]. X-band at 7.9 GHz optimizes performance within the launch vehicle and Venus atmospheric attenuation constraints.

Radar Design and Parameters: The basic requirements driving the radar design are: 1) generate imagery with 20 m resolution for targeted regions; 2) obtain global imagery with 30 m resolution; 3) obtain global topography with 300 m resolution and 10 m height accuracy; and 4) make repeat pass radar interferometric (RPI) deformation measurements. These requirements represent an order of magnitude improvement to Magellan SAR imagery resolution (120 m) and 2 orders of magnitude to the topography resolution (~20 km) with the elevation accuracy improved from 80 m (at best) to 5 m.

To meet these requirements VISAR is configured as a single pass radar interferometer with a 3.1 m cross-track baseline and two 4 m $\times$ 0.6 m antennas at each end of the baseline. VISAR has an operating bandwidth of 20 MHz (slant range resolution of 7.5 m) that enables 15 m cross-track resolution at an incidence angle of 31°. The 3.9 m along-track antenna length provides 2 m along-track resolution. Operating from an orbit of roughly 240 km VISAR has a 14.4 km swath to allow contiguous overlapping swaths covering the 10 km of equatorial planetary rotation between orbits.

Viable repeat pass radar interferometric measurements impose several constraints on the imaging geometry. Primary among these is that the perpendicular baseline (length of the projection of the vector between the two observing vantages perpendicular to the line-of-sight) be less than the critical baseline length that is 400 m for VISAR [3]. To accomplish this the spacecraft will perform an orbital adjustment maneuver to place the spacecraft within a 160 m diameter tube ensuring the perpendicular baseline is < 80 m for 92% of the time.

Onboard processing is required to reduce the onboard data rate by about a 1000 fold enabling global coverage within downlink constraints. Onboard processing consists of range compression, motion compensation, azimuth compression, interferogram formation and multi-looking prior to downlink. Raw radar signal data is downlinked for selected repeat pass targets.

After the data are downlinked the remainder of the interferometric processing including phase unwrapping, height reconstruction (that includes atmospheric compensation) and mosaicking is performed. Tie pointing between tracks is used to improve spacecraft ephemeris and provide cartographically accurate mapping.

Radar Capability and Products: VISAR will generate the following data products, comfortably exceeding science requirements:

1. Radar imagery with 15 m resolution for 40% of the surface.
2. Radar imagery at 30 m and 250 m resolutions globally.
3. Topography with 250 m posting and 5 m elevation accuracy globally.
4. Repeat pass interferograms and correlation maps with 30 m resolution for targeted 200$\times$200 km regions on the surface (between 12 and 24 locations depending on resources) with 2 cm line-of-sight deformation precision.

Conclusion: The proposed VISAR instrument on VOX will provide global high resolution imagery and topography of Venus and as well make the first systematic radar deformation observations using RPI on another planet. Onboard processing enables VISAR to reduce the onboard data rate by about 1000× enabling global high-resolution measurements to be made with planned DNS data downlink capability.

References: [1] Smrekar, S., et al. (2017) this meting [2] Hensley, S., et al, (2001) DEM User's Manual, ASPRS [3] Rosen, P., et al (2000) Proceedings IEEE.

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