THE FUTURE OF MRO/HIRISE. A. S. McEwen[1] and the HiRISE Science and Operations Team [1]LPL, University of Arizona (mcewen@lpl.arizona.edu).

Introduction: The High Resolution Imaging Science Experiment (HiRISE) on the Mars Reconnaisance Orbiter (MRO) has been orbiting Mars since 2006. The nominal mission ended in 2010, but MRO has continued science and relay operations, now in its 4th extended mission. Both the spacecraft and instrument have experienced a variety of anomalies and degradation over time. This presentation describes the accomplishements to date of HiRISE and prospects for the future, with perhaps another decade of imaging.

HiRISE obtains the highest-resolution orbital images of Mars, ranging from 25-35 cm/pixel scale. To acquire such images with a high signal:noise ratio (SNR), HiRISE uses time delay integration (TDI), imaging each patch of ground up to 128 times and summing the signal. Producing sharp images over such a small instantaneous field of view (~1 microradian/pixel) and with 128 TDI lines requires very stable pointing from the spacecraft. HiRISE has 14 CCD detectors: 10 in a broad-band (RED) channel that cover the ~5-6 km wide image swath, plus 2 with a blue-green (BG) filter and 2 with a near-infrared (NIR) filter, producing 3-color imaging in a narrow central swath of each image.

HiRISE Accomplishments: HiRISE has returned over 53,000 large (~giga-pixel) images of Mars, covering a total of 3% of the martian surface if all coverage was unique. HiRISE data have been used to find the best landing sites for multiple landers and rovers. Over 5,400 stereo pairs have been acquired, with over 500 full-resolution digital terrain models (DTMs) produced and archived (https://www.uahirise.org/dtm/). More than 1,300 peer-reviewed publications with "HiRISE" and "Mars" are found by the NASA ADS full-text search.

HiRISE image anomalies:

1. The electronics supporting RED9 was lost in 2011, narrowing the swath width by 10%. Fortunately there have been no further electronics failures to date, but this remains a distinct possibility in the future.

2. Soon after launch we discovered bit flips in some image channels. This problem has affected more and more image channels (each CCD has 2 readout channels). Fortunately we can mitigate this problem by warming the focal plane electronics (FPE) prior to Mars imaging, but this results in shorter images. Early images had up to 120,000 lines at full resolution (no pixel binning), the maximum now is near 50,000 lines (or 150,000 lines with 2x2 binning).

3. The percentage of images with noticeable blur (0.3-1.5 pixels) was up to about 75% of full-resolution images near the end of 2017 (at apoapsis), but has since dropped to <20%. This and other data make it clear that the blur is due to temperature fluctuations in the secondary mirror assembly, related to apoapsis and steps taken to prolong MRO spacecraft battery life. We expect to eliminate this problem via revised thermal control settings.

MRO orbit expectations: MRO has been in a sun-synchronous (nearly polar) orbit at close to 3 PM Local Mean Solar Time (LMST), which is usually close to ideal for imaging the surface because the illumination angle accentuates topography while still providing ample signal for high SNR. However, MRO's batteries are gradually losing capacity. To attempt to keep MRO functioning for another decade, a number of changes are being made to prolong battery life, including a plan to move to a later LMST (near 4:30 PM) after the Mars2020 rover landing (Feb. 2021). This later time of day reduces the duration of eclipses, when the solar arrays are not illuminated and battery power must be used.

The change to 4:30 PM LMST will provide several disadvantages and one advantage to HiRISE science. First, it complicates change detection because we cannot re-image with similar lighting conditions. Second, it limits the latitude range of useful imaging within each season, reducing the seasonal range for monitoring polar processes. Third, it means that stereo pairs must be completed more rapidly to avoid large changes in shadow lengths and positions, although this could be operationally mitigated. An advantage is that relatively flat equatorial regions are better imaged later in the day, to accentuate subtle topographic shading.

Future HiRISE images: Expect more binned images due to the later LMST with lower brightness levels. However, we can cover four times as much of Mars with bin-2 images, and ~0.6 cm/pixel remains better than any other orbital imaging of Mars. There will still be many opportunities for high-quality, full-resolution images.

HiRISE-2? HiRISE-class imaging is highly recommended in a study of the next Mars orbiter (https://mepag.jpl.nasa.gov/reports.cfm). Extending the high-resolution mapping and monitoring has great scientific value and is essential for landing sites. Advances in detector and electronics technologies since 2002 would lead to significantly improved images.