An optical anomaly which affects the flux calibration has been discovered in the data. It consists of a roughly horizontal band with a deficit of counts, and seems to appear in nearly all spectra. It is visible on all four channels, most prominently at wavelengths where the astigmatic height is the largest. Its location in wavelength space changes with time, so it seems to be an optical effect, most likely due to the gratings. Since it is not stable with time, it makes flux calibration uncertain in the regions where it is most prominent. It is not understood at this time.

7. OPERATIONS

7.1. Mission Operations

Mission operations is run from the FUSE Satellite Control Center (SCC) at the Johns Hopkins University, where science and mission operations are co-located. Planning and scheduling of observations, generation of command loads, communication with the satellite through an autonomous ground station, receipt and processing of science and engineering data, monitoring of the health and safety of the satellite and instrument, computation of the FUSE orbital elements, off-line analysis of science and engineering data, and maintenance of flight software all occur at this facility.

Communications with FUSE is primarily through a dedicated ground station antenna located at the University of Puerto Rico in Mayaguez (UPRM). When FUSE passes within range of the ground station, communication is possible for only about 10 minutes of the 100 minute orbit, on average. Furthermore, due to the 25° inclination of the orbital plane, there is a ~12 hour period every day when there is no communication possible from UPRM. Consequently, a high degree of autonomy has been built into the satellite to allow unaided target and guide star acquisitions, instrument alignment, and health and safety checks of the instrument by flight software. Observations proceed autonomously with no intervention from the ground.

Science data are transmitted to the ground station at 1 megabit/sec and are stored locally on disk at the ground station. The data are then transmitted to the SCC via an ISDN line after the ground station contact is over. Level zero processing in the SCC removes the downlink packet structure from the data, which is then sent through the OPUS pipeline[12] and the CALFUSE pipeline, where the spectra are corrected for instrumental effects, turned in to one-dimensional spectra, and calibrated. After calibration, the data are archived by the Multimission Archive at the Space Telescope Science Institute (MAST).

Overall observing efficiency is limited by the low earth orbit, which results in most targets being occulted for part of every orbit. In addition, observations cannot be made during SAA passages, and slewing and peakups add overhead. The mirror motions described in section 4 also decrease the efficiency of observations in the MDRS and HIRS slits. Despite these constraints, the on-orbit efficiency is close to that predicted before launch, and slowly increasing as the number of calibration observations and other special tests decreases with time.

7.2. Event Bursts

An unexplained feature observed in the data is the intermittent increase in the count rate, from an as yet undetermined source. The pulse height distributions of these “event bursts” are consistent with the distributions exhibited by photons, so they are apparently due to light rather than particles or some other source internal to the detector. The source of these photons is unknown, however.

These bursts have durations that range from a few to several hundred seconds, and maximum intensities that are typically 20,000 per second. Their occurrence is uncorrelated with orbital location, ram vector, or other orbital phenomena have been unsuccessful, although they occur primarily in orbital morning, with many occurring near noon. Early in the mission, while the satellite was pointed in the continuous viewing zone in order to avoid observing the bright earth, they occurred on nearly every orbit. The frequency has dropped significantly since that time, but it is unclear if that is an effect of changes in pointing geometry due to constraints provided by the mirror and grating motions, or some other effect, such as a lower pressure in the spectrograph cavity.

Since the bursts are isolated in time, rarely occurring more than once per orbit, they can easily be screened from time tag data during ground processing without a significant loss of observing efficiency; a pipeline module to automatically remove these times from the data is currently under development. It is not possible to remove them from spectral image data, but since these observations typically have much higher count rates, the bursts provide much less contamination.