Astronomical Applications for a Quadrant Detector Instrument

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The quadrant detector (QD) instrument on the 100m Green Bank Telescope (GBT) is designed to detect the motions of the feedarm. Feedarm motions are thought to be one of the main causes of dynamic pointing errors under windy conditions. The quadrant detector should therefore be able to predict the contributions of the feedarm to pointing error at any given time. The purpose of this paper is to provide a calibration of the quadrant detector so that it can be used to provide real-time pointing errors of the telescope. A number of methods were tried to determine this calibration including using a model based purely on engineering surveys of the telescope and a model based on observing astronomical sources with half power-tracks. Half power tracks consist of moving a bright point source to the half power point of the telescope's beam in order to infer pointing errors from the changes in the observed flux.

To determine the effectiveness of this calibration, it was checked by a number of methods. First, the calibration had to be reliable in additional half power tracks. Second, the calibration was used to try to enhance images reconstructed from the MUSTANG bolometer array. Third, the QD was used to try to correct the received flux from a source distorted by feedarm motions. Lastly, the QD was checked against qualitative constraints based on the geometry of its location.

The QD passed all of these tests and was shown to successfully predict the GBT pointing error when the pointing errors inferred from the QD were greater than two arcseconds. Therefore, the QD can be used in a number of practical manners both during observations and afterwards, such as for flagging bad data, correcting pointing for MUSTANG data reduction, and performing archival analysis on how frequently the telescope has a certain pointing accuracy.