Following every reconfiguration of the SMA, we need to calibrate the pointing correction terms in the mount model. The largest changes in pointing are typically due to azimuth encoder DC offset (azimuthal error in the setting of an antenna on the new pad), and the tilt of the azimuth axis (deviation of the azimuth axis from the local vertical). We observe about 200 bright stars all over the sky, with an optical guidescope that is mounted in the back-up structure of each of the SMA antennas. The Electrim EDC-1000 CCD camera that is used in these guidescopes is getting old and is now completely obsolete. We have replaced 5 of the SMA antennas with a newer and more sensitive camera: the Santa Barbara Instrumentation Group’s ST-i auto guider camera. The ST-i camera is also much lighter and smaller compared to the Electrim; the entire guidescopes assembly including the 100 mm focal length lens is only about 20 cm long (Figure 1) The small size and cylindrical shape of the camera allows it to be mounted rigidly on the telescope’s central hub.

Figure 1: (Left) SBIG ST-i guidescopes mounted on the carbon fiber central hub of the backup structure of SMA antenna-1. (Middle) Rob Christensen comparing the sizes of the old and new guidescopes tubes! (Right): ST-I guider scope with the mounting bracket.

We use the Source Extractor program (http://www.astro-matic.net/software/sextractor) for centroiding on bright stars to measure pointing offsets. The plate scale provided by the 100 mm focal length lens is rather coarse, 15.2 arcsec-onds per pixel, but the star light is spread over several pixels (due to poor optical performance, and internal scattering caused by insufficient baffling), and one can obtain sub-pixel centroided offsets. Figure 2 (right) shows an image of Polaris with intensity profile cuts. Centroiding works because of the spread in light across pixels to allow centroiding for offset measurements. (Right): An 800 ms exposure on Polaris with a cut across the horizontal and vertical directions through the center to show the intensity profiles.

These results are shown in Figure 3. The rms of residual off- sets are 1.3” and 1.7” in azimuth and elevation. This performance is slightly better than our old guidescopes but we can improve it further by centroiding on multiple stars in the frame. We are investigating the optimal exposure time for stars of various magnitudes, and also developing the software for multi-star centroiding.

Our tests show that the ST-I camera guidescopes can be used for arcsecond accuracy pointing model calibration following array reconfigurations. Offset-guiding real-time corrections in pointing will require multi-star centroiding and a careful characterization of the plate-rotation. The compact size of this system allows for the possibility of mounting multiple guidescopes on different parts of the antenna structure providing direct measurements of mechanical flexure as a function of elevation.