Preliminary Astrometric Results From PS1

David G. Monet
U.S. Naval Observatory Flagstaff Station
The Pan-STARRS Team
Institute for Astronomy, University of Hawaii

ABSTRACT

Various images taken during the first night of observing with the Pan-STARRS PS1 telescope have been examined. Given the current status of the telescope alignment and collimation, the astrometry appears to be dominated by image photon statistics.

1. DIFFERENTIAL ASTROMETRIC TESTS

The Pan-STARRS PS1 telescope (PS1) and the Gigapixel camera (GPC1) had First Light on August 24, 20007. Observations of M31 were done in the *r*- and *i*-bands, had exposure times between 10 and 100 seconds, and had dithers of about 1000 pixels (260 arcseconds). The images were processed by the IPP software package [1], and the detection lists were computed by the SExtractor software package [2]. The lists of detections from each of the images were merged to produce a list of objects and attributes.

The first question to be answered is whether the astrometric accuracy is limited by the photon statistics from the stellar images or by the residual structure of the seeing (atmospheric turbulence). The prediction of former is that brighter stars will have smaller astrometric residuals whereas the latter predicts a constant astrometric accuracy. A sample of 200 stars each measured on 4 *r*-band and 4 *i*-band frames at each of 4 dithers was divided into three bins of stellar magnitude. (In this result and those that follow, the zero point for the magnitudes is arbitrary. The true brightness is unknown, but the ratio of the fluxes is measured.) Figure 1 shows the results for the *x*-axis (open symbols) and *y*-axis (filled symbols) for each of the bins of apparent magnitude. Two stellar magnitudes is a flux ratio of about 6, and this implies an improvement in image signal-to-noise ratio (SNR) of about 2.5. Although somewhat noisy, Figure 1 shows that brighter stars are measured more accurately and that the improvement scales with the SNR.

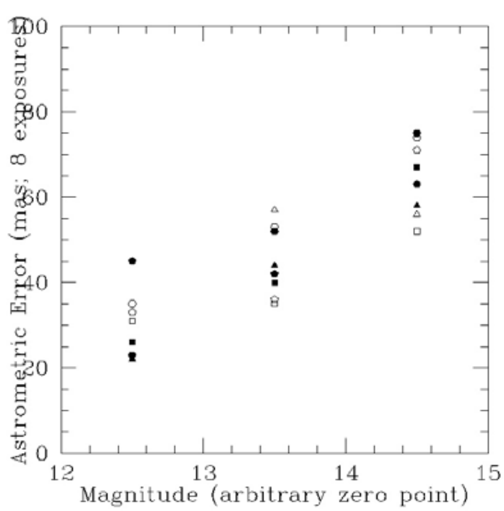

Figure 1

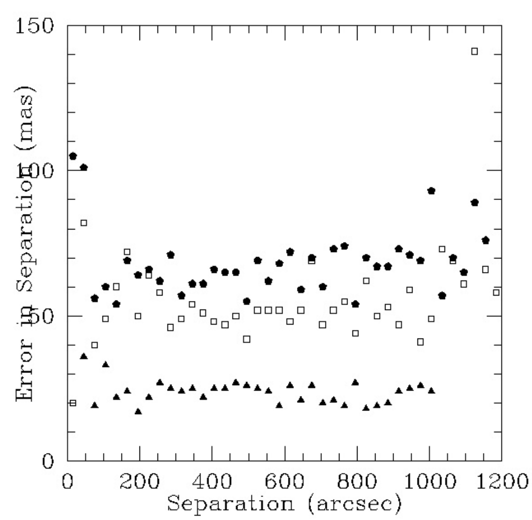

Figure 2

In a similar vein, the second question is whether the signature of the outer scale length of the seeing can be seen in the astrometric results. To test this, all possible pairs of measures from each image were found, and the mean and standard deviation over all images were computed. Figure 2 shows the error in measuring a separation as a function of the separation. The filled triangles are for 13th magnitude, the open squares are for 14th magnitude, and the filled pentagons are for 15th magnitude stars. Were seeing the dominant error source, we would expect to see a characteristic scale below which photon errors would dominate and above which we would see a constant error. Figure 2 shows no such break, and again the inference is that photon statistics dominate the astrometric error at all spatial scales that could be investigated.

2. CONCLUSIONS

Studies of the very first images taken by GPC1 on the PS1 telescope indicate that photon statistics dominate the astrometric error. This is not a surprise because the exposures were quite long (100 seconds) and because the status of the telescope optical alignment and collimation delivered images that were almost three times larger than is expected for PS1 survey conditions. These are preliminary conclusions, and the status of the optical alignment and collimation is being improved with every passing night. However, it is exciting to see real data and reductions coming starting to flow from the instrument. It is pleasure to acknowledge the tremendous efforts of the PS1 team, and these results would not have been possible without their skill and diligence.

3. REFERENCES

1. *http://pan-starrs.ifa.hawaii.edu/project/IPP/*
2. *http://terapix.iap.fr/rubrique.php?id_rubrique=91*