Studying on the Calibration Method for Chang'E-3 Pancam. X. Ren[1], J.J. Liu[1], F.L. Wu[1], F.F. Wang[1], X.X. Zhang[1] and C.L. Li[1], [1]National Astronomical Observatories, Chinese Academy of Sciences(20A Datun Road, Chaoyang District, Beijing, 10012, China, renx@nao.cas.cn).

Introduction: The Panoramic Camera system (Pancam) is a main payload carried on Chang'E-3(CE3) rover, including two cameras. These two cameras are mounted on the rover mast. The separation between the two cameras are defined as baseline, just like the interpupillary distance between human eyes, which will yield stereo images for scientific purposes[1]. The two cameras are toed-in relative to each other. Toe-in results in 100% image overlap at a distance from the camera proportional to the toe-in angle. The scientific goals of the Pancam investigation are to assess the high-resolution morphology and topography around rover at each explorational site. Pancam also provides mission support measurements for CE3 rover, including digital terrain modeling(DEM) to help guide long-term rover traval route and high-resolution images to help guide the selection of in situ sampling targets. Pancam interior orientation elements including focal length, principal point location and the lens distortion correction coefficients, and the relative exterior orientation elements are important input parameters for image processing, such as image mosaic, image geometric correction and DEM generation, etc. This paper mainly studies how to calibrate these parameters[2].

Calibration Method: The test equipments include a calibration board, a total station and two test cameras. The calibration board(see Figure 1) is made of an aluminum board which has been treated closing to zero-stress state under different temperature conditions. The board is 1.0m height and 1.2m width. The calibration targets with 25×30 dots patterns are printed on the board. Each target dot has a crosshair at the central location, which will be used to measure its 3D coordinates by the total station. A Leica TCR1201 R400+ is used in the calibration experiments. Its angle accuracy is 1″ and ranging accuracy is 1mm+1.5ppm. The two test cameras are make up of two Canon 5D Mark II cameras. They have been reinforced, so that its interior orientation elements and relative exterior orientation elements cannot change during the experiments. The cameras will be used to determine the Pancam calibration scheme.

We have investigated the effect of different distance, camera poses, target poses, target image coverages in the camera scene and camera models[3]. Finally, we have come up with a suited calibration scheme for CE3 Pancam. Total 24 stations will be set up at different distance(3m, 4m, 5m, 6m, 7m, 8m, 9m and 10m) away from the Pancam. Each distance has three stations(left, middle and right), the middle station is against the Pancam. Four calibration board poses(being rotated four times) will be placed at each station. About 96 image pairs will be captured in the calibration experiments, and each image covers the camera center central as possible. 2D coordinates of target dots will be determined by image feature extraction. These data will be treated as observations, and their corresponding 3D coordinates will be used as control conditions. The coplanarity condition equation[2], camera modal and baseline constraint equation will be introduced, and error equations will be formed. Then the least squares theory will be used to resolve Pancam parameters, i.e. interior orientation elements and relative exterior orientation elements.

Summary and Conclusions: We use an aluminum calibration board, a total station and two test cameras as the experimental equipments. We have created a suited calibration scheme for CE3 Pancam by comparison of the effect of different distance, camera poses, target poses, target image coverages and camera models. The Precision analysis[2] results show that the calibration errors are less than 0.5 pixels.

References: [1] Bell III J.F. et al. (2003) *JGR, 108*, E12, 8063, doi:10.1029/2003JE002070. [2] Wang, Z.Z. (1990) Principles of Photogrammetry, Press of Wuhan Technical University of Surveying and Mapping, Publishing House of Surveying and Mapping, Beijing, 575 pages. [3] Kim W.S. et al(2004) *JPL D-27015*.

Acknowledgments: We wish to thank all members corresponding to this study from the Ground Research & Application System (GRAS), Xi'an Institute of Optics and Precision Mechanics of CAS (XIOPM) and Beijing Geo-Vision Tech.Co.,Ltd. Their joint efforts have made our study possible.

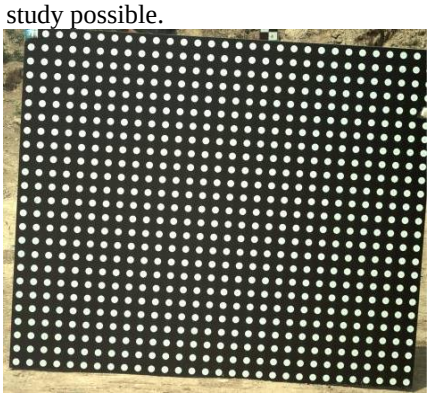

Figure 1 Calibration Board