Electron Multiplying CCD Camera Performance Tests

D. Lewová¹, M. Němec¹, I. Procházka¹, K. Hamat¹, G. Kirchner², F. Koidl², D. Kucharski³, Yang Fumin⁴

1. Czech Technical University in Prague, Brehova 7, 115 19 Prague 1, Czech Republic,
2. Graz Observatory, Austrian Academy of Sciences, Austria
3. Space Research Centre, Polish Academy of Sciences, Poland
4. Shanghai Observatory, Chinese Academy of Science, China

Contact: lew.dana@gmail.com , nemecm1@troja.fjfi.cvut.cz

Abstract

For satellite laser ranging, TV guiding is widely used to point the laser beam on the satellite. The ISIT (Intensified Silicon-Intensifier Target) camera has been applied in last years for its high sensitivity, which enabled to track all satellites of interest. However, there is a strict limitation to use it for daylight observation. The new type of CCD camera Electron Multiplying CCD (EMCCD) provides high sensitivity for short integration time required for fast real time tracking while maintaining the high ruggedness for daylight tracking. An additional internal gain reaches a factor up to 200 in comparison with regular CCD. During our tests in Graz and Shanghai, we did demonstrate the ability for satellite laser ranging during the daylight and during the night time exploiting the higher sensitivity, as well. The test results and a comparison with ISIT technology will be presented.
EMCCD Camera Performance Tests

EMCCD Images of GPS, Etalon 2, Glonass and Lageos 2
illuminated by Sun only

Digital output – no enhancement
(Images are captured with the same EMCCD settings and inverted)

For more details see the following Poster.
Electron Multiplying CCD Camera Performance Tests

D. Lewowa, M. Němec, I. Frocházková, K. Hamal (1)
G. Kirchner, F. Kniill (2)
Yang Fumin (3), D. Kucharski (4)

(1) Czech Technical University in Prague, Czech Republic
(2) Satellite Laser Station Graz, Austrian Academy of Sciences, Austria
(3) Chinese Academy of Sciences, Shanghai, China
(4) Space Research Centre, Polish Academy of Sciences, Poland

For satellite laser ranging, TV guiding is widely used to point the laser beam on the satellite. The ISIT (Intensified Silicon-Intensifier Target) camera has been applied in last years for its high sensitivity, which enabled to track all satellites of interest. However, there is a strict limitation to use it for daylight observation. The new type of CCD camera Electron Multiplying CCD (EMCCD) provides high sensitivity for short integration time required for fast real time tracking while maintaining the high ruggedness for daylight tracking. An additional internal gain reaches a factor up to 250 in comparison with regular CCD. During our tests in Graz and Shanghai we did demonstrate the ability for satellite laser ranging during the daylight and during the night time while exploiting the higher sensitivity as well. The test results and a comparison with ISIT technology will be presented.

Andor Luca DL688 (monochrome):
- Active Pixels (full well pixel 2 x 2): 1024 x 2048
- Image Area (mm): 49 x 49
- Camera sensor: 500 x 500
- Pitch: 2μm
- Minimum Gain (CCD): 200
- Maximum Gain (CCD): 1000
- Gating off (optional)
- Gating on (optional)
- Frame Rate: 1000fps
- Frame Buffer: 5K

EMCCD Camera Tests:
- Shanghai Observatory
- Grund Observatory
- Camera Type: T4-45, 1/2.4, 965 mm, C-mount
- 250x250, additional HD with 3x1, 3 pieces
- Auto LED: 1W, 350nm, 5000K, 3000K
- Software: Andor Ilio, Novalab, Firewire, 5.8.6, 2.6.8
- EMCCD Gain vs. settings/ripple

ISIT vs. EMCCD Comparison

Data Mining - HW
Detection scheme
- Pre-amplification
- Noise Reduction
- SNR Calculation

PC - Software methods
Methods for 3D/4D/cubing
- Gating (time - 30 integration time = 20 in space)
- Spatial Exposure - summation of frames
- Averaging (space - time)
- Flatten - intensity levels calibration
- Background - subtracting frame without object
- Median filter
- Visualisation
- Methods for better visibility of objects in real time
- Identifying - image histogram
- Averaging of centroid and weight
- Gaussian selection
- Color balancing
- Frequency mapping

During tests in Graz and Shanghai we did demonstrate the ability for satellite laser ranging during the daylight and during the night time while exploiting the higher sensitivity.

15th International Workshop on Laser Ranging, Canberra, Australia, 15-20 October, 2006