High Speed Photometry and Scintillation

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Motivation

- High Time Resolution Observations of Transient & High Cadence Events
- Scintillation minimization

Scaled up design to 2.4-m
Theoretical diffraction light curves for lunar occultation of three different binary systems.
Hubble Optics UL20 30fps video capture with VTI
mu Gem Lunar Occ. 1314Mar11

16.5 mas fit (red)  0.1 mas fit (red)

Media, PA  C8, Luca-S at 333fps, unfiltered, LiMovie

Scintillation limited SNR!
FPS (speed) - Pi Sgr at Villanova, 1011Aug11

- Villanova C8, 164CEX-2 CCD, no filter, 30fps
- 9.4mas per datum

- Gravic C8, Andor Luca-S emCCD, Sloan r filter, 120fps
- 2.4 mas per datum
- Again Scintillation limited SNR
Young 1967 on Scintillation

\[ S = \frac{I_{rms}}{I_{DC}} = S_0 d^{-2/3} X^{3/2} e^{-h/h_0} (\Delta f)^{1/2} \]

where \( S_0 \) is 0.05 if aperture \( d \) is in inches, \( X \) is the air mass, scale height \( h_0 \sim 8000 \text{m} \)

Young, A. 1967, AJ 72, 6
Scintillation SNR Theory

- Limit Scintillation imposes on SNR vs. aperture

30-fps, two elevations, 1.2 airmass, 20-mag./sq.as.
SNR Theory for 14” f/4 SCT

- SNR for four cameras vs object mag.

- 30-fps, 100-m elevation, 1.2 airmass, Sky: 20th mag./sq.as.

- Each magnitude fainter worked is about 300% more targets (2.5 mag. is ~30x more)

Scintillation limits photometric SNR for bright objects
Array Scintillation Noise Reduction

Only scintillation per Young (1967) counted in noise.
Desired Capabilities for HTRA Capture Software

- Ability to drive multiple cameras for an array
- Full emCCD camera feature control
- Live-view of the star while recording
- Ability to record for long periods with precise timing and no data loss
- Recover gracefully from equipment failures
Triggering

- Two solutions developed
- Arduino-based
- Camera clock-based
User interface

Main camera control

Live View
164CEX-2 & emCCD capturing LED blinking with 1pps GPS signal,
Photometrics Cascade 128 emCCD capturing LED blinking with 1pps GPS signal at 200fps, Tangra light curve with timings also captured.
Some Results - Hohenstenia

- Hohenstenia (12.8-mag.) on left & TYC5083-00898-1 (10.7-mag.) on right. Occultation miss 2014-07-0708 512B emCCD 250ms 12” LX200

- Tangra 3 Light curve made from 128x128 RoI video @ 96fps. We covered the aperture twice at start, clouds came in later.
Contact and further information

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