Pocket Pumped Image Analysis

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CCD Readout Architecture Terms

- **Image area (exposed to light)**
- **Parallel (vertical) registers**
- **Pixel**
- **Serial (horizontal) register**
- **Output amplifier**

Charge motion
POCKET PUMPED IMAGE, ds9 viewer
Trap identification. Amplitude distribution.
Leveling the field (Base Line subtraction)
Trap identification. Amplitude distribution

![Amplitude distribution graphs for different channels](image_url)
Trap identification. Amplitude-Amplitude plot

- Number of pixels
- Amplitude, a.u.

Cut amp_1
Cut both amp

Amplitude i+1, a.d.u.
Amplitude i, a.d.u.
Trap identification. Amplitude-Amplitude plot
Trap identification. Correlator

\[ C_2 = \frac{amp_i}{\sigma} \ast \frac{amp_{i+1}}{\sigma} \]

the parabolic shape is expected for amplitude dependence since amount of charge lost in one pixel is equal to amount of charge gained by another pixel and \( C_2 \sim \text{amp}^2 \)
Trap count

- Correlator vs amp, ch 12
- Cutted Correlator vs amp, ch 12
- Amp-BL Histogram ch 12, C2 cut
- Trap numbers ch[12]
Trap count
Trap catalog
Trap identification technique has been developed. This technique works on pocket pumped images.

- traps can be counted in individual columns, rows etc
- trap location can be reported as well, for example, trap catalog can be generated
Back up slides
Transformations

The selection of trap bands in the amplitude scatter plot can be simplified using coordinate system transformation. The useful transformation is rotation by 45 degree.

\[
A_+ = \frac{amp_i + amp_{i+1}}{\sqrt{2}}
\]

\[
A_- = \frac{amp_{i+1} - amp_i}{\sqrt{2}}
\]
Transformations
CCD Phased Clocking: Step 1

Time-slice shown in diagram

φ1
φ2
φ3
CCD Phased Clocking: Step 2

φ1
φ2
φ3

φ2
φ1
φ3

+5V
0V
-5V
+5V
0V
-5V
+5V
0V
-5V
CCD Phased Clocking: Step 3

Diagram showing the clocking phases φ1, φ2, and φ3 with voltage levels +5V, 0V, and -5V.
**Charge Transfer Efficiency**

**CTE** = Charge Transfer Efficiency (typically 0.9999 to 0.999999)
= fraction of electrons transferred from one pixel to the next

**CTI** = Charge Transfer Inefficiency = 1 – CTE (typically $10^{-6}$ to $10^{-4}$)
= fraction of electrons deferred by one pixel or more

*Cause of CTI:*
charges are trapped (and later released) by defects in the silicon crystal lattice

CTE of 0.99999 used to be thought of as pretty good but ....

Think of a 2K x 0.5K CCD segment
The Wallet Card

- Three Mirror Anastigmat (TMA) optical design.
  - 8.4 meter primary, 6.5 meter effective aperture
  - 3.4 meter diameter secondary
  - 5 m tertiary is being fabricated in same substrate as primary mirror
  - three-element refractive corrector
  - f/1.2 beam delivered to camera
  - 9.6 square degree field (on science imaging pixels)
  - optics deliver < 0.2 arcsec FWHM spot diagram,
  - 6 filters: ugrizy: 320 nm to 1050 nm (UV atmospheric cutoff to Si bandgap)

- 3.0 Gpixel camera
  - 10 micron pixels, 0.2 arcsec/pixel
  - Deep depletion (100 μm), high-resistivity CCDs for NIR response
  - Dual 15 second exposures (to avoid trailing of solar system objects)
    - 2 second readout (trade between noise and imaging efficiency)
    - 550 kpix/sec through 16 amps/CCD x 189 CCDs = 3024 channels
    - 12 GBytes per image (as floating point numbers), 20 TBytes/night.

- Real-time frame subtraction for time domain alerts, ~850 visits for each patch of sky, allows co-adds to r ~ 27 (AB), over 18,000 square degrees.
Camera

- 3.2 Gigapixels
- 0.2 arcsec pixels
- 9.6 square degree FOV
- 2 second readout
- 6 filters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Diameter</td>
<td>1.65 m</td>
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<tr>
<td>Length</td>
<td>3.7 m</td>
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<tr>
<td>Weight</td>
<td>3000 kg</td>
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<tr>
<td>F.P. Diam</td>
<td>634 mm</td>
</tr>
</tbody>
</table>
Primary/Tertiary in Fabrication, completion in 2014