New Horizons: MVIC Raw and Calibrated Data

Michael S. P. Kelley, UMD

PDS Data Review

Dec 2014

Multispectral Visible Imaging Camera

MVIC detectors share the Ralph instrument with LEISA.

Consists of 7 separate CCD arrays:

- Blue = 490 nm
- Red = 610 nm
- NIR = 850 nm
- CH4 = 890 nm
- 3 CCDs are unfiltered

Primary data products consist of 2D (spatial-spatial) or 3D (spatial-spatial-temporal) arrays.

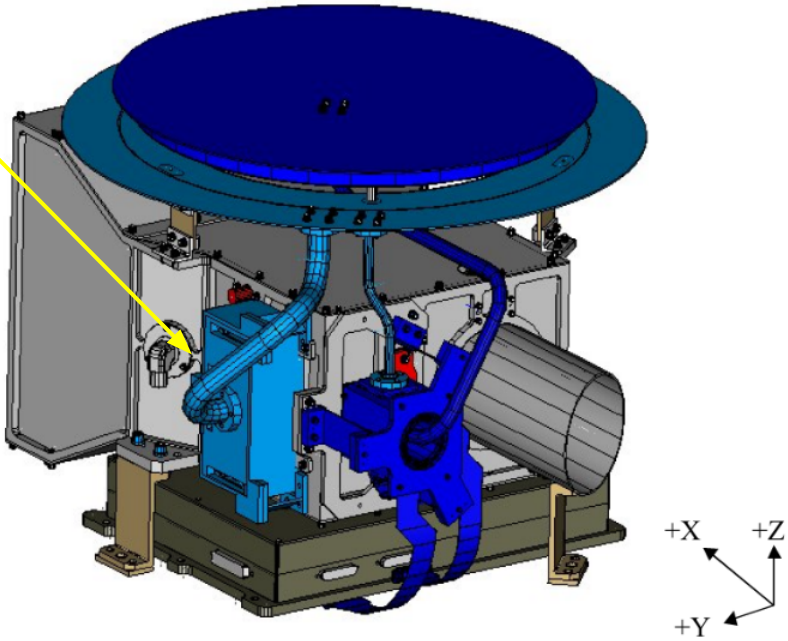


Figure 10-1:A model of Ralph in the spacecraft coordinate system. The Ralph aperture points in the –X direction, the normal to the radiator is in the + Z direction and the SIA points in the + Y direction.

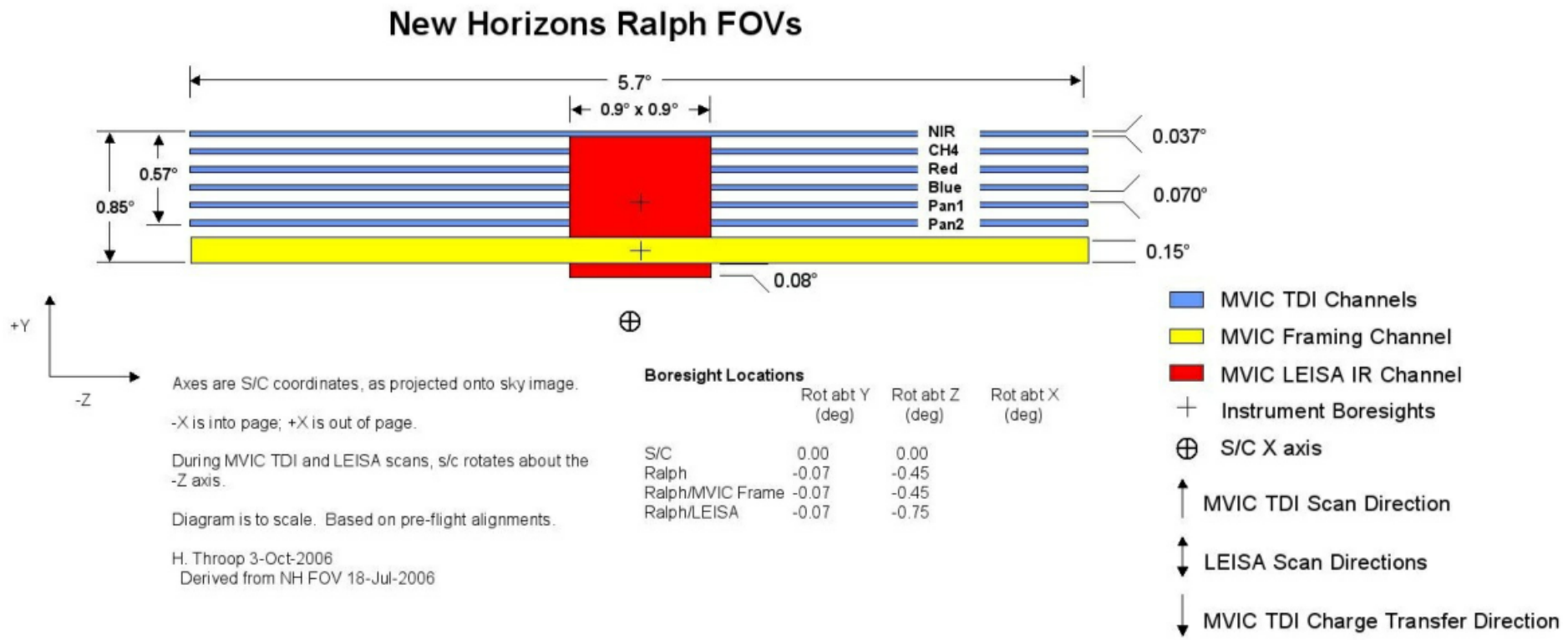


Figure 10-2: RALPH Fields-of-view

The Framing Channel is 5024x128 pixels: multiple images are taken during a scan and saved as a time series.

Time-delay integration (TDI) CCDs are 5024x32 pixels: as the spacecraft scans, charge is shifted row to row at the same rate angular rate resulting in a 2D image of arbitrary length.

Launch → Jupiter → Pluto Cruise

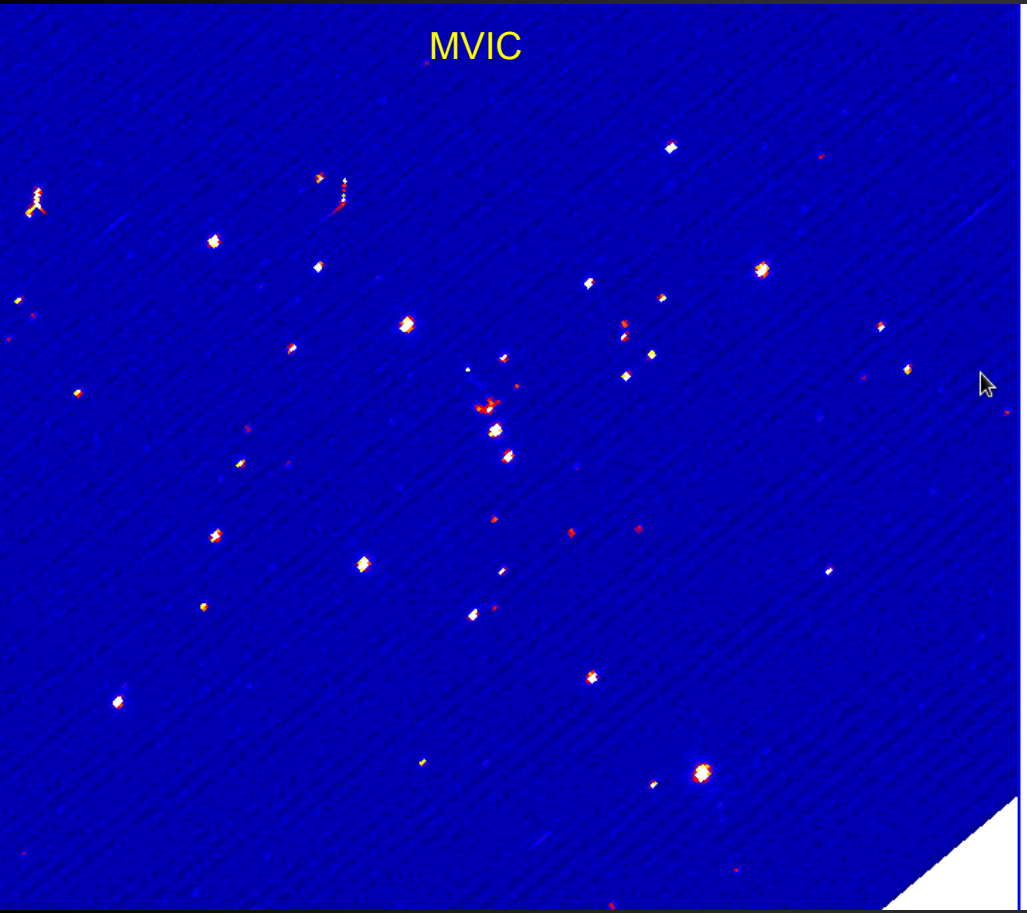
Data from mid-2007 to mid-2014.

- Spacecraft and instrument checkouts,
- science,
- calibration,
- encounter rehearsals.

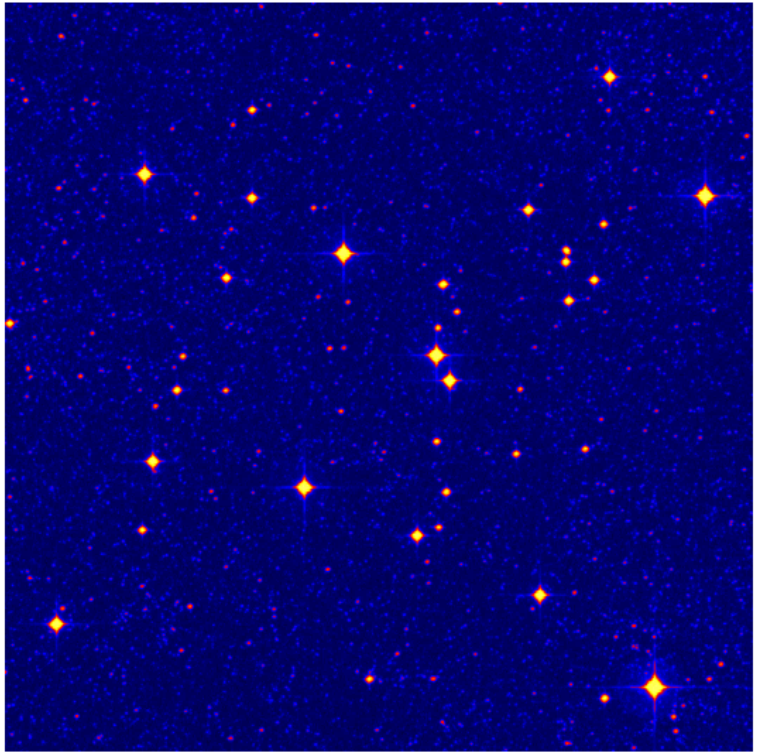
I primarily focused on calibration data of open clusters M6 & M7.

Open cluster M7

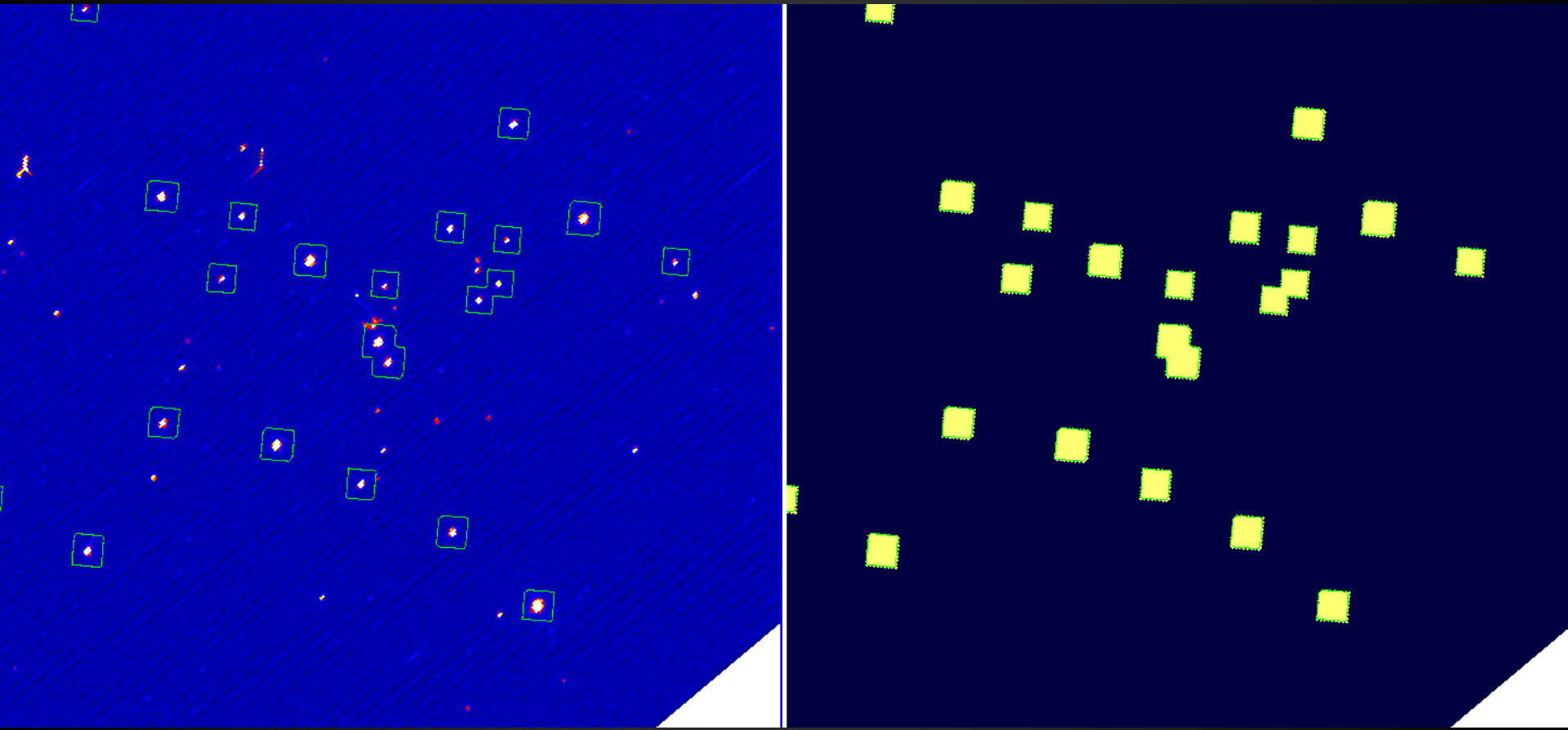
MVIC

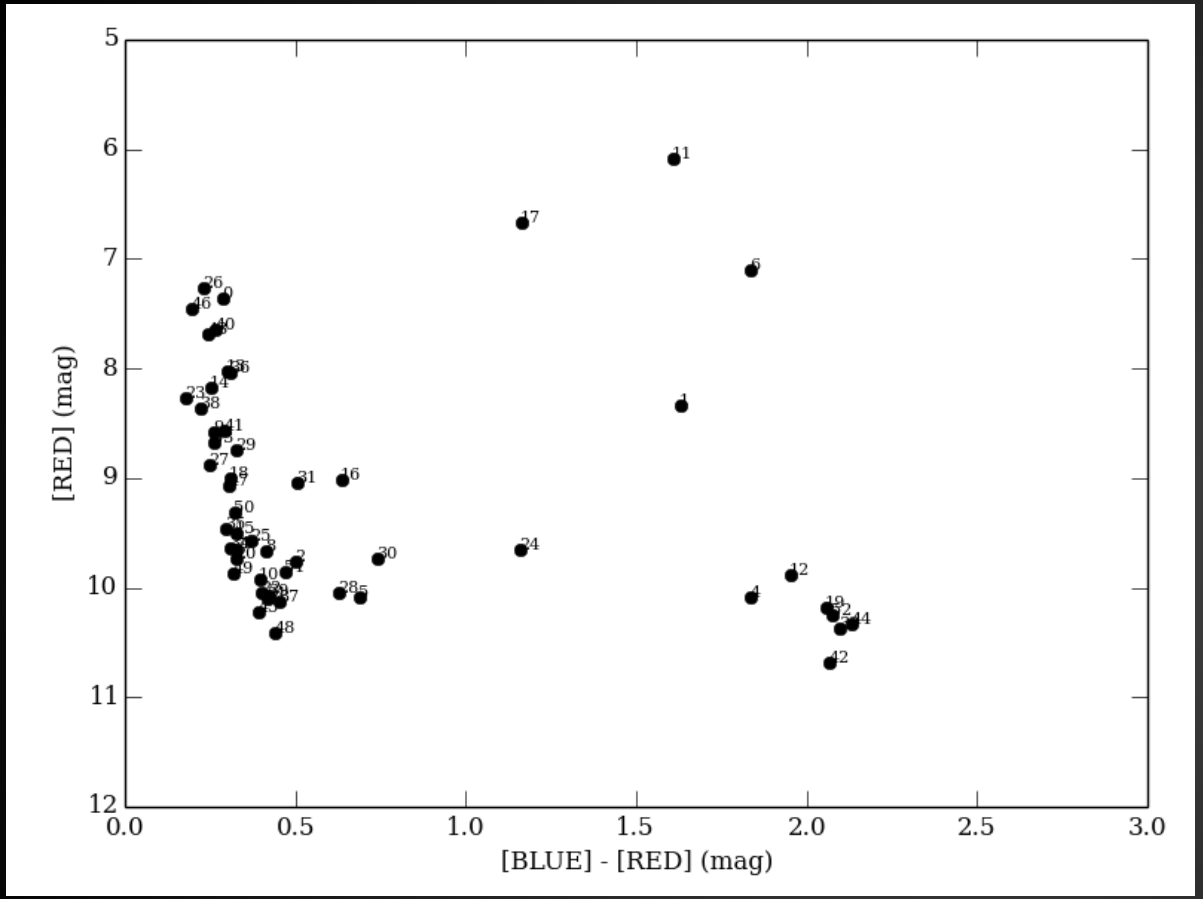


Digital Sky Survey



Stars used for photometry (also other stars in image). Aperture is 4-pix radius centered on peak.





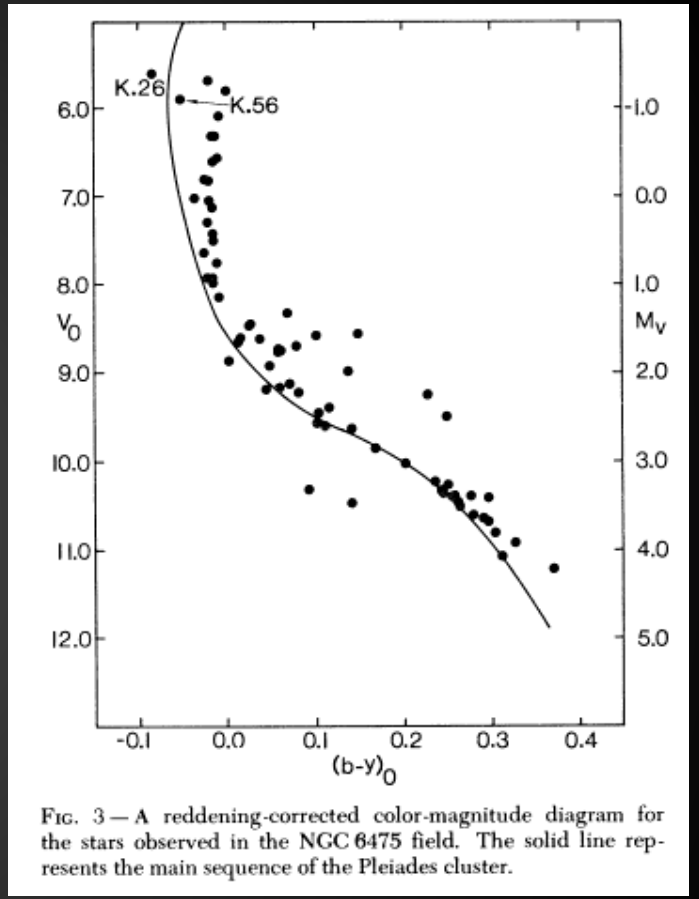


FIG. 3 — A reddening-corrected color-magnitude diagram for the stars observed in the NGC 6475 field. The solid line represents the main sequence of the Pleiades cluster.

Color-magnitude diagrams of M7 & M6 from NH/MVIC and of M7 from Snowden 1975. Main sequence pops out as expected. Very rough reduction and photometry, so I'm not concerned about the faint red clump.

Liens

According to MVIC Interface Control Document (ICD) and to dataset.cat, the science data is absolutely calibrated (radiance), and each file also contains an error array and an array of quality flags.

- The science arrays have only had the bias removed and flat field correction applied. The geometric correction and absolute calibration need to be applied, and descriptions in PDS labels updated.

- The PDS labels for the science data do not agree with the ICD description...

PDS Label for SCI (Level 3) data

This description is accurate for the data, but does not agree with ICD and dataset.cat.

```
OBJECT                          = IMAGE
  DESCRIPTION                   = "
    FITS PDU
      PDU

    Color TDI Image Lossless (CDH 1)
    - Bias-subtracted
    - Flattened
  "
 SAMPLE_BITS                     = 32
  SAMPLE_TYPE                     = "IEEE_REAL"
  AXIS_ORDER_TYPE                 = "FIRST_INDEX_FASTEST"
  LINE_DISPLAY_DIRECTION          = "UP"
  SAMPLE_DISPLAY_DIRECTION        = "RIGHT"
  LINE_SAMPLES                    = 5024
  LINES                           = 629
  OFFSET                          = 0.00000000000
  SCALING_FACTOR                  = 1.00000000000
```

PDS Label for SCI (Level 3) data

I am not sure what this object actually is, but it does not agree with the description.

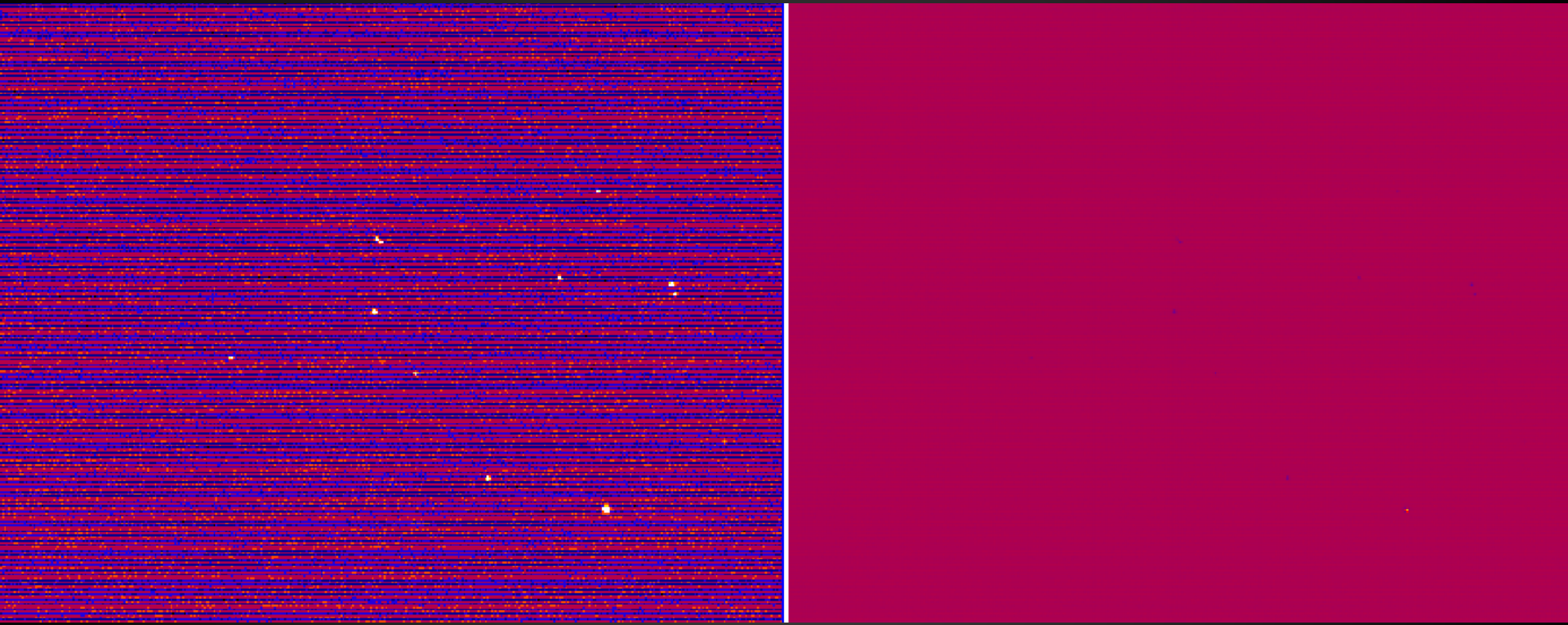
```
OBJECT                          = EXTENSION_CALGEOM_IMAGE
  DESCRIPTION                   = "
    FITS EDU number:  1
      UNNAMED FITS EXTENSION 1

    Color TDI Image Lossless (CDH 1)
    - Bias-subtracted
    - Flattened
    - Distortion removed
  "

 SAMPLE_BITS                     = 32
  SAMPLE_TYPE                    = "IEEE_REAL"
  AXIS_ORDER_TYPE                = "FIRST_INDEX_FASTEST"
  LINE_DISPLAY_DIRECTION         = "UP"
  SAMPLE_DISPLAY_DIRECTION       = "RIGHT"
  LINE_SAMPLES                   = 5024
  LINES                          = 629
END_OBJECT                      = EXTENSION_CALGEOM_IMAGE
```

First object (bias, flat)

Second object (?)



Background became smooth, stars became shallow holes in the background.

PDS Label for SCI (Level 3) data

This extension looks like a data quality array filled with zeros.

```
OBJECT                          = EXTENSION_ERROR_EST_IMAGE
  DESCRIPTION                   = "
    FITS EDU number:  2
      UNNAMED FITS EXTENSION 2

    Color TDI Image Lossless (CDH 1)
    - 1-sigma Error estimate per EDU 1 (CAL) pixels
  "
  SAMPLE_BITS                     = 16
  SAMPLE_TYPE                     = "MSB_INTEGER"
  AXIS_ORDER_TYPE                 = "FIRST_INDEX_FASTEST"
  LINE_DISPLAY_DIRECTION          = "UP"
  SAMPLE_DISPLAY_DIRECTION        = "RIGHT"
  LINE_SAMPLES                    = 5024
  LINES                           = 629
END_OBJECT                      = EXTENSION_ERROR_EST_IMAGE
```

Liens

- nhsc.cat: second ASCII art figure not rendering correctly?
- dataset.cat, line 140: Minor fix to a confusing sentence in dataset.cat.