IR Detector readout and controller options ?

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Detector Readout Schemes – H2RG and H4RG

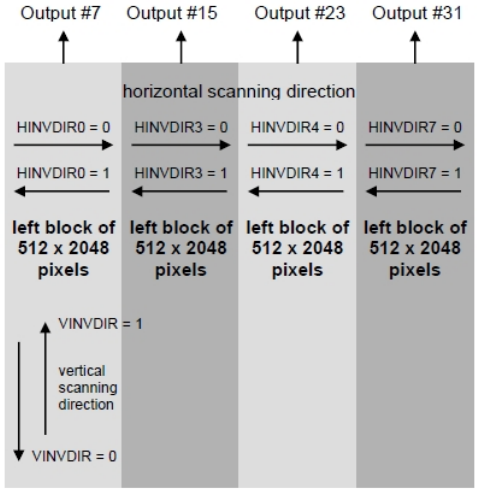


Figure 4-2: Illustration of the 4-output mode

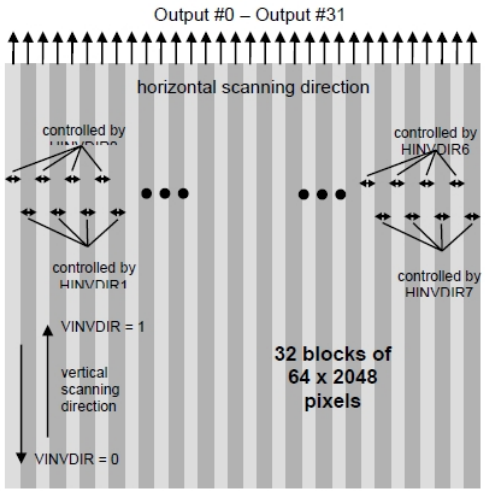
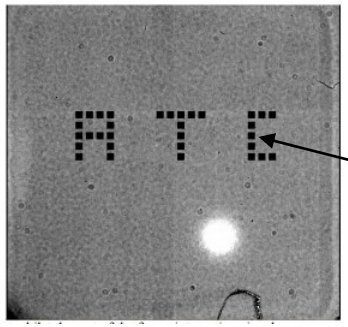


Figure 4-3: Illustration of the 32-output mode

H2RG

Frame rate
~ 1.5 s
(CDS ~3.0s)



Hardware window
? X ?, only 1 output

Software Window

4096 x ?

64 outputs

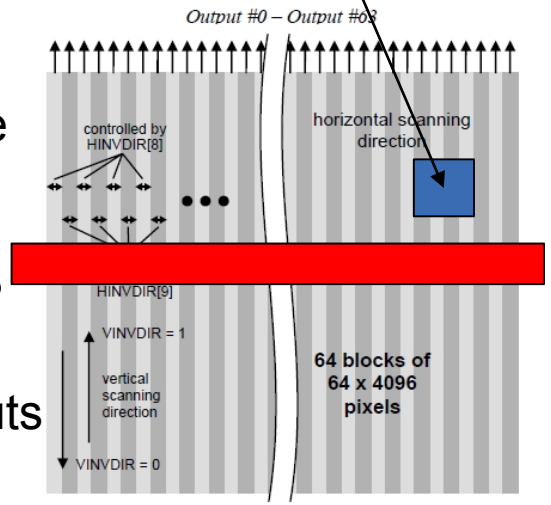


Figure 5-5: Illustration of the 64-output mode

Frame rate
~ 3.0 s
(CDS ~6.0s)

H4RG

AQUARIUS Readout directions

No hardware windowing
(but s/w windows possible)

Reads from centre up/down

Row Read Reset typical
(no CDS but available)

> 100 Hz frame rate

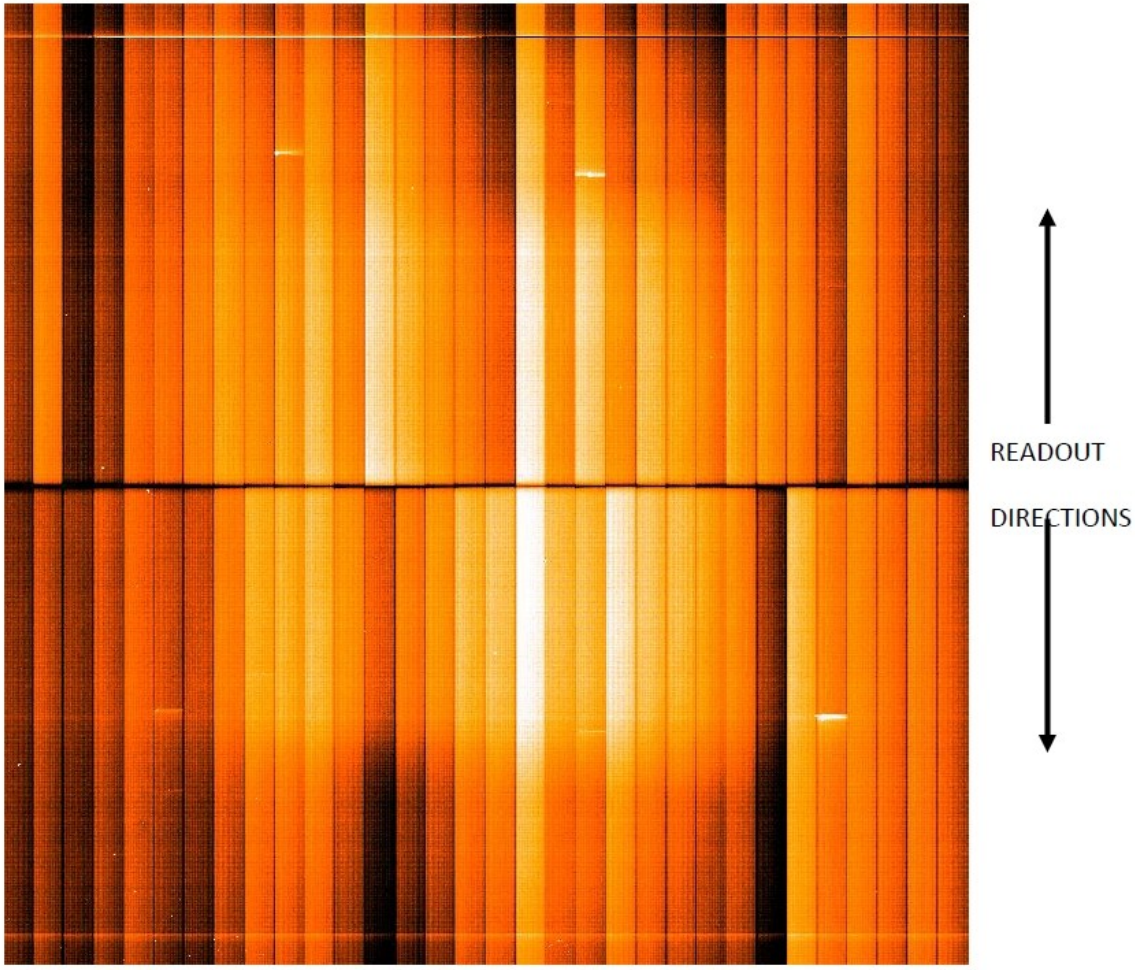
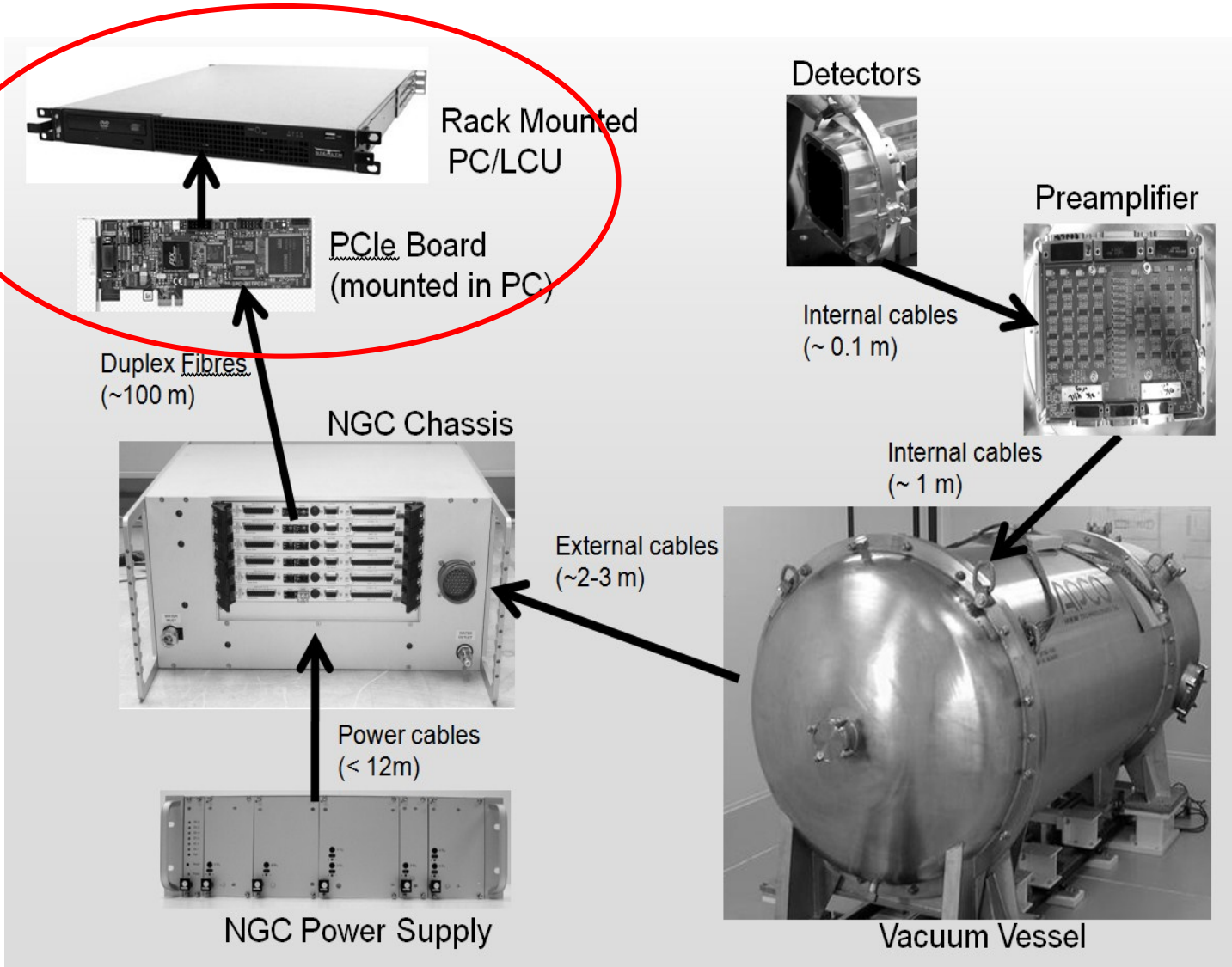


Figure 1 : AQUARIUS detector Rolling mode bias frame, this is FLT112, the VISIR Spectro detector.

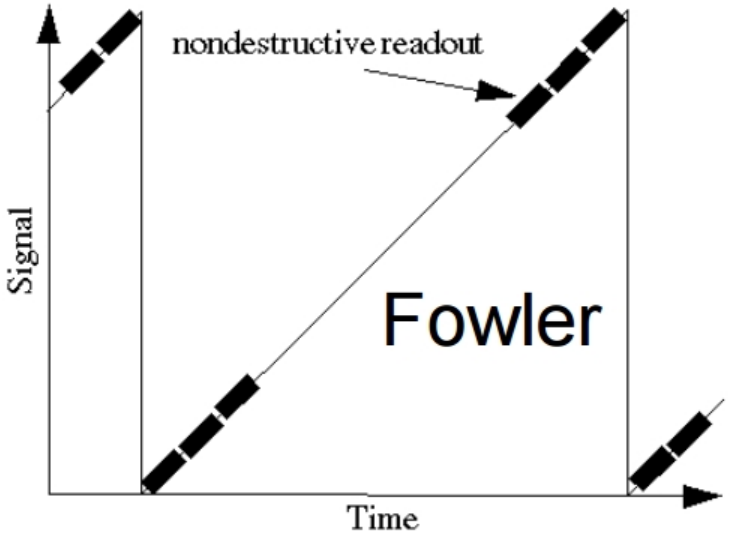
Typical Detector + Detector controller (NGC) configuration

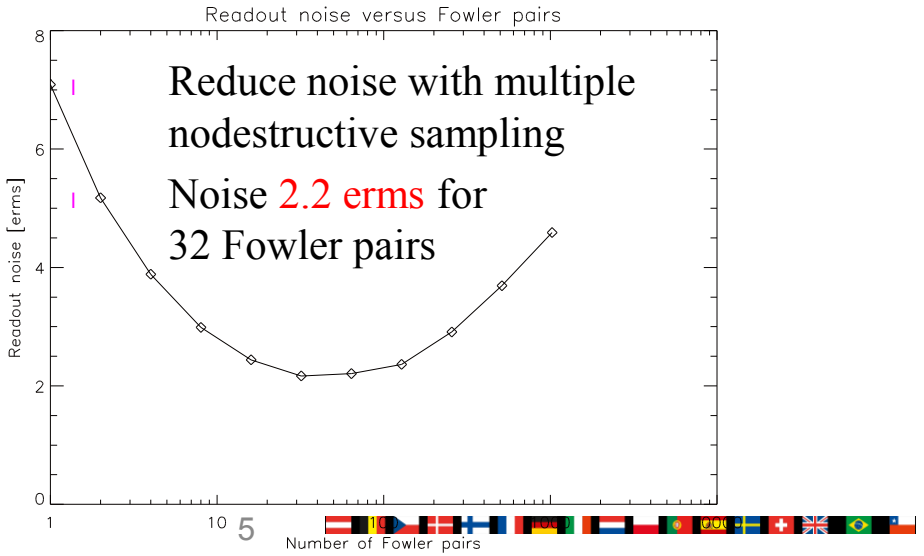


Typical supported readout modes

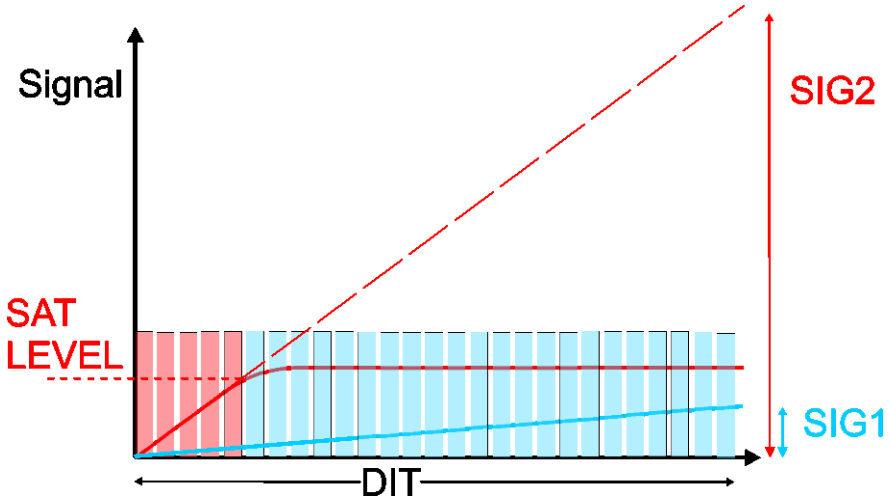
Typically NGC produces a final processed image, of the following type :-

- **SRR** – Single Reset Read, uncorrelated, comes with kTC noise for free !!!
- **CDS** – Correlated Double Sample, Frame Reset, Read (R1), Integrate, Read (R2) = R2 – R1
- **Fowler** – Reset, N Reads Co-added (NR1), Integrate, N Reads Co-added (NR2) = NR2 – NR1 (typically optimal noise achieved for 32-64 reads)





TLI – Threshold Limited Integration



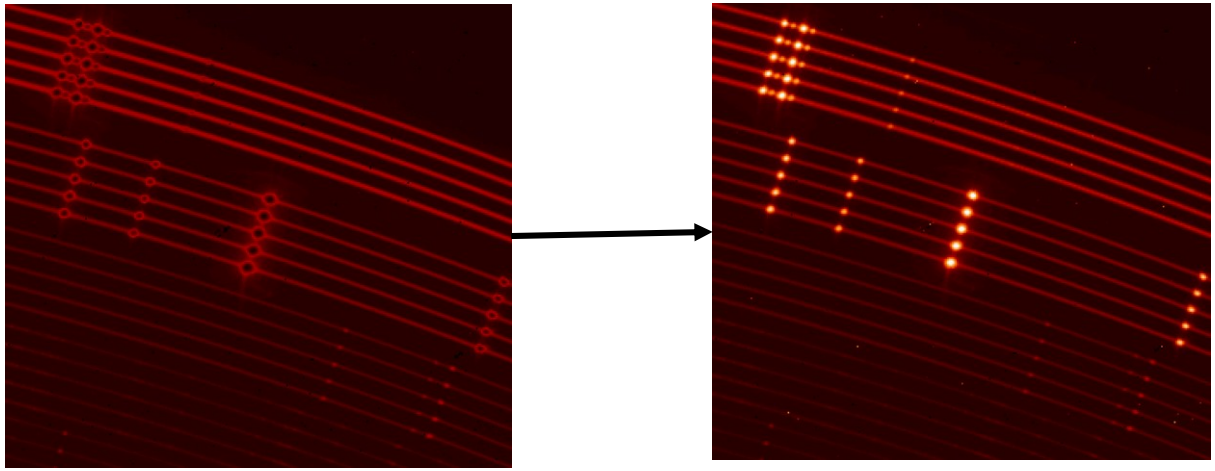
Read up the ramp

Set saturation Level

If Signal > Saturation Level then
Readout not used to calculate slope

Extrapolate signal to DIT

Gain > 2 orders of magnitude
in dynamic range



Reference pixel subtraction – H*RG

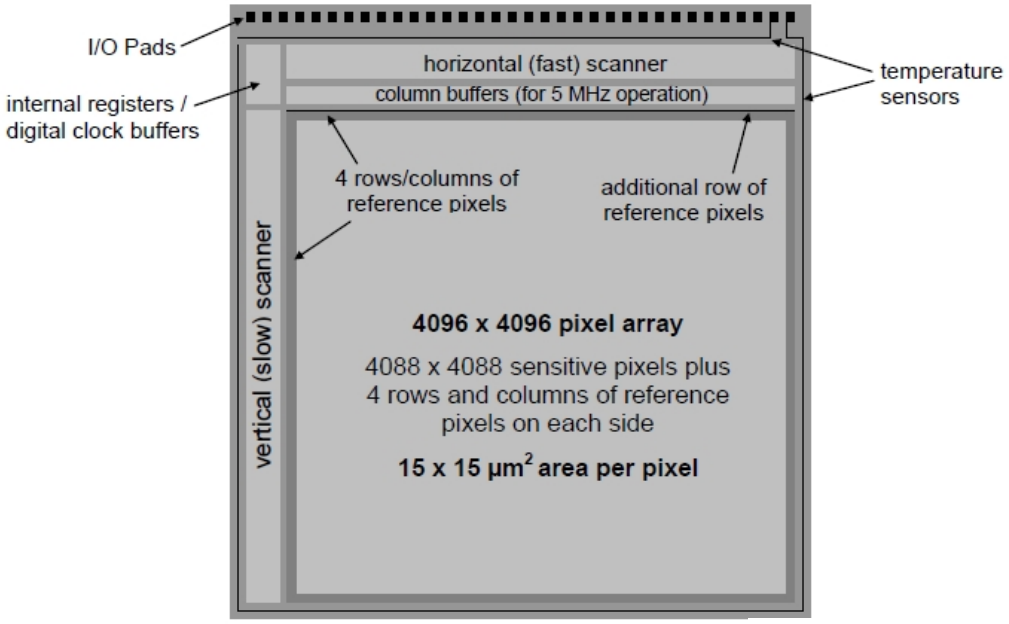
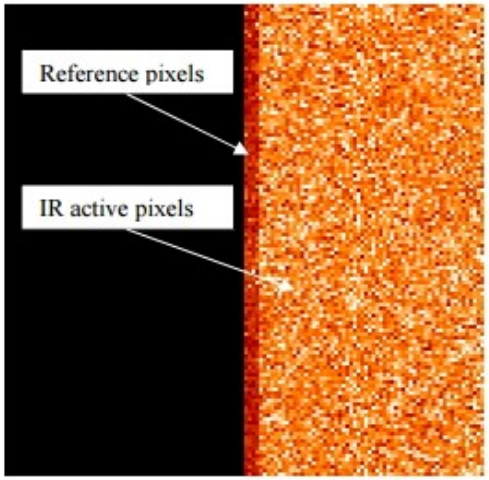


Figure 1-1: Block diagram of the H4RG



- Track bias or temperature drifts
- Contain a simple capacitor
- Upper and lower edges
- used to subtract offsets of the
- 32 video outputs.
- Left right for low frequency.

Many options already implemented

x	Algorithm of reference pixel subtraction
0	no reference pixel subtraction
1	median {left & right}
2	mean {left & right}
3	({median left} + {median right}) / 2
11,13,15,17,19	median left (1,3,5,7,9 rows)
21, 23, 25, 27, 29	median right (1,3,5,7,9 rows)
31, 33, 35, 37, 39	({median left} + {median right}) / 2 (1,3,5,7,9 rows)

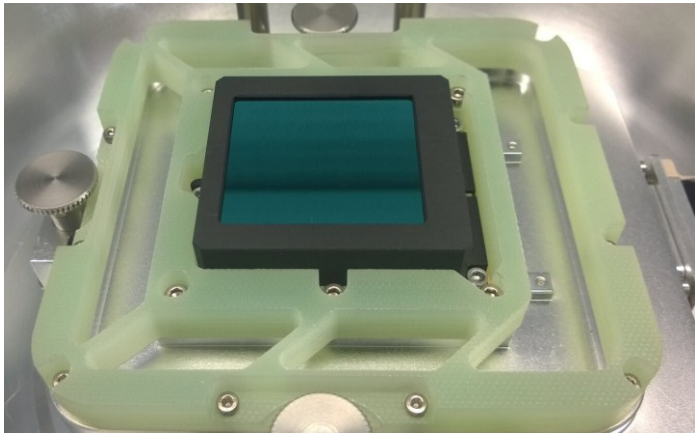
Table 1 algorithms of reference pixel subtraction which can be loaded by executing the command: acqproc 1 ngciracqH2RG4 -setup 0 -ref x.

Alternative – use mask to cover real pixels

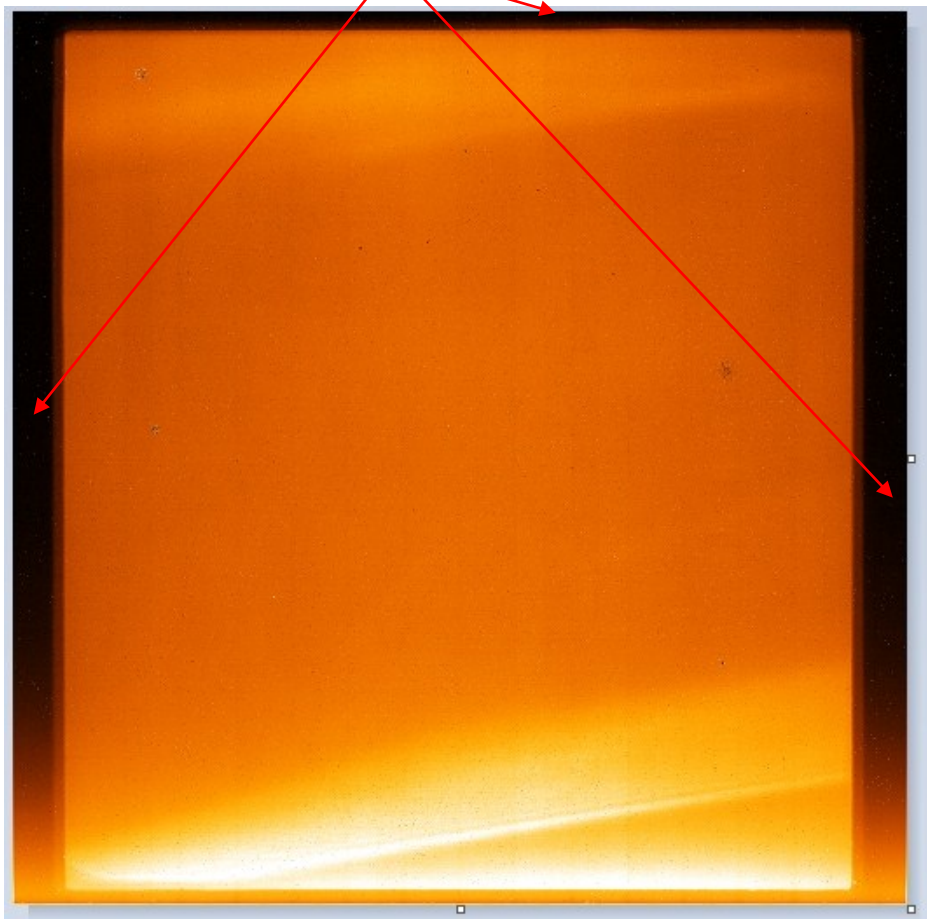
Not possible for mosaics

Mask sits ~ 400 um above detector surface

Real pixels used for corrections (CCD underscan like)

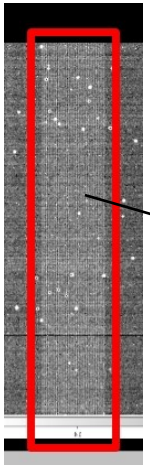


MATISSE masking

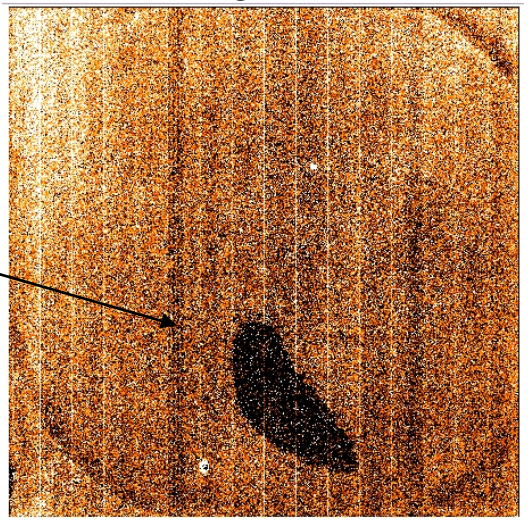


Issues to correct for ?

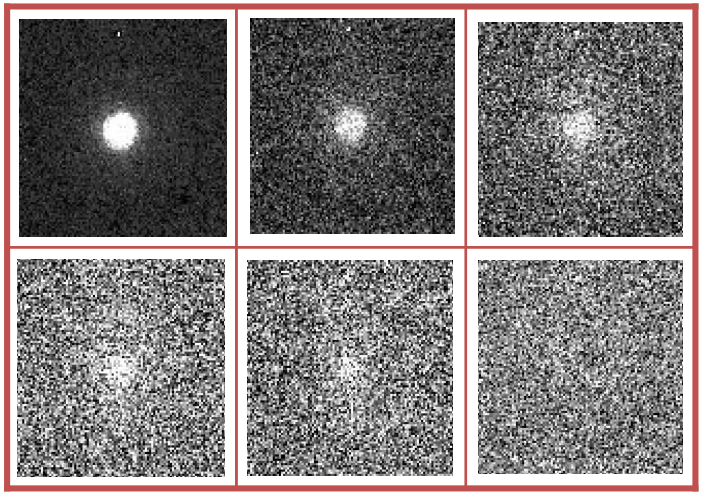
All - Odd/Even



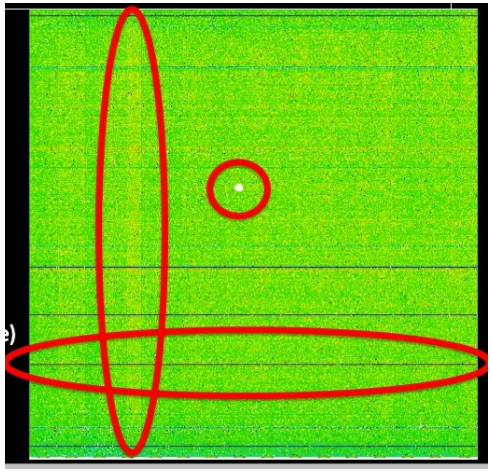
Dark



Persistence

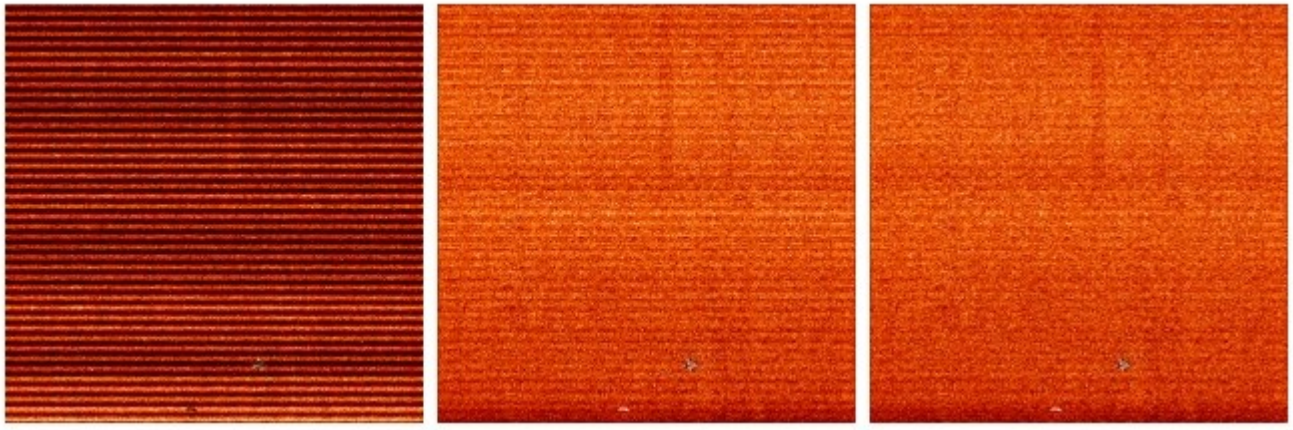


All - H/V structure



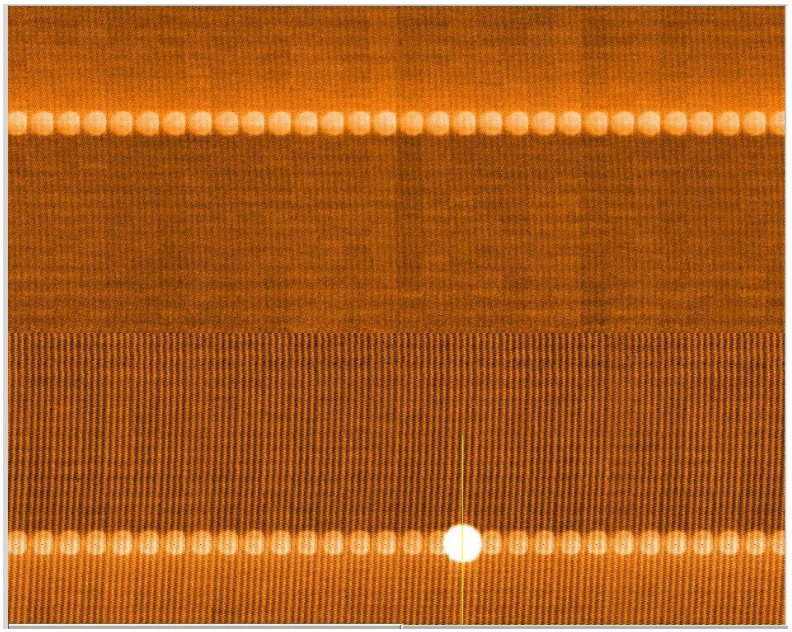
Hot pixels/areas

All - 50 Hz pickup – using different reference pixel subtraction



More issues to correct for ?

Cross talk between outputs



AQUARIUS ELFN

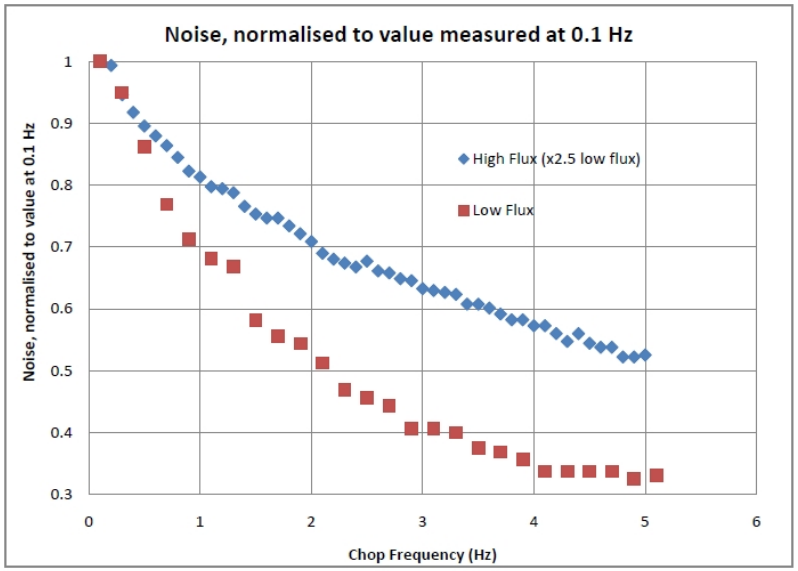
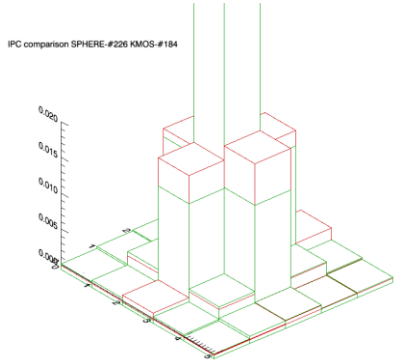
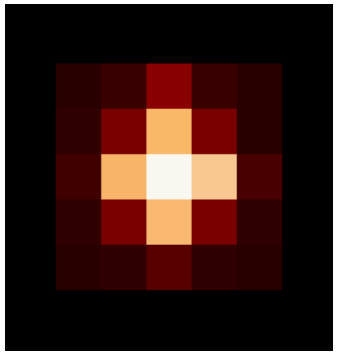
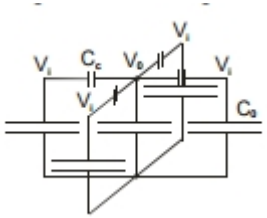


Figure 10 : Measured noise versus chop frequency for low flux (red, ~ 8k DN) and high flux (blue, ~ 28k DN) signal regimes, both datasets normalised to their respective noise values at 0.1 Hz

Capacitive coupling between pixels







Typically < 2% coupling

Other and what we don't do

Other readout modes possible :-

- With H*RG family then interleaved reseting and reading of windows
- With H*RG family then high speed to 2-5 MHz possible (x50 times faster)
- Different reset options, global, row etc.
- Synchronisation to external events for chopping, drift scanning ?

What we don't do :-

- Linearity correction
- Flat field subtraction
- Dark current subtraction
- Cross talk removal

Conclusions

- Raw delivery without processing possible !
- Data volume issues, e.g. (Fowler-32 would have x 64 raw frames) !
- Chopping, synchronization issues ?
- Other modes, drift scanning, chopping ?
- Raw data supply for secondary guiding or telescope vibration issues
- (implies new system configuration design) ?
- Early involvement so that new algorithms can be built into NGC ?