

# Fully differential signal path for the ZTF mosaic

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The Zwicky Transient Facility is a 4x4 mosaic of 6K\*6K CCDs under construction for the 1.2m Palomar Oschin Schmidt Telescope, to survey 80 square degrees per minute at 1 arcsec per pixel.

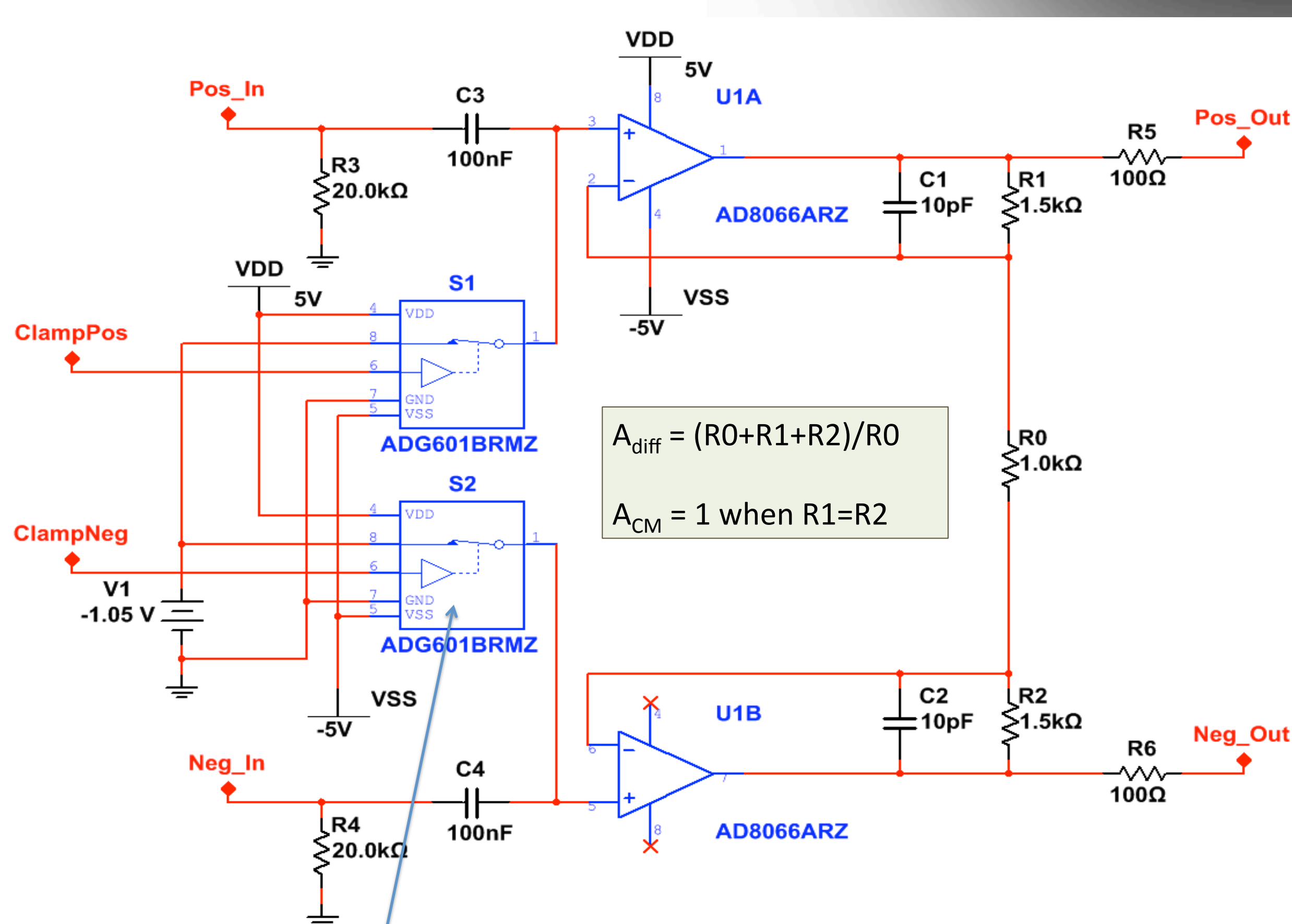
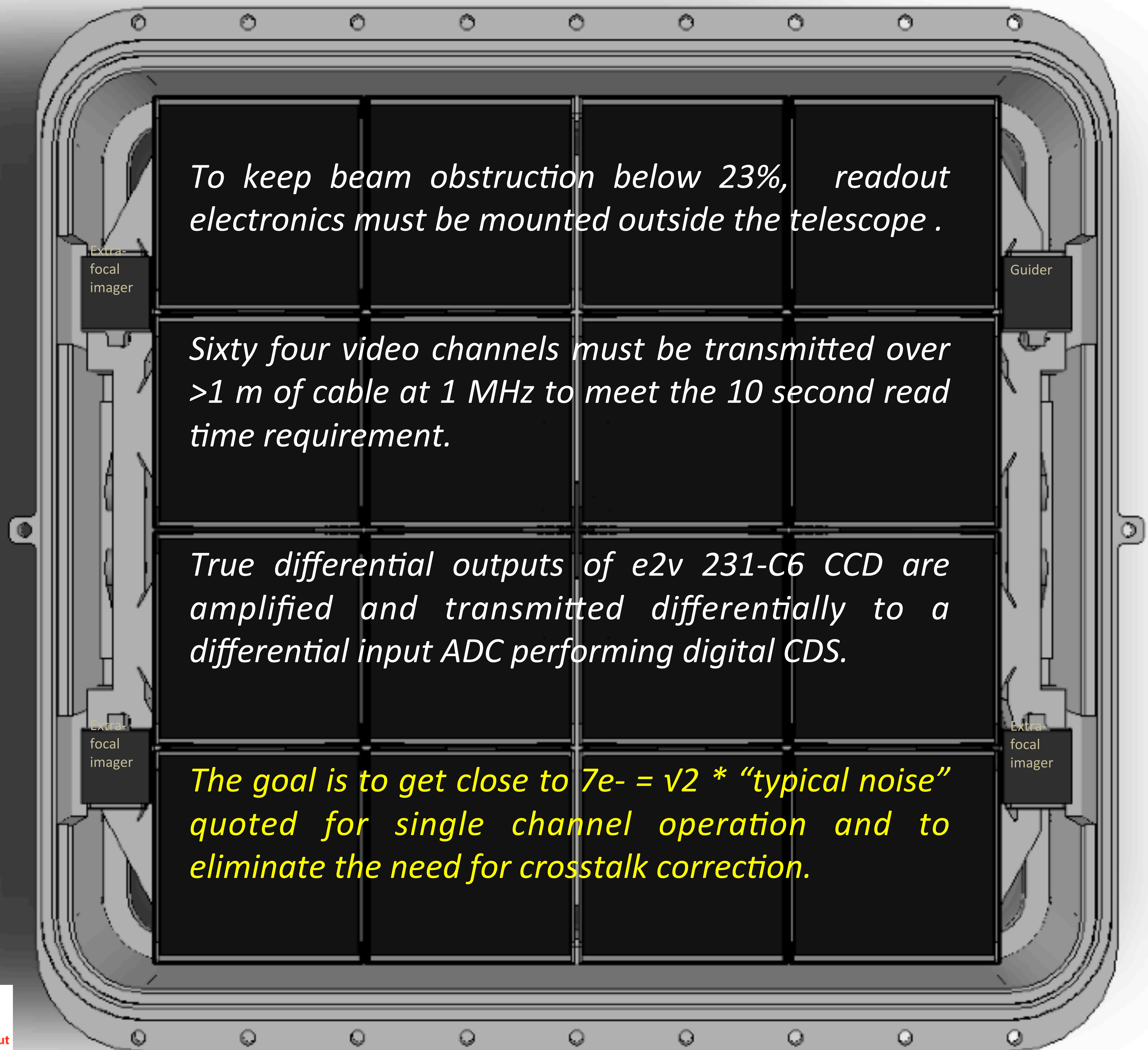
Life size →

## PROS OF DIFFERENTIAL

- Video cross talk reduced  
→ negligible ?
- Less susceptible to interference.
- These become common mode errors which are rejected:
  - Bias noise
  - Ground differentials
  - Reset feedthrough
  - Clock feedthrough
  - Clamp control signal feedthrough.
  - AC coupler drift  
→ clamp once per line.

## CONS

- CCD noise is incurred twice.
- CCD output power is doubled.



AD8066:

- Output swing to 50mV of rail for  $I_0 = 30 \text{ mA}$
- GBW = 146MHz
- $e_n = 7 \text{ nV}/\sqrt{\text{Hz}}$
- $I_B = \pm 1 \text{ pA}$
- $P_D = 132 \text{ mW}$  per ch
- Conductively cooled via ground and supply planes

ADG601:

- $I_L = \pm 10 \text{ pA}$
- $R_{on} = 2.5 \text{ ohm}$

Signal chain increases 50nV/√Hz differential CCD noise by ~ 4%.

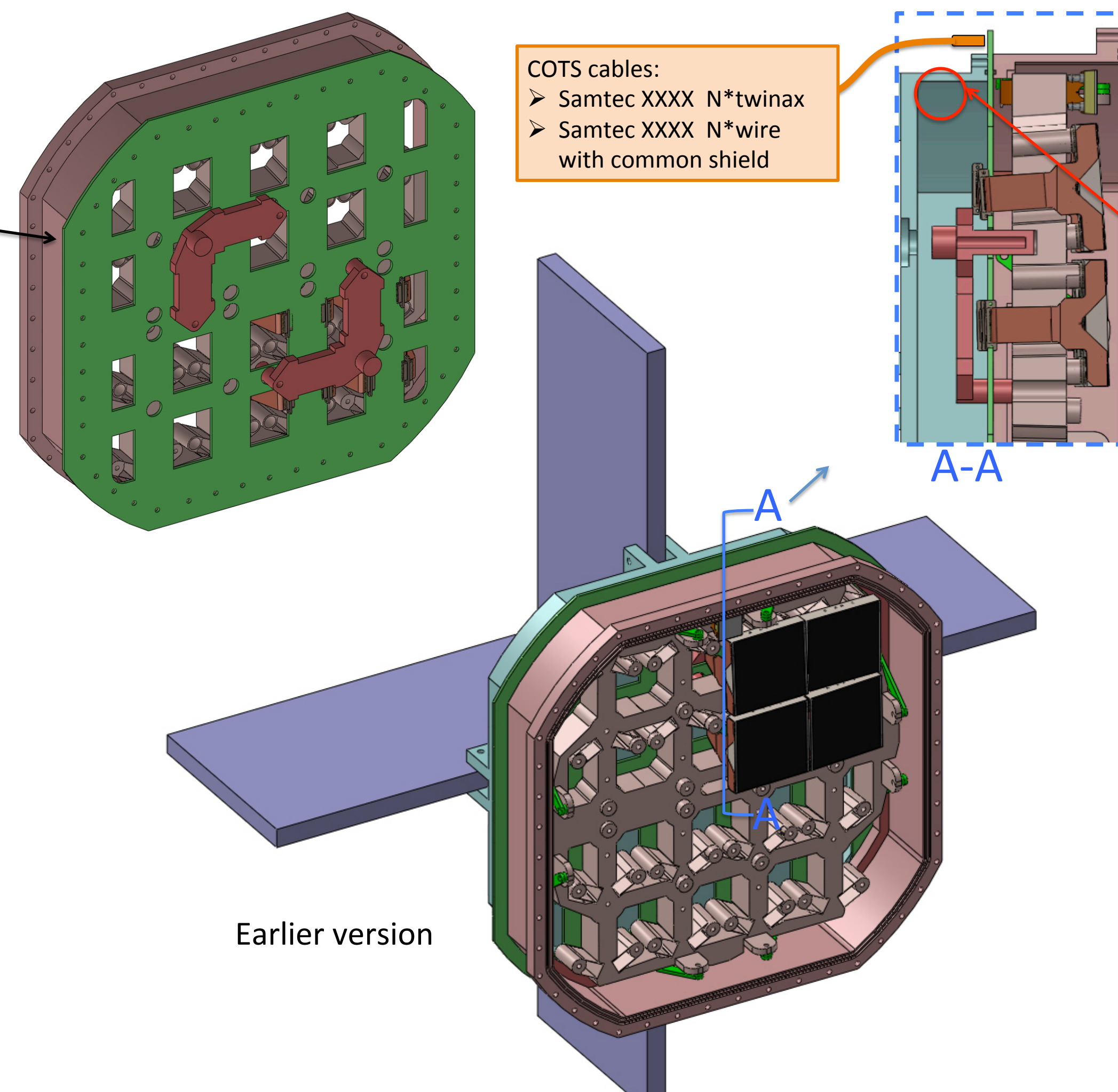
Source	Noise density (each)	#	Basis of estimate
Op amp voltage noise	7.0 nV/√Hz	2	AD8066
Op amp current noise	0.8 fV/√Hz	4	$R_{source} \sim 400 \text{ ohm}$
Feedback resistors	2 nV/√Hz	2	$R_1    R_0 = 300 \Omega$
ADC and postamp	10 nV/√Hz	1	AD7626 = 0.5 ADU rms
Power supplies	6 nV/√Hz	1	Allocation for residual after filtering and PSRR
<b>Total</b>	<b>15 nV/√Hz</b>	-	<b>Added in quadrature</b>

Input referred

Differential preamp is located in vacuum at warm end of CCD flex cable. Drives balanced strip-line implemented in **vacuum interface board**

Black level clamping at AC coupler:

- Active during vertical transfer only
- Can close reference side switch to convert to single sided CCD output (lower noise) while preserving differential transmission.
- Close both switches for shorted input noise test.
- Close signal switch only to check reference side.



## Vacuum Interface Board

- 1/8" thick PCB carries preamps
- Trapped between two O-rings in side wall and back cover.
- Signals routed on internal layers.
- Outer layers are isolated, in contact with case: conduct heat from preamps.
- Eliminates hermetic connectors.
- COTS cables connect directly to edges: all custom wiring in PCB.

Earlier version