Wednesday, February 13th

Estimates of power consumption for 1 Hawaii 1RG chip(1024×1024)

A slow read frequency, below 100 kHz will be used. We shall assume 40 kHz.

Read mode
The lay out is not yet defined, and a (pessimistic) buffered read will be assumed.
worst case with permanent read : 800μW
Integration (data taking) mode
During integration the power consumption is 20 times less (according to the Hawaii 1RG book). We raise it to 1/10. Added contribution during integration:
80 μW $\times$ 1000 s = 80 mJ
power for integration: 80 μW

Reset mode
We shall assume a worst case configuration where all pixel wells are full at 100000 electrons and a voltage of 2V. The associated energy: $2 \times 1.6\ \ 10^{-8}$ J

3 cases
-If the resets are sent pixel by pixel at 40 khz:
Total reset time 25s power: 1.2 10^{-9} W (negligible)
-If row by row at 40 khz:
power is 1000 times higher: 1.2 10^{-6}W (negligible)
-If all detector is reset:the reset time is of the order of 100ns.
instantaneous power of 320 mW
too large and generates perturbations: *Should not be done.*

power for resets 0
Total power consumption in permanent read **880 μW**
IF this were the sole contribution, the radiator surface needed for an equilibrium temperature of 80 K would be of the order of 4 cm^2.

Calibration The readout sampling frequency can be lowered during integration, but remains high in calibration mode. Some extra power will be needed to avoid excessive temperature variations.

Environment radiation into the detector

We assume the environment is in equilibrium (black body) at 140K and radiates into the detector. This additional input flux is large, but takes place at long wave lengths(typically 50-60 microns). The entering flux is the one which would be radiated by the same area at 140K: 9 10^{-3}W This is 10 times more than the power consumption.

This entering power can be reduced by shielding the solid angle associated to the incoming IR light. We shall temporarily assume that this angle is $4\ \pi/8$, and that the shield has a ratio emissivity/reflectivity = 0.02

The window input power would then be (at 140K):
(1/8)*9mW + 0.02*(9/8)*9 (mW) = 1.32 mW
Entering flux from environment: rounded to 1.5 mW.

Cable input power??? Heat can enter by conduction via the cables.
Assuming the cables are shielded, the electronic cooled at 140K
Add for cable (assuming same area as detector): 1.5 mW (?)
Cable heat leak(?) 1.5mW
Total power to compensate by cooling in IR detector 3.8mW
The radiating area needed is then 16 cm^2.