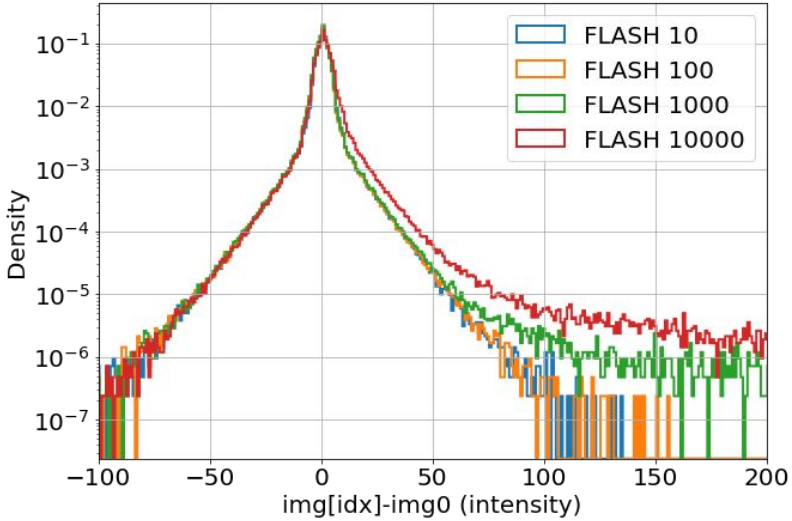
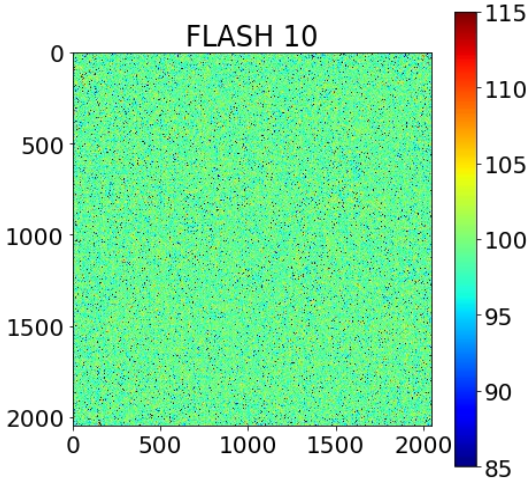
Noise x Exposure Time

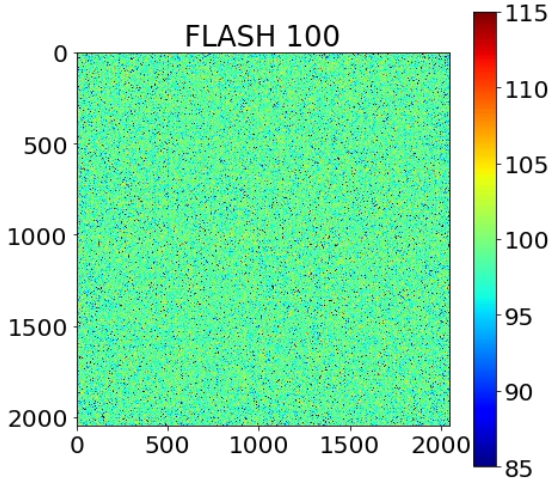
Flash vs. Fusion

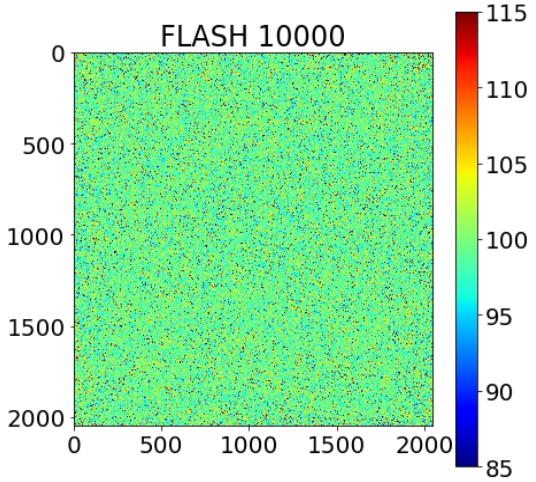
Flash

- Up to 100 ms the noise is practically the same
- The hot pixels are spread ~uniformly throughout the sensor



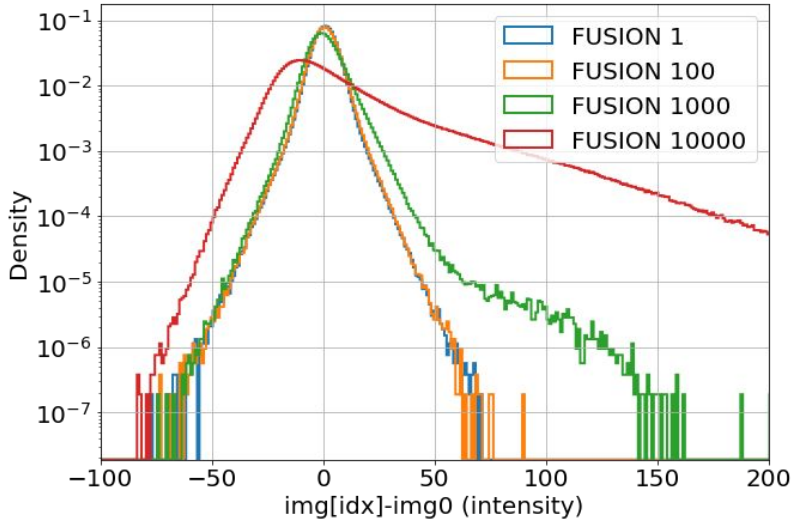


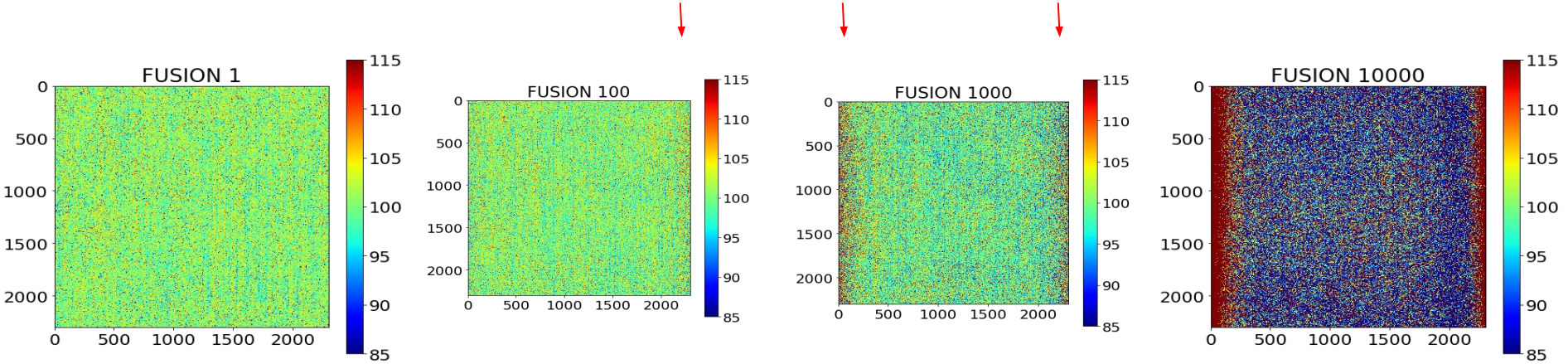




Fusion

- Up to 100 ms the noise is practically the same
- The hot pixels are more concentrated on the borders of the sensor
- Strong effect for 1000 ms and drastic change for 10000 ms
- The mean value of the pixels on the center seems to decrease

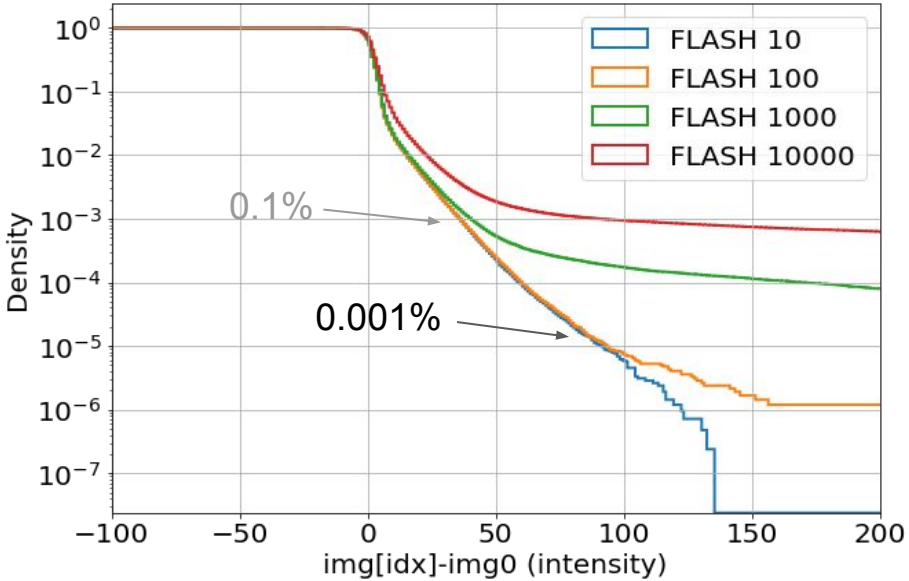


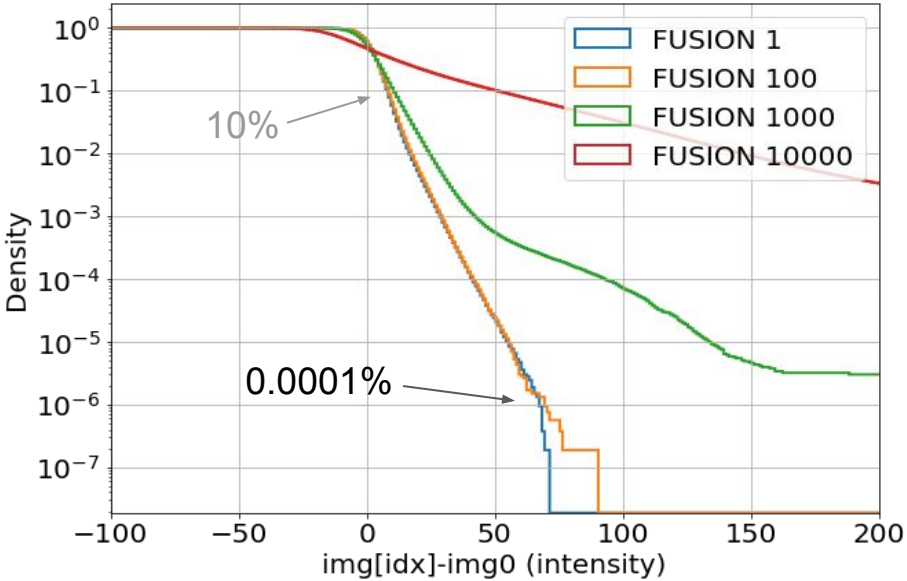


iCDF to see the probabilities

From 1 to 100 ms Fusion presents less noise variation, changing or about 0.0001% pixels

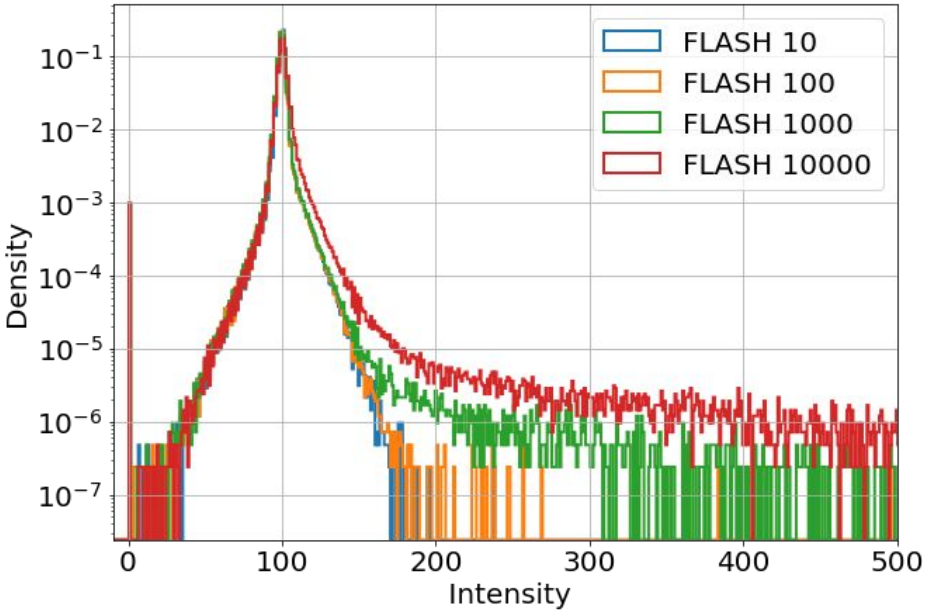
For longer exposure times (>100 ms) Fusion noise starts to increase rapidly

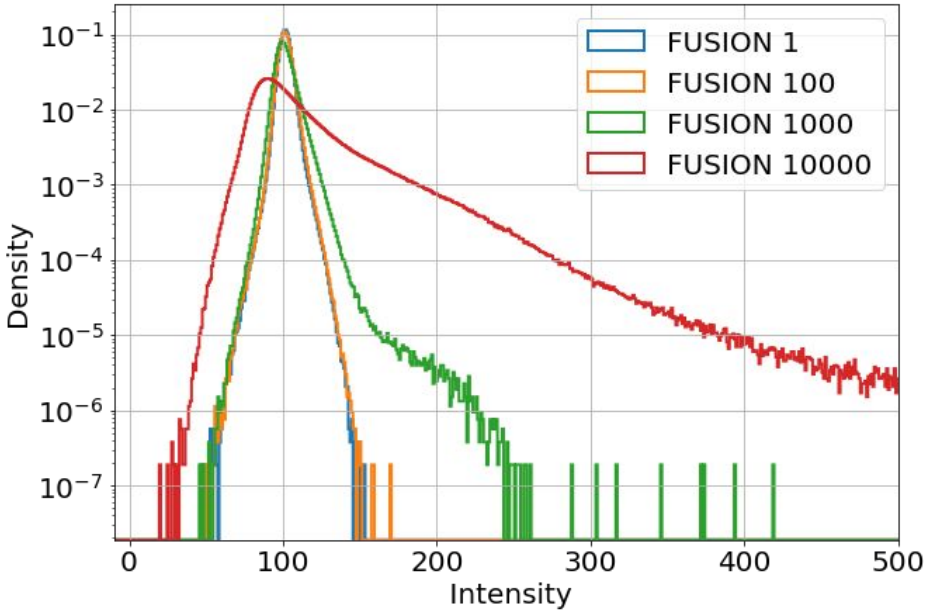




Absolute values (intensity)

Just to see the absolute values….nothing new...

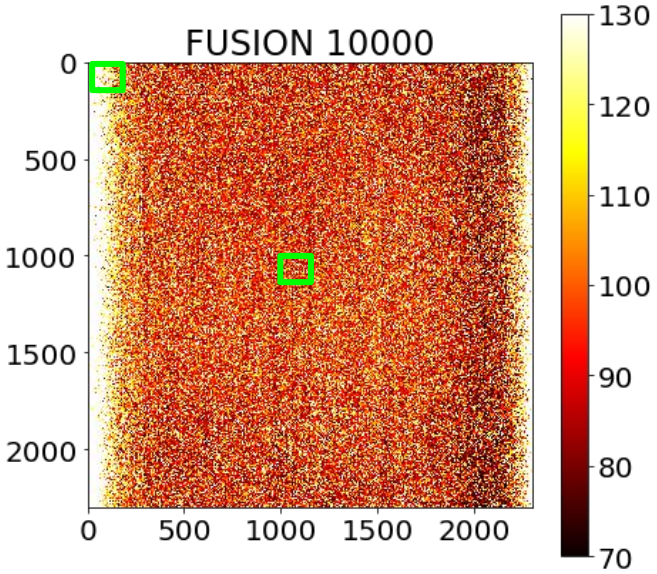


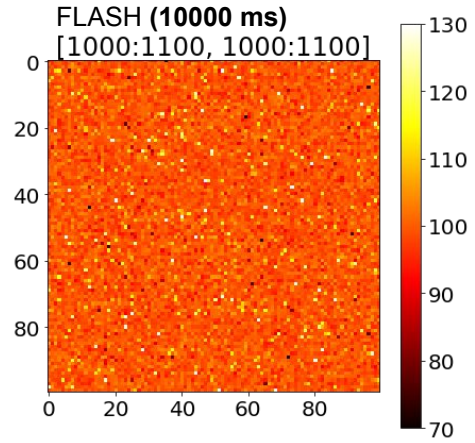


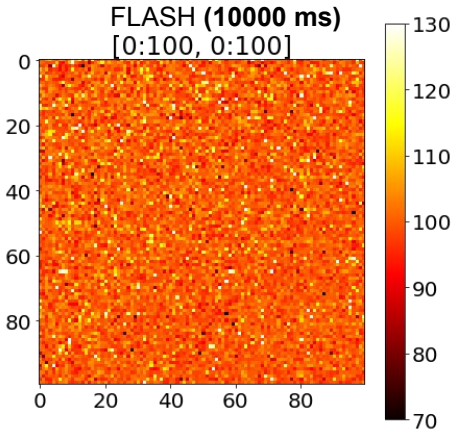
Center vs. Border

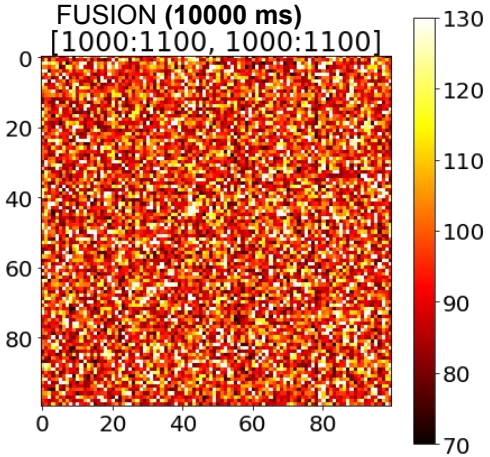
On 10000 ms data

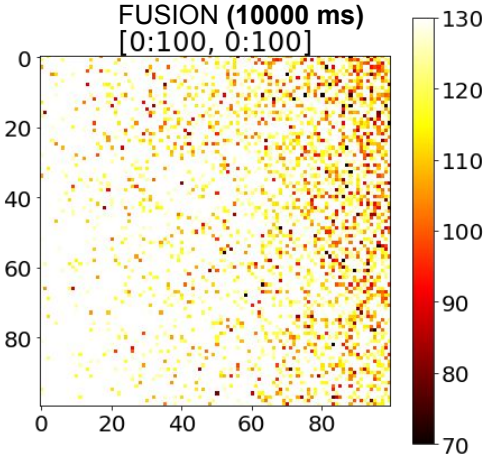
- The concentration on the border is much stronger for the Fusion sensor





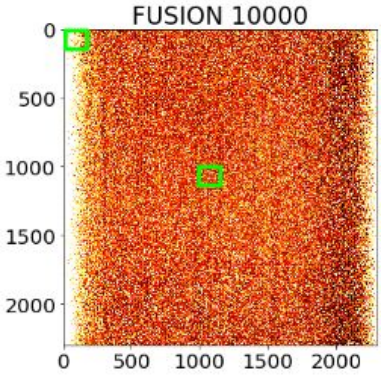




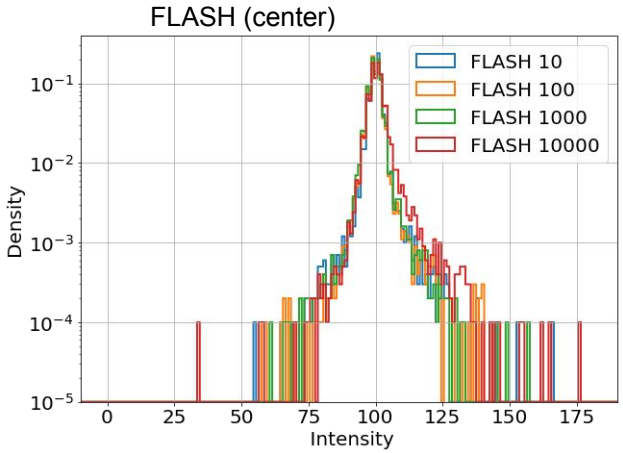


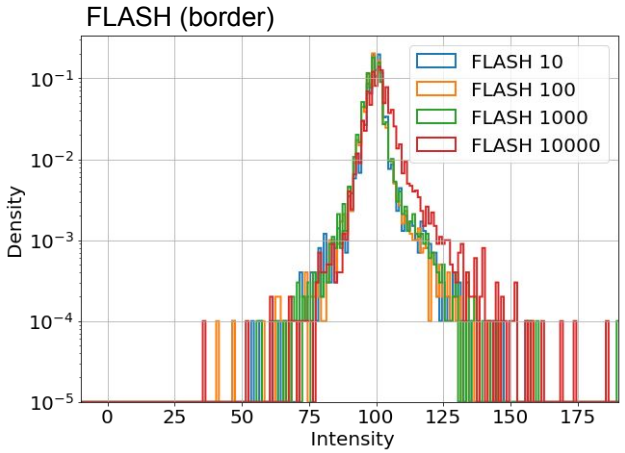
Center vs. Border

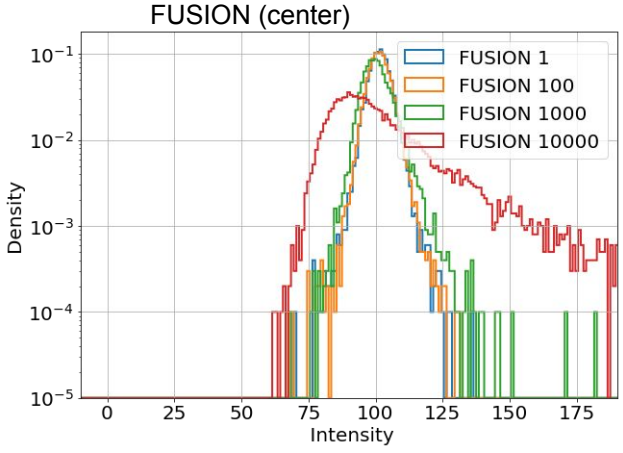
- The concentration on the border is much stronger for the Fusion sensor
- But there are hot pixels on the center as well

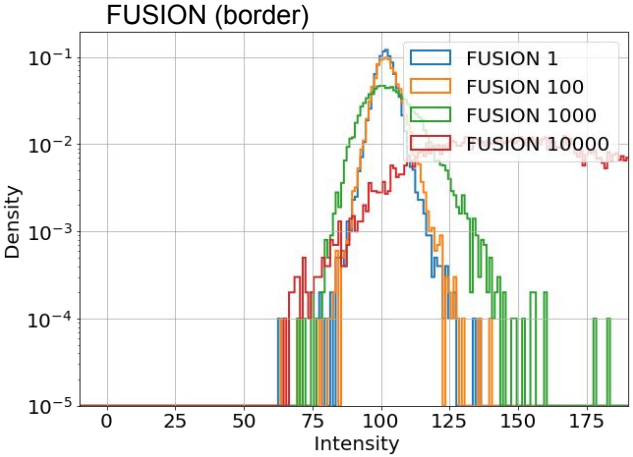


Note that the right side is different from the left side



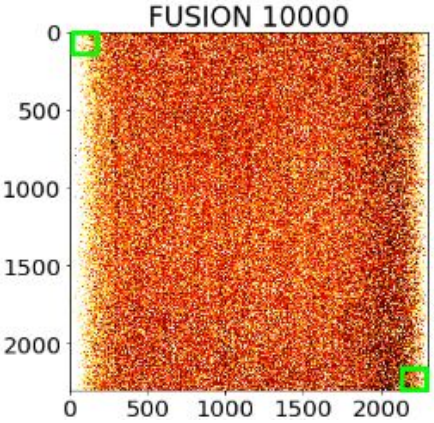


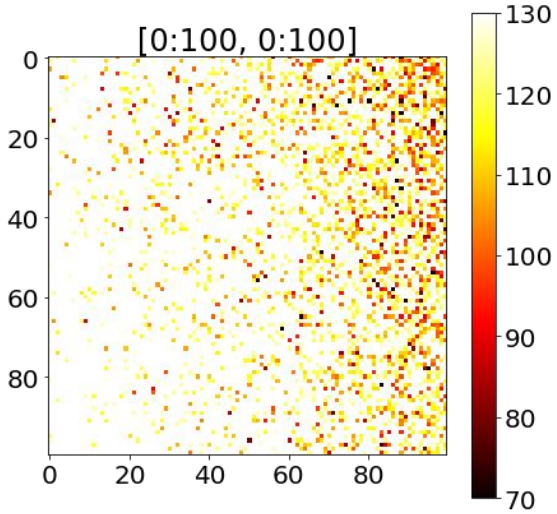


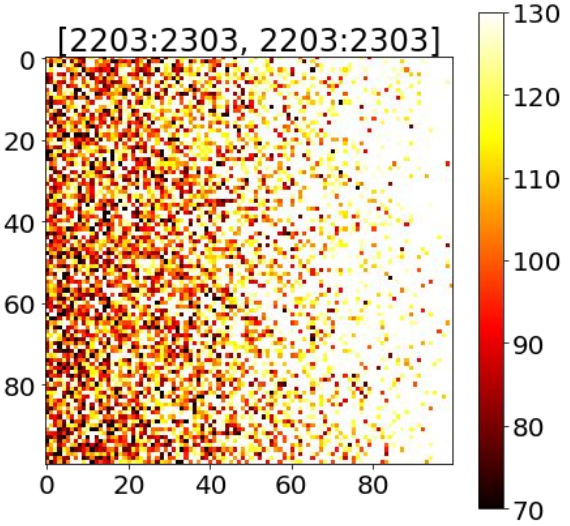


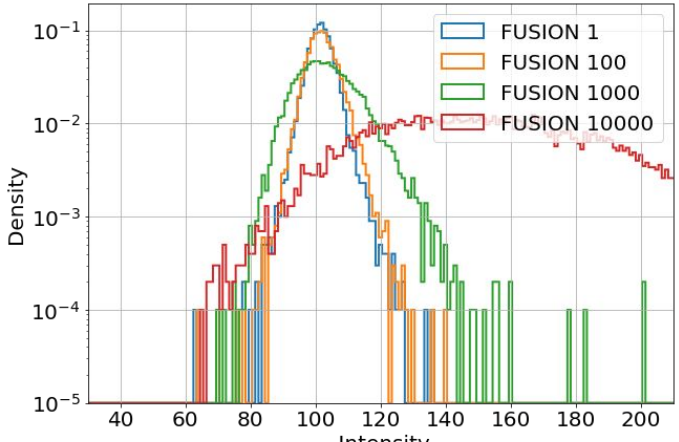
Fusion Borders

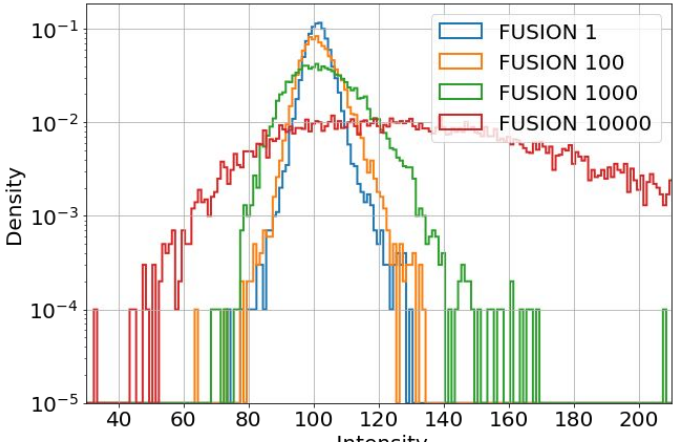
- Fusion is asymmetric...



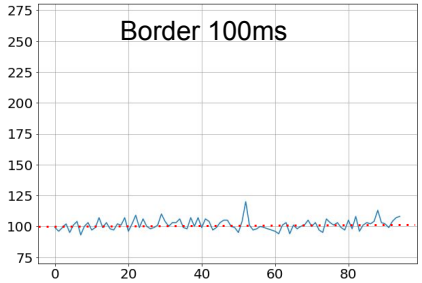


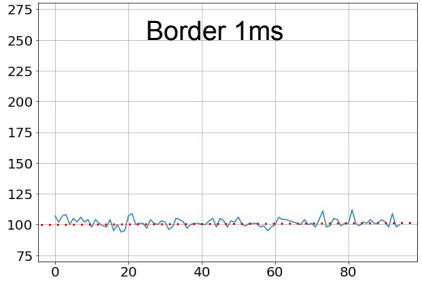


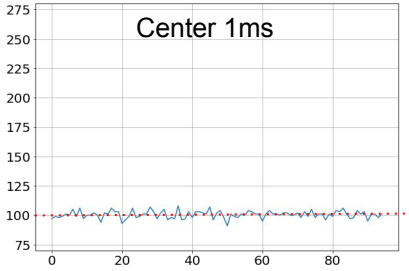


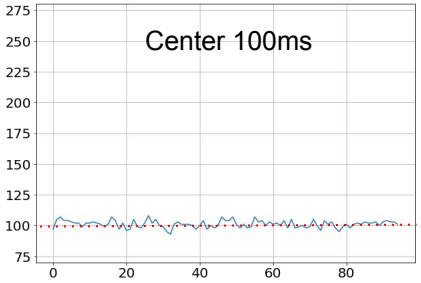


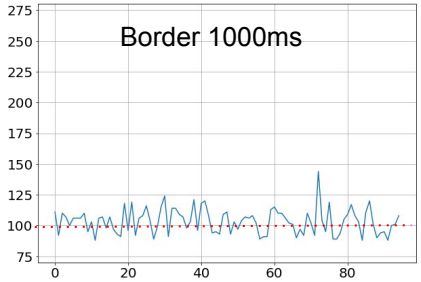
Fusion Border x Center *(checking by eye)*

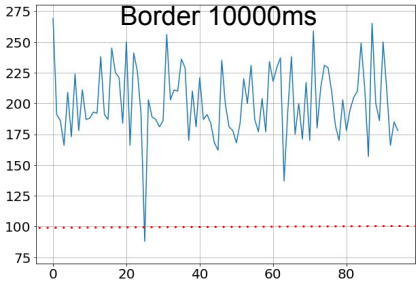




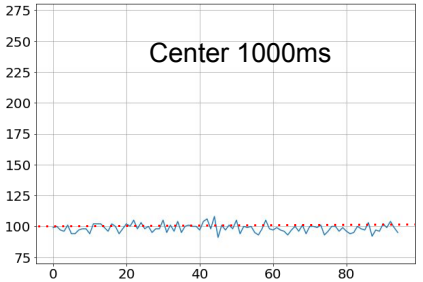


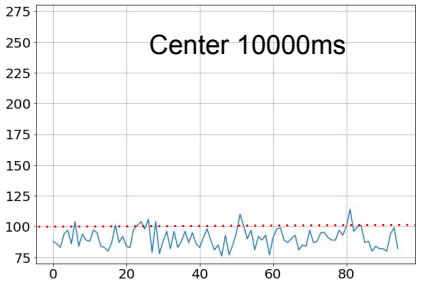






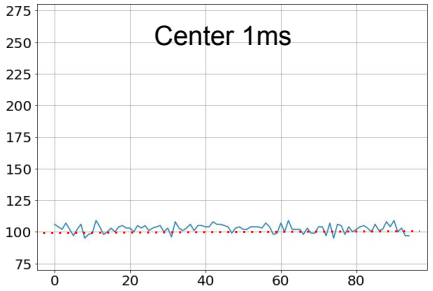
- Examples of:
  - A typical border pixel
    - Mean value increasing
    - Noise increasing
  - A typical center pixel
    - Mean value decreasing
    - Noise increasing (less)

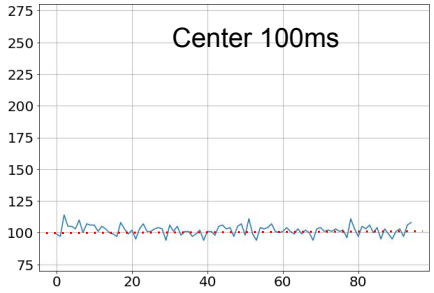


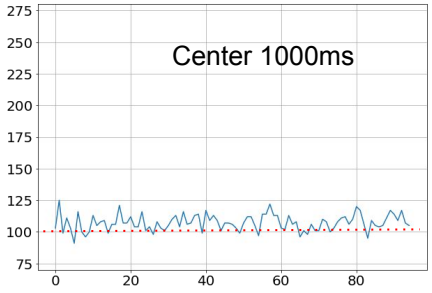


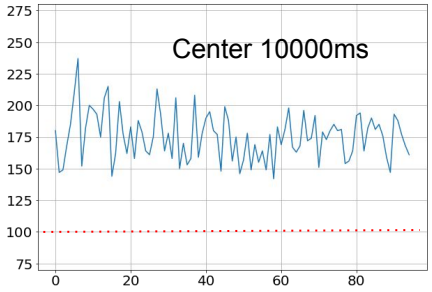
Fusion Border x Center *(checking by eye)*

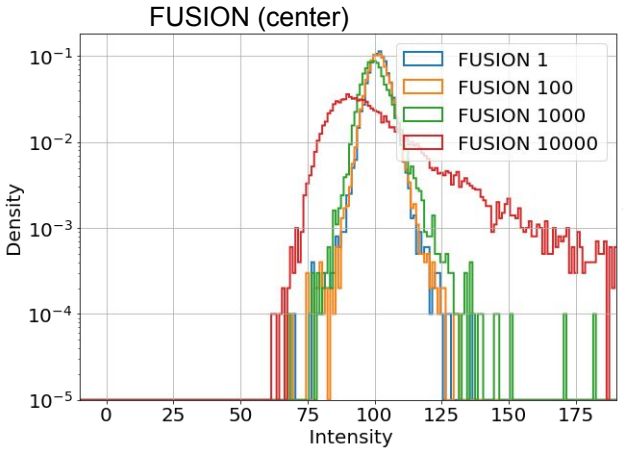
- But center pixels can algo go higher…
  - Mean value increasing
  - Noise increasing (more)

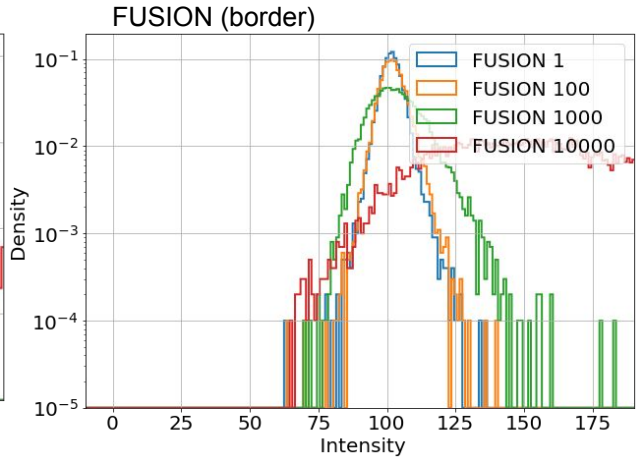












Dark current Flash vs. Fusion

C13440-20CU

ORCA-Flash 4.0 V3 Digital CMOS camera

Dark current	0.06 electrons/pixel/s (Air Cooled to -10° C) (typ.)
	0.06 electrons/pixel/s (Water Cooled to -10° C) (typ.)
	0.006 electrons/pixel/s (Water Cooled to -30° C) (typ.)

- Under investigation but…
  - Dark current is dependent of exposure time
  - For short exposure time it can be ignored (other noise sources dominate)
  - For long exposure times, dark current can dominate
  - **Fusion has a dark current level much higher than the Flash**

ORCA-Fusion
Digital CMOS Camera
C14440-20UP/C14440-20UP01

Dark current ※1	cooling temperature:-5 °C	0.5 electrons/pixel/s
	cooling temperature:-15 °C	0.2 electrons/pixel/s

Preliminary conclusions

- Analysis is ongoing but...
  - Fusion seems to have lower noise up to 100 ms of exposure time
  - Fusion sensor is much more sensitive to long exposure times (>100 ms)
    - Mean shifting and RMS noise increasing
    - With drastic change for 10 seconds