RIPTIDE

November 2024

Aussie ~~Gen-Z~~ Learner's Dictionary

G'day: exclamation. *Hi, Hello, used when meeting or greeting someone.*

RIPTIDE

1) ORCA Sensor characterization using diffraction pattern

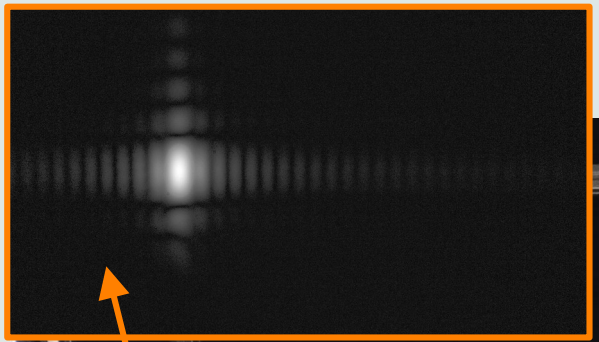
Setup

Objective: to *estimate* the lowest amount of photons that is possible to detect in the sensor camera.

Laser wavelenght : 405 nm
Exposue time : 199 ms

Total amount of light exiting from the slit measured with a **caibrated photodiode**

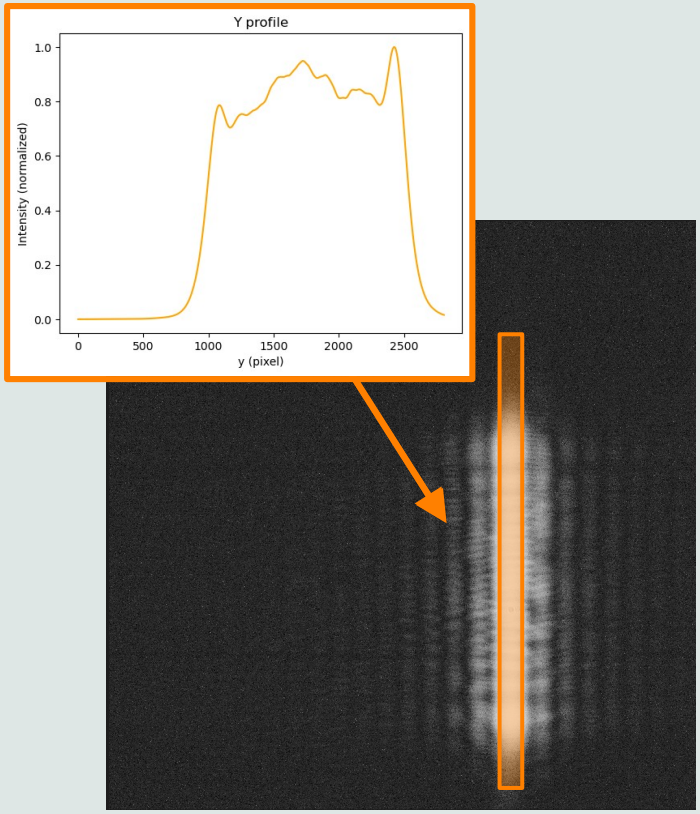
Power : 0.2 nW



Output (GL-image)

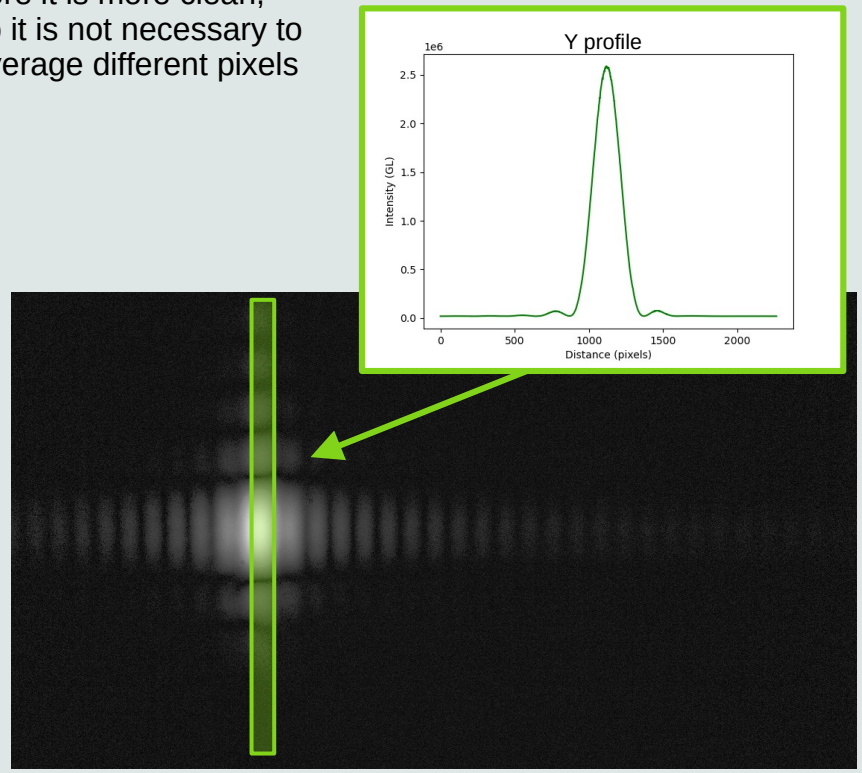
Comparison with ASI533

ASI533 pro



ORCA-Quest

The profile of the laser here it is more clean, so it is not necessary to average different pixels

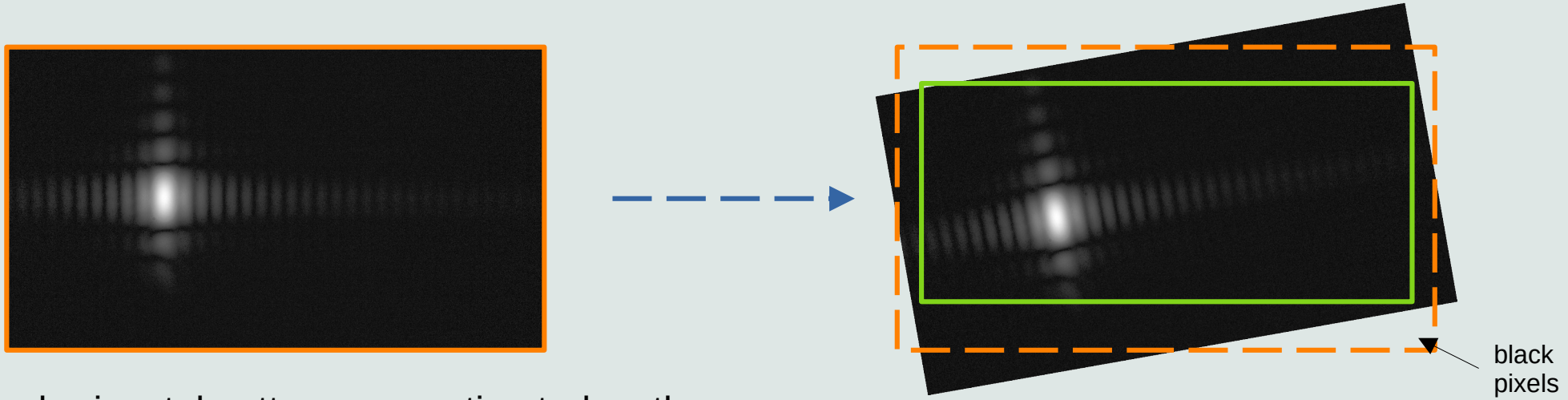


Steps of the analysis

1) Image rotation to make the diffraction pattern horizontal
2) Bias subtraction and GL to photon conversion
3) Selection of one pixel width row
4) Peaks identification and data extrapolation

1) Image rotation to make the diffraction pattern horizontal

Rotation is applied to make the diffraction pattern perfectly horizontal.



The horizontal pattern was estimated as the angle at which the standard deviation along y axis was the lowest.

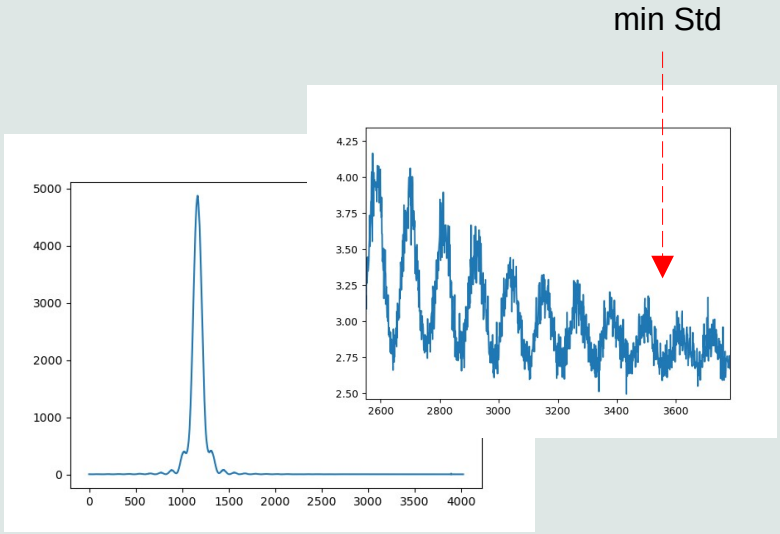
old dimensions

new dimension (cropped to remove black pixels due to rotation)

2) Bias subtraction and GL to photon conversion

Using the rotated image, the bias subtraction was considered as the GL value of the pixel with lowest standard deviation.

NB: the standard deviation has the same shape of the diffraction pattern.



BIAS = 195.86 GL

Once the bias is subtracted, the GL scale was converted in number of photons

$$Img = Img \times \frac{n_{photon}}{n_{GL}}$$

n_{GL} : total number of GL in the image (BIAS subtracted)

n_{photon} : total number of photons exiting from the slit:

λ_{photon} = 405 nm $\dashrightarrow$ $E_{photon} = \frac{hc}{\lambda} = 3.06\,eV$

$Power = 0.2\,nW = 1.248\,10^{9}\,eV$

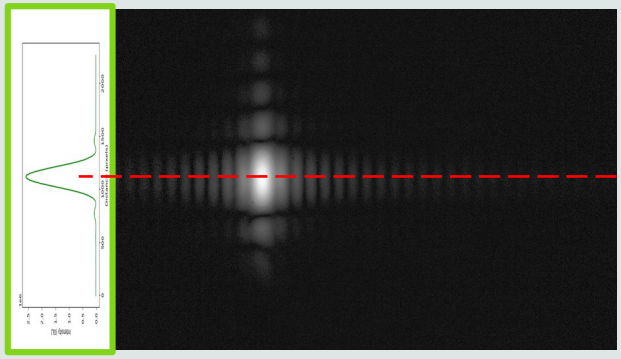
$T_{exp} = 199\,ms$

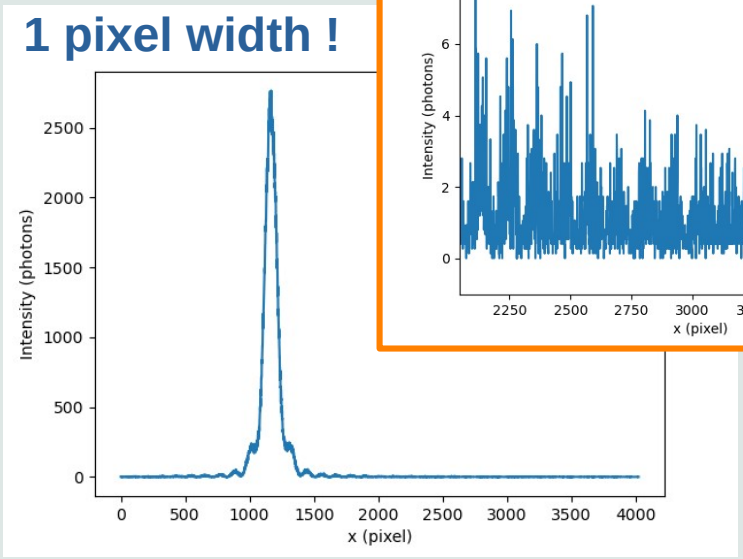
$$n_{photon} = \frac{Power\,[eV] \times T_{exp}}{E_{photon}}$$

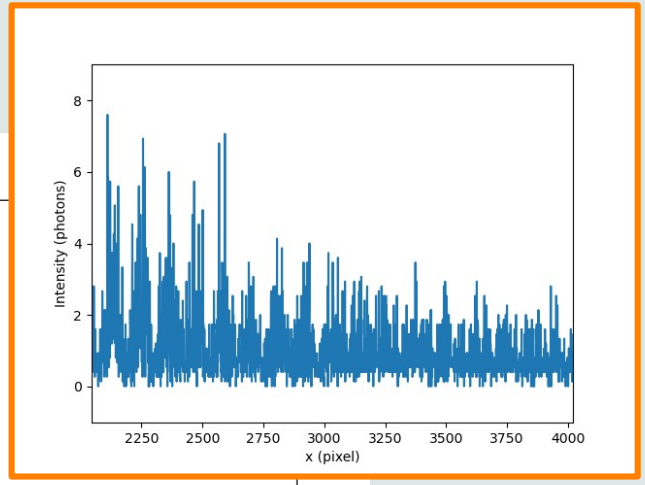
 # photon / # GL = 0.133 (= 3.35 ASI 533)

3) Selection of one pixel width row and GL to photon conversion

From Y profile, the central row of the diffraction pattern was obtained.

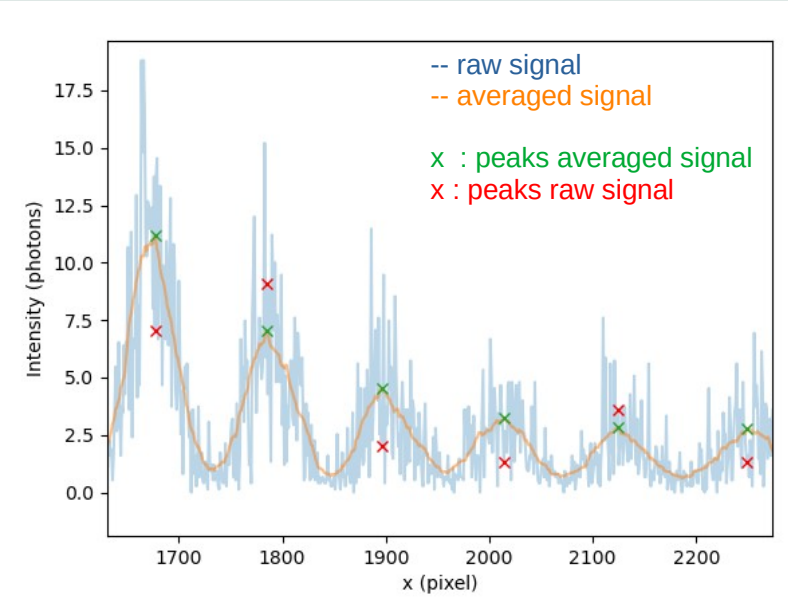






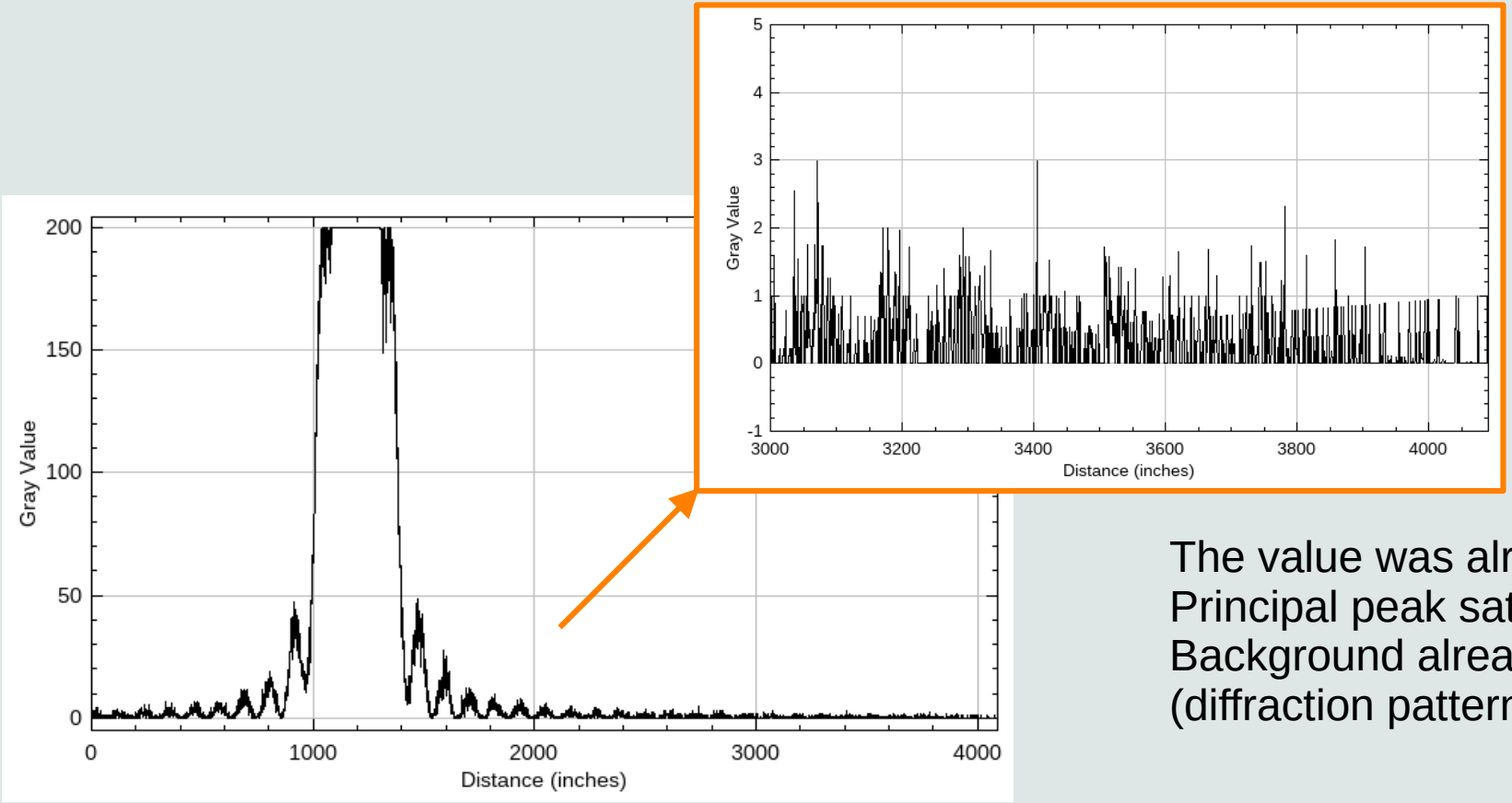
4) Peaks identification and data extrapolation

We can see single photon per pixel !!!



	1	2	5	10	20	30	50
0	2660 ± 90	2670 ± 70	2630 ± 80	2640 ± 80	2540 ± 140	2450 ± 190	2190 ± 390
1	232 ± 6	232 ± 11	226 ± 14	225 ± 13	216 ± 18	213 ± 18	210 ± 49
2	37.6 ± 0.4	41.3 ± 3.9	39.4 ± 5.8	40.6 ± 5.8	38.4 ± 6.6	34.7 ± 8.6	26.5 ± 12.7
3	17.9 ± 2.3	17.2 ± 1.9	16.7 ± 3.3	16.3 ± 3.6	15.7 ± 4.8	14.1 ± 5.1	10.2 ± 6.5
4	10.4 ± 3.3	10.6 ± 3.1	10.9 ± 2.7	10.9 ± 3.0	10.2 ± 3.7	8.7 ± 4.0	6.1 ± 4.5
5	7.5 ± 1.6	8.6 ± 4.2	6.8 ± 3.6	6.9 ± 3.0	6.1 ± 3.2	5.4 ± 3.0	4.0 ± 3.1
6	2.8 ± 0.8	3.4 ± 1.3	4.4 ± 2.5	4.9 ± 2.6	4.0 ± 2.4	3.4 ± 2.4	2.6 ± 2.2
7	2.1 ± 0.7	2.6 ± 0.8	3.0 ± 1.1	3.1 ± 1.3	3.1 ± 1.4	2.7 ± 1.4	2.1 ± 1.5
8	3.2 ± 0.4	2.6 ± 0.9	2.8 ± 1.3	2.6 ± 1.4	2.6 ± 1.6	2.2 ± 1.5	1.8 ± 1.4
9	1.5 ± 0.2	1.8 ± 0.4	2.0 ± 1.1	2.7 ± 1.7	2.6 ± 1.7	2.3 ± 1.5	1.8 ± 1.5
10	2.1 ± 0.9	1.2 ± 1.2	1.6 ± 1.1	2.1 ± 1.4	2.0 ± 1.3	1.8 ± 1.3	1.5 ± 1.2
11	1.4 ± 1.0	1.7 ± 0.9	2.3 ± 1.4	1.7 ± 1.3	1.7 ± 1.2	1.6 ± 1.1	1.3 ± 1.1
12	0.5 ± 0.1	0.6 ± 0.4	1.2 ± 1.0	1.6 ± 1.5	1.5 ± 1.5	1.4 ± 1.3	1.2 ± 1.1
13	1.0 ± 0.5	1.0 ± 0.6	1.7 ± 1.0	1.4 ± 0.9	1.3 ± 0.8	1.2 ± 0.8	1.1 ± 0.7
14	1.0 ± 0.2	1.1 ± 0.3	1.2 ± 0.7	1.3 ± 0.9	1.2 ± 0.9	1.2 ± 0.9	1.0 ± 0.8
15	0.7 ± 0.1	1.4 ± 1.2	1.0 ± 0.9	1.1 ± 0.9	1.2 ± 1.0	1.1 ± 0.9	0.9 ± 0.8
16	1.3 ± 0.7	1.3 ± 0.6	1.3 ± 0.6	1.2 ± 0.8	1.1 ± 0.8	1.1 ± 0.7	1.1 ± 0.8
17	0.5 ± 0.1	0.5 ± 0.1	0.8 ± 0.8	1.0 ± 0.7	1.2 ± 0.8	1.1 ± 0.8	1.0 ± 0.7
18	1.3 ± 0.6	1.0 ± 0.5	1.2 ± 0.6	1.1 ± 0.6	1.0 ± 0.6	0.9 ± 0.6	0.9 ± 0.6
19	1.1 ± 0.3	1.0 ± 0.3	0.8 ± 0.3	0.9 ± 0.6	0.9 ± 0.7	0.9 ± 0.6	0.9 ± 0.6
20	0.9 ± 0.1	1.0 ± 0.3	1.3 ± 0.9	1.2 ± 0.8	1.1 ± 0.7	1.0 ± 0.6	0.9 ± 0.6
21	0.5 ± 0.1	0.5 ± 0.1	1.0 ± 0.7	0.9 ± 0.6	1.0 ± 0.7	0.8 ± 0.6	0.8 ± 0.6
22	1.3 ± 0.7	1.0 ± 0.7	1.1 ± 0.7	1.0 ± 0.6	1.0 ± 0.6	0.9 ± 0.5	0.8 ± 0.5

Q&A What about the photon counting mode for the ORCA?



The value was already converted.
Principal peak saturation
Background already removed
(diffraction pattern less visible)

The end

Single photon counting camera was effctively single photon counting

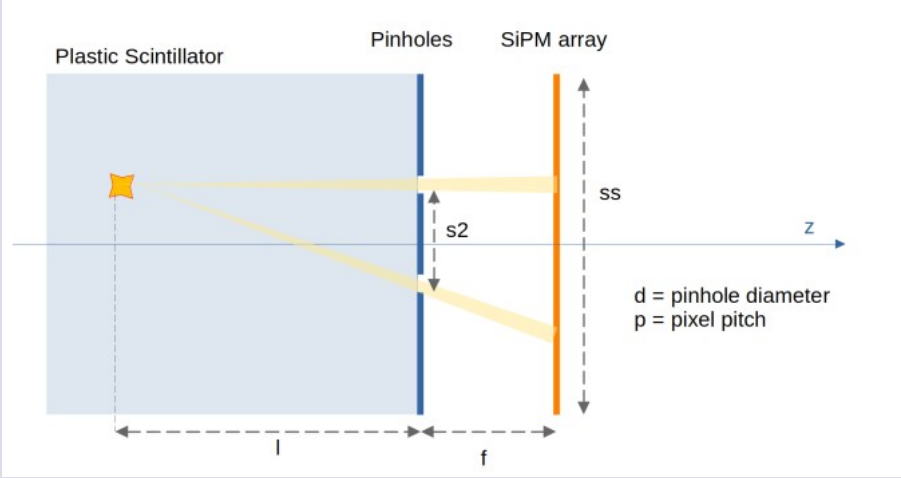
The main problem is the optics

Next months: MCP diffraction

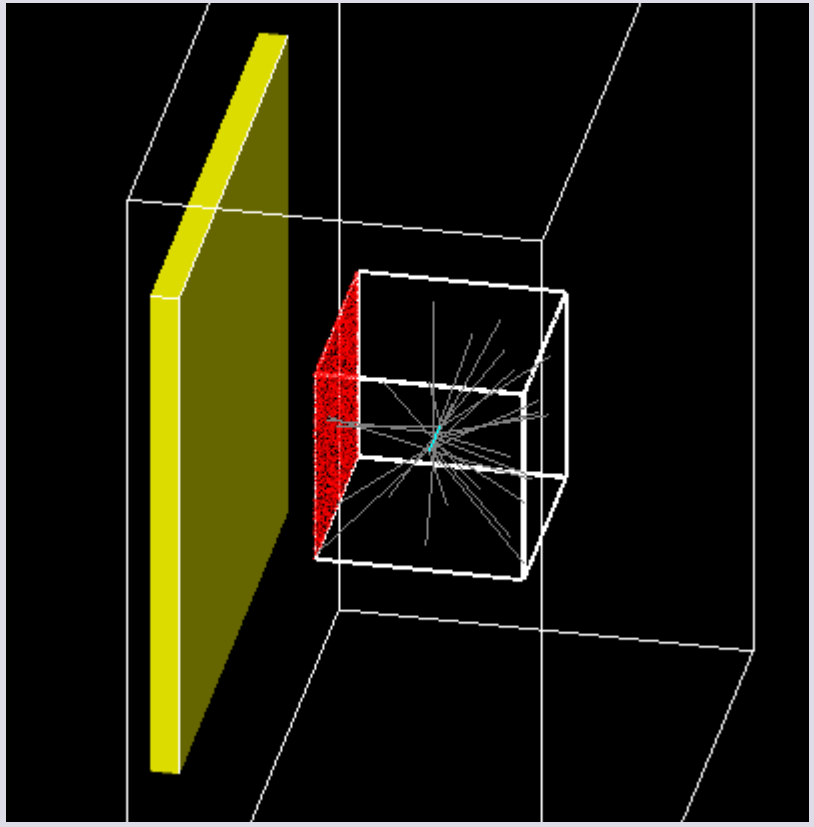
The Aussie project

Simplified model of RIPTIDE

SPI·SPUPAS : Single Particle Ion Stereoscopic Photography Using Pinholes And SiPMs

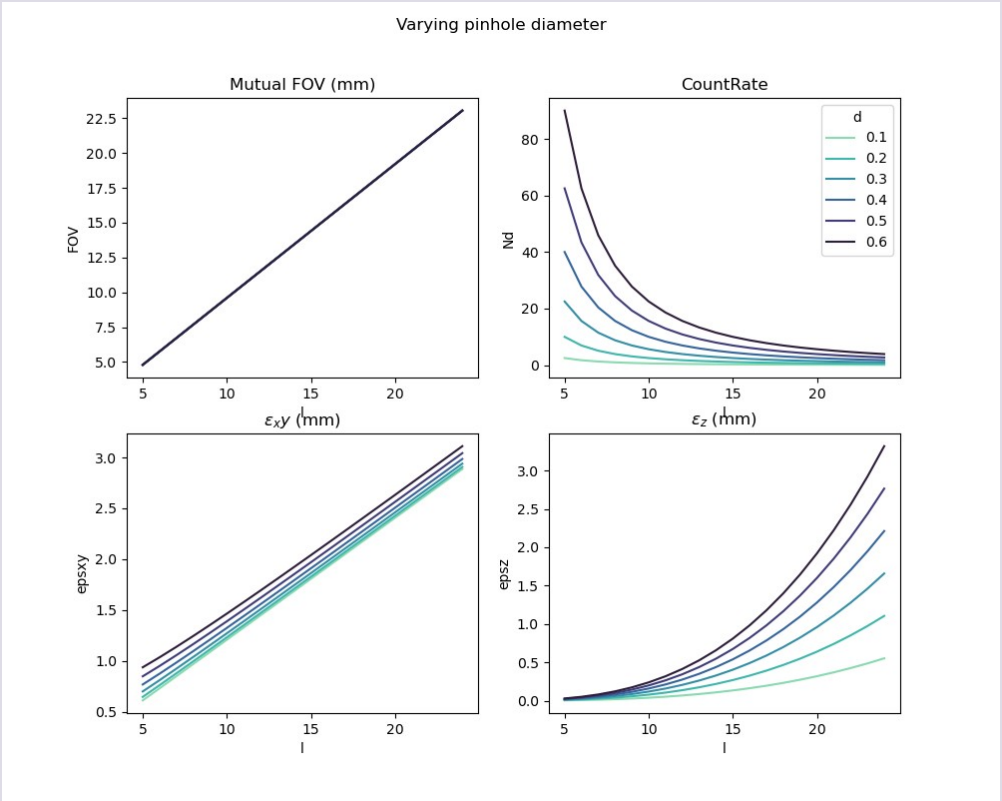


MC simulation



The Aussie project

Varying pinhole diameter



Varying pinhole to sensor distance