Optics

A tentative resume

The Lens

- Since the beginning we are using a Schneider Xenon 0.95/25 lens;

Technical Specifications

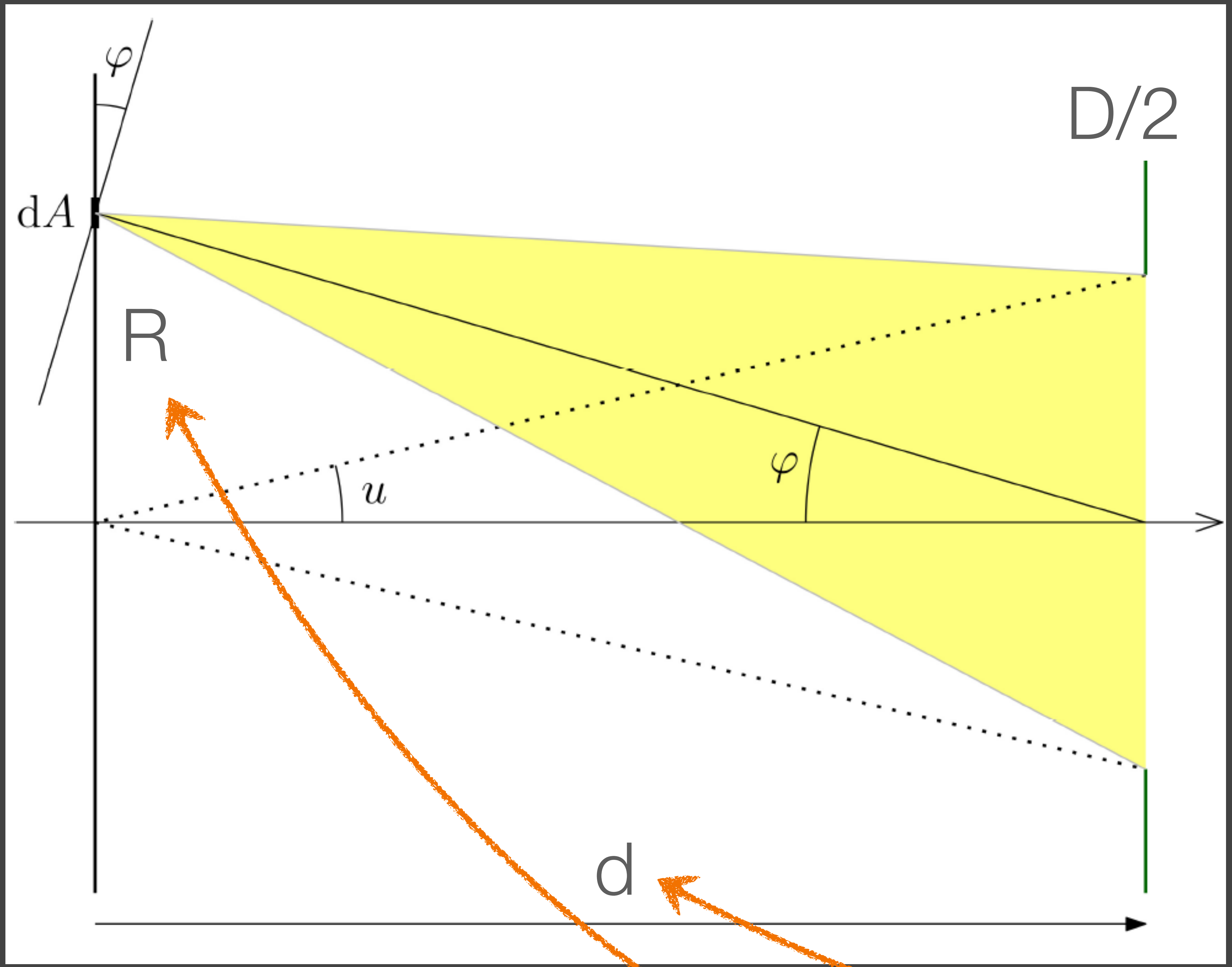
F-number	0.95
Focal length	25.6 mm
Image circle	16 mm
Transmission	400 - 700 nm
Interface	C-Mount

- Large aperture and short focal length allow an “efficient” light collection and easy operation

Vignetting

According to the prime principles, the “vignetting” effect depends on:

- Object distance (d);
- Optical aperture (D/2);
- Object position φ;



$$\Phi(\varphi) = \pi L \, \mathrm{d}A \, u^2 \cos^4 \varphi.$$

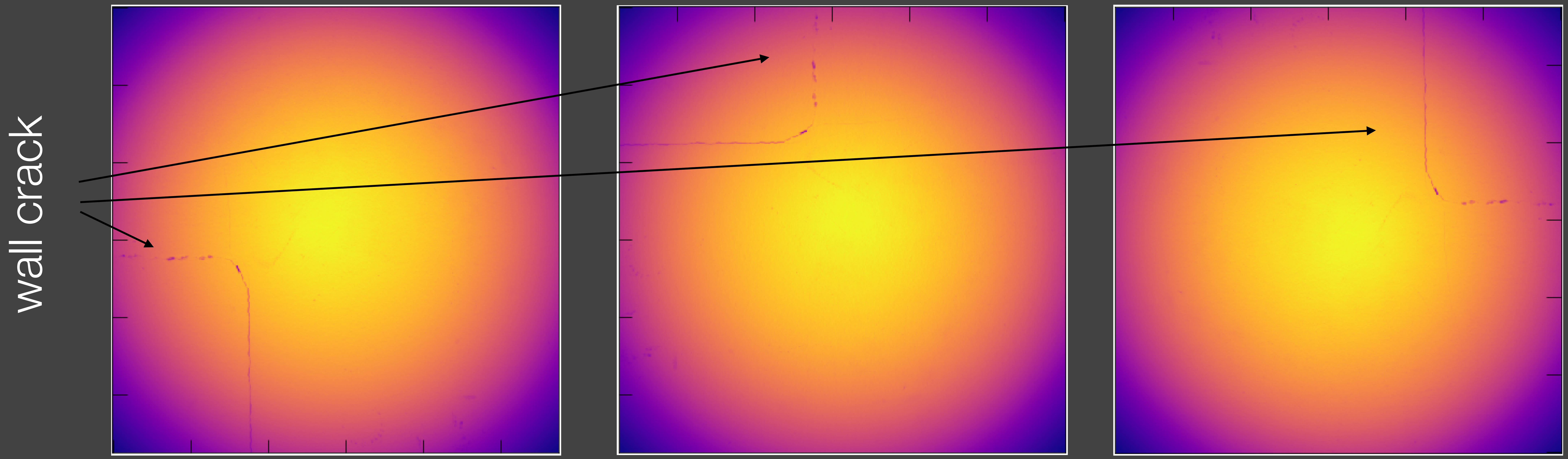
$$L = L_0 \frac{D^2}{d^2} \frac{d^4}{(d^2 + R^2)^2}$$

absolute decrease with d^2

relative decrease with R^4

Vignetting

To evaluate vignetting effect in our lens, we took pictures of a white wall, illuminated from behind the camera by a diffuse "neon" light;

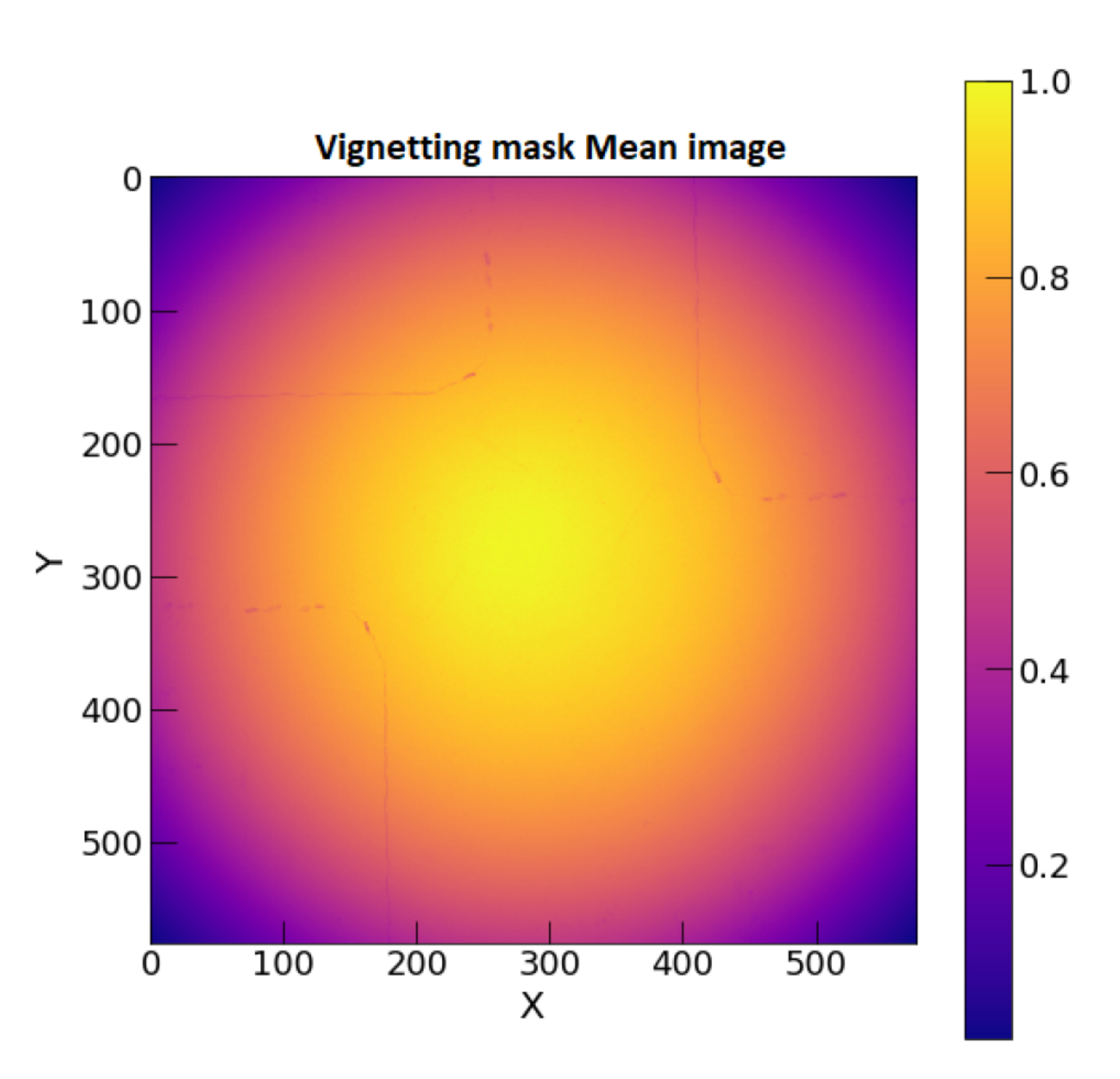


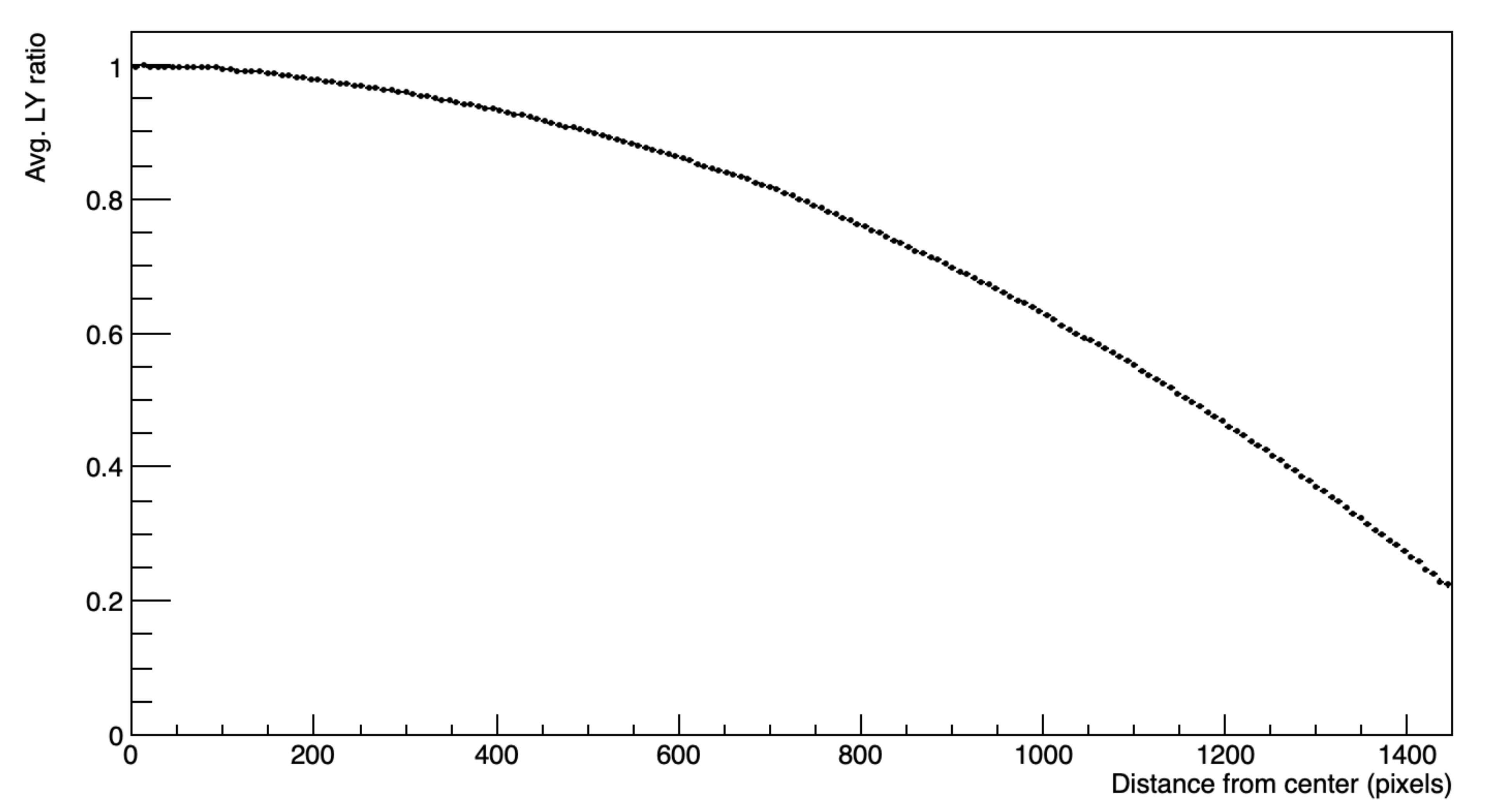
We took 3 pictures by rotating the camera by 90 degrees and averaged them to account for possible light (linear) anisotropies

Vignetting

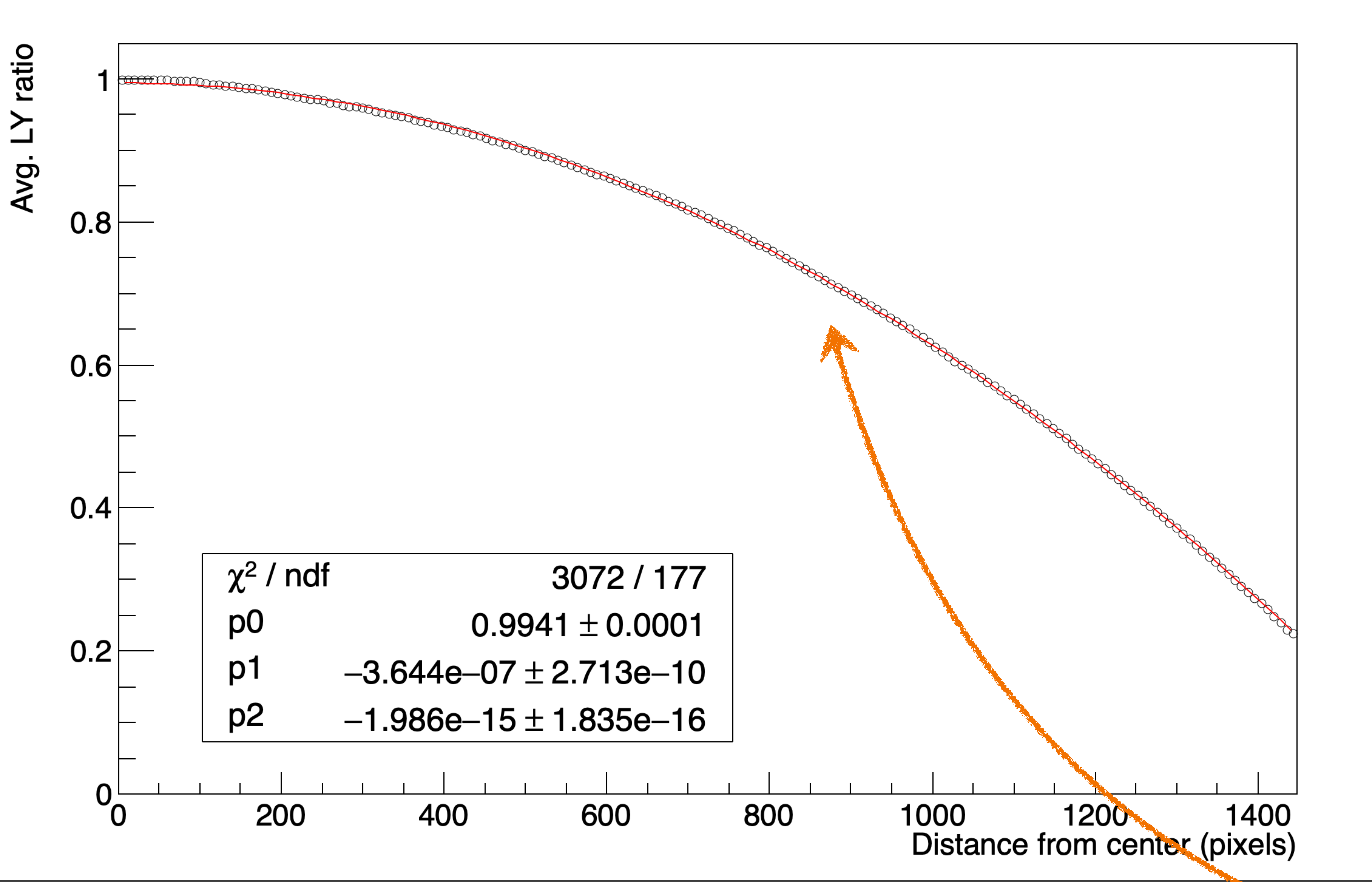
We than obtained an “illumiation” map as the normilised average of the 3 pictures;

Since vignetting is expected to be only a radial effect, from the map we evaluated the average radial profile;





Vignetting



According to the prime principles, the “vignetting” effect depends on:

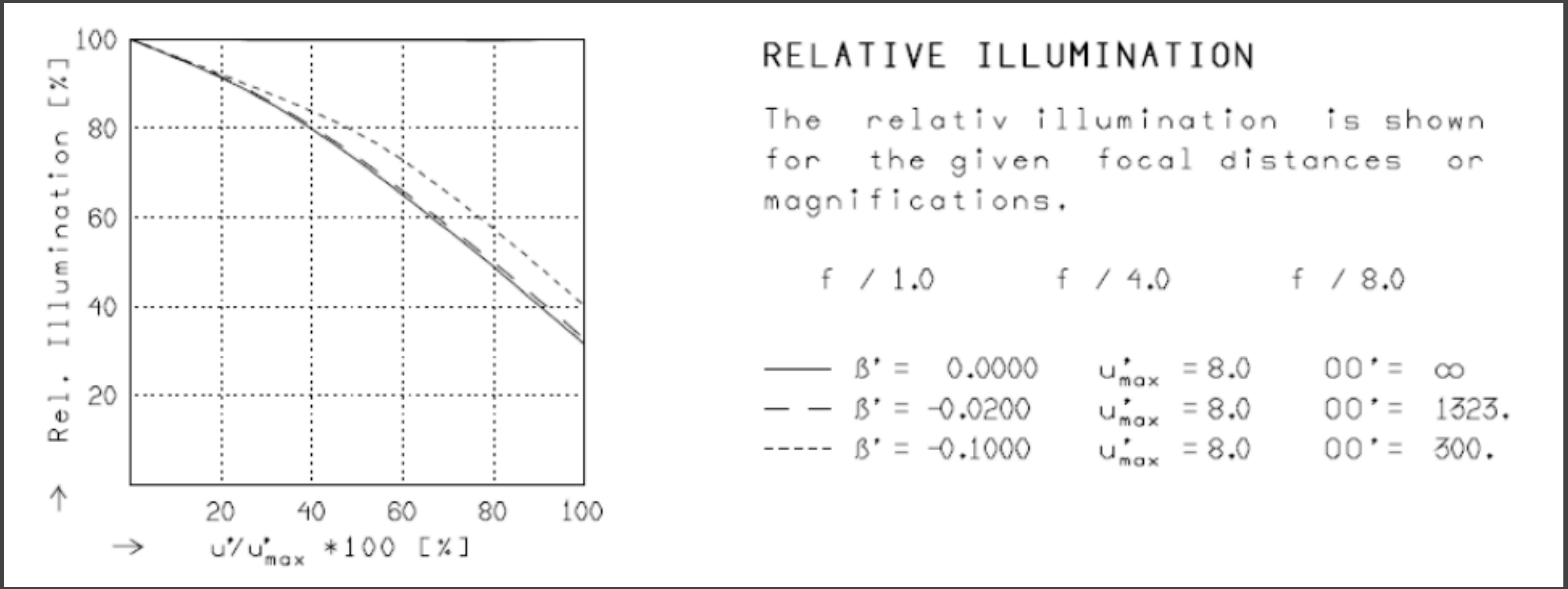
- Object distance (d);
- Optical aperture (D/2);
- Object position φ;

$$\Phi(\varphi) = \pi L \, \mathrm{d}A \, u^2 \cos^4 \varphi.$$

$$L = L_0 \frac{D^2}{d^2} \frac{d^4}{(d^2 + R^2)^2}$$

Fit confirms a fourth power dependence on R

Vignetting



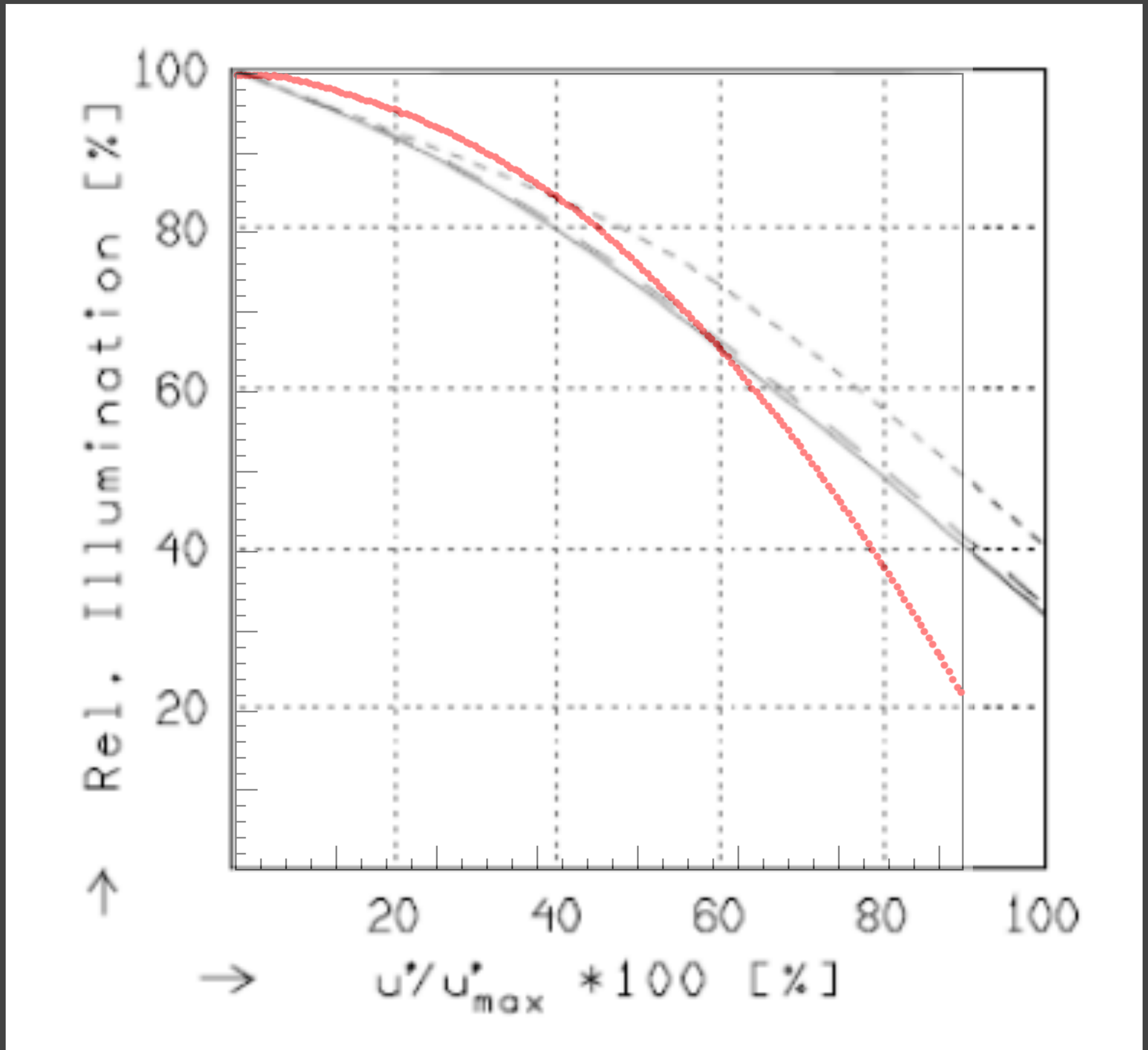
For the lens we are using, data sheet proposes 3 different behaviors according to the object distance (OO') and the aperture;

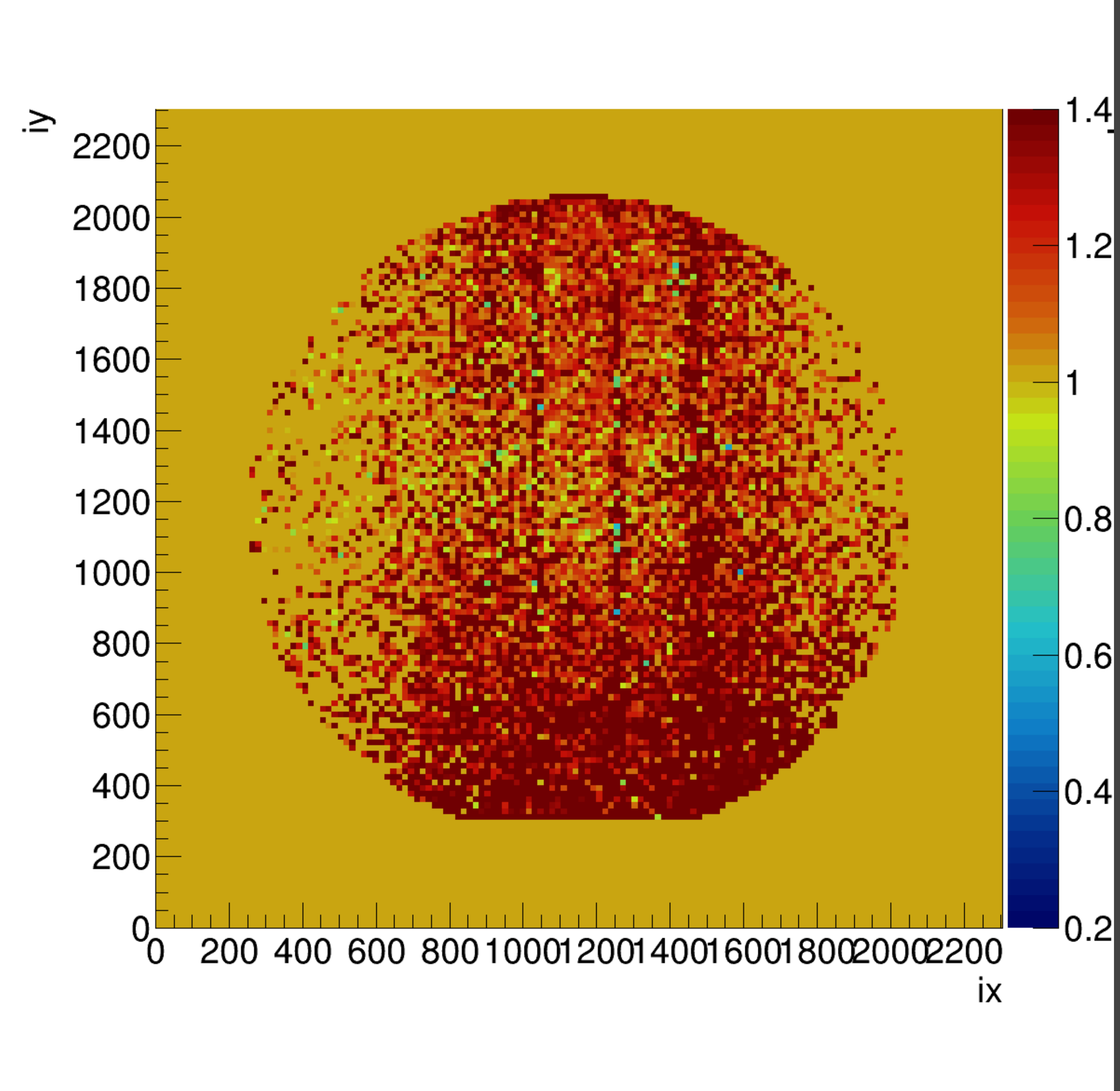
We work with f/0.95 and OO' ~ 650 [mm];

Even if our configuration does not seem to be reported, anyway the comparison between the profile we measured and we use seems different for large R from datasheet

Vignetting

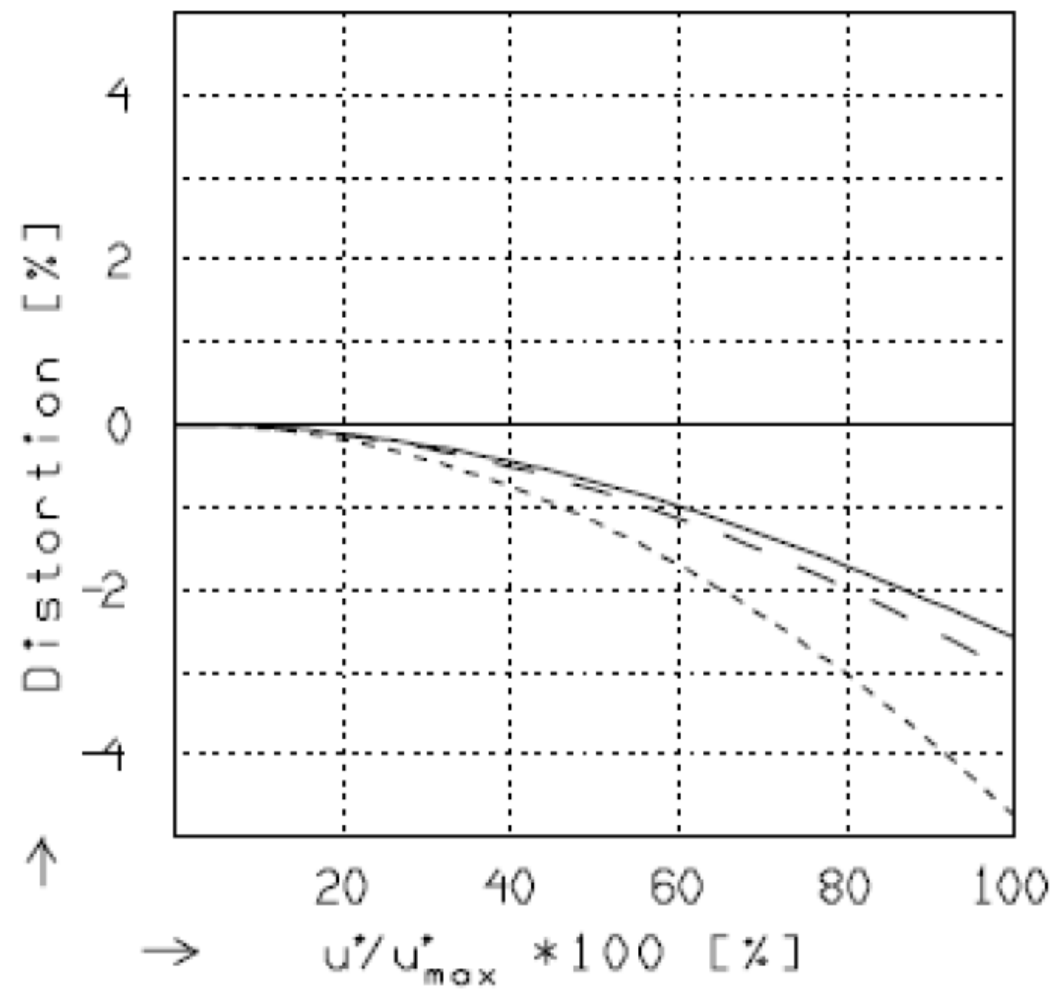
Are we over-estimating the corrections to external events?





Regression seems to compensate more on the borders. To check better

Distortion



DISTORTION

Distortion is shown for the given focal distances or magnifications. Positive values indicate pincushion distortion and negative values barrel distortion.

——	ß' = 0.0000	u'_{max} = 8.0	OO' = ∞
— —	ß' = -0.0200	u'_{max} = 8.0	OO' = 1323.
-----	ß' = -0.1000	u'_{max} = 8.0	OO' = 300.

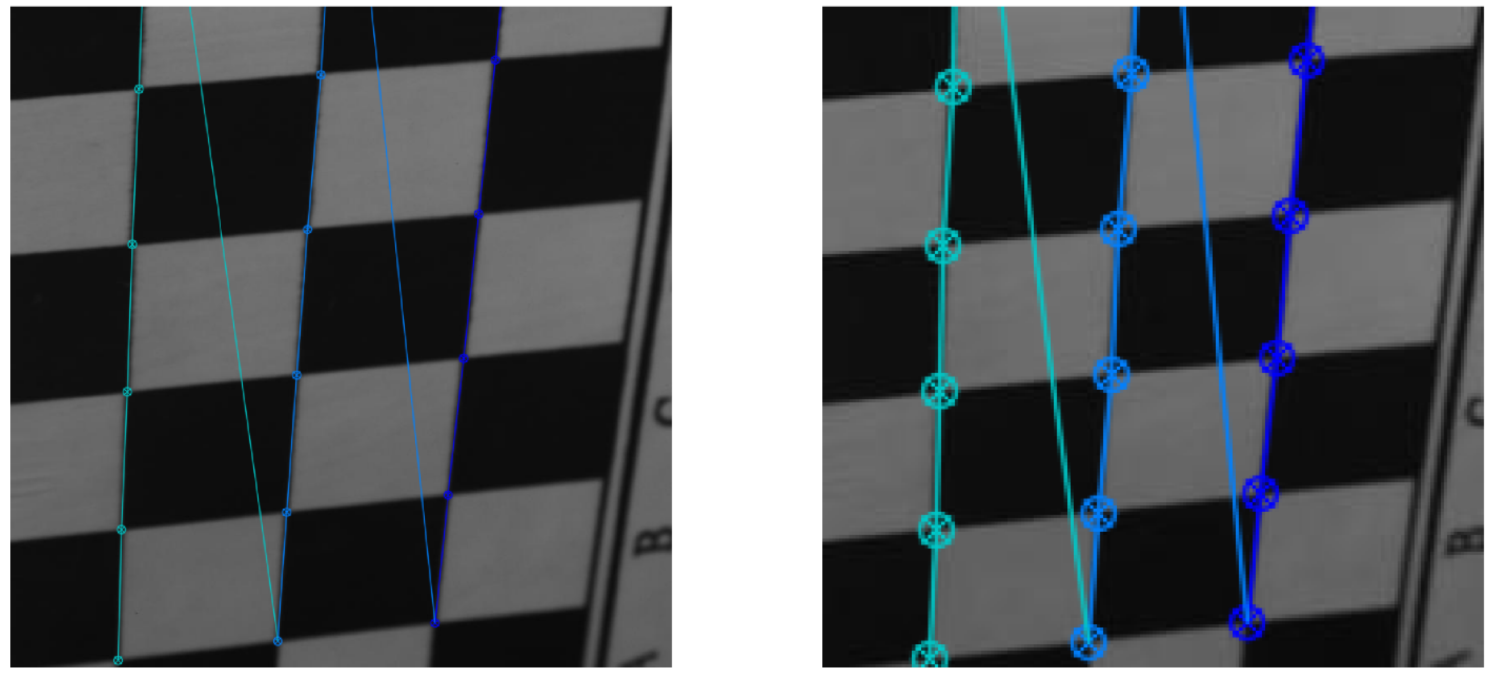
According to the manual, the “vignetting” effect depends on:

- Object distance (OO’);
- Optical aperture;

We expect on the edge of the image a maximum distortion of 4-5%

Distortion

From the image of a chessboard, lab students were able to reconstruct the properties of our lens;



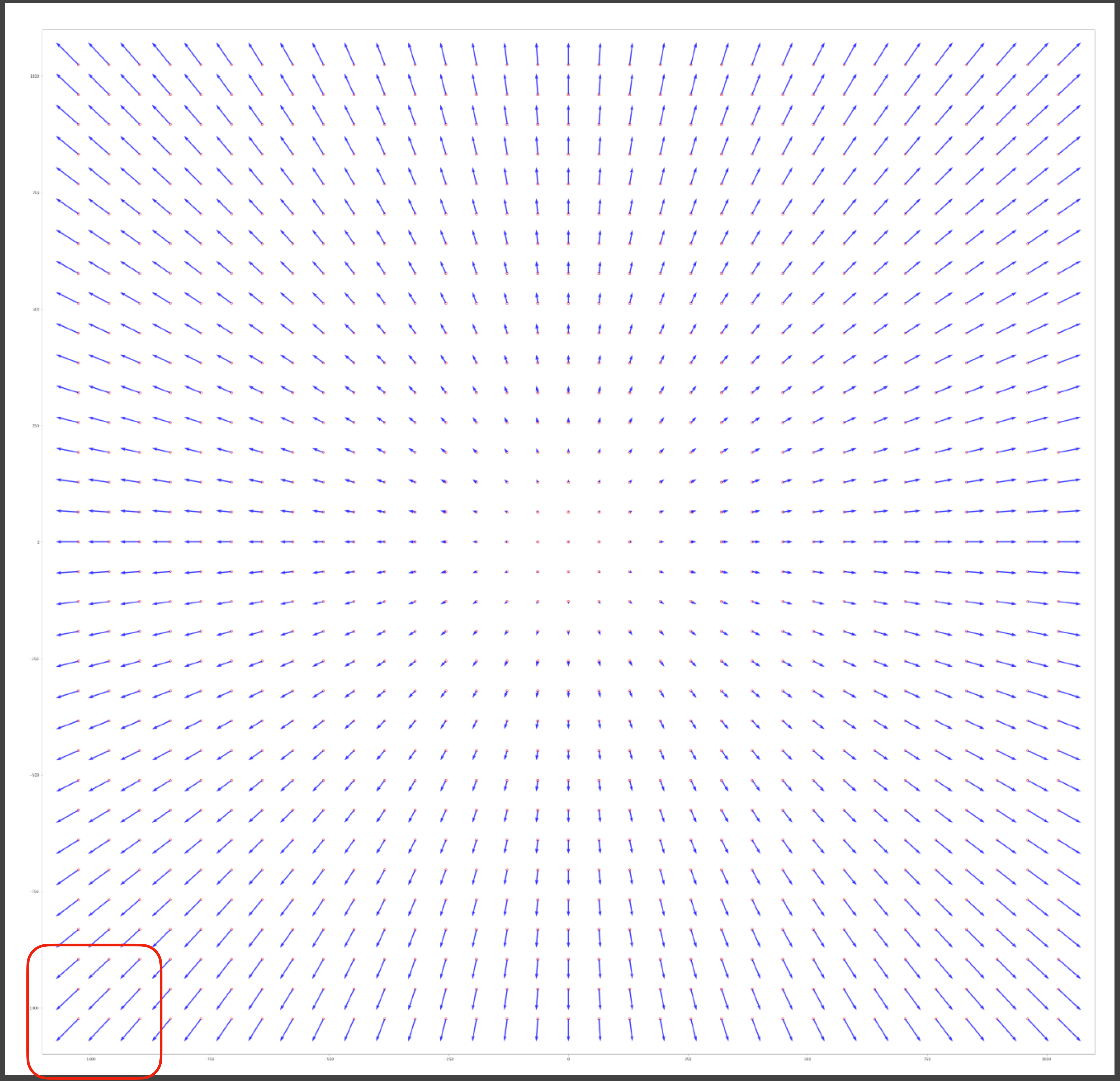
(a) high quality image (b) reduced quality image

Figure 2: The edges of the chessboard identified by our program

1.3.1 Focal Length and Optical Centers

The estimated focal length and image centers are

	Equivalent Pixel Units	Physical units (mm)
f_x	$0.98\ 10^2$	25.5
f_y	$1.00\ 10^2$	26.0
u	$2.39\ 10^2$	6.21
v	$2.63\ 10^2$	6.84



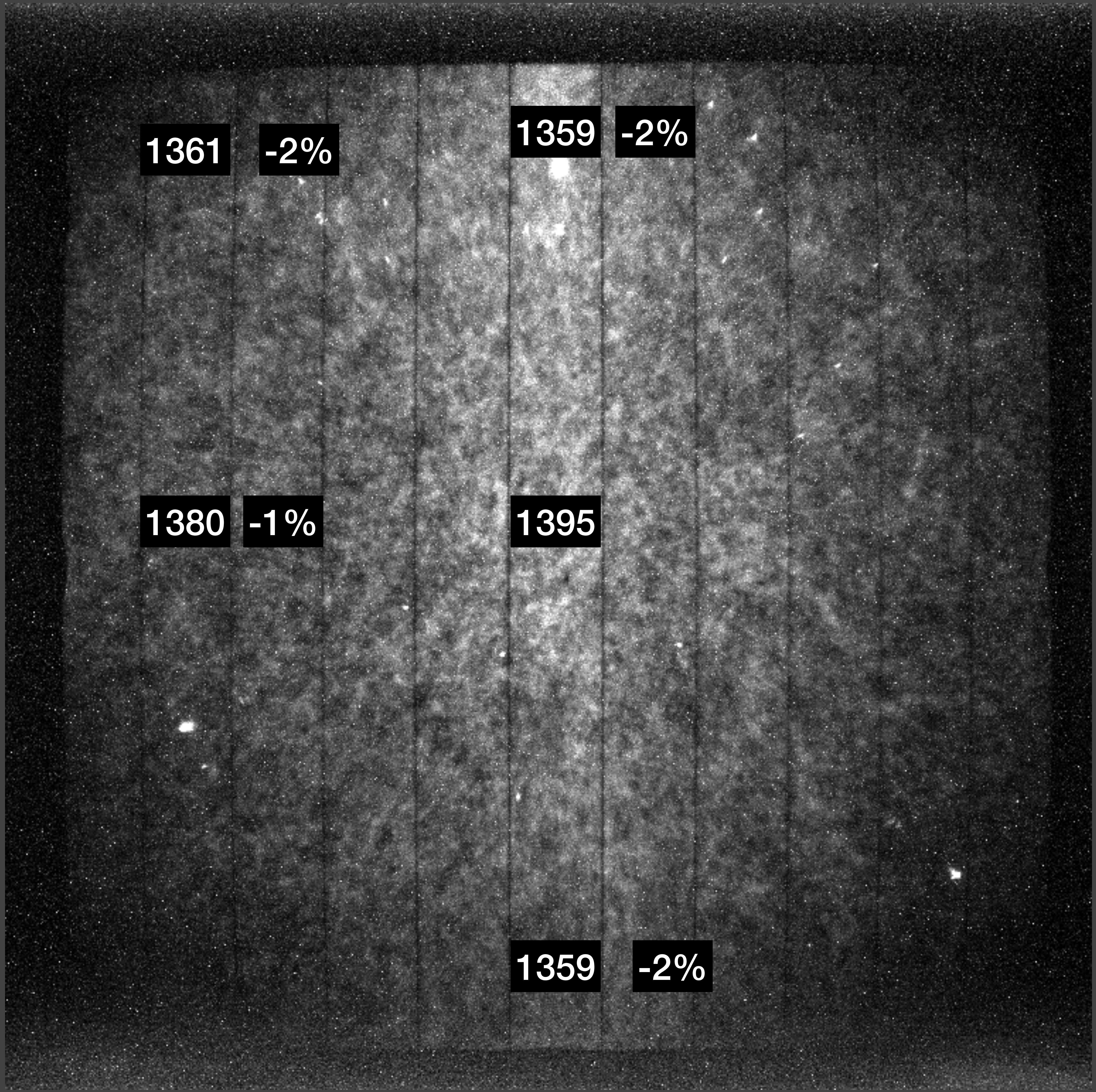
4% maximum displacement

Distortion

Image obtained accumulating radioactivity bkg.

We report the distances in a. u. between the lines produced by the GEM sectore

- W.r.t. the image center, we have 1-2% distortion;
- In particular, the image on the lateral regions is squeezed ;
- A precise map should be realised.

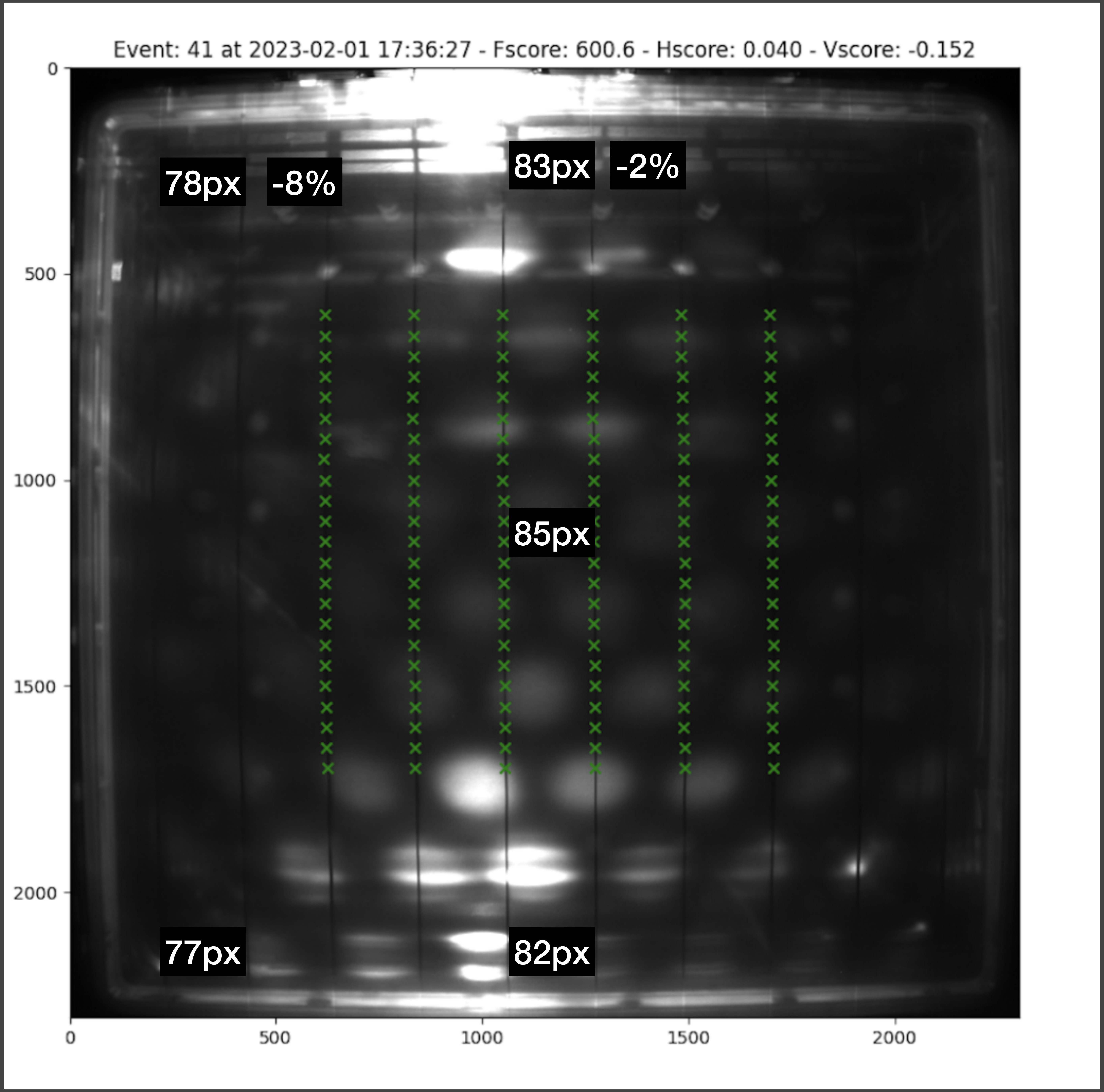


Distortion

Image obtained by illuminating with led

We report the distances in pixels between the lines produced by the GEM sectors

- W.r.t. the image center, we have 2-8% distortion;
- In particular, the image on the lateral regions is squeezed ;
- A precise map should be realised.



Conclusion

Optical effects were studied several times, without a solid conclusion;

We are correcting for an effective vignetting, which is different from the datasheet expectations. We should find a way of properly evaluated it;

Effects of optical distortions are not expected to be very large (4-5% only on the very lateral parts), but we should start to take them into account;

Can we use to LIME-stop period to make measurements?