1. Introduction

This document summarizes the inspections and measurements of the defect in the FLAMES corrector lens, which were made by ESO staff in August 2023.

1.1 Initial Detection of the Defect

The lens defect was initially noticed and inspected in November 2022. It seemingly reaches the edge of the lens on both ends, i.e. is unlikely to grow further (and has not grown since November 2022).

A line defect is clearly visible in figure 1. The defect is in the diverging lens of the corrector (the lens closest to the focal plane). It was also found that parallel to the original defect, 'crack propagation lines' were found, although faint.

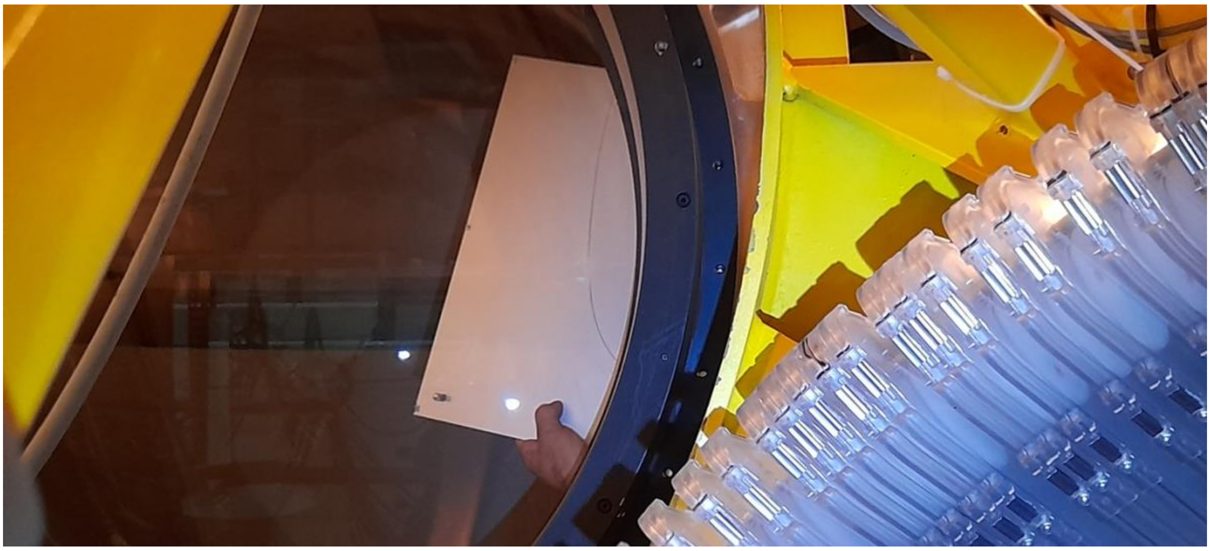

Figure 1: The defect shortly after its discovery

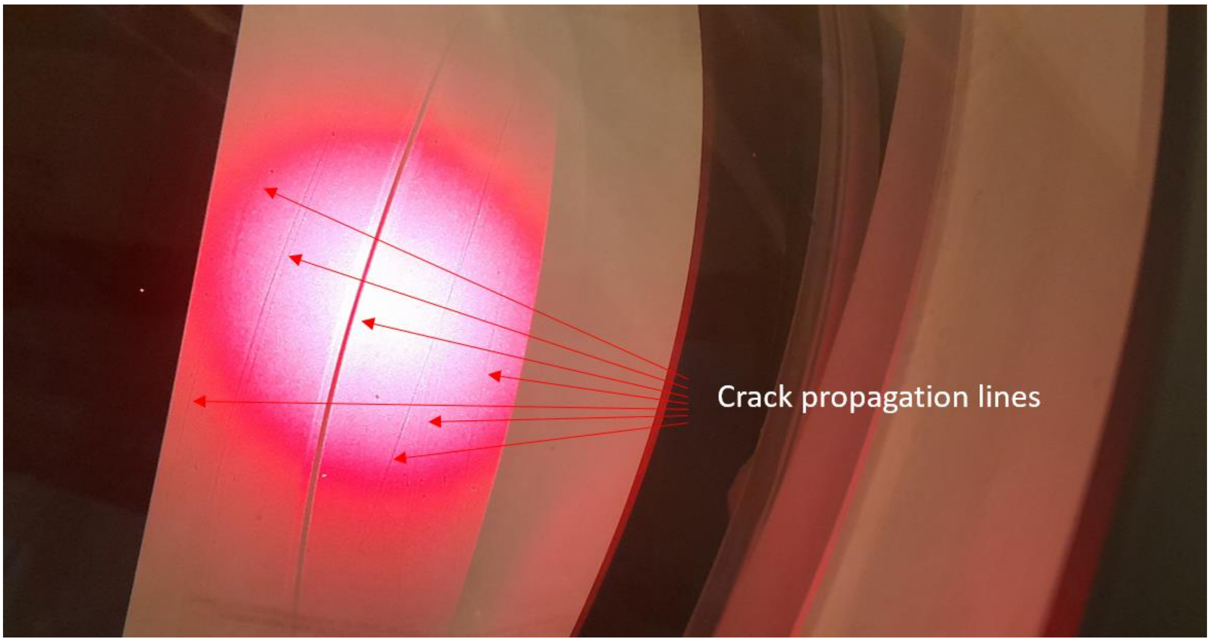

Figure 2: Crack propagation lines were detected as well

2. Footprints and Light Beam at the Corrector Lens

As the converging lens is very close to the focal planes where the FLAMES fibres are located, the footprint of any defect is small, so the impact is very localised. The defect protrudes about 7cm into the lens, which translates to about 11.5 arcmin radius from the centre of the field. In this area close to the edge of the FoV (12.5 arcmin maximum) significant vignetting is already present, and in general, many PIs already avoid this area for that reason. However, in order to minimize any effect on any of the fibres placed by PIs, measures need to be taken and/or the impact on the data understood.

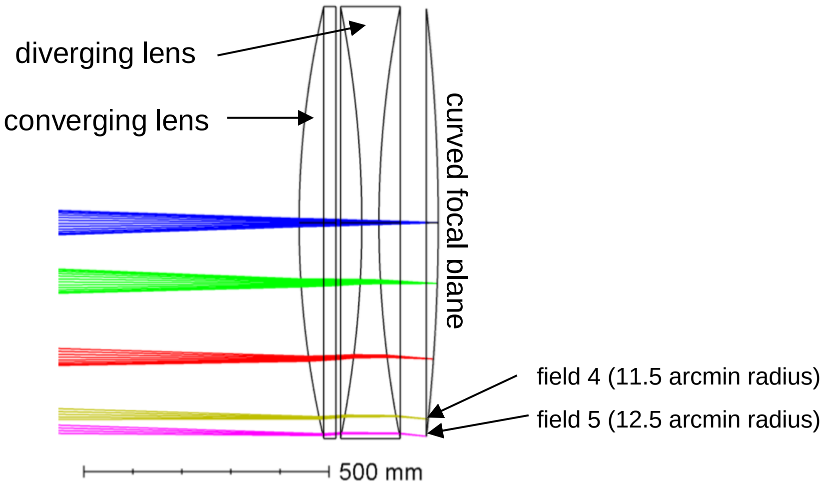

Figure 3: The beam from the telescope passing through the corrector lens

3. Inspections and Measurements in August 2023

3.1 Visual Inspections

Figure shows an image of the line defect as viewed from the Nasmyth tube with fibres placed strategically behind it. The line defect extends to about 11.5 arcmin FoV from the center of the FoV. The ends at the maximum diameter of the lens are close to fibre 122 and fibre 147, corresponding to an angle from the centre of the plate of about 34º.

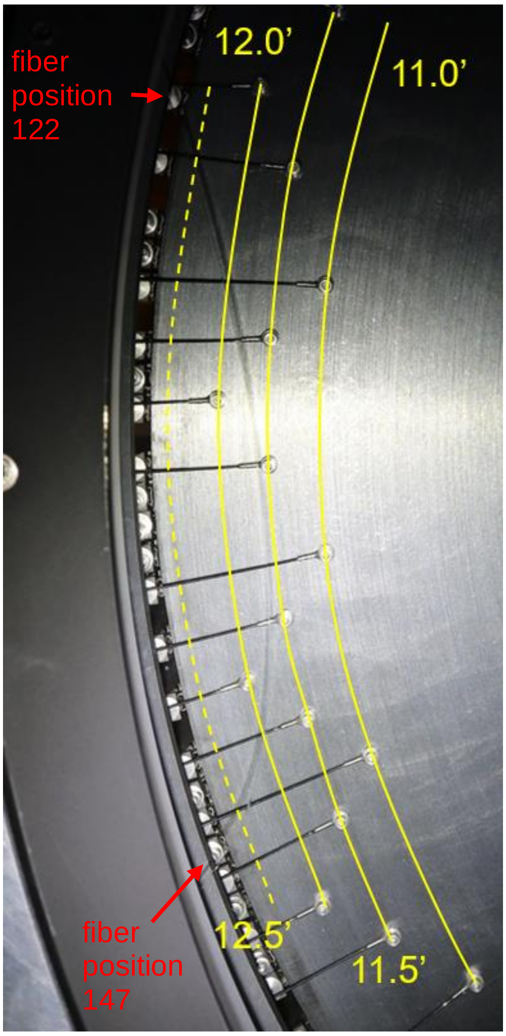

Figure 4: The defect as viewed from the Nasmyth tube (note that in this image, the defect is viewed at an angle at the ends and thus the projection of the defect does not exactly correspond to the fibre numbers stated in the text)

3.2 Laser Measurements

In order to characterize the impact of the defect, laser measurements were performed, and the sensor output recorded with a PC.

Figure shows the intensity when tracking across the defect. The two crossings at the line defect are clearly visible with intensity reductions of roughly 50% and 30%. The first passing also shows an increase in intensity before decreasing. This is likely to a result of reflection and diffraction of the light when crossing the defect. An additional change in intensity can be seen in between both crossings of the line defect. A possible explanation could be the “crack propagation lines”.

Similar measurements were made at different radii in the focal plane, i.e. across different sections of the crack, with similar results.

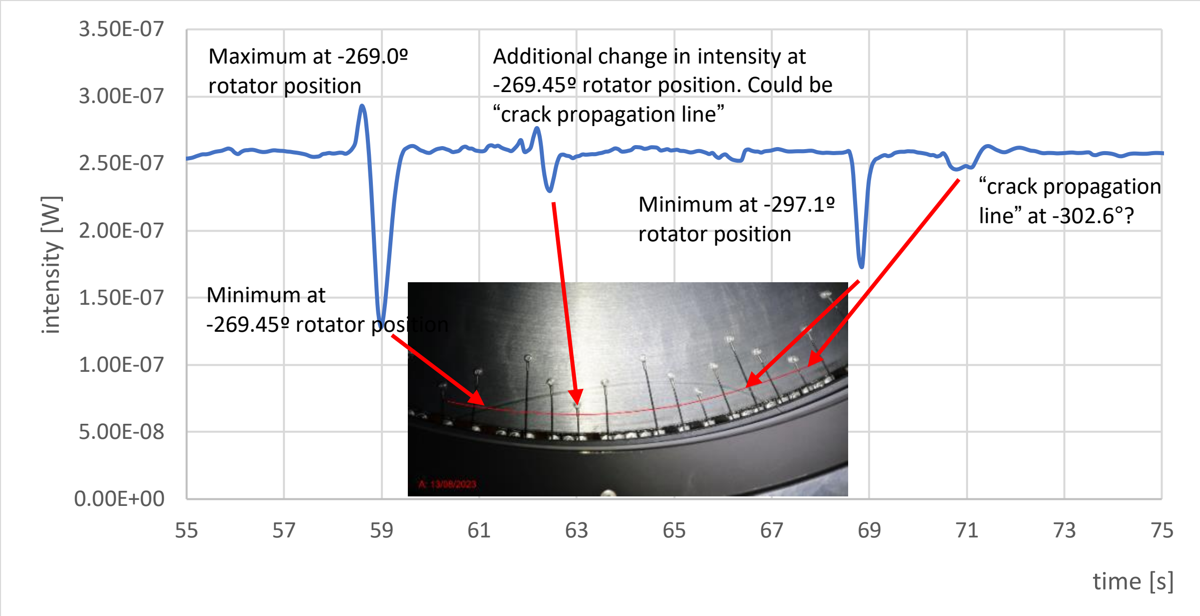

Figure 5: Intensity during rotator movement for measurement across one section of the defect.

After the laser measurements a millimetre paper was used as a screen at a distance of approximately 3.5 m from the lens defect. When positioning the line defect at the minimum intensity positions, a diffraction pattern perpendicular to the direction of the defect could be observed (see **Error! Reference source not found.**). Assuming diffraction at a single slit (i.e. the negative of the line defect), the width of the defect can be estimated to 0.37mm.

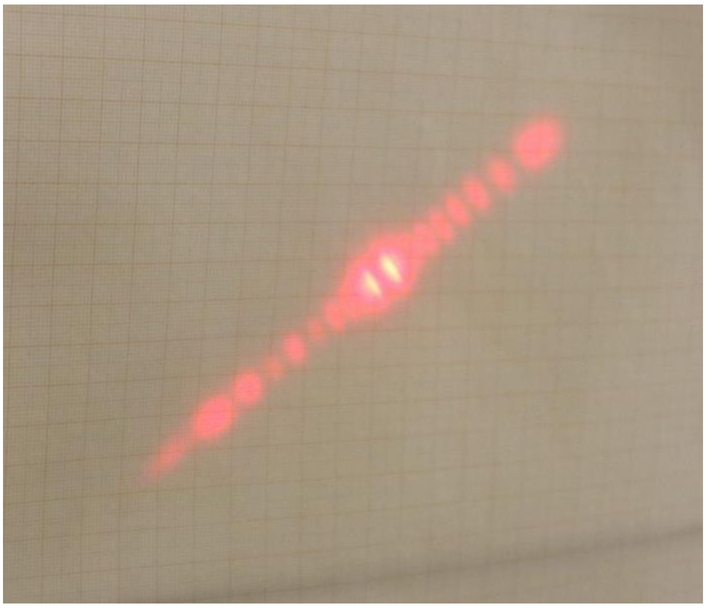

Figure 2: The interference pattern at one of the minima visible in Fig 5.

4. Possible Solution

While the exact effect on data of fibres placed in the area of the defect is extremely difficult to measure as it will be wavelength, position and condition (seeing?) dependent, the field corrector lens is rotating with the fibre plate. As such, the defect impacts a fixed area on the plate, instead of potentially affecting any fibres placed beyond 11.5”. As a result, we propose a no-go zone for the fibres, slightly larger than the area of the defect itself.

In order to limit the impacted area, we have decided to introduce a tight no-go area that covers only the defect itself (starting at fibre position 122, ending at 147 with a distance to the field centre of larger than 11.2 arcmin), but excludes some of the crack propagation lines that could have some impact on the data. While this effect would be smaller, PIs should be aware of the possible small effect on their data in this area.

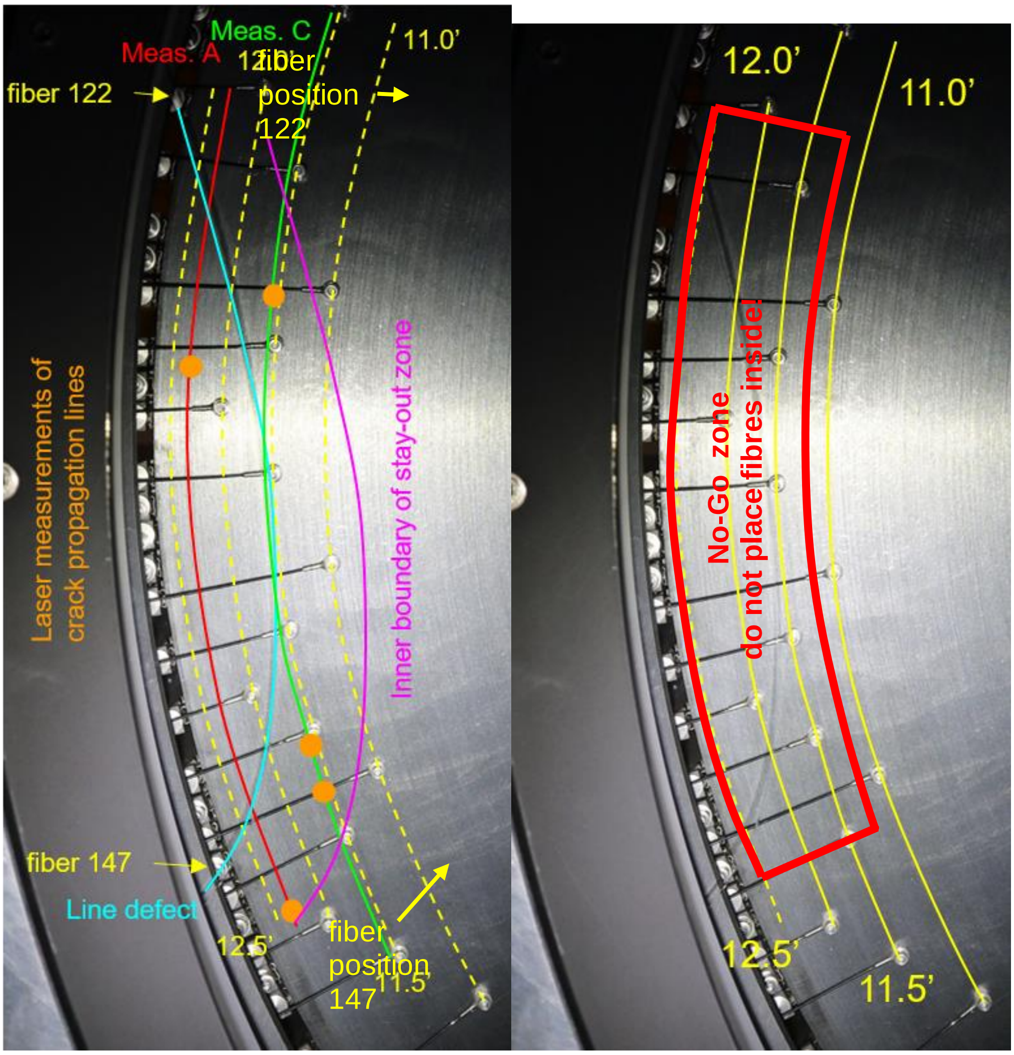

Figure 3: Left: The position of the line defect and the propagation lines. Right: The proposed no-go zone for the fibres in red from fibre 122 to fibre 147 (both included) and distance to the field centre >11.2 arcmin.