Measurement and image quality testing report

Test optical systems:
two samples of Carl Zeiss C Sonnar T* 50mm f1.5 ZM

ESEO lens_1
ESEO lens_2

February, 2017

Tartu
Estonia

Contents:

1. ESEO lens_1

f#=1.5

f’= 50 mm

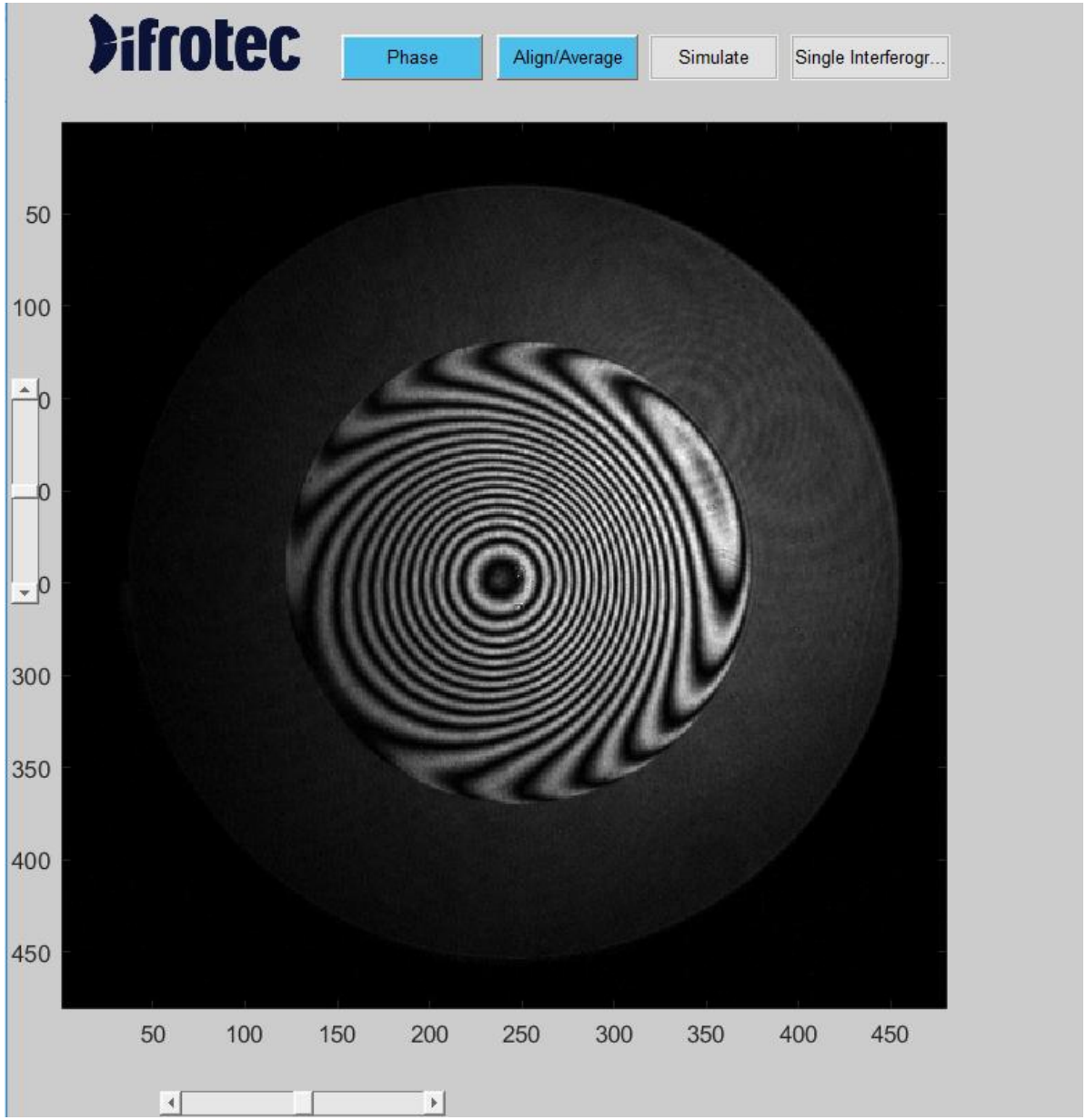


Figure 1. **Interferogram of the on-axis beam**

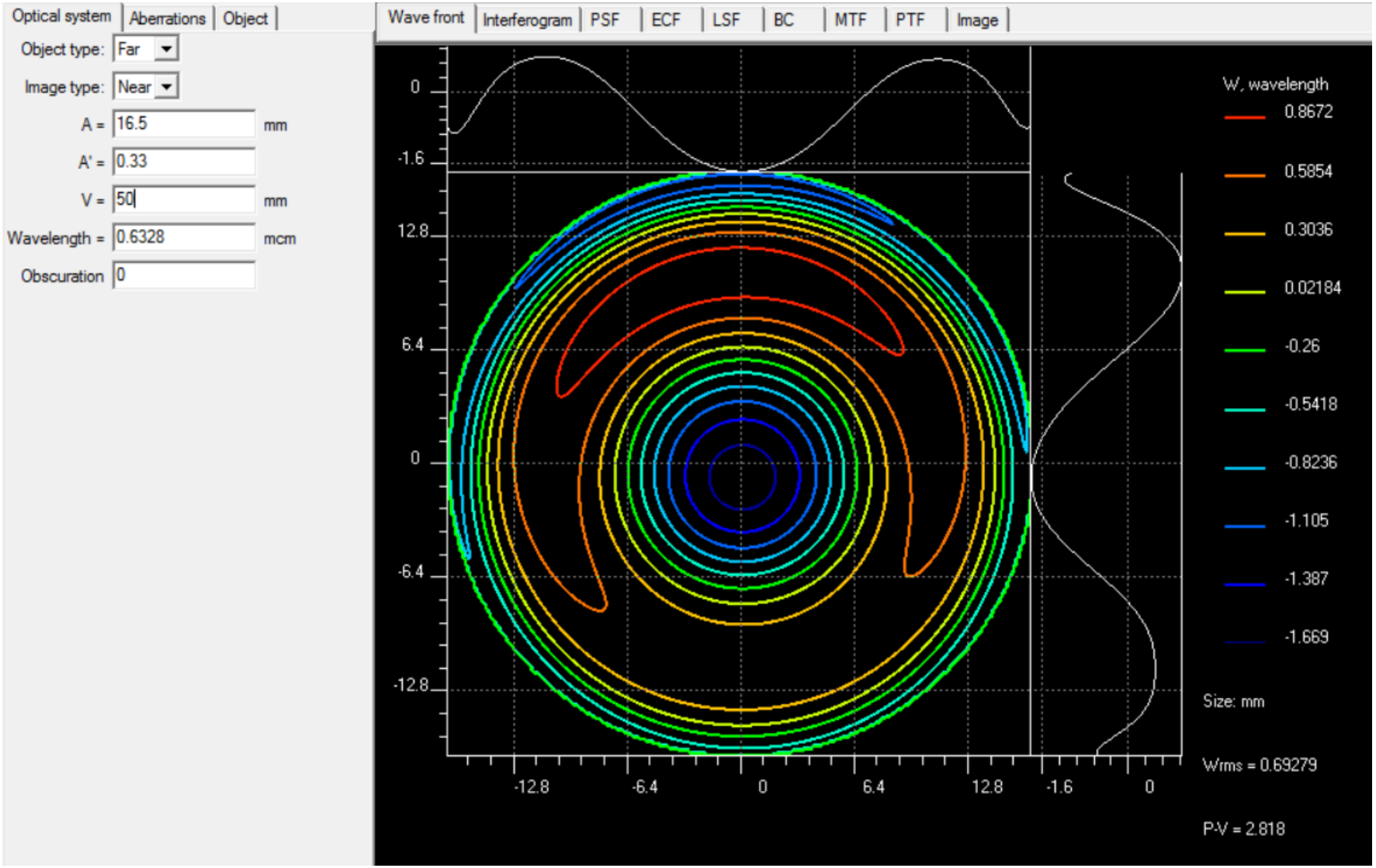
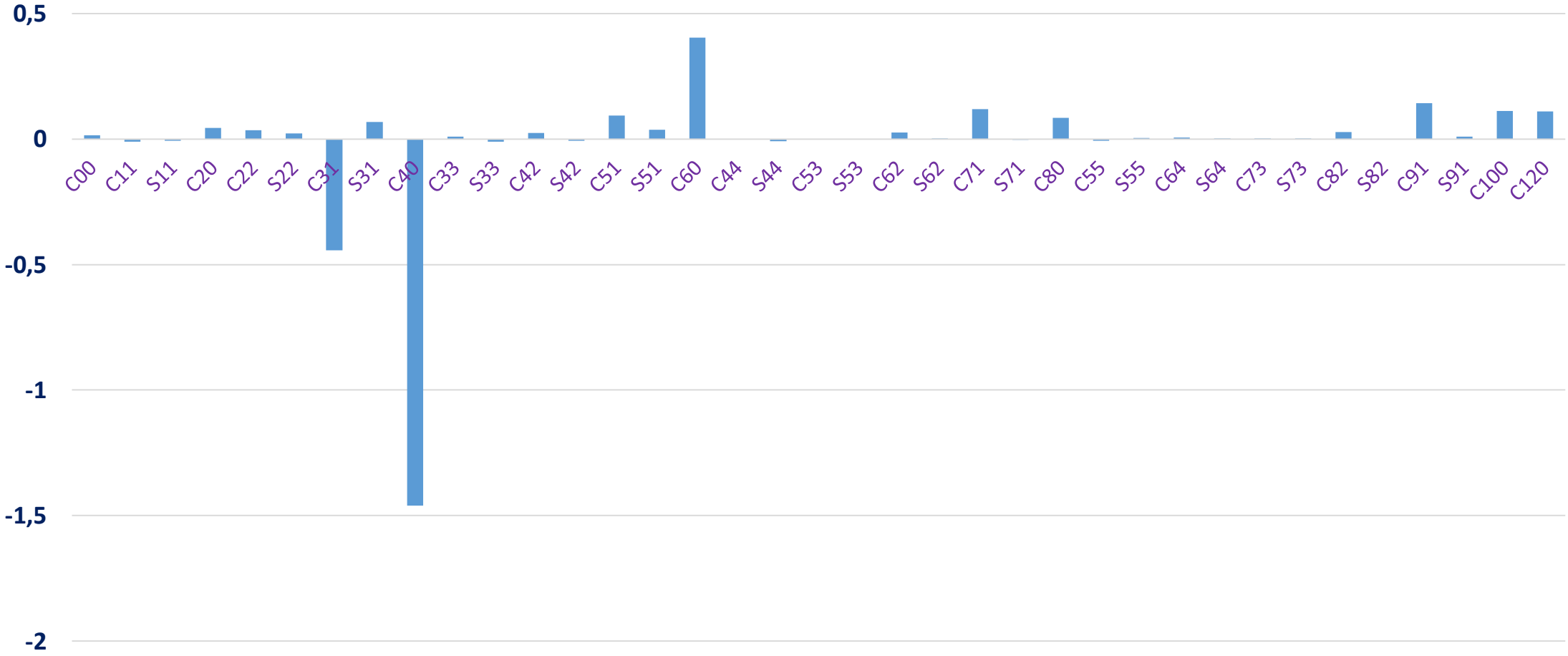


Figure 2. **Wavefront diagram**

Zernike diagramm (in wavelenghts)



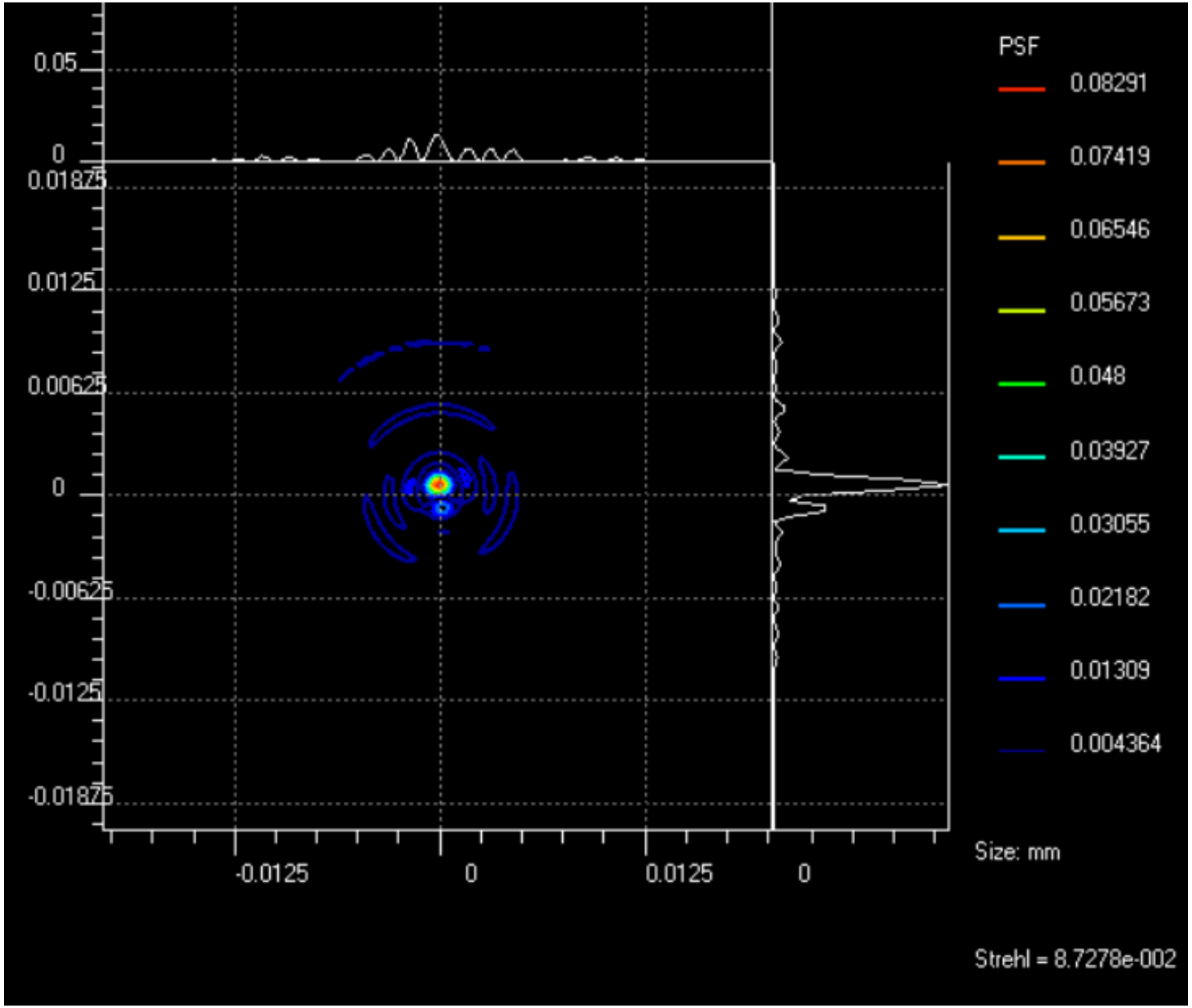


Figure 3. **Point spread function**

10 periods
Y-size: 400 m
X-size: 20 m
X-spacing: 20 m
Distance of shooting: 500 km

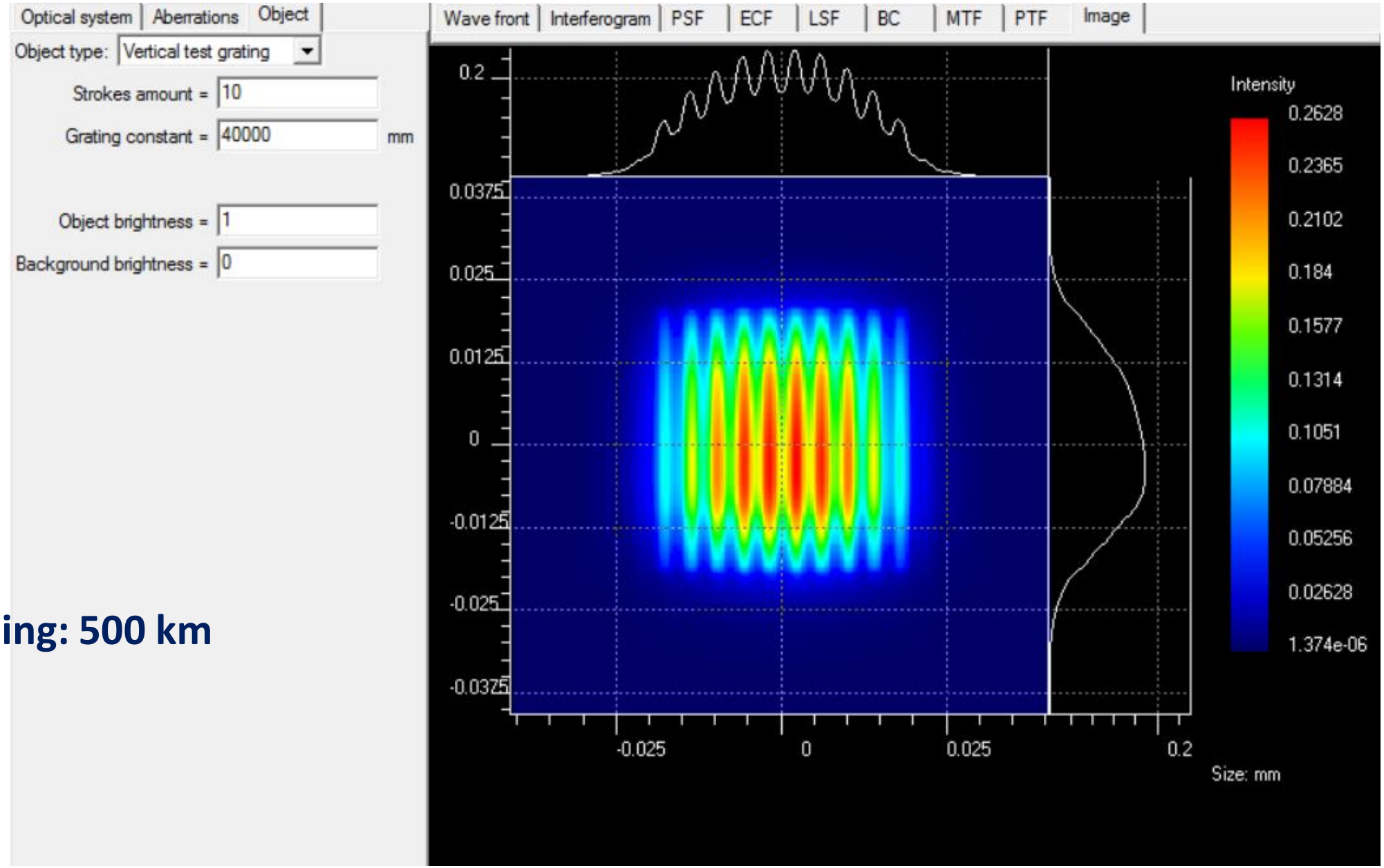


Figure 4. **Y test grating image**

10 periods
Y-size: 400 m
X-size: 20 m
X-spacing: 20 m
Distance of shooting: 500 km

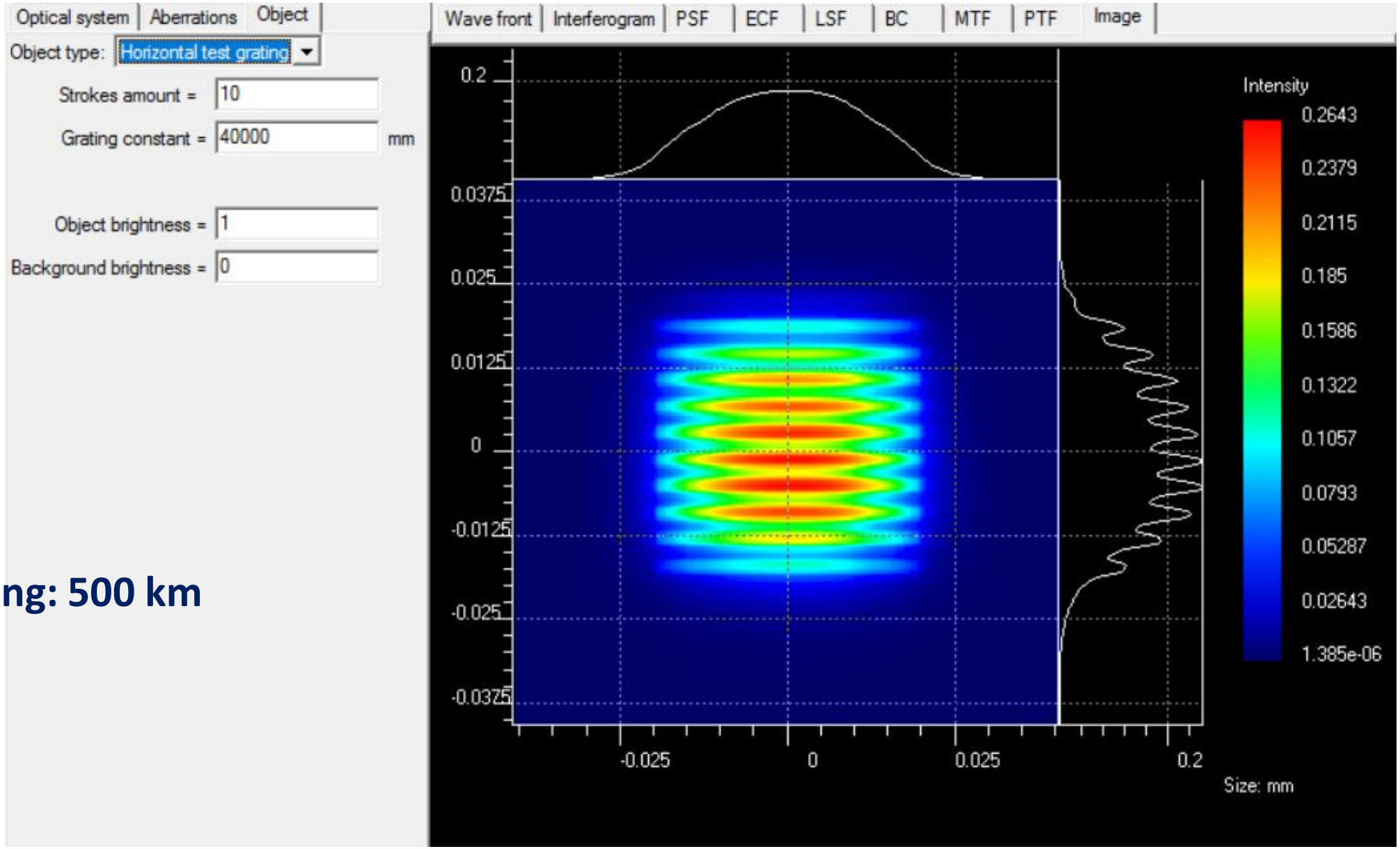


Figure 5. **X test grating image**

Number of segments: 10
Radius: 200 m

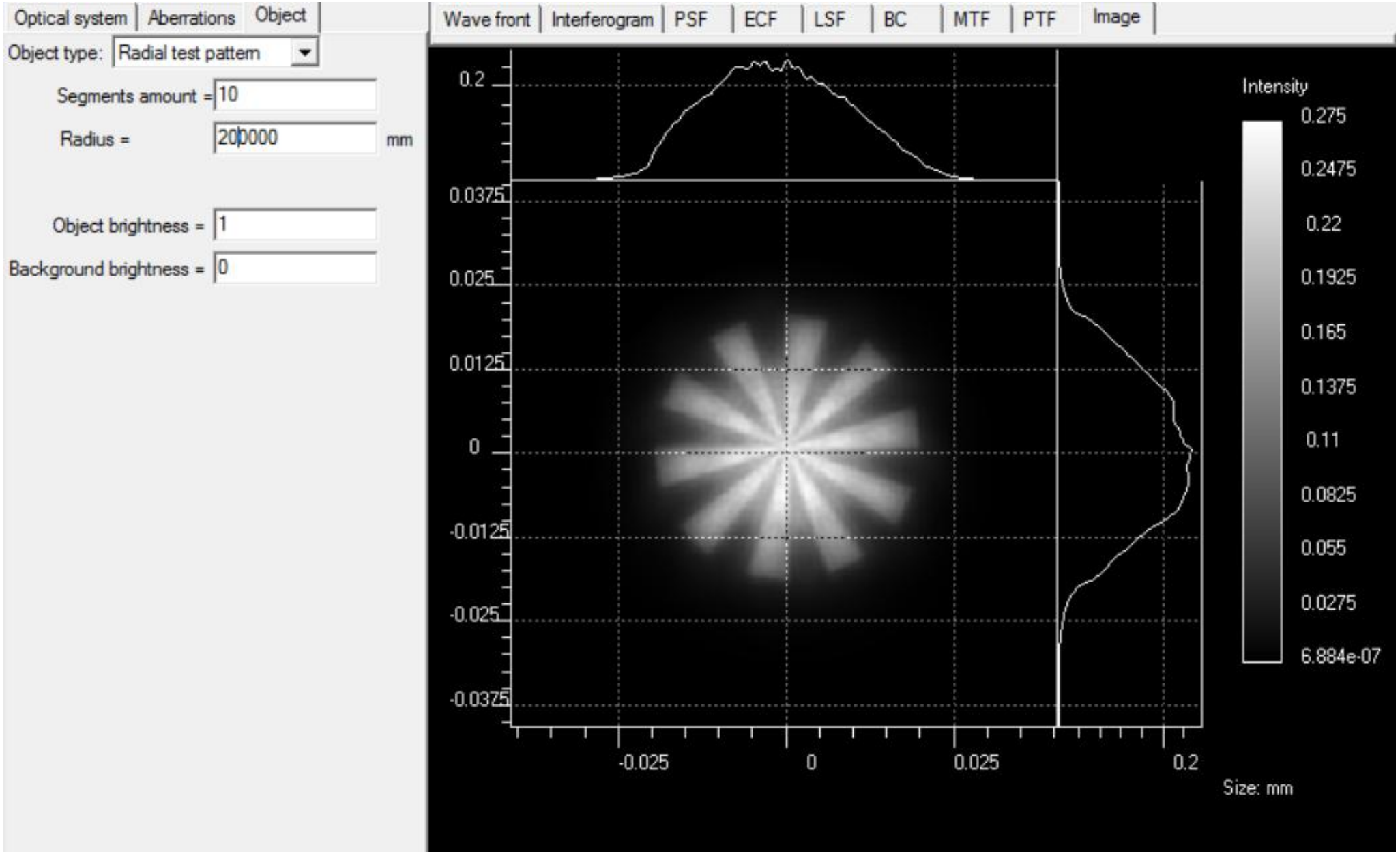


Figure 6. **Radial test target image**

2. ESEO lens_2

f#=1.5

f’= 50 mm

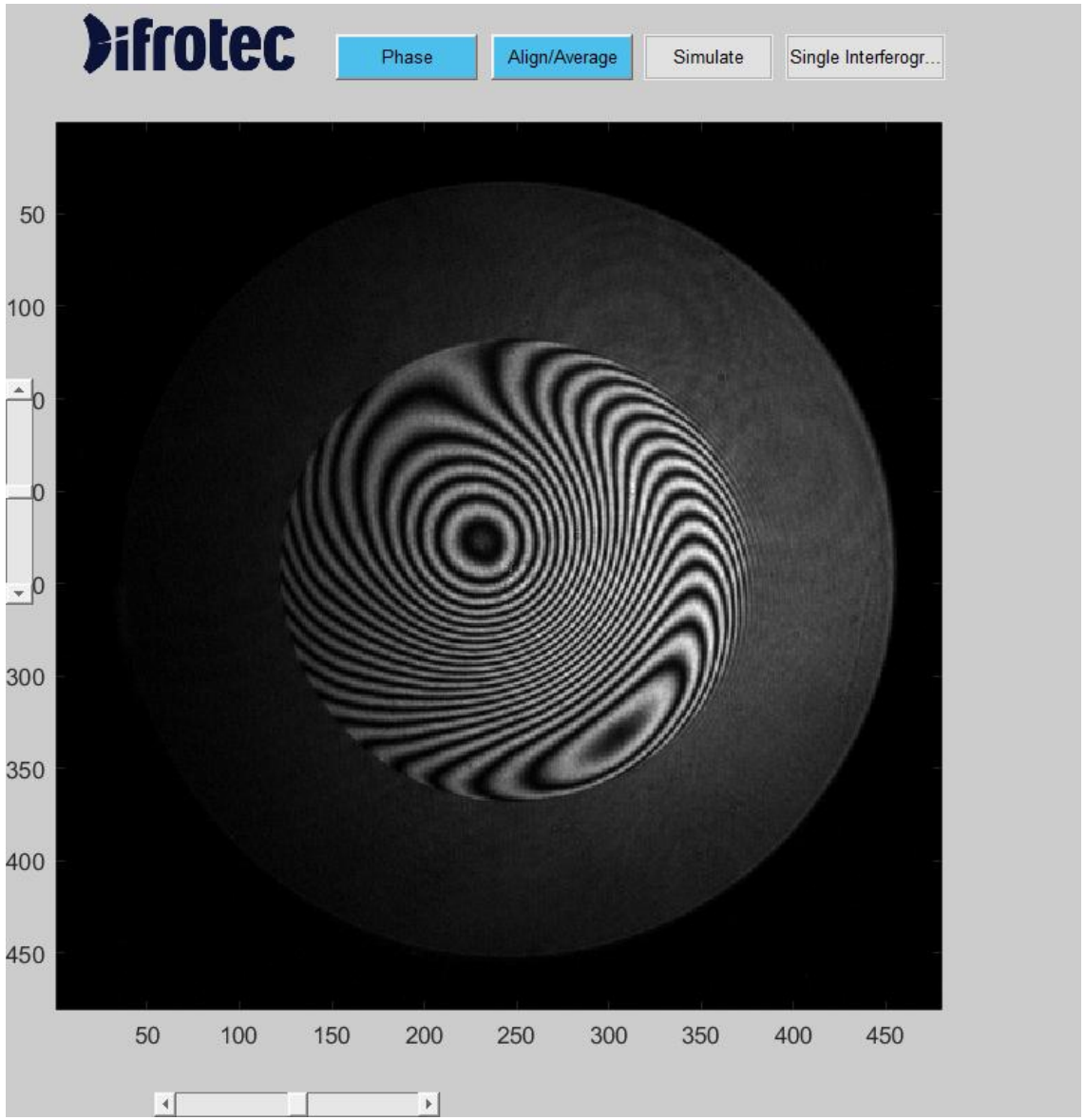


Figure 7. **Interferogram of the on-axis beam**

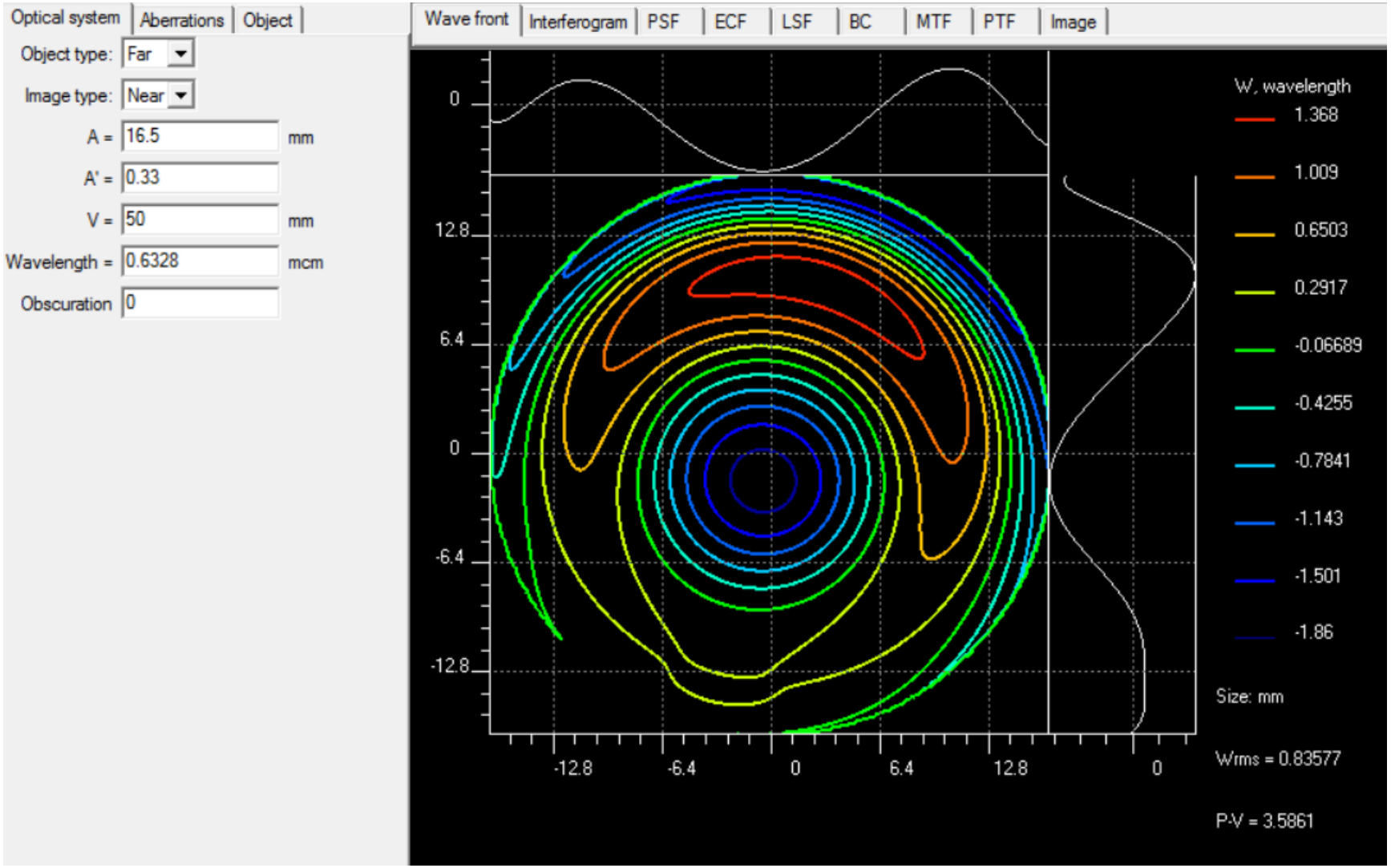
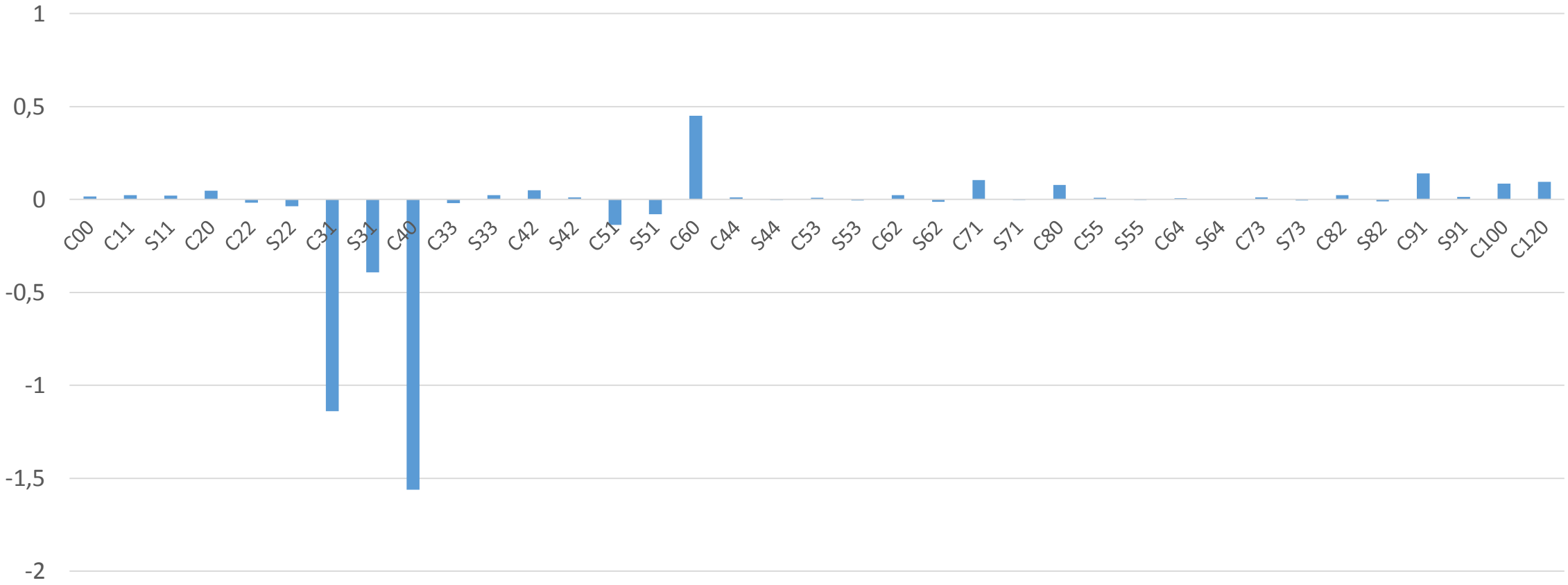


Figure 8. **Wavefront diagram**

Zernike diagramm (in wavelengths)



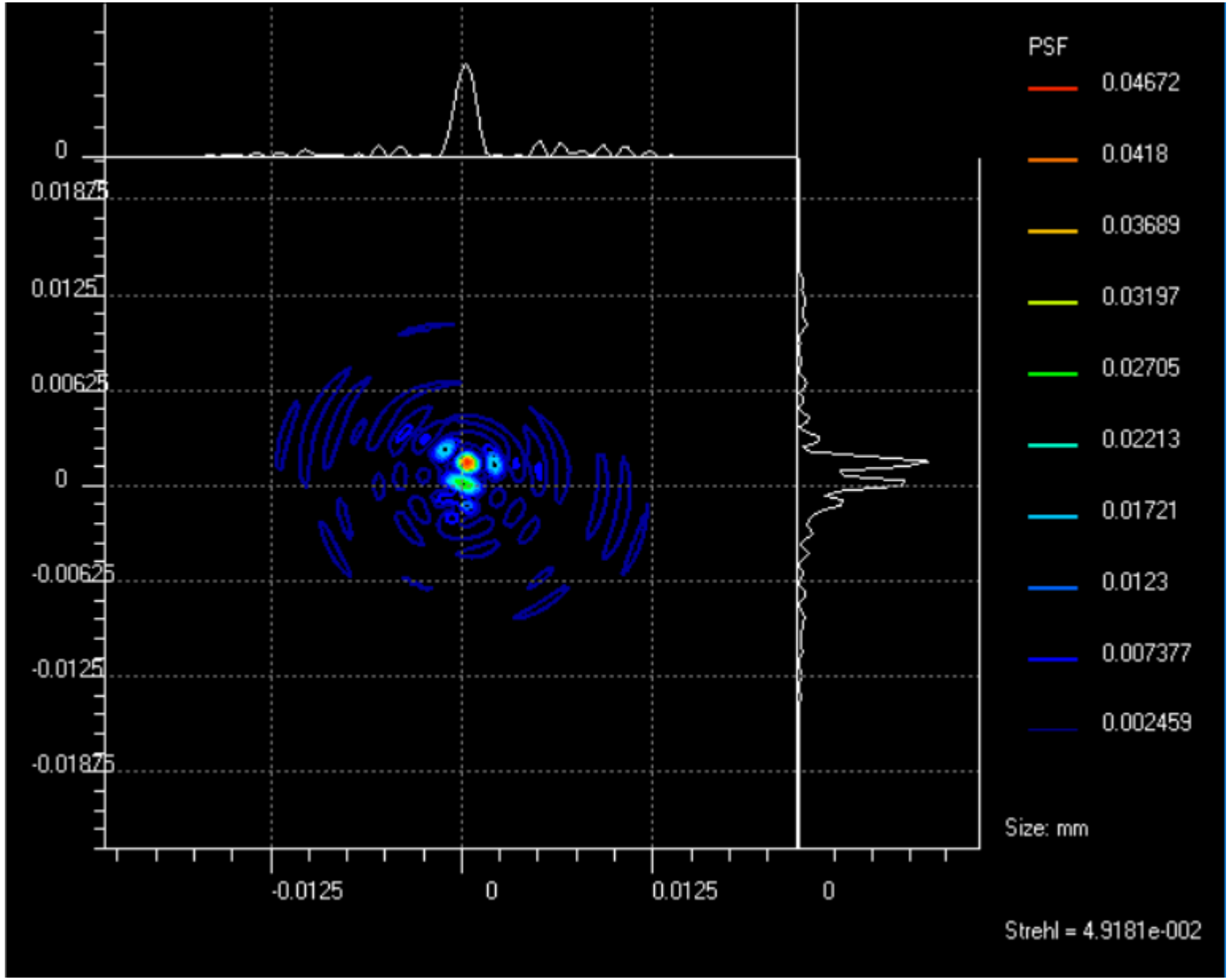


Figure 9. **Point spread function**

10 periods
Y-size: 400 m
X-size: 20 m
X-spacing: 20 m
Distance of shooting: 500 km

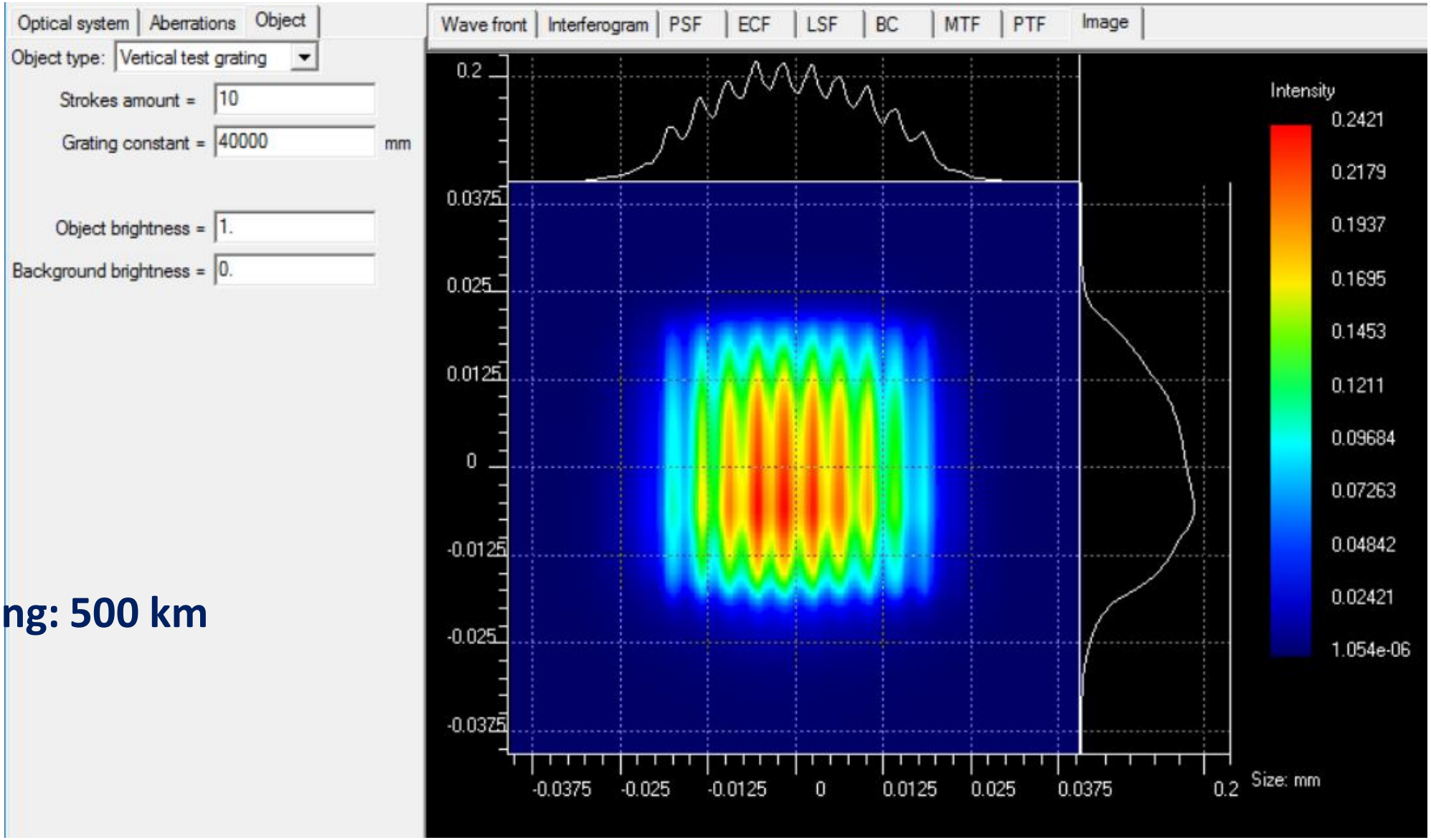


Figure 10. **Y test grating image**

10 periods
Y-size: 400 m
X-size: 20 m
X-spacing: 20 m
Distance of shooting: 500 km

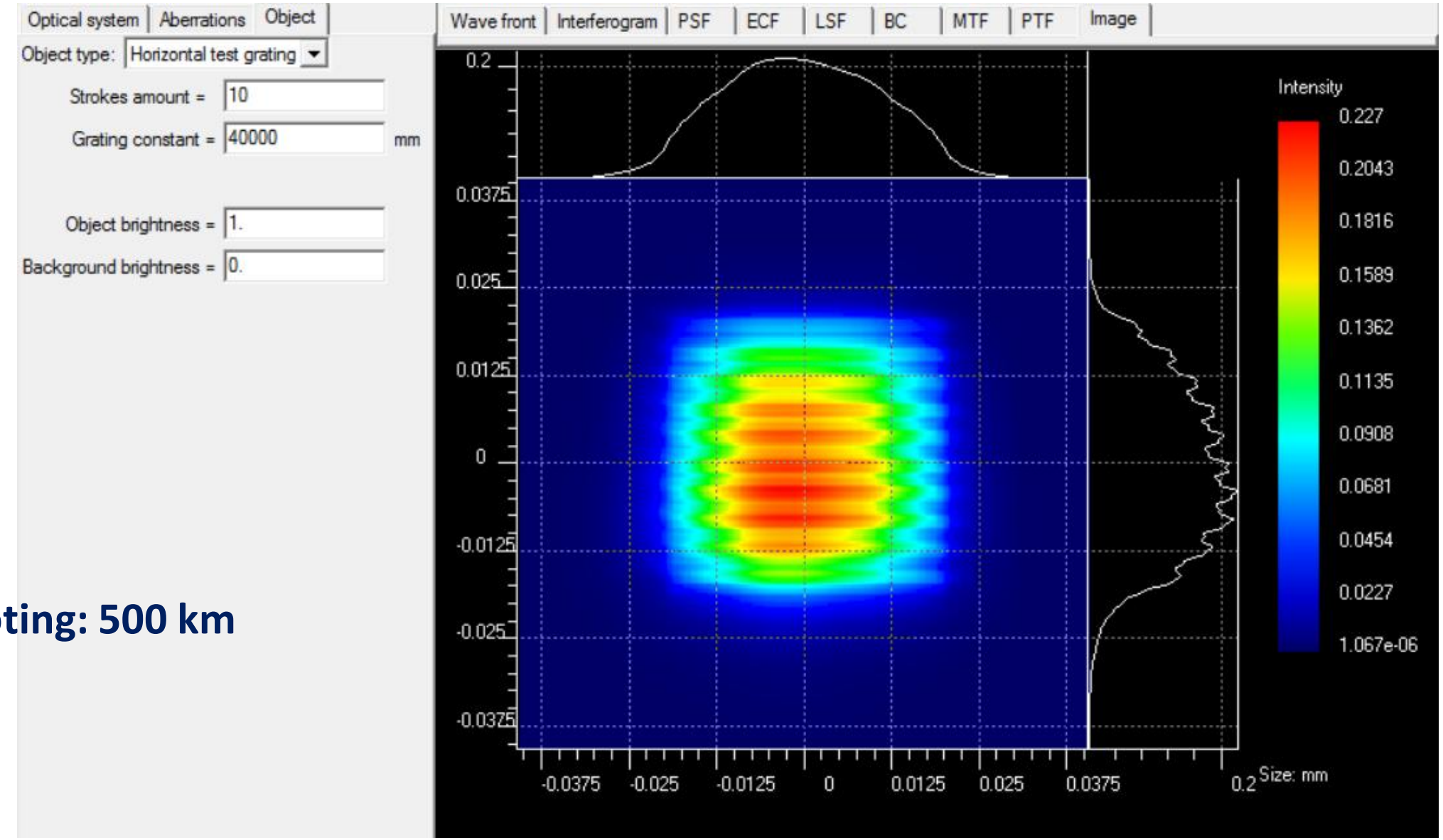


Figure 11. **X test grating image**

Number of segments: 10
Radius: 200 m

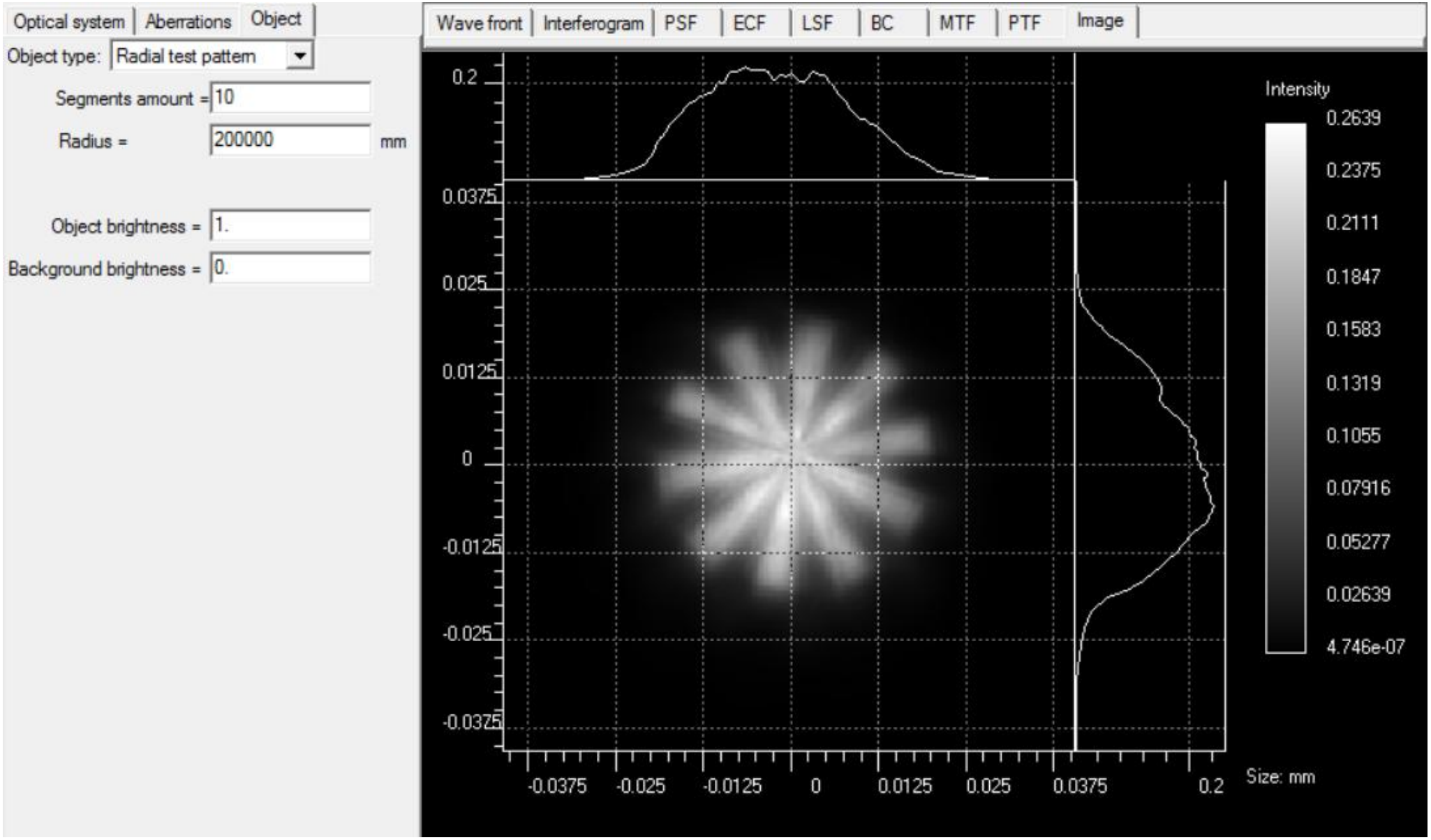


Figure 12. **Radial test target image**

3. Conclusion

The measurement results after processing and image modeling show quality of both lenses common for such kind of optics. Most of photolenses have wave aberration peak_to_valley (P_V) 1 – 3 wavelenghts, therefore their quality cannot be estimated by one value e.g. Strehl ratio or Maréchal criterion. For such lenses besides wavefront and Zernike coefficients diagrams it is necessary to calculate PSF and simulate images of test targets. Measurements and image analysis performed by Difrotec show noticeable difference between two lenses.

1) ESEO lens_1 is assembled better and has smaller spherical aberrations and very small coma. Therefore the images of the same test targets evidently demonstrate better quality.
2) For ESEO lens_1 the min visibility of the features on Earth having size about 20 meters is below the threshold of contrast 5% assumed for CCD receivers.
3) ESEO lens_2 contains some assymetry in its construction. It may be great decenter of the first optical component inside the lens (counted from the image receiver). The value of decenter looks like exceeding allowed tolerance and probably is introduced during recent mechanical work with the lens. Assymetry leads to coma and blurring images of smallest objects. Therefore the accessible quality of image decreases additionally to designed rotationally symmetric aberrations.

Test target	Min contrast (%)	
	ESEO lens_1	ESEO lens_2
Y grating 40 m period	12.5	11.0
X grating 40 m period	12.5	2.5
Radial 10 segments 200 m radius	Radius to 5% contrast	
	50 meters	100 meters

4) ESEO lens_1 at the distance 500 km resloves features with **20 m size**.
5) ESEO lens_2 at the distance 500 km does not resolve features with 20 m size, it is able to resolve features over **60 m**.

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