# 2nd generation ITM M2

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## ABSTRACT

This report describes the study of an alternative optical design for the ITM (International Telescope Maffei) ex-IRAIT telescope installed at Concordia Base in Antarctica[1234] . The goal is to reduce the focal number of the telescope.

**Keywords:** ITM, IRAIT, Concordia, Infrared

## 1. INTRODUCTION

ITM (International Telescope Maffei) is the italian telescope installed at Concordia base at DOME C in Antarctica (ex-IRAIT)[1234] . It was designed to operate in such extreme environment for infrared observations, with its first camera AMICA, a dual band camera in neaar IR (1-5 micron) and medium IR (5-27 micron). The evolution of instrumentation to be installed at the telescope required a dedicated study for a possible change in the focal number from the built f/21.1651 to shorter f/#.

## 2. THE STUDY

In the present technical note we describe few possible scenarios for ITM telescope. The main driver is to provide a choice for a target f/15 and an alternative f/10. The study has several constraints: from the usual "be cheap", to a more severe "preserve the focal extraction" form the Nasmith focus (see Figure 1).

The second one enforces a design that modifies the M2 mounting, moving the secondary mirror closer to the M1 position. It has several implications to be taken in account:

- the reduction of M1-M2 distance implies an increase of the M2 size, since it intercepts the optical beam coming from the primary mirror earlier than the original design;
- this increase in size implies an increased central obscuration and a consequent increase of the vignetting;
- this movement can cause a change in the M3 size, or a further vignetting;
- the change in the M2 position implies a change of the mechanical mounting;

Given such considerations, we focus only on the optical properties of the new M2 possibilities, considering the mirror mounting as free as possible.

The mounted M2 has a radius of -920.470 $mm$, a conic constant of -1.83, is 130 $mm$ of diameter and is 2005 $mm$ far from M1; the f/# is 21.1651. Figure 2 shows the optical quality measured through the spot size. Looking at the central field (number 5) the RMS is 15.942 $\mu m$, the GEO radius is 34.357 $\mu m$. Another figure of merit proposed is the Zemax plot "Field Curvature and Distortion". Figure 3 shows the two plots for the nominal configuration.

### 2.1 f/15

The first scenario is the f/15 focal ratio. We propose two possibilities, one with an hyperbola and the other with aspheric shape. For this scenario the M2 has to be moved at a distance from M1 of 1888 $mm$; 117 $mm$ shorter than today. The mirror becomes 176 $mm$ of diameter.

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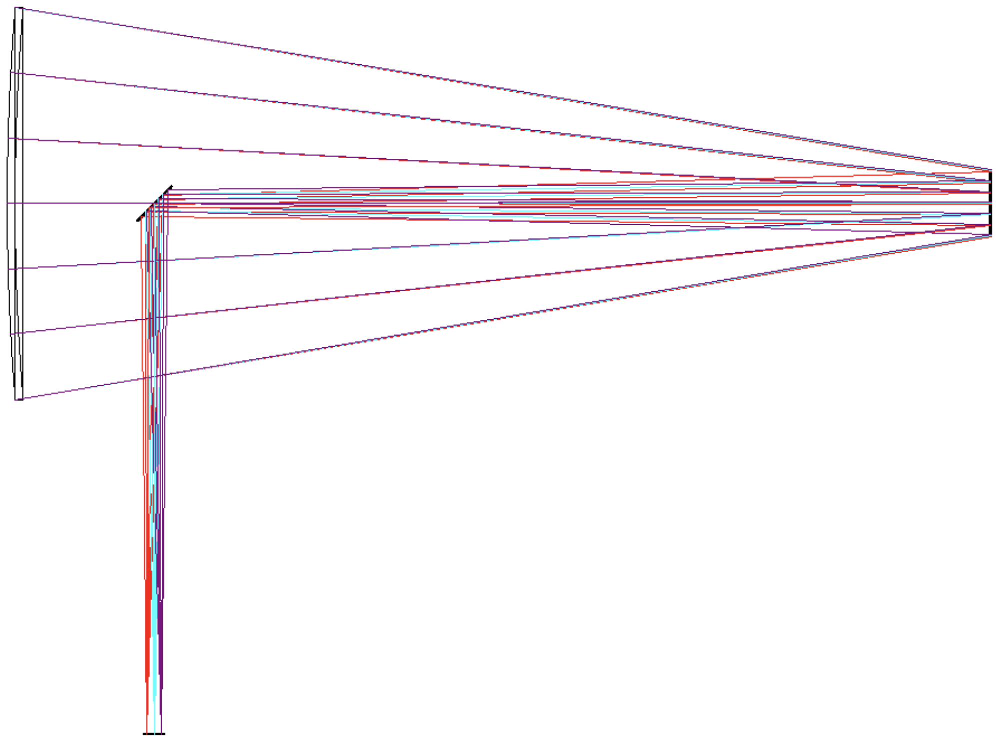

Figure 1. Zemax view of the ITM telescope layout.

#### 2.1.1 Non-aspheric

The first hypothesis is based on a non-aspheric mirror. The radius of the mirror is 1267.195 $mm$, the conic constant is -2.177, and the system will have a resulting f/15.636. Figure 4 represents the spot size for a 6' field of view. Looking at the central field, the RMS is 8.588 $\mu m$, the GEO radius is 22.293 $\mu m$.

#### 2.1.2 Aspheric

The second hypothesis is based on an aspheric mirror. The radius of the mirror is 1267.191 $mm$, the conic constant is -1.586, and the system will have a resulting f/15.635. Figure 5 represents the spot size for a 6' field of view. Looking at the central field, the RMS is 8.600 $\mu m$, the GEO radius is 21.116 $\mu m$. Aspheric terms are:

- 4th: -3.737 E-11;
- 6th: 2.697 E-16;
- 8th: -1.741 E-20;

Figure 6 shows the Field Curvature and Distortion for the two cases of the f/15 scenario.

### 2.2 f/10

The second scenario is the f/10 focal ratio. We propose again two possibilities, one with an hyperbola and the other with aspheric shape. For this scenario the M2 has to be moved at a distance from M1 of 1688 $mm$; 317 $mm$ shorter than today. The mirror becomes 243 $mm$ of diameter.

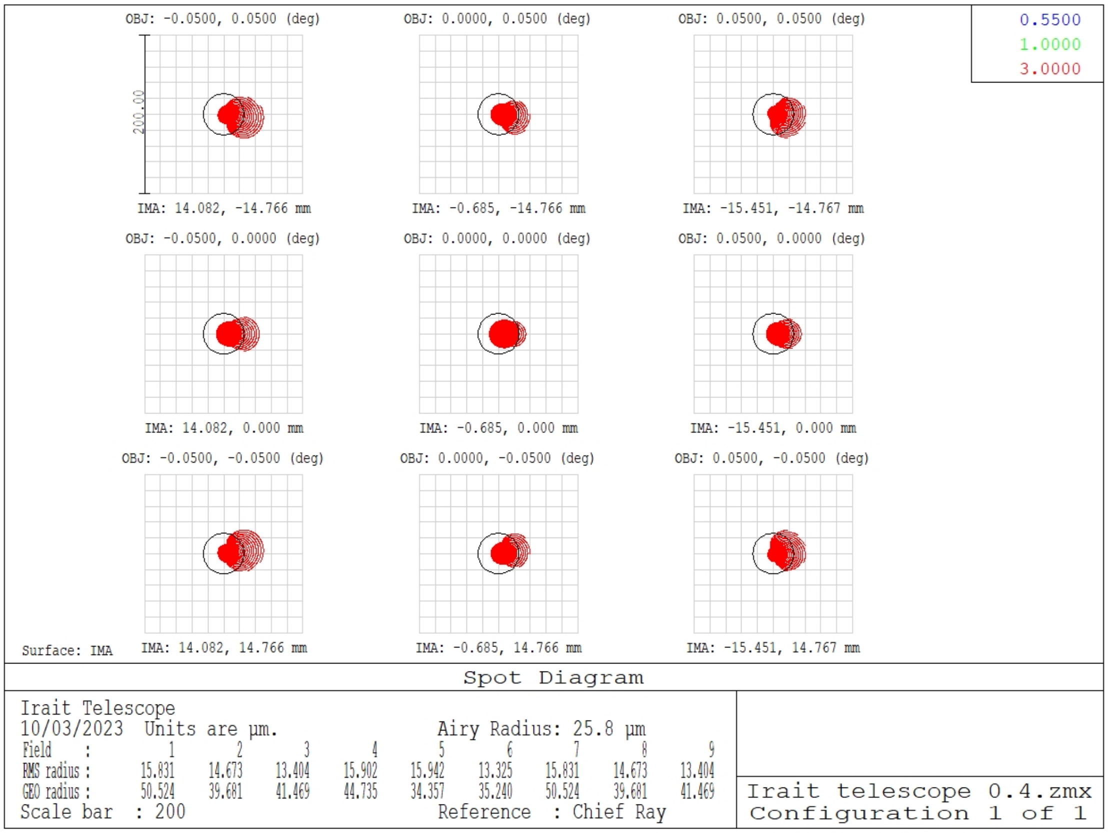


Figure 2. Nominal configuration spot size.

### 2.2.1 Non-aspheric

The third hypothesis is based on a non-aspheric mirror. The radius of the mirror is 2001.474 $mm$, the conic constant is -3.283, and the system will have a resulting f/10.398. Figure 7 represents the spot size for a 6' field of view. Looking at the central field, the RMS is 5.251 $\mu m$, the GEO radius is 13.093 $\mu m$.

### 2.2.2 Aspheric

The fourth hypothesis is based on an aspheric mirror. The radius of the mirror is 2001.464 $mm$, the conic constant is -4.049, and the system will have a resulting f/10.404. Figure 8 represents the spot size for a 6' field of view. Looking at the central field, the RMS is 5.275 $\mu m$, the GEO radius is 11.939 $\mu m$. Aspheric terms are:

- 4th: 1.136 E-11;
- 6th: 6.079 E-17;
- 8th: -2.438 E-21;

Figure 9 shows the Field Curvature and Distortion for the two cases of the f/10 scenario.

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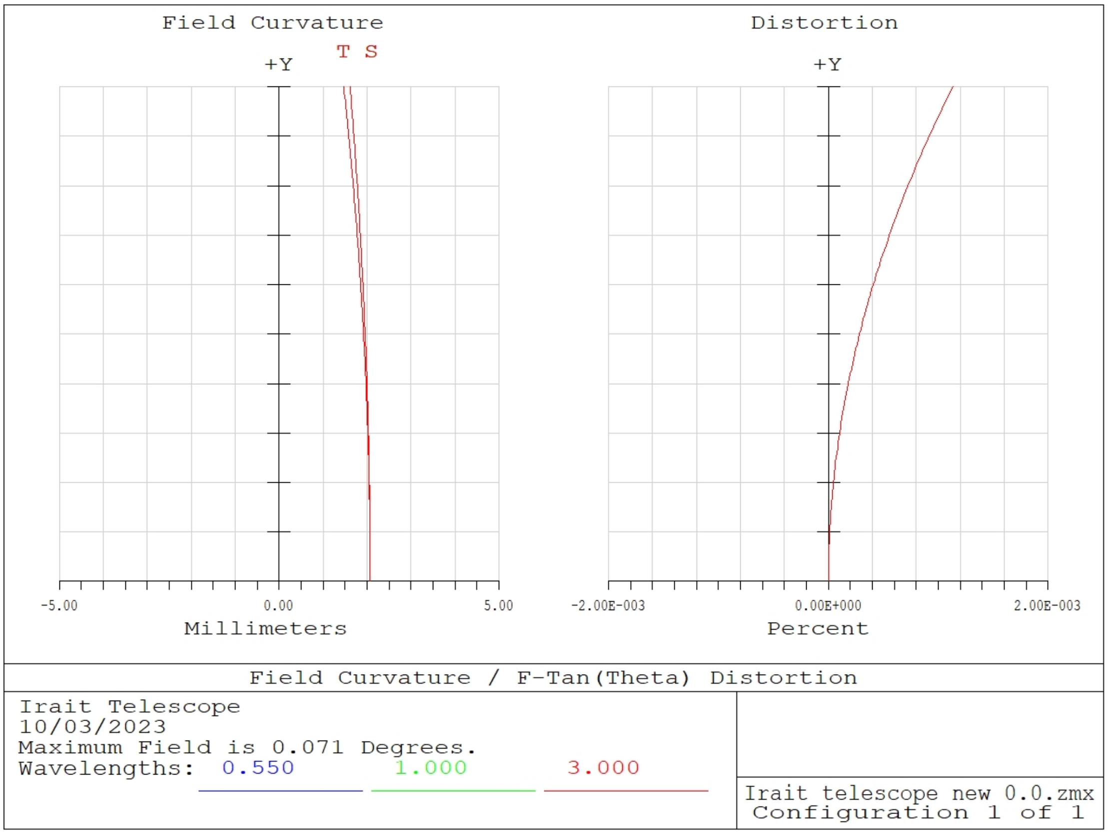


Figure 3. Nominal configuration plot for Field Curvature and Distortion.

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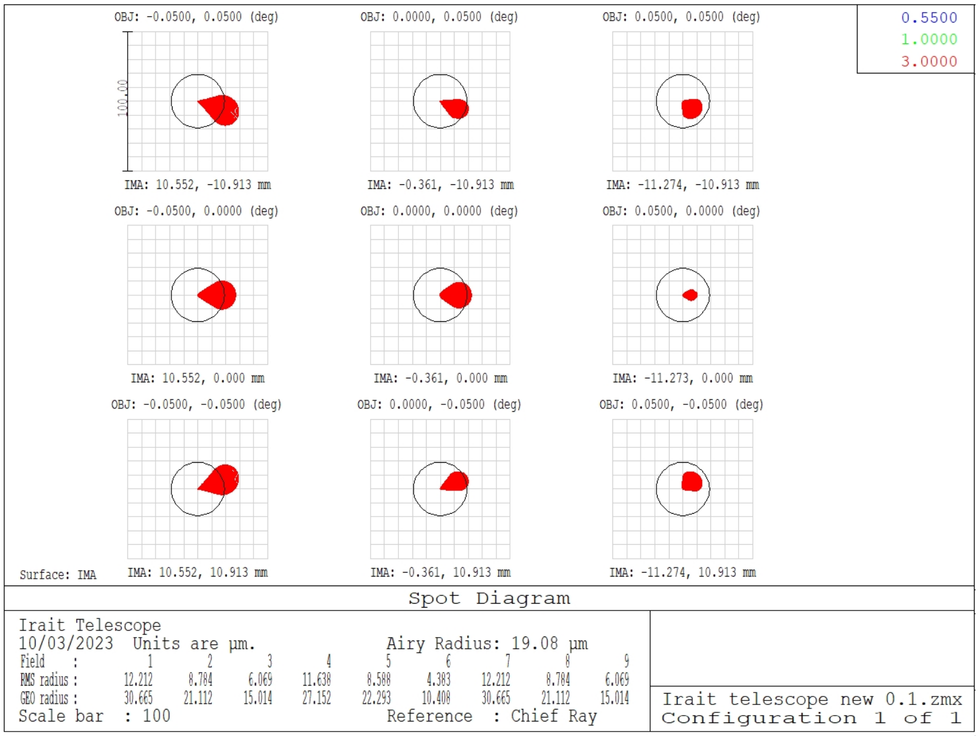


Figure 4. Non-aspheric f/#15 configurations spot size.

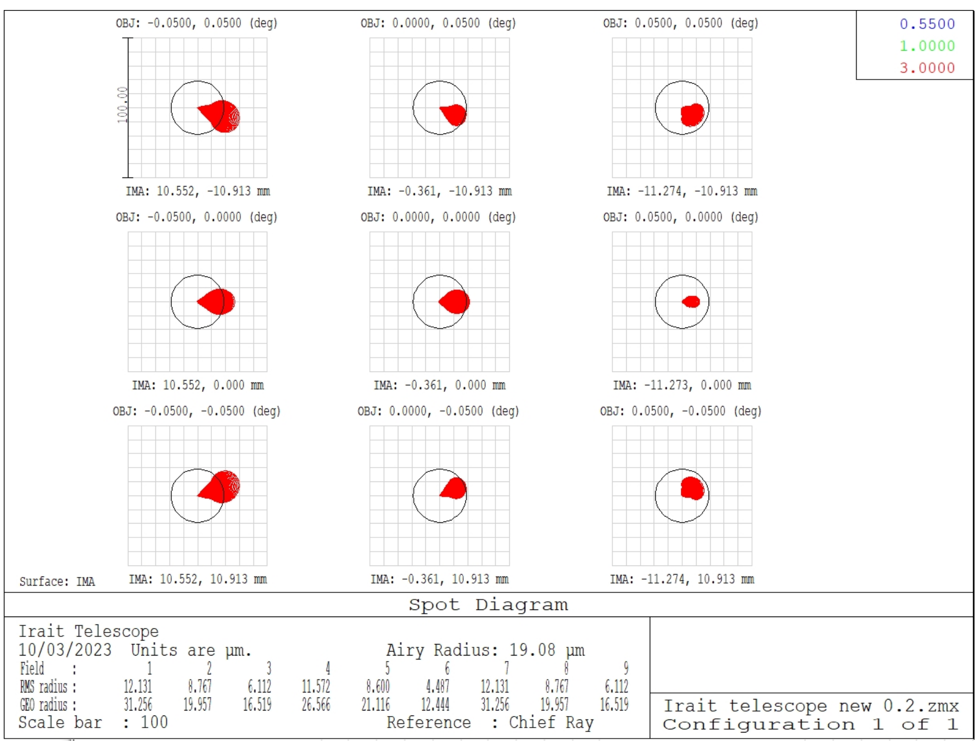


Figure 5. Aspheric f/#15 configurations spot size.

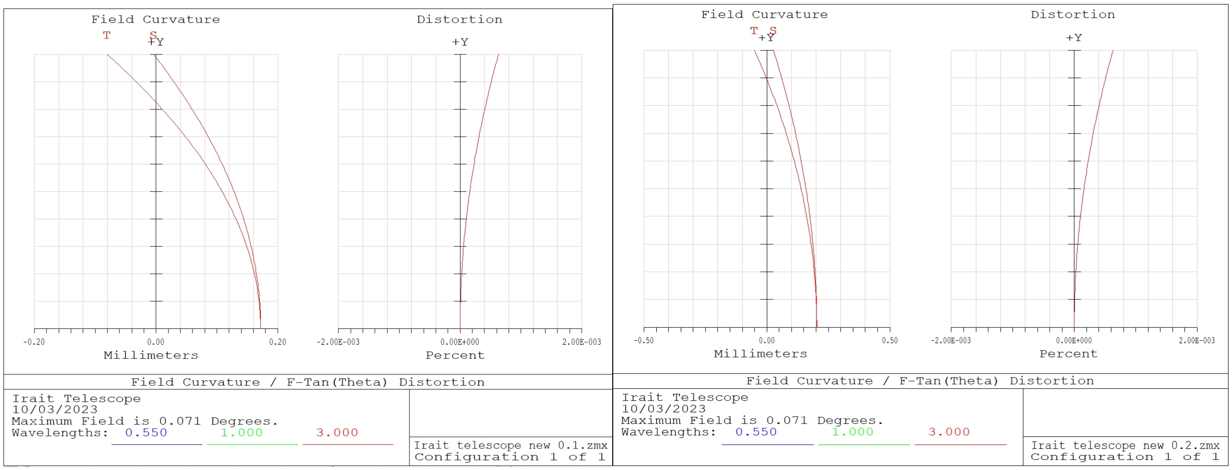


Figure 6. Field Curvature and distortion for the non-aspheric configuration (left panel) and aspheric configuration (right panel) in the f/10 scenario

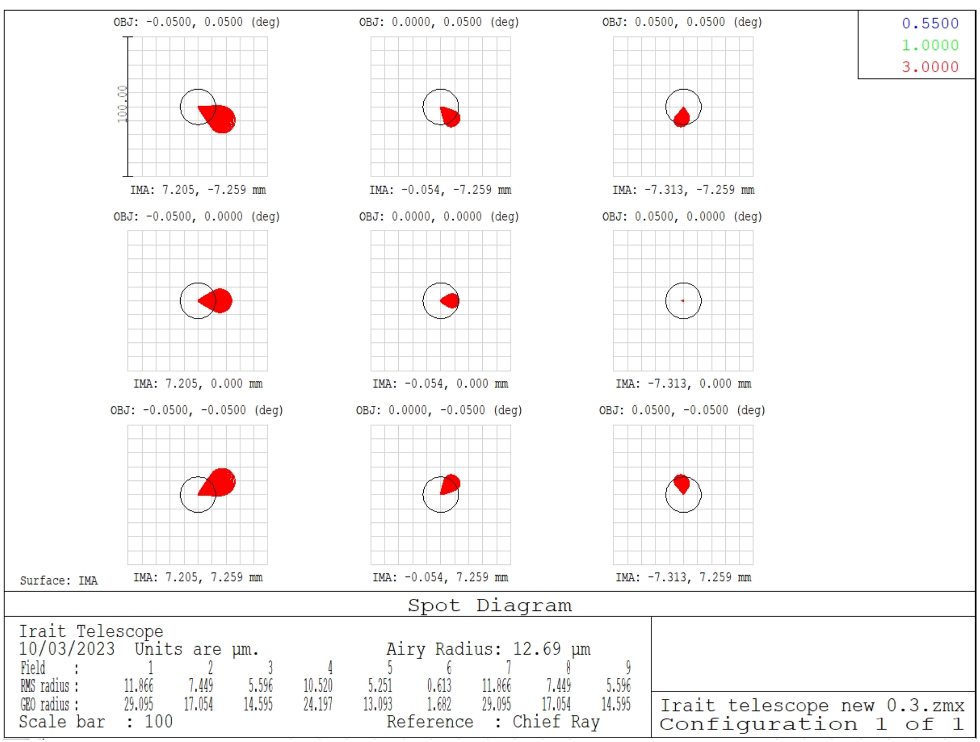


Figure 7. Non-aspheric f/#10 configurations spot size.

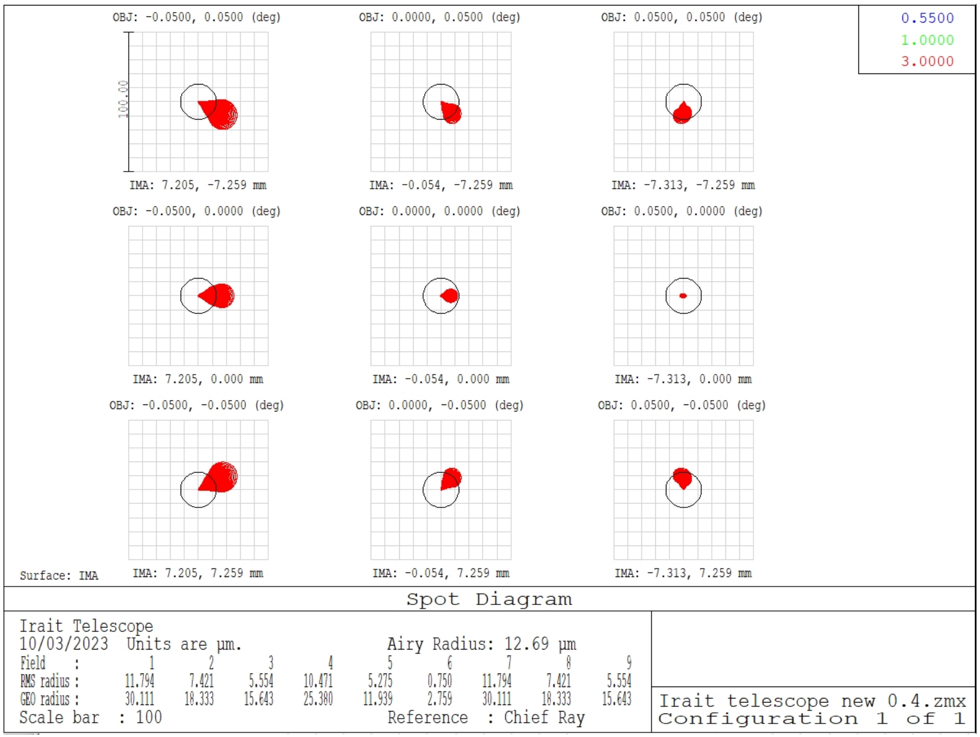


Figure 8. Aspheric f/#10 configurations spot size.

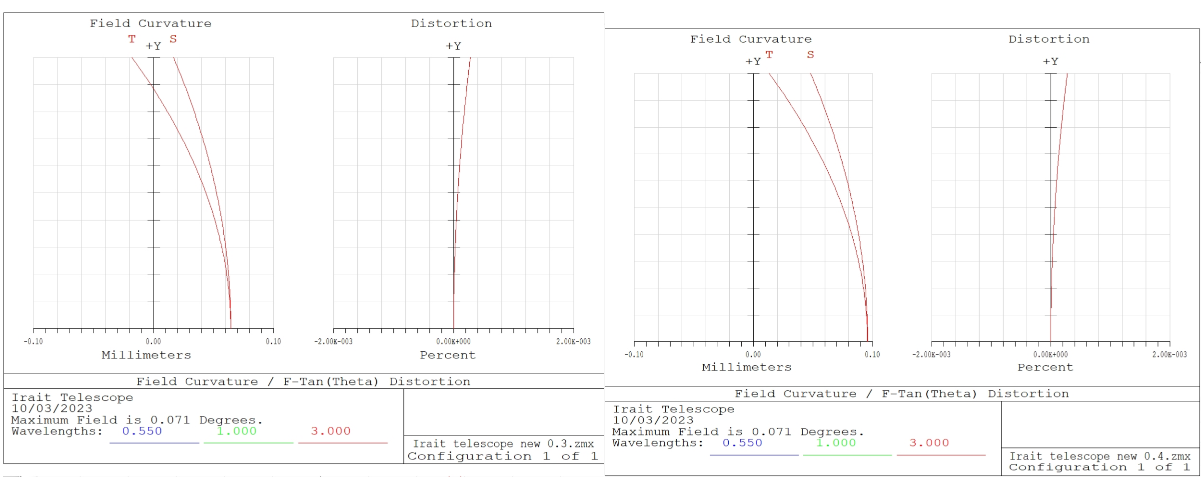


Figure 9. Field Curvature and distortion for the non-aspheric configuration (left panel) and aspheric configuration (right panel) in the f/10 scenario