



Rapporti Tecnici INAF INAF Technical Reports

Number	271
Publication Year	2023
Acceptance in OA@INAF	2023-03-28T12:37:16Z
Title	2nd generation ITM M2
Authors	RIVA, Alberto
Affiliation of first author	O.A. Torino
Handle	http://hdl.handle.net/20.500.12386/34051 , https://doi.org/10.20371/INAF/TechRep/271

2nd generation ITM M2

Alberto Riva^a

^aINAF - Osservatorio Astrofisico di Torino, Strada Osservatorio, 20, I-10025 Pino Torinese (TO), Italy

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 Antarctica¹²³⁴. 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 near 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" from the Nasmyth 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 $15.942\text{ }\mu\text{m}$, the GEO radius is $34.357\text{ }\mu\text{m}$. 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.

Contact: alberto.riva@inaf.it, Telefono +39 011 8101936

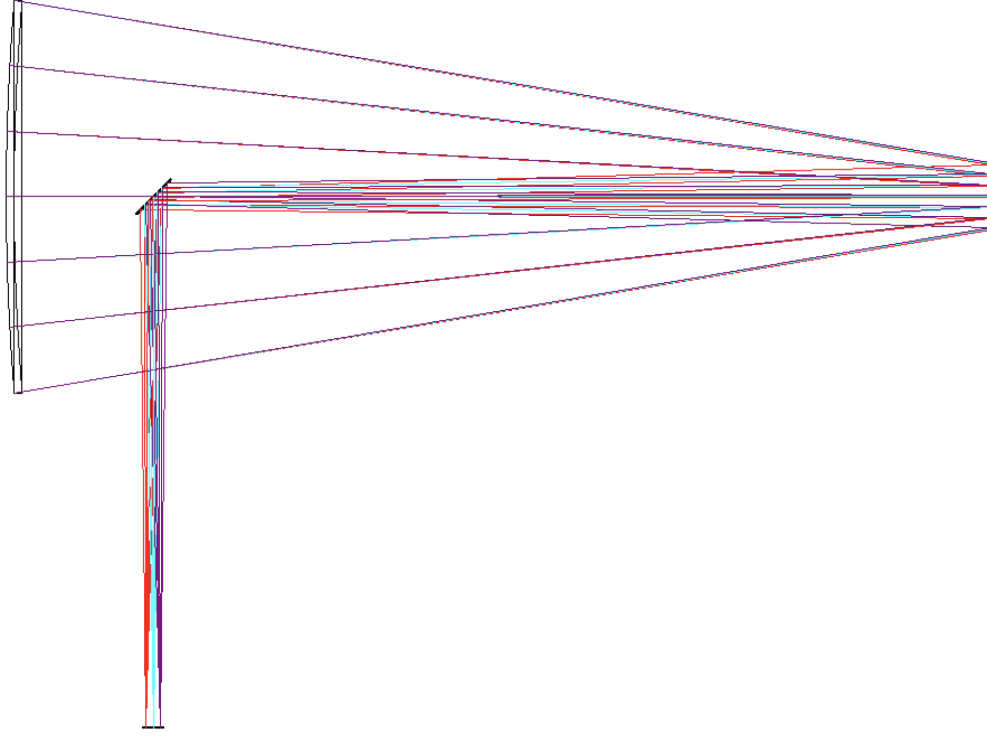


Figure 1. Zemax view of the ITM telescope layout.

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 $8.588 \mu\text{m}$, the GEO radius is $22.293 \mu\text{m}$.

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 $8.600 \mu\text{m}$, the GEO radius is $21.116 \mu\text{m}$. 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.

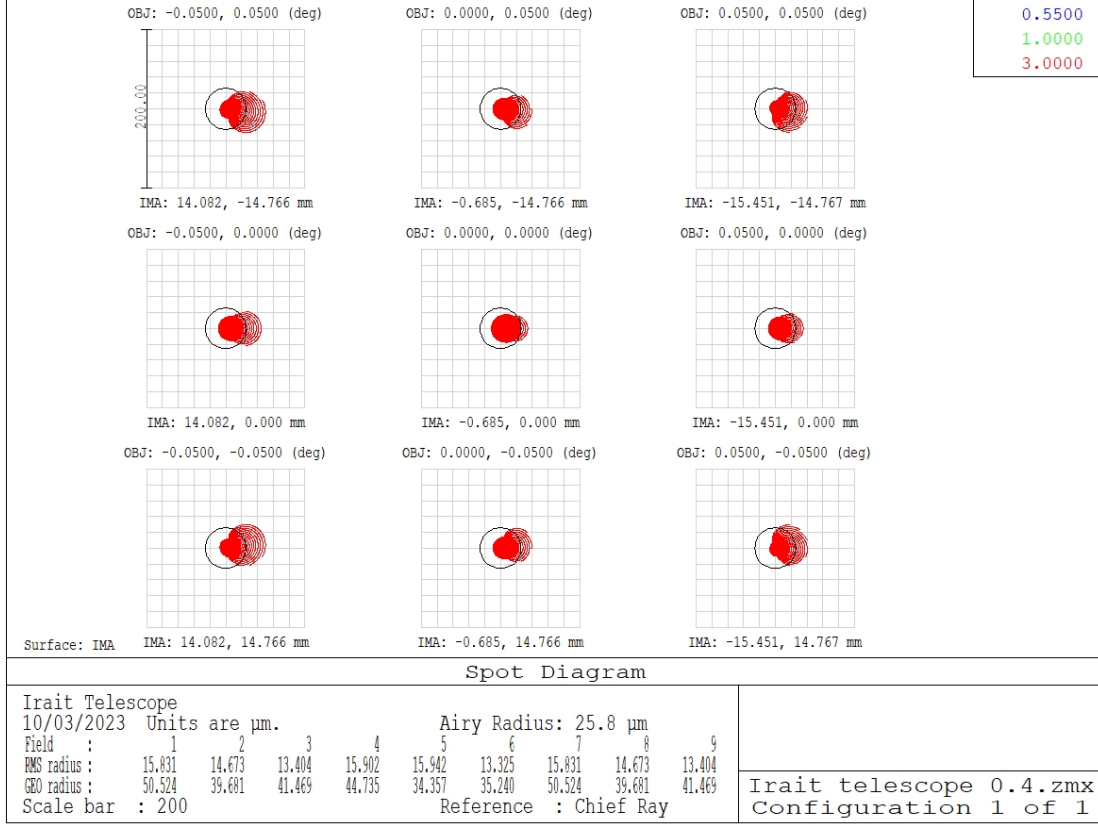


Figure 2. Nominal configuration spot size.

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 $5.251 \mu\text{m}$, the GEO radius is $13.093 \mu\text{m}$.

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 $5.275 \mu\text{m}$, the GEO radius is $11.939 \mu\text{m}$. Aspheric terms are:

- 4th: $1.136 \text{ E-}11$;
- 6th: $6.079 \text{ E-}17$;
- 8th: $-2.438 \text{ E-}21$;

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

REFERENCES

- [1] Durand, G. A., Tremblin, P., Minier, V., Reinert, Y., Leroy dos Santos, C., Rodriguez, L., Joffrin, X., Busso, M., Tosti, G., Nucciarelli, G., Dolci, M., Straniero, O., Valentini, A., Abia, C., Christille, J. M., Doumayrou, E., Lortholary, M., Charron, P., Lotrus, P., Walter, C., Ronayette, S., Challita, Z., Fromont, L., Condamin, M., Kwon, M. K., and Tavagnacco, D., "Antarctic observations at long wavelengths with the IRAIT-ITM

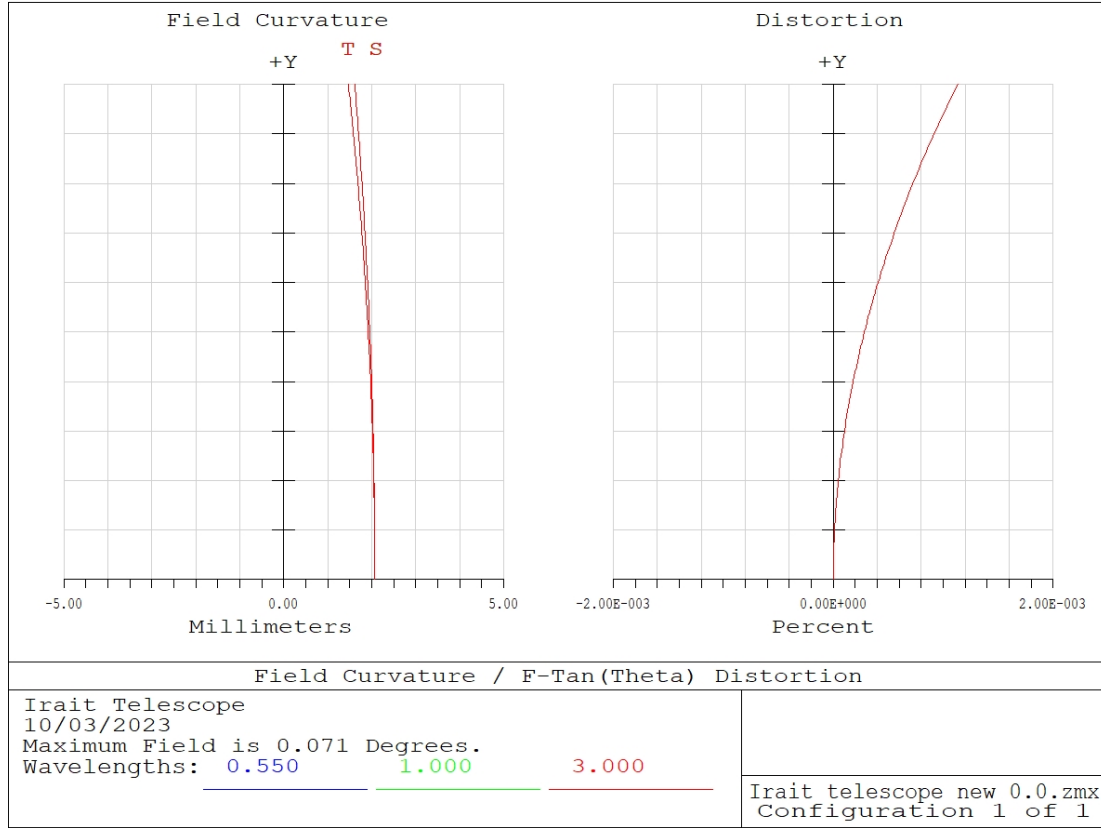


Figure 3. Nominal configuration plot for Field Curvature and Distortion.

Telescope at Dome C,” in [*Ground-based and Airborne Telescopes V*], Stepp, L. M., Gilmozzi, R., and Hall, H. J., eds., *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series* **9145**, 91450D (July 2014).

- [2] Guandalini, R., Tosti, G., and Busso, M., “IRAIT (Science to be done with...),” in [*EAS Publications Series*], Zinnecker, H., Epchtein, N., and Rauer, H., eds., *EAS Publications Series* **33**, 243–247 (Jan. 2008).
- [3] Tosti, G., “IRAIT: A Facility for IR Astronomy at Dome C,” in [*EAS Publications Series*], Epchtein, N. and Candidi, M., eds., *EAS Publications Series* **25**, 209–214 (Jan. 2007).
- [4] Tosti, G., Busso, M., Nucciarelli, G., Bagaglia, M., Roncella, F., Mancini, A., Castellini, S., Mariotti, M., Babucci, E., Chiocci, G., Straniero, O., Dolci, M., Valentini, G., di Varano, I., Pelusi, D., Di Rico, G., Ragni, M., Abia, C., Domínguez, I., Corcione, L., Porcu, F., Conconi, P., De Caprio, V., Riva, A., Molinari, E., Zerbi, F. M., Bortoletto, F., Bonoli, C., D’Alessandro, M., Colomé, J., Isern, J., Briguglio, R., Cacciani, A., Farnesini, L., Checcucci, B., and Strassmeier, K. G., “The International Robotic Antarctic Infrared Telescope (IRAIT),” in [*Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*], Stepp, L. M., ed., *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series* **6267**, 62671H (June 2006).

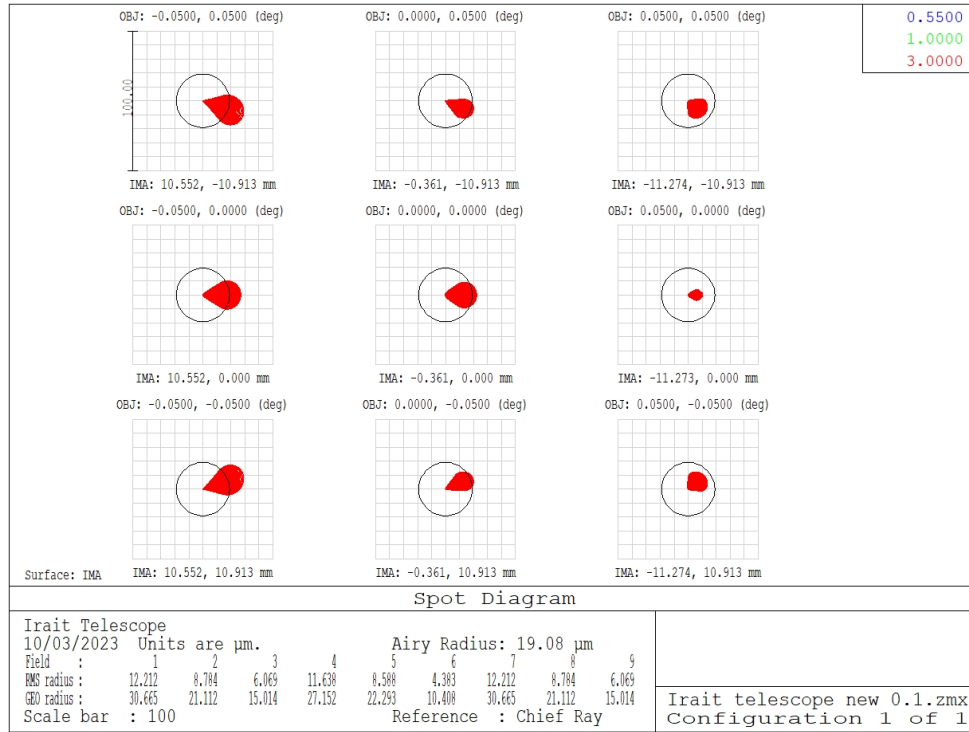


Figure 4. Non-aspheric f/#15 configurations spot size.

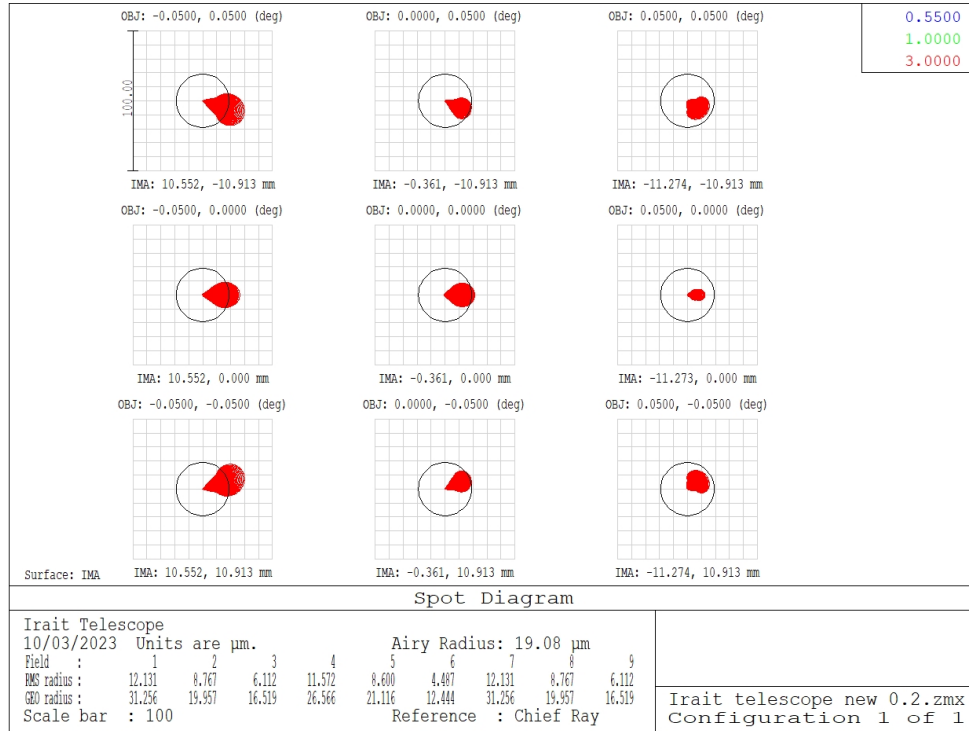


Figure 5. Aspheric f/#15 configurations spot size.

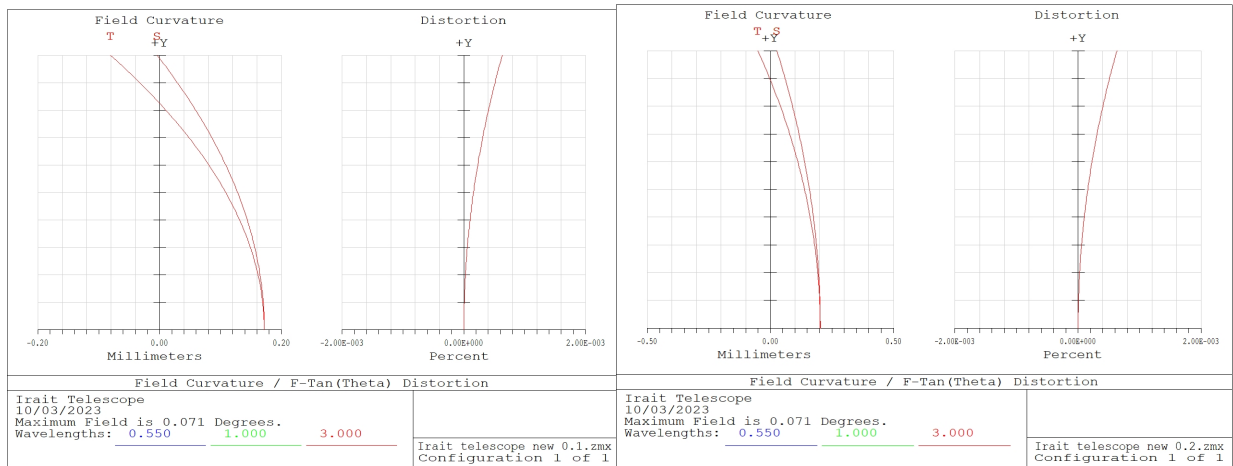


Figure 6. Field Curvature and distortion for the non-aspheric configuration (left panel) and aspheric configuration (right panel) in the f/10 scenario

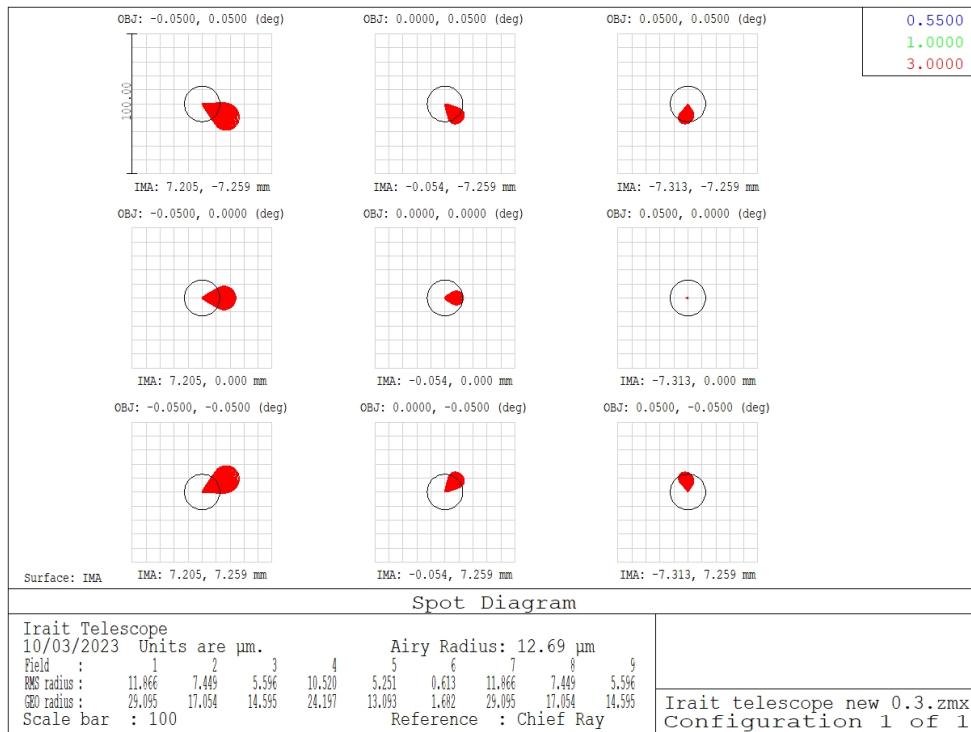


Figure 7. Non-aspheric f/#10 configurations spot size.

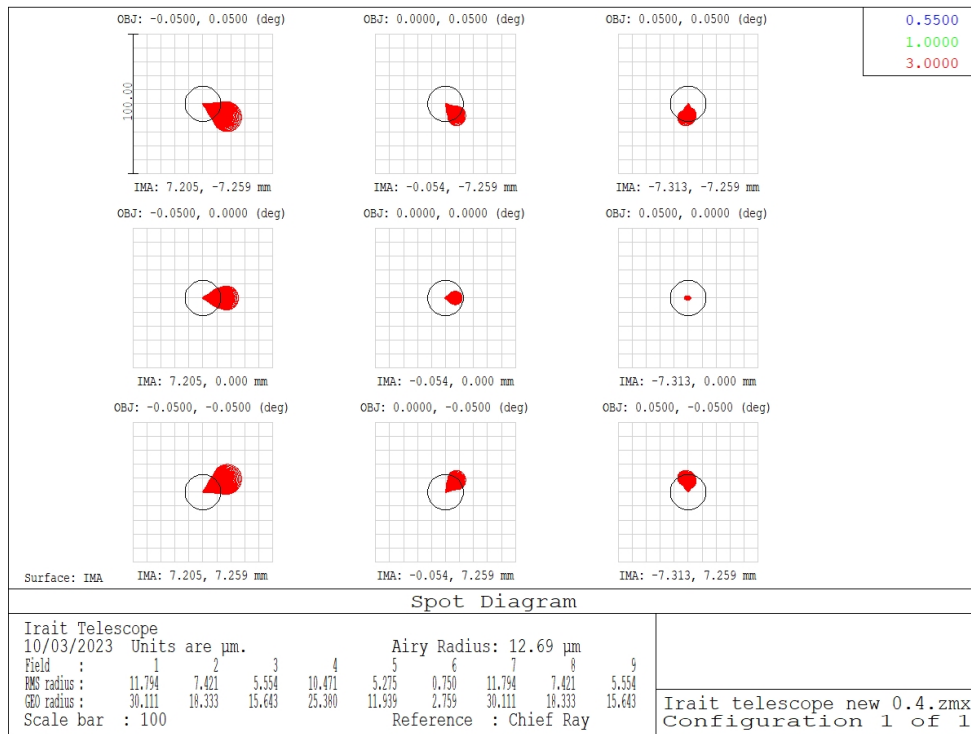


Figure 8. Aspheric f/#10 configurations spot size.

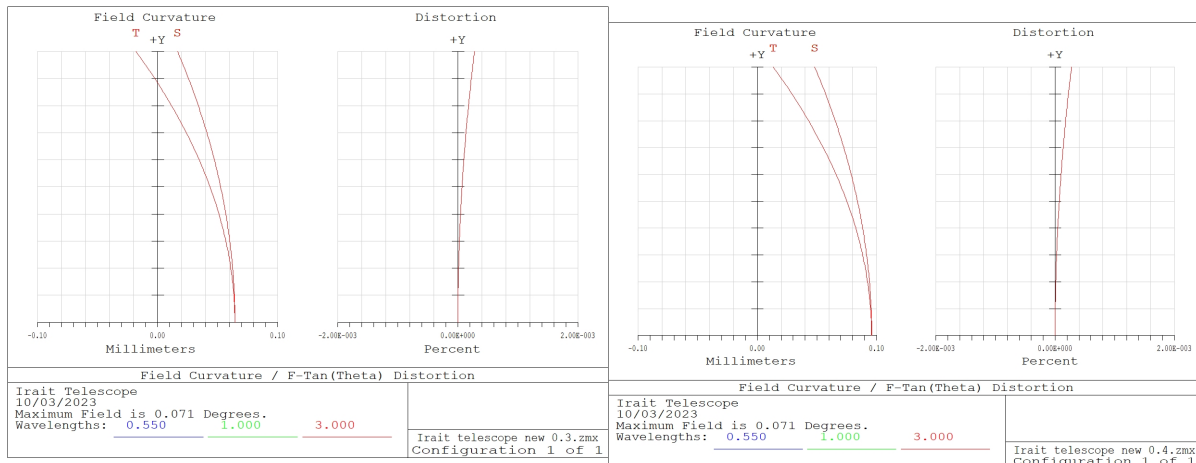


Figure 9. Field Curvature and distortion for the non-aspheric configuration (left panel) and aspheric configuration (right panel) in the f/10 scenario