# OPTICAL PERFORMANCE COMPARISON OF TWO DIGITAL AERIAL CAMERA LENSES

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**KEY WORDS:** Aerial camera lens, Effective Focal Length, MTF, Field Curvature

**ABSTRACT:** In this article we compare the optical performances of two generation digital aerial camera lenses developed by ITRC. These cameras are used in airborne instruments for vegetation and change detection. We run these lenses through a battery of tests. Lens parameters measured are effective focal length, MTF, and field curvature. These results along with their optical design help us to determine the sufficiency of lenses quality to their application.

## 1. INTRODUCTION

It is very important for remote sensing cameras to calibrate the interior and exterior orientation. There are lot of articles shows their efforts in camera calibration(Clarke & Fryer, 1998; Smith et al, 2005; Qtaishat et al, 2008) For most remote sensing image user, exterior orientation is easier to calibration. The interior orientation is hard to access, and it is impossible to improve the lens of the camera.

From the rooting of optical fabrication, Instrument Technology Research Center(ITRC hereafter) develop remote sensing instrument. The interior orientation of the instrument is calibrated. In this article we compare the optical performances of two generation digital aerial camera lenses developed by ITRC. These cameras are used in airborne instruments for vegetation and change detection. We run these lenses through a battery of tests. Lens parameters measured are effective focal length, MTF, and field curvature. These results along with their optical design help us to determine the sufficiency of lenses quality to their application.

## 2. Lens Parameters

A digital aerial camera is composed of a lens and a digital sensor. The lens should be specially designed, manufactured, and assembled for the purpose. Once the lens was made, the spec or the lens parameters should be check. Those parameters are:

- Effective focal length
- Distortion
- MTF
- Field curvature.
- Axial Color
- Transmittance

For checking the quality of the lens, effective focal length and MTF were examined first.

## 3. Vegetation and Change Detection imager

VCDi, abbreviation of Vegetation and Change Detection imager, is an airborne multispectral remote sensing instrument developed by ITRC. This project has gone through design, manufacture, assembly, system integration, functional test, and the last, on-board function test. VCDi for first generation digital aerial camera, and VCDi 660 for the second generation.

The spec of two generation digital aerial camera is hereafter:

Table 1 VCDi Spec

| VCDi Lens Spec | Band width (nm) | Pixel number (pixels) | Pixel size (μm) | Sensor area (mm) | FOV (°) | Effective focal length (mm) | IFOV (mrad) |
|---|---|---|---|---|---|---|---|
| B1 | 450~520 | 2048*2048 | 9×9 | 18.4×18.4 | 40 | 36 | 0.25 |
| B2 | 500~640 | 2048*2048 | 9×9 | 18.4×18.4 | 40 | 36 | 0.25 |
| B3 | 620~770 | 2048*2048 | 9×9 | 18.4×18.4 | 40 | 36 | 0.25 |
| B4 | 750~900 | 2048*2048 | 9×9 | 18.4×18.4 | 40 | 36 | 0.25 |

Table 2 VCDi660 Spec

| VCDi660 Lens Spec | Band width (nm) | Pixel number (pixels) | Pixel size (μm) | Sensor area (mm) | FOV (°) | Effective focal length (mm) | IFOV (mrad) |
|---|---|---|---|---|---|---|---|
| B1 | 450~520 | 4008*2672 | 9×9 | 36×24 | 62 | 36 | 0.25 |
| B2 | 500~640 | 4008*2672 | 9×9 | 36×24 | 62 | 36 | 0.25 |
| B3 | 620~770 | 4008*2672 | 9×9 | 36×24 | 62 | 36 | 0.25 |
| B4 | 750~900 | 4008*2672 | 9×9 | 36×24 | 62 | 36 | 0.25 |
| B5 | 1450~1750 | 320*250 | 20×20 | 6.4×5 | 62 | 9.58 | 3.13 |
| Pan | 250~1100 | 12288 | 5×5 | 61.4 | 82 | 41.5 | 0.12 |

## 5. EXPERIMENTAL SETUP

For measuring the effective focal length, a collimator is used. The band width of its light source cover from 350 nm to 2300 nm, so a filter set was used. The lens under test was set up on a rotary table, and a image analyzer used to analyze the image quality. The experimental setup is hereafter.

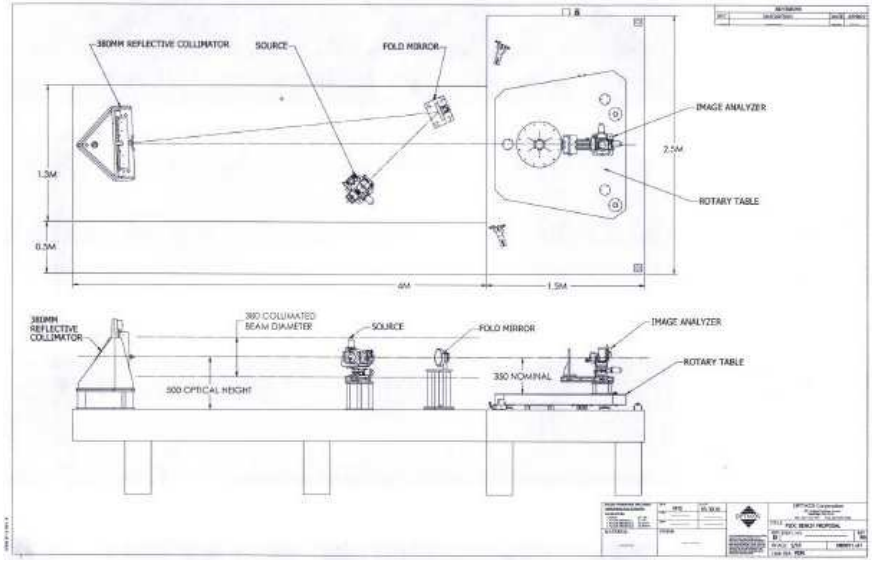


Figure 1 EXPERIMENTAL SETUP

## 6. Results

### 6.1 Effective Focal Length of B2(500~640 nm)

Table 3 Effective Focal Length comparison

| Design value | VCDi | VCDi 660 |
|---|---|---|
| 36 mm | 35.88mm | 36.3 mm |
| Difference | -0.12 mm | +0.3 mm |
| Difference(%) | -0.33% | 0.83% |

## 6.2 MTF

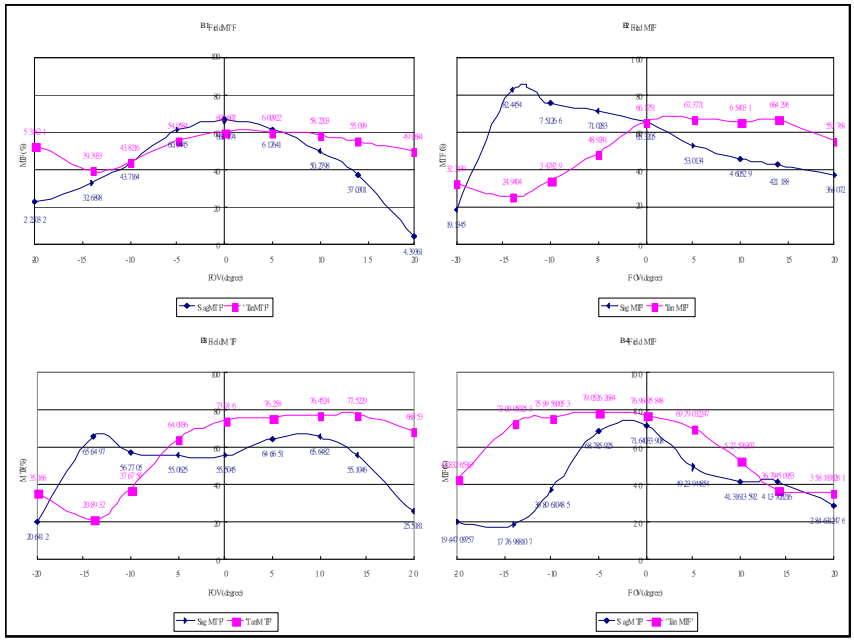

Figure 2 MTF of VCDi B2

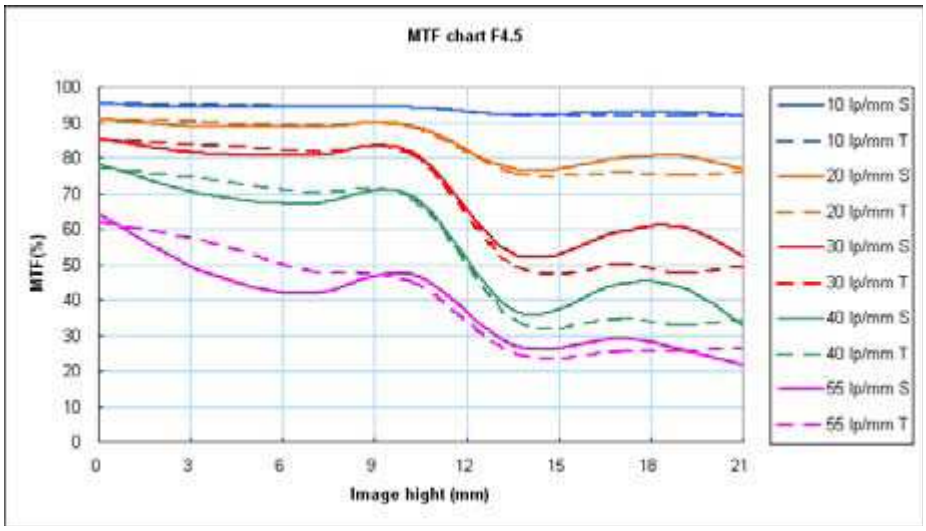


Figure 3 MTF of VCDi660 B2

## 6.3 Field Curvature

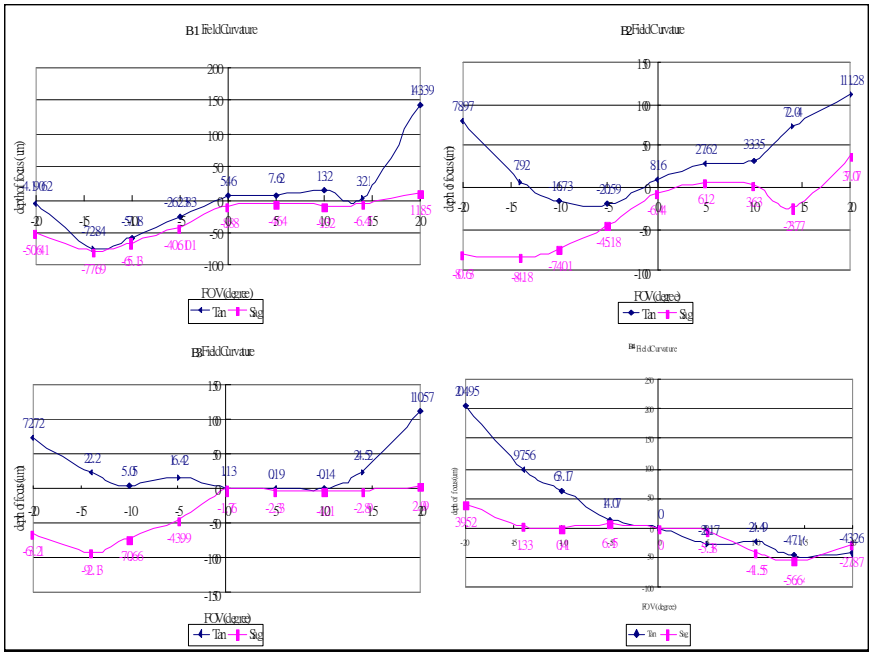


Figure 4　Field Curvature of VCD

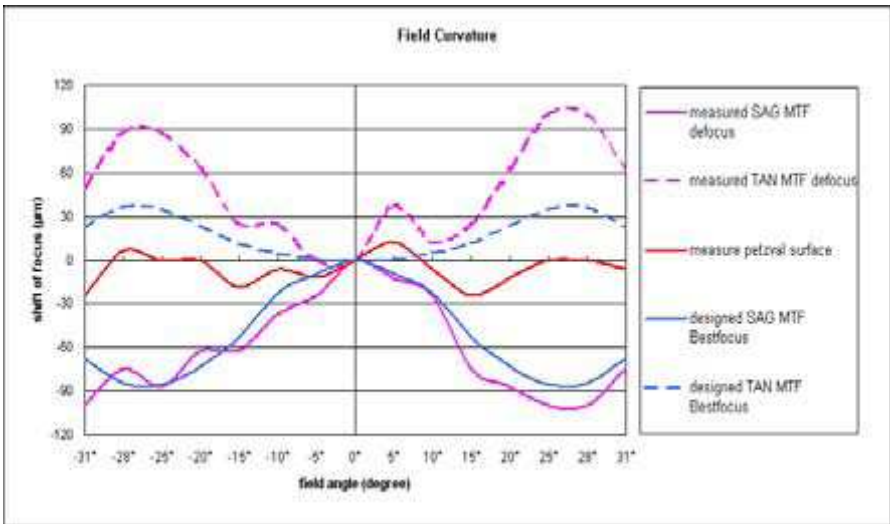


Figure 5　Field Curvature of VCD

## 7. CONCLUSION

Compared VCDi with VCDi660 measurement results, VCDi mostly only in the 20 degree field of view to reach specifications, and VCDi-II mostly in the more than 40 degrees, even in the full field of view. It shows there is an important breakthrough in the lens assembly. The lens quality improved.

## 8. 致謝

## 9. REFERENCE參考文獻(不標號)

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