

Development of High Performance HDTV 88× Zoom Lens, “DIGI POWER 88”

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Abstract

We have developed a high performance compact HDTV 88× zoom lens. By applying a unique lens configuration, the total length required for the optical elements has been considerably shortened and a wider field of view achieved. Moreover, fluctuations in optical performance due to variations of the image size (during zooming) have been greatly reduced through our application of a dual-group focus mechanism.

1. Introduction

FUJINON Corporation began selling the DIGI POWER 88 (model number XA88×8.8) high performance HDTV 88× zoom lens on December 1, 2006 (Fig. 1).

As more and more locations around the world are switching to HD television broadcasting, to record more compelling, high-quality images, fields such as sports broadcasting are demanding easy-to-use, high-power zoom lenses that can handle wider angles and longer distances. The DIGI POWER 88 was developed to meet those demands.



Fig. 1 XA88×8.8HD lens.

2. Background

The DIGI POWER 88's predecessor, the XA87×9.3 HD lens (87× zoom, 9.3-mm minimum focal length), was brought to the market in November 2000 as the HDTV lens with the highest zoom at the time (Fig. 2). Since then, it has served as the fundamental lens for broadcasting applications and is even used on recording sites for digital terrestrial broadcasts. However, because of factors such as the increasing needs of our clients and the strategy developed by our marketing department, we began developing a next-generation zoom lens.



Fig. 2 XA87×9.3 HD lens.

First we compiled market research and customer suggestions to come up with the following three requirements for a next-generation lens.

(1) Wider angle and reduction in total length

High-power zoom lenses are often used in sports broadcasting, where there are many situations in which extremely fast camera work is essential, such as when a home-run ball is chased in a baseball broadcast. In these kinds of situations, a shorter lens length brings the center of gravity of the lens closer to the rotation axis of the tripod, and this makes the lens easier to handle (Fig. 3). Furthermore, even in high-zoom lenses, there is a strong demand for wider angles.

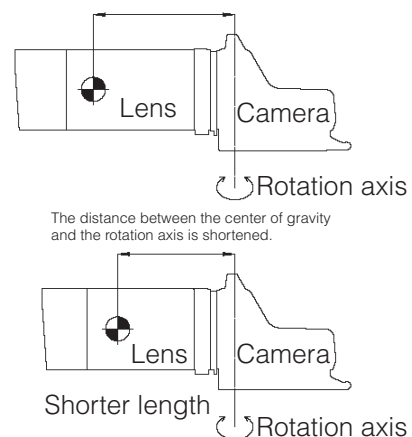


Fig. 3 Effect of reduction in total length.

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(2) Further improvement of optical performance

We sought to improve the optical performance characteristics that accompany changing shooting distances.

(3) New design

We decided that the new lens needed a smart design to complement its high-performance.

We developed the XA88×8.8 (88× zoom, 8.8-mm minimum focal length, 35 mm equivalent focal length of 34.6 to 3056.2 mm) to meet all of these requirements.

3. Technical Problems and Solutions

3.1 Wider Angle and Reduction in Total Lens Length

One of the guidelines that can be used when shortening the total length of a zoom lens is the telephoto ratio (total length ÷ maximum focal length).

Using conventional technology, it is difficult to reduce the total length of a zoom lens so that its telephoto ratio falls below 0.8, because doing so causes a pronounced increase in optical aberration throughout the zooming range. To tackle the contradicting goals of shorter lens length and increased angle width, we used a design method unique to FUJINON Corporation and incorporated a new lens construction and new lens elements. This enabled us to reach both of our goals and to achieve a lens with a telephoto ratio of 0.78 that is approximately 70 mm shorter than the XA87×9.3 (Fig. 4) and whose minimum focal length has been reduced from 9.3 mm to 8.8 mm (35 mm equivalent focal length change of 36.6 mm to 34.6 mm).

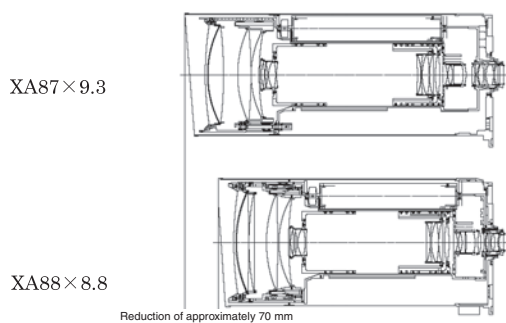


Fig. 4 Comparison between XA87×9.3 and XA88×8.8.

3.2 Improvement of the Optical Performance Characteristics That Accompany Changing Shooting Distances

When the overall lens length is reduced, the variations in optical performance characteristics that accompany changing shooting distances increase. With the conventional single-group inner focus method, this trend is especially pronounced at longer distances. To deal with this problem, we used the double-group floating focus method that has been newly developed by FUJINON Corporation. In this method,

two groups of focus lenses are moved independently. This method reduces the variations in the optical performance characteristics that accompany changing shooting distances.

This section will explain the mechanism of the double-group floating focus. First, the conventional focus mechanism will be explained for comparison. When the conventional focus method is used, the lenses move as a group, and because their motions are linear, they are moved with a feed screw (Fig. 5). This mechanism cannot be used with a floating focus in which two lens groups move independently, so the XA88×8.8 uses a new mechanism with a cylindrical cam (Fig. 6).

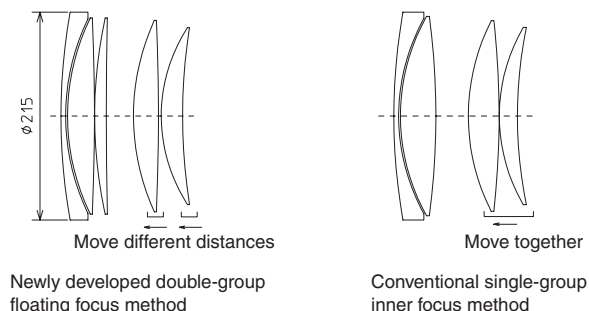


Fig. 5 Comparison of focusing methods.

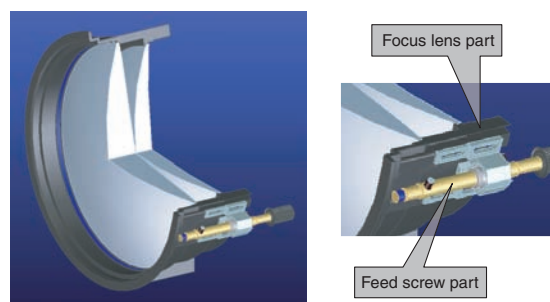


Fig. 6 Conventional focus mechanism.

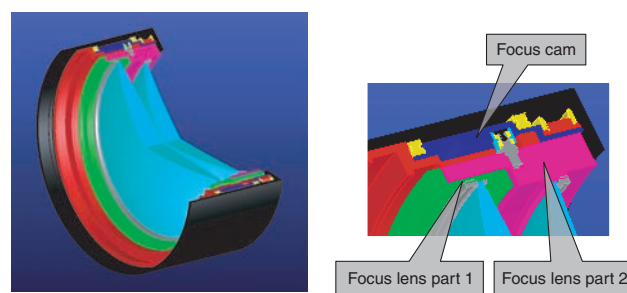


Fig. 7 New focus mechanism.

Next, this section will compare the floating focus of the new model with the previous lens model, XA87×9.3.

Fig. 8 shows the MTF* characteristics plotted against distance for a long shot. The horizontal axis of the graph is the image height (0 is the center of the view and 5.5 is the edge). The vertical axis is the MTF value. The top two graphs are for a shooting distance of 12 m, and the bottom two graphs are for an infinite shooting distance. At an infinite shooting distance, a drop in MTF can be seen at the edges of the older XA87×9.3, but the reduction in MTF has been greatly improved in the new XA88×8.8.

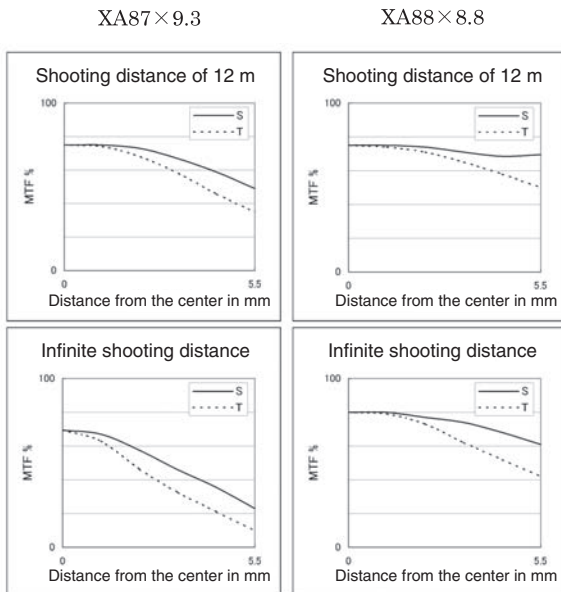


Fig. 8 MTF variation depends on object distances (at tele zoom position).

In the same way, the chromatic aberration characteristics in relation to shooting distance have been greatly improved compared to those of the older XA87x9.3.

* MTF stands for Modulation Transfer Function (a method for evaluation lens performance based on the contrast reproduction ratio)

3.3 New Design

We worked together with the Fujifilm Design Center to create a design with a “high-performance, cutting-edge image.” We decided to work under the themes of “a body design that conveys high-quality and precision” and “a graphic design that sells the brand” as we worked on creating the new product.

We wanted a complete change from the old design (Fig. 9). To decide on the new design, we had the Design Center draw up a number of different graphic and body designs (Figs. 10 and 11), and then we tested the final designs by making prototypes.



Fig. 9 Previous design.



Fig. 10 New package design concept.



Fig. 11 New graphic design concept.

4. Conclusion

The DIGI POWER 88, which, as we discussed earlier, has taken the needs of users into account as much as possible and utilized a unique FUJINON Company lens construction and double-group floating focus method, has been receiving more and more orders since it was first brought to the market.

Also, before sales began, the DIGI POWER 88 won “The Best of IBC2006 Editor’s Award” from the IBC2006 show held in Amsterdam. The high performance and quality of the DIGI POWER 88 is recognized all around the world.

In the future, beginning with big events such as the 2008 Beijing Olympics, the DIGI POWER 88 is expected to show its excellence in a variety of recording situations.

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