Canon

RF LENS

Ver.1.0

RF100-300mm F2.8 L IS USM

Developer Interview

Yuriyo Asami

Product Planning

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ICB Products Unit

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Yumi Toyoda

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Masaaki Igarashi

Design

Design Center

Ken Uraba

Manufacturing Technology

Image Communication Business Operations

ICB Optical Business Unit

Utsunomiya Plant

Note: Measures against COVID-19 were fully implemented for the interviews.

A 300mm f/2.8 lens transformed into a never-before-seen telephoto zoom lens

We worked to develop a lens that seamlessly covers the telephoto range of 100mm to 300mm with a fixed maximum aperture of f/2.8.

Yuriyo Asami,
Product Planning

Makoto Hayakawa,
Chief of Development/
Mechanical Design

Development focused on expanding the range of shooting possibilities

What was your motivation behind the development of this lens?

Asami: The existing model, the EF300mm F2.8L IS II USM, has been used in various settings, including sports photography. Therefore, with the advancements in the EOS R System, we began considering developing a lens that could take advantage of the high speed, shallow depth of field (bokeh), and strong compression effects unique to 300mm, f/2.8 lenses. As a result, this led to the concept of expanding the range of shooting possibilities with a telephoto zoom lens that can be used in all types of photography, such as indoor and outdoor sports, portraits, and wildlife photography.

Hayakawa: We also wanted to create a lens that could respond to the need for a lens with more focal length than the RF70-200mm F2.8 L IS USM but with higher speed than the RF100-500mm F4.5-7.1 L IS USM. The 100-300mm F2.8 came about as a result of considerations focused on optical performance rivaling that of a fixed focal length lens in a lightweight, compact package that would allow for mobility.

We expected technical difficulties in expanding the range of shooting possibilities. However, we were unwilling to compromise on achieving 3x zoom from the 100mm wide-angle end. We also considered a lens with a built-in extender, but we decided to achieve 3x zoom without a built-in extender as it offered the best balance between size, performance, and spec.

Canon's first f/2.8 100–300mm lens

What position will the lens take for RF mount users?

Asami: The RF100-300mm F2.8 L IS USM will fill the gap between 150mm to 300mm focal length for the RF mount f/2.8 L Series Zoom Lenses. This is Canon's first f/2.8 100–300mm lens.

With developments being made in cameras' high-speed continuous shooting and enhanced subject detection, this is an introduction of a large aperture telephoto L zoom lens in line with these developments. The lens achieves both high image quality and lightweight compactness, rivaling that of an f/2.8 fixed focal length lens throughout the 100–300mm zoom range. Also, with its coordinated control with the camera's internal image stabilizer (IS) function mechanism, the lens is the flagship among the RF mount large aperture telephoto L zoom lenses.

Progress made in cultivating team unity online

Did COVID-19 impact development?

Hayakawa: COVID-19 changed the development environment drastically. There was an increase in online communication as well as in-person communication. However, there were some benefits. Previously it was challenging to coordinate our schedules so that all development members could gather in the conference room each time we had a meeting. With the switch to online, we were able to communicate immediately if there were issues by sharing diagrams through screen sharing. I felt that it became easier to work and that each member worked on development with a sense of unity.

Mobility with high image quality. Developing a large-aperture telephoto L zoom lens that can be used in various types of photography and video

Masato Katayose,
Optical Design

Masaaki Igarashi,
Design

Ken Uraba,
Manufacturing Technology

Achieving High Image Quality for the Entire 100–300mm Zoom Range and with an Extender Attached

What was the concept behind product development?

Asami: The concept was to develop a large aperture telephoto L zoom lens that can be used in various types of imaging, that combines superior mobility and image quality rivaling that of a fixed focal length lens. We developed the lens under the theme of high image quality throughout the entire 100–300mm zoom range and with an extender attached and further weight reduction.

Katayose: In terms of optical design, we achieved high image quality from the center to the periphery of the image by making use of the RF mount's short back focus and placing the elements near the mount. We also reduced chromatic aberration through the optimal placement of fluorite and UD elements. In addition, installing two nano USMs (ultrasonic motors) was possible due to efforts to reduce the weight of the focusing and floating lens elements. This results in rapid AF for still images and smooth video AF.

Thorough pursuit of Mount Core Design

What was your design concept?

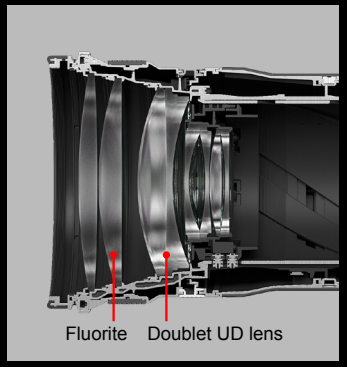
Igarashi: The EOS R System is based on the Mount Core Design concept. The system features a metallic cylinder on the mounts of the camera and lens, which creates an integrated appearance when the lens is attached to the camera body. We designed a new wide-mount core ring for the RF100-300mm F2.8 L IS USM to give it a balanced design when attached to the camera body. As a brand new flagship for the large aperture telephoto L zoom lenses, we gave the RF100-300mm F2.8 L IS USM styling appropriate for a lens that will lead the series from now on.

Uraba: At the production site, we focused on alumite treatment to align the colors of the mount core ring of the lens and the camera body. Also, to reduce the lens's weight, we extensively used magnesium alloys and enhanced our supplier network to ensure a stable supply of parts. In the production and processing process, we promoted environmental initiatives such as devising shapes that reduce cutting loss.

Using a wide-mount core ring for the first time, we pursued an elegant and integrated design for the camera body and lens.

We made several prototypes before deciding on the color of the mount core ring.

Utilizing the advantages of the RF mount to achieve high image quality in a lightweight, compact package



A cross-section of the front end of the RF100-300mm F2.8 L IS USM. We placed three convex lenses in succession after the front element to reduce the lenses' diameter (reduce weight). We reduced chromatic aberration by using fluorite lens for the second lens and a doublet UD lens for the third lens.

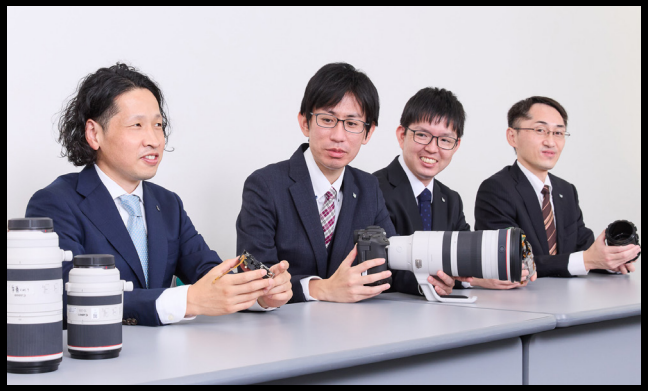
Leveraging expertise in mechanical design, optical design, and manufacturing technology

What enabled you to achieve a drastic weight reduction and enhanced image quality?

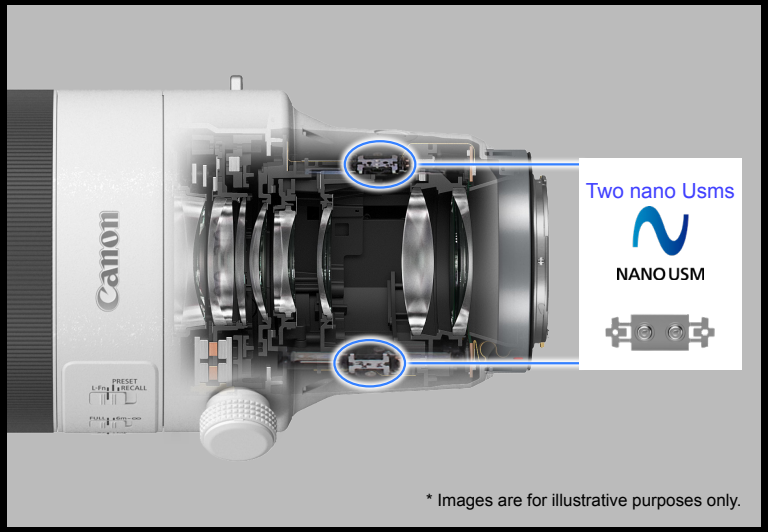
Hayakawa: I was responsible for the mechanical design of the EF400mm F2.8L IS III USM (launched in 2018). At the time, we achieved a weight reduction of over 2.2 lbs. (1kg) compared to the previous model, the EF400mm F2.8L IS II USM, which gave me a feeling for how things were evolving. The EOS R System was launched around the same time, and it became possible to pursue further weight reductions thanks to the RF mount. The RF100-300mm F2.8 L IS USM is a culmination of the expertise we have accumulated to date.

Nagaoka: The RF100-300mm F2.8 L IS USM features two linear-drive type nano USMs. The nano USMs improve the agility of reciprocating movements, and the mechanical structure of the focus drive has been simplified, which contributes to weight and size reduction. I believe we have reached the highest level in terms of AF speed and accuracy, as well as optical performance.

Katayose: In terms of optical design, by placing three consecutive convex lenses next to the front element, we reduced the diameter of the proceeding lenses as much as possible. In addition, we reduced the number of lenses by using large aperture glass-molded (GMo) aspheric lenses. Also, we considered specific gravity in addition to optical characteristics when selecting glass materials. Furthermore, we worked on reducing the thickness of the concave lenses, which led to improved image quality and a significant weight reduction.



Uraba: In lens processing, we made full use of our expertise, including high-precision processing technology for large aperture aspheric lenses at the Utsunomiya Plant. Stabilizing the surface accuracy of thinned concave lenses to near the processing limit significantly contributed to reducing the weight and improving the image quality.



Electronic floating focus control has been further improved by installing two nano USMs, achieving both a size reduction and image quality improvement.

Was there an existing model you used for comparison in reducing weight and size?

Hayakawa: For the RF100-300mm F2.8 L IS USM, we emphasized stability in terms of the center of gravity and robustness. Therefore, we decided to make the lens barrel fully fixed. We used the combination of the EF300mm F2.8L IS II USM with an EF-EOS R Mount Adapter as a yardstick for length, weight, and image quality. The weight of 300mm lens by itself is approx. 5.2 lb. (2,350g). With this as a starting point, for the RF100-300mm F2.8 L IS USM, we added 3x zoom, set a target weight of under 5.7 lbs. (2,600g) for ease of handling when shooting handheld, and developed technologies one by one. With a weight of approx. 5.7 lbs. (2,590g), the RF100-300mm F2.8 L IS USM the lightest* 300mm focal length and f/2.8 zoom lens that is full-size sensor compatible on the market. I believe users will be able to fully appreciate the advantages of the evolution from fixed focal length to 3x zoom and the weight reduction.

**Canon, Inc. survey as of April 19, 2023.*

Improved mobility and portability provide significant advantages in capturing decisive movements

An easy-to-operate lens that makes handheld shooting effortless

What areas did you work on concerning weight balance when the camera is being held?

Asami: Even if we say that the lens is lighter and smaller, I think users can tell the difference between the numerical weight, how easy the lens is to handle, and its weight when taking photos. That is why we took care to create a lens users want to use for handheld shooting that feels light when holding a camera and is easy to operate.

Hayakawa: For example, we adjusted the position of the tripod mount ring so that rather than the support point of the monopod, the center of gravity is closer to the user's hands when shooting with a monopod. In terms of design, the center of gravity is almost the same as the RF400mm F2.8 L IS USM. Users of the RF400mm F2.8 L IS USM will be able to use the RF100-300mm F2.8 L IS USM without discomfort. The smooth movement of the lenses will also reduce fatigue in users' arms.

A significant increase in the range of shooting possibilities with one lens alone

Thanks to its reduced weight and size, in what types of photography can this lens be used?

Asami: Thanks to the improvements in mobility and portability, we expect photographers to use the lens at international sports tournaments where they move through multiple indoor and outdoor sporting venues and in press and wildlife photography.

We also expect that the range of shooting possibilities will be significantly increased as telephoto shooting with fast shutter speeds that prevent blurring of the subject is possible in shooting conditions such as concert venues, theaters, and fashion shows where photographers cannot get close to the subject and there are changes in lighting.

Hayakawa: Also, the RF100-300mm F2.8 L IS USM can be used for 140–420mm shooting with the RF1.4x Extender attached and for 200–600mm shooting with the RF2x Extender attached. By replacing sizeable photographic lens sets with multiple telephoto zoom lenses and large aperture telephoto fixed focal length lenses for the RF100-300mm F2.8 L IS USM, users will have less to carry, and it will be easier for them to move.

Weight when shooting

EOS R3
Approx.
2.3 lbs.
(Including eyecup ER-h, battery LP-E19 and 1 CF express card)

+

RF100-300mm F2.8 L IS USM
Approx. 5.7 lbs.

=

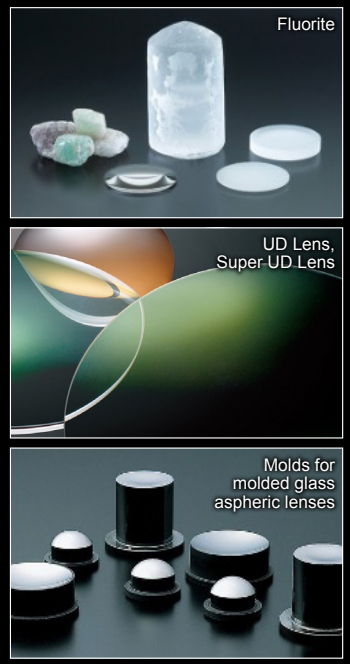
Total
Approx.
8.0 lbs.

EXTENDER RF1.4x
RF100-300mm F2.8 L IS USM
Focal length and maximum aperture when attached
140-420mm f/4

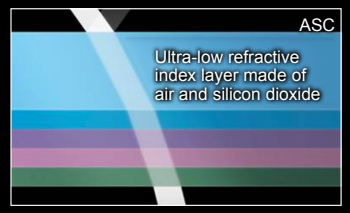
EXTENDER RF2x
RF100-300mm F2.8 L IS USM
Focal length and maximum aperture when attached
200-600mm f/5.6

Combining a high image quality and fast large aperture telephoto L zoom lens with an extender can reduce the weight and size of the lens set carried.

Achieving high image quality rivaling that of fixed focal length lenses for all focal ranges and shooting distances. Thorough pursuit of stable and high optical performance.



Lenses are placed effectively to correct chromatic aberration, resulting in minimal color blurring for the entire image.



We used Air Sphere Coating (ASC) to achieve a high anti-reflective effect, especially for incident light at near vertical angles.

Optimal placement of fluorite, UD lenses, and GMO (glass molded) aspheric lenses

What enabled you to achieve high image quality for all focal ranges and shooting distances?

Katayose: We used fluorite and doublet UD lenses to reduce the chromatic aberration for each lens group to achieve high image quality for the RF100-300mm F2.8 L IS USM, especially at the telephoto end. Fluorite, with its low specific gravity, contributes to reducing weight. We used three UD elements near the diaphragm, reducing chromatic aberration at the center of the image. Another point is that we used a large diameter GMo aspheric lens for the final lens group. This was a significant factor in reducing the number of lenses and achieving high image quality. Also, with a 300mm f/2.8 lens, many users are concerned with the beauty of the bokeh, as well as the large aperture. We designed the lens to thoroughly reduce chromatic aberration and preserve the soft bokeh effect. In addition, to reduce ghosting, we used Air Sphere Coating (ASC) on three different lens elements, to achieve a high anti-reflective effect.

Uraba: For manufacturing, we conducted optical adjustment making full use of the optical technology at the plant. We worked hard to get as close as possible to the ideal quality during design and achieved stable, high optical performance.

For mechanical design, what did you take into account to achieve high image quality?

Nagaoka: Even for the mechanical design, we conducted thorough ghosting reduction simulations. It wasn't easy to reduce ghosting, with very close, complex drive parts around the focusing and floating elements at the back of the lens. However, we designed the lens to keep ghosting to a minimum.

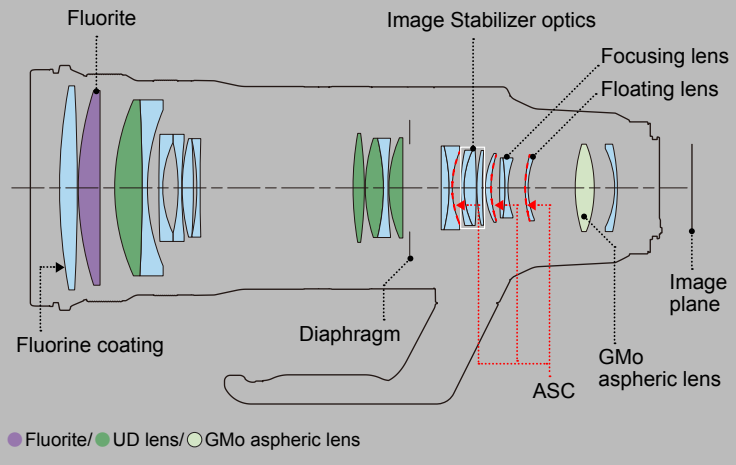
Hayakawa: In addition, in the mechanical design, we installed a new ball-holding structure to hold the cam ring of the zoom lens group. This technology was previously used in holding the cam ring of the *focusing* lens group. The zoom lens group, which moves backward and forward when zooming, can cause lens position instability with changes in direction, such as when shooting vertically. However, the ball-holding structure suppresses rattling and stabilizes the lens position. Through this, despite being a zoom lens, we could ensure optical performance rivaling that of a fixed focal length lens.

How is the image quality when an extender is attached?

Katayose: Attaching an extender causes an amplification in all types of aberration. It is necessary to improve the lens's optical performance as much as possible to maintain high image quality with little aberration. The RF100-300mm F2.8 L IS USM was designed with particular attention to the correction of chromatic aberration, and I believe that we have achieved high image quality worthy of an L Lens, even when an extender is attached.

Ball holding structure for the cam ring

Optical cross-section (when shooting from wide-angle end)
18 groups, 23 elements



Focus control has been advanced, and AF improved by installing two sets of nano USMs

Nobuyuki Nagaoka,
Mechanical Design

Yumi Toyoda,
Electronics/Firmware Design

Precise control with two sets of nano USMs

How has AF control evolved?

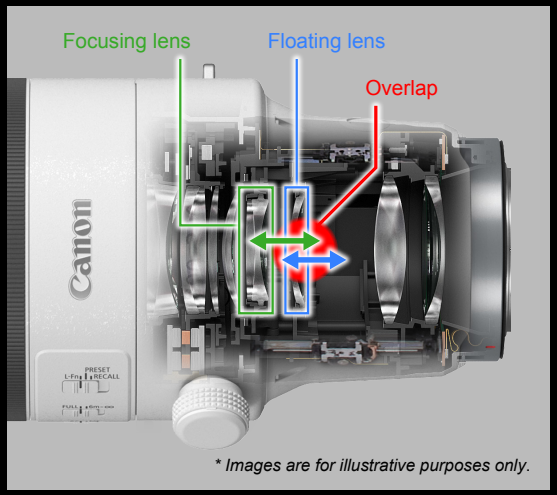
Nagaoka: We used electronic floating focus control with two nano USMs that have been proven in RF telephoto L zoom lenses. Nano USMs have excellent control, are very quiet, and are suitable for video shooting and still photos.

Toyoda: By reducing the weight of the focusing lens, we could use nano USM instead of the previous ring USM, which has also enabled faster focus control.

Nagaoka: For the RF100-300mm F2.8 L IS USM, to increase the freedom in optical design and achieve higher lens performance, we implemented an optical design where the drive ranges of the focusing lens and floating lens overlap. As this was an unprecedented design, we did not know whether it was possible at first. However, following the optical design policy of pursuing optical performance to its limits, the mechanical design and electronics/firmware design teams worked together to take on this challenge.

Toyoda: For electronics/firmware design, we were tasked with creating a control system to avoid clashes between the focusing and floating lenses. To drive lenses using two nano USMs with higher precision, we improved the control algorithm to allow for the control of a complex group of lenses.

Nagaoka: We needed to avoid the risk of collision between the focusing lens and the floating lens due to external impact when the power is switched off. Therefore for the mechanical design, we thoroughly implemented countermeasures against impacts providing a safe and easy-to-use structure.



We adopted a design where the drive ranges of the floating lens and focusing lens overlap, contributing to reduced weight and improved image quality.

AF function for the entire zoom range

How accurate is the AF when an extender is attached?

Nagaoka: We achieved precise AF when an extender is attached by using control proven in the RF100-500mm F4.5-7.1 L IS USM, where a floating element assists the focusing elements throughout the entire zoom range, to reduce focus errors.

For cameras, improvements have been made in terms of high-speed continuous shooting and subject tracking performance with enhanced subject detection. Have improvements been made in the lens focus tracking performance?

Toyoda: We worked to improve the precision of focus tracking when zooming. We improved the alignment method for tracking control so that focus shift is automatically corrected and focus is maintained. As a result, we have achieved high focus tracking performance across the entire zoom range.

Did you make any other enhancements or improvements?

Toyoda: Subject detection performance has evolved rapidly, and I am aware that more people are regularly using Servo AF rather than One-Shot AF. We improved the algorithm to maximize the subject tracking performance demanded by the camera, improving Servo AF's accuracy. In addition, as frame speeds for continuous shooting are also getting faster, we improved the nano USM's drive control algorithms. Also, as the RF100-300mm F2.8 L IS USM supports focus breathing correction installed on the camera body, it can reduce changes in the angle of view when moving the focus during video shooting.

The lens alone features a powerful 5.5-stops*1 of IS, and 6.0-Stops*2 of Coordinated IS control, with the in-body IS

A newly developed actuator responsively controls Image Stabilizer optics.

IS performance has been improved with a newly developed actuator

How has IS performance evolved?

Nagaoka: The IS unit proven in the EF400mm F2.8L IS III USM was the base for our design. We developed an actuator optimized for the weight and amount of movement of the moving lens groups, one of the highest levels ever, to responsively control the IS lens. The lens alone achieves an IS effect of 5.5 stops. Also, 6.0-stop coordinated control is possible when combined with a camera body with the in-body IS function mechanism of an EOS R3 and other cameras. This allows photographers to capture sharper images, even when shooting by handheld.

Toyoda: Coordinated IS control has made it possible to accurately detect and correct shaking information across the camera and lens. This is based on the gyro sensors on both the camera and lens, in addition to the camera's acceleration sensor and live view images. To detect low-frequency swaying, such as movement of the entire body when shooting by handheld, we gave the RF100-300mm F2.8 L IS USM a design that is more resistant to low-frequency sway. It wasn't easy to create an optimal control algorithm to take advantage of the characteristics of the gyro sensor installed inside the lens. We improved performance through constant adjustments and modifications.

The RF mount's high-speed communication contributes to the coordinated control

Is it true that coordinated control between the optical image stabilization in the lens and in-body IS in the camera body, as well as AF functions, have been significantly impacted by the evolution of the camera body?

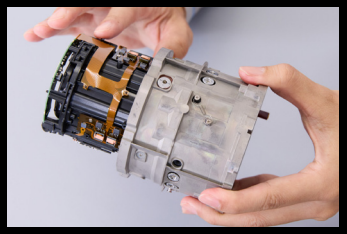
Toyoda: That is correct. In particular, with the RF mount, the communication speed between the camera body and the lens has been significantly improved, and the amount of information has increased dramatically compared to the EF Mount. Information on focus, zoom, aperture, and lens aberrations, as well as IS information, are instantly exchanged. We were able to realize high-performance IS by coordinated control with the camera throughout the entire zoom range due to high-speed communication between the camera body and the lens.

How should users use the three IS modes?

Toyoda: Mode 1 is for stationary subjects. Mode 2 is most suitable for moving subjects and panning. I hear that professional photographers who shoot sports often use Mode 3. Mode 3 is suitable for shooting irregularly moving objects, and image stabilization is only carried out during actual exposure.

**1 Focal length: 300 mm, when using EOS R. Conforms to CIPA standards (yaw/pitch axes)*
**2 Focal length: 300 mm, when using EOS R3. Conforms to CIPA standards (yaw/pitch axes)*

A commitment to durability and effortless operability to meet the demands of professional photographers



We aimed to create a lightweight structure that was also resistant to vibration and shocks for the internal lens components by using a combination of composite materials.

We placed the lens function/focus preset button in front of the lens barrel.

The zoom ring features a sloping surface to provide users with a natural fit and hold.

Aiming for a more robust and lighter lens

What was done to improve durability for professional users?

Hayakawa: The dust- and drip-resistance testing, sand resistance testing, and also zoom rotation durability testing ensure quality that meets the unique requirements of L lenses designed for the shooting requirements of professional photographers.* We used simulations to realize reduced weight with increased strength, and as a result, we achieved a good balance with a lighter lens that is more robust.

The drop-in filter was omitted by pursuing a compact size, reduced weight, and an optical design where the lens group is placed close to the mount. As a result, the large diameter of the lens barrel, which was a concern in terms of lens strength, has been removed, and the thinner outer barrel also contributed to further weight reduction.

Igarashi: For the white thermal barrier coating on the surface, we took color and texture into account, and we used the scratch-resistant, uneven, leather-tone coating, also used in the RF400mm F2.8 L IS III USM and other lenses. As a result, we have achieved high thermal insulation and durability.

**The lens has a dust- and drip-resistant construction, but it does not completely prevent penetration by water or dust.*

Realizing ergonomic operability

Please tell us about your commitment to operability.

Nagaoka: We made as many refinements as possible in terms of mechanical design to realize a smooth zooming action. The RF100-300mm F2.8 L IS USM is also great for shooting video. We also held discussions with each department regarding the placement of each button. The lens function/focus preset button is placed near the camera grip for the first time, so that users can quickly use it while gripping the camera. It is possible to customize the operation of the preset button. We also carefully calibrated the click feeling of the buttons. We put emphasis on the feeling of each button when it is pressed and carefully adjusted the dimensions.

Igarashi: The placement of the lens function/focus preset button was carefully considered for ease of use from a design point of view as well, to determine the optimal position where the fingertips of the right hand naturally reach. Also, in terms of operability, we paid particular attention to the tapered shape of the zoom ring and the molding surrounding the control ring to provide a comfortable hold that fits naturally in hand without causing fatigue.

The specifications for the RF100-300mm F2.8 L IS USM are unprecedented. What points were particularly challenging in developing the lens?

Hayakawa: When designing something completely new, you are bound to come across obstacles, and it makes you think, "I see; that is why this hasn't been done yet." With the RF100-300mm F2.8 L IS USM, we achieved this new specification through gradual advancements in technology and clearing one obstacle at a time.

Asami: I feel like we have created a lens with which professional photographers and high-level amateurs will be happy. I hope that users take the lens in their hands and feel the progress made down to the details, and further expand their range of shooting possibilities.

RF100-300mm F2.8 L IS USM
Developers' Thoughts

Yuriyo Asami
Product Planning

With excellent mobility and image quality rivaling fixed focal length lenses, this lens can be used for various types of photography, such as indoor and outdoor sports, fashion shows, and film festival red carpets.

I believe the RF100-300mm F2.8 L IS USM will allow users to capture decisive moments they were unable to capture until now and will respond to users' commitment to visual expression in a never-before-seen way.

I look forward to seeing users' pictures.

Masato Katayose
Optical Design

We have achieved optical performance rivaling that of fixed focal length lenses. We put particular focus on performance at the telephoto end.

In the process of finalizing the design, we put any extra time we had into improving the performance of the telephoto end.

We gave the manufacturing department a challenging request in terms of lens processing, and they achieved a high level of precision.

Please try out the telephoto end for yourself.

Nobuyuki Nagaoka
Mechanical Design

The team came together with the common goal of maintaining a high level of robustness and optical performance.

I am proud that we worked on design while paying attention to unseen factors such as ghosting reduction and ease of maintenance.

Photos from the telephoto end are impressive, but I was surprised when I saw the quality of a portrait taken from the 100mm wide-angle end, and I look forward to sharing this with many people.

Makoto Hayakawa
Chief of Development/
Mechanical Design

The most important point of the RF100-300mm F2.8 L IS USM is that it is a 100–300mm f/2.8 spec lens in a lightweight package.

To achieve the highest level of basic performance, such as optical performance, reliability, AF speed, and precision, as the flagship lens of the RF mount. Under this basic premise, we were constantly aware of the significance of weight reduction in our efforts.

I think we were able to achieve a reduction in weight without compromising on a single factor.

Yumi Toyoda
Electronics/
Firmware Design

The electronics/firmware design process takes the specifications created by the optical and mechanical design teams and incorporates them into a control algorithm to maximize performance.

There was the pressure that performance could not be ensured if we were not able to do this.

There were many new optical and mechanical factors, but we worked together as a team to create a product that would deliver the highest performance.

Masaaki Igarashi
Design

We worked hard to provide solid ease-of-use and operability that inherits our past achievements and trust while being a new RF mount large aperture telephoto L zoom lens.

I believe the design pursues the beauty of subtraction and will be loved by users for a long time to come.

I expect many photographers and video users will be happy with this lens.

Ken Uraba
Manufacturing
Technology

The Utsunomiya Plant, where the RF100-300mm F2.8 L IS USM is manufactured, is a lens production facility that is one of Canon's most technologically advanced and has one of the most skilled workforces.

We focused on simplifying processes, component shapes, and even the manufacturing line to reliably produce high-quality products.

We gave our all in producing lenses, so we hope users are happy with them.