Welcome to the Autumn 2023 edition of 'Lens Innovation' – a twice yearly eNewsletter from **Resolve Optics Ltd**. Each issue of Lens Innovation is designed to keep you informed about the latest technological developments, applications advances and breaking news in the optical design and manufacture industry.

Please do not hesitate to **contact us** if you would like to comment on a particular feature or ask further questions. We welcome your feedback.

Mark Pontin – *Managing Director*

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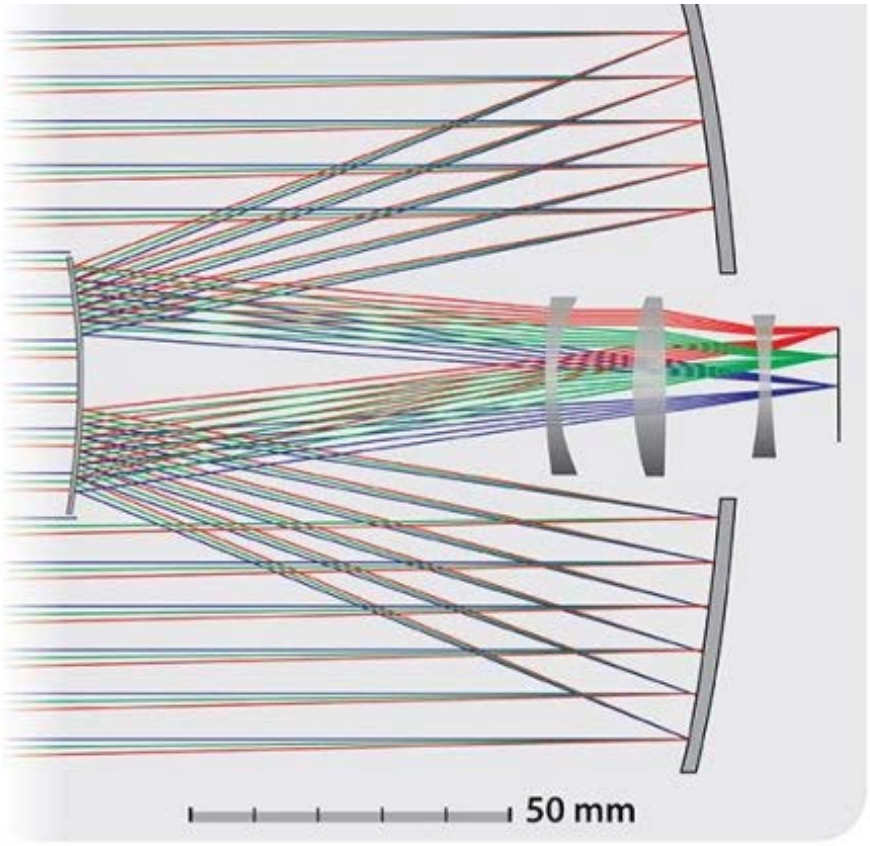


Catadioptric lenses – where might you use them?

Optical systems that make use of lenses and mirrors for the formation of images are commonly known as catadioptric systems. Combining dioptric (lens) and catoptric (mirror) elements – a catadioptric optical system is one in which reflection and refraction occurs.

Catadioptric or mirror lenses are often used when you need an optical system with a long focal length, but you are limited on the length of space in which to fit the lens. Commonly used for telephoto lens applications, the design provides a much shorter, lighter, and less expensive lens than a comparable conventional telephoto lens.

Advantages of a catadioptric lens include diffraction limited performance which means you can get the maximum available resolution for a particular f / number and focal length. Catadioptric lenses are also useful when your application requires operation over a wide bandwidth – as the light is not dispersed through glass optical elements. Using high reflectance coatings on the mirror elements of a catadioptric lens allows you to maximise transmission through the system.

For applications where high magnification and narrow fields of view are required, the catadioptric design provides a very high degree of optical correction, making such lenses popular for astronomy. Catadioptric telescope designs often provide better aberration correction than all-lens or all-mirror telescopes over a wider field of view. However, the key advantages for amateur astronomers are in mechanical size and weight reduction.

The main disadvantage of the catadioptric optical design is that it precludes fitting a diaphragm and the aperture of these lenses is always fixed. Therefore, light adjustment can only be by use of neutral density filters giving no control over depth-of-field, which is always minimal.

Learn more: **click here**.

VIEWPOINT:

Justifying a custom lens for your optical product.

When looking for optical components for your application the first port of call is often the off-the-shelf market, and quite rightly so. Off-the-shelf optical components offer advantages for optical system design, including typically shorter delivery times and lower costs.

Even from our own point of view, we do not want to waste a lot of time for no reason. If a suitable lens is available and that lens meets all your optical and environmental requirements, then why look further.

However, when an application optically requires something a little more demanding such as high performance, high-resolution, compactness or a large format image, using an off-the-shelf lens will force you to accept a compromise in one or more aspects of optical performance. The result of such compromises can be a reduction in optical performance, a bulkier less attractive product, shorter product life and loss of competitive advantage – all of which lead to lower profitability.

When justifying the typically higher cost of a custom design we recommend that you consider the many benefits of an application optimised optical system.

• You will be investing in an optical design that meets or exceeds your application

requirements with no compromise.
• The mechanical design of your optical system can also be optimised to your application.
• You get exclusivity and hence competitive advantage.
• Security of supply is assured, for as long as you require the lens. We will never discontinue production while you still place batch orders. You have the peace of mind that you will not suddenly be forced to redesign your application due to a lens becoming obsolete.

These are a just few advantages that you get from a custom design. A custom design may not cost as much as you think. As an organisation committed to reproducibly producing top quality, application-optimised optical components, and systems for our customers – we operate to strict ISO9001 guidelines and invest in advanced testing equipment and our highly trained staff.

To learn more about the process of sourcing a custom optical system from Resolve Optics please visit **https://www.resolveoptics.com/oem-design-manufacture/**.

TECHNOLOGY FORUM:

CMOS sensor optimised non-browning lenses.

Many applications in nuclear plants and reprocessing facilities incorporate remote monitoring cameras to assist in ensuring safe and productive operation. There are two main types of radiation tolerant CCTV technology used in the nuclear industry, tube cameras based on cathode ray tube technology and digital devices using CMOS

(complementary metal-oxide semiconductor) sensors.

As their availability has decreased – cathode ray tubes have become increasingly more expensive, prompting more manufacturers of radiation tolerant cameras to turn towards CMOS sensors. Although CMOS sensors do not offer the same level of radiation tolerance as tube cameras, they have much higher resolution as well as the ability to provide colour images.

To take advantage of these benefits, nuclear camera developers required a next generation non-browning lens that offered high resolution, high performance, and colour images to match the performance of their CMOS sensor.

Designed specifically for use with colour CMOS cameras in high radiation environments, our Model 357 lens range provide true high definition (HD) quality images over a 10x zoom range. Incorporating specialised non browning glasses – Model 357 lenses produce clear sharp images free of the strong yellow tint that has traditionally been a limiting issue when using radiation tolerant lenses on colour sensors. The glass used in these lenses can withstand long-term exposure to radiation up to an accumulative dose of one hundred million Rad and temperatures up to 85°C without loss of transmission.

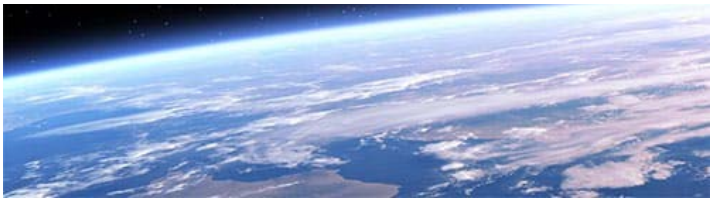
Operating at f/3.6, a two-third inch format version of the Model 357 lens provides high image resolution and minimum geometric distortion from 400 to 770nm and can image objects from 1300mm to infinity. This Model 357-004 is a tracking zoom lens, meaning that once it has been set up, it will maintain focus throughout the entire zoom range. Offering full motorised control of zoom, iris and focusing this robust zoom lens design can be adapted to deliver the full potential of nuclear CMOS sensors.

To read case study, **click here**.

DESIGN FOCUS:

Design considerations for satellite optics.

We are reading new reports of the benefits of optical satellite imaging in applications including inspection, navigation, remote sensing, and telecommunications, as well as ground-breaking scientific space research.



Most optical satellites operate passively taking images in the visible or near-visible portion of the electromagnetic spectrum, using the sun's radiation as it reflects off the Earth and atmosphere. By comparison, radar satellites operate actively, as they emit their own microwaves or radio waves, and usually require much more processing to get an image that makes sense to the human eye. Optical satellites also offer another significant advantage over radar satellites in that they require much less energy, making them cheaper to use. Other advantages of optical satellites over radar satellites are that they offer improved bandwidth, smaller size and weight, electromagnetic interference immunity as well as higher transmission and processing speeds.

Optics designed to be 'space ready' for use in an optical satellite must meet some strict requirements. These requirements are often determined by international space organisations, such as NASA or the ESA, with the aim of ensuring that any optical components used in satellites can withstand the rigors of launch and the harsh environment of space.

When designing optics for satellite applications, one of the first things you need to consider is whether the optics need to use radiation tolerant (non-browning) glass. There are two main factors that will affect this decision. The first is the Earth orbit that your satellite will be deployed into. The levels of radiation that an optical satellite will be exposed to in low earth orbit (LEO) are much lower than a satellite operating in a higher orbit. The second key consideration is the length of time that these optics need to remain operational for. If the mission is short (a few months), then the level of radiation absorbed by the optics may not be enough to have any significant effect on transmission. In this optical satellite application, there should be no requirement to use non-browning glass.

Operating space on optical satellites is typically extremely limited so the lens / optical systems must be designed to fit within the available space envelope and to reduce launch costs under the maximum weight requirements. Other key considerations when designing lenses to be incorporated into optical satellite systems includes how they react to the vibration and shock of launch, extremes of temperature, and the high vacuum environment that is encountered in space.

Read published article on this topic: **click here**.

PROJECT REPORT:

Next generation optical module for ultra-high-speed imaging

As a developer and supplier of custom lenses and optical systems to leading camera, sensor, and optical instrument manufacturers our aim is to help these customers keep at the forefront of the markets they serve through ongoing cooperative developments and providing continuous support.

One such customer is Specialised Imaging – technological market leader in ultra-high-speed imaging and ballistic range cameras. Their SIM family of ultra-high-speed cameras are used by research laboratories around the world. These state-of-the-art cameras can capture up to thirty-two images at one billion frames per second and proven to be able to capture visual data from even the most fleeting of phenomena. To help the SIM camera range remain the ultra-high-speed multichannel imaging camera of choice for researchers working at the edge of what is possible and solving new applications challenges – Resolve Optics have recently supplied a third generation ultra-high-speed camera optical module that is not only more user friendly but also provides improved performance.

In this latest development a key objective was to make it easier for Specialised Imaging to precisely align their sensors with the eight ports on the ultra-high-speed optical module. To provide this enhanced ease-of-use facility we developed a new sensor mounting system that allows for easy adjustment of the whole port in x and y planes. This new adjustment system allows them to align their systems significantly quicker and with much more accuracy than was previously possible.

Managing Director of Specialised Imaging – Wai Chan commented “I am pleased to say that the Resolve Optics optomechanical design team has again risen to the challenge and designed a new and improved optical module that meets all of our specification needs of our SIM cameras.”

For further information on our OEM design, development and development service please visit **www.resolveoptics.com/oem-design-manufacture/**.

BREAKING NEWS

Resolve Optics celebrates 20 years.

Recently members of staff and partners were invited to celebrate our 20th anniversary in a local restaurant. It was back in 2003 that Resolve Optics started its quest to design and deliver application optimised lenses and optical designs in OEM quantities for small and large high technology businesses. Speaking at the celebration – Mark Pontin said “Our experienced team of optical designers is key to the novel solutions we propose. Thanks to our talented workforce we have established ourselves as a market leading supply partner for camera, sensor and instrument companies who seek high performance custom optics to enable them to gain a competitive edge or solve a challenging application problem.”

Learn more about us: **click here**.

Industry interview – ‘Designing and Proving Optics for Military Applications’.

In discussion with the editor of IEN Europe – Rob Watkinson, our customer Support Manager discusses how designing and producing a lens or optical system for military use requires careful consideration of its resistance to vibration, shock, temperature, and water ingress to ensure high reliability and top performance.

Read interview in full: **click here**.

Satellite payload undergoes vibration and classic shock testing.

Recently our vibration test centre was used by Sen Corporation Limited to conduct sine sweeps and random vibration testing on their latest satellite payload.

Using our in-house ETS L215 Shaker, MPA101 amplifier and a DTS Venzo 800 controller the testing consisted of a low-level sine sweep, followed by a random vibration test, and finished with another low-level sine sweep. The three tests were conducted in the X, Y and Z axis.

The output data provided to Sen was in the format of a run status CVS file for each test that enabled the sine test results to be overlayed so that any changes caused by the random test could easily be identified.

Having invested in a this fully calibrated test vibration test centre is able to offer this important new service to its customers. We can currently provide Random, Random on Random, Sine and Classic Shock vibration testing for small test subjects of up to 30 kg depending on the level Grms required.

Learn more about vibration and shock testing: **click here**.

THE LAST WORD:

NASA develops advanced optical communications process.

As NASA prepares to journey back to the Moon, the agency will introduce a similar concept of internet networks in space to enable astronauts to communicate with each other and with researchers back on Earth. However, communicating through space can be difficult because the extreme distances and harsh conditions can cause signal delays. Most space missions use radio frequency communications to send and receive data, as radio

waves have a proven history of success. However, optical, or laser, communications allow for larger data returns, a significant benefit for future exploration.

This editorial feature was first published on the NASA website.

Read article in full: click here.

Download 'An introduction to Space ready optics' – click here.

Printable version (pdf)