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lens innovation

Welcome to the Spring 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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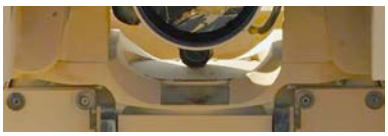
INFORMATION GUIDELINES:

Lens design considerations for military applications

Precision optics are used in many areas of military operations, from vision systems and target designators used by personnel on the ground, through guidance systems used in both manned and unmanned aircraft, to reconnaissance and surveillance packages carried by satellites in Earth orbit.

When designing optics for military applications you will inevitably come up against some quite onerous environmental tests that the lens will have to survive. Producing a lens or optical system for military use requires careful consideration of its resistance to vibration, shock, temperature, and water ingress as well as ensuring high reliability and top performance.



Designing lenses to survive and maintain image quality and mechanical movement in the typically challenging environment of a military application is not something you can leave to theoretical analysis alone. For a lens or optical system to survive the challenges of helping collect high quality images from a piece of military equipment – requires that suppliers undertake rigorous environmental testing to minimize the possibility of failure in operation.

Creating a lens or optical system able to survive these environmental challenges does not just entail beefing up the metal work. The optical and mechanical designers must work together to ensure the best design to meet all aspects of the customer specification is met. At Resolve Optics we take every precaution possible to ensure our lenses and optical systems are optically and mechanically designed to withstand the specific environmental challenges of your military application.

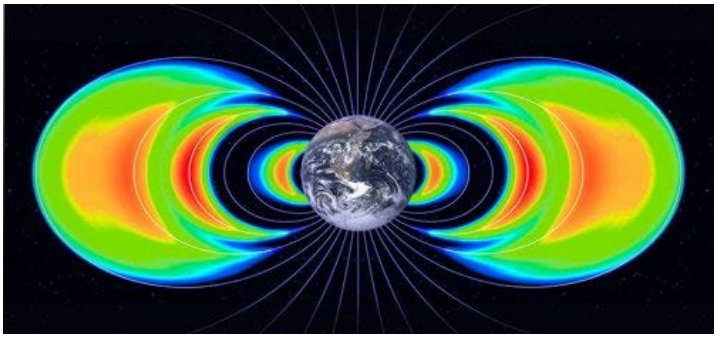
This involves using the advanced stress analysis tools in our 3D CAD software to identify and design out any areas of weakness. Once we have a design that is as rugged as possible, we will then test the lens on our in-house vibration and shock test equipment. Using the correct vibration profile enables us to simulate the conditions the lens will need to survive in your military application. Once the resultant lens has been produced, we can undertake temperature and ingress and pressure (IP) testing at our partner test facility.

Producing a rugged lens or optical system optimised for your military application is a complex task. However, our team of experienced optical, mechanical, and electronic engineers and designers have a proven record of producing top quality, robust fixed focus and zoom lenses and high-performance optical systems for even the most challenging military and defence applications.

To discuss a lens design for your military product, **click here**.

VIEWPOINT:

Earth orbit and space applications – where do I need radiation tolerant lenses?



Depending on what imaging / monitoring task a satellite is designed to accomplish will determine the Earth orbit it operates within.

Satellites are not launched any higher than is needed for a particular mission, because to get them to stay there takes a lot more launch energy and therefore a bigger rocket which costs much more money.

Many Earth observation satellites are launched into geosynchronous orbit, 36,000 miles up, because this lets them orbit at the same rate as the Earth rotates, appearing stationary over a particular spot as the planet revolves with them. In this high orbit, satellites are exposed to far more radiation from the sun. By comparison, space platforms such as the International Space Station orbit at only about 250 miles, below most of the radiation and low enough to be easier to reach for resupply.

The cosmic radiation emitted during solar events such as sunspots, solar flares, coronal mass ejections and proton storms is well known to have a deteriorating effect on orbiting equipment in space as well as astronauts.

If you are looking to launch a satellite into low Earth orbit it may not be necessary to use lenses made from radiation tolerant materials because the Earth's atmosphere works like a shield, keeping out substantial amounts of this radiation. However, if the duration of your low Earth orbit mission is years rather than weeks or a few months then using radiation tolerant optical materials is recommended to minimise loss of optical performance.

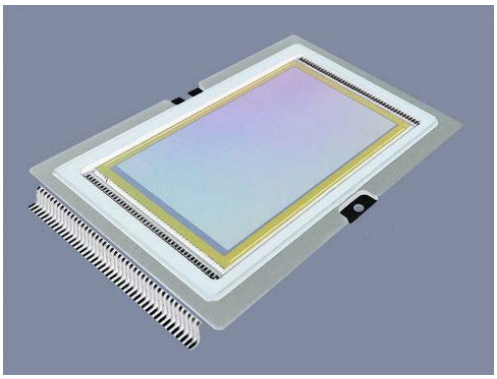
As you move to the higher orbits, and exposure to radiation increases, using radiation tolerant optical materials becomes necessary. Apart from fused silica or quartz – all standard glasses turn dark when exposed to radiation. This means that if you are using a standard lens in higher Earth orbit within weeks or a few months at most, you will start to lose your image.

The widely accepted solution to this is to use non-browning glasses that have Cerium Oxide added which retards the darkening of the glass when exposed to radiation. A non-browning lens will continue to work until it has exceeded its accumulative dose of radiation. In the case of Resolve Optics radiation tolerant lenses, they are rated for one hundred million rad so depending on the level of radiation they are exposed to daily you could expect a space ready lens to have a

life of around 10 years.

To discuss your application and determine the requirement for radiation tolerant lenses please **click here**.

TECHNOLOGY FORUM:



Choosing large format sensors – the impact on lens design.

Over recent years we have seen a trend towards using larger format sensors.

The main benefits encouraging people to use these larger format sensors are their improved low light performance and the increased number of pixels providing potentially much higher resolution. Although these benefits are no doubt significant, the use of a large sensor does also have its drawbacks.

The main challenge when designing optics for larger format sensors is keeping the size of the lens reasonable. The larger the sensor the larger the lens. For example, a 50mm f/2 lens for a one third inch sensor is approximately 50mm long and 25mm in diameter. However, if want the same field of view and f number on a one-inch sensor your lens would need to increase to something in the region of 130mm long and 65mm in diameter. This unfortunately can lead to products that can be oversized and more expensive than necessary.

Leveraging the many years' experience of our optical designers we have found ways of mitigating these increases in lens size. However, they require optical design concessions to be made and even then, there is only so much that can be done. For these reasons it is always worth considering the available space before selecting your sensor especially when available space is of a premium.

Because distinctive design trade-offs may be preferrable for different applications, no individual lens can offer the optimal solution for every imaging application. Resolve Optics prides itself on being able to provide optimised solutions that meet our customers application requirements but unfortunately, we are still bound by the laws of physics. For projects where we find ourselves butting heads with these laws, our aim is always to collaborate closely with our customers to find an optical design solution that is acceptable to you.

For further information please **click here**.

DESIGN FOCUS:

Zoom lenses for space applications.

The sliding parts in a traditional zoom lens use grease to ensure smooth accurate movement, but in the vacuum of space the use of grease is not possible. This makes the driving of the zoom exceedingly difficult as the moving parts need to be dry. Because of this, designs require a greater degree of freedom between moving parts which can lead to the components bouncing when weightless. Avoiding the use of grease is not insurmountable but require the mechanics of the zoom to be complex and even more tightly tolerance.

The next issue is that traditional zoom lenses tend to be big and heavy, especially if you require longer focal lengths. Keeping weight to a minimum is a critical consideration of anything being launched into space. However, the biggest worry is the risk that the lens could suffer mechanical failure of moving parts and it is this that has been the biggest barrier to using traditional zoom lenses in space.

As a result of the unfulfilled demand for a zoom lens for spaceborne applications – Resolve Optics has developed an optically corrected zoom lens. Using this design concept, we have been able to reduce the moving parts of a zoom lens to

just a single push-pull movement. This optical design innovation eliminates the need for complex cams and tubes in tubes that are required in a traditional zoom lens.

Maintaining focus and resolution throughout its zoom range, the maximum magnification of our optically corrected zoom lens is 4x. Achieved without the traditional need for 'grease enabled' moving parts – the contemporary design shows real promise for use in spaceborne applications.

Learn more: **click here**.

PROJECT REPORT:

High-definition Head-Up Display (HUD) lenses

Head Up Display lenses are used to record an aircraft pilots view from the cockpit either directly or through a HUD combiner. Systems that look through a HUD combiner record images of the outside world and the associated data symbology at the same time. Whereas the systems that do not use a combiner will only capture the outside images and then the symbology is overlayed after. Both approaches are primarily used for pilot training and mission analysis.

Today the demand from both the commercial and military aerospace industry is for higher quality images which necessitated the development of a new generation of higher resolution lenses which would meet these needs.

A challenge facing this optical development was that there are many different types of aircraft that use HUD systems and each aircraft type required a slightly different focal length lens depending on its position in the cockpit. To overcome the need to have several different lenses to cover all the aircraft types, Resolve Optics has developed a system where one High Definition (HD) optical design provides an infinite number of field of views (18° to 24°) covering most if not all the scenarios required.

This single HD optical design approach has enabled several HUD system integrators to cover multiple aircraft with one lens helping them keep costs down as they no longer have to order four different lenses for four different aircraft.

Read case study: **click here**

BREAKING NEWS

This feature is here to inform you about what is new at Resolve Optics.

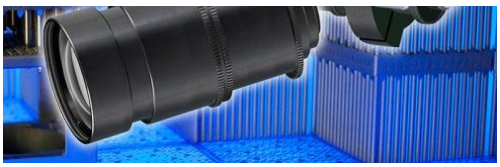
Online presentation – 'An Introduction to Space Ready Optics'

Designing and producing optics for use in space is a highly specialised area where expertise and experience are critical. Resolve Optics has been supplying lenses and optical systems for space applications for over 15 years. During this period, we have acquired a considerable amount of knowledge with regards to the do's and don'ts of designing for this harsh environment of space.

Want to know more: **read this informative 3-minute presentation**.

Industry interview – 'Designing optics for nuclear plants'.

Producing optics able to withstand the elevated levels of radiation



found in and around nuclear plants is the subject of a new interview featuring our customer support manager – Rob Watkinson. Recently published in Processing & Control News Europe, the interview provides an informed insight into radiation tolerant optical materials, design challenges, applications, operational longevity, and non-nuclear applications that are also benefiting from our market-leading expertise in this area.

Click here to read now.

Matching a lens to your camera sensor

Industrial camera sensors come in sizes ranging from 1/4-inch to 1-inch and beyond. The lens(es) you choose to integrate into your product will play a pivotal role in determining your camera performance. A lower resolution lens will reduce the achievable image quality from a high megapixel camera sensor. Likewise selecting non-optimised lenses may compromise your products performance due to limiting the field of view (FOV), increase image distortion or vignette light impacting your camera sensor.

To read more **Click here**.

THE LAST WORD:

SWIR Imaging enhances tumor identification.

UK-based scientists at University College London (UCL) and surgeons at Great Ormond Street Hospital (GOSH) have used a method combining highly detailed, real-time images within the body with shortwave infrared (SWIR) light during surgery to differentiate for the first-time cancerous tumours and healthy tissue.

SWIR imaging offers many advantages over conventional near-infrared imaging including reduced tissue scattering and autofluorescence. Using a high-definition camera to capture SWIR fluorescence, the researchers were able to then distinguish between cancerous tumors and healthy tissue during preclinical tests.

The research team concluded that this interesting development could have implications for treating neuroblastoma, which is among the most common forms of solid cancer tumors found in children. Standard treatment typically involves surgery to completely remove cancerous cells, which can be difficult to see as they appear like the surrounding healthy tissue.

This research was first published in *Cancer Research*

Read article in full: click here.

High performance optics for SWIR imaging: click here.

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