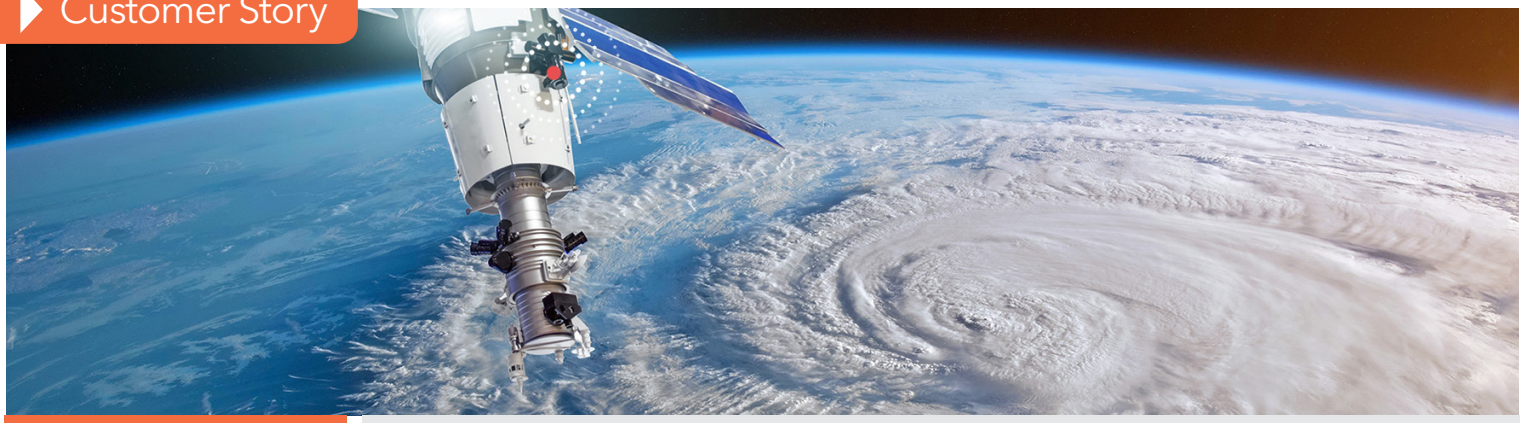
Customer Story



LYNRED

Challenge

Lynred's fit-for-purpose, high-value-added spatial activity technologies – often engineered for a single use – require a significant investment in R&D. Costly prototyping and testing mean that engineers contend with unusually small sample sizes, motivating the need for robust statistical approaches.

Mapping new frontiers in the infrared

Engineers at Lynred design high-performance technology for probes traveling deep into space on a voyage of discovery

In early 2018, the Hayabusa 2 space probe made history when it sent a lander to the surface of Ryugu, a primitive, diamond-shaped asteroid only half a mile wide. The probe was designed to gather data that will deepen scientists' understanding of the solar system's formation nearly 4.6 billion years ago.

This kind of science – unthinkable even just a few decades ago – is only possible today because of advances in engineering and the ingenuity of companies like French infrared (IR) technology pioneer Lynred, whose vast portfolio of IR detectors covers the entire electromagnetic spectrum from near to very far IR.

Lynred and its US-based subsidiary, Lynred USA, are global leaders in the design and manufacture of high-quality IR technologies for aerospace, defense and commercial markets. In addition to having products at the center of multiple military programs, Lynred's IR detectors are now the key component of many top brands in commercial thermal imaging equipment sold across Europe, Asia and North America. Furthermore, Lynred is today the leading European manufacturer for IR detectors deployed in space.

Pioneering technology sheds light on the origins of our solar system

On board Hayabusa's lander, a Lynred detector known as NEPTUNE can scan the rocky surface of Ryugu at the molecular level. "This IR hyperspectral map helps scientists identify the chemical composition of the sediments and therefore understand the history of how and when the asteroid was formed," explains Augustin Cathignol, Principal Engineer for Product Reliability and Data Science at Lynred.

Like many of Lynred's technologies, NEPTUNE was engineered specifically for MicrOmega, the IR microscope developed by IAS (Institut d'Astrophysique Spatiale at Orsay, France) with the support of CNES (Centre National d'Etudes Spatiales, the French space agency) that is transported by the Mascot lander of the Hayabusa 2 mission.

"Lynred's detectors are designed in a way which is really adapted to the mission. They're sur-mesure – bespoke," says Cathignol. Each detector or camera destined for a space mission is only produced once, which can mean years of prototyping and testing for a single end product. But these kinds of innovations open the door to new scientific and industrial applications, and the company doesn't shy away from a heavy investment in R&D.

Quantifying reliability from R&D to production

With international space programs setting sights on ever more distant missions, Lynred's engineers face significant pressure to make IR detector technology smaller, lighter and more efficient. Product reliability is therefore a primary concern. "In our business, it's very important to be present at the beginning stages of research so that we can take reliability into account early on," says Cathignol, who leads a reliability team from the time the first prototype is developed in R&D through to when the final design leaves production.

If at any stage the product is not reliable, it could fail to meet critical deadlines or even fall short of a mission's narrow launch window, Cathignol explains. "We need to reach performance targets and ensure that everything is tuned and designed perfectly in order to achieve this level of performance." Providing quantifiable evidence of reliability to customers, he adds, requires complicated statistical analyses. "So I was very glad when I joined Lynred to see that JMP was in the walls for them."

JMP® Pro, from modeling to visualization

An engineer and semiconductor physicist by training, Cathignol had used JMP statistical discovery software in previous roles. When he came to Lynred, potential applications for the software were even more abundant. "Now I use JMP for various types of linear and sometimes nonlinear modeling," he says. "I also use recreations with either continuous or categorical variables, as well as distribution analysis and advanced techniques, some of which are only available in JMP Pro."

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Statistical Discovery.™ From SAS.

> The user experience, the ergonomics, the aesthetics of visualization, the mathematical rigor and the support – that's why I really love JMP.
>
> Augustin Cathignol,
> Principal Engineer for Product Reliability and Data Science

JMP makes it possible for Cathignol and his colleagues to quickly identify issues with testing or production that affect yield, scrap or opportunities for other cost efficiencies. By catching potential arisings early, the team is able to accelerate the cycle of engineering while keeping costs down and delays infrequent.

In one instance, when a high-value thermal process in the production line was showing signs of low yield, Cathignol and his team used signal processing in the Functional Data Explorer in JMP Pro to optimize the process. "The idea was to look for a correlation between the shape of the signals generated by the equipment itself (called "log files")," he recalls. "For this, we used Functional Data Explorer and dynamic time warping, which generated some distances from signal to signal. Then, with clustering techniques, we were able to see the correlation we were looking for, which were very interesting and useful."

With the lengthy R&D cycles typical of highly specialized technology – and the immense cost of testing prototypes – Lynred's engineers often have a large number of data points but only a very small sample size. And this, Cathignol says, presents some obvious statistical challenges. "Compared to the semiconductor or automotive industry, the number of products we build is pretty small," he says. "This means we work on a small sample size and it's much more difficult to derive conclusions. We often have to adapt our methods to take this [reality] into account." JMP helps to mitigate these limitations, Cathignol says, by boosting the statistical robustness of every analysis.

Quantifying product lifespan in extreme conditions

Once a Lynred product reaches a more advanced stage in its development life cycle, Cathignol and his colleagues are responsible for quantifying product reliability in different mechanical and thermal environments. Whether Lynred's technology succeeds or fails is often related to whether it can function in extreme conditions. To provide customers with the guarantee that a detector will work, engineers must estimate the product's lifetime under an array of environments including cryogenic temperatures and space radiation.

The company is equipped with environmentally controlled labs that simulate these extreme conditions to test the robustness of new prototypes or components. In the development of their NEPTUNE model, for example, Lynred had to ensure the detector could not only survive the journey to Ryugu, but also withstand the conditions at the surface of the asteroid.

Dealing with big data, Cathignol says, "the higher the volume of data we collect, the greater the chance we will get some signals from them that add value and build knowledge. But some data are just not that meaningful and it's a big challenge to sift through and focus only on what will maximize value…. It can be complicated to visualize. I really like JMP for this, especially Graph Builder, which is very practical and efficient."

Speeding innovation, advancing scientific discovery

"We watch our competitors to maintain an innovation rate which is high enough to keep being leaders," Cathignol says. "We're facing tough competition from other companies that are [increasingly achieving good] performance from their own detectors. So we need to keep innovating and we do so."

"That's why I really love JMP! The user experience, the ergonomics, the aesthetics of visualization, the mathematical rigor and the support," he adds, noting that one of the most valuable things about JMP is the close collaborative relationship he maintains with JMP technical experts. JMP staff, Cathignol says, bring a human touch to the software, enabling his team to solve problems quickly and work smarter to drive the innovation the Lynred brand is known for.

"We are very proud of the products we build," Cathignol says. Just think: "At any given time, they are traveling in the universe around asteroids or Mars or other planets in our solar system." It's technology like this that will help humankind traverse the final frontier – space: an unconquered vastness of immense opportunity and discovery.

Solution

JMP® and JMP Pro help Lynred's engineers optimize quality, driving efficiencies from R&D to production and ensuring that each new model fulfills its brief.

Results

Lynred is the only space-qualified manufacturer of IR detectors to have delivered several dozen flight models to most of the major satellite and space missions over the past decade. The company has built more than 70 fit-to-purpose designs, including those that played a critical role in Sentinel 2, Tropomi, Hayabusa 2 and the ExoMars space programs.

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