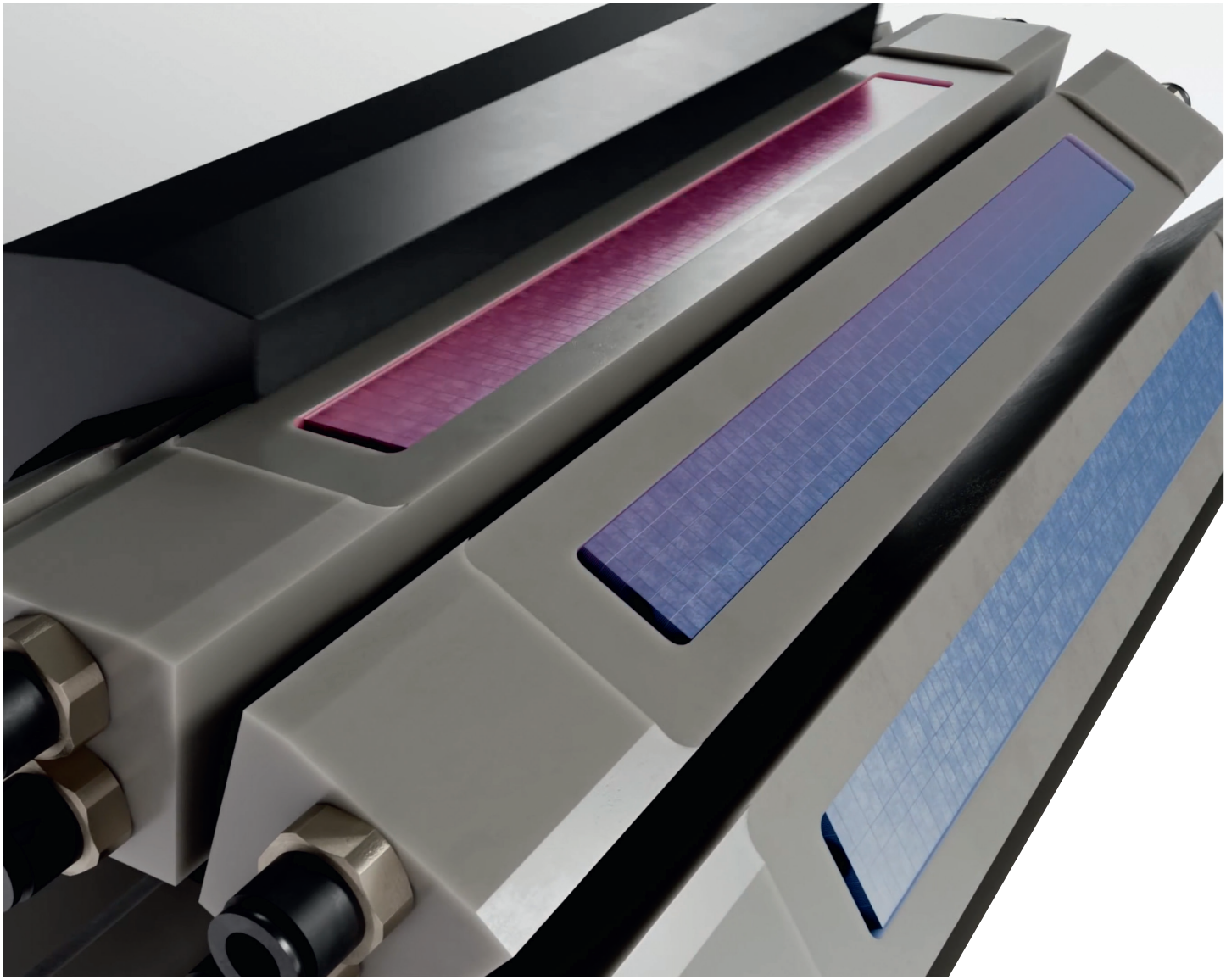


COOLER BY DESIGN

MAGNORIC OPTIMIZES MAGNETIC REFRIGERATION WITH NEXT-LEVEL SIMULATION

About the Customer

Magnoric is a France-based pioneer in next-generation magnetic refrigeration. Its innovative systems are built on active magnetocaloric regenerators (AMRs), offering a sustainable, solid-state alternative to conventional gas-compression cooling. By leveraging magnetocaloric materials and heat-transfer fluids, Magnoric develops energy-efficient and eco-friendly refrigeration solutions, designed to transform industries from food preservation to climate control. With a strong commitment to precision engineering and innovation, Magnoric continually enhances the performance and durability of its cutting-edge cooling technologies.

> “Altair’s powerful solution helped our team explore complex design trade-offs with unmatched speed and accuracy. We were able to rapidly simulate multiphysics models with complex geometry and confidently assess how spacer thickness affected both performance and durability. The solution not only refined our modeling approach but also provided a clear direction for developing more reliable and efficient AMR systems.
>
> Rémi Dubois, Chief Operating Officer, Magnoric

Their Challenge

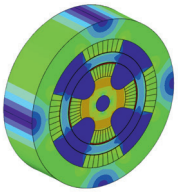
Magnoric's AMR system contains sophisticated cooling channels that hold stacks of magnetocaloric plates separated with spacers. While the spacers prevent mechanical interlocking, they also disturb fluid flow and contribute significantly to pressure drops that raise pumping power demand and reduce overall system efficiency. To improve the design, the team needed to consider spacer specifications: Thinner spacers minimize pressure drops, but lack mechanical robustness and generate debris that blocks flow channels. Thicker spacers are stronger, but increase dead volume, negatively impacting thermal transfer performance.

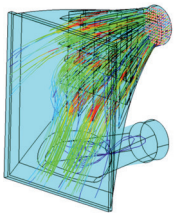
Optimizing the spacers raised two important engineering questions:

• How do pressure losses in real AMR systems compare to those predicted by idealized channel models?

• What spacer thickness provides the best trade-off between structural durability and hydraulic efficiency?

To find the answers, Magnoric needed an advanced simulation and measurement solution that could accurately capture flow behavior, pressure drop, and thermal transport in complex AMR geometries.





TOP: Complete magnetic system simulation using Altair® SimLab®
BOTTOM: Fluid flow simulation inside the diffuser

Our Solution

Magnoric employed the Altair® SimLab® advance thermal, computational fluid dynamics (CFD), and electromagnetic (EM) simulation solution designed to handle multiphysics modeling and complex geometries. Instead of fabricating and testing every design iteration, the project team created a virtual model of the AMR system, focusing on a simplified two-block section separated by a spacer. This setup realistically captured operational conditions, including fluid flow through 44 ultra-thin channels and the intentional misalignment of successive blocks.

Using Altair's simulation environment, the team rapidly explored spacer thickness variations between 0.3 mm and 0.6 mm through targeted what-if analyses. Engineers chose water as their working fluid to reflect real-world behavior, particularly regarding pressure drop and pumping power demand.

The simulations provided clear insights: while 0.3 mm spacers delivered marginally better efficiency, they posed significant risks of mechanical instability. By contrast, 0.6 mm spacers offered far greater robustness with virtually no additional hydraulic penalty. Running these studies in-house enabled Magnoric to validate physical models, optimize design parameters, and select a configuration that achieved both reliable hydraulic performance and long-term structural durability.

Results

With SimLab's thermal, CFD and EM solution, the Magnoric team was able to analyze and make well-founded design choices without relying on costly trial-and-error prototyping. The simulations confirmed that 0.6 mm spacers provided the optimal compromise between hydraulic efficiency and mechanical strength. This finding formed the basis of their go-to-market strategy of developing more robust and durable AMR system designs while reducing the risk of channel blockage and long-term performance loss.

In addition to the technical outcome, the project gave Magnoric's engineers deeper insights into system behavior and a quantitative basis for evaluating design trade-offs that were previously difficult to assess. The team also established a validated calibration factor for pressure losses, strengthening the predictive accuracy of their simulation models for future designs. With these results, Magnoric not only improved the reliability of its current machines but also laid a solid foundation for scaling its technology into commercially viable, energy-efficient refrigeration solutions.

To learn more, please visit altair.com/simlab