

## A REVOLUTIONARY TECHNOLOGY

**THE ULTIMATE LEGACY OF 70 YEARS OF GLOBAL EXPERIENCE  
IN INERTIAL NAVIGATION**

Safran Electronics & Defense is the only company **today that mass produces systems based on all inertial technologies:**

- Mechanical
- Optical (RLG and FOG)
- Resonating (Coriolis vibrating gyros) including the latest Hemispherical Resonating Gyro, dubbed “HRG Crystal”, the best inertial technology in terms of lifespan and reliability.

Building on this unrivaled expertise, Safran Electronics & Defense **addresses all types of applications, from the depths of the oceans to the outer reaches of space, for both the civil and defense sectors.** Given this heritage, the breakthrough HRG Crystal is clearly the most versatile navigation grade device now on the market.

*Safran Electronics & Defense's fleet of gyros operating around the world*

**150,000**  
resonating gyros



**230,000**  
mechanical gyros

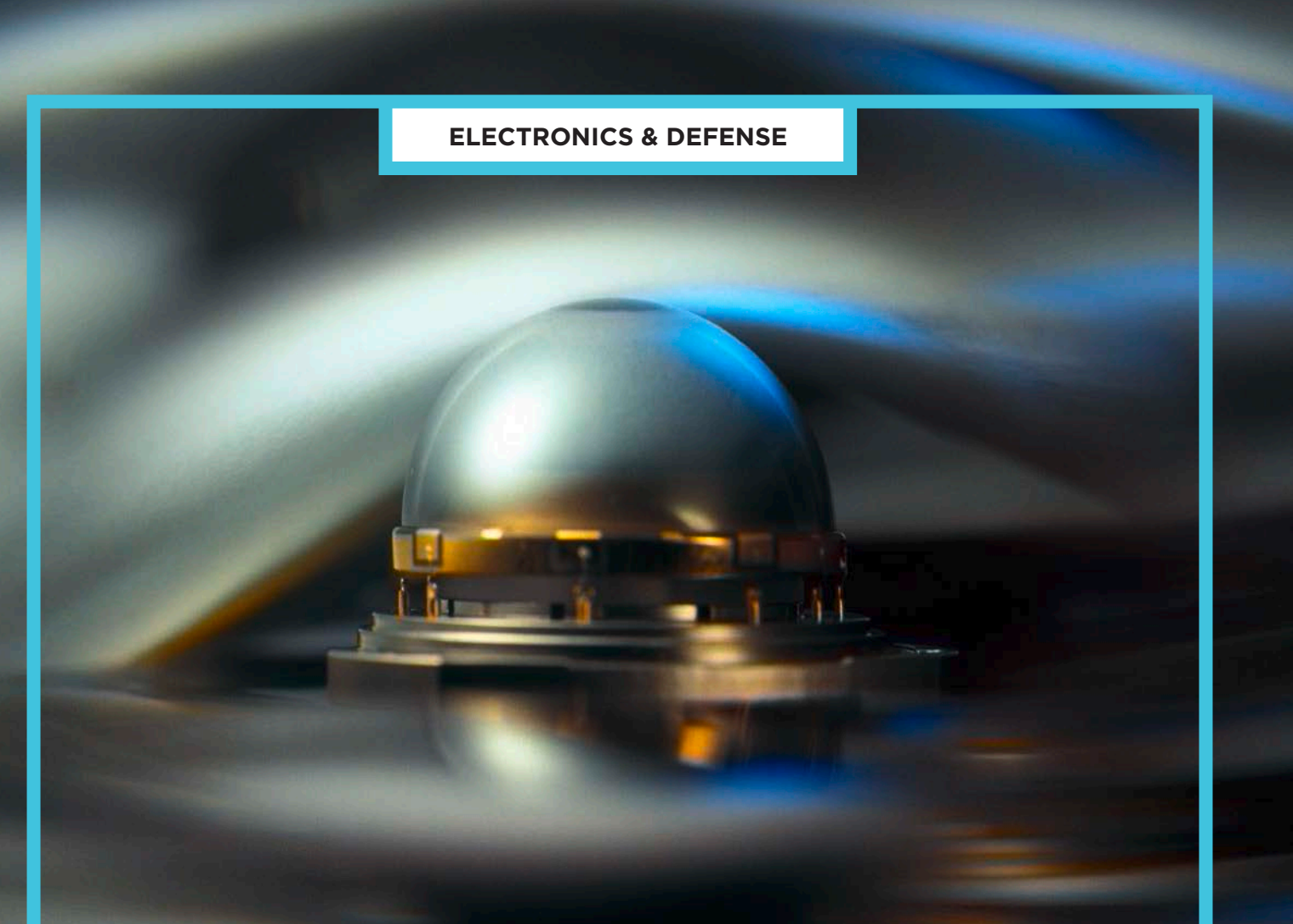
**100,000**  
optical gyros

# POWERED BY TRUST

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ELECTRONICS & DEFENSE

## HRG CRYSTAL

Accurate navigation  
anywhere and under any conditions



# HRG CRYSTAL: THE GAME-CHANGING TECHNOLOGY

Safran's HRG Crystal is a real cutting-edge gyro. Its small size can handle an unmatched range of applications - a first in the gyroscope market. HRG Crystal will clearly set new standards in the inertial navigation sector for many years to come.

<p><b>A SWaP<sup>1</sup> OPTIMIZED SYSTEM</b></p> <p>LOW POWER CONSUMPTION <b>&lt; 1.5 W</b></p> <p>SMALL DIMENSIONS <b>34 x 37 x 37 mm</b></p> <p>LOW WEIGHT <b>50 grams</b></p>	<p><b>ENVIRONMENTAL STRESS IMMUNITY</b></p> <p>VIBRATION, ACCELERATION, SHOCK</p>	<p><b>TOTAL STEALTH</b></p>	<p><b>MTBF<sup>2</sup>: 1,000,000h</b></p>	
<p>WITHSTANDS EXTREME TEMPERATURES: <b>- 95°C to + 155°C</b></p>	<p><b>MAINTENANCE FREE</b></p>	<p><b>HIGHEST RELIABILITY IN THE GYRO MARKET</b></p>		

## HOW THE HRG WORKS



The Hemispherical Resonating Gyro, or HRG, is used to measure the rotation of a platform, whether aircraft, ship, tank or other vehicle, to calculate its exact position and attitude.

A stationary resonance wave is maintained electronically inside a silica hemisphere called a resonator. Using the same principle as originally discovered by Léon Foucault, with his pendulum experiment in 1851, this resonant wave stays fixed in relation to an inertial reference (for example, fixed stars), like a pendulum that continues to oscillate in a fixed plane despite the Earth's rotation around its own axis.

By measuring the relative angle between the vibration plane and the resonator, we can calculate the rotation of the aircraft, ship or other vehicle, and then deduce, using inertial principles, the mobile's position and orientation.

# FROM NAVIGATION AND POINTING, TO TARGETING AND STABILIZATION: THE WIDEST SPECTRUM OF APPLICATIONS

Since the late 1990s, Safran Electronics & Defense has designed and produced a large number of HRG inertial systems and sensors for many different applications. The HRG Crystal is now fully mature, in terms of accuracy and reliability, meaning that Safran can address new markets, from mid-range navigation to high-grade military missions.

<p><b>MAN PORTABLE TRUE NORTH FINDER</b></p> <div>   </div> <div> <p><b>PRIMUS TNF<sup>3</sup></b> Clip-on precision azimuth &amp; vertical angle module</p>  </div> <div> <p><b>STERNA</b> Ultra lightweight north finder</p>  </div>	<p><b>LAND POSITIONING, POINTING &amp; TARGETING</b></p> <div>   </div> <div> <p><b>PASEO GEOLOCATION</b> Paseo advanced modular stabilized sight</p>  </div> <div> <p><b>SIGMA 20</b> INS<sup>4</sup> for land vehicles</p>  </div>	<p><b>SEA NAVIGATION</b></p> <div>   </div> <div> <p><b>BLUENAUTE</b> Gyrocompass, AHRS<sup>5</sup> &amp; INS<sup>4</sup> for merchant ships</p>  </div> <div> <p><b>SIGMA 20M</b> Gyrocompass, AHRS<sup>5</sup> &amp; INS<sup>4</sup> for military or paramilitary ships</p>  </div>	<p><b>WEAPONS &amp; MISSILE GUIDANCE</b></p> <div>  </div> <div> <p><b>HAMMER</b> Air-to-ground smart weapon</p>  </div>	<p><b>AIRCRAFT NAVIGATION</b></p> <div>  </div> <div> <p><b>SKYNAUTE</b> INS<sup>4</sup> for airborne platforms</p>  </div>	<p><b>SPACE NAVIGATION</b></p> <div>   </div> <div> <p><b>REGYS 20</b> Rate Gyro for attitude &amp; orbit control systems</p>  </div> <div> <p><b>SPACENAUTE</b> INS<sup>4</sup> for space vehicles</p>  </div>
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<sup>1</sup> SWaP: Size, Weight and Power.  
<sup>2</sup> MTBF: Mean Time Between Failures.  
<sup>3</sup> TNF: True North Finder.  
<sup>4</sup> INS: Inertial Navigation System.  
<sup>5</sup> AHRS: Attitude and Heading Reference System.