



**exail**

**INERTIAL SOLUTIONS  
FOR MINING**

## **Exail, a reliable partner in the field of mining**

The mining industry encounters numerous challenges that necessitate the use of innovative technologies to conduct operations safely and efficiently. Among these challenges is the need to navigate and operate underground without depending on GNSS signals, which remain inaccessible in subterranean environments. At Exail, we are confident that our technologies, developed through years of experience in the naval, land defense and subsea operations domains, are best suited to address these challenges.

Leveraging 30 years of experience in inertial navigation, Exail offers cutting-edge navigation products based on Fiber-Optic Gyroscope (FOG) technology. This solid-state technology is engineered to provide accurate positioning and navigation data without relying on GNSS signals. Exail's comprehensive range of high-accuracy gyro-compassing products includes Inertial Measurement Units (IMUs), Attitude and Heading Reference Systems (AHRS), and Inertial Navigation Systems (INS) specially designed to endure the rigorous conditions of mining environments. Serving both surface and subsurface mining operations, Exail establishes itself as a dependable partner that delivers unparalleled navigation performance and data stability for all mining applications.

## exail at a glance

---

**80**

YEARS OF  
EXPERIENCE

---

**250+**

MILLION EUROS  
OF TURNOVER

---

**1500+**

EMPLOYEES

---

**25K+**

FIBER-OPTIC  
GYROSCOPES SOLD

---

**400+**

OPERATIONAL MINING  
SYSTEMS

---

**80%**

OF TURNOVER  
ACHIEVED ABROAD

---

**0.001°**

HEADING ACCURACY

---

**15+**

YEARS ONBOARD  
MINING MACHINERY

---

**24/7**

TECHNICAL  
SUPPORT

---

# INERTIAL SOLUTIONS FOR MINING APPLICATIONS



## Atlas 5-AHRS

Atlas 5-AHRS is an all-in-one gyrocompass and motion sensor based on Exail's FOG technology. With algorithms specially designed for civil engineering and industrial applications, Atlas 5-AHRS offers these markets highly accurate 3D orientation with true heading and attitude.



## Atlas 9-AHRS

Atlas 9-AHRS is a high-end export-free gyrocompass and motion sensor for demanding mining and civil engineering applications. With a heading accuracy up to  $0.05^\circ$  seclat RMS, it offers the most accurate heading and attitude with a short settling time.



## Phins E

Phins E is an ultimate INS with a heading accuracy up to  $0.01^\circ$  seclat RMS. Specially designed for civil engineering applications, its numerous interfaces and protocols make it a versatile INS suitable for various applications such as tunneling, mining, pipe inspection, drilling, etc.



## UmiX 40

UmiX 40 is a solid-state-6-axis compact, rugged, high-performance IMU designed for OEM integration in demanding applications. Short-term and long-term stability (with an output up to 10Khz) are provided thanks to north-seeking grade FOGs and high-grade accelerometers.

### Mine survey

**Atlas 5-AHRS**  
Attitude and Heading Reference System (AHRS) for rig alignment, survey and collar pick-up

### High wall mining

**Atlas 9-AHRS**  
High-grade Attitude and Heading Reference System (AHRS) for high-wall mining

### Horizontal directional drilling

**UmiX**  
Compact high-performance Inertial Measurement Unit (IMU) for horizontal directional drilling

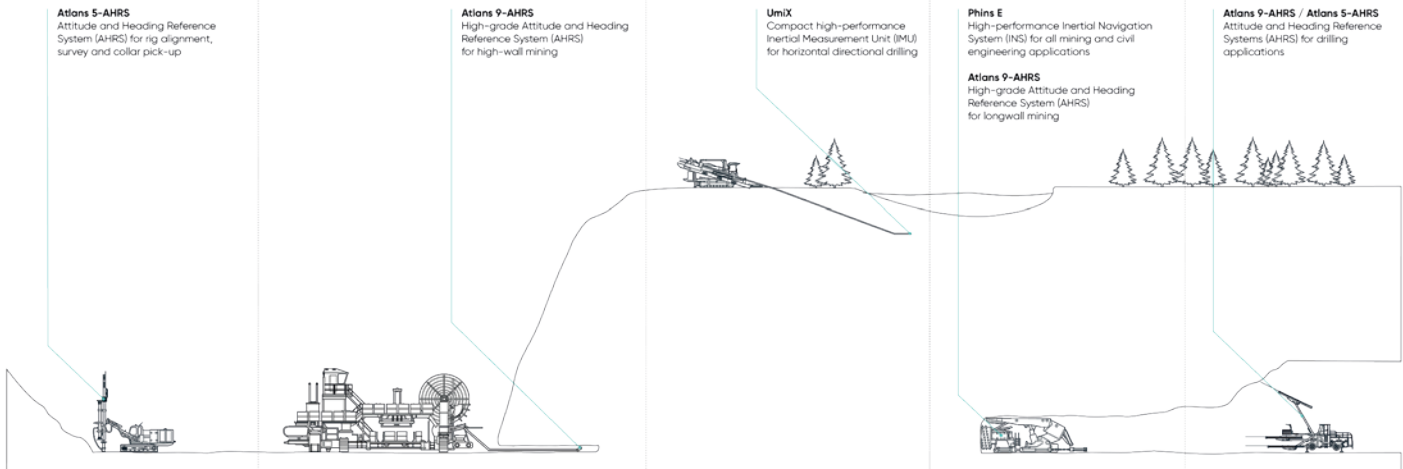
### Longwall mining

**Phins E**  
High-performance Inertial Navigation System (INS) for all mining and civil engineering applications

**Atlas 9-AHRS**  
High-grade Attitude and Heading Reference System (AHRS) for longwall mining

### Rig drilling

**Atlas 9-AHRS / Atlas 5-AHRS**  
Attitude and Heading Reference Systems (AHRS) for drilling applications





# MINE SURVEY

## Highly accurate data

For high-accuracy mining survey applications, the performance and repeatability of measurements are crucial. Phins E offers ultimate performance in GNSS-denied environments with a heading accuracy of up to  $0.05^\circ$  seclat without GNSS, enabling the collection of precise data for mapping and assessing mining sites.

## Real-time monitoring

Exail navigation systems provide real-time data on the device's orientation and motion. When integrated into survey tools, this real-time monitoring capability enables operators to track their movements and adjust their positioning promptly, ensuring accurate survey results.



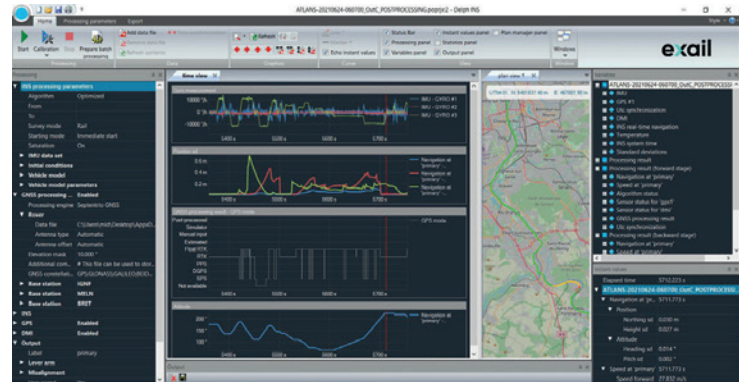
The Atlans 5-AHRS integrated into portable surveying tools enables precise measurements of inclination and roll angles, for rig alignment, surveying, and collar pick-up applications. Being unaffected by magnetism, the Atlans 5-AHRS allows for continuous operation, even in underground sites.

## Low power consumption

With the advent of new sensor technology such as UmiX and Atlans 9-AHRS, power consumption has been significantly reduced. UmiX boasts a power consumption as low as 5W, while the Atlans 9-AHRS requires only 12W. This lower power requirement translates to extended battery life and increased endurance, making them ideal for integration into mobile survey tools.

## Enhanced post-processed data

Data collected by Exail INS can be post-processed using Exail's dedicated Delph INS software. Reference points, GNSS data, or additional sensors such as DMI (Distance Measurement Instrument) can be utilized to compute a precise and optimal trajectory. The forward-backward algorithm significantly enhances performance for non-real-time applications.



Collected data can be shared via a survey data management system and post-processed with Delph INS software to improve data transparency and quality.

# UNDERGROUND MINING

## Accurate underground navigation

Based on FOG technology, Exail's AHRS and INS are able to operate in GNSS-denied underground mining settings, offering undisturbed navigation at all times. Real-time and accurate tracking of equipment and vehicle positions enables:

- optimal route planning
- equipment and personal safety by avoiding potential hazards (underground cavities, unstable terrain...)

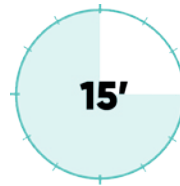
## High-precision drilling

Exail AHRS provide accurate data on drilling machines' attitude and heading, enabling precise drilling operations. Thanks to these data, operators that drill machines reach the desired location accurately and drill the holes with the required precision while maintaining the machine stability. This is crucial for efficient and effective mining operations.

## Continuous operations and high productivity levels

For some mining machines, alignment time can result in significant costs due to operational interruptions. In the cases when electrical devices must be grounded, Exail AHRS or INS need to reinitiate their alignment process. Phins E INS offers rapid startup alignment, as quick as 3 minutes, which results in time and cost savings on the field, enhancing overall efficiency.

In addition, Phins E's capability to operate autonomously, without reliance on external signals, guarantees continuous functionality and maintains high productivity levels, even in GNSS-denied areas.



15' to reach full performance



3' first reliable data output upon restart



## High resistance to shock and vibrations

Exail systems are engineered to endure the challenging conditions found in mining settings, including vibrations, dust, and extreme temperatures. The UmiX IMU, capable of withstanding operating shocks up to 40g – 11ms and vibrations ranging from 10 grms [20-1500Hz], is especially well-suited for rigorous drilling operations such as Horizontal Direction Drilling (HDD). Robust and highly resistant to rugged environments, it features temperature tolerance ranging from -32°C to +71°C, enabling reliable performance under the harshest operational circumstances.

## Unwavering reliability

Leveraging more than 15 years of expertise in sensor design for mining machinery, Exail's robust FOG technology ensures the necessary reliability to endure the demanding conditions of mining environments:

- Exail's FOG technology is integral to all the company's inertial products
- It finds application across critical domains (naval, land defense, satellites)
- Exail's systems have accumulated millions of operational hours
- Observed MTBF (Mean Time Between Failure) exceeding 150,000 hours

## A wide range of mining applications

With algorithms specially designed for civil engineering applications, Exail's INS and AHRS can be used across every mining application, from open-pit mining to underground tunneling to survey, and integrated seamlessly into various equipment types:

- Drilling rigs and Jumbo drilling rigs
- High-wall machines
- Horizontal Directional Drilling (HDD) machines
- Longwall mining machines, and more





# SPECIFICATIONS



Atlans 5-AHRS



Atlans 9-AHRS



Phins E



UmiX 40

Type	AHRS	AHRS	INS	IMU
Export status	Free	Free	Dual use	Dual use
Heading accuracy with GNSS during navigation (° seclat) RMS	0.15°	0.05	0.01	N/A
Heading accuracy in static autonomous mode with rotations at full performance (° seclat) RMS	0.23	0.10	0.05	N/A
Heading accuracy after 15 minutes in static autonomous mode (° seclat) RMS	0.4	0.13	0.083	N/A
Heading accuracy after 5 minutes in static autonomous mode (° seclat) RMS	0.5	0.27	0.25	N/A
Roll / Pitch accuracy (°) RMS	0.1	0.01	0.01	N/A
Linear acceleration	5	15	15	30
Operational temperature range (°C)	-20 / +55	-32 / +71	-20 / +55	-32 / +71
Shocks in g - 11 ms	15	27	27	40
Average consumption (W)	15	12	18	4
Dimensions (mm)	160 x 160 x 113	222.3 x 136 x 138.5	180 x 180 x 162	89.5 x 75
Weight (kg)	2.8	4.6	5.5	0.77