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INERIS
maîtriser le risque pour un développement durable

Special technical specifications

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Supply of a Rayleigh scattering based fiber optic interrogator for Distributed Acoustic Sensing (DAS)

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1. Who are we?

Ineris is an EPIC (French public research body of an industrial and commercial character), whose mission is to carry out expertise or commission studies and research programs aimed at preventing the risks brought about by economic activities on health, the safety of people and property and on the environment.

Continuous parallel development of applied research, expertise and services is a key mission of Ineris. It expands its scientific and technical capabilities in the fields of accidental risk, chronic risk, and ground-level risks, and makes them available to public authorities, local authorities, and businesses to help them make the decisions best suited to improving environmental safety.

With its forward-looking vision of the major challenges of the energy transition and the impact of climate change, Ineris is a public expert of reference in the prevention of risks related to emergent technologies link to the energy transition.

2. Context and objective of the tender

In the framework of research on assessment and prevention of anthropogenic hazards, Ineris aims at using fiber optic technology for monitoring in active and abandoned excavation and solution mines, enhanced geothermal systems (deep geothermal wells), underground energy storage systems, and infrastructure such as railroads, tunnels and highways. In this context, we seek a Distributed Acoustic Sensing (DAS) fiber optic interrogator for the (passive) monitoring of microseismicity, the detection of geological instabilities (faults, cracks, rock falls etc.), underground imaging (tomography) using both active and passive sources, and infrastructure damage or conditions likely to lead to such.

The device should use DAS-based Rayleigh scattering and provide very high spatial and temporal sampling and measurement sensitivity when measuring local, site-specific phenomena with cable lengths less than 20 km. Moreover, it should provide options for larger infrastructure monitoring applications at acceptable spatial and temporal sampling to detect typical failure modes (leakage, rockfall, slope failures) with fiber lengths of 100 km.

The device should be adapted for interrogation of newly deployed fibers (boreholes, trenches) and existing (dark) fibers and should be compatible for short- and long-term real time monitoring applications.

3. Technical requirements and specifications of the DAS interrogator

The DAS interrogator should meet the following technical specifications:

- Single-ended fibre interrogation type;
- Measurands: dynamic strain (strain rate or derivatives);
- Minimum 2 sensing channels for simultaneous measurement; please specify costs for configurations with up to 4 simultaneous channels.
- Flat, stable amplitude response between at least 0.01 Hz and 1 kHz
- Sampling frequency > 10 kHz
- For recording distance of < 20 km, spatial sampling and gauge length should be close but ideally below 1 m
- Please specify self-noise of the instrument in standard units (e.g. nε/s, pε/√Hz) as a function of sensing range, gauge length and frequency; please specify at least for the smallest achievable gauge length for sensing range of <20 km
- Please specify compatible fiber types (single mode, multimode, backscatter enhancing, etc)*
- The ability to remotely configure the acquisition and access data files with standard Linux tools (e.g., SCP).
- Please also state options/solutions for monitoring at 100 km and the associated performance characteristics.

The data acquisition system should provide:

- Local data storage capacity > 8 Tb; please specify extra cost for additional storage capacity and provide best solution to ensure fast access to big data volumes (e.g. 2x 4Tb vs 1 x 8 Tb)
- Access to raw data stored in conventional (non-proprietary) data formats (e.g. HDF5)
- Multiple data timestamping modes (GPS, NTS, NTP, PTP etc.), also specify their accuracies.

The interrogator should be rack mountable and be delivered with adapted supplementary equipment allowing for easy (standard format) and safe transport (resistant against shocks and vibrations), such as a ruggedized case. The system should be suitable for monitoring in potentially dusty and/or humid underground environments, while installed in a protected space such as a niche, shelter or cabinet. If available, a ruggedized version suitable for harsher environments should be proposed as an option. If

possible, the bidder should detail related norms and certificates related to device ruggedness and operability in harsh field environments.

The device should come with user interface (software) allowing for the following parametrization of the measurement:

- A user-friendly interface and software with default settings and guideline/recommendations to configure the measuring campaign
- A Linux- based operating system (for easy interoperability with existing system)
- Simultaneous Trigger and Continuous recording modes
- For continuous data recording mode, the ability to record distinct fiber sections (zones)
- Support to organize data storage on multiple hard drives with configurable buffered recording to manage data overflow.
- For triggering mode, please specify routines/algorithms
- Software configurable pulse width, spatial resolution, and gauge length; specify post-processing possibilities/features e.g. readjust gauge length etc.
- Data visualization
- Self-diagnosis features for detection of technical defaults (power supply, data acquisition, local data storage, and fiber breaks);

Please provide specification and quote for an additional external Workstation (preferentially OS linux) (Rack or laptop) which allows for local data transfer and rapid visualization and processing (denoising, AI calibration and detection etc.)

Requirements of the workstation should be comparable to the following:

- At least 128 GB of ram - At least 128 GB of ram
- High-end CPU (e.g. AMD Threadripper PRO 5975WX / 7975WX or comparable)
- At least two 4 TB NVMe SSDs
- A 10 GbE NIC
- NVIDIA RTX 4090 24GB GPU or comparable (must have at least 24GB VRAM)

Optional:

- Particularities for measurement (velocity mode recordings) and processing modes (denoising, AI detection etc.) which improve data quality and simplify data analysis and interpretation; please specify particularly GPU accelerated and customizable processing routines for detecting and characterizing events of interest such as seismic events, vehicles, leaks, etc.
- Possibility of low power mode (e.g. when powered by solar panel, battery etc.);
- System integrated uninterrupted power supply; please provide quote.
- Remote technical support services.
- If available, please specify the device ATEX certification and associated category/classification.

4. Expected services

The candidate is requested to include the following items in his proposal:

- delivery of a DAS interrogator respecting the above list system requirements;
- recommendations for adapted optical fiber cable types (mode, connection type, encapsulations etc.) sensible and best suited (e.g. sensitivity) for high resolution dynamic strain recordings; if possible, provide quotation for unit price of fiber/cable (own fabrication or via contract manufacturer, outsourcing);
- lifetime license for provided data acquisition and processing software including updates and debugging services;
- description and quotation for training, guidance and field assistance (on-site and/or remote). Specify which services are included in the base price, versus typical rates for services not included.

5. Technical support and training

The equipment should be delivered with a:

- detailed specification sheet;
- detailed user manual describing equipment’s technical composition and maintenance requirements;
- instruction manual for software and data acquisition setting;

- certificate of conformity with French and European standards.

All documents must be provided in English (and, if possible, in French).

The delivery includes the organization of an initial training course. The first course will be attended by Ineris engineers and technicians and will focus on:

- theoretical background on the functioning of the DAS interrogator, the acquisition protocols and parametrization;
- background on cable and optical fiber types and their specifications and adaptability for DAS;
- discussion of case studies;
- practice on data acquisition set-up (e.g. data storage, processing, export and transfer) and measurement parametrization (guidelines and defaults in terms for different experiment set up and scales).

The maximum duration of the training course is to be adapted and defined by the bidder. The course will take place in the Ineris offices and experimental hall in Nancy (France). The date will be mutually agreed between the holder and Ineris following the delivery of the equipment.

6. Warranty and maintenance

The warranty period is a minimum of 24 months from the date of reception. The warranty must cover all equipment, man hours and travel costs.

Throughout the warranty period, technical and scientific support must be provided in order to optimize the use of the equipment.

In case of malfunctioning within the initial warrant period, the warrant will be extended for a period equivalent to the time of non-operation.

The candidate provides a cost estimate for warranty extensions for a period of up to 5 years of support.

The candidate is asked to quote and describe the usual type and frequency of minor and major maintenance support as well as the delay and duration of related interventions.

Description also implies:

- listing of elements of the equipment that must be regularly replaced with their complete product references (reference, price, deliver time).
- a precision on after-sales service support by telephone or by email and response time;
- conditions for supply of temporary equivalent replacement material in case of longer (> 1 month) maintenance operations.

7. Schedule

The candidate is asked to indicate the deadlines for the supply and delivery of the equipment.

Delivery should be ideally in October 2026 and not be later than December 2026.

8. Delivery location and conditions

The location of delivery is as follows:

INERIS
Campus ARTEM
92 Rue Sergent Blandan
54042 Nancy, France

Any damage caused during the delivery and assembly of the device, will be the responsibility of the contract holder. Acceptance of the equipment will take place at the Ineris premises in Nancy

Institut national de l'environnement industriel et des risques
Parc technologique Alata • BP 2 • F-60550 Verneuil-en-Halatte
03 44 55 66 77 • ineris@ineris.fr • www.ineris.fr