

*Purchasing an isotope analyser for measuring the  
isotope composition of water samples*  
Geological Survey of Estonia: 272890

PICARRO

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isotope composition of water samples

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For

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## 1 Introduction

This document is a response to Geological Survey of Estonia Tender 272890 published on the 08 December 2023. It includes a section describing the technical aspect, an administrative section to cover all points raised in the request for quotation and a commercial quotation.

### 1.1 Tender scope

*The subject matter of the procurement is purchasing an isotope analyser for measuring the isotope composition of water samples along with installation and training, in accordance with the requirements and functionalities stated in the procurement documents, including the technical specification*

### 1.2 Qualification of Picarro

Picarro is the global gold standard for concentration and isotopes measuring instruments, which are used in a variety of applications, including atmospheric science, air quality, GHG emissions, hydrology, and more. Unparalleled in their precision, portability, reliability, and ease of use, Picarro's instruments are used by leading universities, corporations, NGOs, and government agencies in 70 countries. Picarro has around 145 employees globally and a presence (office) in all continents. In Europe Picarro has an office in The Netherlands and Switzerland.

### 1.3 Picarro Technology benefits

Picarro's L2140-i provides  $\delta^{18}\text{O}$ ,  $\delta^{17}\text{O}$ ,  $\delta\text{D}$  and  $^{17}\text{O}$ -excess isotope ratios with high precision in a single measurement. The unique Cavity Ring-Down Spectroscopy (CRDS) is a time-based measurement technique that uses a laser to quantify spectral features of gas phase molecules in an optical cavity. CRDS offers significant performance, ease of use and cost of ownership benefits compared to absorption based technologies, including off axis integrated cavity output spectroscopy. Picarro's effective path length of several kilometers provides exceptional precision and sensitivity.

The analyzer high precision and low drift is maintained through a very accurate wavelength monitor with a 2Mhz (8 femto) precision designed on patents US 7420686 and US 7813886, maintaining absolute spectral position, thereby ensuring long term accurate peak quantification. In addition, this technology guarantees that only the spectral features of interest are being monitored, greatly reducing the analyzer's sensitivity to interfering species.

The CRDS technique uses a small optical measurement cavity (35ml) and features an inherent stability due to unique sample controls for temperature and pressure. These controls (Cavity Temperature maintained at +/- 0.005 °C and Pressure +/- 0.0002 of atmospheric pressure) ensure the most precise measurements over long periods of time and enable the most credible data of any analyzer. Picarro analyzer features lowest guaranteed drift specification and higher precision than any commercially-available analysis system and are far more reliable than other non-resonant absorption-based technologies.

Like all other Picarro analyzers, the L2140-i can be operated over the Internet, allowing researchers to collect data remotely, change experiment parameters and monitor instrument processes. Picarro analyzers have been field-tested in hundreds of locations and are used by thousands of scientists around the globe.

## 2 Picarro technical proposal

### 2.1 Picarro L2130-i - Liquid water isotopes Analyzer ( $\delta^{18}\text{O}$ & $\delta\text{D}$ )

The Picarro Isotopic Water Analyzer, L2130-i provides both  $\delta^{18}\text{O}$  and  $\delta\text{D}$  stable isotope ratios at the highest precision levels of any isotope analyzer. This analyzer takes applications in paleoclimatology, water vapor source tracking, hydrologic mapping, and oceanography to an entirely new level of sensitivity. Ongoing research in hydrology, limnology, and ecophysiology will benefit from increased sample throughput and reduced calibration frequency.

- Make highly precise, simultaneous measurements of  $\delta^{18}\text{O}$  and  $\delta\text{D}$  with minimal drift
- Guaranteed precision of 25 per meg ( $\delta^{18}\text{O}$ ) and 100 per meg ( $\delta\text{D}$ ) for liquid analysis
- Allan variance of 10s of per meg for averaged  $\delta^{18}\text{O}$  and  $\delta\text{D}$  vapor measurements
- Calibrate once per day while measuring with sub per mil certainty
- Truly field deployable due to **small footprint and low weight**
- Flexible configuration to adapt to application and sample type due to availability of many different peripherals (solid samples, continuous water analysis etc.)



The analyzer integrates seamlessly with Picarro's exclusive suite of peripherals including the Induction Module for rapid (<5 min.) water extraction and analysis from solid samples, High-Throughput and High-Precision Vaporizers and Autosamplers for measurement of liquid water, and the Standards Delivery Module for delivering multiple liquid standards for calibration and switching between different sources for atmospheric vapor measurements. The operator can easily reconfigure the instrument to measure different sample types in a matter of minutes by switching accessories and associated software modes without recalibrating the analyzer.

Utilizing Cavity Ring-Down Spectroscopy technology, the L2130-i analyzer is a compact and lightweight (21.3 kg) package with closed-loop temperature and pressure control that enables extreme performance in the laboratory and robustness under field conditions. For researchers, the L2130-i delivers a best-in-class combination of flexibility, speed, high-precision, and ease of use that sets a new standard for water isotope analyzers.

### 2.2 Interference management

The Picarro analyzer comes equipped with ChemCorrect™, Picarro's unique postprocessing software package that identifies contamination with organics such as methane and methanol and provides confidence in sample purity as well as quantification of certain organics.

### 2.3 Peripherals for Water Instruments

The operator can easily reconfigure the instrument to measure different sample types in a matter of minutes by switching accessories and associated software modes without recalibrating the analyzer. The analyzer integrates seamlessly with Picarro's exclusive suite of peripherals including:

**SDM** for ambient vapor



**CWS** for continuous, real-time water analysis

**L2130-i or L2140-i**



**IM** for matrix-bound water



**MCM** for plant and soil waters



**Vaporizer and Autosampler** for liquid water and vapor

More information can be found on the follow webpage:

[http://www.picarro.com/products\\_solutions/peripherals/for\\_h2o](http://www.picarro.com/products_solutions/peripherals/for_h2o)

### 2.3.1 High-Precision Vaporizer and Autosampler

The Picarro Autosampler (A0340) and Vaporizer (A0211) offer exceptional precision with minimal maintenance for ocean science, hydrology, and paleoclimatology applications. The Autosampler and Vaporizer fully integrate with the L2130-i and L2140-i water isotope analyzers, including onboard software control.

- Fully integrated solution for automated analysis
- Choice of operating modes: high precision or high throughput
- Onboard software controls both Autosampler and Vaporizer
- Sample analysis conducted automatically with data reported per injection

$\delta^{18}\text{O}$  precision is  $<0.025\text{‰}$  per sample, and 24-hour drift is  $<0.2\text{‰}$ .  $\delta\text{D}$  precision is  $<0.1\text{‰}$  per sample, and 24-hour drift is  $<0.8\text{‰}$ . The vaporizer maintains precision even with briny solutions. It can be cleaned with water, and it is robust enough to be used in remote locations and on boats for field campaigns.

### 2.3.2 Picarro Salt Liner

The Picarro salt liner is an inexpensive, stainless-steel mesh insert that can be placed quickly and easily into the Picarro high-precision vaporizer (right). The mesh liner catches up to 80% of salt precipitates as the injected high total dissolved solids (TDS) water sample is evaporated in the vaporizer chamber. This significantly reduces salt build-up in the vaporizer to extend operating time up to 24 hours for seawater analysis. It can be removed, cleaned, and reinserted within minutes

## 2.4 CRDS Advantage Note

Picarro's L2130-i provides isotope ratios with high precision in a single measurement. This system comes equipped with ChemCorrect™, Picarro's unique post-processing software package that identifies contamination with organics such as methane and methanol, and provides confidence in sample purity as well as quantification

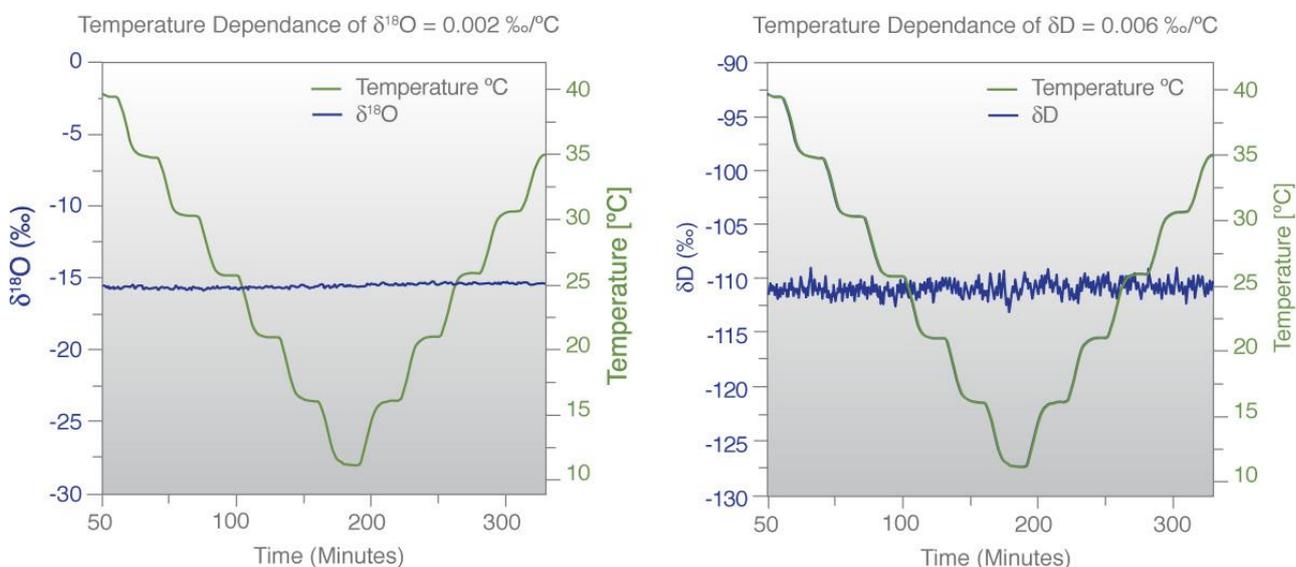
of certain organics. Like all other Picarro analyzers, the L2130-i can be operated over the Internet, allowing researchers to collect data remotely, change experiment parameters and monitor instrument processes.

Picarro's unique Cavity Ring-Down Spectroscopy (CRDS) is a time-based measurement technique that uses a laser to quantify spectral features of gas phase molecules in an optical cavity. CRDS offers significant performance, ease of use and cost of ownership benefits compared to absorption based technologies, including off axis integrated cavity output spectroscopy. Picarro's effective path length of up to 20 kilometers provides exceptional precision and sensitivity. A patented, high precision wavelength monitor maintains absolute spectral position, thereby ensuring accurate peak quantification. In addition, this technology guarantees that only the spectral features of interest are being monitored, greatly reducing the analyzer's sensitivity to interfering species.

### Outstanding temperature and pressure regulation resulting in low drift/less calibration

The influence of temperature and pressure changes on the performance of spectroscopic instruments is highly significant. When one or the other (or both) parameter(s) is/are not controlled well, the instrument will show a higher drift, which ultimately leads to an increase of the calibration frequency. This is why Picarro's optical cavities incorporate precise temperature and pressure control systems, which ensure accurate measurements over long periods of time, even in the harshest environments (Cavity Temperature maintained at +/- 0.005 °C and Pressure +/- 0.0002 of atmospheric pressure). Additionally, Picarro's cavity size is very small, only 35 ml, while other technologies/suppliers' instruments uses cavities/measurement cells of a few 100 ml's. The larger the measurement cell/cavity is, the more difficult it is to keep both temperature and pressure stable.

Combining the high quality control systems with the small cavity size, the analyzer maintains high linearity, precision, and accuracy with minimal calibration required.



Picarro's temperature and pressure control systems enable our analyzers to record data with precision and accuracy that is independent of fluctuating external conditions. These two data sets show that the absolute  $\delta^{18}\text{O}$  and  $\delta\text{D}$  values are unaffected even when the external temperature is stepped through a wide temperature range (~ 10 to 40°C).

### 3 Technical requirements

The following requirements constitute the qualifications of the tenderer.

Question	Answer Picarro
<b>1. The analyser needs to enable simultaneous high-precision measurements of both <math>\delta^{18}\text{O}</math> and <math>\delta^2\text{H}</math> from liquid water samples.</b>	<b>YES</b>
<b>2. The analyser needs to use the laser absorption spectroscopy (LAS) for isotopic analysis.</b>	<b>YES</b> , Cavity Ringdown Spectroscopy
<b>3. Guaranteed precision (<math>1\sigma</math>) of the analyser for liquid water samples should be at least <math>\leq 0.05\text{‰}</math> for <math>\delta^{18}\text{O}</math> and <math>\leq 0.2\text{‰}</math> for <math>\delta^2\text{H}</math> or better in a performance mode with the best possible precision.</b>	<b>YES</b> , Guaranteed performance is $0.025\text{‰}$ for $\delta^{18}\text{O}$ and $0.1\text{‰}$ for $\delta^2\text{H}$ . This precision can be achieved in both Standard and Express mode. Typical performance is roughly 2 times better than the guaranteed performance.
<b>4. The analyser should enable measurements of samples with high total dissolved solids (TDS) of <math>\geq 40\text{ g/kg}</math>.</b>	<b>YES</b> , The Picarro L2130-i (and L2140-i) is the only analyzer that can handle dissolved solids over $40\text{ g/kg}$ . With our Salt Liner we can handle samples of up to $200\text{ g/kg}$ of dissolved solids. The analyzer can run for 24 hours without intervention. The Standard Mode is recommended in this case to minimize the amount of liquid to be injected into the vaporizer and stretch the cleaning intervals.
<b>5. The analyser is able analyse at least 20 samples or more in 24 hours with a guaranteed precision (<math>1\sigma</math>) as stated in point 3.</b>	<b>YES</b> . Picarro is the only analyzer currently on the market that can process 20 or more samples per 24-hours at the above-mentioned guaranteed precision. For one sample 6 injections of each 9 minutes are needed, which means 54 minutes per sample, or 27 samples per 24-hours. 7 Samples can therefore be used as standards. In the Express mode the throughput will practically be $\sim 2$ times higher, and still within the requested specifications. The only competing instrument on the market needs 20 times 4 injections (80 injections) to achieve the 'High-precision' values on their datasheet. With 800 injections per 24-hours, they will only manage to do 10 samples per 24-hours, and standards still need to be measured. See attached method comparison and 'LWIA Post Analysis User Manual' page 117.
<b>6. Auto-injection system is added to the analyser for automated liquid sample injections for isotopic water analysis.</b>	<b>YES</b>
<b>7. Vaporization/evaporation module (vaporizer) for liquid water analysis that works in combination with the automatic injection system is included or such capability is built into the analyser.</b>	<b>YES</b> , a separate Vaporizer allows for much better controlled evaporation and an analysis plateau for much better precision and faster analysis

<p><b>8. Software for controlling analyser operation, data analysis, normalization of measurements, calibration and identification/flagging for possible sample contamination needs to be provided together with access to applicable software updates.</b></p>	<p><b>YES</b></p>
<p><b>9. The analyser needs to be compatible with the “Laboratory Information Management System (LIMS) for Lasers” software for data processing.</b></p>	<p><b>YES</b>, Picarro Water Analyzers are compatible with 'LIMS for Lasers'</p>
<p><b>10. A monitor for working with the analyser needs to be included.</b></p>	<p><i>Will be provided locally by ARMGATE SIA</i></p>
<p><b>11. A kit for processing at least 1000 samples should be provided including at the minimum syringes, glass vials and septa, together with the user manual describing their replacement.</b></p>	<p><b>YES</b></p>
<p><b>12. A vaporizer cleaning kit needs to be included with a manual for carrying out the cleaning procedure if a separate vaporization module is provided (see point 7 above).</b></p>	<p><b>YES</b></p>
<p><b>13. The package needs to include at least 3 laboratory water calibration standards in 4-5 mL ampoules.</b></p>	<p><b>YES</b></p>
<p><b>14. It is possible to operate and monitor the analyser remotely, which includes operations such as start/stop the analysis run, change performance mode, manage job queue etc.</b></p>	<p><b>YES</b>, through remote login, e.g. teamviewer</p>
<p><b>15. The analyser should accept both zero (dry) air and N2 as carrying-gases.</b></p>	<p><b>YES</b>, additionally room air can be dried, due to the low flow rate of the analyzer. This makes the analyzer field suitable as well.</p>
<p><b>16. The analyser works with an alternating voltage of 230V and a frequency of 50 Hz and does not require additional cooling for operation. It has added accessories that allow the instrument to continue working even in the event of a short-term power failure (e.g., UPS system or equivalent solution).</b></p>	<p><i>Will be provided locally by ARMGATE SIA &lt;500W power consumption</i></p>
<p><b>17. The dimensions of the analyser taken separately (i.e., without the accessories described in points 6, 7 and 11) are not larger than 30 x 100 x 60 cm (height x width x depth) and the weight is up to 50 kg. The analyser will be installed into a building in a remote location, and it must be possible to transport from one room to another using manpower.</b></p>	<p><b>YES</b>, the analyzer is 43x43x19 cm (excluding peripherals) and weighs only 20.4 kg (excluding peripherals). Transport is easy and can be done by one (1) person.</p>

<p><b>18. At least 12-month extended warranty for any repairs/replacement of defective parts, maintenance or calibration must be included.</b></p>	<p><b>YES</b>, 15 months after shipment from Picarro</p>
<p><b>19. Cost of the tender must include:</b></p>	
<p><b>19.1 delivery of the analyser and its accessories to the final location;</b></p>	<p><i>Will be provided locally by ARMGATE SIA</i></p>
<p><b>19.2 installation of the analyser and its accessories at the final location and training, after which the contracting authority is able to independently perform isotopic analyses. The training program must include, among other things, hands-on tasks/instruction in routine analyser maintenance, troubleshooting, sample preparation and handling, calibration, isotopic data post-processing, and quality assurance/quality control (QA/QC).</b></p>	<p><b>YES</b>, training on site in Estonia is included</p>

## 4 Installation, Service and Maintenance

### 4.1 Support

Picarro provides response to service requests within 24 hours. Whether an incoming call, email or voice mail, Picarro will provide a written email confirmation to the request and will start an immediate case resolution report. Should the service item not be quickly resolved via standard recommended service and/or troubleshooting protocols, Picarro will arrange for a remote connection to provide a full diagnostic service and root cause resolution.

#### 4.1.1 Free Remote diagnostics

As complimentary service Picarro offers free remote diagnosis & troubleshooting, which means that Picarro will try to remotely correct every issue you may have on your analyzer for its entire lifetime. We will answer your case by email or phone, connect to the analyzer, review your issue and, if possible, fix any failures through a remote connection. You can purchase any needed parts that needs replacement after diagnosis, or you can complement with one of our Service Packages.

#### 4.1.2 Support Center EMEA

Support will be organized by our Branch office in The Netherlands or in our headquarters in Santa Clara (USA)

Our support team can be reached by phone: +31 858 881 650; by email: [support@picarro.com](mailto:support@picarro.com); or through the contact form on our website: <https://www.picarro.com/support>.

#### 4.1.3 Picarro Community

For troubleshooting and best practice sharing, we encourage you to visit the Picarro Community (<https://www.picarro.com/support/community>). This is a great online resource that provides answers to frequently asked questions and showcases videos and how-to guides for many common support and application requests with replies from Picarro Scientists/Engineers and from Picarro users across the Globe. In addition, you can post your own question to be answered by an expert or peers. This service is free of charge.

### 4.2 Annual Service Plans

Picarro instruments are built to last. When maintained properly, they will deliver the precise measurements you need for years to come. To help you keep your Picarro analyzers and peripherals functioning properly, we offer a variety of annual service plans to meet your specific needs.

#### 4.2.1 Essential Service Plan

The Essential Plan W3101 is for those who prefer to maintain their instruments themselves. This plan includes a yearly maintenance kit, remote support for diagnostics and repair, software updates, plus discounts on factory repairs and Field Replaceable Parts that the Picarro technical support group determines are necessary to restore the functionality of the instrument and that can be replaced by the customer on-site.

#### 4.2.2 Premium Service Plan

The Premium Service Plan W3102 eliminates unexpected repair costs. This plan includes a yearly maintenance kit, remote support for diagnostics and repair, software updates, plus free factory repairs and Field Replaceable Parts that the Picarro technical support group determines are necessary to restore the functionality of the instrument and that can be replaced by the customer on-site and remote training once per year.

#### 4.2.3 Commercial Service Plan

The Commercial Service Plan W3103 ensures maximum uptime. This plan includes a yearly visit from a Picarro-certified technician to perform maintenance and repairs, and a complimentary loaner instrument is provided in case of a breakdown. It also includes a yearly maintenance kit, remote support for diagnostics and repair, software updates, free factory repairs and Field Replaceable Parts that the Picarro technical support group determines are necessary to restore the functionality of the instrument, and remote training twice per year.

4.2.4 Overview of Technical Support Options

	Essential	Premium	Commercial
Remote diagnostics	✓	✓	✓
Remote repair support	✓	✓	✓
Software updates	✓	✓	✓
Annual maintenance kit	✓	✓	✓
Field Replaceable Parts	50% Discount	✓	✓
Factory repair	10-20% Discount*	✓	✓
New features upgrade	-	✓	✓
Remote training	-	Once a year	Twice a year
Complimentary loaner	-	-	✓
Yearly preventive maintenance, validation, IQ/OQ	-	-	✓
Picarro Community	✓	✓	✓

\*10% discount for optical repairs and 20% discount for all other repairs

4.3 **Installation and Training**

Installation is easily accomplished using the Picarro Operators Manual and basic interaction with the device. There are no special safety regulations or equipment required to install the analyzer. The Picarro equipment only requires a few quick connections and users can achieve accurate reading after a brief warm up period in less than 1 hour.

Picarro provides a full suite of services that can be purchased in addition to, or separately from, maintenance contracts to make your data collection experience more valuable.

4.3.1 Technical Jumpstart

Picarro Technical Jumpstart is a 4-hour program performed by a Picarro specialist through video conferencing. It assists customers with new system start-up and initial result verification. Technical Jumpstart is an excellent choice for clients new to our Cavity Ring-Down Spectroscopy (CRDS) technology. (Must be used within six months of delivery)

4.3.2 On-Site Installation

On-Site Installation is a 2-day program performed by a Picarro specialist at your location. The program includes: installation of your analyzer; training in method development and considerations for best operation. On-Site Installation is an excellent choice for customers who require local and customized support. Travel and lodging expenses for the Picarro specialist are included. (Must be used within six months of delivery)

4.3.3 Maintenance

The instrument does not need frequent maintenance interventions. Due to the analyzer's modular design, access to the maintenance items (pump, fans and filters) is straightforward and can be done in the field.

Based on the continuous operation time, the vacuum pump will need replacement due to normal wear after 10'000-15'000hrs hours of use.

The system includes a particulate filter that is recommended for replacement annually, or as required (less time or more) based on the cleanliness of the ambient air being sampled. The replacement procedure has been kept very simple, and requires minimal intervention.

The cooling fans generally have a 3-5 year lifetime and are easily replaced. The cooling fan filters should be quarterly removed and cleaned.