ATONARP

AMS-1000™

Molecular Sensor

Datasheet

Robustness
Reliability
Repeatability
Accuracy
Sensitivity

Cloud Ready

Version 15 02/2021

AMS-1000 Smart Spectrometer

The AMS-1000 Smart Spectrometer™ is a high pressure fully integrated small footprint process mass spectrometer.

At the heart of the AMS-1000, is a pre-calibrated modular sensor comprising an open ion source, the mass filter and the Faraday Cup detector. In addition, the AMS-1000 unit houses a sampling sub-system, all control electronics and the complete vacuum pumping assembly.

The system is out-of-the-box plug-and-play ready in less than 5 minutes and supports an Internet-of-Things (IoT) ready Ethernet port communications and easy to use web browser based software user interface.

With the AMS-1000, individual gas components are ionized and then separated using a sophisticated array of miniaturized quadrupole mass filters. Patented algorithms then calculate the mol% of each gas component giving high accuracy quantitative molecular analytical data.

Key Applications

- Lyophilization (freeze-drying)
- Natural Gas analysis
- Residual gas abatement systems
- Semiconductor etch and deposition
- Chamber contamination detection
- Environmental monitoring
- Safety and security
- Leak detection in vacuum systems

AMS-1000 Key Hardware Features

- 1 amu (FWHM) resolution
- 100 amu range
- Real-time data from 10mS/amu
- Quantitative mol% and pressure data
- High $5x10^{-3}$ Torr operating pressure
- Integrated roughing and turbo pumps
- <5min start-up time out-of-the-box
- Ultra-small <0.01m^3 total size
- Field-replaceable sensor and filament
- Internet-of-Things (IoT) Ethernet port
- Minimum partial pressure as low as $1x10^{-9}$ Torr for N_2
- 1ppm sensitivity for N_2 at $1x10^{-3}$ Torr
- <100W power at 24V DC
- >6 orders of magnitude linear range

Key Software Features

- Web based remote access
- Spectrum, bar chart, mol% and mol% fraction history
- Selective m/z scan and step size
- Customizable molecule and fragmentation pattern
- User defined alarms and actions
- System diagnostics access
- Multiple report types and formats supported
- Remote diagnostics and updates

Absolute Maximum Ratings

Specification	Value
Ambient Temperature	0°C to 40°C
Relative Humidity	80% non-condensing
Hydrocarbons $C_{(2-8)}$ in natural gas	<50% at $1x10^{-3}$Torr
Corrosive Gases	<10% at $1x10^{-3}$Torr

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to AMS-1000. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications (below) is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions.

Operating Characteristics

Parameter	Conditions	Min	Typ	Max	Units
Mass Range		2		100	amu
Mass resolution	Full Width Half Maximum Note 1	0.9	1.0	1.1	amu
Mass number stability			0.1		amu
Ion Current Sensitivity	Note 1		$5.0x10^{-6}$		A/Torr
Dynamic range		$1x10^{-9}$		$4x10^{-3}$	Torr
Minimum detectable partial pressure	Note 2		$1x10^{-9}$		Torr
Minimum detectable concentration	Note 2		1		ppm
Maximum operational pressure			$4x10^{-3}$		Torr
Dwell time per amu		1		202	ms
Scan update rate per amu	Note 5		37		ms
Sampling pressure range	Note 3	$1x10^{-5}$		$1x10^{3}$	Torr
Operating temperature	80% relative humidity non-condensing	5		35	^{o}C
Emission current	Note 4	0.1	0.4	1	mA
Emission current accuracy			0.1		%
Start-up time			3		mn
Concentration Accuracy			<1		%
Concentration Stability				±0.5	%
Power consumption	24VDC		100		W
Weight			9		kg
Size	Length x Width x Height	256 x 204 x 200			mm

Notes:

Unless otherwise specified characteristics are stated for Nitrogen

1. Using factory calibration
2. Limits dependent on dwell time
3. With a typical metering valve
4. Max 2mA for Helium leak test mode
5. At dwell time of 32 ms operating from CLI.

AMS-1000 patented quadrupole architecture

Key to AMS Smart Spectrometer™ small form factor (<0.01m^3) is the miniaturized quadrupole array filter. This array of sixteen cylindrical micro-rods generates nine quadrupoles in the spaces bounded by four rods in conventional quadrupole architectures (figure 1)

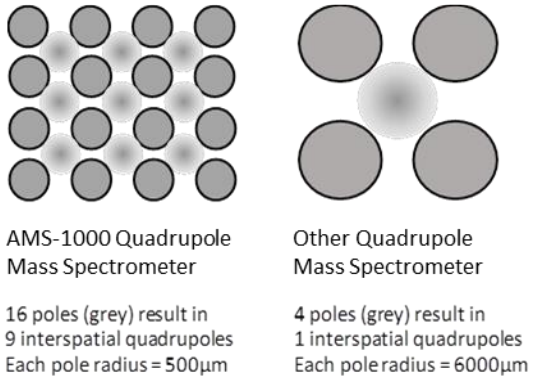


Figure 1. AMS-1000 patented quadrupole architecture

To filter and detect ions (by mass), the system applies a RF voltage (radio frequency) voltage on rods opposite each other across the width of a quadrupole.

The RF voltage is tuned so that ions of particular m/z oscillate through the quadrupole to the detector, while others crash into the rods and disappear. The RF voltage induced oscillations make the ions travel a path longer than the length of the miniaturized quadrupole rods enabling the system to operate at higher pressure (mTorr) than conventional quadrupole systems.

The higher-pressure operation of the AMS-1000 Smart Spectrometer enables the vacuum pumps to be integrated inside the unit, rather than being external devices as with residual gas analyzers (RGA). The AMS-1000 also generates a higher ion current, which allows the Smart Spectrometer to have a rugged and non-drifty Faraday Cup ion detector sensitive to ppm concentrations across more than six decades of dynamic range. Residual gas analyzers, on the other hand, need an electron multiplier detector, which is inherently drifty, to amplify and detect low ion currents from low gas concentrations and achieve similar sensitivity.

Proprietary algorithms then accurately calculate the mole fractions of each gas component with an accuracy of better than 1%. The results appear in real-time in a browser-based software controller.

The AMS Smart Spectrometer is calibrated using an industry standard Capacitance Diaphragm gauge.

Mass Spectrometry for Process Control

High pressure operation is not the only benefit that the AMS-1000's quadrupole architecture brings to process control applications. Unlike RGA solutions the AMS-1000 has integrated turbo and roughing pumps dramatically simplifying equipment deployment and commissioning.

The AMS-1000 is powered by a single low power 24V DC power source and communication to the system for control and data extraction can be performed via the available 10/100/1000MB/s Ethernet

port, USB2.0 or RS232/485. Analog and digital I/O enable flexible and easy interfacing, integration and control of external sample delivery or other process control systems.

Plug-and-Play Ready

The AMS-1000 is a highly integrated system that comes plug-and-play ready for process control applications.

The physical view of the AMS, the various connection functions (figure 2) and panel descriptions associated with the AMS are described below.

Figure 2. The front panel of AMS. For detailed connector description refer Table 1 and 2

Table 1. AMS-1000 Front Panel Connectors

Connector	Description
On/Off Icon	Press this switch to enable electrical power to the system. Press and hold for 10 seconds to power-off the system
Power 24V DC IN	Connect power cord from the provided AC-DC adapter
Ethernet	A 10/100/1000Mbps Ethernet interface is provided for high speed communications and control. User interface loads through this connection
USB 2.0 - USB Host	USB 2.0 port for keyboard, mouse, hubs and storage devices for expansion
USB 2.0 - Micro USB Host OTG	USB 2.0 Host or Device (OTG) configurable port. OTG mode to program the AMS. Host mode for keyboard, mouse, hubs and storage devices for expansion
COMM	Interface for serial communication. Configured from factory for any of these serial protocols via a DB-9 connector – RS232/RS485/RS422
Analog/Digital I/O	The AMS system can connect to external devices such as valves through this interface
Ground	Electrical ground connection to the AMS
SW1	Custom Switch 1
SW2	Custom Switch 2
	Connect to an external vent to safely dispose the used gas. The venting of the AMS exhaust must be in accordance with all federal, state, provincial, and local health and safety regulations

Table 2. Status LED description

LED	STATUS	Description
PWR	Off	System electrical power not available
	Orange	System electrical power available
	Green	On/Off icon pressed and in On state
SYS	Orange	Main CPU initializing
	Green	Main CPU ready
IL1	Orange	Selected emission source off or out of convergence
	Green	Selected emission source on
FIL2	Orange	Emission source 1 selected
	Green	Emission source 2 selected
NET	Orange	Not connected to Network (No IP address assigned)
	Green	Connected to Network (IP address assigned)
SCN	Alternating Green/Orange	Scan in progress
	Orange	Scan stopped

Software

The dashboard (figure 3) is the primary user interface view for the user to interact and monitor the functioning of the AMS.

Key features include:

- Power on and Workflow profile selection
- Spectrum display
- Mole Fraction display – trend and real time
- System Logs
- Gauges displaying system parameters

The AMS user interface provides instrument customizability and exposes many configuration parameters that govern the behavior of the instrument.

Many of these parameter values can be

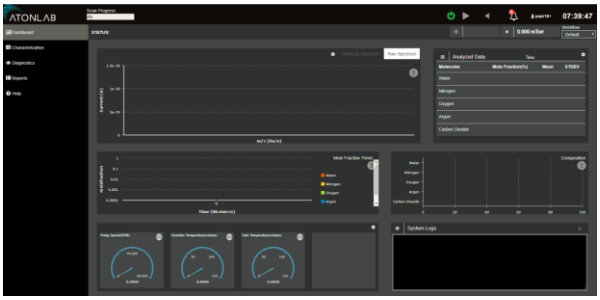


Figure 3: AMS dashboard

saved as profiles. A profile is a user specifiable label for a fixed set of parameter values. This allows a user to switch between various profiles to suit specific application requirements.

Once the system has powered-up, reached vacuum and initialized (approx. 3 mins) a scan can be performed. An example scan is shown (figure 4).

Figure 4: Example post scan dashboard view showing detected m/z peaks and relative mole fraction percentage

Repeated scans are called workflow and while the workflow is in progress, the mass spectrum and the mole fractions are

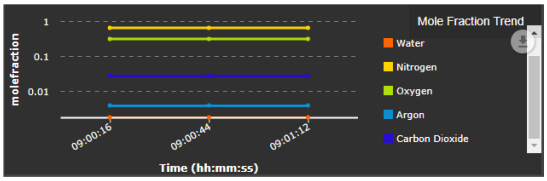


Figure 5: Mole fraction trend is updated after each scan

continually updated in the user interface (figure 5).

Communication with AMS-1000

The simplest way to communicate with the AMS in an already networked environment like an office is to connect the AMS' Ethernet port via a network cable to the enterprise (office) network. The AMS Ethernet port is 10/100/1000MB/s and performs optimally when the networking equipment are also gigabit compliant. When this connection is made, a DHCP server running in the enterprise network is expected to assign an IP address to the AMS system. The user can then open the web browser and access Atonlab by typing the AMS URL https://ams-xx.atonarp.local.

In the absence of an enterprise (office) network communication with the AMS can be performed with a direct connection between the AMS Ethernet interface and the client system using a network cable. In this usage scenario, the AMS must be configured as a DHCP server that will assign an IP address to the user system.

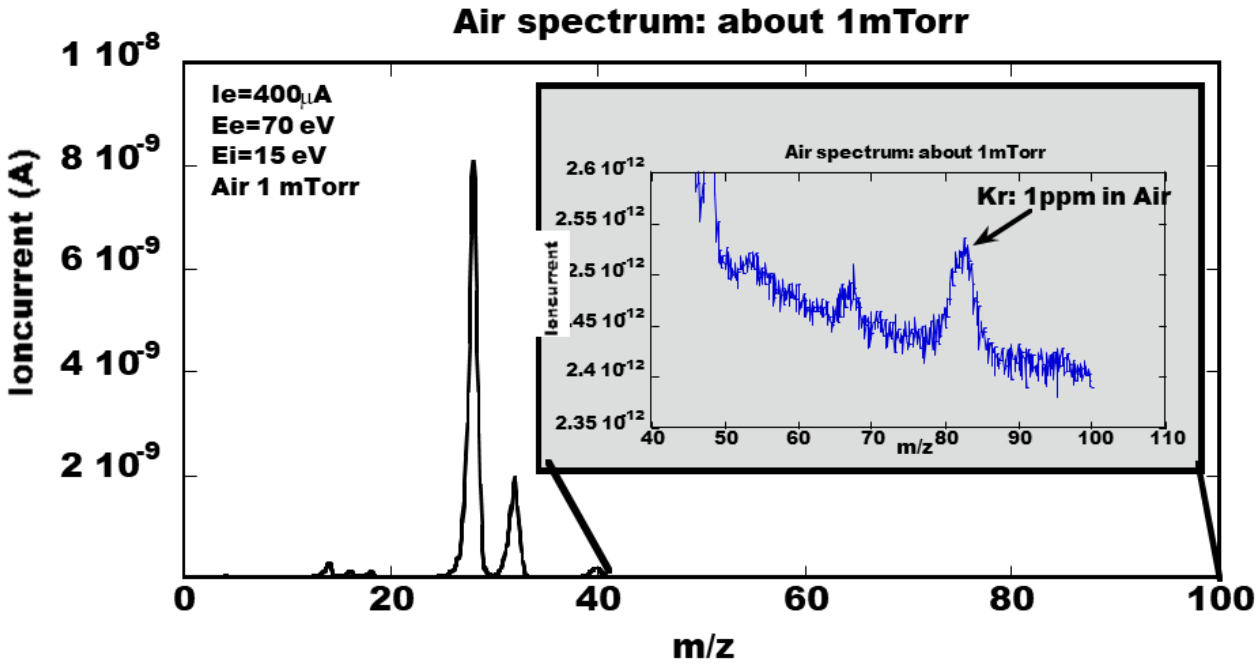
Data generated for each scan is time stamped and stored on the AMS system allowing the system to run autonomously and data to be retrieved at a later time if required. Popular data export formats such as .json and .csv are supported

Future Proof Software

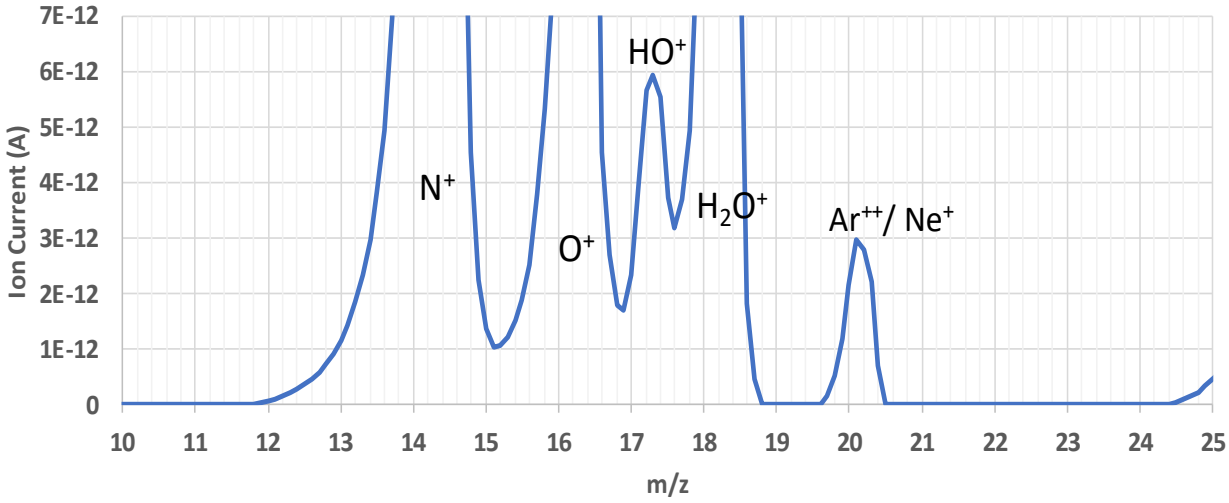
Atonarp is developing support for cloud based services delivery model, analytics and solutions. AMS control and AMS firmware updates over a public or private network are in development and will be released with future updates to the Atonlab framework.

Typical Operating Characteristics

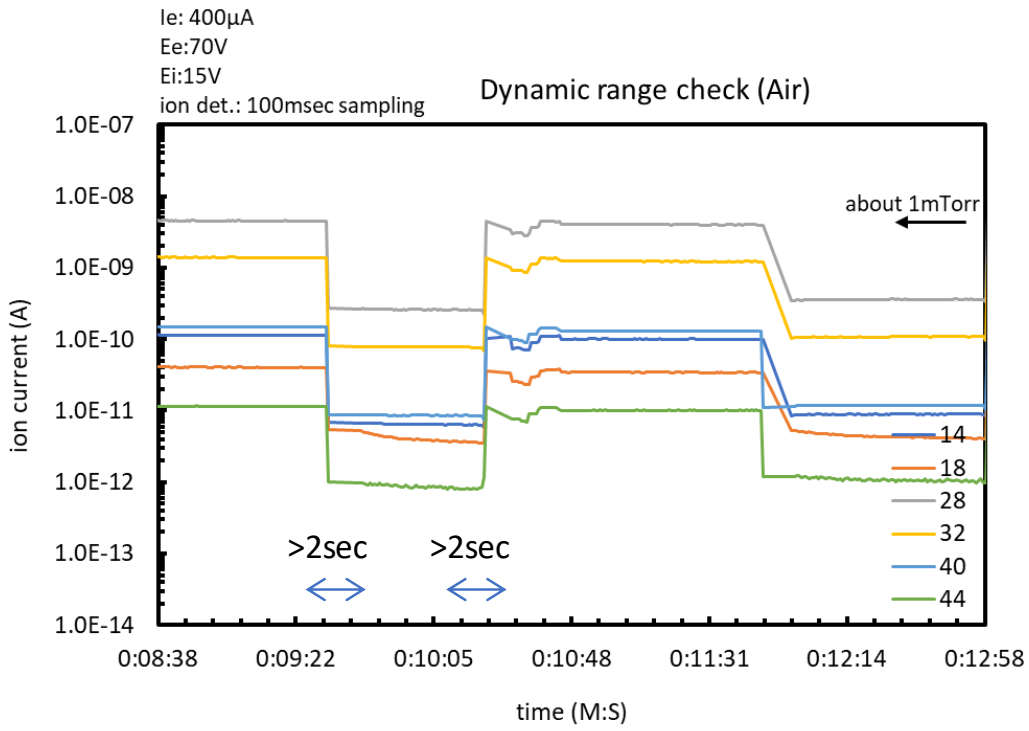
Low PPM sensitivity (<1ppm)



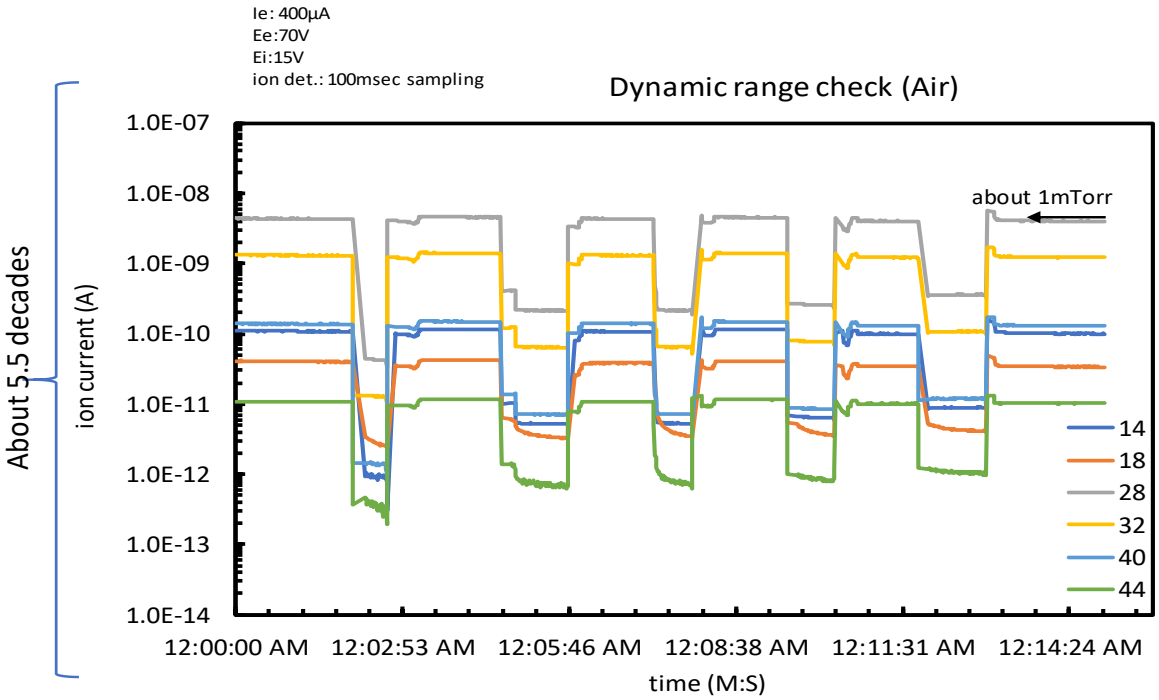
Sub-AMU mass resolution



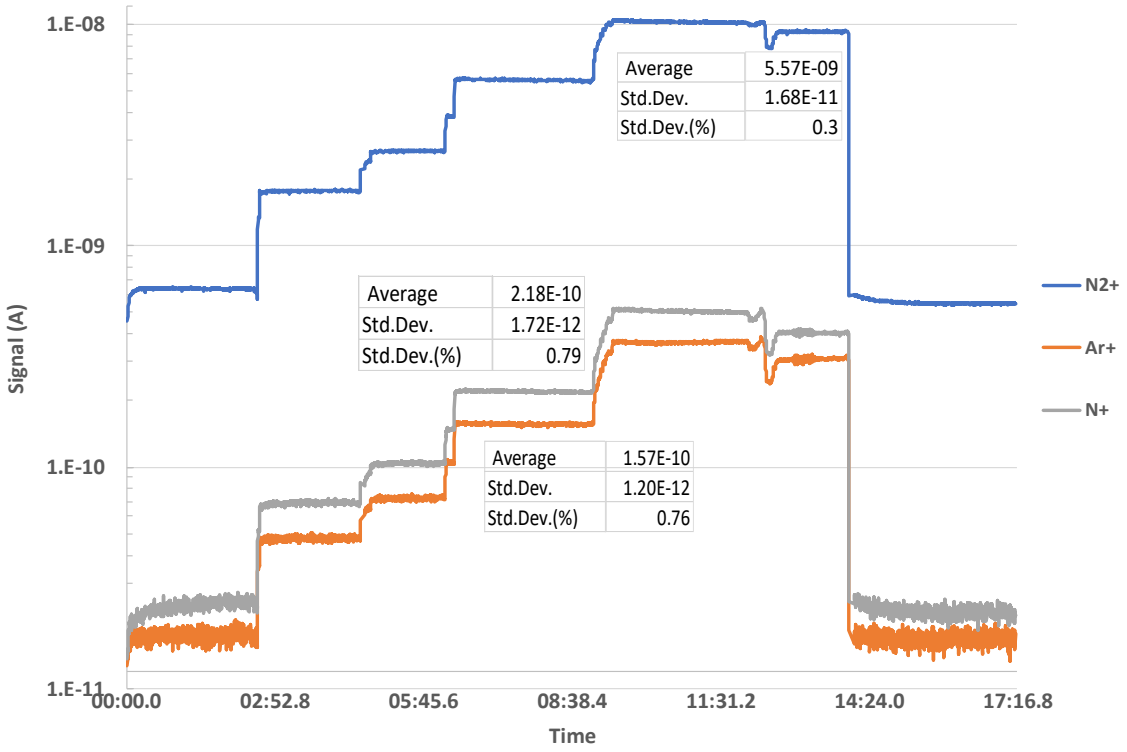
Speed of measurement - fast rise and fall times



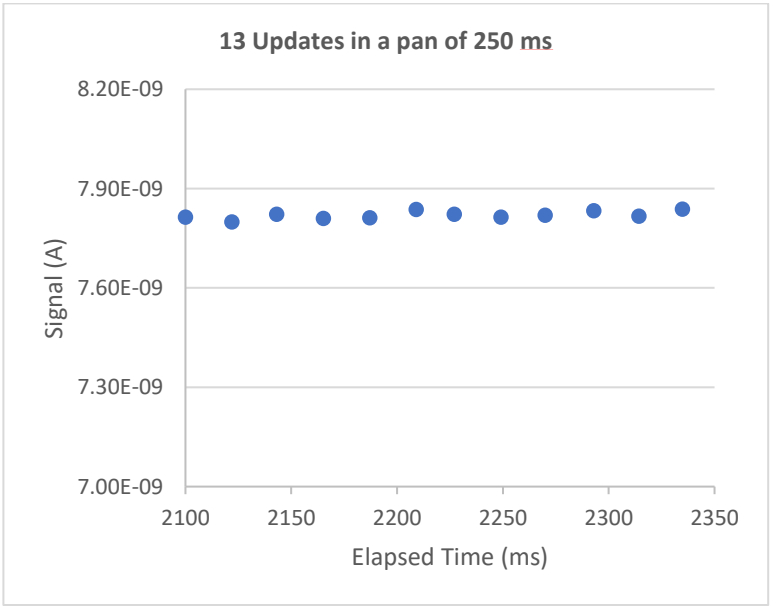
Dynamic Range



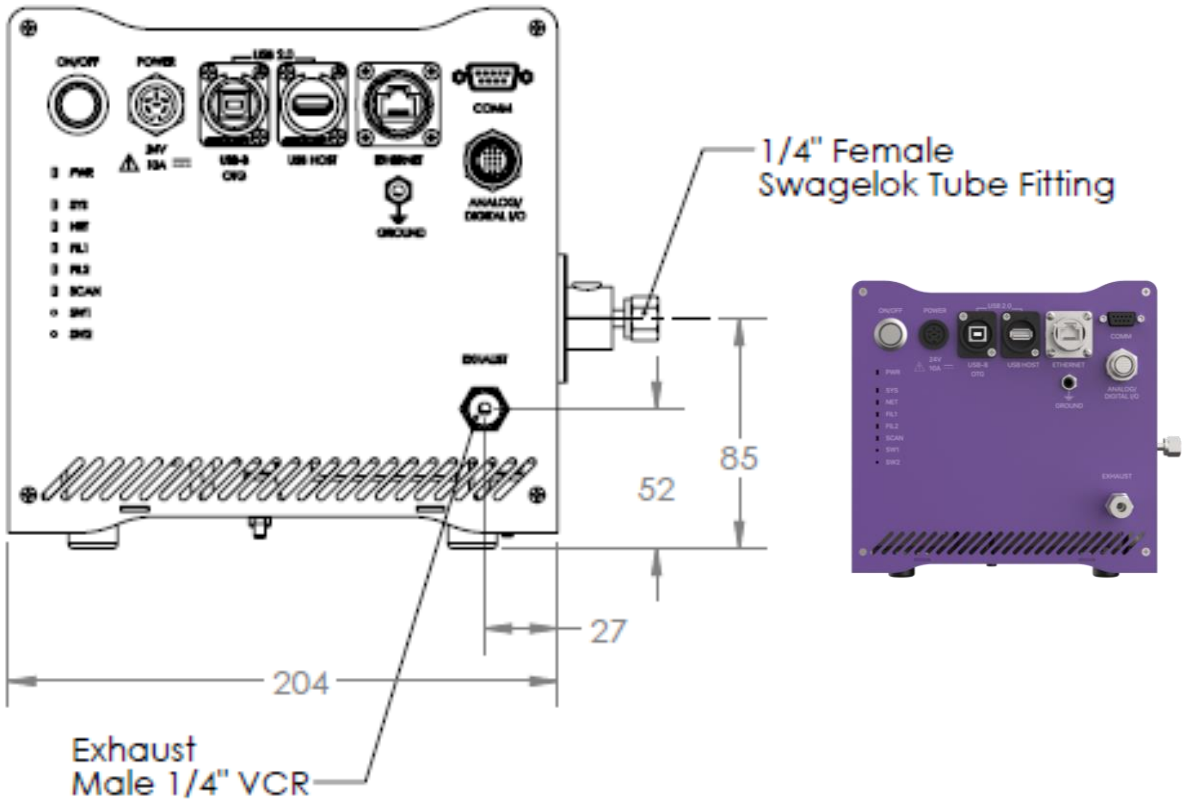
Accuracy and Stability

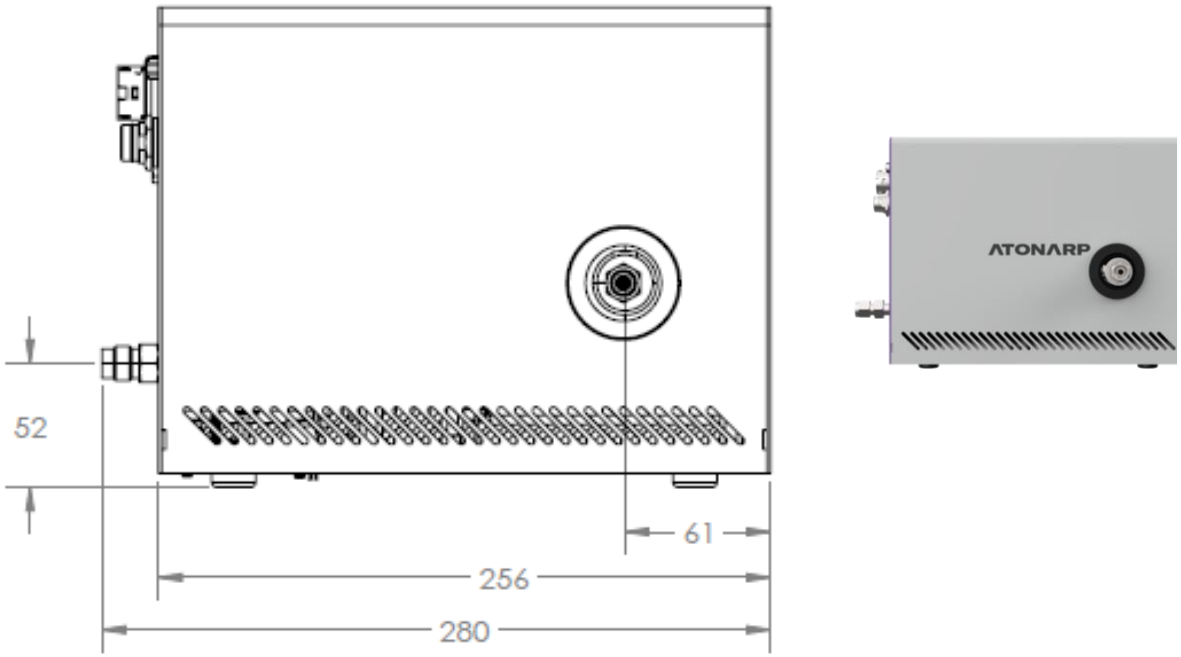


Stability & Repeatability



Dimensional Drawings





Ordering information

Instruments:	Part number
AMS-1000	ASM-900-0001
Roughing Pump Module	ASM-900-0002
Quadruple Mass Analyzer	ASM-900-0003
Controller Box	ASM-900-0004
Pressure Sensor Module	ASM-900-0005
Turbo Pump Module	ASM-900-0006
Power Entry Module	ASM-900-0007
Chamber Heater	ASM-900-0008
Tube Heater	ASM-900-0009
Vertis (Controller Box and Quad Mass Analyzer)	ASM-900-0031

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