Ionplus

Scientific Instruments
for Radiocarbon Dating and
Accelerator Mass Spectrometry

Dedicated to excellence.

Ionplus

Scientific Instruments for Radiocarbon Dating and Accelerator Mass Spectrometry

Based on more than 30 years of research and experience, Ionplus develops and builds innovative instruments for radiocarbon sample preparation and Accelerator Mass Spectrometry (AMS). Our instruments are highly automated and provide excellent reproducibility and stability that allows our customers to deliver outstanding results in their ^{14}C and AMS applications. Versatility and a user-friendly design are achieved through excellent engineering.

Ionplus stands for high-quality scientific instruments made in Switzerland as well as excellent customer service. We are dedicated to providing our customers all over the world with the best solutions for ^{14}C analysis and cutting-edge AMS technology for a wide range of applications. Ionplus offers virtually the entire range of dedicated AMS laboratory and measurement equipment from one source: AMS instruments, fully automated graphitization systems, gas interface systems, automated carbonate handling systems, pneumatic sample presses, vacuum lines for sealing tubes and a range of accessories for all products.

As of 2018, Ionplus introduces the latest innovation in AMS: Our new low-energy multi-isotope AMS system MILEA delivers outstanding performance for ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca, ^{129}I, U and Pu applications at 300 kV.

APPLICATIONS

THE BEST SOLUTIONS FOR ALL AMS APPLICATIONS.

Find the best solutions for your specific needs in ^{14}C and AMS analysis.

We are there for you – from consulting on application requirements and product combinations to trainings and support in your daily work.

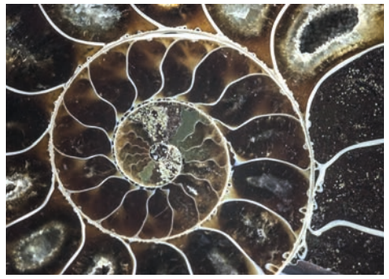
ARCHAEOLOGY High precision

Archeological samples together with samples from paleoclimatology and radiocarbon calibration projects require highest precision, reproducibility and reliability.

ENVIRONMENTAL SCIENCE Small sample sizes

From carbon cycle studies to biogeochemistry, Ionplus offers the right equipment to deal with challenging sample sizes and sample matrices from a wide variety of research areas.

MARINE RESEARCH Handling of carbonates and DIC



From sediments to water samples, from the analysis of single foraminifera to dissolved inorganic carbon, Ionplus offers equipment for fully automated sample treatment, acidification and sampling.

MATERIALS SCIENCE Simultaneous $\delta^{13}C$ measurements

As certification of biofuels and plant-derived materials becomes more important, we offer a fast, reproducible all-in-one solution for simultaneous ^{14}C and $\delta^{13}C$ analysis.

BIOMEDICINE High throughput, carbon quantification

Ionplus combines the excellent sensitivity of AMS with the ultrafast and automated ^{14}C analysis required for high-throughput microtracing studies.

FORENSICS High precision, simultaneous $\delta^{13}C$ measurements

Forensic applications span a wide variety of sample backgrounds and typically rely on the radiocarbon "bomb peak", which can deliver valuable information, in particular when combined with stable isotope information.

GEOLOGY ^{14}C, ^{10}Be and ^{26}Al measurements

Burial and in-situ exposure dating, glacial erosion studies or the determination of denudation rates are just a few of the many applications accessible with the MILEA system through the measurement of ^{10}Be, ^{14}C and ^{26}Al.

ANTHROPOGENIC NUCLIDES Tracing and monitoring

Tracing and monitoring of anthropogenic I, U and Pu nuclides is a steadily growing field. MILEA offers the highest performance for these applications at lowest energies.

For recommended product combinations for most diverse AMS applications please contact us or visit www.ionplus.ch

PRODUCTS

All Ionplus products can be either used as stand-alone instruments or in combination with each other to streamline processes in your ^{14}C or AMS laboratory. The combination of Ionplus instruments ensures the best control over variability and allows you to obtain precise and reproducible outcomes. Take full advantage of our integrated Lab Management Package LMP by combining Ionplus instruments: virtually all steps of the sample processing can be recorded in a database for convenient and safe logging.

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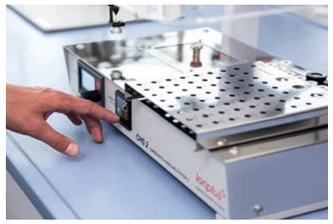

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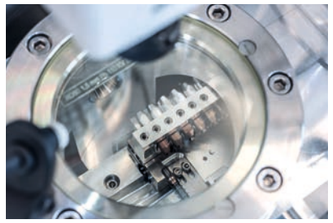

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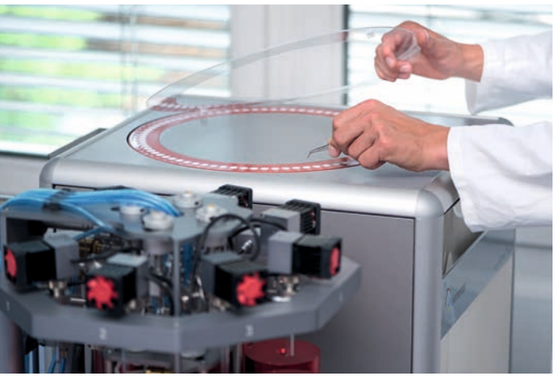
AGE 3

Automated Graphitization Equipment



The third generation of the Automated Graphitization Equipment AGE 3 is the most compact graphitization system on the market. Used in over 30 laboratories around the world, AGE 3 combines sample combustion and graphite production for AMS in a fast and efficient way. Organics are combusted with an Elemental Analyzer EA, carbonates are hydrolyzed and sampled with the fully automated Carbonate Handling System CHS 2. AGE 3 systems run completely unattended and deliver excellent repeatability due to a high degree of automation. This also shows in the AMS data, where good repeatability translates into higher precision.

SPECIFICATIONS

- Required carbon content for regular samples: 1–2 mg
- Required carbon content for small samples: > 0.2 mg
- Samples of up to 200 mg containing > 3 % carbon can be processed
- Produced graphite: 0.2–1.0 mg carbon on 3–5 mg iron
- Processing blank: < 0.002 $F^{14}C$ (> 50'000 radiocarbon years)
- Cross-talk: < 1 ‰ on 1 mg carbon

KEY FEATURES

- Sample combustion and graphitization combined in one compact system
- Fully automated – no user input required after loading samples
- User-friendly software
- No liquid nitrogen required
- Fast graphitization reaction – 120 minutes
- High throughput – 21 samples per day

PSP

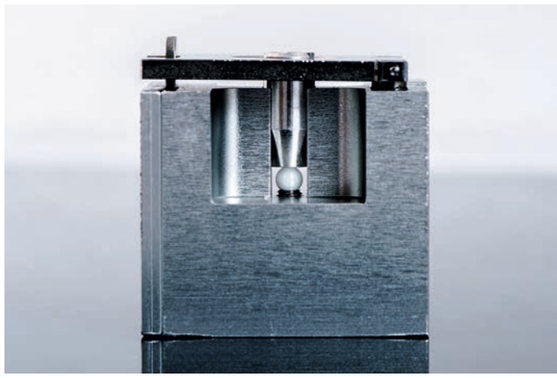
Pneumatic Sample Press

Graphite cathodes are pressed reliably, reproducibly and conveniently with the Pneumatic Sample Press PSP.
By the push of a button, an easy to clean pin presses samples into the back of cathodes. By pressing cathodes from the back, surface contamination is significantly reduced and reproducibility of sample currents is improved due to a well-defined graphite position. Cathode holders for cathodes of all AMS manufacturers are available for PSP.

PSP helps you save time in the preparation of AMS cathodes and plays a key role in making high-precision measurements possible.

SPECIFICATIONS

- Automated pressing by the push of a button
- Adjustable force of 100–800 N for any carbon/catalyst ratio
- Defined pressing time of 1.5 seconds per sample



KEY FEATURES

- Reproducible, reliable and fast pressing of graphite and other materials for AMS cathodes
- Samples are pressed from the back, resulting in low surface contamination and reproducible currents in the AMS measurement
- Cathode holders for Ionplus, NEC and High Voltage cathodes are available

FED

Ferrum Dispenser

The iron dispenser FED dispenses a well-defined and reproducible amount of metal catalyst for AGE 3 systems and other graphitization lines. The fast and easy handling of FED saves time and its reproducibility provides the basis for high-precision ^{14}C measurements. Manually operated and virtually wear-free, FED requires no additional equipment. Repeatability tests indicate that iron masses of typically 4–5 mg* are obtained readily and reliably with a variability of ± 2 %.

*The dispensed mass depends on the mesh size of the iron powder.

SPECIFICATIONS

- Dispenses 4–5 mg of iron powder with a typical variation of ±2 % for a 325 mesh size
- Dosing of iron in ca. 5 seconds per tube
- Accepts any 8 mm O.D. culture tube

KEY FEATURES

- Reproducible dosing of iron or other metallic catalysts for graphitization reactions
- Manually operated
- Maintenance-free

IRMS

*Isotope Ratio Mass Spectrometer**

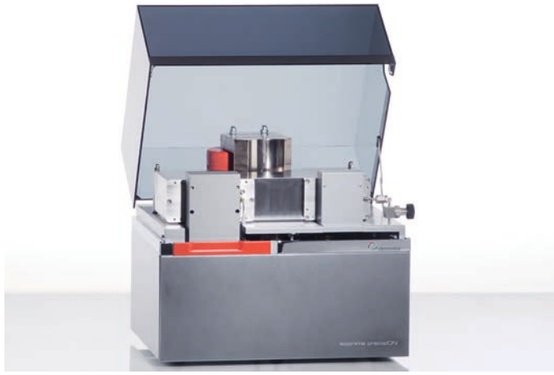
High-precision $\delta^{13}C$ and $\delta^{15}N$** values are conveniently obtained during graphitization with an AGE 3 instrument or during gas measurements with GIS. A newly implemented Elementar precisION® IRMS instrument is coupled to our AGE 3 or GIS system in order to acquire precise and accurate stable isotope information online. Gain new insight into your samples with this convenient coupling. Applications range from archaeological or forensic samples to materials testing and tracer studies.

* The IRMS instrument is a third-party instrument, interfacing with Ionplus AGE 3 and GIS instruments.

** $\delta^{15}N$ values are obtained in conjunction with an Elemental Analyzer only.

SPECIFICATIONS

- Dimensions: 595 x 460 x 650 mm, 102 kg
- Typical mass range at 3 kV: 1–76 amu
- Typical split: 3 % for IRMS, remainder for AGE 3/GIS
- Mass resolution: > 110 m/Δm @ 10 % valley separation



KEY FEATURES

- Performs $\delta^{13}C$ and $\delta^{15}N$ measurements during graphitization or gas measurements
- Fully automated tuning
- Full functionality for other isotopes such as $\delta^{18}O$, $\delta^{33}S$ and $\delta^{34}S$ in conjunction with different combustion/pyrolysis setups

CHS 2

Carbonate Handling System

CHS 2 is the second generation of our head-space sampling system for carbonates, DIC and liquid combustion samples. It is designed for efficient flushing, oxidizing/hydrolyzing and sampling from septum-sealed vials. CHS 2 combines a heater block for up to 64 samples, an adapted auto sampler, a water trap and an adjustable flow regulator. The system is fully implemented in both the AGE 3 and GIS software. As a new feature, CHS 2 comes with a completely automated tool change between acid syringes and sampling needles.
An optional water kit for DIC samples of up to 100 ml is also available. With the additional acid containers, an automated leaching, flushing and sampling is now possible without user intervention.

SPECIFICATIONS

- Dimensions: 830 x 390 x 650 mm, 35 kg
- Tray 1: 64 sample vials 4.5/12 ml
- Tray 2: 9 sample vials 100 ml
- Adjustable flow 0–300 ml/min
- Adjustable temperature: room temperature to 100 °C

KEY FEATURES

- Fully automated flushing/acid addition/sampling (including tool changes) with AGE 3/GIS
- Heater block (20–100 °C) for up to 64 Labco Exetainers® or 9 100 ml serum bottles
- Heated acid containers for phosphoric acid, leaching acid and oxidant (20/40 ml borosilicate vials)
- Integrated flow regulator with LCD readout and flow-alarm
- Integrated water trap with increased capacity for water samples

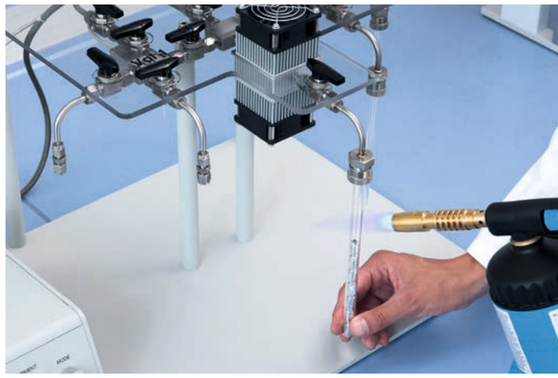
TSE

Tube Sealing Equipment

With its compact design, the Tube Sealing Equipment TSE serves as a simple vacuum line to crack ampoules, split samples into several ampoules or to prepare and seal samples for combustion in quartz tubes. TSE is also a convenient and versatile instrument for ^{14}C preparation laboratories without their own AMS capability. Gas ampoules prepared by TSE can be stored and shipped for later analysis with GIS and vacuum-sealed graphite cathodes can be shipped and stored indefinitely. TSE is manually operated and equipped with two 9 mm Ultra-Torr® ports for sealing of combustion tubes, two 4 mm ports for sealing of quartz and glass tubes and one ½" Ultra-Torr® port with a bellows tube cracker for 9 mm sample tubes. The vacuum line also comprises two calibrated volumes (corresponding to 700 and 2'100 µg carbon as CO_2 at 1 bar), two pressure transducers (0–3'000 mbar) with digital readouts and a Peltier cooler for water removal.

SPECIFICATIONS

- 2 independent pressure transducers
- Calibrated volumes for 700 and 2'100 µg carbon
- Peltier cooler for water removal at -20 °C



KEY FEATURES

- Easy to use vacuum line
- 2 calibrated volumes with pressure readouts
- Peltier cooler for water condensation
- Display of pressures, carbon masses and temperatures

GIS

Gas Interface System

KEY FEATURES

- Direct measurements of CO_2 in conjunction with MICADAS/MILEA
- Fully automated sample handling
- Highest versatility through diverse CO_2 sources
- Highest throughput for ^{14}C measurements
- Blank and reference gases are conveniently measured from pre-mixed gas bottles

The Ionplus Gas Interface System GIS is the most versatile gas handling system for ^{14}C-AMS measurements of CO_2. Direct measurements of CO_2 are performed on ultra-small samples of 3 to 100 µg carbon with the GIS + MICADAS/MILEA coupling. Gas measurements are the ideal solution not only for small samples but also for all lower precision samples in screening and high throughput studies. Sample CO_2 is mixed with helium and the mixture is continuously fed into the ion source of MICADAS/MILEA. All functionalities of the instrument are software-controlled and fully automated for gas measurements without user interaction for 8 to 40 samples. Moreover, the coupling of virtually any CO_2-producing device is possible through the integrated zeolite trap.

SPECIFICATIONS

- Handles CO_2 sample sizes between 3 and 100 µg carbon
- Versatile couplings with an Elemental Analyzer EA, a carbonate system CHS 2 and an automated tube cracker (tube dimensions: 4.0 mm O.D., length: 70–80 mm)
- Online stable isotope information is obtained through a GIS + IRMS coupling
- Fully automated measurements for up to 8 sealed tube samples and up to 40 samples with EA or CHS 2
- 60–150 samples can be handled per day
- 4 auxiliary gas inlets for reference gases

LMP

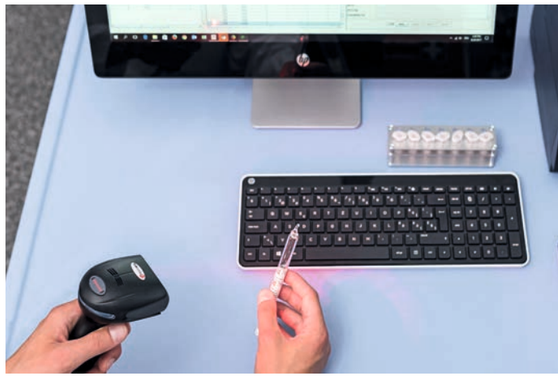
Lab Management Package

Ionplus offers a comprehensive package of hardware and software for the efficient handling of samples, sample preparation information, instrument control, measurements and ^{14}C data reduction. Our Lab Management Package LMP enhances throughput, reliability and quality management of your ^{14}C-AMS laboratory.
Detailed information on every sample is recorded with the user's sample information and measurement data. All this data is safely stored in a database, allowing fast access without the risks associated with file storage.

While the LMP is most useful in conjunction with a MICADAS instrument, the sample management part of it can be operated with AGE 3 instruments or as standalone system e.g. for the management of customer data, sample information and preparation details or for data reduction. Contact us for a system tailored to your specific needs.

LMP ELEMENTS

- Database and software suite for customer and sample information, lab processing information as well as measurement data
- Label printer and bar-code reader for fast and efficient labeling of samples and logging of sample preparation steps
- LMP and the Accelerator Control Software ACS access the same database so that sample information and measurement data are easily traced throughout the entire sample processing chain and measurement.
- LMP works best with the data reduction tool BATS. BATS is a fast and reliable data reduction tool that allows the user to check and visualize the measurement data in real time and performs calibration of radiocarbon dates.



KEY FEATURES

- Ensures data integrity
- Central data storage and backup
- Lab-wide data sharing e.g. between sample preparation on AGE 3 and ^{14}C measurement on MICADAS
- Convenient user interface for standardized data input

MICADAS

Mini Carbon Dating System

The most compact
^{14}C-AMS system in the world

KEY FEATURES

- Simple and fast tuning
- High measurement stability over long time
- Fully automated gas measurements with GIS
- Fast magazine changes for continuous measurements without breaking the vacuum or cooling down any part of the ion source
- Low space requirements through very compact design
- Extremely low power consumption of 2.5 kW
- Fully air-cooled system, no cooling water needed
- Hybrid cesium negative sputter ion source for solid and gas cathodes
- Vacuum insulated accelerator terminal without any moving parts, no SF_6 needed
- Minimal maintenance

Highest performance with the world's smallest AMS system: The Mini Carbon Dating System MICADAS is a true precision instrument for your ^{14}C applications.
With its permanent magnet and new design, MICADAS is also the most energy efficient AMS in the world and has the lowest infrastructure requirements.

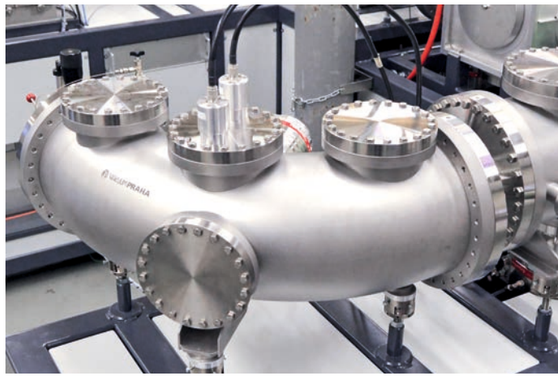
The first prototype of MICADAS was developed and built by the Laboratory of Ion Beam Physics at ETH Zurich in 2004. Since then, more than 20 instruments have been built and delivered to customers worldwide. MICADAS has demonstrated highest performance and reliability and has become the new standard in ^{14}C-AMS.

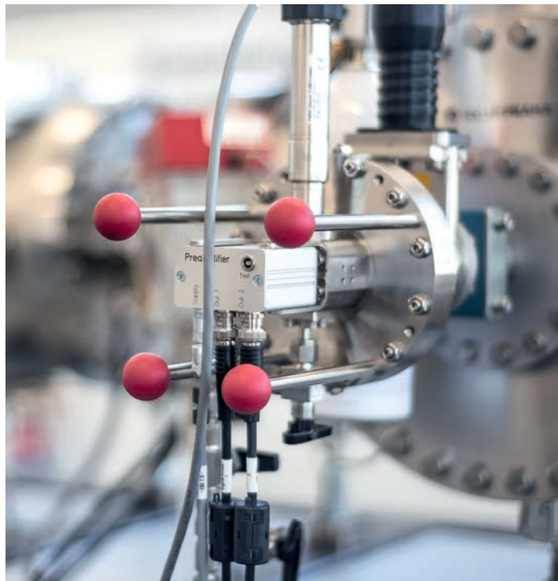
With its dimensions of only 3.2 m x 2.6 m x 2 m, MICADAS is the most compact commercially available ^{14}C-AMS system in the world. Its helium stripping offers a very high transmission of up to 47 % and outstanding measurement stability, thus significantly reducing the need for retuning.

The MICADAS hybrid cesium sputter ion source is equipped with a random-access sample changer that holds up to 40 graphite or gas cathodes. Stable ion beam currents of 50 to 150 µA and 10 to 20 µA C^- are readily achieved in routine operation with solid and gas samples, respectively.

The acceleration potential of 200 kV is provided by a solid-state power supply without any moving parts, the terminal is vacuum insulated – no SF_6 or other insulation gases are required. A state of the art gas ionization detector with low noise and virtually no degradation provides the most reliable detection of ^{14}C ions. With this configuration, blanks older than 50'000 radiocarbon years are readily obtained.

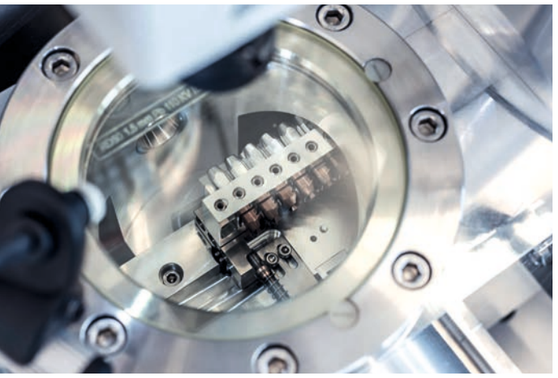
In conjunction with the Gas Interface System GIS, MICADAS performs fully automated gas measurements with an auto sampler, an Elemental Analyzer or CO_2 filled glass or quartz tubes. MICADAS is therefore also the most powerful choice for your small samples and high throughput applications.





MICADAS

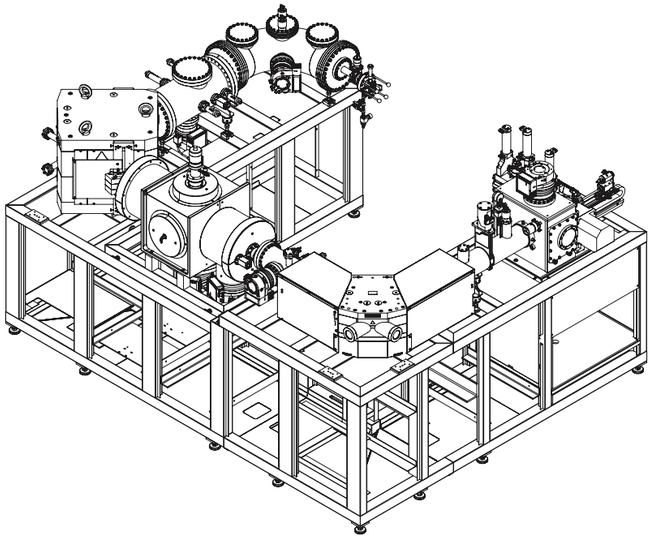
Mini Carbon Dating System



SPECIFICATIONS

- Helium stripping (up to 47 % ^{14}C-transmission)
- Negative ion currents of 50 to 150 µA on full-sized graphite samples and 10 to 20 µA on gas samples (10 µg carbon or more)
- 200 kV accelerator on a vacuum insulated high voltage platform with a low maintenance solid-state power supply
- Dating of samples back to more than 50'000 radiocarbon years
- Machine blank up to 68'000 radiocarbon years
- Random access sample changer with 40 positions
- Dimensions and weight: 3.2 m x 2.6 m x 2.2 m, 4'500 kg
- 2.5 kW average power consumption
- No cooling water or SF_6 needed

Scan the QR code or visit www.ionplus.ch and take a 360° virtual product tour.



INTERFACES

Versatile Gas Measurements

GIS and its peripherals (Elemental Analyzer EA, CHS 2, IRMS) make MICADAS and MILEA the most versatile ^{14}C instruments on the market. A few examples of the coupling and measurement possibilities:

- **Measurement of virtually any volatile organic gas sample in glass ampoules**

  GIS' built-in ampoule cracker not only allows the direct measurement of CO_2 but also enables the measurement of freons, CO and a range of other compounds from sealed glass ampoules with GIS + MICADAS/MILEA.

- **Dating of small carbonate samples**

  Combine CHS 2 + GIS + MICADAS/MILEA for fully automated sample preparation (leaching, flushing, acidification) and measurement of small carbonate samples.

- **Ultrafast screening of solid/liquid samples (biomedical/materials samples)**

  For the fastest ^{14}C analysis in just 8 minutes per sample, run EA + GIS + MICADAS/MILEA in combination. Use the same coupling for more precise measurements by simply increasing the measurement time. To gain precise $\delta^{13}C$ or $\delta^{15}N$ information at the same time, add an IRMS instrument for online sample analysis (EA + IRMS + GIS + MICADAS/MILEA).

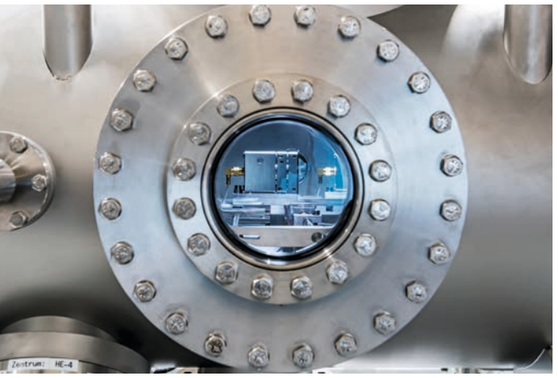
- **Coupling to third-party CO_2-producing instruments**

  GIS + MICADAS/MILEA are compatible with any CO_2-producing instrument with just a few adaptations. Ask us about the coupling possibilities for your CO_2-producing device with GIS + MICADAS/MILEA.

MILEA

Multi-Isotope Low-Energy AMS

The world's most innovative multi-isotope AMS system



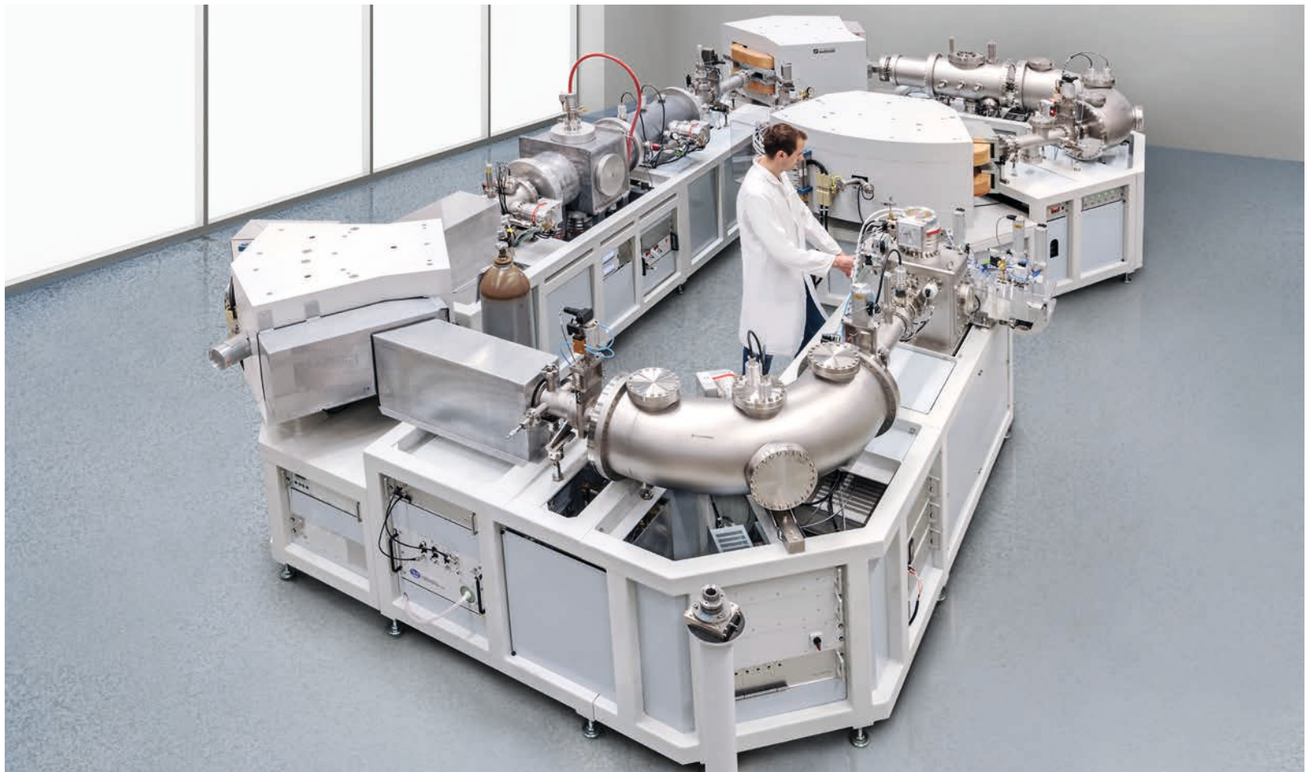
KEY FEATURES

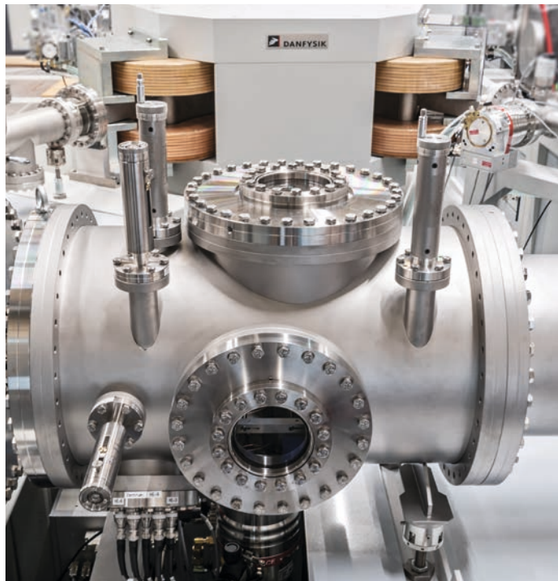
- Isotopes: ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca, ^{129}I, U, Pu and other actinides
- Fast switching between different isotopes
- Optimized ion optics for all isotopes
- Ion source can be equipped with a gas interface for radiocarbon samples
- Fully automated gas measurements with GIS
- Fast magazine changes for continuous measurements without breaking the vacuum or cooling down any part of the ion source
- Low space requirements for a multi-isotope facility through very compact design
- Vacuum insulated accelerator terminal without any moving parts, no SF_6 needed
- Minimal maintenance

In a collaboration, Ionplus and ETH Zurich have developed a next generation multi-isotope AMS system at low energies: MILEA. Covering ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca, ^{129}I, U, Pu and other actinides, the new instrument combines the established accelerator and ion source technology of MICADAS with the well-proven concept of the high-energy spectrometer layout of the ETH "TANDY" instrument.

With a footprint of just 3.5 m x 7 m, the space requirements of this new AMS instrument are very low. The accelerator is based on the vacuum insulated MICADAS design, which has been upgraded to support up to 300 kV. The low energy spectrometer of the new instrument comprises an achromatic combination of a 90° electrostatic and magnetic deflector. The layout of the high energy side is inspired by the "TANDY" spectrometer (90° magnetic, 120° electrostatic and 110° magnetic deflector). A quadrupole triplet after the accelerator unit provides similar ion optical conditions for all measured isotopes and facilitates tuning. A new, improved low-noise ΔE-E_{res} gas ionization chamber at the back end of the new multi-isotope AMS system provides outstanding separation and identification of interfering particles.

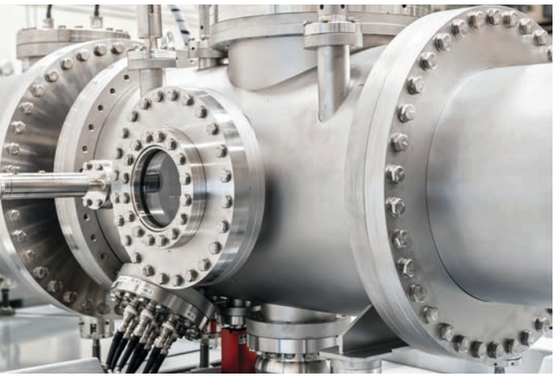
The MILEA prototype instrument built and tested in 2017 has shown excellent performance in all tested applications, similar to or exceeding the performance of its higher energy predecessor at ETH. In combination with the new Accelerator Control Software ACS, MILEA is currently not only the most compact but also the most user-friendly multi-isotope AMS system in the world.
Contact us to learn more about the exciting possibilities with MILEA.

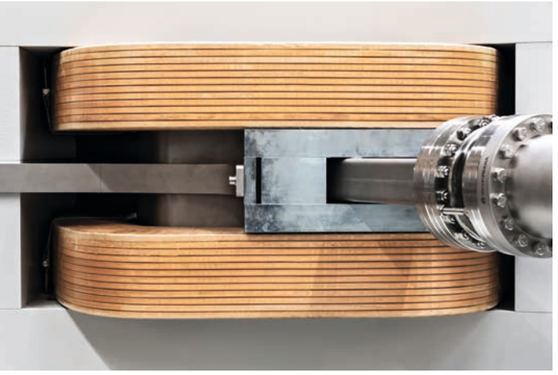


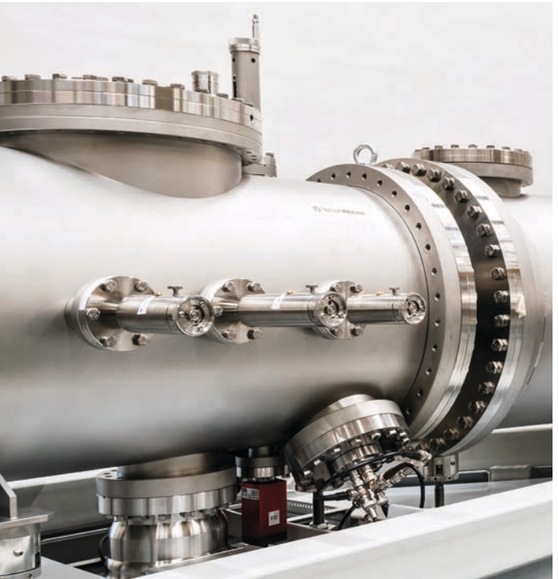


MILEA

Multi-Isotope Low-Energy AMS



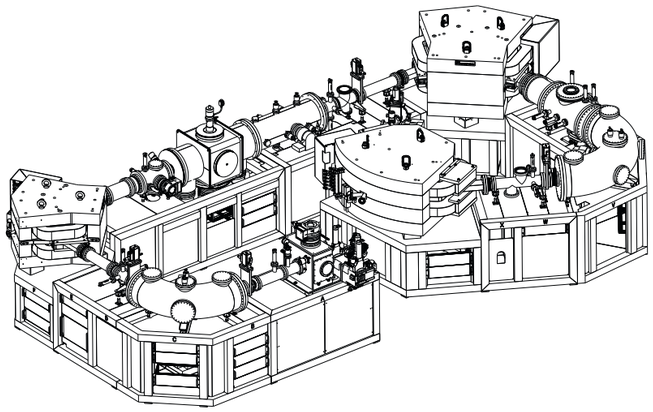




SPECIFICATIONS

- Isotopes: ^{10}Be, ^{14}C, ^{26}Al, ^{41}Ca, ^{129}I, U, Pu and other actinides
- Hybrid cesium negative sputter ion source for solid samples and CO_2 gas
- Radom access sample changer with 40 positions
- 300 kV accelerator on a vacuum insulated high voltage platform with a low maintenance solid-state power supply
- Helium stripping
- High mass selectivity, abundance sensitivity of $<5\cdot10^{-13}$ for U
- 7 Faraday cups and integrators on the HE side covering the entire range of measured currents (1pA – 300µA)
- High resolution ΔE-E_{res} gas ionization chamber with absorber cell and two parameter data acquisition
- Height of beam line: 1.15 m for simple maintenance
- Dimensions and weight: 3.5 m × 7 m x 2 m, 15'000 kg
- No SF_6 insulation gas needed

For more information scan the QR code or visit www.ionplus.ch.



ACS

Accelerator Control Software

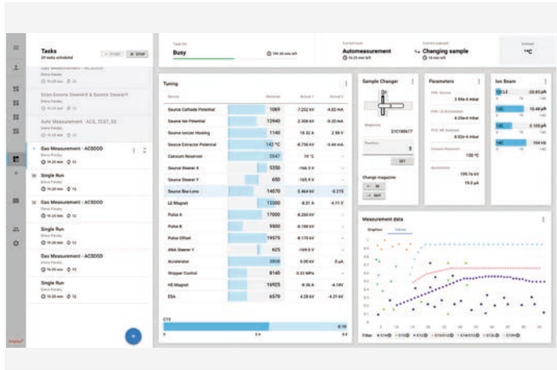
Ionplus' Accelerator Control Software ACS is revolutionizing the operation of AMS systems.

Start MICADAS or MILEA with a scheduled wake-up task, let the instrument tune itself and run batches of samples in the most automated way. Workflows are easily saved to provide the user with the easiest, most reproducible AMS experience. Maintenance work is made easy through maintenance tasks, requiring minimum user interaction to shut down, vent or restart the system while guiding the user through the steps.

ACS runs on MICADAS or MILEA control computers and is accessed through a web GUI from any client with a common web browser. The sophisticated user management ensures secure and simple instrument control while logging all user actions and events.

ACS ELEMENTS

- With the new ACS task engine, MICADAS and MILEA are easily operated through predefined workflows. Running an AMS instrument has never been easier.
- All system parameters are continuously recorded to monitor the system status. Every change to the system and every user interaction is logged to allow the best data quality and security.
- ACS and the Lab Management Package LMP access the same database so that sample information and measurement data are easily traced throughout the entire sample processing chain and measurement.
- Maintenance tasks automate the shut-down and start-up steps and guide the user through the manual steps of the most common maintenance processes.



KEY FEATURES

- Easiest operation of any AMS system
- Highest degree of automation for tuning and measurement
- Intuitive user concept
- Web GUI – Client access through web browser from any device
- Secure logging of users and events
- Logging and monitoring of all readbacks over time
- User chat, built-in lab journal

SERVICES

Besides manufacturing high-quality scientific instruments, Ionplus offers also a wide range of services in the field of radiocarbon dating and AMS.

TRAINING

Benefit from our experience and expertise in radiocarbon dating and AMS. In our in-house laboratory, we offer hands-on trainings and courses on:

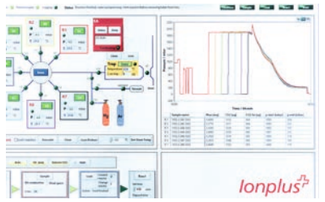
- Operating and maintenance of our instruments
- Sample cleaning and sample preparation for best results
- ^{14}C analysis and data interpretation
- Best practices in ^{14}C analysis




CUSTOM APPLICATIONS AND DEVELOPMENTS

You have a non-standard application or special requests? Or need a custom-built system specific to your analytical questions? Tell us about your unique challenges and we can provide you with custom solutions tailored to your specific needs.



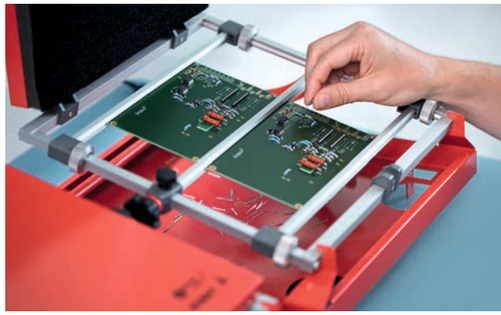


TECHNICAL SUPPORT

Our experienced staff provides prompt assistance and support for any question or technical problem. We are here for you and your questions by e-mail, phone or even through our remote access assistance.

MAINTENANCE PACKAGES

The Ionplus maintenance packages help you avoid costly downtime, reduce repair work and keep your systems up to date and running. Choose the maintenance package that best suits your needs.



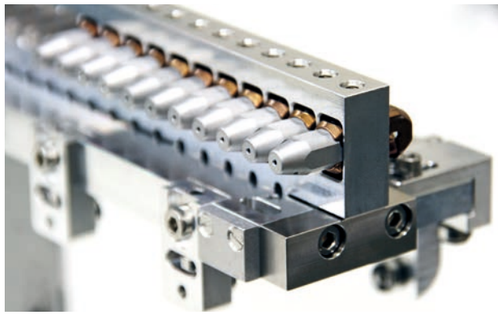
SPARE PARTS AND UPGRADES

Our instruments are designed and built to last. We offer upgrades of equipment and spare parts for all our instruments.

Currently available upgrade options for older systems:

- Helium stripping for MICADAS
- 40 position magazine sample changer for MICADAS
- IT and software upgrades for AGE, GIS and MICADAS

Request a quotation for your desired upgrade at info@ionplus.ch.



CONSUMABLES

To keep your research going, we deliver consumables for all our products such as:

- Cathodes for solid and gas samples
- Vials and tubes for AGE 3, CHS 2 and TSE
- Reference and blank gas mixtures for GIS


HEAD QUARTERS

Ionplus

engineering scientific instruments

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SALES NETWORK

Ionplus has an international network of sales representatives with local and market-oriented partner companies. For a trading company in your region, please check www.ionplus.ch or contact us at info@ionplus.ch.

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