

# Neutral cluster and Air Ion Spectrometer

# NAIS

Model: 103.5

The Neutral cluster and Air Ion Spectrometer measures mobility distributions of **ions from 3.2 to 0.0014 cm<sup>2</sup>/V/s** (from 0.8 to 40 nm size equivalent) and size distributions of **all particles from 2 to 40 nm** with a **time resolution of 1 second** per complete distribution.

## Applications

- Study temporal development of particle and cluster distributions (nucleation, particle formation, particle growth)
- Run long-term continuous field measurements of aerosol and ion distributions
- Study formation and development of ambient air pollution.
- Measure rapidly varying aerosol and ion distributions in laboratory experiments.
- Observe spatial changes of particle distributions on board cars, trains, boats or aircraft

## Features

- Can measure cluster ions as small as 0.8 nm and detect neutral (uncharged) clusters as small as 2 nm.
- Observes quickly changing particle distributions by capturing complete size distributions at once with 1 second time resolution.
- Easy to deploy, operate and maintain. Does not require consumables. Can measure for long periods of time without requiring human attention.
- Works well in a wide range of environmental conditions: operating temperature range from -20 to 40 °C, sample air pressure range from 300 to 1200 hPa.



## Advantages

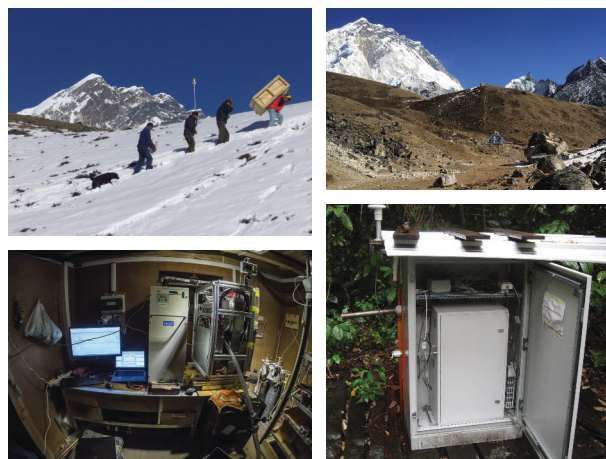
- The measurement process is completely automatic and thoroughly monitored to guarantee reliable results.
- The NAIS can operate in a wide atmospheric pressure range making it suitable for mountain top measurements and aircraft based measurements at altitudes up to and beyond 8 km and chamber experiments with over pressure up to 200 hPa. The internal air flows are automatically adjusted to compensate for the effect of air pressure on particle mobility.
- The instrument is simple to deploy and requires little training for the operator. All parts of the instrument are contained in a single enclosure. No external pressurized air, vacuum or liquid connections are required.
- The instrument does not consume or produce any harmful substances
- Regular maintenance of the instrument only involves cleaning which takes less than 1 hour and can easily be carried out in the field. The maintenance interval can reach several months in clean conditions.

## Scientific Research

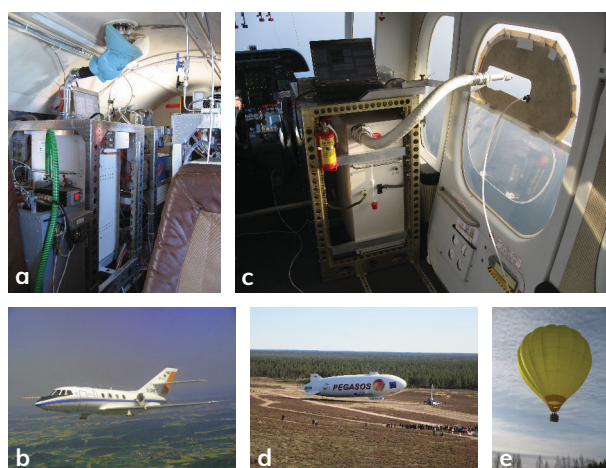
The NAIS instruments are being used to carry out cutting edge aerosol science all over the world. The instruments have been used to study new particle formation and growth in many locations from densely populated mega-cities to rain forests and arctic ice sheet. The NAIS have operated on board aircraft, hot air balloons and a Zeppelin airship.

The instrument has also been extensively used in laboratory experiments, e.g. the CERN CLOUD chamber.

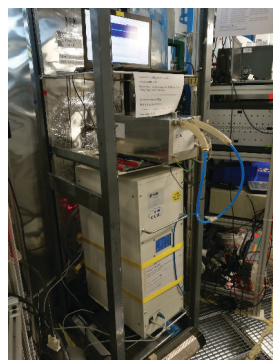
NAIS measurements have been used in over 200 scientific publications.



The NAIS operates well in extreme conditions. It has been used to study new particle formation in many locations from Himalayan mountains to Amazon rain forest.



The NAIS was the first instrument to measure sub-3 nm neutral clusters in the upper layers of the troposphere (a, b: on board DLR Falcon, EUCAARI LON-GREX campaign). It is well suited for different kinds of airborne measurements (c, d: Zeppelin, Pegasus campaign, e: hot air balloon measurements over Finland).



The ability to detect nanometer size particles combined with high time resolution and automatic adaptation to changing environmental conditions makes the NAIS ideal for chamber experiments. (picture from CERN CLOUD experiment)

## Measurement Principle

The NAIS uses two multi-channel differential mobility analyzers to measure the size distribution of both positively and negatively charged ions and uncharged particles. The parallel electrical measurement method allows the instrument to capture the whole size distribution at once without the need for scanning. A specially designed inlet of the DMA allows to keep particle losses at a minimum and achieve a high detection efficiency event for the smallest particles below 1 nm size.

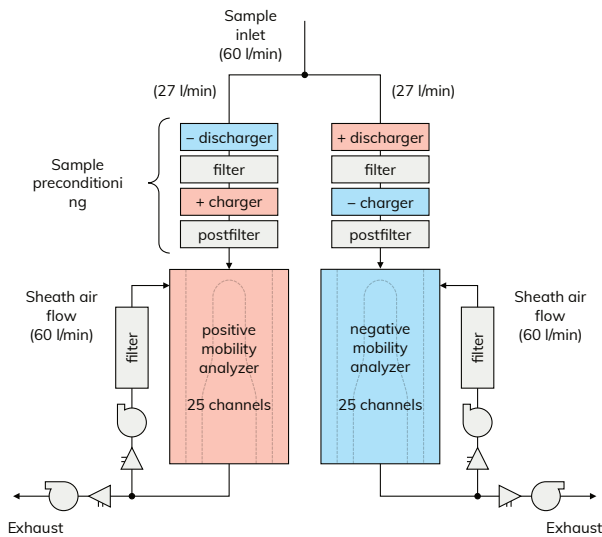
The aerosol sample is first passed through a software controlled charger-filter unit which allows the instrument to choose whether to use unipolar charging to detect uncharged particles or leave the sample untouched and detect naturally charged particles (ions). The sample is mobility-classified in a parallel differential mobility analyzer where particles are deposited on 25 collecting electrodes based on their electrical mobility from covering the equivalent size range from 0.8 nm to 40 nm. The signals are measured in parallel by 25 highly sensitive electrometers and converted to a complete particle size or mobility distribution by a mathematical deconvolution procedure.

## Software

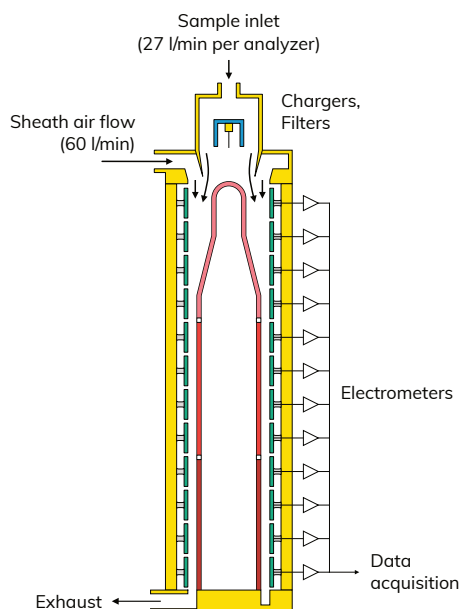
The NAIS comes with a full featured software package.

The Spectops program takes care of measurement control, on-line data processing and provides a live view of the measured data. The software closely monitors the NAIS measurement process to guarantee the measurement quality and notifies the user in case any indicators for possible problems are detected. The program can be reliably used for running long term measurements. Both Windows and Linux versions are available.

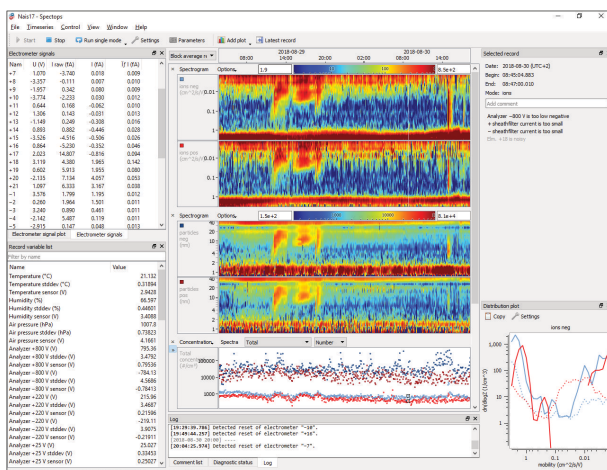
The Retrospect program allows to easily view the measured data files, reprocess the data or export it in another format.



The principal air flow schematic of the NAIS



The schematic of one of the two parallel differential mobility analyzers



The NAIS measurement and data processing software

## Specifications

<b>Name</b>	Neutral cluster and Air Ion Spectrometer (NAIS)
<b>Model</b>	103.5
<b>Ion Measurement Range</b>	3.2 to 0.0013 cm <sup>2</sup> /V/s, positive and negative polarity (0.8 to 40 nm size equivalent)
<b>Particle Measurement Range</b>	~2 to 40 nm
<b>Measurement Principle</b>	parallel differential mobility analysis with software controlled unipolar corona charging
<b>Sample Flow Rate</b>	54 l/min total, 27 l/min per polarity
<b>Time Resolution</b>	1 second
<b>Operating Temperature</b>	–20 to 40 °C
<b>Sample Air Pressure Range</b>	300 to 1200 hPa
<b>Consumables</b>	None
<b>Servicing Interval</b>	Up to 3 months
<b>Power Requirement</b>	70 W, AC 110/240 V
<b>Interface</b>	RJ45 (Ethernet), LAN or direct
<b>Software</b>	Spectops software for data acquisition and on-line processing, Retrospect software for data review and reprocessing Supports Microsoft Windows 7 or newer and Linux
<b>Dimensions</b>	L 580 mm, W 305 mm, H 810 mm
<b>Weight</b>	60 kg

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