GRASP

CATALOGUE

AirPhoton Instruments

GRASP AIRPHOTON IN-SITU INSTRUMENTS CATALOGUE
FOR GROUND BASED AND AIRCRAFT MEASUREMENTS

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Content

AirPhoton

AirPhoton Inc. is a small Maryland based company which opened in 2012. We design and manufacture instruments to measure airborne particulates. Our goal is to provide high-end instruments that can be used by those who study human exposure to pollution and to provide data to understand aerosol effects on climate change.

As scientists who have been working with remote sensing and in-situ instruments since the 90's, we understand the needs of other scientists and strive to maximize the information content provided by our instruments.

We manufacture optics basesd instruments for real time measurements and filter based instruments for later restropective analysis. Our instruments have been deployed globally by the SPARTAN-Network, NASA's MAIA mission and a host of research institutes.

In the summer of 2022 AirPhoton merged with GRASP-SAS, a French company which launched in 2015. GRASP has developed a data platform which is used to create aerosol, cloud and surface property data products for satellite sensors. It is widely used by several space agencies in Europe.

Our goal for the new company, GRASP-Earth is to create an organization that can integrate space and ground observations along with models to advance our monitoring and understanding of Earth's atmosphere.

We use GRASP with our in-situ optical instruments to allow us to maximize their information content and to create advanced products. We are developing a companion catalog for our space products and services.

We are also using GRASP in innovative ways to synergistically combine data from various instruments to create data products which go beyond current offerings. These include: In-situ instruments with satellite data; satellite data from multiple platforms; and data from different types of in-situ instruments

This catalogue presents our in-situ instruments which can be used for ground-based and aircraft measurements. Our instruments have unique features that our competitors do not offer and which you will see on the following pages.

If you have a question or a suggestion for an application or a new instrument please reach out. Innovation is a collaborative process that is enriched by many minds.

Mr. Richard Kleidman
AirPhoton's Chief Marketing Officer
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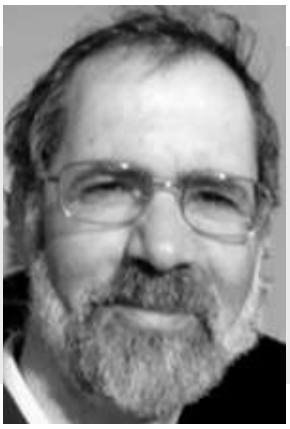


Richard Kleidman
CMO

Richard Kleidman, AirPhoton's CEO, co-developed NASA's international training program. With 30 years of experience in teaching, training, and communicating science and technology, he also boasts 25 years in algorithm development for satellite retrievals.

John Hall
COO

John Hall, AirPhoton's COO, holds a Bachelor of Science in Mechanical Engineering. With 14 years of experience in engineering design and manufacturing, he is also a certified AERMOD Gaussian air dispersion modeler.

Vanderlei Martins
CTO

Vanderlei Martins, CTO, is Director of the UMBC Earth Space Institute and Professor of Physics. He led the HARP 3U cubesat launch in 2019 and is the principal investigator for the HARP2 polarimeter on NASA's PACE mission.

Lorraine Remer
CEO

Lorraine Remer, CSO, led NASA's aerosol product development team from 1998-2012. With 30 years of experience in Remote Sensing and satellite-based science and management, she is also a Fellow of the American Geophysical Union.

In-situ instrumentation

We develop ground-based in-situ instrumentation made by scientists for scientists. Our collection includes instrumentation such as Nephelometers and Filter Stations.

Laboratory instrumentation

Our instruments are suitable for laboratory use as well as in-field deployment. Our Polar Imaging Nephelometer is a very high-grade instrument intended for laboratory or aircraft use.

Custom instrumentation

Our team have skills and experience in developing custom instrumentation and/or measurement solutions for difficult problems. In this regard, we also can provide consulting and training services.

Aircraft instrumentation

Many of our instruments can be modified for deployment in aircraft. Such was the example of the AirPhoton FIREFlly, a system for forest fire identifications.

Satellite Products and Services

We also have developed and launched GAPMAP instrument, a cubesat for spaceborne particulate measurements. Our team works currently on an instrument for greenhouse gas detection.

GRASP+AirPhoton synergistic developments

The GRASP platform provides a distinctive advantage in instrument data analysis by enabling the creation of advanced data products. This platform excels in integrating data from various in-situ instruments, enhancing the richness and accuracy of the results. Furthermore, GRASP can seamlessly combine in-situ data with satellite observations, bridging the gap between ground-based and space-based measurements.

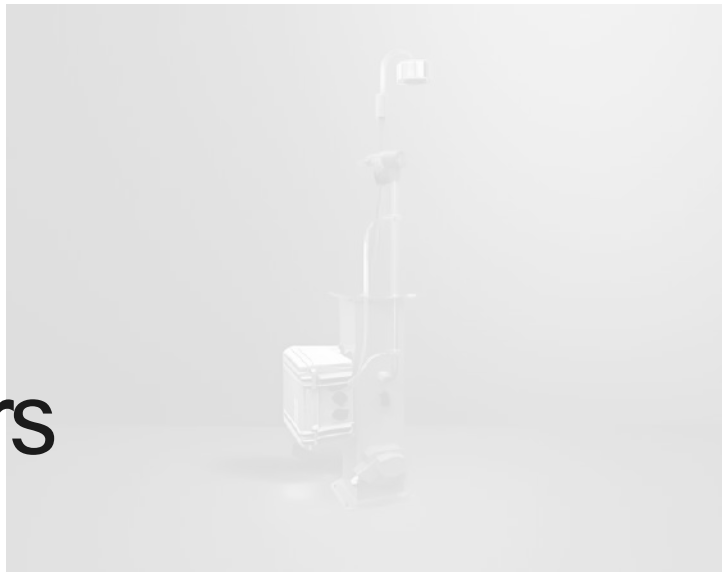
This integration extends to merging data from multiple satellite platforms, offering a comprehensive view that leverages the strengths of each data source. These capabilities significantly improve the ability to monitor and analyze complex environmental phenomena, leading to more informed and accurate scientific conclusions.

Air Quality and Exposure Sciences

As part of AirPhoton's strategy to enhance our offerings, we are currently advancing research in Air Quality and Exposure Sciences. This development broadens our expertise into new areas, including public data modeling and Machine Learning.

By incorporating these cutting-edge technologies, we can significantly enhance the capabilities of our instruments. Public data modeling allows us to better understand and predict air quality trends, while Machine Learning enables more sophisticated data analysis and interpretation. These innovations position AirPhoton at the forefront of the field, providing more comprehensive and precise tools for environmental monitoring and analysis.

AirPhoton Nephelometers



Integrating Nephelometers

AirPhoton Nephelometers provide real-time measurements of aerosol optical properties. We achieve a high degree of sensitivity due to a large angular range and design features which minimize stray light. We produce several different models of nephelometers. Our more advanced models allow for data collection at multiple size cuts.

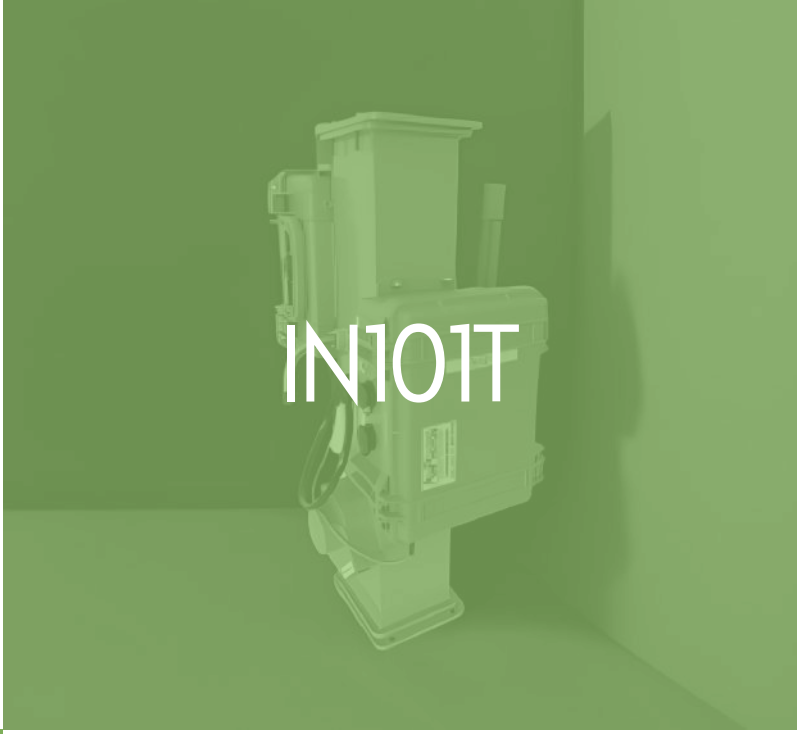
All of them are weather hardend for field deployment and can operate over a large range of heat and humidity. They are deployed globally by both the SPARTAN network and NASA's MAIA mission.

The different models are described in the following pages. All models can be used with our communications module allowing for internet or cell network control and monitoring of the instrument.

Also note that our philosophy is to collect and measure particles under ambient conditions. We can, at additional cost and upon request, provide a nafion tube system to dry the aerosols.

When combined with the GRASP retrieval algorithm, our nephelometers provide a wealth of information beyond what is possible with a standard nephelometer – e.g. retrieving aerosol size distribution, concentration or refractive index –.

The AirPhoton IN101T is our basic Integrating Nephelometer, designed for essential aerosol measurement tasks. It is generally used for simple operations, such as determining the bulk properties of aerosols, including the overall amount and size distribution of the particles. This instrument is highly valued for its accuracy and reliability, providing essential data for environmental monitoring and research.



IN101T

IN102

The IN102 introduces a cyclone inlet to allow for sampling particles in a specific size range. We carefully monitor and adjust the instrument flow rate. In combination with the cyclone inlet, this allows us to measure particles separately at PM2.5 and PM10, the sizes most critical for air quality studies. This capability significantly enhances our precision and effectiveness in environmental monitoring and research applications.

AirPhoton IN102X is the extended version of the IN102. It adds an additional capability to collect particles down to a PM1 size bin. Combined with the GRASP retrieval, this allows us to determine the particulate size distribution, making this model unique for scientific research. The enhanced capabilities of the IN102X provide researchers with more detailed and precise data, which is crucial for advanced environmental studies and air quality assessments.

IN102X

IN101T | AirPhoton Basic Integrating Turbo Nephelometer

Our basic nephelometer designed for robust operation under a wide range of conditions. While its rugged design allows for field deployment, it is also a highly sensitive instrument which can be used in the laboratory or modified for use in aircraft. In this regard, the IN101T is highly versatile and can work in different environments and for different purposes.

Capabiltieis

- Forward and Back Scatter measurements
- Three wavelenghts
- High Speed fan

Suggested use

Measurements of all particle sizes at normal ambient conditions as well as for situations where higher pressure intake is required – i.e. high altitudes, clean condition or long inlet tubes.

Specifications

- Dimensions: 9'' x 10'' x 24”
- Mass: 6.7 Kg
- Operating temperature: -30 to +45oC
- Wavelengths: 450, 532, and 632 nm
- Angular range: 7° to 90° ; 90° to 170°
- Full scattering = forward + back scattering
- Standard range: 0.0-3,000Mm-1
- Extended range: 20,000Mm-1 (upon request)
- Lower detectable limit:
  <0.15 Mm-1 (60 sec AVG)
  < 0.06 Mm-1 for Backscattering (60 sec AVG)
- Time resolution: 15 sec standard – 1 sec minimum
- Sensitivity: < 0.1 Mm – 1

- Clean air reference option provides automatic zero for span calibration
- Data Interfaces: 4GB SD card (possible up to 32GB), RS 485, and USB

IN102 | AirPhoton Size Scanning Nephelometer

The IN102 nephelometer is a highly accurate instrument built to rugged standards that allows for field deployment under a wide range of conditions. Using a cyclone inlet and our feedback flow control system, it can collect and analyze particles in multiple size ranges (PM2.5 and PM10) making this especially useful for air quality studies.

Capabilities

- Forward and Back Scatter measurements
- Three wavelenghts
- High Speed fan
- Feedback Flow control system
- Multiple Size Cuts

Suggested use

High precision measurements for various size cut-offs under all conditions for air quality and health and climate applications.

Specifications

- Dimensions: 9'' x 10'' x 24”
- Mass: 6.8 Kg
- Operating temperature: -30 to +45oC
- Wavelengths: 450, 532, and 632 nm
- Angular range: 7° to 90° ; 90° to 170°
- Full scattering = forward + back scattering
- Standard range: 0.0-3,000Mm-1
- Extended range: 20,000Mm-1 (upon request)
- Lower detectable limit:
  <0.15 Mm-1 (at 60 sec AVG)
  < 0.06 Mm-1 for Backscattering (60 sec AVG)
- Time resolution: 15 sec standard - 1 sec minimum
- Sensitivity: < 0.1 Mm - 1

- Clean air reference option provides automatic zero for span calibration
- Data Interfaces: 4GB SD card (possible up to 32GB), RS 485, and USB

IN102X | AirPhoton Extended Range Size Scanning Nephelometer

Dual pressure taps in inlet to provide accurate flow monitoring

The IN102X extended range nephelometer is built to the same standards as our IN102 instrument. In addition, it has the capability to extend its measurement range down to a separate size bin for PM1. The additional data range allows us to derive a full optical particle size distribution in about 30 - 40 minutes.

Capabilities

- Forward and Back Scatter measurements
- Three wavelenghts
- High Speed fan
- Feedback Flow control system
- Multiple Size Cuts
- Determines Size distribution

Suggested use

High precision measurements for various aerodynamic size cut-offs under all conditions for air quality & health and climate applications with ability to obtain size distribution.

Specifications

- Dimensions: 9'' x 10'' x 24”
- Mass: 6.8 Kg
- Operating temperature: -30 to +45oC
- Wavelengths: 450, 532, and 632 nm
- Angular range: 7 to 90o ; 90 to1 70o
- Full scattering = forward + back scattering
- Standard range: 0.0-3,000Mm-1
- Extended range: 20,000Mm-1 (upon request)
- Lower detectable limit:
  <0.15 Mm-1 (at 60 sec AVG)
  < 0.06 Mm-1 for Backscattering (60 sec AVG)
- Time resolution: 15 sec standard - 1 sec minimum
- Sensitivity: < 0.1 Mm - 1
- Intensity: < 0.01 mM -1

- Clean air reference option provides automatic zero for span calibration
- Data Interfaces: 4GB SD card (possible up to 32GB), RS 485, and USB

CR100 | AirPhoton Clean Air Reference System CRM100 system

CR100 clean air referencce module

The clean air reference module comes as a standard reference add-on for all of our nephelometers. This allows for on the fly zero calibration of the instrument. The user can determine how often to collect the reference data. We generally recommend once per day..

Summary of capabilities

		Forward & Back Scatter Measurement	Three Wavelenghts	High Speed Fan	Feedback flow control system	Multiple Size Cuts	Determine Size Distribution
IN101T	Measurements of all particle sizes at normal ambient conditions as well as for situations where higher pressure intake is required.	●	●	●			
IN102	High precision measurements for various size cut-offs under all conditions for air quality & health and climate applications.	●	●	●	●	●	
IN102X	High precision measurements for various aerodynamic size cut-offs under all conditions for air quality & climate applications with ability to obtain size distribution.	●	●	●	●	●	●

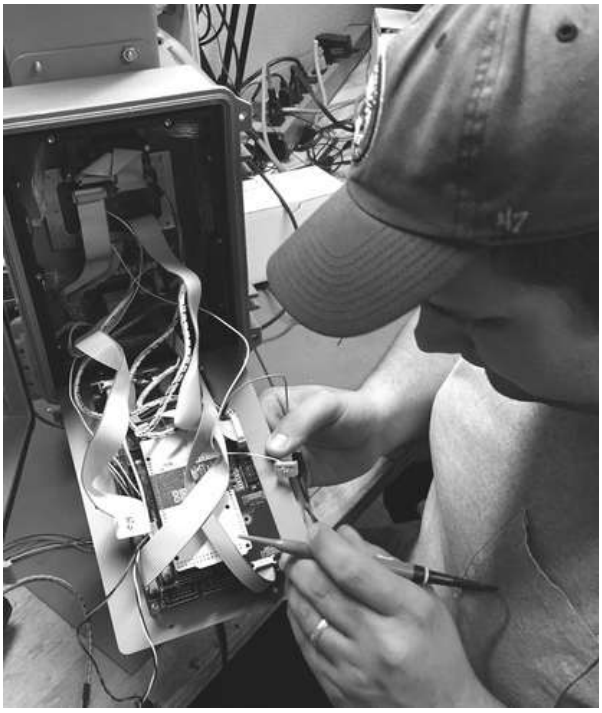
IMAP | AirPhoton Inverse Multi-Angle Polarimeter

The IMAP (Inverse Multi-Angular Polarimeter with Polarization) Nephelometer measures polarized scattered light at multiple angles and at multiple wavelengths.

As with our other instruments, we use our feedback flow control system to collect data at multiple size cuts ranging from PM1 to PM10. Owing to the small size of the sampling chamber and the overall efficiency of the system, this allows us to determine a full optical particle size distribution every minute.

This advanced instrument collects a huge amount of data thanks to its cutting-edge technology: 3 wavelengths x 8 angles x 2 polarization orientations x 4 aerodynamic size cuts. We highly suggest using IMAP for an in-depth understanding of particulate properties. Given its unique combination of aerodynamic and optical sizing, it can be used to effectively connect satellite and ground-based measurements for comprehensive air quality research.

To manage all of this detailed information, we use the GRASP data retrieval algorithm which allows us to accurately determine: particle mass, size distribution scattering phase function, polarization phase function, real refractive index of the particles, sphericity factor of the particles.



The IMAP measures polarized scattered light from a laser at 8 discrete angles ranging from 5 to 170 degrees. This is done via a pair of optical fibers positioned at each of these angles. The fibers transmit the scattered light from the sample chamber to a camera module that collects the light for processing and analysis

Capabilities

- Complete size distribution measurement every 5min.
- Particle mass
- Full phase function
- The real refractive index of the particles
- Sphericity factor

Suggested use

We suggest IMAP for in-depth understanding of particulate properties. Given its unique combination of aerodynamic and optical sizing can be used to connect satellite and ground based measurements for air quality research.

Specifications

- Instrument size: 86 cm x 38 cm x 32cm
- Inlet height: 110 cm
- Flow rate: 2 to 16 LPM (Alaric AE102-2)
- Data: Saved to internal hard drive. Real-time access via Ethernet, RS2323 and RS485.
- Calibration: Built-in clean reference cycle.
- Gas calibration: CO2 and clean air every 3-6 months depending on operating conditions.
- Power: Mains AC power. 120 or 240-Volt systems (50 and 60Hz). 600 W maximum load. A 5-Amp circuit breaker is included that also acts as the on-off switch.
- Time resolution: 1 min averaging (recommended); 15 sec averaging (minimum).
- Angular ranges measured: 8 View angles centered at 5° (unpol.), 10.6°, 31.8°, 52.9°, 95.3°, 116.5°, 137.6°, 158.8°.
- Instantaneous field of view < 7.5°.
- Wavelengths: (3) 450 nm, 520 nm and 638 nm.
- Polarization orientations: 2 Parallel and perpendicular to the scattering plane.
- Size measurements: Independent optical and aerodynamic size measurements.
    - Aerodynamic: 4 Size bins selected up to PM10 (possible every 5min)
    - Optical: Continuous function from 0.05 to 15um (possible every 1 min)

PI Neph | AirPhoton Polar Integrating Nephelometer

The Polar Imaging Nephelometer is a high grade laboratory instrument designed for an in-depth understating of particulate properties. It provides a full particle characterization including the size distribution and the complex refractive index from hyperangle scattering measurements.

Amongst its capabilities, the PI-Neph includes: measuring light scattering from 5° to 175°, angular resolution of less than 1°, standard configuration is 2 wavelengths, customizable for 1 – 3 wavelengths, polarization.

GRASP software included package contributes to the retrieval of parameters such as size distribution, percent sphericity or complex refractive index. In addition, it can provide an overview of the multi-source retrieval capabilities of the algorithm and suggest exploring further analysis.

The fact that the PI Neph brings so much capabilities also makes it more complex to use. In this regard, the learning curve to get to most of his capabilities are accompanied with an extensive instruments training. In sum, the instrument will not only provide a deeper understanding on particulate matter but also will introduce trainees to GRASP software capabilities.

The Polar-Imaging Nephelometer has been employed for the following published uses in research:

1. Ability to measure aerosol light scattering in real-time from aircraft.
2. Retrieval of size distribution and composition dependent optical constants.
3. Provide real-time in-situ information about particle morphology.
4. Classification of aerosols by type such as dust, biomass burning urban/industrial and biogenic aerosols.

Specifications

- Operational temperature: 5 to 40°C
- Wavelengths: Up to 3 in the range of 400-680 nm
- Polarization: P11 and P12 measurements. Other stokes parameters options available
- Angular Range: At least 100 angles from 5-175°
- Range: 0.0 to >20000 Mm-1
- Lower detectable limit: < 1 Mm -1 for phase function measurements
- Programmable flow rate: Available
- Flow range: 2 to 20 lpm & Optional
- Particle size selection: Optional cycling up to 4 cut off sizes
- External pump option: Available
- Automatic Zero and Span check: Automatic Zero with clean air system. GRASP software. Included for span calibration
- Light source: Laser
- Dimensions: 200*100*50cm
- Weight: < 30 Kg
- Storage memory: Internal SSD hard drive
- Data Transfer: USB, Ethernet, wifi
- Environmentally rugged: For Indoor or Aircraft Use

Capabilities

- Size Distribution retrieval.
- Determines sphericity.
- Measures complex refractive index.
- Full particle characterization from hyper-angle scattering measurements.
- Measures light scattering (5°-175°).
- Angular resolution of < 1°
- Standard configuration: 2 visible wavelengths (customizable for 1-3 wavelengths).
- GRASP™ software analysis package included.

Suggested use

For specific scientific research purposes looking for in depth and advanced characterization of particulate properties in laboratory or aircraft settings.

Airphoton Sampling stations

Particulate measurements

AirPhoton has developed a set of filter stations instruments for retrospective analysis of particulate matter. The Aeroexplorer sampling station comes in single and dual inlet models which allow for sequential or simultaneous collection of particulates at two size cuts between PM2.5 and PM10. In conjunction with the real-time measurements from our nephelometers, users can get a complete picture of particulates for air quality.

Additionally, the Aeroexplorer sampling station is highly customizable, accommodating a wide range of research needs. The system components, such as controllers, pumps, inlet boxes, inlet heads, and cartridges, can be configured in various ways to suit specific sampling requirements. This flexibility ensures that users can optimize their setups for accurate and comprehensive particulate matter analysis.

Recently we have developed a new station for collection of trace gas information (see pictures to the right). A variety of gases including ammonia, nitrates and VOCs can be sampled using this instrument. There are four denuders in each instrument which allows us to sample by wind direction. This allows for analysis of source apportionment or fence-line monitoring. This instrument operates at low flow rates which can be supported by solar or battery power so that the instrument can be deployed in remote and or environmentally sensitive areas.

Explorer Model SS5i single inlet

Our sampling station is designed for outdoor use under a variety of harsh environmental conditions. It has several unique features including collection on up to 8 filters. The single inlet model allows for sequential collection of PM2.5 and PM10 on a user programmable schedule. The instrument can be operated on battery or solar power for remote deployment. The instrument can also be configured to separate samples by wind directoin

The Explorer dual inlet model can be configured with two pumps to allow simultaneous collection of PM2.5 and PM10 on separate filters. Like the single inlet model, it is designed for deployment under a variety of harsh condition. For operation under very hot conditions the instrument can be configured with an external air cooled pump enclosure.

Explorer Model SS5i dual inlet

Filter Cartridge Model FC10

Filter Cartridge Model FC10 for sampling stations provides a programmable capability that allows flexibility when designing sampling cycles, moving collection from filter slot to filter slot or turning collection on and off at specified times. A total of 8-slots are available before the filter cartridge must be changed. Filter cartridges are portable and can be prepared in the lab and mailed to the sampling station site.

The Aeroexplorer Sampling Station: Single Inlet System

The Aeroexplorer sampling station is a versatile instrument for collecting particulate matter on filters for later analysis. Particulates can be collected in two sizes typically PM2.5 and PM10 on up to 8 filters on a user programmable scheduled. The instrument has data ports which can be used to communicate with external instruments such as a weather station to enable collection by wind direction or coordination with our nephelometers.

Aeroexplorer Single Inlet Sampling Station

Inlet-box specifciations

- Box dimensions: 12.5″ x 15″ x 9″
- Weight: 6 kg
- Installed height: 40″ but varies per configuration
- Control box option: SS5e, SS5e7-1
- Holds FC10, 8-slot filter cartridge
- Flow rate: 1.5-7 lpm, set to control particle size
- Inlet size cut-off options: PM10, PM4, P2.5, or PM1

Advantages

Autonomous particle sampling. Pump turns on/off and sampling advances to next filter slot, automatically, as function of minutes, hours or days. All directed by operator-initiated programs, input with intuitive button controls or script command uploads.

Control-box specifciations

- Box dimensions: 12.5″ x 18″ x 9″
- Weight: 5.3 kg
- Compatible options: SS5i, SS5i-PMx
- Max flow rate: around 7 lpm standard
- Power inputs: 110/220 VAC 50/60Hz
- Auxiliary power input: nominal 12VDC.
- Solar power compatible.
- User sets sampling protocols with intuitive button commands.
- Controls on/off pump and advance to next filter slot as function of minutes, hours or days.
- Data stored on removable memory cards with automatic backups.

The Aeroexplorer Sampling Station: Dual Inlet System

The Dual Inlet configuration of the sampling station allows for simultaneous collection of particles at two different sizes depending on the choice of inlet size. Shown at left is the instrument configured with two cyclone inlets. The system can also be configured to use mini-impactors for the collection of larger-sized particles. This adaptability ensures precise sampling tailored to diverse research requirements.

Image of the AeroExplorer dual inlet system with two cyclone inlets

Inlet-box specifciations

- Box dimensions: 12.5″ x 15″ x 9″
- Weight: 6 kg
- Installed height: 40″ but varies per configuration
- Control box option: SS5e, SS5e7-1
- Holds FC10, 8-slot filter cartridge
- Flow rate: 1.5-7 lpm, set to control particle size
- Inlet size cut-off options: PM10, PM4, P2.5, or PM1

Advantages

Autonomous particle sampling. Pump turns on/off and sampling advances to next filter slot, automatically, as function of minutes, hours or days. All directed by operator-initiated programs, input with intuitive button controls or script command uploads.

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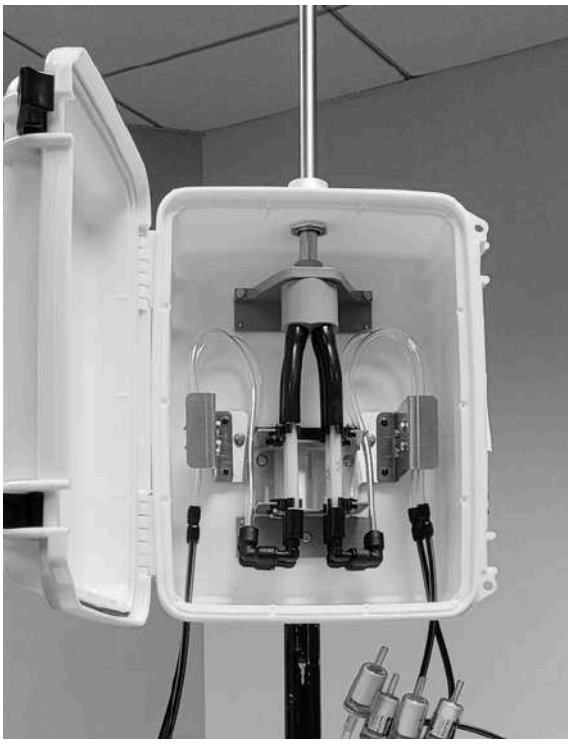
- Controls on/off pump and advance to next filter slot as function of minutes, hours or days.
- Data stored on removable memory cards with automatic backups.

Trace Gas measurements

AirPhoton has recently enhanced its capabilities with a new station designed specifically for trace gas measurements. This advanced instrument can measure a variety of gases, including ammonia, nitrates, and volatile organic compounds. Each gas plays a crucial role in air quality analysis:



Acidic gases such as sulfur dioxide (SO_2), nitrogen oxides (NOx), nitric acid (HNO_3), and hydrogen chloride (HCl).

Basic gases, with ammonia (NH_3) being a primary example, commonly found in agricultural settings and can impact air quality and ecosystem health.

Volatile organic compounds (VOCs), which encompass a wide range of chemicals that can vaporize into the air and are significant both for their health impacts and their role in forming ground-level ozone and secondary organic aerosols.

Reactive gases such as ozone (O_3), a major component of smog. Ozone at ground level is harmful to respiratory health and can damage crops and other vegetation.

Various organic gases, which include a broad spectrum of organic molecules that may originate from both natural sources and human activities. These gases can participate in complex atmospheric reactions and influence air quality and climate.

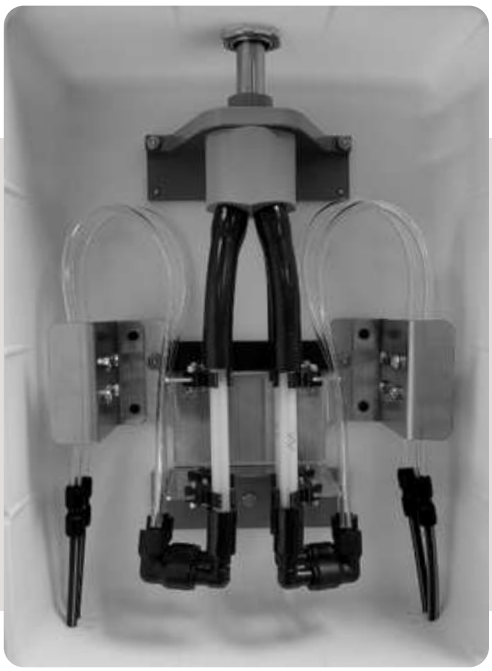


Image of the SS5i box populated with 4 glass denuders

The SS5i instrument can be configured for trace gas sampling as shown at left. The system is populated with 4 glass denuders which can be treated to collect a variety of gases, including VOCs and Various organic gases.

SO_2 NOx HNO_3 HCl NH_3 O_3

Sampling options

When sampling for trace gases the instrument can be configured to sample by time or by wind direction. User can select to upload scripts for either protocol either manually or remotely using our communicatons module which is sold separately.

Above Image of the AeroExplorer Trace Gas sampling system configured for sampling by wind direction

Applications

AirPhoton Partner Networks

AirPhoton Instruments have been deployed globally by the SPARTAN network since its founding in 2012. The network currently comprises 30 instruments world-wide.

In the Spartan Network, AirPhoton Nephelometers and Sampling Stations work in concert with AERONET sun photometers to furnish a rich dataset crucial for understanding air quality dynamics and their impact on human health. Supported by esteemed organizations like NASA and the Clean Air Fund, Spartan represents a collaborative effort aimed at refining satellite remote sensing estimates of PM2.5, thus revolutionizing air quality management globally.

Similarly, in the MAIA Network, AirPhoton's AeroExplorer sampling stations play a pivotal role in ground-level particulate matter collection, contributing essential data for characterizing harmful particulate types. Collaborating with NASA's Jet Propulsion Laboratory (JPL), AirPhoton ensures the seamless integration of ground instruments with satellite data, advancing our understanding of global air pollution dynamics and their implications for public health.

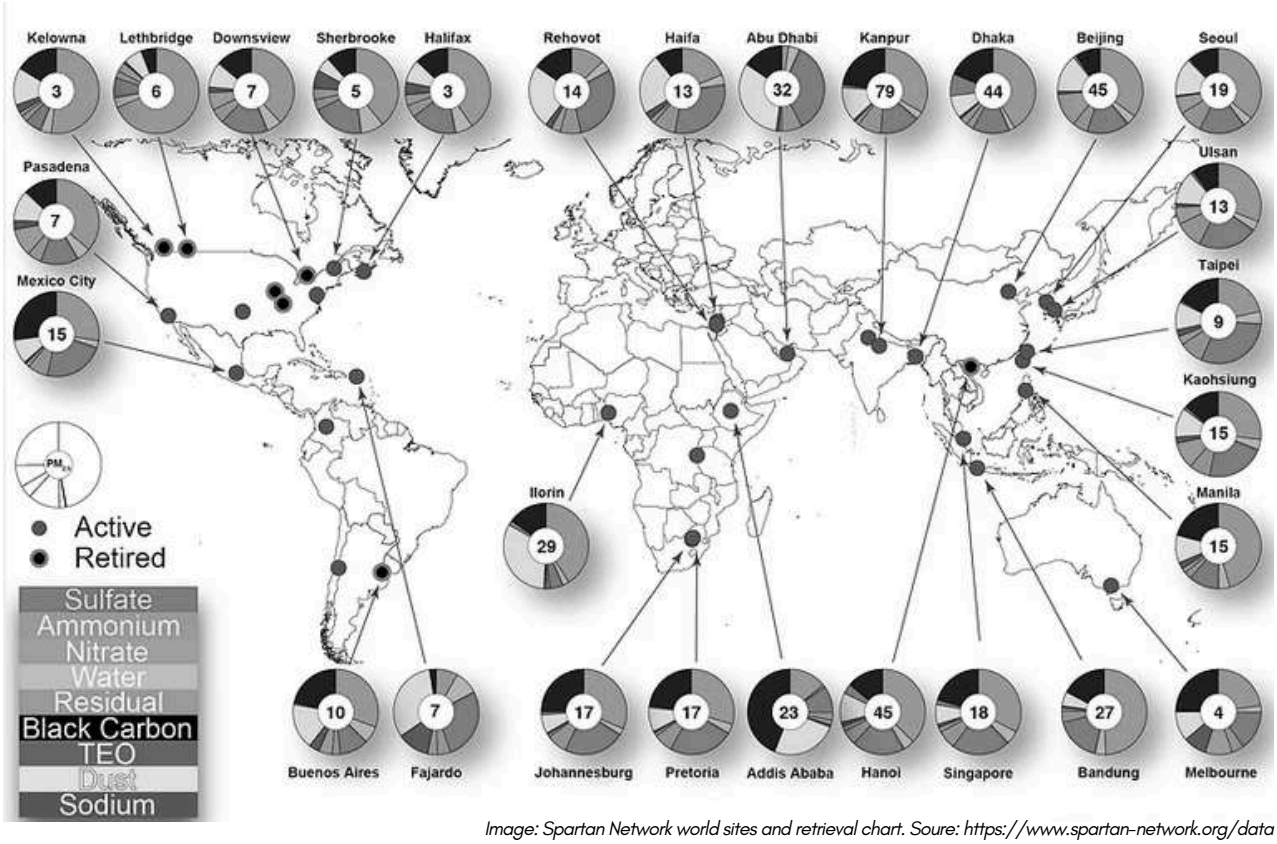


Image: Spartan Network world sites and retrieval chart. Soure: https://www.spartan-network.org/data

Spartan Network

The Spartan Network, a groundbreaking initiative harnessing the prowess of AirPhoton instruments, stands at the forefront of global air quality monitoring efforts. Leveraging AirPhoton Nephelometers and Sampling Stations alongside AERONET sun photometers, Spartan delivers a robust dataset crucial for understanding air quality and its impact on human health. With a primary focus on assessing fine particulate matter (PM2.5), Spartan addresses critical gaps in ground-based observations globally. Supported by prominent entities like NASA and the Clean Air Fund, Spartan embodies a collaborative endeavor aimed at refining satellite remote sensing estimates of PM2.5, thus revolutionizing air quality management and public health initiatives on a global scale, enhancing our capacity for informed decision-making and proactive interventions.

MAIA Network

The MAIA Network, propelled by AirPhoton's cutting-edge AeroExplorer sampling stations, represents a pioneering effort in fine particulate matter (PM2.5) monitoring. Spearheaded by NASA's Jet Propulsion Laboratory (JPL), MAIA revolutionizes our understanding of airborne particulates' impact on human health. With AirPhoton's ground instruments, MAIA provides high-quality data crucial for characterizing hazardous particulate types. By leveraging satellite data alongside atmospheric models, MAIA provides unprecedented insights into global air pollution dynamics. The collaboration ensures the development of remote command modules for seamless communication, thus enhancing MAIA's capabilities in advancing air quality research and mitigating public health risks associated with airborne particulate matter.

GRASP+AirPhoton synergy

The collaboration between AirPhoton Inc. and GRASP has paved the way for an innovative suite of synergistic products that significantly enhance atmospheric monitoring and data analysis capabilities.

Our synergistic approach leverages the strengths of both AirPhoton's precise measurement tools and GRASP's state-of-the-art retrieval capabilities. This integration allows for the comprehensive analysis of aerosol and PM, providing a level of detail and accuracy previously unattainable. For instance, instruments like the PI-Neph, when combined with the GRASP algorithm, have demonstrated exceptional proficiency in retrieving aerosol microphysical properties. These advanced products are invaluable for understanding and mitigating the impacts of air pollution and climate change.

The application of GRASP extends beyond in-situ measurements to include satellite data from multiple platforms, enabling the synthesis of diverse observational data into cohesive and actionable insights. By merging these observations, create comprehensive datasets that offer a more holistic view of atmospheric conditions. This approach effectively monitors pollution episodes like dust storms and biomass burning events, providing detailed, high-accuracy data critical for environmental and health assessments.

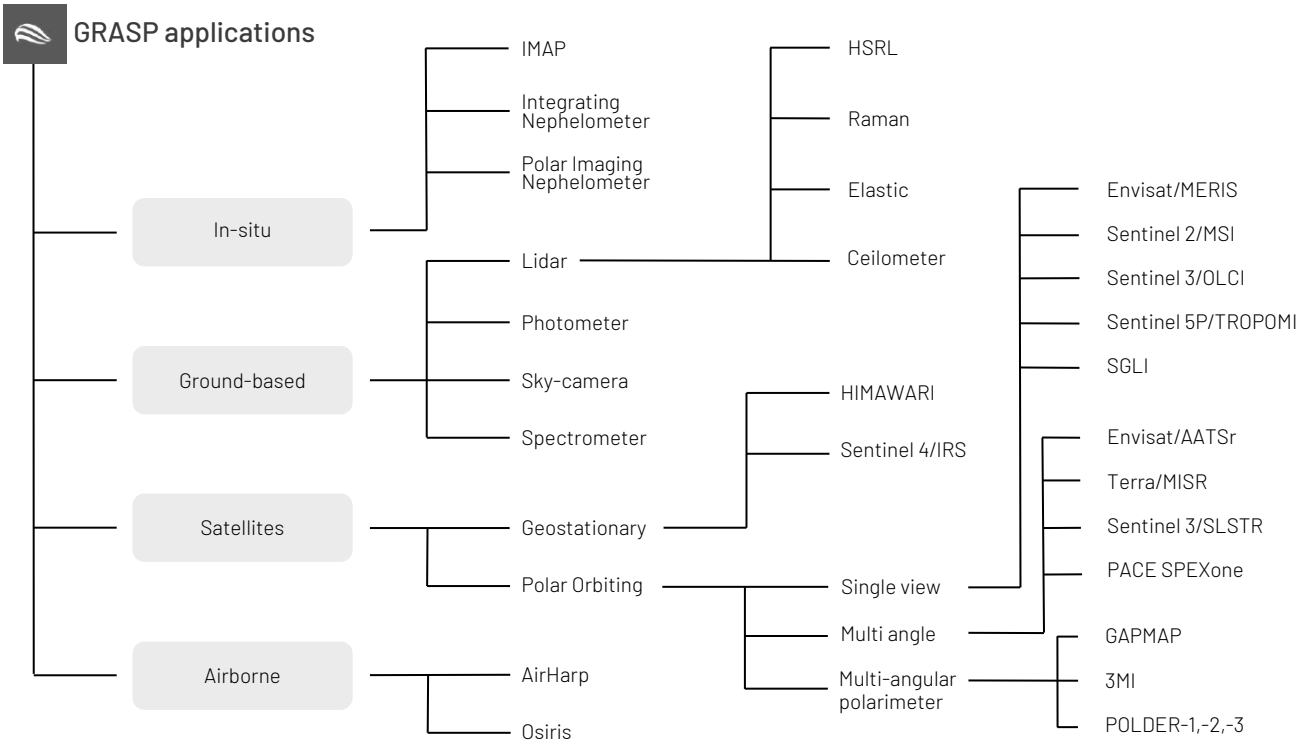


Figure: GRASP algorithm applications schema on different observation instruments

Real measurements vs Synthetic tests: GRASP inversion model

Advanced observations from the Nephelometer, IMAP, and PI-Neph have been integrated into the GRASP algorithm for enhanced aerosol data analysis. This integration includes synthetic tests and real measurements, significantly improving the precision and reliability of our data products.

Int. Nephelometer

IMAP

PI Neph

• Synthetic tests on models such as dust, oceanic, urban, and biomass burning aerosols allow us to introduce random noise into measurements, helping clients and scientists explore the full potential of our observations.

• Real measurements from ground stations during pollution episodes – such as dust storms and biomass burning events – validate our methods under actual conditions. The results demonstrate that the combined instruments and GRASP accurately retrieve aerosol properties like size distribution, refractive index, and sphericity, with low retrieval residuals.

For designing these synthetic tests, GRASP algorithm employs two key modules :

• Forward model, which simulates various remote sensing observations, including those from ground-based and satellite sensors (for nephelometer data, it specifically simulates aerosol single scattering properties).

• Numerical inversion, which employs multi-term least squares fitting to process diverse remote sensing and in-situ observations.

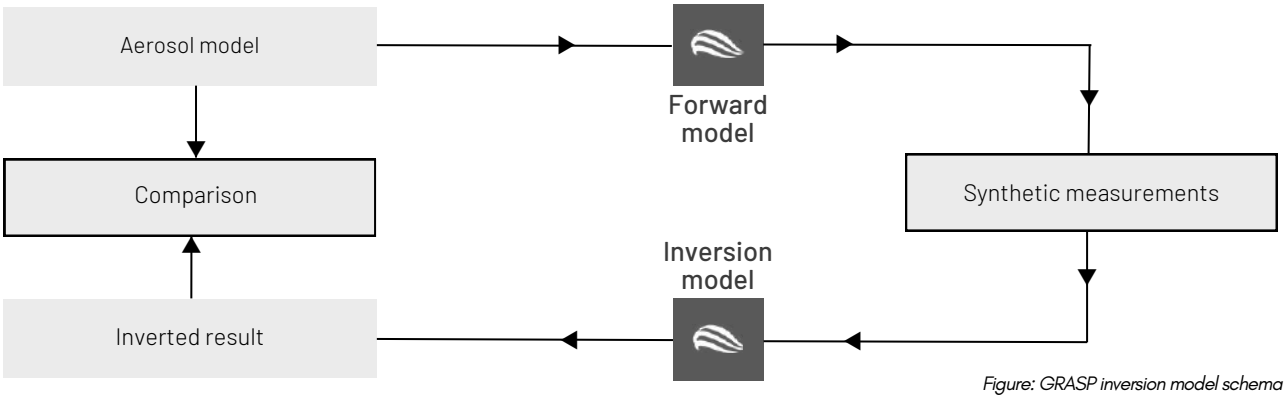


Figure: GRASP inversion model schema

Publications

Spartan Network related publications:

Global sources of fine particulate patter: Interpretation of PM2.5 chemical composition observed by SPARTAN using a global chemical transport Model, Weagle C.L et. al Environ. Sci. Technol. 2018, 52, 20, 11670-11681 https://doi.org/10.1021/acs.est.8b01658

Anthropogenic fugitive, combustion and industrial dust is a significant, underrepresented fine particulate matter source in global atmospheric models Philip, S. et.al Environ. Res. Lett. 12 2017, 044018 doi: https://doi.org/10.1088/1748-9326/aa65a

Variation in global chemical composition of PM2.5: emerging eesults from SPARTAN Snider, G et. al. Atmos. Chem. Phys. 16, 9629-9653, 2016 doi:10.5194/acp-16-9629-2016

SPARTAN: a global network to evaluate and enhance satellite-based estimates of ground-level particulate matter for global health applicationsSnider, G., et al. Atmos. Meas. Tech., 8, 505-521, 2015 , doi:10.5194/amt-8-505-2015

Polar Imaging Nephelometer related publications:

Retrievals of aerosol size distribution,spherical fraction, and complex refractive index from airborne in situ angular light scattering and absorption measurements. Espinosa, W. R.,Vanderlei Martins, J.,Remer, L. A., Dubovik, O.,Lapyonok, T., Fuertes, D., et al. (2019). Journal of Geophysical Research: Atmospheres,124,7997-8024. https://doi.org/10.1029/2018JD030009

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