A new innovative approach for Aerosol Sampling

Aerosol Devices Inc

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주식회사신한기술
Shinhan Technologies Co., Ltd.

Why do we care about aerosols?

- COVID-19 has swept the world by storm
- Pollution is the largest environmental cause of disease and premature deaths
- Diseases caused by pollution were responsible for an estimated 9 million premature deaths in 2015
  - 16% of all deaths worldwide
  - three times more deaths than from AIDS, tuberculosis, and malaria combined

Issues with traditional Aerosol Samplers

Low Sampling / extraction efficiency

Tedious manual sample handling

Sample dilution = low analysis sensitivity

Risk of contamination

Low microorganism viability

Time resolved sampling is difficult

Particle bounce

High steam temperature alters particle's chemistry

Limited to soluble or solids, not both

No regulatory standards for sampling bioaerosols!

SASS 3100
Dry Air Sampler

SASS 3010
Particle Extractor

Sampling Viable Bioaerosols

Viable organisms inactivated by the sampling method

- Desiccation
- Mechanical stress
- Thermal shock

A New Approach for Sampling Aerosols for Biological Analysis

SPOT SAMPLER™-BC
Bioaerosol Particle Collector

- ✓ High collection efficiency
- ✓ Concentrated sample
- ✓ Time-resolved sampling
- ✓ Maintains viability
- ✓ Instant genomic-DNA/RNA preservation

BioSpot-VIVAS™
Bioaerosol Sampler

Patented technology with exclusive license from Aerosol Dynamics Inc.

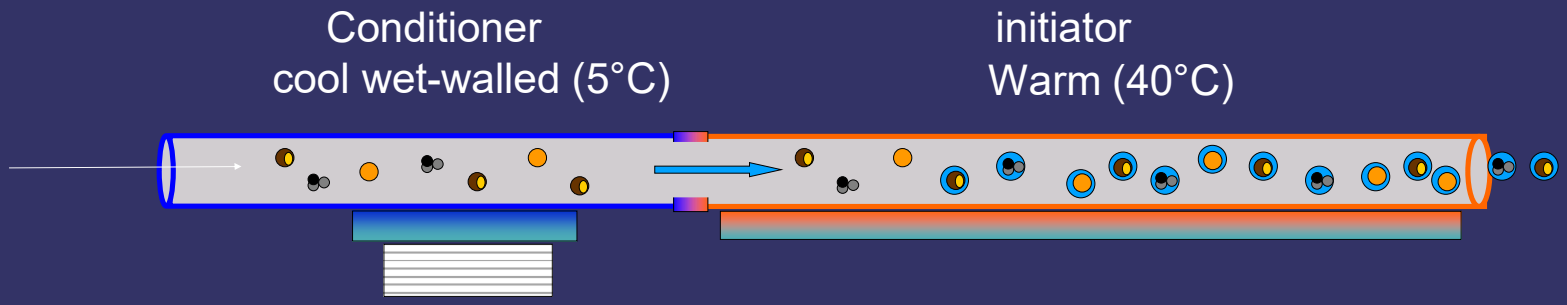
Brief History
Water-based Condensation Particle Growth

First systems:
mix steam into airstream, then cool

- Maze Collector (Simon and Dasgupta, 1995)
- Steam-jet Collector (Khlystov et al, 1995)
- Particle-in-Liquid Sampler (Weber et al, 2001)

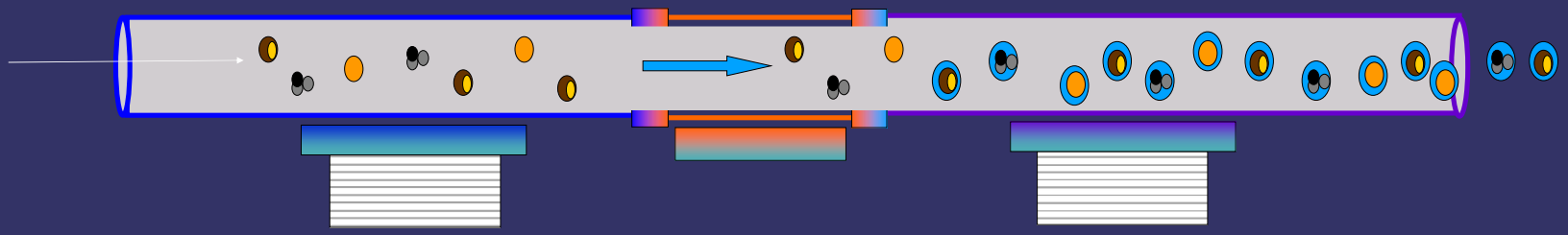
These methods subject the sample to high temperatures

In 2003, S. Hering (Aerosol Dynamics Inc.) introduced the technology that allows particle growth through laminar flow water condensation



A. Eiguren-Fernandez et al., presented at RICTA 2015, the 3rd Iberian Meeting on Aerosol Science and Technology in Elche, Spain, June 29-July 1, 2015.

Condensation Growth Tube = CGT



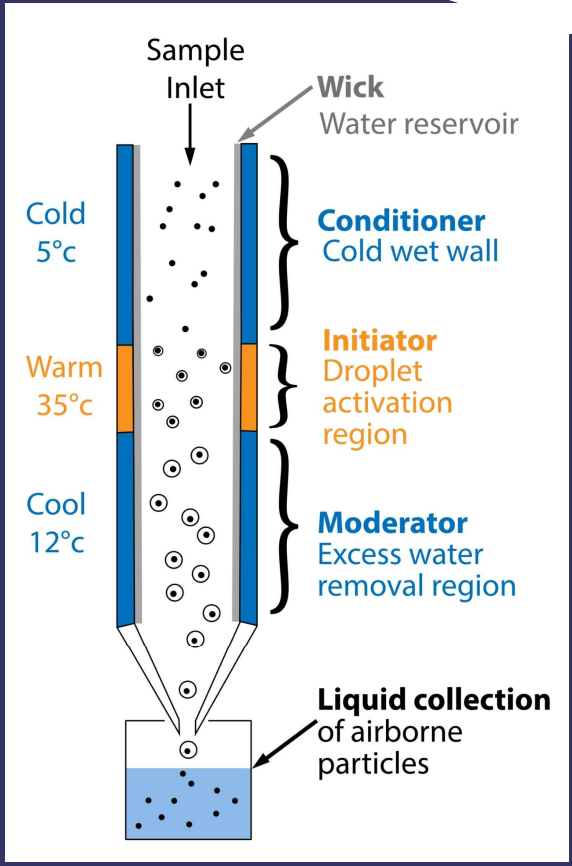
Conditioner (5º C)

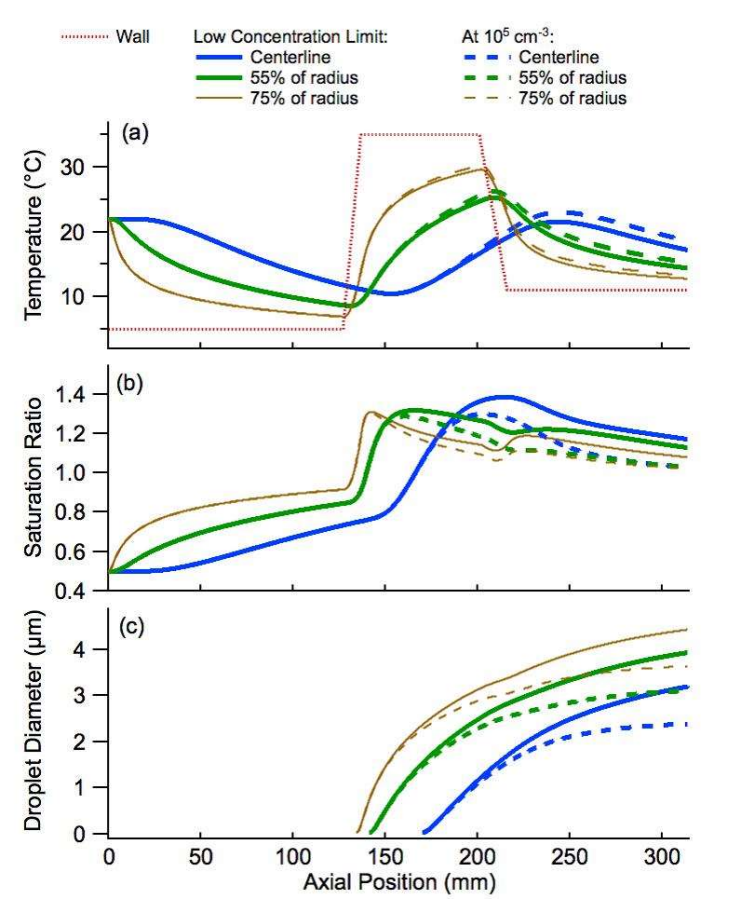
Initiator (35º C)

Moderator (8º-12º C)

Eiguren-Fernandez et al., presented at RICTA 2015, the 3rd Iberian Meeting on Aerosol Science and Technology in Elche, Spain, June 29-July 1, 2015.
Susanne V. Hering , Steven R. Spielman & Gregory S. Lewis, *Aerosol Science and Technology*, 48:4, 401-408: 2014.

Condensation Growth Tube (CGT) Capture





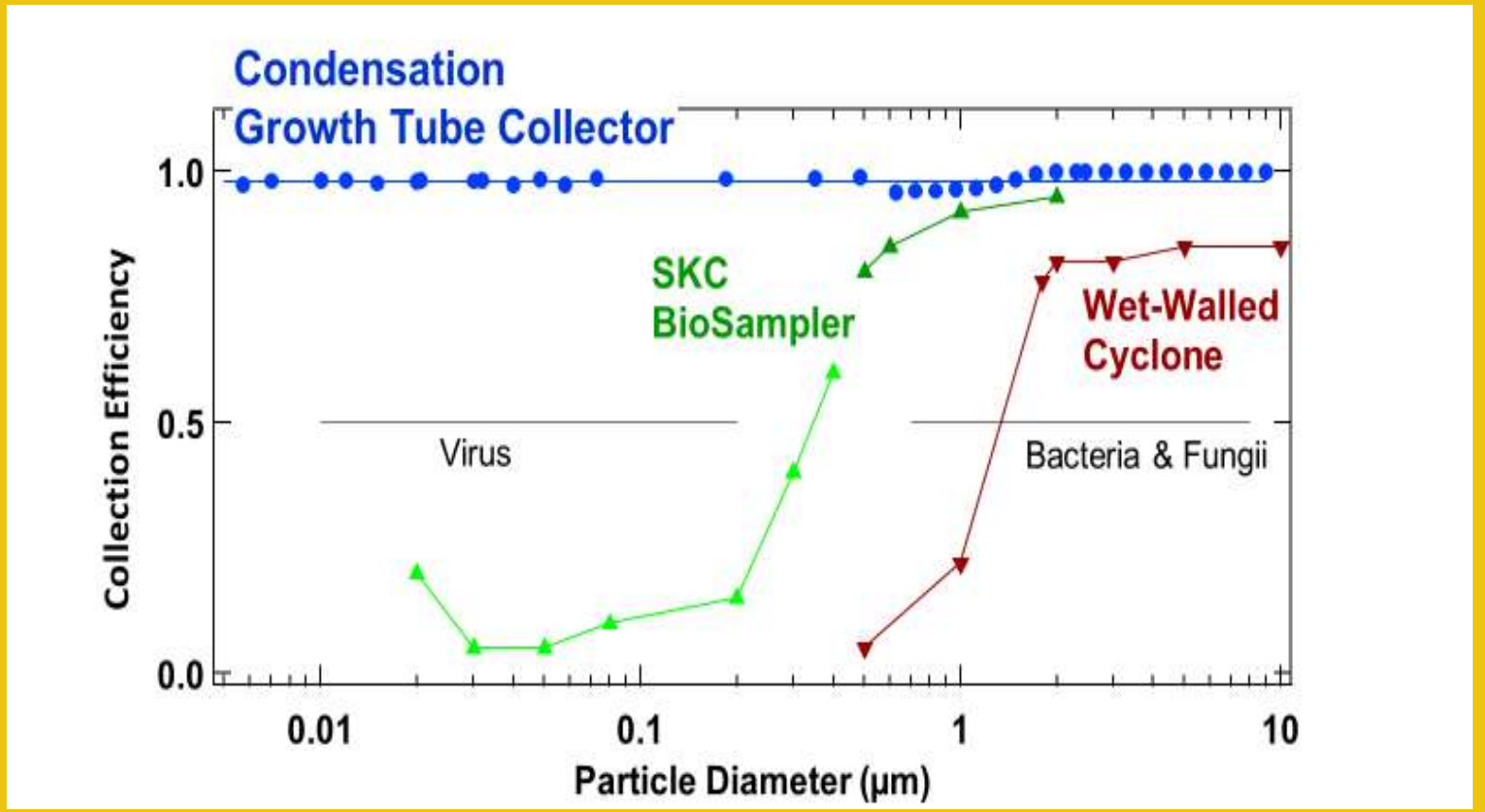
Moderate sample flow temperatures never exceed 30 ℃. Exit flow temperature <18 ℃; dew-point < 20 ℃.

Super-saturation levels of 120-140% activate condensation growth on particles as small as 5 nm.

Droplets grown to nominal 3µm diameter are easily captured by bounce-free, soft inertial impaction on to a solid surface or into liquid

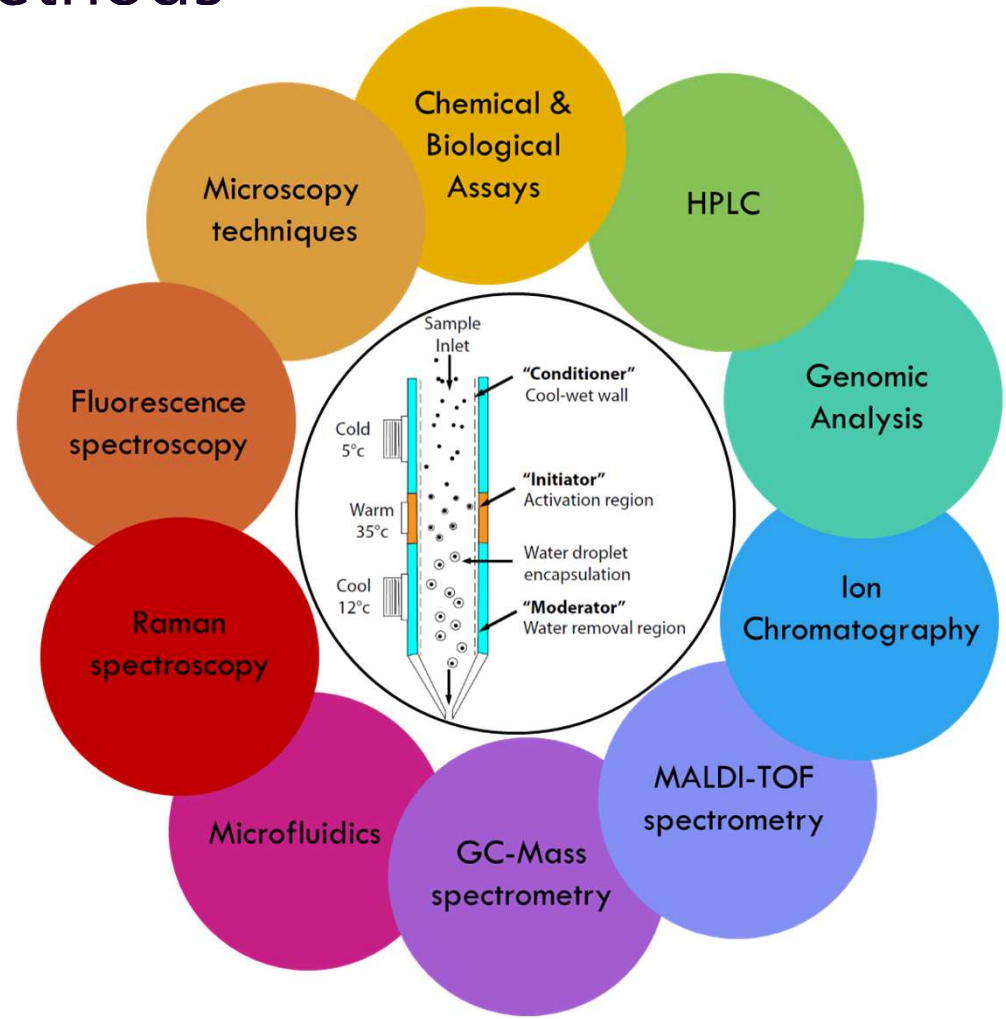
Hering, et. al. (2014) *Aerosol Science & Technology* 48:401-408.

Growth Tube - Efficient over all Particle Sizes



Data for wet-walled cyclone from McFarland et al (2010); BioSampler data from Hogan et al (2005) and Willeke et al. (1998).

Analysis methods



Aerosol Devices Product Range

The 110A Spot Sampler™ aerosol particle collector and bioaerosol collector

The BioSpot VIVAS™ BSS310 bioaerosol collector

Industrial grade bioaerosol collector

The MAGIC™ 210 CPC

The nanoSpotLight™ 410 particle collector

The Spot Sampler

Versatile:
Collect particle into liquid or as a dry deposit

Concentrated:
Increased analysis sensitivity (LOD/LOQ)

High Efficiency:
>95% for particles 5nm – 10µm diameter

Productivity:
Labor savings in analysis; collection plates/vials can be cleaned and re-used; no expensive water source

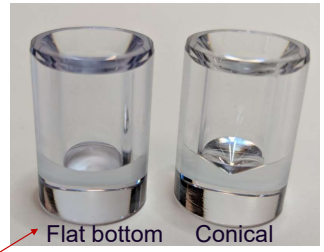
Sample Quality:
Maintain sample integrity and microorganism viability

Time Resolved:
Uninterrupted, time-resolved in a dry multi-well plate

Automated:
Interface with an autosampler

Collection into Liquid with the Spot Sampler™

Vial options, 675 µL



- Concentrated suspensions (~500 µL)
- Changeable collection medium: water, culture media, virus growth medium
- Ready for chemical, toxicological, and virus viability analysis

A. Eiguren-Fernandez et al., presented at RICTA 2015, the 3rd Iberian Meeting on Aerosol Science and Technology in Elche, Spain, June 29-July 1, 2015.

Dry collection with Spot Sampler ™

- Uninterrupted collection of concentrated spots (1-mm) in a 33-well disk
- Time-resolved collection: minutes up to hours
- No bouncing artifact
- Automated extraction and injection for analysis (i.e., IC, HPLC)

Samples ready for analysis using Spot Sampler

Standard Method:

24 hour integrated filter sample

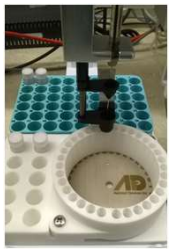
Tedious, inefficient, manual extraction of particulate matter; filter artifacts

Dilute sample in large liquid volume > 2 mL

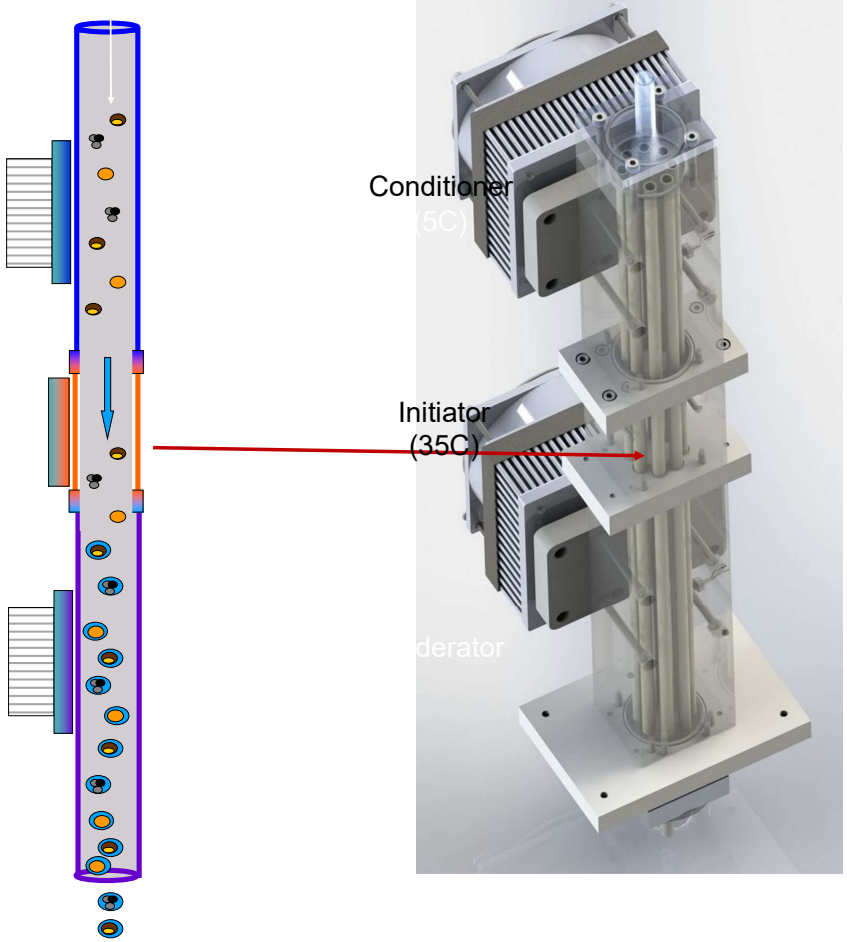
OR…..

30+ time-resolved, pre-concentrated samples on one chemically compatible sample

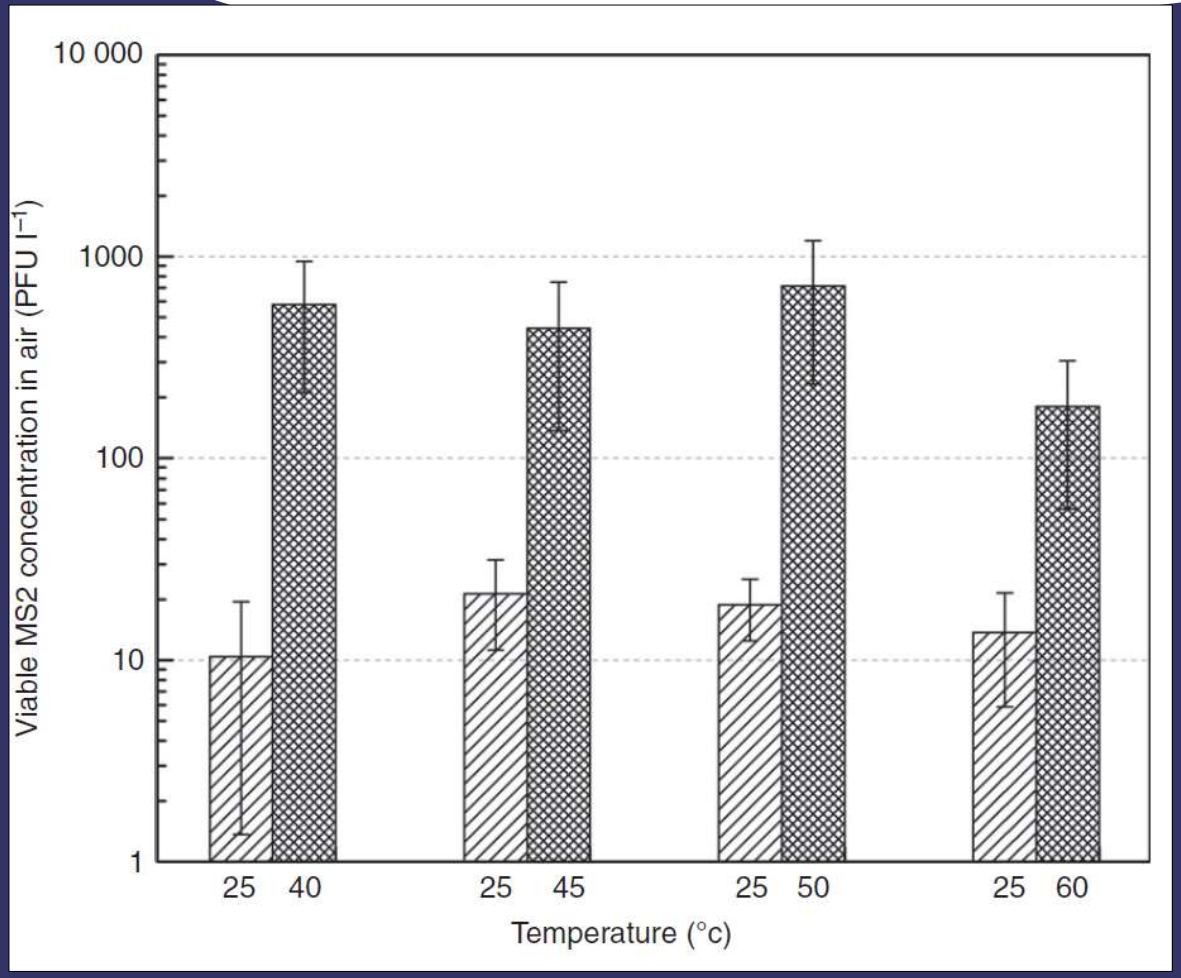
Samples concentrated in 75 µL extraction solvent; use autosampler for sample prep, extraction & small volume injection



BioSpot 310™ bioaerosol particle collector - 8 L/min



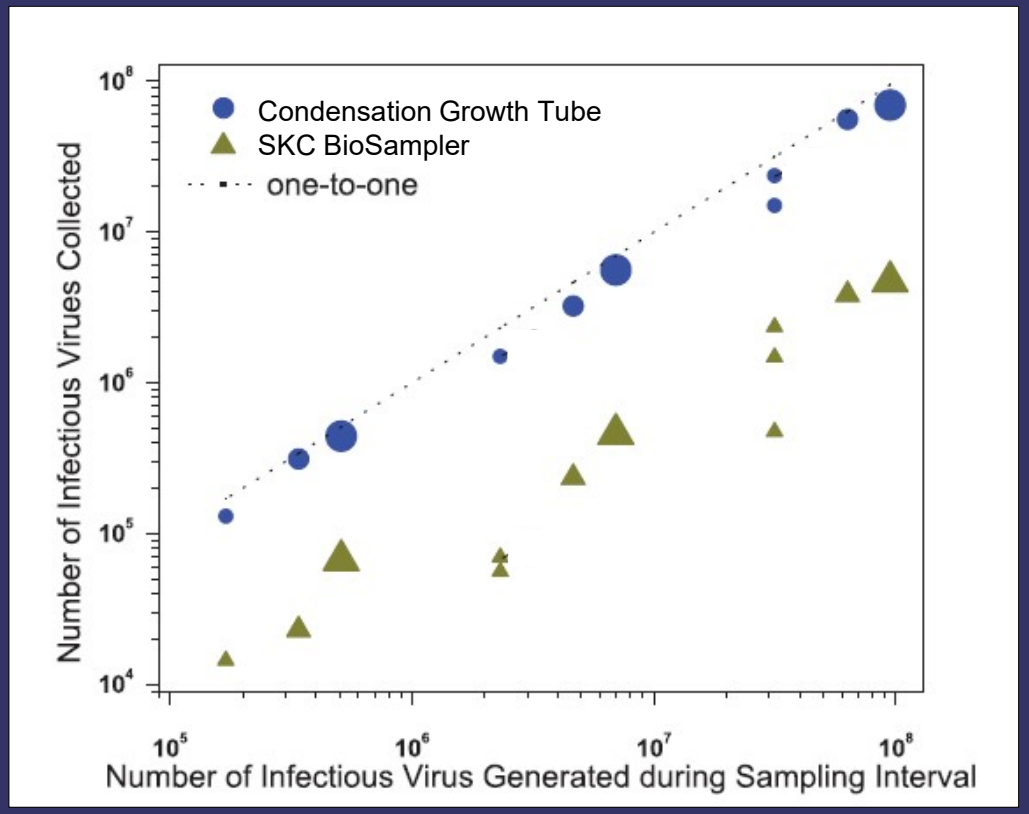
Collection of MS2 virus aerosol



M. Pan et al., Journal of Applied Microbiology; 120, 805-815: 2016.

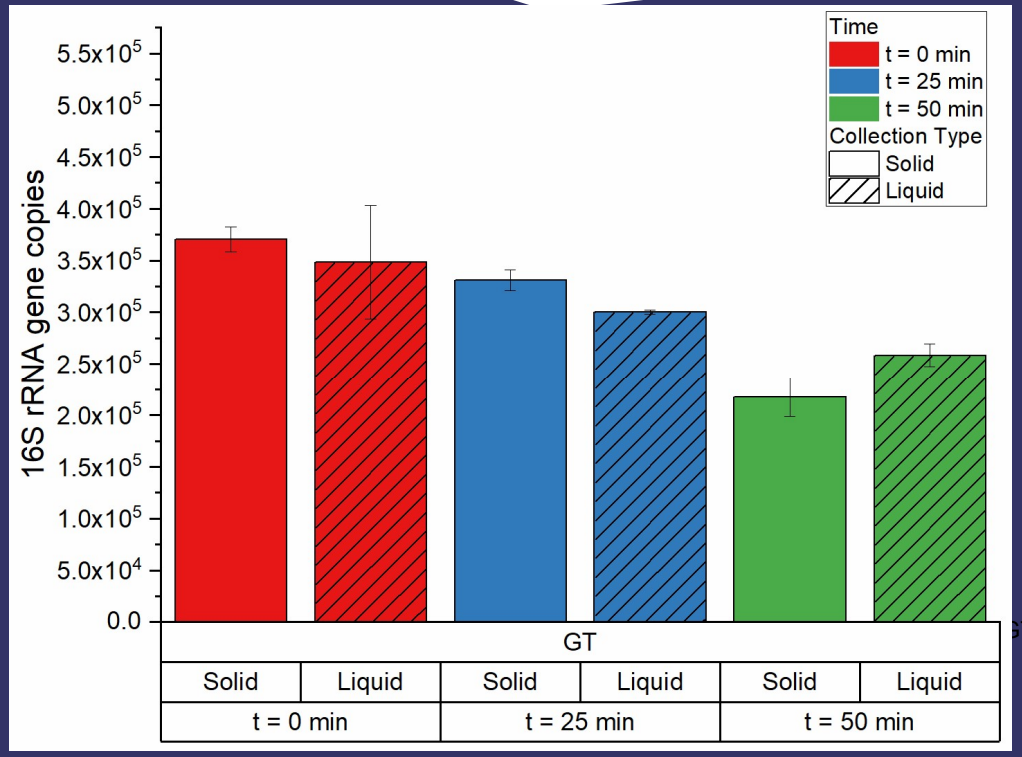
- Condensation Growth Tube
- SKC BioSampler

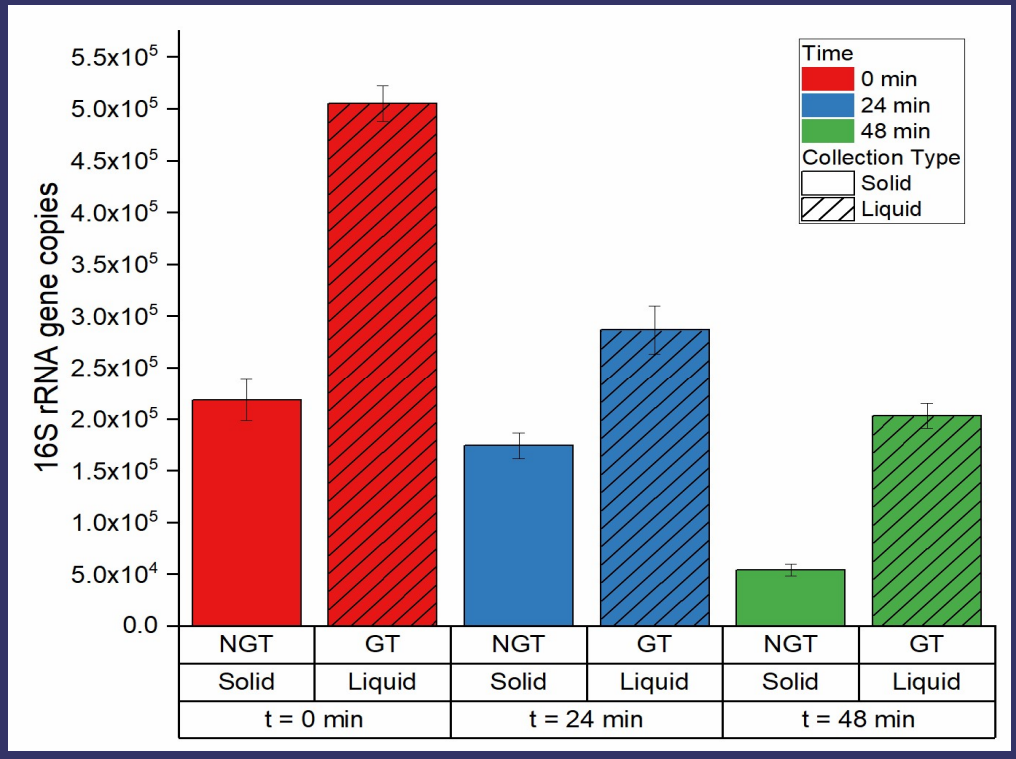
Collection of infectious *viable* influenza H1N1 virus aerosol



J. Lednicky et al., Aerosol Science and Technology, 50:7: 2016.

High Fidelity Recovery of Airborne Microbial Genetic Condensation Capture into Genomic Preservative





Condensation Growth Tube = CGT

No Condensation Growth Tube = NCGT

M. Nieto Caballero et al., 2019, High Fidelity Recovery of Airborne Microbial Genetic Materials by Direct Condensation Capture into Genomic Preservatives. Journal Microbiological Methods. Submitted Nov. 2018 and Under Review.

Application:

Scripps Institution of Oceanography, University of California - San Diego

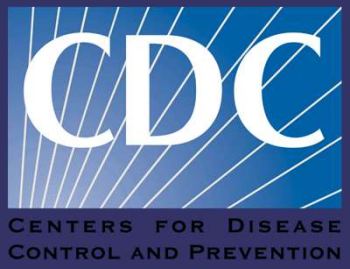
The Spot Sampler on the top deck of the RV Sally Ride while in port in San Diego

RV Sally Ride

The Spot Sampler and aerodynamic particle sizer split the flow and the space inside the housing, while out at sea

Liquid Spot Sampler™ particle collector was been employed to detect enzymes in aerosol along California coastline.

Some of our Researchers….



New Product

- Collects and concentrates airborne particles on an ‘easy-to-analyze’ swab with pre-set sample timing.
- Can be moved from room to room, providing in-the-moment sampling of hard-to-reach areas and blind spots.
- Quiet when running - suitable for offices, schools, hospitals, and nursing homes.
- Swab samples easily transported at room temperature to a lab for high-quality genomic analysis (e.g., RT-qPCR, RNA/DNA sequencing), or analyzed on site with rapid POC detection.

The BioSpot-GEM™ Sampler

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The BioSpot-GEM™ Sampler

End User: Researcher

Sampled air from musical instruments for coronavirus; aerosol sampling for indoor microbiome research

Decision maker

End user; Grant and client funded

Meet Shelly
University Professor, Environmental Engineering

Key Drivers:

- Low cost, quiet, high sample volume
- Test analysis results within 24 hours
- Sample quality

End User: IH/IAQ/Environmental Consultant

Tested efficacy of engineering controls designed to reduce coronavirus exposures in hospitals

Decision maker

End user; Client funded

Key Drivers:

- Sample virus for infectivity
- Multiple samplers, small footprint, portable

Meet David,

Director of large IAQ/CIH consulting company

Critical partner: DNA/RNA lab analysis

Samples are transported to lab for routine genomic analysis of virus presence, sequencing

Partner, Recommender
Possible buyer (rent product to consultants)

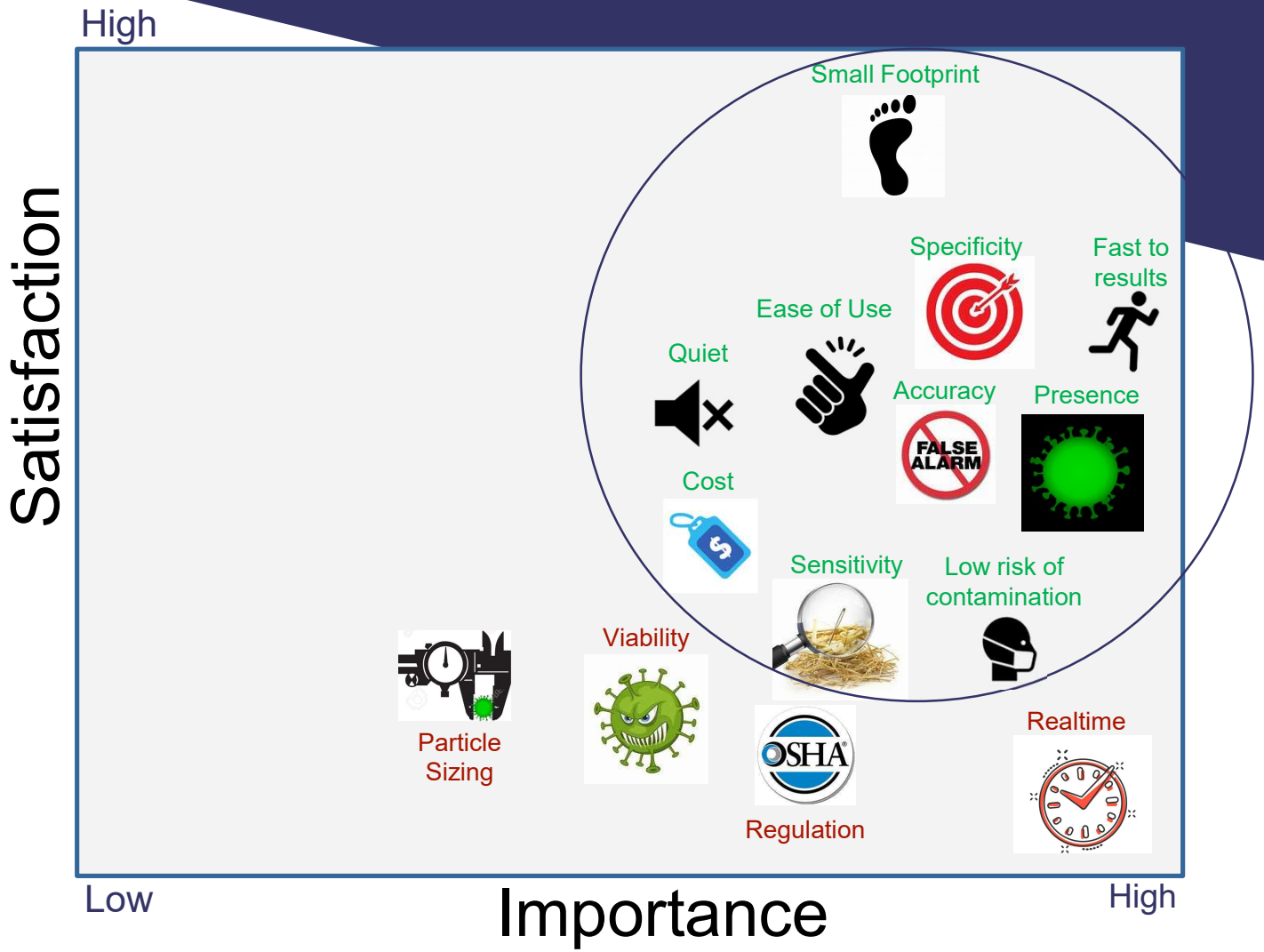
Key Drivers:

- Integrity, quality of samples
- Ease of transport
- Method to routinely analyze in lab

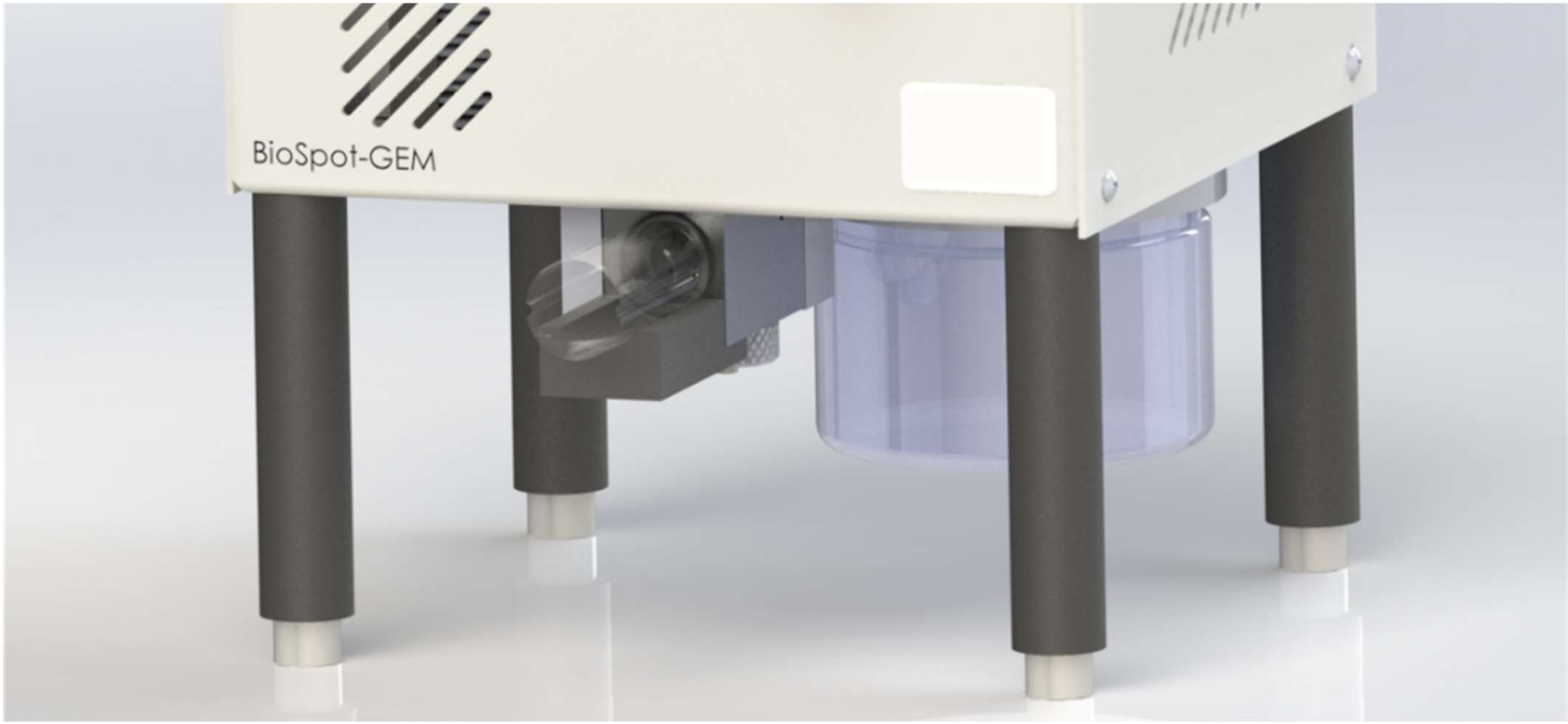
Meet Sergey

Lab Director at large commercial analysis lab

Minimum Viable Product Requirements



Announcing the BSS302 BioSpot-GEM Bioaerosol Sampler



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The BioSpot-GEM™ Sampler

Aerosol Devices Proprietary

Key specifications

- High quality particle sampling onto a **swab**
- Collects **10nm-10um particle size** with equal effectiveness
- Concentrated (**0-10^5 particles/cm^3**) ,efficient **(>95% efficiency),** contamination-free collection
- Small, lightweight and quiet operation (**10lbs**)
- Samples directly onto stabilizer (patent pending) for **instant DNA/RNA preservation**
- 2 presets for time collection, up to **24 hours**: fast auto warm-up
- Can be used for collection of **virus, bacteria, fungal spores, toxins, proteins, allergens**

Includes Sampling Kit for 8 samples
(fits inside instrument bag)

Genomic preservative with pipettes

Sterile Swabs, with vials

Disposable water collection jar for excess (extracted) sample water

Water supply pouch for wetting the wick

Water syringe

+Lab transfer shipping box

List of Consumables

- Sterile Swabs
- Swab vials
- Genomic preservative
- Disposable Collection pot/lid preloaded with Absorbent beads
- Replacement wicks
- Water supply pouch
- Lab transfer container
- Placed in a presentation box