Removing of ultrafine particles

“Når HEPA filtre ikke er nok. Hvordan rense luften for ultrafine partikler? “

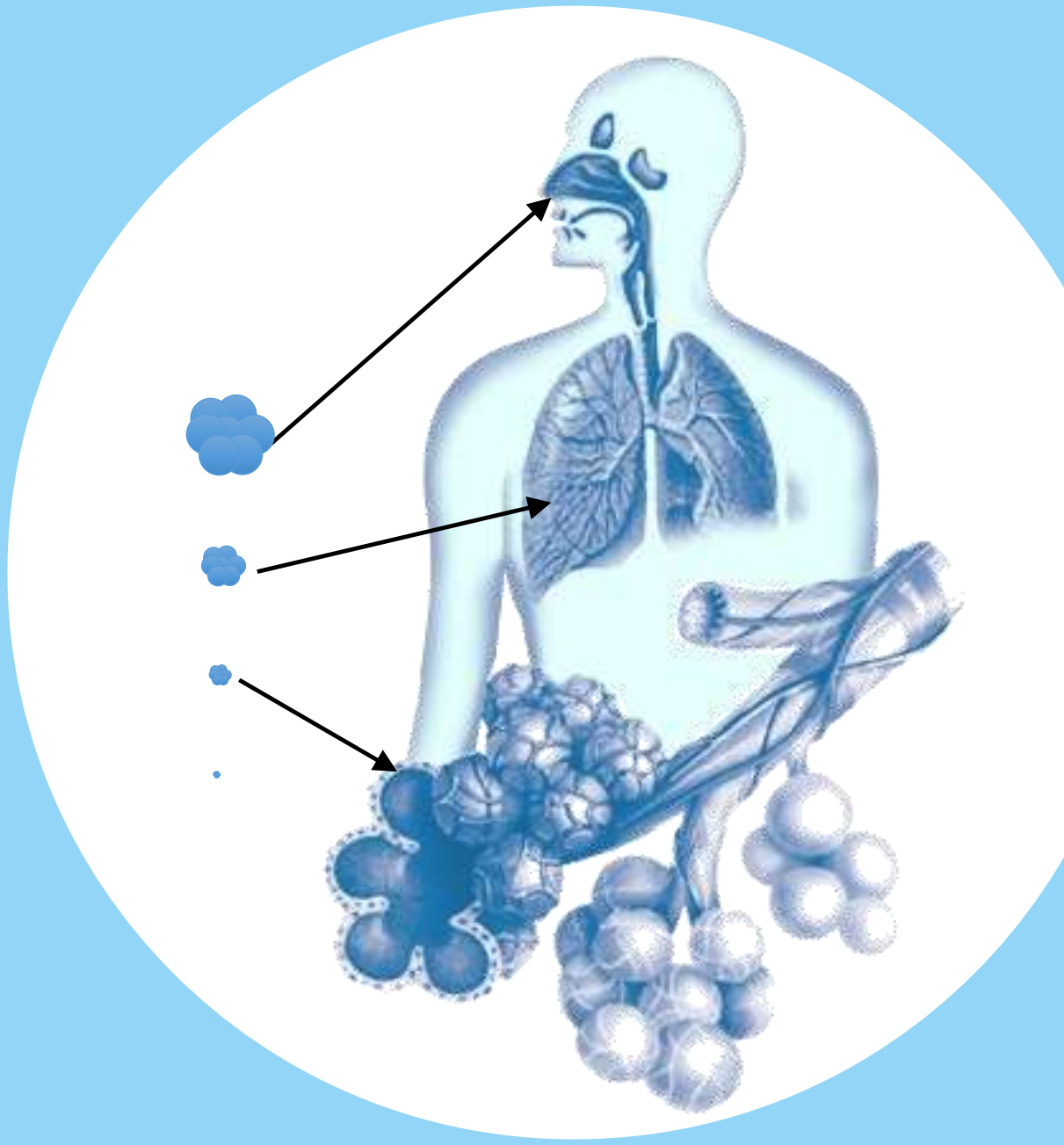
Peter Christiansen
Genano Ltd

Sandnes 12 June 2019

Genano
WHEN EVERY BREATH MATTERS.

PARTICLE PENETRATION

- **Large particles** are mostly captured by mucous membranes of nose and throat
- **Inhalable particles** < 10 µm (called PM_{10}) can enter the lungs
- **Fine particles** < 2,5 µm (called $PM_{2.5}$) can penetrate into alveoles
- **Ultrafine particles** < 0,1 µm (100 nm) can be absorbed directly into bloodstream and are the most dangerous ones, according to WHO

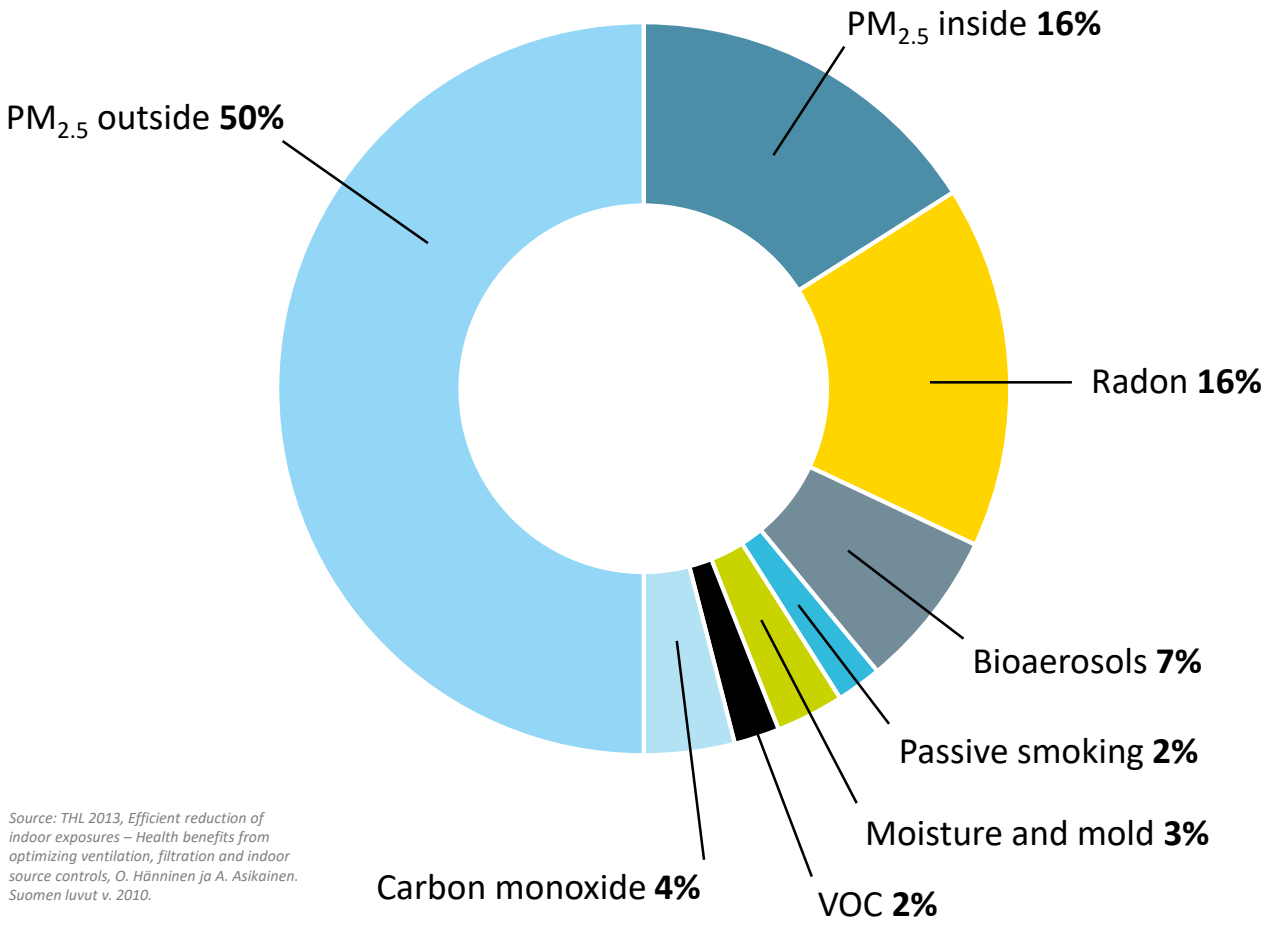


Why clean air matters for all of us

- We all inhale ~10000 liters of air every day
  - We can stay without water for 1 day
  - We can stay without food for 3-5 days
  - We can stay without air less than a minute – only few of us can choose what air they breathe
- The world is more polluted than ever
  - Emission control
  - CO2 pattern & energy consumption
- We spend more than 90% of our time inside
  - Sick buildings, mold, VOCs
  - Preventing bad air from outside to come in
- HAI is a global problem
  - Cost is billions of $ annually for the communities
  - Save lives!
- New technologies require cleaner environments
  - Nanotechnology
  - DNA & Biotech & pharma
  - Electronics, MEMS, optics

Genano

Air is the fuel for humans – what in it makes us sick?



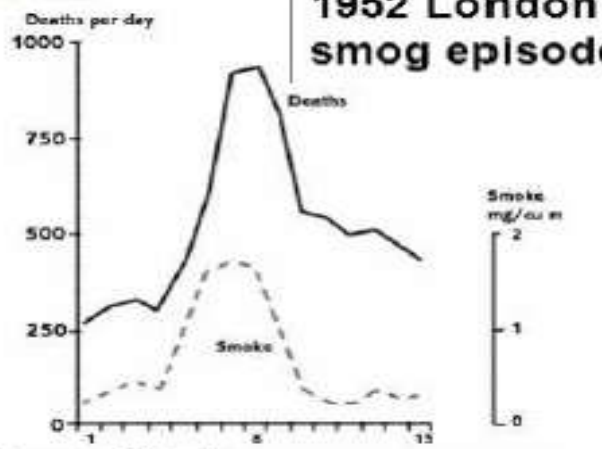
Source: THL 2013, Efficient reduction of indoor exposures – Health benefits from optimizing ventilation, filtration and indoor source controls, O. Hänninen ja A. Asikainen. Suomen luvut v. 2010.

Air quality: Health effects

- Strong correlation between fine particles and health effects
  - Premature death of people with heart or lung disease
  - Nonfatal heart attacks
  - Irregular heartbeat
  - Asthma
  - Decreased lung function
  - Increased respiratory symptoms, such as irritation of the airways, coughing or difficulty with breathing

Figure 1: Death rate with concentrations of smoke

1952 London smog episode



Source: Met Office, UK

2019: premature deaths / year
- **8.8 million globally**
- **790 000 in Europe**
- **4000 in Finland**

Source: European Heart Journal 2019

PM 2.5 exposure is estimated to be globally 9th strongest risk factor in total of all risks for mortality and loss of healthy years of life
There is no reported safe lower limit of the risk in terms of exposure

Source: WHO Global Health Risk Factors 2015

Genano
WHEN EVERY BREATH MATTERS.

Finnish high technology since 1960

1999 FOUNDED IN FINLAND

+5000 MANUFACTURED AIR PURIFIERS

> 50% OF FINNISH MUNICIPALITIES ARE OUR CUSTOMERS

Internationally patented NANOTECHNOLOGY

DESIGN FROM FINLAND

TEHTY SUOMESSA MADE IN FINLAND

OPERATIONS IN OVER **30** COUNTRIES

Kaupunki

Voiko opettajia homeongelma kantelivat sisäi oikeusasiamiehelle

Homekorjaukset usein turhia - on ihan muualla

en sisäilmaongelmat eivät aina joh
osteuden yhdessä synnyttämästä 2
liyhdisteestä. Sanc
mukaan jopa kolm

klo 07:28 | päivitetty 18.12.

Kotimaa

Homeesta tuli miljardiluokan ongelma – HS selvitti, paljonko maailmalla on sisäilmaongelmia ja miten niihin suhtaudutaan

Homeesta on tullut Suomessa miljardiluokan ongelma. HS kysyi asiantuntijoilta, onko maailmalla sisäilmaongelmia lainkaan vai onko niihin muualla vain totuttu.

Etusivu › Pohjois-Suomi › Hirrestä tehty hotelli- ja toimistorakennu

Hirrestä tehty hot oimistorakennus

LAPIN UUTISET 20.08. 21.06 Päivitetty 21.08. 11.46

Savo Julkaistu 20.10.2017 07:15

Julkulan sairaalassa ja Kuopion psykiatrian keskuksessa vakavat sisäilmaongelmat

Poikkijoen päiväkoti Sodankylässä kärsii sisäilmaongelmista – moduuleista koottu rakennus on ollut käytössä kuusi vuotta

LAPIN UUTISET 16.08. 18.00

PAULA HAKALA

JAA: 866

vuodesta 1986

Emmaljunga

STOKKE

muharjoitukset
e Puljujärven huonon
stian Aho mykisti
ähden: "Ota
eäsi niskasta kiinni"

Vastasyntyneiden teholla vaikea sisäilmaongelma

virastotalon työntekijät
ityistie- ja silmäoireista

t tiedossa
. Erityisen

Kotimaa Julkaistu 27.08.2018 15:37

Kuhmoisten yhtenäiskoulun luokkia v – rakenteista löytyi kosteutta

Kuhmoisten yhtenäiskoululla on havaittu kosteusongelma. Kunta sai työterveyslääkärin lausunnon mittausten tuloksista maanantaina. Ruokalan käytävällä sijaitsevista luokista siirrytään nyt väistöti

Rovaniemen virastotalo on jaettu yhteensä 1
mutta osassa talotekniikka on auttamatta jäänyt ajasta jälkeen. Osa rakennuksesta on valmistunut 1950-luvulla ja osa 1980-luvulla.

Oulun tragedia vei yhtäkkiä terveyd kymmeniltä poliiseilta, myös Timo Mälliseltä – tapaus kiteyttää kaiken miksi sisäilmaongelmia ei saada Suomessa kuriin

Oulun poliisilaitoksella yli sata poliisia sai oireita ja 22 astr muutamassa kuukaudessa. Tämä kiinnosti vain kahta lää

Sisäilmaongelmat 3.7.2018 klo 06:30 | päivitetty 3.7.2018 klo 15:59

dustiassa

Genano
WHEN EVERY BREATH MATTERS.

Only 3% of indoor air problems are caused by mould.

Available standards

ISO 16000-34 & 37
indoor air measurement

Work of ISO Technical Committee ISO/TC 146, Air quality, Subcommittee SC 6, Indoor air

- Indoor air — Part 34: General strategies for the measurement of airborne particles
- Indoor air — Part 37: Measurement of PM2,5 mass concentration

What is good indoor climate - particles

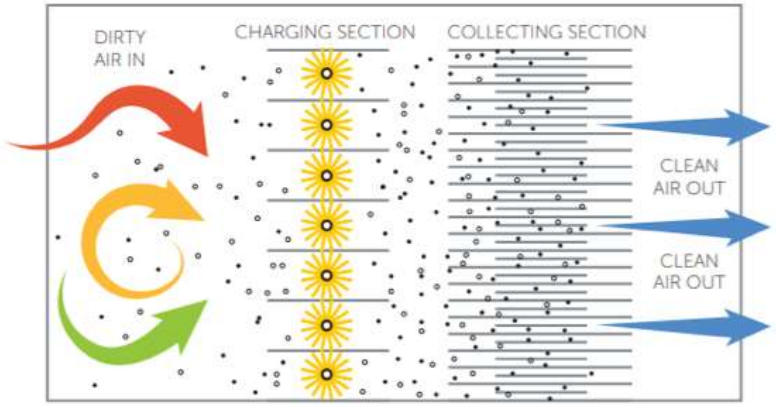
Table A.1 — Empirical values for particle concentration ranges of the fractions PM_{10}, $PM_{2,5}$ and ultrafine particles[11][25]

Indoor situation	Measured particle fraction	Empirical values of typical concentration ranges in Germany	Concentration depends in particular on
Presence and general activities of persons			
Dwellings	PM_{10}	(30 to 80) µg/m³	Number of persons present in the room and respective activity
	$PM_{2,5}$	(10 to 40) µg/m³	
Schools, day nurseries	PM_{10}	(40 to 150) µg/m³	
	$PM_{2,5}$	(10 to 40) µg/m³	
Offices	PM_{10}	(20 to 60) µg/m³	
	$PM_{2,5}$	(10 to 40) µg/m³	
Specific user activities			
Smoking	PM_{10}	(50 to 500) µg/m³	Number/quantity
	$PM_{2,5}$	(20 to 100) µg/m³	
Using a vacuum cleaner	PM_{10}	(30 to 150) µg/m³	Degree of pollution, filtration performance
	$PM_{2,5}$	(10 to 40) µg/m³	
Cooking/preparing hot water	PM_{10}	(40 to 100) µg/m³	Duration and intensity
Stove/fireplace	PM_{10}	(40 to 200) µg/m³	Fireplace/stove construction, heating material, chimney
	$PM_{2,5}$	(20 to 100) µg/m³	

genano

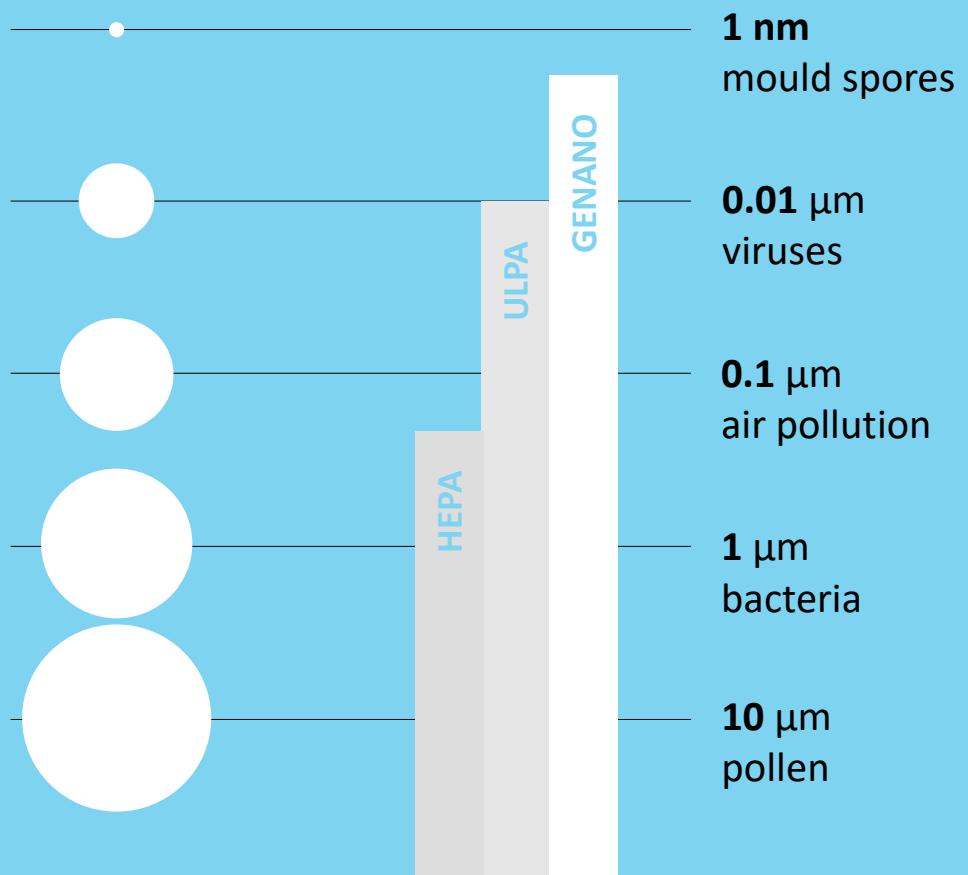
Genano functional principle

Genano Technologies



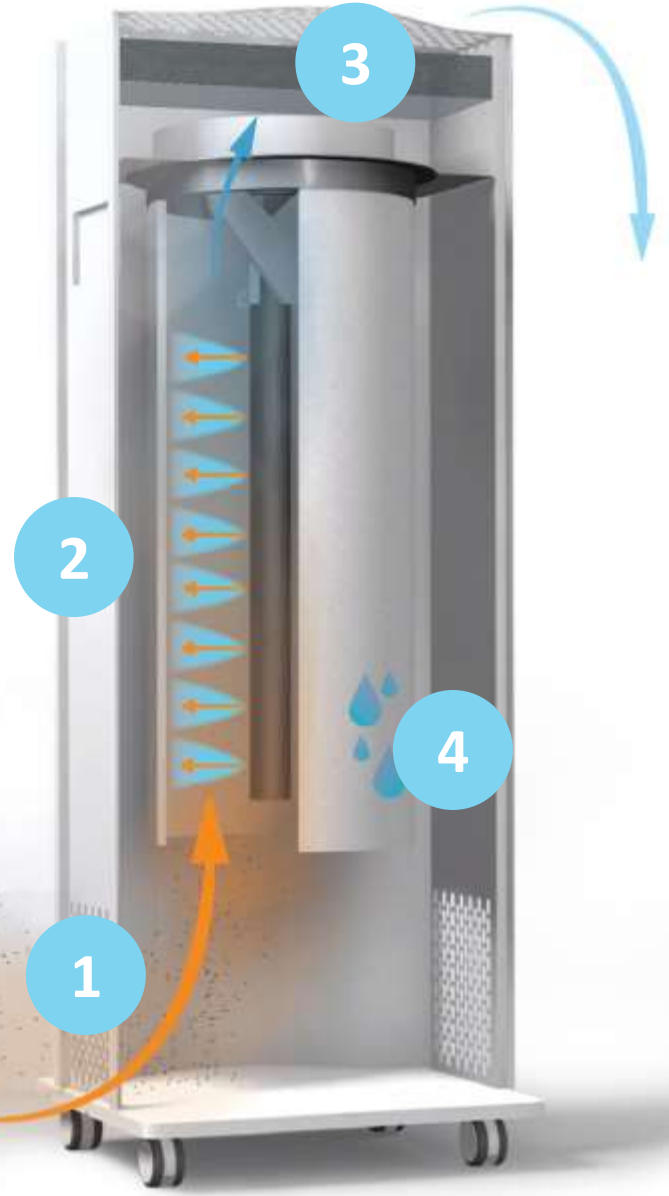
- **NTP (Non Thermal Plasma)** - stand alone purifiers
  - Internationally patented till 2038
  - Filtration rate 99,5% down to 3nm particle size
- **ESP (electrostatic precipitator) Lamell technology** – duct filters & small applications
  - Widely known concept also by a few others
  - Filtration rate >95% down to 300nm particle size
- **Combined NTP+ESP** – purification solutions, G1000
  - Industrial & centralized Real estate solutions
  - Filtration rate >85% down to 20nm particle size
- **RCO technology** – VOC installations
  - Regenerative Catalytic Oxidizer for industrial VOC
  - For concentrations 0,3 – 3 g/Nm^3

Genano is the only technology in the world removing nanoparticles

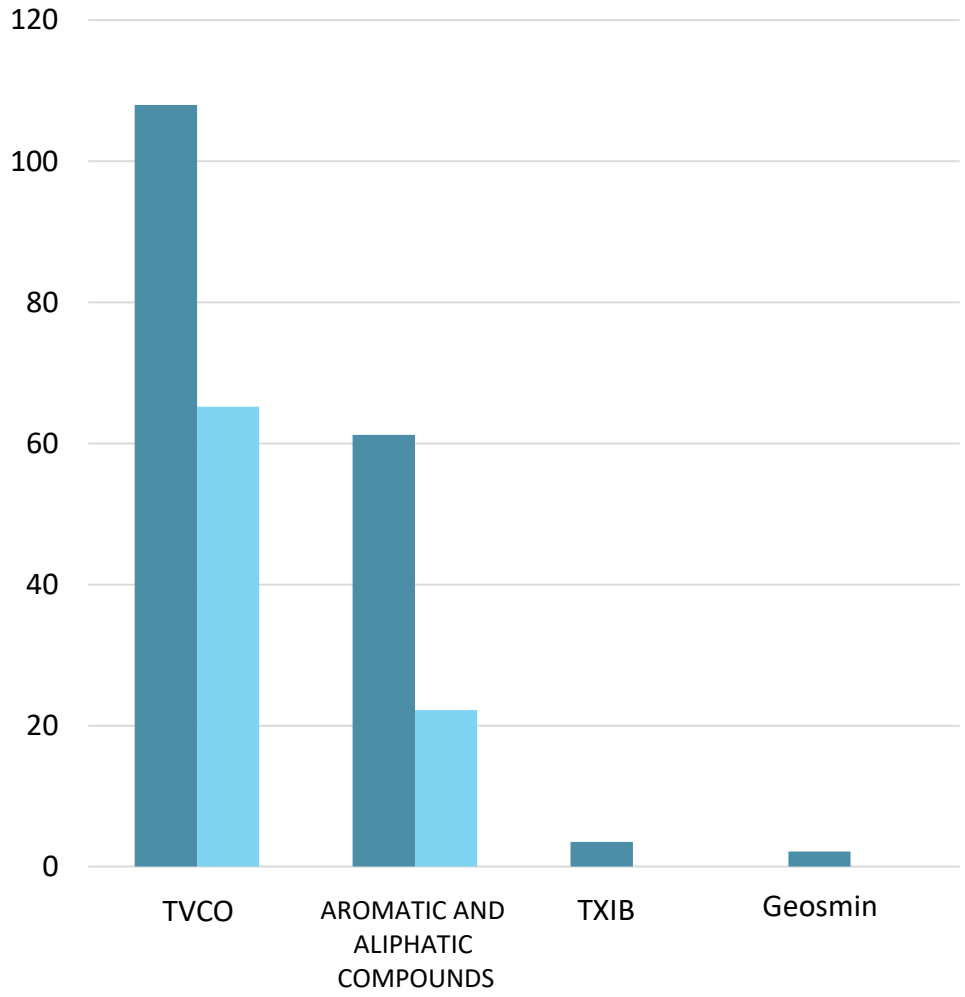


Genano
WHEN EVERY BREATH MATTERS.

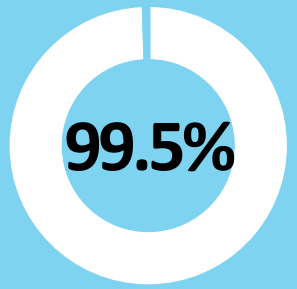
1. Dirty air is sucked into the purifier's collection chamber.
2. Ionized electricity field cleans the ultrafine particles.
3. Active carbon filter removes unpleasant odours and dangerous gases and VOCs.
4. Air purifier stops once a week to clean the impurities automatically.



Proven effectiveness

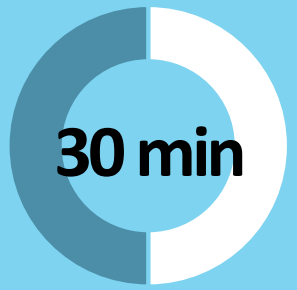


Genano
WHEN EVERY BREATH MATTERS.



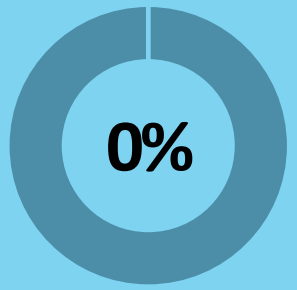
Institute of Occupational Health, Finland

CLEANING POWER
particle sizes 0.003 – 10 µm



Laboiratore National d'Essai, France

100% DESTROYED MICROBES
after turning on the air purifier



MetropoliLab, Finland

AMOUNT OF LIVING MICROBES
in exhaust air or cleaning chamber

INSIDE THE GENANO UNIT

Special 3-layer active carbon collector removes VOC gases and odours.

3

Particles are charged negatively in powerful corona discharges. The negatively charged particles are attached to the positive collection surface.

2

Contaminated air is led inside the unit.

1

4

Outcoming ultrapure air is free from microbes, particles and gaseous substances.

→ **Air decontamination from viruses, bacteria, fungus and spores.**

GENANO TECHNOLOGY® 1/2

4. Active carbon filter absorbs all gases and VOCs.

3. Effective and silent fan circulates air.

2. Negatively charged particles are pulled against the positively charged chamber.

1. Controlled ionizing charges all particles. Multicorona effects destroy microbes.

→ **Generates ultrapure and safe air.**

→ **Total decontamination of viruses, bacteria, fungus and spores.**

GENANO TECHNOLOGY® 2/2

AUTOMATIC WASHING

1. Automatic washing system cleans all particles from the chamber into a container.

2. All microbes are destroyed and the liquid from the cleaning detergent is vaporized through the unit.

→ **No filters that can get clogged up.**

→ **No substrate for microbe growth.**

LAB TESTS AND PUBLICATIONS

- Genano Technology® has been tested in numerous organisations using different methods
- Including standards
  - ISO 14644-1:2000 (Standard for Airborne Particulate Cleanliness Classes in Cleanrooms and Clean Zones)
  - CSN EN 779 (Particulate air filters for general ventilation - Determination of the filtration performance)
- See http://genano.com/products-and-support/research-results/

INDEPENDENT TESTS

Finnish Institute of Occupational Health

Test for particles reduction efficiency and ozone production

- *"Removal efficiency for aerosol particles between 0.003-10 µm was better than 99.5% for all particle size classes."*

VTT Technical Research Centre of Finland

CSN EN 779 standard test for particles reduction between 0.15 – 5 µm

VTT Technical Research Centre of Finland

Filtration efficiency on DNA fragments

- *"The DNA-fragments removed from cleaned flow-through air were detected in the washing liquid and the total DNA quantity of the washing liquids was in the level that corresponded to the DNA quantity removed from the air during the flow-through."*

Epitek Oy, Finland

Cleanroom classification test according to SFS-EN ISO 14644-1:2000 standard.

- ISO Class: 6
- Time to remove 99% of particles ≤ 0.5 µm in a 36 m^3 space: 13 minutes.

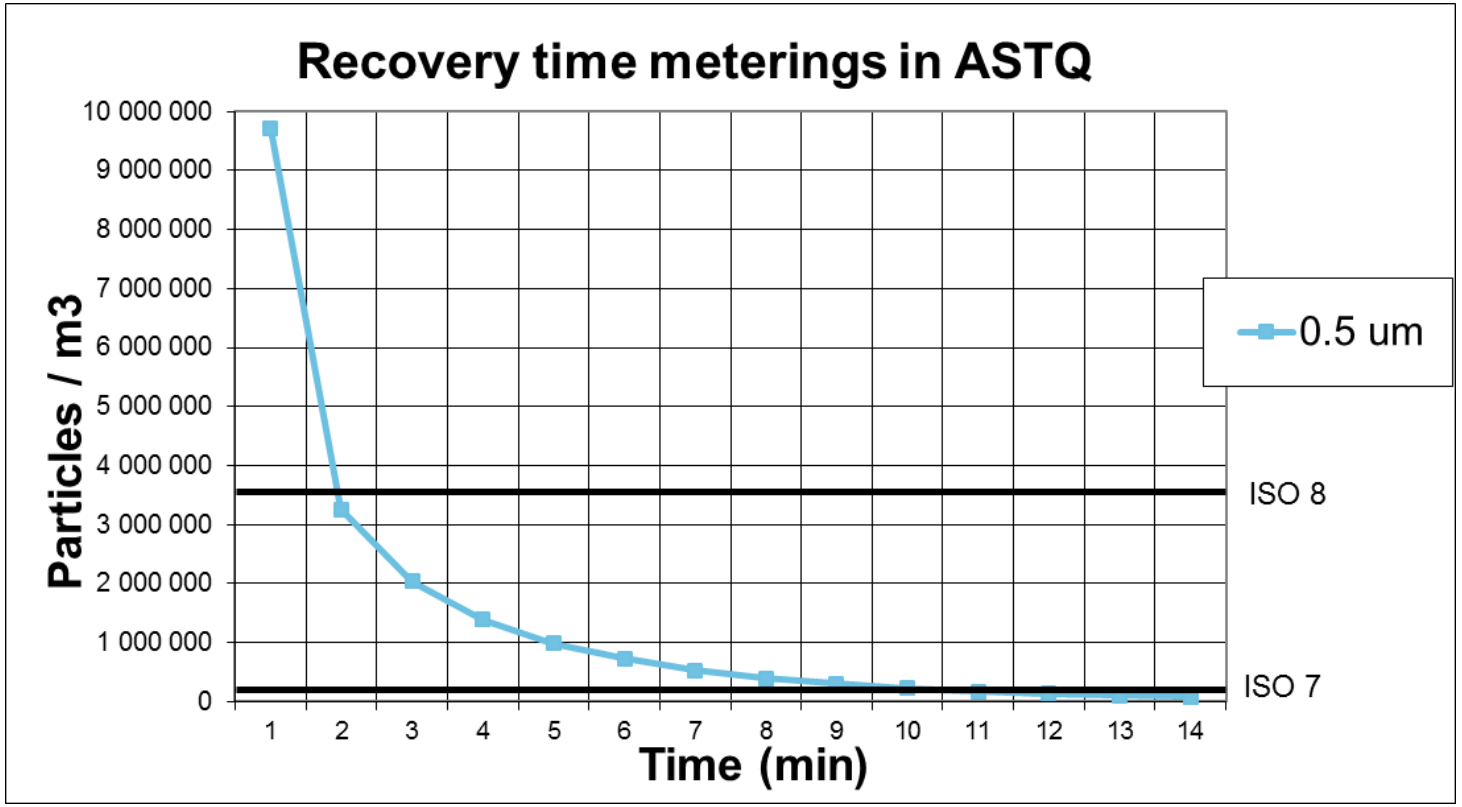
MetropoliLab, Finland

Microbial elimination test

- Results: No microbial contamination inside the device or after washing procedure in the washing liquid.

ISO 14644 Recovery time, Finland 2013

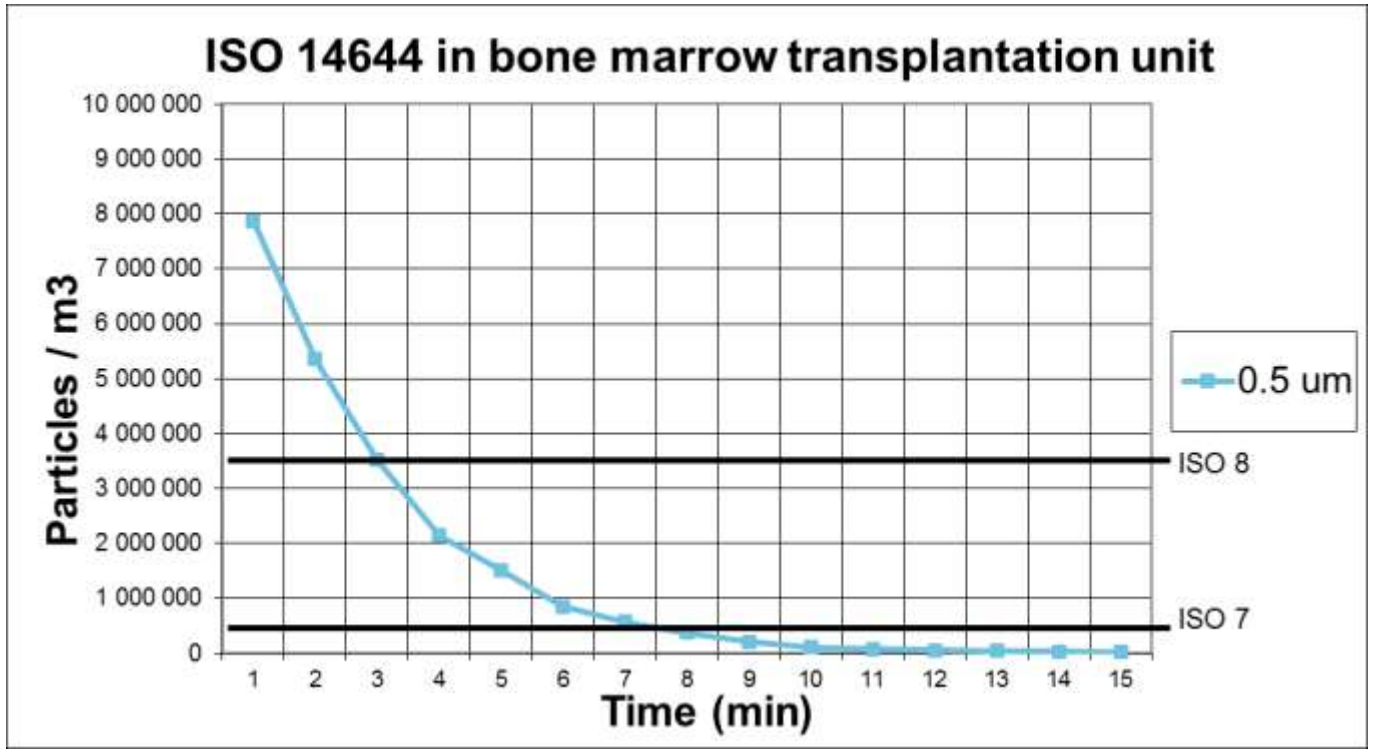
- Cleanroom classification and recovery time meterings were performed in the ASTQ's lightweight structure test room 28th of May, 2013



Time (min)	Particles / m³
1	9 703 617
2	3 260 061
3	2 036 104
4	1 395 092
5	991 048
6	727 639
7	524 029
8	397 231
9	300 721
10	228 321
11	168 240
12	133 823
13	100 817
14	78 684

ISO 14644, Turkey 2014

- Investigation of the Air Purifier in High-Risk Hospital Room
- The effectiveness of the Genano 310 was tested in a bone marrow transplantatio unit. (Istanbul University, Biomedical Device Technology)

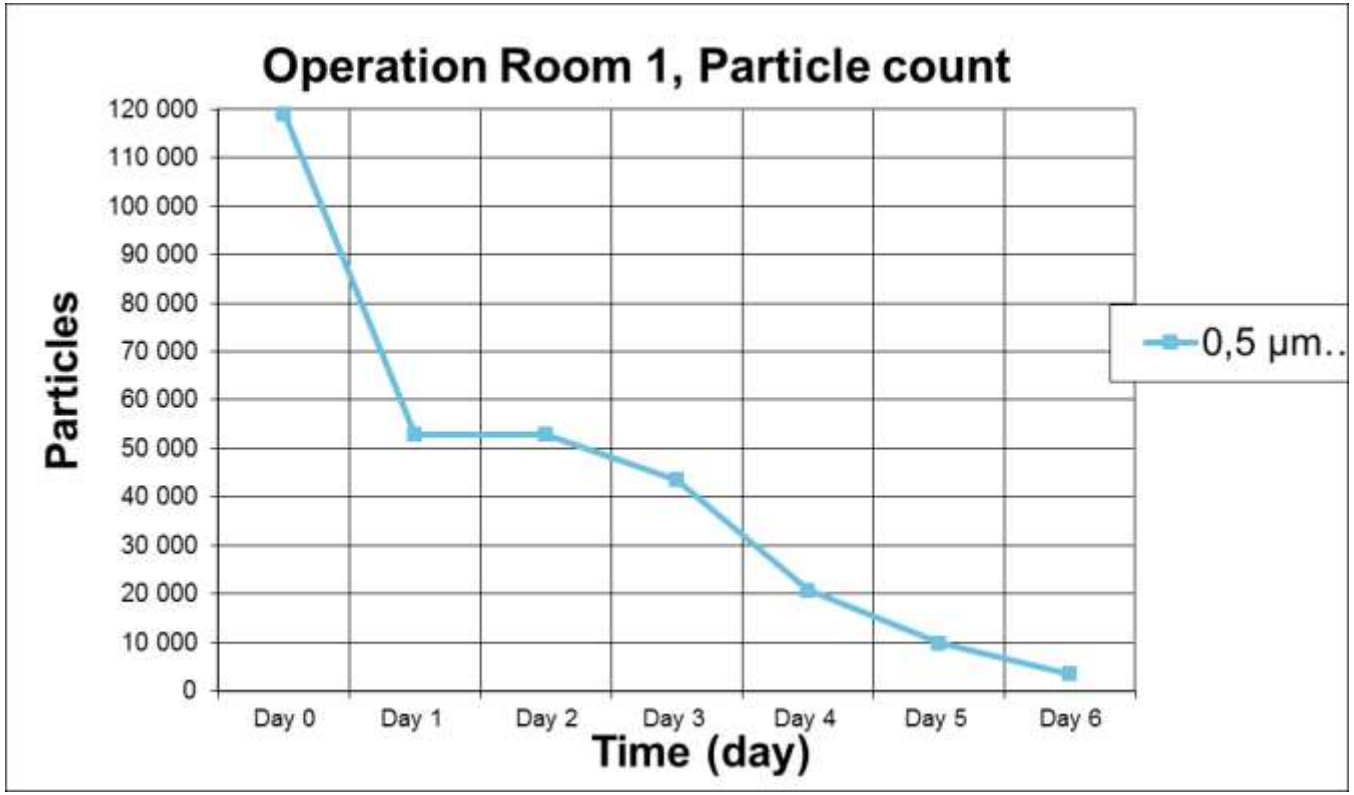


Time (min)	Particles / m³
1	7 866 142
2	5 354 485
3	3 512 979
4	2 148 775
5	1 514 567
6	845 789
7	576 222
8	374 082
9	211 116
10	103 002
11	74 664
12	51 257
13	36 772
14	25 848
15	19 854

Genano 4500 Evaluation Report, Rawalpindi, Pakistan, 2015

- A basic assessment to determine the indoor air quality was conducted at Operation Room 1 (OR-1).
- The pre-Genano (day 0) and post-Genano activity assessment was conducted in the OR-1 between Nov 3rd and 14th 2015.

Time (day)	0,5 µm particles
Day 0	119 154
Day 1	52 937
Day 2	52 937
Day 3	43 489
Day 4	20 799
Day 5	9 886
Day 6	3 480



G1000 series

professional solutions for air purification

Pure Air. Nothing Else.

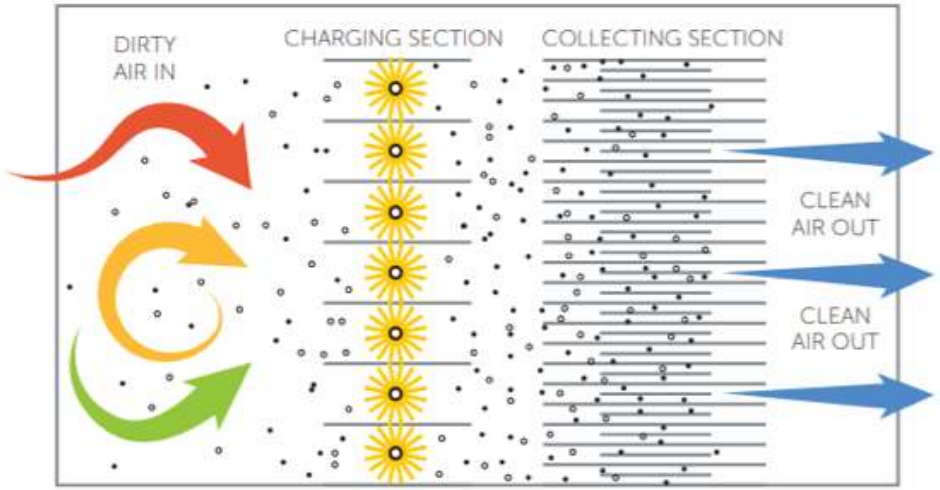
G1000 - high volume air purification solutions

- **Wide application areas**
  - Assembly halls (electronics, metal works…)
  - Logistics centers and warehousing
  - Welding halls
  - Real estate solutions

- **Major advantages**
  - Improved air quality
  - Energy savings
  - Health impact
  - Improved quality and efficiency
  - And many more…

genano

Genano technology



High voltage filtering technology

- Particles floating in the air are charged with high voltage charge
- A strong electrical field forces the particles towards the collector plates eventually capturing them

Automatic washing system

- Pre-adjusted intervals according to the prevailing conditions
- Water will be either collected to a container or directed to the sewage system
- Manual washing occasionally, to ensure superior performance

Superior industrial solution for oil mist and welding fume reduction

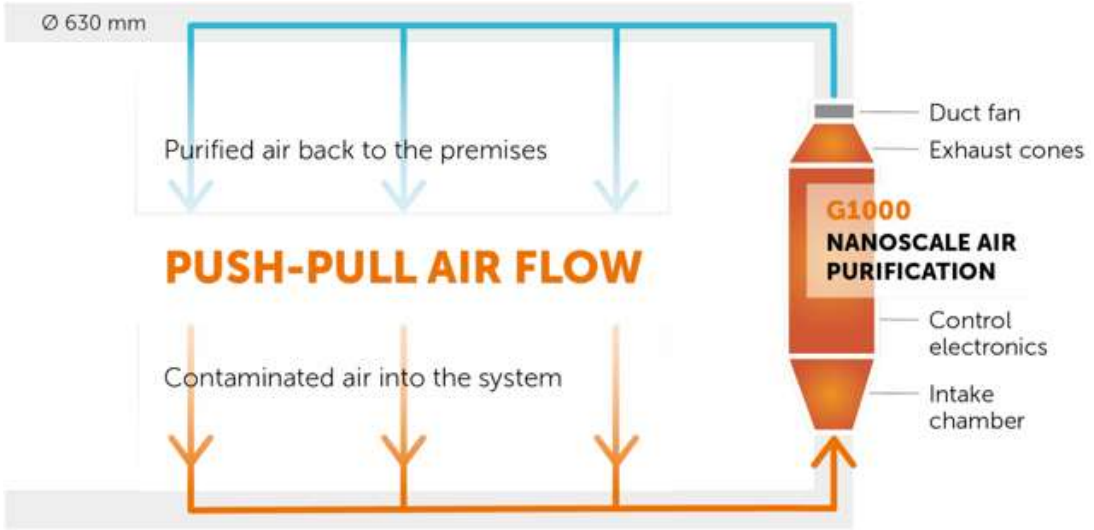
- Filter free solution for efficient particle removal in industrial applications
- Proven Genano Technology: low power consumption with long operation life time
- No need for filter change - continuously high particle filtration efficiency
- Retrofit solution for existing premises

- Major health impact
- Improved well-being and working efficiency

Genano

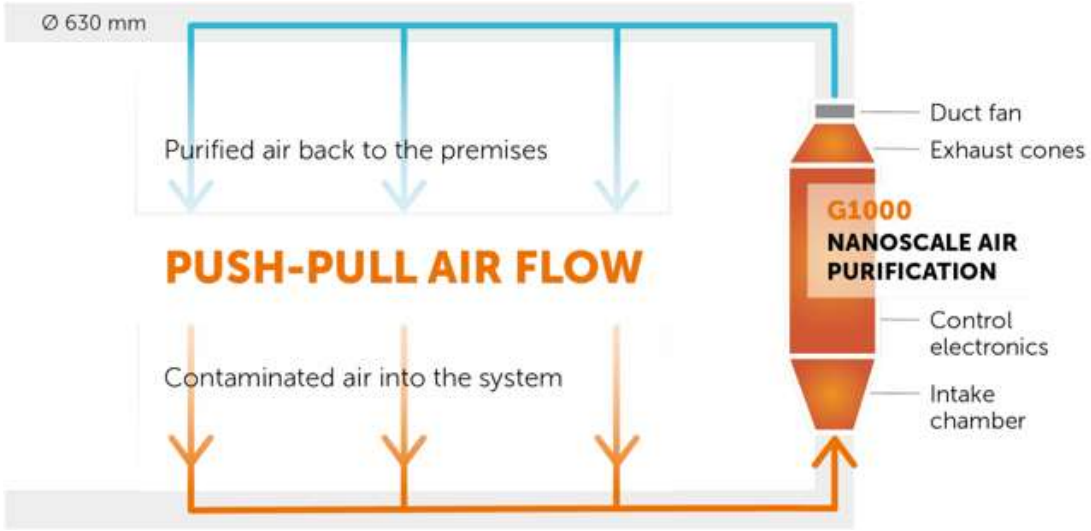
Warehouse and assembly hall dust control and goods protection

- Efficient particle removal to ensure product quality in assembly halls
- Nanoscale air purification to protect stored goods
- Significant energy savings with circulated air flow solution
- Automated washing system for reduced maintenance need



genano

Dive into technology advantages



- Long life cycle
- Very low operational cost
- Low manual maintenance need
- No need for changing fiber filters
- Significant energy savings due to air circulation within the hall
- Maintains high Particle Filtration Efficiency
- Low pressure drop that minimizes fan power need
- Retro fit into existing premises

genano

TECHNICAL INFORMATION	
Clean air delivery rate	3600, 7200, 12600m3/h
Material	Al-Zn
Electrical connection	200-240V, 50/60Hz
Power consumption	200-400W*
Operating temperature	+5…+60°C
Water consumption	150 litres**
Installation site requirement	1m free space above, free access to device
Manufacturing country	Finland

* Additionally ~2kW external duct fan power consumption
** Consumption per washing scene

Genano

INDUSTRIAL AIR PURIFIERS

- **Genano® 1000 Industrial Purifier**
- ESP for industrial & building air purification
- For capacities >3600m3 / h - scalable

Genano Indoor Air Service™

Price starts from 1 €/person/day

SITUATION CHECK-UP

Visit and symptoms survey

ACTION RECOMMENDATIONS

Report and repair recommendations

OFFER AND ACCEPTANCE

Dimensioning and capacity calculation

DELIVERY AND INTRODUCTION

Disposition, installation and user training

ENSURING THE OUTCOME

Follow-up visit, symptoms survey and feedback conversation

MAINTENANCE AND UPKEEP

Accredited annual maintenance service

OUR PROMISE TO YOU – 100% SATISFACTION GUARANTEE

All Genano contracts have a two-month satisfaction guarantee. If you are not satisfied, you get your money back 100%.

Case:
Seppo school, Espoo

“All my symptoms simply disappeared when the air was cleaner. People always ask about the indoor air situation and now we can say that we have these purifiers and our situation is good.”

– JOUNI-JUKKA ANNALA, VICE PRINCIPAL

”The amount of sick leave has declined.”

– PIRJO MYLLYS, SCHOOL SECRETARY

”I’ve never known of a machine with such power. Other types have mainly had a cosmetic effect. This one is effective.”

– TEACHER, SEPPO SCHOOL

Peter Christiansen

Sales Director, Nordic

Tel. +358 405080705
e-mail: peter.christiansen@genano.com

Genano Oy

Metsänneidonkatu 6
02130 Espoo

Finland

www.genano.com