Research and Development on European Cleaning Solutions for Radioactive Applications

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Your speaker:

- Axel Mahler, R&D Director Europe

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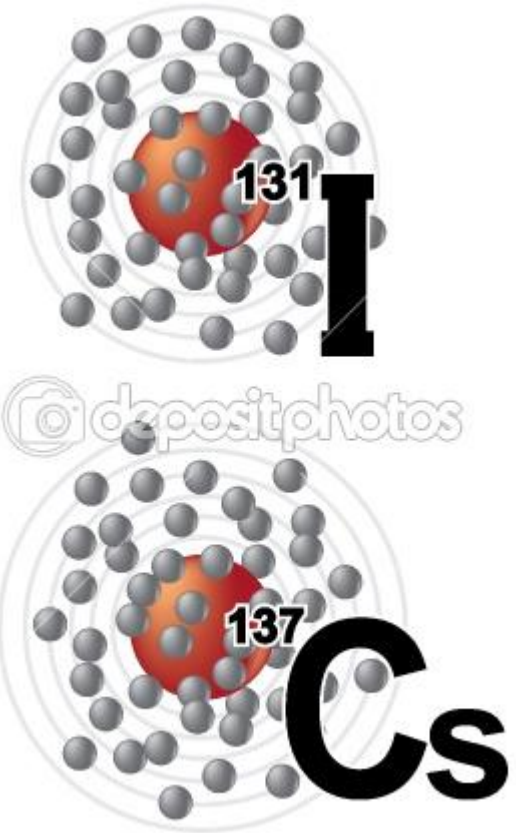
Topics

- **History of filtration for radioactive applications**
- Modern demands for radioactive applications
- State of the Art R&D for radioactive applications
- Examples of modern equipment in Europe for radioactive applications

Forms of radioactive contaminants in the air

- Particles:
  Examples of radioactive particles released into air:
  - Caesium-137 (half-life time of about 30 y)
  - Iodine-131 (half-life time of about 8 d)

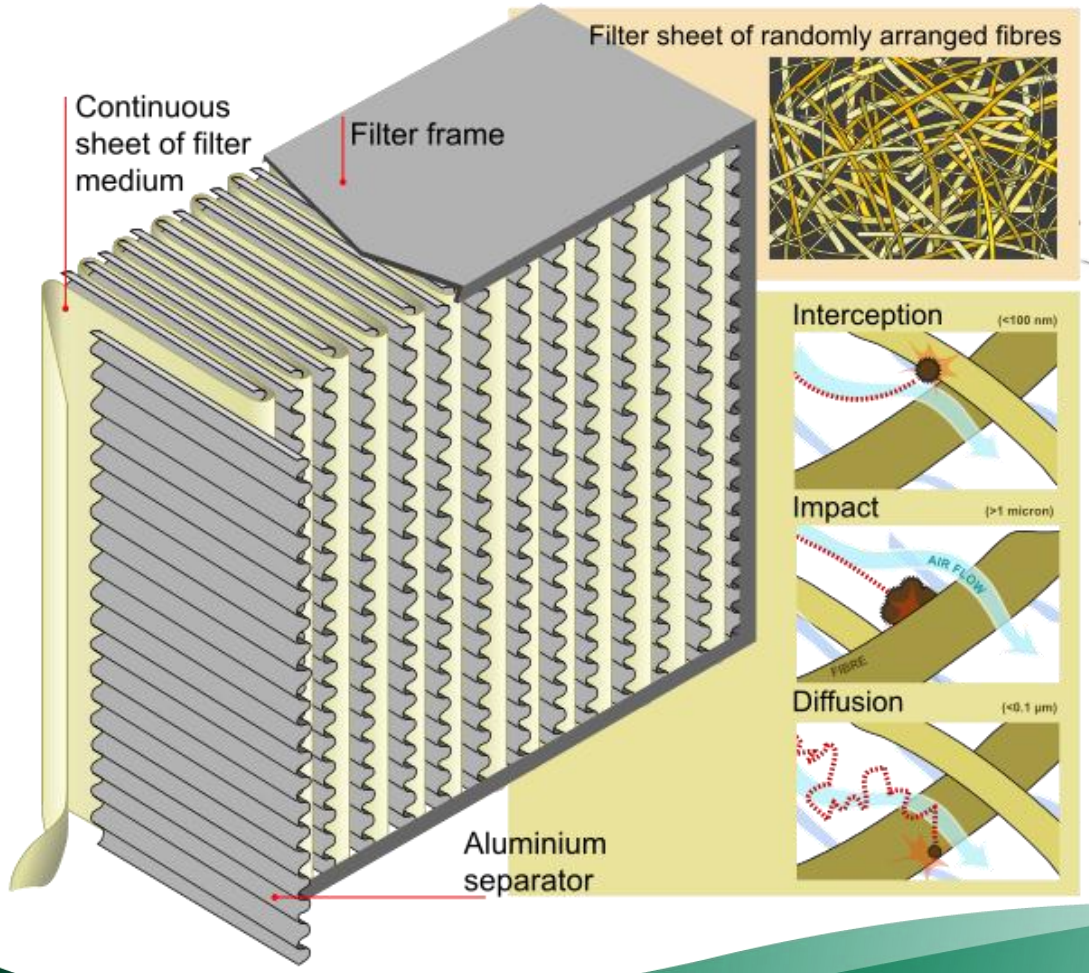
- Gaseous Airborne Nuclide:
  Example of radioactive gas released into the air:
  - Iodine-131



Filtration history for radioactive particles

1940

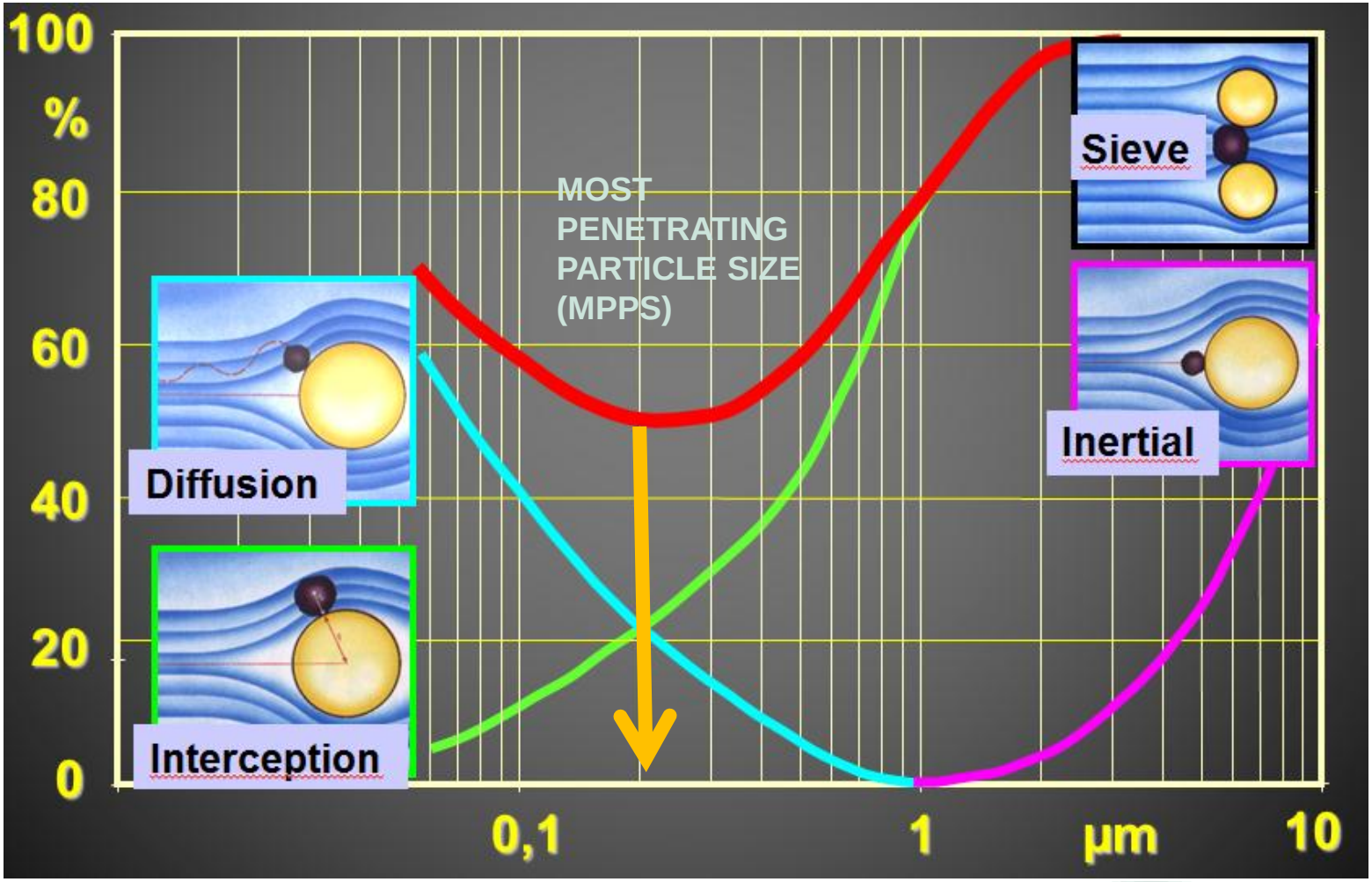
Filtration history for radioactive particles



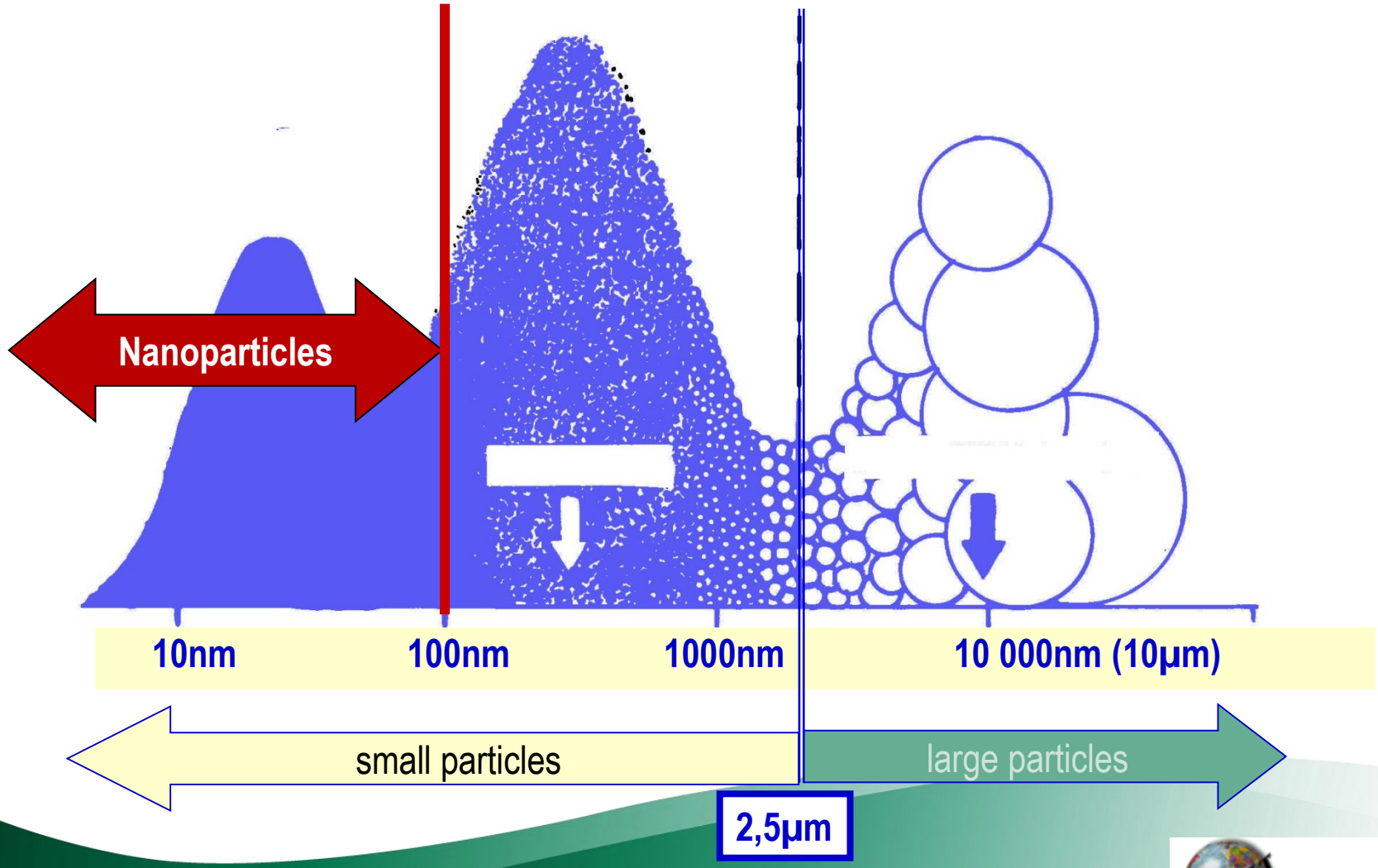
99,9999998

Combined effects for trapping of radioactive particles in the air

Point of lowest filtration performance



What happens with smaller particles ?



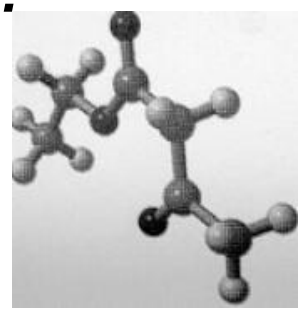
Casings for particle filtration products

- Designed to ensure the safe function of the filter
- Has to be airtight housings according to required Standards and seismic requirements

Filtration history for radioactive gases

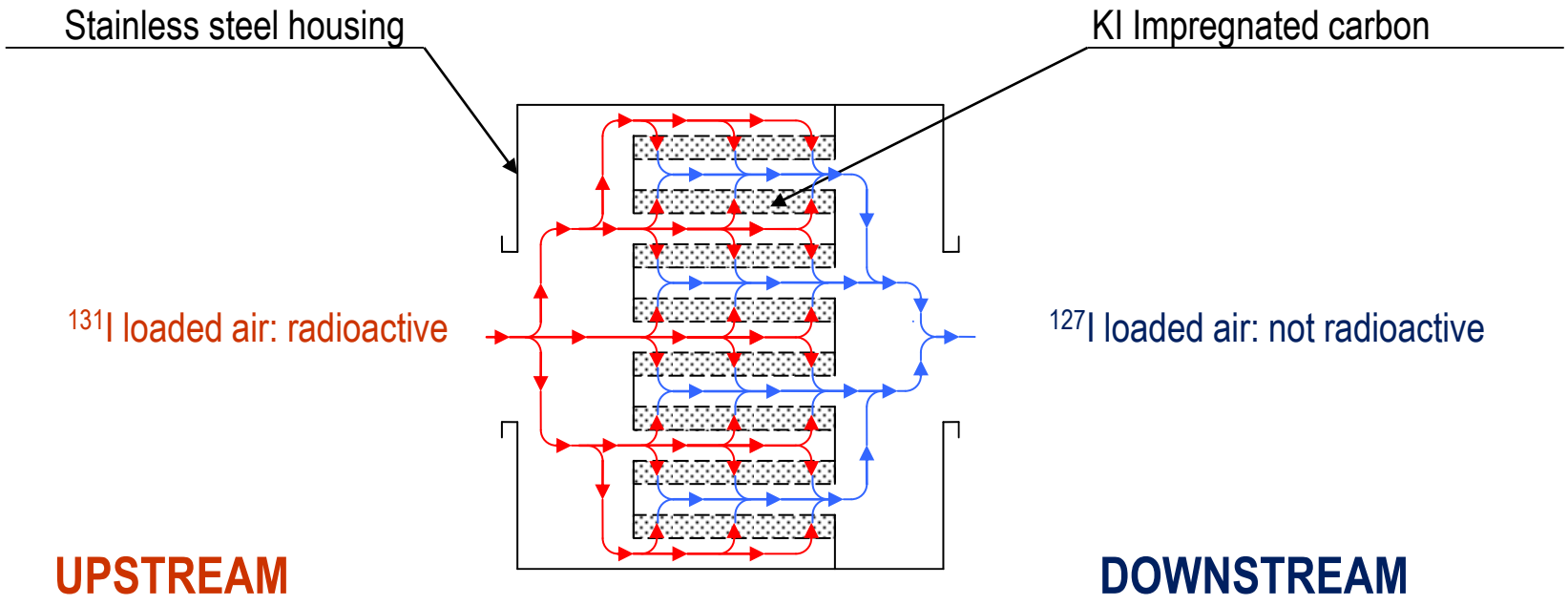
- All ***adsorbent*** materials are full of holes or ***pores*** and have ***very high internal surface areas.***
  - Activated carbon: more than 1000 m^2/gram

- Molecules ***diffuse*** from the external air and become ***trapped*** on the ***internal surface*** of the porous adsorbent.
- ***Different materials for different applications are in use:***
  - ***Activated carbon (broad spectrum behaviour)***
  - ***Impregnated activated carbon (targets specific molecules)***
  - ***Activated alumina***



How does molecular filtration works?

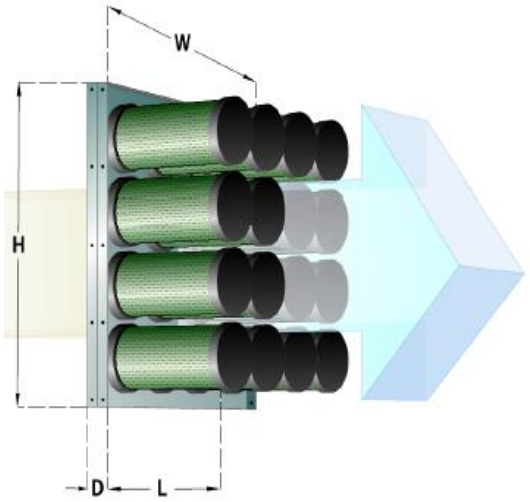
Example Iodine adsorber working theory

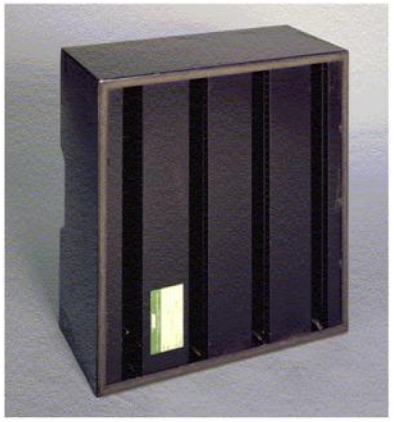


$$K^{127}I + CH_3{}^{131}I \rightarrow K^{131}I_{ads} + CH_3{}^{127}I$$

Trapping of gaseous nuclide in the air

- Carbon Adsorbers:
  - Nuclear power generation
    - Radioactive gases
  - Nuclear fuel production
    - Hydrogen fluoride





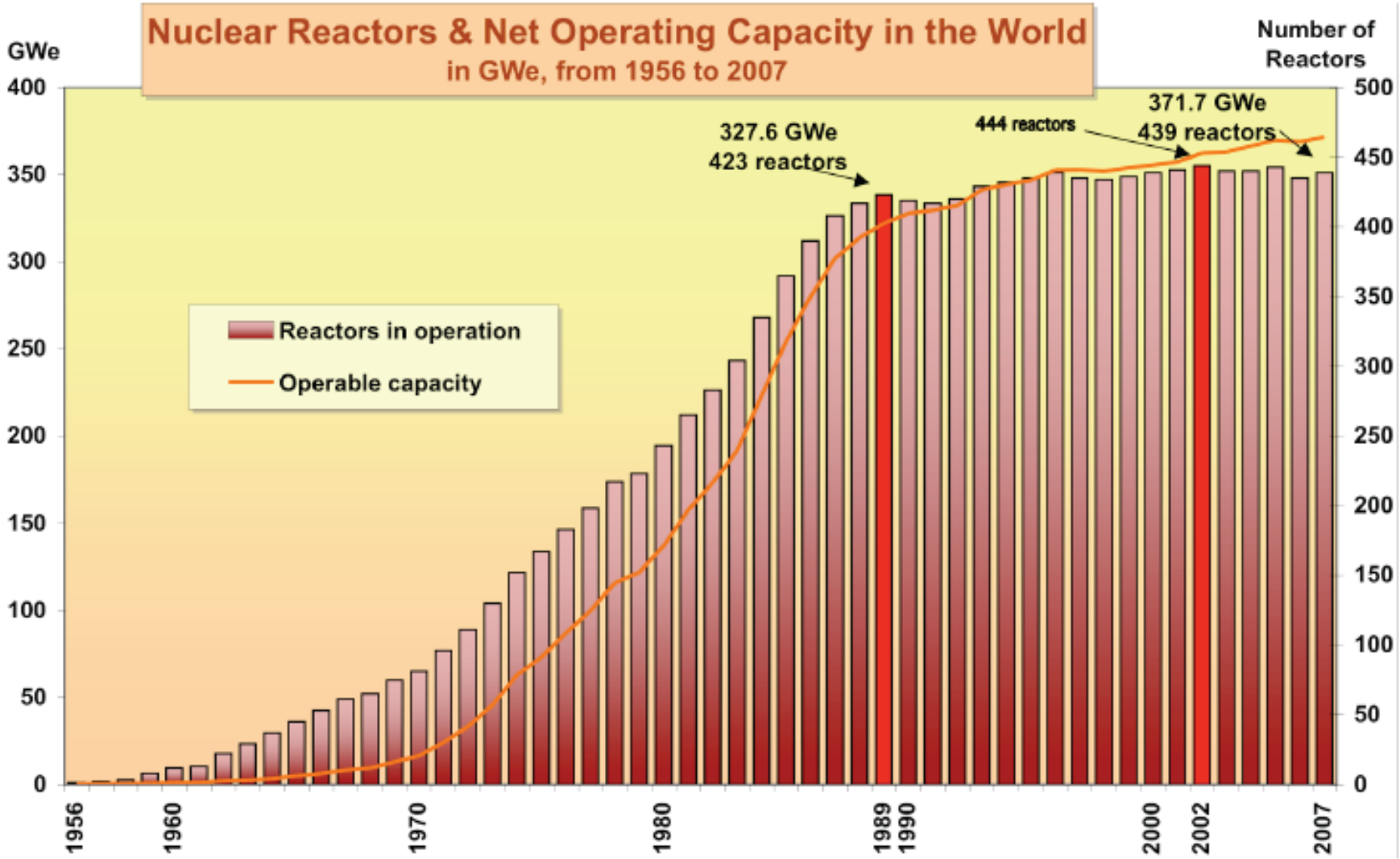
Casings for gas filtration products

- Designed to ensure the safe function of the carbon bed
- Airtight housings according to required Standards and seismic requirements

Historic demands for particle and gas filtration:

- Efficiency against MPPS
- High Airflow
- Reliability for long term use
- Robustness under all possible conditions incl. seismic and temperatures
- Tightness
- Nuclear designs went also into bio safety applications

Historic demands for particle and gas filtration:



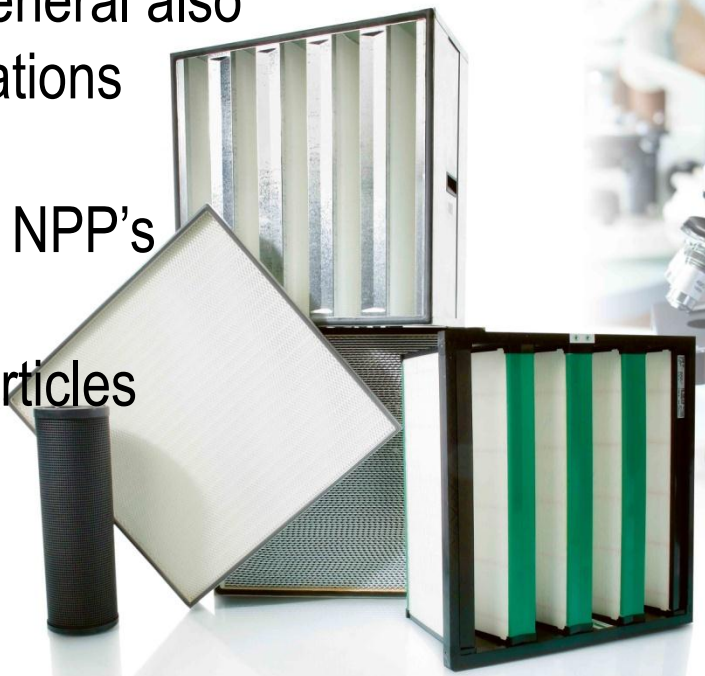
Source: IAEA, PRIS, 2007[2], MSC

Topics

- History of filtration for radioactive applications
- **Modern demands for radioactive applications**
- State of the Art R&D for radioactive applications
- Examples of modern equipment in Europe for radioactive applications

Modern demands for particle and gas filtration:

- Retrofit of Russian NPP's in East Europe
- More special solutions in general also for other radioactive applications
- Solutions for dismantling of NPP's
- Protection against Nano particles
- Waste handling solutions



Modern demands for particle and gas filtration:

- Solutions from bio safety labs going back into nuclear
- ATEX solutions (potentially explosive atmospheres)
- Protections for control rooms and people rest rooms for NPP'S
- State of the Art in situ efficiency and leak test methods
- Measurement of radioactive equipment contamination

Modern demands for particle and gas filtration:

- Solutions for Uranium enrichment facilities
- Mobile filtration applications
- Higher temperature resistant applications (up to 400 °C/ 750 °F)

Topics

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R&D Center Europe in Trosa, Sweden

5 Labs

- Particle Lab 1 + 2
- Molecular Lab
- IAQ Lab
- Gas Turbine Filter Lab
- Mobile in situ test Labs – Camfield Lab

Process development

- Lab production equipment
- Lab pleater
- Rapid prototyping
- Machine development
- Burst test
- Test machines

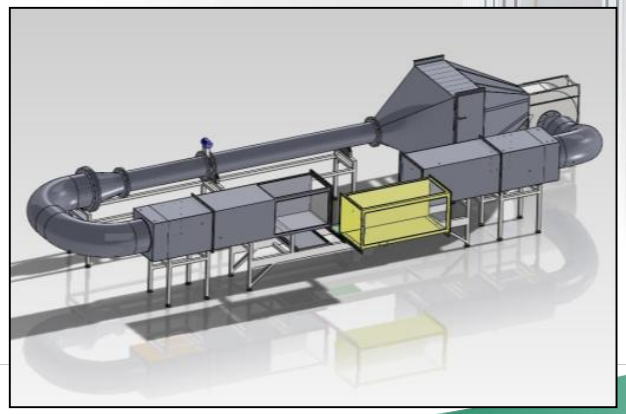
R&D center in Trosa, Sweden

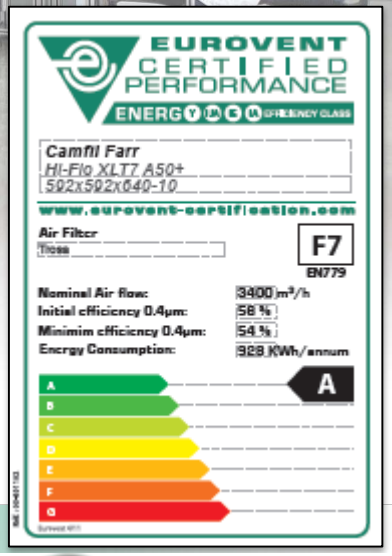
- Molecular test rig with different analyzers and gases
- Evaluation and development of carbon solutions
- Test of complete filter or samples

Particle Lab 1+2

Tests according to several standards for

- Prefilters
- HEPA filters
- Dust loading

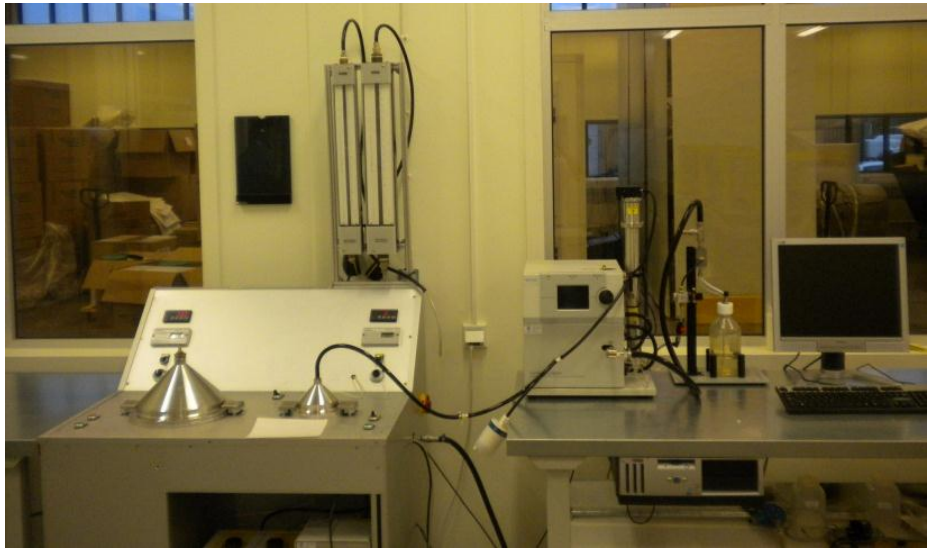




Nano particle test

- MPPS evaluation
- 10-400 nm

Media Tester



Heavy solution test rig

- High airflows
- Special conditions
- High humidity, water, salt, test dusts

GT Rig

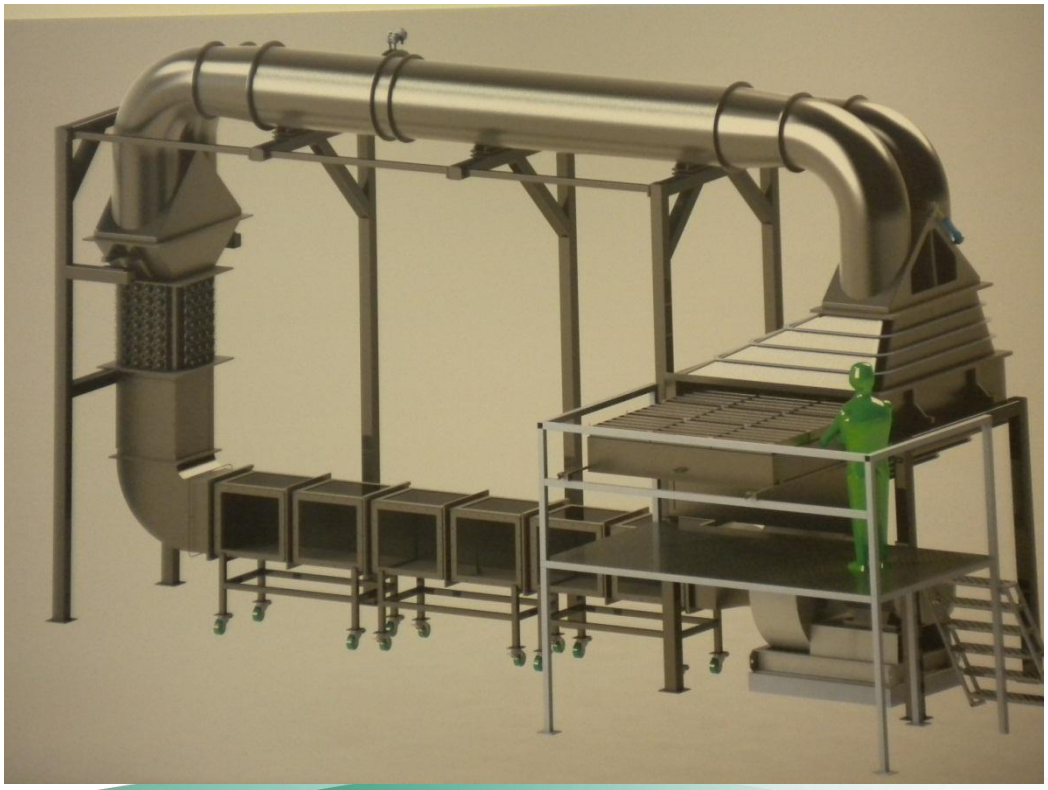
Air Flowrate	1700….~7000m3/h +/- 2% 6000….30000m3/h +/- 3%
Differential Pressure	0….12000 Pa (Entire system)
Filter cross section	610 x 610 mm
Filter length	1600 mm
Required footprint	9,5 x 3,5 m (x 5.25 high)
Number of filters	3 static (in series) 3 x Crossflow 6 x Tenkay

Possible testprocedure

Efficency test (DEHS)	Automated
Pressure drop	Automated
Dust feeding	Automated
Salt Loading	Automated
High humidity	Automated
Temperature control	Automated
Salt efficiency	Manually, using analog SFP
Water spray test	Automation dependent of amount of water

Possibility to n standard tests automatically, including report genera on

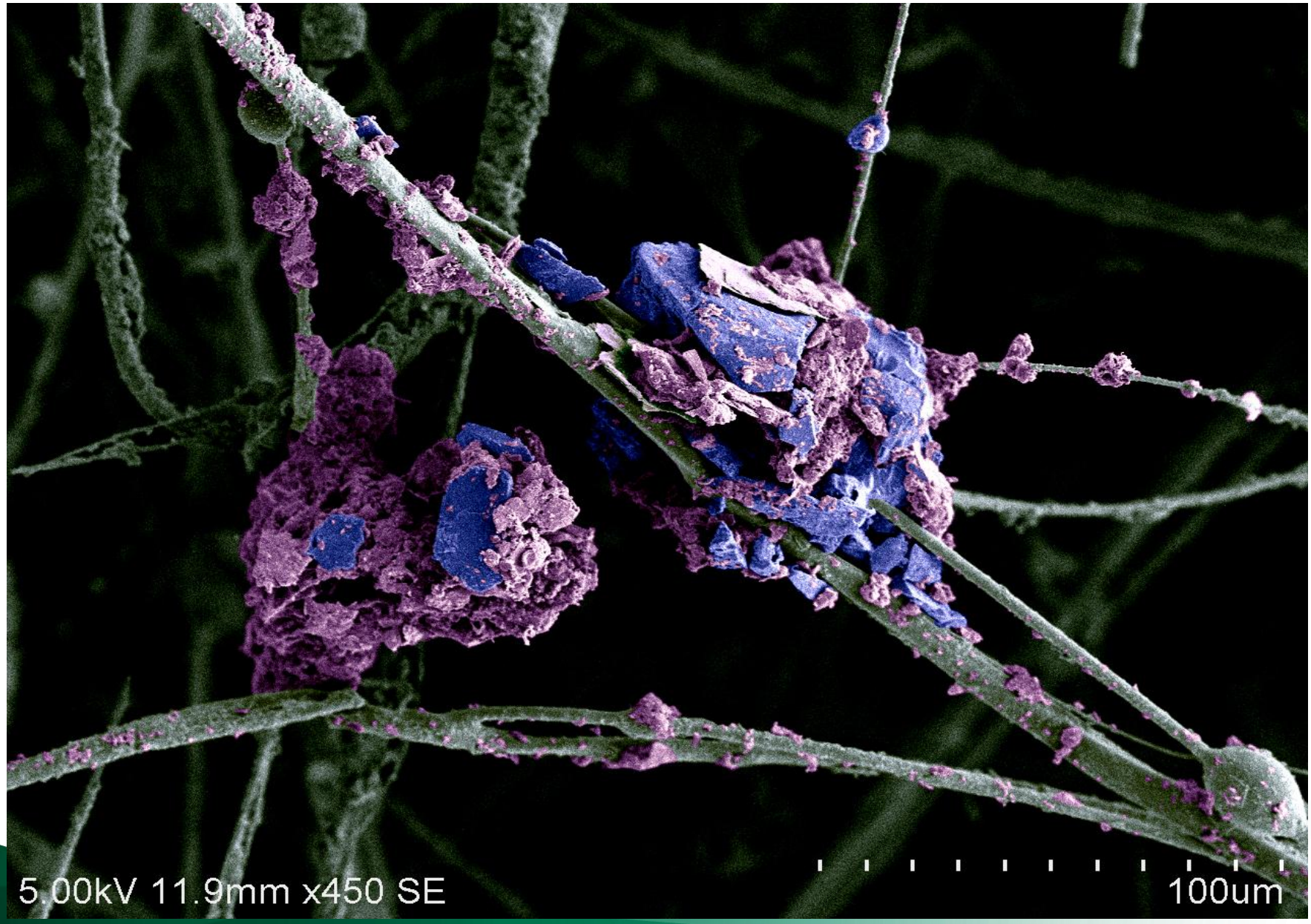
Delivered ar ounted Week 52, preliminary



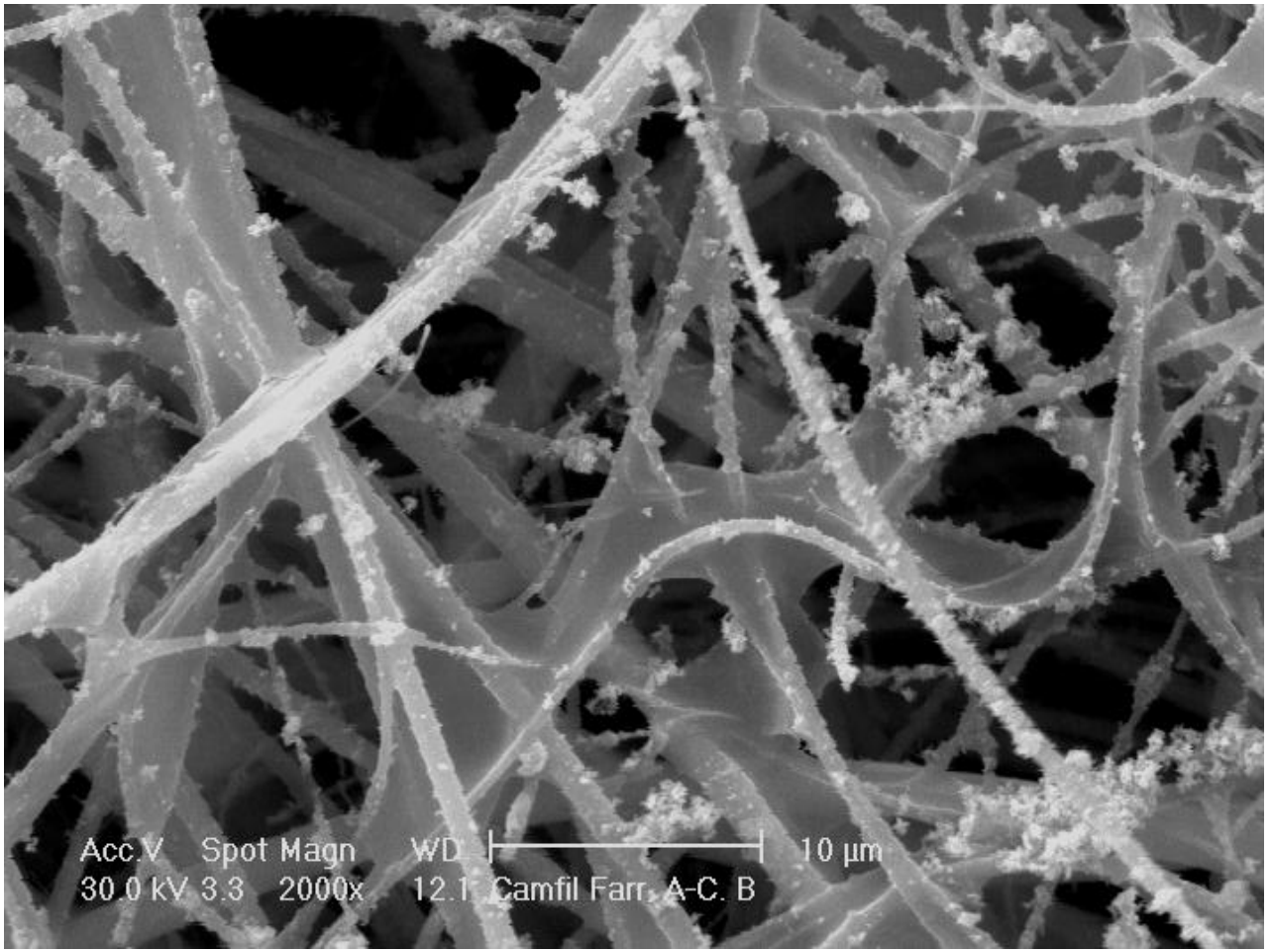
Example developments: Carbon regeneration

SEM Electron Microscope

Evaluation of dust

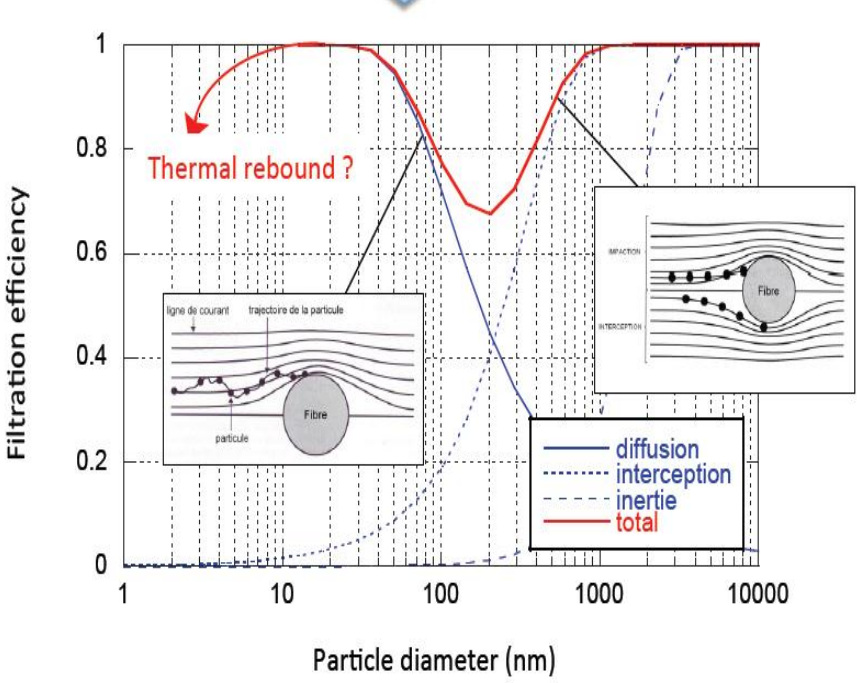


Evaluation of loading conditions



Basic science

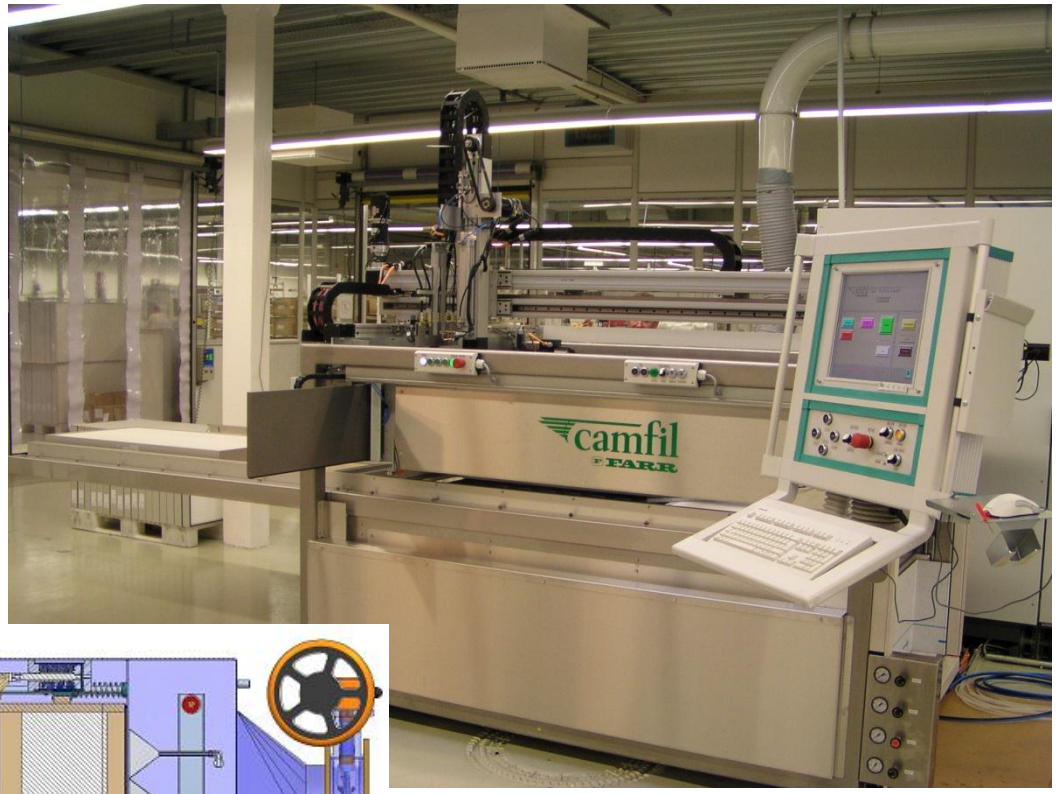
$$E = 1 - P = 1 - \exp\left(\frac{-4\alpha Z\,\eta}{\pi(1-\alpha)d_f}\right)$$

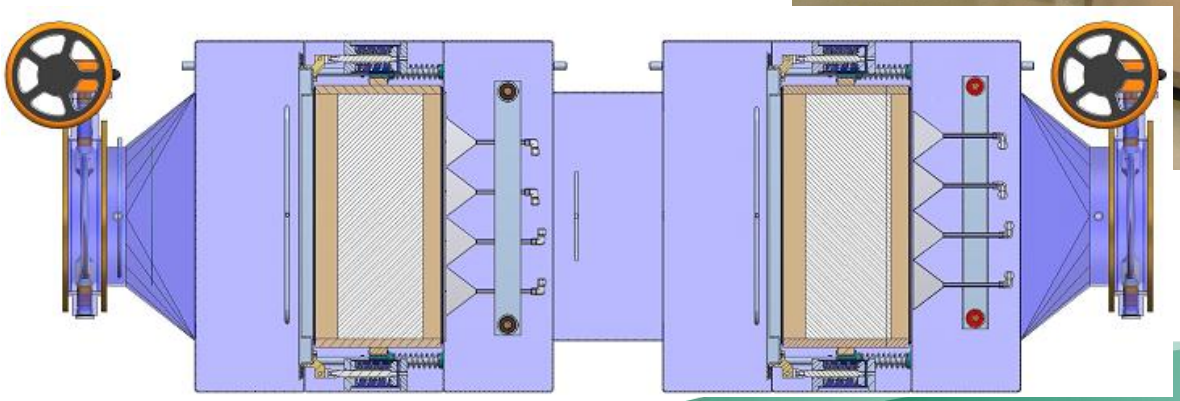


dp (nm)	Mean Thermal Velocity (m/s)
1	100
5	9
10	3
20	1

For particle density = 2 g/cm³

Development of test machines and in situ test solutions





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- **Examples of modern equipment in Europe for radioactive applications**

Mobile units for emergency and decentralized usage

Used for:

- Different places
- Dismantling
- Emergency

Mobile units with ATEX certification

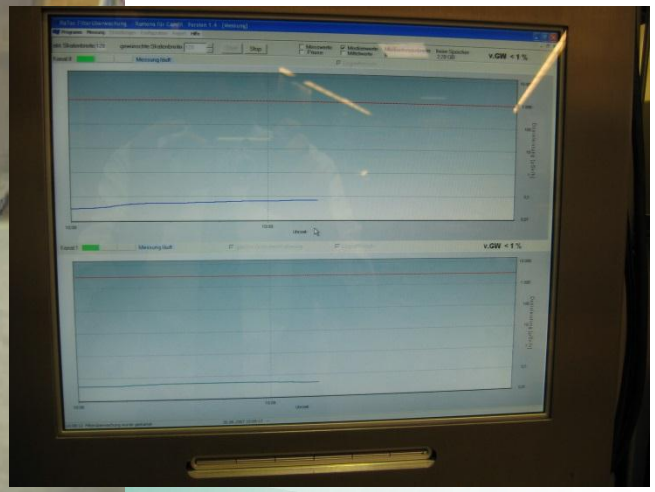
Used for potentially explosive atmospheres :

- Different places
- Dismantling
- Emergency

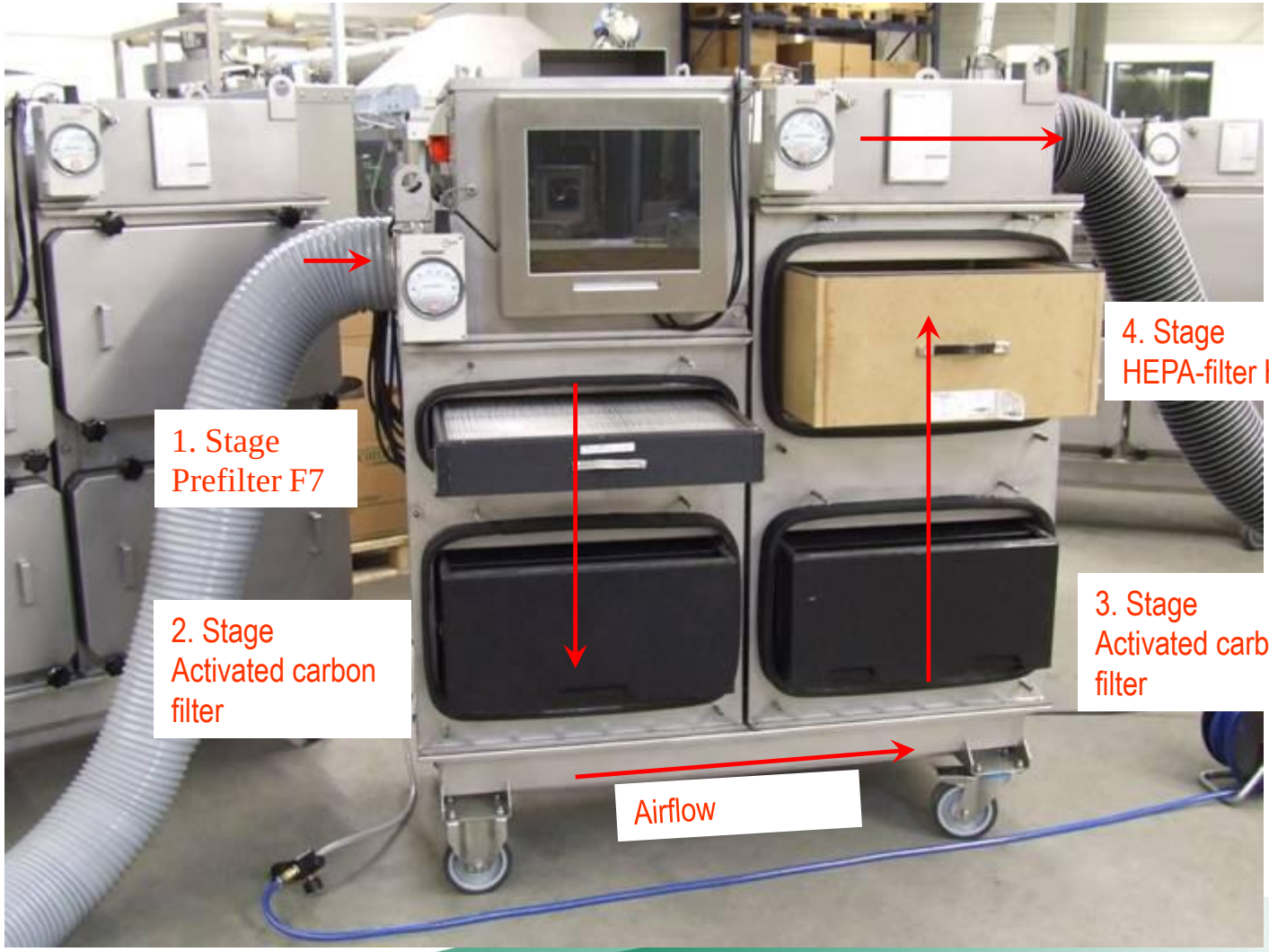
Mobile Unit Type 4 including radioactive control

Used for:

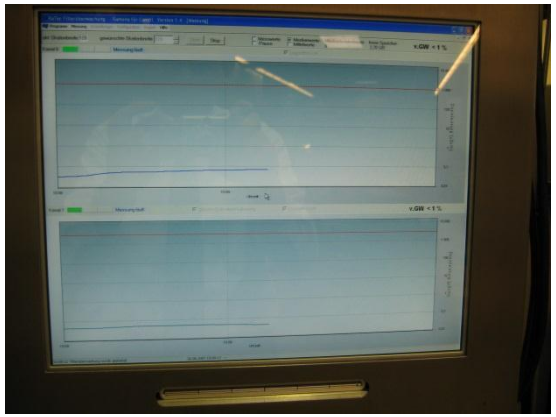
- Different places
- Dismantling
- Emergency



Mobile Unit Type 4 including radioactive control



Mobile Unit Type 4 including radioactive control



Monitor

Filter gasket leak test port (HEPA-filter)

BIBO-technic

Pneumatic filter declamping device for activated carbon - & HEPA-filter

Carbon filling and dust removal unit

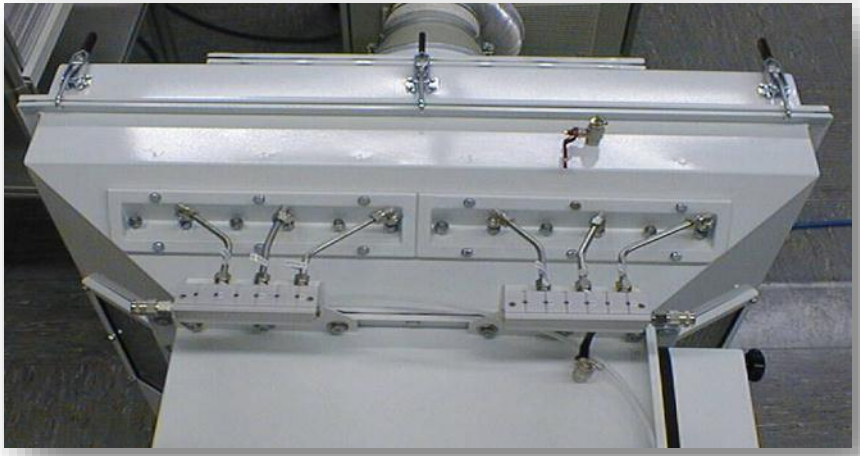
Used for:

- Deep bed filtration

Units with integrated fixed leak detection and in situ measurement system

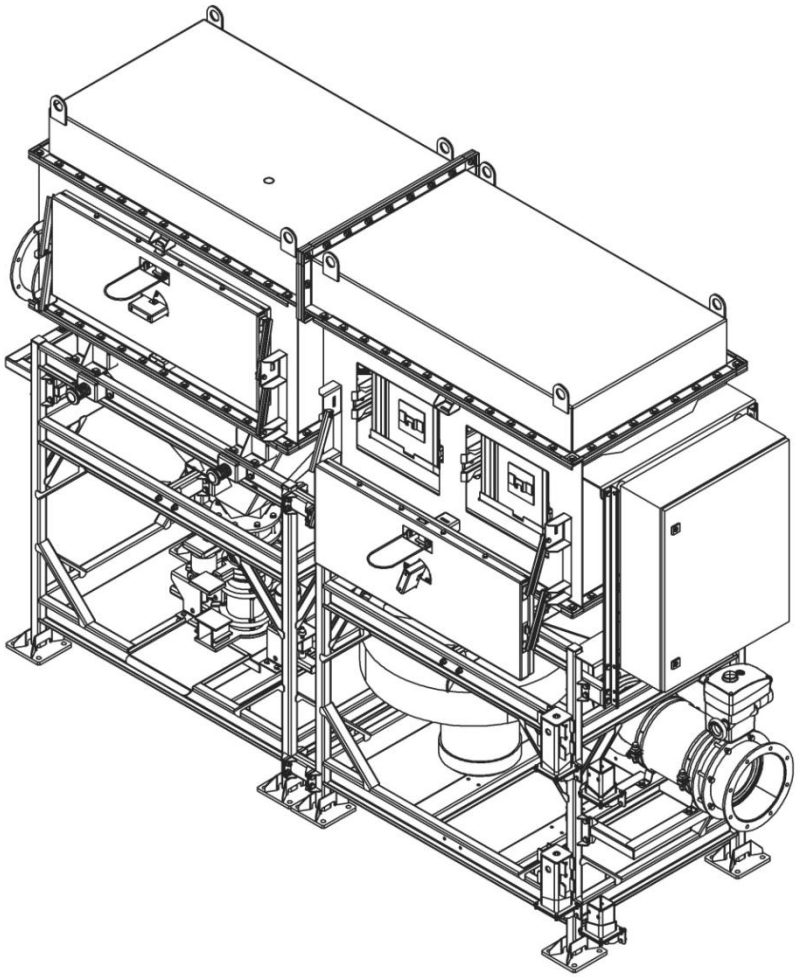
Used for:

- HEPA filtration units



Back from bio safety to nuclear integrated housings with auto scan test

Solution with cleanable HEPA filters and robot exchange



Used for:

- Waste Handling
- Dismantling

Solution for trapping of HF for nuclear enrichment application

- Filter housings with chemically inert fluoride polymer-based coating
- Membrane media instead of glass fiber media
- Alkaline impregnated media (for good HF reaction)

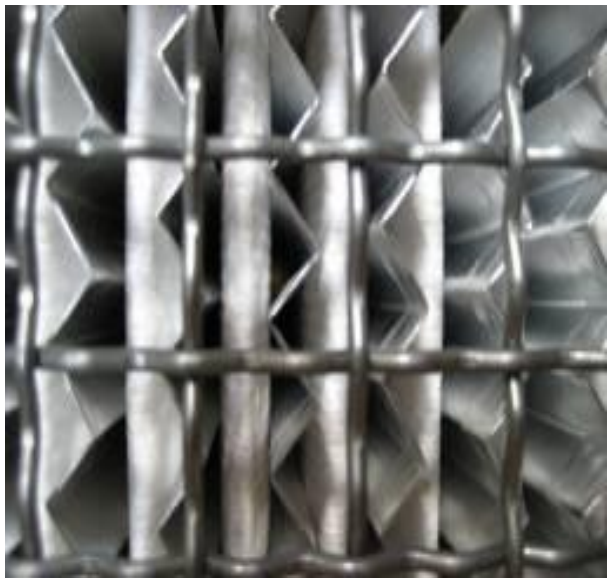
Enforced solution for high pressure applications

System for up to 40.000 Pa under pressure Up to +- 50.000 Pa pressure

Cleanable HEPA filters

Used for:

- Dismantling
- Other high dust applications



Questions??

THANK YOU VERY MUCH!