Investigation of Techniques to Improve Continuous Air Monitors Under High Dust Loading in Environmental Setting

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Introduction

Transport of transuranic nuclear waste on public roads and extensive D&D projects created an urgent need for measurement of airborne plutonium during an accident or site restoration

Construction and improvement of an Environmental Continuous Air Monitors (ECAM) capable of detecting airborne plutonium under harsh conditions were undertaken by LANL in collaboration with Canberra Industries and New Mexico Tech

Project Objectives

Improvements and Performance Optimization of Environmental Continuous Air Monitors (ECAM)

In-depth study of degradation of ECAM performance caused by environmental factors (dust loading, radon progeny)

Selection of ECAM optimum performance parameters (filter media, inlet design, alpha detectors)

Current ECAM

FUNCTION CONCEPTS:

Deaccelerate wind, sample at 4 CFM,

Remove particles with D_p>10 µm

Collect 256-channel alpha energy spectra

Transmit spectral data/air volume/met data to base station

Spectral analysis for removal of Rn progeny interference

Compute Pu DAC·hr & project doses

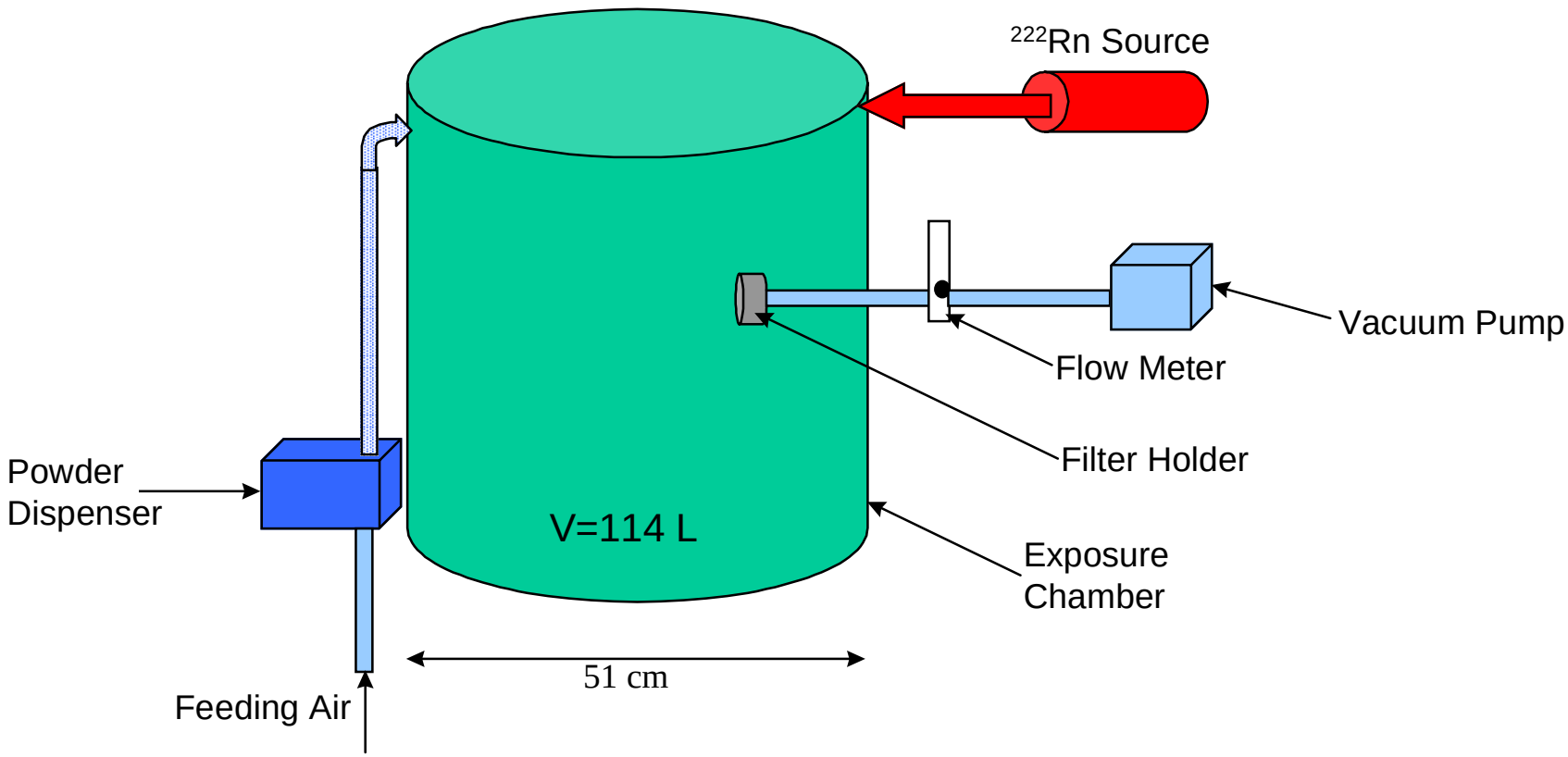
Methods

Laboratory studies on degradation of alpha energy spectra caused by dust loading using radon progeny

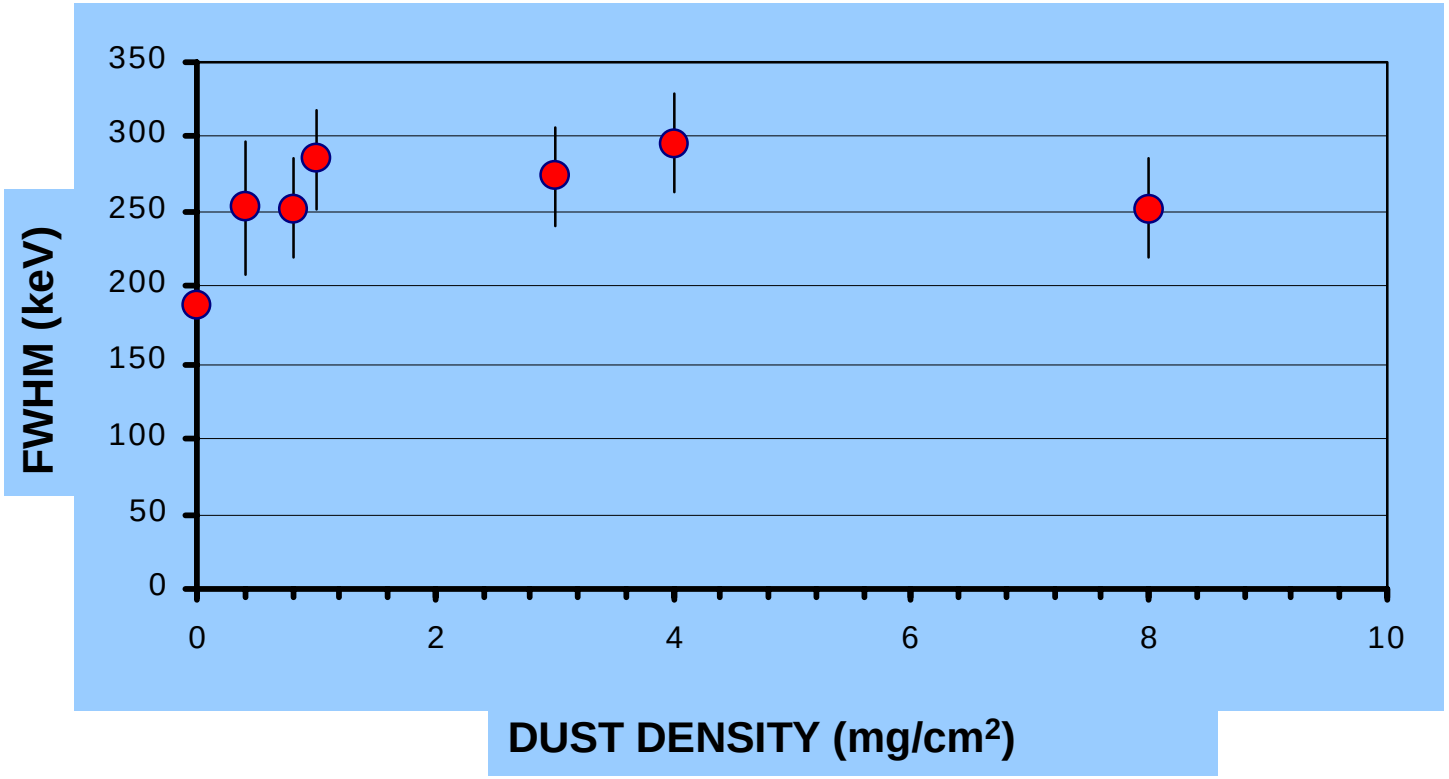
Time-lapse video microscopy of aerosol particle deposition on ECAM filters

Use of pulsed ionization chamber (PIC) as a possible large-area environmental alpha detector

Aerosol Test Chamber

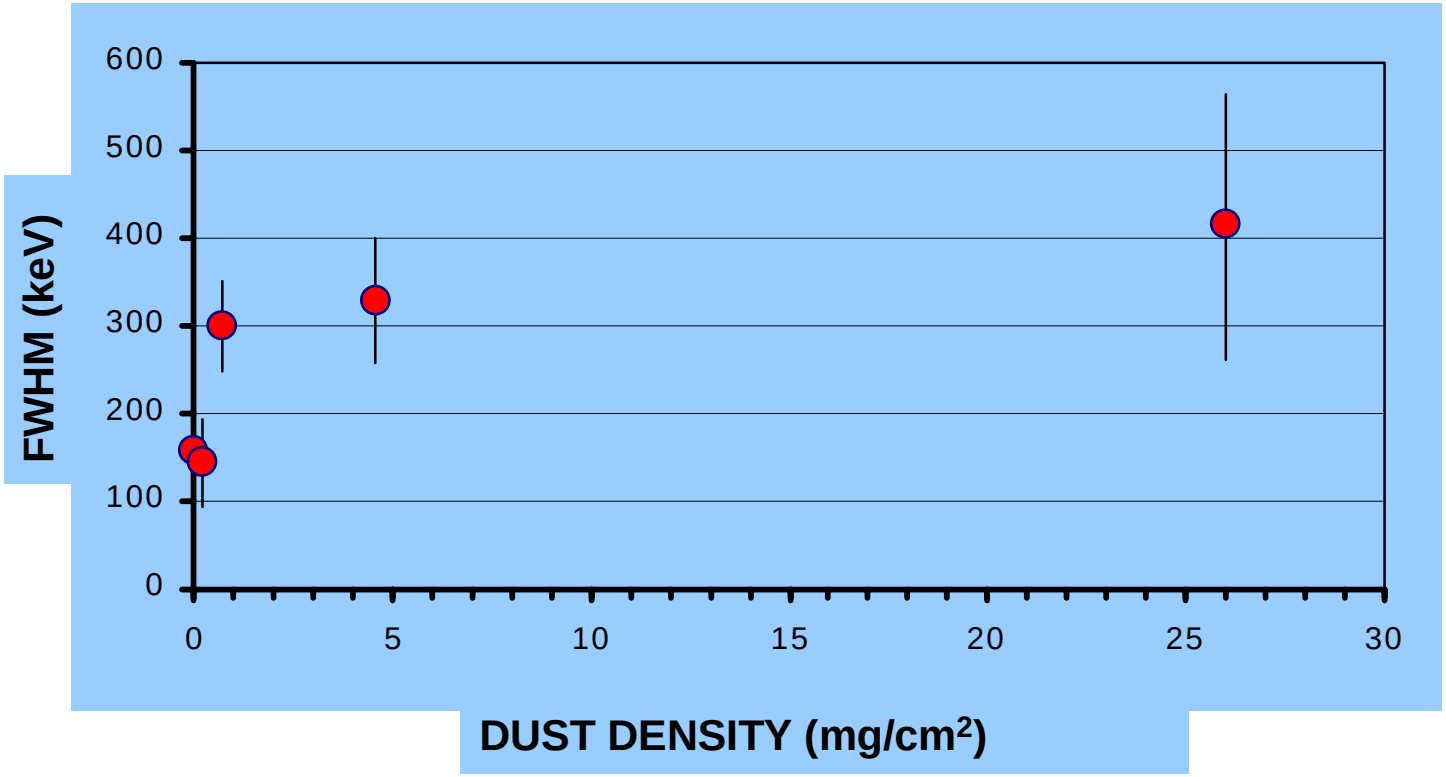


Degradation in Alpha Resolution Under Dust Loading



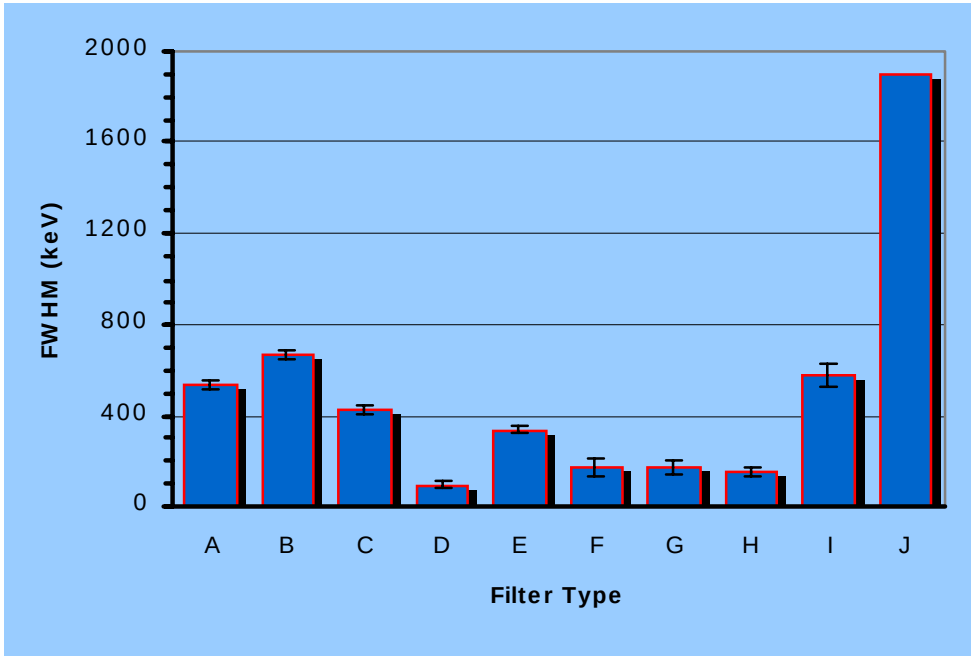
filter: Corning FNMB 1.0 µm, dust: Portland cement, alpha peak: 7.69 MeV, detector: surface barrier

Degradation in Alpha Resolution Under Dust Loading



filter: Millipore SS 3 µm, dust: Portland cement, alpha peak: 7.69 MeV, detector: PIC

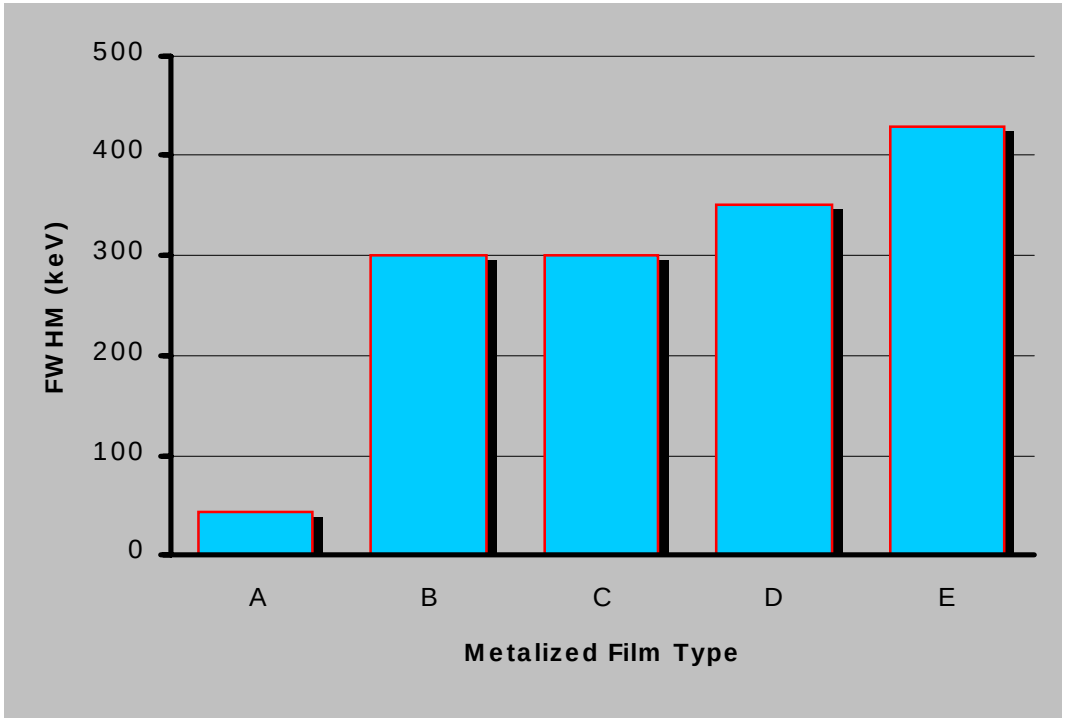
Filter Performance in PIC



A - Corning MFMB (5.0 µm)
B - Corning MFMB (3.0 µm)
C - Corning MFMB (1.2 µm)
D - Corning FNMB (1.0 µm)
E - Millipore RA (1.2 µm)
F - Millipore PH (0.3 µm)
G - Millipore FS (3.0 µm)
H - Millipore SS (3.0 µm)
I - Gelman A/E
J - Gelman Whatman 41

filters covered with metalized film B(10), alpha: 7.69 MeV, PIC intrinsic resolution: 50 keV

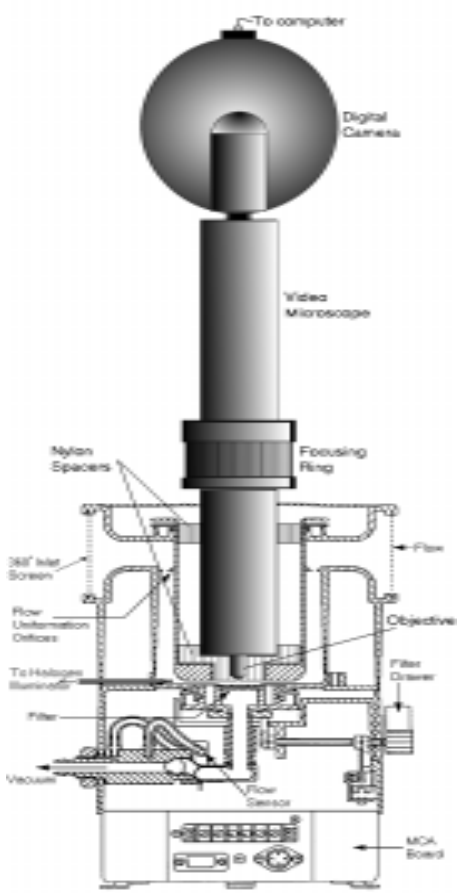
Degradation of Energy by PIC Window



A - none (reference)
B - B(8) 0.20 mg cm^{-2}
C - B(10) 0.25 mg cm^{-2}
D - B(10HH) 0.29 mg cm^{-2}
E - B(17) 0.45 mg cm^{-2}

film supplier: Alexander Vacuum Research, Greenfield, MA, alpha: 4.68 MeV

Aerosol Imaging System

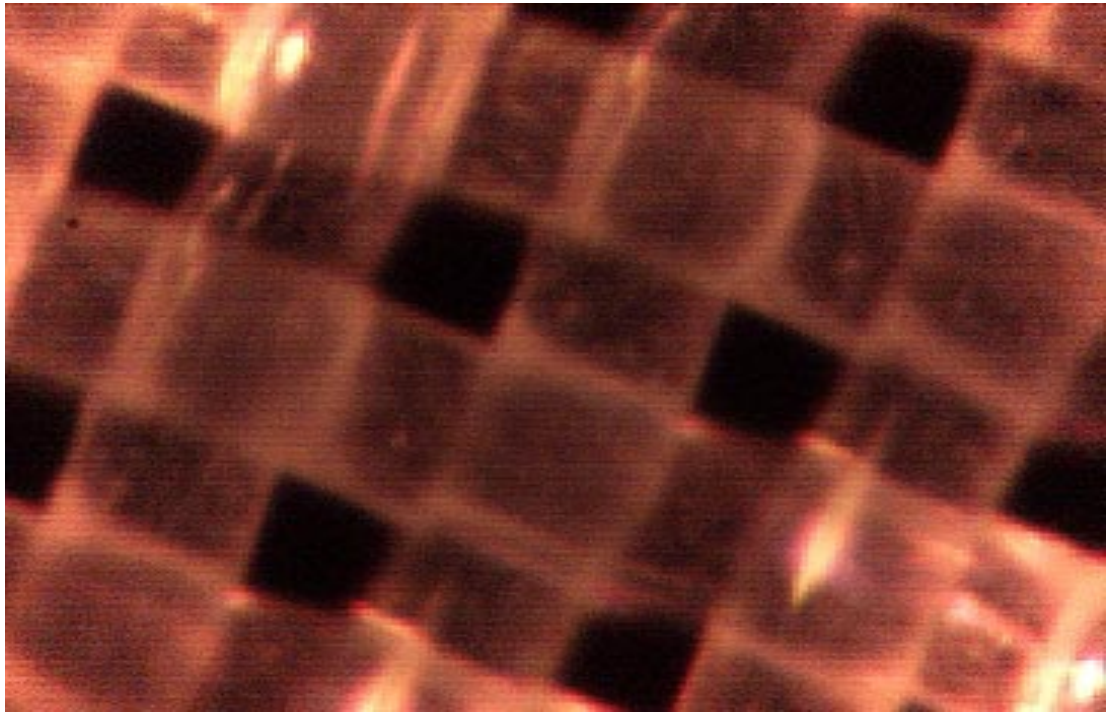


Canberra Alpha Sentry CAM modified for visual observations of aerosol particles deposited on the CAM filter.

Main Components:

1) Canberra CAM
2) InFocus microscope
3) halogen illuminator
3) Pixera digital camera
4) laptop PC

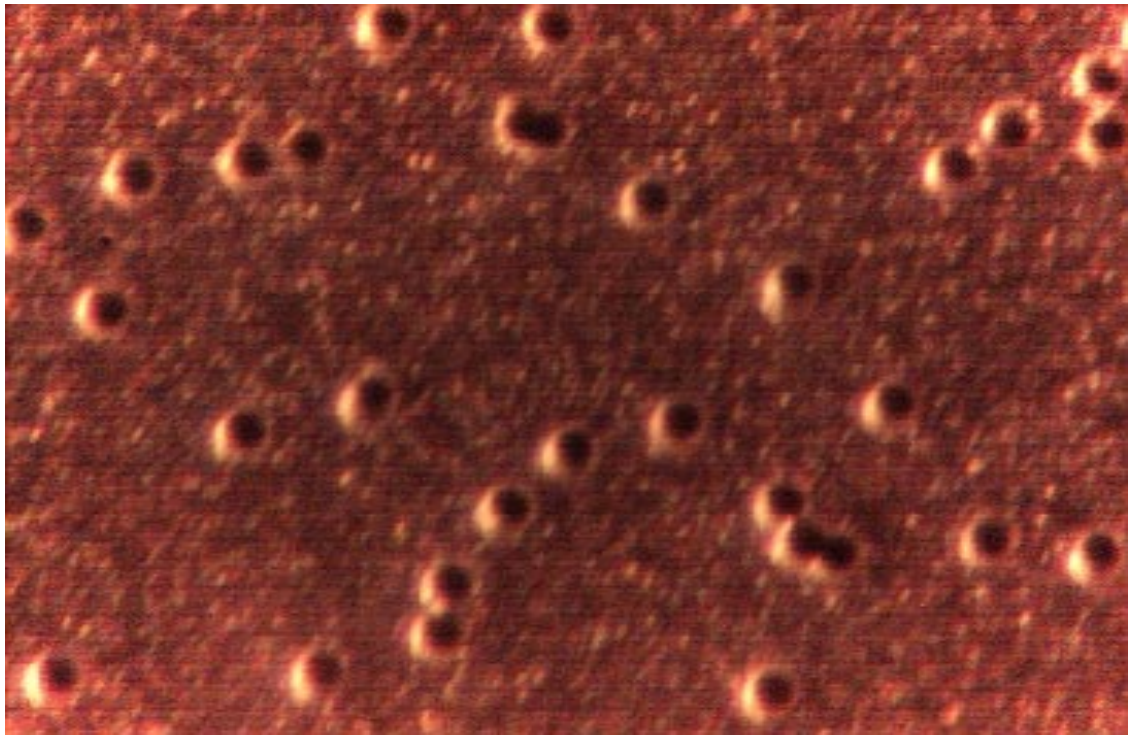
Test Digital Image



Millipore Nylon Net Filter Type NY20

Pore size: 20.0 µm

Test Digital Image



Nuclepore Track-Etch Membrane,
Pore size: 8 µm

Conclusions

Minimal degradation in alpha spectra for dust loading in the range of 0.8 - 8.0 mg cm^{-2}

PIC with a thin window may be a suitable detector for large area alpha spectroscopy

Digital video imaging technology helpful in understanding aerosol particle deposition on ECAM filters

Acknowledgements

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