Development of samplers for aerosol fractions deposited in two regions of the respiratory tract
– the gas-exchange region and the posterior head airways

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Rationale

Measurement of welders' exposure to manganese (Mn)

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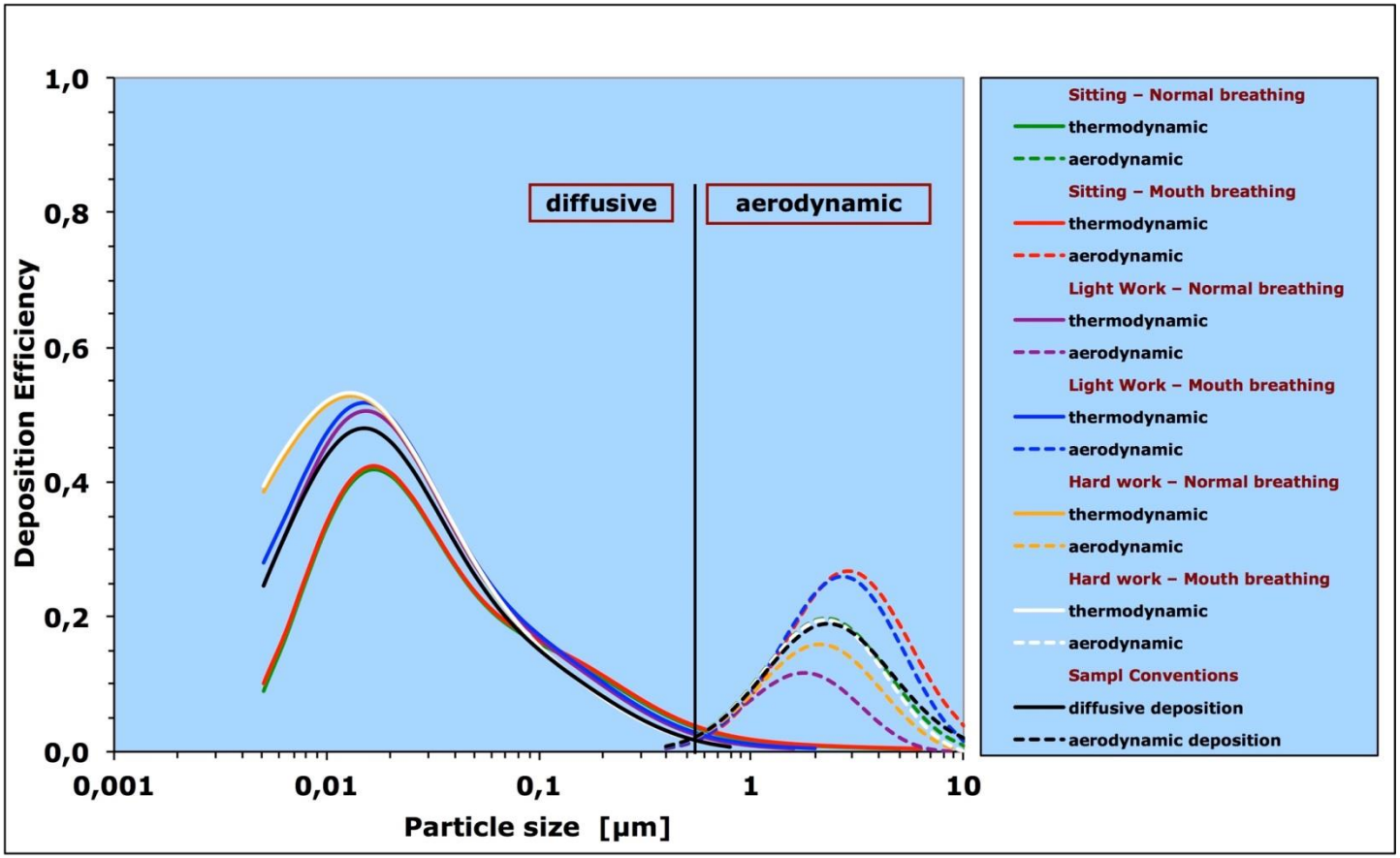
- Mn is neurotoxic
  - Accumulates in mainly in Basal Ganglia in the brain
  - Enters (mainly) across Blood-Brain-Barrier
- Only two important deposition regions for exposure to occupational airborne Mn-containing particles
  - Gas-Exchange region followed by dissolution + transfer to blood
    - Macrophages
    - Extra-cellular liquid
  - Olfactory mucosa at top of nose
    - Transfer to olfactory bulb via olfactory nerve
    - Further in-Brain transport to Basal Ganglia possible
  - Mn deposited in other regions end up in Gastro-Intestinal tract
    - Uptake of Mn in GI tract extremely well regulated
    - Mn is an essential element

Deposition Efficiency

EN ISO13138:2012 *Air Quality — Sampling conventions for airborne particle deposition in the human respiratory system* based on ICRP Report

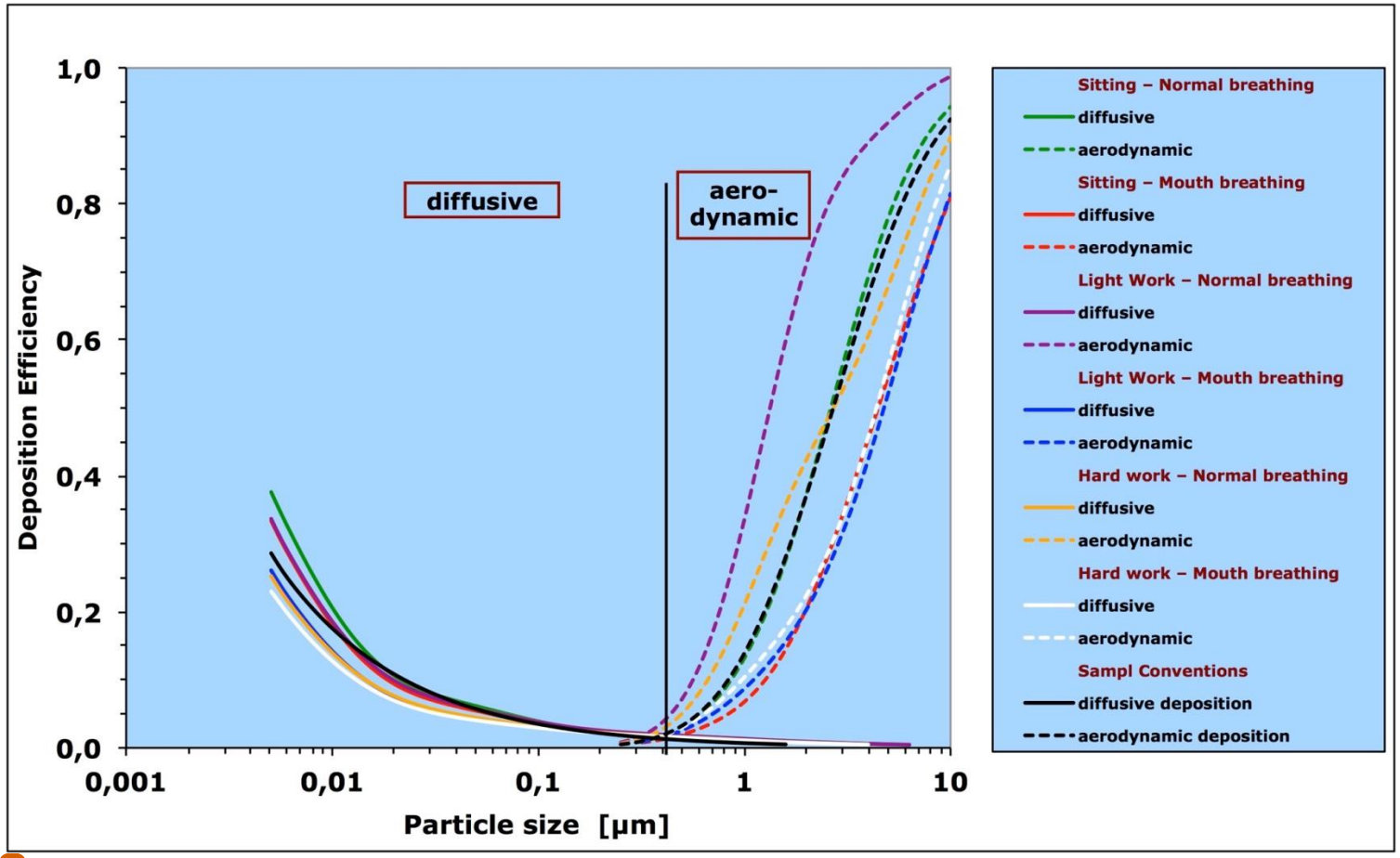
Gas-Exchange (GE) region — Workload & Normal/Mouth breathing



Deposition Efficiency

EN ISO13138:2012 *Air Quality — Sampling conventions for airborne particle deposition in the human respiratory system* based on ICRP Report

Extra-Thoracic (ET1+ET2) regions — Workload & Normal/Mouth breathing



Principles for sampler design

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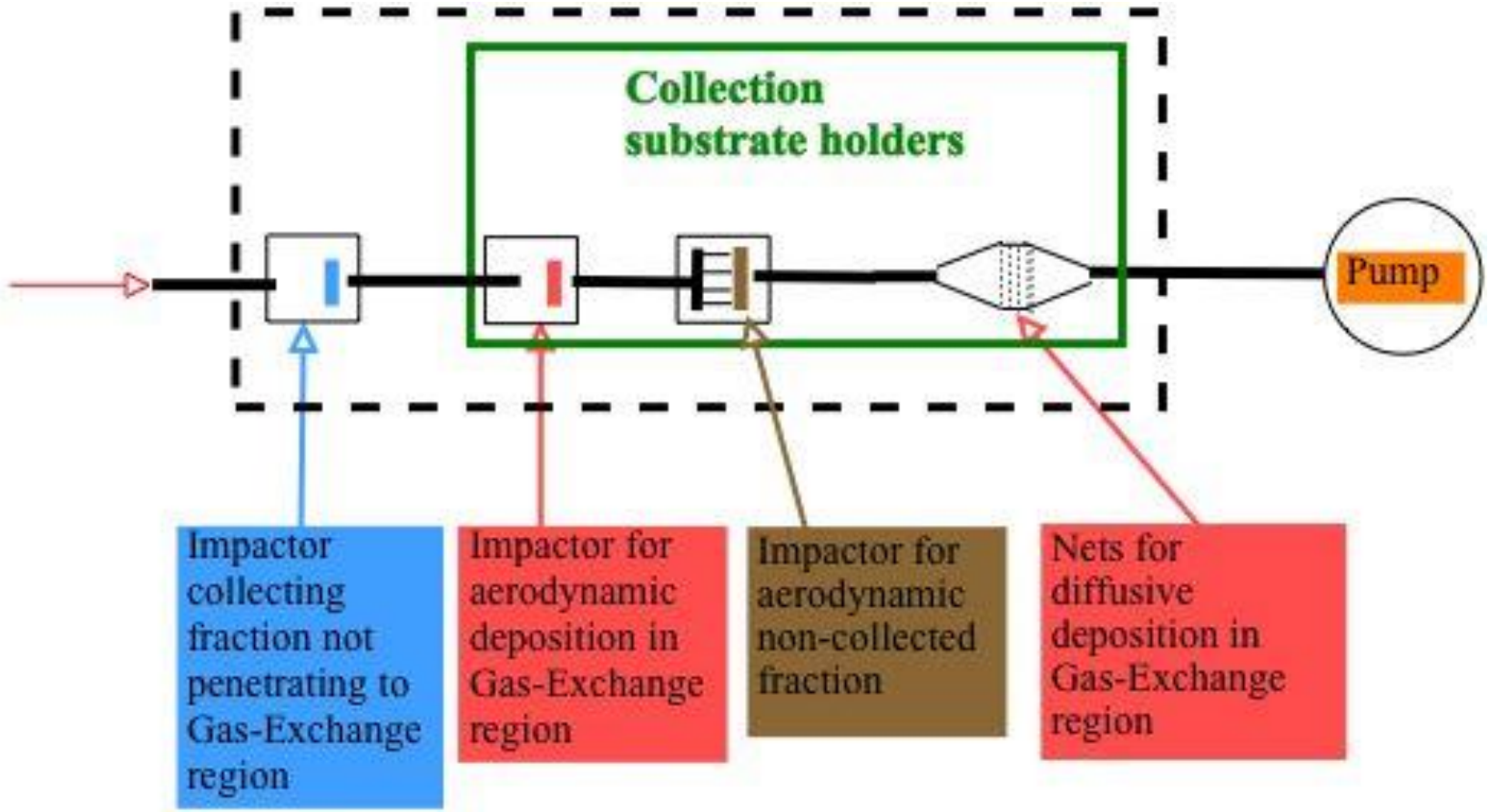
- Small and light sampler
  - Airflow 1-2 LPM
  - Similar as possible for both fractions
- Use available filters, diffusive screens, etc.
  - 13 & 25 mm
- Collection on two stages
  - Aerodynamic
    - Impactor
  - Diffusive
    - Nylon mesh nets
  - Minimal deposition due to diffusion on aerodynamic stage, and opposite
  - Separate large particles from diffusive (second) stage by protective impactor

Design GE sampler



Design of samplers (1)

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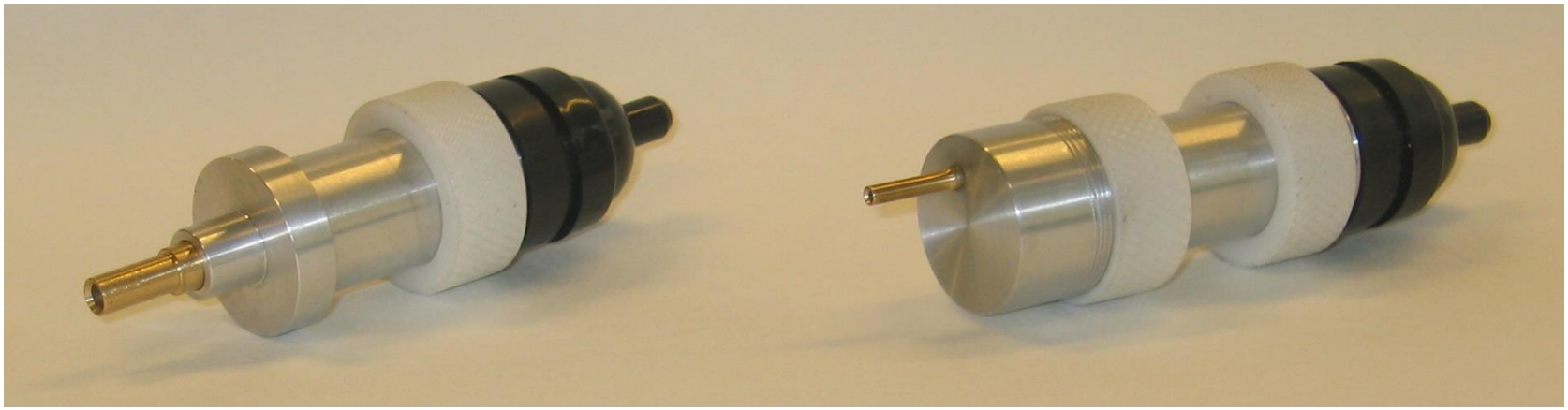
- Both samplers almost identical
  - Q=1.2 LPM
- Apart from
  - Entrance sections
    - Incl. penetration impactor for GE sampler
  - Deposition impactor and tube to collection substrate
    - Different cut-sizes between GE & ET samplers



Design of samplers (2)

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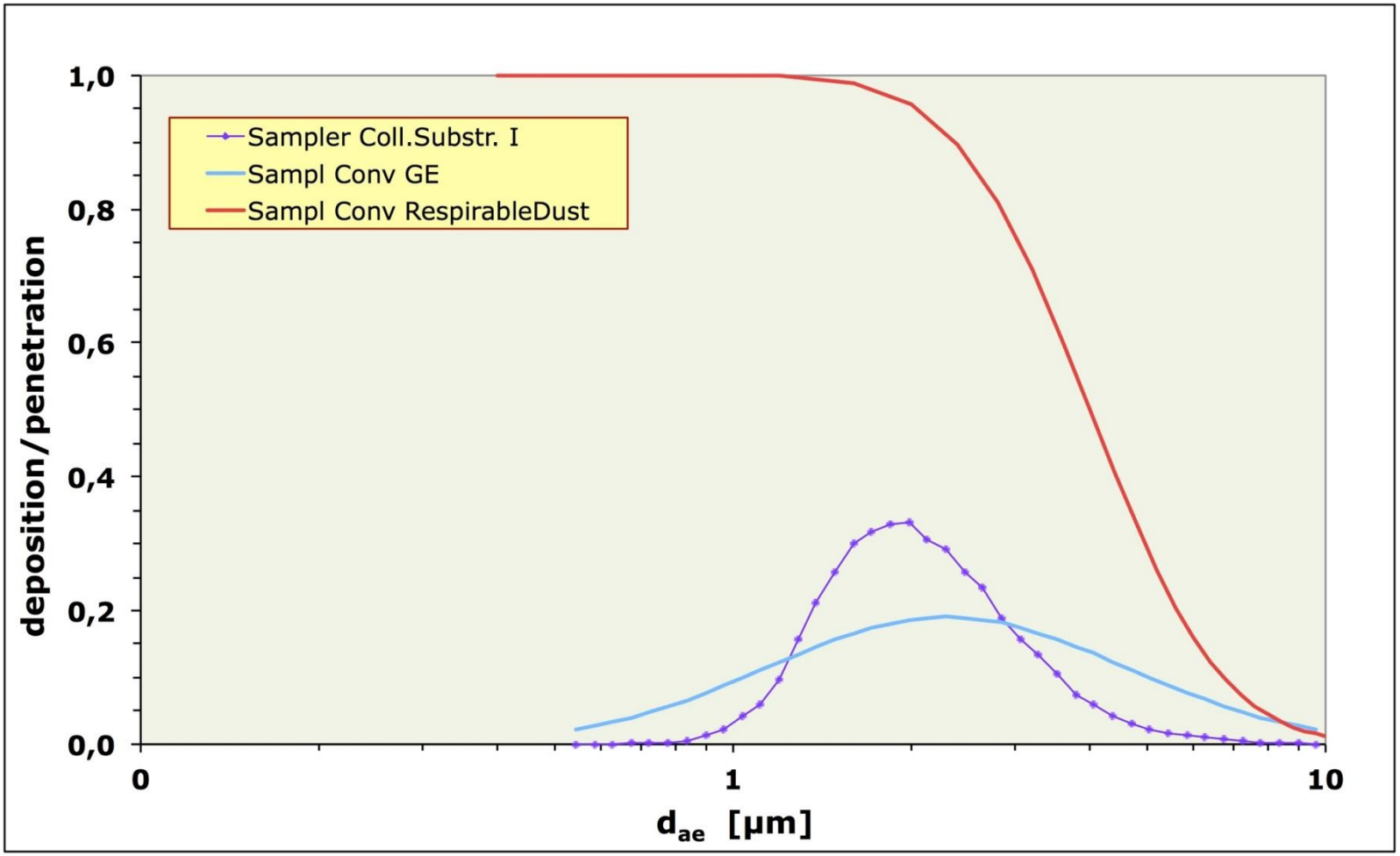
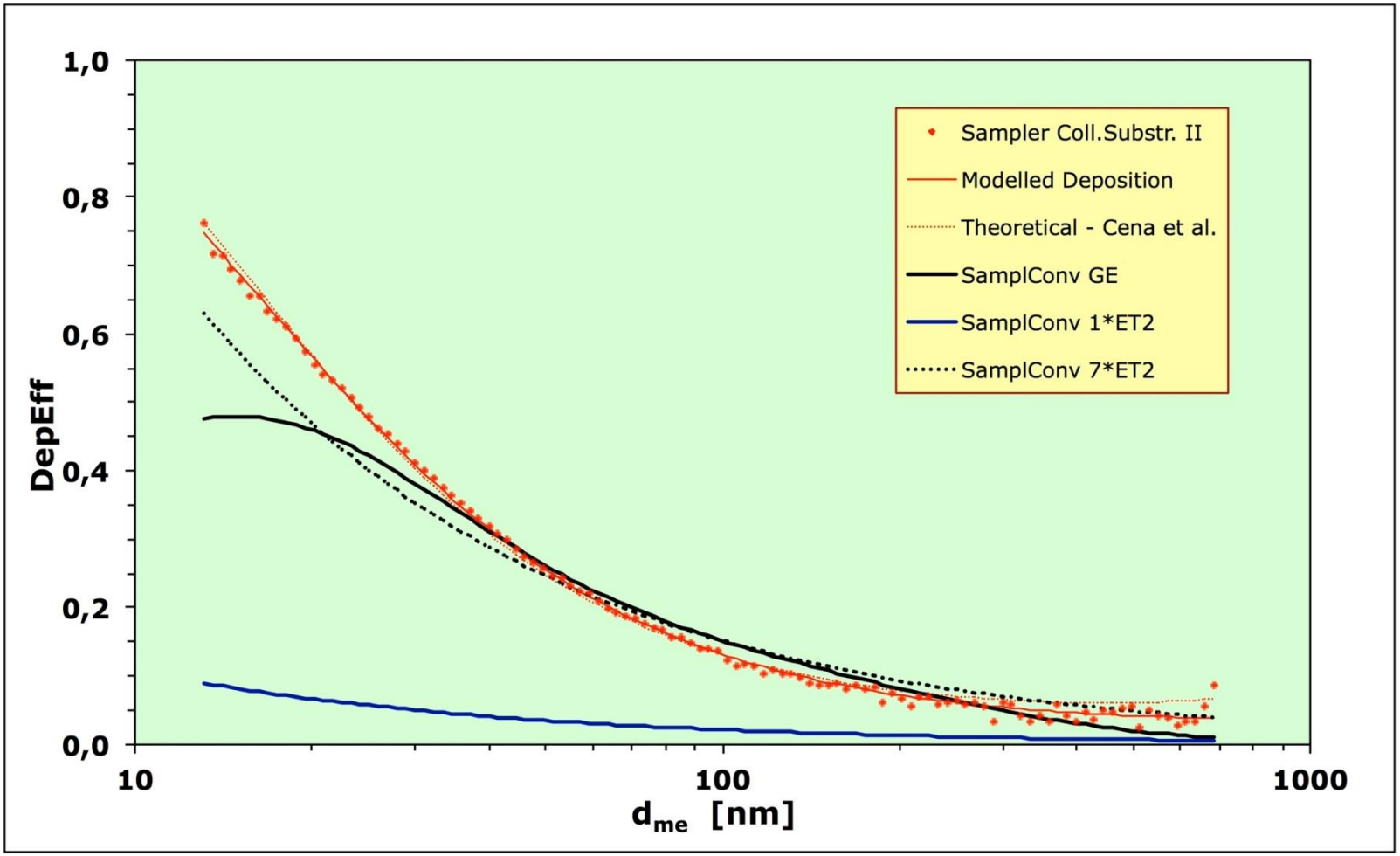
- Penetration impactor (aerodynamic collection stage)
  - Uni-nozzle
  - Designed to have a non-sharp separation curve – $S/W \approx 17$
- Deposition impactor (aerodynamic collection stage)
  - Uni-nozzle
  - Designed to have a non-sharp separation curve – $S/W \approx 17$
  - Collection substrate: oil-soaked filter
- Protective impactor
  - Multi-nozzle
    - 7*Ø0.30 mm
  - Collection substrate: high-vacuum grease (sample discarded)
- Mesh nets
  - Combination of two different nylon nets
    - 4*NY41 + 1*NY20

Aerodynamic collection stage (1)
Sampler collection stage I

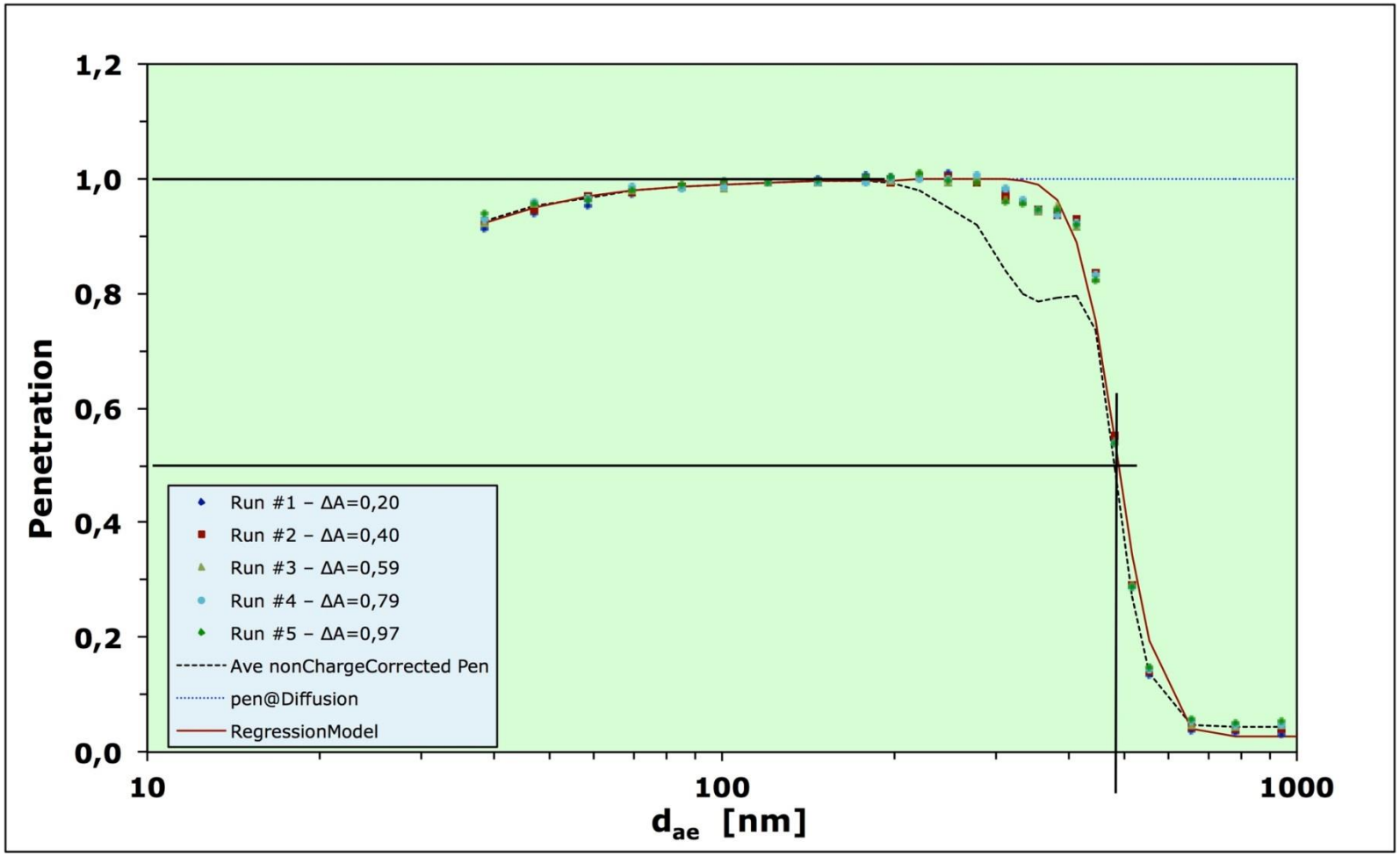


Diffusive collection stage (1)

Sampler collection stage II



Protective impactor (1)
Aerodynamic collection



Summary

- Neurotoxic Mn mainly deposits in Gas-Exchange (GE) and Extra-Thoracic 2 (ET2) regions
- Designed and tested two samplers for airborne particles depositing in these regions
  - Consists of two collection stages
    - Aerodynamic and diffusive collection
  - Protective impactor to prevent aerodynamic deposition in diffusive mesh nets
- Aerodynamic separation – GE_{ae} & $1.5*ET2_{ae}$
  - Mainly qualitative agreement between sampler separation curve and sampling convention
- Diffusive separation – GE_{de} & $7*ET2_{de}$
  - Good agreement between sampler separation curve and sampling convention
- Thanks to
  - A. Gudmundsson (EAT/Design/LTH/LU), J. Waher & L. Bäcklin (ACES/SU) & D. Bartley (exNIOSH)