DUSTINESS OF NANOMATERIAL IN POWDER: OUTCOMES OF THE PRE-NORMATIVE RESEARCH PROJECT CARRIED OUT UNDER THE *M461* EUROPEAN MANDATE.

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Claire Dazon[1], Olivier Witschger[1], Sébastien Bau[1], Keld A. Jensen[2], Elzbieta Jankowska[3], Ilse Tuinmann[4], Delphine Bard[5], Dirk. Dahman[6],

1. Institut National de Recherche et de Sécurité (INRS), France
2. National Research Centre for the Working Environment (NRCWE), Denmark
3. Central Institute for Labour Protection – National Research Institute (CIOP–PIB), Poland
4. TNO Quality of Life, The Netherlands
5. Health and Safety Laboratory (HSL), UK
6. Institut für Gefahrstoff–Forschung (IGF), Germany

Plan

1	Dustiness? Useful for what? What is this M461 mandate?
2	The pre-normative research project
3	The resulting normative documents
4	What perspectives?

Dustiness? Useful for what?

What is this M461 mandate?

Dustiness?

- Generic term used to define the *ability* of a powdered material (e.g., loose, granulated, or pelletized powders) to generate an aerosol (airborne particles) during handling.
- In OH, this *ability* is expressed through *health-related mass fractions*:

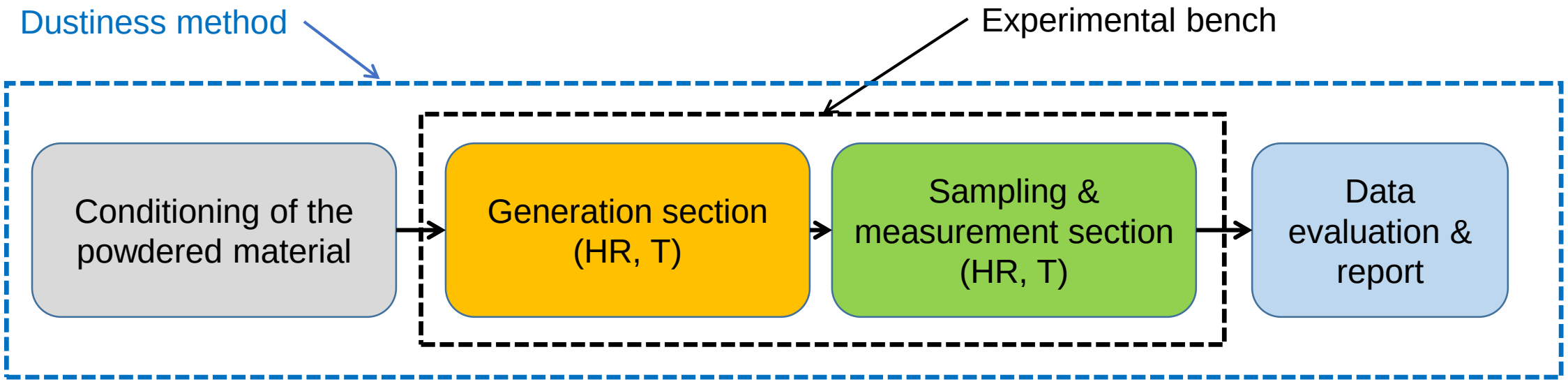
$$w_{f,X} = \frac{\Delta m_f}{m_{sample}} \quad \text{(mg/kg)}$$

f: inhalable, thoracique, respirable → EN 481 & ISO 7708

- Three EU standards → EN15051-1 (2013); EN15051-2 (2016) and EN15051-3 (2013).

Dustiness?

- It is NOT an intrinsic physically or chemically defined property of a powder; its level depends :
  - on the physicochemical properties of the powder & particles
  - the environmental conditions during the experiment,
  - the *energy* supplied in the experimental bench that simulates a given handling (or release) scenario.



Dustiness?

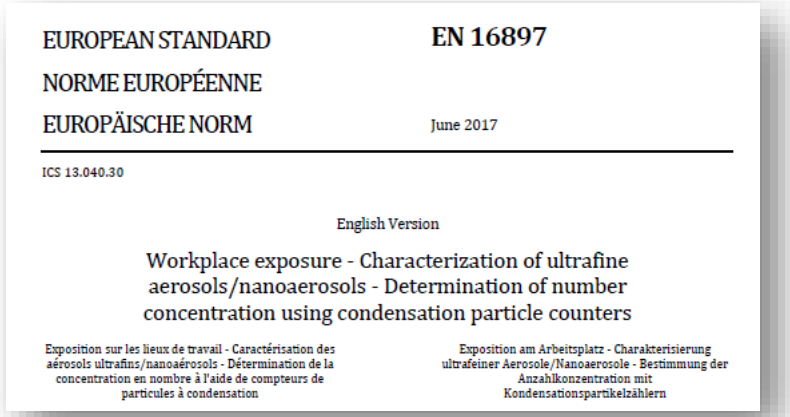
- Keywords for the development of a dustiness method : time, consensus, harmonization, transparency, reliability, repeatability, reproducibility, standardization etc.

Useful for what?

- Important determinant for worker exposure and is (should be) considered during the design and operation of many industrial or research processes.

- It can be used in order to:
  - classify powdered materials according to their propensity to emit dust and thus aid occupational hygienists and process engineers to evaluate and control the health risk of aerosol,
  - produce less dusty powdered materials (e.g. modify surface properties or chemistry),
  - lower aerosol exposure in workplaces while using these powdered materials in specific industrial sectors (e.g. construction, chemicals or industrial minerals),
  - determine the exposure band in control banding tools,
  - input data in aerosol transfer simulation tools, etc.

Mandate 461?



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 16897

June 2017

ICS 13.040.30

English Version

Workplace exposure - Characterization of ultrafine aerosols/nanoaerosols - Determination of number concentration using condensation particle counters

Exposition sur les lieux de travail - Caractérisation des aérosols ultrafins/nanoaérosols - Détermination de la concentration en nombre à l'aide de compteurs de particules à condensation

Exposition am Arbeitsplatz - Charakterisierung ultrafeiner Aerosole/Nanoaerosole - Bestimmung der Anzahlkonzentration mit Kondensationspartikelzählern

- Through mandate M/461 the EC asks ESO

to develop Standards in relation to:

  - Characterization of and exposure from nanomaterials
  - Health, Safety, and Environment

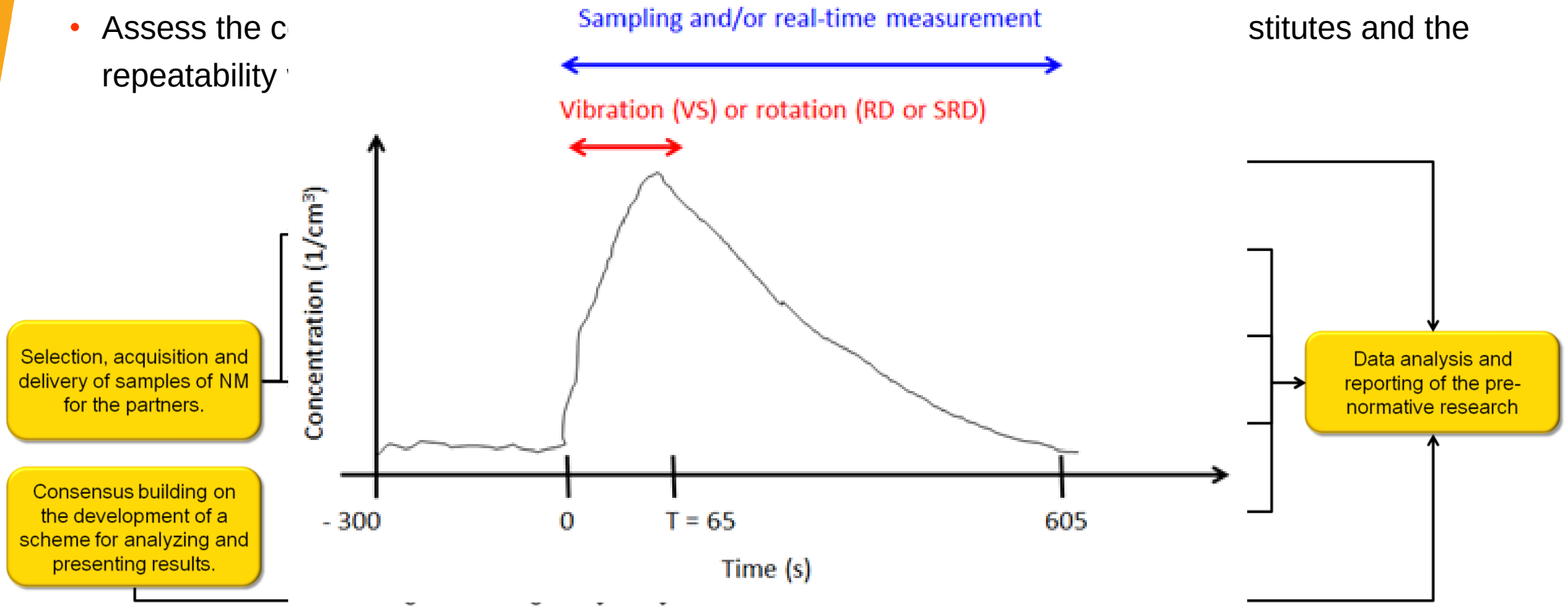
- CEN/TC 137/WG 3 “Particulate matter” proposes to develop 8 Standards:
  - WI#1: Particle number concentration measurement by CPC → EN16897 (June 2017)
  - WI#2: Assessment of inhalation exposure to NOAA → prEN17058
  - WI#3: Guidance on metrics to be used for the measurements exposure to NOAA → prEN 16966
  - WI#4: Measurement of dustiness of bulk nanomaterials → *to be presented now*

➢ Each WI requires to carry out pre-normative research

The prenormative research project

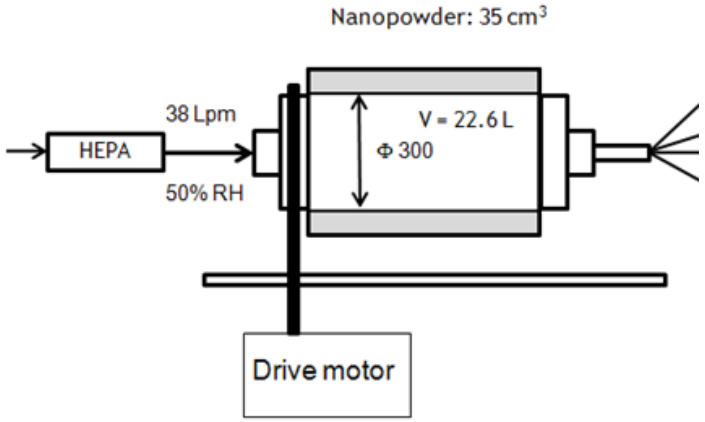
Objectives and progress of the project

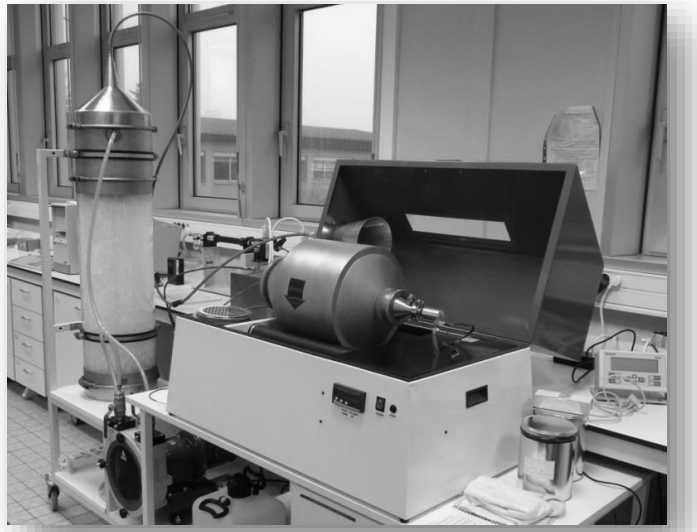
- Develop a harmonized approach for evaluating dustiness for powdered NM taking into account different concepts and test systems
- Assess the c stitutes and the repeatability



Selected methods

- Four selected, which are different in their concept of agitation and energy input
  I. The rotating drum





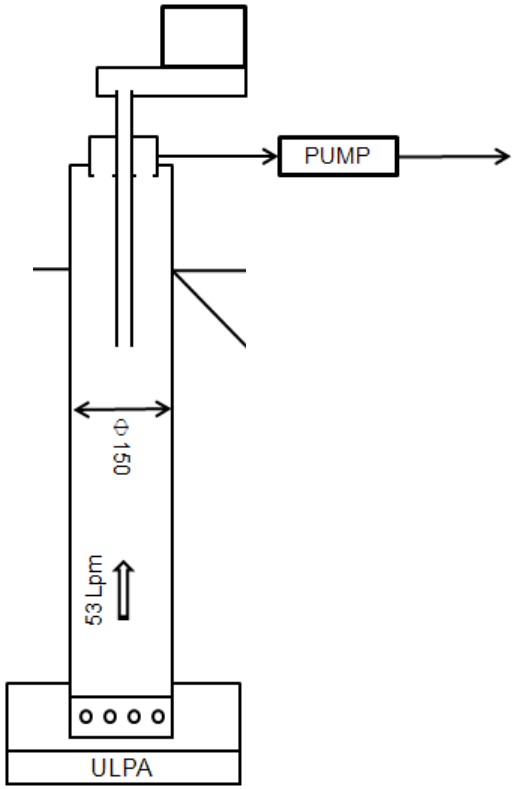
Adapted from EN15051

Availability: HSL, TNO

References: Tsai et al. (2009, 2011, 2012); Burdett et al. (2013), …

Selected methods (cont'd)

- Four selected, which are different in their concept of agitation and energy input
  I. The rotating drum
  II. Continuous drop



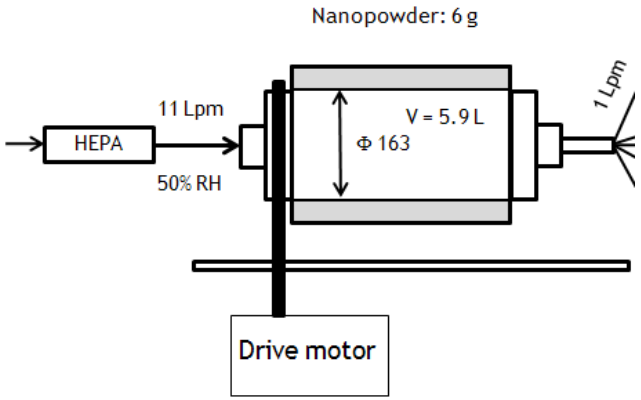
Adapted from EN15051

Availability: IGF, TNO

References: Dahmann and Monz (2011), …

Selected methods (cont'd)

- Four selected, which are different in their concept of agitation and energy input
  I. The rotating drum
  II. Continuous drop
  III. Small rotating drum

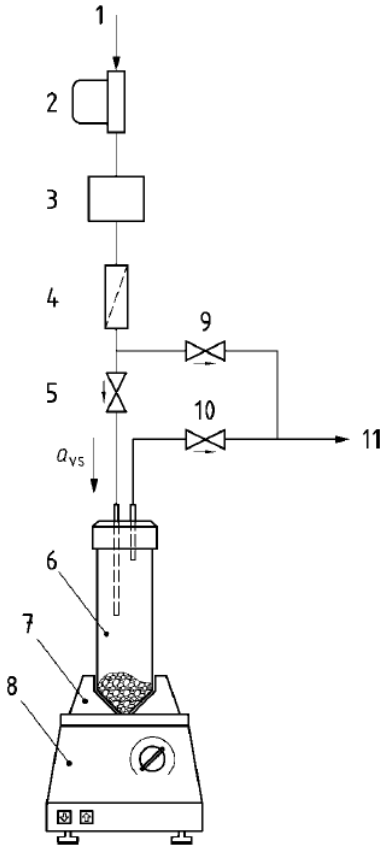


Availability: NRCWE, INRS

References: Schneider and Jensen (2008, 2009), Jensen et al. (2009), ⋯

Selected methods (cont'd)

- Four selected, which are different in their concept of agitation and energy input
  I. The rotating drum
  II. Continuous drop
  III. Small rotating drum
  IV. Vortex shaker



Availability: INRS, CIOP

References: Maynard et al. (2004), Ogura et al. (2008), Ku et al. (2006, 2013), ⋯

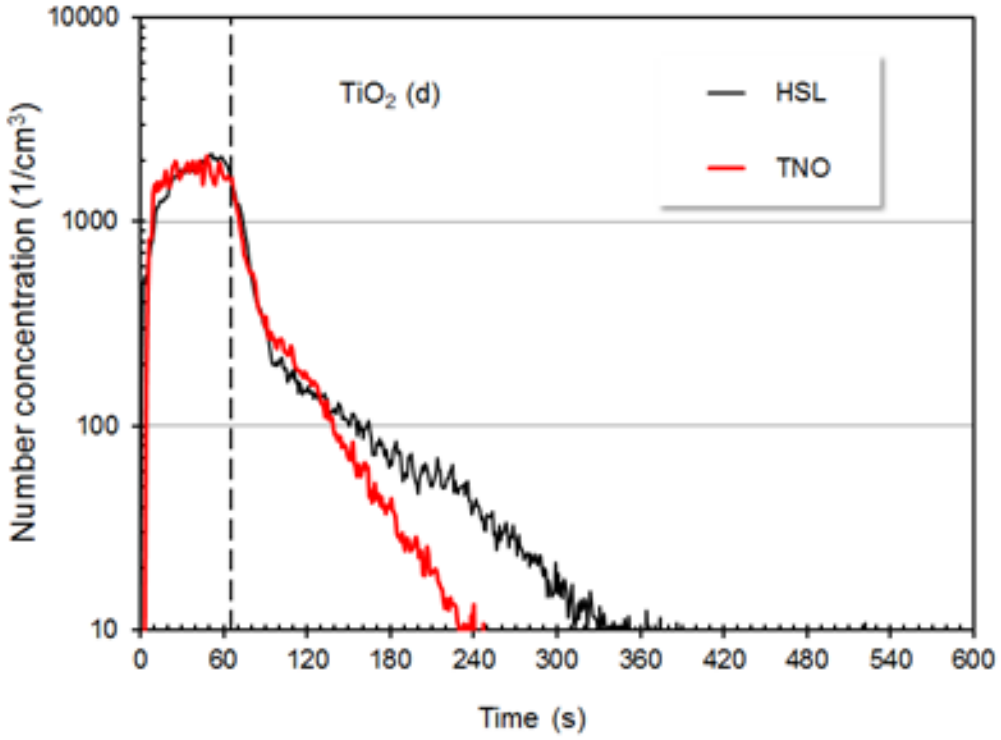
Measurement

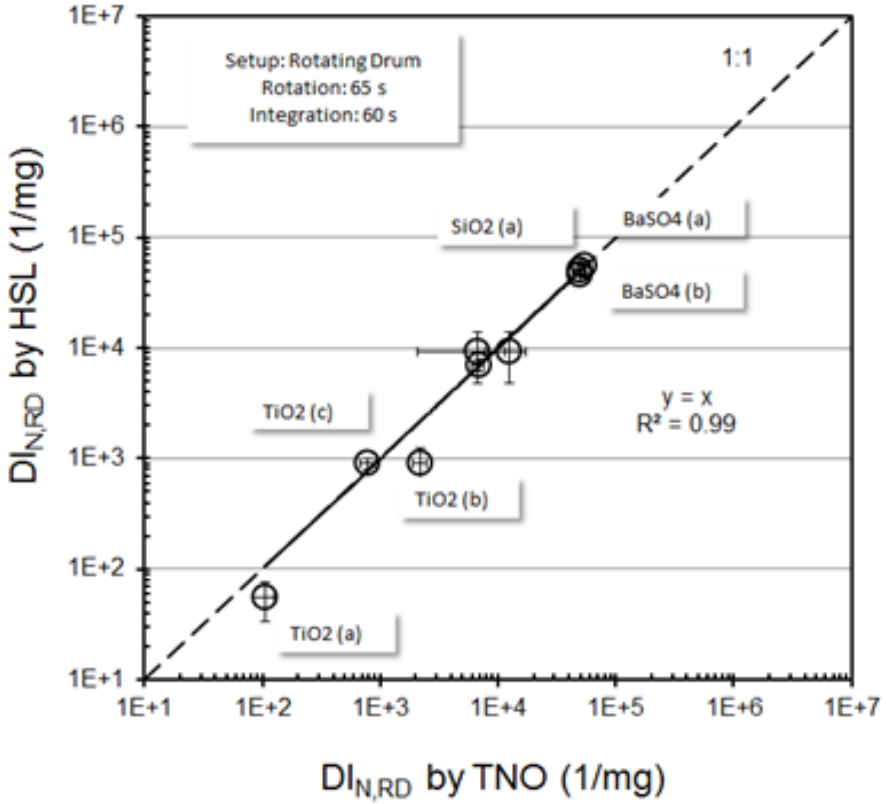
- The real-time instrumentation and sampling devices have been chosen in order to be able to determine the parameters to quantify the released aerosols.

- It was therefore decided to used:

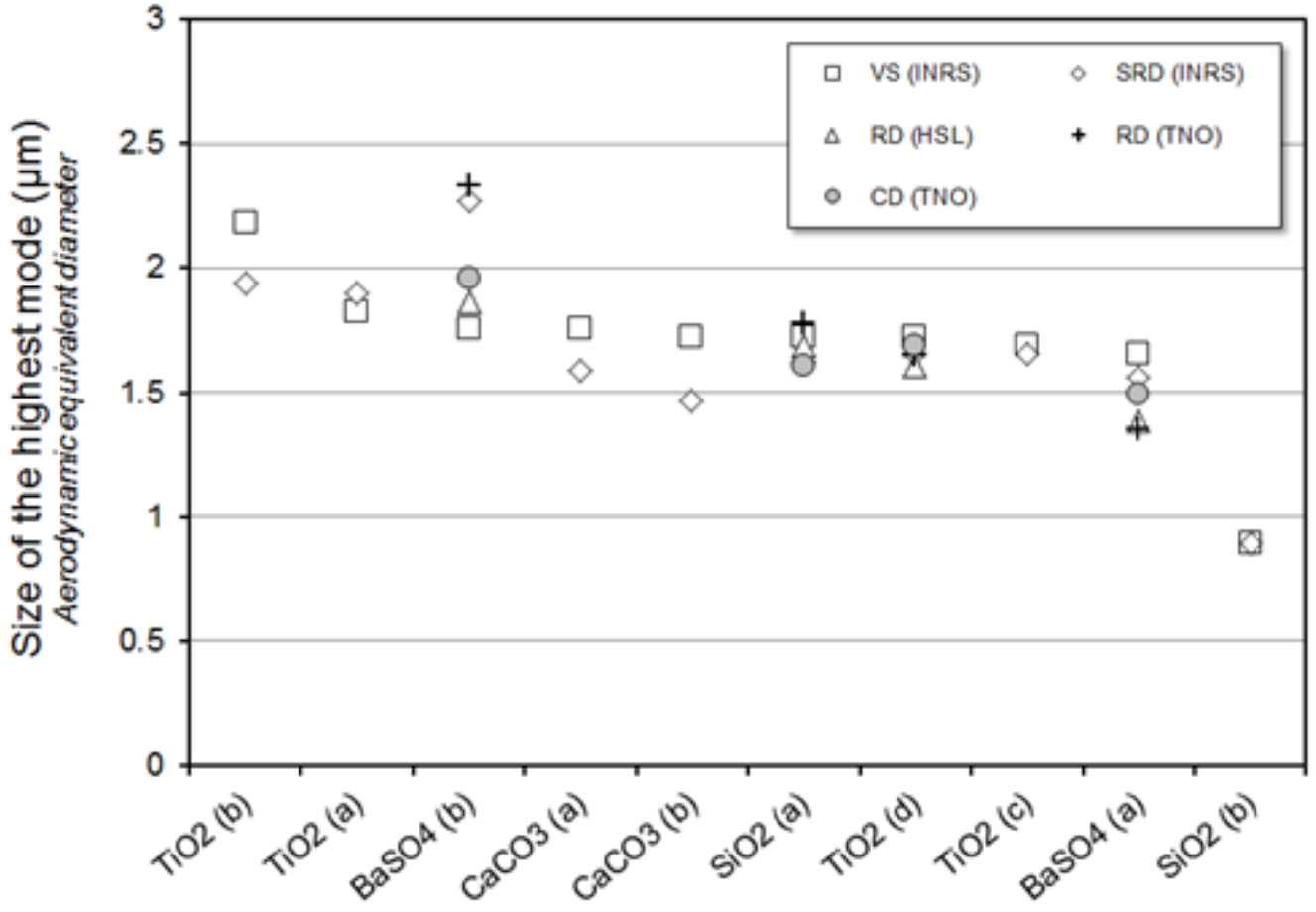
  - a respirable cyclone (GK 2.69, BGI MesaLabs) for gravimetric sampling.
  - a Condensation Particle Counter (3007, TSI) as reference instrument for number concentration measurement
  - the Mini Particle Sampler (MPS, Ecomesure, France) for collection of particles for electron microscopy observations/analysis.
  - a single size-resolved aerosol instrument covering the entire particle size range from about 10 nm up to about 10 µm → ELPI or ELPI+ (Dekati).

Results (selection)





Results (selection)



The resulting normative documents

Five standards

- Workplace exposure - Measurement of dustiness of bulk materials that contain or release respirable NOAA and other respirable particles

  - Part 1: Requirements and choice of test methods → EN 17199-1
  - Part 2: Rotating drum method → EN 17199-2
  - Part 3: Continuous drum method → EN 17199-3
  - Part 4: Small rotating drum method → EN 17199-4
  - Part 5: Vortex shaker method → EN 17199-5

  - Formal Vote until 27 December 2018
  - Publication in March 2019

Perspectives

Perspectives

- Through this project, a certain number of points were highlighted which would require further research actions like on:
  - The influence of the moisture content on the dustiness of powders.
  - The development of methodologies to determine the volume-specific surface area for powders (including the case of mixing of powders).
  - The performance of size-resolved instruments with respect to aerosols released from powders (effective density, electrical charges, data processing, repeatability and reproducibility, etc.).
  - The development operational tools to qualify collected polydisperse particles (aggregates/agglomerates) from powders by electron microcopy analysis.

Perspectives (con't'd)

- Through this project, a certain number of points were highlighted which would require further research actions like on:
  - Correlation of NM quantity, dustiness, and processes with personal exposure should be assessed and validated with laboratory and workplace data
  - Research towards characterizing dustiness of more NMs
  - Inter-comparisons within methods and between methods
  - …

olivier.witschger@inrs.fr

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Merci de votre attention

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