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Towards an optimal adaptation of exposure to NOAA assessment methodology in multi-source industrial scenarios (MSIS): the challenges and the choices

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Motivation and context

- The **assessment of risks related to exposure to chemical agents at work** is a well-established process regulated by OHS European Directives (e.g. Directives 89/391/EC, 98/24/EC, 2004/37/EC) and national legislations that transpose the previous Directives.
- The availability of a suitable instrumentation, well-standardized procedures and limit values, makes **risk assessment a standardized routine tool in the practice of industrial hygiene**.
- In addition, this **methodology provides security and confidence in compliance with legislation**, both for the employer, the worker and its representatives, as well as for the competent public administration responsible for regulation.

Motivation and context

- **For airborne NOAA - chemical agents for all purposes-**, the already enforced occupational regulatory framework **should be also routinely applied to these particular situations by industrial hygienists.**
- However, despite the **significant research efforts** in recent years (new tiered approach, portable and personal instrumentation, proposed NRVs/OELs), **uncertainties** in the risk assessment process of exposure to NOAA in **complex scenarios** still affect significantly the **robustness of the results**, thus limiting the application of existing methods and strategies by industrial hygienists.

In real-life complex Multi-Source Industrial Scenarios (MSIS) uncertainty can significantly increase, mainly due to the lack of an effective distinction of a dynamic background aerosol.

Multi-Source Industrial Scenario (MSIS) characterized by spatially complex distributions of aerosol sources, as well as for potential differences in dynamics, due to the feasibility of multi-task configuration at a given time.

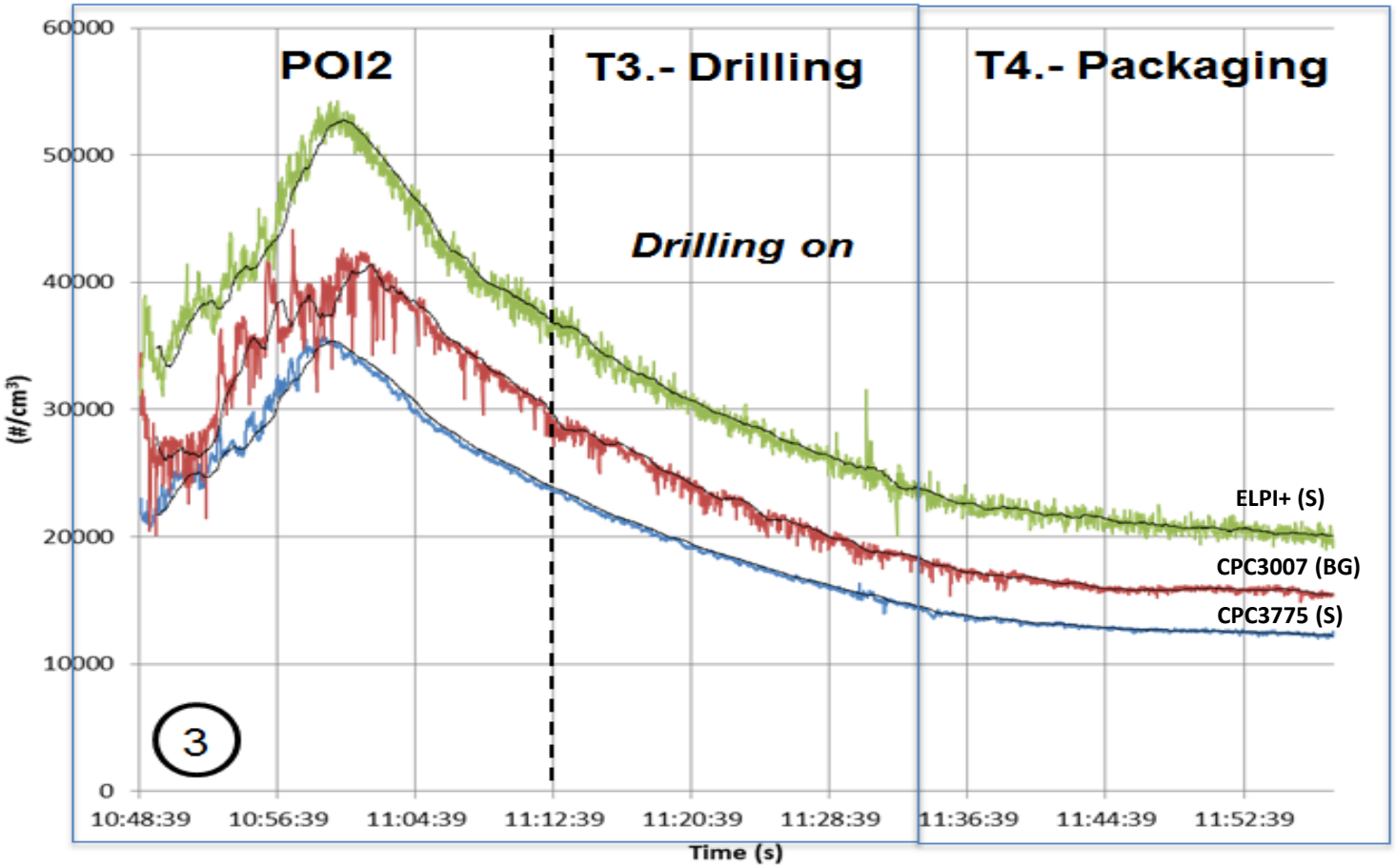
- *J M López de Ipiña, C Vaquero, C Gutierrez-Cañas and D Y H Pui "Analysis of multivariate stochastic signals sampled by on-line particle analyzers: Application to the quantitative assessment of occupational exposure to NOAA in multisource industrial scenarios (MSIS)" J. Phys. Conf. Ser. Vol. 617 (2015), conf. 1.*
- *C. Vaquero, C. Gutierrez-Cañas, N. Galarza, J.M. López de Ipiña "Exposure assessment to engineered nanoparticles handled in industrial workplaces: The case of alloying nano-TiO2 in new steel formulations" J. Aerosol Sci. Vol. 102, Dec. 2016, pp 1–15.*

Typical challenging situations and lessons learned

Here will be presented some examples of typical **challenging situations** from the basis of the **lessons learned** when confronted to those **complex industrial scenarios**, in the frame of some European and Spanish research projects:

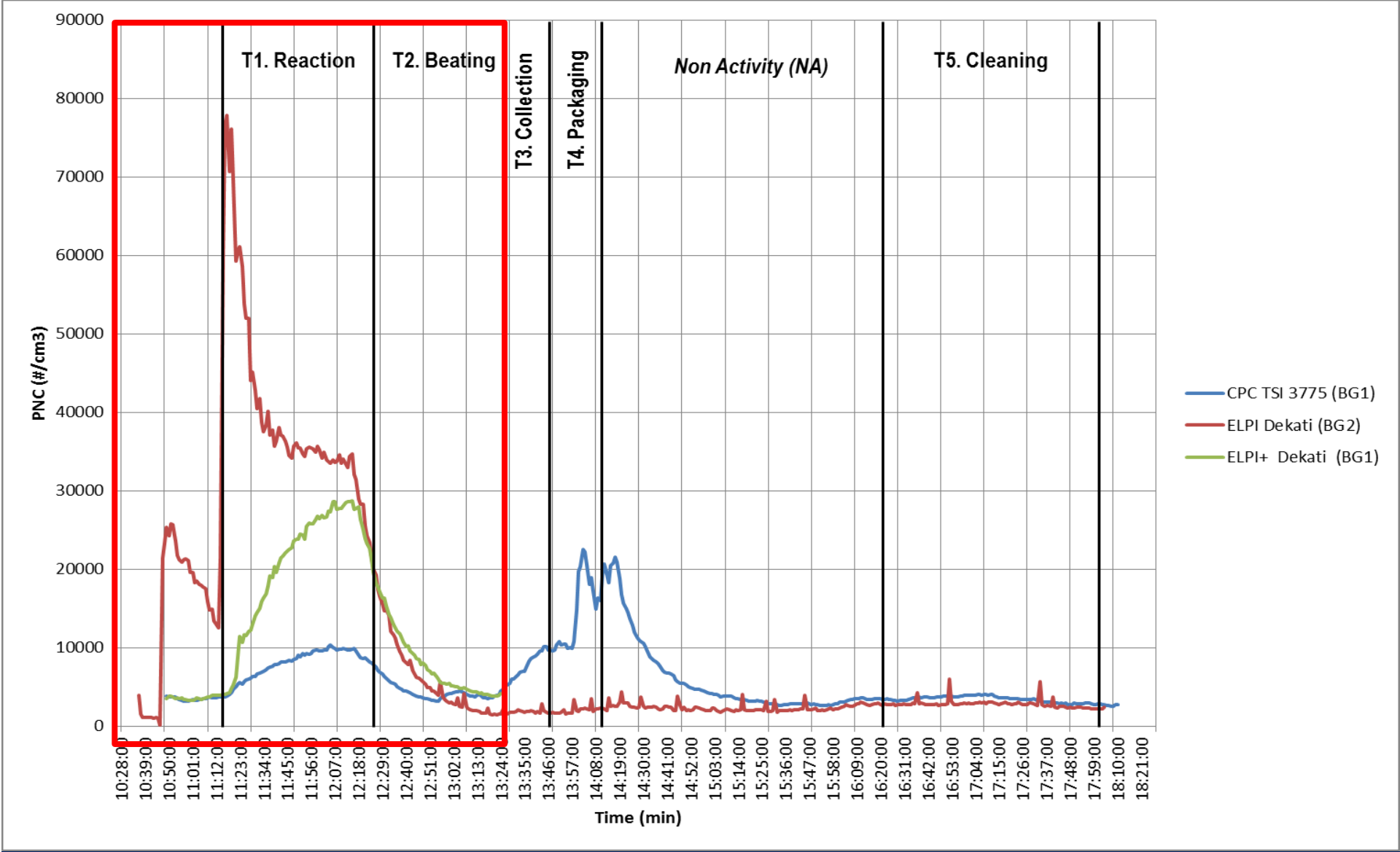
1. **Temporal background signal masking** the potential contribution of NOAA release from the raw series of PNC
2. **Significant disagreement between signals of the background aerosol (PNC)** measured in two positions situated very close to each other.
3. **Discrepancies in PNC records from collocated instruments**. Instrument choice.
4. **Aerosol characteristics retrieval (PNC)** from simultaneous by measured metrics, such as aerodynamic and mobility equivalent diameters.
5. **Decision making**: qualitative vs. quantitative approaches

Today I would like to adapt the point of view of an **industrial hygienist** from a company providing OHS services to SMEs, doing routine assessments of occupational exposure to chemicals in a broad variety of scenarios. In other words, to highlight some real-life implications of the sate-of-the-art.

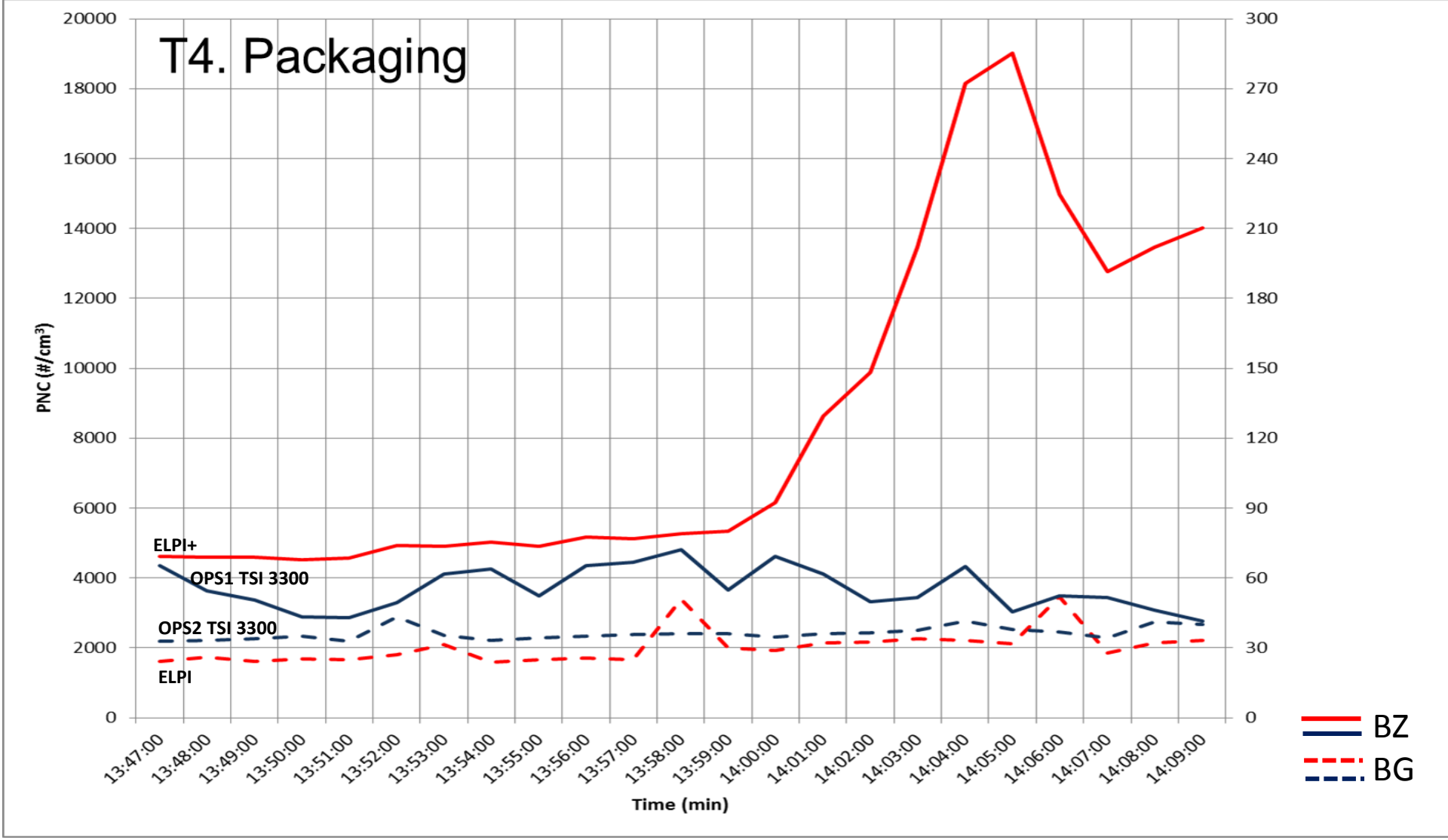


Raw time series of PNC as captured at source and background during drilling and packaging nano-TiO_2 enabled steel tablets. Temporal background signal overrides the potential contribution of NPs release during mechanical processing *(POI2: Period of Inactivity 2)*

1. Temporal background signal masking the potential contribution of NOAA release from the raw series of PNC.

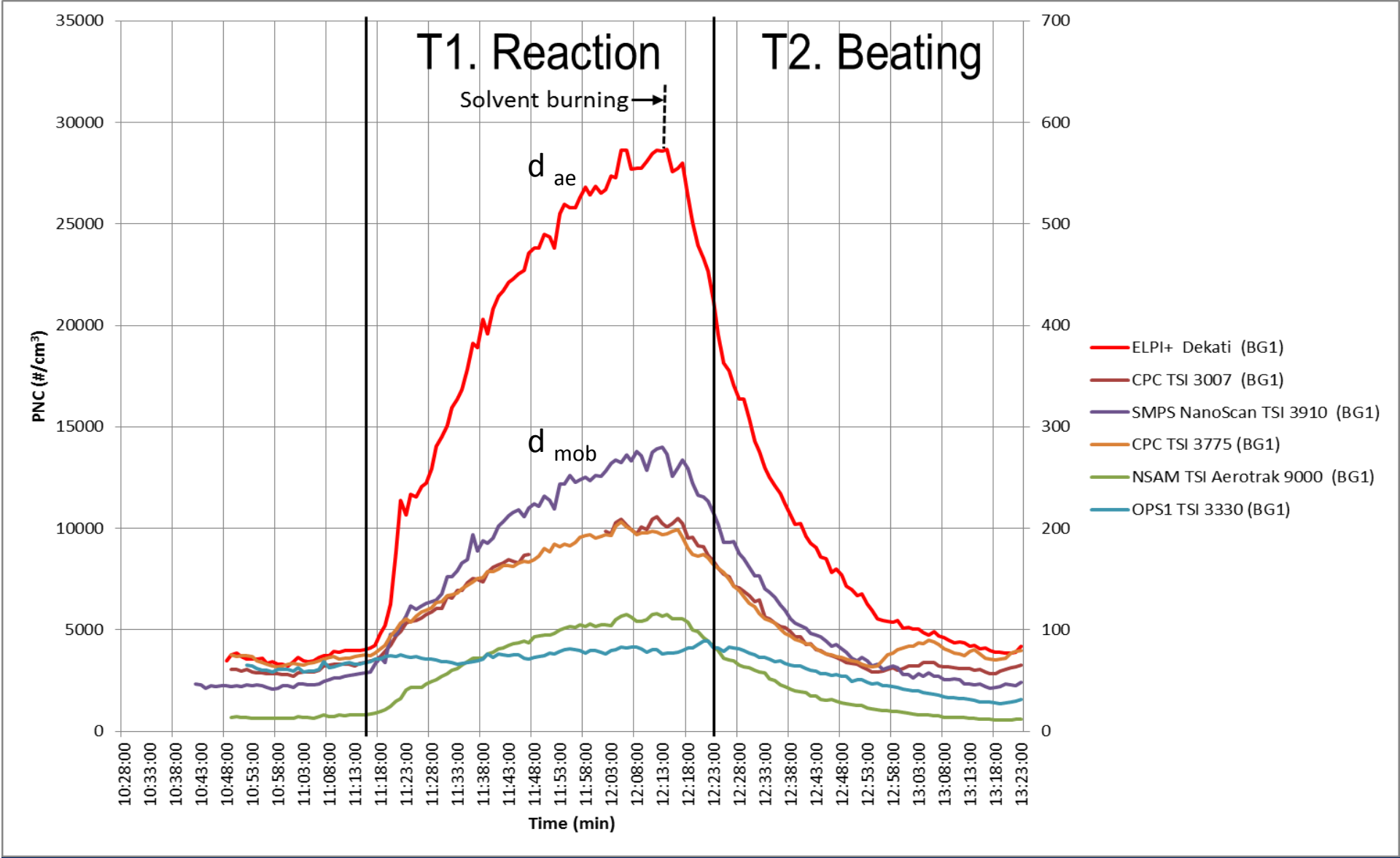


2. Significant disagreement between signals of the background aerosol (PNC) measured in two positions situated very close to each other.



The event observed by the ELPI+ at the BZ is neither observed by the collocated CPC nor at the close-background position.

3. Discrepancies in PNC records from collocated instruments.



4. Aerosol characteristics retrieval (PNC) from simultaneous by measured metrics, such as aerodynamic and mobility equivalent diameters. Instrument choice.

Nano






AIRBORNE EXPOSURE (Inhalation)		QUALITATIVE RISK ASSESSMENT			QUANTITATIVE RISK ASSESSMENT					
		HB	EB	CB	PNC	G	ICP-MS	SEM	$Exposure_{8h}$ (mg/m^3)	OEL (NIOSH 2011) (mg/m^3)
1	Weighing TiO_2	C	3	3	–	BDL	+	+	0,01-0,06	0,3
2	Cold pressing TiO_2	C	3	3	–	BDL	+	+		0,3
3	Drilling tablets	C	3	3	–	BDL	+	+		0,3
4	Packaging tablets	C	3	3	–	BDL	+	+		0,3

(ISO/TS 12901-2 HB=Hazard Band, EB=Exposure Band, CB=Control Band; PNC=Particle Number Concentration; G=Gravimetry (BDL=Below Detection Level); ICP-MS=Inductively Coupled Plasma Mass Spectrometry; SEM=Scanning Electron Microscope; OEL=Occupational Exposure Level).

5. Decision making: qualitative vs. quantitative approaches

(AEROXIDE ® TiO_2 P 25)

To summarize

- With the progressive introduction of ENMs into the industry, **exposure scenarios are evolving** from R&D laboratories and ENMs production plants to industrial processes, that incorporate ENMs for the production of intermediate and final NEPs.

Processes	ENM	NEP (I)	NEP (F)
New processes			
Existing processes			
Example	Pristine ENM: MWCNT	Processed: Composite	Product: Component for aeronautics

To summarize

- **Complex exposure scenarios (MSIS)** will be numerous and associated with these latest processes (NEPs), whether new or existing manufacturing processes.
- In addition, they will **coexist with conventional non-nanotechnological processes,** making the evaluation of occupational exposure more complex and probably expensive for **industrial hygienists**.

To summarize

- The **substantial development achieved during recent years** in the field of occupational exposure assessment to ENMs (tiered approach, portable and personal instrumentation, NRVs/OELs) , allows a widespread use of new methods and instruments in industrial scenarios.
- However the **complexity of some workplaces** highlighted the **next step directions in research**:
  - ✓ The determination of the most reliable strategy for the **background assessment**
  - ✓ The identification/development of **cost effective** and chemical selective methods
  - ✓ The use of DRI as the **core block** of the **engineering controls**


“Building on the already built,
to continue making progress
in nanosafety ”

Thank you very much for your attention!

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