

# **Emerging techniques in nanoparticle analysis**

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# Techniques available

## Light scattering based techniques:

- Widely used however severe limitations
- Difficulties with polydisperse samples (high PDI, PDI is representative of the particle size distribution width)
- Sensitive to matrix components
- Not element specific

## Imaging techniques:

- Formation of artefacts, matrix effects

# **Demands**

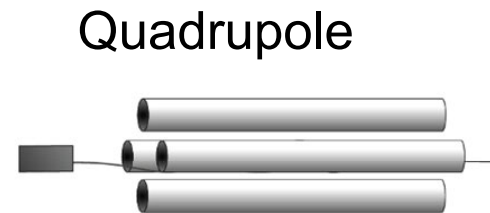
- Particle size
- Particle number concentration
- Elemental composition
- Differentiation between natural and engineered nanoparticles
- High throughput and robustness

# spICP-QMS

- ✧ great potential for the characterization of inorganic nanoparticles (NPs) at relevant concentrations (ppt)
- ✧ enables the measurement of individual particles (PNC)

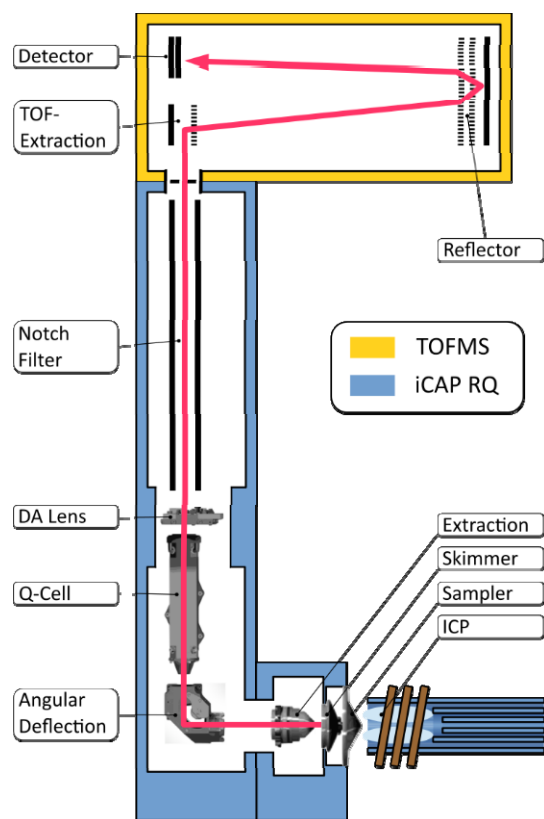
## Limitations

- Only two elements at the individual particle

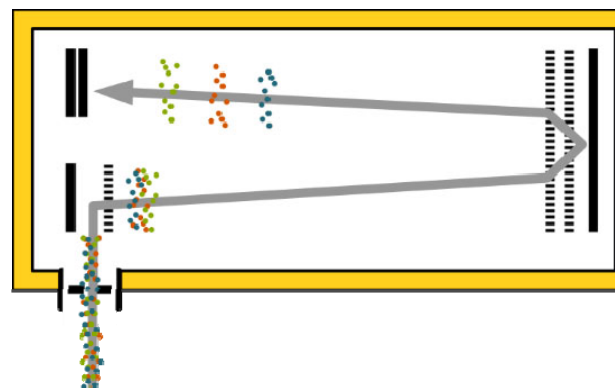


- ✧ analysis of more complex multi-component particles, which are more realistic case, **another mass analyzer is required**

# spICP -TOF- MS



Time-of-flight



- Complete elemental mass spectra for individual NPs
- All isotopes from an individual particle
- Complex particles, complex samples

The most important feature in regard to single particle analysis is simultaneous detection and speed

# Example

## Complex environmental samples

- $\text{CeO}_2$ ,  $\text{TiO}_2$ ,  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CuO}$ ,  $\text{ZnO}$
- Elements are present in the environment at high concentrations
- Engineered particles at very low levels
- Lack of techniques to discriminate

## Solution

- Single particle fingerprinting

### COMMUNICATION

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**Single-particle multi-element fingerprinting (spMEF) using inductively coupled plasma time of flight mass spectrometry (ICP-TOFMS) to identify engineered nanoparticles against the elevated natural background in soils†**

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