

Session B5: Horizontal activities - Safety, Environmental and Health Protection, LCA

## Nanoparticles monitoring in workplaces devoted to nanotechnologies

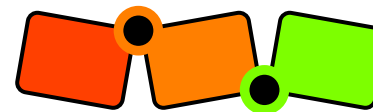
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*Ecsin's strategy*

*Iolanda Olivato – Veneto Nanotech scpa*



EURONANOFORUM 2009  
PRAGUE, June 2<sup>ND</sup> 5<sup>TH</sup> 2009



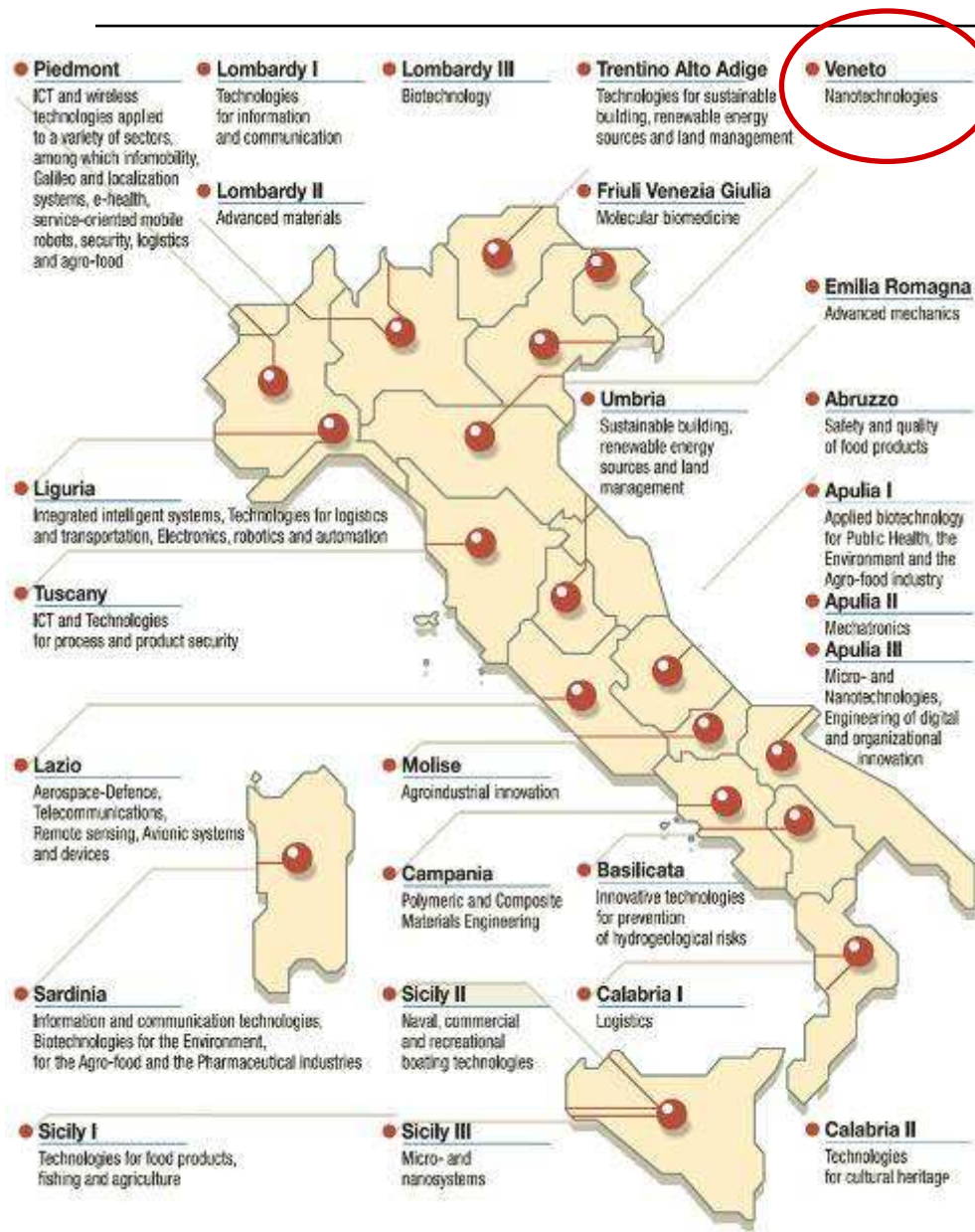
# Outline

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## ▪ The Italian Cluster of Nanotechnology

- The presence of nanoparticles in the workplace
- Risk assessment for nanotechnology

# The Italian clusters



In 2003 the Italian Ministry of University and Research has chosen to relaunch the Italian industrial model, that is the industrial cluster

The choice was to identify different centers of competence and to set up **high tech clusters** as the main tool to foster innovation.

The focus for nanotechnology was appointed in Veneto where the Italian High Tech Cluster for Nanotechnologies was established.

## Description of activities

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### ❑ Developing facilities and fostering technology transfer

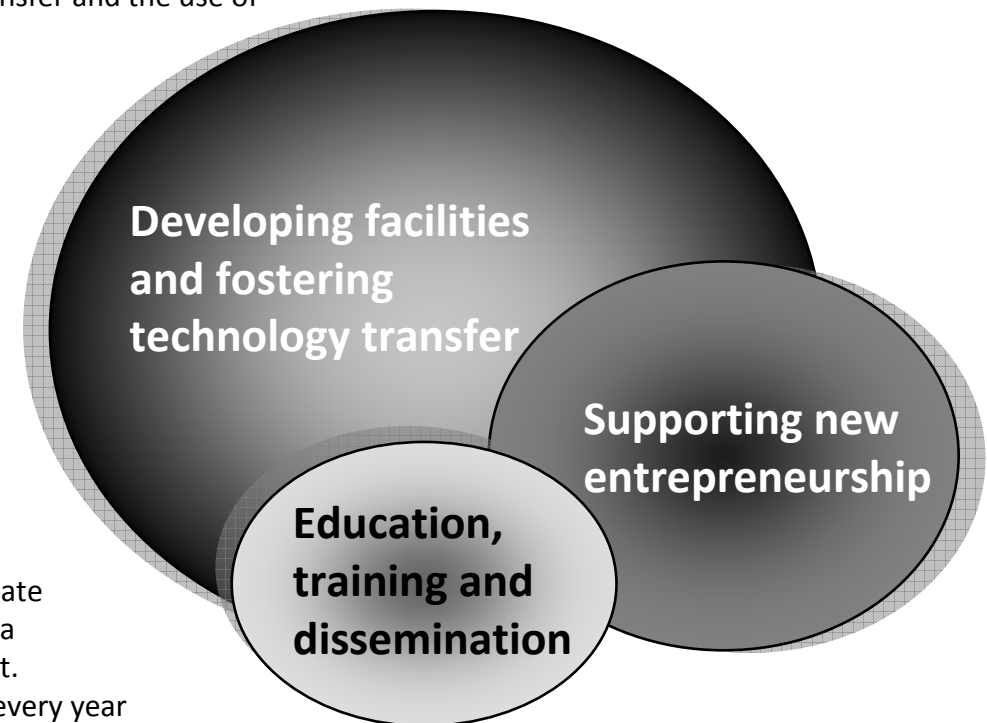
The Cluster plans and develops laboratories and research centres able to draw from the University resources and know-how and to focus on themes of interest for industries. The aim to use nanotechnology as a driver for the development of traditional companies has been delivered with a technology transfer strategy based on structures exclusively dedicated to technology transfer and the use of public funds.

### ❑ Supporting new entrepreneurship

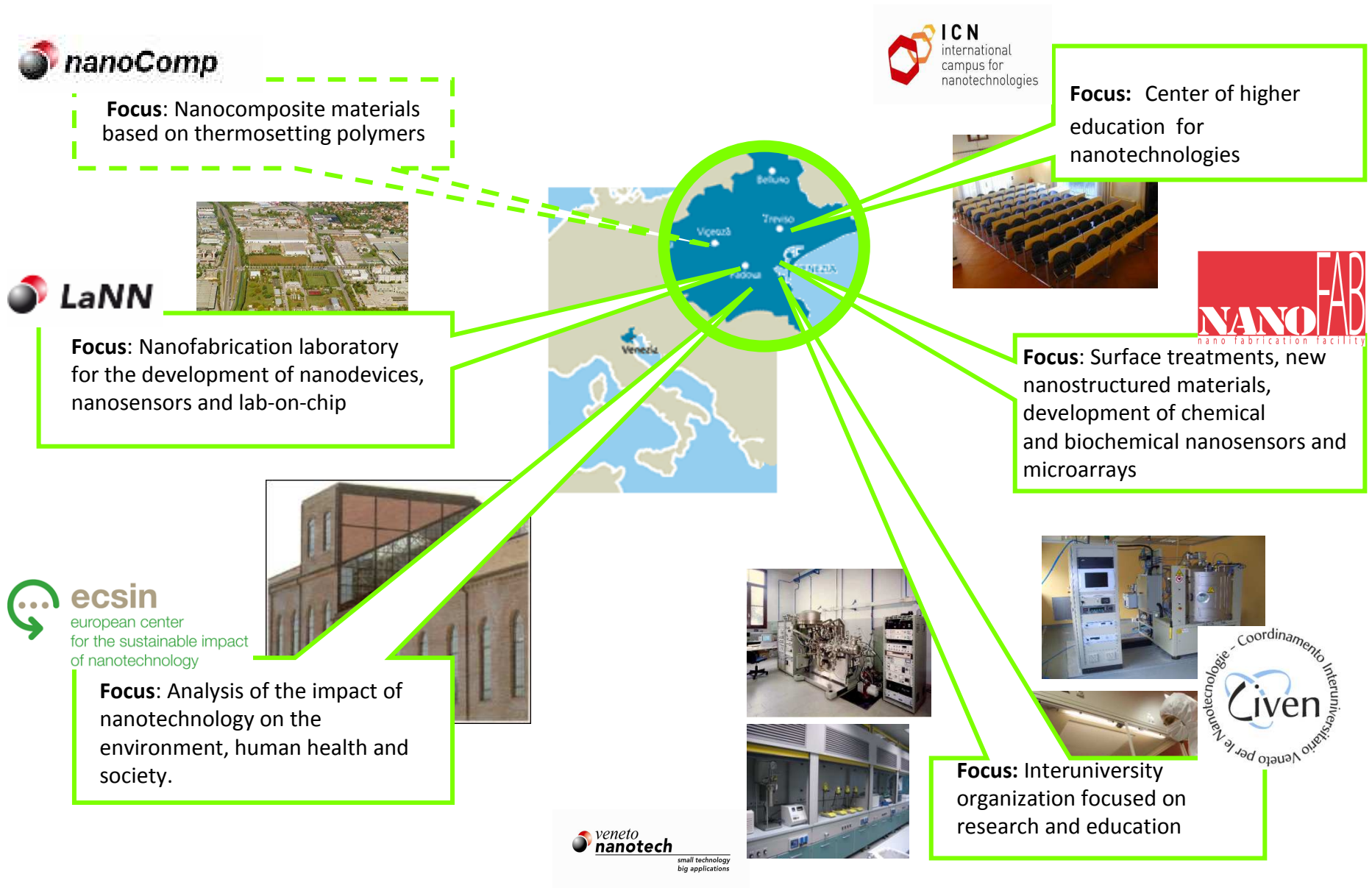
Innovation is a bottom-up process too. The program designed to support new start-ups is *Nanochallenge*, a business plan competition which every year awards a seed capital investment of 300 K€ to the best business idea based on nanotechnology.

### ❑ Education, training and dissemination

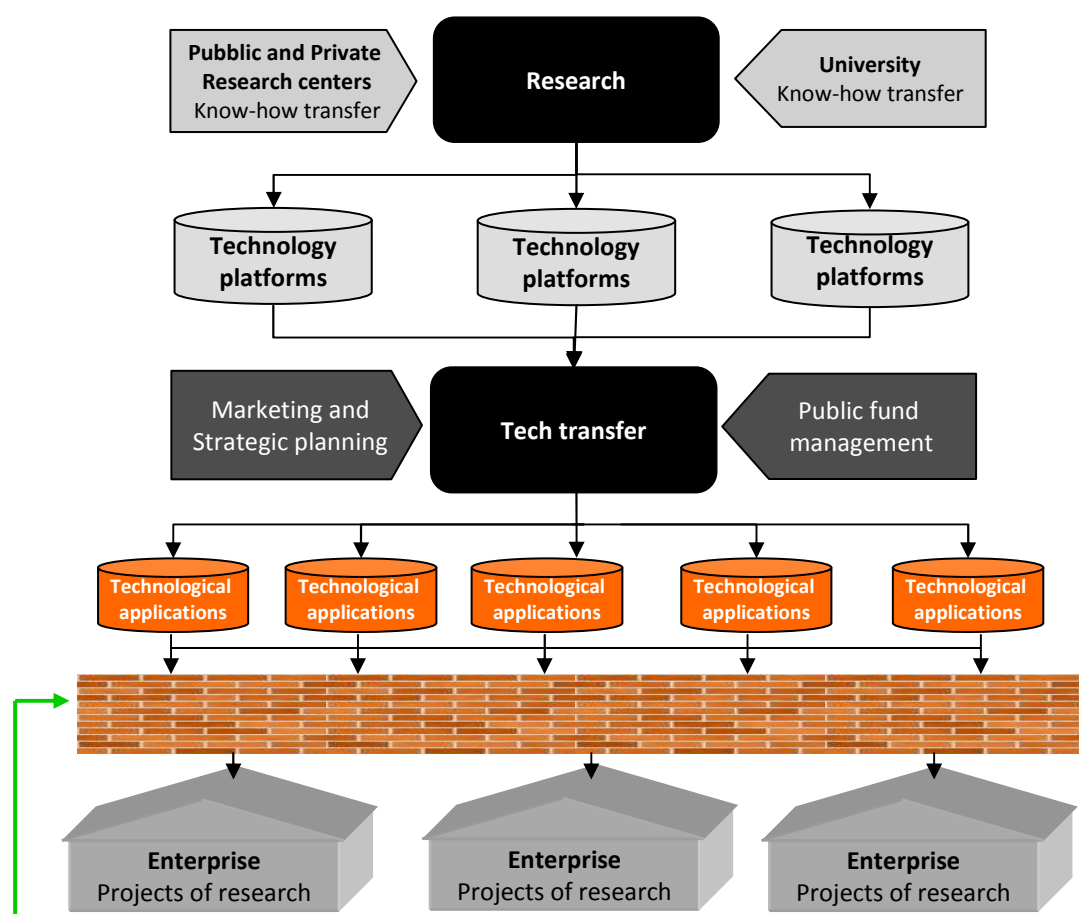
The *International Master in Nanotechnology* is a post-graduate program that attracts young talents from all the world. It is a necessary instrument for the scientific growth of the District. *Nanoweek* is a training and dissemination event organised every year from Veneto Nanotech to promote nanotechnology in the region.



# The cluster for nanotechnologies



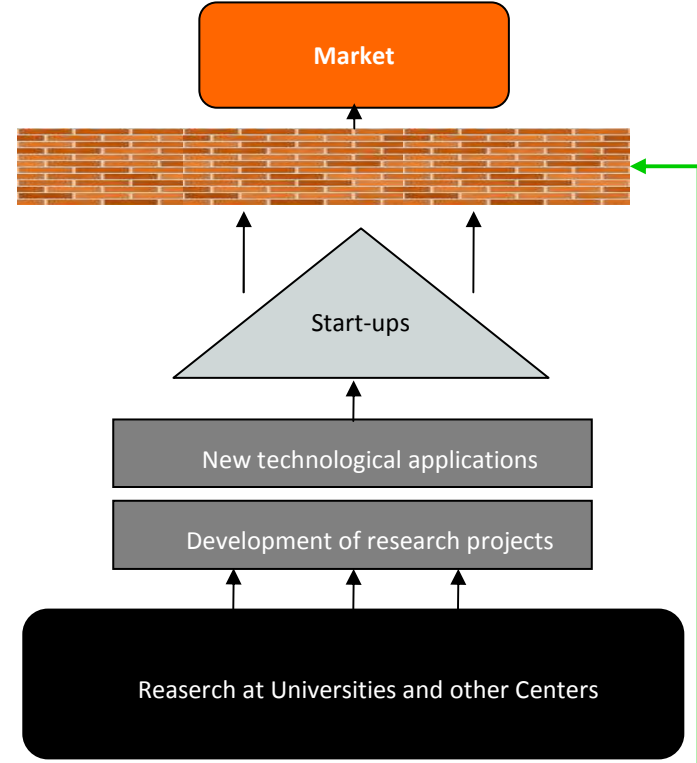
# Technology transfer approaches



**Market entry barriers**

- Business inertia
- Gap between research and producers

**Top Down Approach**



**Market entry barriers**

- Scalability
- Non optimal processing technologies
- Identifying new applications
- Costs

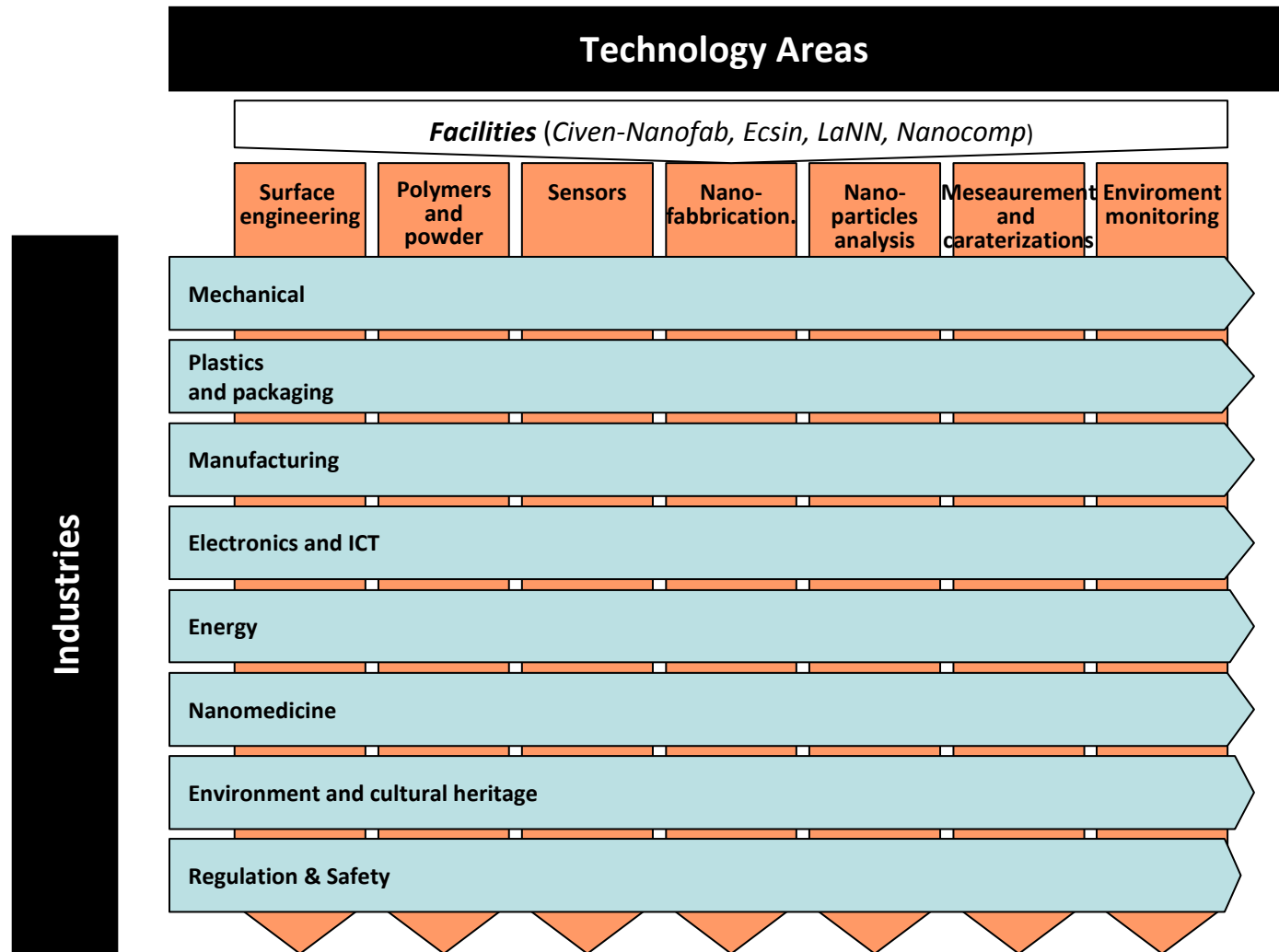
**Bottom Up Approach**

# Technology focus

□ The Cluster is structured in 7 different Technology Areas, performed in its facilities

□ Each Area has different Technology Platforms where many research projects are carried out.

□ The projects have different applications for the most attractive industries



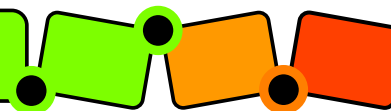
# Outline

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- The Italian Cluster of Nanotechnology

- **The presence of nanoparticles in the workplace**

- Risk assessment for nanotechnology



## Risk: a choice or fate?

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“ I hope that Lord Grey and you are well - no easy thing seeing that there are above 1500 diseases to which man is subjected “

*Sydney Smith to Lady Grey, 1836*

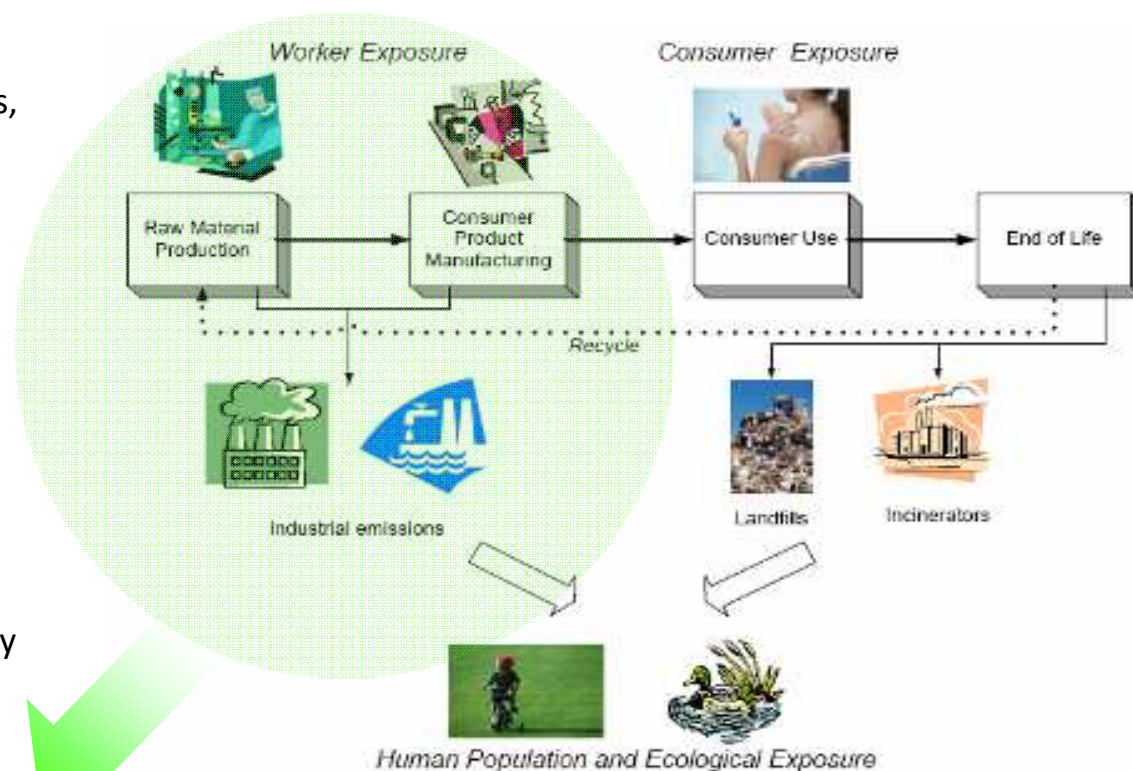
## Things the public may not know

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- ✓ Everybody breathes in at least 10M nanoparticles each minute
- ✓ The majority of the food we eat contains naturally nanoscales components

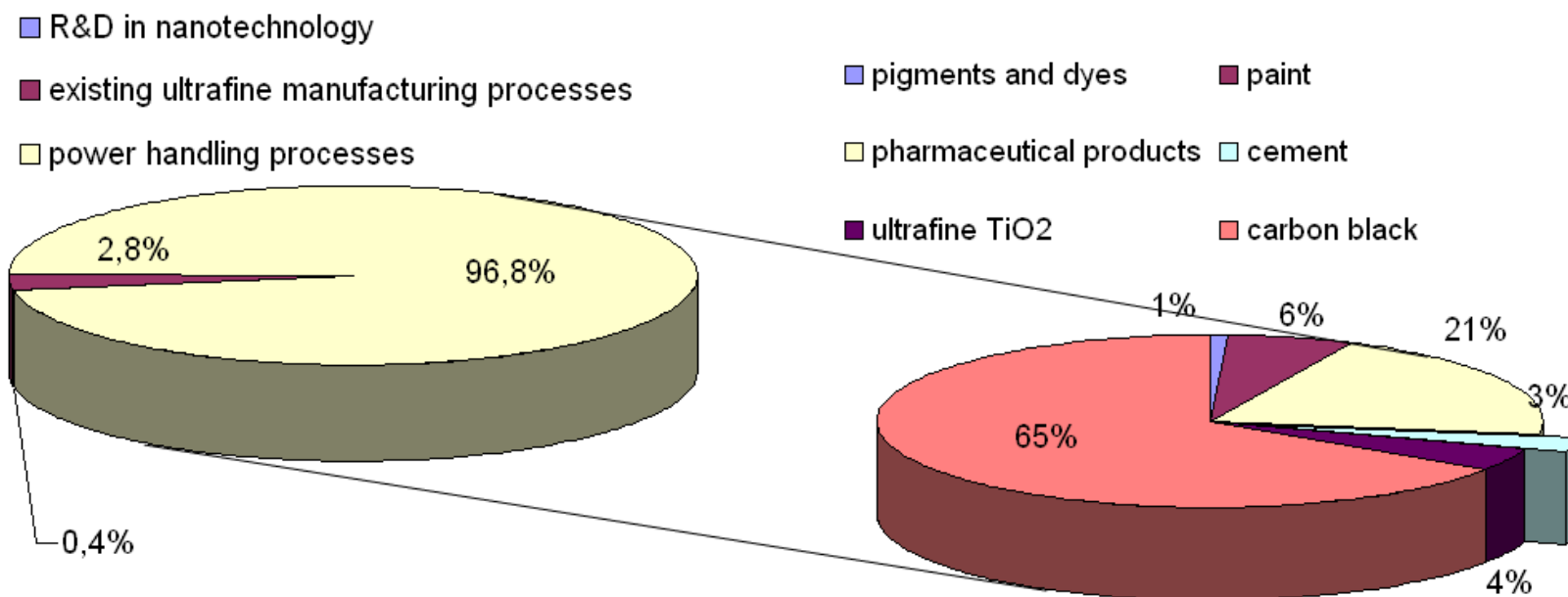
# Engineered nanoparticles

- ❑ The use of nanotechnologies is rapidly growing within several industrial fields (mechanics, accessories, rubber and plastics, textile, construction)
- ❑ Therefore we should expect a large-scale diffusion of nanotechnological products obtained through the use of different techniques (depositions, enrichment with nanoparticles, nanostructures)
- ❑ Consequently the expectation of the impact the use of nanoparticles and nanomaterials may have is currently a highly relevant matter
- ❑ The main dissemination channel is currently constituted by the productive sector, thus the monitoring of the industrial emissions is the first assessment of the engineered nanomaterials impact on health and environment



## Workers exposed to risk in Italy

A recent study estimated the number of workers in Italy potentially exposed to health risk related to engineered nanoparticles



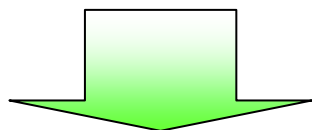
Fonte: Boccuni et al., *Journal of Cleaner Production* 16 (2008) 949-956

## Monitoring in occupational areas

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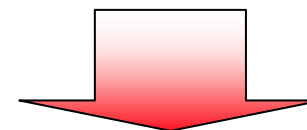
- The debate on how to set the regulations of the use of nanoparticulates and nanostructured materials develops according to two different orientations:

**evidence-oriented**



**voluntary controlled**

**precaution-oriented**



**top-down controlled**

Source: Helland et al., *Environmental Science and Technology* 42 (2008) 640-646

- The responsibility of production and safe products is currently mainly committed to the involved industries' voluntary initiatives.
- However, from some polls it came to light that:
  - most of the enterprises does not perform any nanotechnologies-related risk evaluation;
  - in many cases the tools used for the monitoring of nanoparticles are the conventional ones and therefore not adequate for the nanometer scale;
  - it is often evident a lack of information regarding the practices related to the systems of personal protection, monitoring, waste disposal

Source: *International Council of Nanotechnology, A review of current practices in the nanotechnology industry 2006*  
Schmid & Riediker, *Environmental Science and Technology* 42 (2008) 2253-2260


# Potential sources of nano-aerosol in occupational field

## Heat processes



Metal refining; casting of steel, iron, aluminium; welding; metal cut; hot wax application; coatings deposited via thermal spray

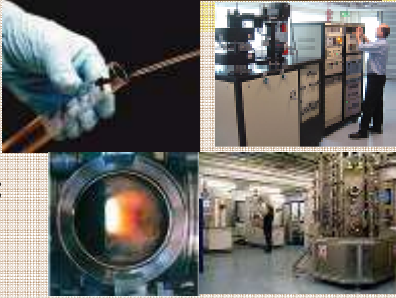
## Combustions



Diesel engines;  
 Petrol engines;  
 Gas engines;  
 Gas heating;  
 incinerators (power plant, heating system)

## Nanotechnologies

Production of carbon nanotubes;  
 Production of engineered nanoparticles (ENP) in the gas-phase;  
 Spraying from suspensions and solutions of ENP;  
 handling and use of ENP dusts?



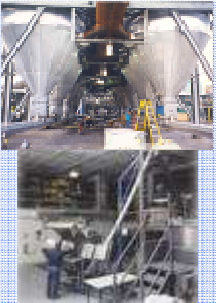
## Mechanical processes

High energy and high speed metal grinding




## Dusts production

carbon black production; TiO<sub>2</sub> ultrafine production; fumed silica production; fumed alumina production



## Handling

Handling of non-processed nanoparticles' dusts;  
 Dry-handling of Colloidal deposits



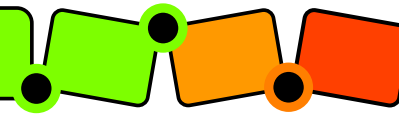
Fonte: ISO/TR 12885:2008

# Outline

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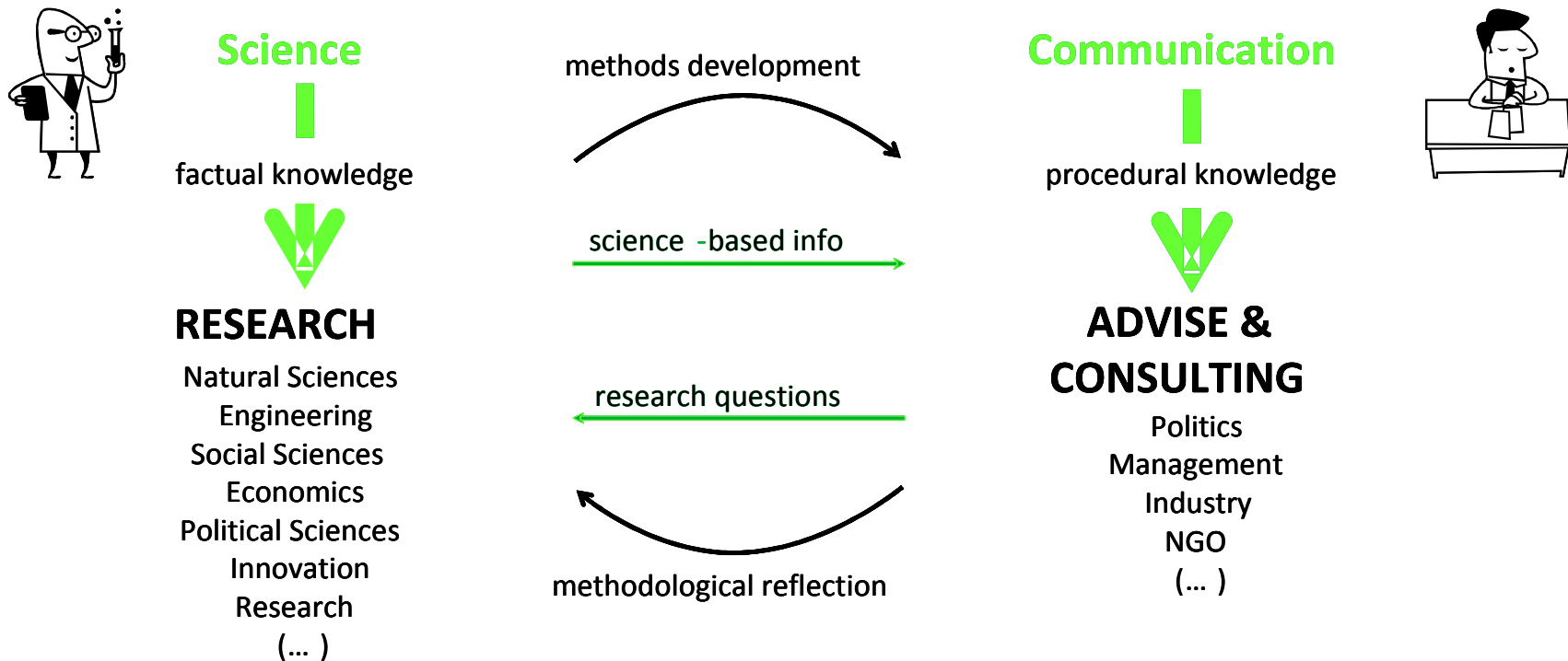
- The Italian Cluster of Nanotechnology
- The presence of nanoparticles in the workplace

▪ **Risk assessment for nanotechnology**

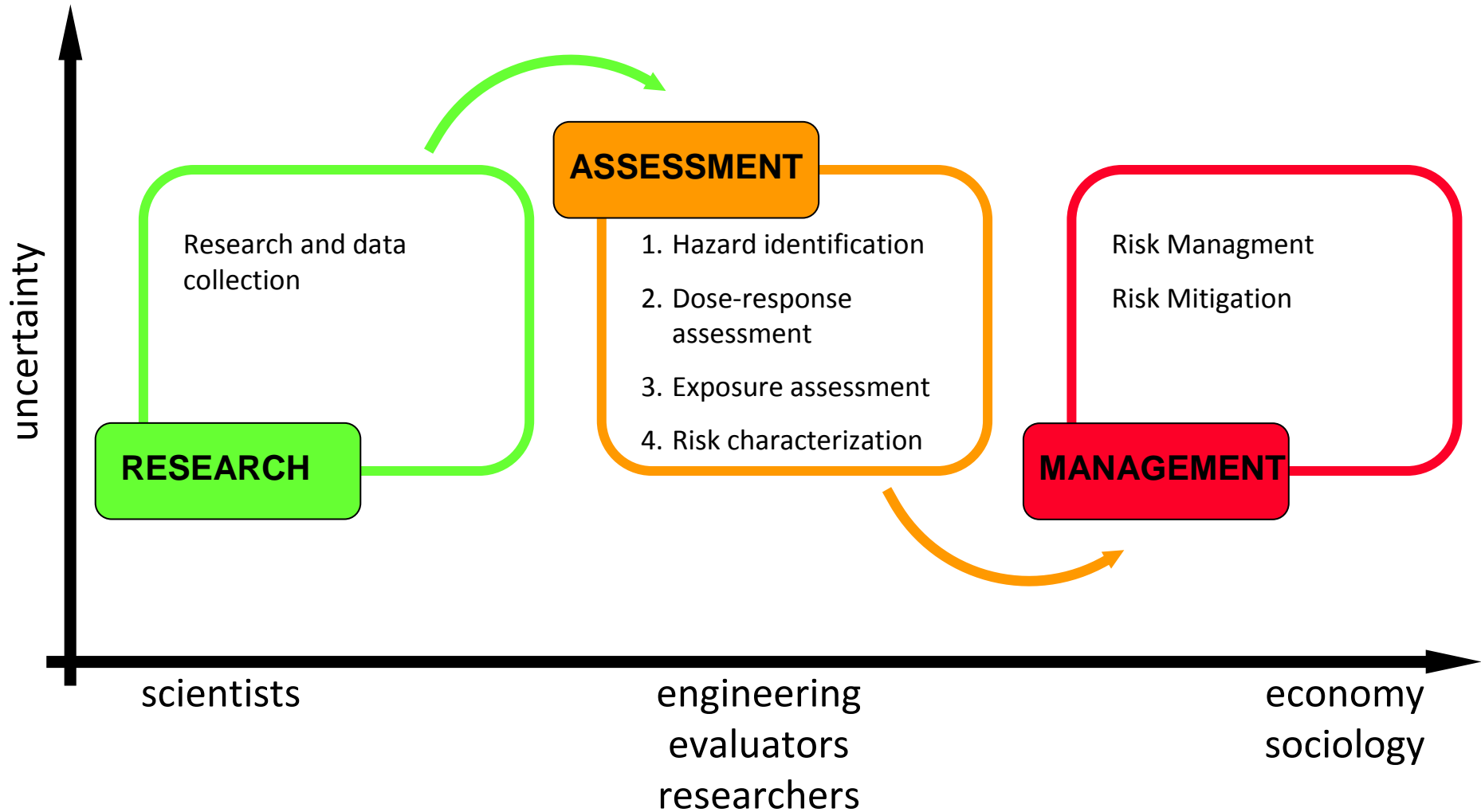


# Technology Assessment

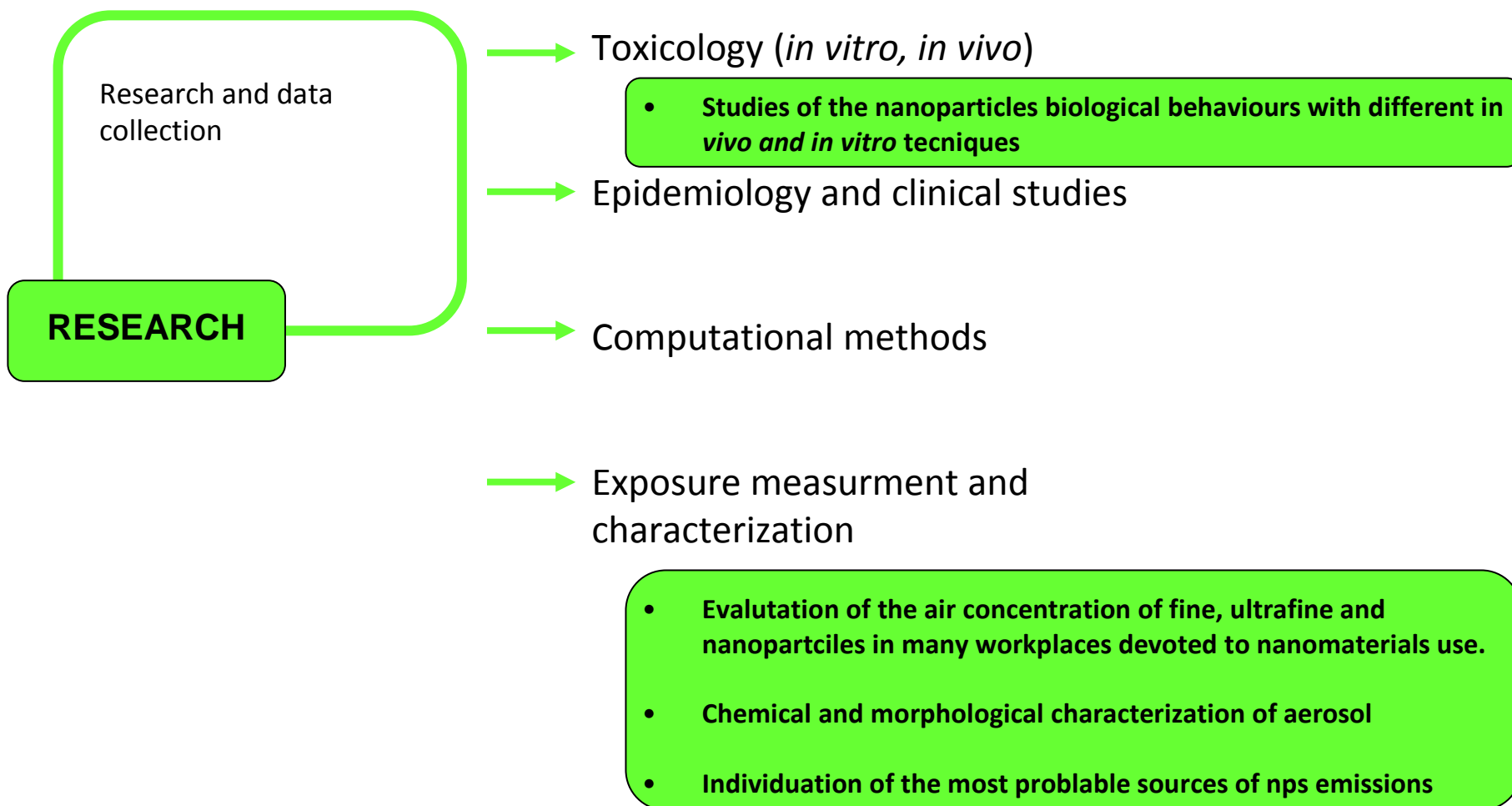
TA is a tool to link R&D activities with visions for applications. It is indeed important for N&N in order to explore its potentials while avoiding pitfalls of ignored risk perception.



# Risk assessment framework

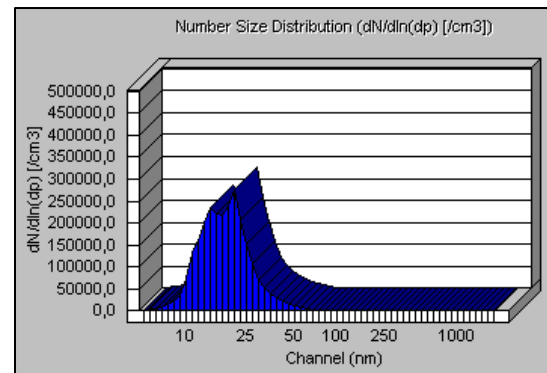


# Nanotoxicology



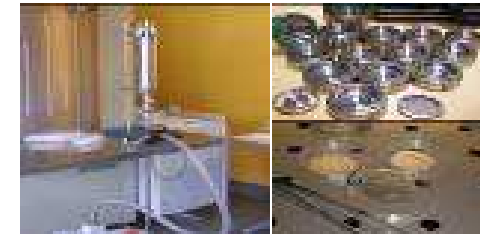
# Workplace monitoring and exposure estimates

1. real-time monitoring by means of the Wide Range Aerosol Spectrometer of the atmospheric particulate concentration and its dimensional distribution in the 5 nm – 20 μm range subdivided into 59 classes



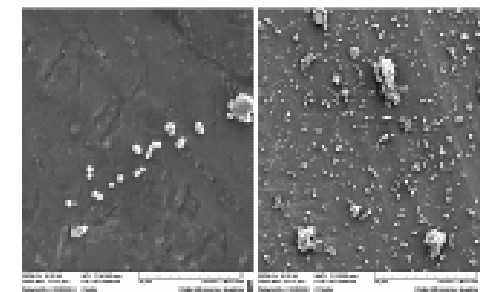
- Toxicology (in vitro, in vivo)
- Epidemiology and clinical studies
- Computational methods
- **Exposure measurement and characterization**

2. Sampling by means of cascade impactor with 13 stages that collects and subdivides the indoor aerosol in the 30 nm range – total suspended particles



3. Characterization by means of off-line analysis:

- Chemical analysis: metals and organic pollutant in trace amounts;
- Microscopic analysis: shape, porosity, agglomeration state.



## Some results

	background conc. <sup>(1)</sup> [particles cm <sup>-3</sup> ]	maximum conc. <sup>(1)</sup> [particles cm <sup>-3</sup> ]	geometric mean <sup>(2)</sup> [nm]	likely source
<b>PECVD</b>	5 x 10 <sup>2</sup>	3 x 10 <sup>3</sup>	-	silica nanoparticles from the deposition chamber
		3.5 x 10 <sup>4</sup>	10-120	nanoparticles from vacuum cleaner
<b>PVD</b>	1 x 10 <sup>3</sup> - 3 x 10 <sup>3</sup>	7 x 10 <sup>3</sup>	-	unknown
<b>nanocomposite compounding</b>	3 x 10 <sup>3</sup>	7 x 10 <sup>6</sup>	30-80 <sup>(3)</sup> 15 <sup>(4)</sup>	polymers fumes and degraded materials

<sup>(1)</sup> measured by CPC; <sup>(2)</sup> measured by WRAS; <sup>(3)</sup> non working conditions; <sup>(4)</sup> mixing



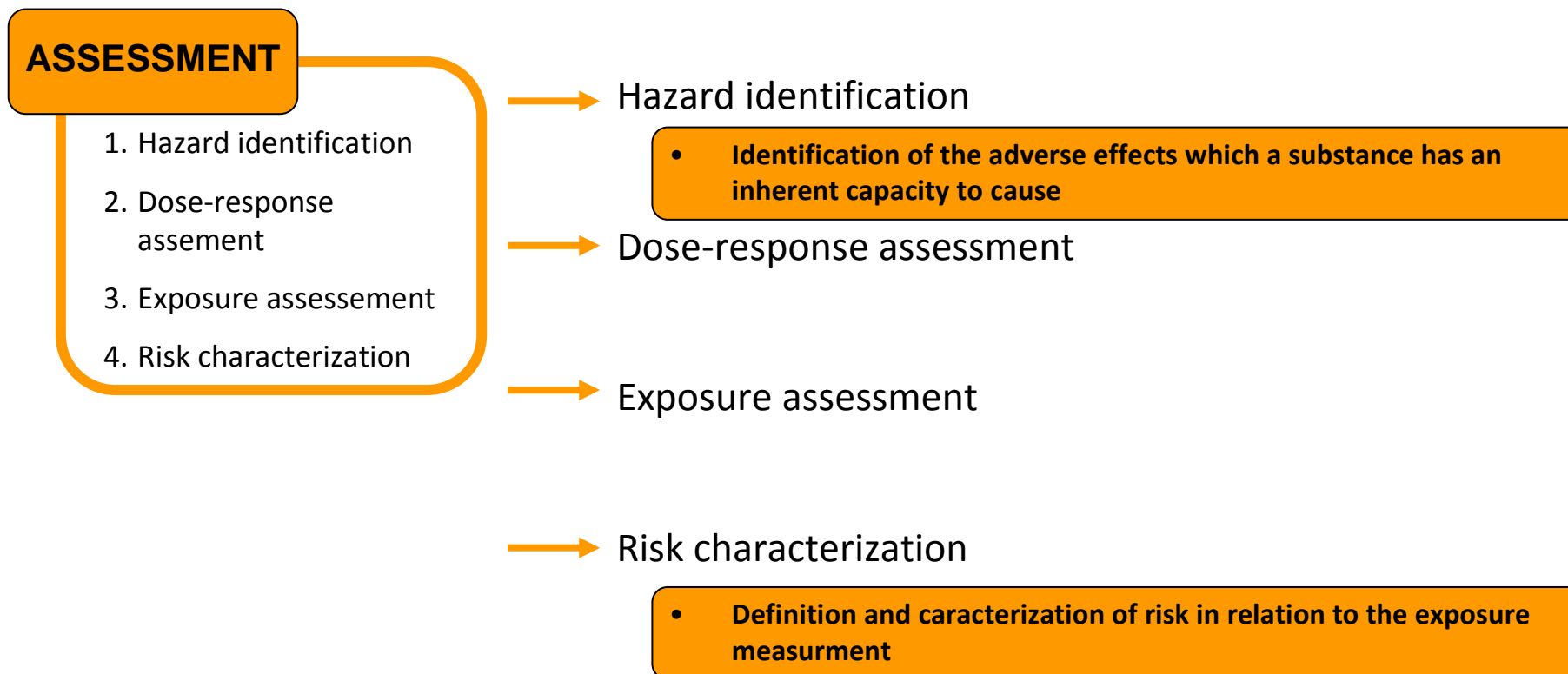
Civen's project  
founded by Regione del Veneto



Nanoparticles monitoring in workplaces devoted to nanotechnologies  
Journal of Physics - Conference Series, *in press*

*L. Manodori & A. Benedetti*

# Risk assessment



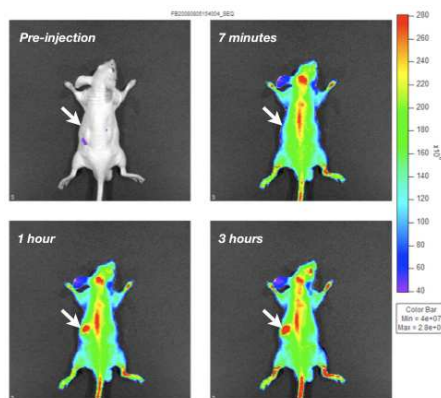
**RISK = HAZARD x EXPOSURE x**

**RISK PERCEPTION**

The analysis of risk perception of the impact of nanotechnology, together with controlled exposure and toxicity data, provides the third term of the equation formulated to evaluate the Risk

# Hazard Identification

- Morphological and ultrastructural analysis for the identification of specific build-up and deposit sites at a cell and organism level
- Cell and molecular biology analysis in order to identify specific mechanisms of biological interaction



IP with Anti APE1/Ref1  
 T C

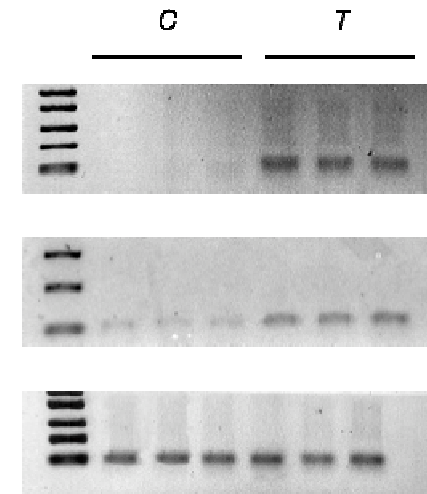
WB Anti p53



GSKN1A

GADD45

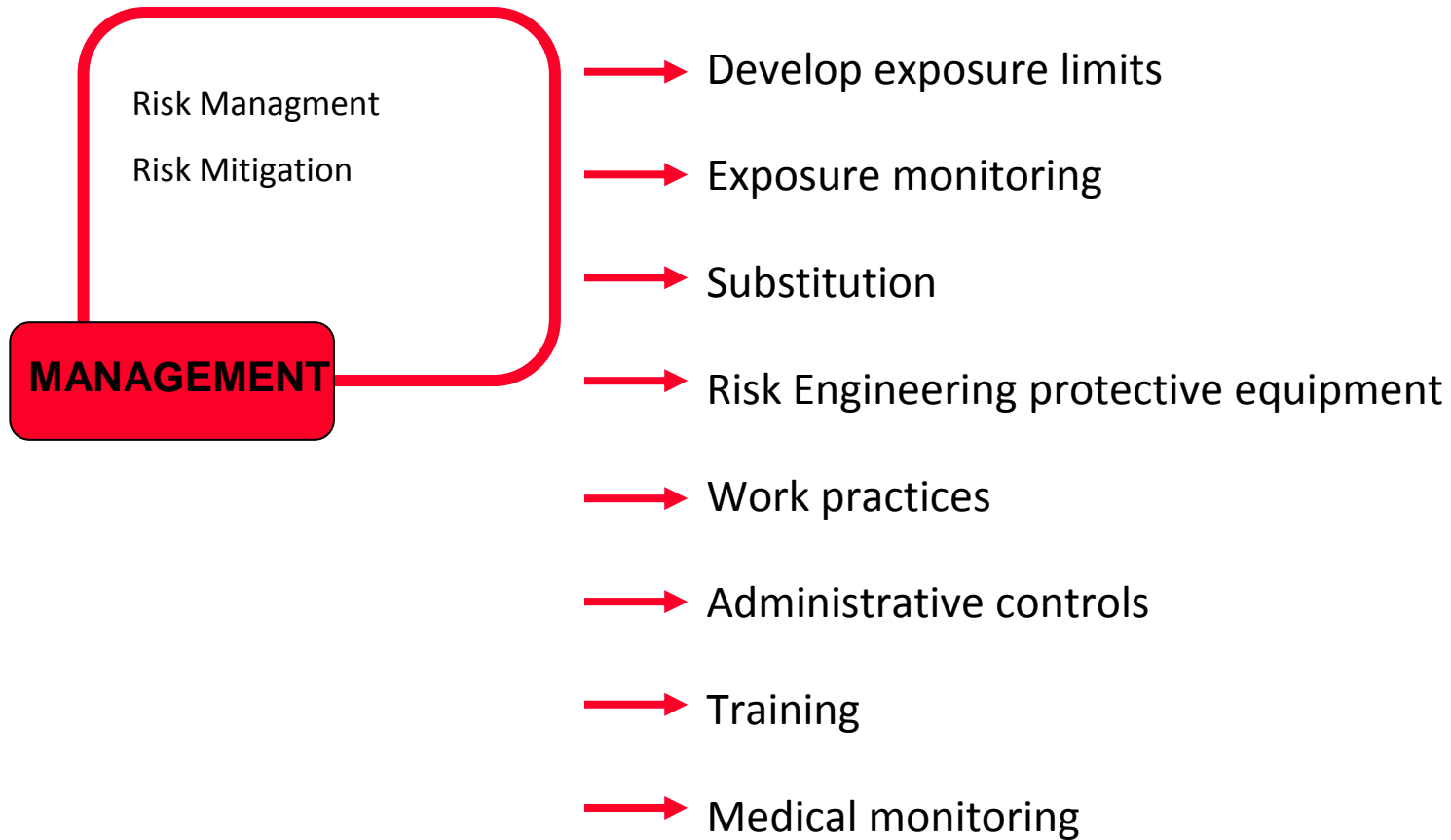
ACTB



- Application of methods that allow the reduction of the use of animal testing in risk assessment procedure (e.g., *phenotype screening* of cell culture)

# Risk management

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Thanks for listening!

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