



Metrology and the challenges in relation to nanotechnology

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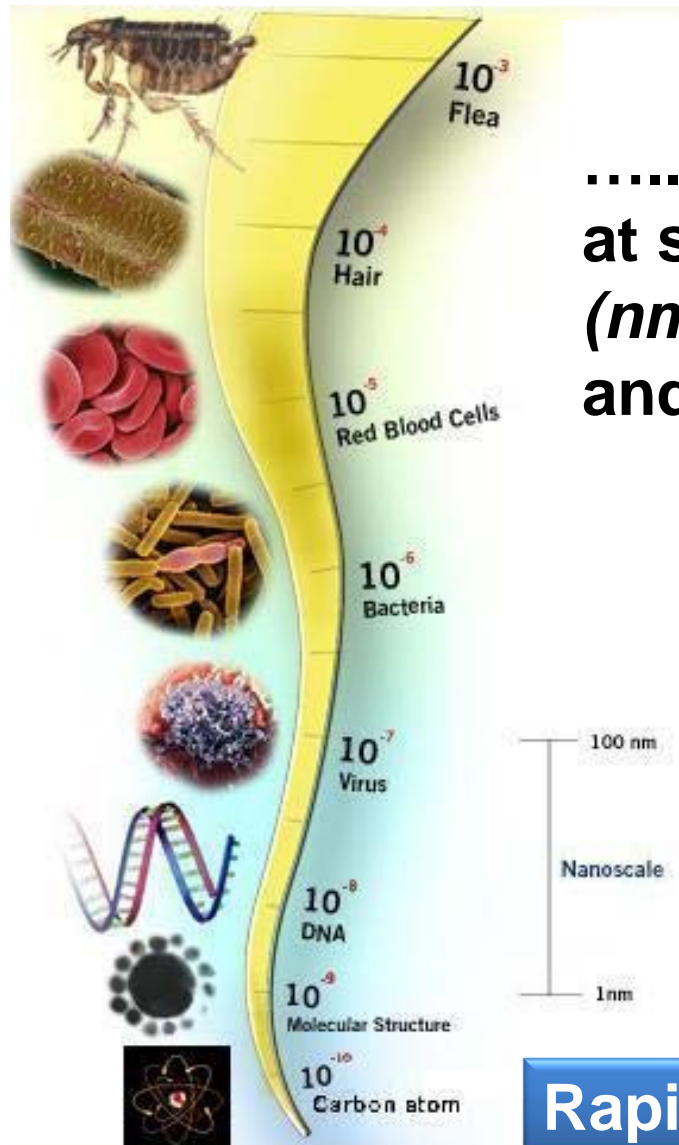
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Prince of Wales Award
For Innovation & Production

EURAMET GA, Dubrovnik, Croatia, 2-5 June 2014

Definition of Nanotechnology



.....The *purposeful engineering* of matter at scales of *less than 100 nanometres (nm)* to achieve *size dependent* properties and functions



I.e:

.....A spectrum of technologies defined by their metrologies!

Rapid progress since ~2000 enabled by.....

Our Ability to Visualise & Measure Structures at the Nanoscale

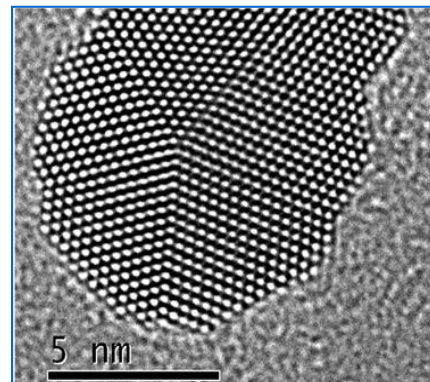


York
JEOL NANOCENTRE

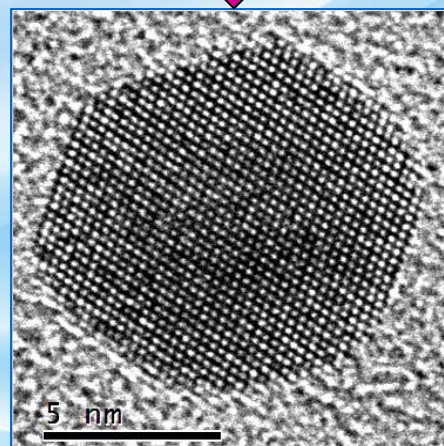
Scanning Transmission
Electron Microscope



10 nm Gold nanoparticles



Heat ↓ 670 Deg C



Single Crystal

Can see individual atoms



Our Ability to Engineer Structures at the Nanoscale



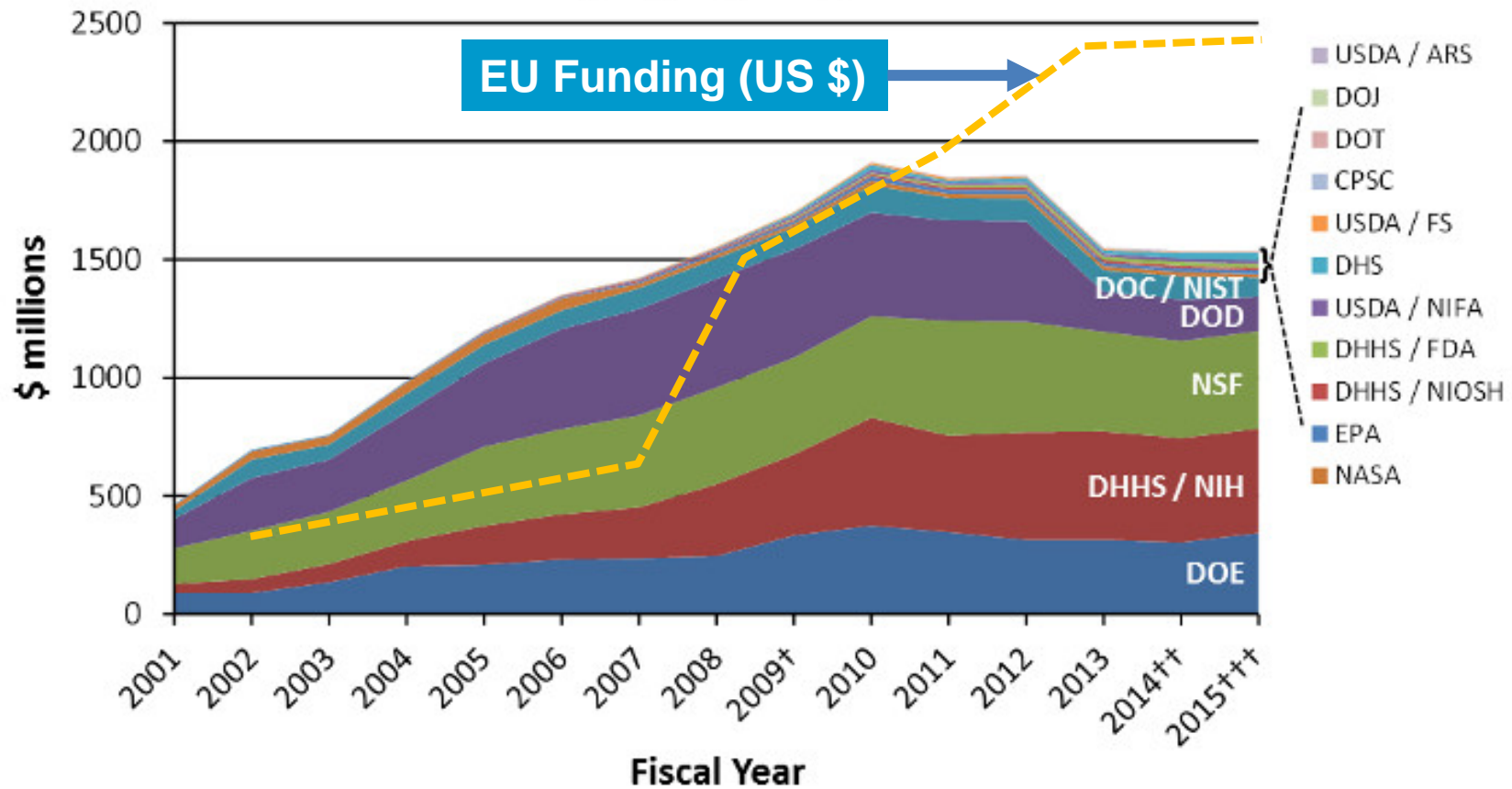
Aerosol reactor for manufacturing Inorganic core-shell nanoparticles for energy applications.



Electro-spinning device for making nanowires & fibres (e.g. bone regeneration scaffolds)

Global Competition in Investment

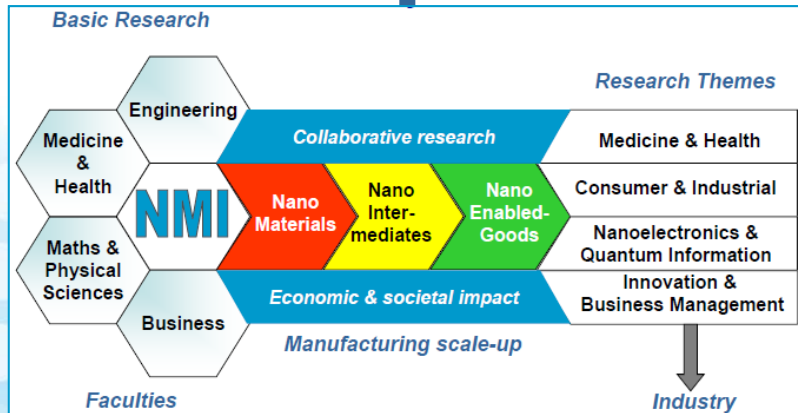
US NNI Funding by Agency, 2001-2015



Nanomanufacturing Innovation Ecosystem System



ERC

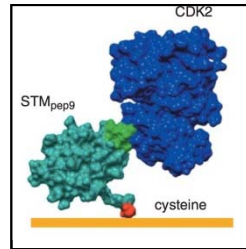


NMP

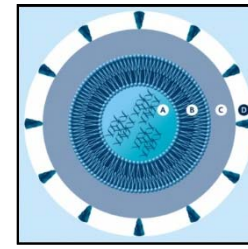
ICT

TRANSPORT

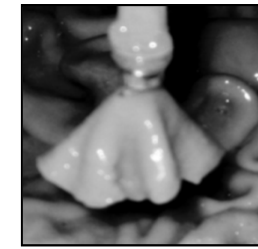
GU & GI Cancer Nanomedicine



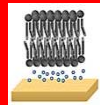
Diagnostics



Theranostics



Surgery



Nano EH&S Risk (7 FP7 Projects)

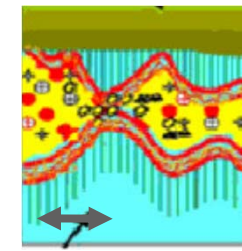
Industrial



Buildings

Earthquake Zones

Efficiency Increase = 19%



Car engines

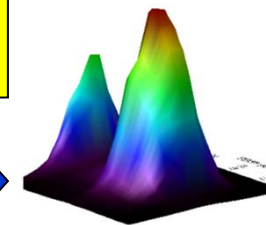
Nanoelectronics & ICT



Spintronics

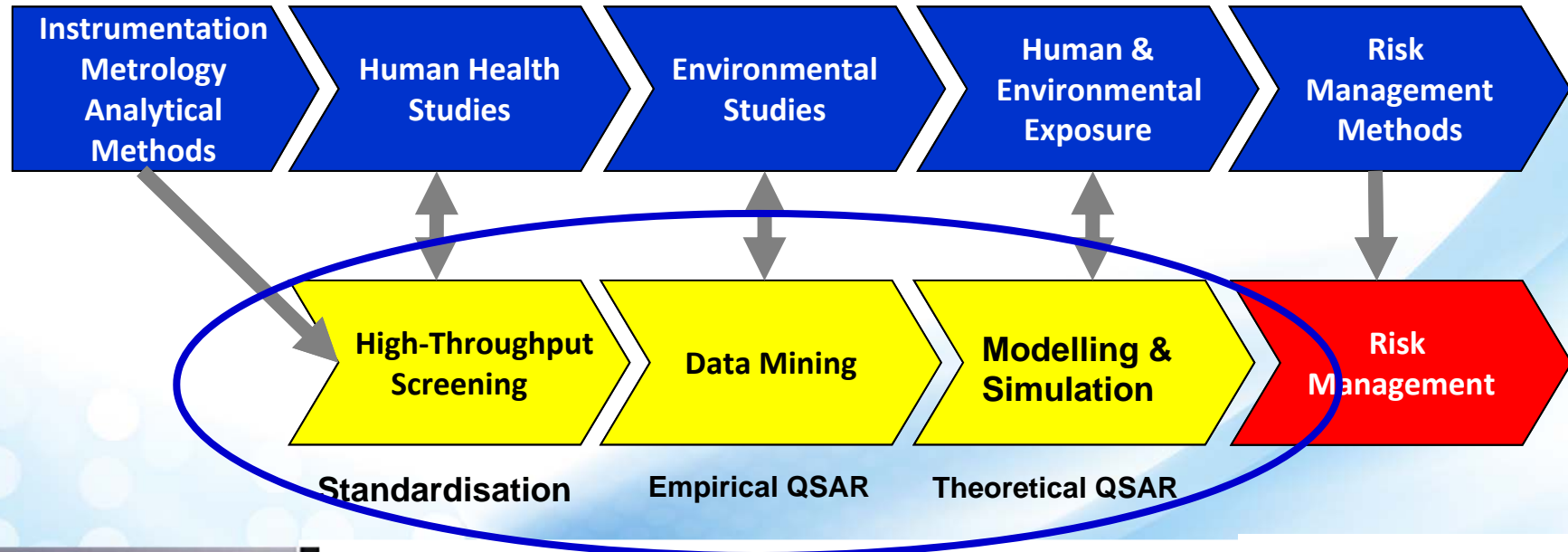
Processors & memory

Sensors & memory

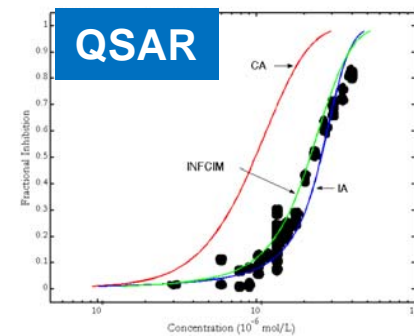


Research Competences Needed

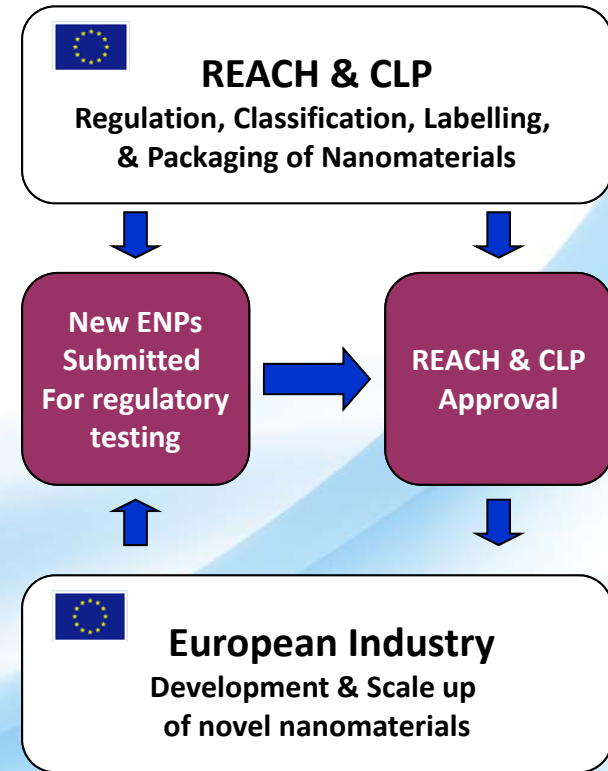
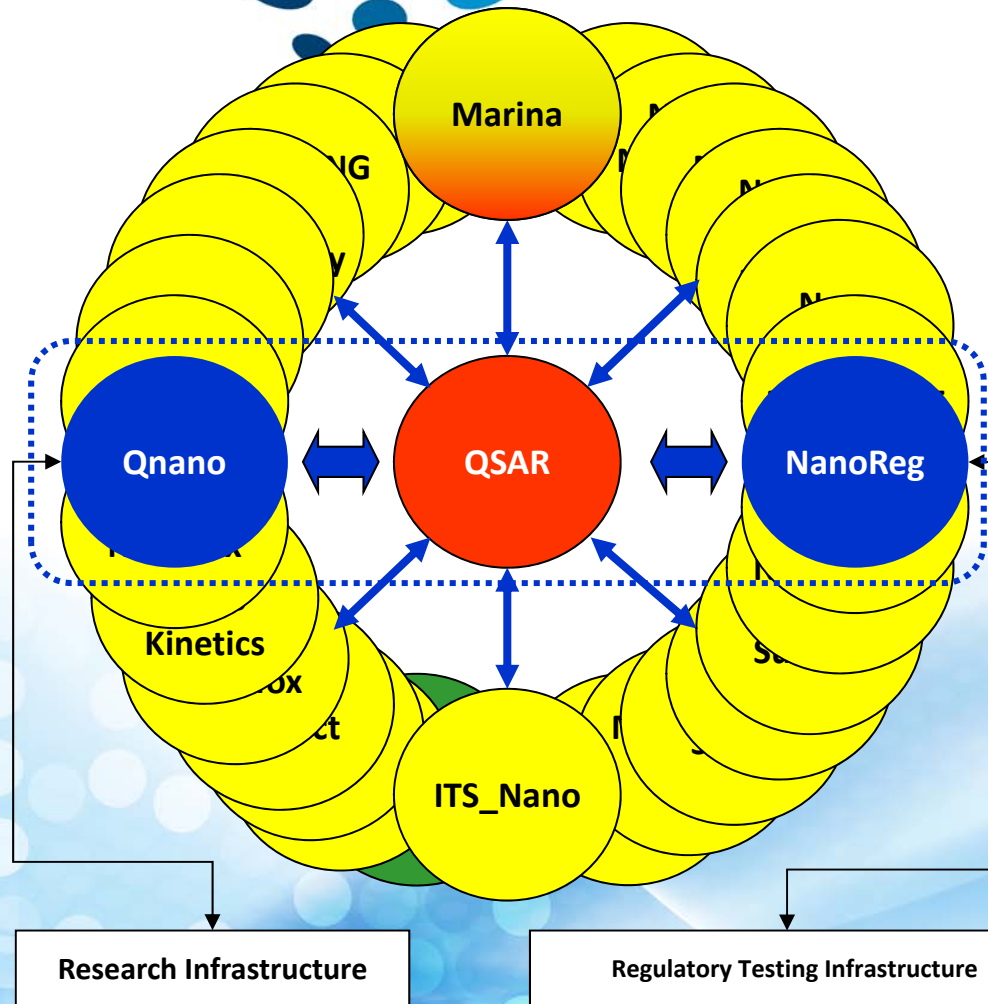
$$\text{Nanosafety RISK} = F[\text{Hazard}] \times F[\text{Exposure}]$$



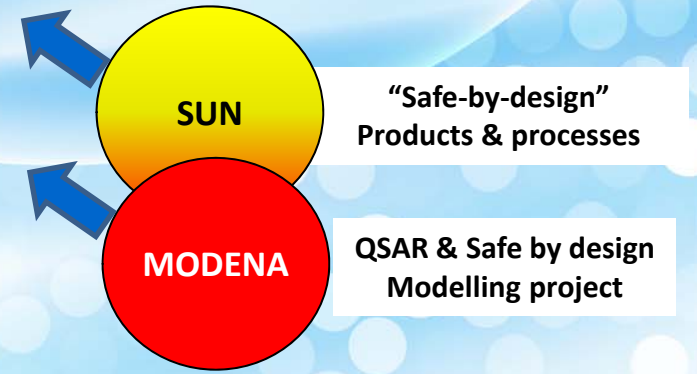
- Captures real knowledge
- Accelerates rate & quality of risk assessment
- Allows us to engineer “Safe by design “products
- Reduces overall costs longer term



Analysis of FP7 Nano EHS Projects in Relation to EU Strategy for REACH



- Key**
- Nanomaterials hazard and risk research and Innovation projects
 - Nanomaterials hazard and risk infrastructure development projects
 - Quantitative Structure Activity Analysis (QSAR)
 - NanoFutures European Technology Platform (11 Industry Sectors Input into nanosafety research needs)





Potential roadblock ahead?

We live in interesting times



Confucius 孔夫子

- Nanotechnology potential downgraded in US
- €160M invested in FP7 nanosafety research...
.....***but clear conclusions still in the future***
- Some Member States worried about risks (e.g. Cosmetics directive in France and EU*)
- CEFIC's big industry members believe some nanotechnology markets will be denied to Europe's chemical industry
- Bayer AG pulling out of CNT sector

*The Cosmetics Directive 76/768/EEC, EU Regulation No 1223/2009



NanoSafetyCluster Road Map

Time	Material	Exposure	Hazard	Risk
2015	Reference methods and nano-bio-interactions	Laboratory and computer simulations	Systems biology approaches available for hazard research	Improved risk communication and tools for risk assessment
2020	Data sets on reference ENM	Database on release	Understanding the association between material characteristics and hazard	Models and standards available
2025	Key metrics for harmful impact	Laboratory tests and models available for exposure assessment	A tool for safety assessment	A tool for the integration of safety by design strategies Guidance, tools, and automation

- Horizon 2020 budget = €30Mn/year for 7 years
- Industry cannot wait 10 years for results.



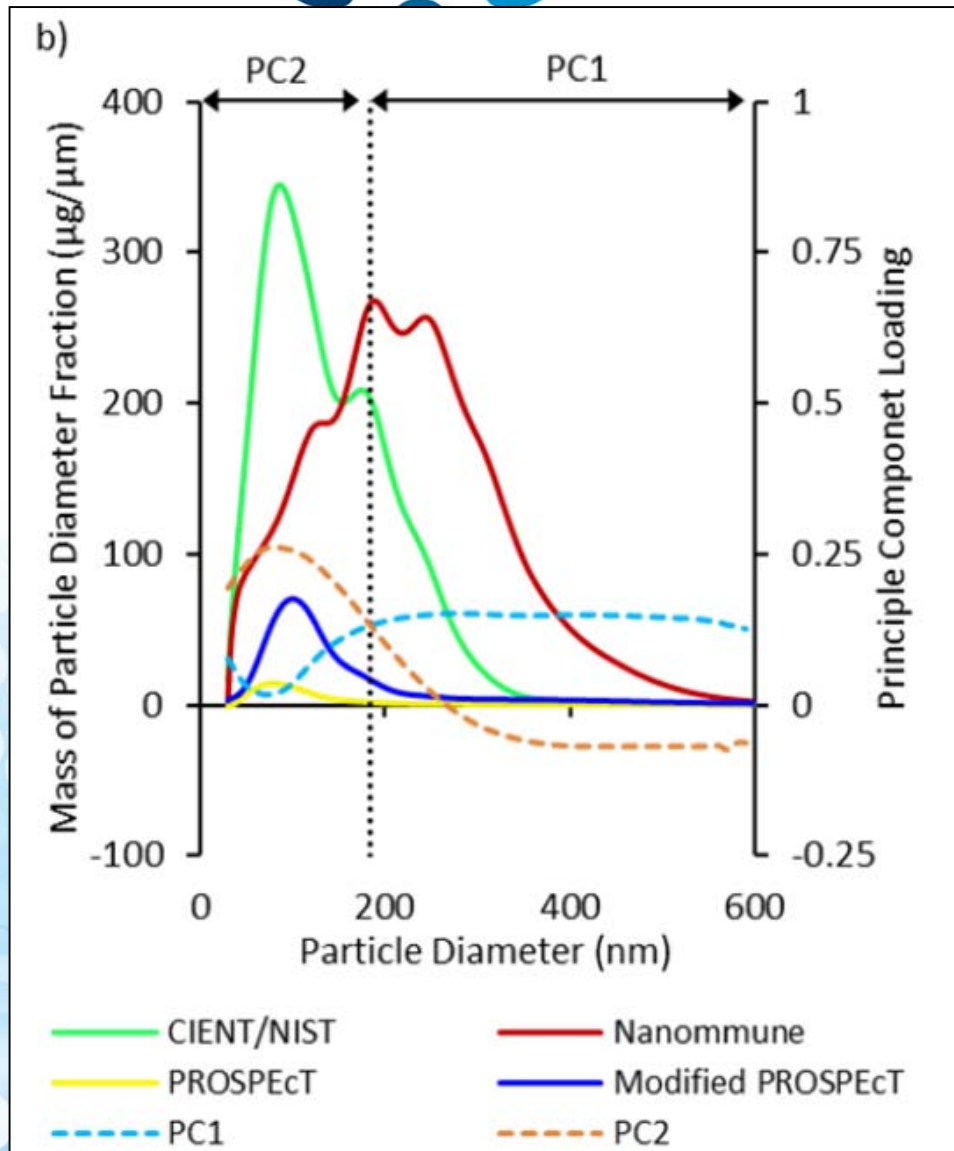
EMRP – Big thank you!



**Nano
ChOp**

Chemical and Optical Characterisation of
Nanomaterials in Biological Systems –
NanoChOp (<http://nano chop.lgcgroup.com>)

Nanoparticle Dispersion - Metrology Problem



Do we have a problem?



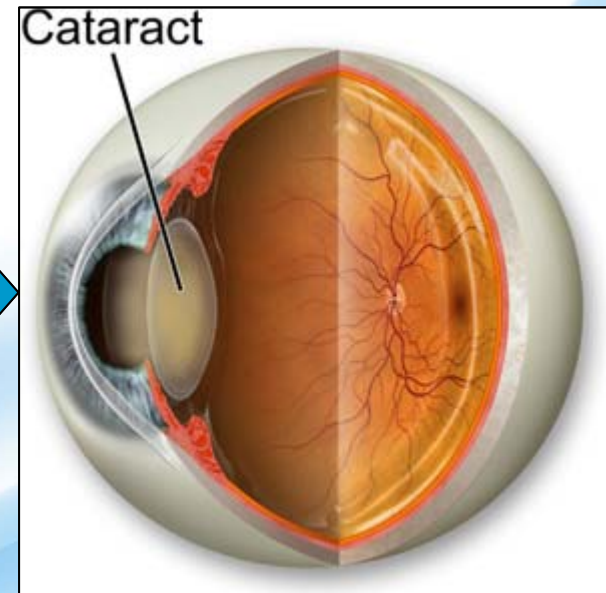
1. Only 1 of the FP7 and US NP dispersion protocols worked in our hands!
2. Does this explain why only 5/22 toxicology labs in the Qnano project "Round Robins" had usable results?
3. How much of the €160M portfolio of excellent projects are affected?
4. What other areas of the FP7 and H2020 portfolios would benefit from greater involvement of EURAMET?

(NPL & Leeds U PCA collaboration (in press)
Funded by EU FP7 MARINA & NANoREG projects

Nanotechnology, Metrology & Safety.....a personal viewpoint!



Jan 2009



Aug 2009

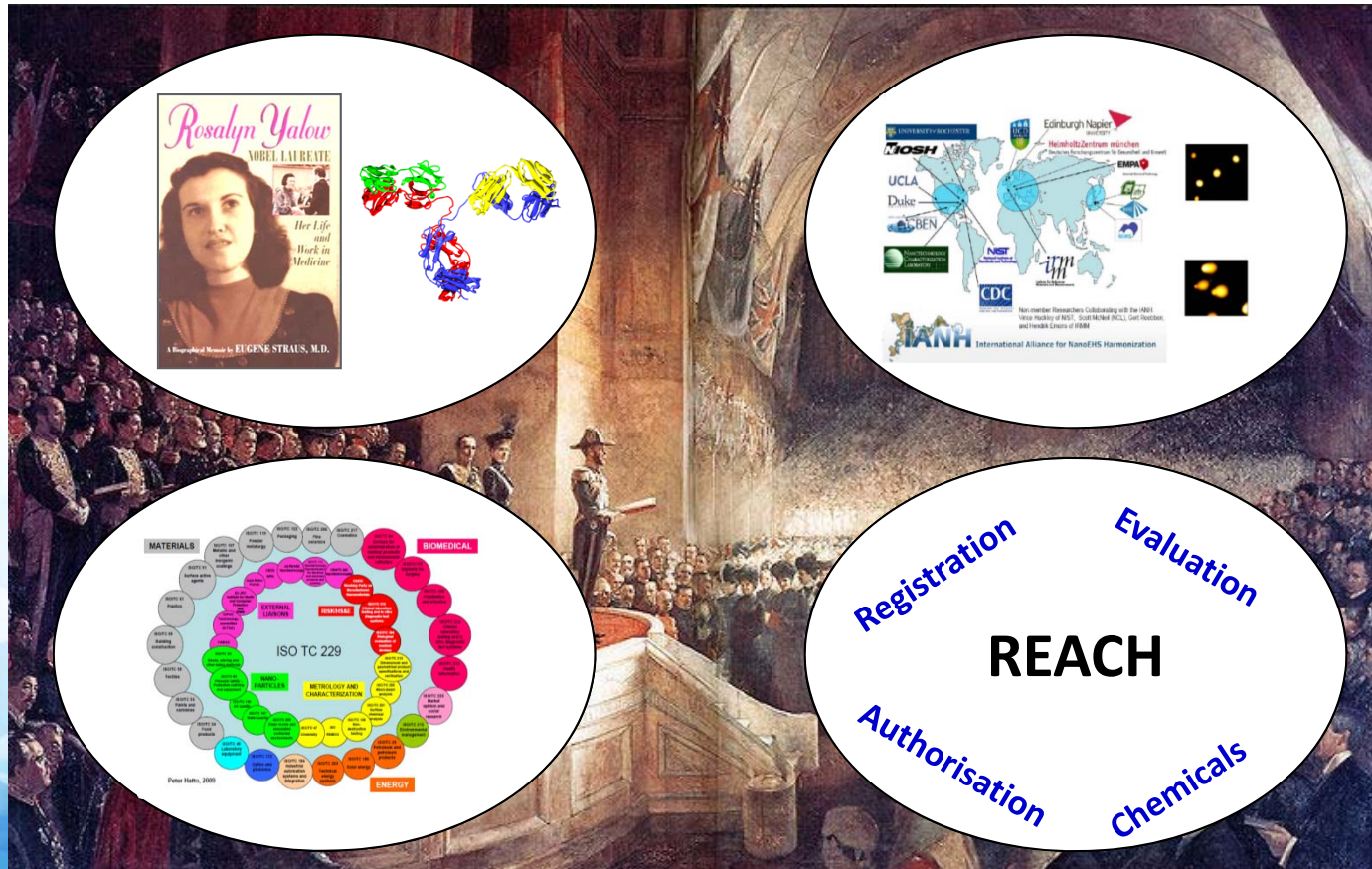
Diffraction Lens Cross-section (~100 nm steps)



Completing the Bigger Picture....

Metrology

QA Schemes



Standards

Regulation

Concluding Thoughts

- Europe invests €2 billion/year in nanotechnology R&I
- Potential global markets are huge ~ € trillions
- Major socioeconomic potential impact for healthcare, energy and nanoelectronics
- Significant opportunities near-term in transport, construction & consumer products
- Europe has a €160M portfolio of **Environment, Health & Safety** research into risks and hazards for engineered nanoparticles
- Open and continuous debate on risks & benefits with all stakeholders will be essential as findings emerge from this research portfolio over the next few years
- Without greater involvement of Europe's NMI's in this research, evidence-based regulation may be delayed or lost and economic benefits and jobs exported overseas



small **SIZE**
BIG impact
Nanotech in society
explained

Thank you for your attention

.....Any Questions

