Background to the report

Independent study undertaken by Royal Society/Royal Academy of Engineering, commissioned by UK Government, in order to

- **define nanoscience and nanotechnology**
- **summarise current and foreseeable applications,**
- **assess any health, environment, safety, ethical or societal implications,**
- **identify areas where additional regulation needs to be considered**

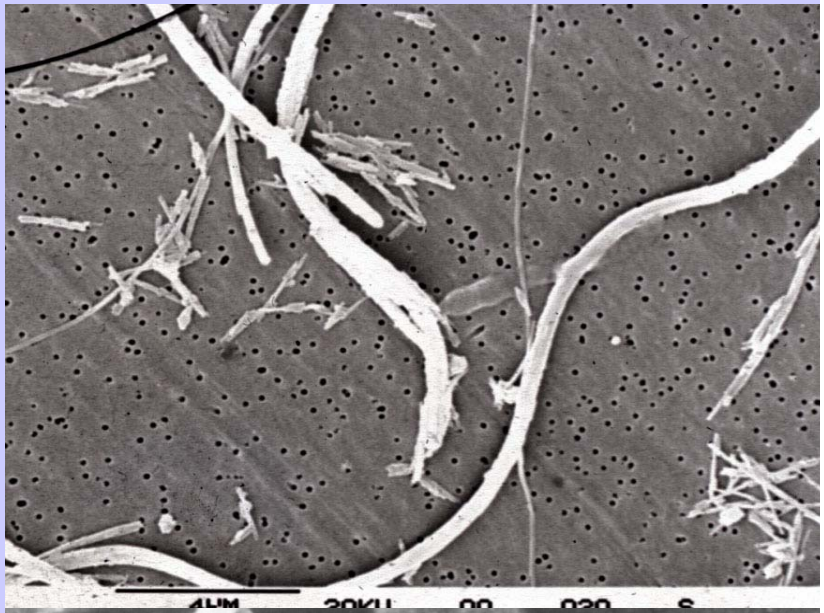
Hazard and risk

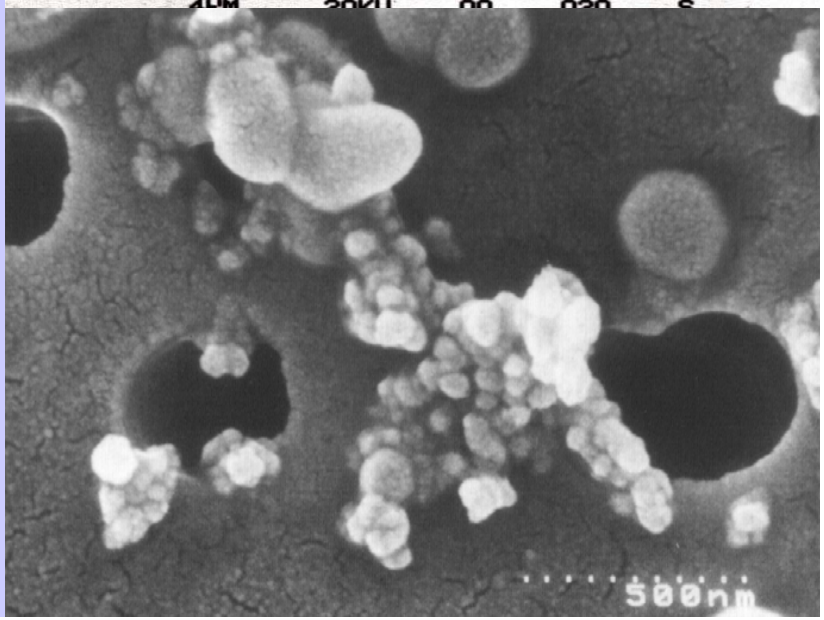
- **Hazard** - the potential to cause harm.
- **Exposure** – the concentration of a substance in the medium multiplied by the duration of contact.
- **Dose** – the amount of a substance that will reach a specific biological system.
- **Risk** – the likelihood of harm occurring.

Hazard and risk are commonly confused

Inhaling nanoparticles

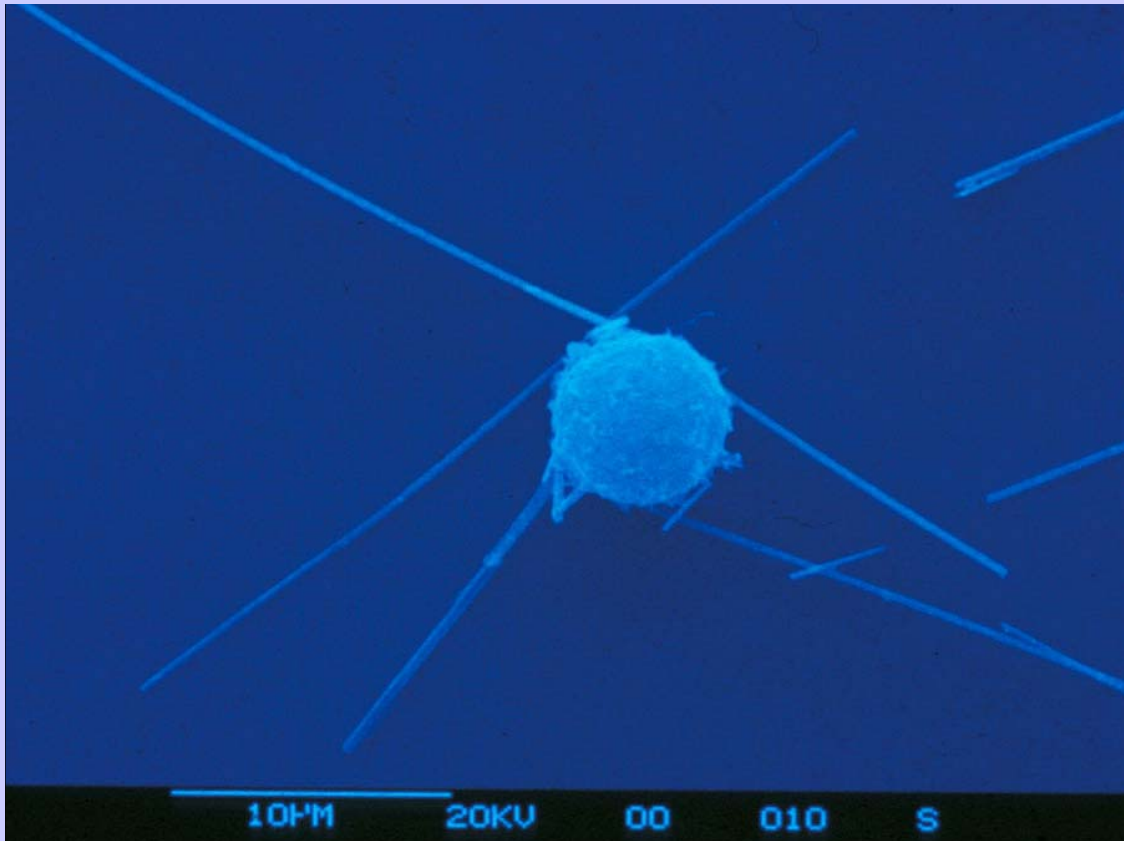
- Fibres
  - asbestos
  - carbon fibres
  - erionite
- Spherical particles
  - combustion-generated
    - vehicles
    - industry
    - cigarettes
  - photochemical





Risks from asbestos are attributable to the fibres’

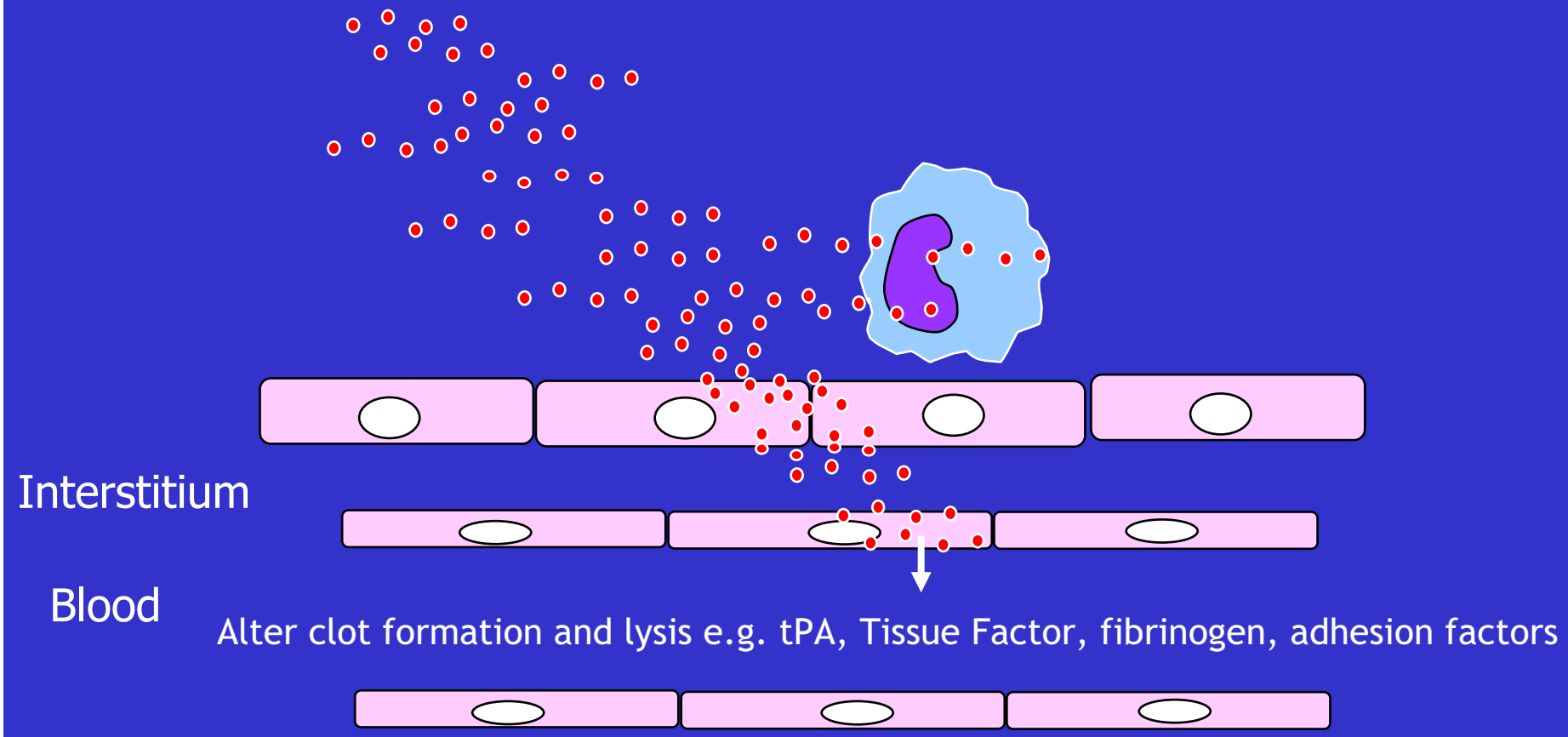
- length > c15μm
- diameter < c3μm
- durability
- surface activity
- dose to target organ



Air pollution – associations with particles

- Increased death rates and hospital admissions
- Effects primarily on heart and lungs
- Increased long-term risk of heart attack
- Why should this be?

Possible difference between microparticles qnd nanoparticles – surface area and ability to penetrate tissue barriers and cell membranes



Particles and health – the heart and the lung

1. Deposition in the deep lung and inflammation
2. Penetration to vascular endothelium
3. Secondary effects on blood
4. Increased liability to coronary artery disease and heart attack

Particles and health – the skin and nervous system

1. Skin penetration and u/v potentiation

   - increasing cancer risks?

2. Penetration across blood-brain barrier along nerves – eg olfactory

   - passage of toxic substances to brain?

3. But also possible beneficial effects

   - treatment of skin and brain diseases?

Manufactured nanoparticles - current exposure scenarios

- Research and manufacture of nanotubes
- Manufacture of mundane nanoparticles (TiO_2, ZnO etc)
- Use of nanoparticles in sunscreens and cosmetics
- Use of nanoparticles in environmental applications
- Introduction of therapeutic or diagnostic nanoparticles into the body

The RAEng/RS report:
Summary

- Nanotechnologies offer great opportunities with many benefits now and in the future
- Development should be debated by the public
- Most nanotechnologies pose no new risks to health, safety or the environment
- Research and regulation required immediately to address uncertainties about hazards and risks of nanoparticles and nanotubes

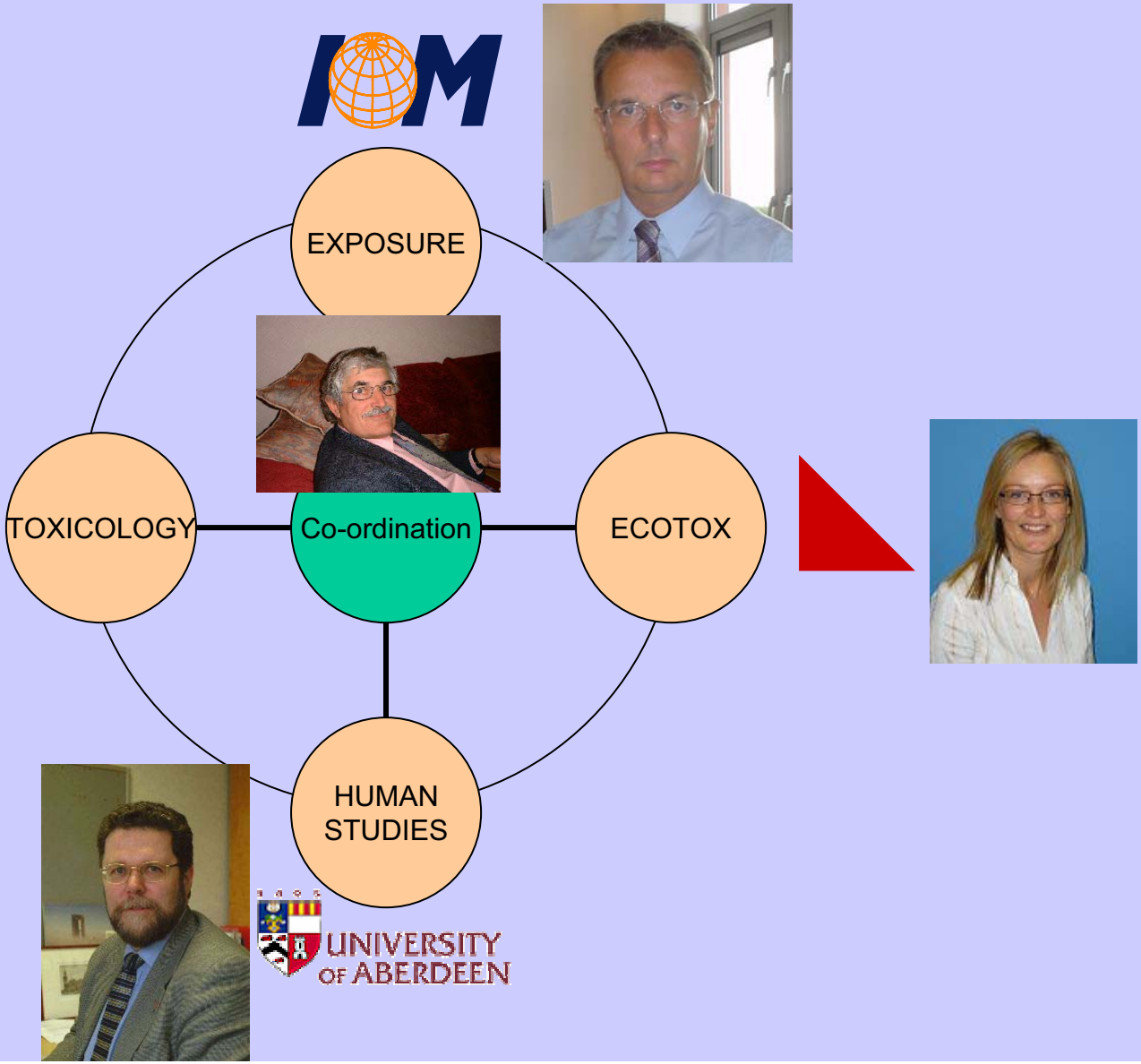
UK Government's response

- Accepted most recommendations
- Work with EU to assure consumer protection
- Encourage public dialogue to guide research & regulation
- Work with industry to improve safety transparency
- Nano Issues Dialogue Group – report in 2 & 5 years
- Research Coordination Group
  - Measurement
  - Toxicology

Background

- Need:
  - To create an interdisciplinary research centre ‘without walls’ to meet the research needs laid out by the Royal Society and Royal Academy of Engineering.
- Response:
  - Formation of Safety of nanomaterials Integrated Research Centre - S*n*IRC

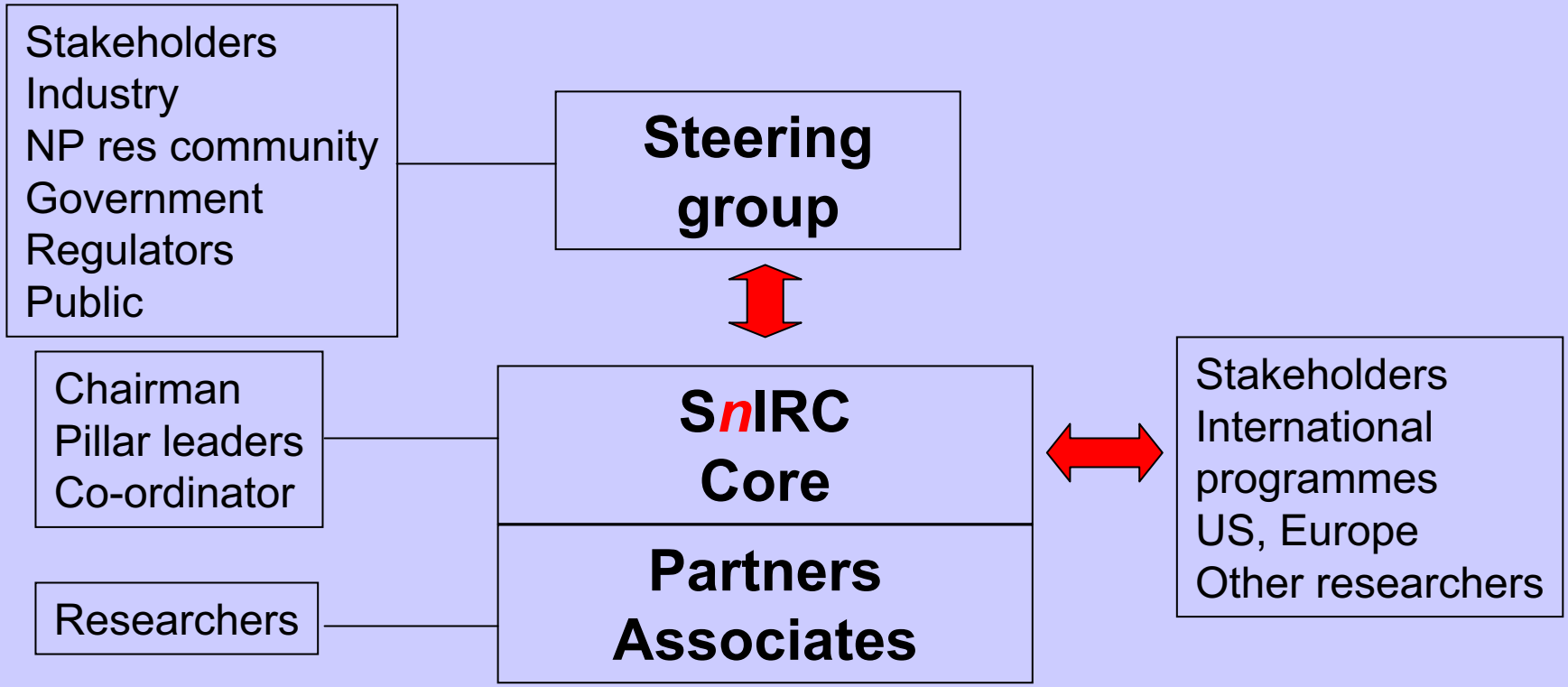
Founding Members of S*n*IRC



Purpose of S*n*IRC

- **To generate a scientific evidence base for:**
  - facilitating growth of UK nanotechnology industry, while
  - safeguarding workplace, public and environmental health
- **To become the UK centre for information, advice on health, safety and environmental impacts of nanoparticles**.
- **To assist UK industry in developing safe nano-materials**.
- **To integrate with other UK and international researchers and regulators.**
- **To assist Government Departments in developing sound strategies for managing public/workplace/environmental health and safety.**

Structure of S*n*IRC



Hazards – health and environment

- Inhalation/injection of large numbers of particles influencing risks of heart disease
- Penetration of particles into the brain via nerve transmission
- Inhalation of nanotubes leading to lung disease
- Potentiation of skin u/v damage by nanoparticles in sunscreens
- Injection of particles for therapeutic/diagnostic purposes leading to unforeseen effects on organs/atheroma
- Environmental use/disposal of particles leading to toxic effects on ecosystems

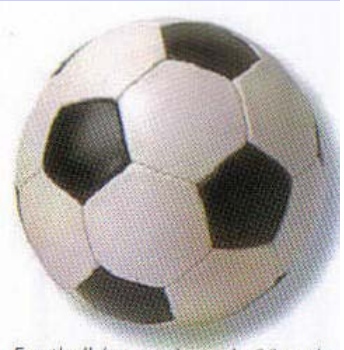
Reduction of risk

- Use intrinsically non-toxic or less toxic substances
- Prevent or reduce likelihood of exposure
  - Enclose process
  - Isolate individuals
  - Dilute toxic substances
  - Monitor exposure concentrations
  - Care with disposal
- Take account of new properties in regulation

carbon 60 (0.7 nm)
R.Drautz

Nanoparticles, health and the environment

Do we need to worry?



Football (approximately 22 cm)

Recommendations - regulation

- **No new specific regulatory bodies needed**
- **But all regulators should review existing regulations**

Recommendations - health and environment

- programme of research to fill knowledge gaps
- restrict exposure to free nanoparticles and nanotubes until they are better understood.
- control release of manufactured nanoparticles and nanotubes