

# NMS Programme Formulation and Roadmaps

Polymeric Materials IAG

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Roadmaps:

Why we need them, what they will be used  
for and how we move forward

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**Rolling formulation 2008+ update**

**NMS MATERIALS /THERMAL PROGRAMME**

**NMS INNOVATION R&D PROGRAMME**

# NMS INNOVATION R&D PROGRAMME

## *Potential project:*

### **Micro-scale characterisation of the properties of polymeric materials**

- High rate viscosity testing by capillary extrusion rheometry.
- Indentation procedures for microscale polymeric components.
  - For determining design data for thin polymer sections at elevated temperatures over extended time period
- Accelerated test procedures for determining property data needed for design for long term performance.
  - For determining long-term tensile property data for lifetime prediction in short timescales of thin sections

## *Potential project:*

### **New measurement on nanoparticles: their size distribution and their dispersion in nanocomposites**

- Traceable characterisation of spherical nanoparticles and shape characterisation.
- Validated dispersion measurements for nanocomposites.
  - Thermal and rheological techniques to measure degree of dispersion of nano-fillers. To investigate platelet, rod and spherical nanoparticles based composites and the effects of processing.
- Technology assessment for a new facility for 3D characterization with 1 nm resolution.

# Roadmaps

Why do we need roadmaps?

- To prioritise the initiation of projects on a strategic basis
- To manage the development of projects using a rolling formulation process

# Who will use roadmaps?

- IAGs to plan the future
- WGs to provide advice to DIUS
- NPL to develop capability and direct impact
- UK PLC to influence content of programmes
- DIUS to decide what to fund

# Roadmaps exist on two levels

- Programme – a snapshot of the programme content and drivers
- Theme – shows the way to meeting technical targets for a strand of work

# Programme Level Roadmaps

- Driver or target need
- What NMS is going to do about it
- What impact the work will have
- Shows which themes deliver in relation to which drivers

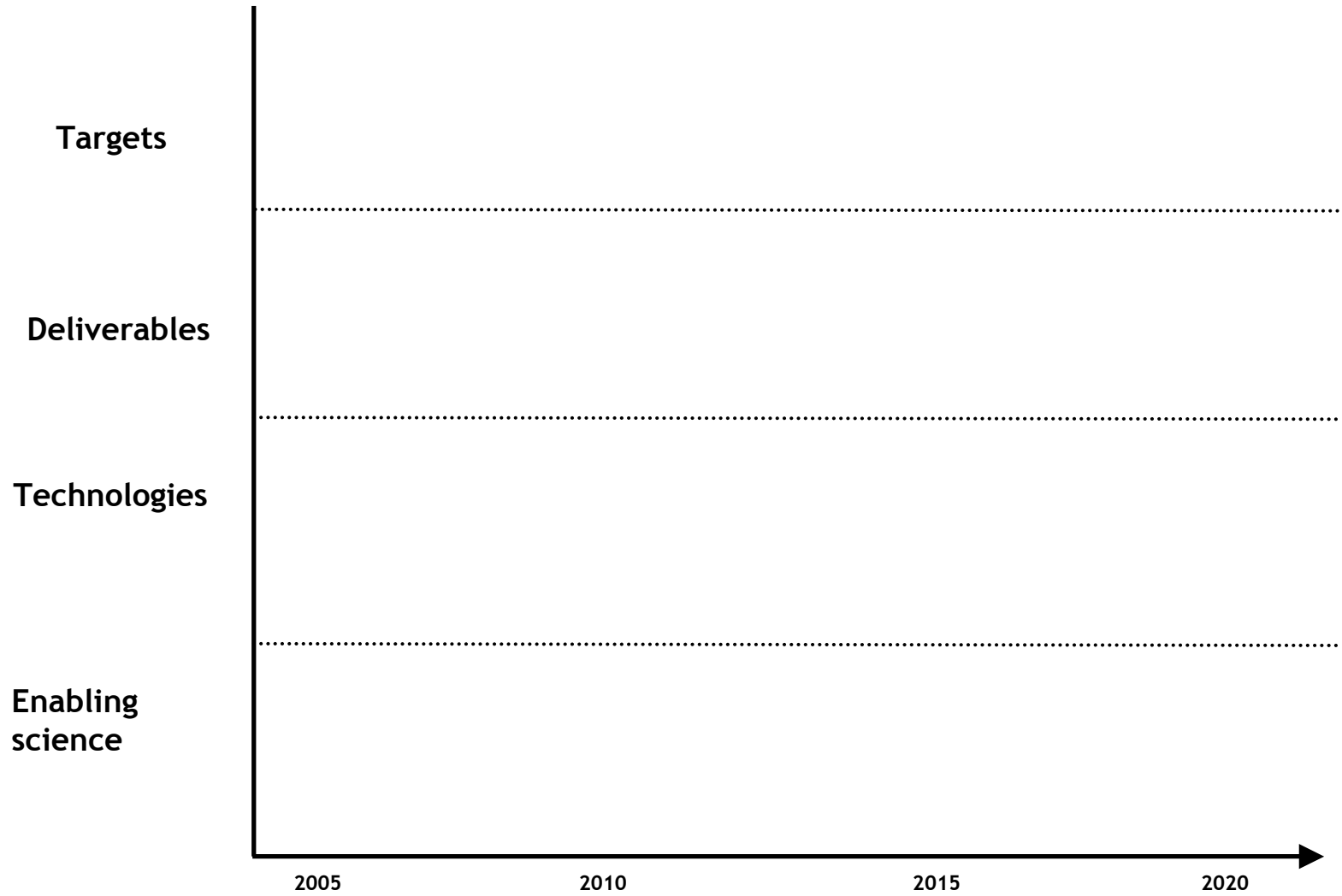
# Example 1

- Driver: To develop new lighter, stronger and tougher, self diagnostic materials based on nano and micro technologies
- What NMS should do: Develop NPL as a world leading centre for characterisation of materials on the nano and microscale (shape, size, functionality and distribution)
- Impact: To enable UKPLC to lead the world in the development of nano and micro materials

# Example 2

- Driver: Maintaining and maximising the lifetime and reducing the environmental impact of the UKs major infrastructural assets
- What NMS should do: Support the development of techniques for the assessment of structural integrity and residual lifetime of assets such as nuclear power stations and bridges
- Impact: Increased safety, lower maintenance costs and less environmental impact

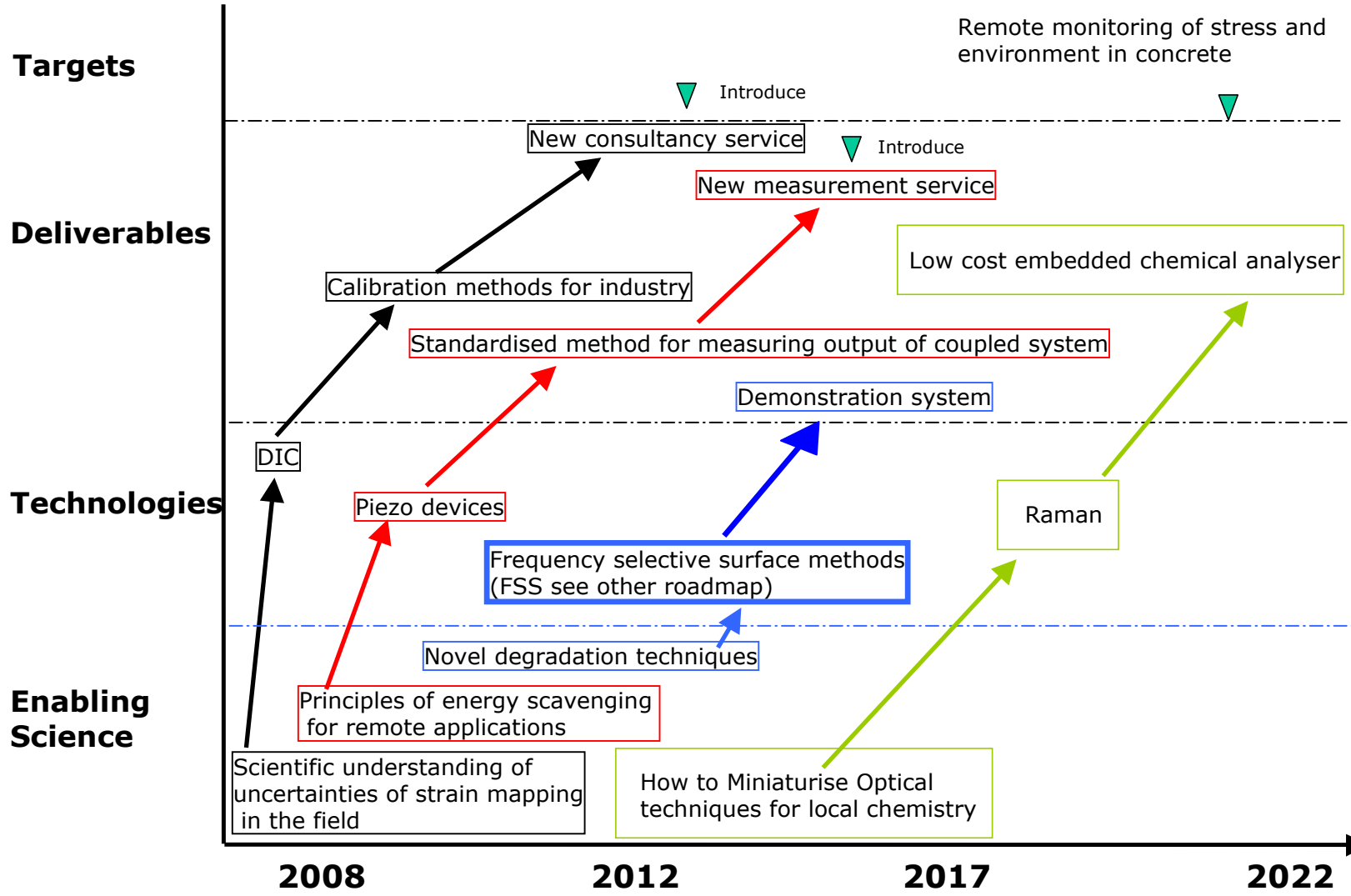
# Theme Roadmap Template



# Example roadmap – structural health monitoring

- Measurement of strain over whole structure (Black)
- Need to be self powered (energy scavenging) (Red)
- Innovative solutions may be required to meet industry needs (Blue)
- Assessment of environmental chemistry (Green)

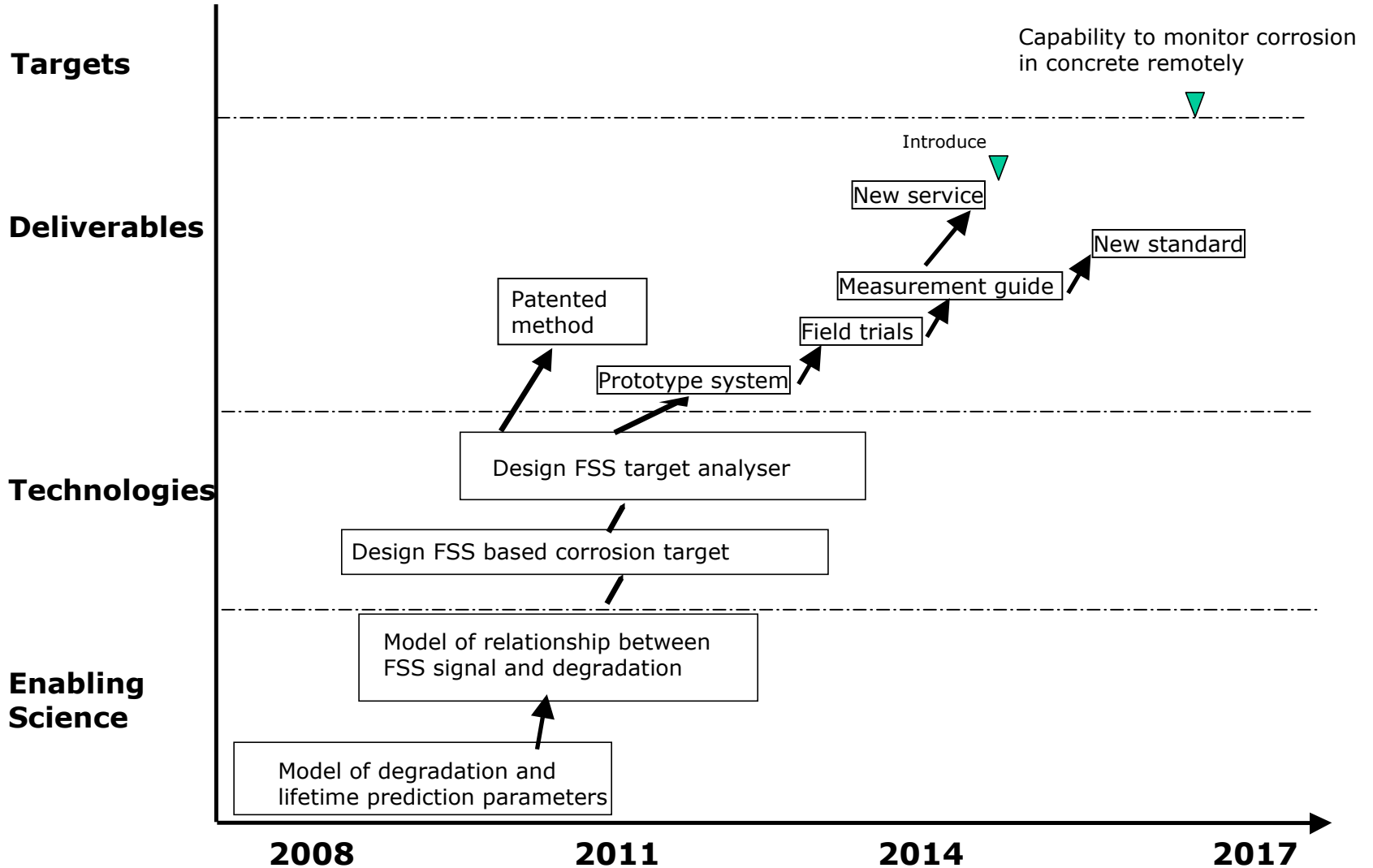
# Theme Roadmap example In-situ measurement - Structural Health monitoring



**Drivers or Challenges**

Maximise cost-benefits of infrastructural assets

# In-situ sub-roadmap example – FSS system for concrete lifetime management



**Drivers or Challenges**

Safety of nuclear power plant  
Maximise cost-benefits of transport infrastructure

# Plastics Multiscale IAG - feedback

## Triggers & targets

- *Sustainable longer life products*
- *Novel polymers and nanocomposites*
- Ageing population ⇒ Increased need for healthcare products
- Biofuel stocks
- *Polymer materials in the nuclear industry*
- Materials recycling
- Global use of materials: higher temperatures moisture, UV.
- Improve knowledge transfer skills especially between industries
- *Improve product lifetime capability*
- *Reduction of materials/Define best design practice*
- *Total design with: Polymers, Processing, Properties - Product*
- *Formulation science as a distinct discipline*
- *Thinner products: less energy, less materials, benefits. Need to retain performance*

## Product realisation

- New polymers from biofuel stocks
- *UK Centre of Excellence for Healthcare product design*
- New Bio-Polymers require longer-term material data in short term
- New Inorganic polymers- Longer life – low flammability
- *Fillers for improved product performance*
- Reduced compression set in foams
- Chemical bonding of mass particles to polymer backbone - improved energy transfer

## Metrological application of basic science & technology

- *Need for more accurate lifetime predictive design*
- *Time/Temperature/moisture behaviour of polymers*
- Long life wear resistant rubber
- *Full characterisation dispersion*

## Enabling measurement science & technology / metrology fundamentals

- *Creep, fatigue, durability data for polymers*
- *Time/temperature superposition for rapid creep testing*
- Latex particle interactions with chemicals and fillers
- *Full characterisation of particle-matrix interfaces*
- Latex technology: + curing, + gelation, + avoid bubbles

# Plastics Multiscale IAG

- Two proposed theme roadmaps on characterisation and lifetime of:
- Nanocomposites
- Polymeric materials

Others ??

# Nanocomposites – Nano-scale Characterisation and Life Time Performance

## Targets

Application focus: novel polymers (e.g. healthcare, electronics), thin films (e.g. polymer electronics), composites (e.g. aerospace, automotive, electronic, fuel cells, ), rubbers (e.g. automotive)

New and improved polymers, rubbers and nanocomposite products

## Deliverables

New measurement facilities and services

Miniaturised test methods for rapid QA and durability assessment

Standardised methods for nanoscale/interfacial characterisation

## Technologies

Nanoparticle sensors– integrated (in-situ) SHM measurement - self-healing

Micro and nano-indentation – durability

Particle interactions with chemicals/fillers

Nano- and macro-scale dispersion measurements

Interfacial property characterisation

## Enabling Science

Development of nanoscale measurement methods for generating data for QA and long term prediction

Development of characterisation and performance test methods relevant to micro- and nano-particulate reinforced polymeric systems

2008

2012

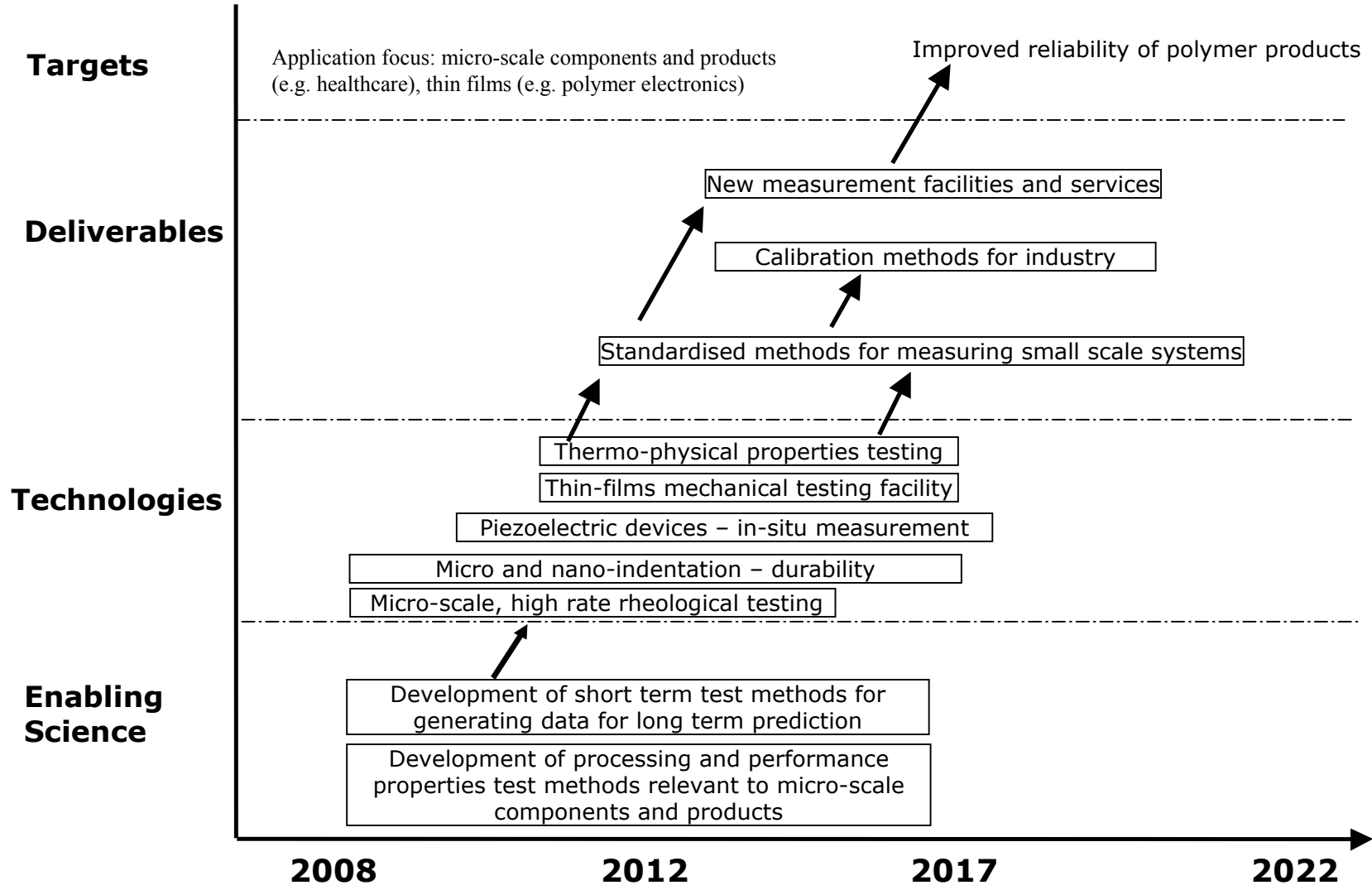
2017

2022

## Drivers or Challenges

Increase in functionality and energy efficient processing  
Improved sustainability – longer life products

# Polymeric materials – micro-scale characterisation and life time performance



**Drivers or Challenges**

Improved sustainability – longer life products