MNBS'12, Demokritos, Athens, May 3 & 4, 2012

Micro-Nano-Bio Convergence Systems: towards Horizon 2020

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Micro-Nano-Bio Converging Technologies & Systems

Microsystems & Smart System Integration

EPoSS (ETP)

ICT for Health
eInclusion
FET

CONVERGING

Micro –Nano-Bio-ICT

Personal Health Systems
Virtual Human Physiom
Bio-Neuro-ICT

Nanomedicine (ETP)
Nanomaterials & processes

Nano and converging Sciences and Technologies

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Horizon 2020

Education and Cu

Europe 2020 priorities

European Research Are

International cooperation

Shared objectives and principles

Tackling Societal Challenges

- Health, demographic change and wellbeing
- Food security and the bio-based economy
- Secure, clean and efficient energy
- Smart, green and integrated transport
- Supply of raw materials
- Resource efficiency and climate action
- Inclusive, innovative and secure societies

EIT and JRC will contribute to addressing these challenges

Creating Industrial Leadership and Competitive Frameworks

- Leadership in enabling and industrial technologies
- Access to risk finance
- Innovation in SMEs

Excellence in the Science Base

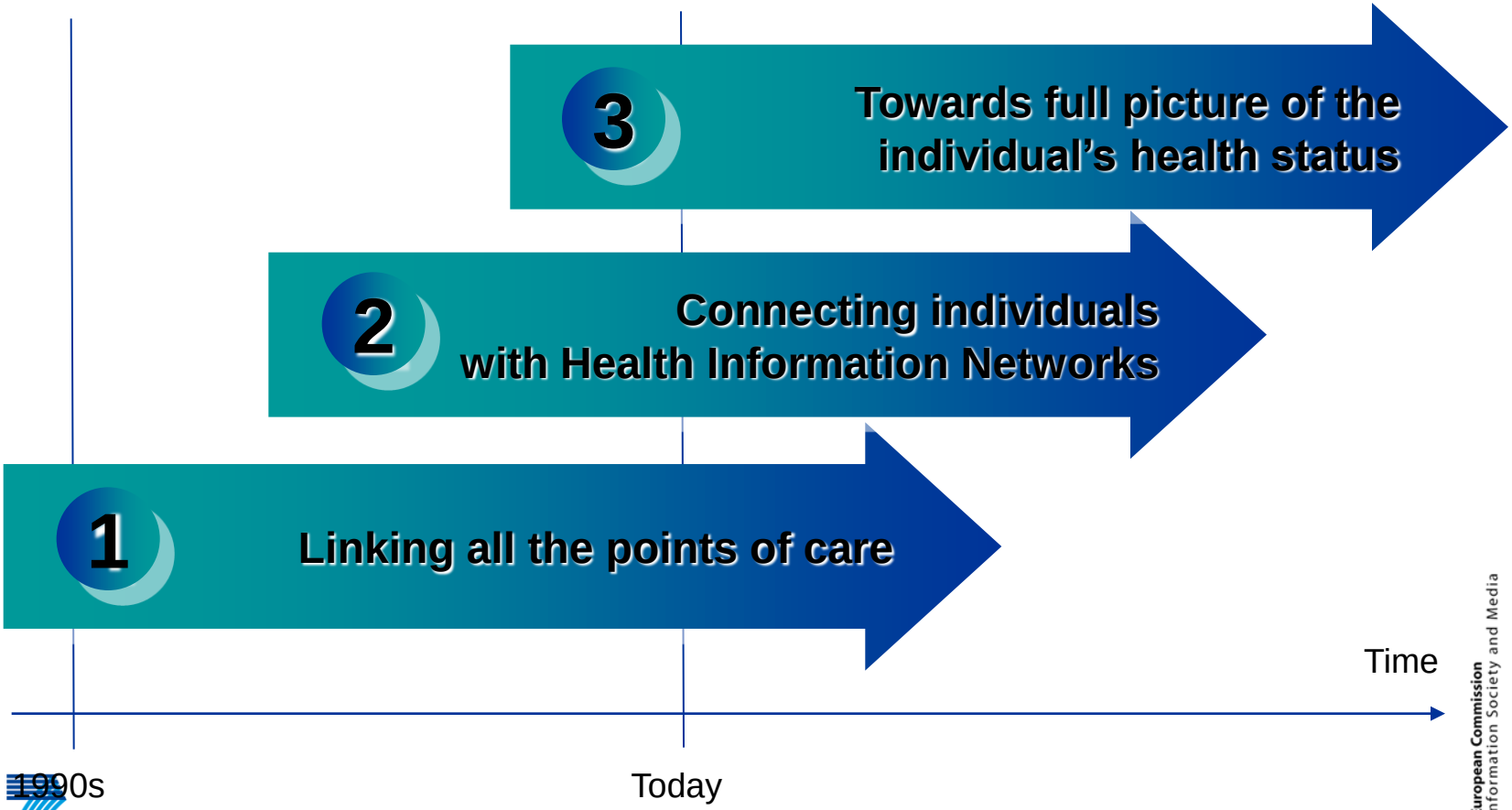
- Frontier research (ERC)
- Future and Emerging Technologies (FET)
- Skills and career development (Marie Curie)
- Research infrastructures

Simplified access

Coherent with other EU a

Common rules, toolkit of funding schemes

The EU roadmap for eHealth



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MNBS: Technological and Application Areas Focus

Biosensors & Lab on Chip Components and Systems for biomedicine, food & environment*, *e.g.:

DNA & protein arrays, LoC (e.g. MNT, surface chemistry, biomarkers, microfluidics, modelling, instrumentation, sample preparation, detection, integration/packaging and cost reduction)

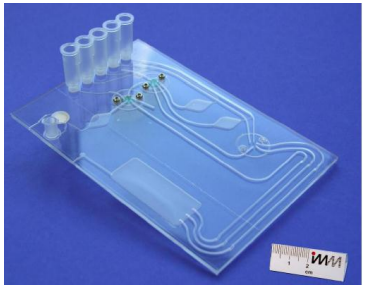
Smart Micro Nano Systems on & inside the body*, *e.g.:

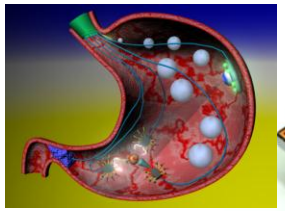
BioMEMS, BioRobots, Actuator-Sensor ("closed loop" systems), Drug delivery systems, Biochemical Wearable Sensing and Active low power implants

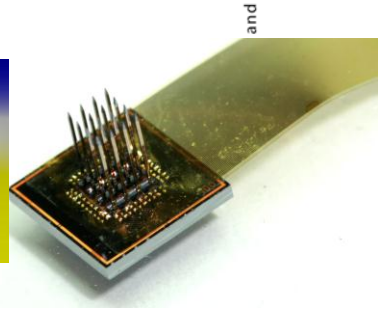
Business and driving forces*, *e.g.:

Driving applications: Healthcare/biomedicine, food, environment, security, leisure

Mass production (cost), user needs, ethical and societal issues.







MNBS is an existing strong European Cluster

41 (FP6 & FP7) Projects, 171 M€ funding (15 currently running)

A. Biomedical
   A1. Miniaturised & Lab-on-chip systems for biological, chemical & biochemical analysis
   A2. Systems for in vivo interaction with the human body
   A3. Other

B. Environment

C. Food and Beverage

Annual Workshops 2007-2011

http://cordis.europa.eu/ist/mnd/events.htm

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ICT Call 8: Micro-Nano-Bio Systems

Coverage of retained proposals

Lab-on Chip (32,4 M€)

Food safety/pathogen Detection: 2

Single Molecule Detection

PoC for Non-Invasive Prenatal Diagnosis

PoC for Multiple therapeutic drug monitoring

PoC for infectious disease diagnosis

Manufacturing platform for pathogen diagnostics, environmental monitoring and immuno-diagnostics

In Vivo MNBS (6,2 M€)

Smart wearable system for wound monitoring and therapy

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ICT Call 8: Smart Components ans Smart Systems Integration
Part b). Micro-Nano-Bio Systems

a) Health and Biomedical Applications

b) Environment protection, food/beverage safety, quality control

IP + STREP
39M€

Increased intelligence of devices
Enhanced miniaturisation and integration
Increased integration of bioactive components

New generation of MNBS: Smaller, perform better, be faster and cheaper, delivering enhanced sensitivity & specificity and highly reproducible & reliable results

Highly competitive area with strong SME participation

Funding scheme	#received	# above threshold	# retained / reserve
IP	26	6 (23%)	3 (11%) / 0
STREP	73	53 (57%)	5 (7%) / 3
Total	99	45 (45%)	8 (8%) / 3

SME Participation: 28% funding, 32% participants

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Design a foresight exercise

Structured Stakeholders' Dialogue

Diagnosis	Prognosis	Prescription
Understanding where we are…	Exploring what could happen…	Debating what we would like to happen … Deciding what should be done …

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Current Microsystems products in Life Sciences, pharmaceutical, diagnostics and therapeutics

Type of Products	*Applications*	*Product examples*
Microarrays (or chips)	Life sciences & pharmaceutical research, in-vitro diagnostics	-Affymetrix-GeneChipR -Roche-Amplichip CYP450
Microfluidic Devices	• Life Sciences & Pharmaceutical (e.g. cell chips, electrophoresis chips, proteomic devices and microdispensers • [illegible] diagnosis (e.g. autonomous diagnostic systems) • Drug delivery (micropumps, atomisers, microneedles)	• Life Sciences - Silicon Biosystems- Smart SlideTM chip. - IMT LifeMEMSTM -Pa[illegible] [illegible] diagnosis A[illegible]-chip device for blood gas & electrolytes - STmicroelectronics-in-Check system for sample preparation, PCR amplification and detection. - Siemens- QuicklabR silicon La-on-chip • Drug Delivery - Boeringer MicroParts RespimatR Inhaler for pulmonary diseases - Medtronic Minimed Inc.-Minimed 2007 Implantable insulin pump

Needs for fast, low-cost and high complexity samples analysis

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In vitro testing & diagnostics

A 10 B€ Market in EU in 2010 (3% growth)

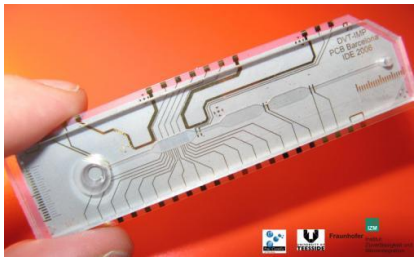
✓MNBS: R&D on Biochips & Arrays

- Integrated Biosensor for Label Free in vitro DNA and Protein Diagnosis
- Microsystem for magnetic isolation and analysis of Single circulating tumour cells for oncology
- DNA analysis: with enclosed microfluidics, integrated detectors and control circuitry using polymer and silicon materials

✓MNBS: R&D on MicroTAS and Lab-On-Chip /Card

- Food safety and Quality monitoring with Microsystems
- Lab-on-chip based protein profiling for Cancer diagnostics
- Mass produced Optical diagnostic Labcards
- Automatic detection of Disease related Molecular cell related activity
- Cell-On-Chip biosensor for detection of cell-to-cell interactions

Courtesy LabOnFoil Project



Courtesy DVT-IMP Project

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MNBS for Molecular, cell and bacteria detection

Main achievements

Improved sensitivity; multianalyte capabilities; rapidity of the biosensing process

- Working prototype modules to analyze real samples of drugs-of-abuse.
- Label-free detection of bio molecules in an integrated device
- Alternative approaches, such as miniaturizing mass spectrometers, could yield broadband diagnostic tools
- Design of LOC device to count and characterize occult circulating tumour cells.

Main Challenges

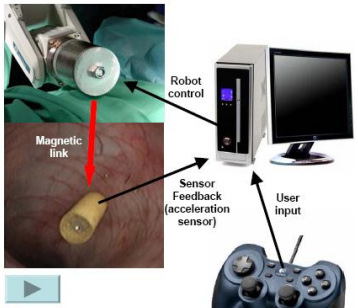
- To achieve portability and sensitivity while keeping the device price low
- To migrate prototype biochips from special purpose fabrication to mass-production technologies as used in Si foundries requires a major redesign
- For the ***integration*** of heterogeneous processes on monolithical substrates serious hurdles have to be overcome
- Performance of the devices' prototypes
- Clinical trials to prove the clinical efficacy and economic advantages of successful prototypes
- To reconcile initial performance goals with market requirements

MNBS Interacting with the Human Body

Smart Micro Nano Systems on & inside the body, e.g.:

BioMEMS, BioRobots, Actuator-Sensor systems, Drug delivery systems, Biochemical Wearable Sensing and Active low power implants

- ✓ Core implant technologies (e.g. biocompatible implant coatings, biofuel cell to power implant electronics and wireless communication), active smart implants and diagnostic equipment for:
  - Restoration of sight (retina implant); Diagnosing glaucoma; Monitoring intra-cranial pressure; Restoration of hearing
  - stimulation & recording of brain activity and disorders (e.g. epilepsy) through modular probes arrays integrating electronic depth control
- ✓ Blood glucose monitoring with the development of subcutaneous glucose biosensor based on glucose binding proteins.
- ✓ Drug delivery (through intraoral microsystems)
- ✓ Endoscopic Smart Capsules for diagnosis and therapy



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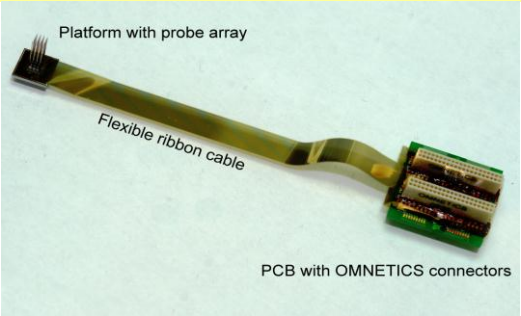
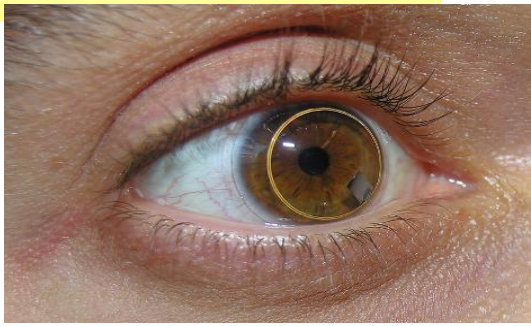


NeuroProbes



Glaucoma Sensor, Healthy Aims

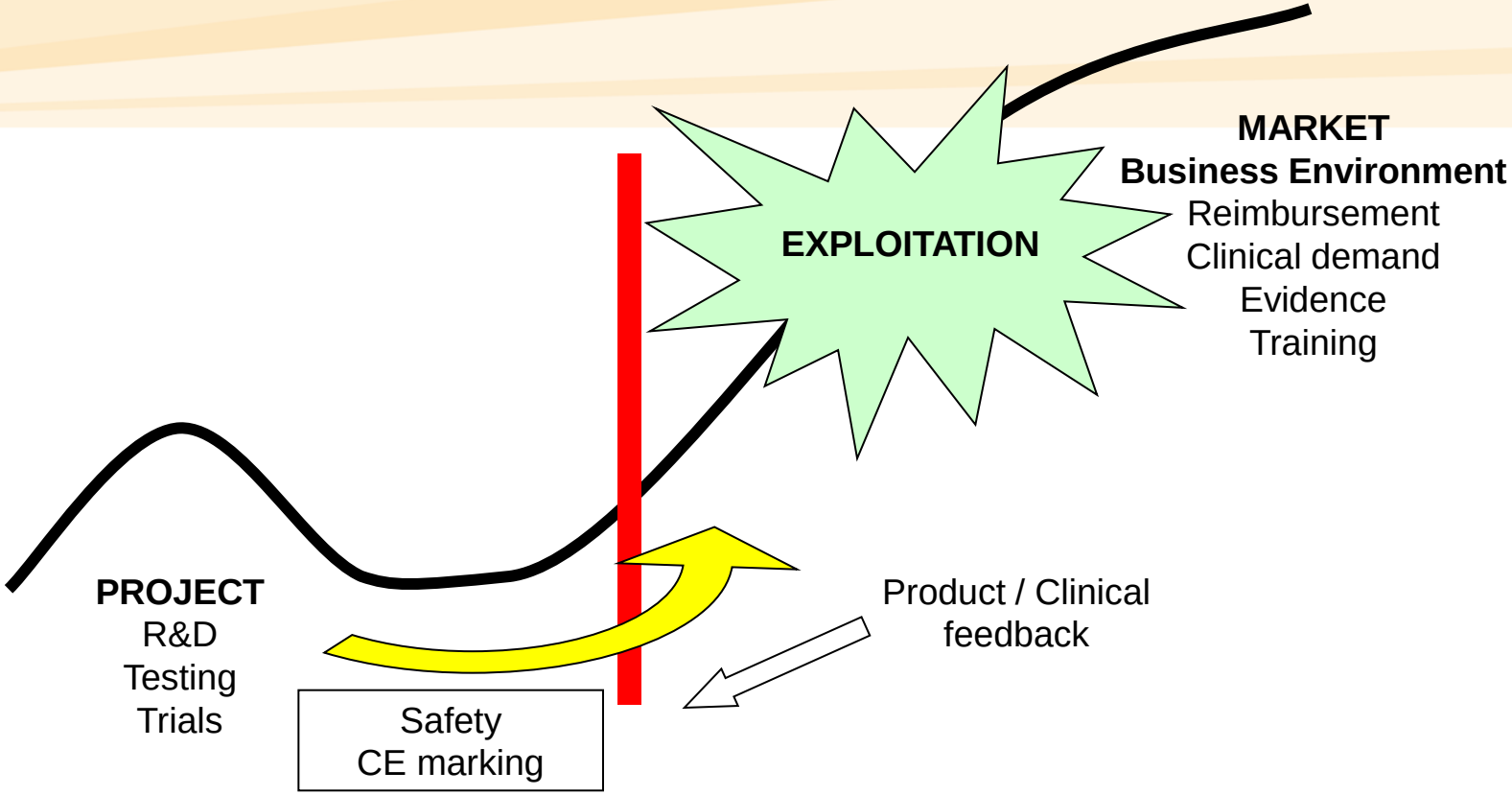
Main Orientation for future R&D

- ***Computerisation***: integration of bioinformatics and medical data management with high data rates and storage power
- ***Miniaturisation***: ability to deliver the given function, integration into the fabrication phase and integration with other devices to make a system
- ***Molecularisation***: new surface chemistry, biomarkers, immobolisation of molecules on surfaces, biocompatibility and multiplexing techniques to ensure powerful and accurate signal output.
- ***Achieve Integration***; Fast and multianalyte performance; validated prototypes with real samples; disposability and low fabrication cost

Grand Challenge of the Cluster: Overcome current limitations and reach the market

- ✓ Low rate and speed of industrialization; many projects are either never completed or do not survive real word testing.
- ✓ More patents should have been filed and more commercial partners and end-users involved.
- ✓ Inexperience in dealing with regulatory affairs (key factor for successful transition from research to innovation).
- ✓ Expected and unexpected technical key challenges for smart autonomous MNBS, e.g. sample pre-treatment, microfluidics and standardization; lack of adequate sample materials, poor sensitivity, reliability and repeatability. Power management, biocompatibility and interfacing ICT with the human body remain

Medical Device Exploitation



R&D	Test	Trial	CE	Product Protocol

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Building on successes and addressing weaknesses

- Concentrating and pulling efforts to achieve breakthroughs
- Opening to a wider stakeholder community (e.g high growth SMEs)
- R&I approaches that combine the supply push with the demand pull/drive for innovation and that aim at addressing Europe's socio-economic challenges.
- Involve the users including the civil society at the earliest stage

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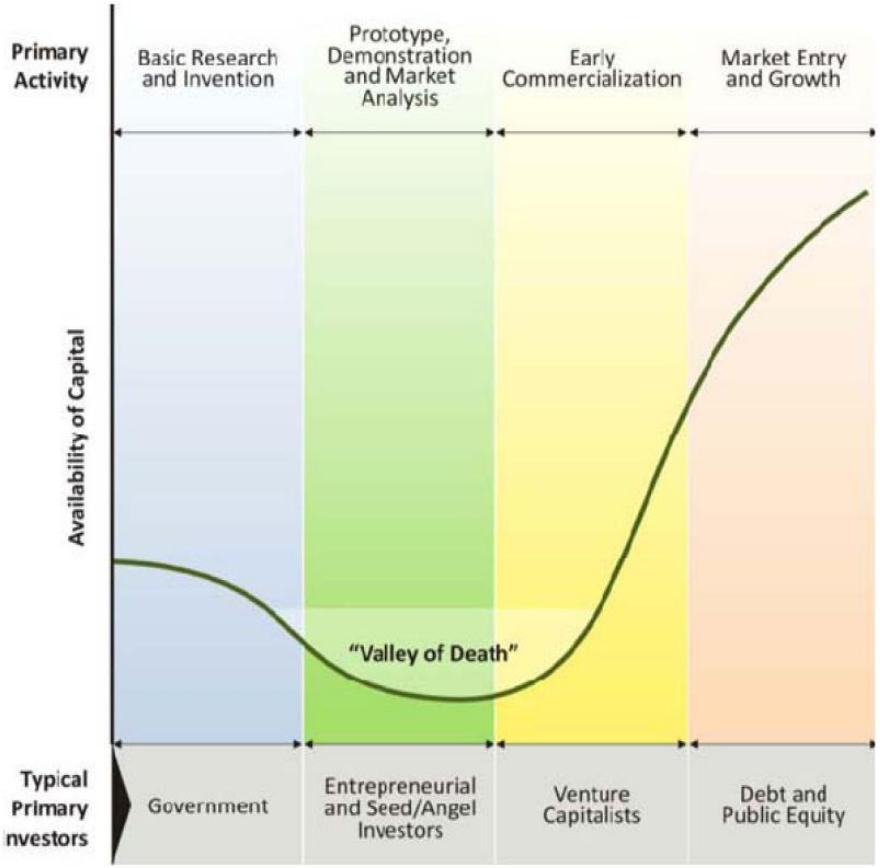
Public & Private Investments Needs

- EU should improve rate of attractiveness to business investments
  (China and USA offer more public funds and/or easier regulations)

- EU needs "smart incentives" to cover all steps, from R&D to the market, to avoid "valley-of-death" for European businesses in particular for new businesses



Source: HLG KET Report, Brussels

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Towards FP8
Towards a Common Strategic Framework (CSF) for EU Research and Innovation Funding

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Political context :
The 2020 Strategy and Flagship initiatives

- 2020 Strategy - 3 Priorities:

- **Smart growth**
  Developing an economy based on knowledge, innovation, education and digital society
- **Sustainable growth**
  Promoting a low-carbon, resource-efficient and competitive economy
- **Inclusive growth**
  Fostering a high employment economy delivering social and territorial cohesion

- Seven Flagship initiatives:

- **Innovation union**
- **A Digital Agenda for Europe**
- **Resource-efficient Europe**
- Youth on the move
- An industrial policy for green growth
- An agenda for new skills and jobs
- European platform against poverty

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TOWARDS AN INNOVATION UNION

Communication
COM(2010)546 of 6.10.2010

- Innovation Union will **advance scientific boundaries**, increase European **competitiveness** and help solve **societal challenges** such as climate change, energy and food security, health and an ageing population.

From idea to the market

Excellent Knowledge Base | Access to finance | Innovation Market

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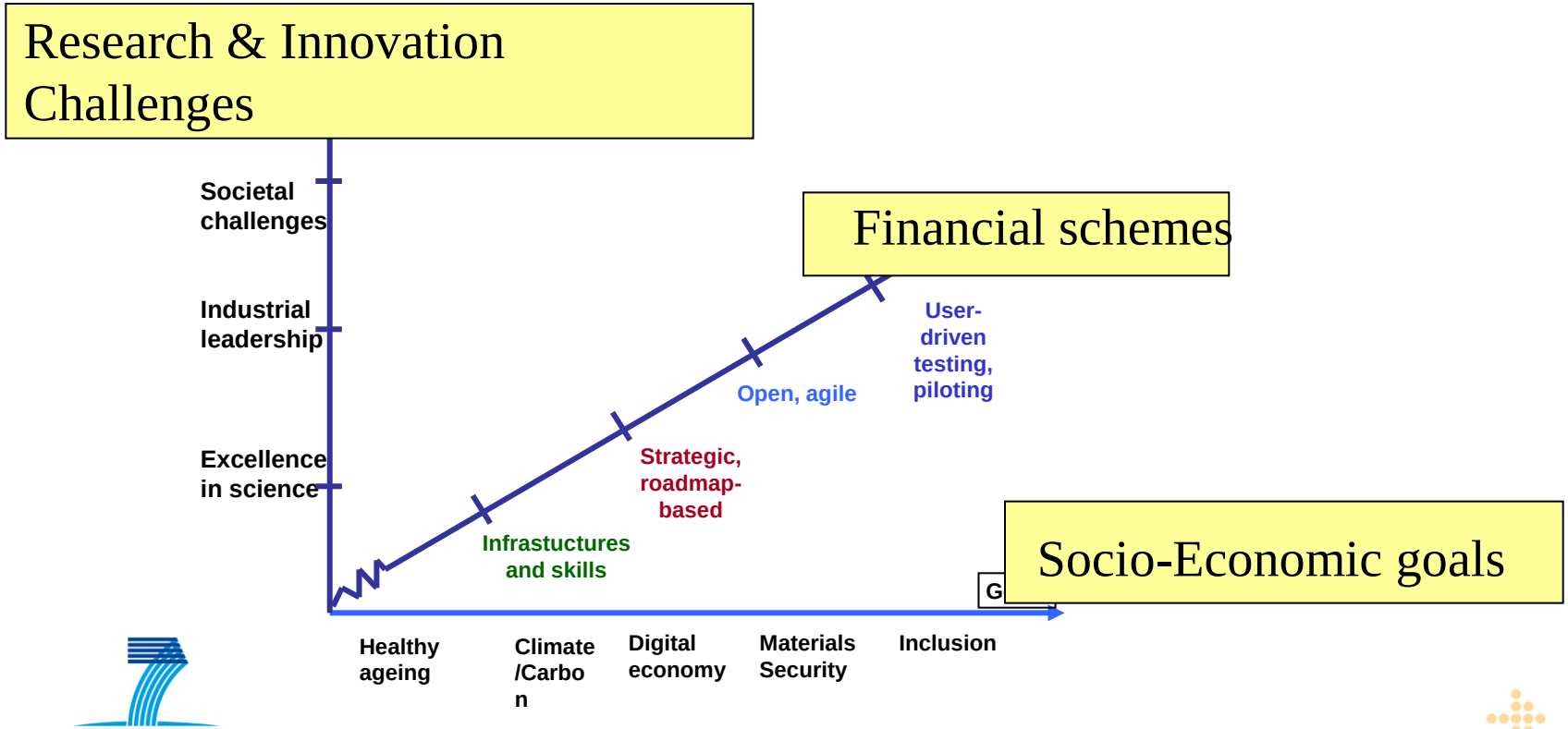
FP8
"R&I Challenges", "Socio-economic Goals" and "Financial schemes"

"The 3-D implementation"



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- What:

Leadership in enabling and industrial technologies ICT *(ICT, nanotechnologies, materials, biotechnology, manufacturing, space)*
Access to risk finance *Leveraging private finance and venture capital for research and innovation* *(Financial instruments, eg Loans, Guarantees, start-up and growth facilities)*
Innovation in SMEs *Fostering all forms of innovation in all types of SMEs*

Priority 3: “Societal challenges”

- What:

ICT	Health, demographic change and wellbeing	
	Food security, sustainable agriculture, marine and maritime research & the bioeconomy	
ICT	Secure, clean and efficient energy	
ICT	Smart, green and integrated transport	
	Climate action, resource efficiency and raw materials	
	Inclusive, innovative and secure societies	

Design a foresight exercise

Structured Stakeholders' Dialogue

Diagnosis	Prognosis	Prescription
Understanding where we are…	Exploring what could happen…	Debating what we would like to happen … Deciding what should be done …

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WP2013 Main features

1. Continuity

- **Completion of activities launched since the start of FP7**

2. Bridge to innovation

- **New activities to enable testing and validation**
- **Support to a better exploitation and take-up**

3. Involving more SMEs

– **Specific SME-targeted activities**

4. Prepare for the launch of Horizon 2020 (2014-2020)

- **Reorganise certain areas to adapt to H2020 structure**
- **Prepare for new activities, new PPPs**

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Challenge 3:
"Alternative paths to Components and Systems"

Overall objectives include:

- Industrial leadership through:
  - Miniaturisation, energy-efficiency, Manufacturability of ICT systems
- Enabling further integration:
  - Convergence of Nanoelectronics, nano-materials, biochemistry…
- Energy- cost-efficiency, end-of-life issues

Overall funding: 186 M€ (as of today !)

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3.3.a: Integrating heterogeneous technologies

R&D / 3.3.a

- *Integration of:*
  - *Key enabling technologies*
    (Nanoelectronics, organic electronics, micro- nano- bio systems,)
  - *Materials: Si, SC, Organic, inorganic* **...**
  - *Functions (Sensing, Actuating, Communication, processing)*
- *Addressing: Design, prototyping, manufacturability, recyclability, low energy etc*

→ ***(i) Miniaturised smart systems*** **(IP, STREPs)**

→ ***(ii) Integration on flexible, large area / stretchable substrates*** **(IP, STREPs)**

→ ***(iii) MNBS (micro-nano-bio systems) and bio-photonics systems - (Further developments and Validation)*** **(STREPs)**

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3.3.b: Take-up and Innovation support

3.3.b

(i) Assessment experiments *(for Nano-electronics & Smart Systems)*

Evaluation of novel equipment

- Bringing together technology suppliers, integrators, and potential customers ***(IP)***

(ii) Access services *(for Nano-electronics & Smart Systems)*

Access to tools, equipments, flexible manufacturing, training

- Pilot runs, Prototyping, ***(IP)***

Coordination and Support actions ***(CSA)***

(iii) *Networks of "innovation multipliers" - across Challenge 3 Take-up projects - needs of SMEs*

(iv) *Development of an* ***eco-system for Smart Systems Integration***

- Structuring regional clusters, Training materials, road mapping,

- Manufacturing / standardisation, actions towards citizens, young talents and entrepreneurs

(v) Linking technology providers and medical end users (MNBS and bio-photonics)

(vi) International cooperation (Point-of-Care diagnosis/treatment in rural areas)

EU2020, Innovation Union and **Horizon 2020** are putting Health, Aging & Wellness and Food security, **high on the European political agenda**.

Europe is focussing, setting its ambition, has planned major initiatives using holistic approaches for **Research, Development and Innovation** and foresees major increase in **resources and the use of industrial policy** to meet future **societal, competitiveness and scientific challenges** targeting this important field.

- £180m government funding to bridge the 'valley of death' for medical breakthroughs

  Promising ideas will be accepted from sectors or disciplines that demonstrate the potential to provide significant positive healthcare and economic impact.

Let us profit from these exciting times and opportunities and take action together

EUROPEAN COMMISSION
European Research Area

Thank you for your attention!

Additional Background / documentation

- **MNBS:**
- *cordis.europa.eu/fp7/ict/micro-nanosystems/projects-mnbs_en.html*
- cordis.europa.eu/fp7/ict/micro-nanosystems/docs/mnbs-projects-portfolio-april-2011_en.pdf
- **MNBS WS, April 2011, Mondragon, ES:**
- *cordis.europa.eu/fp7/ict/micro-nanosystems/events-2011-5thmnbs_en.html*

EPoSS ETP: www.smart-systems-integration.org/public

Nanomedicine ETP: www.etp-nanomedicine.eu/public

twitter

https://twitter.com/#!/Microsystems_eu

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