Ερευνητικο Πεδιο Micro & Nano Systems στο Προγραμμα Εργασιας 2007-2008

Clusters: MNBS (Micro-Nano-Bio convergence Systems) & SFIT (Smart Fabrics & Interactive Textile)

Information Day on ICT Priority, Call 2

Andreas Lymberis
(andreas.lymberis@ec.europa.eu)

European Commission, IST, Micro Systems Unit

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

Presentation outline

- **Micro & Nano Systems**
- **Micro-Nano-Bio Convergence Systems (MNBS)**
- **Smart Fabric & Interactive Textiles Systems (SFIT)**

Smart (micro) Systems

Miniaturised systems able to sense, diagnose, describe and qualify a given situation. Able to interact with their environment and other smart systems.

Interdisciplinarity
Convergence (nano, ICT, bio)
Heterogeneity
Multifunctionality
Integration

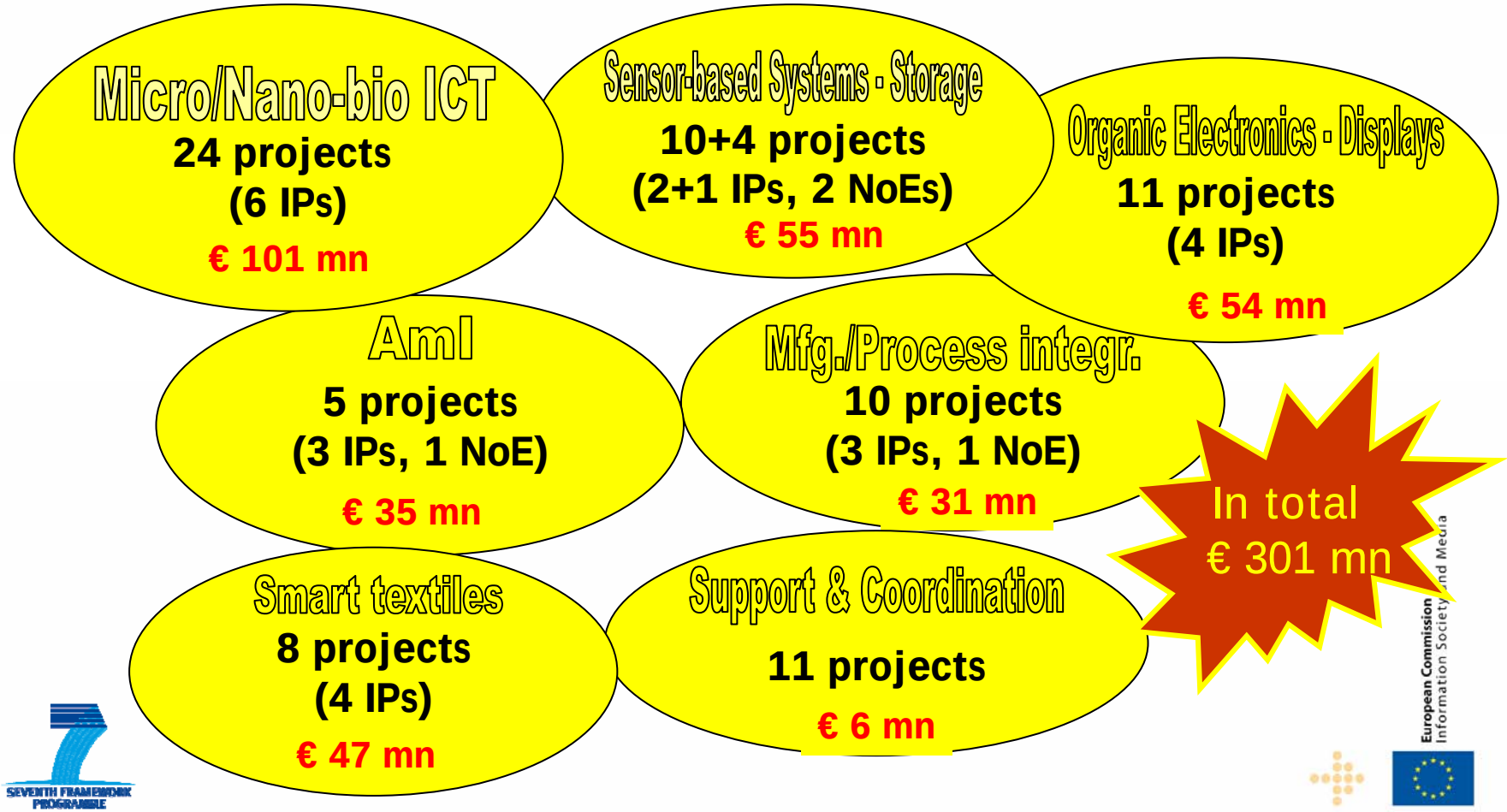
Microsystems in FP6: Thematic areas covered

- **Micro/Nano-bio ICT.**
  Biosensors, lab-on-chip, DNA & protein analysis chips, food safety & quality monitoring, implants, drug delivery, medical imaging
- **Sensor-based systems and Storage.**
  Integrated sensor systems, MEMS, handling of nano-objects, mass storage
- **Organic/Large area electronics and Displays.**
  Organic electronics, flexible electronic systems, flexible displays, large-area applications
- **Systems for Ambient Intelligence (AmI).**
  Mobile phone based platforms, networked multisensors system for elderly people, smart textiles, biosensing textiles
- **Manufacturing and Process integration.**
  Microsystems manufacturing technologies from design to packaging testing and reliability
- **Smart fabrics and interactive textile.**
  Integration of advanced fibres and materials at the fibre core. E-textiles
- **Support and coordination actions.**
  Networking, roadmaps

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

Projects per thematic area (FP6)



SEVENTH FRAMEWORK PROGRAMME

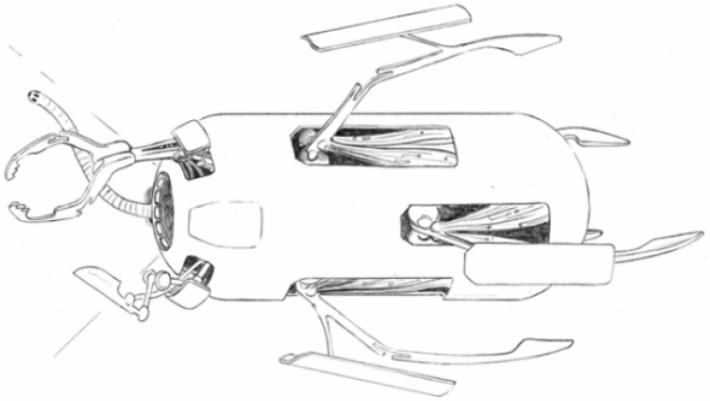
European Commission
Information Society and Media

FP6: Major Projects (IPs) on Smart Systems Integration

- **Healthy Aims:** 24.6 M€, Nano scale materials and sensors and microsystems for medical implants improving health and quality of life
- **GoodFood:** 17.4 M€, Food safety and quality monitoring with microsystems
- **Sensation:** 16.8 M€, Advanced sensor development for attention, stress, vigilance & sleep/wakefulness monitoring
- **P.Cezanne:** 14 M€, Development of an implantable biosensor for continuous care and monitoring of diabetic patients

FP6: Major Projects (IPs) on Smart Systems Integration

- **VECTOR:** 9.5 M€, Versatile endoscopic capsule for gastrointestinal tumor recognition and therapy

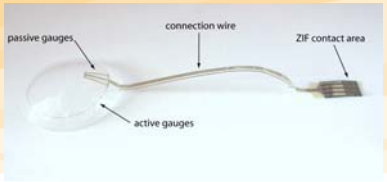


- **MIMOSA:** 23 M€, Microsystems platform for mobile services and applications
- **MINAMI:** 19.6 M€, Micro-Nano integrated platform for transverse ambient intelligence applications
- **ProeTex:** 12.8 M€, Protection e-Textiles: MicroNanoStructured fibre systems for emergency-disaster wear.

SEVENTH FRAMEWORK PROGRAMME

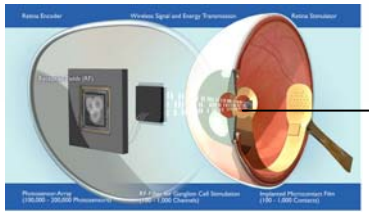
European Commission
Information Society and Media

Healthy Aims

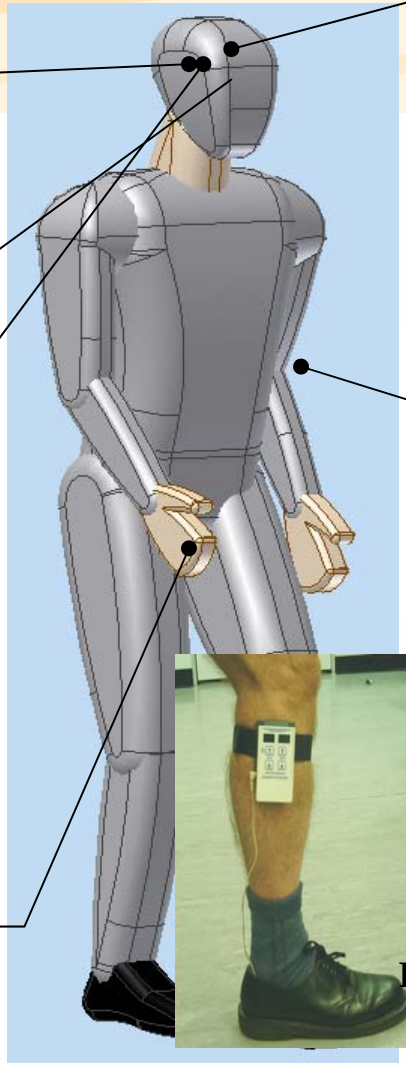


Glaucoma Sensor

Intracranial Pressure Sensor

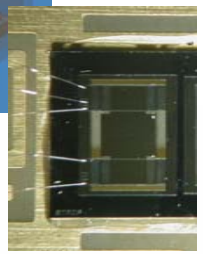


Retina Implant

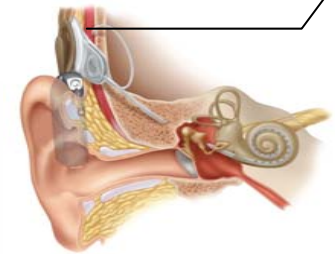


Gyro

IMU for Human Body Motion

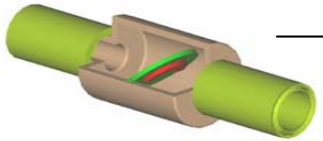


Accelerometer



Cochlear Implant

Functional Electrical Stimulation



Artificial Intra-Urethral Sphincter

Networked, ambient, intelligent

European Commission
Information Society and Media

HEALTHY AIMS

33 EU partners to develop a range of medical implants including:

- Retina implant
- Cochlear implant
- FES system for lower and upper limbs
- Artificial sphincter and sphincter sensor
- Glaucoma sensor
- Pressure sensor for brain cavity and aorta

…and develop a range of core microsystems including:

- Body Area Network to communicate from in body up to 3m away
- Implantable energy source (conventional and fuel cell)
- Micro-electrodes, on non Silicon substrates
- Micro-assembly methods for true 3D systems
- Biomaterials for a range of applications

Good Food: bringing the lab to the foodstuff from the land to the market.

Sensing Scenarios:

- Detection of
  - Chem. Substances
  - Biolog. Substances
- Short Shelf-life time
- Long Storage time
- Multi-sensing systems

Main Food Targets:

- Milk, dairy products
- Fruits, fruit juice
- Wine
- Fish

Remote control

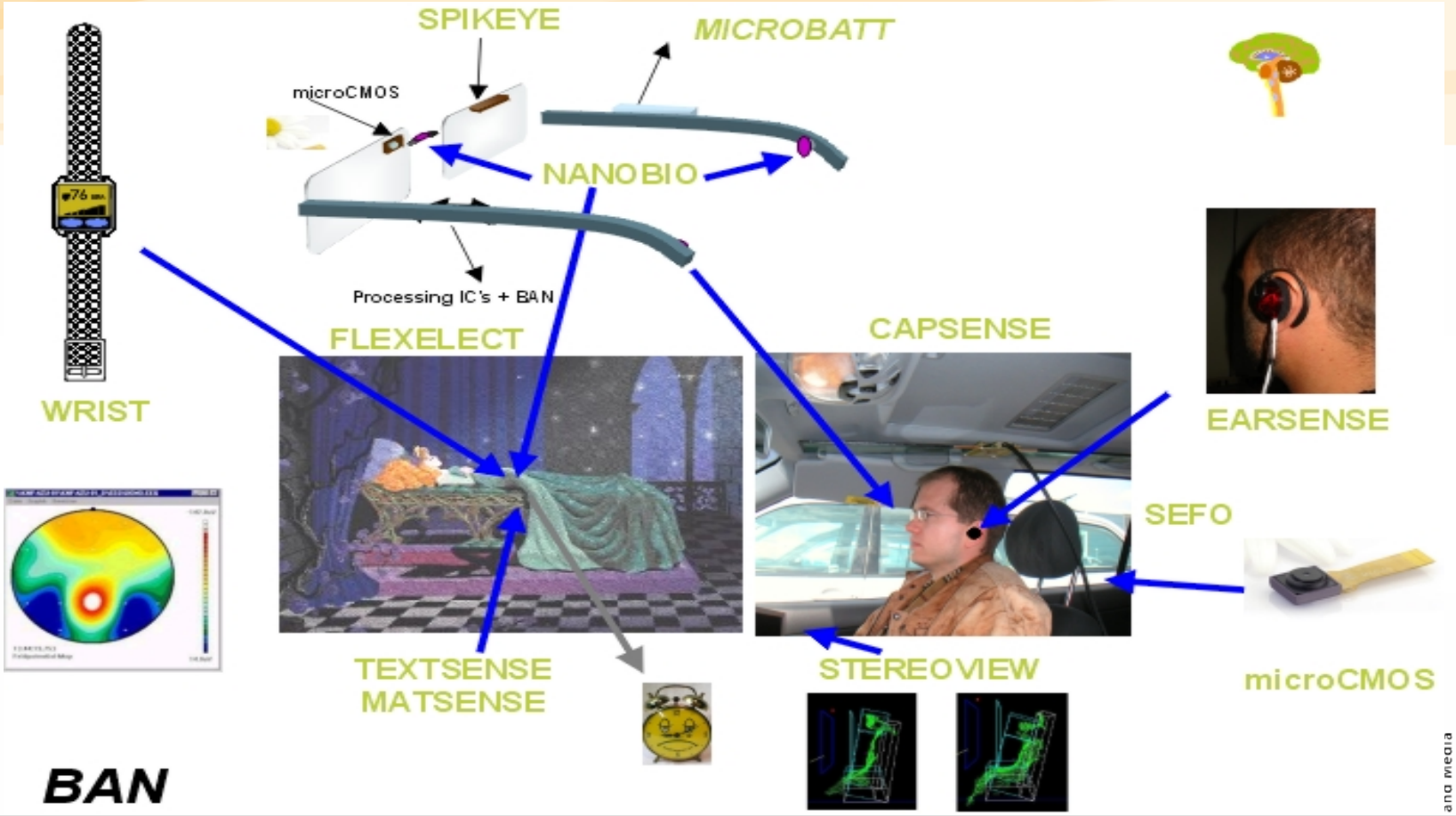
IP and radio based communication

Databases

Demonstration of the AmI concept for improved production in a vineyard

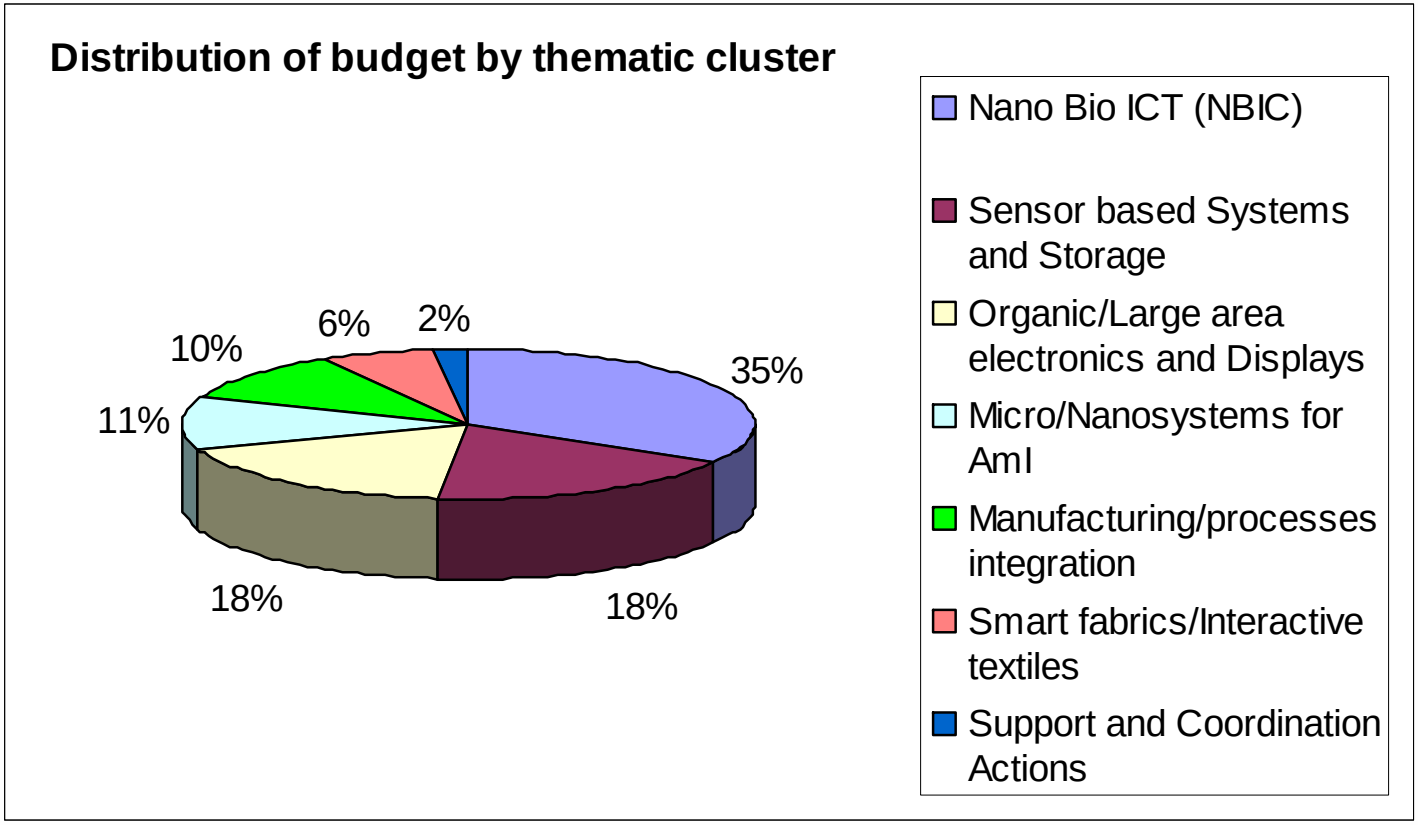
Low cost, low power, simple use, fast response detection systems with full interconnection up to decisional bodies

SENSATION

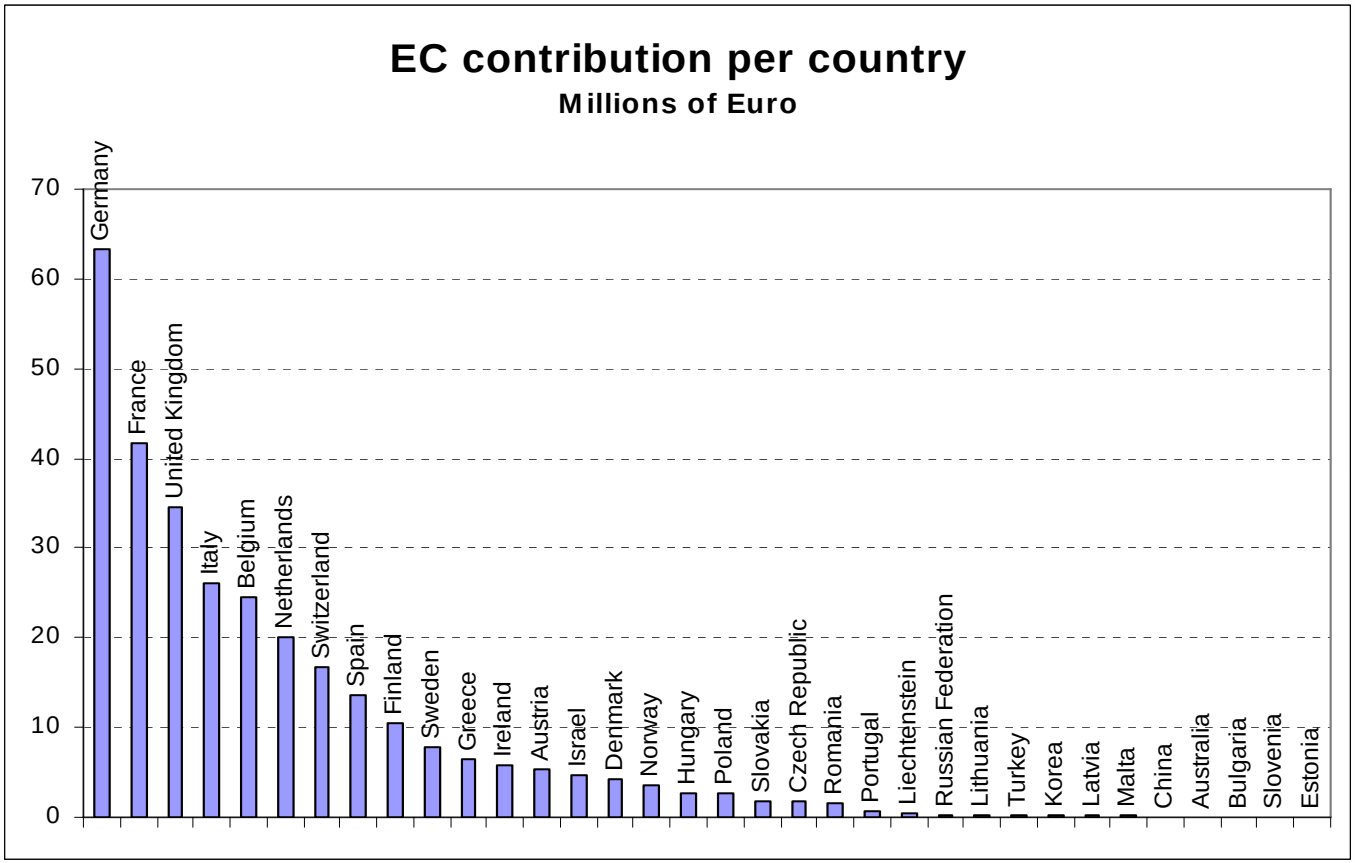


Brain activity monitoring, including the sleep and wakefulness states, stress, inattention and hypovigilance states, for prediction and management as well as diagnosis, treatment and remote monitoring of sleep disorders. Embedded connectivity at the body, the local and the wider area network for monitoring in car, the workplace, at home,...

Microsystems in FP6: Budget



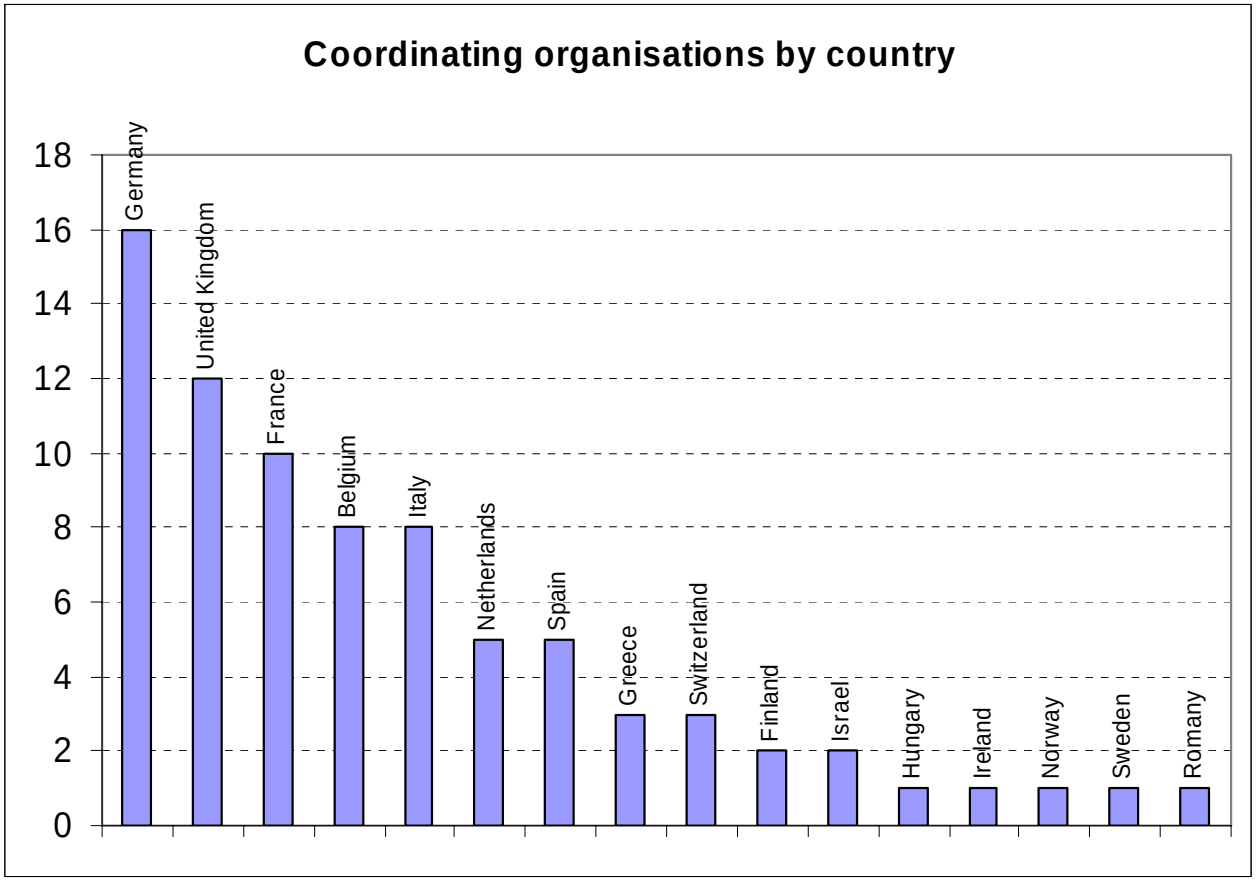
Micro/Nanosystems
FP6 (2002-06)



SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

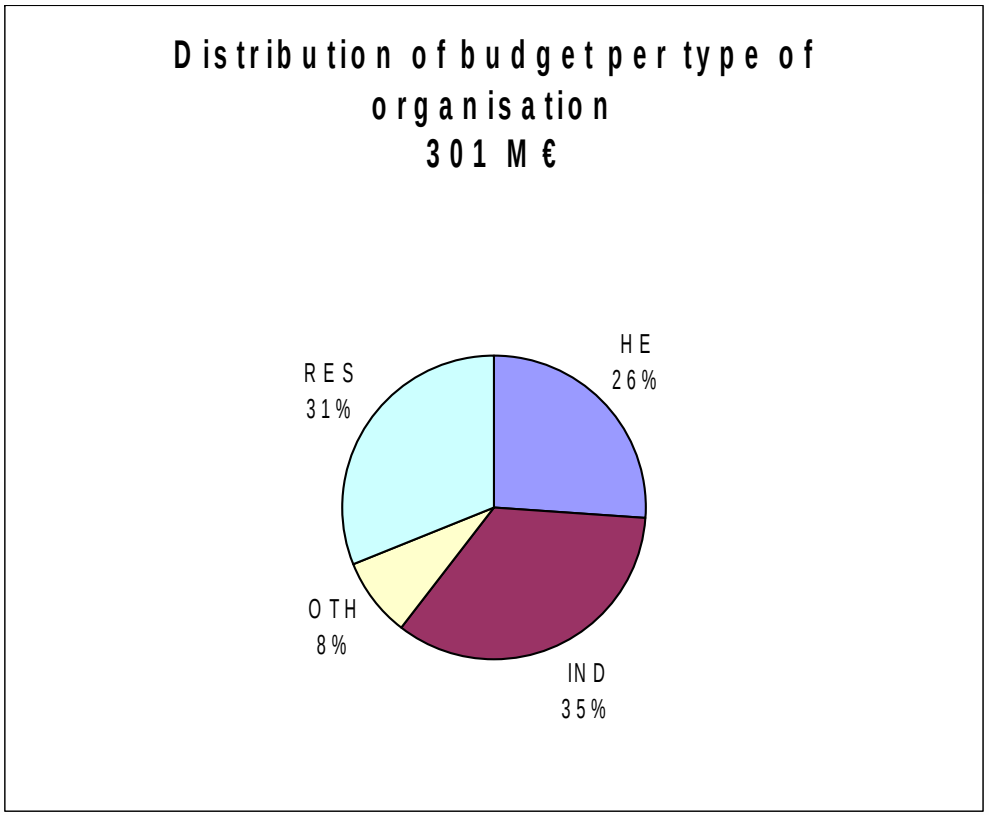
Micro/Nanosystems
FP6 (2002-06)



SEVENTH FRAMEWORK PROGRAMME

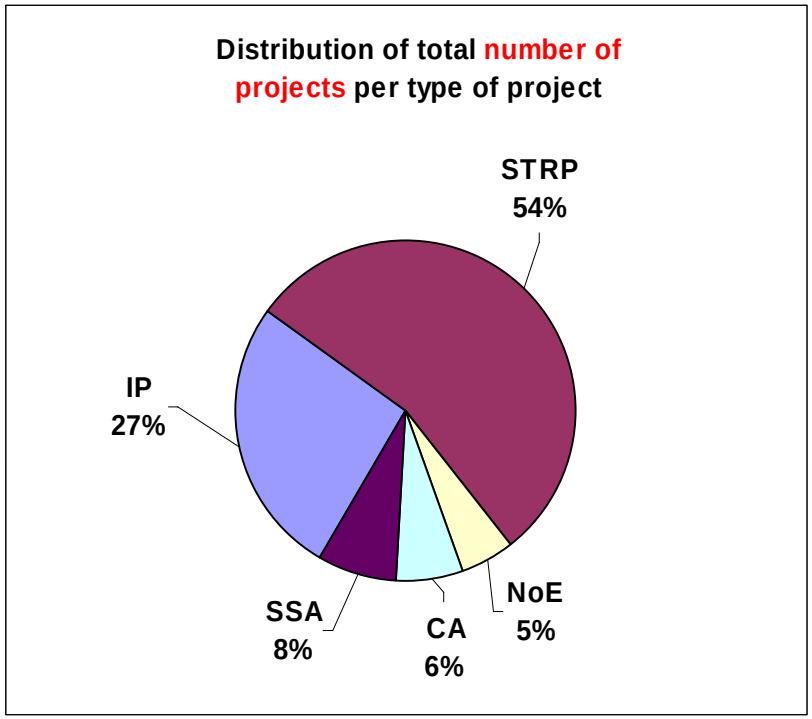
European Commission
Information Society and Media

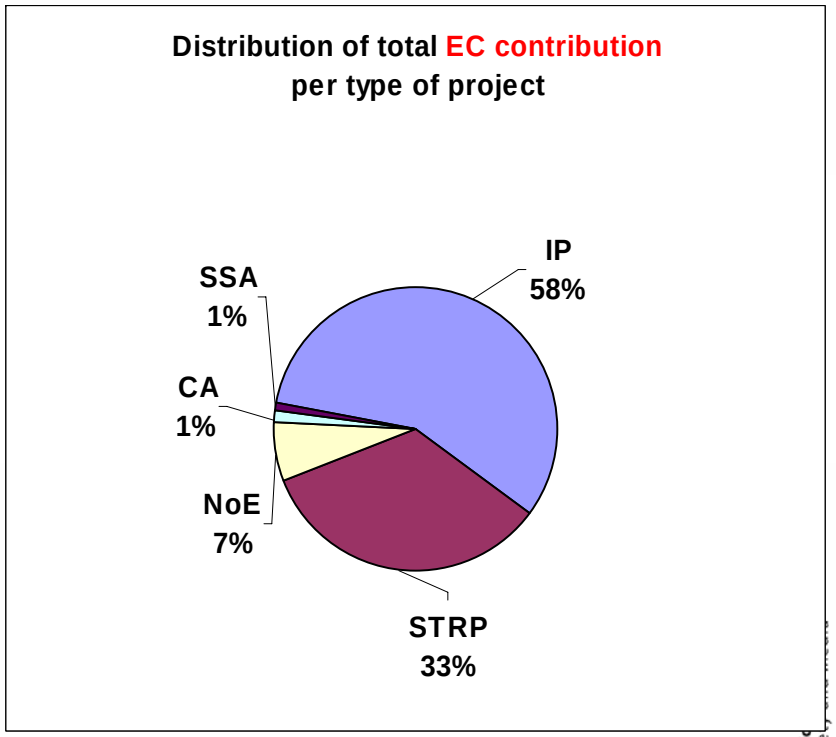
Microsystems
FP6 EC Contribution per type of organisation



RES: Research organisations
HE: Higher education or Training
IND: Industrial organisations private or public
OTH: Organisations not fitting in one of the above categories

Projects and EC contribution per type of projects





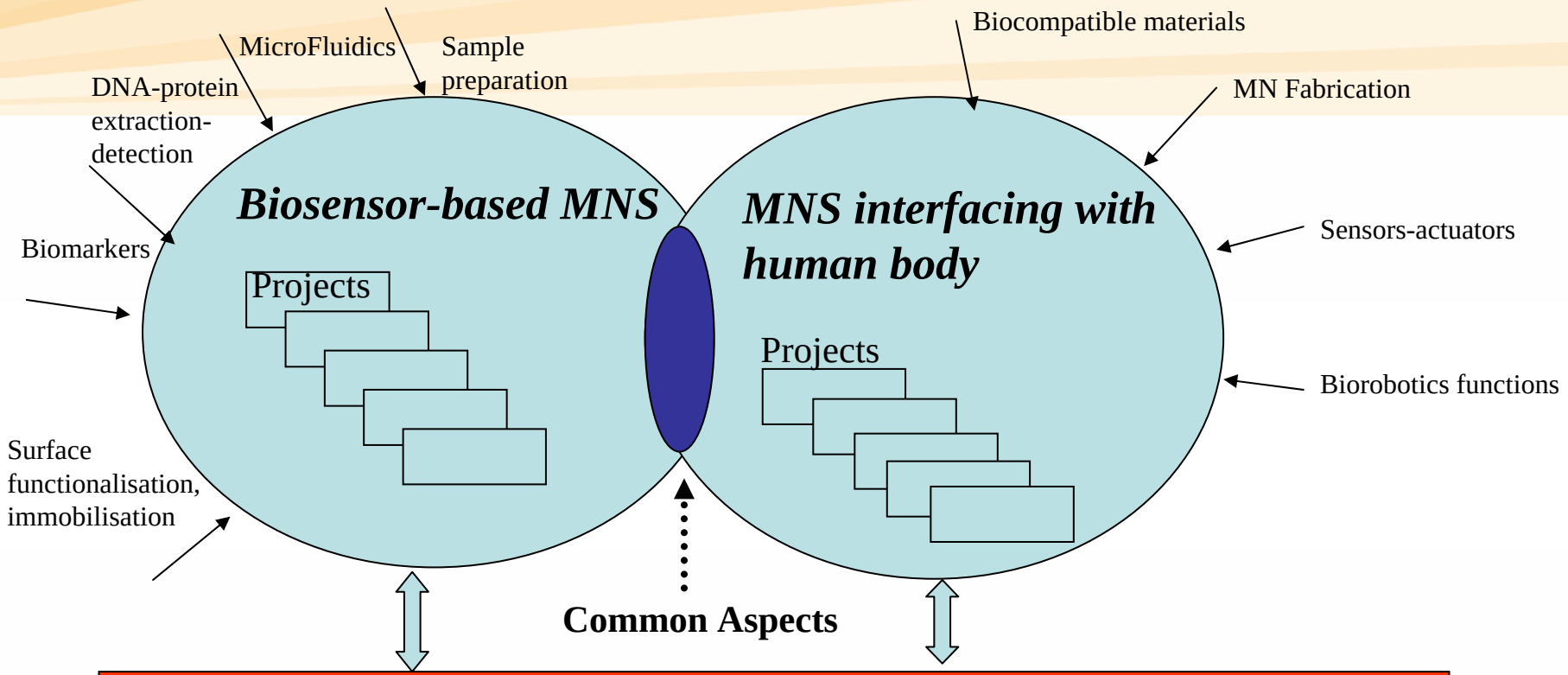
Some more statistics …

	CA	IP	NoE	SSA	STRP	Total
Total number of Projects	5	21	4	6	43	**79**
Total Project costs (M€)	3.4	312.3	22.8	2.9	165.8	**507.2**
Total Project EC contribution (M€)	3.4	173.3	20.8	2.9	100.6	**301**
Average Project costs (M€)	**0.68**	**14.87**	**5.7**	**0.48**	**3.85**	**6.42**
Average EC contribution (M€)	**0.68**	**8.25**	**5.2**	**0.48**	**2.34**	**3.81**
Average Duration (months)	24	42.6	45	31	35.5	**36.8**
Total number of participants	37	339	82	37	333	**828**
Average number of participants	7.4	16.1	20.5	6.2	7.7	**10.5**

Presentation outline

- **Micro & Nano Systems**
- **Micro-Nano-Bio Convergence Systems (MNBS)**
- **Smart Fabric & Interactive Textiles Systems (SFIT)**

MNBS group of FP6 Projects: Structure, links and content



- 27 Projects, 2 Service Actions
- 110 M€, 390 Organisations, 27 MS & AS + China, Australia, USA, Korea, Mexico
- 60 Universities, 50 R&D Centers & Institutes, 70 companies (Research & product evelopment)

European Commission
Information Society and Media

EC MNBS cluster

- **Topics, Technologies, applications:**
  - Biochips & Arrays
  - MicroTAS & Lab-on-Chip
  - Biosensors
  - Body sensors, implants and in-vivo systems
  - Service actions
- **Challenges e.g.:**
  - **Multi-material integration**: Silicon, Glass, Polymer
  - Enhance **microfluidic design and manufacture**
  - **Convergence** of biochemical, magnetic, fluidic. optical, mechanical, electronics disciplines
  - **Biocompatiblity**: electrodes, implants
  - **Ethics**: How to educate and visualize applications
  - **Intellectual property** constraints and conflicts

MNBS: R&D on Biochips & Arrays

- Biognosis – Integrated Biosensor for Label Free in vitro DNA and Protein Diagnosis
- Mascot – Integrated Microsystem for magnetic isolation and analysis of Single circulating tumour cells for oncology diagnostics
- Micro2DNA – DNA analysis: with enclosed microfluidics and integrated detectors and control circuitry using polymer and silicon materials
- NANOSPAD – Protein micro-arrays for enhanced low cost diagnostics
- NEMOSLAB – Monolithic Lab-On-Chip using a Silicon Opto-coupler chip for Protein and DNA detection
- Toxichip – A toxin screening multi-parameter on-line biochip system

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

- GOODFOOD – Food safety and Quality monitoring with Microsystems
- LOCCANDIA – Lab-on-chip based protein profiling for Cancer diagnostics
- OPTOLABCARD – Mass produced Optical diagnostic Labcards based on Micro and Nano SU8 layers
- SmartHEALTH - Smart integrated biodiagnostic systems for healthcare
- MICROACTIVE – Automatic detection of Disease related Molecular cell related activity
- COCHISE – Cell-On-Chip biosensor for detection of cell-to-cell interactions

MNBS: R&D on Biosensor techniques & systems

- BioTEX - Biosensing textiles to support health management
- SEMOFS – Surface Enhanced Micro-Optical fluidic systems
- DVT-IMP – Deep Vein Thrombosis – Impedimetric microanalysis Systems
- INDIGO – Integrated highly sensitive fluorescence-based biosensor for diagnosis applications environments
- SABIO – Ultrahigh sensitivity Slot-waveguide biosensor on a highly integrated chip for simultaneous diagnosis of multiple diseases
- S.I.G.H.T. – Systems for in-situ theranostics using microparticles triggered by ultrasound

MNBS: R&D on Body sensors, implants, neural probes and biorobots

- SENSATION – Advanced sensor development for attention, stress, vigilance, & sleep/wakefulness monitoring
- VECTOR – Versatile endoscopic capsule for gastrointestinal tumour recognition and therapy
- NEUROPROBES – Multifunctional microprobe arrays for cerebral applications
- INTELLIDRUG – Intelligent intraoral medicine delivery microsystem to treat addiction and chronic disease
- IMANE – Implantable Multicontact Active Nerve Electrode
- HEALTHY AIMS – Nanoscale materials and sensors and microsystems for medical implants improving health and quality of life

MNBS: Service actions & support

- INTEGRAMplus – Integrated MNT platforms and services
- MicroBUILDER – Integrated modular services for microfluidics
- SENSACTION - Sensing & action to support mobility in Ambient assisted living
- NETCARITY - Networked multi sensor system for elderly people – healthcare and security in the home
- NANOWAYS - Roadmapping of MNBS applications
- NEXUSPLUS - SME and Eastern European access , dissemination, cross fertilization

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

18-19 January 2007
1st Concertation Workshop of FP6 projects in Micro-Nano-Systems: Specific topic Micro-Nano-Bio convergence Systems (MNBS)
Brussels, Belgium

Preparation of FP7

Consultation Workshop on Micro-Nano-Bio Systems: Future R&D and New Challenges, 3 May 2006, Brussels, www.cordis.lu/ist/mnd/events.htm

- broadening the science, industry and commerce input to the established consultation process,
- addressing some outstanding sector and technology gaps left from the first workshop,
- focusing on the detail of the critical science and technology developments in micro and nano technology necessary to deliver

a ground-breaking and competitive MNBS programme under FP7

Major Challenges and Opportunities: the Broad Spectrum of MNB for Medical and Healthcare applications

- Beyond BioMEMS (sub-category on MNBS) there is a very broad spectrum & too many Application Drivers:
  - **Operation** scale: In-vitro <> In-vivo
  - **Application** scale: Platform for nanotechnology <> component in much larger system
  - **System** aspects: autonomous <> externally powered, decision capable <> open-loop
- Very diverse technology needs (many Technology Platforms):
  - Micro/Nano-**sensing** or **actuation** technology
  - Micro/Nano-**assay** technology
  - Micro/Nano-**motion**
  - Micro/Nano-**delivery**

Nanobiotechnology Markets

- World total $1 trillion market for nanotechnologies in 2015
- 350-500 $billion is allocated to healthcare and pharmaceutical applications
- Nanobiotechnology market: $4b (2002), $8b (2005), $20b (2010), $70b (2015)
- Gap between USA and EU: In 2005, $8b (5.1 USA, 1.5 EU); in 2010, $20b (12 USA, 4 EU); in 2010, $ 70b (35 USA, 21 EU)
- US government recognised the future potential of nanotechnology and academia/research centers move ahead but industrial segment still relies on venture capital (estimates of potential markets of technologies and applications

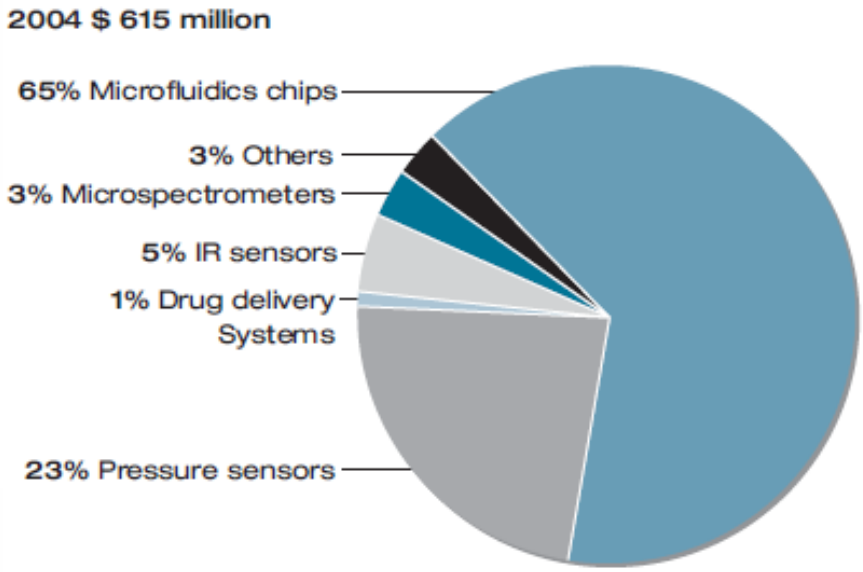
Markets for nanobiotechnology according to areas of application

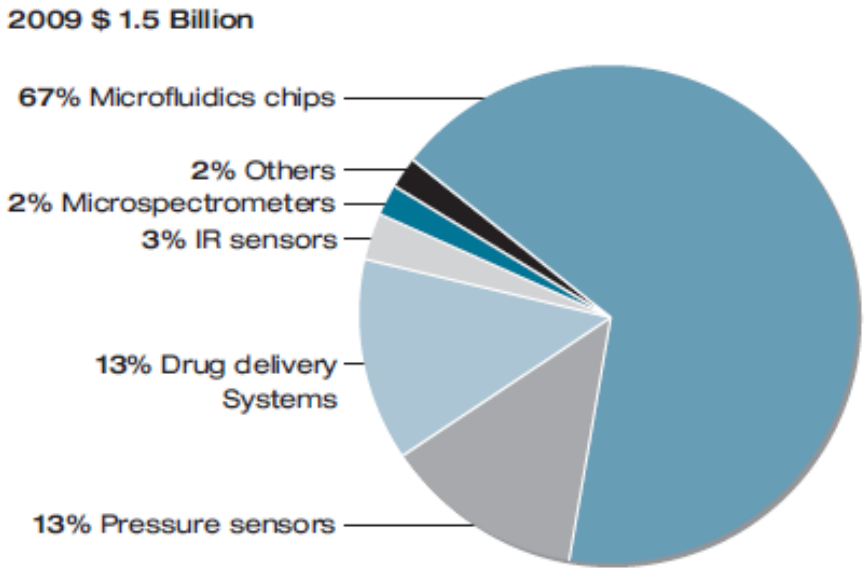
Areas of application	2005 (in $billion)	2010	2015
Nanomedicine	0.75	3	17
In vitro diagnostics	1	2,5	9,5
Imaging agents	0,5	1,25	5
Pharmaceuticals	1,25	5,25	14
Life science research	1,5	2,5	8
Biodefense	1,25	2	5
Environmental	0,5	0,75	2,5
Biomedical nanodevices	0,8	1,5	2,25

Nanobiotechnology: A Jain Pharmabiotech Report

European Commission
Information Society and Media

Medical and Life Sciences Applications





Source: Nexus

Example of socioeconomic impact: Brain disorders

- 21st century will be the century of the brain (devices)
- 30% of the European cost of illness comes from brain diseases
- Europe is losing ground to the US

➢A conservative estimate* of the total costs of *brain disorders* in Europe (2004) amounts to €386B

- ➢Mental disorders: affective disorders (*depression* and *bipolar disorders*) €106B
- ➢Neurological diseases: *migraine* (€27B), *stroke* (€22B, probably heavily underestimated), *epilepsy* (€16B) and *Parkinson's disease* (€11B)

➢Comparable or more costly to society than diabetes or cancer, yet only about 15% of direct European health costs are spent in this field

➢Aging population will increase impact

European Brain Counsel, "Cost of Disorders of the Brain in Europe", Eur J Neurol, 2005, ***12***

Market Questions

- Why doesn´t nano-bio-micro-it take off?
- There is a clear difference between the consumer market (POC, last chains in food distribution system, etc.) and the large players (Universities, Pharma, Hospitals, Clinical Chemistry labs).
  - "Succesful" Biotech companies do not sell for a consumer market (yet? – except perhaps the diabetes sensors) !
- Who is a customer?
  Who makes the money?
  - The health care structure differences within EU
    - How about the regulations (food quality control, water quality, etc.)
- How large investment in R&D is needed?
- The role of EU
  - Better differentiation between Research vs. Development!
  - Scientific focus is important
  - Company involvement

Presentation outline

- **ICT Priority- Challenge 3- Micro & Nano Systems**
- **Micro-Nano-Bio Convergence Systems (MNBS)**
- **Smart Fabric & Interactive Textiles Systems (SFIT)**

The area of wearable technologies and systems is exploding worldwide

International WS/conferences with the collaboration of the EC

Lucca 2003 www.piaggio.ccii.unip.it/~ehealthw/

Belfast 2004 www.phealth2004.ulster.ac.uk/

Lucerne 2006 www.phealth-2006.com/

Many other International Activities

IEEE Body Sensor Networks, Boston April 2006,
bsn.media.mit.edu/

IEEE-EMBS ISSS-MDBS 2006, Boston, Sept 2006
bme.ee.cuhk.edu.hk/isss-mdbs/index.html

Smart NanoTextiles, San Francisco April 2006,
lucy.mrs.org/meetings/spring2006/program/s06_cfp_s.html

TC on WBSS: www.embs.org/wbss/wbss.html

Cluster of EC funded projects of SFIT: www.csem.ch/sfit/default.htm

European Technology Platform for the future of textiles and clothing: www.euratex.org

European Commission
Information Society and Media

EMBS: Wearable Biomedical Sensors and Systems TC - Microsoft Internet Explorer provided by European Commission

File Edit View Favorites Tools Help

Back Favorites

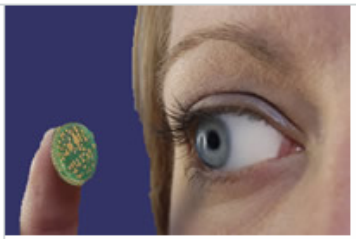
Address http://www.embs.org/wbss/wbss.html Go Links

WBSS

IEEE EMBS Technical Committee on Wearable Biomedical Sensors & Systems

Home | Events | Committee | Documents | Private Area

Overview



Wearable Biomedical Sensors and IEEE EMBS Technical Committees

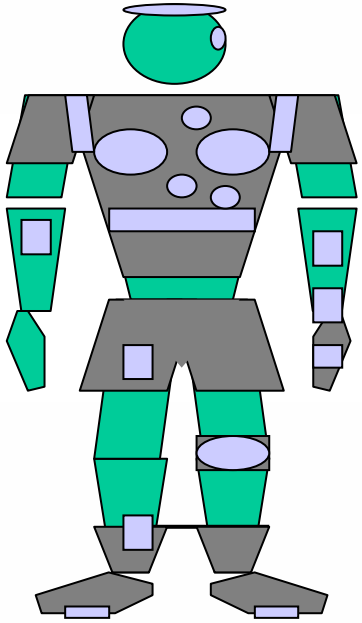
In an effort to focus the scientific and technical excellence within EMBS, a number of Technical Committees (TCs) have been formed in targeted areas of biomedical engineering. The Technical Committee on Wearable Biomedcial Sensors and Systems (WBSS) was one of the first to be formed. WBSS are defined, for the purpose of the TC activities, as biomedical wearable sensors/actuators and sensor-based communicative systems that can monitor and/or stimulate, and/or treat, and/or replace biophysical human functions. Implantable sensors and prostheses are *not* addressed *directly* by the TC. These are considered as systems/technologies interfacing with wearable biomedical sensors and systems.

The Need

Wearable Biomedical Sensors represent a potentially large and rapidly increasing R&D area, involving several cross-disciplines e.g. biology, physiology, physics, chemistry, micro-nano technologies & material sciences, industrial sectors like medical devices, electronics, micro-chips, textile and telecommunications and engineering

Internet

Breakthroughs in textile materials/processes and Information & Communication Technologies (ICT)

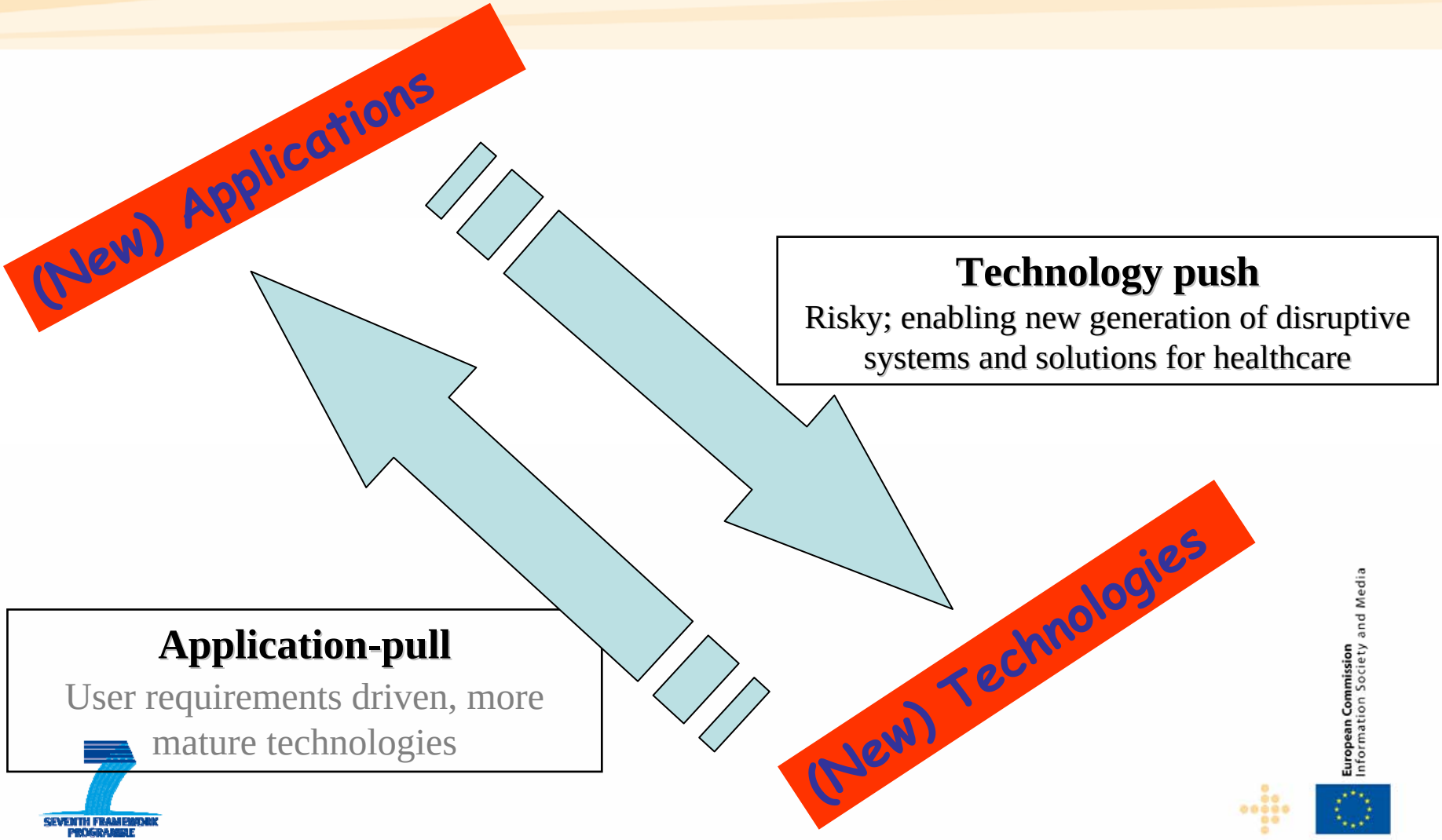


Disappearing technology

Miniaturized, smart sensors

Technology to be integrated into clothing design without being a burden for the user

R&D: Two complementary approaches -*Technology Push* and *Application Pull*

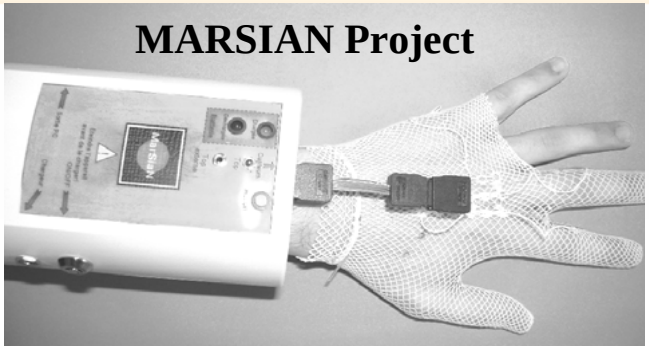


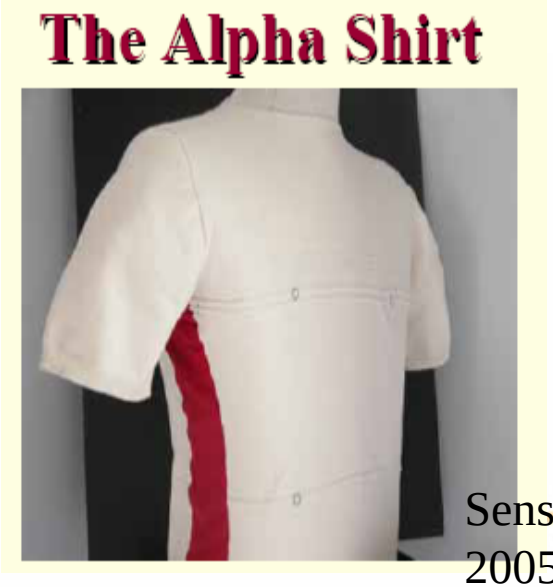
SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

R&D and First prototype Systems

- Body Sensor Networks
- Smart gloves
- Biomedical clothes





Sensatex, 2005

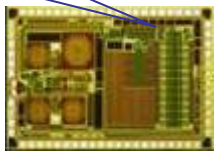
European Commission
Information Society and Media

Development & Integration of innovative sensing, MNT, textile and ICT towards functionalised Smart Fabrics and Interactive Textile

Micro-communicating: sensor interface, processing and wireless

Microsystems physical sensors (attitude, fall, health, …)

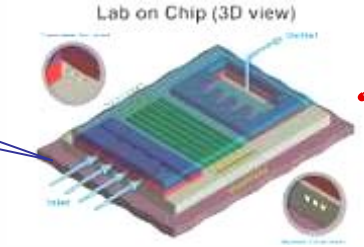
Flexible displays



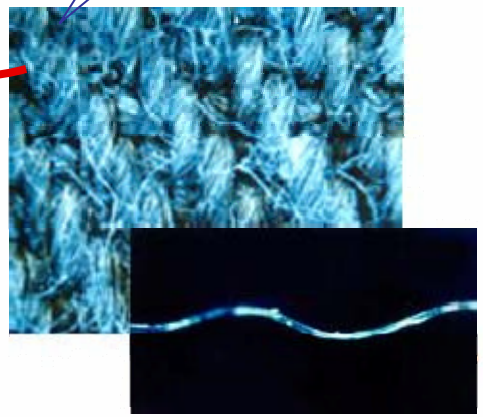
Picture: Courtesy of Plastic Logic Ltd

- Nanoengineered surfaces
- Conductive fabrics
- Micro-interfaces

Point of care



Micro-energy generators



SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

Functional textiles

- Research in textiles properties
- Integration of electronic Hardware and microelectronics
- Advanced garment design: facilitate communication, monitor body signals, interact with the wearer

Merge in appealing ways, the world of textiles with new materials and electronic technologies

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

The e-textile vision

Full integration of sensing, processing, actuating, communicating and power sourcing functions in a woven structure.

SFIT Cluster: An (expandable) group of EU Projects, www.csem.ch/sfit

PROETEX: Protection e-Textiles: MicroNanostructured fibre systems for Emergency-Disaster Wear, (1/02/2006 - 31/1/2010)

STELLA: Stretchable Electronics for Large Area Applications (1/1/2006 – 31/1/ 2010)

BIOTEX: Bio-Sensing Textiles to Support Health Management (1/7/2006-29/02/2008)

CONTEXT: Contact less sensors for body monitoring incorporated in textiles, (1/01/2006-30/6/2008)

MyHeart: Fighting cardio-vascular diseases by preventive lifestyle & early diagnosis, (1/12/2003-30/8/2007)

OFSETH: Optical Fibre Sensors Embedded into technical Textile for Healthcare, (1/3/2006- 30/9/2009)

SFIT Market

- ✓ Modest Current market size for wearable computing and smart fabrics and interactive textiles (SFIT); strong future outlook.
- ✓ Philips, Invista, Siemens Medical Solutions Health Services, Infineon, Santa Fe Sciences and Technologies, Vivometrics, BodyMedia, Sensatex, Smartex
- ✓ Venture Development Corporation (worldwide) :
  - 303 M$ in 2003 for SFIT market
  - 520 – 530 M$ in 2008
- ✓ BCC (US market only)
  - 64.4 M$ in 2004
  - 299 M$ in 2009
    - 80 M$ in Safety field including professional – about 30%
    - 66 M$ in Biomedical – about 20%
    - 122 M$ Consumer – about 40%
    - 31 M$ Military – about 10%
- ✓ SmartFabrics 2006:
  - SFIT, a $340 million dollar industry
  - Growth rate 19% annually
  - Projected to reach $720 million by 2008

Smart Fabrics:
Why the market is modest so far?

- Textile and clothing industries are not sufficiently engaged
- Core technologies e.g. *interface, connectivity, sensing, skin contact, transmission, manufacturing and usability* are not sufficiently developed/tested
- Research community fragmented
- Approach: concentration on Core Modules

FP7: Continuation from FP6 towards the e-Textile vision

Development of the technology

➢ sensing, actuating, processing, communication, power scavenging and storage functions into the fabric

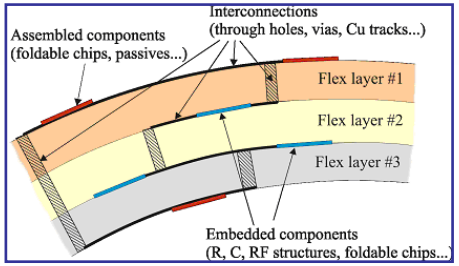
Integration into systems and services

➢through combination of multiple disciplines and processes, materials and technologies required to design, develop and manufacture.

Fp7, Call 2: Objective 3.6 (c) Integration of Smart Materials

Outcome

- Integration of micro-nanosystems into new and traditional materials, e.g. textiles, glass, paper, etc.
- Emphasis on SFIT (Smart Fabric Interactive Textiles) using micro/nanosystems, microelectronics, user interfaces, power sources, for personal wearable applications.
- User-friendliness, quality, cost



Courtesy of project SHIFT

Biocompatible, bioconnective, flexible, durable materials

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

Challenging Issues

- Requirements & Design: ANYONE, AFFORDABLE, ANYTIME, ANYPLACE
- Realization of sensing fabrics with smart materials (e.g. electroactive polymers)
- Several technologies to integrate – service delivery
- How to standardize measurements at the interface skin/ biological entities and device/material, related packaging, etc?
- Competition & combination of technologies (?) e.g. mechanical, electrical and optical detection
- What are the future standard platforms?
- Manufacturing, interconnection robustness, washability, feedback and treatment
- Business propositions ?

FP7 - ICT PRIORITY

INFORMATION DAY on CALL FOR PROPOSALS 2

OBJECTIVE 3.6 MICRO/NANO SYSTEMS

Tuesday, 29 May 2007

http://cordis.europa.eu/fp7/ict/programme/events3-20070529_en.html

http://cordis.europa.eu/fp7/ict/programme/challenge3_en.html

European Commission
Information Society and Media

Thank you!

Websites:

http://cordis.europa.eu/ist/directorate_g

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

Contact:

Andreas.Lymberis@ec.europa.eu

Francisco.ibanez@ec.europa.eu

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media