



# MEMS – Current Markets and New Opportunities!?

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Henne van Heeren

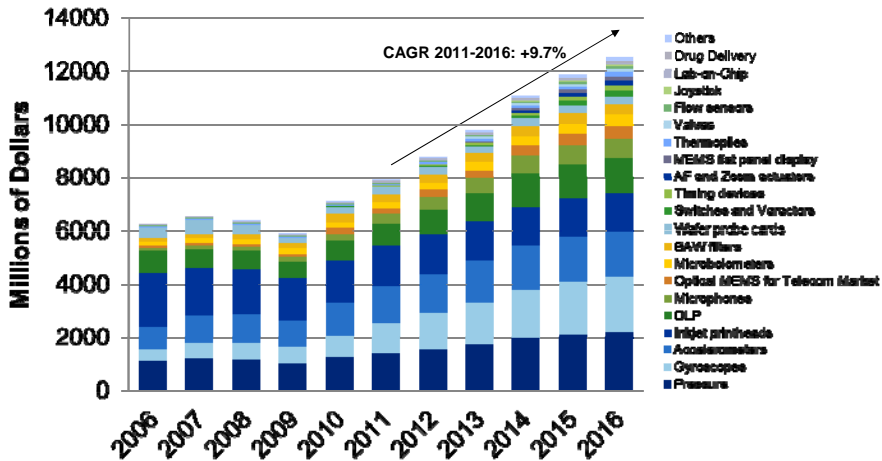
enablingMNT Group The Netherlands  
[www.enablingmnt.com](http://www.enablingmnt.com)

## enablingMNT Group

- The **enablingMNT** group provides support to new and established businesses in the Micro & Nano Technology (MNT) and System Integration sectors where the uptake of MNT offers enhanced performance and potential market advantage.
- Its partners each have 20+ years of experience in business development, marketing, and technology related services delivered to both private and public sector customers.
- The group have maintained a leading position in the field through strong participation in European projects in the MNT and System Integration areas and collaboration with international networking organisations, such as MEMS Industry Group, NEXUS, MANCEF, IVAM, etc. enablingMNT has offices in Germany, The Netherlands and the UK and works with a worldwide network of partners to address global business.
- Recent activities also focus on technology-to-application roadmapping and exploitation strategies, often done in the frame of EC projects.

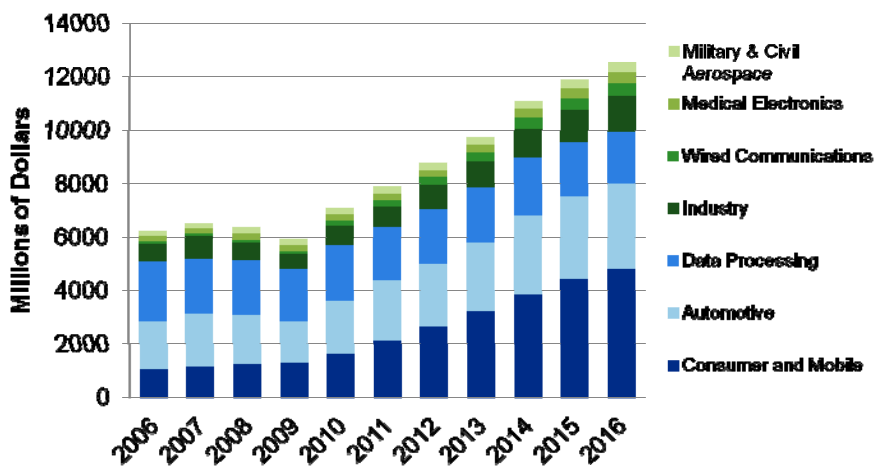
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# MEMS Market by Devices, 2006-2016



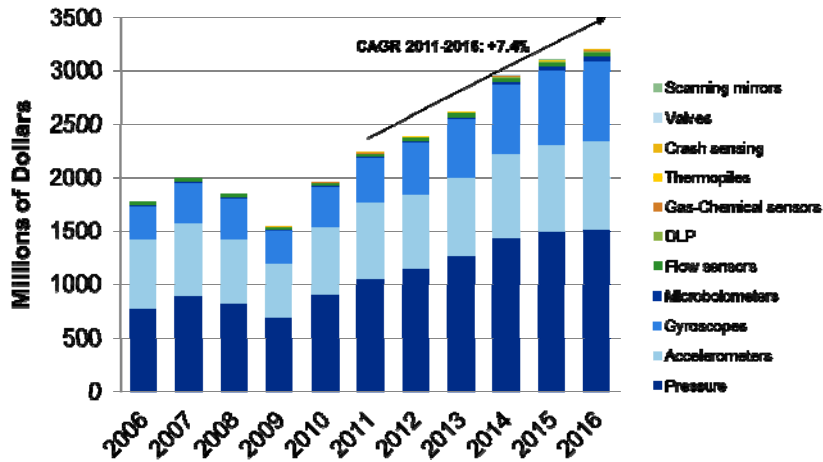
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# MEMS Market by Application, 2006-2016



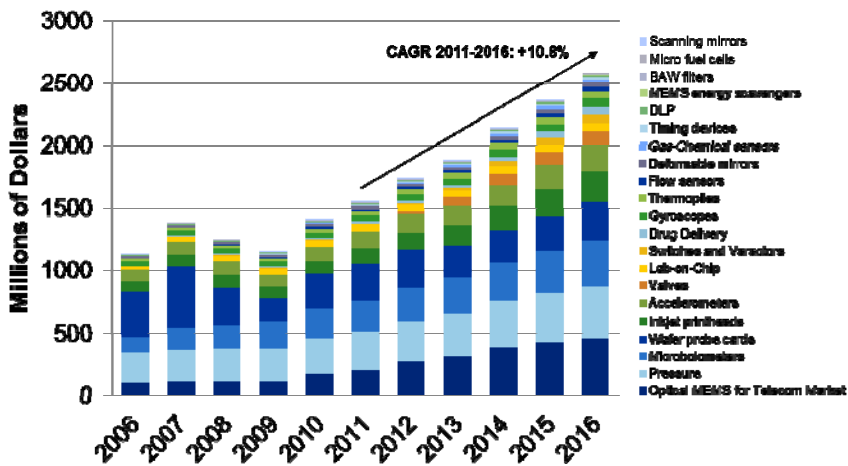
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## MEMS Market for Automotive Applications 2006-2016



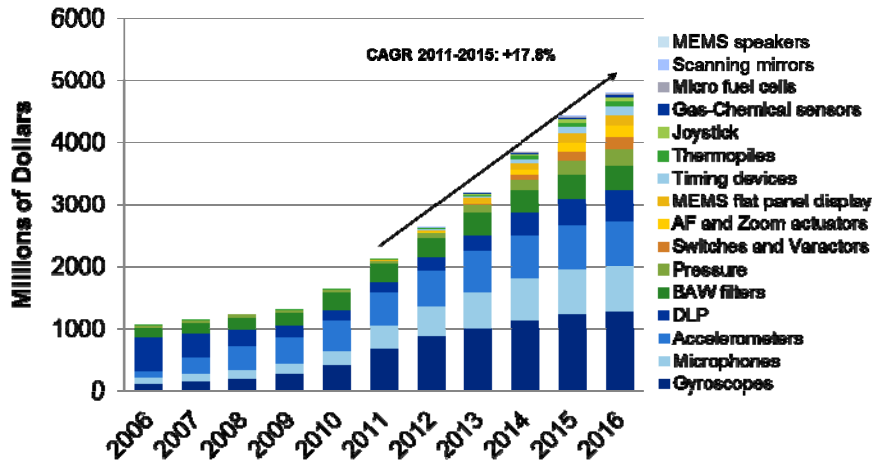
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## MEMS Market for High Value Applications: medical, industrial, aerospace and defense, wired communications



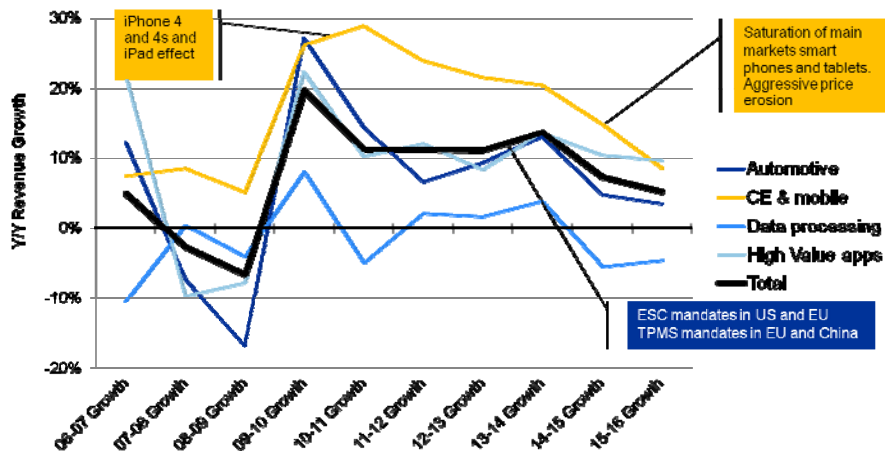
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# MEMS Market for Mobile and Consumer Electronics Applications 2006-2016



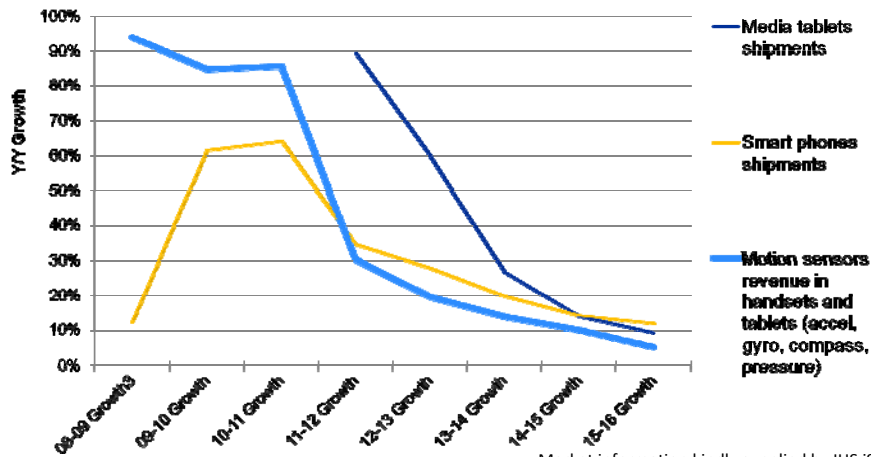
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# MEMS annual revenue growth to drop below 10% in 2015



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## The star market - motion sensors in handsets and tablets- will eventually saturate



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## Looking back... What has fueled the MEMS market growth until now?

Source: Mercedes, Nintendo, Continental, Apple, Knowles, Discera, Tesser, Qualcomm, InvenSense

### Some market related milestones



1997, Mercedes A-class fails „Elk test“  
Breakthrough for Electronic Stability Control  
\$833 M revenue in 2016



2006, Wii made motion sensors popular in gaming.  
Accelero+gyro+compass in gaming = \$236 M 2010



2007, TPMS mandatory in US, EU and China mandate follow in 2012 and 2015.  
\$400 M in 2016



2007, iPhone revolution.  
\$2.9 B for MEMS and compass in smart phones in 2016



2010, Apple launches iPad  
\$608 M for MEMS and compasses in tablets in 2016



2003, Knowles: MEMS microphone. \$750 M market in 2016



2007, Discera and SiTime: MEMS oscillator.  
\$200 M market in 2016



2007, Siimpel: MEMS AF/zoom actuator.  
\$180 M in 2016



2008, Qualcomm commercializes MEMS flat panel display. \$170 M in 2016



2010, ST and InvenSense: 3-axis gyroscope. \$1.1 B in 2016

### New MEMS products

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# What are the next killer apps and killer products?

Source: Apple, ChooseESC, Cisco

## Market related milestones



Next Apple TV with motion sensors based remote?  
TAM for accelero + gyro + compass is \$475 M in 2016



ESC mandate in China?  
TAM \$450 M in 2016



Wireless sensor networks / „Sensory swarm“?

2011 WiSpry: RF MEMS switches and varactors in handsets. \$160 M in 2016

2011 Knowles: MEMS joystick. \$75 M in 2016

**MEMS speakers?**

**MEMS for drug delivery?**

**Environment / bio-sensors in handsets and tablets?**

**MEMS energy scavengers?**

## New MEMS products

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# Environmental / bio sensors in handsets (Sensirion and NTT Docomo)



Humidity sensors from Sensirion in handsets from Fujitsu and Chinese OEMs since 2010.  
API available in Android



Breath analyzer (NTT Docomo, demo at MWC 2012)

Biochip mobile phone analyzing the bio gas  
Prototype of a portable breath acetone analyzer



Just blowing into the device, it gives an estimate of how much fat you are burning and your hunger levels

Gas sensor to monitor fat burning and hunger level (NTT docomo, March 2012)



Weather sensors (pressure, humidity, temperature, UV), NTT demo at MWC 2012

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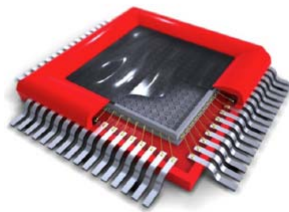
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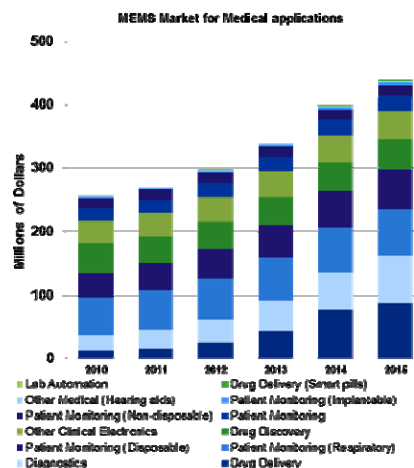
## Can MEMS speakers win against conventional loudspeakers? (Audiopixels)



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## MEMS keep you healthy

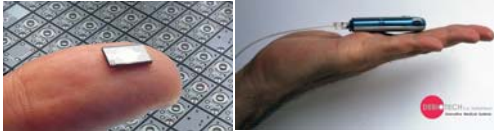
- Patient monitoring (respiratory + disposable) dominates with \$135 million in 2015, 6% CAGR
  - By monitoring patients' blood pressure during and after major operations. Over 35 million such devices are used and thrown away annually
  - And against the rising tide of respiratory disorders: pressure and flow sensors for ventilators, respirators, O2 concentration...
  - Accelerometers used in pacemakers that adjust to activity levels
  - Pressure sensors wirelessly monitor cardiac condition
- Drug delivery opportunity \$87M in 2015 (48% CAGR)
  - Inhalers in serial production today.
  - Next big opportunity is MEMS patch pump for accurate administering of insulin for type 1 diabetes (Debiotech, Microchips)
  - Switch for "smart pill" takes off from 2010
- Diagnostics booming with 26% CAGR 2010-2015, \$75 million in 2015
  - Silicon /glass lab-on-chip e.g. PCR chip from ST. Too expensive for mass market though (\$50-100). Affordable platforms in R&D at foundries such as Dalsa and SVTC.
  - Thermopiles used in advanced thermometers boomed with Avian flu.
- Drug discovery shows slow growth
  - Typically 100-1000s lab-on-chip / series. Mostly captive in hands of big pharmaceutical company's in cooperation with foundries



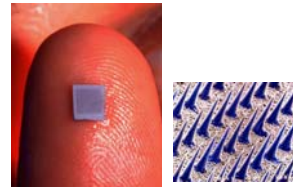
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# Applications of MEMS for drug delivery

## Micro-pumps for portable / implantable drug delivery



Insulin Pump, Debiotech



Silicon micro-needles arrays

## Silicon MEMS for drug delivery

### Automatic injection device



### Nebulizers/Inhalers



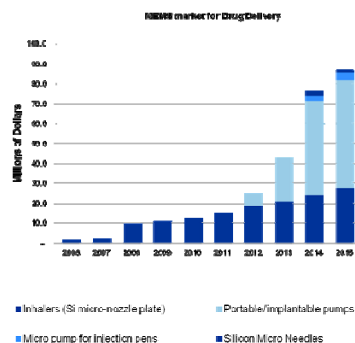
Nebulizer, Microparts

Micronozzle detail, Aradigm

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# MEMS drug delivery: one of the next MEMS killer applications?

- Today only silicon micro-nozzle plates for nebulizers from Boehringer Ingelheim Microparts.
  - About 9 million units in 2010, only in Europe.
  - Shipments accelerate from 2011 (29% 5-year CAGR) to 32 million in 2015 as new countries certify the nebulizer and its medication, and as new companies offer the technology
- Patch pumps for insulin is the killer application in next 5 years
  - TAM: 230 million type 1 diabetes sufferers, 60 patch pumps / year
  - Forecast of \$54 million corresponds to very small penetration of MEMS pumps only!
- Micro pumps for injection pumps: potential for few millions, from 2014
- Silicon micro-needles: huge potential (billions of vaccination / year) but target price is challenging for silicon micro-needles

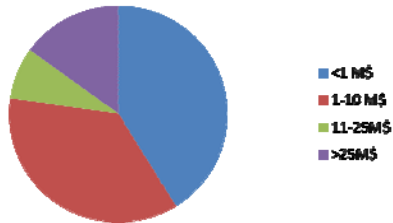


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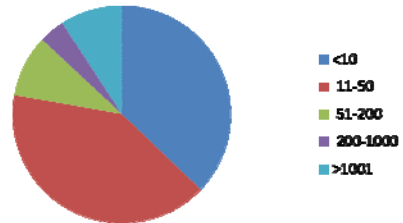


# The microfluidic industry (1)

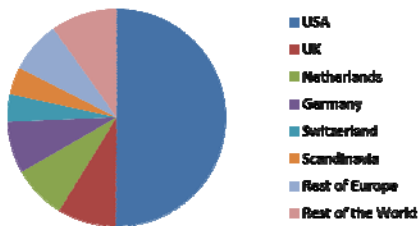
Investment in the companies



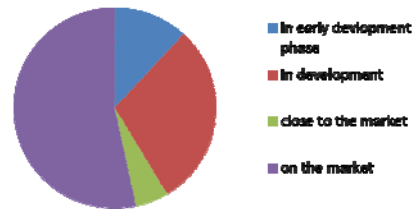
Size of the companies



Microfluidic companies



Product status



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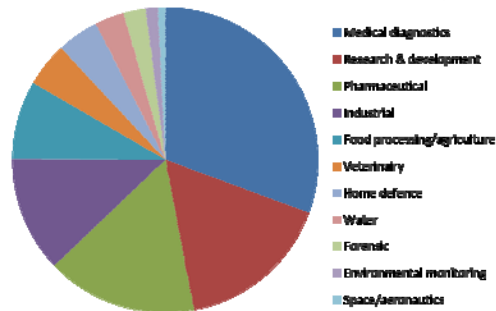
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# The microfluidic industry (2)

- >400 companies worldwide, mainly operating in the medical diagnostic and pharmaceutical field, but also in: R&D, Food, chemical processing, agriculture, veterinary, home defense, water, forensic etc.
- About 25% of the companies discussed are component or service supplier to the microfluidic user community.

Markets



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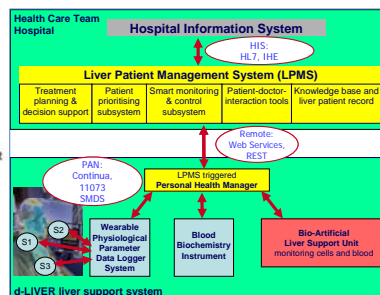
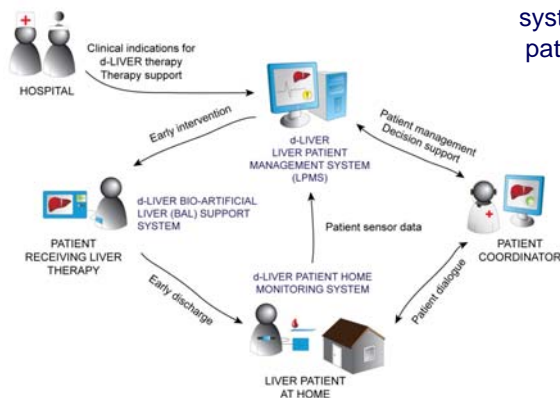
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# University spin off hot spots (microfluidics)

- **Havard** (Claros, Vista Therapeutics, gnuBio, DFA, Nano Terra)
- **MIT** (Bostonms, Firefly BioWorks, Netbio, Pharyx, Biosscale, Hepregen, Microchips)
- **University of California Berkeley** (Cellasic, Nanomix, IntegenX)
- **University of California San Diego** (Celula, Nanosort, Biological Dynamics)
- **University of Texas** (Resonant Sensors, Nanomedical systems, Leonardo Biosystems)
- **Cornell University** (HμREL, Pacific Biosciences, Advion)
- **Caltech** (Labsmith, LeukoDx, Fluidigm)
- **EPFL** (Spinomix, Diagnoswiss, Biocartis, Ayanda, Abionic)
- **Imperial College London** (DNAE, Microsaic, Molecular Vision, Deltadot)
- **Cambridge University** (Cambridge Biomagnetics, Sphere Fluidics)
- **A\*STAR / National University of Singapore** (Micropoint Technologies, Veredus, Cellsievo, Curiox, Clearbridge, CE Resource)
- **IMM** (Ehrfeld, Mikroglas, ThinXXS)
- **University Twente** (U-needle, Aquamarijn, Ibis Technologies, Kryoz, Medimate, mylife technologies, Medimate, Ostendum, Opisense, Senzair)

# d-LIVER

ICT-enabled, cellular artificial liver system incorporating personalized patient management and support  
[www.d-liver.eu](http://www.d-liver.eu)



The d-LIVER EC-funded project applies a scenario-driven development methodology to address the unmet clinical need for an ICT-enabled bio-artificial liver support system (BAL) for remote management of patients with chronic liver disease outside the hospital. The aim is to provide safe, cost-effective systems for continuous, context-aware, multi-parametric monitoring of both patient and BAL parameters in order to: enhance the quality of medical treatment and management, improve the quality of life for patients, reduce the incidence and duration of hospitalization and consequently reduce the health economic burden of chronic liver disease. In a parallel, high-risk, high reward activity, d-LIVER will identify human pancreatic progenitor cells which can differentiate into human hepatocytes and be cultured into the large numbers of functional cells which can supplement vital liver functions.

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micro technology

# www.foodmicrosystems.eu

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**What is FoodMicroSystems?**

FoodMicroSystems objective is to initiate the implementation of microsystems & smart miniaturised systems in the food sector by improving cooperation between suppliers and users of microsystems for food/beverage quality and safety.

[Read more](#)



FoodMicroSystems ambition is to initiate the implementation of microsystems & smart miniaturized systems in the food sector





**Funding opportunities**

List of funding opportunities in the area of smart systems research and innovation.



**Document library**

Selection of key documents relevant to smart (micro) systems and the food sector



**Directory**

Information on key research groups in microsystems that address food-related topics.

**FoodMicroSystems: a FP7 project**

Foodmicrosystems.eu project is supported by the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 287634

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## Identified Trends – towards Microsystems

- Food & Nutrition (& Water) will increasingly need microsystems technology to improve on efficiency in production & logistics and to make food more healthy.
- Health: from lab to point of care diagnostics and telemedicine/telecare.
- Safety: RFID and sensors will be increasingly used to track and trace (products and people).
- Ambient intelligence will invade our environment.
- Cost price of sensors and electronics will decrease.
- Data handling and interpretation might become the bottleneck - what are we measuring and why and how to make sense out of all these data and how to protect our privacy?

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# Thank you for your attention!

*With a special THANKS to Henne van Heeren, enablingMNT The Netherlands, and to Jérémie Bouchaud, IHS iSuppli Germany, for supplying me with valuable market data and advice.*

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Integrating Project: Developing an "ICT-enabled, cellular artificial Liver System incorporating personalized Patient Management and Support"

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FoodMicroSystems: EC-funded Coordination Action to provide a Roadmap of the "Microsystems for Food" Sector  
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