



The μ HUMS Service Cluster

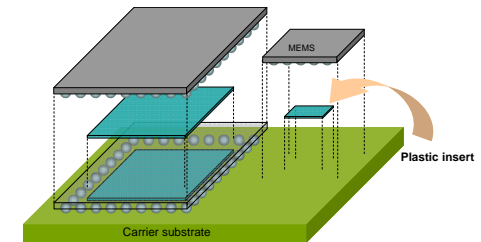
Mark Begbie

Micro&Nano Systems Event

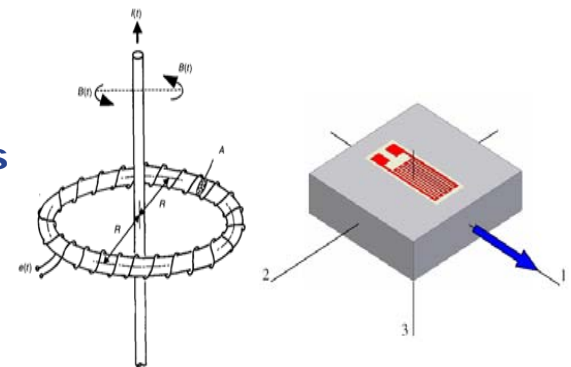
Oct-07

«Design for Micro & Nano Manufacture (NoE PATENT-DfMM)»
Network of Excellence funded by the European Commission (EC FP6: IST, Unit C2, Contract 507255)

- Miniaturised HUMS units containing sensors & on-line test functions
- Library of MEMS and Electronic self-test functions for bespoke HUMS
- A Cluster of >30 experts :
 - Heriot Watt University, Lancaster University, BUTE, iSLI, Oulou University [invited] BCF Designs, ST Microelectronics
- Services
 - Feasibility studies on embedded HUMS solutions systems where periodic or continuous diagnostics or condition monitoring is required
 - Access to extensive information database and consultancy on methods to achieve on-line test, fault tolerance and diagnostic capabilities.
 - Design service for HUMS sensors based on microtechnologies (temperature, stress, humidity, EM fields etc) and electrical self-test functions
 - Prototyping facility (silicon and board based)



Integration into SiP systems with Philips Semiconductors



Microsensors for aircraft wiring monitoring – UK AiGT

- Roll out State-of-the-art technologies and skills to industry
- USP : Provide a higher level of service than the competition.
- Win–Win: Brings benefits to core research and teaching to Universities through engagement with the clusters.
- Gestation: Staffing is being supported through final NoE actions, while revenue stream is developed.
- Focus: Initially, cluster will not extend beyond a single core market to minimise resource needs and maximise market visibility
- Initially the service clusters will not proactively "sell" services outside the "known" community due to resourcing overheads rather, they will build the clusters will key customers and expand based on success.

- Methodology Development
 - Analysis of wiring fault modes
 - Development of FMEA methodologies
 - Detailed assessment of current state-of-the-art in wiring test: LF / HF / TDF / FDR

- Sensor System Development
 - Targeted at wiring environmental monitoring
 - Targeting highly integrated clusters
 - Potential for system integration / smart connectors

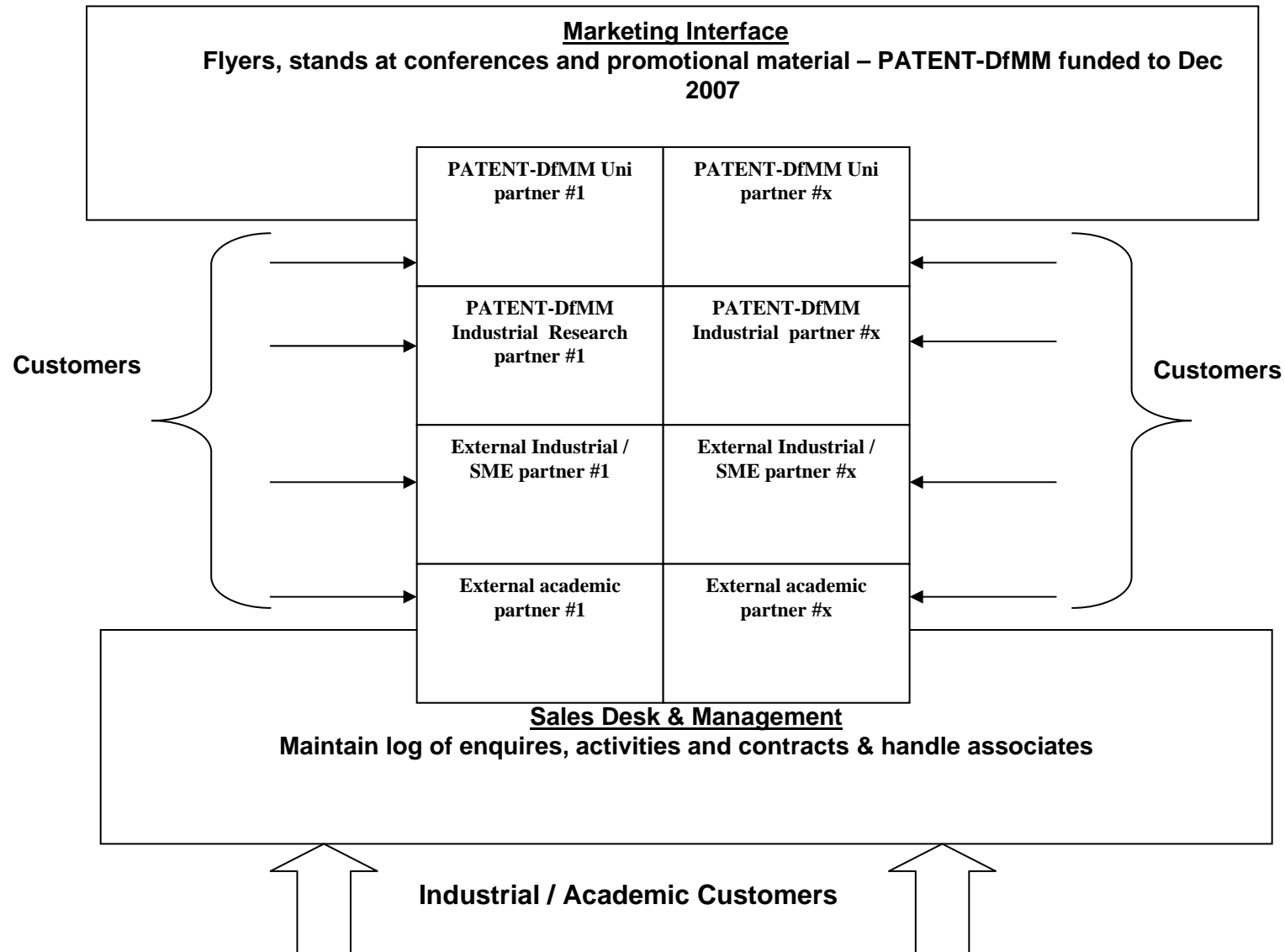
- Follow on engagement / funding – BCF

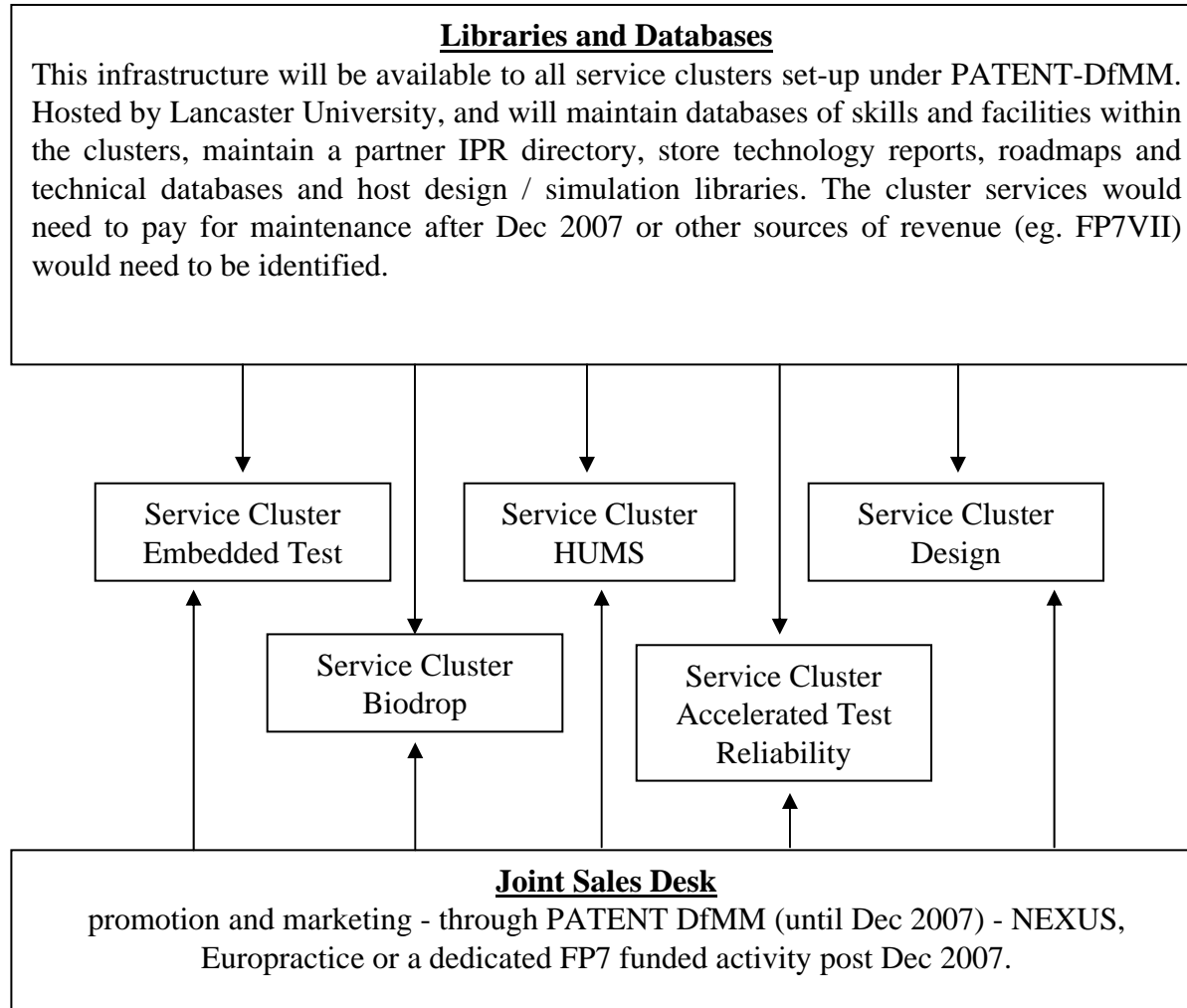


- Rogowski Coil - Current / current change
 - Insulation breakdown
 - Intermittent contact / break
 - Possible chemical breakdown through triboelectric effect
 - Miniaturisation / integration challenges

- Combined humidity and temperature
 - Novel materials development and deployment
 - Design and proof of principal devices

- Sensor integration
 - Monolithic sensor cluster development
 - Current, strain, temperature, humidity...
 - Data fusion and cross correlation
 - Sensor failure mode analysis





- Lancaster University
 - Embedded test and reliability engineering
 - Design methodologies and packaging for MEMS & SiP
 - Extensive engagement with relevant commercial sectors
- Heriot Watt University
 - Lead partner throughout the flagship project phase
 - Extensive sensor portfolio including current, inertial and flow
 - Extensive engagement with relevant commercial sectors
- Budapest University [BUTE]
 - Thermal modelling – sensors, systems and environment
 - Novel sensor technologies in thermal and humidity measurement
- Oulou University
 - Wireless and RF systems
- iSLI
 - Research translation and integration
 - Design for manufacture and customer interfacing
- BCF Designs
 - Current supplier in aerospace diagnostic and monitoring systems
 - Direct market interaction and pull
- ST Microelectronics
 - Manufacturing, integration and volume scale up

- Market needs analysis conducted
 - Professional marketing staff
 - Confidential interviews with senior specifiers
 - Analyses across potential market sectors

- Risk / Competition Analysis
 - Loss of focus – single initial market
 - Strength of knowledge – USP
 - Competitors – identification / differentiation

- Market identification / quantification
 - Substantial relevant budgets identified
 - Local and global routes to growth
 - Key potential customers and fund streams

- Sensor requirements:
 - Vibration, corrosion and impact
 - Mechanical / electrical / optical
 - Cross calibration and fault recognition
 - Extended capabilities through and data correlation / fusion

- Drivers
 - Autonomous airborne vehicles:
 - Greater functionality & mission independence
 - Self monitoring & diagnosis
 - Appropriate corrective action

 - All vehicles
 - Smaller, lighter, more integrated
 - Fault monitoring and reporting
 - System fault tolerance / reconfiguration
 - Constant monitoring - predictive maintenance and fault capture

 - Avoidance of catastrophic failures

□ Renewables

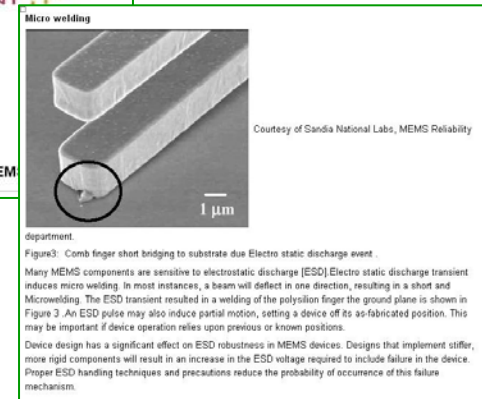
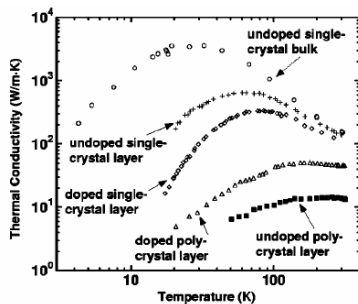
- Many similarities to Aerospace needs
 - Catastrophic failure events characterise market
 - Commonalities in materials, construction, supply chain - manufacturer ownership
 - Rapidly expanding market sector
- Barriers to immediate engagement
 - Need to focus on one clear sector for success
 - Not yet sufficiently mature
 - Lower margin / higher volume

□ Personal Health Monitoring

- Opportunities in ubiquitous monitoring
 - Embedded sensors in converged consumer items
 - Ultimate low cost / huge volume market
- No current customers identified
 - Market at feasibility / research stage



4 different databases are being set-up

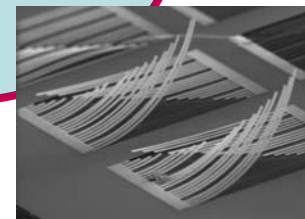
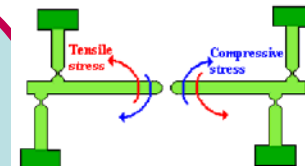
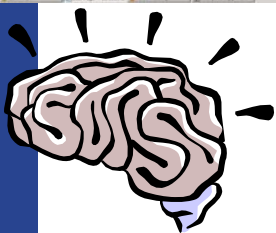
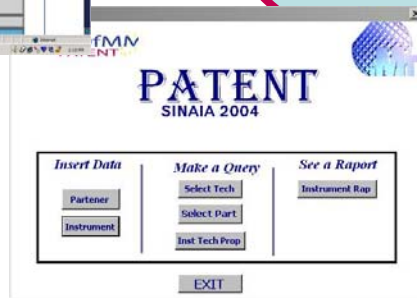
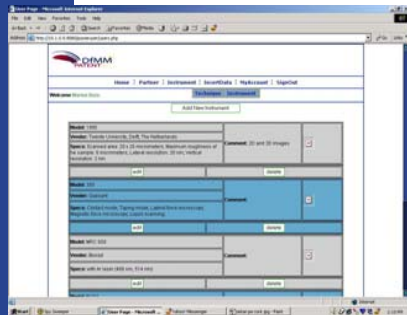


Materials

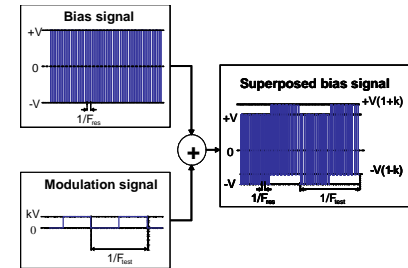
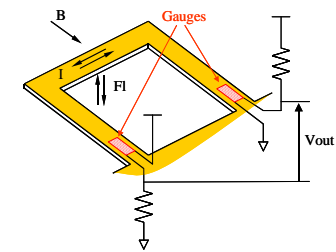
Failure modes

Techniques & know-how

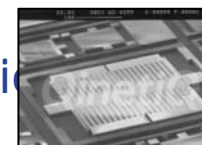
Test structures



- ❑ Embedded electrical only test solutions for functions with non-electrical interfaces
- ❑ **A Network of experts :**
 - Lancaster University, CNRS, Montpellier, QinetiQ
- ❑ **Provision Capabilities :**
 - Feasibility studies on embedded test solutions for microsystems and system-in-package technology featuring functions with non-electrical interfaces
 - Access to extensive information database and consultancy
 - Design service for self-test or condition monitoring functions
 - Prototyping facility (silicon and board based)

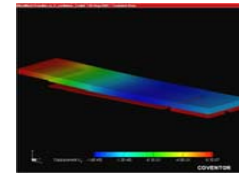
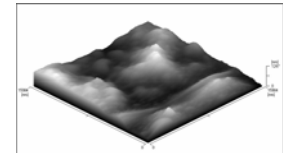
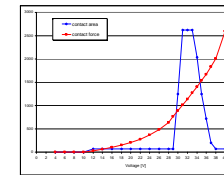


Injection of test signals into bias structures to test magnetometers

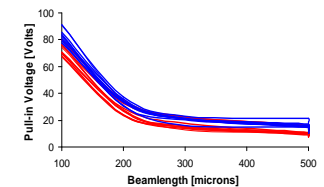
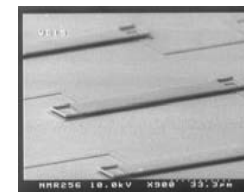


Prototype solution for accelerometers

- MEMS / Integrated MEMS design service targeting high quality, high reliable and economic designs through DfM
- Added Value through experts in key MEMS design challenges : inc : modelling stiction, damping, thermal-mechanical, package interaction, electromigration, degradation mechanisms
- An Expert Network :
 - ISLI, QinetiQ, CEA-LETI, Tyndall, POLIMI Coventor BUTE, Lancaster University, IMT, Heriot Watt, LAAS, ITEM, WUT, Liege
- Provision Capabilities
 - MEMS & uFluidics Design
 - Modelling / Analysis of key Design challenges (Packaging, damping, degradation)
 - Design for robustness, testability , reliability



Skills and IPR in accurate modeling of surfaces and simulation of contact effects in MEMS



Thermomechanical modelling – package interaction

- We offer a capability to embed a range of miniaturized sensors and built-in test functions into HUMS modules for in service diagnostics and condition monitoring.
- Offering to industry:
 - A team of **>30 engineers** from 5 leading organisations in the field of sensor and microsystems design, test engineering and system integration offering services in:
 - **Feasibility studies** on embedded HUMS solutions systems where periodic or continuous diagnostics or condition monitoring is required
 - Access to **extensive information database** and consultancy on methods to achieve on-line test, fault tolerance and diagnostic capabilities.
 - **Design service for HUMS** sensors based on microtechnologies (temperature, stress, humidity, EM fields etc) and electrical self-test functions
 - **Prototyping facilities** (silicon and board based)
 - Services will be through leading experts from MISEC, Heriot watt University, BCF Designs Ltd, Centre for Microsystems Engineering at Lancaster University, ISLI Livingston, Budapest University of Technology and the University of Oulou