MST FOR AEROSPACE IN EADS

THE M1 MICRO-EXPLORER PROJECT

M. Snelling, A. Lecuyot – Astrium Ltd
C. Anzinger, J. Schalk – EADS CRC

OUTLINE

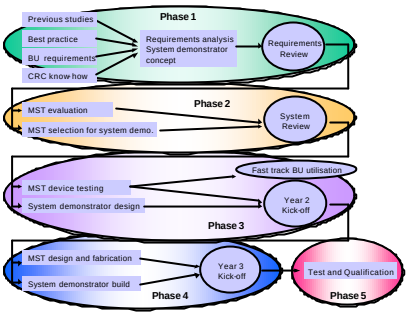
- EADS CRC MICROSYSTEMS CAPACITIES
- M1 PROJECT PLAN
- REQUIREMENTS ANALYSIS
- COTS MEMS REVIEW
- PROCUREMENT AND TESTING
- MICRO-EXPLORER DESIGN
- DEMONSTRATORS
  - I-µP MkI
  - I-µP MkII
  - Atmospheric µP
  - Platform integration
- ESA SPACE APPLICATIONS
- FURTHER WORK

The EADS Corporate Research Programme

- EADS recognises synergy between the R&D activities of the Business Units.
- EADS actively encourages BUs collaboration in R&D through Corporate Research Programmes
- The activity reported here is one such CRP.
- Business Units participating to this CRP "M1":
  - MBDA — Marie-France Ravat, Michel Boubal
  - EADS-LV — Oudea Coumar
  - Sodern — Isabelle Lefesvre
  - EADS CRC — Josef Schalk, Claus Anzinger
  - Astrium Gmbh — Sigmund Manhart
  - Astrium SAS — Sophie Barthe, Christian Vialet
  - Astrium Ltd — Martyn Snelling, Arnaud Lecuyot

EADS CRC MICROSYSTEMS ACTIVITIES

M1 PROJECT PLAN



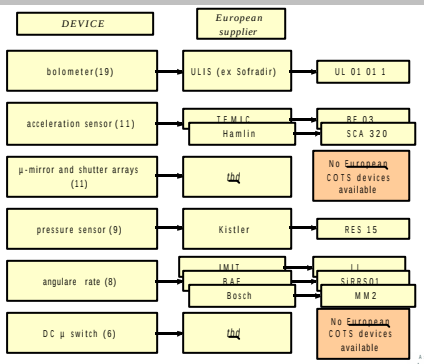
Currently in phase 3/4, year 2

REQUIREMENTS ANALYSIS

- Limited to DC devices (RTG17 RF)
- Low (1-2g) and high (10-20 g) accelerometers
- Similar for rate sensors
- 2 types of temp. and press. sensors
  - Atmospheric
  - Inside craft
- Environment:
  - Mechanical levels “common”
  - Thermal can vary
  - Unique effects (space-radiation, air-moisture)

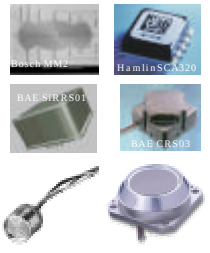
DEVICE	RELATIVE NEED
BOLOMETER	30%
PRESSURE SENSOR	17%
ACCELEROMETER	14%
GYROS	12%
MIRROR	9%
SHUTTERS	9%
DC SWITCHES	9%

COTS MEMS REVIEW



COTS MEMS PROCUREMENT AND TESTING

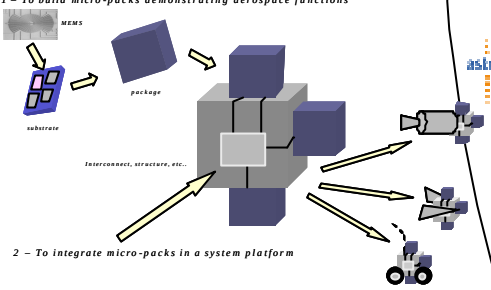
- Gyros and accelerometers
  - Stable against temperature and vibration
  - Also against stability and non-linearity
- Bolometers:
  - Vibration creates random pixels
  - One model not so resistant to radiation
- Pressure sensors:
  - Already space qualified



Device	Bolometer	Pressure sensor	Accelerometer	Gyros	Mirrors	Shutters	Switches
Types (Price, €)	2 (30,000)	3 (200)	1 (200)	2 (2,000)	0	0	0
Procured	✓	✓	✓	✓	×	×	×
Tested	✓	×	✓	✓	×	×	×

MICRO-EXPLORER DESIGN

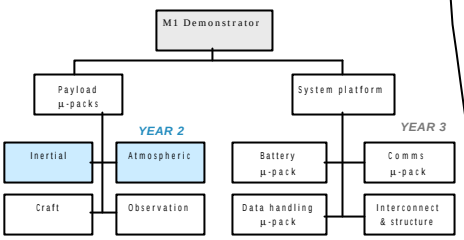
1 – To build micro-packs demonstrating aerospace functions



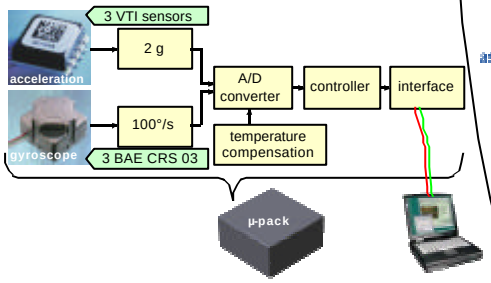
2 – To integrate micro-packs in a system platform

3 – To adapt the platform to specific R&D purposes

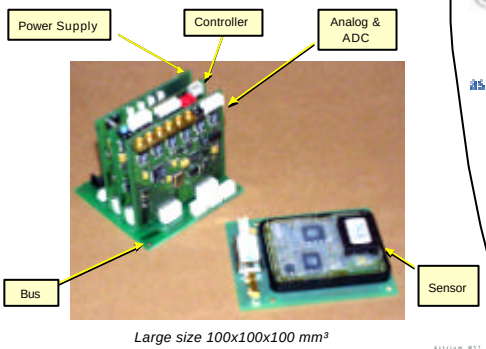
MICRO-EXPLORER DESIGN



DEMONSTRATOR – INERTIA MICRO-PACK (I-µP)



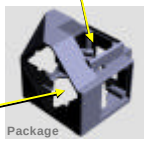
I-µP Mark I FOR BREADBOARD TESTING



Large size 100x100x100 mm³

I-µP Mark II AS INTEGRATED SYSTEM

- ✓ Sensor selection
- ✓ Mechanical design
- ✓ Electrical layout
- ✓ Mechanical realisation
- Electrical realisation
- Software interfacing



ATMOSPHERIC MICRO-PACK – BLOCK DIAGRAM

0...1 bar ± 0.1%

-100…50°C

2 g

IR GAS ANALYSIS SENSOR

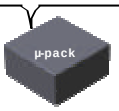
H_2O

A/D converter

Controller

Comms I/F

Additional Electronics

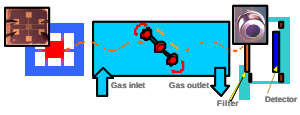


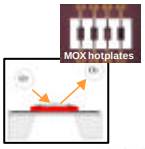
ATMOSPHERIC µP: SENSOR DESIGN

- Pressure sensor needs to be adapted to low-pressure atmospheres (i.e. Mars or high altitude)

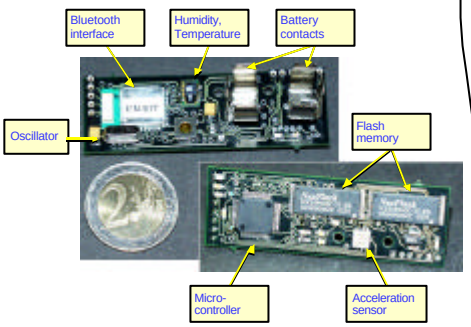
AKTIVSensor ATA0.025

- For chemical atmosphere analysis IR and MOX micro-sensors are tested

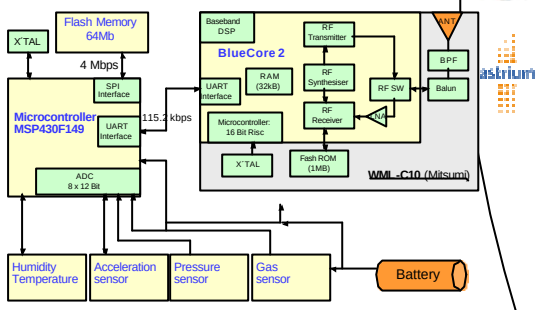




ATMOSPHERIC µP: SENSOR BREADBOARDS



PLATFORM INTEGRATION: WIRELESS SENSORS



ESA SPACE APPLICATIONS

- MICRO-LANDERS
  - ExoMars PASTEUR payload
  - Aurora future lander studies
- MICRO-EXPLORER
  - Platform Architecture studies
  - Distributed sensing studies
- EARTH / SPACE TECH INTERACTION
  - IR sensor developed for forest fires originally
  - Bluetooth (&others) developed for terrestrial comms

FURTHER WORK

- COMPLETE μPACKS DESIGN & INTEGRATION
  - I-μP assembly
  - Gas sensor miniaturisation
  - Atmospheric μpack assembly
- COMPLETE TESTING
  - Testing of A-μP in simulated Martian atmosphere
  - Further testing of I-μP
- COMPLETE SYSTEM DESIGN
  - Micro-power, wireless Comms, Functional structures
- APPLICATIONS
  - Adaptation to other Aerospace applications
  - "Spacifying" the designs
    - Use rad-hard or shield components
    - Adaptation to space OBDH (MIL1553, RS422)