MEDEA+ Scientific Committee
Bio-chips and chips for Bio

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Executive summary

The task given to the MEDEA+ Scientific Committee was to report on the achievements and envisaged developments in the area of 'Bio-chips and chips for Bio'.
The Scientific Committee generated a working group comprising experts from Ecole Polytechnique (F), CEA (F), FhG (D), IMEC (B), EPFL (CH), Universities of Ferrara and Bologna (I), University of Twente (NL) and University of Glasgow (UK). Additional contributions from Industry came from a workshop organised by the working group in Paris in November 2003 and a MEDEA+ workshop organised at Leuven by IMEC in June 2004.

Bio-microsystems represent a very large ensemble of devices encompassing miniaturized and integrated devices for biological/biochemical functions in research & development, diagnostics, therapy and monitoring. Devices are called, sometimes redundantly, biochips, bioMEMS, microarrays, DNA chips, Lab-On-Chips, Cell-Chips, micro implants, drug delivery systems (DDS), and µTAS (micro Total Analysis Systems). Foreseeable applications are numerous and will be implemented on a large scale but without a clear definition of time as yet. Bio-microsystems deal with a field of major importance: healthcare is a primary economic activity and will continue to grow. Additionally, many sectors of healthcare will be impacted by bio-microsystems: diagnostics, drug development, adaptive drug treatment, health monitoring, transplants and implants (natural or artificial). A major change in healthcare practices can be foreseen from the occurrence of smart "lab on chip" for disposable point of care or

home diagnostics. Other markets will also have sizeable needs of chips: the food industry will increasingly require real-time controls. Security and environmental issues are becoming major items on the political agenda.

Bio-microsystems bring speed, parallelism, complexity and redundancy, low cost, and integrated intelligence. These attributes are due to the massively parallel manufacturing of miniature systems allowed by microelectronics fabrication techniques. These unique characteristics, together with a significant number of unmet medical needs, make healthcare a major application area. The increasing sophistication in medical technology has also increased the associated costs, therefore technologies that can provide monitoring, diagnostics and therapeutics with high speed, high accuracy, and high disposability while at low cost, low invasiveness, and low supervision are bound to be quickly incorporated in the medical practice. Additionally other areas that require increasingly refined monitoring such as the food industry can equally benefit from those attributes.

Despite their great potential, bio-microsystems have historically thrived through limited, small-scale isolated successes, with no clear roadmap and no major application in sight within a finite time frame. Any policy to improve the competitive position of Europe requires an increase in solid collaboration between engineers and medical professionals; this could lead to developments of major medical significance and address challenges not yet explored (historically it is known that medical research partnerships have originated most of the successful bio-microsystems applications).

Europe has some of the biggest pharmaceutical and biomedical companies in the world, yet most of the bio-microsystem activity is still happening in the US. As a consequence, most of the present-day intellectual property generation is happening there, which will potentially block future European attempts to compensate for this delay. It is therefore imperative that we be proactive now to avoid such an irreversible situation in the future.

European microsystem research has typically been more systems orientated than that in the US or elsewhere, which could give European chip houses a competitive advantage as some of them are indeed ready to incorporate more non-conventional technologies. They also come with a history of successful packaging solutions, which represent a key effort in the development of bio-microsystems; no matter how novel and unique a device may be, it is usually the packaging and integration schemes that will ultimately gauge its success.

One might wonder why microelectronics companies should feel an urgency to act: there is no large-scale application in view (as is usually

the case for emerging technologies in emerging markets, market studies are of no help to identify the future), the funding situation is bad in Europe (at variance with the massive infusion of US funds for bio-terrorism actions). We see two major reasons:

- Although one can not foresee a date for bio-MEMS becoming a major industry, it will happen somewhere in 10-20 years, as it will be a major technology allowing cost reduction of healthcare systems, already a dominant worldwide activity and growing at a fast pace.
- The importance of that business for microelectronics companies is not clear: will the bulk of the added value be in the bio layer? In any case, the past example of mobile telecommunication systems is clear-cut: the establishment of GSM as the European standard has allowed European manufacturers to become world leaders, with European chip makers having a major thrust from that situation. It was a win-win situation for everyone in Europe.

Therefore, it is in the interest of every European company to have Europe positioned at the best level in the bio-MEMS industry. For that, it is essential that companies (including those in microelectronics, biotech, pharmaceuticals, etc) be brought together with medical centres and healthcare authorities in general to implement specific programs that will facilitate joint work, regulatory compliance, and intellectual property management.

MEDEA+ could have a leading role in promoting actions in Europe in the field, taking stock of what is already available thanks to past or on-going actions at National and European level.

Welcoming new projects in bio-microsystems, as part of MEDEA+ phase-2 (2005-2008) is of course possible since the topic is part of its technical program (White Book 2).

MEDEA+ could also act in helping to bring to existence a 'MEDEA-like' organisation that would specifically deal with the topic, with added strength coming from the participation of the medical community at large as well as biotech and pharmaceutical companies, together with the semiconductor companies interested.