Annex 4: Micro/Photonic Technologies - Detailed Findings (Group A)

A4..1 Introduction

The Micro/Photonic technologies covered Key Actions IV.6, IV.7, IV.8, the FETs VI.2.1 (Quantum Information Processing and Communications) and VI.2.3 (Nanotechnology information devices). There are around 140 projects in these areas.

For the purposes of categorisation and hence analysis, the PIM team used the following technology categories shown in **Table A.1**

24	Advanced optoelectronics, design and coordination actions
25	Advanced microelectronics, design and coordination actions
26	Semiconductor processes, equipment and materials
27	Microsystems
28	Microwave devices and antennas
29	Quantum Research
30	Basic Research
31	Components and Displays

Table A.1

The number on the left is the Technology Code number that applies to a particular category. Most of the projects within the categories focus on the development of hardware components, systems and sub-systems. There are also relatively few projects with software development as a secondary technology focus. Furthermore, a significant amount of the output from these projects feeds into the market category “Electronics Industry”.

Generally, no attempt was made to identify the synergy between projects within a given category. The PIM team understands that the Commission, as part of its negotiations with the various projects will address this issue especially within a particular panel.

Annex 7 contains a complete list of projects, proposal number, Panel number project name and project summary. Readers wanting to gain a quick understanding of how projects within a given category interact are recommended to look at this annex.

A4..2 Content of Programme

The technology areas covered ranged from basic research, through semiconductor equipment and materials to “down-stream” areas such as microwave components and optical elements.

In the case of basic research (which includes nano research) and quantum research there are a significant number of projects which have a 10 to 20 year time horizon.

Within the area of semiconductor materials and equipment, there are several strategic projects which address important issues such as next generation lithography equipment and back–end automation. However, there are no projects in the area of “zero-emission” facilities (i.e. fabrication facilities which minimise the use of energy or aim for the minimum use of inputs such as gases and water). This is unfortunate since there are a number of European companies with interests in this area.

Optoelectronics features projects developing or producing important optical network components such as laser sources, detectors and filters. However, the group believes that coverage in this area is thin and might need to be strengthened in future calls.

The microelectronics category produces a wide range of products and systems. There was no overall focus to this category which produces products for a range of industry sectors Individually, there were some good projects. No projects addressed the important area of silicon carbide.

Microsystems has a considerable number of information actions, and the PIM team felt that some efforts should be made to co-ordinate these various information actions.

Microwave projects, consisting of microwave and antenna projects, were aimed almost exclusively at the mobile telecommunications market. There appeared to be reasonable coverage in this area.

There were relatively few projects covering components and displays, an area that should have attracted more proposals.

As a general comment the group felt that there is a need for projects, in categories outside of Basic and Quantum research, that would deliver results within a 5 to 10 year time frame i.e. medium term research.

A4..2.1 Strengths Weaknesses Opportunities and Threats

A4..2.1.1 STRENGTHS

The projects resulting from the first IST call have built on the lead achieved by European Union laboratories in the opto-electronics area as a result of the previous 4th Framework Programme.

In the microwave area the coverage was adequate, and several projects provide components for the strategic area of next generation mobile networks.

The quantum electronic area has been very well covered and positions Europe strongly for future developments in this area. The results of the calls contained several world-class ideas and concepts. These strengths also apply to other areas namely nano-technology, basic research and biotechnologies.

In the area of sensors several good projects were identified, and in the area of mass storage a few good innovative ideas were proposed.

In the micro-electronic area there are a number of projects which are application focussed and will produce results in a sensible time frame. Some projects produce leading-edge novel products which will strengthen Europe’s position in specific areas.

A4..2.1.2 WEAKNESS

Although the projects cover a wide number of areas, there is a lack of focus and coverage in some areas such as reliability, re-useability and productivity which will make the achievement of critical mass much more difficult. Another important area, packaging / integration and microsystems has few projects. Furthermore, there is a lack in sustainable and continuous effort on next generation components, intended for the 5 to 10 year time scale.

A4..2.1.3 OPPORTUNITIES

The rapid expansion of national and trans-national fibre-based telecommunications networks provides a ready market for much of the output from categories such as optoelectronics. The timely delivery of products from these projects will ensure that Europe maintains and perhaps expands its lead in this area.

Likewise, the explosion of wireless communication and sensing in home, in transport and in industrial processes offers a unique opportunity for the application of microwave microsystems and devices.

A4..2.1.4 THREATS

Failure to deliver the results of projects in a timely fashion in a given area could result in the failure of projects in other areas which in turn could impact on European strengths. The lead currently held by

European industry in opto-electronics, micro-systems, and possibly displays, should not be lost to global competitors outside the European Union just as happened for the micro-electronic industry (e.g. microprocessors).

*A4..2.2 **Multi-Criteria Statistical Analysis***

A4..2.2.1 Category to Key Action Correspondence

Table A.2 shown below covers technology categories and key actions and demonstrates conclusively that there are considerable synergies between the various key actions and action lines. For example, in the case of Technology category 24 (Optoelectronics) there are 13 projects in KA 8.4 (Optoelectronics), which roughly corresponds to category 24. There are also 5 other projects in the area of Optoelectronics which lie outside the action line focusing on Optoelectronics. This situation is repeated across all the technology categories covered by the group. The most dispersed technology category was 25 (microelectronics). Projects in this category are spread over seven key action lines.

The conclusion to be drawn is that some effort needs to be made to ensure that projects in common technology areas (such as optoelectronics or microelectronics) but different key action lines should be made aware of each others existence and activities.

Micro/Photonic Technology Category	24	25	26	27	28	29	30	31
Panel								
CPA 1								
CPA3								
FET Open	1						5	1
FET P1						17	1	
FET P2								
FET P3			1				15	1
FET SM		1					1	1
KAI.5 Environment								1
KAII.1 RTD Spanning			1					
KAIV Support Measures				12				
KAIV. Nwk Management & IS								
KAIV.2 Communications & Networks	2	1						
KAIV.3.1 Software Engineering								
KAIV.3.3-4 S/W Methods & Info Man								
KAIV.5 Mobile & Personal Coms					1			
KAIV.7 Peripherals subsystems & microsystems			1			1		
KAIV.7.2 Subsystems		3	6		2			
KAIV.7.3 Microsystems	1	3	2	1				2
KAIV.8 SEA (Take-up)			6					
KAIV.8.1-2 Microelectronics & appls	1	6			1			1
KAIV.8.3 Processes & Eqpt		5	12					
KAIV.8.4 Opto & Micro Electronics	13	2	1		2	1	2	2

Table A.2

A4..2.2.2 Category to Market Correspondence

Table A.3 shown below is an extract of a larger table covering all technology categories and markets. The table shows that most projects feed into the two markets of electronics and telecommunications. Relatively few projects address other markets such as transport (a strong European market) or health (an important social market). The PIM study team believes that projects in future calls could look more closely at these areas.

Market Categories	Total Number Of Proposals	24	25	26	27	28	29	30	31
1	27								
2	19								
3	17								
4	18	1							
5	21					1			
6	68								
7	31		1		1	1			1
8	46								1
9	24	1			2				
10	110	7	16	27	8		13	23	7
11	33	1						1	
12	63	6	2	2	2	4	5	1	
13	5								
14	19	2	1						
15	13								
16	12		1						
17	4								

Table A.3

A4..3 Risk Profile

A4..3.1 Semiconductor process and materials

Most of the technology in this area is well understood. Time frames also appear realistic given market developments. Projects in this area generally have a low risk profile. However, for some individual projects, delivering results in the correct time frame is essential. If this does not happen, then there could be significant commercial implications for the participants and other projects.

A4..3.2 Optoelectronics

Projects in this category are a mix of high risk leading-edge and those which use well-understood technologies to develop new products. However, end users of many of these products, mostly in the telecommunications industries, may operate with different time frames for the sourcing of new advanced products. Risk in this case is likely to be a mismatch between project results, product availability and the time-frame in which end users need these products.

A4..3.3 Microelectronics

Most projects in this area are application focused. Risk in this category relates to the ability of a project to deliver an application to a given end user market in a sensible time frame or before its competitors.

A4..3.4 Basic Research

Projects in this category have a long technology time frame. In some cases it can be up to 20 years before a commercially useful result will emerge. Risk in this category could be considered as the failure to support a sufficient number of projects so that the failure of an individual project does not jeopardise overall activities in this category. However, this call avoids such a possibility by supporting a sensible number of projects. From this point of view, this category has low risk.

A4..3.5 Quantum Research

The comments made with regard to the category, basic research, could also be applied to Quantum research.

A4..3.6 Microsystems

There are not sufficient projects in this category to develop a sensible risk profile.

A4..3.7 Microwave

Mostly well understood technology. End users for these products are similar to those for the category Opto-electronics. As such the risk element is qualitatively similar to that of this latter category.

A4..3.8 Components and Displays

There is some variation of risk in this area. Many of the projects seem to be leading edge and as such may have a higher level of risk.

A4..4 Participants

There is a mix of academic institutions, SMEs and larger companies taking part in projects within group A. Not surprisingly, there are more academic institutions involved in Basic and Quantum research than in other categories.

A4..5 Findings Analysis

A4..5.1 Links, Synergies and Dependencies

A4..5.1.1 PIM Proximity Link

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
IV 8.4	10450	24	GSQ	Gallium arsenide second window quantum dot lasers	Design development and testing of high performance 1300nm lasers and microcavity LEDs fabricated on GaAs substrate.
IV 8.4	11051	24	TUNVIC	Micromechanical widely tuneable VCSEL for WDM telecommunications systems	Tuneable vertical cavity surface emitting laser for low cost WDM applications at 1.5micron.
FET P1	10243	29	S4P	Solid state sources for single photons	Development of solid state single photon sources for quantum information processing and communication.
FET P1	11311		SQID		
The above projects work on micro-cavities, quantum dots or VCSEL's. They can share some modelling tools, processing and benefit from awareness…					

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
IV 8.4	11239	24	PCIC	Photonic Xtal integrated circuits	Fabrication of optoelectronic components using 2-D photonic Xtals in semiconductors.
FET SM	19009	30	PHOBOS	Photonic crystal based optical structures	Fabrication and testing of an optically readable elastomer.
The projects above work on photonics band-gap. They can benefit from sharing and comparing some modelling tools ….					

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
IV 7.2	11411	28	MEDCOM	Microwave electro-acoustic devices for mobile and land based communications	Apply thin film deposition techniques for piezoelectric material deposition for fabrication of surface acoustic wave filters for microwave applications.
IV 7.3	10945	27	MELODICT	Micromachined electromechanical devices for integrated wireless communications transceivers	Production of capacitors, RF switches and IF filters for radio transceivers using micromachining techniques as integral part of IC production. Validation of these components in an experimental multi-standard radio transceiver.
IV.5	10521	24	SATURN		To develop a 0.1 to 0.13 micron CMOS/SOI technology for high speed low power applications.
IV 8.4	11807	28	FACT	Ferroelectrics for advanced communications technologies	New types of electronic components for microwave engineering
IV 8.1-2	10339	28	PALOMAR	Passive long distance multiple access high radio frequency identification system	Develop the technology to produce inexpensive radio frequency identification cards operating at 2GHz.
The above projects work on design, fabrication, integration for smart antennas. They can benefit from sharing design, technologies and development, awareness…					

A4..5.1.2 PIM Infosharing [Awareness] Link

As a general comment, Group A believes that information sharing links need to be two-way. That is, a dialogue should develop between the projects mentioned below and the industries or groups that they "feed". This will help the projects to better understand industry developments (as the project proceeds) and the evolving needs of the end user.

A4..5.1.2.1 Within this Category:

The project below should build an information sharing links with other industry categories within the areas covered by Group A.

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
KAIV.8.4 Opto & Micro Electronics	11603	25	SIGMOS	SiGe channel and source drain for deep sub-micron CMOS	Development of 50nm channel length CMOS devices in three different configurations.
The above project could have results relevant to work undertaken in Category 26 covering the development of nanometre architectures. It will also have an indirect feed to the industry category Telecommunications – Optical Networks.					

A4..5.1.2.2 Outside this Category:

The projects shown below should develop information sharing links to categories not considered by the Group. For example, end user industries such as Telecommunications.

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
KAIV.7.3 Microsystem	10945	27	MELODICT	Micromachined electromechanical devices for integrated wireless communications transceivers	Production of capacitors, RF switches and IF filters for radio transceivers using micromachining techniques
The above project will produce products relevant to Telecommunications – UMTS & Wireless Access.					
KAIV.8.3 Processes & Eqpt	10521	25	SATURN	To develop a 0.1 to 0.13 micron CMOS/SOI technology for high speed low power applications.	
The low power products developed by Saturn will be of interest to the Telecommunications industry – wireless applications.					

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
FET3	12603	30	NANOMOL	Manufacturing and modelling of nano scale molecular electronic devices	Develop a manufacturing technique and theoretical models for nano scale molecular electronic devices.
FET 3	11974	30	BIOAND	Biomolecular driven assembly of nanoparticles	Lay groundwork to develop new technologies for the bottom up fabrication of nanoscale devices.
FET 3	11565	30	BUN	Bottom up nanomachines	Design, synthesis and test of molecular devices like molecular wires, molecular 3 terminal gates and intramolecular circuits.
FET 3	10557	30	MESI	Molecular electronic spin integrated circuits	Development of techniques for fabricating nanoscale devices on DNA 'scaffolds' and their use to demonstrate the feasibility of transferring electronic signals to and from nano magnetic systems.
FET 3	13099	30	DNA	DNA based electronics	Development of DNA based electronics by exploring the electronic properties of DNA in order to use it as a template for molecular electronic components.
The above projects work on Biotechnologies either for self-assembling or electrical or magnetic properties. They can benefit from sharing common knowledge-base.					

A4..5.1.3 PIM Dependencies:

This are covers issues where projects reviewed by Group A were considered to provide products or components that are critical to the successful development of activities in other categories or other technology areas. By implication there is also an information sharing link between these projects and the relevant industry sector.

A4..5.1.3.1 Within this Category:

For this call, no projects were found to have dependency links to other technology categories within the time frame of the 5th Framework programme.

A4..5.1.3.2 Outside this Category:

The PIM study team believes that the following list of projects have outside category/Group dependencies.

KAIV.8.1-2 Microelectronics & appls	11081	25	LEMON	Design methodology and implementation of a third generation W-CDMA transceiver using deep submicron CMOS technologies.	The design of a next generation mobile communications transceiver using W-CDMA and the use of deep submicron CMOS technologies in its construction

This project could be linked to projects in the Tech Sector and Telecom/UMTS					
KAIV.7.2 Subsystems	12529	25	PROFIT	Prediction of temperature gradients influencing the quality of electronic products	Development of accurate experimental and numerical techniques for determining temperature gradients in packaged devices.
(see also PIM2) This project could be linked to projects in the Telecom technology group (all categories)					
KAIV.8.4 Opto & Micro Electronics	10356	24	ULTRABRIGHT	Reliable ultra bright laser diode sources for terabit telecommunications and photodynamic therapy	Development of high power lasers at 975nm (20W) and 732nm (4W) as pumping sources for optical amplifiers and for use in cancer therapy.
This project could be linked to projects in the Telecom/Optical Net technology group.					
KAIV.8.4 Opto & Micro Electronics	10450	24	GSQ	Gallium Arsenide second window quantum dot lasers	Design development and testing of high performance 1300nm lasers and microcavity LEDs fabricated on GaAs substrate.
This project could be linked to projects in the Telecom/Optical Net technology group.					
KAIV.8.4 Opto & Micro Electronics	10787	24	WILD	Wide aperture coherent laser diodes for Er doped fibre amplifiers	High power pump lasers at 980 and 1500nm for erbium doped fibre amplifiers.
This project could be linked to projects in the Telecom/Optical Net technology group.					
KAIV.8.4 Opto & Micro Electronics	11051	24	TUNVIC	Micromechanical widely tuneable VCSEL for WDM telecommunications systems	Tuneable vertical cavity surface emitting laser for low cost WDM applications at 1.5micron.
This project could be linked to projects in the Telecom/Optical Net technology group.					
KAIV.8.1-2 Microelectronics & appls	10339	28	PALOMAR	Passive long distance multiple access high radio frequency identification system	Develop the technology to produce inexpensive radio frequency identification cards operating at 2GHz.
(see also PIM 2) This project could be linked to projects in the Telecom technology group.					
KAIV.7.2 Subsystems	11411	28	MEDCOM	Microwave electro-acoustic devices for mobile and land based communications	Apply thin film deposition techniques for piezoelectric material deposition for fabrication of surface acoustic wave filters for microwave applications.
(see also PIM 2) This project could be linked to projects in the Telecom group.					

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
IV 8.4	10356	24	ULTRIBRIGHT		
The amplifier in the project ULTRIBRIGHT can probably be used in the demonstrators of the following optical network projects: METEOR (10402), ATLAS (10626), DAVID(11742). The main synergy is availability of devices to other projects.					

Key Action	Project No	Category	Project Acronym	Project Name	Project Description
KAIV.8.4 Opto & Micro Electronics	11051	24	TUNVICS	Micromechanical widely tuneable VCSEL for WDM telecommunications systems	Tuneable vertical cavity surface emitting laser for low cost WDM applications at 1.5micron.
KAIV.8.4	12700	24	GIFT	GaAs based emitters	Development of GaAs based emitters

Opto & Micro Electronics				for fibre optical data and telecommunication	for fibre optical data and telecommunication.
KAIV.2 Communications & Networks	10626	24	ATLAS	All optical terabit lambda shifted transmission	Trials of terabit optical transmission in WDM networks.
	10402		METEOR		
	11742		DAVID		
The projects working on Optoelectronics could feed into projects working on fibre networks. The main type of synergies and dependencies are availability of devices to adjacent developments, awareness.					

A4..5.1.4 PIM External Dependencies:

No project in the Micro/Photonic technology group was found with such a link to other technology groups.

A4..5.1.5 PIM Added Value (Financial & Market):

No project in the Micro/Photonic technology group was found with such a link to other technology groups.

A4..5.1.6 PIM Strategic Link:

No project in the Micro/Photonic technology group was found with such a link to other technology groups.

A4..6 Key Issues

- Reconciliation of coverage between the work programme and the result of the call, lack of broad level of coverage.
- Critical mass was too low in some areas to catalyse significant progress.
- There is a need Encouragement of academics in Europe to exploit commercially their ideas and breakthrough technologies.
- There is a lack of synchronisation between components and products.
- Lack of awareness in SMEs of the technological background available in the RTD program and research institutes in Europe which may be of interest for them
- Sharing of intellectual properties IPR.
- There is a lack in exploiting breakthrough technologies proactively.

A4..7 Recommendations

IST program in components and subsystems should:

- have a broad level of coverage of all basic technological areas but with an appropriate level of effort;
- Identify in each area the more promising and relevant technologies as well as functionalities which can be encouraged further through clusters

The IST programme should provide, through its call, the possibility of focusing on the chosen technologies in order to reach critical mass of effort to meet market demand.

A process should be developed and implemented to spot breakthrough technologies and encourage the development of these technologies.

Participation in the IST programme should encourage the proactive exploitation of project results.

As a general comment, the group felt that there is a need for projects to strengthen the linkage between application and network oriented projects and component oriented projects. Application oriented projects should define the exact technological needs in terms of :

- technical specification and functionality
- time scale at which it should be met
- maximum cost
- quality.