# **Description of the specialization**

#### I. PHYSICAL SENSORS

- 1. Spot and distributed optic fibre sensors, in particular employing microstructural optical wires, for measuring physical quantities, in particular shape, deformation, temperature and others.
- 2. Technology and structure of sensors and detectors of electromagnetic and/or ionizing radiation.
- 3. Technology and structure of sensors employing ultrasounds.
- 4. Technology and structure of sensors and microsensors (MEMS/NEMS/MOEMS), including for mechanical quantities (force, tension, deformation, acceleration, vibrations, position and others).
- 5. Development of flexible and/or printed sensors.
- 6. Technology and structure of electric and magnetic sensors.
- 7. Sensors for material diagnosis, including non-destructive tests.
- 8. Navigation systems in closed objects.
- 9. Physical sensors for automatic diagnosis of machines and devices in M2M or M2H systems.
- 10. Sensors for weight and force measurements, including dynamic measurements.

### **II. CHEMICAL SENSORS**

- Development of new construction solutions and a technology for producing chemical sensors, including the electrochemical, semiconductor, thermometric, mass, optic and optical fiber, lab-on-chip, spectrometer, resonance (MEMS/NEMS) and others.
- 2. Matrices for chemical sensors.
- 3. Chemical sensors for gases (photonic, conductometric and others).
- 4. Techniques and materials for functionalising chemical sensors
- 5. Chemical sensors, detectors and sensor networks for monitoring chemical and radiological security level.

### **III. BIOSENSORS**

- 1. Sensors for bioelectrical measurements of the parameters of living organisms and biological structures.
- 2. Sensors for biomechanical measurements of parameters of biological structures.
- 3. Techniques and materials for functionalising biosensors.
- 4. Technology and structure of biosensors employing MEMS and NEMS structures.

- 5. Biosensors matrices.
- Optoelectronic sensors employing biological structures (enzymes, proteins, nucleic acids and others).
- 7. Sensors for monitoring the vital functions of people operating in extreme conditions (firefighters, rescuers, policemen, athletes and others).
- 8. Sensors and sensor networks for telemedicine, including monitoring human health.
- 9. Sensors for biomedical implants.
- 10. Sensors for biomedical signals for devices control.

## **IV. SENSOR NETWORKS**

- 1. Techniques of management, optimisation and self-organisation of sensor networks.
- 2. Security of sensors and sensor networks as well as security systems for data transmission and collection.
- Localisation in sensor networks (localisation algorithms, techniques for localisation and creation of maps, in particular dedicated to areas of high risk and/or difficult propagation conditions).
- 4. Techniques for processing and collecting data for sensors and sensor networks.
- 5. Artificial intelligence techniques supporting the functioning and use of intelligent sensor networks.
- 6. Smart sensors and sensor networks employing acoustic, seismic, spectral and/or imaging techniques.
- 7. Development of sensors and sensor networks of Body Area Network type (BAN).
- 8. Development of new solutions for autonomising the functioning of sensor networks.
- 9. Sensor networks for monitoring the condition of the human environment.
- 10. Sensor networks for monitoring land, air and water traffic, including radars with a controlled beam.
- 11. Smart sensor networks supporting trade, in particular electronic, and systems integrating electronic sales channels with traditional channels.

## V. HORIZONTAL (CROSS-SECTION) NOTIONS IN SENSOR TECHNOLOGIES

- 1. Electronic and IT technologies for sensor systems.
- 2. Innovative materials for laser technology.
- 3. Techniques and systems for efficient consumption of energy for autonomous sensors and sensor networks.
- 4. Instruments and systems for energy harvesting for sensors and sensor networks.

- 5. Sensor operating within extreme environmental conditions.
- 6. High resolution and high accuracy sensors.
- 7. Housing and packaging technologies for sensor and detector technology.
- 8. The notions of integration and miniaturisation of heterogeneous and smart sensor systems.
- 9. Methods for improving reliability of sensors and sensor systems.
- Sensors of physical and chemical quantities as well as electronic support systems that work

in harsh environment, including cosmic conditions.

- 11. Utilisation of data fusion collected by various types of sensors.
- 12. Microelectronic systems, including specialised ASIC integrated circuits for the needs of sensors and sensor networks.
- 13. Sensors and sensor networks for biomedical diagnosis.
- 14. Sensors and sensor networks for prevention in situations of public safety and/or epidemiological threat.
- 15. Sensor networks for managing the security of critical infrastructure and public facilities.
- 16. Sensors and smart sensor networks for the needs of disabled persons and for rehabilitation.
- 17. Sensors and sensor networks for monitoring technical condition of engineering structures

and/or prediction of the period of their safe exploitation (SHM and PHM).

- 18. Functional sensors and sensor networks for technical devices.
- 19. Sensors and sensor networks for smart buildings and cities.
- 20. Sensors for monitoring natural environment.
- 21. Sensors and sensor networks for the needs of modeling people, their behaviour and environment (work ergonomics, creation of virtual environments and others).
- 22. Sensors and sensor networks supporting agriculture, forestry and agri-food industry.
- 23. Sensors and sensor networks for modelling, simulating, controlling and/or operating of the technological processes in industry.
- 24. Sensors and sensor networks for monitoring storage conditions in the supply chain and tracking products for identification purposes.
- 25. Sensors and sensory networks for the needs of advanced systems of perimetric protection.
- 26. Sensors and sensory networks for the needs of controlling machines with gestures and speech.
- 27. Sensors and smart sensor networks for locating people and things in a dynamically changing environment in a limited area.
- 28. Sensors and sensor networks for adaptive anti-collision and anti-crash systems

in transport and industry.

Dictionary:

**MEMS** (*MicroElectroMechanical Systems*) – a microsystem that is most often produced using semiconductor technology, consisting of mechanical and electrical components.

**NEMS** (*NanoElectroMechanical Systems*) – a microsystem that is most often produced using semiconductor technology, consisting of mechanical and electrical components, including elements in nanometric sizes.

**MOEMS** (*MicroOptoElectroMechanical Systems*) – a microsystem that is most often produced using semiconductor technology, consisting of mechanical, optical and electrical components.

**Body Area Network** – a sensor network, the elements of which are located on or inside living organisms.

**SHM** (*Structural Health Monitoring*) – monitoring technical condition of a structure.

**PHM** (*Prognostics Health Monitoring*) – management and prediction of the lifetime of the structure.

M2M (Machine to Machine) - Communication between machines.

**M2H** (*Machine to Human*) – Communication between a human and a machine.

**Harsh environment** – difficult environmental conditions (e.g. outer space conditions, mining, metallurgy).