

JRA description

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JRA labelling	<i>This field will be filled by the FP7-I3 coordinator</i>
JRA title	New Semiconductor Sensors for Hybrid Pixel Detectors
Reference “June 30 JRA(s)”	JRA #19
Participating facilities	DESY, ESRF, SLS, DIAMOND(+STFC), SOLEIL (+CPPM-Marseille), Elettra, ...

Objectives

The main goal of this research activity is the development of new semiconductor sensors that will improve the performance of X-ray hybrid active pixel detectors (HAPD) in terms of detection efficiency, radiation tolerance and reduction of insensitive area. The evaluation and validation of new materials and sensor structures will make maximum use of existing pixel detector modules. In addition to reducing significantly the development effort and making optimum use of the available resources, this approach will have a direct impact on the outcome of the project; the JRA will not only push future technologies for the next generation of pixel detectors, it will also produce usable detectors with improved characteristics in the short and medium term.

A more detailed list of objectives is the following:

- Development of sensors made of high-Z semiconductor materials like GaAs or CdZnTe (CZT). The aim is to increase the detection efficiency with respect to the currently used Si sensors by a factor of 2.5 at 20 keV and a factor of 10 above 40 keV. The higher density of these new sensors will imply an improvement of the radiation tolerance of the detector assemblies as the higher absorption of the sensor layer inherently protects the underlying readout electronics.
- Development of silicon sensor with reduced insensitive areas at the edges by employing novel “edgeless” sensors. The goal is to extend the sensitive region to less than 50 micrometers from the physical edge of the sensor and therefore to be able to reduce the overall dead area of multimodule detectors by a factor of 10 [OPTIMISTIC?].
- [INCLUDE 3D SENSORS? TO BE DISCUSSED. PF not in favour as non-Si 3D sensors seem out of reach]
- Validation and characterisation of the new sensors by building single and multi-chip modules based on existing pixel detector designs. Production of improved versions of current detectors in terms of detection efficiency and reduced dead area.
- Dissemination of information and results on processing and characterisation of high-Z and active edge sensors.
- Contribution to the establishment of an industrial infrastructure in Europe for the growth and processing of the selected high-Z semiconductors for the production of X-ray sensors.
- Contribution to the establishment of a industrial infrastructure in Europe for the production and processing of edgeless silicon sensors.

Description of work (possibly broken down into tasks), and role of participants

Approximately 1 page

Preparation work (to be done if possible in Barcelona or in any case before the final project proposal in Q1/2008)

- Select the high-Z materials. Two main criteria: the expected “effective” (not theoretical) performance and availability (including cost). [PF in favour of limiting the choice to two materials]. Not necessary to limit the choice to one manufacturer per material type.
- Select two potential sources of active edge devices: one more “industrial” [probably SINTEF] and another more academic (few candidates to choose).
- Only once the sensor materials are chosen, select the chips/modules based on technical considerations.

JRA work (workpackages)

- 1 - Electrical characterisation of chosen raw high-Z material. Update/complete/verify previously published data if exist. Only one WP, the same techniques/procedures should be applied to the different materials.
- 2 - Design and sensor processing with high-Z material (one WP per selected material). If there is more than one target chip, proceed in steps starting by the biggest pixel size.
- 3 - Design and manufacturing of active edge sensors. Even if there are two different sensor sources this should be a single WP.
- 4 - Electrical characterisation of sensors (before bonding). Only one WP, the same procedures for different sensors (high-Z and active-edge).
- 5 - Bump bonding of ASICS and sensors. Including characterisation [possible at this stage?].
- 6 - Assembly of detector modules and electrical tests. Using existing designs and know-how. To be done by the module developers.
- 7 - X-ray tests. Including lab tests and field tests at SR beamlines in real applications.
- 8 - Project coordination. In addition to coordination, this WP is in charge of producing the technical reports that combine information produced from different WP's.

Deliverables (brief description and month of delivery)

Date (months)	Deliverable
T0 + ?	Report compiling the measured electrical properties of the raw materials.
T0 + ?	Report describing the processing of different materials and the results of sensor characterisation.
T0 + ?	Report describing the processing of active edge sensors and results.
T0 + ?	Report on bump bonding techniques and results
T0 + ?	Demonstrator(s) for high-Z material 1. This is one (or more) fully operational detector module.
T0 + ?	Demonstrator(s) for high-Z material 2. This is one (or more) fully operational detector module.
T0 + ?	Demonstrator(s) for active-edge sensors. This is a fully operational few (at least 2) module detector.

Budget (split by participant)

The total requested budget is **2.13M€** over **4 years**, distributed as follows:

Facility in charge	Workpackage / Task	Manpower (k€)	Material resources (k€)	Requested (k€)
Facility1	Characterisation of raw material			
	Sensor material 1			
FacilityA	Sensor design for chip X			
FacilityB	Sensor design for chip Y			
	Sensor material 2			
FacilityQ	Sensor design for chip W			
FacilityJ	Active edge Si sensors			
???	Sensor characterisation			
???	Bump bonding			
	Module assembly			
FacilityA	Assembly of module(s) X			
FacilityB	Assembly of module(s) Y			
FacilityQ	Assembly of module(s) W			
	X-ray tests			
	Laboratory characterisation			
	Beamline characterisation			
DESY	Project coordination			
Total:				2.13 M€

Resource distribution table

Workpackage / Task	Total		Provided (by the facility)		Requested
	Facility/Lab	Manpower	Capital	Manpower	
Characterisation of raw material					
Sensor material 1					
Sensor design for chip X					
Sensor design for chip Y					
Sensor material 2					
Sensor design for chip W					
Active edge Si sensors					
Active edge Si sensors					
Sensor characterisation					
Bump bonding					
Module assembly					
Assembly of module(s) X					
Assembly of module(s) Y					
Assembly of module(s) W					
X-ray tests					
Laboratory characterisation					
Beamline characterisation					
Project coordination	DESY				