ARDESIA

A. Balerna (Resp. Loc.), E. Bernieri, M. Iliescu, S. Mobilio, C. Vaccarezza,
A. Grilli (Tecn.), M. Pietropaoli (Tecn.), A. Raco (Tecn.), V. Sciarra (Tecn.),
V. Tullio (Tecn.), G. Viviani (Tecn.).

1 Summary

The ARDESIA (ARray of DEtectors for Synchrotron radIation Applications) project, for the development of a new detection system for synchrotron radiation XAFS measurements in fluorescence mode, based on arrays of SDD (Silicon Drift Detector) with high energy resolution and able to handle high count rates was approved in 2014 by the INFN National Scientic Committee V and started the 1^{st} of January 2015. The responsible of the project is Prof. Carlo Fiorini from the Politecnico di Milano and INFN. ARDESIA is effectively a collaboration between the Politecnico di Milano, INFN-LNF and TIPFA-FBK at Trento. Discussions about the geometry of the detector involved also F. D'Acapito (CNR), responsible of the LISA beamline at ESRF (Grenoble, France). The LNF DAΦNE-Light laboratory is clearly involved in the project because the final goal will be the realization of a detector to be installed at the DXR1 soft x-ray beamline to perform absorption measurements using synchrotron radiation. Also the realization of some important parts of the detector directly involves technicians of the LNF Synchrotron Radiation Service.

2 Activity

The first part of 2015 has been spent to define the detection module specifications, according to applications using synchrotron light like XAFS (X-ray Absorption Fine Structure) spectroscopy. After considering the state of the art, commercial and non-commercial systems for x-ray synchrotron light detection, studies have been carried out to determine both optimal detection module architecture and geometry (detector channel shape, area, number of channels per module) and readout electronics configuration. The result was a modular structure, whose basic module is composed by a monolithic, four-channels SDD matrix, and a four-channel, monolithic CUBE charge preamplifier. Single module design was made in a way that several modules can be joined together to increase the detection area and number of channels.
Spectroscopic performances have been simulated, at Milano, at different temperatures and signal processing times. Due to new FBK low leakage technology (J_{leak} <200 pA/(cm)^2 at T=25 °C), it is possible to achieve high resolution also with low signal processing times and relatively high temperatures. These performances have been verified using small single channel detectors with several processing times. According to these results, ARDESIA can operate at high count rates (>500 kcps per channel), and high energy resolution (FWHM <145 eV at 5.9 keV) without need of heavy cooling.
In June 2015, a first mechanical design has been finalized for the detection module, as well as for its insertion in the experimental chamber of a synchrotron beamline.
3D printed dummies production and assembly of the basic module mechanical parts has allowed proving design feasibility (Politecnico di Milano). Before producing the detector ceramic (alumina) board, a PCB dummy board has been produced (2 versions), in order to verify detector and preamplifier placing and electrical bonding feasibility. As test results were positive, a first prototype ceramic board is currently under production. Finally, the whole detector system has been designed, for both single modules and multiple (4 and 9) modules configurations. Detector is cooled by two cascaded Peltier stages. Using the COMSOL simulations (Politecnico di Milano)

the cooling system was verified and optimized (Fig. 1).

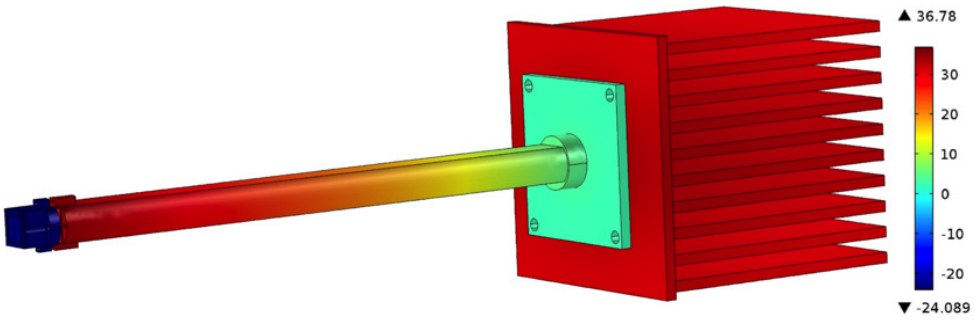

Figure 1: COMSOL simulations of the cooling systems.

According to the specifications described above, the production of the first detector module prototype started. This included the first SDD production run, the first preamplifier production run and ceramic board production. In addition to these components, also the preparations of the first analog DAQ system started.
The ARDESIA detection module has been discussed by Prof. C. Fiorini with experts in the field coming from the synchrotron community (SOLEIL, ESRF, DESY) as well as from industry (DECTRIS). In March 2015 ARDESIA has been presented in a workshop in Paris (http://www.esrf.eu/x-ray-spectroscopy-detectors-meeting). After that, the project has also been discussed with the ESRF detector group in Grenoble in a specific visit.
Research activity by TIFPA-FBK (C. Piemonte and N. Zorzi) mostly concerned the SDD design to fulfill both detection module performance and mechanical mounting constraints. In particular drift time and related ballistic deficit simulation have been addressed. Results obtained with simulator in Trento were compared to results obtained in Milano with a simpler analytical model. After these comparisons, monolithic arrays composed by 2x2 SDDs, 25 mm^2 area per channel have been chosen. Channels with both squared and circular shapes (in that case active area per channel is 19.6 mm^2) have been designed and the first production run started at the end of 2015 and should be ready at the beginning of 2016.
In 2015, LNF part of the ARDESIA project has contributed in the following activities:

1. *Definition of basic module geometry.*
2. *Detector mechanics design, including cooling and vacuum parts (still in progress).*
3. *Digital DAQ evaluation (Digital Pulse Processor).*
4. *Low energies and high energies shielding evaluation and vacuum windows (still in progress).*

At the beginning of 2015, a logo and a website (http://ardesia.lnf.infn.it/index.php/en/) for the experiment have been created.