# ARDESIA

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## 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. 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 in fluorescence mode using synchrotron radiation. Also the realization of some important parts of the detector directly involved technicians of the LNF Synchrotron Radiation Service. 2018, the last year of the project, was very important because tests and measurements with synchrotron radiation were performed at the DAΦNE-Light DXR1 soft-Xray beamline and at the BM08 ″LISA″ CRG beamline at ESRF (Grenoble - France) for 6 months from May to the beginning of December.

## 2 Activity

In february 2018 the ARDESIA detector, a 4-channel array of Silicon Drift Detectors (SDDs) was tested at the DAΦNE-Light DXR1 soft X-ray beamline. The ARDESIA detector, having a finger-like structure, was introduced in the experimental chamber using a specific vacuum-tight translating system and used as an entrance window an AP5 MOXTEK thin polymer with high transmission in the soft X-ray region. In Figure 1 the ARDESIA detector installed in the XAFS experimental chamber is shown.

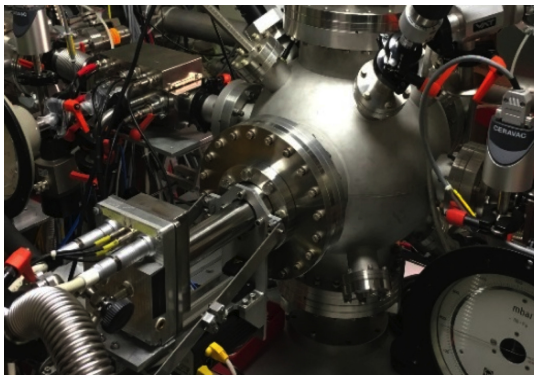

Figure 1: The ARDESIA detector installed in the DXR1 XAFS experimental chamber.

The first XAFS spectrum measured in fluorescence mode at the Si K-edge, is shown in Figure 2.

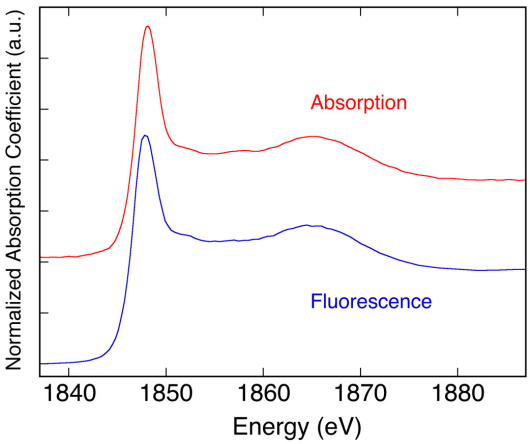


Figure 2: Fluorescence spectrum of Pyrex thin glass measured at the Si K edge and compared with the same measurement in transmission mode.

The values reported for the measurements in fluorescence mode are the average values of the data measured by the four ARDESIA SDD detectors and are compared with the data taken on a Pyrex powder sample measured in transmission mode. The ARDESIA detector opens from 2019 the possibility to accept at the DXR1 beamline also experimental proposals on diluted and supported samples. In 2019 a new software to include definitively the detector in the XAFS acquisition system of the DXR1 beamline will be developed.
In May 2018 the ARDESIA detector was tested at the BM08 ″LISA″ CRG beamline at ESRF. The detector was installed in the XAFS chamber and was tested with many different samples in order to control its high energy resolution and high count rate characteristics. In Figure 3 the ARDESIA detector installed in the XAFS experimental chamber of the LISA beamline is shown.

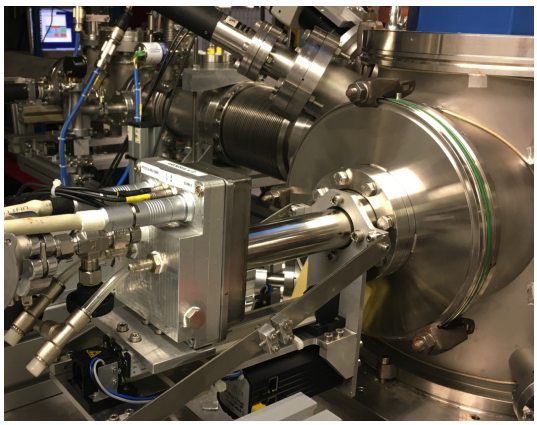

Figure 3: The ARDESIA detector inserted into the XAFS experimental chamber of the BM08 LISA CRG beamline at ESRF.

Many XAFS measurements in fluorescence mode were taken on different and very complex samples

some including elements like As and Tl having fluorescence lines very near in energy. In Figure 4 the $K_\alpha$ and $K_\beta$ peaks of As, present in one of the samples with an higher concentration compared to Tl, are clearly visible. In this figure it is possible to observe that thanks to the energy resolution of ARDESIA the $L_\alpha$ peak of Tl (10269 eV) can be separated form the $K_\alpha$ peak of As (10544 eV). Measurements on samples of this kind show also the importance of handling high count rates. If only interested in one element like Tl in this case, it must be taken into account that also the other element (As) heavily contributes to the total count rate.

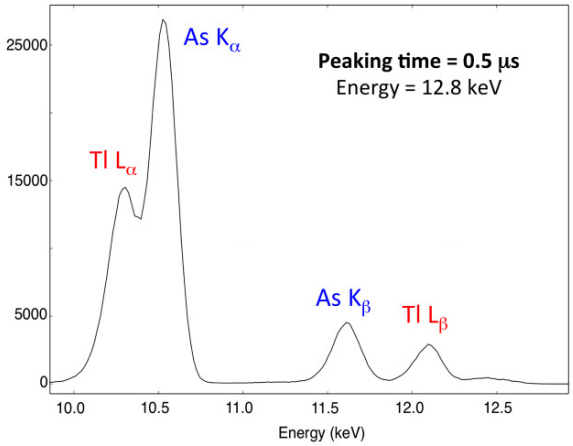


Figure 4: The fluorescence peaks of a sample including As and Tl excited by 12.8 keV X-ray photons.

Using a XIA DPP with 12 channels, 4 channels where used for the Tl $L_\alpha$, 4 for Tl $L_\beta$ and 4 for the Tl $L_\alpha$ + As $K_\alpha$. The signal/noise ratio of the spectra measured using the Tl $L_\alpha$ fluorescence line was better better than the one of the spectrum including both the Tl $L_\alpha$ + As $K_\alpha$ and that could represent data similar to the ones achievable with an HP-Ge detector that does not have the energy resolution to separate these two lines. These first results were really good and for this reason the detector was left at the LISA beamline to have the chance to be used and continuously tested for different experimental proposals. In the near future probably different papers citing the ARDESIA detector will be published.
In 2018, the LNF part of the ARDESIA project gave a contribution to the following activities:

1. *Vacuum tests of the ARDESIA detector using the AP5 MOXTEK window and the DXR1 XAFS experimental chamber.*
2. *Digital DAQ tests and XRF and XAFS measurements with the first finger shaped ARDESIA detector using the DAFNE-L DXR1 beamline.*
3. *Installation and test of the the linear translation system of the ARDESIA detector at ESRF.*
4. *XRF and XAFS measurements with the first finger shaped ARDESIA detector at the BM08 LISA CRG beamline at ESRF (Grenoble - France).*

From 2019 the ARDESIA detector will be installed and used at the DXR1 beamline of the INFN-LNF DAΦNE-Light synchrotron radiation facility and will open the possibility to perform XAFS measurements in fluorescence mode.

## 3 List of Oral Presentations

1. I. Hafizh, G. Bellotti, M. Carminati, G. Utica, M. Gugiatti, A. Balerna, V. Tullio, G. Borghi, A. Gola, N. Zorzi, A. Capsoni, S. Coelli, L. Bombelli, C. Fiorini, *ARDESIA - a Fast SDD X-ray Spectrometer for Synchrotron Applications*, EXRS 2018, Ljubljana, 24 - 29 June 2018

2. I. Hafizh, M. Gugiatti, G. Utica, G. Bellotti, M. Carminati, C. Fiorini, A. Balerna, V. Tullio, G. Borghi, A. Gola, N. Zorzi, A. Capsoni, S. Coelli, L. Bombelli, *Qualification of ARDESIA SDD X-ray Spectrometer in Synchrotron Measurements*, 2018 IEEE Nuclear Science Symposium and Medical Imaging Conference, Sydney (Australia), 10 - 17 November 2018

## 4 Publications

1. G. Bellotti, A. D. Butt, M. Carminati, C. Fiorini, L. Bombelli, G. Borghi, C. Piemonte, N. Zorzi, A. Balerna, ″The ARDESIA Detection Module: A 4-Channel Array of SDDs for Mcps X-ray Spectroscopy in Synchrotron Radiation Applications″ IEEE Trans. Nucl. Sci., **65**, 13551364 (2018) - DOI:10.1109/TNS.2018.2838673

2. I. Hafizh, G. Bellotti, M. Carminati, G. Utica, M. Gugiatti, A. Balerna, V. Tullio, G. Borghi, A. Gola, N. Zorzi, A. Capsoni, S. Coelli, L. Bombelli, C. Fiorini, ″ARDESIA: A fast silicon drift detector X-ray spectrometer for synchrotron applications″ X-Ray Spectrometry, 1-5 (2019) - DOI: 10.1002/xrs.3017