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Nuclear-related techniques at LABEC for the analysis of atmospheric aerosols

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At the 3 MV Tandetron accelerator of the LABEC laboratory of INFN (Florence, Italy) an external beam facility is fully dedicated to PIXE-PIGE measurements of elemental composition of atmospheric aerosols (PM, particulate matter). All the elements with $Z > 10$ are simultaneously detected by PIXE in few minutes, with minimum detection limits ranging between below 1 and 10 ng/m^3. This setup allows us an easy automatic positioning, changing and scanning of samples collected by different kinds of devices (PM low-volume samplers, multistage cascade impactors, continuous streaker samplers): long series of daily PM samples can be analysed in short times, as well as size-segregated and high time-resolution aerosol samples [1]. Owing to X-ray self-absorption inside each individual aerosol particle, the concentrations of the lightest detectable elements (Na, Mg, Al) can be underestimated by PIXE. For this reason PIGE is routinely performed simultaneously with PIXE to improve the quantitative analysis of these elements.
In order to obtain a complete reconstruction of the aerosol mass, we implemented the detection of H, C, N and O, which are main constituents of particulate matter, by means of in-vacuum Elastic Backscattering Spectrometry (EBS) and Particle Elastic Scattering Analysis (PESA) on samples collected on PTFE filters [2].
Furthermore, an experimental procedure for radiocarbon measurements on aerosol samples by Accelerator Mass Spectrometry (AMS) has been recently developed. These analyses give fundamental information for the assessment of the contribution of natural and anthropogenic sources (fossil fuel combustion, biomass burning, biogenic aerosols) to the carbonaceous aerosol load in atmosphere [3].
The experimental set-ups will be described and discussed in this presentation, highlighting advantages and limitations of the different techniques, and a number of results obtained in recent monitoring campaigns, performed in urban and remote areas, both on a daily basis and with high time resolution (hourly samples), will be presented.
Thanks to the capability of detecting all the crustal elements, IBA analysis are unrivalled in the analysis of mineral dust: as a consequence they are very effective in the study of natural aerosols, like, for example, Saharan dust intrusions [4]. Among IBA-detectable elements there are also important markers of anthropogenic sources, which allow effective source apportionment studies in polluted urban environments.

[1] F. Lucarelli et al., X-Ray Spectrom. 40, 162-167 (2011);
[2] M. Chiari et al., X-Ray Spectrom. 34, 323-329 (2005);
[3] G. Calzolai et al., NIMB 269, 203-208 (2011);
[4] S. Nava et al., Atm. Env. 60, 444-452 (2012).