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ACCELERATORS TO STUDY ATMOSPHERIC POLLUTION

Originating from fundamental research, accelerator physics has developed technologies and skills that are currently used in fields that have a direct impact on society such as medicine, health, the environment and the study and conservation of cultural heritage.

Physicists at the Laboratory of nuclear techniques for the Environment and Cultural Heritage (LABEC - INFN) in Florence, in collaboration with the INFN divisions of Genoa and Milan, are exploiting the knowledge and technologies developed in accelerator physics to study particulate pollution and analyse its composition. To identify the sources of pollution and develop appropriate pollution control methods, it is in fact essential to determine not only the concentrations of particulate matter (PM) in the atmosphere, but also its composition: PM is the mixture of particles, suspended in the atmosphere, that have an impact on the environment and climate, and that can be very harmful to the respiratory system. Accelerators are machines capable of generating particle beams and of launching them at very high speeds, close to the speed of light, against another particle beam or a particular fixed target. In this second case, the products of these collisions can be analysed in order to determine the composition of atmospheric particulate. The sample to be analysed is hit with a beam of accelerated charged particles. From the interaction of the beam with the sample-target, which produces for example X- and gamma rays, it is possible to identify and measure the elements in the particulate.

In this research, physicists employ techniques called "Ion beam analysis" (IBA): the most powerful and most widely used of these techniques is Particle Induced X-ray Emission (PIXE), which identifies all elements with an atomic number greater than 10, or heavier than sodium, such as, for example, aluminium, silicon, calcium, titanium and iron (tracers of soil dust), potassium (emissions from biomass combustion), zinc and lead (products of industrial operations), vanadium and nickel (combustion of



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heavy oils), copper and barium (released by vehicular traffic).

One type of sampler that is used to collect atmospheric particulate is the streaker. It separates the components of large and fine particulate (those with a diameter of between 2.5 and 10 micron from those with a diameter of less than 2.5 micron) on an hourly basis, producing a continuous strip (called a streak). By performing a "point to point" analysis of the strips with the dust deposit, which can only be done with the PIXE technique, it is possible to determine the hourly concentration of the elements in the air, hence also to identify peak episodes of pollution. At the end of February results were released from the European LIFE + AIRUSE project, dedicated to particulate air pollution in cities in Southern Europe. Researchers from seven European institutions took part in the project, including the University of Florence and the INFN - which contributed to the investigation with the particle accelerators at the LABEC laboratory. The research teams took samples of air in Athens, Barcelona, Porto, Milan and Florence and used chemical and physical techniques to analyse the air quality. The results indicate that the sources that cause most air pollution are traffic and biomass combustion and, to a lesser extent, industry, port and ship emissions, building works, local or Saharan dust, sea spray, and activities related to agriculture and livestock farming. Moreover, one finding that emerged clearly from the study is that part of the dust (secondary aerosols) is formed in the atmosphere by gaseous pollutants, which may even have been released at a considerable distance from the sampling site.