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RESOURCES, TECHNOLOGIES AND NEW PROJECTS FROM INFN IN RESPONSE TO THE COVID-19 CRISIS

Interview with Diego Bettoni, researcher and member of INFN's Executive Board.

On 11 March 2020, the World Health Organisation raised the alarm level linked to the spread of the new coronavirus SARS-CoV 2, bringing it to the pandemic level. An event, that of the worldwide spread of the virus, which immediately placed the responsibility for rapid responses in the hands of science. And while the scientific community, due to its make-up, is able to coordinate itself very quickly to achieve a shared objective, on this occasion it also showed a versatility that was far from given, establishing cooperation and procedural paradigms that will change the way it moves forward in the short and long term future. When faced with the emergency, even scientific sectors for which life sciences are not their primary mission, have been able to focus their resources. They have made their skills and technologies available to society and established themselves as promoters of research and development initiatives to support the fight against the pandemic and to limit its impact on the health system.

Like many other research bodies, as well as coordinating the internal emergency, through a special crisis committee, INFN has also developed several public utility initiatives to support medical research and the implementation of medical devices for treating the disease and limiting its spread. The INFN initiatives in this field range from the offer for huge computing resources to drug research, to the analysis of air-borne virus and bacteria, the design of medical devices for assisted breathing and the sterilisation, the analysis of materials for anti-infection masks, or the monitoring of the data on the virus spread.

We asked Diego Bettoni, a member of INFN's Executive Committee, to outline the path that, in a very short time, led to the creation of INFN projects to support the battle against the pandemic.

INFN works mainly on particle, nuclear, theoretical, and astroparticle physics, and on the applications of innovations developed in these sectors to public utility. How does the battle against the pandemic that is underway fit into this context?

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Fundamental research requires the construction of complex experimental apparatuses consisting of sophisticated detectors with very high performance both in terms of sensitivity and precision. It is therefore essential, for the realization of our experiments, to develop innovative technologies, which then find their natural application also to other disciplines, including biomedical research. Furthermore, INFN has various technical and technological infrastructures for the development and construction of experimental equipment, large computing centers for the storage and analysis of experimental data, as well as national centers and laboratories. All these ingredients (innovation capabilities, technical and scientific infrastructures, competence and expertise in data analysis) make it possible for INFN to give qualified contributions to the study and contrast of the covid-19 pandemic.

Some of the new projects born in support of the pandemic contrast are due to cutting edge computing infrastructures inside INFN.

Yes, several projects exploit the great computing capabilities of INFN, the competence and expertise in Monte Carlo simulations and data analysis acquired in experimental particle and nuclear physics. Some of them employ the large computing infrastructures built by INFN for the analysis of the data from the LHC experiments. **Sibylla Biotech**, an INFN spinoff, makes simulations in the field of protein folding with the aim of identifying molecules able to interfere with the replication process of the SARS-COV2 virus, in order to slow down its spread while we wait for a vaccine. The project focuses in particular on the ACE2 protein, the cellular receptor located mainly in human cells in tissues in the lungs, heart and intestines, to which the Spike viral protein present on the virus surface binds. INFN makes a significant fraction of its computing resources available (approximately 30000 computing units working in parallel in 8 data centers) available for the simulations of Sibylla Biotech. The results are open access and available to the scientific communities. The project **EXSCALATE4CoV (Horizon 2020)** deals with the simulation and in-silico drug design for the identification of covid-19 inhibitors among the already tested pharmaceuticals and molecules. Also, in this case INFN contributes with its computing resources. **COVIDSTAT INFN** is a website realized by INFN to make available to the INFN covid-19 crisis unit a statistical analysis of the data, provided daily by the Civil Protection Department, on the spread of the pandemic in Italy. The site shows a strictly statistical analysis of the data and provides an up-to-date status report featuring synoptic tables and interactive maps. Other INFN researchers also perform **data analysis** on the covid-19 diffusion in Italy and in other countries, using statistical and epidemiological models in order to study and predict the trend of the pandemic. Among the computing infrastructures which INFN makes available for covid-19 studies

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there is also the **INFN CLOUD** open platform. Finally, other projects pursue the development of models for diagnosis, prognosis and therapy.

Which other capabilities and technologies, besides the computing ones, have demonstrated do to be useful in this context?
Several projects arise from the technological competences acquired in the development and construction of experimental equipment and exploit the technical infrastructures of our institute. **ANTI_COVID_LAB** is a laboratory in Catania for the test of the functional features of fabrics to be employed in the realization of masks and other kinds of PPE (Personal Protection Equipment). The laboratory, to which the Istituto Superiore di Sanità (ISS) has given the green light for the evaluation tests of the Filtering Bacterium Effect (BFE), in accordance with the UNI14683 standard, provides companies with the technical and scientific assistance required to test PPE fabrics according to the standards foreseen by current regulations. The **MVM project (Milano Mechanical Ventilator)** is aimed at the design, development, construction and certification of a safe and effective mechanical ventilator complete with an advanced control system allowing the various ventilation modes. The aim is for the ventilator to be based on a simple design and easily available components allowing its quick production in various countries. MVM is an open access project that has already led to the creation of the first prototypes. It has submitted an application and is now awaiting the certification. Another project is aimed at the realization of an instrument based on a **radiogenic source**, to be used for the sterilization of surfaces.
I will finally mention two projects of environmental context: one studies the **characterization of bacteria and viruses** in the atmosphere and the possible relations between concentration of atmospheric pollutants, metereological parameters and the biological component of the atmospheric aerosol; the other project studies the possible relations between **the atmospheric concentration of some pollutants (in particular aerosols)** and the diffusion of bacterial and viral strains.

Research and development projects like these, launched to respond to the historical moment of crisis, respond to the body's overall strategy or are they instead the result of autonomous initiatives of research groups already engaged, in other ways, in biomedical applications?
Applied and interdisciplinary research has always been an integral part of INFN activity. The relevance of this research is however the result of a precise strategy of the management of INFN, a strategy which has led to the establishment of various applied research programs in fields such as the biomedical, environmental, cultural heritage, to name but a few. In line with the tradition of our

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institute these programs are born both on the initiative of individual researchers or research groups and as response to precise strategic lines coming from the management. In the specific case of Covid19 it has been a deliberate choice of INFN to stimulate the development of projects in this field with the establishment of a coordination at the national level of the individual proposals.

How has it been possible to create a varied set of projects in sectors that aren't priorities for INFN's research activities, and within such time constraints?
We did not start from scratch. As I was saying, interdisciplinary and societal applications have always been part of the DNA of INFN and, in this context, biomedical research has always played a particularly significant role. Let me mention activities such as the development of technology and instrumentation for PET (Positron Emission Tomography) and SPECT (Single Photon Emission Computerized Tomography); studies in dosimetry and radiobiology; the protontherapy programs in Catania and Trento; the construction and utilization of particle accelerators for biomedical applications at the CNAO (National Center of Oncological Hadrontherapy), at the INFN Legnaro and Southern National Laboratories (LNL and LNS). All these activities have contributed not only to strengthen our technological expertise, but they have also allowed us to establish collaborations and synergies with the biomedical and pharmaceutical communities thanks to which we develop truly interdisciplinary research programs.

Which of the skills belonging to your scientific community have proved winners in this context?
Research activities in physics require great flexibility, an open mind and the ability to deal with and find solutions to problems of all kinds. These features are an integral part of our culture and allow us to interact effectively with other communities. As I was saying before, the construction of nuclear and particle physics experiments requires the ability to develop advanced innovative technologies ranging from mechanics to electronics and computing. Of fundamental importance are our competences in computer science, statistics, simulation techniques, data analysis. These competences have allowed us to play a crucial role in the groundbreaking discoveries in basic science, from the Higgs Boson to gravitational waves, and they enable us today to give a qualified contribution to the covid-19 research.

Do you think that this effort by INFN could have an impact on its future strategies? Has the paradigm for conducting research in this scientific community changed in any way?
I am convinced that the events of this period will contribute to consolidate the dedication of our

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institute to applied and interdisciplinary research and that they will further strengthen the synergy between basic and applied science. I believe that this will make our community even more conscious of the societal impact of our research. The exploit of these applications and the transfer of our knowledge and technology to society is the natural fallback of our research. Our community is characterized by a strong sense of belonging of all its components which, at the end of this period, will be enriched by the pride in having given our contribution in this dramatic period in the history of our country. ■

INFN Projects - CoViD-19