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INTERVIEW

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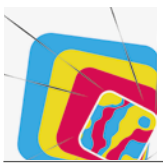

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ESFRI, NEXT STEPS FOR THE NEW STRATEGY FOR EUROPEAN RESEARCH INFRASTRUCTURES

Interview with José Luis Martínez Peña, Research Professor at Instituto de Ciencia de Materiales de Madrid (CSIC) and Chair of the ESFRI Physical Sciences and Engineering Working Group.

September 2019 saw the launch in Europe of the ESFRI Roadmap 2021 update, a two-year process that will ultimately lead to define the forthcoming strategy for European Research Infrastructures. Established in 2002 and made up of representatives of the member states of the European Union appointed by the research ministers, and representatives of the European Commission, the Forum establishes a European Roadmap for the coming 10-20 years for new research infrastructures with a pan-European interest. Main goal of the Forum is the development of a joint vision and a common strategy beyond individual policies, thus providing Europe with the most up-to-date Research Infrastructures, also advancing the knowledge-based technologies and their extended use. The Roadmap combines ESFRI projects, which are new research infrastructures underway towards implementation, and ESFRI landmarks, successfully implemented research infrastructures. The strategic report on research infrastructures will be published by ESFRI in 2021, having 5 May 2020 as the deadline for the submission of proposals.

The Roadmap envisages the internationalization of infrastructures and the expansion of research objectives in a pan-European direction. In this sense, in recent years the INFN has consistently strengthened the participation in European research infrastructures and the internationality of its infrastructures. Two projects involving INFN are included in the 2018 Roadmap: KM3Net 2.0, currently at an advanced stage of implementation in Sicily, under the coordination of the INFN Southern National Laboratories, dedicated to the detection of high energy neutrinos, with important connections with interdisciplinary environmental research; and, in the cultural heritage sector, the E-RHIS (European Research Infrastructure for Heritage Science) project, promoted by the Italian National Research Council (CNR), which sees in the LABEC laboratory of INFN, in Florence, one of its pillars. Among the "Landmarks", the latest Roadmap lists the profitable upgrading of large projects in which the INFN participates significantly. Among these, there are the Cherenkov Telescope Array (CTA), the High-Luminosity LHC (HL-LHC), the Facility for Antiproton and Ion Research (FAIR) and SPIRAL2 (Système de Production d'Ions Radioactifs en Ligne de 2^{e} génération).

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In addition, numerous landmarks of the ESFRI Roadmap 2018 are the result of the common strategy of INFN with CNR and Elettra Sincrotrone Trieste, which define the programs for the construction of accelerator machines and their exploitation by users: the output of this process is the partecipation of Italy in different European projects, such as the XFEL (EU XFEL), the European Spallation Source Facility Extremely Brillian Source (ESS EBS), the Extremely Light Infrastructure (ELI), the European Synchrotron Radiation Facility (ESRF) and the SESAME accelerator, in Jordan. Among the projects not yet included in the ESFRI Roadmap, on which Europe is focusing and that see the INFN in the front row, the EUPRAXIA (Compact European plasma accelerator with superior beam quality) project and the Einstein Telescope (ET) project, for the construction of a large third generation underground interferometer.
Fundamental for drafting the ESFRI Roadmap is a clear picture including societal challenges, the state of the art of research and its projection in the future, the sustainability of projects and their impact on Europe in terms of innovation, knowledge development and investment in incubators for pan-European and global research infrastructures. To pursue this goal, specific working groups have been set up with the task of developing a series of key performance indicators to address the most common objectives of pan-European research infrastructures.
We've asked to José Luis Martínez PEÑA, Research Professor at Instituto de Ciencia de Materiales de Madrid (CSIC) and Chair of the ESFRI Physical Sciences and Engineering Working Group to outline the next steps in the ESFRI Roadmap preparation.

The Physical Sciences and Engineering Strategy Working Group that you lead is one of the six ESFRI Working Groups, besides Energy, Health and Food, Environment, Social and Cultural Innovation, Data, Computing and Digital Research infrastructures. These are research domains that play a relevant role in facing grand societal challenges and give fundamentals to the whole ESFRI strategy building process. How will it be possible to manage the balance among such different themes to enhance a proficient and coherent strategy?

Actually, the organization of ESFRI in six Strategy Working Groups (SWG) is a practical approach, in order to perform the evaluation of the new proposals and the landscape analysis. However, ESFRI is a non-budget Forum and for this reason, as we work without money, we don't need to guarantee "a balance" among the six SWGs. On the other hand, our work is performed after the different proposals are presented by the European researchers. In this sense, at the beginning of ESFRI many requests came from Physical Sciences and Engineering (PSE) SWG, while in recent years the demand is much stronger in Health and Food or Environment.

Nevertheless, the challenge is the development of a coherent strategy in order to face the Societal

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challenges, which are usually multidisciplinary or at the interface among the different areas in the classical thematic organization. For that purpose, in the last ESFRI RoadMap, in 2018, we launched a new section about the interconnections between the ESFRI Research Infrastructures (RI) and the scientific domains, also relating to the way the different RIs are contributing – and they will do it much more in the future - to the various technical and scientific domains.

What are the specific objectives set for this and for the other working groups, in terms of guidelines or recommendations?

All the information, objectives, guidelines and recommendations are public and available on the *ESFRI website*. The main principle of ESFRI is to work in this process of the Roadmap of RI under a transparent, equal opportunities and non-bias approach.

The main principle is to select the cutting edge RI that will reinforce the position of excellence in Europe, by a pan-european added value of the proposals and the progress of the knowledge, in order to contribute to the Excellence Pilar of the Horizon Europe 2020 and, consequently, to the new challenges of Europe.

Can you envisage possible multi-lateral agreements between research infrastructures working in different research domains? What is the best way to optimize efforts and investments by enhancing collaboration and following common or interconnected objectives?

Actually, a clear movement is under way between different RIs in PSE-SWG. And, for the moment, referring to the last two years, this happens between different RIs inside a similar area. As an example, I'd like reporting about the recent effort made by different synchrotrons in Europe to create the League of European Accelerator based Photon Sources (LEAPS), in order to coordinate the technical and development work made by the different members, to enhance the collaboration among them and with the EU, in order to better contribute to the main challenges of the EU (New Green Deal, batteries, ...). In a similar way, the European Neutron Facilities created the LENS (League European Neutron Sources), having similar goals and a similar approach. To simplify, there are two added values in these initiatives: from one side, the optimization of the investments made by the different RIs, which could achieve better results by focusing on synergy and complementarity; from the other side, the possibility to deal with societal challenges and achieve better results faster and using a multidisciplinary and coherent approach. Probably, the next step will be the collaboration between both entities (LENS and LEAPS), in order to bring this Societal Challenges to a further result in the cutting edge of knowledge and technique.

A similar approach is also present in different domains of PSE, for example in Nuclear Physics, a field that operates in Europe under the umbrella of NuPECC, or in the area of High Energy Physics, which is pushed

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forward by the know-how developed at CERN.
It is clear that the main development and progress in the near future, in relation to the Challenges of the Society, will come from this interdisciplinary approach among scientific domains and the collaboration of different excellent RIs. The definition of clear and achievable objectives - as for instance a new type of battery for the energy storage, based on raw material available, with the possibility to be recycled - will be a step forward in the achievement of a better collaboration among RI and a substantial progress to solve the Societal needs.

In your opinion, how can cutting-edge research in Physics contribute in implementing research infrastructures that can be useful to face great societal challenges, stimulate innovation and advanced technologies development in Europe?
I think that this question is very much related to the previous one. Probably the best approach to contribute to the societal challenges inside the RIs will come from the collaboration and the implementation of an objective approach. Nevertheless, the first step (sine-qua-non condition) is providing that the RIs are constantly at the cutting edge of the technical and scientific knowledge. This means that the European RIs should be under a constant upgrade and improvement approach in order to keep a leadership in the technical and scientific domain.
Finally, the RIs are mostly a knowledge "HUB", not simply a Research Infrastructure. Usually, around the knowledge HUBs there is a development of industry, academia and research, that gives a strong contribution to the development of the geographic region where the HUB is located, also enhancing the progress of knowledge and of societal challenges.
At this point, the question could be how many of these HUBs are necessary? And how should they be distributed around Europe?

How does Particle Physics fit in the context of research infrastructures in physics or engineering? What indicators can represent the strengths and weaknesses of infrastructures for fundamental research born to solve quests such as, for example, the nature of dark matter or that of neutrinos?
Particle Physics is a "classical" area for RIs in Europe. The history of the Particle Physics RIs in Europe is one of the best examples of how collaboration improves the quality and brings the knowledge to excellence.
Regarding the indicators and monitoring of RI, I would like to mention that this issue is extremely important and ESFRI recently created a working group on this topic, that has recently finished the work and presented a report that, after being accepted by the ESFRI FORUM, has been made available on the *ESFRI website*.
In relation to that, the concept of the long-term sustainability of the RIs is also important. ESFRI also raised

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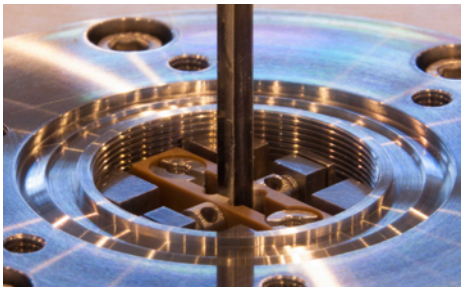
this topic through a specific working group, to offer a complementary approach to the monitoring. Results were also published on the *ESFRI website*. In particular, talking about Infrastructures in the area of dark matter or neutrinos research, probably these topics are very suited to a highly complementary approach with different techniques and different approach, and probably with a "Global Approach, in the OECD terminology", not only at the European scale.■

SPACE

FIRST OBSERVATIONS OF THE MINI-EUSO SPACE EXPERIMENT, ACTIVATED BY THE ESA ASTRONAUT LUCA PARMITANO

The Mini-EUSO space experiment, an ultraviolet telescope launched in August 2019 and activated aboard the International Space Station by the ESA astronaut Luca Parmitano at the beginning of October, has collected its first data. Among them, the observation of several ELVES, (Emission of Light and Very low-frequency perturbations due to Electromagnetic pulse Sources) stands out. ELVES are a class of ring-shaped lightning strikes produced in the high atmosphere, due to a thunderstorm discharge at an altitude of approximately 20 km. In addition to the large size, the event is extremely fast and lasts less than a millisecond: the various rings produced can be generated almost at the same time and give rise to an expansion up to several hundred kilometres, which, only apparently, occurs at a speed higher than the speed of light. Mini-EUSO managed to observe various ELVES, measuring their expansion with a resolution of 6 km. From the detailed study of their characteristics, scientists hope to shed light on the phenomena that produce these elusive events.
In addition to the observation of ELVES, Mini-EUSO has observed dozens of meteorites, searching for the presence of interstellar objects among them, and is making the first night-time map of the Earth in ultraviolet, studying both anthropogenic and bioluminescence emissions. The device is also looking for signs of very high energy cosmic rays, particles whose exact origin is still debated and which are presumed to come from other galaxies.
Mini-EUSO is an ultraviolet telescope developed by an international collaboration led by INFN and the Physics Department of the University of Rome Tor Vergata. The collaboration involves various INFN divisions as well as other national and international institutions. The experiment is one of six selected by the Italian Space Agency for the Beyond mission of the European Space Agency onboard the International Space Station. ■



RESEARCH

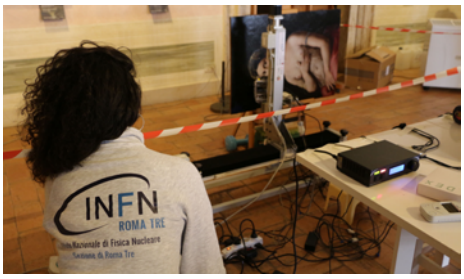
NEW TECHNIQUE PAVES THE WAY TO A FUTURE MUON ACCELERATOR

The MICE (Muon Ionization Cooling Experiment) international collaboration has published a study in Nature in which it announced that it has for the first time studied a crucial process for the construction of future muon accelerators called "muon cooling by ionisation". The result was obtained at the Rutherford Appleton Laboratory (RAL, UK), by the MICE experiment, in which Italy is participating with the INFN divisions of Milan Bicocca, Naples, Pavia, Rome Tre and in the initial phase Genoa and Trieste. The MICE experiment has shown that it is possible to use a completely new technique to transform a disordered ("hot") muon beam into an ordered ("cold") one, and therefore less "voluminous": a technique useful for implementing a very compact particle accelerator (muon collider), for fundamental research at high energies with the use of conventional accelerators. The Italian contribution consisted of the initial design of the superconducting solenoid magnets for the muon trackers, construction of the sophisticated detectors needed to identify the muons used in the experiment and subsequent data analysis. The experiment is extremely interdisciplinary and involves experts in the fields of detectors, accelerators, computer science and cryogenics in a broad international context. The researchers of the MICE collaboration hope that this new technique can help to produce good quality muon beams for other applications, such as the study of the atomic structure of materials, the use of muons as catalysts for nuclear fusion and for the investigation of very dense materials that cannot be explored with X-rays. ■

APPLIED RESEARCH

PERSONALISED ONCOLOGY: ALLIANCE AGAINST CANCER AND CNAF AGREEMENT

An agreement of the highest scientific value aimed at a first, significant completion of the National Personalised Oncology Programme, has been signed between the Alliance Against Cancer (AAC) and CNAF, the National Institute for Nuclear Physics Centre for research and development in the field of information technology applied to nuclear physics and high energy experiments. The partnership represents an important step forward for implementation of perhaps the most futuristic and visionary AAC project among those announced by the Minister of Health, Roberto Speranza: creating a national database in which clinical data and information from the "omics analyses" of patients treated in Research Hospitalization and Treatment Institutes (IRCCS) that are members of AAC (26 research hospitals) will be centralised. The aim, in the future, is to make it accessible to all the National Health System facilities. CNAF, one of the leading public players in the sector, will make its technology available to host AAC's data acquisition IT platform, which will allow information to be analysed faster and in a more complex manner than in the past, allowing doctors to identify the best treatment for each patient. CNAF will provide AAC with a state-of-the-art cloud infrastructure based on technologies that can manage and share big data in healthcare simply and effectively according to current legislation. A service that will be supported by a consultancy activity specialised in the management and security of the software. For this task, CNAF works with the Politecnico di Milano, which plays an integral part in the design of the IT platform. ■



SOCIETY

INFN CELABRATES THE 2020 INTERNATIONAL DAY OF WOMEN AND GIRLS IN SCIENCE

On 11 February, INFN took part in the International Day of Women and Girls in Science, established in 2015 by the United Nations General Assembly to promote the full and equal participation of women and girls in science, education, training, employment, and decision-making processes. INFN participated in the day with numerous initiatives, including seminars, meetings with students and contributions to international events.
In particular, the National Laboratories of Legnaro and Frascati, the INFN divisions of Rome La Sapienza and Tor Vergata and the Gran Sasso Science Institute, with the University of L'Aquila and the INFN Gran Sasso National Laboratories, organised cycles of seminars and meetings between female researchers and students, male students and teachers. INFN participated in the "Women of CTA" event, organised by the Cherenkov Telescope Array Observatory (CTAO) in Bologna, while in Cagliari, Cosenza and Rome an advance session, dedicated exclusively to girls, of the international particle physics Masterclasses was organised, coordinated in Italy by INFN and organised by the International Particle Physics Outreach Group (IPPOG). Finally, INFN social media channels joined the #WomenInScience campaign, in which other international research centres, including CERN, also participated. ■

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PIGNOLETTO – ADVANCED SYSTEMS TO MAP THE SOIL AND THE ENVIRONMENT

Develop soil and environment precision analysis systems to be installed on remotely piloted devices such as drones or satellites to monitor and study the land with the innovative approach of precision agriculture: this is the central idea of the Pignoletto project, which aims to create a technological hub in Lombardy integrating the skills of the aerospace and agri-food sectors, stimulating and enhancing synergies between the scientific and industrial stakeholders present in the Region. The project is supported by a consortium consisting of INAF, INFN and Milan Bicocca University (departments of Biotechnology and Biosciences, Environmental and Earth Sciences, Systems and Communication Information Technology and Physics) for the research world and six Lombard companies for the industrial sector: Antares, Else Nuclear, Fem2 Ambiente, Aermatica 3D Blu Electronic and Redcat Devices.

The project, selected from the 33 winners of the "Research and Innovation Hub" call launched by the Lombardy Region, aims to implement a multi-scale system for the analysis of soil and environment characteristics, based on the combination of traditional geophysical field measurements with measurements obtained from airborne sensors (i.e. gamma-type ionizing radiation, optical hyperspectral and thermal multispectral sensors), satellite information (PRISMA and Copernicus) and proximity surveys. The project is focussed on a specific area and aims to respond concretely to a series of socio-economic and environmental needs of the Po Valley and, in particular, to the needs of agriculture, a sector constantly looking for innovative solutions to ensure production standards and product quality.

Pignoletto falls within the context of precision agriculture and aims to develop a soil and agroecosystem management system capable of measuring the intensity of human action according to specific needs. Achieving this objective requires a profound and precise knowledge of the soil and its spatial and temporal variables, through detailed survey and monitoring methods and efficient data analysis and interpretation systems.

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Pignoletto is a project that is both highly multidisciplinary and territorial. Indeed, it requires the integration of skills ranging from the development of avionic and satellite systems to the physics of particle detectors and new materials, from the study of innovative strategies in the agricultural and environmental fields to the development of sophisticated computational technologies for the processing, analysis, and interpretation of Big Data and the management of remotely-driven vehicle fleets. The proposed HUB will make it possible to acquire this knowledge and also to respond to other needs, such as the sustainability of forestry systems, the planning of compensatory measures and, more generally, it will support the technological renewal of Lombard companies following Industry Plan 4.0. ■

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