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Mexican High Energy Physics Network

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Abstract. The Mexican High Energy Physics Network is one of CONACYT's thematic research networks, created with the aim of increasing the communication and cooperation of the scientific and technology communities of Mexico in strategic areas. In this report we review the evolution, challenges, achievements and opportunities faced by the network.

1. Historical overview

The Mexican community of high energy physics (HEP) originated from several efforts done by different institutions. Some of its first members came from the nuclear physics group at the Physics Institute of UNAM, who eventually moved to higher energies. Others came from the recruitment of foreign researchers in the field by the Department of Physics of CINVESTAV, like Jean Pestieau and Jerzi Plebański. Although not all of them settled permanently in Mexico, they trained some students who after pursuing a Ph.D. abroad, returned to our country consolidating the initial group. Other pioneers in the field were trained abroad in processes not related to the above institutions and, when they returned to Mexico, joined one of the emerging groups in the early 70's. We can say with certainty that, by the end of that decade, there were small but stable groups in both of the aforementioned institutions. Later on, some of their members migrated to other institutions in Mexico City (UAM) or to state universities (BUAP, Univ. of Guanajuato, UMSNH, UASLP), leading the formation of new groups.

In the early 80's systematic process for training of human resources in HEP started with the first editions of the Mexican School of Particles and Fields (MSPF) and the Mexican Workshop of Particles and Fields (MWPF). The foundation of the Division of Particles and Fields of the Mexican Physical Society (DPyC-SMF) in 1984 made possible to work in a coherent and institutional environment towards to the consolidation of the Mexican HEP community. At a later stage, researchers working in more formal aspects of the field, along with those focused on understanding the nature of the gravitational interaction, founded the Division of Gravitation and Mathematical Physics (DGFM-SMF). In an effort to promote the scientific cooperation in the region, in November 1996, the DPyC organized the first edition of the Latin American Symposium on High Energy Physics (SILAFEA). Since then, this symposium has been held without interruption every two years, in different Latin American countries, and has become one of the most important and traditional events on HEP in the region.

In the 70's the interest of the HEP Mexican community focused on theoretical aspects, but in the late 80's the formation of experimental groups begun. Presently, particle physics is a mature discipline in our country, with researchers distributed among the most important Mexican



universities and research centers. Currently, there are about 130 active researchers doing work in understanding the various phenomena related to elementary particles, approximately one third of which are experimental physicists. To them we must add roughly the same number of graduate students, astrophysicists and scientists from other disciplines with an interest in high-energy physics phenomena. The experimental component has been growing up steadily over the past 25 years. Its activity evolved from data analysis to the design and construction of parts of the detectors used in huge experiments (Pierre Auger Observatory, ALICE, CMS) and, more recently, to science and technology of particle accelerators and the development of new detection systems. Today, several frontier experiments in high energy physics and astrophysics around the world have a significant participation of Mexican research groups. Meanwhile, those engaged in theoretical research have been gaining greater international recognition for their work on phenomenological data analysis, model building for physics beyond the Standard Model or non-perturbative aspects of QCD.

Although the HEP community participates actively in the regular meetings organized by the DPyC-SMF, in general terms, its progress has been more a consequence of the efforts of individuals or small groups with specific interests than the result of a systematic planning of the community at the national level. The most important attempt undertaken in this regard has been done within the HEP Thematic Network, known as Red FAE for its Spanish acronym.

2. Mexican High Energy Physics Network

On August 31, 2006, the National Council of Science and Technology (CONACYT) of Mexico, issued a Call for Proposals for the realization of mega projects, with the aim of identifying projects with the potential to strengthen the search of new knowledge focused towards the solution of national problems and to promote the development of basic and applied research. After the evaluation process, 79 proposal passed to a second round and received some support. These proposals, and some others brought subsequently to the consideration of CONACYT, were integrated, in September 2007, within a set of 14 strategic thematic lines, named CONACYT's Thematic Research Networks (RTIC), with the purpose of providing high impact solutions for the country's development and the welfare of its population. This idea was conceived by Dr. José Antonio de la Peña, who at that time was Director for Scientific Development of CONACYT. One of the thematic lines corresponds to the HEP Network and brought six of the approved mega projects together:

- (i) HAWC, Mexico observatory of gamma rays.
- (ii) National network of air showers detectors.
- (iii) Mexican multidisciplinary underground laboratory.
- (iv) Development of particle accelerators. Synchrotron light source.
- (v) Implementation of an advanced light source (UV-VIS-IR-UVV) based on short-pulse lasers.
- (vi) Sensors for detecting IR radiation.

After a year of discussions and work with participation of representatives of various mega projects, in September 2008, the Technical and Administrative Committee of the Institutional Fund approved the Guidelines for the Formation and Consolidation of the RTIC. This marks the beginning of the HEP Network, whose Technical and Academic Committee (CTA) dedicated itself to the task of elaborating the first general working-plan. By then, the Thematic Networks Directorate (DRT) was created by CONACYT, being its first director Dr. Tomás Viveros García.

The activities of the thematic networks started in February 2009 with the First Congress of CONACYT's Thematic Networks, organized by the DRT, in the city of Querétaro. The First National Congress of the HEP Network took place shortly after, from 4 to 7 March 2009, in the city of Taxco, Guerrero. In this meeting, the basis for operation were established and a number

of specific objectives were identified. Despite the long time required to launch the networks, during the congress it became evident the great interest in the new program. In the Call for Integration of RTCI 2009-01, issued by the DRT, on August 10, 2009, 156 researchers joined the HEP Network. The formal integration agreement was signed in February 2010 and the first resources were provided in May 2010. During 2011 the DRT launched a Call for Adherence to Thematic Networks and 68 new members joined the HEP Network, which by December 2010 had a total of 224 members, including scientists, postdocs and graduate students of 25 higher education institutions, distributed over 16 states of the Mexican Republic. Such numbers have suffered some variation and presently the network consists of 171 researchers from 22 institutions and a similar number of graduate students. Network coordination has always been in charge of the representative of the CTA, a responsibility that during the first stage was taken over by Juan Carlos D'Olivo (ICN-UNAM). Subsequently, the coordinators were Heriberto Castilla (CINVESTAV-IPN), from 2012 to 2014, and Mauro Napsuciale (Univ. of Guanajuato), from 2014 to 2016. At present, the representative of the CTA is Eduard de la Cruz Burelo (CINVESTAV-IPN).

The beginnings of the HEP Network led by Juan Carlos D'Olivo were promising and opened new opportunities, despite the vicissitudes of the networks program within CONACYT. To a greater or lesser extent, during this period there were achievements or progress in the various initial goals, both in supporting the activities of experimental and theoretical groups as well as in the planning of the development of the country in HEP. The support provided for mobility and organization of events opened new possibilities for group collaborations both at the national and international level. A large number of meetings, conferences, and other academic events in Mexico and abroad were sponsored by the HEP Network, several of which could not have been done without its support. Also, while most of the projects were already going on before the foundation of the network, they were benefited not only by the financial aid provided, including equipment, but also by the support received when negotiating funds for the international collaborations. Network membership facilitated the communication between the national leaders of such projects and the funding agencies, mainly CONACyT.

By its very genesis, the thematic lines of the network had considerable dispersion and, seeking a greater cohesion, three general lines were defined: i) Physics with accelerators and accelerator physics, ii) Detectors Physics, and iii) Astroparticle Physics. A team was integrated for each of these lines with the task of preparing a diagnostic of the situation in Mexico and making proposals for its development in the short, medium and long term. At the same time, taking into account the importance assigned to the popularization of science, a fourth team addressed this topic. By the end of 2012 the four teams produced documents containing information relevant to an assessment of the "state of the art" and the challenges and opportunities for Mexico in HEP. In addition, a catalogue of infrastructure was completed and, thanks to a collaboration with the Thematic Network on Complexity Science and Society, a Catalog of Human Resources was elaborated.

The successive editions of the National Congresses of the network made evident the interest generated within the HEP community. The second one was held in the city of Tlaxcala, from 20 to 22 January 2011, with a larger audience than the first edition. During this meeting, there were intense and open discussions about the direction of the network, its priorities and badge projects, the future of the discipline in Mexico and other issues of great importance. An important conclusion of this and other similar exercises is that the community of high energy and its network are able and willing to face great challenges and pursue ambitious undertakings, provided they are the result of agreements and consensus within the community.

The second period of the HEP Network led by Heriberto Castilla coincided with changes in the management of CONACyT. Initially, the new administrators do not attach great importance to the program of thematic networks and, accordingly, considerably reduced the budget allocated

to this. Despite the adverse situation, the experimental groups working in international collaborations were supported by the HEP Network, as well as some initiatives of the theoretical groups and popularization of science. The scarce money available caused a lack of interest of most of the members not directly involved in HEP. The situation fortunately improved by the end of 2013, and from 23 to 28 January 2014, the HEP Network organized in the city of Guanajuato two academic events of great importance: The Third National Congress and the Thematic Workshop “Particle Physics and Astrophysics: Challenges and Opportunities in Mexico and Latin America”, the later with the sponsorship of CONACyT and the Ministry of Public Education (SEP). These meetings had particular relevance, since it represented the re-launching of the activities of the network. During the course of them, the achieved goals were examined and future lines of action were discussed. It is worth noting that the main purposes that motivated the realization of the thematic workshop were the integration to the network of Mexican colleagues living abroad, and the seeking for the establishment of links with networks and similar organizations in Mexico and other countries in the region, a still pending issue.

Something worthy to remark is that, up to this point, the HEP network was an entity legally belonging to CONACyT and the administration of the networks was done by the DRT, which eventually caused some difficulties. Under this situation, CONACyT decided to change the administration scheme and switched to conventional group projects for thematic networks, managed by the higher education institutions appointed for this purpose. It was at this point that the original and promising idea that the networks could serve as thematic advisory entities for the administration of national science by CONACyT was lost.

During the third period led by Mauro Napsuciale an inclusive and horizontal exercise of planning was done. Although formally the CTA included only a few members, in practice a wider advisory committee (working group) was formed including members of all experimental groups and representatives of the most active theoretical groups in different topics. In an initial meeting at León Guanajuato on August 2, 2014, the working group conceived a route for an intensive planning exercise changing the focus to the by then conventional frontiers (energy, intensity and cosmos) but including new categories necessary for the Mexican community (conceptual, outreach and education and innovation and technological development). The documents generated during the 2010-2012 period served as background for this intensive planning exercise realized from August to December 2014. An important outcome of this exercise was the formulation of a National Plan for Research in High Energy Physics (PNIFAE), whose content was validated in the Third General Meeting of the HEP Network, held in the city of Manzanillo, Colima, on December 6-7 of 2014. In addition to this important exercise, the working group for every frontier realized topical meetings across the country and all the participating experimental groups received support for their international collaborations. Along the conclusions of the PNIFAE, the 2015 project was organized about working groups that maintained their activity according to their own dynamics and were responsible for applying the funds granted by the project. The Fourth General Meeting of the HEP Network was held in the city of Guanajuato at the beginning of December 2015.

The Mexican community of high energy physics has increased substantially and diversified its activity over the last twenty years, taking increasing responsibility in the international collaborations and generating the critical mass to undertake and lead national projects in the area, in particular the design and operation of a High Energy National Laboratory. The economic importance of promoting high energy projects in our country has been highlighted and the HEP Network is the natural space for their discussion and conceptualization. In this concern, it is important to remark that the academic interest of the HEP Network is focused on research in theoretical or experimental physics of elementary particles and gravitation and their ultimate goal is to understand the structure of nature at the microscopic level, the forces driving this structure and the implications for the macrocosm. Therefore, it is oriented to basic science. However, it is

well known that research at the frontier of knowledge generates cutting edge technology developed for scientific purposes only, but which eventually produces social benefits. In order to explore the phenomena of micro and macrocosm a variety of prototype designs are developed in universities research laboratories, whose massive production is granted to industry usually requiring it to improve existing production processes and generating new opportunities related to the new technologies developed for the industrial production of such prototypes. Another important feature of the activity of the HEP community is an intensive international cooperation. Groups of researchers, technicians, engineers and students in the network take part in multinational collaborations doing work for large laboratories and observatories, such as CERN, Fermilab, Riken, Observatory Pierre Auger and SNOLAB, which carry out high-energy experiments using particles either produced in astrophysical phenomena or produced in colliders.

In the PNIFAE an inventory of the various experimental and theoretical contributions of the HEP Mexican community is done, a review of the state of art of the different frontiers is carried on and the possibilities for technological development projects related to the activities of this community are highlighted. Also the challenges in outreach, education, spin off and cutting edge technologies are unfolded. As a result of this diagnosis we have identified numerous areas of opportunity for the work of the network, in the short, medium and long term. In addition to the recommendations for the frontiers related to their specific problems, the document contains recommendations transverse to the community which are the points of basic agreement for the future work of the HEP community in Mexico. These recommendations were divided into three categories to consider the following aspects of the activities of the HEP Network: i) Strengthening, consolidation and integration of the HEP community; ii) Promoting international leadership of the HEP Mexican groups; iii) Improving the social impact of the Mexican HEP Network. In addition to the HEP community, these recommendations have the potential to target all sectors of the public administration related to the development of science, technology and innovation in Mexico. These include the head of the sector, CONACyT, their state counterparts, the State Councils of Science and Technology, the legislative entities of the federal order, the Congress and the House of Representatives, and state and municipal, local Congress and Councils.

The implementation of the program of Thematic Networks has been a process not without difficulties, especially when it is an innovative idea on how to do science and to boost technological development in Mexico. For a couple of years, after the Dr. de la Peña era in CONACyT, the continuity of the networks was seriously questioned, which was accompanied by a cut in both the amount and the type of the support provided. However, the program's success, as evidenced by the progress achieved and the high adhesion of the scientific community, prevented its cancellation. In this process, the HEP Network has gained presence as a meeting place that fosters the planning and execution of joint activities. Today, the HEP Network is a must in high energy physics and related disciplines in Mexico. However, there are pending issues that need to be addressed by the present leadership, such as:

- To consolidate and institutionalize the network, giving clear operational rules that are known to all its members and which are contained in an Operations Manual.
- To improve and facilitate the administrative management of the network so that resources flow faster.
- Transcend the role of small funding agency and become a true cooperative venture.
- To establish priorities of the network and its badge projects and to work out plans to translate them into short, medium and long term goals.
- To become an essential partner in the definition of national scientific policies related to high energy physics.

This should be accompanied by a change of attitude concerning the role of huge scientific projects in Mexico, not only by the members of the network, but also by CONACyT itself. The

challenge is great, but so are the benefits.

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