Plan Acción - IGFAE

2017 - 2021

Presentamos, para avaliación do Equipo de Dirección da Universidade de Santiago de Compostela, o Plan de Acción do *Instituto Galego de Física de Altas Enerxías (IGFAE)*. Este Plan de Acción está baseado no Plan Estratéxico que o IGFAE foi desenvolvendo nos últimos dous anos. Este plan estratéxico foi presentado ao Ministerio de Innovación nas últimas dúas convocatorias de Centros de Excelencia María de Maetzu. Por ser unha versión dun documento existente, e para permitir a avaliación por parte de investigadores internacionais, o documento preséntase en inglés.

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Part 1

Description and recent activity of IGFAE

The Galician Institute for High-Energy Physics (Instituto Galego de Física de Altas Enerxías IGFAE) is a joint research center of University of Santiago de Compostela and Xunta de Galicia (the Galician Autonomous Government). It was officially created on July 2, 1999. Its main goal is to coordinate and to foster the scientific and technical research in the field of High-Energy Physics, Particle and Nuclear Physics and related areas: Astrophysics, Medical Physics, Instrumentation, etc. The planning and promotion of relations with large experimental facilities are of particular importance, especially with CERN, GSI/FAIR and the Pierre Auger Observatory.

The experimental groups at IGFAE coordinate the Spanish participation in the LHCb and ALICE Collaborations at CERN, the Spanish participation in the Pierre Auger Observatory, as well as the Spanish participation in the GSI/FAIR nuclear facility. Members of the group have a relevant participation in the LHCb upgrade planning, in the LHeC project development and planning, etc. In the last couple of years, a new line has also been launched with the building of a new facility (LaserPet) at University of Santiago de Compostela aiming to produce radioisotopes for medical use by a laser-induced plasma accelerator. Moreover, the theory section of the Institute holds an excellent international reputation, with participation in different international committees, invitations to plenary talks, large-impact publications, etc. One of its members, Carlos Pajares, was the Spanish delegate in the CERN Council between 2008-2012. He is also Doctor Honoris Causa by U. Saint Petersbourg (Russia) and U. Técnica de Lisboa (Portugal).

The IGFAE holds two European Research Council Starting Grants: “Hot and dense QCD in the LHC era” (HotLHC) (Consolidator stream in the 2010 call) by Carlos A. Salgado; “Challenging the Standard Model using an extended Physics program in LHCb” (BSMFLEET) (2014 call) by Diego Martinez Santos. Diego Martinez Santos has also received the Young Experimental Physicist Prize of the EPS High-Energy Physics division in 2013 for his outstanding contributions to the trigger and commissioning of the LHCb experiment, and the analyses leading to first evidence for the rare decay B0s->mu+mu-. This result, whose leading authors are members of IGFAE, was highlighted by CERN Director General as the second result in relevance after the discovery of the Higgs boson in the LHC Run 1. A common analysis of the corresponding LHCb and CMS results was published in Nature. It is worth mentioning this is the only institute in Spain with two Starting Grants in Particle Physics – and the third in number of Starting Grants in total for the panel PE2 (20 out of 156 institutes in Europe). This indicates, in particular, a good record in the education and hiring of young people in the last years, which is expected to continue in the future and will ensure the highest standards of quality for the scientific staff of IGFAE.

A. Organization

The scientific research of the Institute is organized into three Strategic Research Areas (SA) that are the backbone for the strategic planning. Each of them constitutes a wide domain of research with several well established Research Lines (RL). While the SA are expected to suffer little adjustments in the future, the RL could be subject to more frequent changes following the strategy of the Institute. The structure is the following:

SA1 – THE STANDARD MODEL TO THE LIMITS

The Standard Model (SM) is our best construction of the microscopic reality at the most fundamental level. The degree of consistency with experiment is astonishingly good. Our Institute has played a fundamental role in this broad field of research. The plans for the future will be presented later. Here we list our current Research Lines:

RL1. Beyond the SM searches with LHCb (ERC/StG – Diego Martinez)

RL2. Hot and dense QCD in the LHC era and beyond (ERC/StG – Carlos Salgado)

RL3. String theory and relation with other fields

SA2 – COSMIC PARTICLES AND FUNDAMENTAL PHYSICS

Astroparticle Physics, as well as the connections between Particle Physics and Cosmology, are experiencing a new golden age. Our Institute has been one of the pioneers in the Pierre Auger Observatory, a giant air shower array in Argentina proposed by Nobel laureate Prof. Jim Cronin and by Prof. Alan Watson, both close collaborators of the Institute. The group is also initiating new lines in Dark Matter and neutrino astrophysics (NEXT experiment). The corresponding RLs are:

RL4. Extremely energetic cosmic rays and neutrinos – Large exposure experiments

RL5. Dark Matter and the nature of neutrinos – Low background experiments

SA3 – NUCLEAR PHYSICS FROM THE LAB TO IMPROVE PEOPLE'S HEALTH

The participation of IGFAE in new international facilities such as FAIR offers unprecedented opportunities to contribute to understanding the nature of the strong interaction in the non-perturbative regime, the structure of the nuclear many-body systems and their astrophysical implications. In parallel, the Laser Laboratory for Acceleration and Applications (L2A2) will foster IGFAE's contribution to the development of medical applications of this new technology. The main RLs are:

RL6. The structure of the nuclear many-body systems and its astrophysical and cosmological implications

RL7. Commissioning and exploitation of the Laser Laboratory for Accelerator and Applications

Structure and Groups

The Institute is structured into an Experimental Section with 14 senior (permanent or tenure-track) members and a Theory Section with 16 senior members. These senior members are divided into 5 groups.

Experimental Section

1.- Experimental Group of High-Energy Physics (GAES): Coordinator of the Spanish participation in LHCb. (ERC StG Diego Martínez Santos). It participates in RL1 (main), RL2 (measurements of LHCb in proton-lead collisions) and RL5 (NEXT experiment).

2.- The Nucleus and Particles Experimental Group (GENP): Coordinator of the Spanish participation in FAIR. It is also the leading group in the new local infrastructure (January 2016) for laser-induced plasma acceleration (LaserPET project - 5.5MEuros). It participates in RL6 and RL7, with connections to RL2 in terms of nuclear structure.

Theory Section

1.- Astroparticle Physics group: Spanish coordinator in the Pierre Auger Observatory. It participates in RL4 (main) and RL2, and it has connections to RL1 and SA3 in terms of instrumentation.

2.- Theory group: Mostly interested in String Theory, and its connections with Quantum Field Theories and other fields. It participates in RL3 (main) and RL2.

3.- The QCD Phenomenology group: One of the world-leaders in the theory and phenomenology of hot and dense QCD. It coordinates the Spanish participation in ALICE. (ERC StG Carlos A. Salgado). It participates in RL2 (main), RL1, RL3, RL4 and RL6.

Management and governance

According to IGFAE's Internal Regulations *(Regulamento de Reximе Interno*) the present governance is structured as follows:

Xunta de Goberno

Rector + two representatives of the USC

Three representatives of Xunta de Galicia (Autonomous Government)

Director and Secretary of the Institute

Scientific Council

Director + Secretary of the Institute

Three representatives of the Theory and three representatives of the Experimental Sections

A new Scientific Council of the Institute is in the process of being constituted. For this reason we do not list their names in here. It will be included in the web page of the Institute once the process is finalised.

Director and Secretary of the Institute

Director: Carlos A. Salgado

Secretary: Abraham Gallas Torreira

The Institute has also contacted internationally renowned scientist to take part on the International Advisory Committee. This is a new body in the structure of the Institute. The present members are:

- Sergio Bertolucci (U. Bologna) - CERN Director for Research 2009-2016
- Larry McLerran - Director, Institute for Nuclear Theory, Seattle
- Paolo Giubelino - Scientific Director, GSI, Darmstadt
- Francis Halzen - U. Wisconsin
- Fernando Quevedo - Director, ICTP, Trieste

B. Research team, infrastructures and scientific resources

The senior research staff of the IGFAE is mainly composed of university professors from the USC (with different categories, see below) with the exception of one Oportunius researcher, Diego Martinez Santos. (Oportunius is the program of the Autonomous Government of Galicia to attract and secure ERC researchers with internationally competitive conditions.) A large number of postdocs, selected through international competitive calls, and students, together with Ramon y Cajal, Marie Curie, Juan de la Cierva, etc. researchers, complete the research team. The actual breakdown of this research team is as follows (only Doctors listed):

	First Name	Family Name	
Theory Section			
Research Area A: Theoretical Physics	Nestor	Armesto Pérez	Prof. Tit
	José Daniel	Edelstein Glaubach	Prof. Tit
	Elena	González Ferreiro	Prof. Tit
	Javier	Mas Solé	Prof. Tit
	Carlos Miguel	Merino Gayoso	Prof. Tit
	José Luis	Miramontes Antas	Cat.
	Carlos Alberto	Salgado López	Prof. Tit
	Alfonso	Vázquez Ramallo	Cat.
	Christoph	Adam	P.C.D
	Carlos	Pajares Vales	Cat. Em
	José Manuel	Sánchez de Santos	P.C.D.
	Fabio	Domínguez	Marie Curie
	Douglas	Wertepny	Contratado
	Musso	Daniele	Contratado
Research Area B: Astroparticle Physics	Jaime	Álvarez Muñiz	Prof. Tit
	Gonzalo	Parente Bermúdez	Prof. Tit
	Ricardo Antonio	Vázquez López	Prof. Tit
	Enrique	Zas Arregui	Cat.
	Inés	Valiño Rielo	Contratado

Experimental section

Research Area C: Experimental Particle Physics	Bernardo	Adeva Andany	Cat.
	José Angel	Hernando Morata	Prof. Tit
	Máximo Tomás	Pló Casasús	Cat.
	Juan José	Saborido Silva	Prof. Tit
	Abraham Antonio	Gallas Torreira	P.C.D
	Cibrán	Santamarina Ríos	P.C.D.
	Diego	Martínez Santos	Oportunius
	Pablo	Vázquez Regueiro	P.C.D
	Veronika	Chobanova	Contratado
	Xabier	Cid Vidal	JdCierva
	Martino	Borsato	Contratado
	Antonio	Romero Vidal	I2C Xunta
	Jessica	Prisciandaro	Contratado
	Carlos	Vázquez Sierra	Contratado
Research Area D: Nuclear Physics	Héctor	Álvarez Pol	Prof. Tit
	José	Benlliure Anaya	Cat.
	Dolores	Cortina Gil	Prof. Tit
	Ignacio	Durán Escribano	Cat.
	Juan Antonio	Garzón Heydt	Prof. Tit
	Beatriz	Fernández Domínguez	P.C.D
	Manuel	Caamaño Fresco	RyC
	Diego	González Díaz	RyC
	Pablo	Cabanelas Eiras	Contratado

Local Infrastructures

According to the present IGFAE's Internal Regulations *(Regulamento de Rexime Interno*) the Institute may have its own premises[1]; funds from the general budget of the University; and administration and service staff (Transitional provision 1); however before this happens (Transitional provision 2) the Institute will be located in the Department of Particle Physics (hence the Faculty of Physics). This situation has been unchanged since the foundation of the Institute, so, at present, the local workspace infrastructures are those assigned to the groups by the Faculty of Physics and the Institute has no control over them. Also, the administrative staff, essential for the management of an annual budget of ~3MEuros, is paid by the group's own funds, as no sizable budget is assigned to the IGFAE as a whole.

In terms of workspace, the IGFAE has been relocated in the last years into the blocks IV and V of the Faculty of Physics - those in the building *Monte da Condesa.* These two blocks contain basically all office and laboratory workspace with the exception of the LaserPet laboratory, which is placed in a new building with appropriate radiation safety measurements. This laboratory is located 400m away from the IGFAE main site.

Concerning computing capabilities, there is a computer center housing more than 1880 CPUs, half of them dedicated to the Worldwide LHC Computing Grid.

Access to national and international infrastructures

IGFAE has a long tradition of relations with international large-scale facilities, prominently with CERN, for the last 30 years. GAES has formerly participated in several CERN experiments: NA36, SMC and DIRAC, and the historical activity of GENP was developed in GSI in Germany, GANIL in France and CERN (nTOF, ISOLDE).

GAES (SA1): The Experimental High Energy Physics group has access to the European Laboratory for Particle Physics (CERN), particularly to the LHCb experiment. Besides, it has access to the Canfranc Underground Laboratory (LSC, Spain), for the Next experiment. Some of the research activities of the group require the use of singular scientific and technological infrastructures (ICTS), like the Centro Nacional de Microelectrónica (IMB-CNM-CSIC, Barcelona), or the Portuguese Research Reactor (RPI) at the Instituto Superior Técnico (IST, Lisbon). These large scale installations are complemented by the following local facilities: semiconductor detectors laboratory fully equipped for production, metrology and characterization of semiconductor silicon detectors (pixels, micro-strips); microelectronics laboratory dedicated to the assembly of printed circuit boards with SMD technology; electronics laboratory devoted to the design, simulation and testing of electronics for detector readout, high speed data transmission lines and trigger systems; and PVD Evaporation and Laser ablation facilities at the School of Optics.

[1] Referring basically to office and laboratory workspace

There is a Spanish LHCb distributed Tier2 center, located at USC (60% of the computing resources) and UB (40%), providing at present about 1800 processor cores.

GENP (SA3): The Nuclear Physics unit is strongly engaged in the construction of the new FAIR facility in Germany. The group has a local laboratory, devoted to the development of detectors for the different experiments, including inorganic crystals mounting and characterization and nuclear physics electronics.

In parallel, in order to balance fundamental and applied research and increase the transfer of the knowledge generated by the fundamental research activities, this unit has initiated several applied projects that required the construction of local facilities, as the L2A2 at USC and the use of Spanish ICTs such as the tandem accelerators at CNA (Sevilla) and CMAM (Madrid) or ICT (Lisbon). In 2013, GENP got granted a 5,3 MEUR project to build the Laser Laboratory for Acceleration and Applications (L2A2) equipped with a 50 TW laser. The first scientific project of this laboratory, named LaserPET, aims at developing the technologies required for medical isotope production with laser beams. This new and cheaper technology would allow installing radioisotope production units in almost any hospital, giving access to the use of short-lived emitters, which are well adapted for the diagnosis of Parkinson or several types of cancer.

Astroparticle Physics (SA2): The Astroparticle Physics group at IGFAE participated in the construction of the Pierre Auger Observatory, a collaborative effort between nearly 20 countries, which has produced a unique set of data. The Pierre Auger Observatory is by far the largest, most complete and most precise facility for ultra-high energy cosmic ray research. Built near Malargüe, Mendoza (Argentina), it is a unique infrastructure that combines many techniques for cosmic ray detection, namely: a particle detector array of 3000 km^2, 27 fluorescence telescopes, a large R&D antenna array for the measurement of cosmic-ray showers, several underground muon detectors, R&D prototypes of innovative Resistive Plate Counters, a sub-array with 750 m between station and a super-hexagon region in which there are detectors at each of the lattice positions.

C. Scientific production

The next table contains a snapshot of the scientific production in terms of publications from IGFAE in the last 5 years, including the main measurements of their impact.

	2012	2013	2014	2015	2016[2]	TOTAL
Total number of publications	157	198	189	144	109	797
Number of publications within the top 25% (1st Quartile)	136	157	159	114	82	648
Number of publications within the top 10%	111	116	123	79	57	486
Number of citations	4.287	4.832	2.439	1.317	368	13.243

The table was filled according to the following methodology: First, the publications of the permanent academic staff at IGFAE were retrieved in the SCOPUS web site using the corresponding author identifiers logically ored. Two additional requirements were imposed: that the affiliation was with "Universidade de Santiago de Compostela" and that the publication type was either a published article or review (thus excluding conference papers and other non-peer reviewed publications). The publications were then classified in their corresponding category and percentile, also using the SCOPUS database.

The breakdown of the scientific production per year and publication is contained in the following table. We also present as an Annex to this document the whole list of publications as an Excel file.

[2] The results of 2016 are only partial.

SCIENTIFIC PRODUCTION 2012-2016 IGFAE

YEAR	2016	2015	2014	2013	2012	**Total**	2015	2014	2013	2012
PUBLICATION							Quart.	Quart.	Quart.	Quart.
Journal Of High Energy Physics	23	40	36	39	26	**164**	1	1	1	1
Physics Letters Section B	21	23	22	29	33	**128**	1	1	1	1
Physical Review D	11	16	18	15	17	**77**	1	1	1	1
Physical Review C	13	16	19	15	14	**77**	1	1	1	1
Physical Review Letters	13	12	25	31	22	**103**	1	1	1	1
European Physical Journal C	7	8	9	11	11	**46**	2	1	1	1
European Physical Journal A	4	6	3	4	5	**22**	4	2	2	1
Nuclear Instruments And Methods In Physics Research Section A	2	5	5	8	6	**26**	2	2	2	2
Journal Of Instrumentation	3	3	3	12	5	**26**	2	2	2	2
Astrophysical Journal		2	2		1	**5**	1	1	1	1
Hyperfine Interactions		2			1	**3**	3	3	3	3
Nature Physics		2				**2**	1	1	1	1
Acta Physica Polonica B		1	1			**2**	3	3	3	3
Acta Physica Polonica B Proceedings Supplement		1				**1**	4	3	3	4
Astroparticle Physics	1	1	1	1	4	**8**	2	1	1	1
Communications In Mathematical Physics		1				**1**	1	1	1	1
International Journal Of Modern Physics A		1	1			**2**	2	2	3	2
International Journal Of Modern Physics D		1				**1**	2	2	2	2
Journal Of Cosmology And Astroparticle Physics	2	1	1	2	1	**7**	2	1	1	1

Journal Of Microelectromechanical Systems		1				**1**	1	1	1	1
Nature		1				**1**	1	1	1	1
Nuclear And Particle Physics Proceedings	3					**3**				
Annales Henri Poincare	1					**1**	2	1	2	2
Chinese Physics C	1					**1**	3	3	3	4
European Physical Journal Plus	1					**1**	3	3	2	3
Nuclear Instruments & Methods in Physics Research	1					**1**	2	2	2	2
Nuclear Physics A	1		7	13	2	**23**	2	2	2	2
Nuclear Physics B	1		2	6		**9**	1	1	1	1
Nuclear Data Sheets			21			**21**	2	1	1	1
Journal Of Physics G Nuclear And Particle Physics			4	1	1	**6**	2	2	1	2
Advances In High Energy Physics			1	1		**2**	2	2	1	1
Astrophysical Journal Letters			1	1	1	**3**	1	1	1	1
Atmospheric Research			1			**1**	1	1	1	2
General Relativity And Gravitation			1			**1**	2	2	2	1
Journal Of Physics A: Mathematical And Theoretical			1	1		**2**	1	2	1	1
Lecture Notes In Physics			1			**1**	3	2	3	4
New Journal Of Physics			1	1		**2**	1	1	1	1
Physics Of Atomic Nuclei			1		1	**2**	4	3	3	3
Progress Of Theoretical And Experimental Physics			1			**1**	2	2	NA	NA
Theoretical And Mathematical Physics				1		**1**	3	3	4	4
Journal Of Lightwave				1		**1**	1	1	1	1

Technology										
Journal Of Environmental Radioactivity				1		**1**	1	1	1	1
International Journal Of Modern Physics E				1		**1**	3	3	3	3
Few-Body-Systems				1	1	**2**	4	3	2	3
Classical And Quantum Gravity				1		**1**	1	1	1	1
Annals Of Nuclear Energy				1		**1**	1	2	2	1
Astrophysical Journal Supplement Series					1	**1**	1	1	1	1
Communications In Theoretical Physics					1	**1**	3	3	3	3
Nuclear Physics B Proceedings Supplements					1	**1**				
Physica Scripta					1	**1**	3	3	3	3
Fortschritte Der Physik					1	**1**	1	2	2	2

D. Fundraising

The resources of the Institute come basically from two categories. One provided by the University of Santiago, which is the beneficiary organization, and another dedicated to funding the actual research that comes mostly from competitive calls of public nature.

Resources from the Universidade de Santiago de Compostela

The staff cost of all the permanent members of the Institute, who have both teaching and research duties, is fully provided by the University, with the exception of the Oportunius researcher (Diego Martínez Santos) whose salary is paid by GAIN, the Galician Agency for Innovation. These positions were gradually filled since the late 1970s through highly competitive processes shared by the University system in Spain in different periods. This approximately amounts to 2.5 MEuros per year.

Research resources

The total research funds obtained by the Institute during the period 2012-2015 is 12.5 MEuros. A most remarkable fact is that more than half (61,40%) of these funds were obtained in competitive national, international and regional calls. Noticeably, the tough economical constraints during 2012-2015 have reduced to a minimum the contribution to research from the beneficiary organization.

Competitive national sources

(mainly Programa Nacional de Física de Partículas-FPA):

About 4.1 MEuros (33.10%) have been obtained through diverse national research and innovation programmes. An important fraction of this funding is related to the participation of the Institute in international collaborations at CERN, at the Pierre Auger Observatory in Argentina, and at GSI/FAIR in Germany. This number also includes the funds corresponding to 1 postdoctoral contract of the program Ramón y Cajal, 3 postdoctoral contracts of the program Juan de la Cierva, 14 predoctoral contracts of the national programs FPU (Formación de Profesorado Universitario) and FPI (Formación de Personal Investigador), and 1 contract of the national program PTA (Personal Técnico de Apoyo). The approximate breakdown of the full amount in years is as follows (in Euros): 500 thousand (2012), 700 thousand (2013), 900 thousand (2014) and 2 millions (2015). The funding profile reflects the timings of a few large grants obtained by different groups.

In addition, during the period 2012-2015 the Institute has participated in three projects of the Consolider-Ingenio 2010 program. The most important one is CPAN (2007-2015), which has coordinated the whole Spanish community of Particle, Astroparticle and Nuclear Physics with the objective of creating a National Institute. In CPAN, IGFAE was the third group in size out of 22, after IFIC (Severo Ochoa Center of Excellence) and

comparable to CIEMAT (Maria de Maetzu Unit of Excellence). The Institute has significantly participated in all the areas of research of CPAN, obtaining over one million Euros of the 10 millions allocated to the whole project in competitive internal calls. Members of the Institute have also participated in the Consolider projects CUP (2008) and MULTIDARK (2009).

Concerning the attraction of talent, and despite the current difficulties, a new Ramón y Cajal researcher (Diego González) from the 2016 call has joined IGFAE in February 2017.

Competitive European sources

(mainly European Commission and European Research Council):

The second largest source of competitive funding, 1.9 MEuros (15.1%), has been obtained from European programs. It must be highlighted here that two of our younger fellows have received Starting Grants of the ERC. One in 2011 awarded with 1.4 MEuros that is not included in the previous figures, although it has been running in the period 2012-2017, and another one in 2015 funded with 1.5 MEuros. Additional support has been obtained through networks (COST) and international exchange programs for researchers (IRSES Marie Curie actions), including EPLANET (2011-2016) for exchanges between Latin American countries and the EU, and two Marie Curie intra European fellowships (IEF), the most competitive European scheme for fellowships. The breakdown of the full amount in years is as follows (in Euros): 20 thousand (2012), 100 thousand (2013), 110 thousand (2014) and 1.7 million (2015).

Competitive Regional sources

The regional Government (Xunta de Galicia) has a competitive funding system with the aim of supporting the consolidation of the top quality groups, while favouring their coordination in order to increase their multidisciplinary character. All groups in IGFAE have been supported under this scheme since 2006. In addition, Xunta de Galicia also supports a project (AEFIS) whose objective is to boost the interdisciplinary research in different domains of Physics and to increase their degree of cohesion for planning common strategies toward focused goals (research, tech transfer, career development, etc.). IGFAE plays the leading role in the aforementioned structure.

The total amount granted in the period 2012-2015 is 1.6 MEuros (13.2%). These funds have been crucial in providing cohesion to the Institute through a dedicated secretary for research, and in supporting common infrastructures. In particular, this includes computing GRID services, which have been developed in the recent years, with the associated technical staff required for their maintenance. This amount also includes the funds corresponding to 3 predoctoral contracts and 3 postdoctoral contracts obtained in different competitive calls by Xunta de Galicia. The breakdown of the full amount in years is roughly as follows (in Euros): 80 thousand (2012), 900 thousand (2013), 150 thousand (2014) and 500 thousand (2015).

Non-competitive sources

The most important no-competitive funding in this period corresponds to the LaserPET project supported by MINECO from 2013 to 2015 with 4.3 MEuros, with the final objective of developing laser accelerator technology that can be dedicated to the production of radioisotopes for medical applications. Other regional non-competitive funds mostly include contracts dedicated to give additional support to the Starting Grant and the LaserPET projects.

The total amount for the period 2012-2015 is 4.8 MEuros (38,21%), and the breakdown in years is roughly (in Euros): 170 thousand (2012), 4.3 million (2013), 0 (2014) and 275 thousand (2015).

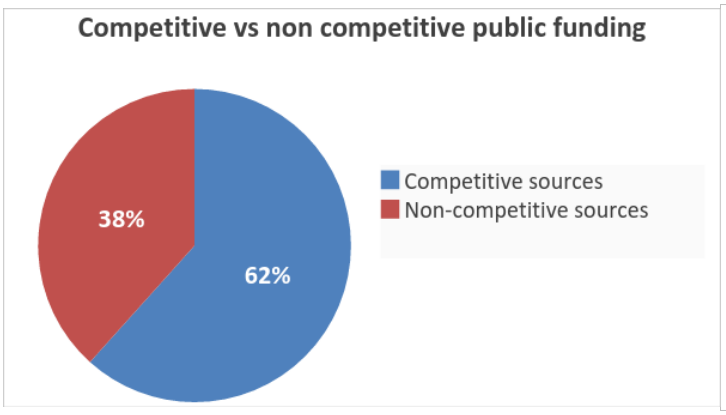
Non-competitive funding from the business sector:

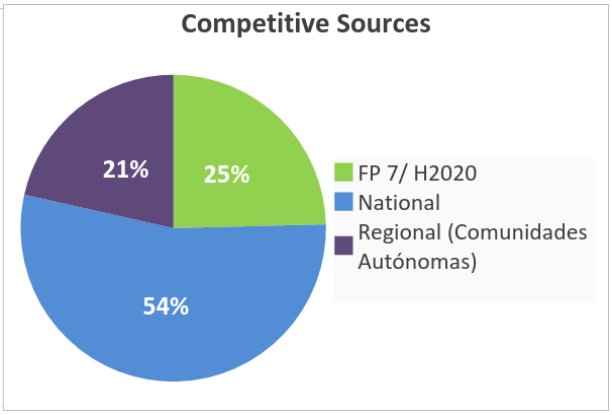
The funds obtained in contracts and services with public or private entities amounts only to 46 thousand Euros, and represents an 0,4% of the total funding. In the future, we will certainly explore the possibility of increasing this kind of funding.

Breakdown of the different sources of funding per year 2012-2015

INCOME	2012	2013	2014	2015	AVERAGE
PUBLIC FUNDING (TOTAL)	756.913	6.049.860	1.222.043	4.378.088	3.101.726
Competitive sources	**591.400**	**1.732.500**	**1.222.043**	**4.103.088**	**1.912.258**
FP 7/ H2020	18.900	97.000	108.119	1.657.977	470.499
National	492.500	721.500 €	963.962 €	1.945.112	1.030.768
Regional (Comunidades Autónomas)	80.000	914.000	149.963	500.000	410.991
Non-competitive sources	**165.513 €**	**4.317.360**	**-**	**275.000**	**1.189.468**
National	-	4.304.040	-	-	1.076.010
Regional (Comunidades Autónomas)	165.513	13.320	-	275.000	113.458
PRIVATE FUNDING (all national)	13.565	6.173	9.547	16.595	11.470
TOTAL FUNDING	**770.478 €**	**6.056.033**	**1.231.590**	**4.394.684**	**3.113.196**

These figures indicate a sizable average amount of funding per year (~3 MEuros) most of it from competitive sources with a 25% of them coming from the FP7/H2020 programs (this figure for international projects would, in fact, be larger if the Starting Grant with IP Carlos Salgado, received in 2011, would be included in the accounting).





It is also worth noticing that in terms of ERC Starting Grants, IGFAE shows a very remarkable record: it is the only institute in Particle Physics in Spain with two Starting Grants and the third in all disciplines in Panel PE2 - that of reference for the scientific topics of the Institute. IGFAE also ranks 20 out of 156 institutes in Europe with ERC Starting Grants in Panel PE2.

E. Other aspects

International leadership

During the period 2012-2016, the researchers of the IGFAE have developed international top-class collaborations within Europe, Latin America, EEUU and Asia. Among the most relevant ones are the two ERC projects led by members of IGFAE, and the participation and leadership in different activities of the Seventh Framework Programme (FP7) and Horizon 2020 of EU.

ERC projects

In year 2011, Carlos A. Salgado was awarded a European Research Council Starting Grant (Consolidator) to develop the project Hot and dense QCD in the LHC era (HotLHC), aiming to fully exploit the possibilities open by the LHC jump in energy. This project is still ongoing until the end of 2017.

In 2015, the European Research Council awarded a second researcher of IGFAE (Diego Martínez) a Starting Grant project (ERG-StG-639068). The goal of this project is to extend the LHCb physics reach to search for new physics beyond the Standard Model in the rare decays of b quarks. This project is also ongoing.

The fact that 2 members of the unit have been awarded a Starting Grant is very significant given the relatively small size of the IGFAE (30 senior members), and proves the large potential of IGFAE. The Starting Grants have also served to further develop two of the capabilities that are essential to the Institute: the exchange of ideas between theory and experiment, and the collaboration with external researchers. The first capability increases the internal scientific coherence of IGFAE, while the second one enhances its international visibility.

Marie Curie Individual Fellowships:

In the mentioned period, two postdoctoral researchers (Matthew Luzum and Fabio Dominguez) have benefited from the prestigious programme of Marie Curie individual fellowships, within the 7th Framework Program and the Horizon 2020.

EU FP7 and H2020

ENSAR

ENSAR is the Integrating Activity (IA) for European nuclear scientists who are performing research in three major sub-fields : Nuclear Structure, Nuclear Astrophysics and Applications of Nuclear Science. The main aim is to provide access to seven of the complementary and most relevant world-class large-scale facilities : GSI (Germany), GANIL (France), joint LNL-LNS (Italy), JYFL (FI), KVI (Netherlands), CERN-ISOLDE

(Switzerland) and ALTO (France). These facilities provide stable and radioactive ion beams of excellent quality ranging in energies from tens of keV/u to a few GeV/u.

ENSAR is funded by the European Commission within its Seventh Framework Programme (FP7) under the specific programme Capacities. The IGFAE Nuclear Physics group has been involved in this integrating activity from 2010 until 2015 through the Joint Research Activity INDESYS.

EURATOM

The objectives of the FP7 Euratom thematic area of "Nuclear[ef2] Fission and Radiation Protection" are: (a) To establish a sound scientific and technical basis in order to accelerate practical developments for the safer management of long-lived radioactive waste; (b) to enhance the safety performance, resource efficiency and cost-effectiveness of nuclear energy; (c) to ensure a robust and socially acceptable system of protection of mankind and the environment against the effects of ionising radiation.

The IGFAE unit is involved in the achievement of those objectives through 2 projects, namely CHANDA and ANDES.

The main objective of the CHANDA (CHAllenges in Nuclear Data) project is to address the challenges in the field of nuclear data for nuclear applications. The IGFAE is involved in this Project since its creation in 2013. Their goals include the creation of a stable organization that will coordinate the nuclear data research program and the infrastructures and capabilities of the EU Member States, well integrated with R&D coordination tools (EERA, HORIZON 2020). The priorities of this organization include (a) the preparation of solutions for the challenges risen by the nuclear data measurements needed by nuclear systems, and (b) the identification and promotion of synergies with other nuclear data applications, particularly in medical applications to optimize performance and minimize radiation dose in diagnosis and treatment of illnesses.

The ANDES (Accurate Nuclear Data for Nuclear Energy Sustainability) projected is oriented to obtain high-precision nuclear data for the major actinides present in advanced reactor fuels, to reduce uncertainties for new isotopes in closed cycles with waste minimization and to achieve a better assessment of uncertainties and correlations in their evaluation. The IGFAE was involved in the ANDES project during the period 2010-2013 together with more than 15 European partners, such as the Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT, Spain), Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA, France), Istituto Nazionale di Fisica Nucleare (INFN, Italy), and Instituto Tecnológico e Nuclear (ITN, Portugal).

HADRONPHYSICS2 and 3:

In the period 2012-2014, the project "Study of Strongly Interacting Matter" (HadronPhysics3) was an Integrating Activity of the Seventh Framework Programme (FP7) of EU.

The project promoted the access to five European Research Infrastructures, and it is structured into nine Networking Activities, plus the Management of the Consortium, and fourteen Joint Research Activities. It involved more than 2.500 European scientists working in the field of hadron physics at a large number of universities and research institutes in Europe, corresponding to a total effort of about 730 full-time equivalents (FTEs).

The IGFAE, through the USC, has participated in 2 working packages of HadronPhysics3, namely, the Networking Activity Network for the heavy flavoured probes of deconfined QCD matter formed in heavy ion collisions at relativistic energies (SaporeGravis), and the Joint Research Activity A Di-Jet Electromagnetic Calorimeter for Jet Quenching Study (Di-JETCAL).

The IGFAE has also been involved in the previous call, HadronPhysics2 (2009-2011), structured in a similar way, taking part in the Networking Activity Testing phases and non-perturbative features of QCD with quarkonium production (ReteQuarkonii), the Joint Research Activities Electromagnetic Calorimeter for Jet Quenching Study (JETCAL) and Development of large-area, low-mass, self-triggered gaseous detectors (FutureGas).

COST Action:

Since 2016, the IGFAE is involved in the COST Action CA15213 "Theory of hot matter and relativistic heavy-ion collisions" (THOR). THOR creates a theoretical community platform as a counterpart to the ongoing vigorous experimental activities. THOR will for the first time allow to fully exploit Europe's exceptional potential in this field of theoretical research. THOR will pioneer novel approaches to the theoretical understanding of the properties of QCD from first principles and on the interpretation of these properties by effective models and numerical simulations of the evolution of the hot matter system. THOR will provide new insights on the paramount questions of the field. Therefore THOR aims at bringing together excellent researchers in order to pinpoint and discuss the challenges that the field is currently facing. In the near future THOR will help creating a vibrant, innovative and world-leading pan-European research environment. THE involves 21 European countries. The IGFAE is leading one of the 3 working groups that conform the action.

EPLANET European Particle Physics Latin American NETwork:

The High Energy Physics (HEP) European scientific community has developed cutting edge, large-scale facilities that make it a world leader. Particle Physics Programmes in Europe are attracting the participation of groups from non-European countries, in particular from Latin America. In the reciprocal direction, the Pierre Auger Observatory for Ultrahigh-Energy Cosmic Rays in Argentina, receives a large European participation. The Latin American HEP community is composed of about 1000 physicists and engineers, with more than half young physicists, graduate and PhD students. In Europe, Latin American physicists collaborate with Research Institutions, Universities and with the European Laboratory for Particle Physics (CERN). The current trend is to increase the

participation in CERN. However, the Latin America-Europe collaboration at large-scale is relatively recent and needs to be consolidated.

The EPLANET program support visits from Argentina, Brazil, Chile and Mexico to CERN and other European Institutions, and from European countries to the Pierre Auger Observatory, with short exchanges (1-2 months) for senior and longer exchanges (2-12 months) for junior researchers, for a total of about 1800 months.

EPLANET is has recently finished running (Starting Date = 01/Feb/2011 -- End Date = 31/Jan/2015) and the Astroparticle Physics group of IGFAE is involved since 2011, while many other groups of IGFAE have also benefited from the funded visits.

ASPERA:

ASPERA is a network of national government agencies responsible for coordinating and funding national research efforts in Astroparticle Physics. ASPERA comprises 24 national funding agencies in Europe providing funding in Astroparticle Physics research. The IGFAE, through the Astroparticle Physics group involved in the Pierre Auger Observatory, participates in this programme.

Marie Curie Actions FP7 IRSES:

The International Research Staff Exchange Scheme (IRSES) of Marie Curie Actions supports research organisations to set up or strengthen long-term cooperation with others, in particular for exchanges outside Europe, through a coordinated exchange programme for their staff.

The IGFAE participates in this program through 2 actions: One involves exchanges with Latin America, in particular researches involved in the Pierre Auger Observatory. The second one corresponds to exchanges with Israel and E.E.U.U., with a strong involvement of the IGFAE Theory group.

Technology transfer

Scientific research and collaborations with the private sector with high societal and economic potential impact:

New technologies for Radon screening and protection.

Radon is a radioactive gas produced in the natural decay of 238U present in the Earth. Under normal conditions Radon (222Rn) is the largest contributor to the natural radiation dose in humans (40-50% of total) and has important health implications. In 2005 the IGFAE Nuclear Physics unit created a laboratory focused on the detection of natural radioactivity (LAR) (www.usc.es/lar), specialised on Radon detection. We have developed a method of indoor radon level determination, that serves as ¨guide¨ and allows to quantify the effectiveness of mitigation action, and has allowed collaborations and contracts with public institutions (i.e. Xunta de Galicia, Concello de Santiago de Compostela, Concello de A Coruña), private companies and individuals.

Presently we are focused on the development of innovative solutions addressing radon mitigation techniques. We got recently Retos Colabora funds (USC, INMB-CSIC, ATIC, Alibava Systems, Sensing&Control and Radiansa S.A) to develop a fast radon monitor based on Si technologies and equipped with high connectivity. The information provided by such sensors will be managed on-line and automatically controlled by an intelligent control unit that would directly act on the building ventilation system in such a way that the indoor radon activity is constantly below the safety threshold. The development of this research project could be the subject of a patent. We also plan to develop a join venture with a Galician company, iNous S.L., for developing software to model indoor radon diffusion that could be the seed for the creation of a spin-off company.

Production of radioisotopes for medical imaging using laser-induced proton acceleration.

Every year over 30 million nuclear medicine procedures based on the use of selected radionuclides are performed worldwide. Although the present technology for production of positron emitters for positron emission tomography (PET) is well established, the cost of the accelerator and the infrastructure to host it forces a production strategy based on a single production center per geographic region and corresponding distribution. This strategy limits the use of PET procedures to radionuclides with half-lives longer than the distribution time. A reduction in the production infrastructure could allow for the installation of radioisotope production units in almost any hospital, increasing the possibilities and impact of the PET procedures. This change could be brought by the laser technology. In the year 2000 it was shown that high power laser pulses can accelerate protons up to energies relevant for radionuclide production. The consolidation of this technology will reduce the radioisotope production cost in the production machine, in the infrastructure that host it, and in the distribution. Some researchers of the IGFAE Nuclear Physics unit initiated in 2011 a project aiming at constructing a research infrastructure at USC devoted to the development of the laser-based proton acceleration technology applied to the medical radioisotope production. This project, called LaserPET, got funded in 2013. Today, the Laser Laboratory for Acceleration and Applications (L2A2) is built, the Laser system operative and experiments dedicated to the production of X-rays and protons are being set. Spanish companies are interested in the research program and transfer of the possible results. As an example, a Retos Colabora project coordinated by the company PLA and the participation of the L2A2, to develop target technologies for laser-based proton acceleration, is ongoing.

Technological impact of the CALIFA project

The design and construction of CALIFA, a state-of-the-art gamma and light charged particle calorimeter, will have both a scientific and technological impact. The new developments in photon detection will influence imaging techniques and medical applications. New scintillation materials, photosensor devices and carbon fiber

technologies are addressed in this project. This will foster intense transfer activities between research groups and hi-tech companies in our country. Some examples are:

1. Hamamatsu Photonics: The USC and Hamamatsu developed a joint venture, consisting on the development of a specific large area photodiode (APD) based on the excellent performances of the S8664 model. As output of this collaboration a new model of 10x20 mm2 active target APD is included in the Hamamatsu semiconductors catalog.

2. Scientifica International: A project funded by CDTI was at the origin of the collaboration of the UVigo, USC and Scientifica, for engineering consulting to develop a crystal scintillator quality control station.

3. Delfinox/Alumodel: This local company has a long experience with Aluminium handling and accepted the charge of investigate an optimum protocol to cut and pre-fold the VME2000 material used as CALIFA CsI wrapping. Several Galician companies have built parts of the CALIFA mechanics (Uniprecis, MecaVigo, and Quantum). In particular, Quantum S.L, a spin-off of UVigo, has been also very helpful, providing engineering solutions to problems related with the CALIFA project developments.

4. ATI systems: We have signed contracts with ATI systems, supplier of different technological solutions for nuclear radiation detection and electronics, in particular related with the crystals for the CALIFA calorimeter.

Technological impact of the LHCb VELO upgrade project

The R&D activities carried out by researchers at the IGFAE in the readout electronics of the upgraded LHCb vertex detector (VELO) have applications outside the HEP instrumentation. The readout ASIC (Velopix), just arrived from the foundry, comes from a family of ASICs developed originally for medical use (Medipix/Timepix). In the past, the commercial exploitation of this family of ASICs has been done by PANalytical (Almelo, The Netherlands). The range of applications for this electronics is rapidly expanding. Some examples are: mass spectroscopy, electron microscopy and proton radiography. Previous versions of the electronics were employed successfully as well in X-ray and neutron imaging, Low Energy Electron Microscopy (LEEM) and PhotoEmission Electron Microscopy (PEEM) using graphene, Background radiation monitoring and dosimetry (terrestrial and spaceborne). New application with these electronics will be pursued at the IGFAE.

Communication with society and outreach

Knowledge transfer and communication are a priority for us. Our goals have been to inspire new generations of students so that they would eventually pursue careers in research, in particular in Physics, to show citizens in which activities the research funds that we receive are being invested and, in general, to communicate the importance and relevance of Science to everyone's lives.

Outreach has played an increasingly important role in the last few years, in terms of the amount of activities and the variety of strategies carried on by many of the researchers associated to the center. IGFAE´s outreach activities comprise dozens of articles published in journals, newspapers and magazines, dozens of talks in high-schools distributed all along the Galician geography, several participations in radio and TV programs, and collaboration with the media whenever important results from our fields got the public attention worldwide.

This huge load of science communication has largely paid-off. For instance, while 5 years ago the number of freshmen students at the University of Santiago de Compostela was around 50 or 60 (most of whom did not choose Physics as their first option), in the last three years it raised to 100 (there is a numerus clausus, the candidates this year reached more than 300), and the grade they needed grew 80% since 2013, the degree in Physics occupying these days a place among the most attractive degrees in the University of Santiago de Compostela (as a comparison, the grade needed in Chemistry or Mathematics is more than 40% lower).

There is an undeniable contribution to these figures that comes from our sustained outreach activity. On the other hand, many of our graduates have ended up working in the industry, ranging from electronics to renewable energies. As such, there is a steady increase in the level of understanding of the fundamental uses of science in modern industry.

Outreach activities (2012-2016)

- 7th, 8th, 9th, 10th, 11th and 12th International Particle Physics: Masterclass 2011-2016 and the Masterclass CPAN 2011. EPPOG European Particle Physics Outreach Group. 1-day Masterclass on Particle Physics. Attended by about 50 high-school students and 20 high school teachers each time. Includes talks, practical work on data analysis of CERN experiments and videoconference with other High School students in Europe.
- Scientific Summer Campus School (Campus Científico de Verano). Searching for the most energetic particles in the Universe, Programa Campus Científicos de Verano, FECYT Fundación Española para la Ciencia y la Tecnología, Ministerio de Educación, Cultura y Deporte. In the Campus Cientifico de Verano, 32 high-school students per year participate on a course on HEP and Astroparticle Physics. Students perform analysis of cosmic ray data and from the Pierre Auger Observatory.
- Exhibition The largest scientific instrument ever constructed: an exhibition of CERN & CPAN (Centro Nacional de Partículas, Astropartículas y Nuclear) Facultad de Física, Univ. Santiago de Compostela. 2 - 20 May 2013 https://www.i-cpan.es/expocern/

Outreach books, articles and presentations

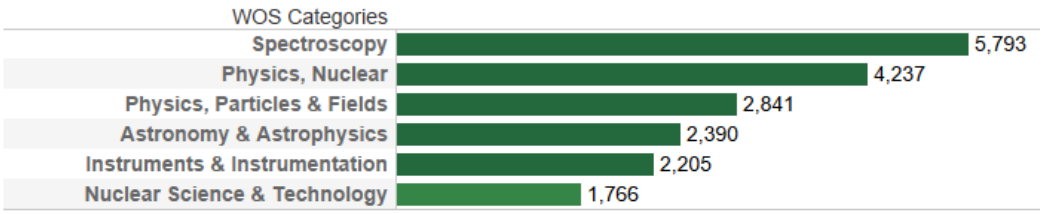
- Title: Antimatter, magic and poetry (in Spanish). Authors: Jose D. Edelstein & Andres Gomberoff. ISBN: 13: 978-84-16183-18-0 (258 pages) Santiago de Compostela University Press. Published on November 11, 2014.
- Title: Strings and superstrings (in Spanish and Italian). Authors: Jose D. Edelstein & Gaston Giribet. ISBN: 978-84-473-8387-0 (153 pages) RBA Libros. Published on October 1, 2016 (Italy) & October 4, 2016 (Spain).
- Articles in outreach journals, newspapers and magazines: More than 50 articles published in several newspapers and magazines and more than 100 talks.

F. Benchmarking

We present in this section a small comparison of the performance of IGFAE with its international peers. The data collected correspond to the same reference period we are using in the rest of the document.

In terms of comparison with the rest of the World, we present the normalized impact factors of the IGFAE publications in each different category. All data are taken from Web of Knowledge and the analysis was performed by SIRS Academics[3], a company specialized on Science Metrics and Consulting.

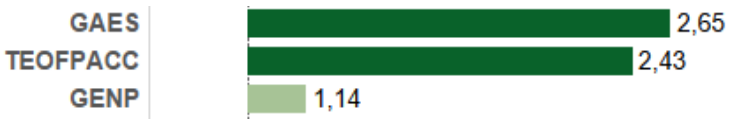
Figure 3: IGFAE: NCI WoS Categories vs. World



The Normalized Citation Impact (NCI) measures how well or bad a team is performing in terms of citations compared with the average citations of the rest of the World in a given category. The previous plot shows an excellent performance of IGFAE, with figures that indicate that most of the papers of the Institute receive more than twice the number of citations than an average paper in the same category.

Also remarkable is the impact of the different groups with respect to the average in Spain. This is plotted in the next Figure, containing the NCI for each group compared to Spain, showing again an excellent performance. Two groups of IGFAE receive 2.5 times more citations per paper than the Spanish average.

Figure 5. NCI IGFAE GROPUS vs. Spain



Finally, we present a small exercise of benchmarking with other international centers of excellence. We have tried to choose centers which are not much larger than IGFAE

[3] What is presented here is only a sample of a more extensive work done for the whole AEFIS - Agrupación Estratéxica de Física

(although all of them are larger) with main scientific interest on Particle Physics and with a geographical distribution which would make the comparison useful (for this reason, two of them are Spanish centers). The centers are

Instituto de Ciencias del Cosmos (ICCUB). http://icc.ub.edu/home/start/

The Institute Cosmos Sciences of the University of Barcelona (ICCUB) is an interdisciplinary center devoted to fundamental research in the field of cosmology, as well as to the technological applications of the sciences of the cosmos in general. It gathers researchers from the departments of Astronomy and Meteorology, Structure and Constituents of Matter, Fundamental Physics, Applied Mathematics, Organic Chemistry and Electronics.

Institute for High Energy Physics (IFAE), BIST, Spain. http://www.ifae.es/eng/

The IFAE personnel is organized in two divisions: experimental and theoretical. Part of the staff is hired with IFAE own funds, but a significant amount of staff members are funded by UAB and/or ICREA. Their essential mission is to conduct theoretical and experimental research in the fields of elementary particle physics, high energy astrophysics and cosmology. Technological knowledge acquired in the experimental division is also applied to medical physics in the field of radiation detection and diagnosis imaging.

IFAE provides also engineering services (mechanics, electronics and computing) that offer essential support to the experimental activities of the institute and, by extension, to external projects.

Wigner Research Centre for Physics (Wigner RCP), HAS, Hungary. http://wigner.mta.hu/en/node/19

The research center was founded on 1st January, 2012, by the merging of two former institutes, the Research Institute for Particle and Nuclear Physics, and the Research Institute for Solid State Physics and Optics of the H.A.S. It is constituted by 40 research groups working on different areas of physics, biophysics, computer technics and chemistry.

Helsinki Institute of Physics (HIP). https://www.hip.fi/

The Helsinki Institute of Physics is a research center coordinated jointly by the University of Helsinki, Aalto University, the University of Jyväskylä, the Lappeenranta University of Technology, and the Tampere University of Technology. Its research activity covers an extensive range of subjects in theoretical physics and experimental subatomic physics. The mandate of the institute is to carry out and facilitate research in basic and applied physics. The institute is responsible for the Finnish research collaboration with CERN. Also, it coordinates the Finnish contribution to the FAIR laboratory (Facility for Antiproton and Ion Research) currently under construction in Darmstadt, Germany.

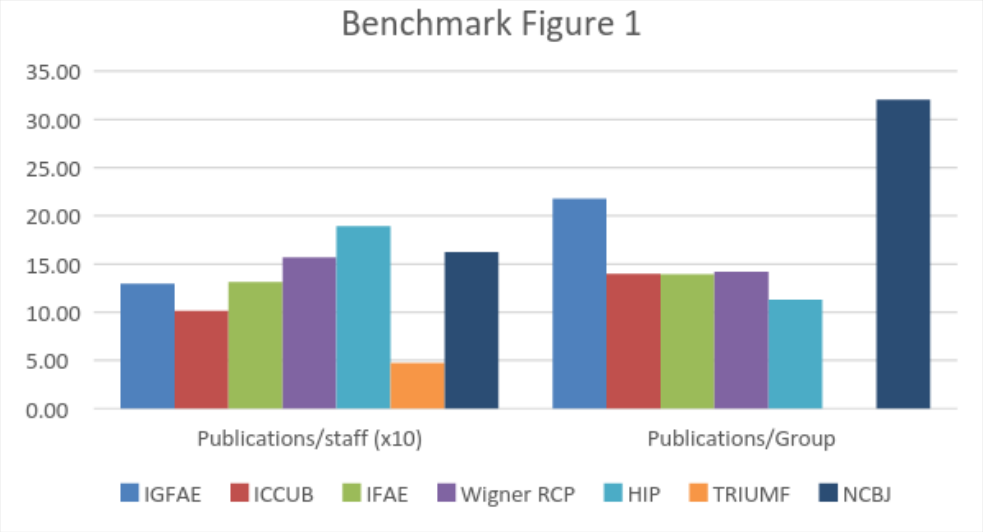
Canada's National Laboratory for Particle and Nuclear Physics (TRIUMF). http://www.triumf.ca/

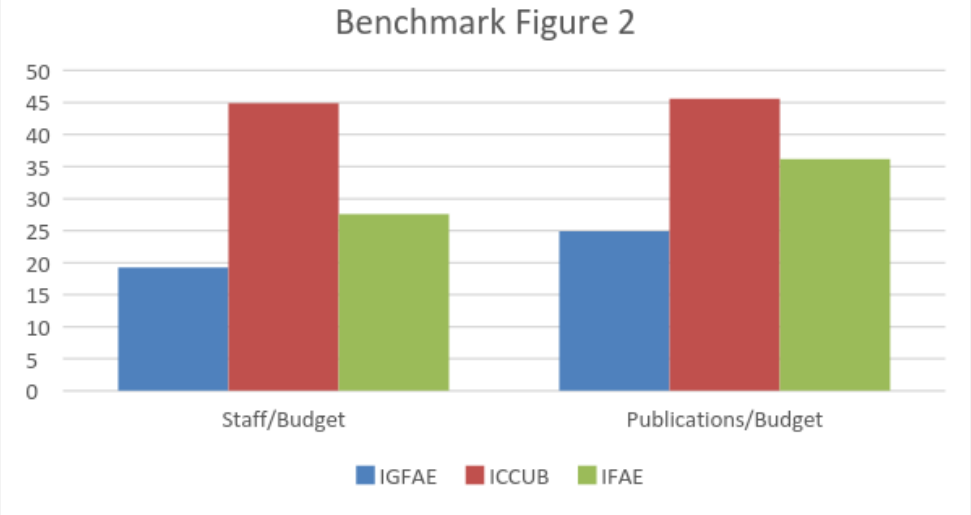
TRIUMF is one of the world's leading subatomic physics laboratories. TRIUMF's main research areas concern particle physics, nuclear physics, nuclear medicine, and materials science. In addition, TRIUMF coordinates the Canadian research on particle accelerators and detection technologies.

National Centre for Nuclear Research (NCBJ), Poland. http://www.ncbj.gov.pl/en

The National Centre for Nuclear Research (NCBJ) was founded by the merging of the Institute of Atomic Energy POLATOM and the Andrzej Sołtan Institute for Nuclear Studies. The NCBJ research profile includes both basic and applied physics on different fields such as nuclear power, elementary particle physics, nuclear physics or hot plasma physics. The centre is strongly involved in the development of nuclear technologies and applications of nuclear physics. Besides, the centre develops radiopharmaceuticals and particle accelerators for science, industry and medicine. The centre provides its expertise and infrastructure to support the development of the nuclear power industry in Poland.

Unfortunately, it was not possible to gather the financial data of most of the aforementioned institutes. The benchmarking is based in a comparison of staff performance (Figure 1). Financial data are shown when available (Figure 2).





The two plots above show that the average publications per staff member of the IGFAE is comparable with the other institutes under study, while the amount of funding per staff is significantly larger in our Institute (plotted is the staff per budget). This shows again the good performance of IGFAE in terms of fundraising. For the same reason, the publications to budget ratio appears to be slightly smaller for IGFAE.

We present in the following table the data used and collected

		IGFAE	ICCUB	IFAE	Wigner RCP	HIP	TRIUMF	NCBJ
INPUT	Research Groups	5	14	13	40	25	na	17
	Budget	4,37	4,3	5	na	na	na	na
	Staff	84	193	138	362	149	500	336
OUTPUT	Publications	109	196	181	568	282	236	545
	Theses	6	10	10	na	na	na	4
METRICS	Nature excelence index (AC)	19	171	123	92	86	82	113
	Nature excelence index (FC	1,08	4,36	6,17	6,24	4,69	4,93	5,43
BENCHMARK	Publications/Staff (x10)	12,98	10,16	13,12	15,69	18,93	4,72	16,22
	Publications/Groups	21,80	14,00	13,92	14,20	11,28	na	32,06
	Publications/b Budget	33,75	75,58	36,2	na	na	na	na
	Staff/Budget	21	41,16	27,6	na	na	na	na
	Source	2015	Web page, Scopus	Ann rev 2015	Ann rev 2014	Ann rew 2014	Web page	Ann rev 2014

Part 2

5-years Strategic Plan

Premises

Our vision for an ambitious but realistic future for IGFAE is presented in the next pages. In order to make an Strategic Plan we need to make some assumptions on both the structure and the funding of the Institute in the coming years. Both of them are subject to large uncertainties at present. This plan is based on **two main Premises**

- The Institute is a main part of a more collective effort within the University of Santiago de Compostela, also with a smaller participation of the University of Vigo, to structure excellent research in some areas of Physics within a larger structure, possibly leading to a new Research Singular Center. This scheme has been concretized in the Agrupación Estratéxica de Física (AEFIS), a structure funded in a competitive call by Xunta de Galicia with 500 KEuros for the period 2015-2017. One main goal of the call is the formulation of a Strategic Plan for the period 2015-2020. This Strategic Plan was presented in fall 2016.

  IGFAE contributes to AEFIS with about 80% of its total fundraising and a similar figure for scientific production in terms of publications; with 60% of the total staff and about 50% of the permanent staff. The Strategic Plan presented here for IGFAE has been designed to be congruent with the Strategic Plan of AEFIS. So, it is assumed that no conflict will appear in the execution of the two plans. Quite the opposite, it is expected that the two will reinforce each other, in particular in terms of scientific collaboration, as it is being the case already in the last year .

- Concerning funding, it is assumed a funding of 500 KEuros per year to put in place IGFAE's Strategic Plan. This corresponds to the funding for the Maria de Maetzu Units of Excellence launched in the last years by Ministerio de Economía, Industria y Competitividad of Spain. Consellería de Cultura e Educación of Xunta de Galicia has a similar scheme for Singular Centers of Excellence with a maximum funding of 800 KEuros per year. Access to this amount of funding for IGFAE is not at all secured but still realistic in the short term.

Introduction

The IGFAE has a relevant scientific performance in relation to its size and has proven its ability to attract international talent. The main objective of the Strategic Research Program is to improve the level of excellence research, going deeper into the preceding lines while exploring new opportunities, especially for interdisciplinary research.

The three cornerstones on which this Strategic Research Program (SRP) is based are: attracting new talent with the potential to develop a first-class international career; leading and participating in new projects linked to large international experimental infrastructures and improving the transferable skills of our researchers. The program also intends to promote activities that enhance the impact of research on society.

As regards the scientific activity, IGFAE is interested in three main topics: Particle Physics, Astroparticle Physics and Nuclear Physics.

Particle Physics is at one of its cross-roads in history, in which new experimental information is needed to define its direction. The successful LHC Run 1 completed the Standard Model (SM) of Particle Physics with the discovery of the Higgs boson. Cosmological observations indicate that the SM is not the final theory. However, contrary to the pre-LHC situation, we have no clear information on the direction Nature has chosen to follow. Exploring the limits within and beyond the SM is one of the Strategic Areas of our SRP.

Particles from cosmological origin are excellent tools for Particle Physics, Cosmological and Astrophysical studies. A new golden age is starting with diverse experiments looking into many different directions, including the breakthrough discovery of gravitational waves off black hole mergers by LIGO. Our second Strategic Area plans to search for cosmic rays and neutrinos with the highest energy and also to study the nature of neutrinos and dark matter.

The characterization of exotic nuclear matter is crucial for understanding the nuclear force, the structure of many-body nuclear-systems, the corresponding equations of state and their astrophysical and cosmological implications. Our third Strategic Area will focus on using non-stable nuclei to address some of these issues and on their practical applications, particularly medical diagnosis and treatment. The commissioning of a new Laser Laboratory for Acceleration and Applications L2A2 at our university will provide the backbone of these practical applications with excellent prospects for TT.

The number of researchers, in terms of permanent staff for the present Research Lines (RL) of the institute, has proven adequate for an excellent international visibility. For this reason, our SRP focuses mainly on attracting international talent to reinforce our Strategic Research Areas (SA). Opening new RL aligned with the strategy of the institute as well as promoting interdisciplinary research both within IGFAE and with external

institutions, will be encouraged. This interdisciplinary research and external collaborations are expected to improve our technology transfer performance.

For any Particle Physics center, defining the right strategy is critical. The scientific program will be completed with a Horizontal Line to fix the strategy on the Institute participation in new experimental facilities. The R&D from different teams will collaborate to establish synergies and to properly assess participation and returns in terms of technology transfer, of the new facilities that are being planned worldwide.

In order to increase the impact of our performance, the SRP will develop two programs:

- on talent attraction and career development of our researchers.

- on Society through technology transfer activities and scientific dissemination

The first one is related to talent management from various perspectives: attraction of talent with high potential, and enhancing scientific training programs, research mobility, career development, etc. We will follow the Research Development Framework of CRAC Vitae. This framework is based on the principles of the European Charter and Code for researchers. Very well-known universities are using this model to define their career development strategy. Our Institute has a long tradition along these lines that will be reinforced with the actions contained in the SRP.

Regarding the second program, the Institute produces a large amount of technology whose transfer to society should be improved. The IGFAE and the TTO of the University of Santiago, with the collaboration of the Oxford University Innovation (one of the top European TTOs in the field of particle physics), will set up a new technology transfer strategy. The principal objective will be to explore and activate the potential business development of our R&D activities and, specially, from the participation in large experimental facilities like CERN, GSI/FAIR, Auger, etc.

Science communication is already a quite intense activity in the institute. Coordination of outreach activity would multiply its impact on society, trying to pay special attention to the educational community.

In short, our Institute:

- has an attractive scientific program aligned with international strategies in Particle, Nuclear and Astroparticle Physics

- fulfills all international standards of a high quality center of Particle Physics

- has an important group of reputed researchers with high-impact performance

- has a very internationalized activity with participation in the main global experiments and presence in decision-making forums.

The Strategic Plan presented here is an ambitious program designed to improve the organizational and managerial structures, to reinforce the recruitment of young researchers with potential to become world-leaders, to strengthen the talent management at all stages of the career development and to improve the impact of the

Institute's performance following the principles of Responsible Research and Innovation.

A. Goals

The main elements that define the recent activity of the Institute are: a good performance in terms of scientific production, talent attraction and fundraising, an intense international activity, especially within large experimental collaborations (LHC, GSI/FAIR, Auger...) and the activation of a new framework to organize the research in terms of Strategic Research Areas (SA).

This working model has served to set up the foundations for a new stage to be characterized not only by improving the high performance of the existing lines of research (RL) but also by identifying new opportunities, attracting international talent to lead new RL and providing a higher level of internal cohesion based on teams integrated in common goals. Our objectives are

O1. Improve the scientific performance

O2. Explore potential synergies among the IGFAE groups and with other research teams

O3. Increase the efficiency of the research facilities and technological capacities

O4. Set up a Responsible Research & Innovation Strategy

O5. Adapt the management to the best international practice

B. Research topics

The structure of IGFAE in terms of Strategic Research Areas has been put in place in the last year, following a rethinking of the role of the Institute. They have been presented in the first part of this document. Here, we extend this description paying special attention to the new opportunities foreseen in the future and that will shape the Institute for the next decade

Scientific Research Program

The new SRP 2017-2020 is built around the three Strategic Research Areas (SA)

SA1 THE STANDARD MODEL TO THE LIMITS

SA2 COSMIC PARTICLES AND FUNDAMENTAL PHYSICS

SA3 NUCLEAR PHYSICS FROM THE LAB TO IMPROVE PEOPLES HEALTH

Each of this SA is a wide field of research in which the groups of the institute have internationally reputed researchers that provide the basis for the future development. Together with this SA, a Horizontal Line provides consistency opportunities and transferable results from the basic research carried out by the groups.

We present now the Research Program for 2017-2020. The different SA are expected to remain unmodified as pillars of the Institute's strategy, while the Research Lines (RL) can be more dynamical and evolve with time, responding to the new challenges and opportunities.

SA1 THE STANDARD MODEL TO THE LIMITS

Our institute has played a fundamental role in this broad field, obtaining the strongest constraints to Supersymmetric models by measuring the Bs->mu mu decay at CERN LHC -led by members of our institute and highlighted by CERN DG as the second most important result of LHC Run1 after Higgs discovery- and describing the theory of jet quenching and saturation physics in high-energy nuclear collisions. Both lines outstand having obtained support of the ERC with Starting Grants. We plan here to drive forward these lines to new frontiers through the following Research Lines:

RL1. Beyond the Standard Model searches with LHCb

The ERC Starting Grant BSMFLEET is designed to probe extensions of the Standard Model. One of its main goals is to extend the LHCb detector for measurements well beyond its original capabilities, aiming to measure s-quark rare decays which probe BSM physics in a way unreachable by any other experiment. This turns LHCb into almost a new experiment: LHCs.

The LHCb detector will be upgraded in 2018 to run at a higher luminosity, the Institute taking a leading part, particularly in the trigger system, enhancing by orders of magnitude the LHCb physics reach. To deal with the new high rate of collisions,

hardware upgrades are needed. The group is involved in the upgrade of the vertex detector (VELO) a lightweight hybrid silicon pixel detector designed for a high speed and high precision track reconstruction.

The original, CONSOLIDATED, LHCb program, in the search for BSM physics will continued to be pursued, as one of the main lines of research, with b-decays into different channels.

RL2. Hot and dense QCD in the LHC era and beyond

The ERC Starting Grant HotLHC has been the main driving force of this line of research in the last 4 years. The findings in this project, and the corresponding new data from the LHC, are opening new lines of research. New techniques and approaches are being found, which include quantum color coherence among different particles in the system as one of the main ingredients. The plan is to continue the CONSOLIDATED part of the program (jet quenching, parton distributions) and start a new program on the interplay between initial and final state physics to answer the question of how thermalization occurs in a theory with fundamental degrees of freedom. This will be the basis of applications to ERC Advanced Grants.

RL3. String theory and relation with other fields

The main field of study in the Institute is the so-called AdS/CFT correspondence, also named Holographic Duality. This correspondence relates in dual form a quantum field theory in d dimensions with a classical gravitational theory in d+1 dimensions. This correspondence has revealed extraordinary versatile in addressing different problems in Particle or Condense Matter Physics.

We plan to continue our CONSOLIDATED work on unquenched dynamical flavor and different aspects of the quark-gluon plasma, on the nature of gravity theories from the fundamental properties of the quantum field theory and on applications of integrability to them.

A new line on numerical holography is being opened – solving numerically the Gravitation equation in a given background – with applications to different fields as quantum coherence/information or thermalization, but with techniques that can be used for usual Cosmological problems.

SA2 COSMIC PARTICLES AND FUNDAMENTAL PHYSICS

The main activity in Astroparticle Physics of the Institute is within the Pierre Auger Observatory, having helped in its founding and playing a recognized role. Our main goal in this CONSOLIDATED line is to enhance its potential in neutrino searches and for composition measurements. The IGFAE played a crucial role, putting the neutrino potential forward with J. Cronin and with the pioneer analysis of inclined shower data with A. Watson. Major developments have followed, opening several new lines of research and providing the basis of the recently approved upgrade AugerPrime.

The Institute has recently expanded its horizons to new experimental facilities under development like NEXT. New exploratory lines include directional Dark Matter detection for which a new RyC has been hired in 2016.

RL4. Extremely energetic cosmic rays and neutrinos - High exposure experiments

The Astroparticle physics group at IGFAE intends to address the Pierre Auger Observatory challenges, particularly updating and improving existing methods, searching for cosmological neutrinos and for coincidences with the newly discovered Gravitational Wave events as well as contributing to the deployment of AugerPrime. The efficiency to find ultra-high energy neutrinos and study composition will be enhanced with improved time resolution and with the capability to separate the muon and electromagnetic parts of the showers.

We also plan to further contribute to the rapid expansion that the radio technique is experiencing and for which the Institute has world-leaders. Significant upgrading of the simulation code will be made, to apply to detectors as AERA and ANITA, with which strong collaborations are ongoing, and to explore new opportunities.

RL5. Dark matter and the nature of neutrinos - Ultra-Low rate experiments

The Institute contributes to the NEXT experiment that ultimately aims at the observation of neutrino-less double beta decay. The latter would imply the neutrino is a Majorana particle with profound implications in Particle Physics and Cosmology. NEXT, a high pressure TPC detector located in the Canfranc Laboratory in 2017 will surpass its competitors after one year of running. The Institute will contribute to the supervision, construction, operation and exploitation of the calibration system and carry responsibilities on the tracking. There are plans to improve the background rejection capabilities, some led by the group, and to expand its reach for direct dark matter searches.

SA3 NUCLEAR PHYSICS FROM THE LAB TO IMPROVE PEOPLE'S HEALTH

Nuclear Physics tries to understand the origin and structure of the visible matter in the Universe bound by the strong interaction, a challenging task because of our limited knowledge in the non perturbative regime. The investigation of nuclei far from stability offers unprecedented possibilities to bridge the gap between complex structures of matter and its fundamental constituents. Moreover, Nuclear physics has a strong impact in applications for society as the development of new tools for medical diagnostic and treatment. The IGFAE group has wide experience in both fundamental and applied research programs. Two main lines are proposed:

RL6. Structure and dynamics of the nuclear many-body system using radioactive nuclear beams

The Institute will develop a competitive research program using the new generation radioactive beam facilities under construction in Europe. We are strongly committed

with the experiments R3B and SuperFRS at the new FAIR facility, we lead structure and fission experiments at GANIL/Spiral II and HIE-ISOLDE, and we contribute to the NToF campaigns at CERN. These activities translate into a relevant participation in the most advanced nuclear physics facilities in the world. FAIR will be the largest worldwide Nuclear Physics facility with unprecedented potential for research. The Institute is leading the international consortium responsible for the construction of the calorimeter CALIFA in the R3B experiment. Its challenging design requires the development of new technologies that could have an impact on medical imaging design. The Institute is also involved in the realization of the series of active target detectors within the ACTAR TPC collaboration at GANIL.

RL7. Commissioning and exploitation of the L2A2 laboratory at USC

In 2000 it was shown that intense laser pulses impinging on thin metal foils (few microns) can accelerate particles up to relativistic energies. This technology could drastically reduce the size and cost of particle accelerators.

In 2013 the IGFAE group obtained a 5,3 M€ grant to build the Laser Laboratory for Acceleration and Applications (L2A2) at the USC, equipped with a 50 TW laser. Its first scientific project, LaserPET, aims at developing the technologies required for medical isotope production. This technology would allow the installation of radioisotope production units in almost any hospital, given access to the use of short-lived emitters, such as 11C (20 min.), which are well adapted for the diagnosis of Parkinson and several types of cancer. This facility is, at present, one of the flagships of the experimental infrastructures in our university with a great potential for research and technology transfer.

HORIZONTAL LINE - STRATEGIES FOR NEW FACILITIES

The institute needs to continuously assess the status of international facilities, looking for new physics opportunities and making strategic decisions. This line aims to provide the discussion ground to decide on strategy for these new opportunities. The LHC will be the reference facility in Particle Physics at least in the next 15-20 years. Two new ones are under serious consideration, the Large Hadron Electron Collider (LHeC) and the International Linear Collider (ILC), while in the longer term Future Circular Collider is also considered.

The LHeC will collide an electron beam of 60-140 GeV with the LHC hadron beam (protons or heavy ions) to study the strong and electroweak interactions. Nestor Armesto is member of the Coordination Group appointed by CERN directorate to produce the Technical Design Report by 2018 in which other IGFAE members participate.

The ILC is a linear electron-positron collider of 250-500 GeV center-of-mass energy and high luminosity, crucial for testing new physics scenarios such as Supersymmetry, Higgs compositeness, new gauge bosons, additional Higgs bosons, and dark matter particles. IGFAE activities are focused on R&D of tracking and vertexing detectors.

Many facilities exist or are being planned in Astroparticle Physics. The future of Ultra High Energy Cosmic Rays (UHECR) will depend on the results of the Auger Observatory. The radio technique, originally considered for ultrahigh energy neutrino searches a decade ago, has recently shown a huge potential for the field of UHECR's too. There are many activities of IGFAE related to radio, mostly within AERA (the radio detector of the Auger Observatory) and ANITA (a balloon experiment aiming to detect radio pulses from neutrinos interacting in the ice sheet of Antarctica).

The expertise of the IGFAE group in simulation is of great value for future facilities such as the Square Kilometer Array (SKA), or GRAND in China, a specific detector to explore the 10-100 PeV neutrino regime with a exposure capable of measuring reasonable extrapolations of the flux detected by IceCube.

FAIR, the leading facility in Nuclear Physics for the next decades, will start in 2022 offering unprecedented opportunities for developing research programs in nuclear structure, hadron physics and compressed baryon matter using beams on stable and unstable ions, and antiprotons. IGFAE researchers have been strongly involved and have occupied several responsibilities as the coordination of the Spanish participation. IGFAE's contribution to the construction and exploitation of several FAIR experiments (NUSTAR, R3B, CALIFA, SuperFRS) will be a priority for the years to come. In parallel, we have also identified complementary opportunities in other facilities such as GANIL/SPIRAL II, or the experiments HIE-ISOLDE and NToF EAR2 at CERN.

The participation in research programs at large-scale international facilities in the fields of Nuclear, Particle and Astroparticle Physics offers unique scientific opportunities, a large visibility and facilitates the development of scientific careers. However, technology transfer takes place around the scientific infrastructures and mostly benefits the hosting countries, hence some actions in this SRP are proposed to balance and improve this situation. The Institute has identified laser-plasma acceleration as a new technology with a large impact potential, requiring an affordable investment for hosting a local infrastructure. These ideas are materialized in the construction of the L2A2 laboratory at USC with a new 50 TW laser system. Its first experimental results are expected soon.

C. Research team

The present PhD staff of the Institute are 42 members, 31 of them permanent or RyC. Instead of describing here a complete list of researchers and CV, we have made a selection of guarantors for each of the research lines of the Institute. The definition of guarantor follows the requirements of the Maria de Maetzu call.

Scientific Director

Carlos A. Salgado

Carlos A. Salgado is a professor of theoretical physics (Profesor Titular) at the University of Santiago de Compostela since Feb 2014. After his PhD in 1998 he was postdoctoral fellow at the Laboratoire de Physique Theorique (CNRS) at the Universite de Paris Sud (1998-2001); then Marie Curie Fellow (FP5) and CERN Fellow at CERN TH-division (2001-2005); then Marie Curie Fellow (FP6) at the Universita di Roma 1 La Sapienza (2006-2007). He got a Ramon y Cajal tenure-track position in 2005 and joined the University of Santiago de Compostela under this scheme in January 2008. In this last nine years he was the driving force for the success of the group in Santiago to become one of the world-leaders in the field of hot and dense QCD (large number of citations; high quality of hired postdocs; sizable funding; invitation and organization of scientific meetings, international committees, etc.). All this was conducted in the middle of the strongest economical crisis in decades where even his tenure got challenging. From June 2014 to July 2015 he was appointed as Vice-chancellor for Internationalization at the University of Santiago de Compostela, with competences, in particular, on research internationalization.

In year 2011 CAS was awarded a European Research Council Starting Grant (Consolidator steam) to put in action the project Hot and dense QCD in the LHC era (HotLHC), aiming to fully exploit the possibilities open by the LHC jump in energy. With this and other funding (including two Marie Curie Grants) the group hosted some 15 postdocs in the period 2012-2016, some of whom have obtained permanent or semi permanent positions afterwards Cyrille Marquet (CNRS CR1 Ecole Polytechnique permanent), Andrea Beraudo (INFN Torino permanent); Guilherme Milhano (Lisbon tenure-track); Yacine Mehtar-Tani (U. Washington 5 year research associate); Tolga Altinoluk (Warsaw Permanent); Matthew Luzum (Sao Paulo Permanent).

CAS has been invited to plenary talks in all the most important conferences in the field, including ICHEP 2012 in Melbourne; Quark Matter 2005 in Budapest and 2011 in Annecy; Hard Probes in Asilomar 2006; Sardinia 2012 (Theory Summary Talk) and Cape Town 2013; the International Europhysics Conference on High Energy Physics, EPS-HEP, in Grenoble 2011; LHCP 2015 in St. Petersburg; PANIC 2011 at the MIT, etc. This amounts a total of 17 invited plenary talks for a total of 146 talks and seminars, most of them by invitation. He has also lectured in 18 international schools for PhD students

and young postdocs, including CERN schools, ECT*, etc. He is member of the International Advisory Committee of Quark Matter, Hard Probes, European Nuclear Physics Conference, Initial Stages, etc and has been chair of several International Conferences. It is worth mentioning that he started in year 2013 a new series International Conference on the Initial Stages of High-Energy Nuclear Collisions (IS) which has become one of the three thematic conferences which complement the Quark Matter series.

The total number of publications in Web of Science are 269 with a total of 10.294 citations and an h-number of 56. About half of these publications are within the ALICE Collaboration, the number of theory papers is 72 with some 80 conference proceedings, often also published in ISI journals. The number of citations for these papers are 4390 with an h-number of 34. The corresponding numbers, only for the theory papers, in INSPIRE database (of reference in Particle Physics) are 7578 cites and h-number 40 with 2 Famous paper (500+), 5 Renowned papers (250-499) and 18 Very well-known papers (100-249). Taking into account the career stage, these numbers correspond to one of the leader theory authors, in terms of total quotations, in the field of hot and dense QCD.

Garantor researchers

José F. Benlliure Anaya

During the period 2011-2015 Prof. José Benlliure has continued his basic research program on the structure and the dynamics of the atomic nucleus, leading several high-impact experiments at GSI (Darmstadt). He also promoted the design and construction of a new facility at the University of Santiago de Compostela aiming at investigating on laser-plasma acceleration technologies. In parallel, Prof. Benlliure contributed to educational activities of undergraduate and post-graduate students at the University of Santiago and participated in several international scientific committees.

The basic research program took advantage of the stable and radioactive heavy-ion beams delivered by GSI to develop three research lines:

Production and characterization of heavy neutron-rich nuclei participating in the stellar nucleo-synthesis r-process. The impact of this project can be evaluated from the six publications produced, including a high-impact one (Phys. Rev. Lett. 113, 022702 (2014)), seven presentations in international conferences and two PhD works.

Investigation of the fission dynamics using complete identification measurements. This work has produced until now five publications, six presentations in international conferences and two PhD works. In-medium excitation of nucleon resonances using isobaric charge exchange reactions. The scientific production in this on-going project is two publications, three presentations in international conferences and one PhD; in 2011 Prof. José Benlliure also proposed the construction of the Laser Laboratory for Acceleration and Applications (L2A2) at the University of Santiago de Compostela. The project got funded in 2013 (5,5 M) and the construction will finalize end of 2015. The

laboratory will be equipped with a high power laser (~50 TW) that should be able to accelerate protons up to few tens of MeV.

Prof. Benlliure has coordinated a team of 15 researches that have contributed to the design and construction of this Facility; Prof. Benlliure has written during this period 15 publications and has contributed to other 33, reaching an h-index of 36. He has also supervised four PhD works and contributed to 16 international conferences (eight of them by invitation). One can highlight his presentation in plenary sessions of three of the most prestigious international conferences in the field of Nuclear Physics; International Nuclear Physics Conference, Vancouver (Canada), July 2010;Gordon Research Conference on Nuclear Chemistry, New London, New Hampshire, (USA) June 2013;International Conference on Nucleus-Nucleus collisions, Catania (Italy), June 2015

Abraham Gallas Torreira

Abraham A. Gallas Torreira is a professor of physics at the University of Santiago de Compostela. He is an experimental particle physicist who is working on studies of hadron collisions produced by the Large Hadron Collider (LHC) with the LHCb experiment. This experiment was designed to search for physics beyond the Standard Model through precision measurements of CP violation and rare decays of heavy-flavoured (beauty and charmed) hadrons. Professor Gallas is the team leader of the USC at the LHCb experiment. This research team consists of 8 senior faculty members, 5 postdocs and 8 PhD students, two microelectronics engineers, a computer science, and a microelectronics technician. He has joined the experiment in 2007, he coordinated the construction, installation and commissioning of the USC contribution to the Silicon Tracker (ST) of the experiment. In this regards, he held positions in the management of the Silicon Tracker project: Deputy project leader 2009-2010-2015-present, Project leader 2011-2014. The detector performance of the ST in the LHC RUN-I has been outstanding and has allowed an excellent momentum resolution of the experiment. This, among other things, was key for the exceptional physics output of the LHCb experiment. Apart from the coordination and operation of the Silicon Tracker detector at CERN, professor Gallas has launched a new R&D line on vertexing technologies using semiconductors at USC six years ago. The goal is to build a new vertex detector (VELO) for the LHCb Upgrade. The USC joined the LHCb VELO Upgrade project, participated in the R&D and the technological choice of the detector (radiation-hard silicon pixel detectors) and will contribute to the construction of the upgraded detector as is stated into the Addendum No. 02 to the Memorandum of Understanding for Collaboration in the Construction of the LHCb Detector (October 2014). During this time he has held positions as Project Leader of different work packages inside the project.

In conclusion, he is a world expert researcher on HEP instrumentation and collider physics two of the subjects of this proposal, with proven scientific leadership skills.

Diego Martínez Santos

Diego Martínez Santos is an Oportunius Distinguished Researcher at the Instituto Galego de Física de Altas Enerxías (IGFAE) of the University of Santiago de Compostela (USC) since September 2016. After his PhD at the USC in 2010, he was a Postdoctoral Research fellow at CERN (2010-2012) and at Nikhef and VU University Amsterdam (2012-2014). He was a Corresponding Associate at CERN in 2013 and 2014 for 4 months each year. Afterwards he was an Associated Researcher at IGFAE since April 2015 until September 2016.

Diego is an experimental particle physicist who has been working on the LHCb experiment since 2005. He was the architect and main contributor of the Bs->mu+mu- measurement (for which the European Physics Society awarded him with the Young Experimental Physicist Prize in 2013), and was the convener of the B decays to Charmonia (B2CC) working group, that takes care of the Bs mixing phase (phi_s) measurement. Both achievements are extremely remarkable: the EPS prize (which for the first time was given to a sole person) acknowledges his work as main contributor of the main measurement of LHCb. The Bs->mu+mu- channel is the principal search forphysics beyond the Standard Model using rare decays. It is very sensitive to Supersymmetry. The second one is at the top of LHCb physics analysis organization (just below the Physics Coordinator and his deputy), and corresponds to the coordination (among other subjects) of the second most relevant measurement of the experiment. The measurement of the electroweak phase phi_s is one of the main CP violating studies at LHCb. It is very sensitive to non-Minimal Flavour Violating Physics, such as models with composite Higgs. In addition to these two big contributions, he was very active in many other analyses (tau->mumumu, B->mumumumu, KS->mumu, Bs->J/psi-K*, Bs- >K*K*) playing a instrumental role on LHCb physics output.

Diegos research goes beyond experimental physics, collaborating very actively with the theory community. This includes works on Supersymmetry papers as well as the organization of joint theory-experiment workshops. He has also supervised several LHCb students in their physics analysis. Finally, in 2015, the European Research Council granted him with a Starting Grant project (ERG-StG-639068). The goal of this project is to extent the LHCb physics reach to search for new physics beyond the Standard Model in the rare decays of s quarks.

In summary, Diego Martínez is a world expert in the heavy flavour experimental and phenomenology research at hadron colliders.

Enrique Zas Arregui

E Zas is responsible for the participation of Spain in the Pierre Auger Observatory which includes now two other groups, Univ. De Granada and Univ. Complutense de Madrid and director since the early nineties of the Astroparticle physics group. As a pioneer of the analysis of inclined showers he has been directing this task since the early days of

the Observatory which deals with a completely new approach. The results of this analysis have demonstrated a better performance than anticipated and have been recently published in three separate articles, one on the method another on the spectrum measurement and a third one on its immediate application to calculating the muon content of the showers (constraining the cosmic ray primary composition) which was highlighted by the Phys Rev D editors. Moreover the combination of inclined data with the events below 60 degrees has led to a significant increase in the sky coverage of the detector that has revealed a dipolar anisotropy of the arrival directions of cosmic rays of energies exceeding 8 EeV (1 EeV=10^18 eV), which will constrain the origin of these enigmatic particles. The study of inclined showers has been crucial to search for high energy neutrinos as had been anticipated by him in collaboration with J.W. Cronin, Nobel laureate responsible for the Observatory (1998 ~200 citations). This task, passed onto his former PhD student, J. Alvarez-Muñiz since 2008, has lead to 6 publications of competitive bounds, four of them in the past 4 years. Moreover the recently prepared upgrade proposal, designed to have coincident array of scintillators to identify the muon signal for composition analysis, stems from the success of a pioneered method I developed by him and L. Cazón exploiting the time structure of the muon front. He has been very active in the analysis and interpretation of results obtained with the R&D array of antennas of the Observatory, which has made significant progress in the very recent past, such as measurements sensitive to the shower energy, suggestive of a possible independent energy calibration, or measurements sensitive to primary composition.

Recently he has reinforced the work on his well known pioneering simulation of radio pulses from high energy particles (1990-92 over 300 citations), in a collaborative effort with J. Alvarez-Muñiz and invited visitors, publishing twelve articles since 2009. Particularly relevant is a simulation program (2012) that extends the original work to the atmosphere (over 40 citations), which revealed unexpected effects in the GHz range that have been confirmed with AERA and other experiments. Another result of last year deals with the effects of reflection (2014) and a most recent one is to be announced at the ICRC 2015 discussing the implications of coherence for transition radiation. These last two results will be very relevant for several initiatives trying to exploit this technique in Antarctica, searching for pulses with high altitude antennas or with arrays of antennas on the ground.

E. Zas has supervised 7 PhD theses, and some of his former students have achieved a high reputation in the field such as M. Ave (Young Scientist Award of the C4 commission of the IUPAP), J. Alvarez-Muñiz, L. Cazón and I. Valiño (now respectively co-leading the neutrino, spectrum and hadronic model groups in the Auger Collaboration).

José Daniel Edelstein Glaubach

Jose Edelstein is a professor of theoretical physics at the University of Santiago de Compostela. He studied physics at the Instituto Balseiro and did his PhD at the

University of La Plata, both in Argentina, and had postdoctoral experiences at the Universities of Santiago de Compostela and Harvard, and at the Instituto Superior Tecnico (Lisbon). He also held research positions in Argentina and Chile. He is currently co-PI of the Spanish research project of the theory group in high energy physics. His interests range from the study of non-perturbative aspects of supersymmetric gauge theories to the understanding of more mathematical subjects such as topological string theory and topological quantum field theory. He has authored 65 scientific articles with a total of 1780 citations and an h-index of 25 (source inSPIRE HEP Literature Database). He has been the supervisor of 4 PhD students and a number of undergraduates, many of whom continued their Master education at Cambridge University's Part III program. Since his postdoc in Harvard University, the AdS/CFT correspondence became the main focus of his research. In a recent paper written with Juan Maldacena, and two PhD students, he showed that weakly coupled gravity beyond General Relativity, under quite conservative assumptions, demands the presence of an infinite tower of massive higher-spin particles with a fine-tuned interaction, something that perturbative string theory displays (while there is no other theory that we are aware of accomplishing these constraints).

Prof. Edelstein also has a quite active profile in science communication, having been awarded several prizes on this field. Most notably, his book "Antimatter, magic and poetry" got the Spanish prize on science communication for university editions. He is viceleader of the Working Group on "Outreach and gender issues" in the COST European Network "The String Theory Universe" that includes researchers from 114 institutions belonging to 23 countries.

Néstor Armesto Pérez

Néstor Armesto is Professor of Theoretical Physics (Profesor Titular) at the Universidade de Santiago de Compostela (USC) since March 2010. He was previously Ramón y Cajal Researcher at the USC (2005-2010), Fellow at CERN (2003-2004), Associate Professor of Atomic, Molecular and Nuclear Physics at the Universidad de Córdoba (1998-2002) and postdoctoral researcher at LPT Orsay and at Universität Hamburg. His activities are focused on the physics of the strong interaction at high temperatures and densities, specifically on the search and characterisation of the Quark-Gluon Plasma, and the study of nuclear collisions, the description of the wave function of hadrons and nuclei and the study of Quantum Chromodynamics at high energies. All these processes have been studied experimentally in the accelerators SPS and LHC at CERN, RHIC at BNL in the US, and HERA at DESY in Germany. He was a member of the ALICE collaboration at the LHC from 2006 to 2014. He is one of the world leading researchers in the study of the initial state and jet physics in nuclear collisions at high energies, with more than 200 published articles in top journals, more than 60 invited plenary talks in conferences, including the top ones in the field, PI on 13 research grants and main organiser of some of the top conferences in the field.

At present, he coordinates research activities in the phenomenology group. Besides, he is the leader of the working group for electron-nucleus collisions in the Large Hadron Electron Collider and Future Circular Collider (in hadron-electron mode) Study Group where he was endorsed by CERN as a member of the Coordination Group for the Technical Proposal for the period 2014-2017, and convener of the WG on small-x physics for the proposal of nuclear collisions at the FCC.

D. Organization chart and governance

The following actions will be implemented to evaluate and follow the progress of the SRP

IGFAE MONITOR.

The Institute will set up a monitoring and evaluation system of its performance. Particular attention will be given to exploratory lines that are expected to be more dynamical, due to either external or internal scientific circumstances (e.g. a new experimental facility which is not approved or which is decided not to be prioritized by the Institute) or to priority changes in the funding agencies. A systematic evaluation will guide the strategic decisions steering the future of the Institute.

We will complement this evaluation and follow up with an additional competitive intelligence exercise (Matheo Analyzer) to have a better understanding of the most attractive opportunities for IGFAE, both in terms of new research topics as well as in potential partnerships with other organizations.

NEW GOVERNANCE MODEL.

This decision-making mechanism based on systematic evaluation of the unit will be implemented in compliance with international project management standards. The new governance model wants to take in consideration the principles of Responsible Research & Innovation, especially those related to transparency and the stakeholders involvement in the IGFAE's government bodies. The following managerial structure will be put into action

Scientific Director: The person in charge of the execution of the Strategic Plan

Local Steering Committee: Composed of six members representatives of the Strategic Research Areas and the Scientific Director.

International Advisory Board Composed by:

- Sergio Bertolucci (CERN Scientific Director until 2016)
- Larry McLerran (Institute of Nuclear Theory, Seattle, Director)
- Paulo Giubelino – (GSI/FAIR Scientific Director)
- Francis Halzen (Director of Inst. for Elementary Part. Phys. Research, Wisconsin)
- Fernando Quevedo (ICTP Director)

ROLES OF THE MANAGERIAL BOARD

The Scientific Director will take the executive responsibility of the IGFAE's Strategic Plan and will play an active role in the internationalization of the unit keeping contact with the local and national entities and stakeholders. He will be the primary contact with the International Advisory Board for consultation.

The Steering Committee is the main forum for decision-taking based on continuous assessment and on competitive intelligence strategy. It will follow the progress of the different lines towards the goals of the Strategic Plan developed here; it will be the decision-taking body in the recruitment policy, international relations and evaluation; it will also take decisions on internal Project calls, especially those involving different groups of the unit and those related with the more exploratory subjects.

Each Strategic Area and the horizontal line will have one person in charge of coordination that will report to the Scientific Director and to the Steering Committee. Talent and Tech transfer Programs will have two conveners to coordinate the actions. Coordinators and conveners will be decided by the Steering Committee.

The Steering Committee will meet on a bimonthly basis to follow the degree of progress for the different strategies marked in this document. The IAB will be contacted in case underperformance or strategy plan change is identified in one of the steering committee meetings.

MANAGEMENT UNIT.

Finally, the IGFAE will strengthen their management capacity by hiring a chief operations officer (COO) to improve the chances of success of the whole Plan. The COO will be in charge of, among other responsibilities, doing fundraising activities (European funds, philanthropists, companies, etc.), managing the IGFAE participation in international experiments and launching the IGFAE Monitor.

E. Adscription of members

The IGFAE´s excellent research is based on the best talent hired and trained during the last years. As we explained before, attracting new talent is one of the main objectives of our Strategic Plan, in particular excellent researchers close to independence that could boost the Institute scientific performance and open new lines of research. Our plan includes a strong program to that end which we will complement with external schemes, especially the newly created Oportunius program by Xunta de Galicia, which offers very competitive contractual conditions for ERC grantees. The Ramon y Cajal program will also be used, complemented with existent starting packages from Xunta and other sources. These exceptional and young researches being attracted should have the potential to become future leaders at the international level while pursuing their careers at our Institute.

IGFAE aims to raise talent attraction process to a new level allowing to

- ❏ have a lever action with other national (Oportunius Program, Ramon y Cajal, or La Caixa Fellowships) and international resources (ERC-STG, Marie Curie, etc.).
- ❏ offer the best research environment and international research networking.
- ❏ give the best career development, advice and training.

In addition, we will follow the recommendations of the European Charter and Code for Researchers assuming that mobility is inherent in a research career. Therefore, we will endow our researchers with the capacities enabling them to work in other cultural environments (international mobility), tackle projects that combine different disciplines (interdisciplinary mobility) or explore career opportunities outside academia (inter-sectoral mobility).

This plan on talent management is based on the following objectives:

O6. Improve doctoral and postdoctoral skills (training courses, training and support facilities and overall management of trainees)

O7. Recruit excellence research staff, including international top researchers

O8. Encouraging research mobility (inter-sectoral, interdisciplinary, international & virtual)

O9. Address the gender gap

TRAINING AND TALENT SUPPORT

NEW INTERNATIONAL PH.D TRAINING PROGRAM IN PARTICLE PHYSICS

(including reviewed academic and non-academic topics) A multidisciplinary approach will be considered as a key element to guarantee a diverse career path and cross-fertilization of ideas. The PH.D programme participates in the IDPASC (International Doctorate Network in Particle Physics, Astrophysics and Cosmology), a

consortium of 27 universities and research institutes in Europe, and in the ISAPP (International Schools in AstroParticle Physics), a network of doctoral schools in 33 institutions organizing a common curriculum in the field, so that international mobility actions will be mandatory. The mobility actions will also include research stays abroad (e.g. CERN, Oxford, UPMC, Padova, GSI, Frankfurt, Brookhaven, etc), collaborations with international partners and attendance to international conferences and workshops.

NEW INTERNATIONAL POSTDOCTORAL TRAINING PROGRAM.

The Postdoctoral Training Program will be a major asset to support IGFAE's scientific goal.

Participants will be selected by a competitive peer-review process. Selected Fellows will be provided with research funds as well as a departmental mentor, an office and Access to international cutting edge experimental infrastructures such as CERN, GSI, Pierre Auger Observatory, etc. Their participation in international meetings and workshops will help them to create a solid scientific network (virtual mobility), broaden their scientific horizons (interdisciplinary mobility) and boost their scientific career not only in academia but also in collaboration with the industry (inter-sectoral mobility).

Advertising on international platforms (Academics Jobs online, https://academicjobsonline.org/ajo) and several communication actions will be deployed by the IGFAE's Steering Committee to guarantee the recruitment of trainees.

The candidates for the INTERNATIONAL POSTDOCTORAL PROGRAM shall pass the following selection criteria:

- ❏ First of all, it will be mandatory to follow the rules of the doctoral school of the Universidad de Santiago, as well as national and European regulations.
- ❏ Each candidate will be reviewed by the Selection Committee to check their qualifications, scientific skills and attitude towards the program.

CAREER DEVELOPMENT PLAN

IGFAE's Career development of researchers in training will be complemented by the following set of actions:

(A) Supervision and mentoring. All the candidates will have a supervisor or mentor to guide their decisions about their careers to take advantage of the best opportunities that arise during their stay in the IGFAE.

(B) International networking. The IGFAE will provide, through its international networks, different opportunities to support the participation of students and R&D staff in activities with foreign researchers.

(C) Funding: Scientists will be encouraged to participate intensively in international funding programs to attract talent, from European Commission programs, including individual grants and international Research Training Networks, fellowships, etc. In particular, it is planned that the International Postdoctoral Program will be funded

through the EC sponsored COFUND and ERC for postdoctoral training and mobility, while the International predoc program will be founded by Subprograma Estatal de Formación, Marie Curie ITN, etc. Good international researchers will also be helped and encouraged to apply to Marie Curie IEF grants - a good success rate was already obtained in the last three calls but the number of applications should be increased.

(D) Selection: The pre-selection of Post docs, Pre Docs and technicians will be based on the candidate's CV, reference letters and on the research interests. Short-listed candidates will receive invitations to visit the IGFAE for a 2 day period of interviews. Candidates will be interviewed, with travel costs paid by IGFAE, to evaluate not only their research experience and potential but also their ambition for excellence and potential for team spirit. Selection process at postdoctoral level will include a presentation of research performed and an additional requirement, related to the capacity of leading research tasks and train young students, will be examined. Offers will be made to the successful candidates shortly after the interview period.

Continuous headhunting of potential new group leaders to identify and recruit will include targeting relevant research centers and conferences and posting advertisements on international science recruitment websites.

(E) Stipends: Both to the IGFAE International PhD and Post doc programs, allowing the incorporation of highly talented and motivated students will offer: 2-year contract with a competitive salary and access to mobility scholarships for post-docs and 3-year contract and access to mobility scholarships for pre-docs.

(F) Continued evaluation process: A committee comprising faculty from IGFAE will review the research results and general performance for pre-doc and post-doc researchers.

TALENT ATTRACTION AND LEADERSHIP DEVELOPMENT

GLOBAL TALENT PROGRAM.

Activity aimed to attract promising and/or outstanding researchers to the IGFAE to develop their ideas and projects. This program will offer not only an excellent scientific environment and a state-of-the-art R&D conditions, but a tailor-made career development program aimed to fit with these researchers expectations.

This program is one of the main additions of the present Strategic Plan for the Institute, which will allow to plan and select the best candidates. The strategy would be to hire for 3 years ERC-level international researchers with very competitive salaries and conditions, with the compromise to apply for ERC during the second year. Therefore, participation in this program also carries a Package Starting Grants, composed by seed money for travelling, equipment, as well as technician and postdoc positions for their new research lines.

The candidates that want to access to the GLOBAL TALENT PROGRAM will run a highly competitive process and only a maximum of 4 candidates will finally join the Program. This means that:

- ❏ Only applications from researchers with outstanding qualifications will be accepted.
- ❏ The process will include a peer-review from a group of senior researchers.
- ❏ Candidates will be asked to propose a 3 years research plan.
- ❏ Candidates will be asked to apply to ERC grants during the second year of the program.

CREATE A SEARCH COMMITTEE in charge of looking for qualified scientific personnel susceptible of being recruited, publicize positions, and guide the recruitment process (Invitation for a seminar, interviews with IGFAE researchers, etc.). The Steering Committee will also be in charge of asking support to the Scientific Advisory Board and selecting candidates.

SOFT SKILLS TRAINING AND LEADERSHIP PROGRAM.

Following the standards of the European Charter and Code for Researchers and HRS4R quality label, a wide range of transferable skills training activities will be offered to all IGFAE researchers focused on improving:

- ❏ The mobility of researchers (international, interdisciplinary, inter-sectoral and Virtual).
- ❏ Scientific leadership capabilities, specially for postdocs candidates.
- ❏ Supervision and mentoring abilities of senior researchers and group leaders.

This program is designed to build internal capability to train researchers at IGFAE through a three-pronged approach. All the activities will be based on the implementation of the CRAC Vitae Research Development Framework. For this, we will ask for collaboration of this institution, the Barrié Foundation (foundation that is promoting the implementation of the RDF in Galicia) and professionals with proven experience in talent development.

The first part of the program will concentrate on the supervision and mentoring relationships as a core aspect of the successful professional development of researchers. Supervisors and mentors from IGFAE will be invited to different training sessions, covering mentoring skills for supervision and an introduction to using the Vitae Researcher Development Framework (RDF) in supervision and mentoring conversations.

A second part of the training program will be oriented to train doctoral and postdoctoral researchers. It will focus on developing competences for successful self-management and development during the doctorate, such as:

- ❏ building understanding, capability and confidence in communication.
- ❏ planning and time management.

- problem solving.
- leadership and assertiveness.

And, finally, a third part of the program, **leadership in action**, will enable postdoctoral researchers and research staff to explore and develop their leadership skills in a highly practical and experiential learning environment.

IGFAE ALUMNI.

The Institute is aware that can not keep and manage all the talent that is formed or developed in its laboratories; however, the IGFAE can manage present and future relationships with this talent. Therefore, the Institute will promote its own Alumni networking, IGFAE Alumni, fostering relationships with universities, research centres, institutions and companies in which they are located. IGFAE Alumni will also be useful for sharing information about opportunities for talent programs, research projects and research and innovation networks. The Alumni will be one of the instruments in order to identify potential partners to implement the SRP. Finally, this network will generate employment and career development opportunities for students and researchers in training at the Institute.

The first step in creating the network will be the development of a tracking report to know the professional status of the latest cohort of researchers trained at IGFAE and have a starting point to deepen contact with potential members. From there, the relationship with the Alumni will be articulated through the invitation to participate in IGFAE scientific activities (seminars, workshops, retreats, etc.), in the website and in diverse networking events organized by the Institute.

GENDER ACTION PLAN

Gender equality is enshrined as one of the key elements of the European Charter for Researchers and is one of the fundamental principles of the Responsible Research & Innovation (RRI) and the HRS4R quality label of excellence scientific talent management.

We strongly believe that every individual, irrespective of gender, race, religion, age and other social characteristics, should have the same opportunities when embarking on a scientific career, based on her/his individual talents and disposition.

Scientific excellence also involves harnessing the potential of all the talent available and taking measures to facilitate conciliation between personal and professional responsibilities, as well as promoting the scientific career development.

Currently, at IGFAE the gender composition is distributed as follows: IGFAE personnel (only researchers, pre and post docs students) included 74 people, 15 of them are women (20%): 3 of them as research professors (in the Theoretical Physics, Nuclear Physics research areas), 5 post-docs and 7 pre-docs students. Thus, the equal representation of women is not fulfilled in IGFAE, as happens in the majority of physics research.

However several actions will be addressed:

POSITIVE RECRUITMENT AND TALENT MANAGEMENT PROGRAMME.

Gender equality will be promoted:

- ❏ to develop and access to the scientific career. The selection committee will be trained in gender equality and have a balanced women/men ratio.
- ❏ to participate in professional development programs, paying particular attention to career advancement opportunities within the IGFAE. All female postdoctoral researchers at exploration or progression to Independence steps will access to the skills leadership program (leadership in action) in order to explore their potential to become as future senior researcher or group leader.
- ❏ to design measures to facilitate personal and professional conciliation, especially as regards STOP-THE-CLOCK POLICIES for tenure and tenure track researchers periodical evaluations. Tenure stop-the-clock policies allow tenure-track faculty members to take a temporary pause from their tenure track, usually after the birth or adoption of a child.
- ❏ to access to the board. Managerial positions to be contracted at IGFAE will be selected taking into account their qualifications and suitability for the work and gender issues.
- ❏ to monitor and evaluate the activities of the Institute. The Monitor IGFAE include gender specific indicators that allow monitoring the progress of the Institute in this regard. Some of the most important indicators to consider are:

  1. Number (and %) of women recruited within the institution.

  2. Number (and %) of women in the external scientific advisory committees.

  3. Number (and %) of women involved at highest decision-making level.

  4. Number (and %) of senior researchers for which a stop-the-clock policy has been implemented.

WOMEN EMPOWERMENT.

It aims to encourage women to actively participate in international scientific boards, presenting IGFAE in relevant international forums, etc. We offer opportunities for female scientists to participate in internally or externally organized networking organizations within our scientific working environment. Here we explicitly support women to take an active role in the scientific community, thereby enhancing the visibility of women in their field of expertise.

GENDER INFORMATION DISSEMINATION

Specific actions within the Institute to increase gender equality may entail: Organizing workshops to raise awareness about the need to increase gender equality, to which everyone independent of his/her position, will be invited to participate.

Educating all members on the unspoken societal rules, which dictate the role of the different genders in the workplace by applying the RRI principles on gender issues, which will be distributed to all members, with documents placed on the intranet along with references to other pertinent websites.

E. Synergies and specific actions

LAUNCHING OF NEW PROJECTS

IGNITE PROGRAM. The Institute will launch two calls during the period to facilitate the definition of specific projects to develop the SRP. Absolute priority will be given to new ideas with high potential to make them ready for external funding. These seed grants will contribute to open new RL aligned with the strategy of the Institute. Interdisciplinary research will also be favored.

Complementary to this program, we are going to organize different collaborative research retreats where these opportunities of collaboration can emerge and be discussed. These retreats will be focused on exploring the synergies between the IGFAE groups and will be also open to invite researchers from other local, national and international institutions.

INTERNATIONALIZATION.

One of the strategic objectives of IGFAE is to reinforce and consolidate its international leadership as a global reference Centre in Particle, Astroparticle and Nuclear Physics, by increasing its presence in international consortiums, by the use of available tools for individual European projects and by establishing strategic partnerships with international actors. The degree of internationalization, especially in terms of participating in international experimental collaborations and the success in EU calls, is already very high. We propose actions to improve the participation in these consortia; to increment the international funding, especially from H2020; to enhance the returns from our participation in the experimental collaborations; and to increment the mobility for training of young researchers. The internationalization process is inherent to the whole SRP and we quote here some particular actions to improve it.

As presented before, one of the main strategies for the future, along with training at the early-stage career, is to attract excellent researchers at the experienced postdoctoral level with a clear career path to independence based on specific evaluations Global Talent Program. These researchers will be hired with the condition that they must apply to ERC grants. Thus, only excellent profiles will be selected. The excellent performance of our Institute in terms of ERC Starting Grants in the last years indicates that this is path to follow is both right and feasible. At the same time, our present senior staff has a profile in terms of international reputation and visibility that fits perfectly the H2020 calls, especially those from the ERC. Some of the actions presented here attempt simply to exploit this potential.

The implementation of human resources tools in order to develop an international scientific carrier for group leaders, Pre- and Post-Doctors, converge on the common objective of fostering international incoming and outgoing mobility. Also, on the goal of attracting new international staff.

These efforts to increase international mobility with other high level research institutions for research and training purposes will be complemented by the additional actions mentioned above.

In this sense, the **internationalization objectives of the IGFAE are**:

O10. Strengthening the IGFAE´s scientific leadership.

O11. Increasing the participation in international consortiums.

O12. Attracting new international staff.

O13. Increasing the number of staff recipients of international grants (ERC, Marie Curie,).

O14. Increasing the amount of international competitive funds.

ACTIONS TO IMPROVE INTERNATIONAL PERFORMANCE

PLAN OF PARTNERSHIPS TO SUPPORT INTERNATIONAL ACTIVITIES (PROJECTS, MOBILITY. TRAINING. ETC).

In order to strengthen international scientific leadership and develop the research activity at the highest level, IGFAE needs interdisciplinary cooperation with renowned international research institutions. Our strategy relays on joining efforts, resources and expertise with the best researchers outside our borders.

In order to achieve the objectives of strategically increase the presence of the IGFAE in international consortiums, research networks and reach their goals of scientific production at the highest level, the Group leaders, with support from the new Management Unit and the USC European Projects Office, will:

- ❏ Apply to Marie Curie ITN, COST actions, ERA-NET calls and to other interesting programs to extend international relationships.
- ❏ Promote the creation and consolidation of key strategic partnerships to support international activities. In order to concentrate IGFAE's efforts, we will sign a strategically alliance with other selected institutes with a preference for international laboratories like CERN, GSI, etc., with the aim of reinforcing the participation in international projects, big international consortiums, European networks, training and mobility activities, etc.
- ❏ Increase the presence of IGFAE and improve leadership positions in international research consortia. In this regard, it is worth noting that the IGFAE is already involved in international consortia (eg, HELEN, HADRONPHYSICS,...) and leads the some aspects within the international collaborations, e.g. the upgrade of the VELO detector in the LHCb Collaboration at CERN ,or the CALIFA calorimeter in R3B experiment at GSI/FAIR. The critical assessment and permanent exploration of the different opportunities made by the Horizontal Line Strategies for new facilities will be the main tool in this direction.

FUNDRAISING COUNSELLING & TRAINING PROGRAMME.

The H2020 program, specifically the Marie Sklodowska-Curie individual fellowship calls and the ERC calls, is an opportunity to maximize our research production. They have become the main financial instruments to support our research activities, covering almost all our scientific disciplines. For this reason, IGFAE researchers will be supported to access training and assistance activities organised both locally, e.g. by Gain (Xunta de Galicia) or Feuga (Galician universities) and internationally, to improve their success options.

In the specific case of ERC calls, proposal success is not only due to numbers but to quality. The identification of potentially successful ideas and the capability to develop adequately the fundamental aspects of the idea, is key to achieve the success. IGFAE has some of the most prestigious researchers in Particle, Astroparticle and Nuclear physics. Because of that, the presentation of new proposals, both from Senior researchers and from Junior researchers eligible for Starting or Consolidator funding, will be promoted.

It is particularly important to support Junior researchers who need additional support in preparing their proposals, both for the documentation presented in the first phase of evaluation and during the preparation of the interviews in the second phase. Therefore, Junior researchers will be advised by the Steering Committee formed by IGFAE researchers who already got and ERC grant.

INTERNATIONAL FUNDRAISING PLAN.

The Management Unit, with the collaboration of the USC R&D Office, will assist the researchers throughout the process related to attraction of international, public and private funds. In this sense, the compliance analysis of the research groups requirements for each call and support in proposal preparation is essential to ensure success in getting the funding eventually granted.

According to this strategy, individual meetings will be set up with team leaders in order to analyse the research areas, the planning and funding in the short and medium term, and the feasibility of proposals lead by IGFAE when appropriate. The individualized counseling will take into account:

- ❏ The selection of funding research sources and "Call tracking" according to the needs and possibilities of the research team;
- ❏ The opportunities to provide support for finding partners for collaboration projects that conform the characteristics of the research team;
- ❏ The possibilities to sharpen the definition of proposals, and to help with the verification of the compliance requirements of the Call, with the procedures to follow up, and with the information and documentation review, with the aim of presenting an application with the highest success potential.
- ❏ The monitoring and evaluation tasks required in the preparation stage and in the implementation of achieved projects: signing of the "grant agreement",

development of management plans, coordination, transfer and exploitation of the results contained in the Collaboration Agreement of the projects.

ACTIONS WITHIN THE EUROPEAN RESEARCH AREA

Finally, the contribution of IGFAE to build the European Research Area (ERA) will be the encouragement of researchers, and of other research institutions and businesses, to work and co-operate. IGFAE members, with the trigger and support of the MANAGEMENT UNIT, will:

LEAD AN INTERNATIONAL TRAINING NETWORK (ITN), and participate in at least 2 ITN.

PARTICIPATE IN 3 ERA-NET. Concrete examples are Hadron and Nuclear Physics; Fixed target experiments; and New facilities.

IMPLEMENT THE C&C The recruitment process is centralized at the University of Santiago, who is at present working on the Gap Analysis and Action Plan and was recently received the HR Excellence in Research Award (HRS4R). IGFAE will automatically implement the Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, (C&C) principles, enhancing the attractiveness of IGFAE to talented researchers. One of the main action will be establishing the bases for a PhD and postdoctoral Career development plan.

Annex 1
Gantt Chart

	ACTIONS	TARGETS (period 2018-2021)		2018				2019				2020				2021			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
8.1 RESEARCH PROGRAMME																			
1	8.1.1 SCIENTIFIC RESEARCH PROGRAMME	400	scientific publications IF>5 (JCR)	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
2	8.1.2 IGNITE PROGRAM	12	projects presented(2 calls)		▶									▶					
3	8.1.3 IGFAE MONITOR	1	monitoring and evaluation system set up				▶												
4	8.1.4 NEW GOVERNANCE MODEL	1	new model running		▶														
5	8.1.5 MANAGEMENT UNIT	1	chief operations officer recruited		▶														
8.2. TRAINING AND RECRUITING STRATEGIC OBJECTIVES 2017-2020																			
6	8.2.1. NEW INTERNATIONAL PH.D TRAINING PROGRAM IN PARTICLE PHYSICS	40	PhD students trained			▶				▶				▶				▶	
7	8.2.2. NEW INTERNATIONAL POSTDOCTORAL TRAINING PROGRAM	20	Post Docs fellows trained			▶				▶				▶				▶	
8	8.2.3. CAREER DEVELOPMENT PLAN IGFAE´S	1	Career development plan runnig			▶													
9	8.2.4. GLOBAL TALENT PROGRAM	8	candidates join the programme				▶	▶											
10	8.2.5 CREATE A SEARCH COMMITTEE	1	Search Committee running			▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
11	8.2.6 SOFT SKILLS TRAINING AND LEADERSHIP PROGRAM.	40	researchers trained			▶				▶				▶				▶	
12	8.2.7. IGFAE ALUMNI	60	alumni identified			▶													
13	8.2.8. POSITIVE RECRUITMENT AND TALENT MANAGEMENT PROGRAMME	25%	of women in research staff			▶	▶	▶											
14	8.2.9. WOMEN EMPOWERMENT	20%	of women taking an active role in the scientifi		▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
15	8.2.10 GENDER INFORMATION DISSEMINATION	2	of dissemination events		▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
8.3. INTERNATIONALIZATION																			
16	8.3.1. PLAN OF PARTNERSHIPS TO SUPPORT INTERNATIONAL ACTIVITIES (PROJECTS, MOBILITY	10	partnerships		▶														
17	8.3.2. FUNDRAISING COUNSELLING & TRAINING PROGRAMME	25	atendees			▶													
18	8.3.3. INTERNATIONAL FUNDRAISING PLAN	12	european propposalls applied			▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
19	8.3.4: LEAD AN INTERNATIONAL TRAINING NETWORK	15	students trained			▶													
20	8.3.5 PROMOTE AN ERA-NET	3	propposals applied at the ERA net		▶														
21	8.3.6. IMPLEMENT THE C&C	1	C&C running		▶														
8.4. EXPLOITATION AND DIFFUSION OF RESEARCH OUTCOMES 2017-2020																			
22	8.4.1. IP PORTOFOLIO ASSESMENT	5	TT oportunities		▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
23	8.4.2. FROM SCIENCE TO BUSINESS TRAINING PROGRAM	20	atendees		▶				▶				▶				▶		
24	8.4.3: HACKATHON IN MEDICINE WITH PHYSICS	40	atendees		▶				▶				▶				▶		
25	8.4.4. TECHNOLOGY UPDATE SEMINARS	20	atendees			▶				▶				▶				▶	
26	8.4.5. IGFAE EDUCATIONAL COMMUNITY	500	atendees				▶				▶				▶				▶
27	8.4.6 IGFAE SCIENCE WEEK	250	atendees			▶				▶				▶				▶	
28	8.4.7. IGFAE ON THE STAGE	250	atendees		▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶	▶
29	8.4.8. COMMUNICATION TRAINING SKILLS SEMINARS	15	atendees			▶				▶				▶				▶	

Set up period ▶ milestone

Annex 2 - Budget

Program	Unit cost	Units	TOTAL	%	Annual average
RESEARCH					
Ignite Program	85.000	2	170.000	8,50%	42.500
Complement Global Talent Program	15.000	12	180.000	9,00%	45.000
Workshops & Collaborative Retreats	3.000	4	12.000	0,60%	3.000
IGFAE Conference	20.000	1	20.000	1,00%	5.000
		TOTAL	**382.000**	**19,10%**	**95.500**
TALENT					
Predoctoral grants (R1)	35.000	-	-	0,00%	-
Postdoctoral grants (R2A y R2B)	40.000	4	320.000	16,00%	80.000
Global Talent Program (R2C)	50.000	4	600.000	30,00%	150.000
Search Committee	10.000	1	10.000	0,50%	2.500
Management staff	25.000	4	100.000	5,00%	25.000
Technical staff	36.000	4	144.000	7,20%	36.000
		TOTAL	**1.174.000**	**58,70%**	**293.500**
CAREER DEVELOPMENT					
Training Skills for young researchers (R1 and R2A - R2B)	10.000	3	30.000	1,50%	7.500
Leadership in Action (R2C and R3)	10.500	2	21.000	1,05%	5.250
Training for Supervisors and mentors (R2C, R3 and R4)	8.000	2	16.000	0,80%	4.000
Study of tracking	15.000	1	15.000	0,75%	3.750
Technical support for talent management	12.000	1	12.000	0,60%	3.000
		TOTAL	**94.000**	**4,70%**	**23.500**
TECH TRANSFER & OUTREACH ACTIVITIES					
IP Portfolio	10.000	2	20.000	1,00%	5.000
Educational project	10.000	2	20.000	1,00%	5.000
		TOTAL	**40.000**	**2,00%**	**10.000**
Audit	10.000	1	**10.000**	**0,50%**	**2.500**
OVERHEADS	75.000	4	**300.000**	**15,00%**	**75.000**
		TOTAL	**2.000.000**	**100,00%**	**500.000**