



IGFAE
Instituto Galego de Física de Altas Enerxías



**XUNTA
DE GALICIA**

Annual Report 2019

Instituto Galego de Física de Altas Enerxías (IGFAE)

July 8th 2020



**EXCELENCIA
MARÍA
DE MAEZTU**

Instituto Galego de Física de Altas Enerxías (IGFAE)

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Index

INTRODUCTION	4
ORGANIZATION & TEAM	7
HUMAN RESOURCES	9
AWARDS	10
ERC- Advanced Grant to Carlos Salgado	10
Honourable mention of the Gravity Research Foundation to José Edelstein	10
Best PhD thesis in Experimental Particle Physics award to Julián García Peñas	11
Lois Peña Novo 2019 award to Carlos Salgado	11
Einstein para perplejos, Prisma 2019 for the best popularization book to José Edelstein	11
FINANCES	12
Fundraising	12
Active Projects	14
RESEARCH OUTPUTS	15
Publications	15
Theses	15
ALLIANCES & NETWORKS	16
Alliances with international centres:	16
Cooperation with research centres and universities:	17
Research networks:	17
Training and Doctorate networks:	18
RESEARCH ACTIVITY: STRATEGIC AREAS (SA)	18
SA1 – THE STANDARD MODEL TO THE LIMITS	18
SA1_LHCB: Beyond the Standard Model with LHCb	18
SA1_HQCD: Hot and dense QCD in the LHC era and beyond	23
SA1_STRI: String theory and related fields	24
SA2 – COSMIC PARTICLES AND FUNDAMENTAL PHYSICS	26
SA2_NEXT: Dark Matter and the nature of neutrinos	26

SA2_AUGE: Extremely energetic cosmic rays & neutrinos – Large exposure experiments	29
SA2_GRWA: Gravitational Wave Astronomy	32
SA3 - Nuclear Physics from the Lab to Improve People's Health	33
SA3_NUCL: The structure of the nuclear many-body systems and its astrophysical and cosmological implications	34
SA3_LACC: Exploitation of the Laser Laboratory for Accelerator and Applications	37
HORIZONTAL LINE: STRATEGIES FOR NEW FACILITIES	39
SCIENCE & SOCIETY	41
Outreach Activity	42
International Masterclass in Particle Physics (LHICMC19)	42
Scientific Summer Campus (FECYT)	42
Summer Fellowships	43
2 nd Science Week 2019: Particle Accelerators	43
Conference	44
Gender Working Group	46
Masterclass "Day of Women and Girls in Science"	46
Minorities in Science: friendly conversations about equity and inclusion	46
Activity of the "Labs"	47
ArtLAB:	47
EduLab	48
TechLab	49
Other activities	49
USC Innovation Faire	49
Public talks	50
EDITIONS	51
Unha breve historia do tempo	51
Ciencia y un gran paso para la humanidad	51
IMPACT IN MEDIA AND SOCIAL NETWORKS	51

ANNEX 1: PERSONNEL IGFAE	53
ANNEX 2: ONGOING PROJECTS	58
ANNEX 3: PUBLICATIONS	61
ANNEX 4: FIGURES	87
ANNEX 5: TABLES	89

INTRODUCTION

This document reports on another prolific year for our Institute, full of changes, with a big progress in terms of the strengthening of the project and with excellent scientific results. The plans included in the Maria de Maeztu Unit of excellence that, in practice, started to be implemented in mid-2018, are in a clear process of consolidation. The new researchers hired through the Global Talent program are attracting external funds and the corresponding new research activities, as well as the new Research Program in experimental detection of gravitational waves, are producing good science in international standards. During this year, another relevant action from the Maria de Maeztu proposal, the IGFAE IGNITE Program, was put in place. IGNITE funds new ideas that have the potential to become relevant research activities at the Institute and attract external funds. Three projects have been granted, all lead by junior staff researchers:

- *PHARMI: Phoswich scintillator assembly for medical imaging* (PI Pablo Cabanelas)
- *Codex-b, an experiment to unveil BSM physics searching for Long Lived Particles* (PI Xabier Cid)
- *Gas TPCs with fast timing capability (To) for the DUNE Near Detector* (PI Diego Gonzalez)

Because of one of this seed projects, the Institute has joined the DUNE collaboration in 2020. The mid-term report of the Maria de Maeztu unit of excellence was submitted in fall 2019 and we expect the report from the Spanish ministry in the near future.

A key activity for the Institute in 2019 was the application to the call from the Galician Regional Government for the Network of Research Centres of Galicia. Resolved in December 2019, for the first time IGFAE is included in this network of research centres, ensuring a much more stable future – this network is part of a long-term plan that include all Galician centres supported by the regional government, with periodical evaluations to fix the amount of funding. The strict evaluation is performed by an external committee. Our Institute was placed first in the rank of all the centres, securing the maximum possible funding (1MEuro per year until 2022). It should be noticed that joining this stable network of research centres in Galicia was one of the main objectives of many of the activities in the last years.

During 2019, a discussion about the new premises for IGFAE was also carried out and an agreement has been reached in the Governing Board of the Institute to refurbish a large surface of the Monte da Condesa building (where IGFAE is now) to fulfil our needs. The project will increase the total surface of the Institute by around an extra 70% but, most importantly, new laboratories will be built in the basement to address one of our historical deficits. Equipment for these laboratories has been also started to be bought in the last couple of years thanks to six successful projects for experimental infrastructures of the Spanish Ministry. Before the Covid19 crisis the works for the new premises were expected to start in fall 2020 but some delays are now expected. We include in the report the first ideas for the new premises that should crystalize in an actual building project expected to be developed in the second half of 2020.

We have also redefined our Responsible Research and Innovation actions in a more structured way, creating the "Labs", that are meant to be spaces for dialog and creation aiming at new ways to communicate with society and respond to its needs. The first of these new proposals is the *ArtLab*, a space of dialog and research on the connection of Arts and Sciences, with several activities in 2019 and with the participation of the Galician Centre of Contemporary Art. A second "Lab", *EduLab*, is being created to contribute to improve how science, and in particular Physics, is taught at schools. A third one, *TechLab*, is expected to be implemented in the second half of 2020. The idea behind these structures is that they are formed by members of IGFAE but also members *external* to the IGFAE that work together in common goals. The Institute has also increased the outreach activities with the first IGFAE Open Day where general public was invited to visit us, especially children and families. This activity was the closing of an IGFAE Science Week when plenty of activities were performed.

Special attention has been taken to diversity. We celebrated for the first time the International Masterclass on Particle Physics during the "Day of Women and Girls in Science" that very successfully gathered several tens of high school female students from Galicia. This day was appraised very highly by the participants and will, indeed, become one of IGFAE annual activities. The members of the Gender Working Group have also actively participated in meetings that help us to shape useful actions towards improving the diversity in our Institute.

We have also enlarged our group of collaborating institutions and participation in international consortia. We have already mentioned DUNE and the Galician Centre of Contemporary Art (CGAC). We have also started an important joint venture with the Galician Supercomputing Centre (CESGA) with a first action to cope with the demanding needs of computing resources of the LIGO collaboration and the local Gravitational Wave activities. This action is expected to be extended to the LHCb Collaboration and the rest of the Institute. Moreover, CESGA is designing its new supercomputer (Finisterrae III) for which several meetings to understand our needs took place. Several members of IGFAE have also received important awards and recognitions as the nomination of Elena Ferreiro as chair of the Governing Board of the Strong2020 consortium or the ERC Advanced Grant "Yoctosecond Imaging of QCD collectivity using jet observables (YoctoLHC)" awarded in 2019 to the Institute.

Finally, it is also worth mentioning that the support of the private sector (in particular the support of Banco Santander and La Caixa Foundation) has contributed to our strategy of talent attraction and training. We have also launched, for the first time a program of summer grants to support 10 students during a summer month at IGFAE. Interestingly, the program was also open to non-STEM students that brought to IGFAE a student in Economics, interested in Innovation, and another student in Communication.

This document reports on the activities of the Institute for 2019, its scientific production and, most importantly, presents the highlights of our different Research Programs.

Carlos A. Salgado
IGFAE Director

ORGANIZATION & TEAM

The scientific research of the Institute is organized into three **Strategic Research Areas (SA)** with several Research Programmes (RP). While in the future these could be subject to changes following the strategy of the Institute, the configuration of Strategic Areas and Research Programs has not changed in 2019. The scientific structure is the following:

SA1. The Standard Model to the Limits. Convener: Elena González Ferreiro.

SA1_LHCB. Beyond the Standard Model with LHCB.

SA1_HQCD. Hot and dense QCD in the LHC era and beyond.

SA1_STRI. String theory and related fields.

SA2. Cosmic particles and Fundamental Physics. Convener: Jaime Álvarez.

SA2_AUGE. Extremely energetic cosmic rays & neutrinos – Large exposure experiments.

SA2_GRWA. Gravitational Wave Astronomy.

SA2_NEXT. Dark Matter and the nature of neutrinos.

SA3. Nuclear Physics from the lab to improve people's Health. Convener: Dolores Cortina

SA3_NUCL. The structure of the nuclear many-body systems and its astrophysical and cosmological implications.

SA3_LACC: Exploitation of the Laser Laboratory for Accelerator and Applications

Strategies for new facilities. Convener: Nestor Armesto.

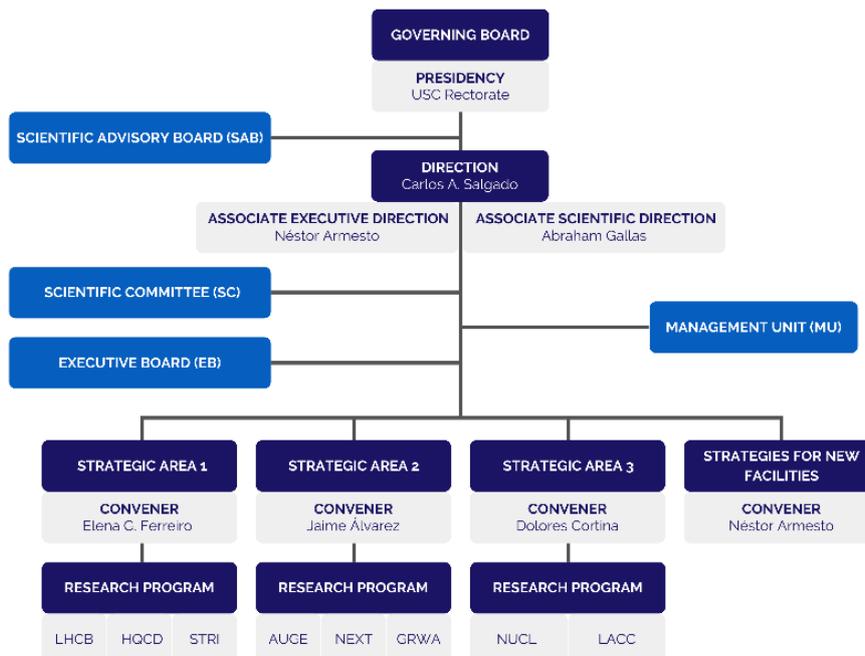


Figure 1. Organization chart.

GOVERNING BOARD (XUNTA DE GOBERNO)	DIRECTION
<p>Members representing U Santiago de Compostela</p> <p>Antonio López (USC Rector – GB Chair)</p> <p>Vicente Pérez Muñuzuri (USC Vicerrector for Research)</p> <p>Máximo Plo Casasús</p> <p>Members representing Xunta de Galicia</p> <p>José Alberto Díaz de Castro (Srio.X. de Universidades)</p> <p>M^a Jesús Tallón Nieto (Subdtora X. Promoción Científica)</p> <p>Faustino Roura Infante (Respons. Servizo de Planificación e Estructuración de Investigación).</p>	<p>Carlos Salgado (Director)</p> <p>Abraham Gallas (Scientific Associate Director)</p> <p>Nestor Armesto (Executive Associate Director)</p> <p>*pending official appointment.</p>
SCIENTIFIC ADVISORY BOARD	SCIENTIFIC COMMITTEE
<p>Sergio Bertolucci (Università di Bologna).</p> <p>Barbara Erasmus (Subatech, Nantes).</p> <p>Paolo Giubelino (GSI and FAIR, Darmstadt).</p> <p>Gabriela González (Louisiana State University).</p> <p>Francis Hanzen (U of Wisconsin Madison).</p> <p>Larry McLerran (Institute for Nuclear Theory de Seattle).</p> <p>Giulia Zanderighi (Max-Planck-Institute für Physik de Munich).</p>	<p>Carlos Salgado (Director)</p> <p>Abraham Gallas (Scientific Associate Director)</p> <p>Elena G. Ferreiro (Convener SA1)</p> <p>Jaime Álvarez Muñiz (Convener SA2)</p> <p>Dolores Cortina (Convener SA3)</p> <p>Néstor Armesto (Convener Strategies for New facilities)</p> <p>José Ángel Hernando (SA2_NEXT)</p> <p>Diego Martínez Santos (SA1_LHCB)</p> <p>José Luis Miramontes (SA1_STRI)</p> <p>Juan Saborido (SA1_LHCB)</p> <p>Enrique Zas (SA2_AUGE)</p>
EXECUTIVE BOARD	MANAGEMENT UNIT
<p>Carlos Salgado (Director)</p> <p>Abraham Gallas (Scientific Associate Director)</p> <p>Elena G. Ferreiro (Convener SA1)</p> <p>Jaime Álvarez Muñiz (Convener SA2)</p> <p>Dolores Cortina (Convener SA3)</p> <p>Néstor Armesto (Convener Strategies for New facilities)</p> <p>Ricardo Rodríguez. Head of Management Unit</p> <p>Berta Mariño. Project Manager Officer.</p>	<p>Ricardo Rodríguez (Head of Management Unit)</p> <p>Berta Mariño Lavía (Project Manager Officer.)</p> <p>Marcos Seco (Responsible Information System).</p> <p>Elena Mora (Communication Officer).</p> <p>Ana Belén Vázquez (Administration technician).</p>

Table 1. Governance.

Personnel

During 2019, 21 new employment contracts (29%, 6, females; 71%, 15, males) were signed to join the institute team.

CATEGORY	Male	Female	Total
Administrative and Technical Staff	8	6	14
Emeritus	2	0	2
Postdocs	15	2	17
Scientific Staff	31	3	34
Students	38	11	49
TOTAL	94	22	116

Table 2. IGFAE Composition by professional category.

The relation of total members is in the [Annex 1](#).

HUMAN RESOURCES

Following the strategy initiated previously, the structure of Management Unit was reinforced with two hires (100%, 2, females): a communication officer working on all inner and outer communication flows, including the design of an overall communication strategy; and a management officer with a clear orientation towards consultancy, focused on call planning and monitoring, and economic control of projects. Both positions are already critical components of the projection of IGFAE and of the construction of a solid identity of the institute, specifically by maximising the autonomy in management of all economic resources that we have access to.

Four postdoctoral fellows (100%, 4, males), all from abroad (Austria, China, Finland and USA), arrived during the year. Unfortunately, we have not been able yet to improve our gender ratio in this group.

One Global Talent Fellow (Antonio Romero) was awarded a Ramón y Cajal contract in 2019 - contract started in Jan 1st, 2020. One of the Global Talent staff members (Riccardo Borsato) was granted a "la Caixa" Junior Leader postdoctoral fellowship, signing his new contract late in the fall 2019. This success validates our strategy of recruiting young researchers through our Global

Talent program and open an interesting way for access to private funding already initiated in 2018 with the incorporation of two predoctoral students. Expectations for 2020 are excellent.

Eleven new PhD students (18%, 2, females; 82%, 9, males) initiated their scientific career at IGFAE. Funds supporting this training period come from Spanish public calls devoted to Human Resources (3 grants linked to the María de Maeztu Excellence Unit coming from the Spanish State Programme for the Promotion of Talent and its Employability in RDI, also known as FPI grants, and 2 grants from the Spanish program of university teacher training, known as FPU, and 1 grant from Xunta de Galicia, our regional government) and competitive funds of research projects.

AWARDS

ERC- Advanced Grant to Carlos Salgado

The European Research Council (ERC) awarded in March the IGFAE's director, Carlos A. Salgado, a 2.5 million euros Advanced Grant to study fundamental aspects of the formation of Quark Gluon Plasma in particle colliders. Researchers from the Laboratório de Instrumentação e Física Experimental de Partículas (LIP) in Lisbon and from the University of Jyväskylä in Finland are part of the project *Yoctosecond imaging of QCD collectivity using jet observables* (YoctoLHC).

Honourable mention of the Gravity Research Foundation to José Edelstein

The Gravity Research Foundation awarded in May one of its Honorable Mentions to the IGFAE researcher José Edelstein. It is the second time that the American institution recognizes the work of this theoretical physicist, awarded in 2015 with another Honorable Mention. The award-winning essay based on the article *Geometric Inflation*¹ presents a work which identifies a mechanism that would explain the rapid expansion of the Universe in the period known as inflation. Such Honorable Mentions was previously granted to figures such as Stephen Hawking and Roger Penrose and several Nobel prizes such as George Smoot, Gerard 't Hooft and Frank Wilczek.

¹ Arciniega, G., Bueno, P., Cano, P.A., Edelstein, J.D., Hennigar, R.A., Jaime, L.G. (2018). Geometric Inflation.

Best PhD thesis in Experimental Particle Physics award to Julián García Peñas

The postdoctoral researcher Julián García Pardiñas was awarded in 19 July 2019 the 1st DFTP Prize (Division of Theoretical and Particle Physics) of the Royal Spanish Society of Physics (RSEF), in the modality *Best PhD thesis in Experimental Physics*, for his work² supervised by IGFAE researchers Maximo Pló and Juan José Saborido. This recognition, granted in the framework of the XXXVII Biennial Meeting of the RSEF to the most outstanding works defended in Spanish universities during 2018, adds to the brilliant career of this young researcher.



Figure 2. Julián García Pardiñas receiving the 1st DFTP Prize (Division of Theoretical and Particle Physics) of the Royal Spanish Society of Physics (RSEF).

Lois Peña Novo 2019 award to Carlos Salgado

On June 27, in Sotomayor, the Lois Peña Novo Foundation awarded the vital and professional career of prominent people who use Galician in their public activities. In this edition, the Director of the IGFAE Carlos Salgado received the Lois Peña Novo 2019 award for his coherence, commitment and dedication to this language in his teaching role which place him among the best scientists in his field at national and international level.



Figure 3. Abraham Gallas receiving the Lois Peña Novo 2019 award on behalf of Carlos Salgado.

Einstein para perplejos, Prisma 2019 for the best popularization book to José Edelstein

The IGFAE researcher and USC Prof. José Edelstein was awarded the most prestigious prize in scientific culture in Spain, the "Prisma 2019" for the best science popularization book, for his work *Einstein para perplejos*, written together with the Chilean physicist Andrés Gomberoff. The "Prisma Casa de las Ciencias" Premios a la Divulgación are an initiative of the Scientific Museums in A Coruña (supported by the City Council of A Coruña)



Figure 4. José Edelstein and rest of winners at the award ceremony.

² Search for flavour anomalies at LHCb: decay-time-dependent CP violation in $Bs \rightarrow K\pi$ and Lepton Universality in $B \rightarrow D^{(*)}l\nu_l$

to reward the dissemination of scientific culture, and to support all professionals working in this field.

FINANCES

This report briefly explains our financial results from several points of view.

Fundraising

The total funds raised during 2019 has been **6.929.684€** (total amount of the raised funds, not only for 2019), with **28 new projects, institutional agreements, and contracts**. Most of the overall funding comes from competitive calls at the regional (50%), national (22%) and international (28%) levels. Four of our researchers obtained projects from the European Commission amounting 1.925.188€, one of them being the ERC Advanced Grant of Carlos Salgado.

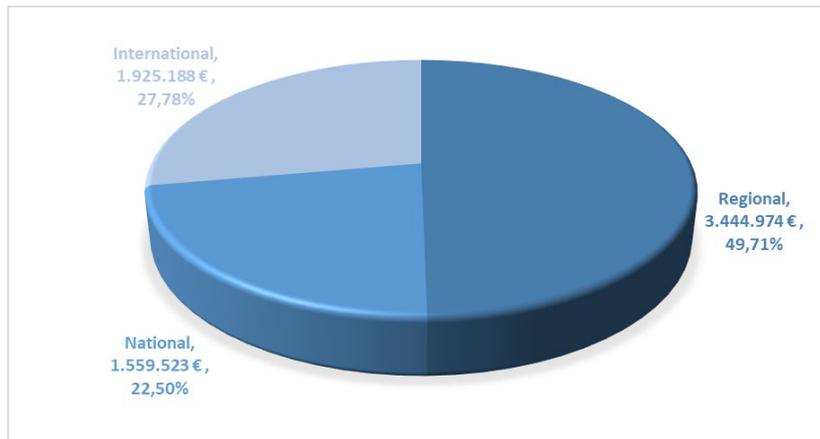


Figure 5. Total funds raised during 2019.

Table 3. projects, institutional agreements, and contracts during 2019.

TITLE	IP/RESP	FINANCED	START DATE	END DATE
Acciones centros singulares de investigación: programa de portas abertas IGFAE. Convenio acciones I+D.	Salgado López, C.	Xunta Galicia	1/1/2019	12/31/2020
Mantenimiento y renovación de infraestructuras científico-técnicas básicas de interés general: Tier3 LIGO e intercomunicación Tier2 e Tier3.	Salgado López, C.	Xunta Galicia	1/1/2019	12/31/2020
Actualización de computación en el CPD del IGFAE. Infraestructuras 2019	Salgado López, C.	AEI	11/20/2019	12/31/2020
Laboratorio de detectores gaseosos: TPCS y RPCS. Infraestructuras 2019	Salgado López, C.	AEI	11/20/2019	12/31/2020
Acelerador láser de iones. Infraestructuras 2019	Salgado López, C.	AEI	11/20/2019	12/31/2020

Acuerdo confidencialidad "Potenciales actividades comerciales e industriales de SENRA"	Cortina Gil, M ^a D.	ESTAÑOS Y SOLDADURAS SENRA, SLU	4/12/2019	4/11/2029
Acuerdo confidencialidad "Potenciales actividades comerciales e industriales de SENRA"	Cortina Gil, M ^a D.	CINDEGAL, SLU	4/12/2019	4/11/2029
Convenio GAIN e Universidades para o fomento da actividade investigadora beneficiarios de ERC	Salgado López, C.	AXENCIA GALEGA DE INNOVACION (GAIN)	1/1/2019	12/31/2020
Becas posdoctorado Junior Leader para la realización de un proyecto de investigación entre universidades y centros de investigación españoles.	Salgado López, C.	FUNDACION BANCARIA LACAIXA	5/14/2019	8/31/2022
Bolsas de verán 2019 IGFAE. Convenio accións I+D (Xunta 2019-2020)	Salgado López, C.	Xunta Galicia	1/1/2019	11/30/2020
Axudas para a acreditación, estruturación e mellora de centros de investigación do SUG. 2019	Salgado López, C.	Xunta Galicia	12/1/2019	11/30/2022
Consolidación e estruturación 2018 GPC GI-2070 Física Corpuscular e aplicacións (FICA)	Fernandez Dominguez, B.	Xunta Galicia	1/1/2019	12/31/2020
The strong interaction at the frontier of knowledge: fundamental research and applications (STRONG2020)	González Ferreiro, E.	EUROPEAN COMMISSION	6/1/2019	5/31/2023
Heavy ion collisions: collectivity and precision in saturation physics (HIEIC)	Armesto Pérez, N.	EUROPEAN COMMISSION	6/1/2019	5/31/2023
Yoctosecond imaging of QCD collectivity using jet observables (YOCTOLHC)	Salgado López, C.	EUROPEAN COMMISSION	10/1/2019	9/30/2024
Supplying accurate nuclear data for energy and non-energy applications (SANDA)	Benlliure Anaya, J.F.	EUROPEAN COMMISSION	9/1/2019	8/31/2023
Aplicaciones médicas de los aceleradores láser. Retos 2018	Benlliure Anaya, J.F.	AEI	1/1/2019	12/31/2021
Calibración, veto de muones y offline en next (CALMU). Retos 2018	Hernando Morata, J.A.	AEI	1/1/2019	12/31/2021
Datos nucleares para estructura y dinámica nuclear. Generación del conocimiento 2018	Fernandez Dominguez, B.	AEI	1/1/2019	12/31/2021
Puesta en marcha y primeros experimentos en r3b. Generación del conocimiento 2018	Cortina Gil, M ^a D.	AEI	1/1/2019	12/31/2021
Explorando sectores oscuros en LHCB. Europa investigación 2019	Cid Vidal, Xabier	AEI	6/1/2019	5/31/2021
Busca de nova física no experimento LHCB do CERN.	Romero Vidal, Antonio	AEI	1/1/2020	12/31/2024
Study of the structure of exotic nuclei	Fernandez Dominguez, B.	USC	7/30/2019	12/31/2019
Servizo medida de radón e outros parámetros radioactivos.	Cortina Gil, M ^a D.	INNOVACIONE S TECNOLÓGICA S RADÓN.	1/1/2019	12/31/2020

Servizo medida de radón e outros parámetros radioactivos.	Cortina Gil, M ^a D.	JULIO BARRIO ALONSO	1/2/2019	12/31/2020
Servizo medida de radón e outros parámetros radioactivos.	Cortina Gil, M ^a D.	BIOTECNICAS APLICADAS	1/3/2019	12/31/2020
Servizo medida de radón e outros parámetros radioactivos.	Cortina Gil, M ^a D.	FABIAN MARCELO CALANDRIA LOPEZ	1/4/2019	12/31/2020
Programa científico IGFAE. Contrato programa.	Salgado López, C.	USC	1/1/2019	31/12/2020

Active Projects

Our researchers are working in 48 ongoing projects with that amount, for this year, to **2.994.985€**. The complete list of ongoing projects is included in [Annex 2](#).

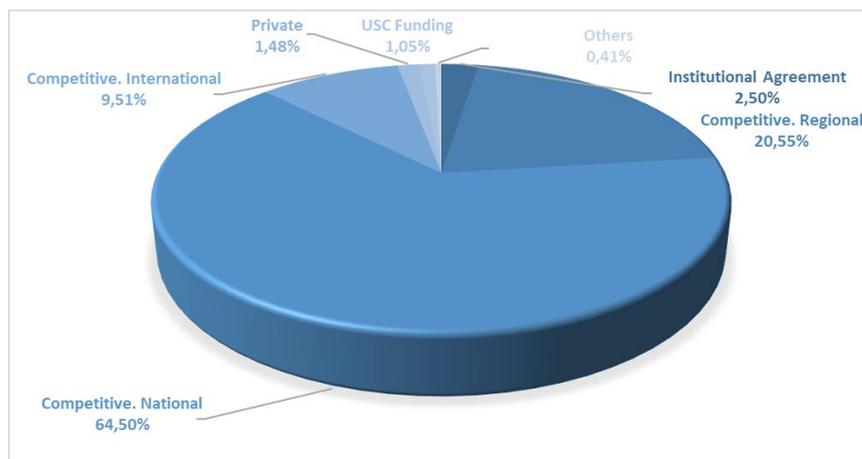


Figure 6. Actives projects & agreements 2019.

The annual budget has increased from 2.631.529€ up to 2.994.985€ since last year (+13,8%). The next figure shows the type of activity with an impact in the increase of the budget.

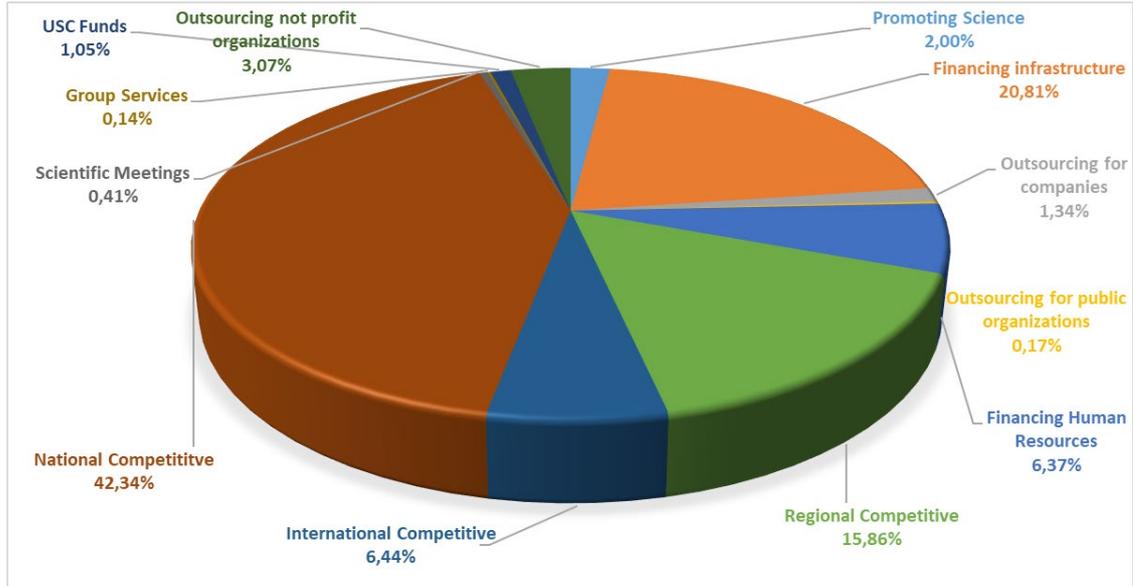


Figure 7. Contribution by activity.

RESEARCH OUTPUTS

Publications

144 articles were published in Scopus Journals (83% of the total publications) and **69%** in the first decile (D1), more than **85%** of the scientific production of the IGFAE is in the first quartile (Q1) Journals classified in the High Energy Physics and other Areas of the Scopus database. The average Scopus CiteScore of the published articles was 9.42.

The complete list of publications is provided in [Annex 3](#), including articles, erratums and proceedings.

Theses

Title	Student	Tutors
Studies on the composition and energy of secondary cosmic rays with the Tragal dabas detector	Yanis Fontenla Barba	Cabanelas Eiras, Pablo Garzón Heydt, Juan Antonio
Holography, dualities, and D-branes	José Manuel Penin Ascariz	Vázquez Ramallo, Alfonso
Long Time Dynamics of Resonant Systems	Anxo Fariña Biasi	Mas Solé, Javier
Quasi-Free Scattering of Light Neutron-Deficient Nuclei	Juan Manuel Boillos Betete	Cortina Gil, M ^a Dolores
New physics implications and searches at LHCb	Miriam Lucio Martínez	Martínez Santos, Diego Cid Vidal, Xabier
Study of the $B_0 \rightarrow \rho(770)0 K^*(892)0$ decay with an amplitude analysis of $B_0 \rightarrow (\pi^+ \pi^-) (K^+ \pi^-)$ decays	Maria Vieites Díaz	Santamarina Ríos, Cibrán Pló Casasús, Máximo Tomás

Table 4. PhD Thesis defended at IGFAE in 2019.

ALLIANCES & NETWORKS

During 2019 IGFAE has maintained and strengthened its long-term alliances with other international research centres, experimental collaborations, research institutions and universities, as well as has participated in training and Doctorate networks.

Alliances with international centres:

In the field of High-Energy Physics, IGFAE has maintained in 2019 a 30-years old close scientific relationship with **CERN (European Organization for Nuclear Research)** in Geneva, Switzerland. Members of IGFAE have participated in several experiments at CERN in the past, such as NA36, SMC, Dirac and ALICE among others. In 2019 IGFAE has kept its participation in nTOF, ISOLDE and most prominently the LHCb experiment, with the LHCb group at IGFAE being the third largest LHCb group in terms of number of researchers and engineers. More than half of IGFAE researchers have spent long stays at CERN working on these experiments. IGFAE also maintains strong contacts with the Theory Division at CERN.

In Nuclear Physics, IGFAE has maintained in 2019 its strong and sustained presence in international research centres such as **GANIL (Grand Accélérateur National d'Ions Lourds)** in Caen (France), as well as **GSI (Helmholtz Centre for Heavy Ion Research)** and in the **Facility for Antiproton and Ion Research in Europe (FAIR)** in Darmstadt (Germany). The presence of IGFAE is strongest in the R3B experiment in which our Institute has had an important participation in its construction and has maintained a leadership position – the current spokesperson of R3B is Prof. D. Cortina of IGFAE. IGFAE is also a founding member of the NEXT collaboration, an experiment located at the **LSC (Laboratorio Subterráneo de Canfranc)** in Huesca, Spain, aiming at deciphering the Dirac or Majorana nature of neutrinos.

In the field of Astroparticle Physics, IGFAE is one of the founding members of the **Pierre Auger Observatory** in Malargüe (Argentina), the largest and most precise ultra-high energy cosmic ray detector in the world. The Observatory was proposed by Prof. J. Cronin (Nobel Prize awardee in Physics in 1980) and Prof. A. Watson, both close collaborators of IGFAE. In 2019 members of IGFAE have continued their contributions to the search for ultra-high energy neutrinos and multi-messenger astronomy with Auger.

Since 2018 IGFAE is a member of the LIGO Collaboration that has discovered gravitational waves (GW) in 2015, a discovery that has opened a new window to the Universe (Nobel Prize in Physics in 2017) and has started the era of Multi-messenger Astronomy with gravitational waves. A

member of IGFAE is one of the main developers of one of the principal analysis pipelines to search for GW from Compact Binary Coalescence events.

Cooperation with research centres and universities:

- IGFAE has also maintained and fostered in 2019 stable collaborations with many research centres such as École Polytechnique (Paris, France), NIKHEF (Holland), INFN (Italy), LBNL, JPL and Fermilab (USA), or INP and NCBJ (Poland); and universities such as Jyväskylä (Finland), Leeds (England), Wuppertal (Germany), St. Petersburg (Russia), Swansea (Wales) or Connecticut and Penn State (USA) among many others.
- IGFAE has started a strategic alliance with Laboratório de Instrumentação e Física Experimental de Partículas (LIP), the centre that coordinates Particle Physics in Portugal, an alliance that has been fostered in 2019 with the celebration in Santiago of the 2nd edition of the Joint Workshop LIP/IGFAE to consolidate the long tradition of scientific cooperation between researchers from both institutes.
- An important alliance has also been established in 2019 with the Supercomputing Centre of Galicia, where the computing cluster TIER3 of LIGO will be installed.
- IGFAE is also a member of the Severo Ochoa and María de Maeztu Alliance (SOMMa), the alliance of all research centres and units with SOMM accreditation. SOMMa is becoming an important interlocutor with the Spanish science authorities.

IGFAE has also started an alliance with the **Galician Centre for Contemporary Art (CGAC)**, as part of IGFAE's ArtLab initiative, one of the initiatives to boost the Responsible Research and Innovation of the Institute.

Research networks:

- IGFAE participates in the INFRAIA STRONG2020, both in the Steering Committee and Executive Board (Carlos Salgado) and in two Networking Activities: *NA2-Small-x: Physics at the LHC and future DIS experiments* with N. Armesto as spokesperson, and *JRA2-FTE@LHC: Fixed Target Experiments at the LHC* (Elena Ferreiro who is also chairperson of the STRONG2020 Governing Board).
- IGFAE participates in the Marie Skłodowska Curie Research and Innovation Staff Exchange (RISE) *Heavy ion collisions: collectivity and precision in saturation physics (HIEIC)* (N. Armesto) with researchers from NCBJ (Poland), Ben-Gurion University (Israel) and UConn (USA).

Training and Doctorate networks:

- IGFAE participates in the *International Doctorate Network in Particle Physics, Astrophysics and Cosmology (IDPASC)*, an interdisciplinary network of research institutes with the aim of forming new high-level experts in the fields of Particle Physics, Astroparticle Physics and Cosmology. In 2019 some IGFAE PhD students attended schools organized by IDPASC, and some IGFAE senior members taught at other schools such as the 5th IDPASC /LIP PhD student Workshop.
- IGFAE has also subscribed in 2019 a new agreement of ISAPP – International School on AstroParticle Physics European Doctorate School, a network of 37 European Institutions with the purpose of organizing a common curriculum in Astroparticle Physics at the level of a Doctorate School with specialized courses on Astroparticle Physics. Bilateral and multilateral student exchanges concerning research activities focused on thesis preparation are also foreseen.

RESEARCH ACTIVITY: STRATEGIC AREAS (SA)

SA1 – THE STANDARD MODEL TO THE LIMITS

Our Institute works actively in the study of the Standard Model (SM) of particle physics, the best physics theory we currently have for explaining the microscopic reality. Our research plays a fundamental role in this broad field, which includes the search for new physics beyond the Standard Model (SM) using the LHCb experiment (SA1_LHCb), the study of the Quantum Chromodynamic (QCD) matter at extreme conditions (SA1_HQCD) and the investigations on string theory from both formal and applied points of view (SA1_STRI).

SA1_LHCb: Beyond the Standard Model with LHCb

The LHCb experiment completed very successfully its data taking in 2018 and the installation period of the Upgrade phase-I has already started in 2019. The upgraded detector will be able to read out all sub-detectors at 40 MHz and to select physics events of interest by means of a pure software trigger at the bunch crossing rate of the LHC. This capability will allow the experiment to collect data with high efficiency at a luminosity of $2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$. Flavour-physics measurements will be performed with much higher precision than was possible with the previous detector, and across a wider range of observables. The flexibility inherent in the new trigger scheme will also allow the experiment to further diversify its physics programme into important areas beyond flavour.

The Upgrade was proposed in the Letter of Intent ³ in 2011, and its main components and cost-envelope were defined in the Framework TDR⁴ one year later. Technical Design Reports (TDRs) have been written for all sub-detector systems as well as for the Software and Computing and the Computing Model and approved by the Research Board at CERN.

Researchers from the IGFAE are involved in the upgrade of the LHCb vertex sub-detector (VELO, Vertex Locator⁵), and the high-level trigger (HLT) since 2008 and 2014 respectively. Concerning the VELO, considerable progress has been made this year. All the ancillary systems for this sub-detector are installed in the cavern, have been already commissioned, or are being commissioned at the time of the writing of this report. The production of the detector modules has started. The installation of this sub-detector was foreseen for May next year (see Figure 8).

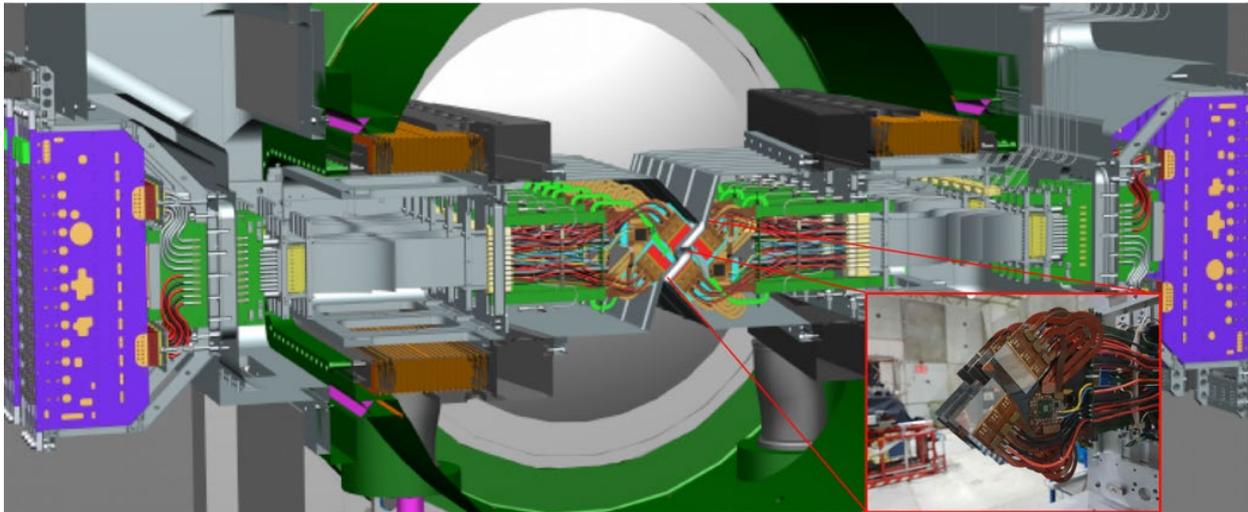


Figure 8. Artistic view of the VELO sub-detector, detail of the detector modules.

For the vertex sub-detector (VELO) the researchers at the IGFAE completed a first version of the readout firmware, the FPGA clustering algorithms, and the Time and Fast Control system (TFC) for the back-end electronics. In addition, 320 High-speed data links were assembled and certified, along with 190 High Voltage cables produced and tested, and the assembly of the Optical Power Boards and the Feedthroughs (see Figure 9). Finally, integration tests were performed for the VELO readout chain and a complete VELO slice with cooling, RO electronics, LV and HV systems, and detector monitoring. Finally, researchers from IGFAE organised several

³ Letter of Intent for the LHCb Upgrade, CERN-LHCC-2011-001. LHCC-I-018, 2011.

⁴ LHCb collaboration, Framework TDR for the LHCb Upgrade: Technical Design Report, CERN-LHCC-2012-007, 2012.

⁵ LHCb collaboration, LHCb VELO Upgrade Technical Design Report, CERN- LHCC-2013-021, 2013.

workshops for the VELO sub-detector and an international conference on instrumentation TWEPP 2019 (Topical Workshop on Electronics for Particle Physics) <https://igfae.usc.es/twepp2019/>.



Figure 9. Assembly of Optical Power Boards, production of High Voltage cables, High-Speed data links

One of the main characteristics of the LHCb upgrade is the full software trigger. The possibility of an HLT based on GPUs instead of CPUs can significantly improve the farm's computing power per euro at any of the LHCb upgrade phases. IGFAE contributes to the development of VELO clusterization algorithms, muon identification algorithms, and track matching algorithms using GPU's. The efforts in the trigger for strangeness decays for the LHCb upgrade progressed smoothly. A fully GPU-based implementation of the first level trigger for the upgrade of the LHCb detector, has been completed and published (Allen: A high level trigger on GPUs for LHCb) (arXiv:1912.09161v2, Computing and Software for Big Science 4, 7 (2020). Allen is the first complete high-throughput GPU trigger proposed for a HEP experiment.

Since 2018, the reconstruction and trigger tasks of LHCb are organized in a subdetector-like working group called Real Time Analysis (RTA). IGFAE became part of the Spanish commitment to RTA.

The year 2019 has been highly successful for the LHCb physics output, with 45 papers published in high impact journals (Nature Physics, Physical Review Letters, Journal of High Energy Physics, etc.) More than 504 scientific publications already published. According to the SCOPUS database, more than 95% of the articles have been published in "first decil" category journals.

The main physics analysis research lines at IGFAE are: measurement of observables sensitive to lepton universality violation in b-hadron decays, measurement of CP-violating observables in B decays, the study of rare decays of mesons with b and s quarks, dark matter searches, and measurement of observables in proton-lead collisions.

The publications below were entirely made or have significant contribution by IGFAE members at LHCb during 2019:

Lepton Universality tests in B decays:

- *Review of Lepton Universality tests in B decays*, **J.Phys. G46 (2019) no.2, 023001.**

CP violating observables in B decays:

- *Study of the $B^0 \rightarrow \rho(770)^0 K^*(892)^0$ decay with an amplitude analysis of $B^0 \rightarrow (\pi^+ \pi^-)(K^+ \pi^-)$ decays*, arXiv:1812.07008, **JHEP05 (2019) 026.**
- *Amplitude analysis of the $B_{(s)}^0 \rightarrow K^{*0} \bar{K}^{*0}$ decays and measurement of the branching fraction of the $B^0 \rightarrow K^{*0} \bar{K}^{*0}$ decay*, arXiv:1905.06662, **JHEP07 (2019) 032.**
- *Amplitude analysis of the $B^+ \rightarrow \pi^+ \pi^+ \pi^-$ decay*, arXiv:1909.05212, **Phys. Rev. D 101 (2020) 012006.**
- *Observation of several sources of CP violation in $B^+ \rightarrow \pi^+ \pi^+ \pi^-$ decays*, arXiv:1909.05211, **Phys. Rev. Lett. 124 (2020) 031801.**
- *Updated measurement of time-dependent CP-violating observables in $B_s^0 \rightarrow J/\psi K^+ K^- B_s^0 \rightarrow J/\psi K^+ K^-$ decays*, arXiv:1906.08356, **Eur. Phys. J. C 79 (2019) 706.**

Rare decays:

- *Strong constraints on the $K_s^0 \rightarrow \mu^+ \mu^-$ branching fraction*, arXiv:2002.08229.

Dark matter searches:

- *Search for $A' \rightarrow \mu^+ \mu^-$ decays*, arXiv:1910.06926v2, **Phys. Rev. Lett. 124, 041801.**

Proton-Lead collisions:

- Nuclear Modification Factor of Charged Primary Particle Spectra in pPb/Pbp/pp Collisions at 5 TeV. **In preparation.**

In addition, the following **PhD theses** were brilliantly defended by IGFAE-LHCb students:

- Study of the $B^0 \rightarrow \rho(770)^0 K^*(892)^0$ decay with an amplitude analysis of $B_s^0 \rightarrow (\pi^+ \pi^-)(K^+ \pi^-)$ decays. **María Vieites Díaz**, 27/03/2019. Now at EPFL.

- New physics implications and searches at LHCb. **Miriam Lucio Martínez**, 26/04/2019. Now at Nikhef.

New research initiatives are being started by Dr. Cid Vidal, for instance the experiment Codex-b. This is a proposed new experiment to be located in the LHCb cavern, providing sensitivity to long-lived particles (LLPs) that cannot be reconstructed by standard LHC detectors. This initiative has received one of the IGFAE Ignite projects.

Concerning **scientific management** the IGFAE researchers were very active during 2019. Dr. Cid Vidal has been involved in the management of different working groups beyond LHCb. In particular, he has been one of the coordinators of the WG of the BSM HL-LHC and is currently one of the coordinators of the WG of the DM LHC. Regarding the first, he was in charge of establishing the physical motivations for HL and HE-LHC in relation to direct searches. The second is responsible for coordinating the efforts of LHC collaborations and the theoretical community in physics related to dark matter searches. Apart from these two aspects, Dr. Cid Vidal has also participated in the LLP LHC working group, which coordinates the LHC's efforts in the area of LLPs. Dr. Jeremy Dalseno is the convener of the BnoC working group at LHCb, dedicated to the study of B-meson decays to final particles with no net content in charm flavour.

Dr Antonio Romero finished in March 2019 his term as sub-convenor of the Semileptonic Tauonic decays. For the instrumentation part of the scientific project, Dr. Lemos Cid, is the VELO DAQ and firmware coordinator, and Prof. Gallas Torreira holds the position of the collaboration chair of the VELO project.

In regards the **organization of scientific conferences**:

- Organization of the sixth edition of the Topical Workshop on Electronics for Particle Physics (TWEPP), held in Santiago de Compostela between September 2 and 6, 2019. <https://igfae.usc.es/twepp2019/>
- During 2019 we were working on the organization of the 2020 edition of the Conference on Flavour Physics and CP Violation (FPCP 2020), that was held online due to the COVID-19 restrictions. <https://igfae.usc.es/igfae/fpcp2020/>

Finally, the group was engaged with great dedication to **science dissemination tasks** during 2019, both giving talks and conferences in secondary and high school institutes and organizing specific events at the IGFAE's premises. In this sense, the organization of the Summer Scientific Campus and the "Master Class" in particle physics for secondary school students stand out.

There is also an organized outreach activity within the framework of IGFAE, for which they were partly responsible.

SA1_HQCD: Hot and dense QCD in the LHC era and beyond

The study of the QCD matter at high temperatures and densities constitutes the main interest of the QCD phenomenology group at IGFAE. Under these extreme conditions, all hadronic matter is in a universal form, generically known as the Quark Gluon Plasma (QGP), which is also the state of the universe right after the Big Bang. The main goal of our research work is the characterisation of this new form of matter. To do so, we have continued our activities on different lines, which include heavy-ion collisions, high-energy QCD and the description of strongly interacting matter in effective models like Skyrme.

Some highlights during 2019 are the following:

Concerning the use of **hard probes as jet quenching and quarkonia** for characterising the QGP, they have been studied in:

- Unveiling the yoctosecond structure of the QGP with top quarks, Nucl.Phys. A982 (2019) 795
- Quarkonium: a theory overview, Nucl.Phys. A982 (2019) 127
- Mapping collinear in-medium parton splittings, Eur.Phys.J.C 80 (2020) 1, 11
- Jet quenching as a probe of the initial stages in heavy-ion collisions, Phys. Lett. B 803 (2020) 135318
- Medium-induced cascade in expanding media, arXiv:1911.12193.
- Jet quenching tests of the QCD Equation of State, arXiv:1911.01309

Central in this point is the proposed use of jet quenching to study the initial stages of a heavy ion collisions, which is the main topic of the ERC Advanced Grant "Yoctosecond Imaging of QCD collectivity using jet observables (YoctoLHC)" granted to Carlos Salgado.

We have also pursued the study of the **initial states** of the collision in the Color Glass Condensate effective theory for high energy QCD, in

- Effect of non-eikonal corrections on azimuthal asymmetries in the Color Glass Condensate, Eur.Phys.J. C79 (2019) no.9, 790
- Non-eikonal corrections to multi-particle production in the Color Glass Condensate, Eur.Phys.J. C79 (2019) no.7, 600
- The Color Glass Condensate density matrix: Lindblad evolution, entanglement entropy and Wigner functional, JHEP 05 (2019) 025

Our group is also heavily involved in the elaboration of physics cases for future experiments. In particular, during 2019 the group has been involved in the elaboration of the Conceptual Design Report of the Future Circular Collider in Eur.Phys.J. C79 (2019) no.6, 474 (FCC-AA, FCC-ee, FCC-hh in Eur.Phys.J.ST 228 (2019) no 2, 4 and 5), on the study of the physics opportunities with fixed target experiments at the LHC (AFTER@LHC), and at the LHeC (Phys.Rev.D 100 (2019) 7, 074022). Moreover, there are still publications related to our ancient collaboration with ALICE experiment.

Néstor Armesto is member of the board of the LHeC and Elena G. Ferreiro is institutional board member from European institutions of the Electron Ion Collider.

Finally, the applications of the effective **Skyrme model** and its soliton solutions are developed in

- Spectral Walls in Soliton Collisions, Phys.Rev.Lett. 122 (2019) no.24, 241601
- BPS soliton-impurity models and supersymmetry, JHEP 07 (2019) 164
- Solvable self-dual impurity models, JHEP 07 (2019) 150
- The ϕ^4 model with the BPS preserving defect, JHEP 03 (2019) 131

As mentioned above, the members of this group have important roles in different activities, as the nomination of Elena Ferreiro as chair of the Governing Board of the Strong2020 consortium, where Carlos Salgado is member of the Executive Board and Nestor Armesto being leader of one of the Working Packages, or the ERC Advanced Grant "Yoctosecond Imaging of QCD collectivity using jet observables (YoctoLHC)" awarded in 2019 to Carlos Salgado.

SA1_STRI: String theory and related fields

Last but not least, the IGFAE theory group has performed research in more formal areas of particle physics, with a strong interest in String Theory, String Theory gives a fruitful framework to explore interesting problems in high-energy physics; most notably, putting together General Relativity and Quantum Mechanics in a consistent manner. One of its most robust ideas is the AdS/CFT correspondence, a holographic duality relating Quantum Field Theory with gravity in higher dimensions. It became by now a powerful tool to describe strongly coupled phenomena ranging from quantum field theories to lower dimensional condensed matter problems. A key aspect of this duality is the appearance of integrable structures. Furthermore, albeit less explored, the AdS/CFT correspondence can be used to understand space-time as an emergent concept and, in particular, to shed some light into a central problem in physics: how to go from General Relativity to Quantum Gravity. Our group is focused on these issues along three lines of

research:

Holographic tools for strongly coupled quantum systems

The group has a wide experience in the uses of the AdS/CFT correspondence to tackle strongly coupled quantum systems. We have studied in the past year the low-energy modes in anisotropic holographic fluids [Nucl. Phys. B940 (2019) 264], the flow of information in strongly coupled so-called ABJM theory [JHEP 1901 (2019) 232], the gravity dual of a multilayer system [JHEP 1903 (2019) 064], the geometry of supersymmetric probes in warped AdS₆ [JHEP 1910 (2019) 021], the spin-2 excitations arising in Gaiotto-Maldacena conformal field theories [JHEP 1910 (2019) 231] and the introduction of holographic fundamental matter in multilayered media [JHEP 1912 (2019) 038].

We have also used holographic tools to deal with time dependent processes in strongly coupled systems, which are mapped to dynamical gravitational problems demanding numerical simulation. We investigated the case of gravitational wave driving of a gapped holographic system [JHEP 1905 (2019) 161] and that of the energy returns in global AdS₄ [Phys. Rev. D100 (2019) 024008]. A broader family of confined (completely resonant) systems whose mildly non-linear wave dynamics was studied are the solvable cubic resonant systems [Commun. Math. Phys. 369 (2019) 433] and the complex plane representations and stationary states in cubic and quintic resonant systems [J. Phys. A52 (2019) 435201].

Integrability in String Theory and the AdS/CFT correspondence

The group is well recognised for its contributions in the application of integrability to the study of the AdS/CFT correspondence. Integrability was found in both sides of the AdS/CFT correspondence and provided new tools to investigate non-perturbatively the conjectured duality. The success of the methods provided by integrability in the AdS/CFT correspondence motivated substantial activity in exploring deformations of string sigma-models that preserve integrability, and in the development of new strategies to obtain exact results in those cases. We have studied in the past year the marginal deformations of WZW models and its relation to the classical Yang-Baxter equation [J. Phys. A52 (2019) 225401], the two-loop conformal invariance for Yang-Baxter deformed strings [arXiv:1910.02011] and the classical spectral curve of the AdS₅×S⁵ lambda-deformed superstring [arXiv:1909.02618].

From General Relativity to Quantum Gravity

This line of research is younger than the other two and currently explores consistence conditions

on local Lorentz invariant gravity Lagrangians. We have studied in the past year the validity of T-duality equivalences beyond string theory by analysing the invariance of the temperature and entropy of black holes [JHEP 1905 (2019) 082]. While studying higher-curvature gravity actions we realized that there is a family with remarkable properties: (i) just gravitons in vacuum, (ii) non-hairy black holes and, most interestingly, (iii) a well-behaved cosmology with a mechanism of geometric inflation deserving further study. We were able to explore the all-orders case [arXiv:1812.11187] finding the possibility of cosmic inflation without the need of an inflaton field [Int. J. Mod. Phys. D28 (2019) 1944008].

SA2 – COSMIC PARTICLES AND FUNDAMENTAL PHYSICS

SA2_NEXT: Dark Matter and the nature of neutrinos

During 2019, the NEXT collaboration has successfully operated the NEXT detector at the Canfranc Underground Laboratorio in Spain. NEXT is an international collaboration mostly from Spain and USA and whose objective is the construction of the NEXT-100 detector. This detector will allow us to search for a hypothetical, very rare decay, a double-beta neutrino-less decay in ^{136}Xe nuclei. In case this decay is realized in Nature, the neutrino will be its own antiparticle, a discovery that will have profound consequences for Particle Physics and Cosmology. NEW is a large prototype, half the size of NEXT-100 that has been successfully operated in 2019 with very small number of sparks and no leaks.

During 2019 we have taken long periods of data with enriched Xe what was exceptional in the past, i.e. to take a million of Kr events for calibration, has become now daily routine. We have taken data with external sources and estimated the energy resolution (better than 1% at the relevant energy range - *JHEP* **10** (2019) 230). We have measured that the signal can be discriminated with a 90% efficiency with respect to the background (*JHEP* **10** (2019) 052), better than the expectations. We have also measured the radio-purity level of the detector (*JHEP* **10** (2019) 051). In the last Scientific Committee of the Laboratory, in November, we have presented a new reconstruction of electron trajectories, based on image algorithms, which allow us to reduce the background by a factor 2 while keeping the same signal efficiency. We have performed the measurement of the half-life of the double beta decay with neutrinos of ^{136}Xe , which demonstrated that we will be able to measure the hypothetical decay with no-neutrinos. These results will be published soon.

The goal of the collaboration has now switched to the commissioning of the NEXT-100 detector to be installed at Canfranc in 2020. The NEXT group in Santiago has had a crucial contribution in

the determination of the energy resolution and the half-life of the double-beta decay with neutrinos of ^{136}Xe , and it is now participating in the studies of the performance of the future NEXT-100 detector.

R&D on gaseous detectors for Rare Event Searches and new lab

Year 2019 marked the start of the experimental activity at the new gaseous detector lab of IGFAE. The lab is equipped with several setups namely, '*Nausicaa*' (**N**uclei with **A** under **U**ranium **S**tudied **I**n a **C**hamber with **A**ccurate **A**-discrimination) an Optical Time-Projection Chamber (OTPC) that serves as technological demonstrator for nuclear and neutrino physics experiments, and applied research, as well as two other systems (N0, N2) devoted to the characterization of new scintillating structures and mixtures, respectively, for next-generation OTPC-based experiments. Currently, these are devoted to R&D for NEXT and the DUNE near detector ('IGNITE' project of IGFAE).

The main technological/scientific milestones achieved in 2019 are: (A) First α -tracks observed in *Nausicaa*-OTPC after equipping it with large-area FAT-GEMs coupled to a CMOS camera. (B) Proof of principle of two new amplification structures: (B1) **FAT-GEMs** (**F**ield-**A**ssisted **T**ransparent **G**as **E**lectroluminescence **M**ultipliers), rugged scintillating structures that can be easily tiled, designed at IGFAE for the NEXT experiment in collaboration with CERN workshops. Operation in high pressure Xe (10 bar) was demonstrated at an energy resolution below the NEXT goal (0.9% at $Q\beta\beta=2.45$ MeV, FWHM) for an optical gain comparable to the one achieved in the experiment ($m = 100\text{ph}/\text{e}/\text{cm}/\text{bar}$) - see Fig. 2 & arXiv:1907.03292. (B2) **LT-RPWell** (**L**ow-**T**emperature, **R**esistive **P**late **W**ell): this charge-multiplication structure is spark-protected through specially developed iron oxide ceramics that can withstand operation at the temperature of Liquid Xe (-108.1 C) (JINST **14** (2019) no.10, P10014). A gain slightly below $m=10^6$ was achieved at cryogenic conditions, demonstrating single-photon sensitivity (Fig.2-left). (C) Time-resolved study of broad-band scintillation of Xe/Ar under irradiation from α -particles and β -electrons. There is still a large uncertainty on the primary scintillation yields of electrons (up to a factor of 4) and no measurements of charge recombination or scintillation outside the conventional VUV-band. We have designed a setup to address these goals. The data is in the final stage of the analysis with preliminary results on the P-dependence of the scintillation in the 250-400nm band - see Fig. 2. (D) Re-factorization of the industry-standard simulation code Magboltz, into Python (*Pyboltz*) in collaboration with Univ. of Texas Arlington, and the Magboltz developer (S. Biagi) (arXiv:1910.06983). This effort will be central to the simulation of the properties of next-generation OTPCs in forthcoming years.

As of today, the experimental efforts concentrate primarily on the development of new scintillating gas mixtures for the Near Detector of DUNE, in collaboration with Spanish, Portuguese, American and British Univs. with synergies with other R&D lines and experiments.

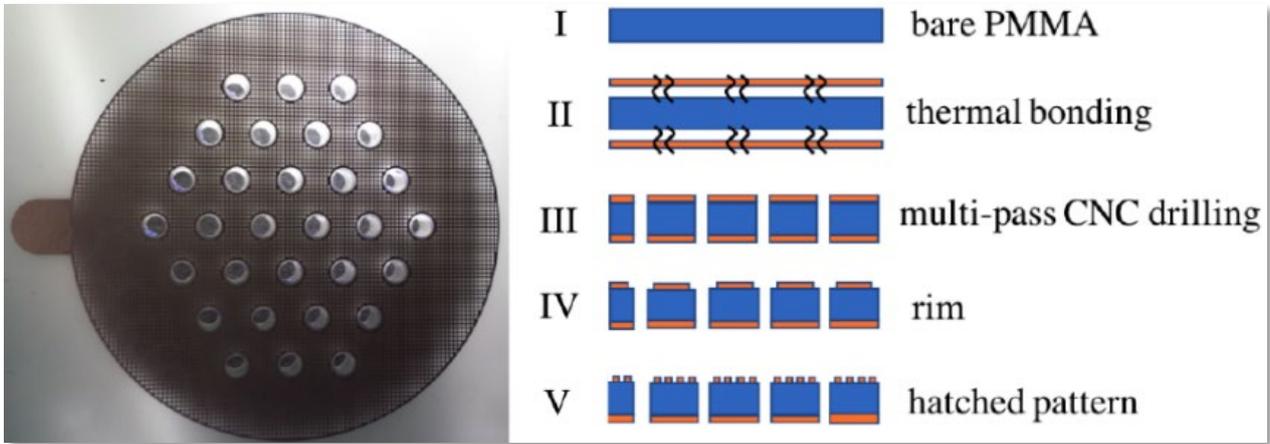


Figure 10. Photograph of one of the FAT-GEM samples and schematic drawing of the fabrication procedure.

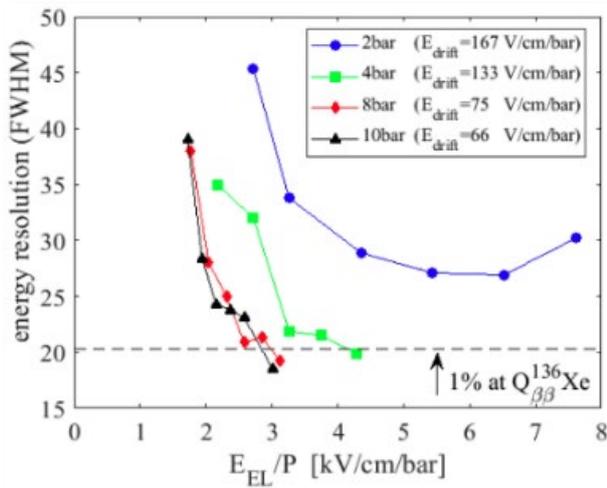


Figure 12. Energy resolution vs reduced electric field across the structure, indicating the NEXT goal as a dashed line. The maximum field achieved (about 3kV/cm/bar at 10bar), limited by the setup and not the FAT-GEM itself, translates into an optical gain of around 500ph per electron, at the same level as the one achieved by the NEXT experiment with conventional meshes

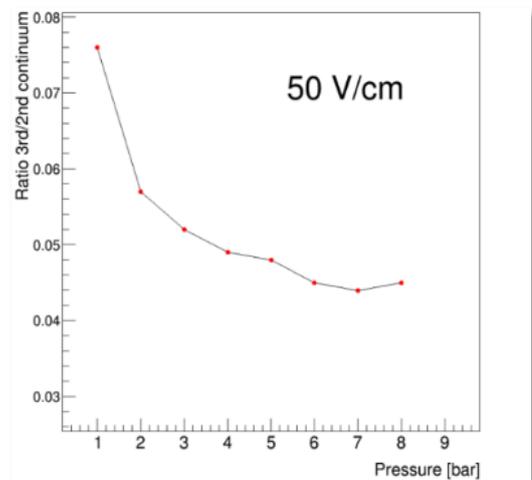


Figure 11. Preliminary results of the ratio of 2nd to 3rd continuum (VUV/UV bands) as a function of pressure, measured for the first time for β -electrons in Xe.

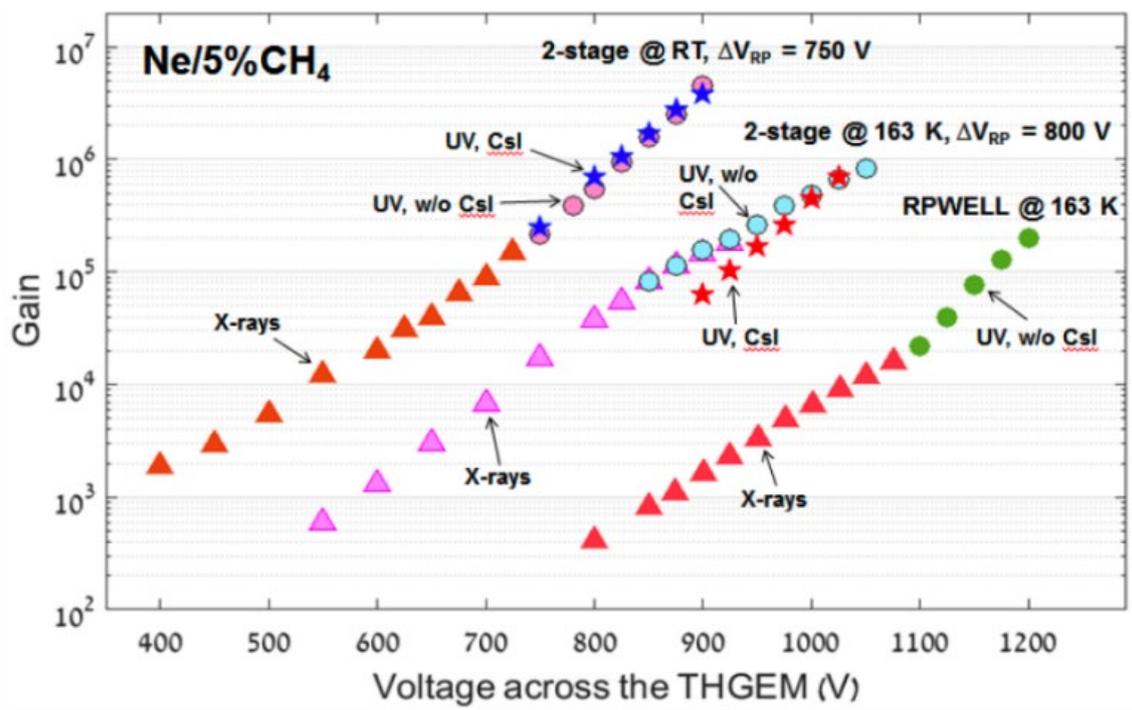


Figure 13. Compilation of main results for RP-WELL structures in single and 2-stage. Blue circles indicate a gain of almost 10⁶ electrons, sufficient for single-photon detection at cryogenic conditions.

SA2_AUGE: Extremely energetic cosmic rays & neutrinos – Large exposure experiments

The Pierre Auger Observatory located in Malargüe, Mendoza (Argentina) is the world's largest ground-based air-shower array for the detection of Ultra-High-Energy (UHE) Cosmic Rays (CR) and UHE neutrinos with energies in excess of 1 EeV (10¹⁸ eV). The Astroparticle Physics group at IGFAE has been involved in the Observatory since its early years. In 2019, the Auger Collab. presented its latest results on the energy spectrum, composition, and arrival directions of the UHECR at the 36th International Cosmic Ray Conference in Madison, Wisconsin, USA. Also, and for the first time, the fluctuations in the number of muons in inclined air showers above 4 EeV have been obtained, a result in which IGFAE members participated directly. The search for UHE neutrinos with the surface detector stations of the Observatory, a direct responsibility of IGFAE members, was another key result. With Auger data we have obtained stringent upper limits to the neutrino flux [JCAP **10** (2019) 022] and shown that Auger has an unmatched sensitivity to sources of UHE neutrinos from a large fraction of the sky [JCAP **11** (2019) 004]. Auger is a key Observatory in MultiMessenger Astronomy (MMA) activities at UHE [Front. Astron. Space Sci. **6**, 24 (2019) – a review paper also led by IGFAE members]. Regarding MMA activities, in 2019 IGFAE has exploited Auger data to search for UHE neutrinos in coincidence with the Gravitational Wave

(GW) candidate events detected in run O3 of LIGO and Virgo GW detectors. In Nov. 2019 about 300 scientists and guests from all over the world celebrated the 20th anniversary of the Pierre Auger Observatory with a ceremony and a scientific symposium in Argentina, where the potential of the upgraded AugerPrime Observatory, under deployment, and which will play a leading role in the field for the next decade was stressed.

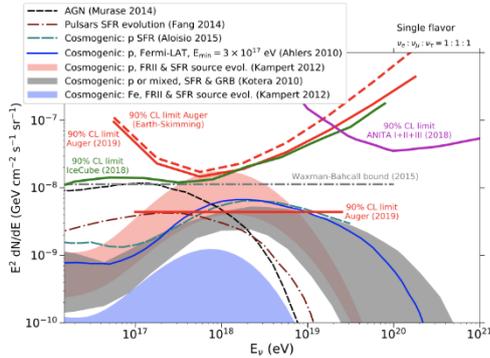


Figure 14. Pierre Auger Observatory limits to the diffuse flux of UHE neutrinos as well as from other experiments along with models of neutrino production.



Figure 15. Participants of the 20th anniversary of the Pierre Auger Observatory in November 2019 in Malargüe, Mendoza (Argentina). More info at: <https://www.auger.org/>

In 2019 IGFAE's Astroparticle Physics group has also been strongly involved on the planning and design of the Tau Airshower Mountain-Based Observatory (TAMBO) an array of particle detectors in a deep valley for the observation of the tau neutrino component of the astrophysical neutrino flux in the 1 – 100 PeV (Astro2020: Decadal Survey on Astronomy and Astrophysics, Bull. of the American Astron. Soc., 51, 7, 046 (2019)). IGFAE has also taken part in the development of the Beamforming Elevated Array for Cosmic Neutrinos (BEACON), a mountain-based detector consisting on an antenna array viewing a large area of ground in the search for radiopulses from the decay of tau leptons induced by Earth-Skimming tau neutrinos (Astro2020: Decadal Survey on Astron. & Astrophys., Bull. of the American Astron. Soc., 51, 7, 191 (2019)). IGFAE members have also taken a leading role in ruling out the interpretation of the anomalous ANITA events as being produced in decays of tau leptons in the atmosphere (PRD **99**, 063011, 2019), in strong tension with the absence of candidates in IceCube and Auger. IGFAE has also participated in the scientific review of the Radio Upgrade of the Pierre Auger Observatory that in 2019 became an integral part of the AugerPrime upgrade. This detector features a SALLA antenna on top of each Auger Cherenkov stations with the aim of detecting radio emission mainly from inclined showers that, in combination with the detection of the muonic component, provides information on composition of UHECR.

Lower-energy cosmic-ray detectors

The LabCAF group at IGFAE is involved in the TRASGO project, a new standard of cosmic-ray detectors with improved capabilities for monitoring, calibration and reconstruction. Three TRASGO detectors are operative and two more under development as part of the Stratos project, in collaboration with the Hydronav company: (1) Tragaldabas, running at the Univ. of Santiago de Compostela; (2) MuTT, devoted to industrial tomography of cargo containers using cosmic rays; (3) Tristan, designed to complement detectors that are part of the ORCA (Observatorio de Rayos Cósricos Antártico), being installed in the Spanish Antarctica Juan Carlos I base in the Livingston island. These devices are devoted to activities in solar and space-weather physics, atmospheric effects on cosmic-rays, muon tomography, and the analysis of the short-range structure on the front-side of Extended Air Showers. During 2019 the monitoring, reconstruction and simulation tools of the Tragaldabas detector have been improved. Tristan gathered cosmic ray data in a two-way journey between Vigo (42°N) in Spain, and Punta Arenas (53°S) in Chile, under the effect of different atmospheric profiles and magnetic rigidity thresholds. Analysis of the data is being done.

During more than one month, Tristan has been taking data at the Univ. of Santiago in coincidence with Tragaldabas in order to cross-calibrate both detectors. In Nov. 2019 Tristan has been installed in the oceanographic vessel BIO HESPERIDES (see Fig.) and will take data in the trip between Spain and the Juan Carlos I base, where it will be installed as a station of the ORCA observatory. An array of 4 SALLA radio antennas has been installed on the roof of the Physics building, on top of the Tragaldabas detector to complement the measurements of bundles of particles belonging to high-energy extended air showers with the measurement of the radio pulse produced during the shower development. The calibration of the SALLA antennas has just started. A wide range of simulations have been performed to understand the response of the array to primary cosmic-ray showers of different energies, core positions and zenithal and azimuthal angles.

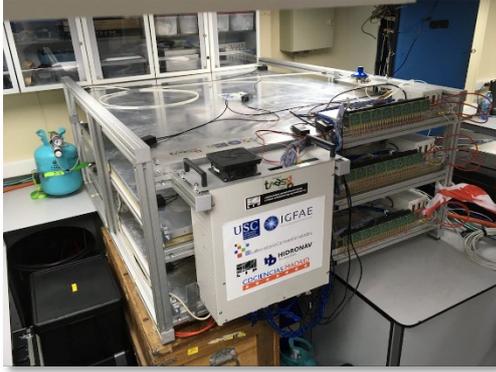


Figure 16. Tristan detector onboard the oceanographic vessel 'BIO Hesperides'



Figure 17. Four SALLA antennas on the roof of the Physics building.

SA2_GRWA: Gravitational Wave Astronomy

The IGFAE Gravitational Wave (GW) Astronomy group was established in October 2018 with funds from IGFAE's Maria de Maeztu award, currently with 5 members (group leader T. Dent, postdoctoral researcher G. Davies, FPI doctoral student V. Villa, faculty E. Zas and J. Alvarez). The group is a member of the LIGO collaboration, and thanks to this membership has access to data from the Virgo detector and will have access to KAGRA data when the detector is brought online in the near future. The main group research activity is analysis of data from the Advanced GW detector network, specifically the search for mergers of binary systems of black holes and neutron stars, and the interpretation of search results, including low latency followup of candidate events for possible high-energy neutrino emission, as well as study of the population properties of binary black hole mergers. The final LIGO-Virgo collaboration (LVC) binary merger search and population results from the second observing run, with significant contributions from the group leader (T. Dent), were released at the end of 2018 [Phys. Rev. X **9**, 031040 (2019); Astrophys. J. Lett. **882**, L24 (2019)]; a review article on LVC data analysis and noise properties appeared during 2019 with T. Dent as internal reviewer [arXiv:1908.11170].

The ongoing O3 observing run is the most sensitive to date to GW signals: unlike in previous runs, 3 detectors have been active from the beginning, with Virgo sensitivity a factor of a few below that of LIGO (see Figure). The IGFAE GW group has played a leading role in adapting and optimizing the PyCBC search pipeline for current multi-detector observations: this improved search has been demonstrated in a re-analysis of O2 open data [arXiv:1910.05331] which identified or confirmed several binary black hole mergers not previously published by LVC. Some aspects of the multi-detector search are, or will be deployed in LIGO-Virgo low-latency

public alerts for followup of GW candidates by electromagnetic observations (see <https://gracedb.ligo.org/superevents/public/O3/>).

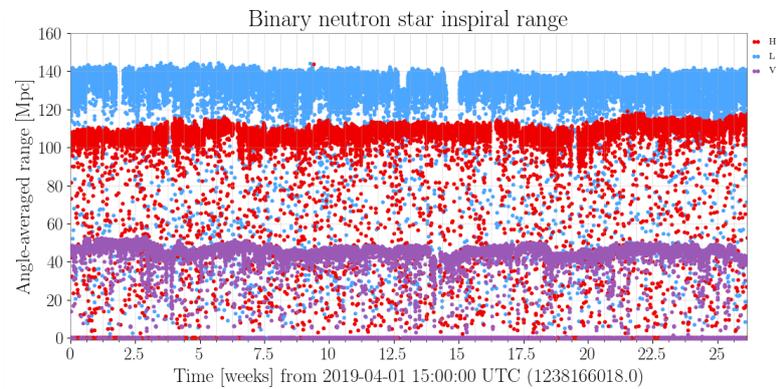


Figure 18. GW signals in 3 detectors during O3 observing run.

The group has recently acquired hardware for a planned high throughput computing cluster: 1150 AMD cores have been delivered at a cost of 170,000 euros funded by Xunta de Galicia. The cluster will be used for production of final O3 observational results and subsequently for prototyping and testing of upgraded analyses for the upcoming O4 and future runs reaching the Advanced network design sensitivity, with up to hundreds of GW signals per year detected.

SA3 - Nuclear Physics from the Lab to Improve People's Health

The strategy of the nuclear physics scientific area at IGFAE covers a broad spectrum of experimental activities from fundamental research, up to development of societal applications, namely in the field of human health. The implementation of this strategy is based on two research programs: the structure of the nuclear many-body systems and its astrophysical and cosmological implication and the exploitation of the Laser Laboratory for Accelerator and Applications.

During the reporting period:

- We have participated in 10 international conferences and workshops.
- We have contributed to 18 SCI publications.
- We are involved in the organization of the International Conference on Direct Reactions with Exotic Beams (DREB) 29 June to 3 July 2020 (<https://indico.cern.ch/event/812362/>) with an expected attendance of 150 people. Due to the Covid-19 crisis this event has been postponed to 2022.

- We won a bid to host the European Nuclear Physics Conference in 2021 EuNPC organized by the Nuclear Physics Board of the EPS with an expected attendance of 300 people.
- We have defended one PhD work and a two Master thesis. 6 PhD students have been working with us in 2019 in the different research programs (4 in RP 6 and 2 in RP 7). 4 new PhD positions and 2 post-docs will join the team along 2020 (2 PhD in RP6 and 2 PhD and 2 Postdocs in RP7)

In the following we present the scientific highlights of the activity performed in 2019.

SA3_NUCL: The structure of the nuclear many-body systems and its astrophysical and cosmological implications

IGFAE pursues the study of the structure and dynamics of the nuclear many-body systems. Our activity concentrates on the following topics:

Experiments at high energy facilities. Contribution to R3B/FAIR experiment

In accordance with the IGFAE's scientific strategy we have aligned our work with the worldwide largest Nuclear Physics Facility FAIR (<https://fair-centre.eu/>). We develop an outstanding scientific program based on the study of nuclear reactions induced by exotic projectiles at relativistic energies together with a relevant contribution to the instrumentation associated to the R3B experiment. R3B FAIR Phase 0 2019 experimental campaign was successfully conducted from February to May 2019. Engineering runs of FAIR Phase 0 2020 have been conducted along November and December 2019. They have been crucial to test all the new equipment installed in the R3B cave during this year.

The strategy of the R3B experimental campaign for 2019-21, the status of the on-going data sorting and the organization of the 2021 campaign was deeply discussed during our annual meetings (May and October 2019 in Darmstadt) with strong participation of the USC group.

We highlight the following activities:

- We are deeply engaged with the construction and exploitation of the CALIFA calorimeter for the R3B experiment. Major milestone has been achieved in 2019 with the installation of CALIFA in R3B FAIR (October-December 2019).
- We have participated in the design and construction of the silicon tracker prototype that has been installed in the target area for FAIR Phase 0 2020 experimental campaign (May-December 2019).
- We have been also working on the installation of the tracking gas detectors that will be used in the next R3B FAIR Phase 0 campaign (October-December 2019).



Figure 19. View of the CALIFA calorimeter installed at the nominal target position in the R3B Cave. Beam direction from right to left.

- P Cabanelas was awarded with one of the projects from the IGFAE internal call IGNITE (December 2019). His research project aims to translate the technology and knowledge acquired with CALIFA to societal applications, in particular the development of novel detector system for PET.
- We took part in the first R3B FAIR Phase 0 campaign conducted from February to May 2019.
- We are deeply committed with the preparation (physics definition, hardware and instrumentation and data analysis and simulation software development) of the R3B FAIR Phase 0 2020 experimental campaign (February –May 2020). As mentioned above and due to the Covid-19 crisis, this experimental campaign has not been 100% completed.
 - Development of software and simulation environment R3BRoot (Elisabeth Galiana PhD expected in February 2021).
 - Neuronal network algorithm developments for high –energy CALIFA event reconstruction (Gabriel García Master Thesis July 2019).
- We have a leading role (JB) in the quasi-free fission induced experimental campaign scheduled for April 2020. We have opened 2 PhD positions (confirmed in May 2020) to reinforce our participation in the R3B Physics program.

- We progress in the data sorting and interpretation of experiments performed within the past years (Juan M. Boillos PhD defended in May 2019 and Manuel Feijoo PhD expected in December 2021).
- We are in charge of the organisation of the International Conference on Direct Reactions with Exotic Beams (DREB) that was scheduled in Santiago from 29 of June to 3 of July 2020 (and finally postponed to the same date in 2022).

In this activity, we have published 6 papers and participated in several workshops and attended 5 conferences (D. Cortina got a plenary talk in the largest Nuclear Physics conference INPC2019) and doctoral schools. One student defended his PhD (JMB, May 2019), we have 2 other PhD on going, plus 2 new FPI PhD students (A. Graña and A. Bembibre) that will start in September 2020.

Experiments with stable and radioactive nuclei at low-energy facilities

The work in focuses mainly on fundamental studies of the structure and dynamics of the nuclei studied using active targets and fission. We highlight the activities led by IGFAE

- We have submitted (B. Fernández) a Letter of Intent to the Experiments Evaluation Committee to take ACTAR TPC to the TRIUMF laboratory (Canada) in July 2019 and an experiment aiming at studying shell effects at the edge of the proton drip-line with ACTAR TPC was approved.
- A proposal to study the spin-orbit origin of the Z=6 shell gap in neutron-rich carbon isotopes with ACTAR TPC (BF) was accepted by the Programme Advisory Committee from GANIL (France). This is part of the PhD work of J. Lois and D. Regueira.
- We have published a NIM paper summarising the simulated response of the ACTAR TPC device performed with the ACTARSim framework.

- We have submitted a Letter of Intent with AT-TPC (American partner on active targets) to perform the spectroscopy of nuclei at the proton drip line using radioactive beams from the newly develop facility FRIB.
- We are in charge of the coordination of the current fission experimental campaign at VAMOS/GANIL (MC) and we have published our results in Phys. Rev Letters and Phys. Rev. C
- We are on charge of the coordination of the current fission experimental campaign at VAMOS/GANIL (MC)
- We have established a new collaboration with LNL-IFN (Legnaro) to widen the possibilities for fission studies and the connections to other setups. A new experimental proposal "Fusion-fission and quasi-fission at PRISMA with a ^{208}Pb beam" (Spokespersons: M. Caamano (USC), D. Ramos (GANIL), A. Gottardo (LNL), J.J. Valiente-Dobon (LNL)) endorsed by the LNL Physics Advisory Committee in March 2019.
- We have started the design and construction of a new fission chamber to be used in the n_TOF facilities at CERN. The construction is being done in collaboration with the Cima group at the University of Vigo.

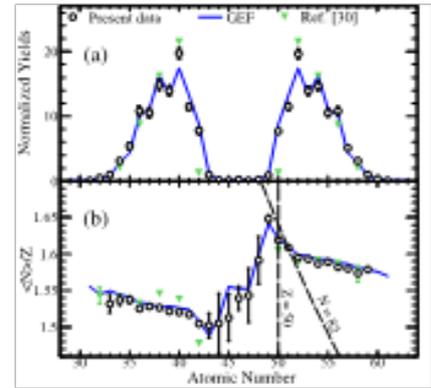


Figure 20. Picture from Phys. Rev. Letters 123, 092503 (2019).

In this activity, we have published 12 papers (3 as first authors in NIMA, Phys. Rev.C and Phys. Rev. Letters) and attended 5 international conferences Nuclear Data 2019 (China), HIAS (Australia), Nuclear Structure and Dynamics (Italy), Gordon Conference (US) and INPC2019 (UK). We have at this moment 4 PhD works on going.

SA3_LACC: Exploitation of the Laser Laboratory for Accelerator and Applications

The scientific program led by IGFAE at the Laser Laboratory for Acceleration and Applications (L2A2) focuses on the development of technologies related to laser-particle acceleration and their used in medical applications. In particular we are working in two initiatives: new laser-driven X-ray sources to develop advanced imaging techniques (LaseX), and the laser-driven production of radioisotopes for PET imaging (LaserPET). The main achievements in these two projects along 2019 are the following:

LaseX

We summarise 2019 highlights for the L2A2 laser induced x-ray source

- Collaboration with the Universidad Complutense established with the goal of improving the image quality of the the X-ray source.
- The company Sedecal S.L got interested on the IGFAE Lasser induced X-ray source. A common research program to apply this technology to medical imaging was submitted to the Retos Colabora program call (October 2019 and approved in June 2020 – a new PhD work will be partially covered with these funds).

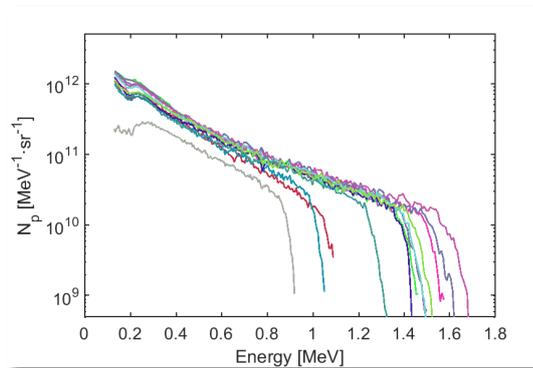


Figure 21. Energy spectrum of protons accelerated by the LaserPET experiment.

LaserPET

The main scientific achievements in 2019 in the L2A2 proton source and LaserPet experimet are:

- Successful production of 1.5 MeV protons in continuous multi-shot mode achieved (May 2019)
- The Technical design of novel a Plasma-mirror to improve the proton production for the ELI-ALPS international facility was approved by February 2019 and the construction is presently in progress.
- A collaboration with the I3M (Instituto de Instrumentación para Imagen Médica) del CSIC-UPValencia and IDICHUS was established to investigate the use of laser- accelerated ions in radio therapy. This research program was granted in the Retos Investigación call 2019.
- A collaboration with the University of Sevilla and the Centro Nacional de Aceleradores

(CAN) was established to investigate the use of laser induced neutron sources.

- A new beam-line for ion- acceleration granted in the Research Infrastructure call.
- We had an important number of long stay visitors attracted by the use of L2A2 facility.
 - Universidad Autónoma de México: Ramiro Contreras and Jesús Delgado
 - Universidad Politécnica de Valencia: Michael Seimetz
 - Universidad de Salamanca: Camilo Ruiz
 - Universidad de Sevilla: Carlos Guerrero y M^o Ángeles Millán
 - Liverpool University: Natasha Khan

In this activity, we have published 1 paper, 2 more are submitted. We have contributed to 3 International Conferences. Two PhD works are on-going (LM and JP). An FPI contract for a new PhD student (A. Bembibre) was recently approved (June 2020) and another PhD (A. Coathup) student will be partially funded with the Retos research project approved also in June 2020 We also succeed in the attraction of young talent: a new postdoc (R. Contreras) funded with an IGFAE internal call and another one funded with the prestigious La Caixa Junior Leadership postdoctoral program (A. Alejo) will join our team along 2020, reinforcing existing research lines and surely opening new research activities.

Despite this intensive and successful program, the operation of the laser facility along 2019 has been rather unstable. A couple of technical failures together with an un-efficient management of the L2A2 facility has resulted in around 6 months operation of the low energy laser beam for the X-ray source but only one week for the high-energy proton source, compromising seriously the future of all the research program above described.

HORIZONTAL LINE: STRATEGIES FOR NEW FACILITIES

2019 was an important year for the strategic decisions at IGFAE, both with respect to the global strategies in Particle Physics and for decisions taken at the level of the Institute.

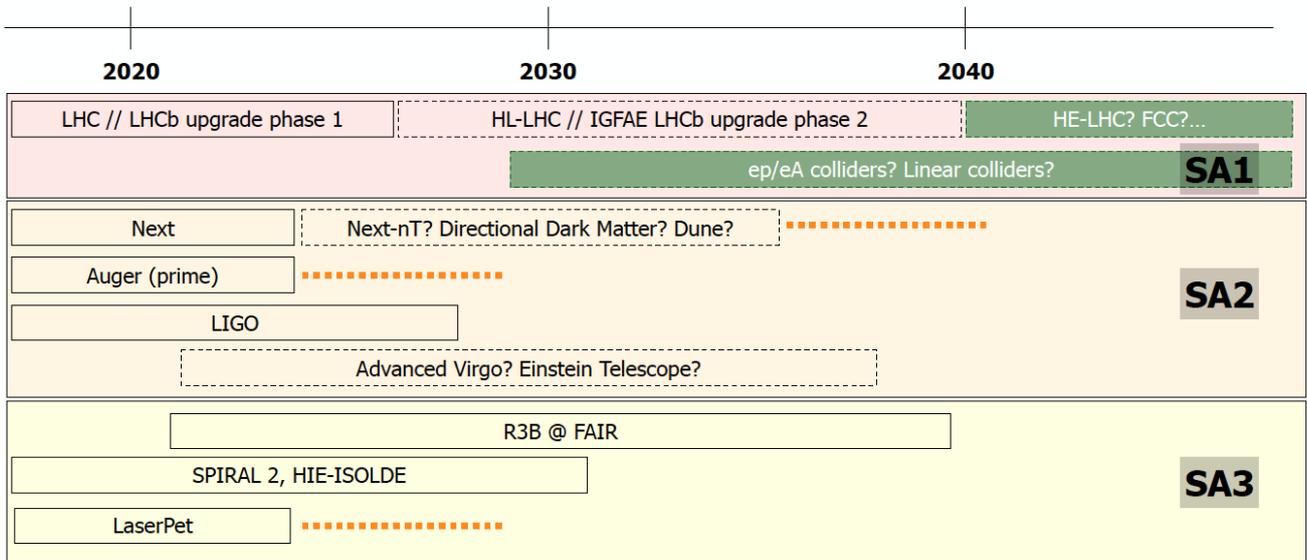
On the global side, 2019 was a crucial year for the European Strategy for Particle Physics Update, launched by CERN in 2017 and that resulted in a decision and final document that has been endorsed by the CERN Council (where all CERN members states are represented and vote) in

June 2020. This new strategy document is intended to guide European actions on Particle Physics for the period 2020-2027 and will greatly constrain the world-wide agenda. A key item was the Town Meeting in Granada in May 2019, where numerous discussions took place. Members of IGFAE (Néstor Armesto) contributed to the discussion at a scientific level and are authors of the corresponding [Briefing Book](#). The main outcomes of the conference were: (i) the lack of theoretical guidance on where new physics can be manifested calls for a wide physics search programme; (ii) the technical requirement of strong R&D on high-field superconducting magnets for hadronic colliders, with the goal of 16 T magnets requiring at least 25 years; (iii) the different electron-positron colliders were analysed with no clear conclusions of the cost-benefit analyses due to the possibilities that they can be built in Asia.

Five scenarios have been proposed that involve different options and extend to 2090. Due to this lack of clear conclusions, IGFAE has decided to keep the efforts on Particle Physics concentrated on the upgrades of the existing LHC at CERN while waiting for the next one-two years before making decisions to explore other possibilities for the future.

On the local side, the IGNITE program supported by María de Maeztu funds, was launched to support three actions (led by Diego González, Xabier Cid and Pablo Cabanelas respectively) with around 100.000 EUR each. First, we decided to explore the possibilities for entering a large neutrino experiment in the USA, [DUNE](#), collaborating on the development of gaseous subdetectors for the Near Detector. Pending the national decision to enter DUNE, this action would allow to join the experiment with a participation on hardware. The second IGNITE action went to join an experiment at the LHC linked to LHCb where IGFAE has already a strong participation. This new small experiment, [CODEX-b](#), will search for new physics beyond the standard model with long-lived particles. Finally, the third action is focused on the development of detectors for PET.

Table 5. Different lines explored by the Institute and timeline.



SCIENCE & SOCIETY

Communication and scientific dissemination are one of our priorities since the foundation of the institute. One of our main objectives is to foster STEM careers (in science, technology, engineering, and mathematics) among students, obviously focusing on Physics, as well as to return to society the knowledge generated in our scientific activity, largely financed by public funding.

Following the path of previous years, the outreach activities in which the IGFAE research staff participated increased and diversified, using all available channels to reach society. In 2019 we organized or participated in more than 80 activities, with an estimated direct audience of 4000 people. Apart from talks in schools, high schools and universities, some other highlighted events were the first edition of ArtLAB with the exhibition *CosmoloXías*; the 2nd Science Week - including the first Open Day Ciencia Singular; the USC Innovation Faire; and the Summer Fellowships.

Facts & Figures:

- Nearly 100 impacts in media.
- 200 new followers and 153 tweets in 2019.
- 94 new items in our website.
- New LinkedIn account.
- More than 80 outreach activities.

Outreach Activity

International Masterclass in Particle Physics (LHICMC19)

On April 5, IGFAE hosted a Masterclass in Particle Physics, inviting around 60 Galician high school students to participate. The students took a day off from school to analyse data of the CMS experiment at the Large Hadron Collider (LHC) under the supervision of IGFAE scientists. At



Figure 22. LHICMC19.

the end of the day, the students discussed the obtained results in a video conference with Fermilab, USA, and the other participating institutes from around the world, giving the experience of working in an international collaboration, which is part of CERN's everyday life.

The Masterclass at IGFAE is part of an annual program called International Masterclasses. Scientists at about 210 universities and laboratories host Masterclasses at their home institutions. The Masterclasses this year are organized from February to April in more than 50 countries worldwide.

Scientific Summer Campus (FECYT)

Every year in July, members of the Department of Particle Physics of the University of Santiago de Compostela (USC) and the Galician Institute of High Energy Physics (IGFAE) participate in the Summer Scientific Campus through the program "A Ponte entre o Ensino Medio a USC". The campus is organized by the Spanish Foundation for Science and Technology (FECYT) and the Ministry of Education, Culture and Sports, with the support of the Obra Social "la Caixa".



Figure 23. First group of the Scientific Summer Campus.

The purpose of this program is to promote the interest of students in 4th year of secondary school and 1st year of Bachillerato in Spain for science, technology and innovation, and

encourage access to scientific-technical qualifications. The project presented is "Looking for the particles produced in the greatest accelerator in history", aimed to put students in contact with the science developed at the Large Hadron Collider (LHC) at CERN, the largest particle accelerator in the world. In the campus, 32 students carry out tasks like those of the scientists working in the LHC experiments: particle detection, data collection and analysis or interpretation and presentation of results.

Summer Fellowships

IGFAE launched the 1st edition of the Summer Fellowships for research initiation, offering 10 grants (2 for no-STEM studies) aimed at undergraduate students interested in having their first research experience. Applicants enjoyed a hands-on extracurricular internship and were assigned a research project belonging to one of the research fields of the IGFAE under the supervision of a senior researcher. The students gained knowledge and know-how in the thematic area and had the opportunity to assist to all scientific and the educational activities offered in the centre.



Figure 24. Poster of the summer fellowships.

2nd Science Week 2019: Particle Accelerators

IGFAE organized its **2nd Science Week** (Semana da Ciencia) from 11th to 16th November 2019. From Monday to Saturday various outreach and educational events took place in Santiago de Compostela, including the first open day "Ciencia Singular" jointly organized among the 4 Singular Research Centres of the USC (CiTIUS, CiQUS, CiMUS and IGFAE). This year the topic was particle accelerators since it is the 90 anniversaries of the first cyclotron developed by Ernest Lawrence.



Figure 25. Poster of the 2nd Science Week.

Conference

Monday 11th: public conference **The Large Hadron Collider: a marvel of technology** by Lyn Evans, former LHC-project leader at CERN. More than 300 people attended the event at Auditorio ABANCA, in Santiago de Compostela.



Figure 26. Lyn Evans at Auditorio ABANCA.

Tuesday 12th: public conference **Physics in concert with the arts** by Ágnes Mócsy, at the Centro Galego de Arte Contemporánea (CGAC). Around 80 people participated. ([see ArtLab section](#)).

Wednesday 13th: **Accelerated NerdNite** at Nave de Vidán, an informal gathering to learn and discuss on particle accelerators in a short talk format and relaxed atmosphere. Four IGFAE researchers gave talks to an audience of 100 people who filled to room.

Thursday 14th: award ceremony of the **2nd IGFAE Science Communication Contest** at the Faculty of Physics. The contest is composed of three categories: scientific monologues (1 participant); experiments, demonstrators, web or app (3 participants); and outreach article (9 participants).



Figure 29. Poster of the "Accelerated NerdNite".



Figure 27. Poster of the 2nd Science Communication Contest.



Figure 28. Part of the winners and committee during the award ceremony.

Friday 15th: colloquium

Minorities in Science: friendly conversations about equity and inclusion over wine and beer by Ágnes Mócsy ([see Gender Group section](#)).

Saturday 16th: IGFAE opened its doors to the citizenship of Santiago de Compostela in its first open day **Ciencia Singular**. More than 120 (85 adults and 42 children) visited the Institute from 10:00 to 20:00 in 4 slots filled with outreach talks, demonstrators, tours to the Laser Laboratory for Acceleration and Applications (L2A2), and educative workshops for kids.



Figure 30. Poster of the Open Days "Cienzia Singular".



Figure 31. Workshops and talks during the Open Days "Cienzia Singular".

Gender Working Group

Masterclass "Day of Women and Girls in Science"

At IGFAE, we believe it is essential to promote the full and equitable access and participation of all people in science. Moved by this same principle, on February 11, 2019 we joined the "International Day of Women and Girls in Science", proclaimed by the General Assembly of the United Nations (UN). We organized a Masterclass aimed at high school students, born as a result of the IGFAE's collaboration with the "International Physics Dissemination Group" (promoters of the initiative)



Figure 32. Presentation of the Masterclass "Day of Women and Girls in Science".

and CERN (European Organization for Nuclear Research). During the day, around 50 females students of the SEK International School in Poio (Pontevedra) got closer to the work of the researchers of the institute, a series of introductory talks on particle physics were given and a practical exercise was carried out with real data from CERN, whose results were discussed by videoconference with CERN and other European centres.

Minorities in Science: friendly conversations about equity and inclusion

On Friday 15th, Ágnes Mócsy, theoretical physicist at Pratt Institute (NY), filmmaker and communicator, gave a talk at O Besbello – Bar cultural in the oldtown of Santiago de Compostela. It was an engaging and respectful a conversation about implicit bias, identity threat, meritocracy, and gender, facilitating inquiry and self-expression, while also demonstrating conscientiousness in understanding how others' viewpoints and experience may be different from our own.



Figure 33. Poster of the dialogue "Minorías en ciencia".

Activity of the “Labs”

Labs are the tools we are developing to improve our Responsible Research and Innovation strategy. These new structures, still in the process to be designed and implemented, try to gather in the same space for dialog IGFAE researchers with external stakeholders. We are planning for three of these Labs, some of which with some activity already in 2019.

ArtLAB:

The first of these spaces is ArtLAB, created in March 2019. This ambitious programme aims to push forward and explore the boundaries between art and science, physics, inviting artists whose work can promote discussion and reach the general public in a different, creative way.

“CosmoloXías”

The first initiative of ArtLAB was Irene Dubrosky's exhibition “CosmoloXías”, a series of cartographic works inspired by the Universe which evoke the real maps that try to explain its origin. The exhibition, that took place in the oldtown of Santiago de Compostela for two weeks, made the headlines of the local media such as La Voz de Galicia, GCiencia o Compostela24horas.



Figure 34. Poster of "CosmoloXías".



Figure 35. Opening of the exhibition "CosmoloXías".

The first edition of ArtLAB also included a colloquium between the audience and renowned representatives of both sides: Agustín Fernández Mallo (writer), José Edelstein (physicist and writer), Elena Vázquez Cendón (Dean of Mathematics at the University of Santiago), Uxia (one of

the most relevant singers in Galicia), David Crooks (painter and physicist), Ainhoa Apestegui (journalist) and Irene Dubrovsky (visual artist). The 2nd edition of ArtLAB is expected for late 2020.



Figure 36. Irene Dubrovsky (left) and colloquium between artist and scientists (right).

Conference Physics in concert with the arts

Ágnes Mócsy gave a public talk at the Centro Galego de Arte Contemporánea (CGAC) on Tuesday 12th, November 2019. She explored the complex and sometimes unexpected relationship that physics and arts share to find opportunities for new and richer narrative forms about science, as well as unconventional educational approaches.



Figure 37. Ágnes Mócsy, Santiago Olmo (Director of CGAC) and Carlos Salgado.

EduLab

We are currently working on teacher training and content updating in secondary schools. Another example, the Stembach Program is oriented to encourage a vocation in Science and Technology: an extra non-curricular student subject with specific topics, and development of a research project with a tutor. The tutoring is shared between a professor from the secondary school and a professor from the University. During 2019 we have also helped in the design and organization of a training course in Particle Physics through the official center for teachers' training CAFI.

TechLab

TechLAB, the third laboratory to transfer part of our scientific-technological activity to the public. During 2019:

Workshop: From the lab to improve people's health

It was held during the 45th Annual meeting of the Spanish Nuclear Society (SNE) in 23-28 September in Vigo. On Wednesday 25, IGFAE researchers Manuel Feijoo, Xabier García and Juan Peñas organized the workshop *From the lab to improve people's health*. The objective was to show the participants, both from science and company sector, how nuclear physics could be useful to produce PET radioisotopes for medical purposes using a laser instead of conventional accelerators. The workshop was complemented with some practical demonstrations of some targeting techniques, micrometric positioning or image reconstruction that are used as auxiliaries in this area of research of the Institute.



Figure 38. Manuel Feijoo, Xabier García and Juan Peñas organized the workshop *From the lab to improve people's health*

Other activities

USC Innovation Faire

On November 27 and 28, IGFAE participated in the 2nd edition of the USC Innovation Faire ad Cidade da Cultura, a university recruitment event aimed at Bachillerato students. The first day, IGFAE researcher Néstor Armesto gave the talk *Dos fundamentos ás aplicacións: para qué sirve a Física de Partículas?* to an audience of around 100 students. The second day, Pablo Baladrón, Alexandre Brea, Adrián Casais and Miguel Ramos deployed the experiment *As cores da luz: análise de espectros atómicos* to explain the quantum nature of matter using a mercury lamp and a diffraction grating.



Figure 39. Nestor Armesto during the public talk (left) and Adrián Casais giving a workshop (right).

Public talks

Gabriela González: Einstein, buratos negros e ondas gravitacionais

In 8 March 2019, coinciding with the International Women's Day, the astrophysicist and former spokesperson of LIGO collaboration, Gabriela González, gave the public talk *Einstein, buratos negros e ondas gravitacionais* at the Faculty of Communication Sciences of the USC. Gabriela was one of four LIGO scientists present for the announcement that the first direct gravitational wave observation had been detected in September 2015.

José Edelstein: Stephen Hawking, in memoriam

IGFAE researcher José Edelstein gave the public conference Stephen Hawking, in memoriam, one year after the death of one of the most brilliant scientists in history. It was held at the Faculty of Physics of the USC.

José Edelstein: a cen anos da eclipse na que Einstein ensombreceu a Newton

On the occasion of the centenary of the total solar eclipse in which was verified one of the predictions of Albert Einstein's General Theory of Relativity for the first time, IGFAE researcher José Edelstein gave a public talk in 29 May at the ABANCA Obra Social Centre (Plaza de Cervantes) in Santiago de Compostela.

Bernard Schutz: How gravitational waves made human evolution possible?

Within the framework of the 9th Iberian gravitational Waves Meeting (IGWM2019) organized by IGFAE in June in Santiago de Compostela, the Director Emeritus of the Max-Planck Institute for Gravitational Physics – Albert Einstein Institute and professor at the University of Cardiff, Bernard F. Schutz, gave the public talk *How gravitational waves made human evolution possible?* on June 3rd, in the Aula Magna of the Faculty of Physics of the USC.



Figure 40. Posters of the public talks.

EDITIONS

Unha breve historia do tempo

In February, the best-seller *A brief history of time* by Stephen Hawking was included in Clásicos do Pensamento Universal, a collection jointly published by USC and the BBVA Foundation since 2002. The professors of the Faculty of Physics José Edelstein and Jorge Mira, the latter also as translator, prologued the translation into Galician.

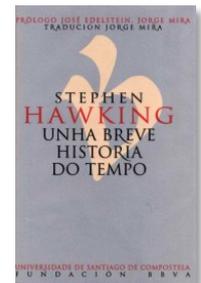


Figure 41. Book "Unha breve historia do tempo".

Ciencia y un gran paso para la humanidad

The book *Ciencia y un gran paso para la humanidad* (2019) discovers the Spanish contribution to the Conquest of the Moon as well as other scientific "great steps". The book consists of twenty-eight chapters written by reputed scientists, who under the premise of "great steps for humanity" draw us a very interesting historical-scientific panorama. IGFAE researcher Bernardo Adeva wrote the chapter *El LHC: acelerador de partículas, acelerador del conocimiento*. It is available under a Creative Commons license.



Figure 42. Book "Ciencia y un gran paso para la humanidad".

IMPACT IN MEDIA AND SOCIAL NETWORKS

In 2019, our presence in the media, either online or in print, was continuous. Some milestones helped to achieve a greater audience: the ERC Advanced Grant to Carlos Salgado, the

appointment of Elena G. Ferreiro as chair of the governing board of STRONG-2020, the installation of the CALIFA detector at FAIR, diverse piece of news related to gravitational waves and the Open Day *Ciencia Singular*. IGFAE activities and new items caught the attention of several radio and television programs and made the headlines in the leading media more than 90 times.



Figure 43. Some newspaper covers and pieces of news in media websites.

ANNEX 1: PERSONNEL IGFAE

Surname	Name	IGFAE Category	Xunta Category
Adam	Christoph	Scientific staff	Profesor Contratado Doutor
Adeva Andany	Bernardo	Scientific staff	Catedrático de Universidade
Agostini Infante	Pedro Augusto	Students	Predoutoral Xunta
Ajoor	Marwaan Yassir K.	Students	Outros
Álvarez Muñiz	Jaime	Scientific staff	Profesor Titular de Universidade
Álvarez Pol	Héctor	Scientific staff	Profesor Titular de Universidade
Alves Junior	Antonio Augusto	Postdocs	Postdoutoral contratado
Armesto Pérez	Nestor	Scientific staff	Profesor Titular de Universidade
Attems	Maximilian	Postdocs	Postdoutoral contratado
Baladrón Rodríguez	Pablo	Students	Predoutoral contratado
Benlliure Anaya	José Fernando	Scientific staff	Catedrático de Universidade
Boente García	Óscar	Students	FPU
Boillos Betete	Juan Manuel	Students	FPI
Borsato	Riccardo	Scientific staff	Postdoutoral contratado
Brea Rodríguez	Alexandre	Students	Predoutoral contratado
Caamaño Fresco	Manuel	Scientific staff	Profesor Contratado Doutor
Cabanelas Eiras	Pablo	Postdocs	Postdoutoral contratado
Cabo Landeira	Cristina	Administrative and Technical staff	Licenciado ou equivalente
Casais Vidal	Adrián	Students	FPI
Castro Pereiro	Asier	Administrative and Technical Staff	Formación Profesional
Chobanova	Veronika	Postdocs	Juan de la Cierva Incorporación
Cid Vidal	Xabier	Scientific staff	Ramón y Cajal
Cortina Gil	María Dolores	Scientific staff	Profesor Titular de Universidade

Dalseno	Jeremy Peter	Postdocs	Postdoutoral contratado
Davies	Gareth	Postdocs	Postdoutoral contratado
Dent	Thomas	Scientific staff	Postdoutoral contratado
Díaz López	María Luisa	Administrative and Technical staff	Licenciado ou equivalente
Díaz López	Gonzalo	Students	Predoutoral Xunta
Durán Escribano	Ignacio	Scientific staff	Catedrático de Universidade
Edelstein Glaubach	José Daniel	Scientific staff	Profesor Titular de Universidade
Escobedo Espinosa	Miguel Ángel	Postdocs	Postdoutoral contratado
Fariña Biasi	Anxo	Students	FPI
Feijoo Rodríguez	Manuel	Students	FPI
Fernández Domínguez	Beatriz	Scientific staff	Profesor Contratado Doutor
Fernández Fernández	Daniel	Students	FPI
Fernández Morales	Miguel Ángel	Students	Outros
Fernández Prieto	Antonio	Students	FPI
Fontenla Barba	Yanis	Students	Predoutoral contratado
Galiana Baldó	Elisabet	Students	Outros
Gallas Torreira	Abraham Antonio	Scientific staff	Profesor Contratado Doutor
Garbayo Peón	Ana	Students	Predoutoral Xunta
García Castro	Damián	Students	FPI
García Feal	Xabier	Postdocs	Postdoutoral Xunta
García Jiménez	Gabriel	Students	Outros
García Martín-Caro	Alberto	Students	FPI
García Plana	Beatriz	Students	FPI
Garzón Heydt	Juan Antonio	Scientific staff	Profesor Titular de Universidade
Gioventú	Alessandra	Students	Predoutoral contratado
González Caamaño	David	Administrative and Technical staff	Licenciado ou equivalente

González Díaz	Diego	Scientific staff	Ramón y Cajal
González Ferreiro	Elena	Scientific staff	Profesor Titular de Universidade
González Martínez	Marcos	Students	FPU
Hernando Morata	José Angel	Scientific staff	Profesor Titular de Universidade
Huidobro García	Miguel	Students	Outros
Juruković	Filip	Students	Predoutoral contratado
Lemos Cid	Edgar	Postdocs	Postdoutoral Xunta
LLerena Cristobo	Juan José	Administrative and Technical staff	Licenciado ou equivalente
Lois Fuentes	Juan	Students	Licenciado ou equivalente
Lomba Castro	Julián	Students	FPU
López Casado	Aida	Students	FPI
Lourenço-Henriques Barata	João	Students	Predoutoral contratado
Lucio Martínez	Miriam	Students	Predoutoral Xunta
Luo	Tan	Postdocs	Postdoutoral contratado
Mantovani	Giorgia	Students	Outros
Mariño Lavía	Berta	Administrative and Technical staff	Técnicos de xestión (proxectos, transferencia,etc.)
Martín Blanco	Lucía	Students	Predoutoral contratado
Martínez Santos	Diego	Scientific staff	Oportunus
Mas Solé	Javier	Scientific staff	Profesor Titular de Universidade
Merino Gayoso	Carlos Miguel	Scientific staff	Profesor Titular de Universidade
Miramontes Antas	José Luis	Scientific staff	Catedrático de Universidade
Mora Cuesta	Elena	Administrative and Technical staff	Técnicos de xestión (proxectos, transferencia,etc.)
Musso	Daniele	Postdocs	Postdoutoral contratado
Paakkinen	Petja Kalle Matias	Postdocs	Postdoutoral contratado

Pajares Vales	Carlos	Emeritus	Outros profesores contratados
Palmeiro Pazos	Brais	Students	Predoutoral contratado
Parente Bermúdez	Gonzalo	Scientific staff	Profesor Titular de Universidade
Pazos Álvarez	Antonio	Administrative and Technical staff	Formación Profesional
Pedreira Giralda	Francisco	Students	FPU, Outros
Peñas Nadales	Juan	Students	FPU
Penín Ascariz	José Manuel	Students	FPU
Pérez Trigo	Eliseo	Administrative and Technical staff	Licenciado ou equivalente
Pló Casasús	Máximo Tomás	Scientific staff	Catedrático de Universidade
Prouve	Claire	Postdocs	Postdoutoral contratado
Ramírez Cancino	Jhony Eredi	Postdocs	Postdoutoral contratado
Ramos Pernas	Miguel	Students	Predoutoral contratado
Regueira Castro	Daniel	Students	FPI
Renner	Joshua Edward	Postdocs	Postdoutoral contratado
Riádigos Sánchez	Irma	Students	Predoutoral contratado
Riehn	Felix	Postdocs	Postdoutoral contratado
Rivadulla Sánchez	Alberto	Students	FPU
Rodríguez Calvo	Manoel	Students	Outros
Rodríguez Fernández	Ricardo Julio	Administrative and Technical staff	Técnicos de xestión (proxectos, transferencia, etc.)
Rodríguez Rodríguez	Efren	Administrative and Technical staff	Licenciado ou equivalente
Rodríguez Sánchez	José Luis	Postdocs	Postdoutoral Xunta
Rodríguez-Moldes Díaz	Manoel Anxo	Students	Outros
Romero Lamas	Marcos	Students	Predoutoral contratado
Romero Vidal	Antonio	Scientific staff	Postdoutoral contratado
Saa Hernández	Ángela	Administrative and Technical staff	Licenciado ou equivalente

Saborido Silva	Juan José	Scientific staff	Profesor Titular de Universidade
Salgado López	Carlos Alberto	Scientific staff	Directores ou responsables de área funcional
Sánchez de-Santos	José Manuel	Scientific staff	Profesor Contratado Doutor
Sánchez Guillén	José Joaquín	Emeritus	Outros profesores contratados
Santamarina Ríos	Cibrán	Scientific staff	Profesor Contratado Doutor
Seco Miguélez	Marcos Antonio	Administrative and Technical staff	Técnicos de xestión (proxectos, transferencia,etc.)
Travieso Mayo	David	Students	Outros
Vázquez Fidalgo	Ana Belén	Administrative and Technical staff	Técnicos de xestión (proxectos, transferencia,etc.)
Vázquez López	Ricardo Antonio	Scientific staff	Profesor Titular de Universidade
Vázquez Ramallo	Alfonso	Scientific staff	Catedrático de Universidade
Vázquez Regueiro	Pablo	Scientific staff	Profesor Contratado Doutor
Vázquez Rodríguez	David	Students	Predoutoral Xunta
Vieites Díaz	María	Students	FPU
Vila Pérez	Víctor	Students	FPU
Vilar López	Alejandro	Students	FPU
Villa Ortega	Verónica	Students	FPI
Xuna	John	Students	Outros
Zas Arregui	Enrique	Scientific staff	Catedrático de Universidade

ANNEX 2: ONGOING PROJECTS

TITLE	IP	FINANCED	START DATE	FINAL DATE
Programa de portas abertas igfae.convenio accións i+d (xunta 2019-2020)	Salgado López, C.	Xunta de Galicia	1/1/2019	12/31/2020
Convenio de colaboración entre a consellería de cultura, educación e ordenación universitaria e a universidade de santiago de compostela e a universidade de vigo para completar as axudas ao persoal investigador principal no programa starting grants.	Martínez Santos, D.	Xunta de Galicia	1/1/2016	12/31/2019
Búsquedas de nueva Física con el experimento mejorado LHCB del CERN. EXCELENCIA 2017	Gallas Torreira, A. Vázquez P.	AEI	1/1/2018	12/31/2020
Mantenemento e renovación de infraestruturas científico-técnicas básicas de interés xeral: tier3 ligo e intercomunicación tier2 e tier3.	Salgado López, C.	Xunta de Galicia	1/1/2019	12/31/2019
Equipo de espectroscopia gamma de alta resolución para la determinación radiológica de muestras ambientales sólidas	Salgado López, C.	AEI	1/1/2018	12/31/2019
Laboratorio de microelectrónica para instrumentación en física de partículas y astrofísica	Salgado López, C.	AEI	1/1/2018	12/31/2019
Taller mecánico de alta precisión para desarrollo y fabricación de instrumentación del igfae	Salgado López, C.	AEI	1/1/2018	12/31/2020
Estacion terrestre para monitorización continua de la temperatura de la estratosfera mediante la medida de flujo direccional de rayos cósmicos (stratos) conecta peme 2018	Garzón Heydt, J.P.	DIGAFER, S.A.	10/1/2018	9/30/2021
Acuerdo confidencialidad "posible acción comercial y posterior estudio técnico consistente en el análisis de la normativa aplicable a potenciales actividades comerciales e industriales de senra"	Cortina Gil, M ^a D.	ESTAÑOS Y SOLDADURAS SENRA	4/11/2019	8/31/2022
Acuerdo confidencialidad "posible acción comercial y posterior estudio técnico consistente en el análisis de la normativa aplicable a potenciales actividades comerciales e industriales de senra"	Cortina Gil, M ^a D.	CINDEGAL		4/11/2019
Plasma mirrors for high-power high-repetition rate laser pulses	Benlliure Anaya, J.F.	ELI-HU NON-PROFIT LTD	12/1/2017	5/1/2021
Convenio de colaboración entre gain e universidades para fomento actividade investigadora do persoal universitario beneficiario do erc	Salgado López, C.	AXENCIA GALEGA DE INNOVACION (GAIN)	1/1/2019	12/31/2020
Becas de doctorado inphinit para estudios de doctorado en centros de investigación españoles de excelencia.	Salgado López, C.	FUNDACION BANCARIA LA CAIXA	12/10/2018	12/27/2021

Becas posdoctorado junior leader	Salgado López, C.	FUNDACION BANCARIA LA CAIXA	5/14/2019	8/31/2022
Bolsas de verán 2019 igfae.	Salgado López, C.	Xunta de Galicia	1/1/2019	11/30/2020
Consolidación e estruturación 2017 grc gi-1493 grupo experimental de núcleos e partículas (genp)	Benlliure Anaya, J.F.	Xunta de Galicia	1/1/2017	12/31/2020
Consolidación e estruturación 2017 grc gi-2033 teoría e fenomenoloxía de partículas, astropartículas, campos e cordas (teofpacc)	Miramontes Antas, J.L.	Xunta de Galicia	1/1/2017	12/31/2020
Consolidación e estruturación 2017 modalidade d (excelencia)	Salgado López, C.	Xunta de Galicia	1/1/2017	12/31/2020
Consolidación e estruturación 2017 modalidade d (excelencia)	González Díaz, D.	Xunta de Galicia	1/1/2017	12/31/2021
Consolidación e estruturación 2018 gpc gi-2070 física corpuscular e aplicacións (fica)	Fernandez Dominguez, B.	Xunta de Galicia	1/1/2019	12/31/2020
Consolidación e estruturación 2018 grc gi-1490 grupo de física de altas enerxías (gaes)	Saborido Silva, J.J.	Xunta de Galicia	1/1/2019	12/31/2021
Novos enfoques na procura de física alén do modelo estándar co-experimento LHCb - modalidade c. Proxectos de excelencia - consolidación e estruturación 2018	Cid Vidal, X.	Xunta de Galicia	1/1/2018	12/31/2022
Axudas para a acreditación, estruturación e mellora de centros de investigación do sug		Xunta de Galicia	12/1/2019	10/30/2022
European nuclear science and application research 2 (ensar2)	Alvarez Pol, H.	EUROPEAN COMMISSION	3/1/2016	8/31/2020
Heavy ion collisions: collectivity and precision in saturation physics (hieic)	Armesto Pérez, N.	EUROPEAN COMMISSION	6/1/2019	5/31/2023
Supplying accurate nuclear data for energy and non-energy applications (sanda)	Benlliure Anaya, J.F.	EUROPEAN COMMISSION	9/1/2019	8/31/2023
The strong interaction at the frontier of knowledge: fundamental research and applications (strong-2020)	González Ferreiro, E.	EUROPEAN COMMISSION	6/1/2019	5/31/2023
Yoctosecond imaging of qcd collectivity using jet observables (yoctolhc)	Salgado López, C.	EUROPEAN COMMISSION	10/1/2019	9/30/2024
Análisis de las partículas más energéticas de la naturaleza: el observatorio pierre auger. Excelencia 2017	Zas Arregui, E.	AEI	1/1/2018	12/31/2020
Aplicaciones médicas de los aceleradores láser - retos 2018	Benlliure Anaya, J.F.	AEI	1/1/2019	12/31/2021
Búsquedas de nueva física con el experimento mejorado lhcb del cern. Excelencia 2017	Martínez Santos, D.	AEI	1/1/2018	12/31/2020

Calibración, veto de muones y offline en next (calmu) - retos 2018	Hernando Morata, J.A.	AEI	1/1/2019	12/31/2021
Datos nucleares para estructura y dinámica nuclear - generación del conocimiento 2018	Fernandez Dominguez, B.	AEI	1/1/2019	12/31/2021
Deseño, construción e posta a punto dun sensor baseado en tecnoloxía de si para o seu emprego como monitor radón, en colaboración co cnm-csic, no marco da actividade de investigación 2016-pn011, co título: 'desarrollo de un sistema de control automático	Cortina Gil, M ^a D.	AEI	3/7/2016	6/30/2020
Estudios de canales de integraciones raras de particulas conteniendo un quark s con datos de lhcb	Chobanova, V.	AEI	12/1/2018	11/30/2020
Explorando sectores oscuros en lhcb. - europa investigación 2019	Cid Vidal, X.	AEI	6/1/2019	5/31/2021
Holografía, gravitación y teorías gauge. Excelencia 2017	Miramontes Antas, J.L.	AEI	1/1/2018	12/31/2020
Medida de rayos cósmicos con un detector tipo trasgo en la base antártica española. Excelencia 2016	Garzón Heydt, J.P.	AEI	12/30/2016	3/29/2020
Puesta en marcha y primeros experimentos en r3b - generación del conocimiento 2018	Cortina Gil, M ^a D.	AEI	1/1/2019	12/31/2021
Ocd a alta temperatura y densidad desde escalas pequeñas a grandes. Excelencia 2017	Salgado López, C.	AEI	1/1/2018	12/31/2020
Refuerzo del papel lhcb como uno de los principales experimentos actuales en física de particulas. Trabajo en el área de machine learning. Realización de actividades de docencia y divulgación.	Cid Vidal, X.	AEI	1/1/2018	12/31/2021
Study of the structure of exotic nuclei	Fernandez Dominguez, B.	USC	7/30/2019	12/31/2019
Servizo de medida de radón e outros parámetros radiactivos en mostras ambientais	Cortina Gil, M ^a D.	QUIRON PREVENCIÓN SL	1/1/2016	12/31/2020
Servizo de medida de radón e outros parámetros radiactivos en mostras ambientais	Cortina Gil, M ^a D.	INNOVACIONES TECNOLÓGICAS RADÓN	1/1/2016	12/31/2020
Servizo de medida de radón e outros parámetros radiactivos en mostras ambientais	Cortina Gil, M ^a D.	JULIO BARRIO ALONSO	1/1/2016	12/31/2020
Servizo de medida de radón e outros parámetros radiactivos en mostras ambientais	Cortina Gil, M ^a D.	BIOTECNICAS APLICADAS, S.L.	1/1/2016	12/31/2020
Programa científico do instituto galego de física de altas enerxías (igfae). Contrato programa igfae	Salgado López, C.	USC	1/1/2019	12/31/2019
Unidades de excelencia "maría de maeztu"	Salgado López, C.	AEI	1/7/2017	30/06/2021

ANNEX 3: PUBLICATIONS⁶

1. **Title:** *Validation of the radiation shielding for the Laser Laboratory for Acceleration and Applications*

Authors: Benlliure J., Cortina-Gil D., Llerena J.J., Ruiz C.

IGFAE Authors: Benlliure, J.; Cortina-Gil, D.

Reference: Nucl. Instr. Meth. Phys. Res. A916(2019)158

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1016/j.nima.2018.10.217

2. **Title:** *Observation of Two Resonances in the $\Lambda b 0 \pi^\pm$ Systems and Precise Measurement of Σb^\pm and $\Sigma b^{*\pm}$ Properties*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)012001

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.012001

3. **Title:** *Measurement of the Charm-Mixing Parameter γ_{CP}*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)011802

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.011802

4. **Title:** *Electroluminescence TPCs at the thermal diffusion limit*

Authors: Henriques, C.A.O. et al.

IGFAE Authors: Gonzalez-Díaz, D.; Hernando Morata, J.A.; Martinez-Lema, G.; Palmeiro, B.

Reference: JHEP1(2019)27

Research Program: SA2_NEXT

DOI: 10.1007/JHEP01(2019)027

5. **Title:** *Properties of the CsI(Tl) detector elements of the CALIFA detector*

Authors: Knyazev, A. et al.

IGFAE Authors: Alvarez-Pol, H.; Cabanelas, P.; Cortina-Gil, D.; Feijoo, M.; Galiana, E.

Reference: Nucl. Instr. Meth. Phys. Res. A940(2019)393

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1016/j.nima.2019.06.045

6. **Title:** *Commissioning of the ACTIVE TARGET and Time Projection Chamber (ACTAR TPC)*

Authors: Mauss, B. et al.

⁶ This appendix includes articles, proceedings and erratums.

IGFAE Authors: Alvarez-Pol, H.; Caamano, M.; Fernandez-Dominguez, B.

Reference: Nucl. Instr. Meth. Phys. Res. A940(2019)498

Research Program: SA3_NUCL

DOI: 10.1016/j.nima.2019.06.067

7. **Title:** *Charged particle timing at sub-25 picosecond precision: The PICOSEC detection concept*

Authors: Iguaz, F.J. et al.

IGFAE Authors: Gonzalez-Díaz, D.

Reference: Nucl. Instr. Meth. Phys. Res. A936(2019)515

Research Program: SA2_NEXT

DOI: 10.1016/j.nima.2018.08.070

8. **Title:** *Quasi-free neutron and proton knockout reactions from light nuclei in a wide neutron-to-proton asymmetry range*

Authors: Holl, M. et al.

IGFAE Authors: Alvarez-Pol, H.; Benlliure, J.; Boillos, J.M.; Caamano, M.; Cortina-Gil, D.

Reference: Phys. Lett. B795(2019)682

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1016/j.physletb.2019.06.069

9. **Title:** *Identical pion intensity interferometry in central Au + Au collisions at 1.23A GeV*

Authors: Adamczewski-Musch, J. et al.

IGFAE Authors: Garzon, J.A.

Reference: Phys. Lett. B795(2019)446

Research Program: SA3_NUCL

DOI: 10.1016/j.physletb.2019.06.047

10. **Title:** *Blip glitches in Advanced LIGO data*

Authors: Cabero, M. et al.

IGFAE Authors: Dent, T.

Reference: Classical Quantum Gravity 36(2019)155010

Research Program: SA2_GRWA

DOI: 10.1088/1361-6382/ab2e14

11. **Title:** *BPS soliton-impurity models and supersymmetry*

Authors: Adam C., Queiruga J.M., Wereszczynski A.

IGFAE Authors: Adam, C.

Reference: JHEP7(2019)164

Research Program: SA1_HQCD

DOI: 10.1007/JHEP07(2019)164

12. **Title:** *Solvable self-dual impurity models*

Authors: Adam C., Oles K., Queiruga J.M., Romanczukiewicz T., Wereszczynski A.

IGFAE Authors: Adam, C.

Reference: JHEP7(2019)150

Research Program: SA1_HQCD

DOI: 10.1007/JHEP07(2019)150

13. **Title:** *Spectral Walls in Soliton Collisions*

Authors: Adam C., Oles K., Romanczukiewicz T., Wereszczynski A.

IGFAE Authors: Adam, C.

Reference: Phys. Rev. Lett. 122(2019)241601

Research Program: SA1_HQCD

DOL: 10.1103/PhysRevLett.122.241601

14. Title: Measurement of the Mass Difference between Neutral Charm-Meson Eigenstates

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)231802

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.231802

15. Title: Observation of an Excited B_c^+ State

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)232001

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.232001

16. Title: Observation of a Narrow Pentaquark State, $P_c(4312)^+$, and of the Two-Peak Structure of the $P_c(4450)^+$

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)222001

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.222001

17. Title: String percolation in AA and p+p collisions

Authors: Bautista I., Pajares C., Ramírez J.E.

IGFAE Authors: Pajares, C.; Ramírez, J.E.

Reference: Rev. Mex. de Fis. 65(2019)197

Research Program: SA1_HQCD

DOL: 10.31349/RevMexFis.65.197

18. Title: Observation of CP Violation in Charm Decays

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)211803

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.211803

19. Title: *New spectroscopic information on TI 211,213: A changing structure beyond the N=126 shell closure*

Authors: Gottardo, A. et al.

IGFAE Authors: Benlliure, J.

Reference: Phys. Rev. C99(2019)054326

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1103/PhysRevC.99.054326

20. Title: *Marginal deformations of WZW models and the classical Yang-Baxter equation*

Authors: Borsato R., Wulff L.

IGFAE Authors: Borsato, R.

Reference: J. Phys. A52(2019)225401

Research Program: SA1_STRI

DOI: 10.1088/1751-8121/ab1b9c

21. Title: *Gravitational wave driving of a gapped holographic system*

Authors: Biasi A., Mas J., Serantes A.

IGFAE Authors: Biasi, A.; Mas, J.

Reference: JHEP5(2019)161

Research Program: SA1_STRI

DOI: 10.1007/JHEP05(2019)161

22. Title: *T-duality equivalences beyond string theory*

Authors: Edelstein J.D., Sftesos K., Sierra-García J.A., López A.V.

IGFAE Authors: Edelstein, J.D.

Reference: JHEP5(2019)82

Research Program: SA1_STRI

DOI: 10.1007/JHEP05(2019)082

23. Title: *Determination of cosmic-ray primary mass on an event-by-event basis using radio detection*

Authors: Carvalho W.R., Jr., Alvarez-Muñiz J.

IGFAE Authors: Alvarez-Muniz, J.

Reference: Astropart. Phys.109(2019)41

Research Program: SA2_AUGE

DOI: 10.1016/j.astropartphys.2019.02.005

24. Title: *The Color Glass Condensate density matrix: Lindblad evolution, entanglement entropy and Wigner functional*

Authors: Armesto N., Domínguez F., Kovner A., Lublinsky M., Skokov V.V.

IGFAE Authors: Armesto, N.

Reference: JHEP5(2019)25

Research Program: SA1_HQCD

DOI: 10.1007/JHEP05(2019)025

25. Title: *A compensated multi-gap RPC with 2 m strips for the LEPS2 experiment*

Authors: Watanabe, K. et al.

IGFAE Authors: Gonzalez-Díaz, D.

Reference: Nucl. Instr. Meth. Phys. Res. A925(2019)188

Research Program: SA2_NEXT

DOI: 10.1016/j.nima.2019.02.014

26. Title: *Prominence of Pairing in Inclusive ($p,2p$) and (p,pn) Cross Sections from Neutron-Rich Nuclei*

Authors: Paul, N. et al.

IGFAE Authors: Rodríguez-Sánchez, J.L.

Reference: Phys. Rev. Lett. 122(2019)162503

Research Program: SA3_NUCL

DOI: 10.1103/PhysRevLett.122.162503

27. Title: *Digging the population of compact binary mergers out of the noise*

Authors: Gaebel S.M., Veitch J., Dent T., Farr W.M.

IGFAE Authors: Dent, T.

Reference: Mon. Not. R. Astron. Soc. 484(2019)4008

Research Program: SA2_GRWA

DOI: 10.1093/mnras/stz225

28. Title: *First Measurement of Charm Production in its Fixed-Target Configuration at the LHC*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.;

Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio

Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva,

J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)132002

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.132002

29. Title: *Comprehensive analysis of anomalous ANITA events disfavors a diffuse tau-neutrino flux origin*

Authors: Romero-Wolf, A. et al.

IGFAE Authors: Alvarez-Muniz, J.; Zas, E.

Reference: Phys. Rev. D99(2019)063011

Research Program: SA2_AUGE

DOI: 10.1103/PhysRevD.99.063011

30. Title: *Gravity dual of a multilayer system*

Authors: Jokela N., Penín J.M., Ramallo A.V., Zoakos D.

IGFAE Authors: Penin, J.M.; Ramallo, A.V.

Reference: JHEP3(2019)64

Research Program: SA1_HQCD, SA1_STRI

DOI: 10.1007/JHEP03(2019)064

31. Title: *Low-energy modes in anisotropic holographic fluids*

Authors: Itsios G., Jokela N., Järvelä J., Ramallo A.V.

IGFAE Authors: Ramallo, A.V.

Reference: Nucl. Phys. B940(2019)264

Research Program: SA1_STRI

DOI: 10.1016/j.nuclphysb.2019.01.018

32. Title: *Effective-field-theory arguments for pursuing lepton-flavor-violating K decays at LHCb*

Authors: Borsato M., Gligorov V.V., Guadagnoli D., Martínez Santos D., Sumensari O.

IGFAE Authors: Borsato, M.; Santos, D.M.

Reference: Phys. Rev. D99(2019)055017

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.99.055017

33. Title: *Insight into excitation energy and structure effects in fission from isotopic information in fission yields*

Authors: Ramos, D. et al.

IGFAE Authors: Benlliure, J.; Caamano, M.; Cortina-Gil, D.; Fernandez-Dominguez, B.

Reference: Phys. Rev. C99(2019)024615

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1103/PhysRevC.99.024615

34. Title: *Quarkonium: a theory overview*

Authors: Ferreiro E.G.

IGFAE Authors: Ferreiro, E.G.

Reference: Nucl. Phys. A982(2019)127

Research Program: SA1_HQCD

DOI: 10.1016/j.nuclphysa.2018.12.002

35. Title: *Unveiling the yoctosecond structure of the QGP with top quarks*

Authors: Apolinário L., Milhano G., Salgado C.A., Salam G.

IGFAE Authors: Salgado, C.A.

Reference: Nucl. Phys. A982(2019)795

Research Program: SA1_HQCD

DOI: 10.1016/j.nuclphysa.2018.11.014

36. Title: *Thermal behavior and entanglement in Pb-Pb and p-p collisions*

Authors: Feal X., Pajares C., Vazquez R.A.

IGFAE Authors: Pajares, C.; Vazquez, R.A.

Reference: Phys. Rev. C99(2019)015205

Research Program: SA1_HQCD, SA2_AUGE

DOI: 10.1103/PhysRevC.99.015205

37. Title: *Transverse spectrum of bremsstrahlung in finite condensed media*

Authors: Feal X., Vazquez R.A.

IGFAE Authors: Vazquez, R.A.

Reference: Phys. Rev. D99(2019)016002

Research Program: SA1_HQCD, SA2_AUGE

DOI: 10.1103/PhysRevD.99.016002

38. Title: *Information flows in strongly coupled ABJM theory*

Authors: Balasubramanian V., Jokela N., Pönni A., Ramallo A.V.

IGFAE Authors: Ramallo, A.V.

Reference: JHEP1(2019)232

Research Program: SA1_STRI

DOI: 10.1007/JHEP01(2019)232

39. Title: *Deep diffused Avalanche photodiodes for charged particles timing*

Authors: Centis Vignali, M. et al.

IGFAE Authors: Otero Ugobono, S.

Reference: Nucl. Instr. Meth. Phys. Res. A(2019)162405

Research Program: SA1_LHCB

DOI: 10.1016/j.nima.2019.162405

40. Title: *Quasi-free proton knockout from ^{12}C on carbon target at 398 MeV/u*

Authors: Panin, V. et al.

IGFAE Authors: Alvarez-Pol, H.; Cortina-Gil, D.

Reference: Phys. Lett. B797(2019)134802

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1016/j.physletb.2019.134802

41. Title: *Measurement of the CP-violating phase ϕ_s from $B_s^0 \rightarrow J/\psi \pi^+ \pi^-$ decays in 13 TeV pp collisions*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Lett. B797(2019)134789

Research Program: SA1_LHCB

DOI: 10.1016/j.physletb.2019.07.036

42. Title: *Inclusive cross sections for one- and multi-nucleon removal from Sn, Sb, and Te projectiles beyond the $N = 82$ shell closure*

Authors: Vaquero, V. et al.

IGFAE Authors: Rodriguez-Sanchez, J.L.

Reference: Phys. Lett. B795(2019)356

Research Program: SA3_NUCL

DOI: 10.1016/j.physletb.2019.06.035

43. Title: *Measurement of CP observables in the process $B^0 \rightarrow DK^*0$ with two- and four-body D decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP8(2019)41

Research Program: SA1_LHCB

DOI: 10.1007/JHEP08(2019)041

44. Title: *Search for the rare decay $B^+ \rightarrow \mu^+ \mu^- \mu^+ \nu_\mu$*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Eur. Phys. J. C79(2019)675

Research Program: SA1_LHCB

DOI: 10.1140/epjc/s10052-019-7112-x

45. Title: *Updated measurement of time-dependent CP -violating observables in $B_s^0 \rightarrow J/\psi K^+ K^-$ decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero

Lamas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Eur. Phys. J. C79(2019)706

Research Program: SA1_LHCB

DOI: 10.1140/epjc/s10052-019-7159-8

46. Title: *First Observation of the Radiative Decay $\Lambda b^0 \rightarrow \Lambda \gamma$*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)031801

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.031801

47. Title: *Strong Absorption of Hadrons with Hidden and Open Strangeness in Nuclear Matter*

Authors: Adamczewski-Musch, J. et al.

IGFAE Authors: Garzon, J.A.

Reference: Phys. Rev. Lett. 123(2019)022002

Research Program: SA3_NUCL

DOI: 10.1103/PhysRevLett.123.022002

48. Title: *Solvable Cubic Resonant Systems*

Authors: Biasi A., Bizoñ P., Evin O.

IGFAE Authors: Biasi, A.

Reference: Commun. Math. Phys. 369(2019)433

Research Program: SA1_STRI

DOI: 10.1007/s00220-019-03365-z

49. Title: *Measurement of the $^{235}\text{U}(n, f)$ cross section relative to the $^6\text{Li}(n, t)$ and $^{10}\text{B}(n, \alpha)$ standards from thermal to 170 keV neutron energy range at n_{TOF}*

Authors: Amaducci, S. et al.

IGFAE Authors: Caamano, M.; Duran, I.; Fernandez-Dominguez, B.

Reference: Eur. Phys. J. A55(2019)120

Research Program: SA3_NUCL

DOI: 10.1140/epja/i2019-12802-7

50. Title: *Amplitude analysis of the $B(s)0 \rightarrow K^*0 K^- *0$ decays and measurement of the branching fraction of the $B \rightarrow K^*0 K^- *0$ decay*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP7(2019)32

Research Program: SA1_LHCB

DOI: 10.1007/JHEP07(2019)032

- 51. Title:** *Near-threshold D (Formula presented.) spectroscopy and observation of a new charmonium state*
Authors: Aaij,R. et al.
IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.
Reference: JHEP7(2019)35
Research Program: SA1_LHCB
DOI: 10.1007/JHEP07(2019)035
- 52. Title:** *Searches for Gravitational Waves from Known Pulsars at Two Harmonics in 2015-2017 LIGO Data*
Authors: Abbott,B.P. et al.
IGFAE Authors: Dent, T.
Reference: Astrophys. J. 879(2019)10
Research Program: SA2_GRWA
DOI: 10.3847/1538-4357/ab20cb
- 53. Title:** *Tests of General Relativity with GW170817*
Authors: Abbott,B.P. et al.
IGFAE Authors: Dent, T.
Reference: Phys. Rev. Lett. 123(2019)011102
Research Program: SA2_GRWA
DOI: 10.1103/PhysRevLett.123.011102
- 54. Title:** *HE-LHC: The High-Energy Large Hadron Collider: Future Circular Collider Conceptual Design Report Volume 4*
Authors: Abada,A. et al.
IGFAE Authors: Armesto, N.; Salgado, C.A.
Reference: Eur. Phys. J. Spec. Top.228(2019)1109
Research Program: SA1_HQCD
DOI: 10.1140/epjst/e2019-g00088-6
- 55. Title:** *FCC-hh: The Hadron Collider: Future Circular Collider Conceptual Design Report Volume 3*
Authors: Abada,A. et al.
IGFAE Authors: Armesto, N.; Salgado, C.A.
Reference: Eur. Phys. J. Spec. Top.228(2019)755
Research Program: SA1_HQCD
DOI: 10.1140/epjst/e2019-g00087-0
- 56. Title:** *Narrow-band search for gravitational waves from known pulsars using the second LIGO observing run*
Authors: Abbott,B.P. et al.
IGFAE Authors: Dent, T.
Reference: Phys. Rev. D99(2019)122002
Research Program: SA2_GRWA
DOI: 10.1103/PhysRevD.99.122002
- 57. Title:** *Sub-threshold production of K s 0 mesons and Λ hyperons in Au+Au collisions at $\sqrt{s_{NN}}=2.4$ GeV*
Authors: Adamczewski-Musch,J. et al.
IGFAE Authors: Garzon, J.A.
Reference: Phys. Lett. B793(2019)457
Research Program: SA3_NUCL

DOL: 10.1016/j.physletb.2019.03.065

58. Title: *Amplitude analysis of $B_s^0 \rightarrow K_S^0 K^\pm \pi^\mp$ decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP6(2019)114

Research Program: SA1_LHCB

DOL: 10.1007/JHEP06(2019)114

59. Title: *Measurement of the branching fraction and CP asymmetry in $B^+ \rightarrow J/\psi \rho^+$ decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Eur. Phys. J. C79(2019)537

Research Program: SA1_LHCB

DOL: 10.1140/epjc/s10052-019-6698-3

60. Title: *FCC Physics Opportunities: Future Circular Collider Conceptual Design Report Volume 1*

Authors: Abada, A. et al.

IGFAE Authors: Armesto, N.; Salgado, C.A.

Reference: Eur. Phys. J. C79(2019)474

Research Program: SA1_HQCD

DOL: 10.1140/epjc/s10052-019-6904-3

61. Title: *FCC-ee: The Lepton Collider: Future Circular Collider Conceptual Design Report Volume 2*

Authors: Abada, A. et al.

IGFAE Authors: Armesto, N.; Salgado, C.A.

Reference: Eur. Phys. J. Spec. Top.228(2019)261

Research Program: SA1_HQCD

DOL: 10.1140/epjst/e2019-900045-4

62. Title: *Experimental study of nuclear fission along the thorium isotopic chain: From asymmetric to symmetric fission*

Authors: Chatillon, A. et al.

IGFAE Authors: Alvarez-Pol, H.; Benlliure, J.; Caamano, M.; Cortina-Gil, D.; Fernandez-Dominguez, B.; Rodriguez-Sanchez, J.L.

Reference: Phys. Rev. C99(2019)054628

Research Program: SA3_NUCL, SA3_LACC

DOL: 10.1103/PhysRevC.99.054628

63. Title: *Validation of the energy-loss response of α particles in $iC4H10$ with ACTARSim*

Authors: Konczykowski, P. et al.

IGFAE Authors: Alvarez-Pol, H.; Caamano, M.; Fernandez-Dominguez, B.

Reference: Nucl. Instr. Meth. Phys. Res. A927(2019)125

Research Program: SA3_NUCL

DOL: 10.1016/j.nima.2019.02.013

64. Title: Search for CP Violation in $Ds^+ \rightarrow K S 0 \pi^+$, $D^+ \rightarrow K S 0 K^+$, and $D^+ \rightarrow \phi \pi^+$ Decays

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)191803

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.191803

65. Title: Observation of $B(s)0 \rightarrow j/\psi p$ Decays and Precision Measurements of the $B(s)0$ Masses

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)191804

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.191804

66. Title: All-sky search for long-duration gravitational-wave transients in the second Advanced LIGO observing run

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. D 99(2019)104033

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevD.99.104033

67. Title: Search for Lepton-Universality Violation in $B^+ \rightarrow k^{++}$ -Decays

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)191801

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.122.191801

68. Title: Neutron-rich fragments produced by in-flight fission of U 238

Authors: Perez-Loureiro, D. et al.

IGFAE Authors: Alvarez-Pol, H.; Benlliure, J.; Rodriguez-Sanchez, J.L.

Reference: Phys. Rev. C 99(2019)054606

Research Program: SA3_NUCL, SA3_LACC

DOI: 10.1103/PhysRevC.99.054606

69. Title: Prospects for measurements with strange hadrons at LHCb

Authors: Alves, A.A., Jr. et al.

IGFAE Authors: Alves, A.A., Jr.; Brea Rodriguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Lucio Martinez, M.; Santos, D.M.; Ramos Pernas, M.

Reference: JHEP5(2019)48

Research Program: SA1_LHCB

DOI: 10.1007/JHEP05(2019)048

70. Title: *Measurement of the relative $B^- \rightarrow d0/D^*0/D^{*0}\mu^- \nu \mu$ branching fractions using B^- mesons from $B^s \rightarrow d0$ decays* MEASUREMENT OF THE RELATIVE $B^- \rightarrow d0/D^*0/D^{*0}\mu^- \nu \mu$... R. Aaij et al.

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D99(2019)092009

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.99.092009

71. Title: *Study of the $B^0 \rightarrow \rho(770)^+ K^*(892)^0$ decay with an amplitude analysis of $B^0 \rightarrow (\pi^+ \pi^-)(K^+ \pi^-)$ decays*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP5(2019)26

Research Program: SA1_LHCB

DOI: 10.1007/JHEP05(2019)026

72. Title: *First Measurement of the Hubble Constant from a Dark Standard Siren using the Dark Energy Survey Galaxies and the LIGO/Virgo Binary-Black-hole Merger GW170814*

Authors: Soares-Santos,M. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. Lett. 876(2019)L7

Research Program: SA2_GRWA

DOI: 10.3847/2041-8213/ab14f1

73. Title: *Low-latency Gravitational-wave Alerts for Multimessenger Astronomy during the Second Advanced LIGO and Virgo Observing Run*

Authors: Abbott,B.P. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. 875(2019)161

Research Program: SA2_GRWA

DOI: 10.3847/1538-4357/ab0e8f

74. Title: *Searches for Continuous Gravitational Waves from 15 Supernova Remnants and Fomalhaut b with Advanced LIGO*

Authors: Abbott,B.P. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. 875(2019)122

Research Program: SA2_GRWA

DOI: 10.3847/1538-4357/ab113b

75. Title: *Search for Gravitational Waves from a Long-lived Remnant of the Binary Neutron Star Merger GW170817*

Authors: Abbott,B.P. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. 875(2019)160

Research Program: SA2_GRWA

DOL: 10.3847/1538-4357/ab0f3d

76. Title: *Model-Independent Observation of Exotic Contributions to $B0 \rightarrow j/\psi K\pi$ - Decays*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 122(2019)152002

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.152002

77. Title: *Observation of the doubly Cabibbo-suppressed decay $\Xi c^+ \rightarrow p\phi$*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP4(2019)84

Research Program: SA1_LHCB

DOL: 10.1007/JHEP04(2019)084

78. Title: *Dalitz plot analysis of the $D^+ \rightarrow K^- K^+ K^+$ decay*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP4(2019)63

Research Program: SA1_LHCB

DOL: 10.1007/JHEP04(2019)063

79. Title: *Search for Transient Gravitational-wave Signals Associated with Magnetar Bursts during Advanced LIGO's Second Observing Run*

Authors: Abbott,B.P. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. 874(2019)163

Research Program: SA2_GRWA

DOL: 10.3847/1538-4357/ab0e15

80. Title: *Measurement of $^{73}\text{Ge}(n,\gamma)$ cross sections and implications for stellar nucleosynthesis*

Authors: Lederer-Woods,C. et al.

IGFAE Authors: Caamano, M.; Duran, I.; Fernandez-Dominguez, B.

Reference: Phys. Lett. B790(2019)458

Research Program: SA3_NUCL

DOL: 10.1016/j.physletb.2019.01.045

81. Title: *Neutron skin and signature of the $N = 14$ shell gap found from measured proton radii of 17–22N*

Authors: Bagchi,S. et al.

IGFAE Authors: Cortina-Gil, D.

Reference: Phys. Lett. B790(2019)251

Research Program: SA3_NUCL, SA3_LACC

DOL: 10.1016/j.physletb.2019.01.024

82. Title: Measurement of the average shape of longitudinal profiles of cosmic-ray air showers at the Pierre Auger Observatory

Authors: Aab, A. et al.

IGFAE Authors: Alvarez-Muniz, J.; Garcia Plana, B.; Lopez Casado, A.; Parente, G.; Pedreira, F.; Torralba Elipe, G.; Valino, I.; Vazquez, R.A.; Zas, E.

Reference: J. Cosmol. Astropart. Phys. 3(2019)018

Research Program: SA1_HQCD, SA2_AUGE

DOL: 10.1088/1475-7516/2019/03/018

83. Title: The ϕ 4 model with the BPS preserving defect

Authors: Adam C., Romanczukiewicz T., Wereszczynski A.

IGFAE Authors: Adam, C.

Reference: JHEP3(2019)131

Research Program: SA1_HQCD

DOL: 10.1007/JHEP03(2019)131

84. Title: First Measurement of a Long-Lived $\pi^+\pi^-$ Atom Lifetime

Authors: Adeva, B. et al.

IGFAE Authors: Adeva, B.; Plo, M.; Romero Vidal, A.; Saborido Silva, J.J.

Reference: Phys. Rev. Lett. 122(2019)082003

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevLett.122.082003

85. Title: Measurement of the mass and production rate of Ξb - baryons

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D99(2019)052006

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevD.99.052006

86. Title: Measurement of B^+ , B^0 and Λb^0 production in pPb collisions at $s_{NN} = 8.16$ TeV

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D99(2019)052011

Research Program: SA1_LHCB

DOL: 10.1103/PhysRevD.99.052011

87. Title: Measurement of the branching fractions of the decays $D^+ \rightarrow K^- K^+ K^+$, $D^+ \rightarrow \pi^- \pi^+ K^+$ and $D^+ s^+ \rightarrow \pi^- K^+ K^+$

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP3(2019)176
Research Program: SA1_LHCB
DOI: 10.1007/JHEP03(2019)176

88. Title: *Measurement of the ratio of branching fractions of the decays $\Lambda b 0 \rightarrow \psi(2S)\Lambda$ and $\Lambda b 0 \rightarrow J/\psi\Lambda$*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP3(2019)126
Research Program: SA1_LHCB
DOI: 10.1007/JHEP03(2019)126

89. Title: *Relative particle yield fluctuations in Pb–Pb collisions at $\sqrt{s_{NN}}=2.76\text{TeV}$*

Authors: Acharya,S. et al.

IGFAE Authors: Ferreiro, E.G.

Reference: Eur. Phys. J. C79(2019)236
Research Program: SA1_HQCD
DOI: 10.1140/epjc/s10052-019-6711-x

90. Title: *A fixed-target programme at the LHC for heavy-ion, hadron, spin and astroparticle physics: AFTER@LHC*

Authors: Kikola,D. et al.

IGFAE Authors: Ferreiro, E.G.

Reference: Nucl. Phys. A982(2019)971
Research Program: SA1_HQCD
DOI: 10.1016/j.nuclphysa.2018.09.063

91. Title: *Search for CP violation through an amplitude analysis of $D 0 \rightarrow K + K - \pi + \pi -$ decays*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP2(2019)126
Research Program: SA1_LHCB
DOI: 10.1007/JHEP02(2019)126

92. Title: *Prompt $\Lambda c +$ production in pPb collisions at $\sqrt{s_{NN}}=5.02\text{TeV}$*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; García Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP2(2019)102
Research Program: SA1_LHCB
DOI: 10.1007/JHEP02(2019)102

93. Title: *Study of multi-neutron emission in the β -decay of ^{11}Li*

Authors: Delaunay,F. et al.

IGFAE Authors: Fernandez-Dominguez, B.

Reference: Nuovo Cimento Soc. Ital. Fis. C42(2019)98
Research Program: SA3_NUCL
DOI: 10.1393/ncc/i2019-19098-5

94. Title: *Cross section measurements of 155,157 Gd(n, γ) induced by thermal and epithermal neutrons*

Authors: Mastromarco, M. et al.

IGFAE Authors: Caamano, M.; Duran, I.; Fernandez-Dominguez, B.

Reference: Eur. Phys. J. A55(2019)9

Research Program: SA3_NUCL

DOI: 10.1140/epja/i2019-12692-7

95. Title: *Cosmic inflation without inflaton*

Authors: Arciniega G., Bueno P., Cano P.A., Edelstein J.D., Hennigar R.A., Jaime L.G.

IGFAE Authors: Edelstein, J.D.

Reference: Int. J. Mod. Phys. D(2019)1944008

Research Program: SA1_STRI

DOI: 10.1142/S0218271819440085

96. Title: *Search for the Lepton-Flavor-Violating Decays $B_s^0 \rightarrow \tau^\pm \mu^\pm$ and $B^0 \rightarrow \tau^\pm \mu^\pm$*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)211801

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.211801

97. Title: *Universal Relaxation in a Holographic Metallic Density Wave Phase*

Authors: Amoretti A., Areán D., Goutéraux B., Musso D.

IGFAE Authors: Musso, D.

Reference: Phys. Rev. Lett. 123(2019)211602

Research Program: SA1_STRI

DOI: 10.1103/PhysRevLett.123.211602

98. Title: *Extracting the spectral signature of α clustering in $Ti\ 44,48,52$ using a continuous wavelet transform*

Authors: Bailey, S. et al.

IGFAE Authors: Fernandez-Dominguez, B.

Reference: Phys. Rev. C100(2019)051302

Research Program: SA3_NUCL

DOI: 10.1103/PhysRevC.100.051302

99. Title: *Data-driven estimation of the invisible energy of cosmic ray showers with the Pierre Auger Observatory*

Authors: Aab, A. et al.

IGFAE Authors: Alvarez-Muniz, J.; Garcia Plana, B.; Lopez Casado, A.; Parente, G.; Pedreira, F.; Riehn, F.; Torralba Elipe, G.; Valino, I.; Vazquez, R.A.; Zas, E.

Reference: Phys. Rev. D100(2019)082003

Research Program: SA1_HQCD, SA2_AUGE

DOI: 10.1103/PhysRevD.100.082003

100. Title: Inclusive diffraction in future electron-proton and electron-ion colliders

Authors: Armesto N., Newman P.R., Stomiński W., Staśto A.M.

IGFAE Authors: Armesto, N.

Reference: Phys. Rev. D100(2019)074022

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevD.100.074022

101. Title: Search for Subsolar Mass Ultracompact Binaries in Advanced LIGO's Second Observing Run

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. Lett. 123(2019)161102

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevLett.123.161102

102. Title: Measurement of the Ge 70 (n,γ) cross section up to 300 keV at the CERN n-TOF facility

Authors: Gawlik, A. et al.

IGFAE Authors: Caamano, M.; Duran, I.; Fernandez-Dominguez, B.

Reference: Phys. Rev. C100(2019)045804

Research Program: SA3_NUCL

DOI: 10.1103/PhysRevC.100.045804

103. Title: Observation of New Resonances in the $\Lambda b0 \pi+\pi$ - System

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Lamas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)152001

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.152001

104. Title: Diffusion and universal relaxation of holographic phonons

Authors: Amoretti A., Aréan D., Goutéraux B., Musso D.

IGFAE Authors: Musso, D.

Reference: JHEP10(2019)68

Research Program: SA1_STRI

DOI: 10.1007/JHEP10(2019)068

105. Title: Supersymmetric probes in warped AdS6

Authors: Penin J.M., Ramallo A.V., Rodríguez-Gómez D.

IGFAE Authors: Penin, J.M.; Ramallo, A.V.

Reference: JHEP10(2019)21

Research Program: SA1_STRI

DOI: 10.1007/JHEP10(2019)021

106. Title: A search for $\Xi_{cc}^{++} \rightarrow D+pK-\pi$ decays

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP10(2019)124
Research Program: SA1_LHCB
DOI: 10.1007/JHEP10(2019)124

107. Title: *Energy calibration of the NEXT-White detector with 1% resolution near Q $\beta\beta$ of 136Xe*

Authors: Renner, J. et al.

IGFAE Authors: Gonzalez-Díaz, D.; Hernando Morata, J.A.; Martinez-Lema, G.; Palmeiro, B.; Renner, J.

Reference: JHEP10(2019)230
Research Program: SA2_NEXT, SA3_NUCL
DOI: 10.1007/JHEP10(2019)230

108. Title: *Demonstration of the event identification capabilities of the NEXT-White detector*

Authors: Ferrario, P. et al.

IGFAE Authors: Gonzalez-Díaz, D.; Hernando Morata, J.A.; Martinez-Lema, G.; Palmeiro, B.; Renner, J.

Reference: JHEP10(2019)52
Research Program: SA2_NEXT, SA3_NUCL
DOI: 10.1007/JHEP10(2019)052

109. Title: *Radiogenic backgrounds in the NEXT double beta decay experiment*

Authors: Novella, P. et al.

IGFAE Authors: Gonzalez-Díaz, D.; Hernando Morata, J.A.; Martinez-Lema, G.; Palmeiro, B.; Renner, J.

Reference: JHEP10(2019)51
Research Program: SA2_NEXT, SA3_NUCL
DOI: 10.1007/JHEP10(2019)051

110. Title: *Probing dense baryon-rich matter with virtual photons*

Authors: Adamczewski-Musch, J. et al.

IGFAE Authors: Garzon, J.A.
Reference: Nat. Phys. 15(2019)1040
Research Program: SA3_NUCL
DOI: 10.1038/s41567-019-0583-8

111. Title: *Search for Eccentric Binary Black Hole Mergers with Advanced LIGO and Advanced Virgo during Their First and Second Observing Runs*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.
Reference: Astrophys. J. 883(2019)149
Research Program: SA2_GRWA
DOI: 10.3847/1538-4357/ab3c2d

112. Title: *Search for intermediate mass black hole binaries in the first and second observing runs of the Advanced LIGO and Virgo network*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.
Reference: Phys. Rev. D100(2019)064064
Research Program: SA2_GRWA
DOI: 10.1103/PhysRevD.100.064064

113. **Title:** *Transport coefficients from in-medium quarkonium dynamics*

Authors: Brambilla N., Escobedo M.A., Vairo A., Vander Griend P.

IGFAE Authors: Escobedo, M.A.

Reference: Phys. Rev. D100(2019)054025

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevD.100.054025

114. **Title:** *Binary Black Hole Population Properties Inferred from the First and Second Observing Runs of Advanced LIGO and Advanced Virgo*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Astrophys. J. Lett. 882(2019)L24

Research Program: SA2_GRWA

DOI: 10.3847/2041-8213/ab3800

115. **Title:** *GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. X9(2019)031040

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevX.9.031040

116. **Title:** *Directional limits on persistent gravitational waves using data from Advanced LIGO's first two observing runs*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. D100(2019)062001

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevD.100.062001

117. **Title:** *Search for the isotropic stochastic background using data from Advanced LIGO's second observing run*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. D100(2019)061101

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevD.100.061101

118. **Title:** *Hadroproduction of neutral K^* -mesons up to LHC energies*

Authors: Arakelyan G.H., Merino C., Shabelski Y.M.

IGFAE Authors: Merino, C.

Reference: Eur. Phys. J. A55(2019)151

Research Program: SA1_HQCD

DOI: 10.1140/epja/i2019-12832-1

119. **Title:** *Effect of non-eikonal corrections on azimuthal asymmetries in the color glass condensate*

Authors: Agostini P., Altinoluk T., Armesto N.

IGFAE Authors: Armesto, N.

Reference: Eur. Phys. J. C79(2019)790

Research Program: SA1_HQCD

DOI: 10.1140/epjc/s10052-019-7315-1

120. **Title:** *Observation of the $\Lambda b0 \rightarrow \chi c1 (3872) pK^-$ decay*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Lamas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: JHEP(2019)28

Research Program: SA1_LHCB

DOI: 10.1007/JHEP09(2019)028

121. **Title:** *Measurements of CP asymmetries in charmless four-body $\Lambda b0$ and $\Xi b0$ decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Cid, E.L.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Eur. Phys. J. C79(2019)745

Research Program: SA1_LHCB

DOI: 10.1140/epjc/s10052-019-7218-1

122. **Title:** *First Direct Measurement of Isotopic Fission-Fragment Yields of U 239*

Authors: Ramos, D. et al.

IGFAE Authors: Alvarez-Pol, H.; Caamano, M.; Fernandez-Dominguez, B.; Galiana, E.

Reference: Phys. Rev. Lett. 123(2019)092503

Research Program: SA3_NUCL

DOI: 10.1103/PhysRevLett.123.092503

123. **Title:** *Measurement of b hadron fractions in 13 TeV pp collisions MEASUREMENT OF b HADRON FRACTIONS in 13 TeV ... AAIJ et al.*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D100(2019)031102

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.100.031102

124. **Title:** *Measurement of CP -Violating and Mixing-Induced Observables in $Bs0 \rightarrow \phi\gamma$ Decays*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)081802

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.081802

125. **Title:** *Area covered by disks in small-bounded continuum percolating systems: An application to the string percolation model*

Authors: Ramírez J.E., Pajares C.

IGFAE Authors: Pajares, C.; Ramírez, J.E.

Reference: Phys. Rev. E100(2019)022123

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevE.100.022123

126. **Title:** *Electron drift and longitudinal diffusion in high pressure xenon-helium gas mixtures*

Authors: McDonald, A.D. et al.

IGFAE Authors: Gonzalez-Díaz, D.; Hernando Morata, J.A.; Martinez-Lema, G.; Palmeiro, B.; Renner, J.

Reference: J. Instrum. 14(2019)P08009

Research Program: SA2_NEXT, SA3_NUCL

DOI: 10.1088/1748-0221/14/08/P08009

127. **Title:** *Precision measurement of the Λc^+ , Ξc^+ , and Ξc^0 baryon lifetimes*

Authors: Aaij, R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D100(2019)032001

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.100.032001

128. **Title:** *Non-eikonal corrections to multi-particle production in the color glass condensate*

Authors: Agostini P., Altinoluk T., Armesto N.

IGFAE Authors: Armesto, N.

Reference: Eur. Phys. J. C79(2019)600

Research Program: SA1_HQCD

DOI: 10.1140/epjc/s10052-019-7097-5

129. **Title:** *Radiative corrections to the jet quenching parameter in dilute and dense media*

Authors: Blaizot J.-P., Dominguez F.

IGFAE Authors: Dominguez, F.

Reference: Phys. Rev. D99(2019)054005

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevD.99.054005

130. **Title:** *Progress on the PICOSEC-Micromegas Detector Development: Towards a precise timing, radiation hard, large-scale particle detector with segmented readout*

Authors: Kordas, K. et al.

IGFAE Authors: Gonzalez-Díaz, D.

Reference: Nucl. Instr. Meth. Phys. Res. A(2019)162877

Research Program: SA2_NEXT

DOI: 10.1016/j.nima.2019.162877

131. **Title:** *Multiparticle production at mid-rapidity in the color-glass condensate*

Authors: Martinez M., Sievert M.D., Wertepny D.E.

IGFAE Authors: Wertepny, D.E.

Reference: JHEP2(2019)24

Research Program: SA1_HQCD
DOI: 10.1007/JHEP02(2019)024

132. Title: *Exploring the initial stage of high multiplicity proton-proton collisions by determining the initial temperature of the quark-gluon plasma*

Authors: Scharenberg R.P., Srivastava B.K., Pajares C.

IGFAE Authors: Pajares, C.

Reference: Phys. Rev. D100(2019)114040

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevD.100.114040

133. Title: *Measurement of the Bc-meson production fraction and asymmetry in 7 and 13 TeV pp collisions MEASUREMENT OF THE Bc-MESON PRODUCTION ... AAIJ R. et al.*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Lamas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. D100(2019)112006

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.100.112006

134. Title: *Search for Lepton-Flavor Violating Decays $B^+ \rightarrow k+\mu\pm e$*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)241802

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.241802

135. Title: *Amplitude Analysis of $B_{\pm} \rightarrow \pi_{\pm}K+K$ Decays*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)231802

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevLett.123.231802

136. Title: *Measurement of Charged Hadron Production in Z-Tagged Jets in Proton-Proton Collisions at $\sqrt{s}=8$ TeV*

Authors: Aaij,R. et al.

IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; Garcia Pardinias, J.; Garcia Plana, B.; Lucio Martinez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Diaz, M.

Reference: Phys. Rev. Lett. 123(2019)232001

Research Program: SA1_LHCB
DOI: 10.1103/PhysRevLett.123.232001

137. Title: *Search for gravitational waves from Scorpius X-1 in the second Advanced LIGO observing run with an improved hidden Markov model*

Authors: Abbott, B.P. et al.
IGFAE Authors: Dent, T.
Reference: Phys. Rev. D100(2019)122002
Research Program: SA2_GRWA
DOI: 10.1103/PhysRevD.100.122002

138. Title: *Holographic fundamental matter in multilayered media*

Authors: Gran U., Jokela N., Musso D., Ramallo A.V., Tornsö M.
IGFAE Authors: Musso, D.; Ramallo, A.V.
Reference: JHEP12(2019)38
Research Program: SA1_STRI
DOI: 10.1007/JHEP12(2019)038

139. Title: *Simplest phonons and pseudo-phonons in field theory*

Authors: Musso D.
IGFAE Authors: Musso, D.
Reference: Eur. Phys. J. C79(2019)986
Research Program: SA1_STRI
DOI: 10.1140/epjc/s10052-019-7498-5

140. Title: *Measurement of CP violation in the $B_s^0 \rightarrow \phi\phi$ decay and search for the $B^0 \rightarrow \phi\phi$ decay*

Authors: Aaij, R. et al.
IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; García Pardinás, J.; García Plana, B.; Lucio Martínez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Díaz, M.
Reference: JHEP12(2019)155
Research Program: SA1_LHCB
DOI: 10.1007/JHEP12(2019)155

141. Title: *Measurement of the electron reconstruction efficiency at LHCb*

Authors: Aaij, R. et al.
IGFAE Authors: Adeva, B.; Alves, A.A., Jr.; Boente García, O.; Borsato, M.; Brea Rodríguez, A.; Casis Vidal, A.; Chobanova, V.; Vidal, X.C.; Dalseno, J.; Fernandez Prieto, A.; Gallas Torreira, A.; García Plana, B.; Lucio Martínez, M.; Santos, D.M.; Plo, M.; Prouvre, C.; Ramos Pernas, M.; Romero Lamas, M.; Romero Vidal, A.; Saborido Silva, J.J.; Santamarina Rios, C.; Vazquez Regueiro, P.; Vieites Díaz, M.
Reference: J. Instrum. 14(2019)P11023
Research Program: SA1_LHCB
DOI: 10.1088/1748-0221/14/11/P11023

142. Title: *Tests of general relativity with the binary black hole signals from the LIGO-Virgo catalog GWTC-1*

Authors: Abbott, B.P. et al.
IGFAE Authors: Dent, T.
Reference: Phys. Rev. D100(2019)104036

Research Program: SA2_GRWA
DOI: 10.1103/PhysRevD.100.104036

143. **Title:** *Search for Gravitational-wave Signals Associated with Gamma-Ray Bursts during the Second Observing Run of Advanced LIGO and Advanced Virgo*

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: *Astrophys. J.* 886(2019)75

Research Program: SA2_GRWA

DOI: 10.3847/1538-4357/ab4b48

144. **Title:** *Global analysis of dark matter simplified models with leptophobic spin-one mediators using MasterCode*

Authors: Bagnaschi, E. et al.

IGFAE Authors: Lucio Martinez, M.; Santos, D.M.

Reference: *Eur. Phys. J. C* 79(2019)895

Research Program: SA1_LHCB

DOI: 10.1140/epjc/s10052-019-7382-3

145. **Title:** *Probing the origin of ultra-high-energy cosmic rays with neutrinos in the EeV energy range using the Pierre Auger Observatory*

Authors: Aab, A. et al.

IGFAE Authors: Alvarez-Muniz, J.; Garcia Plana, B.; Lopez Casado, A.; Parente, G.; Pedreira, F.; Riehn, F.; Torralba Elipe, G.; Valino, I.; Vazquez, R.A.; Zas, E.

Reference: *J. Cosmol. Astropart. Phys.* 10(2019)022

Research Program: SA1_HQCD, SA2_AUGE

DOI: 10.1088/1475-7516/2019/10/022

146. **Title:** *Spin-2 excitations in Gaiotto-Maldacena solutions*

Authors: Itsios G., Penin J.M., Zacarias S.

IGFAE Authors: Penin, J.M.

Reference: *JHEP* 10(2019)231

Research Program: SA1_HQCD

DOI: 10.1007/JHEP10(2019)231

147. **Title:** *Resolving the $\phi_2(\alpha)$ ambiguity in $B_0 \rightarrow a_1 \pi \bar{\pi}$*

Authors: Dalseno J.

IGFAE Authors: Dalseno, J.

Reference: *JHEP* 10(2019)191

Research Program: SA1_LHCB

DOI: 10.1007/JHEP10(2019)191

148. **Title:** *Complex plane representations and stationary states in cubic and quintic resonant systems*

Authors: Biasi A., Bizoń P., Evnin O.

IGFAE Authors: Biasi, A.

Reference: *J. Phys. A* 52(2019)435201

Research Program: SA1_STRI

DOI: 10.1088/1751-8121/ab4406

149. **Title:** *Effects of the second virial coefficient on the adiabatic lapse rate of dry atmospheres*

Authors: Alvarez Navarro E., Diaz B., García-Ariza M.Á., Ramírez J.E.

IGFAE Authors: Ramírez, J.E.

Reference: *Eur. Phys. J. Plus* 134(2019)458

Research Program: SA1_HQCD
DOI: 10.1140/epjp/i2019-12826-4

150. Title: Update on the $b \rightarrow s$ anomalies

Authors: Arbey A., Hurth T., Mahmoudi F., Martínez Santos D., Neshatpour S.

IGFAE Authors: Santos, D.M.

Reference: Phys. Rev. D100(2019)015045

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.100.015045

151. Title: All-sky search for short gravitational-wave bursts in the second Advanced LIGO and Advanced Virgo run

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. D100(2019)024017

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevD.100.024017

152. Title: Stochastic curvature of enclosed semiflexible polymers

Authors: Castro-Villarreal P., Ramírez J.E.

IGFAE Authors: Ramírez, J.E.

Reference: Phys. Rev. E100(2019)012503

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevE.100.012503

153. Title: All-sky search for continuous gravitational waves from isolated neutron stars using Advanced LIGO O2 data

Authors: Abbott, B.P. et al.

IGFAE Authors: Dent, T.

Reference: Phys. Rev. D100(2019)024004

Research Program: SA2_GRWA

DOI: 10.1103/PhysRevD.100.024004

154. Title: Design and performance of the LHCb trigger and full real-time reconstruction in Run 2 of the LHC

Authors: Aaij, R. et al.

IGFAE Authors: Santos, D.M.; Prouvre, C.; Ramos Pernas, M.

Reference: J. Instrum. 14(2019)P04013

Research Program: SA1_LHCB

DOI: 10.1088/1748-0221/14/04/P04013

155. Title: Limits on point-like sources of ultra-high-energy neutrinos with the Pierre Auger Observatory

Authors: Aab, A. et al.

IGFAE Authors: Alvarez-Muniz, J.; García Plana, B.; Lopez Casado, A.; Parente, G.; Pedreira, F.; Riehn, F.; Torralba Elipe, G.; Valino, I.; Vazquez, R.A.; Zas, E.

Reference: J. Cosmol. Astropart. Phys. 11(2019)004

Research Program: SA1_HQCD, SA2_AUGE

DOI: 10.1088/1475-7516/2019/11/004

156. Title: Multi-Messenger Physics With the Pierre Auger Observatory

Authors: Kampert K.-H., Alejandro Mostafa M., Zas E., The Pierre Auger Collaboration

IGFAE Authors: Zas, E.

Reference: Front. Astron. Space Sci.6(2019)24
Research Program: SA2_AUGE
DOI: 10.3389/fspas.2019.00024

157. Title: Modeling the nonperturbative contributions to the complex heavy-quark potential

Authors: Guo Y., Dong L., Pan J., Moldes M.R.

IGFAE Authors: Moldes, M.R.

Reference: Phys. Rev. D100(2019)036011

Research Program: SA1_HQCD

DOI: 10.1103/PhysRevD.100.036011

158. Title: Discovering true muonium at LHCb

Authors: Vidal X.C., Ilten P., Plews J., Shuve B., Soreq Y.

IGFAE Authors: Vidal, X.C.

Reference: Phys. Rev. D100(2019)053003

Research Program: SA1_LHCB

DOI: 10.1103/PhysRevD.100.053003

159. Title: LHCb VELO Timepix3 telescope

Authors: Akiba, K. et al.

IGFAE Authors: Vidal, X.C.; Gallas Torreira, A.; Garcia Pardinias, J.; Vieites Diaz, M.

Reference: J. Instrum. 14(2019)P05026

Research Program: SA1_LHCB

DOI: 10.1088/1748-0221/14/05/P05026

160. Title: New axion searches at flavor factories

Authors: Vidal X.C., Mariotti A., Redigolo D., Sala F., Tobioka K.

IGFAE Authors: Vidal, X.C.

Reference: JHEP1(2019)113

Research Program: SA1_LHCB

DOI: 10.1007/JHEP01(2019)113

161. Title: Review of lepton universality tests in B decays

Authors: Bifani S., Descotes-Genon S., Vidal A.R., Schune M.-H.

IGFAE Authors: Romero Vidal, A.

Reference: J. Phys. G46(2019)023001

Research Program: SA1_LHCB

DOI: 10.1088/1361-6471/aaf5de

ANNEX 4: FIGURES

Figure 1. Organization chart.	7
Figure 2. Julián García Pardiñas receiving the 1st DFTP Prize (Division of Theoretical and Particle Physics) of the Royal Spanish Society of Physics (RSEF).	11
Figure 3. Abraham Gallas receiving the Lois Peña Novo 2019 award on behalf of Carlos Salgado.	11
Figure 4. José Edelstein and rest of winners at the award ceremony.	11
Figure 5. Total funds raised during 2019.	12
Figure 6. Actives projects & agreements 2019.	14
Figure 7. Contribution by activity.	15
Figure 8. Artistic view of the VELO sub-detector, detail of the detector modules.	19
Figure 9. Assembly of Optical Power Boards, production of High Voltage cables, High-Speed data links	20
Figure 10. Photograph of one of the FAT-GEM samples and schematic drawing of the fabrication procedure.	28
Figure 11. Energy resolution vs reduced electric field across the structure, indicating the NEXT goal as a dashed line. The maximum field achieved (about 3kV/cm/bar at 10bar), limited by the setup and not the FAT-GEM itself, translates into an optical gain of around 500ph per electron, at the same level as the one achieved by the NEXT experiment with conventional meshes	28
Figure 12. Preliminary results of the ratio of 2nd to 3rd continuum (VUV/UV bands) as a function of pressured, measured for the first time for β -electrons in Xe.	28
Figure 13. Compilation of main results for RP-WELL structures in single and 2-stage. Blue circles indicate a gain of almost 106 electrons, sufficient for single-photon detection at cryogenic conditions.	29
Figure 14. Pierre Auger Observatory limits to the diffuse flux of UHE neutrinos as well as from other experiments along with models of neutrino production.	30

Figure 15. Participants of the 20th anniversary of the Pierre Auger Observatory in November 2019 in Malargüe, Mendoza (Argentina). More info at: https://www.auger.org/	30
Figure 16. Tristan detector onboard the oceanographic vessel 'BIO Hesperides'	32
Figure 17. Four SALLA antennas on the roof of the Physics building.	32
Figure 18. GW signals in 3 detectors during O3 observing run.	33
Figure 19. View of the CALIFA calorimeter installed at the nominal target position in the R3B Cave. Beam direction from right to left.	35
Figure 20. Picture from Phys. Rev. Letters 123, 092503 (2019).	37
Figure 21. Energy spectrum of protons accelerated by the LaserPET experiment.	38
Figure 22. LHICMC19.	42
Figure 23. First group of the Scientific Summer Campus.	42
Figure 24. Poster of the summer fellowships.	43
Figure 25. Poster of the 2nd Science Week.	43
Figure 26. Lyn Evans at Auditorio ABANCA.	44
Figure 27. Part of the winners and committee during the award ceremony.	44
Figure 28. Poster of the "Acceelerated NerdNite".	44
Figure 29. Poster of the 2nd Science Communication Contest.	44
Figure 30. Poster of the Open Days "Ciencia Singular".	45
Figure 31. Workshops and talks during the Open Days "Ciencia Singular".	45
Figure 32. Presentation of the Masterclass "Day of Women and Girls in Science".	46
Figure 33. Poster of the dialogue "Minorías en ciencia".	46
Figure 34. Poster of "Comosloxías".	47
Figure 35. Opening of the exhibition "Cosmoloxías".	47

Figure 36. Irene Dubrovsky (left) and colloquium between artist and scientists (right).	48
Figure 37. Ágnes Mócsy, Santiago Olmo (Director of CGAC) and Carlos Salgado.	48
Figure 38. Manuel Feijoo, Xabier García and Juan Peñas organized the workshop From the lab to improve people's health	49
Figure 39. Nestor Armesto during the public talk (left) and Adrián Casais giving a workshop (right)..	50
Figure 40. Posters of the public talks.	51
Figure 41. Book "Unha breve historia do tempo".	51
Figure 42. Book "Ciencia y un gran paso para la humanidad".	51
Figure 43. Some newspaper covers and pieces of news in media websites.	52

ANNEX 5: TABLES

Table 1. Governance.	8
Table 2. IGFAE Composition by professional category.	9
Table 3. projects, institutional agreements, and contracts during 2019.	12
Table 4. PhD Thesis defended at IGFAE in 2019.	15
Table 5. Different lines explored by the Institute and timeline.	41
Table 6. Media impacts in 2019.	51