GENERA Project

Dissemination and Valorisation Report

Deliverable D6.3

August 2018

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Overview

The GENERA project brought together 31 organisations, shown in Appendix 1. 23 were major players (RPOs and RFOs) in physics research in Europe. Of these, 11 implemented new Gender Equality Plans (GEPs) or made improvements to existing gender equality activities and goals. The other physics RPOs and RFOs acted as observers or associate partners. The reminder of the partnership included a research evaluation specialist and organisations with expertise and experience of advancing gender equality in science. Therefore, although the project focused on physics, there was a substantial diversity between the organisations involved. Members of the partnership came from across 16 countries. Their organisational networks stretch well beyond Europe, and this enabled the project to engage many external institutions in the dissemination and communication activities.

In terms of attracting attention of the science and policy communities to the importance of implementing Gender Equality Plans (GEPs) as a tool for achieving structural change, the GENERA project benefited from the focus on physics, and from the participation of so many influential physics institutions in the implementation activities. A question often put to the Consortium was 'what is so special about physics?' that requires a discipline-specific approach to GEP implementation. Until GENERA, projects implementing GEPs that were funded under the EU Framework Programmes have, generally, considered structural change as a problem of changing existing organisational processes and practices to remove possible barriers and biases that might be disadvantaging career advancement of women researchers. The influence of discipline-specific cultures and traditions on the attitudes to change were not considered as relevant.

The experience of the many EU-funded projects, and the efforts by individual RPOs and RFOs , to use GEPs as a tool for change shows that achieving structural transformation in research organisations is a hard task. The approach to GEP implementation in GENERA has been influenced by how physicists like solving hard problems, namely spending great deal of time preoccupied with what can and should be measured. In the project, this demonstrated itself in an extensive effort to identify and collect reliable data that could be reliably used to inform actions, and be shared with other physics organisation to monitor change in the longer-term.

The focus on physics offered a very useful device for drawing attention to the GENERA project, and to GEPs as a policy and as a functional tool. The 'physics angle' was deployed when setting up the GENERA communication strategy, which stressed the importance of the project as one that delivers tools for GEP implementation 'from physicists for physicists'. Taking the special-to-physics 'problem solving angle' helped focus the dissemination activities on the value and reliability of the tools developed in GENERA, which included: the Roadmap for development of customised GEPs, the Toolbox with more than 100 measures and interventions, the implementation process Monitoring Tree, the implementation Protocol, and the Minimum Data Set. The discipline-specific context was used to show how these tools can be used to systematize the implementation process, and how they can help ease the adoption of GEPs across the landscape of physics research institutions in European Research Area.

One area were GENERA has had less impact than initially hoped for was in advancing integration of gender dimension into GEP design and implementation. This is not surprising, perhaps, since the concept of 'gender dimension' in the context of research in general is relatively new and so far rarely discussed in the context of a 'hard' science such as physics. Most commonly, the gender dimension concept is presented as a variable or a set of variables to be included in study design, with examples strongly linked to direct human contexts, and health in particular. Physics researchers studying elemental properties of matter or space would generally consider the content of their research to be 'gender neutral'. It is these areas of physics (particle and astrophysics) that were most strongly represented in the Consortium. However, in applied physics, such as medical physics, radiation dosimetry and imaging, or mechanics, there can be a good reason to evaluate the potential influence, direct or indirect, of gender dimension on research results, outcomes or impact, for example, to improve accuracy and safety of diagnostic technologies.

GENERA was invited to give a presentation at the Japan Applied Physics Society's 64th Spring Conference in Yokohama, which combined dissemination of project GEP-related results and the potential for exploring the gender dimension (see examples from the presentation in Appendix 2). The incorporation of the gender dimension into GEPs will be further pursued through the involvement of the GENERA Network in the new Horizon 2020 funded ACT project. Three partners from the GERNERA consortium are members of the ACT consortium. The aim of ACT is to develop communities of practice for the implementation of GEPs, and other gender equality measures, and the GENERA Network has been selected to be one of those communities.

DISSEMINATION AND COMMUNICATION TARGETS

The dissemination and valorisation activities in GENERA had several targets.

1. **Expand ERA systemic capacity for implementing EU gender equality goals by transferring knowledge and lessons to the RPOs and RFOs who are members of Science Europe and EURAXESS**

The main reason for involving Euraxess in the dissemination activities is the driving role that Euraxess have in overseeing and monitoring the adoption by universities in the European Research Area of the Human Resources Strategy for Researchers (HRS4R). HRS4R promotes over 30 measures of HR excellence, 30% of which overlap the objectives of a typical Gender Equality Plan. It is, therefore, of mutual benefit for RPOs that are implementing HRS4R to exchange knowledge and learn from the experience of the institutions implementing GEPs.

The main reason for involving Science Europe in GENERA dissemination activities is its role as an umbrella organisations for RFOs in Europe, and the publication in 2017 of a practical guide "Improving Gender Equality in Research Organisations". The Guide covers some but not the majority of gender issues related to the grant award processes, results, and impacts on researchers' careers. The focus of the guide is on the three elements listed below and on the measures that can be used to monitor them:

- How to avoid unconscious bias in peer-review processes
- How to monitor gender equality
- How to improve grant management practices

In 2016, Science Europe has dismantled its Working Group on Gender and Diversity (set up four years earlier) and instead the organisation aims to "collaborate with other relevant initiatives, institutional groups and stakeholders to further promote gender equality in the research ecosystem". There has been, therefore, insufficient time within the GENERA project's timetable to agree how the project could contribute to this "ecosystem" view, although initial contacts have been established and well received regarding the future when working together can be enabled through the GENERA Network: *"We remain…very interested in hearing about the GENERA network and its activities beyond the initial H2020 project life time (Maud Evrard, Head of Policy Affairs).*

2. Improve gender equality policy commitment in ERA by transferring knowledge to key committees at the European Parliament, i.e. STOA, ITRE, FEMM and EPRS

Three Policy Briefs (attached in Appendix 3) have been prepared to transfer the knowledge and lessons from GENERA to the key policy making/advising bodies, especially the relevant committees in the European Parliament (EP), as well as the EP's research services unit. A special policy brief has been prepared to help physics institutions improve their gender equality policy, including adoption of GEPs as tools to implement those policies.

Policy Brief 1: *Maximising the opportunity to advance gender equality in physics and related fields through gender sensitive research and innovation endeavours*

Policy Brief 2: *Maximising opportunity to advance gender equality in higher education and in careers linked to STEM fields, and physics in particular*

Policy Brief 3**:** *Evidence supporting physics institutions in promoting gender equality*

3. Promote systematic deployment of Gender Equality Plans in ERA through training opportunities targeting RPOs, RFOs and Science Ministries in EU member states

The experience of the 11 GEP implementing partners was used to identify what kind of training may be needed and would be most beneficial to different organisations. These needs fall into the following categories:

- <u>Managing the GEP planning process</u>, and the day-to-day GEP implementation activities (performed in GENERA by "implementation managers"). The key expertise needed is how to best manage organisational change and secure commitment of all relevant decision-makers, at all levels of impact.
- <u>Supporting leadership</u> in setting the organisation's gender equality mission that is feasible but also impactful (performed in GENERA by "gender experts"). The key expertise needed is how to

understand gender equality as a criterion of institutional excellence (e.g. improved work and research cultures, positive behaviours, welcoming climate)

- Monitoring progress and impact from GEP implementation (performed in GENERA by 'evaluation experts'). The key conditions are systematic collection of relevant statistics that can be used for inter-institutional comparisons (GENERA has identified a Minimum Data Set, which represents data that each of the 11 GEP implementing institutions could collect, and which could acts as benchmarks for future comparisons and monitoring).
- Integrating gender dimension in GEP design

Some GENERA partners formed a new Consortium to apply for a new Horizon 2020 project specifically intended to deliver training, however, that proposal was unsuccessful.

The inclusion of the GENERA Network as a Community of Practice (CoP) in the Horizon 2020 project ACT as one of the seven CoPs to be directly supported and developed will provide fresh opportunity to address the training needs identified in the GENERA project.

Notwithstanding, Portia did develop training materials on the gender dimension that include examples from physics. These materials were tested at two seminars for PhDs and Postdocs, one organised by the Irish Research Council and the other by the Danish University of Technology in Copenhagen.

4. **Improve communication of gender equality issues in physics-related sectors by promoting well-defined and shared understanding of the benefits of addressing these issues at organisational level, targeting genSET stakeholder network, genPORT portal, Gender Summit community, LERU, and EUA.**

GENERA connected to multiple research and stakeholder communities through the partners' networks, and as a result of the different members of the Consortium being invited to speak about the project at many conferences, meetings and discussions - see details below.

A good indicator of the impact of GENERA as a project, and of GENERA's products for supporting implementation of GEPs, is the high-level of interest among many individuals attending GENERA events to continue being involved in future activities, and by their readiness to sign the Letter of Intent.

The Letter of Intent is an invitation for RPOs and RFOs across Europe to join the organisations representing the GENERA partners and supporters as members of the GENERA Network. It is a first step towards creating a stronger relationship requiring a Memorandum of Understanding. The Letter of Intent establishes a non-legally binding relationship between members of the GENERA Network to work for a common purpose and specifically in the following four areas:

- Strengthen organisational commitment to advance gender equality in physics, and to promoting a systematic and efficient implementation of GEPs
- Work with others to develop shared standards for data collection and analysis, and adoption of reliable indicators to benchmark progress

- Engage in experience and knowledge sharing activities that target gender equality issues in physics, and development of gender equality best practices for RPOs and RFOs
- Strengthen efforts to attract more women, and members of other underrepresented groups, to choose physics as a career destination, and to enhance research capacity building within national, institutional and disciplinary settings.

5. **Raise public awareness of the GENERA objectives and activities, in particular Gender-in-Physics days, through systematic interactions with relevant media and publicity channels, website, newsletter and social media channels**

Gender in Physics Days (GiPDs) were held within individual partner institutions and had as a target women and men researchers, administrators, managers, students working in each organisation. These events, 12 in total, played an important dissemination, communication, and valorisation role. Their aim was to help raise awareness of gender issues among the leadership, staff and students within an institutions; show how these issues can be addressed in a cooperative way, especially through GEPs; explain what GENERA is doing to help advance gender equality in physics; and to obtain feedback from the physics community on what is needed to achieve systematic and systemic adoption of GEPs by physics institutions in the European Research Area. The GiPD events provided also an excellent opportunity to enhance visibility of women researchers within an institution and beyond, and discuss gender issues that differentially impact on the career paths of women and men, including negative attitudes and practices based on stereotyped roles that favour the success of men more than of women's.

Description of the dissemination activities

This section focuses on the main dissemination activities conducted by partners throughout the project. In addition to those described below and those carried out through the project website, partners have also utilised their own websites, Newsletters, and inter-institutional meetings to report on the project.

The GENERA project ended in August 2018, but its impact will continue through the GENERA Network. The purpose of the Network is to connect and support RPOs and RFOs across Europe in a cooperative effort to implement GEPs and to monitor and evaluate what has changed. The partners of the GENERA Consortium who have joined the new Horizon 2020 funded project ACT, will advance development of the GENERA Network in terms of additional members, geographic spread, and expertise and experience in adopting GEPs.

GENERA outreach through the public website

The GENERA public website provides details of project goals, the work done, deliverable and other products, GENERA events and news, relevant research resources specific to physics, and information about related projects, conferences and products.

Between September 2015 and July 2018 the GENERA website received: 8000 visits 5700 users 16,000 page views and 522 Twitter followers

Although Facebook was considered in the DoA as a possible social media channel, due to the widely reported in the news problems at Facebook about the lack of sufficient data security and apparent tolerance of unethical content, Facebook was not used. Furthermore, experience showed Twitter, website, and the Gender in Physics days were particularly successful in generating interest in GENERA.

DISSEMINATION THROUGH EXTERNAL CONFERENCES, MEETINGS, COMMUNICATION PLATFORMS, AND FORA ON GENDER AND RESEARCH

PRESENTATIONS AT CONFERENCES AND MEETINGS

2015, Gender Summit 7 (Berlin) – 350 participants
2015, APPEC: Astroparticle in H2020 (Zagreb) – 70 participants
2016, Gender Summit 9 (Brussels) – 300 participants
2016, Vitae Conference (Manchester) – 400 participants
2016, Deutsche Physikerinnentagung – 200 participants
2016, European Parliament, GenPORT launch (Brussels) – 100 participants
2016, Open Evaluation Conference (Vienna) – 300 participants
2016, 9th European Conference on Gender Equality in Higher Education (Paris) – 300 participants
2016, 6th STS Italia Conference (Trento) – 200 participants
2016, 55th AIF National Congress "Gran Sasso: a retun, with a view to the future (Gran Sasso) – 150 participants
2016, FCC Workshop, Study to make Gender Equality Sustainable (Rome) – 60 participants
2016, Meeting of the Austrian Panel to the Helsinki Group (Vienna) – 14 participants
2017, 64th Spring Conference of the Japan Society of Applied Physics (Yokohama) – 400 participants
2017, Gender Summit 10 (Tokyo) – 650 participants
2017, Digital Women Workshop (Rome) – 80 participants
2017, International Workshop on Structural Change for Gender Equality in Research: What is it About? (Prague) – 100 participants
2017, Gender Equality in STEM Congress (Amsterdam) – 300 participants
2017, European Research Lights (Rome) – 200 participants
2017, ICECube (Berlin) – 100 participants – 60 participants
2017, European User Offices Meeting (Lund) – 45 participants
2017 Zukunftskonferenz (Graz) – 50 participants
2017, I Scientist. Conference on gender, career paths, and networking (Berlin) – 350 participants
2017, 4th International Scientific Conference on Women in Science (Krakow) – 100 participants
2017, 9th Conference on Women in Science and Business (Krakow) – 100 participants
2017, International Conference on Gender in Research and Application in Projects (Gliwice) – 200 participants
2017, 9th Women's Congress (Poznan) – 200 participants

2018, Physics@Veldhoven conference - 2000 participants
2018 ESA- OECD Workshop (Paris) – 100 participants
2018, 11th Annual Meeting of the European Synchrotron and FEL User Organisation (ESUO), Solaris (Krakow) – 150 participants
2018, Gender Summit 15 (London) – 200 participants
2018, National Center of Physical and Technological Sciences (NFTMC) (Vilnius) – 60 participants
2018, XIX ISA World Congress of Sociology (Toronto) – 300 participants
2018, 10th European Conference on Gender Equality in Higher Education 2018 (Dublin) – 300 participants

DISSEMINATION THROUGH GENERA ORGANISED EVENTS

12 x Gender in Physics Days – with approximately 800 participants in total

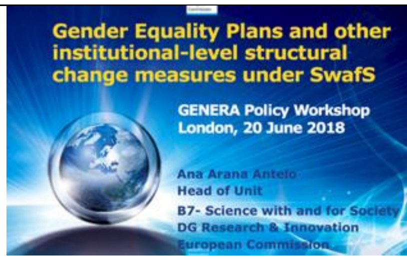
2 x Stakeholder Workshops, one for practitioners and one for policy makers – with 150 participants in total

1 x International Conference “Accelerating ERA Development in STEM by Promotion of Gender Equality in Research" and Baltic Gender in Physics Day, 20-21 Nov 2017, Vilnius – 100 participants

1 x Colloquium, DESY, Hamburg, Oct 217 – 40 participants

1 x Annual Meeting of the MPG Gender Equality Officers, Göttingen, Apr 2016 – 30 participants

GENERA ENGAGING WITH POLICY MAKERS IN ERA

Policy makers in ERA were engaged at the beginning of the project, with the then Director General of DG RTD, Jan Robert Smits, participating as keynote speaker, as well as members of the DG RTD SwfS Unit.

Furthermore, EU and European policy makers participated as speakers at the Policy Workshop in London on 20 June 2018, from DG RTD and from Council of Europe.

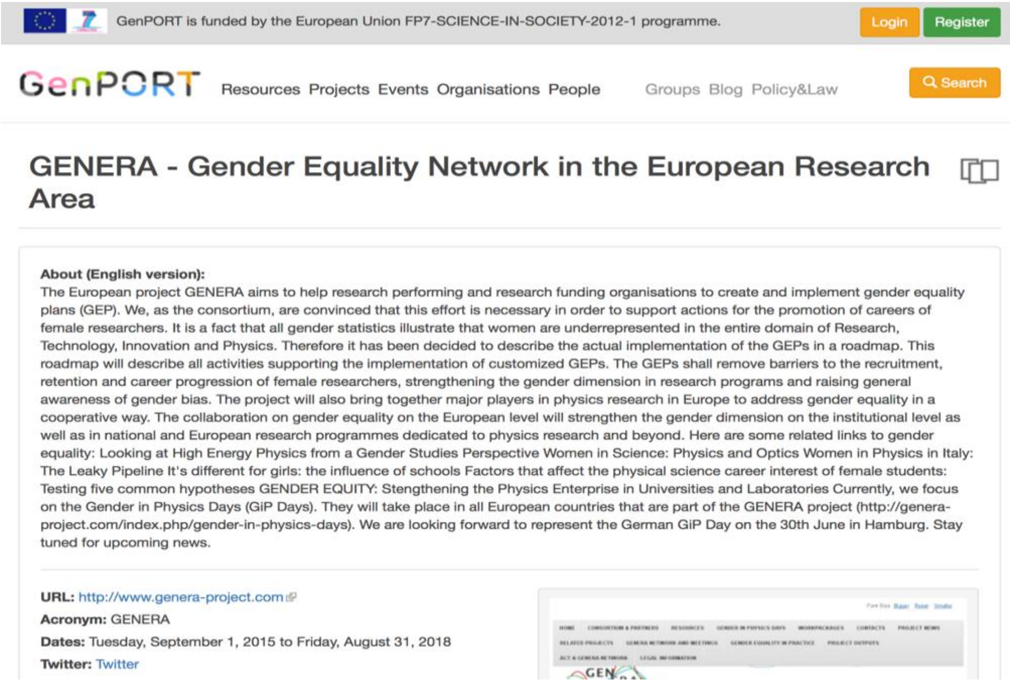
Liaising with and promoting other relevant gender in research projects

GENERA worked closely with another discipline-focused EU project LIBRA, which was implementing GEPs in life sciences. Furthermore, GENERA worked with GenPORT, which was funded under FP7 and created a portal for quality resources in gender and science. Knowledge and experience was shared with several concurrent EU funded GEP implementation projects (listed below).

LIBRA, http://www.eu-libra.eu/content/goals-libra

LIBRA is a project funded under Horizon 2020. It is focused on life science and in particular to increase the representation and participation of women in leadership positions in life sciences. **In relation to GENERA the main interest is in identification of field-specific gender (in)equality conditions**.

GenPORT, www.genderportal.eu GenPORT was a FP7-funded project that has developed the portal for quality resources in gender and science. In May 2018, the portal was 'taken over' by a new Horizon 2020 funded project, ACT, where **it will be expanded to support Communities of Practice, including the GENERA Network**.

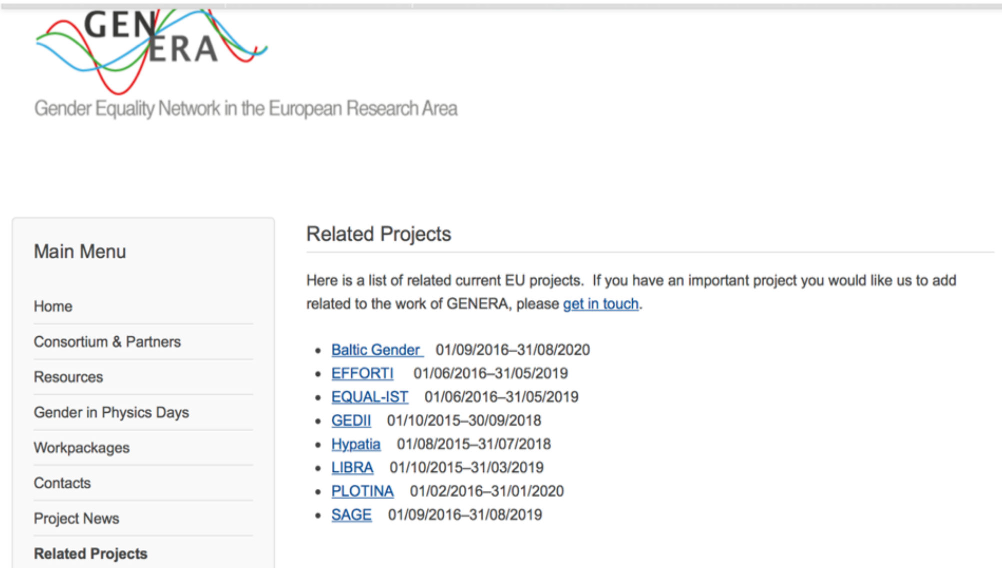

GenPORT is funded by the European Union FP7-SCIENCE-IN-SOCIETY-2012-1 programme. Login Register

GenPORT Resources Projects Events Organisations People Groups Blog Policy&Law Search

GENERA - Gender Equality Network in the European Research Area

About (English version):
The European project GENERA aims to help research performing and research funding organisations to create and implement gender equality plans (GEP). We, as the consortium, are convinced that this effort is necessary in order to support actions for the promotion of careers of female researchers. It is a fact that all gender statistics illustrate that women are underrepresented in the entire domain of Research, Technology, Innovation and Physics. Therefore it has been decided to describe the actual implementation of the GEPs in a roadmap. This roadmap will describe all activities supporting the implementation of customized GEPs. The GEPs shall remove barriers to the recruitment, retention and career progression of female researchers, strengthening the gender dimension in research programs and raising general awareness of gender bias. The project will also bring together major players in physics research in Europe to address gender equality in a cooperative way. The collaboration on gender equality on the European level will strengthen the gender dimension on the institutional level as well as in national and European research programmes dedicated to physics research and beyond. Here are some related links to gender equality: Looking at High Energy Physics from a Gender Studies Perspective Women in Science: Physics and Optics Women in Physics in Italy: The Leaky Pipeline It's different for girls: the influence of schools Factors that affect the physical science career interest of female students: Testing five common hypotheses GENDER EQUITY: Stengthening the Physics Enterprise in Universities and Laboratories Currently, we focus on the Gender in Physics Days (GiP Days). They will take place in all European countries that are part of the GENERA project (http://genera-project.com/index.php/gender-in-physics-days). We are looking forward to represent the German GiP Day on the 30th June in Hamburg. Stay tuned for upcoming news.

URL: http://www.genera-project.com
Acronym: GENERA
Dates: Tuesday, September 1, 2015 to Friday, August 31, 2018
Twitter: Twitter


GENERA
Gender Equality Network in the European Research Area

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- **Related Projects**

Related Projects

Here is a list of related current EU projects. If you have an important project you would like us to add related to the work of GENERA, please get in touch.

- Baltic Gender 01/09/2016–31/08/2020
- EFFORTI 01/06/2016–31/05/2019
- EQUAL-IST 01/06/2016–31/05/2019
- GEDII 01/10/2015–30/09/2018
- Hypatia 01/08/2015–31/07/2018
- LIBRA 01/10/2015–31/03/2019
- PLOTINA 01/02/2016–31/01/2020
- SAGE 01/09/2016–31/08/2019

PUBLISHED MATERIALS FROM GENERA PARTNERS

1. Paulina Sekuła and Paula Pustułka, Jagiellonian University in Krakow

Status of research intensity advancing GEP activities in Europe's RPOs and RFOs

This report documents the findings obtained through a comprehensive literature review, analysis of available data on partner institutions, as well as a widely-scoped cross-sectional selection of Gender Equality Plans (GEPs) implemented across countries and institutions partaking in the GENERA

Consortium and beyond. The selection of literature relied on both the commentary on broad structural dimension, and the more pragmatic approach or unveiling specific examples of good practices, solutions, and their assessment obtained through scholarly research. A good practice is here understood as "any experience or initiative with techniques, methods or approaches that produce effects and results coherent with the definition of gender mainstreaming.

2. Paulina Sekuła, Justyna Struzik, Ewa Krzaklewska, Ewelina Ciaputa

Gender Dimensions of Physics. A qualitative study from the European Research Area

This report presents results from the analysis of the interviews carried out with physicists working in the organisations making up the GENERA Consortium. Members of the GENERA consortium conducted a total of 83 interviews: 67 semi-standardized and 16 expert ones. The goal of the interviews was to identify gender equality conditions in physics be assessing career paths of successful female and male physicists, as well as the major challenges and obligations in their work life. In addition, interviews were used to evaluate how supporting or obstructive with regard to enabling career progression were the working conditions in the respective institutions. Additionally, the analysis explored the physicists' attitudes towards gender equality in science – including how well they were acquainted with institutional interventions aimed at counteracting gender inequality in physics. The motivation behind this study was to provide recommendations for development of Gender Equality Plans in physics. Two separate methods of interviewing were applied: semi-standardized interviews and expert interviews. Semi-standardized interviews were used to identify individual aspects of the physicists work life, if they perceived or experienced gender discrimination, and what strategies were available to them to overcome any barriers to career development. Expert interviews were targeted at physicists occupying leading positions in their organizations The expert interviews were focused on experiences of gender discrimination and measures for fostering gender equality.

Also:

"Gender Equality Network in the European Research Area – a new Horizon 2020 project at JU", Paulina Sekuła, Katarzyna Jurzak, NJUsletter no 58, Summer 2016, pp. 15-16, http://www.dwm.uj.edu.pl/newsletter
"GENERA – gender equality in physics" (in Polish), Paulina Sekuła, Justyna Struzik, Ewelina Ciaputa, Alma Mater no 197, 2017, pp. 89-90, http://www.almamater.uj.edu.pl/archiwum-2017?p_p_id=56_INSTANCE_j66uUM2kcdaf&p_p_lifecycle=0&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_pos=1&p_p_col_count=2&groupId=2910359&articleId=138152311
"How to enhance gender equality in physics?" (in Polish), Paulina Sekuła, Ewelina Ciaputa, Ewa Krzaklewska, Justyna Struzik, Alma Mater no. 201, 2018, pp. 110-111, http://www.almamater.uj.edu.pl/archiwum-2018?p_p_id=56_INSTANCE_pEkusIBNkv6L&groupId=2910359&articleId=140337651

3. Helene Schiffbänker and Silvia Hafellner

Assessment of gender equality in participating research organizations

The core aim of the GENERA project is to foster gender equality in physics by supporting research organizations to implement gender equality plans (GEPs). Eleven research organizations in eight different countries have implemented GEPs. These eleven GENERA partner organizations have been studied in the ex-ante assessment. This report provides insights for each implementing partner organization on the gender policies already implemented, the on-going discussions, and the discourses related to gender equality issues at institutional level.

- What is the status quo of gender policy implementation?
- Which organizational gender targets have been set up?
- Which GENERA activities have been executed so far (process, focus of GEP, awareness about GENERA, actors, communication, micro-practices)?
- What are intended next steps in GENERA (focus of GEP, planned steps for implementation)?
- Which challenges are expected along the next steps/implementation process?
- Which relevant cultural aspects can be identified (gender in physics compared to other fields, gender in physics in other countries, norms about success/excellence)?

Also:

Schiffbänker Helene, Holzinger Florian: „*Challenges in GENERA – how to support 'starters' in a structural change project*" Conference Session at the 10th European Conference on Gender Equality in Higher Education, 20th- 22nd August 2018, Dublin:
https://genderequalityconference2018.com/
Schiffbänker Helene: "*The contextual factors of Structural Change for Gender Equality in Research and Innovation*", Panel Discussion at the International Conference Structural Change for Gender Equality in Research, 19 May 2017, Prague
Schiffbänker Helene, Holzinger Florian, Silvia Hafellner, Streicher Jürgen: „*Evaluierung der Umsetzung von Gleichstellungsaktivitäten in Forschungseinrichtungen: begleitende Beratung oder Wirkungsmessung?*", März 2017, Zukunftskonferenz, Graz
Schiffbänker Helene, Holzinger Florian, Streicher Jürgen: "Evaluation from the inside? Evaluating change process to promote gender equality", Presentation at the Open Evaluation Conference, 24th - 25th November 2016, Vienna: https://conference.zsi.at/index.php/OPENEVAL/OPENEVAL2016

4. Irene Eisemann and Anna Märdian

Gender and Mobility: Insights into the field of Physics

Today, scientists are asked to be more mobile than ever before. In some countries scientists are expected to spend some time abroad. Mobility is described as a crucial factor for career development. While international scientific experience offers many career-related benefits, it also can be challenging to make it happen. This report is not intended to contribute to the extensive academic debate on analysing mobility patterns or the impact of being mobile. It is a small sample that seeks to consider statements from physicists, from young to senior scientists, with regard to the general assumption that international mobility is crucial for scientific careers. Focused on international mobility in the field of physics, this report aims to give a deeper insight into views and opinions from physicists on the controversial issue of the necessity to be mobile. The report tries to better understand some of the push and pull factors affecting scientists' decisions, in particular physicists, with regards to going abroad. The aim is to provide deeper insights into international mobility patterns

- among women and men
- in various career positions
- related to national differences in culture and work environment.

5. Irene Eisemann

GENERA Toolbox for tailored Gender Equality Plans

The GENERA Toolbox aims at assisting GENERA partner organisations that are in the process of the implementation of gender equality plans (GEPs) in tailoring their GEPs and gender equality measures to their needs. For this purpose, the toolbox offers a range of measures that can serve as models for other organisations. It is a structured collection of good practices – measures, instruments, and activities – that aim to address gender inequality. Information was collected and catalogued on gender equality measures related to structural, social, cultural, and political aspects of work environments in various (mainly physics related) research performing organisations (RPOs) and research funding organisations (RFOs) as well as higher education institutions (HEIs). This toolbox does not aim to be exhaustive as it cannot present full details on each of the measures, nor does it provide a comprehensive picture of the gender equality measures implemented in the ERA. Instead it represents only a small selection of practical examples and structures in scientific organisations within Europe, which were seen as successful. It is not a static publication, but rather reflects an ongoing process, which can be updated and expanded.

6. Irene Baraban (Eisemann)

A roadmap for gender equality in the European Research Area

The GENERA Roadmap is meant to support the Implementation Managers within the GENERA Project and persons who are responsible for improving gender equality by implementing a GEP in their organisation. It provides a detailed description of the consecutive steps of how to design and implement a GEP and guides you to resources you may find helpful in the process. These steps will vary in scope and content across organisations. Your specific organisational context is of the highest importance and should be considered at every step along the way. This roadmap should be customized in light of the specific needs of your organisation, e.g. the mechanisms that may be already available for the implementation of gender equality activities. own experiences, supplemented by literature review). All of these collected measures and instruments can directly be implemented into the GEPs or can be structurally integrated to build a bridge from the current state of gender equality to a better state.

7. Sveva Avveduto

Ventisettesima ora blog on women of the Corriere della Sera newspaper
https://www.scienzainrete.it/articolo/scienza-sostantivo-maschile/sveva-avveduto/2018-02-24?utm_source=emailcampaign1138&utm_medium=phpList&utm_content=HTMLemail&utm_campaign=La+Scienza+in+Rete+della+settimana%2C+%23issue+51
Scienza in rete, on line magazine
https://www.scienzainrete.it/articolo/scienza-sostantivo-maschile/sveva-avveduto/2018-02-24?utm_source=emailcampaign1138&utm_medium=phpList&utm_content=HTMLemail&utm_campaign=La+Scienza+in+Rete+della+settimana%2C+%23issue+51
Io Donna, on line magazine of the Corriere della Sera newspaper
http://www.iodonna.it/attualita/in-primo-piano/2018/02/10/giornata-internazionale-delle-donne-e-delle-ragazze-nella-scienza-siamo-piu-vicini-alla-parita-di-genere/
Le ricercatrici in fisica: primi risultati di un progetto di ricercar, Proceedings on the 6th STS Italia Conference

8. Thomas Berghoefer

GENERA: Toward Equity in Physics, OPTICS & PHOTONICS NEWS SEPTEMBER 2018

A European consortium aims to increase the presence of talented women in physics by monitoring and improving gender equity initiatives.

Collected Research references on gender issues specific to or particularly relevant to physics

Whilst there is a vast body of literature on gender issues in science, the proportion of this literature focused on physics or closely related areas is very small. For this reason, key and interesting examples were collected and flagged on the GENERA website to make these reports more easily accessible to the partners and those interested in gender issues in physics.

PHYSICS ENTREPRENEURSHIP AND INNOVATION
Orville R. Butler, M. Juris, and R. Joseph Anderson
This four-year study is focused on investigating the structure and dynamics of physics entrepreneurship and understanding some of the factors that lead to the success or failure of new start-ups, including funding, technology transfer, location, business models, and marketing.

SEXUAL HARASSMENT OF WOMEN: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine
Paula A. Johnson, Sheila E. Widnall, and Frazier F. Benya
Harassing behaviour can be either direct (targeted at an individual) or ambient (a general level of sexual harassment in an environment). Sexual harassment undermines women's professional and educational attainment and mental and physical health. When women experience sexual harassment in the workplace, the professional outcomes include declines in job satisfaction; withdrawal from their organisation (i.e., distancing themselves from the work either physically or mentally without actually quitting, having thoughts or intentions of leaving their job, and actually leaving their job); declines in organisational commitment (i.e., feeling disillusioned or angry with the organisation); increases in job stress; and declines in productivity or performance.

[Sex-Disaggregated Systematics in Canadian Time Allocation Committee Telescope Proposal Reviews](#)
Kristine Spekkensa, Nicholas Cofieb, and Dennis R. Crabtreec
Recent studies have shown that the proposal peer review processes employed by a variety of organizations to allocate astronomical telescope time produce outcomes that are systematically biased depending on whether proposal's principal investigator (PI) is a man or a woman.

[Quantitative evaluation of gender bias in astronomical publications from citation counts](#)
Neven Caplar, Sandro Tacchella & Simon Birrer (Nature Astronomy volume 1, Article number: 0141 (2017))
The study measures the role of gender in the number of citations that papers receive in astronomy. The results show that papers authored by women receive 10.4 ± 0.9% fewer citations than would be expected if the papers with the same non-gender-specific properties were written by men.

[Women and Men in STEM Often at Odds Over Workplace Equity](#)
Cary Funk and Kim Parker
For women working in science, technology, engineering or math (STEM) jobs, the workplace is a different, sometimes more hostile environment than the one their male co-workers experience. Discrimination and sexual harassment are seen as more frequent, and gender is perceived as more of an impediment than an advantage to career success.

[Seven Actionable Strategies for Advancing Women in Science, Engineering, and Medicine](#)
Kristin A. Smith, Paola Arlotta,Fiona M. Watt, The Initiative on Women in Science and Engineering Working Group, and Susan L. Solomon
Achieving gender equality in science will require devising and implementing strategies to overcome the political, administrative, financial, and cultural challenges that exist in the current environment. We propose an initial shortlist of recommendations to promote gender equality in science and stimulate future efforts to level the field.

[The Career Paths of Physics Graduates - A longitudinal Study 2006-2010](#), *IOP* The study gathered information from 5737 nal year undergraduates from 55 institutions, 46 in the UK and nine in Ireland. This represents a response rate of 35–40% of all physics graduates in this period. The study examined the career development of graduates from non-traditional groups, including women, ethnic minorities, students from lower socio-economic backgrounds and those with a disability – information vital to form the basis of projects aimed at encouraging participation in physics from a wider, more diverse community. Alongside this report, a more in-depth analysis was produced, available to download from www.iop.org/diversity.

Silvia Plath in The Bell Jar (Harper & Row, 1971), p. 28-29
"*The day I went into physics class was death* ....A short dark man ......(held)... a little wooden ball. He put the ball on a steep grooved slide and let it run down to the bottom. Then he started talking about let a equal acceleration and let t equal time. And suddenly he was scribbling letters and numbers and equals signs all over the blackboard and my mind went dead. .....Well, I studied those formulas, I went to class and watched balls roll down slides and listened to bells ring and by the end of the semester... I had a straight A....but I was panic-struck. Physics made me sick the whole time I learned it. *What I couldn't stand was this shrinking everything into letters and numbers*."

[Career progress in centralized academic systems: an analysis of French and Italian physicists.](#)
Michele Pezzoni, Valerio Sterzi, Francesco Lissoni
Our analysis confirms the importance of seniority and scientific productivity for academic careers, as

found in the literature. The older the scientist the higher his/her chances of promotion, but only up to an age between 40 and 45 (for promotion from the bottom to the top/intermediate ranks in France and Italy) or well over 50 (for promotion to the top rank in Italy), after which promotion chances decline.

Dark Matters: Metaphorical Black Holes that Affect Ethnic Underrepresentation in Engineering
Tull, Renetta & L Tull, Damon & S. Hester, Shawnisha & M. Johnson, Anthony
Orbits surrounding engineering departments can have negative effects on diverse scholars, and challenges related to broadening participation in engineering can be metaphorical black holes. As an example, inadequate mentoring can cause graduate students to leave engineering degree programs. However faculty mentoring can be influenced by cultures within departments or colleges, under the leadership of chairs and deans respectively.

The Influence of Career Planning, Career Strategies and Organisational Conditions on Gender Disparities in the Career of Mathematicians and Physicists
Bettina Langfeldt
A crucial finding of our research project is that more female mathematicians and physicists than their male counterparts follow a career plan – even if the level of agreement with career planning is altogether rather low. This gender disparity might give evidence of the positive effects of official attempts to support women in their career ambitions by offering mentoring programmes and suchlike.

The Fermi Paradox in STEM—Where Are the Women Leaders?
Heike E. Daldrup-Link
If you try to find a galaxy of female leaders in STEM to date, there is evidence to support the notion that our male leaders are officially alone—or nearly so. While many academic institutions now train close to 50 % female students, there is a major underrepresentation of qualified females in leadership roles. What causes this diversion? The answer is we are all responsible. As a society, we create black holes for our female stars. Science, technology, engineering, and medicine are still pretty much male domains.

Gender Differences in Physics 1: The Impact of a Self-Affirmation Intervention
Lauren E. Kost-Smith, Steven J. Pollock, Noah D. Finkelstein, Geoffrey L. Cohen, Tiffany A. Ito and Akira Miyake
Stereotype threat is, *"the threat of being viewed through the lens of a negative stereotype, or the fear of doing something that would inadvertently confirm that stereotype"*. This fear of confirming the stereotype can negatively impact members of a stereotyped group and result in worse performance. We have demonstrated that two simple, 15-minute writing exercises completed at the beginning of the semester can increase females' performance (while not significantly hurting male performance) and can reduce the gender gap.

MENTORING for WOMEN in PHYSICS
The Supernova Foundation connects undergraduate women in STEM, particularly in Physics, to established female researchers around the world to receive mentoring.

Does Gender of Administrator Matter? National Study Explores U.S. University Administrators' Attitudes About Retaining Women Professors in STEM
Wendy M. Williams, Agrima Mahajan, Felix Thoemmes, Susan M. Barnett, Francoise Vermeylen, Brian M. Cash and Stephen J. Ceci
This study asks Do female administrators agree on which strategies are best, and do men see things differently? A survey was sent to provosts, deans, associate deans, and department chairs of STEM fields at 96 public and private research universities across the U.S. These administrators were asked to rate the

quality and feasibility of each strategy; 474 provided data, of which 334 contained complete numerical data used in the analyses.

COST Action MP1403 Nanoscale Quantum Optics (NQO): Gender Survey 2016

> There is a clear imbalance in the opinions of men and women as regards to the status of women in the COST Action NQO: 59% of women believe that they do not have equal opportunities to men with 14% of women believing this strongly. However, 56% of men believe there is no difference in opportunities.
> The issue felt to be by far the most important was motherhood: there was a broad agreement (67%) between men and women that mothers and other female carers experience disadvantages in their career. 36% of women felt this strongly.
> There was a broad opinion (37%) that women should be the key target group of any future COST Action NQO gender balance actions, closely followed (31%) by an opinion that outside parties such as schools and funding councils should be targeted. Only 17% felt that men should be targeted.

DUAL-SCIENCE-CAREER COUPLES: SURVEY RESULTS: Physics DUAL-SCIENCE-CAREER COUPLES: SURVEY RESULTS: Physics

Laurie McNeil, Marc Sher

Physicists are increasingly faced with the "two-body problem," i.e. the difficulty of finding two professional jobs (possibly two physics jobs) in the same geographic location. This problem has a particularly acute impact on women, in part because 43% of married female physicists are married to other physicists, whereas only 6% of married male physicists have a physicist spouse. The fact that the density of available jobs for physicists is low in most places at any particular time means that the challenge of the dual job search can have a significant effect on a physicist's career. The two-body problem also poses a challenge for institutions that hire physicists, as it is increasingly likely that the top candidate in a search will have a spouse who is also seeking professional employment.

Double jeopardy in astronomy and planetary science: Women of color face greater risks of gendered and racial harassment

Kathryn B. H. Clancy,Katharine M. N. Lee,Erica M. Rodgers,Christina Richey

We conducted an internet-based survey of the workplace experiences of 474 astronomers and planetary scientists between 2011 and 2015 and found that the multiple marginality of women of colour means that they experience a higher frequency of inappropriate remarks, harassment, and assault in the astronomical and planetary science workplace. In this sample, in nearly every significant finding, women of colour experienced the highest rates of negative workplace experiences, including harassment and assault. Further, 40% of women of colour reported feeling unsafe in the workplace as a result of their gender or sex, and 28% of women of colour reported feeling unsafe as a result of their race. Finally, 18% of women of colour, and 12% of white women, skipped professional events because they did not feel safe attending, identifying a significant loss of career opportunities due to a hostile climate.

Meeting the Universe Half Way: Quantum Physics and the Entanglement of Matter and Meaning

Karen Bard ISBN (Link to Amazon): 978-0822339175

Karen Brad has a doctorate in theoretical particle physics. In this book she directs her inquiry into the nature of scientific practice, the purpose of which she says is to demonstrate and explain specific world phenomena. She focuses in particular on Bohr's interpretations of Quantum Mechanics: the role of experimental apparatus and practices, and their effects on experimental outcomes; and examines the nature of measurement in a quantum world as opposed to the classical worldview.

Gender and Doctoral Physics Education: Are We Asking the Right Questions?

Allison J. Gonsalves

Physics provides an interesting discipline in which to study both the gendering of educational trajectories and professional identities in physics, and the production of gendered discourses in the discipline. Moreover, doctoral education warrants particular attention due to its close connection with subsequent professional participation and performance in the discipline, and is therefore seen as a crucial site for programming initiatives to retain women in the profession.

Project Juno: Advancing Gender Equality In Physics Careers In Higher Education In The UK
Marcella Bona Jennifer Dyer, Valerie Gibson, Angela Townsend
From 2003-2005, the Institute of Physics (IOP) ran a successful "Women in University Physics Departments Site Visit Scheme". The site-visit scheme involved visiting 16 physics departments in the UK and Ireland to provide a constructive and broad assessment of their gender friendliness, producing a confidential report for each department and an overall report outlining best practice for the sector. As a result of the site-visit report, the IOP developed Project Juno, building on the best practice identified.

Juno Good Practice Checklist
The Juno Good Practice Checklist is a tool for departments to use in developing their applications for Practitioner status. It is designed to initiate honest discussion and reflection in order for departments to establish where they are in relation to the Juno principles. It could be a useful first task for the Juno committee, and the different perceptions of staff may provide an ideal starting point for discussion and provide initial ideas and evidence for the department to develop its Practitioner action plan. For maximum value, comments should be included to qualify, clarify and support the tick box response.

Exploring Quotas in Academia
Gerlind Wallon, Sandra Bendiscioli, and Michele S. Garfinkel, EMBO, Heidelberg
This report is a synthesis of literature on binding and voluntary quotas, interviews that were conducted with leaders in analyzing and implementing quotas, and the proceedings of the closed expert workshop. The report offers no recommendations about the use of quotas. Rather, it summarizes the positive and negative aspects of the implementation of different types of quotas, and describes a range of conditions of implementation to assist decision-makers in formulating their choices. The potential benefits and real or perceived harms of the use of these quotas will vary depending on who would implement them, and the conditions under which they would be implemented.

Getting Women Into the Physics Leadership Structure Nationally and Internationally
Elvira S. Williams, Lilliam Alvarez Diaz, Katharine B. Gebbie, and Karimat El-Sayed
In 2002 300 physicists, 85% of them women, travelled from 65 different countries to meet in Paris at the First IUPAP International Conference on Women in Physics. It was noted that there is a dearth of women among physicists in positions of leadership worldwide. It was also noted that for women to feel equal partners with men in a technological society, they need to see women participating fully in various scientific endeavours, ranging from policy making to research.

The Athena Survey of Science, Engineering and Technology (ASSET)
Equality Challenge Unit, UK
The Athena Survey of Science, Engineering and Technology (ASSET) is a national survey that seeks to examine academics' experiences, expectations and perceptions of gender equality in science, technology, engineering, mathematics and medicine (STEMM) disciplines and in their HE institution. ECU's annual statistical reports consistently show an underrepresentation of women among STEMM academics, particularly in disciplines such as engineering and physics departments. Moreover, gender differences in relation to recruitment, retention, promotion, pay and committee representation outcomes are commonly observed in the sector.

[Engaging Gatekeepers, Optimizing Decision Making, and Mitigating Bias: Design Specifications for Systemic Diversity Interventions]

Claartje Vinkenburg

Three examples of systemic diversity interventions in academic settings are discussed to highlight the design specifications for interventions effective in promoting diversity in upward mobility systems. By optimizing decision making, mitigating bias, and engaging gatekeepers, each of the three interventions will improve promotion and advancement rates of nondominant group members and thus reduce the overrepresentation of White men at the top of the pyramid. In contrast to many other diversity interventions, the interventions described here do challenge and change existing merit assessment, performance evaluation, and reward allocation practices—and address the resistance that both dominant and nondominant organizational members may experience when these practices are exposed.

[Practical Guide to improving Gender Equality in Research Organisations]

Author: Science Europe

Co-ordination: Science Europe Working Group on Gender and diversity

This guide provides the backbone for the implementation of gender equality in different research funding and performing organisations across Europe. it starts by listing recommendations for the implementation of appropriate indicators, as well as for measures to avoid bias. It follows by providing further recommendations on how to implement an efficient system to monitor gender equality. Finally, it provides an overview of relevant grant management systems.

[Her physics, his physics: Gender issues in Israeli advanced placement physics classes]

Anat Zohar & David Sela

Gender gaps in physics in favour of boys are more prominent in Israel than in other countries. The main research question is to find out what gender issues are at play in Israeli advanced placement physics classes. Matriculation exam scores from approximately 400 high schools were analysed across 12 years. In addition, semi-constructed interviews were conducted with 50 advanced placement physics students (25 girls and 25 boys). In terms of participation, it was found that the ratio of girls to boys has been unchanged from 1988 to 2000 and is roughly 1:3. In terms of performance, it was found that the final matriculation scores of boys and girls are similar. However, breaking up the final scores into its two components - teachers' given grades and matriculation test scores - showed that boy's test scores are usually higher than girls' test scores, while girls' teachers' given grades are usually higher than boys'.

[Women’s and men’s career choices in astronomy and astrophysics]

Rachel Ivie, Susan White, and Raymond Y. Chu

The astronomy community wishes to make every effort to retain young women in astronomy, so they commissioned a longitudinal study to be conducted that would pinpoint the factors that contribute to retention in general, with a focus on differences between women and men. The LSAGS follows a cohort of people who were graduate students in astronomy or astrophysics during 2006–07. The first survey was conducted during 2007–08 and the second during 2012–13. The analysis presented in this paper used a subset of the respondents, all of whom had Ph.Ds in astronomy, astrophysics, or a related field at the time of the second survey.

[Gender equity issues in astronomy: facts, fiction, and what the adaptive optics community can do to close the gap]

Céline d’Orgeville, François Rigaut, Sarah Maddison, Elena Masciadri

Gender equality in modern societies is a topic that never fails to raise passion and controversy, in spite of the large body of research material and studies currently available to inform the general public and scientists alike. This paper brings the gender equity and equality discussion on the Adaptive Optics community doorstep. Its aim is three- fold: (1) Raising awareness about the gender gap in science and astronomy in general, and in Adaptive Optics in particular; (2) Providing a snapshot of real and/or perceived causes for the gender gap existing in science and engineering; and (3) Presenting a range of practical solutions which have been or are being implemented at various institutions in order to bridge this gap and increase female participation at all levels of the scientific enterprise.

Improving Gender Balance. Reflections on the impact of interventions in schools

The Improving Gender Balance (IGB) project was launched in 2014, as part of the Stimulating Physics Network, funded by the Department for Education. It worked with 20 schools in total and trialed school interventions separately that aimed to:

a) improve the confidence and resilience of girls

b) improve the experience of girls in the physics classroom

c) enable students and staff to understand and address the impact of unconscious bias and gender stereotyping. A second project, funded by the Drayson Foundation, investigated the cumulative impact of these interventions.

An investigation into the impact of question structure on the performance of first year physics undergraduate students at the University of Cambridge

Valerie Gibson, Lisa Jardine-Wright and Elizabeth Bateman

We describe a study of the impact of exam question structure on the performance of first year Natural Sciences physics undergraduates from the University of Cambridge. The results show conclusively that a student's performance improves when questions are scaffolded compared with university style questions. In a group of 77 female students we observe that the average exam mark increases by 13.4% for scaffolded questions, which corresponds to a 4.9 standard deviation effect. The equivalent observation for 236 male students is 9% (5.5 standard deviations). We also observe a correlation between exam performance and A2-level marks for UK students, and that students who receive their school education overseas, in a mixed gender environment, or at an independent school are more likely to receive a first class mark in the exam.

A Case Study of Gender Bias at the Postdoctoral Level in Physics, and its Resulting Impact on the Academic Career Advancement of Females

Sherry Towers

This case study of a typical U.S. particle physics experiment explores the issues of gender bias and how it affects the academic career advancement prospects of women in the field of physics beyond the postdoctoral level; we use public databases to study the career paths of the full cohort of 57 former postdoctoral researchers on the Run II Dzero experiment to examine if males and females were treated in a gender-blind fashion on the experiment. The study finds that the female researchers were on average significantly more productive compared to their male peers, yet were allocated only 1/3 the amount of conference presentations based on their productivity.

Juno Project: Advancing gender equality in physics higher education in the UK and Ireland and improving work practices for all

Institute of Physics, UK, 2015

Project Juno is an awards scheme that recognises and rewards physics departments, schools, institutes and groups that can demonstrate they have taken action to address the under-representation of women at all levels and are encouraging better working practices for all. Those engaged in Juno are offered support throughout their Juno journey, including free workshops and resources on best practice, tailored feedback on applications, formal and informal site visits and regular Juno updates.

[Gender in Academia in Finland: Tensions between Policies and Gendering Processes in Physics Departments]

Kristina Rolin and Jenny Vainio,2011

This article contributes to the growing literature on gender and physics by employing the concept of gendering processes to the study of physics departments in Finland. Finland is an interesting national context for studying gender and physics because it enables one to juxtapose gendering processes in fairly well-established equality policies and physics departments, which have low female representation. Despite the gender equality plans, the construction of the ideal worker in physics departments in Finland is surprisingly similar to the construction of the ideal worker in other organizations in other national contexts, reflecting the masculine norm of full- time availability and mobility.

[The Global Survey of Physicists: A Collaborative Effort Illuminates the Situation of Women in Physics]

American Institute of Physics, 2016

The results of the Global Survey of Physicists draw attention to the need to focus on factors other than representation when discussing the situation of women in physics. Previous studies of women in physics have mostly focused on the lack of women in the field. This study goes beyond the obvious shortage of women and shows that there are much deeper issues. For the first time, a multinational study was conducted with approximately 15,000 respondents from 130 countries, showing that problems for women in physics transcend national borders.

[Prof Rolf Tarrach, President, European Universities Association (EUA)]

2016

"Once gender-fairness is achieved we will be able to turn to other, objectively more difficult issues, which, incidentally, might turn out to be easier to be handled in this new, less aggressive, more inclusive society".

[*Nature's* 10]

Nature, 2016

Nature put together a list of *"Ten people who mattered this year"* for 2016. Amongst them are two female physicists, Gabriella Gonzalez (who helped catch the first direct signs of long-sought gravitational waves) and Elena Long (paved the way for greater acceptance of minority groups) .

[What does a physicist look like?]

Institute of Physics, 2016

This booklet contains an infographic showing the results of the 2015 anonymous diversity survey of the UK and Ireland IOP membership. The survey asked questions related to age, ethnicity, disability, gender, sexuality, religion and belief as well as socioeconomic background. This valuable information enables us to gain insights into the profile of the diversity within the IOP membership and how we can continue our work to ensure equality of opportunity for everyone involved with physics.

[Physical review physics education research - Gender in Physics special collection]

Eric Brewe and Vashti Sawtelle (Eds), 2016

A special collection highlighting the current state of the field of physics education research as it relates to gender in physics.

[Gender gaps and gendered action in a first-year physics laboratory]

James Day, Jared B. Stang, N. G. Holmes, Dhaneesh Kumar, and D. A. Bonn, 2016

It is established that male students outperform female students on almost all commonly used physics concept inventories. However, there is significant variation in the factors that contribute to the gap, as well as the direction in which they influence it. It is presently unknown if such a gender gap exists on the relatively new Concise Data Processing Assessment (CDPA) and, therefore, whether gendered actions in the teaching lab might influence—or be influenced by—the gender gap.

Gender-Related Systematics in the NRAO and ALMA Proposal Review Processes
Carol J. Lonsdale, Frederic R. Schwab, Gareth Hunt, 2016
A study has been made of the evidence for gender-related systematics in the proposal review processes for the four facilities operated by NRAO: the Jansky Very Large Array (JVLA; hereafter VLA), the Very Long Baseline Array (VLBA), the Green Bank Telescope (GBT) and the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile which is operated by NRAO/AUI in partnership with the European Southern Observatory (ESO) and the National Astronomical Observatories of Japan (NAOJ), in cooperation with the Republic of Chile. A significant gender-related effect is found in the proposal rankings in favour of men over women in the ALMA Proposal Review Processes (PRP) for ALMA Cycles 2-4.

Gender Systematics in Telescope Time Allocation at ESO
Ferdinando Patat, 2016
The results of a comprehensive statistical analysis of gender systematics in the time allocation process at European Southern Observatory (ESO) are presented. The sample on which the study is based includes more than 13000 Normal and Short proposals, submitted by about 3000 principal investigators (PI) over eight years. The genders of PIs, and of the panel members of the Observing Programmes Committee (OPC), were used, together with their career level, to analyse the grade distributions and the proposal success rates. Proposals submitted by female PIs show a significantly lower probability of being allocated time.

Gender bias found in recommendation letters, physicsworld.com reports
Physics World, 2016
Female postdoctoral fellowship applicants are half as likely as their male counterparts to receive glowing recommendation letters, according to a study by researchers at Columbia University's Lamont-Doherty Earth Observatory (LDEO). Led by Kuheli Dutt, assistant director of academic affairs and diversity at the observatory, the researchers also found that both male and female scientists tend to write stronger recommendation letters for men than for women. The findings add more evidence of implicit, or unconscious, bias that women are perceived as weaker in the sciences than men.

Women in physics: A comparison to science, technology, engineering, and math education over four decades
Linda J. Sax, Kathleen J. Lehman, Ramón S. Barthelemy, and Gloria Lim, 2016
The dearth of women in science, technology, engineering, and math (STEM) fields has been lamented by scholars, administrators, policymakers, and the general public for decades, and the STEM gender gap is particularly pronounced in physics. While previous research has demonstrated that this gap is largely attributable to a lack of women pursuing physics in college, prior research reveals little in terms of the characteristics and career interests of women who do plan to major in physics or how these traits have evolved over time.

Studying Gender Bias in Physics Grading: The role of teaching experience and country
Sarah I. Hofer, 2015
The existence of gender-STEM (science, technology, engineering, and mathematics) stereotypes has been repeatedly documented. This article examines physics teachers ’ gender bias in grading and the influence of teaching experience in Switzerland, Austria, and Germany. In a 2 × 2 between-subjects design, with

years of teaching experience included as moderating variable, physics teachers (N = 780) from Switzerland, Austria, and Germany graded a fictive student's answer to a physics test question. While the answer was exactly the same for each teacher, only the student's gender and specialization in languages vs. science were manipulated. Specialization was included to gauge the relative strength of potential gender bias effects.

Equal Opportunities and Diversity Management Plan. CERCA Institute April 2014

CERCA Institute, 2014

The CERCA Institute is the Government of Catalonia's technical service and its means for supervising, supporting and facilitating the activities of the research centres in the CERCA system. Set up as a foundation, it was created in 2010 to respond to the commitments of the Catalan Agreement on Research and Innovation. This plan is an example which will be useful to other organisations when formulating their own Gender Equality Plan (GEP).

Number of Women in Physics Departments: A Simulation Analysis

S.White and R. Ivie, 2013

Women's representation in physics lags behind most other STEM disciplines. Currently women make up about 13% of faculty members in all degree-granting physics departments, and there are physics departments with no women faculty members at all. In this report, we consider whether or not the lack of a woman among its faculty is sufficient evidence of a hiring bias. Using simulation analysis, we find that the existence of all-male departments is largely due to the representation of women in physics and to the number of faculty members in a single department. Even if half of physics faculty members were women, we would still find over 100 departments with all male or all female faculty members.

Women in Science: Physics and Optics

M. J. Yzuel and A. Peinado, 2013

The number of women is less than the number of men in degrees like physics and engineering. In this paper we present the percentages of female students at the Spanish Universities. The percentage of women decreases for faculty members. We also give some figures for female students in physics degree. The value of mentoring programs is analyzed. The learning societies in physics and in optics have established committees and programs for helping the women in their scientific career. We describe them in general and we focus on the SPIE Women in Optics program.

It's different for girls: the influence of schools

Insitute of Physics, UK, 2012

An exploration of data from the National Pupil Database looking at progression to A-level physics in 2011 from different types of school at Key Stage 4.

Looking at High Energy Physics from a Gender Studies Perspective

H. Götschel, 2011

Presentation at CERN Special Science and Society Colloquium Geneva 2011-03-08 covering

I. Entanglement of Gender and Physics

II. Gender Studies and High Energy Physics – Research Results and Examples

III. Summary and Prospects

Mapping the Future Physics and Chemistry Postdoctoral Researchers' Experiences and Career Intentions

The Institute of Physics (IOP) and the Royal Society of Chemistry (RSC), 2011

The Institute of Physics (IOP) and the Royal Society of Chemistry (RSC) jointly initiated a project, in conjunction with the IOP's Women in Physics Group (WiPG), which was part-funded by the

UKRC's Innovative and Collaborative Grants Scheme (IGCS), to investigate the experiences of postdoctoral researchers (PDRs). The project was designed to build upon previous work by the RSC on the experiences and career intentions of chemistry PhD students, which found that the proportion of females planning a research career in chemistry fell dramatically during the course of their PhD studies, while the proportion of males stayed the same. In contrast, follow-up work by the RSC and the Biochemical Society showed that in molecular biosciences the proportions of men and women intending to pursue a research career remained essentially the same throughout their PhD studies.

Gender Diversity in Play With Physics: The Problem of Premises for Participation in Activities
Cathrine Hasse, 2009
The lack of women engaging themselves in science has been thoroughly discussed in feminist and nonfeminist science studies. It has remained a mystery why so few female students take professional careers as scientists. Though more and more female students enroll in physics studies, for example, they seem to disappear before they reach academic positions. Instead of discussing this as a query of gender inequality in this article, I discuss the more general issues of inclusion and exclusion in communities of practices.

GENDER EQUITY: Strengthening the Physics Enterprise in Universities and Laboratories
American Physical Society, 2007
Maintaining a strong workforce in the physical sciences is of critical importance to the national economy, health care, defense, and domestic security. Increasing the participation of women in these sciences can strengthen that workforce by widening the available pool of talent. Despite the quite considerable increase in the number of female physics faculty over the past three decades, women still represent only 13% of faculty of all ranks from the 760 degree-granting physics departments in the United States and only 9.5% across all ranks at the major research universities. By contrast, all other disciplines measured except mechanical engineering are doing better than physics. If the nation is to enjoy the benefits of further significant increases in the participation of women in the physical sciences, the representation of women on the faculties of research universities must be increased. These women faculty play a critical role in the encouragement of women students.

What Works for Women in Undergraduate Physics?
Barbara L. Whitten, Suzanne R. Foster, and Margaret L. Duncombe, 2003
The predominance of men in physics remains a puzzle. To attract talented women and minorities, the culture of college physics needs a makeover.

Women in Physics in Italy: The Leaky Pipeline
E.Molinari, M. G. Betti, A. Bonfiglio, A. G. Mignani, M. L. Paciello, 2002
Italy is often considered a fortunate country for women in physics. Indeed, the number of women among students in higher education and in the early stages of careers is relatively high, certainly much higher than in most other countries worldwide. However, the percentage of women among physicists decreases very rapidly with increasing level in the profession; also, the presence of women in positions of power is generally negligible. Undergraduate courses in physics in Italy are now well attended by women, who are generally very successful in their studies. In this report we summarize some representative data and discuss briefly some possible explanations and the proposed focus for future actions.

The Future of Physics and Society
UNESCO/ICSU World Conference on Science (WCS),1999
The present Workshop was supported by the UNESCO–Physics Action Council, the European Physical Society, OMFB, OTKA, MTA and MALÉV. It affirmed the ongoing importance of physics for its own sake

and as part of our culture, as a key element in increasingly unified science and as an essential contributor to the solution of environmental and energy problems. The problems faced by physics as an activity and as an educational subject were discussed and actions for both society as a whole and the physics community itself were put forward.

[Factors that affect the physical science career interest of female students: Testing five common hypotheses]

J. A. Marshall, 1997

Student attitudes toward science and scientists were measured with a survey distributed to introductory physics students in a combined class consisting of elementary education majors and general education students. For the control group of students, only the biographical material in the textbook (which was not required reading) was available to students. Brief biographical materials on women scientists were presented to the experimental group of students, and, although this material was not tested on homework or exam questions, it changed student knowledge of women scientists, and also student perceptions of scientists.

APPENDIX 1: GENERA PARTNERS

The GENERA partnership. The first 13 are the Consortium. DESY is the Coordinator

Deutsches Elektronen-Synchrotron (DESY) A Research Centre of the Helmholtz Association

Netherlands Organisation for Scientific Research

Netherlands Organisation for Scientific Research (NWO), Netherlands.

Karlsruher Institut für Technologie

Karlsruhe Institute of Technology (KIT), Germany.

Portia Ltd, United Kingdom.

National Institute for Nuclear Physics (INFN), Italy.

Istituto Nazionale di Fisica Nucleare

Max Planck Society (MPG), Germany.

MAX-PLANCK-GESELLSCHAFT

JOANNEUM RESEARCH, Austria.

Instituto de Astrofísica de Canarias (IAC), Spain.

University of Geneva (UNIGE), Switzerland.

National Research Council (CNR), Italy.

Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH). Romania.

Jagiellonian University, Poland.

National Center for Scientific Research (CNRS), France.

Helmholtz Association, Germany

Dublin Institute of Advanced Studies (DIAS), Ireland

The European Organization for Nuclear Research (CERN)

European Organisation for Astronomical Research (ESO)

Fraunhofer-Gesellschaft

Austrian Science Fund (FWF)

NordForsk

Swiss National Science Foundation (SNSF)

University of Birmingham, School of Physics and Astronomy

University of Rijeka Foundation, Croatia

Intersection, Serbia

Institute of Molecular Physics of the Polish Academy of Sciences

Vilnius University

Weizmann Institute, Israel

School of Physics and Astronomy, University of Manchester, UK

Italian Association for Women in Science

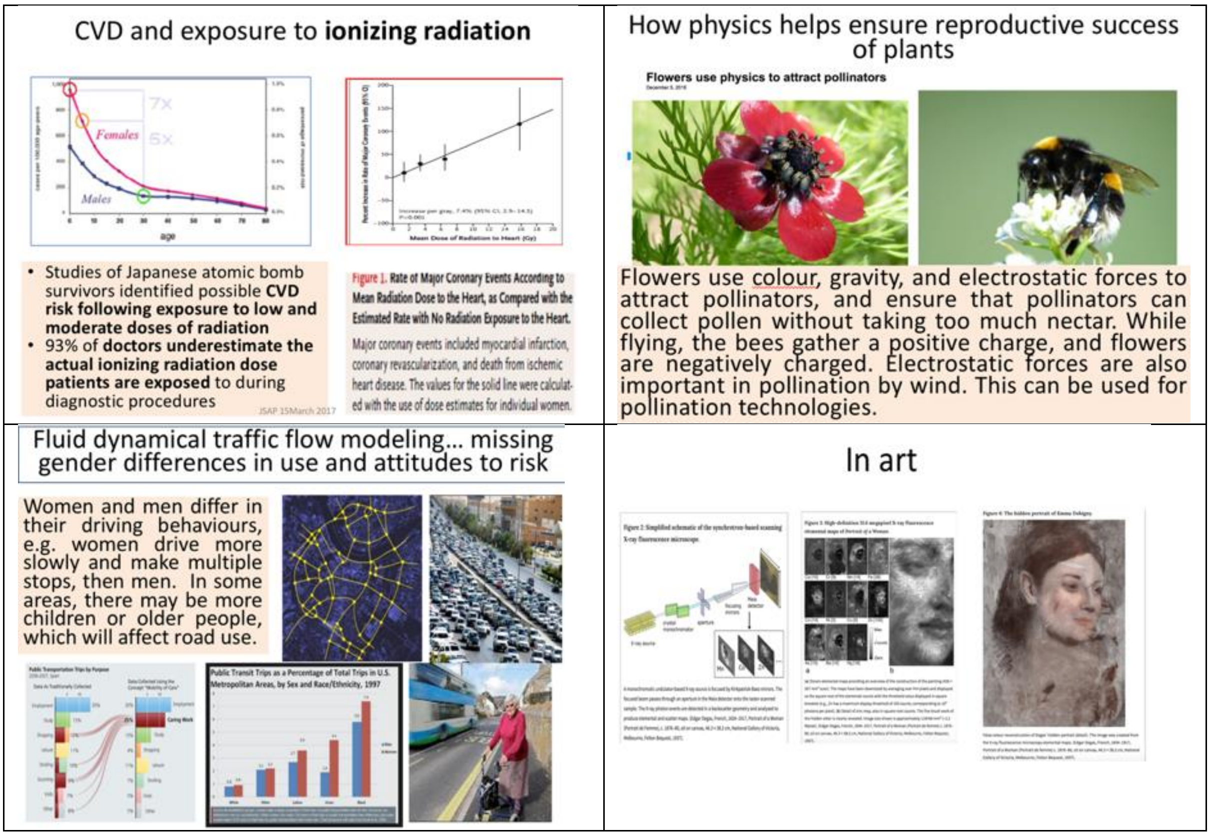
CEA - Commissariat à l'Energie Atomique et aux énergies alternatives, France

HZDR - Helmholtz-Zentrum Dresden-Rossendorf

APPENDIX 2: GENDER DIMENSIONS IN PHYSICS RESEARCH

Examples of gender dimension in physics research where biological relevance or impacts are important

- Assessing ecological and societal impacts of natural and man-made disasters
- Modelling dynamics of natural and urban ecosystems
- Identifying key limiting factors in how human and non-human species adapt to climate change
- Modelling fragmentation and degradation of ecosystems services
- Modelling bio-geographic interactions between species in the context of biodiversity



Appendix 3: Three Policy Briefs

Policy Briefs

- Policy Brief 1: *Maximising the opportunity to advance gender equality in physics and related fields through gender sensitive research and innovation endeavours*
- Policy Brief 2: *Maximising opportunity to advance gender equality in higher education and in careers linked to physics*
- Policy Brief 3**:** *Evidence supporting physics institutions in promoting gender equality*

Policy Brief 1

Maximising the opportunity to advance gender equality in physics and related fields through gender sensitive research and innovation endeavours

This policy brief is intended to inform and improve gender equality policies for upstream interventions (with wide-ranging impact) and mid-stream interventions (with cross-cutting impacts). Relevant intended actors are: the European Commission (e.g. through Innovation Union, and Framework Programmes), ITRE, STOA and FEMM Committees at the European Parliament, national institutions implementing ERA, cross sectorial bodies such as EARTO, etc.

Key messages

- Large body of scientific evidence shows that biological (sex) and sociocultural (gender) elements may produce different research and innovation outcomes for males and females that call for different tailored interventions – and not only in health – to ensure the same quality of benefits for women and men. Equality and quality in science research are therefore often intertwined.
- Scientific quality and societal relevance of research can be improved by improving gender balance and diversity in research/innovation teams, and analysing sex/gender relevance in research content. This applied to all research and innovation which is intended to benefit humans in a direct or an indirect way.
- Understanding when, why and how women and men differ in their biological and socio-cultural characteristics can create novel socio-economic linkages between scientific knowledge production and its translation into new products, processes and services, with improved impact on societal and environmental wellbeing. This is relevant to physics research that underpins understanding of living objects, matter, phenomena.
- It has been estimated that $12 trillion could be added to global GDP by 2025 by advancing gender parity[1], and that by 2015 women will control $28 trillion of consumer budget globally[2]. This growing economic advancement of women should be seen as an opportunity to create new markets for science knowledge that recognise the different needs and interests of women and men. These opportunities can be created through applied physics research.
- Between 2005 and 2011, the compound annual growth rate for researchers in the EU (as reported in She Figures 2015) was higher for women (4.8%) than for men (3.3%). The accumulation of scientific capital held by women creates advantageous conditions to promote "technology push" type innovations based on scientific discoveries that demonstrate critical sex differences in research results, which may also differentiate outcomes. Physics knowledge, instruments, and methods often underpin these technologies.
- Large and established high-technology companies have been increasingly moving away from in-house knowledge creation to technology acquisition through the purchase of technology start-ups or by engaging in Open Innovation. Open Innovation creates variety of opportunities

[1] McKinsey (2015) The Power of Parity: How Advancing Women's Equality can add $12 trillion to Global Growth. See https://www.mckinsey.com/featured-insights/employment-and-growth/how-advancing-womens-equality-can-add-12-trillion-to-global-growth

[2] Silverstein, M.J. and Sayre, K. (2009) The Female Economy, *Harvard Business Review*, September 2009. Online available from: https://hbr.org/2009/09/the-female-economy

to effectively close gender gaps in innovation systems and activities by creating innovation environments that are more inclusive to women as idea creators, problem solvers, innovators, and as target users/consumers. This is an opportunity for physics to tap into the innovative talent of highly educated women.

- Promoting the culture of Open Innovation may provide a vehicle for attracting more tertiary educated women to consider entrepreneurship as a career opportunity. This may be especially attractive in sectors that are not strongly bound by regulatory requirements, where the cost of entry may be too high, or where institutions and cultures have been traditionally dominated by men. Many areas of applied physics can be promoted as sources of entrepreneurial opportunities.
- Gender balance in innovation is often measured by how many women there are among patent applicants. Women are greatly underrepresented in technological innovation. However, the observed increase in the share of women in international patenting activities (PCT) coincides with the increase in women's participation in higher education, and in particular in life sciences, at both undergraduate and PhD level.
- During 2012-2015, the fields with the highest shares of PCT applications with women inventors were those related to life sciences, including biotechnology, where women are well represented. In contrast, the fields with the lowest shares of PCT applications with women inventors were related to engineering and computer technologies, where women are in a minority. Improving gender balance in physics will produce the added advantage of also producing more women inventors in physics related areas.

Conditions that foster participation and success of women in:		
Research[3]	Innovation[4]	Entrepreneurship[5]
• Fair, transparent and gender bias free recruitment, retention, and competition in career advancement • Fair, transparent and gender bias free evaluation of professional performance • Equal access to and chances of success in being awarded a research grant • Fair, transparent and gender bias free recognition of merit in selection to important panels, committees, and decision-making bodies • Access to professional and leadership training • Opportunities to collaborate with excellent	Improving innovation environment by making it more inclusive of women • *in design and implementation of innovation strategies* • *in innovation processes* • *as target users* Improving measurement of women's contribution to • *technological advances* • *non-technological innovations that create functional improvements through design* • *creating new services, and more efficient organisational processes.* Improving quality of innovation outcomes, especially for women	Improving entrepreneurial environment • *Opportunity perceptions* • *Start-up skills* • *Willingness and risk* • *Networking* • *Cultural support* Creating entrepreneurial ecosystem • *Opportunity start-ups* • *Technology sector* • *Quality of human resources* • *Competition* • *Gender gaps* Promoting entrepreneurial aspirations • *Product innovation* • *Process innovation* • *High growth* • *Internationalisation*

[3] Laursen, S. L., & Austin, A. E. (2014). StratEGIC Toolkit: Strategies for Effecting Gender Equity and Institutional Change. Boulder, CO, and East Lansing, MI. www.strategictoolkit.org

[4] Lee, H. and Pollitzer, E, (2017), Gender in science and innovation and as components of socio-economic growth, https://gender-summit.com/images/Gender_and_inclusive_innovation_Gender_Summit_report.pdf

[5] The 2015 Female Entrepreneurship Index, The Global Entrepreneurship and Development Institute

researchers/research teams • Access to research infrastructures and resources • Work-life balance and conducive working environment	• *taking into account the potential influence of sex-gender differences (biological, physical, behavioural)* • *equally valuing different interests and preferences of women and men.*	• *External financing*

Recommendations

- **Recognise gender as a driver for economic growth and socio-economic wellbeing** (e.g. by including gender-related indicators in the Innovation Scoreboard), and an opportunity to create advantageous, cross cutting benefits from knowledge production to multiple applications with relevance for society. *Physics-based businesses form an important part of the economy and employ large proportion of highly skilled people. Physics underpinned past industrial revolutions and will be critical to the success of the 4th Industrial Revolution. To fulfil these goals physics must increase the numbers of women studying and choosing to work in physics related areas.*
- **Recognise women's growing economic and consumer (behaviour influencing) power** as advantageous to promoting new markets for science knowledge that target the special interests and needs of women (that have been traditionally ignored). *For example, car safety systems should be improved to prevent injuries suffered more severely by women than by men in car crash situations. Physics delivers the knowledge and methods used in designing car safety systems and standards. It has responsibility to society to demonstrate the same quality for women and men.*
- **Recognise the growing (at a faster rate than that of men) scientific capital of women as** advantageous to promoting ("technology push") innovations based on scientific discoveries of important sex differences in research outcomes. *Societies everywhere are facing big environmental and security challenges. These problems require physics knowledge and intellectual capital. Increasing the proportion of women in STEM will increase the supply of the talent needed.*
- **Closing the gender gap in innovation is an opportunity to change innovation cultures by making them more inclusive and open to participation by women researchers, and women as users and consumers.** *For example, women have been shown to be very successful in solving technical R&D problems in 'crowd sourcing' innovation environments where companies broadcast problems they cannot solve internally.*[6]
- **Close the gender gap in entrepreneurship** as an opportunity to promote entrepreneurship to the growing body of women graduates, promoting, for example, business-creation conditions that are not strongly bound by restrictive and expensive regulatory compliance requirements (e.g. information and communication technologies), and in knowledge areas where women are well represented (e.g. health). *For example, such opportunities could involve creating entrepreneurial ecosystems linking physics knowledge to the socio-economic and environmental challenges that underlie the goals of the UN Sustainable Development Agenda or the realisation of the vision of the 4th Industrial Revolution.*
- **Ensure continued leadership in Europe in advancing gender in research and innovation, established in Horizon 2020, to solidify the progress made and to strengthen the technical and socio-economic impact of the next Framework Programme 9.** The experience of Horizon 2020

[6] Jeppesen, L.B. and Lakhani, K.R. (2010) Marginality and problem solving effectiveness in broadcast search, 2010. Online available from: http://dash.harvard.edu/bitstream/handle/1/3351241/Jeppesen_Marginality.pdf?sequence=2

of promoting structural change for gender equality and integration of gender dimension in research and innovation content has provided important body of knowledge and experience to make systematic and systemic advancements in FP9. *In FP9, this could provide the basis for promoting gender sensitive socio-economic impact of research outcomes in the fields that have been historically seen as 'gender neutral', e.g. physics, transport, energy, climate change.*

- Increasing the proportion of women in physics and engineering, and retaining those already in the system are key to addressing persistent gender imbalance in product-related, technological innovation.

NOTES

This policy brief is the output from GENERA - Gender Equality Network in the European Research Area - a project funded by the European Commission under GERI-4-2014 01 September 2015 - 31 August 2018 grant agreement 665637. GENERA's main goal has been to implement gender equality plans in physics. For further information about GENERA please contact Dr Thomas Berghoefer, thomas.berghoefer@desy.de

For further information relating to the content of this Policy Brief please contact Dr Elizabeth Pollitzer,

Maximising opportunity to advance gender equality in higher education and in careers linked to STEM fields, and physics in particular

This policy brief is intended to inform and improve policies for midstream gender equality interventions (e.g. within a field and/or inter-institutional partnerships), and for downstream interventions (within organisations). Relevant intended actors are LERU, EUA, EMBO, FEBS, CESAER, RPOs and RFOs, etc.

Key messages

- According to She Figures 2015 (the 2018 issue will be published in March 2019), there has been a slow but positive trend across several key indicators of women's participation and status in higher education and in academic career progression, in the EU (see table below).
- There are, however, still significant (but decreasing) differences between individual Member States in the rate of progress made, which may have historical backgrounds, or indicate the presence/absence of top-level policy commitment to gender equality at national level.
- There are more men than women in Grade A academic positions across all fields, regardless of how many women there are in the 'talent supply pipeline'.
- In the life sciences, for example, more women gain PhD degree than men (EU-28), but this increase in the supply of new research talent has not been translated into matching improvements in subsequent academic career stages. This is a situation that could benefit from the introduction of (cascading model) quota.[7]
- By contrast in the physical sciences, engineering, and computing the low presence of women persists at each stage, from entry into higher education to Grade A positions. However, small improvements between 2004 and 2012 have been reported in She Figures 2015.
- Across EU-28, more men than women apply for research grants; men are more successful in obtaining research grants; and men receive larger grants than women. Some improvements have been reported but overall men still have 4.4% higher chance of success. Carefully thought out quota mechanisms have been shown to deliver positive but fair impact (see the example in NOTES)
- Due to the fact that men in senior academic positions are generally older than women it can be expected that in the next 10 years more men than women will be retiring, creating opportunities for more women at present in Grade B positions to compete for the top academic posts (with the help, perhaps, of cascading quota intervention).
- Among emerging issues in the workplace has been sexual harassment. Academic workplaces have the highest rate of sexual harassment after military (58% vs. 69%).[8]
- Among persistent issues are work-life balance and employment conditions: fewer women researchers than men researchers have children; more women than men hold part-time positions; women earn less than men. This makes academic research careers appear more precarious for women than employment in other sectors.

[7] Wallon, G,. Bendiscioli, S., and Garfinkel, M.S. (2015), Exploring quotas in academia, EMBO
[8] National Academies of Sciences, Engineering, and Medicine. 2018. *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*. Washington, DC: The National Academies Press. doi: https:// doi.org/10.17226/24994.

Data from She Figures 2015 (with some other earlier She Figures data included for comparison)	
Glass Ceiling Index, EU *(GCI = 1.0 means women have same chance top men of being promoted to Grade A position)*	1.76 (decrease from 1.90 in 2004)
Share of women PhD graduates	47.4% (increase from 43.6% in 2004)
Share of women PhD graduates in STEM (LS, PS, M, C)	37.5% (increase from 33% in 2004)
Share of women in Grade A academic positions	20.9% (increase from 15.3 in 2002)
Share of women scientists and engineers in total labour force	2.8% (increase from 1.75% in 2010)
Research grant success rate difference *GSRD = 1.0 means women and men applicants have equal chance to secure a grant*	4.4 (decrease from 6.8 in 2010)
Proportion of RPO's that adopted gender equality plans	36%

Recommendations

- Continue the use of She Figures as a source of reliable statistical overview of progress in achieving gender equality in research and innovation in the EU, including integration of gender dimension in research content, which was introduced in the 2015 edition. However, She Figures do not provide contextual information that can help explain for the observed statistical trends.
- Information is needed to provide field-specific context, behind the statistics in She Figures about the shares of women at each education and academic career level, to help better understand how women transit over time from one level to the next, especially Grade C and Grade B before tenure and after. This would help institutions to improve their gender equality interventions, and make them more responsive to the issues that are specific to each stage, also reflecting the differences between the fields.
- Quantitative, gender-segregated data on career paths and working conditions of researchers are needed to monitor and better understand how the patterns or moves through career positions, institutions, sectors, and nations develop during the 17 years that it takes on average to traverse from gaining a PhD to reaching Grade A position.[9]
- Systematic analyses of the evolving discourse on why more women should choose STEM subjects to study, and/or as a research career, are needed to improve future efforts to promote gender balance. Four separate but interconnected general reasons have dominated the calls to improve women's participation in STEM in the past: social justice; economic benefits from women's intellectual contributions different to those of men; improved intellectual quality and impact of research and innovation; and improved research and work cultures. Choosing the core argument can dictate action, for example, the 'economic' argument has been embraced by industry. The 'quality' argument is attractive to science policy makers. Corrective actions will tend to focus on a particular intervention. For example, many companies have adopted quota in hiring staff. To make STEM more attractive to girls, the focus has to be on why women are not attracted to engineering or computing, perhaps because they simply are not aware of the opportunities or because they do not know what work engineers do, then corrective actions will have to focus on outreach and informing girls of the opportunities engineering careers offer them.[10]
- Work environments, employment conditions, and work-life balance need improving so that women researchers do not have to feel that pursuing a research career means not being able

[9] MORE. (2017). *Final report MORE3: Comparative and policy-relevant analysis of mobility patterns and career paths of researchers*. https://cdn5.euraxess.org/sites/default/files/policy_library/final_report_1.pdf
[10] Beddoes, K. D. (2011). Engineering education discourses on underrepresentation. Why problematization matters. International Journal of Engineering Education, Vol. 27 No 5, pp.1117-1129, 2011

to be a parent or fulfil caring responsibilities; or that pursuing a research career means committing to potentially precarious and uncertain employment future, with short term contracts and necessity to be geographically mobile; resulting in economic penalties in terms of salary and pension levels.

- Actions to prevent and tackle sexual harassment are needed by enabling easy and confident reporting and monitoring of unprofessional behaviour. Academic science and research institutions exhibit at least four characteristics that create higher levels of risk for sexual harassment to occur: 1) strongly male-dominated environments, with men in positions of power and authority; 2) organizational tolerance for sexually harassing behaviour (e.g. failing to take complaints seriously, failing to sanction perpetrators, or failing to protect complainants from retaliation); 3) the fields share hierarchical and dependent relationships between faculty and their trainees (e.g. students, postdoctoral fellows, residents), 4) the fields share isolating environments (e.g. labs, field sites, and hospitals) in which faculty and trainees spend considerable time. Such actions should be included in the design and implementation of gender equality plans (GEPs), and in the institutional commitments to adopt the Euraxess HRS4R.
- Improve the criteria and processes used in the assessment and awarding of research grants to ensure that men have the same chances of winning as women[11], but also allowing time flexibility in grant duration due to maternity leave, maternity cover, and eligible care costs.
- Provide opportunities for leadership training targeting young women researchers, in particular, to provide them with confidence to compete for more senior research and management roles.
- Promote and monitor implementation of Gender Equality Plans by research performing and research funding institutions to ensure systematic and systemic structural and cultural change, across different scientific fields, and sectors.[12]

NOTES

Best Practice in advancing gender equality in research organisations

Science Foundation Ireland: *Increasing the number of applications for research grants from women*

In 2013, the SFI put a cap on 6 applications per University. This resulted in 27% of applicants being female and 27% of awardees being female. In 2015, the SFI added a gender dimension to the process by raising the cap per university to 12 but the maximum 6 could be men. There was no change to the assessment and selection process. This has produced 47% of applications from women and 55% of awardees being female.

GENERA: *Toolbox for implementing GEPs in physics, as well as other fields*

The GENERA Toolbox aims at assisting GENERA partner organisations that are in the process of the implementation of gender equality plans (GEPs) in tailoring their GEPs and gender equality measures to their needs. The Toolbox is a structured collection of over 100 good practices – measures, instruments, and activities –the information for which was collected and catalogued to reflect related structural, social, cultural, and political aspects of work environments in various (mainly physics related) research performing organisations (RPOs) and research funding organisations (RFOs) as well as higher education institutions (HEIs).

[11] https://www.gender-summit.com/attachments/article/1346/Ferguson_GS9Eu.pdf
[12] http://genera-project.com/portia_web/GENERA_Toolbox_2017_final_revision.pdf

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For further information about GENERA please contact Dr Thomas Berghoefer, thomas.berghoefer@desy.de

POLICY BRIEF 3

Evidence and recommendations for Physics institutions to implement and monitor Gender Equality Plans

This policy brief is intended to inform and improve the development, implementation, and evaluation of downstream gender equality interventions and especially gender equality plans (GEPs) in physics institutions (including research producing and funding organizations). Relevant intended actors are implementation managers, gender equality officers (elected or appointed), diversity taskforces or councils, and HR / diversity officers. As important instigator and funder of GEP implementation, the European Commission (through its Framework Programmes), national physics organizations and/or broader science organizations are also the intended audience for this policy brief.

Key messages

- Working within the context of Physics, the GENERA project has circumvented problems that are common to GEP implementation by institutions when conducted in isolation from others, through processes that differ widely in terms of their scope and effectiveness, and often without a proper assessment of gender equality needs and priorities, or the necessary monitoring and evaluation. GENERA's disciplinary focus brought not only recognition and comparability, but also a shared belief in data, measurement, and an experimental approach.
- On the basis of this shared conviction, one of the main strengths of the GENERA project was the development (through an intensive iterative process) of the specifications of a so-called "minimal dataset" (MDS) that physics institutions can use to track gender representation and progress on several comparable indicators across local and national settings. These data currently cannot be found in the She Figures (Europe's go-to statistical source) because information there is: a) not provided on a disciplinary level, and b) is restricted to indicators that can apply to the majority (if not all) of EU countries.
- The role of the evaluation partner in GENERA was transformed into a 'critical friend', realized operationally through ex-ante and ex-post interviews with managers and leaders in the partner institutions. Reflections from the interviews were combined with the data collected elsewhere throughout the project by the evaluation partner to produce a monitoring tool (not anticipated in the deliverables), the Monitoring Tree, which organizations can use to monitor progress made in implementing gender equality policy measures.
- GENERA's aim was to create GEPs that can be adapted to the needs of different organizations but at the same time could promote systematic and systemic improvements. Key to identifying what was needed were the interviews with 83 physics researchers (women and men) from the partner organizations as well as senior leadership and HR staff. This led to a growing understanding and reconciliation of top and bottom expectations of GEP design and implementation in physics organizations.
- The work done in GENERA will be shared, expanded and improved through the GENERA Network, one of the project outputs. The purpose of the Network is to act as a channel for sharing knowledge and experience as well as best practices in implementing GEPs. The practical opportunity to do this is the Horizon 2020 funded project ACT in which three of the GENERA partners are also involved. The purpose of ACT is to develop Communities of Practice for gender equality in research and innovation and the GENERA Network is included as one target for transformation into such a community.

The GENERA protocol "Physics best for all"

Based on several brainstorming and argumentation mapping sessions, the GENERA partners jointly developed "Physics best for all" protocol of predefined procedural method for improving gender equality in physics organizations (in the same vein as the protocols for conducting scientific experiments). This protocol, aimed at institute directors and senior HR, serves as an umbrella under which to develop local, customized GEPs and actions.

GENERA Protocol for improving gender equality in Physics:

- Gender Equality Plan (GEP)-driven
- Systemic change using a transformative approach
- Data-driven, evidence based
- Addressing notions of excellence
- Promoting inclusion and belonging

Recommendations

Based on GENERA experience in designing and implementing GEPs in eleven physics organizations, reflecting on the experiences of the implementation managers (IMs), observers, evaluators, and experts, and taking into account the very different nature of the physics institutions in which many operate, the project offers the following recommendations for improving the GEP approach to promoting gender equality. These recommendations (based on the identified gaps in GEPS) are particularly relevant for physics organizations, but more generally could be adapted to institutions in other STEM fields in which women are severely underrepresented at all career levels.

- **IMs** should be skilled in forging **organizational change**, dealing with resistance, and building support networks to ease their burden. If hiring IMs specifically for this role, project funding should be earmarked and capacity building should be incorporated for skill development.
- As a particular point of attention, IM should be trained in **gender issues** as fitting with the European Commission prioritization of gender in research careers, in decision making bodies and in the content of research and teaching.
- Provisions should be built into calls for proposals for the position of **IMs beyond the direct scope of the project**. If IM positions and contracts are directly tied to project income, this puts them in a precarious position within the institution, and generates issues of continuity and sustainability beyond the project lifetime in terms of gender equality policies and progress tracking.
- **Experts** have relevant knowledge and experiences in promoting gender equality in research organizations above and beyond projects. For future calls for proposals, infrastructure and/or financial support should be built-in to effectively **broker** this expertise among project partners.
- **Instructions for internal evaluators** should be clearer on the task of measuring progress in terms of gender equality, and/or gender equality plans, and/or project management.
- **Symbolic change** is important, next to meeting project deadlines and tracking representation. A well-visited gender in physics day, an exciting video from a school competition, or the signing of a GEP by institute directors need to celebrated.
- Call for proposals should clarify the unique role of **observers** and should allow the reservation of funds for travel etc. for observers to participate in project events. If observers cannot take on a full partner role because of legal or budget constraints, or if observers want to join the project

while it is already running, this lack of funding and clarity limits the potential seeding and community building inherent in the collaborative, cross-national approach of GEPs.

- Most GEP projects develop ways to track and quantify **career progress** of women (and other minorities) in their institutions and/or disciplines, from entry-level students to senior levels. These efforts have rarely been held against guidelines developed for measuring progress in research careers and often do not go beyond representation (in %) at different career stages. We therefore recommend the utilization and further development of the GENERA **Minimal Dataset** (MDS) and a **career progress indicator** to longitudinally collect and compare career data within and across institutional, disciplinary, and national borders.
- **Mobility** is a career expectation and even signal for excellence, but also problematic for physicists (women and men) because of care responsibilities and dual career concerns. While single institutions can do more to support mobility of their (future, former, and current) graduates and employees, an international network of physics organizations can **support intra-organizational mobility** in a more efficient and more visible way.
- GENERA prioritized unconscious or implicit "**bias training**" as its number one gender equality measure in terms of quality, feasibility, and fit in physics institutions during its first stakeholder workshop[13]. Mitigating gender bias in performance evaluation is a diversity intervention that aims to fix the system, uncover meritocracy discourses and bend stereotypically masculine norms dominant in research organizations. At the same time, research shows that only raising bias awareness may result in resistance, denial, and anger. It is therefore crucial to take into account **evidence-based design specifications** for effective bias interventions.[14]

According to Nielsen (2018), few studies have systematically evaluated the effectiveness of different types of gender equality policies and measures in promoting gender equality in research organizations. Furthermore, the field is fragmented in terms of theoretical frameworks and evaluation standards (Müller ea, 2011). Examples of such evaluation studies are Nielsen, 2018 on Scandinavian countries, Timmers ea 2010 on the Netherlands, and Zippel ea 2015 on Germany. Taken together, these studies suggest several important conditions to be met for GEPs to be effective, from support from senior leadership; adaptability to institutional, disciplinary and national gender equality and equal opportunity structures; monitoring of progress on multiple indicators beyond representation; to building a community of practice to share and build knowledge and expertise beyond the lifetime of the funding of GEP projects.

13 See GENERA D6.2 stakeholder workshops report ,on prioritizing gender equality measures

14 EHRC 2018, Unconscious bias training: an assessment of the evidence for effectiveness; https://www.equalityhumanrights.com/en/publication-download/unconscious-bias-training-assessment-evidence-effectiveness
LERU 2018, Implicit bias in academia; https://www.leru.org/files/implicit-bias-in-academia-full-paper.pdf
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NOTES[15]

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15 Müller, J., Castaño, C., González, A., & Palmen, R. (2011). Policy towards gender equality in science and research. Brussels economic review, 54(2/3), 295-316.
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