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**Diversity in the Cultures of Physics:
A European Summer School Curriculum**

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The Strategic Partnership “Diversity in the Cultures of Physics” is an initiative seeking to build a transnational network for launching several key actions geared towards improving the gender balance in physics and its subfields. The strategic partnership consists of the following universities: Freie Universität Berlin, Universitat Autònoma de Barcelona, Universitat de Barcelona, the University of Manchester, the University of Sheffield, and Uppsala Universitet. The partnership was funded by DAAD / Erasmus+ from 2016 – 2019.

Preface

“Diversity in the Cultures of Physics” is an Erasmus+ funded Strategic Partnership launching several key actions aimed at improving the gender balance in physics and its subfields. The Strategic Partnership consists of six universities in four countries: Freie Universität Berlin in Germany, Universitat Autònoma de Barcelona and Universitat de Barcelona in Spain, University of Manchester and University of Sheffield in the United Kingdom and Uppsala Universitet in Sweden.

One of the central activities of the transnational network is an annual international summer school series for female physicists transitioning from Undergraduate/Master programmes to a PhD study. This document presents the curriculum that has been developed for those summer schools and that has been used and evaluated in each round of the summer school series.

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I Introduction

I.1 Why Summer Schools for Female Physicists?

Women are still underrepresented in physics. While women are already a minority from the first year at university on, the field is disproportionately represented by male scientists especially at higher levels of the academic ladder, e.g. among professors. With only slight variations, this holds for most European countries.

The Erasmus+ Strategic Partnership “Diversity in the Cultures of Physics” aims to identify and address some of the causes for the low numbers of women in academic physics research and to support young female physicists in their career planning. In addition to actively supporting young female physicists, structural conditions of gender inequality and their variability depending on national context are addressed as well.

Core activity of the Strategic Partnership is a European summer school programme. In four intensive weeks at two to four partner universities in two different European countries, groups of 15–18 female physics students and doctoral candidates from the partner universities engage with different subfields of physics, combined with reflections on their roles as women in physics. The participants are enabled to find suitable career perspectives in their favourite research fields of physics. They learn to identify different career options that can vary from country to country. Beyond this, they are empowered through network building, workshops on empowerment strategies and through their experience of not being isolated as a woman in physics.

Thanks to the connections of the Strategic Partnership, transnational network building among all actors involved in the summer school and beyond is facilitated: the young female physicists, the partner universities, and other actors involved in the delivery of the summer schools. The emerged networks thereby transgress all levels of the academic hierarchy. This is crucial because there is only little mutual exchange and informal communication between students and department members in higher career stages, i.e. doctoral candidates, PostDocs and professors. Particularly for those students with non-academic social backgrounds, it appears even more difficult or daunting to make contact with PostDocs, senior researchers or professors.

I.2 Objectives of the Summer Schools

What can women learn and experience in the summer schools? From our evaluations, we know that many participants feel at the beginning of the summer school that they definitely want to do a PhD in physics but have no clear idea of what this means or how best to plan the PhD and reach the various decisions that are to be made.

The summer school not only qualifies the participants for a solid decision-making process on whether and how to do their doctorate, but also helps to set the course for a further career in physics early enough and to be aware of the importance of networks. Especially through direct exchange with more senior female scientists, they learn about the challenges and potential difficulties of a career in physics. Knowing that these are not insurmountable, however, promotes self-confidence and assertiveness at the same time. Of utmost importance for this is the knowledge of both the manifold possibilities in physics and the structural barriers, as well as the importance of networks and contacts for successfully facing the obstacles on the desired career path.

Furthermore, the summer school creates room for new experiences: For the young women, it can be a discovery not to experience physics from a minority's standpoint.

The experiences and the scope of agency of young female physicists are thus broadened in a two-fold way: on the one hand, to the benefit of their career and life planning, and on the other hand, to enable them to criticize a too uniformly gendered, i.e. masculine, culture of physics and to intervene in an appropriate and successful way that does not harm their career and well-being.

From these objectives, the following elements that each summer school should consist of were derived:

- (1) giving practical insights into the diversity of physics research cultures and their research institutions in different countries;
- (2) providing information on equality policies and financial support structures in different countries;
- (3) facilitating direct contacts to local scientists and researchers of all genders;
- (4) enabling counter-experiences to being part of a gender minority;
- (5) getting acquainted with the research field of gender & science studies and its research on the role of gender in physics.

Although it is not feasible to present all possible career paths in all countries during one four-week summer school, it is possible to make the participants aware of the diversity of career paths and career decisions by conveying exemplary career paths. The participants can then extrapolate that there might be other options at other locations, perhaps even better suited to them.

I.3 Central Guiding Elements of the Summer Schools

I.3.1 Transnational Exchange

Physics is a very international academic field where close international collaborations are common. International mobility of researchers is the order of the day, and readiness to go abroad and build an international career network is expected of young researchers. Especially when it comes to planning a PhD, national differences in educational systems are important to know for young researchers.

Therefore, international networking and transnationality are crucial for the summer school programme. The cooperation of the partner universities in the summer schools enables an exchange of information about the characteristics of local physics cultures in the different partner countries and an awareness of the extent to which societal structures and national educational systems influence the workplace culture as well as career options of the local physics community. In addition, it can be eye-opening for the participants to view the familiar local workplace culture at their home department in contrast to other styles of workplace cultures of physics abroad, i.e. what has been perceived as “normal” before is now subjected to reflection.

It can be useful e.g. to know about the average actual duration of a doctorate, about financing schemes (scholarships/positions/grants) in the country of focus for a PhD, and about implicit “Do’s and Don’ts” of the local community. Thus, when deciding on whether to do a PhD, the summer school participants are encouraged to look beyond their own national borders in order to find conditions of doing a PhD that meet their interests, and a workplace culture that is suited to their predispositions and strengths. As a side effect, the participants become aware that physics is not void of cultural aspects as is sometimes upheld in self-representations of the field.

1.3.2 Networking in Physics

With respect to networking, an important aspect of the summer school is to connect participants with PhD students on site, particularly since most of them have no clear idea what “doing a PhD” means on a daily basis. Connecting the participants with PhD students on site gives them the opportunity to hear about the daily life of PhD students, to get first-hand tips, but also to ask questions like: What are the difficulties or challenges in doing a PhD here? What is it like as a woman at this research institute? How long are working days here?

Physicists who are more advanced in their career are important contacts as well. Researchers, lecturers and professors can be asked about their experiences and insights. Since most personal experiences do not often find their way into public reports on the careers of physicists, but young women are frequently very interested in them, the summer schools offer several meetings and facilitate encounters where the participants can come into contact with female physicists who illustrate a diversity among possible female role models in physics. For many of the participants, it is important to learn how scientists combine career and family, while for others it is very important to get to know queer women who do not conform to cisheteronormative role clichés.

Another crucial element of the summer schools is the facilitation of contact with Gender Equality Officers. Many participants are not aware of already established funding and support possibilities in physics departments, of existing networks for women and of possibilities for getting financial support for various occasions.

I.4 Structure of the Curriculum and Approach

During the funding period of 2016–2019, six summer schools were carried out in total. Two summer schools took place in parallel each year: Partner universities from two countries each jointly ran a bilateral summer school of four weeks. The binational cooperation took place alternately, so that each year a new combination of exchange programmes could be offered.¹ Therefore, the summer school schedule was re-arranged a little bit each year since it has to be adapted to the specific options, local circumstances and conditions at the universities in charge of running the respective summer school. Each year, the programmes of the summer school were all evaluated internally and with a questionnaire in order for the partners to be able to revise the curriculum. The revisions were made in order to better meet the needs of the participants and to optimize achieving the objectives of the summer school. After now three years and six summer schools, the programme is in a well-developed stage.

Each summer school lasts four weeks, two weeks in each country of the binational collaboration. In-between the two parts, there can be a break of one or two weeks in order to give the participants time to let the intensive experiences of the first two weeks of the summer school sink in and to recharge. The group is accompanied throughout the whole summer school by organizers from both countries in order to guarantee the continuity of the programme. The groups of participants are composed of 15–18 female physics students and doctoral candidates, half from each of the participating countries; e.g. in the Berlin-Uppsala Summer School 2019, seven participants came from Uppsala Universitet and eight from Freie Universität Berlin.

The participants are selected on the basis of written applications consisting of an application form and a motivation letter. Criteria for being selected are:

- (1) engagement with physics;
- (2) gender equality engagement or interest in it;
- (3) engagement in building up professional networks.

After the selection of the participants, local preparatory workshops with the participants from the local university can be planned. During this workshop, the local participants get the chance to meet each other and become familiar with the concept of the summer school. Practical information about housing is also discussed there. At this workshop, the local participants are invited to an online forum where they can interact with the other group. Through this early connection, they are able to help each other with local knowledge and form bonds before the summer school starts.

¹ For more details, see Appendix.

At each of the locations, a summer school consists of four core pillars of sessions and modules:

1. A first pillar entails research stays at the physics departments of the hosting universities. The participants receive an overview of the research profile of the department, followed by short research stays in working groups that can be chosen according to the interests of the young women. In addition, the participants engage in discussions with young as well as more senior scientists.
 2. A second pillar consists of visits to local research institutions that are doing physics in order to get an overview of what physics can look like in institutions beyond the university. Most non-university institutions also offer PhD positions. The formal requirements and the conditions of doing a PhD on site sometimes differ substantially per country, university and even working group. The visits mostly include practical information about how to do a PhD at these research institutions.
 3. The third pillar is empowerment. It consists of introductions into networks of women physicists, coming into contact with PhD students and female role models in physics, as well as empowerment workshops. Especially the latter should offer a safe forum for articulating own experiences with microaggressions, sexual harassment and derogating interactions with peers, i.e. students, or superiors, i.e. team leaders, course leaders. The participants can learn that these experiences are not of an individual but of a structural nature and how to react to derogative communication patterns.
 4. The fourth pillar comprises short seminars and workshops on gender & science studies in physics. Besides individual modules dealing with gender studies issues, a series of lesson plans for an integrated course "Gender Reflections in Physics" was developed in the Strategic Partnership team (Scheich/Erlemann/Schiestl 2018).
- A transversal pillar is built out of sessions concerning group-building processes and group dynamics. Since the participants will spend four weeks together as a group in two different countries, it is important to schedule sessions which trigger and facilitate group commitment and group-building processes so that the group can transform into a peer network during the summer school. Having a peer network based on mutual confidence is indispensable for freely exchanging ideas and talking without fear also about sensitive topics. Thus, giving rise to such a conversational atmosphere is an important criterion for the success of the summer school, which has also been attested through evaluation.

Since there is no fixed sequence of the modules or pillars, i.e. a summer school does not need to start with research stays followed by visits of research institutions etc., the schedules of each summer school need to be adjusted to the local availability of space and time, i.e. of rooms and of persons involved in the summer school as referents for talks, hosts for visits etc.

For each pillar, a manifold variety of modules that pursue the learning objective of the respective pillar have been designed, planned and carried out. The realization of concrete modules strongly depends on the experience, expertise and personal contacts of the organisers of the respective summer school. It hinges on the availability of referents for talks, guides for visits, researchers in working groups for the research stays and experienced trainers for empowerment sessions.

The following curriculum describes aims and functions of the pillars and provides an overview of formats and designs of the modules that have been part of each pillar. For some prominent modules that have been carried out in almost every summer school and might also be practicable in future summer schools, more details are provided. It is pointed out which instructional recommendations are to be considered, what challenges are to be expected and how long the module typically lasts (where it is of relevance).

All descriptions and outlines of modules are based on extensive evaluations collected from the summer school participants through questionnaires, on the regular internal summer school evaluations and on reflections by the summer school organizers, i.e. the partners of the Strategic Partnership. In addition, each binational summer school has been worked out in close collaboration of the network partners and in discussion with the whole network in order to optimally take into account the learning outcomes of the summer schools the years before.

II Syllabus

II.1 Pillar I: Research Stays at Physics Departments

The research stays at the physics departments of the hosting universities are a key element of the summer school since actual research in physics differs substantially from the physics that the students get acquainted with during studying at the university; during their studies, students usually do not have a chance to experience real working groups in physics research or get to know what a researcher's day-to-day life looks like. Therefore, the participants are to gain an insight into actual research in physics, into the everyday working routines of different fields of physics, from laboratory research practices to the daily working schemes of theoretical physicists. They get insight into the team structures of the working groups, into different leadership styles and workplace cultures. In addition, the participants get involved in discussions with young and more senior scientists, and they can establish contacts for their future Master or PhD thesis. During the research stay, they usually work on small-sized concrete research tasks.

In most summer schools, the research stay begins with a guided tour through the physics department. This gives the students an impression of the broad spectrum of the different fields of physics at the specific department so that they receive an overview of the research profile of the hosting physics department. This is followed by presentations of those research groups that offer a stay. The potential hosts present their research topics and describe their plans for the students' activities during the research stay. The students can then select their favourite working groups and rank them according to their interests. The presentation and ranking procedure have been proven to meet the participants' preferences. Depending on the participants' rankings and the capacity of the working groups to host students, between at least two and at maximum four participants are assigned the same working group.

The research stays last for two whole days resp. four half-days. According to evaluations, the duration of two whole days turned out to be better than the format of four half-day research stays as planned in the first round of summer schools. Since some hosting groups have important meetings or experimental activities in the afternoon or early evening, i.e. in the second half of the day, the schedule was revised so that it matches the work-rhythm of the working group. Thus, the participants do not miss important meetings, events or informal gatherings in the group.

After the research stays, the participants are expected to present their experiences shortly in front of the summer school group. This functions as a good opportunity to train presenting and speaking in front of an audience. Since the audience in this case is very benevolent, this exercise can be particularly helpful for untrained students who perceive giving presentations as daunting.

This session is scheduled for a half-day, so the length of each presentation should be set according to the number of groups that will present. Beforehand, e.g. on the day before, a couple of hours should be reserved for the preparation of the presentation.

For implementation of these modules, the following aspects should be taken into account:

The research stays have to be organized some months in advance of the summer school in order to identify working groups that are willing to host a group of two to four students during a research stay and to provide information about aims and structure of the planned research stays within the summer school. The potential pool of working groups that might be willing to collaborate depends also on the personal networks of the organisers within the department. When making the final arrangements, it is important to determine which member of the hosting research group will be in charge of welcoming and guiding the guest students. Furthermore, it turned out to be essential to introduce to the responsible host the outline and objective of the whole summer school as well as to explain that offering research stays is a good opportunity to attract interested and talented students for future Master and PhD projects in their research groups. In addition, it can be pointed out that the research stays can be a good opportunity to explore new ideas for mini projects or labs for advanced courses.

What might turn out to be a challenge is that, at some universities, there might be too few options when the summer school takes place during the usual academic summer break. A second challenge can be that it is easier for experimental groups to host students, although many students prefer visiting research groups of theoretical physics, at least in our experience.

II.2 Pillar II: Visits to Physics Research Institutions

The second pillar consists of visits to physics research institutions beyond the physics department which is hosting the summer school. These can be non-university research facilities, neighbouring universities in the region and R&D companies or even spin-offs. Also physics research institutions that specialize in outreach activities, e.g. science museums, can be a worthwhile destination for guided tours, especially for those future physicists who are interested in outreach as a career option.

The main objective of this pillar is to show the participants that also non-university research institutions or facilities are an option for a Master thesis or a PhD. Consequently, they are encouraged to also consider applying outside of universities. This broadens the scope of options for where to write a Master thesis or obtain a PhD. In addition, depending on the density of research facilities in the region, visits can broaden the spectrum of different subfields of physics and its research facilities, e.g. accelerators, synchrotrons, and observatories. The selection should cover the largest possible variety of different subfields of physics as well as of fields that usually have close links to or topical overlaps

with physics, like engineering fields, computer science, material science or industrial research. Thus, the students gain insight into where physicists can work and get to know different kinds of jobs that are related to physics.

Visits to other universities are only feasible if the hosting university is located in a region where other universities lie within a reasonable distance and can be reached within one or two hours. During our Strategic Partnership, this held for instance for the Berlin region with its different universities, among them a Technical University, as well as for the Uppsala Universitet where Stockholm and its Technical University are within reach.

Core elements of these visits are guided laboratory tours. Ideally, the introduction into the research themes on site is combined with providing information on access to and conditions for Master thesis and PhD positions, e.g. regarding wages and options for combining family life with career planning. There should also be timeslots exclusively dedicated to questions and discussions, e.g. on the differences between working at a university versus working in a non-university research institute.

When possible, it is fruitful to have female physicists or even members of local PhD training programmes as guides since this fuels the engagement of the participants in discussions and inquiries. More informal discussions about work experiences in the research facility can then be triggered more easily.

When preparing the visit, it is substantial not only to have the visit prepared on an organizational level but also to do a briefing with the persons guiding the group during the visit. From our experiences and evaluations, we know that it has to be stressed to the hosts that the audience, the summer school participants, is not a lay audience but consists of physics students or even PhD candidates in physics. Thus, the level of knowledge that can be taken for granted is higher than that of a lay audience. Speakers and guides of the hosting facility should know about this and should take it into account. A second point is to make clear to the guides that they are giving the tour to potential future PhD candidates or future Master students of the research institute. Thus, it should be recommended to the person in charge of the tour to promote the research facility to the students as a potential future research place.

An insight from the internal evaluations of the organizing teams is that participants have to be encouraged explicitly to ask questions during the tours because students of physics are often not familiar with interactive formats and do not feel allowed to ask when they have questions, even though in those guided tours, engagement is key. Furthermore, it might be useful to animate participants early on to claim their space in guided tours, especially if the tour leads through cramped and noisy spaces in facility buildings. Participants' evaluations of the visits showed also that they appreciated meeting someone working in physics who is enthusiastic about the job but who did not obtain a PhD.

Visits to institutions or facilities that do physics outreach are another option. During our Strategic Partnership, these have been offered by the partner universities in the United Kingdom, the University of Manchester and University of Sheffield, since one focus of the UK partner activities within the Strategic Partnership has been on analysing and developing gender inclusive outreach. During the summer school weeks at Sheffield and Manchester, a couple of visits to science museums were scheduled. The objective of these visits is to invite the participants to approach the expositions, displays, and guided tours in the museums from the point of view of evaluating the concepts and realization of science outreach. For instance, they were asked to observe how women were represented in the displays, how the museum tried to engage people of different ages, and also how the visitors interacted with the exhibits when passing through the museum. When participating in guided tours or talks organized by the museum, it can be discussed afterwards how accessible the speakers made the talk for different audiences, and which questions were asked.

II.3 Pillar III: Empowerment and Gender Equality Policy

The third pillar deals with empowerment and networking issues. It comprises a heterogeneous spectrum of modules on personal empowerment strategies against harassment, discrimination, and detrimental effects of unconscious biases, networking events with female physicists in different career stages, and meetings with persons in charge of gender equality policies like gender equality officers. For all modules of this pillar, it is crucial for the learning processes that the students can freely articulate their experiences, attitudes and ideas in the group. The organisers should warrant this partly by involving external experts for the specific field or experienced trainers.

II.3.1 Empowerment Towards Career and Against Discrimination

Since universities are not exempt from discrimination due to gender and even incidents of sexual harassment, there is a need for developing empowerment strategies that are doable for the participants in everyday life at the university. The aim of those modules is to illustrate that stereotypical attributions and discrimination are not individual experiences but are, unfortunately, quite common at the workplace university and are due to structural gender hierarchies. The participants should become aware of different forms of open, unspoken and unconscious discrimination and are invited to discuss and develop countermeasures and coping strategies. These insights can then be an encouragement to take action against discrimination. This spectrum of engagement can range from joining professional organisations representing women's interests and concerns to launching new initiatives, e.g. leading into network activities.

Among the most appreciated modules concerning empowerment are sessions on unconscious bias, microaggressions, intersectionality and master suppression techniques. Further modules deal with

sexual harassment. Concerning empowerment in career contexts, modules on presentation techniques can also be offered.

The feasibility of some of the modules depends on the personal networks of the organisers, i.e. on whether they have contacts to persons who have the necessary expertise and experience, especially when chairing sessions on sexual harassment. This can also be useful concerning modules on microaggressions.

Modules on **unconscious bias** introduce the phenomenon, explain how it may affect a person's actions and discuss techniques to overcome it. The Harvard Implicit Association Test (<https://implicit.harvard.edu/implicit/>, accessed 8th August 2019) can be employed in the module, but it is recommended to plan this only if there are experts, e.g. from psychology or gender studies, available in this field who can introduce the objectives of the tests and explain how test results should be interpreted as well as how biases might be affecting decisions and behaviours of humans. In any case, the limits of the test should be mentioned and discussed.

Modules on **microaggressions** introduce the idea of microaggressions and give a number of real-life examples which can be discussed in groups. It is important to include discussions on appropriate responses, otherwise the session is a lot less useful.

Seminars on **master suppression techniques**, i.e. on interaction patterns in academia that thwart especially women's careers, can be offered. The combination of presentation and discussion covers topics like how to recognize these suppression techniques, what consequences they have and how to counteract them. While this type of gender discrimination is subtle and often difficult to counteract, it is very common in academia.

Modules that focus on **sexual harassment** in science should be prepared even more carefully. In the summer schools so far, this topic was dealt with via analysing recent cases on sexual harassment in science which were broadly discussed, e.g. Geoffrey Marcy, Christian Ott and Walter Lewin, and that the participants were invited to do some research on. Further topics for students' research can be initiatives against sexual harassment, e.g. MeTooSTEM, #astrosh and The 1752 Group, or the department's harassment policy and reporting mechanisms (if there are any). The idea behind this design is to give students the option to discuss sexual harassment removed from their potential own experience. Hence, offering cases that have no direct link to students' home universities resp. home countries is important.

From the evaluations we know that more explicit trigger warnings, especially for those researching the MeTooSTEM case, are advisable. In addition, while this is an important subject that should be covered at some point in the summer school, it is recommended to have this session run by an external person with specific expertise in harassment and trauma work. Secondly, it is important to leave time for the session, e.g. to not have it on a full day where the students are together the whole time, but to give

people a break to process. For this module, it is indispensable to take into account that there can always be persons among the participants who experienced sexual harassment.

A further topic can be **intersectionality**, with a module that introduces students to the notion and invites them to think about concepts of privilege and about how inequalities arise. The design of this module should make intersectionality perceivable. Privilege walks² are a good way to make intersectionality tangible.

Presentation techniques are also subsumed under this pillar since they empower the students' confidence in presenting themselves to potentially male-dominated audiences. Since presentations are part of daily work in science, the participants can train this competence and get useful hints also on gendered aspects of presentation techniques. This session can either be designed as a general workshop on presentation techniques, held by an external coach, or as a workshop on how to give physics presentations, led by an experienced physicist. This module is linked to the participants' presentations of their research stay in the working groups, allowing them to practice giving presentations and to test the techniques learnt in this module. Besides helping the students to prepare the presentation of their work in the different research groups, the aim is also to provide a guideline for presentations in physics that they may have to prepare in the future. Topics of the module are different aspects of public speaking, including e.g. content management, posture, coping mechanisms for anxiety, slide design, interactions with the audience and gendered expectations laid on speakers. It can be useful to have an external trainer give this workshop.

A different objective can be to have the participants do group work on outreach activities. The aim is to get the students to think about how they could use their experience to devise an outreach session that aims at recruiting female students into physics. This module should start with outlining what outreach and widening participation mean before giving them an outreach task to work on for a couple of days or a whole week during specific timeslots. This helps getting the students to discuss why girls might choose not to study physics and how these reasons can vary across cultures and age groups. This can be easily combined with visits to science museums (see chapter II.2).

II.3.2 Network Events

The objective of network events with female physicists is to make the young women learn about the importance of professional networks for pursuing a career in science. The modules can be a first step for creating such personal professional networks. In addition, they encounter potential role models,

² For details about the privilege walk, see the lesson plans, available on <https://refubium.fu-berlin.de/handle/fub188/23146> (accessed on 13th August 2019). They are part of the outcomes of the Strategic Partnership "Diversity in the Cultures of Physics".

i.e. female physicists, doctoral candidates and PostDoc researchers. Studies show that role models only function as such if the young women can identify with them.³ Furthermore, it gives them the opportunity to ask peers, i.e. female physics students or doctoral candidates, about their experiences in research, about doing a PhD and work-life-balances, also on more personal terms.

Modules that aim at furthering the participants' networking activities are **sessions with PhD students** of all genders from the hosting department. The gatherings with PhD students give the participants an opportunity to have an informal meeting and exchange their stories in order to learn about the PhDs research areas and different aspects of doing a PhD, e.g. moving abroad, applications etc. The formats for mutual exchange can be designed differently. One possibility are coffee sessions where each person, participants as well as PhD students, take a seat at a themed table to discuss topics related to that theme, but change tables whenever and how often they wish to do so. Possible themes for tables are e.g. "Experimental Physics", "Theoretical Physics", "Career and Family", "Roads to a PhD" and "Miscellaneous". Another format is "speed networking", where participants have the chance to talk one-on-one with each of the PhD students before a larger group discussion begins.

Another networking module involves more **senior women in physics**. It can be implemented as a panel discussion or a lunchtime session where senior women from physics talk about their research and about what it involves on a day-to-day basis, how they came to do their PhDs and which challenges they had to face. Since this is to give the students exposure to real academic careers, it is useful to have more senior women as panellists and to make sure that they represent very different careers so that there is a good contrast between the guests.

In the **transnational living module**, female PhD students or PostDoc researchers give an informal presentation on their experiences of going abroad and the way of living there, to show that people of all ages can live outside their home country and that such experiences could be very different. The aim is to lower the threshold for going abroad for a PhD or PostDoc. Eventually a lot of the participants in all summer schools conducted have moved abroad to study and could share their own experiences.

In the networking modules, it is desirable to offer a good mix of different fields of physics being represented as well as having some guests working in small groups and some in very large international projects.

Our experience with these modules is that the discussions and conversation climate have been very honest, especially concerning personal stories.

³ C.f. Buck, G. A., Clark, V. L., Leslie-Pelecky, D., Lu, Y. and Cerda-Lizarraga, P. (2008), Examining the cognitive processes used by adolescent girls and women scientists in identifying science role models: A feminist approach. *Sci. Ed.*, 92: 688-707.

II.3.3 Gender Equality Policy

In meetings with gender equality officers, the participants are to gain insights into gender equality policies and financial support structures at site and are thus encouraged to make use of those. They are offered information about official institutions and programmes which are dedicated to the improvement of gender equality in academia and physics as well as given some informal knowledge about the practice of gender equality at site. A well-evaluated format for this is the World Café: After the invited representatives of gender equality institutions give brief talks about their position, several discussion groups are offered, each of them with one of the guests. The participants choose a discussion group and change every half hour to another one. There are as many changes as groups resp. guests, so each participant can join every discussion group. Guiding questions are provided. These modules can be combined with presenting persons from local, regional or national associations of women in physics or science or other local women's groups.

II.4 Pillar IV: Gender Studies and Physics

The aim of this pillar is to introduce the participants to insights and results from gender studies research. The modules of this pillar deal with research from gender studies, feminist theory and from gender studies in physics in particular.

On the one hand, the students learn about the origins and effects of often unconscious processes which lead to the underrepresentation of women in physics on all levels. They understand how gender inequalities are constructed and reproduced during interactions in labs and class rooms while doing physics. On the other hand, the basic structural dynamics linking gender effects in science and society are taken into account. Thus, they learn about the gender hierarchy as part of the invisible social context of their discipline and, above all, to scrutinize situations where perspectives of minorities are ignored in physics. Several different modules have been designed for this pillar, focusing on different approaches to the topic.

A collection of seven lesson plans has been designed and tested, named "**Reflections in Gender & Physics**"⁴. The lesson plans, being available online, are also meant for use beyond the summer school context, e.g. in Bachelor or Master courses in physics, as a whole set or as individual lessons, be it in single units of already existing courses or in workshops on issues of gender and physics.

In these lesson plans, gender imbalances in science and particularly in physics are explored. Each lesson plan represents a teaching unit of 180 minutes that introduces the central issues of the lesson and comprises references for reading materials and other resources, interactive learning tasks and

⁴ The series „Lesson Plans: Reflections on Gender & Physics“ is available on: <https://refubium.fu-berlin.de/handle/fub188/23146> (accessed on 13th August 2019). It is one the outcomes of the Strategic Partnership “Diversity in the Cultures of Physics”.

thematic topics for discussions in class. Taken together, the lesson plans cover a set of key issues based on studies from the field of feminist science and technology studies (STS). Among these key issues are workplace cultures in physics, the effects of stereotypes in and of physics, dis/encouragements in becoming a physicist and gender bias patterns in academia.

Another example for this pillar's modules are **Women History Tours** and Feminist City Tours in the specific city or region where the summer school takes place. Thus, historical women in science who have been ignored in the history of science can be highlighted. For instance, in the Women History Tour in Dahlem in Berlin, the students are provided with historical information about researchers, institutes and buildings that have shaped the academic landscape of the city district. Another approach is to give insights into the history of women and women's rights in the city from a feminist perspective. Further modules deal with the issue of female physicists who have not been awarded the Nobel Prize despite having deserved it, titled "**She should have won the Noble Prize**" in the Uppsala summer schools. The module increases the students' knowledge about brilliant women in physics and stimulates thoughts about gender inequalities in the context of the Nobel prize. For this module, groups of two to three students research the life and work of important female physicists and prepare a presentation. Beforehand, the participants are given a list of names of great women in physics to choose from.

If a study or survey on the situation at the physics department at the hosting university has been carried out from a gender perspective, this might provide fruitful material for a module with discussions on recruitment practices, supervision and workplace culture with regard to gender. The module can combine a presentation of the results of the respective study with discussion elements. In the Uppsala summer school, this kind of project has been conducted and was presented in the module "**Dandelion Physics**".

II.5 Transversal Pillar: Group Organisation and Group Dynamics

The fifth pillar is a form of transversal pillar since it comprises elements that aim at facilitating the group process and group commitment and thus builds a basis for enabling the group's learning processes and reflections. Central group building modules are welcoming events and a shared dinner that should be organized at least once during a summer school.

Welcoming events are crucial as they present the very first moment the group meets. Coordinators and all persons involved in the summer school should be introduced, clarifying their role. A welcome from a representative of the department, e.g. the dean, can transmit a feeling of the summer school being part of the department, at least for the duration of the summer school, and not an isolated activity. Then, the concept of the summer school should be explained, schedules handed out and practical information delivered. An important element of the welcoming part is to offer an introduction

round where the students get to know each other. Ice breaker activities like the Lego Model Game or similar group-based games can help with making contact in informal ways.

In order to set the first steps towards respectful group dynamics and a constructive discussion climate, a session for developing a shared code of conduct can be useful.

The code of conduct can be derived from the following preparation exercise: Each person has about 15 minutes to write down answers to questions like: What kind of experience should the summer school be? What am I afraid of? What do I want the group to be like? From the results, a shared code of conduct can be formulated and be put in written format on a wall, where it is visible throughout most of the modules.

Another approach to warrant a safe space for the participants in order to be able to discuss potentially difficult and painful experiences, e.g. sexual harassment cases, is to spend one to two days overnight at the nearby countryside. These excursions provide a different environment and can bring the group closer together by having all students gathered at one place, cooking together, sleeping over and enjoying nature. The stay can comprise some modules on gender empowerment.

The accommodation site should be usable without the presence of external persons, i.e. the night's stay and the provisions of food should be organized in advance so that the group is among itself. Being outside of the university and the urban region and being together as a group overnight strengthens the mutual confidence in each other. The realization depends strongly on the availability of such a space and might be feasible only in exceptional cases. In the Uppsala summer schools, it was possible to make an excursion to a set of cabins in the middle of the forest by a lake.

Further recommended modules are evaluations of the summer school via questionnaires. One can receive opinions from the students about the activities and organization of the whole summer school. These evaluations can also be done as a kind of mid-term-reflection, where insights from the previous weeks can be collected.

Reflection modules should not be missed at the end of each university stay, and as final reflection and conclusion. In a common format, everybody is encouraged to share their impressions and feedback through the five-finger-principle: What were things that fell short (pinky finger)? What do people take home (ring finger)? What was bad (middle finger)? What needs to be pointed out (index finger)? And what was great (thumb)?

A different format that can be combined with the above one offers three tables that have been prepared for group work with different discussion tasks, namely "What tools have you acquired?", "How do we share what we have learned?" and "How to maintain our network?"

Also, on a daily basis, a reflection session in form of a short round of emotion sharing can be helpful to get information about the group's current state of commitment and well-being: The whole group sits in a semi-circle and each person describes their feeling at that moment in one to three words.

Finally, one timeslot of a couple of hours should be held free in the schedule in order for the organizers to be able to react to the wishes of the summer school group. This can regard the continuation of discussions on open topics from other modules, reflections on selected parts of the summer school or just opening up space for topics the group wants to discuss.

Appendix

Between 2016 and 2019, six summer schools were carried out. Two summer schools took place in parallel each year: Partner universities from two countries each jointly ran a bilateral summer school of four weeks. The binational cooperation took place alternately.

In 2017, one joint summer school took place in Berlin and Barcelona, the other in Sheffield/Manchester and Uppsala. In 2018, the Berlin team collaborated with Sheffield/Manchester, the Uppsala team with Barcelona. The last round in 2019 comprised a Berlin-Uppsala summer school and a Sheffield/Manchester-Barcelona summer school.

Important to note: The partners in Barcelona and in the United Kingdom are formed by two universities each. In Barcelona, summer schools have been organized as a collaboration of the Universitat Autònoma de Barcelona and the Universitat de Barcelona. The partners in United Kingdom consisted of representatives of the University of Manchester and the University of Sheffield.

Each summer school lasted four weeks, two weeks in each country of the binational collaboration. In Barcelona and the United Kingdom, the summer school changed places every week, i.e. in Barcelona from the first week at Universitat Autònoma de Barcelona to the second week at Universitat de Barcelona, in the United Kingdom from Sheffield to Manchester.

Example of Summer School Time Tables

In the following, you find examples for binational summer schools as they were implemented during the Strategic Partnership. Due to the specific conditions and constraints of the specific universities, the schedules differ from one another. Nevertheless, the schedules comprise modules from all central pillars. The following set of schedules is intended to give an impression of how summer school schedules can be designed.

The colours refer to different pillars of the curriculum.

Green signals pillar I: research stays at physics departments;

red marks pillar II: visits to physics research institutions;

orange stands for pillar III: empowerment and gender equality policy;

blue indicates pillar IV: gender studies and physics;

yellow refers to the transversal pillar: group organisation and group dynamics.

Berlin – Uppsala Summer School 2019

Summer School in Berlin from 22nd of July to 2nd August 2019

Week 1 at Freie Universität Berlin, Germany

Monday	Tuesday	Wednesday	Thursday	Friday
Welcome	Introduction to Gender & Science Studies	Reflection on Gender & Physics: Networking against Structural Inequalities	Reflection on Gender & Physics: Career Stages and their shifting Challenges	Visit to Electron Storage Ring BESSY II Helmholtz Center Berlin
Ice Breakers	Guided Tour through the Department and Presentations of the Working Groups Offering Research Stays			
Code of Conduct				
Lunch	Lunch	Lunch	Lunch	Lunch
Feminist City Tour Women History Tour in Dahlem	Guided Tour through the Department and Presentations of the Working Groups Offering Research Stays	Visit to Leibniz-Institute of Astrophysics Potsdam (AIP)	Visit to Fritz-Haber-Institut Department for Molecular Physics and Department for Physical Chemistry	Visit to Max Born Institute for Nonlinear Optics and Short Pulse Spectroscopy

Week 2 at Freie Universität Berlin, Germany

Monday	Tuesday	Wednesday	Thursday	Friday
Research Stay in the Selected Working Groups	Research Stay in the Selected Working Groups	Reflection on Gender & Physics: Identifying and Breaking Stereotypes	Privilege Walk	Presentation of the Research Stays in the Working Groups
		Microaggressions	Reflection on Gender & Physics: Finding Suitable Work Place Culture	
		Lunch	Lunch	Lunch
		World Café with Gender Equality Officers	Networking with PhD Students	Open Discussions
			Time to Prepare Presentations	

Summer School in Uppsala from 12th to 23rd August 2019

Week 3 at Uppsala Universitet, Sweden

Monday	Tuesday	Wednesday	Thursday	Friday
Welcome	"She Should Have Won The Nobel Prize" Introduction and Group Work	"Dandelion Physics" Presentation of a Study on the Situation at the Physics Department at Uppsala Universitet from a Gender Perspective	Unconscious Bias and Master Suppression Techniques	Research Stay in the Selected Working Groups
Guided Tour through the Department and of the Working Groups Offering Research Stays				
Lunch	Lunch	Lunch		
Lunch	"She Should Have Won The Nobel Prize" Group Work	Transnational Living	"Brain Factoids of Gender and Science" Guest Lecture about Critical Reading of Scientific Articles with a Gender Perspective	
Guided Tour through the Department and of the Working Groups Offering Research Stays				
	Group Presentations on "She Should Have Won The Nobel Prize"	Presentation Techniques		
Welcome Dinner				

Week 4 at Uppsala Universitet, Sweden

Monday	Tuesday	Wednesday	Thursday	Friday
Research Stay in the Selected Working Groups	Time to Prepare Presentations	Group bonding activities and time to reflect on the last workshop	Visit to Stockholm University AlbaNova University Center for Physics, Astronomy and Biotechnology	Evaluation of the Summer School
	Departure to Norreda Overnight Stay in Cabins	Departure from Norreda Overnight Stay in Cabins		Lunch
	Lunch	Lunch		
	Sexual Harrasment and #metoo	Presentation of the Research Stays in the Working Groups		Open Discussions
				Farewell Party

Barcelona – Manchester/Sheffield Summer School 2019

Summer School in Barcelona from 15th July to 26th July 2019

Week 1 at Universitat Autònoma de Barcelona, Spain

Monday	Tuesday	Wednesday	Thursday	Friday
Get-together	Get-together	Get-together	Research Stay in Selected Working Groups	Get-together
Welcome & Ice Breakers	Representation of Female Researchers in Movies Guided Tour through the Department and of the Working Groups Offering Research Stays	Visit to 3rd Generation Synchrotron Light Facility ALBA		Group Presentations on "She Should Have Won The Nobel Prize"
Lunch	Lunch	Lunch		Round Table with Female Physicists
Guided Tour through the Department and of the Working Groups Offering Research Stays	"Women in Wikipedia" Presentation and Workshop on the Representation of Women in Wikipedia	Visit to the Computer Vision Center CVC		
Workshop on Misconceptions in Physics		"She Should Have Won The Nobel Prize" Introduction and Group Work		Feminist City Tour
				Dinner

Week 2 at Universitat de Barcelona, Spain

Monday	Tuesday	Wednesday	Thursday	Friday
Welcome	Guided Tour through the Department and of the Working Groups Offering Research Stays	Visit to Catalonia Institute for Energy Research IREC	A Philosophical Introduction to Feminism	Research Stay in Selected Working Groups
Presentation on the History of Women in Science			Feminist Economy	
Lunch	Lunch	Lunch	Lunch	Lunch
Outreach with a Feminist Perspective	Visit to Spin-off Companies from the Physics Department	Visit to the Institute of Photonic Sciences ICFO	Introduction to the Gender Research at UB	Open Discussions
Guided Tour through the Department and of the Working Groups Offering Research Stays	Networking with PhD Students		Workshop on LGBT+ in Academia	Evaluation
			"Científiques a prop" Outreach by AMIT a Women in Physics Network	

Summer School in the United Kingdom from 29th July to 9th August 2019

Week 3 at the University of Manchester, United Kingdom

Monday	Tuesday	Wednesday	Thursday	Friday
Welcome	PhD in the UK	Visit to the Observatory Jodrell Bank	Guided Tour through the Department and Visit to Research Groups	Discussion Session on the Research Group Visits
	Institute of Physics Presentation on Gender Balance Initiatives			
Lunch	Lunch			
Workshop on Intersectionality	Networking with PhD Students over Lunch			Outreach Task Presentation by the Groups
Outreach Project Introduction and Group Work	Round Table with Female Physicists			
	Outreach Project Group Work	Outreach Project Group Work	Open Discussions	
Welcome Dinner				

Week 4 at the University of Sheffield, United Kingdom

Monday	Tuesday	Wednesday	Thursday	Friday
Welcome	Round Table with Female Physicists	Visit to the Advanced Manufacturing Research Centre AMRC	Unconscious Bias	Evaluation of the Summer School
Guided Tour through the Department				
Lunch	Networking with PhD Students over Lunch	Lunch	Lunch	Lunch
"Science, E&D and the Media" Workshop on the Representation of Science and Gender in Different Newspapers	Visit to Epitaxy Research Facility	Visit to Magna Science Centre	"Science, E&D and the Media" Follow Up Workshop and Presentation by Students	Open Discussions
			Dinner	