



TECHNISCHE  
UNIVERSITÄT  
DRESDEN

DRESDEN  
concept



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# Education, Outreach and LHC ErUM-FSP Office

RECFA-Meeting, 01.04.2022, Berlin

# Outline

1. Education at Universities
2. Education and Outreach for  
High School Students and Teachers
3. Communication and Transfer Office



# Particle Physics at German Universities

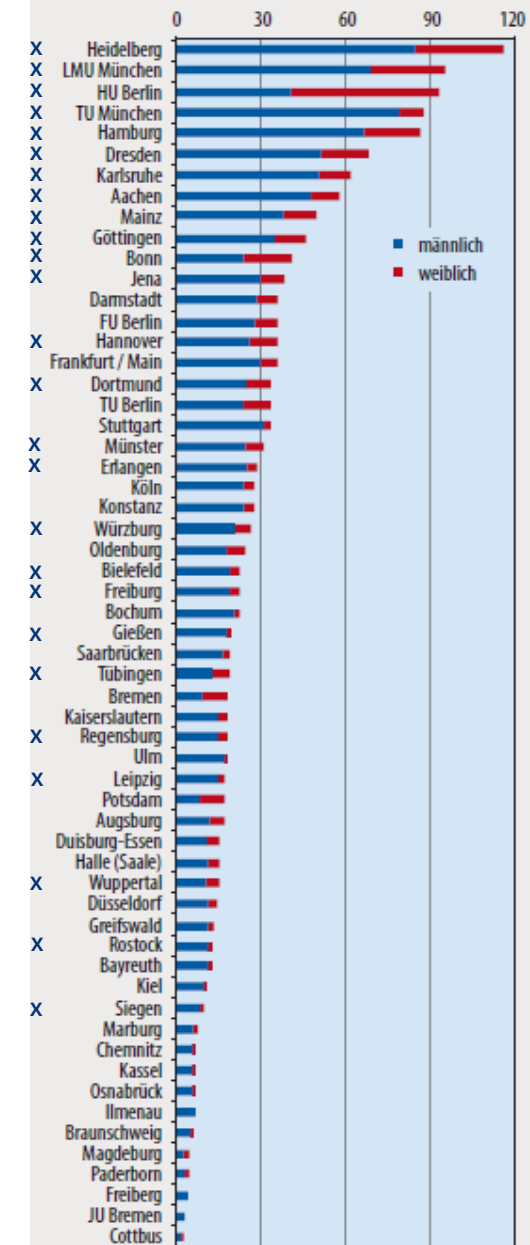
Particle Physics research: 26 out of 59 universities (X)

## Bachelor

- (nearly) all universities: Particle and Nuclear Physics course
- (usually) mandatory in 3rd year of bachelor
- Universities with Particle Physics research:
  - optional **particle physics specialization** in most places
  - Bachelor thesis, fully integrated in local research groups

## Master

- Particle physics as **Master specialization** topic
  - Broad range of lectures: physics, statistics, detectors, accelerators
  - Always complemented by lab courses
- One-year research phase
  - Often integrated in international experiments



PhD exams in physics 2020  
[https://www.kfp-physik.de/statistik/physikstudium\\_2020.pdf](https://www.kfp-physik.de/statistik/physikstudium_2020.pdf)



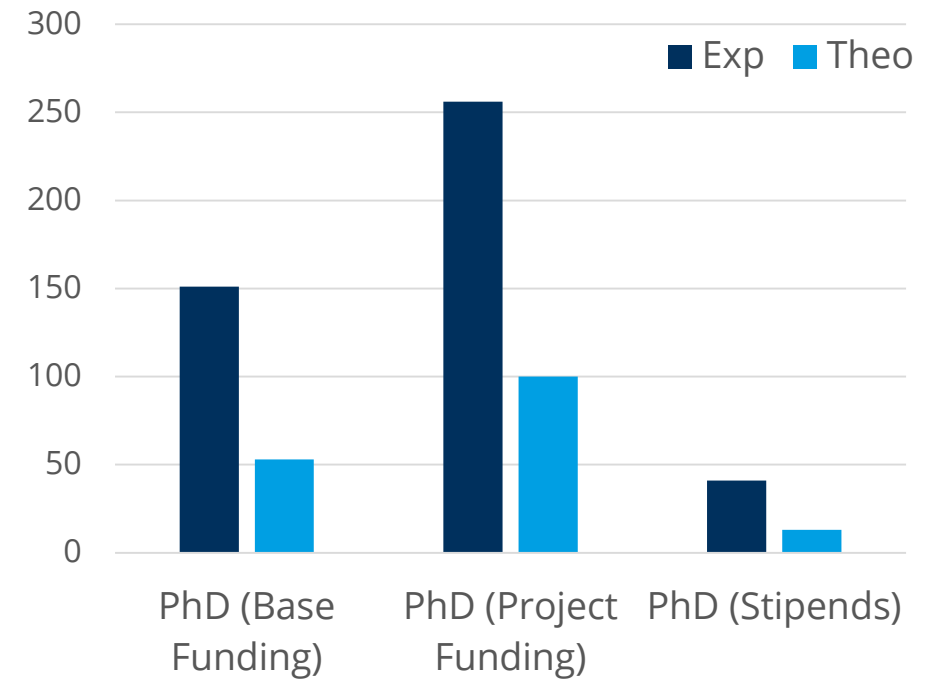
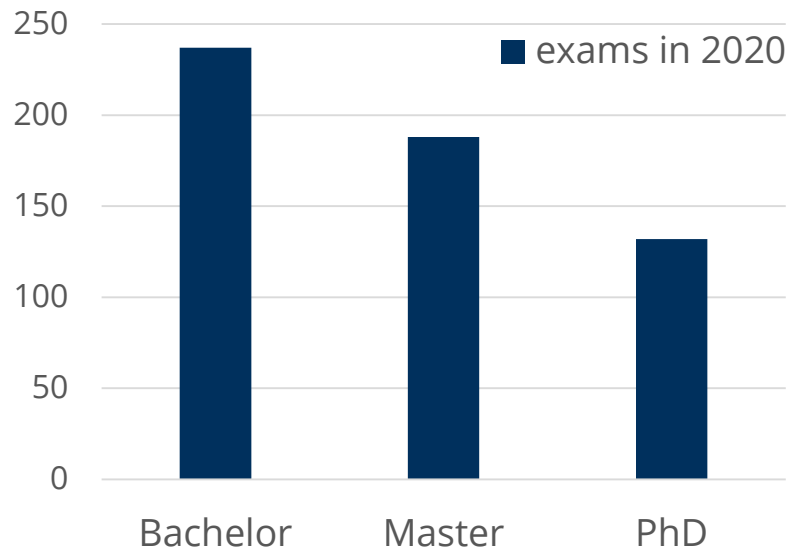
# PhD Students and Theses in Particle Physics

Data from community survey (Jan 2021)

- 190 Master exams in Particle Physics
- 135 PhD exams in Particle Physics

- 610 PhD students (75% experiment, 25% theory)
- 2/3 third party funded (BMBF, DFG, EU, ...)

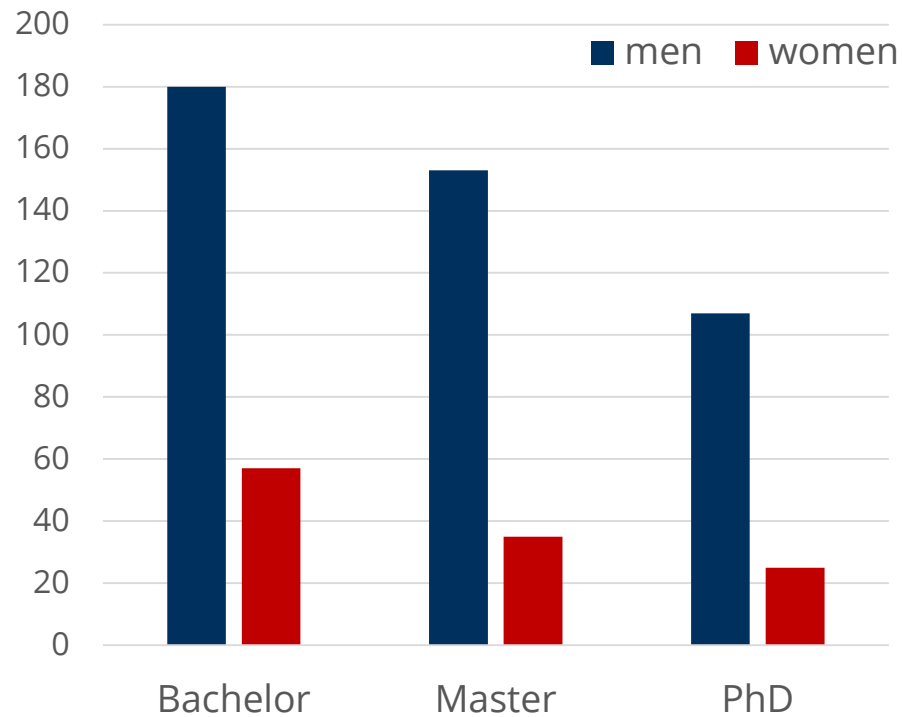
**~ 8% Master and PhD exams in Particle Physics  
/ all degrees in Physics**



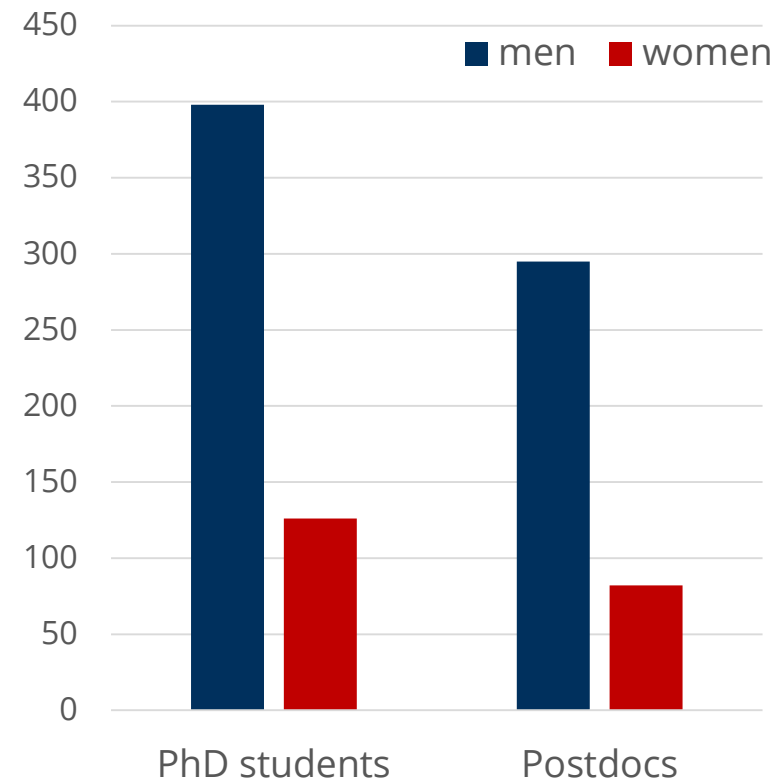


# Gender Balance

- 24% Bachelor exams by female students
- 20% Master exams by female students
- 21% PhD exams by female students



## 22% female PhD students and Postdocs





# Structured PhD Programs

## General features of structured PhD programs

- Structured lecture and seminar programs, often with block courses
- Optional: administration of (small) personal budget, participation in governance, exchange programs (between unis or uni-industry)
- Supervision agreements and independent co-supervisors, large variety of soft skill courses
- Often special support for careers of female physicists (networking, mentoring)

## DFG research training groups „Graduiertenkollegs“

- [GRK 1940](#) Heidelberg University, MPI Heidelberg: „Particle Physics beyond the Standard Model“
- [GRK 2044](#) Freiburg: „Mass and Symmetries after the Discovery of the Higgs Particle at the LHC“
- [GRK 2058](#) Heidelberg „High Resolution and High Rate Detectors in Nuclear and Particle Physics (HighRR)“
- [GRK 2128](#) Darmstadt: „AccelencE: Accelerator Science and Technology for Energy Recovery Linacs“
- [GRK 2149](#) Münster: „Strong and Weak Interactions - from Hadrons to Dark Matter“
- [GRK 2497](#) Aachen: „Physics of the Heaviest Particles at the LHC“

## Many local PhD Research Schools

- complementing the students' education program
- provide funding or act as umbrellas





# More Opportunities for Students

## Schools for PhD students (7-12 days)

- [Helmholtz Terascale Alliance Schools](#)
  - Detectors, statistics, machine learning etc.
- [Maria Laach School](#)
- [BND graduate school](#)



## Schools for Bachelor/Master students (1 week)

- [HASCO school for Master students](#)
- [Fellow School for Bachelor students](#)

## International Summer Student Programs in Germany (6-12 weeks)

- Mix of lectures and practical work
- International atmosphere
- Deeper than university courses

### Locations

- **HZDR Rossendorf** (e.g. accelerator physics)
- **GSI Darmstadt**
  - Accelerator Physics & Technical R&D
  - High Energy Nuclear Collisions
  - Theory
- **DESY at Hamburg and Zeuthen**
  - > 100 places

# Education and Outreach for High School Students and Teachers

Netzwerk Teilchenwelt = 30 universities/MPIs/DESY in Germany + CERN

- Shared programs and structures
- Key concepts:
  - Real data from particle and astroparticle physics research
  - Mobile offers, no local restriction
  - Various levels of specialization (from project day to own research project)

~ **3.500 high school students per year** since 2010

~ **150 PhD students active** as facilitators (1/3 women)

Project team: Dresden University / DESY / CERN  
+ hubs in Bonn, Mainz, Münster

Funded as integral part of research by the BMBF





## Basic Program: Masterclasses

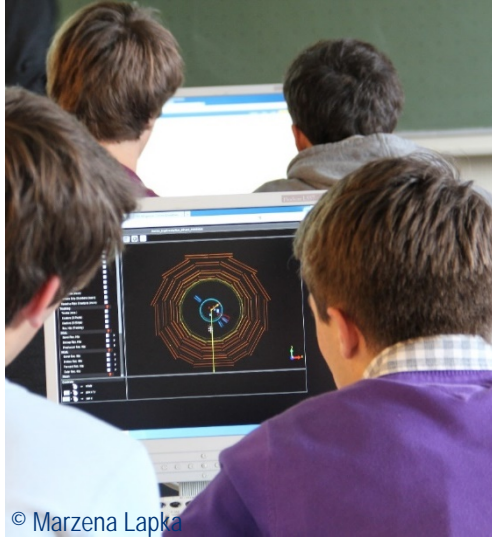
## Engage high school students (aged 15-19)

- Students act as a "scientist for a day"
  - Close to current research
  - Own "hands-on" activities with real data
- Students get insight into the research process
  - Use of relevant methods and tools
  - Comparisons between experiment and theory
- Students gain authentic experiences
  - Analysis of real scientific data
  - Meeting and discussion with scientists



- Broad physics scope: ATLAS, CMS, LHCb, ALICE, Belle II, Particle Therapy, Neutrino experiments, IceCube, Auger, DarkSide, ...
- 160 Masterclasses in 2019
- COVID: online version (Masterclass@home)

# Multi-level Program for High School Students



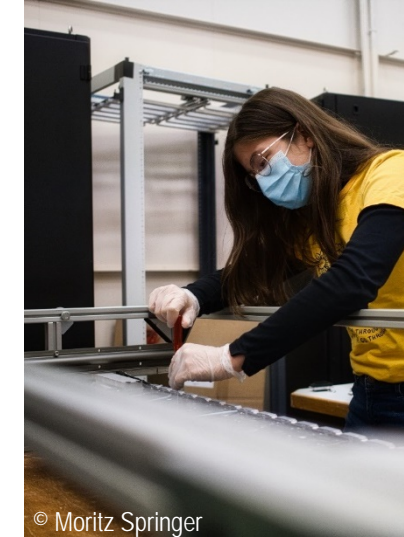
Masterclasses



Active engagement,  
detector projects



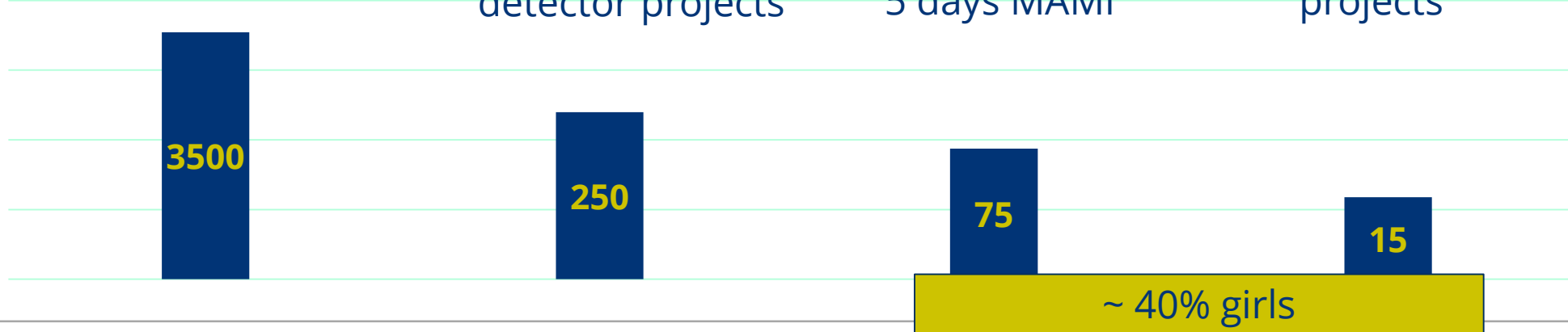
4 days CERN or  
5 days MAMI



Own research  
projects



Number of students  
per year





# Fellow Program Netzwerk Teilchenwelt

- Target group: alumni of CERN workshops
  - Now often studying physics or shortly before that



**Aim: close connection between highly motivated students and research groups**

~ 200 people, 50% young women

**Central offers:** Fellow physics schools (particle physics, detectors), “Ask the expert” sessions (online), national physics conference attendance

**Local offers:** internships, excursions, colloquia, regulars’ table, outreach events etc.



# Material Development and Teacher Training

## Aim: engage teachers as multipliers

- Development of material
  - [Teaching material for schools](#), 4 volumes (>25k printed, >50k downloaded)
  - [Portal Leifi Physik](#): Chapter on particle physics
  - [Particle profile cards](#)
  - [GeoGebra Analysis of Bubble Chamber images](#)
  - [Context material](#)
- [Teacher training „Forschung trifft Schule“](#)
  - 2-day training: Introduction to particle physics, 6 trainings p.a.
  - Summer School at CERN: 6 days, once per year





# Awareness Rising Activities

## Big Bang on the Road (Urknall Unterwegs)

- New interactive mobile exhibition modul on particle physics
  - Tunnel: time travel through the history of the universe
  - Elements with info on research methods, spin-offs
  - Pavilion with games
- Target audience: general public, people with less affinity for science
- On the road since 2021



## Week of Particle Physics

- 1 week in November 2020, next: 2023
- Research institutes organised events
  - Public lectures
  - Virtual visits
  - Masterclasses
  - Science Café
  - Science Slam





# LHC ErUM-FSP Office

**Main tasks: communication and outreach, promoting young scientists, industry transfer**

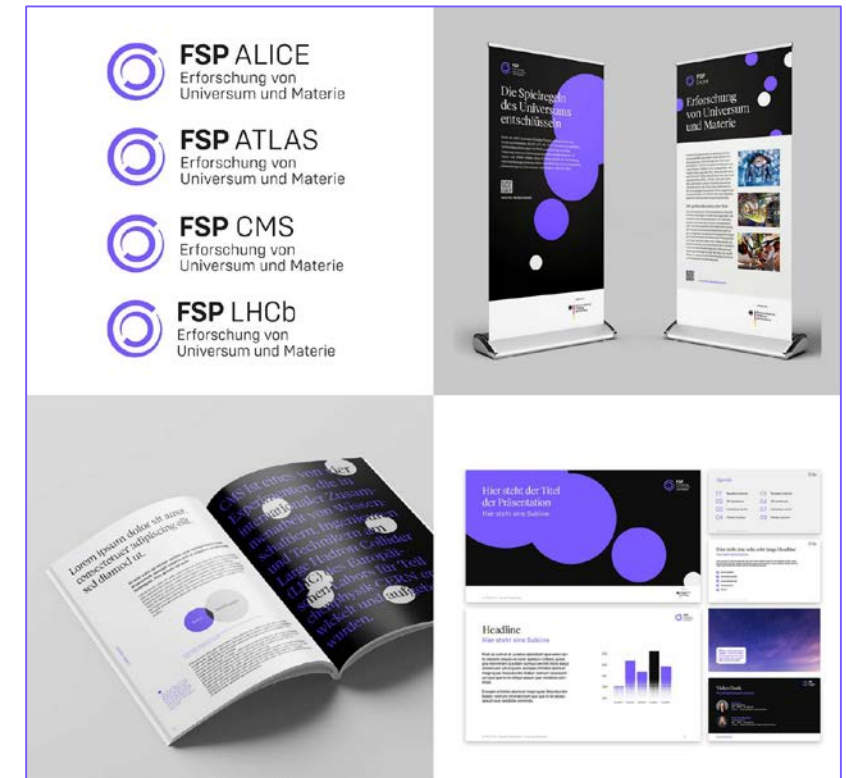
- Joint communication and transfer office for the German institutes involved in the LHC experiments
- Founded in 2020, 2 FTE, funded through the 4 LHC-FSP (research cluster)
- Contact person: Marius Hoffmann



## I. Communication and outreach

- Central website about German LHC participation
- Brochure about German LHC participation
- Joint corporate design for the 4 LHC-FSP
- Target groups: public, scientific community, industry, policy makers

+ coordination of German activities for Higgs anniversary and start of run 3



# LHC ErUM-FSP Office

## II. Promote young scientists

- Workshops for PhD students and Postdocs on leadership, networking, science communication
  - 2021: 4 workshops, 60 participants
  - 2022: 3-4 workshops in process/planned, constantly high demand

- Connect alumni and industry
  - Showcase career paths outside of science
  - Link PhD students and Postdocs with potential employers
  - Alumni talks
  - Industry days
  - Alumni database



## III. Foster connections to industry

- Establish relationship with industrial partners, e.g. in grid computing, electronics or ML
- Exhibition equipment for fairs (e.g. Hannover Messe)



# Summary

- Particle physics courses at **nearly all universities** with physics studies
- **44% of universities** with physics studies involved in particle physics research
- Wide range of **offers for professional training and personal development** along the talent pipeline
- Structured program to attract and promote new talents, already at **high school level**
- Fellow program to **bridge the gap** between high school and university
- Newly established LHC ErUM-FSP Office strengthens **communication** and **promotion of young scientists**
- Special focus on fostering **links to industry**

# Backup slides

# IPPOG Programs

IPPOG = International Particle Physics Outreach Group

## International Masterclasses

- > 60 countries involved
- 220 research labs
- Masterclass concludes with international videoconference (3-5 groups from different countries)
- 2019: 15.000 high school students
- Coordination: **Dresden University** (Germany)

## Global Cosmics

- High School Initiatives Exploring Cosmic Rays
  - International Muon Week
  - International Cosmic Day
- Coordination: **DESY at Zeuthen** (Germany)







# University Education in Physics

All German universities: Bachelor / Master in Physics

- Diploma exams (orange)
- Master exams (light green)
- Master+Diploma exams (grey)
- PhD exams (yellow)

German universities produce  
~ **2700 undergraduates** / year  
~ **1700 graduates** / year

