WOMEN IN PHYSICS: THE AMBIVALENCE OF SUCCESS, FORCES OF INERTIA AND PATHWAYS TO EQUITY

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Universität Stuttgart

JAGIELLONIAN UNIVERSITY
IN KRAKÓW

Introduction

- Normative concepts of science – and why the meritocracy narrative is so dangerous
- The current situation of women in physics and its subdisciplines
- Insights from history I: enablers
- Barriers in academic careers
- Insights from history II: lab cultures
- Interplay of factors and the problem of the positive loop feedback
- Accelerator physics – a special case?
- Best practices

Normative concepts of science – and why the meritocracy narrative is so dangerous

Robert Merton (1910-2003), 1942 *(Science and Technology in a Democratic Order)*

- Common ownership
- Universal validity
- Disinterestedness
- Organized Skepticism

→ privileged epistemological status of science

„A scientist never seeks publicity and expects no reward. If you are successful you really deserve no great credit.“

(Frieda Robscheit-Robbins, 1935)

Normative concepts of science – and why the meritocracy narrative is so dangerous

Merito-cracy: [scientific] merit → status and position in scientific community

Dangers:

1) Discouragement
2) Dishonesty
3) Disregard

Normative concepts of science – and why the meritocracy narrative is so dangerous

1) Discouragement in view of *failure*:
„If you didn‘t make it, you‘re not made for it. You‘re just not good enough.“

2) Dishonesty and double standards in view of *exceptional merit*: Curie effect.
„Of course, a woman scientist will be hired if she‘s as good as Marie Curie.“

3) Disregard of EO commitment and blindness to double standards in view of one‘s own achievement:

Rosalyn Yalow (1921-2011)

- 1977 Nobel Prize for Medicine/Physiology (radioimmunoassay technique)
- 1978 president of the Endocrinological Society, presidential address:

→ *I believe my ascending to the Presidency of the Endocrine Society is the final step in the general recognition that women have come of age in our Society and now participate with full equality in all its functions. I think it unfortunate that the Women's Caucus of the Society has chosen to remain a special interest group rather than changing its name and function […]*

The current situation of women in physics and its subdisciplines

SHE FIGURES 2024

She Figures monitors the state of Gender Equality in R&I. The 2024 edition highlights improvements and persisting gaps in comparison with the 2021 edition. In more detail...

Education

Women continue to account for around half of Doctoral graduates

48% = 0 pp*

(Eurostat, 2021)

Women remain underrepresented among Doctoral graduates in science and engineering

37% ↓1 pp

(Eurostat, 2021)

Employment

Four in 10 scientists and engineers at EU level are women

41% = 0 pp

(Eurostat, 2021)

However, women are still underrepresented as researchers, where they constitute just over one-third

34% ↑1 pp

(Eurostat, 2021)

Women are better represented in lower grades of academic positions, but representation reduces as seniority increases...

47% = 0 pp

of grade C staff (entry-level postdoctoral position e.g. researcher)

(WiS Database, 2022)

42% ↑2 pp

of grade B staff (mid-senior level position e.g. associate professor

(WiS Database, 2022)

Research outputs

Women make up just over one-third of authors on publications across all fields of research and development

34% ↑3 pp

(Scopus, 2018 - 2021)

Women continue to be significantly underrepresented among patent applicants, accounting for fewer than 1 in 10 applicants

9% ↑1 pp

(PATSTAT, 2018 - 2021)

Funding success rates are lower for women than for men

29% ↑2 pp

success rate for women

(WiS Database, 2022)

32% = 0 pp

success rate for men

(WiS Database, 2022)

... with the lowest representation among the highest academic positions, where women comprise one-third of grade A staff (most senior position e.g. full professor)

30% ↑4 pp

(WiS Database, 2022)

Decision making

Women are still underrepresented among board members and leaders, but their representation is growing

38% ↑7 pp

(WiS Database, 2022)

This underrepresentation is more pronounced in science and engineering than across all fields, where women make up

20% ↑1 pp

of grade A staff.

(WiS Database, 2022)

*Number indicates percentage point (pp) difference compared to values reported in She Figures 2021, rounded to the nearest integer.

Gender Equality in Research and Innovation

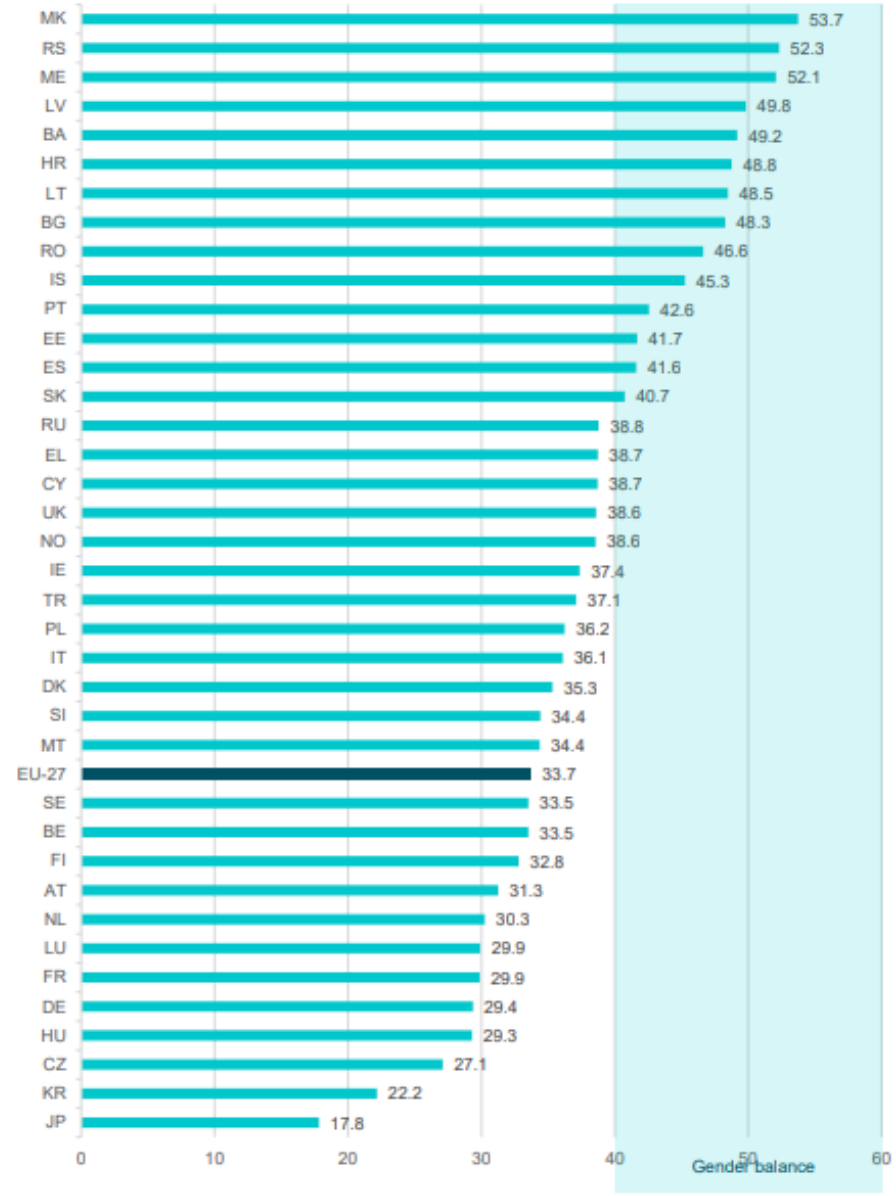
Let's connect

@EUScienceInnov

EU Science, Research and Innovation

Source: https://european-research-area.ec.europa.eu/sites/default/files/documents/2025-03/she%20figures%202024-KI0924569ENN-infographics.pdf

Figure 4.1 Proportion (%) of women researchers, 2021



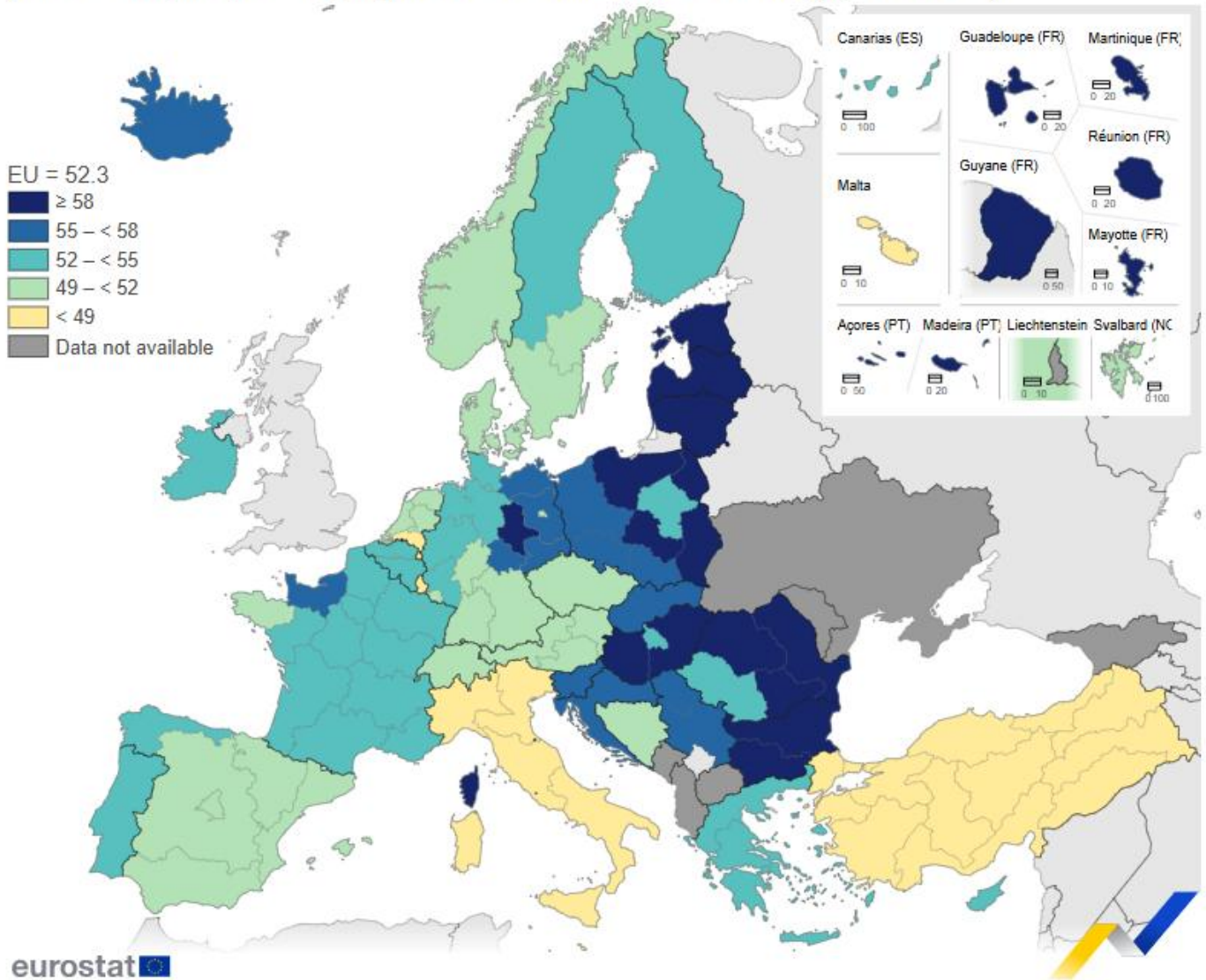
Source: Eurostat – Research and development statistics (online data code: rd_p_persocc) and OECD-R&D personnel by sector and function.

Notes: Definition differs, see metadata: FI (Researchers - Women, Total); Break in time series: BE, SE (Researchers - Women, Total); Estimated: EU-27, UK (Researchers - Women, Total); Provisional: DK (Researchers - Women, Total); Difference in methodology: JP (Researchers - Women, Total); Reference year differs: DK: 2019, UK: 2018, ME: 2019, MK: 2020, RU: 2020; Data not available: IL, US.

Europe/global snapshot: women are about one third of researchers worldwide

Women in science and technology, 2023

(% of total people employed in science and technology, NUTS 1)



Note: Czechia, Denmark, Estonia, Ireland, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Slovenia, Slovakia, Island, Norway, Switzerland single regions at this level of detail.

Source: Eurostat (online data code: hrst_st_rsex)

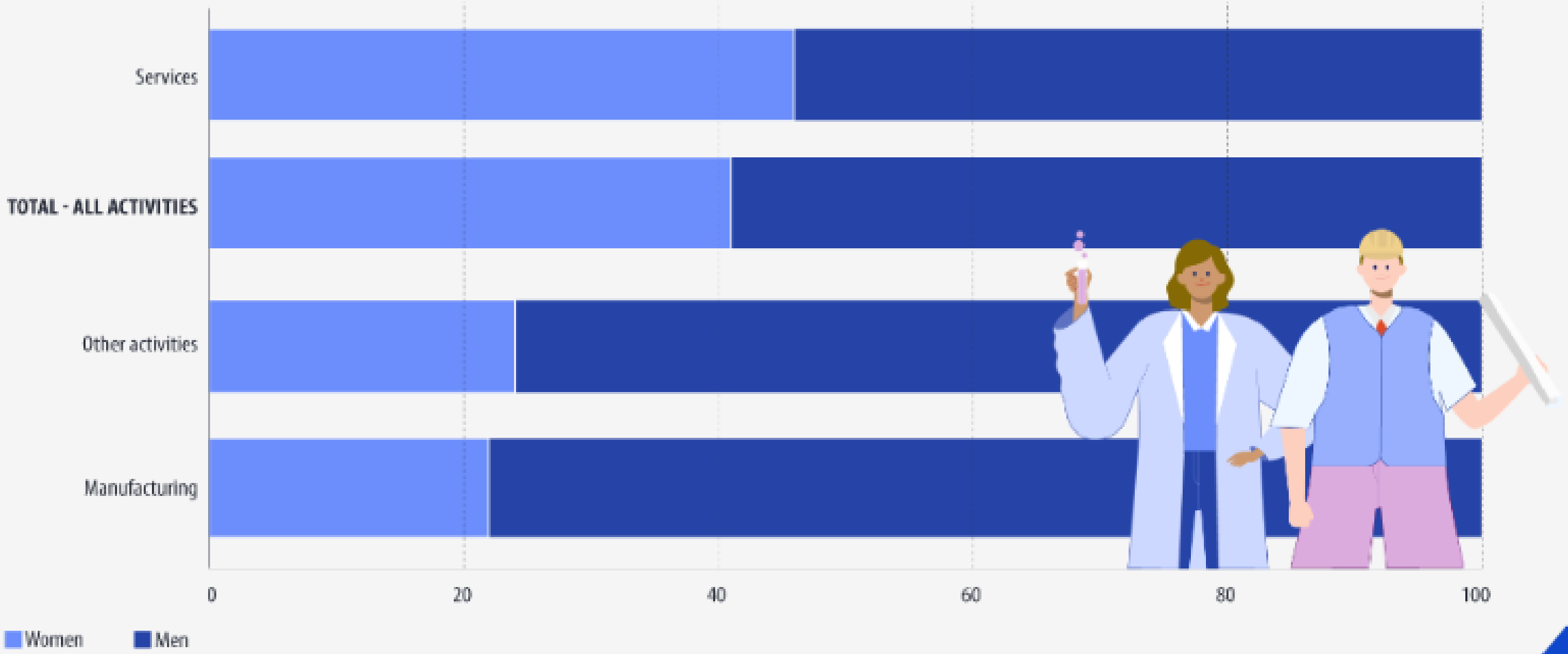
Administrative boundaries: © EuroGeographics © UN–FAO © Turkstat

Cartography: Eurostat – IMAGE, 06/2024

Source: https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20240613-2

Scientists and engineers in the EU, 2023

(% of the total, by sex and sector of activity)*

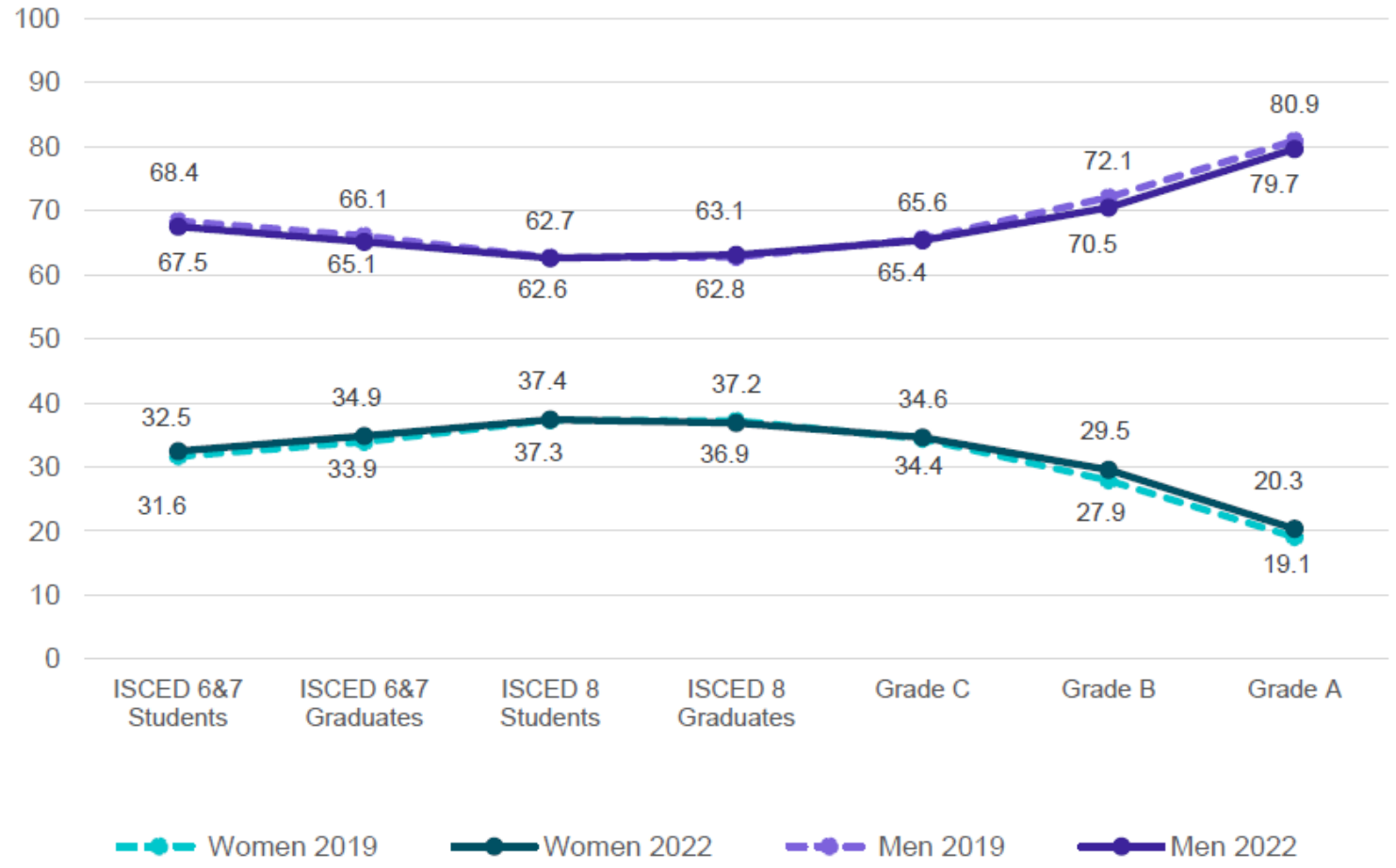


*Sector of activity according to the statistical classification of economic activities in the EU (NACE rev. 2)

eurostat

Source: https://ec.europa.eu/eurostat/web/products-eurostat-news/w/edn-20250211-1

Figure 6.2 Proportion (%) of women and men in a typical academic career in science and engineering, students and academic staff, 2019-2022



Source: WiS database, DG Research and Innovation - T1_questionnaires.

Women shares are lower in STEM fields

In the EU, women are a larger share among researchers than among the most senior academic roles

In STEM, representation drops at each successive career stage; among full professors it is often below 20%

	Status						Grand Total		
	Staff Members			Graduates and Fellows			Total MPE		
	F	M	% F	F	M	% F	F	M	% F
Accelerators & Technology Sector	10	24	29.4	8	9	47.1	**18**	**33**	**35.3**
Accelerator Beams	42	272	13.4	33	108	23.4	**75**	**380**	**16.5**
Director-General	27	14	65.9	2	2	50.0	**29**	**16**	**64.4**
Engineering	41	297	12.1	39	60	39.4	**80**	**357**	**18.3**
Experimental Physics & Support	94	439	17.6	81	218	27.1	**175**	**657**	**21.0**
Finance & Administrative Processes	37	42	46.8	13	19	40.6	**50**	**61**	**45.0**
Human Resources	63	12	84.0	5	3	62.5	**68**	**15**	**81.9**
Occupational Health & Safety & Environmental Protection Unit	41	124	24.8	13	31	29.5	**54**	**155**	**25.8**
Industry, Procurement & Knowledge Transfer	24	27	47.1	18	6	75.0	**42**	**33**	**56.0**
International Relations Units	32	24	57.1	25	6	80.6	**57**	**30**	**65.5**
Information Technologies	32	182	15.0	27	70	27.8	**59**	**252**	**19.0**
Pension Fund Administration	14	7	66.7	3	2	60.0	**17**	**9**	**65.4**
Research & Computing Sector	7	13	35.0	3	5	37.5	**10**	**18**	**35.7**
Site & Civil Engineering	31	72	30.1	16	19	45.7	**47**	**91**	**34.1**
Accelerator Systems	46	276	14.3	46	110	29.5	**92**	**386**	**19.2**
Accelerator Technology	37	276	11.8	28	104	21.2	**65**	**380**	**14.6**
Theoretical Physics	7	18	28.0	9	40	18.4	**16**	**58**	**21.6**
	585	**2,119**	**21.6**	**369**	**812**	**31.2**	**954**	**2,931**	**24.6**

Source: CERN Personnel Statistics 2024

Insights from history I: enablers

1) The confidence of belonging, part I: Earning one‘s living

Lise Meitner to a friend, 1911:

Sometimes I am faint-hearted and my life with the huge uncertainty, the ever recurring worries and the feeling of my exceptional position, of absolute soleness [des absolut Alleinseins] seems hardly tolerable. […] At its best, everything I do is of use only to me, to my ambition […] Somehow our lives should be related to those of the others, should be essential for them. But I am outlawed, because I am of use to nobody.

Lise Meitner to a friend, 1914:

I love physics from all my heart, I can’t imagine my life without physics. It’s a kind of personal love, like love towards a person to whom one is greatly indebted. And although I am so prone to having a guilty conscience I am a physicist without a trace of a bad conscience.

Insights from history I: enablers

2) The confidence of belonging, part II: Excellent relationships

Maria Goeppert Mayer (1906-1972)

1931 PhD in Göttingen with Max Born (quantum theory)

1933ff. Jewish refugees from Germany and Italy (James Franck, Fermi, …)

1941 First paid position: part time teaching at a women‘s college

1942 ff. Manhattan Project (Fermi, Teller, …)

1949 Spin-orbit-coupling in the atomic nucleus → nuclear shell model

1955: Maria Goeppert Mayer and Hans Jensen: *Elementary Theory of Nuclear Shell Structure*

1960 Full Professor at UC San Diego

1963 (half) Nobel prize in physics together wie Hans Jensen

„I have been very lucky in my career.“

Insights from history I: enablers

3) Practical support

Kaiser-Wilhelm-Institut für Hirnforschung (brain research), Berlin (est. 1914)

Directed by Oskar Vogt (1870-1959) who was married to Cécile Vogt (1875-1962)

Institutional innovation: Hiring personnel for the institute‘s scientists

Scientists included two „scientific couples“ with children and a remarkable percentage of female researchers

Barriers in academic careers

- **Underrepresentation is** less **about** individual “leaks” than about **career stı norms, and networks**

- **Formal procedures** can appear open, while informal practices shape who i identified, encouraged, nominated, and recognized

Belonging to a network was fundamental for the development of my career in tl 44_M

You must belong to different research groups, have different professional contacts and collaborate with many people. 24_F

- Hiring and promotion often reward an “**ideal worker**” profile: uninterrupted availability, mobility, constant productivity

I know what I have to do which is working hard and publishing a lot. But other things are not in my hands, such as the number of positions that will be offered in the future. 24_F

- **Exclusion often happens upstream**, before formal decisions, through visibility and nomination dynamics

Barriers in academic careers

- **Care responsibilities and mobility** demands translate into missed opportunities and reduced visibility

Children were influent in the sense that they limited the options I could consider (…) Of course it impacts your career if you get a maternity leave once and again, you travel less, go to few conferences and publish less, just because you are exhausted. 27_F

The most problematic is international mobility, especially when having small children that require constant care and support from other family members. 56_F

Barriers in academic careers

- **Everyday culture matters**: microaggressions and invisibility affect credibility and belonging

We had this experiment and there were very vulnerable electronic modules, they were very capricious and had to be monitored all the time. It was my experiment, so I asked my male colleagues "If something happens to it, let me know, please?" and then they asked me a question "And what will you do? To which expert we should call? What will you do?" and I said what I would come and repair it because I knew how. But for them it was impossible to imagine that a girl could do such things. Although they are educated men and probably have seen many women doing different things, yet still the environment is strongly dominated by men, and they couldn't imagine me doing such things. All in all, they are not against women, but they have in their minds these clichés that we [women] don't do such things. 61_F

Mainly elderly people, (...) older than 50 years, used such sexual overtones or jokes, but it slowly, it somehow slowly changes, however there used to be such distasteful comments 64_F

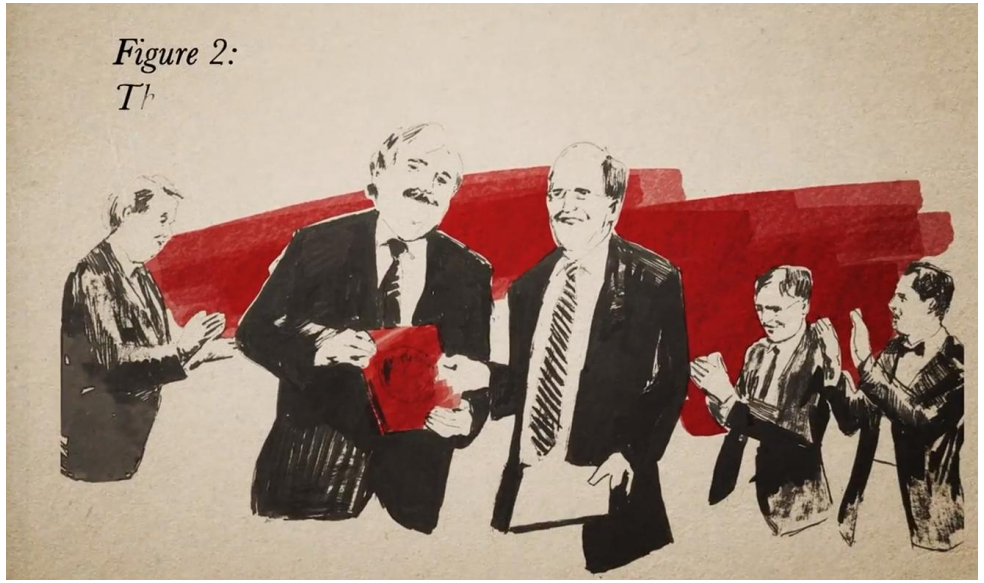
Yesterday I talked to the other women and then it came out that we are both sort of isolated. So we are not allowed until now, we both do not have a project anymore, so no defined project and they [the men] are getting all the new projects, even though one of them is leaving in two months. 07_F

Insights from history II: laboratory cultures

Film tipp: *Picture a Scientist*

Documentary by
Sharon Shattuck and Ian Cheney,
2020

„Picuture a nation,
where brillant minds can florish.“



Nancy Hopkins, MIT

Insights from history II: laboratory cultures

Harriet Brooks to Ernest Ruthereford,1903:

I am afraid I am a terrible bungler in research work, this is so extremely interesting and I am getting along so slowly and so blunderingly with it. I think I shall have to give it up after this year, there are so many other people who can do so much better and in so much less time than I that I do not think my small efforts will ever be missed.

funding situation ↔ lab equipment ↔ competition

Insights from history II: laboratory cultures

MacDonald Lab, McGill Univ. Montreal; E.Rutherford 1898-1907
Physics Lab, Manchester; E. Rutherford, 1908-1919
Cavendish Laboratory, Cambridge; J.J. Thomson, from 1919 E. Rutherford

Institut für Radiumforschung, Vienna; F. Exner/St. Meyer, 1910-

Laboratoire Curie, Paris; M. Curie 1907-

Harriet Brooks (1876-1933)	research 1900-1907
Ellen Gleditsch (1879-1968)	research 1907-1940s
Jadwiga Szmidt (1889-1940)	research 1911-1930s

… and many more

Interplay of factors and the problem of the positive loop feedback

- Underrepresentation has **no “root cause”**
- Outcomes emerge from **interacting structural arrangements, institutional practices, and everyday cultural norms**
- Policy effects are often non-linear and **context-dependent**; single interventions rarely map cleanly onto outcomes
- Many equality initiatives remain **weakly institutionalized**: resources, structures, and monitoring are uneven
- Under-resourced interventions can create **“activity without impact”** when implementation and evaluation capacity are missing
- **Equality work** is often displaced onto individuals as undervalued, additional labour, **creating potential career penalties**
- **Feedback loops reinforce inequality**: low representation sustains norms; performance regimes amplify service-load penalties; limited leadership diversity constrains reform

Accelerator physics – a special case?

1) Big Science – small visibility
Accelerator physics between international (prestige) projects and facility service

2) Theoretical physics – experimental physics – hardware – engineering?
Science, technology, and gender…

Accelerator physics – a special case?

3) Taking the intersectional challenge

Making visible the joy, excitement and pride of your work!

Hildred Blewett (1911-2004),
„the mid-wife of large accelerators“,
in CERN PS Main Control Room, Nov 24, 1959

https://commons.wikimedia.org/wiki/File:Hildred_Blewett_(colorized_image).png

Afterthought

EO is *not* a scientific problem

→no technological fix, no formula, no innate progress, no linear progression

EO has societal, institutional, local, disciplinary aspects

→EO commitment: manifold, lifelong, ever changing, strenous, tentative, rewarding

→ let it (also) be joy!

→ be honest and be kind to one another!

Nancy Hopkins (*1943),

molecular biologist, MIT
„Study on the Status of Women Faculty in Science at MIT“, 1995-1999

Nancy Hopkins featuring in the trailer of *Picture a Scientist*

Best practices

- Treat **equality of opportunity as governance and working conditions**, not a “side project”
- Make **outcomes visible** through annual, disaggregated monitoring of recruitment, promotion, leadership, pay, and participation
- **Improve recruitment and promotion** by using structured criteria, transparent shortlists, diverse panels, and brief de-biasing reminders
- **Act upstream**: strengthen encouragement, nomination practices, and visibility pathways
- Treat **care-conscious policy as research infrastructure**: predictable schedules, leave, tenure-clock adjustments, childcare support
- Culture change requires **full integration, leadership engagement (including men), and intersectional monitoring**

“A TRULY COMPETITIVE AND INNOVATIVE EUROPE IS ONE WHERE EVERY MIND, REGARDLESS OF GENDER, GETS THE CHANCE TO THRIVE.”

Ekaterina Zaharieva

Thank you!