# Meeting report: „Large-Scale Experiments – Reflecting on Theories and Practices". Conference, 2022, Karlsruhe, DE (hybrid)

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Research can be large on spatial and temporal scales, in terms of budget, in the sense of the size of collaborations and infrastructure, and also large in impact. The prevalence of large-scale research projects does not only spark interesting scientific questions but raises epistemic, ethical and societal issues: How does large-scale research influence how science is done? How can we conceptualize and understand large collaborative practices? When should society fund large projects and what are their 'returns'? Inviting perspectives from various branches across the sciences and reflective disciplines, the hybrid "International Conference on Large-Scale Experiments – Reflecting on Theories and Practices" was dedicated to discussing the manifold characteristics and challenges of large-scale research and experimentation; it took place at Karlsruhe Institute of Technology from December 08 to 10, 2022. The event was the second and final international conference of the German Research Association Unit "The Epistemology of the Large Hadron Collider" (ELHC). There were historical, philosophical, and sociological perspectives; skeptical, neutral, and enthusiastic approaches to large-scale experiments; and various facets of 'largeness' were touched upon.

## Peculiarities and challenges of large collaborations

A pertinent topic throughout the entire conference were the implications of the growing size of collaborations in the scientific world, as well as their internal structures. Acknowledging that large-scale research is typically complex not only in terms of its subject but also in its organizational form, Martina Merz (University of Klagenfurt), proposed three strategies for dealing with 'organizational complexity': A segmentation of research infrastructures, the introduction of elements of bureaucratic governance, and the implementation of standards and standardization. Noting that science policy institutions seem to tend towards funding hierarchical rather than egalitarian structures in scientific collaborations, Hanne Anderson (University of Copenhagen) suggested that this preference has epistemic implications since hierarchical structures appear more successful in puzzle solving, but less so in the identification of problems, generation of alternatives and distribution of risks.

Presenting a comparative study of two NASA spacecraft collaborations with different internal structures and hierarchies, Janet Vertesi (Princeton University), stressed how the organizational form and resulting culture of a collaboration matter for the scientific outcome. She impressively showed how the different cultures in the two collaborations influenced the selection of data, the information transfer and the discoveries being made. Furthermore, a symposium explored the possible room for and role of creativity in large-scale collaborations. Although the restriction of creativity by the fairly fixed common goals and procedures was identified as potentially epistemically problematic, it was also illustrated how, in large collaborations, individual creativity can take a back seat to an ideal of 'communal epistemic success', and how certain procedures can channel creativity.

## Epistemic aims and risks in large-scale research

Large research takes place in complex scientific and social settings and involves conscious and unconscious decision-making, e.g. regarding data and method choice, interpretations or communication procedures. Hence, it is inherently prone to various sources of epistemic risks that could potentially affect the achievement of epistemic aims. Therefore, one symposium was explicitly devoted to discussing issues under the header of 'epistemic risk', covering topics such as team culture, the roles of scientists and engineers, masculinity in high energy physics (HEP), and the influences of diversity, homophily or trust on epistemic aims and their achievement.

Another contribution touching upon epistemic risks in large-scale research was by Kent Staley (Saint Louis University). Tackling the question of how exploration in HEP can yield warranted knowledge claims, Staley suggested that the epistemic goals and the methods of exploratory and model-based searches are very similar, but that they prioritize the avoidance of different types of errors. Recognizing that the peculiarities of large research projects may pose significant conceptual and methodological difficulties for historical studies, a symposium on challenges concerning the history of large experiments explored factors affecting how epistemic aims and results in large-scale research are reconstructed, conceptualized and understood.

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## Philosophy of experimentation, observation and theorizing

Large-scale experiments spark interesting questions about the role of theories: To what extent should experimental work be guided by theory? How do theoretical expectations shape the design of large experiments and result interpretation? A symposium on theoretical expectations and large experiments explored questions ranging from how 'flexible' such experiments are with regard to unexpected findings and exploration, over the kinds of theoretical considerations that motivate large experiments, to the nature of guiding principles.

**Fig. 1:** Group picture of the conference participants. *Source: research unit ELHC*

Recognizing that contemporary science challenges traditional distinctions between observational and experimental sciences, another symposium was devoted to critically examining potential differences and similarities between the two in large-scale research. While most agreed that the conceptual distinction carries certain ideas, the concrete differences and their epistemic consequences were subject to debate. Comparing black hole observations with large experiments, Jamee Elder (Harvard University), for example, argued that large-scale observations of black holes have much in common with large experiments and that many traditional stereotypes about observations are inadequate, e.g. that they are more passive or less complex than experiments.

## Democracy and impact on very large systems

One symposium addressed the 'largeness' of experiments in terms of their impact and regarding the systems they affect, hereby emphasizing the societal risks of such experiments rather than the epistemic ones. The focus of the symposium was on climate engineering as a class of interventions with potentially extremely high impact on systems as large as the Earth, mankind and all of nature. The term 'experiment' was used in two senses: a broader one referring to interventions whose consequences no one can fully foresee and a narrower referring to controlled smaller-scale experiments designed to provide insight into the former.

While some regard climate engineering as inevitable for counteracting the effects of global climate change, contributions to the symposium showed the diversity and severity of ethical and practical problems involved, and how under-explored they are. Offering a thorough analysis of the history of climate interventions, the chaotic nature of climate, and the potential for abuse of power, James Fleming (Colby College) even concluded that humans can influence but cannot engineer the climate and should not try to do so. Heather Douglas (Michigan State University) pointed out that, due to several conflicts of interest being at play, big science projects in general have a democratic legitimacy problem, especially if already running, and ongoing projects are difficult to stop, even if they prove harmful. This seems to be all the more true if we apply the statement to climate interventions, albeit partly for different reasons.

## Gender and feminist perspectives

Various contributions illustrated how conceptualizing and critically reflecting on large-scale research sparks a shift in focus: On collaborative structures and institutional arrangements rather than on individual epistemic agents; or on the cognitive and social practices in which researchers are situated rather than their methods and theories alone. Many of such ideas genuinely owe to contributions by feminist scholars, encouraging further exploration of the topic from feminist perspectives.

Although being present throughout the entire conference, the topic of gender was still somewhat underrepresented in the concrete program schedule. One exception was a talk by Nuria Muñoz Garganté (Max Planck Institute for the History of Science), who established a relationship between the male-dominated environment in high-energy physics and certain values underlying the debate by offering a historical perspective on the debate regarding the necessity of particle colliders. A very different manifestation of the topic was revealed in a personal talk of Tiziano Camporesi (European Organization for Nuclear Research, CERN) who – drawing on his decades-long experiences at CERN – gave a detailed illustration of how the complex structures of the Large Hadron Collider have grown over the decades. Among other things, the talk covered the development of the percentages of female physicists at CERN. While it was emphasized that the numbers, which have been stagnating for decades, reflect imbalances in applicant numbers, the reasons for this were left unaddressed. It would be an important next step to make this subject to critical examination, especially in light of the existing large corpus of literature on gender disparities as well as their roots and effects on epistemic practices.

### Further information:

Conference website: https://indico.uni-wuppertal.de/event/152/



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