Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-0000000-0157	Name of the course	Polish	**Big Science**	
			English	**Big Science**	
Type of the course	specialized				
Course coordinator	Dr hab. Georgy Kornakov	Course teacher	Dr hab. Georgy Kornakov		
Implementing unit	Faculty of Physics	Scientific discipline / disciplines*	All disciplines		
Level of education	Doctoral studies	Semester	spring		
Language of the course	~~Polish~~/English				
Type of assessment	Grading	Number of hours in a semester	**24 lectures** ~~30 lectures (90 total)~~	ECTS credits	2
Minimum number of participants	12	Maximum number of participants	50	Available for students (BSc, MSc)	Yes/~~No~~

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2				
	in a semester	24				

* does not apply to the Researcher's Workshop

1. Prerequisites

Good command of scientific English. Basic understanding of concepts in modern physics

2. Course objectives

Overview of the present and future Big Science projects. The main characteristics of Big Science projects are their big budgets, big collaborations, big machines, and big laboratories. The success of the strategy and the impact of technologies developed within big science projects have changed society and technology with deep economic and political impacts. The course will review the history of the Big Science projects, the current facilities, and the ones planned, or which are being discussed in the scientific community. Several accelerators and fusion facilities, devices for the study of gravitational waves, searches of dark matter, astrophysics and space laboratories are going to be discussed in the course.

3. Course content (separate for each type of classes)

Lecture

Overview of the present and future Big Science projects. The main characteristics of Big Science projects are their big budgets, big collaborations, big machines, and big laboratories. The success of the strategy and the impact of technologies developed within big science projects have changed society and technology with deep economic and political impacts. The course will review briefly the history of the Big Science projects starting from the Manhattan Project until recent days. After the introduction, the following topics are going to be studied:
1) Then the present and future accelerator-based facilities are going to be introduced as the LHC (and the upgraded HL-LHC) at CERN, FAIR, RHIC and e-RHIC, FCC, and ESS. Additionally, the main experiments and international collaborations and their missions are going to be discussed during the course.
2) The study of gravitational waves and the LIGO and VIRGO laboratories.
3) Neutrino laboratories: the Long-Baseline Neutrino Facility, Hyper Kamiokande, IceCube
4) Fusion reactors: ITER, Stellarator, and other facilities.
5) Searches of dark matter: XENON
6) Astrophysics: the Square Kilometre Array; Next Generation Very Large Array, European Extremely Large Telescope
7) Space laboratories: International Space Station, James Webb Space Telescope

The seminars given by the lecturer will be complemented will presentations prepared by students where one specific experimental facility will be introduced.
Laboratory

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	Know the organization, methodologies, main technologies and scientific goals of the largest ongoing Big Science projects.	SD_W3	active participation during classes
Skills			
S01	Critical approach to knowing Big Science projects. Understanding of goals and results of scientific activity of large experiments, in particular their impact in the scientific community and advancement of the corresponding fields.	SD_U2	presentation evaluation
S02	Communication and presentation of activities of experiments addressing the actual big scientific questions at international level.	SD_U4	active participation during classes
S03	Debate on scientific, economic and human resources aspects of large scientific projects and infrastructure.	SD_U5	active participation during classes
S04	use English at B2+ level to effectively communicate during the classes and presentations.	SD_U6	presentation evaluation
Social competences			
SC01	Critical assessment of the goals and achievements of the Big Science projects, their impact to society and academia.	SD_K1	presentation evaluation

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Evaluation: the presentation (50% of the course), the attendance (20%), and participation (30%) during the classes are going to be evaluated. The preparation of the presentation is mandatory and participation in the classes will be strongly encouraged. In case the number of students will not permit a presentation of a topic during the class it will be substituted by the preparation of a scientific poster with a 5-minute presentation explaining the main aspects of the assigned facility.

6. Literature

There is no bibliographic overview book and/or summary. The course content is based on Technical Design Reports, official publications, scientific publications, and Reports of several Scientific Commissions and roadmap documents.

references:

1. [1] Weinberg, Alvin M., Impact of Large-Scale Science on the United States, Science, Volume 134, Issue 3473, pp. 161-164, 1961
2. Börner, K., Silva, F.N. & Milojević, S. Visualizing big science projects. Nat Rev Phys 3, 753–761 (2021).
3. The Supercollider That Never Was (https://www.scientificamerican.com/article/the-supercollider-that-never-was/)
4. CERN (http://home.cern/about)
5. https://fair-center.eu
6. BNL RHIC (https://www.bnl.gov/rhic/)
7. Electron-Ion Collider (EIC) (https://www.bnl.gov/eic/)
8. Future Circular Collider Study Default (https://fcc.web.cern.ch/Pages/default.aspx)
9. https://europeanspallationsource.se/
10. LSC - LIGO Scientific Collaboration (https://www.ligo.org/index.php)
11. Virgo (https://www.virgo-gw.eu/)
12. Japan will build the world's largest neutrino detector https://www.nature.com/articles/d41586-019-03874-w
13. IceCube – IceCube Neutrino Observatory (https://icecube.wisc.edu/)
14. ITER - the way to new energy (https://www.iter.org/)
15. Michael Klasen, et. al., Indirect and direct search for dark matter, Prog.Part.Nucl.Phys. 85 (2015) 1-32
16. XENON Dark Matter Search Experiment http://xenon.astro.columbia.edu/overview.html
17. Square Kilometre Array (skatelescope.org) (https://www.skatelescope.org/)
18. ngVLA (https://ngvla.nrao.edu/)
19. ELT | ESO (https://elt.eso.org/)
20. https://webbtelescope.org/

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	60
4	Amount of time devoted to the preparation for exams, test, assessments	
	Total number of hours	**90**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	
Number of ECTS credits earned by a student in a practical course	