DI.108.HEP Particle Detectors II

1. Study program

1.1. University	University of Bucharest
1.2. Faculty	Faculty of Physics
1.3. Department	Department of Theoretical Physics, Mathematics, Optics, Plasma and Lasers
1.4. Field of study	Physics
1.5. Course of study	Master of Science
1.6. Study program	High Energy Physics (in English)
1.7. Study mode	Full-time study

2. Course unit

2.1. Course unit title	**Particle Detectors II**							
2.2. Teacher				Dr. Gabriel Stoicea, Dr. Dorel Pietreanu				
2.3. Tutorials instructor(s)								
2.4. Practicals instructor(s)				Dr. Gabriel Stoicea, Dr. Dorel Pietreanu				
2.5 Year of study	1	2.6. Semester	2	2.7. Type of evaluation	E	2.8. Type of course unit	Content[1)]	**DS**
							Type[2)]	**DO**

[1)] fundamental (DF), specialized (DS); complementary (DC)
[2)] compulsory (DI), elective (DO), noncompulsory disciplines (DFC)

3. Total estimated time (hours/semester)

3.1. Hours per week in curriculum	**4**	distribution: Lecture	**2**	Practicals/Tutorials	**2**
3.2. Total hours per semester	**56**	distribution: Lecture	28	Practicals/Tutorials	28

Distribution of estimated time for study	**hours**
3.2.1. Learning by using one's own course notes, manuals, lecture notes, bibliography	**44**
3.2.2. Research in library, study of electronic resources, field research	**18**
3.2.3. Preparation for practicals/tutorials/projects/reports/homeworks	**28**
3.2.4. Exams	**4**
3.2.5. Other activities	**0**

3.3. Total hours of individual study	**90**
3.4. Total hours per semester	**150**
3.5. ECTS	**6**

4. Prerequisites (if necessary)

4.1. curriculum	Equations of mathematical physics, Electricity, Atomic physics, Nuclear physics, Optics, Quantum physics, Statistical physics, Detectors Fundamentals
4.2. competences	Physical data processing and numerical methods

5. Conditions/Infrastructure (if necessary)

5.1. for lecture	Classroom (preferably, but not required, multimedia facilities)
5.2. for practicals/tutorials	Experimental setups from the Laboratory of Nuclear Physics, the Laboratory of Nuclear Spectroscopy and Detectors

6. Specific competences acquired

Professional competences	• Identification and proper use of the main laws and principles of physics in a given context; identification and use of notions • Solving physics problems under imposed conditions • Creatively applying the knowledge acquired in order to understand and model the processes and physical properties • Communication and analysis of information of a didactic, scientific and popular character in the field of physics • Use / development of specific software tools
Transversal competences	• Efficient use of information sources and resources for communication and training, including in a language of international circulation • Carrying out professional tasks in an efficient and responsible manner, in compliance with the legislation, ethics and deontology specific to the field.

7. Course objectives

7.1. General objective	Experimental techniques for detector characterization; Advanced studies of detector classes specific for particle physics; Electronic signal mapping of particle detection;
7.2. Specific objectives	Understanding correlations and particle reconstruction in physics of multi-detector assemblies.

8. Contents

8.1. Lecture [chapters]	Teaching techniques	Observations
1)Physical characterization and Main Physical Parameters for specific detector classes in particle physics: Sensitivity, Detector Response, Energy Resolution. The Fano Factor. Detector Efficiency, etc..	Systematic presentation - lecture. Examples	4 hours
2) Introduction in Data Acquisition Systems (DAQ) Electronics for data acquisition in particle physics, electronic logic for experiments	Systematic presentation - lecture. Examples	4 hours
3) Pulse signal processing Signal shaping, amplification, digitization, time and amplitude measurement, noise reduction, Pattern Recognition and Event Reconstruction	Systematic presentation - lecture. Examples	4 hours
4) Methods and data analysis for detectors characterization in particle physics Detector Response Measurement, Noise Analysis, Calibration Techniques, Environmental Effects, Data Analysis Methods, Test Beam and Source Studies, Visualization and Reporting	Systematic presentation - lecture. Examples	8 hours
5) Multi-detector assemblies Purpose and Advantages, Types of Multi-Detector Assemblies, Configuration Approaches, Data Analysis in Multi-Detector Assemblies, Applications and Challenges	Systematic presentation - lecture. Examples	8 hours
Bibliography: 1) G.F. Knoll, Radiation Detection and Measurement, Wiley, 2000 2) W.R.Leo, Techniques for Nuclear and Particle Physics Experiments, (Springer-Verlag, Berlin, 1987 and 2003).		

3) C. Grupen, B. A. Swartz, Particle Detectors, Cambridge University Press 2008 4) Claus Grupen, Astroparticle Physics, Springer-Verlag Berlin Heidelberg 2005 5) Particle Data Group, http://pdg.lbl.gov		
8.2. Tutorials [main themes]	Teaching and learning techniques	Observations
Numerical applications and simulations for particle physics detectors		4 h
8.3. Practicals [practical activities, projects, etc.]	Teaching and learning techniques	Observations
1. Monte Carlo Simulation of a basic detector.. 2. Experimental data acquisition chain of a basic detector. 3. Trigger systems and signal pulse processing. 4. Data analysis of experimental data.	Guided work	8 h 8 h 6 h 6 h
Bibliography: Îndrumar de laborator – format electronic		

9. Compatibility of the course unit contents with the expectations of the representatives of epistemic communities, professional associations and employers (in the field of the study program)

This course unit develops some theoretical competences, which are fundamental for a Master student in the field of high energy physics, corresponding to national and international standards. The contents is in line with the requirement of the main employers of research institutes and universities.

10. Assessment

Activity type	10.1. Assessment criteria	10.2. Assessment methods	10.3. Weight in final mark
10.4. Lecture	- coherence and clarity of exposition - correct use of equations/mathematical methods/physical models and theories - ability to indicate/analyse specific examples	Oral examination	70%
10.5.1. Tutorials	- ability to use specific problem solving methods - ability to analyse the results	Homeworks/writen tests	10%
10.5.2. Practicals	- ability to use specific experimental methods/apparatus - ability to perform/design specific experiments - ability to present and discuss the results	Lab reports	20%

10.5.3. Project [only if included in syllabus]			
10.6. Minimal requirements for passing the exam Correct understanding of the concepts and phenomena, the ability to work with them and obtain accurate numerical results on topics imposed.			
Requirements for mark 5 (10 points scale) • Carrying out all the activities during the semester • Obtaining note 5 by summing the points obtained at the activities during the course and examination, according to the weights specified			

Practicals/Tutorials instructor(s)

Teacher's name and signature

Date
05.09.2024

Dr. Gabriel Stoicea
Dr. Dorel Pietreanu

Dr. Gabriel Stoicea
Dr. Dorel Pietreanu

Date of approval

Head of Department
Lect. Dr. Roxana Zus