Study plan

Name of study plan: Nuclear and Particle Physics

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Nuclear and Particle Physics

Type of study: Follow-up master full-time

Required credits: 0

Elective courses credits: 120 Sum of credits in the plan: 120 Note on the plan: P_J FN #

Name of the block: Compulsory courses in the program

Minimal number of credits of the block: 0

The role of the block: P

Code of the group: NMSPJCF1

Name of the group: MDP P_J FN 1st year

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 10 courses

Credits in the group: 0

Note on the group:

Studenti povinně absolvují alespoň jednu skupinu předmětů E, I nebo T

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
02KTPA1	Quantum Field Theory 1 Václav Zatloukal Václav Zatloukal Martin Štefa ák (Gar.)	Z,ZK	8	4P+2C	Z	Р
02KTPA2	Quantum Field Theory 2 Petr Jizba Václav Zatloukal Martin Štefa ák (Gar.)	Z,ZK	8	4P+2C	L	Р
02MTD	Modern Detectors Jaroslav Adam Jaroslav Adam (Gar.)	ZK	2	2P+0C	Z	Р
02SE1	Seminar 1 Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	3	3S	Z	Р
02SE2	Seminar 2 Jaroslav Biel ík Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	3	3S	L	Р
02SZD1	Statistical Data Analysis 1 Miroslav Myška Miroslav Myška (Gar.)	Z,ZK	4	2P+2C	Z	Р
02SZD2	Statistical Data Analysis 2 Miroslav Myška Miroslav Myška (Gar.)	Z,ZK	4	2P+2C	L	Р
02SDSD	Detector Systems and Data Acquisition Michal Broz Martin Štefa ák Michal Broz (Gar.)	ZK	2	2P+0C	L	Р
02VUJC1	Research Project 1 Jaroslav Biel ik Jaroslav Biel ik (Gar.)	Z	6	6C	Z	Р
02VUJC2	Research Project 2 Martin Štefa ák, Jaroslav Biel ík, Michal Broz, Miroslav Kr s, Petr Chaloupka, Dominika Mašlárová, Boris Tomášik, Jakub Vícha, Solangel Rojas Torres, Jaroslav Biel ík Jaroslav Biel ík (Gar.)	KZ	8	8C	L	Р

Characteristics of the courses of this group of Study Plan: Code=NMSPJCF1 Name=MDP P_J FN 1st year

02KTPA1	Quantum Field Theory 1	Z,ZK	8			
The lecture aims to intro	The lecture aims to introduce the students to both fundamental and applied parts of quantum field theory. The focus is in particular on equations of relativistic quantum mechanisms					
canonical quantization	of scalar and bispinor field, perturbation theory (Feynmans rules) and basics of renormalization. The content of the lecture car	n serve as a base	for further study			
in fields of exactly solva	ble models, theory of critical phenomena, molecular chemistry and biochemistry or quantum gravity.					
02KTPA2	Quantum Field Theory 2	Z,ZK	8			
The lecture aims at intre	oducing the students to the Feynmans functional integral and its applications. The focus is on broadening the knowledge of m	odern parts of re	lativistic and			
non-relativistic quantum	n field theory and statistical physics. The content of the lecture can serve as a base for further study in fields of exactly solvab	le models, theory	of critical			
phenomena, molecular	chemistry and biochemistry or quantum gravity.					
02MTD	Modern Detectors	ZK	2			
Lectures will cover all ty	ectures will cover all types of detectors used in modern nuclear and particle physics. Topics include principles of construction of particular types of detectors, materials used for the					
construction, ways of us	onstruction, ways of using and constrains. Emphasis is given also to electronic detector control and voltage suppliers.					

02SE1 Seminar 1 The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics. 02SE2 Seminar 2 3 The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics The course is primarily focused on practical application of methods of experimental data analysis. Students obtain knowledge of different statistical methods and their usage, fitting methods, and testing of hypothesis. The course quickly recapitulates basis of mathematical probability theory but it is recommended to attend a full course of the mathematical probability. 02SZD2 Statistical Data Analysis 2 Individual students work will include implementation and testing of a program for analysis of generated data sample. Background understanding of Monte Carlo generators for hadron collision will be explained. The course covers methods of data smearing and subsequent deconvolution of data. Basics understanding and usage of neural networks and machine learning will be covered. 02SDSD **Detector Systems and Data Acquisition** The goal of the lecture is to present knowledge of modern detector systems. We will concentrate on the aspects of construction and usage for charged-particle tracking, momentum and energy measurement as well as particle identification via various methods from time-of-flight to transition radiation. The lecture will cover also the topic of signal shaping and processing, digitalization, data acquisition and further data processing at the modern collider experiments. Research Project 1 The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions

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ΚZ

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Code of the group: NMSPJCF2

Name of the group: MDP P_J FN 2nd year

Research Project 2

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 6 courses

Credits in the group: 0 Note on the group:

regular meetings and discussions.

02VUJC2

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
02DPJC1	Master Thesis 1 Jaroslav Biel ik Jaroslav Biel ik (Gar.)	Z	10	10C	Z	Р
02DPJC2	Master Thesis 2 Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	20	20C	L	Р
02SE3	Seminar 3 Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	3	3S	Z	Р
02SE4	Seminar 4 Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	3	3S	L	Р
02ZQCD	Quantum Chromodynamics Jana Biel íková Jan epila Jana Biel íková (Gar.)	Z,ZK	6	3+2	Z	Р
02ZELW	Introduction to Theory of Electroweak Interactions	Z,ZK	6	3P+2C	Z	Р

the topics covered in the lectures (such as first measurements of W and Z gauge bosons, Higgs boson discovery) are envisioned.

02DPJC1	Master Thesis 1	Z	10
The master thesis is	based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the	project supervisor	during commor
regular meetings an	d discussions.		
02DPJC2	Master Thesis 2	Z	20
The master thesis is	based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the	project supervisor	during commor
regular meetings an	d discussions.		
02SE3	Seminar 3	Z	3
The aim of the semi	nar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the field	ds of particle physic	cs studied in
	nar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the field diploma theses of their colleagues. Participants will be informed about recent results in particle physics.	ds of particle physic	cs studied in
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research tasks and of 02SE4 The aim of the semi research tasks and of 02ZQCD The goal of these led structure in deep ine in high energy physion 02ZELW	diploma theses of their colleagues. Participants will be informed about recent results in particle physics. Seminar 4 nar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the field diploma theses of their colleagues. Participants will be informed about recent results in particle physics. Quantum Chromodynamics ctures is to acquire knowledge about basic principles of strong interaction starting from the constituent quark model and SU(3) flatastic scattering of leptons on nucleons and parton model to basics of Quantum Chromodynamics and its practical applications in cas and physics of ultra-relativistic heavy-ion collisions.	Z ds of particle physic Z,ZK avour symmetry, steether context of currents Z,ZK	3 cs studied in 6 udies of nucleorent experiments

Name of the block: Compulsory elective courses

Minimal number of credits of the block: 0

The role of the block: PV

Code of the group: NMSPJCFSE

Name of the group: MDP P_J FN group E experimental

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 2 courses

Credits in the group: 0

Note on the group:

Studenti povinně absolvují alespoň jednu skupinu předmětů E, I nebo T

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
02FUJS	Physics of Ultrarelativistic Nuclear Collisions Oliver Matonoha Jaroslav Biel ík Katarína K ížková Gajdošová (Gar.)	ZK	2	2P+0C	L	PV
02VPJRS	Selected topics from relativistic nucleus-nucleus collisions Barbara Antonina Trzeciak Martin Štefa ák Barbara Antonina Trzeciak (Gar.)	Z,ZK	3	2P+1C	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFSE Name=MDP P_J FN group E experimental

02FUJS Physics of Ultrarelativistic Nuclear Collisions ZK 2
The goal of this subject is to introduce students the principles of physics of heavy-ion collisions at large energies. Students will gain insight into phases of a nuclear collision, properties of the created matter (quark-gluon plasma (QGP)), probes which contain information about the QGP and other phases of the collision, and knowledge that these signals brought to us based on the recent measurements at present experiments.

02VPJRS Selected topics from relativistic nucleus-nucleus collisions

Z,ZK

3

The aim of the lecture is to discuss in more depth the physics of the extreme state of the nuclear matter created in relativistic nucleus-nucleus collisions. The course will cover selected topics from the physics of relativistic nucleus-nucleus collisions. The focus will be put on thermodynamic and statistical physics applications to the high-energy nuclear collisions, as well as the medium description using a hydrodynamic approach. Moreover, the in-medium parton energy loss and a related concept of the jet quenching will be discussed. The course will be complemented with computational exercises.

Code of the group: NMSPJCFSI

Name of the group: MDP P_J FN group I Instrumental

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 2 courses

Credits in the group: 0

Note on the group:

Studenti povinně absolvují alespoň jednu skupinu předmětů E, I nebo T

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
02UC1	Particles Accelerators 1 Miroslav Kr s Miroslav Kr s (Gar.)	ZK	2	2P+0C	Z	PV
02UC2	Particle Accelerators 2 Miroslav Kr s Miroslav Kr s (Gar.)	ZK	2	2+0		PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFSI Name=MDP P_J FN group I Instrumental

02UC1	Particles Accelerators 1	ZK	2
Introduction to physics a	and technology of classical (electrostatic and radiofrequency) particle accelerators.		
02UC2	Particle Accelerators 2	ZK	2
Introduction to physics a	and technology of modern and next generation accelerators based on laser and plasma technology.		

Code of the group: NMSPJCFST

Name of the group: MDP P J FN group T Theoretical

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 1 course

Credits in the group: 0

Note on the group: Studenti povinně absolvují alespoň jednu skupinu předmětů E. I nebo T

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Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
02GTR	General Theory of Relativity Boris Tomášik Boris Tomášik Boris Tomášik (Gar.)	Z,ZK	4	2P+2C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFST Name=MDP P_J FN group T Theoretical

02GTR General Theory of Relativity

The goal is to learn the basics of General Relativity theory as well as its applications, mainly in cosmology. The students will get acquainted with the starting points of General Relativity. The course includes the explanation of necessary mathematics: differential geometry. Classic results are derived, like the precession of Mercury, gravitational frequency shift and gravitational bending of light. The participants learn about Schwarzschild metrics and its solution leading to black holes. In the application part the Friedman-Robertson-Walker metrics is introduced and dynamics of the Universe is discussed.

Name of the block: Elective courses Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSPJCFV

Name of the group: MDP P_J FN Optional courses

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the (Name of the course / Name of the group of courses					
Code	(in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
02AQCD	Tutors, authors and guarantors (gar.) Applied Quantum Chromodynamics at High Energies	ZK	2	2+0		
UZAQCD	Ján Nem ík Ján Nem ík Ján Nem ík (Gar.)	ZN		2+0		V
02ACF1	Astroparticle physics 1 Jakub Vícha Jakub Vícha (Gar.)	ZK	2	2P+0C	Z	V
02ACF2	Astroparticle physics 2 Jakub Vícha Jakub Vícha (Gar.)	ZK	2	2P+0C	L	V
01DAS	Data science Ji í Franc Ji í Franc (Gar.)	KZ	3	1P+2C		V
02EPM	Electromagnetic production of mesons	ZK	3	2P+0C	L	V
02EXSH	Extreme States of Matter Michal Šumbera Jaroslav Biel ík Jaroslav Biel ík (Gar.)	ZK	2	2P+0C	Z	V
02FAJ	Physics of Atomic Nuclei Ji í Adam, Petr Veselý Ji í Adam Ji í Adam (Gar.)	ZK	4	4+0	L	V
02BSM	Physics beyond the Standard Model Zden k Hubá ek Zden k Hubá ek (Gar.)	Z	2	2P+0C	Z	V
02JSP	Nuclear Spectroscopy Vladimír Wagner Martin Štefa ák Vladimír Wagner (Gar.)	Z,ZK	5	2+2	L	V
02KMP	Quantum Many-Body Problem in the Theory of Atomic Nuclei Petr Veselý Martin Štefa ák Petr Veselý (Gar.)	ZK	2	2P+0C	Z	V
04MGA1	English for Academic Purposes Speaking Practice - intermediate Darren Copeland Darren Copeland (Gar.)	Z	2	0+2	L,Z	V
04MGA2	Academic English Writing and Presentation Course - intermadiate Darren Copeland (Gar.)	Z	2	0+2	L,Z	V
02MAT	Materials for Experimental Nuclear Physics Libor Škoda Martin Štefa ák Libor Škoda (Gar.)	ZK	2	2+0		V
18MEMC	Monte Carlo Method Jaromír Kukal, Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	Z	V
01NSN	Neural Networks, Machine Learning, and Randomness	Z,ZK	2	1P+1C		V
1800P	Object Oriented Programming Miroslav Virius Miroslav Virius (Gar.)	Z	2	2C	Z	V
02LPA	Particle plasma accelerators Miroslav Kr s Miroslav Kr s Miroslav Kr s (Gar.)	ZK	2	2P+0C	L	V
17PRE	Computer Control of Experiments Martin Kropík Martin Kropík Martin Kropík (Gar.)	Z,ZK	3	2+1	Z	V
02REP	Matrix Lie group representations Lenka Motlochová Lenka Motlochová (Gar.)	Z	2	2+0	Z	V
02ROZ3	Seminar on Quark-Gluon Plasma 3 Jaroslav Biel ík Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	2	2P+0C	Z	V
02ROZ4	Seminar on Quark-Gluon Plasma 4 Jaroslav Biel ík, Boris Tomášik, Jana Biel íková Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	2	2P+0C	L	V
02ROZ5	Seminar on Quark-Gluon Plasma 5 Jaroslav Biel ík Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	2	2P+0C	Z	V
02ROZ6	Seminar on Quark-Gluon Plasma 6 Jaroslav Biel ík, Boris Tomášik, Jana Biel íková Jaroslav Biel ík Jaroslav Biel ík (Gar.)	Z	2	2P+0C	L	V
02SPRA1	Special Practicum 1 Jan epila Jan epila (Gar.)	KZ	6	0+4	Z	V

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DERPER Selected policies from probability theory for physicists Z 2 2 2PHOC Z V O2VS2 Workshop 3 O2VS3 Workshop 3 Devositor bis in American Michael Sumbers Michael Sumbers (Michael Sumbers (D2PRF Selected topics from probability theory for physicists Michal Sumbera Michal Sumbera Michal Sumbera (Gar.) Workshop 2 Jaroslav Biel lik Jaroslav Biel lik Jaroslav Biel lik (Gar.) Characteristics of the courses of this group of Study Plan: Code=NMSPJCFV Name=M D2AQCD Applied Quantum Chromodynamics at High Energies This lecture is oriented to provide basic applications of quantum chromodynamicks that corresponds to understanding on proton and nuclear targets that are currently measured by experiments at RHIC and LHC colliders. Complementary will be provided. D2ACF1 Astroparticle physics 1 Outline of the lecture: 1. History of astroparticle physics 2. Introduction to astronomy (scales, observation windows, type the cosmic radiation (properties, spectral index, age) 4. Direct detection of cosmic radiation (experiments, findings) 5. S superposition model) 6. Composition of cosmic radiation (types of measurements, results, open problems) 7. Spreadir (interaction, magnetic fields) 8. Sources of cosmic radiation (exotic sources, acceleration mechanisms) 9. Indirect detection of showers of cosmic radiation (fluorescence and cherenkov techniques, reconstruction) 11. Surface detection of 2ACF2 Astroparticle physics 2 Outline of the lecture: 1. Detection of neutral particles in the cosmic radiation (accelerators, tomography) 4. Models of Cascade equation, simulation of showers of cosmic radiation (derivation, algorithms) 6. Hands-on public astroparticle universe (introduction to cosmology, relict radiation) 8. Nuclear processes in stars (nuclear synthesis, creation of neutral particles) D1DAS Data science	Z Z Z Z IDP P_J F of the dynamic of informations to the dynamic of the dynamic of of the dynamic of of the dynamic of of the dynamic of of objects, thowers of cosm of of cosmic rate of of cosmic of showers of cosmic of showers of cosmic of showers of cosmic of data (fits data, rinos, final stag	2 1 1 N Optionals of processes to lectures of contemporary mic radiation and g c radiation (expensive radiation for showers of actions (Glaul Auger and K	2P+0C 7D 7D 7D 8I course	Z Z Z Z SS K e physics at uantum chr K 3. Energy Heitler-Ma through the overview) detectors, re K kilation (Aska	V V V V V at high energies romodynamics 2 spectrum of atthews model, e space 10. Optical reconstruction)
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An introduction to the electromagnetic production of mesons, with emphasis on the process of photoproduction. Introducing basic concepts and importand aspects of the models (with emphasis on models based on effective Lagrangians) for understanding the topic. OZEXSH Extreme States of Matter Lectures will provide basics in states of matter in extreme conditions, it deals with broad spectra of phenomena from electromagnetic plasma through phases of nuclear matter at high temperatures or densities to highly speculative forms of matter that may be responsible for initially accelerated expansion of the Universe in its early stages (inflation) or for its current acceleration (dark energy). Lectures may also serve as a brief introduction to parts of modern cosmology connected to nuclear and particle physics. OZFAJ Physics of Atomic Nuclear Nucleon-nucleon(NN) interaction, few-body systems, G matrix, nuclear properties, nuclear models (single-particle model, collective motion, Hartree-Fock approximation, TDA method, RPA method, pairing, quasi-particles, nuclear deformations), electromagnetic and weak processes in nuclei, nuclear reactions (kinematics and mechanisms of nuclear reactions) OZBSM Physics is one of the most successful physical theories. It describes the elementary particles which form the matter and their electromagnetic, weak and strong interactions. It is however an incomplete theory and there are several questions where the new physics beyond the Standard model could be found. OZJSP Nuclear Spectroscopy Nuclear spectroscopy comprises several experimental techniques which are of ultimate importance for experimental nuclear physics and various applications as well. Lecture will be devoted to fundamentals of X- and gamma- ray, charged particle and neutron spectroscopy. OZKMP Quantum Many-Body Problem in the Theory of Atomic Nuclei Nuclear spectroscopy comprises several experimental techniques which are of ultimate importance for experimental nuclear physics and various applications as well. Lecture						
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1800P	Object Oriented Programming	Z	2
This course consist	ts of the contributions of students concerning given topics concerned on technologies uded in program development.		
02LPA	Particle plasma accelerators	ZK	2
	iser physics and technology, CPA systems 2. Physics of plasma and plasma wave generation 3. Plasma instabilities, beam-p		
	ds of beam injection to plasma wave 6. Ultrashort particle bunch generation 7. Dynamics of bunch in plasma wave 8. Plasma	-	
-	na waveguides 10. Plasma charged particle optics 11. Ultrashort bunch diagnostics 12. Handling and transport of ultrashort	bunches 13. Applicatio	n of ultrashort
bunches			
17PRE	Computer Control of Experiments	Z,ZK	3
-	formation about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about sta		
· ·	serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their a	-	-
-	rogramming of measuring systems - special dedicated software, problems of use of high programming languages and especiall	· · ·	ted developme
	ane LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition and e		т
02REP	Matrix Lie group representations	Z	2
	mmetric group, homomorphism, isomorphism, group action, direct product, semidirect product, normal group, simple and ser		
	(n), Lorentz group, Poincaré group. 2.One-parameter group, Lie algebras, Lie group Lie algebra correspondence, exponentia	="	
	O(3) and SU(2). 4.Representation theory, unitary representation, regular representation, equivalent representation, irreducib	• • • • • • • • • • • • • • • • • • • •	
_	bra representation and their connection to Lie group representation, projective representation. 6.Irreducible representations o		_
	resentation. 7.Finite-dimensional representations of Lorentz group, tensor product of representations. 8.Representations of S	SU(3), Gell-Mann matri	ces, weights an
roots. 9. Young table			
02ROZ3	Seminar on Quark-Gluon Plasma 3	Z	2
	theoretical work related to problems of quark-gluon plasma. Students participate on the seminar by preparing the presentat	tion about selected par	
02ROZ4	Seminar on Quark-Gluon Plasma 4	Z	2
Seminar about rece	ent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presenta	tion about selected pa	
02ROZ5	Seminar on Quark-Gluon Plasma 5	Z	2
Seminar about rece	ent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presenta	tion about selected pa	pers.
02ROZ6	Seminar on Quark-Gluon Plasma 6	Z	2
Seminar about rece	ent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presenta	ation about selected pa	pers.
02SPRA1	Special Practicum 1	KZ	6
Physics measurem	ent focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are o	chosen so that student	s can familiarize
with advanced pats	s of experimental physics and metrology.		
02SPRA2	Special Practicum 2	KZ	6
Physics measurem	ent focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are o	chosen so that student	s can familiariz
with advanced pats	s of experimental physics and metrology.		
01SUP	Start-up Project	KZ	2
02AST	Introduction to Astrophysics	ZK	3
-	rse is to offer students an engaging introduction to the fascinating world of astrophysics. They will gain a basic understanding	l	universe, stella
	ore intriguing intersections between nuclear physics and astrophysics.	,	
02PRF	Selected topics from probability theory for physicists	Z	2
-	nuous probability distributions (Binomial, Poisson, negative binomial, normal, etc.) as well as the processes that lead to their		l
	d economics. The impetus for the further expansion of these divisions in the 20th century was their application to the description		-
	and the spread of infectious diseases. The generalization of the properties of these distributions has later on led to the disco		-
infinitely divisible ar	nd stable distributions, which are currently widely used in physics and finance.	•	
02VS2	Workshop 2	Z	1
	will participate on annual Workshop J F, where they will present results obtained during the work on their bachelor thesis. Do	1	· ·
Abstract: Students		0 1	
	also get familiar with scientific topics developed at the department and with methods other colleagues use for their scientific	WORK	
and staff, they will a			1
and staff, they will a	also get familiar with scientific topics developed at the department and with methods other colleagues use for their scientific Workshop 3 will participate on annual Workshop J F, where they will present results obtained during the work on their bachelor thesis. Do	Z	1 ns from studen

List of courses of this pass:

Code	Name of the course	Completion	Credits				
01DAS	Data science	KZ	3				
Practical application of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection to design							
method and its d	method and its division into units for development and implementation into the production. Last, but not least, the cooperation in group and management of a modern data projection.						
crucial. The actua	standard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an emphasis	on team collabora	tion, project				
	planning. At the end of the course, students will present their results to other teams.						
01NSN	Neural Networks, Machine Learning, and Randomness	Z,ZK	2				
	Keywords: Neural networks, data separation, functional approximation, supervised learning		'				
01SUP	Start-up Project	KZ	2				
02ACF1	Astroparticle physics 1	ZK	2				
1 0 00 10 1							

Outline of the lecture: 1. History of astroparticle physics 2. Introduction to astronomy (scales, observation windows, types of objects, contemporary problems) 3. Energy spectrum of the cosmic radiation (properties, spectral index, age) 4. Direct detection of cosmic radiation (experiments, findings) 5. Showers of cosmic radiation (expansion, Heitler-Matthews model, superposition model) 6. Composition of cosmic radiation (types of measurements, results, open problems) 7. Spreading of cosmic radiation and gamma rays through the space (interaction, magnetic fields) 8. Sources of cosmic radiation (exotic sources, acceleration mechanisms) 9. Indirect detection of cosmic radiation (experiments, overview) 10. Optical

detection of showers of cosmic radiation (fluorescence and cherenkov techniques, reconstruction) 11. Surface detection of showers of cosmic radiation (type 12. Detection of gamma rays (principles, experiments)	es of detectors, reco	onstruction)
02ACF2 Astroparticle physics 2	ZK	2
Outline of the lecture: 1. Detection of neutral particles in the cosmic radiation data (neutrons, photons, neutrinos) 2. Radio detection of showers of cosmic		
experiments) 3. Detection and use of secondary mions from cosmic radiation (accelerators, tomography) 4. Models of hadronic interactions (Glaubers m Cascade equation, simulation of showers of cosmic radiation (derivation, algorithms) 6. Hands-on public astroparticle data (fits data, Auger and KASCA		
universe (introduction to cosmology, relict radiation) 8. Nuclear processes in stars (nuclear synthesis, creation of neutrinos, final stages of stars) 9. Dete		
experiments, proton decay, double beta decay) 10. Detection of gravitational waves (principles, experiments) 11. Dark matter (theory, experiments) 12. Matter (theory, experiments) 13. Matter (theory, experiments) 14. Matter (theory, experiments) 14. Matter (theory, experiments) 15. Matter (theory, experiments) 16. Matter (theory, experiments) 17. Matter (theory, experiments) 18. Matter (theory		-
between detection of neutral and charged particles)		
02AQCD Applied Quantum Chromodynamics at High Energies	ZK	. 2
This lecture is oriented to provide basic applications of quantum chromodynamicks that corresponds to understanding of the dynamics of processes in part on proton and nuclear targets that are currently measured by experiments at RHIC and LHC colliders. Complementary informations to lectures of Basics		
will be provided.	or quartum omon	odynamico
02AST Introduction to Astrophysics	ZK	3
The aim of the course is to offer students an engaging introduction to the fascinating world of astrophysics. They will gain a basic understanding of the st	tructure of the unive	erse, stellar
evolution, and explore intriguing intersections between nuclear physics and astrophysics.		
02BSM Physics beyond the Standard Model	Z	2
Standard model of particle physics is one of the most succesful physical theories. It describes the elementary particles which form the matter and thei strong interactions. It is however an incomplete theory and there are several questions which it can not answer. The goal of the lecture is to review the n	_	
model and show potential directions where the new physics beyond the Standard model could be found.	oog poe a	o tanaan a
02DPJC1 Master Thesis 1	Z	10
The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project	ect supervisor durir	ng common
regular meetings and discussions.		
02DPJC2 Master Thesis 2 The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project.	Z Z	20
regular meetings and discussions.	ect supervisor dum	ig common
02EPM Electromagnetic production of mesons	ZK	3
An introduction to the electromagnetic production of mesons, with emphasis on the process of photoproduction. Introducing basic concepts and important	l l	odels (with
emphasis on models based on effective Lagrangians) for understanding the topic.		
02EXSH Extreme States of Matter	ZK	2
Lectures will provide basics in states of matter in extreme conditions. It deals with broad spectra of phenomena from electromagnetic plasma through through the phenomena from electromagnetic plasma through through the phenomena from electromagnetic plasma through through the phenomena from electromagnetic plasma through the phenomena from electromagnetic plasma through the phenomena from electromagnetic plasma through through the phenomena from electromagnetic plasma through t		-
temperatures or densities to highly speculative forms of matter that may be responsible for initially accelerated expansion of the Universe in its early stage acceleration (dark energy). Lectures may also serve as a brief introduction to parts of modern cosmology connected to nuclear and parts.		its current
02FAJ Physics of Atomic Nuclei	ZK	4
Nucleon-nucleon(NN) interaction, few-body systems, G matrix, nuclear properties, nuclear models (single-particle model, collective motion, Hartree-Fool	k approximation, TI	DA method,
RPA method, pairing, quasi-particles, nuclear deformations), electromagnetic and weak processes in nuclei, nuclear reactions (kinematics and mecha	anisms of nuclear re	eactions)
02FUJS Physics of Ultrarelativistic Nuclear Collisions	ZK	2
The goal of this subject is to introduce students the principles of physics of heavy-ion collisions at large energies. Students will gain insight into phases of the created matter (quark-gluon plasma (QGP)), prohes which contain information about the QGP and other phases of the collision, and knowledge the		
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02PRF	Selected topics from probability theory for physicists	Z	2			
Discrete and contin	nuous probability distributions (Binomial, Poisson, negative binomial, normal, etc.) as well as the processes that lead to their origin ha	ive long played a m	najor role in			
physics, biology and economics. The impetus for the further expansion of these divisions in the 20th century was their application to the description of neutron cascades, multiple						
	and the spread of infectious diseases. The generalization of the properties of these distributions has later on led to the discovery of					
	infinitely divisible and stable distributions, which are currently widely used in physics and finance.					
02REP	Matrix Lie group representations	Z	2			
1 Group theory syr	nmetric group, homomorphism, isomorphism, group action, direct product, semidirect product, normal group, simple and semisimple	aroup factor arour	matrix Lie			
	U(n), Lorentz group, Poincaré group. 2.One-parameter group, Lie algebras, Lie group Lie algebra correspondence, exponential map.		'			
relation between SO	O(3) and SU(2). 4.Representation theory, unitary representation, regular representation, equivalent representation, irreducibility, redu	cibility, Schur`s lem	ıma, Weyl`s			
theorem. 5.Lie algel	bra representation and their connection to Lie group representation, projective representation. 6.Irreducible representations of SO(3) a	nd SU(2), raising a	nd lowering			
operators, spin repr	resentation. 7.Finite-dimensional representations of Lorentz group, tensor product of representations. 8.Representations of SU(3), Ge	II-Mann matrices.	weights and			
		,				
	roots. 9. Young tableaux.					
02ROZ3	Seminar on Quark-Gluon Plasma 3	Z	2			
	s with theoretical work related to problems of quark-gluon plasma. Students participate on the seminar by preparing the presentation	about selected pa	pers.			
02ROZ4	Seminar on Quark-Gluon Plasma 4	Z	2			
Seminar abou	at recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation	n about selected pa	apers.			
02ROZ5	Seminar on Quark-Gluon Plasma 5	7	2			
		_				
Seminar abou	at recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation	n about selected pa	apers.			
02ROZ6	Seminar on Quark-Gluon Plasma 6	7	2			
		_				
	t recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation	· · · · · · · · · · · · · · · · · · ·	apers.			
02SDSD	Detector Systems and Data Acquisition	ZK	2			
The goal of the led	ture is to present knowledge of modern detector systems. We will concentrate on the aspects of construction and usage for charged	-narticle tracking r	nomentum			
•	surement as well as particle identification via various methods from time-of-flight to transition radiation. The lecture will cover also the					
and energy meas	·	topic of signal sna	iping and			
	processing, digitalization, data acquisition and further data processing at the modern collider experiments.					
02SE1	Seminar 1	7	3			
		_				
The aim of the se	minar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields		studied in			
	research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics	. .				
02SE2	Seminar 2	7	3			
		_ ,				
ine aim of the se	minar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields		studied in			
	research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics	. .				
02SE3	Seminar 3	Z	3			
ine aim of the se	minar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields		studied in			
	research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics	i.				
02SE4	Seminar 4	7	3			
		_				
ine aim of the se	minar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields		studied in			
	research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics	i.				
02SPRA1	Special Practicum 1	KZ	6			
	·		_			
Physics measurem	ent focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen s	o that students can	i tamiliarize			
	with advanced pats of experimental physics and metrology.					
02SPRA2	Special Practicum 2	KZ	6			
	·		-			
Physics measurem	ent focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen s	o that students can	i familiarize			
	with advanced pats of experimental physics and metrology.					
02SZD1	Statistical Data Analysis 1	Z,ZK	4			
	,					
The course is prin	narily focused on practical application of methods of experimental data analysis. Students obtain knowledge of different statistical me	thods and their usa	age, fitting			
methods, and testin	g of hypothesis. The course quickly recapitulates basis of mathematical probability theory but it is recommended to attend a full course of	of the mathematical	probability.			
0287D2	Statistical Data Analysis 2	7 7V	4			
02SZD2		Z,ZK				
Individual students	work will include implementation and testing of a program for analysis of generated data sample. Background understanding of Montager and the sample in the sample in the sample in the sample is a sample in the sample in the sample is a sample in the sample in the sample is a sample in the sample in the sample is a sample in the sample in the sample is a sample in the sample in the sample in the sample is a sample in the sa	e Carlo generators	for hadron			
collision will be ex	xplained. The course covers methods of data smearing and subsequent deconvolution of data. Basics understanding and usage of n	aural networks and	machine			
	learning will be covered.					
001104		71/	$\overline{}$			
02UC1	Particles Accelerators 1	ZK	2			
	Introduction to physics and technology of classical (electrostatic and radiofrequency) particle accelerators.					
02UC2	Particle Accelerators 2	ZK	2			
02002			-			
	Introduction to physics and technology of modern and next generation accelerators based on laser and plasma technology					
02VPJRS	Selected topics from relativistic nucleus-nucleus collisions	Z,ZK	3			
	ure is to discuss in more depth the physics of the extreme state of the nuclear matter created in relativistic nucleus-nucleus collisions.	'				
	ysics of relativistic nucleus-nucleus collisions. The focus will be put on thermodynamic and statistical physics applications to the high					
well as the medium	description using a hydrodynamic approach. Moreover, the in-medium parton energy loss and a related concept of the jet quenching	, will be discussed.	The course			
	will be complemented with computational exercises.					
001/00		7				
02VS2	Workshop 2	Z	1			
Abstract: Students	will participate on annual Workshop J F, where they will present results obtained during the work on their bachelor thesis. During othe	er presentations fro	m students			
ar	nd staff, they will also get familiar with scientific topics developed at the department and with methods other colleagues use for their s	cientific work				
			1			
02VS3	Workshop 3	Z	1			
Abstract: Students	will participate on annual Workshop J F, where they will present results obtained during the work on their bachelor thesis. During othe	er presentations fro	m students			
an	d staff, they will also get familiar with scientific topics developed at the department and with methods other colleagues use for their s	cientific work.				
			6			
02VUJC1	Research Project 1	Z	6			
The research project	ct is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the proj	ect supervisor duri	ng common			
	regular meetings and discussions.					
03//11/03		KZ	0			
02VUJC2	Research Project 2	l I	8			
The research project	ct is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the proj	ect supervisor duri	ng common			
	regular meetings and discussions					

02ZELW	Introduction to Theory of Electroweak Interactions	Z,ZK	6
The goal of these	electures is to acquire knowledge about theory of weak interaction from Fermi theory of -decay, introduction of charged intermediate	vector boson to un	ification of
electromagnetic a	ind weak interaction in the framework of Standard model including Higgs mechanism. Short student presentations dedicated to exper	imental discoverie	s related to
	the topics covered in the lectures (such as first measurements of W and Z gauge bosons, Higgs boson discovery) are envisio	ned.	
02ZQCD	Quantum Chromodynamics	Z,ZK	6
The goal of these l	ectures is to acquire knowledge about basic principles of strong interaction starting from the constituent quark model and SU(3) flavou	r symmetry, studie	s of nucleon
structure in deep in	nelastic scattering of leptons on nucleons and parton model to basics of Quantum Chromodynamics and its practical applications in the	context of current	experiments
	in high energy physics and physics of ultra-relativistic heavy-ion collisions.		
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2
Optional course o	ffers Master's Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and sp	eaking skills. Cour	se syllabus
will respor	nd to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-grade	d assessment cou	rse.
04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2
Optional course, a	possible free sequel to course 04MGA1, offers Master's degree students at intermediate level of English a chance to develop, improv	e, and strengthen	their writing
and presentation s	skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on	own research topi	c, a search,
instruction on writ	ing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course	is a non-graded a	ssessment
	course.		
17PRE	Computer Control of Experiments	Z,ZK	3
Lectures provide in	information about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about standalone	equipment that c	ommunicate
with computers vi	a serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their advanta	ges and disadvant	ages. Next,
lectures deal with p	rogramming of measuring systems - special dedicated software, problems of use of high programming languages and especially use of $\mathfrak g$	graphical oriented	development
tools	s (Agilent VEE ane LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition	and evaluation.	
18MEMC	Monte Carlo Method	Z,ZK	4
	This courseis devoted to the numerical method Monte Carlo and to its selected applications.		'
1800P	Object Oriented Programming	Z	2
	This course consists of the contributions of students concerning given topics concerned on technologies uded in program develo	pment.	•

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