

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE  
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE  
“Igor Sikorsky Kyiv Polytechnic Institute”**

APPROVED

By the Academic Council of the Igor  
Sikorsky Kyiv Polytechnic Institute

(Protocol № 6 from 07.09.2020)

Head of the Academic Council

Mykhailo ILCHENKO

**PHYSICS**

**EDUCATIONAL AND SCIENTIFIC  
PROGRAM**

third (doctor of philosophy) level of higher education

<b>in specialty</b>	<b>104 – Physics and astronomy</b>
<b>field of knowledge</b>	<b>10 – Natural sciences</b>
<b>qualification</b>	<b>Doctor of Philosophy in Physics and Astronomy</b>

Validated by the Order of the  
Rector of the Igor Sikorsky Kyiv  
Polytechnic Institute

from 17.09.2020 № 1/282

Kyiv – 2020

## PREAMBLE

### Developed by the project team:

Project team leader

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Professor, Professor of the Department of General and Experimental Physics*

Members of the project team:

***Gorshkov Vyacheslav Mykolayovych**, Doctor of Physical and Mathematical Sciences,  
Professor, Professor of the Department of General Physics and Solid State Physics*

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Corresponding Member of the National Academy of Educational Sciences of Ukraine*

*Head of the Department of General Physics and Solid State Physics*

***Kotovskiy Vitaliy Yosypovych**, Doctor of Technical Sciences, Professor*

### AGREED:

Scientific and methodical commission of the Igor Sikorsky Kyiv Polytechnic Institute in the specialty 104 "Physics and astronomy"

Head of the SMCU-104

**Serhii RESHETNIAK**

(Protocol № 2 from 01.09. 2020)

Methodical council of the Igor Sikorsky Kyiv Polytechnic Institute

Head of the Methodical Council

**Yuriy YAKYMENKO**

(Protocol № 1 from 03.09. 2020)

### INCLUDED:

- proposals of the representatives of the National Academy of Sciences of Ukraine on the amount of 60 ECTS credits of the educational component;
- proposals of representatives of the National Academy of Sciences of Ukraine on counting ECTS credits obtained by postgraduate students in other institutions of Ukraine in the framework of national credit mobility;
- proposals of postgraduate students on counting ECTS credits obtained by postgraduate students in other institutions within the framework of international credit mobility;
- proposals of postgraduate students on the possibility of distance learning in certain educational components.

## **APPROVED:**

ESP was discussed after receiving all the wishes and suggestions from postgraduate students and members of the scientific community and approved at an extended meeting of the Department of General and Experimental Physics and the Department of General Physics and Solid State Physics (Protocol № 1 from 31.08.2020)

## **INCLUDED:**

1. Methodical recommendations of the Higher Education Sector of the Scientific and Methodological Council of the Ministry of Education and Science of Ukraine (Protocol № 7 from February 6, 2020) with changes approved by the Order № 584 of Acting Minister of Education and Science of April 30, 2020  
<https://mon.gov.ua/ua/osvita/visha-osvita/naukovo-metodichna-rada-ministerstva-osviti-i-nauki-ukrayini/metodichni-rekomendaciyi-vo>.
2. Draft Standard of Higher Education in the specialty 104 Physics and astronomy for doctors of philosophy, developed by the Scientific and Methodical Commission of the Scientific and Methodical Council of the Ministry of Education and Science of Ukraine.
3. Comments and suggestions of stakeholders based on the results of public discussion:
  - scientific and pedagogical staff of the Department of General and Experimental Physics and the Department of General Physics and Solid State Physics;
  - applicants for higher education who study in educational programs in the specialty 104 Physics and Astronomy;
  - specialists of the educational and methodical department of Igor Sikorsky KPI;
  - representatives of the academic community and specialists in the field of physics and astronomy.

# 1. PROFILE OF THE EDUCATIONAL PROGRAM IN SPECIALTY 104 PHYSICS AND ASTRONOMY

<b>1 – General information</b>	
Complete name of the Institution of higher education and institute/faculty	National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Faculty of Physics and Mathematics
Degree of higher education and qualification title in the original language	Degree: Doctor of Philosophy (доктор філософії) Qualification: Doctor of Philosophy in Physics and Astronomy (доктор філософії з фізики та астрономії)
Official name of the educational program	Physics
Diploma type and workload of the educational program	Doctor of Philosophy diploma, <u>Educational component</u> 60 ECTS credits, term of study is 4 years. <u>Scientific component</u> : provides for its own research and design of its results in the form of a dissertation.
Наявність акредитації	Not accredited
Cycle/level of higher education	National qualifications framework of Ukraine - level 9 QF-EHEA – the third cycle EQF-LLL – level 8
Prerequisites	The master’s degree
Language of teaching	Ukrainian/English
Term of validity of the educational program	Until the next accreditation
Internet address of the permanent location of the educational program	<a href="https://osvita.kpi.ua/">https://osvita.kpi.ua/</a> , <a href="http://fmf.kpi.ua/">http://fmf.kpi.ua/</a> , <a href="http://zfft.kpi.ua/">http://zfft.kpi.ua/</a> , <a href="https://kzef.kpi.ua/">https://kzef.kpi.ua/</a> section "Educational programs"
<b>2 –Objective of the educational program</b>	
<p>Training of highly qualified competitive physics specialists integrated into the European and world scientific and educational space, who have theoretical knowledge, skills, abilities and competencies sufficient to produce new ideas, solve complex problems in the field of professional and/or research and innovation activity in the field of physics, possessing the methodology of scientific and pedagogical activity, are able to initiate and carry out their own research, the results of which have scientific novelty, theoretical and practical significance, while ensuring:</p> <ul style="list-style-type: none"> <li>- fundamentalization of training according to the physical and technical model, which provides for the synthesis of deep general scientific, natural knowledge and engineering art;</li> <li>- adaptation of specialists to work in the global markets of education, science and innovation.</li> </ul>	
<b>3 – Characteristics of the educational program</b>	
Subject area	<p><i>Object</i>: physical and astronomical objects and processes at all structural levels of the matter organization, starting from elementary particles and up to the entire Universe; the most general laws that describe properties, various forms of motion and structure of matter and build new scientific knowledge.</p> <p><i>Learning objectives</i>: training of specialists capable of carrying out scientific research and solving complex</p>

	<p>problems in physics and/or astronomy, as well as their applications in various fields of science and engineering.</p> <p><i>Theoretical content of the subject area:</i> basic concepts, principles and methods of theoretical and experimental physics, astronomy and astrophysics, their application to solve scientific and applied problems.</p> <p><i>Methods, techniques and technologies:</i> methods of experimental physical and astronomical research, mathematical methods of theoretical physics and astronomy, methods of physical and mathematical modeling of physical systems and processes, methods of computer experiment, methods of statistical processing of experimental results and data analysis.</p> <p><i>Tools and equipment:</i> Scientific instruments for physical and astronomical research and measurements, computers, specialized software.</p>
Orientation of the educational program	Educational and scientific
The main focus of the educational program	The program is based on well-known scientific principles, taking into account the current state of physics, focuses on current specializations in which further professional and scientific career is possible: computer modeling of physical processes, theoretical physics, solid state physics, magnetic physics, nanophysics. Keywords: physics, nanophysics, computer modeling, magnetism, phase transitions.
Features of the program	The implementation of the program involves the involvement of famous scientists in the classroom, the mandatory participation of applicants in international scientific events, mastering the skills of presenting the results of their own research.
<b>4 – Suitability of graduates for employment and further education</b>	
Suitability for employment	<p>According to the State Classificatory of Professions 003:2010:</p> <p>2111 "Professionals in physics and astronomy", 231 "Teachers of universities and higher educational institutions", 1237 "Heads of research departments and departments for scientific and technical preparation of production and other managers", 1437 "Managers in the field of research and development", 148 "Managers in education, health care and social sphere".</p> <p>According to the International Standard Classification of Occupations 2008:</p> <p>211 «Physical and earth science professionals», 231 «University and higher education teachers», 1237 «Manager, research», 1345 «Academic, university: head of department or faculty; Manager, department: education».</p>
Further education	Continuing education in doctoral studies and/or participation in postdoctoral programs.

<b>5 – Teaching and evaluation</b>	
Teaching and learning	General learning style is task-oriented with an emphasis on independent work of applicants. Teaching is carried out in the following forms: lectures, seminars, practical classes, laboratory classes in small groups (up to 8 people), independent work with the possibility of consultation with a teacher, individual lessons, application of information and communication technologies (e-learning, online lectures, distance courses) for individual educational components. The formation of teaching skills and relevant competencies takes place by involving students in teaching certain components of student training courses under the guidance of the supervisor and leading teachers. The scientific component of the educational program is provided with access to the available specialized equipment, advising the applicant by the supervisor and leading scientists of the university. Approbation of research results occurs through participation in seminars, professional conferences, publication of scientific articles.
Evaluation	Current and semester control in the form of reports, presentations, written and oral tests and examinations are evaluated in accordance with certain criteria of the rating system, the defense of the dissertation is in accordance with the requirements of the law. Scientific publications of graduate students and their supervisors must meet the requirements of academic integrity.
<b>6 – Program competencies</b>	
Integral competence	Ability to solve complex problems in the field of professional and/or research and innovation activity in the field of physics, which involves a deep rethinking of existing and the creation of new holistic knowledge and/or professional practice.
General Competences (GC)	<p>GC01. Ability to identify, pose and solve problems of a research nature, to understand their place both in their professional field and among other branches of science and in the cultural space; as well as evaluate and ensure the quality of research work.</p> <p>GC02. Ability to generate new ideas (creativity) and manage research projects, and/or make proposals for research funding, registration of intellectual property rights.</p> <p>GC03. Ability to interpersonal communication, the ability to work in a team, including interdisciplinary.</p> <p>GC04. Ability to adhere to the moral and ethical rules of conduct characteristic of participants in the academic environment, as well as the rules of</p>

	<p>academic integrity in research.</p> <p>GC05. Ability to work in an international context.</p> <p>GC06. Ability to make informed decisions.</p> <p>GC07. Ability to work autonomously.</p>
Professional competencies of the specialty (PC)	<p>PC01. Ability to perform original research, achieve scientific results that create new knowledge in physics and/or astronomy and related interdisciplinary areas and can be published in leading scientific journals in physics (astronomy) and related fields.</p> <p>PC02. Ability to make oral and written presentations of the results of own research in Ukrainian and to apply modern information technologies in scientific and educational activities.</p> <p>PC03. Ability to present and discuss the results of their scientific work in a foreign language orally and in writing, as well as a deep understanding of foreign scientific texts on physics and astronomy.</p> <p>PC04. Possession of methodology of pedagogical and scientific activity in the field of physics.</p> <p>PC05. Ability to create theoretical models of physical processes in accordance with the requirements of the task.</p> <p>PC06. Ability to develop optimal algorithms for computer simulation of physical processes.</p>
<b>7 – Program outcomes of learning</b>	
POL01.	Have advanced conceptual and methodological knowledge in physics and at the frontiers of subject areas, as well as research skills sufficient to conduct scientific and applied research at the level of the latest world achievements in the field, gain new knowledge and/or innovate.
POL02.	Be able to freely present and discuss with specialists and non-specialists the results of research, scientific and applied problems of physics and astronomy in state and foreign languages, qualified to reflect the results of research in scientific publications in leading international scientific journals.
POL03.	Be able to formulate and test hypotheses; use appropriate evidence to substantiate the conclusions, in particular, the results of theoretical analysis, experimental research and mathematical and/or computer modeling, available literature data.
POL04.	Be able to develop and research conceptual, mathematical and computer models of processes and systems, effectively use them to obtain new knowledge and/or create innovative products in physics and related interdisciplinary areas.
POL05.	Be able to plan and perform experimental and/or theoretical research in physics and related interdisciplinary areas using modern tools, critically analyze the results of their own research and the results of other researchers in the context of the whole set of modern knowledge about the problem.
POL06.	Be able to apply modern tools and technologies for information retrieval, processing and analysis, in particular, statistical methods of analysis of large data and/or complex structure, specialized databases and information systems.
POL07.	Be able to develop and implement scientific and/or innovative engineering projects that provide an opportunity to rethink existing and create new holistic knowledge and/or professional practice and solve significant scientific and technological

<p>problems of physics and/or astronomy in compliance with academic ethics and social, economic, environmental and legal aspects.</p> <p>POL08. Deeply understand the general principles and methods of natural sciences, as well as the methodology of scientific research, be able to apply them in their own research in physics and in teaching practice.</p> <p>POL09. Be able to lead a reasoned discussion about the discussion of modern problems of physical research.</p> <p>POL10. Be able to work autonomously.</p> <p>POL11. Be able to mathematically formulate theoretical models of physical processes in accordance with the requirements of the problem.</p> <p>POL12. Be able to evaluate the effectiveness of numerical methods and develop optimal algorithms for computer modeling of physical processes.</p>	
<b>8 – Resource support for program implementation</b>	
Staffing	In accordance with the staffing requirements for ensuring providing of educational activities for the appropriate level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 10.05.2018, there is involvement of scientists and practitioners from institutions and enterprises of the relevant branch into the teaching process..
Material and technical support	In accordance with the technological requirements of material and technical support of educational activities for the appropriate level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 23.05.2018 Use of modern software focused on physical research and educational process
Informational, teaching and methodical support	In accordance with the technological requirements for teaching, methodical and informational support of educational activities for the appropriate level of higher education, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.12.2015 № 1187 as amended in accordance with the Resolution of the Cabinet of Ministers of Ukraine №347 dated 23.05.2018 Use of the Scientific and Technical Library, Electronic Campus and other information resources of Igor Sikorsky KPI.
<b>9 – Academic mobility</b>	
National credit mobility	Joint training of doctors of philosophy in the framework of bilateral agreements with other higher educational institutions and academic institutions of Ukraine is allowed. According to the decision of the Academic Council of

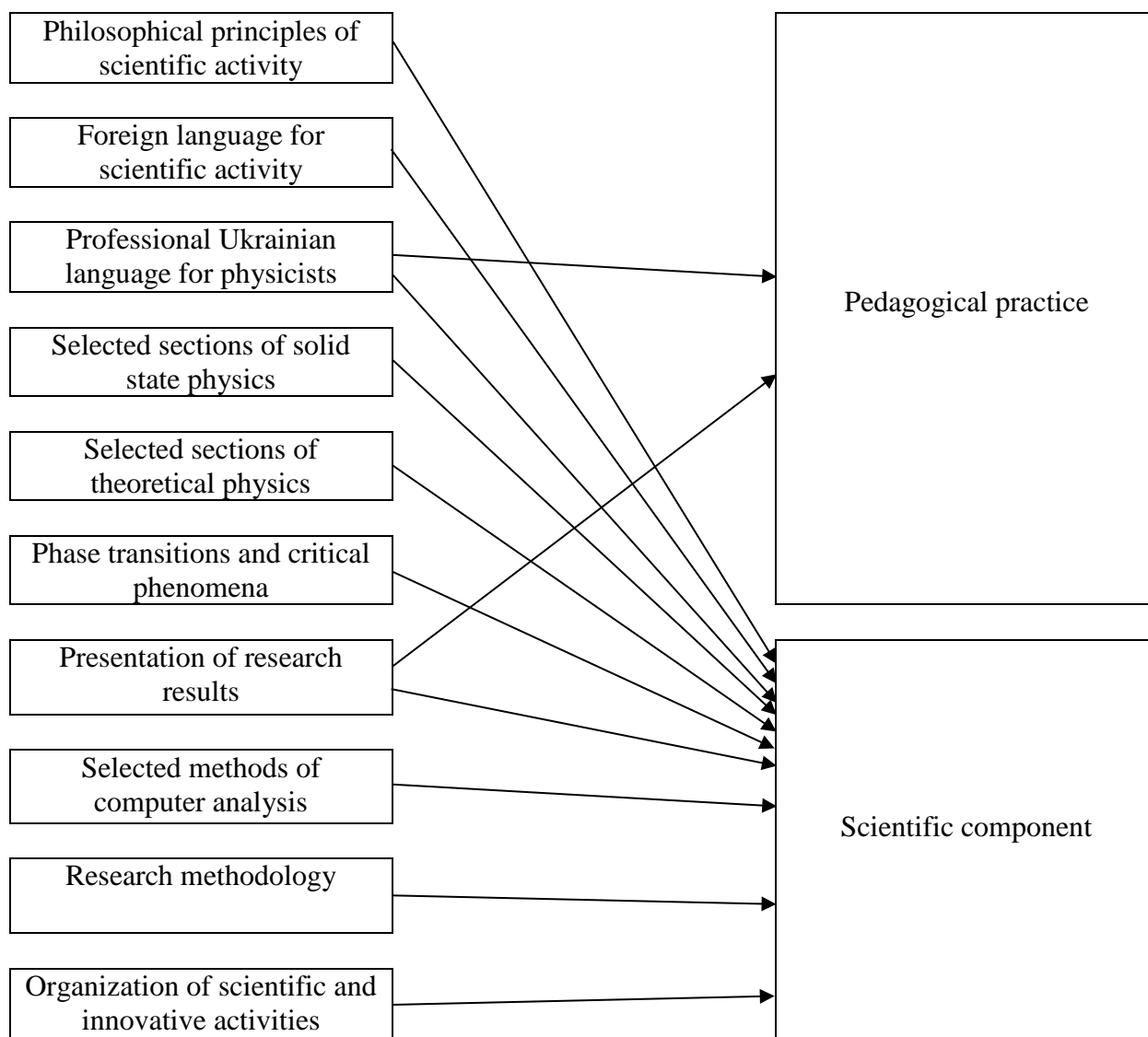


	<p>the Faculty of Physics and Mathematics, it is allowed to take into account ECTS credits obtained by postgraduate students in other institutions of Ukraine (in particular, during summer schools, online training, guest attendance of specialized courses), with the full number of recognized learning outcomes obtained in other institutions postgraduate studies in Ukraine and abroad, may not exceed 25% of the educational program.</p>
International credit mobility	<p>Joint training of doctors of philosophy in the framework of bilateral agreements with higher education institutions and academic institutions of other countries is allowed.</p> <p>According to the decision of the Academic Council of the Faculty of Physics and Mathematics, it is allowed to take into account ECTS credits obtained by graduate students in foreign institutions (in particular, during summer schools, online training, visiting specialized courses), with the full number of recognized learning outcomes obtained in other institutions or postgraduate in Ukraine and abroad, may not exceed 25% of the educational program.</p>
Training of foreign applicants for higher education	<p>For foreign citizens, education is provided in Ukrainian or English.</p>

## 2. LIST OF THE EDUCATIONAL PROGRAM COMPONENTS

Code	Components of the educational program (academic disciplines, course projects (works), practices, qualification work	Number of credits	Form of final control
<b>Normative educational components</b>			
GN1	Philosophical principles of scientific activity	6	test, examination
GN2	Foreign language for scientific activity	6	test, examination
GN3	Professional Ukrainian language for physicists	3	test
GN4	Selected sections of solid state physics	4	examination
GN5	Selected sections of theoretical physics	3	test
GN6	Phase transitions and critical phenomena	5	examination
GN7	Selected methods of computer analysis	4	examination
PN1	Research methodology	4	test
PN2	Organization of scientific and innovative activities	4	test
PN3	Presentation of research results	4	examination
PN4	Pedagogical practice	2	test
<b>Elective educational components</b>			
PE 1	Educational component 1 of the F-Catalog	3	test
PE 2	Educational component 2 of the F-Catalog	5	test
PE 3	Educational component 3 of the F- Catalog	4	test
PE 4	Educational component 4 of the F- Catalog	3	test
Total workload of normative components:			45
Total workload of elective components:			15
<b>TOTAL WORKLOAD OF THE EDUCATIONAL PROGRAM</b>			<b>60</b>

### 3. STRUCTURAL AND LOGICAL SCHEME OF THE EDUCATIONAL PROGRAM



### 4. SCIENTIFIC COMPONENT

Year	The content of the postgraduate student's scientific work	Form of control
1 <sup>st</sup> year	Choice and substantiation of the topic of own scientific research, determination of the content, terms of performance and volume of scientific works; selection and substantiation of the methodology of conducting own research, review and analysis of existing views and approaches that have developed in modern science in the chosen direction. Preparation and publication of at least 1 article in scientific professional publications (domestic or foreign) on the research topic; participation in scientific and practical conferences (seminars) with the publication of abstracts.	Approving the individual plan of work of the graduate student by the Academic Council of the faculty, reporting on the progress of the individual plan of the graduate student twice a year.

Year	The content of the postgraduate student's scientific work	Form of control
2 <sup>nd</sup> year	Conducting, under the guidance of the research supervisor, own research, which involves solving research problems through the use of a set of theoretical and empirical methods. Preparation and publication of at least 1 article in scientific professional publications (domestic or foreign) on the research topic; participation in scientific and practical conferences (seminars) with the publication of abstracts.	Reporting on the progress of the individual graduate student's plan twice a year.
3 <sup>rd</sup> year	Analysis and generalization of the obtained results of own scientific research; substantiation of scientific novelty of the obtained results, their theoretical and/or practical significance. Preparation and publication of at least 1 article in scientific professional publications (domestic or foreign) on the research topic; participation in scientific and practical conferences (seminars) with the publication of abstracts.	Reporting on the progress of the individual graduate student's plan twice a year.
4 <sup>th</sup> year	Resulting scientific achievements of post-graduate student in the form of the dissertation, summing up concerning completeness of coverage of results of the dissertation in scientific articles according to the current requirements. Implementation of the obtained results and receipt of supporting documents. Submission of documents for preliminary expertise of the dissertation. Preparation of a scientific report for final certification (dissertation defense).	Reporting on the progress of the individual graduate student's plan twice a year. Giving the conclusion about scientific novelty, theoretical and practical significance of the results of the thesis.

## 5. FORM OF ATTESTATION OF HIGHER EDUCATION APPLICANTS

Graduation certification of higher education students in the educational program "Physics" specialty 104 "Physics and Astronomy" is carried out in the form of dissertation defense and ends with the issuance of a standard document on awarding him the degree of Doctor of Philosophy with the qualification: Doctor of Philosophy in Physics and Astronomy. Qualification work is checked for plagiarism and after the defense is placed in the repository of the STL of the University for free access. Graduation certification is carried out openly and publicly.

## 6. MATRIX OF ACCORDANCE OF PROGRAM COMPETENCIES TO THE COMPONENTS OF THE EDUCATIONAL PROGRAM

	GN1	GN2	GN3	GN4	GN5	GN6	GN7	PN1	PN2	PN3	PN4	Scientific component
GC01	+			+	+	+		+	+			+
GC02									+			
GC03	+	+	+					+				+
GC04	+	+						+		+		+
GC05									+	+		
GC06								+				+
GC07									+			+
PC01				+	+	+	+	+				+
PC02			+				+			+	+	+
PC03		+								+		
PC04				+	+	+		+			+	+
PC05				+	+	+						+
PC06							+					+

## 7. MATRIX OF PROVIDING OF PROGRAM LEARNING RESULTS BY APPROPRIATE COMPONENTS OF THE EDUCATIONAL PROGRAM

	GN1	GN2	GN3	GN4	GN5	GN6	GN7	PN1	PN2	PN3	PN4	Scientific component
POL01				+	+	+	+	+				+
POL02		+	+					+		+		+
POL03	+			+	+	+	+	+		+		+
POL04				+	+	+	+		+			+
POL05				+	+	+	+	+				+
POL06							+	+				+
POL07								+	+			+
POL08								+			+	+
POL09		+	+					+		+		
POL10								+				+
POL11					+			+				+
POL12							+					+