Security research in ERC grants awarded during 2007–2018 under FP7 and H2020 framework programmes

This paper aims to briefly evaluate participation in funded and successfully implemented European Research Council (ERC) grants concerned with security research and security-related topics solved under the two EU Framework Programmes – the previous 7th Framework Programme for Research and Technological Development (FP7) and the current Horizon 2020 Framework Programme for Research and Innovation (H2020), extending over the period from 2007 until 2018. A large part of the article is devoted to a summary of the topics addressed by security-oriented ERC grants. The identification and categorization of security oriented ERC grants according to research specialization are based on the information obtained from the eCORDA (External COmmon Research DAta warehouse) European Commission database. The ERC grants that support investigator-driven frontier research across all fields are generally considered to represent the most prestigious award available to excellent scientists. The individual character of ERC grants using an investigator-driven and "bottom-up" approach (involving an unrestricted choice of research topics by the researcher) can constitute a suitable format for solving interdisciplinary security problems mentioned mainly in European Agenda on Security published by European Commission in 2016. The paper can be used for larger-scale analyses connected with security research or as a basis for evaluation of past EU research and innovation FPs.

Keywords: security research; ERC grants; FP7; H2020

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Introduction

Security is a core value of European society and one of the top concerns for Europeans. The living space of European society, which affects security in the world, is undergoing dynamic changes. Its predictability decreases due to the increasing interdependence of security trends and factors. Security threats are of both a national and increasingly a transnational character. "While people living in Europe have a very high level of security compared to elsewhere in the world, threats evolve constantly, and security and resilience are constantly being challenged" [1, p. 4]. It can also be assumed that the future security environment will likely become increasingly complex, and with new technologies, new security challenges will arise. It will be necessary to face security challenges which can develop rapidly and bring about a significant security instability.

In connection with the new, complex security threats that have appeared in recent years and which require more synergies and a coordinated response at European level, the European Commission (EC) declared the so-called European Agenda on Security [2], [3], setting out EU priorities in this area. The European Agenda on Security implements the Political Guidelines of European Commission in the area of security and replaces the previous Internal Security Strategy (2010–2014) [4]. The previous 7th Framework Programme for Research and Technological Development (FP7) realized during 2007–2013 [5] and the Horizon 2020 Framework Programme for Research and Innovation (H2020) [6] implemented between 2014 and 2020 play a key role in the public support for security-oriented R&D at EU level. "Protecting Europeans by meeting future security threats and safeguarding their freedom is one of the priorities under Horizon 2020" [1, p. 4]. "The security research funded by the European Union under Horizon 2020 brings both improved security and better industrial performance. Focused research enhances security by developing technologies and tools that meet the real needs of those on the front line of dealing with threats" [1, p. 2]. "Funded projects help to keep the EU's borders secure, build resilience against disasters (both natural and man-made), fight crime (including cybercrime), and prevent and deal with terrorism" [1, p. 4].

"Security research is helping European industry stand its ground against strong competition from the United States and Asia. There is clear added value offered by EU funding in this area" [1, p. 2]. Most Member States are unable to finance their own national security research programmes and therefore, individual countries rely on the European Union for their needs in this area. Current security research can be characterized as transnational and interdisciplinary. These two attributes are the basic pillars of the R&D framework programmes and are strongly encouraged. The EU has budgeted almost EUR 1,3 billion between 2007 and 2013 and 1,7 billion between 2014 and 2020 on research and innovation to boost the security area and effectiveness

of the EU's Security Union (thematic priority Security in FP7 [7] and Social Challenge – Secure societies – Protecting freedom and security of Europe and its citizens (SC7 – Security) in H2020 [8]).

Although the two FPs have both of them primarily defined the abovementioned thematic priorities for the implementation of projects connected with security-oriented topics, it is possible to apply new security-related ideas and their applications to other parts of the FPs (for example [9]). Projects dealing with security can be solved as well under the ERC heading, which is one of the important parts of both the FPs [5], [6]. ERC was brought to life in 2007 as part of FP7 [5], [10]. "The ERC's mission is to encourage the highest quality research in Europe through competitive funding and to support investigator-driven frontier research across all fields, on the basis of scientific excellence" [11]. ERC grants offer ground--breaking research and their potential impacts and objectives go substantially beyond the current state of the art. "The ERC complements other funding activities in Europe such as those of the national research funding agencies, and is a flagship component of Horizon 2020, the European Union's Research Framework Programme for 2014 to 2020. Being 'investigator-driven', or 'bottom-up', in nature, the ERC approach allows researchers to identify new opportunities and directions in any field of research, rather than being led by priorities set by politicians. This ensures that funds are channelled into new and promising areas of research with a greater degree of flexibility. The aim here is to recognise the best ideas, and confer status and visibility on the best brains in Europe, while also attracting talent from abroad. By challenging Europe's brightest minds, the ERC expects that its grants will help to bring about new and unpredictable scientific and technological discoveries - the kind that can form the basis of new industries, markets, and broader social innovations of the future. Ultimately, the ERC aims to make the European research base more prepared to respond to the needs of a knowledge-based society and provide Europe with the capabilities in frontier research necessary to meet global challenges" [11].

The security research and implementation of individual research projects in the FPs are usually built on cooperation of research teams within international, multi-member research consortia. Nevertheless, the individual character of ERC grants using an investigator-driven and "bottom-up" approach can be a suitable format for solving interdisciplinary security problems mentioned mainly in European Agenda on Security published by EC in 2016 [3]. The identification of ERC grants with security aspects situated at the frontiers of knowledge that are funded under the ERC has not yet been mapped and monitored in detail, and this is very desirable in view of what has been shown above.

Methodology

The non-public and expert database of EC called eCORDA (**CO**mmon **R**esearch **DA**ta warehouse) was used as the main data source to identify ERC grants related to security topics (hereinafter referred to as the "security ERC grants" or "security-oriented ERC grants") and to subsequently analyse the participation in these grants in the FP7 and H2020 programmes (FP7 projects database version 06/2017, H2020 grants database version 09/2019 [12]). Data regarding funded projects and grants in both versions of the databases for both FPs cover the period from 2007 until 2018 – encompassing the total duration of FP7 and the first five years of H2020.

ERC proposals are evaluated by scientific panels each covering a range of disciplines. Therefore, the projects must be submitted to one of these panels and further characterised by a set of descriptors. "It is important to underline that neither the ERC panel structure (…) of ERC research projects provides for information regarding the exact disciplinary membership of research projects investigated" [10, p. 54]. The panel structure of ERC is defined very generally and includes an appreciation of interdisciplinary approaches. "The panels themselves are to be interpreted in a flexible and inclusive manner with adequate space and arrangements for cross panel and interdisciplinary proposals. ERC decided to keep the number of panels low, to promote such interdisciplinarity and wide breadth of viewpoints within each panel as required by ongoing evolution of scientific disciplines" [13].

In accordance with the above mentioned facts, the available versions of the eCORDA database do not include any sub-classification of ERC grants (except ERC panels) and do not categorize individual ERC grants in detail according to their research specialisation. The selection of ERC grants addressing security issues had to be done largely by using a set of keywords (approximately 2000). The determination of keywords used to identify security-oriented ERC grants was based mainly on keywords listed in eCORDA and presented by researchers in funded projects in the thematic priority Security in FP7 and the SC7 – Security in H2020. In terms of available data and possibilities of their processing the decisive criterion for inclusion of a specific ERC grant among the grants having a security aspect was the presence of a suitable keyword or a set of keywords in the title or abstract of the given ERC grant. Advanced text search functionalities which are part of the PostgreSQL database system were used to identify the relevant security ERC grants. Nevertheless, being aware of the fact that even the best automatic text analysis cannot identify security oriented ERC grants with 100% reliability, the identified ERC grants had to be examined individually and with considerable effort, and grants which did not deal with security issues were excluded from the selection.

It should be noted that due to limited and incomplete data sources, checking the relevance of individual ERC grants in relation to security research and their categorization within defined areas of security research was a very intensive, difficult and time-consuming process, because the automated algorithms and functions of the given software could not be used in all cases and the relevance and categorization of individual ERC grants had to be carried out very often on the basis of a detailed examination of the abstract of the individual ERC grant ("grant to grant assessment approach"). In addition, the categorization of ERC grants into individual security research areas is problematic as well, owing to the fact that most ERC grants are interdisciplinary and the subjective aspect of the inclusion of a given ERC grant into a given security research area cannot be completely excluded. The multidisciplinary nature of some ERC grants may blur the borderline for inclusion of an ERC grant in one or another security area and make it ambiguous. In addition, identification of the security ERC grants based on the presence of keywords in the title of grant or abstract of grant has some limitations, because the ERC gives the principal investigators[1] quite a lot of flexibility so that research can lead to different results than originally planned in the grant. This may affect the final classification of the grant in the security area.

In order to maintain at least an approximate continuity with the structure of the SC7 – Security, the identified security ERC grants were allotted to four main areas of security research, in a form and structure similar to that presented in the Work Programme of the SC7 [14]:

- DS – Digital Security
- FCT – Fight against Crime and Terrorism, Criminology, Criminality prevention
- DRS – Disaster-Resilience: Safeguarding and securing society
- BES – Border Security and External Security

Each of these main areas of security research was further subdivided into several sub-areas (see Table 1 and other texts). In view of the fact that the article may serve as a basis for more comprehensive studies concerning security research, more emphasis is laid on describing the identified areas of security research in terms of the scientific content of funded ERC grants.

Participation in ERC grants focused on security issues and related topics in the EU Framework Programmes

Number and budget of security-oriented ERC grants in FP7 and H2020 programmes

The total number of ERC grants focused on security or related topics identified in FP7 using the procedure described in the methodological part of the paper was **93**. The financial contribution (EC contribution) approved from the FP7 budget for the solution of these ERC grants was approximately **€ 152** million (see Tables 1 and 2). A total of **143** ERC security-related grants were accepted for funding from the H2020 programme budget from 2014 to 2018. The financial contribution allocated for the solution of these security ERC grants has been close to **€ 226** million (see Tables 1 and 2). Given the fact that the H2020 programme is still ongoing, it can be expected that the number of security-oriented ERC grants will be higher and will significantly exceed the number of security ERC grants solved in FP7. Implemented security-oriented ERC grants make up approximately **2.0** % of the total number of successful ERC grants funded under FP7. The share of ERC grants focused on security topics in the H2020 programme is higher than that in FP7. The security ERC grants represent **2.6** % of the total number of all ERC grants in H2020. To underline the completeness of and the emphasis on the importance of security research under the ERC, we can also mention that security research carried out through security ERC grants in the years 2007–2018 represents almost **16** % of the financial contribution spent on project solutions in the thematic priority Security in FP7 and SC7 – Security in H2020 during this time period (**€** 378 mil./**€** 2 388 mil.). In terms of the budget of these security-focused parts of both FPs, the financial contribution allocated to security ERC grants solution has been **13** % (**€** 378 mil./ **€** 3 000 mil.).

Categorization of ERC grants related to various areas of security research

The ERC supports "high risk / high profit" grants [15]. These grants can bring a major breakthrough in the field of security research, but it is expected that many projects will not deliver the results that were envisaged in the project proposal, as this is a high-risk research of which the results in principle are not fully predictable. This fact should be taken into account when interpreting the overview of the security topics mentioned below which are related to the identified security ERC grants. Let us reiterate that this overview (as indicated above) is based on an analysis of abstracts (and titles) of identified ERC grants, not on published results of these grants.

DS – Digital Security

One of the scientific areas upon which the efforts of many principal investigators of ERC grants related to security topics have been largely directed, is **DS – digital security**. Almost **41** % of the identified security oriented ERC grants (accurately, 96 ERC grants, see Table 1) were associated with this part of security research in both the analysed FPs (44.0 % and 38.5 % in FP7 and in H2020, respectively). Digital security oriented ERC grants acquired more than **40** % of the total EC contribution (the exact amount being **€** 151.639 mil.) allocated for all identified security ERC grants in both FPs (see Table 2). These high funding levels are not surprising because European administrations, businesses and citizens are increasingly dependent on ICTs for their daily activities. Also, it is well recognized that security of ICT products, applications and services is a serious concern for users. More than three-quarters (76 %) of digital security oriented ERC grants is mainly concentrated in PE6 panel: Computer Science and Informatics [15].

Two-thirds of the ERC grants (66.6 %) and two-thirds of the EC contribution (66.8 %) in both FPs aimed at frontier research on **DS – digital security** were related to **cryptography and methods for information security based on cryptography**. Again, this is not surprising because cryptography is a foundation of information security in the digital world. Our digital society used to the ubiquity of electronic devices critically relies on protection of data and communication against espionage and cyber-crime. Underlying all protection mechanisms is cryptography, which we are using daily to protect, for example, internet communication or e-banking. The past thirty years have seen cryptography move from arcane science to a commonplace discipline. Cryptography currently faces fundamentally new challenges. Modern applications and novel technologies like Cloud Computing, Ubiquitous Computing, Big Data, Industry 4.0, and the Internet of Things come not only with a huge demand for practical and efficient cryptosystems, but also with many novel attack surfaces which require cryptographic methods that go far beyond secure communication. Modern theoretical cryptography has been very successful in developing powerful techniques that enable the design and rigorous formal analysis of cryptosystems in theoretical security models.

Some of these ERC grants look for ways to unconditionally secure cryptographic protocols, algorithms and cryptographic technologies that have the power to facilitate appropriate controls for data movement, data privacy and data authenticity. ERC grants are aimed at building cryptographically secure programmes, establish effective methods for security amplification and more efficient and fundamentally new cryptographic primitives. The aim of other ERC grants is exploring and preventing cryptographic hardware backdoors, protecting the Internet of Things against next-generation attacks and providing functional encryption to secure our data and our computation and development of cryptographically secure web applications. Other ERC grants try to increase the efficiency, effectiveness and functionality of cryptographic methods, investigate fundamental understanding of cryptographic security against very powerful adversaries and provide a solid foundation for the design and mathematically rigorous security

analysis of the next generation of cryptosystems that provably meet real-world security requirements and can safely be used to realize secure communication in trustworthy services and products for a modern interconnected society. Many principal investigators of ERC grants concentrate on transitioning current cryptographic algorithms to crypto that resist attacks by large quantum computers, so called "post-quantum cryptography". This is possibly the largest challenge applied cryptography is facing.

The topics related to **safe and secure computer systems, software and web applications** represent another important area of digital security. ERC grants in FP7 and H2020 focused on the protection of digital infrastructures amount to almost one fourth of all digital security oriented ERC grants (22.9 %). The EC contribution for these grants makes up 25 % of the total EC contribution for ERC grants in the area of digital security. Computer systems have become critical to modern society, but they are pervasively subject to security flaws and malicious attacks, with large-scale exposures of confidential data, denial-of-service and ransom attacks. The majority of ERC research grants in computer security are dedicated to the design of detection, protection, and prevention solutions, because these techniques play a critical role in increasing the security and privacy of our digital infrastructure. Principal investigators of ERC grants tried to develop automated techniques to timely and precisely analyse computer security incidents and compromised systems. Excellent research has been focused on security verification and web and software security (for example, in terms of user's account verification), user's identity verification or software and web applications security verification tools for keeping the software or web application updated and secure against potentially erroneous changes, security vulnerabilities, critical bugs and security attacks.

The smallest part of ERC grants (10 ERC grants) focused on digital security is concerned with research of **digital security technologies** whose products could serve in the security sector. ERC grants dealing with sophisticated sound, speech, voice, speaker, face, gestures recognition for surveillance applications and systems for intelligent ubiquitous sensing or real-time sensing that detect a security threat may serve as examples.

FCT – Fight against Crime and Terrorism, Criminology, Criminality prevention

The activities conducted under **FCT (Fight against Crime and Terrorism, Criminology, Criminality prevention)** entertain the ambition to mitigate potential consequences of crime- and/or terrorism-related incidents or to prevent them. "This requires new technologies and capabilities for fighting and preventing crime (…), illegal trafficking and terrorism (…), including understanding and tackling terrorist ideas and beliefs to also avoid aviation related threats" [14, p. 48]. More than one fifth of security oriented ERC grants (22.9 % or 52 ERC grants) were placed in this area of security research (see Table 1). To these ERC grants was channelled more than one fifth of the EC contribution (€ 80.447 mil.) expended on all security ERC grants (see Table 2). Almost two-thirds of these ERC grants (65 %) were evaluated within the SH2 panel: Institutions, Values, Environment and Space and the SH3 panel: The Social World, Diversity, Population [15].

Slightly less than half of ERC grants in this category of security research (42.6 %) should bring new knowledge in the field of **Criminology, criminal law, justice, ethics and education, penal policy**. ERC grants in this field of security research are based on combining social science with development studies, criminology and social psychology, penal policy and penal law. Some funded ERC grants generate policy-relevant research in the fields of human security, conflict, democracy and development. Other ERC grants deal with international criminal justice, jurisdiction to tackle unlawful practices, penal theories, the contemporary prison services, the immigration detention centres and human rights law.

Nearly one third of ERC grants (31.5 %) in this area of security research is focused on research in topics related to **fight against organized crime, criminal offenses and illegal activities** –terrorism, human trafficking, financial criminality and illegal wildlife trade and illegal trade with other commodities. Research is based on an interdisciplinary framework that combines studies, methods and experiences, in many cases combined with the development of new artificial intelligence techniques. These ERC grants are dedicated to the development of new advanced technologies to combat terrorism and transnational organized crime (TOC). They explore the illegal and overlapping flows of migrants and drugs, developing new theoretical and methodological apparatuses for apprehending TOC. Through these ERC grants, scientists reveal the structure, dynamics and behaviour of criminal gangs and transnational criminal networks, mechanisms of smuggling, relationships between migration and human trafficking or the functioning of illicit markets. Several ERC grants holders try to understand financial criminality, analyse suspicious financial transactions and develop anti-corruption technologies. Other funded ERC grants should advance conceptual understanding of environmental crime and illegal wildlife trade.

More than one fourth of ERC grants (25.6 %) in this area of security research focus on **criminality prevention, mitigation of criminal and terrorist acts, social interactions and resolution of interpersonal conflicts**. The researchers of these ERC grants describe and try to understand the causes and consequences of crime, develop methods and recommendations for crime prevention and facilitate criminal rehabilitation of incarcerated criminals, understand how current rehabilitation programmes affect criminal and victim networks, and/or design more effective anti-crime policies. ERC grants have potential to greatly contribute to our understanding of the roots of criminal conduct and to offer a new perspective on criminal behaviour or be conducive to a breakthrough in our understanding of delinquency. On the borderline between security research, psychology and sociology there are ERC grants that investigate pathways leading to intimate partner violence, advance the theoretical frameworks of intimate partner violence and bring innovative methods that can deliver ground-breaking strategies to combat impunity for conflict-related sexual violence. Great attention is paid to understanding the determinants of violence in young people and to analyses of transnational youth gangs in the global age. Border research in criminology, sociology and economics struggles to define, through some solved ERC grants, the crime prevention principles needed to help quantify the risk of such offences, the risk of radicalisation, the risk of violent action, the risk of offending behaviour, corruption etc.

DRS – Disaster-Resilience: Safeguarding and securing society

Disaster protection and disaster preparedness are essential elements of the security of modern society. "There is barely any societal sector which is not to some extent concerned by disasters and related resilience and security issues. The objective of this type of security research is to reduce the loss of human life, environmental, economic and material damage from natural and man-made disasters, including from extreme weather events (…)" [14, p. 9]. The share of ERC grants

Table 1: Numbers of security-oriented ERC grants and their thematic orientation in FP7 (2007–2013) and Horizon 2020 (2014–2018) programmes

Area of security research	Sub-area of security research	FP7 (2007–2013)		H2020* (2014–2018)		TOTAL	
		Number of ERC grants	Number of ERC grants (%)	Number of ERC grants	Number of ERC grants (%)	Number of ERC grants	Number of ERC grants (%)
DS – Digital Security	Cryptography and methods for information security based on cryptography	28	30.1	36	25.1	64	27.1
	Safe and secure computer systems, software and web applications	9	9.6	13	9.1	22	9.3
	Digital technologies usable in the security sector	4	4.3	6	4.2	10	4.3
DS – Total		**41**	**44.0**	**55**	**38.4**	**96**	**40.7**
FCT – Fight against Crime and Terrorism, Criminology, Criminality Prevention	Criminology, criminal law, justice, ethics and education, penal policy	5	5.4	18	12.6	23	9.8
	Fight against organized crime, criminal offenses and illegal activities	1	1.1	16	11.2	17	7.2
	Criminality prevention, mitigation of criminal and terrorist acts, social interactions and resolution of interpersonal conflicts	1	1.1	13	9.1	14	5.9
FCT – Total		**7**	**7.6**	**47**	**32.9**	**54**	**22.9**
DRS – Disaster-Resilience: Safeguarding and Securing Society	Predicting natural disasters, understanding and assessing dangerous phenomena	18	19.4	13	9.1	31	13.1
	Models, technologies, methods for protection against natural and man-made disasters and threats, risk assessment and disaster prevention	5	5.4	9	6.3	14	5.9
	Security sensors, detectors, intelligent monitoring systems and surveillance equipment	3	3.2	4	2.8	7	3.0
DRS – Total		**26**	**28.0**	**26**	**18.2**	**52**	**22.0**
BES – Border Security and External Security	Global security and security risks, security policy and culture, political violence, peacebuilding	16	17.2	10	7.0	26	11.0
	Border security and new security models for researching border areas	3	3.2	5	3.5	8	3.4
BES – Total		**19**	**20.4**	**15**	**10.5**	**34**	**14.4**
TOTAL		**93**	**100.0**	**143**	**100.0**	**236**	**100.0**

Notes: *The data in the table refer to 2014–2018. The H2020 programme runs for seven years (2014–2020).
Source: eCORDA, own data processing and categorization of ERC grants

of this research specialization represents more than one fifth of the total number of security ERC grants (22.0 % or 52 ERC grants) and almost one fourth of the EC contribution (24.8 % or € 93.630 mil.) allocated for all security ERC grants (see Tables 1 and 2). More than two thirds of the ERC grants related to this nature-technical research area have been assessed and evaluated under PE10 panel: Earth System Science [15] and PE8 panel: Products and Processes Engineering [15] – 52 % resp. 17 %.

The report on Human cost of Natural Disasters states that "between 1994 and 2013 were recorded 6,873 natural disasters worldwide, which claimed 1.35 million lives or almost 68,000 lives on average each year. In addition, 218 million people were affected by natural disasters on average per annum during this 20-year period" [16, p. 7]. These serious facts are then reflected in the interest of excellent scientists to solve projects dealing with **predicting natural disasters (mainly earthquakes, volcanic eruptions), understanding and assessing dangerous natural phenomena** (31 ERC grants from the total number of 52 grants in this area of security research).

Earthquakes represent one of the deadliest and costliest natural disasters and hazards affecting our planet – and one of the hardest to predict. Earthquakes are potentially catastrophic phenomena that have a huge impact on the environment and society. For this reason, the aim of many ERC grants is to develop new seismic monitoring models and predictive scenarios. Frontier research under ERC ensures advancement of earthquake risk assessment and forecasting methods. Results of ERC grants should provide unprecedented accuracy in the detection of earthquake precursors and build predictive models for tectonic faulting. Improvement in the ability to forecast devastating events could save thousands of lives and billions of euros. ERC grants of another group on the boundary of natural sciences and security research help to understand the physical processes responsible for earthquakes and to improve seismic hazard evaluation in earthquake-prone regions, because an understanding of earthquake nucleation and the underlying physical-chemical processes controlling earthquake generation is essential to seismic hazard assessment.

Table 2: EC contribution in the thematic areas of security-oriented ERC grants in FP7 (2007–2013) and Horizon 2020 (2014–2018) programmes

Area of security research	Sub-area of security research	FP7 (2007–2013)		H2020* (2014–2018)		TOTAL	
		EC contribution (€ mil.)	EC contribution (%)	EC contribution (€ mil.)	EC contribution (%)	EC contribution (€ mil.)	EC contribution (%)
DS – Digital Security	Cryptography and methods for information security based on cryptography	41.427	27.3	59.915	26.5	101.342	26.8
	Safe and secure computer systems, software and web applications	22.622	14.8	15.123	6.7	37.745	10.0
	Digital technologies usable in the security sector	5.652	3.7	6.900	3.1	12.552	3.3
DS – Total		**69.701**	**45.8**	**81.938**	**36.3**	**151.639**	**40.1**
DRS – Disaster-Resilience: Safeguarding and Securing Society	Predicting natural disasters, understanding and assessing dangerous phenomena	32.927	21.7	30.511	13.5	63.438	16.8
	Models, technologies, methods for protection against natural and man-made disasters and threats, risk assessment and disaster prevention	9.183	6.0	12.314	5.5	21.497	5.7
	Security sensors, detectors, intelligent monitoring systems and surveillance equipment	5.745	3.8	2.950	1.3	8.695	2.3
DRS – Total		**47.855**	**31.5**	**45.775**	**20.3**	**93.630**	**24.8**
FCT – Fight against Crime and Terrorism, Criminology, Criminality Prevention	Criminology, criminal law, justice, ethics and education, penal policy	7.343	4.8	27.598	12.2	34.941	9.2
	Fight against organized crime, criminal offenses and illegal activities	0.990	0.7	23.254	10.3	24.244	6.4
	Criminality prevention, mitigation of criminal and terrorist acts, social interactions and resolution of interpersonal conflicts	1.498	1.0	19.764	8.8	21.262	5.7
FCT – Total		**9.831**	**6.5**	**70.616**	**31.3**	**80.447**	**21.3**
BES – Border Security and External Security	Global security and security risks, security policy and culture, political violence, peacebuilding	20.483	13.5	18.338	8.1	38.821	10.3
	Border security and new security models for researching border areas	4.152	2.7	9.137	4.0	13.289	3.5
BES – Total		**24.635**	**16.2**	**27.475**	**12.1**	**52.110**	**13.8**
TOTAL		**152.022**	**100.0**	**225.804**	**100.0**	**377.826**	**100.0**

Notes: *The data in the table refer to 2014–2018. The H2020 programme runs for seven years (2014–2020).

Source: eCORDA, own data processing and categorization of ERC grants

The Earth's system is constantly influenced by dozens of volcanic eruptions per year. The purpose of several ERC grants is to develop new approaches to assessment of volcanic risk, to improve hazard assessment, to increase early warning capability and forecasts of the recurrence rate of volcanic eruption and to mitigate the impact of volcanic eruptions on our societies. These grants deal with the location of strategic infrastructures and with the requirements of businesses. The ERC grants of this type should extend human knowledge of the dynamics of volcanoes and their impact on the environment and society, of the mechanisms involved and of explosive volcanic eruptions, with a view to volcanic hazard assessment and to monitoring potentially dangerous structures like volcanoes or active fault zones prone to damaging earthquakes.

Several ERC grants are devoted to the lifetime prediction of imminent catastrophic landslides and floods. The goal of these ERC grants is to take a major step toward improving the detection and understanding of landslides and their modelling on the field scale, through analysis of generated seismic waves and prediction of many major and devastating floods that have occurred in the world recently.

Civil emergencies such as flooding, earthquakes, fires, etc. can have devastating impacts on people, infrastructure, and economies. Some principal investigators of ERC grants orientated their efforts on solutions and development of **models, technologies, methods for protection against natural and man-made disasters and threats, risk assessment and disaster prevention**. ERC grants (14 ERC grants from the total number of 52 grants in this area of security research) specialize in understanding disaster risk as a consequence of complex interactions and relationships between landscape, community, science and politics. ERC grants of this type seek answers to questions of how to best respond to emergency and crisis situations caused by natural and man-made disasters, how to reduce the vulnerability of cities and key infrastructures and how to establish new validated methods for enhanced design and risk assessment in order to protect human populations and civil infrastructure. Here the ERC grants suggest

Table 3: Distribution of security-oriented ERC grants in thematic areas of security research in FP7 (2007–2013) and Horizon 2020 (2014–2018) per host institutions country

Host Institutions Country	Country Status	DS – Digital Security	FCT – Fight against Crime and Terrorism, Criminology, Criminality Prevention	DRS – Disaster-Resilience: Safeguarding and Securing Society	BES – Border Security and External Security	Total number of security ERC grants
United Kingdom	EU-15	13	21	9	15	58
France	EU-15	18	1	11	2	32
Germany	EU-15	13	2	5	2	22
Netherlands	EU-15	5	12	2	3	22
Switzerland	AC	7	1	5	5	18
Israel	AC	15	2			17
Italy	EU-15	2	4	7	2	15
Spain	EU-15	2	2	3	1	8
Sweden	EU-15	2	2	2	1	7
Denmark	EU-15	3	2		1	6
Austria	EU-15	4		1		5
Greece	EU-15	2		3		5
Belgium	EU-15	3		1		4
Finland	EU-15	2	2			4
Norway	AC		1	1	2	4
Ireland	EU-15	1	1			2
Portugal	EU-15		1	1		2
Cyprus	EU-13			1		1
Estonia	EU-13	1				1
Luxembourg	EU-15	1				1
Latvia	EU-13	1				1
Poland	EU-13	1				1
TOTAL		96	54	52	34	236

Notes: The data in the table is related to both FPs: FP7 (2007–2013) and H2020 (2014–2018).
Source: eCORDA, own data processing and categorization of ERC grants

innovative methodologies and new standards for safeguarding critical infrastructures against natural and man-made threats, technologiesthat should help to the enhanced design, building and maintenance of new protective constructions under extreme conditions (tsunami, flooding situations, seismic risk).

The last small group of security oriented ERC grants concerning disaster resilience (7 ERC grants) is formed of grants dealing with **security sensors, detectors, intelligent monitoring systems and surveillance equipment**. Most of these ERC grants are focused on technologies leading to the development of security screening and detection technologies such as security sensors to protect critical infrastructures and emergency response, to improve understanding, prediction and warning of emergencies or to detect and diagnose any unexpected events. These sensors, detectors and intelligent monitoring systems are often used for critical infrastructures and soft targets protection, for effective monitoring of buildings, for risk assessment of fires, for real time hazardous gas detection or for natural disasters control (flood control) etc.

BES – Border and External Security

In this area of security research, 34 ERC grants have been identified. More than three quarters of them (76.3 %) are dedicated to **global security and security risks, security policy and culture, political violence, peacebuilding**. The principal investigators of these ERC grants examine violence (its mechanisms, triggers, effects, genealogy and everyday experiences) in conflict and post-conflict zones. Here the ERC grants try to develop systems for conflict forecasting that provide Violence Early-Warning Systems (ViEWS) for several forms of political violence: armed conflict involving states and rebel groups, armed conflict between non-state actors, violence against civilians, and forced population displacement, and try to apply these to specific actors, sub-national geographical units, and countries. Other ERC grants of this group aim to study network and conflict analysis, factors that are crucial for sustaining long-run peace, role of education for sustaining peace, theory and practice of armed conflict that can uncover and explain the escalation and non-escalation of repression and intra-state armed conflict, what types of human rights violations

Table 4: Host institutions with the highest number of security-oriented ERC grants in FP7 (2007–2013) and Horizon 2020 (2014–2018)

Host Institution Name (PI's Host Institution)	Host Institution Country	Host Institution Type	DS – Digital Security	FCT – Fight against Crime and Terrorism, Criminology, Criminality Prevention	DRS – Disaster-Resilience: Safeguarding and Securing Society	BES – Border Security and External Security	Total number of ERC grants
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE (CNRS)	France	REC	6		4	1	11
INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE	France	REC	9				9
EIDGENÖSSISCHE TECHNISCHE HOCHSCHULE ZÜRICH	Switzerland	HES	3		4	1	8
THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD	United Kingdom	HES	2	3	1	1	7
GOLDSMITHS' COLLEGE	United Kingdom	HES		3	1	2	6
BAR ILAN UNIVERSITY	Israel	HES	5	1			6
UNIVERSITY COLLEGE LONDON	United Kingdom	HES	2	2	1		5
UNIVERSITEIT UTRECHT	Netherlands	HES		3	1	1	5
UNIVERSITEIT VAN AMSTERDAM	Netherlands	HES		3		2	5
THE CHANCELLOR MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	United Kingdom	HES	2	1	1		4
THE UNIVERSITY OF MANCHESTER	United Kingdom	HES		1	1	1	3
UNIVERSITÉ GRENOBLE ALPES	France	HES			3		3
LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE	United Kingdom	HES				3	3
LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN	Germany	HES			3		3
TECHNION – ISRAEL INSTITUTE OF TECHNOLOGY	Israel	HES	3				3
UNIVERSITAET DES SAARLANDES	Germany	HES	3		1		3
UPPSALA UNIVERSITET	Sweden	HES		1	1	1	3
CHALMERS TEKNISKA HOEGSKOLA AB	Sweden	HES	2		1		3
TECHNISCHE UNIVERSITEIT DELFT	Netherlands	HES	1	1			3
RUHR-UNIVERSITÄT BOCHUM	Germany	HES	3		1		3
UNIVERSITY OF BRISTOL	United Kingdom	HES	2				3
STICHTING KATHOLIEKE UNIVERSITEIT	Netherlands	HES	3				3
AARHUS UNIVERSITET	Denmark	HES	3				3
other 98 host institutions			47	35	28	21	131
TOTAL			**96**	**54**	**52**	**34**	**236**

Notes: The eCORDA database registers five types of institutions (legal entity types): HES – higher or secondary education establishments, actually universities, REC – research organisations (public research centres, private non-profit research centres, international research centres), PRC – private for-profit entities, consultancy firms, private/commercial research centres (excluding higher or secondary education establishments), PUB – public bodies (excluding research organisations and secondary or higher education establishments), OTH – other (e.g. not-for-profit organisations, trade associations, civil society organisations, non-research private non-profit, non-research international organisations, organisation type not defined, etc.). The data in the table is related to both FPs: FP7 (2007–2013) and H2020 (2014–2018).

Source: eCORDA, own data processing and categorization of ERC grants

lead to the escalation or deterrence of further repression and armed conflict. Some ERC grants concern ethics, law, politics of armed conflict and development of a European security culture.

A small number of ERC grants (8 ERC grants) are oriented on **border security and new security models for researching border areas**. It is supposed that ERC grants are grounded in

Table 5: Number of principal investigators of security-oriented ERC grants according to their nationality in FP7 (2007–2013) and Horizon 2020 (2014–2018)

Nationality of Principal Investigator	Country Status	DS – Digital Security	FCT – Fight against Crime and Terrorism, Criminology, Criminality Prevention	DRS – Disaster-Resilience: Safeguarding and Securing Society	BES – Border Security and External Security	Total number of security ERC grants
United Kingdom	EU-15	8	14	4	6	32
Germany	EU-15	19	2	5	4	30
Italy	EU-15	6	6	12	3	27
Israel	AC	16	3			19
France	EU-15	6	2	7	3	18
Netherlands	EU-15	2	9	2	3	16
Switzerland	AC	6		2	3	11
United States	TC	4	1	2	3	10
Spain	EU-15	2	2	3	2	9
Sweden	EU-15	3	2	3	1	9
Greece	EU-15	3		5		8
Belgium	EU-15	4	1	2		7
Denmark	EU-15	3	2		1	6
Australia	TC	1	2			3
Canada	TC	1	1	1		3
Ireland	EU-15		2		1	3
India	TC	3				3
Norway	AC		1		2	3
Austria	EU-15	1		1		2
Portugal	EU-15		1	1		2
Romania	EU-13	1	1			2
China	TC	1				1
Cyprus	EU-13			1		1
Finland	EU-15	1				1
Croatia	EU-13	1				1
Luxembourg	EU-15	1				1
Latvia	EU-13	1				1
New Zealand	TC		1			1
Poland	EU-13	1				1
Russia	TC			1		1
Singapore	TC	1				1
Slovenia	EU-13				1	1
Slovakia	EU-13				1	1
Turkey	AC		1			1
TOTAL		96	54	52	34	236

Notes: The data in the table is related to both FPs: FP7 (2007–2013) and H2020 (2014–2018).
Source: eCORDA, own data processing and categorization of ERC grants

the necessary combination of knowledge and skills from more than one discipline. For this reason, it is possible in successful ERC grants to find the broad research topics that address for example: border security in the digital age, fair and consistent border controls, violence and crime control in the borderlands of Europe, new models for researching border areas beyond the current top-down

Table 6: Distribution of security-oriented ERC grants in thematic areas of security research in FP7 (2007–2013) and Horizon 2020 (2014–2018) per type of ERC grant

Type of ERC grant	Security ERC grants under FP7 and H2020* (2007–2018)						ERC grants FP7 and H2020* (2007–2018)	
	DS – Digital Security	FCT – Fight against Crime and Terrorism, Criminology, Global Security and Policy, Criminality Prevention	DRS – Disaster-Resilience: Ssafeguarding and Securing Society	BES – Border Security and External Security	TOTAL	TOTAL (%)	TOTAL	TOTAL (%)
ERC-STG	46	25	20	24	115	48.8	4 259	42.3
ERC-ADG	20	8	19	5	52	22.0	2 899	28.8
ERC-COG	18	15	7	5	45	19.1	1 921	19.1
ERC-POC	11	6	6		23	9.7	936	9.3
ERC-SYG	1				1	0.4	51	0.5
TOTAL	**96**	**54**	**52**	**34**	**236**	**100.0**	**10 066**	**100.0**

Notes: Starting Grants – STG are aimed at early-career scientists with 2 to 7 years' postdoctoral experience. Consolidator Grants – COG (from 2013 onwards) are intended for accomplished scientists with 7 to 12 years' postdoctoral experience. Advanced Grants – ADG are aimed at established scientists and outstanding research leaders with a recognized record of research achievements. Proof of Concept Grants - POC (from 2011 onwards) are aimed at existing ERC grant holders, to bring their research ideas closer to market. Synergy Grants – SYG (2012–2013 and from 2018 onwards) are for intended funding small groups of European scientists [19]. *The data in the table refer to 2014–2018. The H2020 programme runs for seven years (2014–2020).

Source: eCORDA, own data processing and categorization of ERC grants

international relations or security perspective, crime control and migration control practices in Europe and an examination of their implications.

International comparison of participation in security oriented ERC grants in the EU Framework Programmes: FP7 an H2020

The table 3 presents distribution of security oriented ERC grants in thematic areas of security research in FP7 (2007–2013) and Horizon 2020 (2014–2018) per host institutions[2] country. The grant distribution shows a clear concentration of 78 % of all grants in only seven host institutions countries – in large countries such as UK, FR, DE, IT and in smaller countries with high research performance such as NL, CH, IL, while the remaining one fifth of ERC grants has been acquired by institutions in 15 medium sized or smaller countries. The host institutions in UK create the conditions for the solution of the highest number of ERC grants in absolute numbers (58 grants or 25 % of all grants), followed by FR (32 grants or 14 %), DE and NL (22 grants or 9 % each). The majority of host institutions have their seats and headquarters in EU-15[3] countries (193 grants from 236 or 82 %). The host institutions in associated countries (mainly CH and IL), play an important role as research centres for principal investigators as well (39 grants or 17 %). On the contrary the share of ERC grants implemented in host institutions from the EU-13 countries is very small – under 2 %. The data in Table 3 make it clear that the host institutions in the UK and NL give space to researchers to solve ERC grants focused on fight against crime and terrorism, criminology, security policy and criminality prevention, while ERC grants aimed at digital security can be found rather at host institutions having their seat in France, Israel, Germany and also in UK. The excellent researchers at the host institutions in France concentrate on solving ERC grants related to natural disaster-resilience and its predicting. Assessment of global security risks and border security is the subject of many ERC grants in the UK.

A more detailed view describing the research performance of the host institutions measured by the ERC grants received is given in Table 4. Table 4 contains a list of 23 host institutions with 3 or more security oriented ERC grants. These host institutions offer their research capacities for holders of 105 security ERC grants. According to their participation, some of them (e.g.: CNRS, University of Oxford, University of Cambridge, University College London, ETH Zürich, TU Delft) have long been ranking among the TOP institutions[4] in both framework programmes – FP7 and H2020 [18]. The remaining 131 ERC grants were investigated at other 98 host institutions. Among the types of host institutions there is a significant prevalence of universities (107 host institutions from 121). Research institutions (REC) are much less numerous among host institutions (11 host institutions from 121). Private for-profit institutions (PRC) are represented in the role of host institution in a minimum number of cases (only 3 host institutions from 121).

More than one third of all security ERC grants (38 %) have been awarded to principal investigators of UK, DE and IT nationality (see Table 5). The principal investigators of these nationalities received more than 25 security ERC grants. One quarter of security ERC grants went to principal investigators

of IL, FR and NL nationality (22 %). The principal investigators of these nationalities were authors in more than 15 ERC grants. The remaining 60% of security ERC grants in FP7 and H2020 programmes were the work of principal investigators of 28 nationalities. More prominent among these were the principal investigators from CH, US, ES, SE, EL, BE and DK. Researchers of these nationalities received more than 5 security ERC grants. From the point of view of security research areas designated for the purposes of this paper, it is apparent that researchers from the UK were more successful than others in submitting ERC grants aimed at deepening knowledge in the areas of criminology and fight against organized crime, criminal offenses and illegal activities. Researchers from NL have successfully provided new insights into criminality prevention, criminology and criminal law. The majority of successful ERC grants submitted by principal investigators from DE and IL dealt with cryptography and methods for information security based on cryptography. It is worth noting that the principal investigators from Italy concentrated their activities on disaster resilience research, especially in the area of predicting natural disasters, understanding and assessing dangerous phenomena. This may be related to the situation in southern Italy, which is aggravated very often by earthquakes and volcanism, and the research community in Italy emphasizes this type of research. The international character and dimension of the FPs is illustrated by the participation of principal investigators from 34 countries in the solution of security ERC grants. Most of them as expected are researchers from EU-15 countries (73 %). Thanks to researchers from IL, CH and NO, associated countries (AC) have a significant share in the number of received security ERC grants as well. From the ranks of non-European researchers, the principal investigators from the USA were the most successful.

Brief analysis of security oriented ERC grants according to their type

The ERC offers several types of ERC grants under the FP7 and H2020 programmes. Two types of individual grants are aimed at young scientists in two categories: Starting Grants – STG and Consolidator Grants – COG. These types of grants make up more than two thirds of all security ERC grants (STG – 48,8 %, COG 19,1 %). Early-career scientists (STG+COG) with 2 to 12 years' postdoctoral experience concentrate their research efforts in particular on the solution of grants focused on digital security (40 %) and fight against crime and terrorism, criminology, global security, policy and criminality prevention (25 %). ERC grants for established scientists are the Advanced Grants – ADG which represent 22 % of all identified security ERC grants. Outstanding research leaders with a recognized record of research achievements are also interested in the field of digital security, but equally in the issue of disaster resilience (mainly predicting and understanding natural disasters). Proof of Concept grants - POC aimed at bringing the results of research ERC grants closer to practical application represent less than 10 % of all security ERC grants. The share of Synergy Grants – SYG in the area of security research is negligible; this is influenced by a limited number of calls for proposals for these types of grants. Table 6 also shows the distribution of all ERC grants implemented in both FPs during the reporting period (the last two columns of Table 6). It can be seen that this distribution of security ERC grants according to type does not differ significantly from the situation of ERC grants in general.

Conclusion

The aim of this paper is to assess the extent of support for security research and its applications in funded i.e. successful ERC grants implemented under the umbrella of two FPs – FP7 and H2020 during the years from 2007 until 2018. The article provides information on the number of identified security ERC grants, participation therein across the host institutions countries, nationality of principal investigators and fields of security research. This paper has no ambition whatsoever to be regarded as an essential document advancing recommendations for the future of European security research or future concept of ERC, but can be used for larger-scale analyses connected with security research or as a basis for evaluation of past EU research and innovation FPs.

In conclusion, a total of 236 ERC grants related to security research and its applications were identified and funded during the 2007–2018 period in both FPs (93 in FP7, 143 in H2020). The established distribution of security-oriented ERC grants in FPs per host institution country came out more or less as expected. The largest number of ERC grants is concentrated in host institutions in large European countries and in the countries that demonstrate higher research performance. Among the host institutions that engage and host the principal investigators of ERC grants there are large centres of European research which consistently occupy first positions in FPs in terms of participation and amount of allocated funds. The distribution of ERC grants across host institution countries correlates to some extent with participation of principal investigators in security oriented ERC grants taking account of their nationality. The researchers from large European countries occupy the leading positions in terms of the number of received security ERC grants. However, the ERC concept is open to researchers from around the world and for this reason, the principal investigators from non-European countries with advanced level of security research (USA, Israel) are also strongly involved in frontier research under ERC, which is considered as an indicator of scientific reputation and excellence. The fact that researchers from 34 countries participated in the security research under ERC can be considered a proof of the international character and dimension of the FPs.

In the different security research areas, excellent researchers largely try to apply novel or unconventional approaches and ideas in security-oriented ERC grants concerned with digital security (40.7 % of all security ERC grants), mainly cryptography and methods for information security based on cryptography (27.1 % of security ERC grants) and development of secure computer systems and web applications (9.3 % of security ERC grants). The other sphere of security research that stimulates considerable interest of excellent researchers toward participation in projects of frontier research is predicting natural disasters (mainly earthquakes and volcanism), understanding and assessing dangerous phenomena (13.1 % of security ERC grants). Principal investigators also are instrumental in advancing the understanding of global problems such as global security and security risks (11.0 % of security ERC grants). A significant share of security ERC projects is devoted to criminology, criminal law, justice, ethics and penal policy (9.8 % of security ERC grants). The research community under ERC strives to substantially advance the frontiers of knowledge and to encourage new productive lines of enquiry and new methods and techniques in the field of fight against organized crime, criminal offences and illegal activities (7.2 % of security ERC grants).

Comparisons of thematic orientation of the security-oriented ERC grants across both FPs or, in other words, the change of focus or the difference of scientific interest of the principal investigators in these FPs (see Table 1) demonstrate that the share of ERC grants focused on the area of digital security is roughly very similar in both FPs (the difference between the shares is less than 6%). It is noteworthy that the shares of ERC grants in the sub-areas of this research area are also almost identical. Digital security and especially cryptography remain for a long time at the forefront of interest of top researchers. There are no dramatic differences in the shares of ERC grants in both FPs (approximately 10 %) in disaster-resilience and border security and external security areas as well. On the other hand, when comparing the two FPs in the field of security research concerning fight against crime and terrorism, criminology, and criminality prevention there has been a significant increase of interest on the part of the principal investigators of ERC grants. This may be related to the increasing number of terrorist attacks in Western Europe (2011 – Oslo, 2015 – Paris, 2016 – Brussels, Nice, Berlin, 2017 – Manchester, Barcelona) and therefore, research topics and projects reflect the increasing challenges of society to solve these serious security problems and threats. However, it is difficult to deduce the exact causes of changes in the shares of ERC grants in both FPs in the field of security research, because the shares of ERC grants are derived from a small absolute number of ERC grants and moreover, the "bottom-up" approach (less dependent on research policy) should be taken into account in the choice of research topic on the part of the researchers.

Generally, the distribution of security ERC grants in terms of their types corresponds to the distribution of ERC grants across the entire scope of research. More than two-thirds of security ERC grants have been solved by young and promising researchers having from 2 to 12 years of scientific experience (STG and COG ERC grants). Nearly 10 % of ERC grants were intended to support the commercial application of the results of ERC grants previously funded (POC ERC grants).

Although the share of security-oriented ERC grants appears to be relatively small compared to the total number of ERC grants implemented in both FPs (2.0 and 2.6 %m respectively), it can be said that security research carried out under the ERC plays a very important role in security research under both FPs. The allocated financial contribution toward the solution of ERC grants related to security research and its applications (€ 378 mil.) reached almost 13 % of the budgets of both security priorities in both FPs (€ 3 000 mil.).

From this finding it is therefore clear that security research within the ERC can help to overcome the security gap resulting from the fact that millions of people live in situations of intolerable insecurity as a consequence of armed conflict, organised crime, terrorism, financial crises, poverty and inequality, environmental degradation, and vulnerability due to natural disasters.

Notes

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The list of identified security ERC grants may be provided by the authors of this article on demand.

Country/nationality codes:
AT – Austria, AU – Australia, BE – Belgium, CA – Canada, CN – China, CY – Cyprus, DE – Germany, DK – Denmark, EE – Estonia, EL – Greece, ES – Spain, FI – Finland, FR – France, HR – Croatia, CH – Switzerland, IE – Ireland, IL – Israel, IN – India, IT – Italy, LU – Luxembourg, LV – Latvia, NL – Netherlands, NO – Norway, NZ – New Zealand, PL – Poland, PT – Portugal, RO – Romania, RU – Russia, SE – Sweden, SG – Singapore, SI – Slovenia, SK – Slovakia, TR – Turkey, UK – United Kingdom, US – United States

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[1] Principal investigator (PI) – Grantee: The individual researcher who may assemble a team to carry out the project under his/her scientific guidance.

[2] Host institution (HI): The applicant legal entity that engages and hosts the principal investigator. (HI refers to the institution that will host the ERC principal investigator (PI). It must be established in a Member States or an Associated Country (country associated to H2020 by Article 7 of the Horizon 2020 Regulation). The HI must provide independence for the principal investigator to direct the research and manage its funding.

[3] EU-15: Old Member States of EU, EU-13: New Member States of EU - countries joined to the EU in 2004 and after, AC: Associated Countries to H2020 by Article 7 of the Horizon 2020 Regulation. The list of AC is available: [17], TC: Third countries – neither EU Member State nor Associated Country.

[4] TOP institutions are defined as institutions that received the highest financial support from the European Commission (EC) to investigate FP7 and H2020 projects – see [18].