Proposal template Part B: technical description

IFIGENEIA

IFIGENEIA: Innovative Facility for Isotope GENeration with Efficient Ion Accelerator

HORIZON-WIDERA-2023-ACCESS-07-01, CSA

Excellence Hubs

#@APP-FORM-HECSA@#

List of participants

#*	Organisation Name	Country	Type
	Greek Hub		
1	**ARISTOTELIO PANEPISTIMIO THESSALONIKIS (AUTH)**	**EL**	**UNI**
2	REGION OF CENTRAL MACEDONIA (RCM)	**EL**	PUB
3	BIOKOSMOS MEDICAL SCIENTIFIC EQUIPMENT COMMERCIAL INDUSTRY SOCIETE ANONYME (BIOKOSMOS)	**EL**	SME
4	Archaeological Museum of Thessaloniki (AMTH)	**EL**	NGO
5	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH)	**EL**	RTO
6	GENIKO NOSOKOMEIO PAPAGEORGIOU (GNP)	**EL**	PUB
7	MANAGEMENT AND ADMINISTRATION AUTHORITY OF TECHNOPOLIS THESSALONIKIS SA (TPOLIS)	**EL**	NPO
8	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS" (NCSRD)	**EL**	RTO
9	ALEXOPOULOS SPYRIDON TOU IOANNOU (AMOLDS)	**EL**	SME
	Slovenian Hub		
10	University of Ljubljana (UL)	**SI**	UNI
11	INSTITUT JOZEF STEFAN (IJS)	**SI**	RTO
12	COSYLAB LABORATORIJ ZA KONTROLNE SISTEME DD (COSYLAB)	**SI**	SME
13	SLOVENSKO INOVACIJSKO STICISCEEVROPSKO GOSPODARSKO INTERESNOZDRUZENJE (SIH)	**SI**	PUB
14	Slovenian Academy of Engineering (IAS)	**SI**	NGO
	Cyprus Hub		
15	RTD TALOS LIMITED (TALOS)	**CY**	SME
16	UNIVERSITY OF CYPRUS (UCY)	**CY**	UNI
17	PAGKYPRIOS SYNDESMOS KARKINOPATHON KAI FILON 1986 (PASYKAF)	**CY**	NGO
18	ORGANISMOS KRATIKON YPIRESION YGEIAS (SHSO)	**CY**	PUB
	Mentoring partners		
19	UNIVERZITET U SARAJEVU (UNSA)	**BiH**	UNI
	Horizontal Partners		
20	GSI HELMHOLTZZENTRUM FUR SCHWERIONENFORSCHUNG GMBH (GSI)	**DE**	NGO
21	DEUTSCHES KREBSFORSCHUNGSZENTRUM HEIDELBERG (DKFZ)	**DE**	RTO
22	ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE (CERN)	**CH**	RTO
	Supporting Partners with Letter of Intent		
1	MINISTRY OF HIGHER EDUCATION, SCIENCE AND INNOVATION	**SI**	PUB
2	South East European International Institute for Sustainable Technologies - SEEIIST	**CH**	NGO
3	Web2Learn	**EL**	SME
4	Verlab Research Institute for Biomedical Engineering, Medical Devices and Artificial Intelligence	**BiH**	RTO

* Please use the same participant numbering and name as that used in the administrative proposal forms.

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1 EXCELLENCE #@REL-EVA-RE@#

1.1 Objectives [e.g. 2 pages] #@PRJ-OBJ-PO@#

1.1.1 Rationale | Background and targeted breakthrough [0,5-1 page]

Nuclear medicine, as well as molecular imaging, are very promising, non-invasive medical procedures, widely used in the last years for the diagnosis and treatment of a large variety of diseases including cancers, cardiovascular and brain disorders like Alzheimer's and Parkinson's disease[1] [2] . Molecular imaging, which encompasses nuclear medicine, involves the use of small amounts of radioactive materials to diagnose and treat a variety of diseases, providing insights into the body's function and enabling the identification of the cause of medical problems based on organ, tissue, or bone malfunctioning[3] and thus enabling personalised patient care.

In Europe, radioisotopes are produced using cyclotrons and nuclear reactors. Cyclotrons offer immediate usability but have high costs and limited production capability. They can produce only about 25% of current radioisotope types. Nuclear reactors provide almost 80% of radioisotopes but face challenges in availability, quantities, and environmental sustainability. Older reactors using highly enriched uranium raise concerns about global availability, environmental impact, and safety, especially for producing 99Mo, the basis for the widely used 99mTc.

The necessity of a cost-effective solution, environmentally sustainable, enabling the safe production and in situ availability of the majority of radioisotopes in large quantities, is evident.

A LINear ACcelerator (LINAC) offers a compact, cost-effective and environmentally friendly option that can be situated in close proximity to hospitals. The tunability of LINACs allows for adjusting energy levels, currents and targets, enabling the production of a broad range of radioisotopes. Notably, a similar facility, named NUSANO[4], is being built in West Valley City, Utah, in the USA, which will become operational in 2025. This facility shares similarities with CERN LINAC4 frontend and aligns with the objectives of the European medical radionuclides program PRISMAP and makes this Excellence hub proposal timely for following an equivalent paradigm and bridging the present technology gap in Europe.

The IFIGENEIA proposal will provide the means to establish Excellence Hubs in the Balkan region which will secure a production platform of a wide range of radioisotopes, which have been, for too long, held back by technical limitations, supply outages, and waste stream concerns.

In addition, the proposed accelerator may also accommodate diverse applications. Thus, initially, this facility can serve as a multipurpose centre, starting with a portable radiofrequency (RFQ) of 2-5 MeV to be used for studies of cultural heritage, for industrial applications, and as irradiation facility for clinical tests. It can also contribute to university education for accelerator physicists, medical physicists, biologists, and medical doctors. At the next stage it will be extended to a cancer treatment facility (up to 40-50 MeV), and the studies will involve different beam parameters for different ranges of isotopes. The feasibility study of a staged LINAC is poised to address all the issues on a wide variety of radioisotopes, supply chains, and availability to drugmakers, researchers, and clinicians.

Specific Needs and Challenges

For decades, radioisotopes have played a crucial role in medicine, acting as tiny tracers to illuminate areas within the body, aiding doctors in the precise targeting and treatment of diseases.

1. **Supply-Demand Discrepancy**: the current supply of radioisotopes falls short of meeting the demand.
2. **Leveraging European Expertise**: IFIGENEIA leverages Europe's expertise in acceleration technology, notably, through the renowned laboratory at CERN.
3. **Knowledge Integration**: The aim is to merge European knowledge in acceleration technology with established methods for radioisotope production.
4. **Breakthroughs and Patents**: IFIGENEIA seeks to pioneer breakthroughs and patent particle acceleration techniques in Europe.
5. **Rapid, Efficient, and Cost-effective Production**: The goal is to enable the rapid, efficient, and cost-effective production of a complete spectrum of highly in-demand radioisotopes today.
6. **Improved Outcomes**: This advancement holds the promise of providing millions of individuals afflicted with cancer and other life-threatening illnesses with renewed hope for improved outcomes.

[1] https://www.snmmi.org/AboutSNMMI/Content.aspx?ItemNumber=6433
[2] https://www.snmmi.org/AboutSNMMI/Content.aspx?ItemNumber=5648
[3] https://med.stanford.edu/nuclearmedicine.html
[4] https://nusano.com/wp-content/uploads/2023/05/Nusano_At211_COSTMeeting_webpub.pdf

Opportunity

The IFIGENEIA Excellence Hub proposes a unique opportunity by developing a local LINAC facility for producing diverse, marketable radioisotopes. These compact, green, and easily tunable accelerators offer a versatile solution for diagnostics and treatment. Leveraging mature technology from CERN, the project focuses initially on beta emitters, expanding later to novel radionuclide therapy agents for cancer treatment. This initiative not only addresses limitations but also presents opportunities for business models, high-tech spin-offs, and broader societal and research applications, including art preservation, sample irradiation, environmental studies, and particle-based therapy.

The EU emphasizes the crucial role of radiopharmaceuticals, especially in cancer treatment, with specific regulations and guidelines in place. [5] [6]. The EU is a global leader in current medical radioisotope supply, maintaining high standards for quality and safety[7]. However, the regulatory framework for radiopharmaceuticals is not fully harmonized across European countries, leading to variations in their preparation and use[8]. This presents an opportunity for initiatives like IFIGENEIA, which aligns with the RIS3 priorities for Greece, Slovenia, and Cyprus, to contribute to the development and harmonization of this important medical field[9] [10] [11].

IFIGENEIA Targeted Breakthrough

The vision of the IFIGENEIA project is to establish a cutting-edge linear accelerator (LINAC) facility in the Balkans, aiming to significantly advance research and innovation (R&I) capabilities in the field of nuclear medicine and molecular imaging, with a specific emphasis on radiopharmaceuticals for medical applications. The project envisions the creation of three Excellence Hubs in Greece, Slovenia, and Cyprus, dedicated to developing a LINAC based facility capable of producing a diverse range of marketable radioisotopes. The project's key pillars include the establishment of Excellence Hubs, the formulation of a cross-border joint R&I Strategy, the crafting of an Investment Strategy & Plan, the implementation of innovative R&I products and services, and the mentorship of Western Balkan countries. Focused on supporting the healthcare sector and scientific research, the project aims to foster and sustain R&I in nuclear medicine and molecular imaging technologies by creating a robust and enduring technological and business framework. The interconnected Excellence Hubs will actively engage in national and international collaborations, fostering cross-border partnerships to achieve common strategic goals and enhance value-adding chains. Each Hub will bring together regional and national stakeholders in healthcare, culture, academia, businesses, public sectors, and societal actors, working collaboratively to strengthen capacities and effectiveness in promoting innovation excellence in sustainable nuclear medicine and culture within their respective regions. Aligned with regional or national smart specialization strategies, the project envisions a transformative impact on the advancement of R&I in the targeted fields.

1.1.2 IFIGENIA Key Objectives [1-1,5 pages]

The project Key objectives follow SMART principles i.e. they are: ***Specific*** linked to specific needs identified in section 2.3 & Deliverables (section 3), ***Measurable*** linked to expected results and KPI related outcomes/impacts see section 2.3, ***Achievable*** as they are based on partners' expertise and technologies that have already been pre-piloted, ***Relevant*** directly linked to the scope of the topic and the work programme, and ***Time-Related*** as they are linked with specific WP/tasks (see GANTT).

[KO#1]: Establishment of LINAC Excellence Hubs and EU-wide LINAC Cluster

Such Hubs will be established as permanent structures in the participating Widening countries (Greece, Slovenia, Cyprus), in cutting-edge science and innovation excellence areas of nuclear medicine and molecular imaging, with the aim of supporting with new solutions and products (e.g. radiopharmaceuticals). The Hubs will be regionally developed innovation ecosystems connected across EU, providing improved access to excellence for R&I actors in Widening countries, reinforcing knowledge transfer and the development of entrepreneurial skills, promoting the uptake of innovative technologies; and offering a paradigm of new European strategic value chain in the domain of nuclear medicine and molecular imaging. To this end, the project will foster the creation of an EU-wide cluster to explore the untapped potential of LINAC at EU scale. These hubs will foster collaboration between academia, industry, government, and society in the field of nuclear medicine and molecular imaging. They will serve as focal points for innovation and R&I activities, aligned with regional smart specialization strategies and EU policies.

KERs	Success indicators
KER1 – KER5	(Y0= by end of project; Y1=1st year post-end, Y3=3rd year post-end) KPI1: *Academia-public-business-societal members (total for 3 Hubs): 286 (at Y3)*, KPI2: *Organisation*

[5] https://pubmed.ncbi.nlm.nih.gov/28124548/
[6] https://link.springer.com/article/10.1007/s00259-023-06472-1
[7] https://energy.ec.europa.eu/topics/nuclear-energy/radiological-and-nuclear-technology-health/medical-uses-radiation_en
[8] https://academic.oup.com/jphsr/article/12/3/363/6325242?login=false
[9] https://ec.europa.eu/regional_policy/assets/s3-observatory/regions/el52.html
[10] https://ec.europa.eu/regional_policy/assets/s3-observatory/regions/si.html
[11] https://ec.europa.eu/regional_policy/assets/s3-observatory/regions/cy.html

	of international multidisciplinary conference:1, KPI3: *Submission of scientific papers: 10*

S: Linked with SN#2, SN#3

M: Linked Call Outcomes: #1, #2, #4, #7, #8 / Linked Destination Impacts: #1, #3, #4 (see § 2.1-2.3)

A: Linked partners: *All partners*

R: Relation to the work programme topic: *Excellent and sustainable place-based R&I ecosystems in Widening countries and beyond in relevant domains of cutting-edge science and innovation*

T: Linked WPs: *WP5, WP2*

[KO#2]: Development of a cross-border cooperative R&I plan for the Hubs' activities

With regard to the Linear Accelerator, the Strategy will work to improve business R&I investment climate, deploy innovative nuclear medicine and molecular imaging technologies, and increase the adoption and visibility of research findings in society and the economy. The following are the main pillars: Infrastructure (e.g., access to technological platforms and tools, infrastructure development and innovation, joint pre-competitive R&D, readiness assessment, technology concept development), Technical Facilitation of Scale up (e.g., concept validation, prototyping), Validation (e.g., product demonstration, validation by end-users). The Strategy will be in line with EU policy aims, including the directives of the European Association of Nuclear Medicine (EANM), and regional and national smart specialization initiatives (RIS3). These strategies will be underpinned by concrete action plans, aligning with regional/national R&I priorities, and EU policy objectives such as the green and digital transition.

KERs	**Success indicators**
KER5	KPI1: *Number of R&I Strategies (1/Hub),* KPI2: *Science-business synergies in 3 Hubs within Strategy and Action Plans: 10*

S: Linked with SN#1, SN#5

M: Linked Call Outcomes: #1, #2, #3, #4, #5 / Linked Destination Impacts: #1, #2, #3, #4 (see § 2.1-2.3)

A: Linked partners: All partners

R: Relation to the work programme topic: *Cross-border joint R&I strategy aligned with regional smart specialisation strategies and/or European policy priorities such as the green and digital transition*

T: Linked WPs: *WP3, WP4, WP5*

[KO#3]: Analysis on the creation of an investment strategy and plan for carrying out the joint R&I strategy.

In order to support regional and cooperative cross-border R&I efforts (such as infrastructures, common solutions or technologies, demonstrators, and pilot projects), this will be organized as common investment plans of the Hubs. It will do this by utilizing national, regional, and EU funds (such as ERDF, HE) as well as private synergistic investments (such as venture capital, business angels, and PPP schemes). Our investment plan will go beyond the duration of the currently proposed project and toward the LINAC Excellence Hubs' sustainable future.

KERs	**Success indicators**
All KERs	KPI1: *Number of Investment Plans for future LINAC investments: 3*

S: Linked with SN#4, SN#5

M: Linked Call Outcomes: #2, #3, #4 / Linked Destination Impacts: #3, #4 (see § 2.1-2.3)

A: Linked partners: *All Partners*

R: Relation to the work programme topic: *Action and investment plans for the implementation of the strategy*

T: Linked WP/tasks: *WP3, WP5*

[KO#4]: Conduct R&I Pilot Projects and Evidence-Based Research

IFIGENEIA project will undertake joint pilot research projects focused on closing knowledge gaps and advancing science and technology development in the field of radioisotope production and radiopharmaceuticals. These pilots will generate evidence to underpin the development of joint R&I strategies and investment plans, driving innovation and competitiveness in the sector. The design and planning for these new pilot projects and demonstrations will be in line with the joint Strategy and the respective Action Plan, taking also into account RIS3 strategies.

KERs	**Success indicators**
KER1, KER, KER4	KPI1: *Number of Pilot Projects Initiated: 2*, KPI2: *Number of scientific publications generated as a result of the pilot projects: 2*

S: Linked with SN#5, SN#6

M: Linked Call Outcomes: #3, #4/ Linked Destination Impacts: #2 (see § 2.1-2.3)

A: Linked partners: *All partners*

R: Relation to the work programme topic: *Conceptual design and pre-planning for pilots and demonstrators*

T: Linked WP/tasks: *WP4*

[KO#5]: Promote Inclusivity and Mentorship for Emerging Innovation Ecosystems

Engage with emerging innovation ecosystems from rural areas, the Western Balkans (Bosnia&Herzegovina), through mentoring modules and knowledge exchange programs (Accelerator school, Master Classes in Particle Therapy and Implementation of a Virtual Interactive Radioisotope Production Unit). This will support the inclusion of these ecosystems in the project activities and facilitate their development towards a full quadruple helix structure, contributing to the overall objectives of the project and the widening of participation in European R&I initiatives.

KERs	**Success indicators**
KER1, KER2	KPI1: *Satisfaction of the mentored ecosystems on the effectiveness and impact of mentoring activities: >80%,* KPI2: *Level of stakeholder engagement, collaboration intensity, and institutional capacity building: >80% satisfaction*

S: Linked with SN#2, SN#3, SN#5, SN#6

M: Linked Call Outcomes: #5, #6, #7 / Linked Destination Impacts: #3, #4 (see § 2.1-2.3)

A: Linked partners: CERN, UNSA, AUTH, ALEXMOLDS, CERTH, GSI, GNP

R: Relation to the work programme topic: *Inclusion of emerging innovation ecosystems from rural areas, Western Balkans and Eastern Partnership countries including Ukraine by optional mentoring module*

T: Linked WP/tasks: *WP3, WP4, WP6*

[KO#6]: Participation in activities that promote cohesion, outreach, and uptake.

Consists of initiatives to increase public awareness of the IFIGENEIA Excellence Hubs, citizen involvement in the Hub ecosystems, technology awards, open shows featuring nuclear medicine and molecular imaging technologies, skill development in these fields through research and innovation, training in entrepreneurship, and staff exchanges between ecosystems (such as reciprocal secondments aimed at fostering long-term relationships and trust). Complementary activities include networking and matchmaking, knowledge transfer, technology, and cross-fertilization between Hub members, as well as the sharing of best practices. They also include feeding RIS3 strategies with components pertaining to the ethical and sustainable valorization and publicizing of Linear Accelerator assets. An examination of the IFIGENEIA Hubs' potential for replication in other EU nations will strengthen the effect of these activities. This analysis will take the form of a roadmap for utilizing project outcomes to construct LINAC Excellence Hubs in other regions and create an EU-wide cluster.

KERs	**Success indicators**
All KERs	KPI1: *Training workshops & participants: at least 10 & 200*, KPI2: *Letter of Interest to join the new cluster: at least 15*, KPI3: *Licensing agreements, spin-off creation, and industry collaborations: >10*

S: Linked with SN#1, SN#3, SN#5

M: Linked Call Outcomes: #5, #7, #8, / Linked Destination Impacts: #3, #4 (see § 2.1-2.3)

A: Linked partners: CERN, AUTH, GSI, TPOLIS, CERTH

R: Relation to the work programme topic: *Accompanying measures (raise visibility, tech-transfer, entrepreneurship training, staff exchange, mutual learning)*

T: Linked WP/tasks: WP2, WP3, WP5, WP6

#§PRJ-OBJ-PO§#

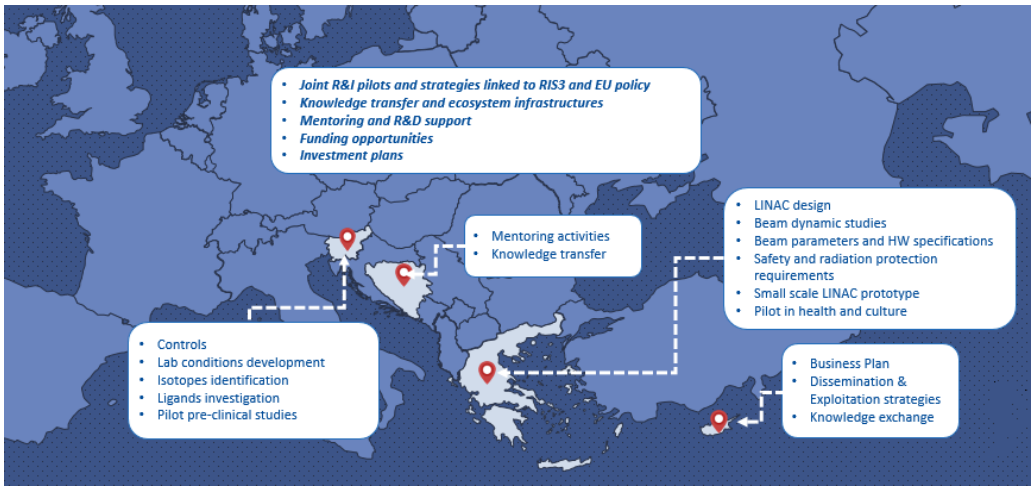
1.2 Coordination and/or support measures and methodology [e.g. 6 pages] #@CON-MET-CM@# #@COM-PLE-CP@#

1.2.1 The IFIGENEIA Concept and Approach [e.g. 4-5 pages]

IFIGENEIA aims to build in the participating Widening countries (i.e. Greece, Slovenia and Cyprus), Linear Accelerator technologies Hubs, as permanent structures, supporting with new innovative solutions and products, the sustainable production, management, accessibility and promotion of nuclear medicine and molecular imaging. Although the new Hubs will be scoped regionally, they will be interconnected and oriented towards national and international synergies (i.e. beyond regional borders), pursuing cross-border collaborations on common strategic goals and alongside value adding chains. Each Excellence Hub will bring together all regional/national actors related to Linear Accelerator applications and radioisotopes, including research/academia, businesses, public sector, and societal actors (i.e. 4-helix approach), which will mutually reinforce their capacities and effectiveness, towards raising innovation excellence in sustainable Nuclear Medicine and Culture in respective regions.

The envisioned Excellence Hubs will provide: (a) improved access to excellence for R&I actors (e.g. trend watching, technology scouting, brokerage and value-chain reinforcement); (b) reinforce knowledge transfer (e.g. training, secondments) and development of entrepreneurial skills (e.g. new competencies and skills for researchers, entrepreneurs and professionals in Nuclear Medicine R&I, new business opportunities for SMEs and new

employment); (c) promote the uptake of innovative technologies; and (d) offer a paradigm of new European strategic value chain in the domain of radiopharmaceuticals. To this end, IFIGENEIA will foster the creation of an EU-wide cluster to explore the untapped potential of Linear Accelerator at EU scale. Furthermore, IFIGENEIA aims to develop an improved R&I business environment and strategy utilizing nuclear medicine and molecular imaging technologies related to healthcare and culture: (a) Research Development & Innovation; (b) Infrastructure; (c) Technical Facilitation of Scale up; and (d) Validation. This strategy will be aligned with regional/national RIS3 and EU policy priorities, while it will be accompanied by an Action Plan setting implementation goals, timeframes, and actors. The Strategy will also address issues related to Hub's permanent establishment (engineering/infrastructural issues, etc).



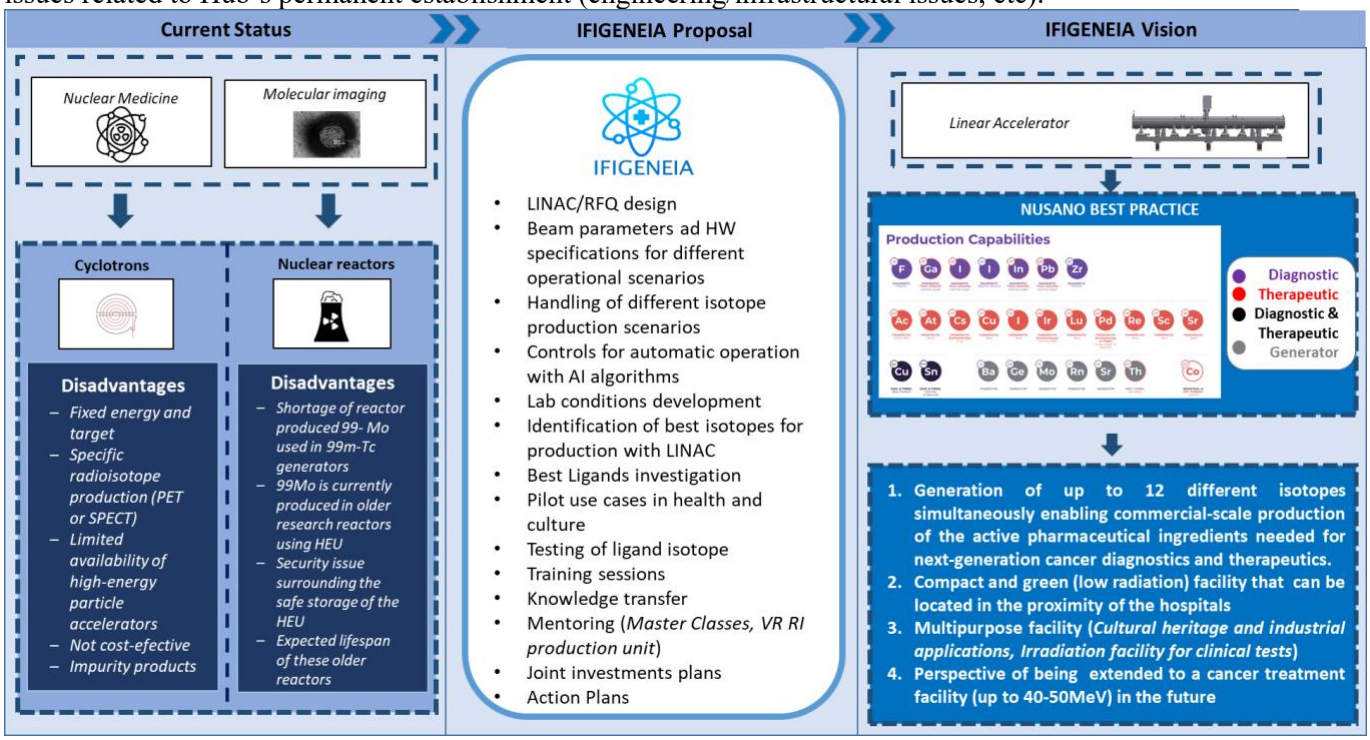


Figure 2. IFIGENEIA conceptual architecture

The implementation approach consists of 5 interrelated phases: **Phase 1: LINAC design and definition of specifications (WP3)**: The first phase (WP3) focuses on designing the LINAC/RFQ and implementing beam dynamics studies, as well as on defining the beam parameters and HW specifications for different operational scenarios in which the IFIGENEIA project will validate its results. This phase also includes the controls for automatic operation and the implementation of a study for the Safety and Radiation protection requirements, while computational tools with the use of AI algorithms will also take place. **Phase 2: Radioisotope production (WP4)**: Phase 2 includes the development of the required lab conditions for producing isotopes and identify the best isotopes for LINAC production. Moreover, an Investigation for the best ligands will take place and a demo implementation in health and culture domain. **Phase 3: Investment plans and financing opportunities (WP5)**: This phase explores sustainable business models for various stakeholders in the Nuclear Medicine domain formalizing practical yet economically viable solutions that can contribute to the scalability and replicability of IFIGENEIA. **Phase 4: Mentorship and Capacity Building (WP6)**: This phase is dedicated to the mentoring module of IFIGENEIA project

that will be offered to UNSA and other entities of Western Balkan area. All above phases are supported by horizontal activities, namely **Education, Dissemination, Inclusion and Diversity (WP2) and Project Management (WP1)**.

1.2.2 Description of IFIGENEIA Excellence Hubs

Greek IFIGENEIA Excellence Hub
Territory: It covers the northern Greece, with the base in the Region of Central Macedonia (Thessaloniki city). AUTH, IFIGENEIA's coordinator in Thessaloniki is the largest University in Greece covering all disciplines.
Core partners (initially): AUTH (academia), RCM (government), CERTH (research), BIOKOSMOS (sme), TPOLIS (NGO), AMTH (public body for culture domain, societal domain), GNP (public hospital), AMOLDS (sme), NCSRD (research). Only AMOLDS and NCSRD are not based in the region of Central Macedonia but they enhance and give added value to the Greek hub with their expertise in manufacturing mechanical parts for the Linear Accelarator and Prototypes (AMOLDS) and in operating Accelerators and RI research (NCSRD).
Relevance with RIS3: C.21 - Basic pharmaceutical products and pharmaceutical preparations; Q.86 - Human health activities
Types of stakeholders to be engaged by the Hub: All quadrupled helix pillars of a cluster incl. local governments at the level of Regions, Universities and Research Centers, societal actors and businesses.
Hub KPIs: (Y0= by end of project; Y1=1st year post-end, Y3=3rd year post-end)**:** no of awareness raising workshops *(Y1=1, Y2=2, Y3=4);* no of regional/national roadshows *(Y1=1, Y2=2, Y3=4);* no of open calls to publish for acceleration *(Y1=2, Y2=2, Y3=4);* no of trained scientists through the virtual radioisotope production unit *(Y1=100, Y2=250, Y3=400);* no of regions involved (*2);* number of mentoring students *(Y1=200, Y2=1000, Y3=2000);* no of training courses*(Y1=2, Y2=4, Y3=6);* **Regional** funds to support IFIGENEIA R&I *(Y1=500K, Y2=1000K, Y3= 2000K).* **IFIGENEIA horizontal KPIs**: No of Research/Academia members*(Y0=3; Y1=4, Y2=7, Y3=10)*; No of public members *(Y0=2; Y1=4, Y2=5, Y3=8)*; No of business *(Y0=2; Y1=10, Y2=20, Y3=35)*; No of societal *(Y0=1; Y1=4, Y2=10, Y3=15)*; Mobilization national+regional+private (PPP) funds/strategic investments in Hub operation(K€) (*Y1=500, Y2=1400, Y3=2300*).
Associated partners & endorsed entities: Associated: CERN, DKFZ, GSI, AMOLDS, NCSRD; Endorsed:
Slovenian IFIGENEIA Excellence Hub
Territory: It covers all the Slovenia country.
Core partners (initially): UL (academia), IJS (research), COSYLAB (industry), SIH (gonvernment), IAS (societal)
Relevance with RIS3: Medical Technologies
Types of stakeholders to be engaged by the Hub: All quadrupled helix pillars of a cluster incl. local governments at the level of Regions, Universities and Research Centers, societal actors and businesses.
Hub KPIs: (Y0= by end of project; Y1=1st year post-end, Y3=3rd year post-end)**:** no of awareness raising workshops *(Y1=1, Y2=1, Y3=2);* no of regional/national roadshows *(Y1=1, Y2=1, Y3=1);* no of open calls to publish for acceleration *(Y1=1, Y2=1, Y3=2);* number of mentoring students *(Y1=50, Y2=100, Y3=100);* no of training courses*(Y1=1, Y2=2, Y3=2);* **Regional** funds to support IFIGENEIA R&I *(Y1=200K, Y2=500K, Y3= 800K).* **IFIGENEIA horizontal KPIs**: No of Research/Academia members*(Y0=2; Y1=3, Y2=3, Y3=4)*; No of public members *(Y0=1; Y1=2, Y2=3, Y3=4)*; No of business *(Y0=1; Y1=3, Y2=5, Y3=10)*; No of societal *(Y0=1; Y1=2, Y2=2, Y3=3)*; Mobilization national+regional+private (PPP) funds/strategic investments in Hub operation(K€) (*Y1=300, Y2=500, Y3=800*).
Associated partners & endorsed entities: Associated: CERN, DKFZ, GSI Endorsed:
Cypriot IFIGENEIA Excellence Hub
Territory: It covers all the Cyprus country.
Core partners (initially): UCY (academia), TALOS (business), PASYKAF (societal), SHSO (government)
Relevance with RIS3: Molecular and Medical Genetics (Medical Translational Research); Digital health; Molecular diagnosis and development of specialised pharmaceuticals
Types of stakeholders to be engaged by the Hub: All quadrupled helix pillars of a cluster incl. local governments at the level of Regions, Universities and Research Centers, societal actors and businesses.
Hub KPIs: (Y0= by end of project; Y1=1st year post-end, Y3=3rd year post-end)**:** no of awareness raising workshops *(Y1=1, Y2=1, Y3=2);* no of regional/national roadshows *(Y1=1, Y2=1, Y3=1);* no of open calls to publish for acceleration *(Y1=1, Y2=1, Y3=2);* number of mentoring students *(Y1=50, Y2=100, Y3=100);* no of training courses*(Y1=1, Y2=2, Y3=2);* **Regional** funds to support IFIGENEIA R&I *(Y1=200K, Y2=500K, Y3= 800K).*

IFIGENEIA horizontal KPIs: No of Research/Academia members*(Y0=1; Y1=2, Y2=3, Y3=4)*; No of public members *(Y0=1; Y1=2, Y2=3, Y3=4)*; No of business *(Y0=2; Y1=3, Y2=5, Y3=10)*; No of societal *(Y0=1; Y1=2, Y2=2, Y3=3)*; Mobilization national+regional+private (PPP) funds/strategic investments in Hub operation(K€) (*Y1=200, Y2=300, Y3=500*).

Associated partners & endorsed entities: Associated: CERN, DKFZ, GSI Endorsed:

1.2.3 Innovative R&I prototype solutions and advancement of the State-of-the-Art

1.2.3.1 Linear Accelerator (LINAC) Technology **[Current TRL4, Final TRL6]**

SoA: LINACs are versatile machines commonly used in medical facilities for cancer treatment, particularly in radiation therapy. They generate high-energy radiation beams that can precisely target tumors to destroy cancerous cells while minimizing damage to surrounding healthy tissue. Although LINAC technology is well-established for radiation therapy, its application for radioisotope production and medical imaging is relatively new. LINACs offer several advantages for radioisotope production, including tunable energy levels, high beam intensities, and flexibility in target material selection. However, optimizing LINAC parameters for efficient radioisotope production and integrating LINACs with medical imaging systems present technical challenges that require innovative solutions.

Beyond SoA: Beyond-state-of-the-art advancements in LINAC technology involve integrating LINACs with medical imaging modalities, such as PET, SPECT, or magnetic resonance imaging (MRI), to enable real-time monitoring of radioisotope production and imaging in a single system. This integrated approach offers several advantages, including improved workflow efficiency, enhanced image-guided radiotherapy (IGRT), and precise dose delivery. By combining radioisotope production and medical imaging capabilities in a single platform, integrated LINAC-medical imaging systems facilitate seamless integration of diagnostic and therapeutic procedures, leading to more personalized and effective patient care. Moreover, R&I strategies involve leveraging big data analytics, machine learning, and artificial intelligence (AI) algorithms to analyze large volumes of data and extract actionable insights for decision-making. This includes mining research publications, patent databases, clinical trial data, and healthcare records to identify emerging trends, predict future developments, and optimize resource allocation in the field of nuclear medicine and molecular imaging. Data-driven R&I strategies enable evidence-based policy.

1.2.3.2 Radioisotope Production **[Current TRL3, Final TRL5]**

SoA: Radioisotopes (RI) are essential for various applications in nuclear medicine, including diagnostic imaging, cancer therapy, and biomedical research. Current methods for RI production primarily rely on cyclotrons and nuclear reactors. Cyclotrons offer immediate usability but have limited production capability and high costs. Nuclear reactors provide a higher yield of RI but face challenges in availability, safety, and environmental sustainability. Despite their widespread use, both methods have limitations, including restricted access to certain RI and concerns over radioactive waste disposal. As a result, there is a need for alternative, more efficient, and sustainable methods of RI production.

Beyond SoA: Beyond-state-of-the-art advancements in RI production involve the development of advanced LINAC technologies capable of producing a wide range of RI with high efficiency, purity, and specificity. This includes optimizing LINAC parameters such as energy levels, beam currents, and target materials to maximize RI yields while minimizing unwanted by-products and radiation exposure. Advanced LINAC-based production methods may also incorporate innovative target design, recycling strategies, and online monitoring systems to enhance safety, reliability, and sustainability.

1.2.3.3 Radiopharmaceutical Development **[Current TRL4, Final TRL6]**

SoA: Radiopharmaceuticals are compounds containing a radioactive isotope used for diagnostic or therapeutic purposes in nuclear medicine. The most widely used diagnostic radiopharmaceutical is technetium-99m (99mTc), which is typically produced from molybdenum-99 (99Mo) obtained from nuclear reactors. While effective, current radiopharmaceuticals may have limitations such as limited targeting specificity, short half-lives, and potential side effects. Additionally, there is growing interest in the development of theranostic radiopharmaceuticals, which combine diagnostic and therapeutic capabilities to enable personalized medicine approaches in cancer treatment.

Beyond SoA: Beyond-state-of-the-art advancements in radiopharmaceutical development focus on the design and synthesis of next-generation compounds with improved targeting specificity, imaging sensitivity, and therapeutic efficacy. This involves leveraging advanced molecular imaging techniques, such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT), to optimize ligand-receptor interactions and enhance disease detection and treatment. Additionally, advancements in radionuclide chemistry, radiolabeling methods, and drug delivery systems enable the creation of theranostic radiopharmaceuticals tailored to individual patient needs and disease characteristics.

1.2.3.4 Virtual Reality (VR) Training for Radioisotope Production **[Current TRL4, Final TRL6]**

SoA: Currently, training programs for radioisotope production primarily rely on traditional methods such as

classroom lectures, hands-on laboratory sessions, and apprenticeships in specialized facilities. While these approaches are effective to some extent, they often face limitations in terms of accessibility, scalability, and realism. Virtual reality (VR) technology has started to emerge as a promising solution to address these challenges. Some existing VR training applications in the medical field focus on anatomy education, surgical simulation, and patient care scenarios. However, the use of VR specifically for training in radioisotope production is relatively limited. Existing VR platforms lack the specificity and fidelity required to accurately simulate the intricate processes involved in radioisotope production, such as target preparation, irradiation, and quality control. Furthermore, the integration of VR into existing training programs for nuclear medicine and molecular imaging professionals is still in its infancy, with few examples of comprehensive VR modules tailored to the specific needs of this niche field.[12]

Beyond SoA: The implementation of a Virtual Reality (VR) Radioisotope production unit within the IFIGENEIA project represents a significant leap beyond the current state of the art. Unlike existing VR applications that offer generic medical training scenarios, the IFIGENEIA VR platform will provide a highly specialized and immersive simulation environment tailored specifically to the complex processes involved in radioisotope production. Leveraging advanced graphics, physics simulations, and interactive elements, the VR unit will offer unprecedented realism and fidelity, allowing users to experience the intricacies of radioisotope production first-hand. Furthermore, the IFIGENEIA VR platform will pioneer the integration of mentoring and collaboration features, enabling experienced professionals to remotely guide and mentor trainees in real-time, fostering knowledge exchange and expertise transfer across geographical boundaries. This innovative approach will revolutionize training and mentoring in the field of nuclear medicine and molecular imaging, accelerating the development of skilled professionals and advancing the adoption of novel radioisotope production technologies for improved patient care.

1.2.4 Relevant national & international research and innovation activities linked with the project

Relevant EU projects from Consortium partners	Results relevant to IFIGENEIA
ARIES: ARIES is an Integrating Activity project which aims to develop European particle accelerator infrastructures. (CERN)	CERN will transfer to IFIGENEIA project all the acquired knowledge regarding the accelerator infrastructures that will be valuable for the future LINAC establishment.
iFAST: iFAST tackles challenges faced by future accelerators and helps to develop breakthrough technologies of multiple accelerator platforms (CERN)	IFIGENEIA will benefit from iFAST as CERN will offer its knowledge for the design of future accelerators, promoting innovation in the accelerator community
EuroCirCol: The project is a conceptual design study for a post-LHC research infrastructure based on an energy-frontier 100 TeV circular hadron collider.	CERN's experience in the design study implemented in EuroCirCOl as part of the Future Circular Collider study proposing a post LHC project will benefit IFIGENEIA.
NOAR – COST Action: Network for Optimized Astatine labeled Radiopharmaceuticals	IFIGENEIA will gain best practices and knowledge from NOAR COST regarding the production, chemistry, radiochemistry, biology, preclinical and clinical research and delivery of radiopharmaceuticals to patients.
PRISMAP: The European medical isotope programme: Production of high purity isotopes by mass separation	IFIGENEIA will benefit from PRISMAP in several issues as 1) access to new radionuclides and new purity grades for the medical research; 2) access to a common entry port and web interface to the starting research community; 3) Regulatory procedures to enhance research with radiopharmaceuticals; 4) Delivered radionuclide data and regulation, along with biomedical research capacity
BCThubs: Blue Culture Technology Excellence Hubs in EU Widening Member States (CERTH)	IFIGENEIA will benefit from the BCThubs regarding the know-how of the establishment of an excellence hubs networking (e.g. infrastructures, regulations, etc.).
SEEIIST: South East European International Institute for Sustainable Technologies (GNP).	IFIGENEIA will benefit from the cutting-edge technologies, such as the ones developed at CERN1 , GSI2 and other hi-tech research laboratories.

[12] https://indico.cern.ch/event/840212/page/17964-enlight-interactive-hadron-therapy-facility

Relevant EU projects from Consortium partners	Results relevant to IFIGENEIA
IAEA technical cooperation project RER6039 : Developing Human Resources for Setting Up an Ion Beam Therapy Centre within the Joint South East European International Institute for Sustainable Technologies" (GNP)	IFIGENEIA can capitalise on the outcomes of RER6039 in multiple ways. By engaging with scientists and experts from RER6039, IFIGENEIA can tap into their knowledge and expertise, facilitating collaboration and learning opportunities.
Factory2Fit: Empowering and participatory adaptation of factory automation to fit for workers	IFIGENEIA will be benefited by the Virtual factory in VR tool that was developed during Factory2Fit.

1.2.5 Open Science practices [e.g. 1 page]

IFIGENEIA will diligently adhere to all necessary measures to align with Open Science practices as outlined in the Horizon Europe guidelines. Specifically, IFIGENEIA will address the following key aspects:

Early and Transparent Sharing of Research: Throughout the project, all partners will employ methods and procedures to ensure the timely and transparent sharing of project outcomes. This includes preregistering research plans before study implementation and submitting registered reports to Open Access Repositories such as Figshare, PeerJ, OSF Preprints, Zenodo.

Research Output Management and Reproducibility Measures: IFIGENEIA will place special emphasis on guaranteeing outputs' reproducibility covering the main research processes: reproduction, replication, and re-use.

Open Access to Research Outputs and Participation in Open Peer-Review: All research outputs resulting from IFIGENEIA will comply with the Open Access and Open Science regulations of the EU. Project publications will be released in Open Access Journals, initially verified through platforms like SHERPA/RoMEO and DOAJ to confirm adherence to open access and copyright policies. Additionally, Open Access Repositories such as PubMed, Zenodo, arXiv, etc., identified through platforms like ROAR, OpenDOAR, OpenAIRE and OAD, will be utilized.

Involvement of Relevant Knowledge Actors in Co-creation: IFIGENEIA will actively engage the public, non-professional scientists, and stakeholders from various domains (public, social, research, and business) in the co-creation of R&I agendas and contents. This will be particularly highlighted during the phases of WP2, WP3, and WP4, playing a crucial role in the implementation and evaluation of the project and the envisioned Excellence Hubs.

1.2.6 Research data management [e.g. 0,5 page]

IFIGENEIA will carry out data collection, including personal data and metadata (in the context of the piloting and monitoring phase). All processing of personal data will be conducted in accordance with the provisions of: **a)** the GDPR (Regulation (EU) 2016/679)[13], **b)** the Universal Declaration of Human Rights and the Convention 108 for the Protection of Individuals with Regard to Automatic Processing of Personal Data, and **c)** the national laws. Data managed during the project will be processed only under the following preconditions: **(i)** when the data subject has given her/his consent; **(ii)** when the processing is necessary for the performance of or the entering into a contract; **(iii)** when processing is necessary for compliance with a legal obligation; **(iv)** when processing is necessary to protect the vital interests of the data subject. Personal data managed within IFIGENEIA will be anonymized and stored in a form which does not permit identification of users. IFIGENEIA will establish a data management framework that guarantees security of collected data from potential abuse, theft, or loss. The **Data Management Plan DMP (D1.4)** will detail what data the project will generate (i.e., content, type, format, volume), which standards and methodologies will be used for data collection and management, whether and how it will be exploited and how they will be made findable, accessible, interoperable, and reusable (**FAIR**). Management of research data will be done in accordance with the related soft law instruments governing scientific research (e.g., the European Code of Conduct for Research Integrity, the Guidelines to rules on Open Access and on Data Management in Horizon Europe. **Types of data/research outputs**: IFIGENEIA will produce energy data monitoring, in several types as numerical data, texts, images, tables and other formats. **Findability of data/research outputs**: the data will have a) Persistent identifiers (PIDs) and will be deposited in trusted repositories as Zenodo; b) rich metadata to support findability, citation and reuse i.e. according to Dublin Core, CERIF, DDI; **Accessibility of data/research outputs**: The shared data will be deposited in an **Open Data repository** through the **re3data** (https://www.re3data.org/). Research outputs will be promoted to a) Open Research Europe platform and b) Horizon Results platform. **Interoperability of data/research outputs**: Produced data will use common formats and standards and community agreed schemas, controlled vocabularies, keywords, thesauri or ontologies where possible in order to be interoperable and be integrated with other data, applications and workflows; **Reusability of data/research outputs**: a README file for ensuring that the data can be correctly interpreted and reanalyzed by others will be created. IFIGENEIA will use the Creative

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.119.01.0001.01.ENG

Commons licenses and more specifically, the Attribution (CC BY) license and Creative Commons Zero (CC0) which is for dedicating works to the public domain. **Archiving and storage/preservation:** Data storage will be performed in a secured form (e.g. data encrypted) in servers indicated by the pilots or the technology providers.
#§CON-MET-CM§# #§COM-PLE-CP§#

2 IMPACT #@IMP-ACT-IA@#

2.1 IFIGENEIA's pathways towards impact [e.g. 4 pages]

2.1.1 IFIGENEIA's Expected Outcomes specified in this topic [1,5 pages]

IFIGENEIA will significantly contribute to the outcomes specified in this topic:

Call Expected OUTCOME #1: Excellent and sustainable place-based R&I ecosystems in Widening countries and beyond in relevant domains of cutting-edge science and innovation

The IFIGENEIA hubs create a well-defined cooperation framework organized among actors who work on relevant fields but are largely disconnected and scattered across EU. These match the quadruple helix and form regional ecosystems (the proposed IFIGENEIA hubs), creating a new R&I sector in EU (novel accelerators for innovative radioisotopes production for cancer therapy and in-therapy imaging). Project activities will contribute so that these place-based ecosystems can evolve and form a solid basis for a permanent partnership and strategic supporting "structure" – an EU-wide IFIGENEIA cluster *(i.e. to be formalized under a legal entity after project end)*. Our project's approach allows employing an open-cluster cooperation procedure, where each Hub's actors can complement with their expertise in R&I and develop related capacities (clustering effect). The Hubs maturing during the project will pave the ground and set the basis of an EU-wide IFIGENEIA cluster, thus securing the necessary continuation and sustainability after the project's end (i.e. innovation, growth, employment).

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**1.1** Organization of 1 international multidisciplinary event, submission of 10 research articles/conference papers ***(Sc)***
	Societal	**1.2**: New cooperation framework among societal actors of 3 hubs with 8 (Y1) and 21 (Y3) societal organizations engaged and 500 (Y1) and 1500 (Y3) citizens involved and outreached (Y0=end of project, Y1=1st year after the end of project). ***(Sc)***; **1.3**: New patents in particle acceleration techniques: at least 1
	Econ./Technological	**1.4**: Growth in the number of startups, spin-offs, and SMEs established within the ecosystem, as well as their revenue and job creation metrics ***(Si)***.

Call Expected OUTCOME #2: Long term joint R&I strategies underpinned by concrete action plans of European relevance

The work of the Hubs collaborators will provide joint R&I Strategies and Action Plans within the RIS3 and EU policies. The IFIGENEIA hubs maturing will result in the long-term "structure" of an EU-wide Cluster; reinforcing collaboration, networking and capacities via mutual learning. This cluster can support further the implementation of the developed joint strategies, and extend project outcomes via e.g. targeted pitching events, etc.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**2.1**: Scientific advances in 2 broad fields: Nuclear Medicine, Molecular Imaging. ***(Si)***; **2.2:** 3 R&I Strategies and Action Plans (1 per Hub) for developing new pilots and demos supporting R&I in IFIGENEIA, in line with EU, RIS3, etc. ***(Sc)***
	Societal	**2.3**: Long-term cooperation framework among IFIGENEIA actors for the benefit of science. ***(Si)***

Call Expected OUTCOME #3: Common investment plans for R&I including infrastructures leveraging national, regional and European funds as well as private capital in a synergetic manner

The established IFIGENENIA Hubs will work towards the preparation of joint Investment Strategies and Action Plans, leveraging PPP synergies. IFIGENEIA proposes a collaborative approach to investment planning for research and innovation (R&I) infrastructures. By establishing Excellence Hubs in the Balkan region and leveraging national, regional, and European funds, as well as private capital, the project aims to create a synergistic environment for R&I activities. Through coordinated investment plans, the project will mobilize resources to support the development of a state-of-the-art linear accelerator (LINAC) facility dedicated to radioisotope production for medical applications. By pooling resources from multiple sources, including public and private stakeholders, IFIGENEIA maximizes the impact of R&I investments, promotes knowledge transfer, and fosters innovation ecosystems in the targeted regions.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Societal**	**3.1**: New Scientific knowledge from implementation of proposed pilots/demonstrators ***(Si)***; **3.2**:>20.000 citizens affected by deployment of IFIGENEIA solutions/demos (incl. Research labs & infrasttructures) ***(Sc)***
	Economic Technologic	**3.2:** Mobilization national/reg.-private funds (PPP investment) in Hub's operation: € 6,8 mil.(Y1-Y3). ***(Sc);*** **3.3:** no of open calls to publish for acceleration (Y1-Y3): 16 ***(Sc)***

Call Expected OUTCOME #4: R&I pilot projects alongside a joint strategy and in line with regional and national strategies, notably regional innovation strategies for smart specialisation (RIS3) taking into account the new Innovation Agenda for Europe

EU has regulations and guidelines that highlight the importance of radiopharmaceuticals in medical applications, including cancer treatment. The development of novel radiopharmaceuticals is subject to rapid and highly innovative regulatory demands in Europe, and there are specific rules, guidelines, and guidance documents in the EU related to the pharmaceutical regulatory framework[14]. Additionally, the legal inclusion of radiopharmaceuticals into the pharmaceutical legislation has been addressed in the EU, with a focus on the need for action in the field of nuclear medicine, particularly in the context of cancer diagnosis and treatment[15]. Furthermore, the EU is a global leader in supplying medical radioisotopes and has established legal standards for quality and safety in radiology, radiotherapy, and nuclear medicine, emphasizing the significance of radiopharmaceuticals in cancer management[16]. Moreover, IFIGENEIA is fully aligned with the RIS3 for Greece, Slovenia and Cyprus for the period 2021-2027 as its scope is included in the high priorities of these countries. The locations of IFIGENEIA Hubs were selected under a common denominator related to **RIS3** and to EU strategies on developments of (a) technology and innovation; (b) cancer treatment modalities (see §1.2.2, Hubs' Description, under headings "Relevance with RIS3").

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**4.1**: Deployment of 1 joint R&I Strategy and Action Plan (incorporating hubs individual strategies and plans) addressing 2 main scientific pillars and 2 technologies. ***(Si)***; **4.2**: 2 New pilots and demonstration plans ***(Sc)*** **See** 3.2
	Societal	

Call Expected OUTCOME #5: New competencies and skills for researchers, entrepreneurs and professionals in R&I intensive domains

Tight links between the project's research/academia and business collaborators (inter-sectoral and cross-border) will result in crucial skills improvements related to cutting-edge LINAC technologies of paramount importance. Each Hub will implement the developed scientific/technological solutions, contributing to participants' enhanced expertise and competences. IFIGENEIA, through its comprehensive approach to project implementation, IFIGENEIA aims to foster a culture of continuous learning, innovation, and knowledge exchange, thereby equipping participants with the expertise and capabilities needed to thrive in a rapidly evolving research and innovation landscape. The project facilitates skills development through various activities, including training programs, workshops, secondments, and collaborative R&I projects, enabling participants to gain hands-on experience, expand their technical knowledge, and enhance their professional networks. By investing in human capital development, IFIGENEIA not only strengthens the capacity of individuals to contribute to R&I advancements but also cultivates a talented workforce capable of driving sustainable innovation and economic growth in the targeted regions and beyond.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**5.1**: 10 Training workshops on IFIGENEIA related fields, with >= 240 participants ***(Sc);*** **5.2**: Implementation of one (1) VR radioisotope production unit for mentoring and training. ***(Si);*** **5.3**: 60 professionals engaged in secondments (research business knowledge transfer). ***(Sc)*** **5.4**: no of trained scientists through the virtual radioisotope production unit (Y1-Y3): 3700 ***(Sc)***
	Economic Technological	**5.5**: Support of entrepreneurship and technology transfer activities among project participants, measured by the number of startups, spin-offs, or commercialization initiatives launched as a result of IFIGENEIA-supported R&I endeavors ***(Si)***

Call Expected OUTCOME #6: Strengthened linkages between science and business

IFIGENEIA creates an environment for interdisciplinary research and innovation that directly addresses the needs of the nuclear medicine industry. By involving industry partners in the design, implementation, and commercialization of research outcomes, the project facilitates technology transfer, promotes the uptake of scientific discoveries in practical applications, and accelerates the translation of R&I into marketable products and services. Moreover, by aligning R&I activities with regional smart specialization strategies and European policy priorities, IFIGENEIA ensures that scientific advancements are relevant and responsive to the needs of the business community, fostering a culture of innovation-driven entrepreneurship and economic growth.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Economic Technological**	**6.1:** no of regional/national roadshows *(Y1-Y3)*: 13 ***(Sc);*** **6.2:** no of open calls to publish for acceleration *(Y1-Y3)*: 16 ***(Sc)***

Call Expected OUTCOME #7: Improved knowledge transfer and development of entrepreneurial skills; New business opportunities especially for SMEs, university spin-offs and start-ups, especially deep tech; Inclusion of emerging innovation ecosystems from rural areas, Western Balkans and Eastern Partnership countries

[14] https://pubmed.ncbi.nlm.nih.gov/28124548/
[15] https://link.springer.com/article/10.1007/s00259-023-06472-1
[16] https://energy.ec.europa.eu/topics/nuclear-energy/radiological-and-nuclear-technology-health/medical-uses-radiation_en

including Ukraine by optional mentoring module

The established IFIGENEIA hubs have a great potential to appeal to talented (and young) professionals originating from the respective widening countries, providing job opportunities in emerging fields involving innovative technologies that are financially scalable and have major societal impacts; thus contributing to reversing brain drain. IFIGENEIA project will offer mentoring to the involved partners from Bosnia&Herzegovina as it was described above through the Accelerator Schools, the Master classes and the VR radioisotope production unit.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**See** 5.2, 5.3, 5.4
	Societal	**7.1**: Increase the employment rate: >300 new positions after the Y3 ***(Sc)***
	Economic	**See** 3.2
	Technological	

Call Expected OUTCOME #8: Contribute to EU-wide access to excellence, ERA Policy Agenda action 16

IFIGENEIA will contribute to the European Research Area (ERA) Policy Agenda action 16 by actively participating in collaborative research and innovation projects, fostering interdisciplinary collaborations, and facilitating knowledge exchange and capacity-building initiatives. The proposed Excellence Hub supports the implementation of open science practices, promote the use of research infrastructures, and facilitate the integration of research results into policy-making processes. By engaging with stakeholders from academia, industry, and government, the Hub can contribute to the ERA advancement and help address the objectives outlined in ERA Policy Agenda action 16.

2.1.2 IFIGENEIA's Expected Impacts specified in the corresponding Destination [1,5 pages]

IFIGENEIA will significantly contribute to the wider impacts, in the long term, specified in Destination Improved access to excellence.

Expected IMPACT #1: Increased science and innovation capacity for all actors in the R&I system in Widening countries; Structural changes leading to modernised and more competitive R&I systems in eligible countries; Reformed R&I systems and institutions leading to increased attractiveness and retention of research talents

IFIGENEIA hubs introduce a new field in R&I, novel approaches in nuclear medicine with great potential impact on nuclear medicine sectors and markets making EU a competitive player internationally. Many cancer cases can benefit from novel RI not used so far because of lack of appropriate specialized production facilities.

Among the project's aim is to raise the interest of potential actors at regions that could host such facilities and, most importantly, engage them into related R&I activities. The seed of this plan is the regional IFIGENEIA hubs and their respective actors which then will expand in an EU-wide cluster to fill the current gaps. Projections foresee expansion of such facilities available to society, further developing R&I procedures and engaging more regional actors. Furthermore, the societal impact will be twofold: leveraging the Research Infrastructure for cultural applications will increase public awareness of the significance of cultural heritage. Simultaneously, the extensive adoption of nuclear medicine for diagnostics and treatment will broaden society's engagement with critical health issues once considered taboo, such as cancer. Structural changes leading to a modernised and more competitive R&I systems across and beyond GR-SI-CY will be facilitated by a) developing joint Strategic R&I Agendas and investment plans (WP5) for research and academic cooperation, Medicine and culture pilots, common use of infrastructure, financing calls for cross border collaboration and promotion of investments, b) defining synergies, collaborations and R&I excellence plans and c) creating a framework for the exploitation and commercialization of the predesigns developed by IFIGENEIA, engaging the cooperation of startups, spinoffs, corporates, investors and other stakeholders

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**1.1**: Increased capacities in widening countries on: a) tech. integration and dev. related to Nuclear Medicine ***(Si)***.**1.2**: Increase over next decade: in number of patents, publications, # of scientists/professionals related to IFIGENEIA scientific field–in average 25% in participating widening countries. ***(Si)***
	Societal	**1.3**: Increase the readiness to host the first LINAC in Europe ***(Si)***
	Economic	**1.4**: no of open calls to publish for acceleration (Y1-Y3): 16 ***(Sc);*** **1.5:** Mobilization national/reg.-private funds (PPP investment) in Hub's operation: €6,8 M.(Y1-Y3). ***(Sc)***
	Technological	

Expected IMPACT #2: Mobilisation of national and EU resources for strategic investments

The expected project's outcomes are going to draw significant stakeholders' attention from private and public sectors. Nuclear medicine has great potential and is a very promising field with crucial impacts on public health. Comparing to its status in earlier years, its expansion has boosted cancer treatment for the benefit of cancer patients, but the field is still far from fully exploiting its real potential. Thus, progress is forecasted to explode in next decades. It is imperative that the early realization of such potential is in line with public funding policies and strategic investments instruments in general. Hence, the developed joint Investment Strategy and Action Plan and the expected investors engagement in the acceleration rounds, will be an important starting point that would then further expand with the EU-wide cluster establishment.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Economic Technological**	**2.1**: 3 R&I Strategies and Action Plans (1 per Hub) for developing new pilots and demos supporting R&I in IFIGENEIA, in line with EU, RIS3, etc. ***(Sc);*** **2.2:** Deployment of 1 joint R&I Strategy and Action Plan (incorporating hubs individual strategies and plans) ***(Si);*** **See** 1.5

Expected IMPACT #3: Higher participation success in Horizon Europe and more consortium leadership roles

Higher participation success in Horizon Europe and more consortium leadership roles will be achieved through increased cooperation between the members of the stakeholders of the participating countries and enhanced capacity of the stakeholders in the selected topics of Nuclear Medicine and the development of innovation acceleration mechanisms for the validation of various scenarios and use cases.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**3.1**: Number of approved HE projects for the consortium partners (Y3): >5 ***(Sc);*** **3.2**: Number of received funding through HE (Y3): >4M ***(Sc)***

Expected IMPACT #4: Stronger links between academia and business and improved career permeability; Strengthened role of the Higher Education sector in research and innovation; Improved outreach to international level for all actors; Greater involvement of regional actors in the R&I process

IFIGENEIA Hubs and the envisaged future cluster are firmly based on the quadruple helix. Hence, it is expected that tight, long-term, reliable links will be generated between academia and professionals (including SMEs) related to nuclear medicine growth and relevant accelerator technologies. Greater involvement of regional actors in R&I process will be facilitated through their participation in the process of reviewing and aligning strategies and plans for enhanced cross-border R&I cooperation and the development of Joint Strategic R&I Agendas and investment plans.

IFIGENEIA OUTCOMES (Sc: Scale) (Si: Significance)	**Scientific**	**4.1**: >50 collaborations (joint publications, internships, projects) among academia-business by Y3. ***(Sc);*** **4.2**: >10 scientific conferences in IFIGENEIA by Y3 (quadruple helix international actors). ***(Sc)***
	Societal	**4.3:** Positive effects on employment in academia or business. ***(Si);*** **4.4:** Regional societal progress from Roadmap for uptaking project outcomes & Hub Replication. ***(Si)***
	Economic Technologic	**4.5**: Increase in Nuclear Medicine market size (revenues) will lead to well-paid jobs for researchers/professionals.***(Si)***

2.1.3 IFIGENEIA's key target groups [0.5 page]

Key target groups identified, including the potential actors and the expected strategic impact of IFIGENEIA to them, are summarized in the following Table.

Table. IFIGENEIA's expected strategic impact for various stakeholders

Key Target Groups	Indicative actors
Academic Institutions	Universities, research institutes, and academic medical centers involved in nuclear medicine, medical physics, and molecular imaging research.
Policy makers	National and regional government bodies responsible for research funding, healthcare policy, and regulatory oversight.
Industry Partners	Pharmaceutical companies, biotechnology firms, medical device manufacturers, and technology providers involved in the development and commercialization of radiopharmaceuticals, imaging systems, and medical technologies.
Healthcare Providers	Hospitals, clinics, and medical centers offering nuclear medicine and molecular imaging services.
Cultural organisations	Museums, cultural heritage organisations, archaeological sites, etc.
Patient Advocacy Groups	Organizations representing patients with diseases targeted by nuclear medicine and molecular imaging technologies, such as cancer advocacy groups or patient associations for neurodegenerative disorders.
Investors and Funding Agencies	Venture capitalists, private equity firms, philanthropic foundations, and public funding agencies interested in supporting R&I initiatives in healthcare and medical technology.
Regulatory Authorities	National regulatory agencies responsible for approving medical devices, pharmaceuticals, and radiopharmaceuticals for clinical use.
Educational Institutions	Technical schools, vocational training centers, and academic programs offering training in medical physics, radiography, and nuclear medicine technology.
Community Partners	Local communities and civic organizations located near project sites or affected by project activities.

2.1.4 Requirements and potential barriers [0,5 page]

In order to map diverse factors that may determine whether the desired outcomes and impacts are achieved,

IFIGENEIA carried out a radiopharmaceutical market macroenvironment analysis using the PRESTEL approach. The table below presents the political (P), regulatory (R), economic (E), social (S), technological (T), environmental (E) and legal (L) factors that can have a hindering impact on IFIGENEIA together with mitigating measures.

P	**NUCLEAR PROLIFERATION CONCERS:** Geopolitical issues (see Russia vs Ukraine) impacting the availability and stable supply of key isotopes such as Molybdenum-98. **GLOBAL SUPPLY CHAINS DISRRUPTION:** Disruptions encountered during the pandemic instigated delays in the transportation of Technetium-99m due to restricted exports/production revealing vulnerability in the supply chain to externalities depended on geopolitics rather than market forces. **Mitigation Measures:** While government aims at diversifying sources of radioisotopes/radiopharmaceuticals to reduce dependency on geopolitically sensitive regions, IFIGENEIA's long-term goal is to establish a LINAC based radiopharmaceutical facility in Greece and thereafter replicate it in Slovenia and Cyprus, thus providing a solution to both threats related mainly to geopolitics such as Nuclear Proliferation Concerns and Global Supply Chain Disruptions.
R	**REGULATORY CHALLENGES:** Delays in the approval of radiopharmaceuticals in the U.S. and the scrutiny faced by Fluciclovine F-18 for prostate cancer imaging, highlight the industry's struggles with evolving and stringent regulatory frameworks. **Mitigation Measures:** The 4-helix structure of IFIGENEIA is well suited to proactively open discussion with policy makers and regulatory bodies, and navigate evolving legal/regulatory issues. Having a governmental arm in each hub can greatly help in smoothing the regulatory hurdles. Also having the societal arm assists in pressing for reforms where necessary. Moreover, investing in technology and training ensures strict compliance with radiation safety regulations and proactively addresses safety concerns by implementing best practices staying ahead of regulatory requirements.
E	**ECONOMIC CONSTRAINTS:** Economic constraints induced by the pandemic have resulted in global healthcare budget reductions, leading to reduced spending on radiopharmaceuticals. **LIMITED REIMBURSEMENT POLICIES:** Healthcare Systems often limit reimbursement towards expensive treatments thus impacting the adoption of radiopharmaceuticals, as seen in both the U.S. and the U.K. For example, Fluciclovine F-18 faced delays in the U.S. market, while reimbursement policies under the NHS in the U.K. restricted patient access to advanced diagnostic services like Gallium-68 PSMA PET scans. **HIGH INITIAL COST:** Furthermore, the high development costs associated with bringing novel radiopharmaceuticals to market, such as Alpha DaRT for cancer treatment and the research on alpha-emitting isotopes, showcase the financial challenges that limit investment. **Mitigation Measures:** IFIGENEIA shall advocate for radiopharmaceutical value and work with policymakers for fair reimbursement policies by emphasizing long-term benefits. Also, will aim at implementing competitive pricing strategies while maintaining focus on cost efficiency by exploring partnerships/collaborations to share costs/resources, enabling sustainable pricing model.
S	**PERCEPTION**: Persistent public perception and concerns, exemplified by the reluctance towards iodine-131 therapy due to radiation misconceptions, underscore the impact of limited awareness on the acceptance of radiopharmaceuticals. **Mitigation Measures:** Launch targeted awareness campaigns, collaborate with healthcare professionals, and address misconceptions through education to address safety concerns and the benefits of radiopharmaceuticals emphasizing rigorous safety measures in place. Building capacity in the 4-helix structure of IFIGENEIA including the societal arm will greatly assist in this direction.
T	**ADVANCED TECH IMPLEMENTATION CHALLENGES**: Challenges in implementing advanced technologies, like total-body PET scanners such as the uEXPLORER, highlight the slow adoption due to technical complexities. **RESULTS INTERPRETATION:** Limited expertise in managing and interpreting results further impedes the widespread integration of these technologies. **ALT TECHS:** Also, growing competition from Alternative Technologies due to preference for non-invasive alternatives, like liquid biopsy technologies such as Guardant360, poses a significant competitive challenge to radiopharmaceutical diagnostic methods. The accessibility and ease of use of alt techs impact healthcare providers' choices, affecting the market dynamics. Advancements in alternative diagnostic technologies, such as AI in medical imaging and non-radioactive tracers, could pose challenges to markets, impacting market share. **Mitigation Measures:** The essence of IFIGENEIA is to invest in joint research and innovation, collaborating with technology developers and medical physicists as well as nuclear medicine doctors and end-users, and highlight unique advantages of radiopharmaceuticals. Efforts and investment will focus on creating novel

	radioisotopes with such characteristics that improve cancer treatment but also apply to other diseases. Knowledge transfer/collaboration will be core instruments in combating the risks of new technology. Convergence in EU policy funding instruments promote solutions that combine technological, economic and social growth, provide incentives for investment pooling together public/private funds and increasing the intensity of joint R&I aiming at breakthrough solutions.
E	**WASTE MANAGEMENT**: Strict environmental regulations have raised operational costs for radiopharmaceutical companies. Initiatives, exemplified by companies like Curium, investing in advanced waste management solutions, reflect the industry's commitment to addressing environmental concerns through environmentally friendly disposal methods for radioactive waste. **Mitigation Measures:** Implement sustainable practices, invest in advanced waste management solutions, advocate for industry-wide compliance, and explore partnerships.
L	**PATENT INFRINGEMENT**: Unwilling infringement of existing IPRs might result in litigation and threaten IFIGENEIA. **Mitigation Measures:** Perform diligence IPRs "freedom to operate" during IFIGENEIA project.

2.2 Measures to maximise impact - Dissemination, Exploitation and Communication [e.g. 5 pages, including Sec. 2.3] #@COM-DIS-VIS-CDV@#

2.2.1 IFIGENEIA's overall dissemination, exploitation and communication strategy [0,5 page]

IFIGENEIA will apply an impact-driven dissemination, exploitation and communication (**D&E&C**) strategy consisting of **three (3) major phases** with a view to **reach**, **engage** and **synergize** key target audiences and stakeholders, maximizing the potential short-term outcomes and long-term impacts of the project and the wide scale roll-out of Key Exploitable Results (KERs). A **more detailed Plan on dissemination and exploitation including communication activities** will be provided until **M6** of the project **(Dissemination & Communication Plan – D2.1 and Project Strategic Investment Plan D5.1)**. This plan will be periodically updated to align with the project's progress. TALOS will be in charge of implementing the D&E&C strategy and activities, capitalizing its extensive experience in EU-funded projects and its far-reaching participation in relevant networks

Phase I – Raise awareness/interest among key stakeholder (Y1): During this phase, IFIGENEIA will focus on establishing a common project identity, raising awareness and interest regarding the project's expected results (e.g., by promoting the project's website and distributing tailored D&C material). A Stakeholder Management Plan (SMP) will be developed (as part of the DEC Plan) to ensure the organized and effective engagement of key stakeholders in order to collect insights for the proper definition of IFIGENEIA requirements and concepts. **Phase II – Enhance acceptance of KERs (Y2-Y3):** During this phase, IFIGENEIA will focus on disseminating its KERs with a view to clearly demonstrate the benefits of the proposed novel solutions, supporting future exploitation of results. Key activities to be conducted during Phase II include publications about project results, the organization of conferences, events, workshops and participatory activities (e.g., labs) promoting knowledge exchange. **Phase III – Foster uptake and replication of KERs (Y4 and beyond):** During this phase, IFIGENEIA will focus on promoting the final KERs and BMs developed, creating the preconditions in order to stimulate broader scalability/replication and engage new end-users and wider audiences. The end-goal of Phase III is to facilitate the market uptake of its KERs and ensure that project's results will continue to be disseminated after project's end.

2.2.2 Dissemination Strategy and measures [1 page]

The overall dissemination strategy addresses multiple stakeholders through multiple channels to be described within the executive DEC Plan (see also 2.2.3). A preliminary identification of the **key target groups** to be addressed by the project and why the project results are relevant to each target group is presented below.

WHO and WHY	
WHO: Academic Institutions	
WHY	Academic institutions possess valuable expertise in nuclear medicine and molecular imaging research, making them essential collaborators for advancing scientific knowledge and innovation. Their involvement can help drive groundbreaking research, foster interdisciplinary collaboration, and train the next generation of researchers and clinicians in cutting-edge medical technologies
WHO: Policy makers	
WHY	Government agencies and policy makers play a crucial role in shaping research priorities, allocating funding, and establishing regulatory frameworks for medical technologies. Engaging with these agencies can ensure alignment with national and regional R&I strategies, secure financial support for project activities, and navigate regulatory pathways for technology development and commercialization.
WHO: Industry Partners	
WHY	Industry partners bring industry-specific expertise, resources, and market insights to the project,

	accelerating the translation of research findings into commercially viable products and services. Collaborating with industry can facilitate technology transfer, promote product development, and create opportunities for commercialization, ultimately driving economic growth and job creation.
WHO: Healthcare Providers	
WHY	Healthcare providers are key stakeholders in the adoption and implementation of new medical technologies, as they are responsible for delivering patient care and integrating innovations into clinical practice. Engaging with healthcare providers can facilitate clinical validation, generate real-world evidence, and drive adoption of novel diagnostic and therapeutic approaches, leading to improved patient outcomes and healthcare delivery.
WHO: Patient Advocacy Groups	
WHY	Patient advocacy groups represent the interests and perspectives of patients and caregivers affected by diseases targeted by nuclear medicine and molecular imaging technologies. Involving patient advocacy groups can ensure that research priorities are aligned with patient needs, promote patient-centered innovation, and enhance the relevance and impact of the project on patient care and quality of life.
WHO: Investors and Funding Agencies	
WHY	Investors and funding agencies provide essential financial resources and strategic guidance to support R&I initiatives and drive technology development and commercialization. Attracting investors and funding agencies can secure funding for project activities, validate the market potential of innovations, and create opportunities for scalability and growth, maximizing the project's impact and sustainability
WHO: Regulatory Authorities	
WHY	Regulatory authorities play a critical role in ensuring the safety, efficacy, and quality of medical devices and pharmaceuticals, including radiopharmaceuticals used in nuclear medicine and molecular imaging. Engaging with regulatory authorities can facilitate compliance with regulatory requirements, expedite the approval process for new technologies, and mitigate regulatory risks, enabling timely market access and commercialization
WHO: Educational Institutions	
WHY	Educational institutions are essential partners for workforce development and capacity building in fields related to nuclear medicine, medical physics, and molecular imaging. Collaborating with educational institutions can enhance training opportunities, attract top talent, and strengthen the pipeline of skilled professionals needed to support R&I activities and drive innovation in the healthcare sector.
WHO: Community Partners	
WHY	Community partners represent the local communities and stakeholders affected by the project's activities and outcomes. Engaging with community partners can foster transparency, build trust, and promote social responsibility, ensuring that the project's activities are culturally sensitive, environmentally sustainable, and socially inclusive, ultimately enhancing its acceptance and impact within the community

According to this provisionally defined strategy, the following dissemination means/channels will be used (**HOW**):

Channels	Objective, target and quantifiable indicators
Communication instruments	IFIGENEIA communication campaign instruments will include i) project's website; (ii) postings to social media, news portals, e-magazines, blogs; (iii) press releases, newsletters, videos in media on channels with diverse audiences; (iv) participation and project presentation in Innovation and Networking events and technological fairs and exhibitions; (v) participation and project presentation in other networks/groups, where partners have strong links. Technical project brochure downloads: <25 = poor; 25-75 = good; >75 = excellent

Scientific publications and presentations at conferences, seminars, workshops, etc.	The **project's results will be published in the international scientific/technical literature**, such as: *Nuclear Medicine & Radiation Therapy*, *European Journal of Nuclear Medicine and Molecular Imaging*, *Journal for Nuclear Medicine*, *International Journal of Radiation Oncology Biology Physics*, *Radiotherapy and Oncology* and other IEEE, EPRI, ASME and ELSEVIER journals as well as in relevant technical literature at national level. Results will be also presented through the Open Research Europe (https://open-research-europe.ec.europa.eu/for-authors/publish-your-research) and at **relevant conferences, seminars, workshops, and other events**, such as *International Conference on Nuclear and Radiochemistry*, *Annual Congress of the European Association of Nuclear Medicine (EANM)*, *German Society for Nuclear Medicine's Annual Meeting*, etc. either through oral or poster presentations. All partners will promote the project among their industrial, research and community networks. **At least one journal paper and one conference paper per year must be submitted.** ❖ Open Access to peer-reviewed scientific publications will be provided. ❖ Number of papers submitted: <4 = poor, 4-8 = good, >8 = excellent ❖ Number of conference presentations: <4 = poor, 4-8 = good, >8 = excellent
Liaison with relevant EU communities	The consortium will seek liaison with the **most relevant EU communities involving potentially interested stakeholders.** IFIGENEIA has the advantage to include in the consortium the European Organization for Nuclear Research (CERN) which presence secures the successful connection with other relevant networks and communities.
Collaboration with relevant projects	The consortium will seek **liaison and collaboration with relevant initiatives and other H2020 and Horizon Europe projects** (section 1.2.5) to **complement project activities with synergies**, and disseminate results to a specialized audience.

2.2.3 Exploitation Strategy and measures

IFIGENEIA **Project Strategic Investment Plan (D5.1)** also includes the **Exploitation Strategy (ES)** implementation steps: **(1) identification/fortification of all KERs** by analysing legal/regulatory aspects for KERs exploitation, including an **IPRs clinic** to identify protection options to be applied from the beginning, **(2) commercial characterisation of KERs** including but not limited the unique value proposition, **macroenvironment analysis** to reveal opportunities, threats, market size, growth and trends by employing PRESTEL model and a **microenvironment analysis** revealing industry specifics such as structure, competition landscape, customers' needs and wants by employing Porter's 5 Forces and Value Chain Frameworks, targeted market and go-to-market strategy, **(3)** risk analysis and mitigation measures, **(4)** development of **individual partners' exploitation strategy** and the **Go-To-Market strategy** with a **joint exploitation plan**. **(5)** design and testing of **novel Business Models** using the Business Model Canva and roadmap for **KERs combinations creating specific Business Cases** under the joint exploitation strategy facilitating the development of an **Investment Plan and a Business Plan** to mobilize and attract funds so that to realize the go-to-market strategy. Methods such as Market Research, Focus Groups and Delphi Panel will be applied as deemed appropriate during the Business Plan Development to assess product/services market penetration s-curve and willingness to pay.

Step (1): Key Exploitable Results & IPR clinic

The main IFIGENEIA innovation is the development of a LINAC based radiopharmaceutical establishment producing new radiopharmaceuticals for therapeutic and diagnostic purposes from novel radioisotopes. A preliminary list of IFIGENEIAS exploitable results/assets (S: Software, H: hardware) is presented in Table X. This list will be continuously updated during the project implementation.

Table X. IFIGENEIA's Key Exploitable Results

Key Exploitable Result (KER)		Type of Result	Owner(s)	Sales Channels	Means of Exploitation
KER1 (main)	New radiopharmaceuticals based on novel radioisotopes produced by a state-of-the-art LINAC in Greece Excellence Hub	P	All	Direct Sales to Hospitals and Clinics, Agreements with Pharmaceutical Companies, Technology Licensing to Radioisotope Manufacturers, Trade Shows and Conferences	Licensed for stand- alone solution or method for integration into nuclear medicine field.
KER2	VR Radioisotope production unit	SaaS	CERTH		
KER3	Compact Linear Accelerator (LINAC) Technology	M	CERN		
KER4	Innovative Radioisotope Production Techniques	M	CERN		
KER5	Capacity Building and Knowledge Transfer Initiatives	TM	AUTH		

**S - Software; TM- Training Material; M - Method; P-Product, SaaS - Software as a Service*

IPR Clinic: Once all KERs are defined, the **rules for the distribution of the Intellectual Property Rights (IPR)** among partners will be determined, also in accordance with the Consortium Agreement (CA). Nonetheless, partners have already achieved a preliminary agreement on the IP strategy. Each partner, owns its IP background and will provide free access to it, to project partners during the implementation of the project. Regarding the foreground, the consortium has identified three levels of IP which will be created from the project: *(i) Individual and joint IP*, which belongs to individual partners or is jointly owned by partners working in a particular task and is restricted to those partners; *(ii) Generic IP*, which can be used by all partners of the consortium; *(iii) Publicly available IP* which will be published on IFIGENEIAS website and made available with no restrictions. Provisions for use of IP background will be determined during the commercialization strategy. Insights that enhance partners' services or enable the launch of new solutions within partners' strategic go-to-market plan will be kept private and protected via non-registered soft IP measures (confidential information, company know, etc.). IPRs will be dealt since the beginning of exploitation activities, starting with a joint exploitation workshop, feeding the Library of Exploitable Results.

Step (2): Preliminary market/competition analysis - size, trends, structure and main competitors

Preliminary Main Market Analysis: KER1 shall enter the market of radiopharmaceuticals, which is experiencing robust growth due to various external factors, primarily the increasing global incidence of cancer. In 2022 alone, there were an estimated **20mil new cancer cases and 9.7 mil deaths due to cancer worldwide. These numbers are projected to rise to 32.6 and 16.9 mil, respectively by 2045**[17] [18]. **In Europe, there were 4.5 mil new cancer cases in 2022, a figure estimated to rise to 5.5 mil in 2045, that is an increase of 22.5%. Similarly in Europe 2M people died due to cancer in 2022 and this will worsen to an estimated 2.6 mil deaths in 2045 (an increase of 32.2%)**[19]**.** This rising prevalence underscores the urgent need for advanced solutions, with radiopharmaceuticals playing a pivotal role in addressing the growing demand for diagnostic and therapeutic interventions. The aging global population, more susceptible to various diseases, including cancer, further amplifies this demand. As of 2020, the global cancer prevalence, representing individuals living with a cancer diagnosis, stood at approximately 50 million, projected to surpass 150 million by 2040. This highlights the critical role of healthcare services, including radiopharmaceuticals, in managing and treating cancer in an aging demographic. In addition, recent applications of radiopharmaceuticals in cardio and neurological disorders append a substantial market to be addressed due to these growing cases worldwide. According to WHO latest statistics, **cardio diseases are the leading cause of death globally as an estimated 17.9M people died from such diseases in 2019, representing ca 32% of all global deaths**[20]. **Similarly, 9.0 mil deaths, a 16.5% of global deaths in 2016 were due to neurological disorders, which is the second leading cause of death after heart disease**[21]. The rising prevalence of cancer and the increasing geriatric population, as well as the increasing adoption of radiopharmaceuticals in various oncology treatments, are the major factors driving the growth of the market. Developing countries are witnessing improved access to diagnostic and therapeutic radiopharmaceuticals, playing a crucial role in addressing the global challenge of cancer. A recent report by Coherent Market Insights[4], values the global diagnostic radiopharmaceuticals and contrast media market at **US$ 6.4 Billion** in 2022, forecast to reach a value of **US$ 10.1Bn** by **2030** at a **CAGR of 5.8%** between **2023 and 2030**[22]. The global diagnostic radiopharmaceuticals and contrast media market is experiencing strong growth due to the rise in burden of cardio diseases and rise in burden of cancer worldwide. However, factors such as short half-life of radiopharmaceuticals and high costs of these techniques are expected to hamper growth of the market. According to the same report, **approximately 40% of the global market is in North America while 25% in Europe**. **KER1-KER5** can therefore benefit from the related market projections and the expected increase to be witnessed Globally and in Europe related to new cancer cases increasing at 2,1% CAGR.

Preliminary Competition Landscape: According to a preliminary industry analysis, the threat of new entrants is low as the industry poses high barriers to entry due to the specialized knowledge/facilities required for the production of radioisotopes, it is a capital-intensive industry and current players benefit from economies of scale and established relationships. While the bargaining power of radioisotopes producers is significant due to their scarcity, the power of byers (that is radiopharmaceuticals) is moderate and depends on the size of their orders and their quality/reliability demands. Switching costs are deemed high due to the unique properties of the radioisotopes required for medical applications. Nevertheless, these powers are somehow tamed within IFIGENEIA as the aim is to establish an integrated LINAC and radiopharmaceutical production facility. Substitutes, such as non-radioactive tracers and AI in medical imaging, pose a challenge to radiopharmaceutical diagnostic methods, but threats posed are moderated by

[17] 900-world-fact-sheet.pdf (who.int)
[18] Cancer Tomorrow (who.int)
[19] 908-europe-fact-sheet.pdf (who.int)
[20] Cardiovascular diseases (CVDs) (who.int)
[21] The global burden of neurological disorders - The Lancet Neurology
[22] Diagnostic Radiopharmaceuticals and Contrast Media Market Size (coherentmarketinsights.com)

the high differentiation gap already gained by the radiopharmaceuticals. Although the radiopharmaceutical industry exhibits a high level of competitive rivalry among its tail base, the industry has a high level of concentration with only a few key players dominating the global market. According to Future Market Insights[23], market consolidation has resulted from intense rivalry among top competitors. The top market participants account for ca 90% of the worldwide market share and some characteristics of these top players in the radiopharmaceutical industry are:

Company	Profile	Sustainable Competitive Advantage	Value Chain Characteristics
1. GE Healthcare	Global player in healthcare, offering medical imaging and diagnostics solutions, including radiopharmaceuticals. Strong presence and global distribution network.	Broad Portfolio - Comprehensive range of radiopharmaceuticals and imaging technologies.	R&D Investment, Robust Manufacturing, and Distribution Chain.
2. Siemens Healthineers	Leading medical technology company specializing in diagnostic and therapeutic solutions, major player in radiopharmaceuticals. Known for advanced imaging technologies and global presence.	Technological Expertise - Advanced imaging technologies.	Collaborative Innovation, Global Manufacturing, and Distribution Network.
3. Cardinal Health, Inc.	Diversified healthcare services company with a global presence. Involved in the distribution of radiopharmaceuticals and nuclear medicine products.	Extensive Distribution Network - Facilitates efficient delivery of radiopharmaceuticals.	Effective Supply Chain Management, Regulatory Compliance in Handling Radioactive Materials.
4. Eckert & Ziegler	Specialized in isotope technology for medical, scientific, and industrial applications. Plays a role in the production and distribution of radioisotopes for medical use.	Radioisotope Expertise - Key player in the supply of radioisotopes.	Isotope Production, Research Collaboration with Institutions.
5. Curium	Nuclear medicine company providing diagnostic and therapeutic radiopharmaceuticals globally. Offers a diverse portfolio covering various medical applications.	Diverse Product Portfolio - Broad range of radiopharmaceuticals for diagnostics and therapy.	Production Excellence, Investment in Therapeutic Applications.
6. Bayer AG (Bayer Radiology)	Global healthcare company with a focus on pharmaceuticals, consumer health, and crop science. Bayer Radiology specializes in diagnostic imaging products.	Research and Innovation - Invests in cutting-edge research and innovation for advanced diagnostic imaging.	Robust Manufacturing Processes, Global Distribution Network, Continuous Research and Development Initiatives.
7. Lantheus Holdings Inc.	Specialized in diagnostic imaging agents and radiopharmaceuticals. Offers a range of products for medical applications.	Strategic Portfolio - Specialized in diagnostic imaging agents.	Focus on Research and Development, Collaborative Efforts in Medical Applications.

Step (3): Risk analysis and mitigation plan (as preliminary presented in Sect 2.1.4)
Step (4): Individual partners' exploitation strategy and a joint exploitation plan..

KERs (Step 1), will be exploited twofold, a) by individual exploitation plans and b) a common exploitation strategy.

Individual partners' exploitation strategy:	AUTH	RCM	BIOKOSM	AMTH	CERTH	GNP	TPOLIS	NCSRD	AMOLDS	UL	IJS	COSYLAB	SIH	IAS	TALOS	UCY	CNE	PASYKAF	SHSO	UNSA	GSI	DKFZ	CERN
Enlarge portfolio of offered solutions	x	x	×		×	x	x	x	x	x	x	x	x		x	x	x		x		x	x	x
Enable the provision of new services	x		×		×	x	x	x	x	x	x	x	x	x	x	x	x	×		×	x	x	x
Certify a product/solution			×																	×			
Create relevant commercial networks			×				x				x	x	x	x	x								
Enhance knowledge basis	x		×		×	x	x	x	x	x	x	x	x	x	x	x	x			×	x	x	x
Apply patent/copyright/granting licenses			×					x			x											x	
Initiate new collaborations	x	x	×	×	×	x	x	x	x	x	x	x	x	x	x	x	x	×	x	×	x	x	x
Enter new/wider markets – Expand sales	x		×									x			x						x	x	
Build capacity (training) of workers	x		×			x		x			x	x	x	x	x	x		×		×	x	x	x
Enhance research portfolio/outcomes	x		×		×	x	x	x		x	x					x				×			x
Publish scientific results (open access)	x		×	×	×	x		x		x	x	x		x	x	x				×	x	x	x
Participate in conferences/workshops	x		×	×	×	x	x	x	x	x	x	x	x	x	x	x	x	×		×	x	x	x
Participate in relevant initiatives	x	x	×	×	×	x	x	x	x	x	x	x	x	x	x	x	x	×	x	×	x		x
Enhance participation in EU R&I projects	x	x	×	×	×	x	x	x		x	x	x	x	x	x	x			x	×	x		x
Support training/teaching activities	x		×	×	×	x	x	x		x	x		x	x		x		×		×	x		x
Technical experts/Specialized personnel	2	0	0		2	2	2	2	2	2	2	3	2	2	2	2	2			1	1	1	2
Researchers (Category A, B, C, D)	4	0	6	2	3	2		5		3	2	2	2	2		3				4	2	2	4

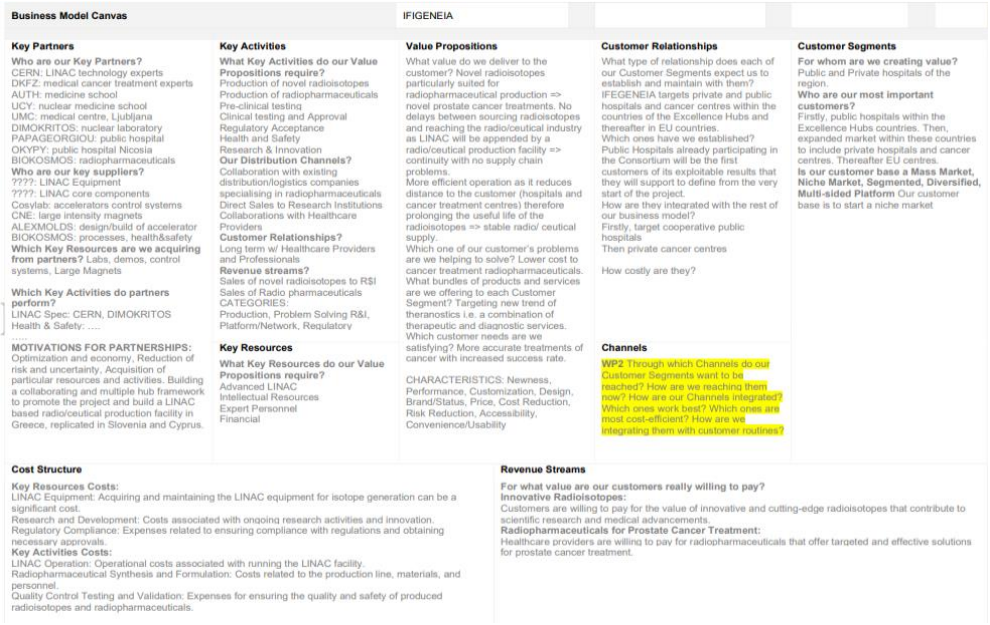
Detailed individual exploitation plans per partner will be developed during project implementation that will detail expected results/products, the targeted users/clients, the sales channels, the number of jobs created during and after the project etc. Below an initial list of foreseen activities relevant to commercial and scientific exploitations is presented per partner, as defined during proposal preparation.

Step 5: Preliminary depiction of the Business Modelling and Draft Business Plan

To inform and kick-start the design and testing of novel BMs (T5.3) the basic IFIGENEIA services that will be created and delivered to the relevant industries within each Excellence Hub under a framework agreement among the Excellence Hubs, are captured are depicted into the Business Model canvas beside. In principle, the target customers could be offered services such as proof-of-concepts, prototyping, piloting and business consultancy. However, the main IFIGENEIA project is the establishment of the LINAC and adjacent radiopharmaceutical production facility with a go-to-market as described above.

[23] Radiopharmaceuticals Market Size, Share & Trends 2032 | FMI (futuremarketinsights.com)

In the next ten years after project completion, IFIGENEIA aims to build the radiopharmaceutical facilities and thereafter to reach an organic growth, targeting first the radiopharmaceuticals market within the Excellence Hubs countries and then by scaling up to target more EU countries in the region. According to OECD[24] the total economic burden in 2018 due to cancer in Greece, Slovenia and Cyprus was ca 2.000, 202 and 160 mil EUR, respectively. However, drug costs were confined in the range 13-21% of the total cost[25] and radiopharmaceuticals are only 7% of the drugs costs[26]. Hence the **total radiopharmaceuticals market in IFIGENEIA countries was ca 25mil EUR in 2022 and it will reach 30mil EUR in 2032 in Y4 after IFGENEIAS completion**. Based on these findings, EU total radiopharmaceuticals market is estimated at 1,5 bn EUR in 2022, revealing a global market of 6 bn EUR in which EU has a contribution of approximately 25% as mentioned in Step (2). Hence these estimates are in line with previous references regarding the global market value. At proposal stage we rely only on rough estimates to access future feasibility of IFIGENEIA. Further development will be performed during the project. Nevertheless, **Capital expenditure is assumed initially to be around 3,8mil EUR** and covers the facility's premises, a small LINAC and a radiopharmaceuticals production line to be deployed between Y1 and Y4 after IFEGENEEIA's completion. **Operational expenses by Y5 are estimated approximately 1,5mil EUR** and cover R&D (0,8mil EUR per year) as well as operations, regulatory compliance and licensing, medical professionals and scientists and marketing. Such Operational expenses are assumed to be gradually increasing during Y1-Y4 starting form 150.000 EUR. **Revenues are assumed to start at 0,9mil EUR Y4 reaching 5,4mil EUR in Y7** (that is acquiring a 20% market share within IFIGENEIA countries). In Y7 a capacity expansion of the LINAC and production facility at a cost of 1,7 mil EUR is assumed, followed by aggressive market capturing outside the Hubs countries, thus reaching a **revenue stream of 9,6mil EUR by Y10**. For this draft business case scenario, **IRR is estimated at 35%** and the **total NPV of the project is 9mil EUR** (using a hefty 20% discounting rate), thus indicating its feasibility trend. Furthermore, the **project financing requirement is found to be ca 5,3mil EUR**, and this is a bold figure to be refine during the project while preparing specific Business Plans to reach private investment and or prepare more proposals to draw financing form public funds. Of course, during the project, a thorough sensitivity analysis and or multi-risk-analysis will be performed by applying the Monte Carlo method.



2.2.4 Communication Strategy and measures [3/4 page]

Communication activities will especially be aimed at **i)** creating a project visual identity and public image; **ii)** providing up-to-date information about the project; **iii)** sustaining the diffusion of results to the general public; and **iv)** translating the scientific/technical results into messages for public outreach (incl. non-technical general public).

Channels and communication tools to maximize the impact

Logo and Visual Identity: A common public image/branding for the project allows an easier identification by the public and ensures visibility. IFIGENEIA will adopt a **captivating project logo** and **common graphics** for the project template (e.g. presentation, template report, etc.) and any published or publicly presented material (e.g. brochures, leaflets etc.). A **project motto** will also be elaborated. **WHEN:** At the very beginning of the project (M3).

Creation of online channels and updating: A **captivating website** will be developed giving **public access to relevant non-IP-sensitive results**, downloadable activity reports and other publishable documents. A **private area** will be developed **for consortium partners internal use**. An **e-newsletter** (every six months) **will be created** and uploaded (also sent beyond the project community with digital means). **WHEN:** The website will be ready by M4.

[24] EU Country Cancer Profiles | OECD iLibrary (oecd-ilibrary.org)
[25] The cost of cancer in Europe 2018 - European Journal of Cancer (ejcancer.com)
[26] Chemotherapy Drug Market Size, Share & Industry Trends By 2030 (databridgemarketresearch.com)

Success indicators and target values: Web page visits per year: <5,000 = poor; 6,000-10,000 = good; >10,000 = excellent // Material downloads: <1,000 = poor; 1,000-2,000 = good; >2,000 = excellent.

Final Conference, workshops and events: IFIGENEIA will hold a minimum of **10 outreach events** in the form of workshops/seminars, conferences and participatory labs. IFIGENEIA partners will also **participate and present the project in other networks and groups**, not directly linked to the project, where consortium partners have strong links and involvement (e.g. IPPOG WG "Applications for society", HEPTech events via GSI, CERN, relevant to WP5 (i.e. from ideas to practice, entrepreneurship, support for start-ups), CERN KT events, TPOLIS, CERTH networks). IFIGENEIA will also organise **one international multidisciplinary event** at the end of the M36. Finally, IFIGENEIA will also organise roadshows in order to attract companies with high capacity in order to maximise the impact of the training seminars. **WHEN:** Outreach evetns, training events and conferences will be held throughout the project duration. Collaboration with other project events will be sought. **Success indicators and target values:** Number of project events: <5 = poor; 5-10 = good; >10 = excellent.

Press – Media: Consortium partners will be in charge of contacting the media in order to increase the project's visibility and spread the activities and results foreseen. This can be achieved by: (1) **Press releases** and **journalistic articles**; (2) promoting the project through **social media (project and partners accounts)**; (3) **inviting media** to the main events of the project. A press kit will be developed to help partners in the elaboration of their press releases, or to help journalists on the elaboration of articles about IFIGENEIA containing: (1) **Writing identity** of the project: Descriptions of the project to be used for different requirements. (2) **Press release**: Detailed information of the project on press format (3) **General presentation**: Description of the project on Power Point format. (4) **Tweetable facts** concerning the project. (4) A list of **frequently asked questions:** Several questions and answers for general public. (5) **Previous press releases & media impacts**: Examples of previous press releases and their respective impact on the media and (6) **Copyright free Photograph**. **WHEN:** On a regular basis. **Success indicators and target values:** Number of press releases: <10=poor; 10 – 25= good; >25=excellent // Mail-outs-downloads of newsletters (per release): <200=poor; 200-500=good; >500= excellent.

Project promotional material (Brochure, Banners, Posters, Video): Graphic materials will be developed to promote the project at selected events providing general information and preliminary results, addressing both technical and non-technical public results. They consist of a **brochure (two releases), posters, a roll-up banner, and a Video News Release**. **Printed/digital material will be translated in the languages of the demo-sites to facilitate local engagement.** All the **printouts will be uploaded to the project website in electronic format and will be available for downloading**. The printable versions will be uploaded in the intranet of the project, and will be available for fairs, congress, forums and workshops participation along with **a project video**. **WHEN:** At the beginning/end of IFIGENEIA. **Success indicators and target values:** Brochure distribution: <1.000=poor; 1.000-2.500=good; >2.500=excellent // Project videos views: <800=poor; 1.000–2.500=good; >2.500= excellent.

Cooperation with other projects and networking: IFIGENEIA will forge communication with other European projects related to Nuclear Medicine, LINAC and radioisotopes like iFAST, ARIES, etc. This will promote synergies to establish cluster participation in events and publications promoting IFIGENEIA results. **WHEN:** Along the project's lifetime with emphasis at the beginning so it is possible to exploit synergies. **Success indicators and target values:** Collaboration with relevant EU projects:<4=poor;4-8=good;>8= excellent

Open field site showcases: Demo sites in IFIGENEIA will be opened up to the general public, permitting access to agencies, students and other interested stakeholders on a regular basis. The open days will allow for discussions with experts on IFIGENEIA related topics, plans at each demonstration site and the socio-economic benefits the project will result in. **WHEN:** At least one open event at each site over the course of the project during demonstration. **Success indicators and target values:** Number of showcases: <3 = poor; 3-7 = good; >7 = excellent

Any dissemination of results will duly display the EU emblem and include information on the EU funding.

2.2.5 Dissemination and communication activities after the end of the project (1/4 page)

Specific IFIGENEIA D&C activities will continue even after the end of the project to support the achievement of long-term impacts and the wide-scale roll out and market uptake of IFIGENEIA solutions. More specifically: **a) IFIGENEIA's website maintenance and support**. The website and all public deliverables will be maintained by D&E&C coordinator TALOS until 2030; **b) Tracking, gathering and dissemination of publications**. Additional publications will most probably be developed after the end of the project. **c) Further dissemination of final results.** IFIGENEIA partners are expected to present the achieved results in relevant forums, networks, conferences, technical events etc. after the end of the project. All partners will ensure that an appropriate reference to IFIGENEIA and EC funding is made to future material which scope originates from or is related to IFIGENEIA, whereas respective material will be sent to D&E&C coordinator for updating the website with new-info.

#§COM-DIS-VIS-CDV§#

2.3 Summary – Key elements of the Impact Section [e.g. 2 pages]

SPECIFIC NEEDS (SN)	EXPECTED RESULTS (ER)	D & E & C MEASURES
SN#1: Supply-Demand Discrepancy of radioisotopes; **SN#2:** Leveraging European Expertise in acceleration technology, notably, through the renowned laboratory at CERN; **SN#3:** Knowledge Integration in acceleration technology ; **SN#4:** Breakthroughs and Patents particle acceleration techniques in Europe.; **SN#5:** Rapid, Efficient, and Cost-effective Production of a complete spectrum of highly in-demand radioisotopes.; **SN#6:** Improved Outcomes in cancer treatment	**ER#1:** New radiopharmaceuticals based on novel radioisotopes produced by a state-of-the-art LINAC in Greece Excellence Hub; **ER#2:** VR Radioisotope production unit; **ER#3:** Compact Linear Accelerator (LINAC) Technology; **ER#4:** Innovative Radioisotope Production Techniques; **ER#5:** Capacity Building and Knowledge Transfer Initiatives; **ER#6:** Students training; **ER#7:** Secondments AND Good practices exchange	**Dissemination:** Online channels, printedmaterial, newsletters, etc. towards all Target Groups. Workshops, conferences, scientific papers, participation in conferences. distribution of material (printed, electronic) and also organization of conferences,workshops and awareness-raising events. organizationof events, workshops and distribution of project publications. **Exploitation:** Direct sales for all KERs; patents.**Communication:** creation of project's logo and visual identity; creation of online channels (i.e. project website); organization of workshops (inc.training workshops), conferences (incl. 1 international) and awareness raising events,promotional material (i.e. brochures, flyers); establish cooperation with other projects and networks.

TARGET GROUPS	OUTCOMES	IMPACTS
TG#1: Academic Institutions; **TG#2:** Policy makers **TG#3:** Industry Partners; **TG#4:** Healthcare Providers; **TG#5:** Patient Advocacy Groups; **TG#6:** Investors and Funding Agencies; **TG#7:** Regulatory Authorities; **TG#8:** Educational Institutions; **TG#9:** Community Partners; **TG#10**: Cultural organisations	**Scientific: 1.1** Organization of 1 international multidisciplinary event, submission of 10 research articles/conference papers; **2.1**: Scientific advances in Nuclear Medicine, Molecular Imaging.; **2.2:** 3 R&I Strategies and Action Plans (1 per Hub); **4.1**: Deployment of 1 joint R&I Strategy and Action Plan addressing 2 main scientific pillars and 2 technologies.; **4.2**: 2 New pilots and demonstration plans; **5.1**: 10 Training workshops on IFIGENEIA related fields, with >= 240 participants***);*** **5.2**: Implementation of one (1) VR radioisotope production unit for mentoring and training.***;*** **5.3**: 60 professionals engaged in secondments.; **5.4**: no of trained scientists through the virtual radioisotope production unit (Y1-Y3): 3700; **Economic/Technological: 1.4**: Growth in the number of startups, spin-offs, and SMEs established within the ecosystem, as well as their revenue and job creation metrics.; **3.2:** Mobilization national/reg.-private funds (PPP investment) in Hub's operation: € 6,8 mil.(Y1-Y3)***.;*** **3.3:** no of open calls to publish for acceleration (Y1-Y3): 16; **5.5**: Support of entrepreneurship and technology transfer activities; **6.1:** no of regional/national roadshows *(Y1-Y3)*: 13*;* **6.2:** no of open calls to publish for acceleration *(Y1-Y3)*: 16; **Societal: 1.2**: New cooperation framework among societal actors of 3 hubs; **1.3**: New patents in particle acceleration techniques: at least 1; **2.3**: Long-term cooperation framework among IFIGENEIA actors for the benefit of science.; **3.1**: New Scientific knowledge from implementation of proposed pilots/demonstrators; **3.2**:>20.000 citizens affected by deployment of IFIGENEIA solutions/demos (incl. Research labs & infrasttructures); **7.1**: Increase the employment rate: >300 new positions after the Y3	**Scientific: 1.1**: Increased capacities in widening countries on: a) tech. integration and dev. related to Nuclear Medicine; **1.2**: Increase over next decade: in number of patents, publications, # of scientists/professionals related to IFIGENEIA scientific field–in average 25% in participating widening countries.; **3.1**: Number of approved HE projects for the consortium partners (Y3): >5***;*** **3.2**: Number of received funding through HE (Y3): >4M; **4.1**: >50 collaborations among academia-business by Y3.***;*** **4.2**: >10 scientific conferences in IFIGENEIA by Y3; **Economic/Technological: 1.4**: no of open calls to publish for acceleration (Y1-Y3): 16***;*** **1.5:** Mobilization national/reg.-private funds (PPP investment) in Hub's operation: €6,8 M.(Y1-Y3).; **2.1**: 3 R&I Strategies and Action Plans (1 per Hub) for developing new pilots and demos supporting R&I in IFIGENEIA, in line with EU, RIS3, etc. ***(Sc);*** **2.2:** Deployment of 1 joint R&I Strategy and Action Plan (incorporating hubs individual strategies and plans); **4.5**: Increase in Nuclear Medicine market size (revenues) will lead to well-paid jobs for researchers/professionals; **Societal: 1.3**: Increase the readiness to host the first LINAC in Europe; **4.3:** Positive effects on employment in academia or business.***;*** **4.4:** Regional societal progress from Roadmap for uptaking project outcomes & Hub Replication.

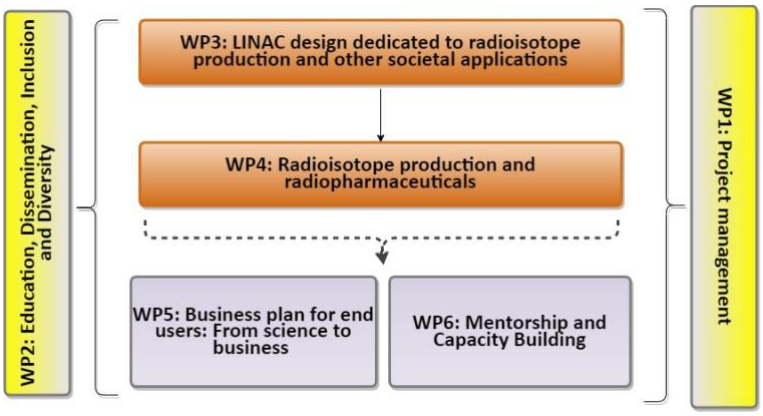
#§IMP-ACT-IA§#

3 QUALITY AND EFFICIENCY OF THE IMPLEMENTATION #@QUA-LIT-QL@# #@WRK-PLA-WP@#

3.1 Work plan and resources [e.g. 10 pages – including tables]

3.1.1 Overall structure of the work plan

The project activities are broken down into **6 WPs** and are implemented within **48 months (4 years)**. More specifically, IFIGENEIA includes two (2) more technical WPs and four (4) more horizontal WPs. WP3 is dedicated to the Linear Accelerator design and WP4 to Radioisotope production and radiopharmaceuticals. WP1 is related to the Project Management while WP2 covers dissemination/communication activities, and training tasks. WP5 is dedicated to the actions needed to secure the sustainability of IFIGENEIA hubs by including more business oriented tasks. WP6 includes tasks that offer high quality mentoring to BiH partners.



3.1.2 IFIGENEIA Gantt Chart

	YEAR 1												YEAR 2												YEAR 3												YEAR 4											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP1: Project Management																																															
T1.1 Project coordination & financial management																																															
T1.2 Quality assurance, risks, ethics and IPR management																																															
T1.3 Scientific, innovation & technical management																																															
T1.4 Data management																																															
WP2: Education, Dissemination, Inclusion and Diversity																																															
T2.1 Communication and dissemination activities and planning																																															
T2.2 Skills training and Trainers' training																																															
T2.3 Secondments and good practices exchange																																															
T2.4 Inclusion strategies and activities																																															
WP3: LINAC design dedicated to radioisotope production and other societal applications																																															
T3.1 LINAC/RFQ design and beam dynamics studies																																															
T3.2 Beam parameters and hardware specifications for different operational scenarios																																															
T3.3 Targets' optimization and handling for different isotope production scenarios																																															
T3.4 Control system development																																															
T3.5 Study of the Safety and Radiation protection requirements																																															
T3.6 Development of Computational tools																																															
WP4: Radioisotope production and radiopharmaceuticals																																															
T4.1 Develop Lab conditions (radiation protection) needed for producing these isotopes.																																															
T4.2 Identify best Isotopes for production with LINAC																																															
T4.3 Investigate best Ligands for development within excellent hub																																															
T4.4 Perform the development and testing of ligand-isotope compound																																															
T4.5 Perform "Pilot" Pre-clinical studies with animal model																																															
WP5: Business plan for end users: From science to business including spinoffs																																															
T5.1 Project Strategic Actions Investment Plan and Financing																																															
T5.2 Management of Key Exploitable Results (KERs)																																															
T5.3 Development of Business Plan(s) for Seeking Financing beyond the Project																																															
T5.4 Basic Sustainability for the Excellence Hubs																																															
WP6: Mentorship and Capacity Building																																															
T6.1 Accelerator School																																															
T6.2 Master Classes in Particle Therapy																																															
T6.3 Implementation of a Virtual Interactive Radiolsotope																																															

3.1.3 Detailed work description

3.1.3.1 List of work packages (Table 3.1a)

No.	Work Package Title	Leader	PMs	Start M.	End M.
1	Project Management	AUTH	79	1	48
2	Education, Dissemination, Inclusion and Diversity	IJS	200	1	48
3	LINAC design dedicated to radioisotope production and other societal applications	AUTH	255	4	42
4	Radioisotope production and radiopharmaceuticals	UL	153	5	48
5	Business plan for end users: From science to business including spinoffs	TALOS	176	7	48

6	Mentorship and Capacity Building	AUTH	151	7	48
		TOTAL	1014	1	48

3.1.3.2 Workpackages description (Table 3.1b)

1	**Project Management**					
	Start Date	**M1**	**End Date**	**M48**	**Leader**	**AUTH**

Objectives

a) Ensure the project is effectively managed, resources are coordinated, and objectives are achieved within the allocated time frame and budget.; b) Facilitate efficient planning, technical coordination, and the smooth flow of information among participants and work packages, while maintaining communication with the EC.; c) Provide both internal and external (to EC) technical and financial reports as required.; d) Continuously monitor project progress and ensure the quality of all deliverables.; e) Identify and evaluate project risks, develop contingency plans for significant ones, and implement necessary preventive or corrective actions.; f) Ensure thorough consideration of all contractual, legal, ethical, and gender equality issues related to the project's research, while adhering to relevant conventions.

Description of work

T1.1 Project coordination & financial management (M1-M48) [AUTH(28), RCM(1), BIOKOSMOS(1), AMTH(1), CERTH(1), GNP(1), TPOLIS(1), NCSRD(1), AMOLDS(1), UL(1), IJS(1), COSYLAB(1), SIH(1), IAS(1), TALOS(1), UCY(1), CNE(1), PASYKAF(1), SHSO(1), UNSA(1), GSI(1), DKFZ(1), CERN(1)**]**

Managing the project comprehensively to ensure both effective execution and overall coordination. This involves overseeing inter-partner cooperation, handling financial and administrative matters, interfacing with funding authorities, maintaining financial records, allocating partner shares based on agreed consortium rules, and liaising with all partners and third parties.

T1.2 Quality assurance, risks, ethics and IPR management (M1-M48) [AUTH(5), UL(1), DKFZ(1), CERN(1)**]**

Ensuring quality, meeting milestones, and fostering collaboration among partners will be prioritized. We will develop templates for project deliverables and guidelines for evaluating procedures. A quality plan and methodology will be established to ensure the deliverables, demonstration plans, and outputs align with project objectives. This effort will also address potential risks through the development of a risk plan and mitigation procedures. Ethical management is crucial to uphold responsible standards and framework conditions for technology development, and this will be addressed both prior to and during the project. Additionally, managing intellectual property rights (IPR) in accordance with EU and international regulations will be a key responsibility. This includes overseeing the use, exploitation, further research, and dissemination of knowledge.

T1.3 Scientific, innovation & technical management (M1-M48) [AUTH(5), CERTH(1), NCSRD(1), COSYLAB(2), UCY(1), DKFZ(1), CERN(2)**]**

This task aims to synchronize the scheduled technical endeavors, ensuring they follow a unified, scientific, and innovative approach. It involves: a) overseeing and tracking the advancement of technical tasks, fostering continuous flow and feedback among interconnected tasks to yield top-notch outcomes, b) assessing the originality of proposed solutions, and c) promptly informing the project coordinator of any notable deviations in technical progress. Given the project's reliance on interdisciplinary collaboration, effective knowledge transfer among diverse disciplines and stakeholders is essential for advancing work within the work package.

T1.4 Data management (M1-M48) [IJS(6), AUTH(1), UCY(1)]

A Data Management Plan (DMP) outlining the generated project data, its potential utilization, accessibility for verification and re-use, as well as its curation and preservation, will be devised at the project's onset and continuously revised to adapt to the changing requirements of the project. This plan will integrate inputs from stakeholders, workshop outcomes, business engagements, and other stakeholder interactions, ensuring alignment with innovation development.

2	**Education, Dissemination, Inclusion and Diversity**					
	Start Date	**M1**	**End Date**	**M48**	**Leader**	**IJS**

Objectives

a) Outreach results and messages to target groups; b)Upskilling of human resources and uptake of new knowledge; c) Development of courses, demos; d) Secondments and exchanges; e) Cultivate culture of Diversity and Inclusion

Description of work

T2.1 Communication and dissemination activities and planning (M1-M48) [IJS(14), AUTH(1), RCM(4),

BIOKOSMOS(1), AMTH(2), CERTH(2), GNP(1), TPOLIS(5), NCSRD(1), AMOLDS(1), UL(1), COSYLAB(1), SIH(1), IAS(1), TALOS(2), UCY(1), CNE(1), PASYKAF(6), SHSO(1), UNSA(2), GSI(3), DKFZ(1), CERN(1)]

Formulation of communication, dissemination plan of IFIGENEIA's results. Coordination of all communication (internal and external) and dissemination planned activities: a) project's website; b) social media, news portals, blogs, influencers etc.; c) press releases, newsletters, videos in popular media channels with diverse, inclusive audiences; d) participation and presentation of the project and its results in Innovation and Networking events and technological fairs and exhibitions; e) participation and presentation of the project in other networks and groups, not directly linked to the project, where consortium partners have strong links and involvement; f) in-house presentations to existing clients and collaborators and brainstorming for further extending the IFIGENEIA's solutions to other applications and markets; g) organization of workshops (incl. training courses) at regional/local level to showcase work done in IFIGENEIA Hubs; h) organization of 1 international multidisciplinary event.

T2.2 Skills training and Trainers' training (M13-M48) [TPOLIS(14), AUTH(1), BIOKOSMOS(1), GNP(2), NCSRD(2), UL(3), IJS(7), COSYLAB(2), SIH(2), IAS(1), UCY(1), PASYKAF(1), SHSO(1), GSI(6), DKFZ(1), CERN(3)**]**

The aim T2.2 aim is to improve the skills (upskill) of each hub's stakeholders, among and beyond the consortium partners, on all IFIGENEIA's topics including its technical developments. The topics of training activities will be directly linked with the activities of WP3 and WP4 and they will be related with the Linear Accelerator operation as well as with the radiopharmaceuticals domain. For each training course, the task includes the (a) identification of subjects; (b) profiles of trainees; (c) development of training instruments and content; (d) time planning; (e) respective logistics. Special training courses will focus on "training the trainers", to train the trainers on different WP3/WP4 topics/tools. Training material will be provided by respective expert partners. The VR radioisotope production unit that will be implemented in Task 6.3 will also provide an innovative tool for the training actions.

T2.3 Secondments and good practices exchange (M25-M48) [GNP(12), AUTH(2), RCM(1), BIOKOSMOS(1), AMTH(1), CERTH(2), TPOLIS(8), NCSRD(1), AMOLDS(1), UL(2), IJS(8), COSYLAB(3), SIH(3), IAS(3), TALOS(2), UCY(2), CNE(2), PASYKAF(1), SHSO(1), GSI(6), CERN(2)**]**

The T2.3 aim is to facilitate the exchange of expertise between IFIGENEIA's partners and research/academia and business/NGO stakeholders of each Hub with the goal of closing the gaps. The task will prepare a proposal (including: who, where, when, how-long) and address related logistics. Indicatively, it is envisaged that 2 staff members, for 2-4 weeks per year, will have the chance to experience new working environments with hands-on learning. Targeted exchanges aim at building bridges (skills/perceptions) among academia/NGO/business. Indicatively, secondments can take place in EU-office (CERN), Knowledge Transfer office (Slovenia, GSI), professional experts centres (i.e. medical personnel, clinicians etc), at CERN, DKFZ, and vise-versa.

T2.4 Inclusion strategies and activities (M19-M36) [UCY(8), AUTH(1), RCM(3), GNP(1), TPOLIS(2), NCSRD(1), UL(1), COSYLAB(1), SIH(2), IAS(3), CNE(1), PASYKAF(6), UNSA(1), GSI(3)**]**

In all the above activities, a special attention will be given in order to remove biases related to ethics, religion, culture, gender etc. In particular, integrating south-east European countries, such as BiH and others, where such issues are more acute, and fusing the WE (CERN, GSI others policies). Some of the actions that will take place in T2.4 are: 1) Diversity/Inclusion Officer appointment, 2) policies regulation, 3) Forum, 4) dedicated space in web page, 5) activities such as presentations in IFIGENEIA's annual meetings, special panels.

3	**LINAC design dedicated to radioisotope production and other societal applications**					
	Start Date	**M4**	**End Date**	**M42**	**Leader**	**AUTH**

Objectives

a) Design of the prototype of the proton LINAC-RFQ and the basic RFQ for the LINAC; b) Development of the front-end applications in cultural heritage field; c) feasibility study of fast elemental imaging using pulsed proton beam; d) demonstration application in culture

Description of work

T3.1 LINAC/RFQ design and beam dynamics studies (M4-M42) [AUTH(20), AMTH(8), NCSRD(5), AMOLDS(13), IJS(3), COSYLAB(1), CNE(2), UNSA(8), DKFZ(1), CERN(18)**]**

During T1.3 a prototype design for the first stage of a proton LINAC-RFQ will be developed. This will include designing the basic RFQ unit aimed at achieving a maximum proton energy of 2-5 MeV, specifically tailored for archaeometry purposes. The front-end application for cultural heritage endeavors will encompass designing various components such as the switching magnet, beamline, ion optics, and proton beam exit nozzle into the air. Additionally, a compact arrangement for gamma, X-ray, and particle spectroscopic systems will be devised to facilitate the detection of Particle Induced X-ray (PIXE), Gamma Emission (PIGE), and Rutherford Backscattered

(RBS) protons. Furthermore, a feasibility study will be conducted on fast elemental imaging utilizing pulsed proton beams. These developments aim to demonstrate the efficacy of Ion Beam analysis (PIXE, PIGE, and RBS) in examining archaeological and artistic objects, shedding light on ancient craftsmanship, artistic techniques, and conservation requirements.

T3.2 Beam parameters and hardware specifications for different operational scenarios (M13-M30) [AUTH(16), BIOKOSMOS(3), AMOLDS(6), IJS(2), COSYLAB(2), IAS(2), CNE(4), DKFZ(1), CERN(8)

A LINAC proton accelerator will be designed with a frequency ranging from 1 to 352 MHz, capable of achieving beam energies of up to 20 MeV. Relevant parameters will be decided upon through collaboration with experts, defining the accelerator parameters including the current repetition rate, pulse length, and final energy. An end-to-end dedicated simulation of all parts of the accelerator will be conducted, encompassing the source, the radiofrequency quadrupole (RFQ), standard drift-tube linacs (DTL), or inter-digital H-mode (IH) DTL, with adaptations made to meet target requirements. Past demonstrations have proven the high current capability necessary for the device.

T3.3 Targets' optimization and handling for different isotope production scenarios (M7-M36) [AUTH(8), UL(6), UCY(6), CNE(2), DKFZ(1), CERN(2)

Concerning the 750 MHz proton and helium accelerator capable of reaching up to 20 MeV/u the following actions will be implemented. Parameters, including current repetition rate, pulse length, and final energy, will be defined in collaboration with target experts. End-to-end simulation of the source, radiofrequency quadrupole, and drift tube linacs or IH structures, which have already been designed, will be conducted to thoroughly assess and adapt parameters to meet target requirements. Additionally, the high current capability, which has not yet been demonstrated, will require source RandD to reduce emittance.

T3.4 Control system development (M13-M42) [COSYLAB(35), AUTH(6), BIOKOSMOS(3), CERTH(12), NCSRD(1), AMOLDS(3), IJS(5), IAS(2), UCY(3), CERN(2)**]**

In T3.4, the first step involves gathering use cases, requirements, and specifications for the accelerator control system. This will entail conducting interviews with experts, operators, and external end-users to ensure a comprehensive understanding of needs. These inputs will serve as the foundation for creating a high-level design, architecture, exploring hardware options, and estimating budgets. The focus will be on crafting a flexible design that addresses various LINAC use cases while minimizing potential delays. Moreover, a paramount consideration will be placed on cost efficiency, aiming to achieve this with a minimal number of hardware/software solutions. The design process will also take into account indirect costs such as repairs, maintenance, training, upgrades, support, purchasing, and licenses. Furthermore, the design will encompass the integration of devices with diverse control interfaces, loops, data throughputs, and security requirements. Guidelines will be specified for the archival of operational data, development of Graphical User Interfaces, and high-level application development frameworks..

T3.5 Study of the Safety and Radiation protection requirements (M7-M36) [NCSRD(8), GNP(2), UL(3), IJS(2), COSYLAB(1), IAS(2), DKFZ(1), CERN(2)**]**

Studies supported by detailed simulations on the Safety and Radiation protection requirements for the forseen accelerator facility/infrastructures.

T3.6 Development of Computational tools (M13-M36) [AUTH(8) ,CERTH(6)]

This is a horizontal task supporting the majority of the WPs. Specifically, concerns the development of simulation, optimisation and modelling tools based on classical and AI algorithms to be used on the simulation and computational studies of the above tasks (T3.1 – T3.5). Furthermore, this task will offer computational modelling support to the tasks of WP4.

4	**Radioisotope production and radiopharmaceuticals**					
	Start Date	**M5**	**End Date**	**M48**	**Leader**	**UL**

Objectives

a) Determine scientific disciplines, experiments and investigations of the laboratory; b) develop lab conditions needed for producing isotopes; c) identify which are the best candidate isotopes for each of the three application areas: theranostics, therapy and diagnostics; d) investigate the optimal combination between the radio-isotope; e) in-vitro radiation biology testing of the combination ligand-isotope to assess the impact of the radio-nuclide; f) Perform "Pilot" Pre-clinical studies with animal model

Description of work

T4.1 Develop Lab conditions (radiation protection) needed for producing these isotopes (M5-M42) [GNP(10), AUTH(1), BIOKOSMOS(8), NCSRD(3), UL(8), UCY(2), CNE(2), SHSO(2), DKFZ(1), CERN(2)**]**

We expect an extensive handling of unsealed radionuclides. We will assess the level of hazard and design the facilities in a way to ensure adequate radiation protection of staff and environment. It will cover factors such as local shielding, benching, washing facilities, and requirements for disposal of radioactive waste to minimize the spread of contamination. Requirements for personnel dose monitoring and contamination monitoring will be set in an agreement with local authorities. The development and determination of sampling, analyzing, measurement and calculation methods will be set beforehand and will also include inter-laboratory comparisons and proficiency test. Two main approaches will be followed, namely: ALARA approach – As Low As Reasonably Achievable – which aims to avoid individuals receiving even the smallest dose. What's more, taking economic aspects into account, the ALARP principle – As Low As Reasonably Practicable – will be applied in the initial developmental phase. The ALARP approach is achieved through forward-thinking design solutions and taking all key radiation protection principles into account.

T4.2 Identify best Isotopes for production with LINAC (M5-M42) [UL(8), AUTH(1), BIOKOSMOS(2), GNP(4), NCSRD(1), AMOLDS(1), DKFZ(2), CERN(2)**]**

This part of the project will focus on the (i) investigation of precise nuclear data for the selection of suitable radionuclides; (ii) chemical and technical concept of the target materials providing radionuclides of interest; (iii) investigation of the optimal chemical forms and the principal separation methods allowing high chemical yields of radionuclides of interest; (iv) consideration of the activity scale with regard to radiation stability and radiation safety; (v) as well as eventual recovery of the target material. The exemplary radionuclides of interest will predominantly focus on radiolanthanides. The produced radionuclides will significantly improve the relevance and robustness of performed pre-clinical experiments and simplify their supply and utilization in the clinics.

T4.3 Investigate best Ligands for development within excellent hub (M5-M42) [UL(7), AUTH(1), BIOKOSMOS(2), GNP(3), NCSRD(2), DKFZ(6), CERN(2)**]**

The aim of T4.3 is to investigate the relevance of several promising cancer targets. In this regard, mRNA expression by bulk RNA sequencing and protein expression by immunohistochemistry (IHC) will be used to examine promising targets in various cancer types. Up to three targets of interest will be selected and evaluated in the literature. Native ligands and their shorter variants will be subsequently designed and synthesized by mean of classical organic chemistry and solid-phase support techniques. Such pharmacophores will be further equipped with radionuclide-tailored chelating ligands. The ultimate aim is to develop highly stable, affine and specific radiotracers and radiopharmaceuticals for the most promising targets strongly and commonly over-expressed in cancer tissues.

T4.4 Perform the development and testing of ligand-isotope compound (M5-M42) [DKFZ(9), AUTH(1), BIOKOSMOS(1), AMTH(3), CERTH(3), GNP(3), NCSRD(1), AMOLDS(1), UL(6), CERN(2)**]**

Novel targeting radioligands/radiopharmaceuticals will be evaluated on their radiolabeling efficiency. The LINAC-produced radionuclides will be tested at different forms (e.g. nitrate, chloride) and at various activities and specific activities (e.g. high and low). The radiolabeling will be performed with multiple chelating ligands (e.g. acyclic, macrocyclic), radiopharmaceuticals (e.g. small molecules, peptides, peptidomimetics), at different experimental conditions (e.g. buffer, pH, temperature, time, scavengers, impurities), in the absence and presence of native chelating ligands (e.g. ferritin, transferrin) and other elements (e.g. Ca^{2+}, $Fe^{2+/3+}$). The further analytical evaluation will include radiolytic stability, logD determination as well as binding to plasma and serum components. The most promising compounds will be tested and compared based on their binding affinity and internalization into target-(non)expressing cancer cells, cell viability and clonogenic assays.

T4.5 Perform "Pilot" Pre-clinical studies with animal model (M19-M48) [GNP(16), AUTH(3), BIOKOSMOS(1), NCSRD(1), UL(6), SHSO(3), DKFZ(8), CERN(2)**]**

Pharmaco-dynamics and -kinetics of the targeting radioligand/radiopharmaceutical will be further evaluated in an immune-suppressed mouse models to perform a proof-of-concept study. Upon success this can be extended in follow up proposals to more mice and immune-competent patient-derived xenograft (PDX) models. For in vivo diagnostic imaging, five healthy mice will be used to access the common tissue distribution profile which will serve as a proof-of-concept of tumor visualization by means of PET or SPECT. For ex vivo biodistribution studies, five PDX mice per time-point and radiolabeled compound will be used to gain the basic information about therapeutic window for prospective therapy studies. Ultimately, in a future study, we can evaluate the efficacy of the targeted radionuclide therapy in PDX mouse models by longitudinal tumor volume measurements and overall survival definitions as well as tumors, relevant organs and tissues evaluation by means of histopathology and IHC.

5	**Business plan for end users: From science to business including spinoffs**					
	Start Date	**M7**	**End Date**	**M48**	**Leader**	**TALOS**
Objectives						

a) Project Strategic Investment Plan and Financing; b) Develop Business Plan(s) for specific Business Cases; c) Secure the long-term sustainability of IFIGENEIA Excellence Hub.

Description of work

T5.1 Project Strategic Actions Investment Plan and Financing (M7-M48) [TALOS(8), AUTH(1), RCM(2), BIOKOSMOS(1), AMTH(3), CERTH(3), TPOLIS(4), NCSRD(1), AMOLDS(1), UL(4), IJS(3), COSYLAB(2), CNE(1), PASYKAF(2), SHSO(4), UNSA(2), GSI(1)**]**

- Finalise the strategic actions articulated in the Proposal. Emphasize on actions such as proof of concepts, prototyping, pilot projects, demonstrations and alternative actions.
- Determine most important and necessary costs associated with each strategic action and calculate the amount of investment needed.
- Determine the most appropriate funding method for each strategic action and list qualitative and quantitative benefits towards appropriate investors (type of funding, the source(s) of funding, appropriate financing scheme, quantitative benefits to investors such as future rights in specific KERs and or qualitative benefits to investors such as publicity, brand awareness etc)
- Organise and facilitate coherent actions aiming to achieving necessary complimentary funding during the Project. Secure agreements for such a complimentary funding.

T5.2 Management of Key Exploitable Results (KERs) (M25-M48) [TALOS(6), AUTH(1), RCM(2), BIOKOSMOS(2), AMTH(2), CERTH(2), TPOLIS(3), NCSRD(1), AMOLDS(1), IJS(3), COSYLAB(2), CNE(1), UNSA(2), DKFZ(2), CERN(2)**]**

- Fortification of Initial Identification of KERs included in the Proposal with a preliminary legal and regulatory analysis of exploitation together with first IPR background and foreground assessment.
- Characterisation of KERs including (i) detailed description, (ii) unique value proposition, (iii) early adopters, (iv) preliminary market macroenvironment analysis opportunities, threats, market size and growth, market trends (v) preliminary microenvironment market analysis including industry structure, competition landscape, customers' needs and wants, (vi) targeted market, (vii) go-to-market strategy.
- Risk assessment and mitigation for KERs based on the threats revealed above and including technological maturity and market/commercial readiness and timing.
- Development/finalization of individual partners' exploitation strategy and development of a joint exploitation strategy in three axes: (i) direct commercial (enhanced product/service portfolio, new product/service, enter new markets etc), (ii) indirect commercial (enrich/create new standards, safeguard IPRs with patents and licensing etc) and (iii) scientific (further R&I). Definition of the stakeholders/ecosystem of the target market and development of a Go-to-Market Strategy under a joint exploitation plan for each Target Group so that to reach the market after the end of the project.
- Preliminary Depiction of relevant Business Modelling using the Business Canvas tool
- Roadmap for KERs combinations creating specific Business Cases under the joint exploitation strategy and decision on exploiting such Business Cases as joint venture(s), spin-off(s) or under alternative agreements and planning relevant activities during and beyond the Project.

T5.3 Development of Business Plan(s) for Seeking Financing beyond the Project (M13-M48) [TALOS(11), AUTH(1), RCM(4), BIOKOSMOS(3), AMTH(2), CERTH(3), TPOLIS(4), NCSRD(1), AMOLDS(1), IJS(4), COSYLAB(6), CNE(1), PASYKAF(2)**]**

By developing Business Case(s) from selected KERs' combinations, for instance:
- Radioisotopes/Radiopharmaceutical Market(s) Analysis
- Costs and timeline for developing a LINAC and producing novel radioisotopes
- Benefits from providing radioisotopes to the radiopharmaceutical industry
- Benefits from the use of radioisotopes for non-medical applications such as proton beams in archeometry
- Continuation of the endeavors of the Excellence Hubs by establishment of a Consulting Arm for the industry, Relevant Business Plan(s) shall be constructed for seeking private investors funding, but also facilitating new Proposals applications for public funds:
- Business Plan Development Assessing the Feasibility of the Project, Investment Requirements and Return on - -
- Investment, including sensitivity analysis and Monte Carlo simulation if deemed necessary.
- Financing Raising Plan including financing options, bankability, roadshow to prospective private investors.

Coordinate and prepare new R&I proposals for seeking further public funding during and or beyond the end of the Project.

T5.4 Basic Sustainability for the Excellence Hubs (M25-M48) [RCM(15), AUTH(1), BIOKOSMOS(1), AMTH(2), CERTH(2), TPOLIS(4), NCSRD(3), AMOLDS(1), UL(2), IJS(6), COSYLAB(4), TALOS(10), SHSO(6), GSI(1)**]**

- Investigate options and decide on providing the Excellence Hubs with a legal identity
- Investigate options and decide upon an optimum organizational structure/framework with minimum financing requirement in order to prolong the life of the Excellence Hubs at least in the short-term beyond the end of the Project.
- Monetize Actions Developed during the Project to finance the optimum structure as defined above such as:

1. Knowledge-Portal for all partners and eventually for an extended ecosystem together with on-line collaborative tools so that to easy and sustain the Excellence Hubs activities beyond the end of the Project in order to continue pursuing its goals. Portal should host best practices, knowledge transfer schemes, institutional cooperations and collaboration. Usage of the portal at a fee for supporting basic sustainability.
2. Develop a Strategy for Enhancing Hub Membership and enlarging the ecosystem participating in the Hubs' Activities, always taking into account the sustainability of the Excellence Hubs. Apply a widening membership fee for supporting basic sustainability.
3. Continue Wider Public Education Actions using the Virtual Reality LINAC/Radiopharmaceutical Facility by organizing educational sessions for high schools and university students, including virtual demos and simulated experiments. Apply a fee for supporting basic sustainability of the Excellence Hubs.
4. Create a forum for providing innovation training, R&I management and entrepreneurship growth by organizing regular linkages of knowledge between science, technology and business aiming at generating new business opportunities around the core activities of the Project. Ideation, pre-design, design and delivery methods shall be employed during such sessions for agile delivery of quick results. Such a forum may be finance by the Project's funds and the Project will benefit from rights in prospective innovations.

6	**Mentorship and Capacity Buildings**					
	Start Date	**M13**	**End Date**	**M48**	**Leader**	**AUTH**

Objectives

a) provide mentoring activities to the BiH partners; b) Enhance the capacity building of the scientific community; c) offer a valuable and innovative VR platform that will continue its operation after the end of the project.

Description of work

T6.1 Accelerator School (M13-M48) [AUTH(8), BIOKOSMOS(5), CERTH(1), TPOLIS(1), NCSRD(3), AMOLDS(1), UL(2), IJS(4), COSYLAB(4), UCY(5), UNSA(3), GSI(5), DKFZ(2), CERN(5)]

The Accelerator School will provide intensive training sessions focused on the principles, operation, and applications of particle accelerators in nuclear medicine and molecular imaging. Led by expert instructors, the school will cover topics such as accelerator physics, beam dynamics, target design, and radiation safety. Participants will gain hands-on experience through practical exercises, simulations, and laboratory demonstrations, preparing them for roles in accelerator-based radioisotope production and research.

T6.2 Master Classes in Particle Therapy (M13-M48) [GNP(10), AUTH(4), BIOKOSMOS(2), CERTH(1), TPOLIS(1), NCSRD(1), AMOLDS(1), UL(4), SIH(6), SHSO(5), UNSA(3), GSI(5), DKFZ(2), CERN(5)**]**

The Master Classes in Particle Therapy will offer advanced training opportunities for medical physicists, oncologists, and radiation therapists interested in the clinical application of particle therapy techniques, such as proton and carbon ion therapy. Led by renowned experts in the field, the master classes will delve into topics such as treatment planning, beam delivery systems, dosimetry, and patient management. Participants will benefit from case studies, clinical demonstrations, and interactive discussions, gaining insights into the latest developments and best practices in particle therapy for cancer treatment.

T6.3 Implementation of a Virtual Interactive RadioIsotope production unit (MX-MX) [CERTH(25), AUTH(2), BIOKOSMOS(2), AMTH(1), GNP(2), TPOLIS(1), NCSRD(1), AMOLDS(2), UL(1),IJS(1), COSYLAB(1), SIH(2), UCY(1), SHSO(1), UNSA(5), GSI(1), DKFZ(1), CERN(2)**]**

The Virtual Interactive Radioisotope Production Unit will be a cutting-edge training tool designed to simulate the entire process of radioisotope production in a realistic and immersive virtual environment. Built on advanced virtual reality technology, the interactive unit will allow trainees to practice key tasks such as target preparation, irradiation, and quality control procedures. Through interactive modules, guided tutorials, and virtual mentoring sessions, users will enhance their understanding of radioisotope production techniques and workflows, facilitating

knowledge transfer and skill development in a safe and controlled setting.

3.1.3.3 List of deliverables (Table 3.1c)

All the deliverables will undergo scrutiny by the Security Officer and the Dissemination Manager who may decide their classification or the removal of sensitive information before public dissemination. The level of classification provided in the following table is just indicative and will be revised during the project. For conciseness reasons, the following table does not include internal nor contractual deliverables listed in the Grant Agreement.

No.	Deliverable Name	WP	Leader	Type[1]	Level[2]	Date
*1: **R**: Document, report | **DEM**: Demonstrator, pilot | **DEC**: Websites, press & media actions, videos, etc. | **OTHER**: Software, etc. 2: Dissemination **PU** = Public | **CO** = Confidential | **CI** = Classified.*						
D1.1	Project Management Handbook	WP1	AUTH	R	SEN	M3
D1.2	Project Quality Provisioning & Risk Management Manual	WP1	AUTH	R	SEN	M4
D1.3	Periodic Project Reports	WP1	AUTH	R	SEN	M12,M24,M36, M48
D1.4	Data Management Plan	WP1	IJS	R	SEN	M6, M24, M48
D2.1	Dissemination & Communication Plan	WP2	IJS	R	PUB	M6, M24, M48
D2.2	Dissemination & Communication activities	WP2	IJS	R	PUB	M24, M48
D2.3	Report of Training, Secondments and good practices exchange activities	WP2	TPOLIS	R	PUB	M24, M48
D3.1	LINAC-RFQ prototype design	WP3	AUTH	R, DEM	SEN	M24, M48
D3.2	Applications in cultural heritage	WP3	AUTH	DEM	SEN	M24, M48
D3.3	Beam parameters and hardware specifications	WP3	AUTH	R	SEN	M24, M48
D3.4	Control system development report	WP3	COZY LAB	R	SEN	M36, M48
D3.5	Study of the Safety and Radiation protection requirements	WP3	NCSRD	R	SEN	M24, M36
D4.1	Report for the specifications for designing and building a radio-isotope lab	WP4	GNP	R	SEN	M24, M42
D4.2	Report for the identification of the best candidate isotopes for each of the three application areas: theranostics, therapy and diagnostics	WP4	UL	R	SEN	M24, M42
D4.3	Evaluation Assessment of the pilot pre-clinical studies	WP4	GNP	R	SEN	M48
D5.1	Project Strategic Investment Plan	WP5	TALOS	R	SEN	M6
D5.2	Report on Financing Achieved for the Project Strategic Investment Plan	WP5	TALOS	R	SEN	M18
D5.3	KERs Exploitation Map	WP5	TALOS	R	SEN	M30
D5.4	Business Plan(s)	WP5	TALOS	R	SEN	M24, M36
D5.5	Report on Financing Achieved to Secure Sustainability	WP5	TALOS	R	SEN	M42
D5.6	Report on the establishment of a Legal Entity with Optimum Organisational Structure and Forecast of Recurrent Income and Costs	WP5	RCM	R	SEN	M36
D6.1	Report of the lessons offered by the Accelerator School and the Master Classes in Particle Therapy	WP6	AUTH	R	PUB	M24, M36
D6.2	Virtual Interactive RadioIsotope production unit	WP6	CERTH	DEM	PUB	M24, M48

3.1.4 List of milestones (Table 3.1d)

No.	Milestone Name	WPs	Date	Means of verification

MS1	Training Activities finalized	WP2	M48	D2.3
MS2	First version of LINC-RFQ prototype	WP3	M24	D3.1
MS3	First versions of Apps for cultural heritage	WP3	M24	D3.2
MS4	Pilot pre-clinical studies finalization	WP4	M48	D4.3
MS5	Secure Financing of the Project Strategic Investment Plan	WP5	M18	D5.2
MS6	Establish the Excellence Hubs as a legal entity	WP5	M36	D5.6
MS7	Secure Project Sustainability	WP5	M42	D5.5
MS8	First mentoring activities	WP6	M24	D6.1
MS9	First version of VR RI production unit	WP6	M24	D6.2

3.1.5 Critical risks for implementation (Table 3.1e)

Description of risk	Likelihood	Severity	WP(s)	Proposed risk-mitigation measures
Underperforming partners	Med	High	All	Low quality of work/ deliverables; systematic delays, etc. Such issues will be clarified on the Quality Plan and CA. Proper internal peer review procedures will be in place, to ensure quality of the deliverables and their preparation in a timely manner. Regular WP & technical meetings will be held to ensure that activities are streamlined and that lessons learnt are shared.
Technical/ administrative disagreement and cooperation problems among partners	Med	Med	All	Continuous communication between all the partners. The Project Coordinator (PC), Technical Manager (TM) and Quality Assurance Manager will work on problem solving during the project. If necessary, the Plenary Board will decide the right solution according to the CA. The Quality Plan will define the communication procedures and the use of communication tools will be encouraged. The PC is responsible of solving communication problems, establishing communication flows and methods and calling to bilateral meetings.
Disputes over ownership of IPR amongst consortium partners	Low	Med	All	Standard IPR and access rights clauses will be included in the CA, will be signed before work starts in order to avoid future disputes. The consortium has already discussed these aspects during the proposal phase for avoiding such problems.
Limited or inadequate resources to manage the project complexity	Med	Med	All	The IFIGENEIA consortium members have long experience in the thematic priority of the proposal and they have already participated in many past projects, thus the possibilities of such problems compromising the project are relatively low. However, the limited financial resources and extended project duration may increase the respective risk. In response to this, the PC will closely and quarterly monitor resource allocation, while the TM will focus on the efficient use of the available personnel resources throughout the project duration.
Limited acceptance by the end-users and relevant stakeholders	High	Med	WP3, WP4	The evaluation of the solution will assess user/ stakeholder acceptance and identify room for improvements. Also, various dissemination activities will be carried out to raise the awareness and increase the interest into the project results. The consortium has strong links with groups of stakeholders as the involved organisations maintain a strong network of important companies in the Nuclear Medicine field, which already indicated their interest by providing signed LoS / LoE.

3.1.6 Resources to be committed

3.1.6.1 Summary of staff effort (Table 3.1f)

No.	Partner	WP1	WP2	WP3	WP4	WP5	WP6	Total PMs
1	AUTH	39	5	58	7	4	14	**127**
2	RCM	1	8	0	0	23	0	**32**
3	BIOKOSMOS	1	3	6	14	7	9	**40**
4	AMTH	1	3	8	3	9	1	**25**
5	CERTH	2	4	18	3	10	27	**64**

6	GNP	1	16	2	36	0	12	**67**
7	TPOLIS	1	29	0	0	15	3	**48**
8	NCSRD	2	5	14	8	6	5	**40**
9	AMOLDS	1	2	22	2	4	4	**35**
10	UL	2	7	9	35	6	7	**66**
11	IJS	7	29	12	0	16	5	**69**
12	COSYLAB	3	7	39	0	14	5	**68**
13	SIH	1	8	0	0	0	8	**17**
14	IAS	1	8	6	0	0	0	**15**
15	TALOS	1	4	0	0	35	0	**40**
16	UCY	3	12	9	2	0	6	**32**
17	PASYKAF	1	14	0	0	4	0	**19**
18	SHSO	1	3	0	5	10	6	**25**
19	UNSA	1	3	8	0	4	11	**27**
20	GSI	1	18	0	0	2	11	**32**
21	DKFZ	3	2	4	26	2	5	**42**
22	CERN	4	6	32	10	2	12	**66**
	TOTAL PMs	**79**	**200**	**255**	**153**	**176**	**151**	**1014**

3.1.6.2 'Subcontracting costs' items (Table 3.1g)

No subcontracting costs in IFIGENEIA.

3.1.6.3 'Purchase costs' items (Table 3.1h)

22/DKFZ		
	Cost (€)	**Justification**
Travel and subsistence	10.000	Consortium meetings and events
Other goods, works and services	100.000	Consumables (consumables E041, consumables E270): 90.000 €; Publication costs: 5000 €; Audit costs: 5.000 €
TOTAL	110.000	

3.1.6.4 'Other costs categories' items (Table 3.1i)

No Internally invoiced goods and services in IFIGENEIA project.

#§QUA-LIT-QL§# #§WRK-PLA-WP§#

3.2 Capacity of participants and consortium as a whole [e.g. 3 pages] #@CON-SOR-CS@# #@PRJ-MGT-PM@#

3.2.1 Consortium as a whole

IFIGENEIA consortium combines multidisciplinary competences and resources from the public, social, research and business community focusing on creating Excellence Hubs targeting the isotope generation domain. It consists of twenty two **(22) partners** from four **(4) EC member states**, Switzerland and BiH as can be seen in the next Figure. This multinational cooperation is essential in order to implement the Excellence Hubs in Europe and beyond. The IFIGENEIA project brings together a team of experienced partners dedicated to contributing, each in their respective area of expertise, to the successful implementation of the project objectives. The consortium is well-positioned to deliver the results promised in this proposal. The IFIGENEIA consortium incorporates:

- Four (4) public authorities (RCM, GNP, SIH, SHSO) directly related to envisioned regional Excellence Hubs.
- Three (3) social actors (AMTH, IAS, PASYKAF) related to the social pillar of the Excellence Hubs.
- Four (4) business actors (BIOKOSMOS, AMOLDS, COSYLAB, TALOS), directly related to the regional Excellence Hubs.
- Nine (9) research/ technological actors (AUTH, CERTH, NCSRD, UL, IJS, UCY, UNSA, DKFZ, CERN). DKFZ and CERN are not involved in a hub but they act as horizontal partners.
- Two (2) Non profit organisations (TPOLIS, GSI)

3.2.2 Partner's main role and contribution to the project

	Unique Role in IFIGENEIA
AUTH	e.g. Project Coordinator (WP1); Dynamic user/ visual interfaces (TX.X - Leader); AI services (TX.X - Leader); optimization and forecasting (TX.X); software integration (TX.X); XXX

RCM	
BIOKOSMOS	
AMTH	
CERTH	
GNP	
TPOLIS	
NCSRD	
AMOLDS	
UL	
IJS	
COSYLAB	
SIH	
IAS	
TALOS	
UCY	
PASYKAF	
SHSO	
UNSA	
GSI	
DKFZ	
CERN	

3.2.3 Complementarity between Participants

As already shown, the ACRONYM consortium has been selected to bring together the skills and expertise necessary to realized next generation **keywords of the project concepts**. In ACRONYM, we have identified **six (6) main types of activities (research and technical expertise)** that impose respective roles of participants required:

Activities/ Roles Identified		Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	Partner 6	Partner 7	Partner 8	Partner 9	Partner 10	Partner 11	Partner 12	Partner 13	Partner 14	Partner 15	Partner 1x
Scientific Research & Technical Expertise	Technology Area 1																
	Technology Area 2	X				X											
	Technology Area 3			X	X							X					
	Technology Area 4		X						X							X	
	Technology Area 5							X									
	Technology Area 6		X						X								
Systems Integration and Technology Mediation											X			X			
Demonstrators Setup, Configuration & Operation																	
Impact	Clustering/ Dissemination		X						X				X			X	
	Communication				X	X				X					X		
	Standardisation & Policy-making			X													X
	Exploitation									X				X			
Coordination and Management																	

Although it might make the impression that our consortium structure contains some redundancy with the same expertise prevalent in different partner sites, all partners bring into the project a different focus of work and a different perspective of emphasis.

In particular, **XXX** works (on the one hand) on **project admin**, as well as on blockchain and system integration, while **XXX** undertakes the **technical coordination** and works on Smart Carbon Farming, **XXX** undertakes the **scientific coordination** and works on the Mix Farming Systems, while **XXX** works on the platform integration; **XXX** drives the Conversion of Cropland, **XXX**, **XXX**, **XXX**, **XXX**, **XXX**, **XXX** and **XXX** contribute with Regenerative Agriculture Methods and **XXX**, **XXX** and **XXX** with Blockchain. With regard to the industrial partners involvement; **XXX**, **XXX**, **XXX**, **XXX** and **XXX** will be responsible for the system integration while **XXX** will drive the standardization and communication activities, **XXX** and **XXX** will contribute on Smart Carbon Farming. Concerning **XXX**, **XXX** and **XXX** will be responsible for the ACRONYM architectural design and conceptualization of the framework, **XXX** and **XXX** for demonstrators' organization; finally, **XXX** that cooperates with **XXX**, **XXX**,

XXX and **XXX** will work towards the realization, evaluation, validation, and dissemination of the ACRONYM platform and activities.

Our experiences with prior European projects showed that a too small overlapping in the basic understandings, goals, and prior knowledge of project partners results in huge communication and negotiation problems which can be a serious risk for project success (see Section 1.2.6). It should also be mentioned that there already exist good relationships among some partners of this consortium, from past successful collaborations, which is expected to be valuable for a quick 'jump-start' of the project, as well as for a smooth running of operations throughout the project life-cycle.

3.2.4 Access to critical infrastructure

ACRONYM will apply strong engagement procedures (WPX, TX.X) to bring on board and build trust with demonstration ecosystems. Owners of the pilot sites and critical infrastructure are already members of the consortium and/or their full approval and commitment has been secured (e.g., through relevant LoS). Contingency plans have already been defined for risks that may affect the full access to the field and critical infrastructure/data (e.g., COVID-related) in Section 3.1.5.

3.2.5 Description of the industrial /commercial involvement

ACRONYM will constitute a valuable resource and framework for European companies involved in the fields of XXX and XXX. As such, ACRONYM has included six highly specialised companies with an active intention and outlook to expand their product/service portfolio that will play an important role on key aspects of the project, including technology area 1 (**PartnerName**), technology area 2 (**PartnerName**), technology area 3 (**PartnerName**), technology area 4 (**PartnerName**), technology area 5 (**PartnerName**) and technology area 6 (**PartnerName**). Furthermore, these companies will contribute in several areas of the project with great innovation potential, including the R&D platform for XXX …. It is important to note that three WPs (5, 7 and 9) are led by SMEs, to reinforce their roles in the implementation and future exploitation of the ACRONYM solution. Finally, these companies represent both SMEs (XXX, XXX, XXX and XXX) and large industrial companies (XXX and XXX), thus providing a variety of viewpoints and experiences to the ACRONYM project.

3.2.6 Other countries and international organisations

All participants belong to EU member states

#§CON-SOR-CS§# #§PRJ-MGT-PM§#