T A
Č R

Program **Delta 2**

PID: **TM04000065**

Slitiny s vysokou entropií připravené metodami aditivní výroby pro využití v jaderné energetice

Support provider:	**Technologická agentura ČR**
Programme:	**TM – Program na podporu aplikovaného výzkumu, experimentálního vývoje a inovací DELTA 2**
Call for proposals:	**4. veřejná soutěž programu DELTA 2**
Project duration:	**01/2023 – 12/2025**
Privacy level:	**C – The subject of the project is subject to trade secrery (§ 504 of the Civil Code No. 89/2012), but the name of the project, project objectives and for a completed or stopped project evaluating the result of the project delivered to CEP, are adjusted so as to be publishable.**
Main applicant:	**ÚJV Řež, a. s.**
Principal investigator:	**Mgr. Jan Klouzal**

I hereby declare that all stated information in the project proposal are true. At the same time, I declare that in the case that I requested effective cooperation within the project proposal between applicant and project partners according to the Article 2 (90) of the Regulation, these applicant and project partners are independent of each other (that means they are not partner or connected subjects) in accordance to the Article 3 of Annex 1 to the Regulation. The initiatives regarding a suspicion of corrupt behaviour may be sent via email to protikorupci@tacr.cz.

Other participant:	**Centrum výzkumu Řež s.r.o.**
Solver:	**RNDr. Ondřej Srba Ph.D.**

Other participant:	**Ústav termomechaniky AV ČR, v. v. i.**
Solver:	**Ing. Jan Kober Ph.D.**
Other participant:	**COMTES FHT a.s.**
Solver:	**Prof., Ing. Ján Džugan Ph.D.**
Other participant:	**Univerzita Karlova**
Solver:	**prof. RNDr. Miloš Janeček CSc.**
Foreign partner:	**Idaho National Laboratory**
Solver:	**Robert Allen Roach**

1. IDENTIFICATION DETAILS

Project identification code

Project identification code

TM04000065

Project title in Czech language

Project title in Czech language

Slitiny s vysokou entropií připravené metodami aditivní výroby pro využití v jaderné energetice

Project title in English language

Project title in English language

Additive manufacturing of high entropy alloys for nuclear applications

Project title - acronym

Project title - acronym

AMHEA

Project duration

Start of the project solution

Start of the project solution

01/2023

Completion of the project solution

Completion of the project solution

12/2025

Call for proposals the project is submitted in

Call for proposals the project is submitted in

4. veřejná soutěž programu DELTA 2

Programme the project is submitted within the call for proposals

Programme the project is submitted within the call for proposals
TM-Program na podporu aplikovaného výzkumu, experimentálního vývoje a inovací DELTA 2

2. APPLICANTS

Main applicant – [P] ÚJV Řež, a. s.

Identification details

Applicant role in project	ID No.	VAT ID
Main applicant	46356088	CZ46356088
Trade name	**Organisational unit**	**Organisational unit code**
ÚJV Řež, a. s.		
Legal form		
POO – Právnická osoba zapsaná v obchodním rejstříku (zákon č. 304/2013 Sb., o veřejných rejstřících právnických a fyzických osob)		
Organisation type		
LE - Large enterprise		

Registered office

Street name	Conscription Number	Orientation Number
Hlavní	130	
Municipality	**Municipal district**	**ZIP code**
Husinec		25068
District	**Region**	**Country**
Praha-východ	Středočeský kraj	the Czech Republic

Other details

Data box	Company establishment date
n3puyxq	01.01.1993

Commentary on automatically completed details

Commentary on automatically completed details

Person authorised to act for the applicant

Person authorised to act for the applicant
Ing. Daniel Jiřička, Chairman of the board Ing. Tomáš Novotný, Member of the board

Financial indicators

The criteria of evaluation of undertaking in difficulty

Indicator	Unit	Source	2018	2019	2020	2021
A.I Registered capital	thous. CZK	Balance sheet	524 139	524 139	524 139	524 139
A.II.1 Share premium	thous. CZK	Balance sheet	0	0	0	0
A.II.2 Other capital funds	thous. CZK	Balance sheet	85 149	85 149	85 149	85 149
A.III Reserves	thous. CZK	Balance sheet	379 231	377 884	375 711	367 897
A.IV Accumulated profit/loss	thous. CZK	Balance sheet	575 224	669 344	751 027	1 060 617
A.V Profit or loss	thous. CZK	Balance sheet	92 766	79 510	301 778	58 329
A.VI Advances on profit distributions (will always be a negative value)	thous. CZK	Balance sheet	0	0	0	0
Indication of an undertaking in difficulties			no (1 656 509 < 262 070)	no (1 736 026 < 262 070)	no (2 037 804 < 262 070)	no (2 096 131 < 262 070)

Commentary on automatically completed details

Commentary on automatically completed details

Ownership structure

Owners/Shareholders

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
ČEZ, a. s.	45274649	52.46
Comment for share		
-		

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
OBEC HUSINEC	00240231	2.38
Comment for share		
-		

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
Slovenské elektrárne, a.s.	35829052	27.77
Comment for share		
-		

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
ŠKODA JS a.s.	25235753	17.39
Comment for share		
The shareholder does not exercise decisive influence within the applicant's company.		

Beneficiaries

List of beneficiaries with a share of 10% or more on the applicant or project partner

List of beneficiaries with a share of 10% or more on the applicant or project partner
nejsou

Ownership interests

Trade name	ID No.	Share in %
Centrum výzkumu Řež s.r.o.	26722445	100
Trade name	ID No.	Share in %
Výzkumný a zkušební ústav Plzeň s.r.o.	47718684	100
Trade name	ID No.	Share in %
Centrum výzkumu Řež s.r.o.	26722445	100
Trade name	ID No.	Share in %
ŠKODA PRAHA a.s.	00128201	100

Project partner – [D] Centrum výzkumu Řež s.r.o.

Identification details

Applicant role in project	ID No.	VAT ID
Project partner	26722445	CZ26722445
Trade name	Organisational unit	Organisational unit code
Centrum výzkumu Řež s.r.o.		
Legal form		
POO – Právnická osoba zapsaná v obchodním rejstříku (zákon č. 304/2013 Sb., o veřejných rejstřících právnických a fyzických osob)		
Organisation type		
RO - Research organization		

Registered office

Street name	Conscription Number	Orientation Number
Hlavní	130	
Municipality	Municipal district	ZIP code
Husinec	Řež	25068
District	Region	Country
Praha-východ	Středočeský kraj	the Czech Republic

Other details

Data box	Company establishment date
pa3vgcj	09.10.2002

Commentary on automatically completed details

Commentary on automatically completed details

Person authorised to act for the applicant

Person authorised to act for the applicant
Ing. Milan Patrík MBA, managing director, Ing. Ján Milčák, managing director, Ing. Petr Březina, MSc., managing director They acting two of them jointly.

Ownership structure

Owners/Shareholders

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
ÚJV Řež, a. s.	46356088	100
Comment for share		

Beneficiaries

List of beneficiaries with a share of 10% or more on the applicant or project partner

List of beneficiaries with a share of 10% or more on the applicant or project partner
CVŘ does not distribute outside company any profit and according to the founding document, all profit is reinvested back into the company.

Ownership interests

Project partner – [D] Ústav termomechaniky AV ČR, v. v. i.

Identification details

Applicant role in project	ID No.	VAT ID
Project partner	61388998	CZ61388998
Trade name	**Organisational unit**	**Organisational unit code**
Ústav termomechaniky AV ČR, v. v. i.		
Legal form		
VVI – Veřejná výzkumná instituce (zákon č. 341/2005 Sb., o veřejných výzkumných institucích)		
Organisation type		
RO - Research organization		

Registered office

Street name	Conscription Number	Orientation Number
Dolejškova	1402	5
Municipality	**Municipal district**	**ZIP code**
Praha 8	Libeň	18200
District	**Region**	**Country**
		the Czech Republic

Other details

Data box	Company establishment date
s8fnqns	01.01.1995

Commentary on automatically completed details

Commentary on automatically completed details

Person authorised to act for the applicant

Person authorised to act for the applicant
doc. Ing. Miroslav Chomát, CSc., statutory body

Ownership structure

Owners/Shareholders

Individual/legal entity	First name	Last name
Legal entity		
Trade name	Personal ID No.	Share in %
Akademie věd České republiky	60165171	
Comment for share		

Beneficiaries

List of beneficiaries with a share of 10% or more on the applicant or project partner

List of beneficiaries with a share of 10% or more on the applicant or project partner

Ownership interests

Project partner – [D] COMTES FHT a.s.

Identification details

Applicant role in project	ID No.	VAT ID
Project partner	26316919	CZ26316919
Trade name	Organisational unit	Organisational unit code
COMTES FHT a.s.		
Legal form		
POO – Právnická osoba zapsaná v obchodním rejstříku (zákon č. 304/2013 Sb., o veřejných rejstřících právnických a fyzických osob)		
Organisation type		
RO - Research organization		

Registered office

Street name	Conscription Number	Orientation Number
Průmyslová	995	
Municipality	**Municipal district**	**ZIP code**
Dobřany		33441
District	**Region**	**Country**
Plzeň-jih	Plzeňský kraj	the Czech Republic

Other details

Data box	Company establishment date
bucdgci	01.12.2000

Commentary on automatically completed details

Commentary on automatically completed details

Person authorised to act for the applicant

Person authorised to act for the applicant
Libor Kraus - chairman of the board of directors Zbyšek Nový - vicechairman of the board of directors At least two members of the board of directors act for the company together. The chairman and the vicechariman of the board each act for the organisation separately.

Ownership structure

Owners/Shareholders

Individual/legal entity	First name	Last name
Individual entity	Libor Ing.	Kraus
Trade name	Personal ID No.	Share in %
	25.1.1967	39.22
Comment for share		
The part corresponds to 5 960 shares of the organization COMTES FHT a.s. according to the Annex to the financial statements audited by the auditor.		

Individual/legal entity	First name	Last name
Individual entity	Bohuslav Doc.Dr.Ing.	Mašek
Trade name	Personal ID No.	Share in %
	29.12.1960	5.88
Comment for share		
The part corresponds to 894 shares according to the Annex to the financial statements audited by the auditor.		

Individual/legal entity	First name	Last name
Individual entity	Jan	Motyčka
Trade name	Personal ID No.	Share in %
	5.12.1974	11.76
Comment for share		
The part corresponds to 1 788 shares according to the Annex to the financial statements audited by the auditor.		

Individual/legal entity	First name	Last name
Individual entity	Zbyšek	Nový
Trade name	Personal ID No.	Share in %
	6.1.1965	43.14
Comment for share		
The part corresponds to 6 556 shares according to the Annex to the financial statements audited by the auditor.		

Beneficiaries

List of beneficiaries with a share of 10% or more on the applicant or project partner

List of beneficiaries with a share of 10% or more on the applicant or project partner
Kraus Libor 39.2% , Motyčka Jan 11.8% , Nový Zbyšek 43.1% . The above-mentioned natural persons hold positions in the top management of the organization. Due to the fact that this is a research organization, all profits are reinvested in the development of the research organization and these persons have no share in the profits of the organization.

Ownership interests

Trade name	ID No.	Share in %
ET Additive s.r.o.	11928883	24.8
Trade name	ID No.	Share in %
COMTES DFM s.r.o.	26351765	75

Project partner – [D] Univerzita Karlova

Identification details

Applicant role in project	ID No.	VAT ID
Project partner	00216208	CZ00216208
Trade name	Organisational unit	Organisational unit code
Univerzita Karlova	Matematicko-fyzikální fakulta	11320
Legal form		
VVS – Veřejná nebo státní vysoká škola (zákon č. 111/1998 Sb., o vysokých školách a o změně a doplnění dalších zákonů)		
Organisation type		
RO - Research organization		

Registered office

Street name	Conscription Number	Orientation Number
Ovocný trh	560	5
Municipality	**Municipal district**	**ZIP code**
Praha 1	Staré Město	11000
District	**Region**	**Country**
		the Czech Republic

Other details

Data box	Company establishment date
piyj9b4	01.01.1972

Commentary on automatically completed details

Commentary on automatically completed details

Person authorised to act for the applicant

Person authorised to act for the applicant
doc. RNDr. Mirko Rokyta, CSc. - dean of the faculty based of on power of attorney of the statutory body (Rector of Charles University)

Ownership structure

Owners/Shareholders

Individual/legal entity	First name	Last name
Legal entity		
Trade name	**Personal ID No.**	**Share in %**
Ministerstvo školství, mládeže a tělovýchovy	00022985	100
Comment for share		

Beneficiaries

List of beneficiaries with a share of 10% or more on the applicant or project partner

List of beneficiaries with a share of 10% or more on the applicant or project partner

Ownership interests

Trade name	ID No.	Share in %
CESNET, zájmové sdružení právnických osob	63839172	15
Trade name	ID No.	Share in %
Charles University Innovations Prague a.s.	07236239	94

Foreign partner – [Z] Idaho National Laboratory

Identification details

Applicant role in project	ID No.	VAT ID
Foreign partner		000
Trade name	Organisational unit	Organisational unit code
Idaho National Laboratory		
Legal form		
OCS – Organizace cizího státu		
Organisation type		
RO - Research organization		
Foreign organisation		
DOE - Department of Energy of the United States of America		

Registered office

Street name	Conscription Number	Orientation Number
1955 N Fremont Ave.	1955	1955
Municipality	Municipal district	ZIP code
Idaho Falls	Idaho Falls	83415
District	Region	Country
District outside the Czech Republic	Region outside the Czech Republic	the United States of America

Other details

Commentary on automatically completed details

Commentary on automatically completed details

The U.S. does not have a VAT system.

Person authorised to act for the applicant

Person authorised to act for the applicant

Peter Wells - Chief Operations Officer - Nuclear Science and Technology Directorate

3. PROJECT INTRODUCTION

Factual focus of the project proposal

Project objectives in Czech language

Project objectives in Czech language

V tomto projektu budou vyrobeny speciální slitiny s vysokou entropií (HEAs) pro jaderné aplikace za vysokých teplot metodami aditivní výroby (3D tisku) ze smíchaných elementálních prášků. Ve spolupráci s americkým partnerem provedou členové českého konsorcia expozici těchto materiálů v korozních prostředích He, roztavených solí a PbLi pro ověření jejich potenciálního využití v rychlých plynových reaktorech (GFR), reaktorech s roztavenými solemi (MSR) a ve fúzních reaktorech. V projektu budou metodou aditivní výroby vyrobeny dva výrobky s přesným tvarem s cílem prokázat využití 3D tisku z nově navržených HEAs - mřížka spaceru pro reaktor GFR a část těsnění pro víko reaktoru. Vyvinutá metoda aditivní výroby s optimalizovanými parametry pro tisk nově navržených slitin bude patentována.

Project objectives in English language

Project objectives in English language

In this project specially designed High Entropy Alloys (HEAs) for high-temperature nuclear applications will be produced by additive manufacturing (AM - 3D printing) from mixed elemental powders. In a close cooperation between the US partner and members of Czech consortium, materials will be exposed to He, molten salt, and PbLi corrosive environments for potential applications in Gas Fast Reactors (GFR), Molten Salt Reactors (MSR) and in fusion power, respectively. Two near net-shape AM products will be fabricated to demonstrate the capabilities of AM of HEAs, namely a spacer grid for GFR and a sealing component for the reactor top. Developed AM procedure with optimized processing parameters will be patented.

Fulfillment of the objectives of the programme and of the call for proposals

Fulfillment of the objectives of the programme and of the call for proposals

The aim of the TACR Delta program is to increase the number of specific outcomes/results of applied (industrial) research. In this project, five different specific outcomes will be achieved including a patent. All results will be implemented by the Czech proposer of the project ÚJV Řež in the field of nuclear power. The project will further enhance competitiveness of the proposer in the field of development of solutions for nuclear application. Nuclear research has a long term and established tradition in the Czech Republic.

Thanks to the cooperation with the top-class partner - Idaho National Laboratory, a national laboratory of the U. S. Department of Energy - Czech partners will gain international knowledge and know-how in the field of modern trends in nuclear solutions. Significant synergistic effect between the Czech consortium and the US partner is achieved by complementary infrastructure, capabilities, experience and know-how. Transfer of "good practice" from the world-leading US partner towards members of Czech consortium in terms of corporate governance, project magement and attitude to the advanced industrial research is guaranteed.

There is currently no doubt that new solutions in nuclear energy are required to increase the energy security, both in the US and in many EU countries including the Czech Republic. The project is devoted to industrial research in this very important field of nuclear energy and will contribute to the safer, cleaner and sustainable energy production.
Finally, close cooperation of the partners of the project is a manifestation of common interests of both the Czech Republic and the USA in the field of nuclear energy.

The zero variant and the incentive effect

The zero variant and the incentive effect

Without the financial support from the TACR-Delta program, the project could not be carried out due to extreme financial costs that are typical for complex projects in nuclear research.

The essence and the timetable of the project proposal

The essence and the timetable of the project proposal

Additive manufacturing (AM) and High Entropy Alloys (HEAs) are hot-topics in materials science and engineering. Simultaneously, there is a recognized need for the development of new materials and methods of their manufacturing in the field of nuclear materials that provide the increased performance required for extreme environments as the radiation, high temperature, and corrosive or oxidation environments. Innovative materials and manufacturing techniques for small modular reactors and advanced fuels must also be created to realize a nuclear future that is economically sustainable.

Selected HEAs potentially suitable for nuclear use in terms of high-temperature mechanical properties, corrosion resistance and neutron activation will be manufactured by Selective Laser Melting (SLM) from mixed elemental powders. Manufactured materials will be exposed to He, molten salt, and PbLi corrosive environments for potential applications in Gas Fast Reactors (GFR), Molten Salt Reactors (MSR) and in fusion power, respectively. Mechanical properties at room and elevated temperatures will be tested at non-active and activated/irradiated samples. For this purpose, samples will be irradiated by neutrons both in the USA and the CR. Radiation damage will be thoroughly studied and related to the manufacturing process. For a comparison, alloys prepared by arc melting and common metallurgy procedures will also be tested.

Tasks & Time schedule

1. Design of HEAs 01/2023 - 02/2023
The design will be focused on the AlMoNbTiZr system, with Cr, Fe and W additions and Si and Y microalloying. Removal (partial removal) of Al, Zr or Mo might be required to balance the resistance to corrosion and the ductility of the material.
(see also State of the Art)

2. Additive manufacturing of HEAs 02/2023 - 12/2023 (round robin manufacturing of selected materials also in later stages of the project)
Elemental powders will be procured (gas atomized elemental powders for AM of all considered metallic elements are readily available from global distributors). Small amounts of powders will be mixed in desired ratios. It is assumed that each alloy will require individual optimized parameters for successful AM. Key parameters are laser power, powder feed, speed of printing, hatch distance, printing scheme and several other settings. The aim is to achieve a material without any porosity with good chemical homogeneity. It is assumed that a homogenization heat-treatment at high temperatures in an inert atmosphere will be required.
(see also State of the Art)

3. Microstructure and mechanical properties 04/2023 - 10/2023
Analysis of material microstructure. Mechanical properties testing. Selection of best alloy composition and processing parameters.

4. Corrosion exposure (Idaho National Laboratory) 01/2024 - 12/2024
Exposure of samples to molten salt and PbLi corrosive environments. Evaluation of the material response.

5. Corrosion exposure (Research Centre Řež) 01/2024 - 12/2024
Exposure of HEA samples to high temperature in He, PbLi and molten salts environments. Evaluation of the material resistance.

6. Neutron irradiation of samples (Research Centre Řež) 04/2024 - 03/2025

7. Ion irradiation (Idaho National Laboratory) 04/2024 - 03/2025

8. Radiation damage of HEAs after irradiation 04/2025 - 10/2025
Analysis of microstructure of studied HEAs after irradiation. Mechanical properties testing of irradiated samples in hot-cells. Selection of the best performing material.

9. Design of reactor components 01/2025 - 06/2025
Design of suitable components demonstrating the AM capability for nuclear applications: Spacer Grid for GFR, Nuclear Seal Component
(see also Results/Outcomes of the project)

10. Near-net shape AM of the components 07/2025 - 12/2025
Fabrication of near-net shape semi-products by AM. Thermal treatment, surface-finishing of the products.

Project management

Project management

The AMHEA project will be headed and coordinated by principal investigator Jan Klouzal. The main proposer UJV Řež will take all strategic and key decisions in order to assure achieving the results and aims of the project. Project Steering Committee consisting of one member from each of the project partners including the foreign partner (5 + 1) will govern the project. The meeting of the committe will take place at least once a month (on-line). Czech members of the Committee will meet also in person to efficiently manage the Czech consortium.
The Project Steering Commitee will
- regularly discuss the development of the project,
- assure that all activities are running according to the time-plan,
- assure access to experimental facilities shared within consortium,
- provide efficient and smooth management of the Czech consortium,
- assure smooth cooperation with the foreign partner.

Intensive cooperation between partners of the project (including the foreign partner) is assumed on a daily basis depending on current activities and progress of work. For instance, the intensive cooperation between the foreign partner INL and Research Centre Řež (dr. Ondřej Srba) is foreseen due to similarities in project activities, and also similar background.

Technical provision, initial know-how, applicants' dispositions

Technical provision, initial know-how, applicants' dispositions

ÚJV Řež
Main proposer is responsible for project management and implementation of the achieved results. The priority of ÚJV Řež is nuclear power engineering, i.e. the support of operating units and the preparation of new nuclear units. Results of the project and hands-on experience with AM of HEAs will be implemented by ÚJV Řež and its industrial partners. ÚJV Řež and, personally the PI of the project Jan Klouzal have appropriate background and all capabilities required for heading and managing this project.

Research Centre Řež (RCR)
The research infrastructure at Řež is dedicated research infrastructure to the testing of materials after irradiation and exposure to corrosive environments. Own research nuclear reactor is available for the project, as well as state-of-the art hot cells for testing and characterization of materials after irradiation. Experts of RCR have a strong background in investigating radiation damage of materials (using electron microscopy etc.) and assessing corrosion damage.

Comtes FHT
The member of the consortium will utilize state-of-the-art InssTek MX-600 3D printer for the Selective Laser Maelting (SLM) of HEAs throughout the project. More importantly, research team will fully exploit its acquired knowledge with AM of nonstandard materials and complex alloys which require creative selection of processing parameters.

Department of Physics of Materials, Charles University
Long-term experience with development of new metallic materials and their thorough microstructural characterization. The partner is fully equipped for complex characterization of microstructure and physical properties of metallic materials. Members of rearch team have deep knowledge of HEAs of various types which will be utilized for alloys design.

Insitute of Thermomechanics
Unique equipment and knowledge for determination of mechanical properties (incl. elastic constants) will be used to link composition, microstructure and mechanical properties.

Current state of knowledge, novelty and research uncertainty

Current state of knowledge, novelty and research uncertainty

New class of metallic alloys called High Entropy Alloys (HEAs) that emerged in the last two decades can be described as concentrated solid solutions of multiple metals.The increasing number of alloying elements enhances the role configuration entropy stabilizing single-phase or two-phase materials exhibiting attractive physical properties such as excellent mechanical performance at room and high temperatures [Stepanov2015], good corrosion resistance [Chou2010] and good resistance against radiation damage [Kumar2016]. HEAs consisting mostly of refractory high-melting metals possess remarkable strength at temperatures of 1000–1600 °C making them candidates for high-temperature use in nuclear applications [Miracle2017, George2020].
The progress in additive manufacturing (AM) technology makes it possible to prepare various HEAs mostly equimolar CoCrFeMnNi and CoCrFeNiAl alloys with fcc structure [Wang2017] and also high temperature MoNbTaW HEA manufactured from mixed elemental powders in a single container [Dobbelstein2016]. Particular focus is paid on the optimization of processing parameters such as laser power and scanning strategies [Ocelik2016, Xiang2019].

AM of HEAs dedicated to nuclear applications represents the novelty of the project. Research uncertainty lies in the selection of alloy composition and in optimization of processing parameters of AM. Methodology of testing of small samples in corrosive environments will be also developed during the project.

[Chou2010] Y.-L. Chou et al. Corr. Sci. 52 (2010) 3481-3491
[Dobbelstein2016] H. Dobbelstein et al. Phys. Procedia 83 (2016)
[George2020] E.P. George et al. Acta Mater. 188 (2020)
[Kumar2016] N.A.P. Kiran Kumar et al. Acta Mater 113 (2016)
[Miracle2017] D.B. Miracle et al., Acta Mater. 122 (2017)
[Ocelik2016] V. Ocelík et al. JOM 68 (2016) 1810–1818
[Stepanov2015] N.D. Stepanov et al. Mater. Lett. 142 (2015)
[Wang2017] R. Wang et al. JAC 694 (2017)
[Xiang2019] S. Xiang et al. JAC 73 (2019)

Differentiation from similar projects and solutions

Differentiation from similar projects and solutions

In the project TK01030153 (2018 - 2024), HEAs for nuclear applications are being developed. Current achieved knowledge will be used for the HEAs design in this project. Project TK01030153 does not involve at all materials produced by additive manufacturing.

The project TK04020056 (2022 - 2025) also involves the development of the high entropy alloys, but only as a limited part of its scope. The TK04020056 project focuses on the additive manufacturing from the already approved nuclear grade materials and solely for the application out of the reactor core.

The project TK04020331 (2022-2025) focuses on additive manufacturing of nuclear fuel components, however, there is no relation to HEAs.

In the GACR 21-14030S project (2021-2023) , additive manufacturing of complex alloy is studied and developed. Current knowledge from this project will be utilized for optimization of parameters of AM. The project has, however, no connection to nuclear applications.

Applicability of outputs / results in practice, the benefits of the project

Applicability of outputs / results in practice, the benefits of the project

The high temperature, radiation and corrosion resistant materials are key materials of several nuclear technologies, all of which have the potential to remove the industry reliance on the fossil fuels for the process heat production. Furthermore, the additive manufacturing is crucial for the standardised supply of these "GenIV" small modular reactors due to limited size of the core, primary circuit and other components on one hand, but stringent requirements on the precision of manufacturing and strength of the component on the other one.

The ability to implement the results in practice

The ability to implement the results in practice

UJV Řež has been actively working on the design and construction of the demonstrator unit of the Gas cooled Fast Reactor (GFR) ALLEGRO as a part of the V4G4 CoE consortium since 2010. Since 2021, the small modular variant of the GFR - HeFASTo has been developed by UJV GenIV teams to provide the industry with high potential heat while closing the fuel cycle with next to zero production of the long lived radioactive transuranic elements. The vision of the HeFASTo project is to finish the conceptual design by 2025, gather the industrial partners by 2028 and set the ground for the deployment of the first units in late 2030s.

Benefits of international cooperation

Benefits of international cooperation

The Czech consortium is sizeable, knowledgable and well equipped for carying out of the majority of the project tasks. However including the foreign partner is the key ingredient of the project. Foreign partner is required in the project mainly due to the following reasons:
- sharing knowledge and expertize in the field od HEAs for nuclear applications,
- sharing equpiment; most importantly tests in corrosive environment,
- sharing methodology of subsequent characterization of corrosion damage and quantification of corrosion resistance of individual tested materials,
- sharing knowledge of small modular reactors as well as the applications of additively manufactured HEAs in the small modular reactors.

Thanks to the cooperation with the top-class partner - Idaho National Laboratory, a national laboratory of the U. S. Department of Energy - Czech partners will gain international knowledge and know-how in the field of modern trends in nuclear solutions. Significant synergistic effect between the Czech consortium and the US partner is achieved by complementary infrastructure, capabilities, experience and know-how. Transfer of "good practice" from the world-leading US partner towards members of Czech consortium in terms of corporate governance, project magement and attitude to the advanced industrial research is guaranteed.

Justification of the need for international cooperation with the Foreign partner(s)

Justification of the need for international cooperation with the Foreign partner(s)

Idaho National Laboratory and DOE National Laboratory, are the nation's leading centers for nuclear energy research and development. INL is a recognized world-leading laboratory for development and testing of materials under extreme environments. INL develops materials that can sustain environments with high radiation, temperature, and pressure, and that may be highly corrosive. It forges new methods to efficiently manufacture components capable of withstanding extreme conditions. INL houses an exceptional array of scientific expertise, equipment and vision to help shape extraordinary new technologies into practical, everyday use. It closely cooperates with industrial partners on implementation of results of industrial research into the commercial practice.

Mutual cooperation and fruitful discussions has already resulted in new ideas and concepts reflected in this project application. INL will provide exposure of samples to molten salt loop and PbLi loop. INL will share knowledge and hands-on experience with corrosion tests and subsequent material characterization.

Thanks to the cooperation with the top-class foreign partner Czech partners will gain international knowledge and know-how in the field of modern trends in nuclear solutions. Significant synergistic effect between Czech consortium and the US partner is achieved by complementary infrastructure, capabilities, experience and know-how. Transfer of "good practice" from the world-leading US partner towards members of Czech consortium in terms of corporate governance, project magement and attitude to the advanced industrial research is guaranteed.

Analysis of risks

Risk identified	Probability	Impact	Risk level
HR (turnover of important staff)	Low	Smaller	4
Organisational (control and management of researchers and other participants)	Very low	Bigger	4
Financial (insolvency of other participants)	Very low	Very small	1
Loss of the commercial potential of the outcomes	Very low	Bigger	4
Project change (based on knowledge obtained during the implementation)	Medium	Smaller	6
Lack of raw materials (elemental powders)	Low	Smaller	4
Delay in project activities	Medium	Smaller	6

Risk analysis

Risk analysis

1) Personal fluctuations
Partners involved in the project are established institutions in materials enginnering and/or nuclear research with sizeable research teams. In case of low probable fluctuancy of members of individual research teams during project execution those can be easily replaced by experts with similar background, abilities and experience.

2) Project management
All partners in the consortium have numerous experiences with running projects of this size (and even bigger ones). Project will be managed by the main proposer and the Project Steering Committee which guarantee efficient management of all project activities.

3) Results implementation
The main proposer has long-term experience with implementation of results of dozens of industrial research projects.
The probability of the risk is very low.

4) Project change
Partial changes of activities during the project are common and quite probable. These directly follow from the nature of the R&D project and inherent research uncertainty. However, there is no risk of major change of the overal project objectives, neither project results/outcomes.

5) Lack of raw materials
Powders for AM will be procured from global distributors. In addition, on-demand powder production is also possible. However, some powders might be hard to manufacture or extremely expensive. The presented HEA design takes into account these facts (for instance Ta should be avoided due to economical reasons). Possiblity of lack of initial materials cannot be completely ruled out even if it is very low.

6) Delay in project activities
Project time-schedule is considerably tight considering the maximum duration of the project and complexity of activities. However, project members have all necessarry equpiment, capabilities and knowledge for carrying out the research activities in a timely manner. Strict project management by the main proposer will also reduce this risk.

Definition of the project

Main CEP field

Main CEP field

JF - Nuclear energy

Additional CEP field

Additional CEP field

JG - Metallurgy, metal materials

Another additional CEP field

Another additional CEP field

JK - Corrosion and material surfaces

Main FORD field

Main FORD field

20305 Nuclear related engineering; (nuclear physics to be 1.3);

Additional FORD field

Additional FORD field

20501 Materials engineering

Another additional FORD field

Another additional FORD field

20704 Energy and fuels

RIS III strategy

Domains of research and innovation specialization

Advanced materials, technologies, and systems

Confidentiality code

Confidentiality code

C - The subject of the project is subject to trade secrery (§ 504 of the Civil Code No. 89/2012), but the name of the project, project objectives and for a completed or stopped project evaluating the result of the project delivered to CEP, are adjusted so as to be publishable.

Keywords

Keywords

Keywords

nuclear energy; additive manufacturing; high entropy alloys

National priorities of oriented research, experimental development and innovation (RDI priorities)

National priorities of oriented research, experimental development and innovation (RDI priorities)

Main priority

1. Sustainable Energy – 1.2 Nuclear resources of the energy – 1.2.6. Research and development in the area of reactor of the IV generation, mostly effective and secure fast reactors

Secondary priority

3. Material base – 3.1 Advanced materials – 3.1.2 Advanced materials for the competitiveness

1. Sustainable Energy – 1.2 Nuclear resources of the energy – 1.2.3 Research ensuring support of the construction and running of the new economically efficient and secure blocks

4. PROJECT TEAM

Key persons

Role		ID of participant	Position held in the organization
Member of the research team		46356088	Senior Researcher
Titles before name	First name	Surname	Titles after name
Ing.	Martin	Dostál	Ph.D.
Nationality		Personal ID	
the Czech Republic		Hidden	
Phone	Mobile phone	E-mail	
+420266172471	+420728612545	martin.dostal@ujv.cz	
Main activities performed during project solving			
Evaluation of novel materials with respect to the in-core conditions of the Gen IV reactors. Definition of the experimental programme based on advanced simulations and modelling			

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.15	0.15	0.15	0.45

Curriculum vitae
Education Czech Technical University in Prague,Faculty of Nuclear Sciences and Physical Engineering
Relevant experience 2004 - now ÚJV Řež, a.s., FEM analysis of in-core components of nuclear reactors, Safety assessment
List of the most significant projects E10142 - OECD Studsvik Cladding Integrity Project II. LA10019 – OECD Halden Reactor Project Fuel licencing and safety analysis for CEZ, a.s.
List of the most significant results OECD NEA EGRFPT PCMI Benchmark - Key Contributor SCIP IV Modelling workshop - Principal investigator
Experience with VaVaI projects K03020169 - Methods for the qualification of the Accident Tolerant Fuels

Role		ID of participant	Position held in the organization
Principal investigator		46356088	Head of severe accidents dpt.
Titles before name	**First name**	**Surname**	**Titles after name**
Mgr.	Jan	Klouzal	
Nationality		**Personal ID**	
the Czech Republic		Hidden	
Phone	**Mobile phone**	**E-mail**	
+420266172471	+420602359091	jan.klouzal@ujv.cz	
Main activities performed during project solving Definition of the performance requirements and material needs of the GenIV reactor systems, coordination of the material and manufacturing techniques development			

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.1	0.1	0.1	0.3

Curriculum vitae
Education MFF UK, Nuclear and Particle physics
Relevant experience 2008 - now ÚJV Řež - Key expert for nuclear fuel performance issues, since 2017 head of Severe Accidents and Thermomechanics dpt. 2006-2008 BNFL / Sellafield ltd. – Risk Assessment
List of the most significant projects Nuclear fuel licensing and operational support for CEZ, a.s.
List of the most significant results Adaptation of TRANSURANUS fuel performance code for CEZ NPPs and for GFR applications Conceptual design of HeFASTo GFR
Experience with VaVaI projects Principal investigator in TK03020169 - Methods for the qualification of the Accident Tolerant Fuels

Role		ID of participant	Position held in the organization
Other solver		26722445	Director of R&D Section
Titles before name	**First name**	**Surname**	**Titles after name**
RNDr.	Ondřej	Srba	Ph.D.
Nationality		**Personal ID**	
the Czech Republic		Hidden	
Phone	**Mobile phone**	**E-mail**	
266173466		ondrej.srba@cvrez.cz	
Main activities performed during project solving Expert management of the project in CVŘ and coordination of project work. Risk management. Presentation of results to the professional public (conferences, professional seminars, workshops, etc.).			

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.1	0.1	0.1	0.3

Curriculum vitae
Education 2010 RNDr. - Solid State Physics, Faculty of Mathematics and Physics, Charles University 2012 Ph.D. - Solid State Physics, Faculty of Mathematics and Physics, Charles University
Relevant experience 2008 - 2012: researcher, Department of Solid State Physics, Faculty of Mathematics and Physics, Charles University 2012 - 2017: Researcher, Research Centre Řež 2017 - 2021: Head of R&D department, Research Centre Řež; Senior Researcher 2021 - 2022: Director of R&D Section
List of the most significant projects SUSEN - Research and Development for Innovation operational Programme (RDI) of the European Regional Development Fund (ERDF), CZ 1.05/2.1.00 /03.0108 Research for SUSEN (R4S) - LQ National Sustainability Programme II, Project LQ1603 CZ.1.05/2.1.00/03.0108 Sustainable Energy/SUSEN (OP VaVpI) - team member, Hot cells leader TAČR Methods for irradiated samples of accident tolerant fuel - project manager TAČR Modern metal materials – project manager JCAMP concrete studies - project manager H2020 - Jules Horowitz Operation Plan 2040 – team member H2020 - Towards improved Assessment of safety performance for LTO of nuclear Civil Engineering Structures - PIE laboratory leader DT3M - Research and Development of a Fuel Expert System (Direct Thermal-Mechanical Margin Monitor) for nuclear reactors – team member
List of the most significant results O. Srba, J. Michalicka, E. Keilova, J. Kocik, "TEM Study of Radiation Induced Defects in Baffle-Former-Barrel Assembly from Decommissioned NPP Greifswald", IEEE Transactions on Nuclear Science 61(4), 2014, p. 2149 - 2154 J. Čížek, M. Janeček, O. Srba, R. Kužel, Z. Barnovská, I. Procházka and S. Dobatkin: “Evolution of defects in copper deformed by high-pressure torsion”, Acta Materialia 59, 2322-2329 (2011) R. Kužel, M. Janeček, Z. Matěj, J. Čížek, M. Dopita, O. Srba. "Microstructure of ECAP Cu and Cu-Zr samples studied by different methods." Metall. Mater. Trans., 2010, A 41, p. 1174-1190. H. Seiner, L. Bodnárová, P. Sedlák, M. Janeček, O. Srba, R. Král, M. Landa. "Application of ultrasonic methods to determine elastic anisotropy of polycrystalline copper processed by equal-channel angular pressing." Acta Mater., 2010, 58, p. 235-247
Experience with VaVaI projects TK03020169 Resources and methodologies for the "Accident Tolerant" qualification of nuclear fuel coverage, DT3M - Direct Thermal-Mechanical Margin Monitor, TK01030153 Modern metallic materials for second, third and fourth generation reactors, JCAMP - concrete studies

Role		ID of participant	Position held in the organization
Member of the research team		26722445	Technical Researcher
Titles before name	**First name**	**Surname**	**Titles after name**
Ing.	Leoš	Křivský	
Nationality		**Personal ID**	
the Czech Republic		Hidden	
Phone	**Mobile phone**	**E-mail**	
266173325		leos.krivsky@cvrez.cz	

Main activities performed during project solving

SEM+EDS analysis, nanoindentation, marginal tensile tests, study of corrosion layers
Preparation and measurement of active samples in hot chambers (CNC, deformation machines, SEM, etc.)
Analysis and processing of results, preparation of research and patent reports, professional publications and conference contributions.
Presentation of results to the professional public (conferences, professional seminars, workshops, etc.).

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.2	0.2	0.2	0.6

Curriculum vitae
Education 2019 - 2021 Master of Science - University of Chemistry and Technology in Prague, Prague 2016 - 2019 Bachelor - University of Chemistry and Technology in Prague, Prague bachelor studies in materials for applied use
Relevant experience 2021 - now Junior research worker Research Centre Rez, Husinec, Rez - junior research worker in Hot Cells department (nanoindentation, SEM analysis, corrosion engineering, dimension measurement 2020 - 2022 Research worker - student at Technopark Kralupy, Kralupy nad Vltavou - research worker in corrosion laboratory 2019 - 2021 - Research worker - student Research Centre Rez, Husinec, Rez, part-time employee (as university student) - SEM analysis, corrosion studies, dimension measurement
List of the most significant projects TAČR - Modern metallic materials for second, third and fourth generation reactors JCAMP, Irradiation of E635 alloys, MEACTOS, INCA, H2020-ECC-SMART, ČEZ-VaV-MCA ETE
List of the most significant results Results/outputs on commercial projects (JCAMP, Irradiation of E635 alloys, ČEZ-VaV-MCA ETE) - publicly unpublished technical/final reports for customers
Experience with VaVaI projects TAČR - Modern metallic materials for second, third and fourth generation reactors JCAMP, Irradiation of E635 alloys, MEACTOS, INCA, H2020-ECC-SMART, ČEZ-VaV-MCA ETE

Role		ID of participant	Position held in the organization
Member of the research team		26722445	Senior Researcher
Titles before name Ing.	First name Michal	Surname Kordač	Titles after name PhD.
Nationality the Czech Republic		Personal ID Hidden	
Phone 266173396	Mobile phone	E-mail Michal.Kordac@cvrez.cz	
Main activities performed during project solving Corrosion tests in a PbLi environment, use for fusion technologies			

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0	0.1	0.1	0.2

Curriculum vitae
Education 2000 - 2003 University of Chemistry and Technology in Prague, Doctor of Philosophy (PhD), Chemical Engineering 1993 - 1998 University of Chemistry and Technology in Prague, Master of Science (Ing.), Chemical Engineering
Relevant experience 2015 - now Senior Researcher in Research centre Řež s.r.o. 2020 - now GSE Engineer in Space Energetics s.r.o. (part-time) 2003 - 2016 Senior Researcher VŠCHT Praha - UCT Prague 1995 - now Process design Independent Consultant - Freelance
List of the most significant projects 2021 - EC: EURATOM-2021-ADHOC-IBA: EUROfusion FP9 2021 - IPNOP: FLUSH - Ultrasound Flow Meter for Heavy Liquid Metals Applications 2017 - Concentrated Solar Power 2016 - Fusion for energy call FPA372 - Experimental tests in support of the Preliminary design of the European TBS
List of the most significant results Measurement of mass transfer characteristics of gas/liquid reactors by sulphite system using on-line monitoring UV absorptionMeasurement of mass transfer characteristics of gas/liquid reactors by sulphite system using on-line monitoring UV absorption; Chemical Engineering Journal 15. 2. 2011
Experience with VaVaI projects

Role		ID of participant	Position held in the organization
Other solver		61388998	Laboratory Head
Titles before name	**First name**	**Surname**	**Titles after name**
Ing.	Jan	Kober	Ph.D.
Nationality		**Personal ID**	
the Czech Republic		Hidden	
Phone	**Mobile phone**	**E-mail**	
+420 266053622	+420 777228006	kober@it.cas.cz	

Main activities performed during project solving

Managment and coordination of activities in IT CAS, development and application of ultrasonic methods, evaluation of elastic properties, reporting and cooperation with project manager.

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.2	0.2	0.2	0.6

Curriculum vitae

Education

2016 Ph.D. studies in the field of materials science, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague
2009 M.Sc. studies in the field of materials science, Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague

Relevant experience

from 2021: Head of the Laboratory of Non-Destructive Testing, Department Impact and Waves in Solids, IT CAS
2016 - 2020: post-doc in IT CAS
2019/2020 - visiting researcher at Department of Applied Science and Technology, Politecnico di Torino (8 months)
2009 - 2016: Ph.D. student at IT CAS (supervisor Z. Prevorovsky)

Curriculum vitae
List of the most significant projects Member of the research team and co-author of project proposal: GA19-14237S: Nonlinear interaction of elastic waves with a single crack (2019-2021) GA17-22615S: Time reversal ultrasonic signal processing used in nondestructive evaluation of materials and structures (2017-2019) Member of the research team: EF 15_003/0000493: Centre of Excellence for Nonlinear Dynamic Behaviour of Advanced Materials in Engineering (2021-2022) TK01030108: Innovative methods for nuclear plant safety evaluation based on SHM technologies and related procedures -NEMENUS (NEw MEthads for NUclear Safety) (2018-2022) FR-TI1/198: Automated diagnostics of extremely loaded structures (engineering constructions) (2009-2012) FR-TI1/274: Evaluation of SHM methods and its integration into aircraft maintenance system (2009-2012)
List of the most significant results Development of ultrasonic method and a theoretical framework for assessment of 3D printed materials: [1] J. Kober et al., “Assessing Porosity in Selective Electron Beam Melting Manufactured Ti – 6Al – 4V by Nonlinear Impact Modulation Spectroscopy,” J. Nondestruct. Eval., 123, 2020. [2] J. Kober and Z. Prevorovsky, “Theoretical investigation of nonlinear ultrasonic wave modulation spectroscopy at crack interface,” NDT E Int., 61, 2014 Methods of assessing material structure: [3] J. Kober et al., “Material Grain Size Determines Relaxation-Time Distributions in Slow-Dynamics Experiments,” Phys. Rev. Appl.,17(1), 2022. [4] J. Kober, A. Kruisová, and M. Scalerandi, “Elastic slow dynamics in polycrystalline metal alloys,” Appl. Sci., 11(18), 2021. Assessing robustness of TR method: [5] J. Kober et al., “Time reversal transfer: Exploring the robustness of time reversed acoustics in media with geometry perturbations,” J. Acoust. Soc. Am., 138(1), 2015.
Experience with VaVaI projects Jan Kober was involved in solution of aforementioned TACR projects with various partners from nuclear power, civil engineering and aerospace industries. Apart from that, he collaborated with Bohemian Technology Group (SME) on a NDT dedicated "Macrocracks II" project for the CEZ Group. He's active in international research of novel ultrasonic methods, elasticity assessment and sensor design.

Role		ID of participant	Position held in the organization
Other solver		26316919	R&D Director
Titles before name	**First name**	**Surname**	**Titles after name**
Prof., Ing.	Ján	Džugan	Ph.D.
Nationality		**Personal ID**	
the Czech Republic		Hidden	
Phone	**Mobile phone**	**E-mail**	
377197304	775201421	jan.dzugan@comtesfht.cz	

Main activities performed during project solving

Management and coordination of activities on behalf of the other applicant COMTES FHT, evaluation of mechanical tests, processing of expert reports on the part of the other participant, communication with the project manager.

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.1	0.1	0.1	0.3

Curriculum vitae

Education

2019 Professor in the field of mechanical Engineering, West Bohemian University
2010 Assistant professor (Habilitation) in the field of mechanical Engineering, West Bohemian University
1999 Ph.D. studies in the field of materials science, West Bohemian University
1995 M.Sc. studies in the field of materials science, West Bohemian University

Relevant experience

Research and Development Director from 2013, COMTES FHT a.s.
2006-2012 - Head of laboratory of mechanical testing and thermophysical measurements, COMTES FHT a.s.
2004 - 2006 - Senior research scientist, ŠKODA Research Ltd., Plzeň
2002 - 2004 - post doc , Institute of Safety Research Rossendorf, Germany
2001 - 2002 - Research scientist, Fracture Research Institute, Tohoku University, Japonsko
1999 - 2001 – post doc , Institute of Safety Research Rossendorf, Germany

Curriculum vitae

List of the most significant projects

1. TK04020331: Additive Manufacturing of Nuclear Fuel Components, 2022 - 2025 - Co-investigator
2. GA21-14030S: Compositionally graded complex concentrated alloys (CCA) prepared by additive manufacturing, 2021 – 2023 - Co-investigator
3. TM02000060: Development of design principles and additive manufacturing of multi-material medical devices, 2021 – 2024 - Co-investigator
4. TM02000084: Applied research and development of long-term small joint replacements based on additive Manufacturing, 2021 – 2023 - Co-investigator
5. TM01000061: Development of Beta-Titanium based individual implants produced by Additive Manufacturing processes, 2020 – 2022 - Co-investigator
6. GA19-03282S: Influence of Complex and Cyclic Loading Modes on Lifetime of Machine Parts Made by Additive Manufacturing, 2019 – 2021 - Co-investigator
7. EF17_048/0007350: Pre-Application Research of Functionally Graduated Materials by Additive Technologies, 2018 – 2022 – Principal investigator

List of the most significant results

1. Patent ID 308776: Monolithic body containing a memory alloy and its production method, 2021
2. Verified technology VZT2100005: Rotary swaging of Ti-35Nb-7Zr-6Ta-0,7O alloy and heat treatment technology, 2021
3. Functional sample VGF2000015: Piercing punch with increased resistance on the functional edge, 2020
4. Utility model ID 34537: Jig for fracture toughness test of miniaturized CT bodies by eccentric tension and assembly with this jig, 2020
5. Functional sample VGF2000012: Depositing on an existing component, 2020
6. Utility model ID 31687: The testing equipment for nonlinear multiaxial loading of samples of a flat semifinished products, 2018

Experience with VaVaI projects

Prof. Džugan has many years of experience in R&D and with work on national, international, projects (investigator or co-investigator of more than 30 research projects, over 60 results in the category of applied research and over hundred of scientific publications). His education and experience proved he is dedicated to the field of R&D and project solutions for many years and therefore has the prerequisites to successfully resolve the presented project.

Role		ID of participant	Position held in the organization
Other solver		00216208	Profesor
Titles before name	First name	Surname	Titles after name
prof. RNDr.	Miloš	Janeček	CSc.
Nationality		Personal ID	
the Czech Republic		Hidden	
Phone	Mobile phone	E-mail	
+42021911359	+420723423093	janecek@met.mff.cuni.cz	

Main activities performed during project solving

Preparation of alloys, microstructure investigation, co-ordination of research at the FMP CUNI, with the PI, other domestic and foreign partners

Number of FTE during project solving

Indicator	Measure unit	2023	2024	2025	Total
Commitment	man-year	0.2	0.2	0.2	0.6

Curriculum vitae

Education

1984: Faculty of Mathematics and Physics, Charles University – MFF UK (RNDr.)
1993: MFF UK (CSc.). Thesis: Plastic deformation of Cu-Ni-Sn polycrystals
2002: Associate Professor of Condensed Matter Physics, Charles University - MFF UK (Doc.)
Habilitation Thesis: Investigation of the structure and properties of grain boundaries and interfaces by transmission electron microscopy
2017: Professor, Charles University

Relevant experience

since 2017 Professor, Deputy Head of the Department of Physics of AMterials, Charles University
2008-2016 Head of the Department of Physics of Materials, Charles University
since 2003 Charles University, Associate professor
1994-2002 Charles University, research fellow
1988-2002 Charles University, scientific fellow
1984-1987 Nuclear Research Institute, Rez near Prague, scientific fellow

Curriculum vitae
List of the most significant projects 1. CSF (GACR) Excellence - Multidisciplinary Centre of Advanced Materials (2014-2018) - PI 2. CSF 21-14030 S - Additive manufacturing of CCAs with gradient composition (2021-2023) - PI 3. TACR theta TK1030153 - Advanced metallic materials for reactors of the second, third and fourth generation (2018-2024) - co-investigator 4. Ministry of Industry (Trio) FV20147 - New generation of joint implants manufactured from beta Ti alloy (2017-2021) - PI 5. Ministry of Education Youth and Sports/European Research and Development Fund - Nanomaterials Cdentre for Advanced Applications (2017-2022) - deputy project head
List of the most significant results 1. Utility model (Industrial Property Office (ÚPV) reg. no. 32 599): Noncemented hip hip joint stem, 2021 2. Verified technology - Technology of beta Ti alloy forming, 2021 3. Patent (IPO) no. 307793 - Biocompatible Ti alloy and the way of its processing, 2021 4. Patent (IPO) no. 309191 - High strength Zr alloy and the way of its processing, 2022
Experience with VaVaI projects M. Janeček has a log experience in application and commercialization of research results, in particular due to long-term co-operation with the company Beznoska, Kladno - an important Czech manufacturer of hip and big joint implants (he was the PI investigator of one joint TACR project TA01011141 and another MPO Trio project FV20147). He has also participated in co-operation with Al Invest Břidličná (investigation of All sheets) and also in an international project EU MAGFORMING.

Role		ID of participant	
Other solver			
Titles before name	First name	Surname	Titles after name
	Robert Allen	Roach	
Nationality		Personal ID	
the United States of America		Hidden	
Phone	Mobile phone	E-mail	
		robert.roach@inl.gov	

Other persons taking part in the applicant's project

Activity designation

Activity designation

Researcher / Designer

Project activities specification

Project activities specification

Incorporation of the new materials into the GFR system desigs (ALLEGRO, HeFASTO)

ID of participant

ID of participant

46356088

Activity designation

Activity designation

Technicians

Project activities specification

Project activities specification

Experiments preparation and execution, data summarization, samples and fixtures preparation, operation of hotcells and reactor

ID of participant

ID of participant

26722445

Activity designation

Activity designation

Researchers

Project activities specification

Project activities specification

Preparation and execution of experiments, summarization of data, processing of results, creation of reports and articles

ID of participant

ID of participant
26722445

Activity designation

Activity designation
Administration

Project activities specification

Project activities specification
Economist, administrative, grant office

ID of participant

ID of participant
26722445

Activity designation

Activity designation
Research assistant-J.Krofta

Project activities specification

Project activities specification
sensor design, 3D printing and signal procesing

ID of participant

ID of participant
61388998

Activity designation

Activity designation
Senior researcher-J. Joch

Project activities specification

Project activities specification

conceptualization, consulting and result synthesis

ID of participant

ID of participant

61388998

Activity designation

Activity designation

PhD/Post Doc - Z. Dvorakova

Project activities specification

Project activities specification

signal analysis, statistical analysis, wave modelling

ID of participant

ID of participant

61388998

Activity designation

Activity designation

PhD student - R. Zeman

Project activities specification

Project activities specification

Ultrasonic measurement, instrument control, sample preparation

ID of participant

ID of participant

61388998

Activity designation

Activity designation

Researcher at COMTES FHT

Project activities specification

Project activities specification

Design of AM processes, AM processes parameters determination, Experimental plans design, Materials properties and microstructres investigations, results analyses, reports writting.

ID of participant

ID of participant

26316919

Activity designation

Activity designation

Technician at COMTES FHT

Project activities specification

Project activities specification

Experiments preparation and execution, data summarization, samples and fixtures preparation.

ID of participant

ID of participant

26316919

Activity designation

Activity designation

Researcher - P. Harcuba

Project activities specification

Project activities specification

Microstructure investigation (TEM, SEM, EBSD, etc.), assitance in material preparation, result analysis

ID of participant

ID of participant
00216208

Activity designation

Activity designation
Res. associate - J. Stráský

Project activities specification

Project activities specification
Processing and analysis of results, co-ordination of junior team members work, co-ordination of material preparation

ID of participant

ID of participant
00216208

Activity designation

Activity designation
Post-doc - D. Preisler

Project activities specification

Project activities specification
Mechanical properties, material treatment

ID of participant

ID of participant
00216208

Activity designation

Activity designation
Post-doc - A. Veverková

Project activities specification

Project activities specification

Phase transitions, X-ray diffraction

ID of participant

ID of participant

00216208

Activity designation

Activity designation

Jr res. fellow - J. Kozlík

Project activities specification

Project activities specification

Advanced techniques of microstructure characterization (ACOM-TEM, TKD, 3D-EBDS, etc.)

ID of participant

ID of participant

00216208

Activity designation

Activity designation

PhD student - E. Jača

Project activities specification

Project activities specification

Light microscopy, mechanical tests

ID of participant

ID of participant

00216208

Activity designation

Activity designation
Technician -. A. Bendová

Project activities specification

Project activities specification
Laboratory work - specimen preparation, management and archivation, maintanence of devices, performing of simple experiments

ID of participant

ID of participant
00216208

5. OUTPUTS/RESULTS

Main outputs/results

Result identification number	Result title
TM04000065-V1	A method of additive manufacturing of a high entropy alloy for nuclear use
Result type	**Deadline of result achieving**
P – Patent	12/2025

Attachments according to result type

Annex type	File name	Description	Size
Rešerše na stav techniky, rešerše technických řešení, patentová rešerše	Patent_research_HEA_delta.pdf	State of the art research, technical solution research, patent research	300 kB

Result description

Result description

The patent will cover the method of additive manufacturing of a selected high entropy alloy for nuclear applications. Both the composition of the alloy and the method of manufactruing will be developed during the project. Additive manufacturing (AM) is a widely used method. However AM of complex alloys from elemental powders is intricate, mainly due to their different melting temperatures. Optimum processing parameters must be therefore found.

Access to output/result

Access to output/result

The rights to the result will be shared by the consortium members with the following shares: ÚJV Řež: 50%, Research center Řež: 20%, Comtes FHT: 10%, Charles University: 10%, Intsitute of Thermomechanics: 10%.

Description of the method of project solution application and its implementation

Description of the method of project solution application and its implementation
The patent will be implemented directly by the members of the project consortium, namely by the main proposer ÚJV Řež, its industrial partners and industrial partners of the consortium members. The result will be implemented in the design of the perspective GFRs - the demonstrator unit ALLEGRO and the industrialised advanced modular reactor HeFASTo as well as in other small modular reactors and advanced fuel systems.

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty
The research uncertainty is given mainly by finding optimum parameters of the additive manufacturing process for a given alloy composition to achieve a material with minimum porosity and acceptable chemical homogeneity (can be improved by subsequent thermal treatment which will be also described in the patent). Searching for such parameters can be uneasy and for some composition of HEAs even impossible. However, research teams involved in the AM processing of such exotic/nonstandard materials (mainly Comtes FHT and Department of Physics of Materials, Charles University) gained significant experience in the last years to succeed in the manufacturing of a selected HEA by AM (in particular by Selective Laser Melting).

Result identification number	Result title
TM04000065-V2	Ultrasonic probe for measuring material anisotropy
Result type	**Deadline of result achieving**
Gfunk – Functional sample	12/2024

Attachments according to result type

Annex type	File name	Description	Size

Result description

Result description

A functional sample of ultrasonic measuring probe for anisotropy assessment will be built in IT CAS. The probe will use multiple excitation and reception elements to induce specific ultrasonic waves in the material. Since ultrasonic wave velocity depends on the elastic constants along the propagation path, material anisotropy can be investigated rapidly and without a need of mechanical testing. A 3D printed template for accurate probe positioning will be designed for particular types of samples.

Access to output/result

Access to output/result

The result/outcome will be in full ownership of Institute of Thermomechanics, Czech Academy of Sciences (IT CAS). The probing system will be installed in the Laboratory of Non-Destructive Testing IT CAS. Measurements using the device will be available for all members of the Czech consortium as well as to the foreign partner of the project.

Description of the method of project solution application and its implementation

Description of the method of project solution application and its implementation

The probe will expedite elasticity assessment of newly developed HEAs in this project reducing the time and material needed for conventional mechanical testing. The results will provide rapid and valuable feedback to material manufacturer. Furthermore, material anisotropy assessment will be advertised as a service to other industrial and research partners.

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Research uncertainty lies in the need of designing the probing system to small samples, samples with potential porosity, samples with potential hetoergoeneities and samples with significant elastic anizotropy (for instance due to columnar grains in material prepared by additive manufacturing). The probing system must take into account these facts which are specific for advanced metallic materials prepared by additive manufacturing. However, the concept of the measurement is well understood and the applicant has sufficient expertise and facilities which ensure successful designing and fabrication of the probe.

Result identification number	Result title
TM04000065-V3	Spacer Grid for GFR fabricated from a High Entropy Alloy
Result type	Deadline of result achieving
Gfunk – Functional sample	12/2025

Attachments according to result type

Annex type	File name	Description	Size

Result description

Result description

A prototype of a selected component of the Gas cooled Fast Reactor fuel assembly (spacer grid segment) will be prepared by additive manufacturing from the selected HEA conforming with the requireements imposed by the GFR core conditions.

Access to output/result

Access to output/result

The rights to the result will be shared by three consortium members with the following shares: ÚJV Řež: 50%, Comtes FHT: 30%, Research center Řež: 20%.

Description of the method of project solution application and its implementation

Description of the method of project solution application and its implementation

The component will be implemented in the design of the perspective GFRs - the demonstrator unit ALLEGRO (V4G4 Centre of Excellence) and the industrialised advanced modular reactor HeFASTo (UJV).

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

The design of the ALLEGRO/HeFASTo refractory fuel assembly is not finalised yet due to the unavailability of the materials providing sufficient high temperature creep and fatigue resistance and being dimensionally stable under high fast neutron fluxes. To reach this goal, an iterative approach will have to be adopted and the design will have to be tuned simultaneously with the development of the HEAs.

Result identification number	Result title
TM04000065-V4	Additive manufacturing technology for developed material
Result type	Deadline of result achieving
Ztech – Verified technology	12/2024

Attachments according to result type

Annex type	File name	Description	Size

Result description

Result description

The verified technology of additive manufacturing of HEAs will describe a particular selection of parameters and the process of Selective Laser Melting (SLM) using the machine for direct laser deposition MX-600 InssTek.

Access to output/result

Access to output/result

The verified technology of additive manufacturing of HEAs will be owned by COMTES FHT a.s. The verified technology will be used for samples manufacturing throughout the project execution and implementation period.

Description of the method of project solution application and its implementation

Description of the method of project solution application and its implementation

The result will be implemented by COMTES FHT a.s. The implementation of the result is the ability to produce samples from several HEAs efficiently and in a repetitive manner.

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Process of Selective Laser Melting is complex and is governed by many parameters. The most important ones are: laser power, powder feed, printing (scanning) speed, hatch distance, printing (scanning) scheme. Such parameters must be optimized to achieve material with low-porosity and satisfactory chemical homogeneity. The parameters must be optimized for each material and in general will be different for each alloy composition. General strategy for materials optimization must be developed and will be described in the verified technology along with the particular parameters selection for several HEA compositions.

Result identification number	Result title
TM04000065-V5	Nuclear Seal Component fabricated by AM
Result type	Deadline of result achieving
Gfunk – Functional sample	12/2025

Attachments according to result type

Annex type	File name	Description	Size

Result description

Result description

Reactor vessel lid seal designed for the use of FLiBe fluoride salt as a pool and pressured type. The component is expected to be a cutout of the lid, seal, screw and vessel itself. The reactor vessel lid seal represents a major milestone in the design of a small modular FHR-type reactor due to the limiting corrosion properties of fluoride salts. (based on the actuall knowledge/documentation in 2024/2025), designed and fabricated by additive manufacturing from a HEA.

Access to output/result

Access to output/result

The rights to the result will belong to CVR (Centrum vyzkumu Rez)

Description of the method of project solution application and its implementation

Description of the method of project solution application and its implementation

The component will be implemented in the design of the prospective small modular FHR-type reactor - Energy Well (CVR)

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

Specific technical and / or utility parameters of the result including the description of the research and / or technical uncertainty

The design of the Energy Well is not fully finalised yet due to the unavailability of the materials providing sufficient high temperature creep and fatigue resistance and being dimensionally stable under high fast neutron fluxes. To reach this goal, an iterative approach will have to be adopted and the design will have to be tuned concurrently with the development of the HEAs.

6. FINANCIAL PLAN

[P] ÚJV Řež, a. s.

Organisation type

Organisation type

LE - Large enterprise

Share of the categories of IR / ED

Indicator	Measure unit	2023	2024	2025
Industrial research	%	65,00	85,00	95,00
Experimental development	%	35,00	15,00	5,00

We require an increase of funding intensity

We require an increase of funding intensity

No

Calculated costs and funding for each category of research / development

Indicator	Measure unit	2023	2024	2025	Total
Industrial research	Kč	650 000	850 000	950 000	2 450 000
Experimental development	Kč	350 000	150 000	50 000	550 000
IR maximum funding rate	Kč	325 000	425 000	475 000	1 225 000
ED maximum funding rate	Kč	87 500	37 500	12 500	137 500

Method for indirect costs applying

Method for indirect costs applying

Full cost

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	529 272	529 272	529 272	1 587 816
Commitment (FTE)	man-year	0,55	0,55	0,55	1,65
Average personnel costs per commitment (FTE)	Kč	962 312,73	962 312,73	962 312,73	962 312,73
Subcontracting costs	Kč	0	0	0	0
Other direct costs	Kč	0	0	0	0
The cost of the intellectual property rights	Kč	0	0	0	0
Another direct costs	Kč	0	0	0	0
Indirect costs	Kč	470 728	470 728	470 728	1 412 184
Total costs	**Kč**	**1 000 000**	**1 000 000**	**1 000 000**	**3 000 000**
Share of costs for indirect costs / overheads	%	88,94	88,94	88,94	88,94

Justification of cost items

Justification of cost items

Personal costs include the wages of all team project team members including statutory deductions (health and social insurance) of total of 33.8%. The personal costs are calculated based on hours each team member as specified in the time sheets and actually paid wages. The overhead costs of UJV Řež a.s. related to project execution and the way of their calculation is given by internal regulations of the company. In individual project years the overhead surcharge is added to direct wages. Overhead costs include the costs of administration and support staff, energy, material and service costs, depreciations and repairs of devices and costs related to project related workplaces (heavily-radiated areas/hot chambers, active air conducts, providing of radiation protection of employees, special single utility tools, etc. In 2022 the overhead costs of 119% of salary costs are set.

Resources

Indicator	Measure unit	2023	2024	2025	Total
Maximum amount of funding	Kč	412 500	462 500	487 500	1 362 500
Non-investment funding	Kč	333 333	333 333	333 334	1 000 000
Other resources	Kč	666 667	666 667	666 666	2 000 000
Total resources	**Kč**	**1 000 000**	**1 000 000**	**1 000 000**	**3 000 000**
Funding rate	%	33,33	33,33	33,33	33,33

Origin of other funds

Origin of other funds

Other sources of financing in this project include own sources of the company. These own sources are generated by business activity of the company in the area of research and development for commercial partners, technical advisory activity, designing in energetics and production of radiofarmaceuticals. Another non-public source of financing are unpaid dividends.

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

No

[D] Centrum výzkumu Řež s.r.o.

Organisation type

Organisation type

RO - Research organization

Share of the categories of IR / ED

Indicator	Measure unit	2023	2024	2025
Industrial research	%	65,00	80,00	90,00
Experimental development	%	35,00	20,00	10,00

Calculated costs and funding for each category of research / development

Indicator	Measure unit	2023	2024	2025	Total
Industrial research	Kč	767 641	11 092 606	2 657 931	14 518 178
Experimental development	Kč	413 345	2 773 151	295 326	3 481 822
IR maximum funding rate	Kč	767 641	11 092 606	2 657 931	14 518 178
ED maximum funding rate	Kč	413 345	2 773 151	295 326	3 481 822

Method for indirect costs applying

Method for indirect costs applying

Full cost

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	394 992	4 536 532	1 379 587	6 311 111
Commitment (FTE)	man-year	0,40	4,60	1,60	6,60
Average personnel costs per commitment (FTE)	Kč	987 480,00	986 202,61	862 241,87	956 228,94
Subcontracting costs	Kč	0	0	0	0
Other direct costs	Kč	470 000	5 700 000	470 000	6 640 000
The cost of the intellectual property rights	Kč	0	0	0	0
Another direct costs	Kč	470 000	5 700 000	470 000	6 640 000
Indirect costs	Kč	315 994	3 629 225	1 103 670	5 048 889
Total costs	**Kč**	**1 180 986**	**13 865 757**	**2 953 257**	**18 000 000**
Share of costs for indirect costs / overheads	%	36,53	35,45	59,67	38,98

Justification of cost items

Justification of cost items

Personal costs are costs planned for wages, salaries, rewards from work activity agreements or work performance agreements and mandatory contributions to social and general health insurance. The research team includes 6 key people, 9 technicians, 5 researchers, an economist and a grant office worker. Subcontracts are not included in the project. Other direct costs in the amount of CZK 6,640,000 are planned in the structure: material costs for sample preparation, machine service costs, energy consumed by machines in hot chambers according to device logs and travel costs incurred in direct connection with the project solution and related travel reimbursements . The largest amount of Other direct costs of CZK 6.4 million is CZK 5,000,000 for the reactor irradiation service (reactor operation, reactor energy, cooling, chimney ventilation, fuel). Indirect costs directly related to the project solution, determined based on the FULLCOST method. The staff cost rate varies over the years depending on the stage of the project. It depends on the expected work done, such as work in hot cells or irradiation, which requires a larger number of specialized workers. In the first year of the project, there is a predominant involvement of more senior researchers due to strategic decisions regarding the choice of alloys and the management of the project as such.

Resources

Indicator	Measure unit	2023	2024	2025	Total
Maximum amount of funding	Kč	1 180 986	13 865 757	2 953 257	18 000 000
Non-investment funding	Kč	852 934	10 014 158	2 132 908	13 000 000
Other resources	Kč	328 052	3 851 599	820 349	5 000 000
Total resources	**Kč**	**1 180 986**	**13 865 757**	**2 953 257**	**18 000 000**
Funding rate	%	72,22	72,22	72,22	72,22

Origin of other funds

Origin of other funds

Irradiation service in the reactor - resources put in as in-kind contributions.

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

No

[D] Ústav termomechaniky AV ČR, v. v. i.

Organisation type

Organisation type
RO - Research organization

Share of the categories of IR / ED

Indicator	Measure unit	2023	2024	2025
Industrial research	%	20,00	20,00	20,00
Experimental development	%	80,00	80,00	80,00

Calculated costs and funding for each category of research / development

Indicator	Measure unit	2023	2024	2025	Total
Industrial research	Kč	300 000	300 000	280 000	880 000
Experimental development	Kč	1 200 000	1 200 000	1 120 000	3 520 000
IR maximum funding rate	Kč	300 000	300 000	280 000	880 000
ED maximum funding rate	Kč	1 200 000	1 200 000	1 120 000	3 520 000

Method for indirect costs applying

Method for indirect costs applying
Flat rate 25%

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	993 404	993 404	993 404	2 980 212
Commitment (FTE)	man-year	1,00	1,00	1,00	3,00
Average personnel costs per commitment (FTE)	Kč	993 404,00	993 404,00	993 404,00	993 404,00
Subcontracting costs	Kč	0	0	0	0
Other direct costs	Kč	206 596	206 596	126 596	539 788
The cost of the intellectual property rights	Kč	0	0	0	0
Another direct costs	Kč	206 596	206 596	126 596	539 788
Indirect costs	Kč	300 000	300 000	280 000	880 000
Total costs	**Kč**	**1 500 000**	**1 500 000**	**1 400 000**	**4 400 000**
Share of costs for indirect costs / overheads	%	25,00	25,00	25,00	25,00

Justification of cost items

Justification of cost items

Personnel costs are based on the assigned FTE per year and expected position salaries for next years (including social and health insurance). Direct costs cover mainly materials needed for assigned experimental work, i.e. ultrasonic elements, electronic components and consumables (cables, glues, US gel, soldering materials) and travel costs for visiting research partners, workshops and conferences.

Resources

Indicator	Measure unit	2023	2024	2025	Total
Maximum amount of funding	Kč	1 500 000	1 500 000	1 400 000	4 400 000
Non-investment funding	Kč	1 350 000	1 350 000	1 260 000	3 960 000
Other resources	Kč	150 000	150 000	140 000	440 000
Total resources	**Kč**	**1 500 000**	**1 500 000**	**1 400 000**	**4 400 000**
Funding rate	%	90,00	90,00	90,00	90,00

Origin of other funds

Origin of other funds
Institute business activities in the field of research.

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing
No

[D] COMTES FHT a.s.

Organisation type

Organisation type
RO - Research organization

Share of the categories of IR / ED

Indicator	Measure unit	2023	2024	2025
Industrial research	%	70,00	60,00	60,00
Experimental development	%	30,00	40,00	40,00

Calculated costs and funding for each category of research / development

Indicator	Measure unit	2023	2024	2025	Total
Industrial research	Kč	2 401 000	2 100 000	1 602 000	6 103 000
Experimental development	Kč	1 029 000	1 400 000	1 068 000	3 497 000
IR maximum funding rate	Kč	2 401 000	2 100 000	1 602 000	6 103 000
ED maximum funding rate	Kč	1 029 000	1 400 000	1 068 000	3 497 000

Method for indirect costs applying

Method for indirect costs applying
Full cost

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	1 650 000	1 700 000	1 400 000	4 750 000
Commitment (FTE)	man-year	2,10	2,00	1,60	5,70
Average personnel costs per commitment (FTE)	Kč	785 714,29	850 000,00	875 000,00	833 333,33
Subcontracting costs	Kč	100 000	100 000	95 000	295 000
Other direct costs	Kč	1 000 000	1 000 000	600 000	2 600 000
The cost of the intellectual property rights	Kč	0	0	0	0
Another direct costs	Kč	1 000 000	1 000 000	600 000	2 600 000
Indirect costs	Kč	680 000	700 000	575 000	1 955 000
Total costs	**Kč**	**3 430 000**	**3 500 000**	**2 670 000**	**9 600 000**
Share of costs for indirect costs / overheads	%	25,66	25,93	28,75	26,60

Justification of cost items

Justification of cost items

Personnel costs are based on the assigned FTE per year and the current level of salaries with expected increase over the project duration taking into account expected evolution of salaries reflecting the current situation.
Subcontracting costs are consisting of expenses related to special services not-available at the workplaces of the project partners. It comprises special machining, special analyses.
Direct costs mainly consist of expenses related to powders for 3D printing purchase. The powder prices are very turbulent recently, but the budget proposed here should secure sufficient amount of the powder for all planed depositions and analyses. Next part of this budget portion are consumable materials for mechanical testing, metallographic investigations, heat treatment, thermos-physical analyses and machining. Travel costs are also considered here.
Indirect costs are calculated based on the audited methodology for its calculation.

Resources

Indicator	Measure unit	2023	2024	2025	Total
Maximum amount of funding	Kč	3 430 000	3 500 000	2 670 000	9 600 000
Non-investment funding	Kč	2 538 200	2 590 000	1 975 800	7 104 000
Other resources	Kč	891 800	910 000	694 200	2 496 000
Total resources	**Kč**	**3 430 000**	**3 500 000**	**2 670 000**	**9 600 000**
Funding rate	%	74,00	74,00	74,00	74,00

Origin of other funds

Origin of other funds

Institute business acctivities in the field of research.

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

No

[D] Univerzita Karlova

Organisation type

Organisation type

RO - Research organization

Share of the categories of IR / ED

Indicator	Measure unit	2023	2024	2025
Industrial research	%	100,00	100,00	100,00
Experimental development	%	0,00	0,00	0,00

Calculated costs and funding for each category of research / development

Indicator	Measure unit	2023	2024	2025	Total
Industrial research	Kč	1 670 000	1 680 000	1 650 000	5 000 000
Experimental development	Kč	0	0	0	0
IR maximum funding rate	Kč	1 670 000	1 680 000	1 650 000	5 000 000
ED maximum funding rate	Kč	0	0	0	0

Method for indirect costs applying

Method for indirect costs applying

Flat rate 25%

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	922 000	922 000	922 000	2 766 000
Commitment (FTE)	man-year	1,20	1,20	1,20	3,60
Average personnel costs per commitment (FTE)	Kč	768 333,33	768 333,33	768 333,33	768 333,33
Subcontracting costs	Kč	0	0	0	0
Other direct costs	Kč	414 000	422 000	398 000	1 234 000
The cost of the intellectual property rights	Kč	5 000	25 000	20 000	50 000
Another direct costs	Kč	409 000	397 000	378 000	1 184 000
Indirect costs	Kč	334 000	336 000	330 000	1 000 000
Total costs	**Kč**	**1 670 000**	**1 680 000**	**1 650 000**	**5 000 000**
Share of costs for indirect costs / overheads	%	25,00	25,00	25,00	25,00

Justification of cost items

Justification of cost items

All figures are in thousands CZK
1. Personnel costs (Total - 922 each year)
Wages of individual team members based on respective FTE and the current salaries at the FPM CUNI - 648
Allowances to social and health insurance and social fund (35.3% of wages) - 229
Work on contract (DPP) - mainly for students - 45
Total: 648 + 229 + 45 = 922

2. Other direct costs 414/422/398
thereof
2i) Property right costs 5/25/20
Costs related with patent submission (patent advisor, Industrial property office costs). Maximum costs are expected in the second year.
2ii) Other direct costs 409/397/378
Material costs - material procurement (alloys, powders), spare parts for machines, consumables for laboratories, technical gasses, etc. Material costs are expected to decrease in the second and the third year due to reduced costs for material procurement.
Service costs - costs related to the maintenance and service of machines used in the project, specimen manufacturing and other conctractual based costs, conference fees, publication costs, etc.
Travel costs - costs related to the presentation of results (conferences, workshops, seminars), visiting of partner laboratories, etc.

3. Indirect costs (flat rate 25%)

Resources

Indicator	Measure unit	2023	2024	2025	Total
Maximum amount of funding	Kč	1 670 000	1 680 000	1 650 000	5 000 000
Non-investment funding	Kč	1 503 000	1 512 000	1 485 000	4 500 000
Other resources	Kč	167 000	168 000	165 000	500 000
Total resources	**Kč**	**1 670 000**	**1 680 000**	**1 650 000**	**5 000 000**
Funding rate	%	90,00	90,00	90,00	90,00

Origin of other funds

Origin of other funds

Other public costs - institutional funds of Charles University. Due to the volume of research, the Faculty of Mathematics and Physics is obtaining significant funds through institutional funding. The expected co-financing of 167k/168k/165k CZK in individual years will be easily available.

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

Interest in the use of advantaged financial instruments of Národní rozvojová banka, a.s. for the purpose of project co-financing

No

[Z] Idaho National Laboratory

Organisation type

Organisation type

RO - Research organization

Prevalent type of research

Prevalent type of research

IR - Industrial reasearch

Costs

Indicator	Measure unit	2023	2024	2025	Total
Costs of the foreign partner	EUR/USD/...	8 783 250	8 783 250	8 783 250	26 349 750

Resources

Indicator	Measure unit	2023	2024	2025	Total
Other fundings of the foreign partner	EUR/USD/...	0	0	0	0
Funding from the domestic country	EUR/USD/...	8 783 250	8 783 250	8 783 250	26 349 750

Project funding overview

Costs

Indicator	Measure unit	2023	2024	2025	Total
Personnel costs	Kč	4 489 668	8 681 208	5 224 263	18 395 139
Commitment (FTE)	man-year	5,25	9,35	5,95	20,55
Average personnel costs per commitment (FTE)	Kč	855 174,86	928 471,44	878 027,39	895 140,58
Subcontracting costs	Kč	100 000	100 000	95 000	295 000
Other direct costs	Kč	2 090 596	7 328 596	1 594 596	11 013 788
The cost of the intellectual property rights	Kč	5 000	25 000	20 000	50 000
Another direct costs	Kč	2 085 596	7 303 596	1 574 596	10 963 788
Indirect costs	Kč	2 100 722	5 435 953	2 759 398	10 296 073
Total costs	**Kč**	**8 780 986**	**21 545 757**	**9 673 257**	**40 000 000**
Share of subcontracting costs	%	1,14	0,46	0,98	0,74

Resources

Indicator	Measure unit	2023	2024	2025	Total
Amount of funding	Kč	6 577 467	15 799 491	7 187 042	29 564 000
Non-investment funding	Kč	6 577 467	15 799 491	7 187 042	29 564 000
Other resources	Kč	2 203 519	5 746 266	2 486 215	10 436 000
Total resources	**Kč**	**8 780 986**	**21 545 757**	**9 673 257**	**40 000 000**
Funding rate	%	74,91	73,33	74,30	73,91

Applicant and project partners funding overview

Applicant	Costs	Costs share (%)	Support	Support share (%)
ÚJV Řež, a. s.	3 000 000	7,5	1 000 000	3,38
Centrum výzkumu Řež s.r.o.	18 000 000	45	13 000 000	43,97
Ústav termomechaniky AV ČR, v. v. i.	4 400 000	11	3 960 000	13,39
COMTES FHT a.s.	9 600 000	24	7 104 000	24,03
Univerzita Karlova	5 000 000	12,5	4 500 000	15,22
Idaho National Laboratory	0	0	0	0
Total	40 000 000	100	29 564 000	100

Celkové finance zahraničních partnerů za projekt

Indicator	Measure unit	2023	2024	2025	Total
Costs of the foreign partner	EUR/USD/...	8 783 250	8 783 250	8 783 250	26 349 750
Funding from the domestic country	EUR/USD/...	8 783 250	8 783 250	8 783 250	26 349 750
Other fundings of the foreign partner	EUR/USD/...	0	0	0	0

7. ADDITIONAL INFORMATION

This section is not being generated in this document.

8. ANNEXES

Mandatory attachments to the results

Result	Annex type	File name	Description	Size
TM04000065-V1	Rešerše na stav techniky, rešerše technických řešení, patentová rešerše	Patent_research_HEA_delta.pdf	State of the art research, technical solution research, patent research	300 kB

Common proposal

File name	Size	Created	Description
Common Proposal_DOE_2022 AMHEA-(3)-sgn.pdf	668 kB	13.07.2022 05:52:15	Common Proposal

Other annexes

File name	Size	Created	Description
Prokazani_vl_struktury_UK.pdf	359 kB	13.07.2022 08:47:51	Ownership structure - Charles University
Plna_moc_rektorka_dekan_MFF.pdf	315 kB	11.07.2022 16:20:40	Authorizarion of the rector of Charles University to the dean of the Faculty of Mathematics and Physics to sign the Coomon proposal on her behalf