

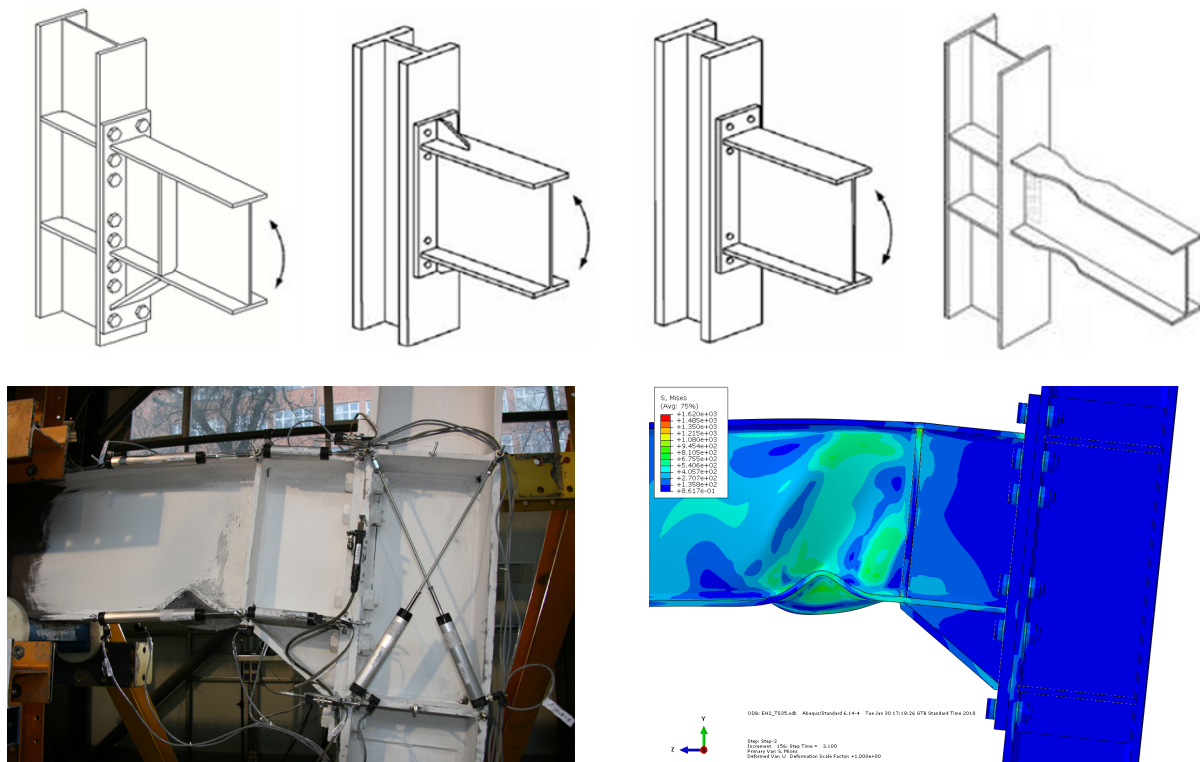
VALORISATION OF KNOWLEDGE FOR EUROPEAN PRE-QUALIFIED STEEL JOINTS

Goal of the project

Seismic prequalification criteria for certain steel joint typologies were developed during the previous RFCS project, EQUALJOINTS. The current project aims to valorize, disseminate and extend the prequalification criteria for practical applications to a wide audience by producing informative documents, design guidelines and organizing seminars and workshops.

Short description of the project

The project aims the implementation of the prequalification criteria of the steel moment resisting beam-to-column joints in the future versions of design codes.



Project implemented by

UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II (UNINA)
- coordinator
ARCELORMITTAL BELVAL & DIFFERDANGE SA (AMBD)
UNIVERSITE DE LIEGE (ULG)
POLITEHNICA UNIVERSITY TIMIȘOARA (UPT)
UNIVERSIDADE DE COIMBRA (UC)
EUROPEAN CONVENTION FOR CONSTRUCTIONAL STEELWORK (ECCS)
UNIVERSITA DEGLI STUDI DI SALERNO (UNISA)
IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE
(Imperial)

Centre Technique Industriel de la Construction Metallique (CTICM)
NATIONAL TECHNICAL UNIVERSITY OF ATHENS (NTUA)
CESKE VYSOKE UCENI TECHNICKE V PRAZE (CVUT)
TECHNISCHE UNIVERSITEIT DELFT (TU Delft)
UNIVERZA V LJUBLJANI (UL)
UNIVERSITET PO ARCHITEKTURA STROITELSTVO I GEODEZIJA (UASG)
UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)
RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN
(RWTH AACHEN)

Implementation period

01.07.2017 – 30.06.2019

Main activities

- Development of informative documents for the 4 beam-to-column joints qualified within the EQUALJOINTS project and translation of these documents from English to 11 additional languages
- Development of recommendations and criteria to be used in setting up limits of applicability between EN 1993:1-8 and EN 1998-1. A set of requirements within EN 1090-2 are defined. The documents are drafted as pre-normative design recommendation in English which are translated 11 additional languages
- Development of guidelines for design and analysis of seismic resistant steel structures accounting for the behaviour of beam-to-column joints. In addition, examples for different structural systems are presented which show the influence of different joint typologies.
- Enhancement of the EQUALJOINTS Matlab software for analytical prediction of the cyclic response of joints, allowing an easy application by users in practice. Moreover, an EQUALJOINTS-app for mobile phone is developed.
- Preparation of the material to be disseminated in English and translation in the mother tongue of the places where seminars/workshop will be taken.
- Organization of workshops and seminars where the pre-normative design guidelines will be disseminated. In addition, the materials will be available in printed forms and downloadable from the project website.

Results

The prequalification criteria for the 4 typologies of steel moment resisting beam-to-column joints from the EQUALJOINTS project (3 bolted connections and 1 reduced beam section – dog-bone) are being considered for the implementation in the next version of the design codes. The dissemination materials will be available in printed form and downloadable from the project website.

Applicability and transferability of the results

- Use of the new versions of design codes with simplified procedures for designing steel moment resisting beam-to-column joints.
- The rotational capacity and ductility demand of the joints required by the current codes are assured using the prequalification seismic design criteria.
- Increased structural safety against the seismic hazard in large parts of Europe.
- Improvement in life cycle costs and sustainability due to the reduction of losses caused by seismic hazards.

Financed through/by

Research Fund for Coal and Steel, grant agreement RFCS 12/04/2017 – number 754048

Research Centre

The Research Centre for Mechanics of Materials and Structural Safety – CEMSIG

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- Assist. Adriana CHESOAN, PhD

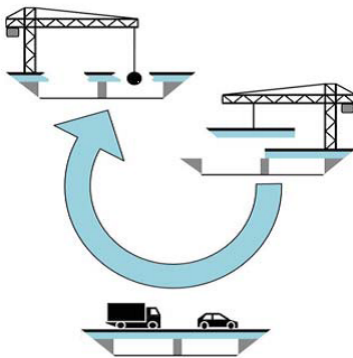
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VALORISATION OF KNOWLEDGE FOR SUSTAINABLE STEEL-COMPOSITE BRIDGES IN BUILT ENVIRONMENT - SBRIPLUS

Goal of the project

Within the RFCS project SBRI, a holistic approach to assess steel-composite bridges by combining Life Cycle Assessment (LCA), Life Cycle Costs (LCC) and Life Cycle Performance (LCP) was developed and applied to some representative bridges. This project aims at the valorisation, dissemination and extension of the developed method for advanced applications and further bridge types. To reach a wide audience among engineers and authorities, two Design Manuals and a software tool will be disseminated in the frame of several seminars across Europe.



Sketch of the life-cycle of a bridge

Short description of the project

The aim of SBRIplus project is to promote the developed knowledge and design methodologies by combining the LCA, LCC and LCP analyses along the entire life-cycle of bridges.

Project implemented by

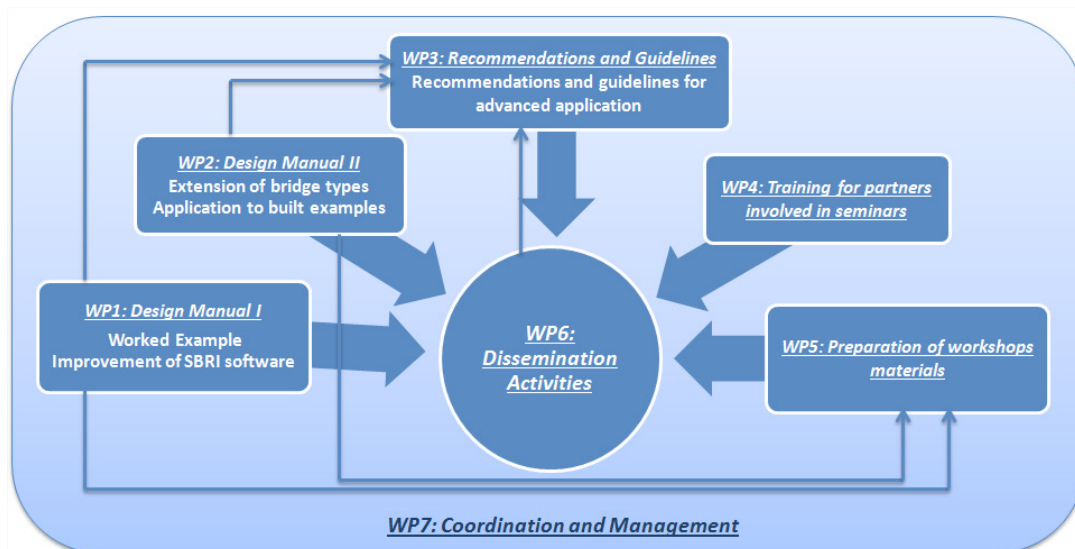
ArcelorMittal Belval & Differdange S.A., Luxembourg

Implementation period

01.07.2016 – 31.06.2018

Main activities

1. Explanation of methodology and background by elaboration of worked examples and improvement of the SBRI-tool;
2. Extension of bridge types by advanced application to innovative bridges across Europe demonstrating the flexibility and applicability of the methods developed;
3. Dissemination activities (11 European languages, organization of 13 workshops);
4. Providing of recommendations for advanced applications and guidelines for bridge authorities;
5. To provide recommendations summing up and concluding the analyses and being the bases for guidelines to be elaborated for bridge authorities.



The 7 Work Packages (WPs) of the SBRIplus project

Results

Two design manuals will be prepared and translated in 11 European languages and distributed within the planned dissemination activities. The first Design Manual includes background information on the methodology and worked examples for easy application with the help of the improved software tool. By analyses of built examples, the SBRI method will be applied to innovative bridge solutions, the results and the conclusions being shown in the second Design Manual.

The seminars around Europe will offer the opportunity to present not only the results of the SBRIplus project, but also the advanced application to innovative solutions in addition to national regulations and practice.



The location of the seminars around Europe

Applicability and transferability of the results

As bridges are an integral part of the European-wide traffic infrastructure, being of vital importance for society, the amount of steel used in the construction of steel and steel-composite bridges represents an important market for the steel industry. The application of a sustainable life cycle design of bridges causes an increased steel consumption. As currently the decisive criteria at tender stage are the minimum construction costs, the needed and promoted shift to a sustainable life cycle decision making, brings the steel-composite bridges forward. The advantages of low environmental inputs, low life cycle costs and low user costs for the entire life cycle are combined in sustainable steel-composite structures. The major objective of the proposal is to valorize and transfer the knowledge gained in the SBRIplus project into practice and thus to make it available to a broad audience along engineers, authorities, bridge operators and designers.

Financed through/by

Research Fund for Coal and Steel, grant agreement No 710068.

Research Centre

Research Center for Mechanics of Materials and Structural Safety (CEMSIG), Politehnica University Timișoara
Research Institute for Renewable Energy (ICER-TM), Politehnica University Timișoara

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University of Coimbra (Portugal);
Aktien-Gesellschaft der Dillinger Hüttenwerke AG (Germany);
Institut Francais des Sciences et Technologies des Transports, de l'Amenagement et des Reseaux (France);
RAMBOLL Sverige AB (Sweden);
BRISA Engenharia e Gestao SA (Portugal);
FOSTA -Forschungsvereinigung Stahlanwendung e.V. (Germany);
Politehnica University Timișoara (Romania);
Ceske Vysoke Uceni Technike V Praze (Czech Republic);
Fundacion Tecnalia Research & Innovation (Spain);
University of Naples Federico II (Italy);
ATKINS Consultants Limited (UK);
Stichting Bouwen met Staal (Netherlands);
BKE sp. z o.o. (Poland);
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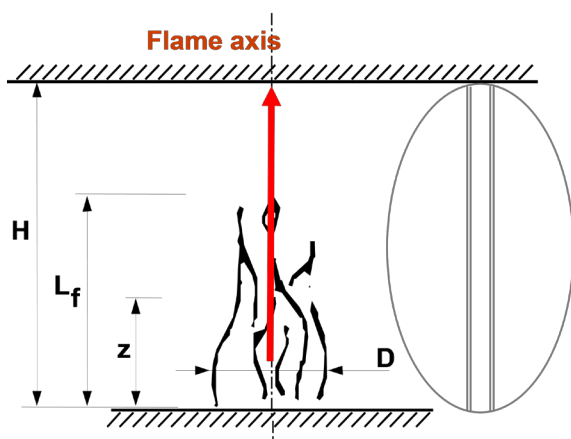
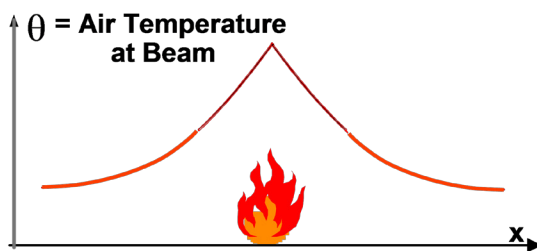
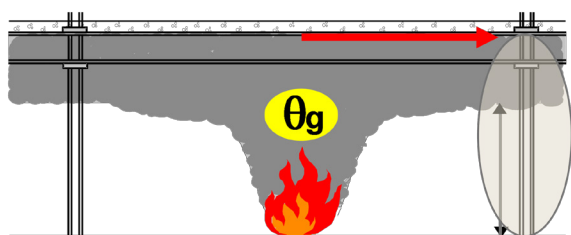
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TEMPERATURE ASSESSMENT OF A VERTICAL MEMBER SUBJECTED TO LOCALISED FIRE - DISSEMINATION

Goal of the project

LOCAFI+ represents the valorisation project of the RFCS project LOCAFI the main objective of which was to provide designers with scientific evidence that will allow them designing steel columns subjected to localised fires.



Short description of the project

The project aims to disseminate the methodology for the fire design of columns under localised fire in several European countries, by means of national seminars.

Project implemented by

ArcelorMittal Luxembourg (coordinator)

Implementation period

1.07.2017-31.12.2018

Main activities

- Development of nomograms for a wide range of different localised fires
- Development of the design guide for practitioners
- Preparation of the PowerPoint presentations for the workshops
- Adaptation of OZone software
- Translation activities and preparation of document with legal context and adapted design examples
- Preparation/ organization of the seminars
- Design of the Internet website with documents available online

Results

An important number of seminars will be organised across Europe to present the simplified method developed within LocaFi project which will be implemented in the latest version of the European standard EN1991-1-2, its background (experimental tests, numerical investigations), user-friendly software and case studies.

Applicability and transferability of the results

The analytical models developed within the LocaFi project were introduced in a user friendly software and in an advanced calculation model for fire design, in order to offer a large utilization of the procedure for the construction market.

Financed through/by

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH AND INNOVATION
Research Fund for Coal and Steel - RFCS

Research Centre

The Research Center for Mechanics of Materials and Structural Safety
- CEMSIG,
Research Centre of Excellence of the Politehnica University Timișoara

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PROVISIONS FOR GREATER REUSE OF STEEL STRUCTURES - PROGRESS

Goal of the project

The PROGRESS project will provide methodologies, tools and recommendations on reusing steel-based components from existing and planned buildings. The project particularly targets the design for deconstruction and reuse of envelopes, load-bearing frames, trusses and secondary elements of single-storey buildings framed in steel. This building type has broad applicability as industrial, commercial, sports, exhibition, warehouse facilities, and shows most potential in suitability for reuse and viability for circular economy business models. The whole life benefits of reusable single-storey steel buildings will be quantified from environmental and economic viewpoints. The outcomes will be extensively disseminated in particular among manufacturers, designers, contractors and researchers.



Short description of the project

The main objective of the proposal is to develop products, systems, methods and protocols that facilitate reuse of various components of steel-framed single-storey buildings. The proposed project addresses both deconstruction and reuse of existing buildings and how new buildings can be designed, constructed and documented to facilitate future reuse. Its scope includes: (a) primary structures (frames), (b) secondary structures, (c) envelope components and hybrid multi-material systems.

Project implemented by

VTT Technical Research Centre of Finland Ltd., (VTT, Finland)

Implementation period

01.07.2017-30.06.2020

Main activities

- review of the experiences from the successful reuse and deconstruction projects collected by the project partners and from the practitioners in the building industry;

Table 1. Reuse scenarios

	In-situ	Same site		Different site	
		Same configuration	Different configuration	Same configuration	Different configuration
Entire primary structure	A	B	C	D	E
Elements of the primary structure	N/A	N/A	F	N/A	G
Individual elements	N/A	N/A	H	N/A	I

- propose methods for the assessment of suitability of materials and elements for the reuse, including recommendations for their modification/adaptation to fit in the new design;
- propose technical recommendations for the increase of reusability of the components to be provided on component and building design levels.
- propose novel hybrid solutions for envelopes of single-storey buildings, either new buildings or renovation projects, that improves the thermal performance of the entire building, service life of envelopes and reusability of solutions themselves;
- propose a methodology to quantify and declare the environmental benefits of reused elements, resulting in recommendations on the circularity and LCA methodology;
- provide benchmark for demolition, classification and testing/verification protocols developed on a real deconstructed building including the laboratory tests to identify mechanical and chemical properties of the materials;
- design case studies to cover the most common reuse situations.

Results

The outcomes of the project will include recommendations to:

- Reduce the technical barriers to reuse through establishing the quality verification procedures for the structural elements and envelopes of deconstructed low-rise buildings to be reused;
- Simplify the implementation of reusable components through recommendations for design for deconstruction and reuse, and for design using reclaimed elements as well as for safe and efficient deconstruction activities;
- Support the product manufacturers', facility owners' and designers' decision making by recommended methodology to calculate the environmental impact and cost of steel components reusing;
- Develop an online reused steel trading portal to co-ordinate the supply and demand for reused steel-based components;
- Develop novel types of hybrid solutions for envelopes in order to improve the thermal performance of a building, extend the service life of an envelope and maximize the reuse potential of components.

Applicability and transferability of the results

The majority of existing steel low-rise buildings can be deconstructed into elements such as cold-formed or hot-rolled sections, sheets, panels, frames or truss girders. These components have very high reuse potential, but require verification of the material quality, dimensions and tolerances in order to be included in new building projects. The future reuse of modern buildings, however, may be different, because those structures are increasingly designed as systems and their design information can be easily maintained for instance as a building information model (BIM).

Financed through/by

Research Fund for Coal and Steel, EU, grant agreement No 747847.

Research Centre

Research Center for Mechanics of Materials and Structural Safety (CEMSIG), Politehnica University Timișoara

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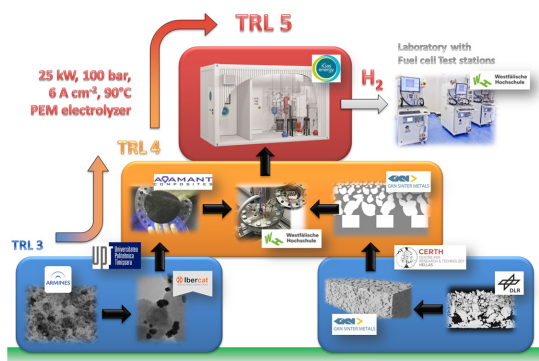
NOVEL MODULAR STACK DESIGN FOR HIGH PRESSURE PEM WATER ELECTROLYZER TECHNOLOGY WITH WIDE OPERATION RANGE AND REDUCED COST (PRETZEL)

Goal of the project

The overall objective of PRETZEL project is to develop an innovative polymer electrolyte membrane electrolyzer (PEMEL) that provides significant improvements in efficiency and operability to satisfy emerging market requirements. Such electrolyzers are urgently needed for the increased demands of the grid balancing services. In this context, PRETZEL is offering breakthrough technologies for becoming game changer in the field of water electrolyzers.

Short description of the project

PRETZEL consortium will develop a 25 kW water electrolysis system based on a patented innovative cell concept, with a production capacity of 4.5 m³ H₂ / h at rated power at a pressure of 100 bar and water temperature of 90°C.



Concept of PRETZEL project with component inputs and expected outcome.

Project implemented by:

Project Coordinator:

German Aerospace Center, Stuttgart, Germany (DLR)

EU Partners:

- Westphalian University of Applied Sciences, Germany (WHS)
- Association for Research and Development of Industrial Methods and Processes, France (ARMINES)
- Politehnica University Timișoara, Romania (UPT)
- Adamant Composites Ltd., Greece
- GKN Sinter Metals Engineering GmbH, Germany (GKN)
- Centre for Research and Technology Hellas, Greece (CERTH)
- Soluciones Catalíticas IBERCAT, Spain
- iGas energy GmbH, Germany



“PRETZEL”-like shape passing over the geographical location of all PRETZEL partners representing the long-term collaboration in know-how, supply chain, business partnership and R&D.

Implementation period

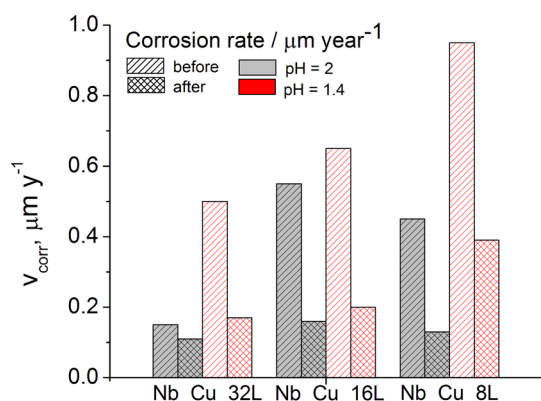
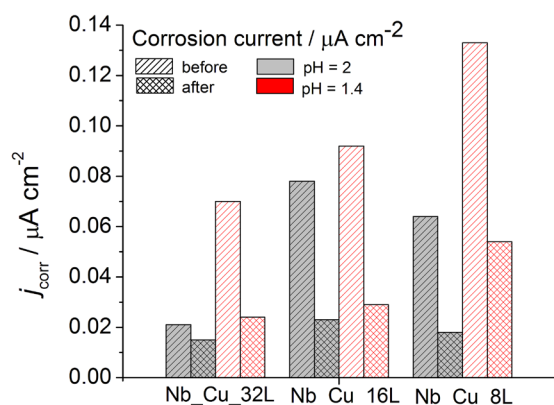
01.01.2018 – 31.12.2020

Main activities

1. Develop and manufacture the components of the PRETZEL for the innovative high pressure PEMEL that operates at increased temperatures.
2. Develop and manufacture the PRETZEL high pressure PEMEL stack based on the novel principle of hydraulic compression.
3. Set-up and undertake continuous procedures to evaluate the development process through all phases against PRETZEL specifications.
4. Integrate the innovative PEMEL stack into a high pressure PEMEL test facility and validate the overall performance and operational criteria.
5. Disseminate and exploit the innovations in PRETZEL in order to prepare the market penetration of the new technology.

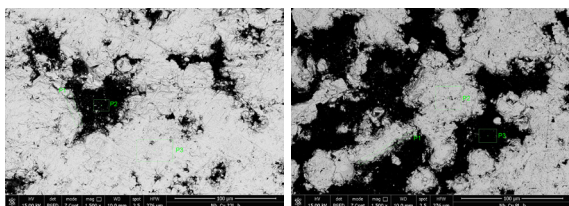
Results

- **Corrosion tests** on vacuum plasma sprayed Nb coatings on copper plates



Comparison of corrosion currents and corrosion rates at pH = 2 and pH = 1.4, before and after stress test at 2 V for 6 h.

- **Physical characterization** of vacuum plasma sprayed Nb coatings on copper plates



FE-SEM images of Nb_Cu_32L and Nb_Cu_8L after corrosion test in $0.05 \text{ M H}_2\text{SO}_4 + 0.1 \text{ ppm F}^-$ (pH = 1.4)

Applicability and transferability of the results:

- **System:** Development and validation of a 25 kW PEM electrolyzer system with hydrogen output pressure of 100 bars or higher. The high pressure will allow reducing costly and ineffective mechanical compression stages.
- **Cell components:** Reduction of critical raw materials such as Ir by the use of new aerogel supports, which allow reducing more than 70 % of the current precious metal loading compared to the state-of-the-art.

Financed through/by

Fuel Cell and Hydrogen 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 779478.

Research Centre

Research Institute for Renewable Energy (ICER-TM), UPT

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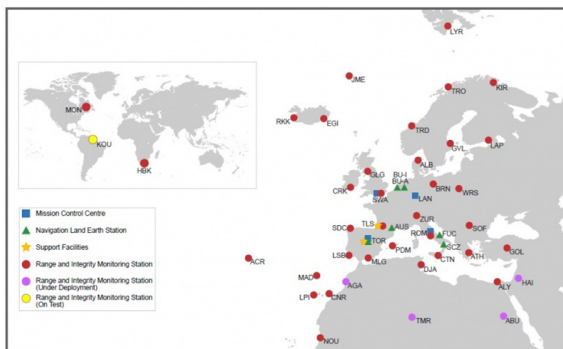
STUDY FOR A MONITORING STATION FOR EGNOS TO SUPPORT SERVICES IN EASTERN EUROPE

Goal of the project

The objective of the study is the automatic reporting of EGNOS performance over Romania as well as the assessment of corrections transmitted by other SBAS.

Short description of the project

Due to its geographical location, Romania is an ideal candidate for system performance monitoring at the border of EGNOS service area. Receivers placed in most parts of Romania will be able to track, in addition to EGNOS, also the Russian Federation's System for Differential Corrections and Monitoring (SDCM) and India's GPS Aided GEO Augmented Navigation system (GAGAN). UPT implemented within ESA regulatory framework and based on ECSS standards, all activities related to: an automatic reporting of EGNOS performance over Romania and assessment of other SBAS visible from Romania.



EGNOS Ranging and Integrity Monitoring Stations (RIMS) Sites

Project implemented by

UPT as contractor and Thales-Alenia Space France, Pildo Labs Spain as subcontractors

Implementation period

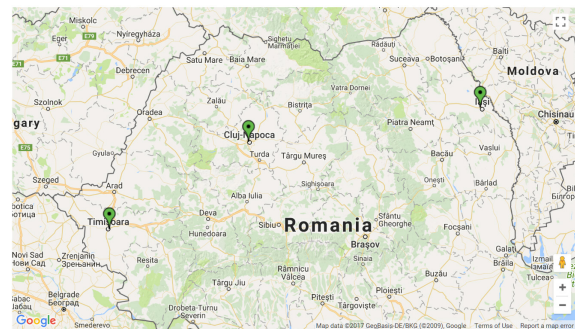
Sep 19 2016 – Mar 19 2018; 1 year of warranty after end of contract

Main activities

- Management;
- Site Ranking;
- Site Selection;
- Deployment;
- Automatic Reporting & Performance Comparison;
- Communication

Results

UPT deployed a monitoring site network, in Timișoara, Cluj-Napoca and Iasi, for the EGNOS service and all GNSS systems within Romania and archived the data for remote access by the Agency.

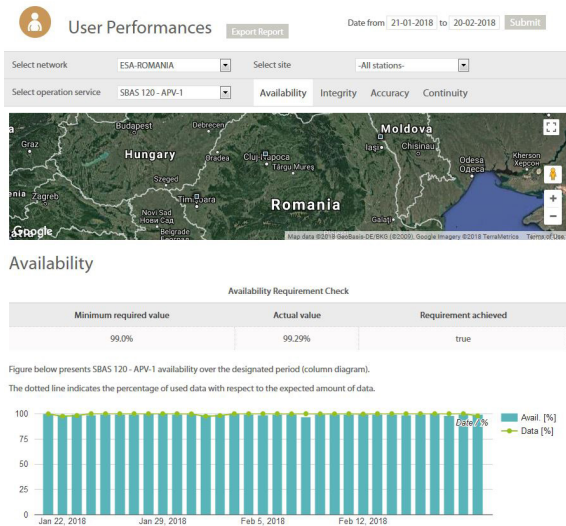


The three stations deployed at UPT-Timișoara, UTCN-Cluj and TUIASI-Iasi.

The respective locations were chosen at technical universities (UTCN and TUIASI), with whom UPT has signed hosting agreements. The user performances are monitored using the owl, a cloud service offered by Pildo Labs. The data is collected by PildoBoxes.

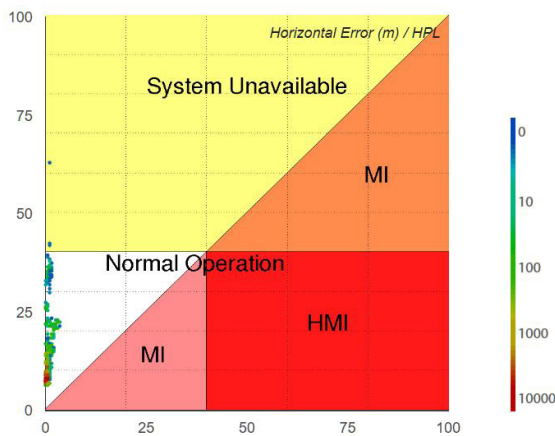


The antenna deployed at UPT.



User Performances monitored using the owl cloud service: availability (SBAS 120- APV 1). This is the probability of the system being available for any given user at any given time.

Stanford Plot Horizontal



Integrity Stanford plot for UPT station (SBAS 120 – APV 1). Integrity is the system's ability to provide warnings to the user when the system is not available for a specific operation.

Deliverables: Site Selection Justification Document, Volume Simulation Plan, Service Volume Simulation Report, Hardware Deployment Plan, Hardware Deployment Report, Project Management Plan, Executive Summary Report, Financial Report, Final Report, Contract Closure Summary.

Applicability and transferability of the results

The subject was evaluated at the start at technology maturity level 1 (Scientific Research) and is aimed to conclude the project at technology readiness level (TRL) 6: Model demonstrating the critical functions of the element in a relevant environment.

Financed through/by

European Space Agency (ESA), contract number No. 4000 117 527 / 16/NL/CBi – UPT: 115.000 EURO, Thales Alenia: 15.000 EURO, Pildo Labs: 20.000 EURO

Research centre

Intelligent Signal Processing Research Centre (ISPRC)

Research team

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REDOUBT - RELIABLE FPGA DATAPATH DESIGN USING CONTROL TECHNIQUES, CONTRACT ESA - 4000123993/18/NL/CRS

Goal of the project

This project proposes a novel control theory inspired fault tolerant methodology for FPGA implementations of processing data-paths working in harsh radiation space environments. The proposed methodology will rely on adding control loops, which will detect and correct the radiation induced faults. We will consider the data-path processing component as a process, for which control components will be added in order to increase the fault tolerance.

The main objectives of this project are:

1. Development of the theoretical background for the control engineering inspired fault tolerant mechanism
2. FPGA implementation for the fault tolerant data-path with control feedback loops
3. Analysis of the proposed methodology in terms of cost and fault tolerance, and comparison with other approaches, such as triple modular redundancy (TMR), reduced precision replicas (RPR), or redundant residue number systems (RRNS).

The proposed technique will target arithmetic dominant applications, which include digital signal processing, robotic arm control, or graphic processing.

Short description of the project

We aim at providing a novel fault tolerant technique for FPGA based digital electronics used in space applications.

Project implemented by

Politehnica University Timișoara (UPT) -lead,
Universitatea Tehnică din Cluj-Napoca (UTCN)- project partner.

Implementation period

July 2018 - June 2019

Main activities

We will investigate the cost and fault tolerance characteristics of the proposed technique, determining the advantages and the pitfalls. Thus, we will provide the theoretical foundation, a proof-of-concept implementation, as well as guidelines and characteristics for the control based reliability enhancement technique.

The project requires the following four steps:

1. SFI for the target datapath circuit in order to characterize the fault behaviour - This step will require RTL model of the targeted arithmetic intensive circuit, as well as performing the SFI at RTL for the implemented circuit.
2. Analytical modelling for the faulty datapath circuits - This step involves determining the high level modelling of faults, and developing the model associated to the process with perturbations. This step will consist of Matlab simulations.
3. Theoretical controller design used for error correction - In this step, the feedback controller will be designed in order to attenuate and mitigate the perturbations within the process associated to the faulty arithmetic datapath. The controller will be developed in Matlab
4. FPGA implementation and SFI based validation - This step will comprise of the RTL model of the control enhanced fault tolerant circuit, and its evaluation in terms of cost (FPGA implementation cost) and fault tolerance (using SFI). Comparisons with TMR, RRNS and RPR will be performed.

Results

The following results are available so far:

1. Control engineering model using Matlab language for the circuit with specific design elements: pipeline, serial processing, adders, multipliers, multiplexors and multiply-add elements.
2. Matlab-Mpdelsim automated framework for co-simulation and fault injection.
3. Fault behavior characterization of the baseline circuit.

The following results are in progress:

1. Controller design for enhancing the fault tolerance of the baseline circuit subjected to SEU.
2. Evaluation of the advantages and limitations of this approach from both the reliability perspective and the cost efficiency perspective.

Applicability and transferability of the results

The REDOUBT project is ongoing work. The results of the project have a high degree of innovation potential.

Financed through/by

Agenția Spațială Europeană (European Space Agency – ESA)

Research centre

Research Centre for Computers and Information Technology

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LINKING TRANSNATIONAL, MULTIMODAL TRAVELLER INFORMATION AND JOURNEY PLANNERS FOR ENVIRONMENTALLY-FRIENDLY MOBILITY IN THE DANUBE REGION

Goal of the project

There is a huge cross-border travel demand within the EU leading to hundred millions of cross-border trips every year by EU residents and further several hundred million trips by international tourists. More than 100 providers of traveller information services exist in Europe covering different levels, from local to regional, national and pan-European. The goal is to work on the inter-linking of existing services in order to enable transnational journey planning that goes beyond the territory covered by the single systems and offers travellers one seamless journey planning result.

Short description of the project

The objective is to develop a decentralised system architecture that enables distributed journey planning.

Project implemented by

An international consortium of journey planner- and transport operators in the frame of the INTERREG project "LinkingDanube" from Austria, Czech Republic, Hungary, Slovakia, Slovenia and Romania (with two partners, UPT and Electronic Solutions Ltd.)

Implementation period

01.01.2017 – 30.06.2019

Main activities

In particular the main objective is to develop a decentralised system architecture that enables distributed journey planning. By developing and establishing a common interface at each of the involved systems, the exchange of requests and results (not data) will be facilitated. The multiple responses of the involved systems have to be merged by means of an intelligent journey planner algorithm. The involved systems will engineer an application programming interface (open API) that allows bi-directional communication of the enquirer system (the system requesting information from other systems) and the responding systems. A common exchange specification will be developed that all participating systems will implement. Besides the method of implementing common gazetteers and exchange points within the distributed system will be one of the crucial points.

Results

The actual development work of LinkingDanube will be done both on national level in a decentralised adaption of the national journey planners as well as on central level in setting up a central entity. In the end this means that national services will be able to "plug into" a common interface and provide seamless information from multiple

systems to cross-border travellers. After implementation and testing, the technical feasibility will be demonstrated for the respective regions in relevant use cases.

The pilot action will demonstrate, test and validate the developed concept and demonstrate how integrated journey planning helps to connect citizens and commuters across borders and rural regions to major hubs. In this way the demonstrations will be the basis for further large-scale implementation.

Applicability and transferability of the results:

A central focus of LinkingDanube is the development of a concept for transnational multimodal journey planners in order to integrate the advantages of hub-to-hub-routing with local routing for cross-border regions and the elaboration of technical specifications for interface and data exchange. This concept shall build on existing structures in the partner countries, enhancing existing journey planners instead of creating a completely new structure and is completely transferable.

Financed through/by

Co-funded by the European Union through the Joint Secretariat of the Danube Transnational Programme

Research team

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CONTRIBUTIONS TO CODIMENSION k BIFURCATIONS IN DYNAMICAL SYSTEMS THEORY

Goal of the project

The overall project objectives are to produce new knowledge in the area of codim k bifurcations for continuous and discrete (smooth and non-smooth) dynamical systems and provide training in this area of research to early stage researchers.

Short description of the project

The project achieves its objectives during secondments.

Project implemented by

1. Politehnica University Timișoara (Coordinator)
2. Autònoma University of Barcelona
3. Obuda University
4. West University of Timisoara
5. University of Craiova
6. Acmit GmbH, Austria
7. University North Caroline at Charlotte
8. Shanghai Jiao Tong University, China
9. University of Sao Paulo, Brazil

Implementation period

1 April 2018 - 31 March 2022

Main activities

1. Study degenerate Bautin bifurcations;
2. Study degenerate Hopf-Hopf bifurcations;
3. Study other codimension k bifurcations in continuous (smooth) systems;
4. Study other codimension k bifurcations in discrete (smooth) systems;
5. Study codim k bifurcations in non-smooth systems;
6. Study bifurcations in non-smooth systems with impacts.

Results

Published articles:

1. J. Llibre, C. Valls, C. Vidal, Global dynamics of the Buckingham's two-body problem, *ASS*, (2018), 363:255.
2. S. Li, J. Llibre, Phase portraits of continuous piecewise linear Liénard, *CSF*, 120 (2019), 149–157.
3. C. Rocsoreanu, M. Sterpu, Approximations of the heteroclinic orbits near a double-zero bifurcation with symmetry of order two (in press).

Applicability and transferability of the results

Not applicable

Financed through/by

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