CONTROL IN STEEL

Deliverable 4:
List of projects (to be disseminated)

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[P1] **7210-PR/337: [CEFLA] Development of new control strategies for enhanced use of automatic flatness control in cold rolling (07/2002 – 12/2005)**
New flatness measurement and control systems have been developed for carbon steel cold rolling mills. An internal model control (IMC) and a model predictive control (MPC) have been designed. These two controllers have been implemented and integrated into the automation systems of a four-high four-stand tandem mill and a six-high reversing mill for sheet products (AHS).

[P2] **7210-PR/338: Control of sheet surface defects and deep drawing properties in final strip production steps (07/2002 – 12/2005)**
A simplified set-up model for the control system of the skin pass was derived from this research and successfully installed in ILVA Novi Ligure Works. The objectives of the project were to understand and control sheet surface defects coming from Luders bands in finishing lines, to guarantee the strip quality by optimising process parameters and to develop and validate industrial procedures to set the optimum temper rolling degree in such a way that plastic bending deformations induced by rolls and by bending caused by coiling are compensated.

[P3] **7210-PR/339: Closed loop automatic shape and residual stress control during levelling (07/2002 12/2005)**
The project aimed at providing closed loop control of the levelling operation to improve flatness performance and consistency. Trials on an advanced plate leveller evaluated the performance of existing levelling strategies for flatness and residual stress control. Pilot tension levelling facilities were used to investigate the significant parameters controlling strip flatness. The developed equations were adapted to produce leveller set-up algorithms and adaptations to improve the flatness of the length of the coil.

[P4] **7215-PP/076: Hot strip flatness optimisation by means of edge masking in the ROT cooling system (07/2002 – 12/2005)**
This research project had the aim to demonstrate the proper operation of the advanced edge-masking technologies in the Hot Strip Mills (HSM) to improve flatness in strip edges. The initial approach of a direct relation between temperature and flatness has been demonstrated not to be so direct, because there are more factors involved (as phase transformation location, for example) although there is a high correlation.

[P5] **RFSR-CT-2003-00003: [CASTDESMON] Improvement, control and prediction of cast and rolled product quality by the development of an understanding of how the casting machine design and condition affects solidification and the development and application of novel engineering monitoring techniques (09/2003 – 10/2007)**
The aim of the project has been to develop improved means of defining, monitoring and assessing the effects of caster design, condition and operation on slab, bloom and rolled product quality in order to enable better control of the processes and to provide the required data for quality prediction. The project has determined the effect of mould taper,

wear, metal level, heat transfer and friction under steady state and dynamic conditions. Potential areas of exploitation for the results from this project have been highlighted.

[P6] **RFSR-CT-2003-00038: [IPCDS] An integrated process control and diagnostics system for hot rolling mills based on comparison of physical data and mathematical process models using artificial intelligence (09/2003 – 08/2006)**
The project aimed at a monitoring and diagnosis system for Hot Strip Mills and other similar processes in steel plants with a view to improve the process control strategy. Artificial Intelligence (AI) techniques and hybrid approaches (e.g. NN + traditional statistics) were applied to interpret and merge data coming from different sensors also overcoming possible source of noise and disturbances. At all the four participated steel plants the process control strategy has been improved after integration of the various modules and achievements along with the resultantrelevant economic benefits are were reported.

[P7] **RFSR-CT-2003-00039: [SHAPEHPM] Reduction of shape defects and yield losses by advanced online adaptation of control systems and new operating strategies in heavy plate rolling mills (09/2003 – 08/2007)**
The aim of the project was the reduction of shape defects and yield losses in heavy plate rolling by providing new operating strategies, ski-end control and optimised set-up adaptation for ski and control for camber/thickness profile. This approach encompasses the application of the new topometrical measurement system TopPlan® to collect data on plan view shape and ski, advanced FE modelling and rules to predict shape defects and the development and use of advanced online models for ski control. To compensate for the deficits of conventional models and control methods, iterative learning control was developed for a pass-to-pass set-up adaptation of ski control and of camber control that considers the cross-thickness profile.

[P8] **RFSR-CT-2003-00045: [AUTOCHECK] Enhancement of product quality and production system reliability by continuous performance assessment of automation systems (09/2003 – 02/2007)**
Novel strategies and systems have been developed and tailored for the performance assessment of control loops in steel processing plants. The methods have been implemented, adapted and applied to a complex structured temperature control and a zinc layer thickness control at hot-dip galvanising lines. A supervision system for continuous monitoring of the set-up system in a hot strip mill has been developed.

[P9] **RFSR-CT-2004-00014: [S5] Optimised through process shape of stainless-steel wide strip (07/2004 – 12/2008)**
To improve flatness a new shape control system is developed and implemented online at a Sendzimir mill of TKS–NR. The integrated thickness and flatness control system considers the cross coupling between thickness and flatness. As a result, all actuators can be used with maximal speed without disturbing thickness of flatness and an

improved flatness is the benefit. To reach all aims at the same time, the realised control system is mainly based on the approach of Internal Model Control.

[P10] **RFSR-CT-2004-00016: [GLOBALSHAPECONTROL] Flatness set-up in hot strip mills tailored to the demands of next step processes and final customers (07/2004 – 12/2007)**
An optimisation algorithm (sequential quadratic programming: SQP) has been prepared for application to the flatness setup improvement taking into account the measured flatness. SQP methods represent the state of the art in nonlinear programming methods. For instance, the MATLAB function fmincon uses SQP, which means that a QP sub problem is solved at each major iteration (also known as iterative quadratic programming).

[P11] **RFSR-CT-2004-00017: [SOFTDETECT] Intelligent soft-sensor technology and automatic model-based diagnosis for improved quality, control and maintenance of mill production lines (07/2004 – 06/2007)**
The main goal of this project is the development and application of software sensors for the estimation of hard-to-measure quality and process parameters (e.g. thermal state, mill state and process state) during processing. This builds up the basis for automatic fault-detection and diagnosis of causes. The considered processing stages are hot rolling, tandem cold rolling and temper rolling.

[P12] **RFSR-CT-2004-00023: [IMGALVA] Investigation, modelling and control of the influence of the process route on steel strip technological parameters and coating appearance after hot dip galvanising (07/2004 – 12/2007)**
In this project, methods were developed for the prediction of quality-relevant product properties for hot dip galvanised material, based on information gained during the hot dip galvanising process and preceding production steps. The models found and the developed applications were used for open-loop quality control.

[P13] **RFSR-CT-2004-00052: [SensoCont] Sensor based on-line-control of pickling lines (07/2004 – 12/2007)**
The main aim of the project was the development of a new sensor-based control technology for operating pickling lines. Pickling is the most important step to remove surface scale layers and is strongly dependent on the exactly controlled pickling liquor composition. When the project started, there was no feasible system available for online control of pickling lines.

[P14] **RFSR-CT-2005-00009: [Smartfire] Real-time intelligent diagnostics and optimisation of reheating furnace performance (07/2005 – 12/2008)**
The Smartfire project was undertaken to identify ways of optimising the operation of reheating furnaces, maintenance and product quality by providing furnace diagnostic tools for monitoring and controlling process parameters. The project was successful in developing a range of

diagnostic techniques to help improve the operation of reheating furnaces as well as product quality.

[P15] **RFSR-CT-2005-00019: [FinalPlateFlatness] Optimisation of final plate flatness by set-up coordination for subsequent manufacturing process (07/2005 – 06/2009)**
The aims of this project had been to optimise local flatness approaches and to progress from this basis by taking the flatness requirements of the subsequent production quantitatively into account in form of a co-ordinated flatness set-up system. Based on this a line set-up optimiser connecting local stage rules by a line optimisation strategy should generate the best fitting actions relevant to the evolution of flatness.

[P16] **RFSR-CT-2005-00020: [Awicco] Advanced width and camber control (07/2005 – 06/2009)**
The aim of the Awicco project was the optimisation of the hot rolled strip geometry concerning width and camber. A new type of side guiding system based on a BFI invention was installed at a pilot mill and used to control the roll gap tilting. The guiding system consists of pairs of rolls which guide the slab at the entry side of the mill during rolling.

[P17] **RFSR-CT-2005-00021: [HIGHPICK] Optimised productivity and quality by on-line control of picklet surface (07/2005 – 06/2008)**
The objective of the project is an enhanced mastering of the pickling process and more precisely gaining high productivity and quality standards. This objective is to be attained via intensive monitoring of the process and the treated strip and via deep knowledge and process modelling. Most of the objectives have been fulfilled (even in some cases data that came out during the project forced to adapt the work strategy).

[P18] **RFSR-CT-2006-00037: [Linecop] Line-coordinated optimisation of strip geometry and surface properties by using model-based predictive technologies (07/2006 – 06/2010)**
Within this project, different strategies have been considered in order to establish a coordinated approach to the coil processing with the focus on the product through different facilities. Different features and tools have been developed for analysing, monitoring and optimisation of strip flatness from entry of cold rolling to the exit of galvanising lines. Control features were developed, implemented and tested at the industrial site to improve the flatness quality.

[P19] **RFSR-CT-2007-00015: [Edgecontrol] Minimised yield losses by innovative integrated edge-drop, width and shape control based on soft-sensor technology and new actuators in cold rolling mills. (07/2007 – 12/2010)**
The project Edge control aims at systematically studying width variation and edge-drop in cold rolling mills. Mechanisms producing these phenomena were investigated and classified for different materials and mill types. Advanced strategies for controlling edge-drop and width were proposed. An integrated model predictive control approach is proposed to simultaneously deal with flatness and edge-drop in combination with appropriately optimised mill scheduling and setup. Since edge-drop

sensors can only be placed some meters away from the roll gap, a dominant time delay will appear, so that classical feedback control is not recommended. Instead, a controller with time delay compensation, e.g. Smith predictor or internal model control (IMC), is suggested.

[P20] **RFSP-CT-2007-00046: [SensorControlPilot] Implementation of sensor-based online control of pickling lines (07/2007 – 06/2010)**
In this project, two stand-alone approaches from the preceding research endeavour were combined to add increased controllability to pickling lines, which were by now controlled only by adaptation of strip speed. A model-based control concept to calculate strip speed set points in pickling lines, developed by UniOvi, and an online concentration measurement based on ultrasonic technology, developed by BFI, were implemented at the pickling line of TKS-RA in-line to obtain a demonstration installation for sulphuric acid pickling lines.

[P21] **RFSR-CT-2008-00007: [Deffree] Integrated models for defect free casting (07/2008 – 12/2011)**
The objective of the project was to develop a new modelling-based optimisation and quality control system for continuous casting. The concept was based on studying critical parameters affecting steel quality and finding safety ranges for them to ensure good quality in continuous casting. For optimising and controlling steel quality during casting the following online models were developed in the project: transient 2D centreline segregation model, dynamic 3D heat transfer model and inverse mould heat flux difference model.

[P22] **RFSR-CT-2009-00034: [SISCON] Improved monitoring and control of flat steel surface quality and production performance by utilisation of results from automatic surface inspection systems (07/2009 – 06/2012)**
Aim of this project is the development of an advanced supervisory system for surface quality and production performance of flat steel production based on the results from automatic surface inspection systems (ASIS). Therefore, first of all a performance monitoring system for ASIS will be realised to ensure the required reliability of the provided data even during long-term operation. Based on this trusted data key performance indices (KPI) related to surface quality and line performance will be defined.

[P23] **RFSR-CT-2009-00035: [Fosucor] Future-oriented supervision of the cold rolling process in reversing mills (07/2009 – 12/2012)**
Pass schedule design and roll geometry are decisive criteria for the productivity of a mill stand and the quality of the final product. Within the framework of this project, the intelligent use of existing process data should replace the use of empirical values at the pass schedule calculation and replace the trial and error approach to achieve optimal roll geometries. The main objectives of the project were to develop an auto-adaptive pass schedule calculation taking into consideration pre-calculated strip flatness and a software programme to help plant operators optimise the roll geometry.

[P24] **RFSR-CT-2010-00010: [MICROCONTROL] Combined Online Microstructure Sensor and Model for a Better Control of Hot Strip Rolling Conditions and Final Products Properties (07/2010 – 12/2013)**
The project provides new knowledge in the field of non-destructive and noncontact laser ultrasonic technique to monitor steel microstructure during hot rolling. Various signal processing techniques based on ultrasonic waves velocity, attenuation, backscattered noise or Poisson's ratio are tested for evaluation of average grain size, grain shape, phase transformation and recrystallization: all methods could be used online except backscattered (grain shape) and velocity methods. This work represents a significant step to move a step closer to a fully automatic feed-back control of microstructure and product properties.

[P25] **RFSR-CT-2010-00017: [Flexpromus] Flexible production by multi sensor process control of pickling lines (07/2010 – 12/2013)**
The project aimed at the smart control of stainless-steel pickling lines by combining advanced process control models and online concentration analysis data to achieve more flexible production processes. An innovative multi-sensor online analysis technique for continuous concentration monitoring was developed and built up at BFI. Andritz developed an improved intelligent concentration control model for the OTK pickling line and a standard control model for the ACX line along with the online analysis data.

[P26] **RFSR-CT-2010-00037: [Cognitive Control] Cognitive control systems in steel processing lines for minimised energy consumption and higher product quality (07/2010 – 12/2013)**
The project aimed at creating cognitive automation systems with the capabilities of automatic control performance monitoring (CPM), self-detection and automatic diagnosis of faults (sensors, actuators, controller) and self-adaptation in control system environments to optimise the product quality and minimise energy consumption in steel during the whole life cycle. In this project several software tools for online Control Performance Monitoring (CPM), monitoring energy efficiency, diagnosis of poor performance root-causes and control re-tuning for univariable and multivariable, linear and nonlinear processes were developed. The software tools also held a Graphical User Interface (GUI) that provided interface to access process data. The implemented methodologies were subsequently published as conference and journal papers. The methods were tested at hot strip mills, annealing furnaces and galvanizing lines.

[P27] **RFSR-CT-2011-00011: [OPTISHAMP] Optimal control of shape and materials properties (12/2011 – 11/2015)**
Customers demand for steel grades with increased strength and balanced formability as well as optimal shape. Shape & mechanical properties are strongly affected by the deformation and thermal treatment during the hot and cold rolling. In this project, a through-process control system is developed for the simultaneous optimisation of shape & mechanical

properties along the production chain of hot and cold rolling. The optimisation system is realised and tested at two mills.

[P28] **RFSR-CT-2011-00016: [ICONTENS] Intelligent self-learning control of levelling processes by use of soft sensor techniques to predict residual stress and flatness (07/2011 12/2014)**
Leveller settings are normally done by experience of the operator, using visual feedback of the geometrical shape of strip. The increasing use of (A)HSS requires levelling strategies preventing loss of deformation properties. This project aims at developing multi-physics process models for different leveller types for automated auto-adaptive set-up and advanced on-line control of residual stress and flatness using intelligent soft sensors predicting residual stresses and flatness. With automated control for minimisation of residual stresses, quality and consistency of the strip levelling process are optimised.

[P29] **RFSR-CT-2011-00040: [TECPLAN] Technology-based assistance system for production planning in stainless mills (07/2011 - 12/2014)**
Production planning systems are essential for minimizing costs and maximizing productivity in steel processing plants. This project introduced and developed a new assistance system that determines the optimal production route for stainless steel, depending on the value of an applicability index as function of the desired strip quality, mill capabilities and customer requirements. This has been based on installation and measurement of strip flatness at different locations in the processing chain, development of prediction (transfer) models for flatness, crossbow, thickness tolerance, other quality parameters and plant throughput and development of new optimisation algorithms for the different processing routes.

[P30] **RFSR-CT-2012-00009: [DYNAMO] Advanced measurements and dynamic modelling for improved furnace operation and control (07/2012 – 12/2015)**
Modern reheating furnace control systems currently use limited measurements of the furnace temperature coupled with simple empirical mathematical models to predict and following regulate stock temperatures. However existing measurement data capture only a small amount of information about the operating state of the furnace. In addition, the mathematical models used in existing reheating furnace control systems are relatively crude so that predictions of process parameters have only limited accuracy and the precision of the supervisory process control system is compromised.

[P31] **RFSR-CT-2012-00037: [ICONSYS] Intelligent control station for improved quality management in flat steel production by a next generation decision support system (07/2012 12/2015)**
The development of an Intelligent Control Station based on four years of very successful operation of a Decision Support System regarding quality of steel strips was the next significant step to support people at the control stations of rolling and finishing mills. Therefore, the following new developments were integrated in existing decision support solutions:

automatic monitoring of used manufacturing specifications and their continuous improvement, evaluation procedures to detect products which exceed the customer requirements significantly and methods to optimise between environmental and technical aspects during the decision about further treatment of coils.

[P32] **RFSR-CT-2012-00038: [I2MSteel] Development of a new automation and information paradigm for integrated intelligent manufacturing in steel industry based on holonic agent technology (07/2012 12/2015)**
The objective of this project is to develop a completely new paradigm for steel specific, factory and company-wide automation and information technologies. This new system is built on a holonic description of the production chain where software agents interact in order to solve complex problems under a negotiation protocol. The production environment is formalized using semantic technologies, ontologies, which provide to the agents a unified description of the information they must process. The global system is designed on a service-oriented architecture which gives all the required flexibility for the agents to interact with legacy applications.

[P33] **RFSR-CT-2013-00031: [PUC] Product Uniformity Control (07/2013 12/2017)**
The project deals with on-line monitoring of flat products uniformity with respect to the microstructural properties of steel by establishing relative relationships between the on-line measurements and microstructure in order to improve both "inter-coil" and "intra-coil" uniformity of steel strip. A relevant amount of data is collected and processed through standard statistics and AI-techniques. AI is also applied to infer relationships between parameters and microstructural properties as well as to correlate the lack of uniformity to its possible cause.

[P34] **RFSR-CT-2014-00028: [SOPROD] Economic and flexible decentral self-optimising production (07/2014 12/2017)**
Aim of this project is increasing flexibility, resource efficiency and productivity as well as decreasing energy consumption of the production. To meet this, aim a new approach was developed and implemented at two industrial sites exploiting a combination of real-time and de-centralised optimisations for scheduling, automatic process self-optimisation and autonomous communication between the processes. This concept allows to de-centrally optimise the scheduling considering detailed product and process knowledge. It facilitates a process self-optimisation by using individual product properties and processing information of neighbouring processes.

[P35] **RFSR-CT-2014-00029: [DYNERGYSteel] Integrated dynamic energy management for steel production (07/2014 – 12/2017)**
Steel Industry is an important energy consumer facing with problems of electrical grid instability due to the increasing of renewable energy sources. Power fluctuations have important influences on production costs (fares) and continuity (grid disconnections); a closer cooperation between grid operators and steel industry is needed to improve the

power engagement forecast. DYNERGYSteel develops dynamic approaches for electricity demand monitoring and timely reactions to grid situation to avoid non-flexible equipment disconnection and financial fines when deviating from energy contingent. Simulation, decision support procedures, control tools will be implemented at several steelmaking plants to improve power management capability.

[P36] **RFSR-CT-2015-00007: [MICROCONTROL-PLUS] Combined Online Microstructure Sensor and Model for a Better Control of Hot Rolling Conditions and Final Products Properties (phase 2) (08/2015 – 07/2019)**
In continuation with the MicroControl (RFS-CR- 2009-10010) project, a new tool combining a microstructural hot rolling model and a Laser Ultrasonic Sensor (LUS) is proposed to predict/control steel properties all along the coil, while maximizing mill productivity. To reach this goal, the all-fibered LUS (prototype successfully tested in previous project) will be improved to a robust, portable, full-industrial version for multi-points measurements at several locations in the hot rolling mill.

[P37] **RFSR-CT-2015-00008: [INFOMAP] Integration of complex measurement information of thick products to optimise the through process geometry of hot rolled material for direct application (07/2015 12/2018)**
Measurement systems covering flatness and dimensional accuracy on plate/strip products are widely available. Output is usually in the form of contour plots or 'maps', providing visual feedback to mill operators who must interpret the information subjectively, and to technical staff for investigative purposes. Objective interpretation of these maps is not straightforward, and comparison of output from devices of different type or manufacturer often presents further difficulties. This project seeks to address this, developing a tool for objective interpretation of maps from different devices along the process route, generating concise data suitable for use within automatic control/advisory systems.

[P38] **RFSR-CT-2015-00012: [ORSC] Optimal Residual Stress Control (07/2015 – 12/2018)**
Client demands for European steel sheet producers are facing a trend in product development where higher quality standards in terms of tighter material property tolerances are demanded. Producers today encounter great problems coupled to residual stresses where an increased number of customer complaints are experienced. Traditional control approaches are not enough anymore whereas this project will develop a new "residual-stress-based" control concept, validated at participating industrial partner plants, applicable by combining inline measurements and accurate modelling approaches.

[P39] **RFSR-CT-2015-00029: [GASNET] Optimization of the management of the process gases network within the integrated steelworks (07/2015 12/2018)**
This project represents a further (and more advanced with respect to ENCOP) example of application of tools and techniques typical for advanced control and optimization. It reduces the environmental impact

of the steel production. It aims at improving off-gases management by minimizing energy losses, air emissions, environmental impact and costs. A decision support tool for process operators and energy managers is developed, which simulates gas networks and optimizes gases distribution, by considering the operating constraints. Multi-period and multi-objective optimization techniques and advanced model-based control techniques are applied.

[P40] **RFSR-CT-2015-00030: [AUTOADAPT] Novel automatic model identification and online parameter adaptation for supporting the industrial deployment of model-based process control (07/2015 12/2018)**
This project applies model-based automation to control and improve the homogeneity of the material throughout the process route from hot-rolling to hot-dip galvanization. Self-learning methods and data-based model identification techniques are applied to implement model-based process control which is capable to self-adapt to new products and plants.

[P41] **709669 (2016): [Cyber-POS] Virtual Design of Cyber-Physical Production Optimization Systems for Long Production Factories (07/2016 12/2019)**
Cyber-POS to develops a virtual simulation platform for the design of cyber-physical production optimization systems (CPPS) for long production facilities with special emphasis to thermal evolution and related material quality, leading to reduced energy consumption, shortened production time and improved product quality. Simulation and verification tools and a new IT framework for establishing feasibility, safety and benefits. Process (thermal, rolling, transport) models, material-quality models, logistics/scheduling models and communication (computers, software, networks) models are merged and used for production optimization, enabling fast dynamic and flexible reaction on changes in set-points, production routes, process disturbances or interruptions.

[P42] **709694 (2016): [MACO PILOT] Optimisation of the mixed acid online monitoring and control in stainless steel pickling plants (07/2016 – 12/2019)**
This project addresses optimisation of the innovative online concentration measuring technique concerning set-up, long-term reliability and operative range. Besides laboratory investigations and pickling process operation model developments, pilot scale tests are carried out at a stainless-steel strip pickling line including acid regeneration, and for the first time at a wire rod plant. Finally, modernisation concepts for existing mixed acid pickling plants are developed. The overall goal of this project is the further optimisation of the mixed acid concentration monitoring and control to improve the pickling plant process operation and working conditions.

[P43] **754130 (2017): [SUPPORT-CAST] Supporting Control by Inspection of Surface Quality and Segregation on Cast Products through integration of Novel Online Monitoring and Advanced Modelling into an Accessible Cloud Access Platform (07/2017 –**

06/2021)
The project develops online-monitoring systems and numerical models able to identify defects as well as support decision making to formulate guidelines that improve the quality of cast products. Sensors include strand-temperature monitoring, high-resolution visualization and topography-scanning integrated into a cloud-access-platform. These are combined to advanced numerical models to develop a regression database for defect prevention to assist operators and enhance process control. Moreover, the project identifies ideal locations for the sensors developed as well as assessing improvements in yield for stainless, carbon and micro-alloyed steels by reducing scarfing and/or grinding; thus, enhancing productivity.

[P44] **800672 (2018): [FlexGap] Industrial demonstration of novel adaptive flat bearing with adjustable thickness for flexible gap control in rolling mills (06/2018 – 11/2021)**
Increasing demands for better product quality, thinner strips and greater flexibility of the production lines confront rolling mills with new challenges. The e-mobility sector requires thinner sheets with even tighter thickness tolerances to increase efficiency of electric motors. Therefore, it is necessary to reduce vibration level at the rolling stands. For this purpose, the adaptive flat bearing for rolling mills was developed, which enables passive and active vibration damping. This project will be the first industrial test of the adaptive flat bearing. Installation will be performed on a cold rolling mill of thyssenkrupp Electrical Steel.

[P45] **800677 (2018): [NEWTECH4STEEEL] Enhanced process stability and product quality in steel production by exploitation of break-through technologies for real-time monitoring, control and forecasting inspired by big data concepts (06/2018 – 11/2021)**
The constantly growing requirements to European steel production concerning product quality and process efficiency are accompanied by massive increases of data and information collection at the processes and about the products. The final aims of this proposed project are the developed and applied methods for an improved process observation and control as well as extended tools to assess and forecast (intermediate) product quality as examples for the successful application of new technologies, to provide evidence of the applicability and efficiency of such methods.

[P46] **800679 (2018): [RADIFLAT] Radar-based flatness measurement and control in strip rolling and processing lines (06/2018 – 11/2021)**
The worldwide first radar-based strip flatness measurement system, including strip edge detection and width measurement is developed for strip processing lines (rolling, levelling, quenching, ...). The basic technology consists of a multi-radar measurement system that is created to operate with high frequency/resolution (240–300GHz) and precisely work under the extreme conditions of strip processing in terms of dust, vapour, high temperatures, etc. Sophisticated signal processing and

process modelling methods will be developed to integrate the measurement technology in the process control and automation.