Interest in **high entropy alloys (HEAs)** is constantly growing due to their promising properties and potential use as **modern engineering materials** in various industrial sectors. **The unique properties of this type of alloy** result from the structural disorder that results from using a minimum of five alloying elements with a similar atomic fraction, and despite the use of so many alloying elements, these materials crystallize as single or dual-phase alloys. These alloys are generally produced using conventional casting methods such as arc melting, induction melting, and Bridgman solidification. However, **it is also possible to produce them in more complex geometries using the additive manufacturing (AM) approach**, especially laser and electron beams. Recently, some of them, such as ZrTiVCrFeN and CoCrFeMnNi, were produced using this approach as simple samples such as plates, cylinders and samples for mechanical testing. **However, there is a lack of knowledge about the production of complex shapes, such as internal cellular topologies, using the selective laser method and spherical-shaped high entropy alloy powder.**

Accordingly, the project assumes to design a new class of entropy-stabilized alloys (especially one-phase high entropy alloys and alloys strengthened by precipitates) with a unique structure that ensures high corrosion resistance and mechanical strength. **For that, the CoCrFeNiMs, where Ms = Nb, Mo, V, Si, B, C high entropy alloy composition, was chosen based on the initial experiments and literature review**. The obtained under project realization results may constitute the input required to perform **numerical simulations of features with a specific geometry and application**. Moreover, **modelling the structure and temperature-induced changes** should extend the current knowledge about the phases' stability in the HEAs, especially from a thermodynamic point of view. Above that, the possibility of the **3D printing of these alloys**, especially in samples **with internal cellular topologies,** will be tested and described together with the **atomization and selective laser melting (SLM) optimized process parameters.**

This project also aims to **combine the modelling at different stages of the material solution development with the experimental results** to obtain comprehensive information about the chemical composition, structure, stability, and functional properties of proposed HEAs. **One of the highest impacts of the proposed project is a combination of both modelling and experimental examination on the different project stages.** This approach will allow us to describe potential applications of the CoCrFeNiMs, where Ms = Nb, Mo, V, Si, B, C high entropy alloy based on developing new production methods (including SLM technology and production of samples with internal cellular structure), description and modelling of their structure and properties and above that implementation of process optimization through modelling at 3D samples preparation stage. Accordingly, the project includes **four levels of modeling**:

- Modeling of the atomic structure in the short and medium range and physical transformations during cooling with a variable rate (with the digital representation of the microstructure);
- Optimization of selective laser melting process parameters by the application of design of experiment and logistic regression models;
- Development of numerical models of samples from high entropy alloys with a cellular structure along with the determination of their mechanical properties;
- Development of multiscale numerical models for the analysis of mechanical properties using digital representations of the microstructure of new CoCrFeNiMs alloys.

According to our knowledge, **this is the first time, so a comprehensive approach will be used to go from chemical composition optimization to samples with complex geometrics production using additive manufacturing**. Planned experiments will allow for gathering information needed to compare the impact of selected thermodynamic parameters on the structure and properties of alloys. The corrosion tests, together with the analysis of corrosion products, not only report the mechanisms of HEAs degradation but also determine the factors influencing the corrosion resistance in this group of materials and will allow us to propose these process models. Tests of samples produced with different cooling rates will result in increased knowledge of phase formation, microstructure and impact on properties. The results of thermal stability tests allow us to determine the stability of the obtained phases and to link them with thermodynamic parameters and methods of production.

The project's results will significantly impact in the development of knowledge of modeling, technology and future applications of innovative high entropy alloys. Furthermore, a wide range of planned research will allow for publishing the developed results in prestigious scientific journals. Moreover, the project's added value is **international cooperation with the Wigner Research Center for Physics** in Budapest.