General description of the proposed subject: The subject concerns the methods, the calculation and the determination of the causes of reduction of transient and residual stresses generated by welding during metal assemblies. The objective is to set up a robust experimental and numerical tool to predict and control the stress and deformation fields (residual, but also during welding) and their geometric consequences on the final part. The scientific lock is to be able to control stress and deformation distributions throughout the welding process. These distributions are essential because they influence the service life of welded parts.

Background:

Mechanical and geometric stability, related to the effects of residual stresses after welding in metal structures, is the main theme of this work. Because of the stress and deformation concentrations generated by the welding and depending on the load carried out (monotone or cyclic) during the use of the welded part, the welded joints remain sites of fragility such as the privileged initiation of cracks, geometric distortions and defects: buckling, buckling, expansion, shrinkage. As a result, the final geometry is no longer consistent with that expected. Experimentally, the identification of the causes of the appearance of stresses and deformations requires on the one hand the use of specific techniques to distinguish between current and post-mortem (strain gauges, RX, neutrons, etc.) then for their calculation to use robust algorithms to take into account all the contributing variables generated by the process and the material: thermal, metallurgical and mechanical with consideration or not of anisotropy. Numerically, the calculation also requires long nonlinear finite element calculations to account for elasto-plastic stress/strain fields. For years, we have been developing a finite element numerical tool that is always supported by experience to calculate residual stresses and deformations. Our experience has allowed us to develop a robust tool taking into account the thermo-metallo-mechanical coupling, the phase transformation rate in the case of steels, the grain orientation. The results with the experiment confirmed our model as well as the geometric deformations of the structures (3D dimensional measurement). In the continuity of this work, we wish to go further by developing a robust tool to determine and control the impact of these stresses and residual deformations from the first stages of the welding process on the conformity of the welded structures, in particular their impact on the geometry of the final structure. Scientifically, we want to develop a model that can link the field of residual stresses and deformations generated by welding to the geometric non-conformity of the final welded parts (overall deformation of the part). The scientific lock comes from the fact that this non-compliance is not always explainable because it is difficult to identify the step during which the defects due to residual stresses appear: initial step put in position, hold in position, nature of process, effect of clamping, effect of material, welding configuration. The goal is to look for the causes and effects. In an industrial use perspective, it will be necessary to characterize and identify geometric signatures of defects that appear during the realization of an assembly in order to establish the degree of contribution of residual stresses and deformations on geometric defects. The approach is to assess the causes and effects from the start of the manufacturing chain.