**Research Topic 02 for the ParisTech/CSC PhD Program**

**FOR APPLICATION, PLEASE CONTACT ADVISOR(S) BY EMAIL WITH COPY TO:**
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***Subfield***: Mechanical Engineering

***ParisTech School***: Arts et Métiers (ENSAM)

***Title***:
Experimental full-field strain and temperature measurement under extreme conditions using digital image correlation and an IR camera. Application to the machining process of a titanium alloy.

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***Short description of possible research topics for a PhD***: (10-15 lines in English + optional figure)
Improving our understanding of the thermal and mechanical phenomena involved during material deformation under extreme conditions is a major scientific challenge, especially for the study of manufacturing processes. This knowledge leads to better modeling of what is a highly nonlinear problem and, consequently, increases the quality of numerical simulations. The latter provides predictions of the strain and temperature fields in order to improve the cutting parameters (cutting speed and cutting angles, tool shape, etc.). However, most of the experiments can only measure global or average values.
The objective of this PhD work is to set up an experimental protocol to measure the full strain and temperature fields generated during machining operations. Initial results, obtained by digital image correlation using a high-speed camera (fig.1), have been used to validate the approach in terms of the strain field measurement. However, this work will require the installation of specific instrumentation for the measurement of the coupled mechanical and thermal fields. Many challenges remain concerning the reliability of the mechanical quantities. The simultaneous evaluation of thermal fields must be developed.

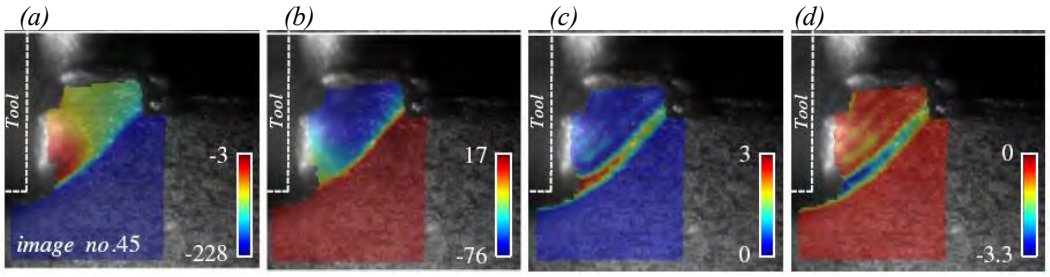


*figure 1 : (a) Horizontal displacement (in µm). (b) Vertical displacement (in µm). (c) Major strain. (d) Minor strain during the machining of the titanium alloys Ti64 (ap = 0.25 mm ; Vc = 6 m/min)*

***Required background of the student***: (Which should be the main field of study of the applicant before applying)
The student must have very good knowledge of continuous solid mechanics and instrumentation (optics).

***A list of 5 (max.) representative publications of the group:*** (Related to the research topic)


- *T. Pottier, G. Germain, M. Calamaz, A. Morel, D. Coupard, 2014, Sub-Millimeter measurement of finite strains at cutting tool tip vicinity, Experimental Mechanics, Vol. 54, Is. 6, pp. 1031-1042*
- *J. Marteau, H. Haddadi, S. Bouvier, 2013, "Investigation of strain heterogeneities between grains in ferritic and ferritic-martensitic steels", Experimental Mechanics, Vol. 53, pp. 427-439.*
- *H. Haddadi, S. Belhabib, 2012, "Improving the characterization of a hardening law using digital image correlation over an enhanced heterogeneous tensile test", International Journal of Mechanical Sciences, Vol. 62, Is. 1, pp. 47-56.*
- *C. Badulescu, M. Grédiac, H. Haddadi, J.-D. Mathias, X. Balandraud, H.-S. Tran, 2011, "Applying the grid method and infrared thermography to investigate plastic deformation in aluminium multicrystal", Mechanics of Materials, Vol. 43, Is. 1, pp. 36-53.*
- *S. Belhabib, H. Haddadi, M. Gaspérini, P. Vacher, 2008, "Heterogeneous tensile test on elastoplastic metallic sheets: Comparison between FEM simulations and full-field strain measurements", International Journal of Mechanical Sciences, Vol. 50, Is. 1, pp. 14-21.*