

8.2 Energies and forces during pole vault flight

Lustig Quentin¹, Homo S.², Brisard S.³, Clanet C.⁴, & Carmigniani R.¹

¹Ecole des Ponts, EDF R&D,² French Athletics Federation,

⁴Université Gustave Eiffel, ⁴Ecole Polytechnique

quentin.lustig@student-cs.fr

When looking at the evolution of the world records and yearly best performances of world class pole vault jumpers, we observe a stagnation of the best performance below the 6.20 m mark, with a current world record held by Armand Duplantis at 6.18 m. Yet, on closer inspection, the number of athletes able to pass the 6.10m mark is small (only 3 in the world, fig.17-a). How to explain such a difference in level ? In the present study, we aim to quantify the energy transfers (fig.17-b) and the interaction forces between the athlete and the pole during an international competition.

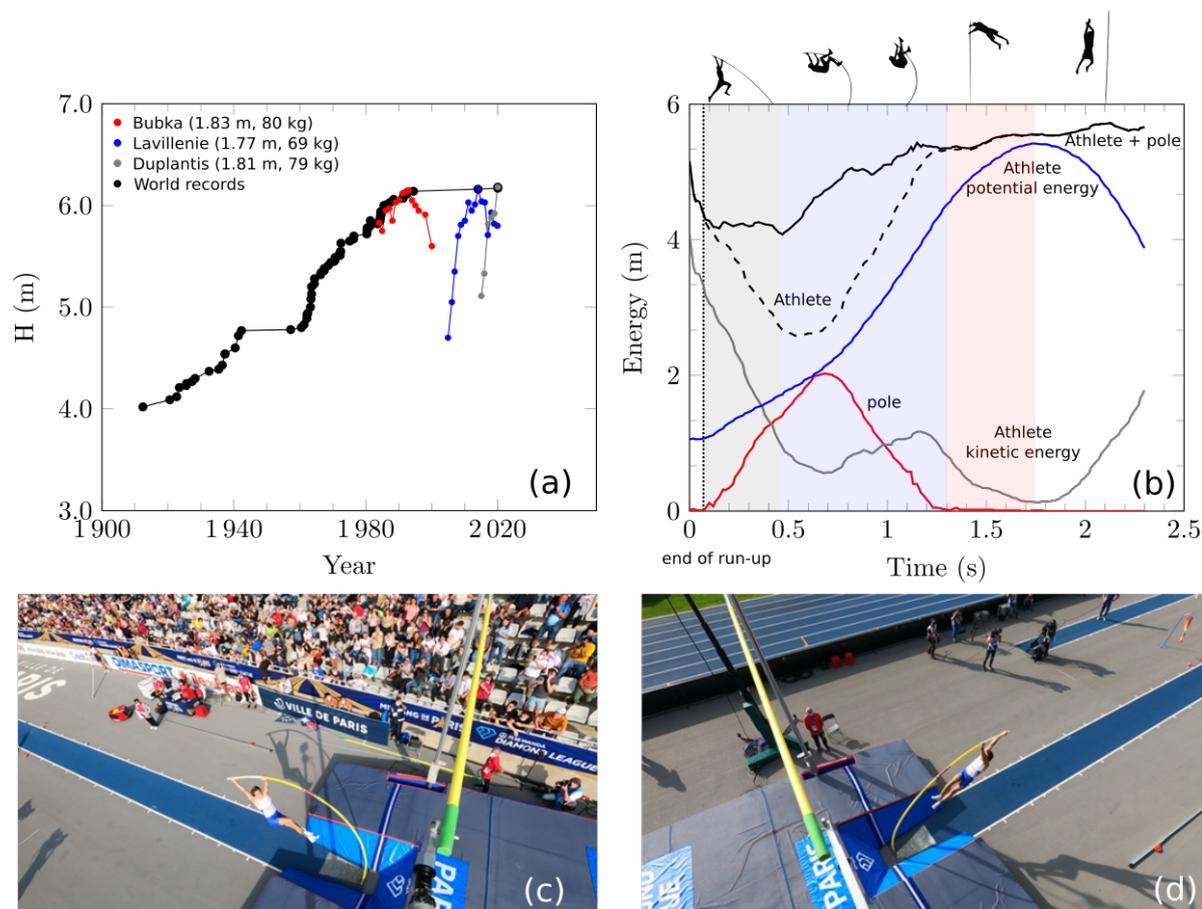


Figure 17: (a) Evolution of the world record in pole vault and yearly best performances of three jumpers. (b) Evolution of the energies measured during vaulting. (c)-(d) Two views of a pole vault from the standards.

To this end, during the Paris Diamond League in August 2021, we used two cameras attached on top of the pole vault standards (fig. 17-c&d). Over 80 jumps were recorded and one jump exceeded the 6m mark. The scene is calibrated and triangulation makes it possible to deduce the 3D deformation of the pole and trajectory of the athletes. A quasi-static approach is used to evaluate the energy stored in the pole and the forces between the pole and the jumper during the jump. Figure 17-(b) shows the evolution of the measured energies during one practice jump of a French pole vault athlete. Our findings confirm that a significant part of the potential energy at release is due to the jumper activity after take-off (in the present case about 20%). This analysis also makes it possible to identify different important phases of the vault for which the athlete inputs or loses energy. These successive phases can be qualitatively observed by the coach. We now provide a methodology to *quantify* these phases. A similar analysis of the dynamics of vaulting will also be discussed.