Cardiac-cycle inspired drag reduction in turbulent pipe flow

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In pipe and channel flows turbulence is responsible for a drastic increase of the wall shear stress and consequently much effort is invested into finding ways to control and subdue turbulence[1],[2]. Curiously, in the case of aortic blood flow, turbulence levels remain low and the motion is predominantly laminar, even though instantaneous Reynolds numbers frequently exceed the steady flow transition threshold. Intense turbulent flow conditions would indeed be unfavourable and potentially damage the highly shear responsive inner layer of blood vessels, the endothelium. In this study we demonstrate that the cardiovascular waveform delays transition and minimizes the amount of turbulence encountered in pipe flow. Applying the same principle to fully turbulent flows at much higher Reynolds numbers, we find that the aortic waveform decreases the drag by more than 25%. This operation mode is considerably more efficient when compared to steady driving which is the status quo for virtually all fluid transport processes ranging from heating circuits to water, gas and oil pipelines.

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[1]Kühnen et al. , *Nature Physics* **14**, (2018).
[2]Scarselli, Kühnen and Hof, *J. Fluid Mech.* **867**, (2019).