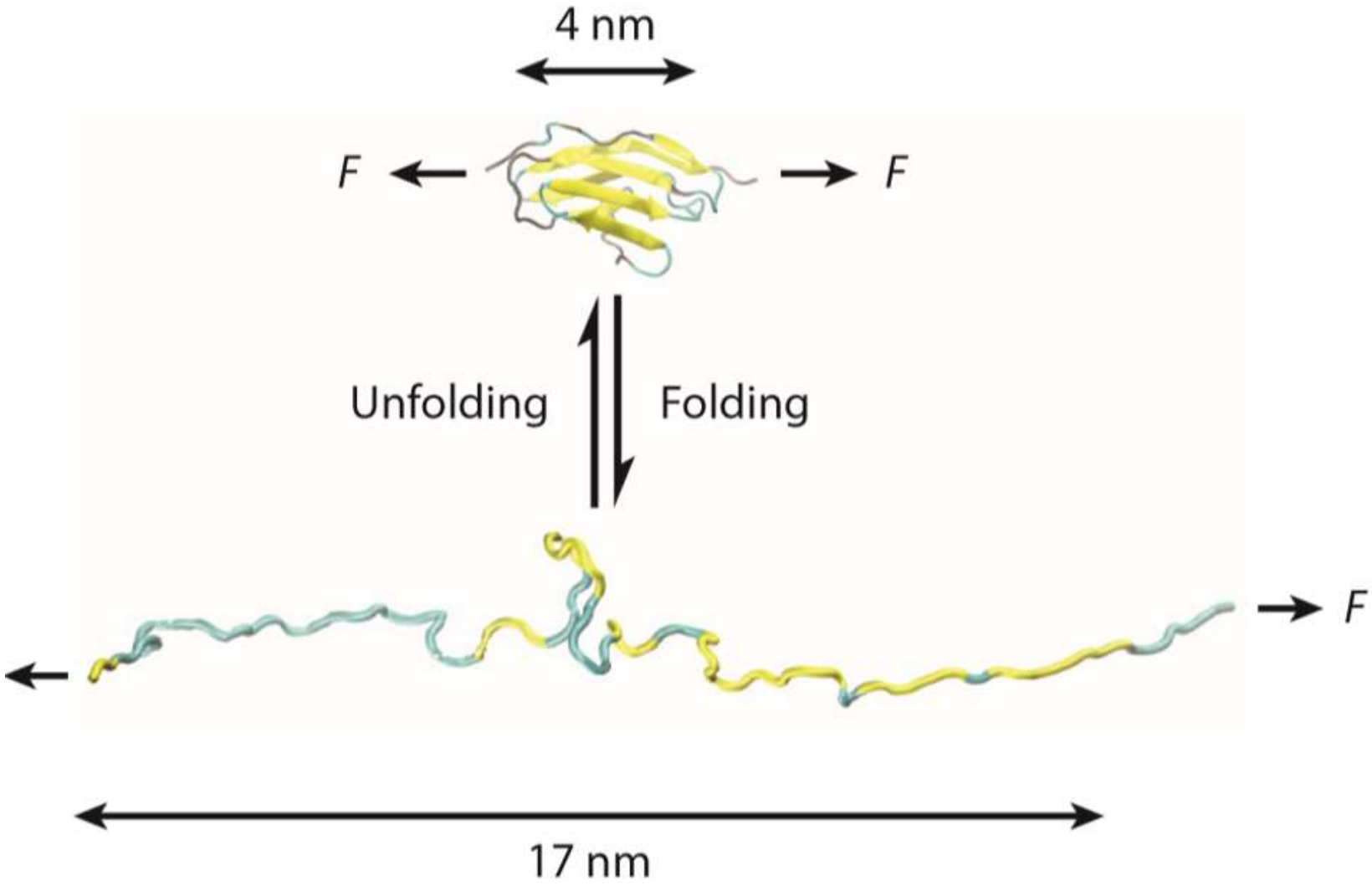
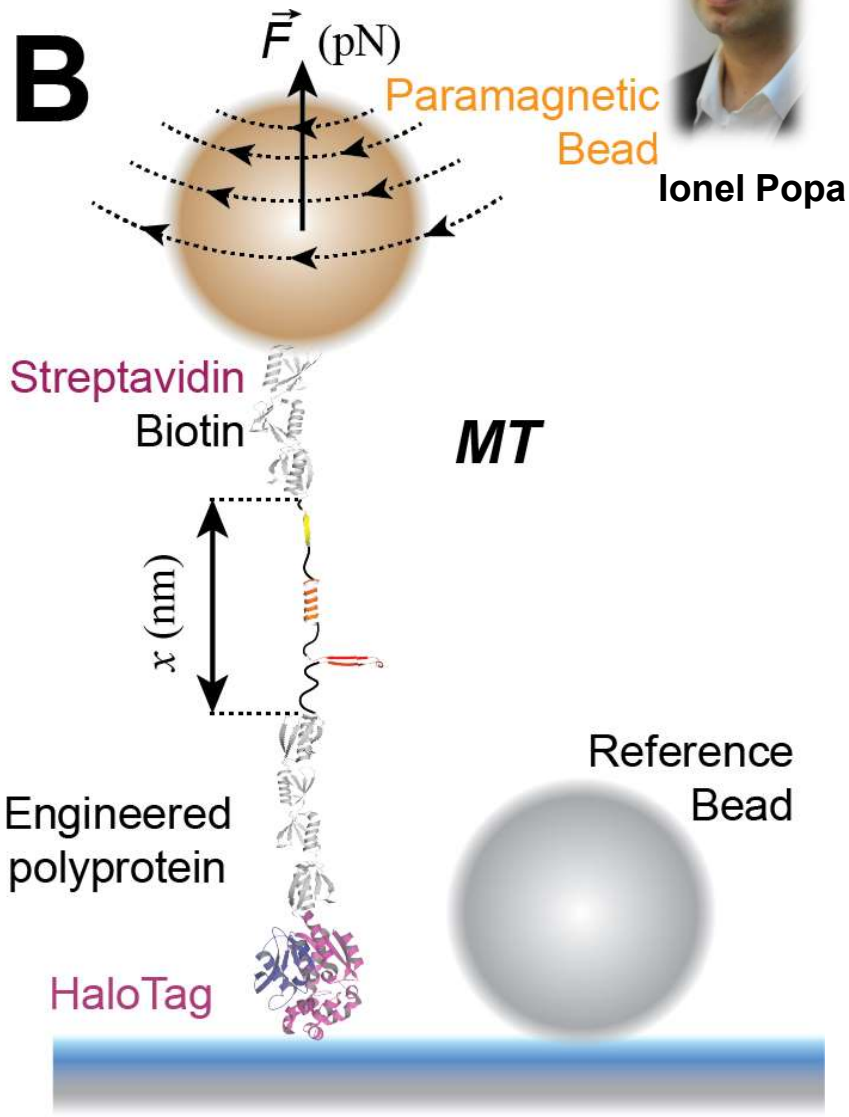
The amazing mechanical power of protein folding



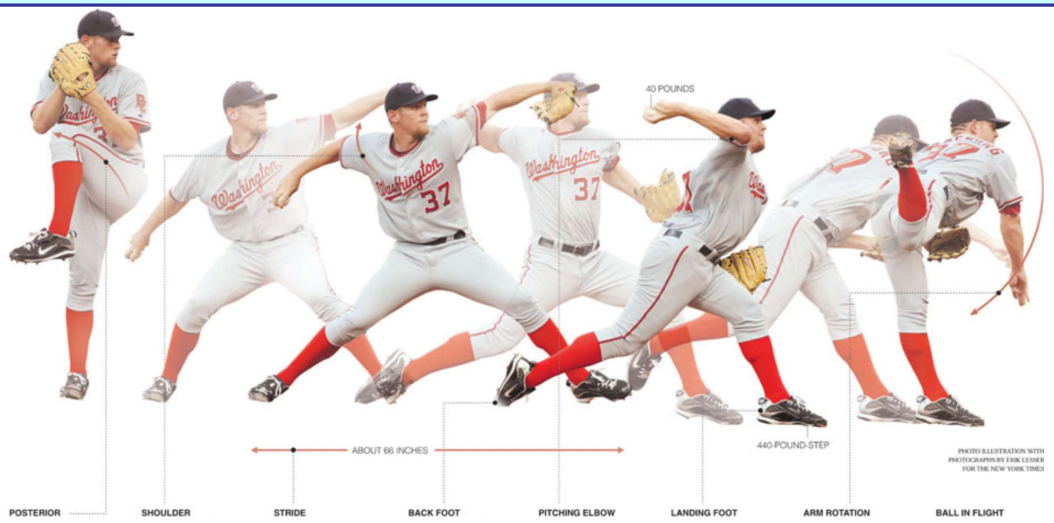
Force spectroscopy measures force, work and power in folding proteins

Carmen Badilla

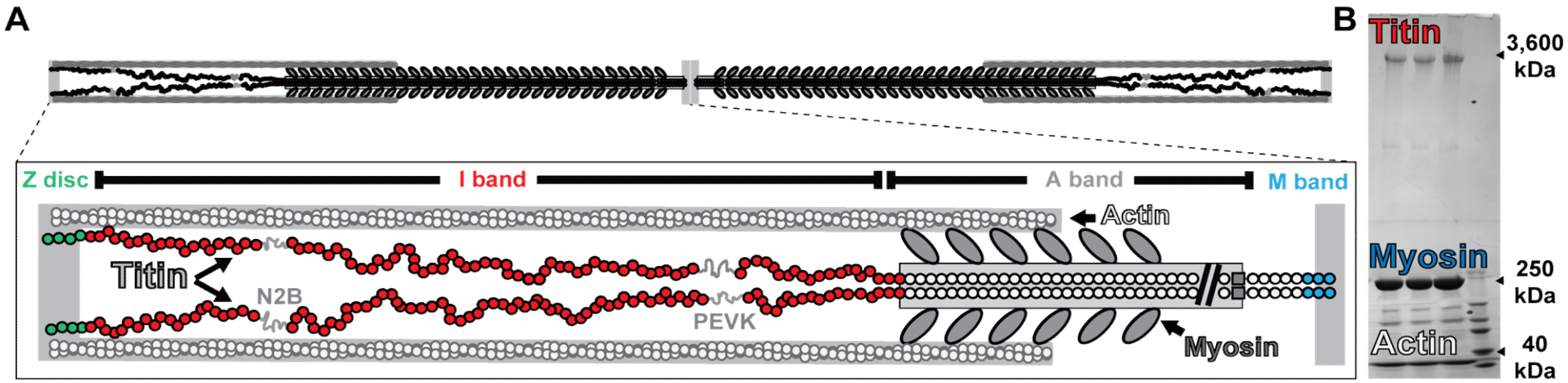
Ionel Popa



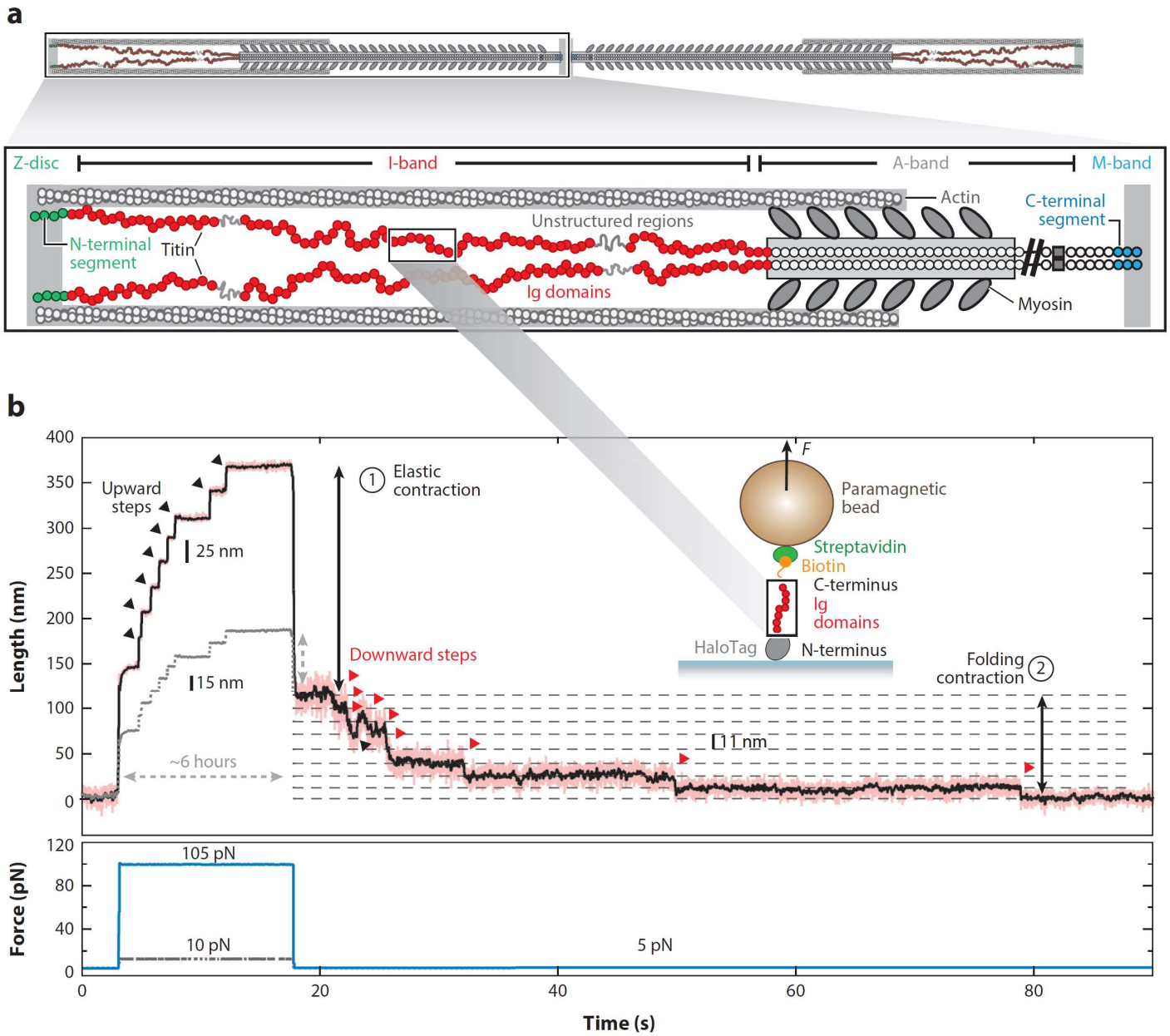
Does titin contribute to pitching a ball at >100 mph?



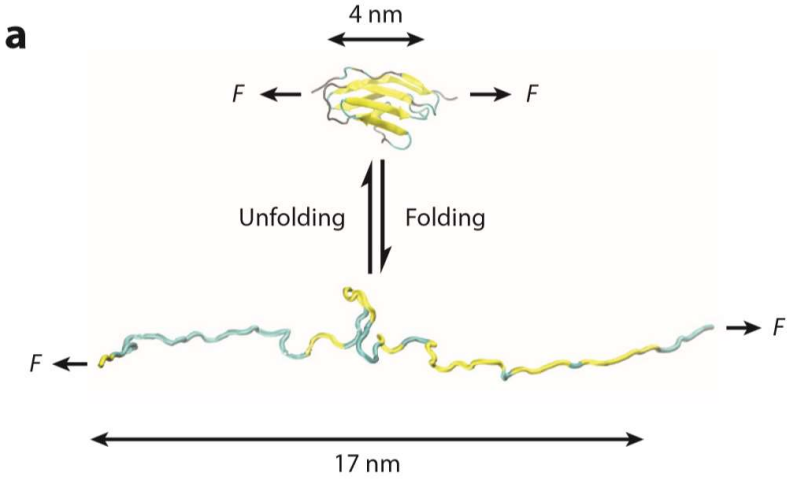
> 100 mph

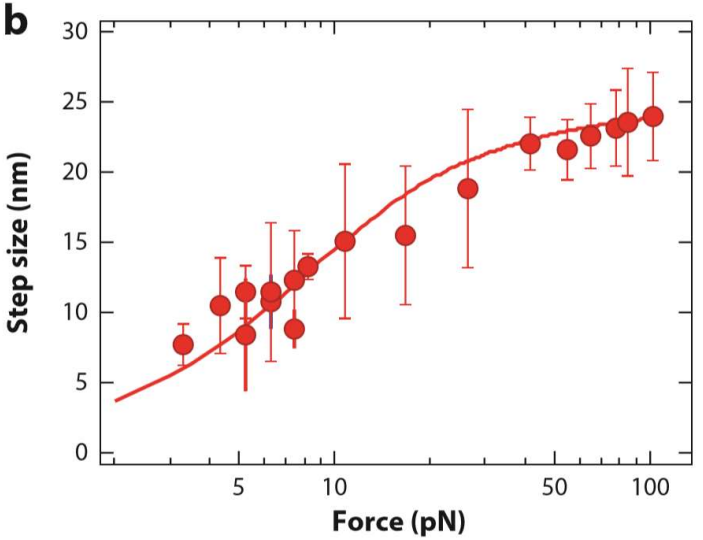


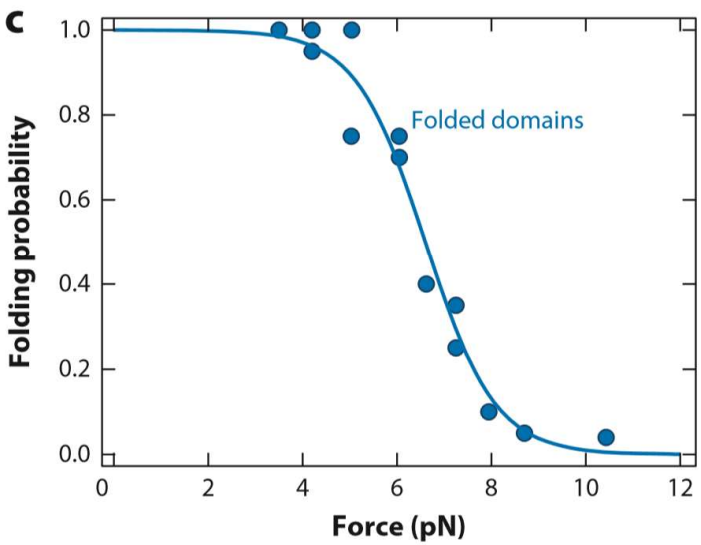
Titin stores and releases elastic energy by folding/unfolding

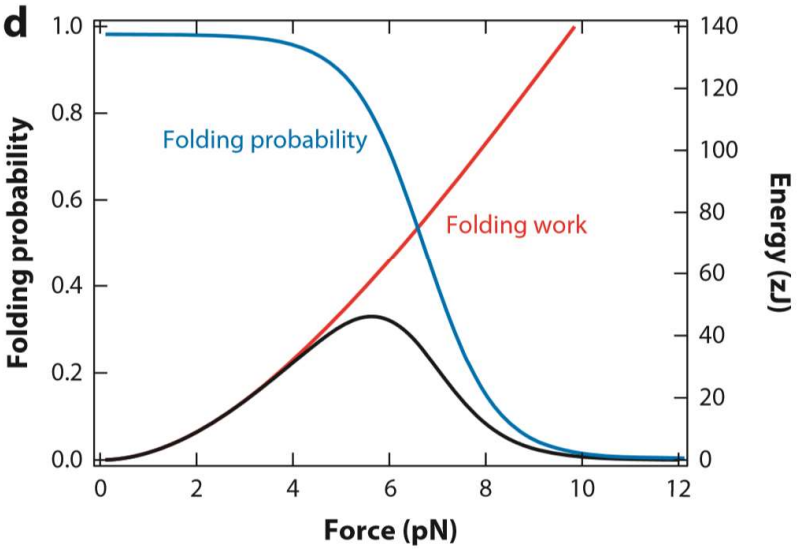


Titin Ig folding work is similar to ATP-driven myosin motors

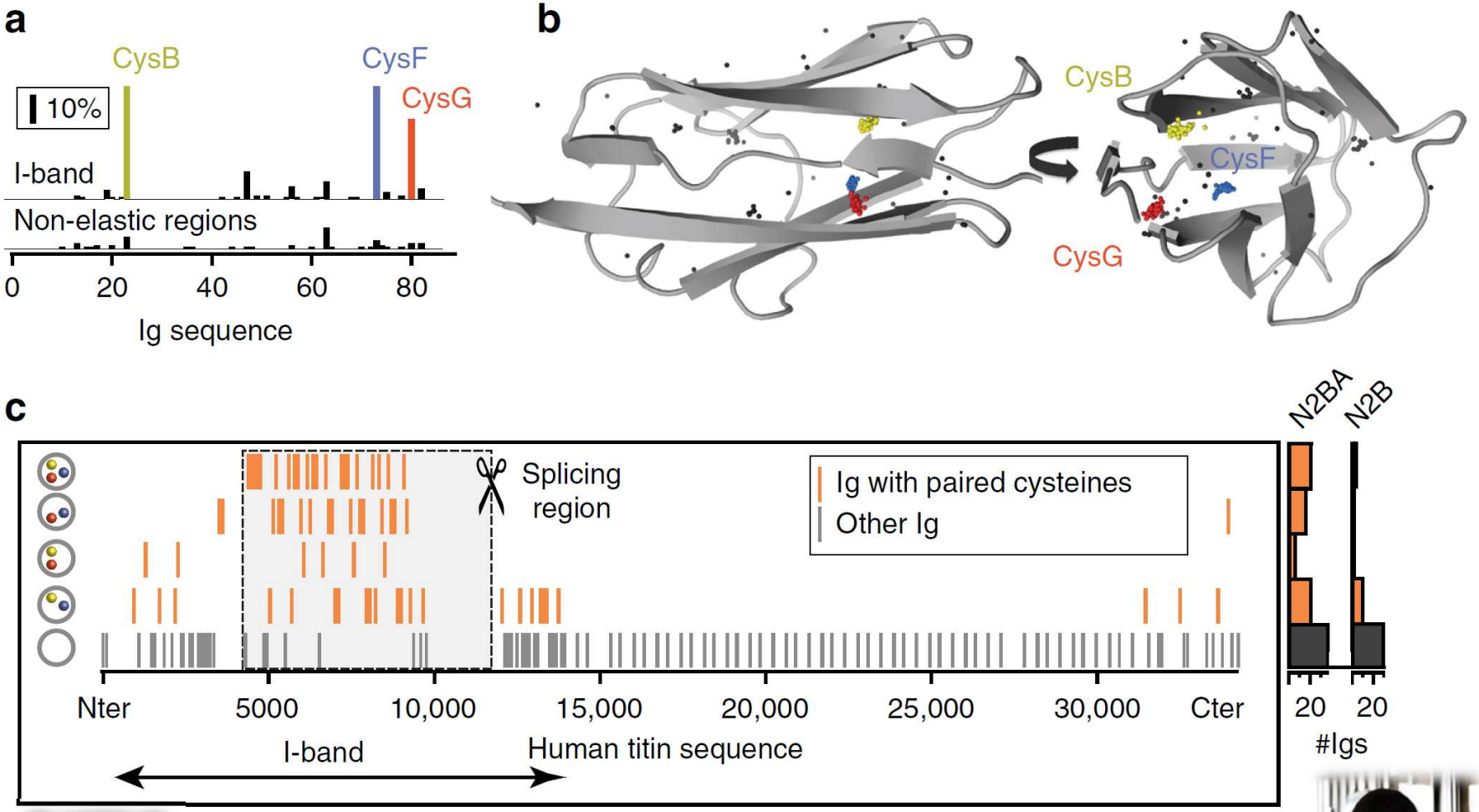








Cryptic cysteines regulate titin folding



Jorge Alegre-Cebollada

Wiita, et al., 2007, **Nature,** 450: 124 - 127

Kosuri, et al., 2012, **Cell,** 151: 794 - 806

Alegre-Cebollada, et al., 2014, **Cell,** 156: 1235 - 1246

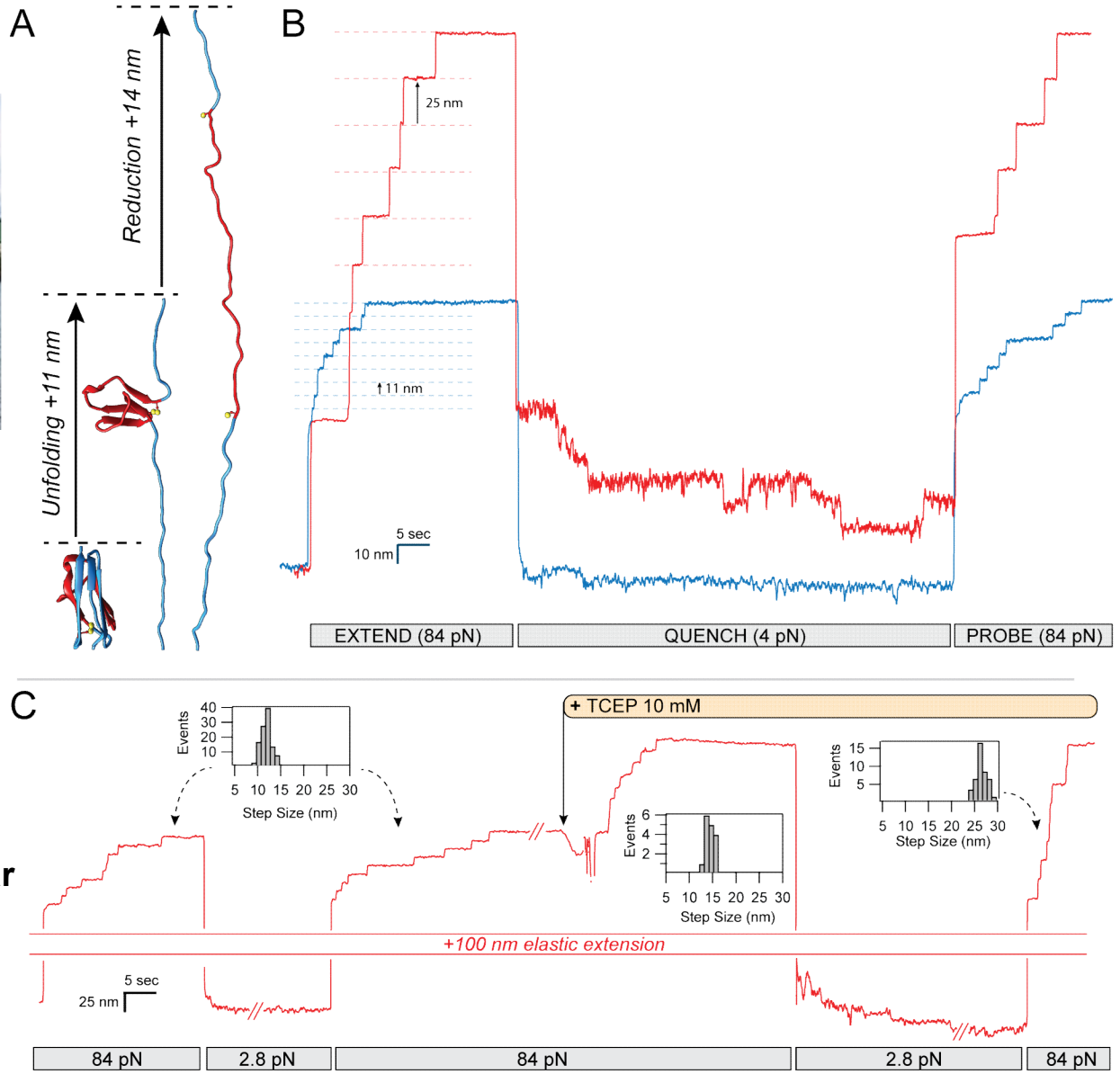
Giganti, et al., 2018, **Nature Comm,** 9: 185

Pallav Kosuri

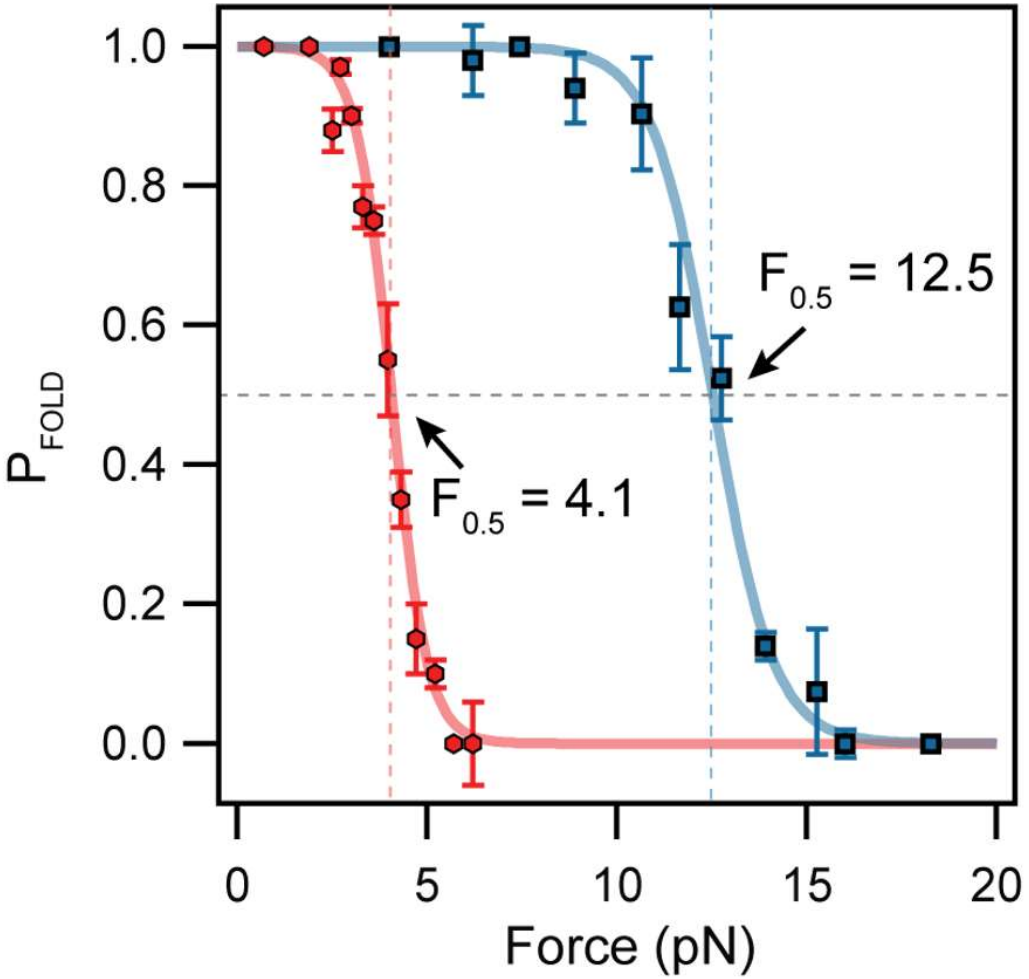
Redox state of a titin domain can be easily controlled

Edward Eckels

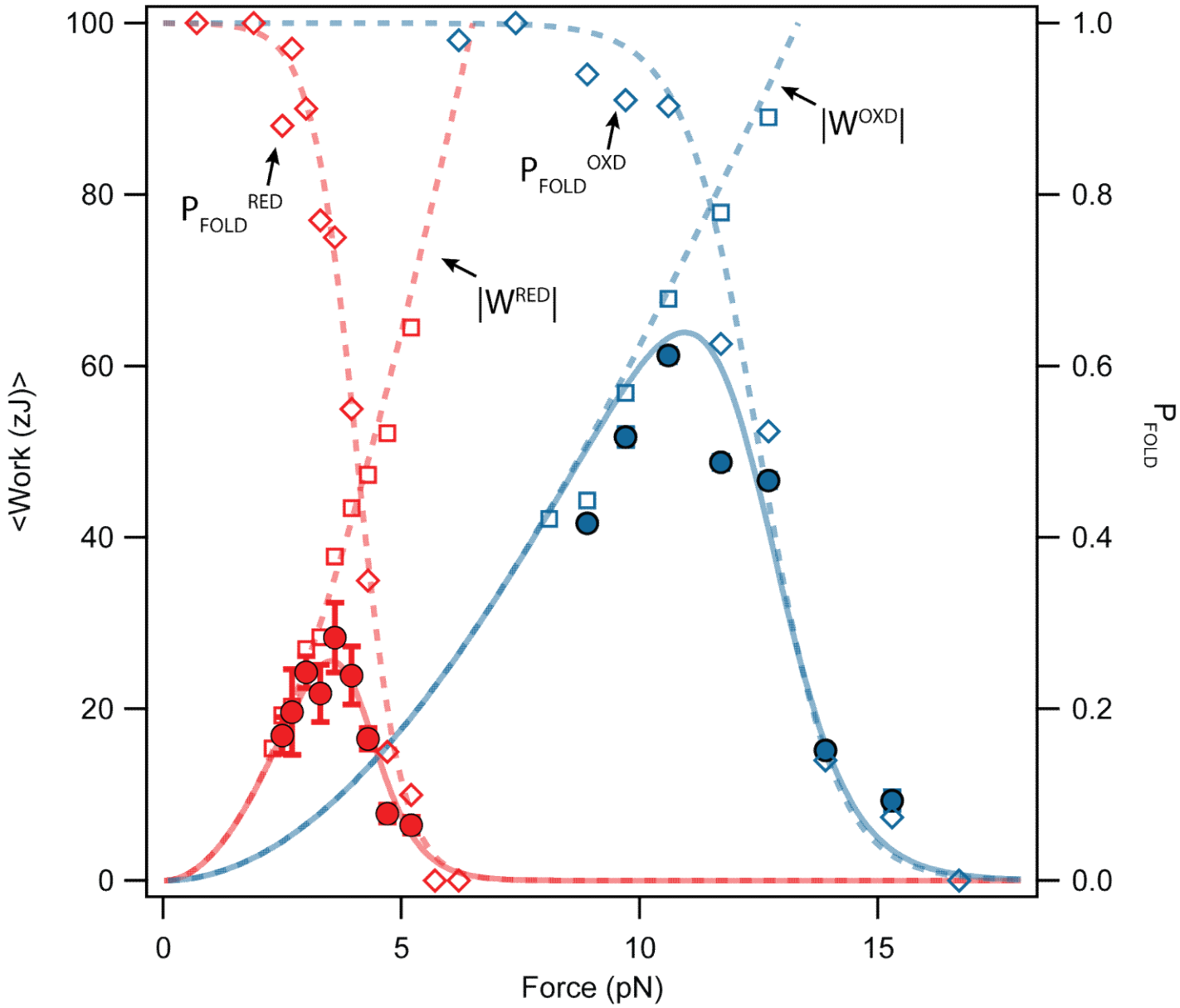
Shubhasis Haldar



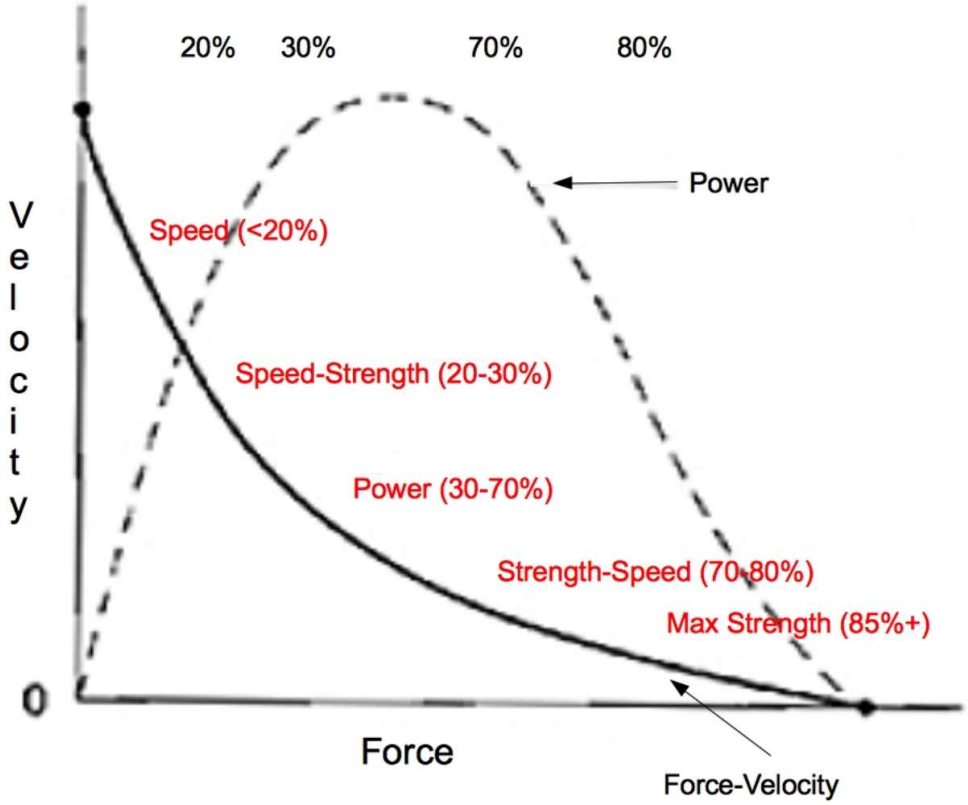
Disulfides shift titin domain folding to higher forces



S-S bonded domains do twice the work at three times the load



Velocity vs Force, and Power



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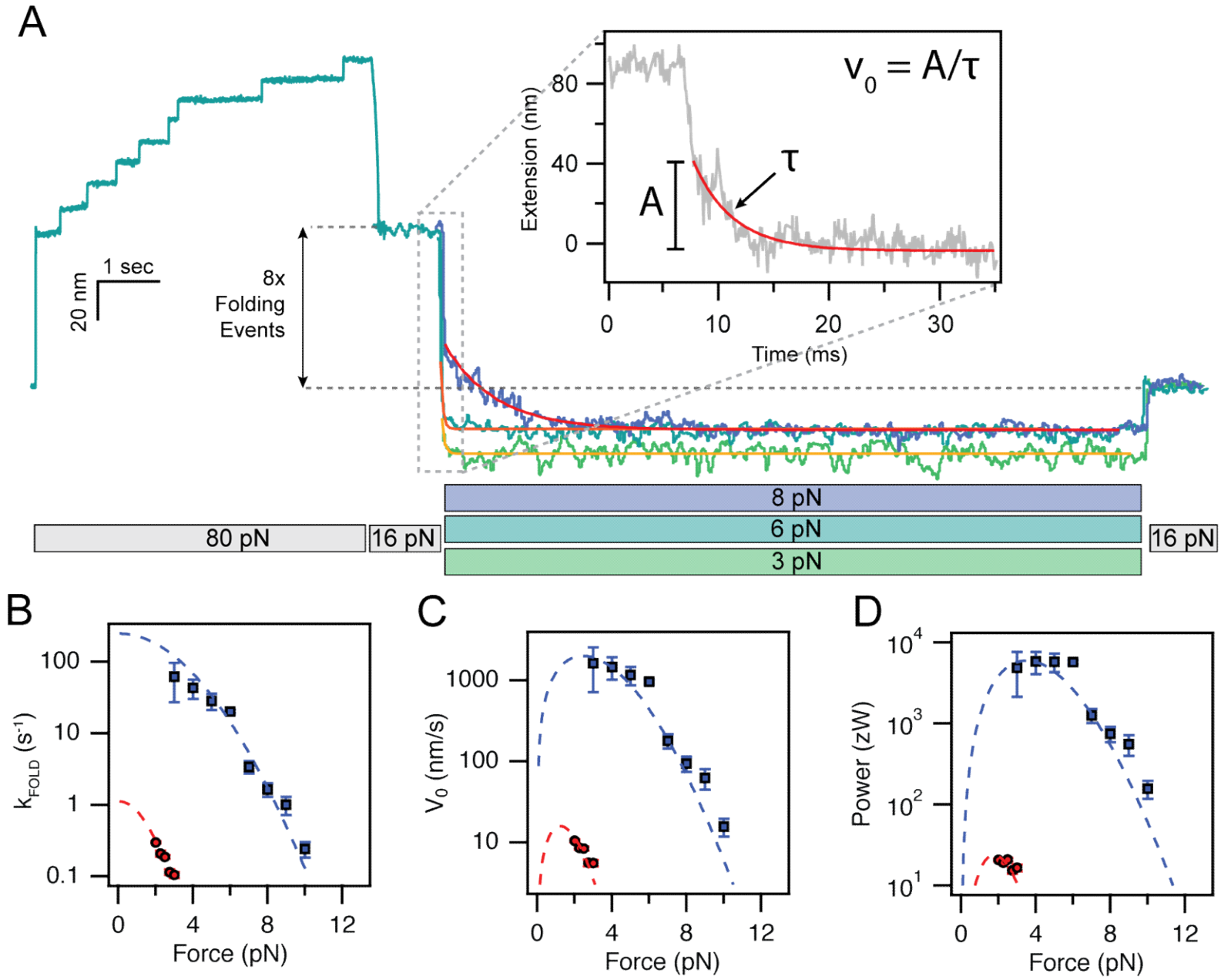
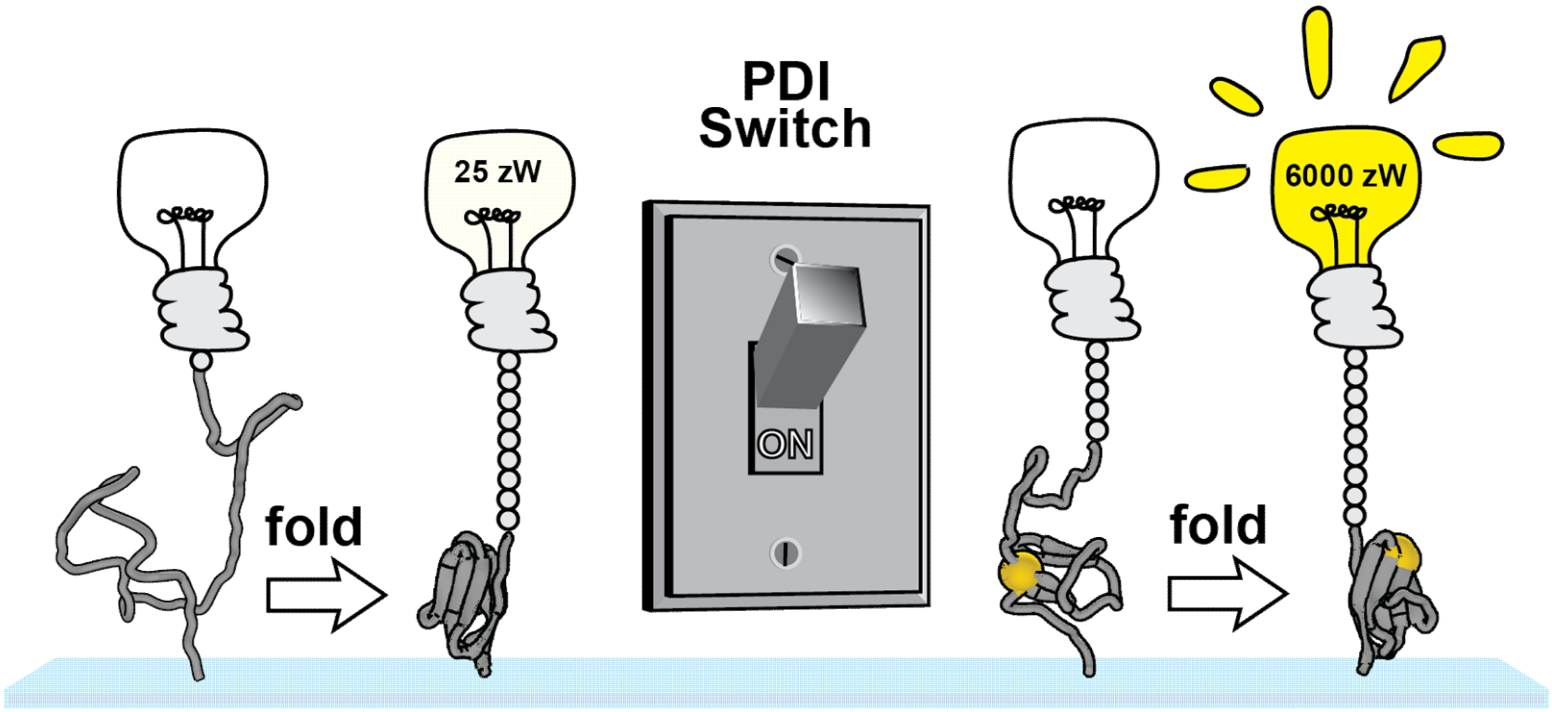
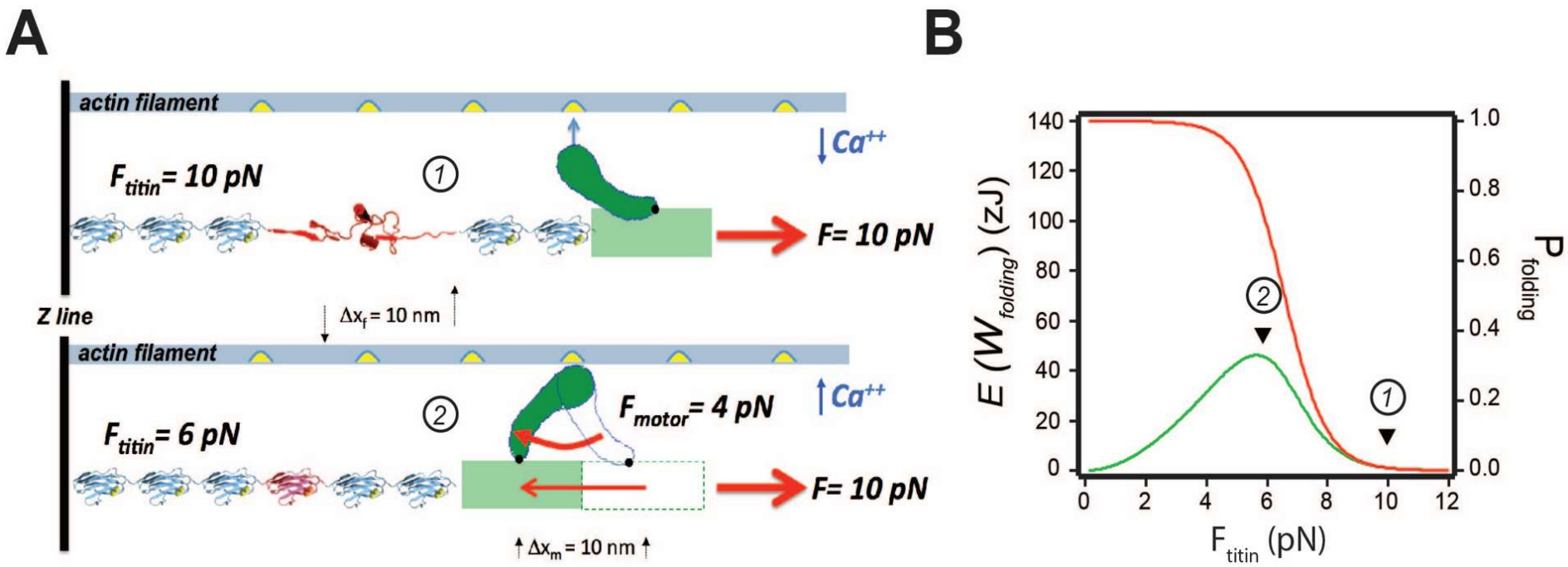
Disulfide bonds greatly increase the power output of folding



Disulfide bonds are the power switches of titin



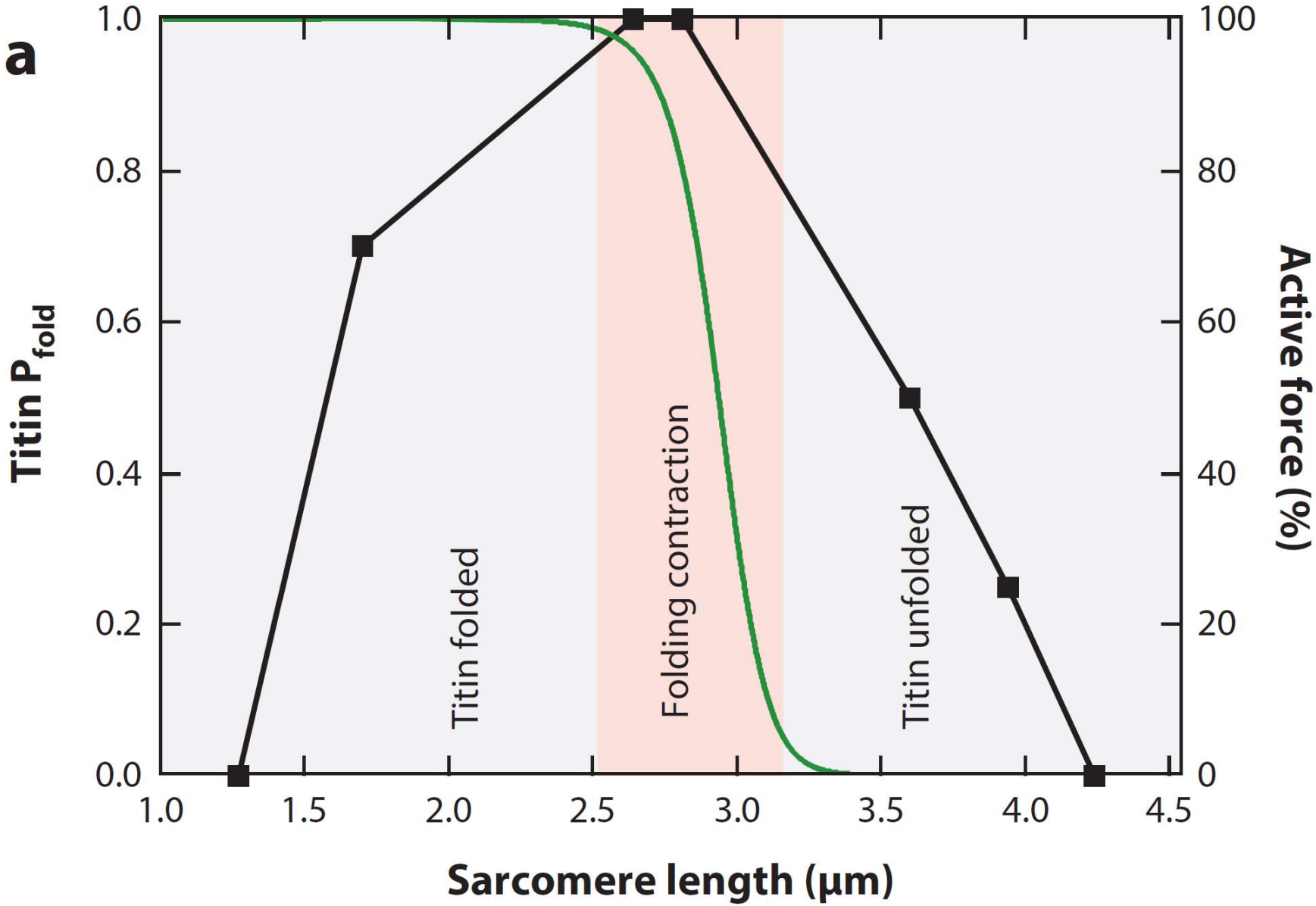
Is titin placed to deliver mechanical power during muscle contraction?



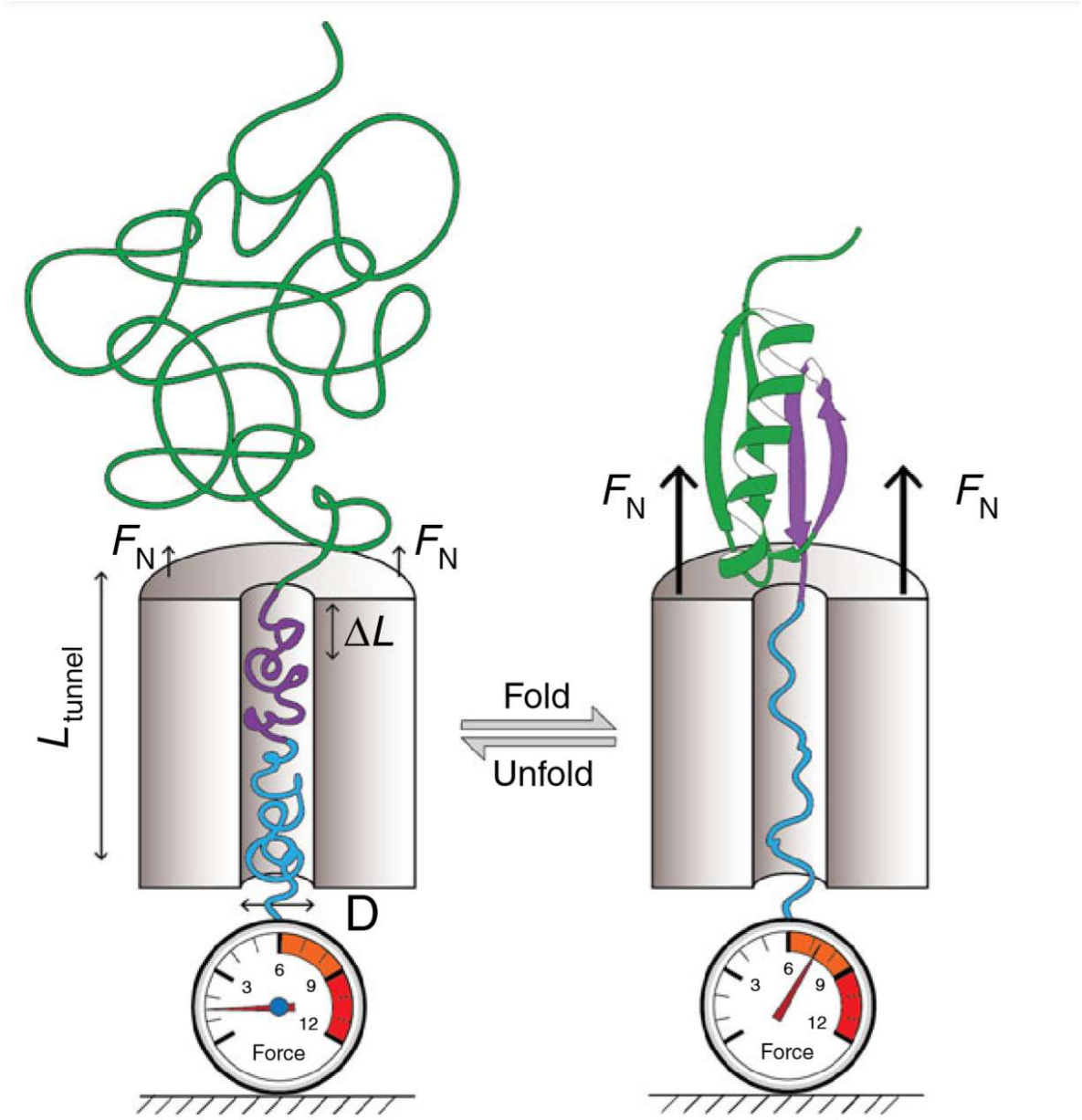
Rivas-Pardo et al., 2016, **Cell Reports,** 14:1339-1347

Eckels et al., 2018, **Annual Reviews of Physiology,** 80:327-351

Titin operates over a tight range of forces



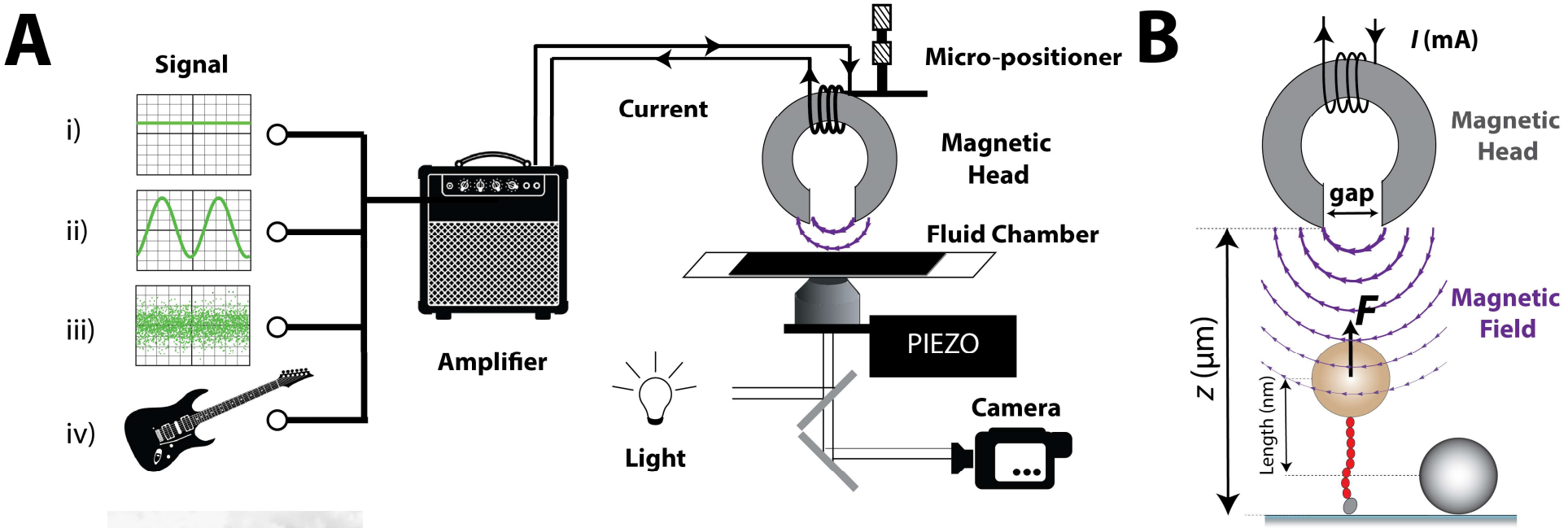
Protein folding powers translocation



Shubhasis Haldar

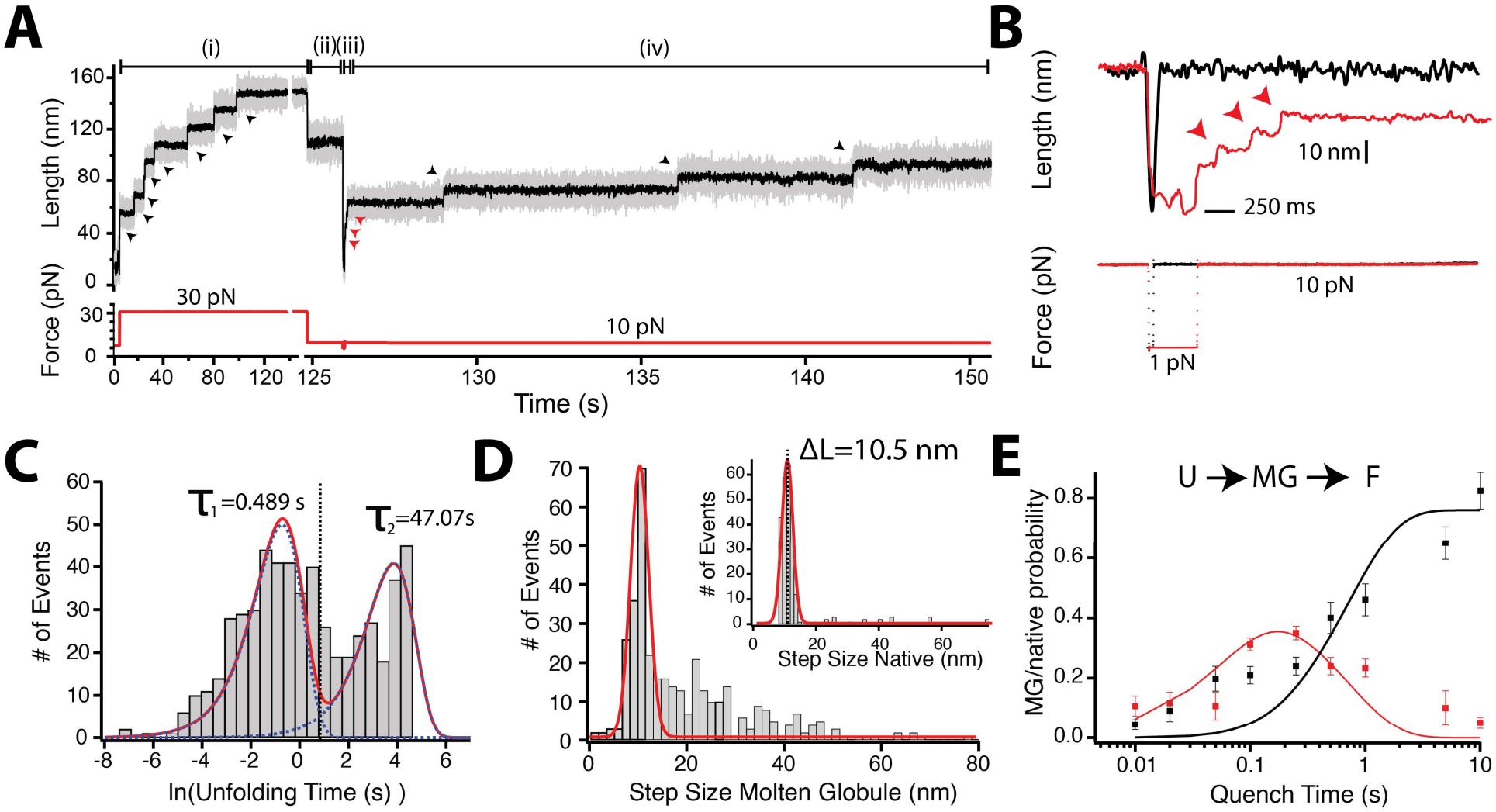
Haldar, et al., 2017, **Nature Communications,** 8: 668

A magnetic-head tweezers

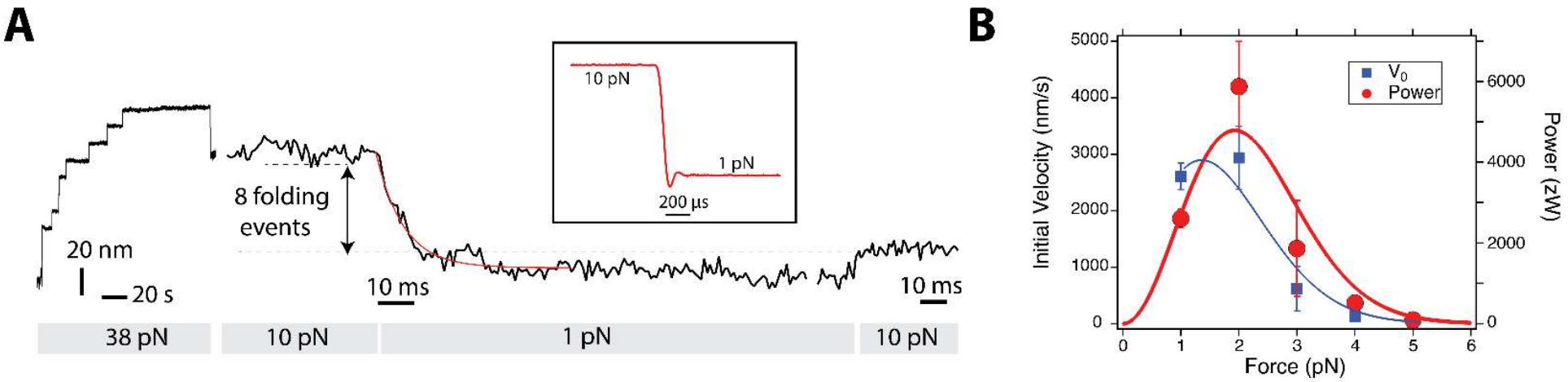


Rafael Tapia

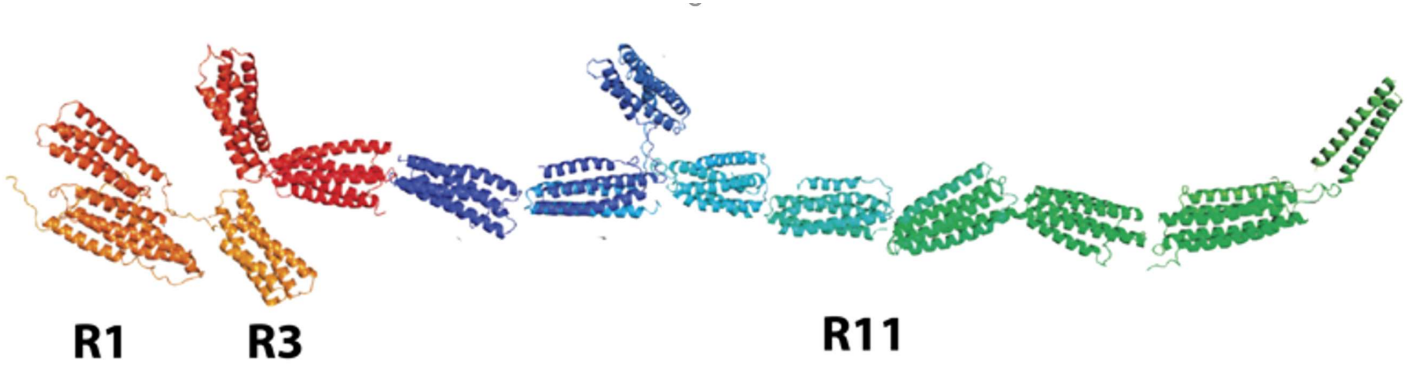
Ultra-fast force pulses capture molten globule states in protein L

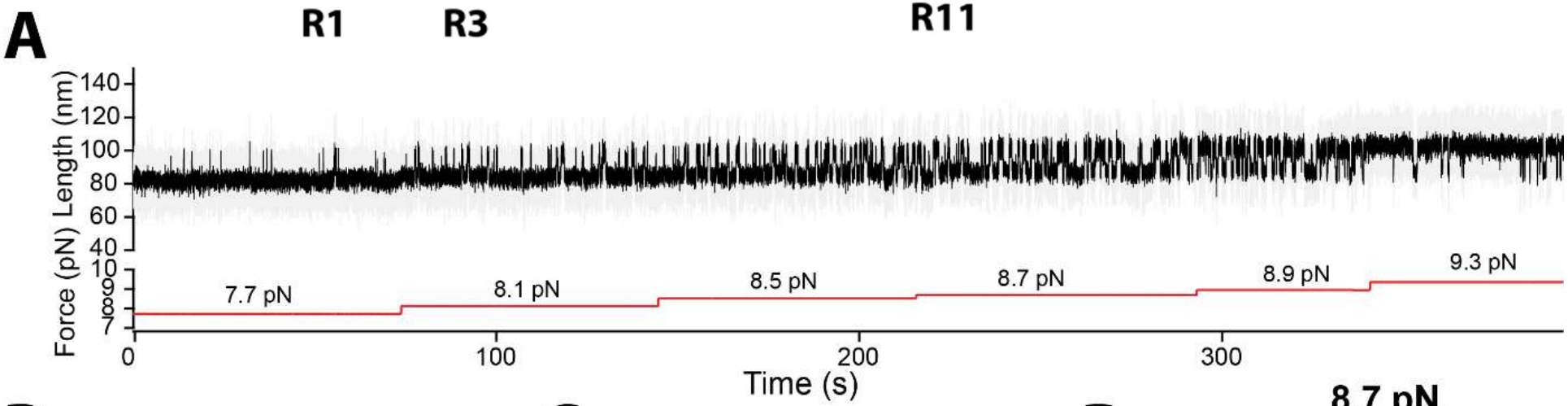


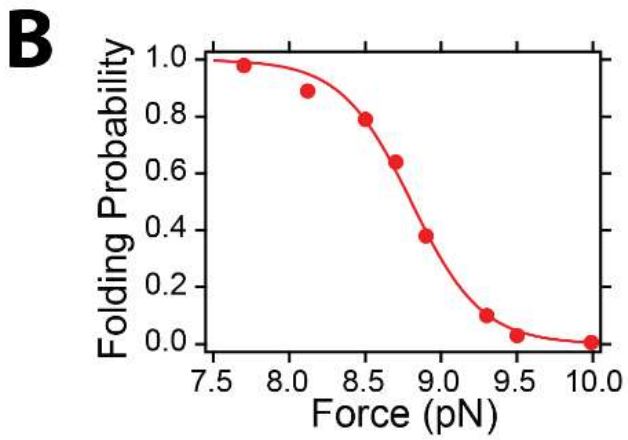
And measures the power output of protein L folding

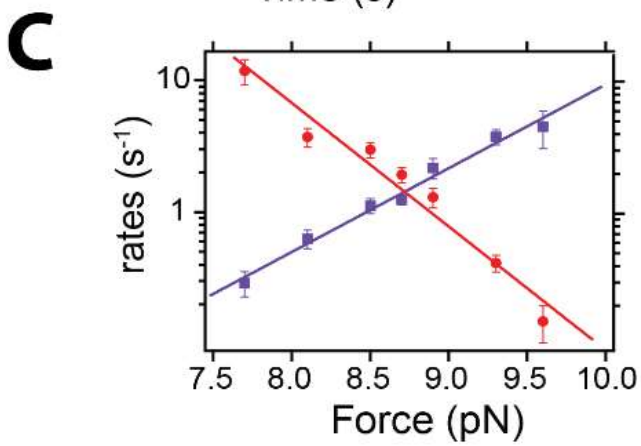


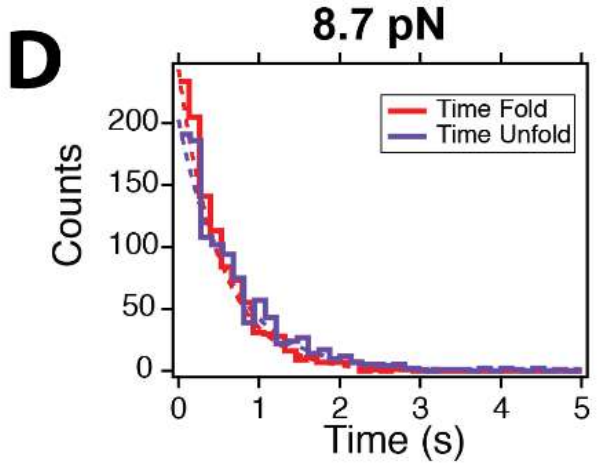
Talin dynamics studied with magnetic-head tweezers



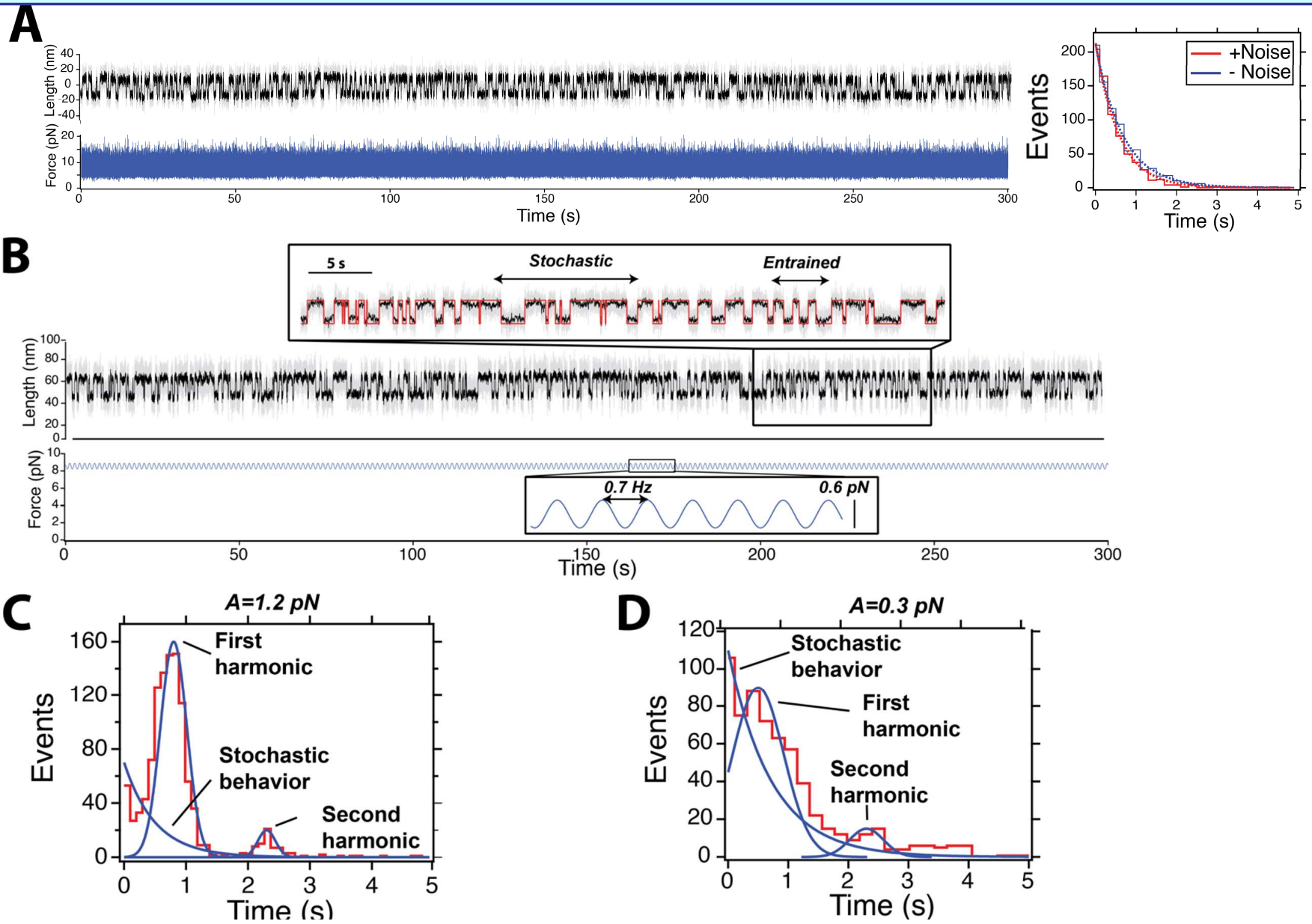




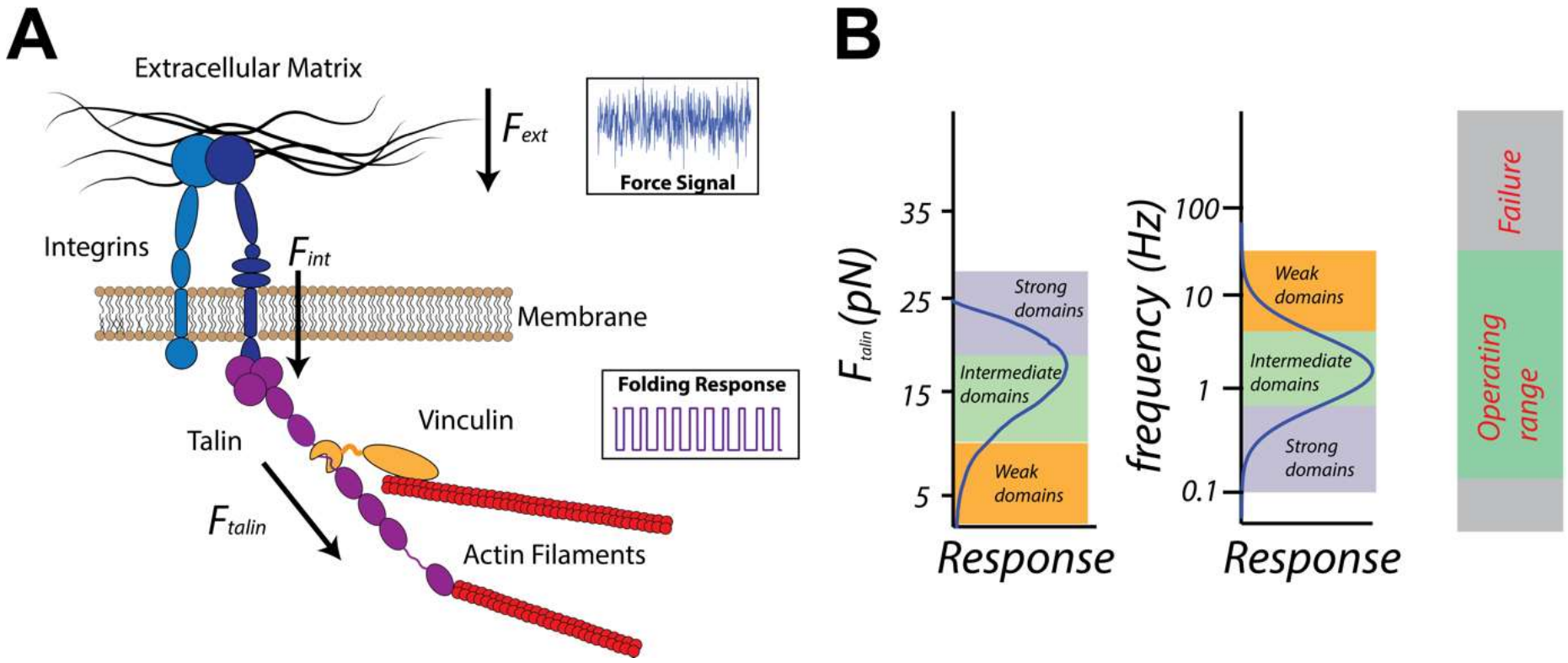




Insensitive to noise but entrains with periodic signals: Stochastic Resonance



Stochastic resonance identifies periodic signals in noisy mechanical environments



heart beat?, respiration?, rigidity sensing?