

## Twitter Thread by NotTheMacAnon



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**This nonspecific cation channel opens when illuminated with blue light, depolarizing the cell [4, 6] to trigger action potentials cells with high temporal precision [5]. Since the initial discovery of ChR2, many modifications have been made to refine the kinetic properties.**

For example, ChETA, engineered to address limitations of spike fidelity with ChR2, has faster temporal kinetics and can maintain reliable spike precision up to 200 Hz [7].

Halorhodopsins (NpHR), light-gated chloride pumps activated by yellow light, allow for temporally specific hyperpolarization with single spike precision [8–10].

Archaeorhodopsin-3 (Arch), a yellow light-activated outward proton pump, is an increasingly popular tool for light-induced hyperpolarization to inhibit cellular activity. Arch recovers spontaneously from inactivation with a much shorter recovery time than NpHRs [11].

Arch currents continue to increase with increasing light intensity, while NpHRs saturate [11]. The increased light sensitivity of the ArchT variant, along with better membrane targeting, allows for improved neural silencing both at cell bodies and terminals [12].

Many more tools have been engineered with unique optical properties and kinetics. Step-function opsins (SFOs) are bistable ChR2s that can maintain a stable open conformation to induce a step in membrane potential [13].

Opsins with shifted excitation wavelengths allow for differential cellular activation. Chrimson, a red-shifted opsin, can be used in combination with Chronos, a blue-green activated channel with increased light sensitivity and faster kinetics,

to achieve two-color activation of distinct neuronal populations [14]. Since proton pumps are relatively inefficient compared to channels, moving only one ion across the membrane per photon rather than a steady current of ions, to achieve improved neural silencing,

ChR2 was genetically engineered to conduct chloride ions (Cl<sup>-</sup>) to create a depolarizing channel [15]. Further modifications generated step-function control and improved light sensitivity and kinetics, making these useful tools for controlling behavior

in freely moving animals

I will hold my tongue.