Jones Research Group

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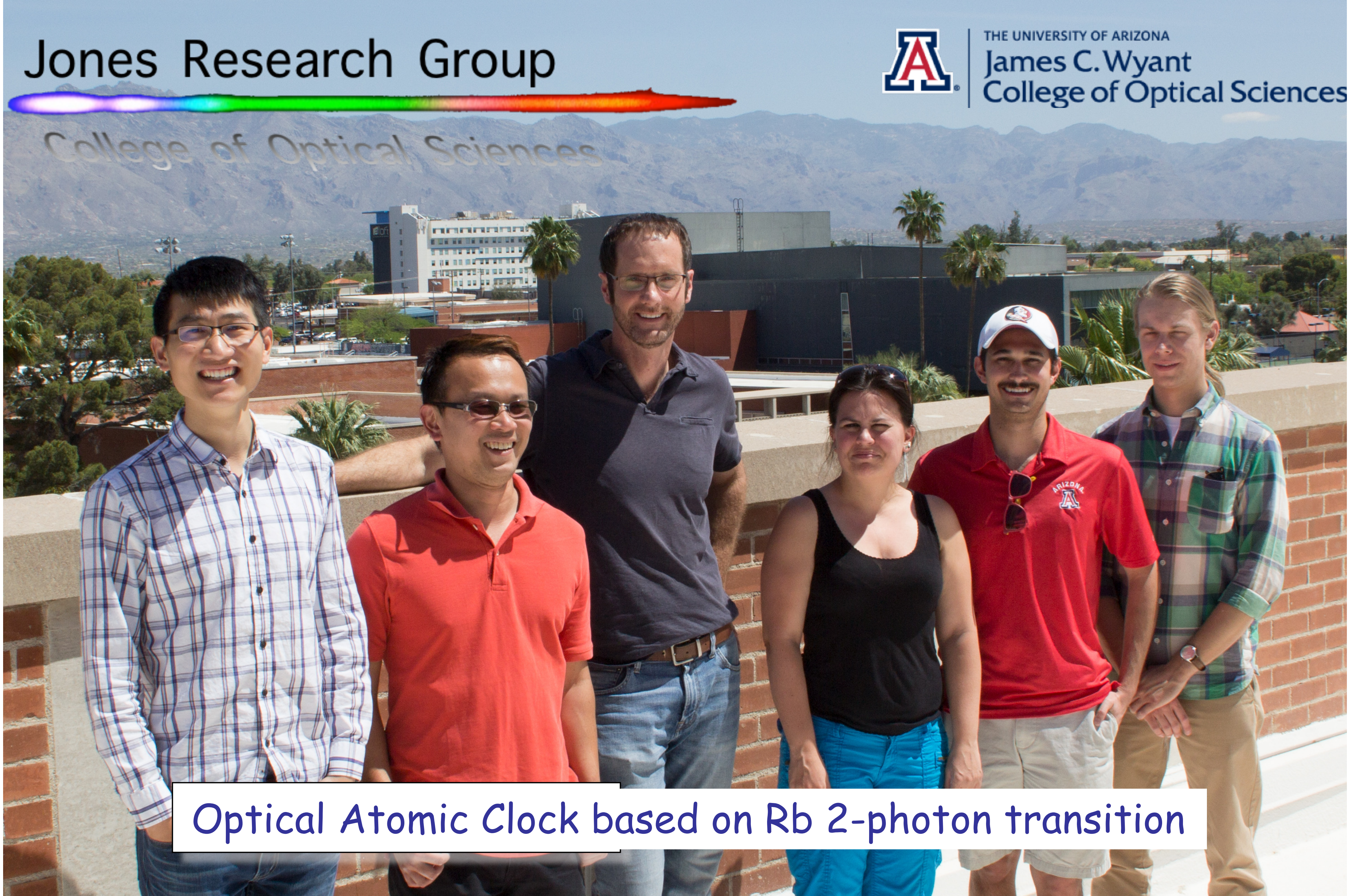
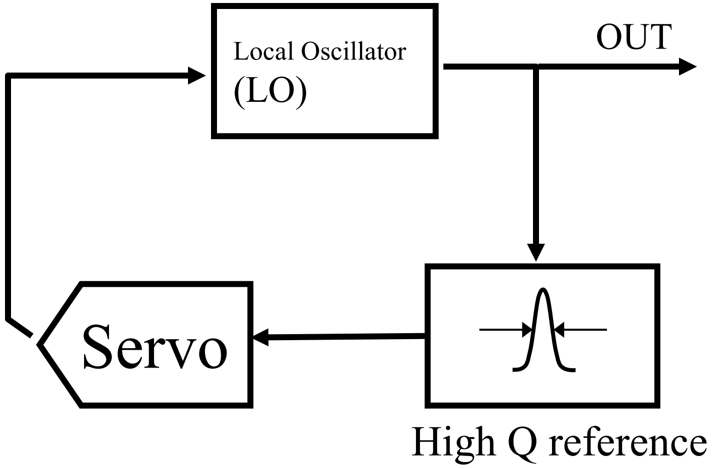


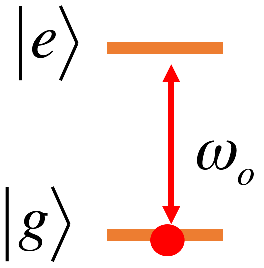
Optical Atomic Clock based on Rb 2-photon transition

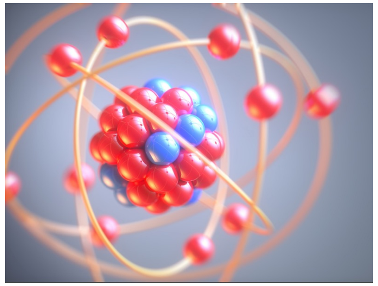
Atomic clock basics



$$\omega = \omega_o \times (1 + \varepsilon + \alpha(t))$$

Unperturbed atom





- **Fractional frequency stability:**

$$\sigma(\tau) = \frac{1}{Q}\frac{1}{S/N}\frac{1}{\sqrt{\tau}}$$

$$\text{where, } Q \equiv \frac{\omega_o}{\Delta\omega}$$

Ex: Cs microwave fountain

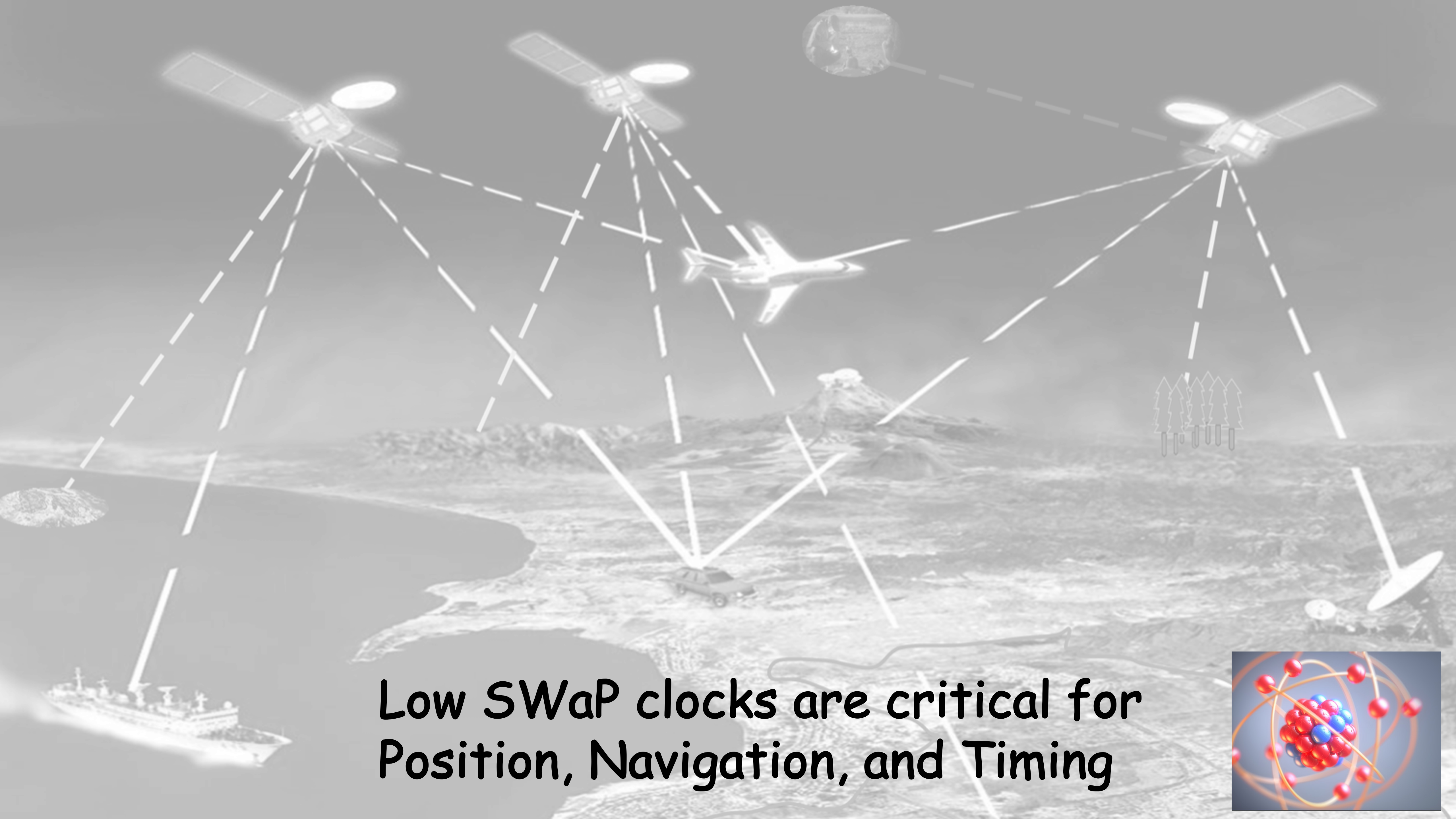
$$\sigma(\tau) \sim 10^{-14}\tau^{-1/2}$$

quantum limit: $\sigma(\tau) = \frac{1}{Q}\frac{1}{\sqrt{N_{atoms}}}\frac{1}{\sqrt{\tau}}$

Optical transitions → $\sigma(\tau) \sim 10^{-18}\tau^{-1/2}$

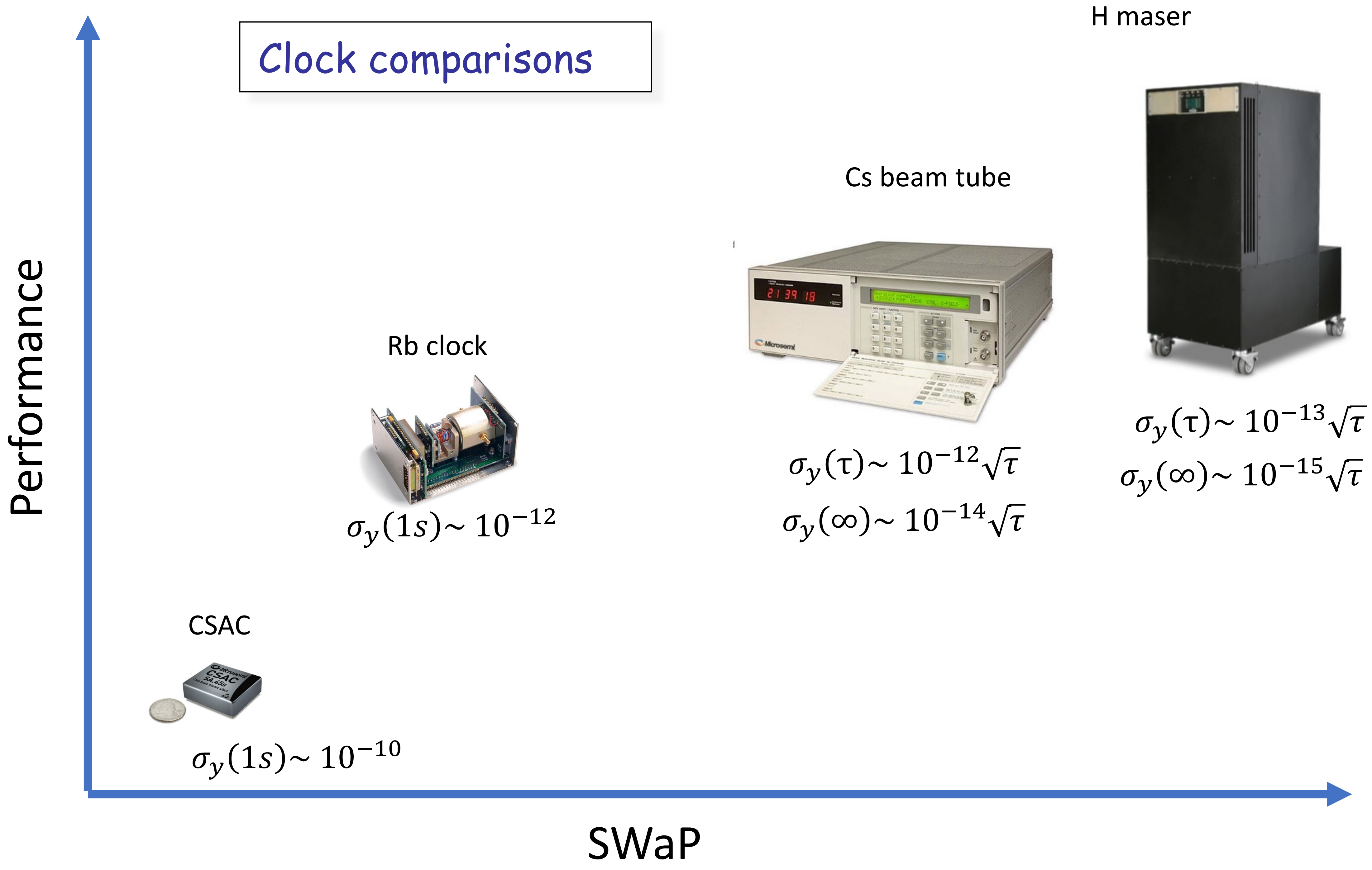
-higher Q's

-many shifts independent of frequency (ie zeeman, collisional…)

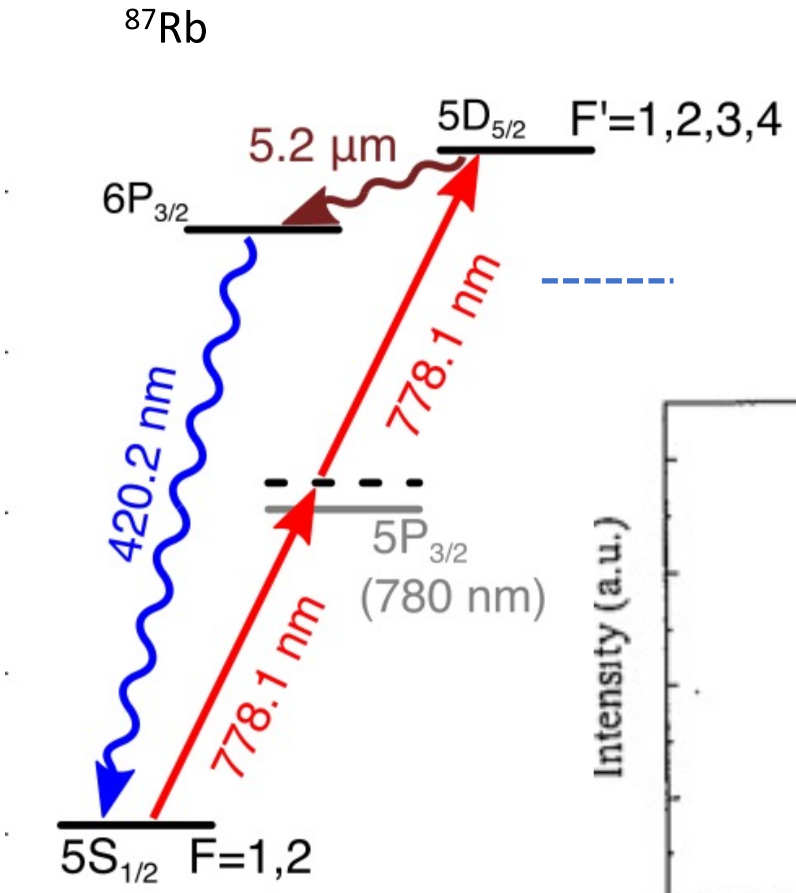


Low SWaP clocks are critical for Position, Navigation, and Timing

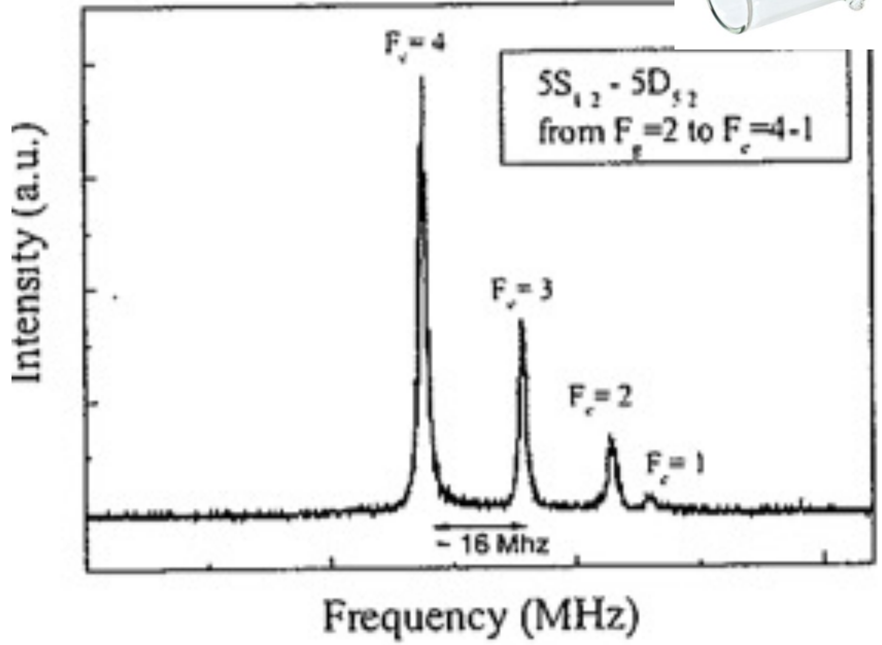
Clock comparisons



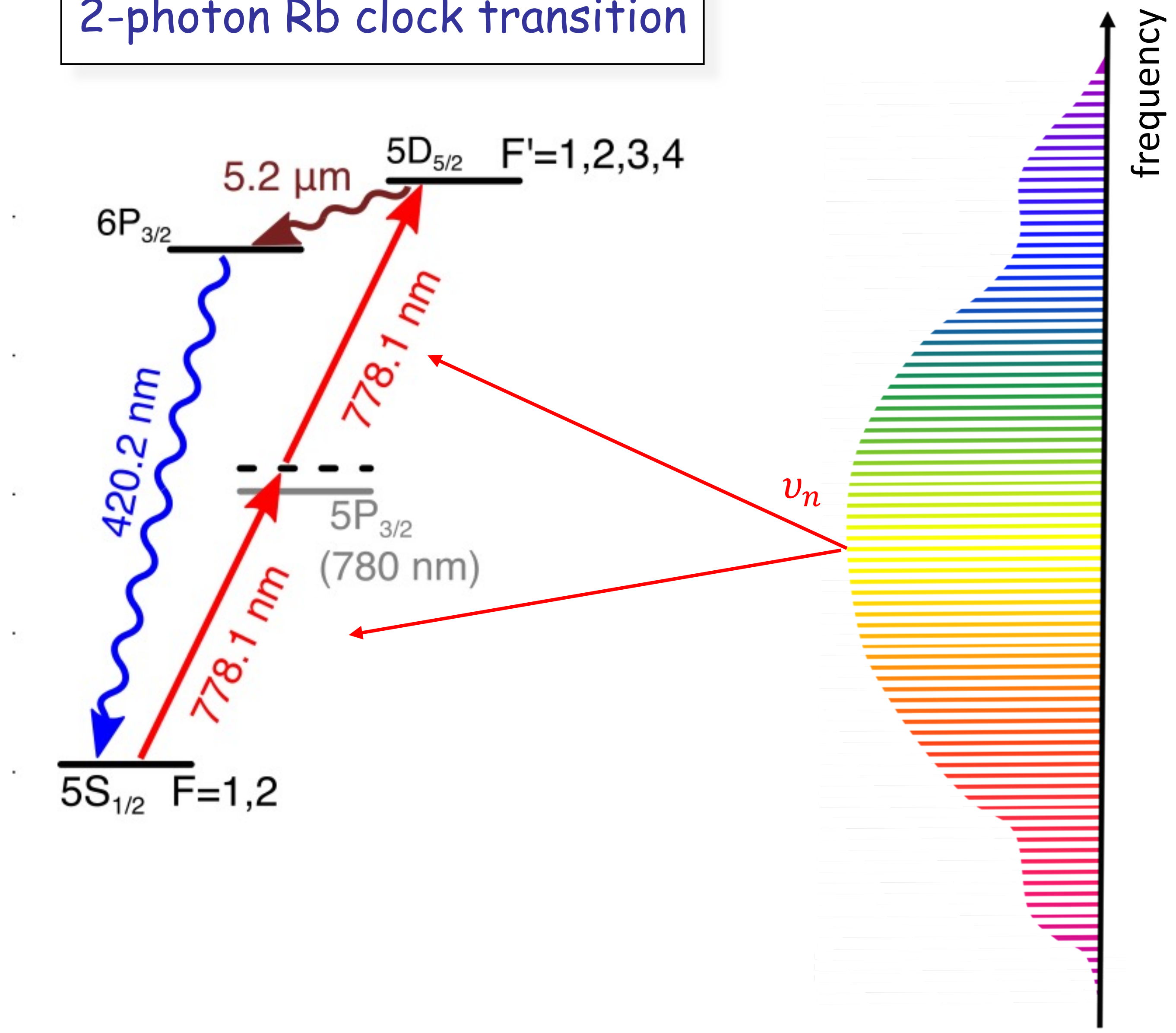
2-photon Rb clock transition



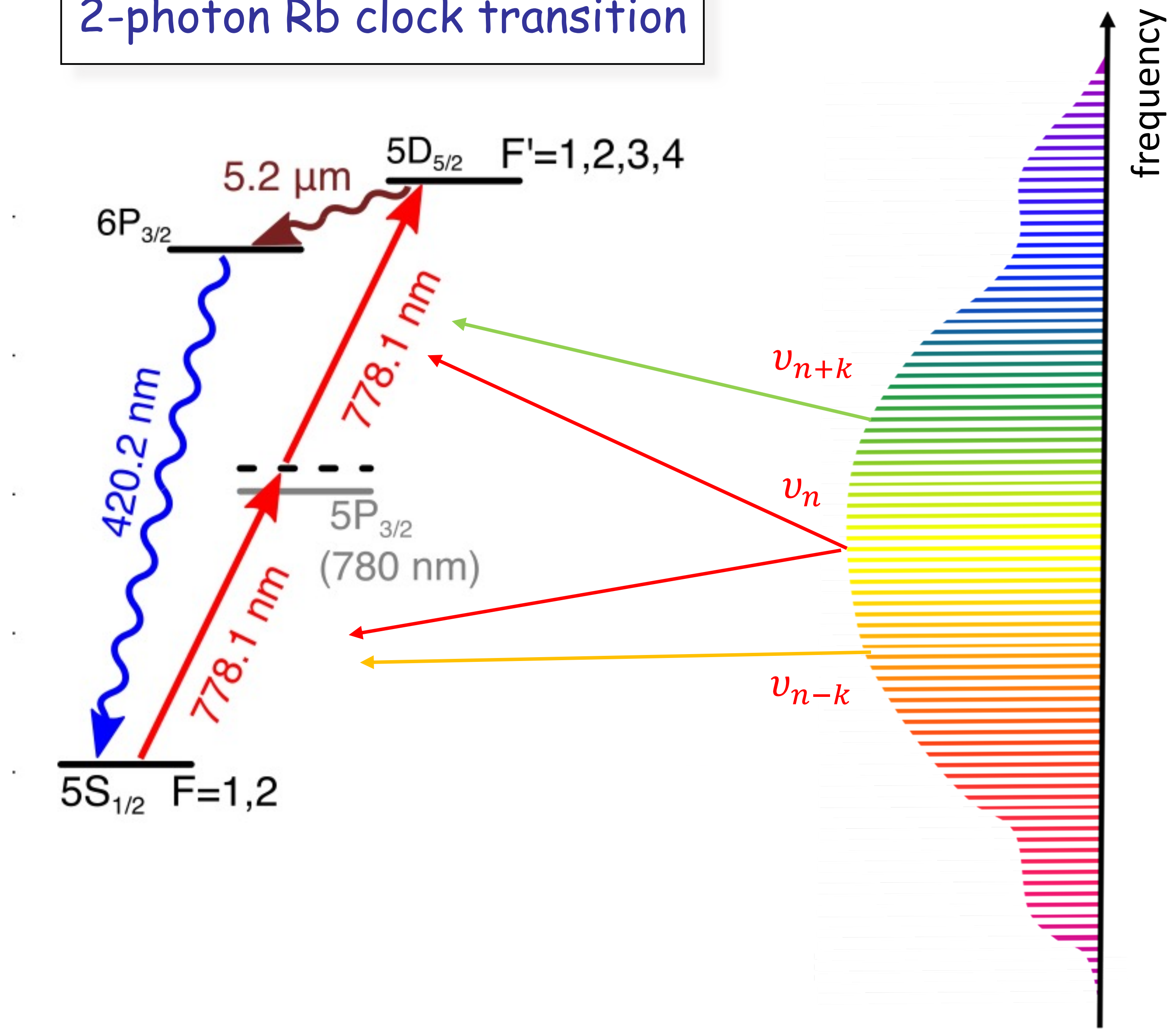
- Strong transition due to intermediate $5P_{3/2}$ state
- Narrow Doppler-free linewidth (~ 330 kHz)
- Utilizes simple room temperature gas cell



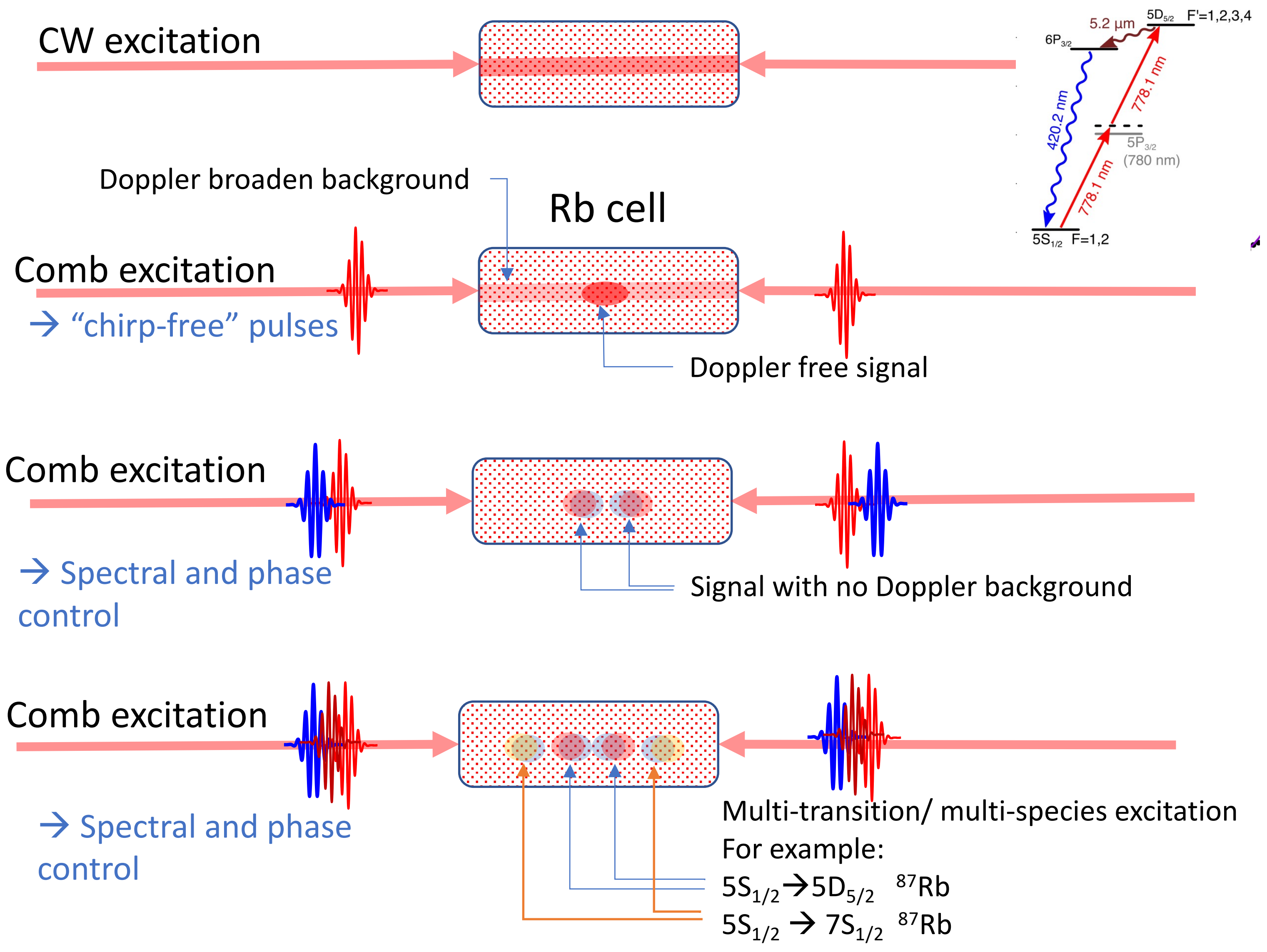
2-photon Rb clock transition



2-photon Rb clock transition



Coherent control of quantum excitation pathways



Our approach...