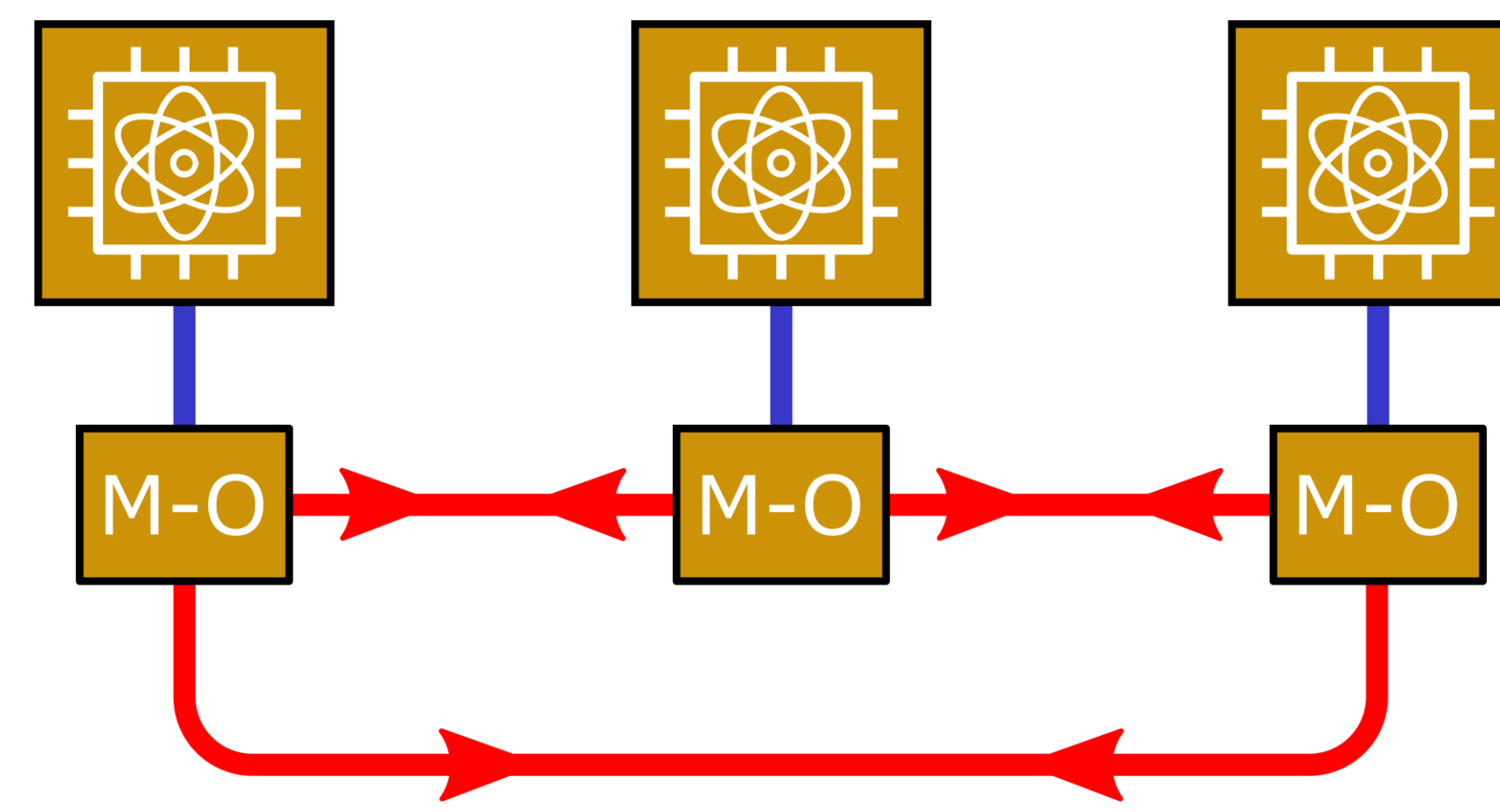


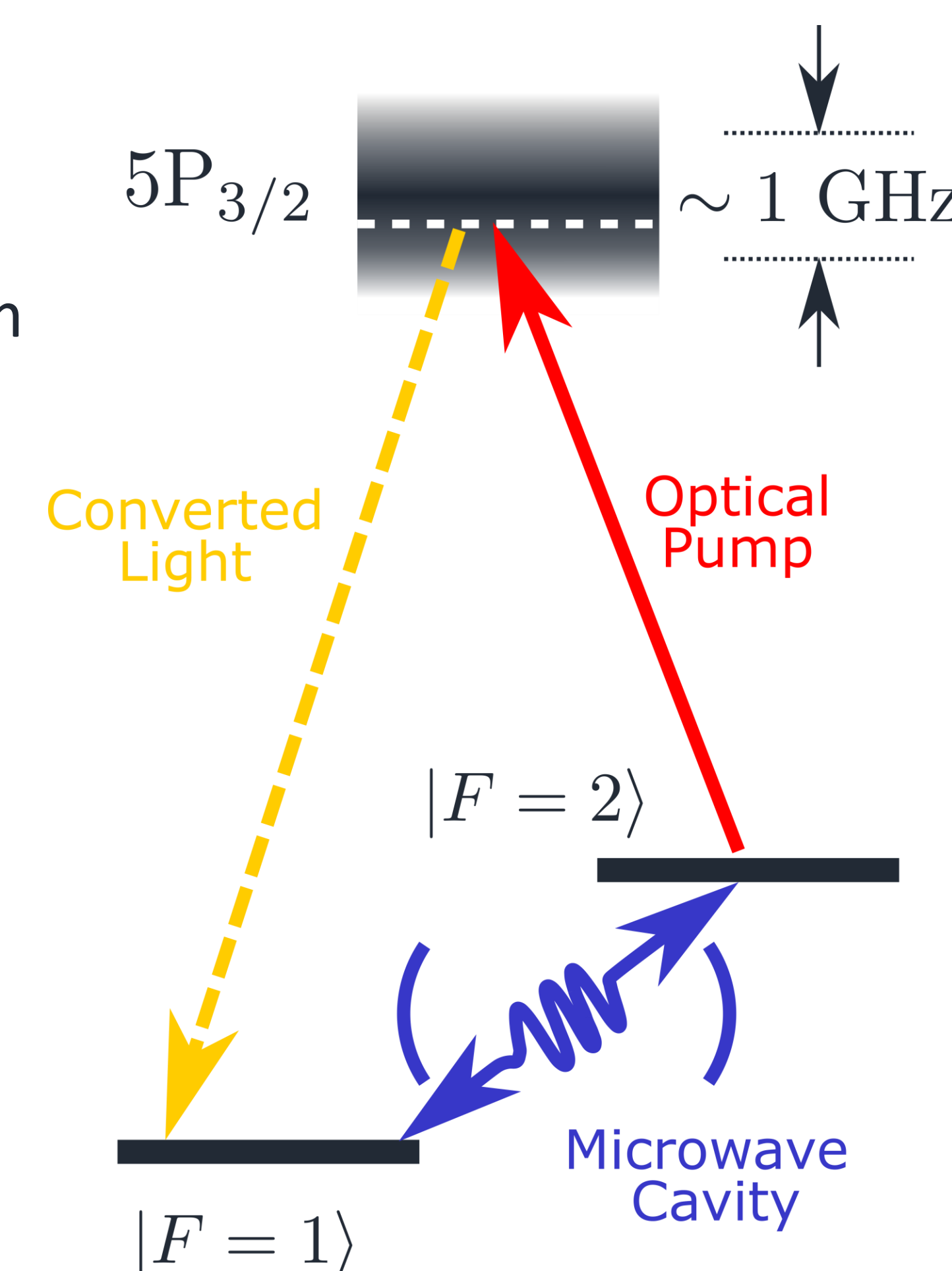
Motivation:

- One approach for scaling up the size of quantum computers is to network multiple smaller devices.
- Quantum processors (working at microwave frequencies) need to efficiently and flexibly convert information for optical channels.



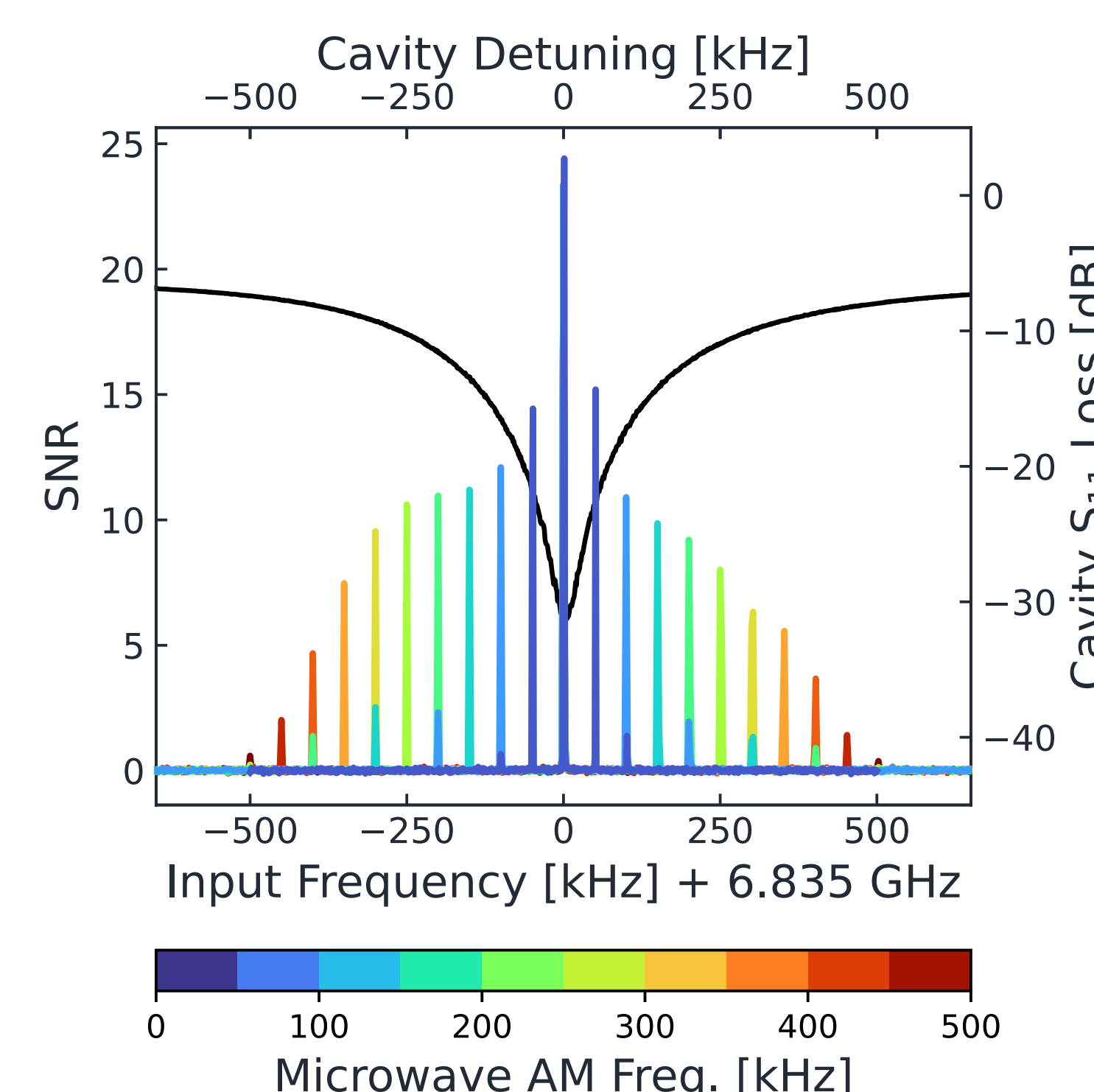
Methods:

- Place a warm ^{87}Rb vapor cell in a high-Q cylindrical microwave cavity resonating at the 6.835 GHz ground state hyperfine transition.
- Pass through the cavity a classical 780 nm CW laser beam on the $5S_{1/2} F=2 \rightarrow 5P_{3/2}$ transition.
- Tune the input optical frequency across the Doppler width using an electro-optic modulator (EOM).
- Detect on a photodiode the beating signal between the generated $5P_{3/2} \rightarrow 5S_{1/2} F=1$ and input light. Measure its frequency with a spectrum analyzer.



What's going on?

- The atomic vapor coherently combines the input fields in a hybrid three-wave mixing scheme. Two-photon (EIT) and three-photon (energy conservation) conditions are automatically satisfied.
- Because the optical transition is Doppler broadened, **conversion can occur for any atomic velocity class.**
- This figure (right) shows multimode conversion from an amplitude modulated microwave field.



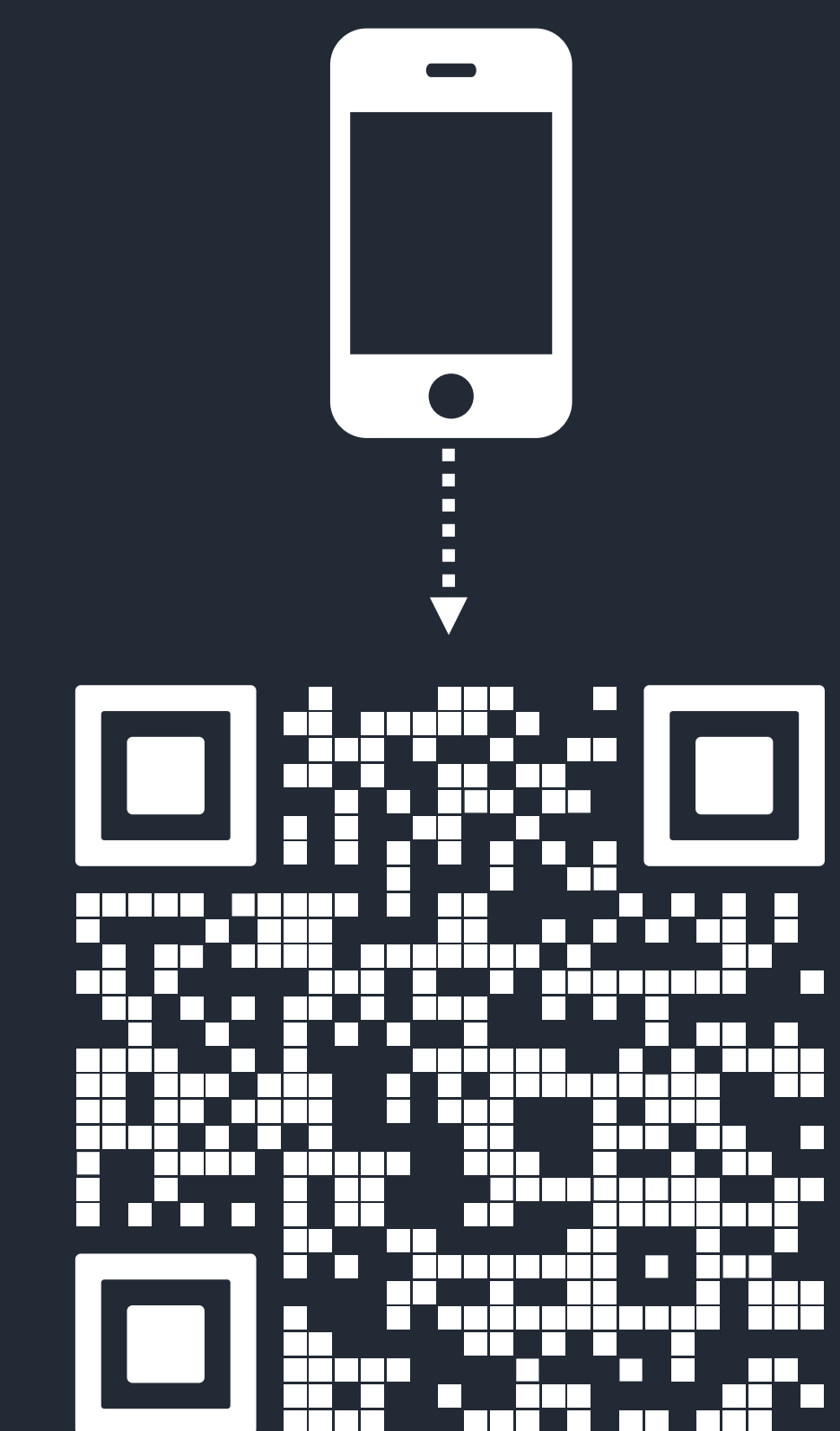
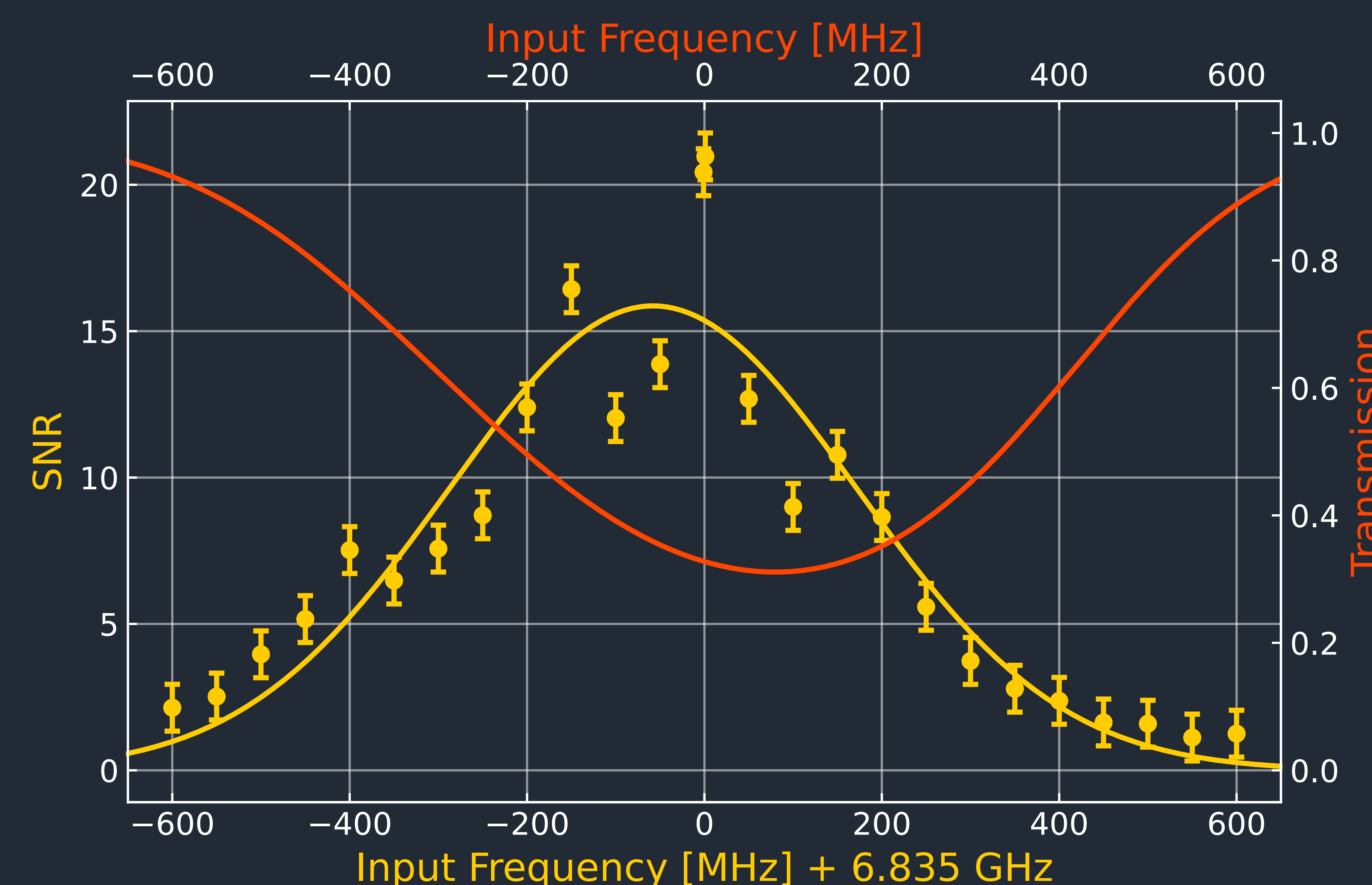
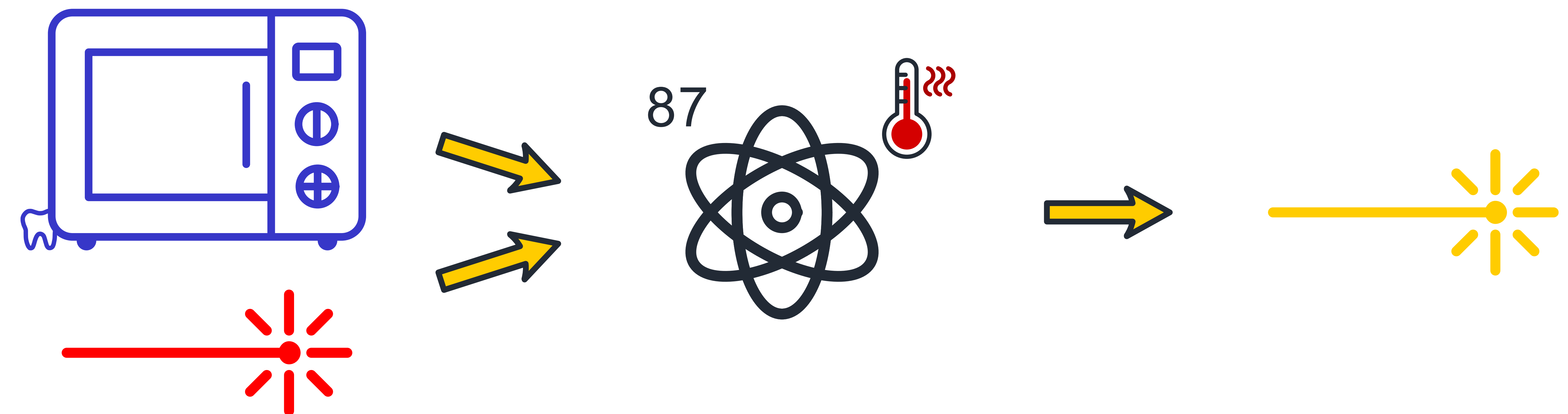
Other Directions:

Conversion Delay: A microwave pulse produces a corresponding pulse of generated light. By varying the microwave amplitude, we can delay the generated pulse by up to 7 μs .

Frequency Beamsplitter: We tune the relative phase between EOM (pump) and AM (microwave) driving to control the amplitudes of defined frequency bins. This is an essential operation of a “quantum frequency processor”.

(Scan the QR code for more on these experiments.)

The Doppler effect helps convert a microwave signal to an optical one – tunable over ~ 1 GHz



Take a picture to download even **MORE**.



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