Development of ultra-stable microwave oscillators

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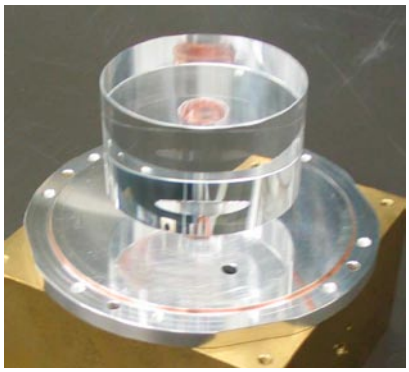
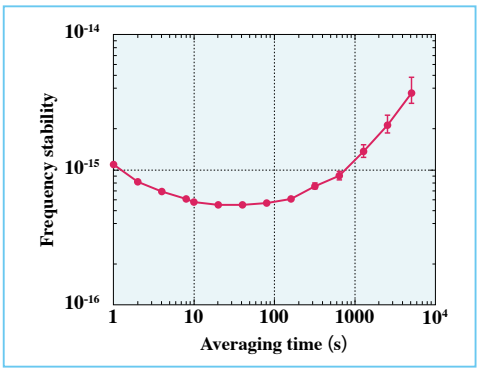
We have developed ultra-stable microwave oscillators using extremely low-loss sapphire crystals in collaboration with the University of Western Australia. The sapphire resonators are cooled with liquid helium to around 6K. At this temperature, frequency of the microwave radiation confined in the crystal exhibits zero temperature sensitivity. Two identical oscillators were built to evaluate their stability at short averaging times. They exhibited a fractional frequency stability of 1×10^{-15} at an averaging time of 1s. Optical frequency synthesis from the oscillator has been implemented using an optical frequency comb. The oscillator will soon be installed as an ultra-stable local oscillator for a cesium atomic fountain frequency standard (NMIJ-F1).



Single-crystal sapphire (diameter:5 cm, length:3 cm)



Frequency stability of the developed oscillator