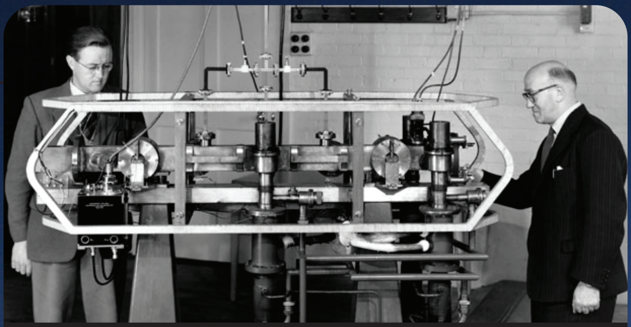
Measuring Time

For thousands of years, the second was defined by the Earth's rotational rate, which was limited in accuracy to ~1 millisecond/day. In 1967, the second was redefined as the duration of 9,192,631,770 energy transitions of the cesium atom. In 2025, a comparison of optical clocks across six countries marked a major step toward redefinition of the SI second and international time scales based on more accurate optical standards.



Louis Essen (right) and Jack Parry with the first cesium-133 atomic clock at the NPL, London, UK. NPL

1955: The first accurate atomic clock, built by Louis Essen at the National Physical Laboratory (NPL), London, UK, was based on a transition of the cesium-133 atom. It achieved an accuracy of 1 part in 10^{10} (~1 second in 300 years).

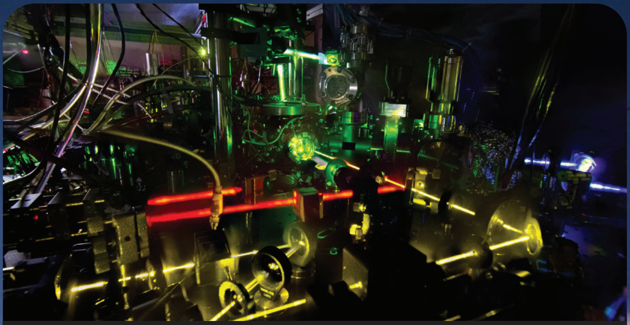
1948: A prototype atomic clock, developed by Harold Lyons at the US National Bureau of Standards, used transitions of the ammonia molecule as its source of frequency.

1921: The Shortt–Synchronome clock, an electrically driven pendulum, was the first clock to be a more accurate timekeeper than the Earth itself.

1656: The pendulum, invented by Christiaan Huygens, was the first harmonic oscillator used in timekeeping. It increased clock accuracy from ~15 minutes/day to ~15 seconds/day.

~3000 BCE: Ancient civilizations observed astronomical bodies to measure the passing of time.

1967: The International System of Units (SI) standardizes the second on the properties of cesium. The SI second is defined as "the duration of periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom."



A ytterbium lattice clock at NIST that uses photons to measure time. N. Phillips / NIST

April 2025: A cesium fountain clock developed at the US National Institute of Standards and Technology (NIST) reports frequency measurements accurate to within 2.2 parts in 10^{16} (~1 second in 100 million years).

June 2025: A coordinated international comparison of optical clocks across six countries marks a major step toward redefinition of the SI second and establishment of a global optical-time standard.

July 2025: A "quantum logic" clock, an optical atomic clock based on a trapped aluminium ion developed at NIST, achieves a systematic uncertainty corresponding to 5.5 parts in 10^{19} (~1 second in 30 billion years).

2030: Target date for possible redefinition of the second.

Summer solstice sunrise over Stonehenge, UK.
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Sources: NIST / Wikipedia
Infographic by Alessia H. Kirkland