



# NEWS! From the NAVAL OBSERVATORY

U.S. NAVAL OBSERVATORY

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## U.S. Naval Observatory Press Release

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### U.S. Naval Observatory Reports First Fountain Clock Data to BIPM

WASHINGTON, DC -- On January 5, 2012 the U.S. Naval Observatory's Time Service Department reported the first data from its Navy Rubidium Fountain Clocks to the International Bureau of Weights and Measures (BIPM).

To mark the occasion, Rear Admiral Jonathan White, USN, Commander, Naval Meteorology and Oceanography Command (CNMOC) will formally declare the new clocks operational in a ceremony at the Observatory on January 20, 2012.

At the heart of each fountain clock is a small high-vacuum chamber where rubidium atoms are trapped and cooled by laser radiation until they reach a temperature of about 5 millionths of a degree above absolute zero, confining them to a volume of space about the size of a marble. The cooled atoms are then launched upward through a microwave cavity where their natural resonance frequency can be used to stabilize a more conventional oscillator. Precision counting of the oscillations of any physical system is what we use to define a "clock". Rubidium atoms oscillate at about 6.8 billion times per second, and their frequency and stability can be measured to a precision of fractions of a trillionth of a second.

The U.S. Naval Observatory Master Clock is used to create a real-time realization of Coordinated Universal Time (UTC), which is termed UTC(USNO). UTC is published by the *Bureau International des Poids et Mesures* (International Bureau of Weights and Measures, or BIPM) in Sevres, France. The world's timing centers, including USNO, submit their individual clock measurements to BIPM, which then uses them to compute a free-running (unsteered) mean timescale (*Echelle Atomique Libre* [EAL]). BIPM then applies frequency corrections ("steers") to EAL, based on measurements from primary frequency standards and intended to keep the International System's basic unit of time, the second, consistent with its definition as 9,192,631,770 periods of oscillation of the undisturbed cesium atom. The result of these

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corrections is another timescale, TAI (*Temps Atomique International* or International Atomic Time). The addition of leap seconds to TAI produces UTC; leap seconds are a way to keep atomic time consistent with the Earth's variable rotation. The world's timing centers have agreed to keep their real-time timescales closely synchronized ("coordinated") with UTC. Hence, all these atomic timescales are called Coordinated Universal Time (UTC), of which USNO's version is UTC(USNO). USNO is currently the largest single contributor to the definition of UTC; its clocks amount to over 20% of the mean weighting of the timescale.

The U.S. Naval Observatory has been keeping time for the Department of the Navy and for the Nation since the year 1845, when Superintendent Matthew F. Maury first put the Washington Time Ball into operation. Timekeeping procedures and technology have evolved dramatically since then, and the U.S. Naval Observatory Time Service Department has aggressively developed new timing methods and timekeeping equipment to meet increasingly rigorous requirements. Its Master Clock is the designated timing reference for all DoD precise timing requirements, many of which (including GPS III) demand a precision that exceeds one nanosecond ( $10^{-9}$  or one-billionth of a second) per day.