

Historical Insights from the 1967 Redefinition of the Second

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This paper presents our ongoing historical research on the technological developments and on the process that led to an agreement, in 1967, to redefine the SI second, for the first time on the base of an atomic reference. Examining the debates and strategies of that period offers insights relevant to current discussions about a new redefinition.

The first operational cesium-beam frequency standard, in 1955 and the other early experimental atomic clocks, generated an intense debate over the best definition of the second. Astronomers argued that atomic clocks could serve ephemeris time much as quartz clocks had served mean-solar timekeeping, whereas physicists maintained that atomic clocks constituted a radical break with timekeeping devices and therefore warranted redefining the second in terms of a quantum transition.

In 1957, the Consultative Committee for the Definition of the Second (CCDS) was established to help astronomers and physicists agree on a single unit of time by coordinating the (competitive) development of atomic frequency standards and their intercomparison. By 1963 the thallium beam and hydrogen maser appeared to match the cesium beam in precision, and by 1967 the CCDS faced a choice: postpone the redefinition until one standard could be shown to be decisively superior, or adopt what seemed best at that moment.

Although the first path framed the decision as a matter of objective criteria, it also risked postponing the redefinition indefinitely; proponents of immediate redefinition pursued a different strategy. They secured support from the two scientific unions most directly concerned with time- and-frequency standards and measurements: the International Union of Radio Science (URSI) and the International Astronomical Union (IAU).

Meanwhile, a decade of intercomparisons among laboratory time scales strengthened confidence in atomic timekeeping. The International Time Bureau (BIH) initially relied on three such scales (at NPL, NBS, and Neuchâtel) to form a mean atomic time scale (A3), which in 1970 became the International Atomic Time (TAI). By 1973, TAI was formed from 68 clocks in 10 laboratories across 8 countries, using a stability algorithm. In this context emerged the notions of “primary” and “secondary” frequency standards, that will also be impacted by the future redefinition.

In our historical research, we are also assembling an inventory of all frequency standards and atomic clocks constructed before and after 1967, which sheds light on the role of dissemination in the decision to adopt the cesium standard, as well as its consequences. Our research also examines the diverse methods used to compare devices and traces how new approaches, infrastructure, and terminology (such as stability, accuracy, precision, reproducibility, etc.) emerged during this period.