Rotation of the Earth and Time Scales

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- **Universal Time UT1 and uniform time**

- **Irregularities of UT1**

- **Predictability of *UT1 – TAI***

- **Time signal emissions and UTC**

Definition of UT1 (IAU, 2000)

- UT1 is strictly proportional to the Earth Rotation Angle (ERA) around the moving rotation axis;

- the linear relationship between UT1 and the ERA has its coefficients chosen so that, approximately, UT1 remains in phase with Greenwich solar time, in average over centuries;

  (It is not possible to fulfil rigorously this second condition)

  Thus UT1 is not, strictly speaking, a form of solar time

- *UT2 = UT1 - annual term* ($\pm$ 30 ms)

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Uniform time references

- Orbital motions in the solar system
  (- 4 x 10^8 years to 1955)

  – Palaeontology (coral growth, sedimentation, …)

  – Ancient eclipses after – 700

  – Occultations of stars by the Moon (mostly after 1860)

- Definition of Ephemeris Time (ET) ca 1950

- Atomic Time since 1955

  – Continuous atomic time scale of BIH, named TAI in 1971

Units and origins

(The following relations are approximate)

Duration of scale units

Second of ET = Second of UT1 averaged over the 19th century

Second of TAI = Second of ET

Thus the second of TAI represents approximately the second of UT1 in the 19th century

Origins

$TAI = ET - 32,184$ s

$TAI = UT2$ on 1958 January 1, 0h UT2

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Fig. 1. Secular term of *UT1-uniform time*, in seconds
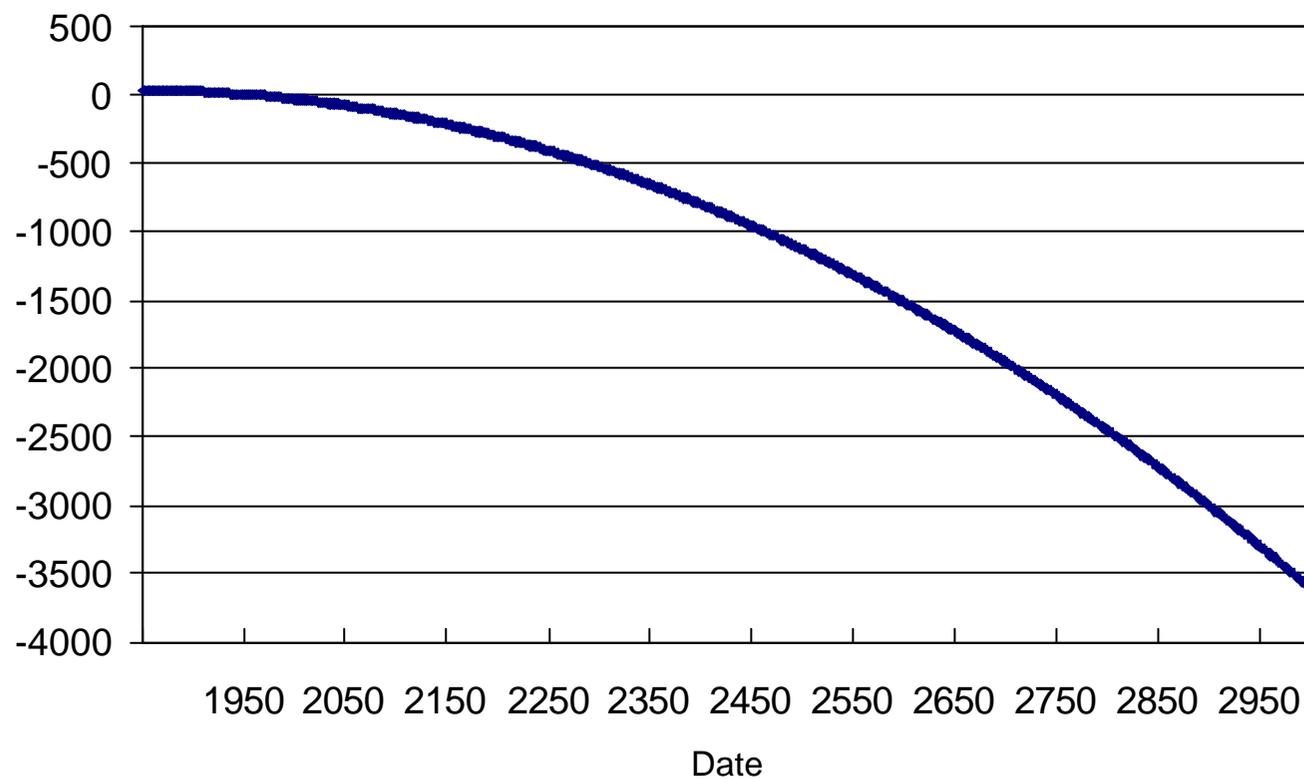
FiG. 2. *UT1-TE* corrected for secular variation, in seconds
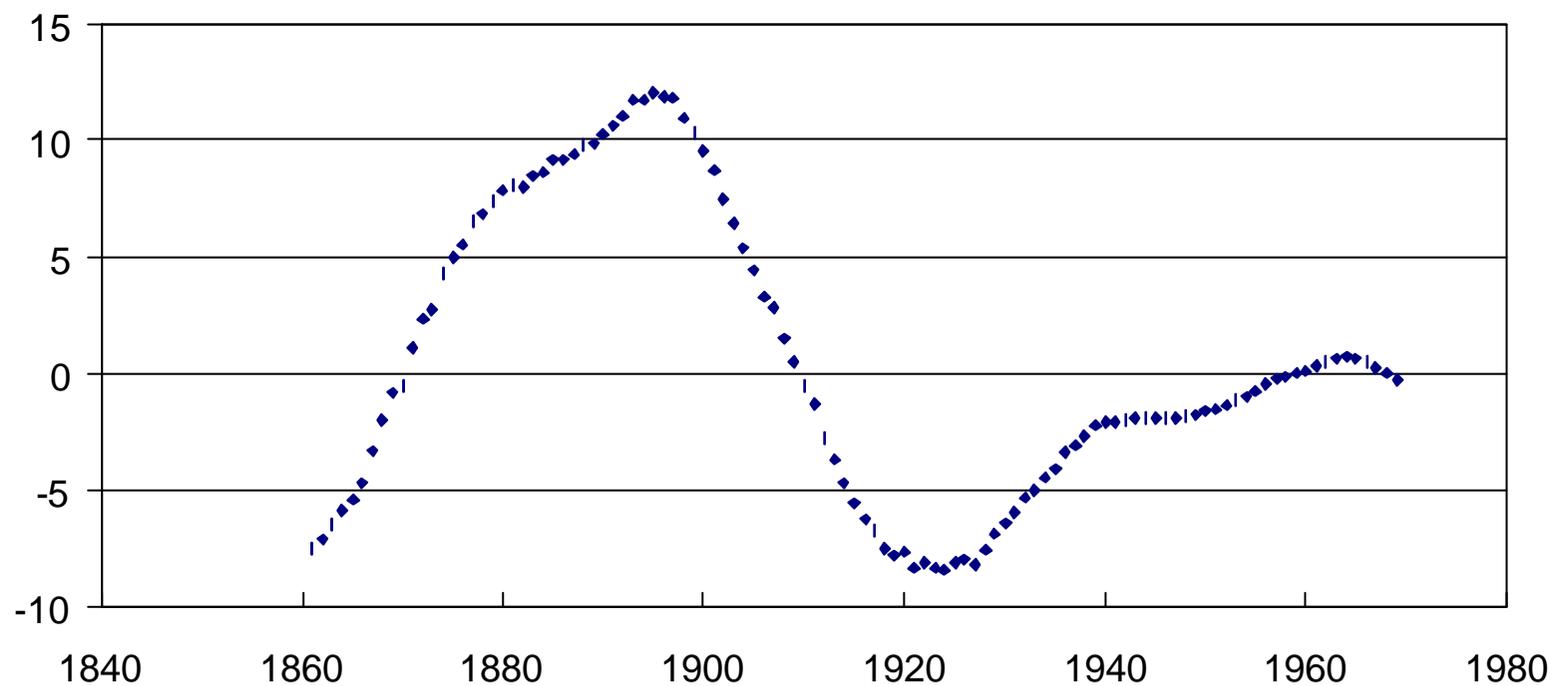
Fig. 3. *UT1-TAI* corrected for secular variation, in seconds
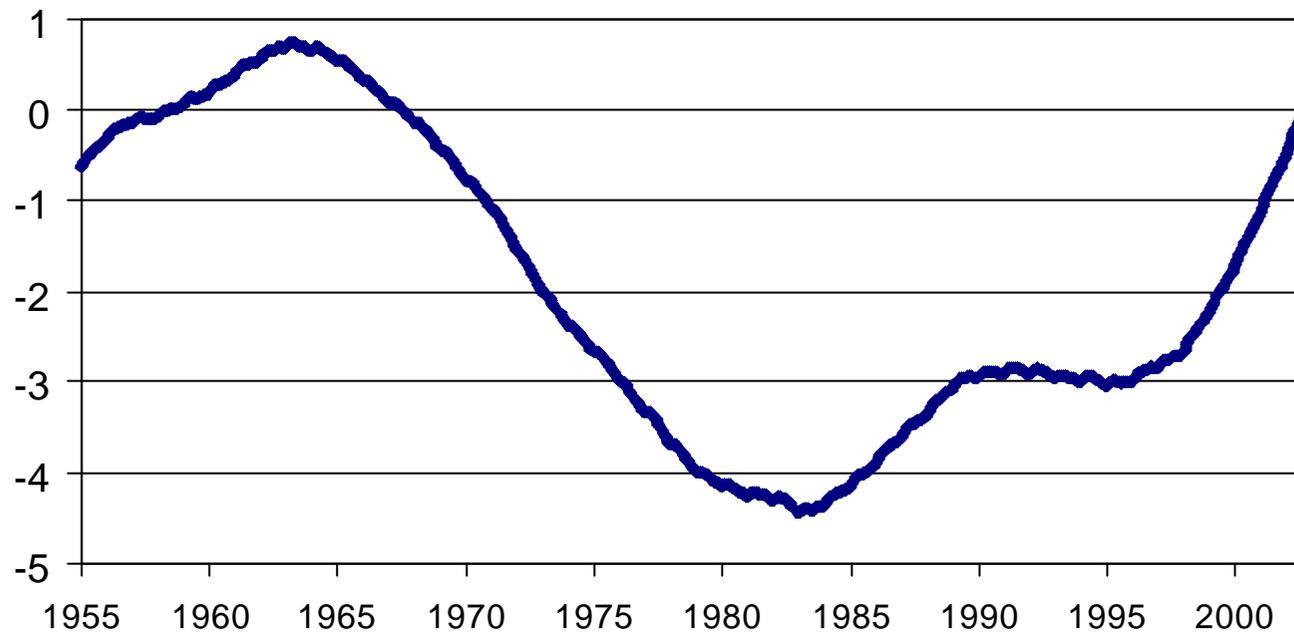
Fig. 4. Two-year prediction of *UT1-TAI* (observed - predicted) in seconds
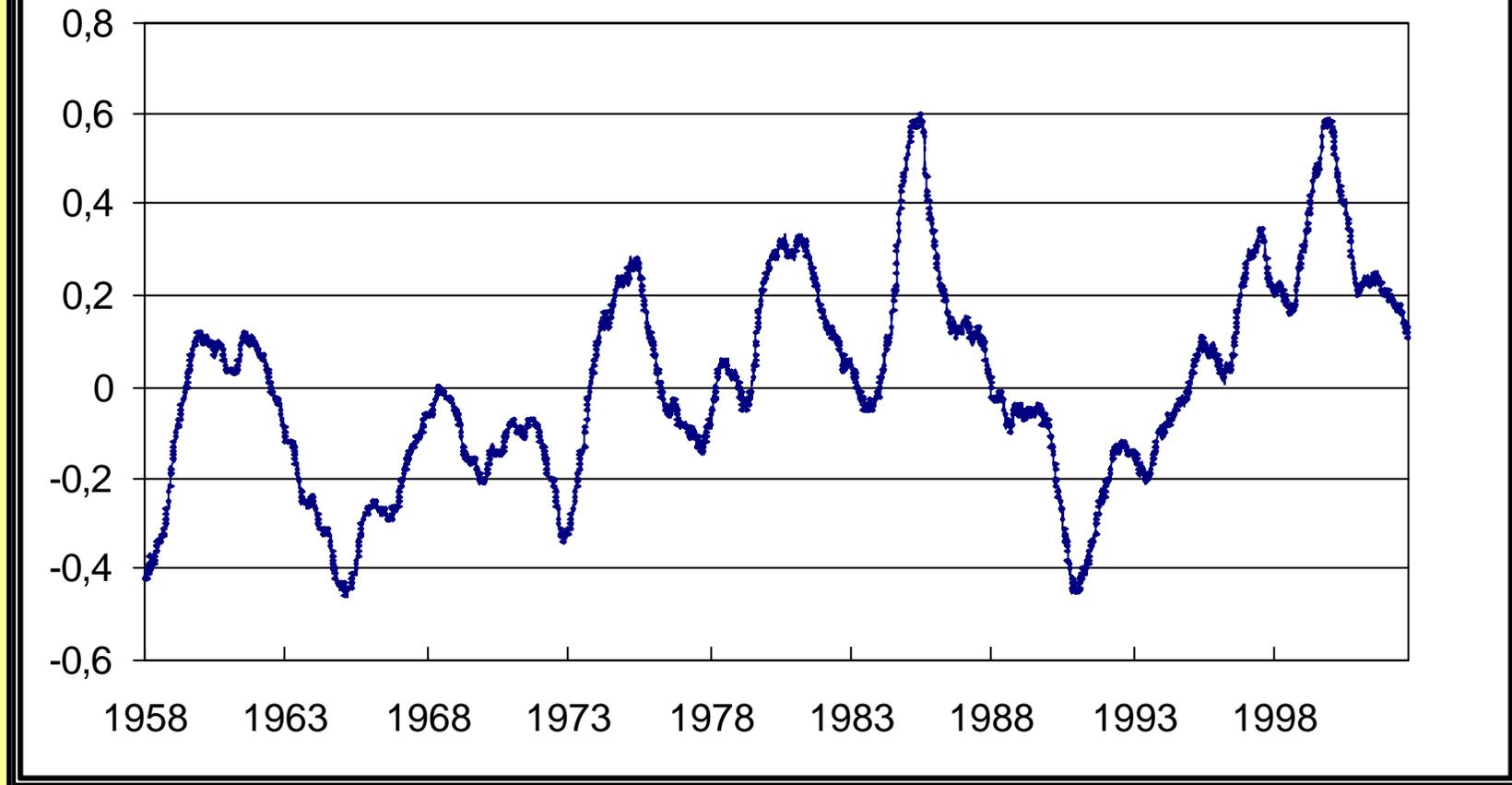
Fig. 5. Three-year prediction of *UT1-TAI* (observed - predicted)
in seconds
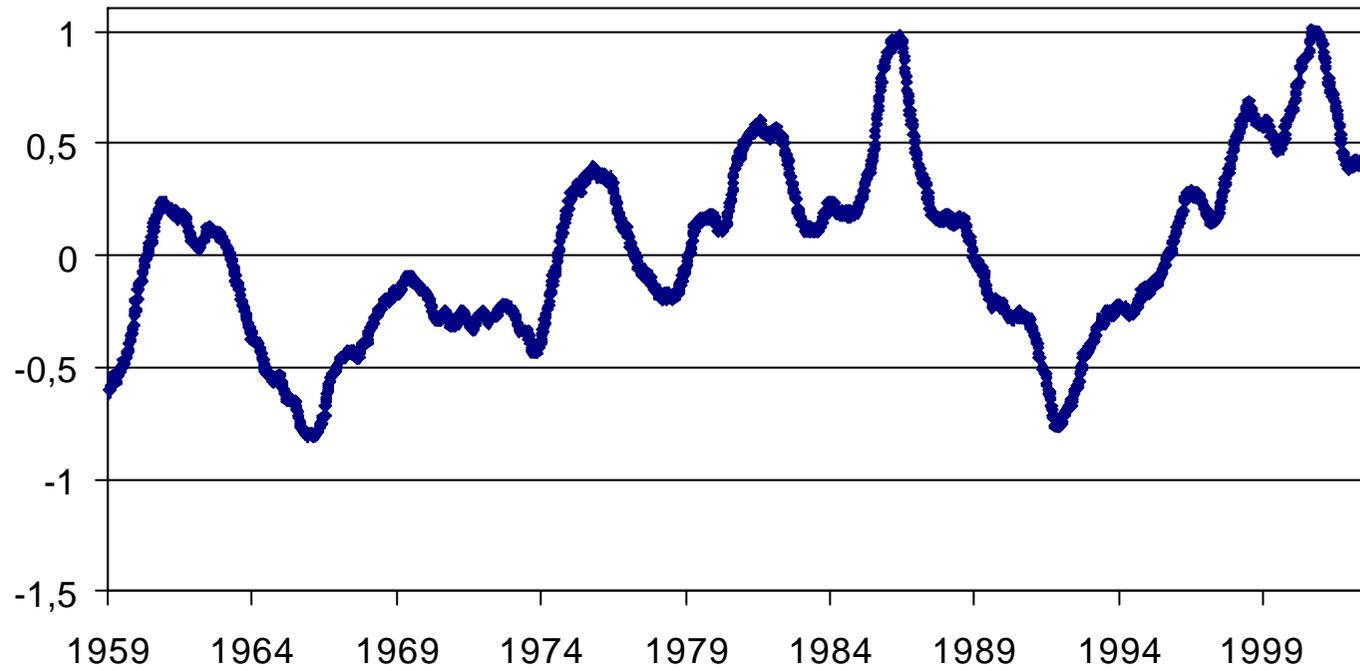
Fig. 6. Two-year prediction of *UT1-TE* (observed - predicted) in seconds
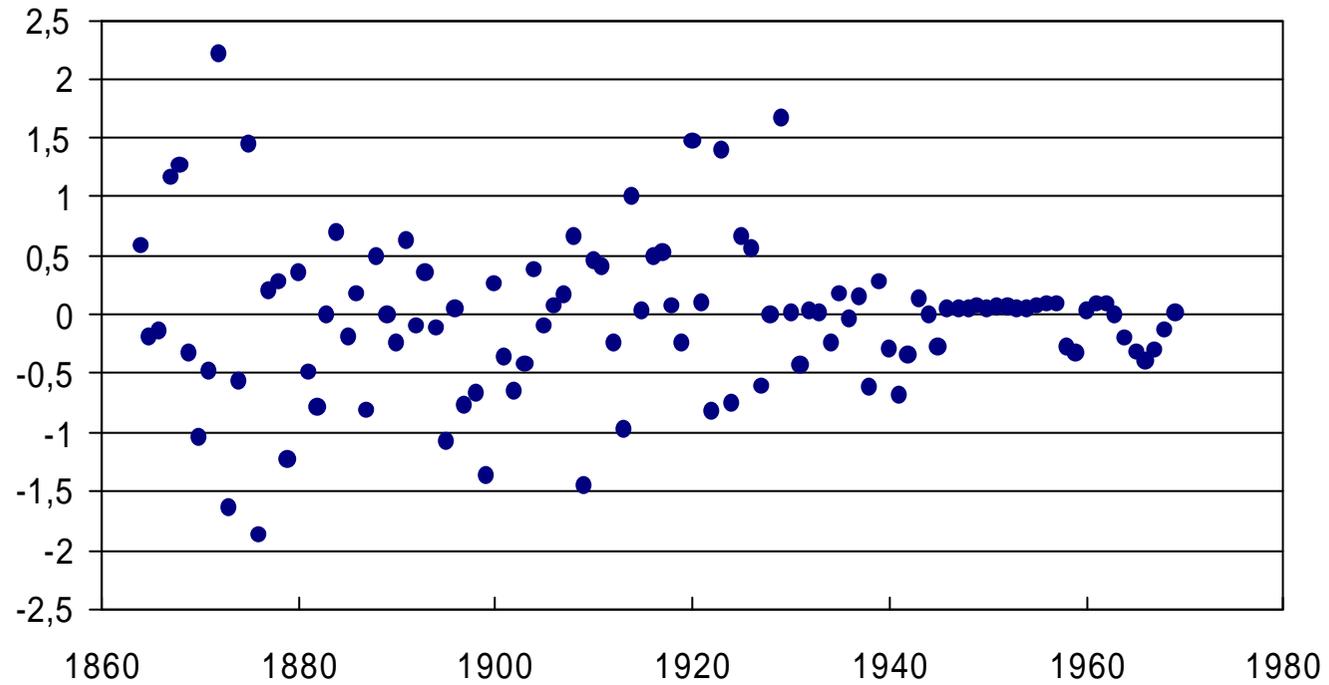
UTC frequency offsets

Relative frequency offset in units of 10^{-10}
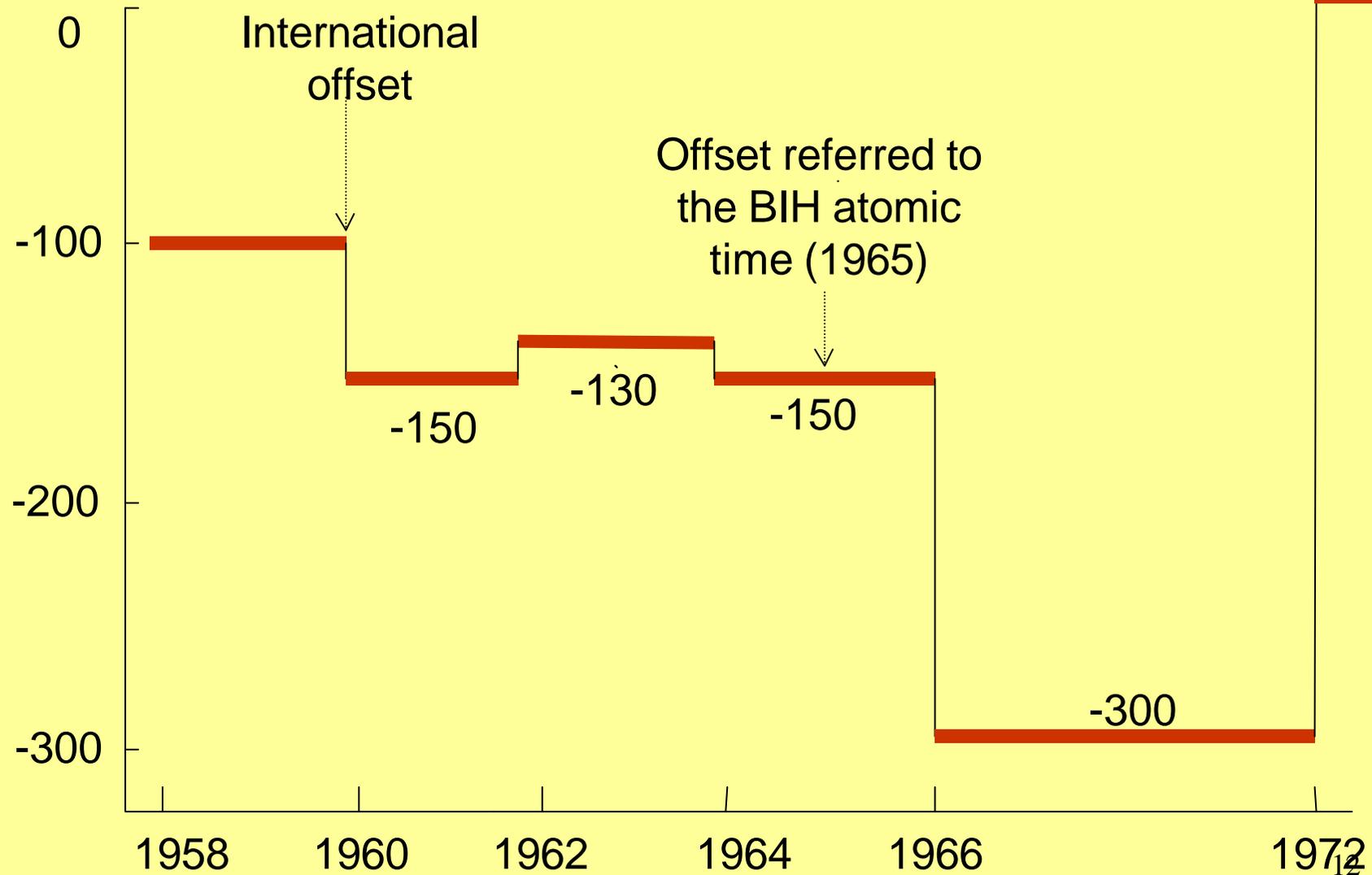
Evolution of UTC time steps

(*n*) Number of time steps

1 s

100 ms (8)

50 ms (1)

20 ms (29)

1957   1962 1963   1967   1972

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