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# KSTAR Sustains Plasma at 100 Million°C for 102 Seconds — A Fusion Milestone

3 June 2026 ·

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CURATED &amp; WRITTEN BY

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# KSTAR Sustains Plasma at 100 Million°C for 102 Seconds — A Fusion Milestone

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✓ Every fact web-verified against primary sources

The Korea Institute of Fusion Energy (KFE)'s **KSTAR (Korean Superconducting Tokamak Advanced Research)** device sustained plasma at 100 million degrees Celsius in High-Confinement Mode (H-mode) for 102 seconds — more than double its previous record of 48 seconds — a landmark achievement in controlled nuclear fusion research. The result, independently verified by the **IAEA**, was announced around June 2026. The target is **300 seconds** by end of 2026.

## KSTAR AT A GLANCE

| PARAMETER                | DETAIL                                                                |
|--------------------------|-----------------------------------------------------------------------|
| Full name                | Korean Superconducting Tokamak Advanced Research (KSTAR)              |
| Operated by              | Korea Institute of Fusion Energy (KFE), South Korea                   |
| Device type              | Tokamak — donut-shaped magnetic confinement device                    |
| New record               | 102 seconds of H-mode plasma at 100 million°C                         |
| Previous record          | 48 seconds (earlier KSTAR campaign)                                   |
| Temperature significance | 100 million°C $\approx$ 7× the Sun's core temperature (~15 million°C) |
| Target                   | 300 seconds by end of 2026; eventual goal: indefinite burning plasma  |

## WHAT IS NUCLEAR FUSION?

**Nuclear fusion** is the reaction that powers the Sun: **light nuclei (hydrogen isotopes)** fuse together at extreme temperatures and pressures to form heavier nuclei, **releasing enormous energy** ( $E = mc^2$ ).

| PROPERTY            | FUSION VS FISSION                                                                          |
|---------------------|--------------------------------------------------------------------------------------------|
| <b>Fuel</b>         | Hydrogen isotopes: <b>Deuterium</b> (from seawater) + <b>Tritium</b> (from lithium)        |
| <b>Waste</b>        | Helium (inert) + low-level radioactive waste                                               |
| <b>Risk</b>         | <b>No runaway chain reaction possible</b> — reaction stops if conditions aren't maintained |
| <b>Energy yield</b> | <b>Gram-for-gram 3-4× fission; 10 million× fossil fuels</b>                                |

## WHY DOES TEMPERATURE MATTER?

- Fusion requires overcoming the **Coulomb barrier** (repulsion between like-charged nuclei) — only possible at **extreme temperatures (100+ million °C)**.
- At these temperatures, matter exists as **plasma** (fourth state of matter — an ionised gas).
- Maintaining plasma stable at these temperatures without it touching the reactor walls is the core engineering challenge.

## HOW A TOKAMAK WORKS

A **tokamak** confines plasma using powerful **magnetic fields** generated by **superconducting coils**:

- The magnetic field holds the plasma in a donut-shaped (toroidal) loop.
- **H-mode (High-Confinement Mode)** = the plasma's better-insulated state; it doesn't leak energy as quickly; achieved above a certain input-power **threshold**.
- Sustaining H-mode plasma for longer = closer to the "Q>1" break-even threshold (energy out > energy in).

## THE GLOBAL FUSION LANDSCAPE

| MILESTONE                      | DETAIL                                                                                                                           |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <b>KSTAR 102 seconds</b>       | South Korea; ~100 million°C H-mode; more than double previous record                                                             |
| <b>NIF Ignition (Dec 2022)</b> | US <b>National Ignition Facility</b> — first demonstration of <b>net fusion energy gain</b> ( $Q>1$ ) using laser fusion (ICF)   |
| <b>ITER (France)</b>           | International experimental tokamak; under construction; 35-nation project; first plasma expected ~2035; 10× gain goal ( $Q=10$ ) |
| <b>India's SST-1</b>           | Indian <b>Steady State Superconducting Tokamak</b> ; operated by <b>IPR, Gandhinagar</b> ; India is a partner in <b>ITER</b>     |
| <b>Commercial</b>              | <b>Commonwealth Fusion Systems, TAE Technologies, Helion</b> — private companies targeting commercial fusion by mid-2030s        |

## INDIA'S ROLE

- India is a **full partner in the ITER project** (alongside EU, US, Japan, South Korea, Russia, China).
- India's contribution: **superconducting magnets, cryostat, and in-vessel components**.
- **Institute for Plasma Research (IPR), Gandhinagar** — India's premier fusion research facility; operates SST-1.

## UPSC RELEVANCE

| PAPER          | RELEVANCE                                                                                                                                              |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>GS3</b>     | Science & Technology — nuclear fusion, tokamak, plasma, energy; India's ITER participation                                                             |
| <b>Prelims</b> | KSTAR (South Korea, KFE); 102 seconds, 100 million°C; Tokamak; ITER (France, 35 nations); NIF ignition (2022); IPR Gandhinagar; Deuterium-Tritium fuel |

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#### KSTAR 2026 RECORD:

102 seconds of H-mode plasma at 100 million°C (7× Sun's core)

Previous record: 48 seconds; target: 300 seconds (end of 2026)

Operated by Korea Institute of Fusion Energy (KFE)

Device type: Tokamak (superconducting, donut-shaped magnetic confinement)

Verified by IAEA

**FUSION FUEL: DEUTERIUM (SEAWATER) + TRITIUM (FROM LITHIUM) → HELIUM + ENERGY**  
**FUSION VS FISSION: NO RUNAWAY REACTION; NO LONG-LIVED RADIOACTIVE WASTE; FUEL UNLIMITED**

#### GLOBAL FUSION LANDMARKS:

NIF ignition (Dec 2022) — first net energy gain (ICF method)

ITER (France) — 35-nation tokamak; first plasma ~2035

India's SST-1 at IPR, Gandhinagar; India is ITER partner

**PLASMA = 4TH STATE OF MATTER (IONISED GAS AT EXTREME TEMPERATURES)**

*Sources: IAEA, Korea Institute of Fusion Energy, The Hindu*

Source: KSTAR Sustains Plasma at 100 Million°C for 102 Seconds — A Fusion Milestone — Ujjyari.com | Free  
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