

High-intensity RF-driven cesiated negative hydrogen ion source equipped with J-PARC-made antenna coil for J-PARC user operation

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Abstract

It has been over a decade since J-PARC initiated negative hydrogen ion beam (H^- beam) supply from its high-intensity radiofrequency-driven (RF-driven) H^- ion source in the autumn of 2014. It is noteworthy that there have been virtually no major incidents to date, with only three instances of operational shutdowns and replacement work due to damage to the antenna coils. **The operation of the ion source equipped with the J-PARC-made antenna coil was initiated for J-PARC users in the autumn of 2025.** The ion source extracts the H^- beams with a beam current of 62.5 mA in order to fulfil the requirement of 50-mA H^- beam current at the end of the linac and a beam energy of 52.5 keV for appropriate injection into the RFQ. **The ion source exhibited a noteworthy operational longevity, sustaining continuous operation for a cumulative duration of 4,597 hours from the autumn of 2025 to the summer of 2026, with no occurrences of substantial issues.**

J-PARC high-intensity RF-driven cesiated H^- ion source

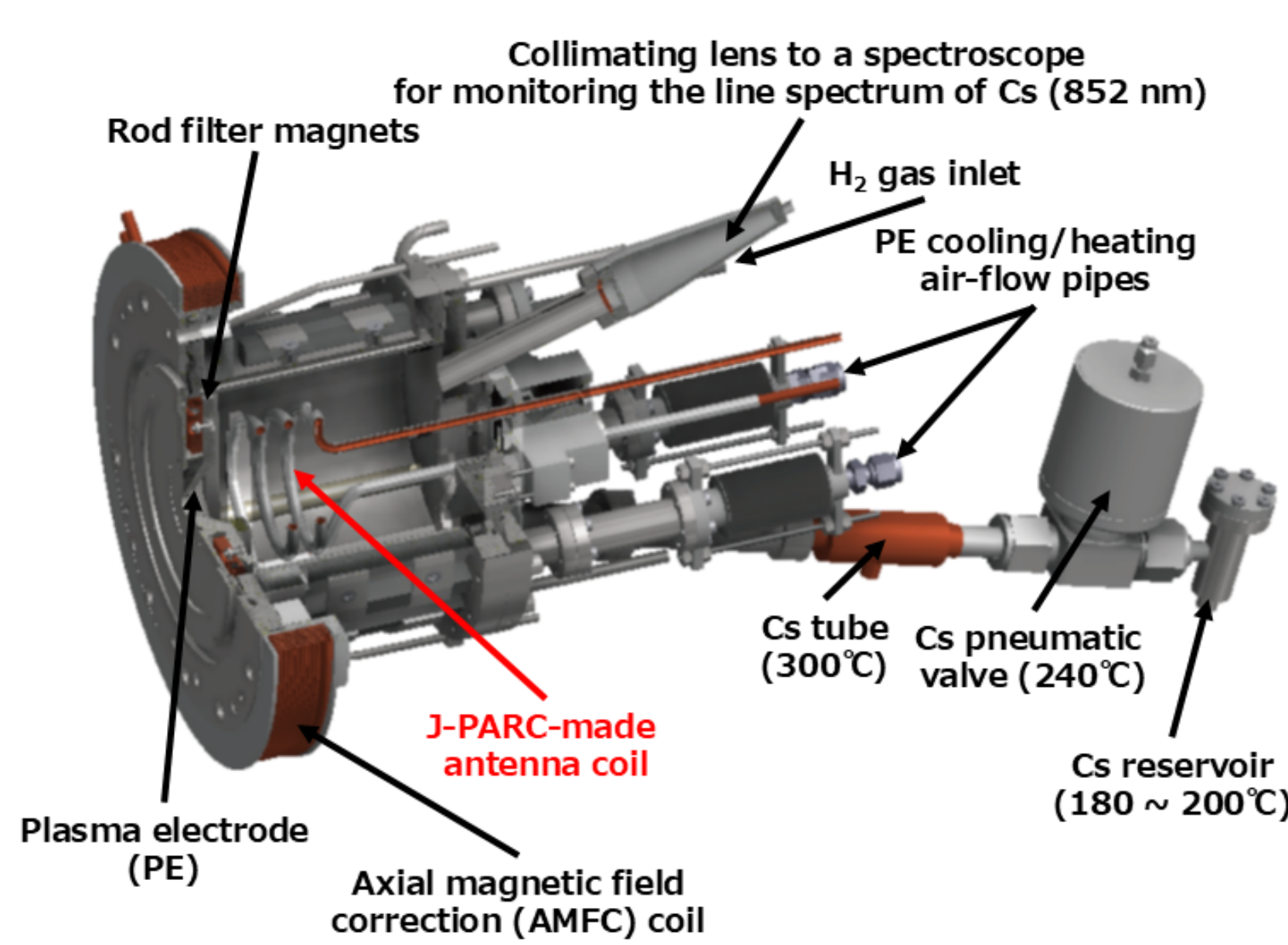


Figure 1: A 3-dimensional drawing of the J-PARC high-intensity RF-driven cesiated H^- ion source.

The ion source, which is **equipped with the J-PARC-made antenna coil**, was operated for the first time in order to deliver the experimental facilities for J-PARC users.

Table 1: Specifications and parameters of the H^- ion source

Specifications and parameters		For J-PARC user operation	For Accelerator beam study
Input RF power		28 kW	31 kW
H_2 gas flow rate		21.0 sccm	21.0 sccm
Applied voltage	PE-EE (V_{ext})	10.3 kV	11.2 kV
	EE-GE ($V_{acc,dc} + V_{acc,m}$)	42.2 kV	41.3 kV
	Total	52.5 kV	52.5 kV
H^- beam current at LEBT		62.5 mA	75.0 mA
Emittance (95% rms)	Vertical	0.24π mm·mrad	0.28π mm·mrad
	Horizontal	0.26π mm·mrad	0.28π mm·mrad

PE: Plasma Electrode, EE: Extraction Electrode, GE: Ground Electrode, V_{ext} : Extraction Voltage, $V_{acc,dc}$: DC Acceleration Voltage, $V_{acc,m}$: Modulated (Pulsed) Acceleration Voltage

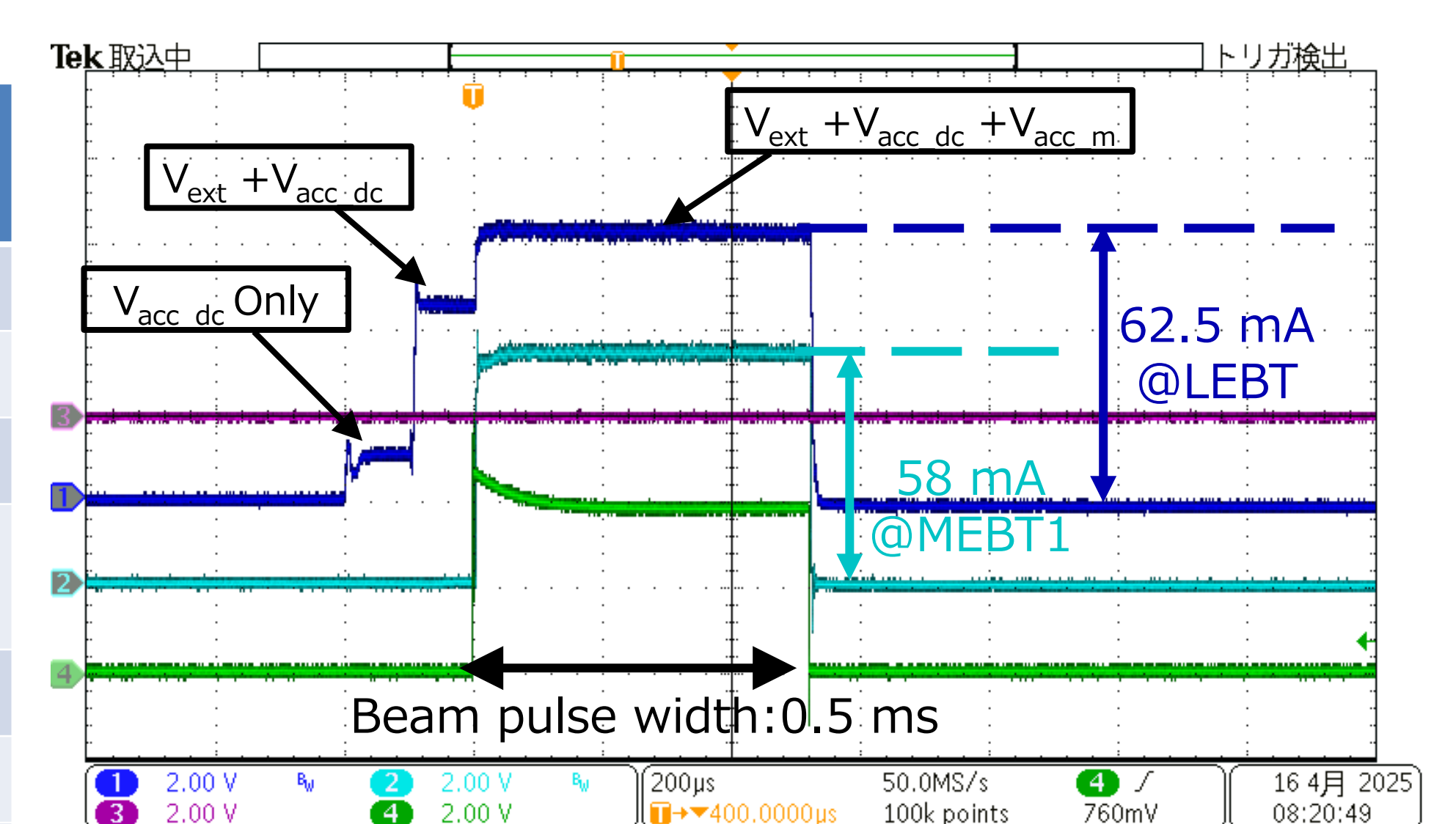


Figure 2: Typical waveforms of the H^- beam current at LEBT between H^- ion source and RFQ, and MEBT1 downstream of RFQ

The **transmission rate of H^- beam extracted from the ion source** was maintained at approximately **92.8%** in the J-PARC RFQ during the campaign.

Status of the beam operation of the J-PARC H^- ion source during the 2025/2026 campaign (Run#93), as well as operating history of the H^- ion source since the initiation of the RF-driven type

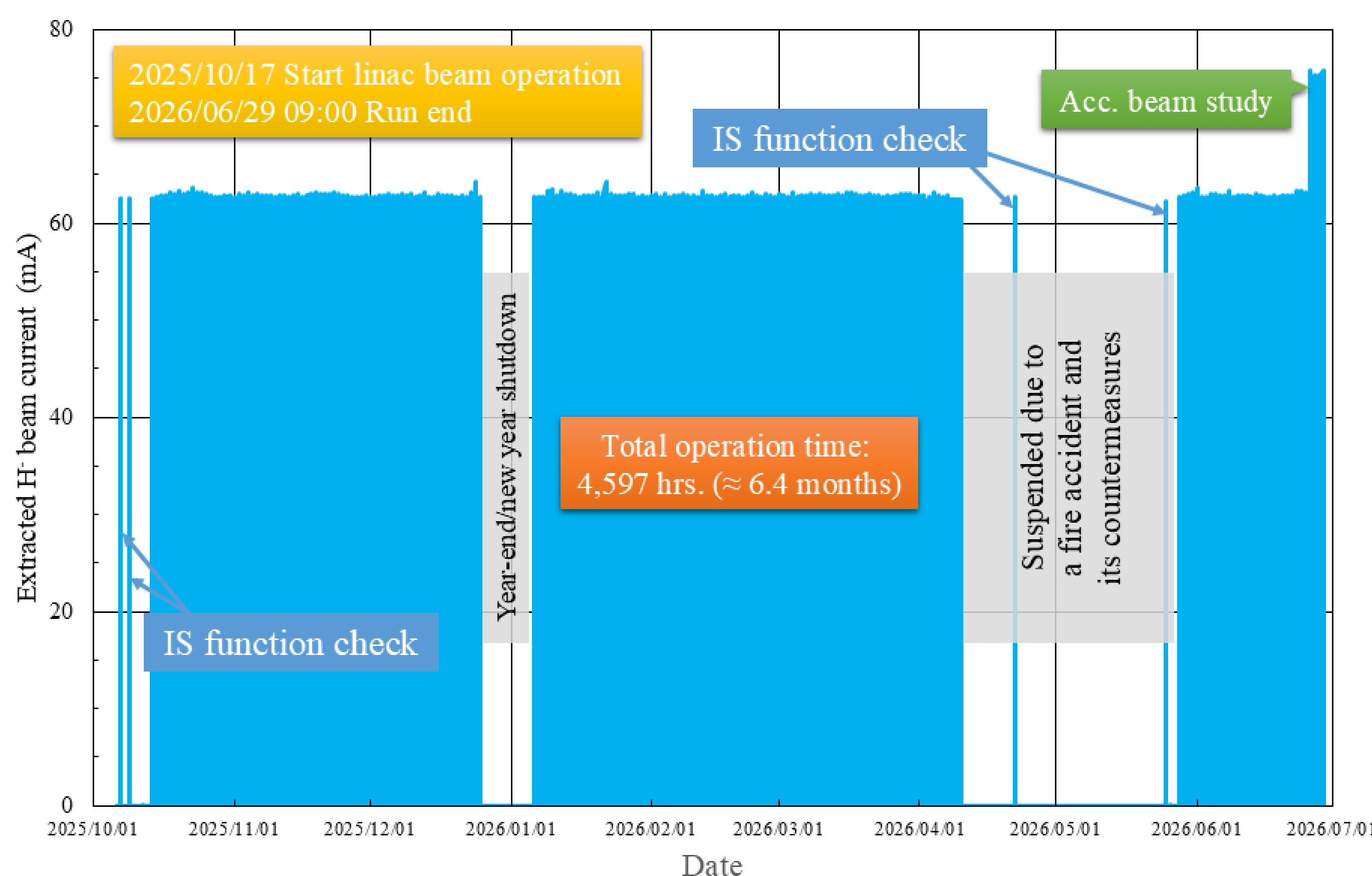


Figure 3: H^- beam current extracted from the ion source during 2025/2026 campaign (Run#93).

The **ion source, equipped with the J-PARC-made antenna coil**, exhibited a noteworthy operational longevity, sustaining **continuous operation for a total of 4,597 hours** from the autumn of 2025 to the summer of 2026, **with no recorded occurrences of significant issues.**

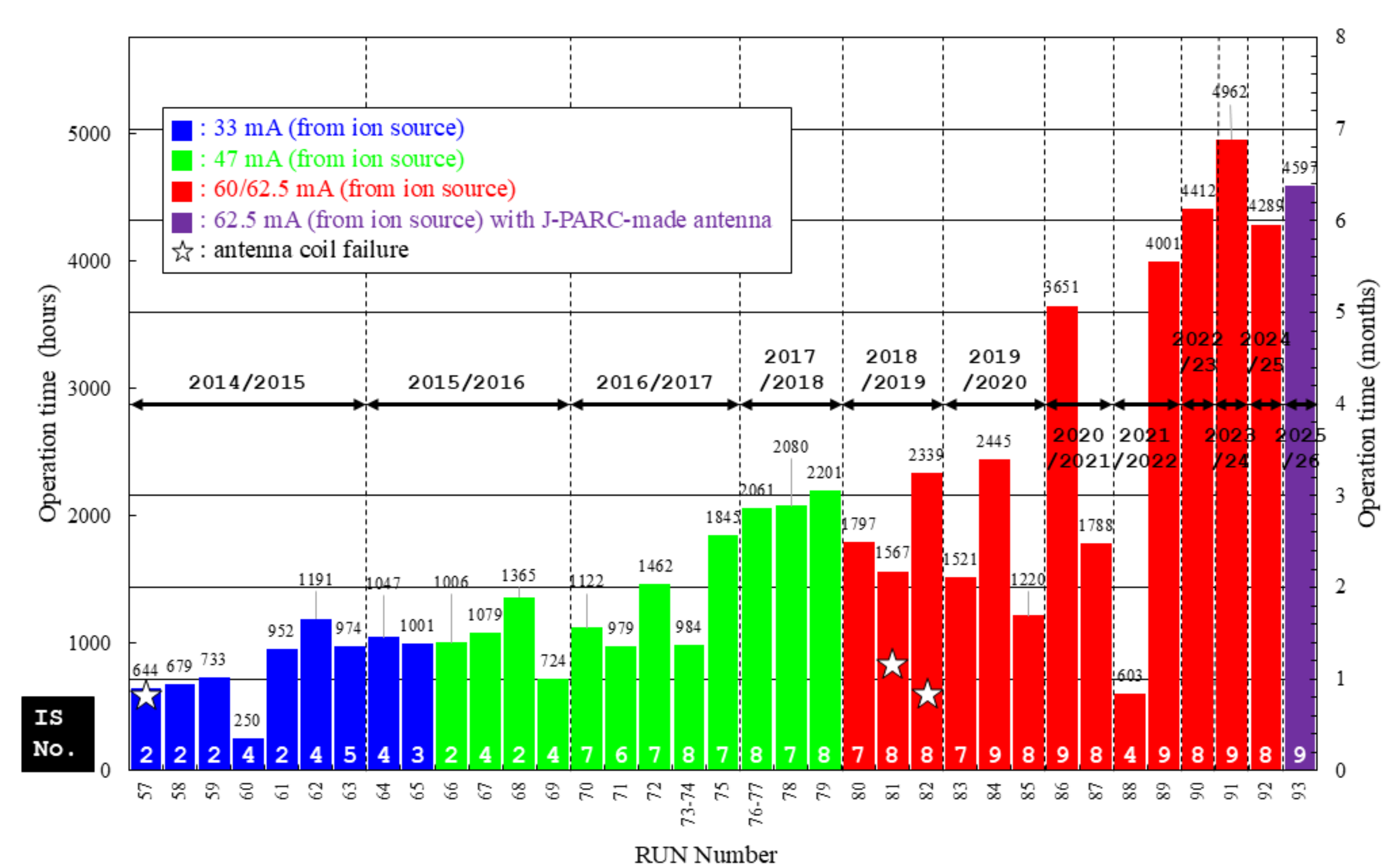


Figure 4: Operating history of the J-PARC RF-driven cesiated H^- ion source since the autumn of 2014.

With the exception of three runs (#57, #81 and #82), **the J-PARC RF-driven cesiated H^- ion source has completed all scheduled run times without encountering any significant issues** to date. Furthermore, since the 2022/2023 campaign (Run#90), **operations have been completed with a single ion source per campaign.**

Summary and prospects

In the course of the 2025/2026 campaign (Run#93), **the high-intensity RF-driven cesiated H^- ion source, equipped with the J-PARC-made antenna coil, was successfully completed for the first time.** The J-PARC user operation was examined by a single ion source with the continuous operating time of 4,597 hours without any significant issues.

It has been determined that **the internal antenna coil exhibited no serious deterioration following its deployment.** We have therefore begun **investigations into the operation of an ion source utilizing an internal antenna coil over a period of several years**, and we plan to carry out various tests on an offline ion source test stand in the future.