

Quantinum H-Series Product Change Notification

Title of Change:	System Model H2 release
Date of Change:	April 19, 2023
Contact Information:	QCSupport@quantinum.com
Products Impacted:	System Model H2 hardware and syntax checker
Changes to Product Data Sheet:	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
Changes to Subscription Contract:	NO <input type="checkbox"/> YES <input checked="" type="checkbox"/>
Changes to Interface:	All <input type="checkbox"/> Quantinum API <input checked="" type="checkbox"/> Microsoft <input type="checkbox"/>
Description and Purpose:	<p>The purpose of this notification is:</p> <ol style="list-style-type: none"> 1) Notify customers that H2-1 quantum computer and syntax checker will be available for customers who have contractual access to H1 + H2 QPUs. 2) Notify customers that the H2-1 emulator will be available as a beta release. <p>See additional information below for more details.</p>
Reason / Motivation for Change:	<p>Release of the H2-1 quantum computer will be available to subscription holders whose subscriptions allow access to H2 on April 19th. Along with the H2-1 quantum computer, we are releasing a beta version of the H2-1 emulator, also available on April 19th.</p>
Action Required by Customers:	None

Additional Information:

The Quantinum System Model H2, powered by Honeywell, is the first release of our second-generation quantum computer. This will be available for users on April 19th. It operates based on qubits implemented through atomic hyperfine states of $^{171}\text{Yb}^+$. The H2 system includes 1 machine, the H2-1, which has 32 physical qubits (ions) that move, individually or in pairs, between four interaction zones where all quantum operations (initialization, measurement, single-, and two-qubit gates) are performed using lasers.

As with H1 QPUs, H2-1 will be continuously upgraded over its product lifecycle with alternating weeks online or in upgrade. Calendars for H2-1 availability are provided monthly for the current month with a one month look ahead.

H2-1 Features

- N = 32 qubit trapped-ion based quantum computers
- All-to-all connectivity
- Laser based quantum gates
- Quantum charge-coupled device (QCCD) architecture with four gate zones in a trap consisting of two connected linear sections.
- Mid-circuit measurement conditioned circuit branching
- Qubit reuse after mid-circuit measurement
- Native gate set: single-qubit rotations, two-qubit ZZ-gates, arbitrary-angle ZZ gates

Subscriptions provide access to both H1 and H2 QPUs. Subscriptions do not guarantee an amount of access to either system but provides access to both systems up to the contractual monthly allocation of HQCs. **For circuits that require ≤ 20 qubits, Quantinuum strongly encourages users to submit these jobs to the System Model H1 computer.**

The official public launch of System Model H2 is tentatively scheduled for May 8th. A datasheet for H2 will be posted on the website on May 8th. Github data with the H2 benchmarking and quantum volume data will also be posted on May 8th.

This launch will include three new targets:

- “H2-1” – Physical hardware
- “H2-1SC” – Syntax checker
- “H2-1E” – Emulator

H2-1 Emulator Beta Release

On April 19th, the H2-1 emulator will be released as a *beta product* as there are planned critical upgrades to improve usability and performance of the system. As with the H1 emulator, the H2 emulator does full state vector emulation. From a technical standpoint the product is fully developed. The noise model, error parameters, and H2 feature sets are all up-to-date and fully implemented. Additionally, all H1 emulation features such as the ability to implement a custom noise model and run noiseless simulations have been retained with the H2 emulator.

Full state vector emulation of System Model H2 with 32 qubits is challenging. The H2 emulator uses a GPU-based backend. Users should expect the following changes when comparing their prior experiences with the H1 emulator to the experiences with H2 emulator:

- For $N > 28$ qubits, the emulation time is very long. Users are unlikely to find much value for emulations that use > 28 qubits. While future improvements may extend the range of useful emulation, users should make it a practice to use the fewest number of qubits possible to risk-reduce circuits before running on the hardware.
- Users may experience longer queued times for their H2 emulations than experienced with the H1 emulator.

- H2 is a more complex trapping geometry than H1. When comparing H2 emulation to H2 QPU performance, users may experience a larger discrepancy than experienced comparing the H1 emulator to the H1 QPU. Quantinuum expects that as done with H1, error models for H2 will mature over time.

As part of the critical and upcoming upgrades, safeguards and features will be implemented to allow users and the emulator to better handle the longer simulations time that come with higher qubit emulations. While in a beta release, we ask that users understand that system is in active development and report any issues to Quantinuum support promptly.