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HIGH PERFORMANCE COMPUTING NEWSLETTER
INSTITUTE FOR PLASMA RESEARCH, GANDHINAGAR

The Next Frontier: HPC Meets Quantum

The HPC World

High-Performance Computing enables users to run large simulations by spreading work across many processors at once. This allows complex models to run faster and at larger scales than would be possible on standard systems. As simulations grow in size and detail, they can become harder to run efficiently due to limits in memory, data movement, and system communication. Getting good performance often depends on how well an application is designed to scale, not just on the size of the machine.

The Quantum World

Quantum computing represents a different approach to computation that complements traditional HPC systems. Instead of operating on binary bits, quantum machines use qubits that can represent multiple states at the same time, allowing certain types of problems to be explored more efficiently. While this makes quantum computing promising for specific workloads, current systems are still small, sensitive to noise, and difficult to operate reliably. As a result, quantum computers are not a replacement for HPC, but an emerging technology that may augment existing systems as the hardware and software mature.

The Bridge: Hybrid Quantum-HPC

The real progress comes from combining HPC and quantum computing in a hybrid model. In this setup:

- HPC systems handle the bulk of the workload, including data management, large simulations, and control tasks.
- Quantum processors are used selectively for problem components where they offer an advantage.

The **hybrid toolchains** that connect HPC clusters with quantum accelerators:

- Qiskit Runtime (IBM) integrates quantum circuits into HPC workflows, enabling hybrid simulations with HPC-powered error mitigation.
- NVIDIA cuQuantum allows GPU-based HPC systems to emulate quantum workloads at scale.
- PennyLane & XACC provide middleware for seamless programming across classical and quantum devices.

This approach enabled by hybrid software stacks that connect HPC clusters with quantum hardware or simulators, allowing quantum routines to be integrated into existing workflows. As a result, users can begin experimenting with quantum-enhanced applications today without waiting for large-scale, fault-tolerant quantum machines.

India's Recent Advancements

India is actively building this bridge through the National Quantum Mission (NQM)[1], approved in 2023 with a budget of ₹6,003 crore to run until 2031. The mission aims to:

- Develop quantum computers with 50–1000 qubits using superconducting, photonic, and other technologies.
- Establish secure quantum communication networks spanning up to 2000 km across India.
- Build satellite-based quantum communication links for long-distance secure data exchange.

Several leading institutions are at the forefront:

- Indian Institute of Science (IISc), Bengaluru → Researching hybrid HPC-quantum workflows for scientific simulations.
- COEP Technological University, Pune → Experimenting with optimization problems using quantum simulators alongside HPC clusters.
- Tata Institute of Fundamental Research (TIFR), Mumbai → Advancing quantum materials and superconducting qubit technologies.
- Indian Institutes of Technology (IITs) in Delhi, Madras, and Kanpur → Developing quantum algorithms, photonic qubits, and secure communication protocols.
- Centre for Development of Advanced Computing (C-DAC) → Integrating quantum toolchains into India's HPC infrastructure.

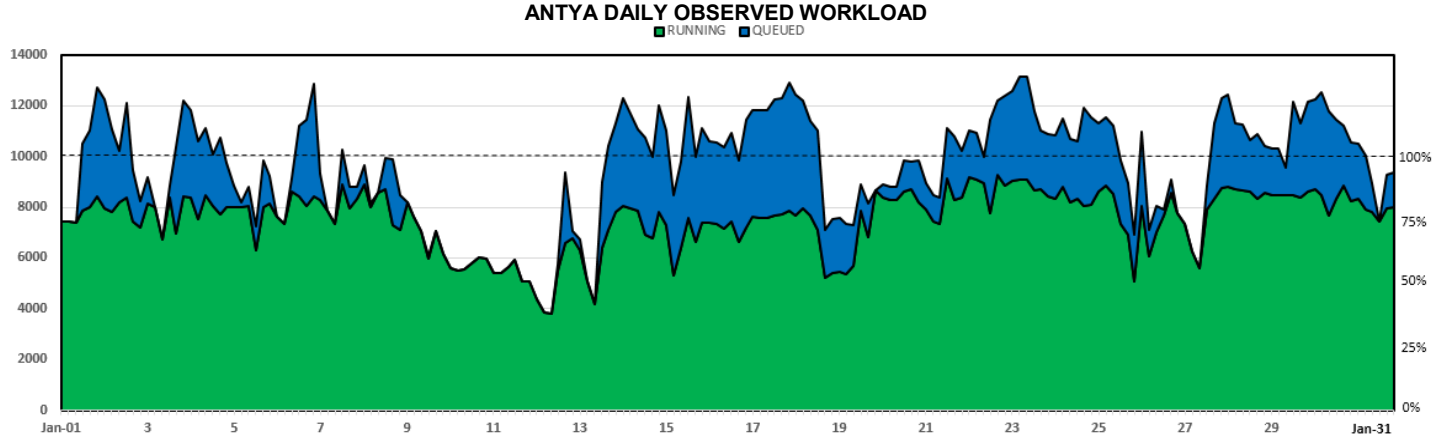
Conclusion

The future of computing is not about choosing between HPC and quantum systems, but about integrating them in a practical and meaningful way. By connecting these technologies, we can extend the capabilities of existing HPC infrastructure while preparing for the gradual adoption of quantum computing. For India, this represents both a challenge and an opportunity — to build expertise, support researchers and industry, and play an active role in shaping the next phase of advanced computing.

References

1) **National Quantum Mission (NQM), Government of India** – (https://dst.gov.in/national-quantum-mission-nqm) Official announcement, Press Information Bureau, April 2023. Press Information Bureau – NQM (https://www.pib.gov.in/PressReleasePage.aspx?PRID=2111953&reg=3&lang=2)
2) **Centre for Development of Advanced Computing (C□DAC)** – Quantum toolchain integration into India's HPC infrastructure. C-DAC Quantum Computing Initiatives (https://www.cdac.in/index.aspx?id=tap&tapcat=Quantum_Computing)
3) **Indian Institute of Science (IISc), Bengaluru** – Research on hybrid HPC–quantum workflows and plasma physics simulations. IISc Quantum Research (https://iqti.iisc.ac.in/)
4) **Tata Institute of Fundamental Research (TIFR), Mumbai** – Advancements in superconducting qubits and quantum materials. (https://www.tifr.res.in/~quantro/)
5) **IT Madras** – Centre for Quantum Information, Communication and Computing. IIT Madras CQICC (https://quantum.iitm.ac.in)
6) **Quantum Materials and Devices Hub (QMDHub), IISc Bengaluru** – A dedicated NQM hub focusing on quantum materials, devices, and integration with HPC. (https://www.qmdhub.co.in)

ANTYA Utilization: JANUARY 2026



ANTYA HPC Users' Statistics
January 2026

Total Successful Jobs~ 716

> Top Users (Cumulative Resources)

- **CPU Cores** — Gopal Mailapalli
- **Walltime** — Someswar Dutta
- **Jobs** — Gopal Mailapalli

ANTYA Usage, Updates and News

- **Scheduled Downtime:** There was no downtime of ANTYA for January 2026.
- **Job Submissions:** The highest job loads were observed in the *regularq*, *serialq*, *mediumq*, *longq and ansysq* queues, reflecting sustained user activity across multiple workloads in various queues.
- **Cluster Utilization:** The system maintained an average utilization of ~75.45% and peak utilisation of ~92.64%.

Packages/Applications Installed: No new modules have been installed this month. To view list of available modules.

> module avail

Other Recent Work on HPC

Maxwellization of non-thermal velocity distributions	**Chingangbam Amudon**
Intermittent Ion Beam Sputtering with Temperature Variation for Controlled Nanopatterning of Silicon Surfaces	**Dr. Rakhi**
Numerical Stability Analysis Of The Edge Harmonic Mode In Boundary Region Of Magnetized Fusion Plasmas	**Kaushalkumar Parikha**
Measurement of (n,p) and (n,α) reaction cross sections for Sn isotopes with theoretical model parameters estimation and sensitivity analysis	**Dr. Zara Aftab**
MHD flow studies in a single and multichannel rectangular ducts in presence of flow obstacles	**Anita Patel**
Absorption of Intense Circularly Polarized Laser in Inhomogeneous Plasmas: A Particle-in-cell Simulation approach	**Shakti Kushwaha**
Impact of inclined magnetic field on MHD flows in complex geometries	**Arpita Vipat**
Effect of static magnetic island on ITG of ADITYA-U tokamak: A Neural Network-Assisted Global Gyrokinetic Code Study	**Sarveshwar Sharma**
Plasma Performance Analysis for Tokamak based Fusion Reactor Design Using TRADE Code	**Prachi Jain**

Join the HPC Users Community

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If you wish to contribute an

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Contact us

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