#### ISSUE 22

# CELEBRATING 3 YEARS OF ANTYA

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# GANANAM (गणनम्)

# HIGH PERFORMANCE *COMPUTING* NEWSLETTER INSTITUTE FOR PLASMA RESEARCH, INDIA

SEPTEMBER 2022

"Institute for Plasma Research (IPR) is internationally known for its high quality experiments in thermonuclear fusion, plasma applications, in fundamental plasma sciences as well in theory of plasmas. A crucial missing component was the "fourth pillar" namely high performance computing, which became a reality with the advent of HPC ANTYA and due to tireless efforts of Late Dr R Srinivasan, who was a visionary and a true leader. ANTYA has resulted in a new academic eco-system within IPR and beyond. I congratulate the HPC Team as well as HPC users for this phenomenal success."

R Ganesh, Head, Computer Division IPR

# **ANTYA's 3 Years Journey:** A Look at Successful HPC Operations to Support Scientific Simulations

Deepak Aggarwal (SO-E, Computer Division, IPR) Email: deepakagg@ipr.res.in

he high performance computing facility, ANTYA [1] housed in the Data Center (DC) located on the 1st floor of the main IPR campus building, went online and opened for production use on 29th July 2019. In terms of computational capacity, ANTYA is one of the kind HPC facility across DAE and perhaps one amongst the top in the nation. The name ANTYA which refers to a quadrillion (1,000,000,000,000,000) in the ancient Indian mathematics, is a Sanskrit word and represents its theoretical peak computational capacity of 1 Peta (10<sup>15</sup>) FLoating-point Operations Per Second (1 PF). ANTYA features 261 compute nodes out of a total of 265 nodes with 2x20-core Intel Xeon Gold Skylake processors per node, a total of 44 P100 GPU cards with 2 cards per node, and 2 petabytes (PB) of storage with a central high-speed network switch enabling 100 Gb/s communication between compute nodes. Out of remaining 4 nodes, 2 are frontend nodes through which users access the cluster and 2 are for cluster management. Figure 1 shows the glimpses of ANTYA components arriving in trucks, shifting them to DC, and then putting them all together to have ANTYA in its current form.

*"If every Indian completes one floating point operation per second, it would take the total population of 130 crores around 6 days to do what ANTYA can do in 1 second"* 

#### Usage Statistics

ANTYA's impact was immediate and 90% of the existing HPC users shifted to ANTYA soon after its commissioning in July 2019. Rest 10% were transitioned gradually by successfully porting their applications on ANTYA. In the year 2020, ANTYA became the primary computational facility after UDBHAV and UDAY facilities were retired. With the additional benefit of huge resources available through a centralized facility that is accessible 24x7, individual workstations were freed up and were put to good use elsewhere. The HPC community has grown extensively from 50 users in July 2019 to 260 users in July 2022 with 10% being external users from DAE units and academic collaborations. Through academic projects, many young students were provided computational resources for the development of codes and performing simulations. Figure 2 shows the usage statistics.



Figure 1: Glimpses of ANTYA from the arrival of its components to assembling them inside DC racks. The installation, testing, and commissioning of ANTYA took around 3 months.



Figure 2: In the last 3 years (a) cumulative sums of Jobs and HPC users, (b) month-wise job distribution with an average of 6454 jobs, and (c) utilization charts showing the (Left) CPU and (Right) GPU compute resources usage of ANTYA cluster by HPC users.

# GANANAM

# ANTYA's 3 Years Journey...



Figure 3: During 3 years of operations, (a) shows the variety of HPC job types submitted in scheduling queues, and utilization of type of computing resources in queues is shown in (b) CPU cores and (c) GPU cards.

The computational resources of ANTYA enabled Users to perform more than 2 lakhs HPC jobs in the last 3 years. ANTYA supports a variety of HPC job types and sizes, including MPI jobs on distributed CPU cores, GPU cards, terabytes of memory as well as serial jobs on a single CPU core or GPU card. Figure 3 shows the HPC jobs and utilization of both CPU and GPU resources in the different job scheduler queues based on the application's capabilities. ANTYA has greatly enhanced research across multiple disciplines and has more than 60 different numerical libraries with more than 30 different codes installed, several of them indigenously developed, some open-source as well as a few commercially licensed software, being used for a variety of numerical simulations covering Computational Fluid Dynamics, Particle-In-Cell, Molecular Dynamics, Magnetohydrodynamics, Artificial Intelligence, etc. In a nutshell, ANTYA has facilitated researchers to complete complex and big tasks in much less time.

- "If you watch 8 movies of 4K quality (~100 GB) in a day, it would take you more than 6.5 years of binge watching to watch 2 PB worth movies
  - which is the storage space of ANTYA"

#### A Boon During Covid-19 Lockdown

Obviously, 2020 did not present the best of circumstances following the scheduled lockdown of the country and IPR from midnight Tuesday, 24th March 2020. However, the availability of ANTYA helped all the users to work remotely. Through the remote working phase, large amounts of computational resources of ANTYA facilitated several new users who shifted to the HPC working environment moving away from their desktops/ workstations. ANTYA's peak usage of ~60% of the total compute resources and more than 2000 total production jobs is a testimony of the fact that how it has played a catalyst for the scientific and engineering community of the institute during the most difficult phase of the 21 days of unprecedented lockdown. As users returned to campus, the use of resources had expanded and we have witnessed more than 90% peak compute resource utilization almost consistently in 2022. The same has been reflected in the number of internal library publications which were more than 100 in 2021. Figure 4 shows the hourly utilization in 2021 and 2022 to highlight the increased usage. In the last 3 years of operations, ANTYA's uptime is ~ 97% with only 2 incidents of unplanned downtime of the full cluster.

"ANTYA is among the top HPC facilities in India having both CPU and GPU and currently ranked in the top 20 in the Top Supercomputers-India list (TopSC.in), a pan-Indian equivalent of the Top500 HPC list" https://topsc.cdacb.in/topsc.php/filterdetails?slug=July2022





Figure 5: Percentage of HPC applications (a) from different programming domains, (b) capable of running on GPU cards employing serial, openMP, and MPI algorithms.

#### **HPC Community Outreach**

Considering the increasingly important role of HPC in research activities, HPC Team has started a monthly HPC Newsletter to disseminate HPC-related technical information starting from December 2020. This new HPC newsletter, christened **GANANAM** (गणनम) [2], meaning Computing, has been serving as an informal platform for sharing our scientific research activities to make the IPR HPC community more vibrant. Every issue contains a new research article on simulations done using the HPC resources apart from useful HPC article focusing on increasing the proficiency of Users towards ANTYA usage and other several updates. Till now 21 issues have been published

#### User Trainings and Workshops

Considering the emergence of Artificial Intelligence (AI) in scientific research and GPU computing, HPC Team IPR organized several workshops and Bootcamps intended to identify AI opportunities and to port user codes to run on GPU cards. More than 15 in-house developed codes have been ported to run on GPU cards and figure 5 shows the applications from various programming languages and their GPC capabilities with a few have been successfully scaled to run across multiple GPU nodes.

#### References:

- Deepak Aggarwal et al., ANTYA High Performance Computing (HPC) System at IPR, IPR/ TR-566/2020, February 2020.
- 2.https://www.ipr.res.in/ANTYA/

# GANANAM

# **HPC Users Testimonials**

#### **Promit Moitra, PDF**

**Basic Theory and Simulation Division** 

*M* Antya has been an exceptional tool for scaling up my research work, leading to an accelerated pipeline for publication. The active support, training and prompt resolution of issues, along with enabling remote access, by the HPC team, has been indispensable to remain productive through the pandemic. It has been the most cherished aspect of my experience at this institute."

#### Kushagra Nigam, SO-D

#### Atmospheric Plasma Division (FCIPT)

*More ANTYA is one of the best facilities of IPR and one of its kind* in India. It has helped me run complex CST simulations that would require about a day in desktop PC. A big credit goes to the team managing this facility with impeccable dedication."

#### Abhishek Agraj, SO-E

#### **MultiDisciplinary Research Division**

I have been using Antya since its commissioning. The 24 x 7 availability, timely problem resolution, ease of usage, modular approach towards libraries, queuing system is commendable. I have been able to train my models on GPUs for more than 1,000 CPU hours without any major breakdown or issues. Thanks Team HPC."

#### Hiral Joshi, SA-D

**RF Plasma Application Division** 

*Mantya has reduced the necessity of compromizing the mesh* size for my simulation which has increased the precision of the results. The HPC has given me the capability of carrying out my research work with improved efficiency and speed."

#### **Devshree Mandal, PhD**

**Basic Theory and Simulation Division** 

**66** My experience with Antya has been whirlwind in last stages of my Ph.D work. I worked on one of best PIC codes available in the world right now i.e. OSIRIS. I never get to experience its full potential due to computational limitations. But coupling OSIRIS with Antya is a different story rather whole different ballgame altogether. I did my scaling and intensive parametric studies on Antya which boosted my understanding of my own research problems by manifolds. I want to endlessly thank the exceptional technical team who work behind the scenes. Working on Antya has been integral part of my Ph.D journey and one of cherished experience truly."

#### Satya Prakash R K, PhD (Engg) Atmospheric Plasma Division (FCIPT)

**66** ANTYA is one of the greatest assets of IPR. In a world where time discretization is very crucial for achieving simulated results which replicate the real counterparts, the freedom to choose the finest time steps is an immeasurable power. I am very glad the researchers at IPR are powered by ANTYA. I wholeheartedly thank the HPC team for keeping up this machine and also providing us with GANANAM newsletter, which keeps up updated with our peers and also acts as a very good manual for running this complex super-computer."

#### Ramesh Kumar Joshi, SO-E

#### **High Power ICRH Systems Division**

66 For the application of the Deep learning model training, ANTYA helped me by which I got the desired results with significant time improvement for the task. With the help of HPC team, I can able to run my jupyter notebook remotely with the allocation of desired resources. I appreciate the efforts made by HPC team for providing useful information in newsletters to run various applications using examples. Keep growing and helping."

#### Srikanta Sahu, SO-E

**Fusion Blanket Division** 

66 ANTYA provides access to commercial softwares like COMSOL, 24 hours a day and 7 days in a week with exceptional computational power. This has led me to simulate/optimize my experimental models faster by allowing me to parameterize the computations in multiple nodes. Kudos to HPC team for running the facility uninterrupted and providing prompt support to the users."

Swapnali Khamaru, PhD Plasma Devices Theory and Simulation Division

66 Antya has been the main simulation and visualization tool through out my PhD work. The OpenMP version of the PEC3PIC code is possible to run because of the availability of many cores in a single Antya node. The availability of sufficient number of nodes made multiple runs possible, which is very crucial for some projects. Because of the GPU cards of Antya, a faster Open-ACC version of the code has been achieved which helped to accelerate some of my complex PhD projects."

#### Gaurav Garg, SO-F

**MultiDisciplinary Research Division** 

*Martial ANTYA has helped me to train deep learning models such as* BERT (Bidirectional Encoder Representations from Transformers) for NLP (Natural Language Processing) and YOLO (You only look once) for object detection. I thank the HPC Team for their round the clock support."

#### Shishir Biswas, PhD **Plasma Devices Theory and Simulation Division**

66 As a research scholar working in the area of computational physics, Antya is everything for me. I use to utilize mainly GPU nodes on Antya. Our application which we have developed and upgraded use to use multiple GPU nodes on Antya. Without Antya, I have never been thought to enter in GPU computation itself, also the scaling study was not possible with out the resources. About data visualization and post processing, I also want to acknowledge the dedicated visualization nodes and the various smart open source visualization tolls available on Antya cluster. Anyway No machine can work properly without the proper help of a man or a team, so I want to thank HPC support team of IPR for their friendly support at every minute and also maintaining the system so nicely."

#### Hardik Mistry, SO-D

#### **High Power ECRH Systems Division**

*Mantya has always come to the rescue for running large-scale* CFD simulations which would normally take days on a normal workstation. The facility of visualization node puts a large amount of resources at the fingertips significantly accelerating the workflow. Such a wonderful HPC facility with a hardworking team is instrumental in augmenting research activities at IPR."

# **ANTYA Utilization: AUGUST 2022**



# Other Recent Work on HPC (Available in IPR Library)

Trapping of waves in a flowing dusty plasma	KRISHAN KUMAR		
Design, Fabrication, and Testing of 0.2 T High-Temperature Super- conducting Solenoid Coil with Room Temperature Bore Cryostat	MAHESH M GHATE	ANTYA HPC USERS'	
Low-pressure adsorption of hydrogen isotopologues on LTA 4A zeo- lites- A Grand Canonical Monte-Carlo study	GAYATHRI V DEVI		
Study of Multi-component Plasma Sheath in Presence of Charged Dust Species and External Magnetic Field	AKSHAYA KUMAR SHAW	AUGUST 2022	
Revisiting Induction Dynamo in 3-dimensional magnetohydrodynamic plasmas: Dynamo transition from non-Helical to Helical flows	SHISHIR BISWAS	◆Top Users (Cumulative	
Implementation of 3D Monte-Carlo simulations in the inboard limited Aditya-U scrape-off layer Plasma	ARZOO MALWAL	Resources):	
Experimental Estimation of Transport Parameters using Microscopic Density Fluctuations of Dusty Plasmas	ANKIT DHAKA	CPU Amit Singh	
Shallow water approach for flooding simulation using OpenFoam	SHAILJA TIWARI	Cores	
Experimental Validation Study to Improve Thermal Performance of an Updated Design of Plasma Pyrolysis Chamber using CFD Analysis	DEEPAK SHARMA	<ul> <li>GPU Suruj Kalita</li> </ul>	
Flood Modelling Simulation: A feasibility study using Open Source Code	SHAILJA TIWARI	Cards	
DESIGN REPORT OF TIN-LITHIUM (Sn-Li) BASED LIQUID METAL PROCESSING FACILITY	SHAILESH ASHOK- BHAI KANPARA	Walltime Someswar Dutta	
Measurement of Plasma Frequency and Collisional Frequency of Plasma-based Microwave absorber using Microwave diagnostics – a Simulation and Experimental Approach	HIRAL B. JOSHI	• Jobs Someswar Dutta	
Effect of DBD Plasma treatment on surface modification of aramid fibers: XPS Study	SADAF ALIBHAI JETHVA		

### **Acknowledgement**

The HPC Team, Computer Division IPR, would like to thank all Contributors including the HPC Users providing their testimonials for the current issue of *GANANAM*.

On Demand Online Tutorial Session on HPC Environment for New Users Available Please send your request to hpcteam@ipr.res.in. Join the HPC Users Community hpcusers@ipr.res.in If you wish to contribute an article in GAŅANAM, please write to us. Contact us HPC Team Computer Division, IPR Email: *hpcteam@ipr.res.in* 

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