ISO 9001:2015 AICTE-CII: GOLD Category Institute NAAC-'A' Grade Institute (CGPA: 3.21)

KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE
Opp : Yerragattu Gutta, Hasanparthy (Mandal), WARANGAL - 506015, TELANGANA, INDIA
काकतीय प्रौद्योगिकी एवं विज्ञान संस्थान, वरंगल - ५०६०१५, तेलंगाना, भारत
కాకతీయ సాంకేతిక విజ్ఞాన శాస్త్ర విద్యాలయం, వరంగల్ - ౫౦౬ ౦౧౫ తెలంగాణ, భారతదేశము
(An Autonomous Institute under Kakatiya University, Warangal)
(Approved by AICTE, New Delhi; Recognised by UGC under 2(f) & 12(B); Sponsored by EKASILA EDUCATION SOCIETY)
Estd: 1980 KITSW

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Annual Report for Academic Year 2023-24

Center of Excellence

INDO-AMERICAN ARTIFICIAL HEART PROJECT (IAAHP)

IAAHP TEAM

		
Prof. K. Venu Madhav **Dept. of EIE.**	**Dr. G. Ganesh Kumar** **Dept. of ME**	**Dr. G. Saikumar** **Dept. of ME**

Indo-American Artificial Heart Project (IAAHP) has been started in the year 2016 headed by **Dr.PesaruSudhakar Reddy**, MD, Professor of Medicine, University of Pittsburgh Medical Center (UPMC) and Chairman, Science Health Allied Research & Education (SHARE), Pittsburgh, PA, USA. Our Institute has joined the team in March 2018.

Objectives of IAAHP for AY 2023-24:

- To publish an abstract in ASAIO-2024
- Develop a prototype model of centrifugal pump using Injection moulding in Vasantha Tool Crafts Pvt. Ltd., (VTC) Hyderabad.
- To rectify the issues of pump raised during hydrodynamic and haemolysis studies and redesign the pump in collaboration with VTC, Hyderabad
- To Perform Hydrodynamic and Haemolysis Test on modified model of the pump to achieve required Normalized index of Haemolysis using mock up loop test rig designed by IAAHP KITSW team.
- To perform Computational Fluid Dynamics (CFD) Analysis of fluid flow using ANSYS work bench for modelling to a new design of Pump.
- To study the properties of magnet to overcome wobbling issue.
- To perform Animal test on INDUS Pump designed by KITSW
- To study the properties of Magnet

Outcomes:

1. Submitted One Conference Paper in American Society of Artificial Internal Organs (ASAIO) Journal, USA and is under review. The details are as below:

   RugvedaThanneeru, Sadia Alvi, Sai K. Gadakary, Ganesh K. Gampa, James Antaki, Harvey S. Borovetz, Naveen Chander Reddy, P. S. Reddy, (2023), "In-Vitro Evaluation of India-US (INDUS) Magnetically Levitated Blood Pump", to 70thASAIO Journal 2024. (Attached Annexure)
2. Purchased Glue Dispensing System for automating Gluing Process and 5000-EC with Light Shield & Manual Shutter.
3. Attended ICEHTMC conference during 10.11.2023 to 13.11.2023 and World Health Innovation Forum during 14.11.2023 to 16.11.2023 at AMTZ, Vizag to interact with AMTZ personnel's for establishing Animal Testing lab.
4. IAAHP team has generated experimental Pressure head Vs discharge (H-Q) curves for the modified model of the centrifugal pump using Mock up loop test rig which was developed to by IAAHP KITSW team.

5. Further conducted Haemolysis Test to calculate NIH (Normalized index of Haemolysis)
6. Developed a new version ofcentrifugal pump in collaboration with Vasantha Tool Crafts Pvt. Ltd., Hyderabad.
7. Gluing machine was purchased to automate the gluing of top and bottom casing as well as magnet cover.
8. Trails on automated Gluing machine was successfully completed and it is made ready to perform the gluing for injection moulded parts.
9. The effect of different curing times and curing methods were tested and made succeed.
10. KITSW team is supporting AMTZ, Visakapatnam to establish equipment for performing Animaltesting in addition to Palamuru Biosciences, Mahabubnagar for validation.
11. IAAHP Team has presented an Interactive session on 'Artificial circulatory support device: Bench to bedside' was organised by AIG Hospitals, 22.02.2024.

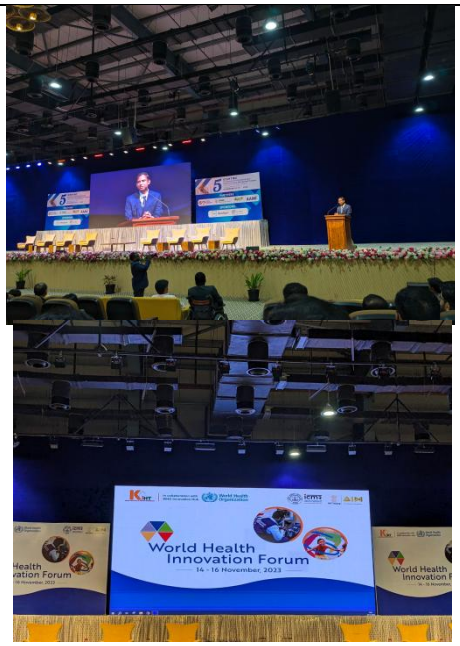
Details of Expenditure:

S. No	Details of Expenditure	Item Details	Amount in INR
Expenditure Spent:			
1	Expenditure Spent on Major Equipment Purchased/ Purchase of Software:	SLA 3 D printer, Glue Dispensing machine and UV curing Machinewere purchased	₹14, 80, 310.00
2	Sponsor faculty to attend ASAIO-2023 Conference/Incentives/ Sponsorship/TA-DA/ Rent Allowance etc., to Faculty	Sponsored Dr. G. Sai Kumar to attend ASAIO held in USA	₹ 2,90,410.00
Total (Rupees Seventeen lakhs Seventy Thousand Seven hundred and Twenty Only)			**₹17, 70, 720**

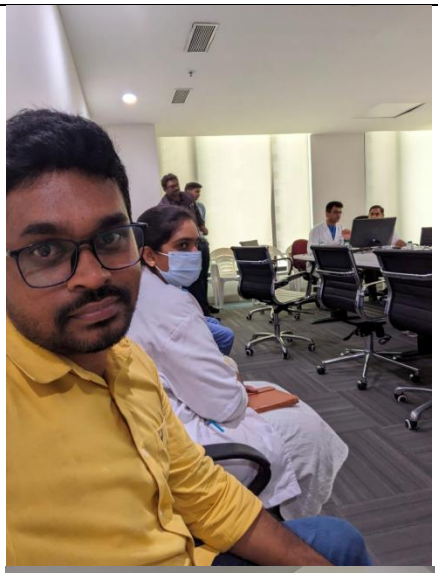
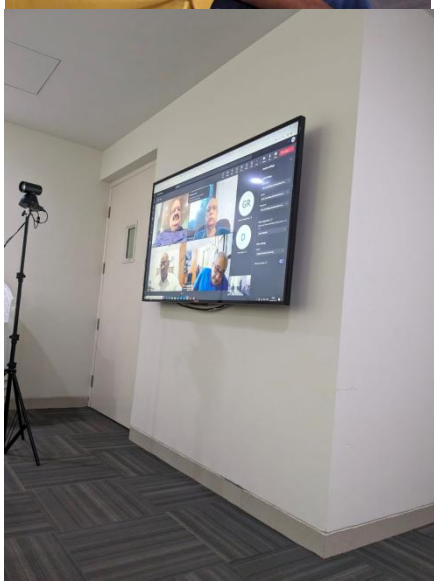
List of Major equipment available /Facilities Available in IAAHP Lab till CAY:

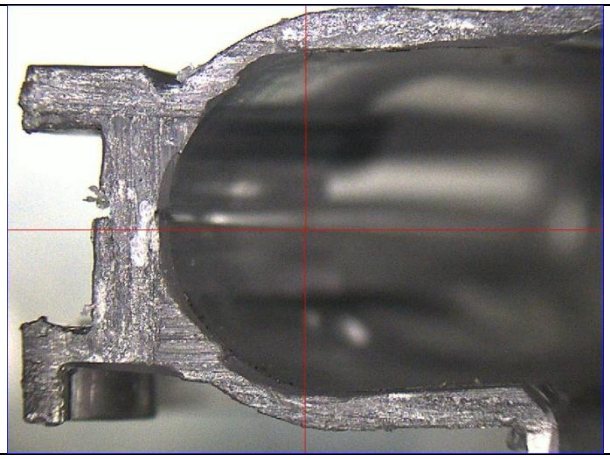
S. No	Name of the Equipment/ Software	Cost of the equipment/ Software in ₹	Purpose of the equipment
3D Printer			
1	*SLA Form 3B +* ***Sponsored by Alumni –Class of 1996 Exit Batch***	*6, 77, 000-00*	To generate the working model of the pump with surface finish of less than 0.2 µm
2	Mark Forge Mark Two 3D printing machine	16, 22, 500-00	To generate the working model of the pump using Onyx Material
3	Flash forge Dreamer Dual Extruder -Think 3D	85,000-00	To generate the experimental models of an artificial heart pump
4	ANSYS 19.2	5, 01, 500-00	To Simulate the fluid flow through pump
5	WORKSTATION-HP Z8 Work Station	10,68,000-00	To Generate H-Q Curves of an Artificial Heart Pump
6	Robot-Glue Dispensing System	6,96,200-00	For Joining Impeller Cover with impeller and also top casing and bottom casing of Heart pump
7	5000-EC with Light Shield& Manual Shutter: PN39823	7,84,110-00	For curing the glue used to join Impeller Cover with impeller and also top casing and bottom casing of Heart pump
Approximately Total Cost Spent Till Now including Sponsored faculty is about **One Crore Five Lakhs Rupees Only**			**₹ 1, 05, 00, 000-00**

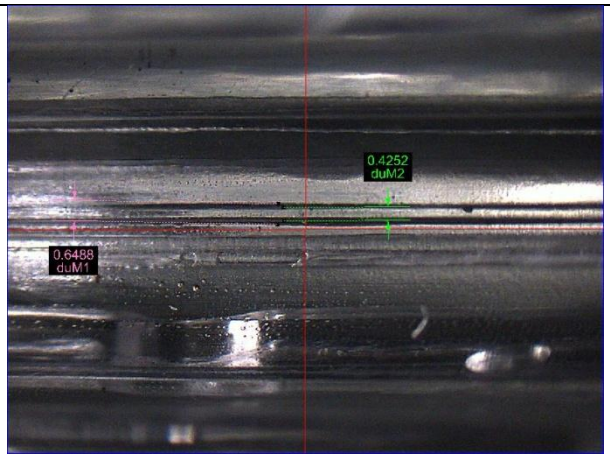
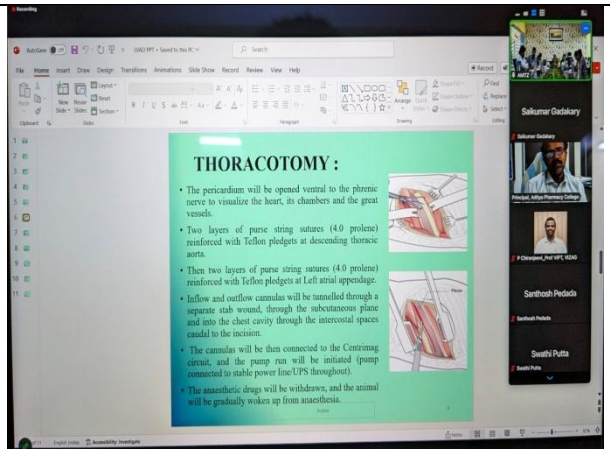
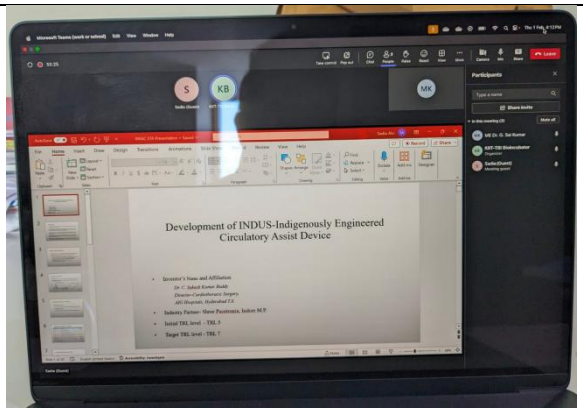
Important Events during 2023-24

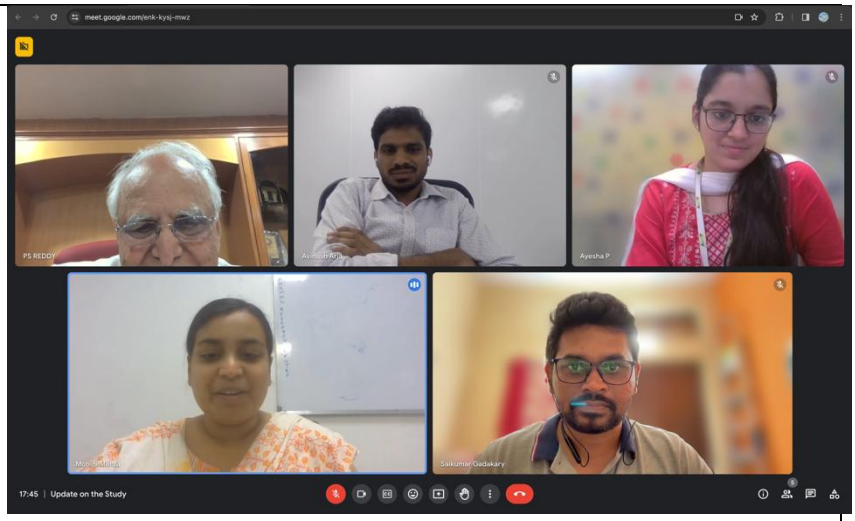
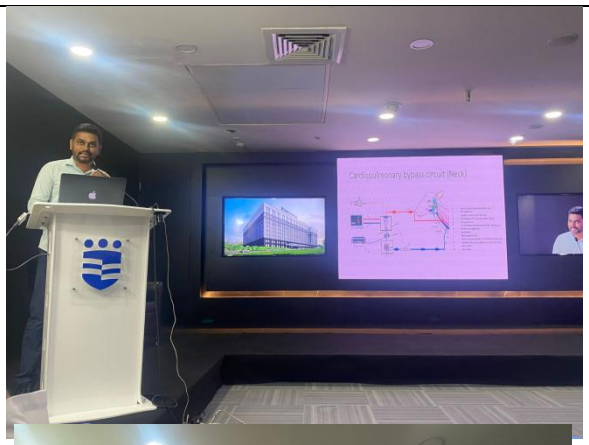
1	ICEHTMC conference during 10.11.2023 to 13.11.2023 and World Health Innovation Forum during 14.11.2023 to 16.11.2023 at AMTZ, Vizag	

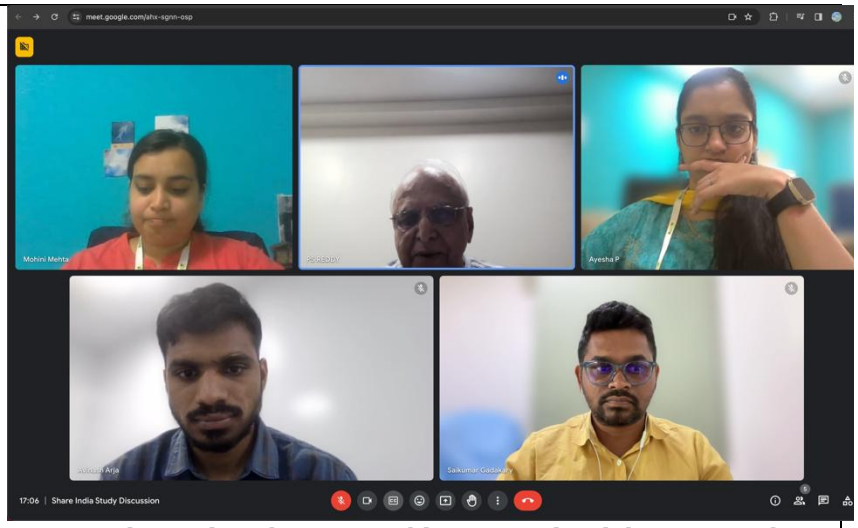
		  *Dr. G. Saikumar, Dr Jitendra Sharma, Managing Director & Chief Executive Officer, AMTZ, Dr. G. Ganesh Kumar at the conference (Left to right)*
2	Visit of Dr.Aditi NayakatIAAHP lab, AIG Hospital	 *Dr. Saikumar, Mrs. Sadia Alvi, Dr. Aditi Nayak, Ms. Havilla Grace (left to right)*

3	Ethics committee meeting at AIG hospitals, Gachibowli	  Ethics meeting at AIG Hospital – took permission to use human fresh frozen plasma to conduct vWF test.
4	Meeting at Laxven Systems with Ramesh reddy sir, and Mr. Suresh kumar, Vasantha Tools	

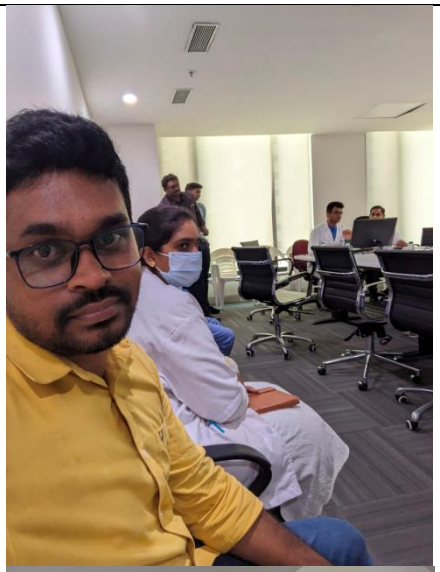
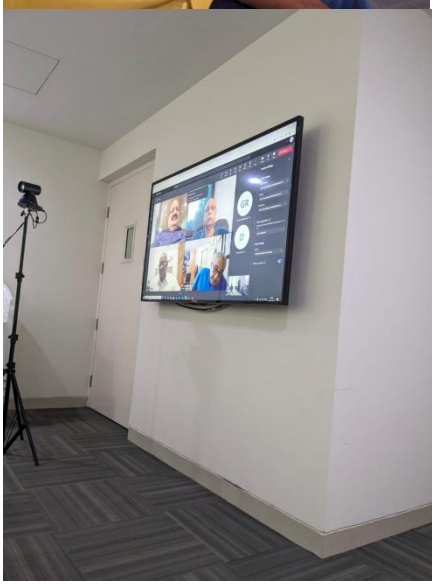
		 Discussion happened regarding the development of the motor and testing of the magnets. Mr. Ramesh Reddyhas said, they will test for the magnet strength requested Vasantha tools to test for ovality of the magnets and position of both inner and outer circle centres.
5	Training on the gluing process using the newly procured Glue dispensing robot at KITSW	
6	Ultrasonic welding of the pump parts and the Microscopic imaging og the joint	

		
7	Ethics committee meeting at AMTZ	 Ethics meeting – took permission for three animals to conduct the left thoracatomy using CentriMag pump
8	BIRAC ETA proposal meeting 01.02.2024	

9	AMTZ meeting 08.02.2024	 Discusiion regarding the Animal study protocl and procurement of the equipment, consumables and stanchion.
10	Interactive session on 'Artificial circulatory support device: Bench to bedside' was organised by AIG Hospitals,22.02.2024.	  Dr. G. Saikumar and Dr. Sukesh Kumar presenting at the session

11	AMTZ meeting 27.02.2024	 Discussed regarding the consumables required and the items such as saddle backpack, retractable hoses, and warm blankets are discussed.
12	Established IAAHP lab in Ci2RE on 14.04.2023	
13	Installed Form Labs Form 3b+ 3D printer in IAAHP Lab on 14.06.2023	

14	ASAIO 2023 14-17 June 2023	 *Dr. G. Saikumar and Dr. Harvey Borovetz*  *Dr. G. Saikumar with UPMC team IAAHP*  *Dr. G. Saikumar presenting the abstract* Abstract on 'INDUS: Economical Maglev Centrifugal Blood Pump for Developing Countries- Preliminary In-Vitro Hemolysis Testing' was selected for oral presentation at ASAIO 2023 annual conference which is held during 14-17 June 2023. Dr. Saikumar G has visited and presented the paper selected.

15	Visit of Dr. Aditi Nayak atIAAHP lab, AIG Hospital	 *Dr. Saikumar, Mrs. Sadia Alvi, Dr. Aditi Nayak, Ms. Havilla Grace (left to right)*
16	Ethics committee meeting at AIG hospitals, Gachibowli	  Ethics meeting at AIG Hospital – took permission to use human fresh frozen plasma to conduct vWF test.

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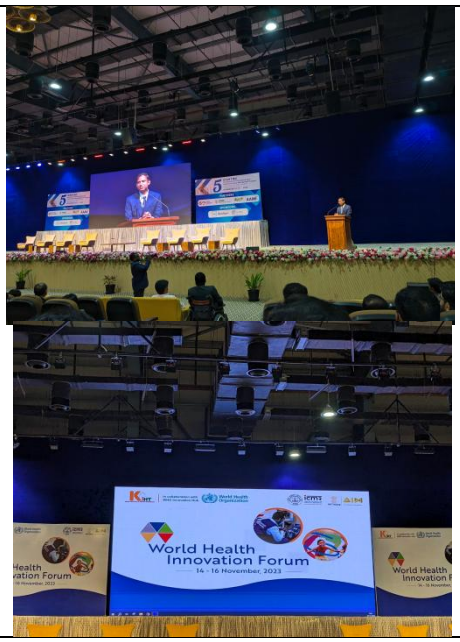
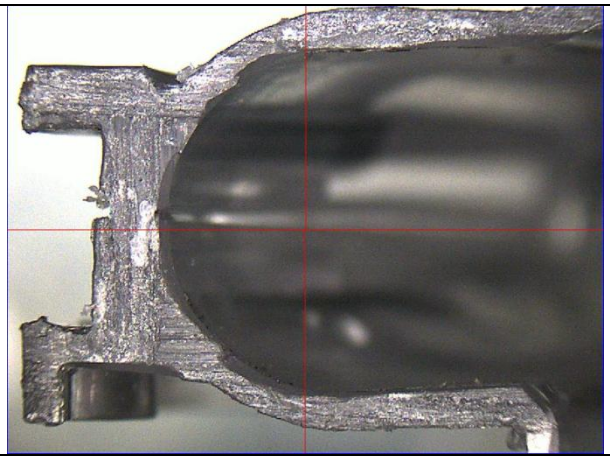
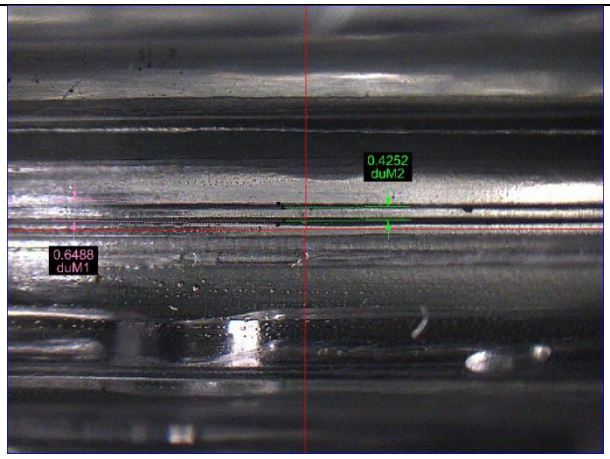
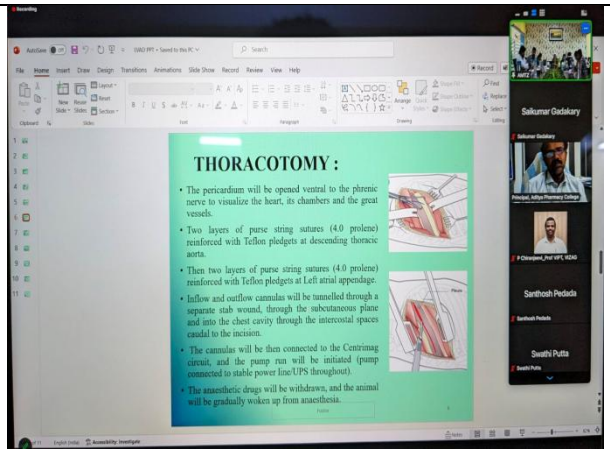
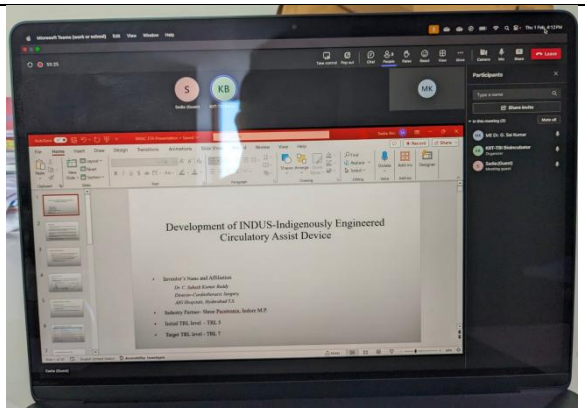
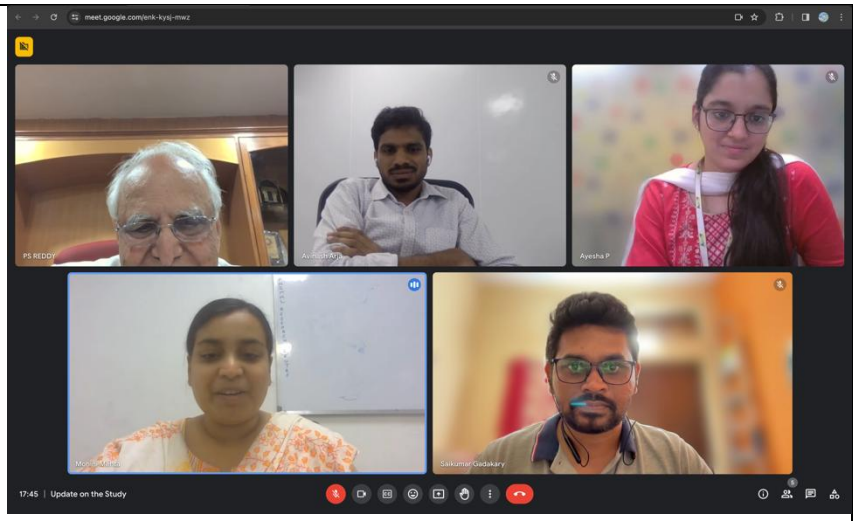
18	ICEHTMC conference during 10.11.2023 to 13.11.2023 and World Health Innovation Forum during 14.11.2023 to 16.11.2023 at AMTZ, Vizag	

		 *Dr. G. Saikumar, Dr Jitendra Sharma, Managing Director & Chief Executive Officer, AMTZ, Dr. G. Ganesh Kumar at the conference (Left to right)*
19	Training on the gluing process using the newly procured Glue dispensing robot at KITSW	
20	Ultrasonic welding of the pump parts and the Microscopic imaging og the joint	

		
21	Ethics committee meeting at AMTZ	 Ethics meeting – took permission for three animals to conduct the left thoracatomy using CentriMag pump
22	BIRAC ETA proposal meeting 01.02.2024	

23	AMTZ meeting 08.02.2024	 Discusiion regarding the Animal study protocl and procurement of the equipment, consumables and stanchion.
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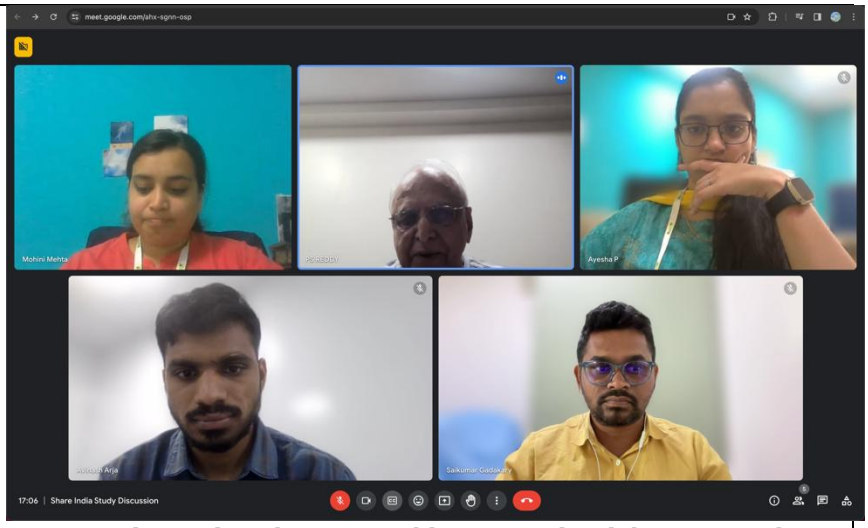
25	AMTZ meeting 27.02.2024	 Discussed regarding the consumables required and the items such as saddle backpack, retractable hoses, and warm blankets are discussed.

<u>IAAHP KITSW team Members:</u>

The following are the members involved in IAAHP in KITSW during 2022-23:

1. Dr. K. Venu Madhav, Prof. & HoD, EIE, Member, KITSW
2. Dr. G. Ganesh Kumar, Assoc. Prof., Member, KITSW
3. Dr. G. Sai Kumar, Asst. Prof. Member, KITSW

Annexure

In-Vitro Evaluation of India-US (INDUS) Magnetically Levitated Blood Pump

Purpose of Study:

Increasing rate of heart failure and shortage of donor hearts in India have made the development of ventricular assist devices (VAD) more prominent. One such attempt is ongoing in Hyderabad, India towards the development of a low-cost indigenous blood pump named INDUS: a magnetically levitated extracorporeal blood pump that can serve both, as a Left Ventricle Assist Device (LVAD) as well as an Extracorporeal Membrane Oxygenation (ECMO) blood pump. It is designed to be fully compatible with the widely used CentriMag® motor and controller. The purpose of this study is to conduct in-vitro hydrodynamic testing and compare the INDUS pump prototype with the CentriMag® pump as a benchmark.

Methods:A rapid prototype of the INDUS pump was developed by SLA 3D printer using a photopolymer resin. It consists of a top housing, bottom housing, impeller, and a permanent magnet that fits inside the impeller (Fig.1). Two tests were conducted sequentially for INDUS pump prototype and CentriMag® pump under identical test conditions. The pumps were used in the mockloop along with theCentriMag® motor and controller, inlet and outlet pressure sensors,non-contact flow sensor and a screw clamp to control the flow rate in the loop (Fig 2). The mock loop was filled with 400±20 mL of a blood analogue Glycerol-Water solution at 37.0°C., adjusted to ~4.0 cP.

The RPM (500-5500) was adjusted with the CentriMag® controller. The flow rate was controlled using the screw clamp at the outlet of the pump, from the fully open condition (Max flow rate) to the fully closed condition (0 LPM) with an increment of 1.0 LPM. The non-contact flow probe displayed the flow rates on the controller. The inlet and outlet pressures were recorded for the corresponding flow rates using the WinDaq® data acquisition software.

Results: Pressure vs Flow Rate or H-Q curves were plotted for various RPMs (Fig.3). The INDUS pump H-Q curves were found to closely approximate the CentriMag®, specifically for low RPMs (up to 3000). The INDUS pump could achieve a maximum pressure head as high as 763 mmHg at 5500 RPM.

Conclusion: The H-Q curves achieved for the initial prototype of INDUS pump meet the design criteria and user requirements as an LVAD (Between 2000-3000 RPM, 4.0-5.0 LPM, 100-120 mmHg) and an ECMO blood pump (Between 4000-5000 RPM, 5.0-6.0 LPM, 500-600 mmHg). This promising result serves as a key step towards the development of a low-cost indigenous blood pump for India. Ongoing work includes further CFD analysis, final development of the injection moulded pump and an indigenous Maglev motor.

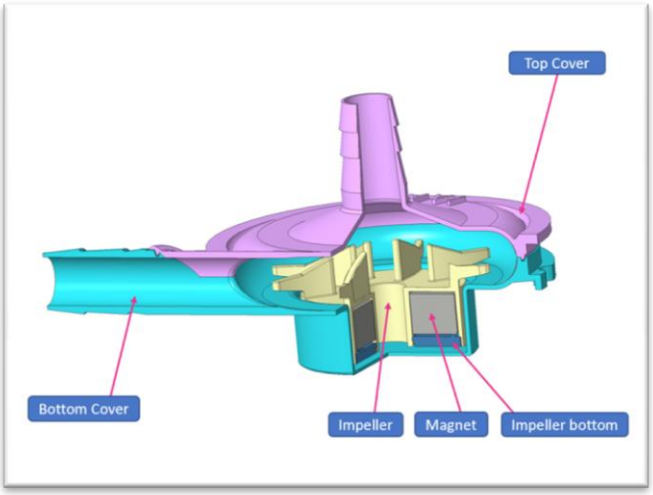


Figure 1 Components of INDUS.

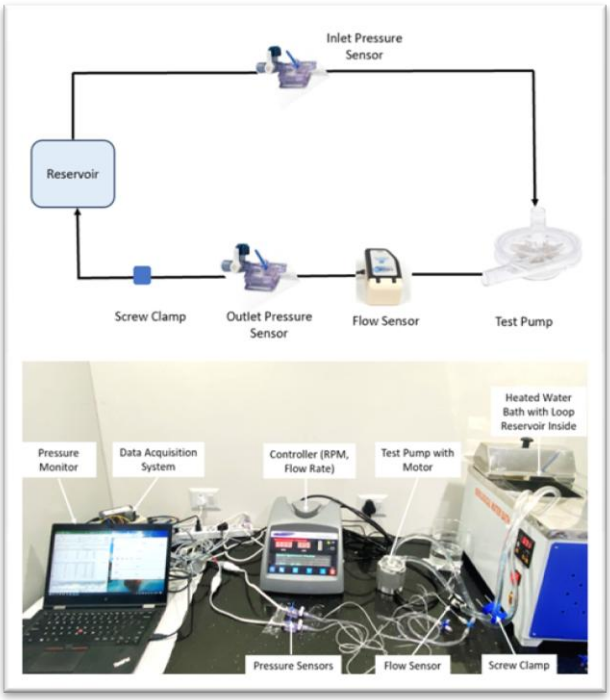


Figure 2 Mock circulatory loop for Hydrodynamic Test.

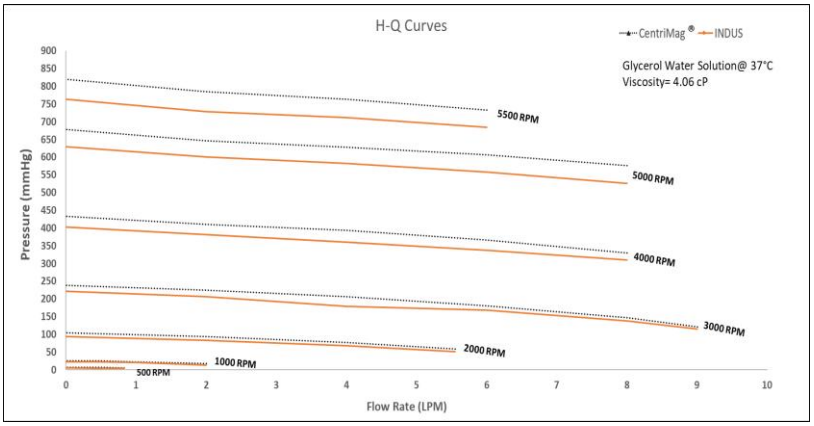


Figure 3H-Q curves comparing INDUS Pump Prototype with CentriMag® Pump.

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