

Proceedings

First Webinar on

Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario

1 August 2020, Saturday

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Editor:

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**Thinkers in Vacuum Electron Devices Group
India**

Programme of the Webinar

Date: 1 August 2020, Saturday

Time: 05:00 – 6:20 pm

Duration	Topic of deliberation	Speaker
05:00 - 05:15 pm	What should be the goals of the group?	Prof. B N Basu Dr. Lalit Kumar Dr. Chandra Shekhar Dr. P C Panchariya
05:15 - 05:35 pm	Requirements of VEDs vis-à-vis demand and supply	Dr. S N Joshi Dr. R R Patnaik Dr. K S Bhat
05:35 - 06:00 pm	Thoughts and deliberations	Group members
06:00 - 06:15 pm	Summing up	Prof. M V Kartikeyan Dr. S U M Reddy
06:15 - 06:20 pm	Vote of thanks	Dr. Vishal Kesari

Organizing Committee

Name	Designation	Affiliation	Role
Prof. B N Basu	Adjunct Professor	Supreme Knowledge Foundation Group of Institutions	Member
Raj Singh	Scientist	Institute of Plasma Research, Gandhinagar	Convener
Dr. Vishal Kesari	Scientist E	Microwave Tube Research and Development Centre, Bangalore	Proposer Vote of Thanks
Dr. Vishant Gahlaut	Assistant Professor	Banasthali Vidyapith, Banasthali	Webinar Coordinator
Subhradeep Chakraborty	Scientist C	Central Electronics Engineering Research Institute, Pilani	Member
Debahish Mondal	Research Scholar	Indian Institute of Technology, Roorkee	Webinar Organizer

Topic of deliberation

Speaker

What should be the goals of the group?

Prof. B N Basu
Dr. Lalit Kumar
Dr. Chandra Shekhar
Dr. P C Panchariya

Requirements of VEDs vis-à-vis demand and supply

Dr. S N Joshi
Dr. R R Patnaik
Dr. K S Bhat

Thoughts and deliberations

Group members and
others

Summing up

Prof. M V Kartikeyan
Dr. S U M Reddy

Vote of thanks

Dr. Vishal Kesari

Part 1

Topic of Deliberation

What should be the goals of the group?

Speakers

Prof. B N Basu

Dr. Lalit Kumar

Dr. Chandra Shekhar

Dr. P C Panchariya

Professor B N Basu

Adjunct Professor, Supreme Knowledge Foundation Group of Institutions
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1. To work as a satellite of the VEDA Society and hence serve the cause of the progress in R&D in the area vacuum electron devices.

The group members may please take the membership of the VEDA Society if they are not members as yet. They may also please arrange the VEDA Society membership of their respective organisations.

2. To create a platform for the expression of thoughts of younger group members.

The group is supposed to explore and encourage younger group members. Through this platform, they should be able to divulge the different aspects of relevance including their thoughts, ideas, aspirations, pointing out related challenges, problems, and difficulties.

3. To appeal the senior group members, who are in the helm in the area, to create for younger group members, the opportunities for jobs as well as for the postgraduate, doctoral, postdoctoral and sponsored research fellowships and arrange lab and industrial training, in the country and abroad.

Dr. Lalit Kumar

Distinguished Research Advisor, SIT-Tumkur, Bangalore
AICTE-INAE Distinguished Visiting Professor, DSATM, Bangalore
Editor, IEEE Transactions ED
Email: dr.kumarlalit@gmail.com

Formerly: Chairman, CEPTAM, DRDO, Delhi, and
Director, MTRDC, DRDO, Bangalore

A. VED Technology Think-Tank

1. Technology forecasting: New application, New generation devices, Disrupting technologies, Generating white papers on specific topics
2. Assessment of Indian Requirement of VED's and Global Technology Trends: Short- and long-term (5/10 years) project perspective of technology area
3. Identification of gap areas and suggest action to fill the gap

B. Cooperation and information exchange

1. Facilitate cooperation among researchers and institutions
2. VED Information Help-line: Answering technical queries
3. VED Notice Board: Posting useful information/ links to the event

C. Mentoring

1. Young researchers, scientists, and academicians in their research work, publications, academic pursuits
2. Topic based sub groups.
3. Career advice

Dr. Chandra Shekhar

Chairman Board of Governors and Chancellor
Academy of Scientific and Innovative Research (AcSIR)
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Ex-Director

CSIR - Central Electronics Engineering Research Institute
Pilani - 333 031, Rajasthan, INDIA

1. To foster ideation: through continuous exchange of views on what to do, for whom to do and in whose partnership(s) [The think tank aspect];
2. To clear doubts and provide suggestions on scientific and technological problems [The Quora aspect];
3. To share research work immediately after publication/ patent filing [Community building];
4. To organize tutorials for PG + Ph.D students and early career R&D scientists and engineers;
5. To share practical knowledge learnt the hard way with the community to ramp up Indian competence;
6. To pose scientific and technical problems one feels stuck up with in one's own environment.

Dr. P C Panchariya

Director

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The goals of the group are inbuilt in the underlined portions of my following message:

It is indeed an excellent attempt to organize a virtual brainstorming meeting on the future directions of Vacuum Electron Devices (VED) research in India amidst the outbreak of Covid-19. VED research and development activity always has been a niche area of CSIR-CEERI since, the inception of our Institute. Over the years, the VED fraternity from CEERI has had proved their excellence in the design and development of TWTs, Magnetrons, Klystrons, Gyrotrons, Cathodes, Plasma Devices and allied components ad systems as part of the sponsored and CSIR projects/programs. This promising initiative has a great potential to make our country "Atmanirbhar" by meeting the massive demands of VED devices for wide class of applications. The VED devices find potential applications in space communications, consumer electronics, fusion research, next generation communication systems, defence radars, electronic warfare and other security systems, weather forecasting radars, deep-space networks, etc.

In the current scenario of multidisciplinary research, it is extremely challenging to evolve and harness newer VED technology that we have to quickly adopt. In the era of 5G and Industry 4.0, we are mandated for striving for the design, development and delivery of advanced VED devices and relevant systems. It is a right time to venture into realization of VED based systems. Being a scientist from Instrumentation Engineering, I would always prefer to dream for the realization of systems. Therefore, we should nurture disruptive innovations for the excellence in innovations and realizations for futuristic microwave,

Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario

millimeter-wave and THz sources, passive components leading to system developments for effectively contributing to the Govt. of India's exclusive initiatives for the import substitutions for "Atmanirbhar Bharat", "Sashakt Bharat", etc.

I thank the organizers and look forward to setting the future directions of VED research in our country through such brainstorming sessions.

Part 2

Topic of Deliberation

Requirements of VEDs vis-à-vis
Demand and Supply

Speakers

Dr. S N Joshi

Dr. R R Patnaik

Dr. K S Bhat

Dr. S N Joshi

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Ex-Emeritus Scientist and National Coordinator-Gyrotron
Microwave Devices Division
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Vacuum Electron Devices (in particular Microwave Tubes) have several requirements in the Country for various sectors including Strategic, Communication, Industrial, Medical, Energy, Environment, Security, Basic research etc.

In the Country, its R&D was initiated at University of Calcutta at a lower pace and then at University of Delhi and National Physical Laboratory, New Delhi. It was also initiated at TIFR, Mumbai. They did basic studies and published number of Internal Reports particularly related to Klystrons and also developed several tube technologies, which were later on used by SAMEER, Mumbai for LINAC development. Later on, it was taken up by CEERI (-now CSIR CEERI) initially in the area of Magnetrons and continued after that till today. This was the history and since then in about six decades, Country has taken a long leap in this area for creating a strong design base as well as infrastructure required for developing sophisticated devices. In between Centre of Research in Microwave Tubes was created at IT, BHU (now IIT), Varanasi with the support of the then DoE. They had established a suitable design base and also created some infrastructure. However, due to some limitations, they could not continue the task of development of these devices and continued for developing a strong design base for almost all type of devices. In addition to them, IIT(R), Roorkee have developed strong design base in the area of Fast wave Devices, particularly Gyrotrons. NIT, Patna has also been carrying out theoretical studies on design of new HPM Devices. DAVV, Indore and few others are also involved in this area.

Though there are several requirements of these devices in the Country, however, as on today, there are mainly two organisations namely CSIR-CEERI, Pilani and MTRDC, Bangalore engaged in design and development of almost all types of devices for several decades. Both of them have very successfully developed a strong design base as well as related advance technologies and infrastructure required for these devices. Very recently SAMEER, Mumbai has established one Centre within IIT, Guwahati Complex (SAMEER, Guwahati). They have plans to develop Pulsed Magnetrons in this Centre.

To take care of the productionisation of these devices, Bharat Electronics, Bangalore is the only production agency in the Country. Initially they were producing these devices with the knowhow from foreign agencies and as of now, they have been producing these devices also with knowhow from our R&D Organisations, particularly from MTRDC, Bangalore. Several decades back, Central Electronics Limited (CEL), Sahibabad also started production of Pulse Magnetrons with knowhow from then CEERI. However, they could not continue for a long time. Pilani Electron Tubes and Devices Private Limited (PET&DPL), Sangrur, Punjab was established by one of the Ex Scientist Dr. G S Sidhu of CEERI in 1993. However, they have involved themselves with the development and production of Power Triodes at different power levels. It is worth to mention that they have been getting excellent yield in the development of their products. I feel that VED Community should persuade them to enter into the area of production of these devices.

Now I will like to discuss different issues at various levels, which are hindering the outcome of the progress of these devices required for different Sectors of our Country.

1. R & D Organisations: The numbers are very few and they are not able to meet the overall requirements. This number has to be increased by involvement of higher echelons of our System, though this process will take time. In addition to conventional users, the existing R&D Organizations should also try to explore other users of these devices,

which will also encourage production agencies. R&D organizations should also involve more and more academic agencies in different aspects of these devices through formal MoU or other means. Efforts should also be made to identify and involve production agency in the beginning itself to reduce the time in transferring the technology.

Another word of caution to developing agencies is to take utmost care in developing these devices within the agreed time line of the Project. What I have observed that in general, it is our general weakness to finish the task in time. While negotiating the project in the beginning, one should try to put up the case strongly before the concerned committee with proper justification of the time schedule.

2. User Agencies: Several times it has been observed that user agencies put up the required specifications of the device out of the best available specifications from the manufacturers around the globe. They should discuss in detail with the concerned developing agency and ask only for those specifications, which are essential for the System being developed by them. They should also remain in touch with the developing agency from the beginning itself.

3. Production Agencies: At present we have only one manufacturing agency Bharat Electronics in Public Sector for productionisation of these devices. In Private Sector, VEM Technologies, Hyderabad and Panacea Medical Technologies, Bangalore are trying to come up. They have to be supported and encouraged in future. We have to explore few more in Public Sector as well as in Private Sector.

4. Academic Agencies: Unfortunately the curriculum in respect of these devices as well as of Microwave Engineering is shrinking in Universities and other academic agencies. Efforts should be made to encourage them in this area by having regular interactions with them.

Though efforts are being made by different agencies to design and develop these sophisticated devices as per the requirement of user agencies, however, there are certain weaknesses and shortcomings. We have to look at them also. I have listed few of them as per following:

1. Cathodes: It is a vital component of any Microwave Tube and performance and life of any device is critically dependent on this component. Even after working for development of different types of Cathodes by various agencies for several decades, we are still mostly dependent on foreign suppliers. All out efforts should be made in this direction for becoming self-sufficient in this vital area.
2. Materials including special ceramics: We have very limited resources in the Country for supply of electron grade materials. Still, as on today, we are mostly dependent on foreign suppliers.
3. High Energy Magnets: We have limited resources and due to that again we are mostly dependent on foreign suppliers.
4. Special High Voltage Power Supplies: This is again a critical area and indigenous resources are not meeting all the demands.
5. Computer Codes: Though some codes have been developed by different agencies and they are being used, we are still mostly dependent on commercial codes. Efforts are still being made to develop own codes, but at a low pace. This activity will have to be strengthened.
6. Competition with Semiconductor Devices: Due to advent of new materials, the capabilities of Semiconductor based devices have been enhanced in terms of Power as well as frequency coverage. However, in far near future, these devices beyond X-band will remain in use at very high power levels. In addition, HPM devices will dominate the frequency spectrum in terms of Output Power. Fast-wave Devices will again dominate in terms of output power.

Again the THz range of RF Spectrum will be based on merger of these two technologies. In view of above, Vacuum based devices will be required. However, the young researchers will have to find new application areas of these devices and will have to keep a watch on the growth of Semiconductor based devices. Hence in place of competition, it should be considered as marriage between the two technologies, utilizing the positive aspects of these two technologies for making a single device.

Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario

To conclude, I express my best wishes particularly to the young researchers in their future endeavours keeping a very watchful eye and also putting all out efforts in meeting the time lines.

Dr. K S Bhat

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It is true that solid-state technology is fast approaching towards higher power levels and frequencies. The solid-state counterparts can meet most of the VED requirements. Even in such a scenario, the VED community has lots to do in the coming years if it can look beyond the conventional tubes used for Radars, EW and communications and try to work on a very challenging area like the Directed Energy Weapon Systems where VEDs like VIRCATOR, BWO, MILO, Relativistic-Magnetron and the like are used. The expertise acquired in design and development of conventional VEDs is very much relevant here.

The basic technologies like high voltage pulsed power engineering, conversion of beam energy into microwave power, tube processing techniques, testing etc. are similar to those techniques that we have already learnt while working with VEDs.

The need of the hour today is very high power (1 to 10 GW range), multi shot (250 to 500 Hz) devices, which can be operated with reasonably long life. The advantage right now is that even in advanced countries the technology has still not matured and there is lots of scope for improvement and innovation and India can take the leading role.

Some of the challenges are enumerated here:

1. Very High voltage, compact, high PRF pulsed power supplies. (500 kV- 1 MV, 500 Hz to kHz)

2. High efficiency sealed off devices like VIRCATOR, BWO, Relativistic Magnetron, MILO etc.
3. Long life Explosive Emission Cathodes.
4. High voltage dc and RF breakdown issues
5. Extraction and delivery of microwave power. (Low loss plumb lines, high gain antennas etc.)

The other is in the area of Advanced Cathodes:

1. In the country we have the technology to develop thermionic dispenser cathodes with stable emission density up to 20 to 30 A/cm². Of late, the requirements for higher emission density up to 50-60 A/cm² are emerging. (ex: MBK)
2. On the Explosive Emission Cathodes required for HPM devices instead of conventional velvet type cathodes advanced cathodes like carbon fibre cathodes and their variants have to be tried for long life and repetitive operation.

Finding the right industry for technology transfer is also an issue as the requirement in terms of number is very small and initial investment is quite high. So, it is suggested that every VED industry takes up manufacture of cathodes required for them.

Shri R R Patnaik

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I would like to speak on the immediate requirements of VEDs in the coming 3 years in the industry especially in BEL's perspective. The requirements of these VEDs, I will categorize application wise and the respective platforms are:

RADARS:

Rohini / Revathi / TCR / 3D CAR

All these surveillance RADARS use S band CCTWT with 100KW of pulsed power and the requirement is about 100 TWTs immediately, each costing about 1 Cr. This TWT was already developed by MTRDC and it is under quality evaluation.

Swathi:

This RADAR is under production since 5 years. Every year the requirement is about 10 TWTs, including the spares. This is a C band TWT of less than 100KW. This also costs about 90 Lac. This tube is under development with 90% completion.

Atulya:

This RADAR also requires a CCTWT in Ka band and RADAR is undergoing trials. MTRDC is also developing this TWT.

Old RADARS:

SFM, Fly Catcher, Pechora and some surveillance Radars are being used by IAF. These RADARS use Magnetrons and BEL stopped

manufacturing these Radars. Now some of the Magnetrons maybe produced by a private agency in Hyderabad, in collaboration with CEEERI, Pillani.

SAR RADAR:

This RADAR needs lot of MPMs and they are under development. The other Radar which are under production at BEL like Ashwini, Bharani, Krithika and Aslesha are already designed with TR module based phased array antenna. Tubes have already lost the race for solid state devices in these type of Radars.

PAR Radar:

This Radar is used in all airports of our country. It uses X band, Pulsed TWT and MTRDC is working on this.

MISSILES:

Akash:

Large numbers of these missiles are required by Air force and Army. These missiles are controlled by surveillance radar and tracking radar like FLR and TLR. Again these Radars use S band and C band TWTs. Also FLR and TLR use MPMS, which are being produced at BEL.

Brahmos:

This particular missile uses an MPM in Ku band and this development activity is almost ready and QT trials are going on with BEL / MTRDC. Huge requirement of this MPM is there once it is inducted.

Astra:

This is a missile seeker application and the MPM requirements are in Ka band. Again huge orders are there in BEL for this missile.

Akash NG:

This is the latest missile that is being developed by DRDO and this needs a TWT with fast warm-up cathode and this MPM development is

also on the verge of completion at MTRDC with concurrent engineering route at BEL.

Nirbhaya:

The MPM for this missile is already proven but the requirements are not yet clear.

Barrack:

This is a Naval ship based missile and requires a CCTWT in Ka band. The other missiles, which are under production at BEL, are LRSAM, MRSAM, QRSAM and other surface-to-surface missiles like Agni, Prithivi, Nag etc. These do not use any VEDs as most of them are using TR Module based system.

ECM APPLICATIONS:

Earlier Naval platforms were using Ajanta, Ellora, Tempest and Tranquill ECM systems and later on other projects like Samyukta, Sangraha and Samudrika projects used lot of TWTs and BEL manufactured them.

Presently big project requirement is there for Shakti, which requires about 400 MPMs and BEL is producing them with MTRDC design. Till now this TWT is being imported, due to which there is an immediate need to indigenize this TWT with the help of MTRDC in coming 3-4 months. The remaining 300 MPMs should go with indigenous TWT.

AVIONICS:

Till last year Mirage2000 aircraft was using X band CCTWT and the requirement for these Mirages were already manufactured by BEL and fitted in the aircraft. About 80 TWTs were produced by BEL and 10 more TWTs will be required for this aircraft.

Su30, LCA and Jaguar aircraft are using an imported transmitter in X band. This TWT needs to be indigenized immediately. Lot of spares

requirement will come up and MTRDC is working on this TWT development.

DRDO is developing a MALE UAV, Tapas. It uses an X band MPM for communication purposes. This MPM has already been developed and qualified by MTRDC however it was using an imported TWT. If the UAV development is successful, there is an urgent need to develop this TWT in house.

SPACE:

ISRO is using lot of TWTs for Satellite applications. Though BEL/ CEERI developed a C band TWT, it did not go into the orbit. SAC Ahmedabad had started a lab for developing space TWTs with the help of CEERI/ BEL. Huge requirements will come up once these TWTAs successfully fly into the satellite. Till now the TWTs used by ISRO satellites are all imported.

DRDO is trying to launch a LEOS satellite into space and requirement of MPMs for this project is under development.

TROPO SYSTEMS:

Earlier lot of Klystrons were made and fitted into the Tropo Systems. Now most of these Tropo systems are converted into SSPA based systems. Due to this Tropo market for VEDs has virtually vanished. A recent requirement of Ku band transmitter system is coming up with TWT based. Hence this particular TWT need to be indigenized.

HPM SYSTEMS:

As the lower end of the frequency of the VEDs are already replaced by solid state devices, its time for us to either push the frequencies beyond 35 GHz or still work with S and X band that have huge power levels of Mega Watts and Gega Watts.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Mentioned below are the VEDs to be developed for high power systems that are required for hard kill of Drones, Aircrafts etc:

- VIRCATOR
- MILO
- BWO
- Relativistic Magnetrons

So there is an urgent need to develop these HPM sources immediately in our country.

In all if we sum up the above said trends, there will be a VEDs market of 1000 to 1500 Cr in our country. We pray God for successful completion of above envisaged projects.

Part 3

Topic of Deliberation

Thoughts and Deliberations

Speakers

Group Members and Others

Dr. R K Sharma

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There are enough requirements of high power microwave tubes in our strategic, energy and other sectors in our country, but there is a requirement to create an eco-system in which timely delivery of commercial grade devices can be made which can really substitute the imports. For that developers (R&D), users and industry have to work in close coordination (hand in hand) right from the beginning to achieve such targets. CSIR-CEERI is following this and working with ISRO for the development of space TWTs with SAC-ISRO and BEL. Ultimately BEL will take the mass production. We are also trying to work with BARC in the same manner for the development of klystron and with IPR for the development of Gyrotron.

If possible, even if we achieve little less of targeted specs, which can be tolerated, user should try to use the device in the system and feedback can be provided to the developer, which can be further improved. We have to be vocal for the local in order to make import substitution under the spirit of Atmanirbhar Bharat.

Part 4

Topic of Deliberation

Summing up

Speakers

Prof. M V Kartikeyan

Dr. S U M Reddy

Prof. M V Kartikeyan

FIEEE, FIET, FVEDAS, FIE, FIETE, Humboldtian
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There is no good science or bad science; similarly, there is no old science or new science as well. Science is science. One has to enjoy it. So many examples are there including myself who is engaged in the teaching of Microwave Integrated Circuits and Antenna Engineering and do research in high-power gyrotrons. A variety of industrial heating applications of high power gyrotrons are: industrial processing of materials including glass shaping, bending, and tempering. In addition, semiconductor, food and automobile industry also use such high-power beams for specific applications. It is a hundred billion dollar industry as per some of the latest estimates. We work on discrete devices for specific requirement of end-users (DAE, DRDO, IPR, and ISRO). The need of the hour is to develop the complete system but not the discrete devices. So, keeping in view the needs of such exquisite electron devices of much technological importance, we have to form a consortium of academia, R&D institutions and Industries to build the complete systems to showcase our strength. This will be the befitting compliment to “make-in-India” campaign.

Dr. S U M Reddy

President VEDAS, FVEDAS, FIETE, SMIEEE

Outstanding Scientist and Director

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At present Microwave tube development is at cross roads. Below Ku-band solid-state devices have taken over most of the applications except some systems likely to be continued in the field. Hence there is a need to go to Ka-band and higher frequencies. Also the development time taken by all the organizations in the country is too long. Unless we reduce the development time and build the infrastructure required to meet the future requirement, there is a good chance we miss the bus again. Hence the VED community in the country has to take note of the constraints and rise to the occasion and grab the new challenges and opportunities.

Part 5

Topic of Deliberation

Vote of Thanks

Proposed by

Dr. Vishal Kesari

Dr. Vishal Kesari
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Respected Sirs and Dear Thinkers in Vacuum Electron Devices, very good evening to all!

Now, it is time to acknowledge the efforts of one and all playing a role to make this very first webinar a fruitful and successful event.

Let me first thank the organizers for giving me this opportunity to propose the vote of thanks!

I wish to thank Professor BN Basu for his thought of bringing together all the thinkers in VEDs under the thinkers' umbrella. Everyone may be observing his effort to increase the shade diameter of the umbrella by adding the members to our group. He is known for gluing the people from the various organizations of national and international levels for uplifting the R&D of VEDs in India.

He is like a braze alloy in VEDs. As the braze alloy helps in joining the two dissimilar materials, Professor Basu helped in linking the various organisations, groups, senior and younger researchers, R&D laboratories, industrial sectors, academia, experts and beginners.

I remember the call of Professor Basu to me on the Saturday evening of 27th June 2020 for discussing about the creation of a whatsapp group of "Thinkers in VED". One may clearly observe his promptness and pursuance that Mr. Subhradeep Chakraborty created a group on Monday 29th June 2020. Just within two days, Mr. Debasish Mondal designed the logo of the group. Let us thank Mr. Subhradeep Chakraborty and Mr. Debasish Mondal for their efforts.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Coming to the today's webinar, let us thank Dr. Lalit Kumar, Dr. Chandra Shekhar, Dr. P C Panchariya and Prof. B N Basu for their detailed deliberations on the goals of the group in serving the vacuum electronic devices community in India.

Let us thank Dr. S N Joshi, Mr. R R Patnaik and Dr. K S Bhat for their discussions on the country's requirements as well as demand and supply of VEDs.

Further, let us thank Prof. M V Kartikeyan and Dr. S U M Reddy for their summing up the deliberated thoughts.

We sincerely thank the other group members as well as Dr. R K Sharma for putting forward their thoughts and deliberations.

We also thank the convener of the webinar Mr. Raj Singh as well as Dr. Vishant Gahlaut, Mr. Debasish Mondol and others helping him for taking all the pains for organizing this webinar.

We also sincerely thank the family members of the group for their support as well as for sparing some time of their weekend evening to make the webinar a success.

Last but not the least, we very sincerely thank all the participants for attending the webinar and all others who directly or indirectly supported and helped us in organizing this webinar.

Thanks one and all!

Annexure I

Journal Publications by Group Members (Jan 2018 onwards)

Year: 2020

- [1] X. Wang, S. Li, X. Zhang, S. Jiang, Z. Wang, H. Gong, Y. Gong, B. N. Basu and Z. Duan, “Novel S-band metamaterial extended interaction klystron, IEEE Electron Device Letters, 2020. Accepted for publication.
- [2] Varun, A. W. Cross, K. Ronald, and U. N. Pal, “PIC simulation of Pseudospark discharge based plasma cathode electron source for the generation of high current density and energetic electron beam”, IEEE Transactions on Electron Devices, vol. 67, no. 4, pp. 1793-1796, 2020.
- [3] Varun and U. N. Pal, “Impact of Irregular Electrode Apertures in Pseudospark discharge geometries for the generation of high density and energetic electron beams,” IEEE Transactions on Electron Devices, vol. 67, no. 5, pp. 2182-2187, 2020.
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Annexure II

Typical WhatsApp Chats with Thinkers in VED

29/06/2020, 22:46 - Subhradeep Chakraborty created group "Thinkers in VED"

29/06/2020, 22:50 - Dr. Vishal Kesari, You're now an admin

29/06/2020, 22:50 - BNBasu Prof: Congratulations for creating this group!

29/06/2020, 23:53 - Subhradeep Chakraborty: "WhatsApp Group: Thinkers in vacuum electron devices

As advised by Professor BN Basu we create this group for a noble cause. The objective of the group is to create a technical forum or platform in the area of vacuum electron devices in which young researchers could raise technical research problems asking for suggestions. Experienced researchers could suggest solutions to such problems with relevant sources of references. They can also suggest newer unsolved problems. Attention may be drawn to the job advertisements, conference announcements, etc. in the area of vacuum electron devices in this forum. The aspirants for post-doctoral fellowships and jobs in the area in the country and abroad can also post their bio-data in this platform if they wish."

29/06/2020, 23:55 - BNBasu Prof: I endorse what is written by Subhradeep.

30/06/2020, 00:04 - Kartikeyan Prof Roorkee: Excellent initiative Sir (from now henceforth, Sir refers to my teacher and mentor Professor BN Basu Sir) VED is more appropriatemy appreciation to Shubradeep ... he can also take help from my boy Debu Mondal ...

30/06/2020, 00:11 - BNBasu Prof: Nice of you, Kartikeyan. You are a great source of inspiration to VED community! Under your guidance, young researchers would get an opportunity to learn both CRM and Weibel instability devices.

30/06/2020, 00:22 – Subhradeep Chakraborty: Some humble submissions-

1. No spamming, no forwards unrelated to the group.
2. The objective of the group is to create a technical forum or platform in the area of microwave tubes in which young researchers could raise technical research problems asking for suggestions.
3. Experienced researchers could suggest solutions to such problems with relevant sources of references. They can also suggest newer unsolved problems.
4. Attention may be drawn to the job advertisements, conference announcements, etc. in the area of vacuum electron devices in this forum.
5. The aspirants for post-doctoral fellowships and jobs in the area in the country and abroad can also post their bio-data in this platform if they wish.

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

6. Also, please free to share relevant information related to conferences, announcement of special issues of journals related to VED, symposia, workshops, summer schools etc.

7. Any other interesting technical advancements which is important for community to know.

8. No sharing of mems and pictures with no technical meaning.

9. No sharing of political news or discussions.

30/06/2020, 00:23 - BNBasu Prof: I fully endorse.

30/06/2020, 05:12 - SNJoshi CEERI: Very nice idea to create this group. Congratulations to the creator and greetings and best wishes to all the members of this very special group.

30/06/2020, 06:00 - LMJoshi CEERI: Wonderful initiative. I am sure this will prove to be an indispensable platform to exchange ideas amongst the VED community. Thanks to Prof Basu and Dr. Shubhradeep.

30/06/2020, 10:50 - BKShukla IPR Gandhinagar: Thank you BasuJi, it's a fantastic idea to club all the "Pandits of VED" so that vacuum electronics should flourish in country.

30/06/2020, 10:59 - BNBasu Prof: Dr. Lalit Kumar, FINAE, took me to BITS, Pilani to attend a lecture by Dr. Amarjit Singh on gyrotrons. Lalit was then my colleague at CEERI. Lalit was engaged in developing gyrotrons. I was with the TWT group led by Dr. SN Joshi. We were fortunate to receive our guidance from legendary SSS. Lalit gave me hard copies of a few papers on gyrotrons when I was leaving CEERI. Later on I handed over those papers to Dr. AK Sinha at RIT, Jamshedpur (now NIT) when I was leaving Jamshedpur to join Varanasi. We were greatly attracted by the fast-wave device gyrotron. Later on Kartikeyan wrote a book with one of close friends Manfred.

01/07/2020, 07:26 - BKShukla IPR Gandhinagar: This will be a good step and very helpful for the development of high power CW tubes. Proper thermal analysis in transient condition and well-designed cooling structure will give us reliable tube. Whatever help is needed we will be happy to support.

Once again I thank Basuji for wonderful initiative to unite the VED community.

01/07/2020, 08:20 - BKShukla IPR Gandhinagar: Yes, BasuJi, It is most emerging area with great need in future. In fact such center on thermal and structural analysis is much needed for the development of high power CW tubes.

01/07/2020, 08:22 - BNBasu Prof: The VED community is grateful to Dr. Chandra Shekhar and Dr. SN Joshi for extending their support to Dr. AK Sinha in founding the first ever Gyrotron Laboratory in the country at CEERI.

01/07/2020, 10:49 - Subhradeep Chakraborty: Hello everyone, this WhatsApp group is for people studying, practising and professionally involved in Vacuum Electron Devices (VED). Please share the following Group Link with interested people to join WhatsApp group:

<https://chat.whatsapp.com/BVqaXGzRXBgJft2dobpW6d>

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

01/07/2020, 22:04 - Dr. Vishal Kesari: Wednesday, 8 July, 2020, at 3:00pm IST an interactive web-workshop on Structural Analysis using COMSOL Multiphysics.

For more details and to register, please visit: <http://comsol.co.in/c/asdq>

During this session:

- Explore the capabilities of the Structural Mechanics Module™ with COMSOL Multiphysics® for structural modeling and analysis
- Learn how to model structural elements including shell, membrane, beam and truss, structural contacts, non-linear materials, creep and fatigue through a live demonstration
- Learn how you can couple structural analysis with other physics including heat transfer, fluid flow, acoustics and electromagnetics

Sign up for this online event here: <http://comsol.co.in/c/asdq>

02/07/2020, 00:39 - Dr. Vishal Kesari: DST Call for Applications under Accelerate Vigyan (AV) – ‘ABHYAAS’ is now open for winter season (Dec 2020 – Jan 2021).

The aim of AV is to expand the research base in the country, with three broad goals - consolidation / aggregation of all scientific training programs, initiating high-end Orientation Workshops and creating opportunities for Research Internships.

‘ABHYAAS’, a program of AV scheme, is an attempt to boost Research & Development in the country by enabling and grooming potential PG / PhD level students by developing dedicated research skills in selected areas / disciplines / fields through its two components – High-End Workshops (‘KARYASHALA’) and Research Internships (‘VRITIKA’).

For application submission, detailed guidelines and further information please visit – www.acceleratevigyan.gov.in

Another new component ‘SAYONJIKA’ under AV is also launched, as an open-ended program, to catalogue the capacity building activities in S&T supported by all government funding agencies in the country.

02/07/2020, 11:34 - BNBasu Prof: In the late 1970's, Dr. Lalit Kumar and I went to BITS, Pilani to listen to a lecture of Padmabhusan Amarjit Singh on gyrotrons. Dr. Kumar gave me hard copies of a few key papers on gyrotrons when I was going back to RIT, Jamshedpur from CEERI, Pilani. Subsequently, I gave those papers to Dr. AK Sinha at RIT, Jamshedpur. Thus, the gyrotron research was initiated. Subsequently, Mr. HN Bandyopadhyaya of CEERI took interest in the subject. With the support of Dr. Chandra Shekhar and Dr. SN Joshi, the Gyrotron Laboratory was built at CEERI, thanks to the tireless effort of Dr. AK Sinha.

02/07/2020, 13:54 - Dr. Vishal Kesari: “International Conference on Photonics Research”

October 14-20, 2020

Convention Centre of the Liberty Hotels Lykia /Oludeniz in Muğla, Turkey.

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Kocaeli University

Laser Technologies Research and Application Center (LATARUM)

<http://www.interphotonics.org/>

02/07/2020, 15:57 - BNBasu Prof: It is a great honor for the group to have you in our midst. The document of the country's requirements of microwave tubes in the coming ten years that you prepared is the great contribution to the group. It's in my lecture note that could be downloaded from the website <www.bnbasu.com> created by Professor Kartikeyan's student Debasish Mondal, who has also designed the logo of this group. Thank you Professor Chandra Shekhar for your help to Dr. Sinha in creating the Gyrotron Lab at CEERI which the country will remember for ever.

03/07/2020, 15:27 - BNBasu Prof: Hello, My team is looking for a Principal Device modelling engineer, the position is open for US , Netherlands and France. Please let me know if someone has relevant experience and looking for job

https://nxp.wd3.myworkdayjobs.com/en-US/careers/job/Chandler-Alma-School-Rd-Office/Principal-Device-Modeling-Engineer_R-10021075

04/07/2020, 12:11 - BNBasu Prof: Dear All,

Greetings from IEEE MTT-S SBC IITBHU !!!!

Welcome to the webinar 1.0 on ""Probing the Universe via Radio waves: From the Perspective of Microwave Engineering" by Prof. Yashwant Gupta, the Center Director of NCRA-TIFR. There is an overwhelming response in the registration of the same and hence we have decided to go live on both Facebook as well as YouTube platforms in our respective channels at 15:30 hours IST. In view of the same, I request you to join using the two links as follows:

Youtube Live:

<https://www.youtube.com/watch?v=EXuTCkGMUic>

Facebook Live:

https://www.facebook.com/permalink.php?story_fbid=158269925863072&id=101331988223533

With regards,

Somak Bhattacharyya

Sougata Chatterjee

Swapnil Goul

05/07/2020, 10:46 - Raj Singh IPR: Excellent creativity, excellent thinking but a humble request that it should be purely technical, no good morning or good evening, only posts which are related to vacuum electronics devices and it's applications should be posted. Otherwise the meaning of this group will be lost and will become a useless group. So you all are sincerely requested not to post any material unless until it is related to vacuum devices and it's applications. Note that very learned and senior people there in this group, wasting their even one minute will be like crime. When you post some things

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

here it is seen by 100's of learned and senior people. Your one post should be worth of their time. So just spend 2 minutes before posting. Request.

05/07/2020, 11:22 - Raj Singh IPR: Thank you sir. And no Happy Birthday and no RIP also. I am sorry but if we real want to enjoy the benefit of this group, we have to follow these rules. If someone has birth, group admin may intimate on the group and people may wish on personal number of the concerned person and not on this group.

05/07/2020, 12:59 - +91 98705 40010: Last semester I was teaching HPM and recalled how much I have learned through interaction with all seniors and colleagues from VEDA group. I send my greetings and gratitude on this auspicious day. Regards KPRay

05/07/2020, 14:24 - BNBasu Prof: Dr. SN Joshi was the National Coordinator of the DST-sponsored project on the development of the first ever gyrotron in the country. He was the group leader of the first ever TWT developed in the country, too. It was a glass tube using all helical slow-wave structure, couplers and attenuator. Dr. SSS Agarwala was the mentor of the team.

05/07/2020, 14:31 - BNBasu Prof: Professor KP Ray, now at DIAT, Pune, developed the first ever microwave unit in the country for the remediation of hospital waste at SAMEER, Mumbai.

06/07/2020, 20:05 – Subhradeep Chakraborty: Hello,

*We're excited to tell you about changes that we are making to the IET journals portfolio. *From January 2021, all IET journals will transition to Open Access. At the same time, content published since 2013 will also be made free-to-view online.*

We are taking this decision in response to the rapidly changing publishing landscape, which has seen an increasing number of funders and countries moving towards an Open Access model. To support us in this transition, *we have selected Wiley to be our partner*.

From January 2021, Wiley will assume responsibility for all elements of publishing and distributing IET journals, including article submissions, article review, typesetting, production, author support and distribution of journals via the new IET Engineering and Technology hub on Wiley Online Library.

In the next few weeks, you will receive a communication from Wiley providing further information about the transition of IET Microwaves, Antennas & Propagation to Open Access.

We hope that you are as excited as we are in this new development. We'd like to take this opportunity to thank you for your continued support of IET Microwaves, Antennas & Propagation and we hope that you will consider publishing your next article with us.

07/07/2020, 16:44 – Subhradeep Chakraborty: Updated impact factor list of SCI journals

08/07/2020, 08:14 - SNJoshi CEERI: Good morning Subhradeep. Thanks for sharing long list of impact factors of various journals varying from 292 to .017

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

running in 325 pages. Thanks a lot for your initiative in this regard as well related to this page Thinkers in VED , of course with the blessings of Prof.B N Basu.

08/07/2020, 10:32 - Chandra Shekhar CEERI: Scimago classifies journals into four 'quartiles'. In this scheme, top 25% journals of each discipline are together grouped into 'quartile1' group. Thus, variations of impact factors across disciplines are largely normalized. At BITS, Pilani this system of ranking of journals into four classes has been used for some time and various stakeholders seem happy with it. Even some top conferences too fall into 'quartile1'.

08/07/2020, 13:25 - SNJoshi CEERI: Thanks DrBera for providing updates about Gyrotron developed with the support of DST and involvement of 5 organizations. Earlier in this group, I had provided some brief about this Project, which you may look into.

08/07/2020, 13:44 - BKShukla IPR Gandhinagar: BeraJi, Thank for the update. With this development if India can deliver professional commercial Gyrotron at 42GHz, I can include it for my future plan to get the Gyrotron from you for our experiments on tokamak.

08/07/2020, 13:55 - A Bera CEERI: Yes sir I do believe we can deliver if we work together, ofcourse we have to travell a path to overcome some issues. I am very much sure we can develop a professional commercial like gyrotron if we work together

08/07/2020, 14:07 - BNBasu Prof: The CEERI gyrotron group can continue to take guidance from Dr. Chandra Shekhar who significantly contributed to developing the Gyrotron Laboratory founded by Dr. AK Sinha taking support and guidance from Dr. SN Joshi. The building researchers can through this forum interact with Dr. Sinha, Professor Jain, Professor Kartikeyan and ITER-India experts.

08/07/2020, 14:59 - Chandra Shekhar CEERI: 53 kV, 125 kW, 500 microseconds operation for the first ever fully indigenously designed and developed tube - that is truly remarkable. Founding project leader Dr. A.K. Sinha, partnering multi institutional experts with their expertise, peer review and peer input competeces and most importantly the spirit of cooperation are still there. Many younger people trained through the project across all the contributing institutions have only grown more confident. I see nothing lacking.

It is really the demand pull from user side which is required. It can hugely enthuse all the experts, and I can trust them to deliver with much better control on schedules.

08/07/2020, 15:09 - Chandra Shekhar CEERI: Dr. S.N.Joshi, who was national coordinator and Prof.B.N.Basu may also like give their crtical evaluation inputs so that we are fully grounded in reality (some romance should be allowed. It is even desirable). I think Dr. Anirban and his team and the partner institution should be demand-swamped from the user side. That will be this community's true contribution to Atmanirbhara Bharat.

08/07/2020, 20:06 - A Bera CEERI: So far the proof of principle was established for Gyrotron however, a number of issues have to be address to

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Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

develop a commercial Gyrotron useful for tokamak research. One of the achievement of the project is that infrastructure and capability have been created to develop a complete high power long pulse Gyrotron. CEERI is working in this field and exploring the possibilities to develop a Gyrotron in collaboration with IPR so that it can be used for plasma heating system.

08/07/2020, 20:12 - BNBasu Prof: It would be nice if the advertisements for the interviews (including walk-in interviews) in the area of VED and related areas are brought into notice in this group.

08/07/2020, 20:17 - BKShukla IPR Gandhinagar: Yes BeraJi, we need to develop a complete high power long pulse Gyrotron with superconducting magnet which can be used for our heating system. We will give full support so that a professional Gyrotron can be developed in India and as per the comment of Dr. Chandra ShekharJi we will be Atmanirbhar in the field of Gyrotron (thank you sir for your motivational word).

08/07/2020, 20:19 - BNBasu Prof: The members in this group may solicit answers to any basic questions in the area of VEDs. Those knowing the answers may kindly respond. One has to take utmost care to see that no proprietary information goes into this group.

09/07/2020, 10:30 - SNJoshi CEERI: Dear all, it is a matter of great pleasure that the indigenous design and development of the first Indian Gyrotron is being recognized by this group also.

Earlier, In my message I had tried to provide an overall executive summary of this prestigious Project.

I am very much grateful that this item is being discussed in this forum. For the information of all, I would like to share that Dr Anirban Bera along with his team in CSIR- CEERI is already in contact with IPR, Gandhinagar and has submitted a proposal for a commercial Gyrotron, which also has support of Director, IPR. The concerned Scientist in IPR is Dr Shukla. This proposal needs further support from DAE and other agencies. This support would definitely help the team Gyrotronin becoming self sufficient for producing Commercial Gyrotrons. It would also need support from mentors like Prof.BN Basu, supporters like Dr Chandra Shekhar and of course from the System. I also take this opportunity to express my best wishes to respective teams.

09/07/2020, 11:17 - BNBasu Prof: Nice to know the developments from the National Coordinator of the project Gyrotron for the project. Best wishes to Dr. Shukla and Dr. Bera and their respective teams. I believe Dr. AK Sinha, Professor Jain, Professor Kartikeyan, Dr. S Das will continue to extend their help. The contributions of Dr. Thottappan and his team should be meaningful for such a cause. The help from Professor Thumm should be of immense help.

09/07/2020, 11:21 - Dr. Lalit Kumar: I congratulate the leaders and facilitators if Indigenous development Gyrotron in India. I agree with Dr. Bera that we have generated the baseline technology in the are fir 42GHz 100-200 kW, 5 msec gyrotron. Meanwhile efforts for 95 GHz 100kW are also in full swing at MTRDC. The ITER and if such a reactor is to he built in Indua would require 170 GHz 1-2 MW. The user: DAE-IPR and ITER India must find a major program to achieve this.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

09/07/2020, 12:09 - BKShukla IPR Gandhinagar: Thank you Basuji, Joshi Ji, Lalitji for your support and best wishes. Actually Gyrotron is a critical need and professional Gyrotron has to be developed in India. A working Gyrotron has many applications in fusion, industry, medical and defence. Of course we need Professional and reliable Gyrotron at IPR for our plasma experiments. Looking all these we are trying hard for a DAE project to develop indigenous complete working Gyrotron starting with moderate parameters 200kW-100ms at 42GHz so that we can use Indian Gyrotron for Plasma experiments. Our Director is very much interested in the development of high power long pulse Gyrotron and giving his full support.

Dr. Sanjay Malhotra is giving full support to develop magnets (normal and superconducting) for the Gyrotron. At this moment this project is at very initial stage at institute's level so we can not say too much as in the present situation we have to work hard to get an approval from the department.

09/07/2020, 13:22 - SNJoshi CEERI: Shuklaji namaskar. Thanks for your comments. I fully agree for the all out support provided by Dr Sanjay Malhotra, otherwise the Gyrotron would have not seen the light of the day. His involvement would definitely be required in future also.

In spite of the full support of Director, IPR, he will have to take the matter with the higher echelons of the system for getting the project sanctioned. As you all know in the present scary situation of COVID 19, majority of funds are being directed to the health system and also to take care of the lower strata of the Society. However, all of us should try our best at our respective levels to meet our goal.

09/07/2020, 14:11 - BKShukla IPR Gandhinagar: Joshi Ji, sadar abhivadan,

I fully agree with you, now budget for scientific project is limited. This is the reason, we are not in position to say anything related to this proposal. We shall try only. If situation will favor us we may get approval.

09/07/2020, 20:55 - Dr. Vishal Kesari: Recruitment of Scientist B in DRDO closing date 10 July 2020 (tomorrow)

09/07/2020, 21:00 - BNBasu Prof: Wonderful Dr. Vishal Kesari. I was eagerly awaiting this type of contributions to cause of the benefit of young researchers.

09/07/2020, 21:50 - BKShukla IPR Gandhinagar: Sure Sir, we shall plan for it, but after sometime. From tomorrow we are busy with SST1 plasma campaign and in this our 42GHz EC system is mandatory for each shot. We have made our system ready with 300kW - 150ms, we will go up in parameters as per the need. After SST1, I will carry out ECRH Expt on Aditya. So we shall plan after this plasma campaign. We will certainly plan for a definite roadmap for working reliable Gyrotron in India. I am sure India has capability to develop Gyrotron, MTRDC is progressing on 95GHz which will also give us a confidence in developing Gyrotron.

09/07/2020, 22:23 - Sanjay Malhotra BARC: Dear Sirs, I offer full support to indigenous development of gyrotron. This is an important requirement of the forthcoming collaborations and Indian programmes.

09/07/2020, 22:42 – Shyam BHU: As in this group, we have experts in vacuum devices. Some of them are very well acquainted with the components

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

of the device (electron gun, coupler, collector, window), and they all have something to share with us, which will certainly expand our knowledge. So I am requesting to senior members to organize a series of webinars on vacuum electronic devices and components design that will be useful to us.

10/07/2020, 16:29 - BNBasu Prof: Professor KP Maheshwari and Professor Y Choyal to whom goes the credit of developing the first ever relativistic BWO in India have joined our group along with some of their students joined our group. Welcome to the group!

10/07/2020, 17:14 - Y. Choyal Pf. DAVV: Thank you sir for adding us in this group and such nice words.

BWO happened because it is very simple device. We were well supported by MTRDC and APPD, BARC. Extremely grateful to Dr. PH Ron, Dr. KC Mittal and Dr. Lalit Kumar.

10/07/2020, 18:00 - BNBasu Prof: I am happy that Mumtaz has completed the formalities of his doctoral work at IIT-BHU. Professor Thottappan was his supervisor. It would be nice if he could know the avenues for his placement.

10/07/2020, 20:38 - BNBasu Prof: Mumtaz has useful publications in IEEE Transactions on ED and PS in the areas of dual-band relativistic BWO, pulse shortening phenomena in relativistic BWO, high power overmoded relativistic BWO, and so on. For details you may contact Mumtaz and his mentor Professor Thottappan.

11/07/2020, 11:29 - BNBasu Prof: Dr. Sanjay Malhotra and his team joining the group is warmly welcomed. But for his help it became so difficult for the first ever gyrotron in the country to see the day of light. Those who have problems related to magnetic field design may approach him.

11/07/2020, 11:47 - Sanjay Malhotra BARC: Thanks Sir for your kind message. We look forward to contribute in the important area of development of microwave tubes. This has huge requirements within the country and dependence on import needs to be reduced systematically.

Regards Sanjay Malhotra

11/07/2020, 12:10 - SNJoshi CEERI: Good morning Dr Sanjay Malhotra and welcome to this group to you and your colleagues. Though I had mentioned your contributions in my earlier message, I would like to reiterate that the Gyrotron was developed and partially tested also at IPR. However, the contributions of you and your team made it possible to extract rf power from the Gyrotron. The whole Gyrotron team is grateful to you. We would definitely need your role in future also.

11/07/2020, 12:33 - Reddy SUM MTRDC: Dear members of this team. Congratulations to team Gyatron led by Dr S N JOSHI for achieving one important Mile stone. I wish the team further success in the next project. Also as most of you know MTRDC is developing 95 GHz Gyatron. This device will be tested in a month's time. Covid delayed the testing. I want place it on record contribution of BARC team led by Dr Sanjay Malhotra. They have successfully developed the Solenoid Magnet for the 1st prototype and also they are going to develop Super Conducting Magnet for the final version of the device.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

11/07/2020, 13:08 - BNBasu Prof: It is so nice of Dr. SUM Reddy, the Director, MTRDC joining the group. He is also President of VEDA Society of India. He patronized the effort of Dr. Rajib Singh in making VEDs popular among the teachers of Uttar Pradesh technical universities. A couple of years ago, in short-term course at Lucknow, Dr. Reddy, Dr. SK Datta, Dr. Purushothaman, Mr. Subhradeep Chakrabarti, Mr. Raktim Guha, Dr. Vishal Kesari and Professor Subal Kar, the author of 'Microwave Engineering ' under the imprint of Universities Press, delivered their presentations. I attended the course, too. The Proceedings are available in www.bnbasu.com.

The short-term course on VEDs at the Technical University of Uttar Pradesh was immensely enriched by Dr. AK Sinha and Dr. LM Joshi.

14/07/2020, 08:35 - BNBasu Prof: "Know how to ask. There is nothing more difficult for some people. Nor for others, easier."---- Baltasar Gracian (a Spanish writer and philosopher)

14/07/2020, 08:39 - BNBasu Prof: I encourage the young researchers to ask questions of relevance to VED community and thinkers in this group of thinkers.

14/07/2020, 13:01 - BNBasu Prof: Space sector's new frontiers <https://www.thehindu.com/opinion/open-page/space-sectors-new-frontiers/article32051645.ece>

14/07/2020, 13:07 - BNBasu Prof: The above article on Space Sector has been authored by Dr. S Pal. He was instrumental in supporting the initial activities on the development of space-TWTs at CSIR-CEERI.

14/07/2020, 21:54 - Sanjay Malhotra BARC: Sir, collaborative, focused efforts will bring results. Analysis & design tools and beam physics understanding is there. It needs channel and a leader. Right now we are trying a collaborative effort between CEERI, IPR and BARC for one such gyrotron, in a time-bound manner. We request support and blessings of sister institutions MTRDC, BEL and academia. MTRDC is also steering gyrotron development. Let's hope for the best and maximize indigenisation.

Regards Sanjay Malhotra

14/07/2020, 22:05 - UttamGoswami CEERI: Sir, University of Fukui with Mitsubishi has developed a heating system using 28 GHz gyrotron for material processing....so it is a matter of fund, why we are not building a bridge between labs and industries. We have great thinkers and we have very talented researchers in the vacuum tube. We can develop a commercial tube with joint efforts... regards

14/07/2020, 22:25 - +91 99784 07094: We need to recollect the mistakes that were made during 42 GHz project.

We have to become Atmanirbhar for our indigenous fusion reactor by developing 42 GHz and higher harmonic tubes ... Regards uttamgoswami

14/07/2020, 22:56 - BNBasu Prof: The reaction of Mr. Malhotra on the issue raised by Mr. Dilip Sharan is very realistic. Finally, perhaps BEL has to manufacture the gyrotron. A brainstorming session on the issue is warranted.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

14/07/2020, 23:04 - BNBasu Prof: I endorse the view of Mr. Sharan. First the requirements have to be worked out as was done by Dr. Chandra Shekhar for all microwave tubes including the gyrotron. ---BN Basu

14/07/2020, 23:25 - +91 97057 98798: In order to cultivate an ecosystem, we must make of pool of resources which are mutually usable.

Resources: Test facilities, Test Setups, Test Equipment, & most importantly experiences of those tests (even of they're remote to success)

14/07/2020, 23:26 - +91 97057 98798: (even if they're remote to success)

14/07/2020, 23:31 - Chandra Shekhar CEERI: Very glad to share what I just learnt from Dr. Shivendra Maurya of CEERI. They have transferred the know how for a magnetron used in radiation therapy machine to an Indian manufacturer of medical equipment including radiation therapy machines for cancer treatment. The project was supported by DoE, Govt of India as a part of the effort to develop radiation therapy machines.

The project got launched and had completed during my tenure at CEERI.

I am glad to learn that it has now fully fructified.

I do recall the unrealistic time frame that was given for completing the project, and the threat of a stage closure that we had to find a way out of. Fortunately, Dr. Debashish Dutta, group director microelectronics and components could understand the difficulties delaying the project and helped out and today CEERI and DoE have tasted success.

Moral of the story is persevere, persevere in the pursuit of excellence. The world is not perfect. You are bound to face difficulties. Don't give in, don't get disheartened. Only you best understand the importance of your work and you owe it to your society to deliver upon it. So move on... ..and on.

16/07/2020, 09:21 - BNBasu Prof: I have no words to congratulate Dr. S Mourya for this grand success. It's a wonderful welcome gift to Dr. P C Panchariya, the Director, CSIR-CEERI. An attempt to develop a magnetron for the first time in India at the Institute of Radiophysics and Electronics, Calcutta University. Shortly after that Dr. Amarjit Singh took a leading role in developing the device first at CSIR-NPL and then at CSIR-CEERI.

16/07/2020, 09:23 - BNBasu Prof: *magnetron was made

16/07/2020, 09:24 - Reddy SUM MTRDC: Solid state devices are replacing many applications where microwave tubes were used. There is a need to discuss what is the future direction for microwave tubes.

16/07/2020, 09:36 - BNBasu Prof: Dr. Reddy, You may recall Dr. Chandra Shekhar together with Dr. SN Joshi prepared a position paper on the requirements of microwave tubes in India. Now, you may perhaps in the Director level discuss your timely concern with Dr. Panchariya, BEL and other user agencies in view of the competitive incursion of solid state devices. Dr. Chandra Shekhar may kindly show us the path.

16/07/2020, 09:59 - Dr. Lalit Kumar: Dear Dr Reddy

You have raised a very timely issue where the whole VED comm. van put together their ideas. There is definitely a need to assess the future trend

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

based on global developments in view of disrupting technologies (such as the one you mentioned and others like active phased arrays) as well as new opportunities. The 5G onwards comm. tech. would require mm-wave devices for the last mile connectivity. HPM, plasma heating?, and appl. in industrial, agricultural, environmental, scientific and space applications, microwave power transmission etc. would offer new exciting opportunities. The foundations of devices for these techs. has to be laid now. (we pretty well know our device development takes decades).

We must also definitely assess the current and near future needs of the VEDs for systems and vigorously work on those. I see huge proliferation of work on planar devices and innovation to enhance performance on all fronts.

16/07/2020, 10:03 - Reddy SUM MTRDC: Can we have a brain storming session on this. In fact this can be the first video Tele-conference of this group.

16/07/2020, 10:08 - +91 88020 64566: it's really a good topic and even a question for the researchers to think about...

what I personally observed that "can solid state devices bear the power in watts at microwave frequency range?" but microwave tubes can... however we have to think over the miniaturization of the vacuum electron devices... that can be achieved by reducing the requirement of external guiding magnetic field and many other prospective...

16/07/2020, 10:13 - +91 88020 64566: even if we talk about the 5G requirements... the technology require the power source and amplifiers that can bear watts of power at mm range of frequency... beside this if we talk about HPM devices that can generate the power in MW to GW range for very short durations about 100 ns, which is again not possible with solid state devices...

16/07/2020, 10:43 - Chandra Shekhar CEERI: I think the community needs to brainstorm and update (1) current device scenario and power levels achieved and potential for VEDs and Semiconductor Devices in the entire frequency spectrum from L-band to THz.

This could be the topic of an online technical meeting of this group. We may invite members of this group to review and present their findings by dividing the entire frequency spectrum into 3 or 4 sub-spectra. For each spectral range, one can have a team of 2 or 3 members. 1 or 2 members can present the current technological status of all devices in that spectrum and another two members can present the status of applications at the global and national levels.

This technical meeting should later be followed up with a second meeting with a review of our national application needs (in view of planned programs of the users).

The earlier work done at CEERI leading to a position paper on MWTs can serve as an existing base line.

16/07/2020, 10:50 - Chandra Shekhar CEERI: The second meeting shall form the basis of identification of devices and their specs, which then can be used for formulating specific R&D programs.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

16/07/2020, 10:51 - Chandra Shekhar CEERI: The existing base line document can then be revised and updated.

16/07/2020, 11:25 - Reddy SUM MTRDC: Dr Chandrasekhar has nicely decided the work. I think we can have the meeting sometime in the end of this month so that all of us get time to prepare. The position paper can be shared to this group if it is not confidential.

16/07/2020, 12:59 - Chandra Shekhar CEERI: Position paper is not confidential. It is available with CEERI in the PME section as a part of the record of Research Council meetings.

16/07/2020, 13:09 - Chandra Shekhar CEERI: When created, it was meant to provide an authentic user side requirement scenario with which CEERI as a development agency could work to synergize user needs, external funding and inhouse resources and plans for infrastructure augmentation.

16/07/2020, 13:18 – Subhradeep Chakraborty:

<https://www.tandfonline.com/doi/full/10.1080/09205071.2017.1375646>

16/07/2020, 13:21 - Subhradeep Chakraborty: The following paper authored by Basu Sir, published in the Proceedings of URSI-RCRS 2020, is really insightful and provides significant information.

Title: Scenario of R&D in Microwave Tubes in India vis-à-vis Global Trends

16/07/2020, 13:22 - Subhradeep Chakraborty:

<https://ieeexplore.ieee.org/document/9113543>

16/07/2020, 14:50 - BNBasu Prof: Kindly see page 97 onward of the pdf for the summary of the position paper on the requirements of microwave tubes in coming ten years presented by Dr. Chandra Shekhar in 2006.

16/07/2020, 18:17 - Kartikeyan Prof Roorkee: Congratulations Dr. Shivendra and the Magnetron team members. My warm wishes and compliments to Shri Sharda Prasad Ji, Dr. Harish Da, and Dr. Vindhya Vasini Bhratashri for mentoring the group so affectionately. I too was a part of the Magnetron team during 02/2000-06/2001; and I really appreciate the dedication, sincerity, and team work and culture of the scientific fraternity in the group.

I take this opportunity to thank an entire array of our illustrious senior colleagues and teachers: Professor BN Basu Sir, Dr. SN Joshi Ji, Dr. Lalit Kumar Ji, Dr. RS Raju Ji, Dr. LM Joshi Ji, Dr. Vishnu Srivastava Ji, for providing necessary guidance and carefully nurturing the younger generations over decades. Kudos to all of you.

Warm regards,

Kartik from IIT-Roorkee

16/07/2020, 18:45 - KSBhat MTRDC: I am K S Bhat, retired from MTRDC, Bangalore. I worked on high power TWTs and various types of cathodes including those for use in HPM.

I am really overwhelmed to see the kind of response and enthusiasm that this group has created. It's really matter of pride that in the country we have developed devices like magnetrons, klystrons, TWTs and the whole range of

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

devices and established the technology in the country. But this is only the beginning. Our real success is when these products reach the users.

I feel, in India there is always a big gap between the development and delivery. Many products do come out successful but late. By The time we say it's ready user doesn't require it any more. This is one aspect that we as research community must address.

The second aspect is funding. We in the country have the best of the brains but unfortunately the least of the resources. Compared to many developing countries where they spend more than 1.5 to 2 percent of their GDP our expenditure on R&D is about 0.5 percent of our GDP. So funding is also a problem.

The third aspect is the lack of skilled manpower. Our manpower as of now in R&D and production centres must be at least doubled if we have to meet the present challenges. Also many bright minds who get trained here look for greener pastures elsewhere. The loser is India.

The fourth and most important of all is high vacuum grade materials which we are import dependent. I don't see a solution to this in a near future.

May be together we should find solutions to the above aspects.

Regards to all

Dr K S Bhat

DRDO Fellow at MTRDC.

16/07/2020, 19:12 - Patnaik BEL BLR: In addition to DrBhat's views, the bigger problem lies in translating the designs into saleable product, mostly by Defence Forces by completing the QT procedures where we are not able to run the last lap of the leg in many a product. The manpower at BEL is totally depleted and virtually nobody left in the operator level. In spite of repeated requests from MTRDC management is not able to induct skilled manpower who can translate the designs into commercial product. This aspect needs to be addressed immediately,

16/07/2020, 19:15 - Patnaik BEL BLR: The design of any product can be done especially in mm wave tubes and THz devices. But how to translate them into products is another problem to be addressed as the dimensions involved are in microns.

16/07/2020, 20:01 - Seshadri MTRDC: In today's situation younger generation are not keen in the area of VED and really a lot of persuasion is needed to make them work due to uncertainties in job opportunities and the technological advancements in the area of solid state devices that will be dominating in the near future especially upto Ku band. This is a great concern.

16/07/2020, 22:11 - BNBasu Prof: Let us all move forward with the positivity in our mind for the development of self-reliance in the strategic areas we are working on. For the progress of our country all the organizations have to work together. Young researchers should be aware of the limitations and with this awareness move forward and take a leading role. If we have the determination, we will succeed.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

16/07/2020, 22:12 - +91 88020 64566: exactly sir... we have to be motivated for each and every upcoming task as an opportunity...

16/07/2020, 22:33 - BNBasu Prof:

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- EMC Standard Overview
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- Points to be considered while performing / establishing EMC Test / facility
- EMC System Calibration and its importance
- Typical System & Chamber Layout

21st July 2 PM to 3 PM: Antenna Measurements & VNAs

- RF Connectors
- S Parameter Basics
- What is Vector Network Analyzer
- Calibration & its types
- Antenna Measurements
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17/07/2020, 00:15 - +91 97236 65881: Young people can learn new things quickly, better control of simulation tools and use advance problem solving techniques. Senior people have in depth knowledge and expertise in particular area of interest. To achieve success they have to work together as a team for single goal. *Therefore respect and positivity form each other much needed.*

17/07/2020, 12:05 - BNBasu Prof: I had a word with Dr. Ayan of CEERI belonging to this group. According to him, Dr. Mourya has done a commendable job that would lead to the commercialization of magnetrons. Dr. Panchariya, the Director, CEERI, with his passion as usual of him, would see to reach the goal. So, I as well as young researchers like Mumtaz am very much encouraged. We have to reach our goal.

17/07/2020, 15:01 - Dr. Lalit Kumar: It's a great success story. The major breakthrough in this is: a private co. pitching in to manufacture magnetrons in

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

India. There is a significant market for those for medical and scientific apps. Most western countries have stopped manufacturing those. Hope the company will get enough orders to sustain as it a high-risk high investment and low volume business. Congratulate Dr Maurya his team mentors and collaborators. I see in it culmination of tireless efforts over several decades coming to fruition. The timing signifies a good omen for the new Director Dr Panchariya. Hope CEERI would continue to support the firm and continually improve the product reliability life and yield which are crucial for a new player to sustain in the market.

18/07/2020, 10:05 - BNBasu Prof: <https://youtu.be/ZVxHeJTbSjc>

19/07/2020, 10:22 - +91 98153 09603: Good morning. I am looking for good source of metallized and nickel plated beryllium oxide. Kindly help. Regards..Guriqbal

19/07/2020, 11:12 - BNBasu Prof: Hats off to you, Guriqbal from BN Basu. That the first ever carcinotron was built in India under the leadership of your father Dr. GS Sidhu at CEERI will be remembered forever by the VED community in India. The electron tubes manufactured by you in one go are indicative of the success of your company at Sangrur, Punjab.

19/07/2020, 11:19 - BNBasu Prof: I reiterate the request of Guriqbal for informing him of the good sources of metallized and nickel-plated beryllium oxide.

19/07/2020, 12:28 - Raman Rao MTRDC: (1) CBL ceramics, UK
(2) American Beryllia, USA

Supply metallised BeO ceramics.

19/07/2020, 12:32 - Raman Rao MTRDC: 16 First Avenue
Haskell, NJ 07420
Tel: 973-248-8080, Fax: 973-248-8012

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19/07/2020, 12:35 - Raman Rao MTRDC: *C B L CERAMICS LTD*

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**Proceedings First Webinar on
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19/07/2020, 14:29 - +91 98153 09603: Thank you Sir. I attribute PET's success to Dr. G.S.Sidhu and his colleagues. Best Regards...Guriqbal

19/07/2020, 15:13 - Dr. Lalit Kumar: Metallized Berrilicm oxide is rather rare to get these days. Most VEDs now use Aluminium Nitride which has comparable and even better props. for some apps. 3M Ceradyne is a major source. You may find a few others on net. MTRDC and DMRL have jointly worked on this technology and may offer some advice.

19/07/2020, 15:28 - SNJoshi CEERI: We got an opportunity to visit Pilani Electron Tubes and Devices Private Limited (PETDPL), established by Dr GS Sidhu, Ex CEERI. In our first visit we were astonished to see the facilities set up in a short time by Dr Sidhu and they were getting almost hundred percent yield in development of Power Triodes. In established organisations, having excellent infrastructure, it becomes very difficult to get such yield. His Son Mr Guriqbal has been associated with this Company and has acquired excellent knowledge in this vital area, which is very creditable. Now his elder brother Mr Daljit has also joined this organisation. I express my best wishes in their endeavours.

I thank Prof. BN Basu for including him in this group.

19/07/2020, 15:31 - Dr. Lalit Kumar: May I just add that, Dr Sidhu is also credited with the development of a family of coaxial triodes, Multicavity klystron, induction heaters at CEERI and a founder of the only company in pvt. sector producing VEDs in India. I always wished they could diversify to take up more devices. All the best to Dr Sudhu, Guru Iqbal and their team.

20/07/2020, 08:56 - BNBasu Prof: Yes. It would be nice to have the meeting online as suggested by Dr. Panchariya preferably beyond the office hours or on any Sunday. The young researchers have to please take active role in the meeting. Hence, the agenda points may be suggested by the group members.

21/07/2020, 08:53 - BNBasu Prof: The status of the development of VEDs in our country has vividly been placed by Dr. Bhat and reiterated by Mr. Patnaik. This could be some of the points of agenda of the upcoming online meeting suggested by Dr. Panchariya. The other points may be added by young researchers. Professor Chandra Shekhar, Dr. Lalit Kumar, Professor PK Jain, Professor Kartikeyan, Dr. AK Sinha, Dr. LM Joshi, Professor Choyal, Dr. Thottappan and show paths to us. Thanks again to Dr. Panchariya and Dr. Raj Singh for taking the initiative. Dr. SN Joshi has always been with us. There are numerous students looking forward to knowing the potential in the area.

21/07/2020, 09:07 - BNBasu Prof: Guriqbal from PE, Sangrur and BEL members may kindly give the inputs to Dr. Raj Singh in connection with the issues to be deliberated upon in the meeting.

21/07/2020, 14:00 - SNJoshi CEERI: Dear Prof. Basu,

I am glad to know that a meeting is being planned to discuss about Vacuum Electron Devices and Mr Raj Singh of IPR will be coordinating it. I have few following points. Some of them may be discussed in the first meeting (-as all cannot be taken).

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

1. There are enormous requirements of these devices in various systems of different sectors. However, we have limited R&D Centers, Production Agencies as well as Academic Centres in this vital area.
2. Vacuum Electron Devices need several technologies, special materials and infrastructure. Still on date, we are dependent on foreign suppliers, as in the Country they are available in limited amount. Same is the status of Cathodes, High Energy Magnets and special Ceramics.
3. Methodologies have to be established for pooling the resources as well as special infrastructure available in the Country.
4. All efforts should be done to reduce the lead time in the development of the devices using different measures.
5. The user agencies should also keep some flexibility in specifications, particularly for new type of devices. Best of the best Specifications may be avoided (unless very essential for the performance of the System).
6. University-Lab-Industry linkage needs to be promoted.
7. One Position Paper was prepared by CSIR- CEERI quite some time back, after taking inputs from different user agencies as well as from Industries, R&D Organisations and Academic Agencies. This exercise needs to be repeated again and either CSIR- CEERI or MTRDC, Bangalore may take this role of getting inputs from different agencies by formulating a required questionnaire for getting the inputs. It may then be discussed in a Committee.

These are some points, which have come to my mind at this point of time.

Regards,

SN Joshi

21/07/2020, 14:34 - Reddy SUM MTRDC: MTRDC can get inputs defence users. CEERI Pilani can take inputs from Space and other users. Also request the meeting can be held on some working day may after office hours so that participation will be more. These are important matters we are discussing. I don't think anybody will bother about using office time.

21/07/2020, 16:53 - +91 75700 06188: One can involve system developers like Pancea (who have taken know-how on magnetrons from CEERI recently, I suppose), ECIL (who were mandated during 2012 for supply of cargo scanners to all ports in India) and others. From a need perspective, system developers can also provide good insight.

22/07/2020, 10:46 - +91 75700 06188: Friends, I am away from microwave tubes research activity since around 2000, but was active in industry to follow-up on its requirements up to 2009-10. But, since I have been added in this group, I feel it is my prime duty to provide my inputs, in whatever way, I can. Please find attached my 2-3 observations and suggestion. These are based upon my understanding and I may be completely wrong also.

22/07/2020, 13:12 - BNBasu Prof: I am proud to inform all that Professor KP Ray and his blessed team of DRDO-DIAT, Pune have invented the machine ATULYA for neutralizing Covid-19 using a 800 W, 2.45 GHz magnetron. Hats off to him and his team!

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

22/07/2020, 15:32 - Chandra Shekhar CEERI: While our research publications are our communications aimed at our peers (only they can understand and appreciate them), our patents and device level technology deliveries are our communications with industry, our system level technology deliveries are our communications with the public at large, because the public can understand and appreciate their benefits. That is the fruition of the innovation chain that starts in the mind and ends at the market. Unless the mind to market chain is closed often enough public at large will neither understand nor appreciate the efforts of the Scientific community. Atmanirbhara Bharat is really about closing this chain whose individual links have been built over the years but not that effectively chained.

22/07/2020, 21:31 - Patnaik BEL BLR: Congratulations to Prof Ray n his team at DIAT. Is the magnetron used in the system, similar to the one used in our microwave ovens. Or else it can't be that cheap. The frequency is same that of a microwave oven.

22/07/2020, 22:27 - +91 92696 26411: Sir, I have some curiosity regarding this invention.

Is the corona virus killed because of the temperature created by the microwave heating effect or due to some other effect of the microwave? Because if it is killed due to temperature, then the required time of microwave radiation to achieve a fixe value of temperature will be different for a different object. How will a common people decide the required radiation time for a particular object?

Is there any IR temperature sensor attached to it that will tell us how much temperature is being generated on that object due to microwave? For safety purposes also it is important to know the value of temperature on object because the amount of power is high.

If this high power microwave emanating in the wrong direction by mistake then a big accident can happen because the energy of emanating radiation is not visible to us and the common man does not know. The reflected wave can also create a safety issue.

23/07/2020, 00:08 – Uttam Goswami CEERI: Sandeep,

From my understanding, this microwave sanitizer is for dielectric objects only and since corona virus is a biological tissue/organisms having volatiles inside DNA structure and as we all know that MW heating principle is based on loss tangent of dielectric material. Very common microbial load or bacteria are E-coli and salmonella which has fatal temp as 60 to 65 degree and not survived if exposed to microwave radiations. I thought that this is the base of this invented technology.

23/07/2020, 08:37 - BNBasu Prof: Mr. Sanjay Malhotra from BARC informs that the N25 mask sanitizer using microwave heating with humidity control has been developed. Better than resistive damp it saves the crucial filter. The filter was tested after treatment and found intact. Mr. Malhotra can elaborate the invention further.

23/07/2020, 09:11 - Dr. Lalit Kumar: Congratulations Dr KP ray on this achievement. I hope the product would find use in many scenarios requiring

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

volumetric sanitization. it would be nice to couple it with bio-sensors (optical or MEMS based at a distance to see the efficacy and set the timings. I would suggest it may be hybridized with UV(A/B for ozone production for sanitizing hidden areas) and UVC rays alone.to enhance efficacy if metal objects are present too.

Adding UV is simple as UV lamps are easily available commercially.

Incidentally I made a UVC cabinet at home for sanitizing objects you don't want to make wet.

23/07/2020, 09:16 - Surendra Pal Prof: Dr. Lalit Kumar: In larger interest of the public share your design. In vegetables market in Indore this is being done. I wish to make my self. Request share procurement source, design and also how effective it is? Whether radiation doses are sufficient for such a sturdy virus which did not get eliminated even in harsh summer of India, middle east and part of Africa.

23/07/2020, 09:22 - Dr. Lalit Kumar: I could do that. However, as regards efficacy, I have gone through published reports. It is not the heat, it is the ionizing energy of the 254nm UV

23/07/2020, 09:35 - KSBhat MTRDC: https://servotech.in/lp/uv-lamp/?utm_source=google&utm_campaign=search&utm_medium=ads&gclid=CjwKCAjwx9_4BRAHEiwApAt0zgMGK18pbftZ1CEbigESGVFxAmcuEeoBel1WgdAapdigrdVFbjyByxoCs2kQAvD_BwE

24/07/2020, 16:02 - Chandra Shekhar CEERI: <https://phys.org/news/2020-07-physicists-technology-microwaves-optical.amp>

27/07/2020, 09:49 - KP Maheshwari: Dear Professor Basu, Thanks for your kind efforts for bringing cohesiveness within VEDA members. It has brought to the knowledge of members of the type of works being done. This will promote and inspire further research work. I am at present involved with the research work related to ion acceleration as a result of intense laser interacting with thin plasma foil (plasma mirrors). Thanks for your inspiring efforts. K P Maheshwari.

27/07/2020, 10:47 - Datta S K MTRDC: Could anyone make a one page White Paper as to what frequency and power levels are required for W-band to THz range MVEDs in Indian Scenario indicating the applications.

This would greatly help in formulating our future plan.

Members need not send the references or review papers. We have sufficient of those.

Let us restrict to only one page write-up.

I will compile the responses and make a final document.

We have talked sufficiently. Let us get to the point and contribute.

In order to excite the debate: In my opinion we do not need any THz MVED in India. Solid State would suffice our need.

Let us get concrete feedback from the members.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

27/07/2020, 10:57 - BNBasu Prof: Nice of you motivating me and our young researchers doing excellent work in the area of VEDs encompassing plasma-assisted devices.

27/07/2020, 15:11 - SNJoshi CEERI: Doctor Datta, you have raised significant issue. I feel such paper should come from user agencies. Unfortunately, if I am correct, we have only limited numbers from them. It would be worthwhile to have such inputs from them.

27/07/2020, 18:16 - Dr. Lalit Kumar: If we want to know the Indian requirement, the reps. of major organizations: DRDO (Defence and Para military services through them), CSIR, ISRO, DAE and DEITY have to put forward their SPECIFIC present and future requirement. However, in such a frequency domain considering the long gestation period of technology, we need to forecast the GENERIC requirements, based on Global trends in application and device areas.

27/07/2020, 20:49 - Chandra Shekhar CEERI: The question is who catches the trend first and defines the direction and possible specs for Device R&D: the Device Designer or the System Designer or the end user.

Who has the best foresight?

The best practical solution in this scenario is to allow device researchers to follow trends and target "reference specifications" to build expertise and facilities. The output expected would be improved "expertise and facilities readiness level"

System designers can leverage that by providing actual specifications for devices when they are ready.

So, R&D work and funding should start in right earnest with "reference specs" in device "directions" agreed upon between device designers and system designers.

That is the only way when no single oracle has all the detailed wisdom.

28/07/2020, 10:43 - Raj Singh IPR: Dear All, as you all are waiting, we are holding the first ever meeting of Thinkers in VED on this Saturday, 1st of August from 5:00 to 6:15. List of speakers and tentative schedule will follow. We have kept the meeting on Saturday because many members expressed their unavailability on working days because of their other assignments.

28/07/2020, 22:36 - Dr. Lalit Kumar: I wish to bring to the attention of the VED community about the developments in GaN technology. Please refer to the abstract of a plenary talk to be presented in IVEC2020 in Sep., 2020 by Sarbanti Chowdhary, Professor, Stanford Uni. on: Advances in Wide Bandgap, High Power Density Semiconductor Devices, which talks of taking the GaN devices from 10kW- 10MW
[//ieeivec.org/assets/img/speakers/Srabanti%20Chowdhury%20Abstract.pdf](http://ieeivec.org/assets/img/speakers/Srabanti%20Chowdhury%20Abstract.pdf)

28/07/2020, 22:36 - Dr. Lalit Kumar: I wish someone in the group gathers info on the current status and trends in the competing technology of GaN technology, which would sooner or latter replace the VEDs.

28/07/2020, 22:50 - BNBasu Prof: Dr. SK Datta, along with me, in the guest editorial on a special issue on microwave tubes of J. EM Waves and

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Applications (posted earlier here a few days ago) highlighted the issue. I am wondering if Dr. Datta opts to take the responsibility of gathering the relevant information for the benefit of the group as suggested by Dr. Lalit Kumar.

29/07/2020, 08:23 - Datta S K MTRDC: Some of us at MTRDC are already trying to keep a track of the competition.

That's why I raised the concern a few days ago.

As mentioned by you, in the Guest Editorial of the special issue of JEMWA we tried to map the competition.

29/07/2020, 11:43 - Dr. Lalit Kumar: I am thankful for your response.

I know that the community is conscious of the threat and has written articles on the subject and keeping track.

The point I wish to make is that the technology in the competing areas is advancing very fast. Hence it is essential to not only know the status today but make prediction for the near/far future to factor it into our VED plan. The future prediction part can be best done by involving people from the GaN community at SSPL and IISc.

30/07/2020, 08:38 - Debasish IIT Roorkee: This is glad to inform that Thinkers in VED WhatsApp group is organizing a meeting on "Recent Trends and Challenges of Vacuum Electronic Devices in Indian Scenario".

Meeting#1 Schedule:

Date: 1st Aug 2020, Saturday

Time: From 5 to 6-15 pm

Convener: Mr. Raj Singh

Speakers:

05:00 - 05:15 pm: What should be the goal of the group? Dr. Lalit Kumar, Dr. Chandra Shekhar, Dr. P C Panchariya, Prof. B N Basu

05:15 - 05:35 pm: Requirement of VEDs vis-à-vis demand and supply. Dr. S N Joshi, Dr. R R Patnaik, Dr. S Kamath, Dr. K S Bhat

05:35 - 06:00 pm: Thoughts and deliberations. Group members

06:00 - 06:15 pm: Summing up. Prof. M V Kartikeyan, Dr. S U M Reddy, Dr. S K Datta

06:15: Vote of thanks: Dr. V Kesari, Mr. Raj Singh

Registration Form:

<https://docs.google.com/forms/d/e/1FAIpQLScybXeZhYGpvh3LBxNiINah0iHz8CTqq8PKjPsXlviDimN3Ag/viewform>

Online Meeting platform details (Google Meet) will be shared soon.

30/07/2020, 11:11 – Vishant Gahlaut Bansthali: Good Morning All!

Please find the google meet link regarding our upcoming meeting "Recent Trends and Challenges of Vacuum Electronic Devices in Indian Scenario" scheduled on August 01, 2020 at 5 pm.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

<https://meet.google.com/jgh-korz-cig>

Where 250 people can join the meeting with NO Time bar.

30/07/2020, 22:43 - Dr. Lalit Kumar: Free Mini Circuits Microwave calculator on android/ IOS phones

30/07/2020, 22:43 - Dr. Lalit Kumar:

<https://play.google.com/store/apps/details?id=com.minicircuits.android.mclcalc>

31/07/2020, 10:13 - +91 75700 06188: <http://www.healair.io>/Plasma based disinfectant air for Corona control

31/07/2020, 10:13 - +91 75700 06188: This can overcome some difficulty of UVC to provide disinfection even in a corner, not sighted by UVC.

01/08/2020, 11:12 - Raj Singh IPR: Dear Participants, 31st July 2020

It is an honour for us to invite you on behalf of the VED Thinkers Group to kindly participate and enrich the group in a webinar on

"Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario"

scheduled to be held at 05:00 PM on 1st August 2020.

The programme details appended at the end of this letter.

We sincerely believe that your participation and deliberation in the meeting will immensely benefit the Group and especially young researchers in their professional careers.

The platform for the meeting is the link: <<https://meet.google.com/jgh-korz-cig>>.

With sincere regards,

Raj Singh (Convener of the meeting on behalf of VED Thinkers Group)

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Programme of the Webinar:

Date: 1st Aug 2020, Saturday

Time: From 5 to 6-15 pm

Convener: Mr. Raj Singh

Speakers:

(1) 05:00 - 05:15 pm:

What should be the goal of the group?

Dr. Lalit Kumar,

Dr. Chandra Shekhar,

Dr. P C Panchariya,

Prof. B N Basu

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

(2) 05:15 - 05:35 pm:

Requirement of VEDs vis-à-vis demand and supply

Dr. S N Joshi,

Dr. R RPatnaik,

Dr. S Kamath,

Dr. K S Bhat

(3) 05:35 - 06:00 pm:

Thoughts and deliberations among Group members

(4) 06:00 - 06:15 pm:

Summing up

Prof. M V Kartikeyan,

Dr. S U M Reddy,

(5) 06:15: Vote of thanks:

Dr. V Kesari,

Mr. Raj Singh.

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01/08/2020, 12:43 - BNBasu Prof: Goal of the Group:

I set from my personal end the following goals of the group:

(1) One of the goals of the group is to work as a satellite of the VEDA Society and hence serve the cause of R&D in vacuum electron devices. The group members may please take the membership of the VEDA Society if they are not as yet. They may also please arrange the VEDA Society membership of their organisations.

(2) The goal is to create a platform for the expression of thoughts of younger group members. The group is supposed to explore and encourage them. Through this platform, younger group members should be able to point out the different aspects of relevance including their aspirations and related challenges and problems.

(3) The goal is also to appeal the senior group members, who are in the helm in the area, to create the opportunities for jobs as well as for the postgraduate, doctoral, postdoctoral and sponsored research fellowships and arrange lab and industrial training, in the country and abroad, for younger group members.

01/08/2020, 19:18 - Dr. Vishal Kesari: Respected Sirs and Dear Thinkers in Vacuum Electron Devices, Very good evening to all!

Now its time to acknowledge the efforts of one and all, who played a role to bring this very first webinar a fruitful and successful episode.

First thank the organizers for giving me this opportunity to propose vote of thanks!

I wish to thank Professor BN Basu for his thought of bringing together all the thinkers in VEDs under thinkers' umbrella. Everyone may be observing he is

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

keep increasing the shade diameter of that umbrella by adding the members in the whatsapp group. He is known for gluing the people from various organizations of national and international level for uplifting the R&D of VEDs in India.

He is like braze alloy in VEDs. As the braze alloy helps in joining two dissimilar materials, Professor Basu also helped in linking various organisations, various groups, senior and young researchers, R&D, industry and academia, experts and beginners, etc.

I remember the call of Professor BN Basu to me by a Saturday evening of 27 June 2020 for discussing about creation of a whatsapp group on "Thinkers in VED". One may clearly observe his promptness and pursuance that a group is created by Mr. Subhradeep Chakraborty on Monday 29 June 2020, just in two days for which logo is designed on 1 July 2020 by Mr. Debahish Mondal. Lets thank Mr. Subhradeep Chakraborty and Mr. Debasish Mondal for their efforts.

Coming to the today's webinar, let us thank Dr. Lalit Kumar, Dr. Chandra Shekhar, Dr. P C Panchariya and Prof. B N Basu for their detailed deliberations on goal of the vacuum electronic devices community in India.

Secondly, we should thank Dr. S N Joshi, Shri R RPatnaik and Dr. K S Bhat for their discussions on national level Requirement, demand and supply of VEDs.

Further lets thank Prof. M V Kartikeyan and Dr. S U M Reddy for their Summing up the deliberated thoughts.

We must thank other group members for putting forward their thoughts and deliberations.

It is also required to thank the convenor Mr. Raj Singh and his team including Dr. Vishant Gahlaut, Mr. Debasish Mondol and others for taking all the pains for organizing this webinar.

Last but not the least, I would like to thank all the participants for attending the webinar and all others who were directly or indirectly supported organization of this webinar.

01/08/2020, 22:46 - Kartikeyan Prof Roorkee: Dear Colleagues and Friends:

On behalf of the august gathering of today's webinar, I sincerely thank: (i) Professor BN Basu for mentoring the activities, (ii) all the participants for their unflinching support, enthusiasm and endurance, and (iii) Dr. Dr. Raj Singh (IPR), Dr. Vishal Kesari (MTRDC), Mr. Shubradeep Chakravorty (CEERI), Mr. Debasish Mondal (IIT-Roorkee), Dr. Vishant Gahlaut and others for organizing the webinar so meticulously. I may kindly be pardoned, if I miss anyone.

02/08/2020, 10:05 - Raj Singh IPR: Dear all, it's my pleasure to thank you all participants of yesterday's webinar. After four months of lockdown we could somehow open the lock of our scientific discussions across the different labs and institutes all over the country. The talks and discussions were full of information, knowledge and material. The material that we accumulated from different talks of eminent scientists of this webinar will be a subject of discussion for a long period, may be through out the year. This was a starting point from where the building of AtmaNirbhar Bharat will be build at least in

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

VEDs and Semiconductor devices. We have to take this legacy till the END. Till the DELIVERABLES. Deliverables r must. Anything less than that shouldn't be acceptable to us. So let's make this small step towards building our country self sufficient in VED requirement. HOW it will be, we will discuss in further discussions with one determination that we CAN do it and we WILL do it.

On behalf of organising committee of this Webinar, I thank all distinguished speakers who found the time out of their very very tight schedule and shared their knowledge. Thanks Distinguished Speakers.

I will also convey my sincere thanks to my teammates Debashis, Dr. Vishant, Dr. Subhradeep, Prof. Kartikeyan, Dr. Vishal, who worked very hard for making this webinar a success. Thanks to all participants again. Have a nice weekend.

02/08/2020, 10:39 - BKShukla IPR Gandhinagar: Thank you BasuJi for excellent initiative. Yesterday webinar was very informative and successful. We see there is great demand of tubes in recent future. We need to adopt a professional approach to cater this need with indigenous development. This VED platform can certainly show a path to nation in the field of microwave tubes.

I thank Dr. Raj Singh, Dr. Kartikeyan, Dr Vishal and all team members for hosting a successful webinar.

02/08/2020, 10:52 - SNJoshi CEERI: Good morning and my greetings to all the members of this very vibrant group.

I hope the torch lit by Prof. BN Basu of this particular group, will be taken forward by our esteemed young members with their active participation and sustained support from their respective senior members as well as from the mentors.

I hope you all must have enjoyed yesterday's deliberations. On behalf of everyone, I would like to thank Dr Raj Singh of IPR for convening the meeting and the entire support team (I am not putting up their names) for making this event very lively. I specially thank Dr PC Pancharia, Director CSIR- CEERI and Dr SUM Reddy, Director, MTRDC and anticipate their continued support for the growth of VEDs in the Country.

We definitely missed the presence of Dr. Sudhir Kamath, DG, DRDO, Dr PK Jain, Director, NIT, Patna and few others, who could not participate due to other prior engagements. My special gratitude to Dr Chandra Shekhar, former Director, CSIR- CEERI for providing his sustained support to these activities, particularly in CEERI.

I also thank Prof. MV Katikeyan for his concluding remarks and Dr. Vishal Kesari for proposing vote of thanks.

02/08/2020, 11:19 - Raj Singh IPR: I am sorry, I forgot to thank, captain of my team, in fact our team, Prof. Basu, who took the initiative to start this fruitful activity. Hats off to you sir for taking this challenging and fruitful step.

02/08/2020, 20:12 - BNBasu Prof: "Vacuum electron devices (VEDs) have played a central role in electrical engineering almost since the birth of the

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

profession near the end of the nineteenth century. However, despite all the successes of VEDs, including the Voyager twin spacecraft, which are still chugging along, logging 35 000 miles an hour as they zoom farther and farther into the cosmos, forty years after their launch, VEDs are still cast in a negative light. Recall Senator Lloyd Bentsen's comments on NBC's program Meet the Press during the 1988 United States Presidential Campaign as Michael Dukakis's candidate for Vice President: 'You can't compete if you build vacuum tubes in a solid-state world.'

"Of course, nothing can be further from the truth. Although solid-state microwave devices are making progress in achieving higher output power levels, they have important limitations (electrons transport in a solid-state medium in solid-state devices, whereas electrons are 'free' in vacuum in VEDs) that will prevent them from overtaking VEDs. VEDs play essential roles in communications, manufacturing, healthcare, homeland security, defense, manufacturing, the food industry, and in many other areas."

Edl Schamiloglu (from the Foreword of the book: V. Kesari and B. N. Basu, High Power Microwave Tubes: Basics and Trends, Volume 1, Morgan and Claypool Publishers, San Rafael (California)/Bristol: IOP Publishing (2018))

03/08/2020, 09:03 - Chandra Shekhar CEERI: Please take the comments of VED vs Semiconductors in the context of building digital logic circuits and computers.

Fundamentally, a transconductor is required for any signal amplification and also storage. All analog and digital functions need a transconductor. Triode valve, BJT, UJT and FET are all different ways of realizing a transconductor. When you need high output powers, the VED transconductors win. When you want to create a circuit that needs many thousands or millions of transconductors, the MOS FET transconductors and the IC technology to interconnect them serves the best.

People are still actively searching for newer ways to realize transconductors, because they so fundamental to Electronics.

03/08/2020, 09:05 - Chandra Shekhar CEERI: *they are so fundamental to Electronics.

03/08/2020, 09:43 - Reddy SUM MTRDC: To bring down drones Jammers are available. Still people are working on HPM to kill drones. Any reason for this.

03/08/2020, 10:06 - Raj Singh IPR: Sir, please post only VED related things on this group. We r sorry but that is the way we r maintaining this group. Extremely sorry for the inconvenience.

03/08/2020, 10:10 - Chandra Shekhar CEERI: In fact, initially the MOS FET based IC technology had started as a low-power but slow-speed technology. At that time the BJT based DTL, TTL and ECL technologies were the technologies of choice in that order for increasing speeds. However, the speed disadvantage of MOS technology was soon overcome, while maintaining its power advantage. Theoretically it was established (by Dennard of IBM labs.) that you can go on scaling down the MOS FET device dimensions and circuit's operating voltage in such a way that you can go on increasing the number of transistors per unit area, operate them at

increasingly faster speeds and yet not increase the power consumption per unit area. This theoretical prescription made for successive generations of MOS technologies that realized MOSFETs with successively smaller dimensions which operated at successively higher speeds while still keeping power consumed per unit area constant. Thus, roughly two dozen technology generations evolved over the last 50 years - a breathtaking technology evolution, unparalleled in human history.

Now scaling down of dimensions has apparently hit fundamental physics barriers. MOS FETs with sizes less than 3 nanometres are the envisaged limit.

Currently 5 nm technology line establishment is underway in Taiwan and Korea, and Intel Company has dropped off tired from this technology race only last week.

03/08/2020, 10:17 - Chandra Shekhar CEERI: Vacuum Microelectronics devices conceptually hold a great promise - if a high current cold cathode / emitter with a long life and reliable operation can be found.

03/08/2020, 10:33 - Chandra Shekhar CEERI: For my younger colleagues let me point out that an emitter junction of a BJT (or the source terminal of a MOSFET is really a cold emitter of electrons (with voltage controlled emission rate). Fortunately for semiconductor devices the electrons (or holes) need to be emitted only into the same material, albeit with opposite doping. Thus the emission barrier is only the work function difference between the two oppositely doped materials, which is relatively small. By contrast, VEDs need emission of electrons into vacuum, and thus the emission barrier involves the full work function of the cathode.

In a sense, a reliable, long life low current electron gun is trivial to design and fabricate in semiconductor devices as opposed to an electron gun in VEDs. To my understanding that is the crux of the matter in VMEDs.

03/08/2020, 10:38 - Chandra Shekhar CEERI: I also would like younger colleagues to think in terms of sheet beam VMEDs, because an etched indentation where the sheet beam is launched can serve as the interaction region at the end of which a collector can collect the spent beam.

03/08/2020, 11:03 - +91 95217 21812: Thank You for such valuable suggestions. I have come across some articles where researchers have come up with the concept of nan-channel vacuum transistors. They are claiming this device to have better radiation and temperature immunity and also faster response. The field emitter is one of the critical components of the device. Also, lateral and vertical structures have been fabricated. Though they are calling it a vacuum channel but instead of vacuum, there is air. They have made the channel length smaller than the mean free path for the ionization. So, in this case, the nm fabrication and the field emitter technology is very critical.

03/08/2020, 12:49 - Chandra Shekhar CEERI: In fact collisionless travel in a gas (if the travel distance is significantly shorter than the mean free path for collisions with gas atoms) is like travel in vacuum only, though dielectric constant may differ from vacuum due to presence of the gas.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Even in semiconductors, an extremely small channel length makes for a collisionless (ballistic) transport of electrons. But there, not only dielectric constant is different (corresponding to the material), but the effective electron mass is also different, corresponding to the material. And, interestingly, this effective electron mass can be less than the mass of a free electron in vacuum. Does this mean such a semiconductor material for short distance charge transport can be a better medium than vacuum? I think the answer is yes. A quasi particle of charge 'q' with a mass less than that of a free electron 'm' should be a better transporter of charge in a solid material over short distances than would be an electron in vacuum over similar short distances. Will that challenge VMEDs?

03/08/2020, 13:28 - +91 95217 21812: Thanks a lot Sir. I hope there is a way to model such kind of devices with such short channel length. With vacuum as the media, I think it may be possible but with regarding the semiconducting media, I have no idea.

03/08/2020, 14:28 - Dr. Lalit Kumar: Maya Meyappan at NASA developed a vacuum transistor way back in 2012

<https://www.sciencemag.org/news/2012/05/return-vacuum-tube>

I had during my time at MTRDC had discussed with some people in CENSE at IISc. But perhaps the time was not ripe. We have most of the facility to do such work in India but someone from the nanotechnology hastobe encouraged to take up such work. Dr. M Ravi CEO CSTAR having background in VED and now in microelectronics/MEMS or people at CEERI may be the right people to initiate such work.

03/08/2020, 14:41 - Chandra Shekhar CEERI: Thanks Lalitji for bringing this piece of research at NASA to my and many other group members' attention. Let us use all ideas as inputs to try and hypothesize something better.

03/08/2020, 15:43 - Raj Singh IPR: Dear All, we are compiling all the material including talks, discussed in our webinar#1. The work is being done by a team under the supervision of Dr. Vishal. Speakers are requested to send their talk material to Dr. Vishal by email with a copy to Prof. Basu. Participants may also send their inputs to Dr. Vishal.

03/08/2020, 17:04 - Ghanshyam Singh: As DrLalit Kumar refere that Science article is interesting and in that nanovacuun devices is explored. Even this article has published on 2012 but still now there are lot of scope. The sources and detector in THz regime of the spectrum for healthcare Industry, ITS (vehicular Industry) and homeland security.

03/08/2020, 20:06 - Dr. Lalit Kumar: It would be nice that some of the seniors from the major institutions: CU, NPL, CEERI, SAMEER, BARC, MTRDC, IIT BHU, DELHI, ROORKEE, DAVV, NIT Trichy and many new centers nay contribute to compile a history of Vacuum electronics in India. There are a few articles some of us have authored, which can become the baseline and expanded to make a good historical document. I also request the people at helms in the major institutions to archive relevant records.

I invite reactions/suggestions from all colleagues.

03/08/2020, 20:38 - Subhradeep Chakraborty: Dear young VED researchers,

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Witnessing the enormous responses and supports received from the VED community of our country a second online meeting is being planned. All the Young researchers, doctoral and post-doctoral fellows are requested to kindly share/float their suggestions/questions/queries to "vedthinkers@gmail.com" by on or before 31st August for possible inclusion in the agenda of next meeting.

We look forward to hearing from you all.

With best wishes,

Admins

03/08/2020, 20:45 - Dr. Vishal Kesari: Dear Colleagues,

Additionally in the said proceedings, we are planning to bring out a list of journal publications by present group members in the past two years (January 2018 onwards). I request all the members to send the details of their journal publications in the area of VED in IEEE format to my email: vishalKesari@gmail.com on or before 30 Aug 2020.

Requesting the cooperation of group members.

Regards

Vishal Kesari

04/08/2020, 06:08 - BNBasu Prof: The Convener of #1 Webinar wishes that the speakers may kindly send the Abstracts of their talks to him through email keeping me in copy. He is thinking of bringing out Proceedings of the meet and include there these Abstracts. He also requests the other group members to send their remarks to be included in the Proceedings. I solicit the cooperation of one and all.

The Abstracts may be sent to the Convener (RS) or Dr. Kesari (Vishal).

05/08/2020, 15:26 - Kartikeyan Prof Roorkee: Explanation for the specific query of Dr. Sadeep Vyas on mobility and conductivity [Courtesy - my colleague Dr. Vishvendra Poonia (IITR)]: Let's look at the qualitative definitions of both conductivity and mobility. Conductivity is the ability of a material to transport carriers (electrons or holes) upon an external excitation (electric field or heat). Mobility is how quickly a carrier (electron or hole) can move across a material when an electric field is applied. Conductivity depends on the product of carrier concentration and mobility, more precisely: conductivity (σ) = $nq\mu$ where μ is the mobility and n is the number of free carriers in the material. In metals, n is generally 5-6 orders of magnitude (or even more) larger than semiconductors. The mobility of a carrier is deterred by the collisions that it encounters in its path. Electrons in metals undergo more collisions therefore the mobility of electrons in metals is generally one order of magnitude smaller than that of semiconductors. But effectively the conductivity of metals is more than that of semiconductors owing to a large excess of carriers therein.

05/08/2020, 15:40 - BNBasu Prof: Thanks so much for sharing the contributions from Dr. Poonia. The concept is helpful in the context of the discussion initiated by Dr. Sandeep Vyas from Seoul National University.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

05/08/2020, 16:26 - Chandra Shekhar CEERI: This is an excellent explanation. If one wants to look at conductivity and mobility only from an operational or user point of view, then one can see them as follows:

Conductivity is the proportionality constant that relates current density in a medium to the electric field in the medium.

Mobility is the proportionality constant that relates average electron velocity in a medium to electric field in the medium.

05/08/2020, 16:30 - Chandra Shekhar CEERI: *conduction current density (rather than current density) to be precise.

05/08/2020, 16:35 - +91 92696 26411: Thank you Prof. Kartiken sir for replying to my questions.... I have removed the questions as I thought might be its a silly question thanks again for showing interest in it and explaining it.. Raj Singh sir has told me to put the question again in the group.. So I am sending the question.

05/08/2020, 16:39 - +91 92696 26411: Why metal's mobility is lower than semiconductor while conductivity of metal is much higher than semiconductor, actually we want to relate conductivity and mobility effect on the electron beam emission from a cold cathode.

05/08/2020, 17:02 - Chandra Shekhar CEERI: As Prof. Kartikeyan has already explained, conductivity involves the product of electron concentration and mobility (because it relates current density in a medium to electric field in the medium).

05/08/2020, 17:12 - Chandra Shekhar CEERI: Materials with high electron mobility can still be poor conductors (having poor conductivity) because the electron concentration in them can be very low. In fact, intrinsic semiconductors (having no doping) have very poor conductivity, because they have a very low electron-hole concentration, even though they possess a high mobility. When they are doped with n-type material, then conductivity of the same semiconductor material increases by orders of magnitude because of orders of magnitude increase in their electron concentration (w.r.t. intrinsic material), while mobility remains the same.

05/08/2020, 17:21 - Chandra Shekhar CEERI: In fact, it should not come as a surprise that many insulators have very good electron mobilities. The reason they are insulators is because they do not have free electrons (that can leverage that mobility to transport charge and thereby set up conduction current).

05/08/2020, 18:08 - +91 70047 27085: Thank you Sir for the explanation. I think that mobility will decrease with increasing doping concentration in a semiconductor and will not remain same as that of intrinsic semiconductor. Although the conductivity will increase with doping concentration.

05/08/2020, 18:42 - Dr. Vishal Kesari: From COMSOL

Respected Dr. Kesari,

Join us online on Wednesday, 12 August 2020, at 3:00pm IST for an interactiveweb workshop on Structural Analysis using COMSOL Multiphysics®.

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For more details and to register, please visit: <http://comsol.co.in/c/augp>

During this session, you will:

- Explore the capabilities of the Structural Mechanics Module™ with COMSOL

- Multiphysics ® for structural modeling and analysis

- Learn how to model structural elements including shell, membrane, beam and truss, structural contacts, non-linear materials, creep, and fatigue through a live demonstration

- Learn how you can couple structural analysis with other physics including heat transfer, fluid flow, acoustics and electromagnetics

This web workshop also includes a Q&A session with the instructor to discuss any questions or doubts you may have.

Sign up for this online event here: <http://comsol.co.in/c/augp>

I look forward to seeing you there! Feel free to invite your colleagues too.

Best Regards,

Ashwin S. Mecheri,

COMSOL, Phone: 080-6738 3620

Email: Ashwin.S.Mecheri@comsol.com

05/08/2020, 20:44 - Chandra Shekhar CEERI: Indeed mobility reduces in doped semiconductors due to an additional electron scattering process - by ionized impurities (that is not there in the case of intrinsic semiconductors). Also electron-electron scattering increases due to increased electron concentration. Consequently, there is a reduction in mobility, but that is usually by a factor of 2 or so. But the increase in electron concentration via doping is by a factor of around tens of thousands to millions.

05/08/2020, 20:49 - Chandra Shekhar CEERI: Thus, as a zeroth order approximation one can say that doping changes electron concentration without affecting mobility.

05/08/2020, 21:12 - Kartikeyan Prof Roorkee: Also, please see Chapter-8 of "Introduction to Solid State Physics by Charles Kittel (8th Edition: Wiley Press)" for further reading. It's a beautiful book.

06/08/2020, 15:44 - Raj Singh IPR: Dear All, keeping the track live, we are announcing the tentative program for the second webinar, to be held on 5th September, at 4:45 to 6:45 PM. The first webinar was well appreciated by VED community for its timely execution, talks, contents and discussions. The gap between two webinars has been kept of around one and half months, not too small not too large. Gap may be increased or decreased depending on your feedback. Please do write to us your opinion freely about webinars and related activities.

06/08/2020, 15:47 - Raj Singh IPR: *Tentative Programme of Webniar#2*

5th September 2020

04-45 pm---06-45 pm:

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

Convener: Mr. Raj Singh

Chair: Dr. Lalit Kumar

Vote of Thanks: Dr. B. K. Shukla

Topic 1: Past and present status of the magnetron development in the country and the efforts at CSIR-CEERI leading to the product development for users: Dr. S. Moyurya

(Duration: 30 -- 40 mts)

Topic 2: Series 1: Research *contributions of younger researchers in VEDs:*

Contributors: (i) Dr. Manpuran Mahato, (ii) Mr. Mumtaz Ansari, (iii) Dr. S. Yuvaraj, and (iv) Dr. Richards Joe

(Duration: 1 hr 20 mt -- 1 hr 30 mt)

Host: Dr. N. Purushothaman

06/08/2020, 22:13 - Raj Singh IPR: Group email is vedthinkers@gmail.com

Members can mail their suggestions on this email also.

07/08/2020, 11:10 - Raj Singh IPR: A Conclave on Transformational Reforms in Higher Education under National Education Policy-2020 is being organized online by UGC, MHRD on 7th August, 2020 from 10:00 AM onwards. The Inaugural address in the Conclave will be delivered by the Hon'ble Prime Minister.

Please participate in the Conclave using the below live streaming links:

MHRD Facebook Page:

<https://www.facebook.com/HRDMinistry/>

UGC YouTube Channel:

<https://www.youtube.com/channel/UCIbbWYTjSiXnhShJ0Z1-05g>

UGC Twitter Handle:

https://twitter.com/ugc_india?s=12

07/08/2020, 13:35 - SNJoshi CEERI: We should try our best to involve industries as well as users from different sectors in this group. This joint participation would be very beneficial in particular to young researchers of VED. Kindly remember that A part of VEDA has lot of significance. Unfortunately, we still have very less involvement of A. That should be one of the very important priority of the senior members of this group.

After this exercise, we should hold a Webinar involving all related agencies (R& D labs, Academic agencies, User agencies from different sectors and Industries). This type of Webinar or Seminar would help in creating a future direction for VEDs, which is essential in particular for young researchers as well as to Heads of different organizations to take care of them by remaining in touch with the higher echelons at different levels.

Another point about the time interval between two Webinar, I feel it should have a gap of at least three to four months in the major Webinars involving all concerned.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

This is what has come to my mind at present.

With best wishes to all,

SN Joshi

07/08/2020, 15:30 - BNBasu Prof: Could we reduce three to four months gap suggested by Dr. Joshi to two to three months? Let's discuss on the issue. I endorse the remaining thoughts of Dr. Joshi. It would be nice others including our younger friends also give their opinions.

07/08/2020, 20:10 - Dr. Vishal Kesari: In my opinion, quarterly one meet may be planned. Each meet may be limited to one and half hour. We may have 1) one senior and two junior speakers, 2) two senior speakers or 3) four junior speakers.

09/08/2020, 17:13 - Chandra Shekhar CEERI: <https://www.ndtv.com/india-news/here-is-list-of-101-defence-items-banned-for-import-by-india-2276602>

09/08/2020, 17:53 - Chandra Shekhar CEERI: Systems people should be consulted to look at and identify opportunities for VED development and (viable) production inherent in this decision of the government. It is designed to attract investment for defence production in the country - foreign or local or joint. It is neutral in terms of technology sourcing - indigenous or foreign, as long as production is done in India. My hunch is major prospective investors would like to engage consulting companies to locate and evaluate technology sources and advise them. Our labs should get involved in the process and actively bring themselves on the radars of consulting companies and consultants. Please notice the subtle shift implied here: government only cares for the local production of systems. System developers will choose who their subsystem or component level OEMs are. This leaves the decision of sourcing of these OEM parts on the techno-economic viability of such sourcing, whether from foreign sources, or local manufacture based on foreign or local technologies. Government is unlikely to insist on through and through indigenization of technology down to component or material level. Government seems primarily concerned about attracting private investment into setting up of local production of defence systems and associated job creation. So, component developers like VED community would now have to adapt to this environment where shots would be called by the private sector.

09/08/2020, 18:05 - Chandra Shekhar CEERI: We will be required to seek projects from private sources to fit ourselves in this new firmament of enhancement of defence production in the country through increased privatisation of defence technology and production base in the country.

10/08/2020, 10:22 - Dr. Lalit Kumar: Our labs should get involved in the process and actively bring themselves on the radars of consulting companies and consultants.component developers like VED community would now have to adapt to this environment where shots would be called by the private sector.

10/08/2020, 10:44 - Dr. Lalit Kumar: Dear Dr Chandrasekhar, the above are taking home points from your comments. It is time to aggressively showcase our achievements, capabilities and technologies and facilities to attract companies wanting to setup shop here. The laboratories have to facilitate

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

what is called as GOCO (Government Owned Company Operated) model to facilitate pilot/ batch production, The VED industry being a high investment high risk and low volume industry Indian companies would hesitate investing in capital equipment. On the other hand we should be ready for VED MNC's setting up shop here, sucking your manpower and gradually decimating the Indian R&D (unless enough safeguards are put in place by the government). R&D activity which aims at 'indigenizing' a device available commercially elsewhere would have no future. This would lead to a paradigm shift in our R&D to work for innovation rather than reinventing the wheel. I think that is definitely progress but at a heavy price. Our institutions, the mind set of people, is risk-averse and we do only those things which have succeeded/ proven elsewhere. Our funding agencies and audits are the first institutions which should change their philosophy and procedures.

10/08/2020, 10:45 - Dr. Lalit Kumar: <http://www.nrdcindia.com/LatestDetail/38>

10/08/2020, 11:25 - Dr. Lalit Kumar: LINK TO WIPO WEBINAR:

<https://register.gotowebinar.com/register/8428108879339929355>

10/08/2020, 11:34 - Dr. Lalit Kumar: Dear Prof Basu 1. Thanks for your initiative and am glad to know that Drs. Raju and Bhat would be organizing a webinar on the very crucial technology of cathodes. Dr Bhat has closely worked with for ToT of cathodes to BEL and Dr Ravi has also worked with FICCI for commercialization of this technology.

10/08/2020, 11:38 - Chandra Shekhar CEERI: I completely agree with you Lalit ji. There is a clear paradigm shift involved. The community, particularly it's younger members need to understand the shift clearly. Defence sector is a completely government controlled large sector. It was, so far, served equipment by three means: (1) outright import (2) ToT and licenced production by Defence PSUs (3) Indigenous design and development by DRDO productionised by Defence PSUs.

The new decision throws open this sector to private production based on foreign/ indigenous/mixed sources of OEM technologies.

I have heard of DRDO-ANURAG and a defence PSU being marked for shut down. VED community will have to survive by innovation and linkages. There is no other way. We have skills - without a question. We had begun to think and innovate. So, there should not be any worry. Given the high design skills and low cost highly skilled technical manpower India has a great potential to become a design and production hub for global supply of VEDs. Who would lead this effort? Most likely some MNC. In VLSI design we had seen this phenomenon 25 years ago. There, India offered a huge advantage in design and huge disadvantage in manufacturing technology. Consequently, India has become a global hub for VLSI design (on the back of private MNC investment) and has had no private investment in VLSI manufacturing - not withstanding continuing government exhortations.

In VEDs I clearly see India's advantage in both design and manufacture. So, we will see both flourish with private (largely MNC) investments. But government labs would have to reposition themselves and reconnect in the new value chains that will emerge.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

10/08/2020, 11:39 - Dr. Lalit Kumar: 2. Just a suggestion about the contributions to the webinar proceedings: Any information contained in the articles should either have been taken from the open literature with relevant reference or authorized to be disclosed by the present/ former employer of the author to avoid any complications as some articles would be dealing with confidential information: name of program, frequency, power level, application etc.

11/08/2020, 09:58 - Chandra Shekhar CEERI: Wherever services are buying DRDO developed, Defence PSU produced equipment, there would still be an opportunity to "indigenise" VED components to secure supplies of spares and replacements for future - as these systems have long field lives and also see upgrades. That will be one kind of market segment for government labs.

The second market segment will come from global front running in research.

11/08/2020, 10:03 - Chandra Shekhar CEERI: Today, DRDO designed, Defence PSU produced systems may well be using imported VED components, but securing the supply of those components for a long time in future will require their "indigenization".

11/08/2020, 10:05 - Chandra Shekhar CEERI: Huge systems may get dysfunctional otherwise. Also, system upgrades would need upgraded versions of crucial VED components.

11/08/2020, 13:01 - Vishant Gahlaut Bansthali: Good morning to All,

Please find the link below for full video recording of 1st meeting held on August 01, 2020.

<https://drive.google.com/file/d/1BIU2ecGMG5Mhh0Et6O00vdeB0bL25zt4/view?usp=sharing>

11/08/2020, 22:29 - Student BNB Mankundu: Dear learned group members,

Very recently I came across a invaluable document titled "Technology Vision 2035" prepared and published by Technology Information Forecasting Assessment Council (TIFAC), an autonomous organisation set up by DST, Government of India. I am sharing the main document for your kind perusal.

11/08/2020, 22:40 - Student BNB Mankundu: In another document titled "Technology Roadmap on Information and Communication Technologies" in the same series, Respected Prof Chandra Shekhar Sir was one of the key contributor in preparation of the exhaustive document. The document (size 150 mb) is very relevant to the people belong to Electronics Engineering and allied disciplines and available from in TIFAC website.

12/08/2020, 10:59 - Chandra Shekhar CEERI: What Dr. Dwivedi makes is a great point. It would need the most experienced human resources (in terms of Technology application domain breadth and user linkages)of the community to set up a TRAM. Industry associations can provide a platform and linkage-umbrella.

They wouldn't be able to able to provide the expertise - unless some of the VED group members are fielded by them as their representatives on TRAM.

One can also explore sourcing institutional support from the forum of IETE.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

12/08/2020, 16:14 - Harish Dwivedi: Yes. IETE can also be a part of this. Also, the team from VED-involved in such work will find itself highly enriched in domain breadth in coming 1-2 years.

Friends,

With new ideas coming in to find Applications and for developing technologies for next decade or so in VEDS, I thought of following suggestions for VEDA:

1. Create a TRAM (Team for Research & Analysis on Market) or TRAN (-Need) - Any other name can also be given- I am just being nostalgic about Kolkata Tram. The team can be given a mandate to study markets with long and short term perspectives with following guidelines:

a. Team will focus only on Market/ Need and its Impact value (both at national and global level): Information is scattered, but can be assembled.

b. Team will not think of technology, while conducting the study. However, it can think of VEDs, only on three major scientific aspects (i) mean free path (as medium dimension) — it can be single or multiple (explained earlier in this group, I think by Dr Chandra Sekhar); (ii) Charge Dynamics; (iii) Electromagnetics. One can add or delete more scientific aspects (but try to keep it minimum), but will certainly not analyse VED technology vis-à-vis market.

c. There is an understanding with successful industries, which says— “if need/market and its impact is understood, technology will be available, sooner or later”.

d. 1-2 industry /market analysts should be part of this team. FICCI/CII/ASSOHGM may help here. Private VED industry people can be persuaded to join.

e. The team will have milestones for each need study.

2. Customized Survey:

a. A separate team from VEDA can work on firming up tie-ups with major secondary/ primary user agencies for commitment for sharing of their needs on long term basis.

b. OR VEDA can start a drive to induct members from Users (private and Public, both) in its fold. An independent periodic status report from VEDA with such tie-ups will help generate information from an observer’s perspective from time to time.

c. Although different labs will be doing it on their own.

3. TRAM feed will be consumed by TREAD (Team for Research & Evaluation of Applications vis-à-vis Design) to covert needs into possible design approach and technology needs (which may or may not be available, at an instant of time).

4. I do not expect VEDA to do more than above, as it does not conduct R&D. But its feedbacks with periodic reports will add critical value to help Government/ industry/labs to frame policies/directions.

13/08/2020, 15:29 - Raj Singh IPR: As Dr. Dwivedi said and endorsed by Dr. Chandra Sekhar, there are two things Demand and Supply. A clear-cut picture

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

is must for taking any further step. It is very essential that someone has to find out the requirement of VEDs in the country and abroad and can we fulfil that demand. What r the requirements to fulfil that demand? Are the resources required are available and sufficient? And if today we r not in a position to cater final solution or end products, can we provide component level help and get the end product made from outside or other way round.

One thing is sure that to give a viable solution we have to deliver the requirement to the user. User may be defence, it may be Govt. or it may be private users or companies. A minute and through analysis is required to do something useful. We should know the requirement and should know, up to what extend we can be helpful in getting those requirements fulfilled. Then we have to see how to fulfil that requirement.

In order to make these things more deliverable oriented, I suggest opening a start-up or a company, owned, controlled and operated by superannuated Govt. Officials and unemployed researchers and Scientists. Superannuated senior and experienced Govt. Officials can be the controlling and guiding authority while researchers can be the workforce or executives. This company can work on No Profit No Loss basis. Every person involved or working in this establishment will get the remuneration as per his contribution towards achieving the targets or goal. In that way experience and time of retired experienced and willing Scientists can be used efficiently and unemployed researchers will get job and country will get indigenous products. Someone may say that these things are already being done by private companies. But private companies are doing with profit motive and hence are not interested in taking risk. To start new things one need to take risk. The motive of this establishment will be development of technology and deliverables. Projects will be taken from Govt. This establishment will work as a consulting firm also. And as it will be based on no profit no loss basis, everyone will get sufficient amount of remuneration. We would like to get comments on this line of thinking. Space and other Govt. approvals can be arranged and the company can be established. Getting projects and complete these products will be collective responsibility. If you feel some substance in it, please feel free to comment or suggest. Minute details can be worked out, once the idea is approved.

13/08/2020, 16:34 - Harish Dwivedi: Very thoughtful observation. Excellent. Will identify critical points and try to address by Sunday (the only free day during this lockdown).

13/08/2020, 16:40 - Harish Dwivedi: In the meantime, one can find 1-2 groups, which did similar exercise at a lower level and while working on VEDs involved system experts and converted parts of work for societal applications.

13/08/2020, 20:37 - +91 98809 86248 left

13/08/2020, 21:50 - Raj Singh IPR: (1) Young researcher group members: Please present your work on this platform through ppts each restricting to 10-15 slides in webinars to be arranged in future, from time to time. One such webinar is going to be held on 5th September 2020 (Webinar#2). (Webinar#1 was held on 1st August 2020).

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

(2) We are planning to hold our next Webinar#3 on Cathodes: Trends and Challenges, sometime in November 2020.

(3) We have decided to say 'yes' to the Students Branch of IEEE-MTT Society at IIT-BHU in case they arrange a webinar lecture tentatively in October 2020 by Dr. S K Datta on a topic around 'Safety for VED engineers with due attention to microwave hazards'. It will be an opportunity for us to join them in the said webinar. Some of the members of our group are working for this parallel program on VEDs at IIT-BHU.

(4) FUTURE WEBINARS TOPICS:

DEAR MEMBERS, PLEASE ADD TO THE FOLLOWING LIST:

(A) Cathodes: Trends and challenges;

(B) Position paper for the requirements of VEDs (with industrial inputs including those with respect to VEDs and their components as well as VED based systems, for defence and space sectors for the benefit of PSUs. (It will be a follow-up of (i) the document prepared earlier by CEERI and (ii) the continuation of the vivid presentation by Mr. R R Patnaik in Webinar#1);

(C) Experience of developing the first ever TWT in India;

(D) Experience of developing the first ever relativistic BWO in India;

(E) Experience of developing the first ever gyrotron in India;

(F) Safety measure from microwave radiation;

(G) Microwave power module;

(H) Microfabricated/ vacuum microelectronic VEDs/Terahertz VEDs;

(I) Magnetic fields for VEDs;

(J) Depressed collectors; (K) Electron guns;

(L) Cooling systems for and thermal and structural analysis of VEDs;

(M) Power supplies and EPCs for VEDs;

(N) VED based transmitters;

(O) HPM devices;

(P) Gyro-devices (CRM and Weibel instability based);

(Q) Klystrons and klystron variants;

(R) Plasma-assisted VEDs;

(S) Plasma based switches;

(T) Metamaterial assisted VEDs.

14/08/2020, 09:15 - Dr. Lalit Kumar: global industry outlook reports for various industries are periodically done and commercially sold. one such report is available costs USD 5-10k some institution can possibly buy

https://www-persistencemarketresearch-com.cdn.ampproject.org/v/s/www.persistencemarketresearch.com/amp/market-research/microwave-tubes-market.asp?amp_js_v=a3&_gsa=1&usqp=mq331AQFKAGwASA%3D#a

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

oh=15973764451196&referrer=https%3A%2F%2Fwww.google.com&_tf=From%20%251%24s&share=https%3A%2F%2Fwww.persistencemarketresearch.com%2Fmarket-research%2Fmicrowave-tubes-market.asp

14/08/2020, 09:17 - Dr. Lalit Kumar:

<https://www.advancemarketanalytics.com/reports/41716-global-microwave-tubes-market>

14/08/2020, 10:01 - Dr. Lalit Kumar: In my opinion the identification of indian requirement is a minor issue. The major issue is the gaps in our capability to design and develop the devices in a reasonable time. We can mostly achieve 80-90 % specs. but the last mile issues are a big challenge. Those issues unfortunately relate to the disrupting phenomenon and processes happening in the device: sub optimal design, impurities imperfections in the raw material, fabrication induced contamination, geometrical asymmetries, misalignment, residual stresses stray electrons/ions, seconaries, degassing, impurities contamination, virtual/real leaks, evaporation products, thermal effects, multipactor, arcing, higher order modes, mode competition, noise and so on.

Our understanding of those is rather limited and some of these are random. It requires years of experience and experimentation to understand and develop mitigation techniques and estimate their effects.

It is these aspects we need to focus having achieved competence in forward design and development processes.

These aspects are the ones we should focus on. I wish to invite comments from VED developers and suggestions to initiate a plan to work on these to reduce the struggle and develop rugged devices in a reasonable time.

14/08/2020, 12:09 - +91 93143 96993:

<https://www.titech.ac.jp/english/news/2020/047487.html>

14/08/2020, 13:56 - Chandra Shekhar CEERI: You have raised a very pertinent point. Perfecting a product really tests our understanding and practice. If we don't understand the possible issues or phenomena that may be occurring, we can't proceed to attack them. One can then go round and round in dark circles. So, qualitatively identifying the causes or phenomena and then trying to model them quantitatively is what is required. In random causative factors, statistical approaches are to be taken as is done for the case of noises of various kind. Technological imperfections can also be analysed through simulations to gain an understanding of their possible effects, which can convincingly guide the adoption of better processes, including buying of newer equipment or outsourcing to a better equipped vendor/ facility. Since this requires more money, the institutional leadership would need convincing that you have correctly identified the problem in the first place, and that the proposed solution (and the expenditure on it) will produce desired improvement.

14/08/2020, 14:04 - Chandra Shekhar CEERI: Identification of possible causes qualitatively, analyzing their effects on performance quantitatively and proposing and showing the effects of proposed improvements through simulation is the route to perfection. Simulations have the power to reduce the experimentation required for perfection drastically.

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

15/08/2020, 11:06 - Dr. Lalit Kumar: Thanks for elaborating on my note. There is a serious need to identify the gaps in our understanding about the disruptive factors. Many times the issues are low tech and more often due to our inadequate understanding or care or lack of good skill/workmanship.

if the community is really serious we should devote attention to these now. The last Mile is the toughest Mile and only overcome by focusing on such issues. The means could observation, intuition, empirical laws, statistical models, theory, simulation or 'hardware in loop simulation'. This is an area where very little gets published as these issues are managed in ingenious ways by most industries and regarded as trade secret or tacit knowledge. A synergistic team of engineers with experience and those actively involved in development shall work and make a difference. There may be lot of requirements of VEDs in the country but unless we meet the specs, the user would continue to depend on foreign companies.

I wish to request Prof Basu that we use the webinars to understand the real crux of the problem in each area and how to attack it. Talking about our glorious achievements may be inspiring and motivating and give us a sense of contentment. What is reqd. is an approach to take the bull from the horn, which I am sure the young engineers are capable of.

15/08/2020, 18:52 - Chandra Shekhar CEERI: May be, a beginning should be made in this forum by cross sharing such experiences among community members who have certainly faced some of these issues and gotten over some of them the hard way. The proverbial last mile actually involves the finer and deeper issues - usually cross-cutting and less charted, if not entirely uncharted. They are, as you rightly said, typically off the standard book/journal material. Sharing experiences and discussing them would be definitely beneficial for every body.

15/08/2020, 19:12 - +91 90055 02333: I have some doubt in linear accelerator. Anybody working on that so I can discuss my doubt.

16/08/2020, 00:01 - BNBasu Prof: Thought from one of the group members:

Broad scope for the upcoming meetings: The first meeting organized through the "Thinkers in VED" Whatsapp group on August 1, 2020 was quite successful in bringing together the experts and researchers in the VED community across the country. The general tone of the message was centred on acknowledging the stiff competition that VEDs face from the solid-state devices and laying the future for VED research across the key research institutes and universities. The upcoming meetings should follow the momentum set by the first introductory meet. In order to ensure that the subsequent discussions keep up the relevance and focus of the topic of interest, I, with feedback from other young researchers in CSIR-CEERI, have listed out some thoughts.

1. The urgent outcome is a roadmap for future research direction in VEDs and solid-state devices. Taking up activities in solid-state devices along with futuristic VEDs will keep us relevant no matter which side the scales tilt.
2. The agenda set for the second the subsequent meetings resemble a workshop series and it is the opinion of several group members that it does not seem aligned with the goals of the group. The group should consciously

keep away from a typical seminar/workshop template. The pattern of the meetings has to be changed to ensure that brainstorming is continued. Every meeting should bring the group closer in framing specific goals.

3. The meetings should have panel discussions. Any presentation must be oriented towards the future goals and must focus less on the past achievements.

4. Reflecting on Dr. Lalit Kumar's views, the panel discussion and the relevant presentations can include statistics on device demand, current and future trends, expected market growth, etc. The near-future and the long-term demand for VEDs and solid-state devices must be worked out from the users during these discussions. This would help us to prepare a market survey in the Indian context.

5. The presentations can, briefly, list out the current activities being carried out in the respective labs. Considering the limited man power, healthy debates on the hard choices of letting go of some of the current activities must be taken up.

6. The panellists can be given relevant questions before hand so that they would have enough time to prepare with relevant data and statistics to support their arguments. At the end of every round of discussion, the audience can be allowed to ask questions pertinent to the discussion.

It is a good initiative to include research contributions of young researchers. However, we should also allot some time for the presenters to talk about their personal journey in PhD or PostDoc. PhD scholars are almost always stressed and are apprehensive about their future. At times, they find their PhDs stretched out due to the supervisor's personal goals and ambitions. Moreover, there is a misconception that PhD is the measure of how good a researcher is. As we are recognizing and appreciating the valuable research done by the presenters, I feel, it is our duty as a community to send out a strong message that PhD in itself is by no means a measure of someone's research aptitude and it is, sometimes, okay to choose not to do a PhD. Since this forum is composed of a mix of academicians and researchers from government labs, it would also be of value to discuss the relevance of a doctoral degree as a route to research or academic career. In other words, "should PhD really be considered the rite of passage for a research career"? We also need to stress upon the mental health issues that the PhD students, and researchers in general, face and the woeful support system available for them (more important for PhD students in labs like CEERI). The data showing PhD dropouts is a valid point of discussion as well. While we are bringing out these issues, we can touch upon the funding schemes and how they make PhD to be a mandatory or a "desirable" criterion for the application. I believe that short discussions like these in such eclectic fora will have an impact on the research landscape in the country.

16/08/2020, 00:05 - BNBasu Prof: I got your thoughts in the right spirit. I am happy that the group has started functioning with the usual teething problems.

We have perhaps built a residential complex and allotted the flats to the members. I have owned a flat in this complex along with all other members of

the group. Ours is now a welfare society of the complex. Thank you for bringing out a few valid points to the society.

However, let the vehicle move first in the first gear. Eventually, we will pick up the speed in higher gears and move in the right direction according to your suggestions and many suggestions from others. Eventually, we will hand over the steering wheel to you and other thinkers of the group. Let the vehicle reach its destination.

16/08/2020, 06:45 - Harish Dwivedi: Very pertinent thought for VEDs. This also seems very relevant in the context of an organization like CEERI, where solid state Devices and VED R&D goes one. Then system teams are there for integrated solutions. I recall some groups really worked in such spirit, albeit at a smaller level. May be these were the thoughts of fore father's at CEERI.

16/08/2020, 06:51 - Harish Dwivedi: The observation about PhD, reflects situation of the complete eco-system in PhD system in the country and abroad, also.

16/08/2020, 16:29 - +91 90055 02333: My doubt is that, in the standing wave LINAC configuration should we apply input RF signal or not ?

Or for acceleration the electron should we design a linac cavity in such a way that the RF signal grows inside the cavity is responsible for the acceleration.

16/08/2020, 16:35 - Dr. Lalit Kumar: In a LINAC, the beam acceleration happens due to the rf field set up by the rf input into the LINAC structure. The rf source is usually a magnetron or a klystron. The beam velocity being smaller than the phase velocity of the rf wave, the interaction is such that the beam draws energy from the rf field and gets accelerated.

16/08/2020, 16:46 - +91 99220 92509: Hi Sir, I am Shahrukh Mujawar was working in SAMEER, I have question regarding the accelerating gradient in standing wave cavity. Suppose if Accelerating gradient increase upto 47MV/m at 2998 MHz frequency what will happen?

16/08/2020, 23:44 - Dr. Lalit Kumar: The rf field gradient limitation comes from the field emission and surface breakdown in the cavities, It very much depends on the vacuum environment in the linac the cavity geometry, surface finish, and material. A 47MV/m may be reasonable at 2998 MHz. Please refer to an old paper:

<https://cds.cern.ch/record/201288/files/p225.pdf>

16/08/2020, 23:46 - Sanjay Malhotra BARC: Check kilpatrick limits. With clean vacuum systems we can go to high gradients. 47 MV/m is high at 3 GHz. Can be achieved only in pulsed linacs. For CW linacs, superconducting cavities are the only solution to achieve this high gradient. Refer RF Linacs by Thomas Wangler

16/08/2020, 23:53 - +91 88020 64566: kilpatrick criteria gives idea of breakdown RF field wrt to the frequency of operation inside any cavity... if i m not wrong??

16/08/2020, 23:55 - +91 88020 64566: but as the time passes, people used to take more than thrice the value of RF breakdown field at some particular frequency (mainly at desired frequency)...

**Proceedings First Webinar on
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17/08/2020, 09:31 - +91 89859 43925: Good morning everyone. I am a VED enthusiast with little knowledge on RF/ plasma physics. I have two questions on magnetron.

1. When I looked up at pulsed magnetron data sheets, the maximum pulse width or duty cycle is 5microseconds/0.002. Is that a limitation based on plasma transit time similar to that in BWO where choice of cathode material determines the plasma speed and hence the useful size of input pulse. If so how that limitation is overcome in CW magnetrons?

2. How does the mounting position of magnetrons effect their operation when gravitational interaction is the weakest?

If needed, please point me to some resources on basics to begin with to be able to understand the answers better.

17/08/2020, 10:47 - +91 92696 26411: There are various factors (Applications like radar, LINAC, etc. Thermal issue, most important factor is type of cathode) decides the pulse width and duty cycle in the magnetron. The pulsed magnetron uses an oxide-coated cathode, which has emission current density (50 ma/cm² to 500 ma/cm²). But Pulse magnetron operates on the very high value of current (example 3.1 MW S band magnetron it is 117 A). To obtain this amount current required a very large area of the cathode. But the magnetron science supports us to come out from this problem (The most of current of this type magnetron is obtain due to the secondary emission). The secondary current cannot possibly supply in the continuous mode by this type of cathode.

The CW magnetron operates on very low current (for 1 kW is 0.400 A, 10 Kw is 1-2 Amps). These magnetron have tungsten and thoriated tungsten type cathode. These cathodes have 25 ma/ cm² current density. But as the requirement is low we can use them.

The relativistic magnetron operates in ns pulse scale and produces very large power. For this also similar region.....

17/08/2020, 10:54 - +91 92696 26411: The mounting issues are also related to some fabrication issue of cathode, heater, magnetic field direction and tuner and various It is very difficult to explain them in few words.

17/08/2020, 10:57 - +91 92696 26411: For detail see the following "the magnetron oscillator by e. kettle", and The Resonant Cavity Magnetron [R. S. H. Boulding]

17/08/2020, 11:03 - Shivendra CEERI: If your cathode support and any internal part is good enough that it don't tilt or sagg then orientation should not have any effect on orientation of magnetron. You can operate magnetron in any orientation. Regarding pulse width: Limitation is due to cathode and thermal issue. If you cathode can supply the required current at desired pulse width with reasonable life and you can manage thermal issue. You can increase pulse width. I think this is not related to BWO or relativistic magnetron in which limitations is due to pulse shortening.

17/08/2020, 11:06 - +91 92696 26411: In S-band magnetron do not has orientation issue but x band has due to size and some

**Proceedings First Webinar on
Recent Trends and Challenges in Vacuum Electron Devices in Indian Scenario**

I just give rm as example of very small pulse size. And we cannot compare BWO with magnetron. The operation and power generation is totally different

17/08/2020, 11:18 - Dr. Lalit Kumar: I wish to add: 1a. the pulse magnetrons you are referring, are mostly built for radar applications- requiring short pulses and a certain rep rate.

1b. The difference between CW and pulsed magnetron has nothing to do with transit time. It is mainly related to the thermal management and resulting effects like anode tip erosion (as almost 60% input power is wasted as heat).

1c. The CW emission current density of most cathodes is usually lower than the pulsed emission current density. So one uses an appropriate anode voltage and current to achieve the right VI product

2. The mounting position could in principle be any. But the cathode is suspended in the anode hole as a cantilever, and therefore, the cathode stem is usually aligned with the vertical axis. Additionally you have to keep all magnetic materials away due to strong magnet and a dry atmosphere to ensure no HV arcing.

19/08/2020, 23:33 - BNBasu Prof: I propose a series of lectures, each of 30-40 mt. duration, on the platform of VED Thinkers Group on the development of the first ever VED in India on different days: (1) the first ever TWT in India (Dr. SN Joshi); (2) the first ever gyrotron in India (Dr. SN Joshi to kindly help and coordinate); (3) the first ever magnetron in India (Dr. SN Joshi/Dr. Lalit Kumar to kindly help and coordinate), (4) the first ever carcinotron in India (Dr. LM Joshi/Dr. SN Joshi/Dr. Lalit Kumar to kindly help and coordinate), (5) the first ever klystron in India (Dr. LM Joshi to kindly help and coordinate), (6) the first ever relativistic BWO in India (Professor KP Maheshwari/Professor Y Choyal), (7) the first ever pasotron in India (Dr. Udit N Pal/Dr. Niraj Kumar), (8) the first ever FEL in India (Professor BK Shukla to kindly help and coordinate), the first ever vircator in India (Dr. S Malhotra to kindly help and coordinate), and so on. Each such lecture on a day may be followed by the presentations of 3 young researchers on their R&D contributions to the area of VEDs.

19/08/2020, 23:40 - Dr. Lalit Kumar: The list may add First: Mini TWT, Coupled- cavity TWT, Multi-beam Klystron, Relativistic Magnetron, MILO, MPM and Cathodes of various types, if you wish to consider.

20/08/2020, 08:25 - BNBasu Prof:

I propose a series of lectures, each of 30-40 mt. duration, on the platform of VED Thinkers Group on the development of the first ever VED in India on different days: (1) the first ever TWT in India (Dr. SN Joshi); (2) the first ever space-TWT in India (Dr. SN Joshi); (3) the first ever mini-TWT in India (Dr. SN Joshi/Dr. AK Sinha); (4) the first ever coupled-cavity TWT in India (Dr. Latha Christie/Dr. SK Datta); (5) the first ever gyrotron in India (Dr. SN Joshi to kindly help and coordinate); (6) the first ever magnetron in India (Dr. SN Joshi/Dr. Lalit Kumar to kindly help and coordinate); (7) the first ever relativistic magnetron in India (Dr. SK Chhotray/Dr. SUM Reddy); (8) the first ever carcinotron in India (Dr. LM Joshi/Dr. SN Joshi/Dr. Lalit Kumar to kindly help and coordinate); (9) the first ever klystron in India (Dr. LM Joshi); (10) the first ever multi-beam klystron in India (Dr. SUM Reddy, Dr. LM Joshi to kindly

**Proceedings First Webinar on
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help and coordinate); (11) the first ever relativistic BWO in India (Professor KP Maheshwari/Professor Y Choyal), (12) the first ever pasotron in India (Dr. Udit N Pal/Dr. Niraj Kumar); (13) the first ever FEL in India (Professor BK Shukla to kindly help and coordinate); (14) the first ever vircator in India (Dr. S Malhotra to kindly help and coordinate); (15) the first ever MILO in India (Dr. SUM Reddy to kindly help and coordinate); (16) the first ever MPM in India (Dr. SUM Reddy to kindly help and coordinate); (17) the first ever cathodes of various types in India (Dr. KS Bhat/Dr. RS Raju/Dr. M Ravi/Dr. R Barik); and so on. Each such lecture on a day may be followed by the presentations of 3 young researchers on their R&D contributions to the area of VEDs.

20/08/2020, 09:45 - SNJoshi CEERI: Dear Prof. Basu,

Thanks for upgraded version of the lecture schedules.

You may consider Dr Visnu Srivastava for Space TWTs along with myself.

20/08/2020, 09:48 - BNBasu Prof: Certainly yes. Besides, please we have to request him to present his concepts in the large-signal analysis of TWTs and the code SUNRAY he has developed.