NEWSLETTER

of the International Consortium "Development of High-Power Terahertz Science & Technology"

February 2019 № 11

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EDITORIAL: HOW TO CONTRIBUTE TO THE NEWSLETTER

Dear Reader,

We are inviting contributions to the following rubrics:

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- Short regular papers.
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- Information about conferences, symposia, workshops, seminars.
- Programs and frameworks for an exchange of visits and mobility of researchers. Job opportunities (especially for young researchers, e.g. postdoctoral positions, specializations, internships).
- Annotations of books, conference proceedings, software and internet resources. Additions to the list of the recent scientific publications and conference reports at the website of the Consortium (http://fir.ufukui.ac.jp/Website_Consortium/publist.html).
- Information and announcements about awards and nominations.
- Short presentations of laboratories and research groups belonging to the participating institutions.

Please submit your contributions to the Newsletter as well as requests for information to:

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20th ANNIVERSARY OF FIR UF

The Research Center for Development of Far-Infrared region at the University of Fukui (FIR UF Center) was established at the beginning of the academic year 1999/2000 by Professor Toshitaka Idehara as a founding Director. It is remarkable that at the same time a similar center at KIT (in Karlsruhe, Germany) led by Professor Manfred Thumm was created. Soon these two institutions became longstanding research partners and collaborators and now share a common history. In September 1999, the first International Workshop on Far-Infrared Technologies (IW-FIRT 1999) was held to commemorate the foundation of FUR UF and to discuss the prospects for development of both the science and the technologies in the most unexplored region of the electromagnetic spectrum, namely the so-called THz gap. Soon afterward the FIR Center was recognized worldwide as one of the leaders in the development, study, and application of gyrotrons operating in this frequency range. From the very beginning, besides the gyrotrons many other research topics related to the far-infrared technologies have been pursued as well. Upon the completion of the first five-year period, an international panel of distinguished researchers has evaluated positively the work that has been done by the Center and emphasized its important role both at the national and international level. Such high appraisal based on the significant achievements of FIR UF in reaching its goals has open the way to the next stage. It has been marked by further extension of the research topics to new fields. Recognized as a leading institution the FIR Center has become an attractive place nationally- and internationally-wide. In the frameworks of the signed bilateral Agreements for Academic Exchange and Memorandums of Understanding an active international collaboration with many academic institutions around the world has been promoted. The first International Consortium organized and led by FIR UF on "Promoting international collaboration for development and application of sub-millimeter gyrotrons." Its success demonstrated clearly the advantages of such organization and in 2015 it was renewed in an extended format. Now, the current International Consortium for Development of High-Power Terahertz Science and Technology includes 13 institutions from 9 countries from all over the world.

The 20th Anniversary of the FIR Center will be commemorated publishing a booklet with a photo gallery that reflects its history. For many researchers who have connected their both professional and personal life with this institution now it is time for nice recollections. Below, we present some of the greetings and memorial notes of some of them.

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Research Center for Development of Far Infrared Region

University of Fukui (FIR UF)

Fukui, Japan

20th Anniversary of FIR-UF in April 2019

Dear Colleagues from FIR-UF,

On behalf of the staff of the Institute for Pulsed Power and Microwave Technology (IHM) at Karlsruhe Institute of Technology (KIT) we would like to congratulate you and the staff of Research Center for Development of Far Infrared Region, University of Fukui, very much on the occasion of your 20th anniversary in April 2019. FIR-UF is one of the most famous and worldwide leading institutions doing very broad R&D in the field of generation, transmission and application of sub-millimeter and terahertz waves.

FIT-FU and IHM-KIT are like biovular twins, because also IHM-FZK (Forschungszentrum Karlsruhe, since 2009 KIT), was founded on April 1, 1999. Since the formation and beginning of your center in 1999, FIT-UF and IHM-KIT in collaboration Institute for Plasma Research (IPF, now Institute for Interfacial Process Engineering and Plasma Technology (IGVP)) of the University of Stuttgart and Max-Planck-Institute for Plasma Physics in Garching (IPP), are having a well-established, long-term and very successful collaboration in the fields of sub-millimeter-wave gyrotrons and the related oversized waveguide and quasi-optical transmission systems for various applications in spectroscopy, collective Thomson scattering (CTS) diagnostics in plasmas for environmentally-friendly generation of energy by controlled thermonuclear fusion and for materials processing.

The first Memorandum of Understanding between FIR-FU and IHM-FZK for the development of gyrotrons operating under extreme conditions (ultra-high power and ultra-high frequency gyrotrons) was already signed in June 1999, followed by a corresponding Agreement of Academic Exchange in March 2001. This collaboration was continued in October 2003 under a new umbrella when Fukui

University (FU) and Fukui Medical University merged to become University of Fukui (UF). In 2004 Prof. Thumm served as Chairman of the International Advisory Board for FIR-UF. In 2005, a common international MEXT project "Promoting International Collaboration of Submillimeter Wave Gyrotrons" with partners from Russia, Bulgaria, UK and USA was started. Later, in collaboration with the Scientific-Technical Center of Pulse Power of the D.V. Efremov Institute of Electro-Physical Apparatus, a common program on development and realization of ceramics and mixed-matrix-materials by sintering with millimeter and sub-millimeter waves or microsecond intense electron beams was conducted. Currently, IHM-KIT is one of the 13 members from 9 countries of the International Consortium for Development of High-Power THz-Science and Technology, which was signed and managed in by FIR-UF.

The principal main objective of the collaboration between FIR-UF and IHM-KIT, IPF and IPP has been to achieve high mode purity of the gyrotron output waves in order to guarantee low transmission losses and optimum wave polarization for the different applications [see references 1-27]. This can be obtained by optimized non-linear gyrotron cavity and up-taper contours, as well as via advanced quasi-optical mode converters and transmission line components. The first three common journal publications describe the worldwide first analysis of a complete gyrotron oscillator with axial output waveguide (including the broadband multi-disk output window) using a scattering matrix code in the frequency range from 273 to 1034 GHz [1,2]. Figure 1 shows the geometry of the complete, approximately 1.1 m long second harmonic Gyrotron FU IVA (cavity radius 1.52 mm) with optimized cavity contour, rounded cavity output iris and non-linear up-taper to the waveguide radius of 2.55 mm. Table 1 summarizes the simulation results. Later, in 2002, in the 301 GHz-CW Gyrotron VA, also the linear up-taper to the window waveguide diameter got an optimized, non-linear contour, resulting in high-purity output modes [3].

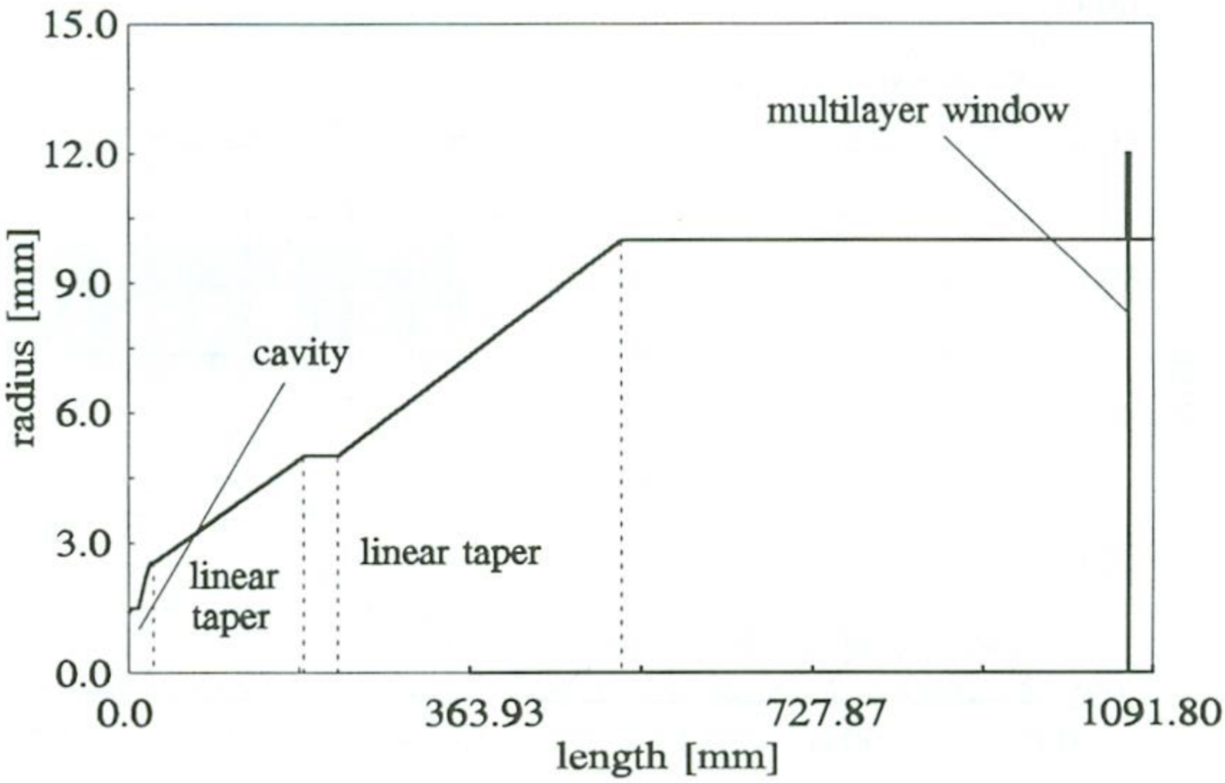


Figure 1. Geometry of the complete Gyrotron FU IVA (see refs. [1,2]).

mode	f_{res}[GHz]	cavity		complete tube		
		Q_D	η[%]	Q_D	η[%]	R_w[%]
$TE_{7,1}$	273.53	1326	99.99	2205	90.25	7.44
$TE_{8,1}$	307.47	1624	99.99	14234	69.27	27.78
$TE_{3,3}$	361.45	3349	99.73	6094	88.38	23.36
$TE_{6,2}$	373.80	3430	99.96	3294	94.91	4.21
$TE_{9,3}$	604.92	19219	99.88	18545	88.65	13.80
$TE_{5,6}$	757.53	57875	99.56	48315	82.22	17.63
$TE_{3,7}$	768.38	61248	99.53	43589	71.08	39.57
$TE_{1,9}$	873.72	118737	99.37	165884	70.67	3.33
$TE_{2,10}$	1022.25	301240	98.73	951200	43.58	45.50
$TE_{9,7}$	1034.28	338571	98.67	269579	74.73	10.73

Table 1. Calculated resonance frequencies, diffractive quality factors and output mode purities for both, the cavity and the complete Gyrotron FU IV A with non-linear up-taper as well as the window reflection coefficients in the frequency range from 273.53 to 1034.28 GHz. A 3-disk quartz-sapphire-quartz output window was utilized (see refs. [1,2]).

Several common publications deal with improved quasi-optical gyrotron output couplers for generation of a pure, linearly polarized fundamental Gaussian wave beam [14-27]. The very recent collaborative paper [5] describes a high purity mode CW gyrotron covering the sub-THz to THz range using a 20 T superconducting magnet.

Since the foundation of the workshop series International Workshop on Far-Infrared Technologies (IW-FIRT) in autumn 1999, always members of IHM-KIT attended these very interesting meetings giving a broad overview on what is worldwide going on in this R&D field (see Figs. 2 and 3). The same is valid for the International Symposium on Development of Terahertz Gyrotrons and Applications, founded by FIR-UF in 2013 (2nd Symposium in 2017) and the 2018 43rd International Conference on Infrared, Millimeter and Terahertz Waves in Nagoya, chaired by Profs. Idehara and Tani. Earlier, starting from 1994, Prof. Manfred Thumm gave in total 5 seminar talks in the Department of Physics of Fukui University.

Big delegations of FIR-UF took part at the First Joint 29th International Conference on Infrared and Millimeter Waves and 12th International Conference on Terahertz Electronics in 2004 and at the 35th IEEE International Conference on Plasma Science in 2008, both organized in Karlsruhe by IHM. In addition, several very interesting seminar talks were presented by FIR-UF staff at IHM.

Figure 2. Group photo of the 5th IW-FIRT in 2014 with Profs. Idehara, Saito, Tani and Thumm in the center of the front row.

Figure 3. Group photo of the 6th IW-FIRT in 2017 with Profs. Idehara, Saito, Tani and Jelonnek in the center of the front and second row.

The paragraphs above clearly show and prove that since their establishments in April 1999, FIR-UF and IHM-KIT have well-organized, long-term and very successful collaboration in the field of high-power gyrotrons for spectroscopy, CTS, and fusion plasma heating as well as for application of technological gyrotron systems for processing of various materials.

In conclusion we wish FIR-UF to be also in the future one of the most competent and worldwide leading institutions for developing and manufacturing of gyrotron systems from millimeter to terahertz wave bands and using them in many different, very interesting applications.

Prof. Dr.-Ing. John Jelonnek

Prof. Dr. rer. nat. Dr. h.c. Manfred Thumm

References of Common Publications of FIR-FU and IHM-KIT

Peer-Reviewed Journal Papers

[1] Wagner, D., M. Thumm, G. Gantenbein, W. Kasparek, T. Idehara: Analysis of a complete gyrotron oscillator using the scattering matrix description, Int. J. Infrared and Millimeter Waves, **19**, 185-194 (1998).

[2] Idehara, T., N. Nishida, K. Yoshida, I. Ogawa, T. Tatsukawa, D. Wagner, G. Gantenbein, W. Kasparek, M. Thumm: High frequency and high mode purity operations of gyrotron FU IVA, Int. J. Infrared and Millimeter Waves, **19**, 919-930 (1998).

[3] Idehara, T., I. Ogawa, S. Maeda, R. Pavlichenko, S. Mitsudo, D. Wagner, M. Thumm: Observation of mode patterns for high purity mode operation in the submillimeter wave gyrotron FU VA, Int. J. of Infrared and Millimeter Waves, **23**, 973-980 (2002).

[4] Ogawa, I., T. Idehara, T. Okada, S. Maeda, Y. Iwata, R. Pavlichenko, S. Mitsudo, D. Wagner, M. Thumm: High quality operation of a submillimeter wave gyrotron for plasma diagnostics application, J. Plasma Fusion Res. Series, **5**, 205-209 (2002).

[5] Idehara, T., I. Ogawa, D. Wagner, M. Thumm, K. Kosuga, S.P. Sabchevski: High purity mode CW gyrotron covering the subterahertz to terahertz range using a 20 T superconducting magnet. IEEE Trans. on Electron Devices, **65**, No. 8, 3486-3491 (2018).

Institute of Applied Physics
of the Russian Academy of Sciences

CONGRATULATIONS AND SOME PERSONAL REMARKS ON THE TWENTIETH ANNIVERSARY OF FIR UF CENTER

Dear colleagues,

On behalf of the IAP RAS team, we would like to send our congratulations and best wishes to the Research Center for Development of Far Infrared Region, University of Fukui (FIR UF) on the occasion of your 20th anniversary! For us, it is a great pleasure and honor that the history of our collaboration started from the very foundation of FIR UF by Prof. T. Idehara. In fact, IAP RAS was one of the first among a great number of FIR UF collaborators to sign an agreement on joint scientific research. Now we can make a remarkable conclusion that our cooperation has been very fruitful, and we are pleased that it is successfully going on.

Over the past two decades, together we all have created the basis for a new promising scientific direction dedicated to the development of terahertz-range high power vacuum electronic sources for modern high-power terahertz techniques. As important milestones on this path, we would like to point out overcoming the “magic” frequency of 1 THz in the pulse gyrotron, generation at high-order (up to the fifth) cyclotron harmonics in the large-orbit gyrotron with a permanent magnet, successful ceramic sintering based on gyrotron and gyro-BWO systems, the realization of a double-beam gyrotron tube, etc. All these projects were supported by an international team with the active participation of many researchers from IAP. This experience made us happy and proud of the obtained results. We will not forget our cooperation with such an outstanding person as the first FIR UF Director Prof. T. Idehara whose contribution was of utmost importance for the success of our joint work. Due to his efforts and the efforts of Prof. T. Saito and Prof. M. Tani, who continued the guidance of the Center, new horizons opened for applications of terahertz radiation sources.

Looking back in the past, we would like to note that during this long lasting cooperation friendly relations, and even personal friendships, established. We wish prosperity and success to FIR UF in the future research and good health and luck to our dear friends and colleagues!

A. G. Litvak, G. G. Denisov, and M. Yu. Glyavin

Institute of Applied Physics RAS, Nizhny Novgorod, Russia

Vladimir Bratman

I was lucky to visit the University of Fukui and work with Prof. T. Idehara and his group shortly before the FIR Center was established. At that time, there was not yet wonderful new building. In my next visit, it was rapidly built with the number of floors greater than the number of full-time employees. Then, in front of my eyes, this building was very quickly filled with advanced installations, on which unique devices were soon created. Over twenty years of existence of the Center, the researchers have obtained there many of world-class results. Prof. T. Idehara and his followers Prof. T. Saito and Prof. M. Tani have undoubtedly many reasons for their well-deserved pride. For me and my colleagues, many years of fruitful cooperation with the Center not only obtained a number of important results, but also made it possible to get to know Japan quite well, as well as its wonderful people and centuries-old culture. I am very grateful to Prof. T. Idehara and all employees of the Center for their cooperation and benevolence. I wish you all a long, active and successful work in science and happiness in your personal life.

Mikhail Glyavin

As far as I know, I was the first foreign FIR UF research fellow and, after my initial visit to Fukui in 1999, I had a total of over 20 visits for more than 3 years. I saw how the Center was built (with my humble participation) and was very impressed by how quickly the Center established and new scientific results appeared. I would like to mention that the collaboration with the FIR UF team opened new opportunities for me and encouraged me to concentrate on the THz science. I took part in several common research projects, which resulted in a great success in the high frequency gyrotrons development; we published more than 150 journal and conference proceeding papers together, and I am very thankful to the FIR UF team for excellent conditions for scientific research, hospitality, support in all cases (including an unforgettable experience with the Nippon surgery), and friendship. We not only became real friends, but I became a Nippon guy to some degree; Fukui city became a "hometown" for me, and staying here is my honor and pleasure every time. I wish you good health, long life (as the history of the Eiheiji Temple), new scientific achievements (as impressive as Mikuni Firework Festival and Tojinbo rocks), and of course I hope to continue our collaboration.

Vladimir Manuilov

My story of collaboration with FIR UF is also very long. It started more than 15 years ago after the invitation of the first Director of the Center Prof. Idehara in 2003. And even during the first days of my stay in Fukui I was very impressed by the Japanese nature, traditions, culture and language (my first impression was that it is like a beautiful and friendly song, especially if some nice Japanese lady says something). Not only such well-known places as Asakusa Family Village, Maruoka Castle, Mikuni beach, but even each Japanese home surrounded by a small beautiful garden attracted my attention. Of course, I remember very interesting and colorful Tea Ceremonies organized every year at the University Hall and the parties which took place in the Center with their very friendly and cozy atmosphere. I am very thankful to all staff for their friendship and support, *good relations and desire to show all remarkable places not only in Fukui, but all around central Japan, including such unique places as Kyoto, Nara, Osaka, Nagoya, and Tokyo.*

The collaboration with FIR UF team under the leadership of Professors T. Idehara, T. Saito, and M. Tani opened for me a new and very unique opportunity to widen the area of my scientific activity and to be involved in many promising projects such as new versions of Large Orbit Gyrotrons, powerful tubes for Collective Thomson Scattering, and novel terahertz range gyrotrons. I wish new outstanding results to all FIR *UF staff and hope that our common efforts will open a new remarkable page in the development of new sources of RF radiation.*

Irina Zotova

My story of collaboration with FIR UF is not as long as of some other colleagues, but I have fallen in love with this place. I am honored to be the first female professor of the Center and the first participant of the Cross-Appointment Scheme. Working in the renowned THz gyrotron center was a great experience which inspired me with new ideas for further scientific research. I am grateful to Prof. T. Idehara and Prof. M. Tani for inviting me to the Center and also to Prof. S. Mitsudo and Prof. Y. Tatemasu for creating the atmosphere for fruitful scientific discussions.

My memories

Professor Olgierd Dumbrajs

The Research Center for Development of Far -Infrared Region at the University of Fukui (FIR UF) was established in 1999. At that time I was working at the Helsinki University of Technology in Finland. With great satisfaction I can mention that I was one of those who wrote a letter of recommendation to Japanese authorities in favor of establishing the FIR center.

In 2001 26th International Infrared and Millimeter conference took place in Toulouse, France. During the conference Professor T. Idehara approached me and invited me to come to FIR as a visiting professor. I accepted the invitation with genuine pleasure.

I came to Fukui for the first time in 2002 (01 April - 30 June). In April the new FIR building was not yet completed. I spent first few weeks in the old building. I was the first visiting professor whose accommodation was in the University guest house. The accommodation was uninhabited. Professor I. Ogawa helped me very much in getting essentials to life and in settling in. Moreover, he helped me to convert my German driver’s license into Japanese license. On many occasions I rented a car and was driving throughout Japan.

Altogether I visited FIR as a guest professor 10 times, for the last time in 2016 (01 October - 31 December). My first common publication with FIR physicists appeared in 2003, the last one in 2018, the total number over 20. Common reports at International conferences over 10.

My collaboration with FIR was strengthened when the final version of the Agreement for establishing an International Consortium for “Development of High – Power Terahertz Science and Technology” was signed by all participating institutions in October, 2015. At that time I was working at the Institute of Solid State Physics, University of Latvia, Riga. My institute became one of 13 participating institutions from 9 countries.

During my vacations I travelled extensively all over Japan (Hokkaido, Okinawa, Tokyo, Osaka, Sapporo, Hiroshima, etc.) and learned the rich culture of the great nation.

My sincere gratitude to FIR founder and first director Professor T. Idehara and his successors for hospitality. My special thanks to FIR long-term secretary Mrs. Mijuki Morito for her amiability and efficiency.

I wish FIR UF next 20 fruitful years!

O. Dumbrajs,

Leading researcher, Institute of Solid State Physics, University of Latvia.

COOPERATION IN GYROTRON RESEARCH WITH THE UNIVERSITY OF SYDNEY, AUSTRALIA

Dr Ferg Brand

School of Physics, University of Sydney, NSW, 2006, AUSTRALIA

Until recently, the portion of the electromagnetic spectrum with frequencies immediately above microwaves, known variously as the far-infrared, sub-millimetre wavelength or terahertz region, has suffered from a lack of suitable sources. This has meant that the study of the behaviour of matter at these frequencies was severely limited and that no applications could be developed. Without doubt the most successful source in this wavelength range is the gyrotron, an electron tube that relies on the tiny relativistic mass change of rapidly moving electrons to generate the radiation. The state of the art is a 1 megawatt gyrotron operating at a frequency of 140 gigahertz. This type of source has been developed to heat plasmas in the next generation of magnetically-confined fusion experiments. However gyrotrons of much lower power have an important role to play in the probing of such plasmas and in the study of other materials. Lower power gyrotrons were the objects of study by groups in the Research Center for Development of Far-Infrared Region at the University of Fukui, led by Professor T. Idehara, and the School of Physics at the University of Sydney, led by myself.

The cooperation between the two gyrotron groups was initiated by Professor T. Idehara in 1988. A formal agreement of cooperation was signed by the Dean of the Faculty of Engineering, Fukui University, Professor I. Toriumi and the Head of the School of Physics, University of Sydney, Professor M.H. Brennan, in 1989. The cooperation has been supported by the Japanese Ministry of Education, Science and Culture's Monbusho International Scientific Research Program. Since Professor Idehara's first visit to Sydney in 1988, there have been numerous visits by Fukui staff members and post-graduate students to Sydney and vice-versa. Many of which were sponsored by this program. The last visits were in 2002.

During the collaboration, the work of the Sydney group focussed on the design and construction of tunable gyrotrons with the aim of achieving useful continuous output in the terahertz regime. With operation at the second harmonic of the electron cyclotron frequency, a frequency of 615 GHz was achieved – a record at the time. Adding a parabolic blazed grating to our quasioptical antenna proved to be very effective at separating second harmonic from any fundamental present. In addition we demonstrated how our gyrotrons could be used in plasma diagnostics (scattering from discrete Alfven waves) and the study of materials (phase transitions in thiourea). The gyrotron work at the University of Sydney concluded in 2002. Later work in the field embraced various aspects of millimetre-wave propagation; in particular, the study of optical vortices.

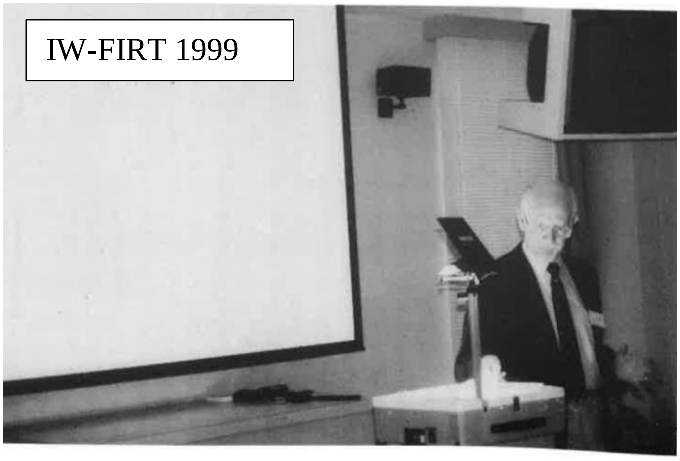
My experience has been that the work of the two groups complemented each other and the efforts of both groups were enhanced by the cooperation.

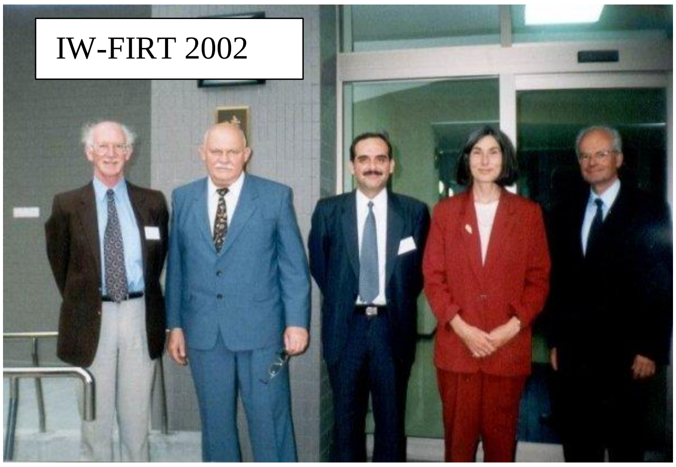
Of course there are benefits beyond the scientific ones. The increasing understanding between Japan and Australia is reflected by the fact that almost all of the Plasma Physics Department's academic staff and several post-graduate students have visited Japan. Besides attending conferences and workshops on plasma physics, millimetre waves and lasers, our department has cooperated with individuals at Shizuoka, Kyoto and Kyushu Universities. However, ours was the largest cooperation between two groups.

My own experience has been most happy. I enjoyed the close contact with my Japanese colleagues when they visited Australia and I enjoyed the warm hospitality they showed me on the occasions I visited Fukui University.

In conclusion, on behalf of the Sydney group, I wish to thank Professor T. Idehara for his energetic work in establishing the cooperation and his colleagues for their hospitality. And I wish to thank the Japan Ministry of Education, Science and Culture for their generous support of this international venture.

January 2019


IW-FIRT 1999


IW-FIRT 2002

My personal recollections on the history of the FIR UF Center and the gyrotrons development

S.P. Sabchevski

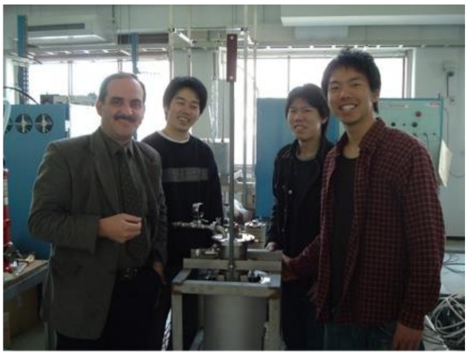
For the first time, I heard about the gyrotrons while studying microwave electron devices at St. Petersburg State Electrotechnical University. Many years later, in 1997 I met Professor T. Idehara at the International Conference on Electron-Beam Technologies in Varna (Bulgaria) and was very impressed by his report on the development of gyrotrons at Fukui University. His enthusiastic and visionary look at the future of these devices was captivating for me and we started our collaboration. During my first visit to the University of Fukui in February 1999, Professor Idehara told me that he is going to establish a Research Center for Development of Far-Infrared Region (on the basis of the preceding Laboratory for application of superconducting magnet) and invited me to join his research team. I realized that this is a great opportunity to start work in such promising and very interesting new field and in September 1999 I arrived in Fukui with my wife Petia and our children Peter and Joana. We were immediately fascinated by the natural beauty of Japan, its rich culture, traditions, vibrant modern life, and delicious cuisine – something that has become a lifelong affection. The establishment of the FIR Center was commemorated by the First International Workshop on Far-Infrared Technologies, which was held in September 1999. Besides the research work at the Center, as an Associate Professor of the Department of Applied Physics of the Faculty of Engineering, I conducted two courses of lectures on electron-beam technologies and propagation of electromagnetic waves, respectively. After my return back to my permanent position at the Institute of Electronics of the Bulgarian Academic of Sciences (IE-BAS) I have continued my collaboration with the FIR Center and in the period 2002-2018 was appointed several times as a Visiting Professor and in recent years as a Specially Appointed Professor and Cross-Appointed Professor. Each of my visits was a great and unforgettable experience! Over the years, the longstanding and fruitful collaboration between FIR UF and IE-BAS has been carried out in the framework of the signed agreements for academic exchange, memorandums of understanding and lately using the cross-appointment scheme. IE-BAS is among the 13 institutions from 9 countries worldwide that participate in the International Consortium for Development of High-Power THz science and Technology, which was established in 2015 by FIR UF. I am very grateful to the first director of FIR UF Professor Idehara, and his successors Professor Saito, and Professor Tani for their support of the international collaboration. Together with all other colleagues at FIR UF they have created nice working conditions and stimulating atmosphere. In this respect, I also appreciate very much the contribution of Professor Mitsudo, Professor Ogawa, Professor Tatematsu, and Professor Yamamoto.

Nowadays, the FIR Center is well recognized worldwide as one of the leaders in the broad field of development, study, and applications of gyrotrons. Among the most significant achievements are: (i) the crossing of the symbolic threshold of 1 THz that opened the road of the gyrotrons towards the terahertz frequencies; (ii) development of two series of gyrotrons (Gyrotron FU and Gyrotron FU CW) operating in pulsed and CW regimes, respectively; (iii) development of a Large Orbit Gyrotron (LOG) with a permanent magnet that operates on the third, fourth and the fifth harmonics of the cyclotron frequency; (iv) development of a double-beam gyrotron; (v) development of a series of dedicated gyrotrons with internal mode converters and Gaussian output beams (GO-series) for various advanced spectroscopic techniques. Using and studying these devices, significant advancements in the understanding of the gyrotron physics have been made by the researchers of FIR Center. They are based on detailed investigations of the: (i) mode interaction (competition, co-operation etc.); (ii) frequency tunability; (iii) modulation and stabilization of both the output power and frequency; (iv) operation at high harmonics of the cyclotron frequency. The progress in gyrotron development at FIR UF has opened many new and even pioneering applications in the high-power terahertz science and technologies that use gyrotrons as powerful sources of coherent radiation in the sub-THz and THz frequency range. Some of them are: (i) ESR spectroscopy; (ii) DNP-NMR spectroscopy; (iii) spectroscopy based on X-ray detected magnetic resonance (XDMR); (iv) studies on the hyperfine splitting of positronium; (v) fusion plasma diagnostics based on Thompson scattering; (vi) sintering of advanced ceramic materials; (vii) novel medical technologies; (viii) study of the effects of the irradiation of different materials (e.g. C12A7 electride, ZnO single crystals, etc.) by terahertz waves.

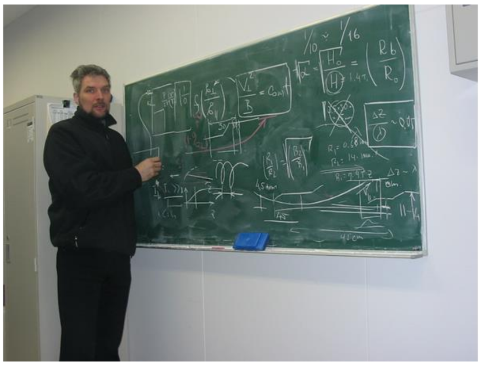
I feel privileged and honored for the opportunity to take part in some of the mentioned research topics and projects. Now, in the eve of the 20th anniversary of the FIR Center, I would like to express my sincere gratitude to all my colleagues and students at the University of Fukui for the collaboration and friendly attitude wishing them a further progress in their research, and many remarkable achievements.

Congratulations for 20th anniversary and long life to the FIR Center!





The next collage contains photos provided by Prof. M. Glyavin – a prominent collaborator of the FIR UF and a devoted cameraman



INTERNATIONAL COLLABORATIVE RESEARCH PROGRAM

Announcement of International Collaborative Research Program 2019

The Research Center for Development of Far-Infrared Region, University of Fukui (FIR UF), has started the International Collaborative Research Program from FY 2017. This program aims to support the development of the high-power far-infrared region research through the international personnel exchanges and studies, being performed at the FIR UF in a wide array of fields, including the development of light sources, applied research, and research and development of new technologies. FIR UF are now accepting proposals for the FY 2019 (April 2019 – March 2020).

How to apply

Please send an application form (Form 1) through the members of the FIR UF faculty after setting a research theme and organizing a research team. The deadline for applications is March 31, 2019.

Procedure

Term: Within one year (from July 1, 2019 to March 31, 2020)
Collaborative research will be performed approximately for two weeks at the FIR UF.

Venue: The Research Center for Development of Far-Infrared Region, University of Fukui

Financial Support: A part of travel expenses and accommodation fee will be covered.

Report: You are expected to submit a one-page research report in A4 sheet.

The number of adoptions is limited. Notice of the adoption will be scheduled around the end of April.

Application to be sent to

International Collaboration Office, FIR UF
e-mail: int-office@fir.u-fukui.ac.jp

The Research Center for Development of Far-Infrared Region,
University of Fukui
Director
Masahiko Tani

For detailed information and application forms please follow the **link**.

Gyrotrons for powerful neutron generators facilities

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Neutron sources are widely used in fundamental and applied research. Manifold applications require neutron fluxes of various intensities, energy spectra, and degrees of collimation. Several types of neutron sources have been developed for the purpose including nuclear reactors, radioisotope sources, D-D and D-T generators, plasma pinch machines, accelerators etc.

The present short invited paper presents the results of recent investigations devoted to the development of a new generation of compact D-D (D-T) neutron generators capable to generate neutron fluxes that surpass the state-of-the-art devices by an order of magnitude. The neutron generator consists of the following main parts: plasma source, electrostatic extraction system for deuterium beam formation/acceleration and the neutron-generating target containing deuterium or tritium. Improving the performance of each of these subsystems increases the total neutron flux. According to the present level of neutron generators development, the only foreseeable method to improve its performance is a significant increase in the ion beam intensity. This, in turn, could be done by increasing the plasma density in the ion source. Various types of discharges have been studied earlier for the purpose: RF, Penning, vacuum arc, laser, ECR. Existing state-of-the-art ion sources are able to deliver deuterium beams with the current density up to 100 mA/cm^2.

The technological breakthroughs on a number of key components of the gyrotron have led to steadily increasing performance of the ESR system and, today, ECRH is one of the more viable methods to plasma heating. At the moment, gyrotrons are the most powerful generator at frequency band from 20 GHz to 1 THz and the most impressive example are gyrotrons for ITER which produced more than 1 MW/CW at 170 GHz. During the last 10 years, IAP RAS team developed a series CW setup based on 24-30 GHz tubes for a number of technological applications.

Here we suggest using for such purpose a high-current quasi-gasdynamic ECR ion source, which utilizes powerful gyrotron radiation of mm-waveband for plasma creation and heating. Such ion sources are capable to form ion beams with record current densities of 1 eA/cm^2 and low emittance. The reported current density is more than an order of magnitude greater in comparison to rivaling technologies. Accordingly, the use of quasi-gasdynamic ion source is expected to increase the density of the neutron flux from the target by a corresponding factor.

Using powerful mm-waveband radiation allows increasing the plasma density in the discharge significantly (proportional to the square of the radiation frequency) in comparison to conventional ECRISs, which utilize microwave radiation with frequencies on the order of 10 GHz. In experiments with 37.5 GHz and 75 GHz pulsed gyrotrons the plasma density reaches values of 10^{13} - 10^{14} cm^{-3}. A sgnificant increase of the plasma density leads to a change of the confinement mode. So-called quasi-gasdynamic confinement is realized under such conditions instead of the classical one, which is common for modern ECRISs.

Such discharge conditions allowed to reach extremely high values of ion current density. Using a single aperture extraction system with a plasma electrode aperture of 10 mm it was possible to produce the deuterium ion beam with the current of 500 meA, which corresponds to a current density of 650 meA/cm^2 at the plasma electrode. Emittance of the beam measured with a “pepper-pot” method was 0.07 pi-mm-mrad. The ion beam consisted mainly of deuterons, the ratio of molecular D_2^+ ions was less than 6% of the total current, which according to our knowledge surpasses the best results achieved ion sources of any type. Lower ratio of molecular ions in the beam increases the neutron yield of the target at the same level of thermal load. Measurement of the produced neutron flux was performed by bombarding of a “heavy ice” target with 300 meA D^+ beam accelerated to 50 keV energy. Under such conditions, the neutron yield was 10^{10} neutrons per second. This result could be significantly increased at higher ion beam energies.

The described experiments were performed in pulsed mode. Many applications, however, require a continuous (CW) flux of neutrons. Therefore a completely new system has been built at the IAP RAS. The facility has been named GISMO (Gasdynamic Ion Source for Multipurpose Operation). It is aimed to produce continuous high-current (>200 mA) ion beams with low emittance (<0.2 π·mm·mrad). The scheme of the facility is shown in Fig. 1. The key elements of the setup are 28 GHz/10 kW and 37.5 GHz/20 kW (after an upgrade within the next year) CW gyrotrons manufactured by Gycom. These microwave generators are equipped with power supplies suitable for CW or pulsed operation. A fully permanent magnet magnetic trap is used for plasma confinement. For effective plasma heating, a set of requirements were applied to the system. Magnetic field configuration was designed to be similar to a simple mirror trap close to the system axis with field strength at magnetic mirrors not less than 1.4 T and not less 0.2 T at the trap center. The distance between magnetic mirrors should be about 12-15 cm. The mirror ratio should be in the range $3 \leq Bmax / Bmin \leq 7$. The inside diameter must be not less than 5 cm in order to allow assembling together with an insulated plasma chamber with a minimum diameter of 4 cm. For ion beam extraction it is planed to use a 4-electrode system with maximum acceleration voltage up to 100 kV. Such extraction requires the development of appropriate high-voltage insulation of the discharge chamber from other parts. In this regard, one of the key elements of the installation is the DC-break of the microwave transmission line. It was proposed to implement a quasioptical system shown in Fig. 1. The electromagnetic radiation of the gyrotron (mode TE_{21}) is fed to the converter to Gaussian beam. The Gaussian beam passes through the air gap of 15 cm which is used as a DC-break. After that gap, the radiation goes to the converter into TE_{11} mode of a circular waveguide and then to a microwave coupling system implemented with the plasma chamber. Overall transmission efficiency of the microwave line, DC-break and microwave injection system is 94%. The plasma chamber is 30 cm in length and 4 cm in diameter. It is equipped with water cooling along the whole surface from the coupling system to the flange.

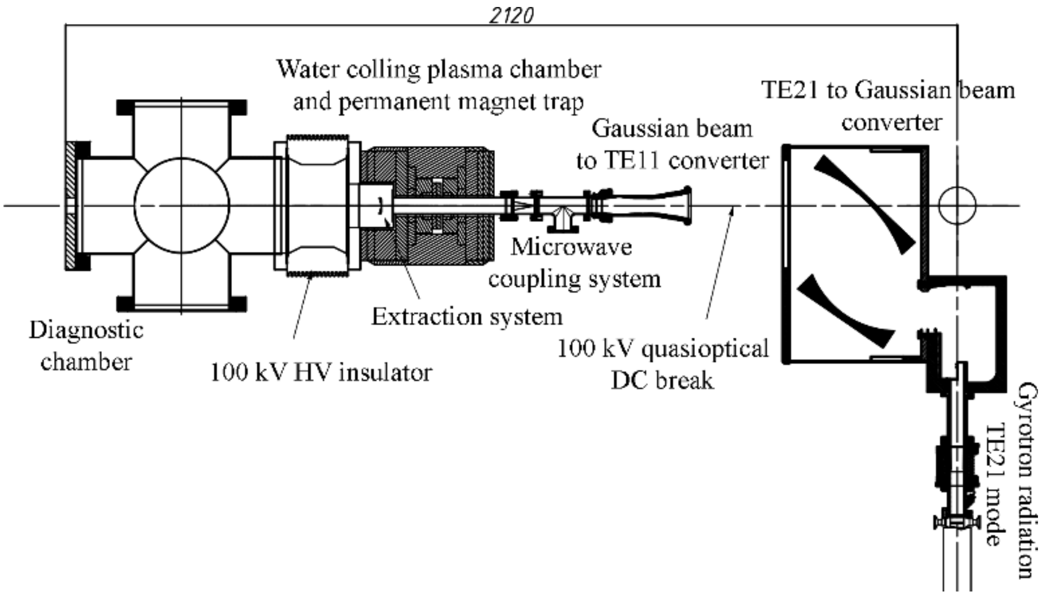

Fig. 1. Scheme of the GISMO 28 CW high current ion source.

The first plasma at GISMO facility was ignited in June 2018. In the future, it is expected that GISMO would be able to generate deuteron ion beams with 1 eA current and 100 keV energy. Modern neutron-generating targets consist of a substrate coated with a metal which can effectively absorb deuterium (such as Ti). The performance of these commercially available targets is about 10^8 neutrons/second per 1 mA current of the incident deuteron beam accelerated to an energy of 100 keV. Thus, the bombardment of such target by a desirable deuteron beam would theoretically yield a neutron flux up to 10^{11} s^{-1}. Also the possibility of using gaseous targets is under investigations now to reach higher neutron yields without tritium.

One of the most interesting and important applications of high yield neutron generators discussed above is boron-neutron capture therapy (BNCT) of oncologic diseases. The main problem hindering the development of BNCT is the necessity of neutron fluxes over 10^9 $s^{-1}\cdot cm^{-2}$. The only machines able to produce the required neutron flux are nuclear reactors and large-scale accelerators plagued by tremendous price and strict safety rules for protecting the staff and patients. The D-D neutron generator scheme discussed here is free of those shortcomings as it does not use radioactive isotopes including tritium and/or high energy particles, thus not requiring heavy X-Ray shielding. Moreover, the device has a compact size allowing it to be installed in literally any existing clinic and has a significantly lower price in comparison to the aforementioned technologies. In summary, a neutron generator based on high-current quasi-gasdynamic ECR ion (deuterium) source with plasma heating by powerful gyrotron radiation could be very perspective for BNCT application.

Another application of high-density neutron fluxes is neutronography [59-60], one of the most important achievements of nuclear physics over the past decades. It provides great opportunities in micro-analysis of not only physical but also chemical and biological entities. Structural neutronography is a well-developed and widely used method of crystal structure analysis. The emergence in recent years of high neutron flux nuclear reactors,

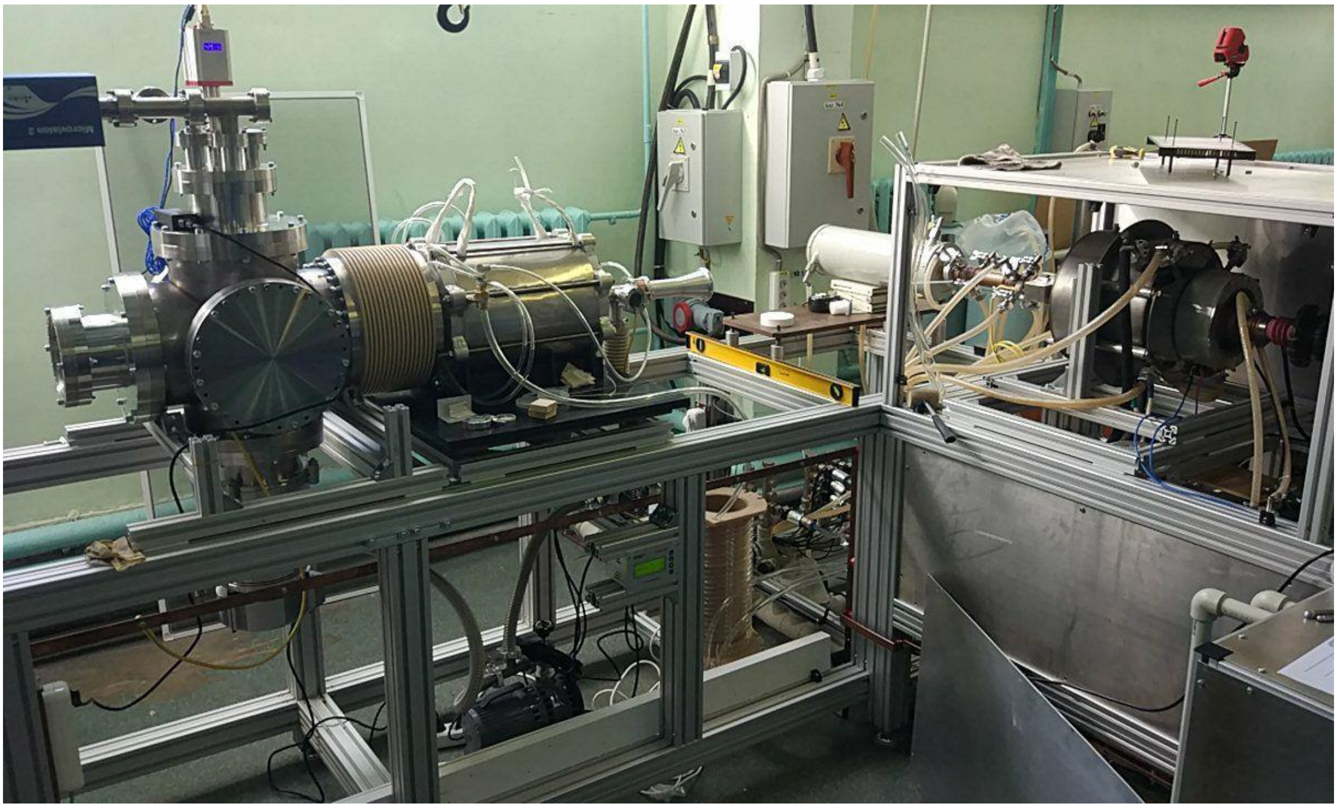

Fig. 2. General view of the GISMO 28 CW high current ion source (gyrotron part to the right and plasma camera to the left side).

computer-controlled automatic neutron diffractometers and specialized data processing software have greatly expanded the possibilities of structural neutronography and have led to a sharp increase of interest in it by physicists, chemists, biologists, metallurgists, etc.. The development of a compact high yield neutron generator could facilitate further developments of neutronography methods in laboratory conditions, previously available at nuclear reactors and large-scale accelerator facilities, thus greatly increasing the accessibility of this analysis method. Also, pulsed neutron generators with high yield could be very prospective for such kind of applications.

For additional information, please see the following reference:

S.V. Golubev, I.V. Izotov, S.V. Razin, A.V. Sidorov, V.A. Skalyga, "A Compact Neutron Source for Boron Neutron Capture Therapy," Radiophysics and Quantum Electronics, vol. 59, n. 8-9 (2017) 682–689. DOI: 10.1007/s11141-017-9735-9.

Numerical Simulation of sub-THz and THz Clinotrons

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Currently, our research activity is connected with the computer modeling for the sub-THz and THz CW clinotrons and verification of the obtained simulation data using the statistical processing of real device operational parameters. Recently developed simulation model considers several important effects occurring in clinotron tube. Among them are: the effect of a weakly inhomogeneous magnetic field; the effect of the surface roughness and thermal heating of the grating structure; the effect of wave reflections and transformation of surface slow modes into fast ones in the clinotron cavity resonator. The carried out 3D particle tracking simulation demonstrated the electron beam adjustment in clinotron oscillator in the case of different distributions of the focusing magnetic field, and provided the velocity distributions in the beam that have been accounted in the beam-wave interaction model. The value of high-frequency ohmic losses has been evaluated in the framework of 3D thermal heating analysis in clinotron and the experimental investigation of the surface roughness appearing in the grating structure manufactured with the wire-EDM processing. Theory of sub-THz and THz clinotrons was extended by use of the modes scattering matrix in ends of the oversized clinotron cavity resonator. Because of reflection and transformation of surface slow modes into fast ones, such theory reveals resonant behavior of clinotron even in the case of strong attenuation of the surface mode. We analyzed resonances both by fast waves with low loss and surface wave appearing in the collector area of the grating because of fast wave transformation. Also scattering matrix in the grating gun area (FIG. 1. a) enables evaluating of power propagating through anode slot into the cathode area. Results of simulations are in good agreement with conducted experiments (FIG. 1. b,

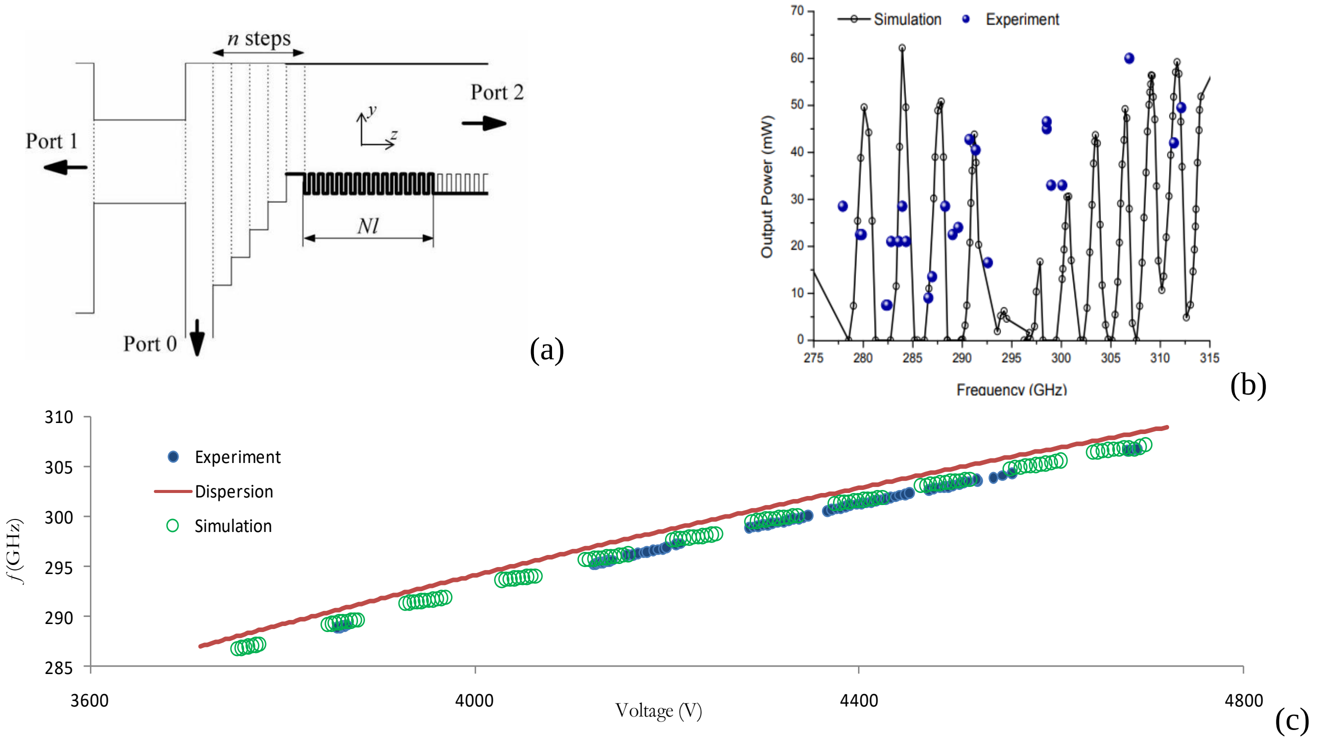


FIG. 1. Simulation model of the power output section (a); Experimental and simulation results obtained for 300 GHz CW Clinotron Tube.

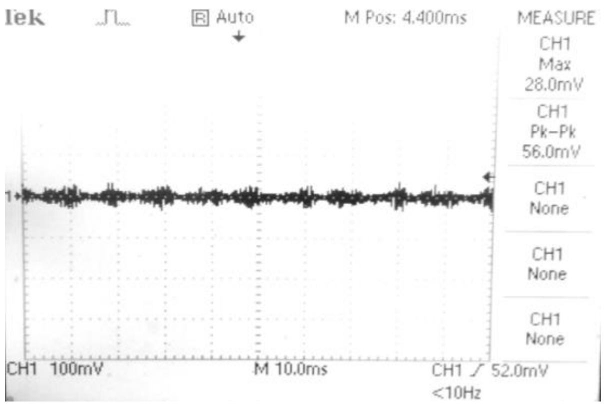
c). Using the developed theory, we plan to optimize the geometry of the output section to maximize the power portion into the output waveguide.

Development of High-Voltage Power Supply with High Stability

Due to the dispersion properties of slow-wave structures applied in clinotrons the high-voltage instability of the electron beam significantly affects their operating parameters. To improve the spectra quality of the clinotron we have developed a compact high-voltage power supply with the voltage stability better than 20 ppm in the accelerating voltage range from 0.5 to 6 kV (FIG. 2). The compact high-voltage power supply employs the microcontroller scheme providing the remote control and data communications via USB using standard software packages such as National Instruments LabVIEW and etc.

The developed HV power supply for the clinotron allows us to realize the developed PID controller scheme. In order to stabilize the clinotron output power, the simplest way is to provide the feedback in beam current circuit controlling the filament current in the case of stabilized high-voltage. In this case, the stabilization of the beam current with the negligible effect of thermal shifts of the electromagnetic system at a fixed frequency will result in the stabilization of output power. The stabilization of the beam current in the case of thermionic emission is realized due to the control of filament current. Also, the inertia of the system provides a serious limit in the case of the stabilization of output power with fast changes. In such a case, it is required to use the double PID control, which can be realized in the clinotron with three-electrode electron gun. Output power value measured with the help of both the waveguide coupler and the power meter is compared with desired value and the PID controller provides the feedback in filament power supply scheme.

(a)

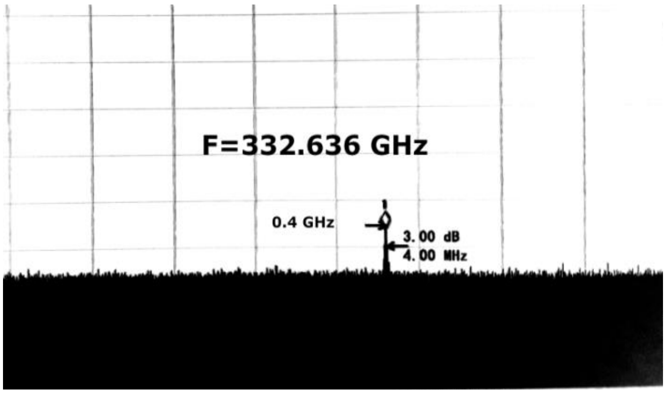


(b)

FIG. 2. High-voltage power supply developed for sub-THz and THz CW Clinotrons (left). The output voltage stability of the power supply (right).

Development of Compact CW Radiation Modules for THz Applications

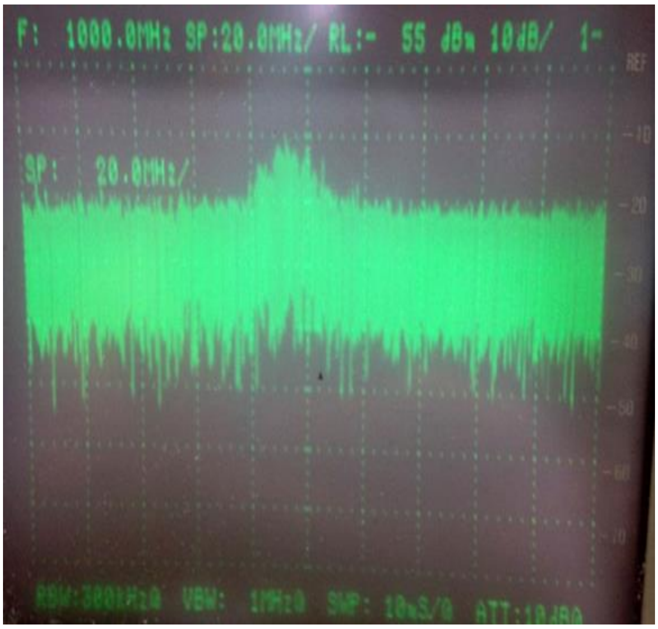
Sub-THz and THz Clinotrons generate radiation with the output power higher than in mass-produced conventional BWO more than an order under the close parameters of electronic tuning of the oscillation frequency in a wide range. These advantages show the attractive opportunity to use the clinotron tubes in different system employed for THz applications. Recently we have developed and manufactured the compact radiation modules based on the clinotron oscillators with the output power up to 100 mW in the frequency range from 290 to 370 GHz (FIG. 3. a, FIG. 4. a). The "hot" simulation has been carried out and the results were used during the clinotrons design optimization. The results were used to estimate the effect of beam voltage instability on the frequency fluctuation and to define the required stability of the clinotron power supply. In this connection, the high-voltage power supply with stability of 20 ppm has been employed in the Compact CW Radiation Modules. The spectra quality of the output electromagnetic radiation has been studied experimentally and is shown in FIG. 3. (b) and FIG. 4. (b). The long-term frequency stability < 40 ppm has been observed during the clinotrons operation within several hours that satisfies the requirements for DNP-NMR spectroscopy. The Compact CW Radiation Modules have remote control and data communication via USB connection therefore the additional external PID-control scheme can be implemented for the improved frequency and power stabilization.



(b)

(a)

FIG. 3. Compact CW Radiation Module for THz Applications based on 340 GHz CW Clinotron (a) and their oscillation spectra (b).



(a) (b)

FIG. 4. Compact CW Radiation Module for THz Applications based on 300 GHz CW Clinotron (a) and their oscillation spectra (b).

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4. Y. Kovshov et al., "Tracking Analysis of a Sheet Electron Beam for Clinotron Tube," 2018 IEEE 17th International Conference on Mathematical Methods in Electromagnetic Theory (MMET), Kiev, 2018, pp. 330-333.

5. Y. Kovshov et al., "Electron Beam Velocity Spread Effect on a Clinotron Operation," 2018 IEEE 17th International Conference on Mathematical Methods in Electromagnetic Theory (MMET), Kiev, 2018, pp. 326-329.
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7. Y. Kovshov et al., "0.1–0.4 THz clinotron table-top modules for spectroscopy applications," 2017 IEEE International Young Scientists Forum on Applied Physics and Engineering (YSF), Lviv, 2017, pp. 275-278.

FORTHCOMING EVENTS

IW-FIRT 2019

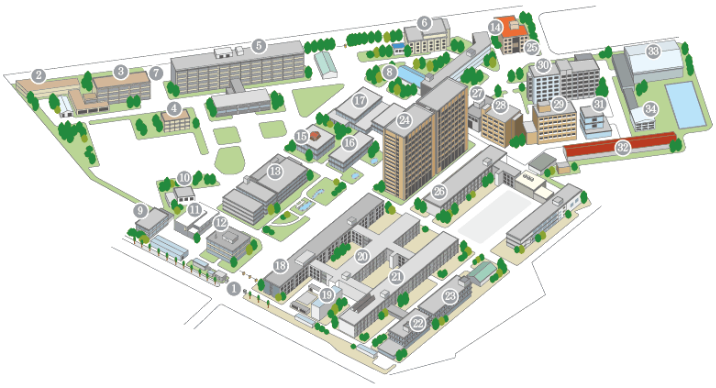
The 7th International Workshop on Far-Infrared Technologies (IW-FIRT 2019)
(5-7 March, 2019, University of Fukui, Fukui, Japan)

The International Workshops on Far-Infrared Technologies (IW-FIRT) has been held six times in the past from 1999 to 2017. In these workshops it was aimed to discuss the recent development and future directions of far-infrared and terahertz science and technologies with a special emphasis on high power radiation sources in this frequency region and their applications. We feel that it is the time to organize the next IW-FIRT to update our knowledge and understanding in this rapidly developing field. Therefore, we organize the Seventh International Workshop on Far-Infrared Technologies (IW-FIRT 2019).
The workshop consists of invited talks, oral presentations and a poster session with the following scope of topics:

1) Development of high power radiation sources in the far-infrared region,
2) Application of high power terahertz technologies especially to the following topics
  2-1) Terahertz spectroscopy,
  2-2) Magnetic resonance phenomena in the far-infrared region,
  2-3) Material development with high-power FIR sources, and
3) Other subjects related to the far-infrared region.

Past Workshops of IW-FIRT and DHP-TST:
6th IW-FIRT 2017 and DHP-TST 2017, 5th IW-FIRT 2014, 4th IW-FIRT 2012, 3rd IW-FIRT 2010, and DHP-TST 2013.

Venue: Bunkyo Campus, University of Fukui (Fukui, Japan). Main conference room and poster session: On the 13th floor of the Science Tower I (No.24 in the campus map). Workshop banquet: At the academy hall (No.11 in the campus map)



List of invited speakers (In alphabetical order of family names):

Marco Battiato (*Nanyang Technological Univ., Singapore*)
Elmer S. Estacio (*The Univ. of the Philippines Diliman, Philippines*)
Gerd Gantenbein (*IHM, Karlsruhe Institute of Technology, Germany*)
Mikhail Yu. Glyavin (*Institute of Applied Physics, RAS, Russia*)
Jarno Järvinen (*Univ. of Turku, Finland*)
Tae-In Jeon (*Korea Maritime and Ocean Univ., Korea*)
Yusuke Kajihara (*The Univ. of Tokyo, Japan*)
Shojiro Kimura (*Tohoku Univ., Japan*)
Stefan Knirck (*Max-Planck-Institut für Physik, Germany*)
Masami Kojima (*Kanazawa Medical Univ., Japan*)
Seitaro Mitsudo (*FIR UF, Japan*)
Yuichi Ogawa (*Kyoto Univ., Japan*)
Hitoshi Ohta (*Kobe Univ., Japan*)
Michael Shapiro (*Massachusetts Institute of Technology, USA*)
Kohei Shimamura (*Univ. of Tsukuba, Japa*n)
Yukihisa Suzuki (*Tokyo Metropolitan Univ., Japan*)
Susumu Takahashi (*Univ. of Southern California, USA*)
Masahiko Tani (*FIR UF, Japan*)
Yoshinori Tatematsu (*FIR UF, Japan*)
Keisuke Tominaga (*Kobe Univ., Japan*)
Johan van Tol (National High Magnetic Field Laboratory, Florida State Univ., USA)

For up-to-date information of the Workshop please visit the **link** ***and contact by an E-mail the Secretariat*: iwfirt2019_secretariat@fir.u-fukui.ac.jp.**

IRMMW-THz 2019

44th International Conference on Infrared, Millimeter, and Terahertz Waves
Paris, France, 1-6 September 2019

For detailed information visit the website of the conference following the link

The IRMMW-THz conference alternates between Asia, Europe and America on a continuous three year cycle. In 2019, the conference returns to Europe and will be held in Paris, France, from September 1st to 6th. The venue is the Maison de la Chimie Conference Center, in the heart of Paris.

Given the diversity of the topics, comprising fundamental and applied research, and in view of the variety of applications (communications, security, energy, astrophysics, medicine,...) the conference gathers several communities of physicists, academics and industrials, who meet in this occasion each year to review the state of the art and determine the axes of future works and future collaborations.

The conference also comprises a large exhibition presenting and highlighting the latest products and innovations in the millimetre, terahertz and infrared spectral region.

CALL FOR ABSTRACTS

Topics

1. Basic physics
   - 1.1. Spectroscopy of gases
   - 1.2. Spectroscopy of the solid state
   - 1.3. Ultrafast phenomena
   - 1.4. High field THz generation and nonlinear physics
   - 1.5. 2D materials
2. Electronics
   - 2.1. Electron devices
   - 2.2. Nano and quantum devices
   - 2.3. MMW components and systems
3. Optoelectronics
   - 3.1. Laser driven sources and detectors
   - 3.2. Time-domain systems
   - 3.3. QCL
4. Materials
   - 4.1. Materials properties
   - 4.2. Metamaterials, plasmonics and artificial materials
5. Systems
   - 5.1. Components
   - 5.2. Near-field techniques and microscopy
   - 5.3. Imaging and remote sensing: components and systems
   - 5.4. Metrology
6. Large facilities and high power equipement
   - 6.1. Tubes, gyrotrons, amplifiers
   - 6.2. FEL and synchrotrons
   - 6.3. Plasma diagnostics
7. Applications
   - 7.1. Industry
   - 7.2. Defense and security
   - 7.3. Biology and Medicine
   - 7.4. Telecoms and radars
8. Astronomy, Astrophysics and Atmospheric Science
   - 8.1. Components and devices for mm-wave astronomy
   - 8.2. Monitoring the atmosphere

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Technical Program Committee

Technical Program Chairs: Jean-Louis COUTAZ - University of Savoie, France
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Frédéric TEPPE - Montpellier University

Conference General Secretary: ellipse&co

Important dates

One-page abstract submission opening: January 2019
Abstract submission deadline: 18 March 2019
Notification of acceptance: 24 May 2019
Early registration deadline: 3 June 2019
Extended abstract submission deadline: 30 June 2019
Conference: 1-6 September 2019

Conference website: www.irmmw-thz2019.org
Contact: secretariat@irmmw-thz2019.org

The 29th International Crimean Conference “Microwave and Telecommunication Technology”

The 29th International Crimean Conference “Microwave and Telecommunication Technology” will be held in the city of Sevastopol, Russia from 8 to 14 September 2019.

The conference has been held in Sevastopol since 1991. For 28 years, the conference has become a well-known forum where in 2018 alone over 300 reports were presented on theoretical, experimental, industrial and technological, applied and historical aspects of microwave equipment and telecommunication technologies. The authors of these reports are 606 scientists and specialists, representing 126 universities and enterprises in 9 countries: Armenia, Belarus, Great Britain, China, the Netherlands, Russia, the USA, Ukraine and Sweden. A collection of materials was published annually, for 28 years, 9060 reports were published in the conference materials, the authors of which are scientists and specialists of about 800 universities and enterprises in 43 countries (8 CIS countries and 35 foreign countries). Conference materials are indexed and refereed by many reputable databases, including the Scopus database.

For more detailed information please visit the conference website at the following **link**.

The 20th International Vacuum Electronics Conference (IVEC 2019)

For more detailed information please visit the conference website at the following **link**

LIST OF SELECTED RECENT PUBLICATIONS

Bibliography and links to selected recent publications on topics related to the research field of the International Consortium and published after October 2018, i.e. after issuing the previous Newsletter #10. This cumulative list is in chronological order as collected from various bibliographical and alert services

A. Publications by authors from the institutions participating in the International Consortium

Mishakin S.V., Samsonov S.V., "An Approach to Thermal Analysis of Helically Corrugated Waveguide Elements of Vacuum Electron Devices," IEEE Trans. on Microwave Theory and Techniques, (2018). DOI: 10.1109/TMTT.2018.2873362.
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C. Patents

Methods and apparatus for adjusting a wavelength electromagnetic waves
Inventor: Paul Shala Henry, Giovanni Vannucci, Thomas M. Willis, III, Shikik Johnson, Robert Bennett, Farhad Barzegar, Irwin Gerszberg, Donald J. Barnickel
US Patent: US10096883B2
Date of publication: 2018-06-07
https://patents.google.com/patent/US20180159197A1/en

Self-referencing frequency comb based on high-order sideband generation
Inventors: Mark Sherwin, Hunter Banks, Darren Valovcin
Patent Application Publication: No. :US 2018 / 0301868 A1

Publication date: 18 Oct 2018
https://tinyurl.com/y96s49fk

Extended interaction device comprising coaxial resonant cavities and multiple electron beams
Inventors: Yong YIN, Lin MENG, Bin WANG, Hailong LI
Patent Application Publication: No.: US 2018 / 0301311 A1
https://tinyurl.com/y8hpppad

Slow-wave structure for a traveling-wave tube
Inventors: G.V. Torgashov, N.M., Ryskin, D. Shalaev
Russian patent: RU 183912
Publication date: 9 Oct 2018
https://www.researchgate.net/publication/328702502_Slow-wave_structure_for_a_traveling-wave_tube

Up and down conversion systems for production of emitted light from various energy sources including radio frequency, microwave energy and magnetic induction sources for upconversion
Inventors: Frederic A. Bourke, Jr., Zakaryae Fathi, Ian Nicholas Stanton, Michael J. Therien, Paul Rath Stauffer, Paolo MacCarini, Katherine Sarah Hansen, Diane Renee Fels, Cory Robert Wyatt
US Patent Application: US20180317307A1
Publication date: 1 Nov 2018
https://patents.google.com/patent/US20180317307A1/en

Method and apparatus of communication utilizing waveguide and wireless devices
Inventors: David M. Britz, John W. MacNeill, David DeVincentis, Robert Bennett, Paul Shala Henry, Irwin Gerszberg, Farhad Barzegar, Thomas M. Willis, III, Donald J. Barnickel
US Application US20180219579A1
Publication date: 23 Oct 2018
https://patents.google.com/patent/US20180219579A1/en

Microwave Electrothermal Thruster Adapted for In-Space Electrothermal Propulsion
Inventors: Rohan M. Ganapathy, Bellary (IN)
Patent application: US 2018 / 0327118 A1
Publication date: 15 Nov 2018
https://patents.google.com/patent/WO2017085746A1/en

Slow Wave Circuit and Travelling Wave Tube
Inventors: Norio Masuda, Tokyo (JP) , Takashi Nakano, Tokyo (JP)
Patent application: US 2018 / 0337016 A1
Publication date: 22 Nov 2018
https://tinyurl.com/y8x9b66j

Magnets for Magnetic Resonance Applications
United States Patent Application: 20180340994
Inventors: Ibragimova Olena (Ottweiler-Fuerth, DE), Ibragimov Ilgiz (Ottweiler-Fuerth, DE)
Publication date: 29 Nov 2018
http://www.freepatentsonline.com/y2018/0340994.html

Real-Time Methods for Magnetic Resonance Spectra Acquisition
United States Patent Application 20180340997
Inventors: Ibragimova Olena (Ottweiler-Fuerth, DE), Ibragimov Ilgiz (Ottweiler-Fuerth, DE)
Publication date: 29 Nov 2018
http://www.freepatentsonline.com/y2018/0340997.html

Apparatus and methods for launching guided waves via an antenna

United States Patent US10135147B2
Inventors: Paul Shala Henry, Robert Bennett, Farhad Barzegar, Irwin Gerszberg, Donald J. Barnickel, Thomas M. Willis, III
Publication date: 20 Nov 2018
https://patents.google.com/patent/US20180108998A1/en

Accelerating cavity and accelerator
United States Patent Application US20190014653A1
Inventors: Mitsuhiro Yoshida, Daisuke Satoh, Nobuyuki Shigeoka, Sadao Miura
Publication date: 10 Jan 2019
https://patents.google.com/patent/US20190014653A1/en

Relativistic magnetron using a virtual cathode
United States Patent US10192709B2
Inventors: Edl Schamiloglu, Mikhail I. Fuks
Publication date: 29 Jan 2019
https://patents.google.com/patent/US10192709B2/en

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http://iopscience.iop.org/book/978-1-64327-114-9.pdf

Jean-Louis Coutaz, Frederic Garet, Vincent P. Wallace, Principles of Terahertz Time-Domain Spectroscopy: An Introductory Textbook, (CRC Press, Dec 3, 2018) 622 pages. ISBN 1351356364, 9781351356367.
https://www.crcpress.com/Principles-of-Terahertz-Time-Domain-Spectroscopy/Coutaz-Garet-Wallace/p/book/9789814774567

Zhang C, Zhang XC, Tani M., Infrared, Millimeter-Wave, and Terahertz Technologies V. InProc. of SPIE Vol 2018 Nov (Vol. 10826, pp. 1082601-1).
https://www.spiedigitallibrary.org/conference-proceedings-of-spie/10826/1082601/Front-Matter-Volume-10826/10.1117/12.2522342.full?SSO=1

Marcus Seidel, A New Generation of High-Power, Waveform Controlled, Few-Cycle Light Sources, Springer Theses, 2019). (DOI:10.1007/978-3-030-10791-8. Print ISBN 978-3-030-10790-1 Online ISBN 978-3-030-10791-8.
https://link.springer.com/book/10.1007/978-3-030-10791-8

NEWS

57th Annual Meeting of the Electronic Spin Science Association

The 57th Annual Meetings of the Society of Electron Spin Science and Technology (SEST2018) was held at the Conference Hall, Hokkaido University from 1st to 3rd October 2018.

Assistant Professor Yuya Ishikawa has been awarded by the Excellence Presentation Award for your work on the development of Ultra-Low-Temperature ESR / NMR Measurement System for Millimeter Wave Band.

Source: The Society of Electron Spin Science and Technology (SEST)