NPSS NEWS

ISSUE 4: DEC. 2018

A PUBLICATION OF THE INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS

28th Symposium on Fusion Engineering

June 2nd–6th, 2019

Dennis Youchison
General Chairman

The 28th Symposium on Fusion Engineering (SOFE) will be held June 2nd–6th, 2019 near Jacksonville, Florida at the Sawgrass Marriott Golf Resort and Spa at Ponte Vedra Beach. The conference has an outstanding technical program presented at a world-class PGA golf and beach resort on the east coast of the United States.

Early registration and abstract submission are now open on the conference web site. The early registration deadline is 15th April 2019, but abstracts must have been submitted by 7th December 2018. Early abstract review was available to international participants to allow adequate time to process visa requests. The hotel room block at a reduced conference rate is available until 6th May 2019. The number of rooms is limited, and participants are encouraged to book early.

The technical program includes four plenary sessions as well as fourteen oral and three poster sessions. Topics include Experimental Devices, Next-step Devices and Power Plants, MFE and IFE Alternate Concepts, Innovative and Disruptive Technologies, Divertors and High Heat Flux Components, Chambers, Blankets, and Shields, Fueling, exhaust, and vacuum systems, IFE Fusion Studies and Technologies, Plasma-facing Materials and Surface Engineering, Diagnostics Engineering and Integration, Safety and Neutronics Materials, Heating and Current Drive, Disruption Mitigation and Control, Operation and Maintenance, Remote Handling and RAMI Magnet Engineering, Power and Control, Process Simulation and Plant Simulators, Systems Engineering and Large Scale Integration. Special guest speakers will address reactor technology development for ITER and beyond.

The SOFE 2019 conference will include an exciting social program, where all conference attendees will be invited to participate. In addition to the opening reception (Sunday evening) and the conference banquet (Wednesday evening), SOFE 2019 attendees are encouraged to join the Women in Engineering luncheon on Monday, and the Young Professionals reception on Tuesday. A Town Hall meeting on the topic of "Accelerating the Development of Fusion Power" will follow immediately after the Young Professionals reception on Tuesday evening.

All authors of SOFE-2019 presentations, whether oral or poster, will have the opportunity to publish their work in a special issue of IEEE *Transactions on Plasma Science* (TPS), a peer-reviewed journal. Submitted manuscripts will be reviewed anonymously by two peer reviewers and must meet the journal's normal standards to be accepted. Please see the publication policy on the conference website for more details.

Two short courses are being offered that cover two of the most important topics in fusion engineering. The first minicourse is on Plasma-Material Interactions (PMI) which is being organized by Professor Davide Curreli from the University of Illinois Urbana-Champaign. This minicourse will introduce the breadth and depth of the subject including: plasma-surface interactions in fusion edge plasmas, plasma diagnostics for PMI and modeling of the plasma edge and materials. The second minicourse is on Neutronics in Fusion and is being organized and run by Professors Laila El Guebaly and Mohamed Sawan from the University of Wisconsin Madison. The aim of this neutronics minicourse is to provide an overview of the state-of-the-art nuclear assessment, targeting students and new researchers in the fusion field to bring them up to speed on the basics and pertinent topics over the course of one day.

Both minicourses will be held on Sunday, 2nd June 2019 at the Sawgrass Marriott Resort. The courses run in parallel and offer continuing education credits with certificates available to participants completing the short course. Eligible attendees may apply for a Paul Phelps Continuing Education Grant to help offset some of the costs of participating in the short courses. Please visit http://ieee.npss.org/awards/conference-awards/ for details. For more information please visit the SOFE2019 minicourse website https://sofe2019.utk.edu/courses.html.

For more information, contact the Conference General Chairman, Dennis Youchison, by E-mail at youchisondl@ornl.gov or visit the conference website: http://sofe2019.utk.edu/

CONFERENCES Continued on **PAGE 2**

Conferences

Continued from **PAGE 1**

ANIMMA 2019, June 17th–21st, 2019, Portorož, Slovenia

The next ANIMMA international conference co-organized by Jospeh Stephan Institute (JSI, Slovenia), French Atomic Energy and Alternative Energies CEA, the Belgian nuclear research center SCK-CEN, Aix-Marseille University and IEEE NPSS will take place for its sixth issue at the Grand Hotel Bernardin in Portorož, Slovenia from June 17th–21st 2019 www.animma.com.

The main objective of the conference is to unite the various scientific communities not only involved in nuclear instrumentation and measurements, but also in their wide fields of applications such as fundamental physics, nuclear medicine, medical and environmental sciences.

The conference is all about getting scientists, engineers, students and members of industry to meet, exchange cultures and identify new scientific and technical prospects to help overcome both current and future unresolved issues. The ANIMMA conference provides scientists and engineers with a unique opportunity to compare their latest research and development in different areas of applications: physics, nuclear energy, nuclear fuel cycle, safety, security, future energies (GEN III+, GEN IV, ITER), medical and environmental sciences.

This is the sixth conference in this biennial series. About 400 participants from more than 35 countries will participate in a collegial environment. The conference is organized around opening and closing sessions, and oral and posters sessions. Posters are promoted by special minioral intensive sessions. In addition some topical workshops and specific short courses are organized prior to the conference.

The updated ANIMMA 2019 topics include instrumentation and measurement in:

- Fundamental physics
- Fusion diagnostics and technology
- Nuclear power reactors monitoring and control
- Research reactors
- Nuclear fuel cycle
- Decommissioning, dismantling and remote handling
- Safeguards, homeland security
- Severe accidents monitoring
- Environmental and medical sciences
- Education, training and outreach

Authors had been invited to submit abstracts on any of the above topics, before November 6th, 2018 via the following link: www.animma.com/call-for-papers/

Abstract Submission Guidelines, important dates and deadlines and all others details are given on the conference web site: www.animma.com

We are looking forward to welcoming you in Portoroz https://www.portoroz.si/en/

For any other specific information concerning the Call for Papers campaign or the conference organization in general you can contact: conference@animma.com

Conference Reports

ICOPS 2018

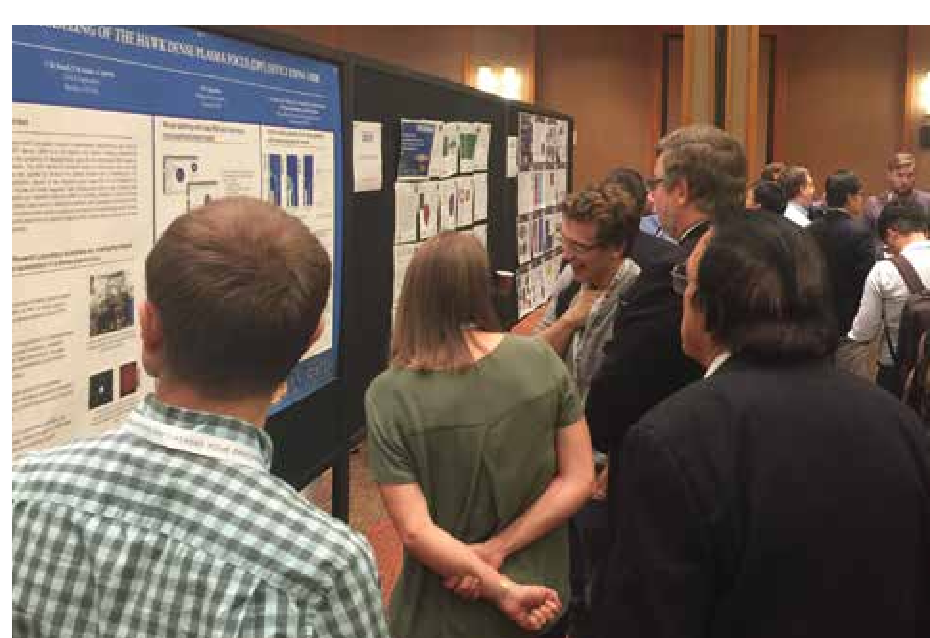
Plasma and beam scientists came together in Denver, CO, from June 24th–28th, 2018, for the 45th meeting of the IEEE International Conference on Plasma Science (ICOPS.) Researchers from 40 countries attended the meeting, held at the Sheraton Denver Downtown, with scientists from China and South Korea making the largest contribution to the international contingent.

Highlights of the technical program included seven plenary talks, including a talk by the 2018 IEEE Plasma Science and Applications Award winner, John Booske, entitled "A Career in Electron Beams, Plasmas and EM Fields & Waves: Everything I Needed to Succeed I Learned in Kindergarten." The other plenary talks included: Michael Fazio of SLAC National Accelerator Laboratory discussing the future of particle accelerator technology, John Cary of Tech-X Corporation and University of Colorado providing an overview of the growth of computational physics, Njema Frazier of D.O.E. National Nuclear Security Administration focusing on the future hurdles in high-energy-density physics and inertial fusion, Petr Lukes from the Institute of Plasma Physics of the Czech Academy of Sciences speaking on the interactions of nonequilibrium plasma with liquids, Alex Friedman of Lawrence Livermore National Laboratory highlighting computer simulations of plasmas, and Bruce Carlsten of Los Alamos National Laboratory proposing the use of antennas and beams to protect against energetic particles from the radiation belts.

ICOPS Plenary Session

In addition to the technical program, other highlights included a reception hosted by Women in Engineering with a keynote address given by Mei Lai of Clovis Oncology, and a Young Professionals Symposium during which students and early career scientists present their posters to professionals and potential employers. The minicourse, on New Directions in Plasma Diagnostics for High Energy Density Burning Plasmas, was also well attended.

Brooke Stutzman, who submitted this note, can be reached by E-mail at: Brooke.S.Stutzman@uscga.edu.



Animated ICOPS poster session

NUCLEAR & PLASMA SCIENCES SOCIETY NEWS

(USPS 000-560) is published quarterly by the Nuclear & Plasma Sciences Society of the Institute of Electrical and Electronics Engineers, Inc. Corporate Office: 3 Park Avenue, 17th Floor, New York, NY 10016-5997, https://www.ieee.org/about/contact.html. Printed in the USA. One dollar per member per year is included in the Society fee for each member of the Nuclear & Plasma Sciences Society. Periodicals postage paid at New York, NY and at additional mailing offices. Postmaster: Send address changes to Nuclear & Plasma Sciences News, IEEE, 445 Hoes Lane, Piscataway, NJ 08854.

President's Report

Stefan Ritt
IEEE NPSS President

With mixed feelings, I am writing my last newsletter article as NPSS president. On one hand I look forward to having more time for my "day job" and my family, and on the other hand I will miss many things: meeting new brilliant people, the creative process of shaping the society, writing newsletter articles (yeah!) and – most important for me – learning lots of things. You not only get training from IEEE in chairing meetings and other management-related things, but you learn to sharpen your social skills in working with volunteers. Members of our Administrative Committee (AdCom), journal editors and reviewers as well as conference organizers are all volunteers. You cannot just give orders and tell them what to do, but you have to convince them that what you want is the right thing, maybe even give them the impression that it was their own idea. This gives volunteers lots of motivation and keeps them in the boat. Training in these skills over my term as president not only helped me to run AdCom meetings and to lead the society but is also something I will benefit from for the rest of my life. This was an unexpected reward for the two years full of activities.

What has the society achieved during my term? Looking back at my ideas from the March newsletter 2017, I see that some things have been implemented successfully, and other things are still to come. We strengthened our Facebook page with regular posts concerning our conferences, awards, Women in Engineering events and more. Several of our conferences produced promotional videos which had a significant outreach to promote future events. Many of our conferences have had Women in Engineering (WIE) and Young Professional (YP) events. I had the pleasure to attend some of these that were quite inspiring. We have not yet succeeded in producing recordings of invited talks and lectures from our Distinguished Lecturer program or our Summer Schools, but plans are underway to create such digital content and publish it in the IEEE resources center.

On the conference software side, we now have two well-documented and maintained packages organizers can choose from. One is a free package while the other one is commercial. They cover all conference aspects such as registration, abstract submission and review, agenda management and paper submission. About half of our conference take advantage of these software systems, which are continuously improved and extended to the benefit of our conference organizers and our attendees.

Another goal we have achieved is to use more video conferencing. Our AdCom meetings are regularly broadcast, and reports are occasionally given remotely if people cannot participate in person. Most of our technical committees now have regular video conferences, which significantly improves the communication within these committees and saves lots of costs and CO_2 required for in-person meetings.

Our AdCom has seen some changes as well. The Fusion Technology Committee (FTC) has been converted from appointed to elected, resulting in increased volunteer enthusiasm and emerging quality leadership. With the help of many AdCom members, we developed an NPSS Operational Manual explaining many details of our society, which should help present and future members of our leadership. Two additional AdCom positions have been created. One is our Membership Vice-Chair for Industry – Heiko Körte from N.A.T. Germany - who will strengthen our relationship to our industry members. He is in close contact with exhibitors at our conferences, collecting their feedback and bringing industry needs closer to our society. The other AdCom position is the Membership Vice-Chair Africa – Bruce Mellado from Witswatersrand University, Johannesburg, South Africa. He was the organizer of the highly successful NPSS International School for Real-Time Systems in Particle Physics in Cape Town, South Africa, and brings a unique view of the needs and opportunities in the engineering community in Africa. Having him on AdCom gives us a unique chance of extending our activities to Africa and bringing new people into the society.

Even having accomplished much in the past, our society sees significant challenges ahead. The biggest one I see in the change of publications towards open access (OA) models. With more and more funding agencies requiring publicly funded research to be published in pure OA journals, our publications will see a severe financial impact and new models have to be established and pursued across all IEEE societies.

Finally, I would like to thank all volunteers from our society and the IEEE headquarters for all their support and encouragement during the past two years. It was a great pleasure working with you, learning a lot from everybody and having a great time. My special thanks go to Albe Larsen, Bill Moses, Hal Flescher, Peter Clout, Paul Dressendorfer and John Verboncoeur for their special mentoring and teaching me the ropes of our society. I ask your support for my designated successor, NPSS Vice President Ronald Schrimpf, pending approval at the November AdCom meeting. Ron is a professor at Vanderbilt University, Nashville, Tennessee and brings a broad technical background to the leadership of our society. He was named IEEE Fellow for his work on radiation effects in semiconductors and has received several teaching awards. I look forward to continuing working with him to tackle the big challenges for our society.

My last big "thank you" goes to all of you as members of our society. Through your support of our society you help us build a better tomorrow in engineering, computing and technology around the globe, and it has been a distinct honor and privilege for me to make my small contribution as your president.

Sincerely,

Stefan Ritt, IEEE NPSS President, can be reached at the Paul Scherrer Institute CH-5232 Villigen PSI, WBWA/140, Switzerland; Phone: +41 56 310 3728; Fax: +41 56 310 2199; E-mail: stefan.ritt@psi.ch.

Secretary's Report

As our NPSS AdCom will not hold its Annual Meeting until too late to include a report in this Newsletter, there will be a full report in the March 2019 issue.

I would to take this opportunity to thank members after AdCom who are completing their terms Paul Lecoq, Radiation Instrumentation; Steve McClure, Radiation Effects; Steve Meikle, Nuclear Medical and Imaging Sciences; and Stephen Milton, Particle Accelerator Science and Technology; for their four years of dedicated service to NPSS. And I am delighted to welcome our newly elected members; Sara Pozzi, Radiation Instrumentaion; Keith Avery, Radiation Effects; Adam Alessio, Nuclear Medical and Imaging Sciences; and Anna Grasselino, Particle Accelerator Science and Technology, to the AdCom Class of 2022. Their terms will begin on January 1st, 2019. We will greet them at our first AdCom meeting of 2019, to be held in Nashville, TN. Look for their biographies in the March 2019 newsletter as well as for news of our new officers and new technical committee chairmen.

I also take this opportunity to thank Stefan Ritt Peter Clout, Ken Dawson, Ralf Engels and Ron and Merry Keyser for their gracious support over these years, but especially over this last year which has been challenging.

Albe Larsen, IEEE NPSS Secretary and Newsletter Editor, can be reached by E-mail at a.m.larsen@ieee.org.

Albe Larsen
IEEE NPSS Secretary and Newsletter Editor

Technical Committees

COMPUTER APPLICATIONS IN NUCLEAR AND PLASMA SCIENCES

Martin Grossmann
CANPS Chair

The last issue of our newsletter featured a report on the 21st Real Time Conference in Williamsburg, Virginia and at that time mentioned the outcome of the Student Paper Awards. Starting with the current issue we will have a small series of articles by the award winners. This time Nicholas Tan Jerome from Karlsruhe Institute of Technology who had won the first place for his paper "Real-Time Local Noise Filter in 3D Visualization of CT Data" reports about his work on improving the quality of three-dimensional images of insect samples obtained with synchrotron light. See Articles, p. 7

While most committee members took a break after the Real Time conference some CANPS members continued more or less straight on as lecturers at the International School for Real Time Systems in Particle Physics in July. You can read more about the school in the separate article (Articles, p. 9) in this newsletter.

As already announced, the next Real Time Conference will take place in Vietnam in spring 2020. We are currently exploring options for the conference site and hope to be able to fix the exact time and place soon.

Martin Grossmann, Chairman of the CANPS Technical Committee, can be reached by E-mail at martin.grossmann@psi.ch.

FUSION TECHNOLOGY

I'm very pleased to report on the results of the first election of members to the Fusion Technology Standing Committee (FTC). This milestone marks

Charles Neumeyer
FTSC Chair

the beginning of a transition to an elected committee whereby four new members are elected each year to serve four-year terms and replace four legacy members on the 16-member committee. The newly elected members are Kevin Freudenberg, Ankita Jariwala, Ingo Kuehn, and Gregory Wallace.

Kevin Freudenberg (ORNL) is the lead analyst of the US ITER Central Solenoid Magnet Team. He is now serving as the Treasurer for the upcoming 2019 IEEE 28th Symposium on Fusion Engineering (SOFE).

Ankita Jariwala (PPPL) is a mechanical engineer currently working on the implementation of a new set of Plasma Facing Components for the NSTX-U device. Her interests in Women in Engineering and her volunteer efforts to bring women into STEM careers will be a valuable component of her participation in FTC.

Ingo Kuehn (ITER) is a key member of the Design Integration Section of the ITER project in France. He has served on the organizing committee of several SOFE conferences, beginning in 2011, and brings direct representation of the ITER community to the FTC.

Gregory Wallace (MIT) is an expert in the physics and technology of plasma heating using lower hybrid RF waves, and collaborates on experiments domestically (DIII-D), in Europe (WEST), and in Asia (EAST). Greg plans to encourage more engagement with "early career" fusion scientists and engineers who will be the leaders in the field as we approach the era of burning plasmas.

These new members will serve very will to reinvigorate the FTC and diversify the representation of geographic regions and institutions. For those candidates not chosen this year, I note that the voting was very close, and hope that they will choose to participate again in next year's election that begins with the identification of candidates in May.

Charles Neumeyer, Chairman of the Fusion Technology Committee, can be reached by E-mail at neumeyer@pppl.gov.

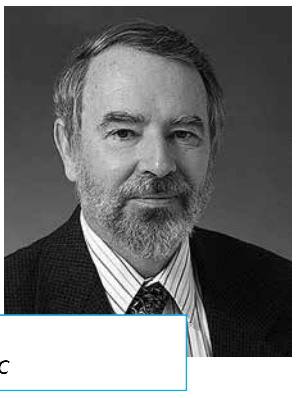
TECHNICAL COMMITTEES Continued on **PAGE 4**

Technical Committees

Continued from **PAGE 3**

RADIATION EFFECTS NEWS

Allan Johnston, J-K Associates, is the outgoing Chair of the Radiation Effects Steering Group, which oversees NSREC Conferences.



Allan Johnston
Chairman RE TC

Teresa Farris
Publicity Vice Chair

The IEEE Radiation Effects Committee (REC) held its annual Open Meeting on July 19th, 2018, at the Hilton Waikoloa Village Hotel (near Kona, HI). The meeting was held during the 2018 Nuclear and Space Radiation Effects Conference (NSREC). Presentations were given by the general chairs of the 2018 through 2020 NSRECs. Changes in the Steering Committee were made, following the election, administered by IEEE in May 2018, of a new Vice Chair and Secretary.

Allan Johnston, the outgoing REC Chair, opened the meeting by recognizing elected and appointed members of the Radiation Effects Steering Group (RESG), who had served the previous three years. These included Marty Shaneyfelt, Sandia National Laboratories, Past Chair; Janet Barth, NASA Goddard Space Flight Center (ret.), Vice Chair; Paul Dodd, Sandia National Laboratories, Secretary; Tom Turflinger, Aerospace Corporation, Senior Member-at-Large; Dan Fleetwood, Vanderbilt University, Vice Chair for Publications; Teresa Farris, Cobham, Vice Chair for Publicity; Jeff Black, Sandia National Laboratories, Webmaster; and Paul Dressendorfer, Sandia National Laboratories (ret.), Special Publications.

Allan then introduced the new elected members of the Steering Group. Janet Barth, NASA Goddard Space Flight Center (ret.) is the new Executive Chair; Robert Reed, Vanderbilt University is the new Vice Chair; and Sarah Armstrong, Naval Surface Weapons Center (Crane) is the new Secretary. Allan continues to serve on the RESG as Past Chair. Although the new Executive Chair would normally chair the meeting at this point, Janet Barth was unable to attend due to a sudden illness (likely food poisoning). Allan continued to chair the meeting, consistent with the rules established in our Bylaws when the Executive Chair is unavailable.

An election was held during the Open Meeting for a new Member-at-Large. Kyle Miller, Ball Aerospace, is the newly elected Junior Member-at-Large. He joins Ethan Cannon, Boeing, and Julien Mekki, CNES, who are serving as Senior Member-at-Large and Member-at-Large, respectively.

Allan announced the general chairs for future NSREC Conferences: John Stone, Southwest Research Institute, 2019; Hugh Barnaby, Arizona State University, 2020; Steve McClure, Jet Propulsion Laboratory, 2021; and Tom Turflinger, Aerospace Corporation, 2022.

Ron Lacoe, the General Chair of the 2018 Conference, summarized statistics and highlights of this year's conference. A total of 429 people registered for the technical sessions, and 297 people attended the short course. There were 281 registered guests, and 40 exhibit-only registrants. The highlight of the social program was a luau on Wednesday, which was attended by 518 people.

The technical sessions featured 162 papers that were presented during the four-day conference.; 44 oral presentations, 54 poster presentations (four of the 58 that were initially accepted were withdrawn and not presented), and 64 poster presentations in the Data Workshop. Four tutorial presentations were given at the Short Course, held on Monday, July 16th. All short-course attendees received copies of this year's course, as well as copies of all past Short Courses. The Industrial Exhibit, which had 38 exhibitors, was well attended.

John Stone, SWRI, General Chair of the 2019 Conference, discussed his plans for the 2019 Conference that will take place at the Marriott Rivercenter Hotel, San Antonio, Texas, July 8th – 12th, 2019. The conference will feature a technical program with ten sessions of contributed papers that describe the latest observations and research results in radiation effects. The program will include oral and poster papers, with a separate dedicated poster session where authors of poster papers can discuss their results with conference attendees. A Radiation Effects Data Workshop will be held, as well as an Industrial Exhibit. Attendees will also have the opportunity to participate in a one-day Short Course on Monday, July 8th. The theme for the Short Course is "Predicting, Characterizing and Mitigation of SEE in Advanced Technologies." The Short Course is being organized by Steve Moss, Aerospace Corp. (ret.). Topics and speakers for the Short Course include:

Single-Event Mechanisms,
D. Kobayashi, ISAS/JAXA and Univ. of Tokyo

Particle Beam Tests and Focused Ion Beams,
A. Javanainen, U. Jyväskylä, Finland

Photon-Based Testing

Laser Testing,
D. McMorrow, NRL

Short-Pulse X-ray Testing,
S. Lalumondiere, Aerospace Corporation

SEE Tests of Emerging Technologies,
M. Cabanas-Holman, Boeing

The short course should be of interest to radiation effects specialists as well as newcomers to the field. Electronic copies of the short course notes will be distributed to short course attendees.

The most current information about the Nuclear and Space Radiation Effects Conference, including contact information and paper submission requirements, can be obtained on www.nsrec.com.

Janet Barth, Executive Chair of the Radiation Effects Committee, can be reached by E-mail at jbarth@ieee.com.

RADIATION INSTRUMENTATION

Lorenzo Fabris
Chair, RI Steering Committee

The year is ending soon; the new year will bring about many changes to the Radiation Instrumentation Steering Committee. As in every year, some people are going to leave us, having reached the end of their term, and some new and some known faces will join us to form a new RISC. During the latest NPSS elections the following members were elected by the community to serve on RISC for the term 2019-2021.

Reynold (Ren) J. Cooper, LBNL, USA
Audrey Corbeil Therrien, SLAC, USA
Giulia Hull, IN2P3, France
Paul Lecoq, CERN, Switzerland
Abdallah Lyoussi, CEA, France

In addition of the new RISC members, Sara Pozzi (University of Michigan, USA) has been elected to the AdCom Class of 2022.

Please join me in congratulating out newly elected officers and to thank the outgoing members, Malcom Joyce, Susanne Kuehn, Riccardo Paoletti, Anatoly Rozenfeld, and Andre Sopczak for the help and dedication they demonstrated during the three years of their commitment. We also thank outgoing AdCom member Paul Lecoq.

The 2018 NSS/MIC and RTSD conference has successfully come to a conclusion. I sincerely hope everyone in attendance found it as interesting and stimulating as I did. We are already thinking ahead to the next year's conference that, as everyone knows by now, will be held in Manchester, UK, with Paul Marsden at the helm as General Chair assisted by Patrick Le Dû, Cinzia Da Via and Yoshinobu Unno in charge of NSS and Dimitra Darambara and Suleman Surti for MIC. In keeping with our tradition, I am sure this will be another noteworthy conference.

Speaking of future conferences, for 2020, NSS/MIC will be held in Boston, USA at the Westin Waterfront and the Boston Convention and Exhibition Center. For 2021, Yokohama, Japan was recently selected by the Joint Oversight Subcommittee. Dr. Ikuo Kanno will be General Chair.

The last change 2019 will bring to RISC is my stepping down from the position of chair, having completed my mandate. Chiara Guazzoni from the Polytechnic of Milan, Italy, our present Deputy Chair, will be the new chair for two years. I will not leave yet though, as I will continue serving as past chair for another two years to assist Chiara in her job, just like Patrick Le Dû assisted me for the last two years (thank you, Patrick!). I am very grateful for my tenure as RISC chair, as I learned a great deal about our society, met many new colleagues and had a chance to participate in promoting our culture of respect, equality and strong ethics. This opportunity also gave me a chance to grow as a volunteer and be prepared to take on leadership and responsibility in roles I may not have been prepared for otherwise. As I indicated in my very first newsletter article, I encourage everyone, especially our young members, to volunteer for our society, experience the multitude of opportunities it offers and be part of a unique organization.

Lorenzo Fabris. Chairman of the Radiation Instrumentation Steering Committee, can be reached by E-mail at fabrisl@ornl.gov.

LONG-RANGE ATTRACTION
We sleep in separate bedrooms, we have dinner apart, we take separate vacations—we're doing everything to keep our marriage together.
Rodney Dangerfield

YOU CAN BANK ON IT!
Don't marry for money. You can borrow it cheaper.
Scottish Proverb

Functional Committees

AWARDS

Janet Barth
IEEE NPSS Awards Committee Chair

The NPSS Awards Committee and Technical Committees are soliciting nominations for our 2019 awards that encompass recognition of both scientific and technical achievement at various levels for scientific and professional service. Nominations for the NPSS Awards are due January 31st, 2019. The due dates for the Technical Committee and Conference awards are dependent on the date of the conference, so please check the NPSS Technical Committee website at http://ieee-npss.org/technical-committees/ for details.

The NPSS level awards comprise:

Merit Award

Description: To recognize outstanding technical contributions to the fields of Nuclear and Plasma Sciences. The prize is $5,000, plaque, and certificate. Any IEEE NPSS member who has made technical contributions to the fields of Nuclear and Plasma Sciences is eligible for the award. Selection criteria, in order of importance, are: 1) importance of individual technical contributions; 2) importance of technical contributions made by teams led by the candidate; 3) quality and significance of publications and patents; 4) years of technical distinction; 5) leadership and service within the fields of nuclear and plasma sciences and related disciplines. One award is presented annually at an NPSS sponsored meeting chosen by the Awardee.

Richard F. Shea Distinguished Member Award

Description: To recognize outstanding contributions through leadership and service to the NPSS and to the fields of Nuclear and Plasma Sciences. The prize is $5,000, plaque, and certificate. Any member of the IEEE and NPSS who has contributed to the fields of nuclear and plasma sciences through leadership and service is eligible for the award. Selection criteria are leadership roles and leadership quality; innovative and important contributions to Society activities; service and dedication to the NPSS; and technical achievements. One award is presented annually at an NPSS sponsored meeting chosen by the Awardee.

Early Achievement Award

Description: To recognize outstanding contributions to any of the fields making up Nuclear and Plasma Sciences, within the first ten years of an individual's career. The prize is $3,000, plaque, and certificate. Any member of the IEEE NPSS who at the time of the nomination is within the first ten years of his or her career within the fields of interest of NPSS is eligible for the award. Judging is based on three letters of recommendation, publications and/or reports, patents, etc. which demonstrate outstanding contributions early in the nominee's career. One award is presented annually at any major NPSS sponsored meeting chosen by the Awardee.

Graduate Scholarship Award

Description: To recognize contributions to the fields of Nuclear and Plasma Sciences. The prize is $1,500, certificate, and one-year paid membership in the NPSS. Any graduate student in the fields of Nuclear and Plasma Sciences is eligible for the award. Judging is based on evidence of scholarship such as academic record, reports, presentations, publications, research plans, related projects and related work experience. Participation in IEEE activities through presentations, publications, student Chapter involvement, etc., will also be considered. Up to four awards are presented annually. Checks and certificates are sent to nominator and are to be presented at a special occasion at the winner's institution or at any NPSS sponsored meeting chosen by the Awardee.

Charles K. Birdsall Award for Contributions to Computational Nuclear and Plasma Sciences

Description: For outstanding contributions in computational nuclear and plasma science, with preference given to areas within the broadest scope of plasma physics encompassing the interaction of charged particles and electromagnetic fields. The award is funded by the IEEE Foundation though a gift from Ginger Birdsall and funds provided by the Nuclear and Plasma Sciences Society. The prize is $2,000 and a plaque. All members in good standing of the IEEE NPSS are eligible. Judging is based on outstanding contributions to computational nuclear and plasma science, with preference given to areas within the broadest scope of plasma physics encompassing the interaction of charged particles and electromagnetic fields. One award is presented annually at an NPSS sponsored meeting chosen by the Awardee.

Magne "Kris" Kristiansen Award for Contributions to Experimental Nuclear and Plasma Science

Description: To recognize individuals for outstanding contributions in experimental nuclear and plasma science with preference given to areas within the broadest scope of plasma sciences encompassing the generation of strong pulsed electromagnetic fields including their interaction with plasmas and other pulsed power applications. The award is funded by the IEEE Foundation though a gift from Aud Kristiansen and funds provided by the Nuclear and Plasma Sciences Society. The prize is $2,000 and a plaque. All members in good standing of the IEEE NPSS are eligible. Judging is based on outstanding contributions to experimental nuclear and plasma science with preference given to areas within the broadest scope of plasma sciences encompassing the generation of strong pulsed electromagnetic fields including their interaction with plasmas and other pulsed power applications. One award is presented annually at an NPSS sponsored meeting chosen by the Awardee.

Ronald J. Jaszczak Graduate Award

Description: Recognizes and enables an outstanding graduate student enrolled in an accredited Ph.D. curriculum, Post-doctoral Fellow or Ph.D. level Research Associate in the field of nuclear and medical imaging sciences to advance his/her research activities. The award is funded by the IEEE Foundation though a gift from Ronald Jaszczak and funds provided by the Nuclear and Plasma Sciences Society. The prize provides support for one year to one individual recipient for expenses up to a maximum of U.S. $5,000 one year to support, for example, the following academic and/or research activities: attendance at appropriate scientific workshops, visits to appropriate colleague research laboratories, travel to make presentations during the annual IEEE NPSS Medical Imaging Conference (MIC) or IEEE Nuclear Science Symposium (NSS), annual IEEE and NPSS membership fees, and purchase of appropriate specialized research publications, software or hardware when traditional institutional or grant support is unavailable. There are several requirements for eligibility, which can be found at http://ieee-npss.org/awards/npss-awards/. Judging is based on demonstrated contribution to the field of nuclear and medical imaging sciences via quality of scientific publications, proposed innovative nuclear medical imaging approaches (including hardware or software technologies), patents and/or high-quality recognition of the nominee's scientific and engineering skills by her or his colleagues; potential leadership skills; and potential to serve as role model for other Ph.D. level graduate students, or Post-doctoral Fellows or Ph.D. level Research Associates.

Glenn F. Knoll Post Doctoral Educational Grant

Description: For outstanding post doctoral researchers in the field of nuclear science instrumentation, medical instrumentation, or instrumentation for security applications. The grant is intended to support travel and attendance to conferences, workshops or summer schools, or special research projects. The award is funded by the IEEE Foundation through gifts from Gladys H. Knoll and Valentin T. Jordanov and funds provided by the IEEE Nuclear and Plasma Sciences Society. The prize is $5,000 and a plaque. Any post doctoral researcher who is a member in good standing of the IEEE and NPSS and is within 10 years of having received their doctoral degree is eligible for the award. Judging is based on the accomplishments of the candidate in their field of study and will include number of publications, talks and presentations at conferences, other awards and recognitions, quality of research and potential for future accomplishment. Up to three letters of recommendation may also be submitted with the nomination that will be used in the selection process. One award is presented annually at an IEEE NPSS conference mutually agreed upon by the recipient and NPSS.

Glenn F. Knoll Graduate Educational Grant

Description: For outstanding graduate students in the field of nuclear science instrumentation, medical instrumentation, or instrumentation for security applications. The grant is intended to support travel and attendance to conferences, workshops or summer schools, or special research projects. The award is funded by the IEEE Foundation through gifts from Gladys H. Knoll and Valentin T. Jordanov and funds provided by the IEEE Nuclear and Plasma Sciences Society. The prize is $5,000 and a plaque. Any graduate student who is a member in good standing of the IEEE and NPSS is eligible for the award. Judging is based on the accomplishments of the candidate in their field of study and will include number of publications, talks and presentations at conferences, other awards and recognitions, quality of research and potential for future accomplishment. Up to three letters of recommendation may also be submitted with the nomination that will be used in the selection process. One award is presented annually at an IEEE NPSS conference mutually agreed upon by the recipient and NPSS.

Women in Engineering Leadership Development Travel Grant

Description: To provide leading-edge professional development for women who are in mid-level to senior phases of their careers. One awardee per year will receive a Certificate and be reimbursed for expenses associated with traveling to and participating in the IEEE Women in Engineering International Leadership Conference (WIE ILC) up to a maximum of $3,000. Eligible nominees must be women who are in mid-level to senior phases of their careers who are members of the IEEE Nuclear and Plasma Sciences Society and whose prior technical accomplishments and future potential earmark them as current and future leaders in the field of nuclear and plasma sciences and as role models for future generations of women in the field. Mid-level and senior is defined as no less than 10 years of experience in the nuclear and plasma sciences field after obtaining the highest degree (Bachelor; Master; PhD). Nominees must be able to attend the WIE ILC in the year of the travel grant call. Preference shall be given to applicants who are also members of the IEEE Women in Engineering. Judging is based on leadership roles and leadership quality, technical achievements, and mentoring and outreach activities in areas related to recruitment and retention of women in STEM careers. The award is presented at an NPSS sponsored conference chosen by the Awardee.

Phelps Grants

Additionally, NPSS funds the Paul Phelps Continuing Education Grants, given to encourage attendance at NPSS conference short courses. Description: To promote continuing education and encourage membership in NPSS. The prize is a maximum of $8,000/year for all recipients, mostly for tuition in NPSS Sponsored Short Courses but in selected cases, also for partial travel expenses to NPSS Short Courses. Outstanding Student Members of NPSS and unemployed Members of NPSS who need assistance in changing career direction are eligible for the award. The basis for judging is exceptional promise as a Graduate Student in any of the fields of the NPSS, exceptionally good work in those fields for currently unemployed NPSS members and an expectation that attendance to one or more of the Short Courses will result in improved possibility of obtaining a job in the NPSS fields. The awards are presented each year at the NPSS-sponsored conference in which the Short Courses are given. The awards will be handled prior to the dates of the Conference, so that award recipients can apply the corresponding funds towards covering tuition and/or traveling costs to the Short Courses. Those interested in applying for a Phelps Grant should contact the Technical Committee chair hosting the conference with a Short Course.

BUT WE NEED NOMINATIONS FOR THESE AWARDS

Please nominate one of your colleagues, or yourself, for one of the many NPSS awards or grants (self nominations are allowed for some of the awards... just check the details online to be sure). It's a great opportunity to recognize the many outstanding colleagues in our field and to raise the level of prestige of our Society. Visit the NPSS Awards website for details of each award, nomination forms, and submission instructions. http://ieee-npss.org/awards/npss-awards/

Before preparing a nomination please note the IEEE policy on Hierarchy of Awards. More information about the hierarchy of awards is provided on the NPSS Awards website. IEEE Policy on Award Limitations states "Normally, an individual shall receive only one honor in recognition of a given achievement, unless the significance of the achievement is such as to merit subsequently a higher award. A higher award may be given in the following year or thereafter."

Janet Barth, Chairwoman of the IEEE NPSS Awards Committee can be reached at Phone: +1 301 602-3706 ; E-mail : jbarth@ieee.org.

Computer Applications in Nuclear and Plasma Sciences Phelps Grants

The Paul Phelps Continuing Education Grant was awarded to two student members at this year's Real Time Conference. The purpose of the Phelps Grant is to promote continuing education and encourage membership in the Nuclear and Plasma Sciences Society (NPSS). The criteria for judging are exceptional promise as a student, postdoc or research associate in any of the fields of NPSS, or exceptional work in those fields by currently unemployed NPSS members with an expectation that attendance at the Short Course will improve the possibility of obtaining a job in an NPSS field.

Marc-André Tétrault
2018 Phelps Award Recipient

Marc-André Tétrault is a Postdoctoral Fellow at the Gordon Center for Medical Imaging, Harvard Medical School and Massachusetts General Hospital. He received his M.S. degree in electrical engineering from Université de Sherbrooke in 2006 and worked as a research assistant for 4 years. In 2017 he completed his Ph.D. degree in electrical engineering, also at Université de Sherbrooke. During this period he conducted research on real-time data acquisition systems and time-of-flight detector instrumentation for small animal PET under Dr. Roger Lecomte, Dr. Réjean Fontaine and Dr. Jean-François Pratte. His many contributions to the field were recognized by the 2016 IEEE NPSS Radiation Instrumentation Early Career Award and by the 2017 CMC Microsystem Douglas R. Colton Medal for Research Excellence (Canada). He is currently collaborating with Dr. Georges El Fakhri, Dr. Marc Normandin (both from the Gordon Center) and Dr. Yongjin Sung (University of Wisconsin-Milwaukee) on the development of a multimodal radioluminescence microscopy platform to study PET tracers at the single cell level. His long-term goals are to continue research in radiation instrumentation but also be involved as an instructor for higher level education.

Fernando Carrió Argos
2018 Phelps Award Recipient

Fernando Carrió Argos holds a B.E. degree, M.Tech. and Ph.D. degrees in Electronics Engineering from the University of Valencia, Valencia, Spain. In 2010, he joined the Department of Electrical Engineering, University of Valencia, as a Research Engineer, where he was involved in the development of instrumentation for High Energy Physics (HEP) experiments at CERN. Since February 2012, he has been with the Department of Experimental Physics, Instituto de Física Corpuscular (UV-CSIC), and CERN, designing the new off-detector readout electronics of the ATLAS Hadronic Calorimeter for the High Luminosity Large Hadron Collider (HL-LHC, CERN). His current research interests include Data Acquisition systems for HEP experiments, high-throughput electronics based on FPGAs, and signal and power integrity techniques for high-speed digital systems. He received the 2017 Best Ph.D. Thesis award from the Spanish Institution of Graduates in Telecommunications Engineering (COGITT).

2018 ICOPS Outstanding Student Paper Awards

Each year at the International Conference on Plasma Science, the Nuclear and Plasma Sciences Society presents two cash awards of $500 for the Outstanding Student Paper and the two runners-up receive certificates. These awards highlight the outstanding contributions made by students in the plasma physics community and encourage greater participation by students as first or sole authors on papers. This year's award winners are Revathi Jambunathan from the University of Illinois, Urbana-Champaign and Angela Hanna from Colorado State University. Jambunathan's work focuses

FUNCTIONAL COMMITTEES Continued on PAGE 6

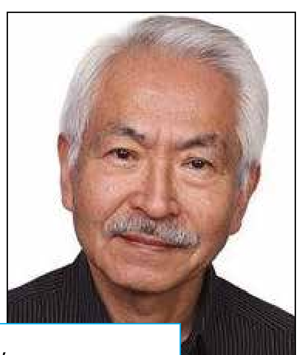
Functional Committees

Continued from PAGE 5

on understanding plasma plume characteristics using a fully kinetic PIC code and Hanna's work concentrates on the molecule formation and decomposition pathways and plasma chemistry in NxOy discharges relevant to pollution control efforts. The runners-up are Moiz Siddiqi for his work on multipactor theory and Giacomo Galli for his work on extending Paschen's Law to extreme pressures and temperatures. Additional finalists include Hang Li, Huihui Wang, Kern Lee, Janis Lai, Lukasz Marciniak, Amith Narayan, and Benjamin Vincent.

Students are reminded that abstracts are to be marked for consideration for the Student Paper Award at the time of submission. Advisors must submit their letter of support within approximately a month of the abstract deadline. (See ICOPS 2019 website for actual dates.)

2018 IEEE/NPSS Radiation Effects Award



Dr. Rocky Koga,
2018 IEEE/NPSS Radiation Effects Award Recipient

Dr. Rocky Koga has been a well-known and highly respected member of the single event effects community for more than 35 years, from almost the very beginning of ground based accelerator testing. He performed, along with Al Kolasinski, some of the earliest tests at the Lawrence Berkelely Laboratory Bevalac and 88" accelerators demonstrating that SEE in microelectronics devices can be induced by cosmic rays. He played a critical role in developing the techniques for accelerator testing that are in common use at multiple facilities today.

Shortly after joining The Aerospace Corporation in 1980, he demonstrated a dependence of the upset rate in CMOS RAMs on the power supply voltage. The team correlated the results with a simple model of the relatively new concept of critical charge to predict an on-orbit upset rate. Following the first ground-based demonstration of ion-induced upsets and latchup by Kolasinski and Blake in 1979, Drs. Koga and Kolasinski showed, in 1986, that latchup sensititivy has a strong temperature dependence. The two observed heavy-ion-induced digital transients in 1987 with later work contributing to the understanding of the frequency dependence. Dr. Koga is credited with the first observation of heavy-ion-induced snapback in 1989, a high-current effect similar to latchup but with distinct characteristics related to the power supply bias. Single event transients from heavy ions were observed in analog devices in 1993. Dr. Koga's contributions continued to the present including work on high current effects in bipolar devices, single event burnout in FETs, and many others.

Dr. Koga has quietly mentored many in his field. In his support for US space programs, he has taught the art of SEE testing to numerous people across the industry, many of whom are now active testers and researchers in our community. He is widely respected for his integrity, his knowledge, and his generosity.

Citation: *for sustained contributions to single-event testing for microelectronics.*

NOMINATIONS FOR 2019 AWARDS

Nominations are due January 25th, 2019 for awards that will be presented at the IEEE NSREC 2019 Conference July 8th–12th, 2019 in San Antonio, Texas.

Radiation Effects Award Nominations

Nominations are currently being accepted for the 2019 IEEE Nuclear and Plasma Sciences Society (NPSS) Radiation Effects Award. The purpose of the award is to recognize individuals who have had a sustained history of outstanding and innovative technical and/or leadership contributions to the radiation effects community. The $3000 cash award and plaque will be presented at NSREC San Antonio. Nomination forms are available electronically at http://ieee-npss.org/technical-committees/radiation-effects/ and must be submitted by January 25, 2019. Additional information can be obtained from Ethan Cannon, Senior Member-at- Large, for the Radiation Effects Steering Group. Ethan can be reached at ethan.cannon@boeing.com.

Janet Barth gives Distinguished Lecture at ISAE-SUPAERO

Paul Phelps Continuing Education Grant Nominations

Nominations are currently being accepted for the 2019 Paul Phelps Continuing Education Grant. The purpose of the grant is to promote continuing education (attendance at the 2019 NSREC Short Course) and encourage membership in NPSS. Outstanding members of NPSS who are either Student Members, Post-Doctoral Fellows or Research Associates, or unemployed members needing assistance in changing career direction can be nominated for the award. The actual amount of the grant will be determined prior to the 2019 NSREC in San Antonio. Funds are to be used towards covering travel costs to attend the NSREC Short Course. The grant also provides complimentary short course registration.

Nomination forms are available electronically at http://ieee-npss.org/technical-committees/radiation-effects/ and must be submitted by January 25th, 2019. Additional information can be obtained from Julien Mekki, Member-at-Large, CNES, for the Radiation Effects Steering Group. Julien can be reached at 33 5 61 27 40 49, Julien.mekki@cnes.fr.

DISTINGUISHED LECTURERS

Janet Barth gives Distinguished Lecture at ISAE-SUPAERO

On September 13, 2018, NPSS Distinguished Lecturer Janet Barth presented a talk entitled "Space Environments and Effects" that was hosted by the ISAE-SUPAERO (Institut Supérieur de l'Aéronautique et de l'Espace, translated as "National Higher French Institute of Aeronautics and Space") Student Branch Chapter in Toulouse, France. The lecture was attended by an enthusiastic audience of about 400 people (see photo). The student branch chapter of ISAE-SUPAERO was formed in 2017, with founding branch president, Ms. Clémentine Dumez and student branch counselor, Professor Vincent Goiffon. Alexandre Le Roch, the current chapter president, hosted the lecture. During her visit, Janet also presented an IEEE Women in Engineering (WIE) lecture entitled "Finding Our Voices – Gender Bias in Engineering" that was also well attended and received. Adèle Balog, the president of the ISA'ELLES club, hosted the WIE event.

Janet Barth is a past president of IEEE NPSS, and incoming chair of the Radiation Effects Technical Committee of NPSS. At the time of her retirement from NASA Goddard Space Flight Center (GSFC), Janet served as Chief of GSFC's Electrical Engineering Division where she was responsible for the delivery of spacecraft and instrument avionics to NASA's science missions, including the Solar Dynamics Observatory, the SWIFT Burst Alert Telescope, the Lunar Reconnaissance Orbiter, the Global Precipitation Measurement mission, and the Magnetospheric Multiscale Mission.

NPSS Chapter members and officers are reminded that NPSS will support lecturer expenses for up to two lectures per chapter per year. On the web site, ieee.org/npss, you will find the list of the current pool of speakers, including representatives from each of our technical communities. These lectures can be tailored to the level of a particular audience. All speakers have been selected for their ability to communicate their knowledge with skill and enthusiasm. To invite a specific lecturer, please contact that lecturer directly using the email links provided on the webpage. If there is flexibility in the date then sometimes the lecturer can fit the presentation in with other travel to the area.

Submitted by Dan Fleetwood, Vanderbilt University, IEEE NPSS Distinguished Lecturers Chair.

Dan Fleetwood, Distinguished Lecturers Program Chairman, can be reached by phone at +1 515 322-2498 or by E-mail at dan.fleetwood@vanderbilt.edu.

Liaison Report

COALITION FOR PLASMA SCIENCE

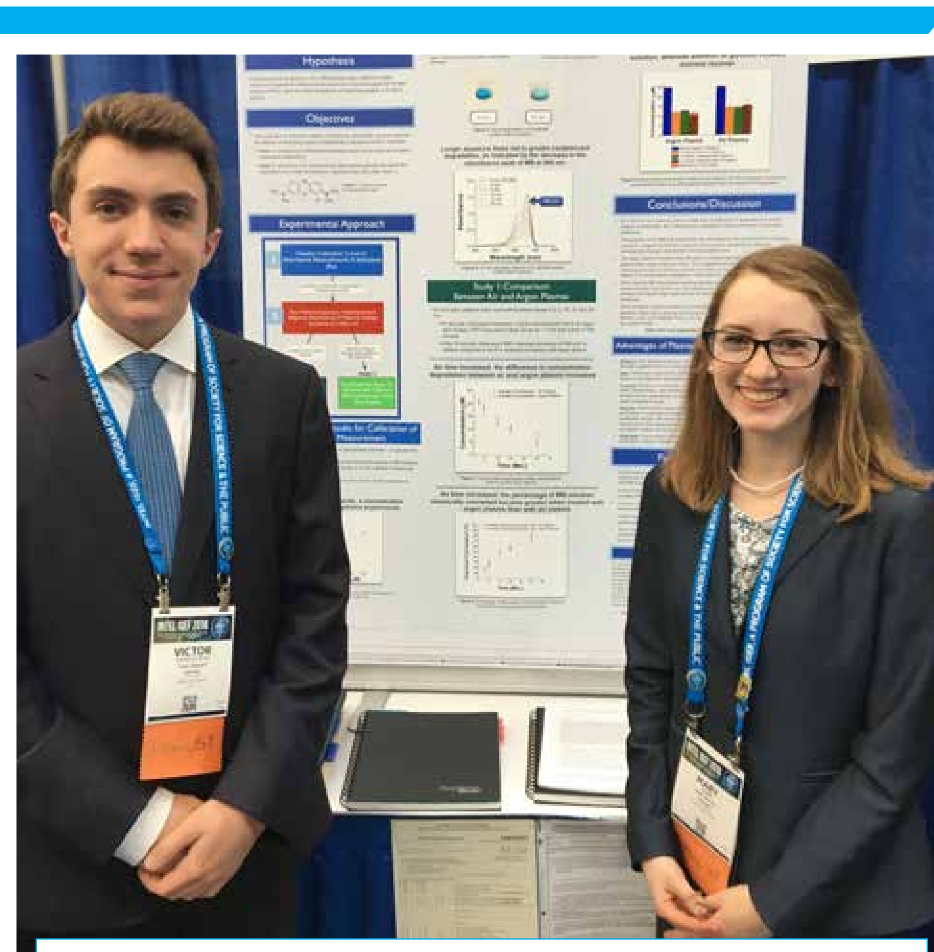
Two Plasma Projects Share CPS First Award at Intel ISEF

The Coalition for Plasma Science (CPS) has awarded its prize ($5000) at the Intel International Science and Engineering Fair (ISEF) to two projects that demonstrate the breadth of plasma research – from fusion to environmental remediation.

Victor Karwacinski and Mary Sgroi of Trinity School at Greenlawn (South Bend, IN) shared half of the award for their project "Non-Thermal, Atmospheric Plasma: A Means of Water Purification." The team explored how nonthermal plasmas degrade organic contaminants—like methylene blue (MB)—in water. Observing the effects on MB of both air and Argon plasmas, they discovered that at exposures of over 10 minutes Argon was more effective. Further experiments indicated that hydroxyl radicals are partially responsible for the MB degradation.

The second winning project, entitled "Langmuir Plasma Research," was presented by another two-person team—Daniel Christensen and Michaela Fennel of Northwest Nuclear Laboratories (NWNL), an organization that uses a research-grade ion collider to teach high school students nuclear engineering principles.

The team set out to create and develop a probe that could help them map the density of plasma inside an Inertial Electrostatic Confinement (IEC) D-D fusor. Fennel explains that they were compelled to take up this research after noticing for years a diamond-shaped pattern left on the interior of the reactor chamber. She and Christensen decided they needed a way to quantify what exactly was happening inside of the plasma, as opposed to what could be happening around it.

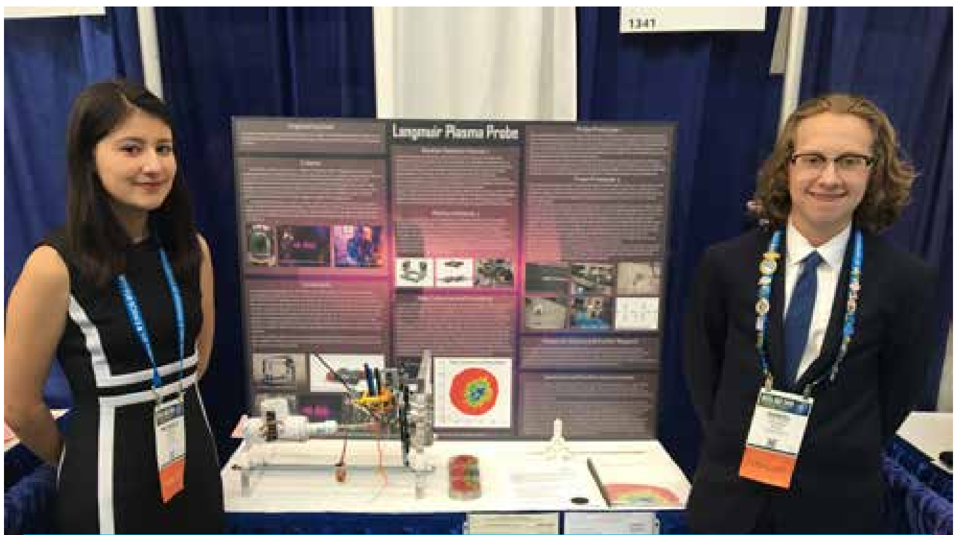


Victor Karwacinski and Mary Sgroi of Trinity School at Greenlawn (South Bend, IN) shared CPS First Award at Intel ISEF.

HEADSTRONG HEADWAY

The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends upon the unreasonable man.

George Bernard Shaw



Daniel Christensen and Michaela Fennel of Northwest Nuclear Laboratories (NWNL) shared CPS First Award at Intel ISEF.

"These two projects had contrasting strengths," according to Paul Miller, who judged on behalf of CPS. "The environmental work of Karwacinski and Sgroi was a carefully designed study in which a model pollutant was treated with plasma, and represented a promising first step in addressing a specific kind of contamination problem. The work of Christensen and Fennel demonstrated student-driven achievement in plasma diagnostic control and data interpretation in a laboratory setting."

The Intel ISEF, a program of the Society for Science and the Public, is the world's largest international precollege competition. In 2018 approximately 1800 young scientists, entrepreneurs and makers, convened in Pittsburgh, PA for the final competition. These finalists were selected from 420 fairs in 81 countries, regions and territories.

The CPS Excellence in Plasma Physics Award is supported in part by contributions from the American Physical Society Division of Plasma Physics and the Institute of Electrical and Electronic Engineers, Nuclear and Plasma Science Society.

Lee Berry, the IEEE NPSS liaison to CPS, can be reached by E-mail at leeaberry223@gmail.com.

TAKE A DEEP BREATH—PLEASE!

There's so much pollution in the air now that if it weren't for our lungs there'd be no place to put it all.

Robert Orben

Articles

Real-time Local Noise Filter in 3D Visualization of CT Data

Nicholas Tan Jerome
2018 CANPS Student Paper Award recipient

X-ray computed tomography (CT) imaging has opened up new opportunities for biologists to better understand the function and evolution of small animals such as insects and other arthropods. Mainly, the shorter wavelength and higher penetration depth of X-rays, in contrast to visible light, allow X-rays to travel predominantly through matter, hence provides detailed interior information of the biological structures and organisms [1]. For example, a recent discovery of four species of parasitoid wasps inside ancient fossils has improved our understanding of the morphology and ecology of wasps. The study is based on the result after scanning 1500 mineralized fly pupae using the nondestructive X-ray CT imaging method [2].

In a synchrotron radiation facility, biologists can perform X-ray CT imaging of biological specimens and visualize them in real time. Noise from various sources (photon statistics, detector misalignment, reconstruction algorithms etc) obscures the clarity of the final visualization [3]. Often, biologists try to manually filter out the unnecessary portion from the data which obviously is not very efficient.

The goal of our work is to provide a real-time CT data visualization system that automatically filters out the unwanted background. To provide the final visualization, we use a 3D visualization framework that incorporates state-of-the-art rendering techniques [4]. Notably, the framework enables the surface rendering method where a filter function differentiates between noise or specimen based on the surface information of the biological sample. Rather than removing the noise from the original data, the filter suppresses the noise without modifying the original data structure.

Before filtering the data, it is essential to separate data and background noise automatically. We adopt the Otsu threshold method that serves as the first stage of preparing the CT data. The Otsu method scans through the dynamic range of the data to find the threshold that minimizes the intraclass variance [5]. Thus we perform coarse filtering that has less computational demands and shows the biological specimen partially. Then, we perform the local noise filter that can suppress the noise entirely.

The most common filter function is the straight averaging filter (mean filter), where the filter averages the values within a predefined kernel region. The kernel region represents the volume space around the surface intersection point. Despite its simplicity, the mean filter tends to provide an overaveraged result: using a small kernel region (3 x 3 x 3) cannot suppress spot noise, whereas using a larger kernel (5 x 5 x 5 or 7 x 7 x 7) removes fine details from the data. Instead, we modify the mean filter by considering the average smaller regions (3 x 3 x 3) and an additional eight small regions spread diagonally with a distance of √3 units from the surface point (Fig 1.). At each region, we calculate the average value base on the central voxel and its six adjacent neighboring positions (average cluster).

To evaluate the effectiveness of our filter, we compare the visual quality, and the performance of a tachinid fly data set with another three filters: the sigma filter, the Okada filter, and the entropy filter (Fig 2). Our approach significantly improves the visual quality and needs only slightly more time.

CONCLUSION

We presented a local noise filter which is a combination of Otsu-threshold and the extended mean filter methods to automate the 3D visual rendering of CT data. Our filter suppresses even spot noise which was not possible with other filters. Despite the similarity of our approach to the mean filter, we include more information by considering the eight additional regions spread diagonally away from the surface intersection point, which improves the final average value. The processing time is kept short enough to make it suitable for interactive visualization systems. For future work, we want to test our filter with a broader set of CT data. We would like to study the effectiveness of our filter to maintain the fine structure of other small samples. Also, rather than the current additional eight spread regions, it would be interesting to analyze several variations of spread.

REAL-TIME LOCAL NOISE FILTER Continued on **PAGE 8**

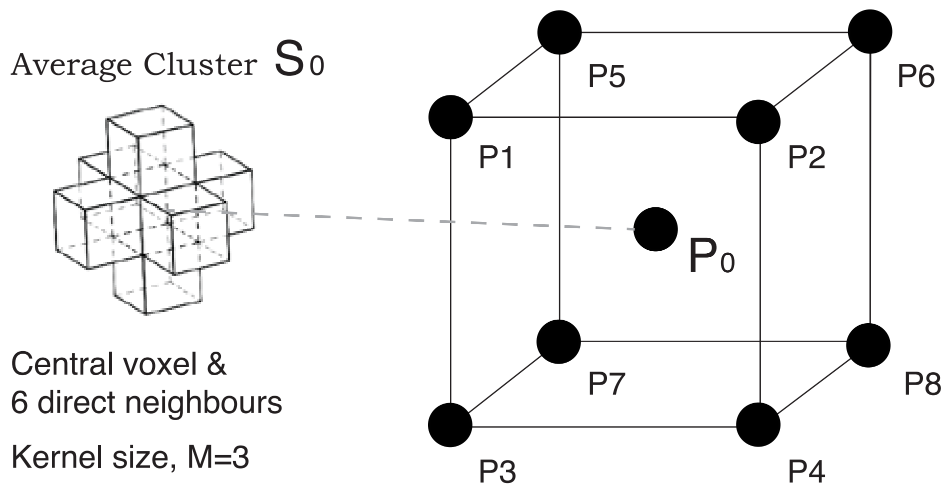


Fig.1 – Illustration of the average cluster which takes the average of central voxels and its adjacent neighbors. P denotes the voxel, and S represents the average cluster. The average of nine average clusters (S0…S8) is used to represent the surface intersection point.

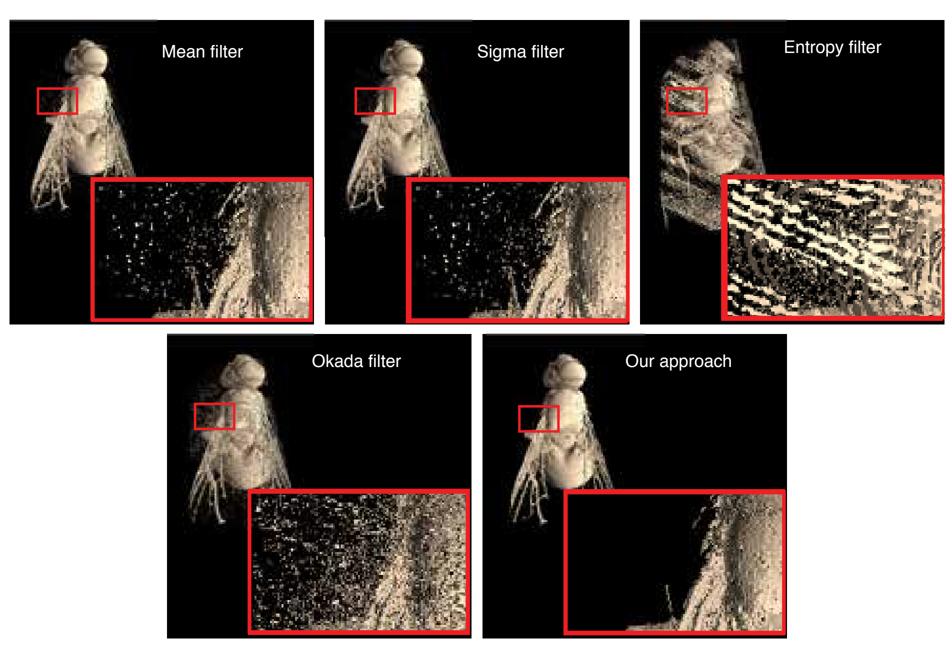


Fig.2 – A visual comparison of the tachinid fly Gymnosoma nudifrons (Herting, 1966) data set between the mean filter (top left), the sigma filter (top middle), the entropy filter (top right), the Okada filter (bottom left) and our approach (bottom right). The entropy filter fails to suppress the noise completely. Also, there is still spot noise in the mean, sigma and Okada filters which our approach can suppress.

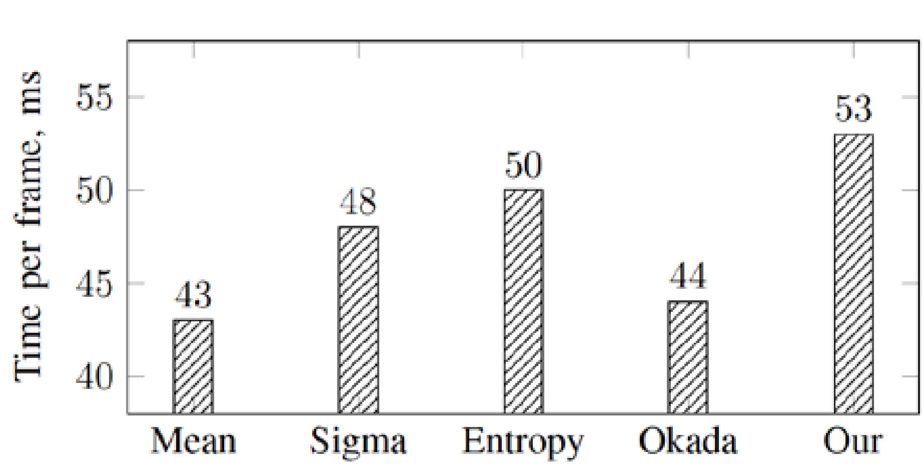


Fig.3 – Performance: Time measurement per frame of the mean filter, the sigma filter, the entropy filter, the Okada filter and our approach. Less time indicates a better performance.

Real-time Local Noise Filter

Continued from **PAGE 7**

REFERENCES

[1] O. Betz, U. Wegst, D. Weide, M. Heethoff, L. Helfen, W.-K. Lee, and P. Cloetens, "Imaging applications of synchrotron X-ray phase-contrast microtomography in biological morphology and biomaterials science. I. General aspects of the technique and its advantages in the analysis of millimetre-sized arthropod structure," Journal of Microscopy, vol. 227,no. 1, pp. 51–71, 2007.

[2] van de Kamp, T., Schwermann, A.H., dos Santos Rolo, T., Lösel, P.D., Engler, T., Etter, W. Faragó, T., Göttlicher, J., Heuveline, V., Kopmann, A., Mähler, B., Mörs, T., Odar, J., Rust, J., Tan Jerome, N., Vogelgesang, M, Baumbach, T. & Krogmann, L. Parasitoid biology preserved in mineralized fossils. Nature Communications 9: 3325, 2018.

[3] F. E. Boas and D. Fleischmann, "CT artifacts: causes and reduction techniques," Imaging Med, vol. 4, no. 2, pp. 229–240, 2012.

[4] N. Tan Jerome, S. Chilingaryan, A. Shkarin, A. Kopmann, M. Zapf, A. Lizin, and T. Bergmann, "WAVE: A 3D online previewing framework for big data archives," in VISIGRAPP (3: IVAPP), 2017, pp. 152–163.

[5] N. Otsu, "A threshold selection method from gray-level histograms," IEEE transactions on systems, man, and cybernetics, vol. 9, no. 1, pp. 62–66, 1979.

GRAND THEFT

The greatest tragedy in mankind's entire history may be the hijacking of morality by religion.

Arthur C. Clarke

SWEET TALK??

[She] told enough white lies to ice a wedding cake.

Margot Asquith

A Skipper-CCD Image Sensor With Subelectron Readout Noise

Instituto Balseiro, Centro Atómico Bariloche—CNEA/CONICET, Argentina]

Submitted by the Radiation Instrumentation Committee

Miguel Sofo Haro
Author

The Skipper-CCD was first introduced in 1990 by Janesick et al [Chandler]. In this article the first Skipper-CCD sensor with deep subelectron readout noise and single electron counting capabilities is presented. The sensor was designed in the MicroSystem Labs of the Lawrence Berkeley National Laboratory, and the read-out electronics and optimization of the operation parameters at the Fermilab National Laboratory. The Skipper-CCD described in this work is a p-channel CCD fabricated on high resistivity, float-zone refined, n-type silicon. A substrate bias is applied to fully deplete the substrate, which is 200μm thick. The high resistivity, ≈10kΩ.cm allows for fully depleted operation at a substrate voltage over 40V. The detector has 4126x866 square pixels of 15x15 μm^2 covering an area of 7cm^2. The Skipper-CCD vertical and horizontal registers have three-phase clocks that are designed for split readout, through the output stage at each quadrant of the sensor.

A simplified diagram of the Skipper-CCD output stage is presented in **Figure (1)**. Like the gate of the clock phases, the gate of the transistor M1 is floating over the CCD channel, allowing one to take multiple samples of the charge packet without destroying it. The transistor M1 is in a source follower polarization and the load resistor (RL) is external to the CCD. The sense node (SN) is under the floating gate (FG). At t0, all the charge in the SN, from the previously read pixel, is removed to Vdrain applying a voltage pulse to the dump gate (DG). A pulse to the reset gate (RG) is used to polarize the FG and restore the voltage of the SN around Vref. Then, at t1 the summing well gate (SG) is raised to transfer the charge packet to the SN, and sense the first sample of the charge packet. To take the second sample, the output and summing gates go down at t2, moving the charge packet in the SN back under the SG. This cycle can be repeated to take several samples of the charge packet. One major advantage of the nondestructive readout technique is that individual samples are uncorrelated measurements of the charge in each pixel. For uncorrelated Gaussian readout noise, the standard deviation, σ, of the effective readout noise distribution after averaging N samples per pixel is σ1/ , where σ1 is the standard deviation of the readout noise for a single sample of the pixel.

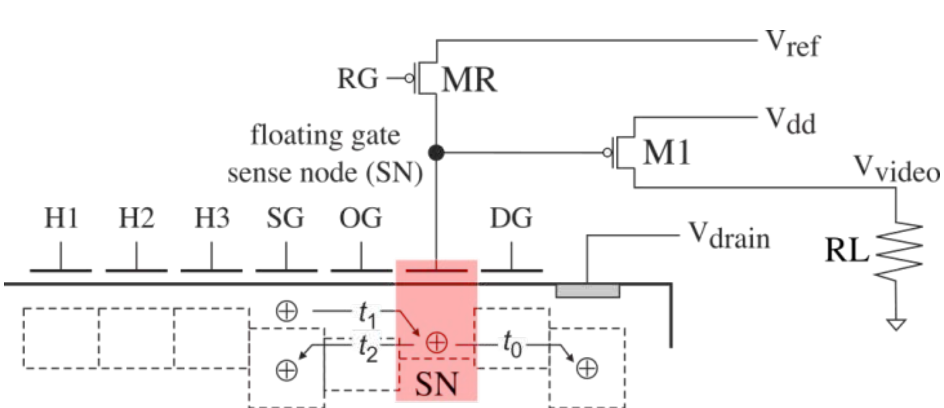


Fig. (1). Simplified diagram of the Skipper-CCD output stage. H1, H2 and H3 are the horizontal register clock phases. MR is a switch to charge the floating gate and polarize M1. M1 is a MOSFET in a source follower configuration. Due to its floating gate, it senses in a non-destructive way the charge at the SN.

The sensor is operated in a vacuum chamber and below 140 K to reduce the number of electrons promoted to the conduction band by thermal fluctuations ("dark current"). The readout electronics were fully optimized to achieve the maximum signal-to-noise ratio and to remove the presence of correlated noise in the video signal. The voltage level of the clock signal and the operation of the floating gate are crucial to make the device work. The voltage gradient between the SN, and the summing and output gate were properly adjusted to return all the charge packet from the SN to SW during t2. The Vref voltage and timing of the RG pulse was adjusted to keep the floating gate charged and M1 polarized during the multiple sampling process. The high and low level voltage of the clock phases were adjusted to minimize the generation of spurious charge.

The single pixel spectrum for different number of samples per pixel is shown in figure (2). At 1000 samples per pixel it is possible to distinguish peaks of pixels with a discrete number of electrons. As illustrated in figure (3), for 4000 samples the noise is 0.068e-rms/pixel, and it is possible to count the amount of electrons per pixel. At this noise level, the probability that the charge per pixel is misestimated by >0.5e$^-$ is. This represents the first accurate single-electron counting on a large-format (4126x866 pixel) silicon detector. The Skipper-CCD studied here has a single-sample readout noise of σ1=3.55 e-rms/pixel with a readout time of 10μs/pixel/sample. A readout noise of 0.1 e-rms/pixel requires 1200 samples per pixel, corresponding to a readout time of 12 ms/pixel. The readout speed could be increased with the techniques proposed in [Tiffenberg]

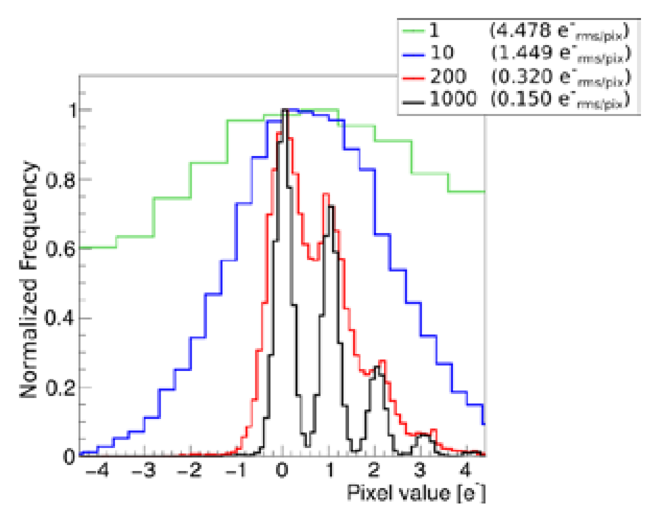


Fig. (2). Single pixel spectrum of an image region for different amounts of samples per pixel. The pixel value was calibrated using the system gain obtained from a exposure of the detector to a 55Fe source. The spectrum is shown after averaging different amount of samples per pixel. For 1000 samples individual electron counting per pixel is possible.

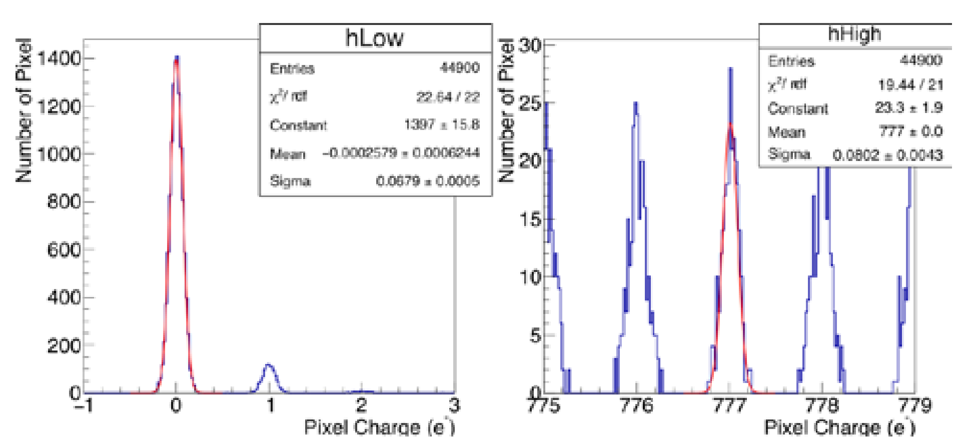


Fig. (3). Single-electron charge resolution using a Skipper-CCD with 4000 samples per pixel (bin width of 0.03e-. The measured charge per pixel is shown for low (main) and high (inset) illumination levels. Integer electron peaks can be distinctly resolved in both regimes. The 0e- peak has RMS noise of 0.068 e-rms/pixel while the 777e- peak has 0.086 e-rms/pixel, demonstrating single-electron sensitivity over a large dynamical range. The Gaussian fits have and, respectively.

The Skipper-CCD presented in this work is fully-depleted and back-side illuminated, and can achieve a read-out noise as low as 0.068 e$^{rms/pixel}$ over the whole pixels of the device. This makes the Skipper-CCD the most sensitive and robust electromagnetic calorimeter that can operate above liquid nitrogen temperatures. The Skipper-CCD can also count individual optical and near-infrared photons. Because nondestructive readout is achieved without any major modification to the CCD fabrication process, this new technology can be directly implemented in existing CCD manufacturing facilities. The extremely low read-out noise and important silicon mass (up to few grams) enable a new generation of ultra low threshold particle detector experiments like neutrino detection with CCD, exoplanets searches, spectroscopic applications and single photon imaging. Currently, this detectors are used by the SENSEI (Sub-Electron Noise Skipper-CCD Experimental Instrument) collaboration in dark matter searches.

REFERENCES:

[Chandler] C. E. Chandler et al., "Sub-electron noise charge coupled devices," in Charge-Coupled Devices and Solid State Optical Sensors, ser. Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, M. M. Blouke, Ed., vol. 1242, 1990, pp. 238–251.

[Tiffenberg] J. Tiffenberg et al., "Single-electron and single-photon sensitivity with a silicon skipper ccd," Phys. Rev. Lett., vol. 119, p. 131802, Sep 2017. [Online]. Available: https://link.aps.org/doi/10.1103/PhysRevLett.119.131802

The IEEE NPSS International School for Real Time Systems in Particle Physics 2018

The school was organized by NPSS and the South Africa-CERN consortium and was held at iThemba LABS in Cape Town July 7th–17th. The iThemba Laboratory for Accelerator Based Sciences is Africa's largest facility for particle and nuclear research (in fact the largest in the southern hemisphere). This institution and a few high-ranking universities gave South Africa a good but narrow base in this area of education. The aim is to widen this base so that it can satisfy the growing needs of society. Here it was felt that an instrumentation school could help to stimulate interest in physics and technology. It would also help South Africa's endeavor to take a place in the international high tech scene. The intention was to give practical experience in developing and controlling midrange real-time experiments. This opportunity to provide hands-on experience was considered very important.

Bruce Mellado presents a lecture to students.

The school included lectures and laboratory exercises, given mostly by NPSS experts in radiation measurements with state-of-the-art experience. The lectures introduced firmware, software and web-based programming for remote control and showed how this could be used in different areas of science. In order to minimize the hardware cost, educational single-board computers, Raspberry Pis, were used as controllers. This is an advantage allowing the students to develop their own systems with limited resources. The Raspberry Pi operating system is similar to Linux which means that it supports many of the standard Data Acquisition software tools. Much of the experience is therefore easily transferable to high-end systems.

The school required the student to have undergraduate knowledge in physics and electronics. The total number of students was limited to about 50. Most of them were honor or master students and 20% of them were women. Although almost all were students at South African universities, a few were from Nigeria, Botswana, Ghana, Kenya, Uganda and Japan.

The lectures covered different areas from "The history of detectors" to "Writing papers and preparing presentations – some hints" (see https://indico.cern.ch/e/ISREPP2018/ for a full description).

The exercises were of different types: in the beginning of the school there was a full day (Sunday) FPGA workshop with practical exercises in FPGA programming limited to about 20 students. Later there were six half-day exercises. For these the students were divided into smaller groups. All students participated in all of the exercises (except the FPGA workshop). "Raspberry Pi/RCDAQ" and "Control using modern Web technologies" introduced useful technologies as well as concepts required by some of the exercises that followed. Then there were four exercises covering: "HVcontrol for PMTs," "Waveform capture" with a DRS4 waveform digitizer, "EasyPET" using a PET SiPM-based demonstrator from CAEN and the "TimePix" based pixel detector kit developed by Prague University.

A Women In Engineering event was held on one afternoon where a vibrant discussion followed presentations by three scientists on the theme "being a Woman Scientist in South Africa". The event involved all school participants, members of the laboratory and students from a local high school. There were many engaged contributions from the audience and in particular from students attending the school who intervened in the debate by reporting their experiences. It was felt that the event was a useful forum for discussions on equality and diversity in the scientific environment beyond gender and that such debates should always be present for men and women in schools, workshops and conferences.

There were also memorable social events, common meals, a welcome and a dinner party as well as an excursion to the Cape of Good Hope.

Both lectures and exercises were highly appreciated by the students. After an initial period of getting to know each other, a pleasant informal atmosphere developed between lecturers and students. One reason for the successful result was the excellent support from iThemba LABS and the efficient local organization led by Prof. Bruce Mellado. As was the case for the previous instrumentation school in Vietnam, the school was very successful and well suited for repeating in yet another place e.g., somewhere else in Africa. Several countries are being considered.

Christian Bohm can be reached by E-mail at bohm@fysik.su.se; Cinzia Da Via can be reached at Cinzia.Da.Via@cern.ch; and Patrick Le Dû can be reached at patrickledu@me.com.

Dr. Martin Purschke leads student exercise.

Students at lecture with Professor Bruce Mellado looking on

Student small group works to prepare final presentation.

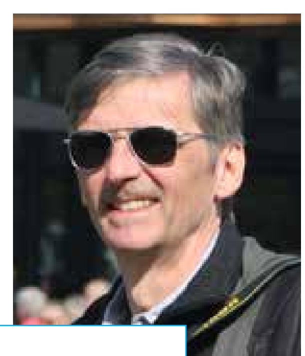
Students perform laboratory exercise.

International School Continued from PAGE 9

Faculty and Students at 2018 School for Real Time Systems in Particle Physics.

History of MicroTCA Workshops at IEEE Real Time Conferences (RTC)

Heiko Koerte
N.A.T. Europe



Kay Rehlich
DESY, ret.

There is already a long tradition to have MicroTCA workshops at IEEE Real Time Conferences. The first workshop was held in Fermilab and led by Ray Larsen (SLAC) 2007. Since then this series was continued in Beijing (2009), Lisbon (2010), Berkeley (2012), Nara (2014), and this year in Williamsburg. In the first years these workshops covered the ATCA and MicroTCA standard because they were new and of high interest for the community. Meanwhile MicroTCA was adopted by many institutes worldwide to control particle accelerators and experiments among other facilities. Therefore the workshops now focus mainly on MicroTCA.

WHAT IS MICROTCA?

MicroTCA (aka MTCA) took off with its adoption by PICMG back in 2007 and was the first modular open standard providing high speed serial communication. Because of its flexibility on the one side and its well thought-through definitions, MicroTCA allows users to tailor a system to their exact needs while still relying on standardized and thus commonly and long-term availably building blocks, from simple to full redundancy. Because of its modularity and the rich eco system many of today's systems are based on MicroTCA, serving ruggedized and harsh environments as well as standard industrial use cases.

WORKSHOP CONTENT

Introducing the standard to more persons is a key goal of the workshops. About 35 attendees this year indicates a mature interest in the topic. Today's hardware platforms are quite complex. MicroTCA was developed for the telecom industry to solve high availability demands. Redundancy, modularity, full managed system, hot-swap, high speed communication are some of the buzzwords describing this state-of-the-art system. An introduction for beginners has to address all these points. During the workshop in Williamsburg theoretical presentations were followed by practical demonstrations. The second half of the full-day workshop was dedicated to talks about recent developments, achievements and experiences with world-wide projects.

CONCLUSIONS

The continued interest in the MicroTCA workshops prove that the workshop format of providing both hands-on training and presentations by real users from science and industry as well as MicroTCA vendors is valid. At the end of the workshop attendees reported that the information they have received is either vital to their use case or their decision to use MTCA in the future. Industrial sponsors of the workshop emphasized the spirit and the close connection to the attendees and thus stated their strong interest in supporting the next MicroTCA workshop, to be held at RTC 2020.

For more information contact Heiko Körte at Heiko.Koerte@nateurope.com or Kay Rehlich at kay@rehlich.de.

International audience at the MicroTCA workshop at the RTC, Williamsburg

Front view of low-level RF system for beam control at XFEL, Hamburg Germany, used for demonstration and training

Rear view of low-level RF system with RF modules

OVERWORKED, I GUESS

Physicists have been looking for the Higgs particle since [1964], but have been unable to find it because they have not had enough energy.

BBC Radio Times

WHAT, ME WORRY?

If you can keep your head when all about you are losing theirs , it's just possible you haven't grasped the situation.

Jean Kerr

An Investigation Into The Development Of A Low-Cost Plasma Mapping System For Use In An Inertial Electrostatic Confinement Fusor

This research aimed to create a system which would acquire density maps of plasmas inside of an Inertial Electrostatic Confinement (IEC) Fusor. This fusor generates a single beam of plasma **(Figure 1)**, as opposed to several converging beams. One characteristic of the plasma beam that has been consistently observed during operation is a diamond-shaped discoloration left on any surface the beam has made prolonged contact with **(Figure 2)**. The lack of quantitative data about the diamond phenomenon led towards the research detailed in this report.

Out of the several probe designs investigated, it was decided to develop a voltage potential probe. The final probe design consists of a structural steel tube, an insulating ceramic tube, a tungsten electrode, and an electronic density measurement and safety system. A conflat flange housing a central ball joint allowed the probe to move about the chamber.

A voltage potential probe functions by measuring the relative electrical potential of a plasma. To build an operational voltage potential probe, a 20 megaohm voltage divider with a ratio of 100:1 was connected to the central tungsten electrode of the probe and the vacuum chamber of the fusor. The fusor was run at 10kV DC and 10mA of beam current, thus necessitating a fail-safe crowbar device in the probe circuitry **(Figure 3).**

A system built of LEGO Technic pieces functioned as a position measurement system. Use of LEGO parts allowed for rapid prototyping out of readily available materials with sufficient structural properties for a prototype. The architecture implemented used two potentiometers connected to the probe by mechanical linkages, thus turning the position sensors as the probe moved around its plane.

The potentiometer data and probe voltage were recorded on a digital oscilloscope and then transferred to a spreadsheet. The data were processed to convert the polar data from the position sensors into Cartesian points with an associated voltage. When the coordinates of the probe were binned and graphed along with relative electrical potential readings from the probe, a cross-sectional image of the plasma was created, in which the relative electrical potential could be observed through color (Figure 4).

The plasma mapping device we developed is a technology that has not been extensively implemented in the small-scale and low budget environment in which this research was conducted, thus providing a new avenue of research for those in the amateur fusion community. The data collection systems suffered from precision and accuracy problems due to rigidity issues that will be revised in future prototypes. Even when taking these into account, the system produced a map that can be correlated to plasma densities in the fusor.

For more information, contact Lee Berry, the Coalition for Plasma Sciences Liaison, by E-mail at leeaberry223@gmail.com.

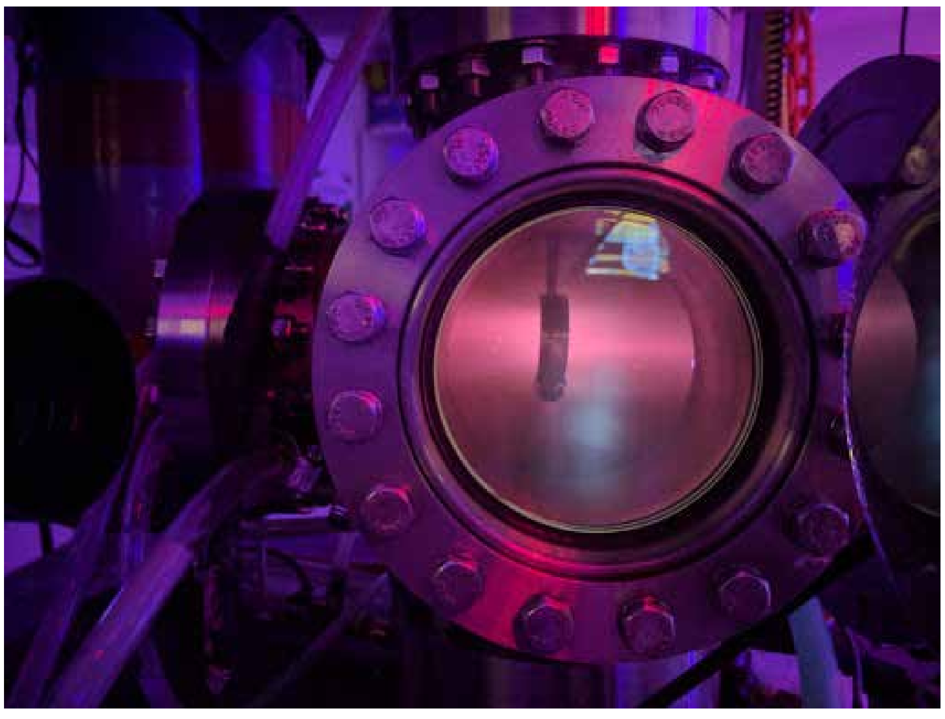


Figure 1: A beam of plasma generated by the fusor's unique anode design

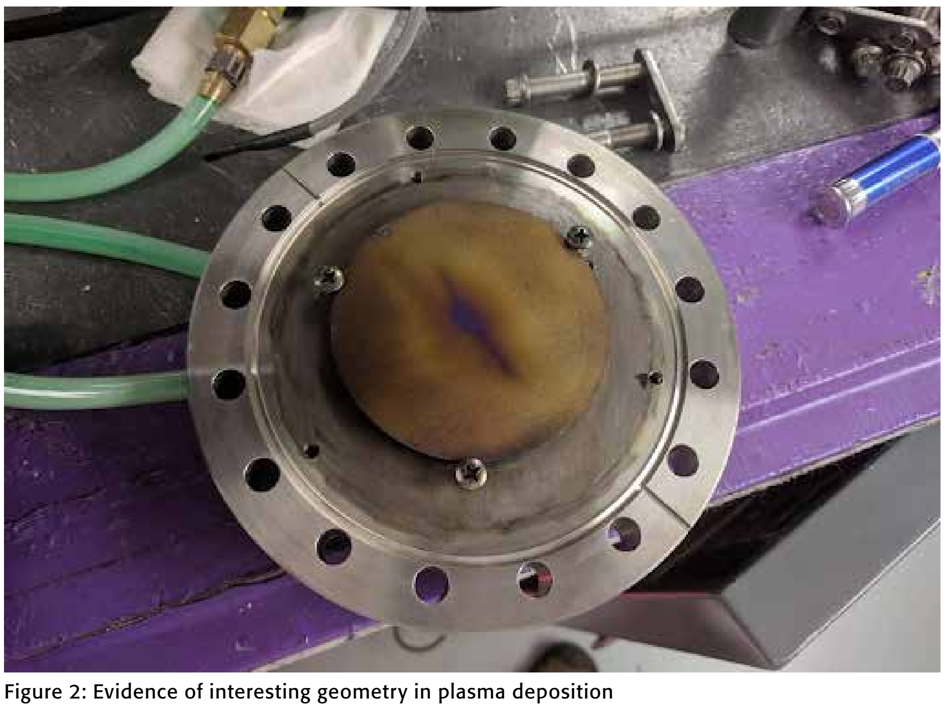


Figure 2: Evidence of interesting geometry in plasma deposition

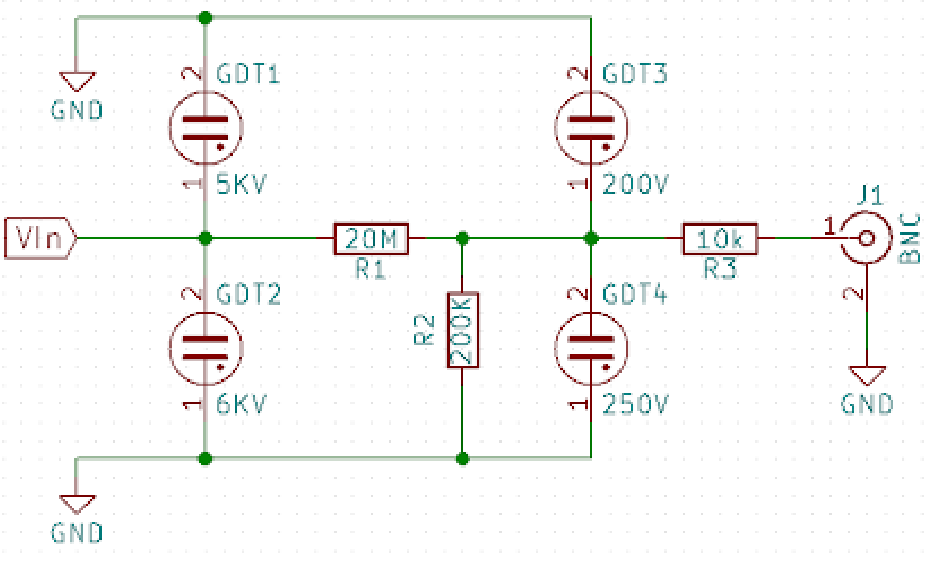


Figure 3: When the input voltage exceeds the threshold set by the gas discharge tubes (GDTs), the GDTs start to conduct, shunting the current from the probe input to ground thus reducing the input voltage to the sub 50V range until the fault is cleared.

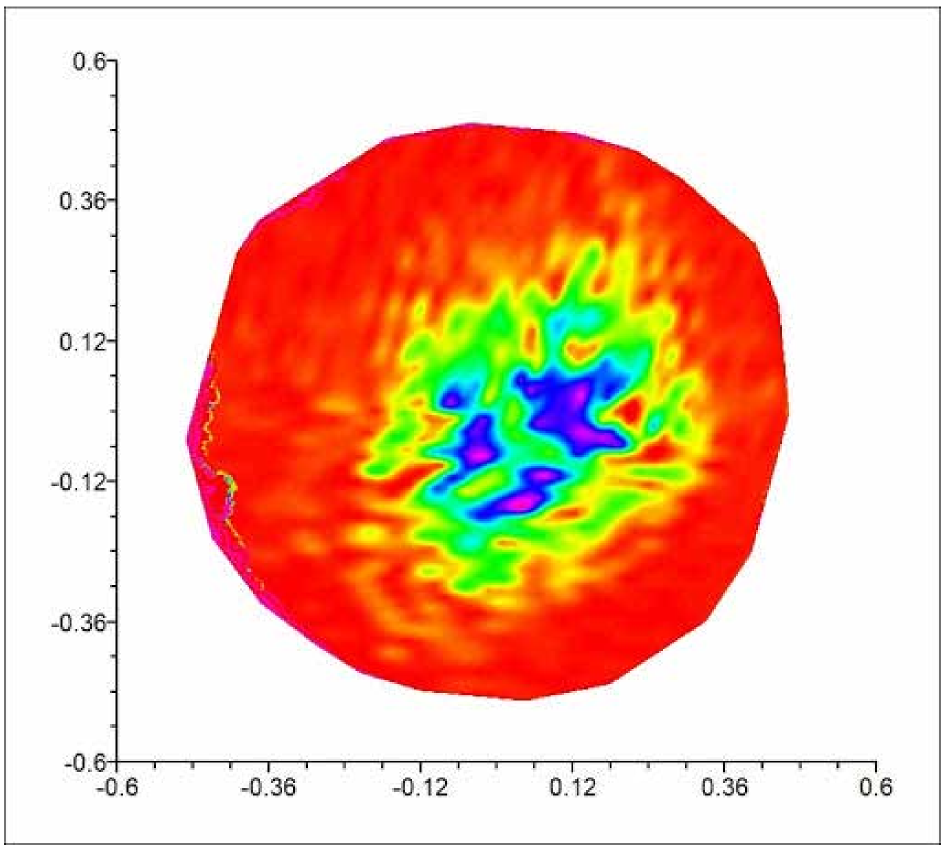


Figure 4: Relative Plasma Voltage Potential Map in which magenta represents areas of highest potential and red represents areas of lowest potential.

KNOW-IT-ALL'S FAILURE
The greatest obstacle to discovery is not ignorance – it is the illusion of knowledge.
Daniel Boorstin

BUT THEY DON'T TALK BACK
Being president is very much like running a cemetery; you've got a lot of people under you but they are not listening.
Bill Clinton

INFRARED INFLUENCE
People don't change when they see the light. They change when they feel the heat.
Adage

QED!
The Republicans are a party that says government doesn't work – and then get elected and prove it.
P. J. O'Rourke

EARLY TO RISE AIN'T SO WISE
I think we consider too much the luck of the early bird and not enough the bad luck of the early worm.
Franklin D. Roosevelt

I WANT MY MONEY BACK
Age is too high a price to pay for maturity.
Tom Stoppard

A Novel LiCl-BaCl$_2$:Eu^{2+} Eutectic Scintillator for Thermal Neutron Detection

Yuntao Wu [a,b,*], Eric D. Lukosi [c], Mariya Zhuravleva [a,b], Adam C. Lindsey [a,b], Charles L. Melcher [a,b]

a Scintillation Materials Research Center, University of Tennessee, Knoxville, TN 37996, USA
b Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996, USA
c Nuclear Engineering Department, University of Tennessee, Knoxville, TN 37996, USA

ABSTRACT

A ^{nat}LiCl–BaCl$_2$:Eu^{2}+ eutectic scintillator was synthesized by the vertical Bridgman method aiming at the application of thermal neutron detection. The molar ratio of LiCl and BaCl$_2$ was 75.1/24.9, which corresponds to the eutectic composition in the LiCl–BaCl$_2$ system. The grown eutectic showed a periodic microstructure of BaCl$_2$:Eu$_2$+ and LiCl phases with 2–3 μm thickness. The α-particle induced radioluminescence spectrum of the scintillator showed an intense emission peak at 406 nm due to the Eu^2 5d$_1$→4f emission from the BaCl$_2$:Eu^2+ phase and an additional weak emission peak at 526 nm. The scintillation decay time was 412 ns. LiCl–BaCl$_2$:Eu^2+ eutectic samples exhibited non-correlated neutron detection efficiency and light yield as a function of crystal length, suggesting material non-uniformities within the boule. The relative light yield was equal to or greater than that of Nucsafe lithium glass. Gamma-ray exposures indicate that gamma/neutron threshold discrimination for higher energy gamma-rays will be limited.

©2015 Elsevier B.V. All rights reserved.

1. INTRODUCTION

Neutron detection and imaging devices are used in various fields such as crystallography, particle physics, and homeland security. Up to now, most of the thermal neutron detectors were gas proportional counters filled with ^{3}He gas, due to its large cross-section of ~5300 barns for thermal neutron capture and low background sensitivity for γ-rays [1]. Nevertheless, because of the continuous depletion of ^{3}He sources and the increasing demand of neutron detectors, it is urgent to find suitable alternative candidates to replace the contemporary ^{3}He-based system. The current candidates include boron-coated straws, plastic and liquid scintillators, and inorganic scintillators based on ^{10}Band ^{6}Li. The high Q-value of 4.8 MeV for the ^{6}Liþn reaction as well as the high energies of the resulting alpha particle and triton offer high sensitivity for thermal neutron detection with Li-containing scintillation materials such as Li-glass, LiF/ZnS ceramics, and Cs$_2$LiYCl$_6$:Ce3þ,Li6Gd(BO$_3$)$_3$:Ce^{3+} and LiCaAlF$_6$:Ce^{3+} crystals. However, the currently available materials are limited in size and high in cost. In addition, existing neutron-sensitive scintillators tend to have poor spatial resolution due to low light yield, light scattering, or pixel size.

Recently, micro-structured eutectic scintillators containing lithium have been proposed for the detection of thermal neutrons. They are potentially more efficient and less expensive than traditional single-phase scintillators. The reduction of the production cost is based on exploiting advantages of the eutectic structure, i.e. faster synthesis process at the growth speed of mm/min as compared to mm/h of single crystals, and the ability to control the microstructure and dimensionality (λ) by tuning the solidification speed (v) thus satisfying the equation of vλ2=constant [2]. So far, several methods were successfully used for fabrication of eutectic scintillators, including the micro-pulling down, the Bridgman, and the Czochralski methods [2,3]. The eutectic is formed by two immiscible phases from a completely miscible melt, and its typical microstructure is represented by a periodic arrangement of lamellar and rod-like phases [4–6].Asa scintillator used for neutron detection, its matrix is a neutron sensitive compound, and the layer/cylinder part is a scintillator acting as a visible light converter. The visible light is produced, confined and transported along the cylindrical axis by a total reflection mode.

Halide and oxide eutectic materials composed of scintillators with rod-like microstructure and a surrounding matrix with higher refractive index such as CsI–NaCl:Tl$^+$ [7,8] and α-Al$_2$O$_3$–GdAlO$_3$:Ce^{3+} [9] have been developed for X-ray imaging,. Their excellent contrast transfer function (CTF) values indicate the scintillation light was transported to the surface of the eutectic scintillators with total reflection at the interface between scintillator and the matrix, and almost reached the theoretical resolution limit of the material itself. More importantly, a 2-in. diameter ^{6}LiF–CaF$_2$:Eu eutectic scintillator for neutron detection was successfully produced by the Bridgman method [10]. This result demonstrates the feasibility of large-size eutectic scintillator growth by using the Bridgman method. In the following years, several fluoride-based eutectics were developed, including LiF–SrF$_2$ and LiF–CaF$_2$ [11], Ce^{3+}-doped LiF/CaF$_2$ [12],Ce^{3+}-doped LiF/LiYF$_4$ [13] and Ce^{3+}–LiF/LiLuF$_4$ [14]. The neutron induced absolute light yield of LiF–SrF$_2$ has already reached 9400 ph/neutron, which is higher than that of Li-glass [11]. The aim of the current work is to develop the first chloride-based eutectic scintillator, LiCl–BaCl$_2$:Eu^{2+}, for the purpose of thermal neutron detection and potential applicability for fast neutron detection due to the presence of chlorine. The BaCl$_2$:Eu^{2+} phase, used as a visible light converter, can achieve a light yield of 20,000 photons/MeV under γ-ray irradiation [15]. In our investigation, the LiCl–BaCl$_2$:0.5 mol%Eu^{2+} eutectic was directionally solidified by the vertical Bridgman method. Then scanning electron microscopy, photoluminescence excitation and emission, γ-ray excited radioluminescence, and Pu/Be induced pulse height spectra were employed to evaluate the microstructure, optical and scintillation properties.

2. MATERIALS AND EXPERIMENT

Anhydrous, high-purity (99.99%) beads of LiCl (natural abun-dance), BaCl$_2$, and EuCl$_2$, (Sigma-Aldrich) were used as starting materials. The LiCl and (Ba$_{0.995}$Eu$_{0.005}$)Cl$_2$ beads were mixed in 75.1:24.9 mol ratio that corresponds to the eutectic composition in the LiCl-BaCl$_2$ phase diagram [16], and the mixtures were then loaded into quartz crucibles. The crucible was evacuated to 10^{-6} mbar and heated to 250 degree Celsius and kept for 3 h at this tempera-ture in order to remove residual water and oxygen impurities. After baking, the crucible was sealed and transferred to the Bridgman growth furnace. The furnace temperature of hot zone and cold zone were set to 530 degree Celsius and 400 degree Celsius, respectively, to achieve a temperature gradient of about 20 degree Celsius/cm (the melting point of the eutectic composition is 514 degree Celsius) and allowed to equilibrate for 1 h, followed by crucible translation at a pulling rate of 2 mm/h. Finally, the furnace was cooled down to the room temperature at a cooling rate of 0.5 degree Celsius/min. The finished boule was cut and polished into different sizes. Considering the mole ratio and densities of LiCl (2.07 g/cm^3) and BaCl$_2$ (3.86 g/cm³), the theoretical density of this eutectic should be about 2.5 g/cm³.

Scanning electron microscope (SEM) images were obtained using a Zeiss Auriga SEM operating at an electron accelerating voltage of 3 kV. Photoluminescence emission and excitation spectra were measured with a HORIBA Jobin Yvon Fluorolog-3 spectro-fluorometer. A 450 W continuous xenon lamp was used as the excitation source. The excitation light passed through a monochromator with a 1 nm bandpass to ensure monochromaticity. Similarly, the emission monochromator was set at 1 nm bandpass to select emission light of a specific wavelength. Photoluminescence (PL) decay was measured with the same spectrofluorometer using a time-correlated-single-photon counting module. HORIBA Jobin Yvon NanoLEDs (pulsed light-emitting diodes) were used as excitation sources. The duration of the light pulse was shorter than 2 ns and therefore was not deconvolved from the much longer decay time profiles. The light pulse repetition rate for excitation was 1 MHz. For x-ray and α-particle excited radioluminescence (RL) measurements, an x-ray tube operated at 35 kV and 0.1 mA and ^{241}Am source were used as the excitation sources, respectively. Scintillation decay times were measured using an integrated time-correlated single photon counting setup.

The responses of three LiCl–BaCl$_2$:Eu^{2+} samples (E558-1, E558-2, and E558-3) from the same boule and a Nucsafe lithium glass sample were characterized for their neutron response. All samples were cylindrical. The dimensions for all the samples are provided in **Table 1**. A 2Ci Pu/Be neutron source located in the center of a 25 x 45 x 30 in. polyethylene moderator was used for thermal neutron response measurements. Each sample was coupled to a photomultiplier and oriented with its smallest surface facing the neutron source which was ~1 m away. All measurements were taken from 12–36 h time intervals to achieve statistical significance. The pulse chain for all measurements consisted of a H6533 Hamamatsu photomultiplier tube assembly (PMT), CR-113 Cremat preamplifier, ORTEC 572A amplifier with a 6 ms shaping time, and ASPEC 927A MCA. Measurements were taken with and without a 0.25 mm cadmium sheath to remove the contribution of fast neutrons and the 4.4 MeV and 2.2 MeV gamma-rays intrinsic to the neutron source setup. Relative light yield for all samples was determined through comparison with a Saint Gobain 1R1 1 x 1in. NaI(Tl) detector exposed to 137Cs 661.7 keV gamma-rays on the same pulse chain, which resulted in 146.971.5 photons per channel. The PMT bialkali photocathode was not spectrally calibrated, so the results presented are relative to the light yield of NaI (Tl) and not corrected for differences in their emission spectra. However, the peak emission energy for the three scintillators are very similar, so a direct comparison provides a good qualitative description of the LiCl-BaCl$_2$:Eu^{2+} light yield. Finally, to provide a qualitative description of the gamma-neutron discrimination capability of LiCl-BaCl$_2$:Eu^{2+}, sample E558-1 was exposed to 109Cd, 57Co, 137Cs, 60Co, and ^{22}Na gamma-ray sources.

3. RESULTS AND DISCUSSION

Stable growth of the eutectic structure was achieved with a flat solid–liquid interface as can be observed in **Fig. 1(a)**. The temperature measured at the interface agrees well with the eutectic point at 514 degree Celsius, indicating the uniform growth of the eutectic structure. The finished ingot and cut and polished plates of LiCl–BaCl$_2$:Eu^{2+} are shown in **Fig. 1(b)** and **(c)**, respectively. The samples are translucent due to the characteristic eutectic structure, which comprises a periodic arrangement of the two thin phases with different refractive indices, e.g. about 1.75 for BaCl$_2$ [17] and 1.67 for LiCl [18]. In this structure, the neutrons are captured by the Li-containing matrix (LiCl), then the reaction products (alpha and triton) interact with highly ordered cylindrical/lamellar scintillator BaCl$_2$Eu^2=, thus producing scintillation light pulses corresponding to each neutron capture event.

Table 1
Dimensions and scintillation properties of LiCl:BaCl$_2$:Eu2+ eutectics compared with a commercial Nucsafe lithium glass scintillator.

Sample	Dimension (mm³)	Detection efficiency (%)[a]	Relative light yield (photons/MeV)
LiCl–BaCl$_2$:Eu2+	Ø6.11 x 10.01	26.470.50	1518±16
LiCl–BaCl$_2$:Eu2+ (E558-2)	Ø6.33 x 2.23	4.04±0.07	2779±29
LiCl–BaCl$_2$:Eu2+ (E558-3)	Ø5.93 x 1.44	4.77±0.07	2382±24
Li-glass (Nucsafe)	Ø4.97 x 3.72	100	1543±16

[a] The detection efficiency reported for the Li-glass NucSafe glass is quoted as 1. The relative neutron detection efficiency of the eutectic detector was determined by comparing the net count rate with that of Li-glass Nucsafe glass obtained under the same moderator configuration.

Because of the larger refractive index of cylinder/lamellar phase (n₁) compared to that of matrix (n₁), the visible light is confined and transports along the cylindrical axis by a total reflection mode. Thus, the ratio of n_1/n_2 less than 1 is a key factor for high light transport efficiency. It is expected that the Eu^{2+} activator ions preferentially incorporate into BaCl$_2$ phase because of the ionic radius of Eu^{2+} (117 pm) allows it to easily substitute for the Ba^{2+} ion (136 pm) compared to the much smaller Li$^+$ ion (76 pm) site [19]. Moreover, the charge of the Eu ion is the same as the Ba host ion whereas Li is monovalent. Thus, integration of the Eu^{2+} into the BaCl$_2$ phase creates less stress and fewer structural defects (vacancies and/or interstitials) when compared with integration of the Eu2þ into the LiCl phase. Both these factors make incorporation of the Eu^{2+} into the BaCl$_2$ preferable.

*Corresponding author at: Scintillation Materials Research Center, University of Tennessee, Knoxville, TN 37996, USA and Department of Materials Science and Engineering, University of Tennessee, Knoxville, TN 37996, USA.
E-mail addresses: ywu52@utk.edu, caswyt@hotmail.com (Y. Wu).
http://dx.doi.org/10.1016/j.nima.2015.06.064
0168-9002/& 2015 Elsevier B.V. All rights reserved.

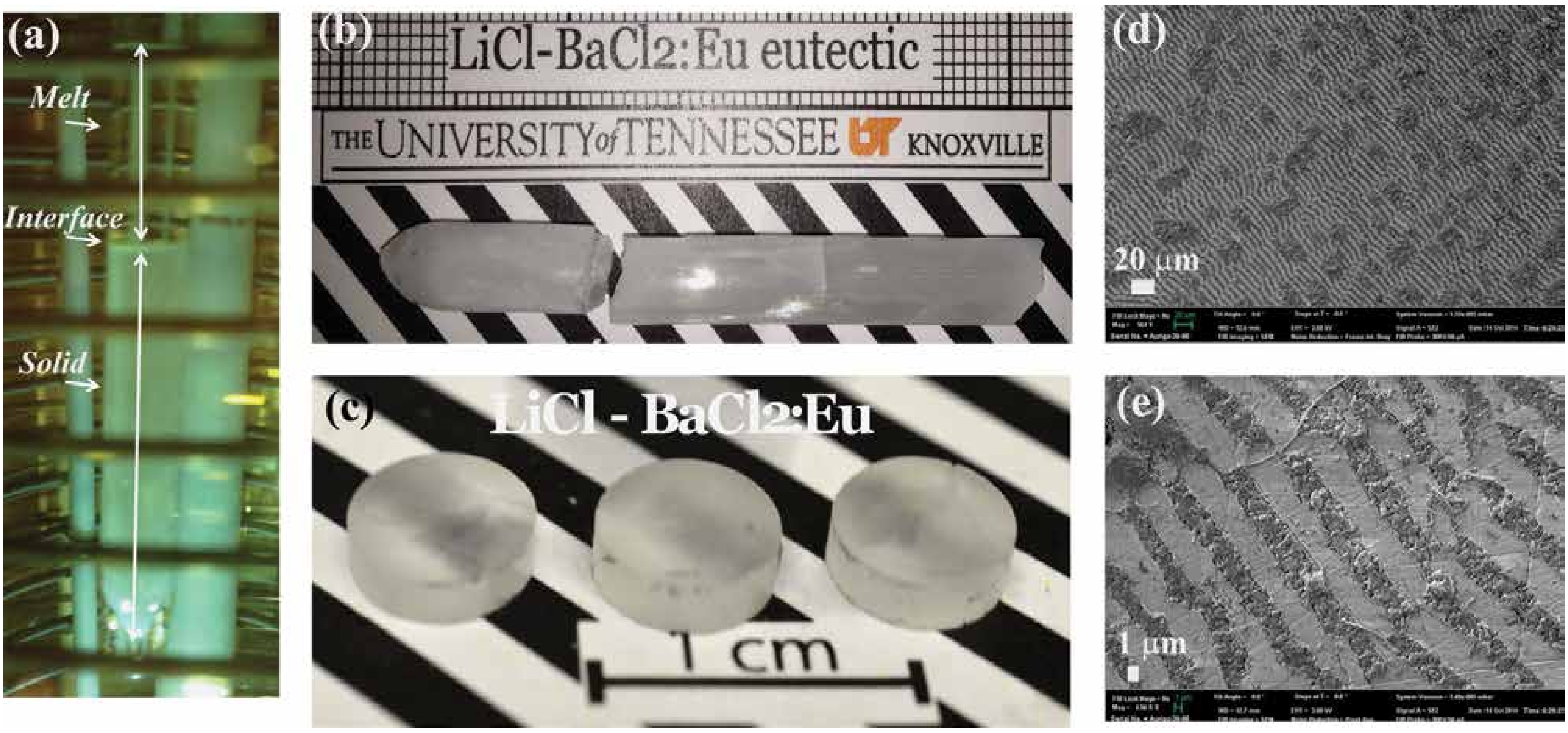


Fig. 1. Photograph of the LiCl–BaCl2:Eu2+ eutectic during growth process in a transparent furnace (a), finished ingot (b), and ~Ø6 x 1.5 mm3 polished samples (c); SEM images of LiCl–BaCl2:Eu2+ eutectic with different magnifications: (d) 20 µm and (e) 1 µm.

The alignment of the microstructure in longitudinal cross-sections is presented in SEM images, Fig. 1(d) and (e). It shows the lamellar structure of the eutectic, similar to the structure reported for Eu-doped $LiF–CaF_2$ [10] and Ce-doped LiF–SrF₂ [12] eutectics. The phases are elongated along the pulling direction. The black and gray colored areas correspond to the LiCl and $BaCl_2$: Eu phase, respectively. The layer thicknesses of present eutectics were typically 2–3 µm. Except for some aggregation islands with a size of 20 µm, LiCl and $BaCl_2$:Eu phases are clearly separated. The homogeneous microstructures are critical for uniform absorption of thermal neutrons.

The photoluminescence excitation and emission spectra are plotted in Fig. 2(a). The featured Eu^{2+} 5d–4f emissions peaking at 406 nm are observed upon 289 and 367 nm excitation. When monitoring emission at 406 nm, an unresolved broad excitation band from 240 nm to 380 nm corresponding to the 4f–5d transitions is observed. The Stoke's shift is calculated to be 2372 cm-1. **Fig. 2(b)** shows the decay profiles of $LiCl–BaCl_2:Eu^{2+}$ under UV and ^{137}Cs γ-ray excitation. In both cases, decay profiles were well reproduced by a single-exponential function. The decay constant of $LiCl–BaCl_2:Eu^{2+}$ is 383 ns for UV excitation and 412 ns for ^{137}Cs γ-ray excitation. The latter one is quite consistent with the scintillation decay time of 390 ns in $BaCl_2:Eu^{2+}$ single crystal [15].

The α-ray and x-ray excited radioluminescence (RL) spectra are shown in Fig. 2(c). The RL spectra of $Eu:BaCl_2$–LiCl eutectic could be well fitted into two emission peaks at 406 and 526 nm. The emission peak at 406 nm is the result of the radiative 5d1-4f transition of Eu^{2+}. The peak position is in a good agreement with the reported value in Ref. 15. However, the emission peak at 526 nm observed in both α-ray and X-ray excited emission spectra cannot be assigned to the $LiCl:Eu^{2+}$ luminescence. Although the $5d_1$-4f emission of Eu^{2+} in LiCl host is unknown, because of a weaker crystal field splitting of 5d levels of Eu^{2+} in LiCl host than in LiI host, a blueshift of Eu^{2+} emission in LiCl host is expected compared to the 475 nm emission in $LiI:Eu^{2+}$ [20]. Also in barium-based halides, the emission at a similar wavelength was specifically assigned to the oxygen containing impurities emission [21]. No corresponding emission at 526 nm was observed in photoluminescence measurements.

Collected spectra for each thermal neutron-sensitive scintillator are provided in **Fig. 3(a)**. Relative light yield in units of (photons/MeV) and neutron detection efficiency relative to the Nucsafe lithium glass scintillator are given in **Table 1.** The relative light yield of all $LiCl–BaCl_2:Eu^{2+}$ samples are equal to or greater than the light yield of the Nucsafe lithium glass. However, the detection efficiency is much lower than the Nucsafe lithium glass, which is attributed to a lower lithium-6 concentration in the $LiCl–BaCl_2:Eu^{2+}$ samples and/or the differences in sample volume. From inspection of **Table 1**, it can be seen that the light yields of the $LiCl–BaCl_2:Eu^{2+}$ samples are not correlated with sample volumes, since sample E558-2 has the highest light yield. Furthermore, detection efficiency does not scale up with volume, since the smaller E558-3 sample has higher detection efficiency than the larger E558-2 sample. First order calculations indicate that the intrinsic detection efficiency of E558-1 is 14%, and therefore neutron field modification is not responsible for the observed data. These results suggest that there may be non-uniformity within the boule, and in need of further optimization in growth technology. It should be also noted that the non-corrected spectra for all $LiCl–BaCl_2:Eu^{2+}$ samples were filled with counts from 2.2 MeV and 4.4 MeV gamma-rays present at the point of measurement. The differential pulse height spectrum shows no peaks in either scintillator, but a broad distribution, and only the comparison of bare and cadmium covered exposures reveals the neutron response as displayed in **Fig. 3 (a)**. Gamma-ray exposure data on E558-1 is provided in **Fig. 3 (b)** as well as its neutron spectrum for comparison. Comparison of this data with the neutron spectrum obtained for E558-1 suggests that threshold discrimination against gamma rays above 662 keV (Cs^{137}) may not be possible, because the gamma-ray spectrum under Co^{60} (1.17 and 1.33 MeV) or Na^{22} (1.2 MeV) irradiation is hard to be discriminated from its neutron spectrum.

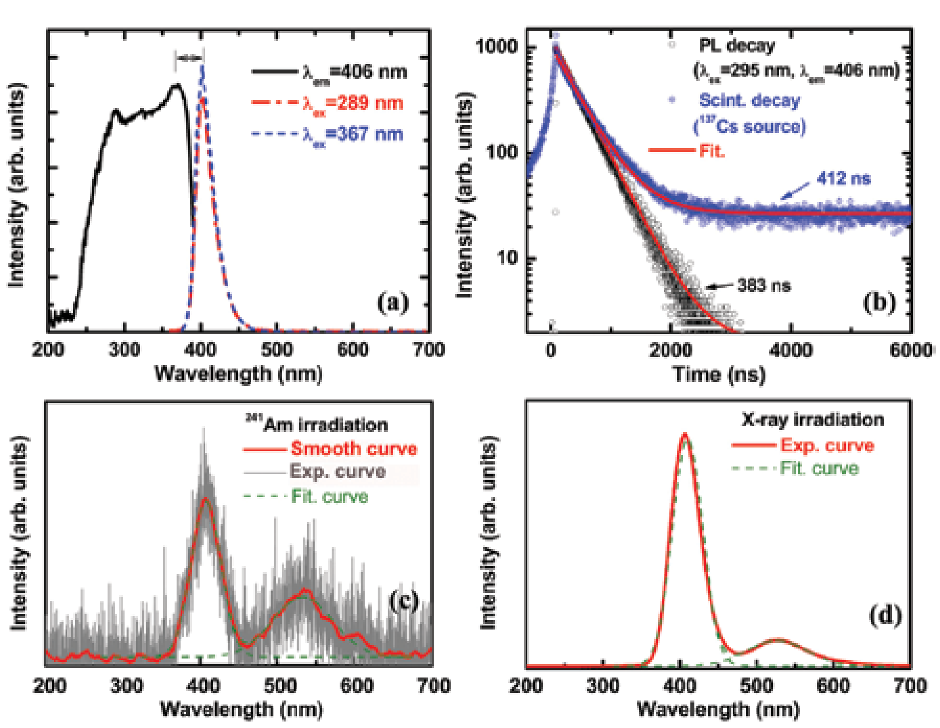


Fig. 2. Photoluminescence excitation and emission spectra (a), and decay time profile under 295 nm and 137Cs excitation (b), radioluminescence spectra under ^{241}Am source (c) and continuous X-ray (d) excitation of LiCl–BaCl2:Eu2+ eutectic.

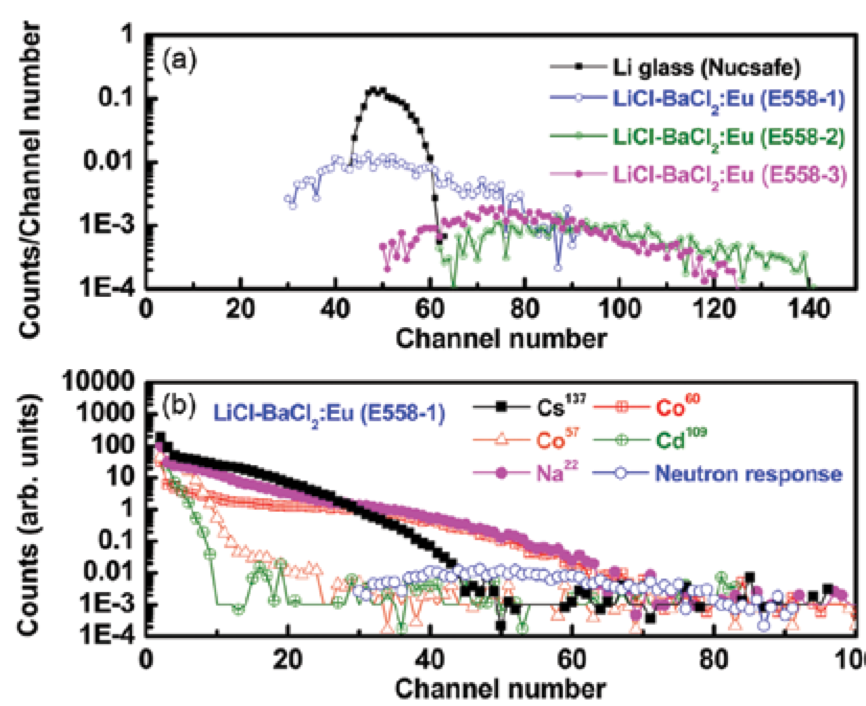


Fig. 3. Cd-covered corrected spectra collected for three $LiCl–BaCl_2:Eu^{2+}$, one LiInSe2, and one Li-glass (Nucsafe) scintillators (a), pulse height spectra for $LiCl–BaCl_2:Eu^{2+}$ E558-1 sample under different gamma-ray energies: ^{137}Cs (662 keV), ^{60}Co (1173 keV and 1132 keV), ^{57}Co (122 keV), ^{109}Cd (88 keV), and ^{22}Na (511 keV and 1274 keV) (b).

4. SUMMARY

A new $^{nat}LiCl–BaCl_2:Eu^{2+}$ eutectic scintillator with a density of about 2.5 g/cm³ was synthesized via the vertical Bridgman method. The X-ray induced radioluminescence spectrum of the scintillator showed an intense emission peak at 406 nm due to the Eu^{2+} 5d–4f emission from the $BaCl_2:Eu^{2+}$ layers and a weak unidentified emission peak at 526 nm. Scintillation decay time of $LiCl–BaCl_2:Eu^{2+}$ was 412 ns. The relative light yield measured against a 1 x 1 in. NaI(Tl) scintillator for $LiCl–BaCl_2:Eu^{2+}$ was equal to or greater than that of a commercial Nucsafe lithium glass scintillator. Threshold discrimination of gamma-rays above 500 keV may not be possible. However, considering the potential for its faster growth rate, its light yield and using isotopically enriched lithium yield promise for $LiCl–BaCl_2:Eu^{2+}$ as a scintillator for thermal neutron detection.

EUTECTIC SCINTILLATOR Continued on **PAGE 10**

Thermal Neutron Detection

Continued from **PAGE 13**

ACKNOWLEDGMENT

This work has been supported by the US Department of Homeland Security, Domestic Nuclear Detection Office, under competitively awarded Grant #2012-DN-077-ARI067-04. This support does not constitute an express or implied endorsement on the part of the Government.

REFERENCES

[1] C.W.E. van Eijk, A. Bessière, P. Dorenbos, Nucl. Instrum. Meth. Phys. Res. A 529 (2004) 260.

[2] M. Acosta, S. Ganschow, D. Klimm, S. Serrano-Zabaleta, Á. Larrea, R.I. Merino, J. Eur. Ceram. Soc. 34 (2004) 2051.

[3] N. Yasui, T. Kobayashi, Y. Ohashi, T. Den, J. Cryst. Growth 399 (2014) 7.

[4] D.A. Pawlak, K. Kolodziejak, S. Turczynski, J. Kisielewski, K. Rozniatowski, R. Diduszko, M. Kaczkan,

M. Malinowski, Chem. Mater. 18 (2006) 2450.

[5] D.A. Pawlak, K. Kolodziejak, P. Diduszko, K. Rozniatowski, M. Kaczkan, M. Malinowski, J. Kisielewski, T. Lukasiewicz, Chem. Mater. 19 (2007) 2195.

[6] S. Kurosawa, A. Yamaji, Y. Yokota, Y. Futami, K. Nishimoto, N. Kawaguchi, K. Fukuda, A. Yoshikawa, J. Eur. Ceram. Soc. 34 (2014) 2111.

[7] T. Den, T. Saito, R. Horie, Y. Ohash, N. Yasui, IEEE Trans. Nucl. Sci. 60 (1) (2013) 16.

[8] N. Yasui, Y. Ohashi, T. Kobayashi, T. Den, Adv. Mater. 24 (2012) 5464.

[9] Y. Ohashi, N. Yasui, Y. Yokota, A. Yoshikawa, T. Den, Appl. Phys. Lett. 102 (2013) 051907.

[10] N. Kawaguchi, K. Fukuda, T. Yanagida, Y. Fujimoto, Y. Yokota, T. Suyama, K. Watanabe, A. Yamazaki, A. Yoshikawa, Nucl. Instrum. Meth. Phys. Res. A, 652, 2011209.

[11] T. Yanagida, N. Kawaguchi, Y. Fujimoto, K. Fukuda, K. Watabe, A. Yamazaki, A. Uritani, J. Lumin. 144 (2013) 212.

[12] T. Yanagida, Y. Fujimoto, K. Fukuda, N. Kawaguchi, K. Watanabe, A. Yamazaki, A. Uritani, V. Chani, Opt. Mater. 35 (2013) 1449.

[13] K. Nishimoto, Y. Yokota, S. Kurosawa, Y. Fujimoto, N. Kawaguchi, K. Fukuda, A. Yoshikawa, J. Eur. Ceram. Soc. 34 (2014) 2117.

[14] Y. Yokota, S. Kurosawa, K. Nishimoto, V. Chani, Yoshikawa, J. Euro. Ceram. Soc. 34 (2014) 2095.

[15] J. Selling, M.D. Birowosuto, P. Dorenbos, S. Schweizer, J. Appl. Phys. 101 (2007) 034901.

[16] M.N. Zakhvalinskii, V.G. Romanovskaya, V.F. Tkachenko, N.A. Finkel'shtein, Russ. J. Inog. Chem. 16 (12) (1971) 1753.

[17] D.J. Singh, Phys. Rev. B 82 (2010) 155145.

[18] H.H. Li, J. Phys. Chem. Ref. Data 5 (1976) 329.

[19] R.D. Shannon, Acta Cryst. 32 (1976) 751.

[20] A. Syntfeld, M. Moszynski, R. Arlt, M. Balcerzyk, M. Kapusta, M. Majorov, R.Marcinkowski, P. Schotanus, M. Swoboda, D. Wolski, IEEE Trans. Nucl. Sci. 52 (2005) 3151.

[21] M. Gascon, R. Gaume, E. Bourret-Courchesne, and G. Bizarri, Barium-based bright scintillators as transparent ceramics, In: Proceedings of the IEEE Nuclear Science Symposium and medical Imaging Conference, Seattle WA, USA, N42-2.

ADCOM OFFICERS 2016

President: Stefan Ritt
Vice President: Ron Schrimpf
Treasurer: Ralf Engels
Assistant Treasurer: Ron Keyser
Secretary: Albe Larsen

ADCOM CLASS OF 2021

David Abbott (CANPS)
Jeffrey Black (RE)
Christopher Deeney PSAC)
Frank Hegeler (PPST)

ADCOM CLASS OF 2020

Christian Bohm (TNC)
Brendan Godfrey (PSAC)
Vesna Sossi (NMISC)
Dennis Youchison (Fusion)

ADCOM CLASS OF 2019

Monica Blank (PSAC)
Bryan Oliver (PPST)
Ron Schrimpf (RE)

ADCOM CLASS OF 2018

Paul Lecoq (RI)
Steven McClure (RE)
Steve Meikle (NMISC)
Stephen Milton (PAST)

TECHNICAL COMMITTEE CHAIRS

Fulvia Pilat (PAST)
Allan Johnston (RE)
Lorenzo Fabris (RI)
Jae Sung Lee (NMISC)
Susan Heidger (PPST)
Charles Neumeyer (Fusion)
Martin Grossmann (CANPS)
Michaerl Kong(PSAC)

FUNCTIONAL COMMITTEE CHAIRS

Janet Barth (Awards)
Peter Clout (Communications)
Steve Gold (Chapters and Local Activities)
Susanne Kuehn (Conferences)
Dan Fleetwood (Distinguished Lecturers)
Christian Bohm (Transnational)
Heiko Koerte (Membership–Industry)
Christoph Ilgner (Young Professionals)
Jane Lehr (Fellow Evaluation Vice Chair)
Sal Portillo (Membership)
Ned Sauthoff (Fellow Evaluation)
Paul Dressendorfer (Publications)
John Verboncoeur (Nominations)

LIAISONS

Lee Berry (Coalition for Plasma Science)
Peter Clout (ICALEPCS)
Stan Schriber (PAC OC; APS-DPB)
Ray Larsen (SSIT , SIGHT, IEEE Smart Village)
Brendan Godfrey (IEEE-USA R&D Policy)
Martin Grossmann (Social Media)
Michael King (TMI)
Suleman Surti (TMI)
Cinzia Da Via (Women in Engineering)
Edl Schamiloglu (Educational Activities Board)
Harold Flescher (RADECS)

NEWSLETTER EDITOR:

Albe Dawson Larsen
E-mail: a.m.larsen@ieee.org

EDITOR EMERITUS:

W. Kenneth Dawson
E-mail: k.dawson@ieee.org

CONTRIBUTORS LISTED ALPHABETICALLY:

Fernando Carrio Agros, Janet Barth, Lee Berry, Christian Bohm, Daniel Christiansen, Ken Dawson, Lorenzo Fabris, Teresa Farris, Michaela Fennel, Martin Grossmann, Nicholas Tan Jerome, Allan Johnston, Heiko Koerte, Albe LArsen, Patrick Le Du, Adam C. Lindsap, Eric Lukosi, Abdallah Lyoussi, Charles L. Melcher, Charles Neumeyer, Kay Rehlich, Stefan Ritt, Paul Rivenberg, Miguel Sofo Haro, Brooke Stutzman, Marc Andre Tetrault, Yutan Wu, Dennis Youchison

CONTRIBUTED ARTICLES

Publicity releases for forthcoming meetings, items of interest from local chapters, committee reports, announcements, awards, or other materials requiring society publicity or relevant to NPSS should be submitted to the Newsletter Editor by January 5, 2019 for the March 2019 Newsletter.

News articles are actively solicited from contributing editors, particularly related to important R&D activities, significant industrial applications, early reports on technical breakthroughs, accomplishments at the big laboratories and similar subjects. The various *Transactions*, of course, deal with formal treatment in depth of technical subjects. News articles should have an element of general interest or contribute to a general understanding of technical problems or fields of technical interest or could be assessments of important ongoing technical endeavors.

Advice on possible authors or offers of such articles are invited by the editor.

©2018 IEEE. Information contained in this newsletter may be copied without permission provided that the copies are not made or distributed for direct commercial advantage, and the publication title and date appear.