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 new 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 must have been submitted by 7th December 2018.

The technical program includes four plenary sessions as well as fourteen oral and three poster sessions. The number of rooms is limited, and participants are encouraged to book early.

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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, IFE and IFE-Neutronics 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 Simulation, Systems Engineering and Large Scale Integration. Special guests 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://npss.ieee.org/conference-awards/conference-awards/ for details. For more information please visit the SOFE2019 minicourse website http://sofe2019.utk.edu/courses.html.

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

Continued from PAGE 1

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

The next ANIMMA international conference co-organized by Joseph-Stephan Institute (JSI, Slovenia), French Atomic Energy and Alternative Energies (CEA, the Belgian nuclear research center SCK-CEN, and Institute of Nuclear Physics and Electronics, Russia) will take place for its sixth issue at the Grand Hotel Bernardin in Portorož, Slovenia from June 17th –21st 2019.

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 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 poster sessions. Posters are presented by special minorials intensive sessions. In addition some topical workshops and specific short courses are organized prior to the conference.

The updated ANIMMA 2019 topics include:

- 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

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). Researches from 40 countries attended the meeting, held at the Denver 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 Lawrence Livermore National Laboratory proposing the use of antennas and beams to protect against energetic particles from the radiation belts.

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 Nuclear 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.

We are looking forward to welcoming you in Portorož.

ICOPS Plenary Session

SUAC 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 Carlson of Los Alamos National Laboratory proposing the use of antennas and beams to protect against energetic particles from the radiation belts.

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

For more information about the ANIMMA conference, please visit the conference web site: www.animma.com
President’s Report

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 Lecture 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 benefit the conference organizers and our attendees.

Another goal we have achieved is to use more video conferencing in our AdCom meetings: regular 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 those committees and saves lots of costs and CO2 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 – Hello Kölle from N.A. 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 is to change in the use of publications towards open access (OA) models. With more and more funding agencies requiring OA 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.

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 like to take this opportunity to thank members after AdCom who are completing their terms Paul Leoc, Radiation Instrumentation; Steve McClure, Radiation Effects; Adam Alessio, Nuclear Medical and Imaging Sciences; and Steven 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 Instrumentation; Keith Avery, Radiation Effects; Adam Alessio, Nuclear Medical and Imaging Sciences; and Feria Gerasimou, 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 forward to continuing with working with you to tackle the big challenges for our society.

Albre Lansen, IEEE NPSs Secretary and Newsletter Editor, can be reached by E-mail at albre.lansen@ieee.org.

Technical Committees

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Albre Lansen, IEEE NPSs Secretary and Newsletter Editor, can be reached by E-mail at albre.lansen@ieee.org.

Technical Committees

FUSION TECHNOLOGY

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

Albre Lansen, IEEE NPSs Secretary and Newsletter Editor, can be reached by E-mail at albre.lansen@ieee.org.

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 Albre Lansen, Bill Motes, Hal Fletcher, Peter Clout, Paul Drescherendorf 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 with working with him to tackle the big challenges for our society.

Stefan Ritt, IEEE NPSs President, can be reached at the Paul Scherrer Institute CH-5232 1803 Villigen, PSI, WBA/W140, Switzerland; Phone: +41 56 310 3728; Fax: +41 56 310 2199; E-mail: stefan.ritt@psi.ch.
RADIATION EFFECTS NEWS

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

Scottish Proverb

Don’t marry for money. You can borrow it cheaper.

We sleep in separate bedrooms, we have dinner apart, and we don’t talk much. But we do love each other...or do we?

We sleep in separate bedrooms, we have dinner apart, we don’t talk much. But we do love each other...or do we?

The NPSS News Team

NPSS News

Functional Committees

The NPSS Awards Committee and Technical Committees are selecting 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 Committees 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:

1. Merit Award
2. Richard F. Shea Distinguished Member Award
3. NPSS Award for Early Achievement
4. NPSS Award for Lifetime Achievement

The descriptions of the awards are as follows:

1. Merit Award: To recognize outstanding 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: This award is presented annually at an NPSS sponsored meeting chosen by the Awardee.

NPSS Award for Early Achievement: 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 award is within the first ten years of his/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 presentations, patents, etc., that 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 within the NPSS. Any graduate student in the fields of Nuclear and Plasma Sciences is eligible for the award. Judging is based on outstanding contributions to the fields of Nuclear and Plasma Sciences, including high-quality research papers, presentations, and other related accomplishments.

Chapter involvement, etc., will also be considered. 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 nominator’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 through 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 physics 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 through 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 Scholarship Award

Description: Recognizes and enables an outstanding graduate student enrolled in an accredited Ph.D. program to attend a conference. Awards for Doctoral or Ph.D. level Research Associate in any of the fields of NPSS, 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 grants from Gladys H. Knoll and co-founder, Dr. Valerio T. Jovanes. The prize is $5,000 and a plaque. Any post-doctoral researcher who is a member in good standing of the IEEE and NPSS is within 10 years of having received their highest 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 grants from Gladys H. Knoll and co-founder, Dr. Valerio T. Jovanes. The prize is $5,000 and a plaque. Any graduate student who is a member in good standing of the IEEE and NPSS is within 10 years of having received their highest 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.

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 awards per year up to $2,000. Candidates must be nominated for expenses associated with traveling to and participating in the IEEE Women in Engineering International Leadership Conference (WEILC) up to a maximum of $1,000. Eligible candidates 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 professional 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 WEILC in the year of the travel grant. 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 of high priority to the National Society. The award is presented at an NPSS sponsored conference chosen by the Awardees.

Phelps Grants

Additionally, NPSS funds the Paul Phelps Continuing Education Grants, given to encourage attendance at NPSS conferences 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 performance as a Graduate Student or Post-doctoral Fellow 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 of more of the Short Courses will result in having essential skills for 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 through the conference chair of the conference, so that award recipients can apply the corresponding funds towards covering tuition and/or traveling costs to the Short Courses. These 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 see if it’s allowed) to recognize the outstanding contributions to the NPSS award in the same field. The criteria for judging are 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.

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 continue sponsoring education and encourage membership in the NPSS and Related Subspecialties. 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 to the Short Course will improve their possibility of obtaining a job in an NPSS field.

NPSS NEWS

ieee.org/npss

FUNCTIONAL COMMITTEES

Marc-André Tréhault 2018 Phelps Award Recipient

Marc-André Tréhault 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 detection instrumentation for small animal PET under Dr. Roger Lacoste, Dr. Râfiel Fontaine and Dr. Jean-François Pratte. His main contributions to the field were recognized with the 2016 IEEE NPSS Radiation Instrumentation Early Career Award and the 2017 OMG Microsystem Douglas R. Gibbon Medal for Research Excellence (Canada). He is currently collaborating with Dr. Georges El Fahli, Dr. Marc Naminden (both from the Gordon Center) and Dr. Yuanjing Sun (University of Wisconsin-Milwaukee) on the development of a modulated radionuclide microscopy platform to study PET tracers at the single cell level. His long-term goal is to continue research in radiation instrumentation but also be involved as an instructor for higher level education.

Fernando Carrió Argos 2016 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, 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 (IFIC), CSIC, designing the new off-detector readout electronics of the ATLAS Hadronic Calorimeter for the luminosity Large Hadron Collider (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 (COGITI).

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 two runner-up receive certificates. The prizes are for outstanding contributions made by students in the nuclear physics community and encourage greater participation by students as first or sole authors on papers. This year, the recipients are for Outstanding Student Paper Awards.

2018 ICOPS Outstanding Student Paper Awards

2018 Phelps Award Recipient

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on understanding plasma plasma characteristics using a fully kinetic PIC code and many’s work concentrates on the molecular formation and decomposition pathways and plasma chemistry in Ne/Ar discharges relevant to pollution control efforts. The runners-up are Moi Siddiq for his work on multipactor theory and Cacacco Galli for his work on extending Paschen’s Law to extreme pressures and temperatures. Additional finalists include Hang Li, Huihui Wang, Kern Lee, Jenis Lai, Ljudmila Markovinich, Amith Nayaan, and Benjamin Vincent. Students are reminded that abstracts are to be marked for consideration for the Student Paper Award at the time of submission. Authors must submit their letter of support within approximately a month of the abstract deadline. (See ICFPS 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 Kolodinski, some of the earliest tests at the Lawrence Berkeley Laboratory Bevalac and B8 accelerator 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 1960, he demonstrated a dependence of the upset rate on CMOS NAMs 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 latchup by Kolasinski and Blake in 1979, Drs. Koga and Kolodinski showed, in 1986, that latchup sensitivity 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 snapshot 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.

NAMINATIONS 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 made sustained contributions to our field over the years. The award is presented at the IEEE NSREC in San Antonio, Texas. Nomination forms are available electronically at http://www.ieee-npss.org/radiation-effects and must be submitted by January 25th, 2019. Additional information can be obtained from Julian Wikki, Member-at-Large, CNES, for the Radiation Effects Steering Group. Julien can be reached at 33 (0) 1 40 49 02 12. (See JULIEN.WIKKI@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” at host the ISAE-SUPAERO Institute of Aeronautics and Space (“IAESTE”) 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. Clairetine Dumez and student branch counselor, Professor Vincent Geoffrin.

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.

Nominations forms are available electronically at http://www.iee-npss.org/technical-committees/education-effects and must be submitted by January 25th, 2019. Additional information can be obtained from Julian Wikki, Member-at-Large, CNES, for the Radiation Effects Steering Group. Julien can be reached at 33 (0) 1 40 49 02 12. (See JULIEN.WIKKI@CNES.FR)

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 Karacznicki and Mary Syng at 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 “Ionizing Plasma Research,” was presented by another two-person team—Daniel Christensen and Michavela Fennel of Northwest Nuclear Laboratories (NNL), 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 fusion plasma. 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.

HEADSTRONG HEJWAD

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

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

Janet Barth gives Distinguished Lecture at ISAE-SUPAERO

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/npps, 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 web site. If there is flexibility in the date or time, the lecturer can then adjust the presentation in order to fit better within that community.

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

Dan Fleetwood, Distinguished Lectures Program Chairman, can be reached by phone at +1 515 322-2483 or by e-mail at dan.fleetwood@vanderbilt.edu.
Real-time Local Noise Filter in 3D Visualization of CT Data

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 parasitized 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 CBCT system in a synchrotron radiation facility. Biologists can perform X-ray CT imaging of biological specimens and visualise them in real-time. Noise from various sources (photon statistics, detector misalignment, reconstruction algorithms etc) obscures the clarity of the final visualization [2]. 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 a threshold that maximizes the interclass 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) cannot suppress spot noise, whereas using a larger kernel (5 x 5 or 7 x 7) removes fine details from the data. Instead, we modify the mean filter by considering the average smaller kernel region (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 based on the central voxel and its six adjacency neighboring positions (average cluster). The average of nine average clusters (S0…S8) is used to represent the surface intersection point.

To evaluate the effectiveness of our filter, we compare the visual quality, and the performance of a traditional fly data set with another three filters: the sigma filter, the entropy filter, and the Okada 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 visualization 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.
The detector has 4126x866 square pixels of 15x15 μm² covering an area of 7cm². The Skipper-CCD vertical.

At this noise level, the probability that the charge per pixel is misestimated by >0.5e- is. This represents the first.

The single pixel spectrum for different number of samples per pixel is shown in figure (2). At 1000 samples per.

voltage of the clock phases were adjusted to minimize the generation of spurious charge.

The sensor is operated in a vacuum chamber and below 140 K to reduce the number of electrons promoted.


GRAND THEFT

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


The sensor was designed in the MicroSystem Labs of the Lawrence Berkeley National Laboratory, and the read-out.

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Instituto Balseiro, Centro Atómico Bariloche—

CNEA/CONICET, Argentina.

Submitted to the Radiation Instrumentation Committee.

The Skipper-CCD was first introduced in 1990 by Janesick et al [Chandler] in this article, the first Skipper-

A Skipper-CCD Image Sensor With Subelectron Readout Noise

Miguel Sofo Haro

Author

Fig. (1). Simplified diagram of the Skipper-CCD output stage. H1, H2 and H3 are the horizontal register.

The sensor value was calibrated using the system gain obtained from a exposure of the detector.

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.

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 for the 777e- peak has 0.086 e-rms/pixel, demonstrating single-electron sensitivity over a large dynamical range. The Gaussian fits have, and respectively.

REFERENCES:

[Chandler] C. E. Chandler et al., “Sub-electron noise charge coupled devices,” in Charge-Coupled Devices and


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SWEET TALK?

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

Margarita Asquith

Margot Asquith

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


The 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 200um thick. The high resistivity, >10kΩcm allows for fully depleted operation at a substrate voltage over 40V.

The detector has 4126x866 square pixels of 15x15 μm² covering an area of 7mm². The Skipper-CCD vertical and horizontal registers have three-phase clocks that are designed for 48kHz readout, through the output stage at each quadrants of the sensor.

A simplified diagram of the Skipper-CCD output stage is presented in figure (1). Like the gate of the clock.

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 all the charge in the SN, from the previously read pixel, is removed to Vdd 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 FG. The cycle can be repeated to take several samples of the same 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 σe/√N, where σe is the standard deviation of the readout noise for a single sample of the pixel.

σe=σ/√N, of the effective readout noise distribution after averaging N samples per pixel is

where σ e is the single-sample readout noise of e=3.55 e- per pixel with a readout time of 1μs/pixel/sample. A readout noise of 0.1 e- per 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 [Tiffinberg].

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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.

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 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.
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 available 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 workshops 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 Koerte at Heiko.Koerte@nateurope.com or Kay Rehlich at kay@rehlich.de.

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.
Li-containing scintillation materials such as Li-glass, LiF/ZnS ceramics, and Cs\textsubscript{2}LiYCl\textsubscript{6}:Ce\textsuperscript{3+}, Li\textsubscript{6}Gd(BO\textsubscript{3})\textsubscript{3}:Ce\textsuperscript{3+} and corresponds to the eutectic composition in the LiCl-BaCl\textsubscript{2} phase diagram [16], and the mixtures were then spectra were employed to evaluate the microstructure, optical and scintillation properties. γ-photoluminescence excitation and emission, that of Li-glass [11].

The aim of the current work is to develop the first chloride-based eutectic scintillator, LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+}. This is realized by the use of highly ordered lamellar and rod-like phases, which are formed through a Bridgman growth method [12–14]. To this end, a LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+} crystal was grown using the Bridgman method. In the following years, several fluoride-based eutectics were developed, including LiF–SrF\textsubscript{2} and LiF–CaF\textsubscript{2} [11], Ce\textsuperscript{3+}-doped LiF/CaF\textsubscript{2} [12], Ce\textsuperscript{3+}-doped LiF/LiYF\textsubscript{4} [13] and Ce\textsuperscript{3+}–LiF/LiLuF\textsubscript{4} [14]. The temperature measured at the interface agrees well with the eutectic point at 514 degree Celsius, Fig. 1(a). Stable growth of the eutectic structure was achieved with a flat solid–liquid interface as can be observed in the LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+} sample (E558-3). The temperature measured at the interface agrees well with the eutectic point at 514 degree Celsius, Fig. 1(a).

2. MATERIALS AND EXPERIMENT

Anhydrous, high-purity (99.99%) beads of LiCl (natural abun-dance), BaCl\textsubscript{2}, and EuCl\textsubscript{3} (Sigma-Aldrich) were used as starting materials. The LiCl and (Ba\textsubscript{1-x}Eu\textsubscript{x})\textsubscript{2}Cl\textsubscript{2} were mixed in 7:1.249 mol ratio that corresponds to the eutectic composition in the LiCl-BaCl\textsubscript{2} phase diagram [16], and the mixtures were then loaded into quartz crucibles. The crucible was evacuated to 10\textsuperscript{−8} mbar and heated to 250 degree Celsius and kept for 3 h at the temperature in order to remove residual water and oxygen impurities. After baking, the crucible was sealed and transferred to the Bridgman growth furnaces. 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/mm (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 work temperature at a cooling rate of 0.5 degree Celsius/min. The finished boule was cut and polished into different sizes. Considering the melt ratio and densities of LiCl (2.07 g/cm\textsuperscript{3}) and BaCl\textsubscript{2} (3.16 g/cm\textsuperscript{3}), the theoretical density of this eutectic should be about 2.5 g/cm\textsuperscript{3}. Scanning electron microscopy (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 HORIBAJOBIN Yvon Fluorolog-3 spectrometer. A 450 W xenon continuous lamp was used as the excitation source. The excitation light passed through a monochromator with a 1 mm bandpass to ensure monochromatity. Similarly, the emission monochromator was set at 1 mm bandpass to select emission light of a specific wavelength. Photoluminescence (PL) decay was measured with the same spectrometer/counter 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 deconvoluted from the much longer decay time profiles. The light pulse repetition rate for excitation was 1 MHz. For x-ray and γ-activated radioluminescence (RL) measurements, a x-ray tube operated at 35 kV and 1.0 mA and 5.0 Am 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\textsubscript{2}:Eu\textsuperscript{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 20 Pn Pileup-free neutron source located in the center of a 25 x 45 x 30 in. polycarbonate 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 located 1 m away. All measurements were taken from 2–16 h time intervals to achieve statistical significance. The pulse chain for all measurements consisted of a HESS3 Hamamatsu photomultiplier tube assembly (PMT), ORTEC 132 Cremat preamplifier, ORTEC 572 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 Nucsafe glass sample exposed to 137Cs 661.7 keV gamma-rays on the same pulse chain, which resulted in 146797.5 photons per channel. The PMT background 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\textsubscript{2}:Eu\textsuperscript{2+} light yield. Finally, to provide a qualitative description of the gamma-neutron discrimination capability of LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+}, sample E558-1 was exposed to 109Cd, 57Co, 137Cs, GeO\textsubscript{2}, and Na\textsubscript{2}MoO\textsubscript{4} 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\textsubscript{2}:Eu\textsuperscript{2+} are shown in Fig. 1(b) and (c), respectively. The samples are transparent 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 LiCl [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 LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+}, thus producing scintillation light pulses corresponding to each neutron capture event.

Table 1 Dimensions and scintillation properties of LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+} eutectics compared with a commercial Nucsafe lithium glass scintillator.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Dimension (mm)</th>
<th>Detection efficiency (%)</th>
<th>Relative light yield (photons/MeV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiCl-BaCl\textsubscript{2}:Eu\textsuperscript{2+}</td>
<td>Ø6.11 x 1.00</td>
<td>26.470 ± 0.05</td>
<td>1518 ± 16</td>
</tr>
<tr>
<td>LiCl-BaCl\textsubscript{2}:Eu\textsuperscript{2+}</td>
<td>Ø5.25 x 2.23</td>
<td>0.04 ± 0.07</td>
<td>2779 ± 29</td>
</tr>
<tr>
<td>LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+}</td>
<td>Ø5.03 x 1.44</td>
<td>0.47 ± 0.07</td>
<td>2382 ± 24</td>
</tr>
<tr>
<td>Li-glass (Nucsafe)</td>
<td>Ø4.97 x 3.72</td>
<td>0.10 ± 0.00</td>
<td>1543 ± 16</td>
</tr>
</tbody>
</table>

* 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 LiCl–BaCl\textsubscript{2}:Eu\textsuperscript{2+} eutectics, which were excited with a γ-source produced by a Co\textsubscript{60} source and detected with a NaI(Tl) detector exposed to 137Cs γ-rays.

Becasue of the larger refractive index of cylinder/lamellar phase (n<1) compared to that of matrix (n>1), the viable light is confined and transports along the cylindrical/ lamellar axis by a total reflection mode. Thus, the ratio of light yield is less than 1 is a key factor for high light transport efficiency. It is expected that the Eu\textsuperscript{2+} activator ions preferentially incorporate into BaCl\textsubscript{2} phase because of theionic radius of Eu\textsuperscript{2+} (1.17 pm) allows it to easily substitute for the Ba\textsuperscript{2+} (1.56 pm) compared to much smaller ura (1.27 pm) site [19]. Moreover, the charge of the Eu ion is the same as the Na ion because of its monovalent nature. Thus, Eu was expected to induce a greater efficiency than Co\textsubscript{2+} because of the smaller ionic radius. Neither 137Cs γ-rays nor 60Co γ-rays create less stress and fewer structural defects (vacancies and/or interstitials) when compared with integration of the Eu\textsuperscript{2+} into the LiCl phase. Moreover, these factors may incorporate the Eu\textsuperscript{2+} into the BaCl\textsubscript{2} phase.
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 Co-doped LiF-SrF$_2$ [12] eutectics. The phases are elongated along the pulling direction. The black and grey-colored areas correspond to the LiCl and BaCl$_2$:Eu phases, respectively. The layer thicknesses of [10] and Ce-doped LiF–SrF$_2$ [12] eutectics. The phases are elongated along the pulling direction. The black
grey-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 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 $\gamma$-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 $\gamma$-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 way-and-x-ray excited radium-luminescence (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 nm and 526 nm. The emission peak at 406 nm is the result of the radiative 5d–4f transition of Eu$^{2+}$. The peak position is in a good agreement with the reported values in Ref. 15. However, the emission peak at 526 nm observed in both way-and-x-ray excited emission spectra cannot be assigned to the LiCl:Eu$^{2+}$ luminescence. Although the 5d–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 LiF host, a high-stiff of Eu$^{2+}$ emission in LiCl host is expected compared to the 475 nm emission in LiF:Eu$^{2+}$ [20]. Also in barium-based halides, the emission at a similar wavelength was specifically assigned to the oxygen containing impurities [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(b). 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 or greater than the light yield of 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$^{2+}$

![Fig. 1. Photograph of the LiCl–BaCl$_2$:Eu$^{2+}$ eutectic during growth process in a transparent furnace (a), finished ingot (b), and ~Ø6 x 1.5 mm$^3$ polished samples (c); SEM images of LiCl–BaCl$_2$:Eu$^{2+}$ eutectic with different magnifications: (d) 20 μm and (e) 1 μm.](image)

4. SUMMARY

A new LiCl–BaCl$_2$:Eu$^{2+}$ eutectic scintillator with a density of about 2.5 g/cm$^3$ was synthesized via the vertical Bridgman method. The X-ray induced radium luminescence 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 or greater than that of a commercial Nucsafe lithium glass scintillator. Threshold discrimination of gamma-rays above 500 keV may not be possible, because the gamma-ray spectrum under $\gamma$-ray exposure 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 (Co$^{57}$) may not be possible, because the gamma-ray spectrum under Co$^{57}$ (1.17 and 1.33 MeV) irradiation is hard to be discriminated from its neutron spectrum.
Thermal Neutron Detection

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