



**American Nuclear Society  
Fusion Energy Division  
December 2003 Newsletter**

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**Chair's Letter**, René Raffray, University of California-San Diego, San Diego, CA.

First, I would like to thank Dr. Wayne Meier, the former Fusion Energy Division (FED) Chair and the 2002-2003 officers and members of the Executive Committee for their effort over the past year in helping FED move forward. I would also like to welcome the new officers and members of the Executive Committee, in particular Dr. Jake Blanchard as Vice-Chair and Dr. Jeff Latkowski as Secretary/Treasurer.

In my first message as Chair of the Fusion Energy Division of the American Nuclear Society (ANS), I would like to address a number of topics ranging from national and international fusion developments to the latest news on FED, specifically: the ITER status, the Department of Energy (DOE) FY04 Fusion Budget, FESAC, ANS Division Metrics, and other FED news including TOFE.

### **ITER**

The US is currently in negotiation to rejoin ITER. With the interest expressed by Korea and China to join ITER, there are now seven parties at the negotiation table: Canada, China, the European Union (EU), Japan, Korea, the Russian Federation and the US. The negotiations are being pursued over a series of meetings at three levels: the Senior Negotiators' meeting (P series) where the US delegation is led by Dr. Raymond Orbach, Director of DOE Office of Science; the Broader Negotiators' meeting (N series); and the Working Level Meetings (NSSG series).

There are now three candidate sites to host ITER. The EU has just selected Cadarache, France as its sole candidate site (prior to this decision, the other EU candidate site was Vandellós, Spain). The other two candidate sites are Clarington, Canada, and Rokkasho-Mura, Japan. The project's participants will meet on December 4, 2003 to discuss the final choice and it is hoped that a site decision can be made shortly thereafter.

In support of these ITER developments, Dr. Anne Davies, head of the Office of Fusion Energy Sciences (OFES), showed at the June 2003 FESAC meeting the proposed reorganization of OFES. Under this proposal, there would be two divisions under Dr. Davies: a Research Division with Dr. John Willis as Director, and an ITER & International Division with Dr. Michael Roberts as Director.

### **Fusion Budget**

The President's FY04 fusion budget had drastically cut fusion technology funding, which seems to me in contradiction with the US currently negotiating to rejoin ITER, or, at the very least, sends conflicting signals to our international ITER partners. I believe that it is important for the US to send a strong budgetary message of our seriousness to be full partners not only on the physics mission of ITER but on the development of the many technology components of the machine as well as on the testing of power-plant relevant in-vessel components.

Fortunately, both the House and Senate appropriation committees have helped to different extents to redress this situation. The House has specifically added \$10.8M to the

President's request of \$257.3M, with all of the additional funding specifically allocated to ITER and FIRE, fusion technology and advanced design and analysis. The Senate has not changed the level of funding but has added text recommending that DOE make adjustments to redress the imbalance resulting from the cuts in fusion technology and advanced design.

The House and Senate conference to finalize these budget numbers has just concluded at the time of submitting this letter. It provides \$264.1M to DOE's OFES, an increase of \$6.8M over the President's request. It directs that this money be restored to domestic fusion research and strongly cautions DOE against submitting any future budget requests for ITER that are funded at the expense of domestic research.

On inertial fusion energy, the agreement includes \$25M to continue the high average power laser (HAPL) program and \$4M to initiate assessments, and development and testing of Z-pinch inertial fusion energy. These will be funded within the DOE National Nuclear Security Administration's inertial confinement fusion program.

### **FESAC**

The Fusion Energy Science Advisory Committee (FESAC) recently completed its charge on Non-Electric Application of Fusion. A panel led by Dr. Kathy McCarthy (who is very much active in ANS and FED) was appointed to address this charge and reported its findings at the July 2003 FESAC meeting. The panel identified the most promising options as:

- Near Term Applications (mainly production of neutrons for applications such as medical diagnosis and detection of clandestine materials): the Panel recommended that these would be best pursued through a SBIR-like process.
- Transmutation: the Panel recommended maintaining a "watching brief" on current fuel cycle activities to guide any future expansion of fusion transmutation of waste program.
- Hydrogen Production: the Panel recommended including hydrogen production as a goal of the fusion program.
- Space Propulsion: the Panel recommended that the fusion program be ready to respond to any NASA request to support evaluation (and development) of space fusion propulsion systems.

However, they noted that none of these opportunities should be pursued at the expense of existing program in light of the many significant budget cuts seen by the fusion program lately.

FESAC has now been provided four new charges:

- 1) An assessment of the status of the inertial fusion energy (IFE) program in response to the considerable scientific and technical progress in the IFE program during the past few years.
- 2) Workforce development addressing the question of whether the current system of education and training of scientists and engineers assures the workforce needed in the future.

This is a question that we should be asking also as we try to promote student interest and membership in FED. A survey to help FESAC assess the current situation has been circulated among the FED membership.

- 3) Target and indicators addressing whether the program long term and annual performance measures are appropriate and sufficiently ambitious.
- 4) The fourth and most recent charge follows the endorsement by the National Research Council (NRC) of FESAC's recommendation that the US should join the negotiation to build and operate ITER, and NRC's recommendation that a new effort be made to integrate ITER into the domestic program. Per the charge letter of October 23, 2003 from Dr. Raymond Orbach, the DOE Office of Science Director, to Prof. Richard Hazeltine, the FESAC Chair, the specific charge is to assist in establishing priorities for the fusion program by identifying the major science and technology issues that need to be addressed, recommending how to organize campaigns to address those issues, and recommending the priority order for these campaigns. Different funding scenarios should be considered with the assumption that funding for ITER construction is provided in addition to these funds. In addition to magnetic fusion, inertial fusion and relevant aspects of high energy density physics should be included in recommending priorities for a balanced Fusion Energy Sciences program.

Please see the FESAC website for more information about the above and other FESAC activities: [http://www.ofes.fusion.doe.gov/More\\_HTML/FESAC\\_Charges\\_Reports.html](http://www.ofes.fusion.doe.gov/More_HTML/FESAC_Charges_Reports.html)

### **ANS Division Metrics**

Over the last couple of years, the ANS Professional Divisions Committee (PDC) has developed a set of metrics and measures of division vitality as a process to help divisions assess their current status and identify areas where progress would be beneficial. This is a continuous process with the metrics being updated and providing the opportunity for discussion and sharing of information within each division and among divisions for the benefit of all.

These metrics cover four areas: Division Meetings; Division Governance; Division Contributions to Society; and Division Services to Membership. I am pleased to report that FED fared very well in nearly all areas and in particular on the critical vitality measures. We are currently addressing the one area requiring some effort, namely division and succession planning.

Our ranking reflects very well on FED, on the contribution of individual members and on the past Executive Committees. However, I would like to take this opportunity to invite the overall membership (in the high 600's currently) to become more involved in helping to strengthen FED as a dynamic and forward-looking division. There are many ways to become involved such as providing feedback and suggestions to myself (raffray@fusion.ucsd.edu) and/or to members of the Executive Committee on matters affecting FED, participating in TOFE conferences, and running for membership on the Executive Committee.

## **TOFE & Other FED News**

Our budget is relatively healthy (at our modest level) thanks in good part to the revenues from the Topical Meetings on the Technology of Fusion Energy (TOFE). This allows us to maintain our different activities including student support and FED awards.

The last TOFE was embedded in the 2002 ANS winter meeting. The next TOFE (16<sup>th</sup>) will be held as a stand-alone conference in Madison, Wisconsin on September 14-16, 2004. Professor Gerald Kulcinski is the Conference Chair and Dr. Laila El-Guebaly is the Technical Program Chair. They have put together with short notice an impressive organization structure and we are looking forward to a very successful TOFE conference. I would like to encourage all members of the fusion technology community to submit papers and/or attend. In light of the US negotiating to rejoin ITER, of the message sent by Congress on the importance of funding fusion technology, and of the recent scientific and technical progress in IFE (as reflected by the current FESAC charge on IFE), this should be a timely conference on fusion technology which would help energize the community.

After several years of much appreciated service as Chair of the FED Honors and Awards Standing Committee, Prof. Gerald Kulcinski has requested to step down from this position. The FED Executive Committee has appointed a new Chair, Prof. Farrokh Najmabadi of the University of California, San Diego, whom I am glad to welcome to this FED Standing Committee.

FED has revised the 1999 ANS Statement on Fusion Energy posted on the ANS website to include updated information and emphasis on the burning plasma experiment, rejoining ITER, and use of the National Ignition Facility as it comes on line. The revised statement has been approved by the ANS Board and should soon appear on the ANS website. I would like to thank Dr. Bill Hogan, the FED Representative on the ANS Public Policy Committee and Dr. Wayne Meier, the former FED Chair, for revising the Fusion Energy Statement.

**FED Slate of Candidates**, Wayne Meier, Lawrence Livermore National Laboratory, Livermore, CA.

All FED members will receive a ballot early next year for the election of FED Officers and Executive Committee members. We encourage each member to vote in this election, so please take the time to mark and return your ballot. The outcome of the election will be announced before the June ANS Annual meeting in Pittsburgh. The FED is always looking for members who would like to become active in the operation of the Division. Please contact any Officer or member of the Executive Committee if you are interested.

We have an excellent slate of candidates for the upcoming FED election. The current Vice Chair/Chair-Elect, Jake Blanchard of the University of Wisconsin, Madison, will become FED Chair at the end of the FED Executive Committee meeting in June 2004. Said Abdel-Khalik from Georgia Institute of Technology is the sole candidate for Vice Chair. Jeff Latkowski (LLNL) will continue as treasurer as this is now a two-year term.

We have five candidates for the four spots to fill on the Executive Committee. The candidates for the 2004 FED elections are:

Vice Chair: Said Abdel-Khalik (Georgia Institute of Technology)

Executive Committee: Gianfranco Federici (Max Planck Inst. for Plasma Physics-Germany)  
Farrokh Najmabadi (UCSD)  
Akio Sagara (National Institute for Fusion Science-Japan)  
Roger Stoller (ORNL)  
Scott Willms (LANL)

**16<sup>th</sup> ANS Topical Meeting on the Technology of Fusion Energy**, Gerald Kulcinski and Laila El-Guebaly, University of Wisconsin-Madison, Madison, WI.

The Wisconsin Local Section of the American Nuclear Society (ANS) and the University of Wisconsin (UW) Fusion Technology Institute are pleased to host the ANS biennial Topical Meeting on the Technology of Fusion Energy (TOFE) in Madison, Wisconsin, on September 14-16, 2004 at the Monona Terrace Community and Convention Center. Madison, Wisconsin is a city of 210,000 people and the seat of the State Capital and the home of the University of Wisconsin. On the shore of Lake Monona, the meeting place (Monona Terrace Community and Convention Center) is the premier location for large meetings in Madison. The internationally renowned architect, Frank Lloyd Wright, designed the center. The unique location of Madison and the spectacular Monona Terrace promise to make the 16<sup>th</sup> TOFE an excellent meeting.

The 16<sup>th</sup> TOFE meeting will continue the tradition of stand-alone topical meetings originated in the early 1970's, continued through the 80's, and re-established in the year 2000 in Park City, Utah. The scope of the TOFE meeting is to provide a forum for sharing the exciting new progress that has been made in fusion research as well as presenting the future of the national and worldwide fusion program. The TOFE meetings typically draw scientists, engineers, and students from various countries, including representation from the US, Japan, Europe, Russian Federation, Canada, China, and Korea.

### **Organizing Committee**

*General Chair*

Gerald Kulcinski (UW)

*Vice Chair*

Masahiro Seki (JAERI)

*Technical Program Chair*

Laila El-Guebaly (UW)

*Assistant Technical Program Chairs*

Ichiro Yamamoto (Nagoya U.)

René Raffray (UCSD)

*Finance Chair*

James Blanchard (UW)

*Publications Chair*

Mohamed Sawan (UW)

*Registration Chair*  
*Student Awards*  
*Special Events and Guest Program*

Mark Anderson (UW)  
Paul Wilson (UW)  
John Santarius (UW)  
Linda Kraft (UW)  
Dennis Bruggink (UW)

*Publicity and Webmaster*

## **Topics**

TOFE participants will enjoy presentations, technical discussions, and special sessions on various topics, covering all aspects of magnetic and inertial fusion technology. The “Call for Papers” has been issued. Paper submissions are solicited in all areas of fusion technology that include, but are not limited to, the following topics:

- Engineering of experimental devices
- Power plant studies
- High heat flux components
- IFE target fabrication, injection, and tracking
- In-vessel components (blanket, shield, vacuum vessel)
- IFE chamber dynamics and clearing
- Magnets
- Nuclear analysis and experiments (neutronics, shielding, and activation)
- Structural and breeding materials
- Material and component test facilities
- Blanket testing
- Safety and environment
- Radwaste management
- Tritium handling and processing
- Plasma engineering, heating, and control
- Diagnostics
- Fabrication, assembly, and maintenance
- Power conversion and conditioning
- Computational tools and validation experiments
- Alternate, non-electric applications of fusion
- Hydrogen production
- Socioeconomics.

## **Technical Program**

The two and a half day program of the 16<sup>th</sup> TOFE meeting will have plenary, oral, and poster sessions, including a mix of invited oral papers and a significant number of contributed oral and poster papers. The technical program will cover the 20+ topical fusion areas. In addition, special sessions are planned on various projects (such as HAPL, ARIES, APEX, ITER, etc.) as well as tours of UW experimental facilities.

## **Technical Program Committee**

The Technical Program Committee (TPC) is drawn from various National Laboratories, Industry, and Universities engaged in fusion research. The TPC list includes:

*Chair:* Laila El-Guebaly (UW)  
*Assistant Chairs:* Ichiro Yamamoto (Nagoya U.)  
 René Raffray (UCSD)

*TPC Members:*

S. Abdel-Khalik	GT	M. Nishikawa	Kyushu U.-J
M. Abdou	UCLA	C. Olson	SNL
M. Anderson	UW	P. Peterson	UCB
C. Baker	VLТ	R. Peterson	LANL
J. Blanchard	UW	A. Sagara	NIFS-J
L. Cadwallader	INL	J. Santarius	UW
M. Enoeda	JAERI-J	M. Sawan	UW
G. Federici	ITER-EU	K. Schultz	GA
Y. Gohar	ANL	J. Sethian	NRL
D. Goodin	GA	L. Snead	ORNL
A. Hassanein	ANL	M. Sugimoto	JAERI-J
D. Johnson	PPPL	I. Sviatoslavsky	UW
A. Kohyama	Kyoto U.-J	N. Taylor	UKAEA-EU
TK. Mau	UCSD	P. Titus	MIT
D. Meade	PPPL	L. Waganer	Boeing
W. Meier	LLNL	P. Wilson	UW
K. Mima	Osaka U.-J	S. Zinkle	ORNL
N. Morley	UCLA		

### **Awards**

Professional recognition has traditionally been important to the TOFE meeting. The ANS-FED will offer three awards to provide technical recognition in the fusion area. These are the Outstanding Technical Accomplishment Award, Outstanding Achievement Award, and Best Student Paper Award (see the FED Awards article).

### **Registration and Publications**

The entire process of registration and abstract and full paper submission/review will be done electronically. You are invited to submit one-page abstracts describing work that is new, significant, and relevant to both MFE and IFE fusion technologies. A Microsoft Word template that can be used to create the abstract is available on the TOFE website: <http://fti.neep.wisc.edu/tofe>. Full papers will be due at the meeting. Papers that are accepted by the peer review process will be published in Fusion Science and Technology. Register online before August 10, 2004 and save on the registration fees. The registration includes admittance to all technical sessions, a copy of the abstract book, and tickets to the Welcome Reception, Banquet, and daily refreshment breaks. Publication of the proceedings and CD-ROM will be sent to registrants after the meeting. There are special registration opportunities for students, ANS emeritus members, and spouses/guests.

Student participation is strongly encouraged. All student first authors presenting a paper at the meeting can compete for the Best Student Paper Award and ANS student members can apply to the ANS Fusion Energy Division for partial reimbursement of expenses.



### Accommodations and Hotel Information

Blocks of rooms have been reserved at two hotels for ANS-TOFE attendees. The Hilton (meeting hotel) is connected to the Monona Terrace by a skywalk and the Best Western is four blocks from the Convention Center. The hotel rates span a range of \$69-109 per night for single or double occupancy:

	<u>Rate per Night</u>	<u>Phone Number</u>
Hilton (Meeting Hotel)	\$109 + tax	(608) 255-5100 (800) HILTONS
Best Western	\$69 + tax	(608) 257-8811 (800) 279-8811

Two major events are taking place in Madison before and after the TOFE meeting. Madison's hotels could be fully booked during the week of Sept. 13, 2004. We encourage you to make the hotel reservation NOW or ASAP.

### Sponsorship

The primary sponsor of the 16<sup>th</sup> TOFE is the ANS Fusion Energy Division. The ANS Wisconsin Local Section, Fusion Energy Division of the Atomic Energy Society of Japan, the US Department of Energy, and the University of Wisconsin-Madison agreed to co-sponsor the 16<sup>th</sup> TOFE meeting.

### Key Deadlines

One-page abstracts	May 1, 2004
Nominations for ANS-FED awards	May 31, 2004
Notification to authors	June 1, 2004
Early registration deadline	August 10, 2004
Hotel reservation cutoff date	August 10, 2004
Full papers due at the meeting	September 14, 2004

Please visit the TOFE website for additional details: <http://fti.neep.wisc.edu/tofe>. Mark your calendar and plan to attend the 16<sup>th</sup> TOFE in Madison, WI. We're looking forward to seeing you all in Madison next summer!



**FED Awards**, Farrokh Najmabadi, University of California-San Diego, San Diego, CA and Paul Wilson, University of Wisconsin-Madison, Madison, WI.

### **Professional Awards - Call for Nominations**

Enclosed you will find announcements for two awards to be given at the 16<sup>th</sup> Topical Meeting on the Technology Fusion Energy in Madison, WI, September 14-16, 2004.

These awards are:

- \* 2004 Outstanding Technical Accomplishment Award
- \* 2004 Outstanding Achievement Award

### **Nomination deadline is May 31, 2004.**

Please make this announcement known to your colleagues. Thank you for your cooperation and I am looking forward to your submissions.

Mail nominations to: Professor Farrokh Najmabadi  
Chair FED Honors and Awards Committee  
University of California-San Diego,  
Department of Electrical & Computer Engineering  
Center for Energy Research  
460 EBU II  
La Jolla, CA 92093-0438

### **A- 2004 Outstanding Technical Accomplishment Award**

#### **Purpose**

- \* For recognition of a specific exemplary individual technical accomplishment requiring professional excellence and leadership of a high caliber in the fusion science and engineering area.
- \* So others will understand that the Fusion Energy Division of the American Nuclear Society encourages such technical accomplishment and recognizes its importance to fusion.
- \* Award to recognize technical accomplishment and professional excellence by a member of the American Nuclear Society.

#### **Criteria**

- \* Emphasis is on individual accomplishment through a specific technical accomplishment. Therefore, the award is usually given to an individual, however, there could be a partnership.
- \* Emphasis is on a single technical contribution to fusion science and engineering however that contribution is made.
- \* Contribution to be measured as recognized by others in the field.

#### **Procedure**

- \* Nominations can be made by anyone at anytime to the Honors and Awards Committee Chair of the Fusion Energy Division of the American Nuclear Society.
- \* On an annual basis, a call will be made for candidates and the Committee will evaluate the information, gather additional information if necessary, and may actively search for additional nominations.

- \* A decision is made whether an award will be given to any nominee in a specific year.
- \* The recommended accomplishment is presented to the Fusion Energy Division Executive Committee for approval and to the ANS Honors and Awards Committee for concurrence.

#### Award

- \* An object of ornamental or useful type with intrinsic value.
- \* A certificate designating the presentation of the award.
- \* Presented at any American Nuclear Society Annual Meeting or Division Topical Meeting.

### **B- 2004 Outstanding Achievement Award**

#### Purpose

- \* For recognition of a continued history of exemplary individual achievement requiring professional excellence and leadership of a high caliber in the fusion science and engineering area.
- \* So others will understand that the Fusion Energy Division of the American Nuclear Society encourages such achievement and recognizes its importance to fusion.
- \* Award to recognize achievement, leadership, and professional excellence by a member of the American Nuclear Society.

#### Criteria

- \* Emphasis is on a history of achievements in advancing the technological development of fusion.
- \* Emphasis is on a continued series of contributions to fusion science and engineering however those contributions are made.
- \* Contributions to be measured as recognized by others in the field.

#### Procedure

- \* Nominations can be made by anyone at anytime to the Honors and Awards Committee Chair of the Fusion Energy Division of the American Nuclear Society.
- \* On an annual basis, a call will be made for candidates and the Committee will evaluate the information, gather additional information if necessary, and may actively search for additional nominations.
- \* A decision is made whether an award will be given to any nominee in a specific year.
- \* Nominees not receiving an award will be re-evaluated for the next three years.

#### Award

- \* An object of ornamental or useful type with intrinsic value.
- \* A certificate designating the presentation of the award.
- \* Presented at any American Nuclear Society Annual Meeting or Division Topical Meeting.

### **Award for Best Student Work Presented at 16<sup>th</sup> TOFE Meeting**

Students are encouraged to submit their work for presentation at the 16<sup>th</sup> Topical Meeting on the Technology of Fusion Energy. The Technical Program Committee will review all student-authored submissions and select the best student work presented at the meeting. Formal evaluation criteria will be used to assess the quality of the student's work based

on discussion with the student, the quality of the presentation/poster, and the technical merit of the work. The author of this work will receive a cash award and a plaque recognizing their accomplishment. Please make this announcement known to your students.

**News from Fusion Science and Technology (FS&T) Journal**, Nermin A. Uckan, FS&T Editor, Oak Ridge National Laboratory, Oak Ridge, TN.

Now in its third decade of publication, FS&T publishes eight issues (in two volumes) per year in addition to special topical fusion-related meeting proceedings. Electronic access to FS&T is available online (from 1999-to-current). Tables of contents and abstracts of papers can be accessed at <http://www.ans.org/pubs/journals/fst/>. Individual and library subscribers can access the full text articles at <http://epubs.ans.org/>.

In 2003, FS&T published an excellent selection of contributed papers and several special issues. The 2003 subscription has provided readers with up-to-date fusion information with the following special issues:

January 2003	Transactions of FS&T, 4 <sup>th</sup> International Conference on Open Magnetic Systems for Plasma Confinement
May 2003	Selected peer-reviewed papers from the 2 <sup>nd</sup> IAEA Technical Meeting on Inertial Fusion Energy Targets and Chambers
July 2003 & September 2003	Peer-reviewed papers from the 15 <sup>th</sup> Topical Meeting on the Technology of Fusion Energy (TOFE, Parts I & II)
November 2003	ASDEX-Upgrade Tokamak

The 2004-2005 special issues will include coverage on IFE targets and chambers, plasma and fusion energy physics and technology, the ARIES-IFE Study, FTU Tokamak (Frascati, Italy), NCSX (PPPL), magnetic fusion reactor studies (EU, JA, US), the NIF program and beyond (LLNL), the TEXTOR Tokamak (Juelich, Germany), Fast Ignition (US, JA, EU), DIII-D Tokamak (GA), Alcator C-Mod (MIT), tritium technology, 16<sup>th</sup> TOFE, and much more.

Don't miss any of these issues. Sign up for an individual ANS member subscription or check with your libraries to make sure they have both paper copy and electronic subscriptions.

Looking forward to receiving comments and feedback from readers, authors, and reviewers on FS&T contents and coverage, and potential future topical areas that are timely and of interest. Contact E-mail address: [fst@ans.org](mailto:fst@ans.org).

## **ONGOING FUSION RESEARCH:**

**Progress on Thick-Liquid Protected IFE Power Plant Design at UC Berkeley**, Christophe Debonnel, Per Peterson, and the Thermal-Hydraulics Team  
University of California-Berkeley, Berkeley, CA.

The Nuclear Engineering Thermal-Hydraulics Laboratory at the University of California at Berkeley (UCB) performs research on phenomena that occur in thick-liquid protected inertial fusion target chambers. Thick liquid protection provides an attractive approach to withstanding the hostile fusion environment while meeting the stringent beam and target propagation requirements. Previous work in the Laboratory focused on the design and assessment of the HYLIFE-II chamber [1]. Recent work has focused on improvements to this design, improvements that have been incorporated into the new heavy-ion fusion Robust Point Design (RPD), completed in 2002 [2]. This power plant study presents a self-consistent design based on an induction linear accelerator driver, indirect drive target, and thick-liquid protected target chamber. Major contributions to the RPD and ongoing work are outlined in this short review.

### **Thick-Liquid Protected Target Chamber and Beam Tubes**

#### **A. Flinable, a New Molten Salt**

Typically a mixture of LiF and BeF<sub>2</sub> known as “flibe” was considered for the HYLIFE-II design [1]. An approach to reducing the melting temperature of flibe has recently been identified [3]. Some of the LiF may be replaced by sodium fluoride to make “flinabe.” Adding enough NaF to flibe depresses the melting temperature from 733 K to less than 673 K. When used at temperatures below the melting point of flibe, flinabe has a very low vapor pressure, which makes it compatible for use in neutralized ballistic transport beam tubes. We recommend using flinabe for the target chamber coolant as well [3].

Properties of both flibe and flinabe are being investigated. Following up on a thorough theoretical prediction of flibe vapor pressure [4], UCB is currently measuring the vapor pressures of various simple molten salt mixtures using the Knudsen effusion method. Ultimately, flibe and flinabe vapor pressures will be measured at relevant target chamber operating temperatures.

#### **B. New Target Chamber Liquid Jet Configuration**

In the original HYLIFE-II design, the protection of the first wall and final-focus magnets was performed by an array of slab jets and an oscillating liquid pocket. The main ideas have been retained for the RPD target chamber, with a few modifications [5]. “Voided” slab jets are used for the pocket, as they provide a better abatement of shocks. Voided slab jets are made of a slab jet and an array of packed cylindrical jets. The use of cylindrical jets is recommended to protect the beam ports—an array of cylindrical jets is easier to design. A “vortex” is used to coat the first half of the beam tube—it serves as a buffer between the target chamber and final-focus magnet region where the requirements on background gas and cleanliness are different. All three kinds of jets have been demonstrated experimentally in scaled experiments [5].

As an alternative to a pocket-like chamber, we are exploring the possibility of coating the inside of the target chamber with a liquid vortex layer. Concurrently, we are investigating the vortex flow properties. Very little is known about rotating turbulent flows with a free surface; we are exploring the vortex surface roughness, surface renewability rate and heat transfer coefficients, as well as droplet ejection rates.

### **C. Extensive Studies of Target Chamber Response to Target Threats**

The response of target chambers to x-rays, neutrons and fast ions has been studied. (Most of the neutron and chamber activation work is done at the Lawrence Livermore National Laboratory.)

#### **1. Sub-Millisecond Response**

Early response of thick-liquid pocket include x-ray ablation, impulse to pocket and gas venting—phenomena that have been the object of extensive analysis in the Thermal-Hydraulics Laboratory, where the computational fluid dynamics code TSUNAMI has been developed and maintained. The code was recently upgraded with a user-friendly input file builder and output file processor. Recent work includes high-fidelity modeling of a target chamber [3], the first investigation of gas transport in beam tubes [6], and a thorough analysis of gas control in the Robust Point Design target chamber and beam tubes [7]. A new beam line has been proposed and included in the RPD. A liquid vortex and magnetic shutters assure the cleanliness requirements of the final-focus region. Vortex flows help maintain a low background gas in the final-focus region and the magnetic shutters help prevent any debris ingress upstream of the neutralizing region.

Present work focuses on a thorough review of models in the TSUNAMI code for higher-fidelity simulations. The upcoming new version, currently under development and benchmarking, will be highly user-friendly and more versatile than the previous versions, while still providing tailored models to describe thick-liquid target chambers.

#### **2. Target Chamber Response Past the First Millisecond**

Past work focused on the disruption and recovery of the liquid pocket. The disruption of voided slab jets is now somewhat understood: The snowplow model has been experimentally verified. Recovery can be obtained in a timely fashion [5].

Current work includes upgrading the firing mechanism of the Vacuum Hydraulic EXperiment (VHEX) for higher fidelity simulations and scaled partial pocket disruption experiments. The VHEX used blank shotguns to simulate the IFE impulse. We have just started using high explosives for a better repeatability of the impulse delivered to the jets. New disruption experiments will use a scaled pocket that includes oscillating voided slab jets and an array of cylindrical jets. We aim at proving that the pocket and cylindrical jets can be restored and we want to characterize the breakup of jets into droplets. Some analysis of long term condensation and equilibrium density distribution in target chambers and beam tubes is being performed as well.

## Heat Exchanger

A new power conversion cycle has recently been identified and included in the Robust Point Design, which is now based on a multiple-reheat helium Brayton cycle. The helium Brayton cycle has a great advantage over a Rankine steam cycle in terms of efficiency and control of tritium inventory.

We are studying compact plate heat exchangers made of liquid silicon infiltrated (LSI) carbon-carbon composites for transferring heat from molten salts to helium. For fusion blankets of molten salt at 620°C, we can obtain thermodynamic efficiency in the range of 45% with this new Brayton cycle. LSI carbon-carbon composites provide a potentially very attractive construction material for high-temperature heat exchangers, piping, pumps, and vessels, due to their ability to maintain nearly full mechanical strength at high temperatures (up to 1400°C), the simplicity of their fabrication, their excellent compatibility with molten salts, and their low cost. The size and fluid volume in compact heat exchangers are significantly less than in conventional heat exchangers, which reduces the total size of the power conversion system and molten salt inventory, and therefore the capital cost.

More information can be obtained from the authors (debonnel@nuc.berkeley.edu; peterson@nuc.berkeley.edu.) or on our website (<http://www.nuc.berkeley.edu/thyd/thyd.html>.)

### References:

- [1] R.W. Moir et al., "HYLIFE-II: A Molten-Salt Inertial Fusion Energy Power Plant Design—Final Report," *Fusion Technology*, **25**, 5-25 (1994).
- [2] S.S. Yu et al., "An Updated Point Design for Heavy Ion Fusion," *Fusion Science and Technology*, **44**, Volume 2, 266-273 (2003).
- [3] C.S. Debonnel et al., "Control of the Heavy-Ion Beam Line Gas Pressure and Density in the HYLIFE Thick-Liquid Chamber," *Fusion Engineering and Design*, **63-64**, 647-652 (2002).
- [4] D.R. Olander et al., "Equilibrium Pressures Over BeF<sub>2</sub>/LiF (flibe) Molten Mixtures," *Fusion Science and Technology*, **41**, Volume 2, 141-150 (2002).
- [5] S.J. Pemberton et al., "Thick-Liquid Blanket Configuration and Response for the HIF Point Design," *Fusion Science and Technology*, **44**, Volume 2, 294-299 (2003).
- [6] C.S. Debonnel et al., "Gas Transport and Density Control in the HYLIFE Heavy-Ion Beam Lines," *Fusion Science and Technology*, **43**, Volume 3, 408-413 (2003).
- [7] C.S. Debonnel et al., "X-ray Ablation and Debris Venting for the Heavy-Ion Point Design," *Fusion Science and Technology*, **44**, Volume 2, 274-278 (2003).

## **INTERNATIONAL ACTIVITIES:**

**Summary Report on IFSA-2003 Conference**, William Hogan, Lawrence Livermore National Laboratory, Livermore, CA.

The Third International Conference on Inertial Fusion Sciences and Applications (IFSA2003) was held in Monterey, CA on September 7-12, 2003. The goal of IFSA2003 was to bring together scientists and engineers in the fields of inertial fusion sciences, high energy density physics, inertial fusion energy (IFE), and other related research and applications. By all measures, IFSA2003 was a resounding success.

IFSA2003 was hosted by the University of California, which was supported in organizing the conference by seven organizations: General Atomics, Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Naval Research Laboratory, Sandia National Laboratory, and the University of Rochester Laboratory for Laser Energetics.

IFSA2003 was the largest IFSA conference yet with 392 participants from 17 countries. The table shows a comparison of the three IFSA conferences held to date. IFSA1999 was in Bordeaux, France and IFSA2001 was in Kyoto, Japan. As can be seen, the host continent always has the largest number of participants but there is always significant participation from the other continents, which makes IFSA the international forum it was intended to be. One thing to note in the table is that there were many fewer participants from Russia and China. That is directly attributable to the new visa procedures installed last summer in the United States. The last two weeks before IFSA2003 a large number of Russians and Chinese had to cancel due to a failure to obtain a US Visa. The few who were able to come had open visas previously obtained. It was speculated at IFSA that there could soon be some reciprocation by Russia and China making it more difficult for US scientists and engineers to attend conferences in those countries. If any of you intend trips there, early application for a visa is advised.

IFSA2003 also saw a record number of papers. More than 440 abstracts were submitted and reviewed by an international Technical Program Committee. More than 150 oral and 280 poster presentations were done. There were papers on all areas of inertial fusion, both scientific and technology aspects. A large number of papers focused on the fast ignition concept and its progress in understanding the necessary target physics. All papers turned in at the conference are being peer reviewed and proceedings will be published by the American Nuclear Society in book and CD forms in about April 2004. All participants will receive the IFSA2003 proceedings that will be available for purchase at the ANS website after the publication date. For news on the progress toward publication you may visit the IFSA2003 website at: <http://www.llnl.gov/nif/ifsa03>.



<b>Country</b>	<b>Participants 2003</b>	<b>Participants 2001</b>	<b>Participants 1999</b>
Australia	2	2	1
Austria	0	1	1
Canada	0	2	2
Czech Rep.	2	3	1
France	41	32	132
Georgia	0	2	0
Germany	7	16	21
India	1	2	0
Israel	5	5	9
Italy	3	3	4
Iran	0	0	2
Japan	46	149	52
Korea	4	3	0
Nepal	0	1	0
P.R. China	0	13	2
Kuwait	1	0	0
Pakistan	0	0	1
Poland	1	0	2
Russia	5	24	14
Ukraine	2	0	0
Spain	10	3	8
UK	12	3	13
USA	250	63	55
Yugoslavia	0	1	0
<b>Total</b>	<b>392</b>	<b>328</b>	<b>320</b>

At the IFSA2003 banquet, the prestigious ANS/FED Edward Teller Medal was presented to Hideaki Takabe of ILE, Osaka University and Laurence Suter of LLNL. For the first time, each recipient received a check for \$1000 to accompany the plaque mounted silver medal bearing the likeness of Edward Teller. It was a particularly touching ceremony since Edward Teller had just passed away two days before the presentations were made. Also at the banquet ceremony, Bill Hogan announced the agreement to continue the IFSA conferences in the future by the three host organizations (Univ. California, Osaka University, and École Polytechnique). He also announced his retirement from being the IFSA Organizing Chair. He was presented with a plaque thanking him for his role in organizing IFSA and his eight years of service in the OC position. Finally, it was announced at the end of IFSA2003 that the next conference, IFSA2005, would be held in France and likely in September 2005. Watch the IFSA website cited above for a definitive announcement on IFSA2005.

Besides the technical program there was also an Exhibition at which 12 organizations displayed their wares and expertise in the area of inertial fusion. The exhibitors were Applied Integrated Management, Cleveland Crystals, General Atomics, Hamamatsu Photonics, Institute for Laser Engineering, Institute for Laser Technology/Fusion Energy Forum, LLNL, LANL, Nikon Instruments, Raytheon, SNL, and Yvon Jobin. In addition financial sponsorships were purchased by Raytheon, SNL, Spectra Physics, Yvon Jobin, and LLNL. Funds raised through these means helped the organizers keep the registration fees at a reasonable level.

Finally, almost 200 participants participated in the tours of the National Ignition Facility at LLNL and the heavy ion accelerator developments at LBNL. NIF had demonstrated “first light” just before the conference so there was much interest in seeing the facility.

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