

Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee

**March 12-13, 2015
Hilton North – Gaithersburg, MD**

**Thursday, March 12, 2015
8:30 AM**

Committee Members Present:

Mark Koepke (Chair) — West Virginia University
Amitava Bhattacharjee — Princeton Plasma Physics Laboratory
Troy Carter — University of California, Los Angeles
Bruce Cohen – Lawrence Livermore National Laboratory
Arati Dasgupta — Naval Research Laboratory
John E. Foster — University of Michigan, Ann Arbor
Charles Greenfield – General Atomics
Richard J. Groebner — General Atomics
Chris Hegna — University of Wisconsin, Madison
Valerie Izzo — University of California, San Diego
Christopher J. Keane — Washington State University
Jin-Soo Kim — FAR-TECH, Inc.
Gertrude Patello — Pacific Northwest National Laboratory
Juergen Rapp — Oak Ridge National Laboratory
Don Rej — Los Alamos National Laboratory
Robert Rosner — University of Chicago
Linda E. Sugiyama — Massachusetts Institute of Technology
Steven J. Zinkle — Oak Ridge National Laboratory, University of Tennessee
Ellen G. Zweibel — University of Wisconsin, Madison

Committee Members Absent:

George H. Neilson — Princeton Plasma Physics Laboratory

Ex-Officio Members Present:

Riccardo Betti – University of Rochester
Susana Reyes — Lawrence Livermore National Laboratory

Ex-Officio Member Absent:

John Steadman – University of South Alabama

DOE Personnel on the dais:

Patricia Dehmer – Acting Director, Office of Science
Edmund Synakowski – FES, Associate Director
Samuel Barish – FES, FESAC Manager

Other members of FES and of the fusion community were present.

Mark Koepke - Opening Remarks

Mark Koepke welcomed members and guests to Gaithersburg and bid farewell to members whose terms will end in June 2015. Dr. Koepke said that the primary agenda features a presentation/discussion of the COV Report. He added that anyone from the public wishing to speak during the public comment portions should contact Sam Barish. He gave a brief overview of the agenda and introduced Pat Dehmer before being informed that shortly before the meeting the order of the first two presentations had been switched.

Edmund Synakowski – FES Update on Strategic Planning

Ed Synakowski prefaced his remarks by explaining that he would typically discuss the budget in detail. However, he is going to use his time to discuss the status and outline the next steps for engaging the community for two reasons. First, he previously reviewed the budget during a conference call that included more than 100 participants. Second, strategic planning is high on everyone's mind. He added that a likely title of this talk could be "The Office of Science's Fusion Energy Sciences Program – a 10-year Perspective."

Ed Synakowski highlighted four primary thrusts of the FESAC 2014 report, as produced by the last planning activity:

- Control of Transient Events
- Plasma-Materials Interactions
- Predictive Capability
- Fusion Nuclear Sciences Subprogram and Facility

Dr. Synakowski said the Office of Science supports the four primary research thrusts of FESAC 2014, but with some qualifications. He added that we must "distill what has the strongest pedigree from the FESAC 2014 report." He proposed two qualifications to determining what is important. First, support from the community and, second, the Administration agrees about where we are going with high leverage ideas with the potential to get real traction.

Concerning the Administration's budget request, Dr. Synakowski said that we should pay attention to the large emphasis on exascale computing.

Dr. Synakowski noted that writing the section on accomplishments is always a great deal of fun because it is an opportunity to articulate the promise of the science that you conduct. He added, "I encourage you to offer us more suggestions of high level

achievements to include in the report because the policy makers and people just now getting an interest want to know how we got to this point.”

He wrapped up his talk by re-emphasizing the Administration’s interest in computing. Our essential principles are aligned with those of the Administration.

Questions/ Comments:

- *Dr. Zinkle:* Is there a longer vision or next step?
- *Dr. Synakowski:* The FES strategic plan that is in the concurrence process is a 10-year theme, but not beyond 10 years.
- *Dr. Rosner:* How will work on the FES strategic plan be coupled with work that the FESAC-NFA subcommittee is also developing in plasma science?
- *Dr. Koepke:* There is engagement and that will be covered later.
- *Dr. Groebner:* Is there dialogue with Congress, specifically about the FES strategic plan?
- *Dr. Synakowski:* Congress is aware of and pleased with what we are doing. Having community support for the plan is important.
- *Dr. Betti:* People rarely refer to burning plasma science as discovery science.
- *Dr. Synakowski:* We are entering into a new realm, and burning plasma science is a vehicle for discovery. However, burning plasma science needs to be framed within the realm of energy, full of opportunity.
- *Dr. Greenfield:* This is a roadmap that doesn’t tell people where we are going. Dr. Synakowski agreed, but offered that the intention is targeting fusion energy science that is relevant to the end of the century.
- *Dr. Dasgupta:* Discovery Plasma Science belongs to each and every one of us and should not be jeopardized.
- *Dr. Koepke:* A right-turn in FES strategy is not how I categorize FESAC 2014.
- *Dr. Synakowski:* The best thing we can do is to heal fractures in the community and speak with one voice.
- *Dr. Bhattacharjee:* Are there any plans for DIII-D now that NSTX-U is complete?
- *Dr. Synakowski* offered that it is reasonable to expect an upgrade to DIII-D, but there are no particular decisions, and any plans for DIII-D, including FESAC 2014’s recommendations for DIII-D upgrades, will be driven by the budget.

Pat Dehmer – DOE/SC Perspective and the FY 2016 President’s Budget Request for SC

Pat Dehmer began her talk by emphasizing the importance of understanding the priorities of the Office of Science (SC). She reviewed a few slides depicting specific budget numbers. This included a 5.3% increase in funding for the Office of Science. She noted that the increase is good when compared to other programs, but the challenge will be to hold onto that funding through the appropriations process. The largest increase was for

exascale research, with a goal of having an exascale computer by the early 2020s. She added that the Linear Coherent Light Source is another high priority.

Dr. Dehmer reviewed several reports dating back to the 1980s through FESAC 2014, and their effectiveness. She said there is no one size fits all for reports. However, they must be in a form that the Department can absorb and readily act upon. In addition, they must have community support.

She said that FES is competing against a lot of things in the Office of Science, including things that the Administration feels are very important for the world, including computing.

Questions/ Comments:

- *Dr. Bhattacharjee:* What facility can the community look forward to in the next decade? Is there any thought that if promising developments occur, then the FES program might be able to make a move? Can the office make a case to OMB and Congress that we need a certain facility?
- *Dr. Dehmer:* Things tend to happen over a five-year time span. Dramatic things can happen in a short time.
- *Dr. Rej:* The FESAC 2014 report commented on international collaborations. How should we balance US leadership with collaboration?
- *Dr. Dehmer:* Typically in the past ten years, sometimes the US says we have to have our own facilities (an example being light sources). But some facilities grow so large that there is only one project in the world (e.g., LHC). For the neutrino sector, the 2014 P5 report advised starting over with an international facility. That facility will be the first international mega-science project on US soil. Megaprojects need not and should not be sited only outside the US. HEP is struggling to make an international partnership within the US system. The US system, in general, is not well suited to accept these megaprojects. There is a trend to conduct cutting-edge science through mega-project facilities, and it is time for the US to step up in megaproject involvement.
- *Dr. Carter:* DOE has a great track record of user facilities. You showed a pie chart of where users are distributed. Our facilities are different from light sources, without a clear separation between operation and experimentation. Our facilities are more collaborative - more like NP and HEP. Users are important to SC. How does this color your view of FES facilities?
- *Dr. Dehmer:* 75 % of SC users go to ASCR and BES, and we are trying to include LHC users. The number of users is not an absolute metric, nor are the dollars spent.
- *Dr. Rosner:* I thought the guiding principle was to always have a future project in your back pocket. Is there any guidance to this community to have such a plan ready?
- *Dr. Dehmer:* Yes. Always be prepared with such ideas.
- *Dr. Betti:* Is there something else you'd like to see in order to grow FES? A wish list?

- *Dr. Dehmer:* What grew the other offices and worked for them? The BES heyday resulted from advice from its FACA and the NRC that characterization tools would become critical. That drove the light sources and SNS. BES managed to capture roll-off from construction. Predating that was consensus advice from the community about what was very important. So there was a unified community and timely reports; the appropriators could see the value. Take the BER office: They used to look at the effect of ionization on the human body. Then they recognized that biology is useful for energy. There was an impactful NAS study on bio-energy - cellulose fuel from plants. Three centers were formed, and the budget had a \$70M/year increase. NAS and FACA recommendations that uniformly supported compelling and doable investments are very important. Facilities are easier to support than research. It took us five years to get the basis for the EFRCs. What made the step function in progress are funding opportunity announcements that have wide support, and are affordable and timely, with Administration and DOE support.
- *Dr. Zweibel:* What are your observations about how communities become unified?
- *Dr. Dehmer:* They recognize that they have failed and then find another way to unify.
- *Keane:* How are you communicating the various elements of the FES program to the Hill?
- *Dr. Dehmer:* I say that it is troubled, but we are working on a strategic plan informed by FESAC 2014 and other activities which are to be determined. The report that comes out must be simple, easy to accept, and thoughtful.
- *Dr. Groebner:* FESAC 2014 follows on a series of workshops and meetings over the years. ReNew identified fusion materials and transients, but until 2012 we had not been asked to prioritize, and that was part of the strategic planning charge. That led to fractiousness. People were very concerned. At the first Snowmass, the community talked about understanding transport at a fundamental level and it seemed crazy, but now it has happened. Workshops will have much community input for how to do this, but some people see workshops as more of the same.
- *Dr. Dehmer:* If I were a reporter and asked you about the purpose of workshops and you said “more of the same” - that would be my lead.
- *Dr. Groebner:* They will produce something useful.
- *Dr. Dehmer:* They had better.
- *Dr. Groebner:* Guiding principles?
- *Dr. Dehmer:* How can we manage so that people won’t complain to reporters? You start with a premise.

Under Secretary for Science Franklin Orr – Perspectives on Science and Energy at DOE

I recognize Pat Dehmer's management style and have watched her in action over time. She is a tough taskmaster, but she has also represented us all very well. SC is widely regarded as one of the best-managed programs in DOE.

Secretary Moniz restructured DOE into three parts. He put science and energy back together (the way it was when he was the Under Secretary). It helps to create active links. Some things in the portfolio will have short time scales for payoff, while others will have longer time scales. We need to invest widely. We have bigger efforts: e.g., Energy Hubs. We have national laboratories. The laboratories put the grid modernization consortium together.

Concerning the FY16 budget request: SC is the largest Federal sponsor of basic research. It provides strong support for R&D and basic science. The proposed FES budget is a small increase over last year's request, but a decline from the FY15 appropriated budget. I am aware that concern is being expressed about this.

The time to see ourselves as global actors and acting accordingly is now. The scientific community is strongly behind getting to the science and engineering behind climate change. There is no shortage of primary energy sources. We need to convert the energy sources into services that are cleaner. We have a president who recognizes this need and gave us challenges – reducing greenhouse gases by using tools we already have, in addition to inventing new tools. Fusion is one of those tools.

Grid modernization is of high importance. The grid of the future will be sensor-laden and nested with micro grids. High performance computing will greatly aid this process. Some fusion energy will also be beneficial. The FY16 budget provides \$5.3 B for the Office of Science. That is a 5% increase and reflects the President's commitment to R&D.

Fusion is in a very competitive environment. It holds enormous promise. In a portfolio, you invest across a range of options, but there are different times for investing in some options. Policymakers seek alternatives having promise in the near-term. That is not to say we aren't investing in fusion energy.

The Department stands by its commitment to ITER, but is concerned about management. We met with the new Director General who will provide us with his management plans and baseline assessments this coming Summer. We will make hard decisions at that time because of the increased costs and time delays.

The budget period inevitably involves tradeoffs. This community (fusion) has been openly divided. This shows up in the press at times and is not helpful for attracting support – that is, support from appropriators.

Your workshops are encouraged because the fusion community speaking in a unified voice is greatly beneficial. The Administration is committed to a diverse portfolio that definitely includes fusion energy sciences.

Questions/ Comments:

- *Dr. Zinkle:* What is the importance and time scale of developing fusion energy as a viable energy source?
- *Dr. Orr:* It is less important to argue about something that is thirty years away, than to plot steps to get there. Research is what we are doing when we don't know where we are going.
- *Dr. Betti:* Groups who study energy for the future do not consider fusion, due to its long term and its uncertainties. Is there a key science result that would change their minds?
- *Dr. Orr:* Fusion is too far out, so you can't see the path to get there in the time frame for the current estimates. Looking a decade out is not very accurate. As for the question about whether a single scientific result would change things, I would say that getting close to a self-sustained reaction would be important.

Amitava Bhattacharjee – Committee of Visitors (COV) Report

Amitava Bhattacharjee, reporting on behalf of the committee, explained the April 8, 2014 charge from Pat Dehmer to Mark Koepke. Dr. Bhattacharjee described the process and the key points of the report. He added that there is not sufficient time to review the entire report, and it is still in draft form and likely to be changed. However, he invited comments.

The committee agreed by unanimous consent to reconvene for consideration of the COV Report during the Friday, March 13 session.

Questions/ Comments:

- *Dr. Zweibel:* There is nothing in the report about Early Career.
- *Dr. Bhattacharjee:* The Office of Science manages that program separately. However, Dr. James Van Dam (FES) presented to the COV a report about the program, and the awardees are doing very well.
- *Dr. Rapp:* Was ITER not part of the COV charge, and how was COI handled by the COV?
- *Dr. Bhattacharjee:* FES diligently advised us on COI, and we followed those guidelines.
- *Dr. Rapp:* Did you look at the subject of COI within peer reviews?
- *Dr. Bhattacharjee:* To our best determination, FES program managers are diligent in selecting reviewers and in weighting the reviews received, especially for closely ranked proposals. In every case that we followed up, we received detailed answers.
- *Dr. Keane:* I like the idea of separating the programs and projects. Question #1: Is there any effort to look at FES practices compared to those of other SC offices?

Question #2: Did the COV look at why NSTX's upgrade is an MIE project instead of a 403.3b project (NSTX's upgrade is only a \$94M project)?

- *Dr. Rej:* Civil construction is typically 403.3b, but an upgrade is an MIE. ITER was an MIE, but was moved to a line item. The difference is the budget sheet that has to go to Congress.
- *Dr. Keane:* Was there no project data sheet for NSTX's upgrade?
- *Mr. May:* There is no data sheet for NSTX's upgrade. ITER is a line asset, but not a capital asset.
- *Dr. Bhattacharjee:* PAMS is instituted across the Office of Science (SC) and we had a good presentation from the SC person in charge of PAMS. FES is making an effort on metrics, which is a newer effort in SC overall, so I give them a nod. Other offices will follow their lead.
- *Dr. Carter:* It is good to have an FOA regularly, but collaborators are supported in other ways. I think DIII-D does a great job facilitating users, even sacrificing on their side to help collaborations. But this project suffers from the same issues as FES's international program. The NSTX-U process for users has a way of documenting communication with the project leaders.
- *Dr. Bhattacharjee:* The NSTX-U process for users brought in new people and ideas.
- *Dr. Carter:* Could you clarify this in the document so it will not be misunderstood by outsiders?
- *Dr. Bhattacharjee:* Please suggest text modifications.
- *Dr. Patello:* Were proposers involved in the reviewing process, or just the reviewers themselves?
- *Dr. Bhattacharjee:* Reviewers.
- *Dr. Patello:* Are there any policy rules to implement across the office?
- *Dr. Bhattacharjee:* The DOE decision-making process is different from NSF and NASA.
- *Dr. Dasgupta:* How many FOAs?
- *Dr. Bhattacharjee:* There was only one.
- *Dr. Greenfield:* There are no targeted solicitations at DIII-D, but it still has a very large user community. Proposals go through peer review every three years, albeit not in response to an FOA. I suggest changing that language.
- *Dr. Greenfield:* You suggest that the lack of new participants is a problem. However, with flat funding, new participants must be offset by pushing others out. What is the proper balance?
- *Dr. Bhattacharjee:* You have to make some tough choices. If there are too many renewals and not enough new starts, new faculty members and young aspiring scientists will have no place.
- *Dr. Koepke:* Dr. Bhattacharjee will welcome E-mail messages from FESAC members about wording changes.
- *Dr. Barish:* What is not permitted is group communications among FESAC members. Individual communications to Dr. Bhattacharjee are acceptable.

- *Dr. Hegna:* My sense from reading the report is that it does not reflect the level of frustration with FES management processes. Should this be reflected in the report?
- *Dr. Bhattacharjee:* Delayed funding may not be within the scope of the report to be responsive to the charge. We report to Dr. Dehmer.
- *Dr. Koepke:* Send your comments.
- *Dr. Betti:* There are concerns about the process of closing C-Mod, but that also applies to NDCX-II. That facility was built and then cancelled, even though it keeps running. Should it have been built?
- *Dr. Bhattacharjee:* The Project Management group of the COV looked at that and did not raise any issues.
- *Dr. Rosner:* I chaired a panel for NSF and there was a panel report that ranked the proposals. We solicited input from the PIs and had a teleconference with each of them. Panel membership was public. Did the COV discuss the difference between the two ways of doing reviews?
- *Dr. Bhattacharjee:* I did not know about NSF reviews soliciting input from PIs, nor did the COV. We did ask the question, which came up in the context of holding a virtual panel and implementing it more broadly. FES said they cannot do this in the way you indicated.
- *Dr. Rosner:* In SC, panel members write reviews, then HQ collates, and HQ writes the panel response. Are the ground rules different from those of NSF?
- *Dr. Van Dam:* NNSA and NSF make their panel reviewers be temporary Special Government Employees, which allows them (just as with FESAC members) to do consensus ranking.
- *Dr. Zweibel:* There is a very low new-award rate.
- *Dr. Bhattacharjee:* One reason is that we require more and more specificity in technical proposals. Upcoming workshops may open up new directions.
- *Dr. Brian Nelson (member of the COV):* In the Theory section of the COV report, we included that statement about the low new-award rate. We got a spreadsheet from FES and looked at the entire new versus renewal statistics and found only 12% new versus 20% renewal within FES as a whole.
- *Dr. Synakowski:* My appropriate role is to listen here. In the absence of growing the funding, it is not easy to have more new awards.
- *Dr. Nelson:* We came to the exact same conclusion after scrutinizing it.
- *Dr. Synakowski:* Thanks to the COV for a professional and constructive attitude and all their work.

James Van Dam – A New Charge for a Report about Fusion Energy Sciences Contributions and Technology Discoveries Beyond Fusion Energy

James Van Dam addressed the new charge in response to a request by Congress. The timeline provided by Congress for delivery of a report is 180 days after the FY2015 appropriations bill (mid-June 2015). Dr. Van Dam provided nine examples of similar

reports dating back to 1984. He added that input would come from the subcommittee as well as from the entire FES community.

Questions/ Comments:

- *Dr. Rej:* This is where plasma physicists whose careers have migrated out of a fusion program can really get involved.
- *Dr. Groebner:* Do we have more insight about what Congress is looking for?
- *Dr. Synakowski:* Congressional staff said this report would help with fusion-funding challenges on the Hill. This could help us inform members of Congress about this non-fusion-related activity and could capture someone's attention.
- *Dr. Zweibel:* I suggest that previous workshops related to the NFA charge not be overlooked.
- *Dr. Foster:* What is the topical scope of the NFA charge?
- *Dr. Koepke:* Science and technology advances that can be linked to present and past fusion energy sciences investments.
- *Dr. Synakowski:* The scope is also explaining a plasma science "start." Areas of other advances in science are also fair game.
- *Dr. Greenfield:* We need to be careful not to misrepresent anything that is claimed to have come out of the fusion power program.
- *Dr. Zinkle:* This represents the full FES portfolio.
- *Dr. Koepke:* We will have more to say when the subcommittee draft is finalized.

Gene Nardella (FES) – Update on Community Engagement Workshops

Gene Nardella and a panel of workshop co-chairs and FES program managers briefly described a series of four community engagement workshops. Three of the workshops will have reports due by June/July 2015. The report on Plasma Science will be due in October 2015.

Integrated Simulation Workshop (Paul Bonoli)

Paul Bonoli commented that the Integrated Simulation Workshop panel members are all enthusiastic.

Questions/ Comments:

- *Dr. Hegna:* I hope that the Transients group will also deal with these topics.
- *Dr. Bonoli:* The charge letter mentioned these areas as specific applications. So we think it is good to hold those out as high level physics areas.
- *Dr. John Mandrekas (FES):* Community workshops in the recent past have been very informative.
- *Dr. Izzo:* Were only panel members at the last Integrated Simulation Workshop panel meeting?

- *Dr. Bonoli:* DOE wanted us to keep the cost of the workshop below \$100K so we could expedite approval for the workshop. Hence we had to limit the number of attendees.
- *Dr. Bonoli:* Dr. Greenfield suggested to broadcast the plenary talks by the panel chairs.
- *Dr. Rej:* Are panel leads and co-leads posted on BPO web site?
- *Dr. Bonoli:* Yes.

Plasma Science Frontiers Workshop (Jonathan Wurtele)

- The Town Meeting is tentatively scheduled for July 1-2, 2015.
- PSF Workshop #1 (identify physics frontiers and opportunities) is scheduled for the week of August 17 (2.0-2.5 days)
- PSF Workshop #2 (platforms and capabilities) is scheduled for the week of October 19 (2.0-2.5 days)
- PSF workshops will be organized by cross-cutting themes, but the Town Hall meeting will be organized by research areas.

Questions/ Comments:

- *Dr. Carter:* Will you ask for white papers for both opportunity and platform workshops, or separate?
- *Dr. Wurtele:* One white paper may be considered for both opportunity and platform workshops.

Plasma-Materials Interactions Workshop (Steve Zinkle)

- The workshop is scheduled for May 4-6, 2015 at PPPL.

Questions/ Comments:

- None

Transients Workshop

- The workshop mostly concerns Thrust 2 of ReNew.
- It includes a panel on disruptions (Dr. Greenfield, with co-lead Dylan Brennan), and a panel on ELMs (Raffi Nazikian, with co-lead John Canik).
- March 30-April 2 is the time during which the virtual workshop will gather community input.
- June 8-10 is the workshop at GA. The room holds 100 people, but the plenary sessions will be video broadcast. Holding it at GA brings down the cost. The panel members will stay an extra day for writing on June 11.

Questions/ Comments:

- *Dr. Rej:* I hope the other workshops follow your lead with your FAQs on your web page.

- *Dr. Bonoli:* We think those FAQs should be elevated higher on the website so you can see them for all the workshops.
- *Dr. Greenfield:* This depends on what the other workshops would like to do.
- *Dr. Foster:* Will you interact with the integrated simulation workshop?
- *Dr. Greenfield:* That workshop is the week before.
- *Dr. Rapp:* Will the effects of transients on materials be in the PMI section?
- *Dr. Greenfield:* We thought the main linkage would be pedestal issues, but recently realized the materials implications (for mitigating ELMs). Dr. Fenstermacher will address that, and we will work with Rajesh Maingi. This is also true for disruptions (asymmetrical radiation).
- *Dr. Patello:* Is there a schedule disconnect between plasma science and the other workshops because the latter are focused on a June 30 delivery date? Plasma science is expected in October.
- *Mr. Nardella:* Plasma science has not had a ReNew analysis, so it needs more time.

General Questions

- *Dr. Groebner:* FES will get a lot of reports, and what do you need to see distilled down?
- *Dr. Synakowski:* Clarity with respect to the needs, specificity with respect to approach to gaps, limitations of specific approaches, and relation to past activities. Please stay away from prioritization, and talk about needs as opposed to specific embodiments.
- *Dr. Rosner:* How does this community prepare some projects, if they do not fit a funding profile?
- *Dr. Synakowski:* The workshop activities are a valuable step in that regard, to be in a state of readiness.
- *Dr. Bonoli:* We could have scheduled an open town meeting for input, in lieu of white papers. But we thought we did not have enough time to do that. Depending on the number of white papers and how the panel views them, we might have a videoconference town meeting.
- *Dr. Sugiyama:* The workshops on whole-device modeling were highly contentious.
- *Dr. Bonoli:* I agree that they were contentious. To address that, I think that we have eminently reasonable panel chairs and that they will reach out and also present a balanced view.
- *Dr. Rosner:* That does not answer how this workshop is different from the other two.
- *Dr. Synakowski:* I don't know the specifics surrounding those two workshops, but let me emphasize that these community workshops are not linked to solicitations. Therefore, they provide real opportunities for discussion.

Mark Koepke – Public Comment

Michael Zarnstorff (PPPL)

- One comment about the four workshops: The importance of achieving community consensus. We learned this gruesomely in the late 1990s when we lost TPX, BPX, and ITER. We went through two Snowmass meetings to achieve it, plus preparatory workshops. It resulted in enough consensus that we were able to re-engage. In the NAS study at that time, it was said that consensus is absolutely essential. We need to spend time to do this. So important with the workshops is to have enough time to discuss what the issues are and how to address them. We have been here before.
- Strategic plan: Four workshops are great, but will take time. However, other high priority issues have also been identified such as high-performance steady-state operation.

Martin Greenwald (MIT)

- Planned workshops are a step in the direction of community input, but I am concerned about their charge.
- Mike Z. commented already that they are not comprehensive. Some broad questions like the relation to a massive program like ITER, energy versus science, and the role of universities in the ITER era.
- Another issue is the time frame. Is there time to write the reports? Congress suggested we use a process modeled after that of other communities. Those typically take much longer than one year and have a summer study, town halls, etc... So I am concerned that the workshops should go beyond what we have already done. We've already done a fine job of analyzing the issues. What is lacking has to do with technical options for addressing the issues. Having options in our back pocket is something that we should welcome. So give these activities more time to work.

David Maurer (Auburn)

- Let me comment on a vibrant university research program, speaking on behalf of the University Fusion Association, which represents fusion and plasma science at universities.
- After years of declining support, I wish to alert FESAC that university research programs are nearing a tipping point. The FY16 budget proposal narrative projects a 15% decrease in domestic research, a 15% decrease in sponsored postdocs, and a 27% decrease in graduate students.
- The head count of plasma researchers at universities is steadily declining, going back to 2010 - almost a factor-of-two reduction from FY2010 to FY2014.
- We ask FESAC to express strong support for university fusion and plasma science research as it advises DOE on FES research priorities and strategies.

Steve Dean (Fusion Power Associates)

- Dr. Dean commented about the community speaking with one voice. Dr. Dehmer made a point of saying that our community is fractured, and she referred to articles in Nature and Science. She said it is harmful to the program. Her

comments stem from the situation last fall after the FESAC 2014 planning report when articles appeared saying people disagreed. The charge letter from Dr. Dehmer required the panel to set priorities, which naturally led to tiers. Dr. Orr's comments indicate that she has fed this idea up to him, and that he also thinks the community is not unified. Shortly after last Fall's FESAC meeting, it was clear that FESAC could not unanimously support the report. Then Dr. Synakowski said that FESAC could not agree with the report recommendation about having FNSF anchor the ten-year period where it is heading. Also, there was criticism that the report was not exciting enough. The community has been struggling to scope out what we could do with an exciting facility. The panel rallied around the FNSF, even without a detailed design. Those things in the report did not sit well with the community. Dr. Dehmer should not have expected the community to be agreeable. Problems can be traced back to the charge, hemmed in in so many ways—budgets too tight, told to prioritize. FESAC was not given a charge to report what fusion really needs. The charge was not to look at the energy mission. I don't think the community is so fractured. The FY13 budget would have slashed the domestic program. The community spoke with a unified voice that this was wrong. ITER was promised to be funded, in addition to the domestic program. Every year since then, DOE has sent over budgets that cut the domestic program a little bit more. The community is unified to get the money back from Congress. So Congress hears the community. Ask us what can we do? Give us a charge to tell Congress what we can do. The community will be unified behind that charge to tell the opportunities. If we tell them how we live with a bad budget, we will never get a good budget.

Adjourn 5:20 PM

**Friday, March 13, 2015
8:30 AM**

Committee Members Present:

Mark Koepke (Chair) — West Virginia University
Amitava Bhattacharjee — Princeton Plasma Physics Laboratory (by televideo)
Troy Carter — University of California, Los Angeles
Bruce Cohen — Lawrence Livermore National Laboratory
Arati Dasgupta — Naval Research Laboratory
John E. Foster — University of Michigan, Ann Arbor
Charles Greenfield — General Atomics
Richard J. Groebner — General Atomics
Chris Hegna — University of Wisconsin, Madison
Valerie Izzo — University of California, San Diego

Christopher J. Keane — Washington State University
Jin-Soo Kim — FAR-TECH, Inc.
Gertrude Patello — Pacific Northwest National Laboratory
Juergen Rapp — Oak Ridge National Laboratory
Don Rej — Los Alamos National Laboratory
Robert Rosner — University of Chicago
Linda E. Sugiyama — Massachusetts Institute of Technology
Steven J. Zinkle — Univ. of Tennessee
Ellen G. Zweibel — University of Wisconsin, Madison

Committee Members Absent:

George H. Neilson — Princeton Plasma Physics Laboratory

Ex-Officio Members Present:

Riccardo Betti – University of Rochester
Susana Reyes — Lawrence Livermore National Laboratory

Ex-Officio Member Absent:

John Steadman – University of South Alabama

DOE Personnel on the dais:

Edmund Synakowski – FES, Associate Director
Samuel Barish – FES, FESAC Manager

Other members of FES and of the fusion community were present.

Amitava Bhattacharjee (remotely present by telephone) – Consideration for Approval of the COV Report

The report was approved by unanimous consent.

Sam Barish reminded the members to send comments directly to Mark Koepke, but not to the entire group.

Timothy Hallman – Frontiers, Challenges, and Opportunities for U.S. Nuclear Science

- NSF is a modest sponsor of nuclear science (about 10% of what SC-NP provides).
- RHIC performance in 2014 set new records. It illuminated more luminosity than the sum of all previous years. It is the highest performance machine in the world.
- The 12 GeV upgrade of CEBAF is 90% complete. The upgrade was re-baselined in 2013.
- FRIB will be a world-unique facility. It will increase the number of isotopes with known properties from 2,000 to over 5,000 and will keep nuclear science in the

US going forward for decades. Measuring one isotope after another is merely stamp collecting; we want to produce a consolidated understanding with predictive power.

- We will use krypton to date water in ancient aquifers underground. There is an article in the *New York Times* about the Nubian aquifer. Becoming a very important issue now is figuring out how old aquifers are, how they are replenished, and how long replenishment takes.
- The DOE isotope program used to reside in the Office of Nuclear Energy, but was transferred to the Office of Science/Nuclear Physics program office. This program does not compete with industry. It only works to produce isotopes and radioisotopes in short supply. NP conducts an annual meeting with many Federal agencies and institutes. The program is only \$20M but has a large impact.
- The medical field wants alpha emitting isotopes for cancer therapy because an isotope's effect in tissue is very localized. LANL recently found out how to use proton beams to produce large amounts of Actinium isotope.
- Isotopes are used for many applications.
- Today's nuclear physics program is not your father's nuclear physics program. Today, the program addresses evolution of the universe except for those aspects that are uniquely the purview of HEP.
- Every five to seven years, we develop a long-range plan. It takes 1.0-1.5 years. The plan identifies priorities by saying positive things about what they consider high priorities (and does not say negative things about low priority things). Everybody gets to have a say. The community weighs in through a series of town meetings, organized by the Division of Nuclear Physics of APS in partnership with NSAC. The long-range plan writing team has the biggest job. That will give us a roadmap (not a blueprint) for the coming years of challenges and opportunities. This involves sacrifice; over the years, a number of NP facilities have achieved their missions and have been phased out. (Opportunities passed over due to prioritization are not shown.)
- The next big thing in the quantum chromodynamics area is a possible electron-ion collider.

Questions/ Comments:

- *Dr. Carter:* Please speak to your coordination with NSF.
- *Dr. Hallman:* The budget levels don't matter. We consult and coordinate closely with NSF on MIE projects, solicitations, etc... We don't talk weekly, but we have a regularly scheduled oversight meeting. FRIB is being built on the foundation of a cyclotron facility, which is an NSF facility, so we work together and at some point there will be a handoff.
- *Dr. Rej:* There are many similarities with FES, which is the steward of basic plasma science. What is the role of NP's university programs that do not have large facilities?
- *Dr. Hallman:* Separate out theory, which is inexpensive. In the experimental arena, most experimental groups work on one or another U.S. national facility. These groups may also have lower level activity on an international facility—lower level

due to expensive travel costs, so these groups select facilities having unique capabilities well suited for the group's project. There is a third category - Texas A&M has its own cyclotron. It is not a national user facility, but exists for their own use and has significant regional participation. Another example is the Tri-University Group. These facilities allow direct hands-on use by students. RHIC is not available for hands on work. So these have value in that complementary way, beyond doing experiments.

- *Dr. Keane:* What is the plan for interacting with FAIR at GSI?
- *Dr. Hallman:* With respect to FAIR, we respond to proposals. However, there has not yet been a ground swell in the nuclear science community to go work there. At the moment, there is no particular plan other than receiving proposals. With respect to international collaborations in general, I have been observing CERN and Dubna, which have been effective in gathering resources from international partners. However, in the U.S., we allow foreign participation but fund and govern facilities ourselves. When we get to the scale of megaprojects, they are too big for a region to handle. We will have to consider another collaboration model more like CERN, where everyone contributes resources and has a seat at the table. HEP is exploring this with LBNE. We might do the same with the electron-ion collider.
- *Dr. Sugiyama:* This is a world-leading science program. Do you have any good metrics for measuring the U.S. program with respect to the rest of the world?
- *Dr. Hallman:* For our facilities, we project operation for a certain number of hours. Are you delivering run time? As for quality and impact of research, we recently did a two-year review. It started in 2013 with a comparative review (past work): we brought together all groups and had an international panel rank them in terms of competitiveness. Then, in the second year we had a competitive review of what people would like to do going forward. That is how we benchmark our science. Everyone with a blue dot on the chart was involved. We treated university and lab research on an equal footing.
- *Dr. Patello:* You also have a separate committee of NSAC for isotope-production planning.
- *Dr. Hallman:* The isotope program is managed differently from our fundamental nuclear science program. It has an appropriation, which maintains mission readiness and sells isotopes to the community at full cost. Therefore, it has revenues. NSAC-I is like a separate advisory committee. It is developing a 5-10 year plan for isotope production, which will be presented to NSAC at its next meeting in April.
- *Dr. Hegna:* You didn't say much about theory in NP. In fusion, we are being pushed to massive computation.
- *Dr. Hallman:* The NP community is pushing us in that direction. Computational power is becoming so significant that we can now simulate certain processes. There is now a consortium in the community that wants significant investment (\$10-20M) for this purpose.
- *Dr. Groebner:* You said that the community provides input through town meetings. How do they work?

- *Dr. Hallman:* Yes. Anyone with something to say has the opportunity to speak. The Division of Nuclear Physics finds intellectual leaders to organize the meetings. They are careful in the selection of the organizers so as not to have the town hall meetings be too narrow. They give 5-10 minutes to whoever wants to talk. Plus there are overview presentations by intellectual leaders.
- *Dr. Groebner:* Does the community have a chance to see the draft document?
- *Dr. Hallman:* The leaders of town meetings see it. Readers go through it to make sure it reads OK. But this is done fairly quickly. When submitted to NSAC for comments and approval, it becomes a public document, so anyone in the public can comment before NSAC approval.
- *Dr. Foster:* NP has a decadal study. How is that integrated into your strategic plan?
- *Dr. Hallman:* Yes, NAS does a study every decade. It stands alone. It is an important guidepost, but is not integrated into our formal planning process. The long-range plan group may use it and borrow text from it. Hopefully they are fairly well aligned.
- *Dr. Foster:* NASA is interested in Plutonium 238.
- *Dr. Hallman:* That is a responsibility of the Office of Nuclear Energy, due to the connection with NASA. They produce the isotope at HFIR. The Office of Nuclear Physics consults with the Office of Nuclear Energy about this project, and one result was the conclusion that four times less is needed to be produced.
- *Dr. Reyes:* You said that NP organizes these town meetings.
- *Dr. Hallman:* Yes. NP organizes these meetings, not APS.
- *Dr. Dasgupta:* Does NP collaborate with other programs such as the Matter in Extreme Conditions instrument?
- *Dr. Hallman:* A tidal flow of university PIs from Europe came to RHIC for work while they were building LHC. Japan even contributed \$70M. After five years, they moved back to Europe. It accelerated their research program when it started up in Europe. Another example is Daiebei in China. They got experiments done for 30 cents on the dollar.

Graeme Murdoch – ITER Project Process

Bernard Bigot recently became the ITER Director-General on March 5, 2015. He developed an action plan that was endorsed by the ITER Council. He expects a fully functional organization by December 2015.

Questions/ Comments:

- *Dr. Greenfield:* I'd like to compliment the USIPO. In December at the ITER Organization site, I saw a chart of deliveries posted by the door of the conference room and 16 of the 18 listed were from the U.S. Also, the poloidal field winding building is currently being used as a warehouse for U.S. deliveries. I hope we can maintain U.S. timeliness in deliveries.

- *Dr. Rej:* Ten years of good behavior. For diagnostics, PPPL subcontracts to businesses and laboratories. How is that being managed? For disruption mitigation, it is fixed price. Is the U.S. on the hook to make sure ITER will never experience a disruption?
- *Mr. Murdoch:* The USIPO will walk up to the fixed line and then have discussions for DMS. For diagnostics, Dave Johnson, the work breakdown structure (WBS) manager wanted to scale back to 60% of his time. Therefore, we replaced him with a mechanical engineer, Russ Feder. It is a different flavor from a WBS lead, but they are going into the design stage. This is difficult to manage and needs someone to do the yeoman's work of keeping track of everything, including EVMS. Dave, Russ, and I met and figured out a new organization structure, which seems to be working well. Diagnostics themselves are challenging, and it is hard to find vendors who can or want to build them.
- *Dr. Foster:* The fabrication instruments and oven are impressive. Are there any plans for this hardware afterwards?
- *Mr. Murdoch:* High Performance Magnetics is a startup company in Tallahassee. When they finish integrating the TF conductor, that company will go away. Some of the equipment is government furnished, so there will be an opportunity for others to use it. The vacuum tank belongs to DOE. Any equipment that belongs to DOE will be offered up to the community. There is not much we can do with the CS once we put it in the vacuum impregnation unit, because it is difficult to scrape off the resin. Therefore, it will be scrapped.

Further discussion

None

Adjourn 11:25 AM.

The video, Neutrino Wind, was viewed following the adjournment.

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