PPPL Research Council

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Richard E. Siemon
Nuclear Systems Program Office
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Dear Dick,

I understand from Paul Rutherford that FEAC-1 is seriously considering endorsing a small blanket testing facility to operate in parallel with ITER. I find this a very disturbing development, since I see such a machine as technically infeasible and politically suicidal. I am sending you my comments on this idea as a "concerned outsider." Please excuse the intensity of my remarks, but I do feel that this approach is very dangerous.

In my opinion, a small nuclear blanket testing machine, such as described by Ron Parker, should only be proposed if ITER, as it is presently conceived with both a physics and a nuclear technology mission, does not go forward. ITER's nuclear technology testing capability far exceeds what could be done in a machine of the type Ron has proposed. For example, for ITER the blanket testing community called for a *minimum* port size of 2-3m^2, and consequently ITER provides 5 ports of 3.74m^2, giving a total of 18.7m^2 of testing area. It is hard to imagine how an R = 2m machine with remote maintenance, auxiliary heating, and even minimal diagnostics could provide more than 3 or 4 ports of 1m^2 area each, thus failing both the single port area criterion and the total area requirement. Simple scaling with surface area from the CDA ITER would give a total testing area of 1.44m^2. John Sheffield sug-

gests that one could make the machine "easily" demountable, and use nearly the full surface area for testing. I don't see how this would realistically allow high availability, if this highly radioactive machine has to be almost fully dismantled for each new blanket test. The ORNL team on TPX seems to have come to the conclusion that the demountable coils and their services are too unweildy to be realistic. Furthermore, the requirement for a reactor-relevant *depth* of the testing volume is also important, and a deep test module is inconsistent with a compact machine.

The goal of Ron Parker's machine is to provide 0.5 MW/m^2 of neutron flux, with a fluence of 0.25 MW•yr/m^2. ITER's goal is to provide 1.34MW/m^2, and 1.53MW•yr/m^2. The blanket testing is planned to occur according to a complicated series/parallel schedule, which involves at some times even testing modules that break the ITER ports into four separate sections, and involves no single blanket module being tested for a large fraction of the full 1.53MW•yr/m^2. Consequently it can be argued that a very important measure of "testing capability" is testing area x fluence. For ITER this is 28.6 MW•yr. For the smaller device under discussion, the numbers above give a range of 0.36 – 1 MW•yr. I understand that FEAC-1 is leaning towards increasing the fluence requirement on the small blanket testing facility to the range of 1-3 MW•yr/m^2, and raising the flux requirement as well. This would, of course, help somewhat for the nuclear testing mission of this device, but probably not enough to make it significantly more valuable than the first phase of ITER. Moreover, let me point out a key feasibility issue here. **It is 6 times harder to get a given neutron flux at Q=1 than at ignition**. At ignition the surface power density of neutrons is 4x the thermal heat flux across the plasma surface. At Q=1 the neutron power density is 2/3 of the thermal heat flux. Thus if you want 1 MW/m^2 of neutron flux at Q=1 (1.25 MW/m^2 of total fusion power), you are providing 1.25 MW/m^2 of heating power. Coupled with the α loss power, this gives 1.5 MW/m^2 of total thermal heat flux, compared with about 0.3 MW/m^2 for the ignited ITER making slightly greater than 1MW/m^2, which is already an extreme challenge. When I discussed

in some detail with Rebut the idea that people in the U.S. were thinking about a Q~1 machine for blanket testing, he threw his hands up in disgust: "More promising what you cannot deliver. When will the fusion program ever learn?" **LET US NOT GO OUT ON A LIMB WITH A MACHINE WHICH DOES NOT EXIST IN ANY POSSIBLE FORM.**

Another important consideration is the probability that ITER will really abandon its testing mission. The Japanese review of the ITER CDA calls for maintaining the present flux and fluence goals, but I understand would accept the European idea of delaying installation of the driver blanket. The European review (and Dr. Rebut) would cut the fluence goal for a first phase by a factor of about 5, with a less well defined second phase. It is critical to recognize that this first phase would still exceed the capability of Parker's device by a factor of 8. In light of the positions being taken by the Parties, it seems to me extremely unlikely that ITER will abandon its nuclear testing mission, and so I believe that a proposal for a small blanket testing machine must be viewed in essence as a vote of "no confidence" in ITER, and thus should be avoided at all costs. The small machine under discussion would be doing its testing during 2005-2015, precisely at the same time as the ITER "first phase" proposed by the Europeans. We need to have some "peripheral vision" as we move forward towards SWG-1. Let us not have the EC and Japan thinking that we are lunatics. We need to have a vision of a realistic ITER, with a 14 MeV source for materials development. It is not in the cards to have 2 blanket-testing machines: ITER Phase II and also a small blanket test facility. We should take as a more realistic goal a "commitment" to the second phase of ITER, which takes the best then available blanket technology, and the best then available long-pulse / high availability tokamak capabilities, and plans for a full hot-blanket test, to the highest fluence possible, in preparation for DEMO. This should be a plenty strong driver for blanket technology development.

Let me get to my final point, which I think is also very important. We have already tried proposing a $1.5B machine which was meant to reduce the risk and speed up ITER's ability to get to technology testing. We were told that the U.S. was not willing to pay that much money for the specified purpose – Watkins was willing to take the risk. (He does, after all, have solar as a back-up to fusion.) The international community certainly will not support such an initiative, which undercuts their position on what ITER can provide for $5B. **If we come back to Watkins curing his $1.5B BPX problem with a $1.5B solution, he will think we are deaf, crazy, or malevolent. He may be correct on all counts.**

Sorry for the intensity of my diatribe, but I am sincerely concerned that we should not upset a delicate international process which seems to be moving towards a reasonable consensus, based on an (I believe) technically and fiscally impossible machine proposal.

Good luck with the balance of FEAC-1. Sorry to throw a hand-grenade at the last minute.

Sincerely,

Rob Goldston