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General Discussion to The approach to ignited plasma. A Discussion Meeting held at the Royal Society on 15 and 16 July 1998

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General discussion

K. Lackner (*Tokamak Physics Division, Garching, Germany*). What is the time-scale for fusion? Dr Sheffield spoke of a need for fusion in 2050, and from that date one can work backwards along the critical path, at the tasks in both physics and technology which need to be done. In magnetic fusion we are following this integrated approach. Inertial fusion is doing the exact opposite! It is advancing the physics, but not the power technology.

J. Sheffield (*Energy Technology Programs, Oak Ridge National Laboratory and the Joint Institute for Energy and the Environment, University of Tennessee, USA*). If you ask people outside our community, 'Do you believe fusion will work?', people are not sure. We have to demonstrate it more clearly than we have done so far.

M. Key (*LLNL, University of California, USA*). We have to acknowledge that there are major road-blocks in the present situation. Is the fusion community facing up to this, and finding an acceptable path forward?

R. J. Hawryluk. How are concept improvements at the DEMO level integrated? It is difficult to see how you could go from, for instance, a Wendelstein-7X straight to a DEMO.

D. C. Robinson (*UKAEA Fusion, Culham Science Centre, Abingdon, UK*). ITER will perform many generic technological tasks, such as first wall, breeder and divertor development that will make the integration of any other concept improvement at the DEMO level much easier.

R. Aymar (*ITER, La Jolla, USA*). It may look as if there is a conflict between focusing on one line, the tokamak, against another view that would explore several concept improvements on different machines. I do not think that there is any such conflict. ITER will not test just plasma physics. It is an engineering tool for solving the problems which will arise from any type of toroidal geometry we might use.

A. Kelly (*Quo-Tec Limited, Amersham, UK*). If fusion is ever to become of some practical use in a non-military context, then some formidable material problems will have to be solved, particularly those adumbrated by Professor Ehrlich. Problems of very high thermal loading are of great interest in other important industries. You have testing facilities and diagnostic facilities, which I know are of great interest. If I may give advice: do not hide these problems, for fear that fusion funding will be cut. Parade them a little more. You will find that you can be of help to others and they may turn out to be of help to you.

R. Aymar. I have two comments on a general strategy towards a fusion reactor.

1. Assuming a DEMO reactor should produce electric power with such a reliability/availability to be worth being linked to the grid, an integrated experiment, like ITER, prefiguring the requirements and achievements in physics, technology and safety, is obviously a necessary step.

Design studies of possible fusion reactors are certainly useful in providing some guidance and more to avoid dead-ends from basic principles. Nevertheless, their conclusions should be taken cautiously, when compared to next-step designs. Examples, limits in plasma performances to deduce cost of electricity, or modular approach to in-vessel components maintenance, etc.

2. Materials development towards resistance against increased 14 MeV neutron fluence is a necessity; a 'point source' should be available for tests to allow results for DEMO. The need for a 'volume' source, capable of testing components, rather than samples, is debatable. Its mere feasibility and availability, and even its role before DEMO operation, are largely questionable. Even DEMO components, which play no role in safety, should have their lifetime experimentally assessed precisely from DEMO operation. A less debatable need for a timely development towards a fusion reactor is the tritium availability, uniquely from Canadian Candu fission reactors. Its implication will require a limited time window for the fusion reactor development.

H. Bruhns (*European Commission, Brussels, Belgium*). It might be worthwhile recalling something which has not explicitly shown up in this discussion. A modular approach is also pursued in magnetic fusion, where possible; in Europe there are a number of medium-sized and small devices which pursue R&D on special aspects. There are the developments for neutral-beam injection and RF systems, and there is a vigorous technology programme. Through this, and international collaboration, we have had impressive progress in fusion and are now at a stage where these specific developments which have been tested, e.g. on JET, need to be incorporated in an integrated experiment that is able to give the information on the physics of a long-burning plasma. The ITER EDA has provided an excellent scientific and technological basis of such an experiment. It is this basis which allows us now to look for options which could be realized with a smaller budget, but which still can provide the step we need to go. We also work on concept improvements and understand them much better than earlier. There has been a tremendous improvement in the modelling capabilities, and I am now quite convinced that with information from an integrated experiment such as ITER it might be possible to go to a stellarator Demo if this appeared the best way to proceed further. The many technological elements developed for, and with, ITER are anyhow valid for other magnetic fusion concepts. To revisit on a general basis the more peripheral concepts which have been ruled out over past decades is not the way to go—the arguments for turning them down are still valid. I think we should look forwards, not backwards.

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