

**Short White Paper**  
**Operational Considerations for U.S. Scientists Collaborating on Experimental**  
**Magnetic Fusion Devices Abroad**

*December 2011*

Kenneth M. Young (PPPL-retired)

There are many opportunities for US people to collaborate abroad in excellent facilities to enhance the fusion program. For tokamaks, these opportunities include the preparations for and participation in ITER operation, potential high-power D-T operation in JET, long-pulse studies in the Asian superconducting tokamaks and potent plasma-wall interaction studies in devices like Tore-supra. Stellarators are represented by LHD and Wendelstein-X, the latter due to start operation soon. There are also facilities for testing the performance of different wall materials at very high powers. This outreach abroad should enable many US experts to participate in the best research now ongoing elsewhere.

Many successful collaborations have been completed on these devices, but these have been rather splintered, involving at most only a few people at a time or a specific joint experiment under the auspices of the ITPA. A coordinated collaboration must be set up to optimize the value of the work to individuals, the US Institutions for which they work, the overall US program and to the success of the fusion program. This short paper makes suggestions as to how to make collaborations work.

1) Collaborations should be undertaken on a basis of teamwork rather than on individual participation: These teams can be from one institution, from a few US institutions and also could include personnel from foreign-based institutions. The last type of collaboration will be particularly important during the run-up to operation of ITER. One expects that different aspects of ITER physics, the operation of particular diagnostics or heating systems, etc. will bring together groups with similar goals to bring up the ITER performance. But such teams can optimize any collaboration at a foreign device, since it ensures continuity of support for a particular study. Defining the leadership of individual teams will be a key part in arranging the collaboration.

2) Clear definition of problems of interest to all the parties involved in a collaboration: The priorities for different R&D in different countries and at different institutions are not the same. Hence one might expect that individual members of a team may need to work on areas slightly different from their

preference. A starting point, from the US point of view, might be to take the list of priority items prepared by the FNS-PA team under Chuck Kessel (restricted to technological R&D) for FESAC and negotiate from those to good compromises. But one must remember that the hosts will have made the big investment and will be biased strongly to their own program, often set down for many years' ahead. They are most likely to favor collaborations which promise expertise and hardware skills, and often financing, which will enhance their program or, possibly, advance their planned schedule.

3) Detailed understanding of the needs of the foreign collaborator:

a) Negotiation issues: In negotiation there must be clear understanding of the operational organization of the relevant device. For example, in the EU, such as for JET, the main financial role is provided by the participating institutions and negotiating must be done directly with one of them. In addition to participating scientists, it is very helpful to be able to provide important hardware and available support services such as technicians or computer analysis codes. Preferably the hardware should be of a specialist high-technology nature, since the work involved will benefit the home US institution. Realism in the budget and proposed schedule is as critical as for any work at the home institutions because of the need to match another device's schedule. Promises which cannot be fulfilled undermine any goodwill built up otherwise.

In the case of individual exchanges, the potential for exchanges back to the US, perhaps in different specializations (e.g. theory visits in exchange for an experimental participation) should be explored at the earliest point in the negotiation.

b) Scientific Issues: Experimental proposals must initially conform to the program currently in progress at the host institution; with extensive participation, influence on changing the experimental path can grow. The participation must be seen to be of long term and should include all team members, physicists, engineers and technical staff, spending long periods at the host institution. The visiting team must expect to take on operational support of the device in addition to its own special interest.

The leadership of the team chosen for the collaboration must have significant experience and have achieved recognition in their expertise. Post-docs, and even graduate students, should play key roles in the collaboration, together with engineering and technical staff. Senior scientists must be committed fully to manage their program, with significant amounts of time spent with junior personnel at a foreign site.

4) Management support of the US collaborating institutions: The management of the US institutions must inform the participating team scientists that their work is

critically important to the institution, at least as equally important as the programs current inside the institution. The best engineering in-house must be provided and schedules must be met for fabrication; expert physicists should be assigned despite apparent voids in their expertise in-house. Upper management must care as much (or more) about budget/schedule/quality performance of international projects as for the in-house work. The management must be prepared to direct staff to participate in these collaborations.

5) Incentives for the scientists/engineers: Collaborating internationally requires definite sacrifices by the participants in a team. Now, with most households having two wage-earners, long-stays abroad create significant challenges. For people with school-age children, there are other difficulties. Financial and travel benefits should be generous, with some flexibility for individual cases. It must also be made very clear that the status of the individuals at the US institutions will be properly recognized with appropriate advancement and salary awards.