

A world-wide collaboration based on ITER in Cadarache

The European community of fusion scientists has consistently pursued the aim of demonstrating the viability of fusion so that it will be available as a commercial source of electricity before the middle of this century. On this roadmap, the ITER experiment is the crucial step in the demonstration of the scientific and technological feasibility of fusion and should be constructed as soon as possible. We are convinced that the proposed European site for ITER, Cadarache in France, offers not only the best technical conditions for a rapid realisation of the project, but also optimum conditions for attracting high-level scientists and technologists during both the construction and exploitation phases. In the current international negotiations, in which Cadarache is competing with the Japanese site of Rokkasho-Mura, we also feel that every effort should be made to maintain the world-wide character of the ITER project, gathering together the efforts of all the international partners into a broader approach to fusion.

Why fusion energy? Fusion is a safe and clean energy source, which will be able to provide base-load electricity for highly populated regions. The raw materials required are available in abundance and widely distributed over the planet. Fusion is the subject of a concentrated research effort in many countries and attracts increasingly the attention of policy makers, the media and the general public.

Why ITER? Over the last decade, fusion research has reached a mature state with an increased understanding of the science of very hot, magnetized plasmas (the same reacting medium as in the sun and other stars) and - with the development of relevant technologies - can now embark on a full-size scientific demonstration of fusion power. The entire international fusion research community has emphasised that ITER has the optimum configuration and characteristics to make this demonstration.

The great progress made so far in fusion research is the fruit of a broad international collaboration over several decades involving the European Union, Japan, Russia and the United States, with China and South Korea having joined the effort at a later stage. In this respect, the European Union has been a leader in the field, benefiting since 1958 from Euratom, to which all member states (plus Switzerland) belong. As a result, Europe has a fully integrated programme involving experiments in many countries. The largest and most successful has been the joint European experiment JET which produced 16 MW of fusion power in 1997. (JET, as ITER, is a tokamak, a magnetic fusion configuration discovered in Russia.) The present ITER concept was developed between 1992 and 2001 by the EU, Japan, and Russia (and by the USA until 1998). The major features of the ITER design were developed in Europe and tested successfully on JET.

Where should ITER be sited? Recently, there has been growing interest worldwide to host the project or to participate in it. Canada, Japan, Spain and France have offered sites; in 2003 China, Korea and the USA joined the negotiations that were being conducted by the EU, Japan and Russia for the construction and exploitation of ITER. After an internal EU negotiating process, the European Union decided unanimously in November 2003 to select Cadarache near Aix en Provence as the European candidate site for the experiment and Spain for the European ITER headquarters. Today, the ITER Partners have to choose between two sites: the European site Cadarache in France and Rokkasho-Mura in Japan.

Why Cadarache? The largest European centre for energy research is situated in Cadarache. It contains more than 3500 experts in advanced science and technology, including more than 400 fusion researchers who work on the super-conducting fusion experiment, the tokamak Tore Supra. This scientific environment with its excellent technical infrastructure stands in sharp contrast to a remote, "green-field" site. The already existing fusion experiment Tore Supra in Cadarache was completed in time because of the logistics on site which were instrumental in assisting the project team. The success of JET has also been based on very similar considerations and great assistance from the neighbouring British fusion research complex. On the other hand, there are many examples of the difficulties encountered in completing a major R&D project on a "green-field" site. At Cadarache, the ITER organisation would be equipped from day one to operate under appropriate conditions and to welcome engineers and scientists from all over the world. At the same time, it would maintain fully its autonomy.

A few technical aspects of the European candidate site Cadarache merit attention, since these have been recently called into question. The transportation of heavy and/or large loads has been thoroughly investigated. The modifications of the roads and bridges required between the Fos harbour and Cadarache merely involve the adaptation of existing infrastructure with the exception of the enlargement of one road by-passing a tunnel (this is also required independently of ITER in order to improve the local traffic). The cost and schedule of road works have been studied in detail in the light of the successful experience of the transportation between Bordeaux and Toulouse of comparable loads for the assembly of the Airbus 380. Road transport in itself does not add any significant risk to the overall construction which includes, for any site, transfer of heavy loads and transportation by sea. This statement is supported by the comparison of the insurance fees for each part of the process.

Building on site the largest magnetic coils, which cannot be transported by road due to their size and fragility, is a clever choice that was actually made by the International Project Team. It also offers the possibility of better quality control, reduced construction time and a broader, more competitive tender. After coil fabrication, the building used for the construction of these coils will host the cryogenic plant, which should reduce costs. An industrial study for coil manufacturing in Cadarache is currently under way with excellent prospects of success.

The exhaustive historical records of the Cadarache region indicate a very moderate level of seismic activity. Moreover, the physical properties of the compact limestone bedrock are excellent. The seismic situation of Cadarache does not require stringent measures for the building, for the machine itself and, above all, for the protection of the staff and their families.

In our view, an insurmountable drawback for staffing ITER would be a location at a remote and inhospitable site. As scientists and Chairmen of the relevant committees of the European fusion programme, we are particularly mindful of the participation of our engineering and scientific staff. We feel that the international character of this very large project can only be guaranteed by building ITER in a region which has a long tradition of hosting international communities. In this respect the Provence region of France is ideal.

Fusion worldwide? For a long time, the European Union has followed a strategy oriented towards the ultimate goal of achieving a fusion reactor that generates electricity. On the European roadmap for fusion, physics and technology have been considered as enabling activities, not just as goals in themselves. In this spirit, the European Union, more than any other partner, has provided constant, substantial support to the ITER project since its inception. The remarkable support given by Japan should also be mentioned at this point, although in terms of financial and human resources it has taken place at a significantly lower level.

In contrast to Japan, Europe has therefore chosen not to devote resources to prepare another ambitious tokamak project which would be a complement to ITER. Here, "ambitious" means larger than JET but less expensive than ITER so that a single partner could still build it. The planned Japanese super-conducting tokamak, called NCT, would, however, offer the opportunity - parallel to ITER and with enhanced flexibility - to test many components or concepts and thus to contribute to a faster track to fusion power.

We feel that the ITER partners should now decide very quickly to locate ITER in Cadarache and that this decision should be accompanied by a commitment at the highest political level to elaborate and implement a broader approach to fusion energy, well balanced between the needs of the programme and the capabilities of the partners. The world programme could include, in addition to ITER, the technology programme required for a commercial reactor (e.g. a material testing facility) and the joint exploitation of "satellite" tokamak facilities. This coherent approach would be the best way of getting on as quickly as possible with one of the major and important world challenges in this century.

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