

The Importance of Fusion Energy Research

Fusion is the physical process, by which two light nuclei (typically isotopes of hydrogen) fuse and produce one heavier nucleus and at the same time release part of the energy trapped in the mass of the initial nuclei. This is the dominant energy-producing process in nature, as it provides the power radiated by all stars (for example, our sun). The artificial reproduction on earth of this process represents an important long-term option to the ever-increasing energy demand, in view also of the advantages it is associated with.

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The most significant advantages of thermonuclear fusion are:

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The raw material needed is practically inexhaustible and geographically wide-spread on earth. (Deuterium, the heavy isotope of hydrogen is available in all forms of water; Lithium, needed to generate tritium, the super-heavy isotope of hydrogen, constitutes a respectable percentage of the earth's crust.)

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The industrial waste (the "ash") of a power station would be hydrogen and helium; they are ideal, not only because they are non-toxic, non-pollutant etc, but also because they have a significant commercial value.

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No long-term radioactivity is foreseen and therefore the future generations will not be burdened with possibly undesired responsibilities: Tritium and neutrons, which are involved in the process, can be easily controlled and in addition their half-life is short, while the radioactivity imparted on the structural material can be also controlled.

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The process is inherently stable and therefore it is impossible that it runs out of control.

The only, so to say, disadvantage of controlled thermonuclear fusion is that it requires conditions not fully explored yet. This has required co-ordinated research and development in science and technology. The world leader is the European Fusion Programme, in which the fusion activities of the member states (and the Suisse Confederation) are co-ordinated through Contracts of Association with the European Commission and EFDA (the European Fusion Development Agreement), which has produced excellent results, including those from JET, the leading Tokamak device on earth. More progress is expected from ITER (presently under construction in Europe), which is a global undertaking with the European Union as the major partner. There is confidence, that the results from ITER will pave the way for the design and construction of DEMO, the demonstration reactor which will be the basis for the subsequent construction of commercial reactors.

Organisation of the Fusion Programme of the Hellenic Republic

The Association Euratom-Hellenic Republic was formally instituted, when the Association Contract ERB 5005 CT 99 0100 between Euratom and the Hellenic Republic was signed on 22 June 1999 and the Steering Committee and the Head of the Research Unit (J.

L. Vomvouridis) were appointed. In addition, an Administrative Committee has been established as the governing body for fusion activities in Greece and the responsibilities for administering the Contract of Association have been delegated to the Institute for Nuclear Technology and Radiation Protection of the National Centre for Scientific Research "Demokritos" (Director: A. Youtsos). Before the establishment of the Association, fusion activities were co-ordinated by the Consultative Committee for Fusion Activities in Greece (CCFA-G) and being funded by Euratom via cost-sharing contracts (since 1991).

Fusion Research in Greece and International Collaborations

The work programme of the Association includes activities in Physics and Underlying Technology. In addition, the Association undertakes Technology Tasks. These activities are conducted in collaboration with other partners to the Euratom Fusion Programme.

In particular, the present scientific and technical **Physics Programme** is performed in the following laboratories (with mention of Principal Investigators):

1. National Centre for Scientific Research “Demokritos”, Institute for Nuclear Technology and Radiation Protection, Athens (M. Tsalas),
2. National Technical University, School of Electrical and Computer Engineering, Athens (J. Vomvouridis and K. Hizanidis),
3. University of Athens, Department of Physics, Athens (I. Tigelis),
4. University of Ioannina, Department of Physics, Ioannina (G. Throumoulopoulos),
5. FORTH, Institute of Electronic Structure and Lasers, Heraklion (P. Lalousis),
6. University of Thessaly, Department of Mechanical and Industrial Engineering, Volos (N. Vlachos, D. Valougeorgis, and N. Pelekasis),
7. University of Thessaloniki, Department of Physics, Thessaloniki (L. Vlahos),
8. University of Thrace, Department of Environmental Engineering, Xanthi (E. Evangelidis),
9. Technical University of Crete, General Department, Chania (S. Moustazis).

The **Underlying Technology** and the **Technology Programme** is performed at:

National Centre for Scientific Research “Demokritos”, Institute for Nuclear Technology and Radiation Protection, Athens (S. Messoloras and K. Mergia).

In addition, a **Trans-national Research Team**, contributing both to the **Physics** and **Underlying Technology Programme**, is at the:

University of Cyprus, Department of Mechanical and Manufacturing Engineering, Nicosia (S. Kassinos).

Outline of the 2007 Annual Report

The Physics, Underlying Technology and Technology work of the period 01 January to 31 December 2007 has been performed according to the work programme approved by the

Steering Committee. It is presented, along with a brief outline of the corresponding background and objectives, in sections 1-3 (Physics), 4 (Underlying Technology) and 5 (Technology) of chapter B. For several of these activities, the work has reached a level of maturity, for which more extensive self-contained articles could be prepared, on the work completed in year 2007. These articles, 33 in all, are attached as Annexes to this Report, with appropriate reference made in the main body of the text.

Additional activities of the Association are presented in chapter C. They refer to the “Sixth School on Fusion Physics and Technology”, which took place in Volos (26 to 31 March 2007), to other fusion-related educational activities, to the expenditure, personnel, co-operations and mobility missions of the Association in year 2007, as well as to the publications that have appeared (or have been accepted) in year 2007.