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“ECH&CD AND THE EURATOM FUSION RESEARCH”

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Abstract

The present paper summarises the situation of the topic Electron Cyclotron Heating and Current Drive (ECH&CD) R&D activities within the frame of the coming EURATOM 7th Framework Programme (FP-7) presently under preparation, together with the status of the current discussion on Fusion Energy Research within that FP-7, in particular its objectives, main instruments and areas of activities.

Furthermore, the main features of the recently established advisory group ‘European ISTC & STCU Contact Expert Group on Fusion RTD’ (CEG-FUSION) for collaboration with the non-proliferation programmes ISTC (International Science and Technology Center) and STCU (Science and Technology Center in Ukraine) are also described.

1. Fusion research in the EURATOM 7th Framework Programme

The 7th Research Framework Programme is considered a pillar of the renewed EU Lisbon Strategy’s action programme concerning the leverage of knowledge and innovation for growth. The EC proposal of the 7th Research Framework Programme is presently being discussed and negotiated at the European Council and European Parliament. It consists of two programmes, (i) the 7th Framework Programme of the European Community for research, technological development and demonstration activities and (ii) the 7th Framework Programme of EURATOM for nuclear research and training activities (FP-7). The latter [1] encompasses the period 2007-2011 and covers two parts: Fusion Energy Research and Nuclear Fission and Radiation Protection. This proposal is

The overall objective of the Fusion Energy Research part is “to develop the knowledge base for, and to realise ITER as the major step towards, the creation of prototype reactors for power stations that are safe, sustainable, environmentally responsible, and economically viable”. The final budget for fusion research will also result from the present negotiations with European Council and European Parliament.

The main instruments for the implementation of fusion energy research are the European Legal Entity (ELE) as the EU Domestic Agency for ITER with envisaged contribution of the

European industry, the European Fusion Development Agreement (EFDA) and the Contracts of Association between EURATOM and European Associations.

The ELE is being created as Joint Undertaking according the EURATOM Treaty and will be responsible for the European ITER procurement and for the joint 'Broader Approach' activities agreed between EURATOM and Japan on (i) the establishment of a dedicated project team and implementation of the Engineering Validation and Engineering Design Activities (EVEDA) to prepare for the construction of the International Fusion Materials Irradiation Facility (IFMIF), and (ii) the DEMO design and related R&D.

EFDA will be oriented to provide the framework for the collective use of the Joint European Torus (JET), to co-ordinate physics and technology activities of the Associations, as well as common tools or facilities. The present twenty-three Contracts of Association between EURATOM and European Associations will be prolonged with revised technical scopes. Staff mobility, training actions and fellowships will continue to be a very successful element for the implementation of FP-7. The main activities of FP-7 on fusion energy research are classified in the following areas:

a) The realisation of ITER

The EU will have a special responsibility within the ITER Organisation as the host of the project and will assume a leading role in the joint realisation of ITER as an international research infrastructure, in particular regarding the site preparation, the support for the establishment of the ITER organisation, management and staffing. It will also include contributions to the construction of equipment and installations, development and testing of components and systems and the establishment of the referred European Legal Entity. Those R&D activities in support of ITER construction will be carried out in the fusion Associations and European industries.

b) R&D in preparation of ITER operation

A focused physics and technology programme will aim at consolidation of ITER project choices and preparation for the start-up of ITER operation. It will be executed through co-ordinated experimental, theoretical and modelling activities using the JET facilities and other devices in the Associations. It will include the assessment of specific key technologies for ITER operation through the completion and exploitation of the JET Enhancements (first wall, heating systems, diagnostics); and the exploration of ITER operating scenarios by means of targeted experiments on existing facilities, and co-ordinated modelling activities. A review will be carried out of the facilities in the programme, examining the possibility of phasing out some of them, and considering the need for new devices in parallel to ITER exploitation.

c) Technology activities in preparation of DEMO

Key technologies and materials required for the licensing, construction and operation of the DEMO power plant will be further developed in Associations and industry in order to test them in ITER and to position European industry to be able to construct and develop DEMO. It will include (i) the establishment of IFMIF-EVEDA to be used for testing materials of a fusion power station as essential pre-condition for the licensing of DEMO; and (ii) the development, irradiation testing and modelling of low activation and radiation resistant materials; development of key technologies required for fusion power plant operation; and conceptual design of DEMO including safety and environmental aspects.

d) R&D activities for the longer term

Building on the activities aimed specifically at ITER and DEMO, the fusion programme will develop competences and enlarge the knowledge base in fields strategically relevant to enhanced technical feasibility and economic viability of fusion power. It will include: (i) the completion of the W7-X stellarator; (ii) the utilisation of devices for expansion of the experimental databases; an experimental fusion physics programme to realise a comprehensive understanding of fusion plasmas aimed at the optimisation of power station design; (iii) theory and further modelling with the ultimate aim of a comprehensive understanding of reactor-grade fusion plasmas; and (iv) studies of the socio-economical aspects of fusion power generation and the promotion of public awareness of fusion.

e) Human resources, education and training

This area is aimed at ensuring adequate human resources and a high level of cooperation within the programme, both for the immediate and medium term needs of ITER. For the further development of fusion, will be addressed by: (i) support for the mobility of researchers between organisations participating in the programme, in order to promote enhanced collaboration and integration of the programme, and to foster international co-operation; (ii) high-level training for engineers and researchers at post-graduate and post-doctoral level, including the use of facilities in the programme as training platforms and dedicated seminars and workshops; and (iii) promotion of innovation and exchange of know-how with related universities, research institutes and industry.

2. R&D activities on ECH&CD within the EURATOM 7th Framework Programme

The R&D activities on ECH&CD are included in the FP-7 in particular within the aforesaid area on the realisation of ITER also aimed at achieving the ITER target design parameters in time for its construction. One of the main references in this concern is the last revision of the indicative “EFDA Work Plan 1999-2007” [2]. The main objectives related to ECH&CD address the development of the ITER ECRH upper launcher and steady state high power (up to 2 MW) gyrotrons with 170 GHz frequency, together with the associated long pulse, high power EC test stand at an Association (CRPP).

Moreover, according to the agreed ITER procurement allocation sharing, the party EU is involved in the following three ECH&CD packages. Up to now, various multilateral interactions have been taken place between EFDA and the mentioned Associations:

ITER packages	EU share	ITER components	Involved EU Associations
5.2P1B	88%	Upper launcher	FZK, CRPP, FOM
5.2P3	31%	RF power sources & control	CRPP, FZK
5.2P4	92%	Power supply	CRPP, ENEA, FOM

The aforesaid European Legal Entity (as European Joint Undertaking) will manage the ITER procurement of the party EU. The development of 2 MW gyrotrons has started through collaboration between Associations and industry, while the development of the critical components of the upper launcher for ITER will be pursued. A European consortium with stronger industrial involvement will be established, and the Associations are expected to act as the industry in liability terms.

3. Establishment of a “European ISTC & STCU Contact Expert Group on Fusion RTD” (CEG-FUSION).

There are presently various frames of co-operation in the field of fusion energy between European organisations and CIS (Commonwealth of Independent States) institutions:

- Ongoing specific bilateral co-operation between some European Fusion Associations and specific CIS institutions.
- Three specific EURATOM Co-operation Agreements on fusion energy, with Ukraine (1999), the Russian Federation (2001) and Kazakhstan (2002) addressing relevant S&T issues. However, there no specific EU budget is available for these co-operation agreements.
- European collaboration and partnership with CIS institutions through the ISTC and STCU non-proliferation programmes, which are oriented to provide CIS weapons scientists, particularly those with knowledge and skills related to weapons of mass destruction (WMD) and their delivery systems, with civil research opportunities to permanently redirect their talents to peaceful activities. The EU is one of the main financing parties of these programmes together with United States and Japan.

In order to exploit more efficiently that third possibility for fusion energy research, a ‘European ISTC & STCU Contact Expert Group on Fusion RTD (CEG-FUSION)’ has been established aimed at supporting the decision making process of the financing party EU on ISTC and STCU proposals or projects, e.g. covering both programmes, ISTC and STCU.

According to the adopted specific CEG-FUSION guidelines and in order to fulfil the goal of proper S&T support to the financing party EU, its main objectives are basically to guide the initiation and preparation of ISTC / STCU project proposals, to monitor on-going projects, and to review or assess final reports against specific project objectives. Furthermore, the CEG-FUSION can also make other recommendations to the financing party EU, which are oriented (i) to foster exchange of information between ISTC / STCU projects and other related projects in the same field, e.g. those undertaken as part of the EURATOM Fusion Programmes, in order to facilitate cross fertilisation among them, to support international co-operation and information dissemination; (ii) to identify potential new projects promoting proposals that would contribute to the aims of fusion RTD; and (iii) to promote possibilities of joint industrial applications of R&D results, as well as of further joint research in the frame of the ISTC / STCU Agreements.

The S&T scope of CEG-FUSION is focussed on the EU fusion policy implemented through specific activities of the Fusion Associations and supported by the EURATOM Fusion Programmes, so that policy-oriented assessment should be assured by the CEG-FUSION and relevant ISTC or STCU proposals might benefit from its advice. For this purpose, the expertise of the group is coming from institutions participating in the EURATOM Fusion Programme, i.e. mainly from Associations and EFDA. For any project to be funded by the EU financing party it is important to establish international collaboration at early stages of the proposal preparation between ISTC applicants and EU organisations working in relevant RTD areas, thus the existence of firm EU collaborators is a necessary condition to assess proposals by the EU as financing party.

The establishment of CEG-FUSION can represent a win-win situation aimed at activating and deepening contacts, creating new synergies and consolidating co-operation between Fusion Associations and CIS institutions working in fusion RTD issues. It is also expected

that this CEG-FUSION will facilitate the Fusion Associations to act as collaborators in ISTC & STCU proposals and projects, will also help CIS researchers to better integrate into the world scientific fusion energy community, and will improve co-ordination between CIS institutions and European actors in the fusion field.

Both programmes ISTC and STCU finance fusion energy related projects amongst a wide range of S&T fields, e.g. environmental health and safety, radioactive waste treatment, nuclear safety, immunology and vaccines, nanotechnologies, renewable energy production, high-energy physics, etc. It means that fusion energy projects are competing for financing with projects of other scientific areas.

It can be finally remarked as short descriptions, that the International Science and Technology Center (ISTC) [3] was established in 1992 as an intergovernmental organisation dedicated to the non-proliferation of weapons and technologies of mass destruction by agreement between the European Union, Japan, US and the Russian Federation. In later stages, Norway, South Korea and Canada joined ISTC as further donors. The beneficiary countries are the Russian Federation, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan and Tajikistan. In the other side, the Science and Technology Center in Ukraine (STCU) [3] was established in 1993 as another intergovernmental organisation dedicated to the prevention of the proliferation of expertise related to WMD by agreement among Canada, Sweden, Ukraine and US. In a later stage, the European Union took over the Swedish role, so that the present main financing parties are EU, US and Canada, being the beneficiary countries Ukraine, Georgia, Uzbekistan and Azerbaijan.

Conclusions

The EC proposed FP-7 on fusion energy research, presently under negotiation with European Council and European Parliament, with its three pillars (ELE, EFDA and Fusion Associations) will play a key role in the commitment of the EU as leading partner to build ITER. Within this frame, ECH&CD will continue to be supported in order to fulfil the specific EU share in the ITER procurement. The recent establishment of the advisory CEG-FUSION is expected to efficiently exploit the potentialities of the ISTC and STCU programmes for fusion energy research and to strengthen the collaboration with CIS institutions in the field of fusion energy.

References

- [1] COM(2005) 119 final – 6.4.2005 (EUR 21730 EN):
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- [2] EFDA (06) 30/4.4 issue 21 March 2006:
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- [3] “International Science and Technological Center” (ISTC) [www.istc.ru]
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