**Forschungszentrum Karlsruhe**
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**Wissenschaftliche Berichte**
FZKA 7383

# Nuclear Fusion Programme Annual Report of the Association Forschungszentrum Karlsruhe/EURATOM

## January 2007 – December 2007

**Programm Kernfusion**

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compiled by I. Pleli
Programm Kernfusion

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Forschungszentrum Karlsruhe GmbH
Postfach 3640, 76021 Karlsruhe

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## Introduction

The worldwide energy consumption is mainly covered by fossil energy sources. Their environmental impact, to a certain extent already visible, requires in the long term new ways of energy supply. In addition the worldwide energy demand will substantially increase in the course of this century in particular in populous countries such as China and India. Nuclear fusion offers an option of an environmental benign energy source with favourable safety features and almost unlimited fuel resources.

Nuclear fusion research is aiming to generate the physical and technical basis of a fusion power station which, similar to the sun, gains energy from the fusion of light atoms. In order to attain ignition of the plasma, the fuel, a mixture of deuterium/tritium (isotopes of hydrogen), must be confined by strong magnetic fields and heated up to more than 100 million degrees.

The construction of the experimental reactor ITER which will start in Cadarache/France in the framewok of a worldwide project by 2008 marks the next big step on the way to a fusion power station. For the first time a fusion power of 500 Mega Watt will be generated by a long burning plasma and applied technologies will undergo extended tests. The construction costs including personnel are about 5 billion EURO.

In the framework of the European Fusion Programme the Association FZK-EURATOM is developing key technologies in the areas of superconducting magnets, microwave heating systems (Electron-Cyclotron-Resonance-Heating, ECRH), the deuterium-tritium fuel cycle, He-cooled breeding blankets, a He-cooled divertor and structural materials as well as refractory metals for high heat flux applications including a major participation in the international IFMIF project. Furthermore investigations on plasma wall interactions and core and divertor modelling are carried out and a global plasma model is being developed.

The results from experimental activities such as the tests of high temperature superconducting current leads in the test facility TOSKA, the quasi-stationary gyrotron operation and the operation of fuel cycle subsystems and components with deuterium-tritium have already been utilised for the design work for ITER. In addition large progress has been made in the engineering design of test blanket modules for ITER.

With the construction of ITER new challenges have to be mastered by the EURATOM-Associations. While up to now concepts for components and systems have been developed and their functionality has been tested in laboratory scale or semi-technical scale, now plant components have to be constructed for fabrication and their integration into the plant has to be supported. In order to effectively deploy personal and financial resources consortia of European Association Laboratories are being formed which will bear the responsibility for the realisation of components and systems in accordance with the procurement packages of ITER. This concerns systems in the range of ten up to one hundred millions EURO which require the specific know-how of fusion laboratories. The Association FZK-EURATOM is going to lead a consortium for the construction of the European test blanket module (TBM) systems and a consortium for the construction of the upper port plug ECRH microwave launcher. The negotiations to form these consortia are near to be finalized. In addition the Association FZK-EURATOM is also involved in other consortia such as the fuel cycle and the development and procurement of gyrotrons providing microwaves of 170 GHz and 2 MW output power for ITER. Furthermore the already existing co-operation with industrial companies is being intensified.

The detailed design and construction of ITER components and subsystems needs to be supported by experiments such as prototype testing, validation of scale up factors and additional R&D. For this purpose a helium loop HELOKA is being constructed which not only serves for experimental investigations of the TBM, but also as a pilot loop in view of the loops to be installed in ITER for the cooling of test blanket modules.