AGREEMENT ON A COLLABORATIVE PROGRAMME TO DEVELOP A COLLECTIVE THOMSON SCATTERING DIAGNOSTIC SYSTEM FOR FAST IONS AND ALPHA PARTICLES

between

THE JOINT EUROPEAN TORUS (JET) JOINT UNDERTAKING

and

THE UNITED STATES DEPARTMENT OF ENERGY

Whereas an Agreement for Cooperation Between the European Atomic Energy Community (hereinafter referred to as "EURATOM") and the United States Department of Energy (hereinafter referred to as "DOE") on behalf of the United States Government in the Field of Controlled Thermonuclear Research (hereinafter referred to as the "DOE-EURATOM Fusion Agreement") was concluded on 15 December 1986 with the objective to help, maintain, and intensify cooperation and collaboration in magnetic fusion research and development,

Whereas the Council of the European Communities on 30 May 1978 established the Joint European Torus (JET) Joint Undertaking (hereinafter referred to as "JET"), whose aim is to construct, operate and exploit, as part of the EURATOM Fusion programme, a large torus facility of the tokamak type in order to extend the parameter range applicable to controlled thermonuclear fusion experiments up to conditions close to those needed in a thermonuclear reactor,

Whereas Article III, paragraph 2 of the DOE-EURATOM Fusion Agreement provides for arrangements to be made between DOE and JET,

Whereas a suitable high power (400 kW) gyrotron source has been developed by Varian Inc. with funding from DOE, which has been selected by JET for use in a planned collective Thomson scattering diagnostic,

Whereas the design and specification of the other subsystems for the collective Thomson scattering diagnostic, including the microwave transmission systems, antennas and detectors are at an advanced stage and contracts have been placed by JET for some items requiring development or with long delivery times,

Whereas the Massachusetts Institute of Technology (MIT) has scientific expertise in collective Thomson scattering and the Lawrence Livermore National Laboratory (LLNL) has engineering expertise in gyrotron power supply systems,

Whereas the development of this new diagnostic technique will be important for the fusion programs of both DOE and EURATOM and will have important applications for future experiments,

Whereas the data will be important to understand the confinement of alpha particles in plasmas in reactor-like conditions,

Whereas DOE and JET, each having capabilities which can assist each other in their efforts to advance the status of research and development of magnetic fusion energy as a potential energy source, desire to work together in a collaborative programme of mutual interest and benefit,

DOE and JET (hereinafter referred to as the "Participants") agree to a collaborative programme to develop a Diagnostic System for Fast Ions and Alpha Particles as detailed below.

Article 1
OBJECTIVES

1.1. The objective of this Collaborative Programme is to have DOE participate with JET in the development and validation of a diagnostic system based on collective Thomson scattering for diagnosing fast ions and alpha particles in JET.

Article 2
THE COLLABORATIVE PROGRAMME

2.1. The Fast Ion and Alpha Particle Diagnostic System will utilize the principles of collective Thomson scattering whereby, when light is scattered from a plasma under suitable conditions, the spectrum of the scattered light contains information about the plasma ions.

2.2. The Diagnostic System requires a high intensity light source in a region of the spectrum that satisfies the conditions for collective Thomson scattering and where background emission from the plasma is small. These conditions are met for JET plasma parameters in the microwave region of the spectrum at a frequency around 140 GHz.

2.3. The Collaborative Programme will consist of:

2.3.1 optimization of the design of the diagnostic system for JET;

2.3.2 installation and commissioning of the components of the diagnostic system including the necessary power supplies and control systems;

2.3.3 operation and interpretation of the experimental data resulting from the scattering diagnostic, initially in deuterium plasmas to study fast ion distributions and, at a later stage, in plasmas with tritium to study alpha particles; and

2.3.4 exploring the relationship between the experimental data and alpha particle physics, in order to determine the relevance of the data to the intended objective.

2.4. In support of this collaboration, DOE will:

2.4.1 loan appropriate gyrotron power supplies as detailed in the attached Annexes 1 and 2 to this Agreement. DOE intends to make these power supplies available for the duration of this Agreement;

2.4.2 designate MIT and LLNL to implement the design, modification, testing and shipment of the power supplies and associated control systems, as detailed in attached Annexes 1 and 2;

2.4.3 loan selected ancillary equipment, which will be detailed in future Annexes, if necessary;

2.4.4 give strong support to JET in its efforts to acquire a suitable U.S. high power, 140GHz gyrotron source on the time scale agreed for the initial phase of the collaboration; and

2.4.5 provide scientific personnel to participate in the design, installation, commissioning and operation of the diagnostic system and in the interpretation of the results, which constitutes a significant contribution to the development of this diagnostic system. DOE shall designate MIT as the principal participant in the scientific collaboration and LLNL as the lead in engineering of the gyrotron power supply system.

2.5. In support of this collaboration, JET will:

2.5.1 be responsible for the overall design, construction, installation, commissioning, operation and interpretation of results of the diagnostic system;

2.5.2 provide information to MIT and LLNL on JET interface standards and requirements necessary for the modification of the power supplies and associated control systems;

2.5.3 provide data to MIT which will allow modeling of the scattering experiment;

2.5.4 be responsible for specific costs within a limit of $300,000 involved in the modification and installation of the power supplies and related equipment at JET; and

2.5.5 be responsible for all costs associated with the packaging and shipping of equipment from the United States to JET and for the return of this equipment from JET to the United States.

2.6. Both Participants will:

2.6.1 promptly exchange all data needed for the design of equipment and evaluation of the performance of the diagnostic; and

2.6.2 encourage and assist the publication of results in appropriate scientific journals. Such publications will normally be in the form of joint reports with authorship by the individuals who contributed to the work reported therein. All publications resulting from work carried out under this agreement must receive written approval from both Participants. Publications are to contain the acknowledgement "This work has been performed under a collaborative agreement between the JET

Joint Undertaking and U.S. Department of Energy." Whenever results are incorporated in JET publications of a more general nature, the authorship shall follow the usual rules applied by JET and acknowledgement shall be made to the collaborative agreement.

Article 3
MANAGEMENT

3.1. Each Participant will appoint Programme Managers who will communicate annually (or more often if necessary) to review the progress of the activities, to determine if the objectives of this Agreement are being met, and to approve appropriate actions. The Programme Managers, or their representatives, will provide information pertaining to activities under this Agreement to the US-EC Coordinating Committee. In addition, the Programme Managers will be responsible for maintaining liaison between the individual staff who are involved in this collaboration and who will inform the Participants about the status of the collaboration.

3.2. DOE personnel on assignment from the U.S. to JET under this agreement will be invited to participate in all internal JET meetings concerned with planning the JET program insofar as these planning meetings are related to the Diagnostic System for Fast Ions and Alpha Particles.

Article 4
SCHEDULE

4.1. Under present planning assumptions, the first implementation of the diagnostic will be installed on JET during 1991. Subject to the prolongation of JET being approved, the diagnostic system would then be upgraded to its final implementation during 1992 when JET would be shut down for the installation of the new pumped divertor. Operation in deuterium plasmas would follow during 1993 and 1994 when the main emphasis would be on measurements of fast ion distributions in deuterium plasmas with high power heating. The diagnostic would finally be used to study confined alpha particles during 1995 and 1996 when it is planned that JET would operate in tritium.

Article 5
GENERAL PROVISIONS

5.1. Articles V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, and XVI of the DOE-EURATOM Fusion Agreement are hereby incorporated by reference.

5.2. This Agreement is not intended to diminish or duplicate any existing agreements between DOE and EURATOM or any multinational agreements to which DOE or EURATOM are parties.

Article 6
DURATION, AMENDMENT, AND TERMINATION

6.1. This Agreement will enter into force upon signature and will continue in force until 15 December 1996 or until the end of the JET project, whichever comes first.

6.2. The Agreement may be amended or extended by written agreement of both Participants as long as the DOE-EURATOM Fusion Agreement remains in force.

6.3. This Agreement may be terminated at any time at the discretion of either Participant upon one year advanced notification in writing by the Participant seeking to terminate the Agreement. Such termination will be without prejudice to the rights that may have accrued under this Agreement to either Participant up to the date of termination.

6.4. Either Participant will have the right to request revisions in the scope and terms of this Agreement in the event that the nature of either Participant's fusion programme should change substantially during the term of the Agreement.

Done in Duplicate at Washington, DC this 1st day of March 1991.

FOR THE UNITED STATES
DEPARTMENT OF ENERGY

(Signature)

N. Anne Davies
(Printed Name)

Acting Associate Director
for Fusion Energy
(Title)

FOR THE JET
JOINT UNDERTAKING

(Signature)

DR P H REBUT
(Printed Name)

Director
(Title)

ANNEX 1 to the "Agreement on a Collaborative Programme
to Develop a Collective Thomson Scattering Diagnostic System
for Fast Ions and Alpha Particles between
the Joint European Torus (JET) Joint Undertaking and
the United States Department of Energy"

Power Supplies Originally at
Massachusetts Institute of Technology (MIT)

A loan will be made of two power supplies originally located at MIT. The loan will be for the duration of the agreement. Upon termination of the agreement, the power supplies will be returned within 12 months, with the understanding that should the United States require the power supplies sooner, the one-year notice for this return may be implemented when needed.

A description of the power supplies to be loaned is as follows:

Item 1: NWL Transformer Corporation
Model # 30670 with SCR controller cabinet,
Serial # 84-0595-84-0596

Item 2: NWL Transformer Corporation
Model # 30670 with SCR controller cabinet,
Serial # 84-0593-84-0595

Each of these items consists of two cabinets. The transformer rectifier cabinet has dimensions of 82 x 68 x 69 inches and the SCR controller cabinet has dimensions of 54 x 28 x 74 inches.

ANNEX 2 to the "Agreement on a Collaborative Programme
to Develop a Collective Thomson Scattering Diagnostic System
for Fast Ions and Alpha Particles between
the Joint European Torus (JET) Joint Undertaking and
the United States Department of Energy"

Power Supply Task at
Lawrence Livermore National Laboratory (LLNL)

Using DOE equipment now at LLNL, LLNL will modify a gyrotron modulator/regulator unit for 80 kV, 40A output suitable for operating the 400 kW, 140 GHz gyrotron to be delivered to JET from Varian for the alpha scattering diagnostic. LLNL will also furnish the required capacitor bank and crowbar (minus the ignitrons), and controls that are the same as those developed at LLNL for a similar gyrotron power supply. The Hewlett Packard series 9000, Model 400t computer used in the controls, all other control parts, and CAMAC units will be supplied by JET. LLNL will furnish cables and other miscellaneous items. LLNL will modify a gyrotron tank and supply it to JET.

Included in this agreement are packing and crating of the Mod/Reg unit and one man-month of activity by LLNL personnel at JET for planning, installation, and power supply checkout, exclusive of travel and per diem costs.

These items (see list below) will be integrated, and made consistent, with the MIT power supply described in ANNEX 1. They will be loaned to JET for the duration of the agreement, and then returned within 12 months, with the understanding that should the United States require the power supplies sooner, the one-year notice for return of this equipment may be implemented when needed.

Equipment for JET

1. Mod/Reg, Universal Voltronics Corporation Model BAXS85-10,000 modified by LLNL for 80kV, 40A operation.

2. Capacitor Bank, with crowbar, LLNL design LEA83-2359.

3. CAMAC crates and modules
   - 1 @ Kinetic Systems 3472
   - 3 @ Kinetic Systems 3112
   - 1 @ Standard Engineering OD512
   - 2 @ DSP 5488, crate controllers
   - 1 set Timing generators, LLNL LEA89-1997-21, LEA89-1997-11, LEA90-1908-11

4. Software control system for the MOD/REG (LLNL) and former supply (MIT), based upon TACL.

5. Gyrotron socket tank Model AAA84-119139.

6. Necessary cables, bits, and pieces.