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ALT-II Progress Report and Proposal December, 1989-December, 1990

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Summary

The Advanced Limiter Test (ALT-II) is a joint international program among the United States, the Federal Republic of Germany, and Japan to investigate the performance of a toroidal belt pump limiter in a tokamak, to investigate the behavior of the plasma edge (including fluctuations), and to relate edge behavior to overall core energy and particle confinement. The experiments are carried out in the TEXTOR tokamak at KFA Jülich, Federal Republic of Germany. The ALT-II experiment was installed in TEXTOR in 1987 with the objectives of optimizing plasma performance in a limiter tokamak, and of studying the physics of particle removal, density and impurity control, and confinement enhancement by a toroidal belt pump limiter. The ALT-II program addresses large area limiter tokamak operation issues by providing a program specifically directed toward plasma optimization and particle and impurity control by a toroidal belt limiter in a machine dedicated to the investigation of plasma-wall interactions. TEXTOR features the most advanced set of edge plasma diagnostics of any tokamak for the task of diagnosing and understanding the impact of the limiter on the plasma confinement and performance. With the addition of 3.4 MW of neutral beam injection heating (NBI) to the existing 4 MW of ion cyclotron resonance heating (ICRH), TEXTOR also provides power densities equivalent to larger tokamaks.

The ALT-II toroidal belt pump limiter was installed in TEXTOR and commissioned in April, 1987. First plasma operation was achieved in May, 1987. The Phase "0" objectives of conditioning, testing of the limiter systems, and initial evaluation of the plasma performance with the belt limiter were successfully completed in August, 1987. The Phase I program plan was completed in March, 1988 and emphasized the optimization of the

plasma parameters during OH and ICRH auxiliary heating experiments, and included initial particle removal experiments on two of the eight pumping systems. The Phase II program began in September, 1988 following a TEXTOR operational pause to install two neutral beam injectors, and will last until the end of December, 1989. Phase II objectives include investigation of scrape-off layer (SOL) and particle exhaust physics during NBI; measurement of helium removal by the pump limiter; investigation of materials performance, impurity release, and power sharing capabilities of a toroidal belt limiter; evaluation of plasma confinement with ALT-II and high power auxiliary heating (ICRH and NBI); comparison of plasma performance between the inner bumper limiter and ALT-II; investigation of limiter biasing to enhance particle exhaust, affect power deposition, and improve plasma confinement; and achievement of enhanced confinement modes of operation.

This proposal is for the continuation of the ALT-II program at TEXTOR during the third year of the three year contract period starting in December, 1987 and ending in December, 1990. The U.S. contribution to the ALT-II experimental program is coordinated and directed by UCLA, which will continue to lead the program and staff the experiments at TEXTOR. The proposal encompasses direction of the ALT-II experiments in collaboration with the international partners, operation of the edge plasma diagnostics and data acquisition system associated with the belt limiter, interpretation and analysis of the data from the toroidal belt limiter experiments, and staffing of the experiments on site in the Federal Republic of Germany.

TEXTOR Status

TEXTOR is a medium size (R = 1.75 m; a = 0.44-0.50 m) tokamak dedicated to the investigation of plasma-wall interactions. As such, TEXTOR is equipped with the most

advanced set of edge plasma diagnostics of any tokamak for diagnosing and understanding the physics of plasma-wall interactions, the plasma edge and SOL, and pump limiter performance.

During Phase II, several modifications were made to TEXTOR and the ALT-II toroidal belt pump limiter system that enhance the experimental capabilities of the ALT-II program. The available ICRH power was increased to 4 MW. Two neutral beam injectors, one injecting parallel (co-) and one anti-parallel (counter-) to the plasma current and each capable of delivering up to 1.7 MW, provide up to 3.4 MW for comparative studies of ICRH and NBI auxiliary heating. Together, these systems enable the physics of plasma-wall interactions, the plasma edge and SOL, and pump limiter performance to be studied at high power densities. Core ion temperatures, impurity concentrations, and toroidal rotation can be monitored with the charge exchange recombination spectroscopy (CXRS) diagnostic added primarily for measuring the core helium concentration for the ALT-II helium removal experiments. The ion temperature measurements will be supplemented by a Rutherford scattering diagnostic. The addition of a large surface area graphite toroidal bumper limiter on the inner wall permits comparative study of power deposition, impurity release, and deuterium retention and release ("wall pumping") with ALT-II. This comparative study has been facilitated by the adaptation of a port for H_α, CCD camera, and IR camera observation of the bumper limiter.

Completion of the ALT-II pumping system in September, 1989 will permit particle exhaust, recycle and density control, and helium removal measurements to be completed. In Phase I, particle removal and exhaust experiments utilized only two of the eight pumping systems and results had to be extrapolated to a full pumping system. The helium removal measurements are also possible due to the installation of the CXRS diagnostic to measure helium concentration in the plasma core and periphery, and the installation of calibrated Penning gauges and an ion backscattering diagnostic in two ALT-II pumping ducts for

measuring the helium concentration in the ALT-II pumping system. The removal of liner to blade electrical connections permits limiter biasing experiments that investigate the enhancement of the pump limiter exhaust capability and may also provide novel means for influencing the core plasma confinement. The UCLA scanning probe is being modified to measure density and potential fluctuations and radial and poloidal electric fields in order to understand the effect of limiter biasing and the influence of these parameters on core plasma confinement.

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