DOE/ER/51069--T2

DE93 004139

PROGRESS REPORT - FY 1985

Advanced Limiter Test-II Program to Field a Toroidal Belt Pump Limiter in the TEXTOR Tokamak

U.S.	Europe	Japan
UCLA	KFA-Juelich	IPP-Nagoya
Sandia		
ORNL		

R. W. CONN, Principal Investigator
D. M. GOEBEL, CO-Principal Investigator

Mechanical, Aerospace and Nuclear Engineering Dept.
and
Center for Plasma Physics and Fusion Engineering
University of California, Los Angeles

Los Angeles, California

INTRODUCTION

The ALT-II Program in the U.S. is the responsibility of the UCLA group with participation from Sandia National Laboratories and the Oak Ridge National Laboratory. The ALT-II Project in the U.S. is led by Sandia National Labs-Alburquerque with participation from SNL-Livermore, UCLA and ORNL. The progress report from the project has been submitted by Sandia. UCLA has contributed quarterly program reports to each project quarterly report. This report summarizes progress during FY 1985 in the ALT-II Program.

1.0 PROGRAM PROGRESS SUMMARY - FIRST QUARTER

During the first quarter, the UCLA members of the ALT-II team worked primarily on the development of the experimental program plan and the diagnostics selection, and on the data acquisition system.

1.1 PROGRAM PLAN

The development of the experimental plan is required early in the ALT-II program to identify the design elements of the limiter structures for the experimental studies and to select the location and type of diagnostics prior to the completion of the engineering design of the pump limiter. This allows implementation of the diagnostics and any mechancial additions in the final design and before construction. An initial layout of the pumping requirements led to a meeting at UCLA with SNLL in November, 1984 to specify the gas handling requirements. It was decided to phase the installation of the entire pumping system over two years and to concentrate on particle removal at two pumping ports of the initial physics studies in the first year of operation. Gas handling systems based on the successful ALT-I gas injection and pumping system were presented by M. Malinowski of SNLL. In addition, the pumping speed requirements for hydrogen and helium were examined because of the cost impact of the original specifi-

cations. These questions led to renewed efforts at UCLA to apply the DEGAS code to model the specific ALT-II ducting design and pumping system. Results are expected in the next few months.

Preparation for the ALT-II Experimental Program Meeting at UCLA in January, 1985 began during the first quarter. The purpose of the January meeting was to bring together the ALT-II members from the various laboratories for discussion of the program plan. This will ensure that experimental studies desired by the different groups are discussed and included in the program plan, if approved. In addition to planning the meeting and contacting all the members, the program elements were identified in a preliminary plan to be presented at the meeting.

The diagnostics desired for the preliminary program plan were identified for presentation at the meeting. In addition to the standard TEXTOR plasma diagnostics, the diagnostics specific to the ALT-I pump limiter, such as probe arrays and H-alpha spectroscopy, for example, were listed. Measurements of helium concentrations in the tokamak core and edge, and total H-alpha emission for particle confinement time determination, were identified as necessary for ALT-II and singled out for special discussion at the January meeting.

1.2 DATA ACQUISITION SYSTEM

The preliminary cost estimate for an independent data acquisition system for ALT-II, intended to bypass the presently overloaded TEXTOR computer system, proved to be too expensive for the ALT-II budget to support. A reduced system designed by K. Andrews, of UCLA, which still includes a separate VAX for ALT-II data taking and analysis, cut the cost in half. However, this system still remained over budget. The implementation in the fall of 1984 of an additional VAX at TEXTOR made possible the coupling of the ALT-II system to the expanded TEXTOR computer. Software developed at ORNL and implemented at TEXTOR will result in rapid acquisition

and display of the ALT-II data. Mr. Andrews visited ORNL and KFA to discuss this system and a new satellite computer link with KFA Juelich. A new data acquisition system with a reasonable cost was recently designed and will be discussed at the January meeting.

The voltage isolation and data processing electronics for ALT-I Langmuir probes were designed and fabricated at UCLA. Because of the full toroidal extent of ALT-II, fiber optics between the diagnostic ports and the data loggers are being considered to eliminate high voltage and electrical noise problems. Two prototype circuits, one fiber-optic and one optically isolated, were designed, constructed and evaluated for ALT-II.

2.0 PROGRAM PROGRESS SUMMARY - SECOND QUARTER

The ALT-II Experimental Program Meeting was held at UCLA January 15-17. The purpose of this meeting was to bring together the ALT-II members from the various laboratories for discussion of the experimental program plan, diagnostics, pumping system, and data acquisition system. The development of the experimental plan early in the ALT-II schedule is required to identify the design elements of the limiter structures and vacuum system for the experimental physics and material studies and to select the location and type of diagnostics prior to the completion of the engineering design of the pump limiter. This allows implementation of the diagnostics and any mechanical additions in the final design and before construction. The three-day meeting was organized so the first day's presentations were from members on the status of TEXTOR and the engineering work on the blades and pumping system; the second and third days finished with working group meetings on the diagnostics and general discussion.

2.1 MEETING SUMMARY

The present status of the ALT-II engineering design of the blades and supports was presented by Dr. J. A. Koski of Sandia,

Albuquerque. Information on the impact of diagnostics on the blade design was requested and discussed in the task groups. This information was required for the ALT-II engineering design review held at KFA, Juelich in February. The vacuum system, pumps and gas injection system design were presented by Dr. M. Malinowski of Sandia, Livermore. The installation of the entire pumping system is to be phased over the first two years, primarily driven by cost considerations. Experiments in the first year of operation will concentrate on pumping and gas injection at two pumping ports for initial physics studies of the particle removal capabilities of ALT-II. Turbomolecular and solid getter pumps together will be used to remove both hydrogen and helium with adequate pumping speeds. Gas injection systems based on the successful ALT-I system will be used for fueling and impurity removal studies.

The TEXTOR status and present diagnostics were presented by Dr. K. Dippel and Dr. A. Pospieszczyk of KFA, Juelich. The TEXTOR edge diagnostics are of great interest for the ALT-II team with the spectroscopic and CCD camera imaging capabilities being closely integrated into the ALT-II program plan. The TEXTOR plasma core diagnostics are essential for the experimental items identified in the program plan.

The major program elements of helium removal experiments and particle balance and confinement time determination were discussed by Dr. D. Hillis, and Dr. T. Uckan of Oak Ridge National Laboratory. The helium removal experiments are complicated by the necessity of quantitative measurements of the helium concentration in the core, edge, and pumping chambers. The edge concentration can be determined from the thermal Li beam (now on TEXTOR) and active charge exchange enhanced spectroscopy (CEX). During the shot the amount of helium in the vacuum syscem will be measured by an RGA system similar to that presently being used on ALT-I. The core helium content measurement requires either fusion reaction byproduct detection or a diagnostic neutral beam for CEX. The TEXTOR plan to install a 30 keV Li beam may solve this problem if

the beam penetrates sufficiently into the core. An evaluation of this system for helium detection will be undertaken for the next meeting. A measurement of the total H-alpha radiation from the plasma gives information on the ionization rate and particle confinement time. The poloidal and toroidal asymmetries in TEXTOR dictate that many detectors may be necessary to provide reasonable accuracy. The ability to install these small detectors on TEXTOR will be investigated, and the level of effort required for this measurement will be evaluated in the next few months.

The data acquisition design was presented by Mr. K. Andrews of UCLA. The implementation of an additional VAX at TEXTOR with software developed at Oak Ridge will result in rapid acquisition and display of the ALT-II data. The data acquisition system based on this concept will include standard Camac Crates, data loggers, and serial highway drivers used at TEXTOR to insure that replacement parts and fast maintenance are available. Voltage isolation and data processing electronics similar to those used on ALT-I will be inserted in all electrical channels from the blades. Because of the full toroidal extent of ALT-II, these optical isolator/fiber optic systems are needed between the diagnostic ports and the data loggers to eliminate high voltage, ground loops, and electrical noise problems.

A discussion of the program elements and experimental plan was lead by Dr. D. Goebel of UCLA. The major experimental items to be investigated by ALT-II are:

1. Hydrogen Particle Removal
2. Helium Removal and Impurity Control
3. Heat Load Distribution on the Blades and Tiles
4. Materials Performance
5. Optimization of Tokamak Performance with ALT-II

The experimental program was divided into operation phases in which major foci were identified.

1. Initial Cleaning and Conditioning
   - Plasma Operation with an Axisymmetric Belt Limiter

2. Phase I - "Particle Removal at Two Ports"
   - Ohmic
   - ICRH Auxiliary Heating
   - Pellet Injection (if hardware is available)

3. Phase II - "Particle Removal at all Eight Ports"
   - Ohmic (Benchmark)
   - ICRH Auxiliary Heating
   - Pellet Fueling

4. Phase III - "Full Auxiliary Heating"
   - ICRH plus Beams

Issues which must be considered in designing experiments to address each element of the major items to be investigated were presented. Discussions during this talk centered on the diagnostic needs of each item. A strawman experimental plan and time line were presented, and based on discussions, these have been further developed since the meeting.

With the identification of the diagnostics required to investigate the program elements, the members broke up into four working groups organized by Professor Conn. These groups discussed the specific diagnostics, availability, port requirements, data acquisition needs, and action items needed to field the experiments. Diagnostic port access was identified as a major item to be pursued as soon as possible. Responsibility for actions to be taken and specific diagnostics were assigned.

2.2 PROGRAM GROUP PROGRESS

Since the meeting, the program plan has been further developed based on the discussions and assigned responsibilities organized at the meeting. Program members have continued the design work on specific diagnostics which were assigned to each. Resultant information will be presented at the next program meeting. The data acquisition system basic design has been completed, and purchasing the components needed for software and hardware development started. Diagnostics identified during the meeting were presented at the ALT-II Engineering Design Review meeting by Dr. Goebel. The implications of these diagnostics on the engineering design were discussed. Only the probes and thermocouples directly attached to the blade, and their electrical connections and feedthroughs, impact the engineering design. These diagnostics were identified for further interfacing between the project and program groups. Diagnostic port requirements were questioned at the meeting, but the exact requirements will not be specified until the next meeting and, therefore, were not discussed at length.

3.0 PROGRAM PROGRESS SUMMARY - THIRD QUARTER

3.1 PHASE II EURATOM PREFERENTIAL SUPPORT HEARINGS

An ad hoc review panel that was to report to the Program Comittee of the European Fusion Program on the application for Phase II approval of preferential support for the ALT-II Project met at the KFA, Juelich, April 28-30, 1985. This group, chaired by Dr. W. Lomer, recommended in favor of preferential funding for the ALT-II Project. A similar group, chaired by Dr. F. Engelmann, had met in September, 1984 to examine the Phase I application. That group also recommended in favor of preferential support for ALT-II.

The Phase I preferential support discussions concentrated on the physics basis of ALT-II, both in terms of pump limiter experiments per se and within the context of the overall TEXTOR program and capabilities. For the Phase II review, engineering and technology issues were emphasized. The Phase II Panel consisted of:

W. Lomer, Chairman (Culham)
M. Steinmetz (Garching)
H. Vernickel (Garching)
M. Tendler (Stockholm)
P. Stott (Culman)
A. Grosman (Fontenay-aux-Roses)
J. Rager (Commission of the European Communities, Brussels)
F. Hofmann (CRPP Lausanne)
M. Harrison (Culham)

In addition, all laboratories participating in ALT-II were represented.

3.2 ALT-II PROGRAM MEETING SUMMARY

The ALT-II experimental program meeting started with formal presentations by most of the U.S. members on the status of the specific diagnostics and systems that had been previously assigned to them at the last meeting. This brought the group up to date on the current status and any topics of special interest, and informed the Japanese participants about the plans developed over the past half year. Dr. Koski presented the engineering status and announced the next engineering meeting at Albuquerque, New Mexico, in July. Mr. Grotz and Drs. Goebel and Leung from UCLA will attend the meeting as representatives of the program group.

The general experimental program as outlined previously was presented by Dr. Geobel of UCLA. This plan included the present schedule of the experimental phases and the program emphasis during each phase. The status of the program group integration

was discussed, and the series of meetings (of which this was one), which are designed to provide an experimental team for ALT-II, were reviewed. All the group members seemed to agree that only by these meetings could an integrated effort be made on the ALT-II collabration, and that this "team" effort is necessary to complete the objectives of the program.

The vacuum system and gas injection system design was presented by Dr. Malinowski of SNLL, and appears to be near completion. The pressure measurement time constants, pumping speed calculations of the getter-turbomolecular pump combination, and gas injection rates were discussed. It was decided that the 50 msec time constants and 10 torr-l/sec injection rates of the designed system were adequate. The pumping speed of the system was reported to be about 4000 l/sec for hydrogen and 1000 l/sec for helium per duct. Estimates of the exhaust efficiency of ALT-II for the approximate pumping speed of the present vacuum system design were presented by Bob Schafer from UCLA. The initial results were from a combined Monte-Carlo and radially averaged 1-D fluid code applied to the ALT-II geometry. Final calculations will be completed in the next months.

The probes, thermocouples and IR camera were discussed by Drs. Goebel and Watkins of UCLA and SNLA, respectively. The discussions centered around the electrical connection techniques to be used in the 300^0C, ultra-high vacuum TEXTOR vessel. Special braided wires and bakable double-sided plugs will be used so that the blades can be independently removed for maintenance. The thermocouples that will be used will be discussed in detail with W. Kohlhaas of KFA at the engineering meeting.

The desire to monitor the neutralizer plate region radiation prompted an investigation by Dr. Finken of KFA of the visual access to this area by viewing ports. The complicated path from the blades into the pumping ducts and the port locations makes direct viewing impossible. Fiber optics appear to be unusable due

to the high temperatures in the vessel and liner regions. Further studies of the possible use of mirrors will be completed by the end of the summer. The H-alpha detector arrays were described by Dr. Uckan of ORNL. The port availability and prototype detector sensitivity will be studied by him in late September during a visit to TEXTOR.

Finally, the helium detection experiments in the plasma were described by Dr. Hillis from ORNL. This major research task of ALT-II requires measurements of the helium concentrations in the plasma, which are complicated by the lack of a suitable charge-exchange excitation diagnostic beam. The TEXTOR 30 keV Li beam will not penetrate to the core, and the heating neutral beam will not be installed until 1988. A search for an appropriate diagnostic neutral beam and the associated VUV spectrometer is underway.

3.2.1 Discussion Topics

A part of the meeting time was dedicated to discussions on the program plan, diagnostics, and integration of the Japanese group into the experimental team. Several of the Japanese visitors had spent some time thinking about the ALT-II experiments, and made presentations on their progress. Dr. Kadota investigated the applicability of the 30 keV Li beam system for helium detection in the core plasma. He concluded that significant penetration was not achieved by this beam to measure the core concentration, but that edge and scrape-off concentrations could be determined. Dr. Sato investigated the requirements on the pellet injector parameters for use in the TEXTOR plasma. It appeared that present technology and reasonable pellet sizes could be effectively used on TEXTOR. Additional information on the fueling physics is available if laser and spectroscopic diagnostics are included with the pellet injection experiments.

Techniques for helium detection in the pumping systems in the presence of deuterium and hydrogen were discussed in detail. Alternates to the standard RGA techniques were proposed. Dr. Finken is investigating excitation of the gas in the vacuum system and then spectroscopic determination of the mass ratios. An ion backscattering technique was also proposed for this purpose, and Dr. Akaishi will pursue this diagnostic.

The impact of carburization of the TEXTOR walls on the ALT-II experiments was discussed. The major fear was coating of the windows used for the optical diagnostics. Materials tests with the coating may not be useful, and this will be addressed in the next months.

3.2.2 Data Acquisition System

The data acquisition system was described by Mr. Andrews of UCLA. Significant progress on this system was achieved during the third quarter. Several of the CAMAC crate systems and highway drivers were purchased for testing with the vacuum system controls at SNLL and other diagnostics at UCLA. The ORNL software to control the acquisition system was implemented at the KFA and ORNL plus MIT software was investigated for use by the ALT-II system. The final system design was completed and the purchasing schedule determined.

A model computer link from the KFA VAX to UCLA, ORNL, and Japan was proposed during this quarter. This computer link will provide status information and data file access between the experiments at TEXTOR and the home institutions of the team members. From the ALT-I experience, this will greatly decrease the travel requirements by individual members because the data is readily accessible. The ALT-I procedure of carrying tapes of the data from Germany to the U.S. proved too cumbersome and inflexible, and actually required extra trips to be made to make tapes. The satellite computer link may decrease personnel requirements during

experiments, and will allow additional analysis and planning to be carried out by members at the home institutions. This will help relieve the extended travel time requirements of international collaborations that conflicts with the personal life of many people.

The ORNL and SNL institutions already have VAX computer facilities, and a VAX 780 will be obtained for the UCLA group. These facilities and the satellite link will be used for software development, to test diagnostics and data acquisition systems, and to aid in the data analysis.

TABLE I

ALT-II PROGRAM TASKS SUMMARY

Task/Diagnostics	Responsible Person
Pump system and gas injector design	M. Malinowski
He detection techniques in pumping chamber	
- Malinowski/Guthrie (RGA), Finken (spectroscopy)	Akaishi (IBS)
Gas removal physics and plans	M. Malinowsk
IR camera and view port selection	J. Watkins
Ports-IR and external probe	K. H. Dippel
Thermoscouple locations in blade	J. Watkins
Probe designs and locations	Goebel/Campbell
Electronics and HV isolation	Andrews/Geobel
Electrical connections, routes	Goebel/Watkins
Data acquisition system	Andrews/VerBerkmoes
H-alpha detection system	T. Uckan
Spectrometers (H, He, etc)	A. Pospieszczyk
H-alpha spectroscopy	K. H. Finken
Helium detection	Hillis/Kadota
Diagnostic neutral beam investigation	F. Hillis
Pellet injector	Sato
COD camera system interface	Pospieszczyk
Engineering interface	J. Koski
Program interface	Goebel/Mioduszewski
Materials evaluation, carburization	?
Conditioning procedure (interface)	?/winter
Core interface	?

4.0 OVERALL SUMMARY AND - FOURTH QUARTER PROGRESS

4.1 JAPANESE ALT-II DECISION

The Japanese Ministry of Education approved the participation of IPP-Nagoya University in the ALT-II Project. This makes the ALT-II effort a true multinational one involving Euratom, Japan and the U.S. The Japanese responsibilities in the project are being worked out by Sandia but it is expected they will be responsible for blade fabrication.

In the scientific program, Japan has identified Dr. Sato for pellet injection, Dr. Akaishi for helium measurements in the vacuum system, and Dr. Kadota for core helium diagnostic using a lithium beam. Professor Fujita visited IPP-Juelich in September, and we hope for further clarification in the first quarter of FY 1986.

4.2 U.S. - JAPAN PUMP LIMITER WORKSHOP ON PUMP LIMITER PHYSICS AND EXPERIMENTS

SUMMARY

A U.S.-Japan Workshop on the Physics and Experiments of Pump Limiters was held at UCLA on June 18-21, 1985. There were eight participants from Japan and twenty-one from the U.S. The purpose of the Workshop was to review recent experimental results, to identify the major issues in pump limiter physics, to establish how these issues would be addressed in the forthcoming pump limiter experiments, and to discuss present and future collaborations. Members of the Workshop gave prepared talks on selected topics and recent experimental results related to pump limiter operation and physics. The agenda for the Workshop with the presentation titles is attached to this summary. After the presentations, four working groups were established to summarize

findings of the Workshop in the areas of particle exhaust, power handling and materials, diagnostics, and core plasma improvement and future experiments. The summary viewgraphs of these groups are also attached.

Presentations at the Workshop were invited from researchers working on pump limiter experiments and related topics in the U.S. and Japan. The talks were organized to review results from the most recent pump limiter experiments. These included:

Advanced Limiter Test (ALT-I) on TEXTOR
Pump Limiter Modules on ISX-B
Rotatable Pump Limiter on PLT
Scoop Limiter on PDX

The design features and physics issues to be addressed were presented for these near term experiments:

ALT-II Toroidal Belt Pump Limiter on TEXTOR
JT-60 Pump Limiter
JIPP-T2 Pump Limiter
JFT-2M Pump Limiter
DIIID [illegible]
Heliotron-E Pump Limiters (with ORNL modules)

Related experiments on limiter power handling and divertor operation in Doublet-III at GA, pellet injection, helium removal, and heating issues with ICRF and limiters were presented by the Workshop participants.

The present modular pump limiter experiments listed above are providing data on particle exhaust capabilities and power handling. The global exhaust efficiencies in these experiments can exceed 15%, which is more than adequate for density control and future helium exhaust requirements. However, these modular experiments are normally the main limiters in the tokamak and must

handle a large fraction (up to half) of the total power in the machine. The finite size of the modules produces relatively long scrape-off lengths and high particle fluxes into the collection openings, enhancing the removal efficiency. The performance of a full toroidal belt pump limiter with a large area to handle the full power loading in the tokamak will be studied in ALT-II. Comprehensive modular pump limiter studies are now starting in Japan, which will contribute to the database in the next year. Active cooling of pump limiter geometries will be investigated in TORE-SUPRA starting in 1988, but was not discussed in detail at the Workshop.

The processes leading to efficient particle removal by pump limiters are not completely understood at this time. Exhaust efficiencies are observed to depend on the local plasma parameters and the design of the entrance collecting regions of the limiter. In general, long entrances (throats) which inhibit the backflow of gas from the neutralizer plates to the plasma (so called closed geometries) have a higher removal efficiency. The optimum design of this critical region is the subject of the present studies in ALT-I in TEXTOR and the PISCES experiments at UCLA. The preliminary studies on helium removal by pump limiters indicate that the removal rates are within a factor of two hydrogen removal rates. The reported experiments lacked a good measurement of helium concentration in the core and edge plasmas to quantify the removal efficiencies. These helium diagnostics will be included in the ALT-II experiments as a part of the helium removal physics studies.

The database on impurity control with limiters is completely inadequate. The identification of the impurity sources as the wall or the limiters is not comprehensive because of the mixing of materials in the tokamak. Studies at ORNL indicate that impurities that are recycled in the edge can be removed by pump limiters, but removal of core impurities was not demonstrated. Gas injection experiments suggest screening of the core by the

edge plasma in high density discharges. This screening supports the edge impurity removal results by pump limiters, but does not provide data about impurities produced at the face of the limiters.

The issues to be addressed in the forthcoming pump limiter experiments were discussed and summarized in the working groups. While the heat loads and particle fluxes are determined by the physics of the edge plasma, the actual dependence of the characteristic scrape-off lengths on the operating conditions and limiter configuration needs to be determined. Scaling of the scrape-off lengths for larger machines requires more studies of the edge plasma physics. How the fluxes to the limiter depend on the pump limiter operation, recycling, local radiations sources, and asymmetries in the edge must be investigated. The optimum design of this critical region is the subject of the present studies in ALT-I in TEXTOR and the PISCES experiments at UCLA. The preliminary studies cooling, and the preconditioning of limiter materials are important issues that should be addressed in forthcoming experiments.

The diagnostics for pump limiters are relatively well known and have been applied to many of the experiments. As the pulse length of the machines increases, however, there must be an greater emphasis on diagnostics that utilize beams and optical techniques. Standard probe diagnostics are very useful, but must be engineered for long pulse or continuous operation and better time resolution. Techniques to measure the plasma potential in the edge, the parallel and perpendicular flow velocities, the local particle confinement time, and helium mass fractions must be further developed. The diagnostic development program should include better and less costly high energy, high current beam probes and fast scanning probes. Finally, a comprehensive study of the impact of edge fluctuations on transport to the limiters in the edge plasma should be made.

While the modular pump limiter experiments have provided a sufficient database to evaluate the particle control capabilities for future experiments, the performance of full toroidal belt pump limiters has yet to be demonstrated. The effect of local plasma parameters in the throat regions on particle removal efficiency must be studied further in future experiments. Data on helium removal is largely qualitative, with information on helium transport and interactions in the edge needed. In addition, information on the improvement of plasma performance with pump limiters is incomplete. Future experiments should address how to achieve high confinement and beta, and provide data on how and why pump limiters behave differently than standard limiters.

Specific recommendations to address these issues were made for some of the near term experiments. In TEXTOR, higher heating powers are needed, and ALT-I and ALT-II performance should be comprehensively compared with the standard limiters. The DIIID pump limiters should be designed with a more closed geometry for higher exhaust efficiency, and pumping capability is needed. The PLT experiments should utilize higher heating power by ICRH, and pump limiters in TEXT should investigate removal with an ergodic edge which takes advantage of the island formation. Finally, the laboratory pump limiter simulations in PISCES should investigate adjustable throat geometries at higher densities and temperatures.

The development of pump limiters is at an early stage compared to standard limiters and divertors. Pump limiter experiments have been completed on ISX-B and PDX. There are ongoing pump limiter experiments on PLT, TEXTOR, TFR, JIPP-T2, and JFT-2M. There will be new pump limiter experiments on DIIID, JT-60, Heliotron E, and TEXT within the next year. In the near future, there will be pump limiters on TEXTOR (ALT-II, a full toroidal belt), JT-60 (a large area pump limiter), TORE-SUPRA (with an ergodic magnetic limiter), TFTR, PBX-UG, ATF (a stellarator), and CCT (a continuous tokamak). Some of these experiments such as ALT-II and TORE-SUPRA are being carried out for the development of the pump limiter concept, while

others are being used as tools to enhance plasma performance. It is expected that these programs will provide the information in the next few years to complete the database on the capabilities of pump limiters.

Japanese Participants

A. Miyahara	IPP, Nagoya University
K. Akaishi	Nagoya University
K. Kadota	IPP, Nagoya University
K. Matsura	IPP, Nagoya University
Y. Ogawa	IPP, Nagoya University
M. Shimada	JAERI
Y. Sakamoto	RIKEN
K. Sato	IPP, Nagoya University

U.S.-JAPAN WORKSHOP ON PUMP LIMITER PHYSICS AND EXPERIMENTS

U.S Participants

R. Budny	PPPL
G. Campbell	UCLA
R. Conn	UCLA
R. Fonck	PPPL
C. Foster	ORNL
D. Goebel	UCLA
S. Grotz	UCLA
D. Hillis	ORNL
J. Koshi	SNLA
P. Lee	GA
W. Leung	UCLA
B. Lipschultz	MIT
A. Mahdavi	GA
M. Malinowski	SNLL
P. Mioduszewski	ORNL
E. Oktay	DOE
A. Pontau	SNLL
T. Petrie	GA
T. Taylor	GA
T. Uckan	ORNL
J. Watkins	SNLA

4.3 GENERAL PROGRAM PROGRESS

Professor Conn visited IPP-Nagoya in July, 1985 for discussions and coordination on ALT-II. He confirmed the participation of the people listed in section 4.1, presented a seminar on ALT-I results, and had extensive discussions on diagnostics and experimental planning for ALT-II.

Dr. Goebel visited Juelich during May, 1985 for the Phase II ALT-II preferential funding review and then travelled to Cadarache and participated in U.S. - French discussions regarding cooperation with TORE-SUPRA.

Progress on the design of diagnostics continued. Drs. Hillis, Mioduszewski and Uckan from Oak Ridge visited for four weeks of UCLA during the quarter. Dr. Uckan continued work on design and plans for H_2 measurements and visited IPP-Juelich for further discussions in September, 1985. Dr. Hillis helped develop the plan for core Helium diagnostics using a 30 keV Li beam and made plans for his visit to Japan in October, 1985. During this visit, he will coordinate with Dr. Kadota of IPP-Nagoya. Drs. Goebel and Leung, and Mr. Grotz attended the ALT-II project workshop at Sandia-Albuquerque in July to provide program input to the project. Dr. Conn also met with the Sandia group.

4.4 DATA ACQUISITION SYSTEM

Progress continued on the planned course for data acquisition during the quarter and Mr. Andrews will work further with IPP-Juelich during his visit in October. The major decision to provide UCLA with a VAX 11/780 was made, and delivery is expected about January, 1986. This will allow us to implement a model link from the KFA-Juelich VAX to UCLA, ORNL (and Japan, if they desire it). The computer link will provide status information and data file access between the experiments at TEXTOR and the home institutions. We expect the link to help us control personnel

requirements during experiments and allow analysis, planning, and theory/interpretation to go on steadily, without trips to Germany, at each home institution.

4.5 Summary

During the year, specific accomplishments included:

1. Identification of Physics Issues
2. Outline Program Plan to Address Issues
3. Diagnostics Selected with Priorities
4. Computer/Data Acquisition System Designed
5. Data Acquisition System Purchased
6. SNL-L Data Acquisition Needs Organized;
7. Designed and built prototype optical isolation system for High Voltage Data Isolation on ALT-II
8. Finalized location of Diagnostics on Blade
9. Selected tasks by person and group for each diagnostic
10. Designed Langmuir Probes and Fabricated Prototypes
11. Designed electrical system, wiring and vacuum interfaces
12. Held two Program Meetings (Semi-Annual), in January, 1985, and the other in June, 1985.

In addition, program personnel worked regularly with the project on design issues, worked with all other groups, travelled for meetings to both Germany and Japan, and contributed to the development of the pump limiter program on TORE-SUPRA.

END

DATE FILMED

12/29/92