

Seventh International Workshop on Stellarators

The Seventh International Workshop on Stellarators will be held in Oak Ridge, Tennessee, April 10–14, 1989. A detailed announcement can be obtained from the Editor.

The IAEA has agreed to publish the papers from this meeting. To facilitate this, participants who wish to have their papers appear in the *Proceedings*, must bring camera-ready copy for their papers. There will be a strict limit of four pages for each contribution. A one-page abstract of each presentation is also due by March 6, 1989, so that a book of abstracts may be prepared for all of the Workshop participants. Please send the abstracts to James A. Rome, the Workshop Secretary.



Around the Labs

Progress on Wendelstein VII-AS

Experiments in Wendelstein VII-AS were continued at $B = 1.25$ T during November and December 1988 under improved conditions. These improvements were in a number of areas :

- The operational conditions of the experiment were enlarged by full exploitation of the variation of ϵ by the external field.
- Nearly stationary plasma conditions could be attained with one to three gyrotrons used for plasma production and heating in helium and deuterium, up to pulse lengths of 0.5 s.
- First and tentative experiments started with one neutral beam in an ECRH-produced helium plasma. Increasing the stored plasma energy by increasing the density to near cut-off was associated with a simultaneous drop in the electron temperature.

Recently, even at the low magnetic field used in the present experiments, deuterium plasmas could be maintained by neutral beam injection alone after switching off the gyrotrons.

- The diagnostics and data evaluation were improved. Thomson scattering profiles for density and electron temperature are available, radial electron temperatures agree well with those obtained by electron cyclotron emission, central ion temperatures are obtained by a five-channel system, and soft x-ray diagnostics and bolometric measurements yield radial profiles versus time. These data supplement the global signals from loop voltage, line density, H_{α} measurement, and diamagnetic loop.

An essential requirement for stationary plasma conditions in Wendelstein VII-AS is the control of the plasma current. Without such control the usually small currents (typically of the order of 1 to 3 kA and increasing with the stored energy) tend to drive the discharge to rational values of the rotational transform at the edge. When ϵ_{edge} attains a low order rational number, low values of the stored plasma energy, typically about 1/2 or less of the optimum values attained, result. With plasma currents kept at low values by an external loop voltage, optimum plasma conditions, so far, were seen in the range of $\epsilon_{\text{edge}} = 0.52$ to 0.54 , with a stored plasma energy of 1 kJ with one gyrotron and 1.2 kJ with two gyrotrons. Under these optimum conditions it was possible to externally impose plasma currents oscillating linearly in time up to a value of ± 0.5 kA, while keeping the line density constant at a value of $5 \times 10^{18} \text{ m}^{-2}$ for about 0.4 s. This experiment was done with a programmed loop voltage of approximately ± 0.1 V, oscillating around its average value of -0.1 V.

More information on the current status and the latest results in Wendelstein VII-AS will be given in the following contributions to the forthcoming 16th European Conference on Controlled Fusion and Plasma Physics, Venice, (Italy), 13–17 March 1989.

H. Renner Initial Operation of the Advanced Stellarator Wendelstein VII-AS (invited paper)

- R. Jaenicke* Experimental Results of Magnetic Surface Mapping in the Stellarator WVII-AS
- H. Maassberg* Neoclassical Transport in the W VII-AS Stellarator
- U. Gasparino* Toroidal Current Control in the W VII-AS Stellarator
- F. Sardei* Neutral Gas Transport and Particle Recycling in the W VII-AS Stellarator

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Report on Wendelstein VII-X

Since June 1988 the activity of the Wendelstein VII-X planning group has been concentrated on Helias configurations with five field periods, because they offer a higher stability β limit than formerly favored configurations with four periods. As reported by G. Grieger at the IAEA conference in Nice (paper CN50/C-I-4), several configurations are known, for which theory predicts that the stability limit is close to a value of $\langle \beta \rangle \approx 5\%$.

In the meantime, modular coils for these configurations have been optimized, taking into account constraints given by technical feasibility, improved access, minimum modular ripple, and enlarged distance between plasma and first wall. A paper on this issue will be given by J. Kisslinger at the 16th European Conference on Controlled Fusion and Plasma Physics, Venice (Italy), 13-17 March 1989. The paper will also cover the parameter range accessible by a novel system of additional coils.

The impact of modular ripple on neoclassical transport has been investigated by C. Beidler in his contribution to the above conference, showing that at least 12 coils per field period are required to minimize these additional losses. Such Helias coil systems still leave sufficient space for heating systems and diagnostic ports.

Another important feature of Helias vacuum fields is the occurrence of magnetic islands and stochasticity in the edge region at rational ι values. This issue is being investigated by F. Rau in his paper at the Venice conference, and constitutes a basis for studies of plasma-wall interaction and heat removal in Wendelstein VII-X.

Understanding of neoclassical losses in Helias configurations has been improved by the work of W. Lotz, C. Beidler, and H. Maassberg, who used either Monte Carlo techniques or Fokker-Planck solvers to predict neoclassical transport coefficients. By various methods it could be verified that neoclassical losses of localized particles can be reduced to a large extent by proper choice of the Helias geometry, leading to an equivalent ripple of about 1%. Thus, neoclassical transport losses in Helias configurations can be made as small as losses in tokamaks with 1% field ripple from the TF coils.

Another matter of concern in Helias configurations is the bootstrap current, which may change the magnetic field topology. New results were obtained by H. Maassberg using the DKES code, which had been developed by S. Hirshman (ORNL) and made available to us. According to these results the bootstrap current can be made negligibly small by proper choice of the Helias configuration; however, since the bootstrap current also depends on the self-consistent electric field, its precise value is hard to predict. A paper on this matter will be given by H. Wobig at the Venice Conference, see also Garching Report IPP 2/297, (October 1988).

Magnetic islands in vacuum field configurations (given by a set of Dommaschk potentials of low order) are reduced by a novel method. Starting from the Cary-Hanson method of reducing residues at a pair of X- and O-points, it is found that the island size is small, but remains finite. If, however, the constraint of vanishing flux between the two associated rational field lines is used to determine an additional analytic field, the resulting configuration has negligibly small magnetic islands. This algorithm is being applied to an optimization procedure. A paper on this topic will be given by F. Herrnegger at the Venice Conference.

The *Proceedings of the 2nd Workshop on Wendelstein VII-X* have been published by the Commission of the European Communities, Brussels, as Report EUR 11705 EN. They contain all contributed papers. Copies can be purchased from the Office for Official Publications of the European Communities, L-2985 Luxembourg, at a price of \$50 (US).

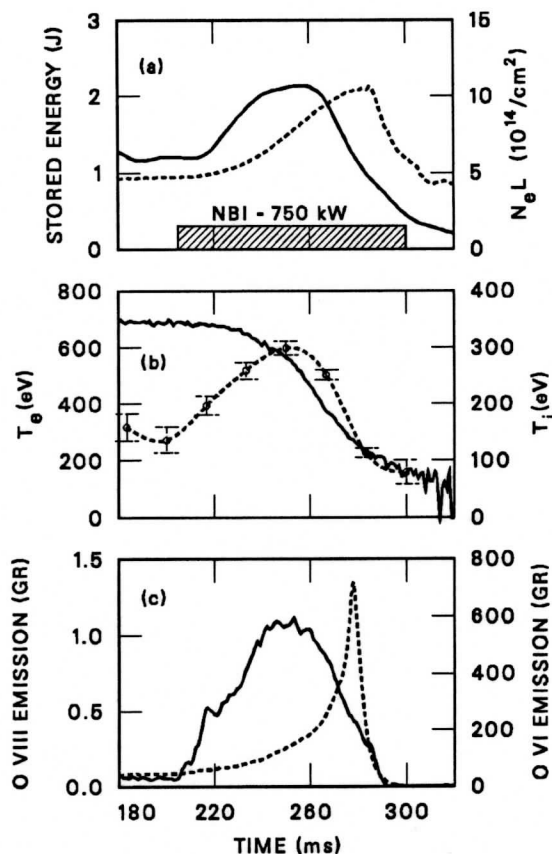
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NEUTRAL-BEAM INJECTION IN ATF

Wall conditioning and chromium gettering have made it possible to operate ECH discharges under essentially steady-state conditions without the uncontrolled growth of the electron and impurity densities observed in the very earliest discharges. Radiative collapses still are observed during neutral beam injection, however, both with and without gettering. The collapse takes place despite the fact that Z_{eff} changes little after injection starts, remaining in the range 1.5–2.0.

Typical time histories of several parameters are illustrated in the figure for a non-gettered discharge having 750 kW of neutral-beam power injected into a plasma that is sustained by 200 kW of ECH for 300 ms. (Left ordinates pertain to solid lines, right ordinates to dashed lines.) Both the stored energy and electron density rise as the neutral beam is turned on at 200 ms. The stored energy attains a maximum at 250 ms, and thereafter declines rapidly. About 30 ms later the electron density begins to fall. The central electron temperature exhibits no heating when the beam is turned on despite the fact that most of the energy is coupled to electrons. In contrast, the central ion temperature rises from about 100 eV to 250 eV, up to the time of the stored energy collapse, before it too begins to drop. Typical emissions from O VI and O VIII are shown in the lower set of curves. Most of the O VIII signal is produced by charge-exchange excitation. The initial rapid jump in the OVIII signal indicates the concentration of fully stripped oxygen in the ECH target plasma as injection is initiated, and the subsequent evolution of the emission indicates the change of O^{8+} during the beam pulse. The charge-exchange signals from C, N, and O all point to a rise of factors of 2–3 in the low-Z impurity content during injection. Radiation from edge ions also increases by factors of 2–3 up to the peak of the stored energy when $P_{\text{rad}} = 220$ kW. The rapid rise in edge radiation thereafter appears to result from the decline of T_e rather than an influx of impurities, and P_{rad} at the peak of the O VI signal is equal to the input power. (Radiation from metals is negligible in non-gettered discharges.) Since the radiation level at the peak of the stored energy is much less than the input power, it is somewhat puzzling why the plasmas evolve to a collapse. One possible explanation is that the small effective plasma radius caused by large islands leads to excessive charge-exchange losses while simultaneously failing to shield the impurity influx from the center of the plasmas adequately. This hypothesis will be tested during the next operating period when field errors have been reduced.

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VAX VMS 5.0 CAMAC Device Driver

For people awaiting the availability of a release of the ORNL CAMAC device driver compatible with version 5.0 of VAX VMS, the Fusion Energy Division announces the availability of Release-1 of a VMS 5.0-compatible driver. The driver is necessary for anyone using the Model Data System (MDS) from MIT or using any of the stand alone systems developed at ORNL. This release of the driver (written by Dan Million) is compatible with version 5.0 of VMS, but does not yet support multi-processor (SMP) systems. Further work is under way. Anyone on the MFE network can request a BACKUP Saveset distribution by sending an MFE TELL message to MILLION@ATF; others should send a written request to:

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CHS Ends ECH and Starts RF Experiments

Compact Helical System (CHS) is an $l=2$ torsatron type device which has the following major parameters: $R/a_p = 1.0 \text{ m}/0.2 \text{ m}$, $m = 8$, $B = 1.5 \text{ T}$, $t(0)/t(a_p) \sim 0.3/1.0$.

After the machine was constructed (May 1988), magnetic surfaces were measured by the use of an electron beam and a fluorescent mesh. The first plasma was produced with a 28-GHz, 200 kW, 75 ms gyrotron in early July. We adopted high field side launching using an inboard-side port, expecting a higher density operation with X-mode. The injection power was up to around 100 kW. The results of magnetic field measurements and an initial confinement study of ECR heated plasmas were reported at the Nice Conference (IAEA-CN-50/I-1-3). A summary follows:

- Widths of observed $m/n=2/1$ islands showed a dependence proportional to $B_0^{-1/2}$ ($400 \text{ G} < B_0 < 2400 \text{ G}$), which indicates that the dominant perturbation field is the ambient field in the experimental building, including the earth's field.
- Typical parameters of ECR heated plasmas were: $T_e(0)=300\text{-}900 \text{ eV}$ and $\bar{n}_e=(2\text{-}6)\times 10^{12} \text{ cm}^{-3}$. Electron energy decay time was determined from the measured decay rates of electron temperature (Thomson scattering, ECE) and density (Thomson scattering). The decay time is in the range of 1–6 ms depending on the electron temperature and density. The electron energy confinement time estimated from the simplified neoclassical analysis is within factor 2–3 of the electron energy decay time, when the energy transferred from electrons to ions (which is the possible loss channel of electron energy) neglected in the analysis, is taken into account. The minimum confinement time of the electrons as defined by W_{el}/P_{in} is 1 ms, where W_{el} and P_{in} are the stored energy of electrons and the input power through the port, respectively.
- Electron temperature and density profiles were obtained from Thomson scattering. Temperature profiles are rather peaked, while density profiles have a hollow tendency. This hollowness is enhanced as the electron density decreases and ECH power increases. This phenomenon could be explained by the increase in the pitch angle of heated electrons, which causes large displacements of their drift orbits from the magnetic surface.

After the IAEA conference, ECH experiments were continued till mid-November and switched to ICRF experiments, because the ECH power supply had to be modified for the coming 53 GHz gyrotron system.

Experimental results so far can be summarized as follows:

- Dependence of plasma parameters on the magnetic axis position has been investigated for three cases: $R_{axis}=94.9 \text{ cm}$, 97.4 cm , and 101.5 cm . The helical ripple on axis is zero for the configuration with the inward shifted magnetic axis (94.9 cm). As the axis moves outward, the ripple on axis increases to 6% (101.5 cm). The highest electron temperature was obtained in the zero ripple configuration. This phenomenon may be explained by considering the loss cone from the standpoint of the single particle orbit picture.
- High-field side and low-field side (using a vertical port) launchings have been compared. There is almost no difference in the ECH power dependence of electron temperature, radiated power and so on. Plasma parameters are almost same for both launchings. This is due to the low one-path absorption rate for 28 GHz. The mode mixing due to scattering at the wall plays an essential role in the heating process.
- Plasma production experiment using the IBWH antenna (13 MHz, 400 kW, 30 ms) has been done at $B_0=0.7\text{-}1.5 \text{ T}$ with hydrogen gas. Plasma parameters of $\bar{n}_e \approx 5 \times 10^{12} \text{ cm}^{-3}$, $T_i(0)=100\text{-}200 \text{ eV}$ (from a time-of-flight neutral particle analyzer) have been obtained. However, so far, the electron temperature has only increased up to 120 eV at $B_0=1.1 \text{ T}$. The production mechanism at the high field is considered to be Alfvén resonance while that at the low field would be attributed to IBW. The same experiment using helium gas shows successful plasma production, where there is no possibility of an Alfvén resonance mechanism.
- Plasma production with whistler waves using poloidal antennas (two quarter turn loops) has been started for the purpose of (i) high- β plasma at low field and (ii) high-density target plasma for NBI. Plasmas have been produced successfully for the wide range of $B_0 = 0.15\text{-}1.5 \text{ T}$.

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Status Report of Heliotron E

Edge Plasma Study

The experimentally observed plasma density and heat flux distributions in the intrinsic divertor field region are consistent with the field line analysis: they localize at the "fish-tail" (outboard) and "fish-mouth" (inboard) parts of the divertor field pattern. Very high heat flux is observed on the inboard side for NBI plasmas. The amount of this flux seems to depend on the injection angle (higher for perpendicular injection) and the toroidal position. On the other hand, the density and temperature estimated from the probe characteristics seem to be independent of the injection angle and the position. The plasma behavior in the divertor region is analyzed using a 1-D model. The experimental study of the divertor baffle effects is being performed.

Magnetic Axis Shift

In both ECH and NBI plasmas, by shifting the magnetic axis 2 cm inward, a plasma with 15% higher temperature and 20% better central confinement was obtained. This suggests a reduction of the transport coefficients compared to the standard configuration. The effects of the shift on the MHD activity have also been studied at $B = 1.9$ T, extending previous studies at $B = 0.94$ T. It was found that an inside shift causes an internal disruption at lower β value.

Multiple Pellet Injection

A new six-pellet (H_2 , D_2) injector has started operation. With this device, the operational parameter range has been expanded, and transport, MHD stability, pellet ablation, and behavior of the edge plasma are being studied.

Potential Measurement

A system of heavy neutral beam probes (100 kV cesium) has been constructed and installed on Heliotron E. The final adjustment is now being carried out. Thus, the potential measurements will soon begin.

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Confinement Experiments with Laser-Produced Plasmas in SHATLET-M

A small modular-coil helical machine of the torsatron/heliotron type ($l=2$, $m=12$, with a pitch modulation), SHATLET-M, has been filled with plasmas produced by the irradiation of an intense pulsed CO laser beam on a tiny free-falling deuterium pellet near the magnetic axis. The machine has a major coil radius of 42 cm, a minor coil radius of 9.6 cm, a minor plasma radius of about 5 cm, and a maximum toroidal field of 1.5 kG on the magnetic axis. Its rotational transform in vacuum increases radially from a central value of 0.3–0.7, to an edge value of 0.5–0.9. Its spatial profile can be varied by changing the ratio of the modular coil current to the vertical field coil current.

The plasma parameters measured (line-integrated density, spatially averaged β value, and their decay constants) strongly depend on the rotational transform. Operations with a central rotational transform slightly above 0.5 in vacuum have been observed to exhibit optimum plasma confinement. The deuterium pellets are typically 0.2 mm in diameter and 1 mm in length. The pellets are irradiated by a CO laser pulse with a total energy of about 300 J and a pulse width of 1 μ s. Within 10 μ s, a toroidal plasma is rapidly formed that has a small initial toroidal plasma current with a peak value of less than 105 A. This initial toroidal current is rapidly damped in about 20 μ s, and a net-current-free toroidal plasma is confined for another 200–400 μ s. The diamagnetic loop measurement shows that the initial peak value of spatially averaged β ranges from 3 to 5%, where the plasma density is about 1×10^{13} cm^{-3} and the ion temperature is about 100 eV, corresponding to a thermal energy of about 3–5 J.

Experiments with various rotational transforms in vacuum have been performed to investigate the dependence of the confinement property of the plasma on the rotational transform. The plasma confinement has been found to be very poor with a central rotational transform in vacuum less than 0.4, and relatively poor when it is near $2/3$. Work is underway to determine whether the observed peak β value is limited by the intrinsic β limit of the magnetic configuration or by an initial large amount of plasma loss across magnetic field.

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Large Helical Device

A planning office for the new National Fusion Research Institute has been open on the Nagoya University campus since April 1988. It is headed by Prof. Atsuo Iiyoshi and its main functions are (i) to make a budgetary proposal for the new Fusion Institute to the Japanese government and (ii) to coordinate the design work of the so-called Large Superconducting Helical Device (Heliotron/Torsatron type), the major device of the new institute.

At the end of July 1988, we made a proposal for the establishment of the new Fusion Research Institute, including the construction of the Large Helical Device, to the Ministry of Education, Science, and Culture (MESC; the Monbusho).

Budgetary negotiation between the Monbusho and the Ministry of Finance has just begun, and budgetary approval is expected to occur in the middle of January 1989. If so, the new institute will open in April 1989 and the following organizational changes will take place: The Institute of Plasma Physics (Nagoya University) will be abolished, and the majority of its researchers will be transferred to the new institute. The Heliotron group (Kyoto University) and the Fusion Theory group (Hiroshima University) will also join the new institute. The institute will be the fusion research center ("Inter-University Research Institute for Joint Use") under the Monbusho, and many researchers of various universities will participate in the research activities of the institute. The new institute will be at Toki in Gifu Prefecture, a small city at the outskirts of Nagoya. Presently the leveling of the land site is under way. For a few years, the researchers will stay at the site of the "former" Institute of Plasma Physics on the Nagoya University Campus. The major activity in the first several years will be the design and construction of the Large Helical Device. We will also keep operating existing small devices such as CHS, NTX, and Heliotron E (Kyoto University) until the large new experiment starts.

In our plan, we will start experiments on the Large Helical Device in 1995. To achieve this, we have to finalize its design specification early in 1990. We also need a year of development time for the superconducting coil, which is the major development component of the device required before the final design specification. This means that we need a tentative decision on the coil design, particularly the m number of the helical coil, during 1988. At the design review meeting held on Nov. 22, 1988, we decided the following parameters of the device:

Large Helical Device Parameters

$m = 10$	$l = 2$	$B_T \sim 4 \text{ T}$
$R \sim 4 \text{ m}$	pitch ~ 1.2	$0 \leq \alpha < 0.2$ $a \sim 0.5 \text{ m}$

However, we will continue to optimize B_T , R , and α (the winding modulation parameter) to satisfy our experimental requirements:

- 1) $\beta > 5\%$
- 2) no particle loss cone within $a/3$
- 3) $B_T \sim 4T$, $a > 0.5 \text{ m}$, $R \sim 4 \text{ m}$
- 4) current density in the superconducting helical winding = 40 A/mm^2

The poloidal field system gives the proposed configuration versatility, and with the magnetic axis pushed 10–20 cm inward, it satisfies criteria 1–3.

With the proposed configuration, we expect that the following physics and engineering objectives in our original proposal will be achieved.

Physics objectives

- 1) To achieve high $n\tau_{ET}$ plasmas and investigate the transport in a reactor relevant plasma.
- 2) To achieve average $\beta \sim 5\%$ required for a reactor and to investigate the MHD instabilities associated with β limits.
- 3) To operate quasi-steady-state discharges using a helical divertor to minimize impurity contamination and control the particle flux.
- 4) To study behavior of the high-energy particles in the helical magnetic configuration and to do simulation experiments of α -particle behavior in a reactor.
- 5) To improve and deepen physics understanding of toroidally confined plasmas in general.

Engineering objectives

- 1) Development and construction of a large superconducting coil with stored energy greater than 2 GJ.
- 2) Control of plasma-wall interaction in near-steady-state, high-power discharges to aid in the development of first wall materials.

Performance Goals

The performance goals of the Large Helical Device are summarized in the table on the next page.

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Continued on next page

Large Helical Device Plasma Performance Goals	
High $n\tau_E T$ Operation	
$\bar{n} = 10^{14} \text{ cm}^{-3}$	$\tau_E = 0.1\text{--}0.3 \text{ s}$
$\bar{T} = 3\text{--}4 \text{ keV}$	$B_T = 4 \text{ T}$
High T_i Operation	
$T_i(0) = 10 \text{ keV}$	$\bar{n} = 2 \times 10^{13} \text{ cm}^{-3}$
$B_T = 4 \text{ T}$	
High β Operation	
$\beta \geq 5\%$	$B_T \sim 1 \text{ T}$

Progress on ATF

In ATF, the field errors caused by the coil leads have been corrected and the e-beam experiment to confirm the fix is in progress. The initial indications are promising in that the islands at $\iota = 1/2$ were reduced very substantially, although smaller inner islands (such as those at $\iota = 1/3$) have become more visible.

Meanwhile, we continued the analysis of the data obtained during the previous run period. Of particular interest are our findings that the field errors may have facilitated access to the second stability regime.

In the last Newsletter, we reported that the $T_e(r)$ profiles measured by Thomson scattering were very narrow, probably due to the islands at the $\iota = 1/2$ surface, which effectively reduced the plasma radius to $r_p = 0.6 a$. The narrow pressure profile resulted in a large outward Shafranov shift, which in turn dug a deeper magnetic well, thereby improving MHD stability for a given value of β . The best H^+ discharge with balanced beam injection of 1.4 MW total H^0 power into the chromium-gettered torus reached a stored energy $W_{\text{dia}} = 7 \text{ kJ}$ with $n_e = 2.5 \times 10^{19} \text{ m}^{-3}$, $n_{e0} = 5 \times 10^{19} \text{ m}^{-3}$, $T_{e0} = 0.6 \text{ keV}$, $T_{i0} = 0.26 \text{ keV}$. This stored energy (W_{dia}) at $B_0 = 0.95 \text{ T}$ corresponds to volume-average $\beta = 0.5\%$. For this case, the central β is $\beta_0 = 2.8\text{--}3.2\%$, depending on diamagnetic or equilibrium weighting of small anisotropic beam contributions.

Ideal MHD stability was examined for the equilibrium sequence with the experimental pressure profiles. The theoretically predicted threshold for complete stability at all radii is attained at $\beta_0 = 1.3\text{--}1.6\%$, depending on equilibrium sequences, for zero-current equilibria or the flux-conserving equilibria. The values achieved in the experiment ($\beta_0 = 3\%$) are well above the theoretical predictions for this threshold. Theory also predicts that the

fluctuations caused by the resistive interchange modes do not disappear in the second stability regime (particularly near the plasma edge), but the fluctuations should show the effects of beta self-stabilization.

The initial fluctuation measurements on ATF were made using a soft X-ray diode array (on loan from the Heliotron-E group) viewing the central portion of the plasma ($r \leq 0.5a$) and Mirnov coils (\tilde{B}_θ) located at about 30 cm outside the plasma. The soft X-ray signals show no evidence of gross instabilities such as sawteeth or disruptions. Spectral analysis of the \tilde{B}_θ data from Mirnov coils separated in toroidal angle by $\Delta\phi = 30, 150,$ and 180 degrees, reveals coherent fluctuations (frequency-resolved coherence function $\gamma > 0.7$) in the frequency range $8\text{--}40 \text{ kHz}$ with amplitudes of $\sim 10^{-3} \text{ G}$. The relative phase shifts of the signals are predominantly consistent with $n=1$ toroidal mode symmetry, but some evidence of $n=3$ components is seen for $\Delta\phi = 30$ degrees. No corresponding coherent activity is seen on soft X-ray signals. It is difficult to determine the poloidal (m) mode number spectrum at present, because only two poloidally spaced Mirnov coils ($\Delta\theta = 150$ degrees) were available for these experiments; the non-circular flux surface geometry of ATF further complicates the determination of poloidal mode numbers. The available spectral data indicate that the fluctuations contain at least two poloidal harmonics, one of which can most simply be interpreted as $m=2$.

The dependence of the \tilde{B}_θ amplitudes of the $n=1$ mode (integrated over $8\text{--}40 \text{ kHz}$) on plasma pressure is shown in Fig. 1 and suggests (1) a pressure threshold for the fluctuations at $\beta_0 < 1\%$; (2) saturation and possible reduc-

Figure 1

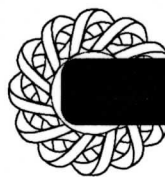
tion of $\tilde{B}_\theta(n=1)$ as β_0 exceeds 1.5%. Additional trend analysis shows no obvious correlation with beam injection, configuration, or plasma current. The amplitude and overall behavior of the fluctuations is strongly reminiscent of theoretical predictions for pressure-driven instabilities in ATF, as discussed above.

Figure 2 shows a profile "broadness" parameter (and corresponding approximate $\langle\beta\rangle/\beta_0$ based on a limited number of profile-analysed cases) plotted as a function of $\langle\beta\rangle$ for the fluctuation shot database. The pressure profiles broaden rapidly as beta increases; this effect saturates for $\beta_0 > 1.5\%$. Although many possible mechanisms could be responsible for such broadening (e.g., change of heating deposition profile), this behavior is consistent with a theoretical picture in which the plasma volume with a reduced level of fluctuations (or anomalous transport losses) grows as the region of magnetic well expands with increasing β .

Figure 2

More comprehensive studies in the future will be aimed at correlations among transport, β , and fluctuations. These studies will use configuration control (with vertical fields), profile variations (with limiter, intentional field errors, and pellet injection), and internal fluctuation diagnostics (reciprocating Langmuir probe, microwave reflectometer, and heavy ion beam probe).

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People

Saltmarsh and Neilson promoted at ORNL

On November 2, Michael J. Saltmarsh was appointed Associate Director for Operations of the ORNL Fusion Energy Division. In this position, Mike will assist the Division Director in overseeing the Division's major projects, including operation of ATF.

Mike is a nuclear physicist who received a PhD from Oxford University in 1966. Mike came to ORNL in 1968 as a member of the cyclotron group of the Electronuclear and then Physics Division. In 1976, he joined the Fusion Energy Division. For the past four years, he has been Head of the Confinement Projects Section, where his primary responsibility has been construction and operation of ATF.

G. H. (Hutch) Neilson will replace Saltmarsh as Head of the Confinement Projects Section. Hutch has been with FED since 1974 and has worked on ORMAK, ISX, and ATF. He was named deputy project manager of the ATF facilities in 1984 and project manager in 1987. Hutch received his SB and SM degrees in Electrical Engineering from MIT, and his PhD from the University of Tennessee.



From the Editor

The deadline for the next issue of Stellarator News is the end of February. Please try to submit all articles electronically, as described in the last issue.