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Task III: UCSD/DIII-D/TEXTOR FY-97-98 Accomplishments

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The UCSD/TEXTOR collaboration has achieved the completion of three major tasks this year:

1-Pump limiter studies

A comprehensive report on the physics of pump limiters and particularly, the characterization of ALT-II, was published in Nuclear Fusion, bringing the project to a closure. The performance of the toroidal pump limiter was characterized under full auxiliary heating of 7 MW of NBI and ICRH and full pumping, as stated in the project milestones. Relevant highlights are:

- Pumping with ALT-II allows for density control.
- The achieved exhaust efficiency is 4% during NBI operation and near 2% during OH or ICRH operation.
- We have shown that an exhaust efficiency of 2% is sufficient to satisfy the ash removal requirements of fusion reactors.
- The plasma particle efflux and the pumped flux both increase with density and heating power.
- The particle confinement time is less than the energy confinement time by a factor of 4.

In summary, pumped belt limiters could provide the density control and ash exhaust requirements of fusion reactors.

2-RI-mode turbulence studies

We have found that turbulence and radial particle turbulent transport are reduced in the edge of RI-mode discharges as shown in Figs. 1 and 2. The reduction results in increased particle confinement time and concomitant energy confinement time. We are now investigating the mechanism causing the turbulence reduction and so far no edge localized velocity shear layer has been found. The most likely candidate at this point is the stabilization of ITG modes and ITG-trapped electron drift instabilities . The stabilization of ITG modes is produced by the presence of radiating impurities and their influence on the growth rate of ITG modes.

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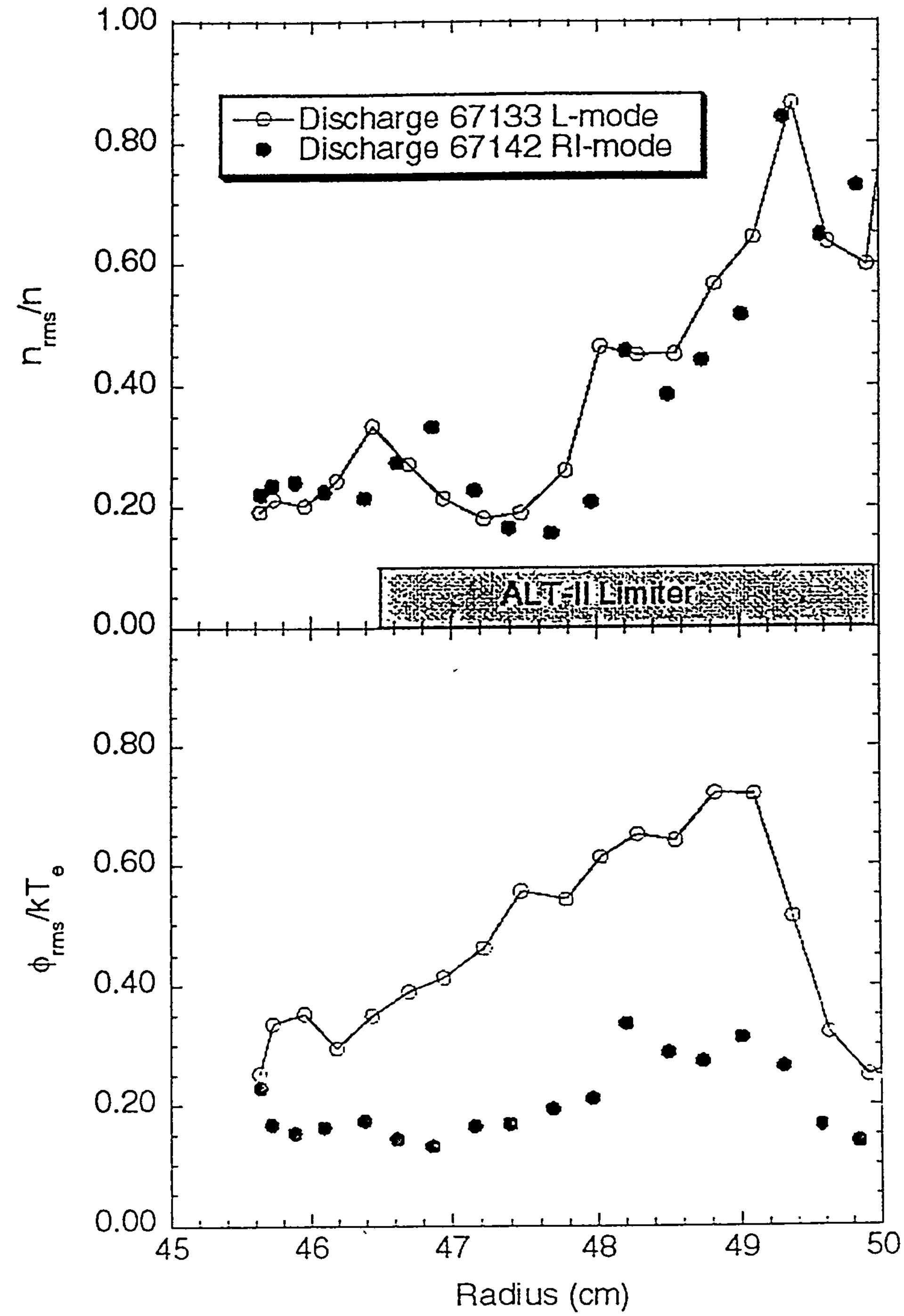

Fig. 1: Reduction of normalized potential fluctuations by factors of 2-5 is observed in the bottom panel. The normalized density fluctuation levels are not much affected by the RI-mode.

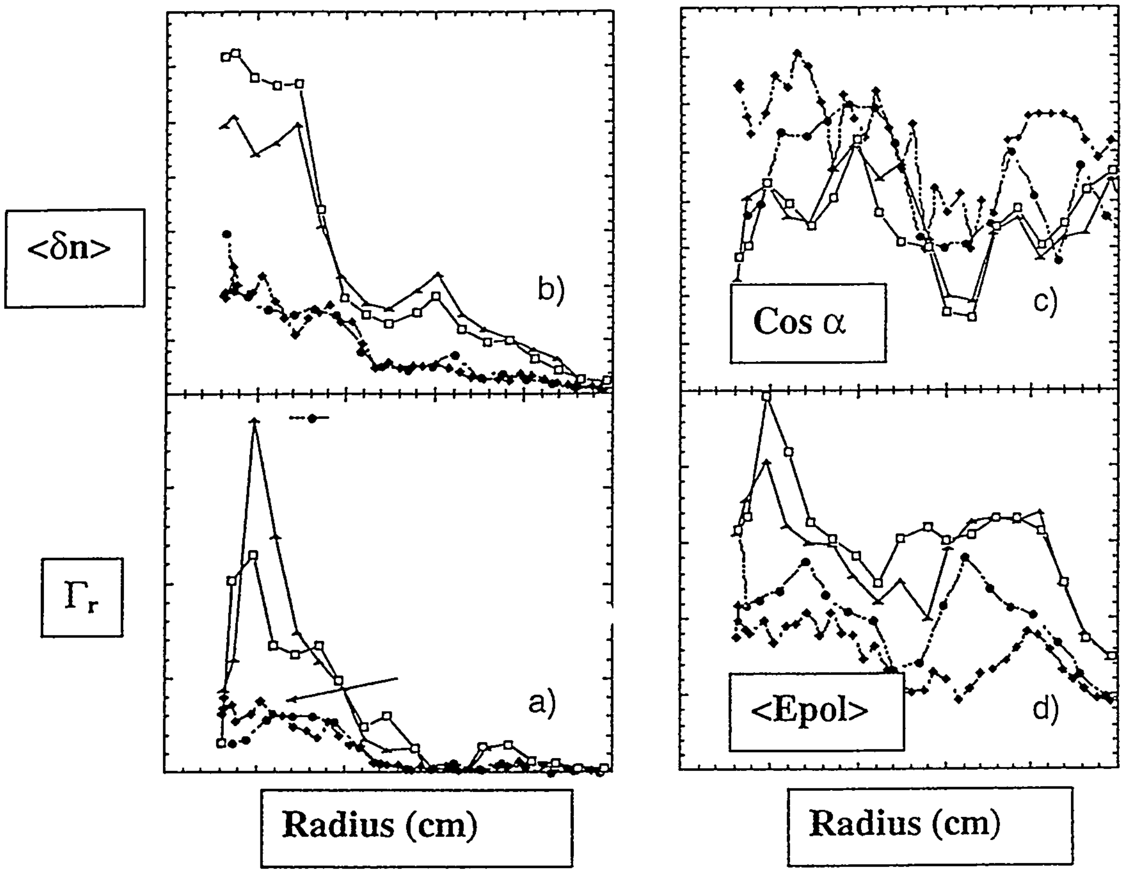

Fig. 2: Turbulent radial particle flux (a), absolute density turbulence level (b), the cosine of the phase between density and poloidal field fluctuations (c) and the poloidal field fluctuation levels (d) are shown vs. radius during RI-mode discharges in TEXTOR. The limiter and SOL are shown as a dark square.

3-Velocity shear stabilization of turbulence.

Experiments conducted in TEXTOR during electrode polarization show that a large poloidal velocity shear is produced in the plasma edge. This velocity shear has the effect of stabilizing turbulence and thus reducing turbulent radial particle transport, resulting ion increased particle and energy confinement times. Our results show that:

1. Density and potential fluctuations are reduced due to the velocity shear.

2. The phase between the density and poloidal electric field fluctuations is also changed by the velocity shear.
3. The concomitant changes in turbulent levels and phase result in a reduction in radial turbulent particle transport by factors of 7.
4. The reduced particle fluxes result in increased particle and energy confinement times and energy content in the plasma.
5. We have found an asymmetry in the effect of the velocity shear $\nabla_r V_{ph}$ on the cross-phase. The asymmetry is strong for $\nabla_r V_{ph} > 0$ and weak for $\nabla_r V_{ph} < 0$

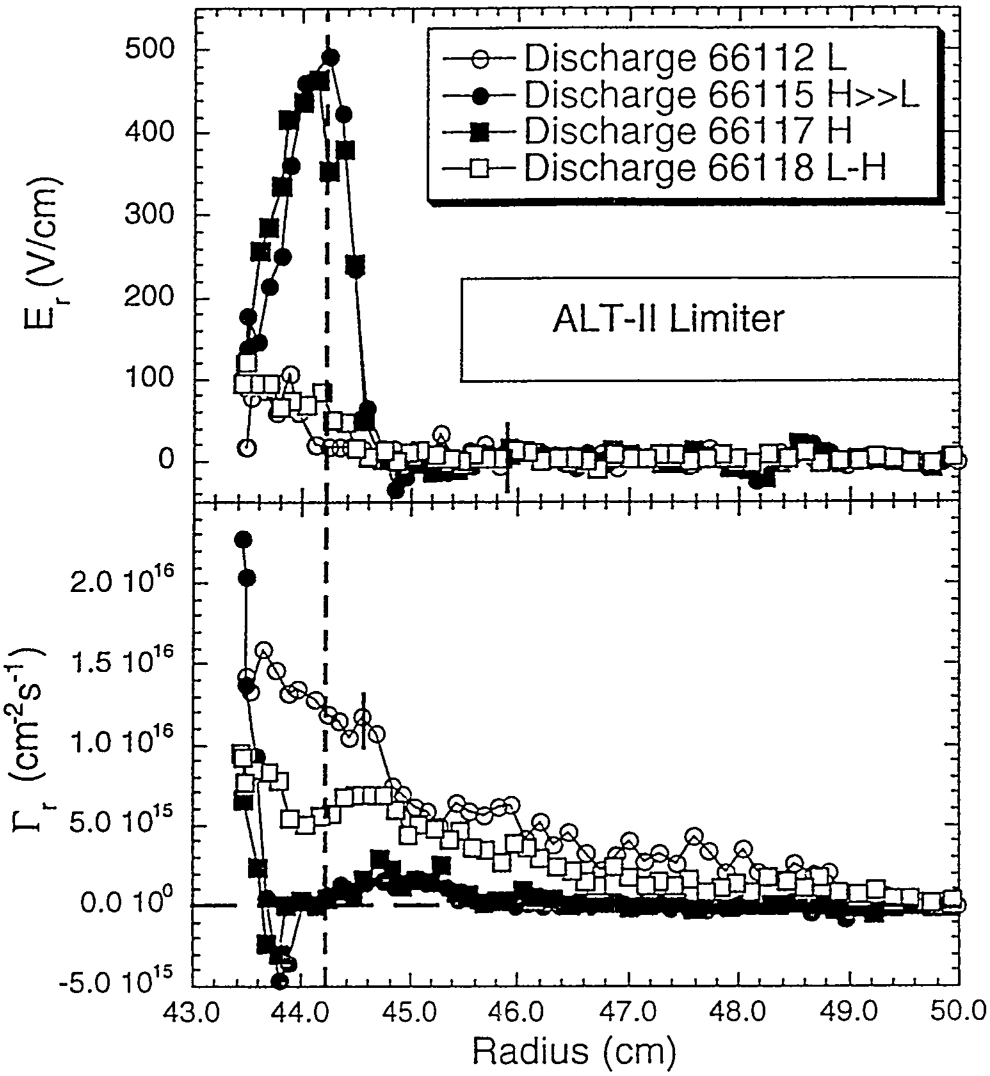

Figure 3: The radial electric field is shown in the upper panel for various applied electrode voltages. The radial particle flux is shown in the bottom panel for the same discharges.

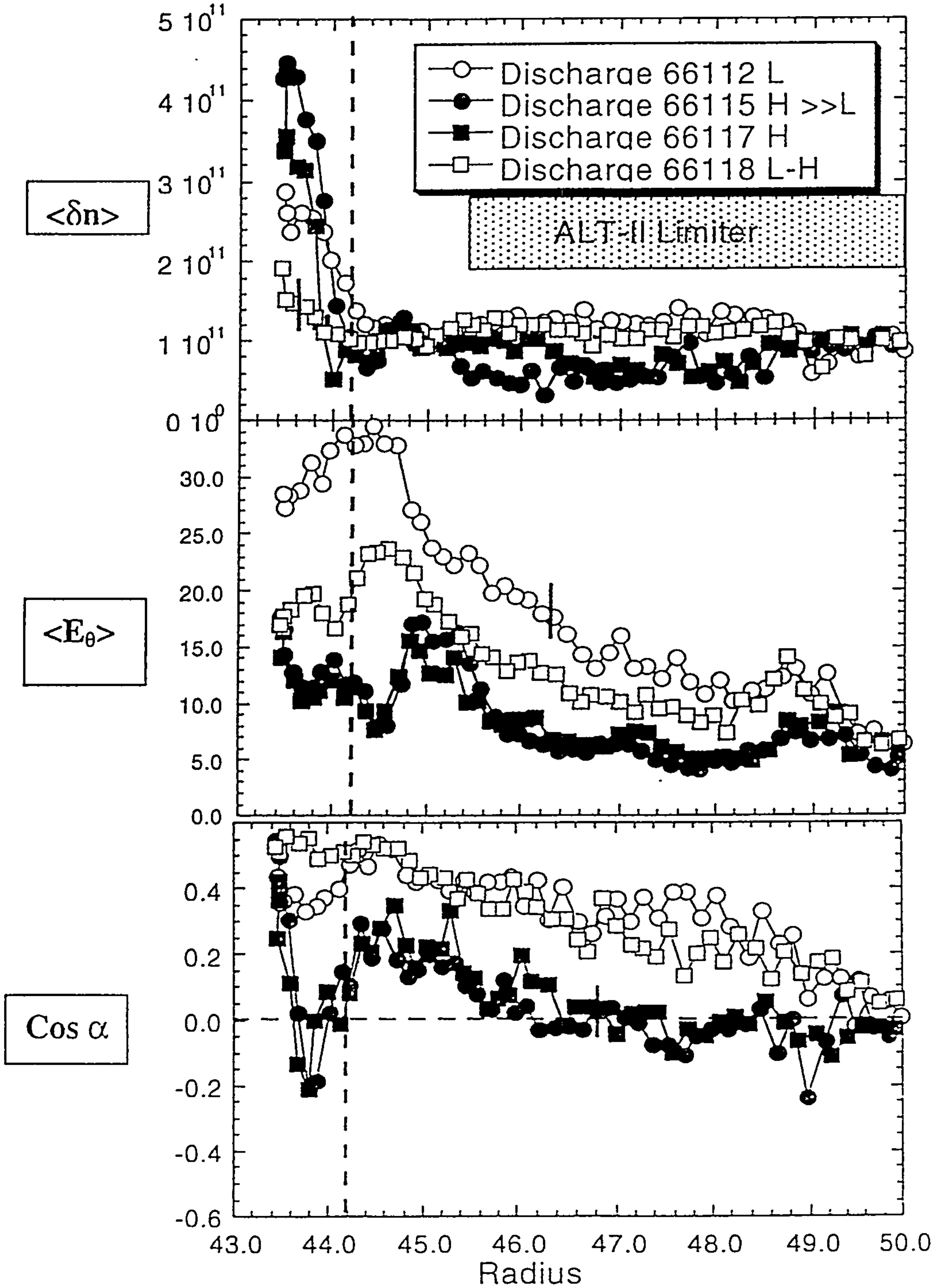

Figure 4: We show the density rms level (top panel), the poloidal field rms levels (middle panel) and the cross-phase (bottom panel) for various degrees of stabilization.

UCSD/DIII-D/TEXTOR FY-99 Future Plans

The UCSD group will continue participation at TEXTOR as part of the DIII-D/UCSD activities in FY99. Two visits are scheduled during RI-mode experiments.

UCSD/DIII-D/TEXTOR FY-97-98 Publications and Conference Papers

1) Plasma exhaust and density control in tokamak fusion experiments with neutral beam or ICRF auxiliary heating by Gray, Boedo, Baelmans, Conn. Moyer, Dippel, Finken, Pospieszczyk, Reiter, Doerner, Hillis, Mank, Wolf, TEXTOR team.

2) Unterberg, B.; Messiaen, A.M.; Ongena, J.; Brix, M., Boedo, J. A.; and others. The influence of plasma-edge properties on high confinement discharges with a radiating plasma mantle at the tokamak TEXTOR-94. (24th European Physical Society Conference on Controlled Fusion and Plasma Physics, Berchtesgaden, Germany, 9-13 June 1997). Plasma Physics and Controlled Fusion, Dec. 1997, vol.39, (no.12B):B189-206.

3) Koch, R.; Lyssoivan, A.I.; Giesen, B.; Esser, H.G., Boedo, J. A. ; and others. ICRF plasma production in TEXTOR-94. (Radio Frequency Power in Plasmas. 12th Topical Conference, Savannah, GA, USA, 1-3 April 1997). AIP Conference Proceedings, 1997 (no.403):105-8.

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