August 1980 INT 100/80

THE FIRST SEVEN DAYS OF TCA

TCA GROUP

INTRODUCTION

This note summarises the progress made during the first seven days of Tokamak operation. We defined a "Tokamak Day" as one in which gas and OH voltage were both present, to differentiate between these and true test days.

DAY 1 (11 July)

The torus leak was found and during the afternoon the OH, preionization and $B\phi$ were fired together for the first time ($B\phi$ = 7.5 kG constant during all these tests). With 0.5 kV OH and 1.6 10^{-4} torr (G) we obtained a small H_α signal demonstrating the start of breakdown. Increasing the OH charging voltage to 1 kV actually reduced the ionization, and at 1.5 kV there was no ionization. Conclusion: the trimming coils (E_T, E_B) will be necessary. We tried breakdown with the trimming coils but without a preionization pulse. No ionization was produced.

../2

DAY 2 (15 July)

The damping of the preionization pulse due to the presence of the trimming coils was demonstrated to be negligible. A scan of filling pressure was made with just Bϕ + Preionization, to find an optimum starting pressure ($\sim$ 0.3 10^{-4} torr (G) at power No 1, $\sim$ 1.0 10^{-4} torr (G) at power No 3). Various triggering troubles were sorted out and then the E-coils and OH circuit were added. 2 kV on the OH and .8 kV on each E-coil produced immediately a plasma current pulse of $\sim$ 8 kA. These trimming coil values were those found to be optimal during the stray-field mapping. The timing of the E-coils (again previously optimized during stray-field mapping) was fairly critical but the charging voltage could be increased by 60% with no difference noted. With 2.5 kV OH voltage, we obtained a current pulse of 8 kA of FWMH $\sim$ 1.8 msec. The filling pressure was doubled and a good breakdown still was obtained. Conclusion: Vertical field can now usefully be added.

DAY 3 (17 July)

The initial pulse was set up quickly. A radial trimming field (by unbalancing the E-coils) was tried and produced no observable effect. The SIN generator was brought into operation. The preionization voltage was reduced by a half (as foreseen!). With no input signal the SIN generator already passively increased the current pulse to 28 kA, 2.5 msec. (Effectively increasing the shell conductivity.) A first attempt at a driving term (2.20 x $\dot{I}_p$) produced 55 kA, 4 msec and a second produced > 60 kA (q = 3) and a baby disruption. We then adjusted the OH-resistors (adjusting the volts/turn as a function of time) prolonging the pulse to 12 msec. Adding a B_V resistive correction produced a pulse of 27 msec terminating at q $\simeq$ 3. Conclusion : TCA appears to want to work.

../3

DAY 4 (18 July)

Startup was quickly achieved but (for reasons as yet understood) there was insufficient ionization and hence (we assumed) a very low density plasma. H_α and V_{Loop} both showed violent activity and the loop volts were low. With vertical field, 50 kA, 75 msec were obtained but with a flat (anomalous) current waveform and a great deal of hard-X emission. 70 mRem were indicated outside the screened room. Conclusion: We need density information.

Day 5 (29 July)

2mm works (roughly). Soft-X being commissioned, vacuum repumped. The day was spent attempting to improve the plasma duration.

DAY 6 (30 July)

Lower density operation established (2-3 fringes $\sim$ 1.6 10^{13} peak density). Build-up phase was worked on and feedback looked at. Feedback now has a 15 kHz filter to remove preionization cross-talk and the cos-coil back-off has been improved. The SIN system was unstable with large feedback. Conclusion: startup is still not correct.

DAY 7 (5 Augusut)

Cos-coil cross-talk from poloidal system was reduced. The B_V control was systematically studied working up the driving term and resistive correction. The OH-resistors were adjusted to give a proper

"bosse" on the current waveform. Finally, a pulse of 60 kA, $V < 3$ Volts, $\hat{n}_e \sim 2\ 10^{13}$, 80 msec long was obtained (Fig. 1). A preliminary analysis of this shot gave $\hat{T}_e \sim 400$ eV if $Z \simeq 6$ (anomalous resitivity ~ 4). The temperature profile was adjusted to give $q_o \sim 1$. With 4.5 fringes (estimated!) we have $\tau_{Ee} \sim 1.2$ msec and $\beta_{\Theta e} \sim 0.2$. We note that Shafranov's Γ deduced from current measurements is 3.52, much larger than expected ($\Gamma \simeq 2.9$) although the position measurement suggests that the plasma is roughly centred (as does $q_a = 3.0$). The soft-X measurements showed a long, smooth pulse suggesting a minimal contribution from hard-X. Conclusion: TCA has fired an apparently good shot for the first time.

STATUS

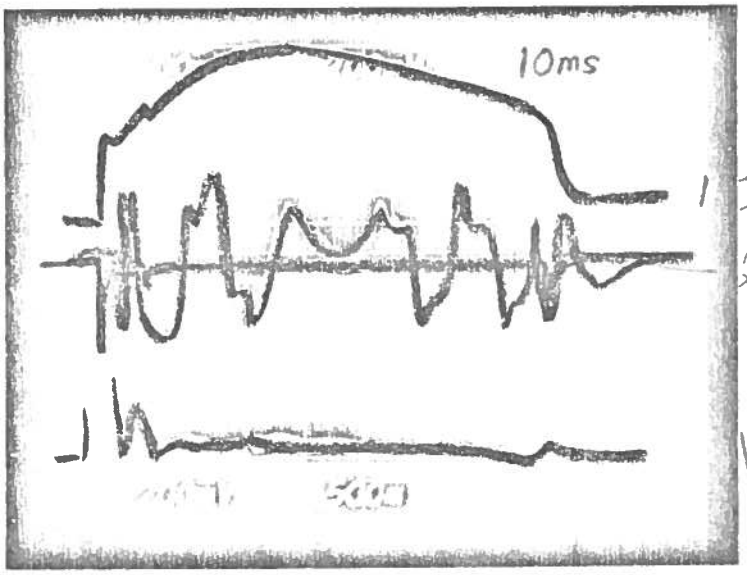
All main components of the machine function more or less. $B\phi$ will soon be up to 15 kG. We can already use 84% of available volt-seconds. The SIN generator works well and the steering of it needs optimising. The preionization supply preionizes. The vacuum is excellent. The control system would save effort. The acquisition system must be put into operation now.

As for diagnostics, the pick-up coils all function and are thought to be calibrated. H_α and hard-X detectors work. The O_{II} detector had a cable fault and now works. The 2mm-interferometer functions and the absolute phase measurement will be implemented as soon as possible. The soft-X give intelligent signals. We require a T_e measurement (soft-X or Ruby scattering) to measure Z_{eff}.

../5

FIG 1.

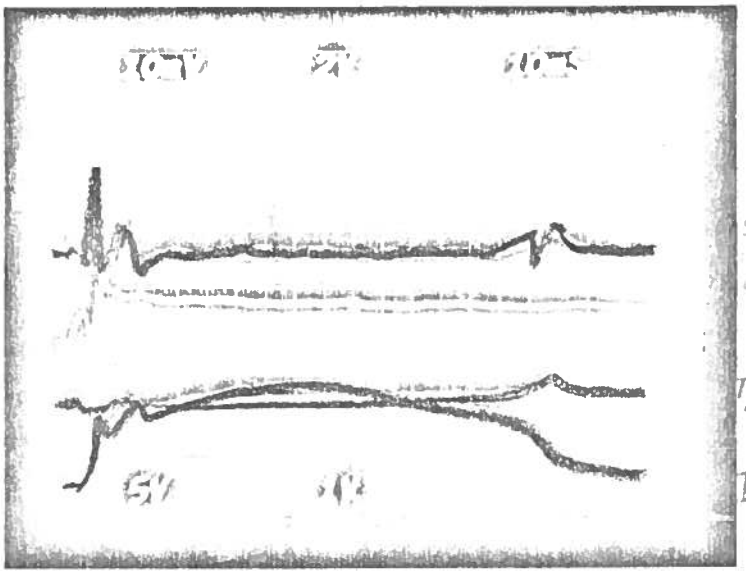
Tokamak Shot on Day 7



~ 60kA peak

~ 4 fringes ?

~3V at current peak



Vertical field control signal

Plasma position (cos coil)

Vertical field windi... current.