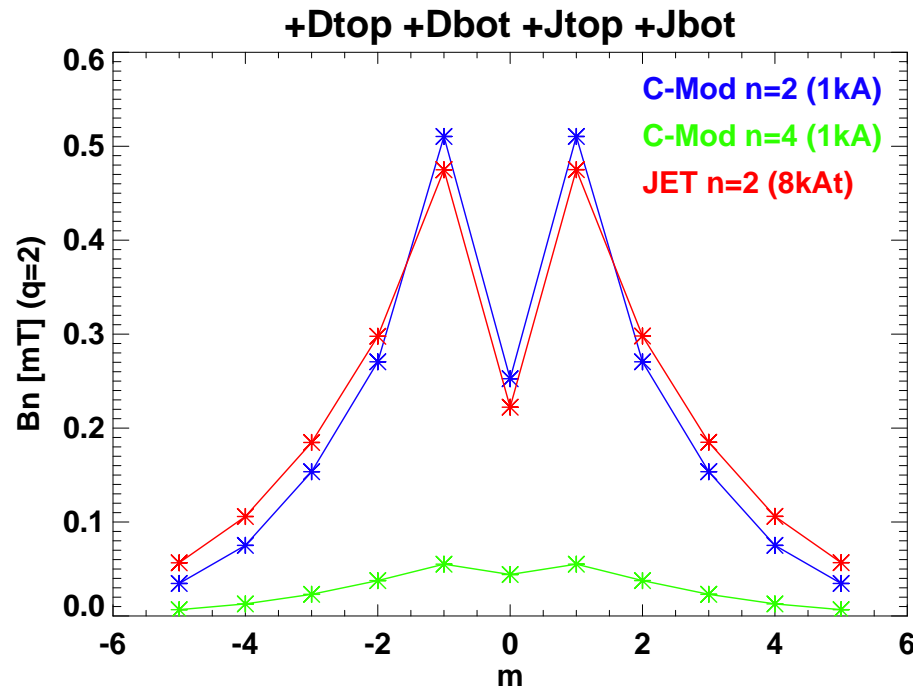


## Joint C-Mod/JET experiment

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A Kirk<sup>1</sup> and the MAST team.



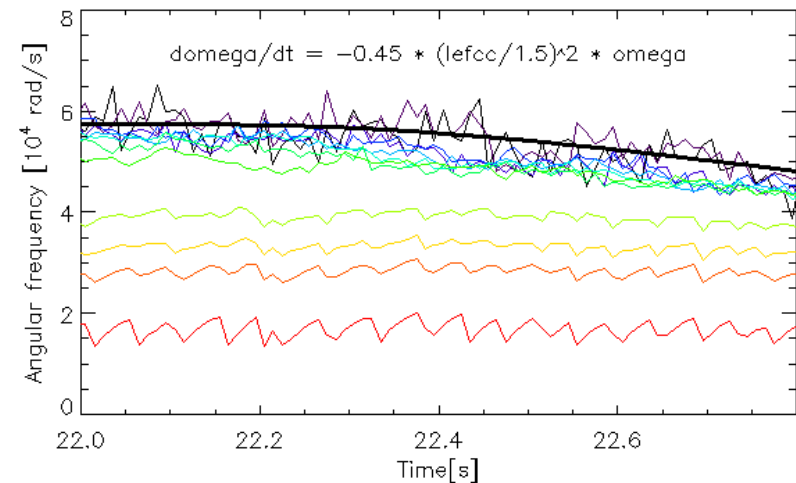
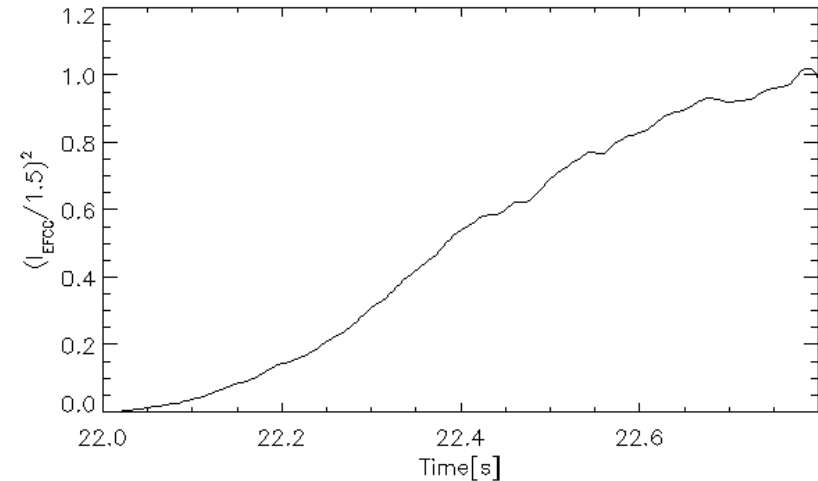
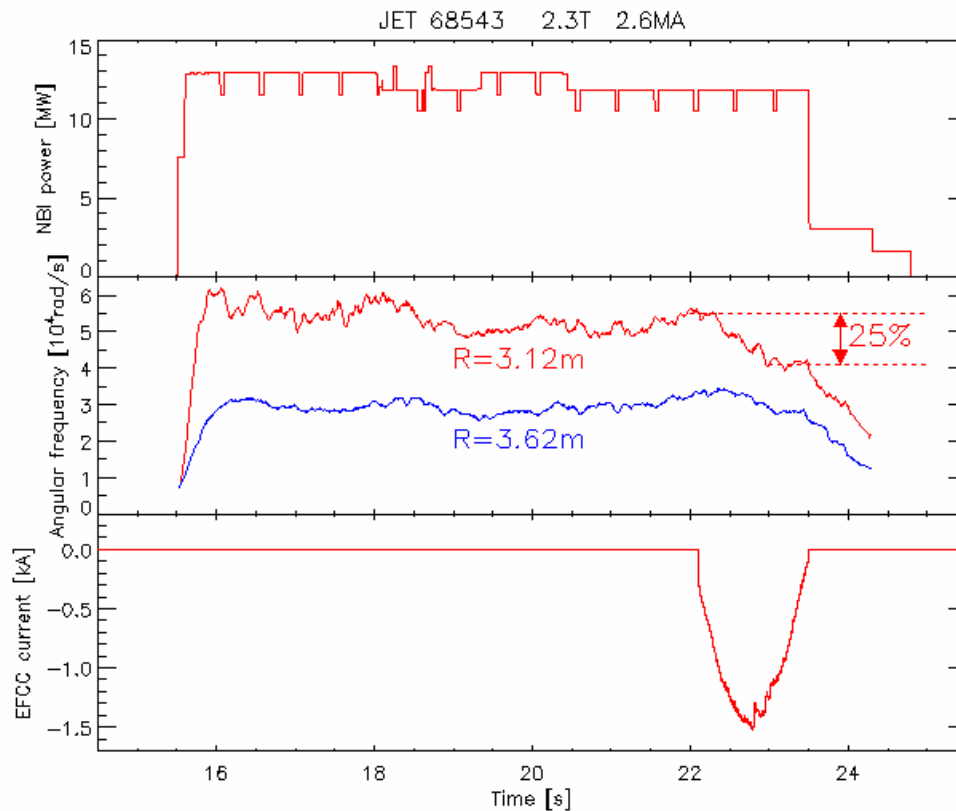
- Joint C-Mod/JET experiment based around ability to reproduce JET n=2 EFCC spectrum using A-coils on C-Mod

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Significant braking is observed on JET when an n=2 error field is applied.

Can this be explained using NTV theory?



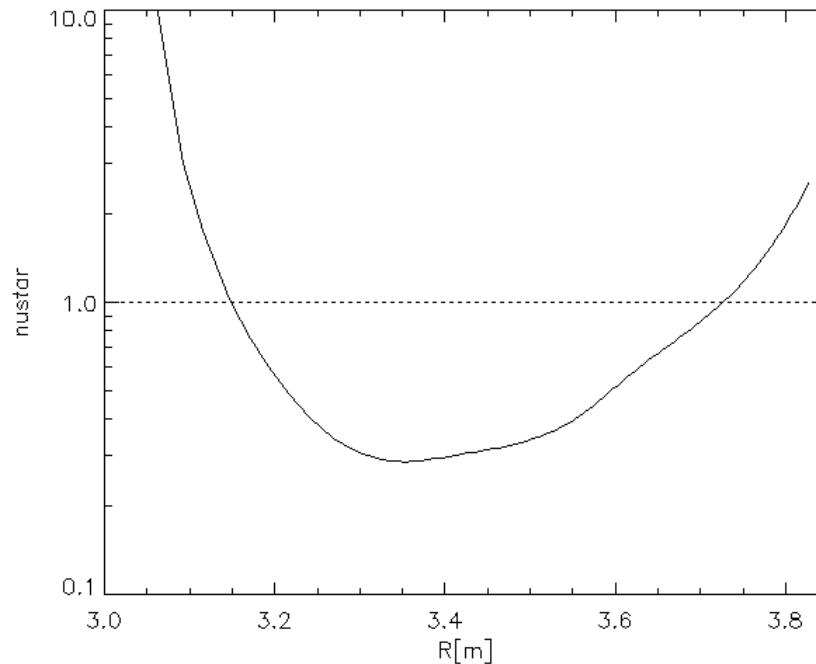
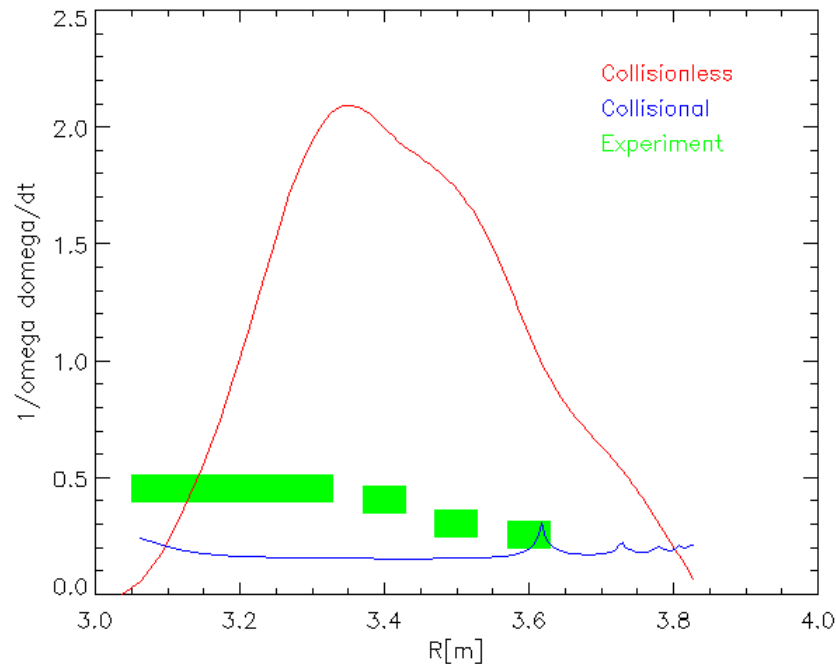
$(1/\Omega_\phi)d\Omega_\phi/dt = -0.45/s$  in the core

At  $I_{EFCC} = 12$  kA.turns.

From Shaing, PoP 2003, Zhu et al, PRL 2006 the NTV causes a slowing:-

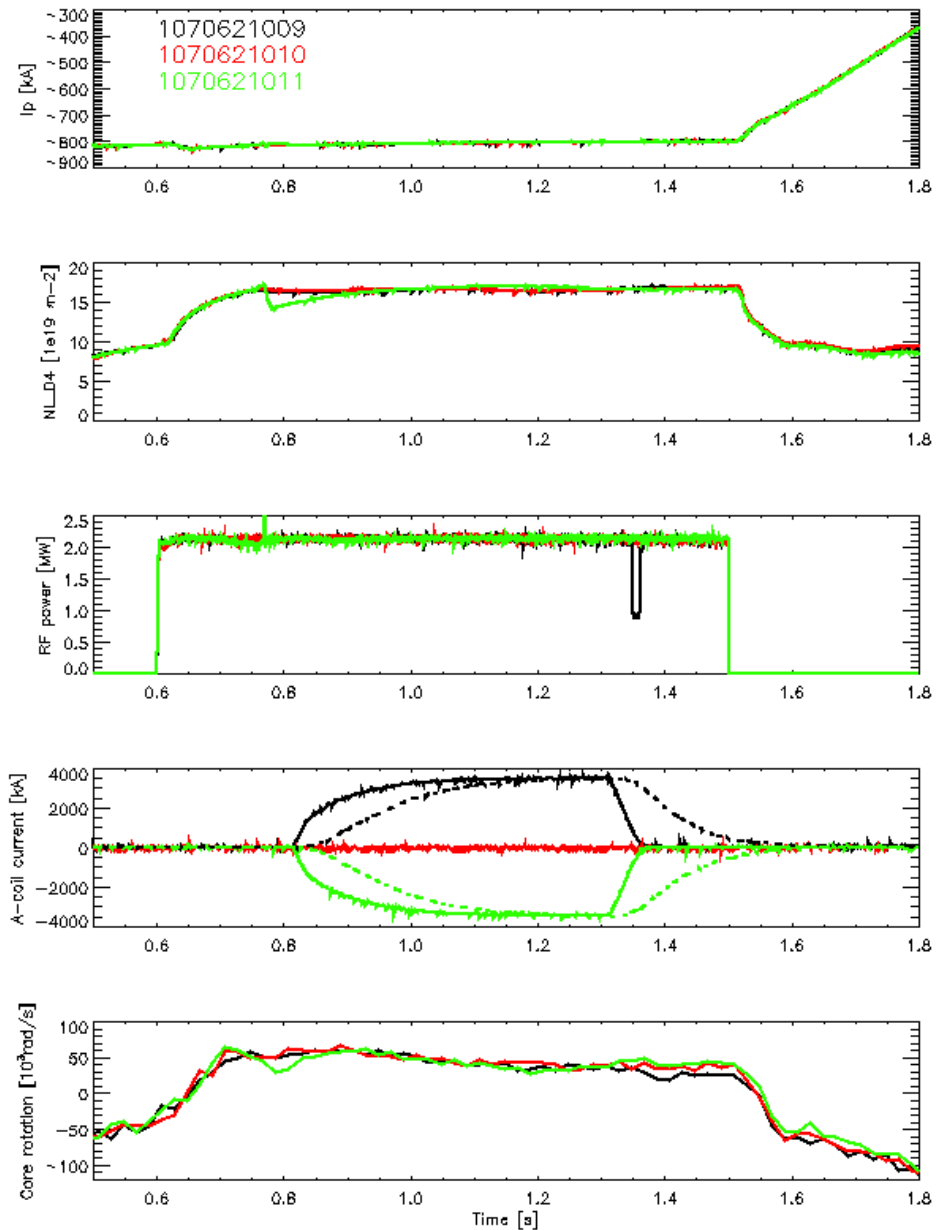
$$\frac{\partial \Omega_\phi}{\partial t} \approx -1.74 B_\phi \epsilon^{1.5} \frac{P_i}{\rho_m v_i} \left\langle \frac{1}{B_\phi} \right\rangle \left\langle \frac{1}{R^2} \right\rangle \sum n^2 |B_{m,n} / B|^2 W_{m,n} (\Omega_\phi - \Omega_{NC}^*) \quad (\text{collisionless})$$

$$\frac{\partial \Omega_\phi}{\partial t} \approx -1.77 B_\phi^0 R B_\phi q \frac{P_i}{\rho_m V_{Ti}} \left\langle \frac{1}{B B_\phi} \right\rangle \left\langle \frac{1}{R^2} \right\rangle \sum n^2 |B_{m,n} / B|^2 \frac{1.365}{1.18 v_i \frac{R^0 q}{V_{Ti}} + 1.365 |m - nq|} (\Omega_\phi - \Omega_{NC}^*) \quad (\text{collisional})$$

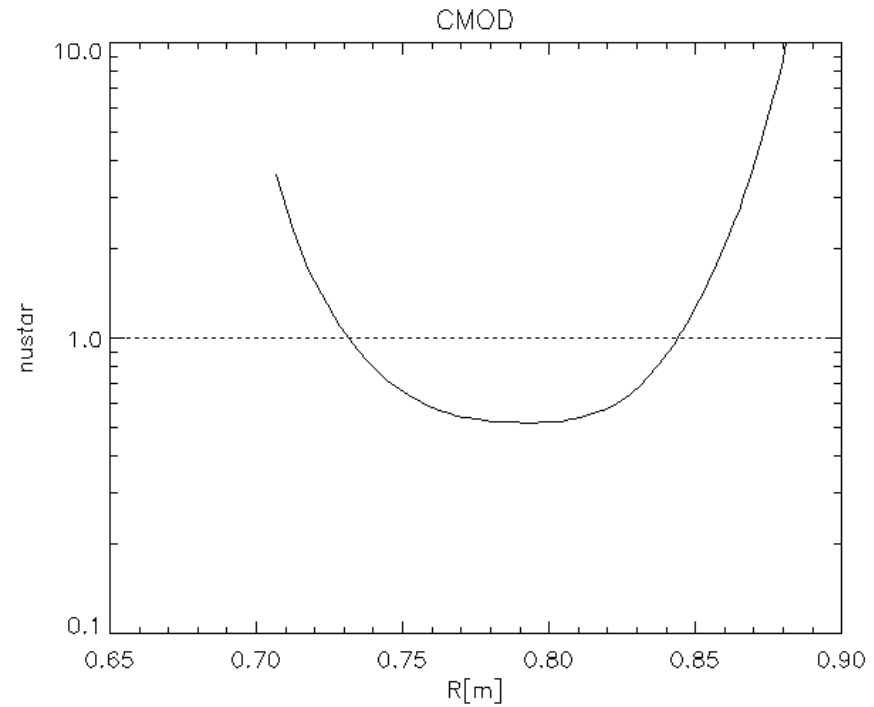
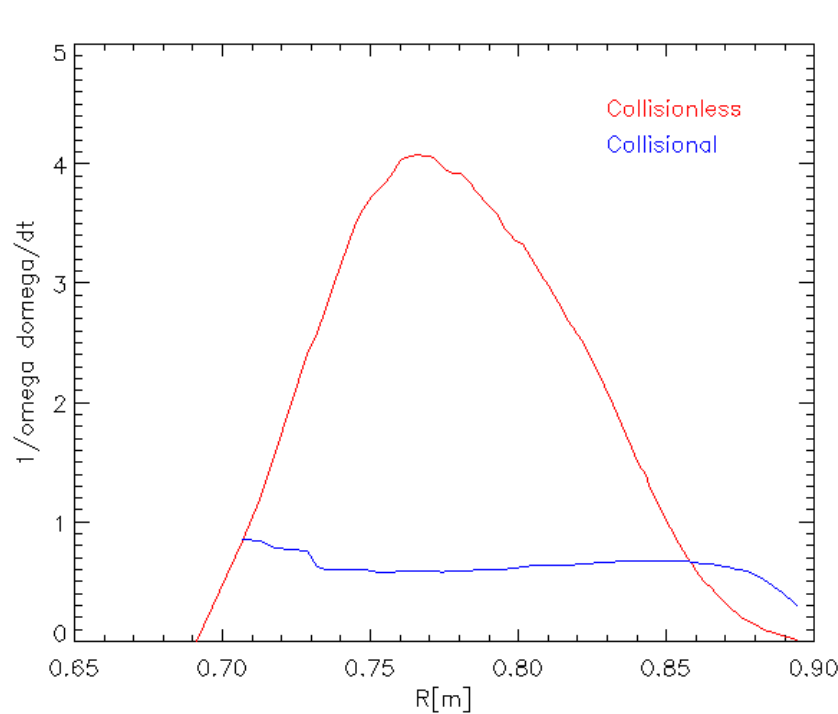


The experimentally observed braking lies between that predicted for the two regimes, although it is closer to that of the collisional model.

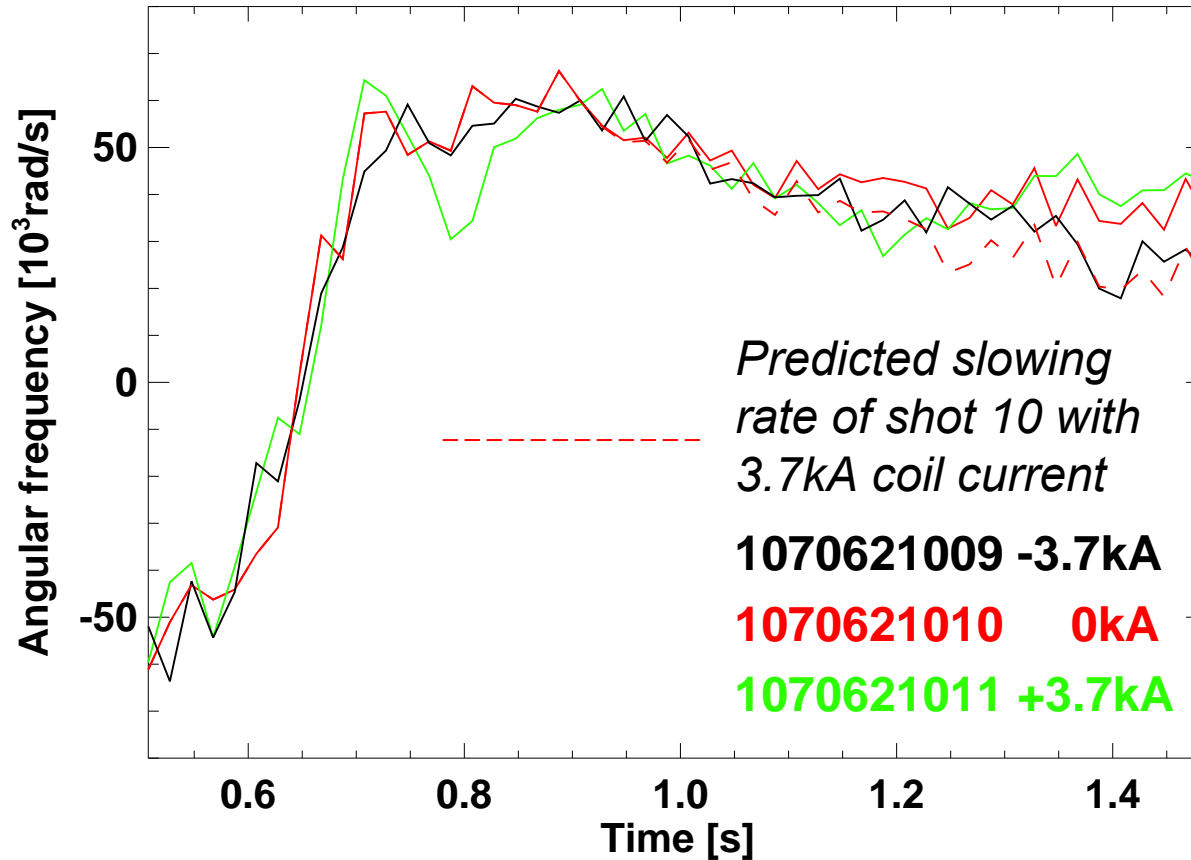
- We obtained a set of three discharges which are well matched in  $B_t$ ,  $I_p$ , density and RF power.
- The A-coil current was varied between +3.7kA and -3.7kA
- No significant effect on plasma rotation was observed.
- One notable difference in the experiments on JET and C-Mod is that the JET rotation is beam driven, while the C-Mod rotation is not.



Theory predicts the braking on C-Mod to be about a factor of 2 greater than on JET. If the experimental value on C-Mod behaves in a similar way to that on JET  $\Rightarrow (1/\Omega_\phi)d\Omega_\phi/dt \sim -1.0/s$  in the core on C-Mod



## Inferred rotation decrease is low



$$\frac{1}{\Omega_\phi} \frac{\partial \Omega_\phi}{\partial t} \propto \frac{T_i^{5/2}}{n_i}$$

(collisionless)

$$\frac{1}{\Omega_\phi} \frac{\partial \Omega_\phi}{\partial t} \propto T_i^{1/2}$$

(collisional)

- Getting new data at higher  $T_i$  and lower  $n_i$  would help in the collisionless regime, although the improvement is smaller for a collisional plasma. The braking is also low due to the short time at coil current flat-top.

# EFDA JET Initial MAST results

Initial results on n=2 braking have been obtained on MAST.

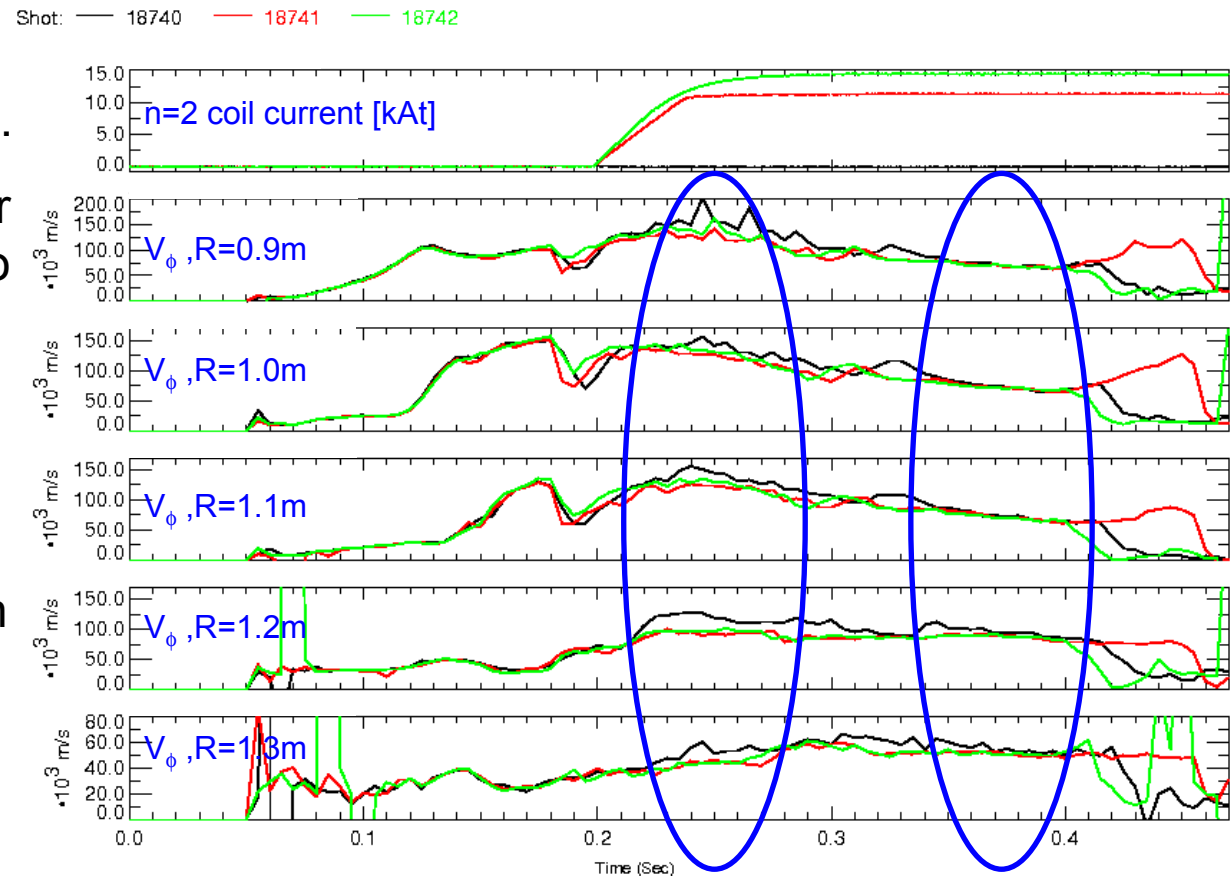
Used one pair of coils for error field correction and one pair to create n=2 fields.

Same shot repeated with different levels of n=2 error field.

An initial drop in rotation when the n=2 field is switched on, but rotation the same in all three shots at a later time.

Observed level of braking much smaller than that expected from theory.

Needs further investigation.



- Experiments have been carried out on JET, C-Mod and MAST to measure the effect of n=2 error fields on toroidal rotation.
- JET results show significant braking. A quantitative match to NTV theory has yet to be made, but it is within a factor of 2 of the prediction of the collisional theory.
- Theory predicts that the braking rate on C-Mod should be larger than on JET for the same  $B_{\text{applied}}/B_0$ , but no significant effect was seen in the experiment.
- Modelling confirms that the error field waveforms used in the C-Mod experiments would only have had a small effect as the error field current was only in flat-top for a short time.
- Initial results on MAST show reduced rotation when the n=2 fields are first switched on, but not at a later time. This needs further study.