DIII-D collaboration activities
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Resistive Wall Mode studies

•Benchmarking

Following the previously reported differences between PEST and GATO analysis results, Turnbull and I agreed to first establish a common point by using a up-down symmetric case where more accurate equilibria are available. This was done for an NSTX equilibrium set where the cutoff flux was varied from 0.99 to 0.999, the details of the profiles are shown in figure 1. The stability analysis indicates a dependence on the cutoff flux with marginal stability for $\psi/\psi_{\rm sep}$ ~0.993, see figure 2. A convergence study with PEST-2 including data from the stable side is shown in figure 3. The corresponding analysis using GATO is shown in Fig. 4. GATO converges from the unstable side and when $\psi/\psi_{\rm sep}$ exceeds 99.35 there is no unstable mode. In fact even the 99.35 case converges to a stable value. This implies excellent agreement for the marginal stability point between the two codes for this sequence of equilibria.

•EFIT mapper debugged

Treating the symmetric case as though it was an up-down asymmetric case, and errors related to the mapping of the EFIT equilibrium were identified and corrected. This resolved the approach of correctly treating up-down asymmetric EFIT equilibria. These changes were implemented and I re-examined the single null DIII-D case.

•DIII-D shot 92544 at t=1370 ms. revisited.

The plasma profiles are shown in figure 5 . Here only two choices for $\psi/\psi_{\rm sep}$ are shown, 0.99 amd 0.999 in black and red respectively. Note that the only significant difference is in $q_{\rm edge}$ and $q'_{\rm edge}$. Note also that there is significant finite edge current density. The plasma equilibrium flux surfaces as obtained from EFIT are shown in figure 6. The seperatrix is marked in red. Stability analysis was done with PEST-2 and an unstable mode was found even when $\psi/\psi_{\rm sep}$ =0.999. The convergence and growth-rate are shown in Fig. 7. The analysis was repeated with PEST-1 with $\psi/\psi_{\rm sep}$ =0.995, the resulting instability is shown in Fig. 8. The radial structure of the fourier amplitudes is shown in figures 9 and 10 for the cosine and sine terms.

To determine the proximity to marginal stability, we determine the critical wall position where the mode is stabilized. This is shown in figure 11. The stabilizing wall is a conforming wall at a distance b/a where b represents the wall radius and a the plasma radius. The value $b/a = 1$ represents a conducting wall on the plasma surface. This result is not converged, the effect of numerical convergence would be to lower the curve.

Future Work:

Benchmark the JSOLVER interface to GATO

Edge current effects

This starts a new scope of work with Ed Lazarus to examine the effect of different current rampe rates. Two shots have been identified, the EQDSK files are g097741.01604 and g097743.02304. The profiles are shown in Fig. 12. As can be seen g097741 has a a significantly hump in the edge current density, however g097743 has a slightly larger edge current density. Note also that both cases have $q < 1$ on axis, and further g097743 has ver weak shear in the core. Preliminary analysis of these equilibria indicates that g097443 is at marginal stability to an $n/m = 1/1$ internal kink and an external peeling mode. The latter feature depends on the value of q_{edge} , which in turn depends on the choice of plasma-vaccum interface as the q_{edge} varies between 2.96 and 3.92 as ψ/ψ_{sep} varies between 0.995 and 0.999. In contrast 97441 has a slightly higher q_{edge} ,($\sim$3.3), and is stable to the internal kink. However if the B-field is scaled to make q_{edge} less than 3 then an external kink is driven unstable.

Future Work:

Modifying the profiles to avoid having $q_{\text{axis}} < 1$ and repeating the analysis.

User friendly PEST

An IDL based user-friendly version of PEST is under development. The goal is to access EFIT equilibria from the MDSplus database and provide a rapid analysis of low$n$ stability to ideal modes. This project overlaps several devices which use EFIT and the MDSplus system. R. Granetz from teh CMOD group is helping on the MDSplus interface. Once the benchmarking is complete this tool can be nmade available to interested experimentalists.

Future Work:

Complete the testing of this tool and then provide instructions for its use.

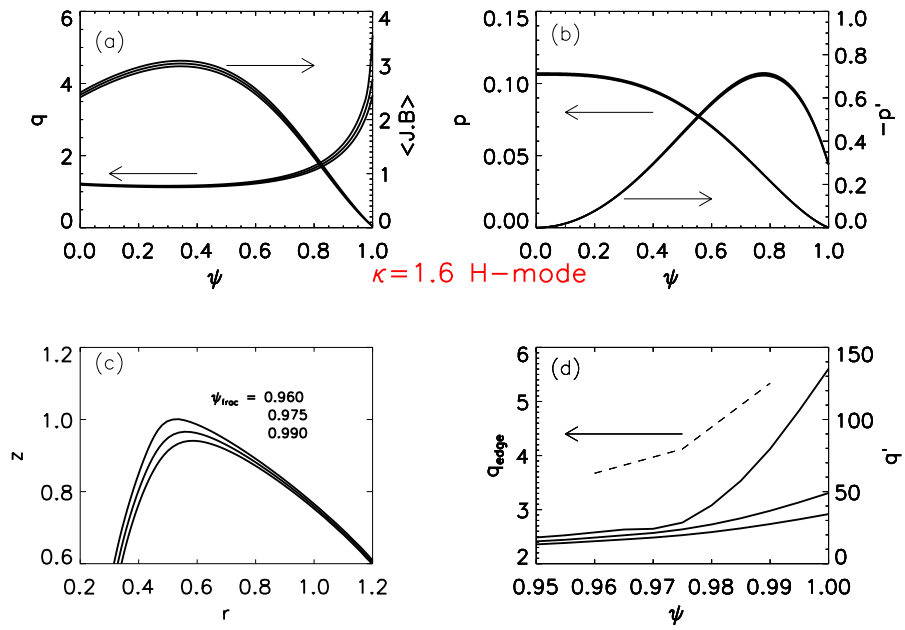


Figure 1: Profiles for an up-down symmetric NSTX equilibrium

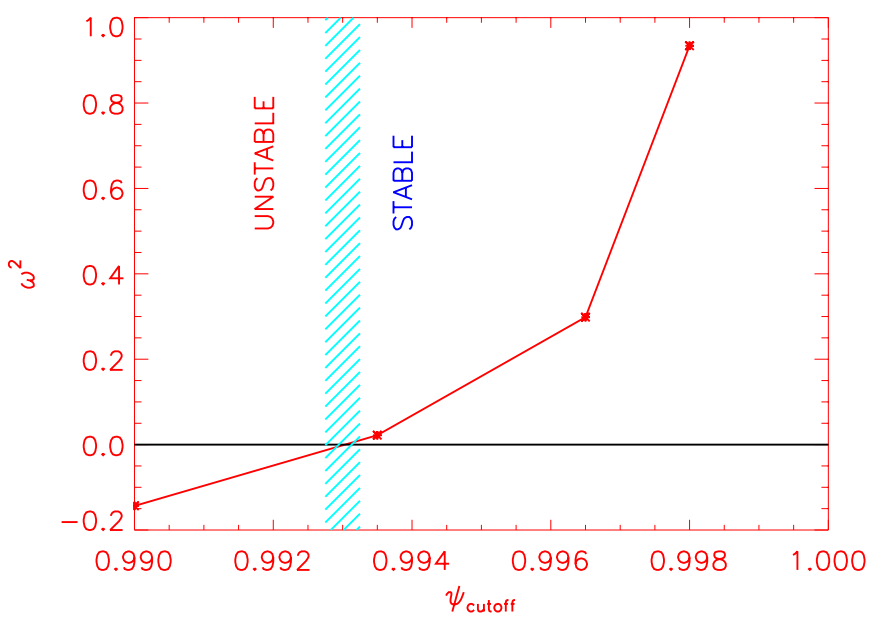


Figure 2: Marginal stability from PEST using converged growth-rates

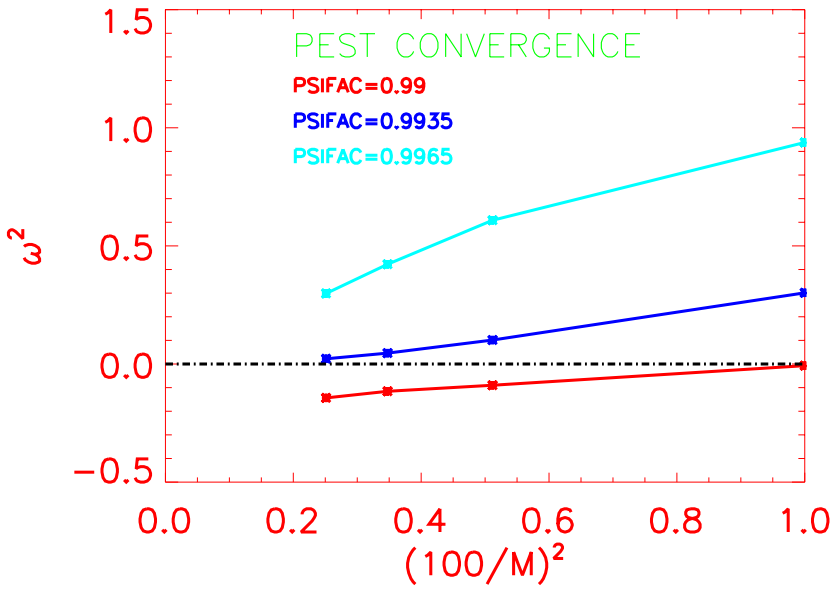


Figure 3: Results of a convergence study from PEST

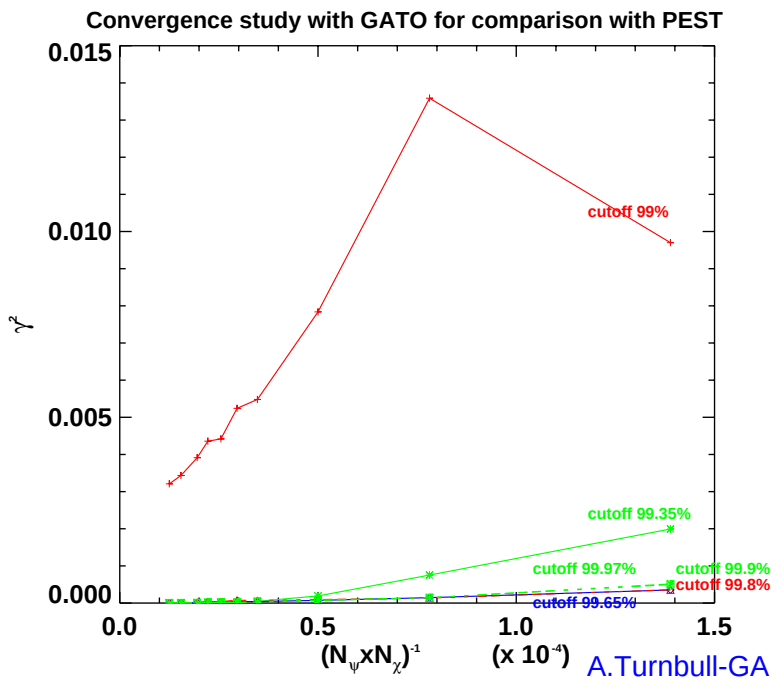


Figure 4: Results of a convergence study from GATO- Courtesy of Turnbull

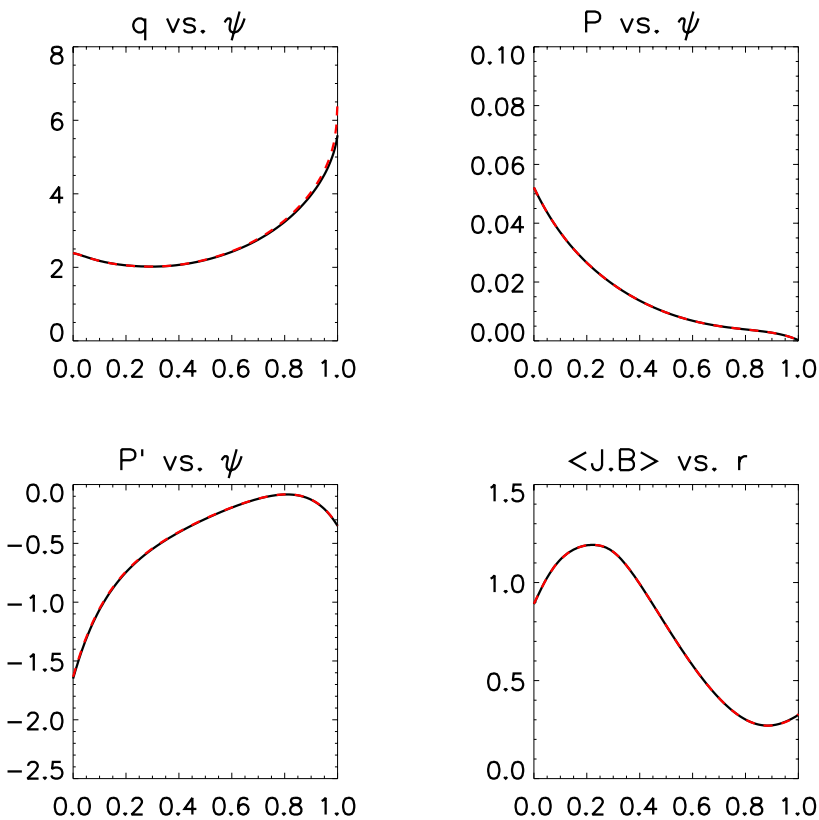


Figure 5: Profiles of the DIII-D resistive wall mode case

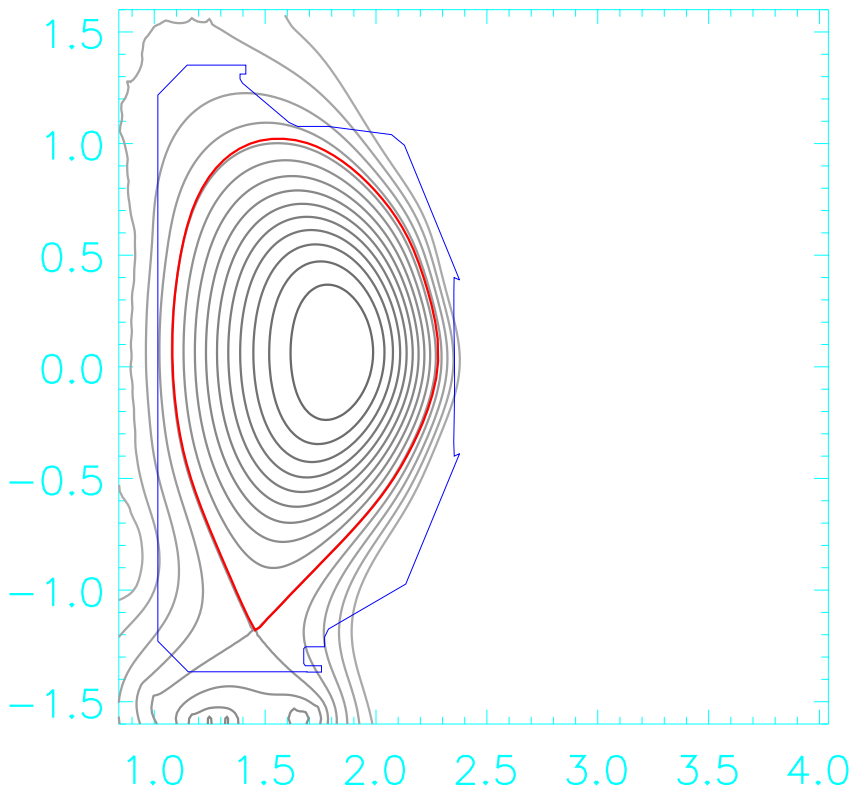


Figure 6: Flux surfaces for the DIII-D resistive wall mode case

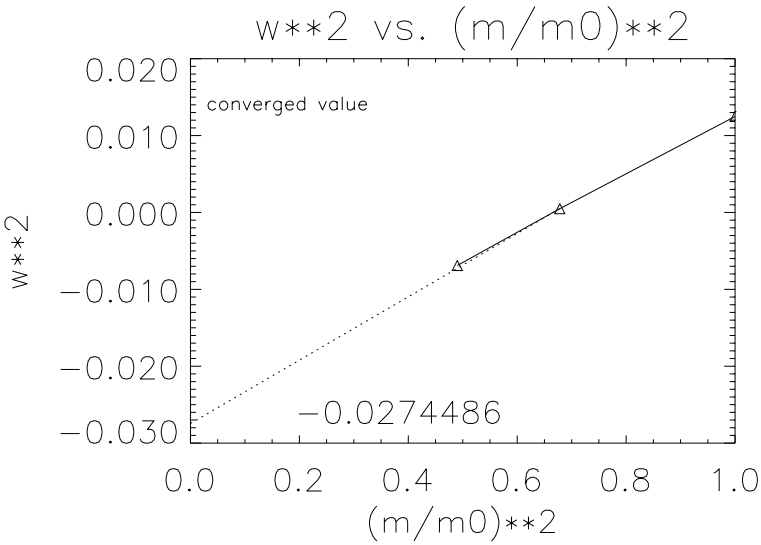
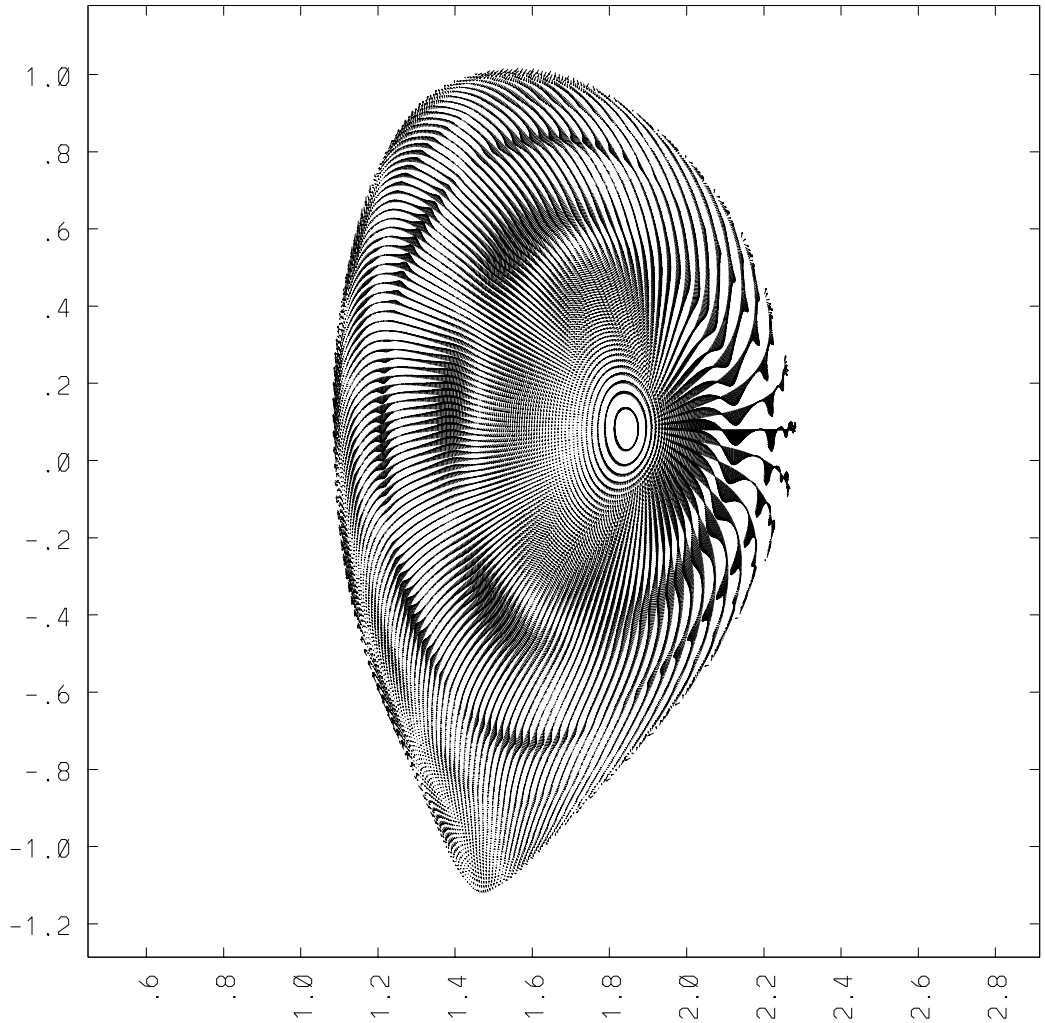


Figure 7: Convergence study for the growth-rate when $\psi/\psi_{\rm sep}$ =0.999



I=61302 EIGENVALUE=-0.16804E-02 PHI IN DEG. 0.00000E+00

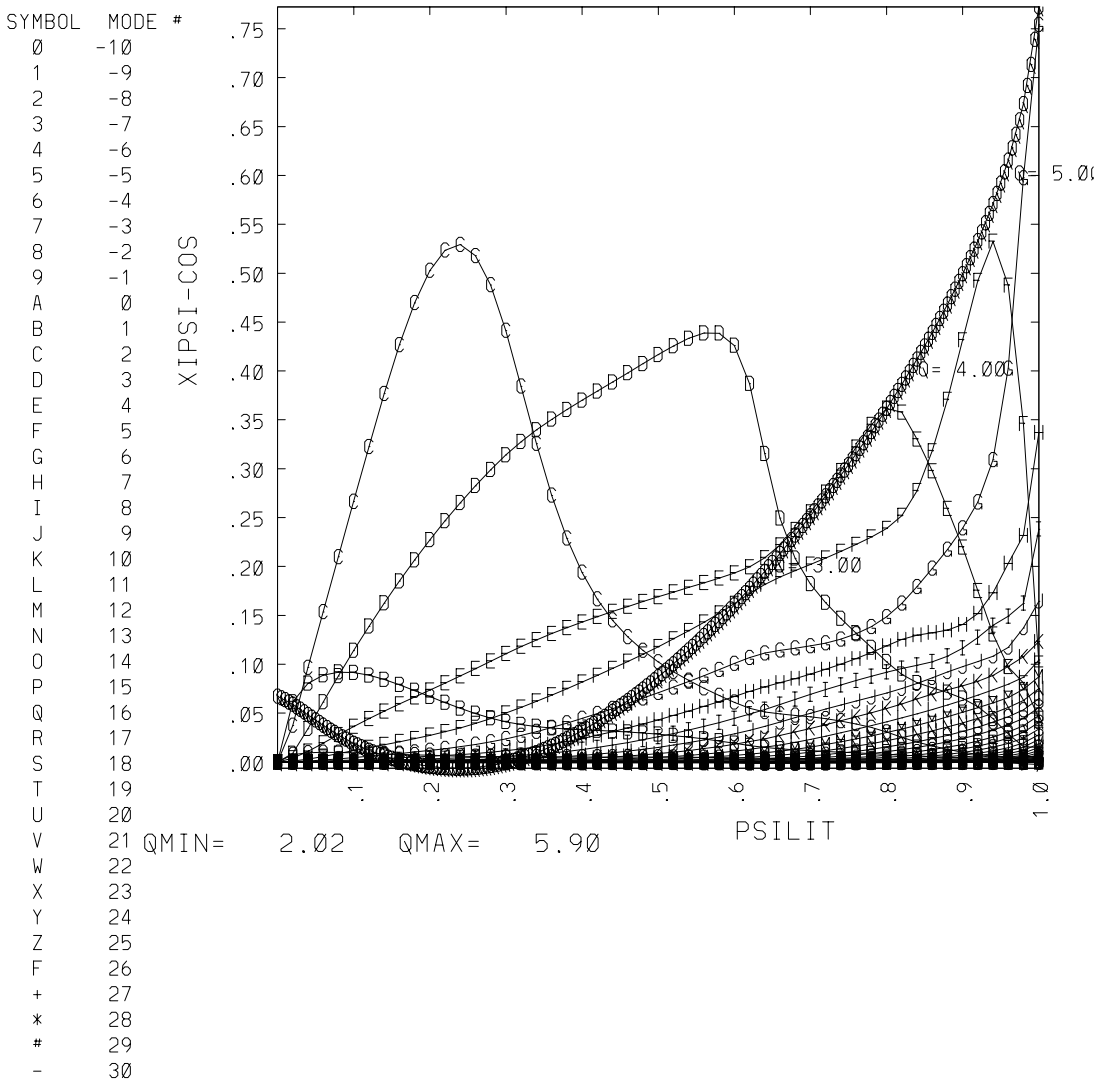


Figure 9: Fourier amplitudes of the Cosine terms from PEST-1 when $\psi/\psi_{\rm sep}$ =0.995

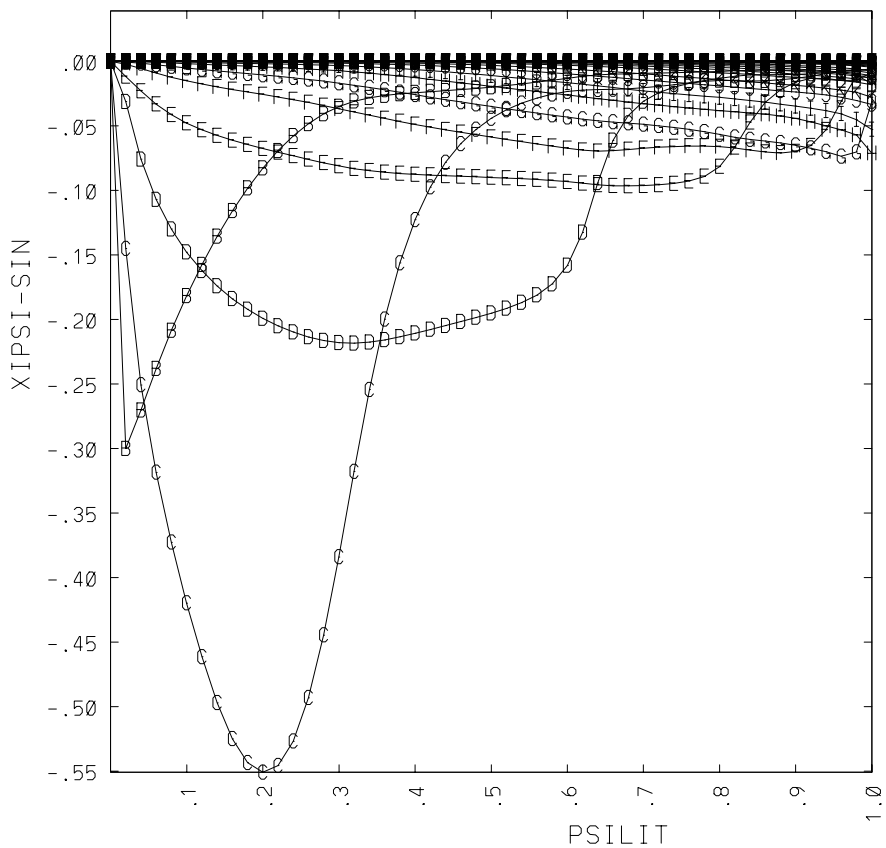


Figure 10: Fourier amplitudes of the Sine terms from PEST-1 when $\psi/\psi_{\rm sep}$ =0.995

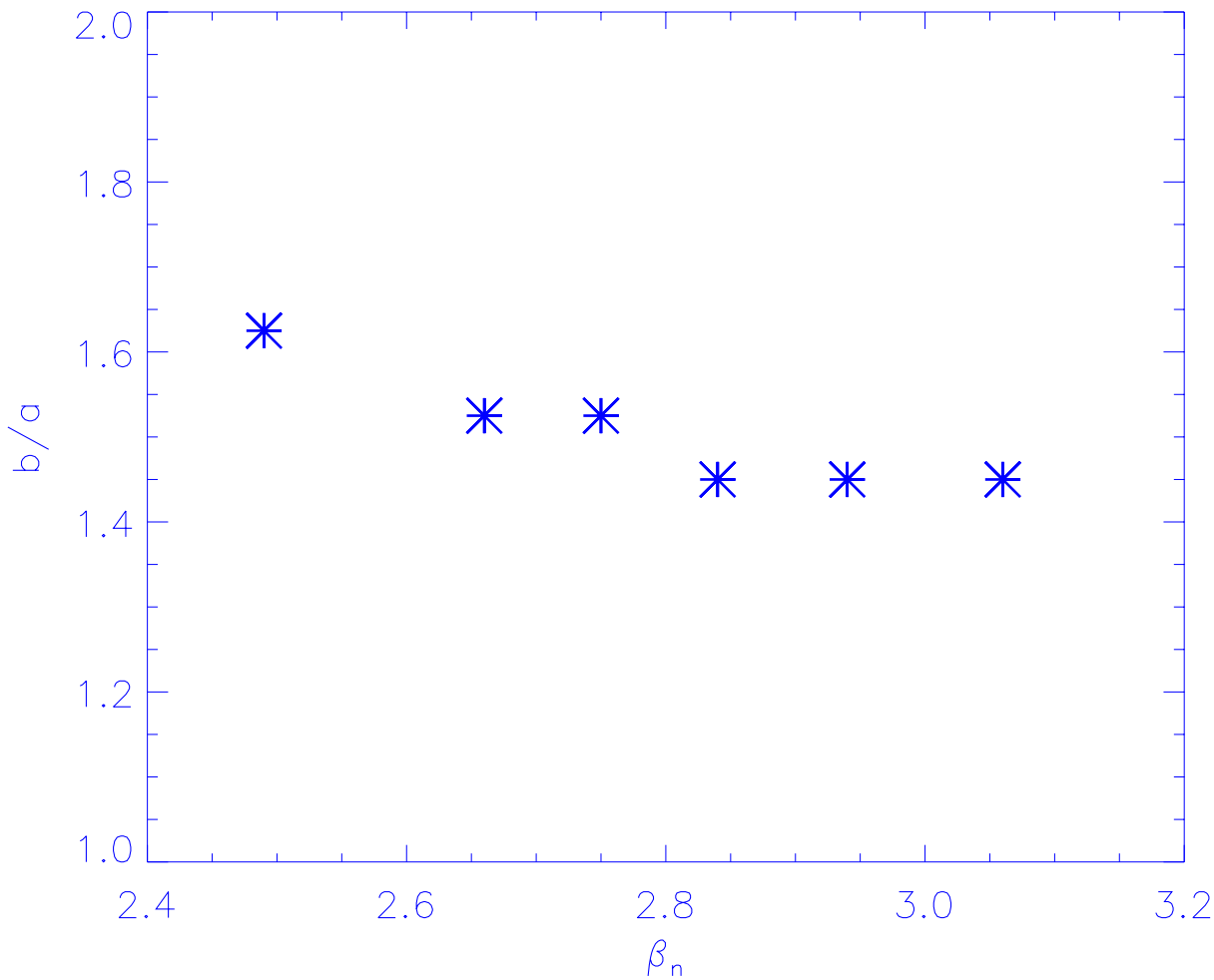


Figure 11: Dependence of the critical wall distance as the B-field is scaled, the X-axis shows the normalized β , the Y-axis the ratio of b/a, when $\psi/\psi_{\rm sep}$ =0.999

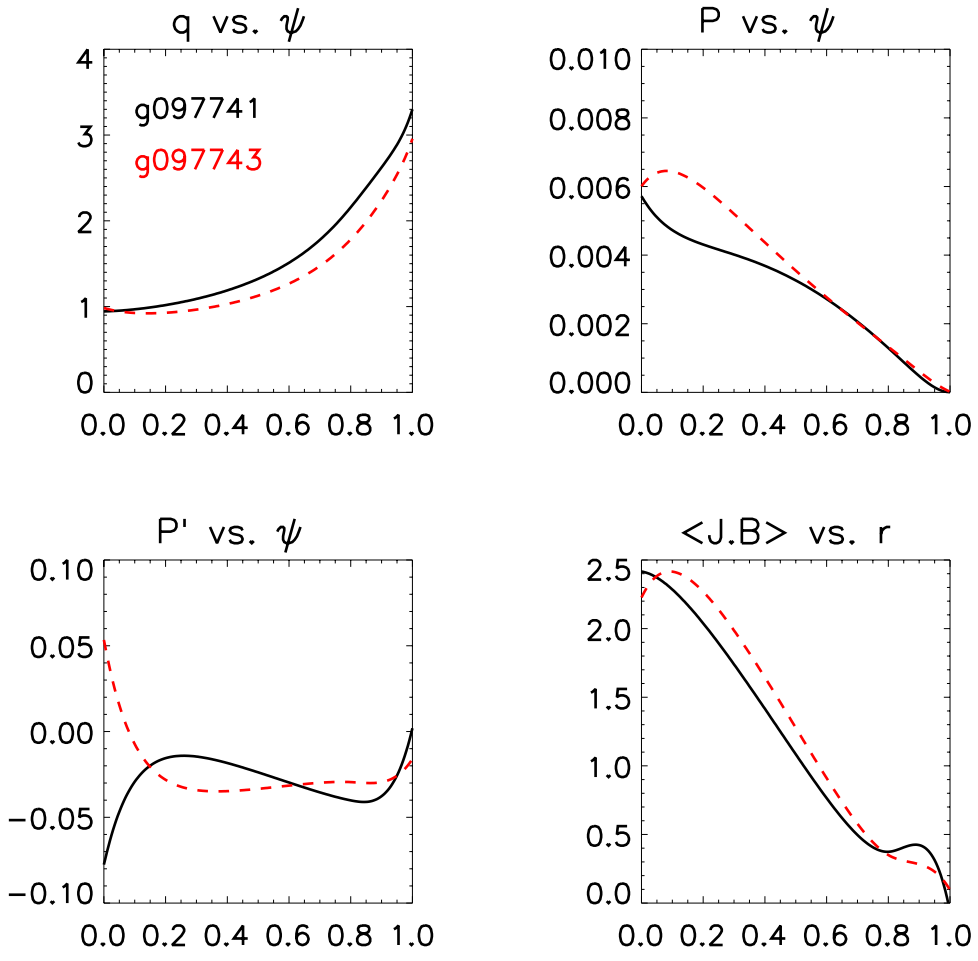


Figure 12: Profiles for shots g097741 and g097743