Physics Flexibility using 18M5PF Coilset

Neil Pomphrey, NCSX Project Mtg 28-29 August 2001

Modular coils and TF coils: coils.li383_0711a2

(see /u/ftp/pub/abrooks/NCSX_COIL_DATA/li383_1.4m/modular/07_11_01)

- 18 modular coils, none on symmetry planes => 6 coils/period, 3 independent currents (c.f. 4 for M1017 coilset of PVR…… Have we lost significant flexibility?…… **NO!)**
- 18 discrete TF coils (1/R, treated as single circuit)

PF coils (W. Reirsen:010621_Improved 5 coil PF design.ppt + subsequent tweaking by D. Williamson)

Coils file with entire system of coils is named **coils.li383_0711a2w1tf** stored (together with mgrid file) in /scr3/rhatcher/public/ on hecate.

We test the ability of the coil system to produce configurations corresponding to the corners of flexibility space identified in Ch 9 of PVR. For a full discussion of what this involves see my presentation "PF Coil Flexibility – Status Report" in NCSX Project Mtg., 24 July 2001.

CALCULATIONS ARE PERFORMED FOR THE 1.4m DESIGN

Results Summary

1. **A kink/balloon stable s3 state with I_p = 174 kA, β = 4.2%**

was prepared by varying currents in M1, M2, M3, P3, P4, P5, T1 (each of the 3 Modulars, 3 out of 5 PF coils (the 3 ring coils), and the TF coil)

→ **χ^2(Bmn) = 7.80/(17.74)^2 =0.0247** run id = li383.s3

2. **An s2 state with I_p = 174 kA, β = 0% was prepared (for ι-scan experiments):**

χ^2(Bmn) = 0.0223 run id = li383.s2

3. **An enhanced β state with I_p = 174 kA, β = 5.0%**

χ^2(Bmn) = 0.0836 (presently trying to improve this by adjusting weights)

run id = li383.i1740b50.rs3

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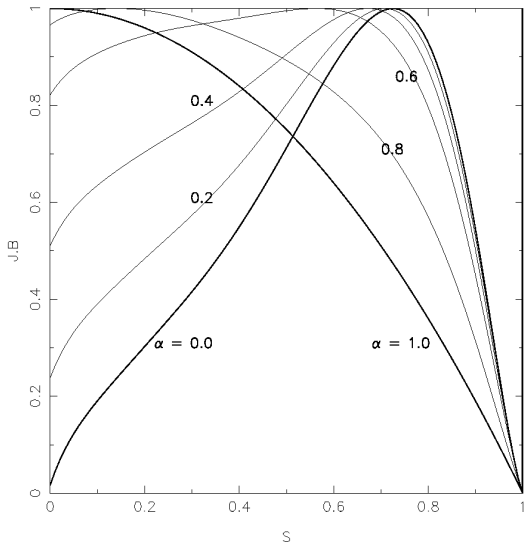
4. **J.B profile variation at I_p = 174 kA, β = 3.0%:**

α = 0.5 was stable! with **χ^2(Bmn) = 0.0477** run id = pvr9.7_a=0.5.rsa.1

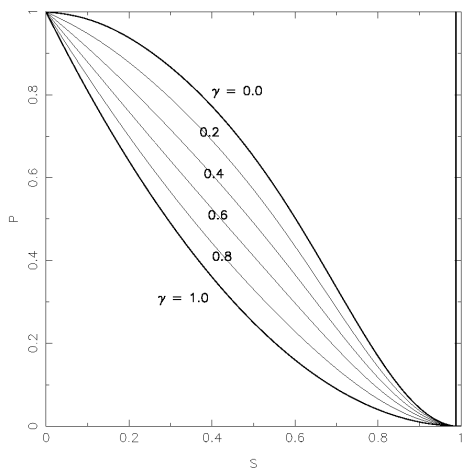


➔ even wider range of stable current profiles than reported for M1017 at PVR!

5. **P profile variation at I_p = 174 kA, β = 3.0%:**

γ = 0.8 stable to kink modes, and stable to Ballooning with exception of 1st radial surface

χ^2(Bmn) = 0.0189 run id = pvr9.9_g=0.8a.rs1



- **Same results as presented at PVR**

6. **I_p – β scan:**

In addition to stable s3, s2 states and the I_p = 174 kA, β = 3.0% state used in the profile variation studies, and the enhanced β case with I_p = 174 kA, β = 5.0%, the following stable states were successfully prepared

I_p = 43.5 kA, β = 1.0% (χ^2(Bmn) = 0.0298) run id = pvr9.4i435b10

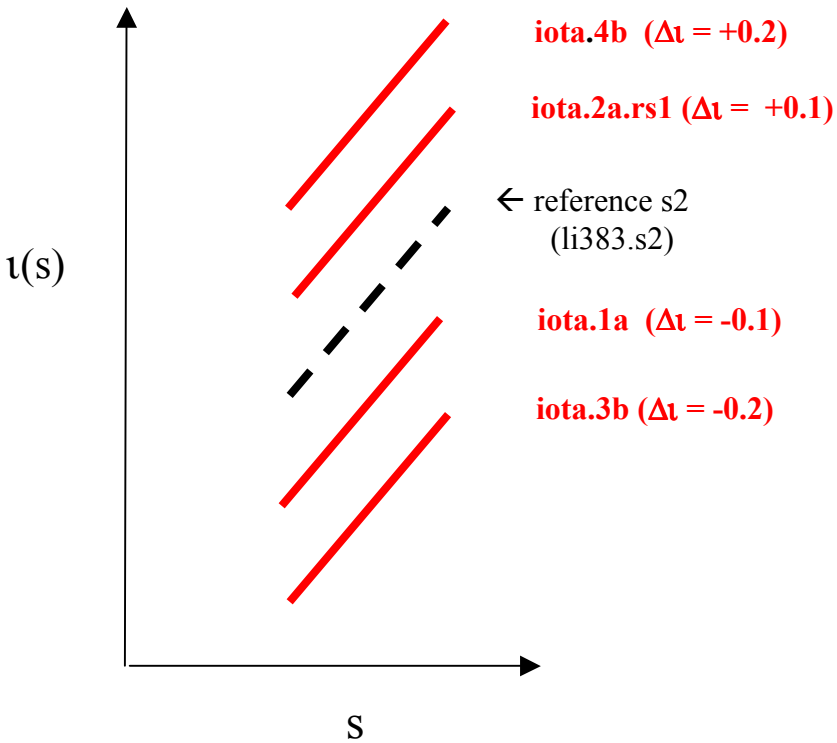
I_p = 43.5 kA, β = 2.0% (χ^2(Bmn) = 0.0242) run id = pvr9.4i435b20

These were used in the PVR to argue that configurations can be developed to study the effect of shape on β –limits at low β using day-1 beam power.

7. **Iota scan experiments**

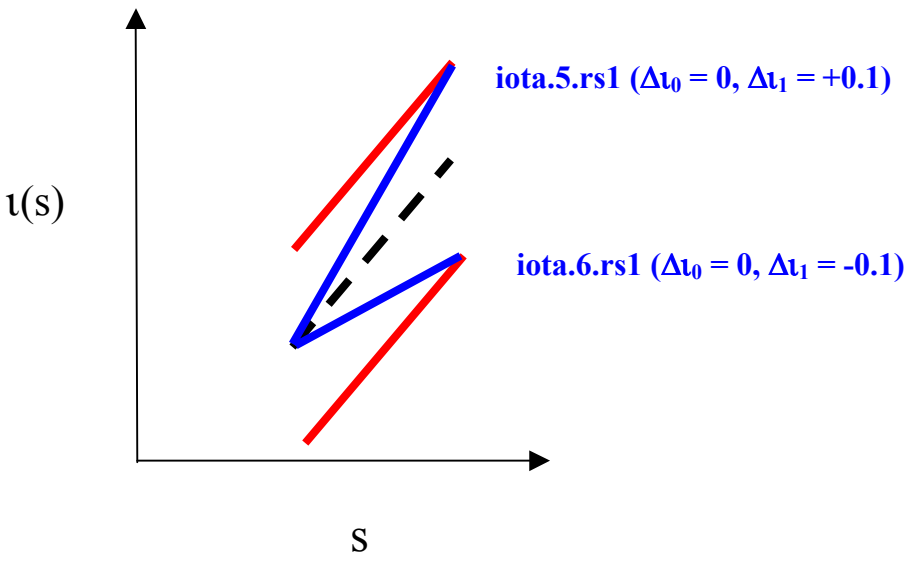
(a) Constant Shear:

Starting from s2 state (ι_0 = 0.37, ι_1 = 0.66), 18M5PF has successfully produced configurations with $\Delta\iota(s)$ = ±0.1, - 0.2 (+0.2 run incomplete)



(b) Shear change

Starting from s2 state, keep ι_0 fixed and raise/lower ι_1 by ±0.1



8. **Good quality of ohmic field from the 5 PF coils:**

- An ohmic field distribution was derived for the 5 PF coils by minimizing $|B_{pol}|$ in a toroidal box $R_{min} < R < R_{max}$, $Z_{min} < Z < Z_{max}$ where $R_{min/max}$, $Z_{min/max}$ are min/max radial and vertical positions of the plasma edge at any ϕ:
  $(I_1, I_2, I_3, I_4, I_5)_{OH} = (1.28 \times 10^6, 1.44 \times 10^6, 2.30 \times 10^5, 7.51 \times 10^4, -7.30 \times 10^4)$[A]
  links 0.5 Wb at R = 1.4 m, Z = 0

- The quality of the ohmic field was tested by adding this I_{OH} to the **s2** coil current solution and verifying that the configuration supported by $I_{s2} + I_{OH}$ overlays in shape and produces the same physics as the s2 configuration.

CONCLUSIONS

- An 18 modular /5PF (18M5PF) + discrete 1/R TF coil set has successfully reproduced a wide range of configurations presented at the PVR using M1017 + 4 multipoles.

- **18M5PF has good flexibility and can adequately reproduce the range of stable plasma configurations with good quasi-axisymmetry presented at the PVR.**

- Calculations which target changes in global shear at fixed ι_0 or ι_1 are still in progress, but preliminary indications are that these too will be successfully reproduced by the 18M5PF.

- **The 5PF coils produce a high quality ohmic field.**

- **A memo will summarize these results in more detail**.