MS XP-805
n=2 Error Fields and RWM Critical Rotation

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XP-805 Applied n=2 Fields to Look For Intrinsic Error Fields*

1: Create a reproducible target plasma
- *Should have an RWM in mid-discharge.*

2: Apply n=2 fields of various magnitudes and phases.

3: Look for improved performance:
- *Increased rotation staves of instability, leading to…*
- *Longer pulse length*

4: If n=2 fields improve performance, then optimize amplitude and phase.

Side Benefit: Generate RWMs with n=2 braking, complement previous studies with n=1 & 3 braking.

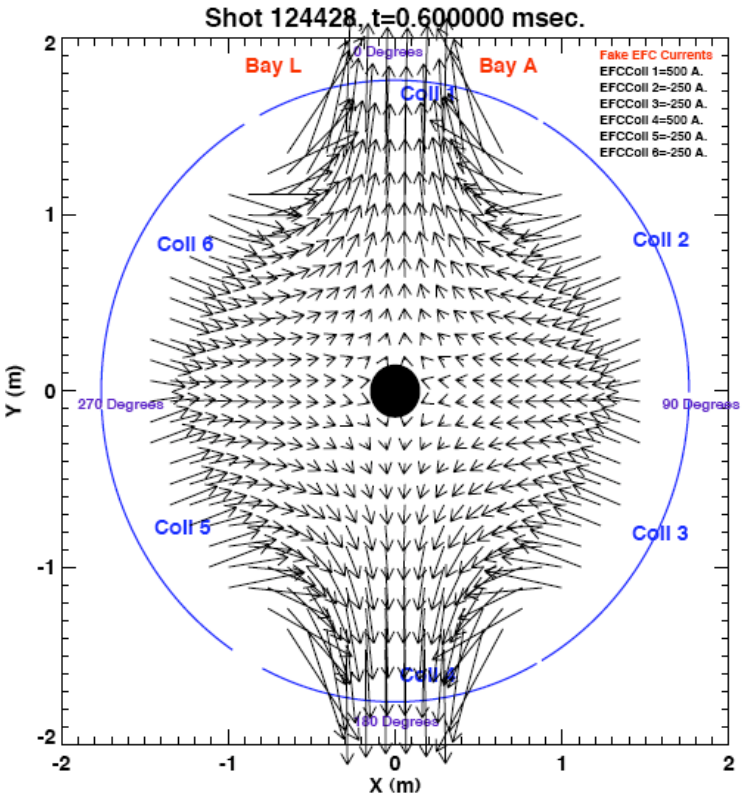
Day 1: Trouble achieving sufficient reproducibility over necessary # of shots in a scan.
- Jitter in H-mode lead to large, yet irreproducible, rotating MHD.

Day 2: Discharge development from XP823 allowed efficient scans.
- Data presented today all from that scan.

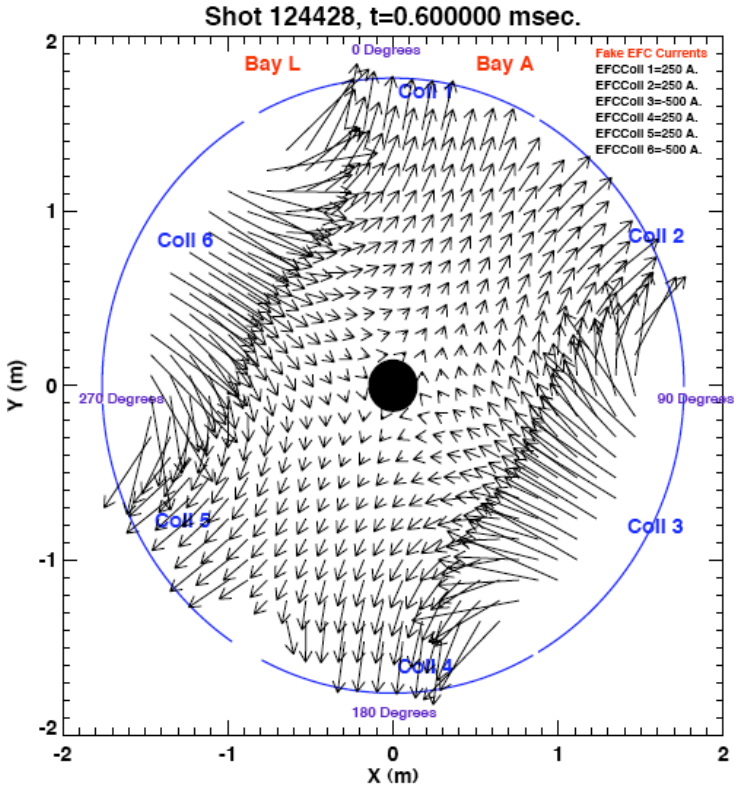
Need a Sign Convention for n=2 Fields

Views From the Top of NSTX

0° Configuration



30° Configuration



Convention Leads to the Following Coil and SPA Currents

Mapping of SPA Units To Coil Pairs

SPA	Coils
1	-3,-6
2	-1,-4
3	-2,-5

- Positive Coil Field Points Out of the Vessel
- Positive SPA Current Leaves the Positive Terminal

Mapping of n=2 Phase to Coil And SPA Currents

Phase	Coil1	Coil 2	Coil 3	Coil 4	Coil 5	Coil 6	SPA1	SPA2	SPA 3
0	1	-1/2	-1/2	1	-1/2	-1/2	1/2	-1	1/2
30	1/2	1/2	-1	1/2	1/2	-1	1	-1/2	-1/2
60	-1/2	1	-1/2	-1/2	1	-1/2	1/2	1/2	-1
90	-1	1/2	1/2	1	1/2	1/2	-1/2	1	-1/2
120	-1/2	-1/2	1	-1/2	-1/2	1	-1	1/2	1/2
150	1/2	-1	1/2	1/2	-1	1/2	-1/2	-1/2	1

XP805 Day 2 Shot List

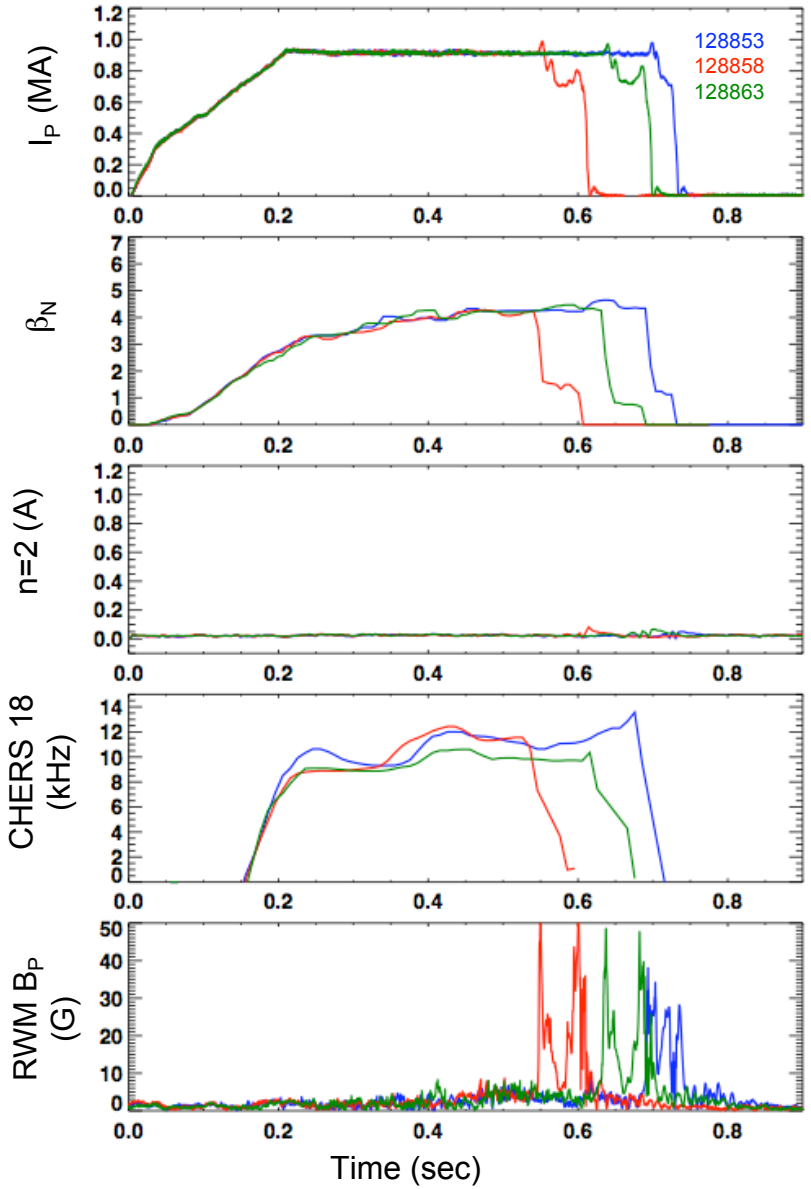
Shot	n=2 Amplitude	n=2 Phase	Note
128852	0	NA	Fiducial
128853	0	NA	
128855	500	120	
128856	500	30	
128857	500	60	Very long, repeated below to verify that it is a fluke
128858	0	NA	Reference Shot
128859	500	150	
128860	500	0	
128861	500	90	
128862	500	60	Repeat of 128857, short
128863	0	NA	Reference Shot
128864	1000	60	
128865	1000	150	
128866	1000	0	
128867	1000	90	
128868	1000	120	No CHERS
128869	1000	30	No CHERS
128870	500	60	Repeat of 128857, short, No CHERS

3 Reference Shots Demonstrated Reliable Target Through the Day

- Three reference shots distributed through scan.
- All three showed “RWM” at intermediate rotation values.
- Range of discharge durations:

$$0.575 < t_{RWM} < 0.7$$

Now Apply n=2 Fields and Look For Faster Rotation, Longer Pulse Lengths!



First Scan Utilized 500 A

Did 500A of n=2 help?…no.

No cases lasted longer than the reference discharges.

Rotation slower than in the reference discharges.

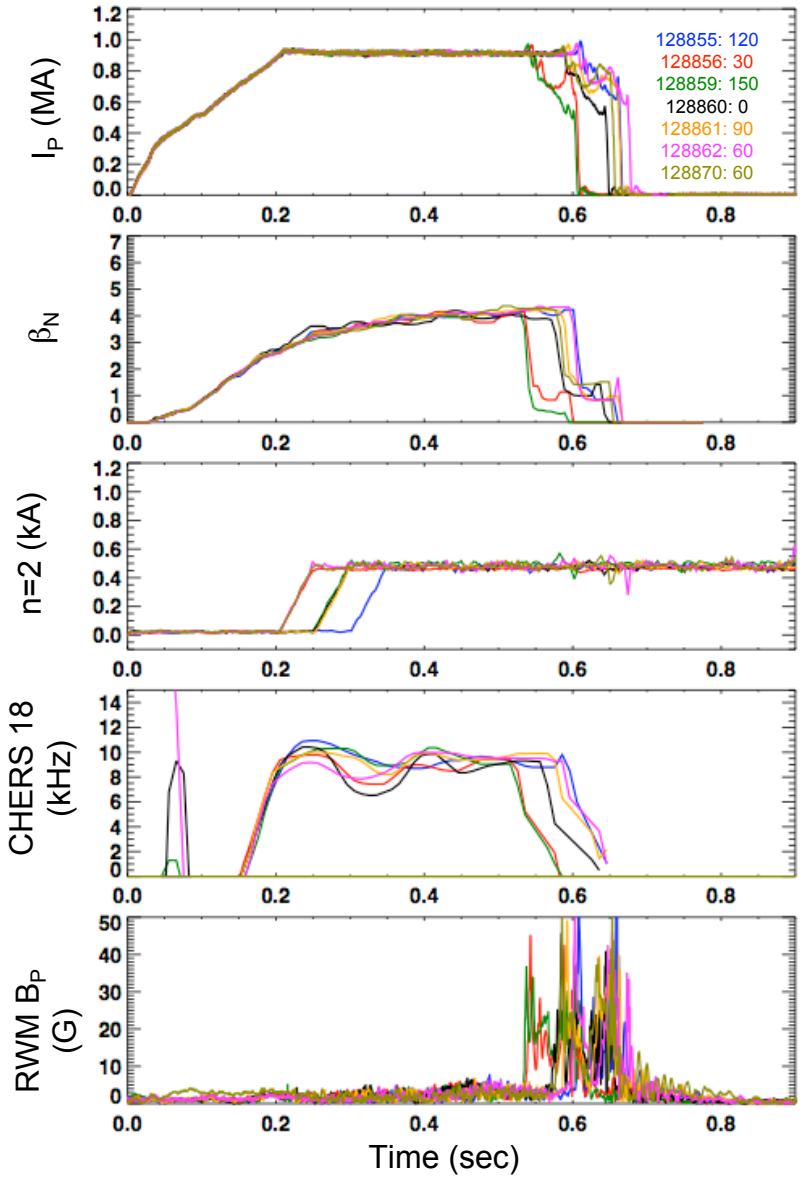
Why? Either…

n=2 EFs are smaller (and we don't care),

or

n=2 EFs are bigger (and we *really* care)

Repeat the Scan With Larger n=2 Fields



1000 A of n=2 Only Shortened the Discharges

Did 1000A of n=2 help?…no!

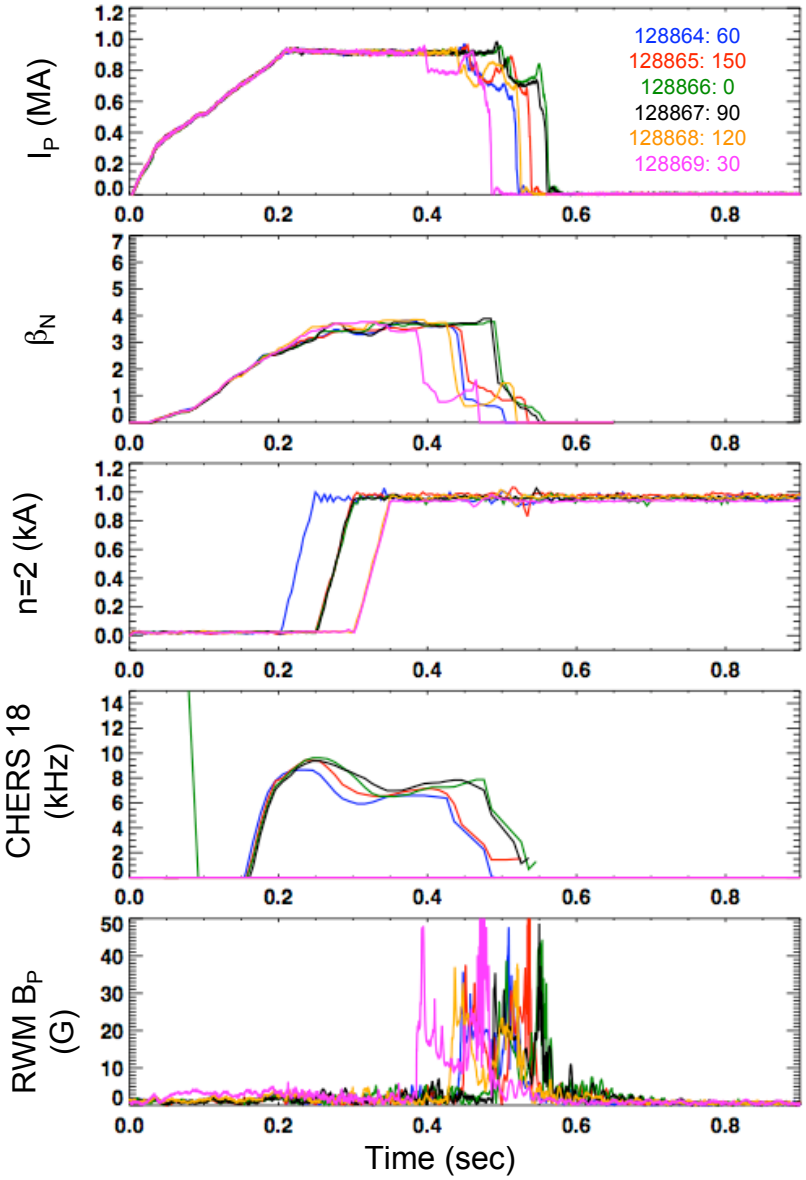
Shot duration was dramatically shortened.

Rotation substantially slower.

So maybe smaller correction is better?

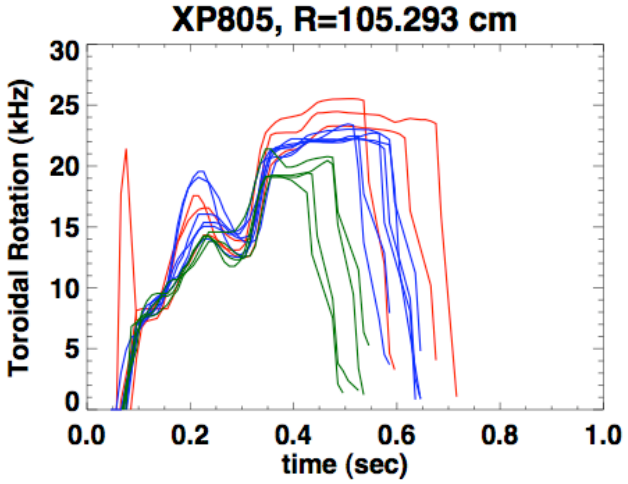
From Day1 Scans at 250A.

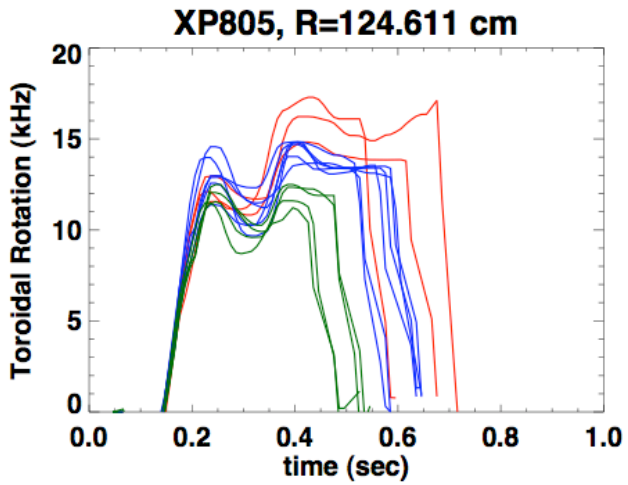
Although data was difficult to analyze due to reproducibility problems, found no benefit for 250A correction.

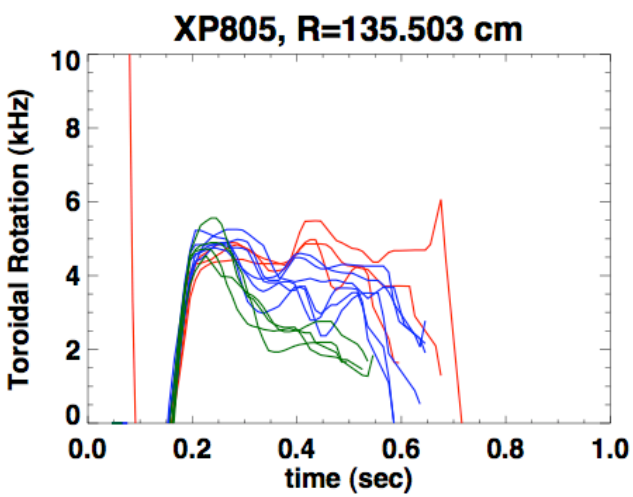


Rotation Is Always Slower with Applied n=2 Fields

Monotonic Decrease in Rotation with Applied n=2 Fields







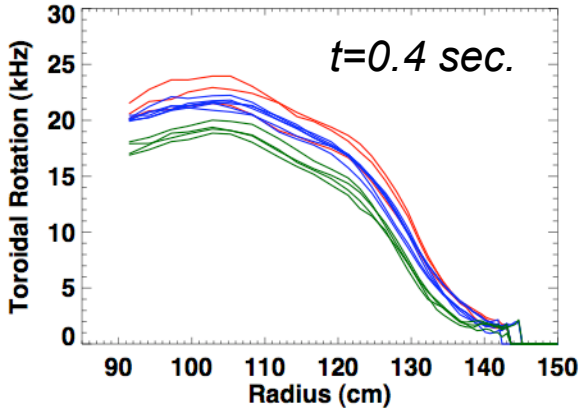
Color Code

3 Reference Shots

7 Shots with 500 A n=2

4 Shots with 1000A n=2

Decrease Occurs Across the Entire Profile



Summary: XP 805

n=2 error fields, if present, are sufficiently small that correcting them does not yield performance benefits.

Discharge duration is not improved, and often degraded, by application of n=2 fields.

Rotation across the entire profile is reduced by application of n=2 fields.

This is "good" news…no need for n=2 correction!