NSTX-U

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NCC Optimization Update

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and the NSTX Research Team

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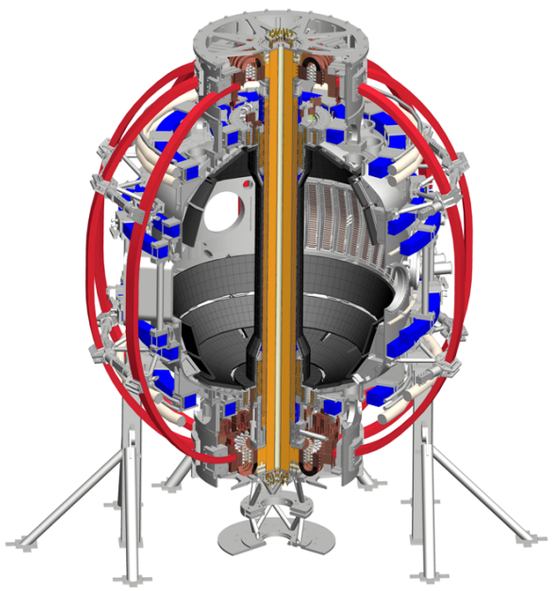

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Progress Review

- The IPECOPT optimizer optimizes the input fields to the IPEC code to target NTV torque profiles as calculated by the PENT code
- Initial work suggested n=1 fields be used to modify core torque density profiles while n=3 fields could be used for edge torque control
- Optimization of the full NCC coil currents indicated similar results
- Additional target equilibria have been examined
- Partial-NCC coil design has been examined
- Work underway to include vacuum island overlap parameter as target

IPECOPT optimizes normal fields to target NTV torque

- Calculates a least squares fit of IPEC input parameters to target physics parameters
  - Based on STELLOPT
  - Multiple optimization techniques
  - Targeting NTV torque as calculated by PENT
  - Fixed and free boundary optimizations
  - Coil current optimization capability

$$\chi^2 = \sum_{i=1}^{m} \frac{\left(Y_i - y_i\right)^2}{\sigma_i^2}$$

m: number of targets

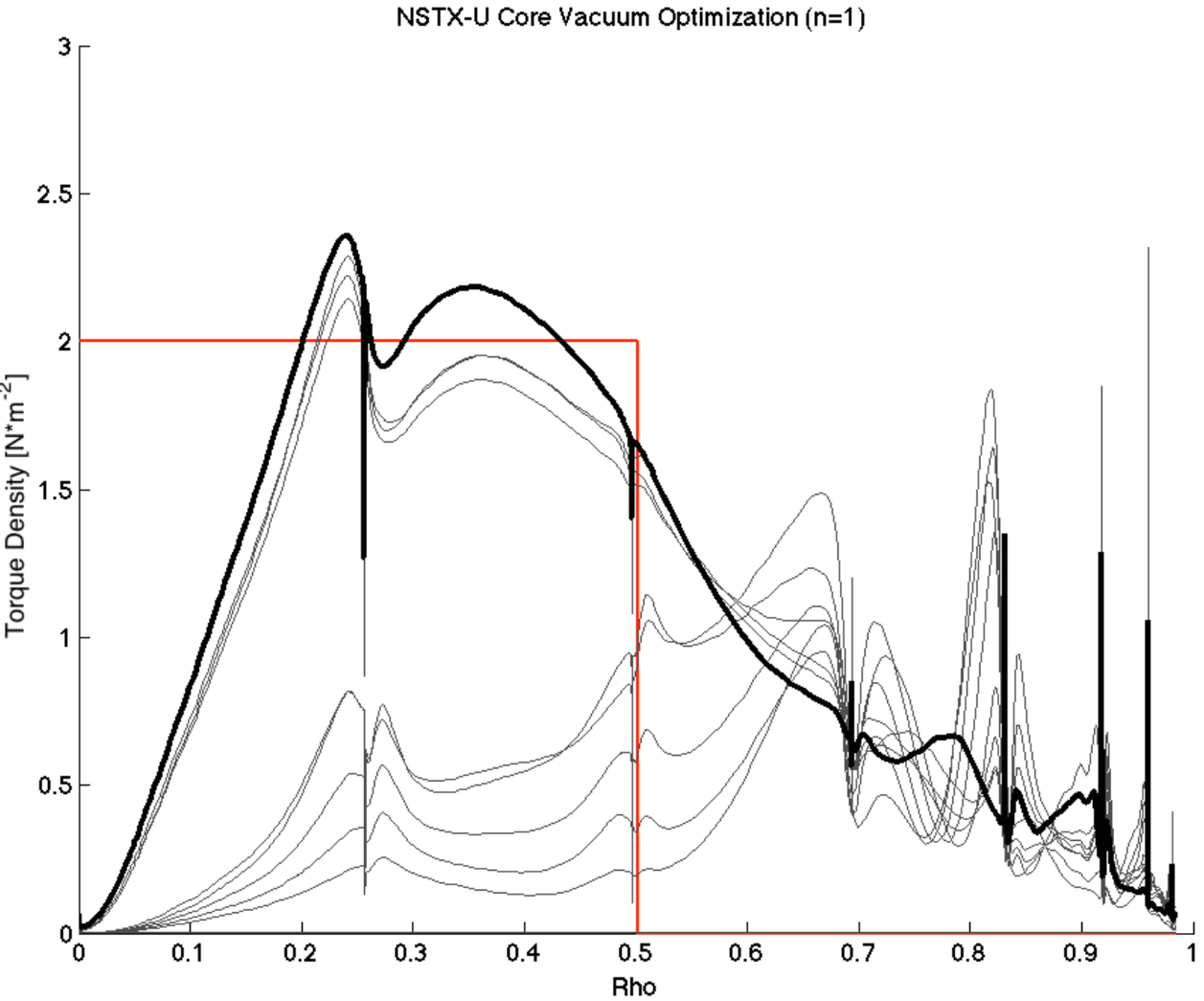
Y: target values

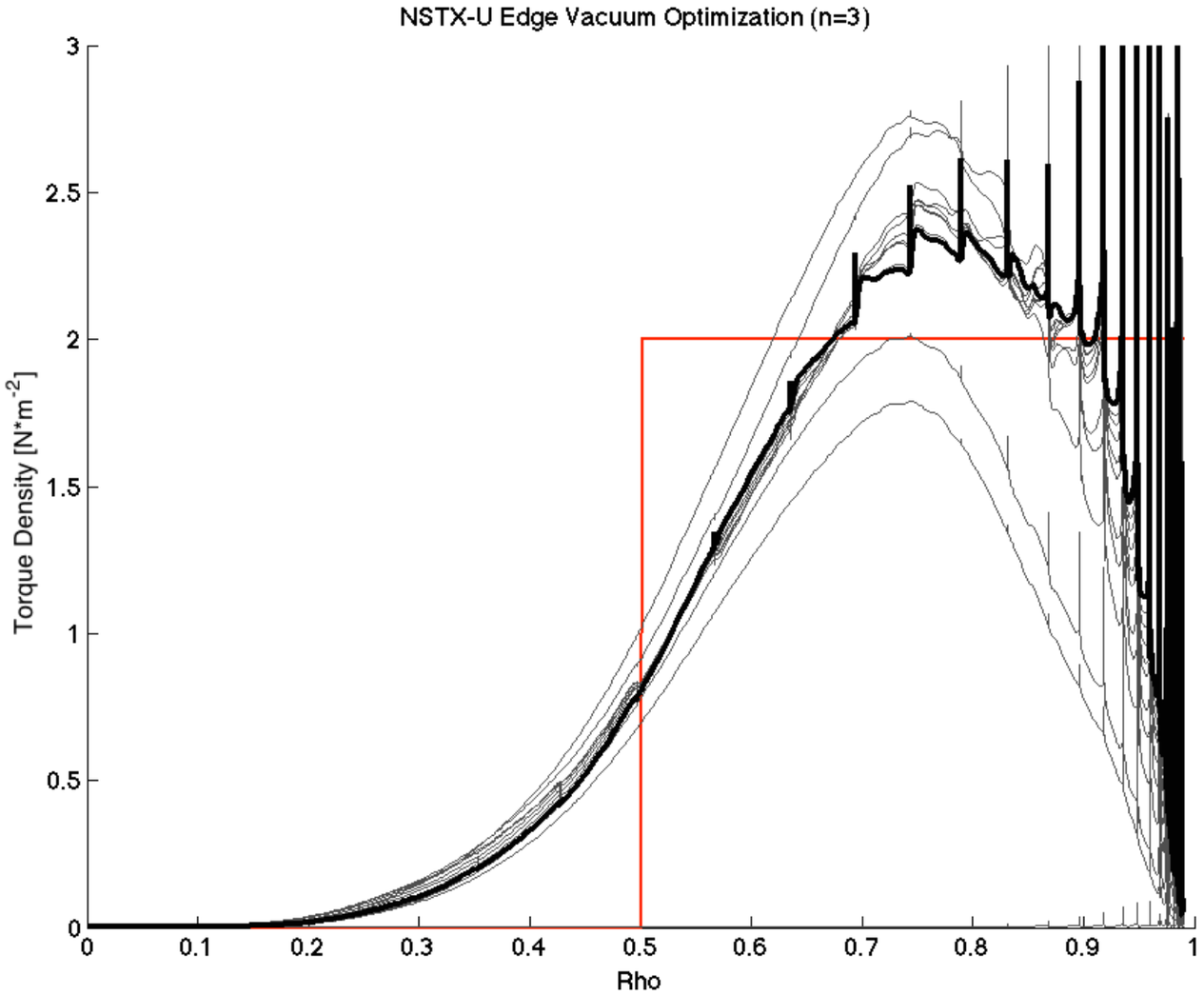
y: simulated values

sigma: weights

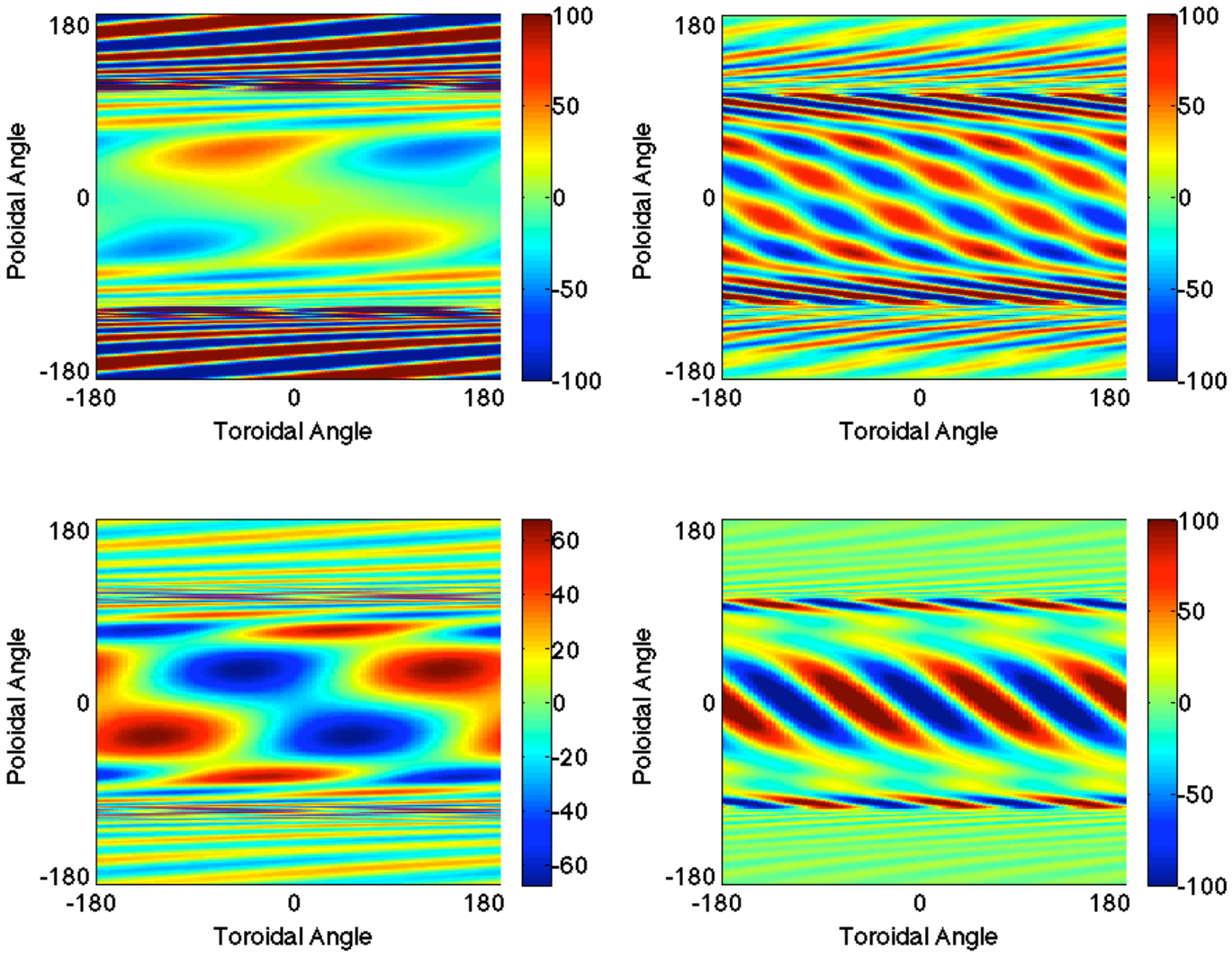
NSTX-U B-normal harmonics were optimized to core and edge torque targets

- Initial work suggests both core and edge profiles could be targeted independently





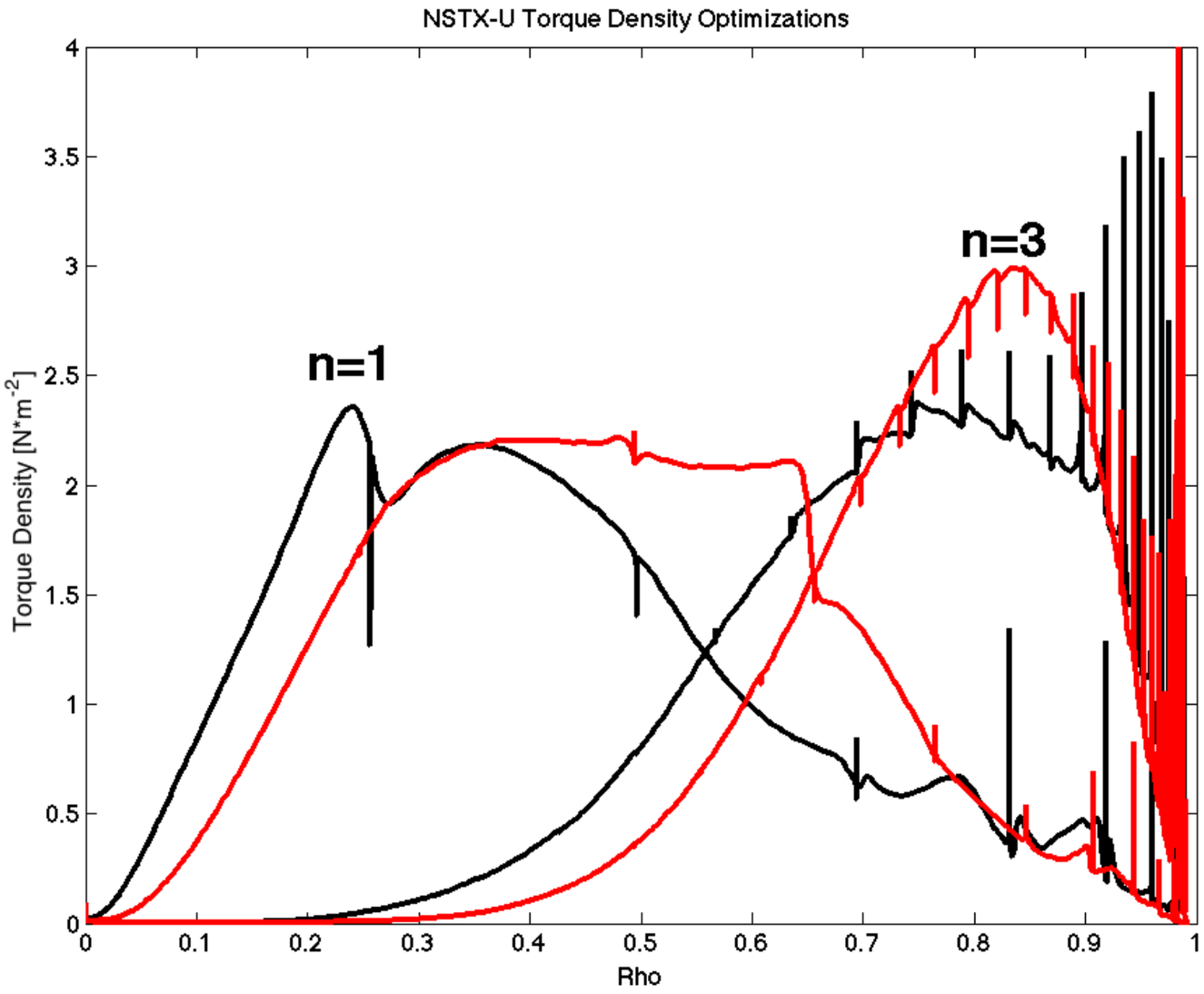
Normal field distributions were within acceptable limits

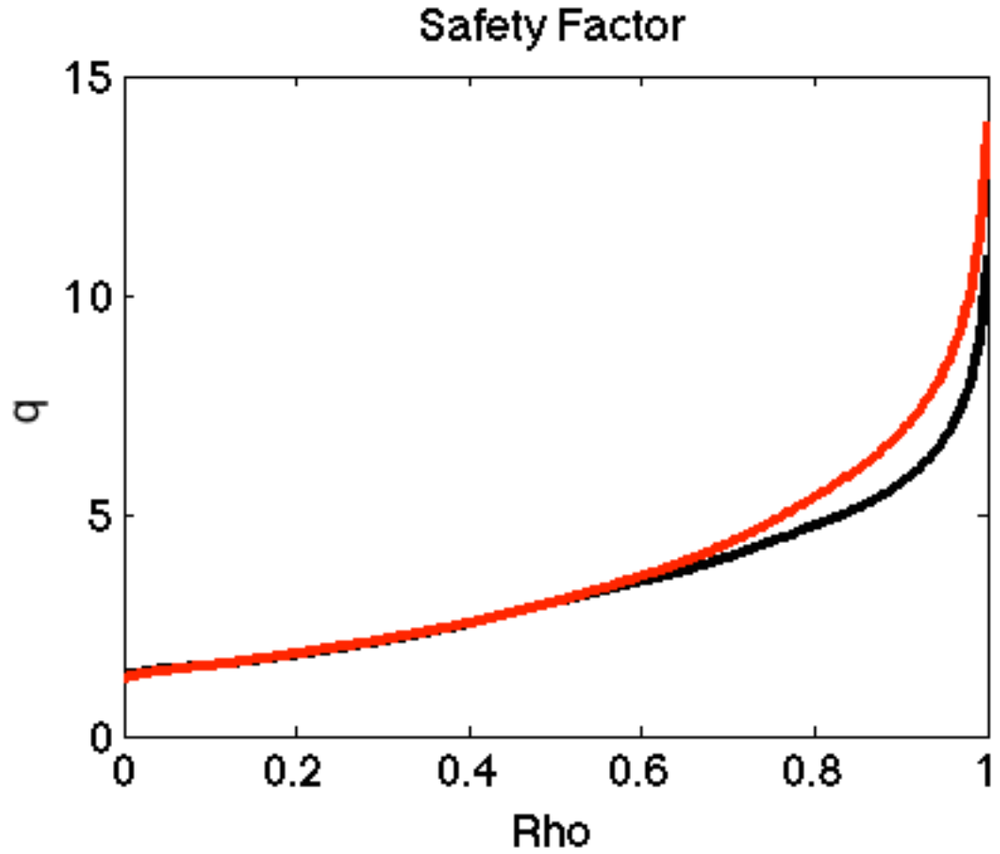


- Field distributions looked possible with NCC coils
- Attempts to mimic these by hand were partially successful
- Optimization of both the NCC and RWM coil currents would be necessary

Extension of optimization to other target equilibria reproduced results

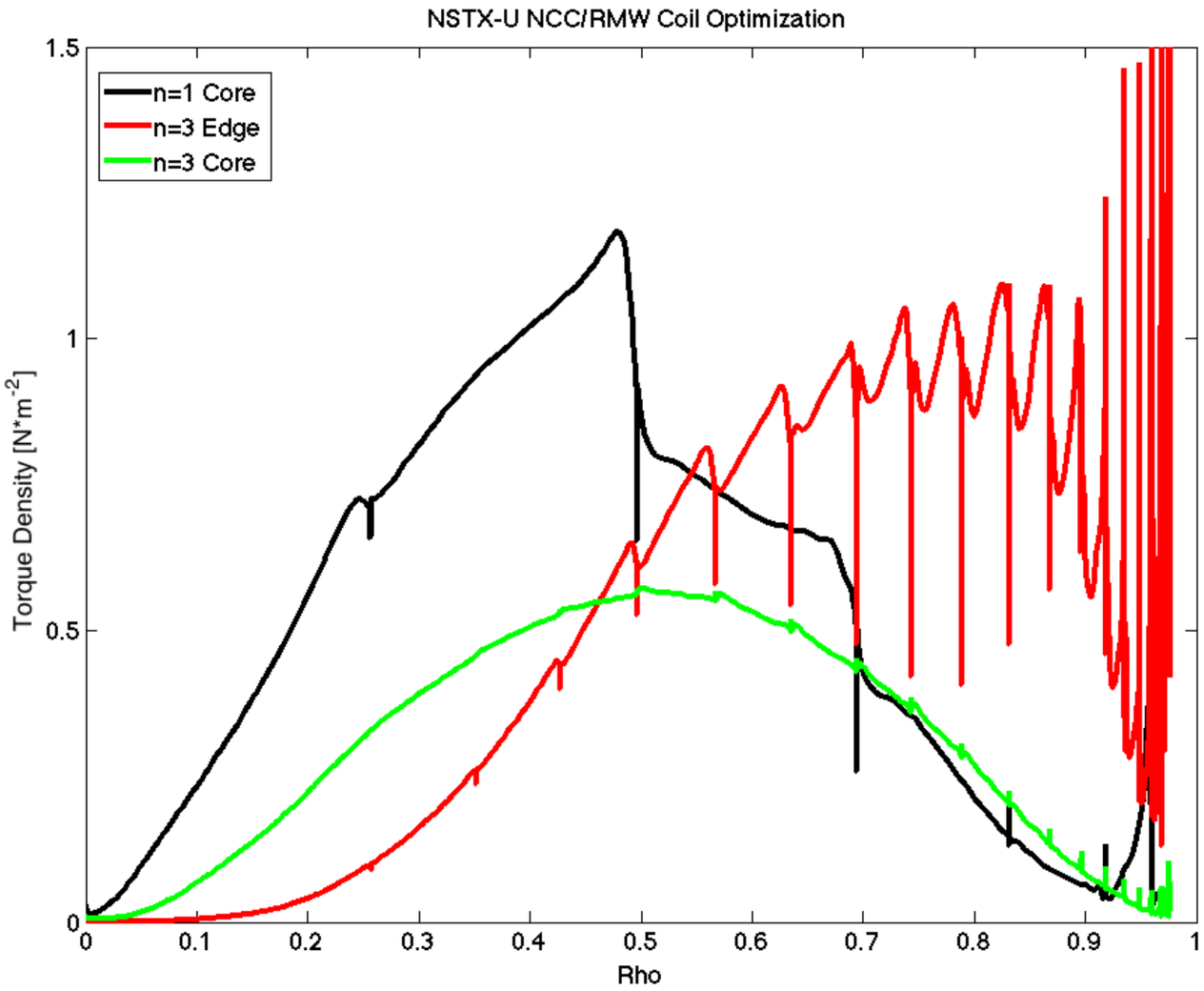
- High and low q-edge profile equilibria were examined
- The n=3 field could consistently drive edge torque
- Core torque drive suffered at higher q-edge





Optimization of full NCC coil and RWM coil suggest 3 torque profiles

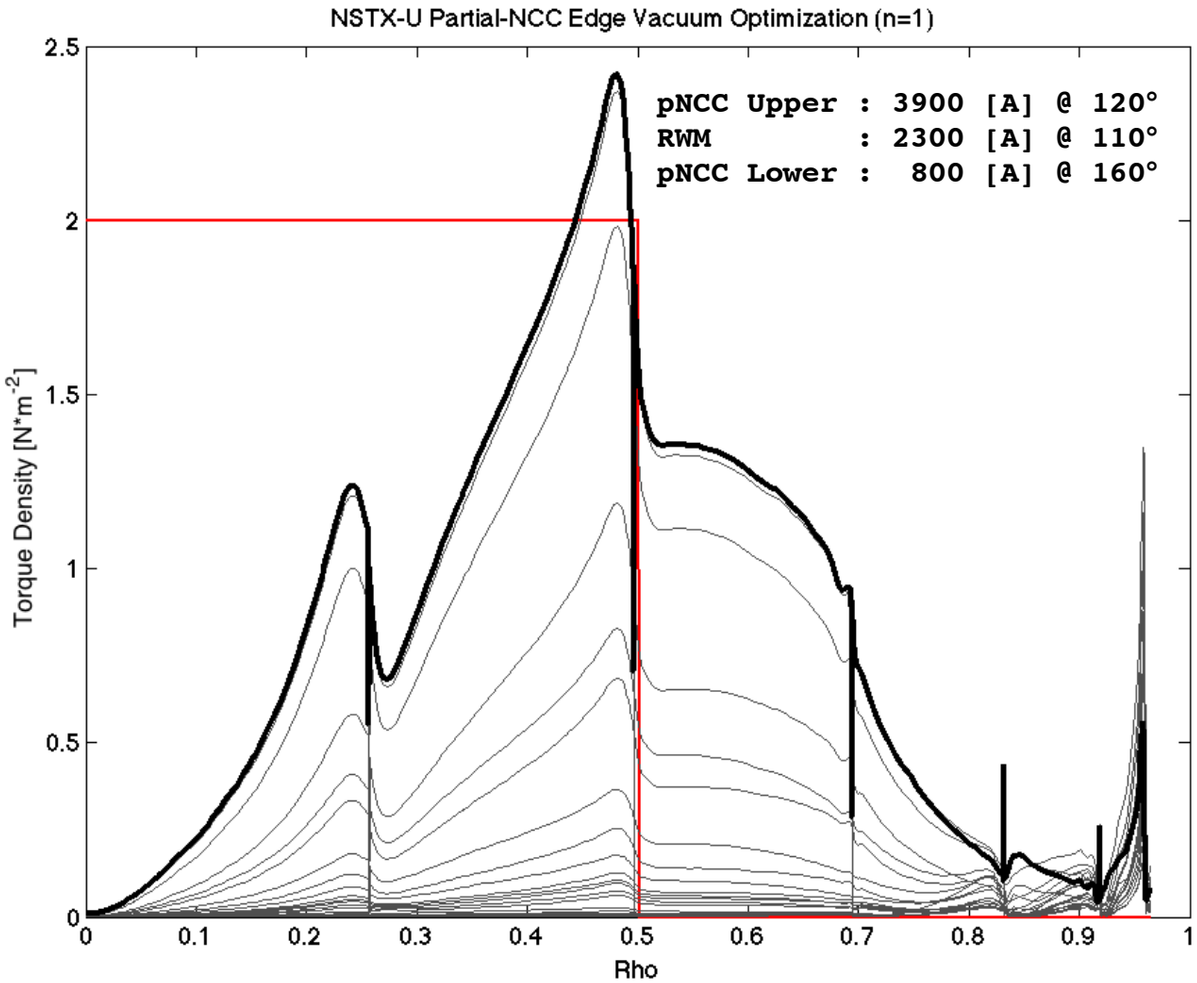
- Core, Edge, and mixed torque profiles were possible.

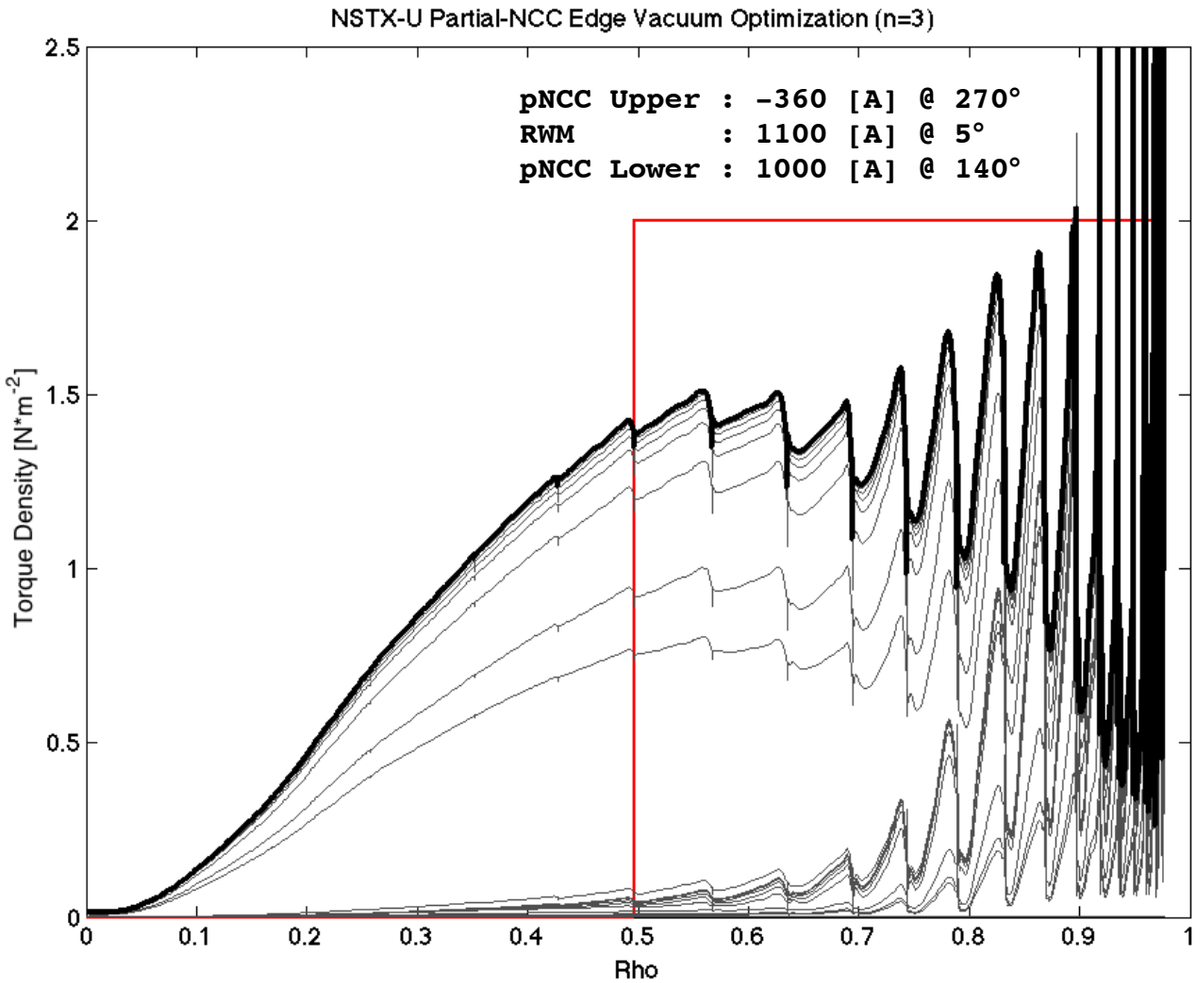


	$n=1$ Core	$n=1$ Edge	$n=3$ Core	$n=3$ Edge
Upper NCC	-1260 A-t @ 107^o	7850 A-t @ 33^o	577 A-t @ 100^o	2060 A-t @ 175^o
RWM	510 A-t @ 36^o	165 A-t @ 167^o	450 A-t @ 54^o	240 A-t @ 109^o
Lower NCC	1810 A-t @ 176	5640 A-t @ 225^o	573 A-t @ 80^o	2520 A-t @ 11^o

Optimization of partial NCC coil and RWM coil suggested less flexibility

- The n=1 and n=3 applied fields from the partial coils set fail to drive anything but a broad torque profile.





Overview

- The full NCC coil set appears to allow for both core and edge torque profiles
- The odd phase partial NCC coils fail to drive anything but a broad torque profile
- In terms of NTV torque, the full NCC coils set should be considered.

Could a full set be considered for installation, but only a partial set installed to reduce cost and split the topic over two upgrade phases?