ATEN variations

Self-consistent Bootstrap Current (bootsj) with COBRAVMEC Ballooning Stability

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- Self-consistent bootstrap current inside of STELLOPT optimization loop
  - BOOTSJ
  - SFINCS (not shown today)

- Ballooning stability (with COBRAVMEC)
  - Fast; multiple points on a flux surface; all VMEC surfaces (exc. 1st and last)
  - Target: A ‘stable’ configuration with all growth rates <= 0

1. Vary boundary coefficients
2. Find self-consistent bootstrap current profile
3. Calculate ballooning stability

Repeat Steps 1-3 until stable solution is found at end of step 3.

2 stellopt runs with 1.7% Beta

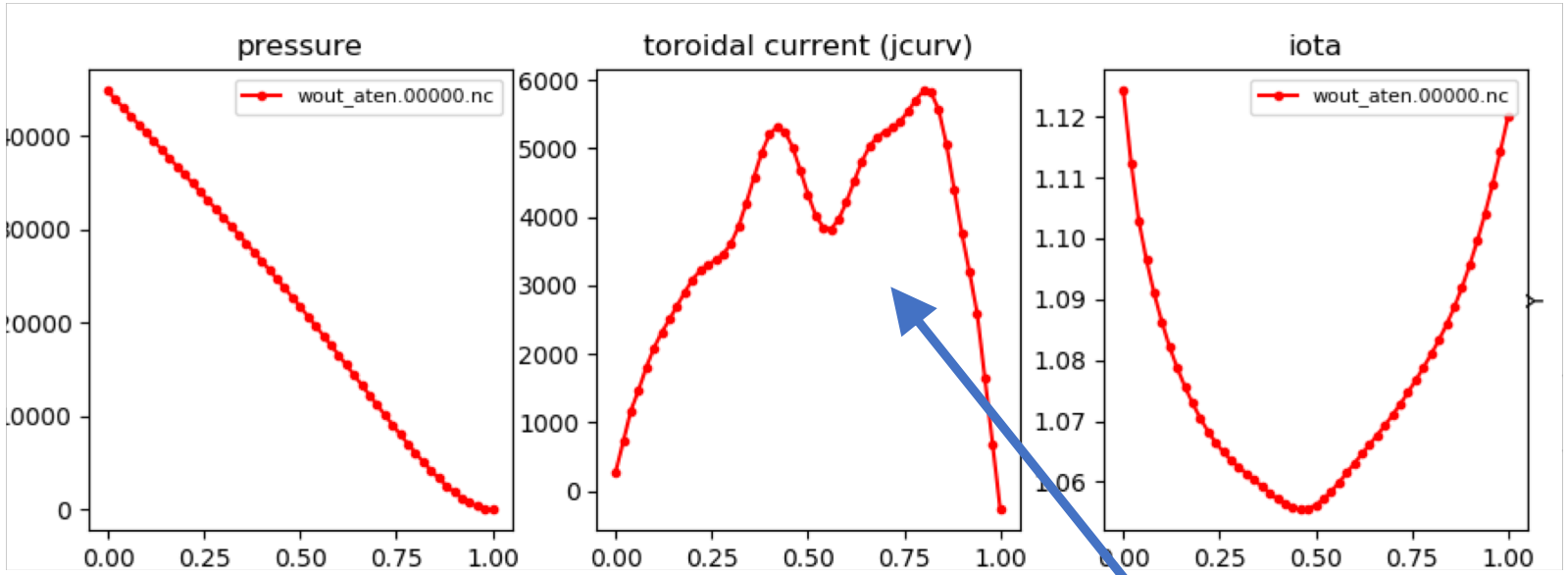
2 stellopt runs with 3% Beta (different starting points)

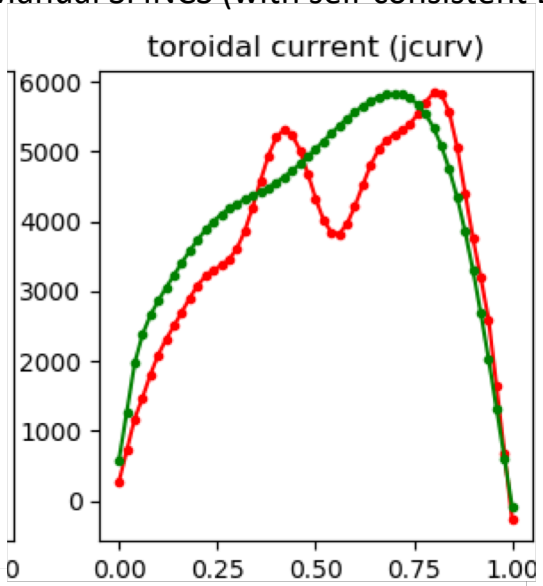
- Slides 5-12: Flux surfaces
- Slides 13-17: Boozer septra

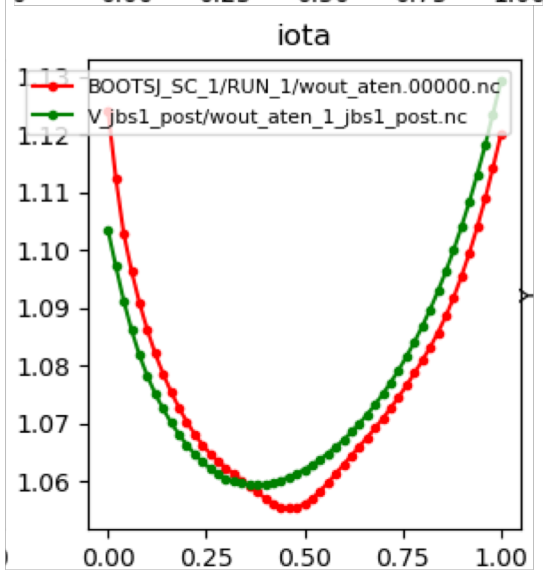
Briefly, bootsj and sfincs (0.8% Beta)

Red: BOOTSJ

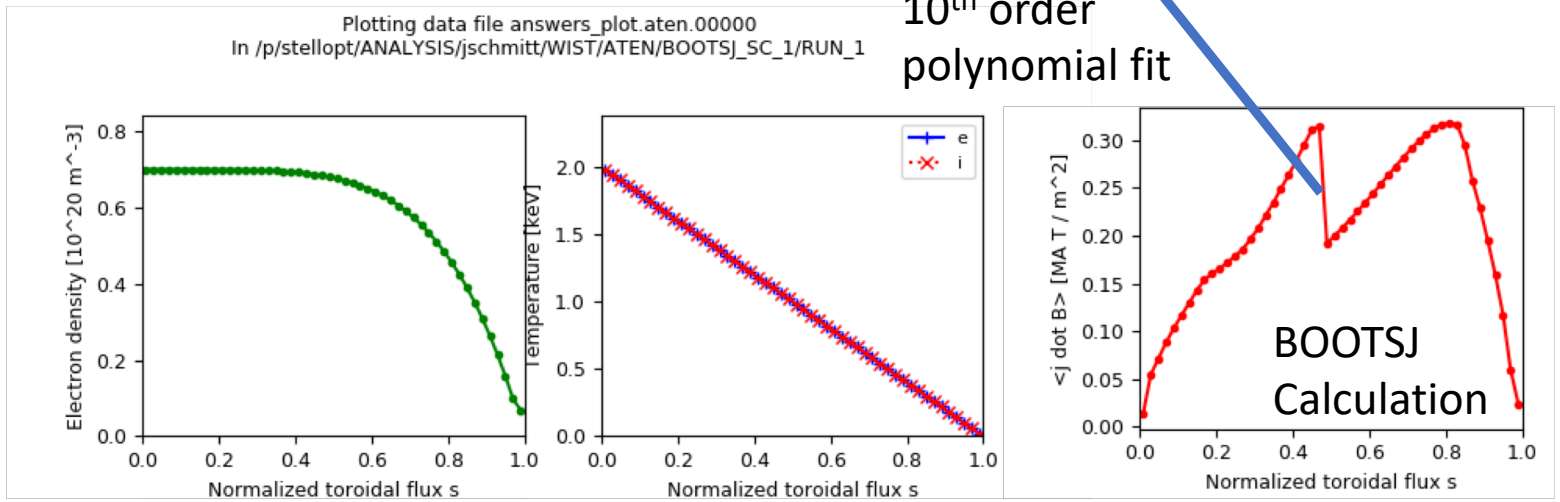
Green: Manual SFINCS (with self-consistent Er)







10^{th} order polynomial fit

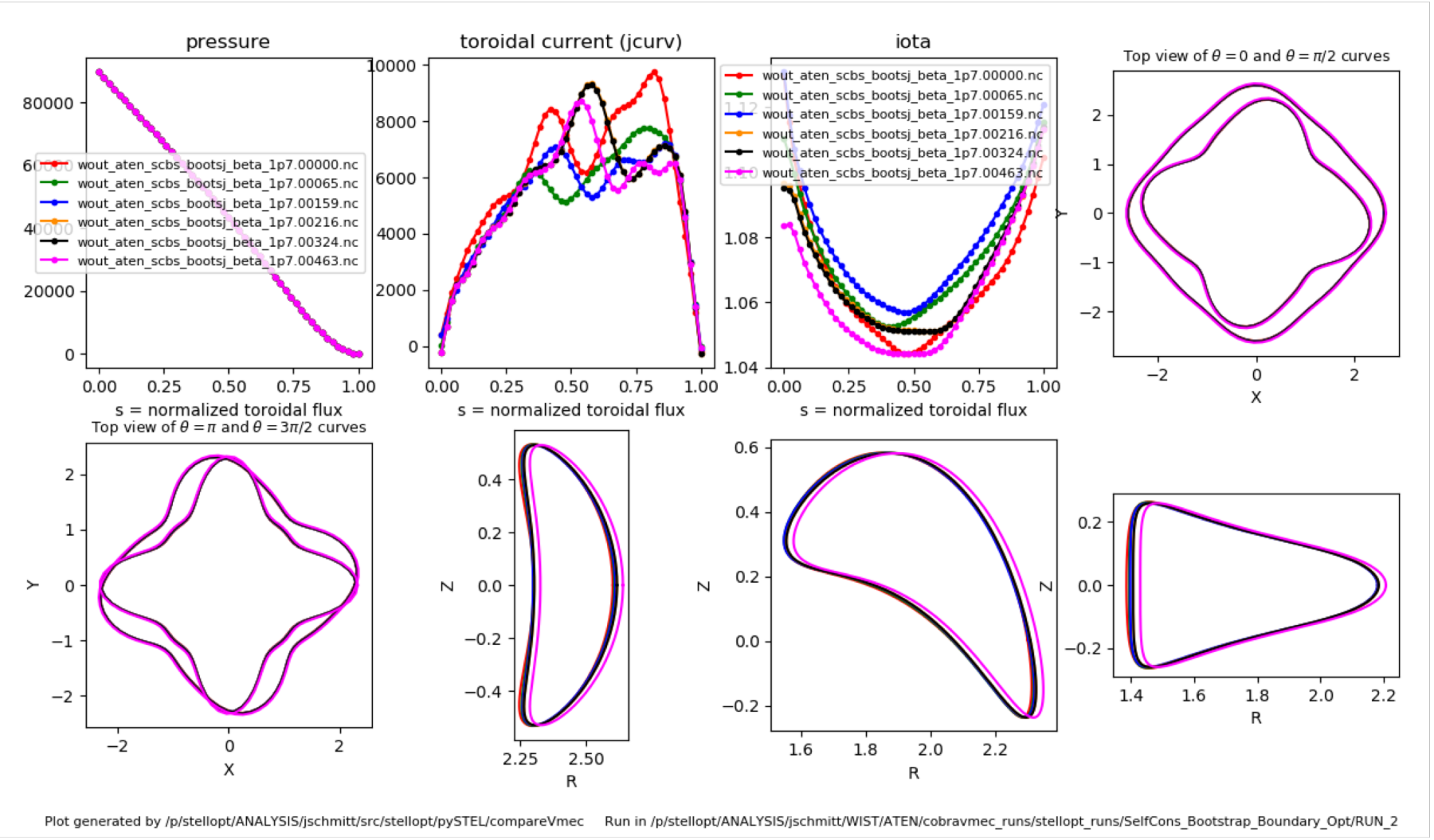


49 Free parameters: RMNC and ZMNS

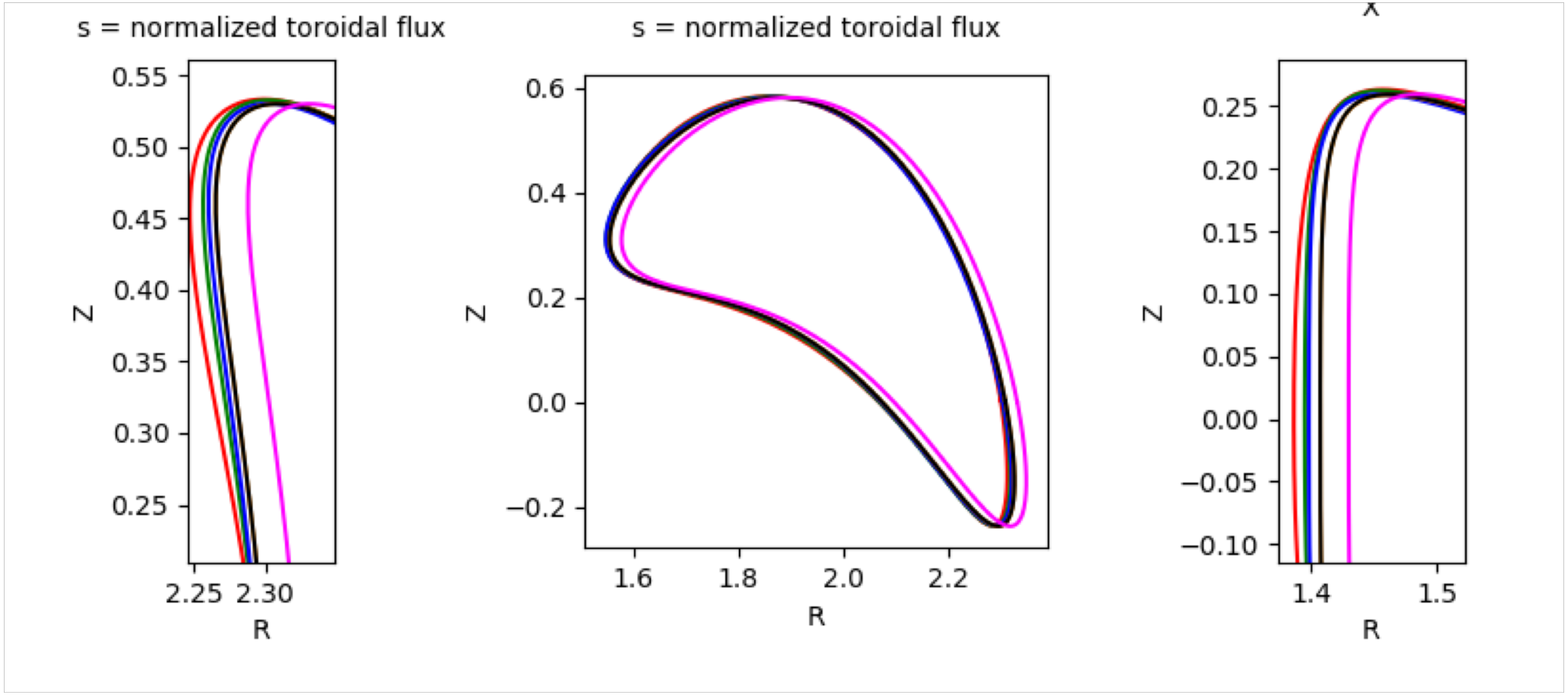
- Stellarator symmetric
- Poloidal M: -3:3
- Toroidal N: 0:3
- 49 Free parameters

- Fixed boundary runs (no coil set)
- BOOTSJ used for self-consistent bootstrap calculation

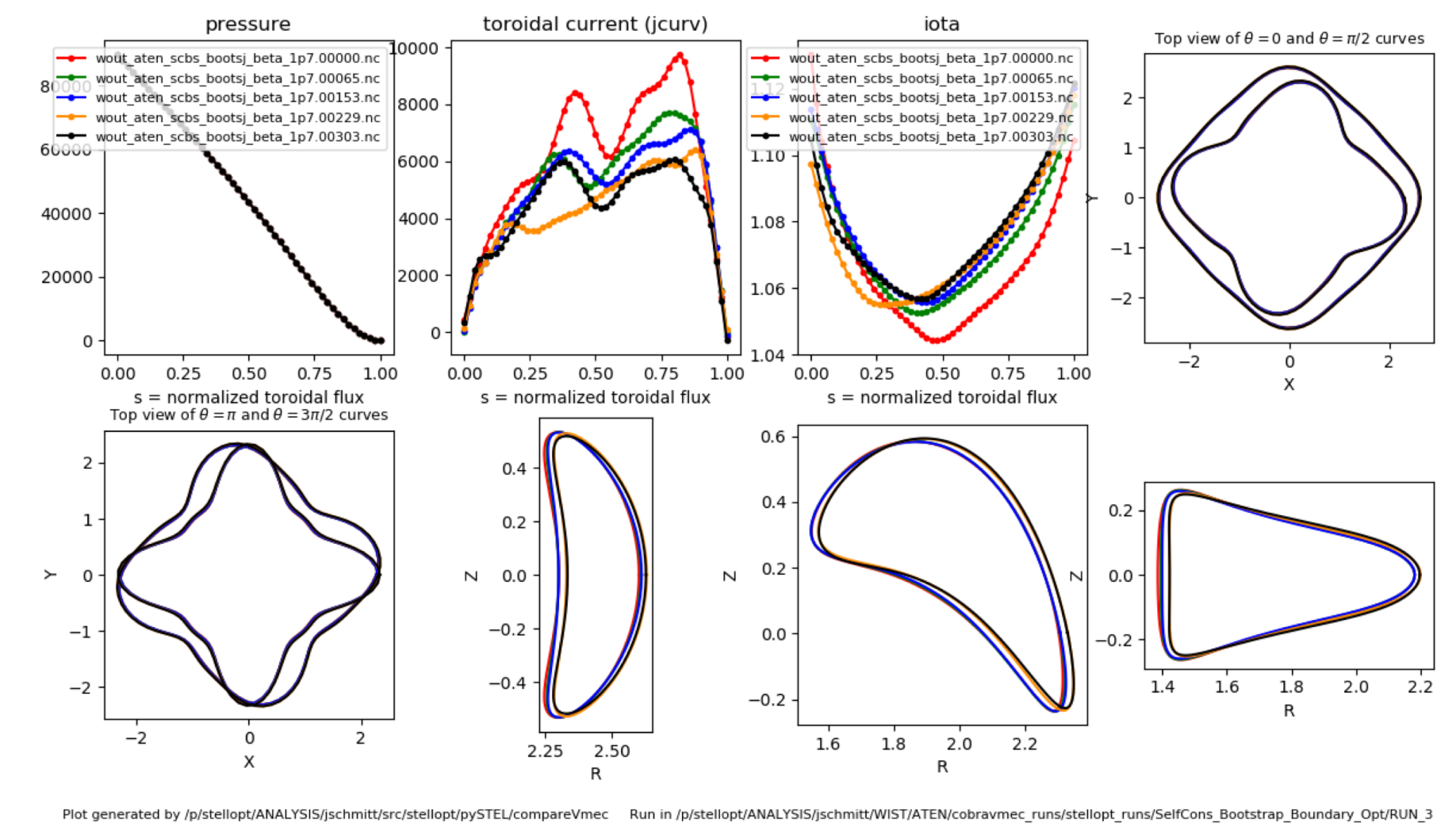
ATEN 1.7%: STELLOPT iterative solutions shown; Final iteration has largest major radius



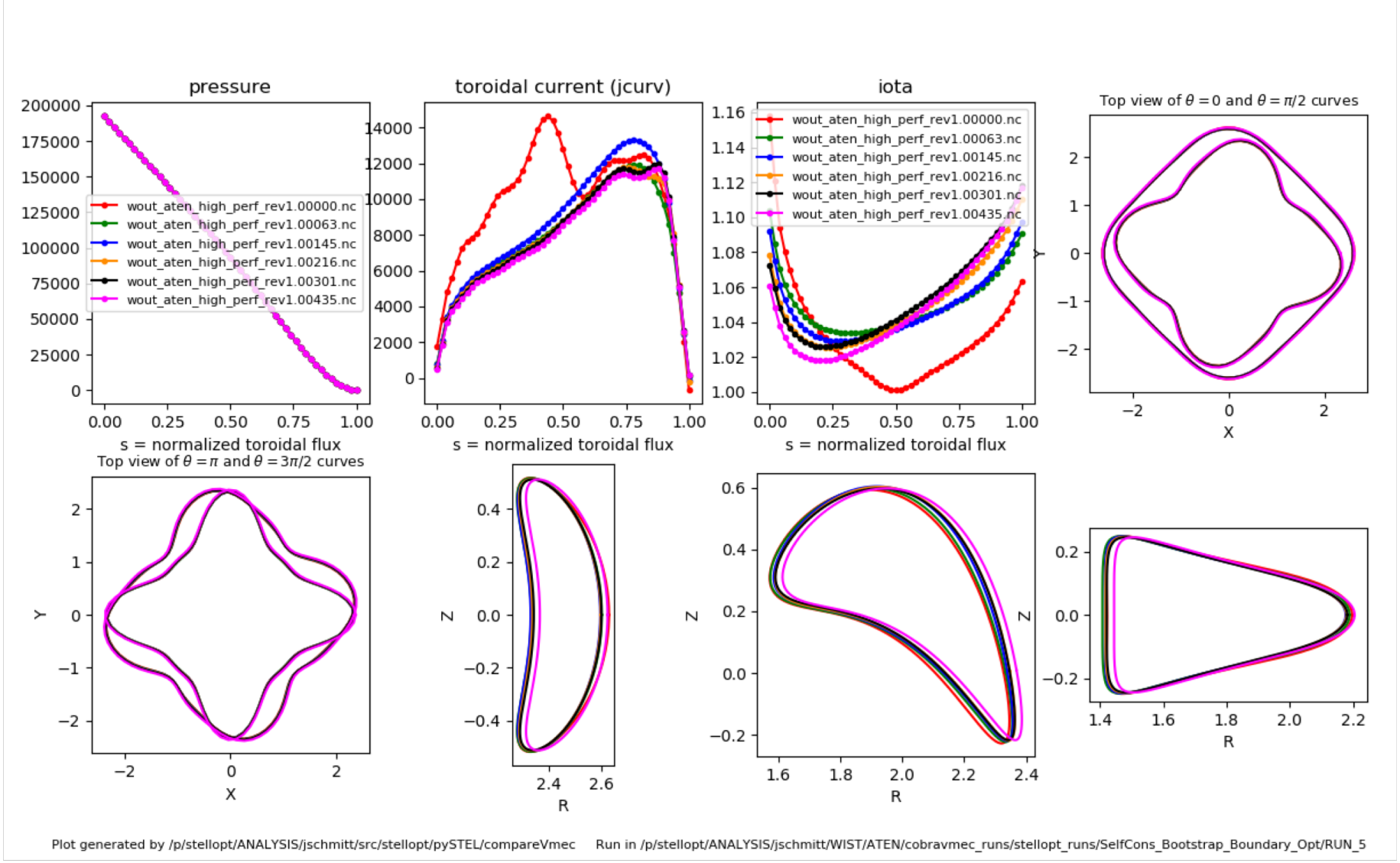
ATEN 1.7%: STELLOPT iterative solutions shown; Final iteration has largest major radius



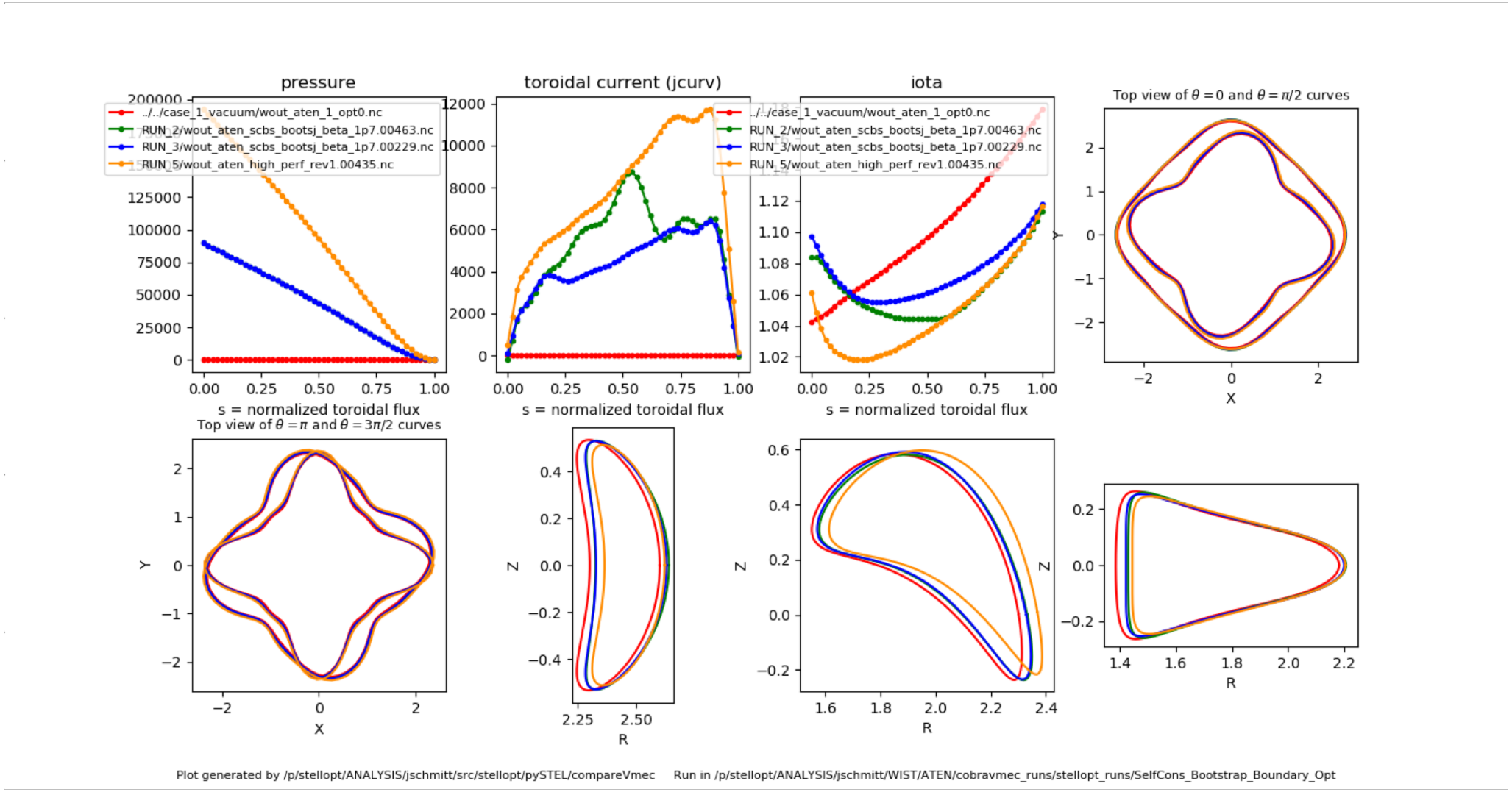
ATEN 1.7%, Run #2; Final iteration has largest major radius



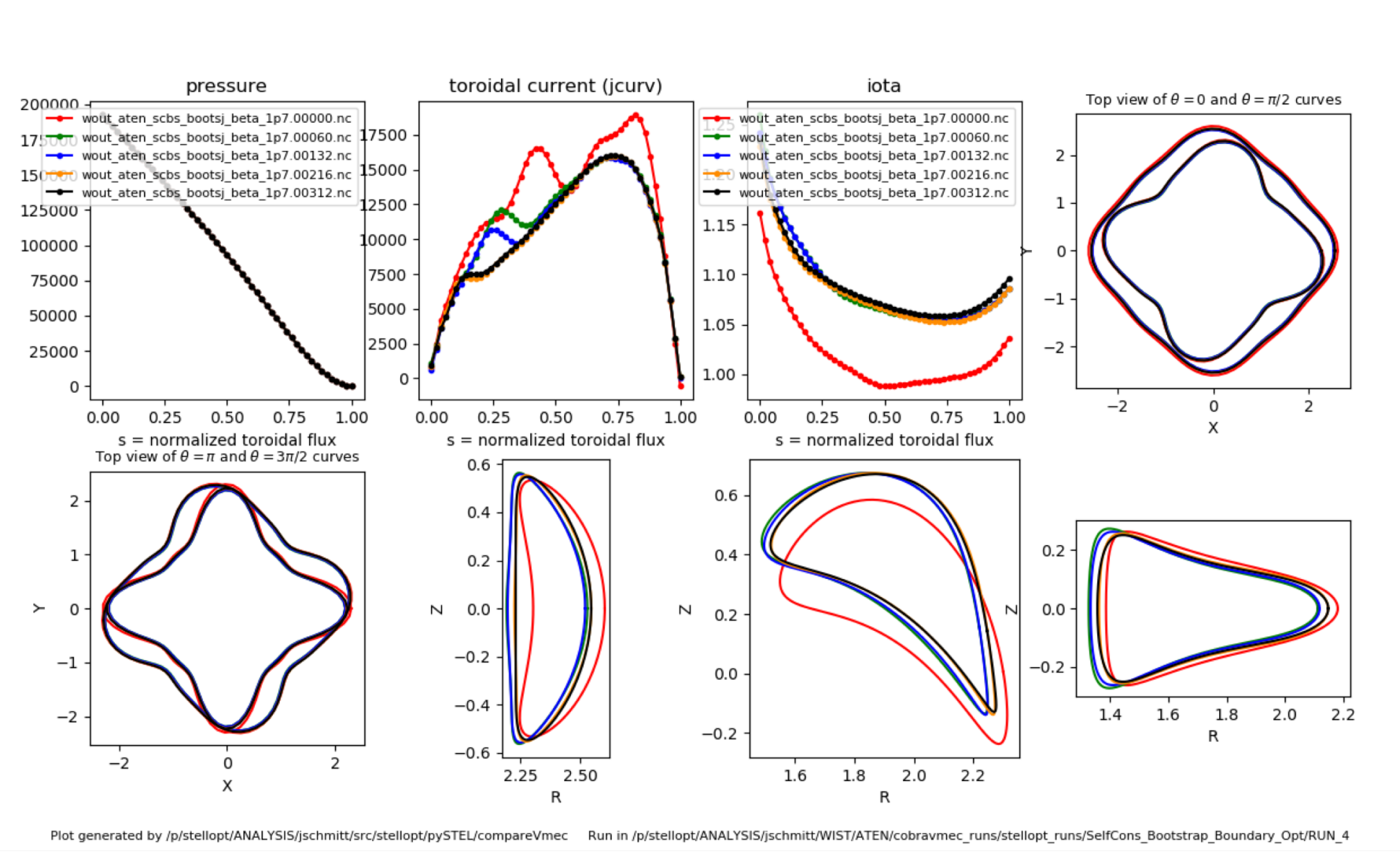
ATEN 3%, Version 1: Using 1.7% version 2 as a starting point



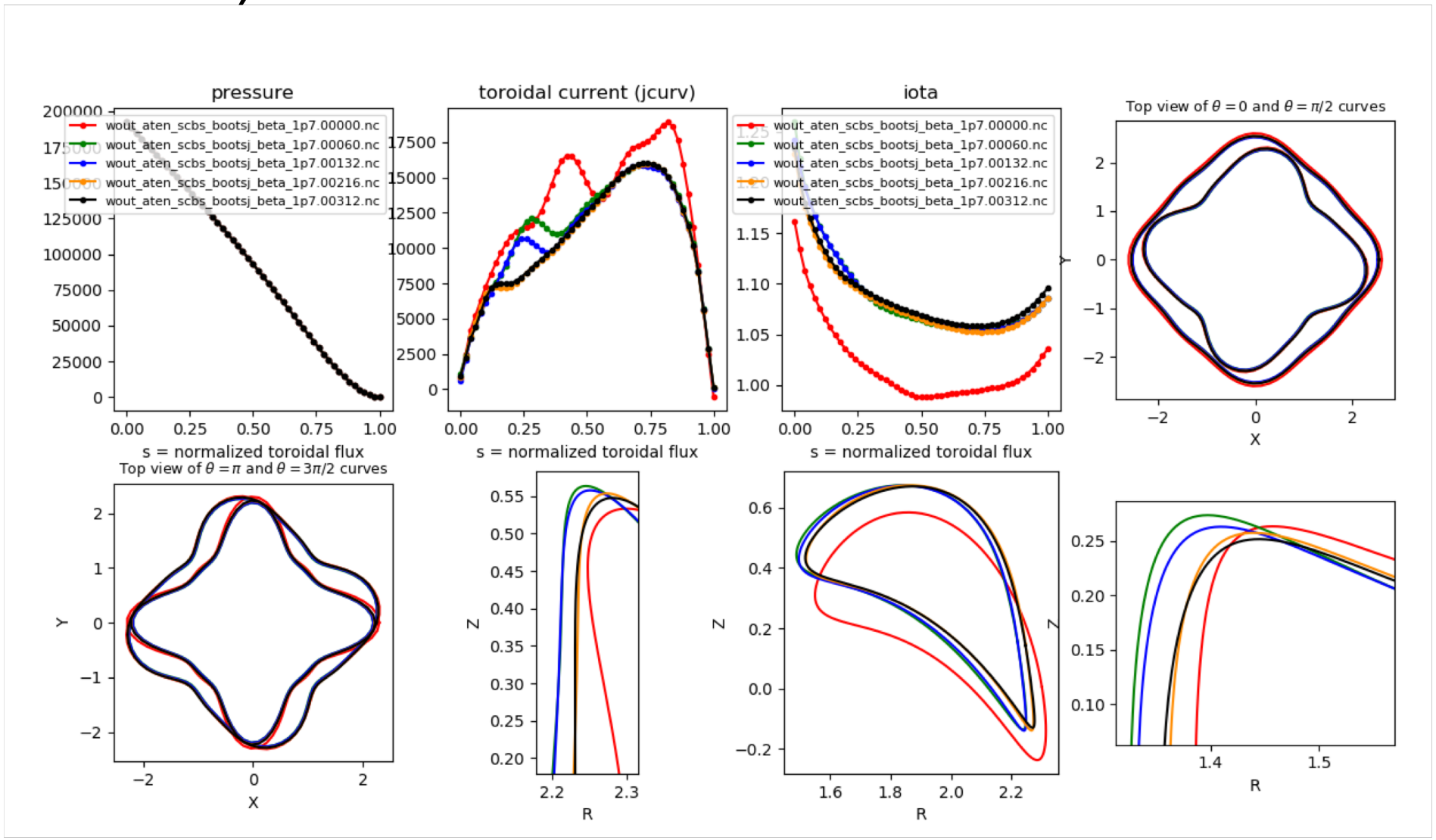
Vacuum, 1.7%, 1.7%, 3%



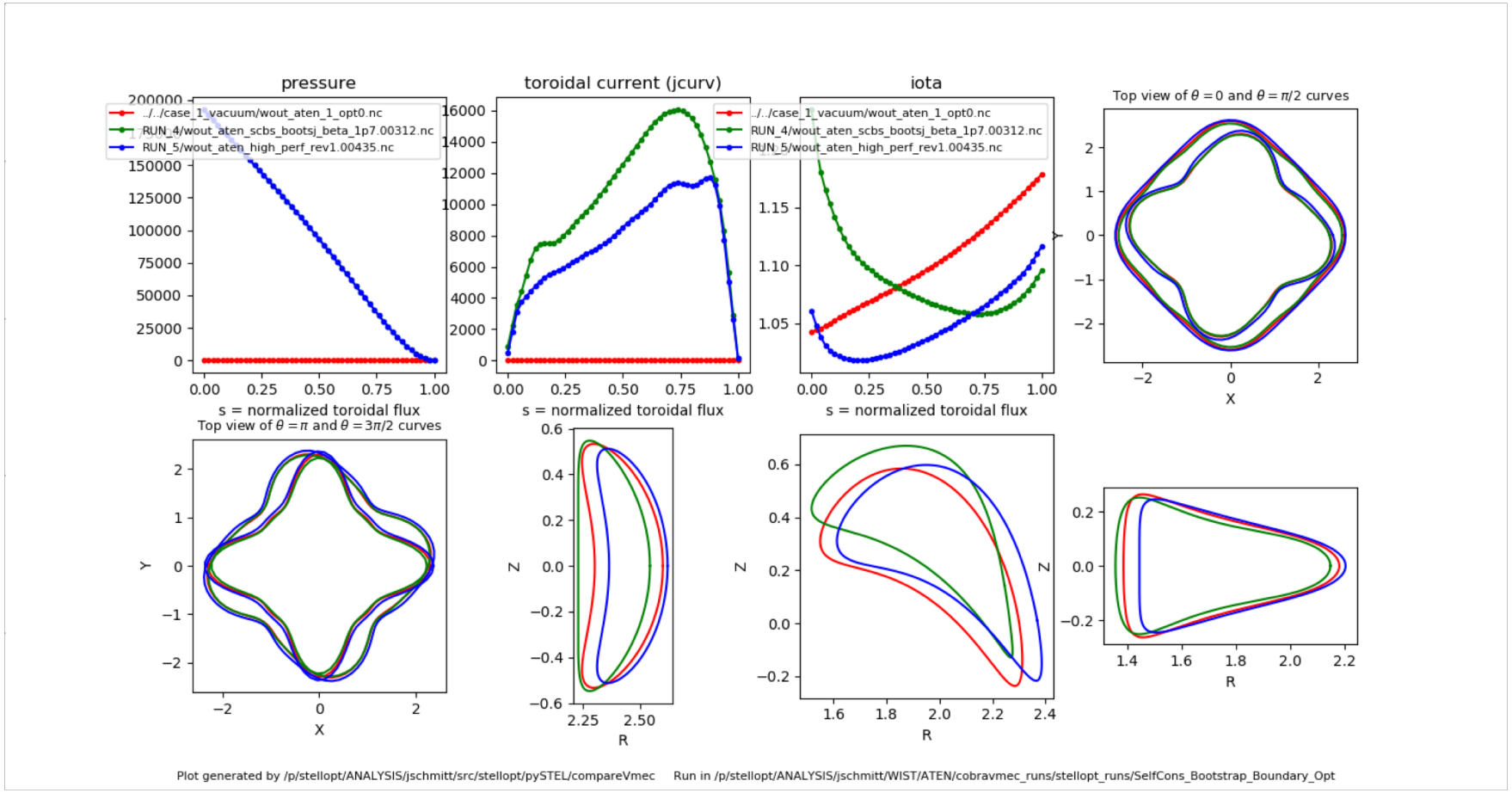
ATEN 3%, Version 2. Using ATEN as a initial point



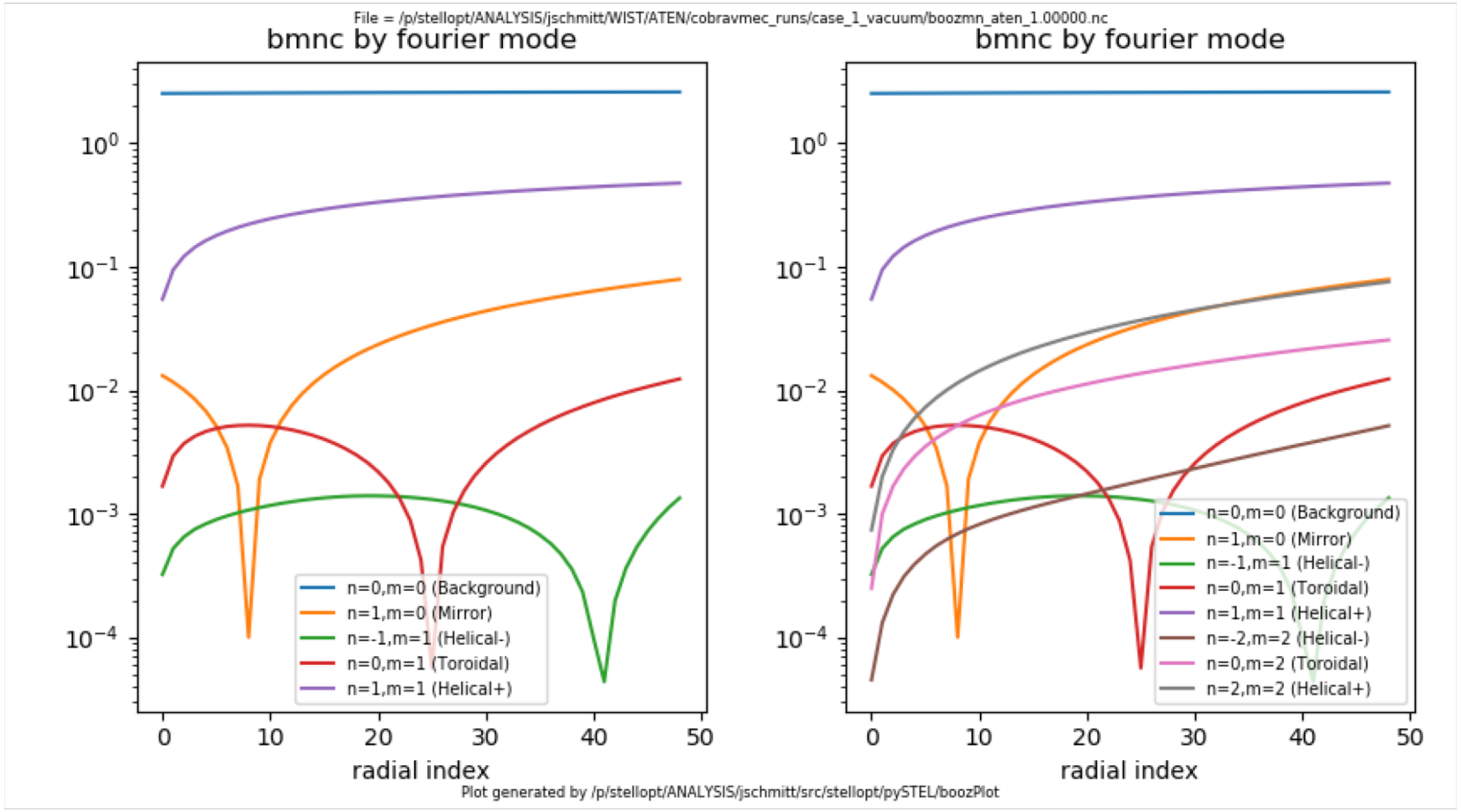
ATEN 3%, Version 2



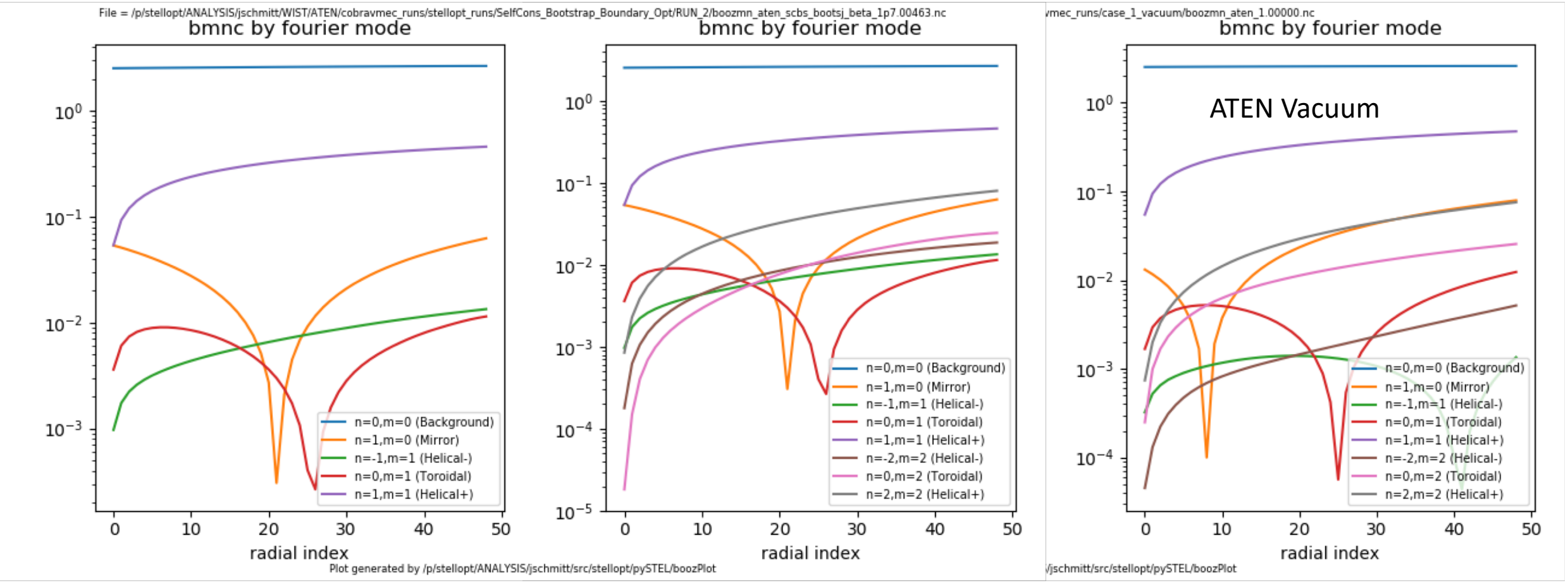
“Vacuum”, “3% Version 1” and “3% Version 2” Separate ‘Branches’



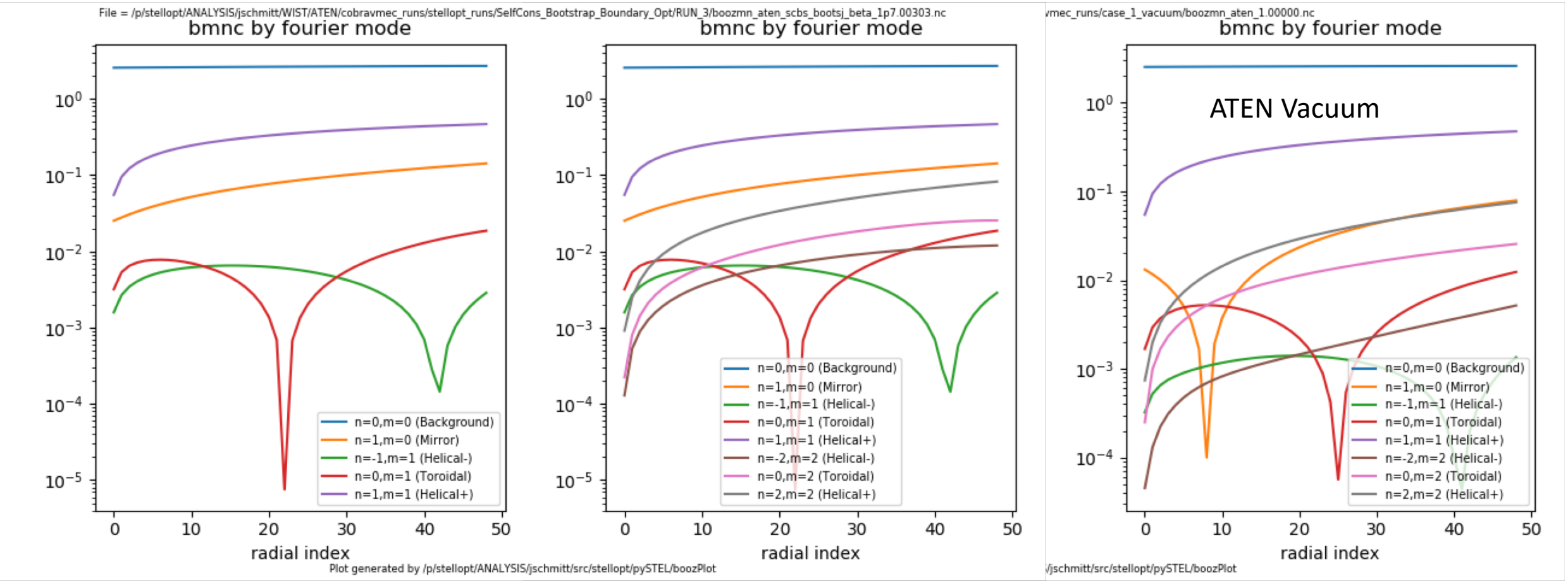
Boozer spectrum plots: Vacuum



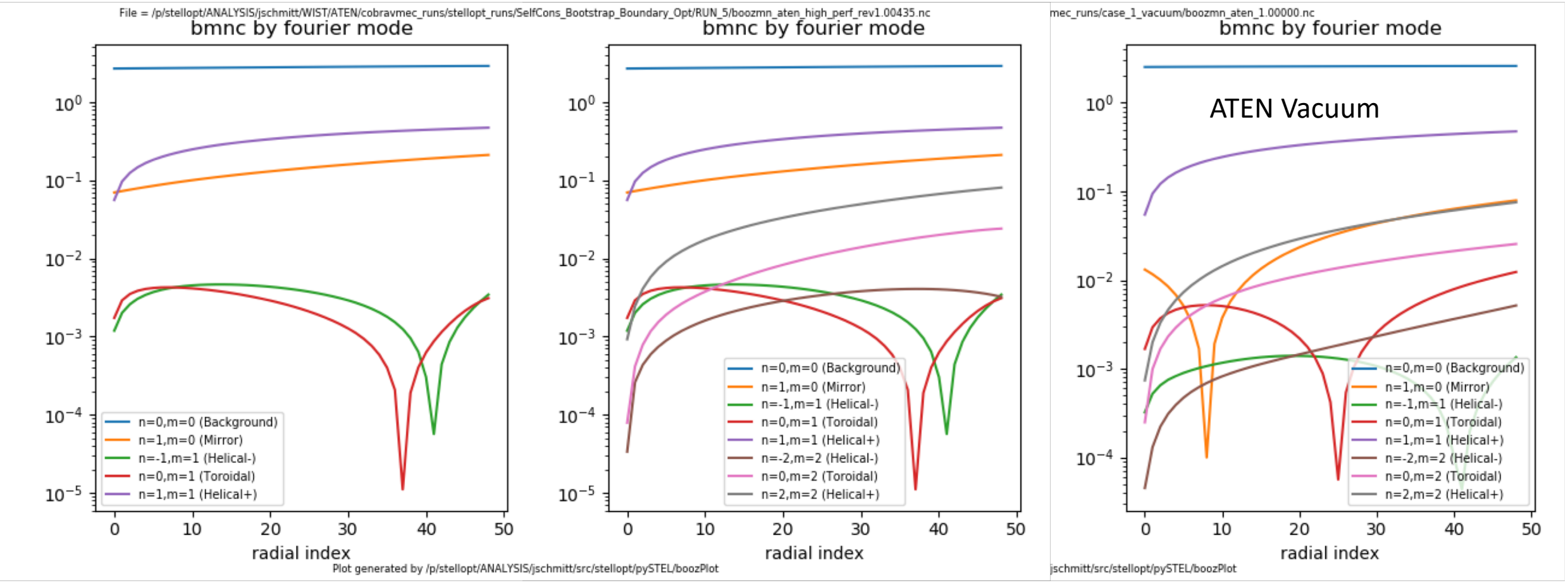
Boozer spectrum plots: 1.7%, Run 1



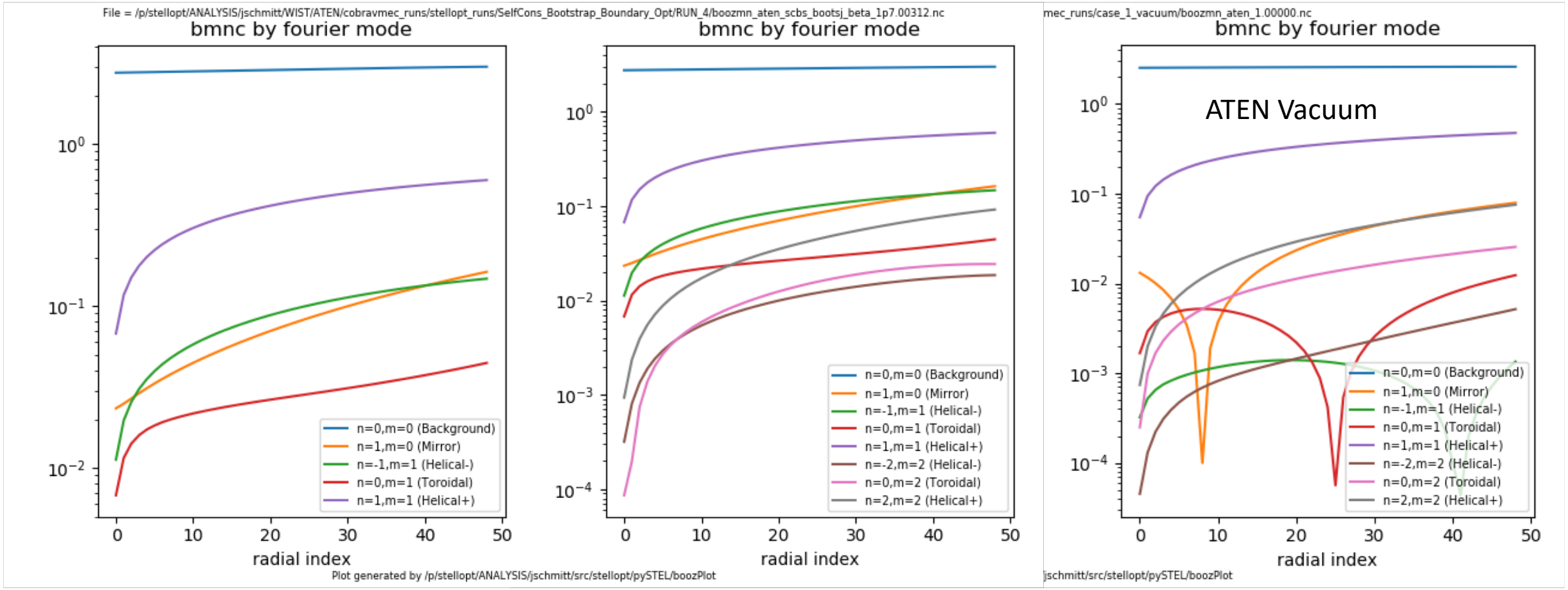
Boozer spectrum plots: 1.7%, Run 2



Boozer spectrum plots: 3%, Run 1



Boozer spectrum plots: 3%, Run 2



Summary

- STELLOPT optimization successfully removes the predicted ballooning instabilities of the ATEN configuration for values of beta up to 3.1% *

  * Convergence tests to be completed, but settings used were already used for another similar QH configuration

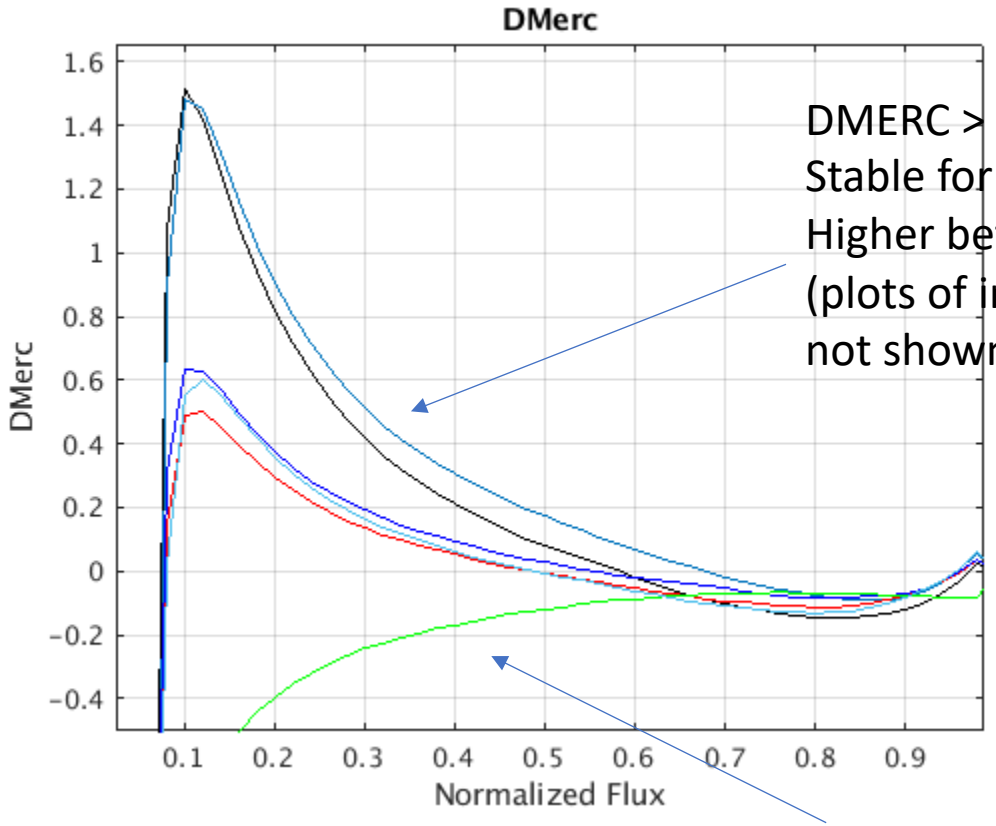
- ‘Moderate’ beta (1.7%)
  - Stable configurations have a slightly larger major radius

- ‘Higher’ beta (3.1%)
  - Two ‘branches’ of configurations are found for stabilization at higher beta

- Mercier stability criterion**. Violated at axis, near edge. Satisfied near core up to mid-radius. 0.05 <S < 0.5 (approx.)

  **DMERC > 0

DMERC output from several VMEC runs with and without finite pressure, bootstrap current



DMERC > 0
Stable for finite beta
Higher beta -> Better stability
(plots of individual contributions not shown here)

Vacuum stability curve
DMERC < 0, unstable