"Benchmarking" ROSE and STELLOPT

A. Bader

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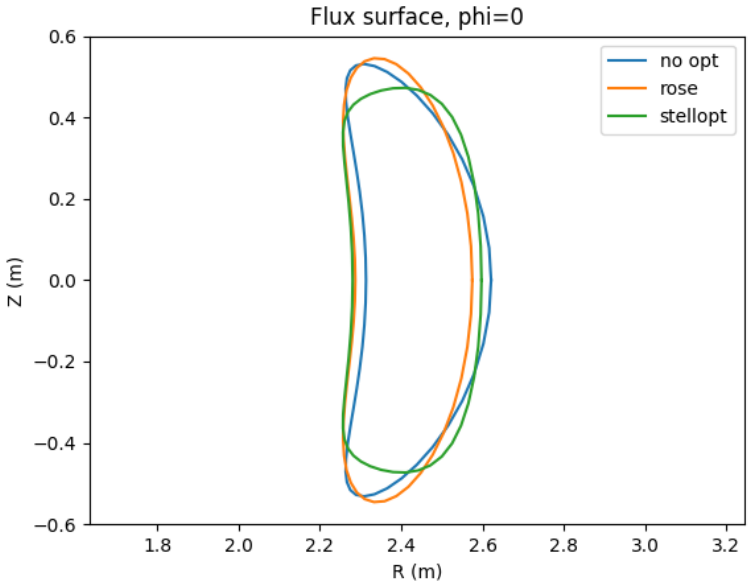
ROSE and STELLOPT have different strengths and weakness

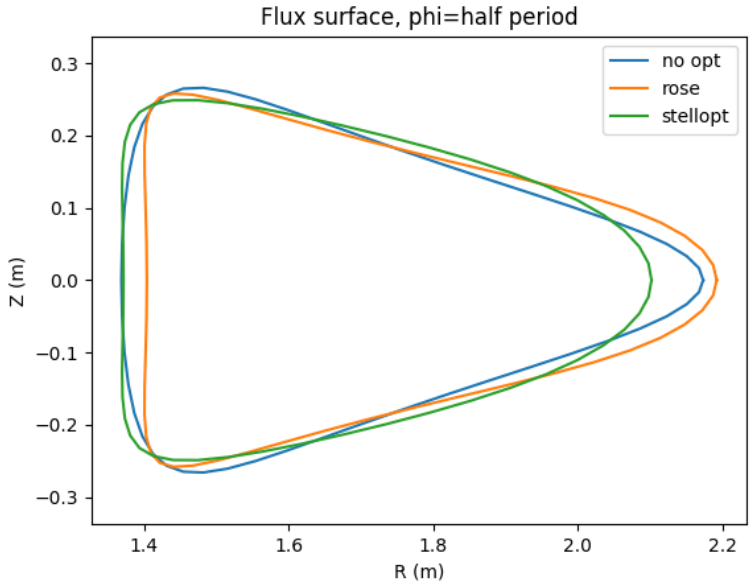
STELLOPT	ROSE
Parallelizable to number of targets	Parallelizable to subfunctions only
Non-convex	Non-convex
Susceptible to local minima	Susceptible to local minima
Source code available	Source code not yet available
EP metrics absent	Many EP metrics present
Coupled to PTSM3D, Regcoil	Coupled to ONSET
Individual contribution to penalty function is obtuse	Individual contribution to penalty function available with diagnostic run
Output bloat	Output paucity

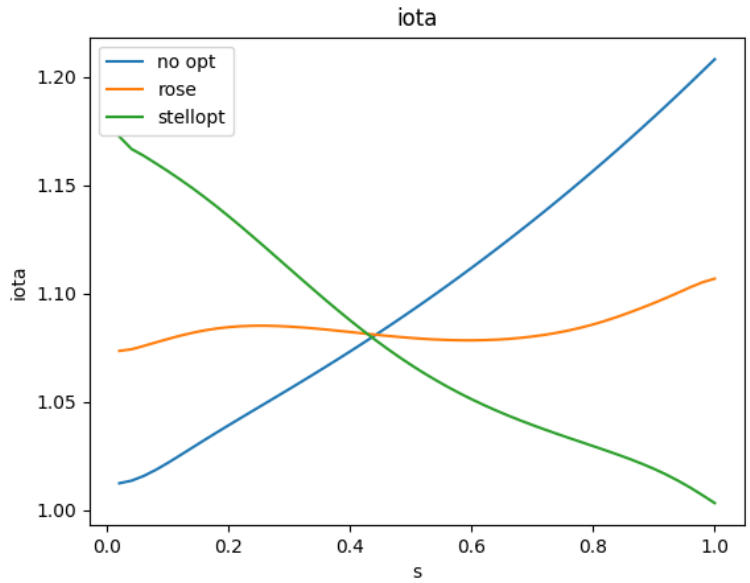
Four optimization cases, based off of the QHS46 configuration

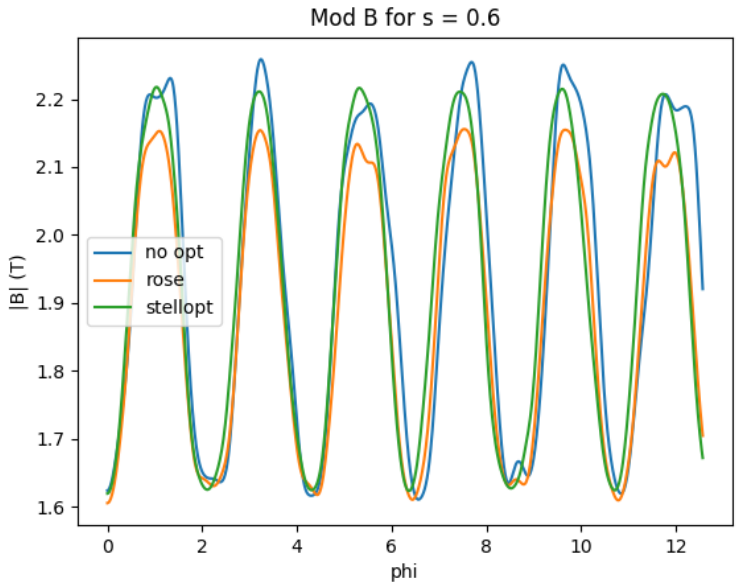
- Optimize for QH only at s=0.6 (all runs have this optimization)
- Optimize for 'low ι' vacuum configuration
- Optimize for the QHS46 configuration with $\beta \approx 2\%$, with realistic current profile
- Optimize for low ι at finite β
- Methodology
  - Run similar targets for both ROSE and STELLOPT
  - Run ROSE diagnostic on initial configurations and outputs to get values of various metrics
  - Current profiles come from SFINCS - calculated by J. Schmitt
  - ROSE optimizations for profiles with current need to be redone

Optimize for QH

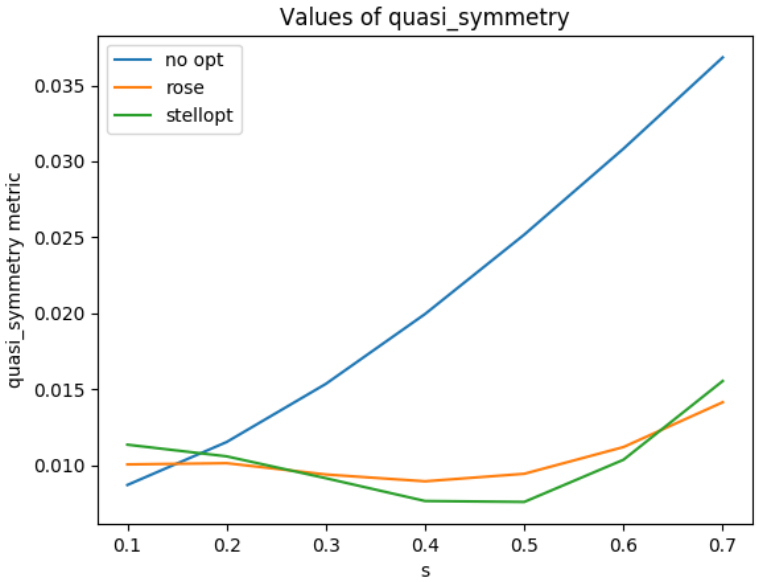


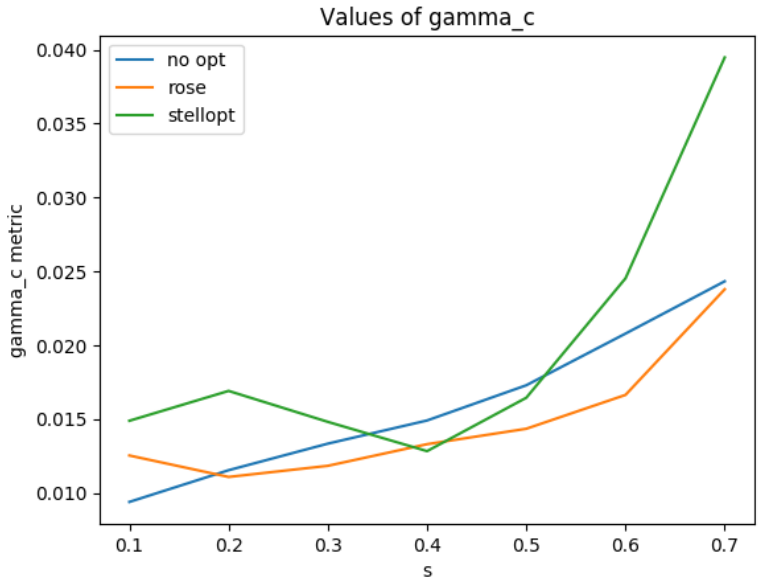


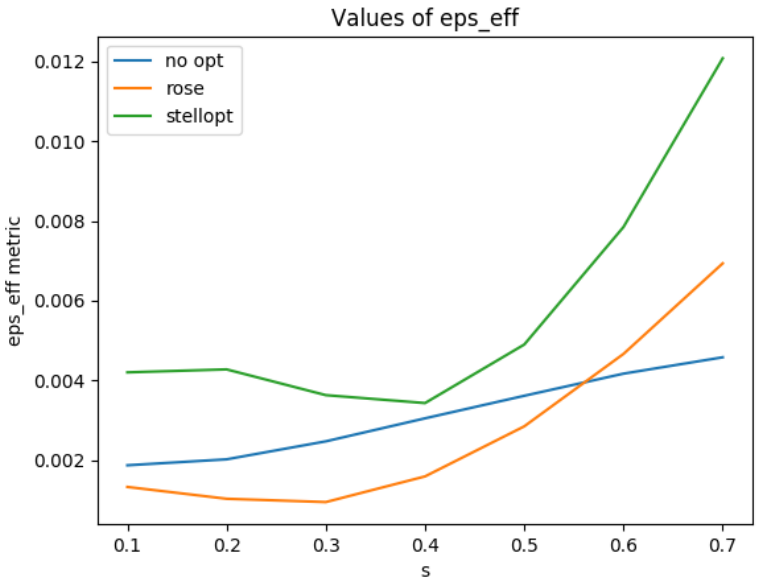




Optimize for QH

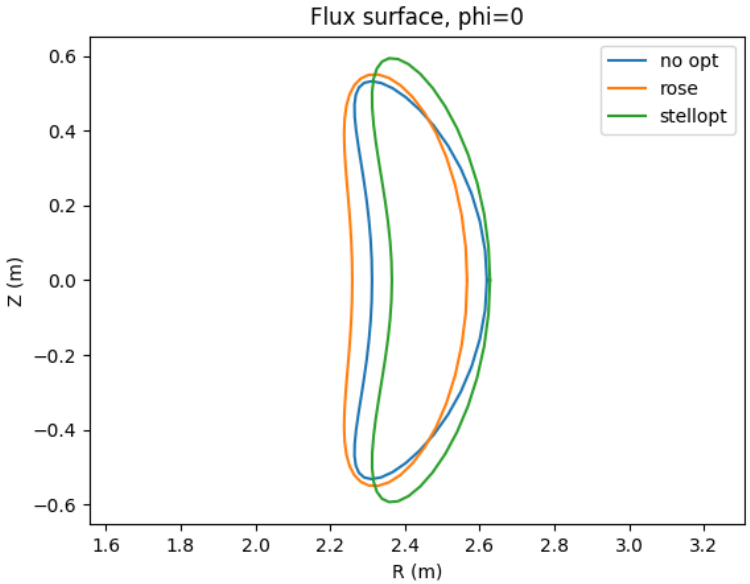


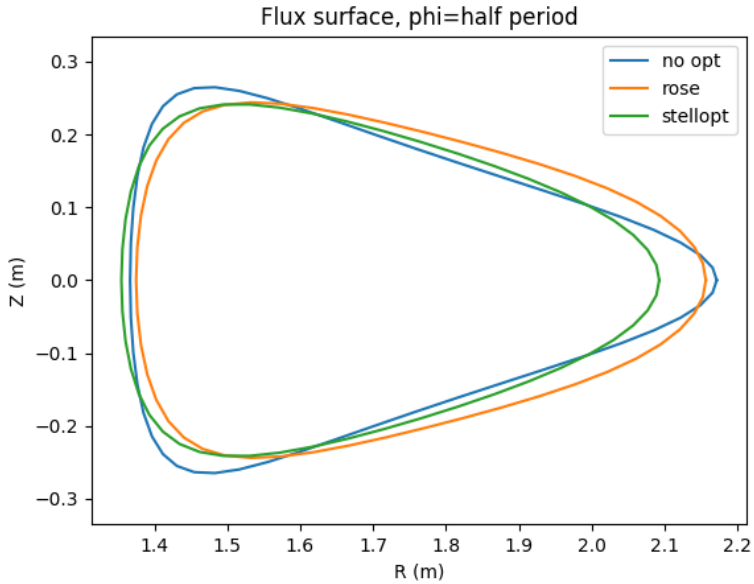


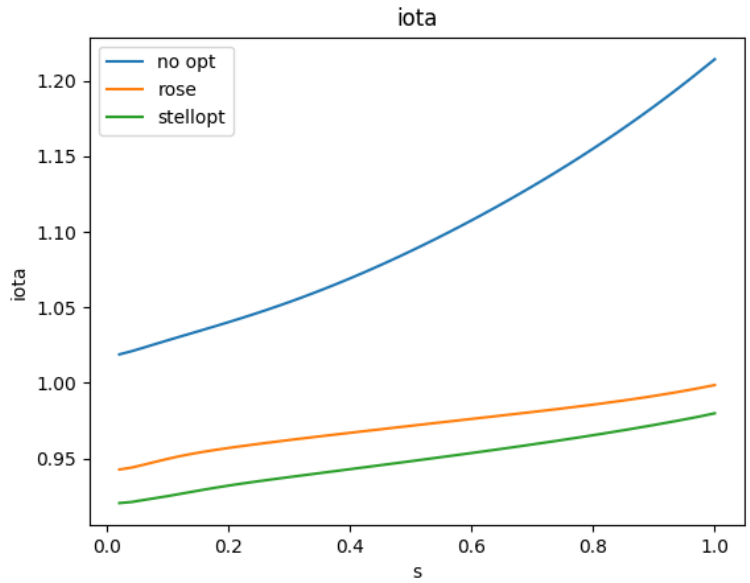


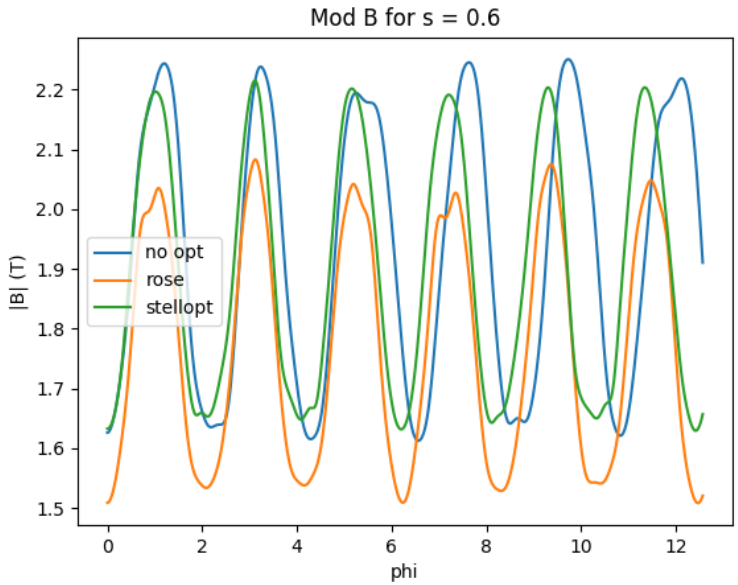
Rotational transform targeted to be 0.92 on axis and 0.98 at edge

Optimize for low iota









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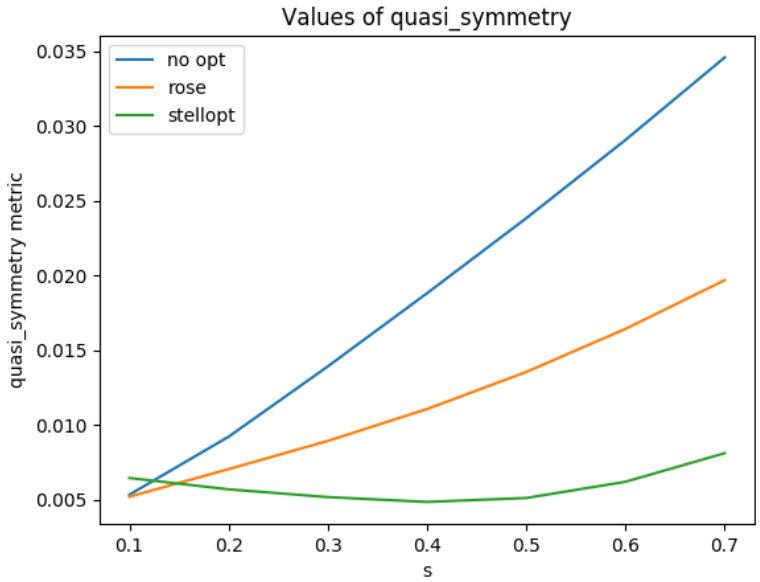
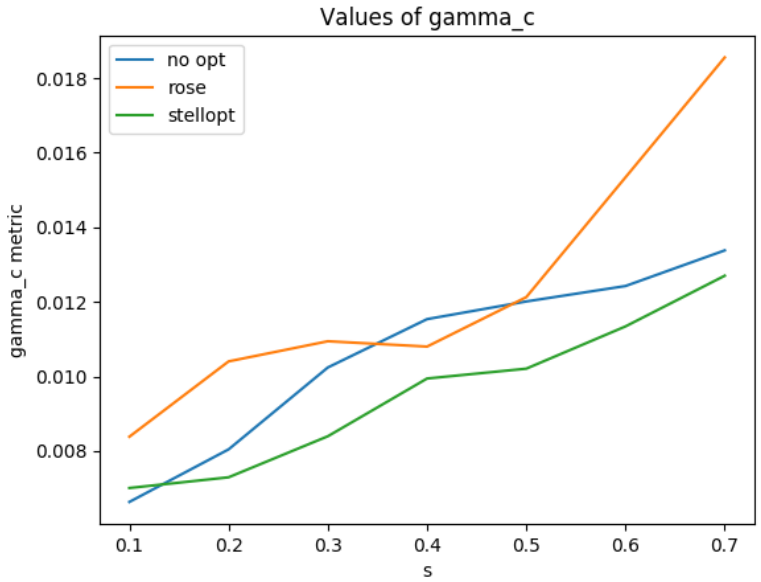
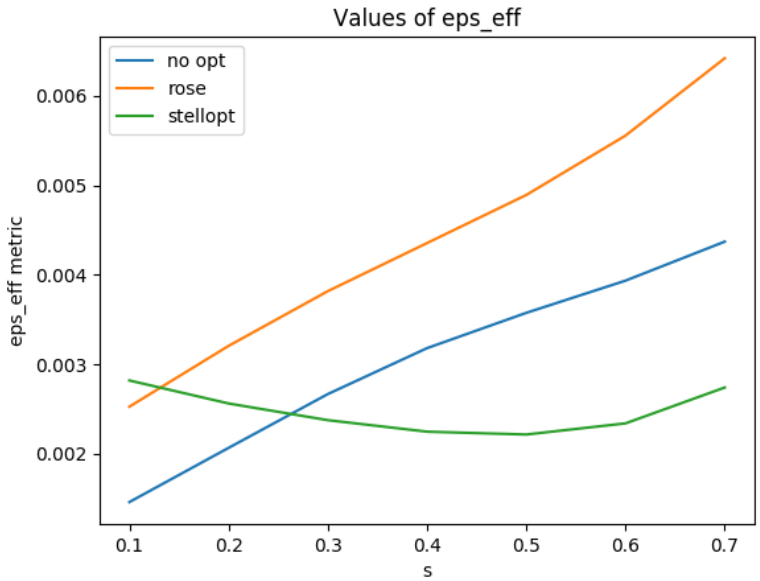
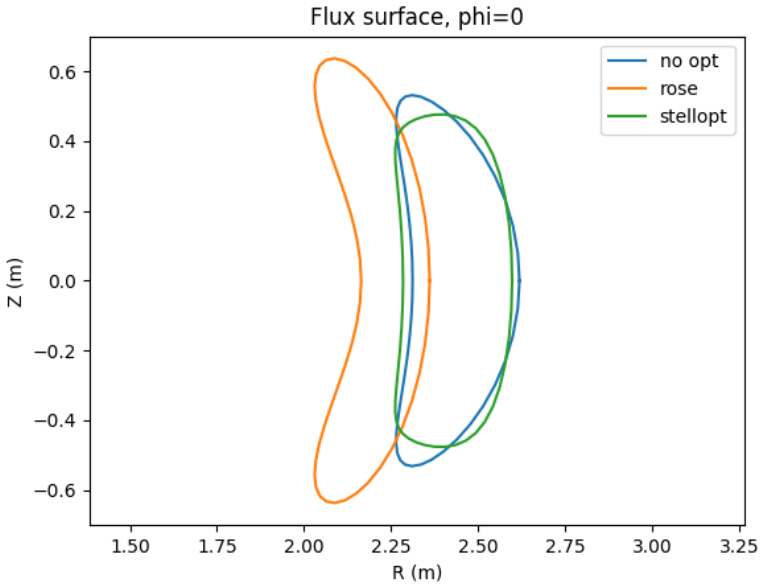


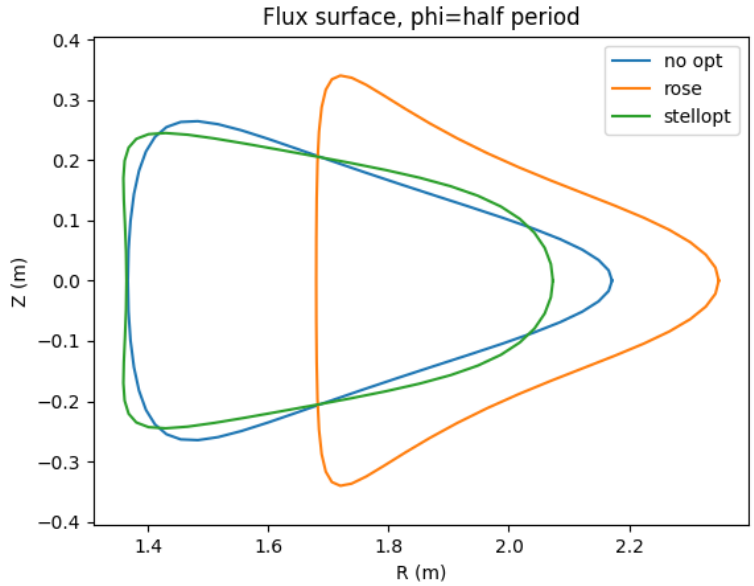


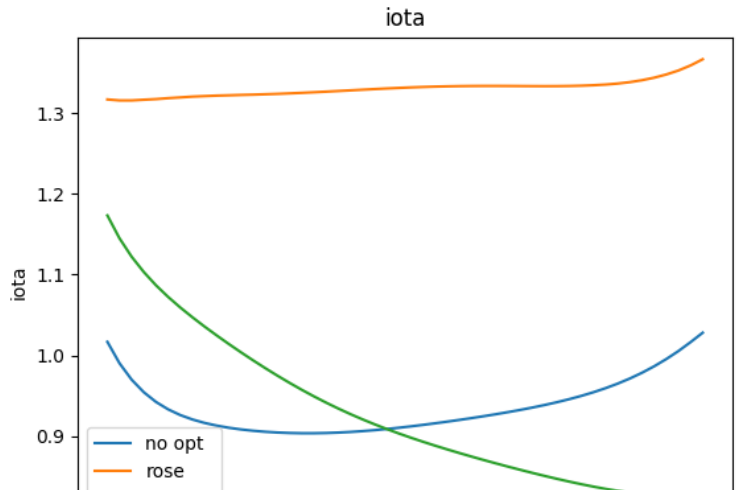


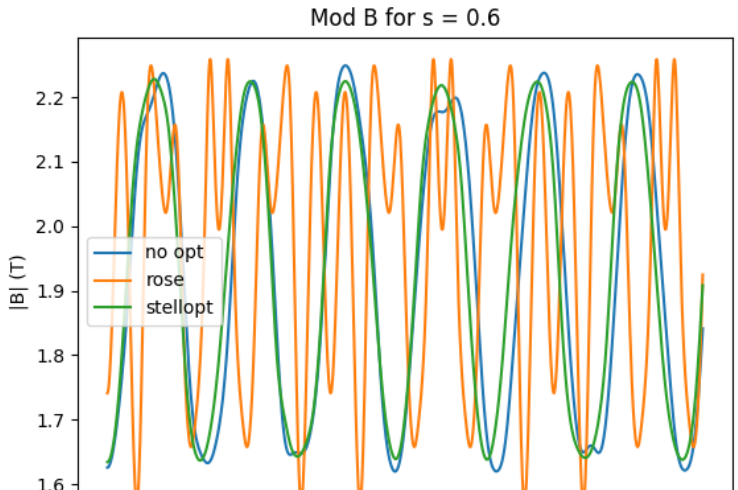
Optimize for low iota with finite current

WARNING: ROSE results look strange, weight for ι profile too high









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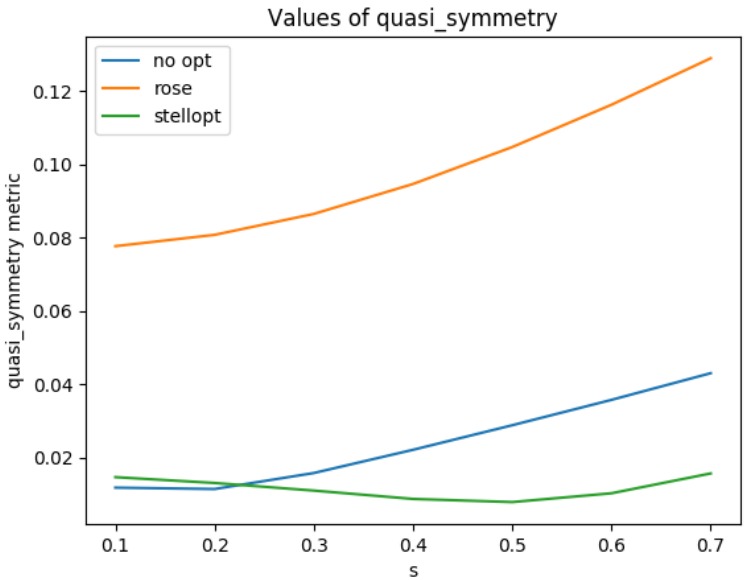

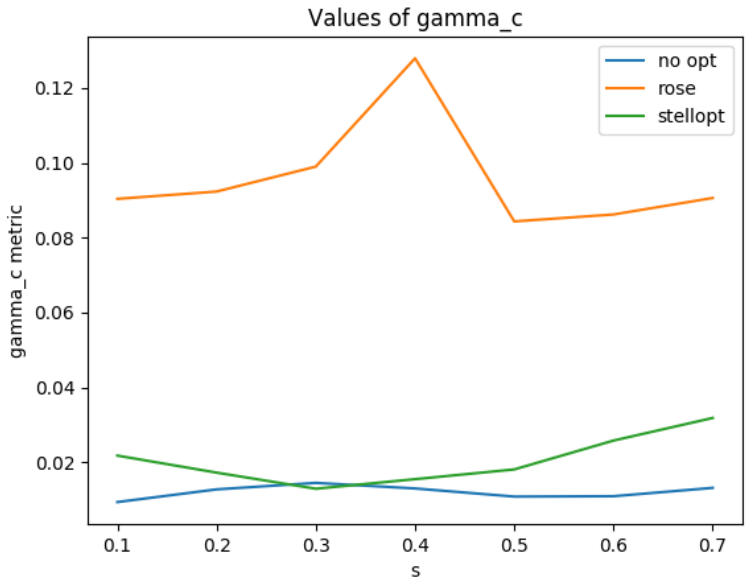

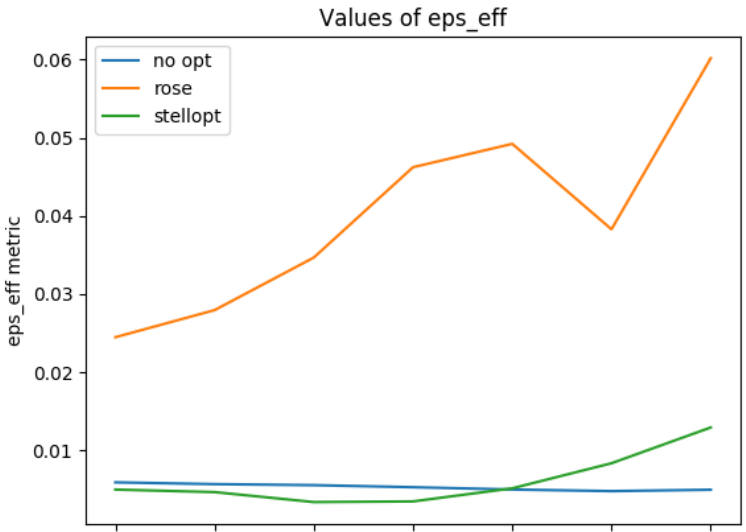

Optimize for QHS with finite current

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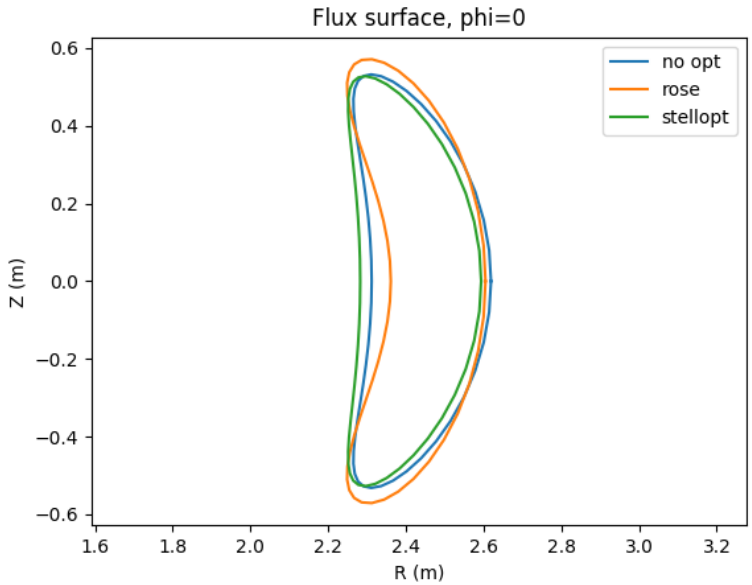

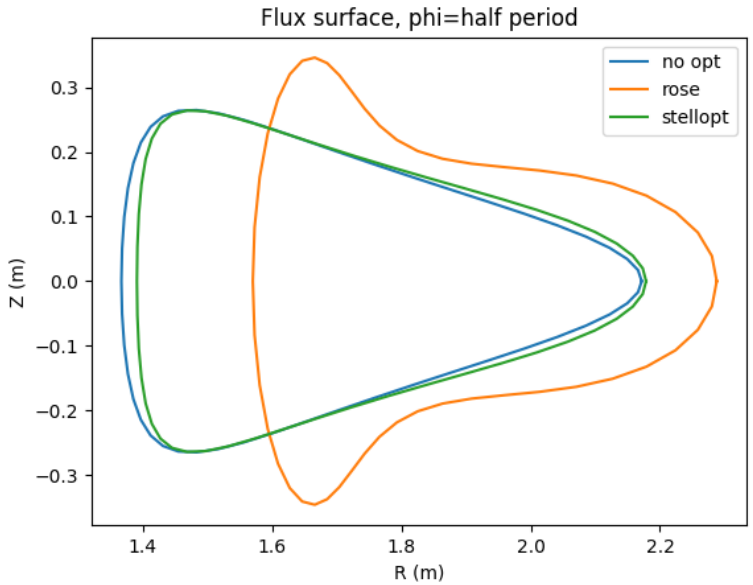

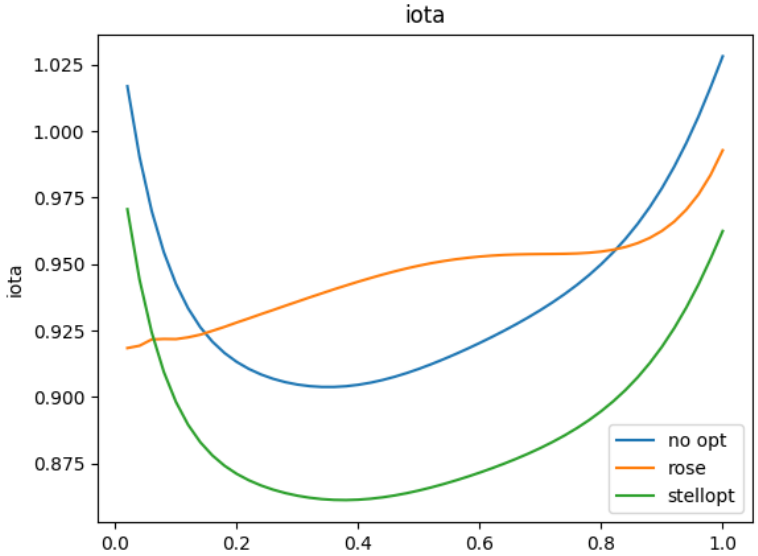

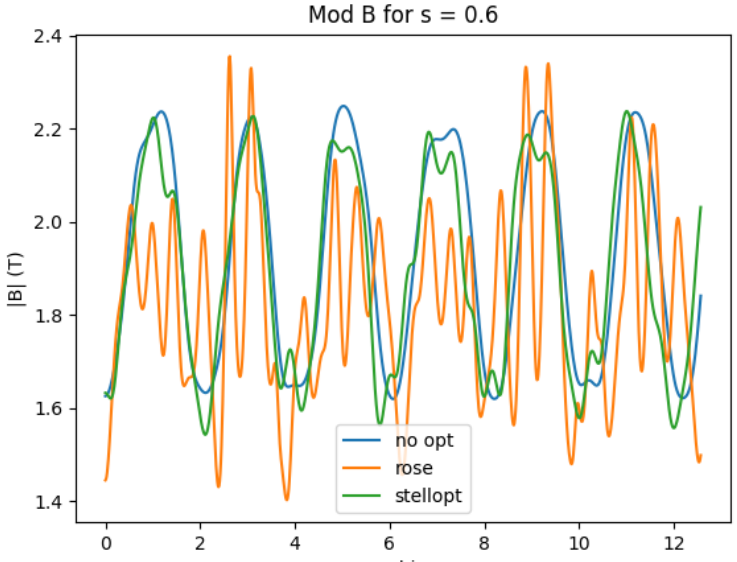

Optimize for QHS with finite current

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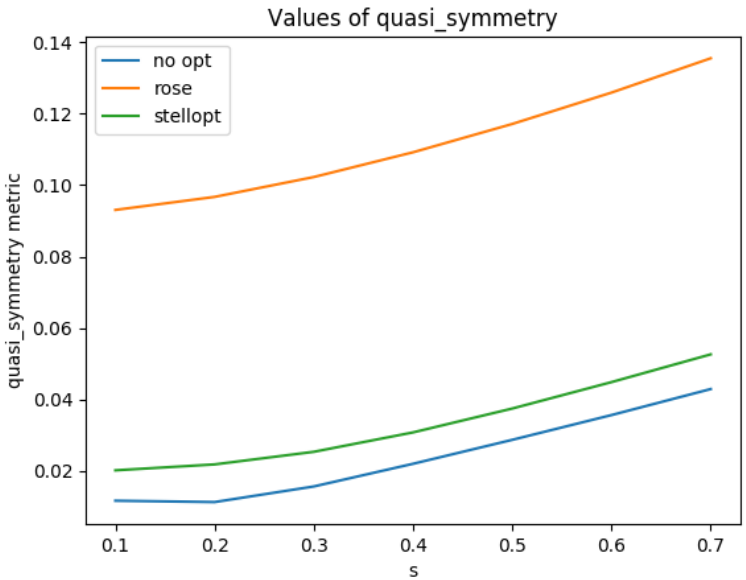

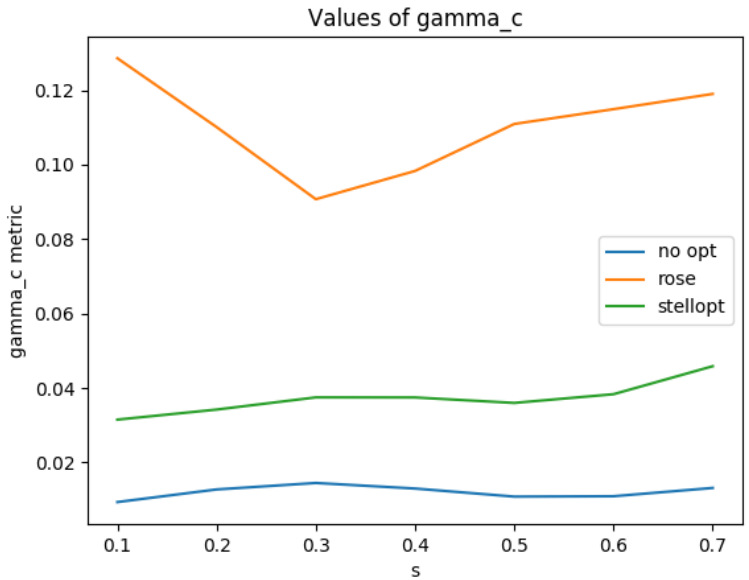

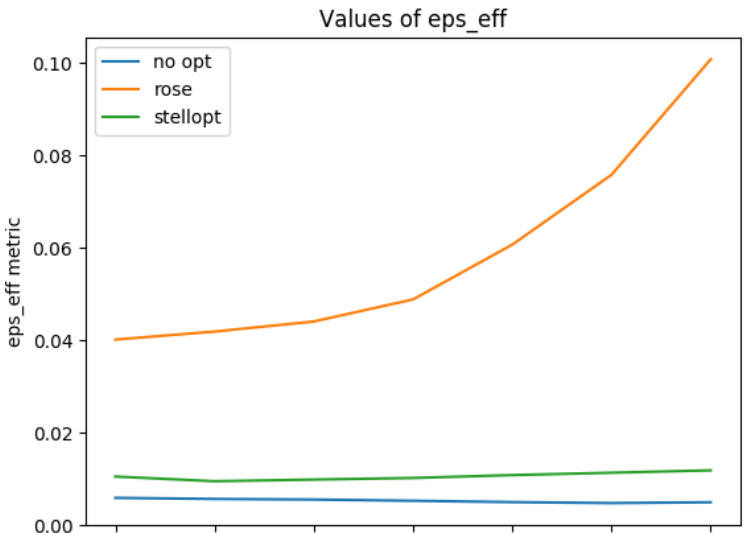

Rotational transform targeted to be 0.88 on axis and 0.95 at edge

Long list of caveats as to why this isn't an apples to apples comparison

- Optimization algorithms are different - and both are non-convex and likely to fall into local minima
- Evaluation of the total target function is different
  - STELLOPT - evaluate each metric individually and create a matrix for LM
  - ROSE - evaluate a total χ^2 value as the sum of individual components
  - ROSE provides access to the unweighted values, STELLOPT does not
- Individual metric calculations are different as well
  - STELLOPT - for QHS, divide by energy in all symmetric modes
  - ROSE - for QHS, divide by energy in B_{00} mode

Long list of caveats as to why this isn't an apples to apples comparison (cont.)

- Availability of targets differs
  - STELLOPT - for ι only allows the targeting of ι at individual flux surfaces
  - ROSE - allows for constraint or full targeting of iota, and also can target monotonicity of ι profile
- Independent variables (R_{mn}, Z_{mn}) have different access
  - STELLOPT - uninitialized coefficients are available but because of line-search don't tend to contribute when initially zeroed
  - ROSE - uninitialized coefficients are unavailable

Basic conclusions from this study

- It's unsurprising that the results yield different equilibria - convexity studies predict this is a likely outcome
- There might be use to passing equilibria back and forth between the two optimization codes
- ROSE appears to be more sensitive to starting weights than STELLOPT, could be a feature of the algorithm
- It's also easier to get information on the current weighting from ROSE than STELLOPT - area where STELLOPT needs improvement