Comparison of best configurations so far

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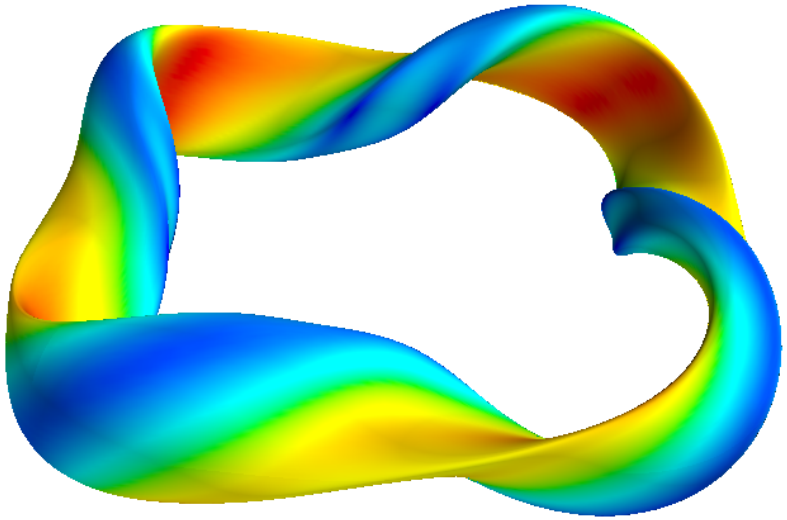
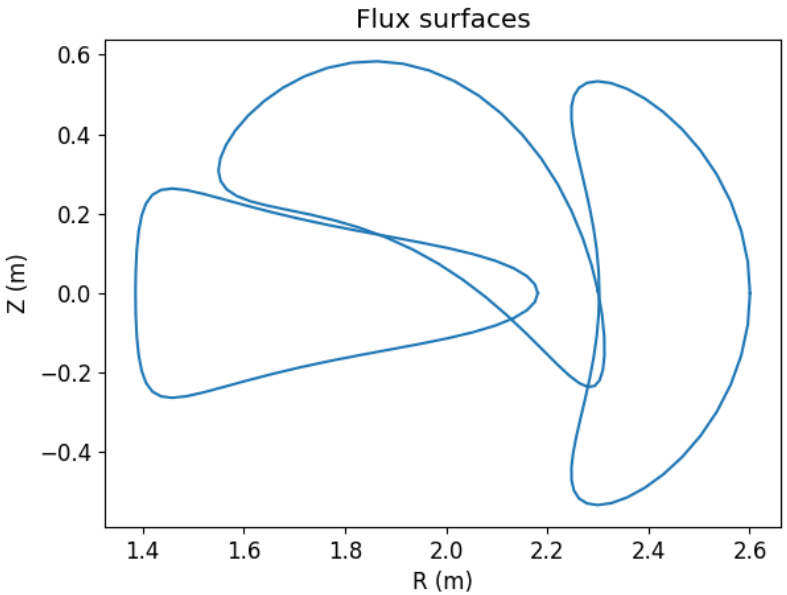
5 candidate configurations identified

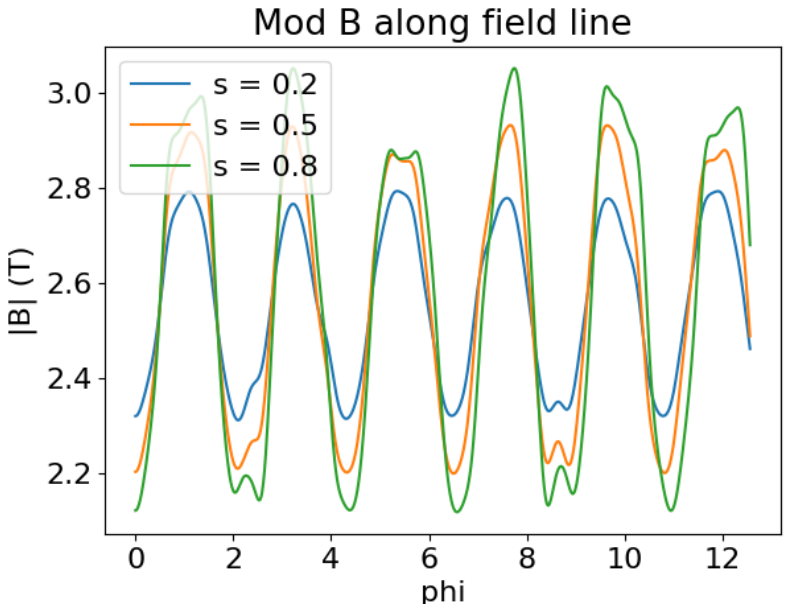
- Introduce each configuration
- Compare configurations as to different metrics
  - PTSM3D evaluation of turbulent transport
  - EP confinement at ARIES scale
  - Quasi-symmetry metric
  - Rotational transform
  - Epsilon effective metric
  - Presence of magnetic well

Current Wistell champion: ATEN

NFP	4
Aspect	6.72
Well	Yes
Iota r=0	1.09
Iota r=1	1.17
Created by	ROSE from QH

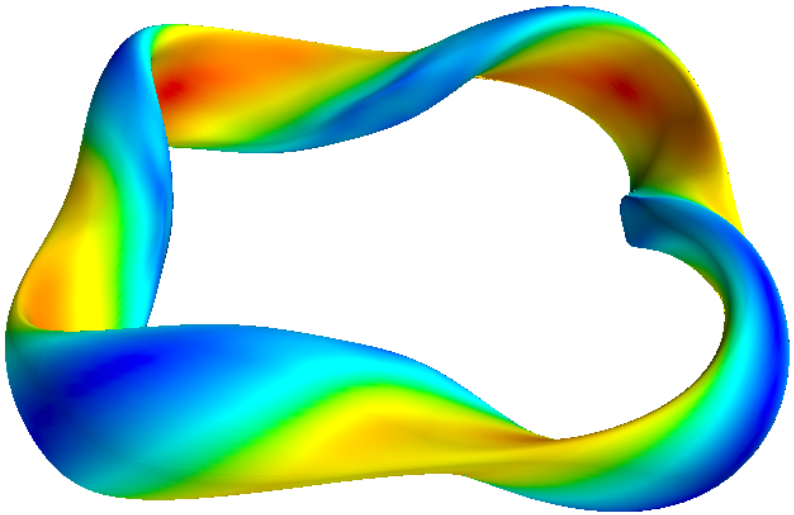


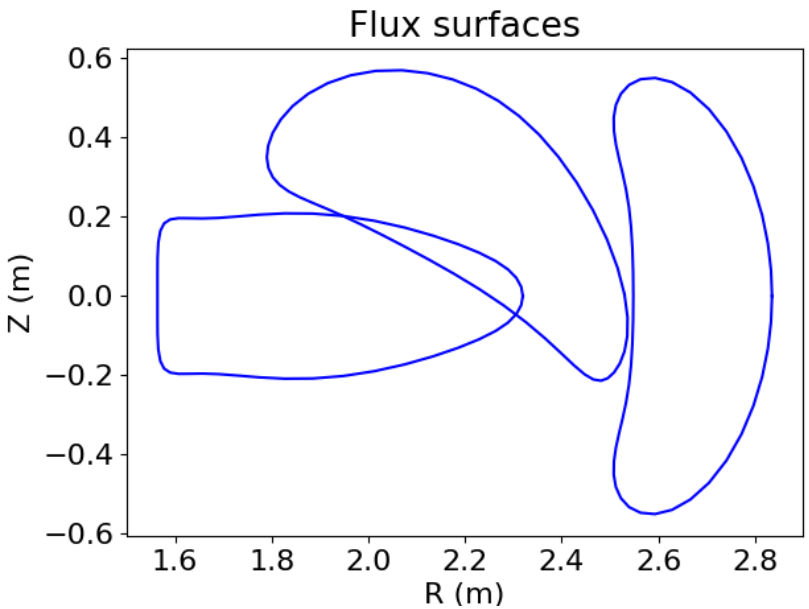


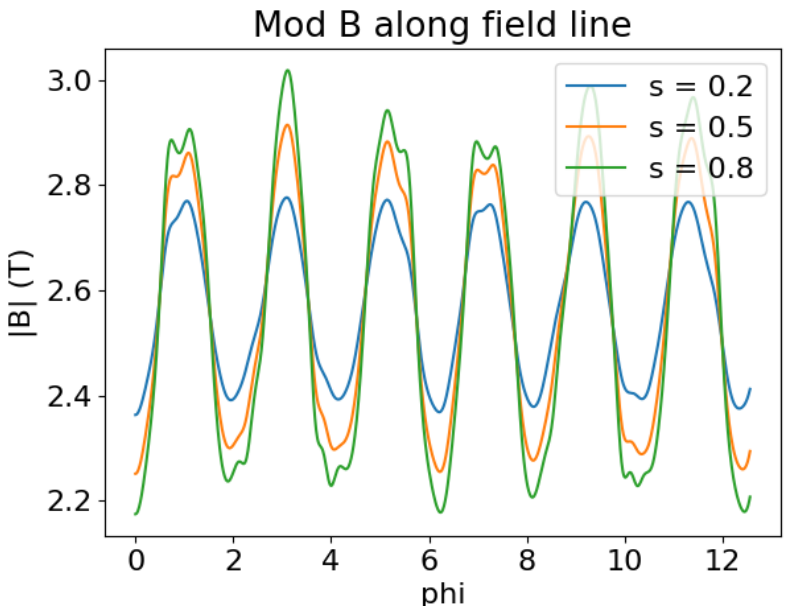


Low iota option: wistb_24

NFP	4
Aspect	7.46
Well	No :(
Iota r=0	0.925
Iota r=1	0.965
Created by	ROSE from AT

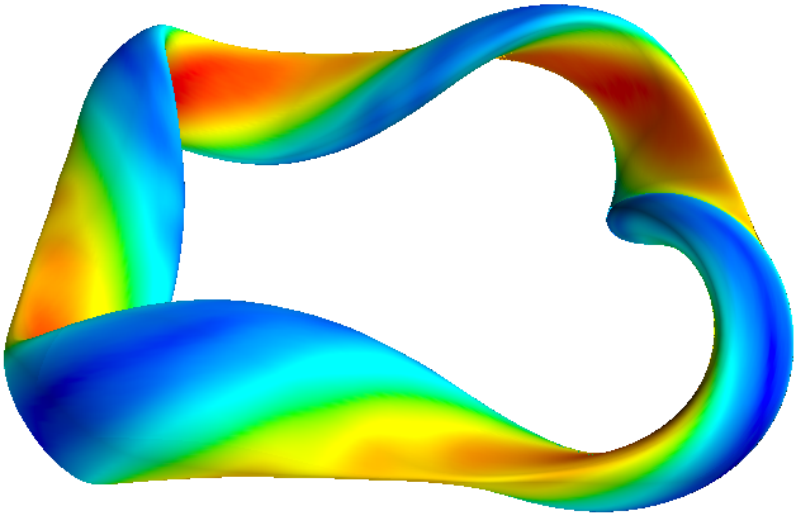


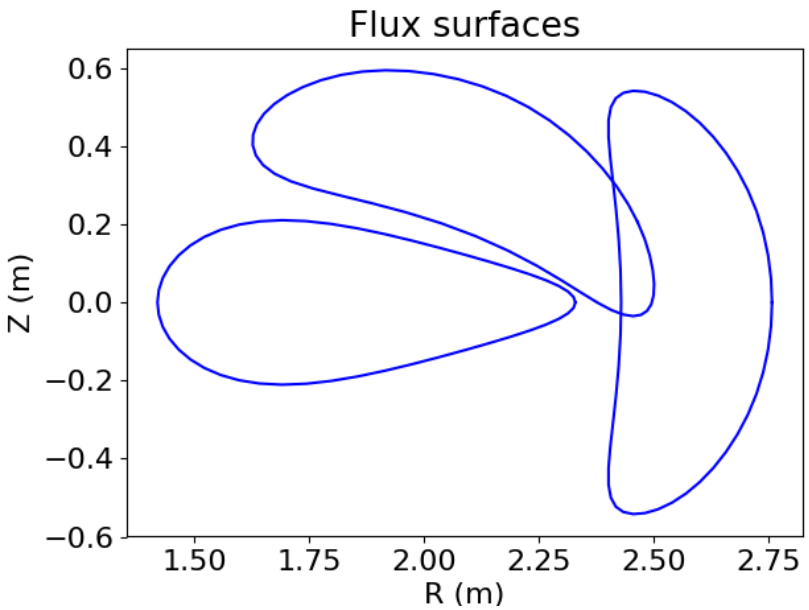


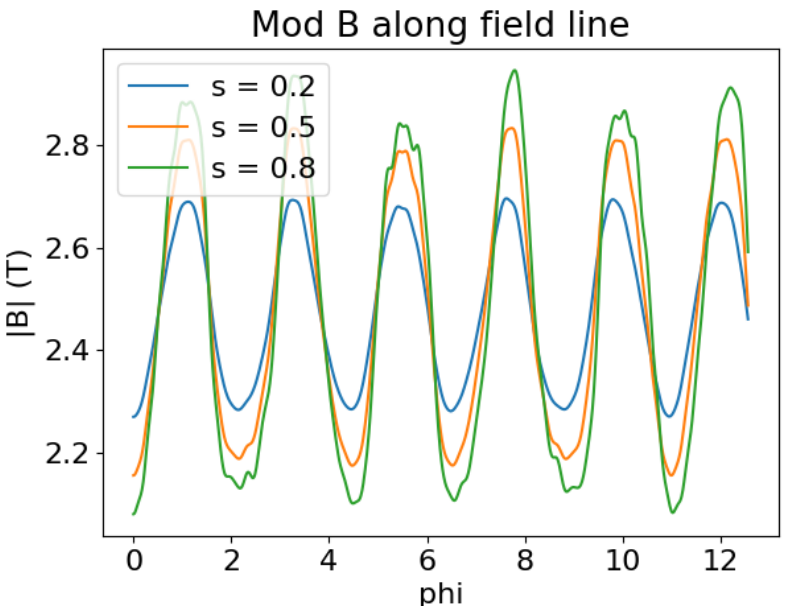


Constructed: mljs_2

NFP	4
Aspect	7.14
Well	Yes
Iota r=0	1.12
Iota r=1	1.18
Created by	$O(r^2)$ const.

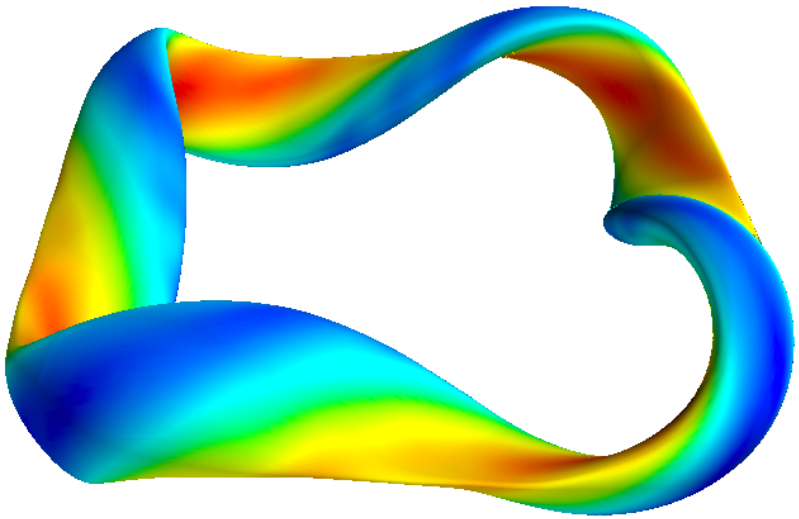


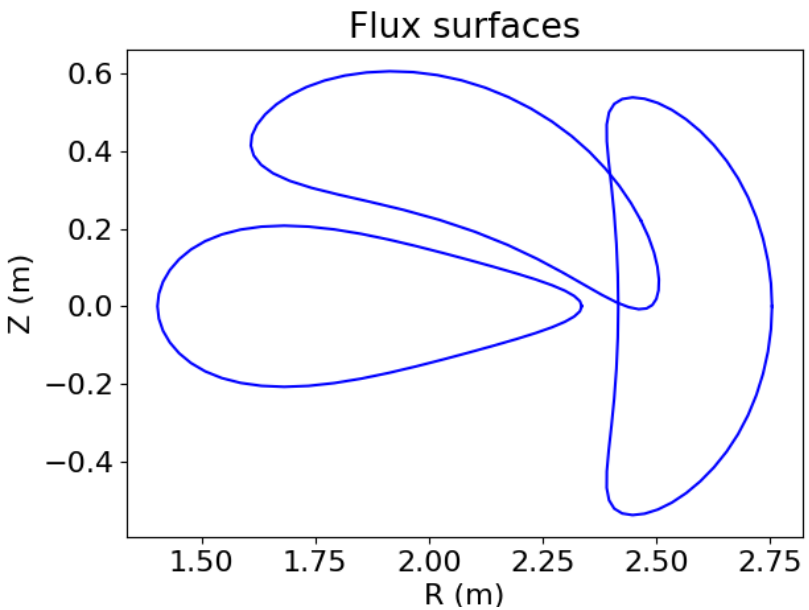


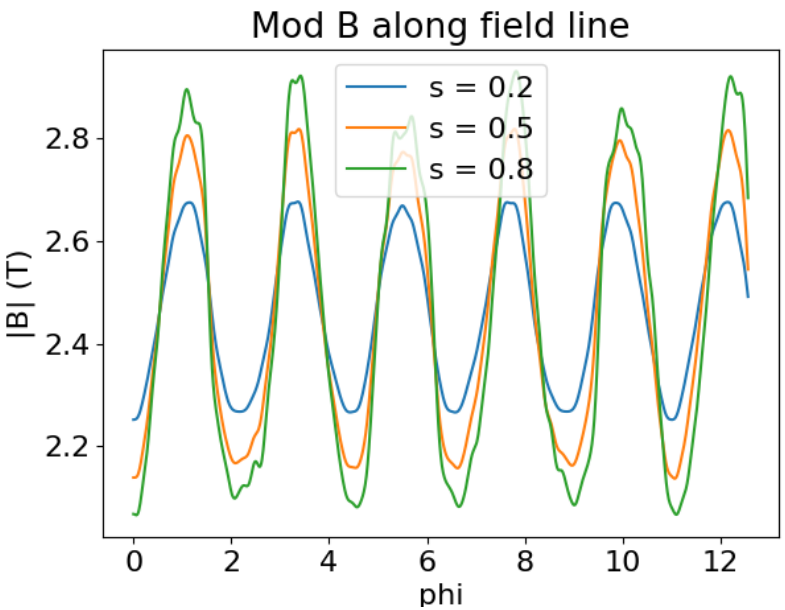


Constructed: mljs_3

NFP	4
Aspect	7.11
Well	Yes
Iota r=0	1.14
Iota r=1	1.20
Created by	$O(r^2)$ const.

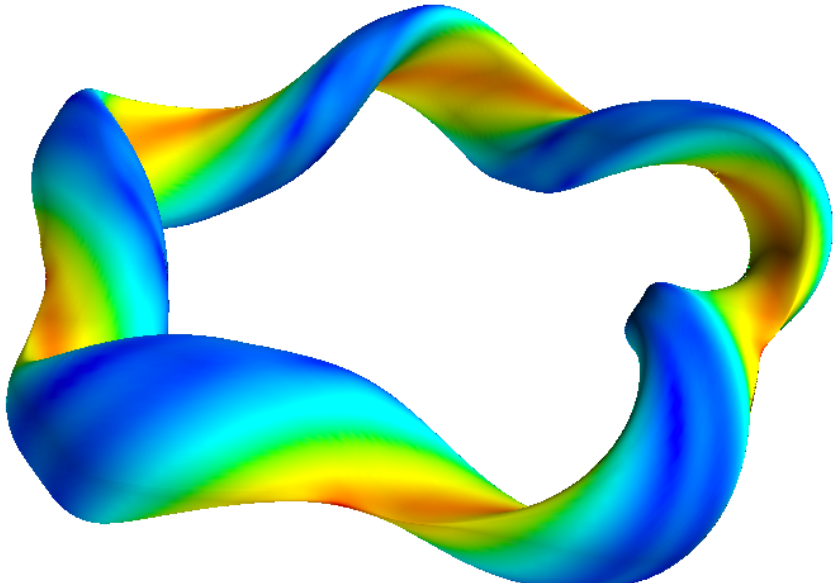


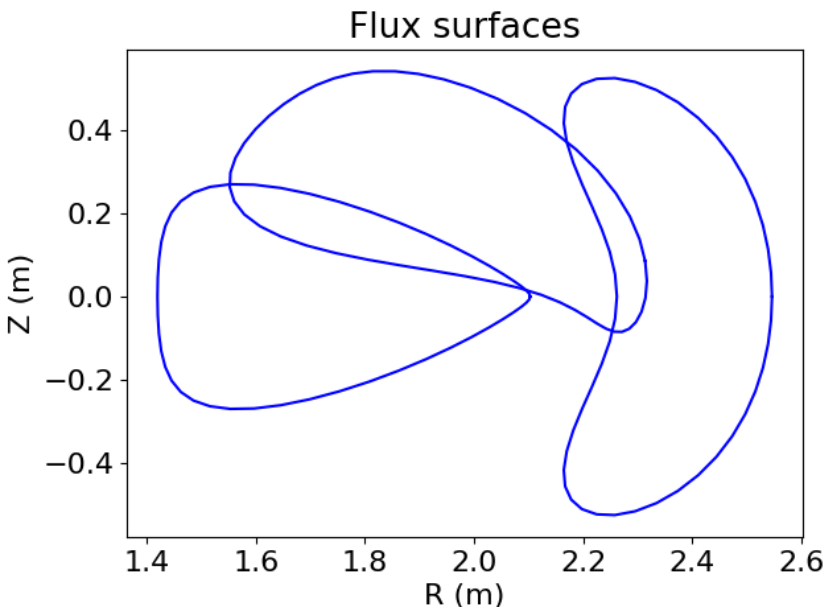


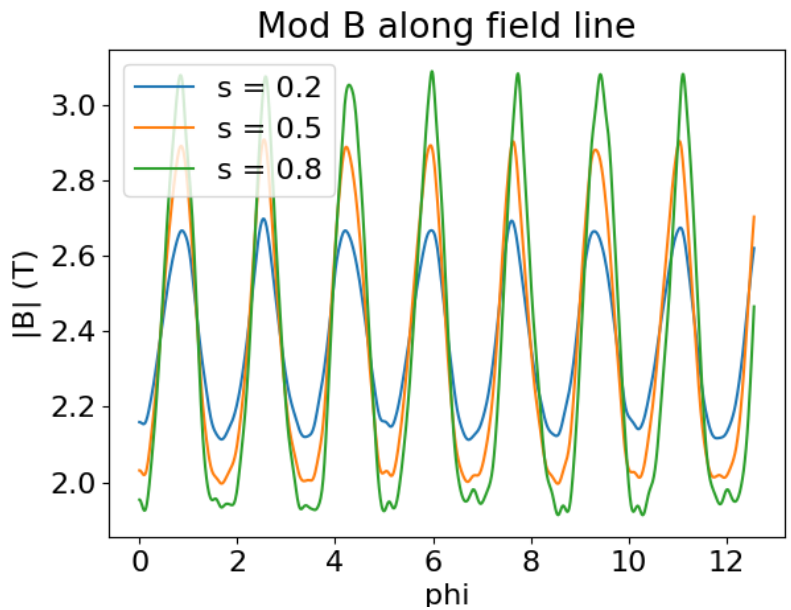


5 period option: ware5p_2

NFP	5
Aspect	6.63
Well	Yes
Iota r=0	1.3
Iota r=1	1.42
Created by	STELLOPT then ROSE

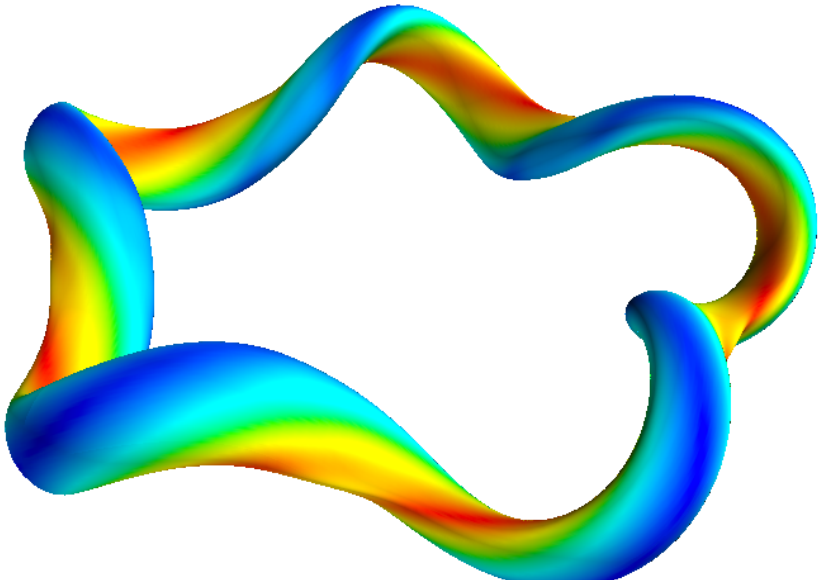


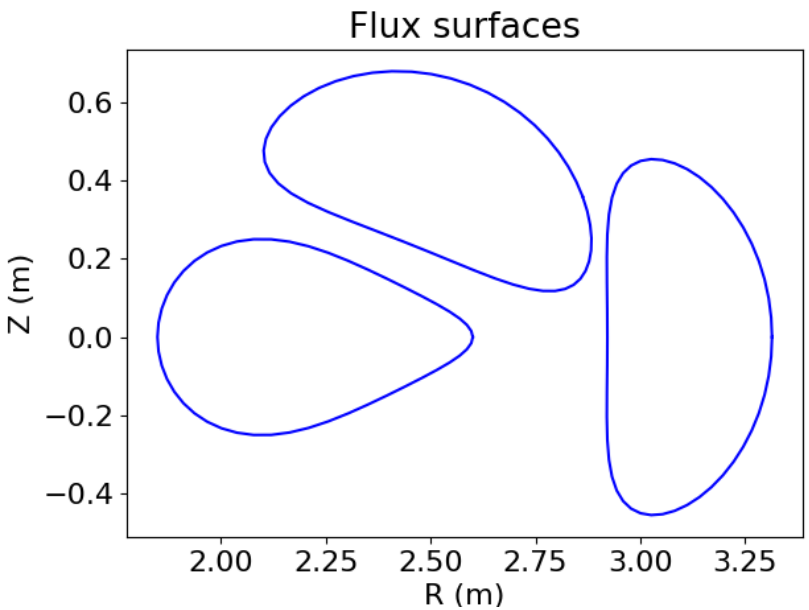


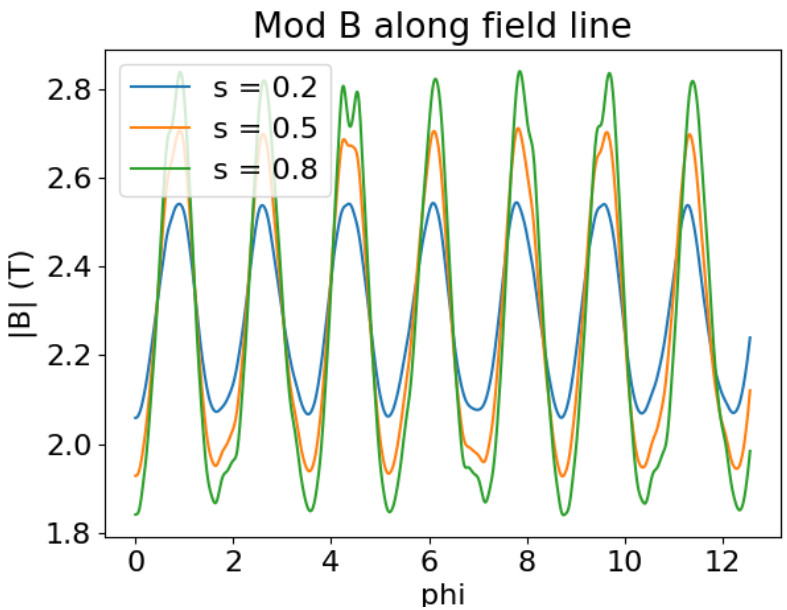


5 period option: mljs_4

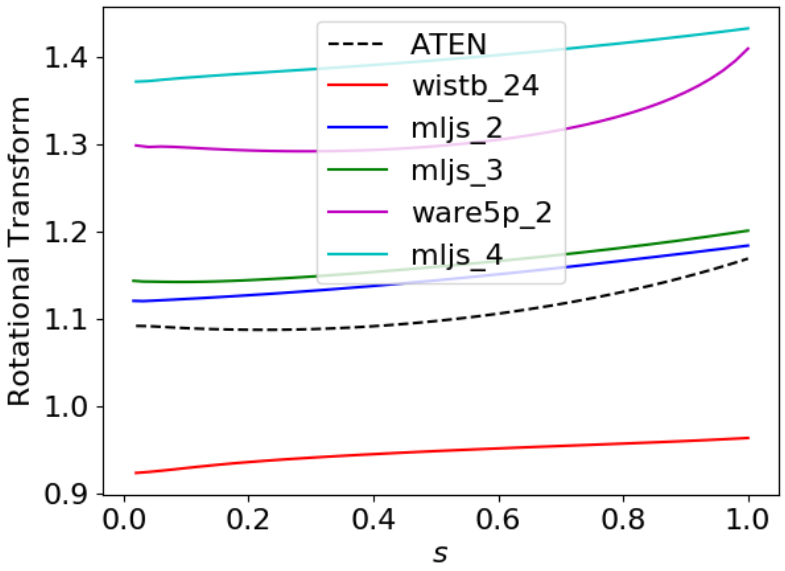
NFP	5
Aspect	8.6
Well	Yes
Iota r=0	1.37
Iota r=1	1.435
Created by	$O(r^2)$ const.

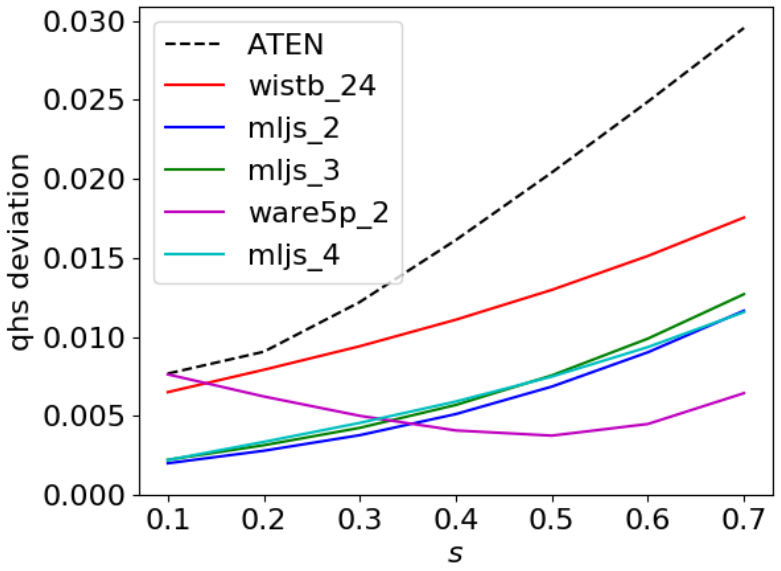




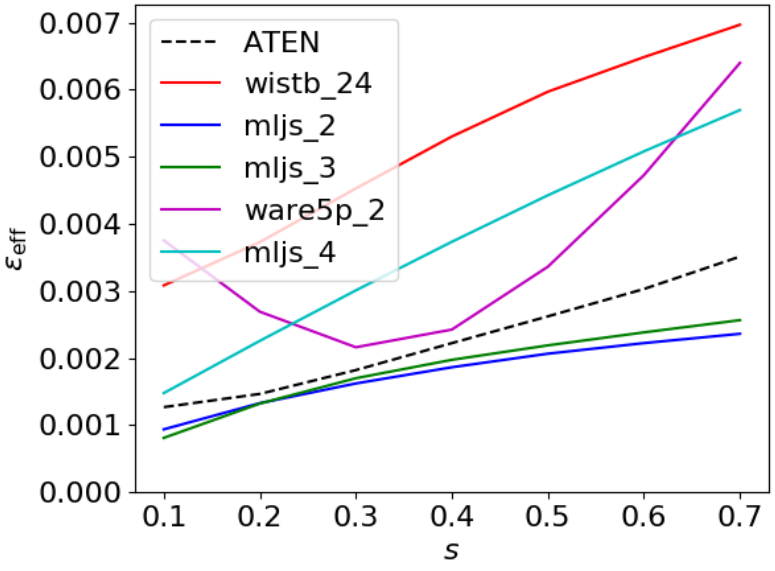


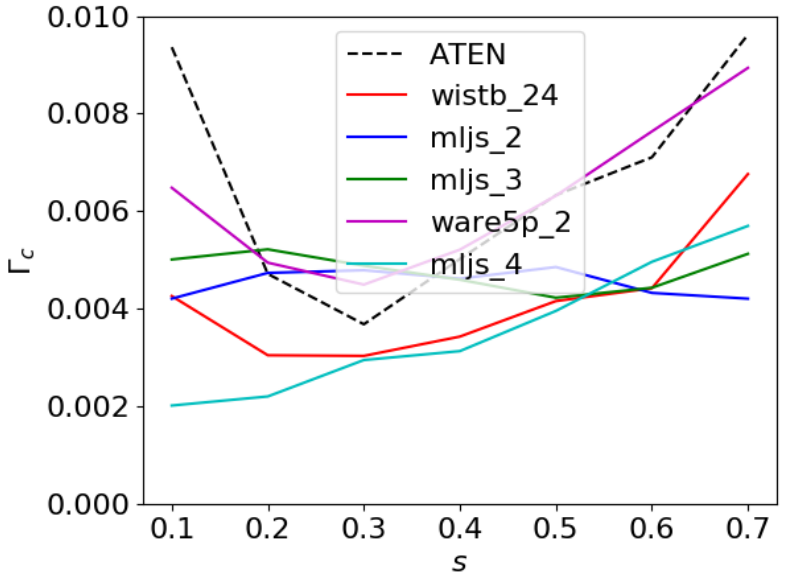
Performance evaluation - rotational transform & QH





Performance evaluation - ϵ_{eff} & Γ_c





- Might expect that mljs_4 performs well for EP based on Γ_c and QHS metric.
- Similarly, might expect that ATEN performs poorer than other configurations

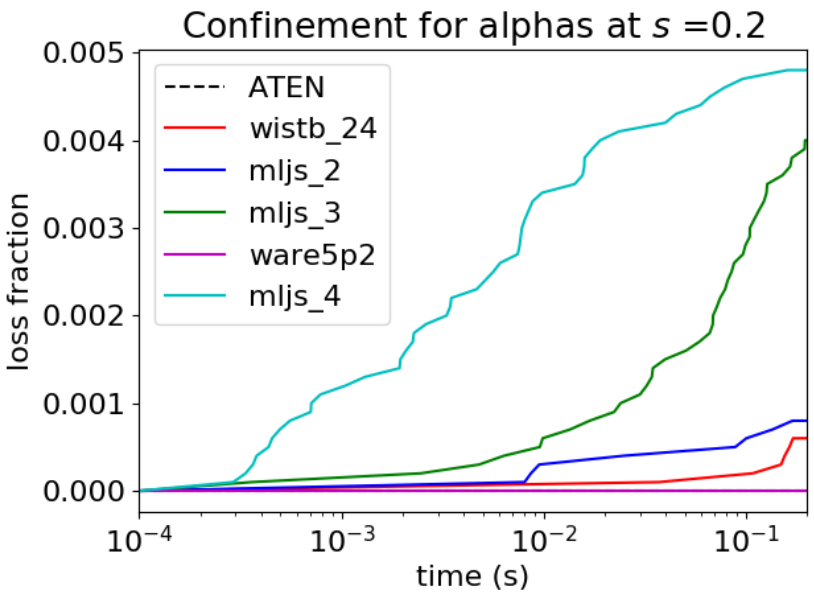
Performance evaluation - PTSM3D

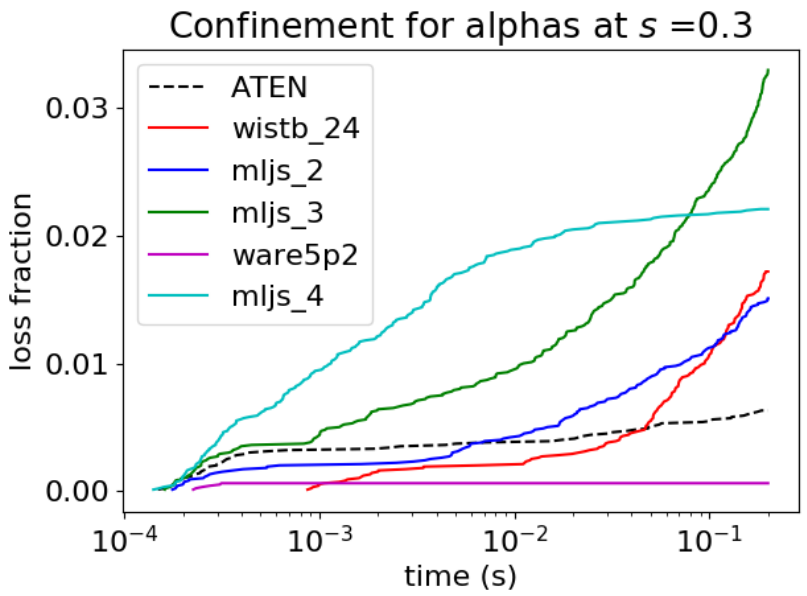
Values of $\tau_c/\tau_c^{\mathrm{HSX}}$

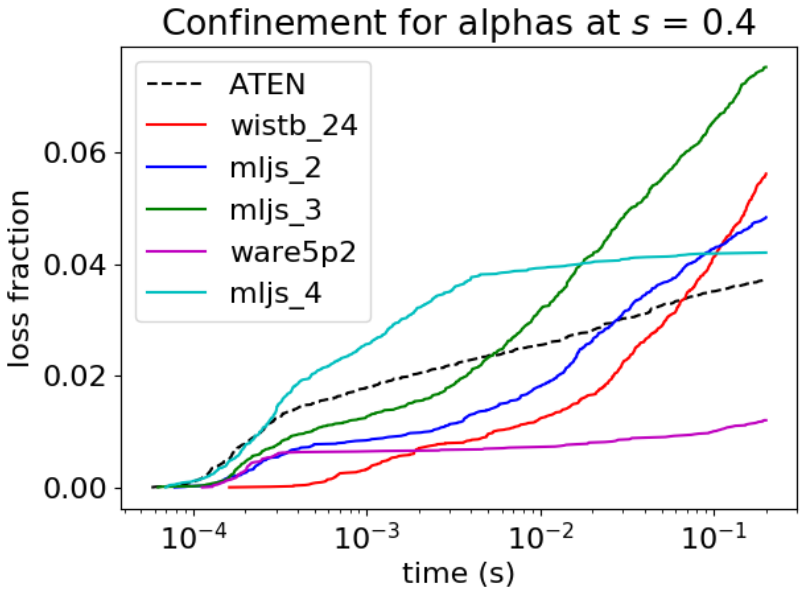
Config	Zonal	Non-Zonal
ATEN	0.819936	0.758255
wistb_24	**1.328254**	**3.343897**
mljs_2	1.115622	0.870768
mljs_3	0.937568	0.487022
ware5p2	0.786367	0.771038
mljs_4	???	???

- Non-linear heat flux $Q \sim 1/\tau_c$, higher values are better
- One configuration, wistb_24 clearly outperforms the others with respect to the metric
- NB: Nonlinear Gene simulations showed that ATEN outperformed HSX contrary to expectations from the metric

Performance evaluation - Energetic Particles







- All configurations scaled to ARIES field and volume
- All below 0.5% losses at s=0.2
- ware5p2 outperforms all other configurations, including ATEN

Performance evaluation - Coils

Coil evaluations done by J. Schmitt using REGCOIL

- **ATEN**: Has a narrow window for good conditions for coils
- wistb_24: Medium window for good conditions
- mljs_2: Slightly better than **ATEN**,
  but not as good as wistb_24
- mljs_3: Medium window of good conditions,
  similar to wistb_24
- ware5p2: Very large window for good conditions, but difficult to match $|B|$, especially near crescent region
- mljs_4: Narrow window, slightly better than **ATEN**.
  Similar to mljs_2

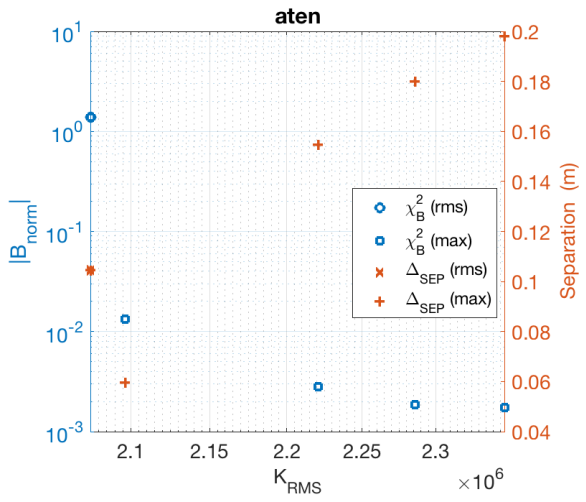
For each configuration, REGCOIL was run in both ‘target = rms_K’ and ‘target = max_K’ modes, with many different target values.
For each target value, the separation between plasma & winding surface was varied to find minimum residual Bnorm that could be achieved.

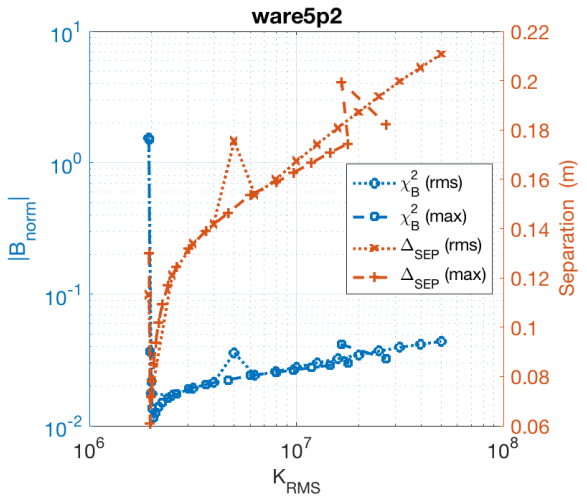
- Slide 2
- X-axis: KRMS
- Left Axis: Bnorm @ optimal separation
- Right Axis: Optimal separation

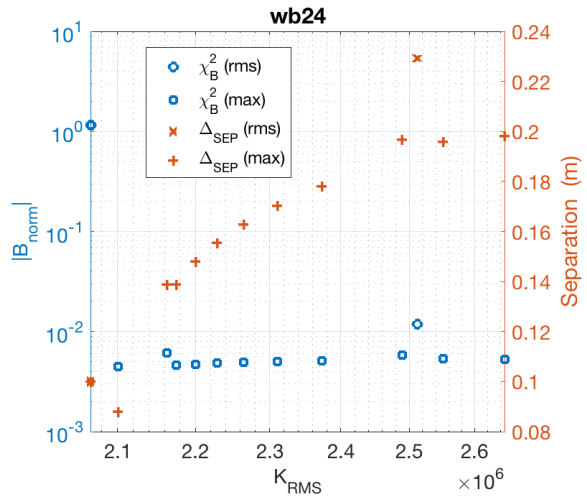
- Slide 3
- X-axis: KRMS
- Left Axis: Bnorm @ optimal separation
- Right Axis: Kmax

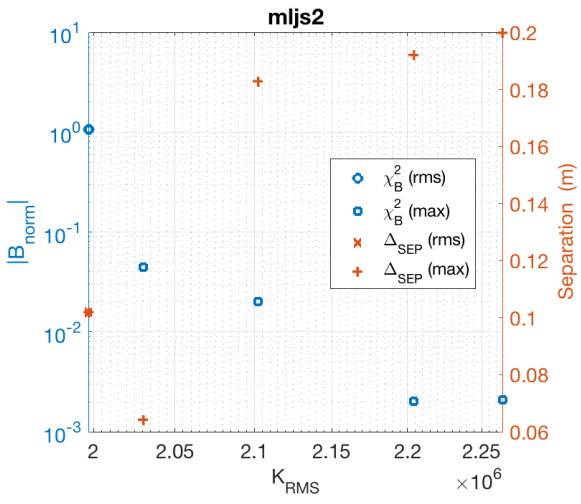
KRMS ~ Average coil curvature (smaller means ‘simpler’ coils)
Kmax ~ Maximum coil curvature (a measure of the ‘tightest bends’ in the coils)

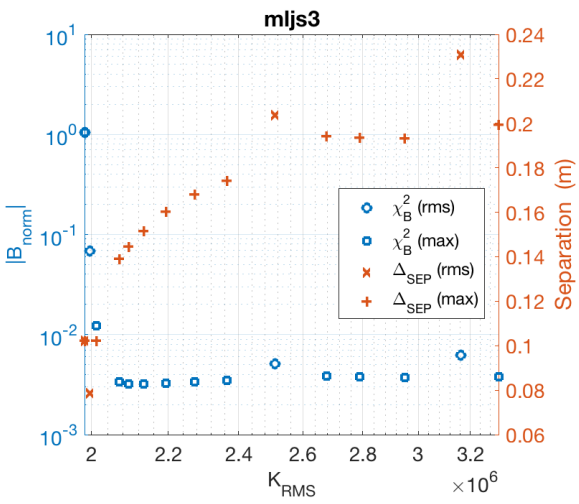
ATEN: Narrow window of good conditions for for coils
WARE5p2: Very Large window of good conditions, but |B| is slightly larger.
WB24: Medium window of good condition
MLJS2: Similar to, but slightly better than, ATEN
MLJS3: Similar to WB24
MLJS4: Similar to MLJS2

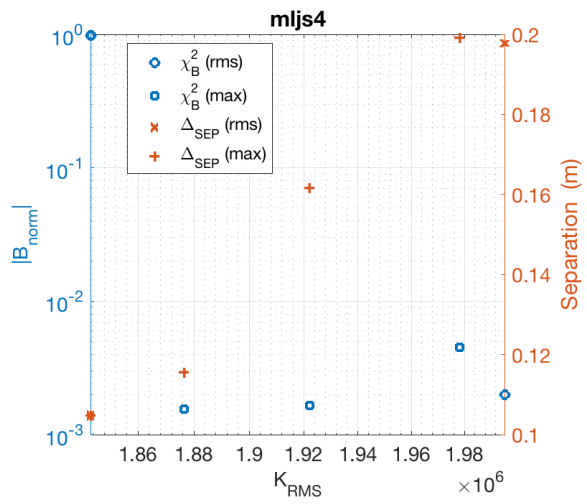

aten
$|B_{norm}|$
Separation (m)
K_{RMS}
$\times 10^6$
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

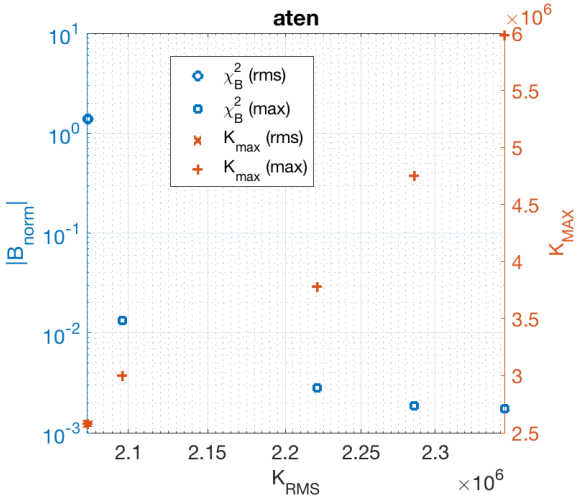

ware5p2
$|B_{norm}|$
Separation (m)
K_{RMS}
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

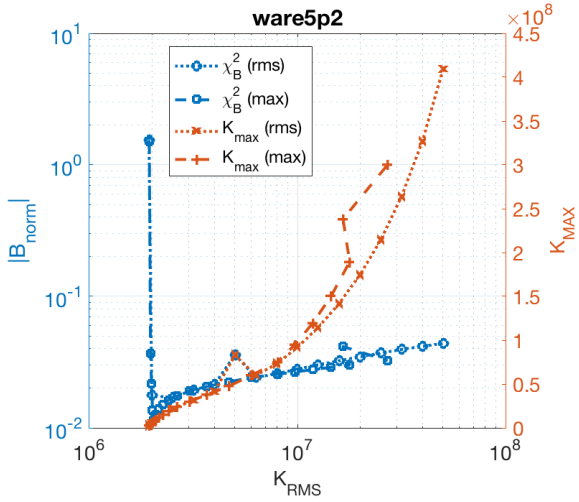

wb24
$|B_{norm}|$
Separation (m)
K_{RMS}
$\times 10^6$
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

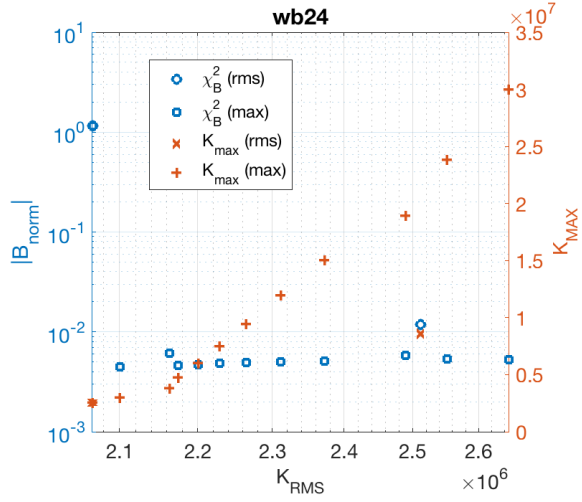

mljs2
$|B_{norm}|$
Separation (m)
K_{RMS}
$\times 10^6$
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

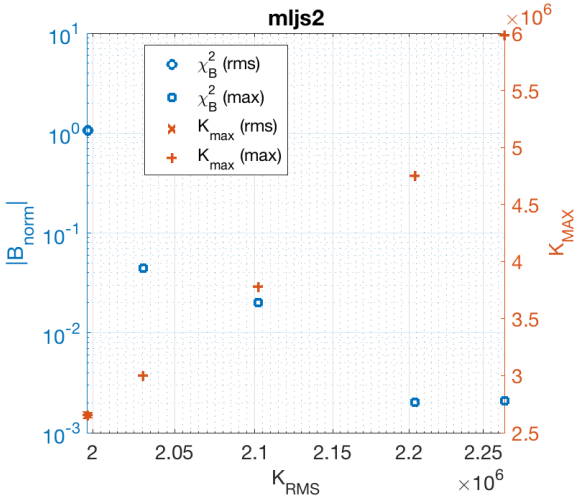

mljs3
$|B_{norm}|$
Separation (m)
K_{RMS}
$\times 10^6$
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

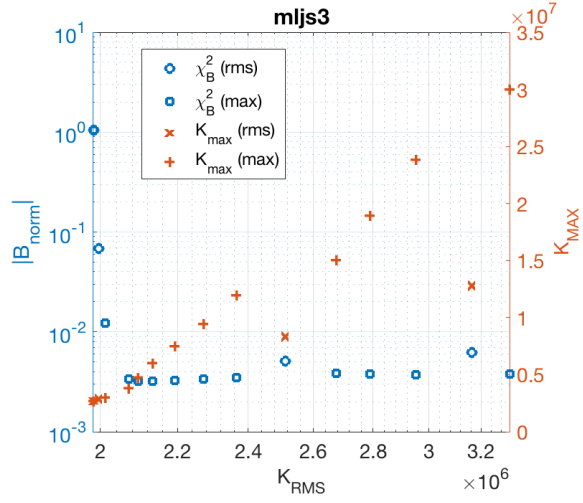

mljs4
$|B_{norm}|$
Separation (m)
K_{RMS}
$\times 10^6$
χ_B^2 (rms)
χ_B^2 (max)
Δ_{SEP} (rms)
Δ_{SEP} (max)

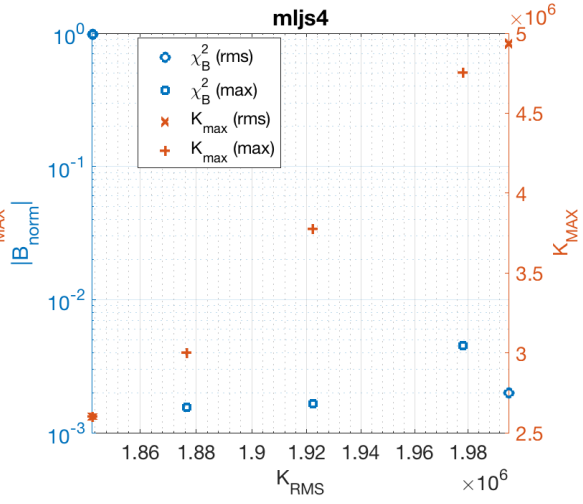

aten
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^6$


ware5p2
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^8$


wb24
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^7$
$\times 10^6$


mljs2
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^6$


mljs3
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^7$
$\times 10^6$


mljs4
χ_B^2 (rms)
χ_B^2 (max)
K_{max} (rms)
K_{max} (max)
$|B_{norm}|$
K_{MAX}
K_{RMS}
$\times 10^6$