Magnetic Field Topology of the NCSX Scrape-Off Layer: 1.4m Major Radius LI383 Plasmas

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UCSD

24-25 July 2001 NCSX Project Meeting

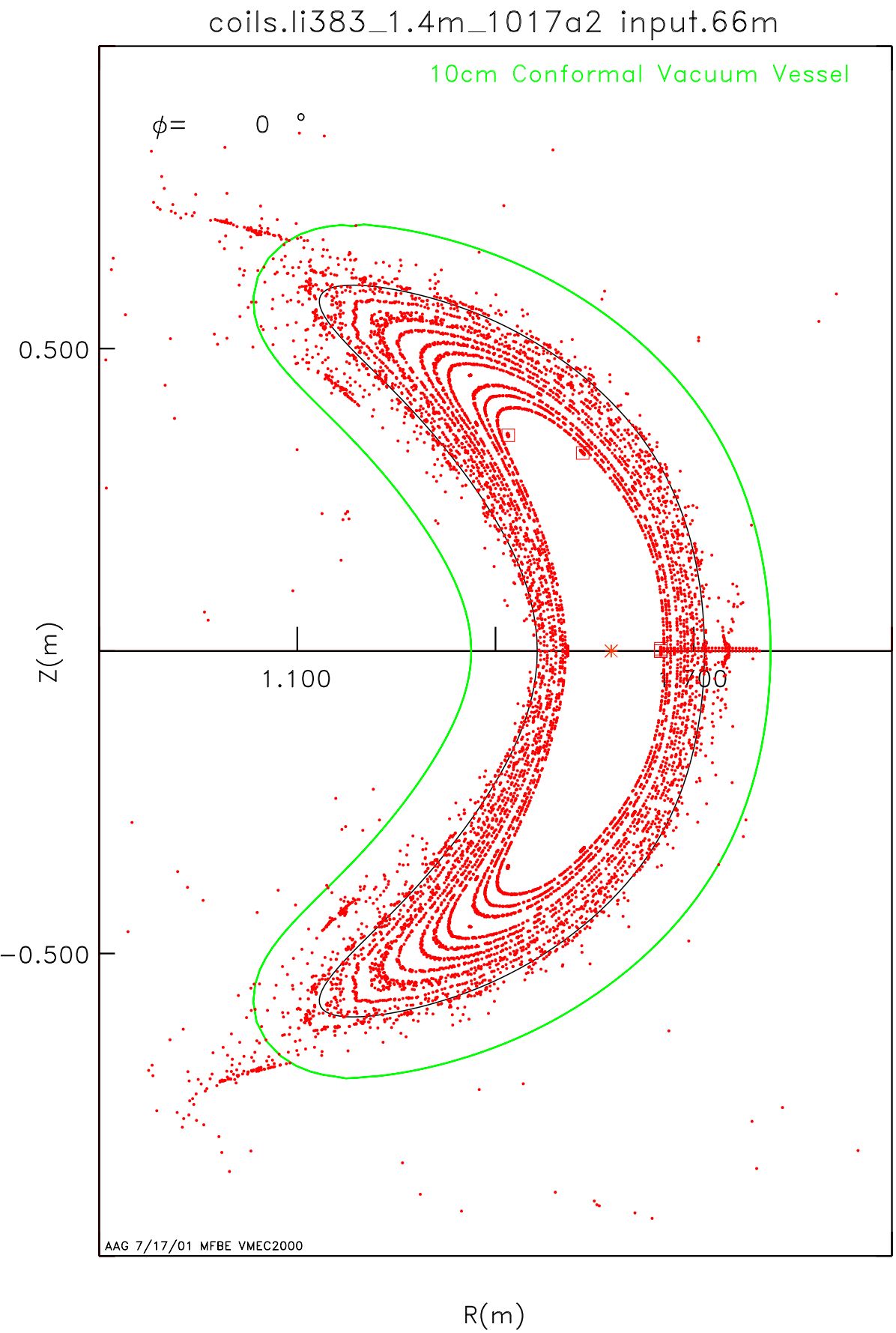
Princeton Plasma Physics Laboratory

Conventions

- Black- LCMS from free boundary VMEC2000.
- Green- Conformal vacuum vessel
- Red- Poincare punctures; punctures from first three periods of the outermost radial starting points are enclosed by a red square.
- Star- Magnetic axis

Demonstration of MFBE Closed Surfaces When Some Launches Are Inside the LCMS

- 15 launch points evenly spaced between R=1.65m and R=1.8m, all with Z=0
- Conformal vessel (green) is 10cm from LCMS (black).
- Maximum number of toroidal turns is 200. All 3 period punctures are superimposed.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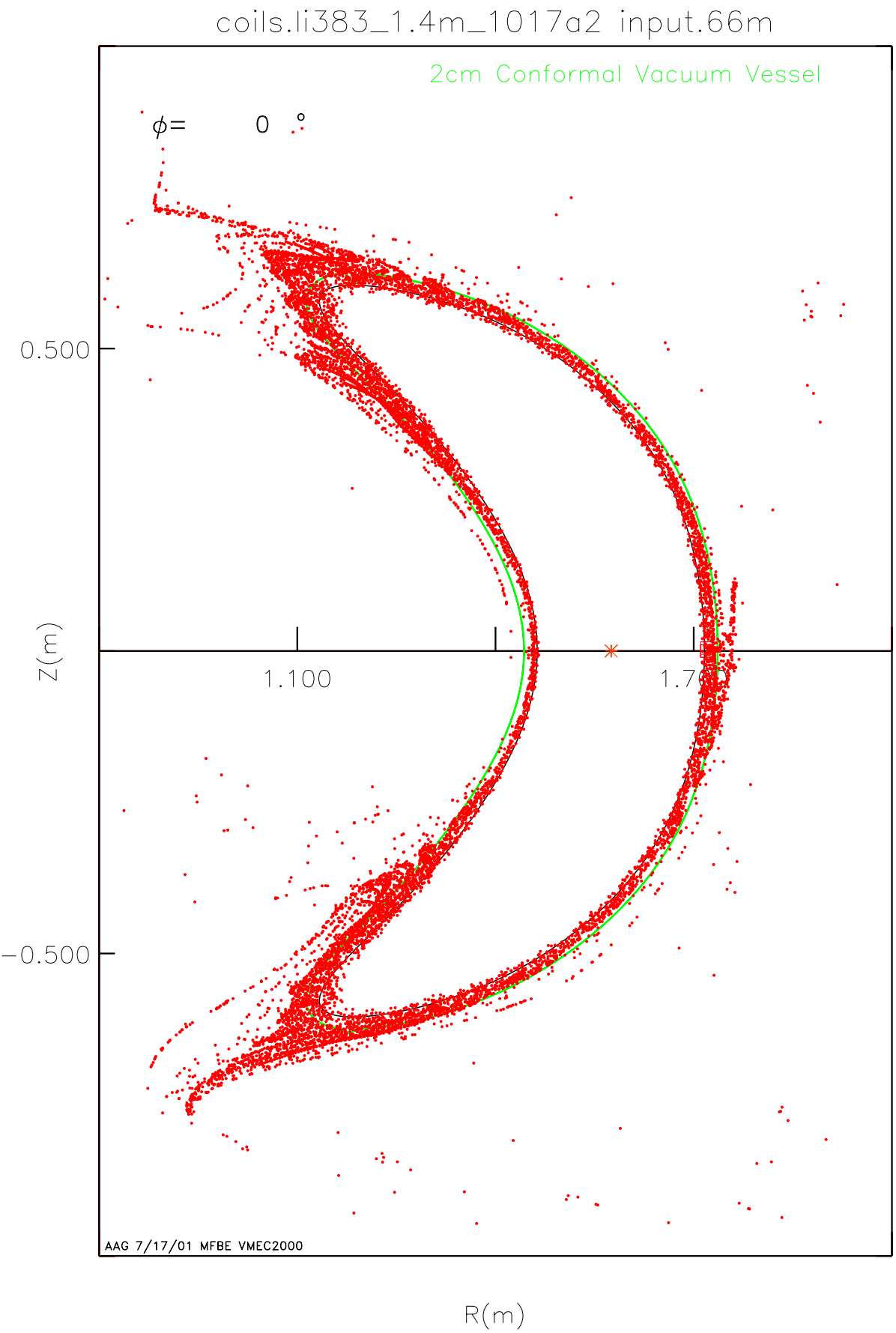
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

2 cm Conformal Vessel: Too Close

- 15 launch points evenly spaced between R=1.7m and R=1.9m, all with Z=0
- Conformal vessel (green) is 2cm from LCMS (black).
- Maximum number of toroidal turns is 200. All 3 period punctures are superimposed.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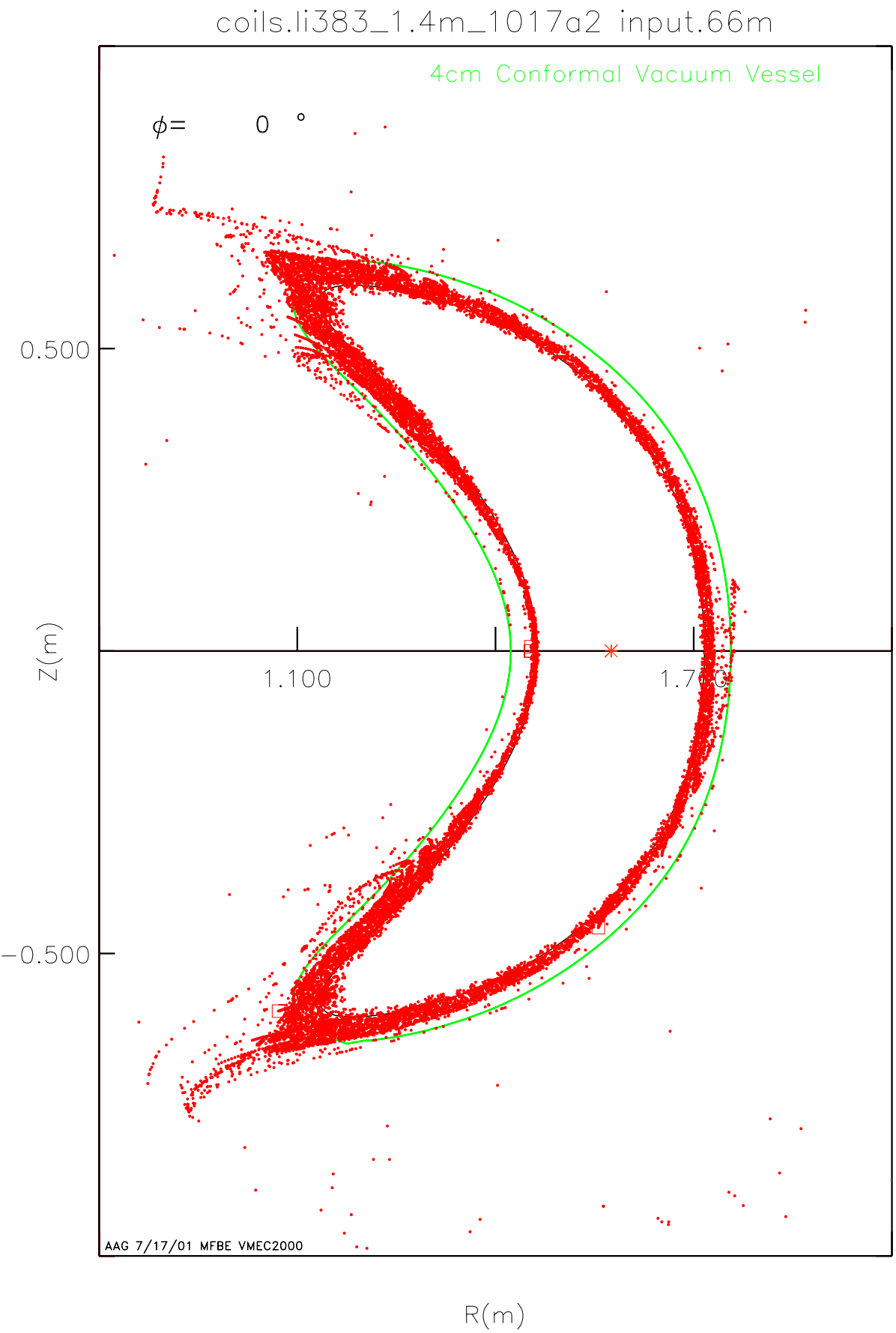
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 0 to 1 cm from LCMS

- 60 launch points evenly spaced between R=1.4532m and R=1.4632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 200. All 3 period punctures are superimposed.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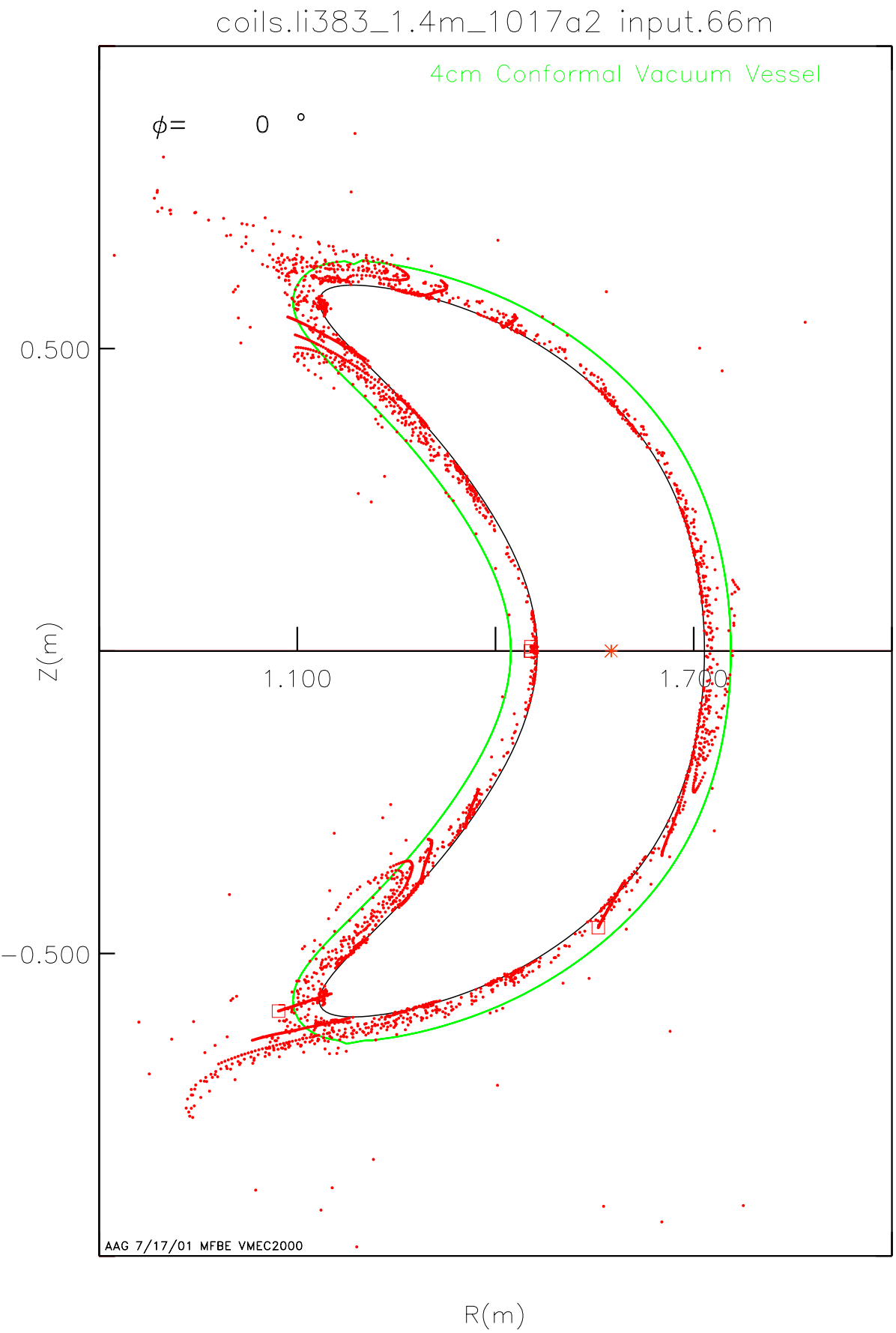
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 0 to 1 cm from LCMS

- 60 launch points evenly spaced between R=1.4532m and R=1.4632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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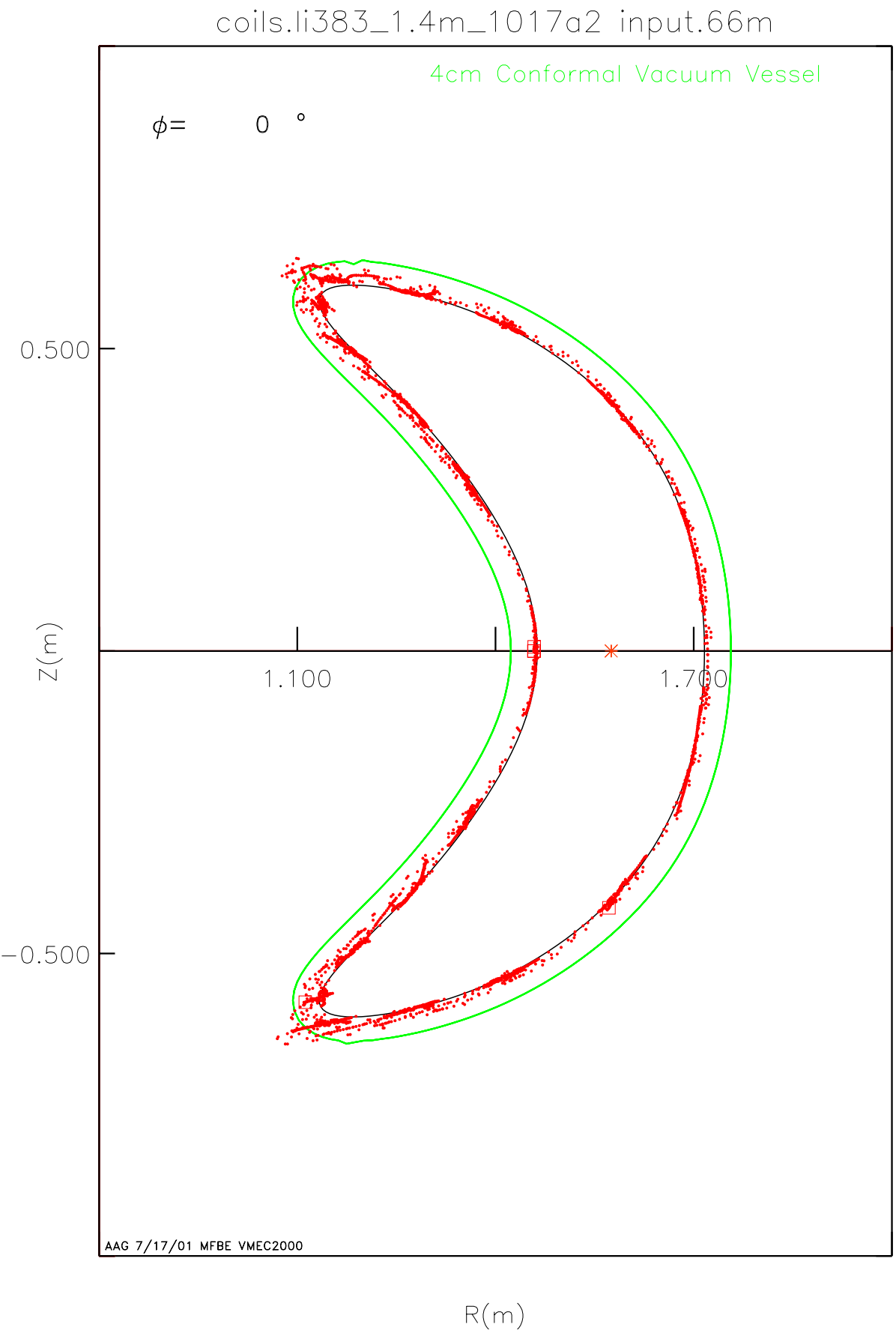
4cm Conformal Vacuum Vessel
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 0 to 1/2 cm from LCMS

- 60 launch points evenly spaced between R=1.4582m and R=1.4632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20.
- Agreement between the MFBE and LCMS field line trace appears good.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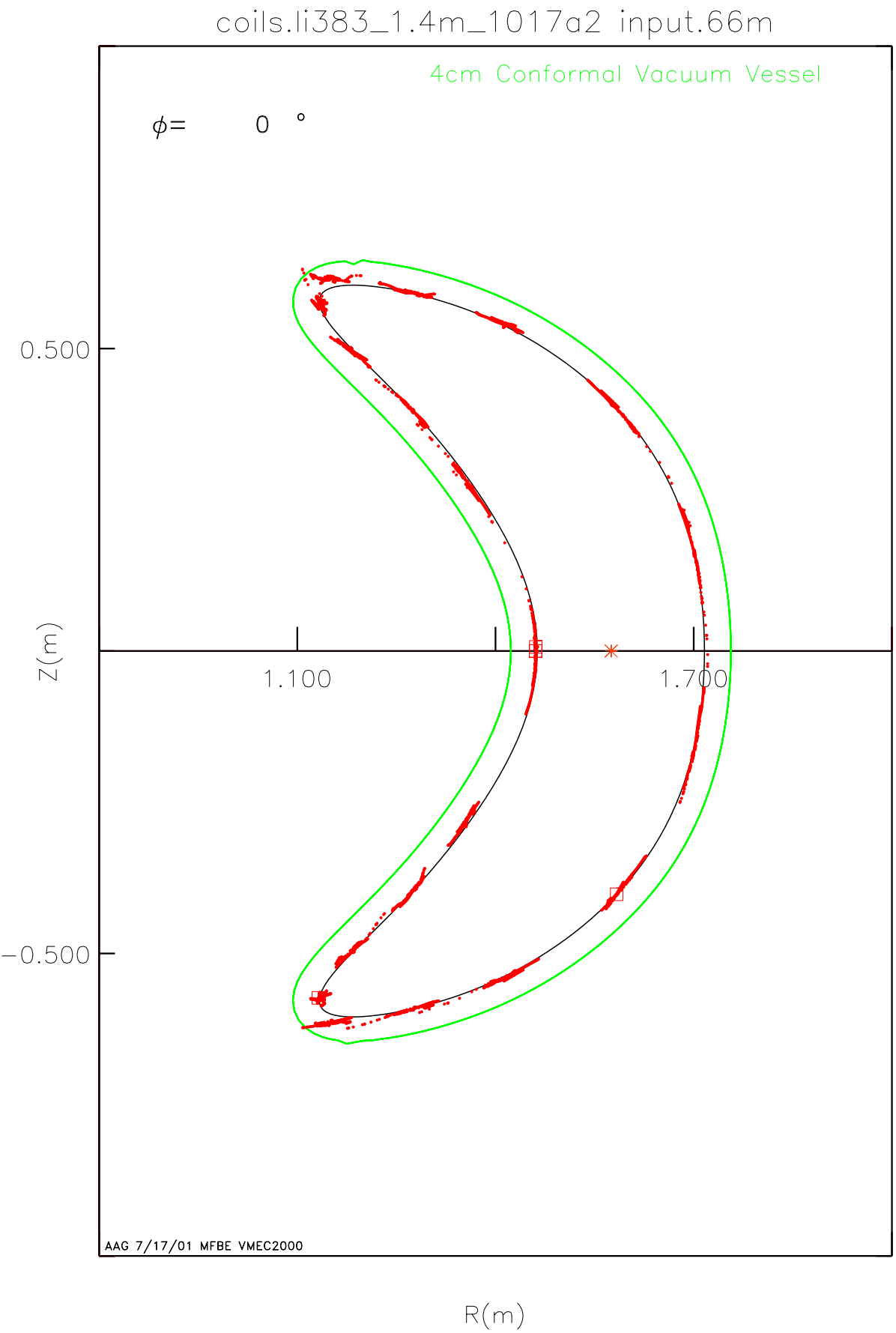
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 0 to 1/4 cm from LCMS

- 60 launch points evenly spaced between R=1.4607m and R=1.4632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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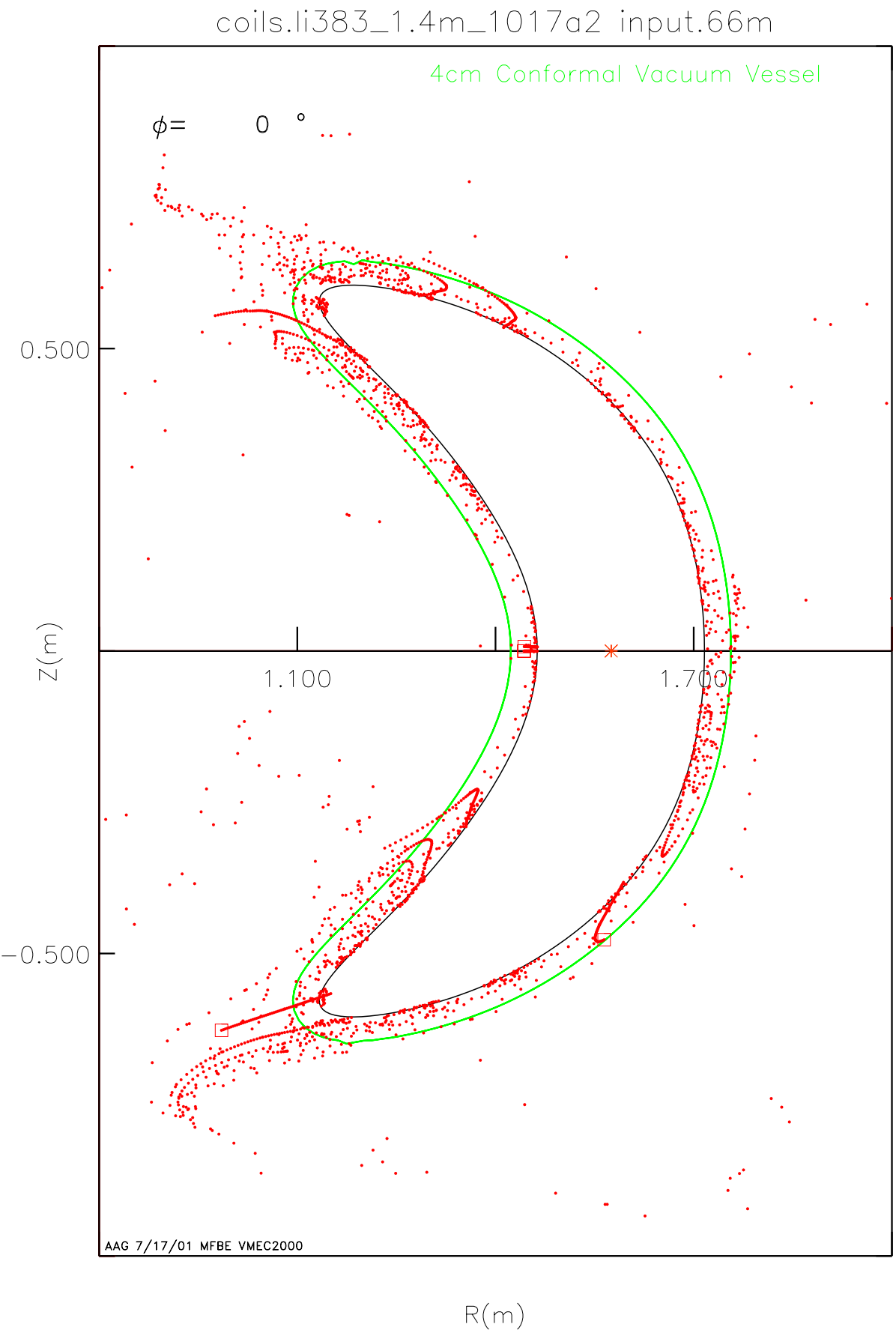
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 0 to 2 cm from LCMS

- 60 launch points evenly spaced between R=1.4432m and R=1.4632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.
- Whiskered torus appears. Radial ordering is preserved.
- Many points map outside vv.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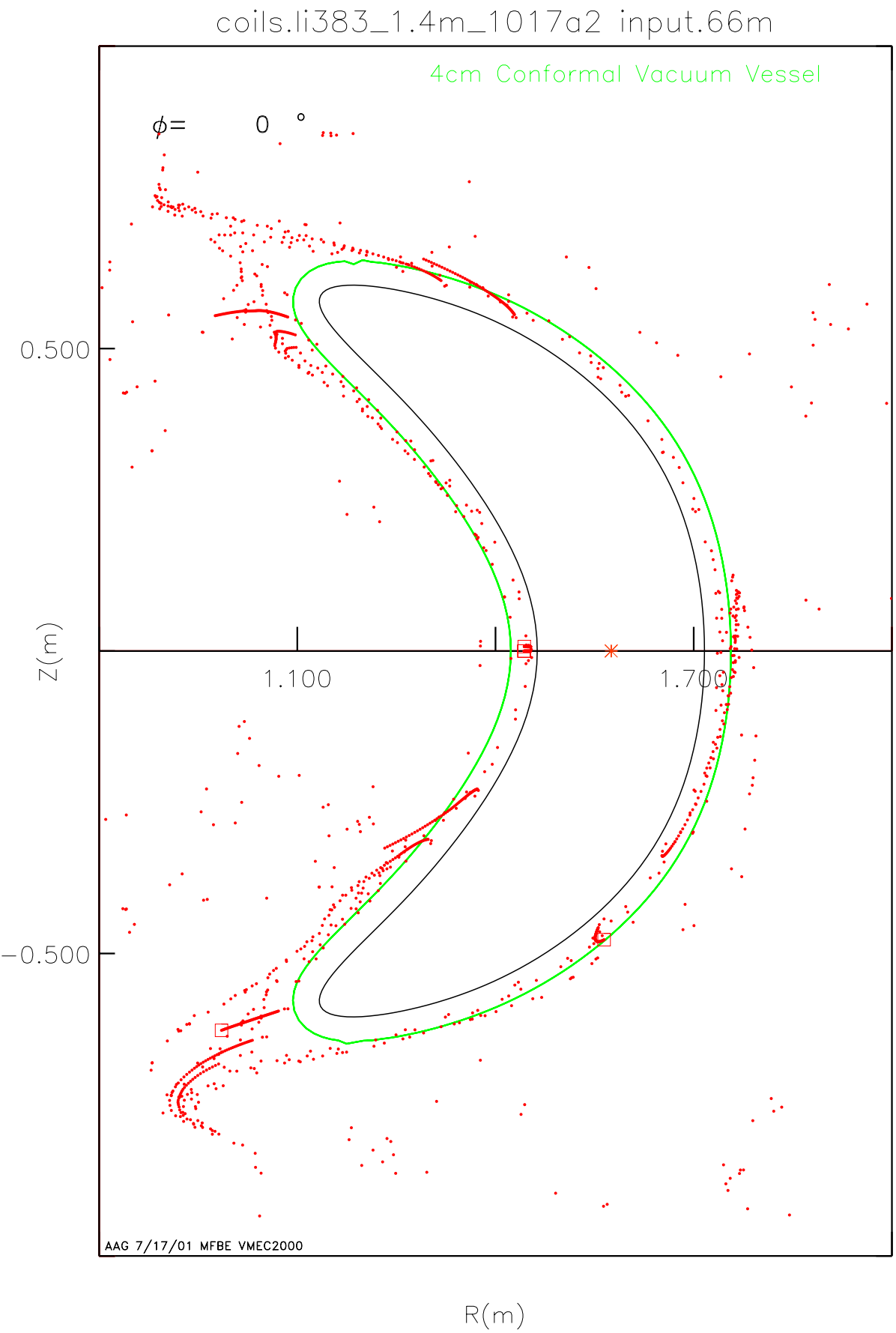
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 1 to 2 cm from LCMS

- 60 launch points evenly spaced between R=1.4432m and R=1.4532m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.
- Radial excursion maximal in the 1st period transit to banana tips, moves back inside on next period.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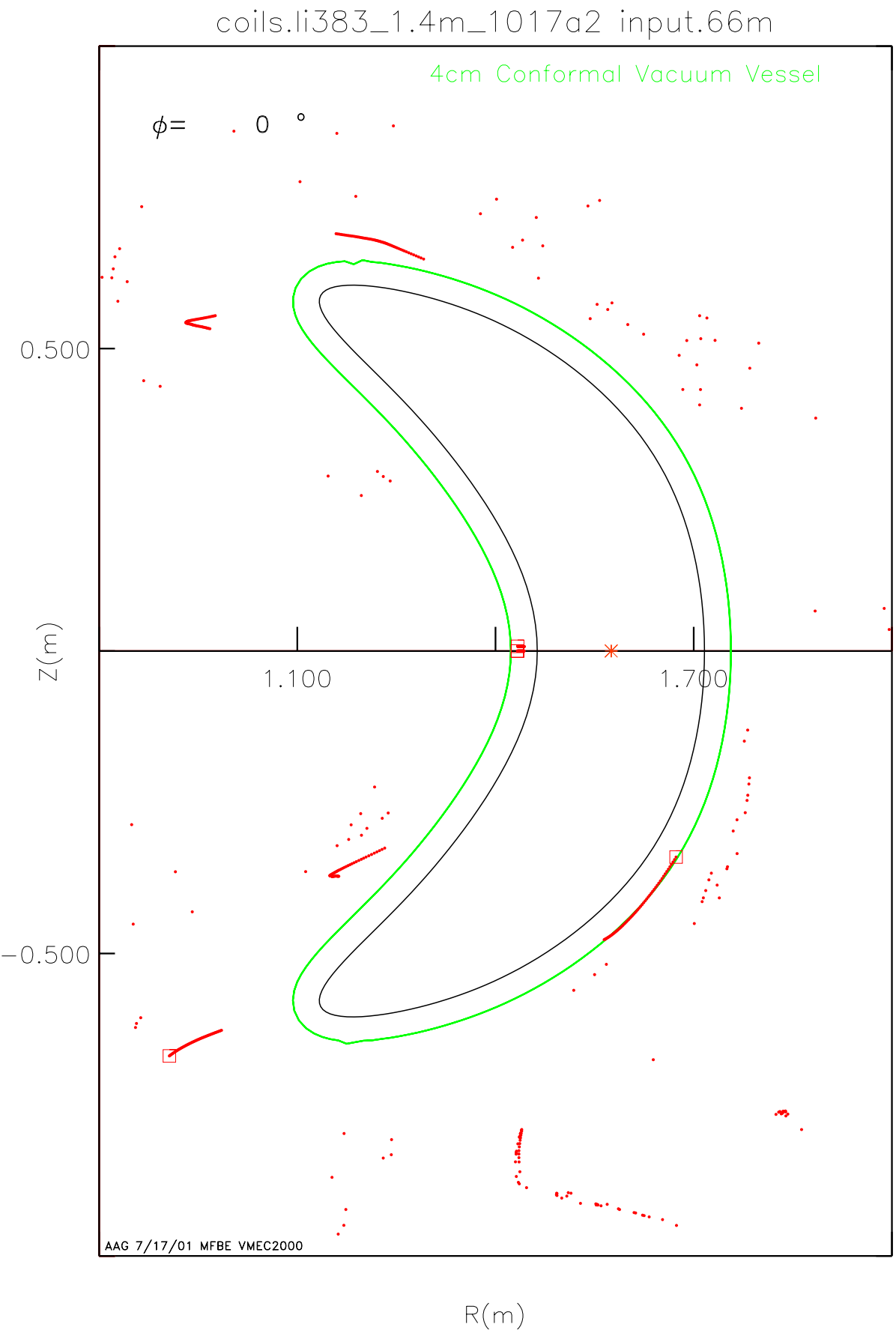
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 2 to 3 cm from LCMS

- 60 launch points evenly spaced between R=1.4332m and R=1.4432m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.
- Large radial displacement, leaves domain after only a few toroidal transits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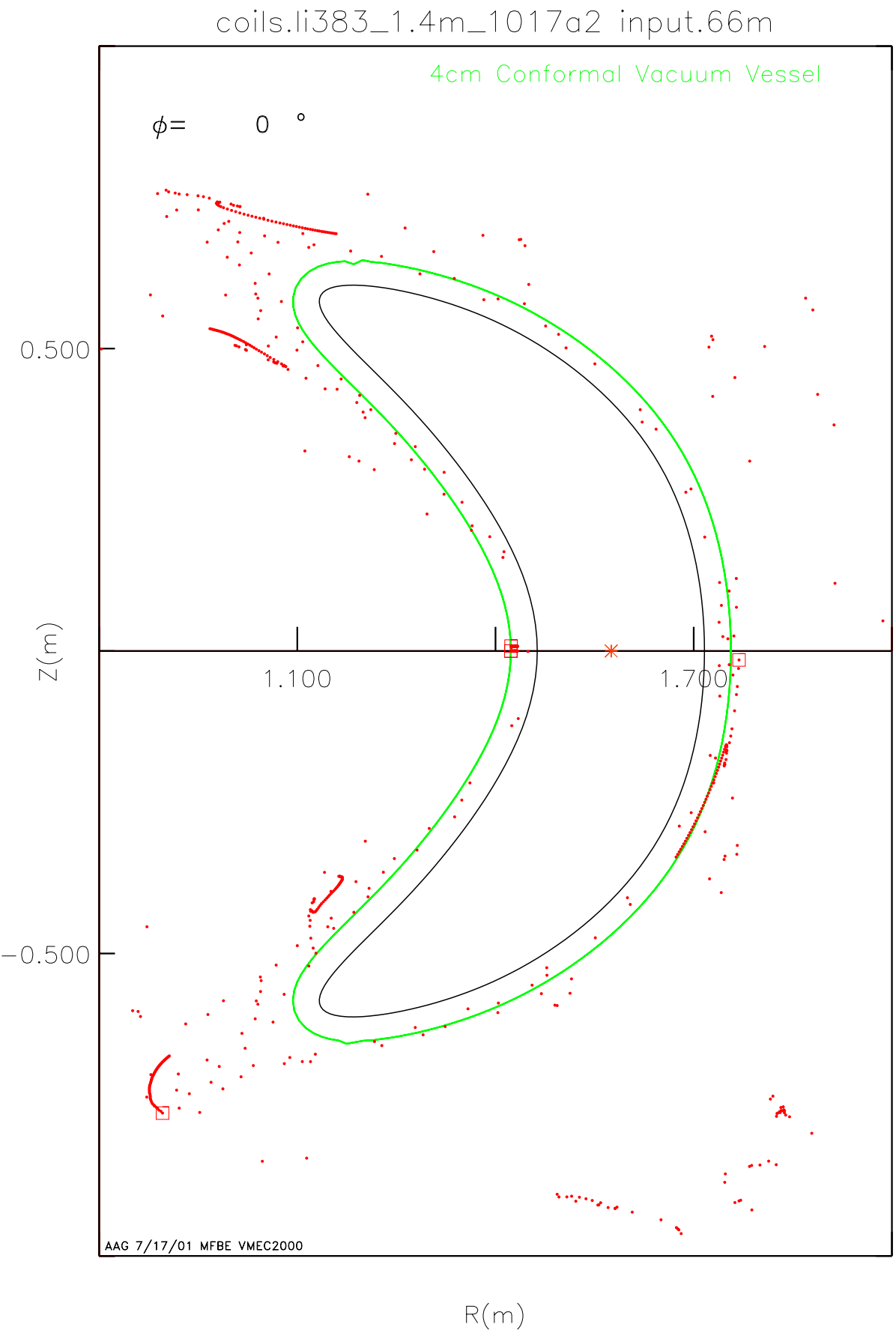
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 3 to 4 cm from LCMS

- 60 launch points evenly spaced between R=1.4232m and R=1.4332m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.
- Less sparse than previous mapping. Loosing radiali ordering, results depend more on launch point.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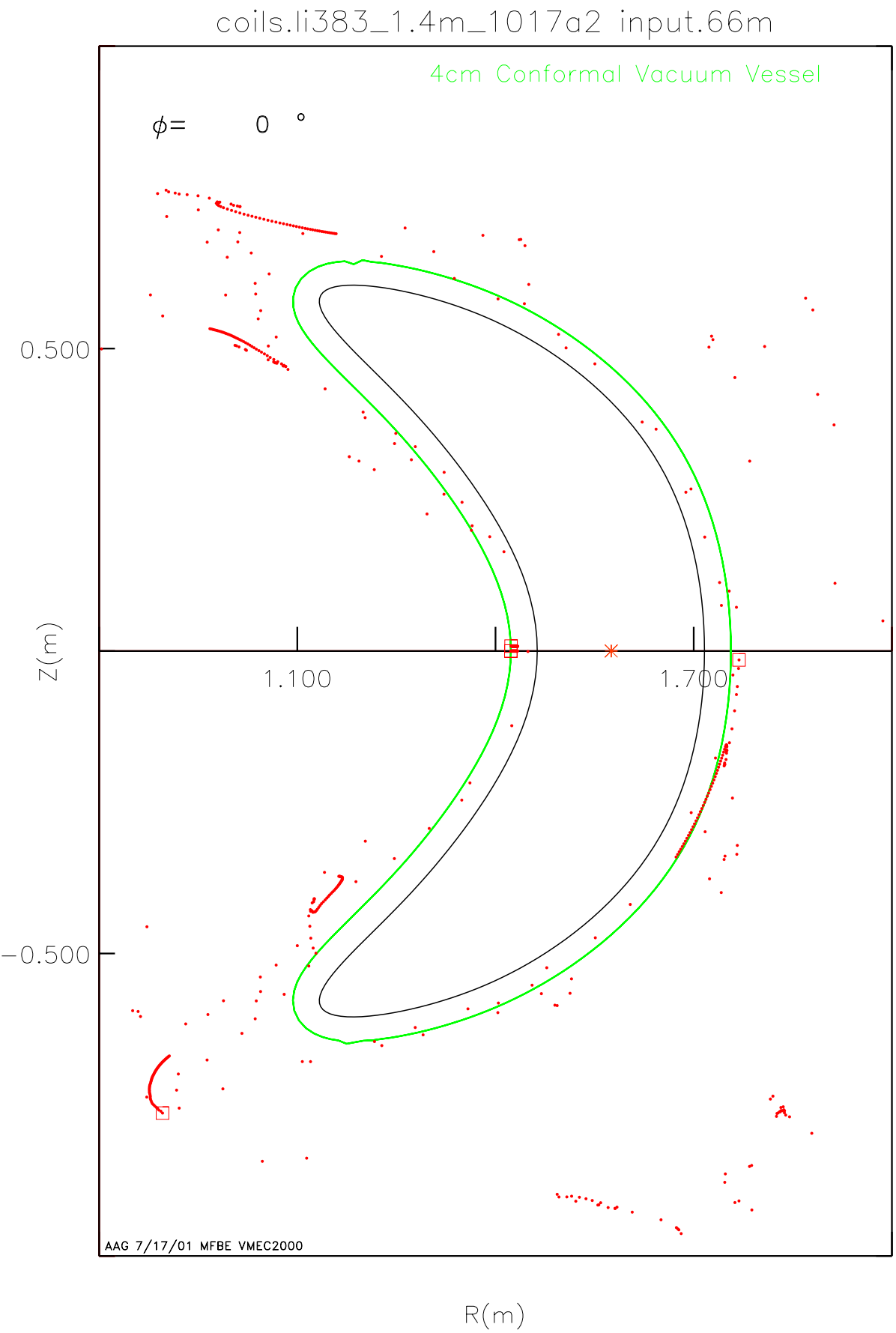
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Inside Launch: 3 to 4 cm from LCMS Series of Decreasing Toroidal Turns: 10, 9 , …,1

- 60 launch points evenly spaced between R=1.4232m and R=1.4332m, all with Z=0
- Cases have 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, toroidal turns. (hold page down to rapidly scan the next 10 pages).
- Whiskered torus appears on first turn, which are stretched on second, large displacment occurs by third period.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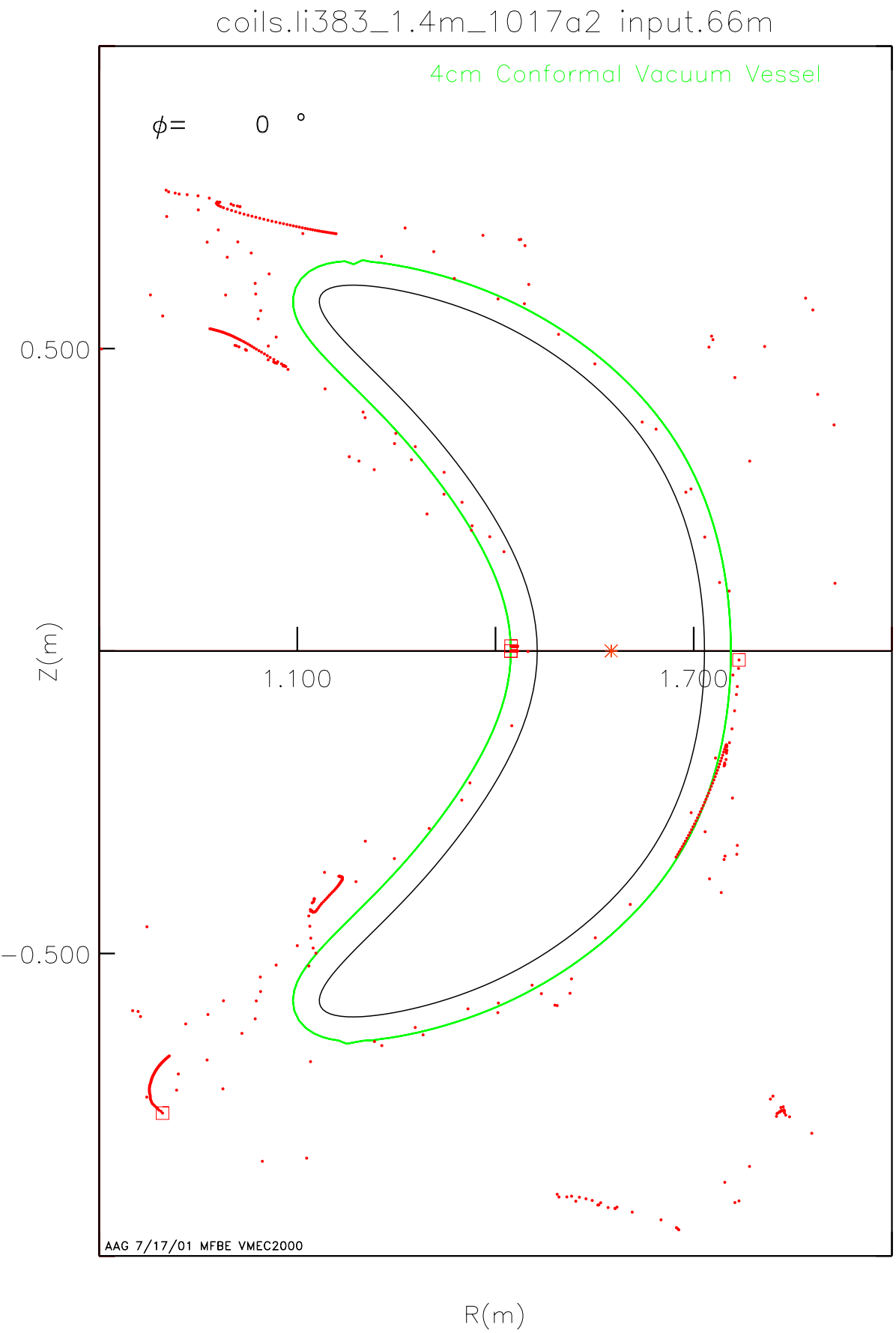
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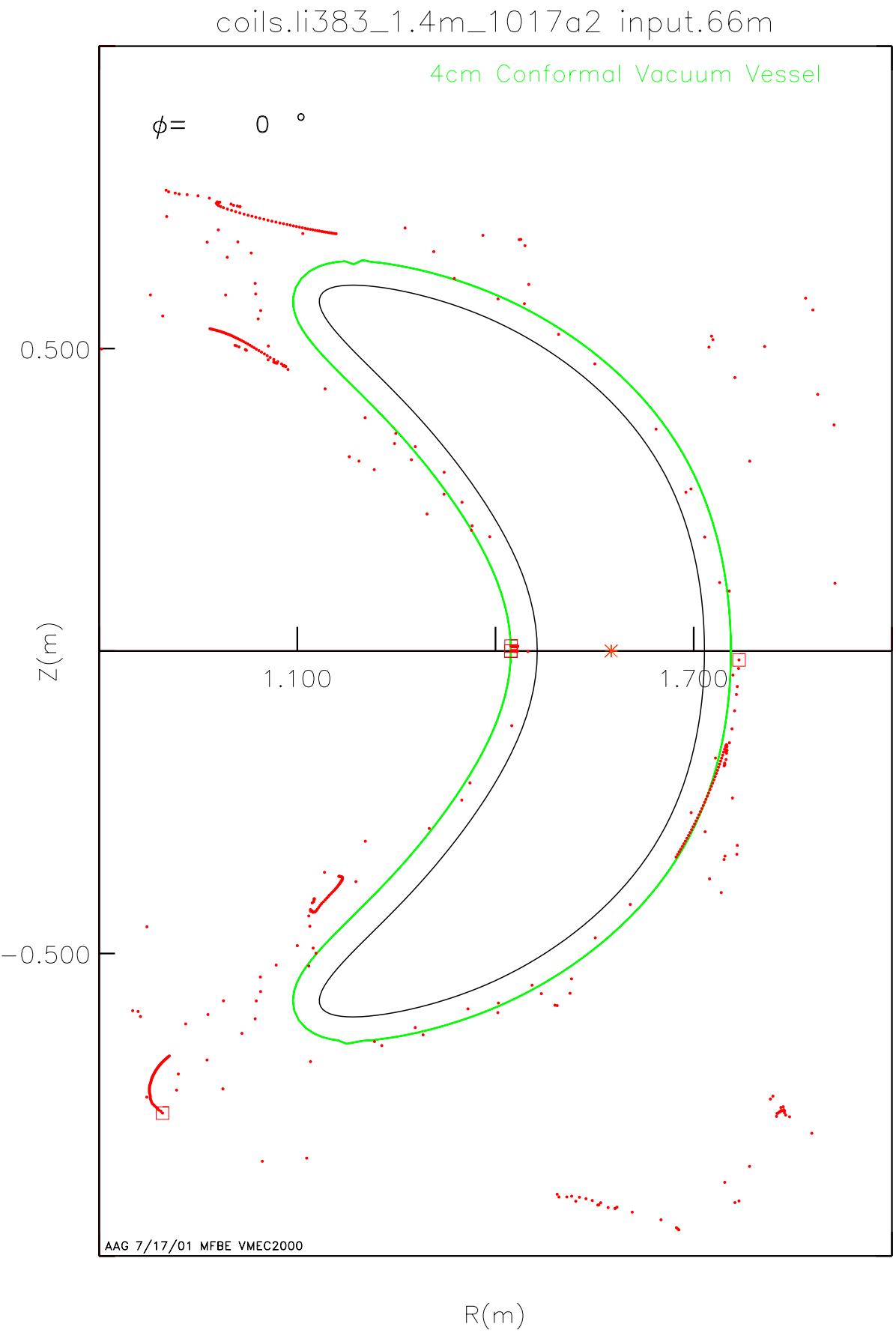
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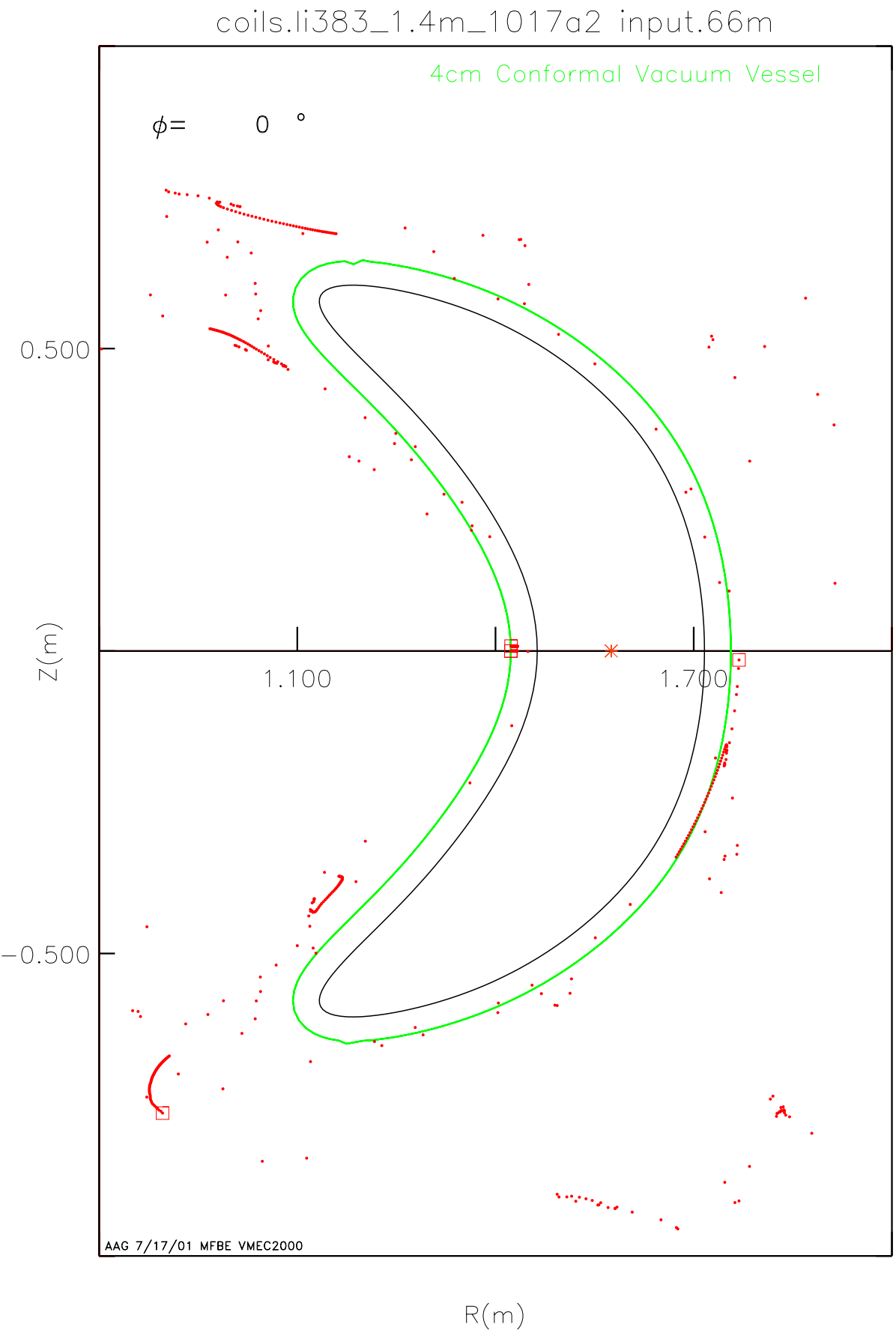
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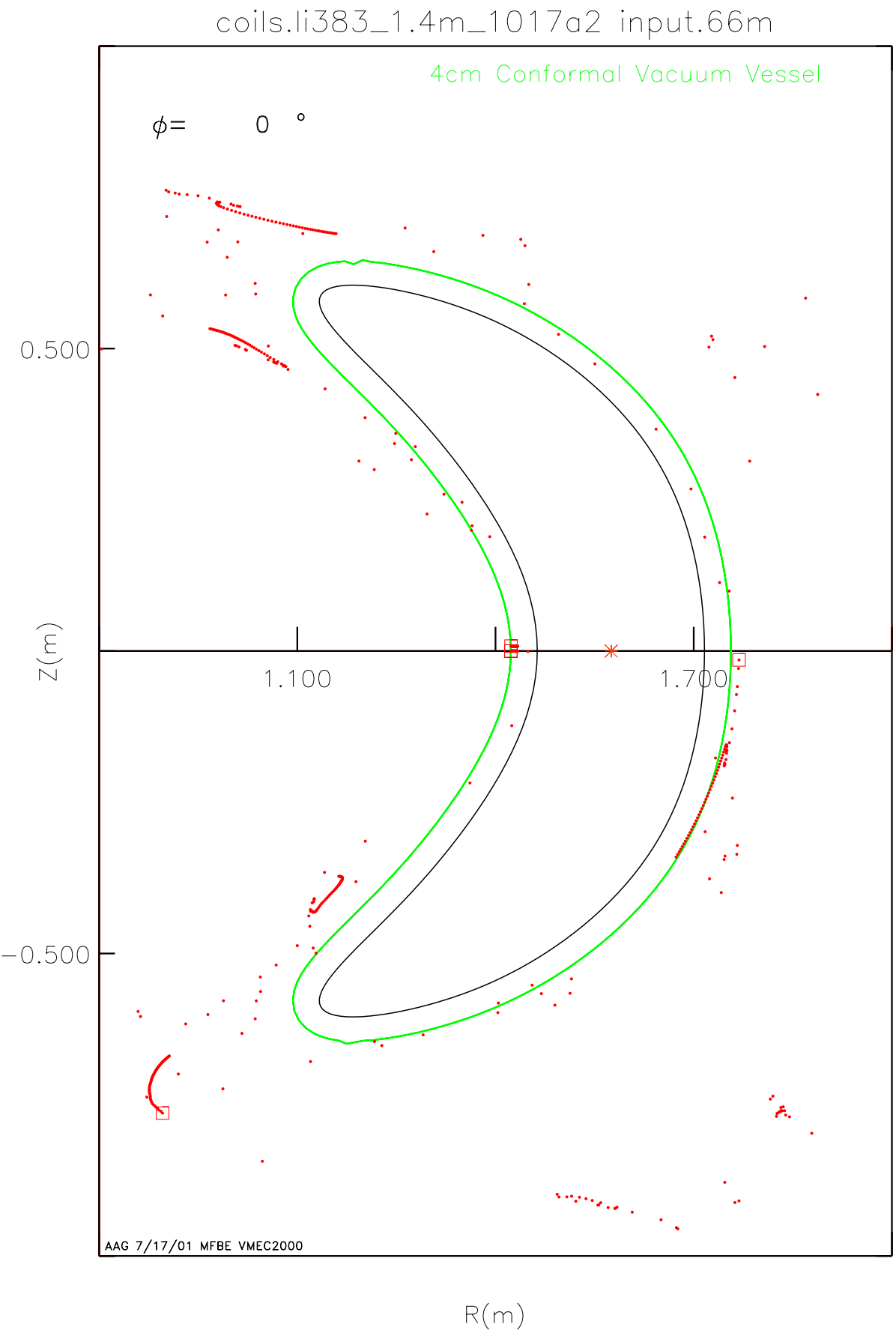
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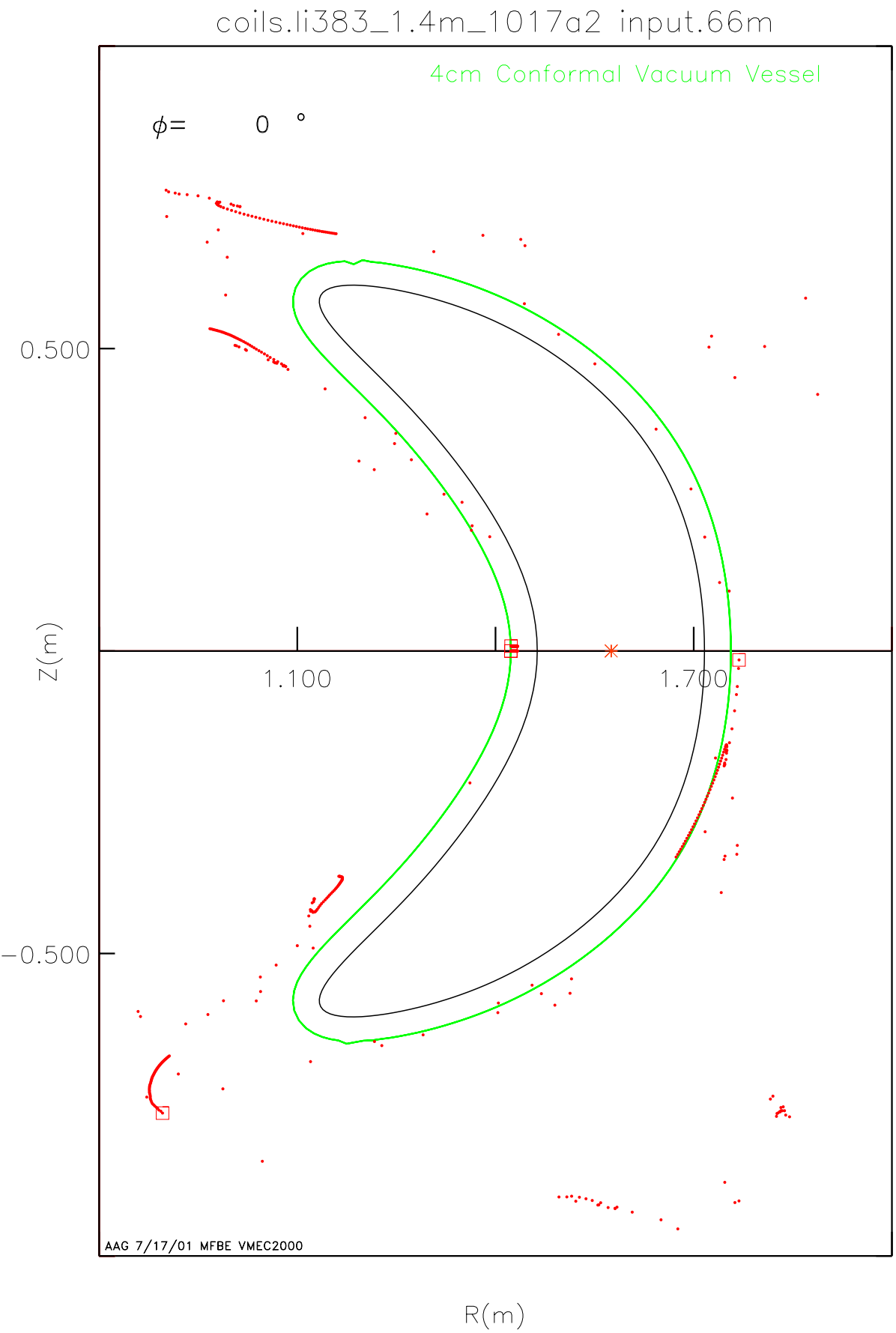
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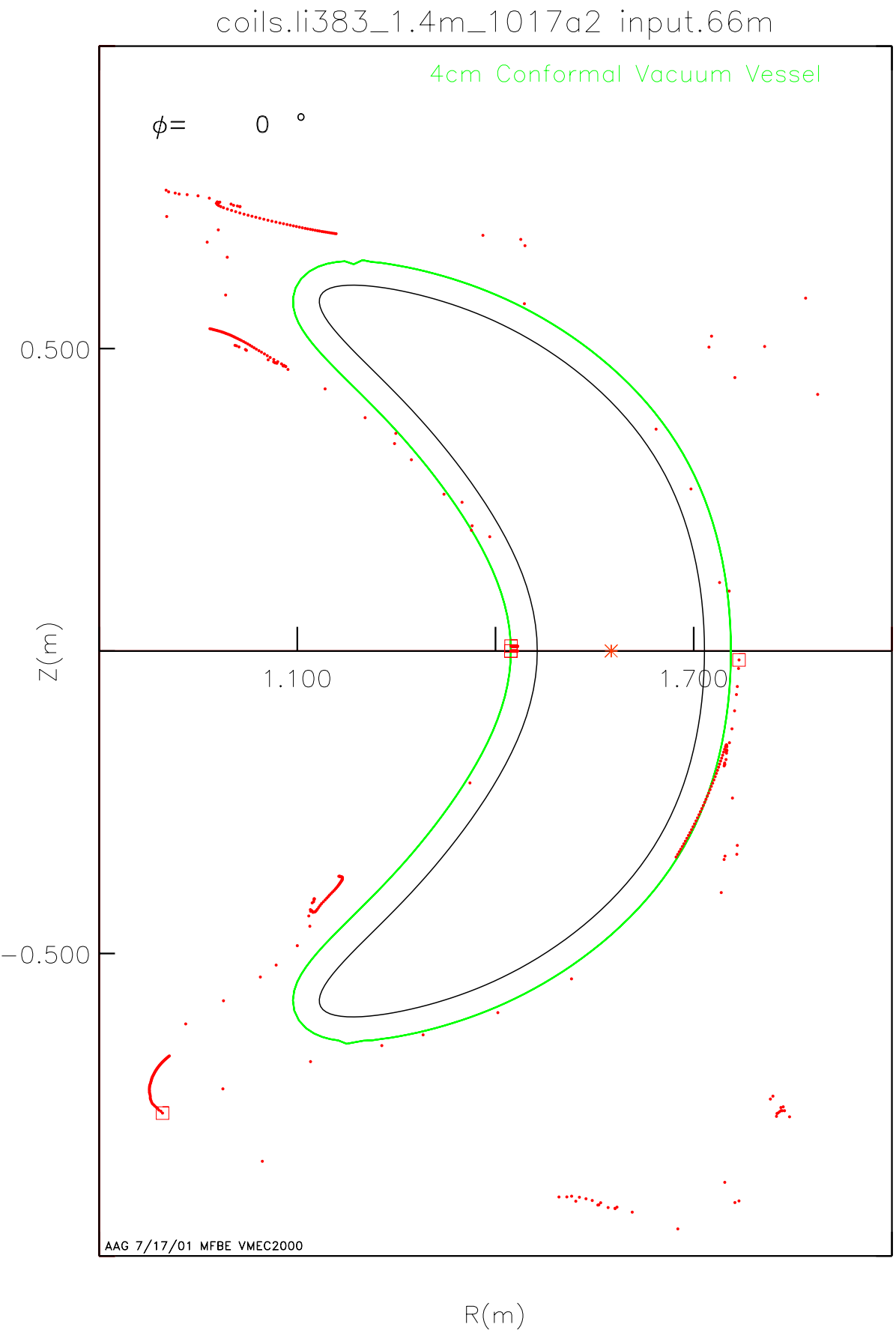
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φ= 0 °
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Z(m)
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1.700
R(m)
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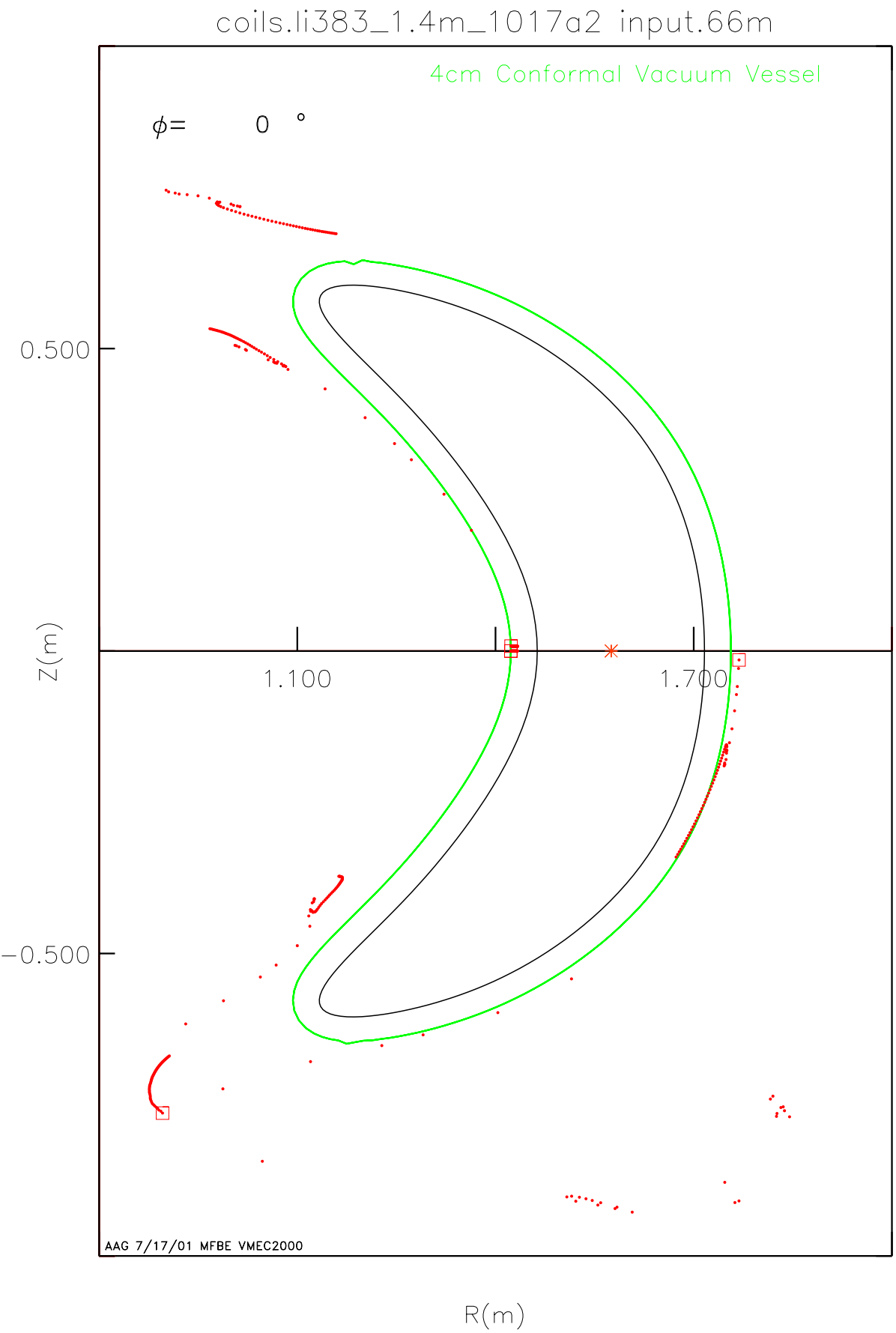
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Z(m)
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R(m)
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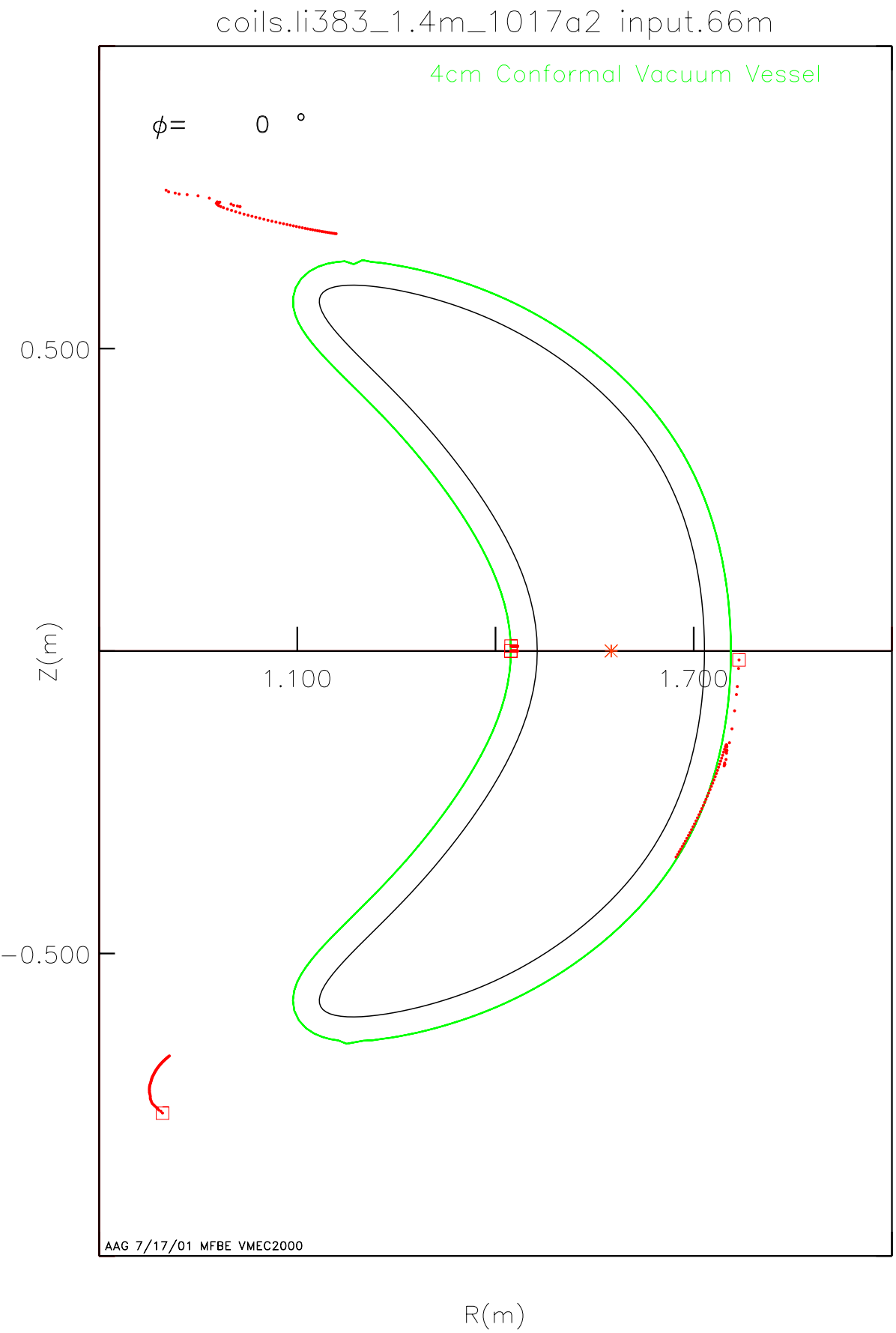
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R(m)
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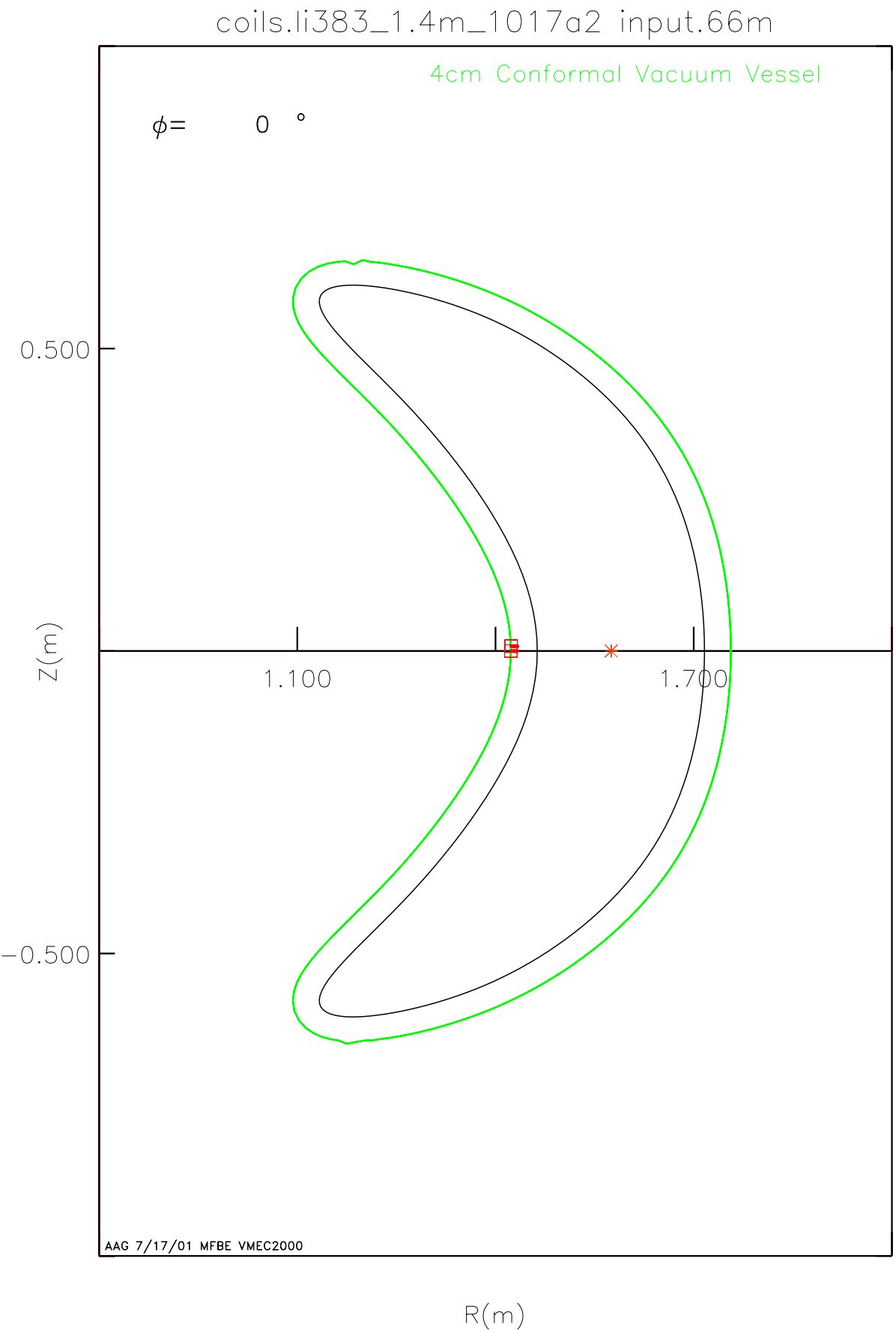
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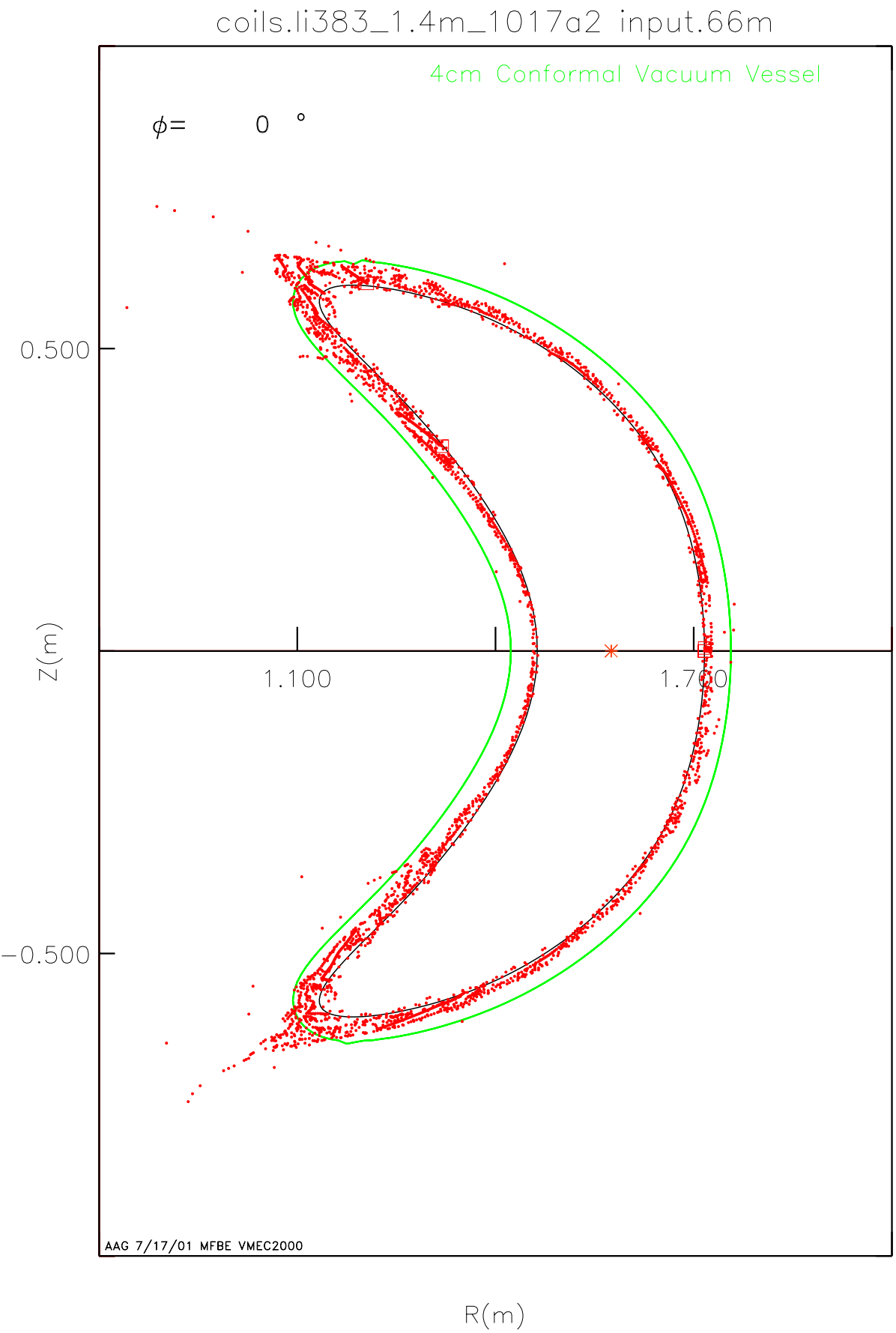
4cm Conformal Vacuum Vessel
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 0 to 1 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.72632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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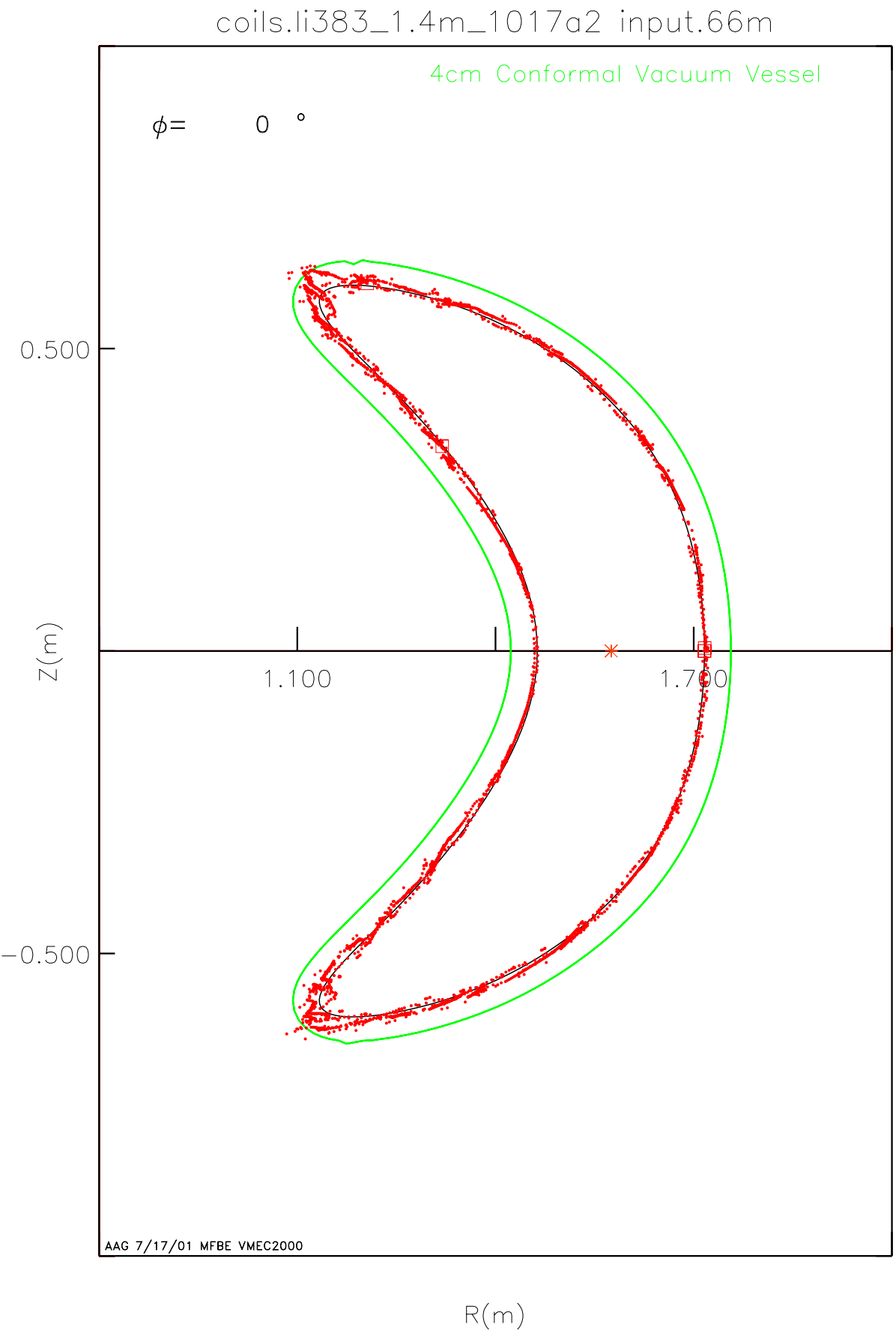
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 0 to 1/2 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.72132m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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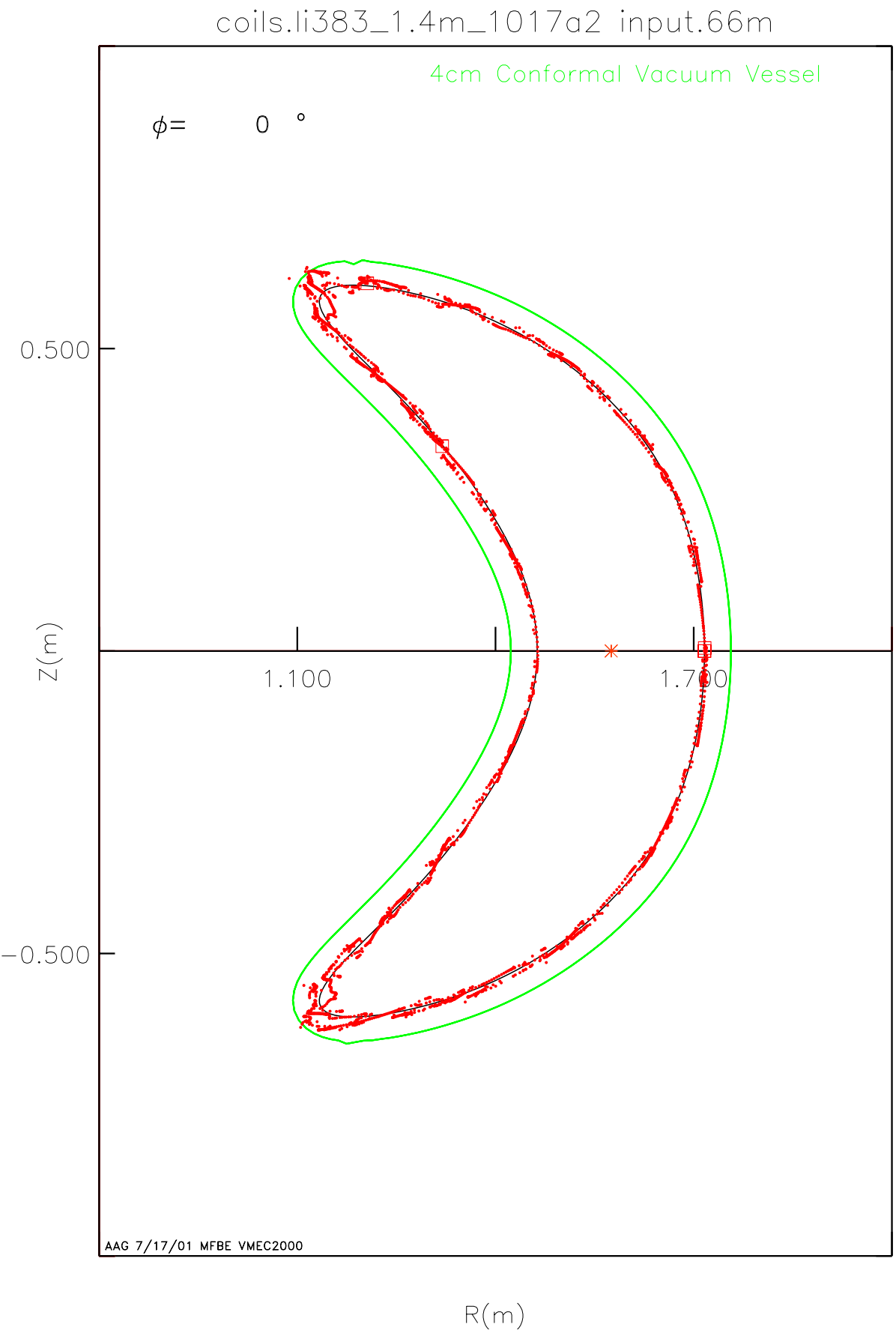
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 0 to 1/4 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.71882m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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0.500
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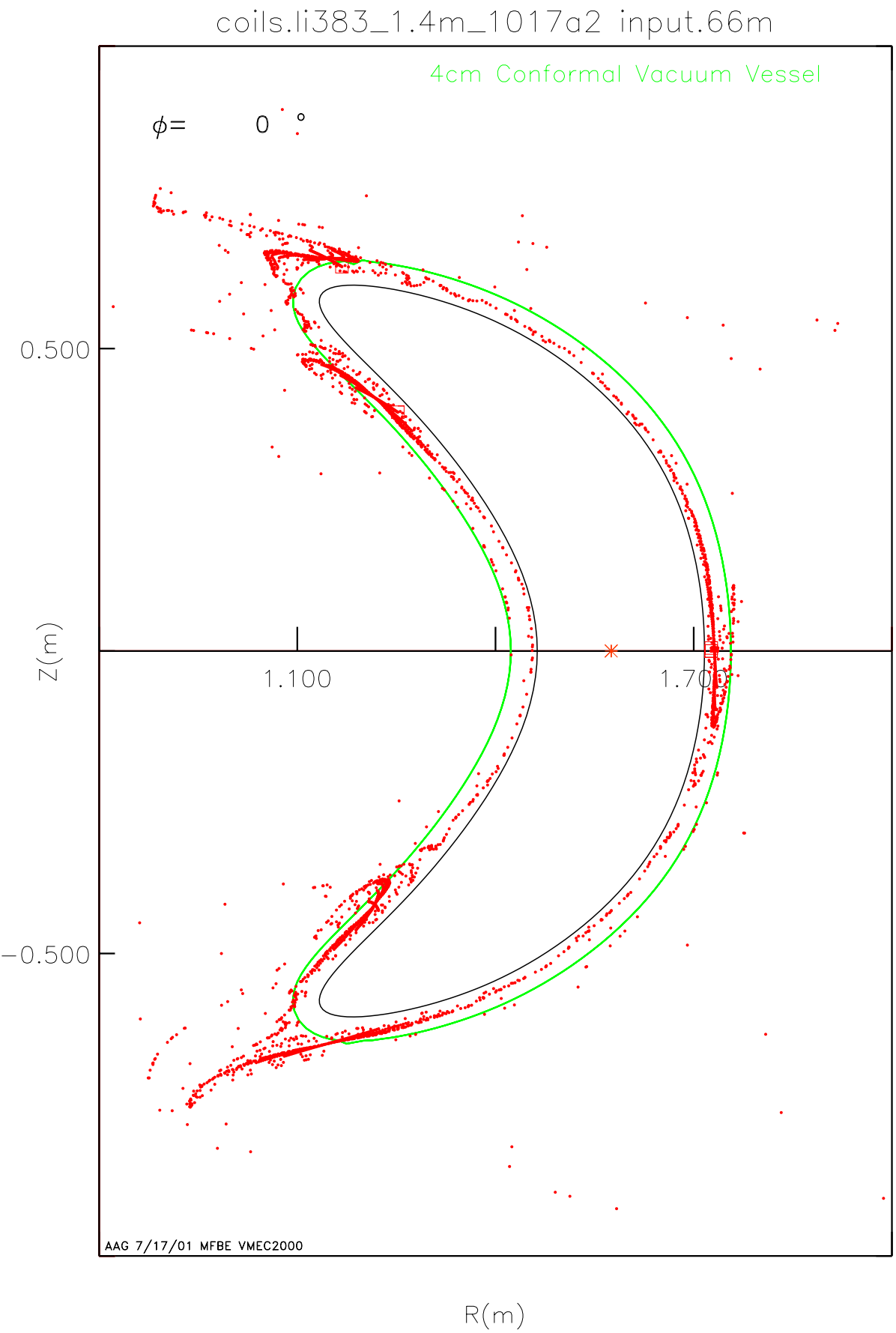
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 1 to 2 cm from LCMS

- 60 launch points evenly spaced between R=1.72632m and R=1.73632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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Z(m)
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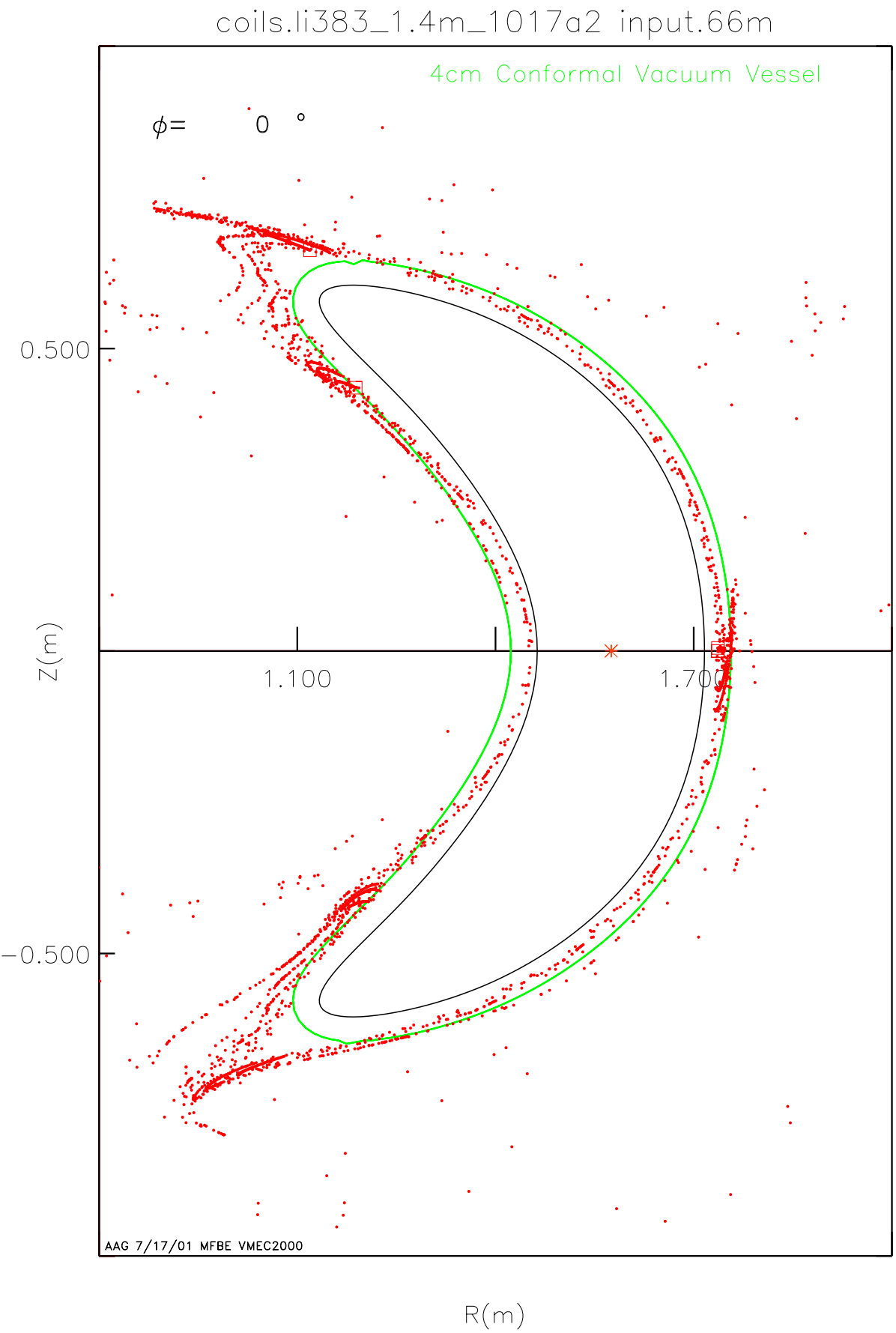
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 2 to 3 cm from LCMS

- 60 launch points evenly spaced between R=1.73632m and R=1.74632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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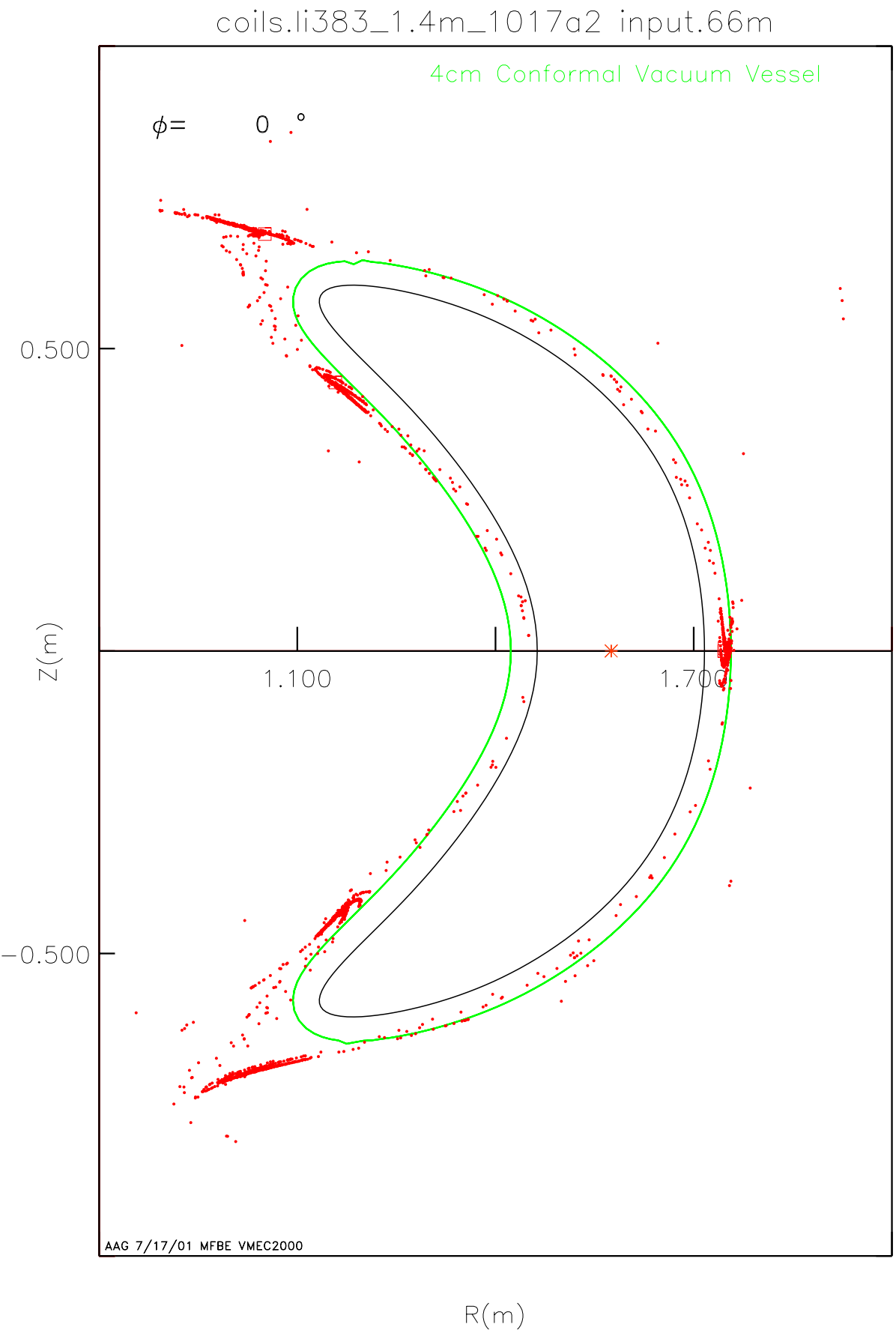
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 3 to 4 cm from LCMS

- 60 launch points evenly spaced between R=1.74632m and R=1.75632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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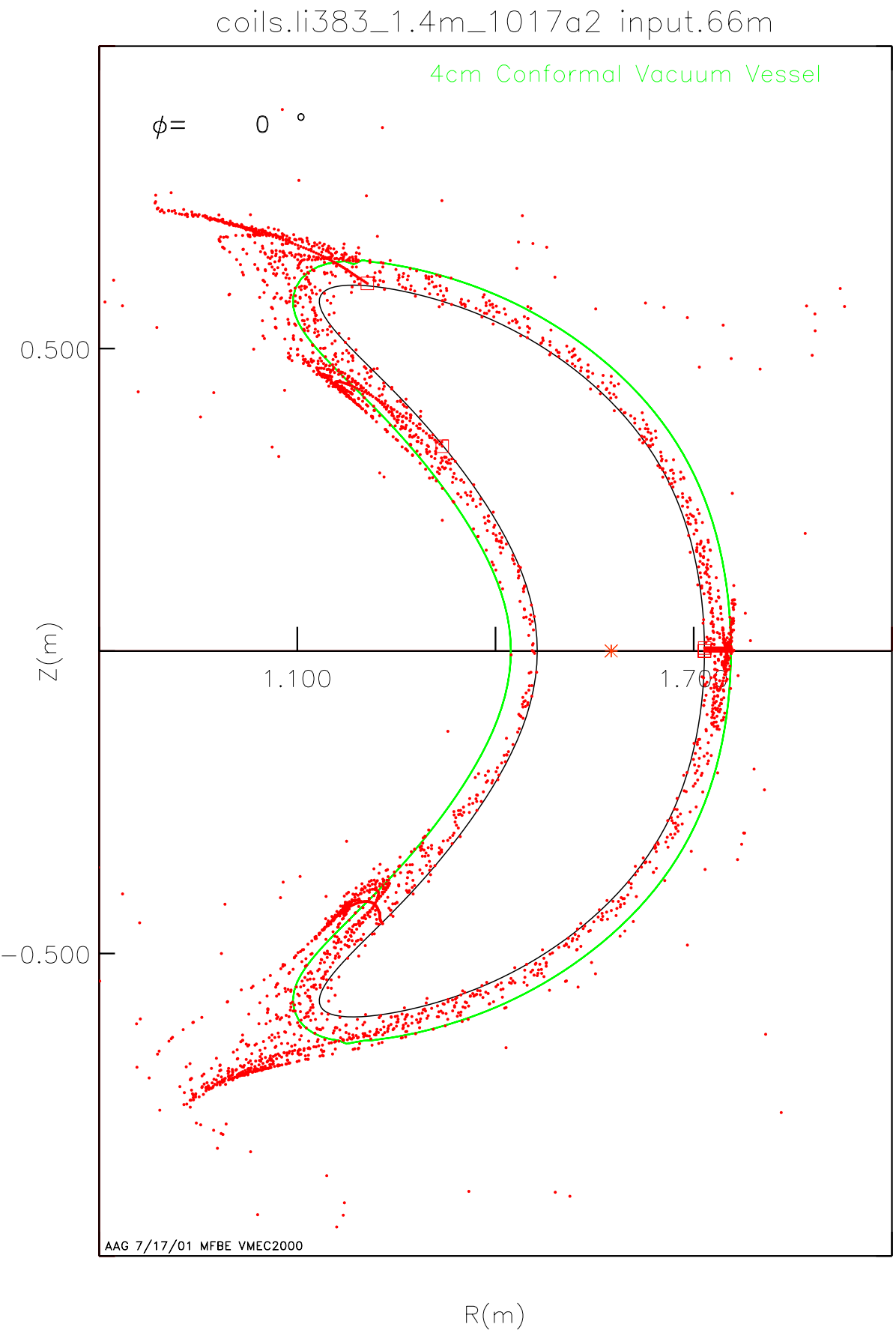
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 0 to 4 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.75632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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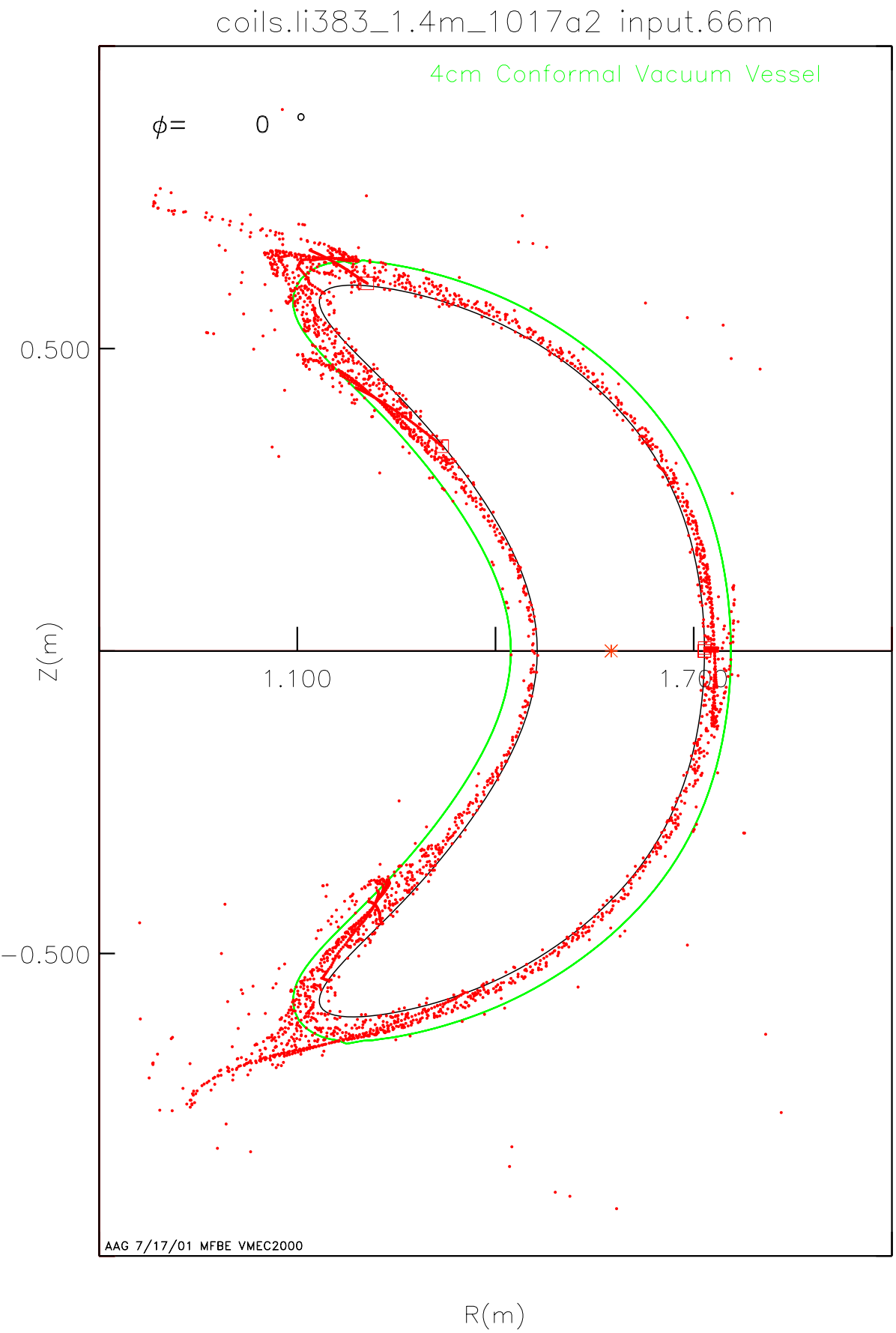
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Outside Launch: 0 to 2 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.73632m, all with Z=0
- Conformal vessel (green) is 4cm from LCMS (black).
- Maximum number of toroidal turns is 20. All 3 period punctures are superimposed.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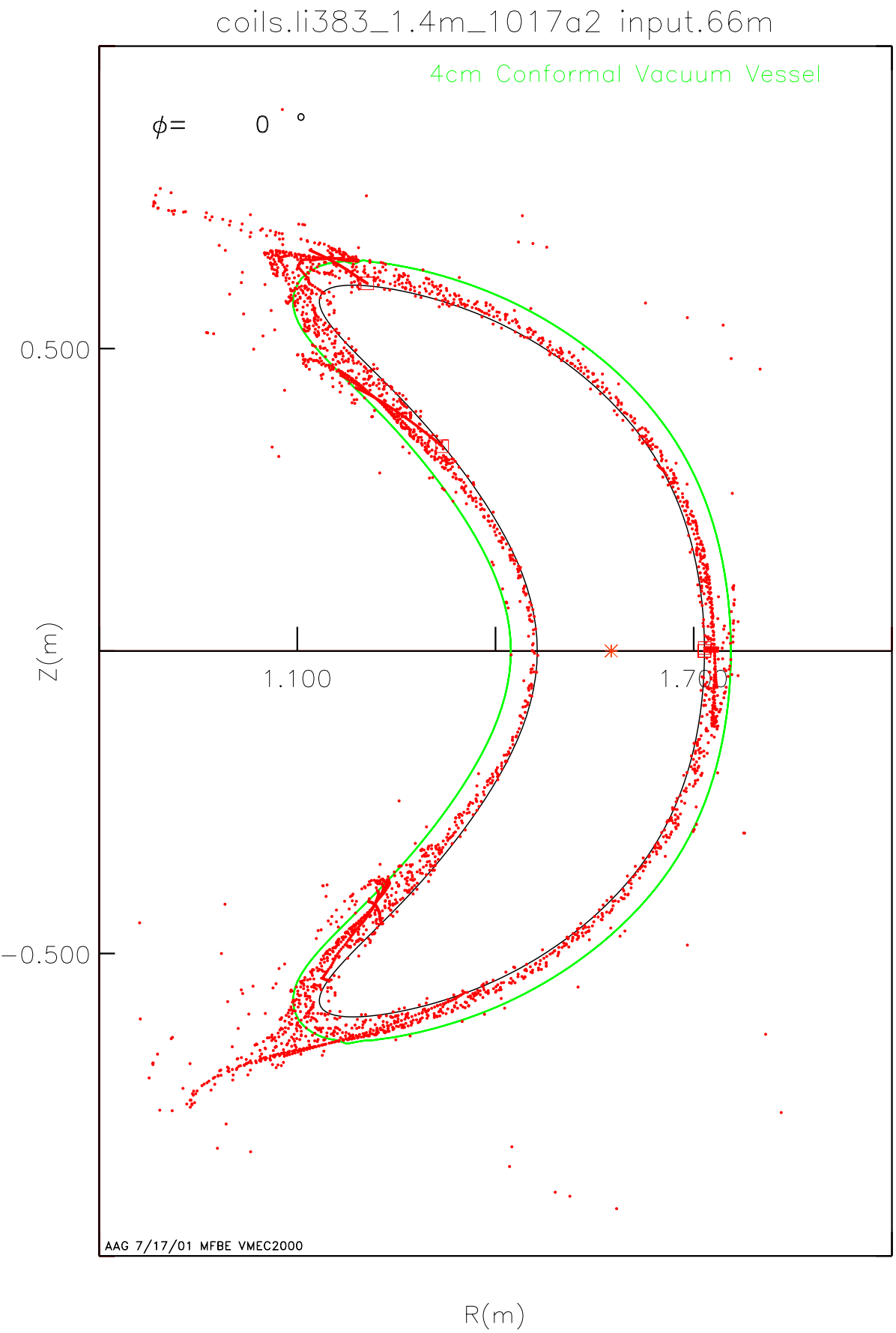
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Series of Toroidal Planes 0,5,10,15,…115 degrees with Outside Launch: 0 to 2 cm from LCMS

- 60 launch points evenly spaced between R=1.71632m and R=1.73632m, all with Z=0

- Field lines are launched at the 0 degree toroidal plane. Series are the punctures at successive toroidal planes, incrementing 5 degrees per plane.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4cm Conformal Vacuum Vessel
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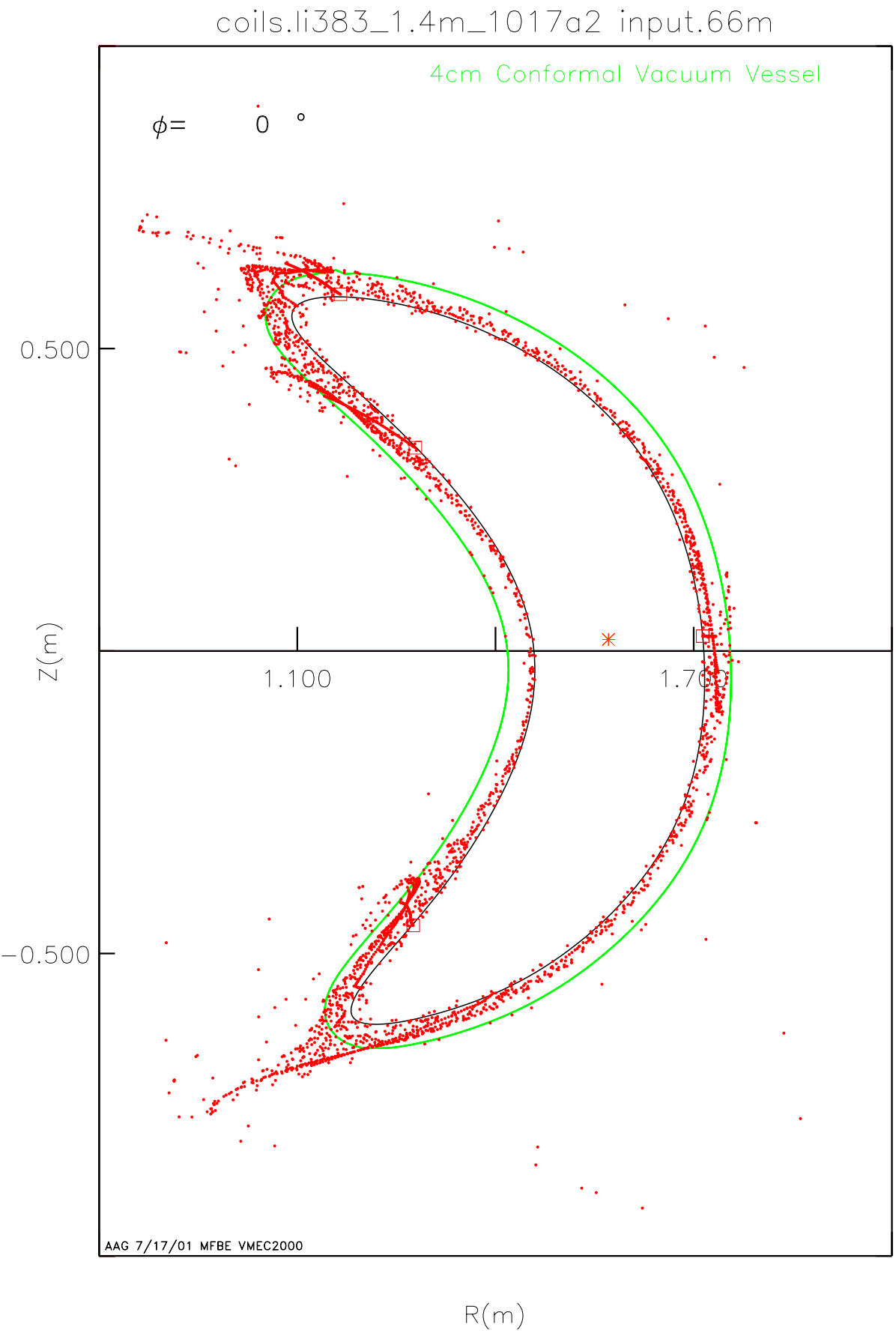
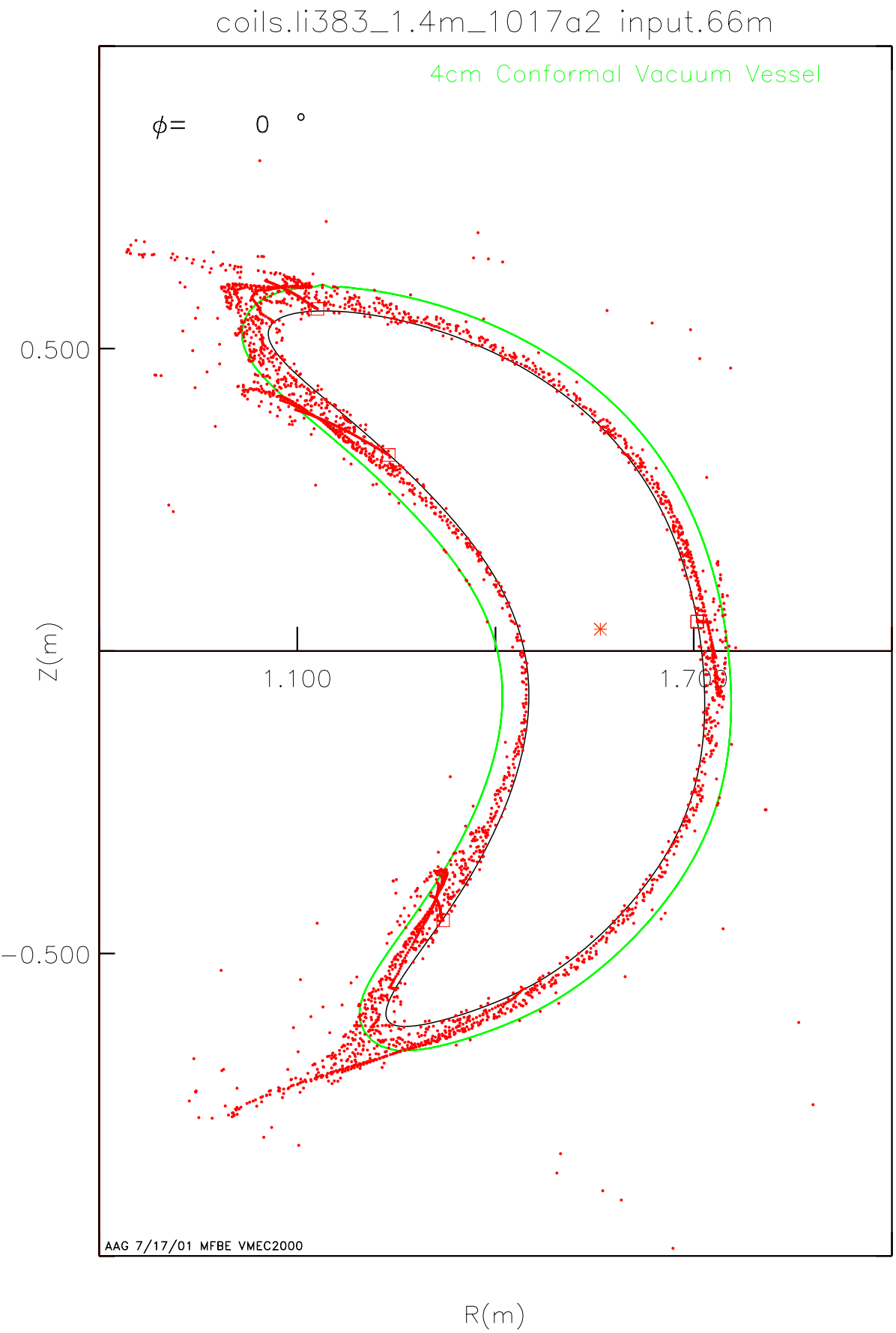
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
4cm Conformal Vacuum Vessel
φ= 0 °
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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4cm Conformal Vacuum Vessel
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Z(m)
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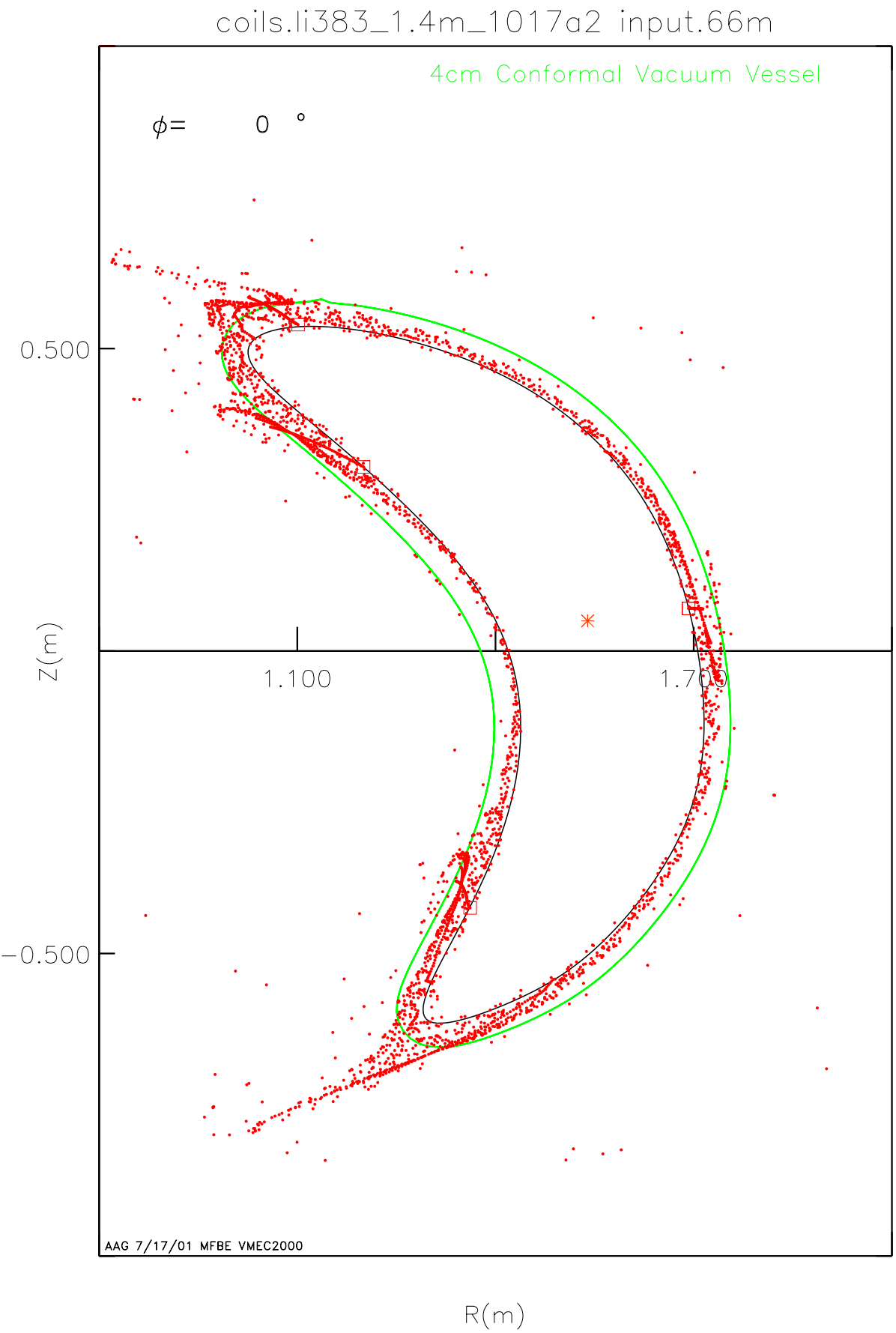
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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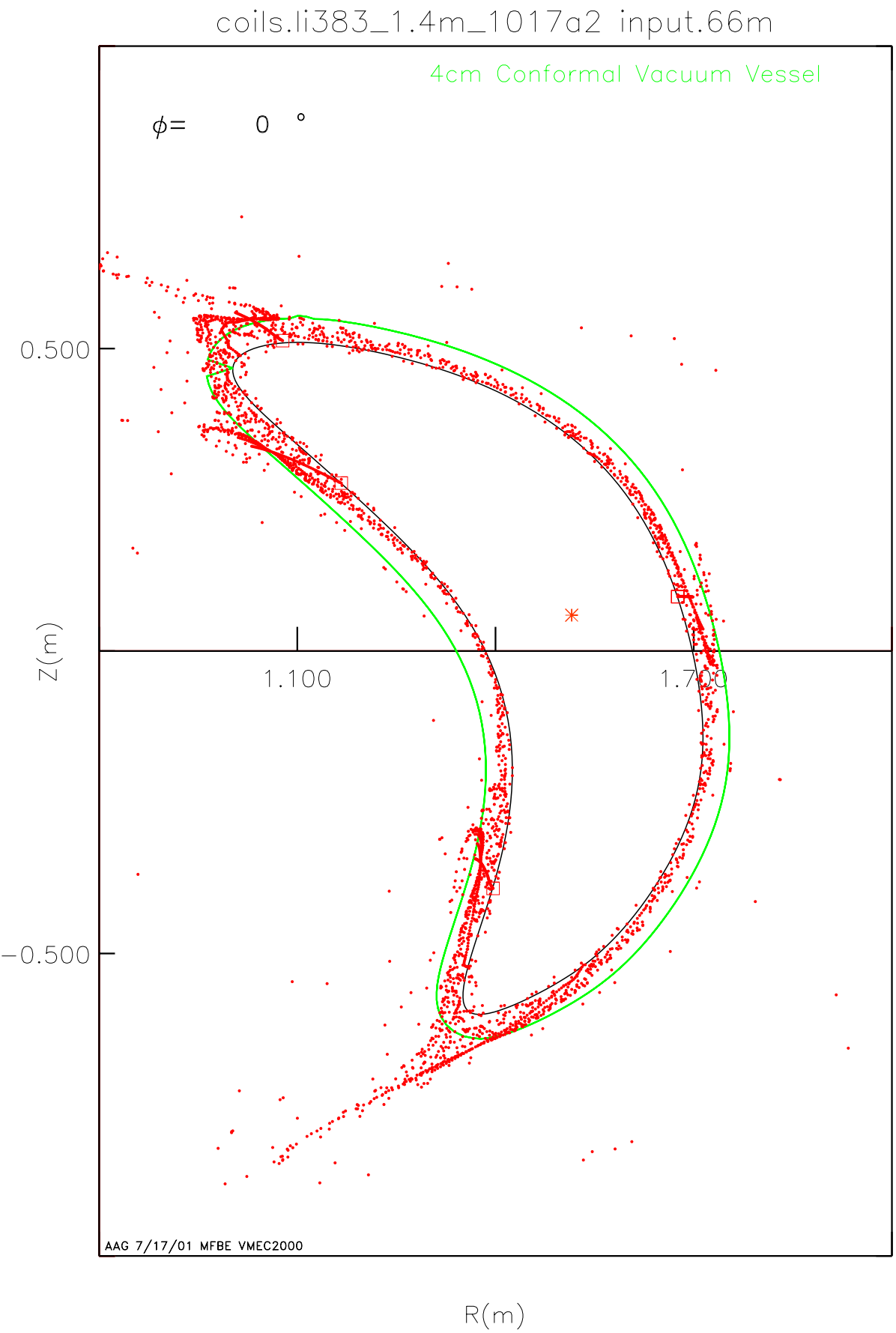
R(m)
AAG 7/17/01 MFBE VMEC2000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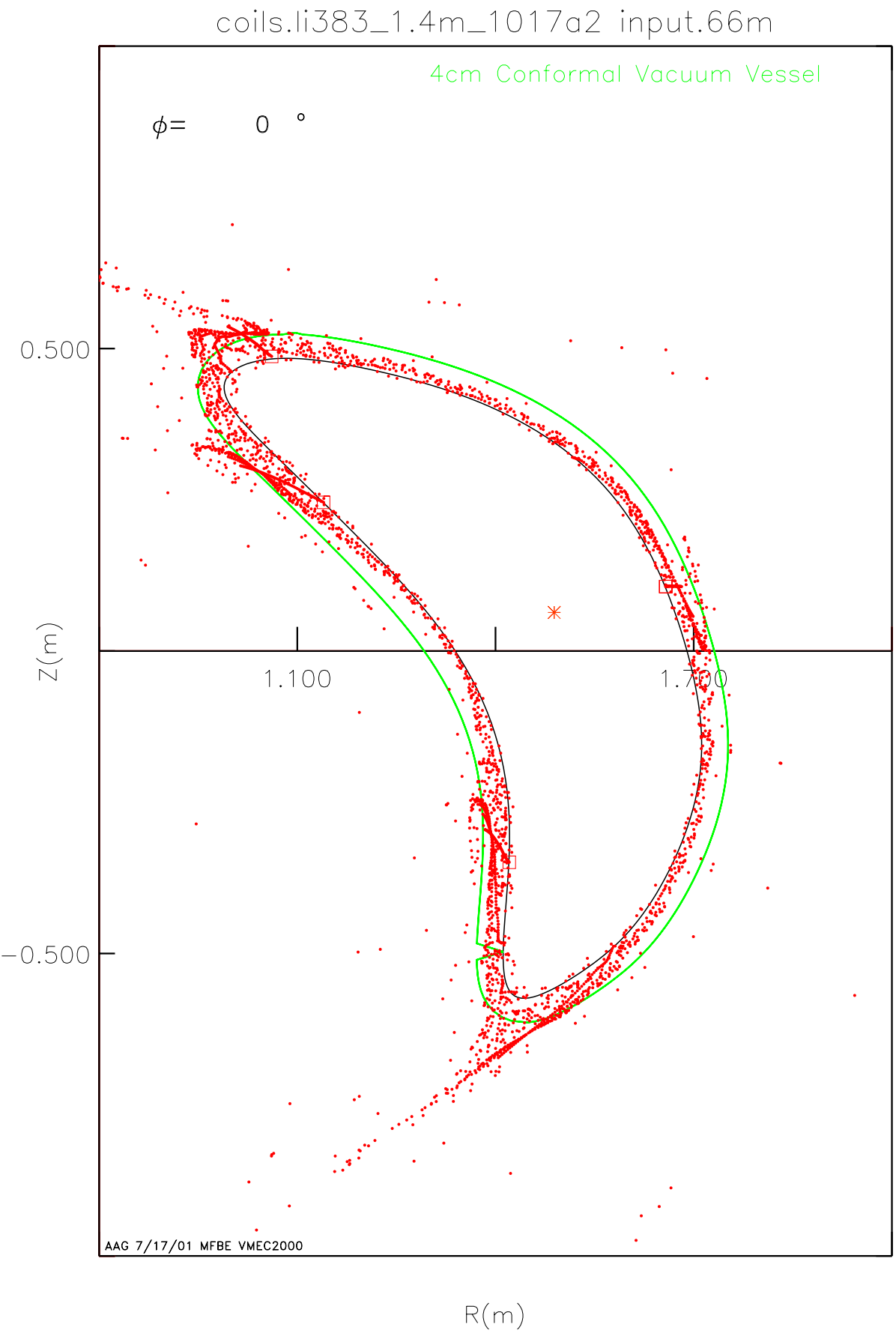
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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Z(m)
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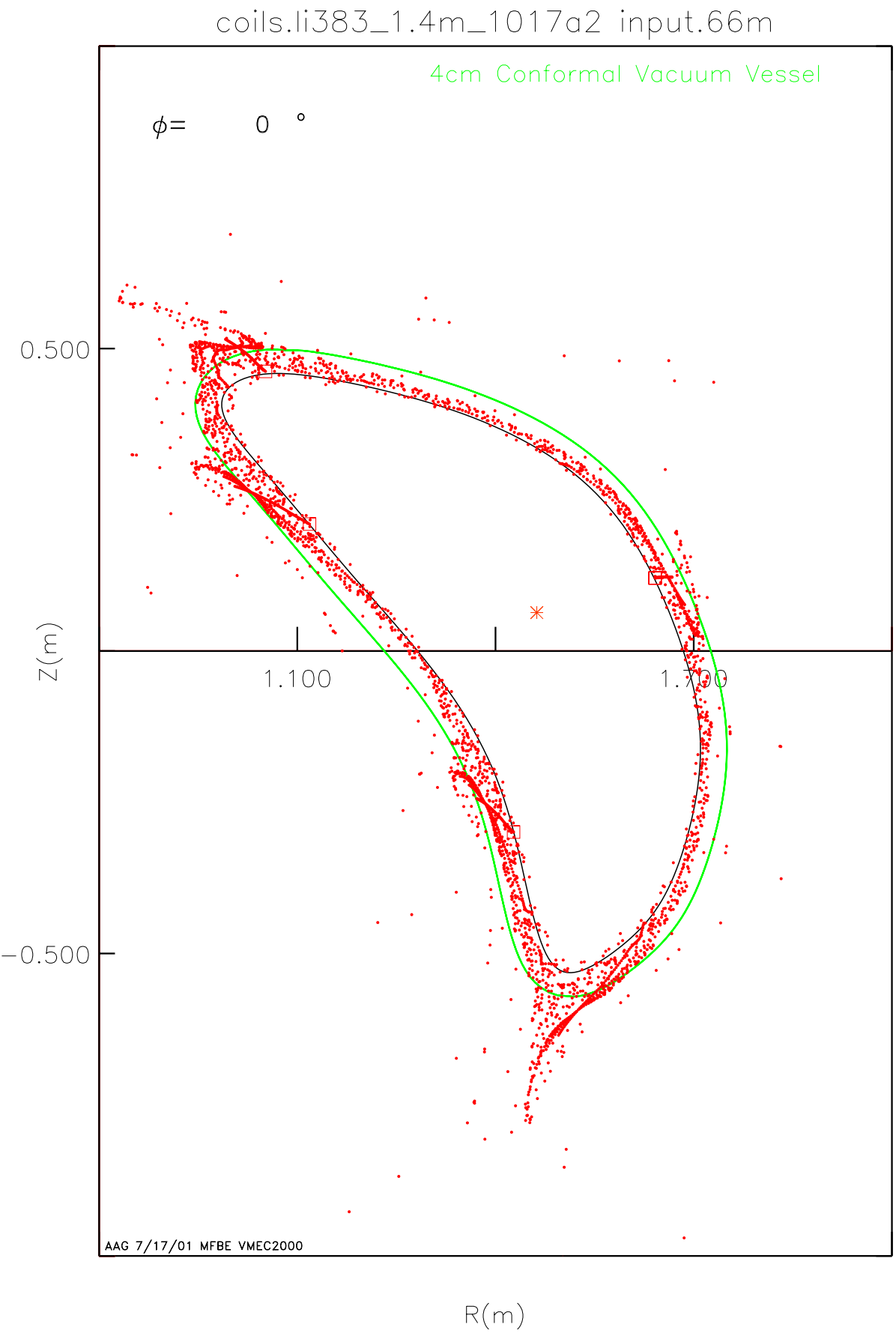
R(m)
AAG 7/17/01 MFBE VMEC2000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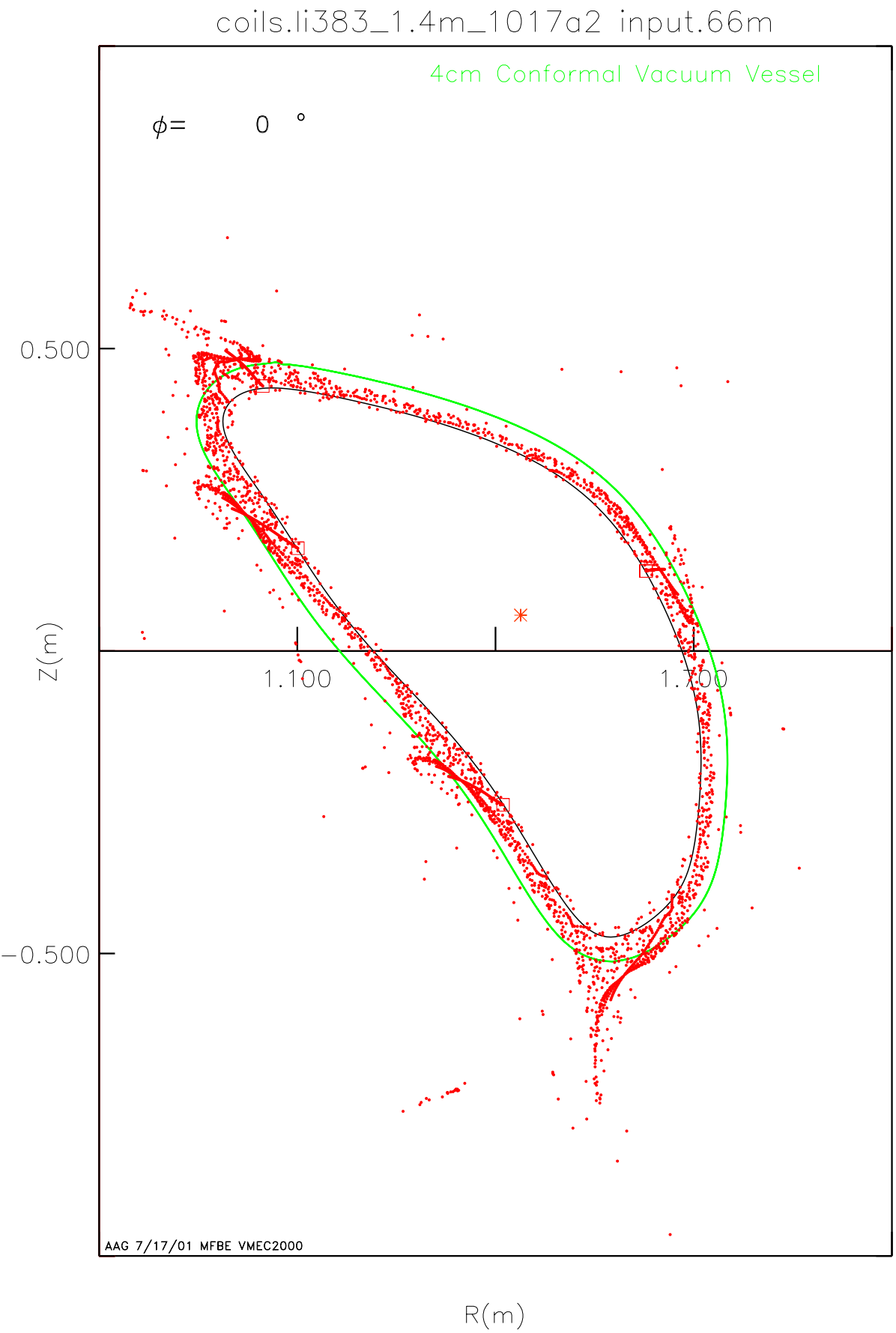
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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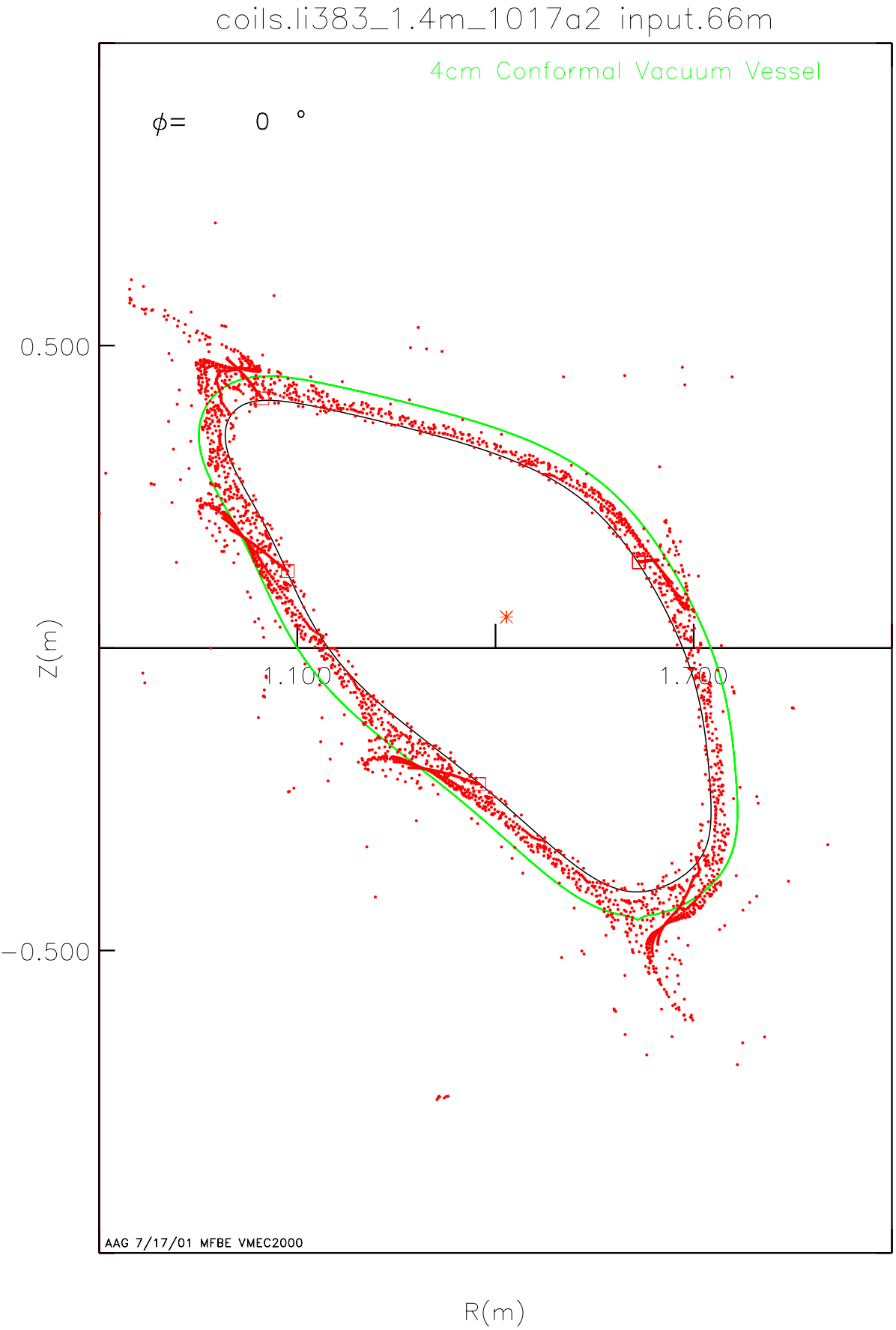
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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Z(m)
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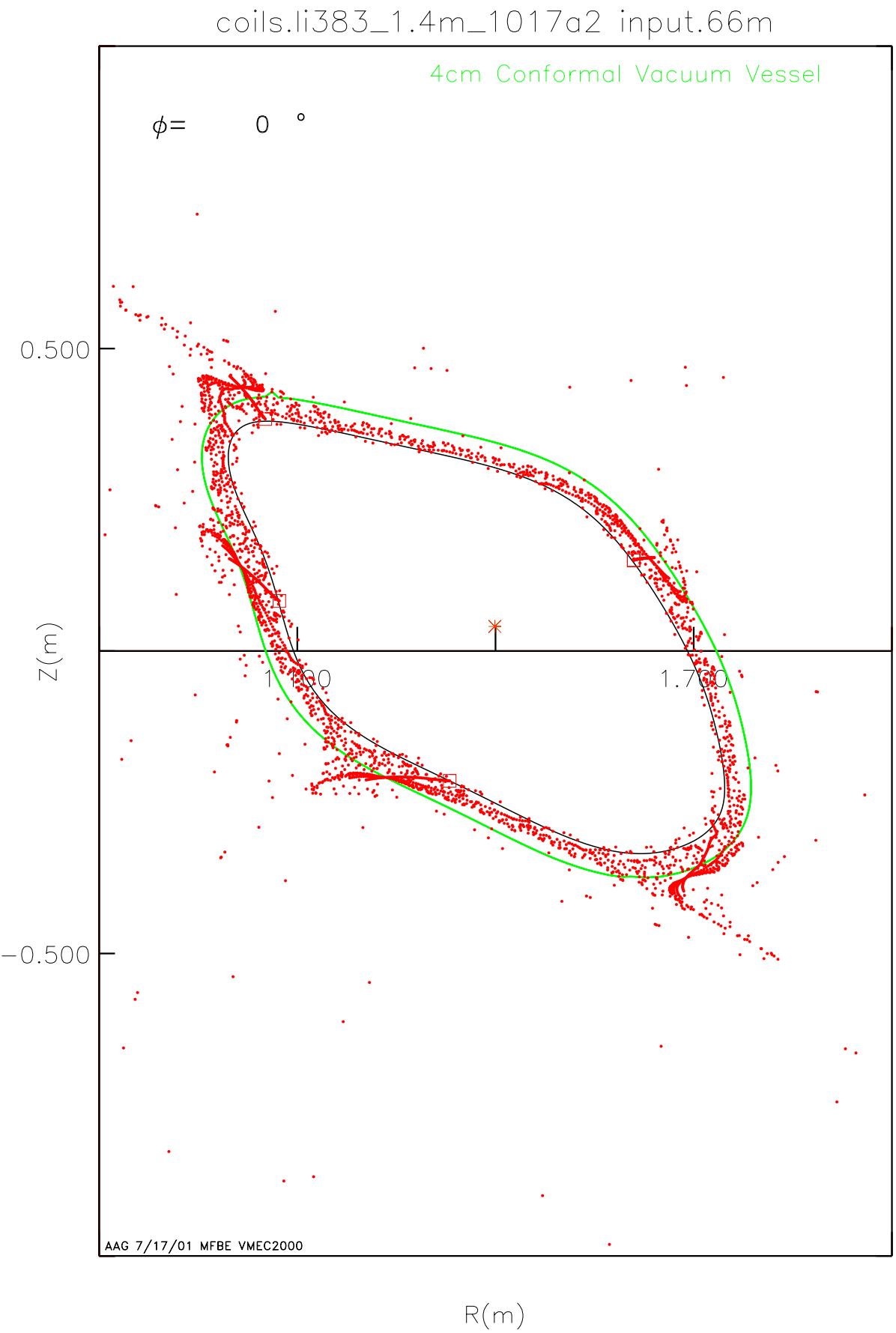
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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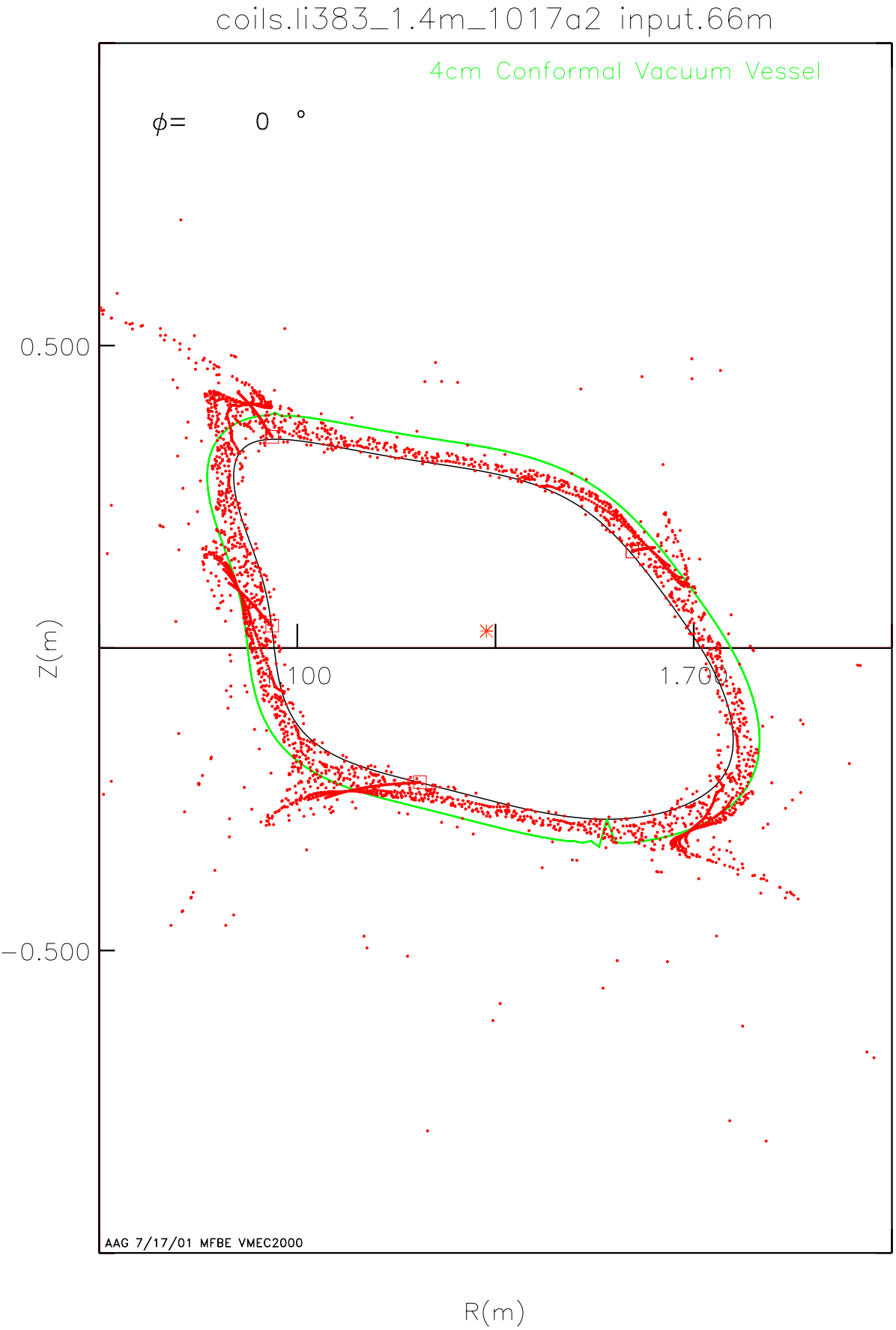
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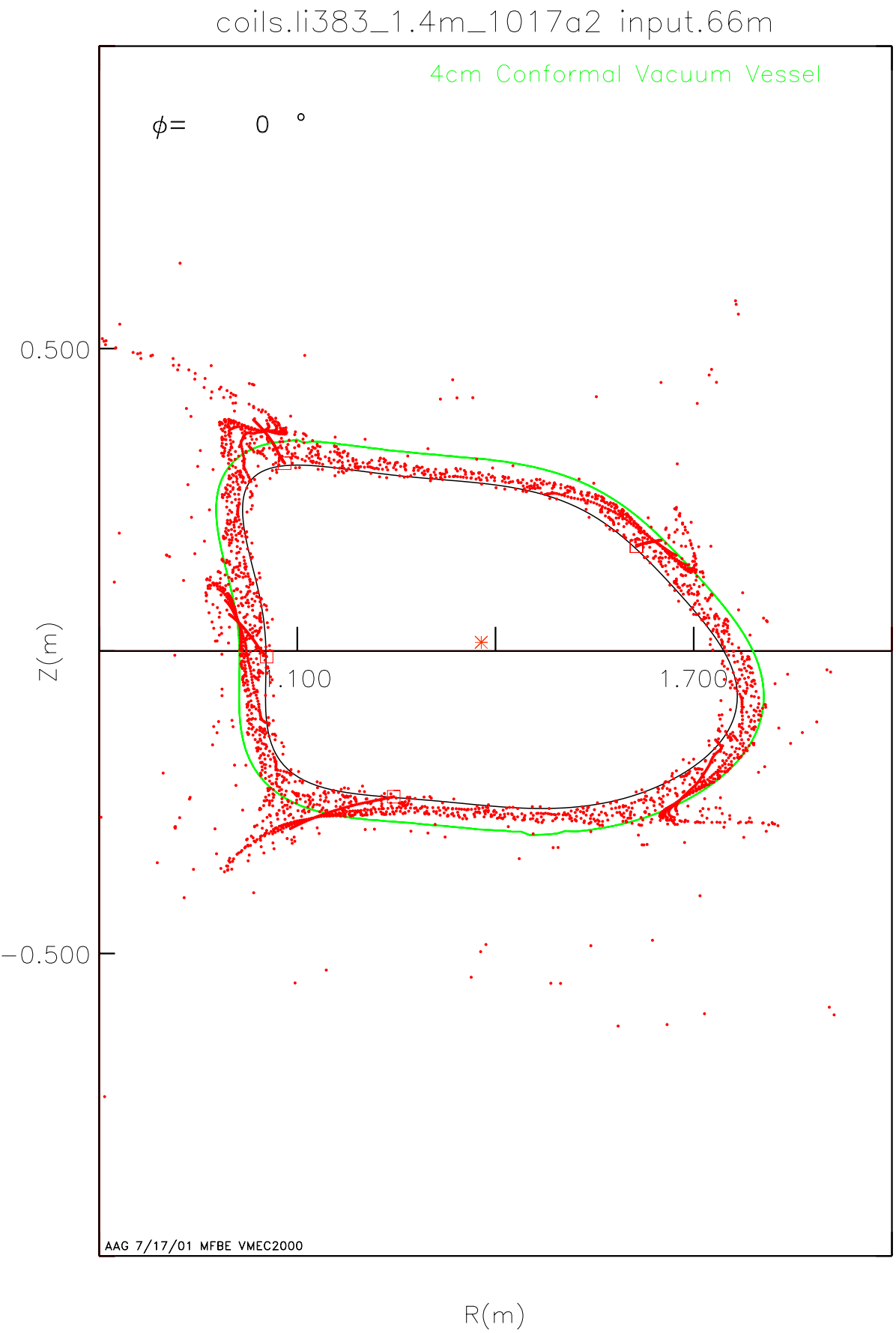
AAG 7/17/01 MFBE VMEC2000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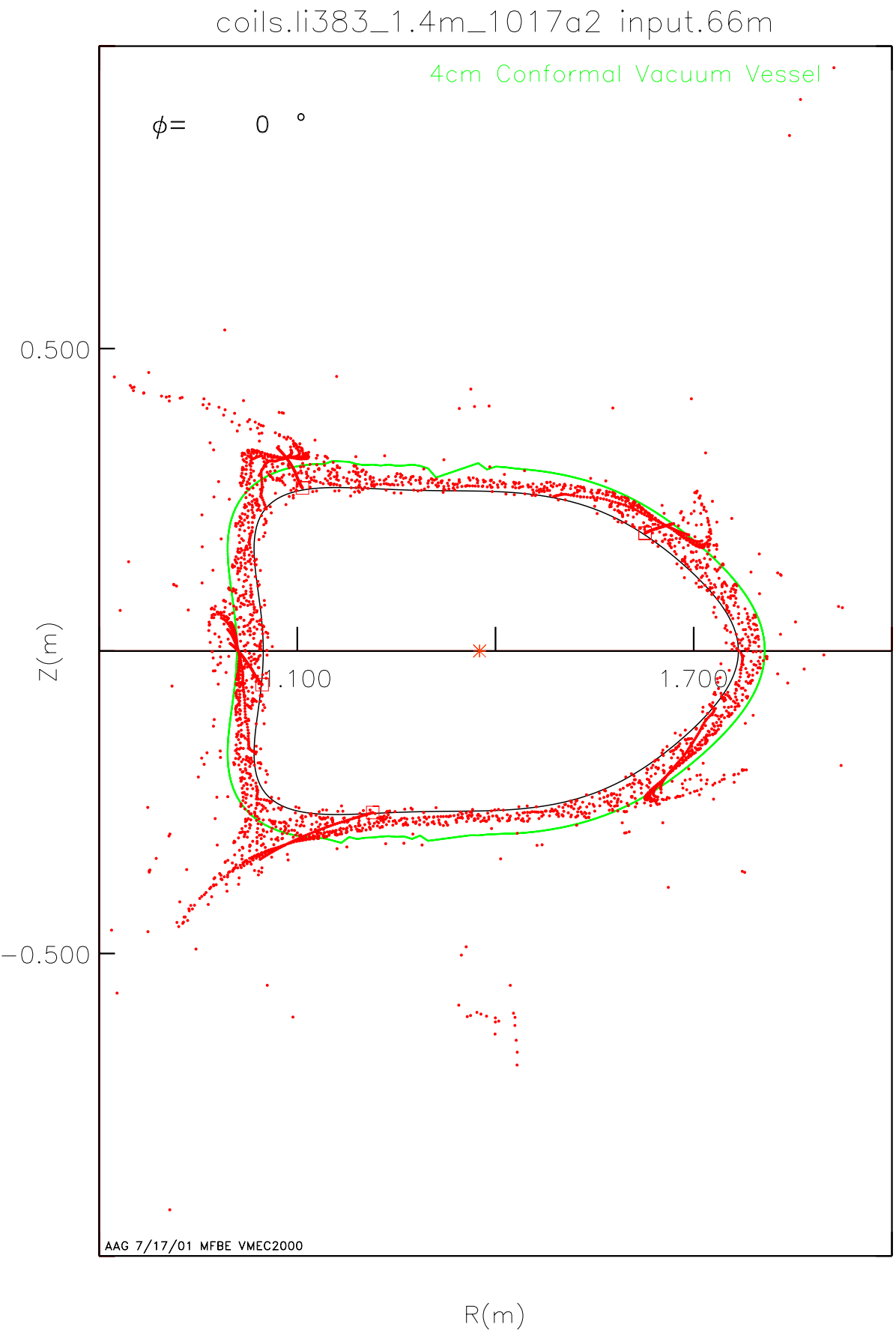
1.700
AAG 7/17/01 MFBE VMEC2000
R(m)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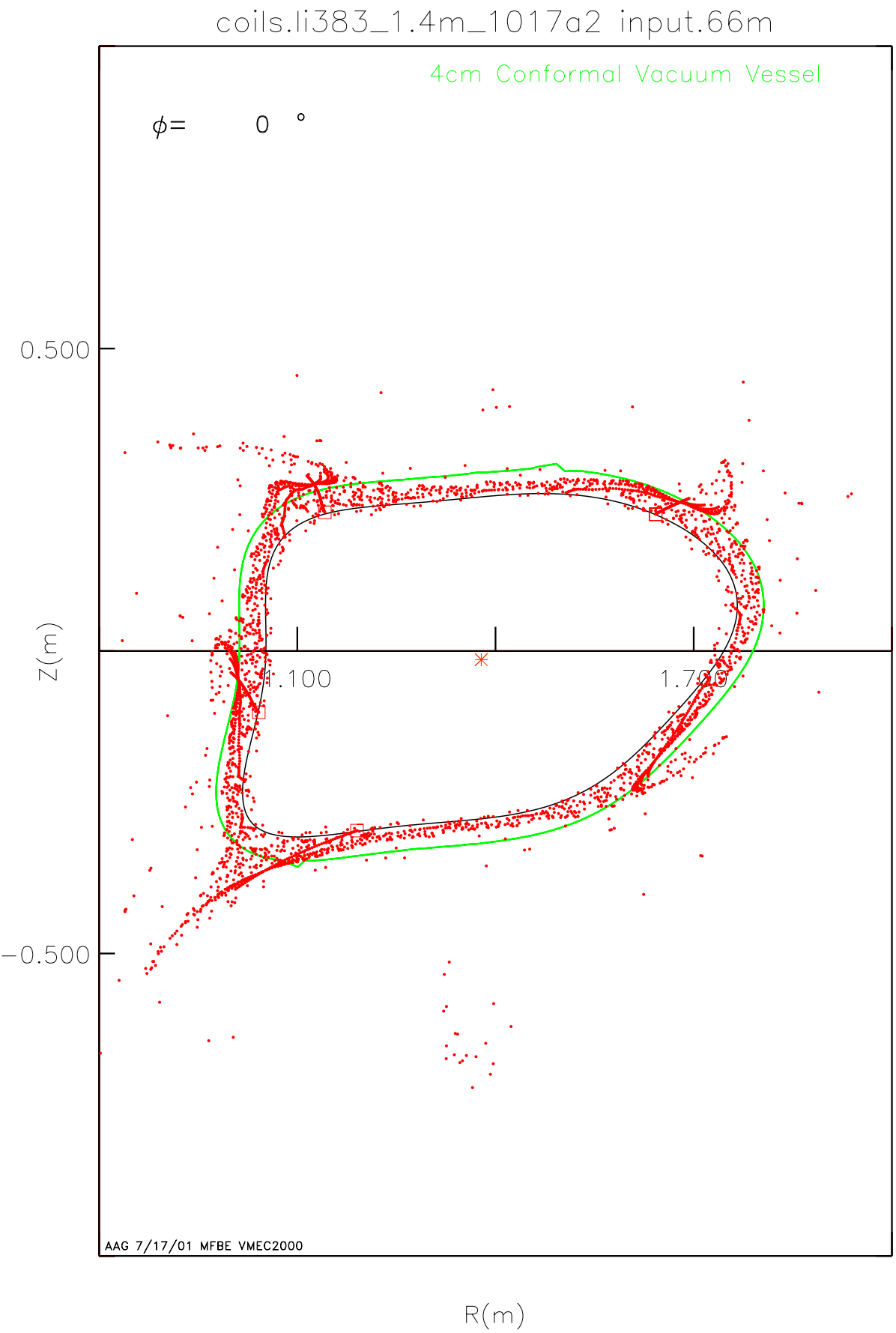
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
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φ= 0 °
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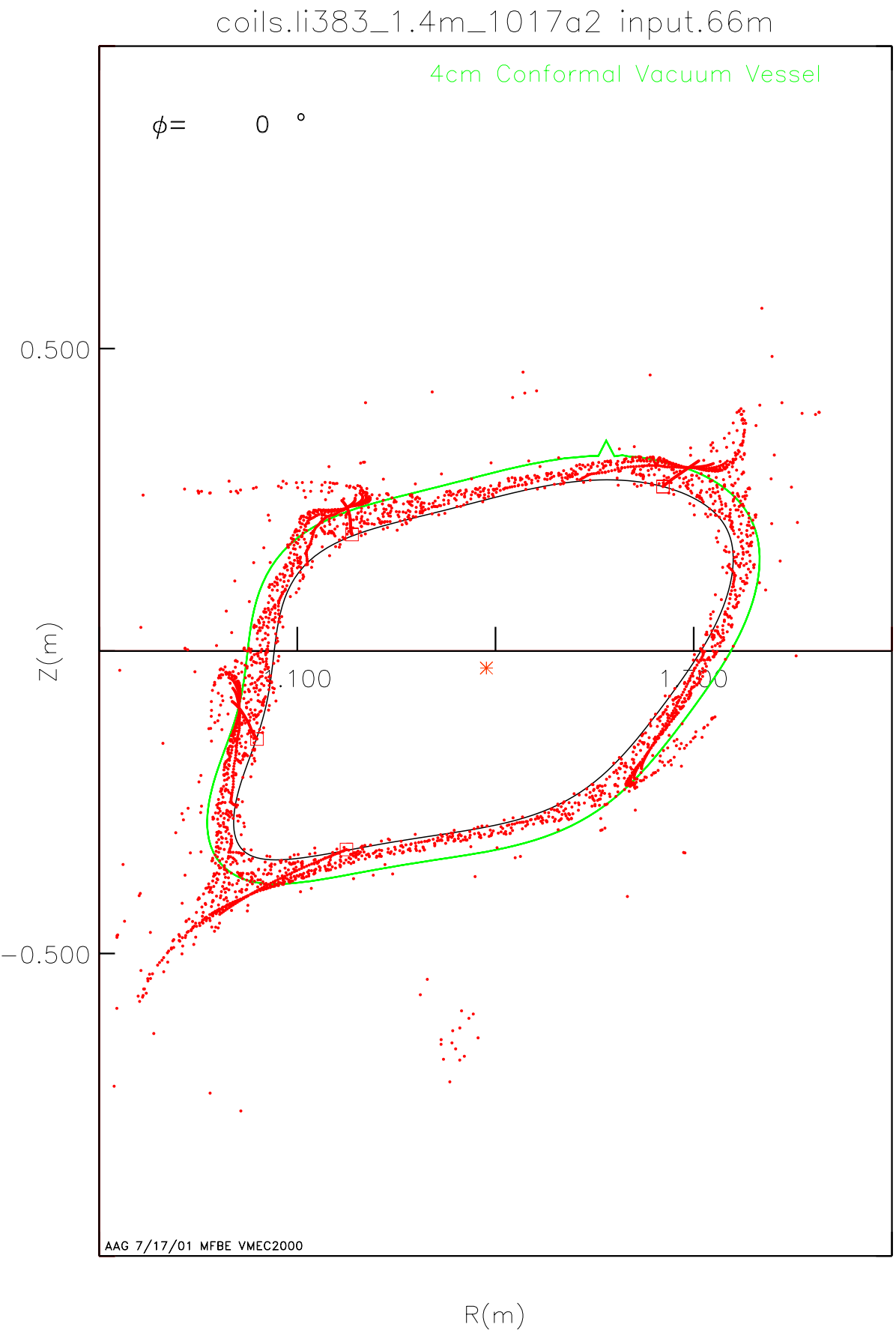
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
4cm Conformal Vacuum Vessel
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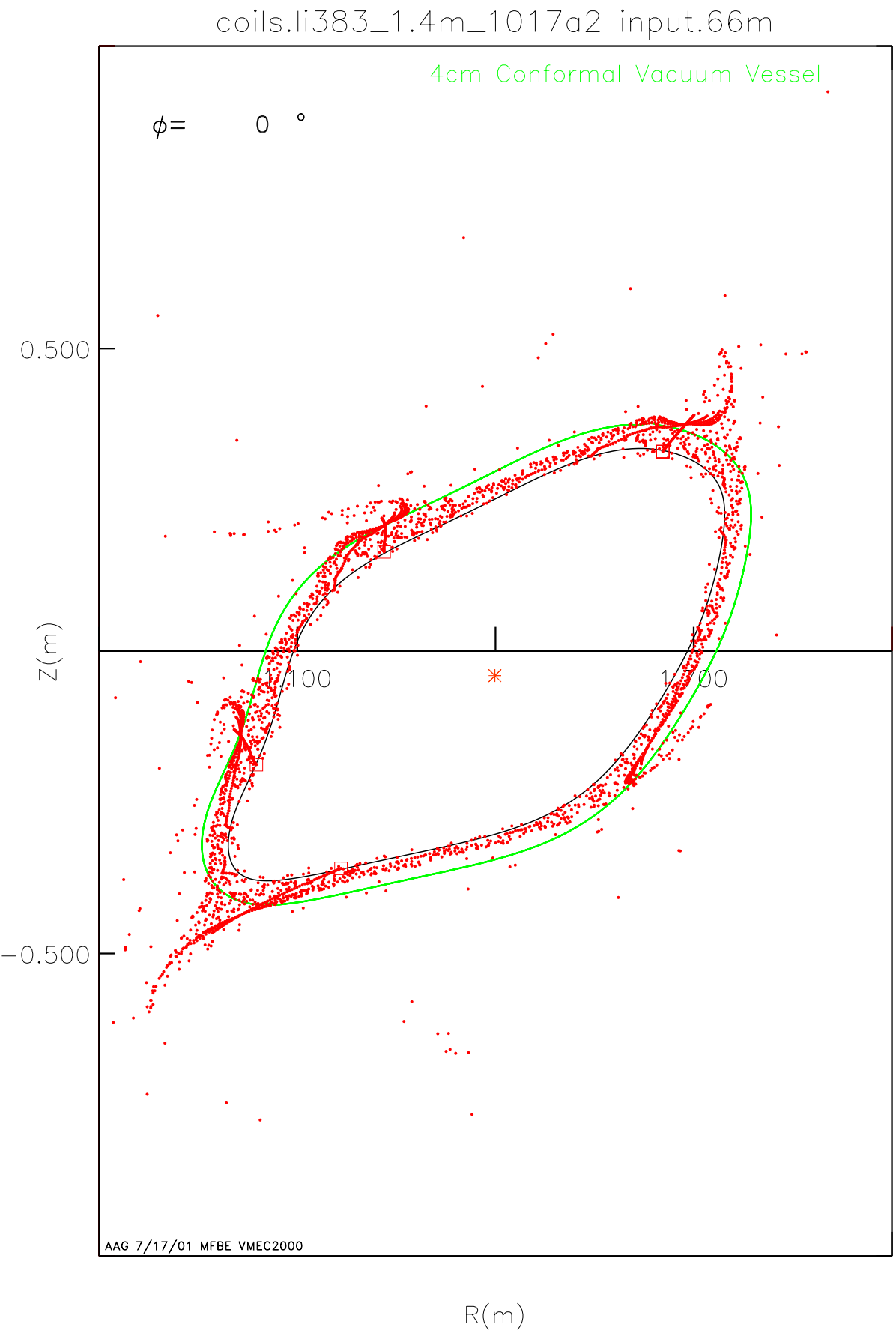
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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φ= 0 °
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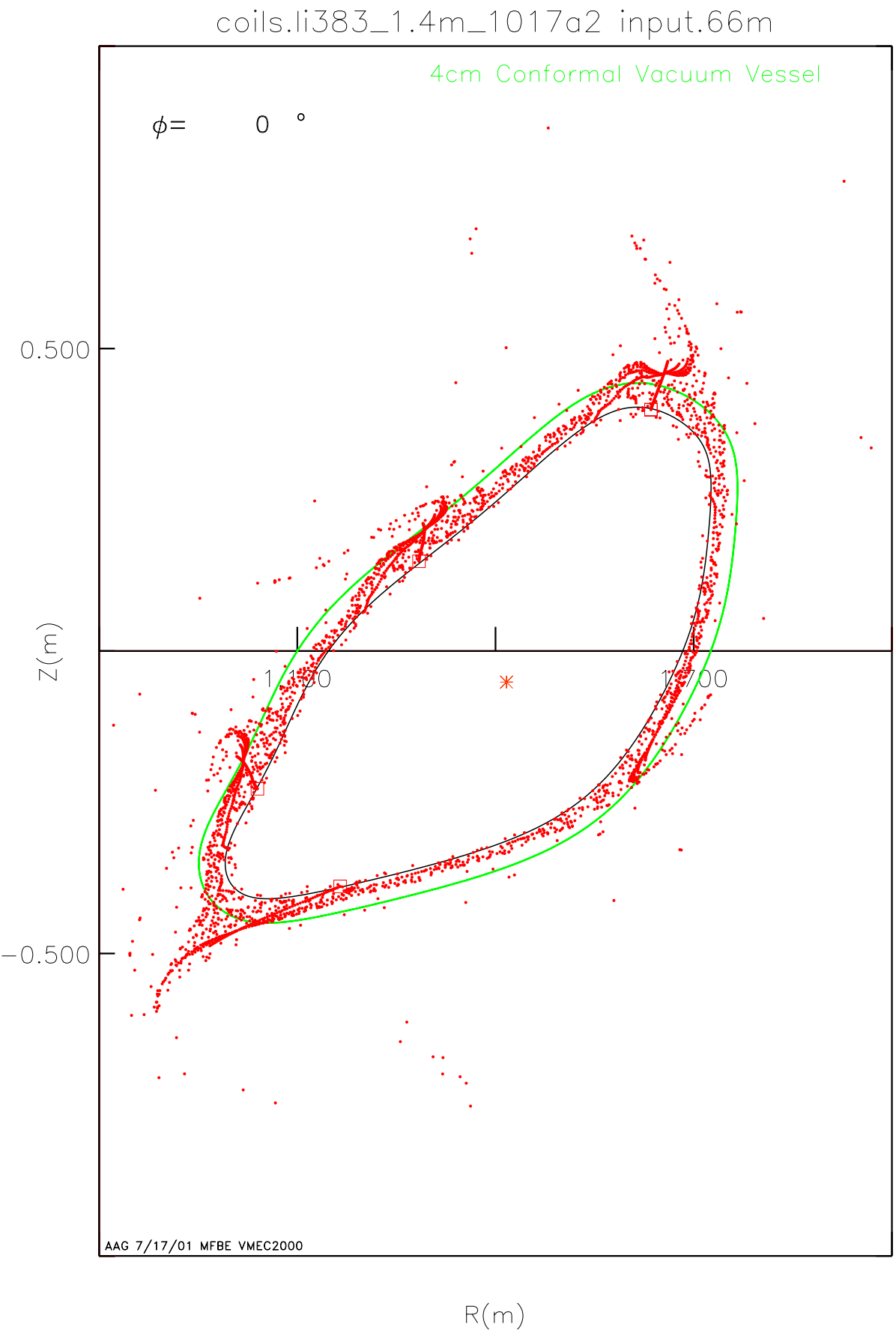
−0.500
Z(m)
R(m)
AAG 7/17/01 MFBE VMEC2000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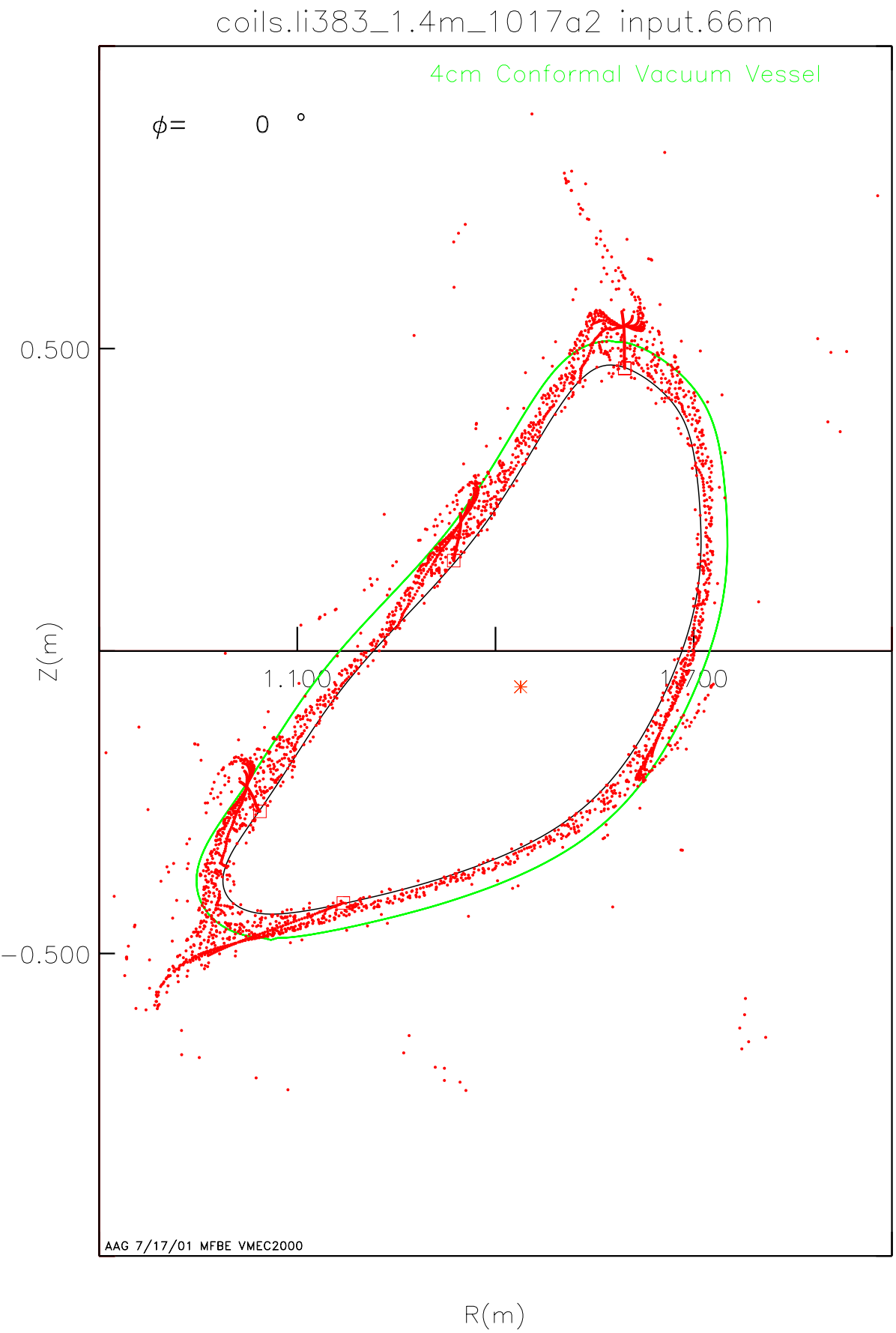
Z(m)
R(m)
AAG 7/17/01 MFBE VMEC2000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Z(m)
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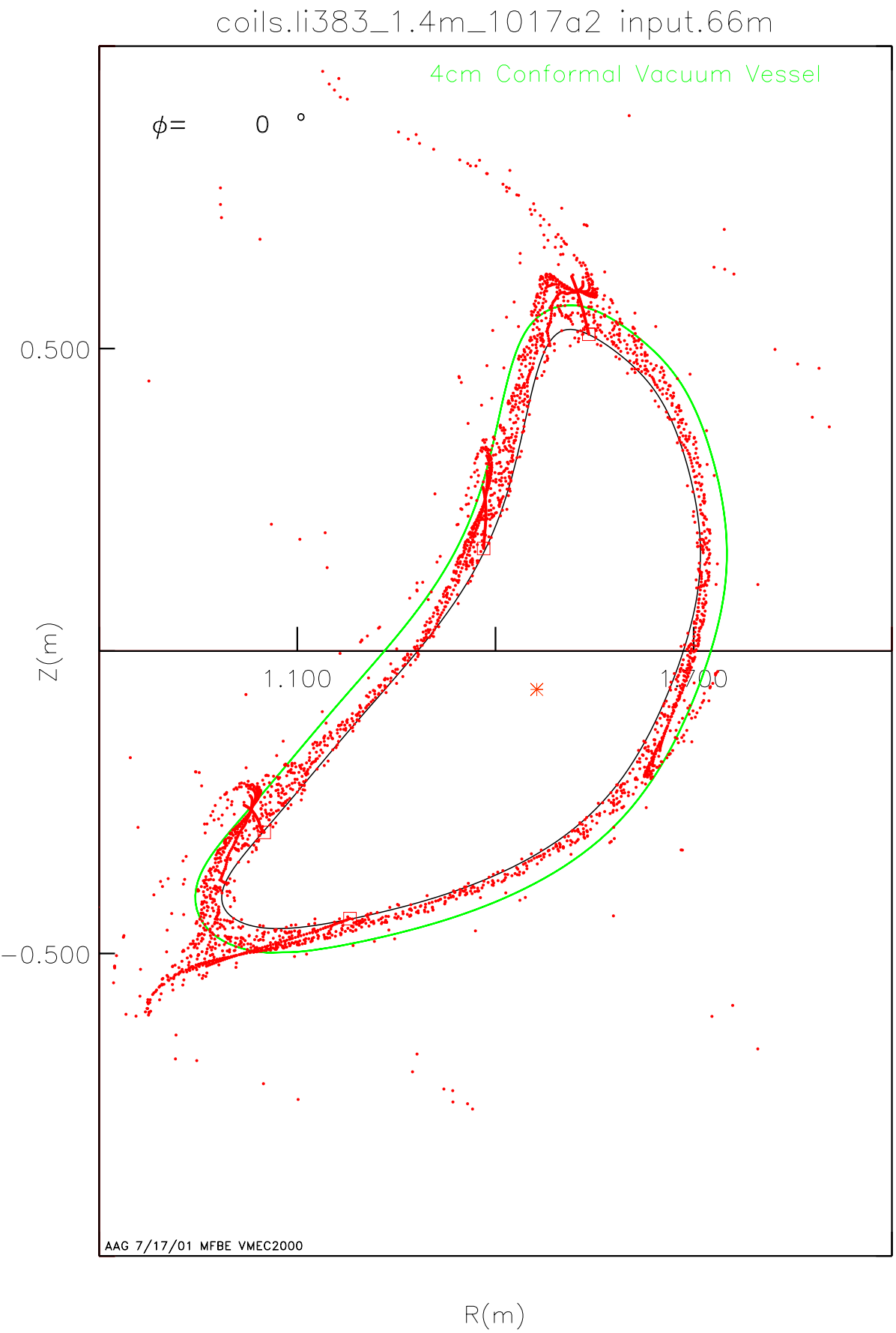
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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Z(m)
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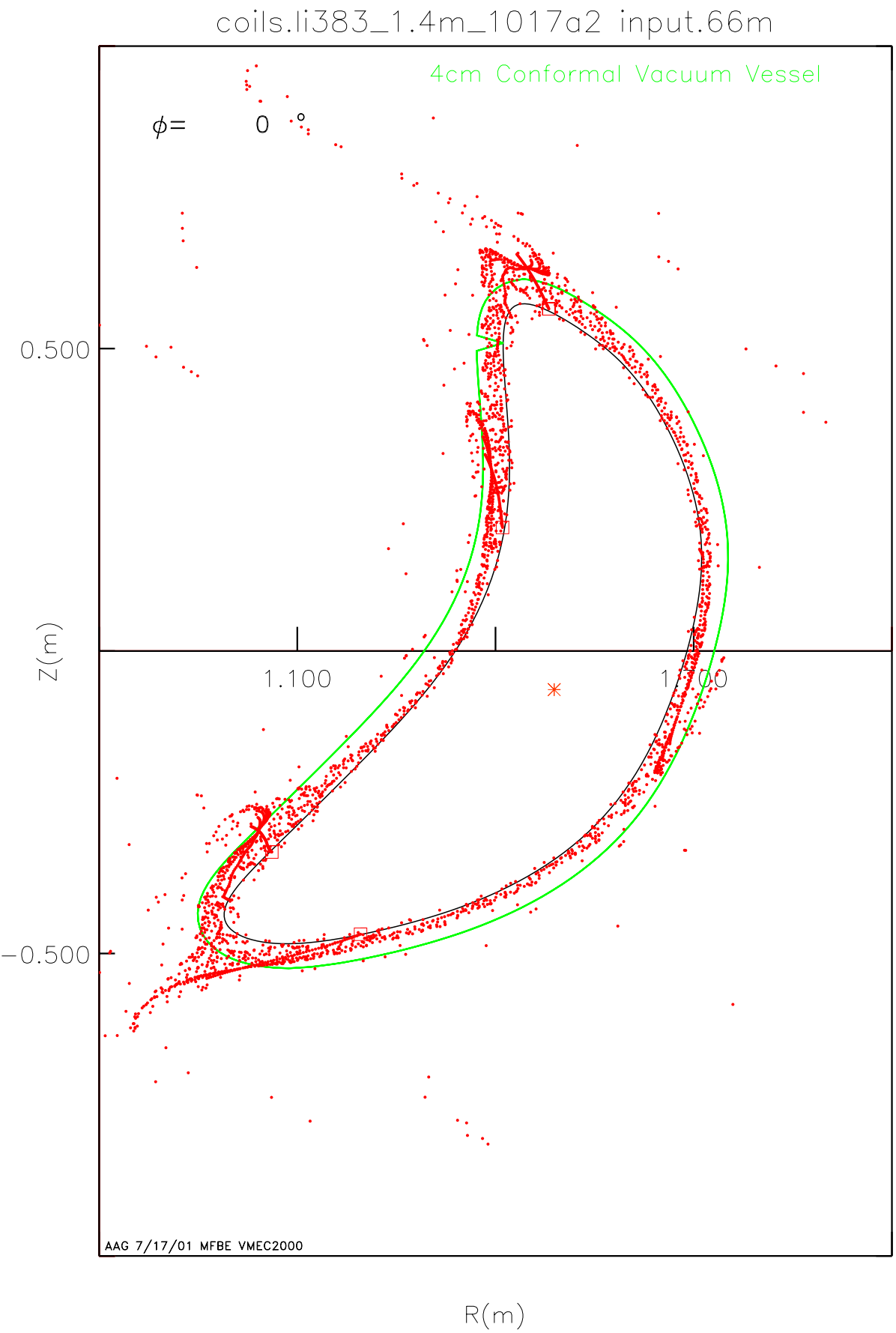
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000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R(m)
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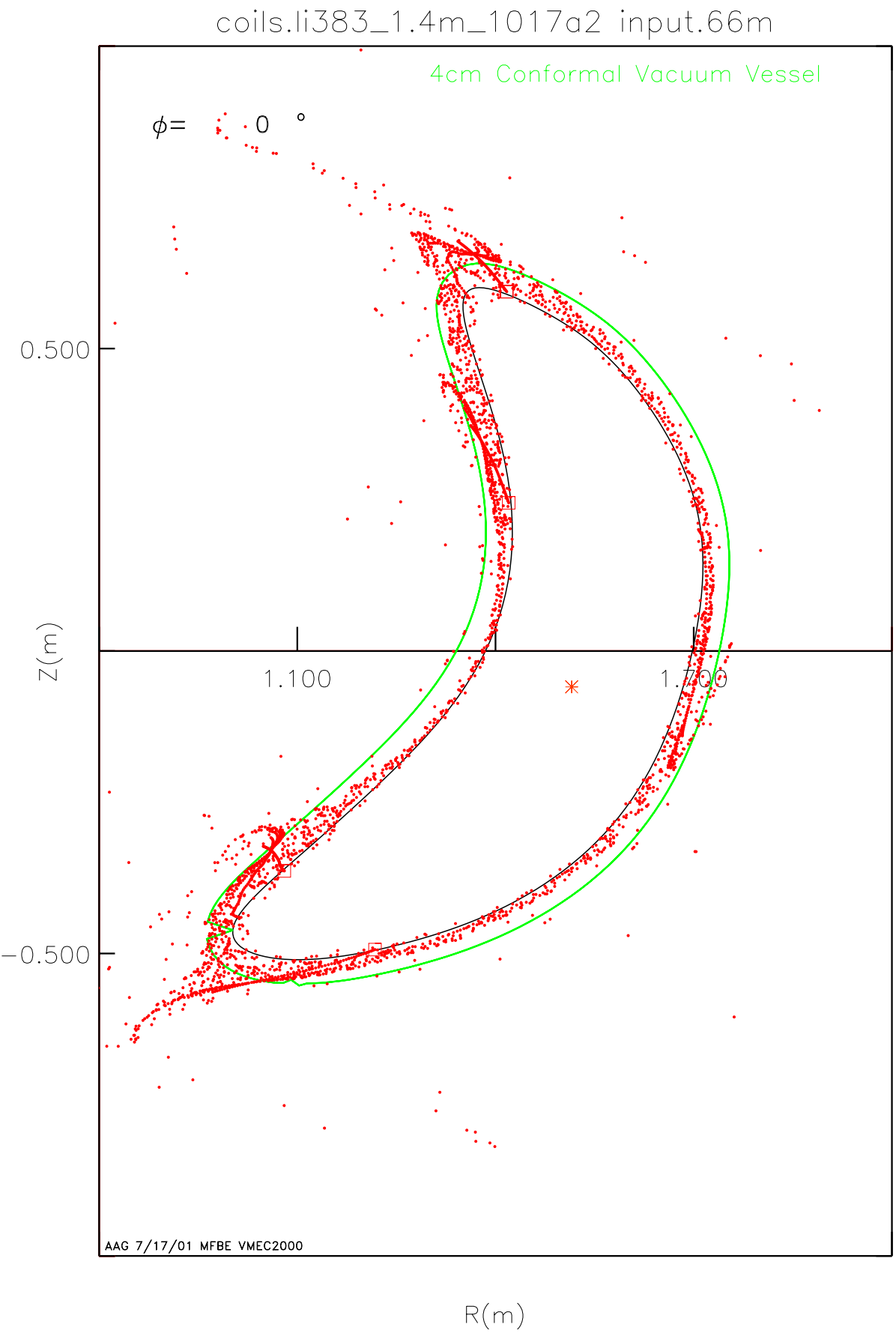
coils.li383_1.4m_1017a2 input.66m
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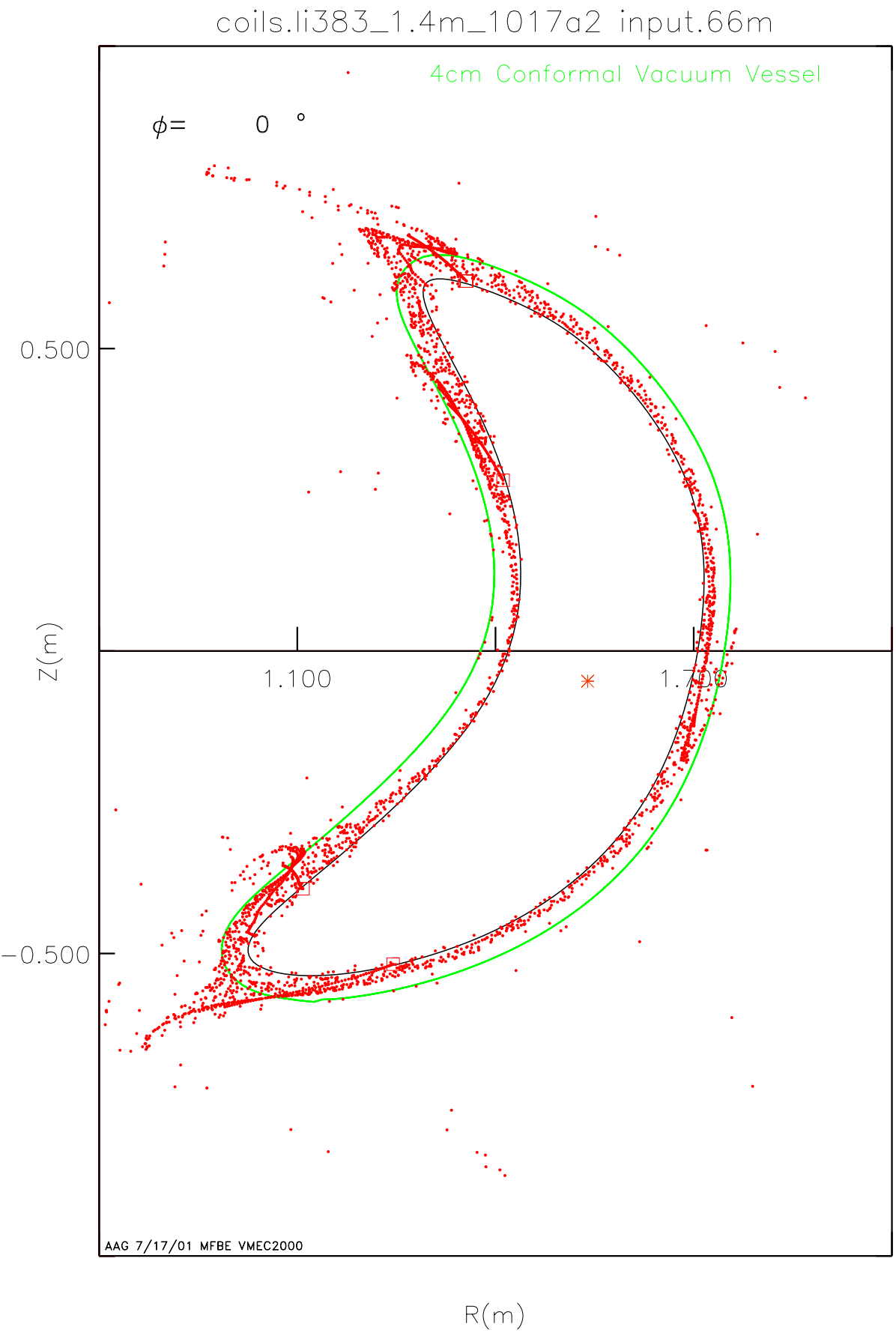
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
4cm Conformal Vacuum Vessel
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0.500
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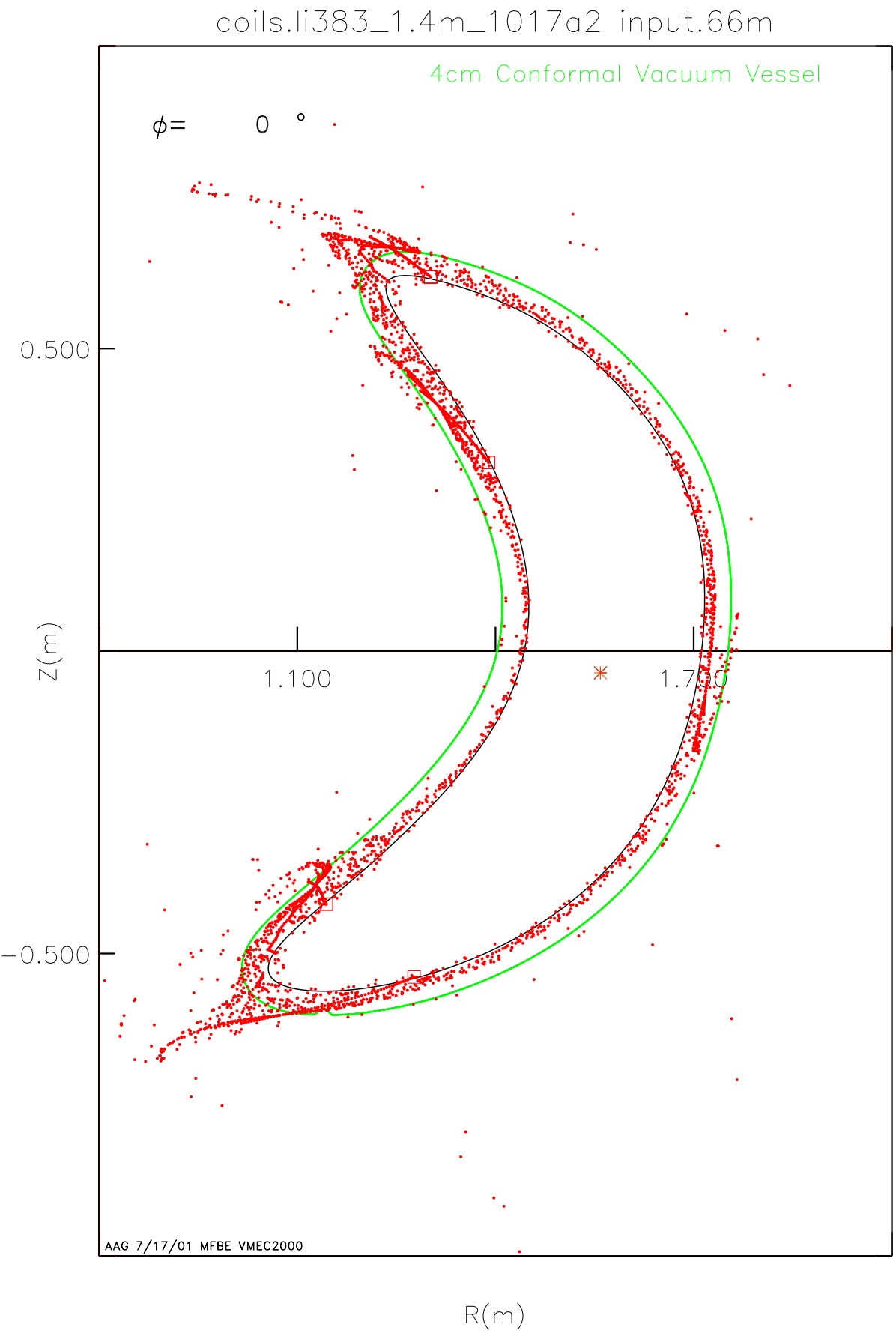
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
4cm Conformal Vacuum Vessel
φ= 0 °
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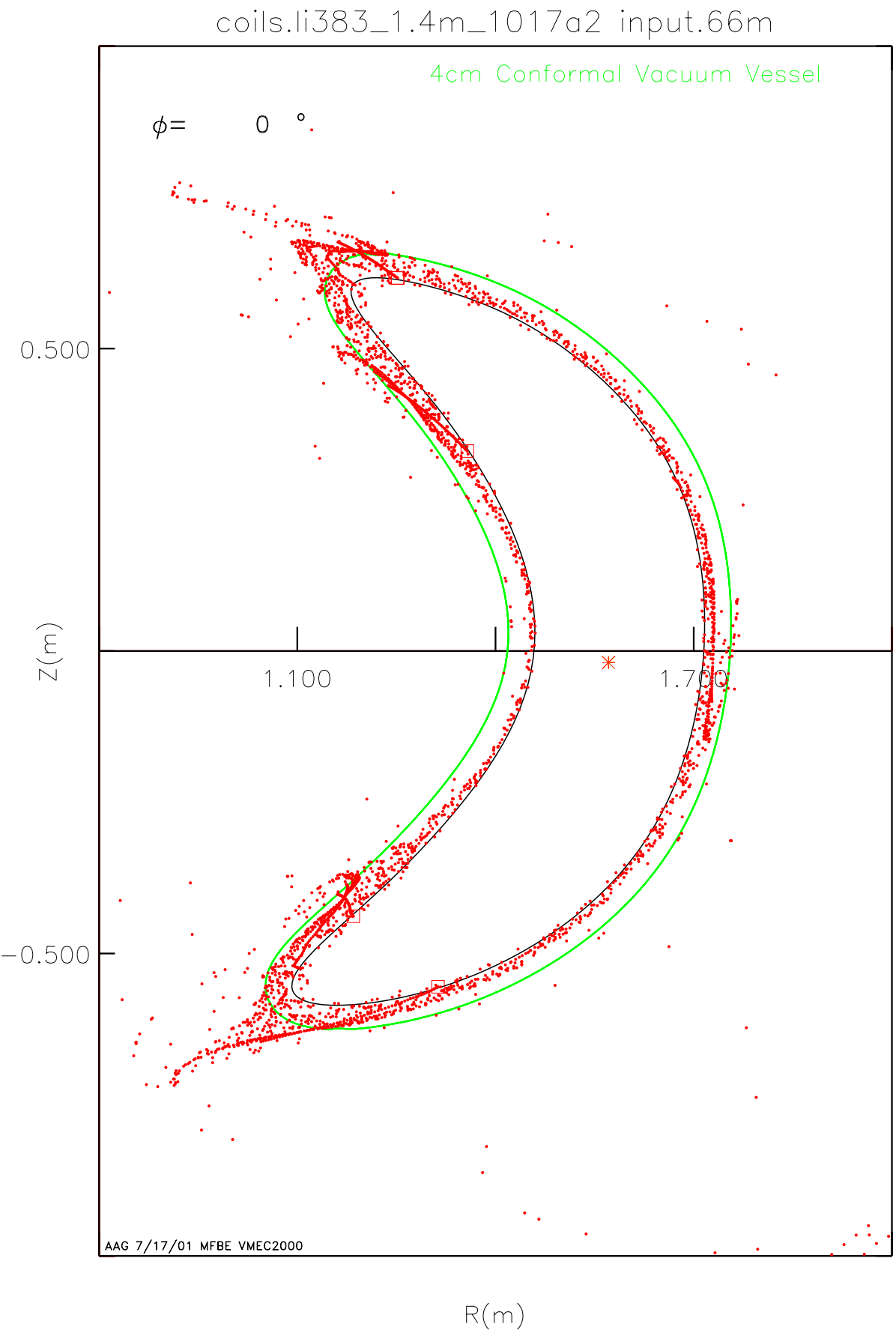
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000


coils.li383_1.4m_1017a2 input.66m
4cm Conformal Vacuum Vessel
φ= 0 °.
0.500
−0.500
Z(m)
1.100
1.700
R(m)
AAG 7/17/01 MFBE VMEC2000

Conclusions

- Good free boundary VMEC at 1.4m obtained by conversion of scaled fixed boundary LI383. Careful matching of vacuum currents with VMEC eliminates islands inside LCMS.
- Ergodized (results independent of launch point) near LCMS.
- Whiskered torus, stochasticity for launches away (>2cm) from LCMS.
- Preservation of radial ordering.