Edge Magnetic Configuration: Maps of NCSX 1017 SOL Field Line Structure and Footprint on 10cm Conformal Vacuum Vessel

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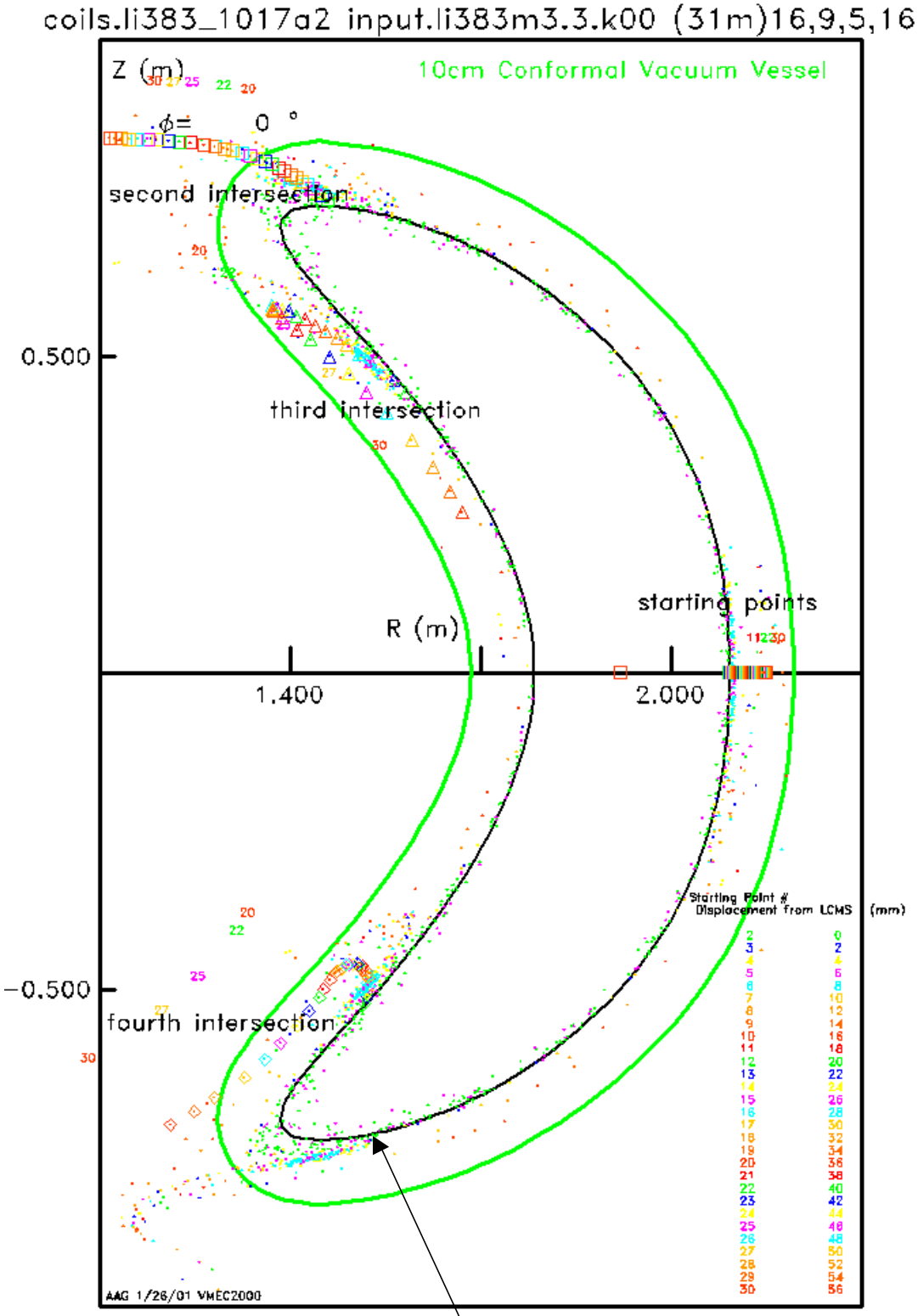
Field Line Mapping As Characterization of SOL

- Magnetic field lines started radially from LCMS outward and traced noting intersections with wall. Tracing continues until line leaves computational box or for 200 toroidal turns, which ever is first.
- For NCSX series equilibria, a clear correlation is seen between LCMS distance and field line length.
  - An inner ergodic area characterized by very long connection lengths and radial clustering is seen for starting points within 2 cm of the LCMS.
  - An outer ergodic area characterized by very short connection lengths prevails for field lines started beyond 2 cm radially from the LCMS. These lines exhibit an ordered layer structure similar to the axysymmetric tokamak when intercepted by a conformal wall located 10 cm from the LCMS.

Slide Show of Mapping of 1017 SOL Field Line Structure and Footprint on 10cm Conformal Vacuum Vessel

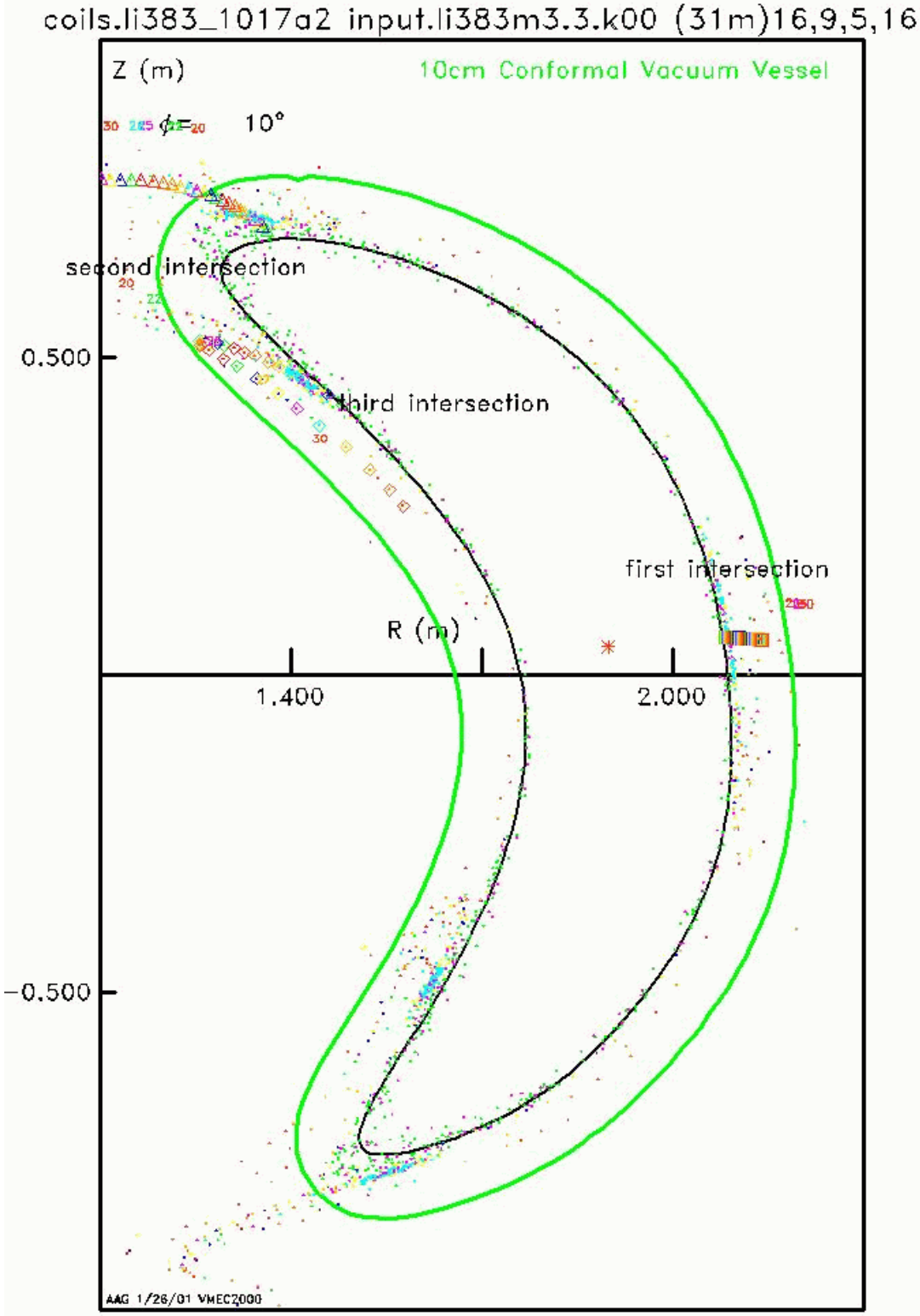
- 1017a2 Coil Set- Modular, but no island healing.
- VMEC2000 (latest version) free boundary equilibrium using li383m3.3k0.0 full current, full beta- not optimized.
- Standard NCSX resolution, with NTHETA=16, NZETA=16, MPOL=9, NTOR=5.
- Follow 30 field lines starting at bean shaped cross-section midplane, at 2mm increments from VMEC LCMS.

Toroidal Angle = 0°

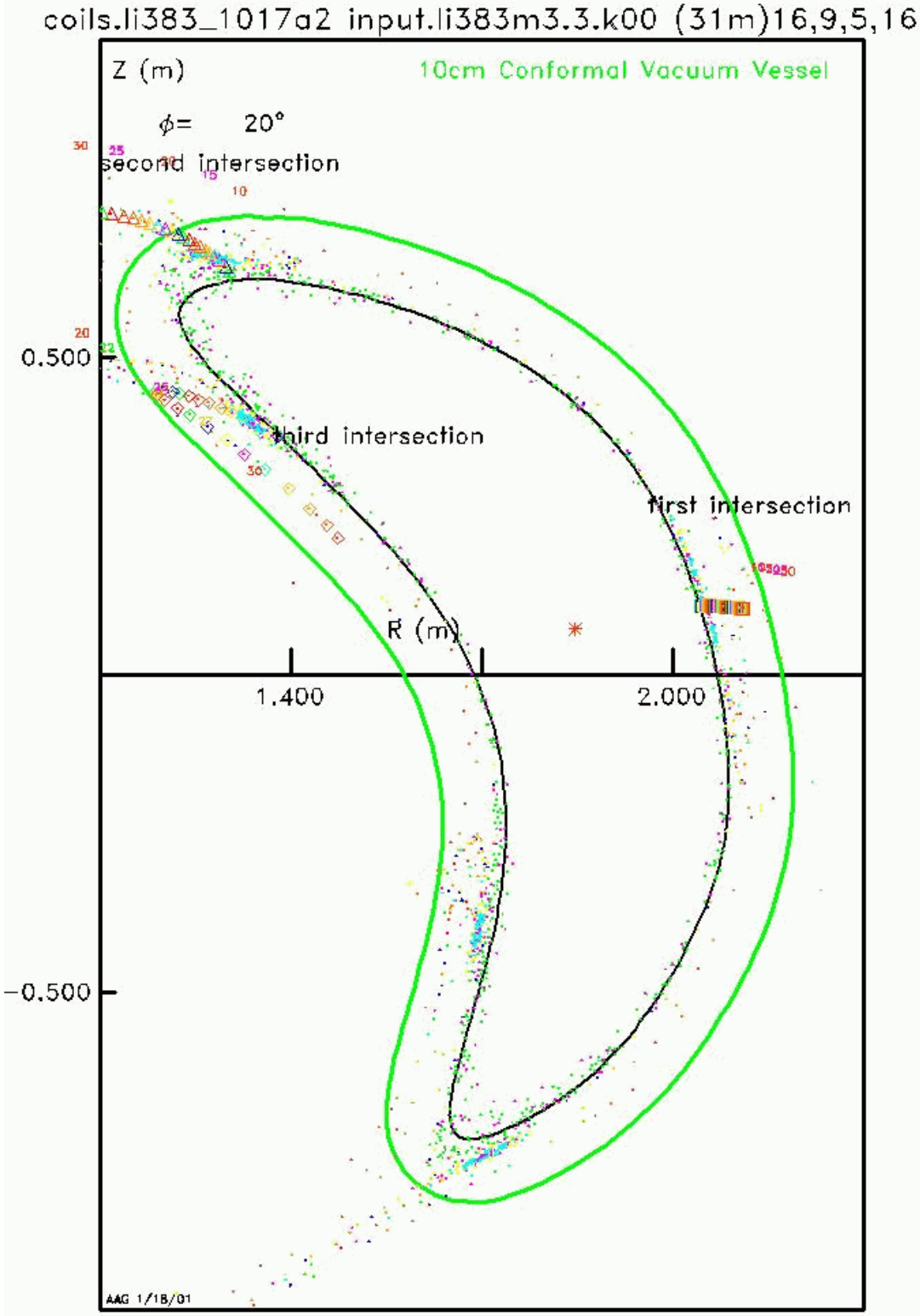


VMEC LCMS

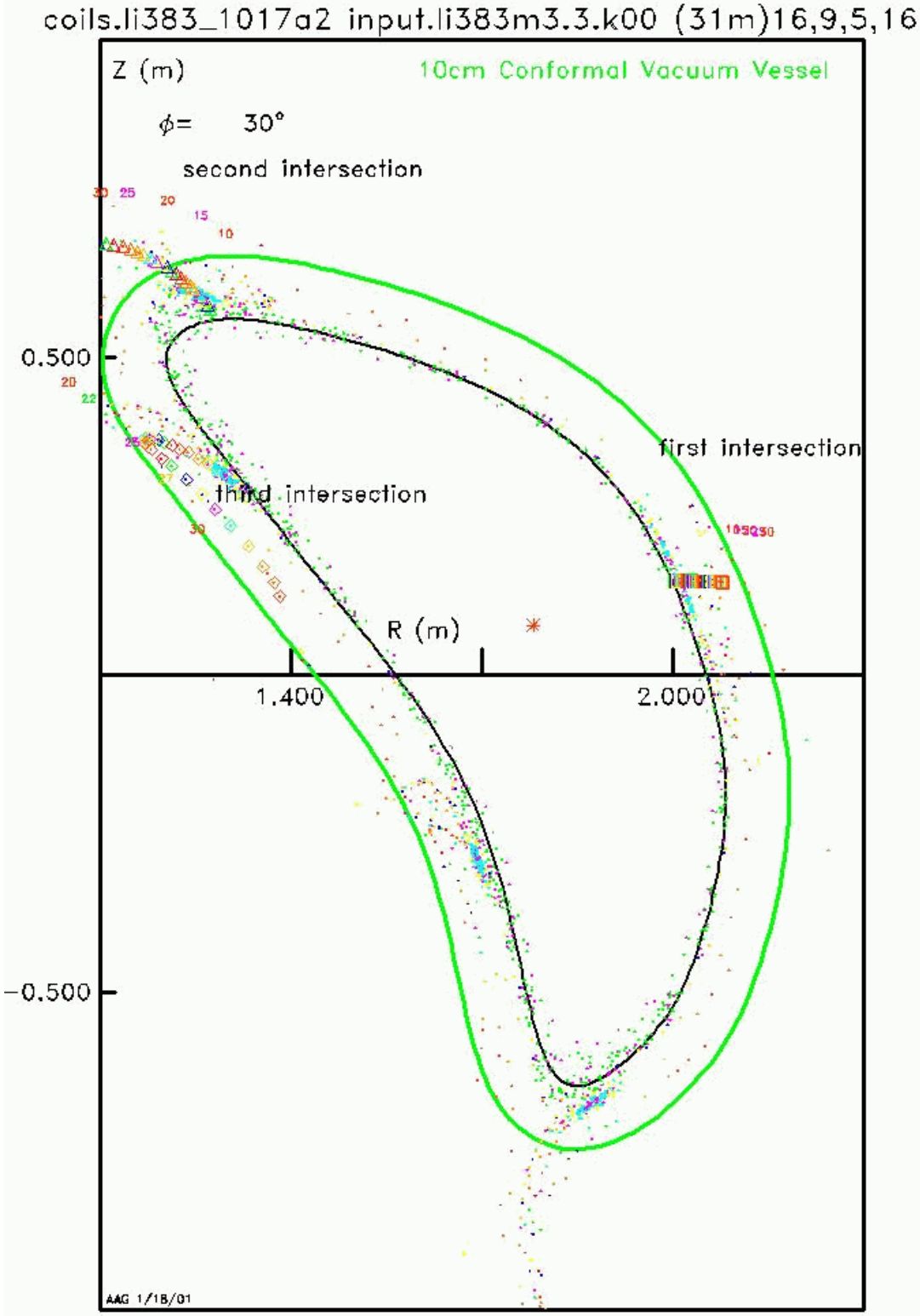
Toroidal Angle=10°



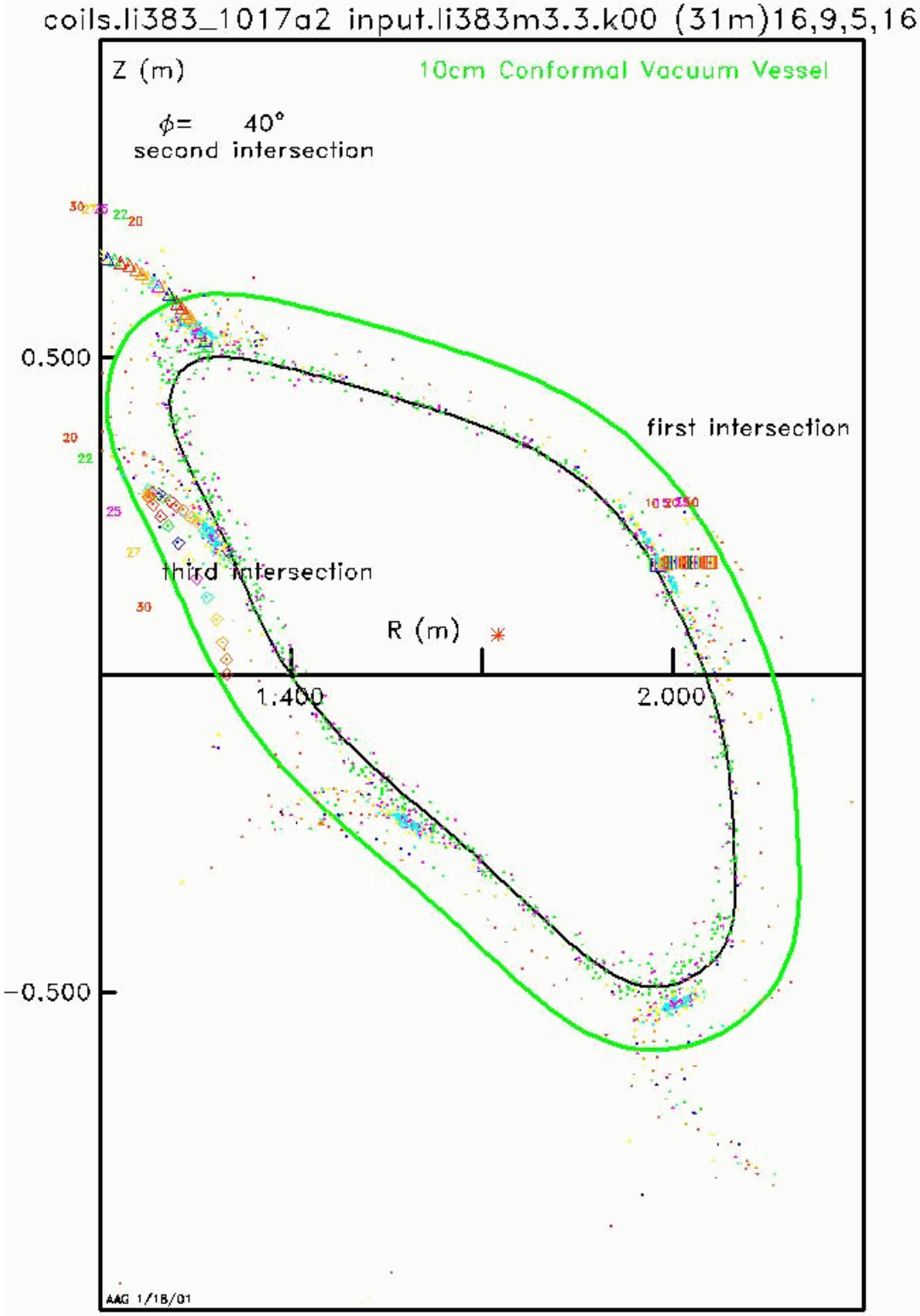
Toroidal Angle=20°



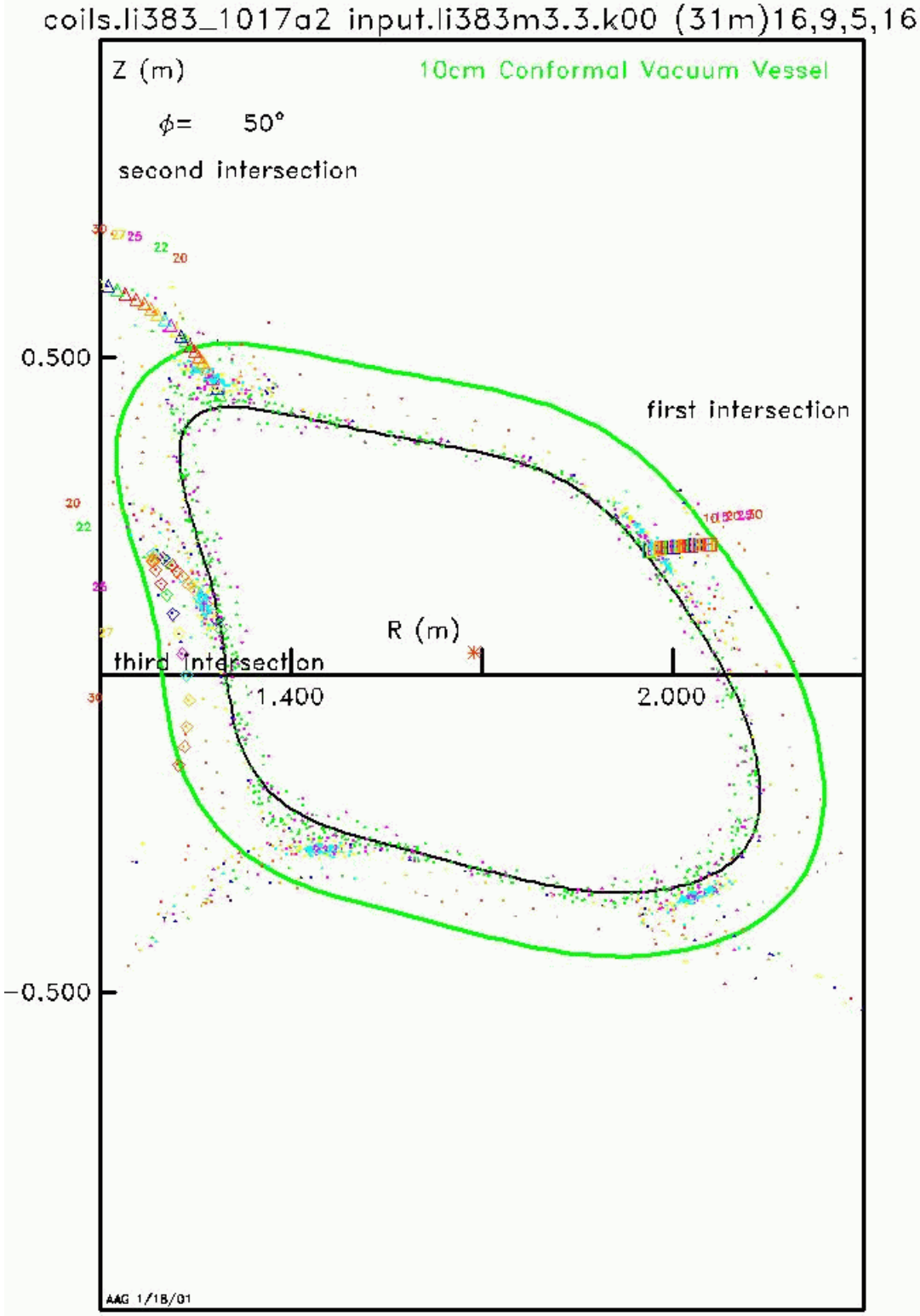
Toroidal Angle=30°



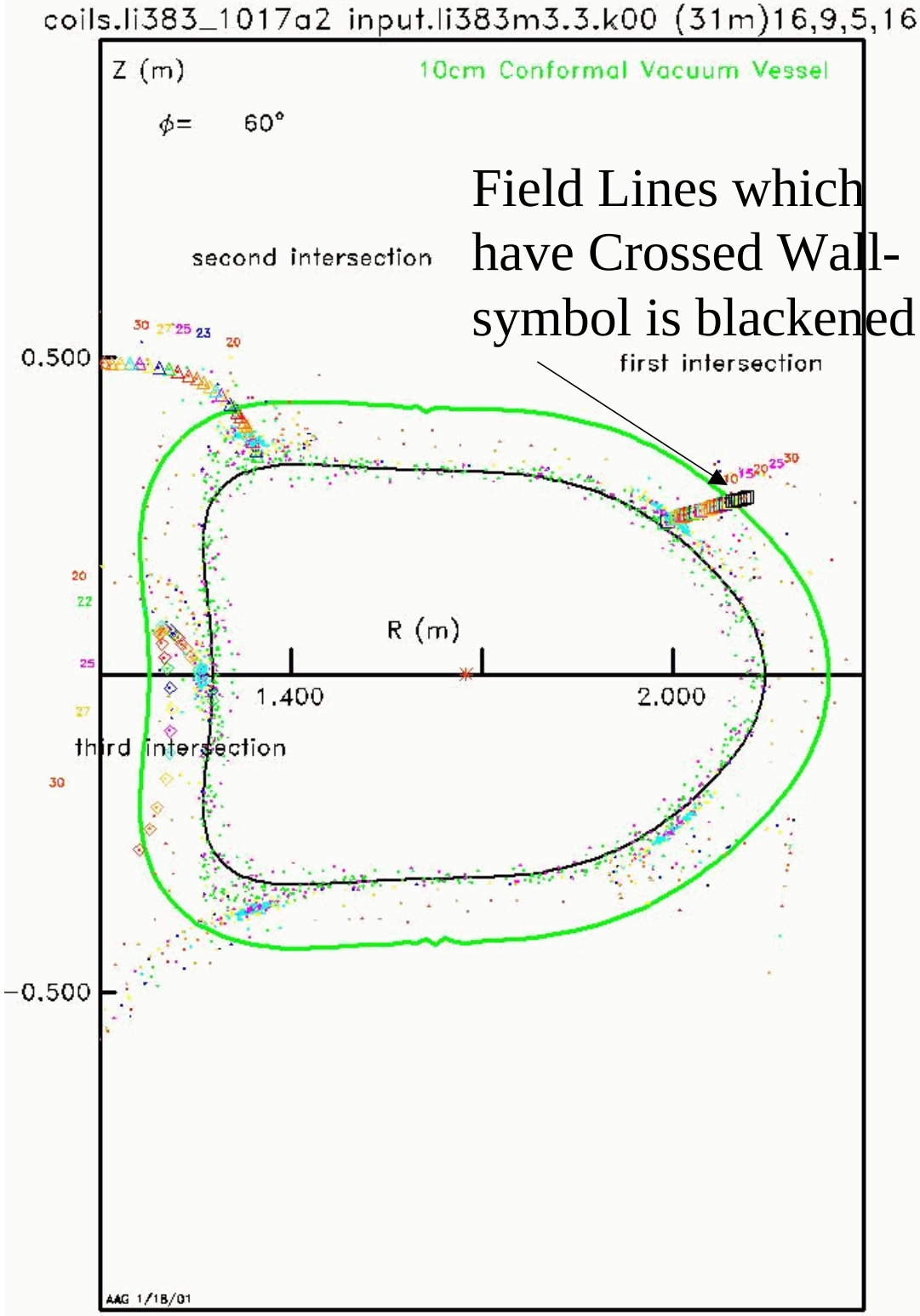
Toroidal Angle=40°



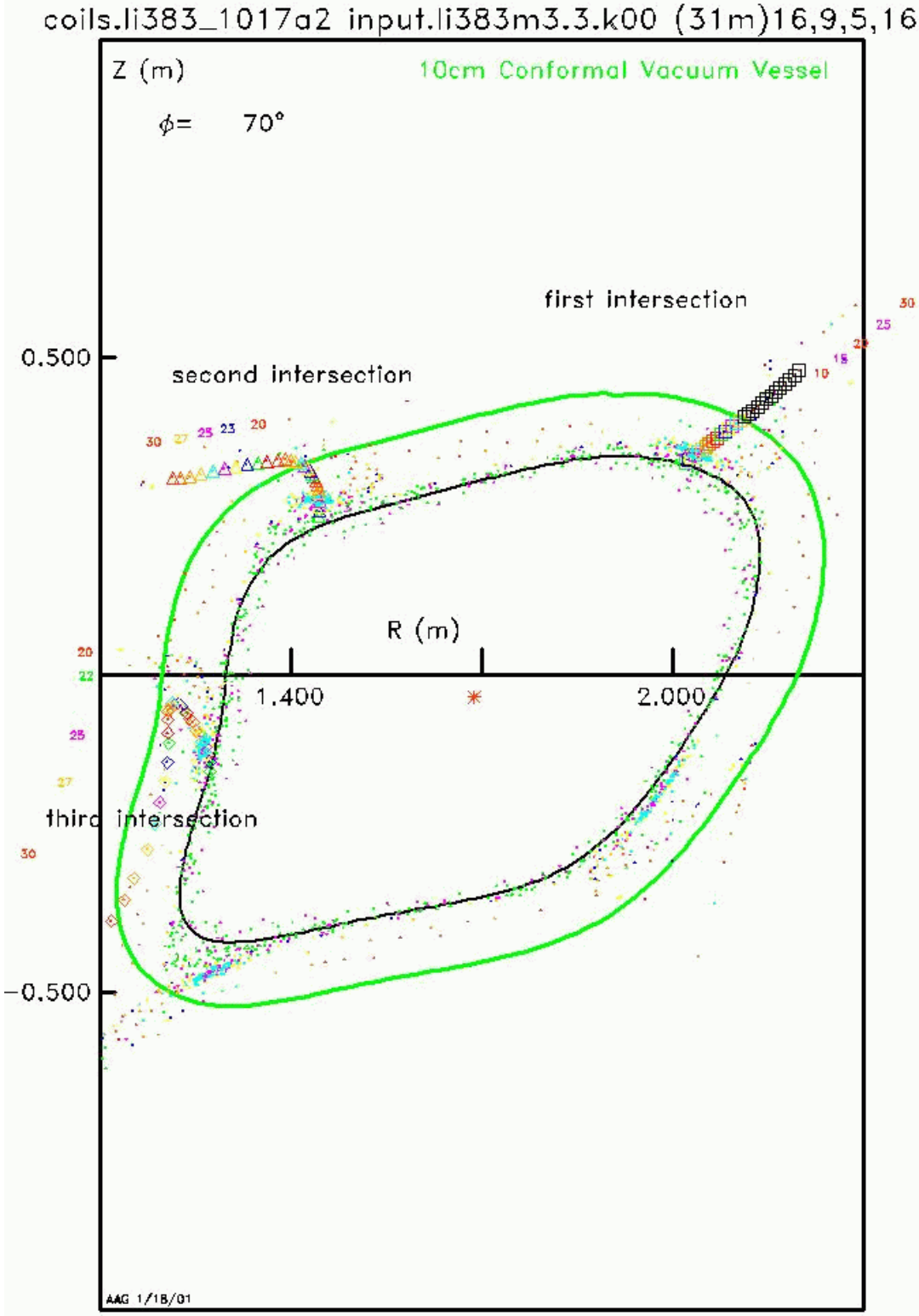
Toroidal Angle=50°



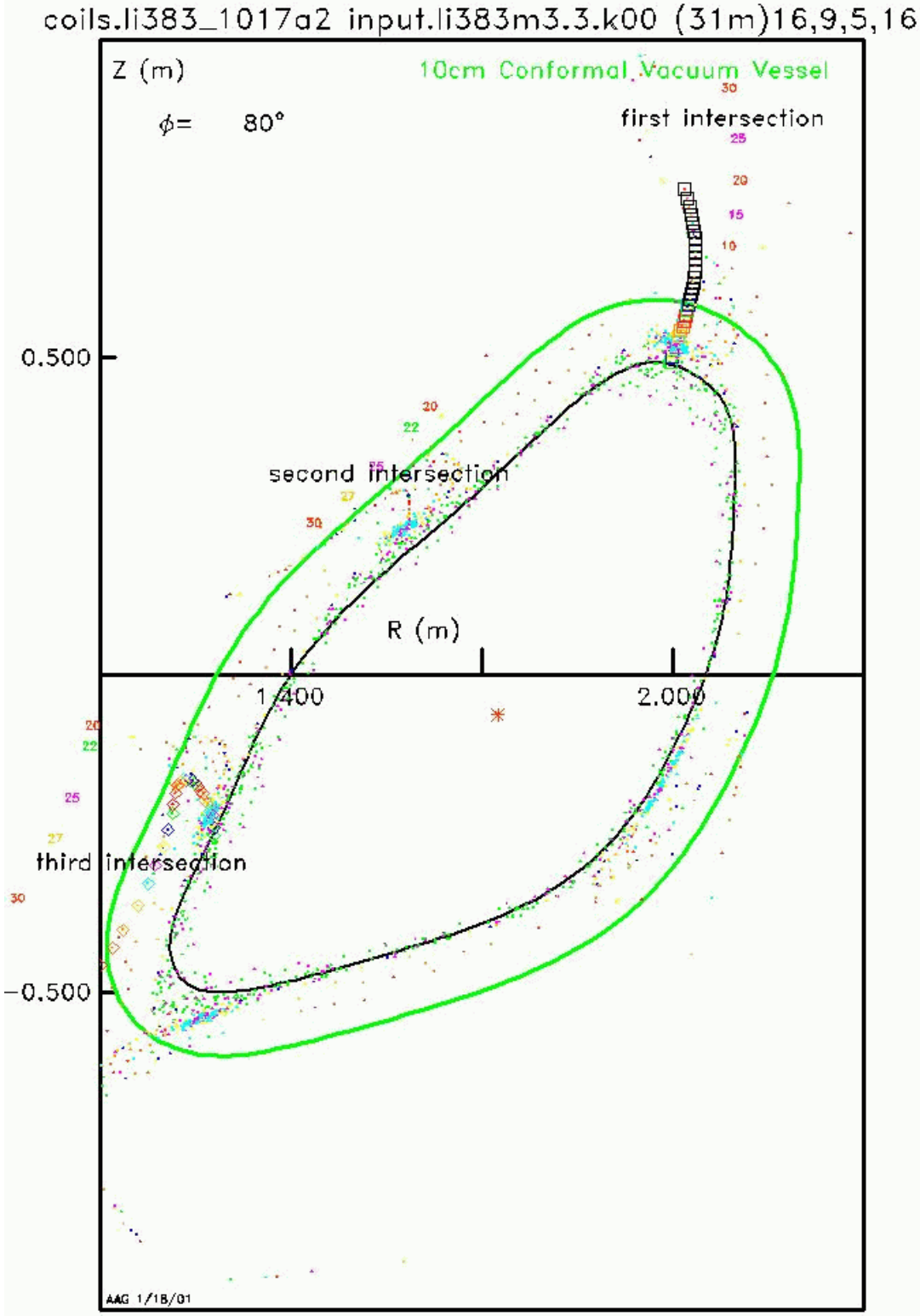
Toroidal Angle=60°



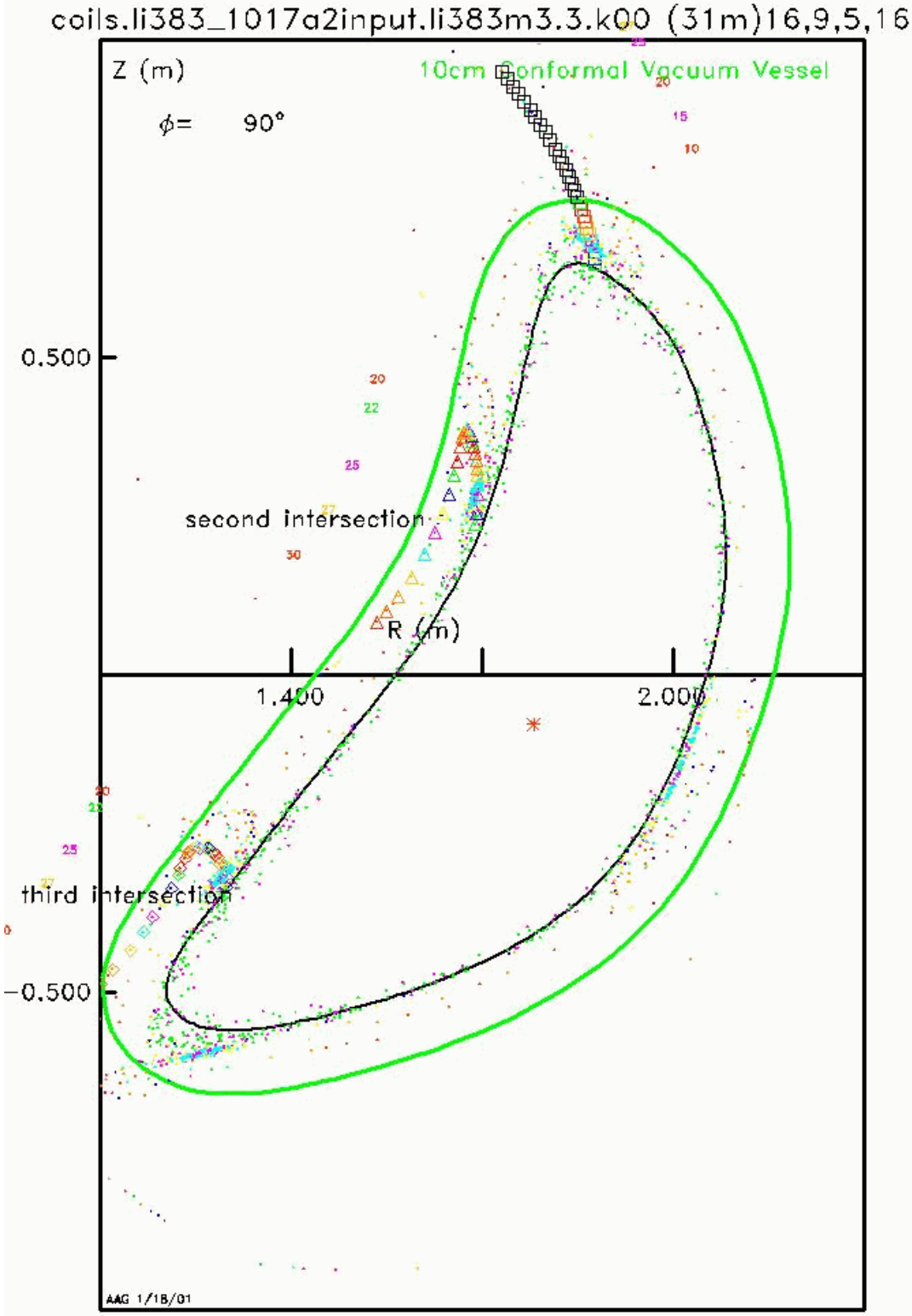
Toroidal Angle=70°



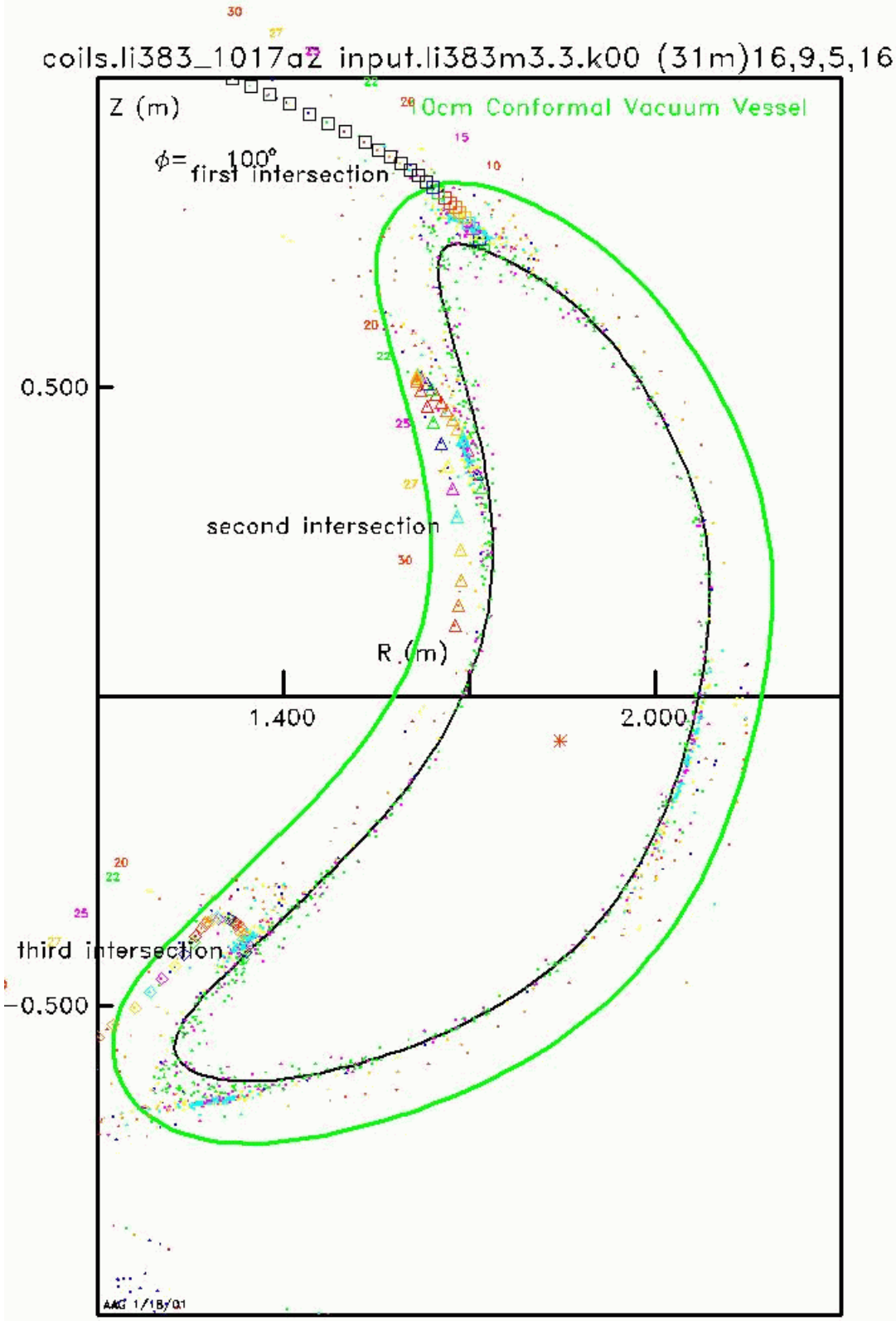
Toroidal Angle=80°



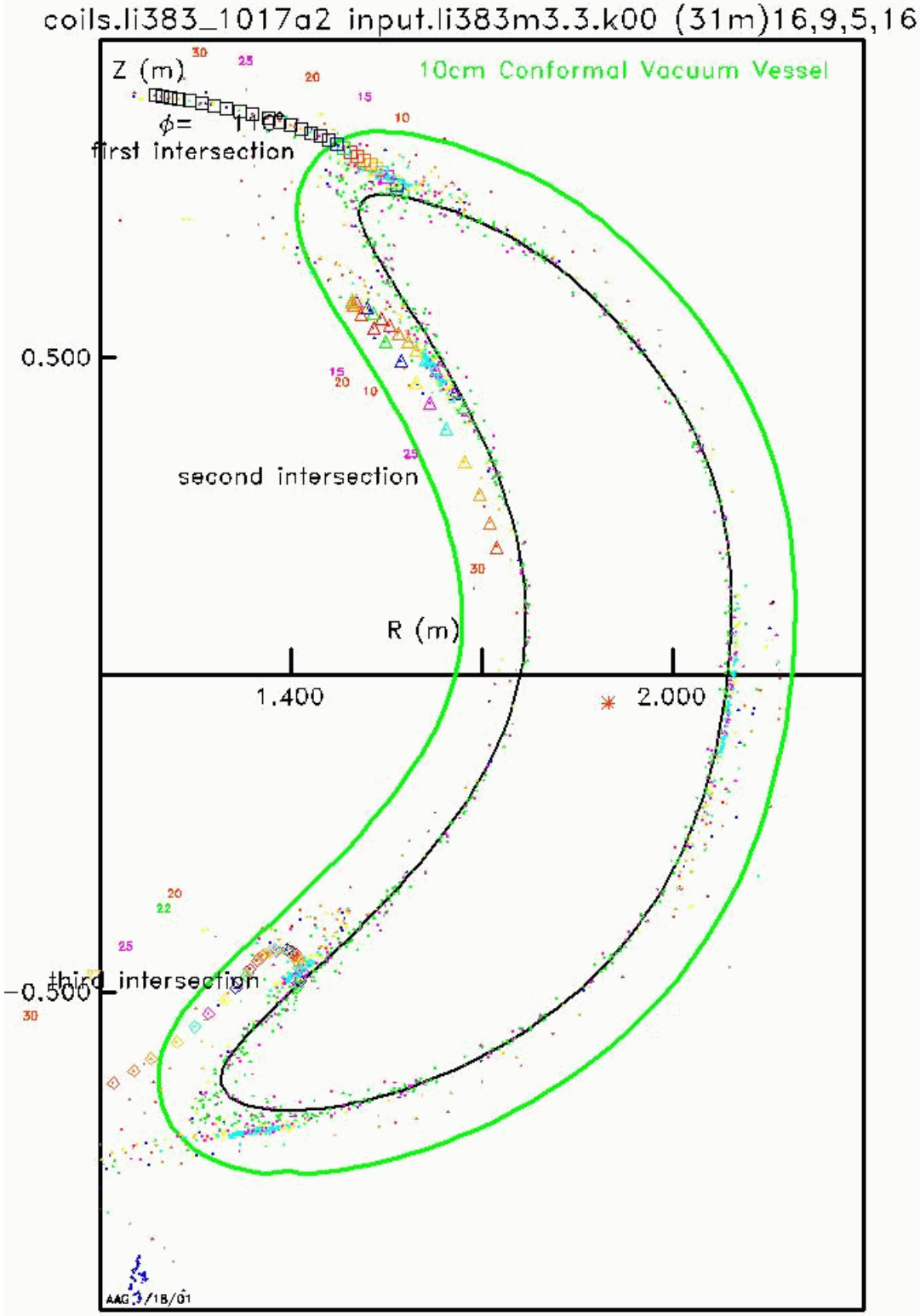
Toroidal Angle=90°



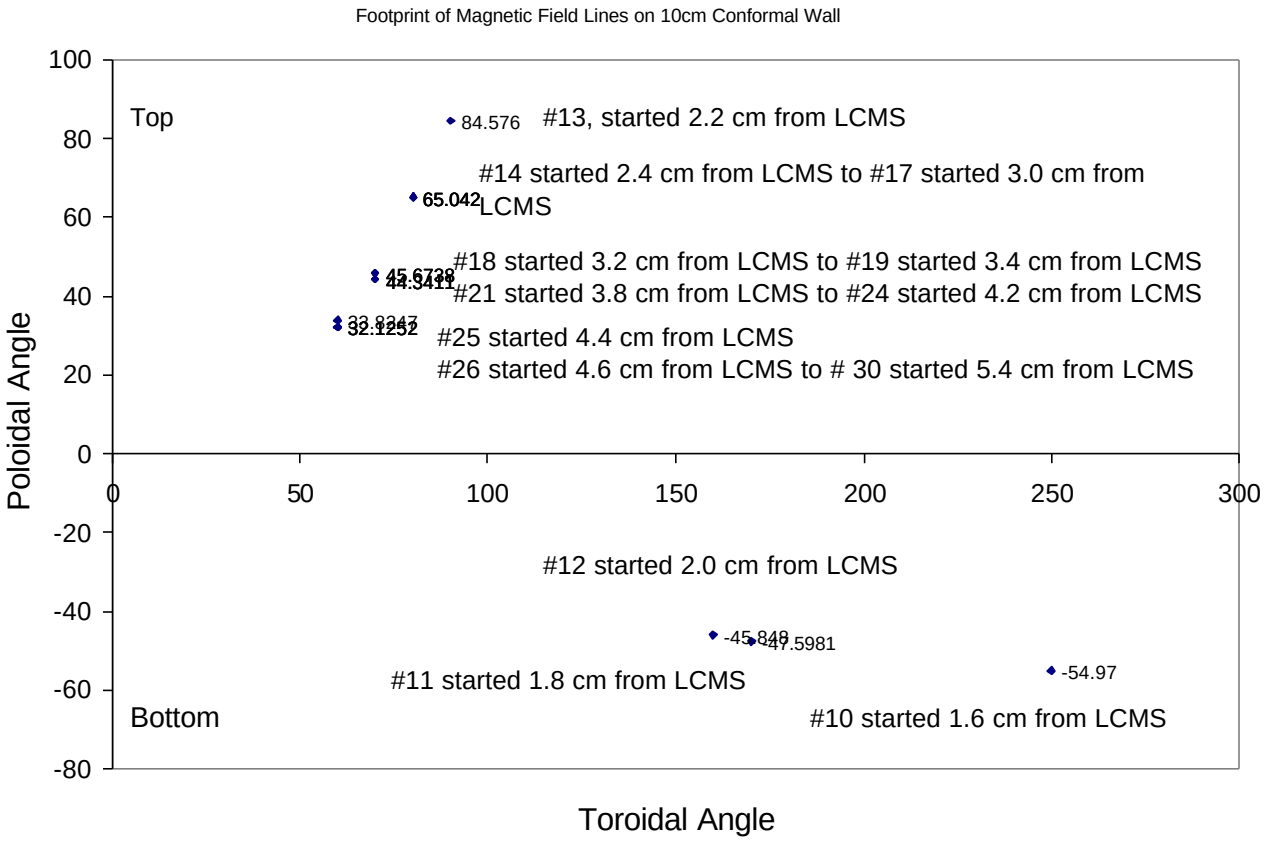
Toroidal Angle=100°



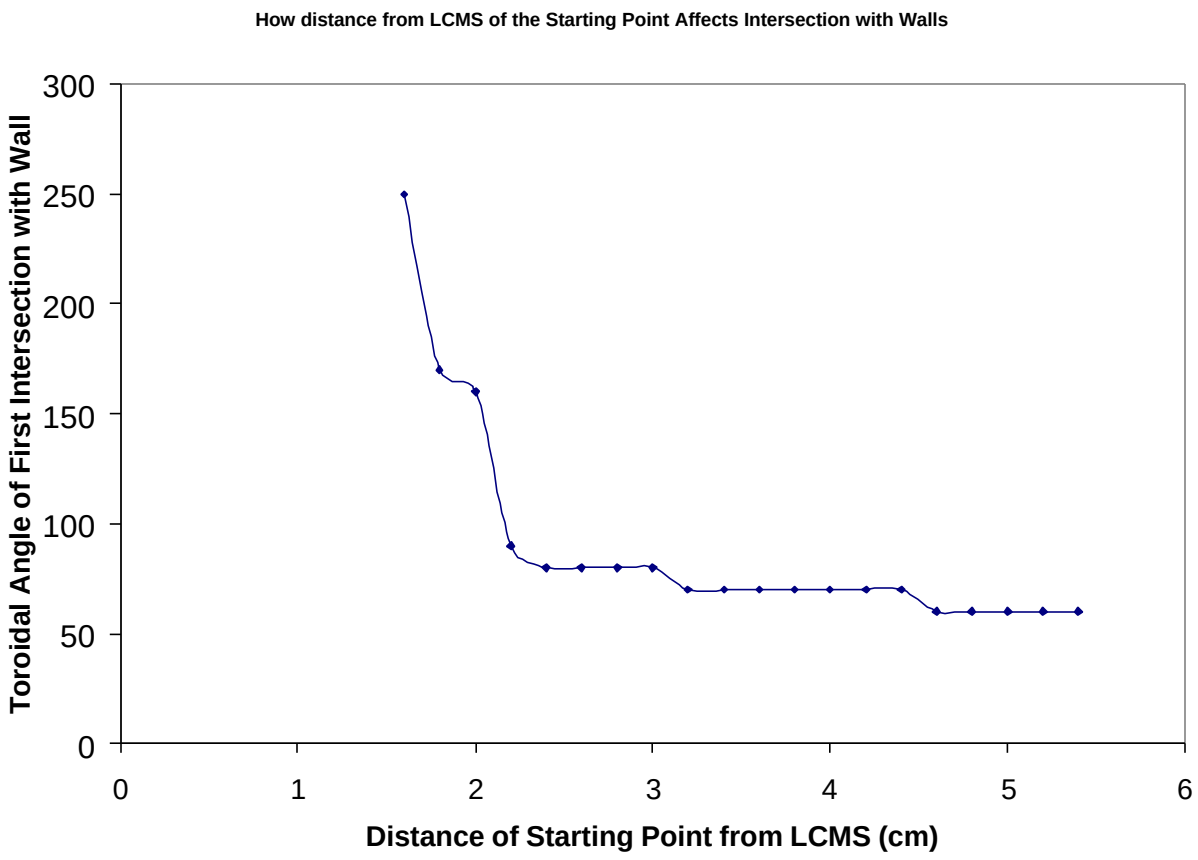
Toroidal Angle=110°



Footprint of Magnetic Field Lines on 10 cm Conformal Wall



Field Lines Which are Started Farther From the LCMS Intersect Walls After Traversing Only a Small Number of Toroidal Planes



Conclusions

- Natural islands in the edge not found: indications of island remnants embedded in ergodic lines.
- Maximum excursion of field lines at tips of banana cross-section. But field lines cross wall well before this section.
- Evidence for two zone ergodic areas, with ordered structure:
  - Field lines started more than 2cm from LCMS intersect the 10cm vessel in less than a single turn toroidally, and well before reaching the banana shaped cross-section.
  - The further out the lines are started from the LCMS the more rapidly they reach the walls, but their intersection is relatively localized.
  - Lines which rapidly reach the wall preserve their radial ordering and are more like the tokamak SOL than lines that have more of a chance to ergodize.
  - Lines started less than 2cm from LCMS tend to cluster radially at certain poloidal angles although remaining within vessel even after many turns.
    - May indicate islands within LCMS that may disappear with Hudson's island healing configuration.
    - May indicate a surface just outside of the VMEC LCMS that can be eliminated by a small change in the VMEC PHIEDGE parameter (toroidal flux is a free parameter in VMEC).
    - Need to check VMEC free boundary convergence, with MFBE runs for equilibria with increasing numbers of Mpol,Ntor, Ntheta and Nzeta. Clusters have symmetries that reflect stronger higher order (l = 4 and higher) fourier components.