Power and Particle Control in NCSX

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presented
for the NCSX Plasma Boundary Group
by

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Boundary Plasma Tasks

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1. **Generating plots of the foot prints on the vacuum vessel (conformal surface) which should give us the best idea yet where to put the PFCs:** *Grossman*

   (The conformal surface is a start, but we need the real vacuum vessel, because it is not all that conformal and the plasma-wall distances are quite different there.)

2. **Generating more Poincaré plots of field lines outside the LCMS:** *Grossman*

   a) We need to develop a better understanding of the 3-D nature of the field line configuration outside the LCMS.

   b) We need a better understanding of the "average" field line length for 2-point-model estimates of plasma parameters.

   We suggested to start field lines at several poloidal and toroidal locations and follow them until they hit the wall. This way we can plot the connection lengths as a function of location. A reasonable average would be the basis for the 2-point model.

Boundary Plasma Tasks (cont'd)

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3. **2-point model of the boundary plasma parameters (at LCMS and at divertor plate):** *Fenstermacher, Rognlien*

   using an average connection length from Art Grossman's field line plots

4. **Applying the Gourdon code for field line tracing with diffusion turned on:** *Rognlien, Koniges*

   this will simulate particle diffusion, i.e. broaden the spreading of the field lines and give us an improved picture of the power deposition pattern on the wall

5. **Develop 2-D estimates of neutrals penetration at relevant cross-sections:** *Stotler*

   since SOL is very different from W7-AS, will use 2-point model results for plasma parameters

Limiter/Divertor Locations

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1. Outboard limiters - movable

=> experience in tokamaks seems to be negative with major recycling sources on the outboard

2. Top/bottom limiters - movable

=> need 3 pairs for symmetry, not much plasma interaction surface area unless strongly shaped

3. Inboard limiters - fixed

=> good experience in tokamaks (TFTR), need 3 for symmetry,

4. Top/bottom divertor baffles @ ϕ=0

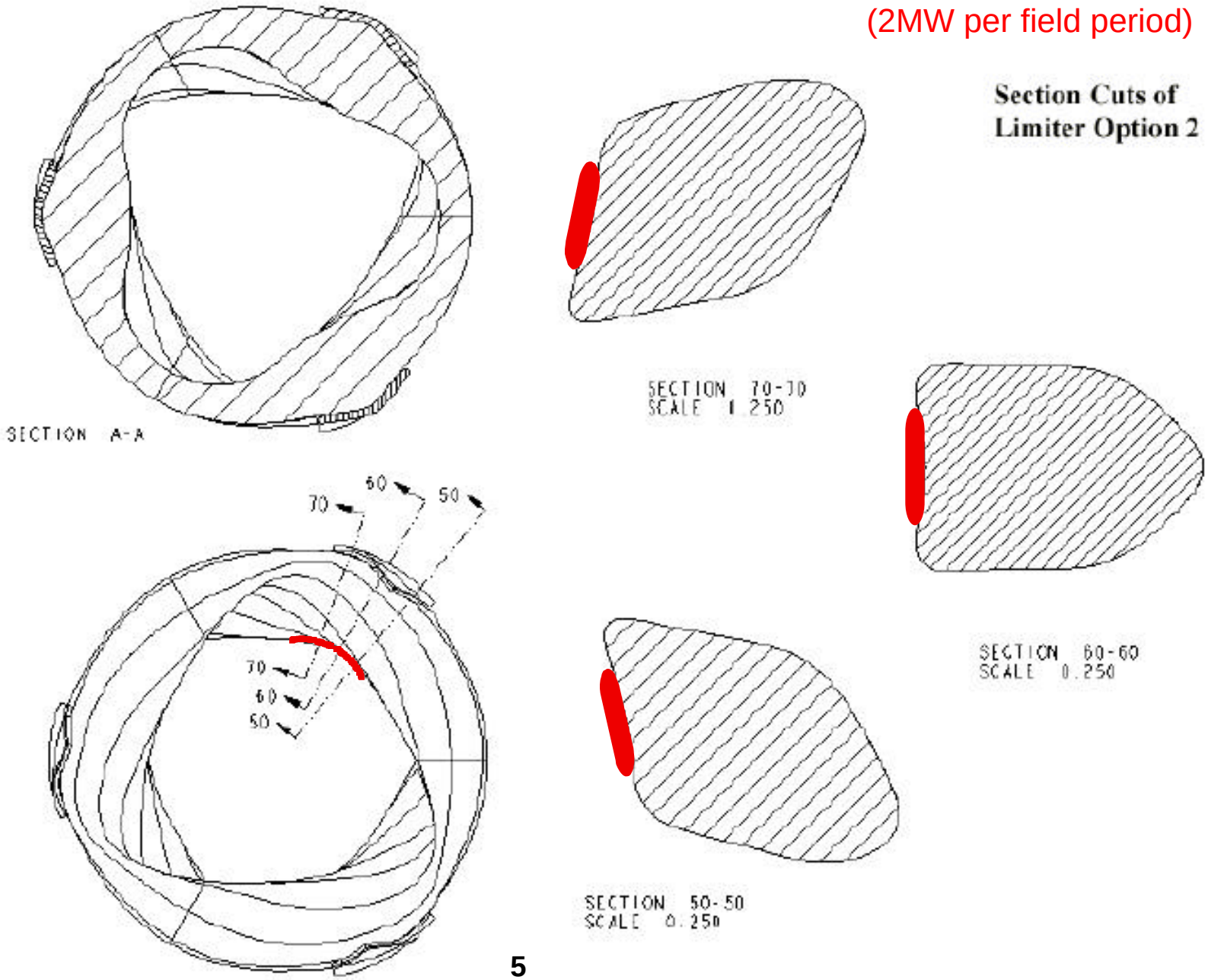
probably favorable for neutrals control, but doesn't allow limiter operation which might be <u>needed initially</u> to create "simple" SOL

5. Combination of inboard limiters with top/bottom neutrals baffles @ ϕ=0

will allow limiter operation and could also provide divertor baffles, if plasma is moved away from limiters

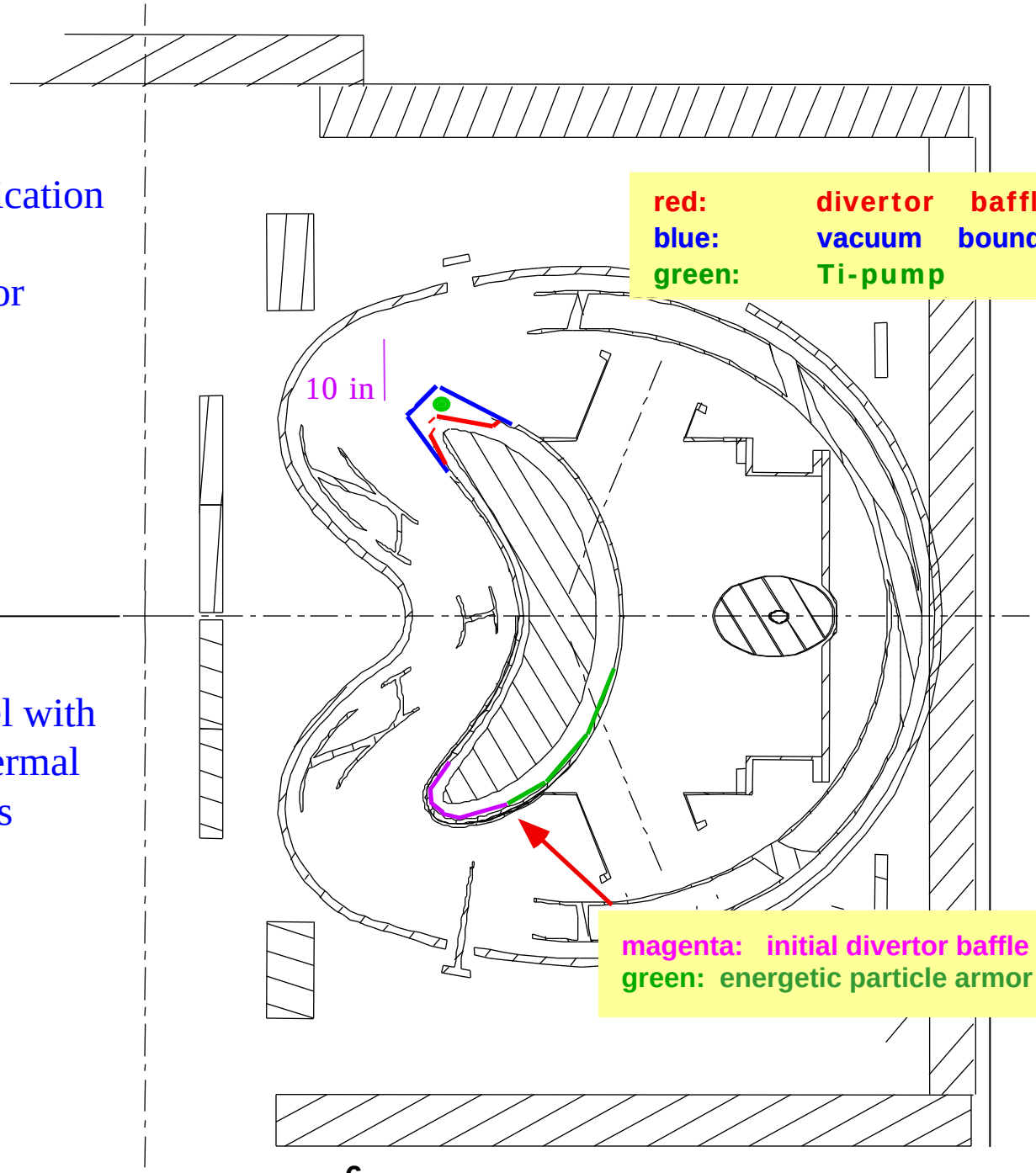
Inboard Limiters for NCSX (one for each field period)

(2MW per field period)



Top:
vacuum vessel modification
to accomodate
future pumped divertor

Bottom:
present vacuum vessel with
graphite armor for thermal
and energetic particles



Wall Armor for Energetic Particles

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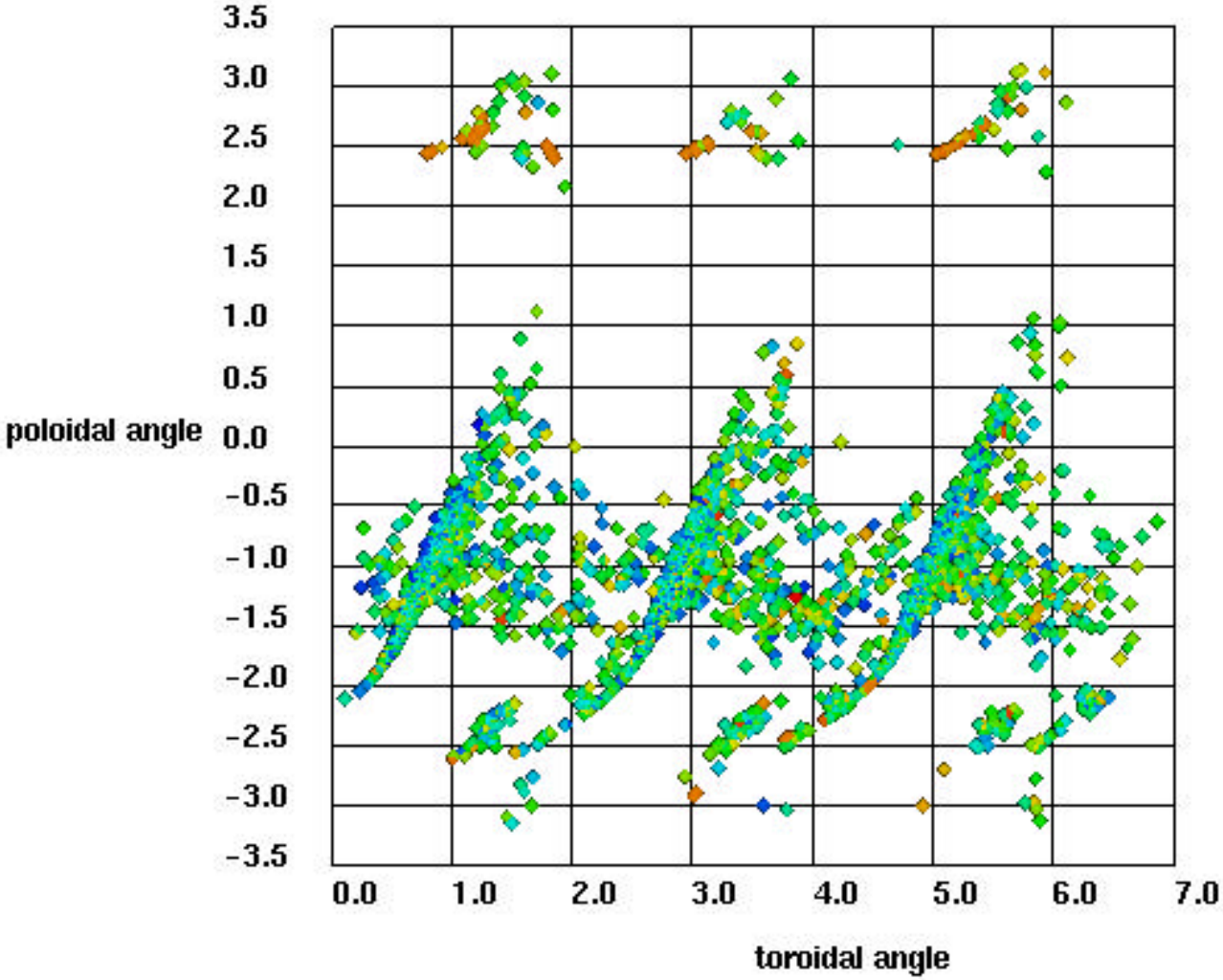
- The story on energetic particles has not quite converged yet.
- There could be up to 2MW of energetic particles, but power flux densities still need to be clarified.
- The surface areas of deposition need to be determined in 3-D geometry on the vessel walls to estimate power flux and possibly peaking factors.
- Impurity generation might be benign, because the high particle energies (average ~20 keV) are beyond the maximum of the sputtering curve.
- The safest approach would be to line the vessel areas of highest intensity with graphite


3.5
3.0
2.5
2.0
1.5
1.0
0.5
poloidal angle
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
toroidal angle

(D. Spong)

0
10
19
28
37
46

Energetic Particle Exits in Real-Space Coord.

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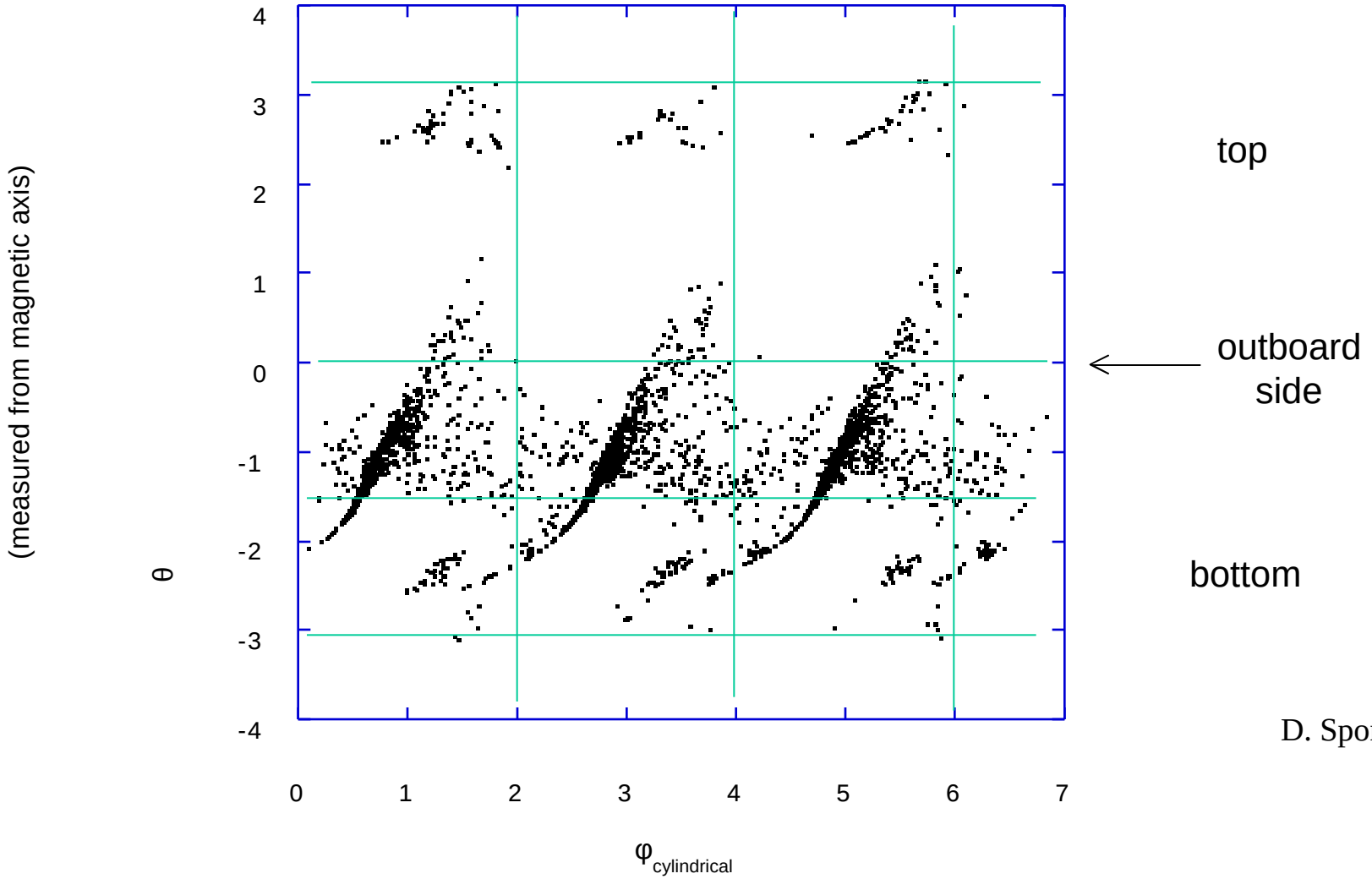

D. Spong

ornl

Summary

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- **A configuration consisting of inner limiters (one for each field period) and top/bottom baffles in the bean cross-section might provide the initial flexibility needed for operation:**

  1. Initial limiter operation with a defined plasma edge
  2. Separatrix operation with power and particle interception by the top/bottom wall segments in the bean section *(divertor baffles)*

- **The following tasks are in progress :**

  1. Estimates of the power flux densitites on the wall due to fast particles
  2. More field line studies to develop a better picture of the ergodic 3-D field structure
  3. Field line deposition patterns (foot prints) on the wall to aid in the design and location of PFCs
  4. Diffusion of field lines to investigate the spreading of particles and power fluxes on the wall
  5. Evaluation of neutrals penetration in various cross-sections