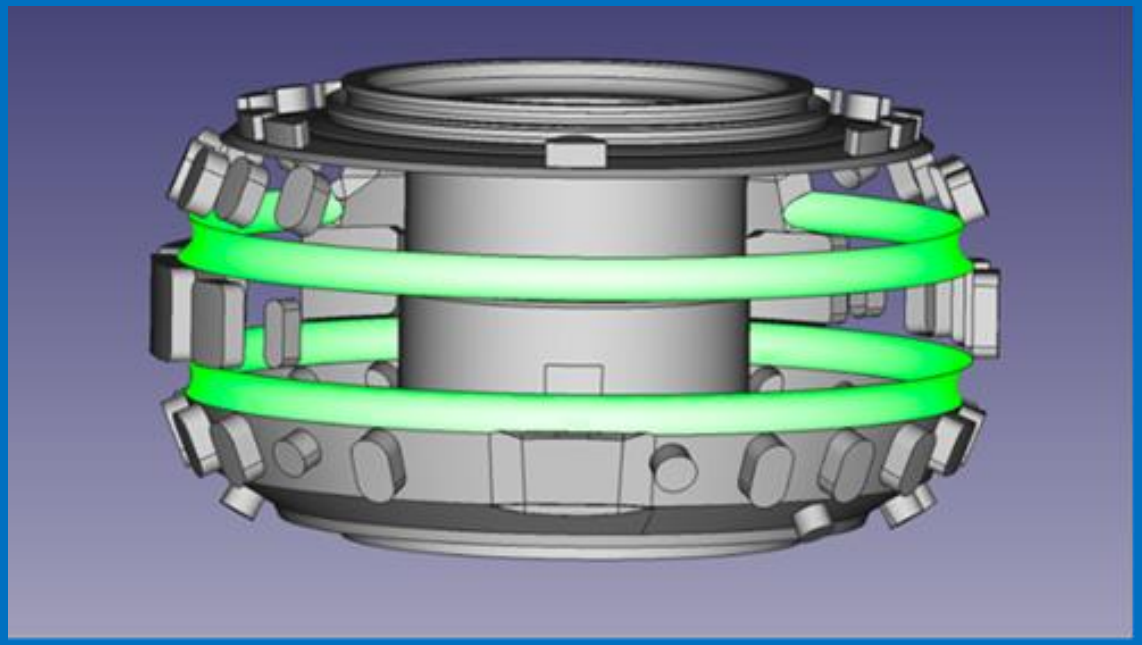
Why DIII-D needs toroidal limiters at the outer wall

Peter Stangeby

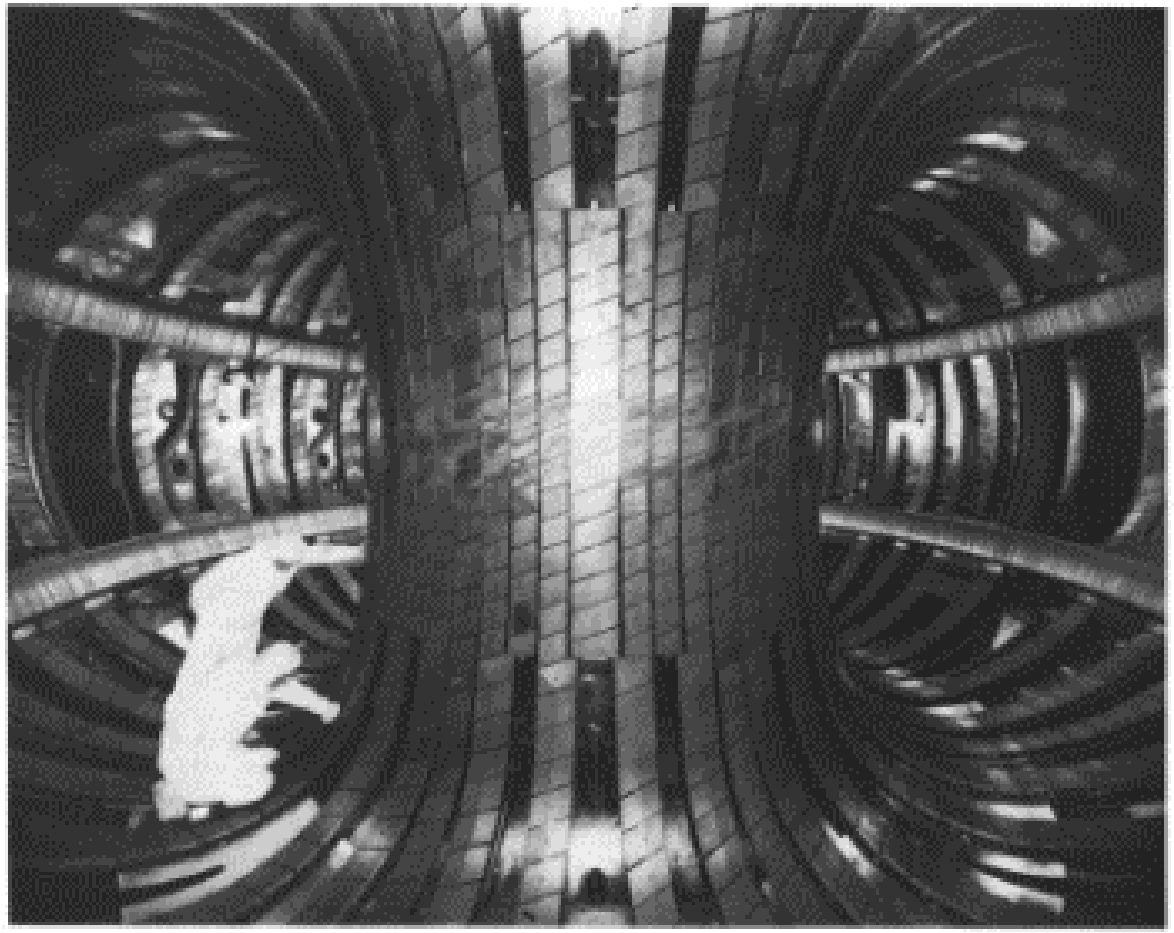


DIII-D Wall Change Community Forum
June 12-13, 2024

Institute for Aerospace Studies
UNIVERSITY OF TORONTO

Why are limiters a critically important matter today?

- after all, tokamaks converted to poloidal divertors years ago



JET 1989

Why limiters are a critically important matter today

- Until now, T-breeding has not been required, even for ITER.
- Pilot Plants must demonstrate TBR>1, necessitating a very thin wall that can only handle <1MW/m^2.
- Divertor targets handle ~ 10 MW/m2 to remove the power flow in the near-SOL - a relatively well understood region.
- The wall contacts the far-SOL - a region which too little is known about today to safely design the main-wall of Pilot Plants etc.

Why are we so ignorant about the far-SOL ?

- Because the walls on the low field side of present tokamaks pose a practically intractable 3D challenge to both diagnosis and interpretive-modeling.

Poloidal divertors make the near-SOL 2D, toroidally symmetric

- > 40 years ago, tokamaks replaced toroidal divertors, e.g. DITE's bundle divertor, which create 3D SOLs, with poloidal divertors which create 2D toroidally-symmetric SOLs.

poloidal limiter = toroidal divertor

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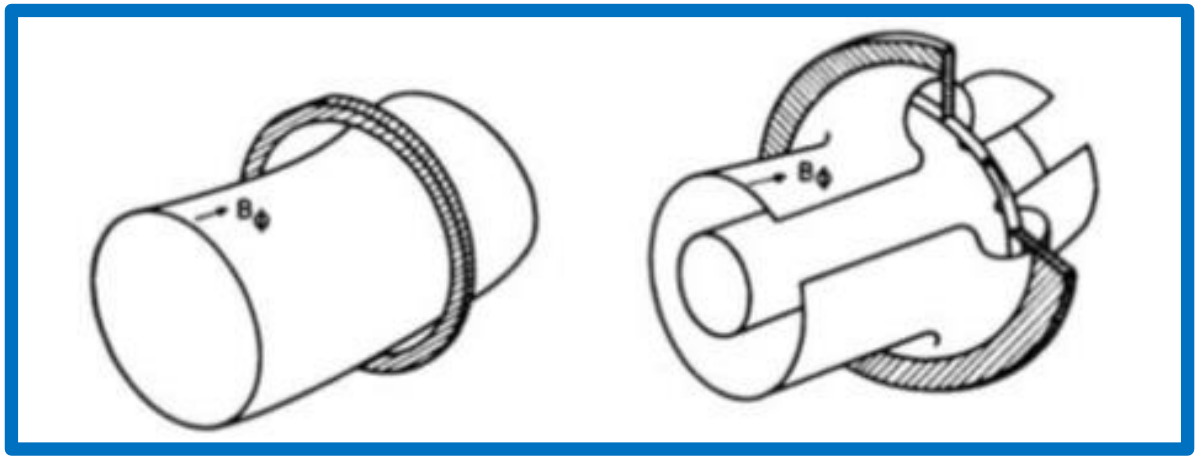
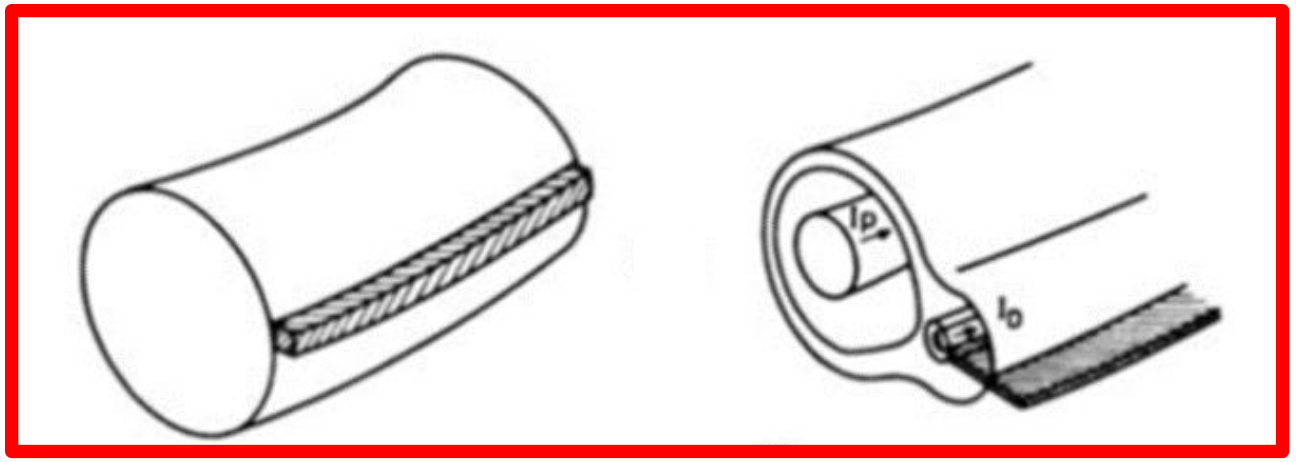


create 3D SOLs



create 2D SOLs

Why limiters are a critically important matter today

- Tokamaks converted to poloidal divertors years ago.
- If the scientific challenge hadn't been made tractable in this way, the enormous progress that has been made in understanding the divertor and the near-SOL would not have occurred.
- Today the equivalent conversion is needed for the far-SOL, which toroidal limiters can provide.

Why we need 2D far-SOLs, thus toroidal limiters at the wall

1. An equivalent diagnosis of a 3D far-SOL plasma needs an order of magnitude larger investment than for a 2D one, thus, in practice there is insufficient experimental input (a) to adequately constrain the code-modeling, and (b) to compare the code output with.

2. The great majority of the large investment in edge code modeling, as well as in its validation, has been for 2D edge codes like SOLPS.

Why wall material research needs toroidal limiters

Toroidal limiters provide the ideal means for assessing main-wall materials: then the only significant plasma surface interactions in the main chamber occur where we are best able to monitor and understand the effects of the change.