Opportunities for Compact Tori in the ITER Era: Technology and Physics

Simon Woodruff
WOODRUFF SCIENTIFIC, Inc.

Presenting on behalf of the sub-panel for CT Opportunities:

Prof Mike Brown, Swarthmore
Dr E. Bick Hooper, Lawrence Livermore National Laboratory
Dr Richard Milroy, Redmond Plasma Physics Lab
Dr Mike Schaffer, General Atomics

ReNeW
March 16th 2009

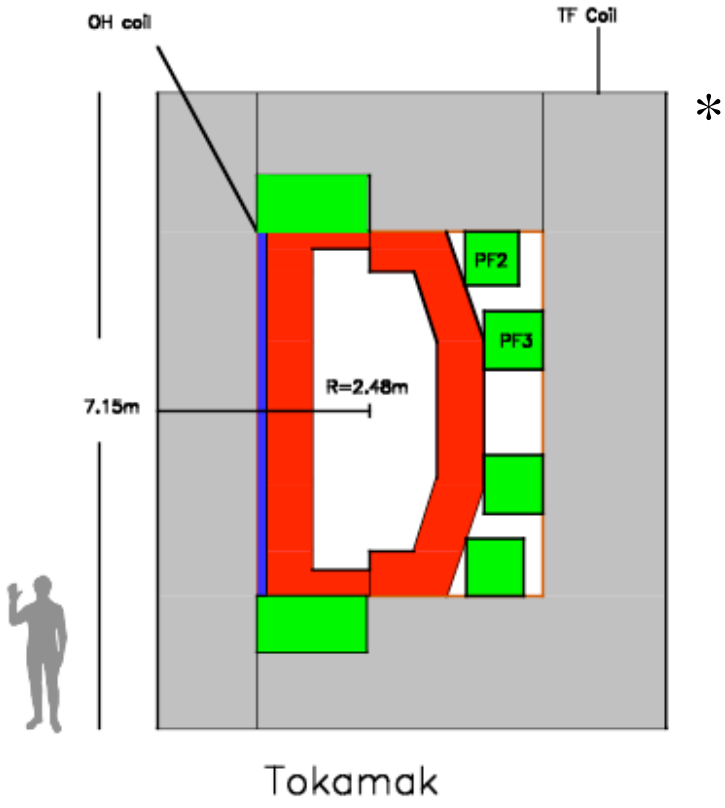
Outline

Compact Tori: toroidal plasmas without TF and OH coils.

Physics of Compact Tori.

ITER era goal.

Challenges.



Tokamak

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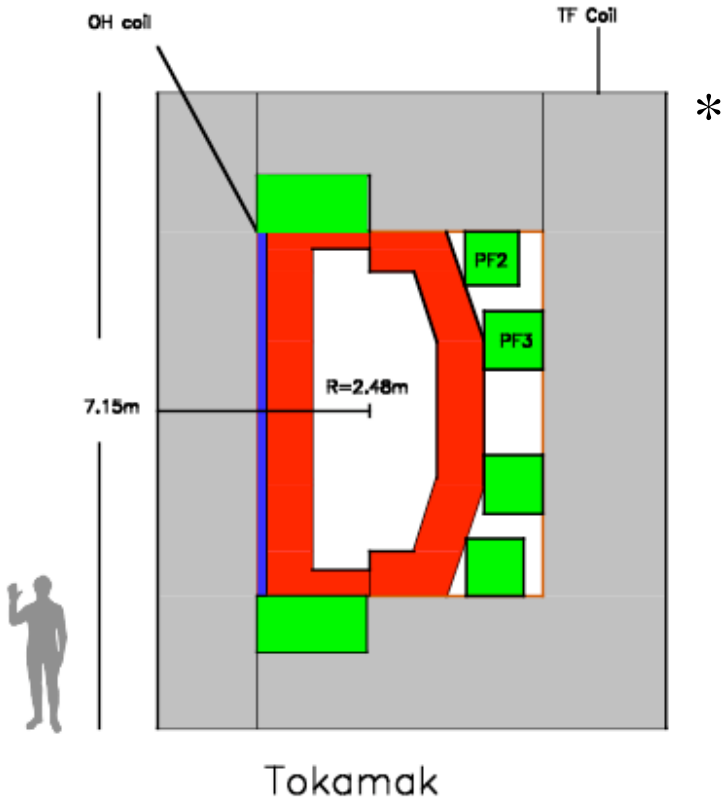
*Stambaugh, Fusion Development Facility

What happens when we omit TF and OH coils entirely?



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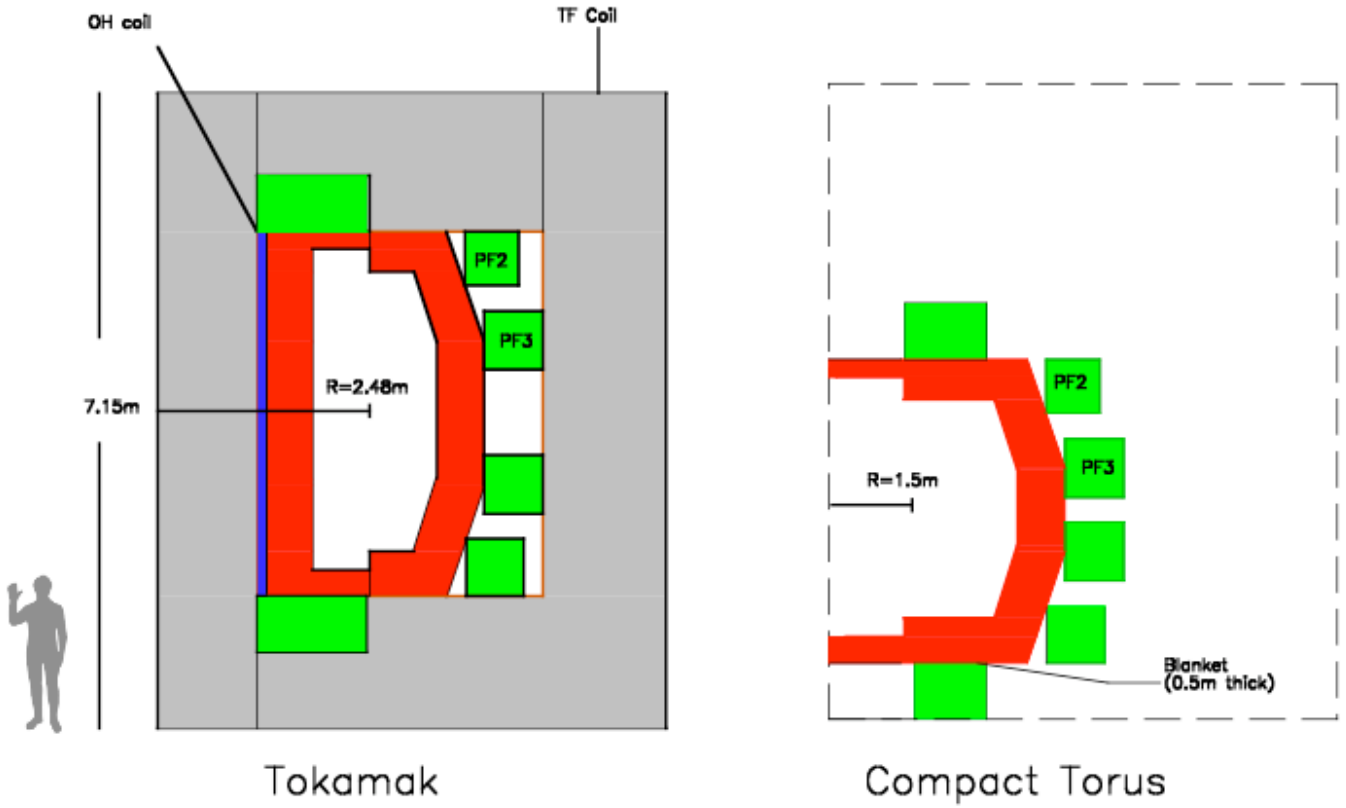

System becomes compact and easier to construct and maintain

--> lower cost core.

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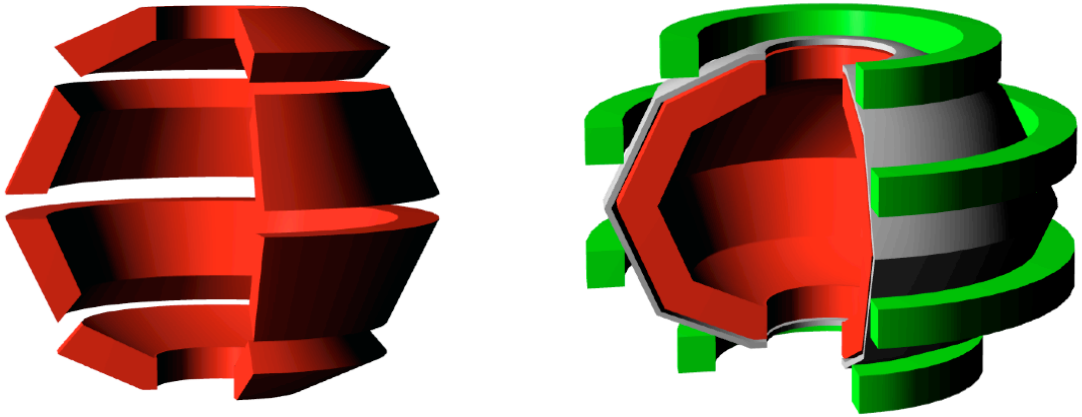

Blanket and coils demountable as annular sections

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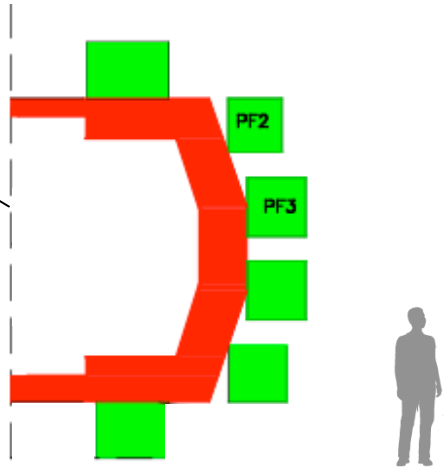

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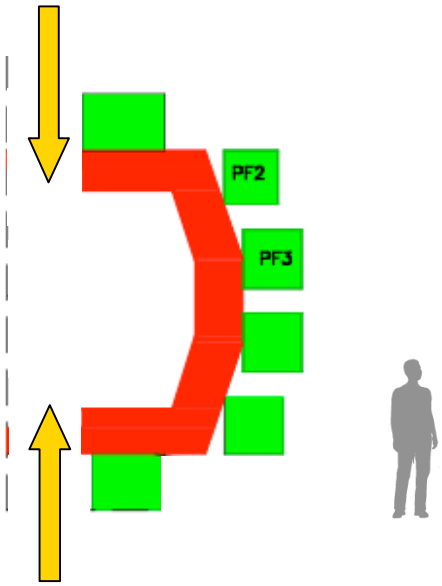

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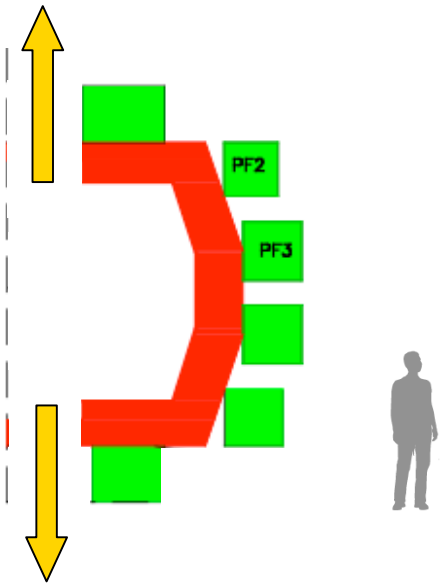

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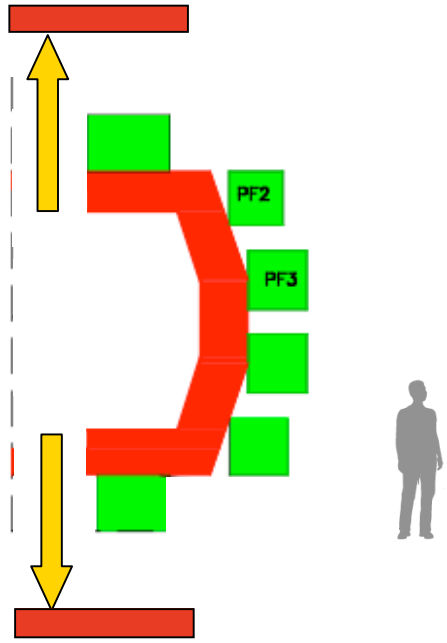

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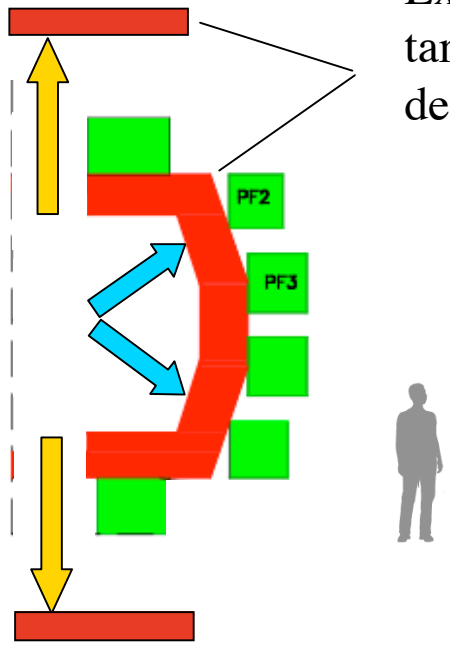

External divertor target, loading a design choice.

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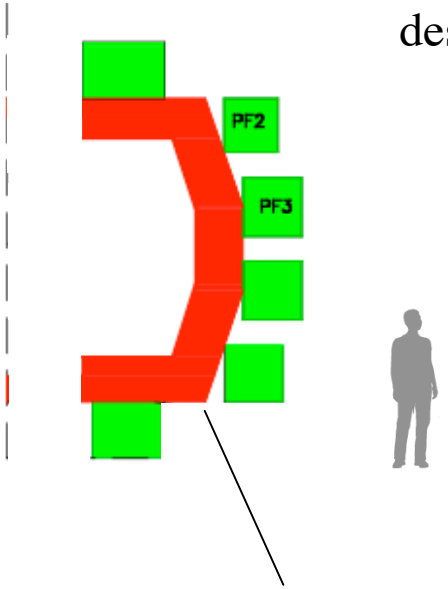


External divertor target, loading a design choice.

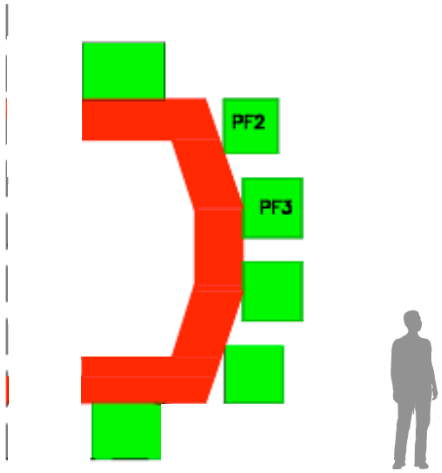
Liquid metal walls easier to implement.

Physics of compact tori

Two main research areas:

1. With toroidal field (Spheromaks)

2. Without toroidal field / weak field (FRCs)



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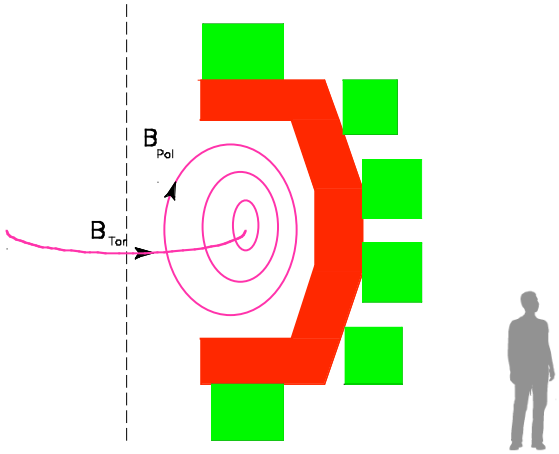

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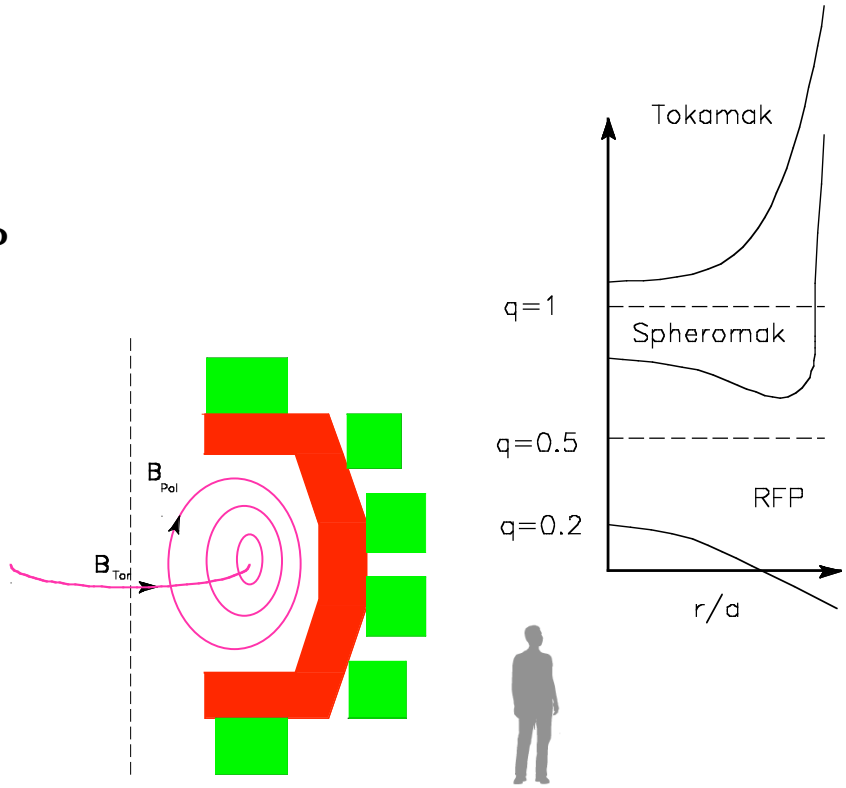

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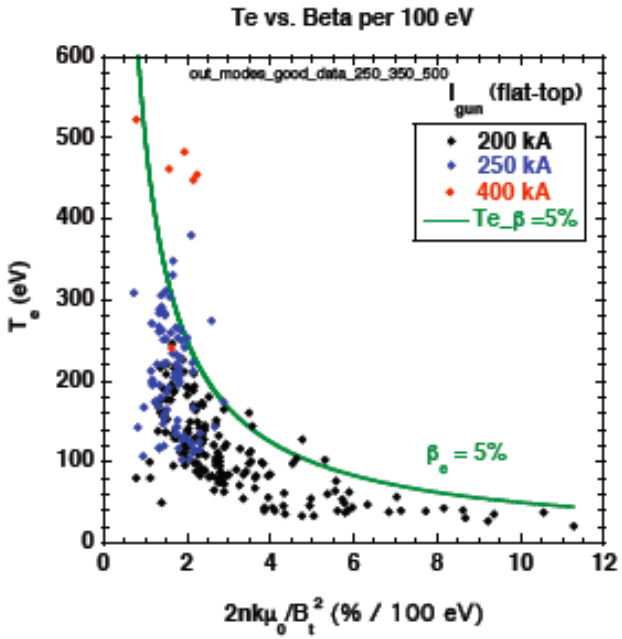

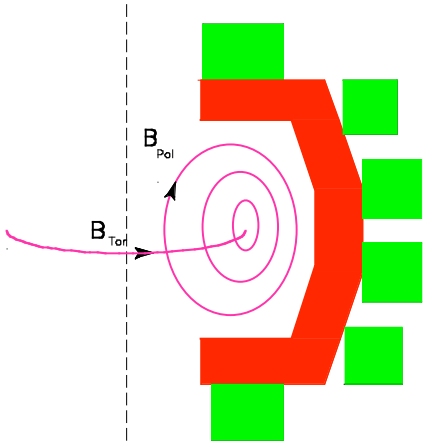

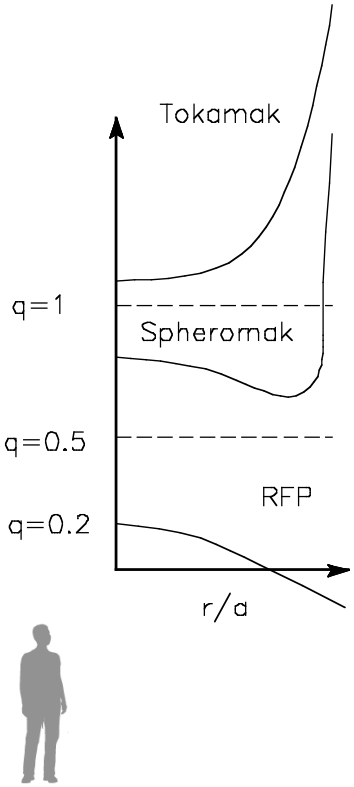

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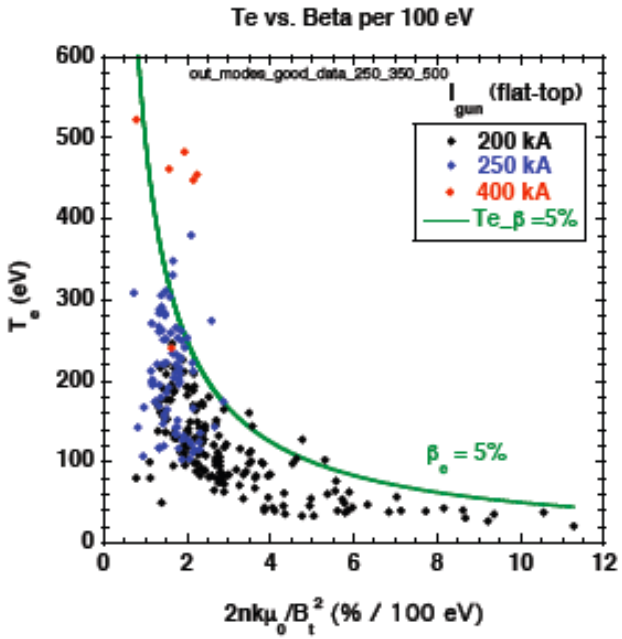
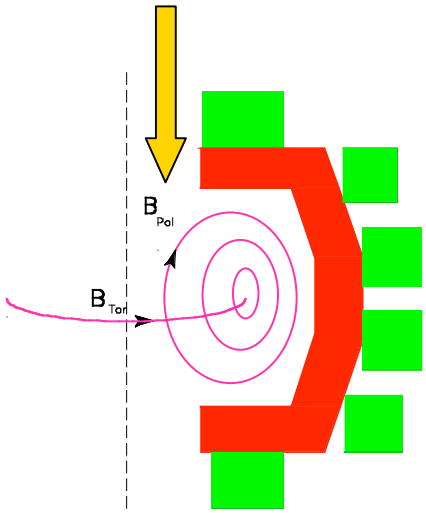
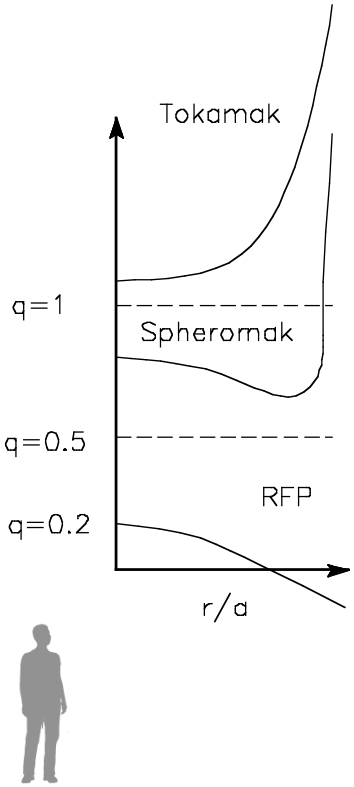


Pulsed build-up

Steady inductive injection





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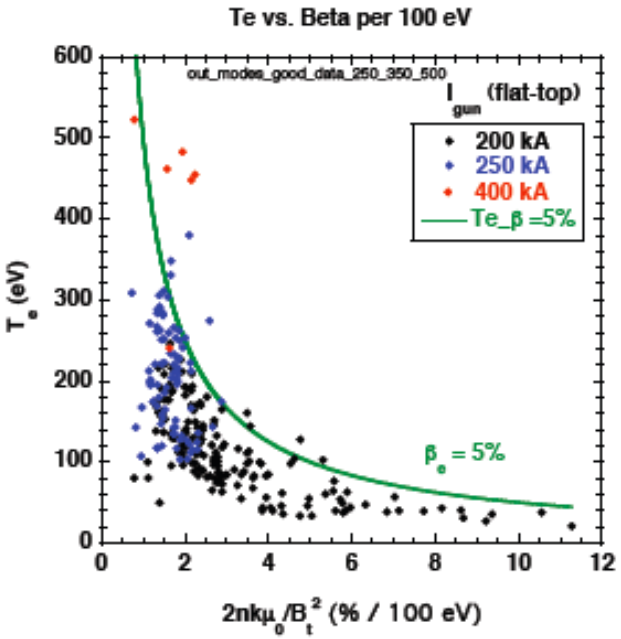

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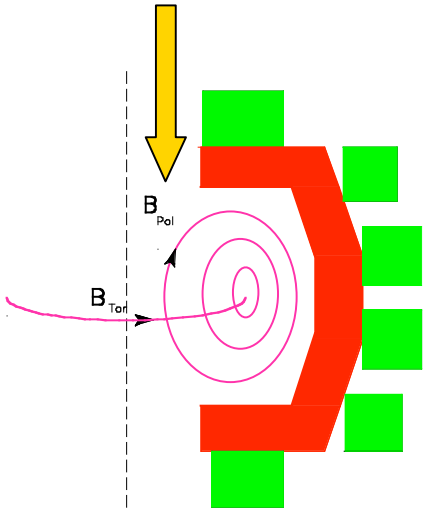
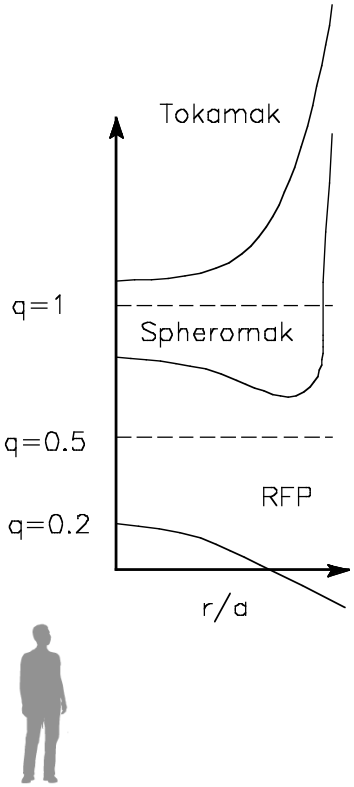
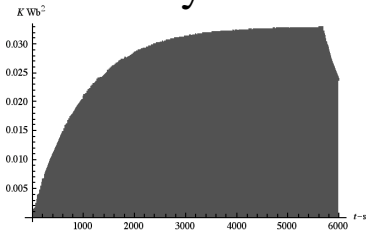
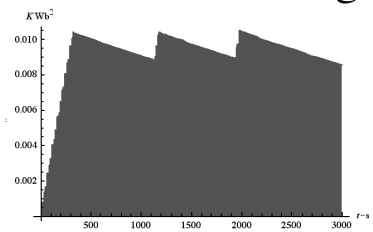




Steady-state



Pulsed refluxing



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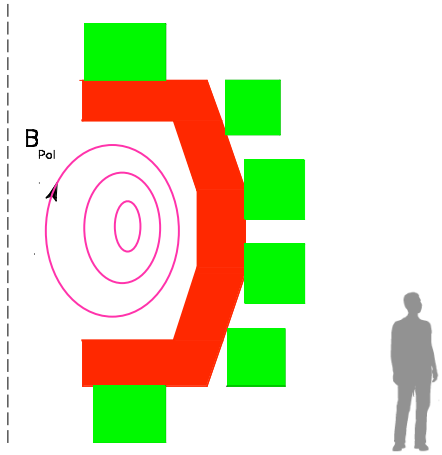

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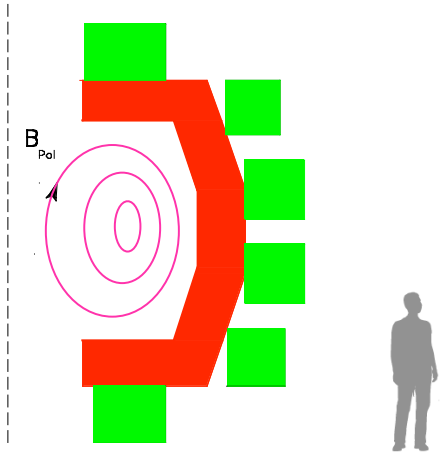
2. Without toroidal field / weak field (FRCs)
--kinetic stabilization



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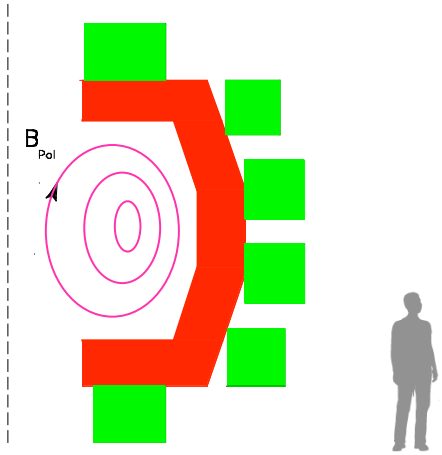
--high beta ~100%



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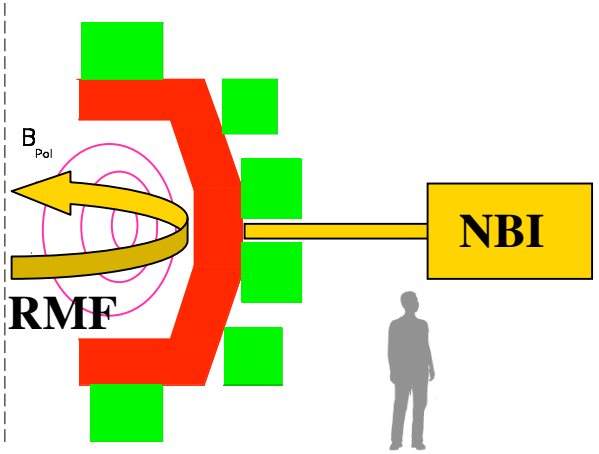
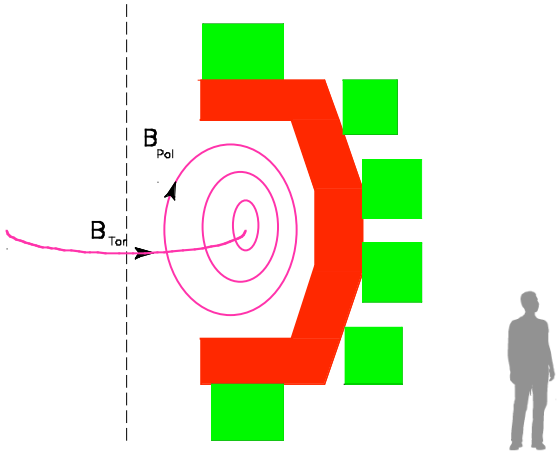
2. Without toroidal field / weak field (FRCs)
--kinetic stabilization
--high beta ~100%
--sustainment with rotating magnetic fields
or neutral beams



ITER era goal *

"To demonstrate that a CT with simply connected vessel can achieve stable, sustained or long pulsed plasmas at kilovolt temperatures, with favorable confinement scaling to proceed to a pre-burning CT plasma experiment."



* FESAC TAP

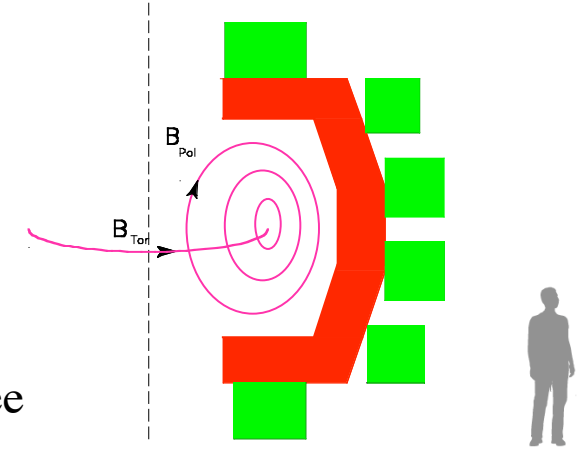
ITER era challenges *

(1) Formation/stability in the reactor-relevant regime.

(2) Anomalous transport/energy confinement

(3) Efficient current drive/flux sustainment.

To remain a viable alternative, these three challenges should be addressed in next step CT experiments.



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