

# Decoupling functional requirements and materials for different regions of the main wall

Jake Nichols, ORNL

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ORNL is managed by UT-Battelle LLC for the US Department of Energy

with contributions from  
E.A. Unterberg, J. Rapp, P.C. Stangeby

# Challenges are looming for the first wall of a reactor-scale tokamak

- **Divertor-relevant high-density regimes lead to enhanced heat/particle transport to the main wall**
  - Density shoulders <sup>1-4</sup>, grassy ELMs/QCE <sup>5-7</sup>, ...
- **Thin main walls are needed for adequate T breeding**
  - TBR > 1 requires armor < 5 mm <sup>8-10</sup>
  - Limited to LHF components, < 1 MW/m<sup>2</sup>
- **Possible integration options:**
  - Shaped HHF walls (ITER) → **Poor TBR**
  - Large plasma-wall gaps (EU DEMO) → **Poor economics**
  - Decouple plasma contact regions from breeding regions → **Next slides**

<sup>1</sup> Lipschultz PPCF 2002

<sup>2</sup> Rudakov NF 2005

<sup>3</sup> Carralero JNM 2015

<sup>4</sup> Vianello NF 2017

<sup>5</sup> Perillo PoP 2024

<sup>6</sup> Faitsch NME 2023

<sup>7</sup> Redl NME 2023

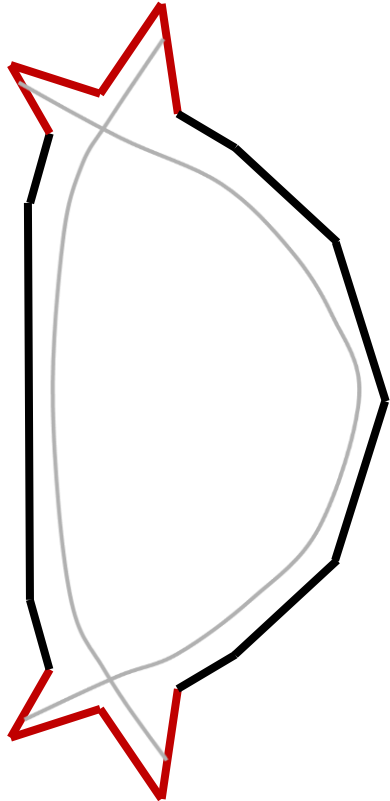
<sup>8</sup> Tillack FST 2015

<sup>9</sup> Hernandez FED 2017

<sup>10</sup> Tillack FED 2022

# Functional requirements of the main wall in a reactor

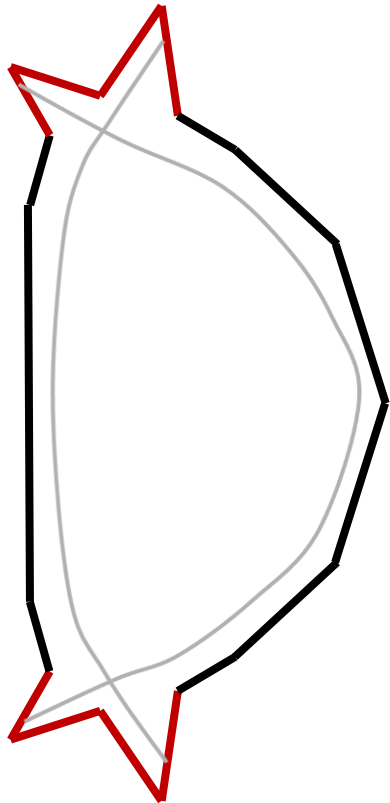
## Monolithic main wall



- HHF tolerant
- Core compatible
- Neutron transparent
- Low erosion (ions)
- Low erosion (CXN)
- Long lifetime
- Oxygen getter
- Low T retention
- Low activation/  
transmutation

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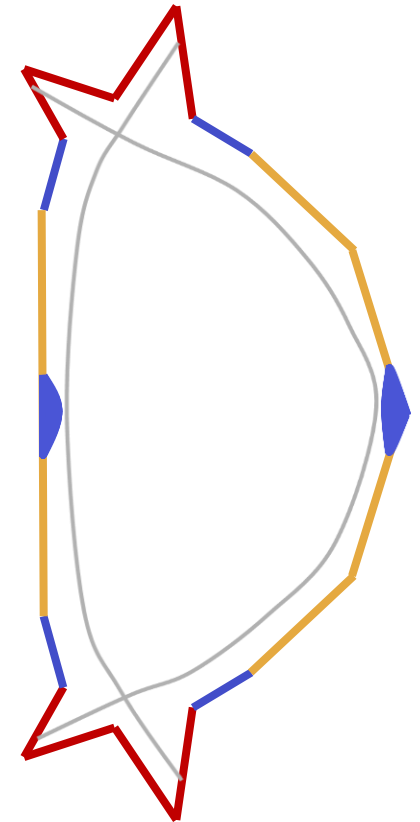
Remove  
requirement  
that main  
wall must be  
one material

## Plasma-wetted wall (protection limiters, divertor entrances)

- HHF tolerant
- Core compatible
- Low erosion (ions)
- Oxygen getter
- Low T retention

## Recessed wall

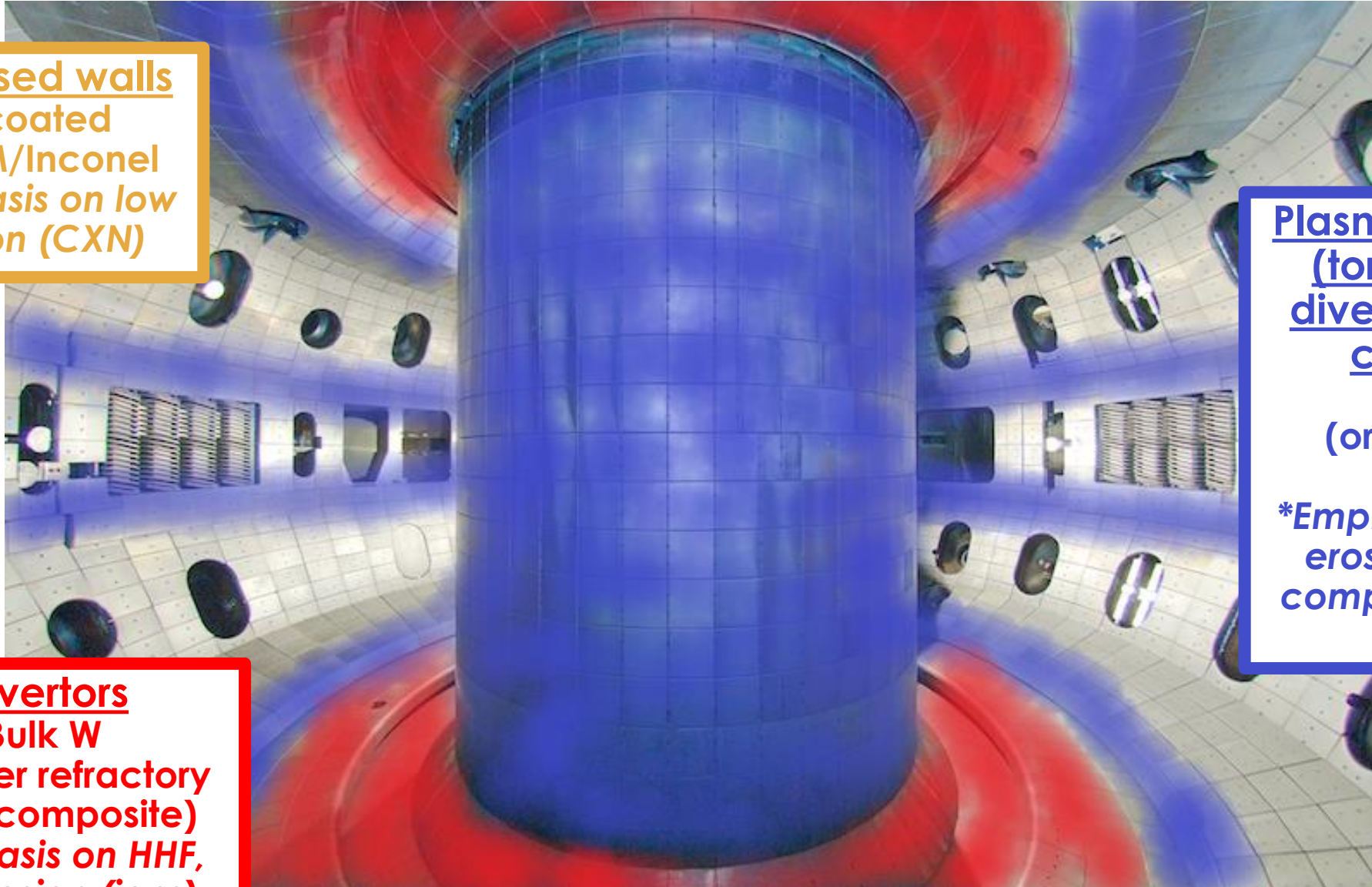
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# Proposal for a decoupled main wall in DIII-D

## Recessed walls

W-coated  
SS/TZM/Inconel  
*\*Emphasis on low erosion (CXN)*



## Plasma-wetted walls (toroidal limiters, divertor entrances, centerstack)

Bulk SiC  
(or other hi-temp ceramic)  
*\*Emphasis on HHF, low erosion (ions), core compatibility, oxygen gettering*

## Divertors

Bulk W  
(or other refractory alloy/composite)  
*\*Emphasis on HHF, low erosion (ions)*