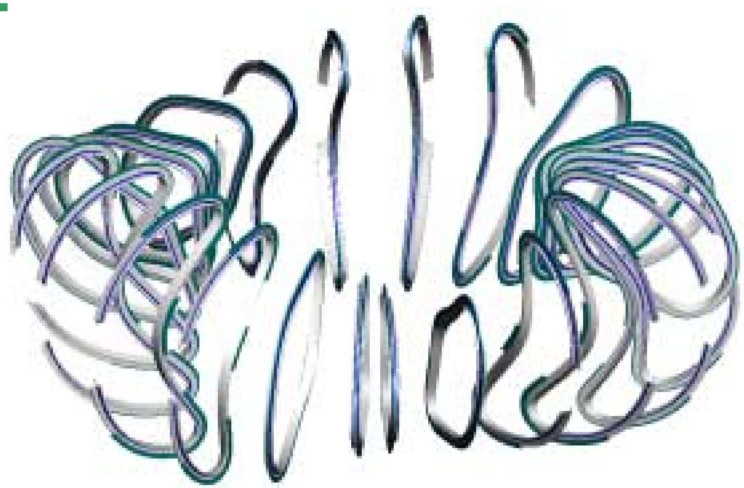
PFC requirements

- **Basic requirements**
  - **Carbon based, bakeable to 350C**
  - **Provisions for:**
    - **NBI armor**
    - **Trim coil armor**
    - **Inboard limiter / coverage**
    - **Divertor baffles and plates**
    - **Divertor “pumping”**
    - **Energetic ion loss armor**
  - **Make first plasma, field line mapping, ohmic operation**
  - **0.2 MW for 0.3 s**
  - **> 60 % of power to divertor region, balance can be intercepted by walls**
  - **Provide penetrations, accommodate in-vessel diagnostics mounted on VV**
- **Upgrade requirements**
  - **Geometric tolerance of FW surface TBD, should be tune-able**
  - **Capable to bias the individual panels electrically 1kV**
  - **Full coverage of surfaces with carbon**
  - **12 MW for 1.2 s**

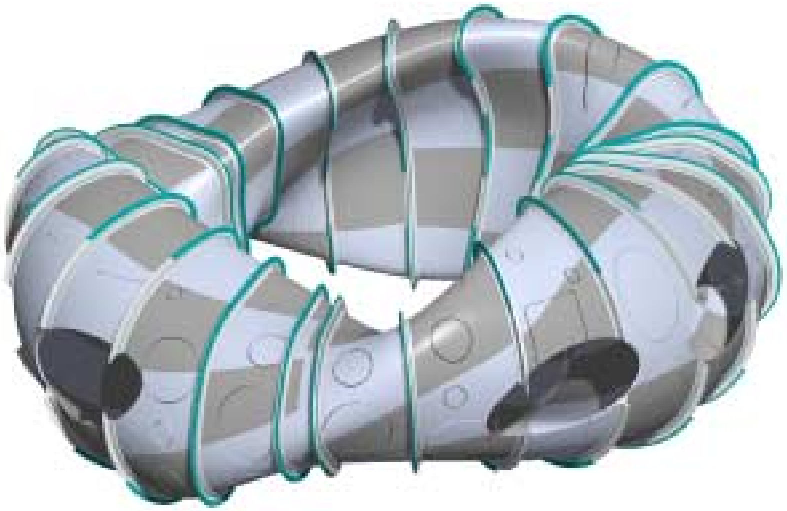
PFC design concept

- **Staged implementation planned**
  - **Initial coverage with low Z tiles mounted on poloidal ribs to form array of poloidal limiters**
  - **Panels for NB armor and divertor region will also be provided after NBI installed**
- **Full coverage provided by mounting molded carbon fiber composite (CFC) panels on poloidal ribs**
  - **Panel size based on advice from BFG aerospace (~ 60 cm square, 1 cm thick)**
- **Ribs are separately cooled / heated with He gas for bakeout (350C) and normal operation**
- **Ribs are registered toroidally to VV but allowed to grow radially and vertically**

Poloidal ribs

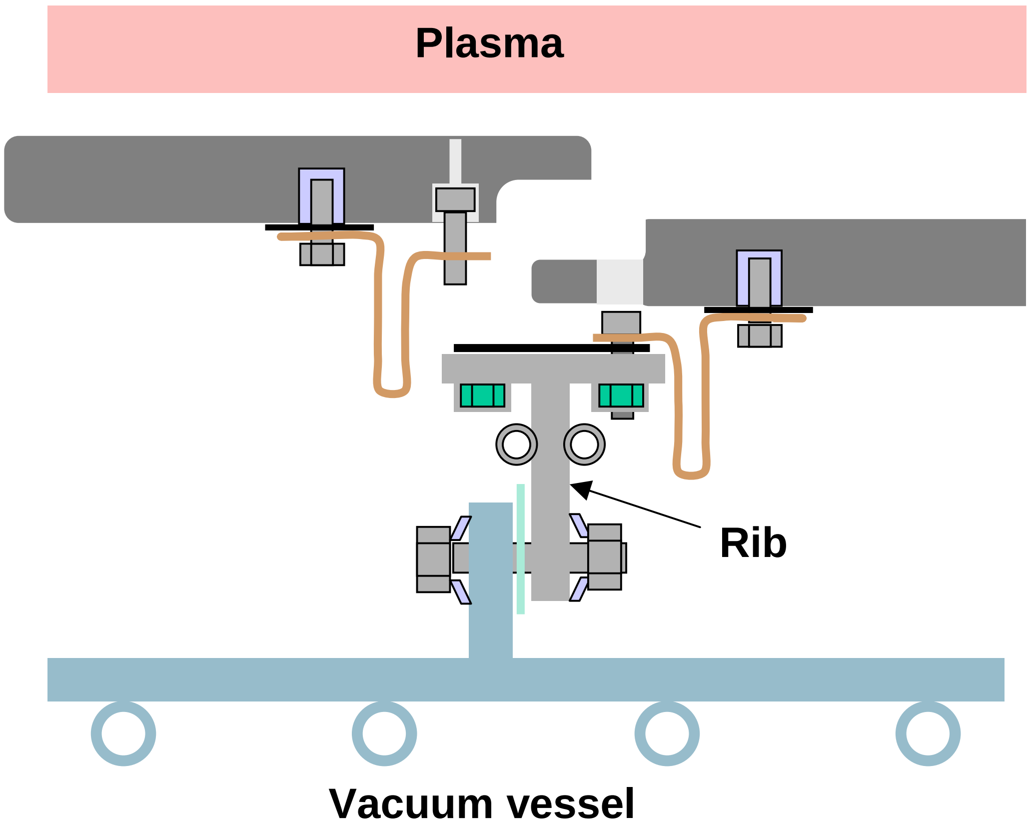


CFC panels mounted on poloidal ribs



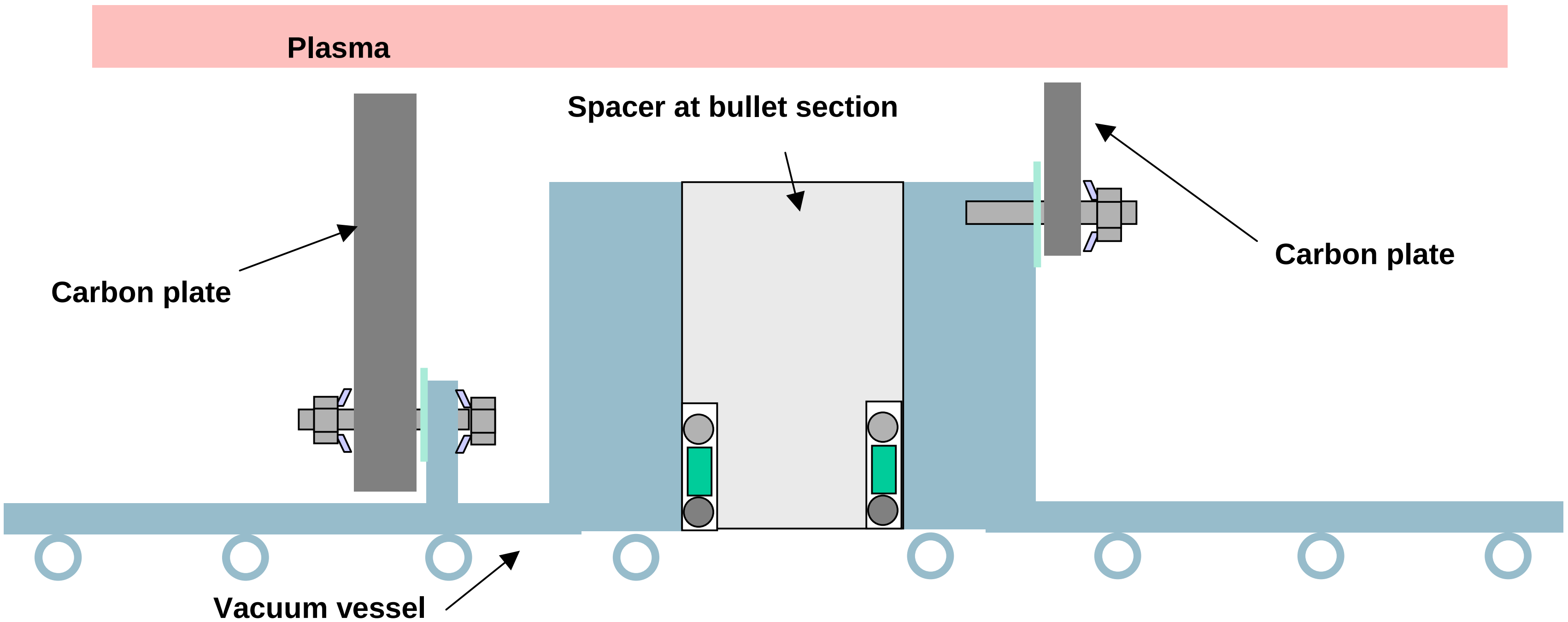
PFC panel / rib detail

- **Details for one concept for panel attachment developed with BFG Aerospace**



PFC simple limiter detail

- **Details for flat carbon plates at either side of bullet shaped section (vessel field joint)**

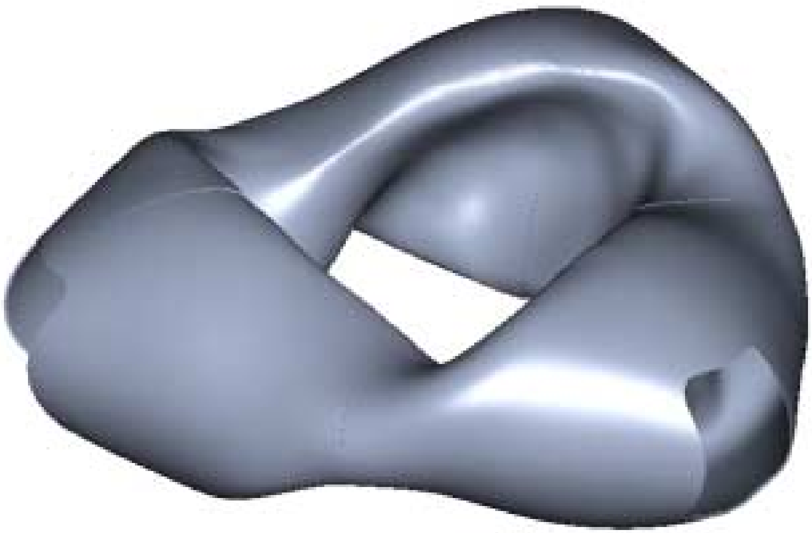


Option 1: separate fin

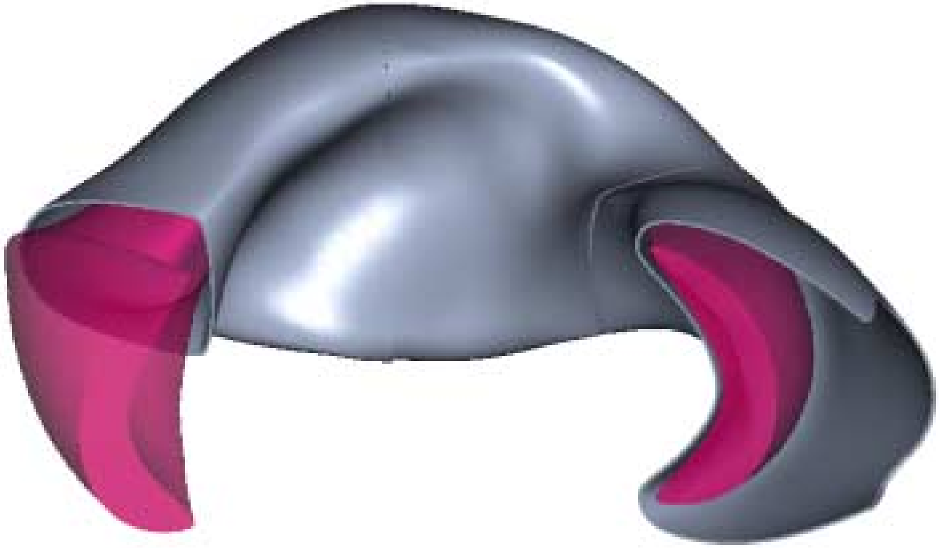
Option 2: use VV flange

PFC envelope maximized inside vessel

- **PFC envelope is pushed out to vessel wall to provide maximum plasma shape flexibility**
- **Divertor envelope is still evolving, but baffles for neutral particle control must be accommodated**

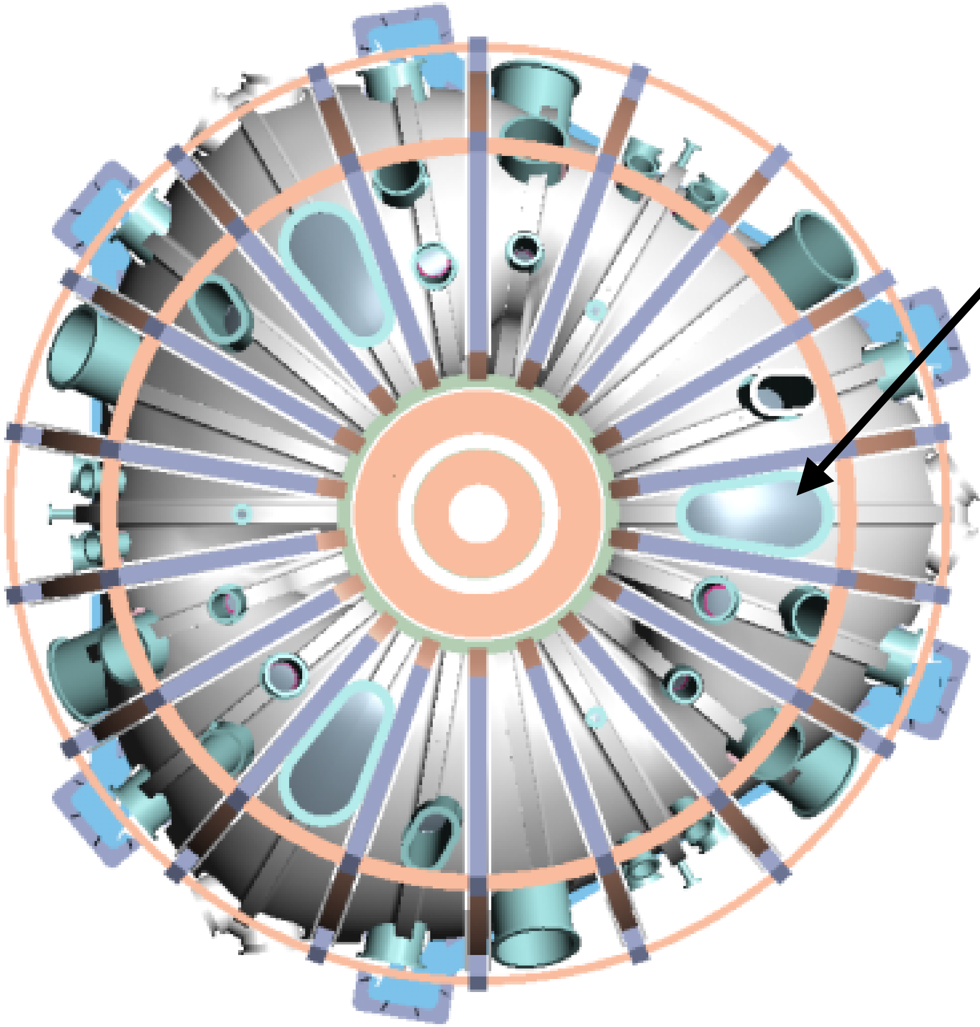


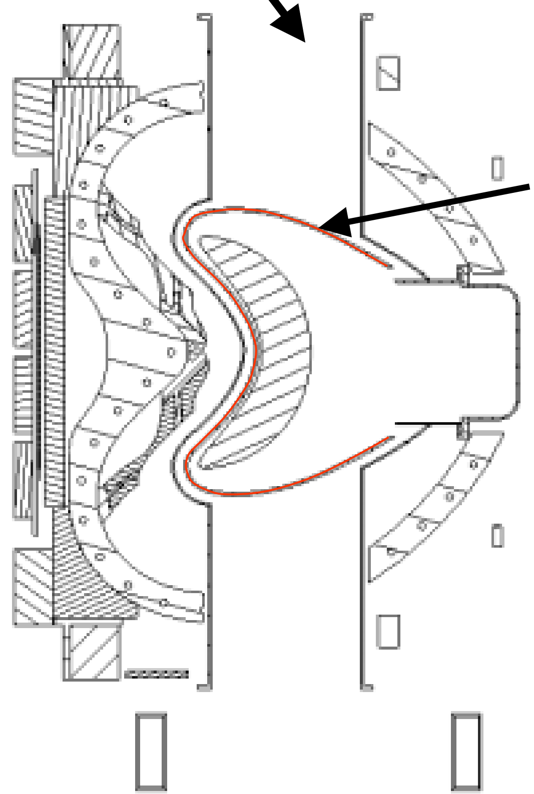
PFC envelope



PFC envelope with plasma

New coil set has improved access for maintenance and re-configuration



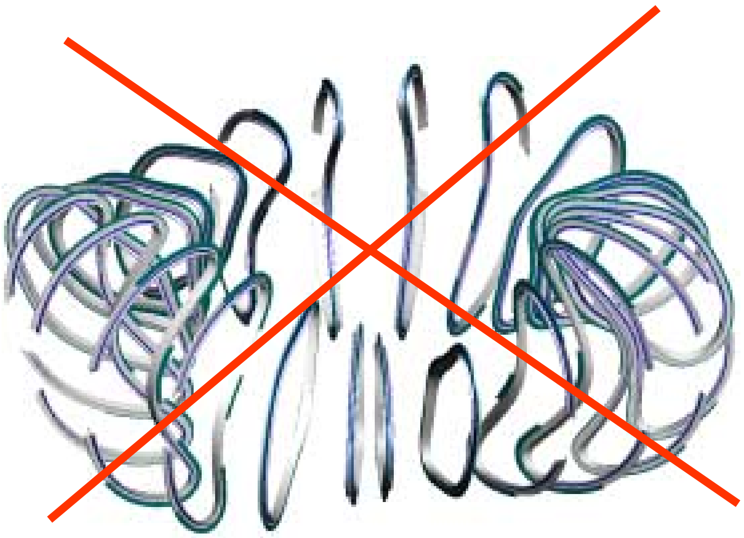


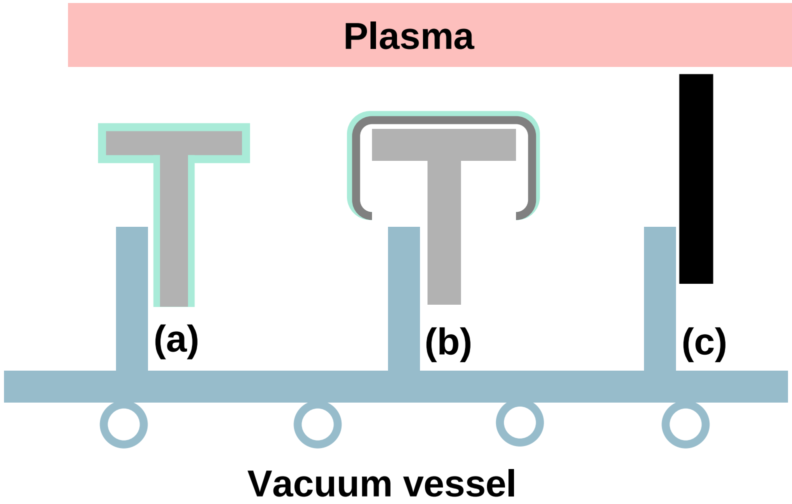
PFC issues

Requirements	Design	Fab.	Ass'y
• PFC stayout zone • divertor geometry • In-vessel diagnostics (e.g., magnetic loops) • Max plasma current • Divertor pumping upgrade	• transition from day 1 to full coverage • RF launcher integration with limiters, diag. • trim coil integration • low z rail cover configuration	• CFC cost • Low z coatings	• personnel access for –installation –reconfiguration

PFC implementation: Stage 1

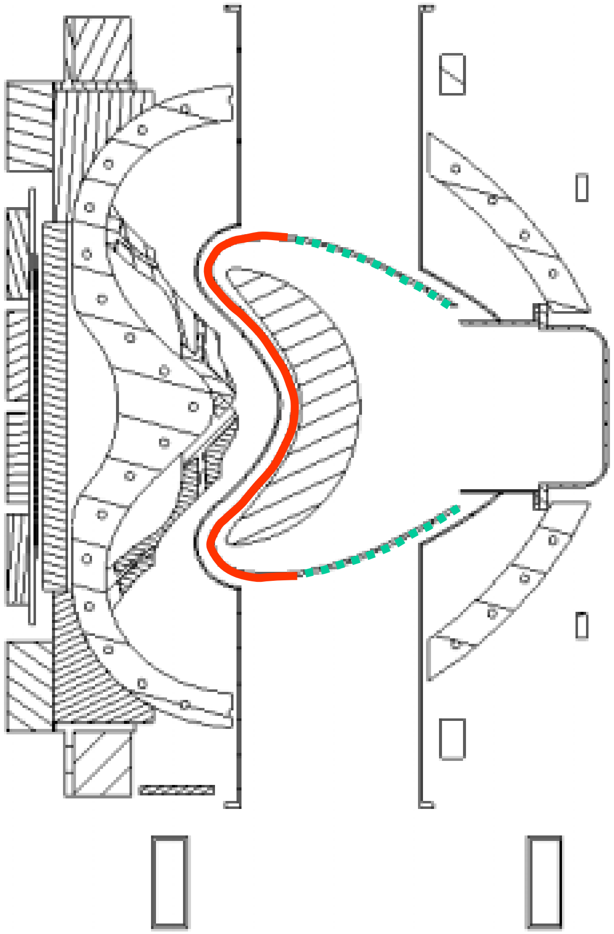
- **NO Rib structure with cooling/heating lines**
- **Ribs protected with low Z coating by:**
  a) **B4C spray coating**
  b) **Sheet metal covers with B4C coating**
  c) **Carbon (e.g. Poco, ATJ) tiles *mounted directly to VV***
- **Carbon limiters are installed only at v=1/2 (bullet) cross section, but are semi-continuous poloidally**





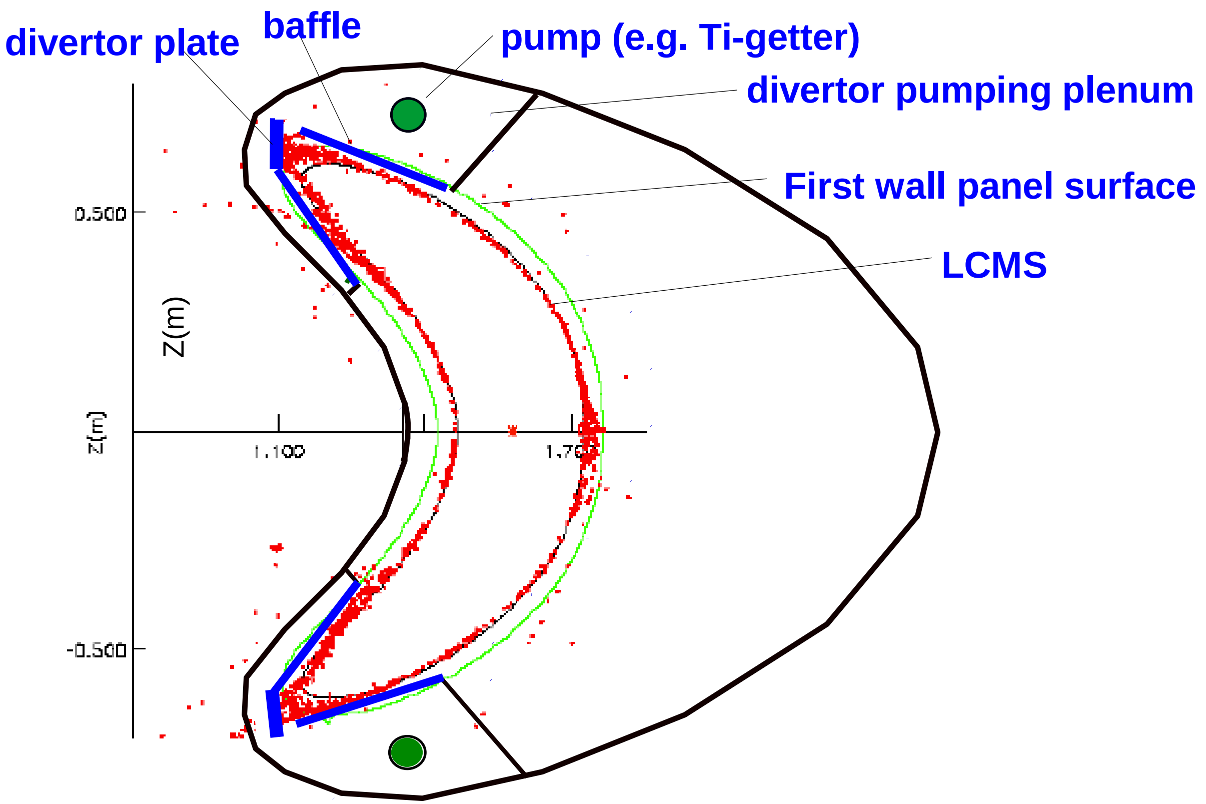
PFC implementation: Stage 2

- **Rib structure with cooling/heating lines**
- **Panel coverage from upper divertor to lower divertor on inboard side**
- **Panel coverage for NBI armor on outboard side**
- **Exposed ribs protected with low Z coating as in stage 1**



PFC implementation: Stage 3, 4

- **Stage 3, divertor baffles**
- **Stage 4, with active pump**



- **Panel coverage everywhere?**

Ref. Peter Mioduszewski.

PFC implementation plan

PFC Stage:	Heating:	CFC panel support ribs	CFC panel coverage					Divertor		
			In-board limiter	NBI armor	Trim coil armor	Fast ion loss armor	Full CFC coverage	Diver-tor panels	Diver-tor baffles	Active Divertor pumping
1	Ohmic		x							
2	3 MW NBI, 0.3 s	x	x	x	?			x		
?	6 MW NBI, 0.3 s	x	x	x	?	?		x		
?	2 MW RF, 0.5 s	x	x	x	x	?		?	?	
?	6 MW RF, 0.5 s	x	x	x	x	x		?	?	
3	6 MW NBI + 6 MW RF, 0.3 s	x	x	x	x	x	?		x	
4	6 MW NBI + 6 MW RF, 1.2 s	x	x	x	x	x	x		x	x

Project cost: (pink)　　**Program cost:** (green)