Neutronics Parameters for the Reference HAPL Chamber

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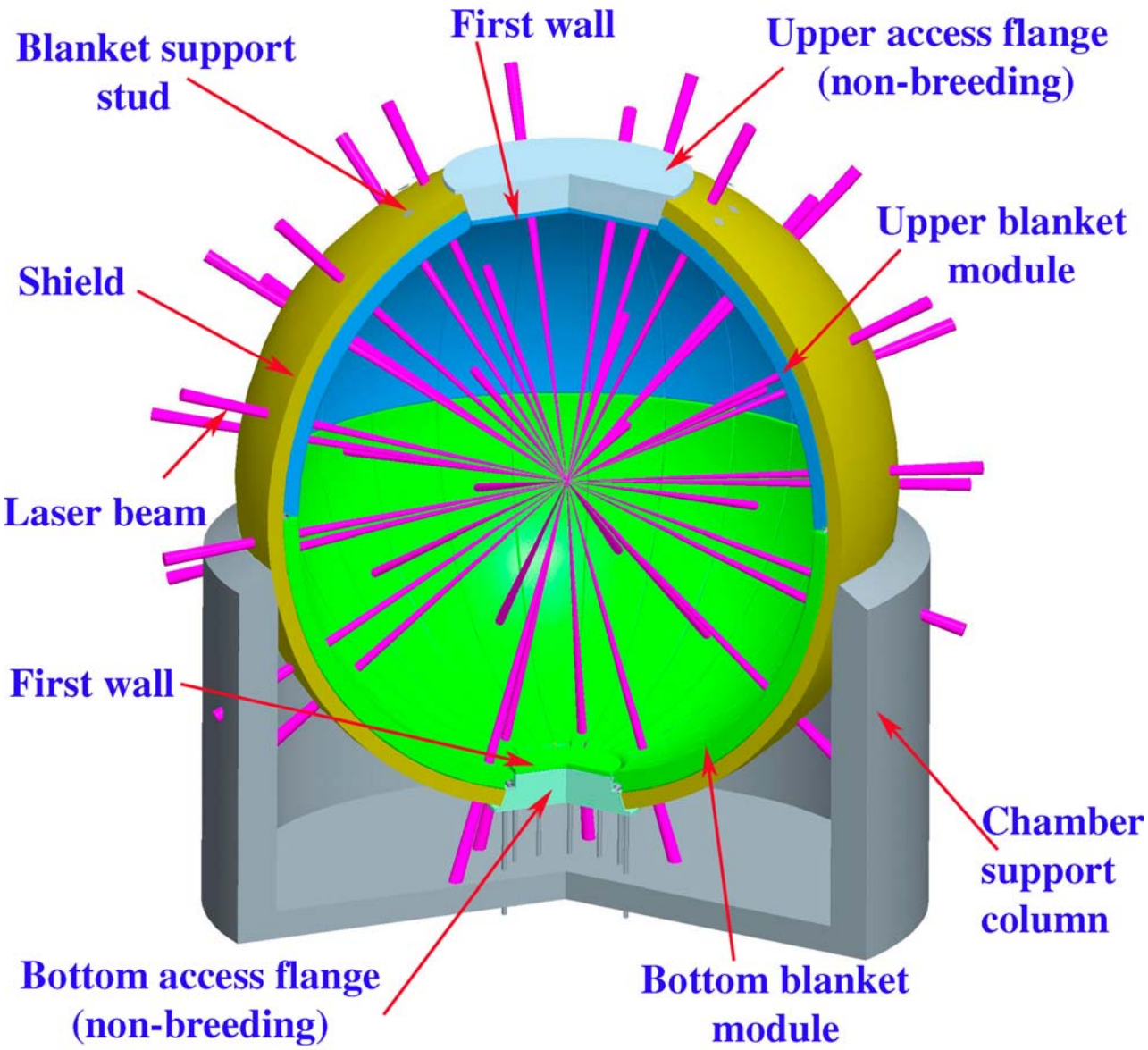
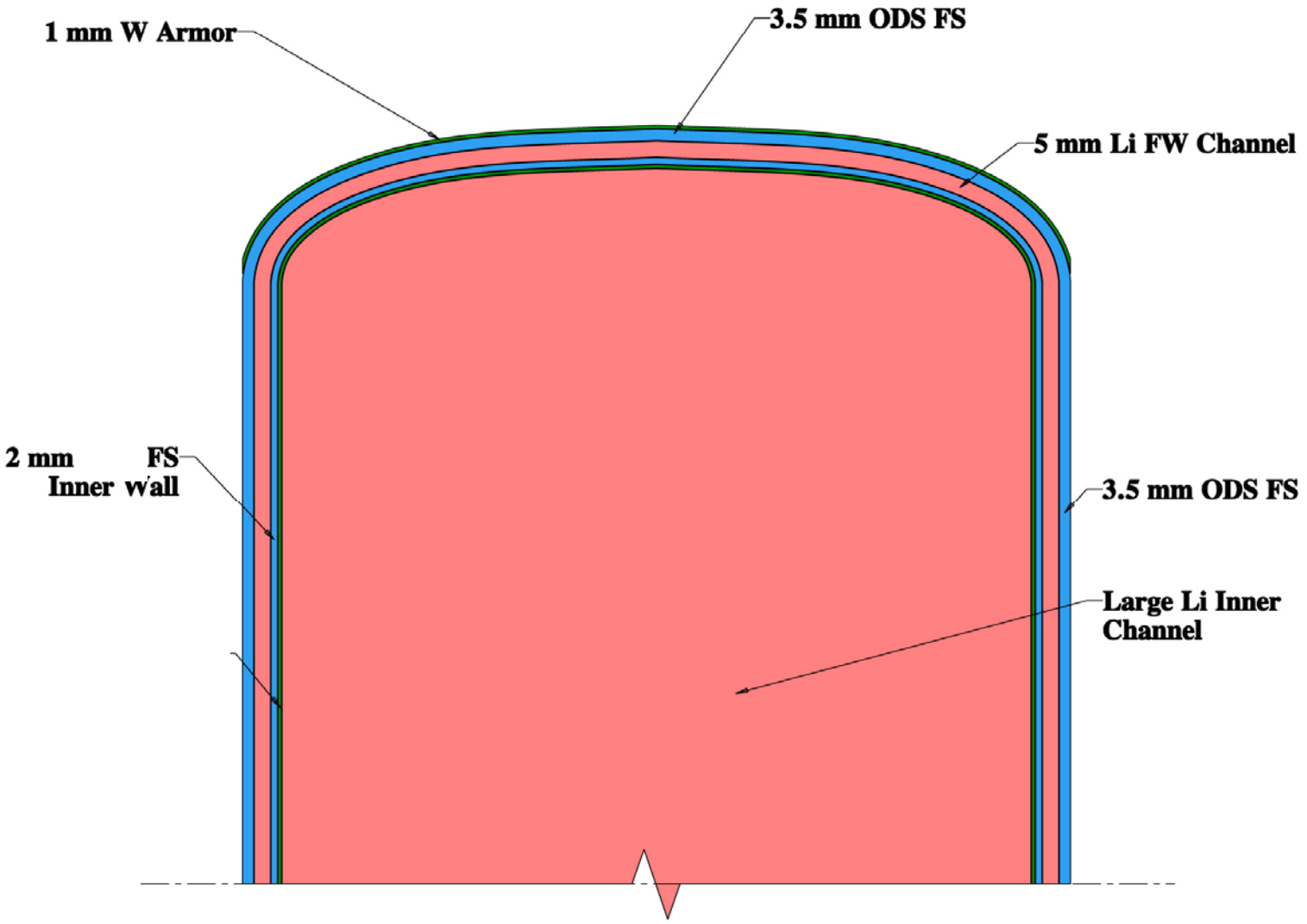
10.5 m Radius Chamber Configuration with Li Blanket



Parameters Used for Baseline Chamber Design

- 1 mm W armor on low activation ferritic steel (F82H) FW
- Used target spectrum from LASNEX results (Perkins) for NRL direct-drive target
- 70.5% of target yield carried by neutrons with 12.4 MeV average energy
- Target yield 350 MJ
- 5 Hz rep rate
- 1.75 GW fusion power
- Chamber radius 10.5 m at mid-plane
- Peak neutron wall loading at mid-plane is 0.89 MW/m^2

Schematic of Self-Cooled Li Blanket Sub-Module



Radial Build and Material Composition of Blanket and Shield/VV

Zone	Description	Thick (mm)	% W	% FS	% Li	% B_4C	% He
1	**Armor**	1	100	0	0	0	0
2	**FW**	3.5	0	100	0	0	0
3	**FW Li channel**	3	0	1.1	98.9	0	0
4	**Inner wall**	2	0	96.7	3.3	0	0
5	**Large Li inner channel**	582	0	3.6	96.4	0	0
6	**Back inner wall**	2	0	96.7	3.3	0	0
7	**Li channel in back wall**	3	0	1.1	98.9	0	0
8	**Back wall**	3.5	0	100	0	0	0
9	**Front plate of shield/VV**	30	0	100	0	0	0
10	**Inner zone of shield/VV**	370	0	2.8	0	66.1	31.1
11	**Back plate of shield/VV**	100	0	100	0	0	0
	Total	**1100**					

Homogenized material composition accounts for side walls of blanket sub-module

- Blanket thickness 60 cm
- Shield/VV thickness 50 cm

Design Requirements

- Overall TBR >1.1 taking into account lost breeding blanket coverage (6%)
  - 0.4% beam ports
  - 3.6% top access flange
  - 2% bottom access flanges
- End-of-life (40 FPY) peak dpa in shield <200 dpa for shield/VV to be lifetime component
- End-of-life (40 FPY) peak He production at back of shield/VV <1 He appm to allow for rewelding

Neutronics Parameters

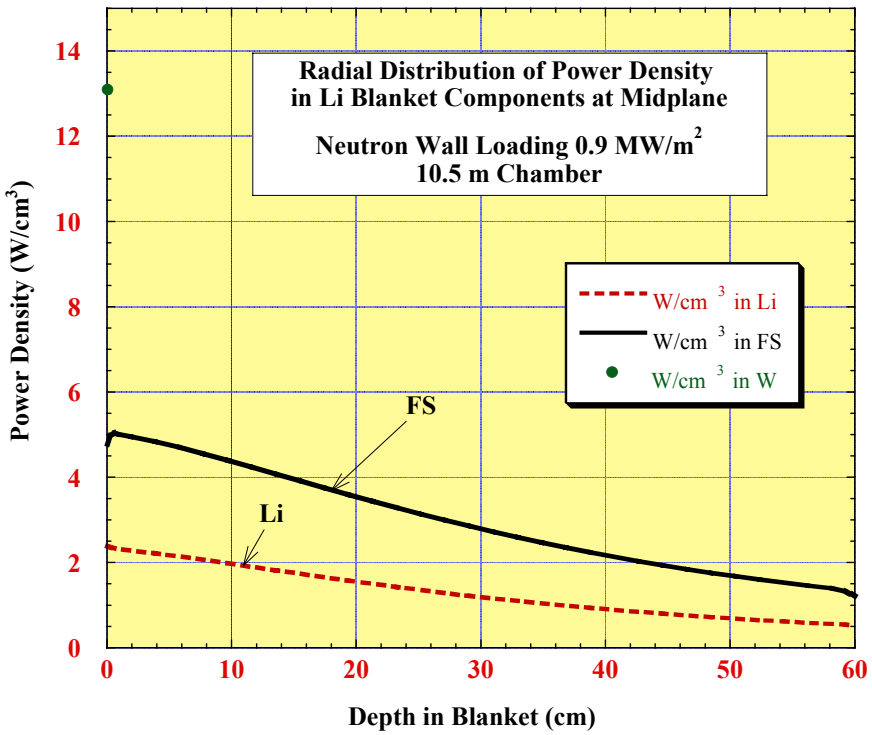
Tritium Breeding

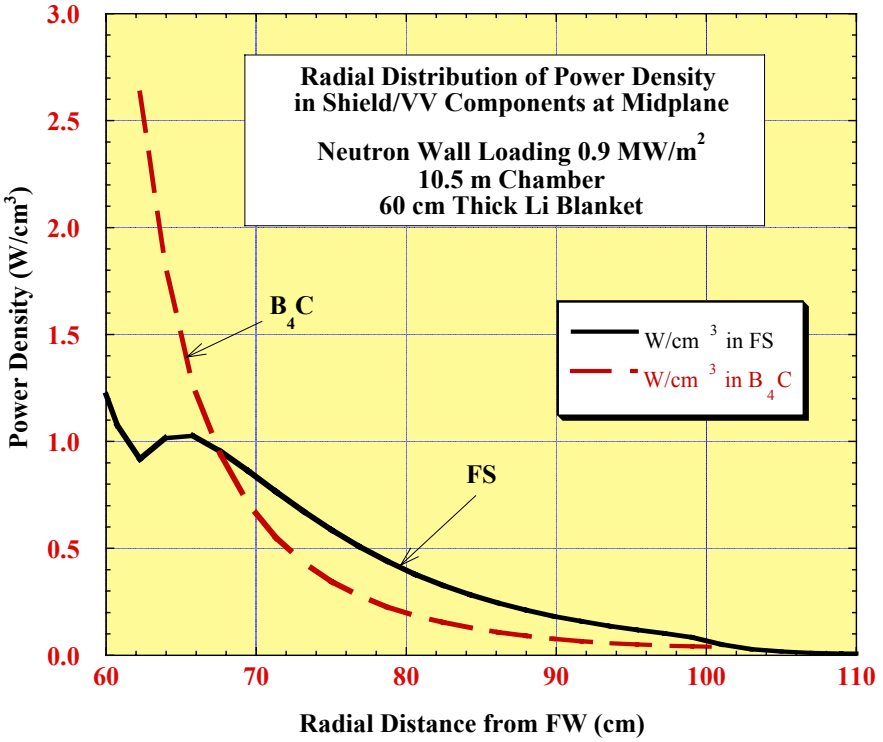
- Natural lithium is used
- Local 1-D TBR is 1.18
- With 94% blanket coverage the overall TBR is estimated to be 1.11
- Lithium enrichment can be used to enhance TBR if needed

Nuclear Energy Multiplication

- Local nuclear energy multiplication in blanket and shield/VV behind it is 1.15
- Local nuclear energy multiplication in 1.03 m thick top and bottom flanges (62% B4C, 5% FS, 33% He) is 0.96
- Overall nuclear energy multiplication is estimated to be 1.135

Nuclear Heating Profiles

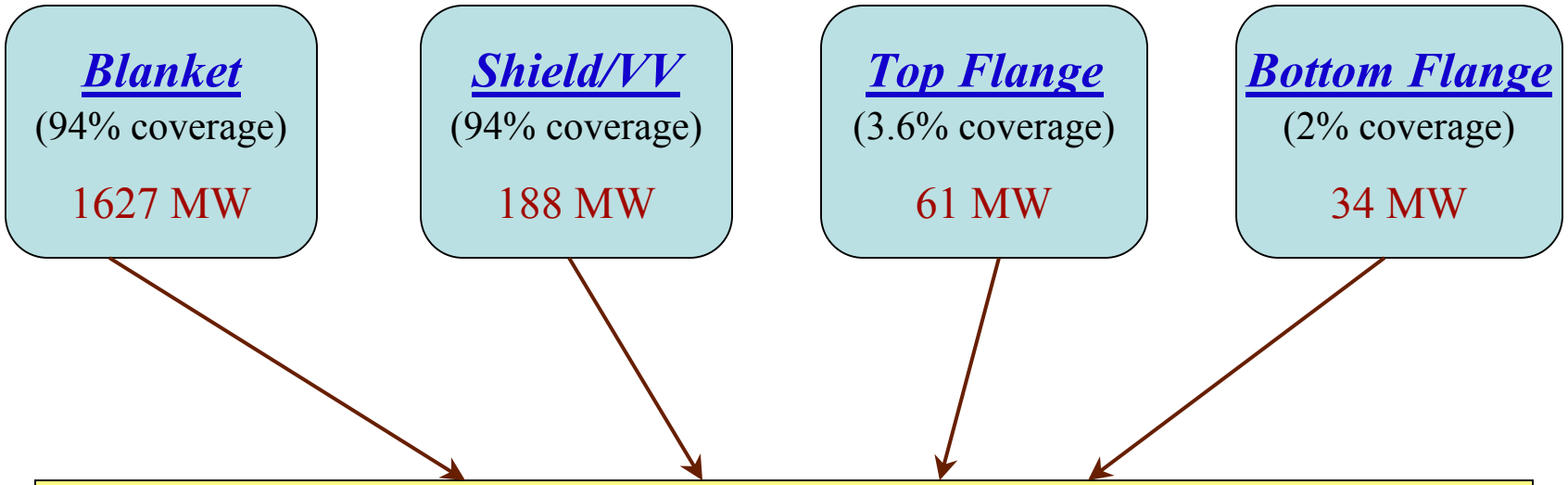




Self-cooled Li blanket

Shield/VV behind blanket

Plant Thermal Power for 1750 MW Fusion Power



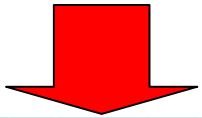
Total Thermal Power = 1910 MW

1627 MW* removed from blanket *by Li* *(85% of thermal power)

283 MW* removed from shield/VV and top/bottom flanges *by He

Radiation Damage

	dpa/FPY	He appm/FPY
W armor	2.3	1.6
FS first wall	9.6	91
Front of shield/VV	1.3	6.5
Back of shield/VV	0.009	0.017
Back of flanges	0.001	0.004



- At W/FS interface, W dpa is lower than FS dpa by a factor of 4 and W He production is lower by a factor of 57
- Based on 200 dpa lifetime limit for FS structure blanket and flanges lifetime is ~20 FPY and they have to be replaced at least once during the plant lifetime
- End-of-life (40 FPY) peak dpa in shield/VV is 52 dpa implying that it will be lifetime component
- End-of-life (40 FPY) peak He production is 0.68 He appm at back of shield/VV and 0.16 appm at back of flanges allowing for rewelding

Impact of Increasing Rep Rate

- The option of increasing the rep rate above 5 Hz was considered
- TBR and energy multiplication are independent of rep rate
- Damage rates and power densities scale linearly with rep rate
- Lifetime of blanket and flanges decreases with increased rep rate (20 FPY for 5 Hz, 10 FPY for 10 Hz)
- We have enough margin for shield/VV to be lifetime component even if rep rate is increased by a factor of 3 (52 dpa @ 5Hz, 104 dpa @ 10 Hz, 156 dpa @ 15 Hz)
- Rewelding at back of flanges remains possible for higher re rates (0.16 appm @ 5 Hz, 0.32 appm @ 10 Hz)
- Rewelding at back of shield/VV will not be possible with 10 Hz (1.38 appm) and ~5 cm increase in thickness will be required
- Thermal power of plant increases linearly with rep rate

Summary

- Overall TBR >1.1 can be achieved without breeding in the shield/VV and top and bottom flanges
- Shield/VV is lifetime component with 60 cm blanket
- Lifetime of blanket and top/bottom flanges is expected to be ~20 FPY
- Rewelding at the back of the 50 cm He-cooled shield/VV and 103 cm thick top/bottom flanges is possible
- For 1750 MW_f, total thermal power is 1910 MW_{th} with 15% of it carried by the He coolant of the shield/VV and top/bottom flanges
- Nuclear requirements are still satisfied if rep rate is increased to 10 Hz except that the frequency of blanket and flange replacement is increased and the shield/VV thickness should be increased by ~5 cm to allow for rewelding at its back