Nuclear Heating Profile for ARIES-ACT-DCLL Design

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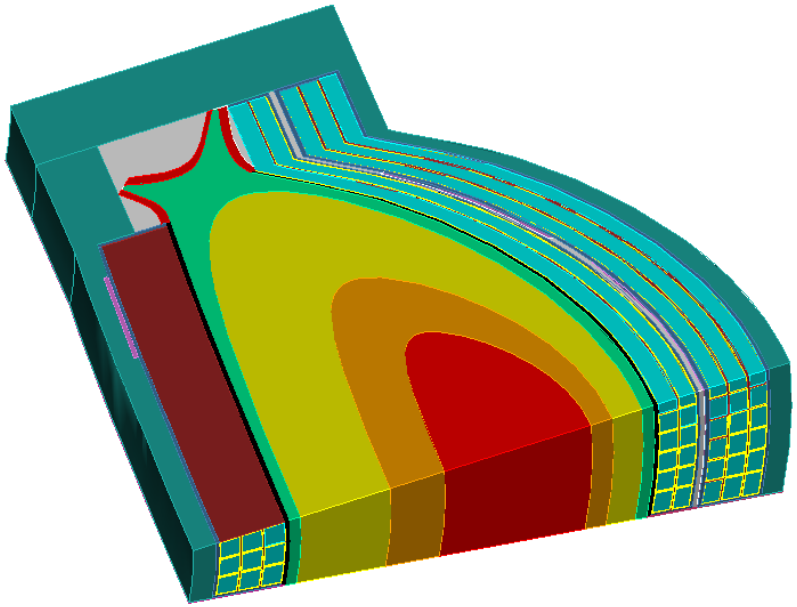
UCSD

Key parameters for 3-D Nuclear Heating Analysis

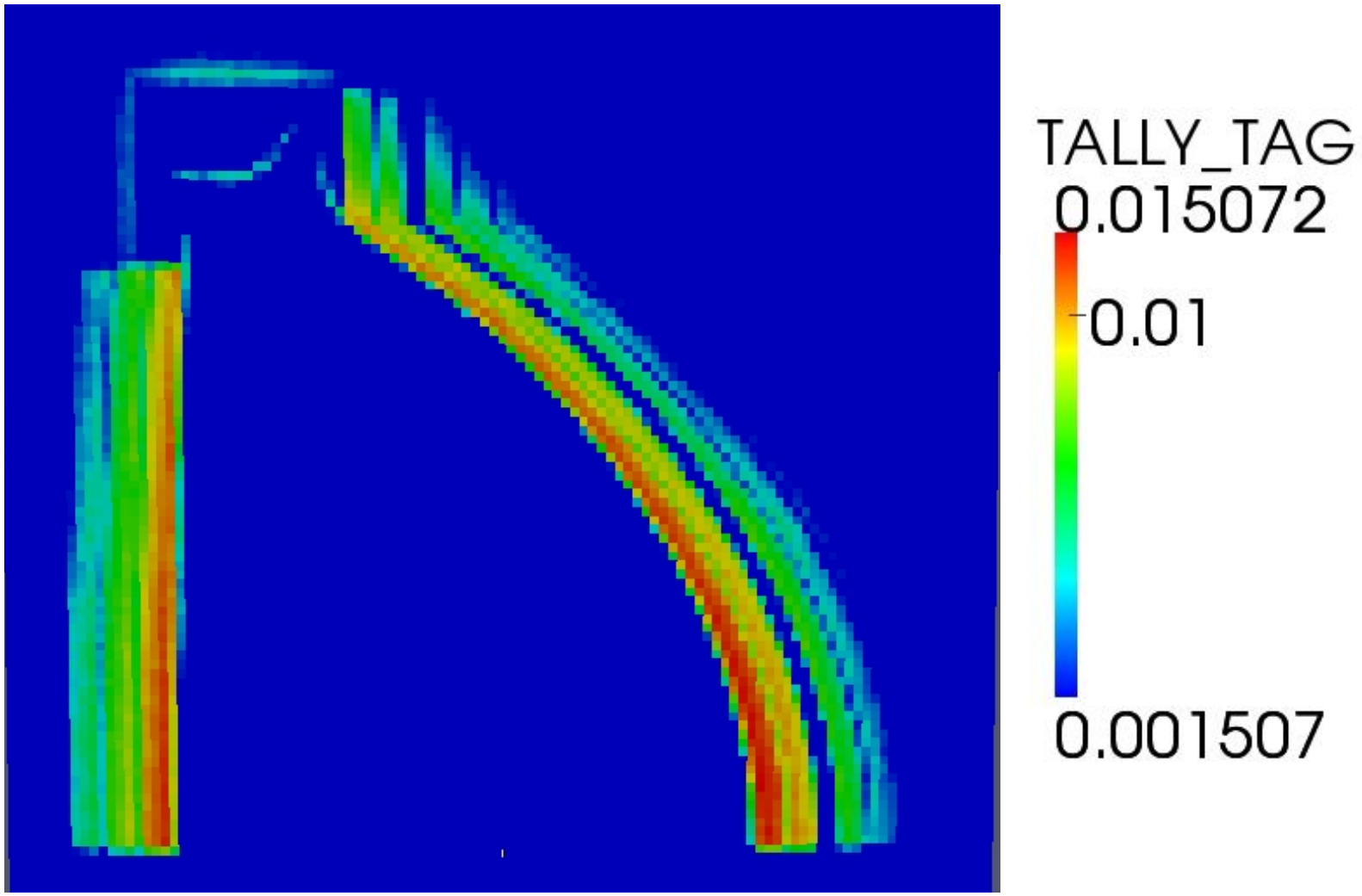


3-D MCNP Model
(upper half of 1/32th Module
with 3 reflecting boundaries.
Same model as for TBR analysis
presented at 7/2011 ARIES meeting)

ARIES-ACT-DCLL
Aggressive Physics

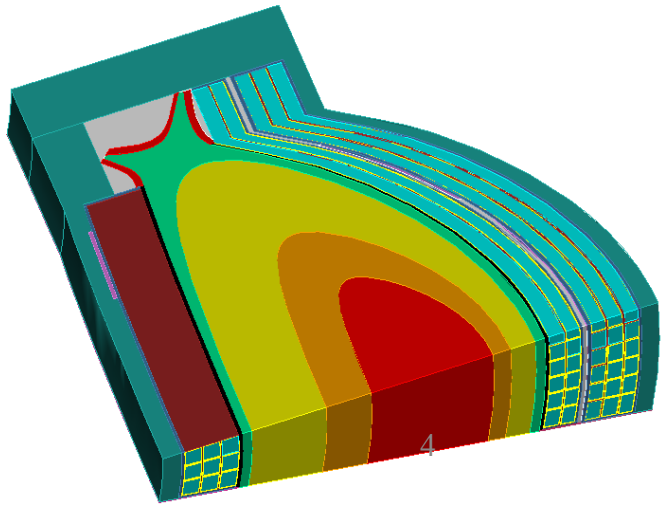
Fusion Power	2767.5 MW; early 2011 Pre-Strawman (2757 MW; Oct 2011 Strawman)
Major Radius	6 m
Minor Radius	1.5 m
Elongation	2.2

Nuclear Heating Profile



Nuclear Heating Distribution in Upper Half of 1/32th Module (1/64th of torus, as modeled)

Nuclear Heating (MW)	Inboard	Outboard	Divertor	Total
FW/Blanket	8.32	25.11	-	33.43
Divertor Plates			0.55	0.55
Stabilizing Shells	0.07	1.20	-	1.27
Shield	0.36	0.32	2.83	3.51
Total	8.75	26.62	3.38	38.76

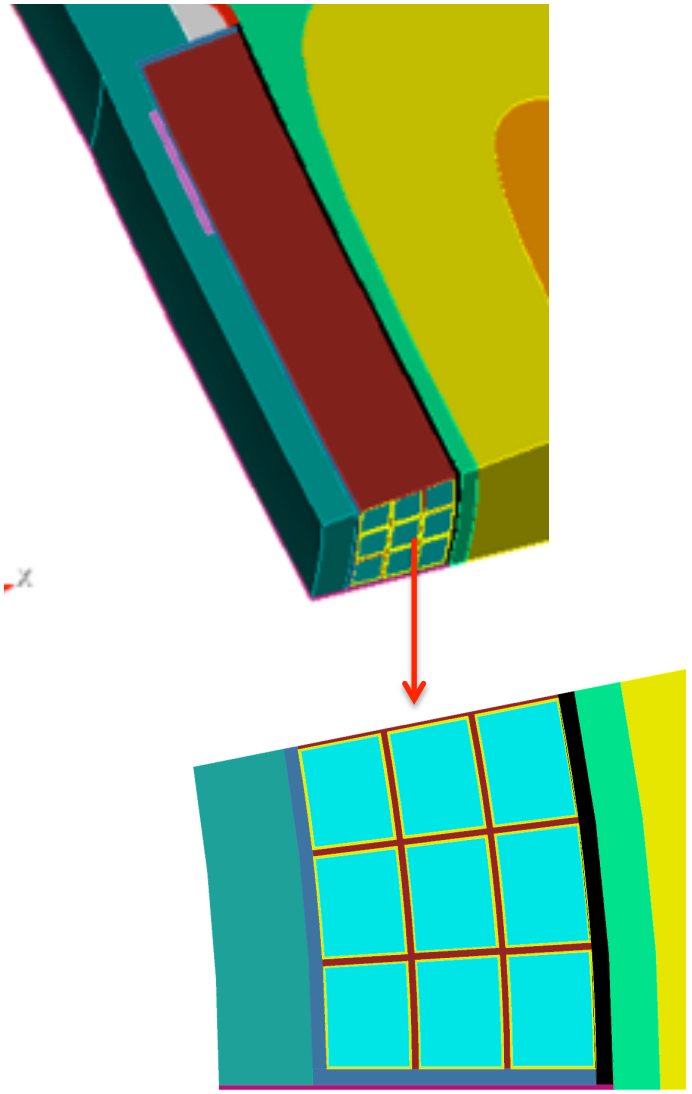


Nuclear Heating Distribution in 1/16th Module

Nuclear Heating (MW)	Inboard	Outboard	Divertor	Total
FW/Blanket	33.29	100.42	---	**133.72**
Divertor Plates	---	---	2.22	**2.22**
Stabilizing Shells	0.29	4.80	---	**5.09**
Shield	1.45	1.27	11.32	**14.04**
Total	**35.03**	**106.49**	**13.54**	**155.06**

Breakdown of Inboard Nuclear Heating (1/16th IB Module)

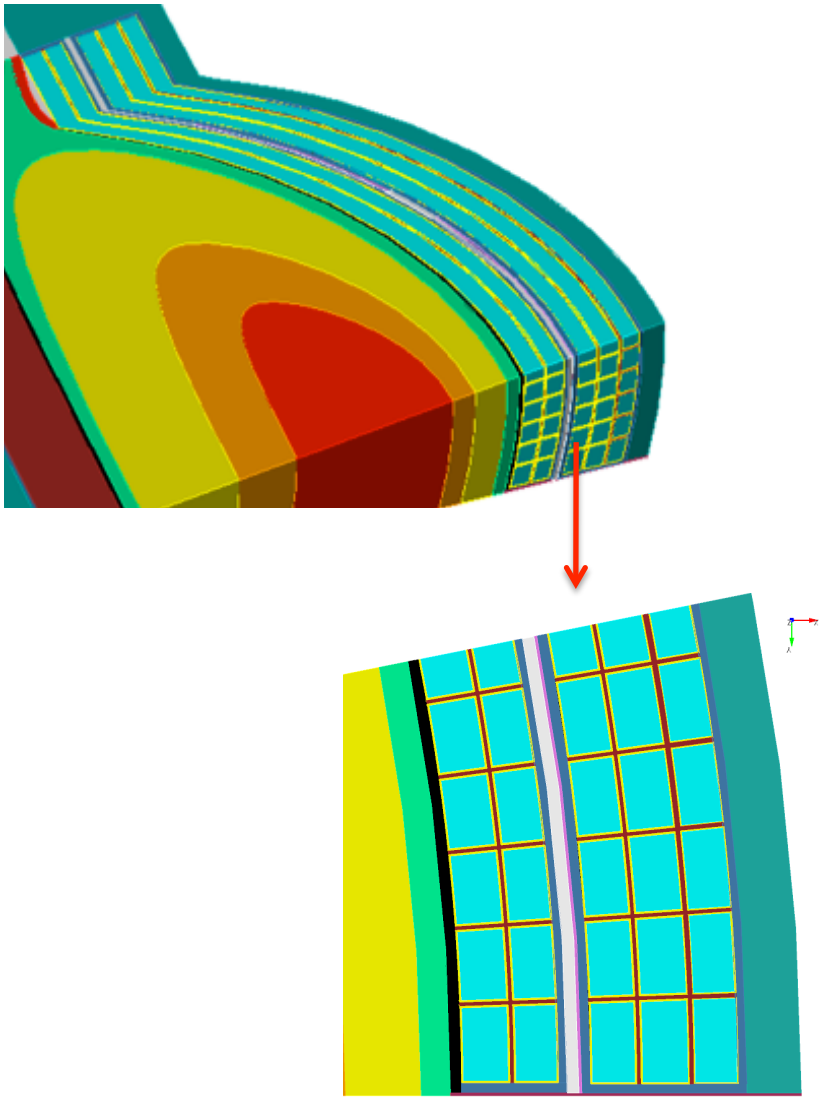
Inboard Nuclear Heating (MW)	
65 cm Thick IB Blanket:	
3.8 cm FW	3.18
58.2 cm Breeding Zone	
LiPb Flow Channels	27.29
SiC Flow Channel Inserts (FCI)	1.10
FS/He Cooling Channels	0.97
Total	29.37
3 cm Back Wall	0.13
3.5 cm Side Wall	0.43
3.5 cm Top/Bottom Walls	0.18
4 cm VS Shell	0.29
IB Shield	1.45
Total	**35.03**



Breakdown of Outboard Nuclear Heating (1/16th OB Module)

Outboard Nuclear Heating (MW)

40 cm Thick OB-I Blanket:	
3.8 cm FW	7.42
33.2 cm Breeding Zone	
LiPb Flow Channels	64.63
SiC FCI	3.51
FS/He Cooling Channels	3.16
Total	71.30
3 cm Back Wall	1.80
3.5 cm Side Wall	0.72
3.5 cm Top/Bottom Walls	0.02
Stabilizing Shells:	
1 cm Kink Shell	1.27
4 cm VS Shells	3.53
60 cm Thick OB-II Blanket:	
3 cm FW	1.51
54 cm Breeding Zone	
LiPb Flow Channels	16.54
SiC FCI	0.35
FS/He Cooling Channels	0.38
Total	17.27
3 cm Back Wall	0.09
3 cm Side Wall	0.28
3 cm Top/Bottom Walls	0.01
OB Shield	1.27
Total	**106.49**



Breakdown of Divertor Nuclear Heating (1/16th Div Module)

Divertor Nuclear Heating (MW)

Upper Divertor:

7.7 cm W-based Divertor Plates:

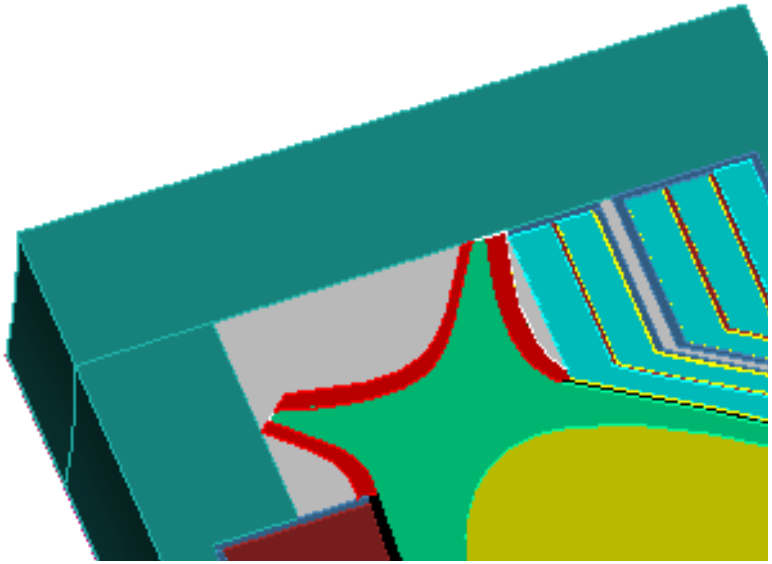
Inner Plate	0.19
Dome	0.56
Outer Plate	0.36
Divertor Shield	5.66

Lower Divertor:

7.7 cm W-based Divertor Plates:

Inner Plate	0.19
Dome	0.56
Outer Plate	0.36
Divertor Shield	5.66

Total	**13.54**



Total Nuclear Heating in all 16 Modules

Nuclear Heating (MW)	Inboard	Outboard	Divertor	Total	
FW/Blanket	532.64	1606.81	---	**2139.45**	(86.3%)
Divertor Plates	---	---	35.52	**35.52**	(1.4%)
Stabilizing Shells	4.66	76.73	---	**81.39**	(3.3%)
Shield	23.26	20.24	181.10	**224.60**	(9%)
Total	**560.55** (22%)	**1703.79** (69%)	**216.62** (9%)	**2480.96**	

Energy Multiplication (M_n) = 2480.96 / (2767.5 x 0.8) = 1.12

Thermal Power Split between He and LiPb Coolants

Thermal Power (MW_{th})	He	LiPb	Total
Surface Heating	674*	---	**674**
Recovered Power from Div Pumping	26*	---	**26**
Recovered Power from Blanket Pumping	~8*	~8*	**16**
FW	170	---	**170**
Breeding Zones and Walls	236	1815	**2051**
Divertor	36	---	**36**
Shields	224	---	**224**
Leakage from LiPb to He	~ +100	~ -100	**0**
Total	**1474** (46%)	**1723** (54%)	**3197**

* Oct 2011 Strawman

He : LiPb power ratio = 46 : 54 for DCLL design