



ARIES-ACT-1 Nuclear Heating Profile

L. El-Guebaly and L. Mynsberge

Fusion Technology Institute
University of Wisconsin-Madison

<http://fti.neep.wisc.edu/UWNeutronicsCenterOfExcellence>

Contributors:

X. Wang, M. Tillack, S. Malang (UCSD)

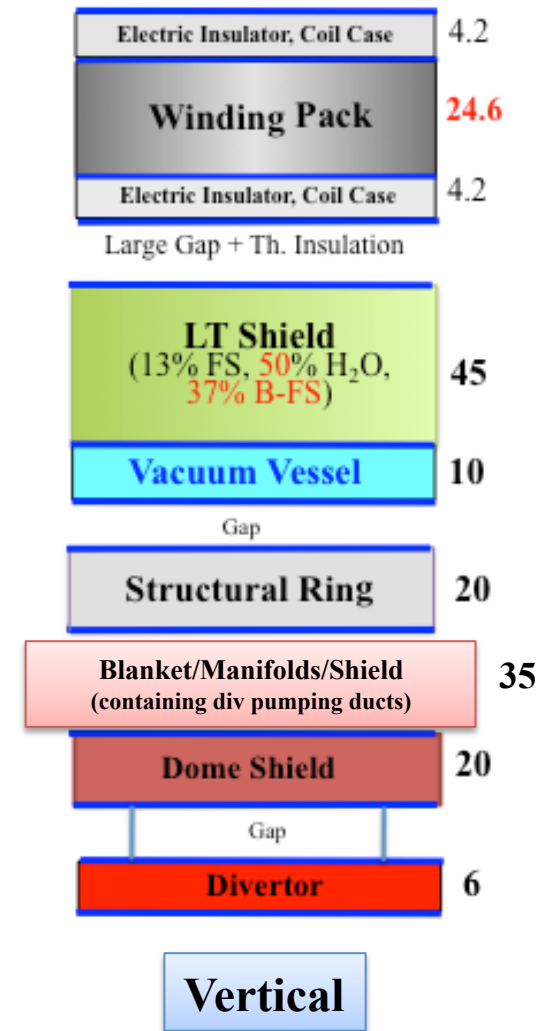
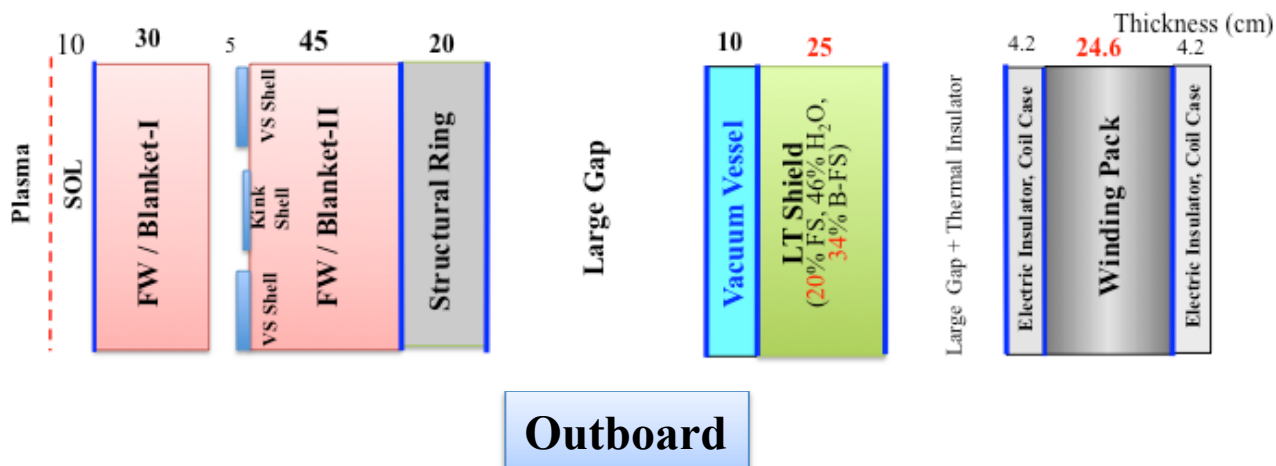
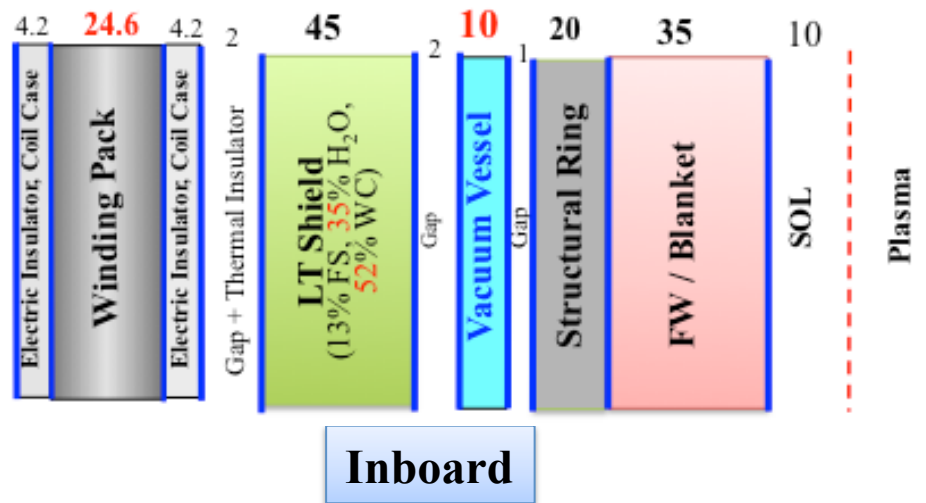
ARIES Project Meeting

September 26-27, 2012

Bethesda, MD

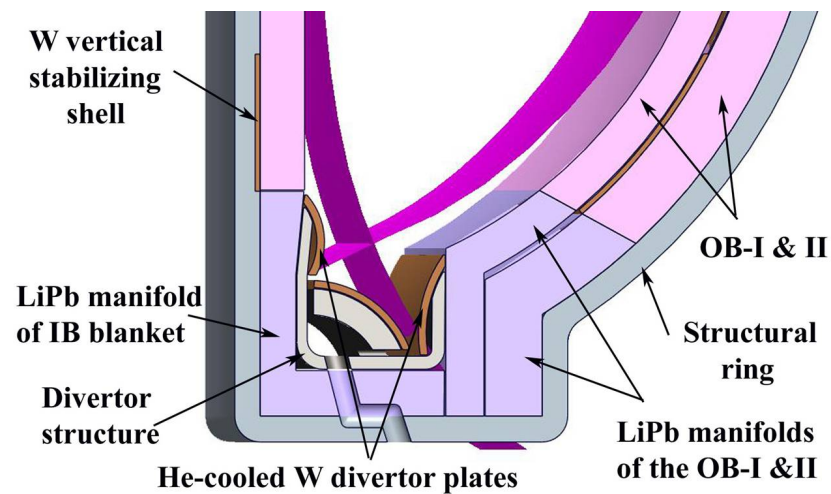
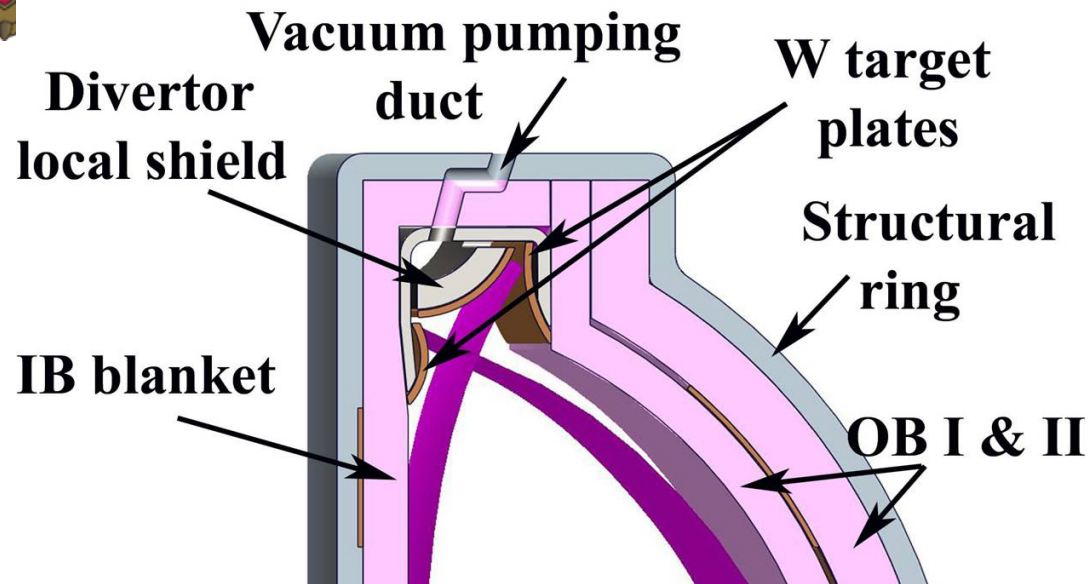


Radial and Vertical Builds





CAD Models

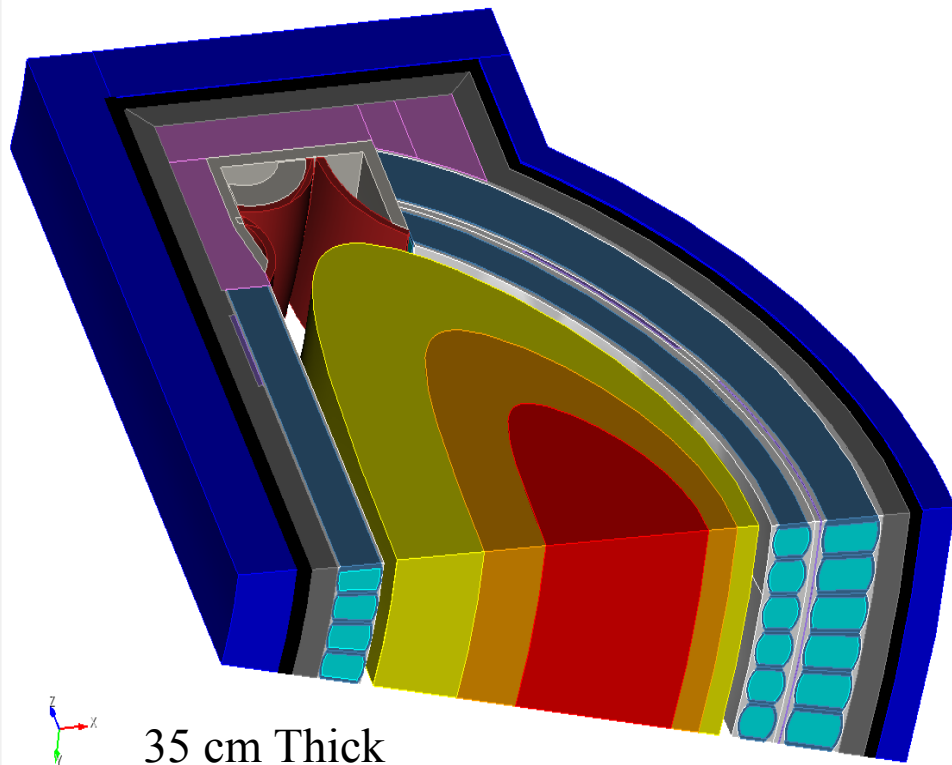




3-D Nuclear Heating Model

(Includes 2 cm wide assembly gaps between 16 modules)

3-D MCNP Model with Reflecting Boundaries
(upper half of 1/32th Module)



35 cm Thick
IB Blanket

30 + 45 cm Thick
OB Blanket

ARIES-ACT-1

SiC/LiPb Blanket

60% Li-6 enrichment

Aggressive Physics

Fusion Power	1804 MW
Major Radius	5.5 m
Minor Radius	1.375 m

Nuclear heating results are
scalable with fusion power



Nuclear Heating Distribution in 1/16th Module w/ 2 cm gap

Nuclear Heating (MW)	Inboard	Outboard	Divertor	Total
FW/Blanket	16.32	61.56	4.45	82.31
Divertor Plates, Support Structure, and Dome Shield	---	---	11.10	11.10
Stabilizing Shells	0.51	2.83	---	3.34
Structural Ring	2.39	1.56	0.20	4.15
Vacuum Vessel	0.88	0.42	0.07	1.37
Total	20.12	66.36	15.82	102.31
LT Shield	3.22	1.29	0.14	4.65 (4.5%)



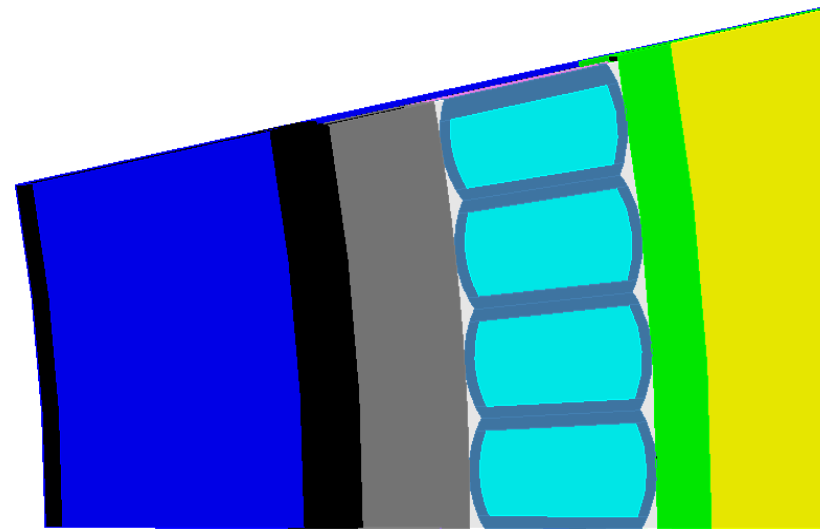
Breakdown of **Inboard** Nuclear Heating (1/16th IB Module)

Inboard Nuclear Heating (MW)

IB Blanket:	16.34
FW	1.13
Back Walls	0.21
Side Walls	2.20
LiPb Breeding Zones	12.80
4 cm Thick VS W Shell	0.51
Structural Ring	2.39
Vacuum Vessel	0.88

Total	20.12
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LT Shield	3.22 (16%)
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Breakdown of **Outboard** Nuclear Heating (1/16th OB Module)

Outboard Nuclear Heating (MW)

OB-I Blanket:

	44.11
FW	3.53
Back Walls	0.89
Side Walls	4.87
LiPb Breeding Zones	34.42
OB-I Vertical Blanket	0.40

Stabilizing Shells:

	2.83
1 cm thick Kink Shell	0.81
4 cm thick VS Shells	2.02

OB-II Blanket:

	17.44
FW	1.06
Back Walls	0.24
Side Walls	2.21
LiPb Breeding Zones	13.54
OB-II Vertical Blanket	0.39

Structural Ring

1.56

Vacuum Vessel*

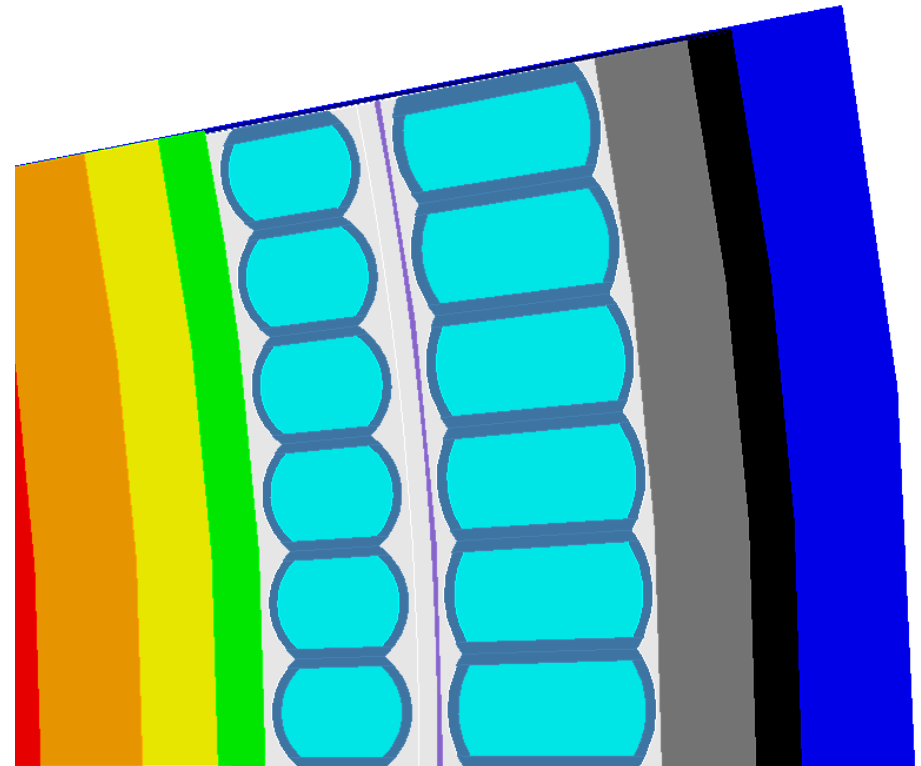
0.42

Total

66.36

LT Shield*

1.30 (2%)



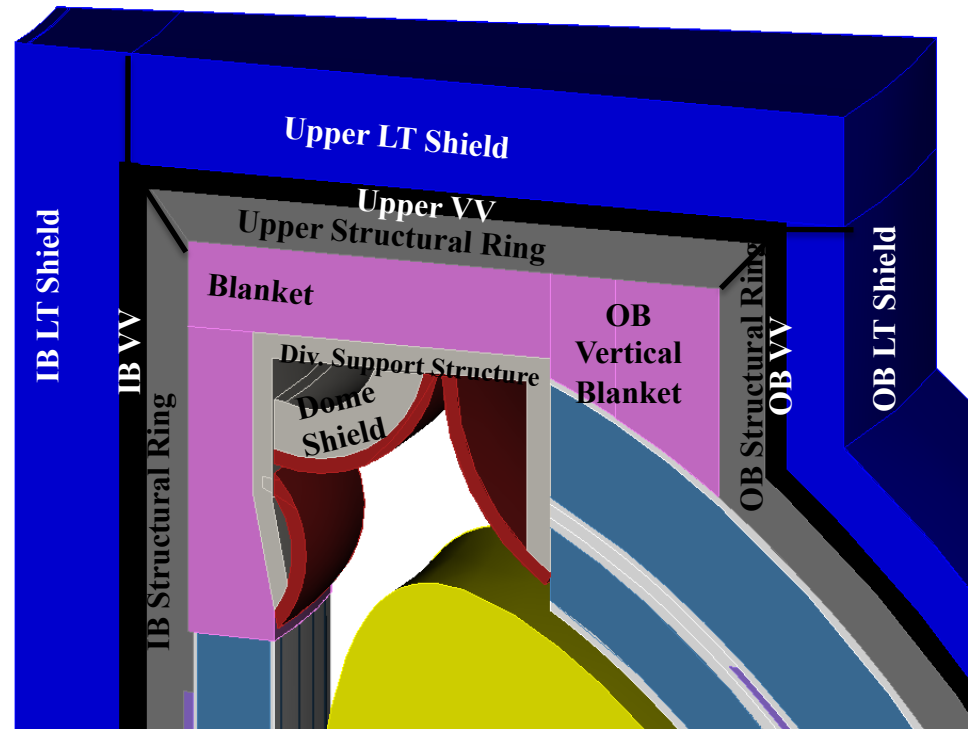
* TBD: redistribution of heating between OB VV, LT shield, and shield plugs (at entrance of maintenance ports). Distribution depends on coverage fraction of each components.



Breakdown of **Upper Divertor** Nuclear Heating (1/32nd Div Module)

Upper Divertor Nuclear Heating (MW):

6 cm W-based Divertor Plates:	3.26
Inner Plate	0.74
Dome	1.20
Outer Plate	1.32
Divertor Dome Shield	0.95
Divertor Support Structure	1.30
Blanket	2.22
Upper Structural Ring	0.10
Upper Vacuum Vessel	0.04



Total **7.87**

Upper LT Shield 0.07 (1%)



Breakdown of **Lower Divertor** Nuclear Heating (1/32nd Div Module)

Lower Divertor Nuclear Heating (MW):

6 cm W-based Divertor Plates:	3.28
Inner Plate	0.75
Dome	1.21
Outer Plate	1.32

Divertor Dome Shield	0.96
Divertor Support Structure	1.35

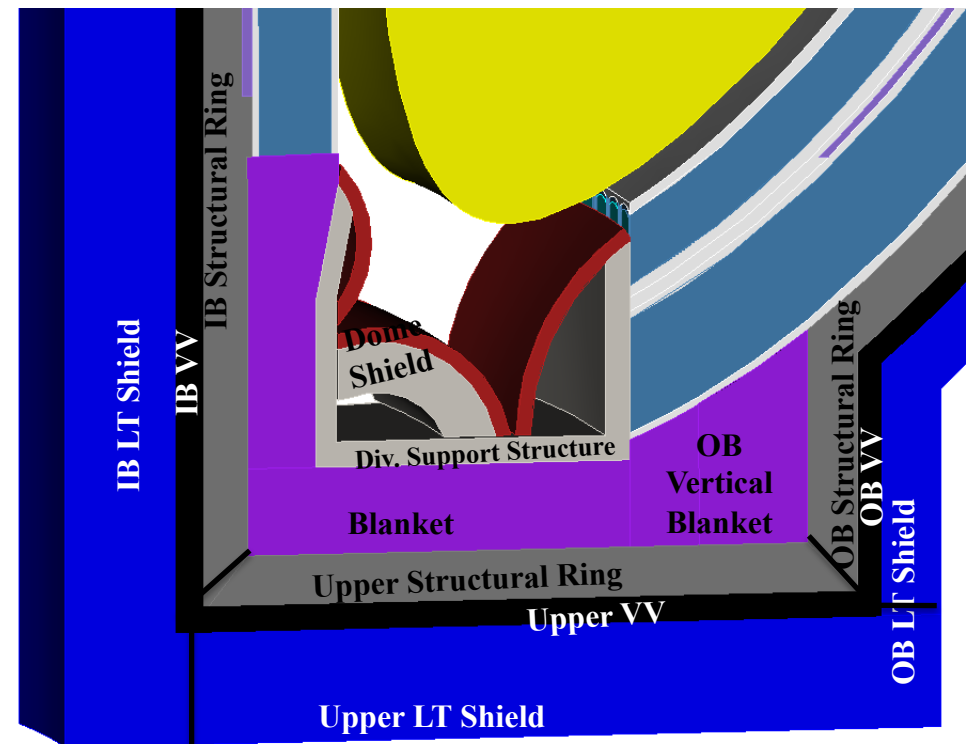
Blanket	2.23
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Lower Structural Ring	0.11
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Lower Vacuum Vessel	0.03
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Total	7.96
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Lower LT Shield	0.07 (1%)
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Total Nuclear Heating in all 16 Modules

Nuclear Heating (MW)	Inboard	Outboard	Divertor	Total
FW/Blanket	261.12	984.96	71.20	1317.44
Divertor Plates, Support Structure, and Dome Shield	---	---	177.60	177.60
Stabilizing Shells	8.16	45.28	---	53.44
Structural Ring	38.24	24.96	3.20	66.40
Vacuum Vessel	14.08	6.72	1.12	21.92
Total	321.60 (19.7%)	1061.76 (64.8%)	253.12 (15.5%)	1636.64
LT Shield	51.52	20.64	2.24	74.40 (4.5%)

$$\text{Energy Multiplication (M}_n\text{)} = 1636.64 / (1804 \times 0.8) \\ = 1.134$$



Thermal Power Split between He and LiPb Coolants of ARIES-ACT-1

Thermal Power (MW _{th})	He	LiPb	Total
Surface Heating	275*	130*	405
Recovered Power from Div Pumping	9*	---	9
Recovered Power from Blanket Pumping	---	4*	4
FW/Blanket, Manifolds	---	1366.64	1366.64
Divertor Plates, Support Structure, Dome Shield	177.6	---	177.6
Structural Ring and VV	92.4	---	92.4
Total	554 (27%)	1500.64 (73%)	2054.64

* July 2012 Strawman

He / LiPb power ratio = 27 : 73 for ARIES-ACT-1 design