

# Assessment of Power Core Parameters and Related Costs (Part-III)

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UW

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# Account # 21.2 (Reactor Building)

ARIES-CS building volume  $V_{RB}$  (in  $m^3$ ) =  $1.3 \times 10^5 \times 1.3^\#$ , per Les and Xueren

**Old costing algorithm (R. Miller):**

$$\text{Cost (2004 M\$)} = [77.1 (V_{RB}^\# / 80,000)^{0.62}] \times \text{LSA Factor} \times 1.256^*$$

**New costing algorithm (L. Waganer):**

$$\text{Cost (2004 M\$)} = [33 + 0.00025 \times V_{RB}] \times \text{LSA Factor}$$

ARIES-	RS	AT	CS	
LSA	2	1	2	
21.2 Reactor Bldg (M\$ - 2004\$)	~ 160 old	~ 100 old	~ 140 old	~ 68 new

New costing algorithm results in factor of 2 lower building cost

# Correction factor to account for unaccounted buildings.

\* 2004\$ = 1992\$ x 1.256, per Les.

# Account # 22.1.5 (Primary Structure)

$$\text{Cost (2004 M\$)} = [\text{volume} \times \text{steel density (7.8 gm/cm}^3) \times \text{vol. fract. (0.95)} \\ \times \text{unit cost (~25 \$/kg)}] \times \text{LSA Factor} \times 1.256$$

$$\text{Volume} = 18.4\% \text{ FPC volume}$$

$$\text{FPC volume}^* = \text{actual volume of FW + blanket + divertor + shield + VV} \\ + \text{winding pack + coil structure (including bucking structure)} \\ \approx 400 \text{ m}^3$$

ARIES-	RS	AT	1/06	CS	3/06
LSA	2	1		2	
21.1.5 Primary Str. (M\$- 2004\$)	67	34	46		~ 90

\* Should not include primary structure, cryostat, bioshield, nor buildings.



# Account # 22.1.6 (Vacuum System)

Includes cost of VV, cryostat, and pumping system

ARIES-	RS	AT	CS		
LSA	2	1	9/05	2 1/06	3/06
VV	62 (20-30 cm)	922 (25-40 cm)	53 (28 cm)	55 (28 cm)	? (~55) (28 cm)
Cryostat	100 (4.3 cm)	9 (0.4 cm)	0 (0 cm)	? (~75) (8 cm)	? (~50) (5 cm)
Pumping System*	38	23	81	?	?
<b>21.1.6 Vacuum System</b> (M\$- 2004\$)	<b>200</b>	<b>124</b>	<b>134</b>	<b>96</b> (should be >130)	<b>?</b> (should be >100)

ARIES-CS pumping system is too expensive. Why?

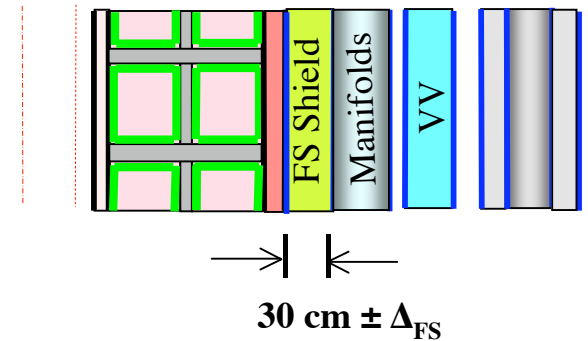
\* Depends on plasma parameters.

# Shield vs NWL Scaling Law

(Near-final radial build; average  $\bar{q} \sim 3 \text{ MW/m}^2$ )

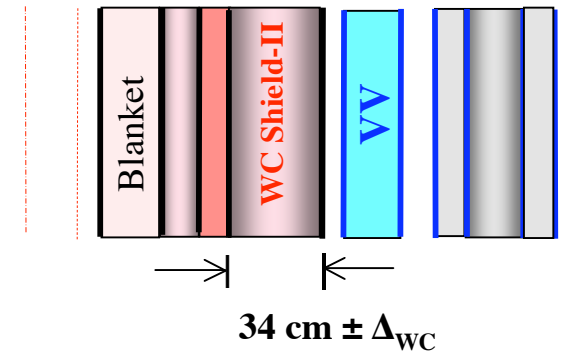
- Incremental change to nominal 30 cm FS shield:

$$\Delta_{\text{FS-shield}} = 7.3 \ln(\bar{q} / 3)$$



- Incremental change to 34 cm WC shield-II @  $\Delta_{\text{min}}$ :

$$\Delta_{\text{WC-shield-I}} = 5.9 \ln(\bar{q} / 3)$$



\*  $\Delta$  in cm and average  $\bar{q}$  in  $\text{MW/m}^2$ .



# Cryogenic Heat Load to Magnet

(Near-final radial build; average  $\square \sim 3 \text{ MW/m}^2$ )

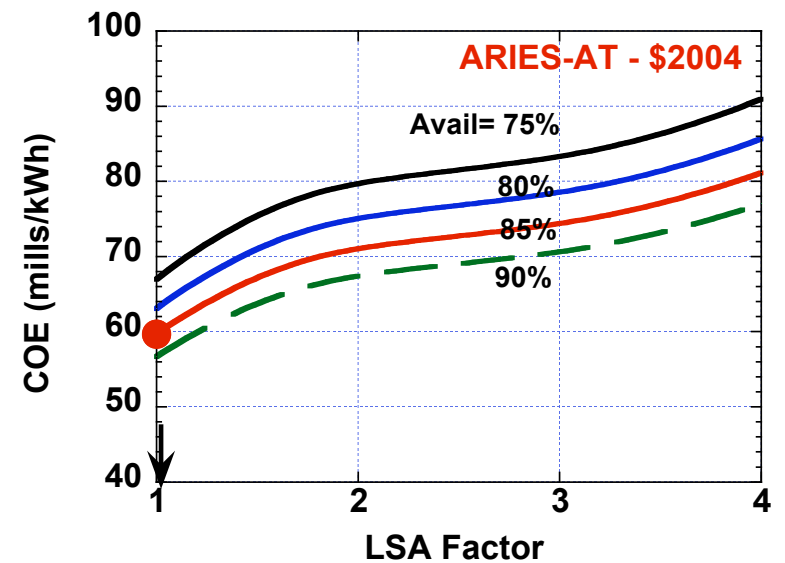
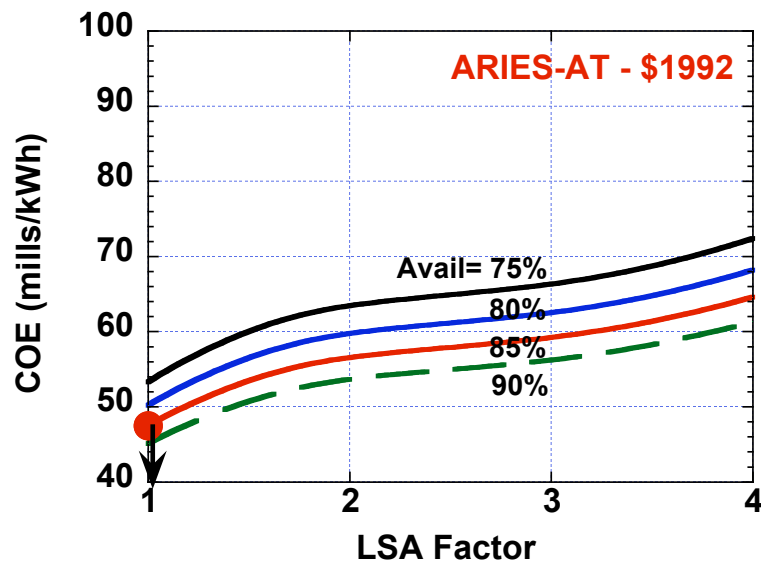
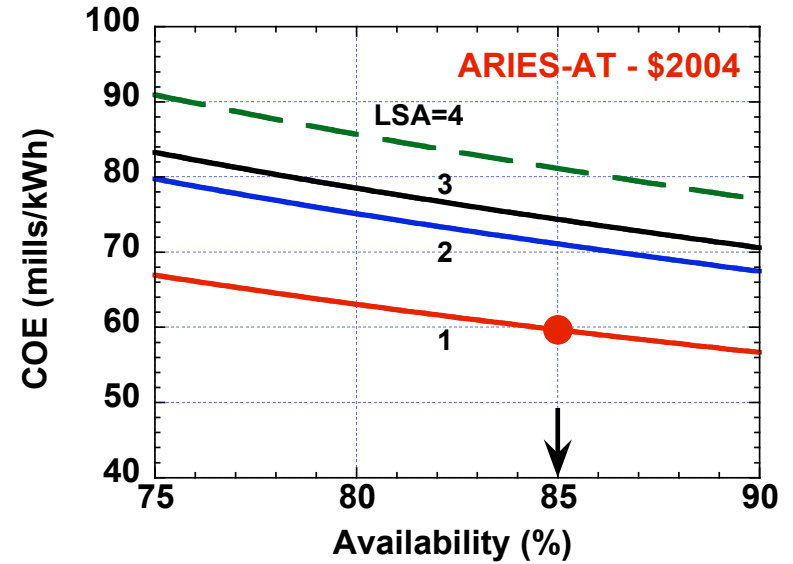
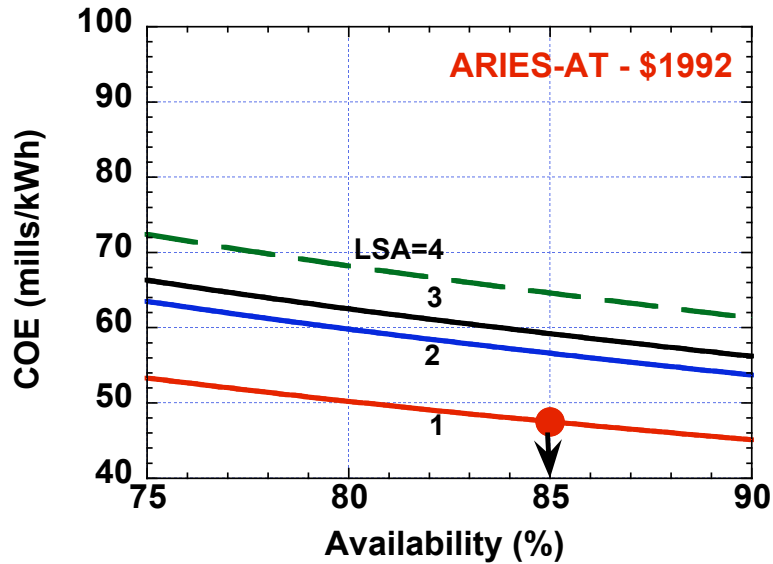
## Assumptions:

- Winding packs (WP) cover 32% of area.
- Inter-coil structure covers 68% of area.
- WP and structure @ 4K.
- 300  $W_e$  to remove 1 W of nuclear heating.

	<b>Nuclear Heating</b> (kW)	<b>Cryogenic Load</b> (MW <sub>e</sub> )
<b>2 cm Coil Case</b>	2.0	0.6
<b>18 cm Winding Pack</b>	2.9	0.7
<b>66 cm External Structure*</b>	<u>0.07</u>	<u>0.02</u>
<b>subtotal</b>	<b>5</b>	<b>1.5</b>
<b>35 cm Inter-coil Structure</b>	<b>10.7</b>	<b>3.2</b>
<b>Total</b>	<b>16 kW</b>	<b>~ 5 MW<sub>e</sub></b>

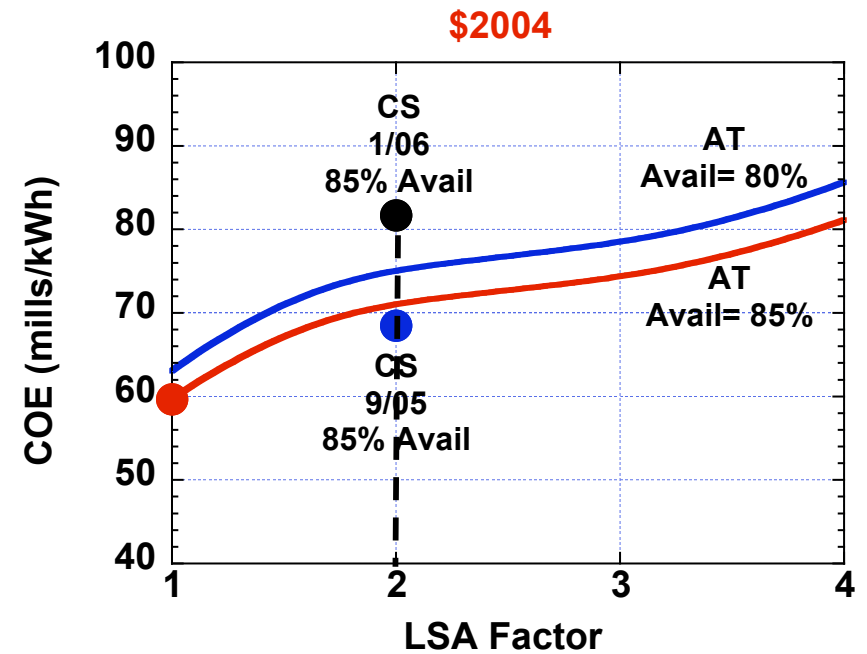
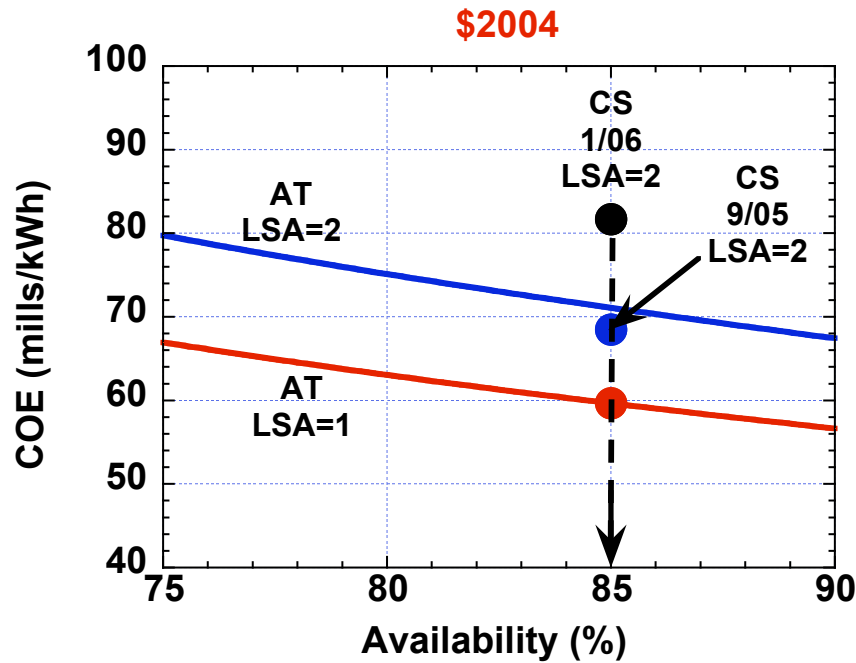
\* Behind WP only.

# Sensitivity of **ARIES-AT** COE to Availability and LSA



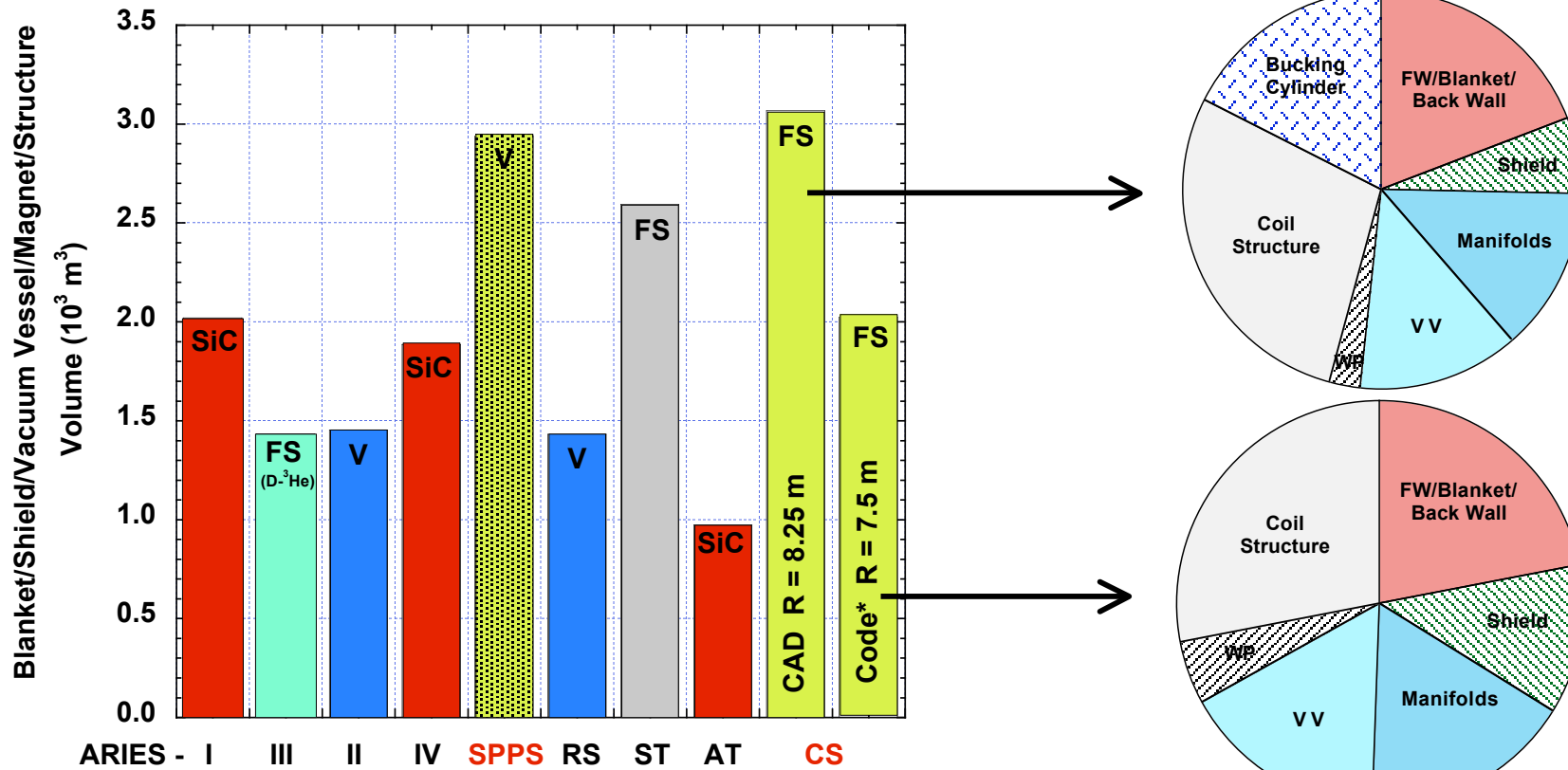


# Sensitivity of COE to Availability and LSA



# Radwaste Volume Comparison

(not compacted, no replacements)  
(cryostat and bioshield excluded)



Compared to 8.25 m machine, more compact 7.5 m ARIES-CS  
**and** removal of bucking cylinder reduced waste volume by 30%



# Future Plan

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- Changes to Systems code:
  - 30 \$/kg of WC, per Les
  - availability: 80 or 85% ? TBD.
- Provide radial build for **LiPb/SiC design** to systems code
- Provide radial build for **2 FP configuration** to systems code