

NCSX

WBS 1 Stellarator Core
Cost Considerations

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Cost Study

- **Goal:** Evaluate cost for each configuration to determine
 - What is relative cost of options?
 - Are cost differences among options significant?
 - Can any cost savings be identified?

- **Approach:**
 - Identify Cost Drivers / Discriminators
 - Develop a set of algorithms that can help evaluate the various configurations (relatively) quickly
 - Develop Cost estimate for each configuration option

Configuration Options to be considered

Option	Plasma	Conformal coils	Toroidal field / background coils	Poloidal field background coils
PBX-M	C82	4064* 30 saddles	20 PBX-M TF coils	PBX OH, EF21, 3 new pairs EF
Tilted TF	C82	536.3 30 saddles, 5 wavy PF	6 tilted TF coils per case 536	New OH system One pair VF
L=3	C82	619.4 36 saddles, 8 wavy PF	3 L=3 ,3 tilted TF per case 619	New OH system One pair VF
No-conformal	C82	N/A	TBD	New OH system
Modular	C82	N/A	0424 27 mod coils	2 pairs VF New OH system
TBD	PG2	TBD	TBD	TBD

* Access studies used FD121 coil set

Some of the Cost Drivers

Perceived cost drivers	Influences	Driven by	Scalable?
General			
overall size	nearly everything	physics req., cost constraints, PBX constraints	yes, over a small range
field	structure, current, etc.	physics mission	yes, over a small range
pulse length	current density, coolant type	physics mission	yes, over a small range
symmetry of background coils	no. of different component variations	PBX	somewhat
coolant / oper. temp.	need for cryostat	pulse length, current density	step function
PFCs			
no. of different types of tiles	tooling, NC tapes, assy time, spares	geometry, clearance	yes, if no. is known
VV			
shape of vessel	no. of dies, no. of weld seams	shape of plasma, periods	with CAD model
no. of field welds	assembly time	shape of plasma, periods	if no. of dies is known
no. of ports	no. of port interfaces	diagnostics, htg, coil shape	yes, if no. is known
bakeout temp.	port interfaces, insulation, cooling/heating tracing	physics req.	nebulous
Conformal coils			
no. of coil types	no. of leads, power supplies	coil optimization	somewhat
no. of turns	winding time, packing fraction	field errors, power supplies	somewhat
total no. of shell segments	no. of shell seg. casting patterns, no. of shell seg. NC tapes	time constant requirements	
width and length of slot	machining time	coil optimization	somewhat
no. of sizes of conductor	manf and winding tooling	coil optimization	somewhat

Cost Algorithm Progress

- Cost algorithms for various systems combined in spreadsheet format
- PFC, VV, Cryostat, TF, PF, Conformal Coils have been incorporated
- Costs mapped into new WBS (April 00 version)
- The WBS 1 systems will be completed first (stellarator system, incl background coils), then WBS 7 (machine assembly).
- First cut at “In-PBX”, “Tilted TF” and “L=3” options
- Machine structure, assembly and Modular coils not incorporated yet

What do we expect for different options?

	Opt. 2C, (12/98) (\$k)	4064 in PBX (\$k)	Tilted TF coil (\$k)	L=3 option (\$k)
1 Core Systems	\$12,869			
conceptual design	\$984	No change	No change	No change
11 - Plasma Facing Components	\$4,045	No change	No change	No change
12 - Vacuum vessel	(incl in PFCs)	No change	No change	No change
13 - TF (background) Coil Systems	\$26	No change, maybe +	Much higher, new coil set	Much higher, new coil set
14 - PF Coil Systems	\$0	Higher, 3 pairs new coils	Higher, 1 pair new coils	Higher, 1 pair new coils
15 - Cryostat	\$575	Lower for new design	Cost = 0 for J<10kA/cm ²	Cost = 0 for J<10kA/cm ²
16 - Machine Structure	\$695	About the same	Unknown, assume higher	Unknown, assume higher
17 -Conformal Coils	\$6,544	higher	No change?	No change?

How do options compare so far?

Core Systems Preliminary information

	Opt. 2C, (12/98) (\$k)	4064 in PBX (\$k)	Tilted TF coil (\$k)	L=3 option (\$k)
1 Core Systems	\$12,869	\$15,646	\$20,480*	\$20,856*
conceptual design	\$984	\$984	\$984	\$984
11 - Plasma Facing Components	\$4,045	\$1,748	\$1,748	\$1,748
12 - Vacuum vessel	(incl in PFCs)	\$2,975	\$2,975	\$2,975
13 - TF (background) Coil Systems	\$26	\$53	\$5,377	\$5,671
14 - PF Coil Systems	\$0	\$398	\$159	\$150
15 - Cryostat	\$575	\$189	\$189	\$189
16 - Machine Structure	\$695	\$365	\$0*	\$0*
17 -Conformal Coils	\$6,544	\$8,934	\$9,048	\$9,140

*incomplete cost

How do options compare so far?

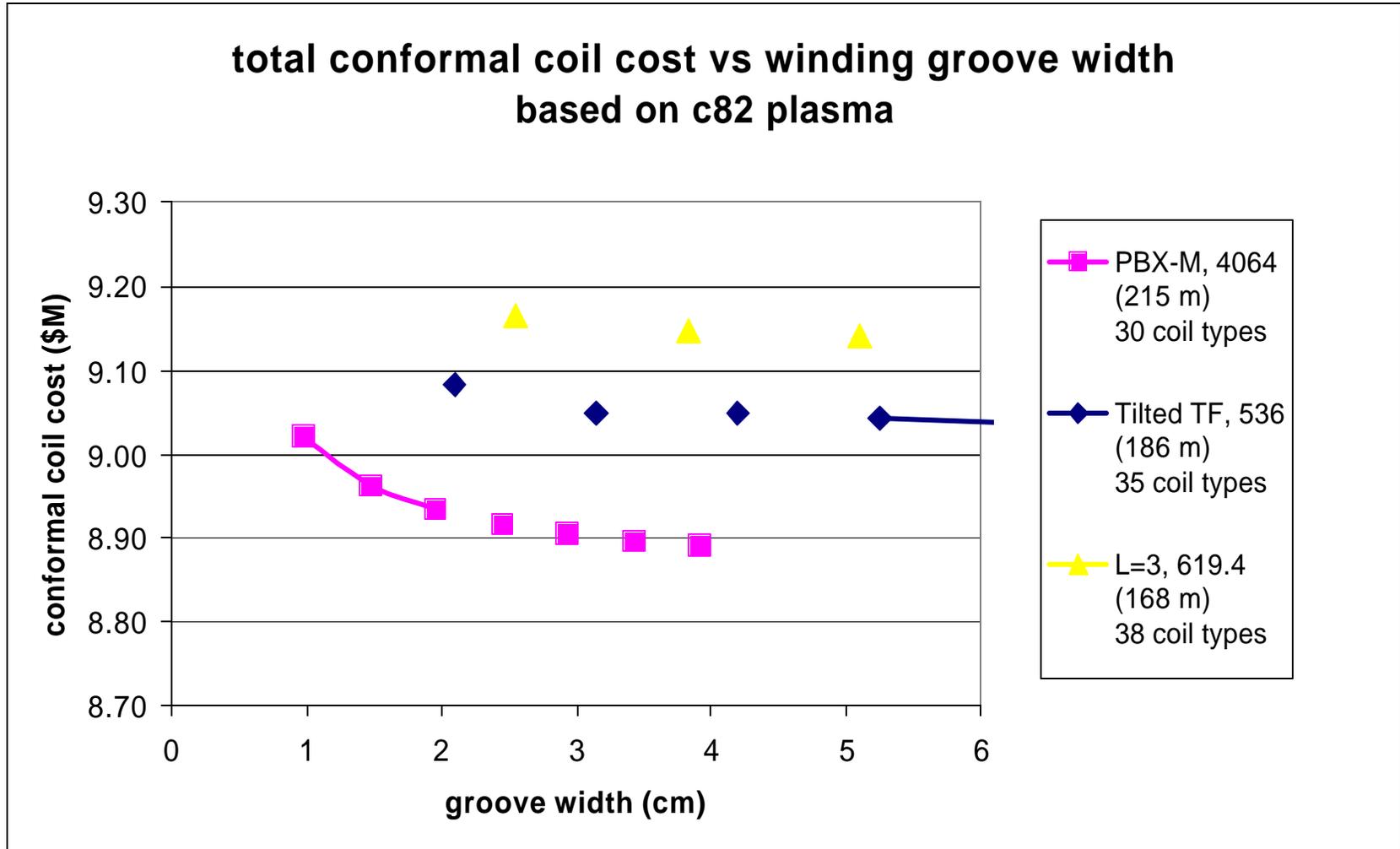
All Systems Preliminary information

	Opt. 2C, (12/98) (\$k)	4064 in PBX (\$k)	Tilted TF coil (\$k)	L=3 option (\$k)
1 Fusion Core Systems	\$12,869	\$15,646	\$20,480*	\$20,856*
2 - Auxiliary Sys (Htg, fuel, etc)	\$2,288	\$2,288	\$2,288	\$2,288
3 - Diagnostics	\$1,674	\$1,674	\$1,674	\$1,674
4 - Power Systems	\$1,864	\$1,864**	\$1,864	\$1,864
5 - Central I&C and Data Acq.	\$2,323	\$2,323	\$2,323	\$2,323
6 - Site and Facilities	\$6,495	\$6,495	\$6,495	\$6,495
7 - Machine Assembly	\$4,775	\$4,775	\$2,497	\$2,497
8 - Project Oversight & Support	\$11,402	\$11,402	\$11,402	\$11,402
9 - Pre-Op. Planning / Testing	\$260	\$260	\$260	\$260
Total, with contingency:	\$43,950	\$46,727	\$49,659*	\$49,659*
Average Contingency	20%	21%	21%	21%

*incomplete cost

**inconsistent with coil requirements

Scaling: Conformal coil cost vs winding slot width



Cost Algorithm Questions and Issues

- Main issue is including all the cost elements. This requires additional design, which should be the focus near term.
- Secondary issue is including all the cost drivers, or variables that discriminate one configuration from another, and which could provide some scaling information
- Finally, the cost algorithm should be reviewed again by interested parties

Cost summary

- **Are we reaching goal?**

- What is relative cost of options? ~\$50M +/- \$5M
- Are cost differences among options significant? New coils cost more
- Can any cost savings be identified? Cryostat, meas. system

- **Status:**

- Identified Cost Drivers / Discriminators
- Cost algorithm framework developed
- Cost estimates developed to some level for three configurations