



ILC RF Unit Industrial Cost Study Methodology & Results

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Overview

- As part of the GDE mission, Advanced Energy Systems, Inc. (AES) and their team partners, Communications and Power Industries (CPI) and Meyer Tool and Mfg. Company (Meyer), were contracted through Fermilab to conduct a US industry based cost study for fabrication of the Cryomodules and RF Power systems that make up the RF Units of the ILC.
- Production quantities of 1, 250 and 750 RF Units were specified
- This talk will review the costing methodology used and top level results

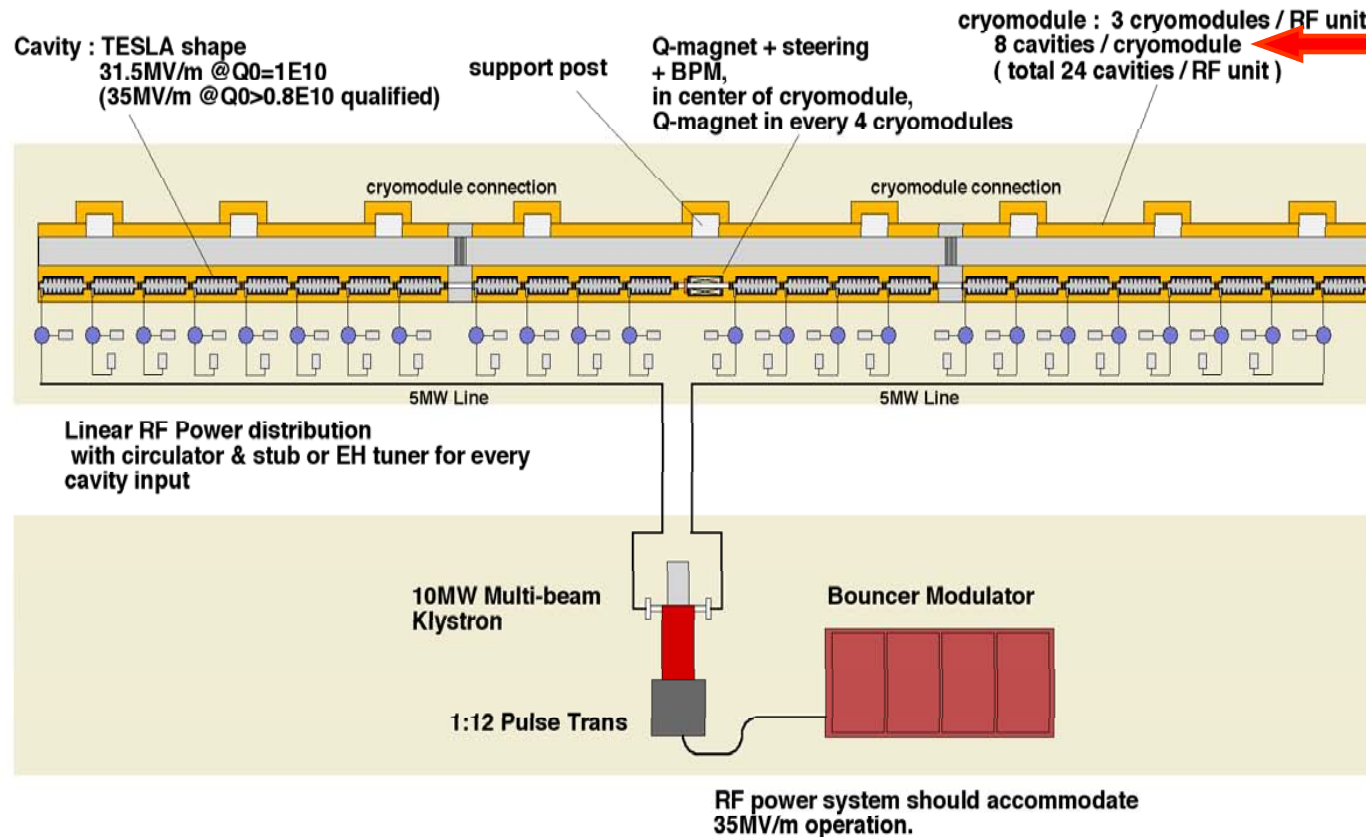


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RF Unit Configuration (8 cavities/cryomodule)



Note: The RF Unit configuration has since been changed from 24 to 26 cavities

An RF Unit consists of 3 cryomodules and one RF power system

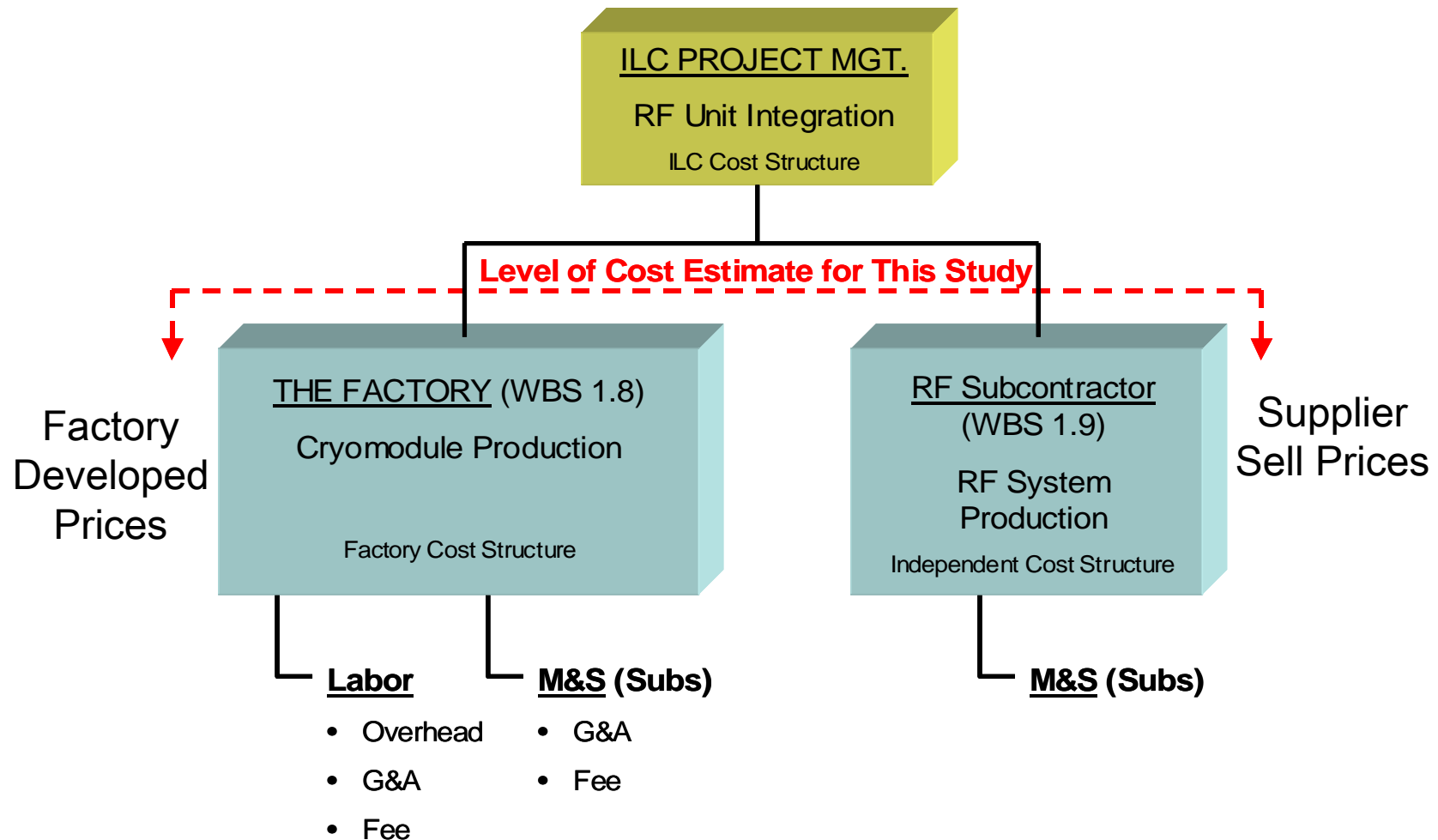


Main Assumptions

- A government-owned facility (“The Factory”) will provide the equipment and space for superconducting cavity fabrication and processing, and integration and checkout of the cryomodules
 - Located at or nearby Fermilab.
 - The cost of the setup of The Factory is not part of this study
 - Industry will conduct the work at The Factory, so they will also operate it (overhead & G&A costs included)
- RF Equipment will be procured through the local ILC program infrastructure – not through The Factory



Cost Model





Resulting Top-Level Costs (Normalized)

Quantity of RF Units	1	250	750
Total Quantity Cost	2.35	250	694
Per RF Unit Cost	2.35	1.00	0.92
CM w/Magnet (1 per RF Unit)	0.51	0.23	0.21
CM wo/Magnet (2 per RF Unit)	0.33	0.20	0.20
Per RF Power System	1.17	0.36	0.32

(1) The fidelity of the cost estimate is +/- 24%

(2) The cost of one RF Unit in this study is not representative of what the cost of an initial prototype would cost today because the single unit cost presented herein is based upon production methodology that is not yet in place.

Nominal Case

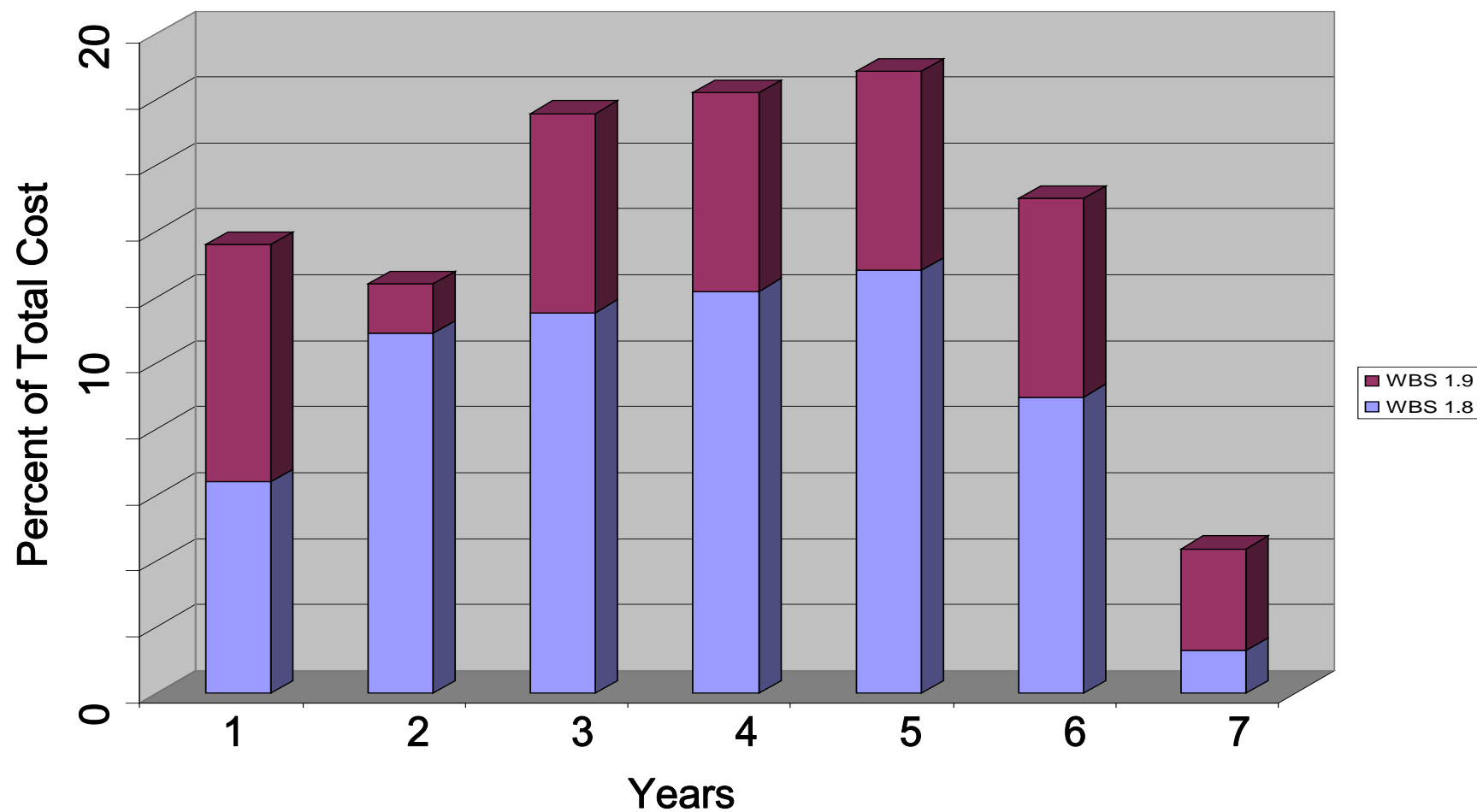


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Funding Profile for 250 RF Units



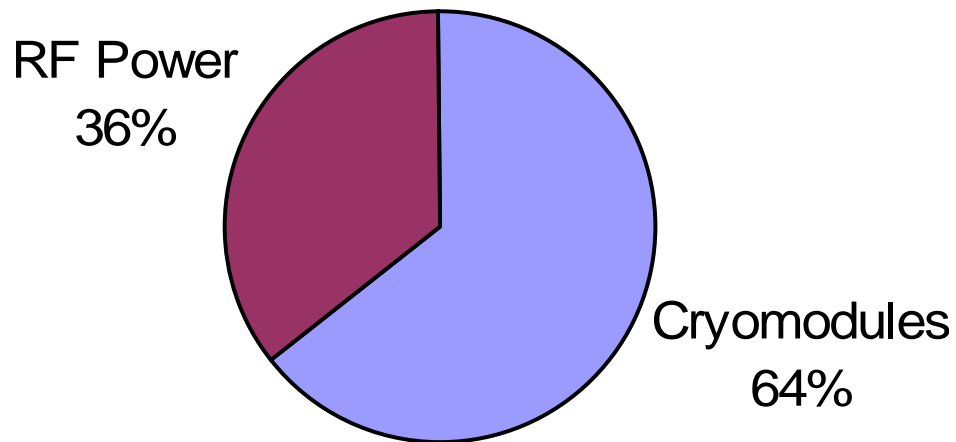
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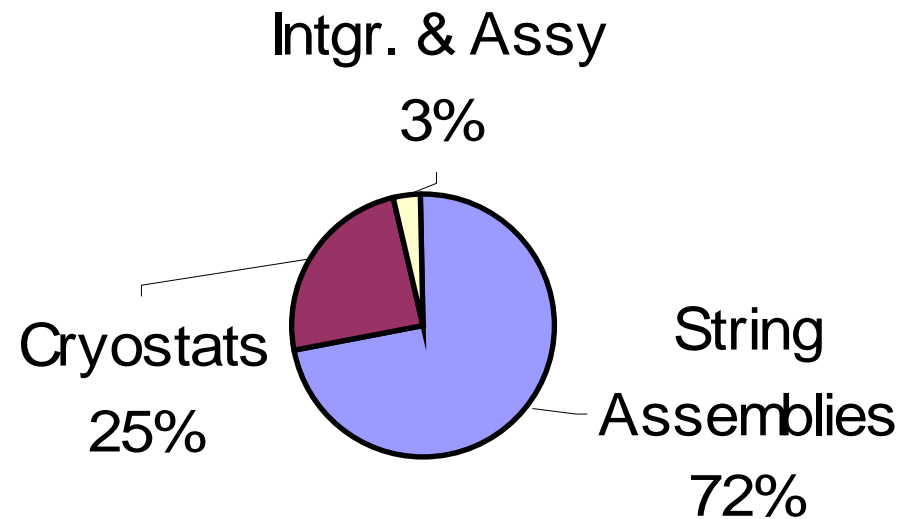


Cost Drivers (i)

RF UNIT COST



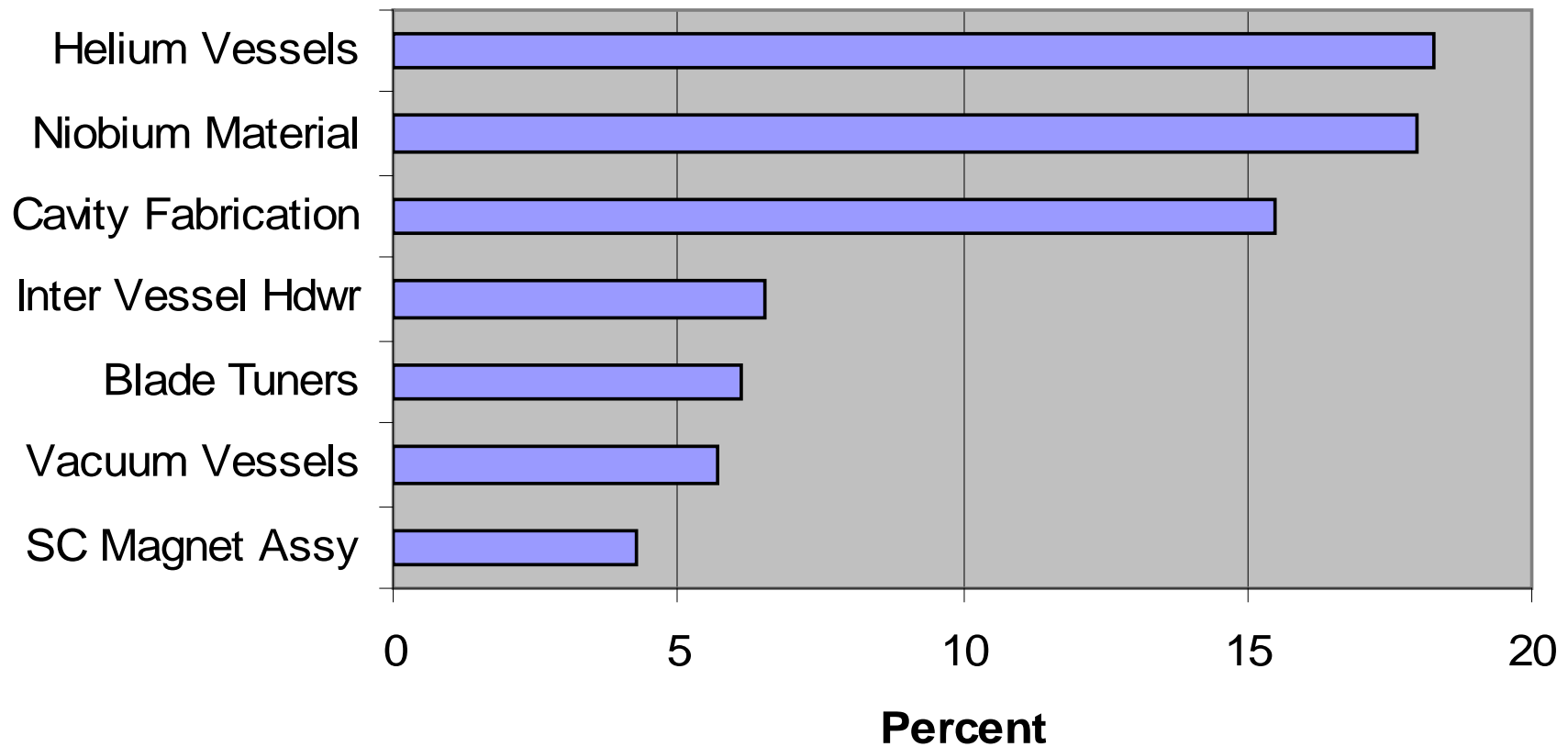
CRYOMODULE COST





Cost Drivers (ii)

PERCENT OF CRYOMODULE COST





Planned Production Rate

Year	RF Units Annual Production Rate
1	--
2	SOP @ 20 months
3	6
4	36
5	82
6	86
7	40 (only 1/2 year)

Production work in The Factory begins after 20 months to allow for factory setup and startup.

Procurement of materials and RF subcontracts can begin during the first year.

Peak rate of 9 SC cavities per day



Factory Equipment Requirements

For the Nominal Production Run of 250 RF Units

Equipment Description	Quantity
Niobium Material Scanners	6
NC Machines	11
BCP Systems	2
E-Beam Welders	18
RF Tuning Benches	8
Electro-polishing Systems	7
High Temp. Vacuum Ovens	7
High Pressure Water Rinse Systems	12
VTA Systems (may be able to share RF power)	18
String Assembly Lines	5
Vacuum Vessel Final Assembly Fixtures	5
Cryomodule Integration & Assembly Lines	21



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Summary & Conclusions

- This is the first time that US industry has participated in ILC costing
 - Presented costs are realistic based upon current knowledge
- Some WBS element costs may be reduced further by:
 - Design configuration refinements
 - Cavity processing optimization
 - Manufacturing optimization & workflow improvement
- The few key companies that have been previously involved in SC cryomodule fabrication were responsive to our cost inquiries
- There was very little demonstrated interest by other outside fabricators to participate
 - They do not believe it is real
 - It will interfere with their present long term business



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Follow-up Recommendations

- Evaluate potential revisions to the present cost study
 - Incorporate the latest guidance of the GDE on configuration & processing
- Develop qualified set of contract machining companies for niobium cavity parts
 - Potentially significant (~25%) cavity fabrication cost reduction
- Develop process improvements (fabrication & processing)
 - Study was based mostly upon present methods
- Develop cost estimate for design & fabrication of special production tooling for cryomodule fabrication & assembly
 - This was not part of the initial study scope
- Develop plan & cost estimate for “The Factory” setup
 - This was not part of the initial study scope (significant project cost)



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