Status of U.S. Industrial Cryomodule Studies in U.S.

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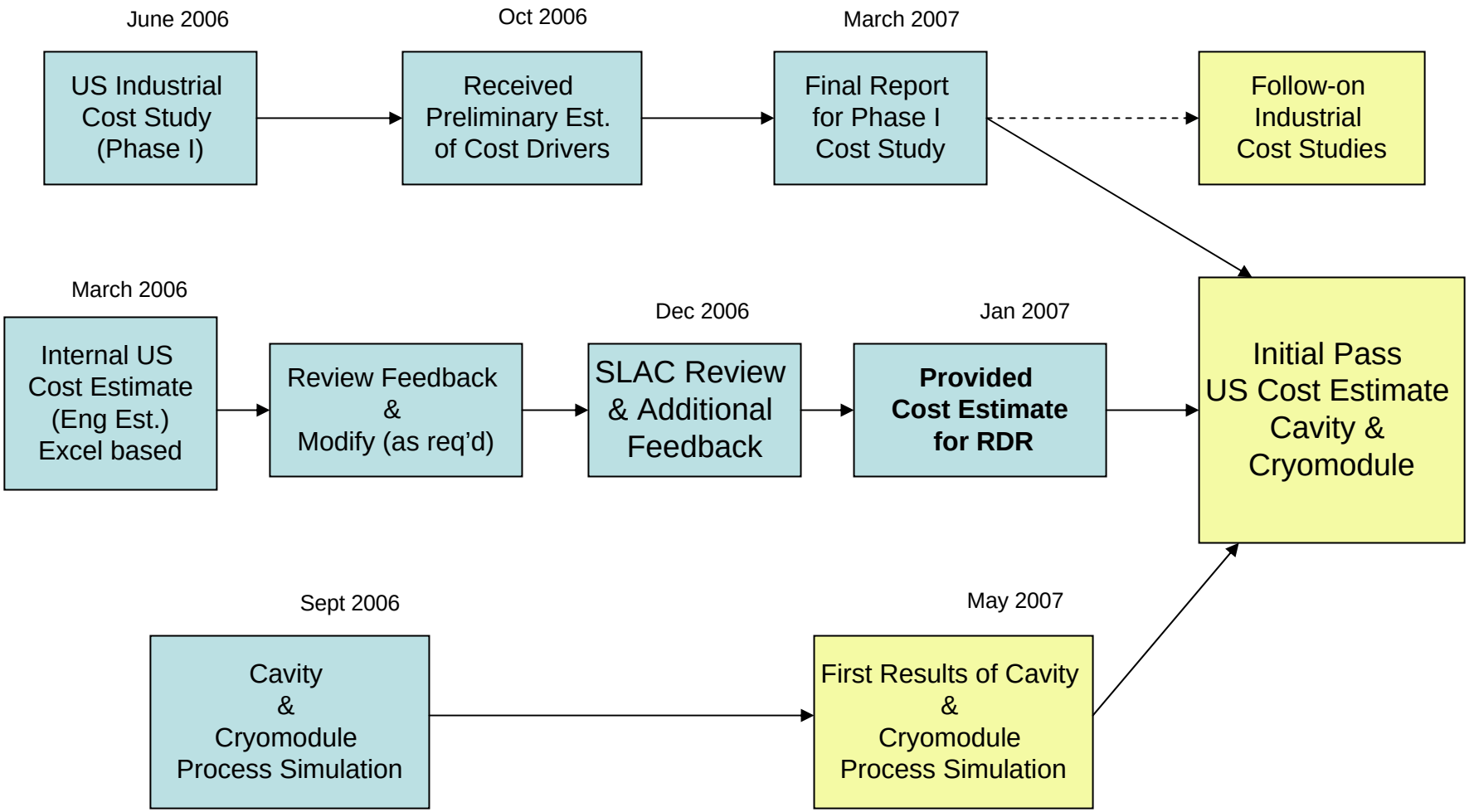
Preface

- U.S. effort to develop a cost estimate for ILC cryomodules was split into two parts
  - **Internal Estimate**
    - Using team from FNAL, JLab and SLAC
    - Developed a cost model using engineering estimates, vendor quotes, scaling from actual purchases, etc. as basis
    - Costed all elements of cryomodule construction
    - MS Excel based (easy to modify to look at scenarios)
    - Used as U.S. input for RDR cost estimate
  - **Industrial Cost Study (first part – cryomodule only)**
    - Industrial team led by AES, Meyer Tool and CPI
    - Got a very late start (inability to get PO in place) but made up a lot of time and produced a final report in early 2007
    - Very systematic with many details and vendor quotes as back up
    - Presentation at PAC 2007 (June - Albuquerque)

Process of Cost Estimation



ILC RF Unit Industrial Cost Study Methodology & Results

E. Bonnema - Meyer Tool & Mfg., Inc.

J. Sredniawski - Advanced Energy Systems, Inc.

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

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Resulting Top-Level Costs (Normalized)

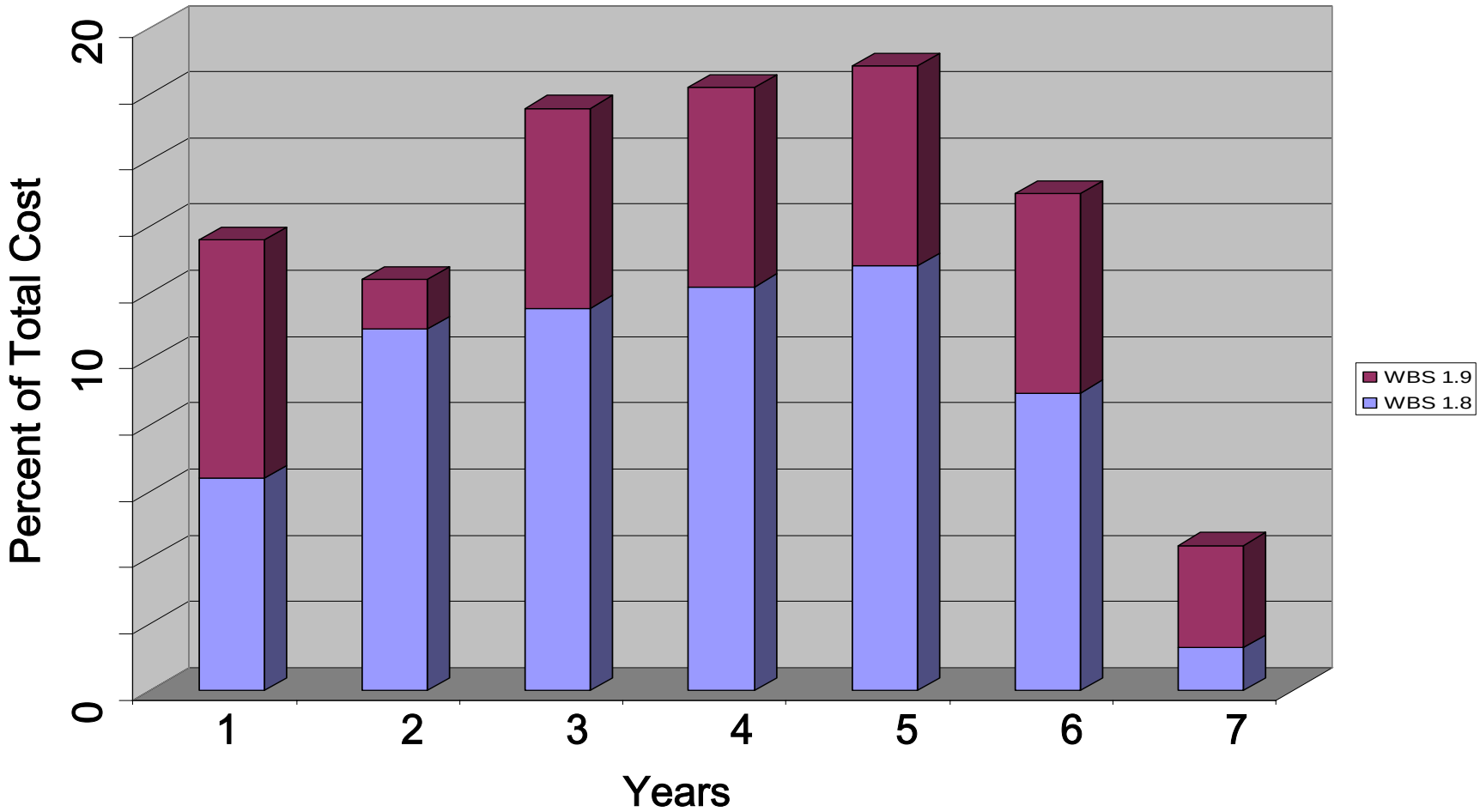
Quantity of RF Units	1	250	750
Total Quantity Cost	2.35	250	694
Per RF Unit Cost	2.35	1.00	0.92
CM w/Magnet (1 per RF Unit)	0.51	0.23	0.21
CM wo/Magnet (2 per RF Unit)	10.33	0.20	0.20
Per RF Power System	1.17	0.36	0.32

Nominal Case

(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.

Funding Profile for 250 RF Units



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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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Where Are We Now

- U.S. RF Unit Cost Study gives us a very independent cost estimate based on industrial supplier input (actual suppliers of components)
  - **Need to use it to the fullest extent possible to question ourselves and improve our final numbers**
- Internal estimate gives us an easy way to incorporate new component costs
- U.S. just beginning to begin to build ILC cryomodules => better understand entire process
- Have a group of industrial companies that has an interest and expertise in SRF technology and now has a better feel for cost driver issues
  - **Need to build on this and try to integrate them with the ongoing U.S. ILC cryomodule efforts**

What's Next

- Comparison of Internal vs. Industrial cost estimates
  - **Cost for individual cryomodule components**
  - **Assembly times**
  - **Amount of infrastructure (EBW, EP stations, Ass'y lines, etc.)**
  - **Try to understand the differences**
- Finish off the Type IV cryomodule design so we can estimate more exactly what we will build
- Incorporate industry's ideas for cost reduction and Design for Manufacturing (DFM)

What's Next (cont'd)

- Better track the cost of a cryomodule (now)
  - **Use data from FNAL production and other efforts (Cornell ERL)**
- Finish off the U.S. Industrial Cost Study by estimating the cost of infrastructure (The Facility)
- Targeted industrial studies => attack cost drivers (include funds for industry-aided design & production of components to test assumptions)
  - **Include new fabrication techniques (hydro-forming and high speed machining)**
- **Develop an U.S. Industrialization Plan**

Summary

- ILC cryomodule cost estimation is a process
  - **Have started this process but we're not finished**
- Need to question our assumptions and be able to defend our estimates to our funding agencies (review committees)
  - **Develop a strategy (time line) for adjusting the assumptions/designs (proven validity) and locking down the cost estimate**
- U.S. cost estimation effort got a late start but has hopefully supplied some important information to the ILC Cost Engineers
  - **Will continue this effort as time and funding allows**