ILC Industrial Forum @SLAC
May 1-2

RF Sources

Process:Parts Ratios
Cost Reduction Strategies
Manufacturing Model

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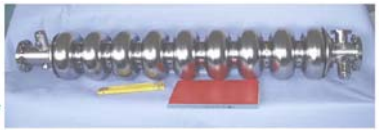
Part/Assembly Counts

- Klystrons and Modulators ~700
  - Waveguide Components
    - WG Flange Joints ~200,000
    - WR650 ~175000 ft
    - E-plane bends ~72,100
    - Flex WG, Directional Couplers, Circulators and load ~17,000
    - Hybrid Couplers and loads ~14,000
    - H-plane bends ~8000
    - Magic Tee ~700
  - Cryomodules ~2100
  - Cavities and RF Coupler ~17,000

Process:Parts Ratio (Labor:Material Cost) as a Function of Final Product/Assembly Cost



SRF Cavity 2:1

RF Coupler 2:1

New MBK 1:2

Active WG Components

Passive WG Components

Modulators 1:9

Process:Parts Ratio: Low → High

Final Product/Assembly Cost: Low → High

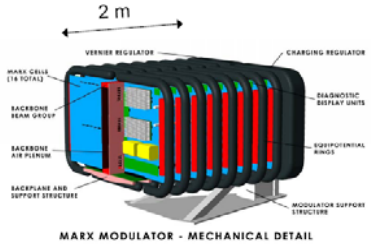
Cost Reduction Strategies

Process:Parts Ratio

High

Low

Redesign
•Smaller
•Compact
•Modular
•Reduced Part Count



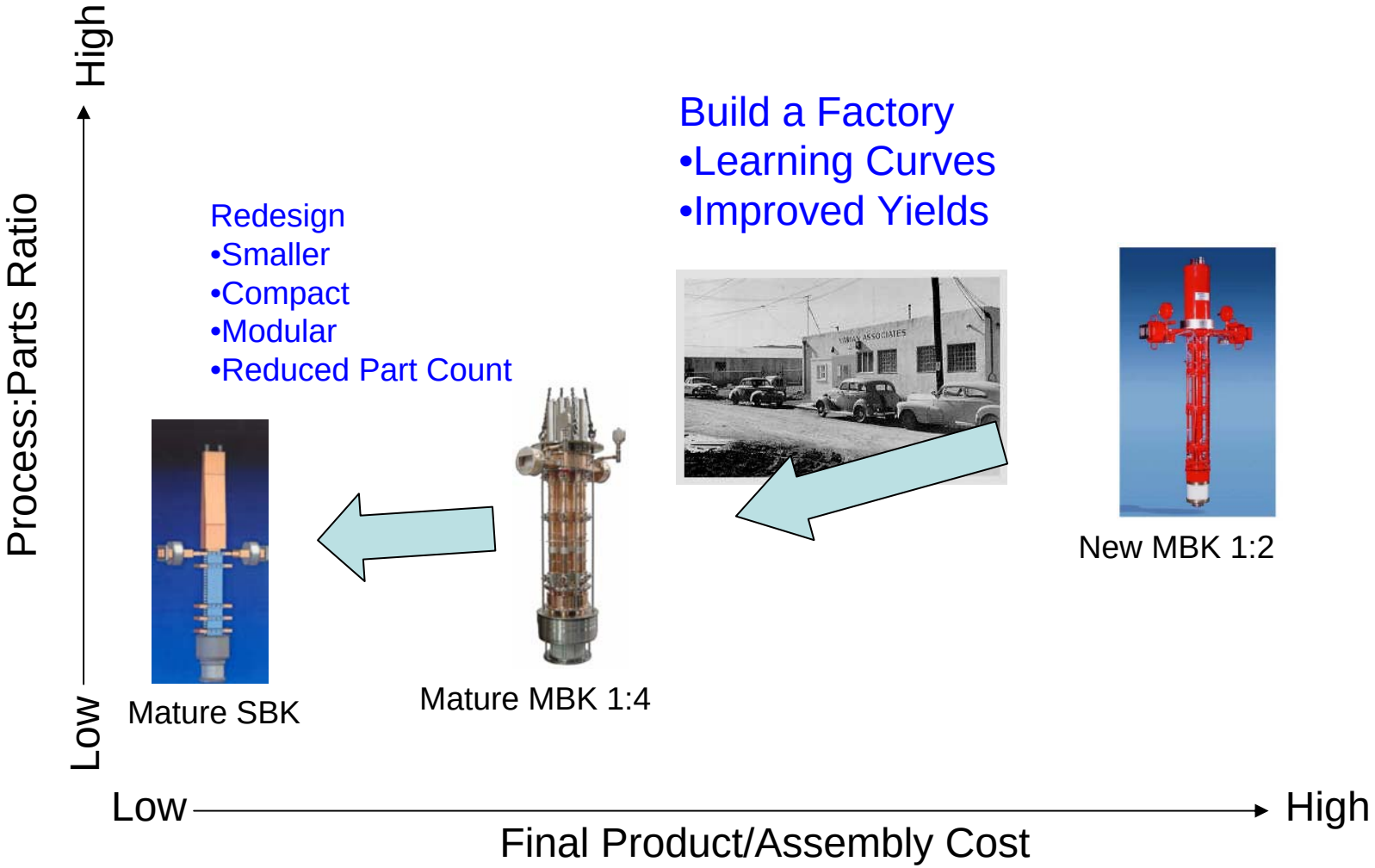
MARX Modulator

Modulators 1:9

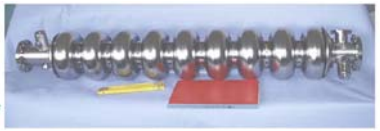
Low — High

Final Product/Assembly Cost

Cost Reduction Strategies

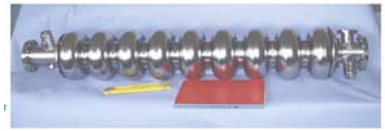


Cost Reduction Strategies



SRF Cavity 2:1

RF Coupler 2:1



SRF Cavity

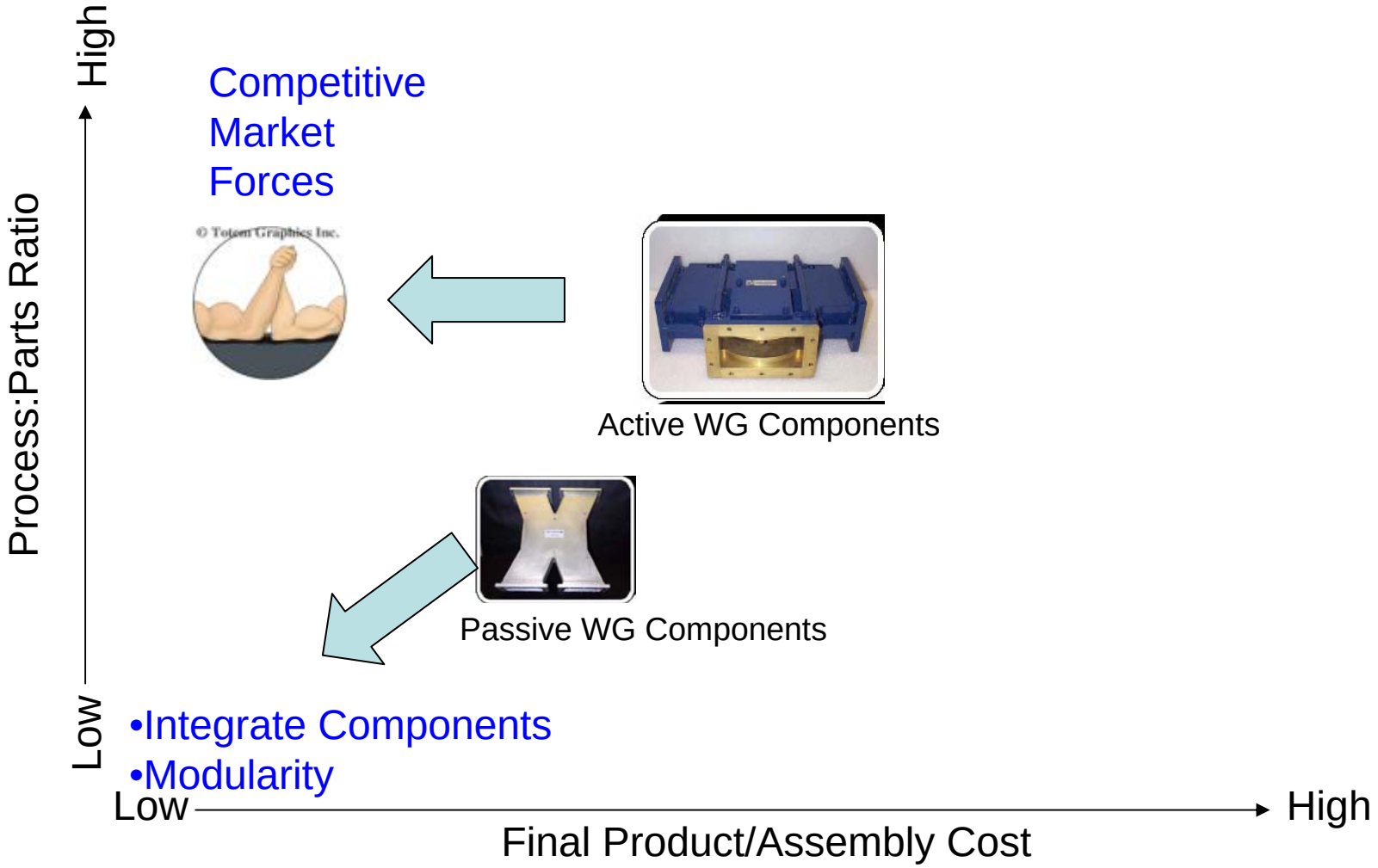
RF Coupler

- Redesign/New Processes
  - Ti coating RF coupler
- Automate Processes
- Pre-Process Raw materials
  - Large/single grain Niobium

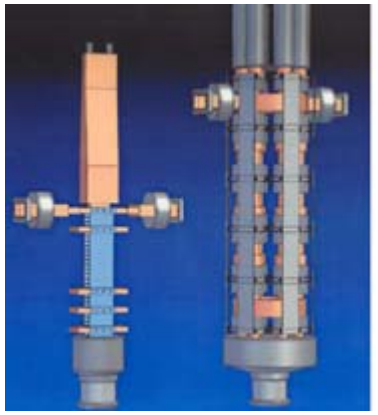
Process:Parts Ratio: High / Low

Final Product/Assembly Cost: Low → High

Cost Reduction Strategies



Process:Parts Ratios Tend to Drive Cost Reduction Strategies



SRF Cavity 67:33

High Power RF Coupler

Redesign materials and processes

Mature MBK 33:67

Factory learning curves

Mature MBK 18:82

Basic Redesign

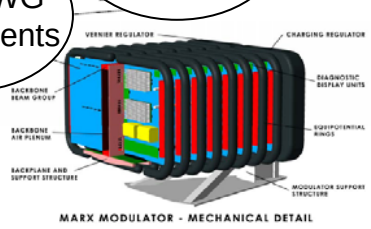
Mature SBK 18:82

Market Forces

Active WG components

Passive WG components

Modularity



MARX

Basic Redesign

Modulators 10:90

Process:Parts Cost

High

Low

Low

High

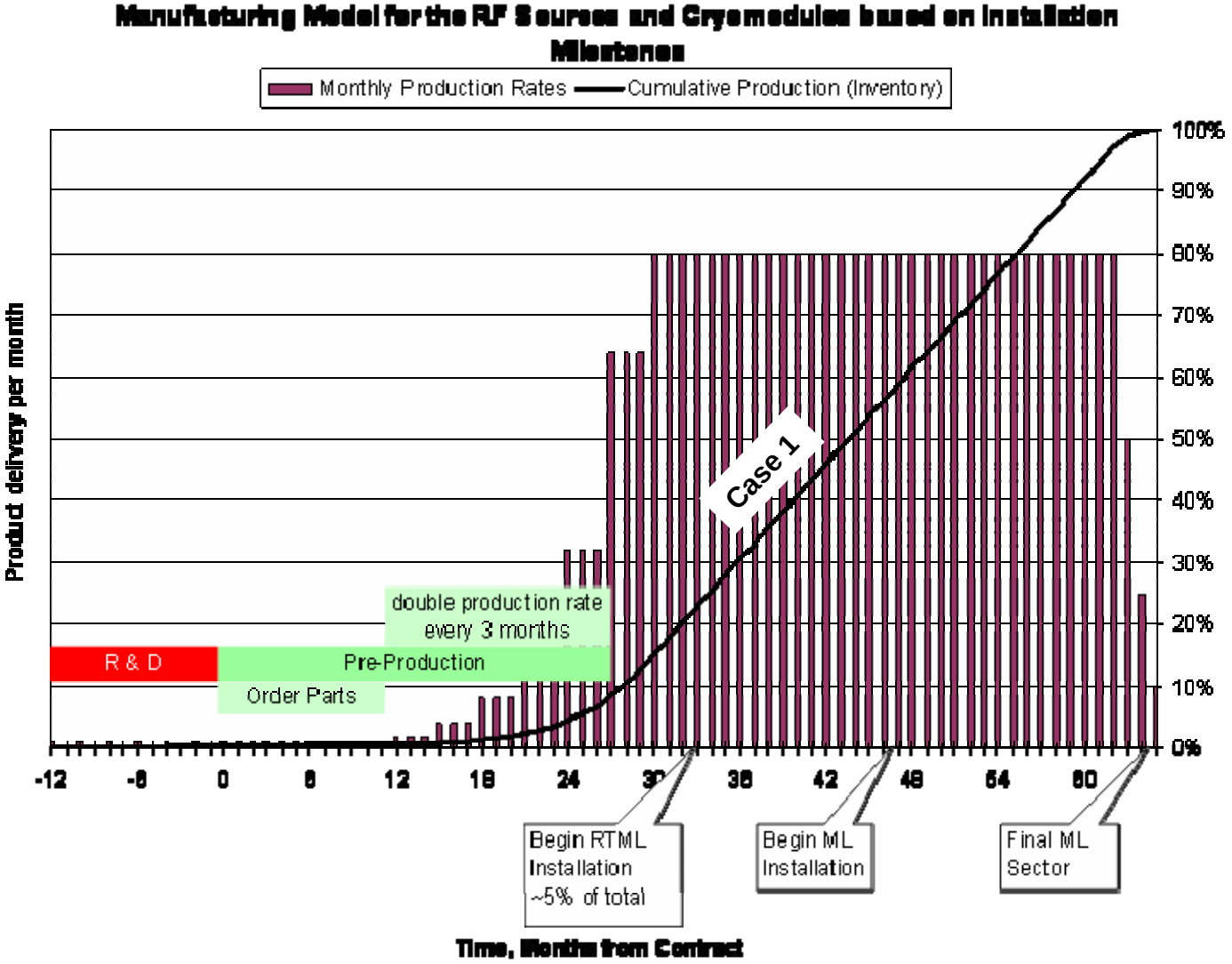
Final Product/Assembly Cost

Manufacturing Model
Program Planning

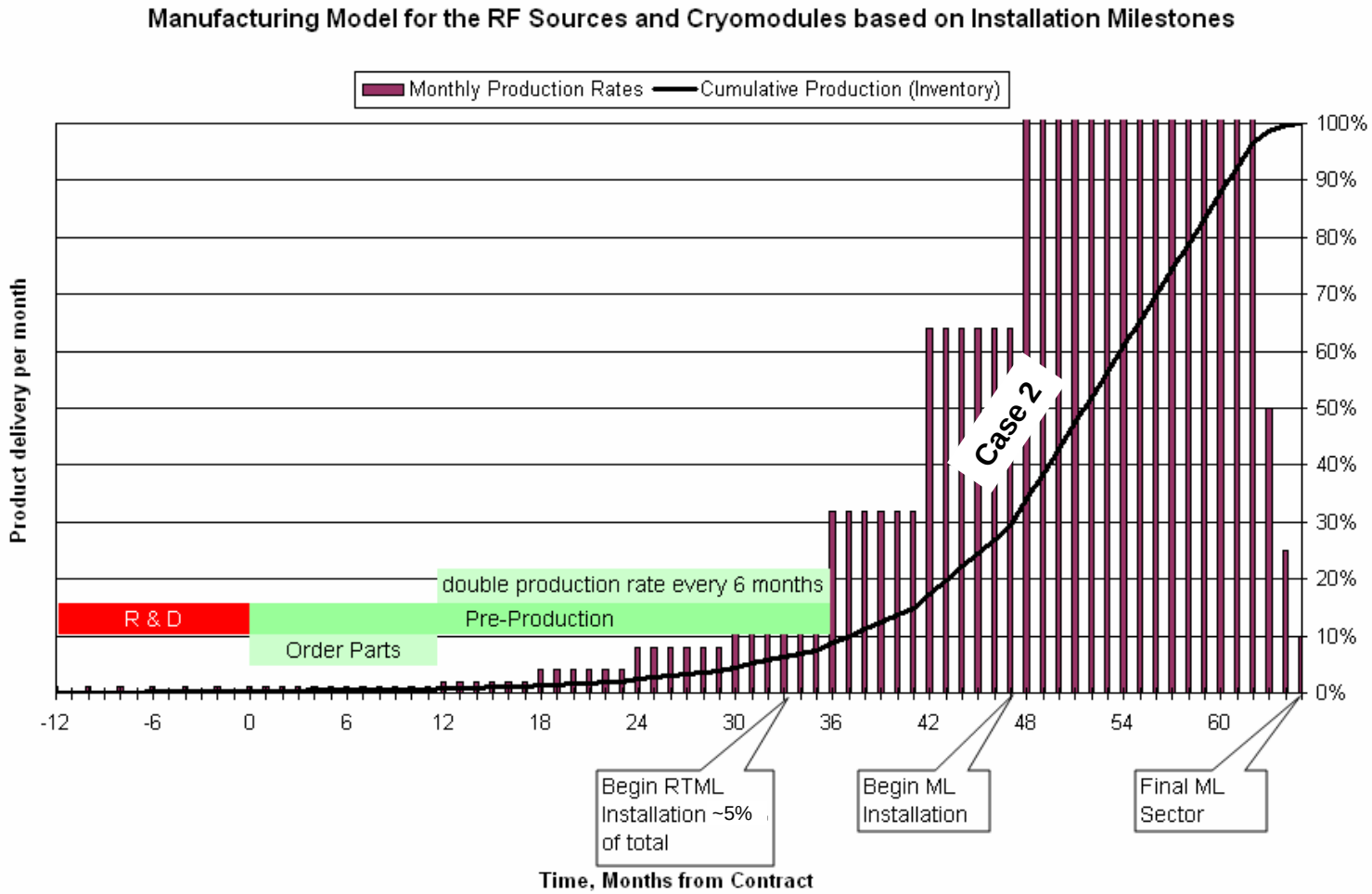
- A general high volume microwave tube rule
  - ~10% of the production contract is needed to produce sufficient learning to begin to go down the learning curve

Implications for Program Planning and Costing

- High upfront costs
- Need Sufficient pre-production volume
  - Need upfront DFM capability
- Manpower Requirements
  - Front loaded technicians and engineers
- Design and Fabrication of fixturing



Concept Design	R&D	Design	Sustaining Eng, Test Systems	Install, Integrate, and Test



Concept Design	R&D	Design	Sustaining Eng, Test Systems	Install, Integrate, and Test

Implications of the Manufacturing Model based on Installation Milestones

- Large Inventories at beginning of ML installation or high production rates (capacity)
  - Case 1 (~3 years flat production rates)
    - peak rates of ~57 cryomodules and ~19 Klystrons and modulators per month
    - Inventory at start of ML installation ~1000 cryomodules
    - ~2 years in storage
  - Case 2 (~1.5 years flat production rates)
    - Peak rates of ~100 cryomodules and ~33 Klystrons and modulators per month
    - Klystron Factory model: 50% increase in manufacturing plant and equipment costs
    - Inventory at start of ML installation ~500 cryomodules
    - ~1 year in storage
    - Klystron Factory model: ~5% added total costs

Summary for Industry Feedback

- Are the cost-reduction strategies in the right place?
- Are the tradeoffs between production rates and inventory problematic?