Project Evaluation
Overview and Cost Evaluation

Winter 2001 Collaboration Meeting
February 27 - March 2, 2001
Overall Perspective

• Lehman Review of NLC R&D Program in May, 1999
• Subsequent DOE Guidance: Vigorous R&D Program to:
  – Improve the Energy Reach of the NLC
  – Reduce the Cost of the NLC
• Machine Topology Changed to Extend Energy Reach
• Ongoing R&D Cost Reduction Efforts
  – First Checkpoint in April, 2000 (CD 0.4)
  – Current Checkpoint – NLC 2001
  – Categories of Activity (Oversimplified):
    • Analytical Solutions – Apply Accepted Methodology in a New Way
    • Technology Demonstrations – Validate a New or Extended Technology
      – Increased Emphasis Here to Capture Bigger Payoff Technologies
Path to April, 2000

- **Injector Systems**
  - Improved Optics/Lattices
  - Simplified Bunch Compressor 2 (Improved Optics)

- **Main Linac RF System**
  - Reduced the Modulator and Klystron Count by 2
    - Doubled the Pulse Length
  - Moved to a Two-Mode RF Distribution System (Was One Mode)

- **Beam Delivery**
  - Improved Optics Throughout – Major Length Reductions

- **Conventional Facilities (FESS)**
  - Cut and Cover with Fewer Access Points
  - Reduced Redundancy Allowance and Central Campus Scope

- **Electrical/Mechanical Systems**
  - Permanent Magnets; Electromagnets on Strings; More Power Supply Varieties (Not One Size Fits All)
  - Electronics in Enclosures in Tunnel
Size of the Task
(Costs w/o Escalation and Contingency)

• **Cost**
  – May, 1999 NLC Cost was $5.1 B
  – May, 2000 NLC Cost was $3.7 B
    • 27% Reduction

• **That Was the Good News. The Other News:**
  – Klystron Must Run with Twice the Average Power
  – Solid State Modulator Must Run Eight Klystrons at Once
  – Two Mode RF Distribution System Must Work
  – Permanent Magnets and Beam-Based-Alignment Need to Co-Exist
  – Main Linac Structures are Being Unacceptably Damaged in Tests
  – The Positron Target Cannot Handle the Required Power
  – Collimation and Ground Motion Solutions Remain Un-validated
  – We Need More Machine (Two IR’s; Low Energy Bypass Lines)
Path to NLC 2001

- **Physics (Voice of the Customer) Input Assimilated**
  - Two IR’s (Concurrency Not Excluded), 120 Hz, Bypass Lines, 1 TeV Tunnels, 70 MV/m Gradient

- **Injector Systems**
  - Optimized Site-Specific Topology
  - Cost/Performance/Risk Trade-Offs Made (e.g. S-Band)

- **Main Linac**
  - 90 cm X-Band Structures

- **Beam Delivery**
  - Optimizing Around Two IR’s Decision

- **Conventional Facilities/FESS**
  - Siting and Cooling Optimization Underway

- **Execution (Implementation) Choices**
  - Low Energy IR Start-Up, Annual Funding/Years to Complete Options Being Explored
Where Are We Today?

- Current NLC 2001 Cost Unknown
  - Range is $3.5 B - $4.0 B
- NLC 2001 Configuration Being Digested
- Many of the Choices to Reduce Cost…
  - Add More Risk
  - Need Demonstration
  - Remain to be Demonstrated
  - Are the Basis of Our R&D Plans Discussed This Week
  - Or, Require More Optimization/Trade Studies/Conceptual Design
- We Know Enough to Move Ahead On:
  - Positron Target
  - Optimized Siting
  - Cooling System Optimization
  - Many Other Areas
Where is the Money?
(Very Rough JCC Estimates)

- Injector Systems ~ $590 M (35% Sources / 40% DR’s / 25% Pre-Linacs)
  - Large Variety; Low Quantities
- Main Linac ~ $1550 M (20% Structures / 14% Klys & Mods / 13% DLDS)
  - ~ 30% is Housings Cost (Length)
  - Minimal Variety; Large Quantities
- Beam Delivery ~ $450 M
  - ~ 50% is Housings Cost (Length)
  - Variety/Quantity a Combination of Injector Systems and Main Linac
- Other Systems ~ $570 M (Water and Power, Buildings, Controls)
- Other Project Related Costs ~ $630 M (25% Pre-Ops / 20% Assy & Test Facil.)
  - e.g. Project Management, Administration, Systems Engineering, Pre-Ops

Includes Extra Positron Vaults, S-Band Linacs, NLC 2001 Injector Layout
91 cm 150° Phase Advance X-Band Structures, Bypass Lines, Two IR’s
Two Collimator Regions, 1 TeV Tunnels, Cut and Cover Site, High $\Delta T$ Water
Tomorrow and Beyond

- Need a Project Cost Roll-Up Soon For
  - Feedback to Ourselves on the NLC 2001 Choices
  - Feedback on Our R&D Plans
  - Keeping the MAC Informed
  - In Case It Comes Up at Snowmass

- Cost Roll-Up Lessons to Date
  - Don’t Make It Overly Precise
    - Takes Too Much Time (Both Elapsed and Individual)
    - Something is Sure To Change Anyway
    - Rough Completeness Always Beats Precise Incompleteness
    - At This Stage, Our Accuracy is Imperfect Anyway
      - Some of Our Technology Choices to Reduce Costs Have Further Reduced Our Accuracy (Extended Our Cost Risk)
  - Tie It to a Documented Configuration
Fitting It All Together

• We Must Deliver the Desired Physics at an Affordable Cost

• To Make It Affordable, We Selected Technologies That:
  – Provided Great Performance
  – Had Lower Overall Cost
  – But, In Many Cases, Were Undemonstrated/Unproven

• We Have Only So Much Time and R&D Funding, So:
  – We Need to Make the “Right” R&D Choices
  – We May Need to Juggle Technology Choices and Operating Points to Optimize Our Physics/Technology/Performance/Cost Phase Space (Portfolio)
  – We Must Continue Our Ongoing Process of Checkpoints and Re-Evaluation