North American Linear Collider Group

Towards an International Linear Collider:

Mark Oreglia
The University of Chicago

- Linear Collider prehistory
- Internationalization and organizations
- Machine Scope Documents
- Technology Choice
- A euro, a yen, a buck, or a pound
- Role of the Laboratories and Universities
- LC Resources

Brief LC History

- Late 1980s:
  - Next Linear Collider:
    - SLAC/KEK warm RF designs
    - NLC detector group
  - TESLA:
    - European effort; superconducting RF design
    - Some participation by FNAL, Cornell
    - ECFA-DESY physics/detector organization
- 1990s:
  - World-Wide Study of Physics & Detectors
    - Baltay/Grannis link US to regional efforts
    - Create detector scope paper
- 2000s:
  - Snowmass 2001: penultimate discussion of LC in HEP community
  - HEPAP roadmap endorses LC as next large accelerator project

Emerging LC Activity

- The German government announced support for international LC activity, though no site in Germany
- The Asian community announced serious planning in February and potential Asian sites
- An International LC Steering Committee has been established as an official arm of the Worldwide LC group, and it is now taking serious steps:
  - Political & organizational planning
  - Technology choice
  - Outreach
- … and there is emerging US support for LC

Wagner updated us on the status of LC in Germany

Future Direction for LC

Community will now take the other path used for international projects (e.g. ITER):

- unite first behind one project with all its aspects, including the technology choice, and then
- approach all possible governments in parallel in order to trigger the decision process and site selection.

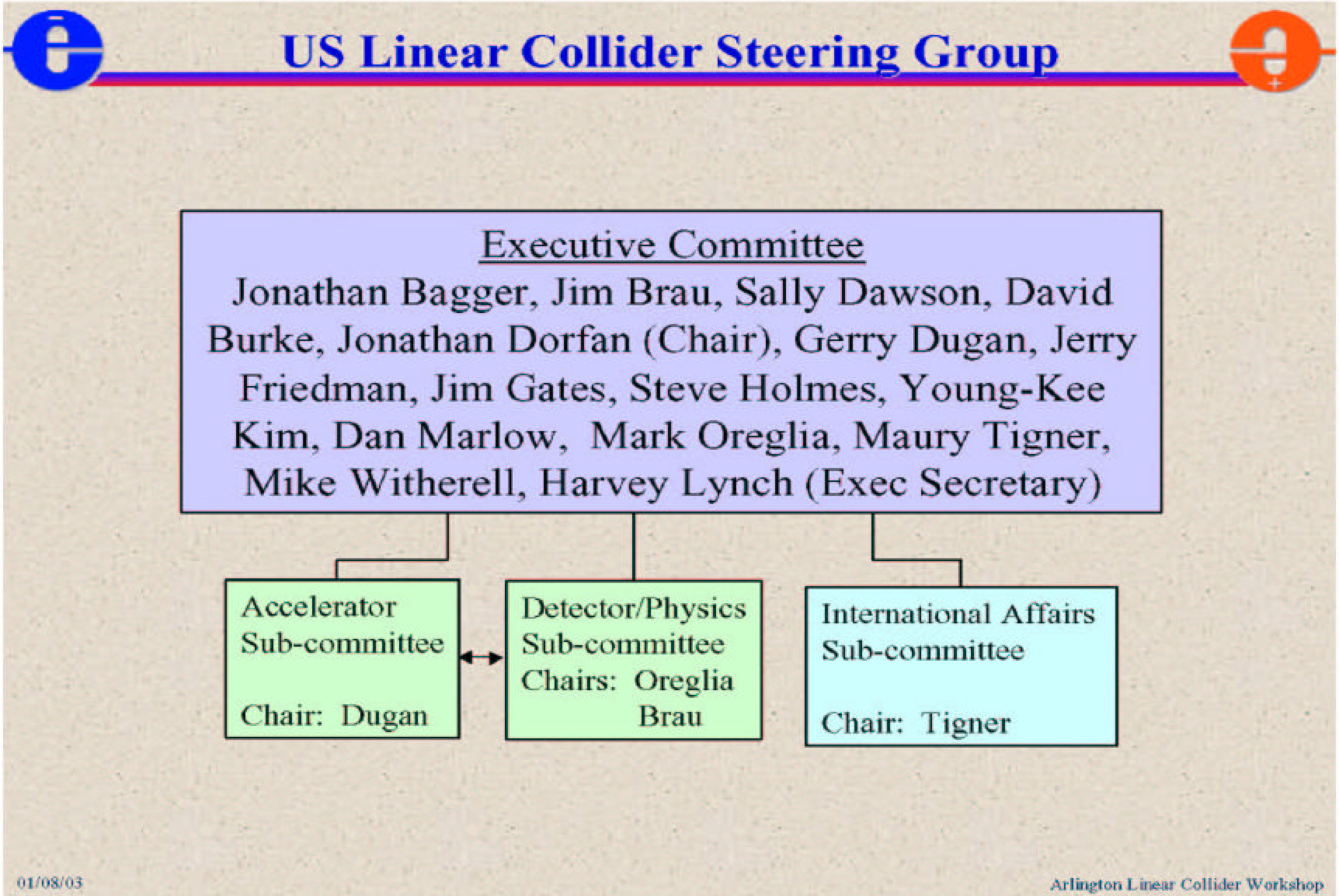
Important to note: The statement by the German government

- is positive on a linear collider in general,
- approves continued R&D on TESLA,
- encourages the German participation in a global project,
- but leaves the site selection open for the time being.

Albrecht Wagner, DESY 17

Regions and Issues

- To facilitate basic actions, 3 regions: America (HEPAP), Asia (ACFA), Europe, new and old (ECFA)
- Regional groups will decide what LC they each want
- Intl SC will create machinery to link the 3 regions and make choices and take political actions
- Organizations:
  - International Linear Collider Steering Committee (ILCSC)
    - ILC Technical Review Committee (ILC-TRC)
    - WW scope committee … and 3 regional ctte's
    - Worldwide Study of Physics & Detectors … 3 regional ctte's
    - LHC/LC Physics study group (G. Weiglein)
  - US LC Steering Group (USLCSG)
    - Led by lab directors (Dorfan currently chairing)
    - Physics, accelerator, internationalization groups
      - Outreach separated from HEPAP
    - American Linear Collider Physics & Detector Group (ALCPG)
      - Executive Ctte


US Linear Collider Steering Group
Executive Committee
Jonathan Bagger, Jim Brau, Sally Dawson, David Burke, Jonathan Dorfan (Chair), Gerry Dugan, Jerry Friedman, Jim Gates, Steve Holmes, Young-Kee Kim, Dan Marlow, Mark Oreglia, Maury Tigner, Mike Witherell, Harvey Lynch (Exec Secretary)
Accelerator Sub-committee
Chair: Dugan
Detector/Physics Sub-committee
Chairs: Oreglia
Brau
International Affairs Sub-committee
Chair: Tigner
01/08/03
Arlington Linear Collider Workshop


U.S.
Steering Group
Asian
Steering Group
European
Steering Group
Govt.
Agencies
Govt.
Agencies
Govt.
Agencies
International Steering / Oversight Group
Steers towards
International Organization / Laboratory
Charged with Constructing LC
Global Goal

Mandate of the ILCSC (Chair: Tigner)

The ILCSC will:

1. Engage in outreach, explaining the intrinsic scientific and technological importance of the project to the scientific community at large, to industry, to government officials and politicians and to the general public.
2. Based upon the extensive work already done in the three regions, engage in defining the scientific roadmap, the scope and primary parameters for machine and detector. It is particularly important that the initial energy, the initial operations scenario and the goals for upgradability be properly assessed.
3. Monitor the machine R&D activities and make recommendations on the coordination and sharing of R&D tasks as appropriate. Although the accelerator technology choice may well be determined by the host country, the ILCSC should help facilitate this choice to the largest degree possible.
4. Identify models of the organizational structure, based on international partnerships, adequate for constructing the LC facility. In addition, the ILCSC should make recommendations regarding the role of the host country in the construction and operation of the facility.
5. Carry out such other tasks as may be approved or directed by ICFA.

Machine Scope Documents

- The "scope papers" are the requisite white papers needed to justify a new machine
  - The American paper has been issued
  - Europe's is underway
  - An ILC committee has been established to unify them
- But first:
  - "Item 2 of the ILCSC Mandate calls for an early consensus on the scope of the facility in terms of physics capability. Thus it seemed natural to think about a subcommittee that would aid this function…. It has been suggested that the World Wide Physics and Detector Study Group, now chaired jointly by S. Komomiya, David Miller and Charlie Baltay, take a major role in this subcommittee."
  - This is the "consensus document" you were asked to consider signing to show community support for LC

The Consensus Document

Sign http://flc25.desy.de/lcsurvey !!!

(1400 signatories so far)

Understanding Matter, Energy, Space and Time :
The Case for the e^+e^- Linear Collider

A world-wide consensus has formed for a baseline LC project in which *positrons* collide with *electrons* at energies up to 500 GeV, with *luminosity* above 10^{34} $cm^{-2}s^{-1}$.

The energy should be upgradable to about 1 TeV.

Above this firm baseline, several options are envisioned whose priority will depend upon the nature of the discoveries made at the LHC and in the initial LC operation.

3

http://sbhep1.physics.sunysb.edu/~grannis/wwlc_report.html

This can be linked from Jim Brau's LC page:

http://blueox.uoregon.edu/~jimbrau/LC/

The USLCSG Scope Paper

“Design Considerations for an Int’l LC”

(http://blueox.uoregon.edu/~lc/scope.ps)

What the document accomplishes

- Document Structure
- Initial Energy and Luminosity
- Ultimate Energy
- Polarization
- Interaction Points
- Z running
- Collision Options
- Machine-Detector Issues

Intent of the Scope Paper

- In June the USLCSG asked that the ALCPG write a white paper describing the physics-motivated machine parameters …
  - A document the machine planners can start using now
  - A document to define the goals before funding agencies

- The Executive Committee used the "Orange book" and input from the working groups to:
  - define the minimal acceptable parameters
  - prioritize options
  - not really to be used to choose technologies

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Document Structure

- brief (12 pgs) and to the point
- summarizes the physics driving the parameters
- does not suggest a technology choice
  - … and no parameters suggest one
- Difficult issue:
  - Phase-II energy:
    - > 1 TeV GeV

Physics Intro	Machine-Detector Issues
Initial Energy and Luminosity	Z Running
Beam Polarization	Energy upgradeability
IP Configurations	Collision Options

Initial Energy and Luminosity

- Initial Energy: 200-500 GeV at 2×10^{34} $cm^{-2}s^{-1}$
- … actually, we also state this in integrated lumi
  - Higgs:
    - Precision EW Higgs range m_h=115-200 GeV
      - peak energy suggests E ~ 400 GeV
    - H self-coupling: need ~ 500 GeV
    - WW fusion production requires 500 GeV
    - 5% Statistics for precision measurements
    - threshold scan requires longer run
  - SUSY:
    - pair production grounds for emphasizing 500 GeV and higher
  - Extended Models
    - Same luminosity serves well in large class of models
  - Polarization:
    - 80% on e^- initially (?) Positron polarization later???

Ultimate Energy

- Controversial, but we must address this
- I think all of us are convinced =1 TeV is required
  - SUSY spectra in many benchmarks
  - Current views on SSB from lattice calculations
  - Higgs self coupling is a must-do!
  - MSSM Higgs spectra
  - Dynamical SB scenarios are high-energy scale
- For self-coupling: need *large integrated luminosity* too
- The LC will be the *frontier machine* after LHC
  - we make a strong case for E upgrades/longevity
  - table of physics-return versus E and integrated lumi
- Thus, a case is be made for > 1 TeV upgrades

Interaction Regions

- We make the case for 2 interaction halls
  - The obvious benefits from 2 detectors
    - cross checking; competition; broader physics; specialization
  - Functionality of LC role in HEP community
  - Necessary for $\gamma\gamma$, e^-e^- options
  - Impact: crossing angle
    - this is a big point for us
    - we feel good beam diagnostics require angle

Z Running

- Calibration: This is one of the debated points!
  - How much calibration running is necessary at the Z?
  - Good calibration essential for precision EW
  - Is this an absolute requirement? How much?
  - Working Groups: now is the time for more work!

- Giga-Z remains an upgrade option
  - depends on what new physics is discovered
  - Not discussed at length

- Despite uncertainties, a scenario for Z-pole running must be there!

Collision Options

- We discuss the highly desirable options $\gamma\gamma$, e^-e^-
  - Strongly endorsed and impacts IP design
  - Physics:
    - Production cross sections
    - $H\gamma\gamma$ coupling
    - Measure CP assignments
    - Rare decays
    - Sensitivity to extended models

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How Machine Parameters Affect the Detector

- Crossing angle:
  - Beam instrumentation possible or greatly enhanced
    - Average energy measurement
    - Polarization measurement
    - Beam halo and stay-clear affect detector
- Beamstrahlung:
  - Warm/cold really pretty similar here
  - argument of larger e^+e^- background not compelling
- Bunch structure and timing:
  - Warm/cold have major difference in duty cycles, readout time.
  - Pros and cons for both technologies;
    - probably no showstoppers

The ECFA Scope Document

- Physics arguments for the parameter values may be found in the TESLA TDR, in the contributions to the ECFA/DESY Extended Study and in the document from the World Wide Study Group ("Understanding Matter, Energy, Space and Time: The Case for the e+e- Linear Collider"

- Phase 1
  - A cms-energy range of 91 to 500 GeV
  - At 500 GeV instantaneous luminosity and reliability sufficient to deliver a total of some 500 fb-1 in the first 4 years of running
  - tunnel and floorspace available for two interaction regions, at least one of them with finite crossing angle, and at least one fully functional detector
  - both interaction regions allowing the same energy range and luminosity for e+e- collisions
  - 80% electron polarisation
  - capability to run e-e- experiments
  - possibility to get to higher energies (some 750 GeV cms) without increasing cooling and RF power, i.e., with reduced luminosity at increased gradient

- Priorities on the options listed below will depend on the results obtained from LHC and the first phase LC.
-
- Options
  - positron polarisation of some 60%
  - high luminosity 'low energy' running (i.e. running at the Z-pole and WW threshold) with at least 50 fb-1/year and with e- and e+ polarisation at the Z-pole
  - cms-energy upgradeable to approximately 1 TeV, but at least 800 GeV
  - integrated luminosity approximately 500 fb-1/year at the high energy
  - ??, e? laser facility with Lumi(??) = Lumi(e+e-)/2

The Technology Choice

- ILCSC has taken serious steps towards making a choice within a year
  - The “Loew Committee”: ILC-Technical Review Committee spent a year considering the status of the warm and cold designs
  - They ranked essential elements as to criticality and whether the technology was proven
  - http://www.slac.stanford.edu/xorg/ilc-trc/2002/2002/report/03rep.htm

- USLCSC requested that Gerry Dugan perform a realistic cost comparison of the baseline warm and cold designs

- ILCSC is forming a panel of wise persons
  - Will use ILCSC criteria to recommend technology choise to ILCSC
  - Each region will nominate 3-4 members, for a panel of 9-10
  - First discussions of the panel makeup in August

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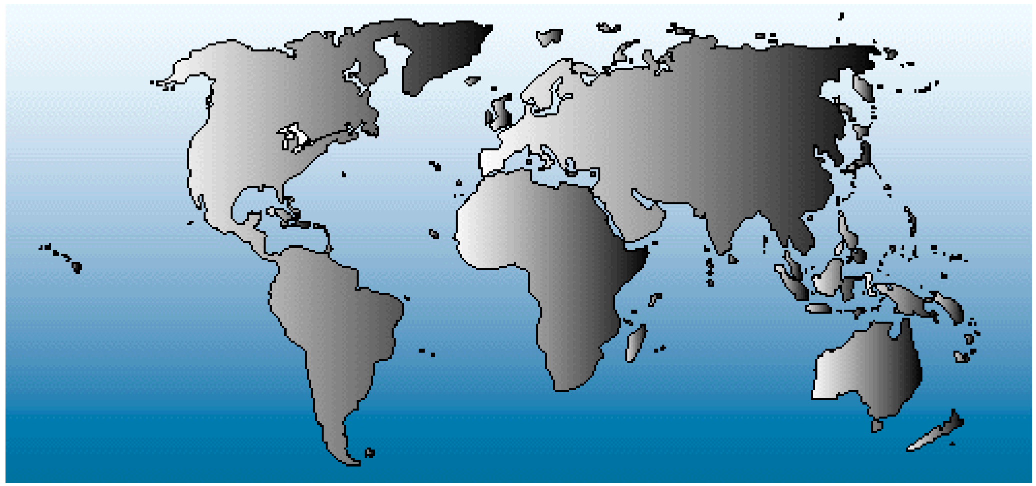
Interlaboratory Collaboration for R&D Towards TeV-scale Electron-Positron Linear Colliders



International Linear Collider Technical Review Committee

ILC-TRC

International Linear Collider
Technical Review Committee

Thanks to: Nick Walker (DESY) for these slides

ILC-TRC Organisation

North American Linear Collider Group

Chair
Greg Loew (SLAC)

Steering Committee

WG I
Technology, RF Power, and Energy Performance Assessment

WG II
Luminosity Performance Assessment

WG III
Reliability, Availability and Operability

North American Linear Collider Group

Technology Working Group

Chair

Daniel Boussard (CERN)

Members

C. Adolphsen (SLAC)
H. Braun (CERN)
H. Edwards (FNAL)
K. Hubner (CERN)
L. Lilje (DESY)
P. Logatchov (BINP)
R. Pasquinelli (FNAL)
M. Ross (SLAC)
T. Schintake (KEK)
N. Toge (KEK)
H. Weise (DESY)
P. Wilson (SLAC)

- Injector, DR, and BDS
- Power Sources
  - klystrons, power supplies, modulators, low level RF etc.
- Power Distribution
  - RF pulse compression, waveguides, two-beam acceleration (CLIC) etc.
- Accelerator Structures

Luminosity Working Group

North American Linear Collider Group

Chair

Gerry Dugen (Cornell)

Members

R. Assmann (CERN)
W. Decking (DESY)
J. Gareyte (CERN)
K. Kubo (KEK)
W. Kozanecki (Saclay)
N. Phiney (SLAC)
J. Rogers (Cornell)
D. Schulte (CERN)
A. Seryi (SLAC)
R. Settles (MPI)
P. Tenenbaum (SLAC)
N. Walker (DESY)
A. Wolski (LBNL)

- $e^{\pm}$ Sources (gun $\rightarrow$ DR)
- DR
- Low Emittance Transport (LET, from DR $\rightarrow$ IP)
  - bunch compressors
  - main linac
  - beam delivery
- Machine Detector Interface

Many new studies (simulations) performed

THIS was much more than a review!

Reliability Working Group

Co-Chairs

Ralph Pasquinelli (FNAL)
Nan Phinney (SLAC)

Members

technology:

C. Adolphsen (SLAC)
Y. Chin (KEK)
H. Edwards (FNAL)
K. Hubner (CERN)
L. Lilje (DESY)
M. Ross (SLAC)
N. Toge (KEK)
H. Weise (DESY)

luminosity:

R. Assmann (CERN)
W. Kozanecki (Saclay)
D. Schulte (CERN)
A. Seryi (SLAC)
P. Tenenbaum (SLAC)
N. Walker (DESY)

- Reliability
  - hardware components
  - MTBF
- Availability
  - fraction of time available for delivering luminosity
- Operability
  - impact of (invasive) tuning, machine studies etc.

The Rankings for R&D

- Ranking 1
- Ranking 2
- Ranking 3
- Ranking 4

The Rankings for R&D

- Ranking 1
- Ranking 2
- Ranking 3
- Ranking 4

R&D needed for feasibility demonstration of the machine

what you must do before you can honestly say the machine will work (proof of principle)

The Rankings for R&D

- Ranking 1
- Ranking 2
- Ranking 3
- Ranking 4

R&D needed to finalize design choices and ensure reliability

Still critical R&D, but not central to proof of principle

Not mandatory before formal proposal

The Rankings for R&D

- Ranking 1
- Ranking 2
- Ranking 3
- Ranking 4

R&D needed before starting production of systems and components

Necessary engineering (prototyping) before (for example) transferring to industry (mass production)

The Rankings for R&D

- Ranking 1
- Ranking 2
- Ranking 3
- Ranking 4

R&D desirable for technical or cost optimisation

Would be useful to do but is not strictly mandatory

Basically all things that ‘fell off the list’ for R1-3

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Rankings Score Sheet

	TESLA		JLC-C	JLC-X/NLC		CLIC		Common
E_{cm}	500	800	500	500	1000	500	3000	
R1	0	1	2	2	0	5	2	0
R2	7	4	2	3	0	6	2	8
R3	10	3	3	11	0	5	0	19
R4	1	0	1	2	2	0	0	8

The Specific R1 Items

- TESLA
- JLC-C
- NLC/JLC-X
- CLIC

The Specific R1 Items

- TESLA
- JLC-C
- NLC/JLC-X
- CLIC

- E_{cm} = 800 GeV
  Building and testing of a cryomodule at 35 MV/m and measurements of dark current

The Specific R1 Items

- TESLA
- JLC-C
- NLC/JLC-X
- CLIC

- E_{cm} = 500 GeV
  High power tests of of C-band choke-mode and dark current
- E_{cm} = 500 GeV
  Demonstration of SLED-II pulse compressor at full power

The Specific R1 Items

- TESLA
- JLC-C
- NLC/JLC-X
- CLIC

- E_{cm} = 500 GeV
  Test of complete accelerator structure at design gradient with detuning and damping, including study of breakdown and dark current
- E_{cm} = 500 GeV
  Demonstration of SLED-II pulse compressor at full power

Goal: end of 2003 for proof of principle tests

The Specific R1 Items

- TESLA
- JLC-C
- NLC/JLC-X
- CLIC

- Test existing structures at 130ns pulse length and design gradient.
- High power tests of structures with wakefield damping
- design and test of switchable power extraction transfer structures
- Validation of drive beam generation with fully loaded linac
- full test of a basic hardware unit (at reduce length)

Many basic questions as expected for an R&D project

The Positive Side

Rankings reflect the concerns of the working groups

But TRC overall findings were extremely positive

The ILC-TRC

"did not find any insurmountable obstacle to building TESLA, JLC-C, JLC-X/NLC within the next few years…"

Which Brings Us to Money!

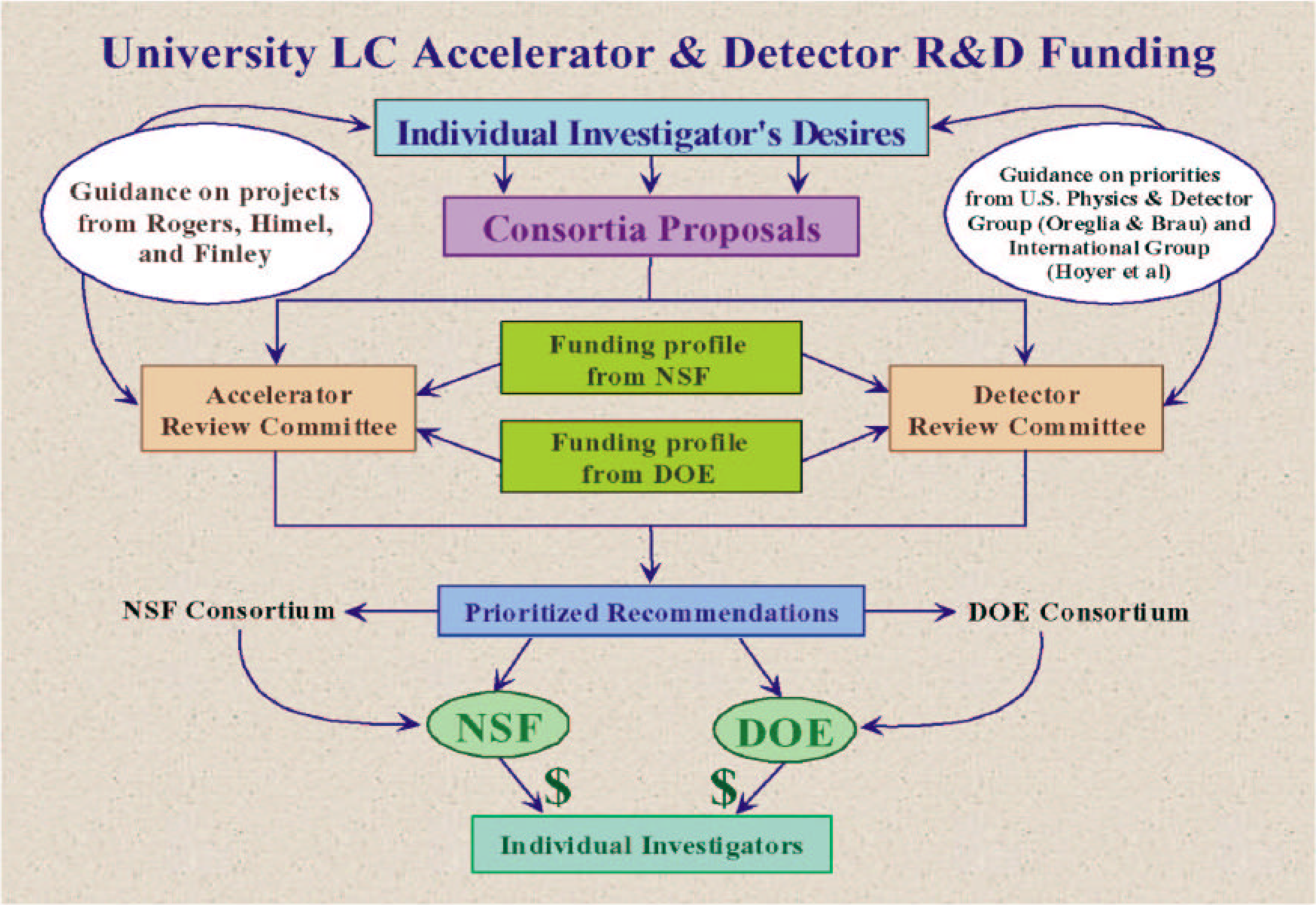
- Immediate need: funding for R2-4 workups and detector studies
  - R1: 35 MV cold cavities and warm 8-pack test are underfunded, but moving along
- The “cap”: supposedly there is no longer a ceiling on what FNAL and SLAC can spend on LC R/D, but this appears to be a moot point
- FNAL and Cornell program work on cold technology still appears to be ”disfavored”
- University involvement is ready and willing, but needs funding
  - LCRD (DOE) program has been pared down somewhat, but it looks like money will flow very shortly
  - UCLC (NSF) program is still stymied … Dugan and Tigner will speak with Jim Whitmore next week
- But on the international front there is much progress

International LC Progress

- The German government demonstrated LC is “rising to the top of the agenda”
  - talks at ministerial level between UK and Germany
- Orbach appears to be a real supporter
  - Talked to Ian Halliday (PPARC) about setting up US-Europe meeting
  - Marburger visited DESY to join the discussion …
    - considers LC important
    - he even spoke of a (somewhat) enhanced HEP budget for LC!
  - 2nd Halliday meeting is scheduled in near future
- Timelines: Many consider 2005 as too early for a decision on site and construction … but most key players do not find 2007 unrealistic
- The role of CERN is still uncertain
  - CERN is participating in the WW scope committee
  - Is proposing CLIC as 1st-generation a possibility now???
  - All agree CERN must be an important player
  - CERN justifiably must be the defender of LHC now

How We All Fit In

- Our first duty is to participate in discussions of a well balanced long term program of HEP (SM, CP, neutrino, heavy quark, E frontier, cosmo)
  - HEPAP roadmap is a great step … lauded by rest of the world
  - We must inform our colleagues of this balanced program
- For LC, we must demonstrate our support before scientists and govmnt
- LC RD needs manpower and money … detector and accelerator
  - LCRD and UCLC are great ideas … they will become realities
  - … but the labs are the key to strong, organized problem solving
    - FNAL has so much to gain from a strong LC role
    - Illinois siting is a strong possibility
  - Therefore: FNAL needs a more visible LC involvement
    - With devoted funding, the accelerator effort will be clear
    - Start a seminar series on LC matters
    - Be home base to LCRD


University LC Accelerator & Detector R&D Funding
Individual Investigator's Desires
Guidance on projects from Rogers, Himel, and Finley
Consortia Proposals
Guidance on priorities from U.S. Physics & Detector Group (Oreglia & Brau) and International Group (Hoyer et al)
Funding profile from NSF
Accelerator Review Committee
Detector Review Committee
Funding profile from DOE
NSF Consortium
Prioritized Recommendations
DOE Consortium
NSF
DOE
$
$
Individual Investigators

American LC Resources

- http://www.linearcollider.org (and a database just operational now)
- Next ALCPG + accelerator meeting: Cornell, 13-16 July
  - http://www.lns.cornell.edu/public/LC/workshop/
  - This meeting will have both the traditional Physics+Detector activity together with accelerator RD groups
- LC Broadcasts:
  - VRVS + phone + slides-on-web
  - Thursdays at 3PM Central time
    - Sally Dawson, Dec 13, summary of LHC/LC meeting
    - Jonathan Feng, Feb 20, The LC-Cosmology Connection
    - Jon Bagger, May 8, TeV-scale Physics
    - Marty Breidenbach, June 5, SD Introduction
- FNAL "Octet" LC Advisory Group (Kronfeld) and PPD (Fisk/Tkaczyk)
- LCRD (Amidei/Gollin) and UCLC (Dugan/Patterson) consortia

ALCPG Working Groups

http:blueox.uoregon.edu/~lc/alcpg

North American Linear Collider Group

Detector and Physics Simulations:

Vertex Detector:

Tracking:

Particle I.D.:

Calorimetry:

Muon Detector:

DAcq, Magnet, and Infrastructure:

Interaction Regions, Backgrounds:

IP Beam Instrumentation:

Higgs:

SUSY:

New Physics at the TeV Scale and Beyond:

Radiative Corrections (Loopverein):

Top Physics, QCD, and Two Photon:

Precision Electroweak:

gamma-gamma, e-gamma Options:

e-e-:

UCLC and LCRD

Liaison to accel. R&D

Testbeams

LHC/LC Study Group

Global Detector Network

How to Get Involved

- Physics & Detector:
  - The ALCPG Working Groups … they have websites
  - The UCLC and LCRD consortia
  - The LHC/LC working groups
  - There is plenty of work to do …
  - … many areas of overlap with LHC detectors (energy flow)

- Accelerator Innovation
  - Plenty of opportunity to work on self-contained problems
    - American WG on Linear Collider Accelerator Technology
    - Tom Himel (thimel@slac.stanford.edu)
    - Joe Rogers (jtr1@cornell.edu)
    - Dave Finley (finley@fnal.gov)
    - http://www-conf.slac.stanford.edu/lcprojectlist/projectlist/intro.htm

Extra Slides

ILCSC Membership

Category	Current incumbent
Directors	
KEK	Yukihide Kamiya
SLAC	Jonathan Dorfan
DESY	Albrecht Wagner
CERN	Luciano Maiani
FNAL	Michael Witherell
LC Steering Group Chairs	
Asian	Won Namkung
European	Brian Foster
N. American	Jonathan Dorfan
Other	
Chair	Maury Tigner
China (IHEP Director)	Hsheng Chen
Russia (BINP Director)	Alexander Skrinsky
ICFA outside LC regions	C. Garcia Canal
Asia Rep.	Sachio Komamiya
Europe Rep.	David Miller
N. American Rep.	Paul Grannis

ALCPG Executive Committee

- Jim Brau (co-chair) (University of Oregon, Eugene, jimbrau@faraday.uoregon.edu)
- Mark Oreglia (co-chair) (University of Chicago, m-oreglia@uchicago.edu)

- Ed Blucher (University of Chicago, blucher@hep.uchicago.edu)
- Dave Gerdes (University of Michigan, gerdes@umich.edu)
- Lawrence Gibbons (Cornell, lkg@mail.lns.cornell.edu)
- Dean Karlen (University of Victoria, karlen@uvic.ca)
- Young-Kee Kim (University of Chicago, ykkim@lbl.gov)
- Hitoshi Murayama (University of California, Berkeley, murayama@hitoshi.berkeley.edu)
- Jeff Richman (University of California, Santa Barbara, richman@hep.ucsb.edu)
- Rick Van Kooten (Indiana University, rickv@paoli.physics.indiana.edu)

ALCPG Working Group Leaders

- Detector and Physics Simulations: Norman Graf (ngraf@slac.stanford.edu) Mike Peskin (mpeskin@slac.stanford.edu)
- Vertex Detector: Jim Brau (jimbrau@faraday.uoregon.edu) Natalie Roe (natalie@design.lbl.gov)
- Tracking: Bruce Schumm (schumm@scipp.ucsc.edu) Dean Karlen (karlen@uvic.ca) Keith Riles (kriles@umich.edu)
- Particle I.D.: Bob Wilson (wilson@lamar.colostate.edu)
- Calorimetry: Ray Frey (rayfrey@bovine.uoregon.edu) Andre Turcot (turcot@fnal.gov) Dhiman Chakraborty (dhiman@fnal.gov)
- Muon Detector: Gene Fisk (hefisk@fnal.gov) Data Acquisition and Trigger: Usha Mallik (Usha-Mallik@uiowa.edu)
- Interaction Regions, Backgrounds: Tom Markiewicz (twmark@slac.stanford.edu) Stan Hertzbach (hertzbac@slac.stanford.edu)
- IP Beam Instrumentation: Mike Woods (mwoods@slac.stanford.edu) Eric Torrence (torrence@physics.uoregon.edu) Dave Cinabro (cinabro@physics.wayne.edu)

ALCPG Working Group Leaders (cont'd)

- Higgs: Rick Van Kooten (rvankoot@indiana.edu) Marcela Carena (carena@fnal.gov) Howie Haber (haber@scipp.ucsc.edu)
- SUSY: Uriel Nauenberg (uriel@cuhep.colorado.edu) Jonathan Feng (jlf@uci.edu) Frank Paige (paige@bnl.gov)
- New Physics at the TeV Scale and Beyond: Joanne Hewett (hewett@slac.stanford.edu) David Strom (strom@maxwell.uoregon.edu) Slawek Tkaczyk (tka@fnal.gov)
- Radiative Corrections (Loopverein): Ulrich Baur (baur@ubhex.physics.buffalo.edu) Sally Dawson (dawson@bnl.gov) Doreen Wackeroth (dow@pas.rochester.edu)
- Top Physics, QCD, and Two Photon: Lynne Orr (orr@pas.rochester.edu) Dave Gerdes (gerdes@umich.edu)
- Precision Electroweak: Graham Wilson (graham.wilson@cern.ch) Bill Marciano (marciano@bnl.gov)
- gamma-gamma, e-gamma Options: Jeff Gronberg (gronberg1@poptop.llnl.gov) Mayda Velasco (mvelasco@lotus.phys.nwu.edu)
- e-e-: Clem Heusch (heusch@slac.stanford.edu)
- LHC/LC Study Group: * Frank Paige (paige@bnl.gov) * Heidi Schellman (schellman@fnal.gov) Tim Barklow (timb@slac.stanford.edu) Ed Berger (berger@anl.gov) Kaushik De (kaushik@uta.edu) Nick Hadley (njhadley@physics.umd.edu) Ian Hinchliffe (I_Hinchliffe@lbl.gov) Heather Logan (logan@fnal.gov) Carlos Wagner (cwagner@hep.anl.gov) Jim Wells (jwells@physics.ucdavis.edu) Dieter Zeppenfeld (dieter@pheno.physics.wisc.edu)

Additional ALCPG Committees

- R&D Proposal Coordinating Group
  - Dan Amidei
  - Gerry Dugan
  - Dave Finley
  - George Gollin
  - Tom Himel
  - John Jaros
  - Usha Mallik
  - Ritchie Patterson
  - Joe Rogers
  - Slawek Tkaczyk

- liaison to accelerator R&D
  - Tom Himel (SLAC, thimel@SLAC.Stanford.EDU)
  - Dave Finley (Fermilab, finley@fnal.gov)
  - Joe Rogers (Cornell, jtr1@cornell.edu)

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