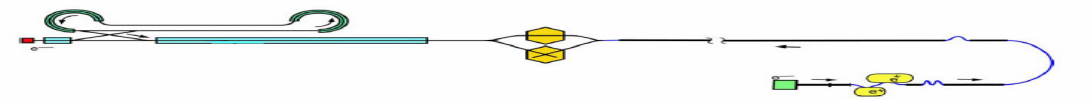
Linear Collider Planning



- Physics Motivation, International Consensus, and Scope
- Accelerator Technology Development
- Accelerator Technology Selection
- Detector Development and Planning
- International "Collaboration"
- Governmental Agreements and Planning

Note: throughout talk, where JLC is used, this is now the GLC

Jim Brau

Aspen Winter Meeting

February 7, 2004

History of Support for the Linear Collider

- **The Physics Motivation has been outlined by other speakers:**
  - **Klaus Desch**
  - **JoAnne Hewett**
  - **Lisa Everett**
  - **Mark Trodden**
  - **others**

- **A broad segment of the community has joined in support of the goal to realize the Linear Collider**
  - **ICFA Statement on Linear Colliders – 1999**
    - Recommends vigorous R&D to be ready in a few years (http://www.fnal.gov/directorate/icfa/icfa_LCstatement.html)
  - **Snowmass Consensus Statement – 2001**
    - strongly recommends the expeditious construction of a Linear Collider as the next major international High Energy Physics project
  - **DOE/NSF Subpanel Report – 2002**
    - recommends that the highest priority of the U.S. program be a high-energy, high-luminosity, electron-positron linear collider
  - **"Understanding Matter, Energy, Space and Time: The Case for the e^+e^- Linear Collider" - 2003/4**
    - >2035 signatories
  - **2004 – ACFA, ECFA, and HEPAP reaffirm their commitment to the Linear Collider (J. Dorfan, ICFA Chair)**

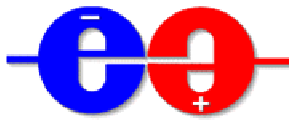
Understanding Matter, Energy, Space and Time: The Case for the e^+e^- Linear Collider

- **2003/4 – this statement presents a unified vision of the physics potential of the linear collider.**
- **The statement has helped the International Linear Collider Steering Committee to define the scope of the baseline facility.**
- **This "consensus document" signed by over 2000 members of the world-wide community**
  - **It's still possible to sign:**

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

The Scope

- **What machine is required to reach the physics goals?**
  - **USLCSG Detector/Physics Subcommittee took on the task of defining the key machine parameters. They have produced a document which is the basis for the comparative study of warm and cold technologies**
    - USLCSG – Scope Document - March, 2003 (http://www.slac.stanford.edu/~hll/USLCSG/BidToHost/MachineScopeA30323.pdf)
  - **Subsequently, the ILCSC Parameters Subcommittee developed an international consensus on the required parameters:**
    - ILCSC – Parameter Subcommittee Report – September, 2003 (http://www.fnal.gov/directorate/icfa/LC_parameters.pdf)



Design Considerations for an International Linear Collider
(USLCSG Scope Document)

The American Linear Collider Physics Group
Executive Committee

23 March 2003

E. Blucher (University of Chicago)
J. Brau (University of Oregon, Eugene)
D. Gerdes (University of Michigan)
L. Gibbons (Cornell University)
D. Karlen (University of Victoria)
Y-K. Kim (University of Chicago)
H. Murayama (University of California, Berkeley)
M. Oreglia (Editor, University of Chicago)
J. Richman (University of California, Santa Barbara)
R. Van Kooten (Indiana University)

Abstract

We describe the physics-motivated minimal design specifications for an e^+e^- linear collider. Machine options and upgrades are also discussed. We conclude that such a Machine should have the following capabilities:

- Initial center-of-mass energy: $\sqrt{s} = 500$ GeV
- Integrated luminosity at $\sqrt{s} = 500$ GeV: 500 fb^{-1} within four years of physics running, corresponding to a design luminosity of approximately 2×10^{34} cm^{-2} s^{-1}
- Electron polarization: at least 80%
- Energy upgradeable to approximately 1 TeV or more
- Capability for occasional running at $\sqrt{s} = 91$ GeV
- Accomodation for two experimental halls
- Probability of a beam crossing angle

Report from the Int'l Parameters Subcommittee

- **Comparison of ILC parameters and US scope parameters interpreted by M. Oreglia**

  - Baseline energy:
    - US: 90-500 GeV with √s luminosity scaling from 500 GeV; ILC: 200-500 GeV with √s scaling; *90 GeV at lower luminosity for calibration.*
  - Baseline integrated luminosity:
    - US: 500 fb^{-1} in 4 years; ILC: 500 fb-1 in 4 years *plus option for another 500 fb^{-1} by year 6.*
  - Baseline energy quality:
    - US: *beamstrahlung spread similar to ISR*; ILC: *0.1% energy precision and stability.*
  - Beam polarization:
    - US: >80% electrons, and positrons >60% as upgrade; ILC: >80% electrons, and positrons *>50%* as upgrade.
  - IRs:
    - US: allow for crossing angle; ILC: allow for crossing *angle in at least 1 IR.*
    - US: construct 2 IRs; ILC: construct 2 IRs *and 2 detectors at beginning.*
  - Energy upgrade, integrated luminosity:
    - US: approx. 1 TeV, *0.5-2 ab^{-1}* ; ILC: approx. 1 TeV, *1 ab^{-1} in 4 years with √s scaling at all E.*
  - e^-e^- collisions:
    - US: *in baseline*; ILC: *option*
  - $\gamma\gamma$, $e\gamma$ collisions:
    - US: upgrade; ILC: option.

Parameters for the Linear Collider

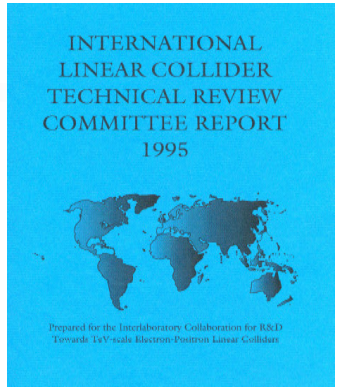
September 30, 2003

Released by the ILCSC at its Nov 19, 2003 Paris meeting

Accelerator Technology and Designs

- 'Mature' Designs
  - TESLA, based at DESY
    - 1.3 GHz Superconducting Technology
  - NLC, based at SLAC and JLC-X, based at KEK
    - 11.4 GHz Normal-Conducting Technology
- 'Conventional' Design
  - JLC-C, based at Super Photon ring-8 GeV (SPring-8) and KEK
    - 5.7 GHz Normal-Conducting Technology
- 'Futuristic' Design – Aimed for 3 TeV c.m.
  - CLIC, based at CERN
    - Drive Beam Power Source
    - 30 GHz Normal-Conducting Linac Technology

ILC-TRC 2003



1994 - A Technical Review Committee was created in 1994

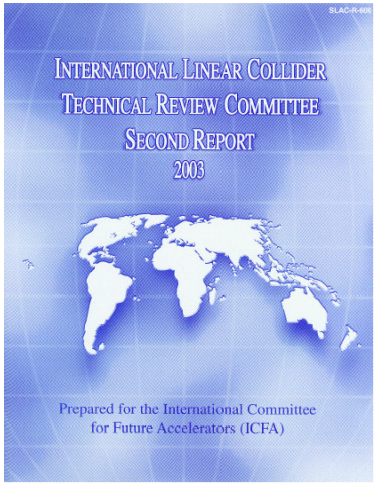
1995 - report

2001 – ICFA requested a second report – new committee – same chair: G. Loew

- **To assess the present technical status of the four LC designs at hand, and their potentials for meeting the advertised parameters at 500 GeV c.m.. Use common criteria, definitions, computer codes, etc., for the assessments**
- **To assess the potential of each design for reaching higher energies above 500 GeV c.m.**
- **To establish, for each design, the R&D work that remains to be done in the next few years**
- **To suggest future areas of collaboration**

TRC Ranking Criteria for R&D Tasks

- **R1: R&D needed for feasibility demonstration of the machine**
- **R2: R&D needed to finalize design choices and ensure reliability of the machine**
- **R3: R&D needed before starting production of systems and components**
- **R4: R&D desirable for technical or cost optimization**



	TESLA	JLC-C	JLC-X/NLC	CLIC	Common
R1	1	1	2	3	0
R2	6	2	2	6	9
R3	17	2	15	>7	26
R4	5	1	5	N/A	7

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

R1 Tasks

R&D needed for feasibility demonstration of the machine

TESLA (Upgrade to 800 GeV c.m.)

- Building and testing of a complete cryomodule at 35 MV/m, with couplers. Measurement of quench rates and dark current.

JLC-C (Valid for 500 GeV c.m.)

- High power tests of RF pulse compressor and choke-mode accelerator structure

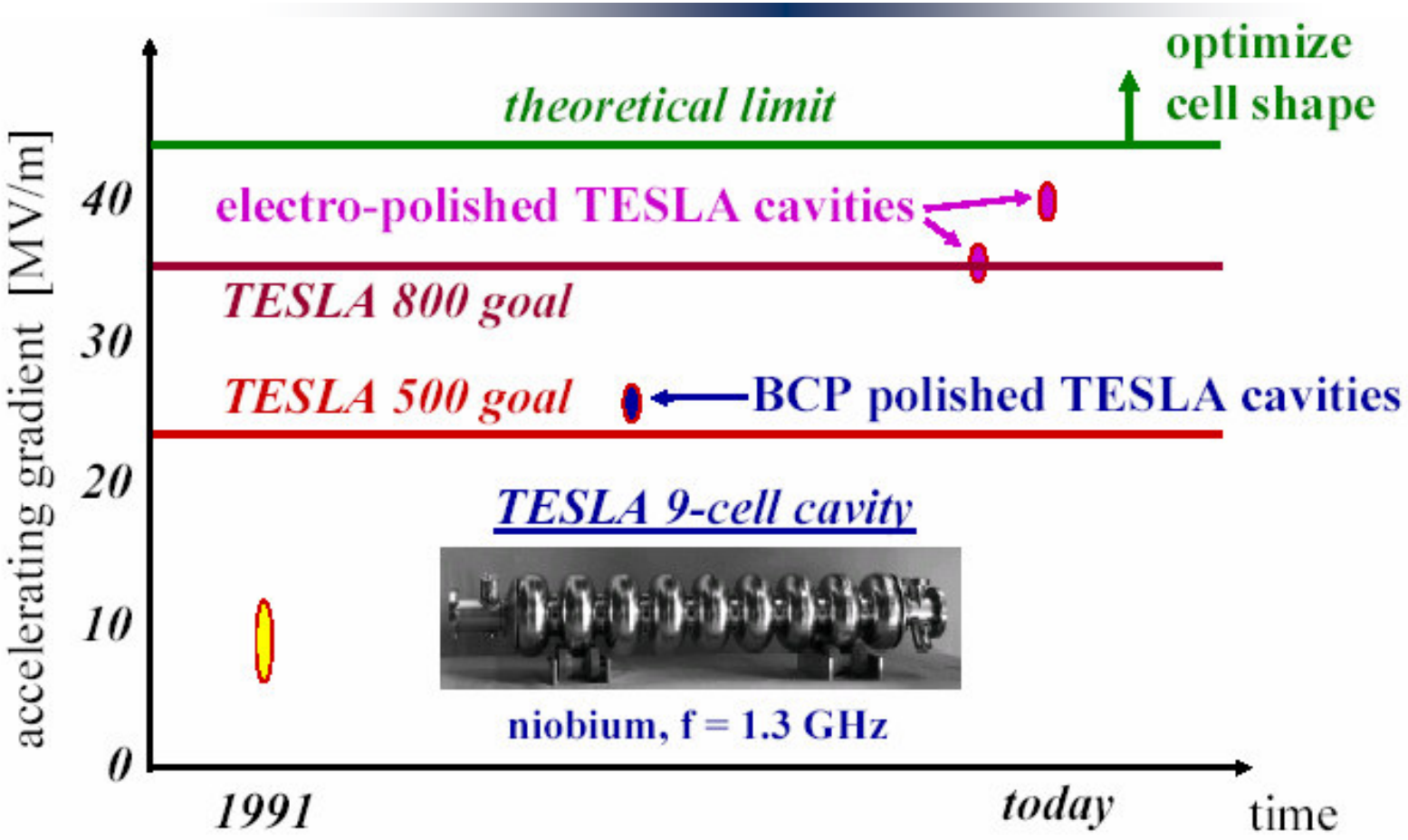
JLC-X/NLC (Valid for 500 GeV and 1 TeV c.m.)

- Test of a complete accelerator structure at design gradient (65/50 MV/m) with detuning and damping manifolds, couplers and loads, including study of breakdown and dark current
- Test of complete dual-moded SLED-II pulse compression system at design power and energy handling

CLIC (Valid for 500 GeV – 3 TeV c.m.)

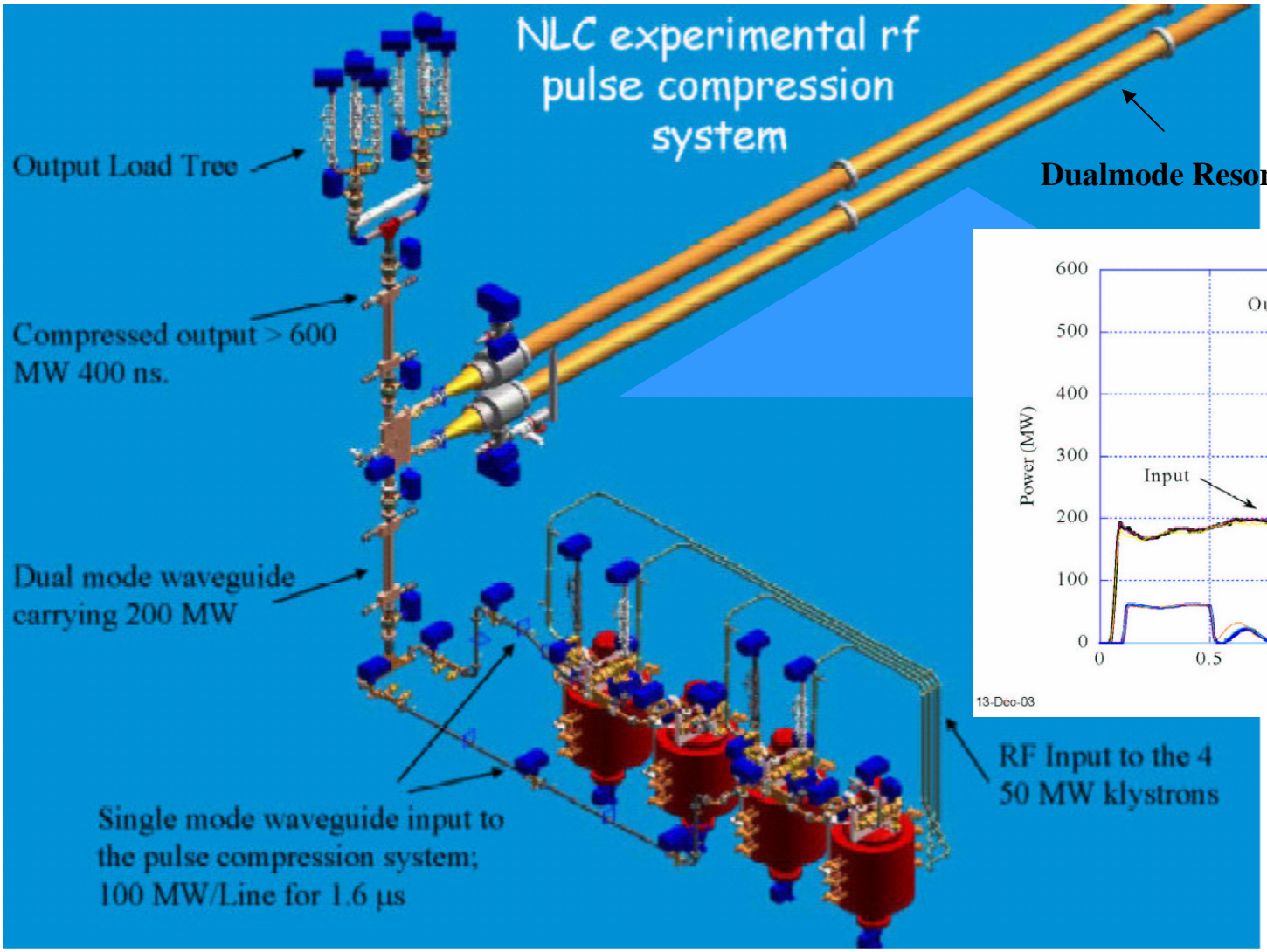
- High power tests of accelerator structures at 172/150 MV/m, 130 ns
- Validation of drive beam generation in fully loaded linac at CTF3
- Development of mechanism to turn off few structures which break down

Progress Toward Superconducting R1

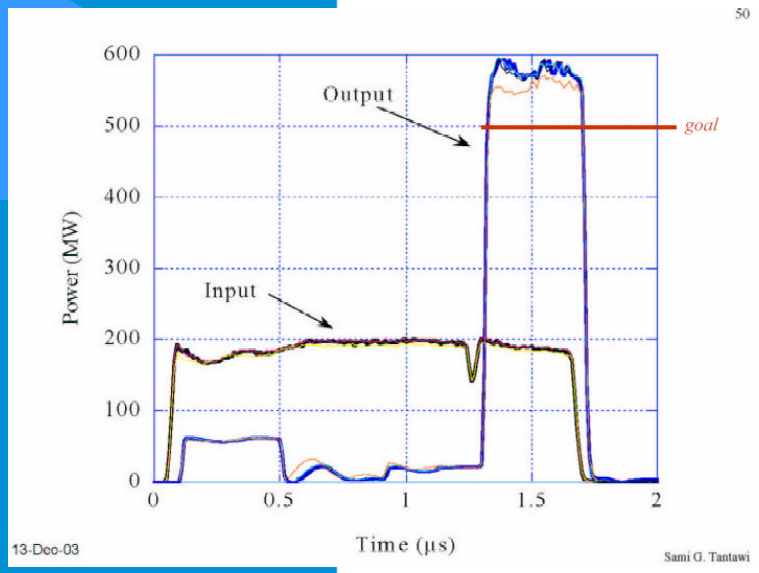


Remaining R1: Building and testing of a complete Cryomodule at 35 MV/m, with couplers. Measurements of quench rates and dark currents

X-Band Pulse Compression R1 Achieved - 2003



Dualmode Resonant Delay Lines ~30 m



Accelerator Technology Selection (ITRP)

- **ILCSC has set up an International Technology Recommendation Panel (ITRP) to recommend to ILCSC/ICFA the RF technology of the main linacs. The ITRP comprises 12 persons, four from each region.**
- **First meeting of the ITRP was held at RAL January 27-28, 2004.**

Jean-Eudes Augustin
Jonathan Bagger
Barry Barish (Chair)
Giorgio Bellettini
Paul Grannis
Norbert Holtkamp
George Kalmus
Gyung-Soo Lee
Akira Masaike
Katsunobu Oide
Volker Soergel
Hirotaka Sugawara

Schedule of Meetings

January 27-28, 2004 –
held at the Rutherford Appleton Laboratory.
April 5-6, 2004 - to be held at DESY.
April 26-27, 2004 - to be held at SLAC.

May 25-26, 2004 - to be held at KEK.

Charge for the ITRP

General Considerations

- **Recommend a Linear Collider (LC) technology to the International Linear Collider Steering Committee(ILCSC).**
- **Choice should be between TESLA and JLC-X/NLC (if necessary, C-band incorporation should be evaluated)**
- **Base recommendation on all relevant scientific, technical, schedule, and cost considerations. Major references:**
  - **ITRC Second Report 2003**
  - **the document "Understanding Matter, Energy, Space and Time", which outlines the case for the electron-positron linear collider**
- **Panel will hear presentations from the design proponents addressing the above issues.**
  - **The agendas of the presentations will be approved by the Panel in advance to assure uniformity of coverage of the technologies put forward.**
  - **Panel may ask for expert advice on any of the considerations, drawing first on the ILCSC and its expert subcommittees, then moving beyond the ILCSC as necessary and appropriate.**
  - **Relevant input from the world particle physics community will be solicited.**

Charge for the IRTP (continued)

Scientific Criteria

- Scope and parameters are defined in the document "Parameters for the Linear Collider"

Technical Criteria

- Technical Review Committee report (2003)
- Materials supplied by technical experts that may be called
- Potential of each conceptual design to achieve the energies and peak and integrated luminosities needed for the scientific program of "Parameters for the Linear Collider"

Schedule Criteria

- Compare milestones relating to design, engineering and industrialization for each of the two technologies

Cost Criteria

- Cost differential between the two designs at 500 GeV and possibly for upgrades set forth in the ILC Parameters Document.
- Cost information based on available estimates as well as on the Panel's judgments of the reliability or completeness of the cost estimates.
- Decide items to be included in the cost estimates in arriving at a comparative analyses.

Charge for the IRTP (continued)

Report of the Panel

Unanimity in the Panel's recommendation is highly desirable in order to establish the firmest foundation for this challenging global project.

The Panel is urged to report its recommendation as soon as possible, with a firm deadline by the end of 2004.

A full written report with the Panel's evaluation of each of the technologies considered should be available as soon as possible after the Panel's deliberations have been concluded.

The making of the technology choice is a key event in the world particle physics program and thus timeliness in the Panel's reporting is of prime importance. The science agencies need to see a demonstration of the particle physics community's determination and ability to collaborate and to unite around the technology chosen by the Panel, as a trigger for their efforts to collaborate in forming a global project.

Charge for the IRTP (continued)

Operation of the Panel

The ILCSC suggestions regarding procedure.

- The Accelerator Subcommittee of the ILCSC to give an extensive tutorial on the LC.
  - **Inform the Panel about LC issues and acquaint it with the experts from whom they can solicit advice.**
- Visits to the major LC technology sites, in as close a sequence as possible, would help to solidify understanding of the status and issues while allowing the Panel to receive input on each technology.
- The ILCSC Accelerator Subcommittee should be in session on site at the Panel meeting place during their meetings.
- Presentation sessions will be open to the scientific and funding agency communities.

Advisory Group to ITRP: the ILCSC Accelerator Subcommittee

- Co-opted the core members of the second TRC
- This subcommittee will play a key role as subject-matter experts for the International Technology Recommendation Panel
- To provide expert advise to the ITRP, the accelerator subcommittee will meet in parallel, on-site, during the ITRP meetings

ILCSC Accelerator Subcommittee

G. Loew, Chair (SLAC)	G. Dugan, Deputy Chair (Cornell)
H. Braun (CERN)	N. Toge (KEK)
J. Urakawa (KEK)	K. Yokoya (KEK)
M. Yoshioka (KEK)	G. Geschonke (CERN)
R. Brinkmann (DESY)	T. Raubenheimer (SLAC)
N. Solyak (FNAL)	A. Wolski (LBNL)
O. Napoly (CEA, Saclay)	

US Input to ITRP

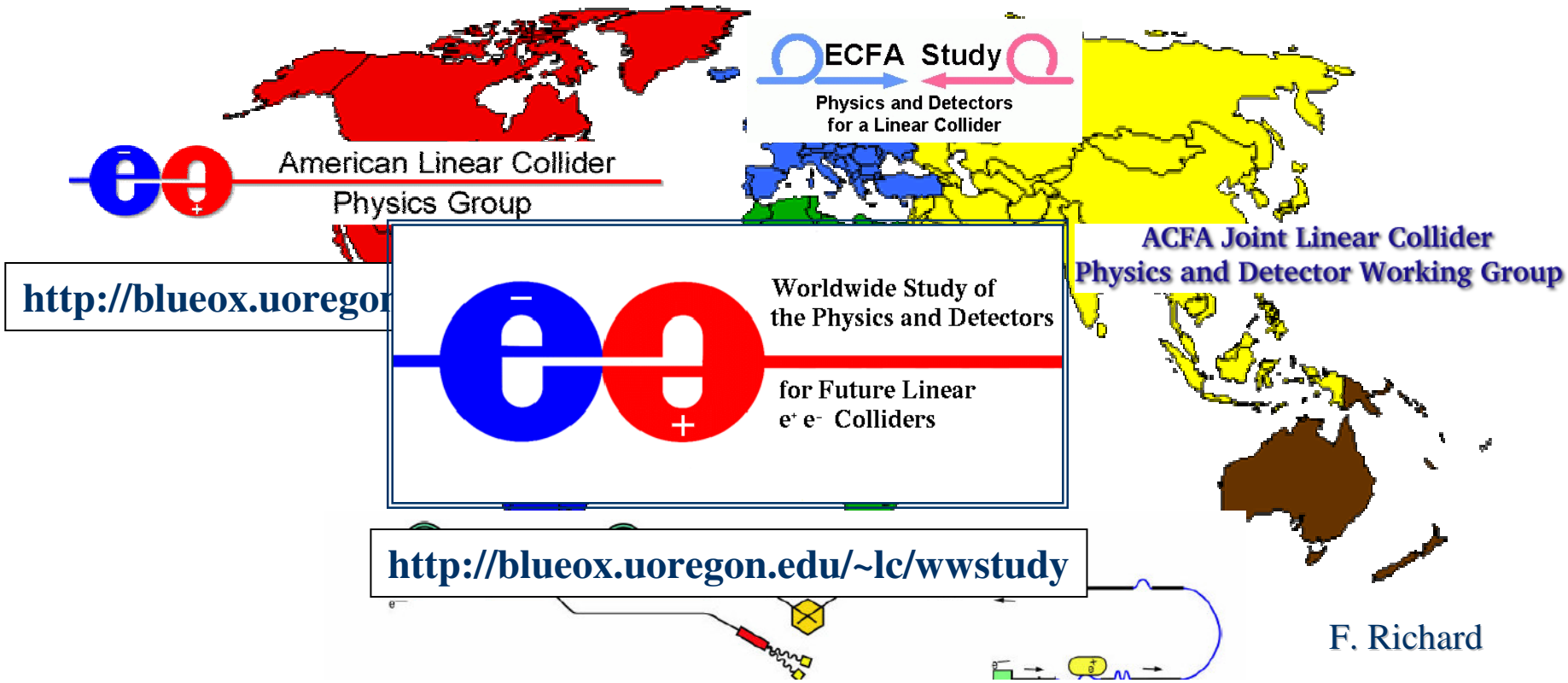
- **The USLCSG accelerator subcommittee (chair: G. Dugan) took on the challenging task of providing for the world community a comparison of a US-based machine using either warm or cold technology.**
- **Report will be completed in early 2004**
  - **USLCSG review of the draft report at FNAL, Thursday, Dec 11, 2003**
  - **Report will be reviewed at DESY and KEK soon, and then released**
- **Highly detailed and technically rich report (475 pages) will be available to the ITRP during its deliberations. (see soon at www.linearcollider.org)**
- **This report does not make a technical recommendation.**

USLCSG Charge for Technology Options Study

- **Two technology options are to be developed: a warm option, based on the design of the NLC Collaboration, and a cold option, similar to the TESLA design at DESY.**
- **Both options will meet the physics design requirements specified by the USLCSG Scope document.**
- **Both options will be developed in concert, using, as much as possible, similar approaches in technical design for similar accelerator systems, and a common approach to cost and schedule estimation methodology, and to risk/reliability assessments.**

Detector Development and Planning

- **Physics and Detector Studies and R&D are being conducted, coordinated, and merged to the extent possible through the World-wide Study**

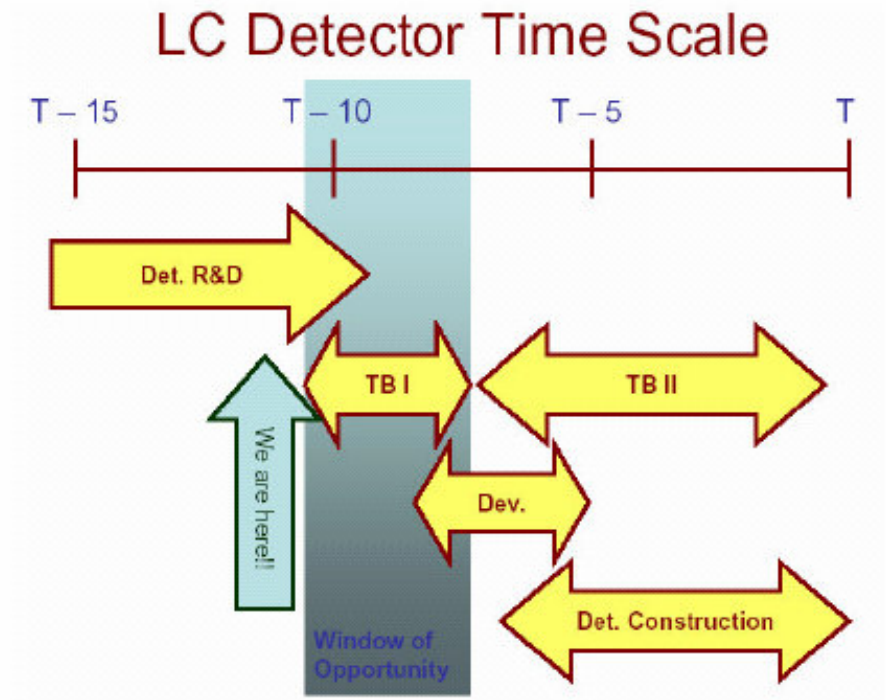


Collaborating on Physics World-wide

- **Detector R&D**
  - **Subsystem working groups (eg. Calorimetry, Tracking,…..)**
  - **International R&D Committee**
  - **TPC, CALICE, SILC**
    - Examples of International Detector Development Collaborations
- **Physics Studies**
  - **eg. LC/LHC Study, Connections to Cosmology**
  - **Standard topics (Higgs, SUSY, etc.)**
- **Regional Meetings – strong in[illegible]ticipation**
  - **ALCPG meeting [illegible], 2004)**
  - **ALCPG [illegible]en (August, 2003)**
  - **[illegible]g at Mumbai (December, 2003)**
  - **[illegible]A meeting at Montpellier (September, 2003)**
- **World-wide Workshops**
  - **LCWS 2002 at Jeju, Korea**
  - **LCWS 2004 in Paris**

Next ALCPG meeting in Victoria, July 28-31

Detector R&D is Critical



Time	T=2015	Tasks
T – >10~11	Before 2005	Detector R&D
T – 10~11	2005~6	Test Beam I
T – 8~9	2006~7	•Detector Technology chosen. •Detector Development and design begins
T – 6	2009	Detector Construction begins Test Beam II (Calibration)
T	2015	LC and Detector ready

Graphically summarized
by Jae Yu

Forming an International LC Design Group

- **ILCSC established a task force to recommend how best to establish an internationally federated design group**
  - **Will start the machine design as soon after the technology decision as possible.**
  - **First step in internationalizing the LC.**
  - **The goal is to have the structure of this design group agreed upon by ICFA and the funding agencies prior to finalizing the technology choice.**

Members of the task force are

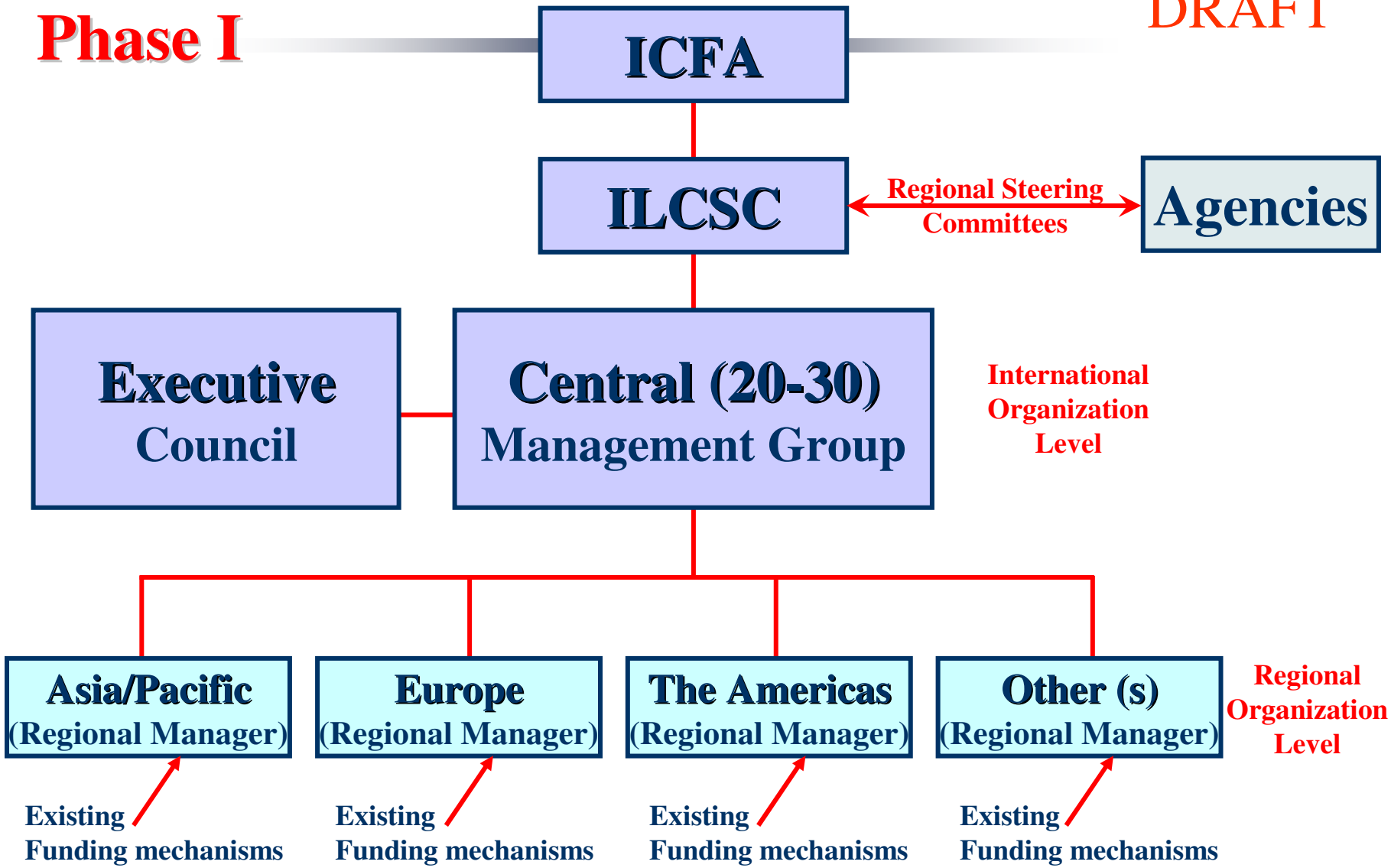
Satoshi Ozaki (Chair), Jonathan Dorfan, Brian Foster, Won Namkung, Yoji Totsuka, Albrecht Wagner .

Report expected February, 2004

USLCSC Proposal - July 2003

DRAFT

Phase I



Deliverable: CDR and plan for realizing a TDR

Regional Proposals for Linear Collider Organization

- **JLC Globalization Report (Dec, 2002)**
  - **http://lcdev.kek.jp/GLCC/**

- **ECFA Sub-group on Organisational Matters (Kalmus report)**
  - **Possible collaborative arrangements for the design, construction and operation**
  - **Administrative structures needed to realise the above, including chains of responsibility**
  - **Obligations and responsibilities of partners, including models for stable funding of the construction and operation**
  - **Mechanisms for ensuring proper project and budgetary control**
  - **Formal aspects of the collaborative arrangements (free access, intellectual property etc.)**

    http://committees.web.cern.ch/Committees/ECFA/Cern03KalmusReport.pdf

- **The USLCSG International Affairs subcommittee has a draft report which will be released in February 2004**

Governmental Actions, Agreements and Planning

- **Very significant step in the US: "The Linear Collider is the first priority among the mid-term facilities" for the Office of Science – Nov 10, 2003**
  - **http://www.er.doe.gov/Sub/Facilities_for_future/20-Year-Outlook-screen.pdf**
- **Another important step in US – Vest Report**
- **July 30 London – "premeeting" of Agency folks (Europe and N.America) to enumerate the challenges and questions facing creation of agency based governance for an international project organization.**
  - This meeting was an informal body to share views and opinions on prospects and issues in each of the states involved. The group discussed the status of current funding for a linear collider (LC) and their perceptions of the prospects for the future.
  - **Next meeting of "Agency folks" – April (6-7 ??)**
- **OECD – latest meeting - January 29-30, 2004 – Paris**

Organisation for Economic Co-operation and Development

- **OECD Global Science Forum analysis of particle physics (July 2002)**
  - agreed with the world-wide consensus on LC – concurrent operation with LHC
  - recommends continuation of consultations in preparation of the meeting of the OECD science ministers in 2004.
- **Meeting of the OECD Science Ministers**
  - January 28-29, 2004

OECD Building Partnerships for Progress

•Acknowledged the importance of ensuring access to large-scale research infrastructure and the importance of the long-term vitality of high-energy physics.
•Noted worldwide consensus of the scientific community for an electron-positron linear collider as the next accelerator-based facility to complement and expand on the discoveries of the LHC
•Agreed that the planning and implementation should be carried out on a global basis, and should involve consultations among scientists and representatives of science funding agencies from interested countries.

•Noted the need for strong international R&D collaboration and studies of the organisational, legal, financial, and administrative issues required to realise the next major accelerator facility, a next-generation electron-positron collider with a significant concurrent running with the LHC.

Summary

- **The past two years (since the Bagger/Barish subpanel report) have seen many positive developments toward realizing the linear collider**
  - **Regional Steering Groups Formed**
  - **International Steering Committee Formed**
  - **Scope Defined Internationally**
  - **Consensus Document Expressed Physics Goals and Drove Scope**
  - **TRC Evaluation of Technologies**
  - **ITRP Commissioned and Working**
  - **Central Design Group Being Planned**
  - **US (and Japanese) Project Comparisons**
  - **OECD and Governmental Attention and Deliberation**

- **Many of the necessary steps are being taken**