International Technology Recommandation Panel (ITRP)

The charge is:

- choose between TESLA & JLC-X/NLC

  assuming construction <2010

  based on considerations:

  scientific, technical, schedule and cost

- reference: **ILC-TRC** (Loew) 2003 report
- **LC parameters**: ICFA document 9-30-2003
- Recommandation to be issued ASAP,

  firm deadline by **end of 2004**.

- http://www.ligo.caltech.edu/~donna/ITRP_Home.htm

The members are:

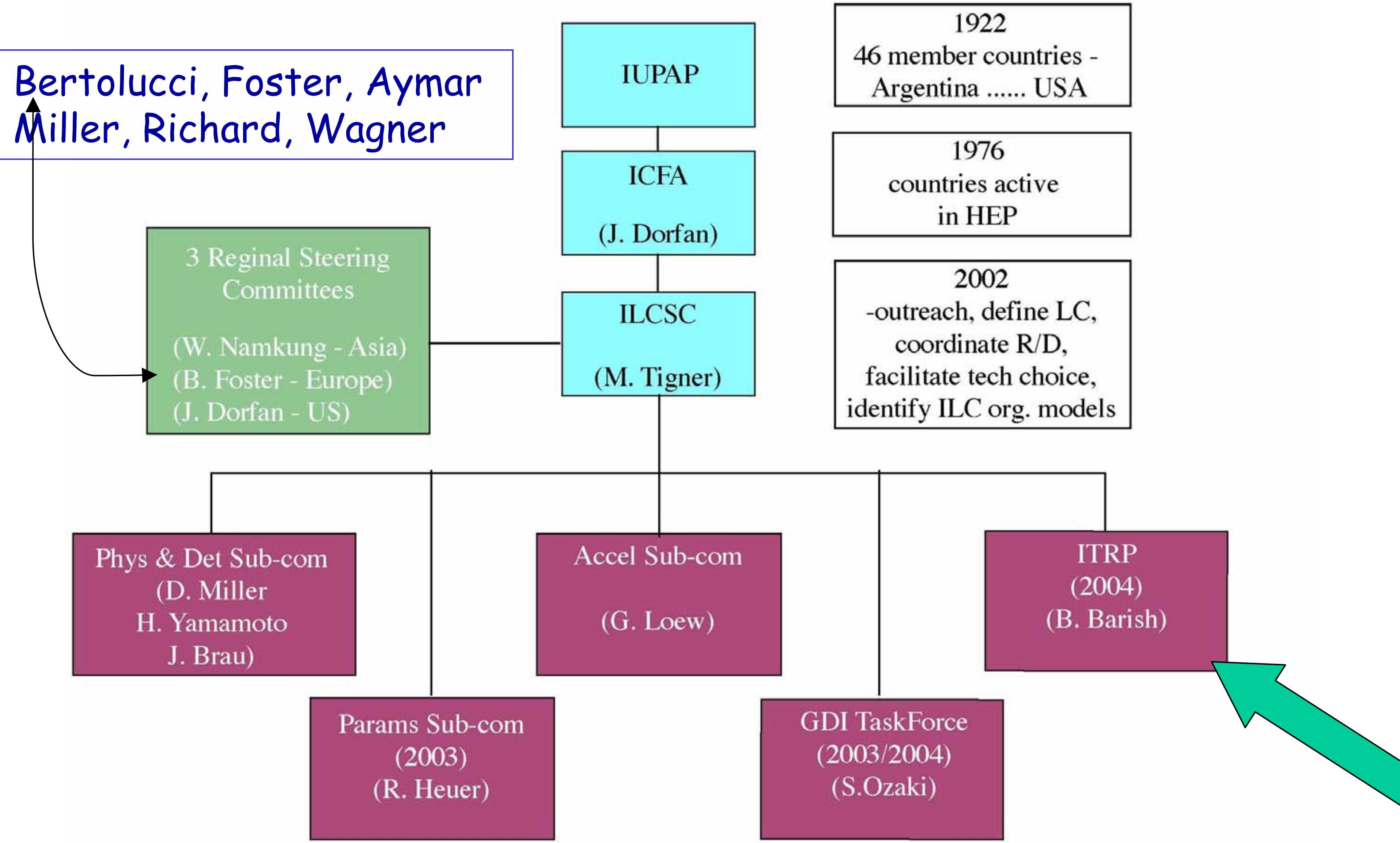
Barry Barish(chair)
Jonathan Bagger
Paul Grannis
Norbert Holtkamp
for North America

Gyung-Sun Lee
Akira Masaike
Katsunobu Oide
Hirotaka Sugawara
for Asia

Jean-Eudes Augustin
Giorgio Bellettini
George Kalmus
Volker Soergel
for Europe

+David Plane secretary

Community Setting



International Linear Collider Steering Cttee (ILCSC)

Chair: Maury Tigner

Current Members

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

International Linear Collider

Technical Review Committee

"Greg Loew Committee"

Second Report

2003

480pp

Validated Readiness of Tesla and NLC-X Concepts

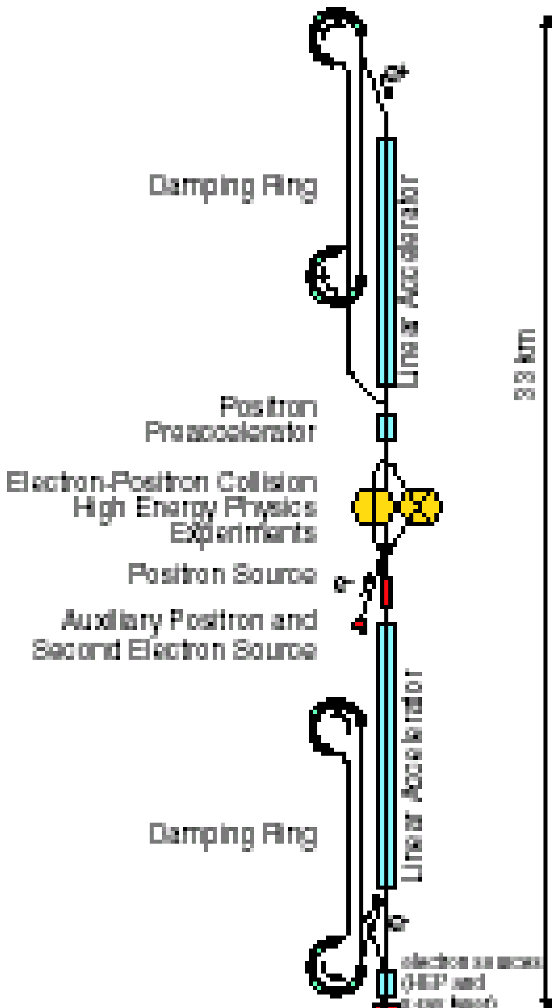
Why ITRP?

Recommandation!

- Two parallel developments over the past few years (the science & the technology)
  - The precision information from LEP and other data have pointed to a low mass Higg's; Understanding electroweak symmetry breaking, whether supersymmetry or an alternate will require precision measurements.
  - Designs and technology demonstrations have matured on two technical approaches for such an accelerator that would be well matched to our present understanding of the physics
  - There are strong arguments for having a period of complementarity between such a machine and LHC

B.Barish,LCWS2004

TESLA



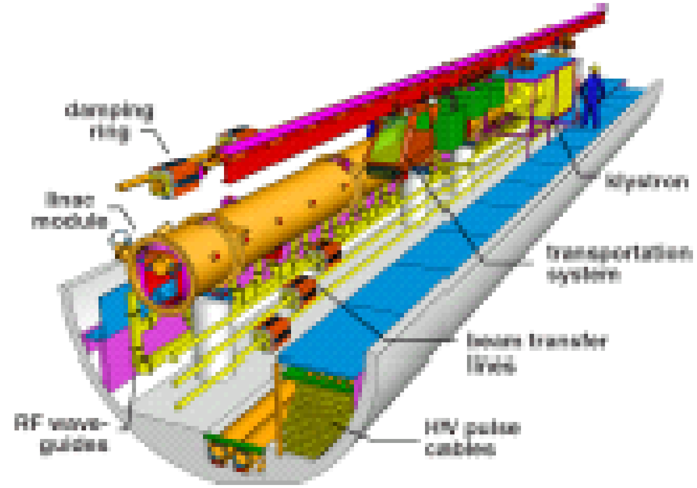
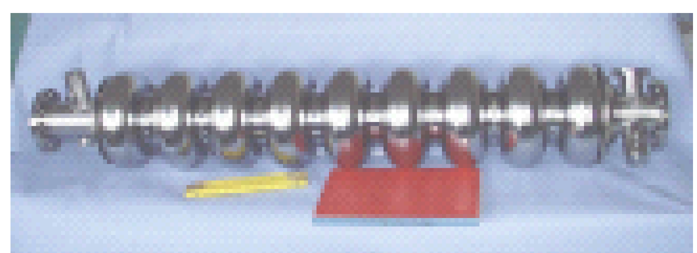
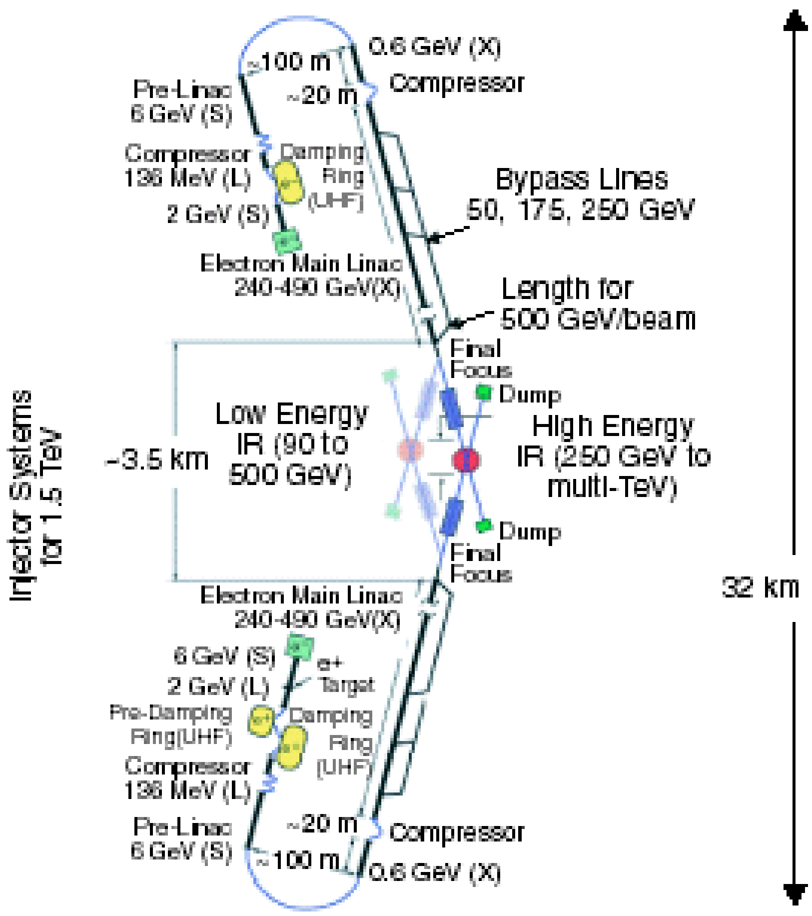


FIGURE 2. Sketch of the 5 m diameter TESLA linac tunnel



Superconducting RF

NLC-X



Normal conducting

Main Collider Parameters

	TESLA		NLC/JLX(X)	
c.m energy *GeV*	500	800	500	1000
RF frequency *GHz*	1.3		11.4	
Luminosity 10^34/cm2/s	3.4	5.8	2.5	
nb bunches/pulse	2820	4500	192	
N± /bunch (*10*^10)	2	4	0.75	
Bunch separation *ns*	337	176	1.4	
Repetition rate *Hz*	5	4	150	100
σ_y at Xing point **nm**	5	2.8	3	2.1
ΔE/E beamstrahlung	3.2%	4.3%	4.6%	7.5%
Accel. Gradient **MV/m**	23.4	35	65/50*	
Total AC power **MW**	140	200	243	292
Site length **km**	33		32	

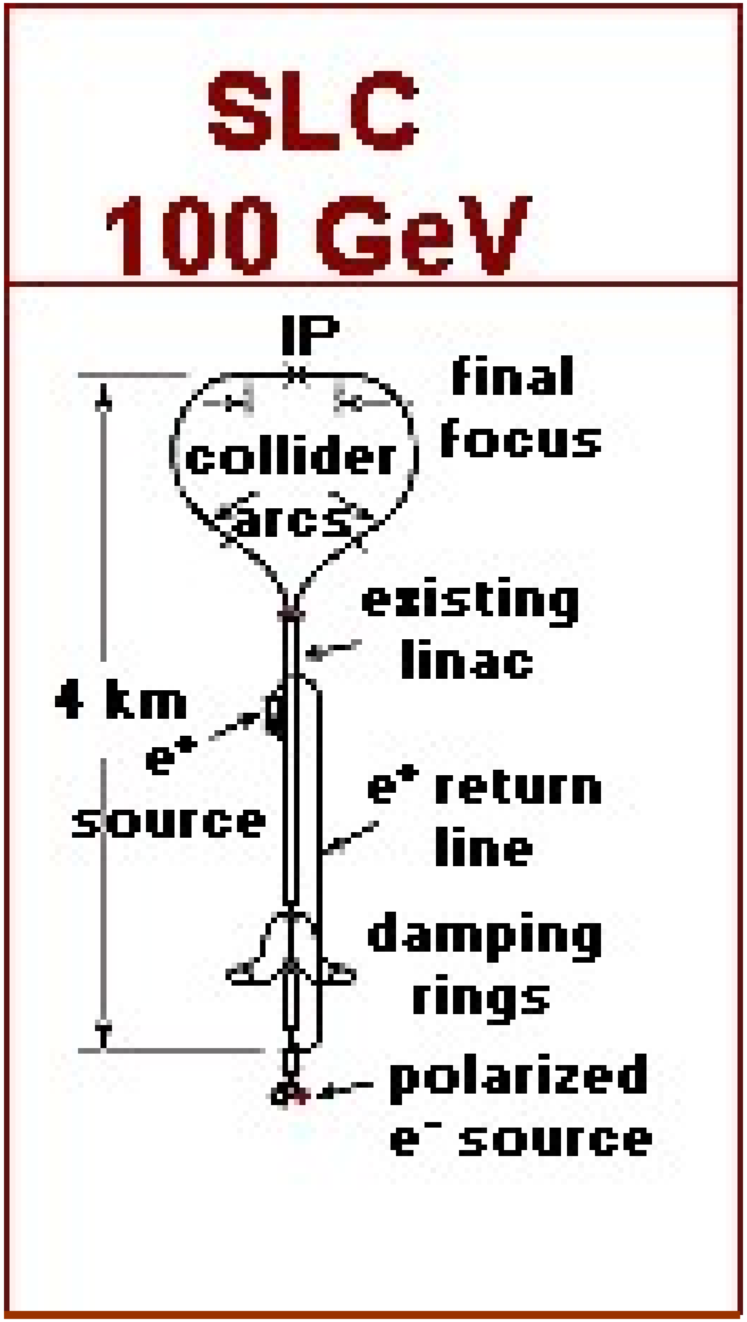
* loaded

Remember

SLC:

proof of principle of the feasibility of the linear collider

$\mathcal{L}=3.10^{30}\ cm^{-2}\ s^{-1}$



LC: Machine Components:

Energy: RF cavities, pulse compression, klystrons, modulators

Intensity: e+ sources, undulator vs. conventionnal

Luminosity:

damping rings, bunch compressors

Beam delivery system & final focus σ_y = 5to3 nm

$$\mathcal{L} = \frac{f_{rep}\, n_b\, N_+ N_-}{4\pi\sigma_x\sigma_y} H_D$$ (H_D pinch enhancement factor)

Extraction & Dump

- Emittance & preservation: Source, Damping Ring, Linac, BDS
- $$\mathcal{L} = \eta\, P_{AC} \left(\frac{1}{E_{cm}}\right) \left(\frac{N_\pm}{\sigma_x}\right) \left(\frac{1}{\sigma_y}\right) H_D$$

  Efficiency AC Power

  and integrated $\mathcal{L}$: **reliability**
- Costs for construction and **operation**

Ranking Criteria for R&D

Greg Loew Committee = ILC-TRC

R1

R&D needed for feasibility demonstration

R2

R&D needed to finalize design choices and ensure reliability of the machine

R3

R&D needed before starting production

R4

R&D desirable for technical or cost optimisation

ILC-TRC rankings (2003)

	TESLA		NLC/JLX(X)		Common
c.m energy	500	800	500	1000	
R1*	0	1	2	0	0
R2	5	1	2	0	9
R3	10	3	11	0	19
R4	4	1	3	2	8

* *Expected to be demonstrated by 2003...*

RANKING OF RECOMMENDED R&D ISSUES

Specific concerns and assessments (which are described in great detail in Chapter 6, Chapter 7, and Chapter 8) resulted in targeted R&D tasks ranked in categories R1, R2, R3, and R4 listed in Chapter 9. Only R1 and R2 tasks are included here in the Executive Summary, both because of space and because they lead to important conclusions for the immediate future.

Ranking 1

TESLA Upgrade to 800 GeV c.m.

Energy

The Energy Working Group considers that a feasibility demonstration of the machine requires the proof of existence of the basic building blocks of the linacs. In the case of TESLA at 500 GeV, such demonstration requires in particular that s.c. cavities installed in a cryomodule be running at the design gradient of 23.8 MV/m. This has been practically demonstrated at TTF1 with cavities treated by chemical processing[1]. The other critical elements of a linac unit (multibeam klystron, modulator and power distribution) already exist.

- The feasibility demonstration of the TESLA energy upgrade to about 800 GeV requires that a cryomodule be assembled and tested at the design gradient of

[1] Knowing that electropolished cavities sustain significantly higher gradients than chemically polished cavities, there is little doubt that cryomodules running at about 24 MV/m can be built.

35 MV/m. The test should prove that quench rates and breakdowns, including couplers, are commensurate with the operational expectations. It should also show that dark currents at the design gradient are manageable, which means that several cavities should be assembled together in the cryomodule. Tests with electropolished cavities assembled in a cryomodule are foreseen in 2003.

JLC-C

Energy

- The proposed choke-mode structures have not been tested at high power yet. High power testing of structures and pulse compressors at the design parameters are needed for JLC-C. Tests are foreseen at KEK and at the SPring-8 facility in the next years.

JLC-X/NLC

Energy

- For JLC-X/NLC, the validation of the presently achieved performance (gradient and trip rates) of low group velocity structures—but with an acceptable average iris radius, dipole mode detuning and manifolds for damping—constitutes the most critical Ranking 1 R&D issue. Tests of structures with these features are foreseen in 2003.
- The other critical element of the rf system is the dual-moded SLED-II pulse compression system. Tests of its rf power and energy handling capability at JLC-X/NLC design levels are planned in 2003. As far as the 75 MW X-band PPM klystron is concerned, the Working Group considers the JLC-X PPM-2 klystron a proof of existence (although tested only at half the repetition rate). A similar comment can be made regarding the solid-state modulator tested at SLAC.

Ranking 2

TESLA

Energy

- To finalize the design choices and evaluate reliability issues it is important to fully test the basic building block of the linac. For TESLA, this means several cryomodules installed in their future machine environment, with all auxiliaries running, like pumps, controls, *etc.* The test should as much as possible simulate realistic machine operating conditions, with the proposed klystron, power distribution system and with beam. The cavities must be equipped with their final HOM couplers, and their relative alignment must be shown to be within requirements. The cryomodules must be run at or above their nominal field for long enough periods to realistically evaluate their quench and breakdown rates. This Ranking 2 R&D requirement also applies to the upgrade. Here, the objectives and time scale are obviously much more difficult.
- The development of a damping ring kicker with very fast rise and fall times is needed.

Luminosity

Damping Rings

- For the TESLA damping ring particle loss simulations, systematic and random multipole errors, and random wiggler errors must be included. Further dynamic aperture optimization of the rings is also needed.
- The energy and luminosity upgrade to 800 GeV will put tighter requirements on damping ring alignment tolerances, and on suppression of electron and ion instabilities in the rings. Further studies of these effects are required.

Machine-Detector Interface

- In the present TESLA design, the beams collide head-on in one of the IRs. The trade-offs between head-on and crossing-angle collisions must be reviewed, especially the implications of the present extraction-line design. Pending the outcome of this review, the possibility of eventually adopting a crossing-angle layout should be retained.

Reliability

- The TESLA single tunnel configuration appears to pose a significant reliability and operability risk because of the possible frequency of required linac accesses and the impact of these accesses on other systems, particularly the damping rings. TESLA needs a detailed analysis of the impact on operability resulting from a single tunnel.

JLC-C

Energy

- The klystrons and modulators should be tested successfully at the nominal 100 Hz repetition rate.
- This should lead to the full test of the linac subunit, with beam. This will include klystrons, modulator, pulse compression system, LLRF control and several structures in their future environment.

JLC-X/NLC

Energy

- There must be a full test of the JLC-X PPM klystron at the specified repetition rate of 120 or 150 Hz.
- These klystrons should be tested with the NLC modulator (at full specs and including arcing tests) and form part of a linac subunit test. The latter should also comprise the dual-moded SLED-II complete system, several damped and detuned structures, installed in the accelerator environment (with temperature control, for instance), and LLRF and controls systems. The test should be made with beam. The present plan is to perform this sort of test with a full girder of structures (some of them being detuned and damped) in 2004.

Items Common to All Machines

Luminosity

Damping Rings

- For all the damping ring designs, further simulation studies are needed to understand the magnitude of the electron cloud effects and to explore possible means of suppressing these effects. Experiments in existing rings are needed to test the electron cloud simulations. Possible cures for the electron cloud (including chamber coatings, superimposed magnetic fields, and gaps in the bunch pattern) need to be experimentally investigated.
- Further simulations of the fast ion instability are also necessary. Experiments in the ATF and other suitable rings are needed to test the predictions of these simulations.
- Damping ring extraction kicker stability, required at the level of $<10^{-3}$, is an important issue. Continued studies including experiments with the ATF double kicker system are needed.
- Finally, additional simulations of emittance correction in the damping rings are needed, including the effects listed in Section 7.2.3.2. Additional experiments in the ATF and other operating rings are needed to test the emittance correction algorithms.

Low Emittance Transport

- For all low emittance transport designs, the static tuning studies, including dynamic effects during correction, must be completed.
- The most critical beam instrumentation, including the intra-train luminosity monitor, must be developed, and an acceptable laser-wire profile monitor must be provided where needed in each design. A vigorous R&D program is mandatory for beam instrumentation in general; it would be appropriate for a collaborative effort between laboratories.
- A sufficiently detailed prototype of the main linac module (girder or cryomodule with quadrupole) must be developed to provide information about on-girder sources of vibration.

Reliability

- A detailed evaluation of critical subsystem reliability is needed to demonstrate that adequate redundancy is provided and that the assumed failure rate of individual components has been achieved.
- The performance of beam based tuning procedures to align magnets and structures must be demonstrated by complete simulations, in the presence of a wide variety of errors, both in the beam and in the components.

Parameters for the Linear Collider

September 30, 2003

Parameters for the Linear Collider

Parameter Sub-committee

(S.Komamiya, Dongsul Son, R.Heuer(Chair), F.Richard, P.Grannis, M.Oreglia)

- Baseline machine: $\sqrt{s}$ = 500 GeV, 500 fb^{-1} (in 4 yrs)
  - Scans 200 to 500 GeV, - E stable to 0.1%,
  - Two Int. Regions, at least one with Xing angle ($\gamma\gamma$)
  - Calibn at 91 GeV (Z0), - e^- Polarisation 80%
- Energy Upgradeable to about 1 TeV, 1 at^{-1} in 3-4 yrs
- 6 Options:
  - 1 at^{-1} in next 2 yrs,
  - e^-e^- collisions,
  - positron polarisation to 50%,
  - "Giga Z" $\mathcal{L}$ several 10^{33} cm^{-2} sec^{-1}, E to < 0.1%,
  - WW threshold, $\mathcal{L}$ several 10^{33} cm^{-2} sec^{-1}, **E to 10^{-5}**,
  - and $\gamma\gamma$ from backscattered laser beams in one IR.

Why Downselect Now?

- We have an embarrassment of riches !!!!
  - Two alternate designs -- “warm” and “cold” have come to the stage where the show stoppers have been eliminated and the concepts are well understood.
  - R & D is very expensive (especially D) and to move to the “next step” (being ready to construct such a machine within ~ 5 years) will require lots of money, organization and worldwide effort.
  - It is too expensive and too wasteful to try to do this for both technologies (and governments will not support it).
  - The final decision on construction of such a new machine will be enabled by such a down select and design program consistent with LHC and physics developments.
  - The final decision and funding to build such a machine will be decided at that time.

Charge for the International Technology Recommendation Panel

General Considerations

The International Technology Recommendation Panel (the Panel) should recommend a Linear Collider (LC) technology to the International Linear Collider Steering Committee (ILCSC).

On the assumption that a linear collider construction commences before 2010 and given the assessment by the ITRC that both TESLA and JLC-X/NLC have rather mature conceptual designs, the choice should be between these two designs. If necessary, a solution incorporating C-band technology should be evaluated.

The recommendation should be based on all relevant scientific, technical, schedule and cost considerations. Major references for the Panel will be the recently issued "International Linear Collider Technical Review Committee Second Report 2003" (http://www.slac.stanford.edu/xorg/ilc-trc/2002/2002/report/03rep.htm) and the document outlining the case for the electron-positron linear collider "Understanding Matter, Energy, Space and Time" (http://sbhep1.physics.sunysb.edu/~grannis/lc_consensus.html)
To reach its recommendation the 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. The Panel may ask for expert advice on any of the considerations listed above, 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.

Scientific Criteria

The technology recommended shall be capable of meeting the scope and parameters set forth by the ILCSC, in the document "Parameters for the Linear Collider", as accepted by the ILCSC on 19 November 2003.

Technical Criteria

Using the ICFA Technical Review Committee report and materials supplied by technical experts that may be called, the Panel will make its recommendation based on its judgment of the potential capabilities of each conceptual design for achieving the energies and the peak and integrated luminosities needed to carry out the currently understood scientific program, as envisioned in the ILC Parameters Document.

Schedule Criteria

Aiming for timely completion of the project, the Panel should compare milestones relating to design, engineering and industrialization for each of the two technologies being considered.

Cost Criteria

The Panel will need to know if there is a significant cost differential between the two designs being examined for completing the 500 GeV project and possibly any upgrades set forth in the ILC Parameters Document. The cost information should be based on available estimates as well as on the Panel's judgments as to the reliability or completeness of the cost estimates. The Panel needs to decide what items are to be included in the cost estimates in arriving at its own comparative analyses.

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.

Operation of the Panel

The ILCSC would like to make some suggestions regarding procedure. The Accelerator Sub-committee of the ILCSC is prepared to give an extensive tutorial on the LC. This would inform the Panel about LC issues and acquaint it with the experts from whom they can solicit advice.

Following that, 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.

To afford the Panel access to expert advice when needed, the ILCSC Accelerator Sub-committee should be in session on site at the Panel meeting place during their meetings.

It is expected that the presentation sessions will be open to the scientific and funding agency communities.

ITRP

- Six Meetings scheduled
  - RAL (Jan 27,28 2004) → **Tutorial and organization**
  - DESY (April 5,6 2004)
  - SLAC (April 26,27 2004) **Site Visits**
  - KEK (May 25,26 2004)
  - Caltech (June 28,29,30 2004) → **Deliberations Begin**
  - Korea (August 11,12,13)
  - More meetings as needed

1st Meeting RAL

Tuesday 27 January

Morning (9:00 – 12:30) – Meeting of the Panel, including :
§ Discussion on how to organize the panel's work
§ Presentation of the ITRP charge – Maury Tigner
§ Telephone inputs from the Laboratory Directors & ICFA Chair
§ Round table – panellists present issues which they think are key to the ITRP recommendation
§ Coffee break in the middle of the morning
Afternoon (13:30 – 18:00) - Tutorials
§ 13:30 – 14:30 : Detector related issues – David Miller
§ 14:30 - 17:45 : X-band linear collider – Kaoru Yokoya, Tor Raubenheimer
§ 15:30 – 15:45 : Tea break
Evening : Dinner, hosted by RAL. Leave hotel at 19:15 h.

Wednesday 28 January

Morning (9:00 – 13:00) – Tutorials
§ 9:00 – 12:15 : L-band linear collider – Reinhard Brinkmann, Nick Walker
§ 10:30 – 10:45 : coffee break
§ 12:15 – 13:15 : conclusions of the Technical Review Committee report – Gerald Dugan
Afternoon (14:00 – 18:00) – panel discussions

USLC report

…new info since beginning of ITRP

availability, cost, schedule, site, risk assessment

U.S. Linear Collider
Technology Options Study
U.S. Linear Collider Steering Group
Accelerator Sub-committee
Linear Collider Option Task Forces
March 4, 2004

Table 3.2.0.1: US Linear Collider: overall parameters

Parameter	X-band ***(warm)*** Reference design	***(cold)*** L-band Reference design	X-band **upgrade**	L-band **upgrade**
Beam Energy [GeV]	250	250	500	500
Loaded RF gradient[MV/m]	52	28	52	35
Two-Linac total length[km]	15.94	27.00	29.36	42.54
Bunches/pulse	192	2820	192	2820
Electrons/bunch[10^{10}]	0.75	2	0.75	2
Pulse/s[Hz]	120	5	120	5
$\gamma\varepsilon x$(IP)[μm-rad]	3.6	9.6	3.6	9.6
$\gamma\varepsilon y$(IP)[μm-rad]	0.04	0.04	0.04	0.04
βx(IP)[mm]	8	15	13	24.4
βy(IP)[mm]	0.11	0.4	0.11	0.4
σx(IP)[nm]	243	543	219	489
σy(IP)[nm]	3.0	5.7	2.1	4.0
σz(IP)[mm]	0.11	0.3	0.11	0.3
Dy	12.9	22.0	10.1	17.3
H_D	1.46	1.77	1.41	1.68

USLC report

Parameter	X-band ***(warm)*** Reference design	***(cold)*** L-band Reference design	X-band **upgrade**	L-band **upgrade**
$\mathcal{L}_{geom}[10^{33} cm^{-2} s^{-1}]$	14.2	14.5	22.2	22.7
$\mathcal{L}[10^{33} cm^{-2} s^{-1}]$	20.8	25.6	31.3	38.1
N γ/e	1.19	1.48	1.24	1.58
δE_b[%]	4.6	3.0	8.2	5.9
Average power/beam [MW]	6.9	11.3	13.8	22.6
Peak beam current in pulse [mA]	855	9.51	855	9.51
Beam pulse length [μs]	0.270	950	0.270	950
Total number of klystrons	4520	603	8984	1211
Peak RF power per klystron [MW]	75	10.0	75	9.7
Total number of structures	18080	18096	35936	29064
Peak RF power per structure [MW]	56	0.276	56	0.345
Linac AC power [MW]	207.6	132.7	389.9	295.9
Linac AC to beam efficiency [%]	6.6	17.0	7.1	15.3

http://www.slac.stanford.edu/xorg/accelops/

12-March-04

ITRP

To: Laboratory Directors
From: ITRP

To guide and make our site visits most useful, we have assembled a set of questions we would like to pose to the proponents of each technology. Clearly the status and plans for the TRC R1 – R4 have a large overlap with our questions and are a prime focus.
Nevertheless, we have formulated a set of questions that address scientific issues and technical considerations that we need to better understand as we work toward making a technology recommendation. Some of this may already be documented and only needs to be pulled out for us. We propose that you give us written answers to these questions, but they may also provide some guidance to you in where to place the emphasis in your presentations during our site visits.

Clearly, our panel process is just getting underway and our focus and questions will become sharper as our process evolve.

A. Common LC technology comparison related questions

ITRP

1) Please analyze for us the prospects and problems associated with **achieving the parameter goals** outlined in the report of the Parameters Subcommittee of the ILCSC.

2) Describe the methods for **measuring the luminosity profile with energy**, absolute beam energy and polarization to the specified precision.

3) Are the **klystrons** now developed sufficiently to power the LC in an efficient way at full energy? What further development is necessary? What margins are needed for adequate performance in the number of spares, MTBF, delivered power, pulse shaping? What is required for breakdown recovery, repair and replacement procedures?

4) Describe the tests and simulations needed to demonstrate that the **couplers** between waveguides to the linac vacuum within structures or cavities will be sufficiently robust.

5) How will the **low level rf systems** required for bunch compression, cavity tuning, machine protection, etc. be designed so as to perform reliably enough not to compromise machine operation?

6) Describe the **positron production** design, and detail the measurements and simulations needed to establish the mechanical, thermal designs and the system reliability. Describe the reasons for your particular choice and the advantages and disadvantages.

7) Describe the steps in the scheme to **align** the rf structures/cavities, quadrupoles, BPMs, and beam delivery elements needed to obtain the *ab initio* gold orbit and subsequent corrections on the time scale of intrabunch train, train to train, and slower time scales from seconds to days. What tests assure that this procedure will work and what R&D remains? Describe the time requirements for the **tuning** procedures and distinguish between intercepting and non-intercepting techniques.

8) Evaluate the **electron-cloud effects for the positron beam** in damping ring, bunch compressor, linac, and beam delivery system. Is there an R&D plan to cure them?

9) What demonstration can be offered now, or during the R&D phase, that the **damping rings** design is robust with respect to space charge induced **emittance growth**, fast kickers, the x-y emittance coupling and emittance growth limitation. What estimates for loss of beam availability can be made? Describe the timing requirements for the tuning procedures.

10) What are the most severe **radiation damage** (to electronics or machine elements) issues, and how will they be mitigated? Describe the machine protection system and the studies needed to demonstrate its effectiveness? Describe the analysis of probabilities for **catastrophic beam loss**.

11) Describe how the effects of **power supply failures** on integrated luminosity will be mitigated.

12) Describe the way that **vacuum failures** in the linacs will be controlled so as not to compromise machine operation or cause damage to sensitive components. What is the **impact from repairs** that require bringing major sections of the linac to atmospheric pressure?

13) Describe the steps needed to operate the LC for **precision electroweak measurements at 90 (or 160)** GeV with the necessary control of beam energy calibration and stability. What special hardware modifications are needed? What luminosity may be expected? What setup time is required to change from high to low energy operation?

14) What is the **time estimated to change the energy** and re-establish stable operation by steps of ~1% (threshold scan), a few%, or more than 10%?

L-band specific questions

15) How can the **R1 cryomodule test** issue be addressed without the full cryomodule availability at this time?

16) What evidence can be given that the **2.5 km cables** for transporting high voltage pulses from moderators to klystrons will provide adequate repairability and reliability?

17) How will the TESLA **cryogenic systems** be controlled to avoid loss of luminosity or component damage?

X-band specific questions:

18) Detail the status of the **rf structure** design and testing. What vulnerabilities still exist for structure damage that could limit the useful life of the accelerator complex. What further studies of the structures are needed to arrive at an engineering design?

19) Detail the status of the tests of the full **rf delivery system**. What vulnerabilities still exist, and how much R&D is required to reach a full technical design.

20) The X-band collider has much tighter requirements for the **alignment** of the beam orbit with the structure axis, yet the basic instrumentatal precision for alignment is the same as for the L-band collider. The SLC had great difficulty reaching its design luminosity in part because of the difficulty in controlling the beam orbit How can it be demonstrated that the necessary **control of the orbit** can be obtained for the GLC/NLC?

B. Cost and Schedule related questions

21) Comment on the **construction costs and life cycle costs** for the two technologies, noting any exceptions or additional information that will help our understanding of the cost comparison.

22) What are the reasons and comparisons between **one and two tunnel** designs for cost optimization, radiation damage, rf system repairs and reliability?

23) What is the ratio of the **cost increment for raising the energy from 500 to 1000 GeV** to the cost of the baseline 500 GeV machine?

24) **For L-band**, provide a modified cost estimation for **500 GeV, assuming 35 MV/m** operation and a **shorter linac** from the beginning. .For X-band, provide a modified cost estimation with unloaded gradients 60 and 55 MV/m.

25) Delineate the **R&D program remaining** before a technical design review (TDR) and full cost estimate can be prepared. What are the major projects and the approximate cost of the technical system R&D needed to validate the design.

26) Show a **technically limited schedule** for proceeding to a **full TDR**, and estimate the schedule for the subsequent linear collider construction. What are the controlling milestones? What are the major technical schedule vulnerabilities?

27) Outline the **key steps for industrialization** of machine components, the likely remaining vulnerabilities in achieving them.

28) What is the **site power** required?

29) Provide a **technically limited schedule**, starting with construction, moving to operation at 500 GeV **until 500 fb-1** have been accumulated, and followed by an upgrade to 1 TeV.

C. General LC related Questions:

ITRP

30) Machine Goals

- Does your technology allow an earlier start to the physics programme, so as to be **as concurrent as possible with LHC operation?**
- How do you make the case for determining the final energy choice for the LC prior to LHC results? **What if LHC results** indicate that a higher energy than design is required ?
- What are the prospects of a **luminosity upgrade** ?
- Considering that LC will start much later (although it can have concurrent operation period) than LHC, what **physics capability does LC have which LHC does not share**? Can this be realized at 500Gev or does it require much higher energy?

31) : Does your technology offer a higher probability of reaching the **baseline energy goal earlier**, and why ? Would your technology allow an easier upgrade path ?

32) Does your technology offer a higher probability of **reaching luminosity goal** of acquiring 500 fb-1 within 5 years of turn-on?

33) Describe the **effect upon your laboratory** of a) the warm vs. cold decision, and b) choice of site.

34) Discuss the **support of the accelerator community** for your technology and to whatever extent your technology has **outreach** into other accelerator areas?

Criteria for making the Linear Collider technology choice

This document sets out the criteria by which the International Technology Recommendation Panel (ITRP) (http://www.fnal.gov/directorate/icfa/ITRP_Charge.pdf) will select the technology for a e+e- Linear Collider (LC), initially operating at energies up to 500 GeV, with subsequent upgradability to about 1 TeV, and with some potential options. The parameters for the LC were adopted by the International Linear Collider Steering Committee (ILCSC) in November 2003 (http://www.fnal.gov/directorate/icfa/LC_parameters.pdf).

ITRP

The elements of the criteria 'matrix' below will be evaluated for the superconducting and room temperature rf technologies on the basis of demonstrated test results, simulations, and experience with similar systems. They will be made with a judgment of the risks for technical performance, costs, schedule, remaining R&D, and the ability to meet the scientific goals of the LC. The information needed to make the judgments will be taken from the written design descriptions for the warm and cold technologies, presentations to the ITRP, responses to questions posed to the machine designers for discussion at ITRP visits, the 2003 Technology Review Committee (TRC) report (http://www.slac.stanford.edu/xorg/ilc-trc/2002/2002/report/03rep.htm), documents prepared both regionally and inter-regionally for the scientific case and detector requirements for the LC, and special documents solicited by the ITRP from other experts.

ITRP

The overriding criterion for the choice of technologies will be the ability to meet the scientific goals for the Linear Collider, as set forth in *"Understanding Matter, Energy, Space and Time: the Case for the Linear Collider"*, prepared under the auspices of the ILCSC (http://blueox.uoregon.edu/~lc/wwstudy/), and the documents prepared by the Asian, European and North American collaborations cited therein.

The elements for the criteria matrix are grouped into six major areas:

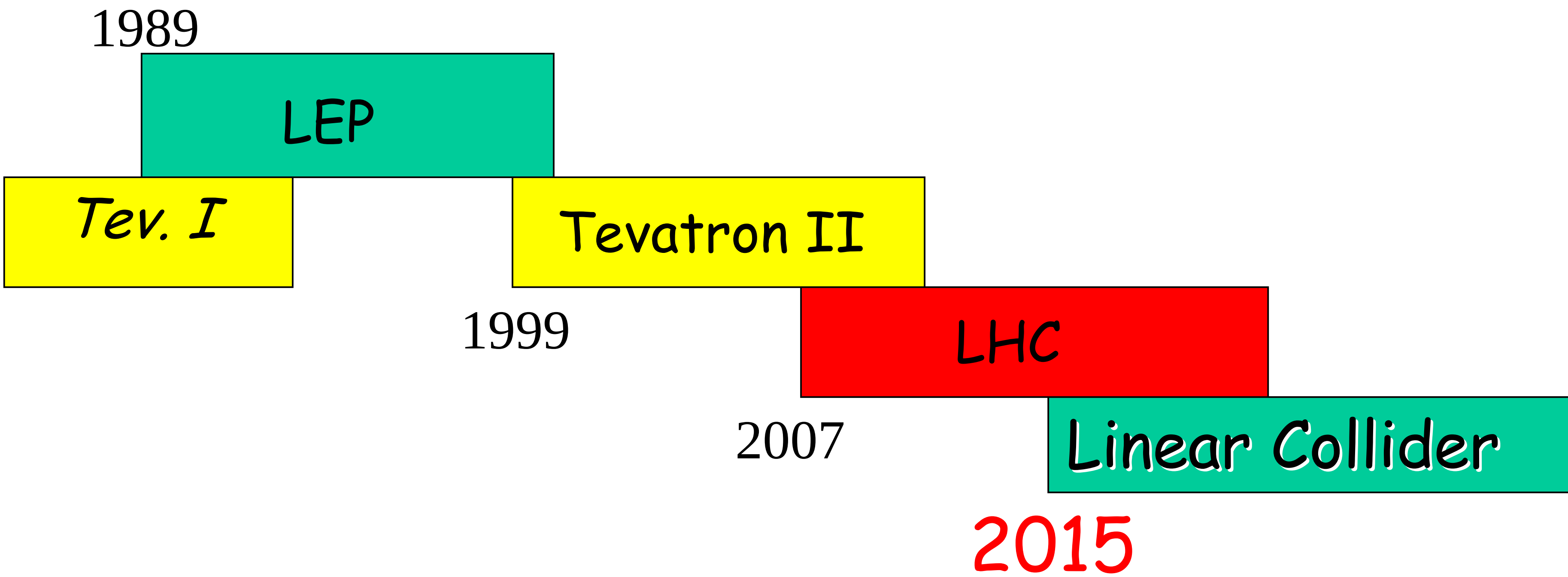
- **the scope and parameters specified by the ILCSC;**
- **technical issues;**
- **cost issues;**
- **schedule issues;**
- **physics operation issues;**
- **and more general considerations that reflect the impact of the LC on science, technology and society.**

The matrix will be used qualitatively to guide the ITRP in differentiating the two technologies, and in highlighting the areas that require particular focus during the process.

Status

- The ITRP process is underway
- You can follow our progress at
  http://www.ligo.caltech.edu/~donna/ITRP_Home.htm
- We are analyzing the design choice through studing a matrix having six general categories:
  - the scope and parameters specified by the ILCSC;
  - technical issues;
  - cost issues;
  - schedule issues;
  - physics operation issues;
  - and more general considerations that reflect the impact of the LC on science, technology and society
- We need input and opinions from the community

Conclusion (sort of)



We need it !