Report From
The International Linear Collider Technical Review Committee

Gregory A. Loew

Santa Cruz Linear Collider Retreat
UC Santa Cruz

June 26-29, 2002

Talk Outline

- You have had two elaborate LC technical talks (G. Dugan and H. Weise)
- This talk will not present technical conclusions
- Emphasis today is on the TRC process, progress and prospects
- TRC Charge
- Structure and responsibilities of the Committee
- Milestones to date
- Contents
- Big issues
- Future milestones

SECOND ILC-TRC CHARGE

- 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

6/20/02

Steering Committee

Chair: Gregory Loew

Members:
1) Reinhard Brinkmann (DESY)
2) Kaoru Yokoya (KEK)
3) Tor Raubenheimer (SLAC)
4) Gilbert Guignard

Working Groups

Technology, RF and Energy Performance
Chair: Daniel Boussard

Luminosity Performance
Chair: Gerry Dugan

The Four Technical LC Approaches to be Assessed

1) TESLA
2) JLC (C-band)
3) JLC (X-band)/NLC (X-band)
4) CLIC

Second ILC-TRC Report
Major Milestones to Date

February 8-9, 2001	ICFA at its DESY meeting requests second ILC-TRC study and report
July 27, 2001	After several months of work and discussions, ILC-TRC Steering Committee is formed, and new proposal is submitted to ICFA in Rome. ICFA accepts proposal.
August-October 2001	Constitution of the Working Groups
February 4-8, 2002	First review and discussion of Working Group reports at LC 2002 (SLAC)
April 10-12, 2002	Second review (CERN)
June 7-9, 2002	Third review following EPAC (Paris)

ILC-TRC REPORT
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Table 1.1 Overall Parameters

	TESLA		JLC (C)		JLC/NLC* (X)		CLIC	
Center of mass energy	500 GeV	800 GeV	500 GeV	1000 GeV	500 GeV	1000 GeV	500 GeV	3000 GeV
RF frequency of main linac (GHz)	1.3		5.7	5.7/11.4¶	11.4		30	
Design luminosity ($10^{33}cm^{-2}s^{-1}$)	34.0	58.0	16.8	25.0	25.0 (20.0)	25.0 (30.0)	14.1	100.0
Linac repetition rate (Hz)	5	4	100		150 (120)	100 (120)	200	100
No. of particles/bunch at IP (10^{10})	2	1.4	0.75		0.75		0.4	
No. of bunches/pulse	2820	4886	192		192		154	
Bunch separation (nsec)	337	176	1.4		1.4		0.67	
Bunch train length (μsec)	950	860	0.267		0.267		0.102	
Beam power/beam (MW)	11.3	17.5	5.8	11.5	8.7 (6.9)	11.5 (13.8)	4.9	14.8
Unloaded/loaded gradient† (MV/m)	23.4 / 23.4	35 / 35	41.8/31.5	41.8/31.5 / 70/54	70 / 54		172 / 150	
Total two-linac length (km)	30	30	17.1	29.2	12.6	25.8	5.0	27.5
Total beam delivery length (km)	3		3.7		3.7		5	
Proposed site length (km)	33		33		32		40	
Total site AC power‡ (MW)	140	200	235	310	215 (185)	280 (320)	XX	XX
Tunnel configuration‖	Single		Separate		Separate		Two-Beam	

* Numbers in ( ) for the JLC/NLC correspond to US site with 120 Hz repetition rate.

¶ The 1 TeV JLC-C collider uses a C-band rf system for the first 200 GeV of each linac followed by an X-band rf system for the remaining 300 GeV of acceleration – the X-band rf system would be identical to that described for the JLC-X band collider.

† The main linac loaded gradient includes the effect of single-bunch (all modes) and multibunch beam loading, assuming that the bunches ride on crest. Beam loading is based on bunch charges in the linacs, which are slightly higher than at the IP.

‡ Total site power includes AC for linac rf and cooling systems as well as power for all other beam lines and site facilties except for the JLC-C case where the AC power only includes that for the main linac rf generation.

‖ The single tunnel layout has both the klystrons and accelerator structures in the main linac tunnel while the separate tunnel layout places the klystrons and modulators in a separate enclosure. The Two-Beam scheme uses the separate tunnel layout for the drive linac–there are no klystrons and modulators associated with the main linac.

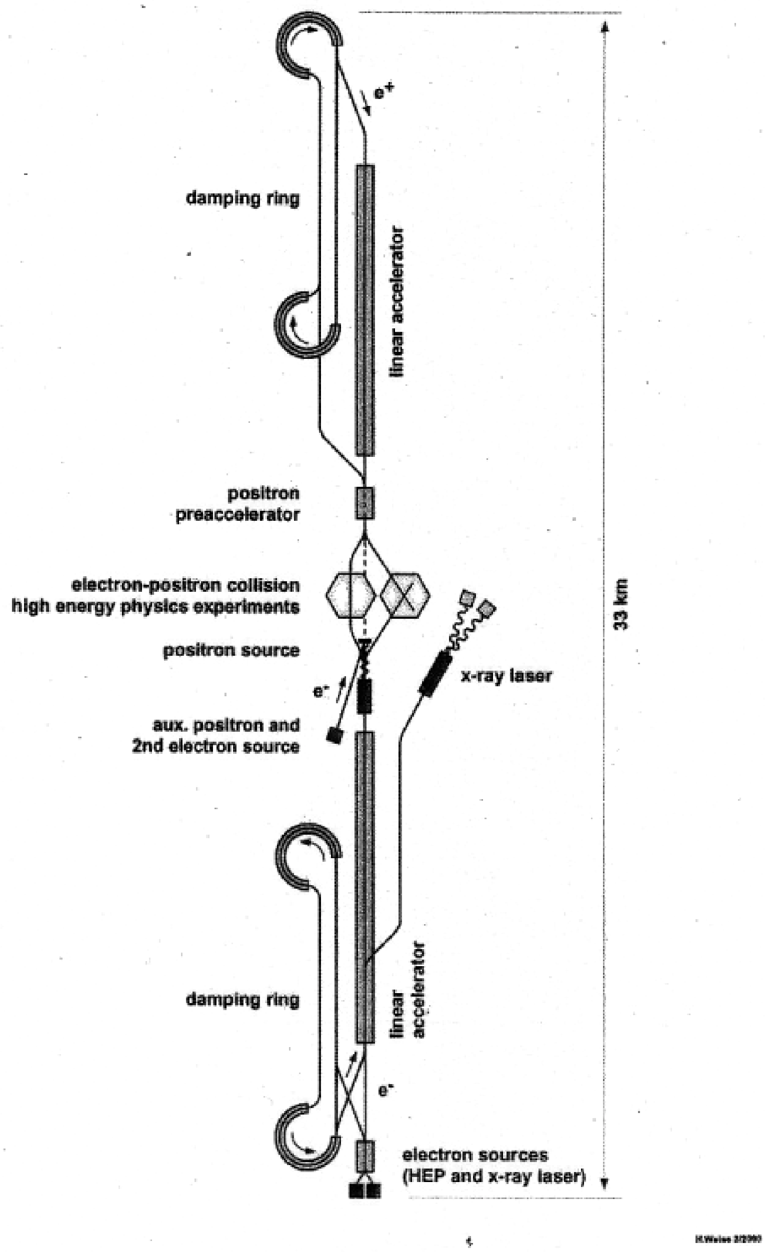


Figure 2: Sketch of the overall layout of TESLA.

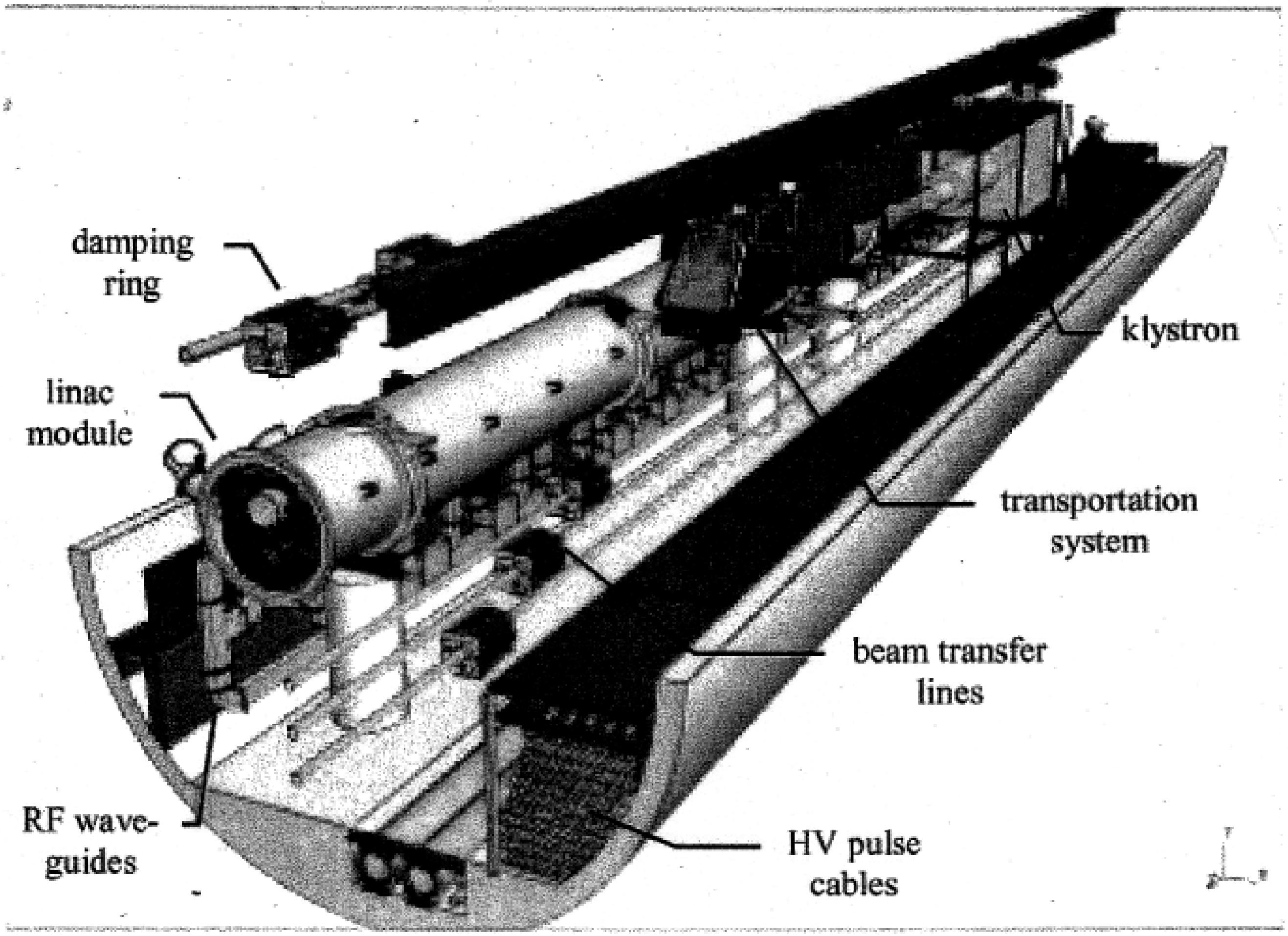
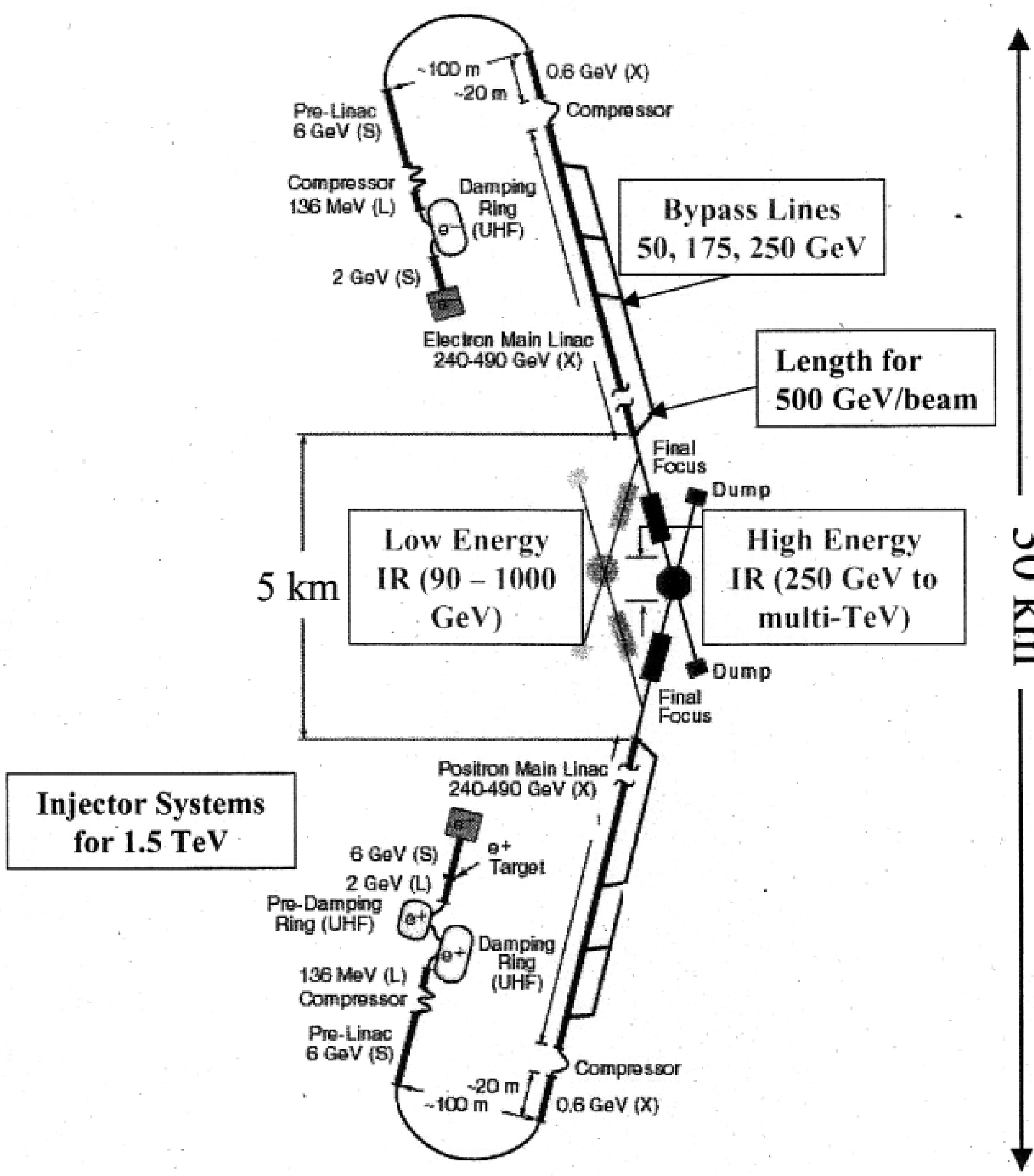


Figure 3: Sketch of the 5 m diameter TESLA linac tunnel.

Phase-I R&D Summary

C-band Klystron	Klystron Modulator	RF Pulse Compressor	Accelerating Structure
50 MW, OK 2.5 sec, 47 %	110 MW OK 100 pps	Flat Pulse Gain 3.3	1.8 m OK Choke-Mode
Life test >5000 hour, OK. 	**Smart modulator** using inverter HV charger. Running for klystron life test. 	Three-cell cavity.  1 m long cold model. 	Beam acceleration at 50 MV/m was done at ATF-KEK, with S-band model. HOM damping performance was proved by ASSET-SLAC test, 1998. 

The NLC Configuration



NLC - The Next Linear Collider Project

NLC Main Linac RF System

Low Level RF System

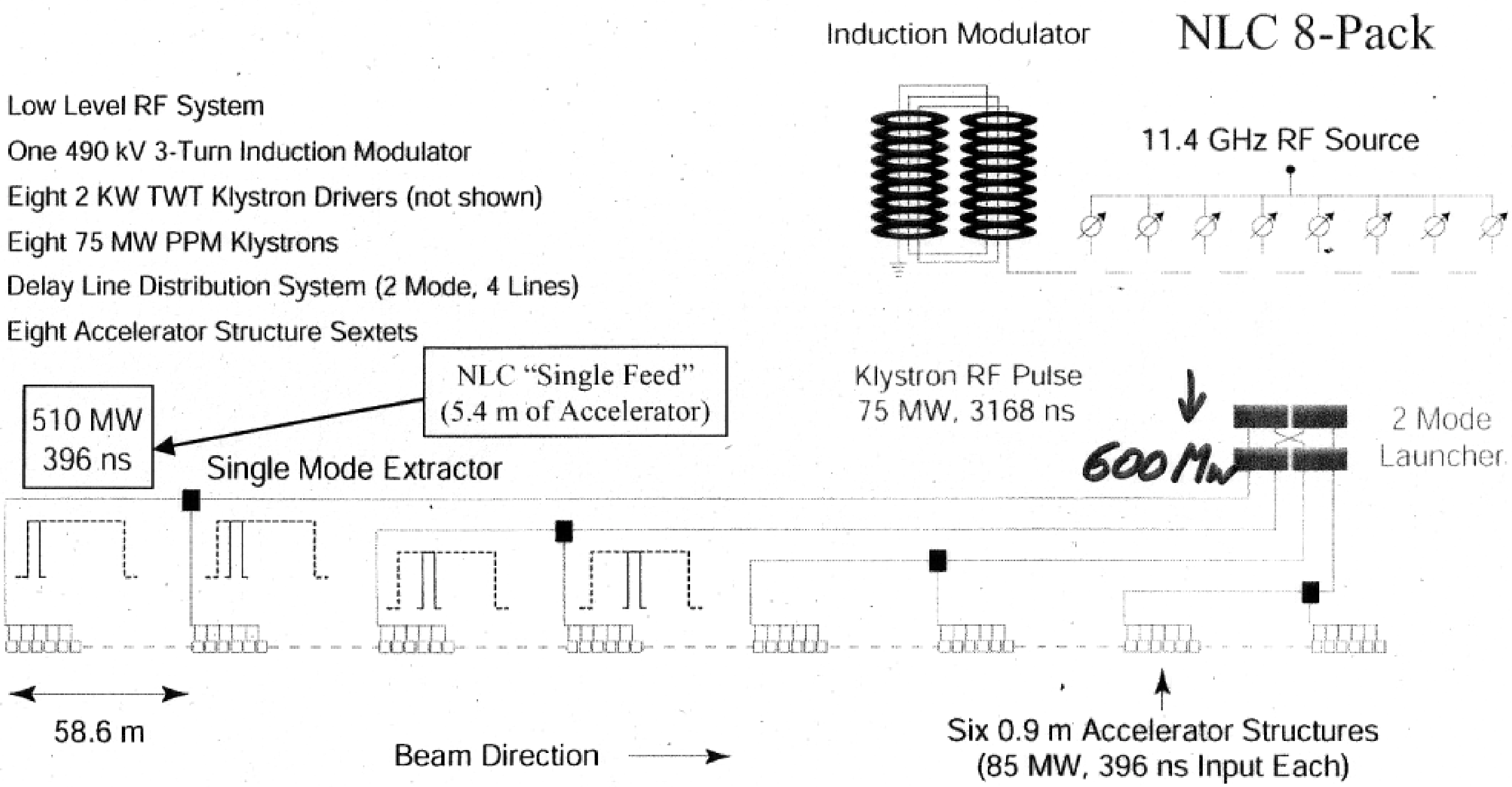
One 490 kV 3-Turn Induction Modulator

Eight 2 KW TWT Klystron Drivers (not shown)

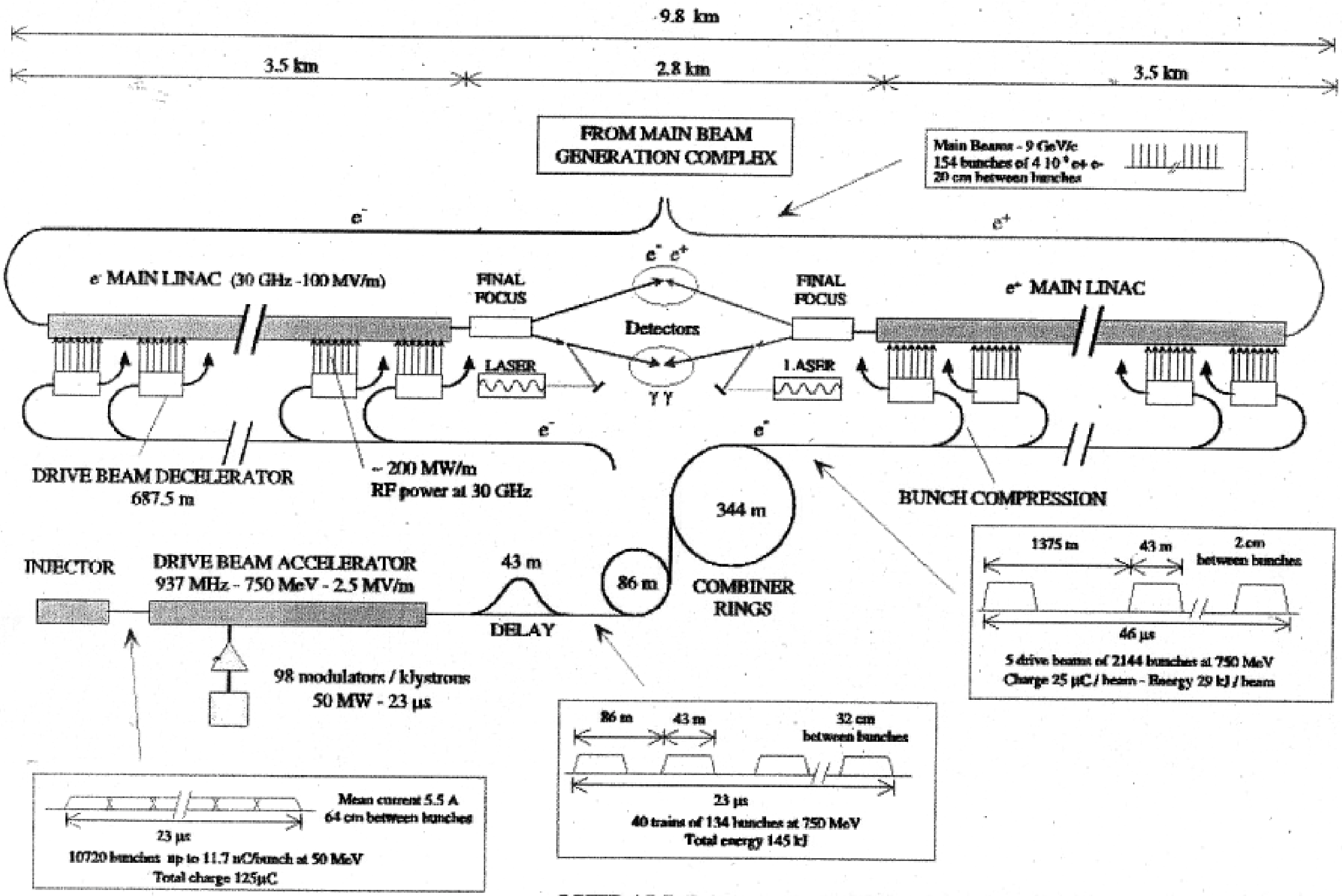
Eight 75 MW PPM Klystrons

Delay Line Distribution System (2 Mode, 4 Lines)

Eight Accelerator Structure Sextets



GOAL 70 MV/m (UNLOADED)



OVERALL LAYOUT OF THE CLIC COMPLEX AT 500 GeV C.M.

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sln February 2001

Test Facilities, etc.

TTF I	2 modules (16 9-cell structures) ~ 25 MV/m Test of superstructure this September Tests conclude in Fall 2002 Electropolished 9-cell structure reaches 35 MV/m (March 2002)
TTF II	Commissioning starts summer 2003
C-Band	Tests proceed at KEK and towards FEL construction at SPRING-8 (next three years)
ATF (KEK)	DR testing for next three years
NLCTA (SLAC)	X-Band structure tests and 8-pack tests continue for next three years
ASSET	Ongoing collimator and structure tests
CTF-2	Ends operation in Fall 2002
CTF-3	Tests will start in late 2004 and continue for 3-4 years

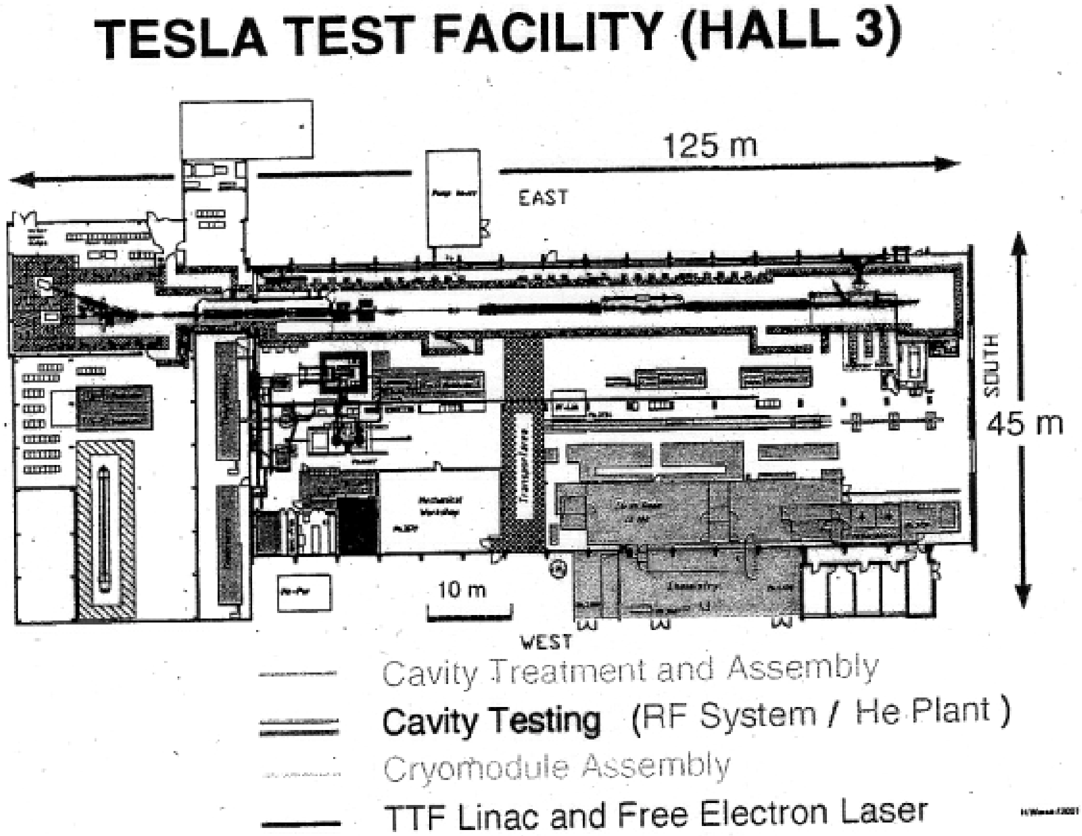
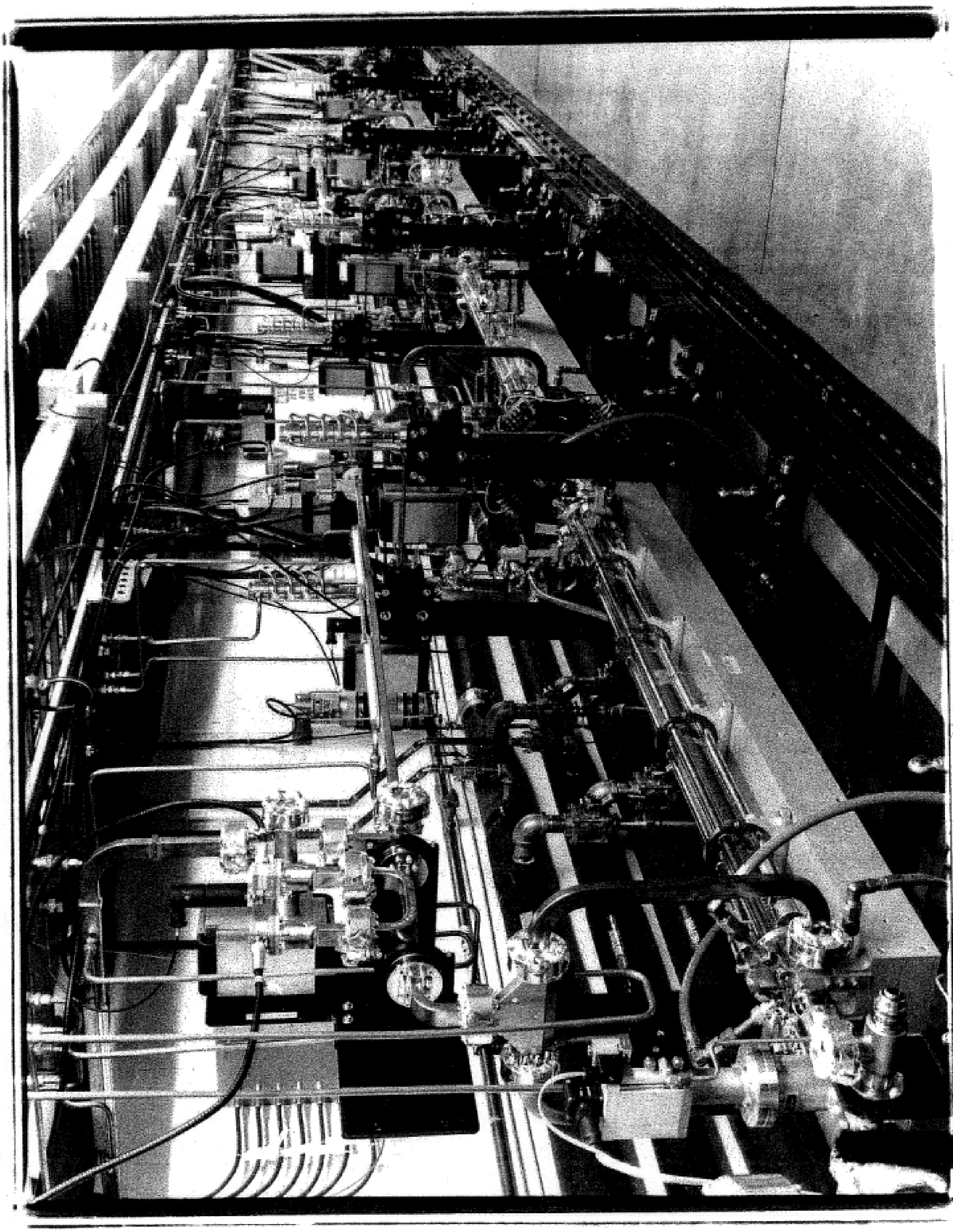


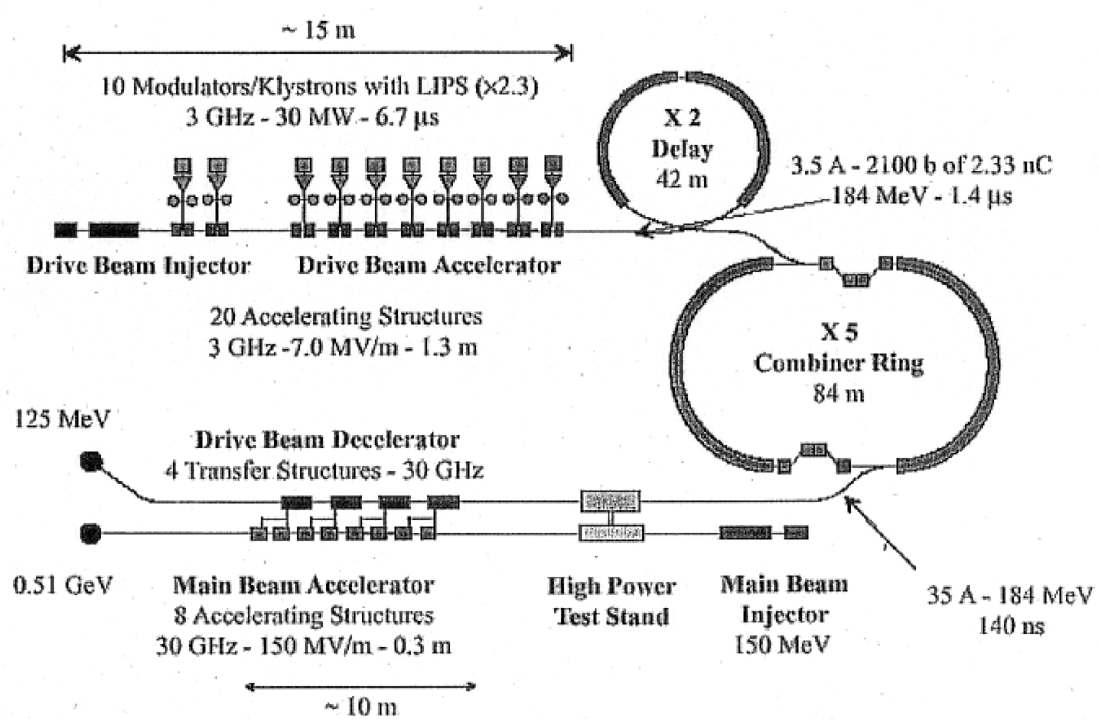
Figure 1: Layout of the TESLA test Facility at DESY.



CERN — European Organization for Nuclear Research

Overall Layouts

CLIC Test Facility CTF3



TRC Working Group Members

Technology, RF Power & Energy Performance Group	Luminosity Performance Group
Daniel Boussard	**Gerry Dugan**
Adolphsen, Chris	Assmann, Ralph
Braun, Hans H.	Decking, Winfried
Chin, YongHo	Gareyte, Jacques
Edwards, Helen	Kozanecki, Witold
Hübner, Kurt	Kubo, Kiyoshi
Lilje, Lutz	Phinney, Nan
Logatchov, Pavel	Rogers, Joe
Pasquinelli, Ralph	Schulte, Daniel
Ross, Marc	Seryi, Andrei
Shintake, Tsumoru	Settles, Ronald
Toge, Nobu	Tenenbaum, Peter
Weise, Hans	Wolski, Andy
Wilson, Perry	Walker, Nick

Technology, RF Power and Energy Working Group

(D. Boussard)

Sub-group 1 *(P. Wilson)*

Accelerator Structures

Sub-group 2 *(Y.H. Chin)*

Power Sources
(Klystrons, Power Supplies, Modulators
and Low Level RF)

Sub-group 3 *(K. Hübner)*

Power Distribution
(RF Pulse Compression, Waveguides,
Two-beam)

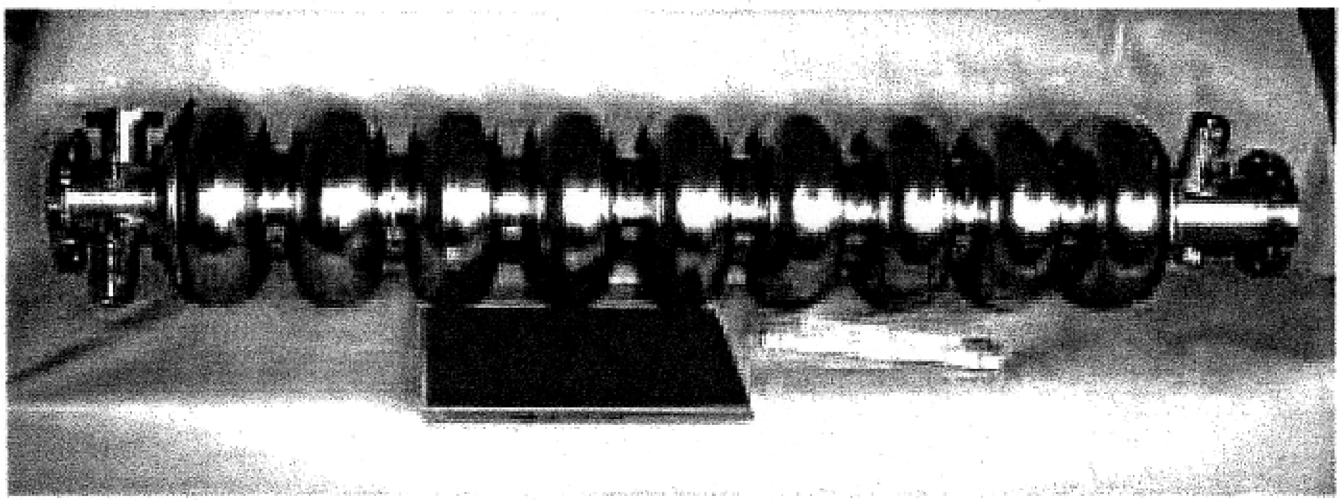
Sub-group 4 *(W. Decking & H. Weise)*

Injectors, Damping Rings and Beam Delivery

Sub-group 5 *(R. Pasquinelli)*

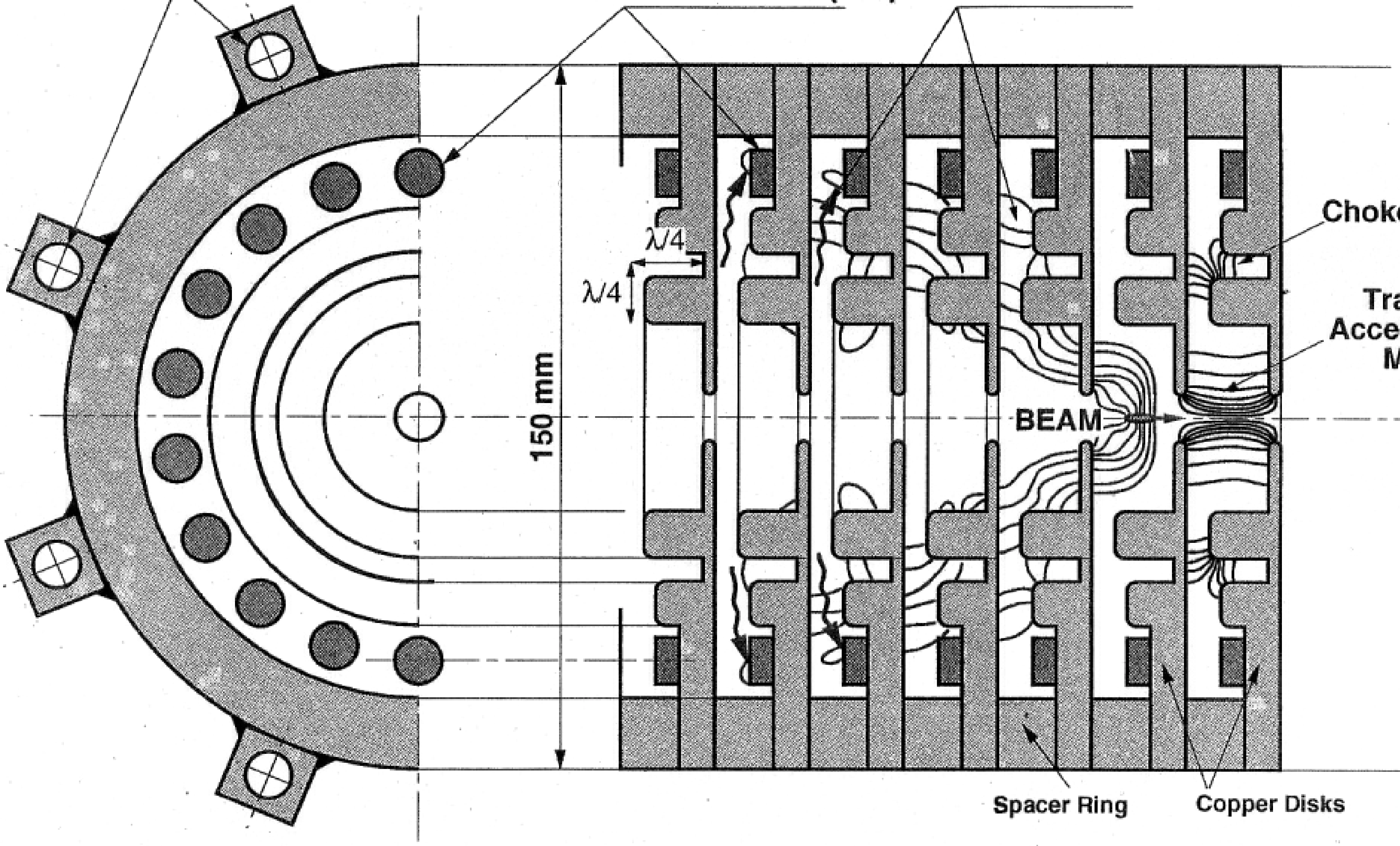
Reliability and Availability

6/20/02

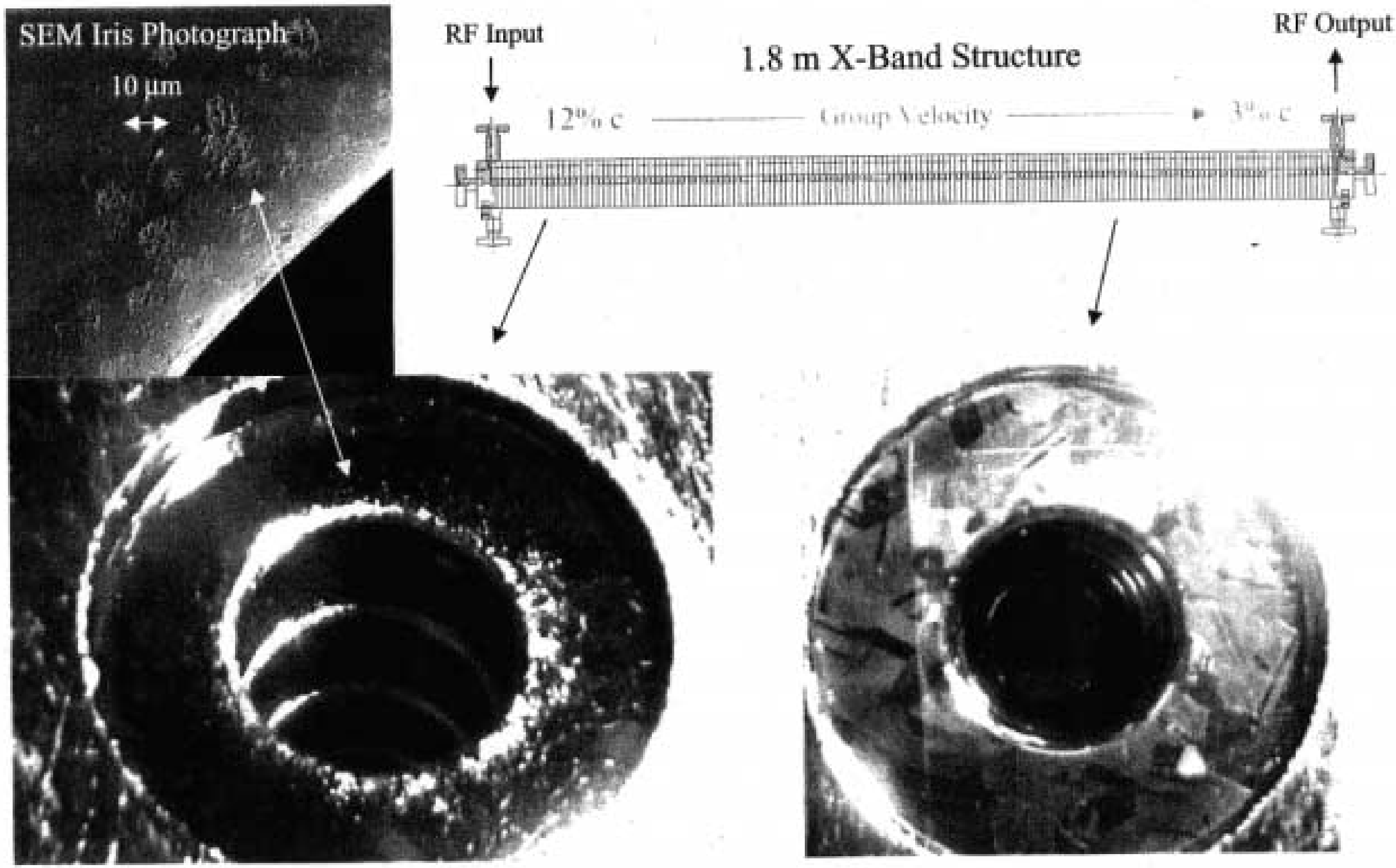


HOM-Free Linear Accelerating Structure

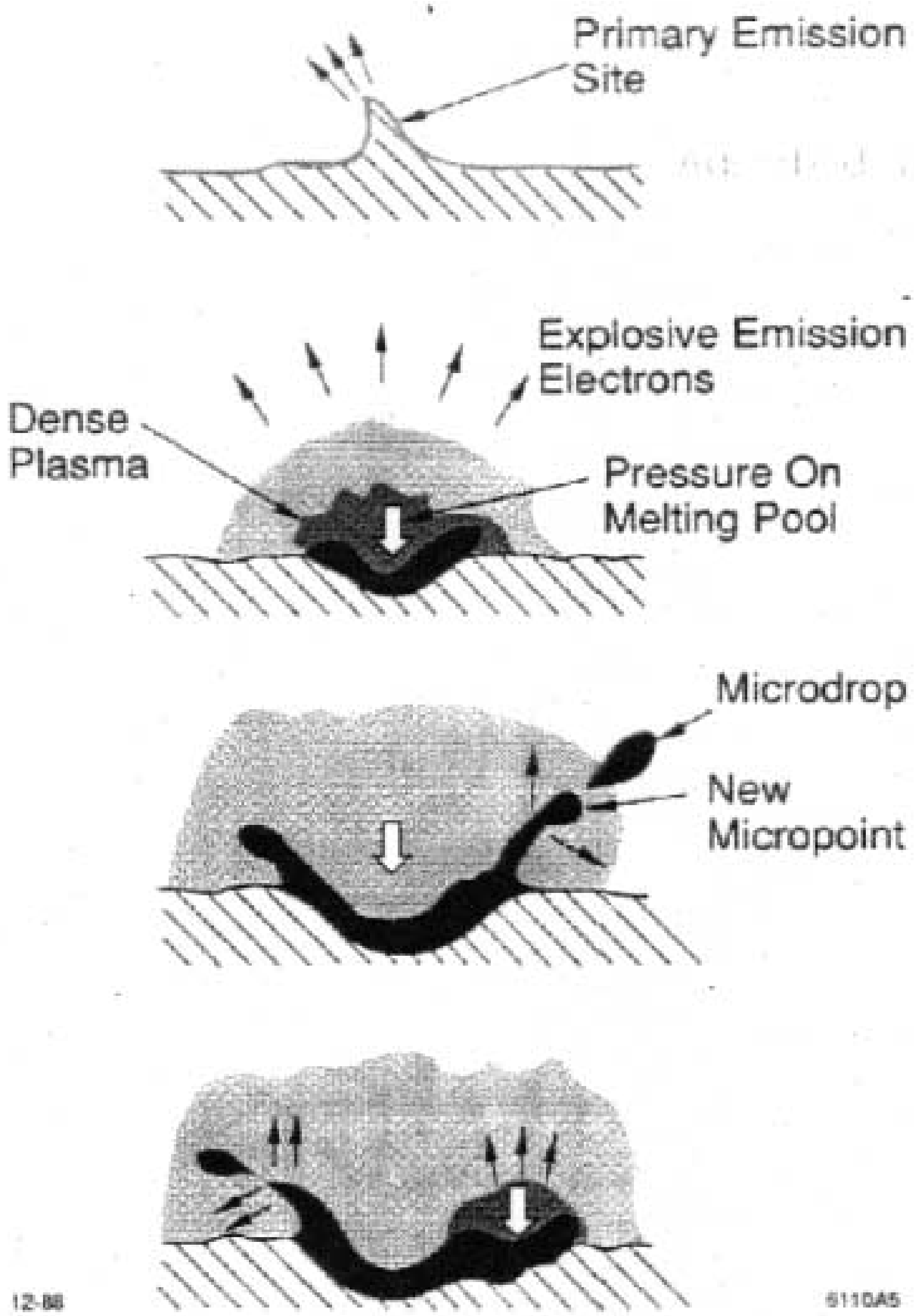
"Choke-Mode Cavit
T. Shintake 1992



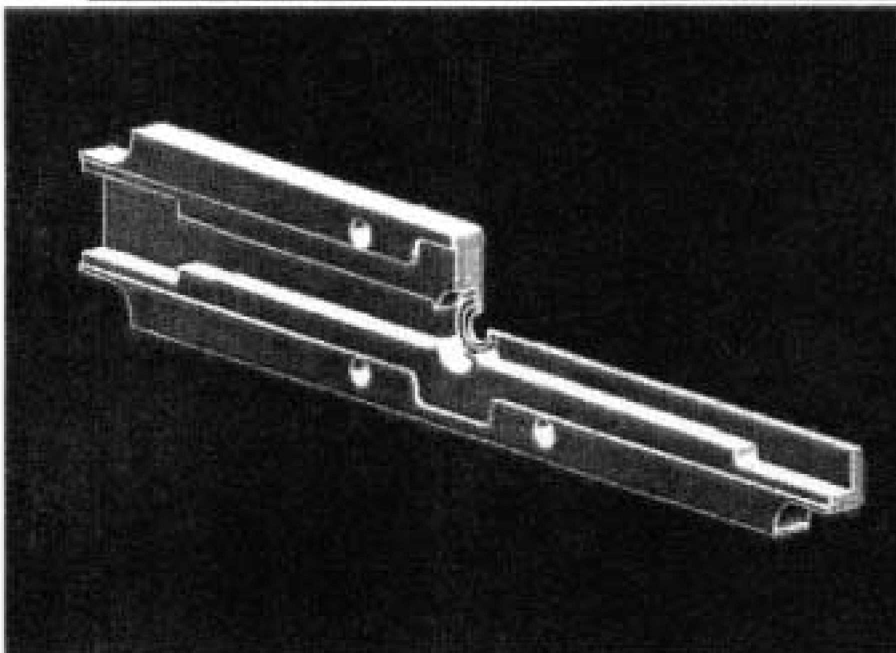
Pitting on Cell Irises of a 1.8 m Structure After Operation at Gradients up to 50 MV/m

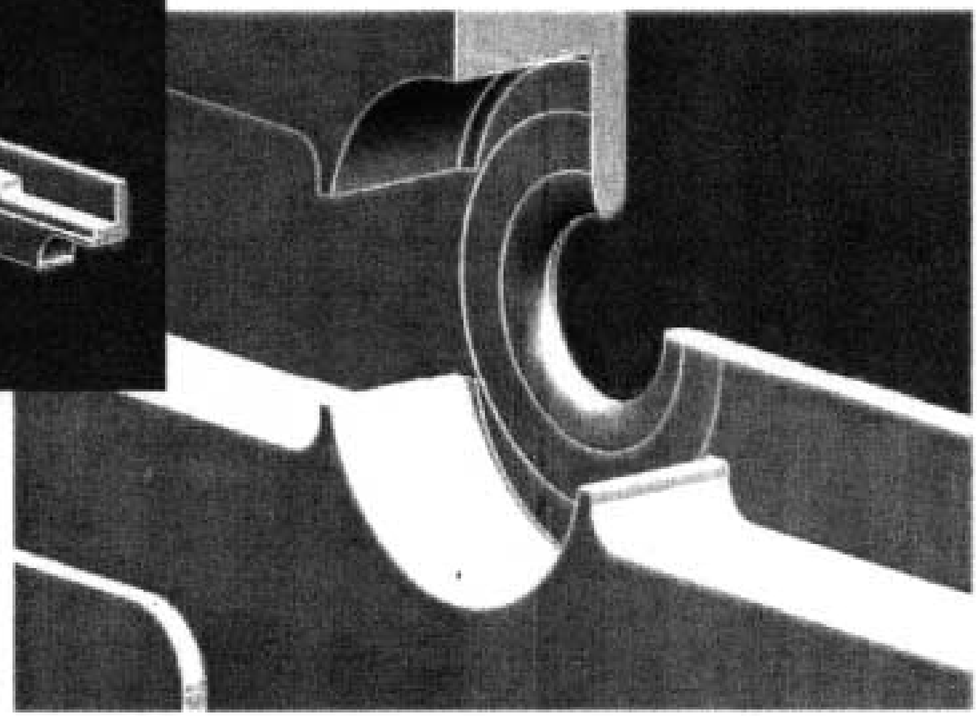


Explosive Electron Emission



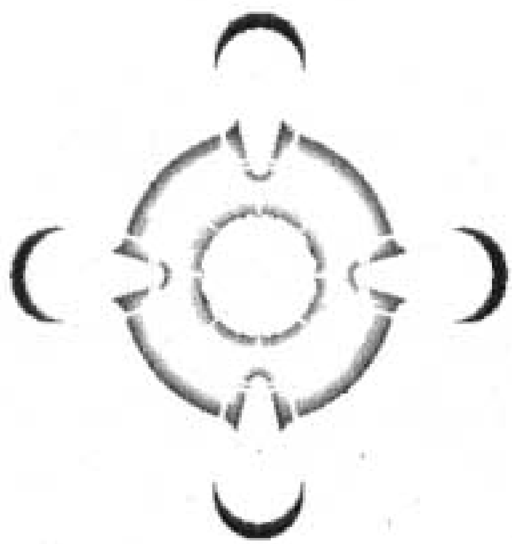
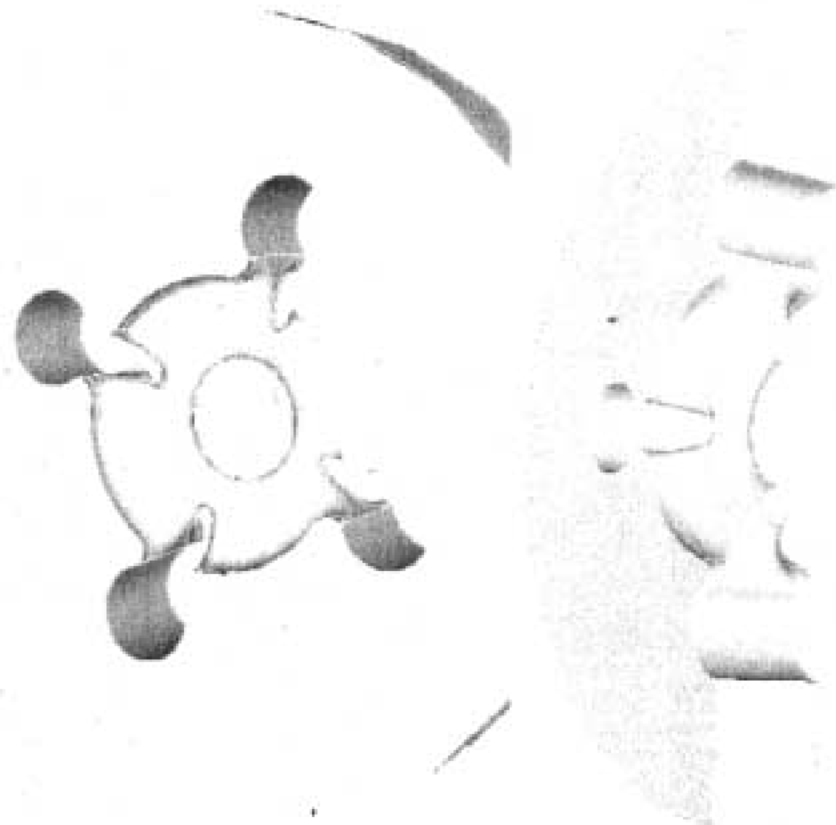
T53VG3RA Input Coupler





Juwen Wang

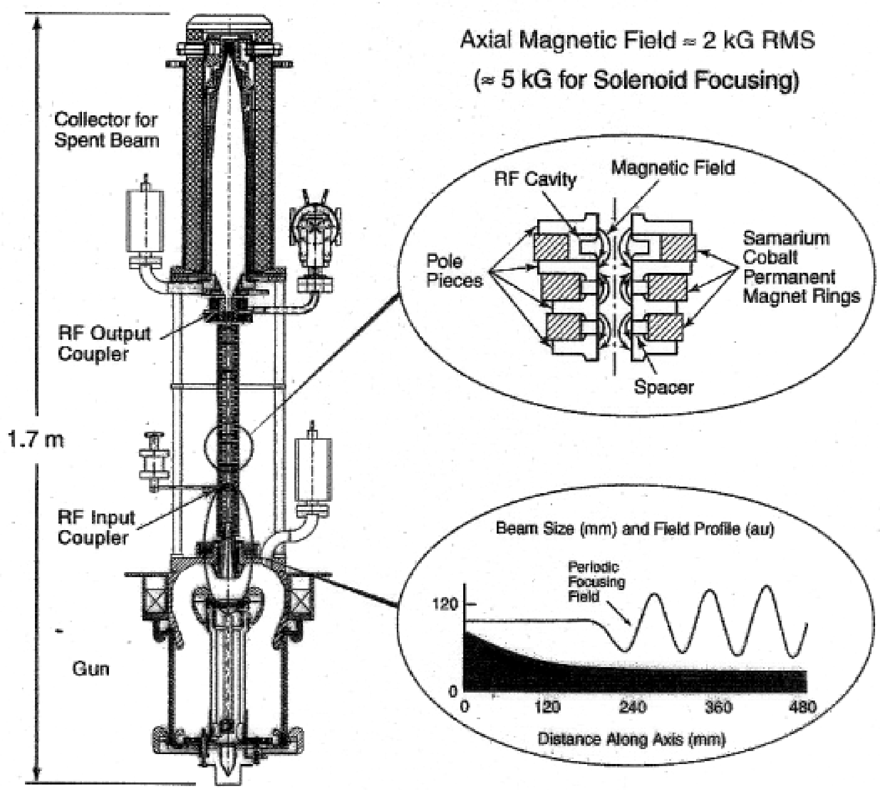
PIE-shaped Slot – rounded cell

NLC - The Next Linear Collider Project

PPM Focused X-Band Klystron

Periodic Permanent Magnet (PPM) Focused X-Band (11.4 GHz) Klystron



D. L. Burke

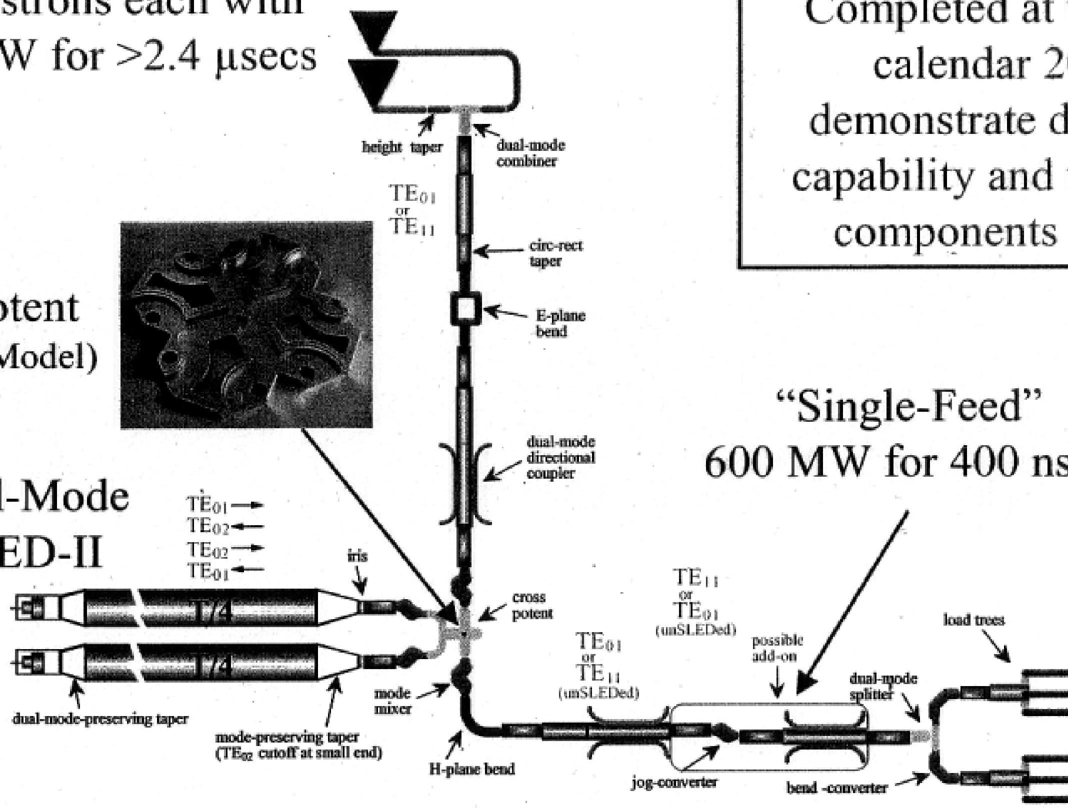
NLC Report
April 2000

8-Pack Phase-I (SLED-II System)

2 Klystrons each with
75 MW for >2.4 μsecs

Completed at the end of calendar 2002 to demonstrate dual-mode capability and test DLDS components in 2003.

Cross-Potent
(Cold Test Model)



Dual-Mode
SLED-II

"Single-Feed"
600 MW for 400 nsec

600 MW
400 ms

Luminosity Performance Working Group

(G. Dugan)

Sub-group 1 *(W. Decking, H. Weise)*

Electron and Positron Sources
(up to Damping Rings)

Sub-group 2 *(J. Rogers)*

Damping Rings

Sub-group 3 *(D. Schulte & P. Tenenbaum)*

Low Emittance Transport
(from Damping Rings to IP)

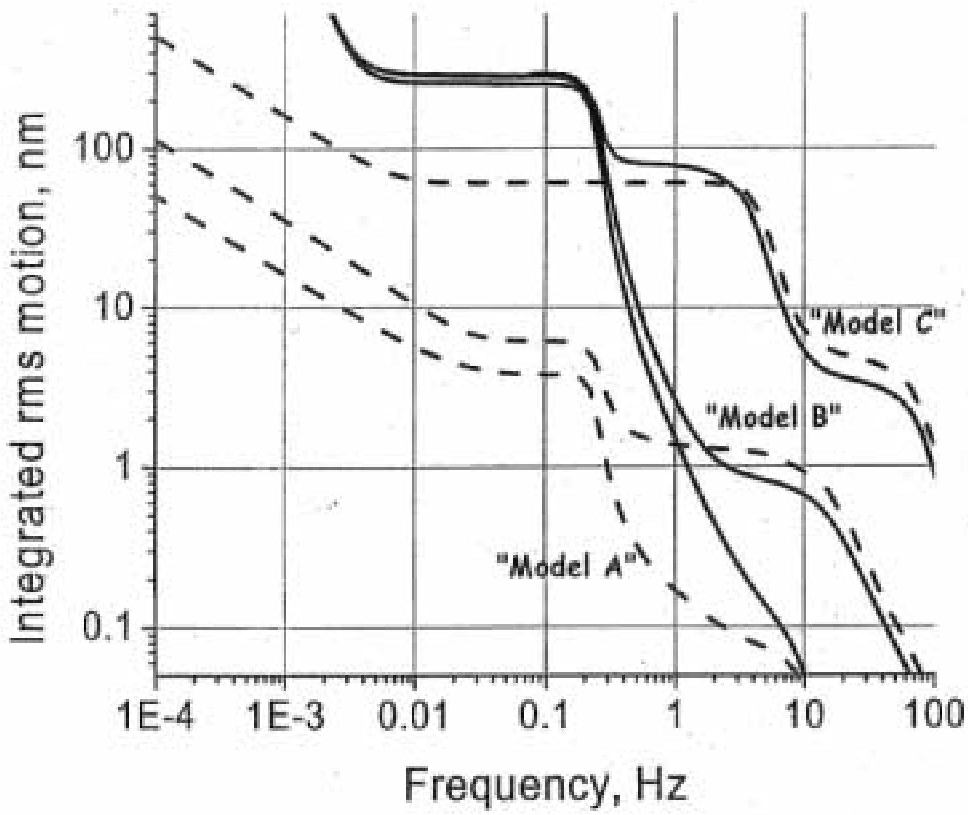
Sub-group 4 *(W. Kozanecki)*

Machine Detector Interface

Sub-group 5 *(N. Phinney)*

Reliability and Availability

Ground Motion Models



3 models used for simulations

A - quiet

B - medium

C - noisy

Based on data from various accelerators

Machine Tuning Simulations Sequence

1. Start with a perfect machine and calculate luminosity

2. Introduce errors likely to exist upon installation

3. Make corrections using Beam Based Alignment (BBA) and Beam Bumps

4. Now include diluted input emittance, magnet jitter and ground motion assumptions along with energy jitter and changing klystron populations

5. Verify that beam-based feedbacks stabilize the beam and maintain luminosity over short-term

6. Repeat BBA and emittance tuning – verify that BBA and tuning algorithms converge in the presence of jitter (try to model realistic diagnostic performance)

7. Unfortunately, step 5 will take several months to complete; hence steps 4 and 6 must proceed in parallel on the basis of guessed assumptions for the effectiveness of the BBA and beam tuning

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Conclusions

- Impressive technical inventions and discoveries are being made on all fronts
- But projects suffer from insufficient R&D funding, which seriously slows down indispensable experimental work
- TRC team work is outstanding although everybody is overextended and often sidetracked by internal lab deadlines, summer conferences and necessary vacations
- TRC "Process" is healthy in unifying accelerator community and will continue long after October 2002