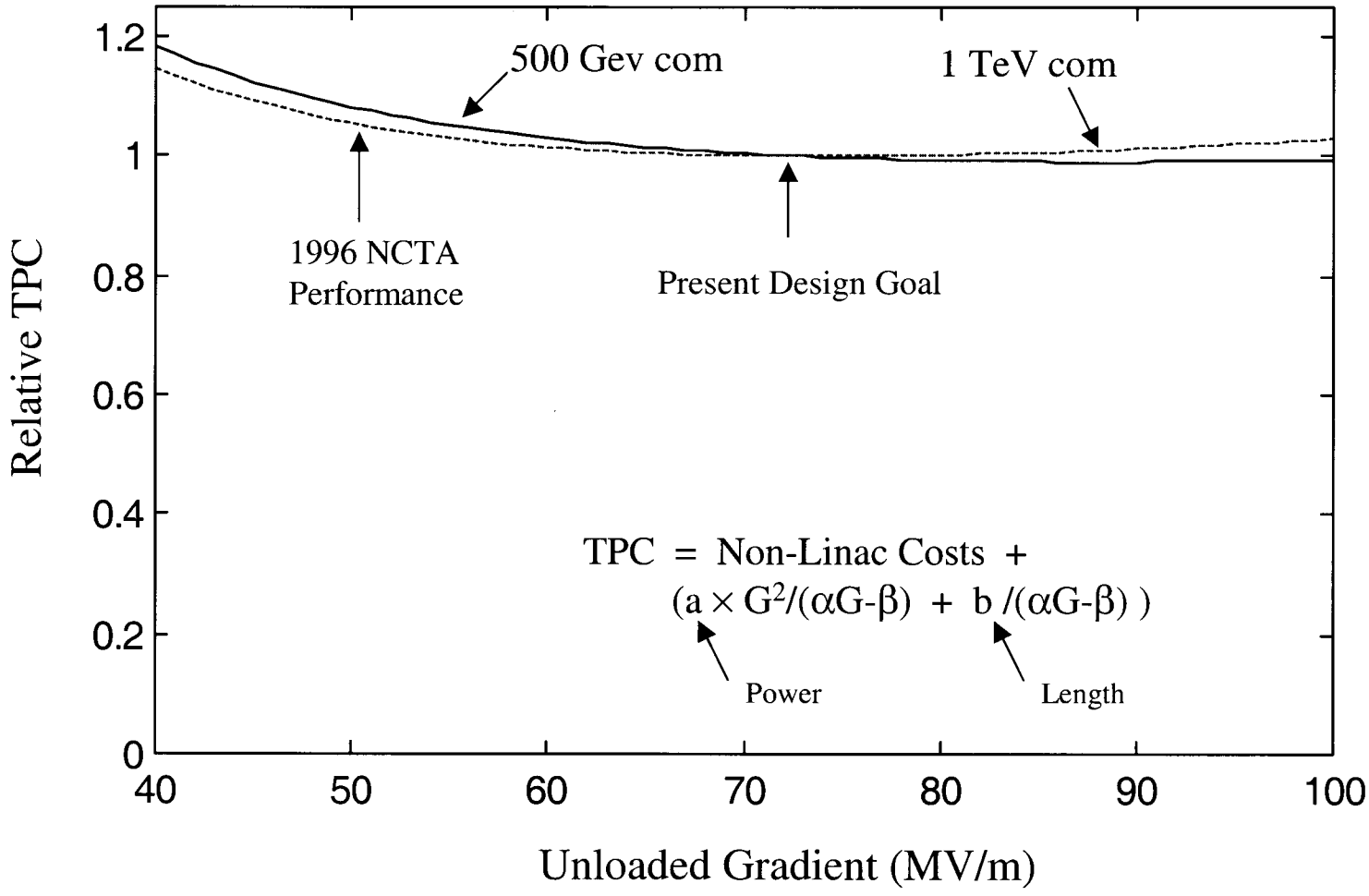
**NLC - The Next Linear Collider Project**

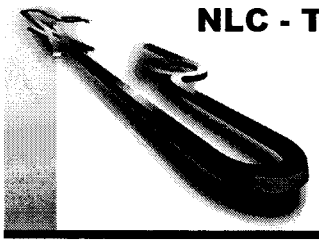
# NLC High Gradient R&D

D. L. Burke
NLC Project Director

NLC Collaboration Video Meeting
January 4, 2001

# Relative Total Project Cost



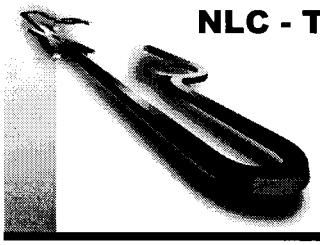




# NLC Model

## May 1999

| | |
|---|---|
| **Total Project Cost** | **5,107 M$** |
| **(FY2000, without detectors, contingency, or escalation)** | |
| Injector Systems | 19 % |
| Main Linacs | 39 % |
| RF Power Systems | 18 % |
| Beamline Systems | 10 % |
| Civil Construction/Facilities | 11 % |
| Beam Delivery | 11 % |
| Global Costs | 17 % |
| E.g. Controls/Software | |
| Central Facilities | |
| Management, Business Services, and Miscellaneous | 14 % |
| Total | 100 % |



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# High Gradient R&D Coordinating Committee

Goal: Reliable operation of NLC X-Band accelerator structures at design gradients ($E_a \approx 75$ MV/m).

Charge : Coordinate use of resources and facilities to achieve this goal.

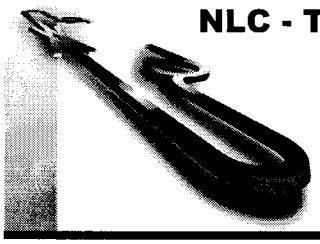
Committee

D. Burke, Chair
C. Adolphsen
J. Cornuelle
E. Garwin
R. Miller
C. Pearson
M. Ross
D. Sprehn
S. Tantawi
J. Wang

**Our colleagues at KEK have aggressively joined in this effort.**

Meeting once per week since September.

For access to notes, schedule, and plans on the web, follow: NLC Technical Home → Main Linac Systems → High Gradient R&D Coordinating Committee.



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# High Gradient R&D Coordinating Committee

## Guidelines and Tasks:

- Focus on NLC X-Band accelerator structures to the exclusion (if need be) of other issues.

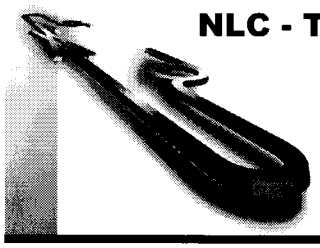
- Attack problems on each major front – theory, design, manufacture/QC, and operations.

- Fully utilize experience at all sources.
  - SLAC linac/ATF linac
  - X-Band structures and tests to date
  - R&D in superconducting systems
  - Semiconductor industry
  - Space technologies
  - Others as identified

- Identify resources needed or jobs to be done that will speed up or focus the R&D process.
  - Scientific/technical support
  - Programming support
  - Facilities

- Develop a roadmap and schedule of activities.

- Track results, costs, and schedules.



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# High Gradient R&D Coordinating Committee

**There is a large parameter space that might be explored.**

- Define a path that optimizes success.
- Fishing expeditions to experimentally eliminate a wide range of possibilities is not going to get us there!
- Start with processes that have recognized success and acceptance (good practices).

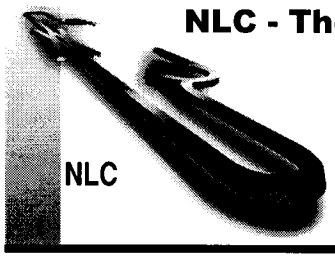
## Sub-Committees

1. Breakdown Theory (Tantawi/Wilson)
2. Structure Design (Wang/Adolphsen/Miller)
3. Manufacturing and QC (Cornuelle/Garwin/Pearson)
4. Operations and Processing (Ross/Sprehn)

Each of these meet once per week in addition to the meeting of the entire Committee.

## General Information and Discussion

Once per week meeting on Monday afternoons for presentation and discussion (coordinated by Chris Adolphsen).






# High Gradient R&D

## Structure Breakdown Workshop

**August 28 - 30 , 2000**

**Coordinators: C. Adolphsen, M. Ross, D. Sprehn, N. Holtkamp, D. Finley, J.-P. Delahaye, N. Toge**

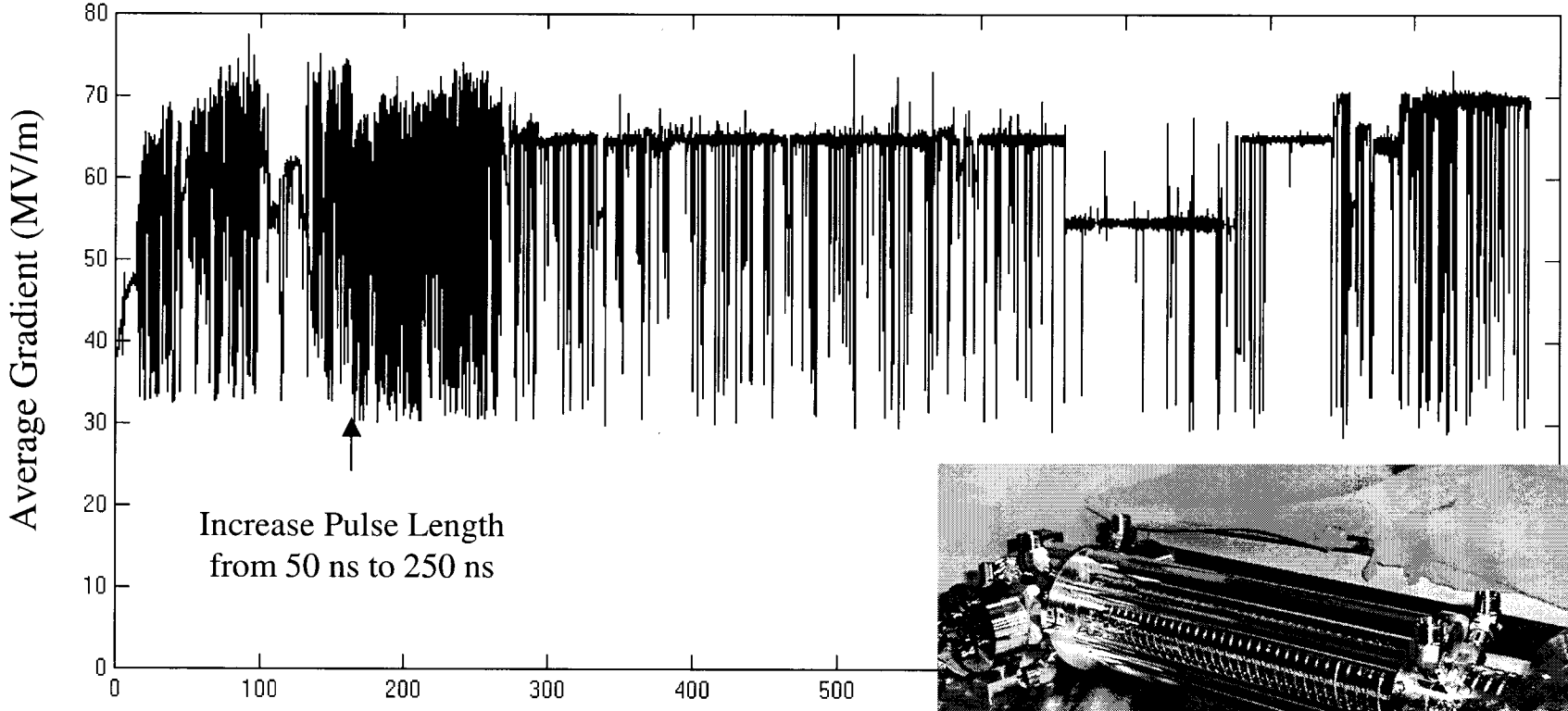
**http//:www.project.slac.stanford.edu/lc/wkshp/RFBreakdwn/references/publist.htm**

Areas of Concentration

- Circuit design
- Manufacturing and QC
- System Diagnostics, Control, and RF Conditioning

High-Power Facilities
NLCTA
Microwave Test Stand ("Window-tron")

# DS2S Operation in NLCTA

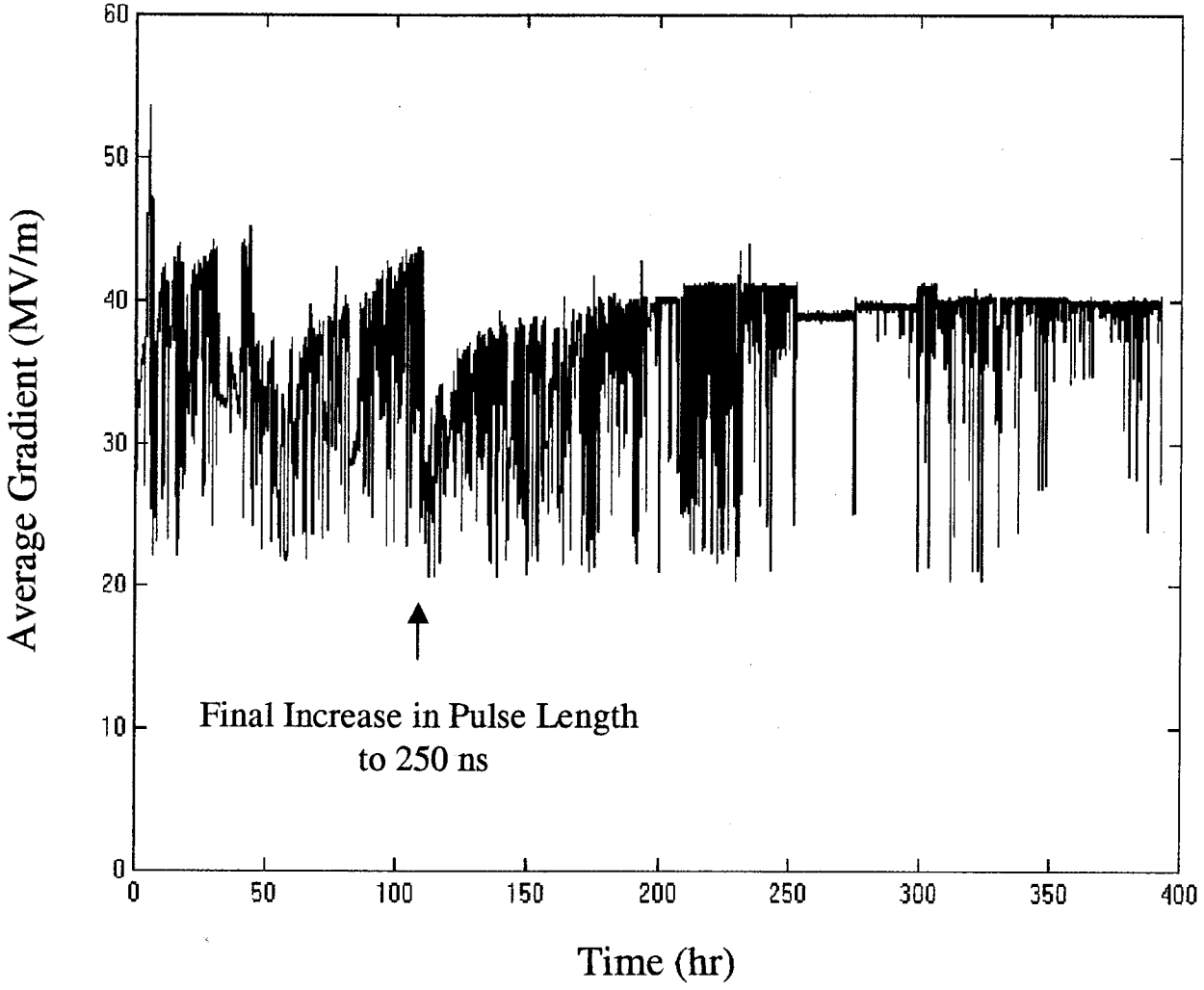





Last 52 Cells of DS2

Group Velocity Varies from 5% to 3% c

# DDS3 Processing




Goal

- Run > 500 hours @ 40 MV/m and 250 ns.

Improvements: Better

- Cell Cleaning Method
- Vacuum Pumping

'Gentler' Processing

- Progressive Length of Pulses
- Wait 5 Minutes before Resetting after a Trip
- Trip on Missing Transmitted Power as Well as Reflected, and Eliminate Multi-Pulse Trips.

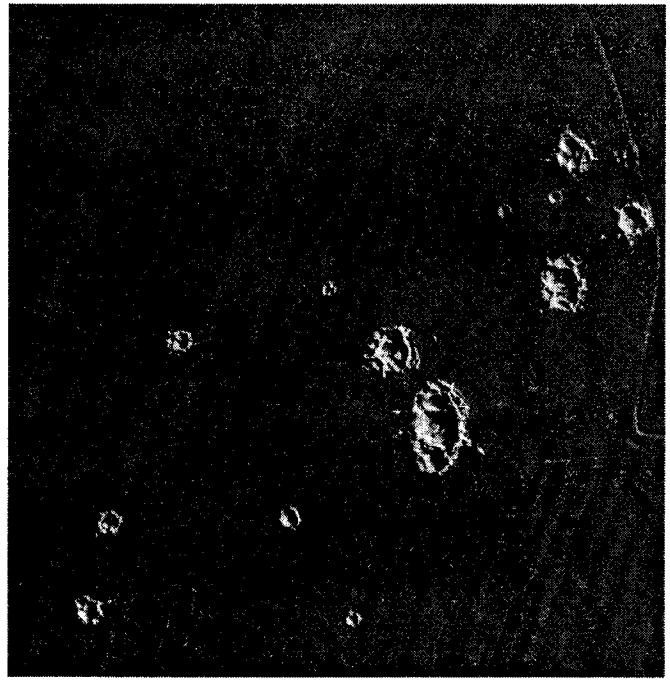
# "Window-tron" Studies Breakdown Patterns

## High-Q Cell

(Low $v_g$)

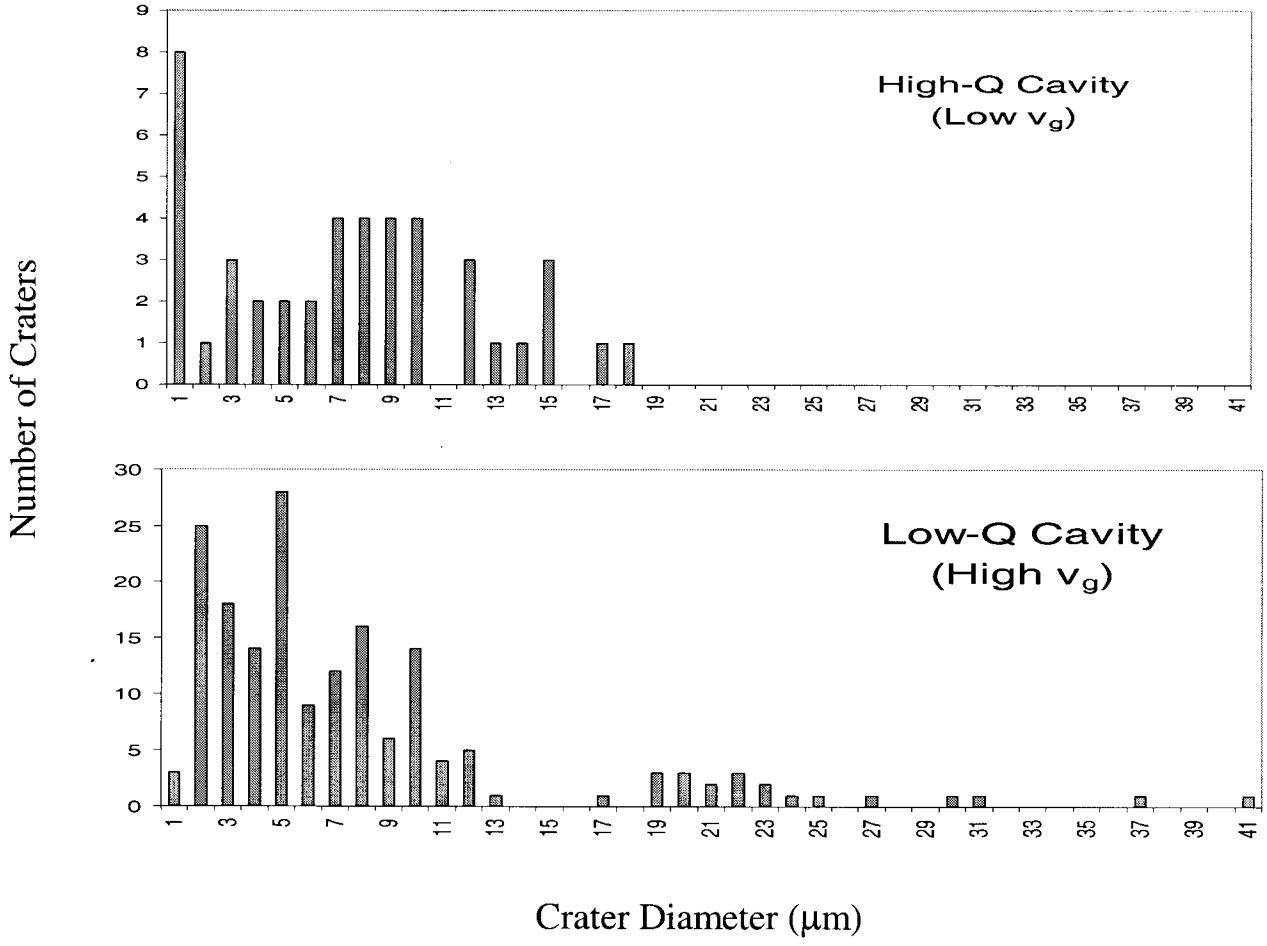
## Low-Q Cell

(High $v_g$)



(Scale 3-4 times High-Q picture.)

# "Window-tron" Studies
# Damage Dimension



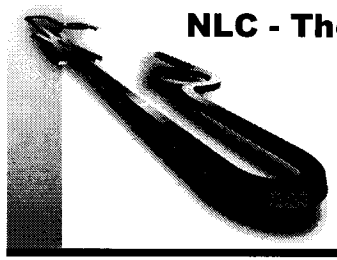
# Structure Fabrication/Test Strategy

SLAC-KEK ISG6 (Updated 12-Dec-200)

| | Length Cells | Vg % | Gas Surface Process[a] | Adiabatic Coupler[b] | Surface Finish | Part Cleaning | Joining | Test Schedule |
|---|---|---|---|---|---|---|---|---|
| T20VG5N | 20 | 5 | Y | N | Diamond | Chemical | $H_2$-DB/$H_2$-Braze | Feb-Mar |
| T105VG5N | 105 | 5 | Y | N | Diamond | Chemical | $H_2$-DB/$H_2$-Braze | Feb-Mar |
| T20VG5NA | 20 | 5 | ? | Y | Diamond | Chemical | $H_2$-DB/$H_2$-Braze | Apr-May |
| T53VG3F | 53 | 3 | ? | N | Diamond | $O_3$ water | VAC-DB/$H_2$-Braze | May-Jun |
| T53VG5F | 53 | 5 | ? | N | Diamond | $O_3$ water | VAC-DB/$H_2$-Braze | May-Jun |
| T53VG3R | 53 | 3 | ? | N | Regular | Chemical | $H_2$-DB/$H_2$-Braze | Mar-Apr |
| T53VG5R | 53 | 5 | ? | N | Regular | Chemical | $H_2$-DB/$H_2$-Braze | Mar-Apr |
| HxxVGyM | ? | ? | ? | ? | Diamond | $O_3$ water | VAC-DB/$H_2$-Braze | ??? |
| S20PI | 13 | SW | ? | NA | Diamond | Chemical | $H_2$-DB/$H_2$-Braze | Apr-May |

(a) Gas Surface Process: Wet $H_2$ → Dry $H_2$ → Vacuum firing (650° C for 10-14 days).

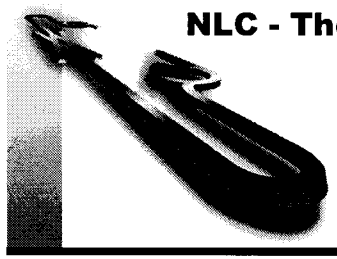
(b) Adiabatic Coupler: Reduced surface field at input coupler and first two cells.



# High Gradient R&D

## Status

- Next NLCTA Vacuum Access – February
  - DS2S Out.
  - T20VG5N and T105VG5N In.
- T20VG5N/T105VG5N
  - New structures – no previous exposure to high voltage.
  - Assess effect of length on gradient limit and processing speed.
  - Do wet $H_2$ firing and vacuum firing help significantly?
  - Are new processing protocols from study of DDS3/DS2S effective?
  - Expect answers by the "Ides of March".
- Outcomes – Not necessarily a crisp answer, but follow up paths include:
  - Positive Results
    - Manufacture next structures in similar manner.
    - Optimize structure design and evaluate alternatives.
  - Negative Results
    - Push aggressively for **"Next Big Breakthrough"** in manufacturing and design.



# High Gradient R&D
## Next Steps

- Design – All in manufacture now!
  - Optimization of group velocity and length T53VG5/3 (KEK/Robertson-SLAC).
  - Optimization of input impedance match T20VG5NA (KEK-SLAC).
  - **Next Big Breakthrough: Standing-wave structure S20PI (LLNL-SLAC).**
- Processing
  - Optimization of RF Processing Protocol.
- Manufacture/QC
  - Enhanced "Standard" Cleaning (Cells Only).
  - **Next Big Breakthrough: Ultra-Pure Water Rinsing (Cells Only).**
  - **Next Big Breakthrough: Glow Discharge Cleaning (Completed Structure).**
  - In the queue: Ultra-Pure Water Rinsing (Completed Structure).
  - In the queue: High Pressure Water Rinsing.
  - In the queue: Megasonics Cleaning.

"Next Big Breakthrough" manufacturing options being studied with coupon and "Window-tron" samples.