2-Pack Experiment

1. Description of this experiment

The 2-Pack klystrons are located in the north half of End Station B, immediately adjacent to the NLCTA Accelerator Enclosure in the old “8-Pack” location.

This modulator power source is a new IGBT transformer coupled modulator. The modulator is not a source of radiation.

Installed on the oil tank is a pair of XL-4 X-band klystrons.

The scope of this Experimental Authorization is for:

- two klystrons:
  - connected to high power microwave vacuum waveguides
  - connected to SLED line pulse compressor
  - all microwave power end up in water cooled microwave loads
  - no high-q devices such as single-cell cavities or accelerators
- klystron beam voltage: 405 kV
- maximum repetition rate: 120 PPS
- maximum pulse length of klystron outputs around 1.5 us at no more than about 50MW

2. Brief description of the expected radiation production. Identify shielding to address this source:

Klystron: The klystron’s electron beam generates X-rays at any point of beam interception. The major sources of radiation are the tank, gun, the body, and the collector.

RF systems: RF breakdown in high power components can produce bursts of radiation.

Other RF processes and conditioning can generate low-level radiation. These elements (including high-power RF loads) will be locally shielded with lead sheeting as needed to maintain radiation levels below 100mR/hr contact and 2 mR/hr at the rope.

3. Discussion of the maximum radiation produced under Operating Conditions:

Klystrons shielding is designed to result in radiological emissions less than 100 mR/hr on contact and 2 mR/hr “at the rope” (approximately 1.5 m). Local shielding of RF components will keep emissions below same levels.

4. Discussion of the maximum radiation produced under Fault Conditions:

RF breakdown in RF power handling waveguides has been shown to produce radiation bursts in excess of 25uR per event at 1 meter. This level will trip a BSOIC set at 4mR/hr above the internal source.

5. Does the device or system present any unusual radiation sources or hazards? Please explain unusual sources and related controls.

There are no unusual radiation sources. The major hazards associated with this experiment are electrical in nature.
6. **Description of the initial requirements for shielding:**

Operation of the klystron will consist of the standard production XL-4 klystron shielding. Additional shielding of a layer of lead around the RF loads and RF power combiners will follow the standards developed for the 8-pack operations. These components are typically shielded with one of two layers of 1/8 inch lead sheeting.

All shielding is labeled. All shielding is strapped, glued, or bolted in position.

7. **Description of shielding upgrade options (discuss locations and type of shielding modifications considered likely):**

Local shielding will be added as needed to limit radiological exposure and to maintain emission levels at less than 100 mR/hr on contact and less than 5 mR/hr at the Radiation Boundary. Note that radiation levels of up to 100 mR/hr at 30 cm is permitted for short periods to allow surveys and shielding requirements to be determined.

Modifications to the shielding must be noted in the NLCTA operations log and Radiation Physics must be informed.

8. **Run up and Operation plan. Indicate hold points for radiological surveys and subsequent survey frequency:**

   1. If any klystron has not operated in this configuration, survey using Initial Klystron Radiation Survey sheet at 100 kV and at each 100 kV operational step.
   3. Klystron at maximum RF output power for current program.
   4. If klystron shielding is removed (and reinstalled) or modified, repeat full voltage survey using Initial Klystron Radiation Survey sheet.
   5. Once running at full power, RP Field Operations will conduct and record a comprehensive survey.
   6. Regular walkthrough radiological surveys will be conducted and recorded by RP Field Operations.

Daily operation meetings are held to discuss the program of the NLCTA (including the 2-Pack Operations). RF processing history and program is an agenda at this meeting.

All survey sheets are filed in NLCTA Radiation Survey Binder in the NLCTA control room.

9. **Specific plan of Radiation Measurements.**

Survey with radiation detector as determined by RP Field Operations. Survey operational klystrons and RF transport components as indicated on survey sheet and suggested by RF diagnostic information.

10. **Radiation Engineering Controls.**

RF signals are connected to interlock systems (ala MPS systems) which detect anomalous RF breakdown processes. Interlock system response is to interrupt triggers (reduce rate to 0), reducing power, and/or changing of RF phase or pulse length controls.

Two BSOIC area radiation monitors near the klystrons are likely to respond to radiation production of these systems. The BSOIC nearest the klystrons is set to trip at 4 mR/hr above internal source
level and the other local units are set at 10 mR/hr. The BSOIC interlock system is interlocked to the
power supply. These devices are set according the NLCTA BAS and cannot be bypassed. NLCTA
Operations has a procedure BSOIC Trip Alarm Response Procedure (02-05-05-01) that details the
response by an Operator to the trip.


The End Station B is a RCA (Radiologically Controlled Area). An area surrounding the klystrons
and high power RF systems shall be posted as a Radiation Area as requested by Operational
Health Physics.

End Station B is visited by SLAC Security as part of their regular surveillance of the research yard
area. All regular surveillance visits are noted on a clipboard in the End Station - typical 5-6 visits a
day.


Area Monitors may be placed in the area by Operational Health Physics.

13. Envelope of Global Operating Parameters not to be exceeded (operating safety
envelope)

This authorization is for operation as described in section 1.

14. Line Management Responsibility:

The 2-Pack system is part of the ILC Division activities. The ILC Division Head is Tor
Raubenheimer.

The 2-Pack Operations Manager is responsible for the safe operation of the 2-Pack klystron,
modulator, RF systems, and any other experimental equipment associated with the 2-Pack
development in End Station B.

The 2-Pack Operations Manager is responsible for ensuring that either a) operational authorization
for this experiment is maintained, or b) the experiment is secured to render it inoperable.

Operational and safety management of this project are as described in the NLCTA procedures.
ADSO and Radiation Physics shall continue to provide radiological safety support.

15. Experiment operators:

Qualified operators are listed on the “2-Pack Experimental Authorization Sheet” [SLAC-I-ILC-001-
04-01-01]. All operators must satisfy the “L-band Operator Training Requirements” [SLAC-I-ILC-
001-03-04-01] and record their qualifications on the “2-Pack Operator Workbook” [SLAC-I-ILC-001-
04-04-02]. Each operator is approved by the 2-Pack Operations Manager or the ILC Safety Officer.
2-Pack operation is independent of NLCTA accelerator components and is not described in the
NLCTA BAS.

Emergency contact information is found on the NLCTA call-in list is (posted in the control room)
which contains the names, telephone numbers, and alternate contact numbers (cell phones,
pagers, etc.) of all EOIG-qualified operators as well as the names and telephone numbers of other
personnel who support the experimental activities. NLCTA contact information is also available in
two other notable call-in lists: a) the Emergency Call-In list (in MCC) and b) the Emergency
Management Database (distributed to MCC, Security, Fire, the laboratory Director and all Associate
Directors).
Management of the program is included in the daily operations meeting, and the status of the experiment is included in the operations log.

16. Operation of the 2-Pack system

Normal “Attended Operation” mode: Qualified operators must be present in the control room (including End Station B) for all modes of operation. If the operator must leave the building for an extended period of time and is unable to designate a substitute operator, the experimental program must be terminated. An entry must be made in the NLCTA Operations Log.

17. Operational Requirements:

2-Pack Klystron Daily checklists (SLAC-I-ILC-001-04-01-01) for the 2-Pack systems shall be performed by qualified operators every day while the 2-Pack system is operating. The checklists are continually modified as necessary to include items which, for operational or safety reasons, need operator verification.

The 2-Pack operator shall sign the daily signoff sheet in this Experimental Authorization for each day that the 2-Pack is operating to indicate that the Experimental Authorization requirements are met.

18. Document Approvals:

Approval to run this experiment as described above is granted. Any change in the experimental equipment or operating parameters not described herein is prohibited. Any change in this document must be initialed by the Safety Officer or ADSO, and must be initialed by Radiation Physics.

ILC 2-Pack Operations Manager: ________________ R. Swent ____________ ______
ILC Safety Officer: ________________ K. Jobe ____________ ______
ADSO: ________________ P. Miller ____________ ______
RP Field Operations: ________________ J. Allan ____________ ______
Responsible Radiation Physicist: ________________ H. Tran ____________ ______

Signature Name Date