Minutes of Linac Klystron Meeting held Monday, August 31, 1998

Attendees: Carlson, Schmidt, Allen, Ganger, Ma, Popovic, Noble, Pasquinelli, Czarapata, Webber

Meeting was called by Webber to present status and plan activities to address the very tenuous situation with respect to useable spare 10 Mw Linac klystrons. It has been five months or more since a tube has produced rf power in the klystron test station. Recent attempts have been thwarted by water leaks on and vacuum problems in the klystron tubes. We currently have no spare tube in a socket, recently tested, and ready as a known good spare.

Kermit made a presentation on the status of 15 klystrons.

1. Tubes with serial numbers 4, 5, 6, 7, 9, 10, and 15 are installed in the seven operating high energy stations and are presently operating without problems. Four of these tubes have greater than 40,000 hours of operation, one have 35,000 hours, and the other two about 26,000 hours.
2. Two tubes are at Litton for rebuilding. Serial #2 failed in operation at 36,000 hours and has been with Litton since May 1997; at last report it was scheduled for return to us in October of this year. Serial #8 failed under power in the test station at 3,000 hours and was sent to Litton at the end of May, 1998. The schedule for it's repair and return is not known.
3. Tubes #12 and 13 have never been pulsed at Fermilab. These tubes were both found this summer to have water leaks at factory welds at the collector end of the tube. They were re-welded here and those water leaks appear to have been fixed. In addition, #13 was found to have a water leak at a factory welded water fitting near the center of the tube body; that too has been repaired by Fermilab welders and no longer leaks. However, both of these tubes presently exhibit vacuum problems as manifested by high ion pump current at small or no filament power. The tubes had been under ion pump vacuum throughout their lifetime and showed symptoms of vacuum problems only when heated at the cathode. Attempts to recover good vacuum in these tubes have proven unsuccessful thus far and prospects do not bode well. #13 is currently in a socket at the Linac test stand; #12 is in a holding fixture.
4. Tube #1 has some large, but unrecorded, number of operating hours at A0; it is presently in a holding fixture.
5. Tube #11 has had 12,000 operating hours in the Linac. It was last pulsed about four years ago. It is now in a holding fixture.
6. Tube #3 is an isolated collector type tube that has never been heated or pulsed at Fermilab. It is now in a holding fixture.
7. Tube #14 has never been heated or pulsed at Fermilab. It is now in a socket in the "blue" tank in the Linac gallery.

In summary, there appear to be only four tubes that remain as possibly usable.

Webber has requested of Kermit that individual "traveler" logbooks be immediately started and maintained for each klystron to record all events in the tube's life.

Noble recalled that Litton had produced a "users manual" for Fermilab when the tubes were first procured. He recommended that the manual be reviewed thoroughly in light of recent experiences and as a possible guide to future actions. Litton may have additional and more recent information which might be incorporated into the document. He also recommended involving Litton on site when the first rebuilt tube is received and tested and involving the Fermilab business more closely in the repair and scheduling of rebuilt tubes. Seeking additional advice from experienced individuals was strongly recommended. In addition to Litton engineers, George Caryotakis of SLAC and John Lyle of LANL were suggested.

Webber stressed that the priority of klystron work must be second only to immediate Linac operational tasks.

Webber prioritized tasks for this week as:

1. Apply low power to filaments on tubes #1, 3, and 11 while monitoring ion pump currents to get a quick check on the vacuum state of these tubes.
2. Same on #14 in the "blue" tank.
3. Install #11 in the test stand to ready and prove it as a good spare.

It is expected that meeting on this topic shall continue on a weekly basis until the immediate spares situation has been resolved and a long term plan for continuing a stream of good spares has been established.

Minutes of Linac Klystron Meeting held Monday, September 9, 1998

Attendees: Allen, Moretti, Carlson, Ganger, Popovic, Webber

Meeting was called by Webber to update status from previous meeting and to plan activities for the coming week.

Moretti updated klystron status:

1. Tubes #1 (lots of A0 hours) and #11 (12,000 Linac hours) manifest slight if any ion pump current rise when filaments are heated to over 100 watts.
2. Tube #3 (0 hours) shows 10-20 microamps ion pump current at about 100 watts filament power but recovers quickly and seems to show improvement with time as though it will condition properly.
3. Tube #14 (0 hours) looks good at 100 watts; somewhere between tubes #1 and #11.
4. Tube #12 now draws 100 microamps ion pump current with no filament heat. No change is noted between time pump is first turned on and after it has been on for a long time. The same current is drawn even if the ion pump magnets are removed. This tube was hipotted across the gun insulator and breaks down at 4KV.
5. Tube #13 which had showed excessive ion pump activity even at low filament power (>100 microamps with 10 watts for an hour) was given full filament black heat power in an attempt to condition it. That only made the situation worse and it now shows 600 microamp ion pump current with no filament heat.

It was noted that both #12 and 13 were recently welded, before applying filament heat, to repair water leaks at the collector end of the tube.

Moretti has talked with Litton. They claim that the cathode can absorb gases. They apparently were not surprised by initial outgassing, though they had not experienced the magnitude of the problem shown by these tubes. Moretti suggested that noble gases may exist in the tubes which are not readily pumped by the ion pumps. He further suggested that during power operation of the tubes these gases get drawn to and trapped in the collector of the tube. This might explain the differences between tubes with some hours of operation and tubes that have not experienced any operation beyond manufacturer test.

Webber suggested organizing a "klystron summit" at Fermilab with experts from Litton, SLAC, et al. to be invited to hear of our problems and share their experiences. Moretti will consider this.

Webber brought up the possibility of opening the vacuum system of #12 or 13 in an attempt to pump out a tube here since those tubes seem to be unusable in any case. The idea met a decidedly lukewarm reception. A post-meeting discussion between Webber and Kris Anderson of BD/ME lead to the suggestion of pumping vacuum on the water lines of #12 and/or #13 while monitoring the tube ion pump current to determine if a possible leak between the tube water passages and vacuum vessel may be detected.

Plan of action for the coming week is to perform a static water pressure test on klystron #14 and, if that goes well, to place that tube in the "brown" tank in the Linac klystron test stand and then perform power tests. This tube should be installed in the test stand by 9/19. Klystron #3 will be placed in the "blue" tank to be next in line for the test stand. Preparations will be made to ship #12 and #13 to Litton for rebuild.

Moretti will obtain manufacturer data for the ion pumps used on the klystron tubes. He will also provide Webber with a copy of the klystron operator's manual written by Litton when the tubes were delivered and a copy of the current rebuild contract with Litton. Moretti or Carlson will contact Litton to have them send us the two klystron shipping coffins so we can return #12 and 13 for rebuild.

Minutes of Linac Klystron Meeting held Thursday, September 24, 1998
Previous meeting was held on Sept. 9

Attendees: Allen, Moretti, Ma, Carlson, Ganger, Popovic, and Webber

Status update:
1. Tube #14 (0+ hours) - removed from "blue" tank and installed in test stand in "brown" tank. This tube powered up as a good tube should; it produced rf power as of 9/24/98. Webber requests that this tube be operated at full power around the clock for two full weeks before tube and tank are removed from test stand and set aside as a spare unit.
2. Tube #13 (vacuum problems) - removed from "brown" tank and placed in holding fixture. No further change in status since last report.
3. Tube #12 (vacuum problems) – no change in status since last report.
4. Tubes #1 (lots of A0 hours) and #11 (12,000 Linac hours) – no change in status since last report.
5. Tube #3 (0 hours) – no change in status since last report

Moretti reported on the delivery schedule for tubes currently undergoing rebuild at Litton:
1. Tube #2 - promised for mid-October 1998.
2. Tube #8 – promised for April 1999.

During the week prior to this meeting an effort was made to install the adjustable attenuators and trombone lines in the operating stations and to readjust the low level rf systems. During this work it was discovered that an amplifier in the rf reference system had partially failed resulting in reduced drive to the Linac 805 Mhz reference line. The amplifier was replaced with a spare and plans are to be implemented to monitor the output of this amplifier via the control system. It was also determined that much of the circuitry in the rf reference system is un-documented and some without spares. Ma and Popovic will attempt to organize what documentation can be found.

All but one of the 7 operating low level rf systems have been successfully tuned up. That last station will be tuned soon. There appears to be some disagreement as to the status of Station #1. Apparently the system gain is different from what it had been. Currently the adjustable attenuator is set to zero db, leaving no more adjustment range in that direction.

A situation occurred on the evening of Tuesday, September 22, resulting in loss of gradient control and sparking in Stations #6 and 7. Somehow the software feedback loops in the IRMs got lost and kept trying to crank up the klystron power to the point of sparking. Allen resolved this by shutting down the loops, re-starting the stations, then re-enabling the loops. All has been quite since. Popovic will speak with Elliott McCrory about possible improvements to the loops to prevent re-occurrence.

Carlson reported on work necessary to bring the klystron test station up the the standard of the operating stations. The rack monitor needs to be upgraded to the current IRM version, the low level system needs to be brought up to date once the IRM is in place, and the solenoid magnet power supply rack needs to be rebuilt.

High priority activities for the coming week include:
1. Test stand operation of klystron #14 at full power.
2. "Painting" of areas of possible vacuum leaks on tubes #12 and #13.
3. Completion of the "off-line" filament power supply with full interlocks.
4. Installation of tube #1 in the "blue" tank and, vacuum permitting, full power filament operation away from the test stand.

Pending the results of attempts to seal possible vacuum leaks on tubes #12 and #13, Moretti will request Litton to return an empty shipping coffin to send in one of these tubes for rebuild. It is expected that the effectiveness of the "painting" can be known within two weeks of doing the job.

Minutes of Linac Klystron Meeting held Monday, October 5, 1998
Previous meeting was held on Sept. 24

Attendees: Schmidt, Noble, Moretti, Ma, Carlson, Ganger, Popovic, Douglas, Ogert, and Webber

Status update:
1. Tube #14 (250+ hours) - has been operating at full power in the test stand since 9/24/98.
2. Tube #13 (vacuum problems) - no change in status since last report.
3. Tube #12 (vacuum problems) – has been painted with vacseal but vacuum shows no improvement. Ion pump current remains at 100 microamperes. Moretti recommends waiting one more week while monitoring pump current before giving up on this tube.
4. Tubes #1 (lots of A0 hours) and #11 (12,000 Linac hours) – no change in status since last report.
5. Tube #3 (0 hours) – no change in status since last report.
6. Low Level RF system on the last of the seven operating stations has been tuned up with adjustable attenuator and phase shifter installed.
7. Carlson reports that he is still waiting to receive parts necessary to build up "off-line" filament supply system.
8. Atteunators and phase shifters for the low power klystron systems have been requisitioned.
9. Test station improvements outlined in last meeting remain below the current priority threshold.
10. There was no report on communications between Popovic and McCrory to address the software feedback loop problems discussed at previous meeting.

Discussion centered on possible methods to recover vacuum in tubes #12 and #13. In the end, it was concluded that Litton should be involved in any tube vacuum work due to the sensitivity of the cathode to poisoning. Popovic brought up the possibility that the tube ion pumps may simply be approaching the end of their useful lifetime exacerbating the problems that may occur when cathodes outgas upon initial filament heat. Noble noted that Litton had supplied tube repair/test schedules during original klystron production. He suggested that similar schedules be requested to show the progress of tubes currently undergoing rebuild.

Action items:
1. Tube #14 shall continue to be operated in the test stand at full power until 10/12. At that time tube and tank shall be removed from test stand and set aside as a spare unit.
2. Tube #13 shall be painted with vacseal by the end of the day 10/6.
3. "Blue" tank shall be readied to accept tube #1. An aluminum fabrication must be delivered from the machine shop for this to happen; delivery is expected 10/6. "Blue" tank with oil processed and tube #1 installed is scheduled to be ready to move into the test stand October 13.
4. Moretti shall contact Litton to get update on schedule for delivery of repaired tube #2 and to request return of an empty shipping coffin in preparation to return next tube, likely #12 or #13.
5. Schmidt or Webber is to be notified as soon as possible of any difficulties that prevent this work from being accomplished on the above schedule.

Minutes of Linac Klystron Meeting held Monday, October 22, 1998
Previous meeting was held on October 5

Attendees: Schmidt, Noble, Moretti, Allen, Ma, Carlson, Ganger, Douglas, Ogert, and Webber

Status update:

1. Tube #14 (300+ hours) - has been removed from test stand and set aside in "brown" tank as a spare unit.
1. Tube #13 (vacuum problems) - has been painted with vacseal, but vacuum shows no change.
2. Tube #12 (vacuum problems) - no change in status since last report..
3. Tube #1 (lots of A0 hours) and - installed in test stand in "blue" tank and operating at full power.
4. Tube #11 (12,000 Linac hours) – no change in status since last report.
5. Tube #3 (0 hours) – no change in status since last report.
6. Carlson reports that he now has on hand all parts necessary to build up "off-line" filament supply system. Estimates one week's work to complete.
7. Empty shipping coffin has been received from Litton.
8. Shipping date of rebuilt tube #2 from Litton now extended to mid-November.

Tube #14 operated in test station at full power for well over 300 hours before it was moved aside in "brown" tank. Tube #1 in "blue" tank came up in test station without problem. It has been operating at full power at 15 Hz for two days now. Mike Foley observed the process of tube handling, moving, and installation into the test stand in response to Webber's request that he propose changes to improve the process. Foley will be invited to next meeting to present and discuss his ideas.

There was discussion on how to maintain integrity of water passages of spare tubes in storage. It was agreed that spare tube should be maintained with flowing water, but details of the mechanics were left to be determined.

Moretti reported observations of reduced ion pump current on tube #12 when the tube was exposed to cool outdoor air. Pump current reduction to 10 microamps from the typical 100 microamps was observed. When the tube was returned to normal indoor temperatures the pump current increased again to the high value. Tube #13 showed the effect to a significantly lesser degree, only a 10% change in pump current under the same conditions.

Action items:

1. Tube #1 shall continue to be operated in the test station at full power until 10/26 give or take a day or two. At that time this tube shall be moved to a holding stand. Tube #3 shall then be installed in the "blue" tank. Filament heat shall be applied and, if vacuum checks OK, the tube will be fitted with lead shielding and water, and moved into the test station.
2. Tube #12 or #13, to be selected by Moretti, shall be loaded into the shipping coffin by 10/30 for return to Litton for repair.
3. Carlson will continue work on the "off-line" filament supply system as time permits giving priority to items 1 and 2 above.
4. Schmidt will meet with Controls Group to plan for upgrade of test station controls to make them equal to normal station controls.
5. Ma will investigate complaints and problems with klystron water system monitoring, controls, and interlocks. Allen and Todd Sullivan will assist and provide information they have. Ma will present his findings to Webber.

Minutes of Linac Klystron Meeting held Thursday, November 12, 1998
Previous meeting was held on October 22

Attendees: Schmidt, Noble, Moretti, Allen, Ma, Carlson, Ganger, Douglas, Ogert, Popovic, Foley, and Webber

Status update:
1. Tubes #4, 5, 6, 7, 9, 10, and 15 are operating in the active Linac systems.
2. Tube #1 (lots of A0 hours, good spare) was operated in test station, then removed from "blue" tank and set aside as tested spare since last meeting.
3. Tube #2 (unavailable) is still being rebuilt at Litton; delivery now extended to mid-December.
4. Tube #3 (0 hours, in test) - has been installed in blue tank since last meeting.
5. Tube #8 (unavailable) is at Litton for rebuild; delivery expected in April?
6. Tube #11 (12,000 Linac hours, good spare?) - no change in status since last report; has not been pulsed for about four years.
7. Tube #12 (unavailable, vacuum problems) - no change in status since last report.
8. Tube #13 (unavailable, vacuum problems) has been loaded into shipping coffin and awaits actual shipment to Litton for rebuild.
9. Tube #14 (good spare) in brown tank as available spare.

Scoreboard:
7 operational
2 known good spares
1 likely good spare, though not pulsed in four years
1 in test
4 dead

Tube #1 operated in test station at full power for a couple hundred hours before it was recently removed from the station, taken out of the "blue" tank, and set aside in a holding fixture as a tested spare. Tube #3 is now installed in the "blue" tank in preparation for test station operation. The off-line filament supply is now complete and will be used to heat #3 to test for vacuum problems before final assembly of that tank/klystron system.

Delivery of tube #2 from Litton has been delayed a month from last meeting's report. Apparently a window failure occurred as the tube was being processed in their oven. They tell Moretti that they expect to begin power tests of the tube in early December. Moretti and Ma will both travel to Litton to witness the acceptance tests when Litton is ready.

Schmidt, with the help of Florian, is investigating the status of controls hardware required to make the test station equivalent to an operating station.

There was spirited discussion as to observations of the stability (or not) of the recently installed klystron low level RF attenuators and phase shifters. The jury is still out on this question.

Foley shared his ideas for improving the equipment and procedures for safely moving klystron and tank assemblies. He hopes to have a co-op engineer available in January to begin to detail the plans for cost estimates and project approval. Discussions brought up further suggestions to be considered.

Carlson is scheduled to move from the Proton Source Dept. to the Accelerator Technologies Dept. He will remain available for important Linac operational needs. Good luck Kermit.

Action items:
1. Tube #3 to be installed and tested in the test station. It should be operated for several hundred hours to demonstrate its condition. It is presently expected that by the time that test is complete, #2 will be on the way from Litton. It must then be operated in the test stand to complete its acceptance tests.

2. Schmidt will continue work with Controls Group to plan for upgrade of test station controls to make them equal to normal station controls.
3. Ganger will procure and install clear plastic panels to cover the adjustable attenuator and phase shifter components in the low level systems.
4. Moretti and Popovic will work with McCrory to make improvements to software control loops to keep them from "getting lost"

Minutes of Linac Klystron Meeting held Wednesday, January 13, 1999
Previous meeting was held on November 12

Attendees: Schmidt, Noble, Moretti, Allen, Ma, Carlson, Douglas, Ogert, Popovic, Florian, and Webber

Status update:
1. Tubes #4, 5, 6, 7, 9, 10, and 15 are still operating in the active Linac systems.
2. Tube #1 (lots of A0 hours, good spare) in holding stand.
3. Tube #2 (unavailable) beginning post-rebuild testing at Litton; delivery now delayed until February.
4. Tube #3 (600 hrs, good spare?) has run 600 hrs operation in test stand since last meeting, somewhat high ion pump current.
5. Tube #8 (unavailable) is at Litton for rebuild; delivery expected in April?
6. Tube #11 (12,000 Linac hours, good spare?) - no change in status since last report; has not been pulsed for about four years.
7. Tube #12 (unavailable, vacuum problems) - no change in status since last report.
8. Tube #13 (unavailable, vacuum problems) has been shipped to Litton for rebuild.
9. Tube #14 (good spare) in brown tank as available spare.

Tube #3 has been successfully operated in the test station at full power for a couple hundred hours even as it continues to show 10 microamps of ion pump current (one other operating tube manifests similar ion pump current). Tube #3 will remain in the test station until replaced there by tube #2 that is to be received from Litton.

Delivery of tube #2 from Litton has again been delayed by more than a month from last meeting's report. Litton tells Moretti that power tests of the tube have begun. Moretti and Ma expect to travel to Litton to witness the acceptance tests sometime end of January or first of February. Litton has analyzed tube #8. Its repair schedule remains undetermined as Moretti works with Fermilab contracts personnel to reach agreement with Litton as to extent and cost of repairs. Moretti also reported that Litton has pronounced tube #13 to have a vacuum leak in agreement with our observations.

Schmidt has talked with Florian and determined that the test station can run a standard Linac LLRF system VXI crate with the rack monitors presently in the test station. This will be the path pursued to make the test station equivalent to an operating station until the Controls Group has time to assemble and test additional rack monitors. There are spare rack monitors in case of failure, but it was decided to not commit them to the test station at this time. It has been learned that Linac has no spare VXI computer for any stations. Ma will check with Brian Chase in an attempt to locate a spare which might be used in the test station system.

No progress has been made on the upgraded solenoid power supply rack for the test station. Schmidt reports that manpower may soon be available to address that.

Allen has worked with McCrory to make some changes and improvements in the software control loops. The gradient loop tolerance was tightened to reduce system sparking under certain conditions and the automatic learning feature for the cavity loading parameter was made to be manually switched on or off. Previously this learning loop was always ON. Allen reports that all stations currently have this learning switched OFF.

Foley now has a co-op engineer actively designing equipment and procedures for more safely moving klystron and tank assemblies.

Action items:
1. Tube #3 is to continue to be run in the test station. It will be replaced there by tube #2, when received from Litton, to complete its acceptance tests. After tube #2 is tested, tube #11 will be run through the test stand to verify its status.
2. Ma will work to install a "standard" set of VXI LLRF components in the test station.

Minutes of Linac Klystron Meeting held Wednesday, March 24, 1999
Previous meeting was held on January 13

Attendees: Schmidt, Moretti, Ma, Ganger, Carlson, Douglas, Ogert, Foley, Kubantseva

Status update:
1. Tubes #4, 5, 6, 7, 9, 10, and 15 are still operating in the active Linac systems.
2. Tube #1 (lots of A0 hours, good spare) in holding stand.
3. Tube #2 (repaired and received in February '99) in holding stand awaiting test at FNAL.
4. Tube #3 (>800 hrs. operation in test stand, good spare) in blue tank in test stand.
5. Tube #8 (unavailable) at Litton for rebuild; delivery expected in August '99.
6. Tube #11 (12,000 Linac hours, good spare?) not pulsed for about 4 years.
7. Tube #12 (unavailable) awaiting shipment to Litton.
8. Tube #13 (unavailable) at Litton for rebuild; delivery expected in April '99?
9. Tube #14 (good spare) in brown tank as available spare.

Tube #2 has been received from Litton following an apparently successful rebuild. Moretti and Ma witnessed acceptance tests at Litton in early February (see Moretti's trip report attached below). It has been removed from the shipping crate and placed in a holding stand.

The planned order of tubes for the test station is #2 followed by #11 or perhaps #13 depending when it is received from repair. Once #2 is proven satisfactory in the test stand, the plan is that it become the prime operational spare so that it might in fact be put into service while still under warranty.

Tube #12 has been loaded into the shipping crate and shall be returned to Litton shortly for rebuild.

Ma is continuing to work on bringing the test station up to par with operating stations.

Douglas questioned the status of proposed plans to supply flowing water to spare klystrons in storage. Webber stated his desire that this arrangement be realized and Schmidt was assigned to plan and lead the effort. (Note: since the meeting, the value of doing this has been questioned; discussions shall continue.)

Further work on the test station solenoid power supply rack is "on hold" pending manpower.

Foley introduced Natalia Kubantseva who reported on the design of an improved klystron moving support structure that she developed in cooperation with Foley, Douglas and Ogert. The proposed solution offers greater stability, safety, and ease of handling during klystron moves. Procurement of components and fabrication of the equipment is to begin shortly.

Action items:
1. Tube #14 shall be removed from the spare brown tank and placed into a holding stand. Tube #2 shall be installed in the brown tank.
2. The blue tank containing tube #3 shall be removed from the test stand and set aside as the prime operational spare in the short term. The brown tank containing tube #2 shall be installed in the test stand for completion of acceptance testing.
3. Foley and Kubantseva shall generate requisitions and commence fabrication of the new klystron moving structure.
4. Ma shall continue test station improvements and spare parts assessment.
5. Schmidt shall pursue establishing a storage arrangement for spare klystrons that they might be maintained with flowing water.

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Subject: Trip to Litton 02/03/99
Submitted by: Al Moretti, Proton Source Group

On the afternoon of Wed., Feb 3 rd, Hengjie and I visited the Litton plant to give Henjgie his first tour of a tube plant and view and assess the status of work being done on our tubes.

Klystron tube SN0002 was on the test stand and running at full output power of 12.5 MW. Because it was late we decided to continue with the acceptance testing of the tube, more completely, the next day.

During the tour of the facilities, Litton showed us the damaged tube parts. First the beam collector had a golf ball size cavity (indentation) to the side of the solid copper cone beam collector and had many surface cracks and discolorations. The other damage was to the isolating collector ceramic. The brazing alloy between the ceramic and copper tube body and collector support rings was almost completely spudderred away. In addition a fine black powder was found covering the inside of the tube. This may explain the intermittent and unstable power output of this tube. This tube was the most unstable of all the tubes over its lifetime.

The first generation of tubes up to serial number 8 were built with ceramic isolated collectors. Klystrons with serial numbers 1, 3 and 4 were shipped to Fermilab with isolated collectors. Klystrons with serial numbers 2, 5, 6, 7, and 8 (first batch built by Litton) were shipped with the ceramic shorted out with external copper rings, but still with the isolating ceramic inside. The second batch, serial numbers 9 as the 15, were built as the final design specification without ceramics.

The repairs done on SN0002 klystron were:

1. Add adapter rings to replace the ceramic,
2. Install new collector, new ceramic waveguide window and new gun,
3. Remove as much as possible the black powder from inside of the tube and add support gusset to collector input and output water pipes.

On thur, the 4 th, the acceptance of the tube was continued. We witnessed and helped with measurement of important tube parameters and found tube in conformance with tube specification:

Pulse Power output (125 microsec)	=====	12.5 MW
Gain	=====	52.2 dB
Bandwidth	=====	3.0 MHz, -0.5 dB
Tube Perveance	=====	2.0 microPerv
Ion pump current	=====	4.0 microAmps
Focus Solenoid currents	=====	Same as original tube test.

During our visit we also discussed the repair status of SN0008 and SN0013 klystrons.

SN0008 klystron was first vacuum checked and a leak was found in the tube anode. The tube was cut open at the anode and gun and examined for any other damage. No other damage was found. The repair of this tube will consist of intalling a new gun and anode. The cost of the repair will be about $124.7 k.

SN0013 klystron was vacuum checked and found to have a vacuum leak in the tunner bellow for cavity number 2. The repair of this tube should be less than or equal to cost of repair of SN0008. However, since the repair of SN0013 is easier than SN0008, it maybe repaired first and be on the test stand in April. The next tube will be then repaired toward the end of summer.

Minutes of Linac Klystron Meeting held Wednesday, July 14, 1999
Previous meeting was held on March 24

Attendees: Webber, Schmidt, Moretti, Ma, Wahl, Douglas, Foley

Status update:
1. Tubes #4, 5, 6, 7, 9, 10, and 15 are still operating in the active Linac systems.
2. Tube #1 (lots of A0 hours, good spare) in holding stand.
3. Tube #2 (received February '99, >200 hrs test stand operation, good spare) in brown tank in test stand.
4. Tube #3 (>800 hrs. operation in test stand, good spare) in blue tank.
5. Tube #8 (unavailable) at Litton for rebuild; delivery expected October '99.
6. Tube #11 (12,000 Linac hours, good spare?) not pulsed for about 4 years.
7. Tube #12 (unavailable) at Litton for rebuild; delivery expected ?January '00?.
8. Tube #13 (repaired and tested at Litton) presently in shipment to FNAL.
9. Tube #14 (good spare) in holding stand.

Tube #12 has been returned to Litton for rebuild.

Tube #13 expected to be received from Litton any day now following an apparently successful rebuild. Moretti and Ma witnessed acceptance tests at Litton in early July. This tube shall be tested in our test station soon after receipt.

Ma is continuing to work on bringing the test station up to par with operating stations.

The question of suppling clean flowing water to spare klystrons in storage remains open. Schmidt is assigned to make a determination of this issue and lead any implementation activities.

The components of the improved klystron moving support structure have been fabricated and assembled. Several issues remain to be resolved: interference of one caster with the frame, suitability of the present caster/spring assembly to support the required weight, and the weight of some components of the structure that must be manhandled during each operational use. It is expected that work shall continue actively and at rather high priority to resolve these issue and complete the project with a satisfactory piece of equipment.

There was discussion of the need for replacement of the cooling coils on the Low Energy Linac modulators. The coils are 30 years old, the water catch pans are rusted, and the piping is problematic. Foley will work with Wahl on this job. It was suggested that application of a cooling coil assembly for the High Energy Linac PFN and charging supply cabinets be investigated in parallel with this activity.

There has been a request for one klystron and the "blue" tank for activities at Lab G. Approval and scheduling of this is under discussion with Division management.

Action items:
1. Test tube # 13 upon receipt.
2. Foley and Douglas shall actively pursue resolution of issues with the new klystron moving structure.
3. Ma shall continue test station improvements and spare parts assessment.
4. Schmidt shall pursue the advisability of establishing a storage arrangement for spare klystrons that they might be maintained with flowing water.
5. Foley and Wahl shall pursue replacement of the LE Linac modulator cooling coils and investigate possibilities for a coil assembly to be installed on the HE Linac PFN and charging supply cabinets.

Minutes of Linac Klystron Meeting held Tuesday, October 31, 2000
Previous meeting was held on July 14, 1999

Attendees: Webber, Schmidt, Moretti, Wahl, Quinn, Walters, Allen, Hren

Status update:

- Tubes #2, 4, 6, 7, 9, 13, and 15 are operating in the active Linac systems.
- Tube #1 (unavailable) at Litton for rebuild; delivery expected, April '01.
- Tube #3 (good spare, >800 hrs. operation in test stand) in holding stand.
- Tube #5 (unavailable) failed in K6 w/filament short 10/00, awaiting shipment to Litton for rebuild.
- Tube #8 (unavailable) at Litton for rebuild; delivery expected, November '00.
- Tube #10 (good spare??, 57K hrs, to be tested) removed from K6 10/00, problem in filament circuit.
- Tube #11 (good spare, 14K hrs.) at Lab G in blue tank.
- Tube #12 (unavailable) at Litton for rebuild; delivery expected, December '00.
- Tube #14 (good spare, 500 hrs.) in test stand in brown tank.

The anticipated delivery dates for tubes undergoing repair were supplied by Al Moretti based a conversation with Litton this week. Note that as far back as March 1999, #8 was given an expected delivery date of August 1999! Litton has not had a good history of delivering repaired klystrons. A plan was defined to improve our record keeping in order to better document the process.

There was discussion on how to test questionable and incoming klystrons while minimizing downtime vulnerabilities in the event of failure of an operational klystron. The problem is an issue now because the second spare tank/socket is at Lab G. The question was raised as to the possibility of procuring an additional spare tank/socket assembly. It was estimated that recovery time from klystron failure would be 24-48 hours if the one spare is not functional at the time of an operational failure. It was noted that the November 2000 - January 2001 is a valuable time for testing with minimal operational impact, provided repaired tube are available during that time.

Action items:

1. Moretti and Hren will assemble records of failure, shipment, PO, and return delivery dates for klystrons now at or previously returned to Litton.
2. Plans for further testing of klystron #10 and klystrons #8 and 12 as they return from Litton need to be laid out as delivery dates become more certain.