
SLAC MEMORANDUM

August 1, 2005
RSO-05-07

To: Hesham Khater

From: Sayed Rokni, Radiation Safety Officer



Title: L-Band RF Penetration in the NLCTA roof

Thank you for your memo of July 29, 2005 [1], and your note of June 22, 2005 [2] analyzing the radiation safety aspects of adding a new penetration to the other existing penetrations in the NLCTA roof. Your analysis is thorough and the MCNPX simulations informative. The request is approved; the work needs to be controlled through the issuance of RSWCF.

References:


- 1) H. Khater, "Analysis of the New L-band RF Penetration in the NLCTA Roof," SLAC Memo, July 29, 2005.
- 2) H. Khater, "Analysis of the New L-band RF Penetration in the NLCTA Roof," Radiation Physics Technical Note, RP-TN-05-13, June 22, 2005.

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SLAC MEMORANDUM

July 29, 2005

Subject: Analysis of the New L-band RF Penetration in the NLCTA Roof
To: Sayed Rokni
From: Hesham Khater 

I analyzed the request¹ from S. Doebert to add a new penetration to the roof of the NLCTA. The radiation safety analysis of the new penetration has been documented in a Radiation Physics Technical Note (RP-TN-05-13, June 22, 2005). I conclude that adding the new penetration to the roof of the NLCTA may proceed under the following conditions:

1. The space between the 11"-diameter hole and the RF waveguide is filled with equivalent shielding material (e. g., gravel).
2. The penetration is blocked when not in use.
3. Proper RSWCF is issued.

approved S.H. Rokni 8/1/05

¹ S. Doebert, "Evaluation of New Penetration into the NLCTA Housing," Memo to Hesham Khater, March 23, 2005.

Analysis of the New L-band RF Penetration in the NLCTA Roof

Hesham Y. Khater

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Introduction

The ILC group requested adding a new penetration to the roof of the NLCTA [1]. The new penetration will be used for L-band RF waveguide. The standard waveguide size is 6.5" x 3.25" but the associated flanges require an 11"-diameter hole. Figure 1 shows an elevation view indicating the position of the new penetration relative to the NLCTA beamline. The waveguide will be connected to L-band structure located in the high energy region of the NLCTA beamline. The level of radiation streaming through the penetration was analyzed for the nominal and safety envelop beam powers previously analyzed [2] and included in the NLCTA safety Assessment Document (SAD) [3]. In addition to radiation streaming through the penetrations, direct dose rates are also calculated on the top of the 4'-thick concrete.

Calculational Procedure

In order to calculate the dose rates outside the penetration, a Monte Carlo simulation was performed using the MCNPX code [4]. The MCNPX code was run with incident electron kinetic energy of 1.1 GeV, and with electron cutoff energy of 1 MeV. The kinetic energy represents the highest possible energy included in the NLCTA SAD. The beam was assumed to hit a 12"-long cylindrical copper target which has a 2" radius. Results obtained for the maximum energy and power (5747 W) specified by the SAD (safety envelop for upgraded power level) were scaled for power levels specified for nominal operation (438 and 1451 W) as well as the safety envelop design power level (3233 W). Figure 2 shows the MCNPX model used in the calculation. In this figure, the inside of the NLCTA enclosure is shown in light blue, the enclosure concrete walls in light green, penetration in dark green, scoring region in yellow. In addition, the beam line is shown in dark blue. Finally, the two circles shown in blue are not part of the geometry and only represent DXTRAN spheres (for MCNPX variance reduction).

Calculations were performed for two penetration options. The first option (Option I) represents the requested 11"-diameter hole. On the other hand, the second option (Option II) assumes that the roof hole matches the actual size of the wave guide size (6.5" x 3.25"). Finally, dose rates resulting from radiation streaming through the penetrations were compared to direct dose rates on top of the 4'-thick concrete roof. The direct dose rates were calculated by using the SHIELD11 code [5]. Unlike the MCNPX calculations where dose rate results were obtained for the highest energy (1.1 GeV) and highest power (5747 W), the SHIELD11 calculations were performed for

the different beam energies (varied between 480 and 1066 MeV) associated with the different beam powers. The dose rates obtained from the MCNPX penetration calculation associated the maximum power and energy were scaled down to the lower power and energy levels based on the same reduction levels calculated by SHIELD11.

Results

Table I shows a comparison between the dose rates resulting from radiation streaming through the penetrations and the direct dose rates on top of the 4'-thick concrete roof for Option I. Since the full body is not exposed to the streaming radiation through the hole, the calculated whole body effective dose equivalent values are reduced by a factor of 4. As shown in the table, the dose rates caused by radiation streaming through the penetration are higher than the direct dose rates on the roof. The dose rates on the top of the penetration, at nominal power levels, which are caused by normal beam loss (0.5% loss at a point) or mis-steering beam losses (100% loss at a point), exceeds the maximum dose rates on top of the 4'-thick concrete roof by more than factor of four. Similarly, 100% beam losses of the power levels identified by the safety envelop produced dose rates are also more than factor of four higher for the penetration case. The dose rates caused by neutron streaming through the penetration are more than twice the dose rate caused by photon streaming. Since the NLCTA roof is classified as a Radiation Area (RA) with a dose limit of 1000 mrem/y, the dose rates associated with the two nominal power levels, 2.5 and 11.8 mrem/h, are quite high even with a limited access to the roof.

Table II shows a comparison between the dose rates resulting from radiation streaming through the penetrations and the direct dose rates on top of the 4'-thick concrete roof for Option II. As shown in the table, the dose rates caused by radiation streaming through the penetration are slightly lower than the direct dose rates on the roof for the nominal power levels. As well as the safety envelop power levels. In this case, the dose rates caused by photon streaming through the penetration are twice the dose rate caused by neutron streaming. Comparing dose rates results from Tables I and II shows that using Option II penetration (RF waveguide size) results in a reduction of radiation streaming through the penetration by about factor of 5. The reduction is due to a drop in photon and neutron dose rates by factors of 2 and 10, respectively. These results clearly indicate that using the Option II will result in maintaining the dose rate level above the roof to < 1 mrem/h.

Conclusions and Required Actions

Adding the new penetration to the roof of the NLCTA may proceed under the following conditions:

1. The space between the 11"-diameter hole and the RF waveguide (option II) is filled with equivalent shielding material (e. g., gravel).
2. The penetration is blocked when not in use.
3. Proper RSWCF is issued.

REFERENCES

1. S. Doebert, "Evaluation of New Penetration into the NLCTA Housing," Memo to Hesham Khater, March 23, 2005.
2. V. Vylet and T. Lavine, "Radiation Protection in the NLCTA," NLCTA-Note # 46.2, January 8, 1996.
3. SLAC Technical Division, "Safety Assessment Document – Next Linear Collider Test Accelerator," April 24, 1996.
4. L. Walters (Ed.), "Monte Carlo N-Particle Transport Code System for Multiparticle and High Energy Applications, Version 2.5.f, LANL, 2005.
5. W. Nelson and T. Jenkins, "The SHIELD11 Computer Code," SLAC-R-737, February 2005.

Table I. Summary of dose rates (mrem/hr) on top of the NLCTA roof (11"-diameter hole "Option I").

Parameter	Nominal		Safety Envelop	
	Design	Upgrade	Design	Upgrade
Power (W)	438	1451	3233	5747
Energy (MeV)	480	796	600	1066
Normal Dose Rate Outside 4'-thick Concrete Roof (mrem/h) ¹	0.6	2.8	1043	2806
Normal Dose Rate on Top of the Roof Penetration (mrem/h) ^{1,2}	2.5	11.8	4403	11845
Mis-steering Dose Rate Outside 4'-thick Concrete Roof (mrem/h) ³	114	568	1043	2806
Mis-steering Dose Rate on Top of the Roof Penetration (mrem/h) ^{2,3}	481	2398	4403	11845

¹ Normal loss at a point is 0.5% for nominal and 100% for safety envelop.

² Effective dose equivalent values are reduced by a factor of 4.

³ Mis-steering loss at a point is 100% for nominal and safety envelop.

Table II. Summary of dose rates (mrem/hr) on top of the NLCTA roof (6.5" x 3.25" hole "Option II").

Parameter	Nominal		Safety Envelop	
	Design	Upgrade	Design	Upgrade
Power (W)	438	1451	3233	5747
Energy (MeV)	480	796	600	1066
Normal Dose Rate Outside 4'-thick Concrete Roof (mrem/h) ¹	0.6	2.8	1043	2806
Normal Dose Rate on Top of the Roof Penetration (mrem/h) ^{1,2}	0.56	2.6	957	2575
Mis-steering Dose Rate Outside 4'-thick Concrete Roof (mrem/h) ³	114	568	1043	2806
Mis-steering Dose Rate on Top of the Roof Penetration (mrem/h) ^{2,3}	105	521	957	2575

¹ Normal loss at a point is 0.5% for nominal and 100% for safety envelop.

² Effective dose equivalent values are reduced by a factor of 4.

³ Mis-steering loss at a point is 100% for nominal and safety envelop.

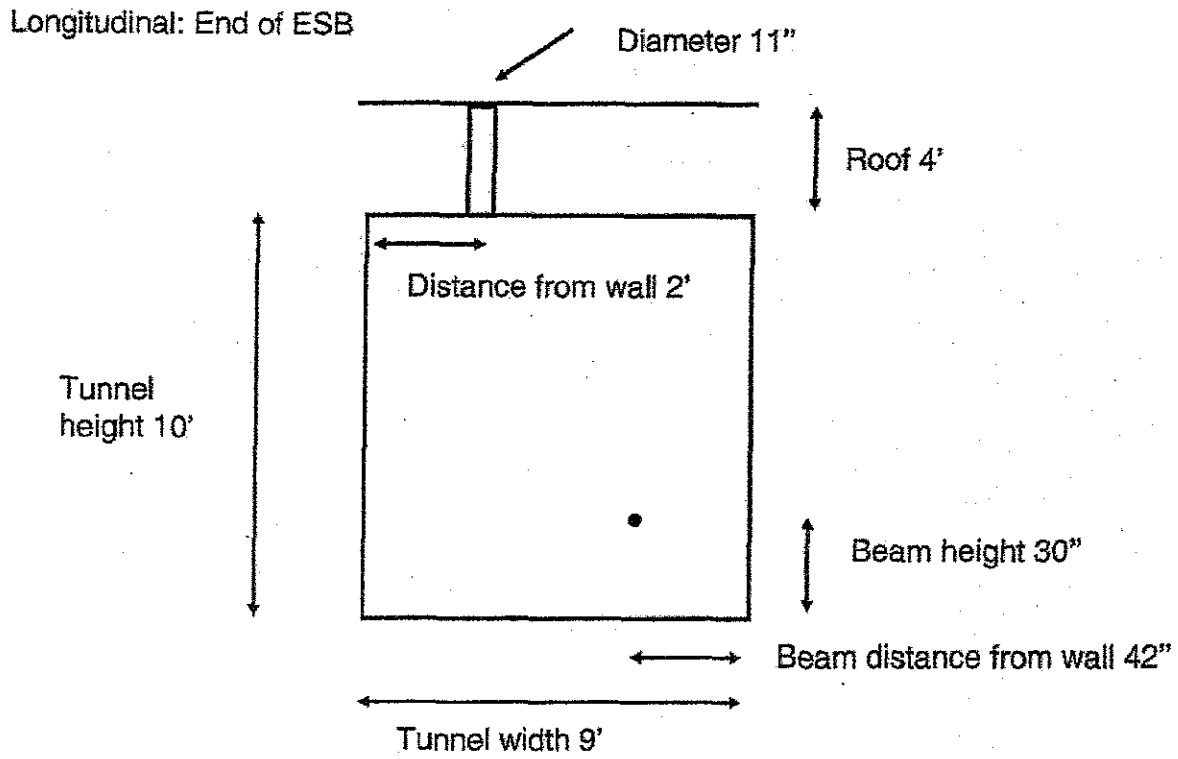


Fig. 1. Elevation view of the NLCTA roof penetrations.

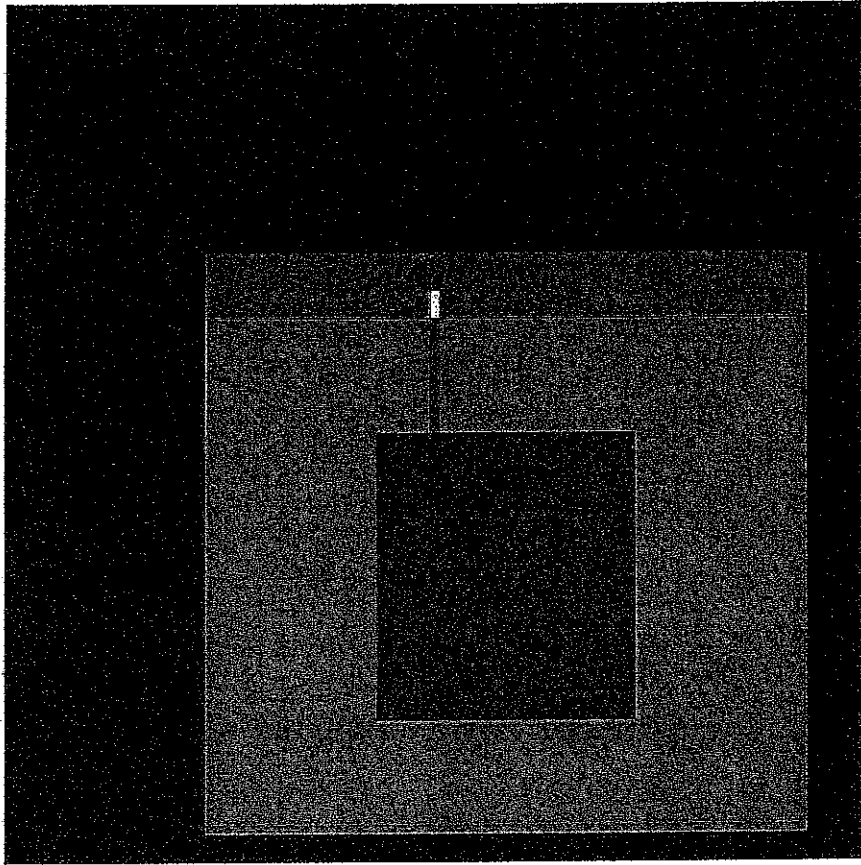
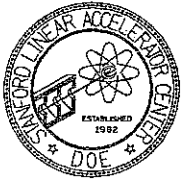


Fig. 2. Elevation view of MCNPX model.



MEMORANDUM

Technical Division – ILC-Group

To: Hesham Khater
From: Steffen Doebert
Date: March 23, 2005
CC: Sayed Rokni; Tor Raubenheimer; Keith Jobe
Attachments: Sketch of the NLCTA housing

SUBJECT: Evaluation of a new penetration into the NLCTA housing

The ILC-group plans to construct a new L-band RF test stand in Endstation B. The test stand consist out of a Modulator powering a Klystron (1.3 GHz, 5 MW, 1.5 ms pulse length, 5 Hz repletion rate), a high power circulator and a wave guide run to a testing area which will be in the NLCTA housing. The Klystron will be installed in the 8-pack area and the waveguide run should go up to the roof of the accelerator housing and than enter the housing through a new penetration in the roof. The standard waveguide size is WR650 (6.5''x3.25'') but the associated flanges require an 11'' diameter hole. A drawing is attached indicating the position of the new penetration relative to the beam line and the tunnel walls. The size of the waveguide doesn't allow us to enlarge existing 8-pack holes. The longitudinal position of the penetration will be close to the east-wall of the Endstation. The beam energy doesn't exceed 250 MeV at this point for the current configuration. Could you please evaluate the feasibility of such a penetration from a radiation point of view and give advice on eventually necessary additional safety measures associated with the penetration.

Please contact me if additional information is needed.

A handwritten signature in black ink, appearing to read "Steffen Doebert".

New penetration in NLCTA

Longitudinal: End of ESB

