Collider-Accelerator Department

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Memo

Date: *March 4, 2015*

To: *RSC, A. Zaltsman & P. Bergh*

From: *D. Beavis*

Subject: *Testing 9 MHz Cavity in Building 925*

The RF group has asked for a review of necessary radiologic requirements to test the 9 MHz cavity in building 925. The building is an uncontrolled area, although if necessary a temporary Controlled Area can be established around the cavity. The cavity will not be under vacuum so that this portion of the device will not generate x-rays. The only HV component that will have vacuum is a capacitor that has already been conditioned to 100kV. The 9 MHz cavity will be tested with a temporary amplifier that has a max power of 500W. It is expected that this power can produce a maximum of 20 kV in the system including the vacuum capacitor. The outside housing of the cavity has a shell of Al that is 1 cm thick.

The potential dose rate can be estimated using the air kerma from Figure B.1 of NCRP Report No. 147. At 25 kV the estimated kerma 0.14 rads/(mA-min) at one meter. The energy-absorption coefficient is given as 3.09 cm^2/g. The 1 cm Al wall thickness therefore has an energy absorption of exp(-2.7*3.09) or $2.4*10^{-4}$. This conservative dose rate is estimated to 5 mrads/hr at 1 meter. The assumption is that the entire amplifier power is driving electrons across a 20 kV gap and all photons created are at 20 kV. In reality most of the amplifier power is producing heat in the cavity walls and not accelerating electrons across the capacitor gap. In addition only a small portion of the electrons would have energies approaching 20kV. For 10kV photons the energy-absorption coefficient for Al is 25.4 cm^2/g resulting in an attenuation of 10^{-30} for the Al wall.

MCNPX was used in a simple test to ensure that the reasoning above is valid. 20 keV electrons were transported onto a thin Al target. The dose at one meter to the side was scored. The dose with no Al shell was found to be 105 rads/hr for 2.5 mA of beam. This is in reasonable agreement with the 22 rads/hr extracted from the figure in NCRP Report No. 147. The dominate portion of the dose was caused by photons with energies less than 10 keV. An Al shell was placed around the target with a thickness of 1 cm and a density of 0.27 g/cm^2. The dose rate was reduced to 595 mrads/hr and there were essentially no x-rays below 11 keV. The shell density was increased to 0.54 g/cm^2 and the dose rate was reduced to 67 mrads/hr. If we now assume that all the remaining x-rays are at 20 keV then the additional Al when increasing the density to 2.7 g/cm^2 would reduce the dose rate to 80 micro-rad/hr at a meter. This is still conservative since most of the amplifier power does not go into accelerating electrons.

The only precaution recommended is that when the cavity is tested for the first time HP should make radiation measurements with an instrument that is sensitive to the energy range 15 to 20 keV. Should radiation levels above 50 micro-rem/hr at a foot be detected then HP should establish a Controlled Area around the cavity.

I would do not judge this device to be an RGD but other can decide if they think it meets the criteria.

Members should review this memo as the plan will be to conduct the test starting March 5, 2015.