Progress on the shielding evaluation for the beam dump

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The facility upgrade project includes the commissioning of the Light Ion Guide, a device capable to produce radioactive beams via (p,n) reaction [1]. The primary beam (proton) should have high intensity, in order to increase the efficiency of the entire system. The primary beam will be stopped in a beam dump located at about 3 meters away from the gas cell.

We propose to build the beam dump from Aluminum (1199 alloy). Initially we have considered Carbon and Copper as material for the beam dump. Carbon has poor heat transfer and Copper will lead to higher prompt neutron flux, approx. 5 times bigger than in the case of Aluminum. The particular shape was chosen in order to increase the thermal radiation surface, an important parameter for the efficient cooling. The fairly large diameter, 19 cm, is enough to contain the entire beam. The power distribution in the beam dump was introduced from a PHITS [2] calculation. This power dumped highly exceeds the normal operation of the device. Engineering calculations done with ALGOR software show a temperature

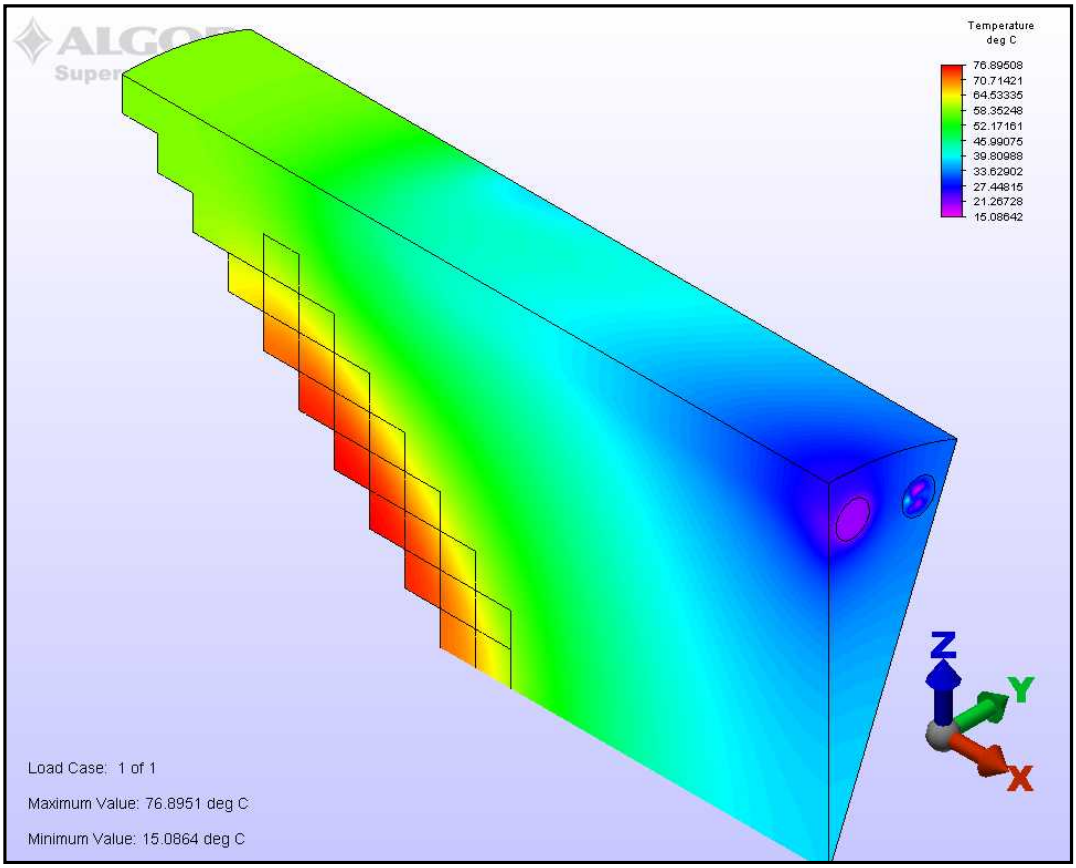

Figure 1. Beam dump view with the temperature profile.

of about 1000° C without cooling. A cooling tube was attached running a coolant with entrance

temperature of 15° C. It was found that the temperature will not exceed 100° C locally. Commercial chillers with closed loop cycles easily can provide the performance required.

The shielding proposed is based on concrete blocks, borated polyethylene and lead. The beam dump will be located in vacuum and the vacuum pipe will be enclosed in a concrete castle. Also a concrete block is place on top of this structure. In the Table 1 we present the equivalent dose estimations in five locations:

Table I. Equivalent dose [mrem/h] in 5 different locations at three different times after shutdown.

Time after shutdown	**Location 1 Outside cave [mrem/h]**	**Location 2 Behind beam dump [mrem/h]**	**Location 3 Side [mrem/h]**	**Location 4 Top [mrem/h]**	**Location 5 Upstream [mrem/h]**
10 min	3.90×10^{-6}	2.5	6.8	7.6	62.9
1 hour	1.96×10^{-6}	1.8	5.9	6.1	35.2
1 day	7.02×10^{-8}	0.6	2.1	2.1	12.9

The equivalent doses estimated shows reasonable values in five different locations after a day following 10 days of intense irradiation. The Health Physics Department will enforce the rules concerning the access in the cave.

[1] G. Tabacaru, J. Arje and H. L. Clark. *Progress in Research*, Cyclotron Institute, Texas A&M University (2006-2007), p.V-20.

[2] H. Iwase, K. Niita and T. Makamura, J. Nucl. Sci. Tech., **39,** 1142 (2002).