18 June 2015 - Revision 2.

To: Dana Beavis
Cc: Ed Lessard, C Cullen

From: Suzanne Smith

Subject : Irradiation of As target – **Commercial in Confidence**

I would like to conduct an irradiation of GAW target on Thursday 18 June for three hours at 70 uA. Previous safety submission is attached to this memo. A summary of variation/and or similarities to the current study is given below.

Background:

The GAW target has been irradiated previously for 30 mins at 50 uA successfully without incident. The thermal analysis conducted (in 2013) showed that the target could withstand up to 113 uA. Figure 1 and 2 illustrate thermal profile for 113 and 50 uA profiles, respectively.

Figure 1. Steady State Thermal for GAW target in housed under helium gas in aluminium target can at 50 uA with entry energy of 49.6 and exit 47.98 MeV.

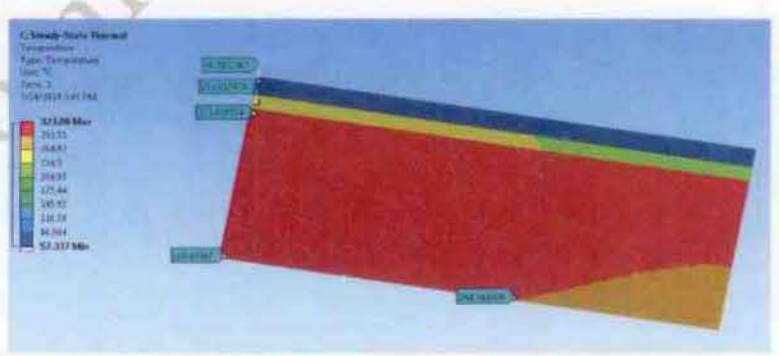

Figure 2. Steady State Thermal for GAW target in aluminium target can at 50 uA and entry energy of 49.6 and exit 47.98 MeV.

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Isotopes production and doses from the targets were calculated for conservative scenarios (100% beam on target and 100% target content). Therefore are applicable to the current study. However for this study we will evaluate dose from irradiated As target can at BLIP and if at acceptable levels transport the target to TPL directly after irradiation.

Target Canning: After the original safety review of the GAW target in July 2014 it was requested that the target be sealed under helium gas. For all irradiations this has been implemented and for the current study the GAW target has already been prepared under helium gas and has passed it's leak test.

A **new target array** is given in Table 1. The new array has a similar entry and exit proton energy however for this study the entry energy for the beam to target assembly box will be tuned to 117.0 MeV instead of 66 MeV as reported in the attached original safety submission. As per email 17 June 5.15 pm the entry energy to the target assembly box can tolerate a variation up to 0.5 MeV without affecting the delta E on the target and still ensure the beam stops in the Aluminum degrader (0.315).

Table 1 Target Array for Irradiation of GAW target for 3 hours at 70 uA.

Entry Energy		**117.0**	**MeV**			
Layer #	Material (enter short name)	Length (mm)	Length (inches)	Entrance Energy (MeV)	Exit Energy (MeV)	Energy Loss (MeV)
Layer 1	Be	0.305	0.012	117.0	116.7	0.3
Layer 2	Ab	0.305	0.012	116.7	116.4	0.3
Layer 3	SS	0.787	0.031	116.4	113.4	3.0
Layer 4	wa	2.692	0.106	113.4	111.5	1.8
Layer 5	ss	0.508	0.020	111.5	109.5	2.0
Inside Box1						
Layer 6	Wa	5.080	0.200	109.5	106.0	3.6
Layer 7	SS	0.737	0.029	106.0	102.9	3.0
Layer 8	V	15.140	0.596	102.9	102.9	0.0
Layer 9	ss	0.737	0.029	102.9	99.9	3.1
Layer 10	Wa	5.080	0.200	99.9	96.0	3.9
Layer 11	Al	5.588	0.220	96.0	86.6	9.4
Layer 12	Wa	2.540	0.100	86.6	84.5	2.1
Layer 13	Al	4.699	0.185	84.5	75.7	8.7
Layer 14	Wa	2.540	0.100	75.7	73.3	2.4
Layer 15	Al	7.493	0.295	73.3	57.1	16.2
Layer 16	Wa	5.080	0.200	57.1	50.9	6.2

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Layer 17	Al	0.508	0.020	50.9	49.6	1.3
Layer 18	Gaw	0.380	0.015	49.6	48.0	1.6
Layer 19	Al	4.191	0.165	48.0	35.2	12.8
Layer 20	Wa	7.569	0.298	35.2	19.7	15.5
Layer 21	wa	2.540	0.100	19.7	11.6	8.1
Layer 22	Al	8.001	0.315	11.6	0.0	0.0
Layer 23	SS	0.508	0.020	0.0	0.0	0.0

New Thermal Analysis: The thermal analysis of the new target array has been conducted by Chris Cullen, using the recently implemented thresholds, at both 100 uA (data presented in Figure 3) and 70 uA (data presented in Figure 4a,b and c). Data show that a 70 uA focused Gaussian beam on 1.1 inch diameter GAW target (0.015mm thick) is acceptable.

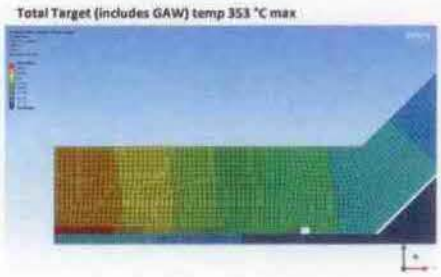
100 μA, 1500 W total

Thermal analysis indicates that the current focused Gaussian beam deposited on target of 1.1 inch diameter is too high – therefore target is not safe.

Too hot for BLIP

Figure 3 New Thermal Analysis for 100 uA on GAW target (1.1 inch diameter) in Aluminum Can

70 μA, 1050 W total



a) Thermal model show that the target (GAW and Aluminium can) is acceptable reaching max temp of 353 °C. Well below the GAW melting point of 1238°C and Aluminium melting point of 660.3 °C.

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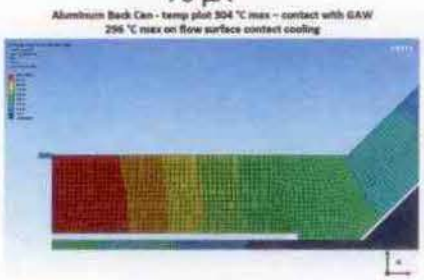
70 μA



b) Aluminium can (back) in contact with GAW target reaches 304 °C.

70 μA

c) Heat flux on boiling is 63 W/cm^2 well within the recently defined limit of 132 W/cm^2.

Figure 4. Thermal model for GAW target (1.1 inch diameter) at 70 uA in aluminium target.

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