APEX experiment, 2019

Considerations for ALARA

This document summarizes the expected radiological conditions around the Hall A target area during and after the experiment, and the measures implemented to maintain personnel doses as low as reasonably achievable.

Radiation budget for 2019 run

The radiation budget form is an estimate of dose at the JLab site boundary from prompt radiation. It is part of the Radiation Safety Analysis Document. The budget provides a metric giving insight into the relative level of activation in/around the target. This is the "% of allowed dose" for the run time of the experiment. Values >100% warrant more detailed analysis, evaluations of experiment schedules and possible additional mitigating measures.

Hall: A **RADIATION BUDGET FORM** *page:* 1 of 1

Exp. # E12-10-009 **rev: A** **run dates: 2019** **name of liaison: R. Essig**

setup number			1	2	3	
beam	energy	GeV	2.1	2.1	2.1	*totals:*
	current	uA(CW)	10.0	100.0	15.0	
exp't target	element		C	W	W	
	thickness	mg/cm2	226	193	386	
	dist. to pivot	m	0.0	0.0	0.0	
	Z		6	74	74	
	A		12	184	184	
critical window	radius	cm	5.2324	5.2324	5.2324	
	dist. to pivot	m	3.33	3.33	3.33	
scattering weighting factor			0.50	0.50	0.50	
time	run time (100% eff.)	hours	48	424	8	480
		days	2.0	17.7	0.3	20.0
	installation time	hours				0
		days	0.0	0.0	0.0	0.0
dose rate at the fence post (run time)	method 1	urem/hr	0.08	2.15	0.70	
	method 2	urem/hr				
	conservative	urem/hr	0.08	2.15	0.70	
dose per setup		urem	4	910	6	918.89
% of annual dose budget		%	0.0	9.1	0.1	9.1889
% of allowed dose for the total time						167.7
% of allowed dose for the run time only						167.7

If > 200%, discuss result with Physics Research EH&S officer

date form issued: December 21, 2018 *authors:* P.Degtiarenko

Expected Activation Levels

The thick tungsten targets used in APEX in combination with low energy beam result in significant residual radioactivity. G. Kharashvili conducted FLUKA simulations to estimate dose rates around the target area from activation. Note that beam conditions in this estimate are not identical to the finalized radiation budget values, and actual target thicknesses in the experiment are somewhat larger.

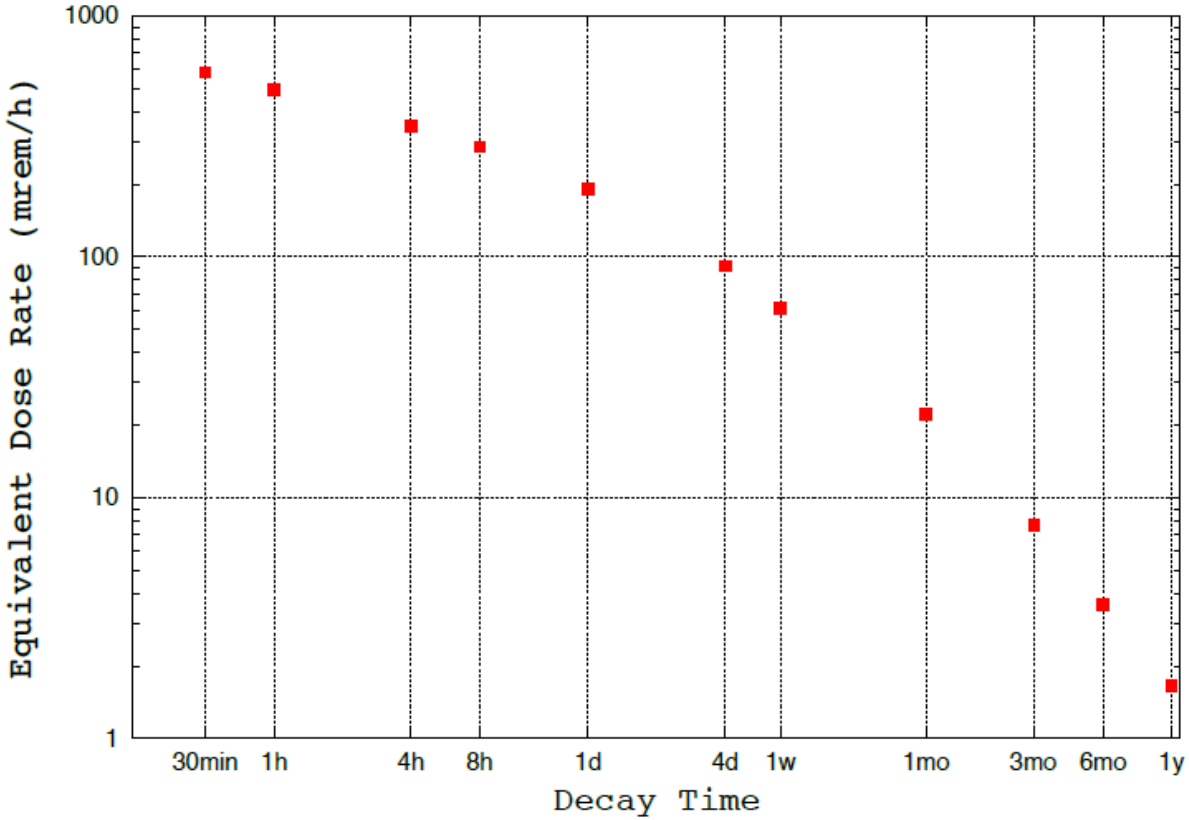

Figure 3: Expected equivalent dose rates at 30 cm from the 0.053 X_0 tungsten target after 170 hours of irradiation with 3.3-GeV, 120-μA beam followed by 314 hours of irradiation with 4.4-GeV, 90-μA beam.

Expected Activation Levels

Excerpt from G. Kharashvili's simulation summary

> Based on the presented results it is likely that the target chamber platform will have to be posted as a radiation area, or high radiation area for much of the experiment. Any access of the targets will likely require the following:
>
> - High radiation area posting
> - Job specific radiation work permit
> - Supplemental dosimetry
> - Contamination controls
>
> The potential of creating a 1 R/h area should also be acknowledged. It would invoke additional controls, such as physical access control to the target chamber platform.

Considering the thicker targets and lower energy beam, there is a significant likelihood of dose rates > 1 R/h and residual contamination around the target area.

- Prevailing 30 cm dose rate above 1 R/h requires "physical" controls on access (locked barriers, guards, etc.)
- Formal ALARA review (via JRRP) for work in 1 R/h radiation field is required
- Contamination controls include RWP, protective clothing (Radworker-II training)

Planned Work Around Target

During the APEX experiment two types of access are expected.
Most of the access will be during the first few days of running.

1) Open/close of the sieve slit – 5-10 minutes at 2 m from the pivot.
   - Movement of the sieve slit handle will be done by hand via a 1.5 m long wooden stick.

   The distance from the target should allow this work to occur without bodily entry to a 1 R/h radiation field.

2) HRS detector checkout – 2-4 hours in the HRS hut.
   - This work should not be affected by the radiation area

ALARA Measures

Planning of the experiment included design features intended to reduce personnel radiation exposure. Work plans and controls are in place to ensure exposures are minimized.

- The target assembly includes redundant target foils to avoid the need for target work in the event of single target element failure
- The target assembly can be removed and replaced relatively quickly, reducing the amount of hands-on work that might be needed in the event of multiple target failures
- Hall A has installed a lockable physical barrier around the target area
- Sieve slit adjustment employs extended tools and working at a distance
- The RadCon department has drafted an RWP for target area work (details to be added when specific tasks are conducted), with advance notice to the Jefferson Lab Radiation Review Panel
- A one-week decay period has been included in the schedule to allow dose rates to drop following the experiment, prior to decommissioning and removal

Summary

Planning of the APEX experiment has included design features, procedures and controls intended to reduce personnel radiation exposure.

Communications between the Hall Work Coordinator and RadCon are excellent

The APEX RSAD incorporates a summary of required work controls, including locked barriers and RWP requirements

Advanced planning has taken place in order to facilitate ALARA for expected work in the target area