GMn Radiation Dose Update

SBS Weekly Meeting

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7/19/21

Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

Reminder: Calculations from 2017

- Pavel Degtiarenko performed radiation dose calculations for the GMn ERR in 2017
  - Total dose = 676.5 μrem (6.7% of annual dose budget*)
  - GMn ERR 2017 talk

Hall: A — **RADIATION BUDGET FORM** — page: 1 of 2

Exp. # GMn E12-09-016 — **rev: 0** — **run dates: 2019** — **name of liaison: Eric Fuchey**

setup number			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
beam	energy	GeV	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	6.6	6.6	6.6	8.8	8.8	8.8	8.8	8.8
	current	uA(CW)	19.2	52.4	30.9	19.2	39.0	30.9	24.0	58.1	24.0	24.0	52.5	22.5	30.0	52.5	30.0	30.0	53.3
radiator	element																		
	thickness	mg/cm2																	
	dist. to pivot	m																	
	Z		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
exp't target	element		D	H	Al	D	H	Al	D	H	Al	D	H	Al	D	H	Al	D	H
	thickness	mg/cm2	2435	1062	935	2435	1062	935	2435	1062	935	2435	1062	935	2435	1062	935	2435	1062
	dist. to piv																		
	Z																		
	A																		
cryo tgt window	element																		
	thickness																		
	dist. to piv																		
	Z																		
	A																		
critical window	radius																		
	dist. to piv																		
scattering weighting factor																			
time	run time (100% eff.)																		
	installation time																		
dose rate at the fence post (run time)	method 1																		
	method 2																		
	conservative																		
dose per setup																			
% of annual dose budget																			

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Exp. # GMn E12-09-016 — **rev: 0** — **run dates: 2019** — **name of liaison: Eric Fuchey**

setup number			18	19	20	21	22	23	24	25	26	27		
beam	energy	GeV	8.8	11.0	11.0	11.0	4.4	4.4	4.4	4.4	4.4	4.4		totals:
	current	uA(CW)	30.0	30.0	55.4	30.0	20.0	20.0	60.0	20.0	20.0	60.0		
radiator	element						Cu	Cu		Cu	Cu			
	thickness	mg/cm2					772	772		772	772			
	dist. to pivot	m					-0.15	-0.15		-0.15	-0.15			
	Z		0	0	0	0	29	29	0	29	29	0		
	A		0	0	0	0	64	64	0	64	64	0		
exp't target	element		Al	D	H	Al	H	Al	H	H	Al	H		
	thickness	mg/cm2	935	2435	1062	935	1062	935	1062	1062	935	1062		
	dist. to pivot	m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
	Z		13	1	1	13	1	13	1	1	13	1		
	A		27	2	1	27	1	27	1	1	27	1		
cryo tgt window	element			Al	Al		Al		Al	Al		Al		
	thickness	mg/cm2		83	83		83		83	83		83		
	dist. to pivot	m		0.0	0.0		0.0		0.0	0.0		0.0		
	Z		0	13	13	0	13	0	13	13	0	13		
	A		0	27	27	0	27	0	27	27	0	27		
critical window	radius	cm	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8		
	dist. to pivot	m	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10	5.10		
scattering weighting factor			0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50		
time	run time (100% eff.)	hours	4	100	13	8	12	2	3	24	2	6		543
		days	0.2	4.2	0.5	0.3	0.5	0.1	0.1	1.0	0.1	0.3		22.6
	installation time	hours												0
		days	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
dose rate at the fence post (run time)	method 1	urem/hr	1.58	1.94	0.59	1.65	1.57	2.53	0.61	1.57	2.53	0.61		
	method 2	urem/hr												
	conservative	urem/hr	1.58	1.94	0.59	1.65	1.57	2.53	0.61	1.57	2.53	0.61		
dose per setup		urem	6	194	8	13	19	5	2	38	5	4		676.46
% of annual dose budget		%	0.1	1.9	0.1	0.1	0.2	0.1	0.0	0.4	0.1	0.0		6.7646
% of allowed dose for the total time														109.13
% of allowed dose for the run time only														109.13

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

date form issued: May 15, 2017 *authors:* P.Degtiarenko

***JLab design:** *10 mrem to public at site boundary*

Jefferson Lab

From 2017: Dose in GEM Electronics Bunker

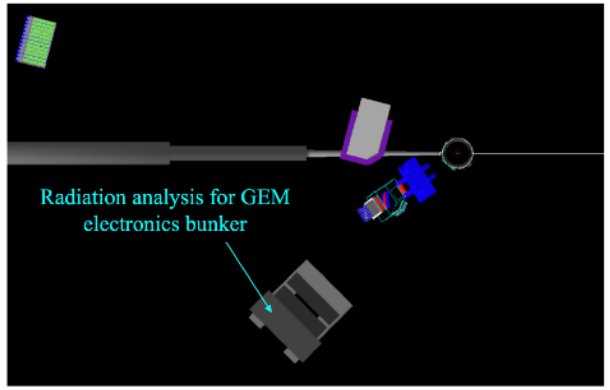
- Calculations from Eric, Freddy Obrecht

$Q^2(GeV^2)$	$\theta_{BB}(deg)$	$d_{BB}(m)$	$E_{beam}(GeV)$	$I_{beam}(\mu A)$
13.5	33.0	1.55	11.0	44.0

- Ran 15 $\times 10^9$ events with the beam generator
- Silicon sensitive region is 101.6 x 101.6 x 2.54 cm^3
- Density of Silicon used = 2.33 g/cm^3
- Total energy deposited = 910 MeV
- Results:

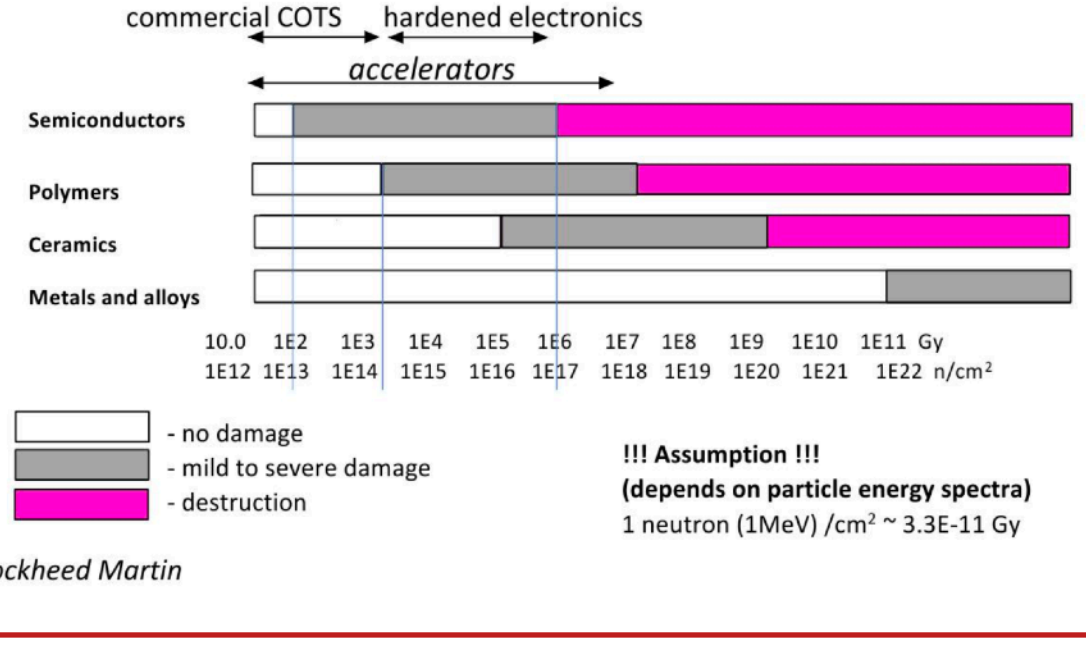
Note: This estimate was performed for the "baseline" scenario (no beamline shielding)

Dose rate = 0.016 rad/hr



Damage estimate

- Production + commissioning (beam-on) ~ 1400 hrs
- Total dose = (0.016 rad/hr)(1400 hrs) = 22.4 rad = 0.22 Gy
- No discernible damage to electronics for the GMn run (see below)



2021 Update

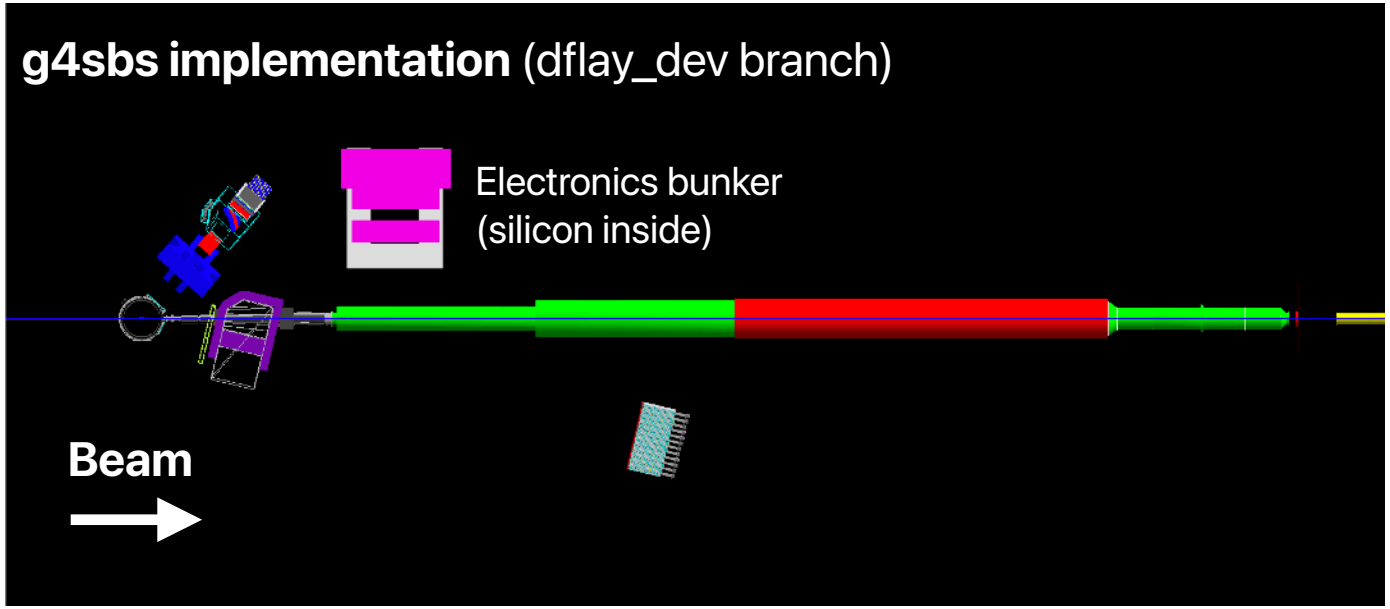
- Kinematics have slightly changed; lower beam energies, spectrometer angles are different
- Eric, DF working with Pavel for new calculations; we now include GEn-RP, WAPP, nTPE explicitly
- Contacted RadCon about deploying radiation monitors in the GEM electronics bunker

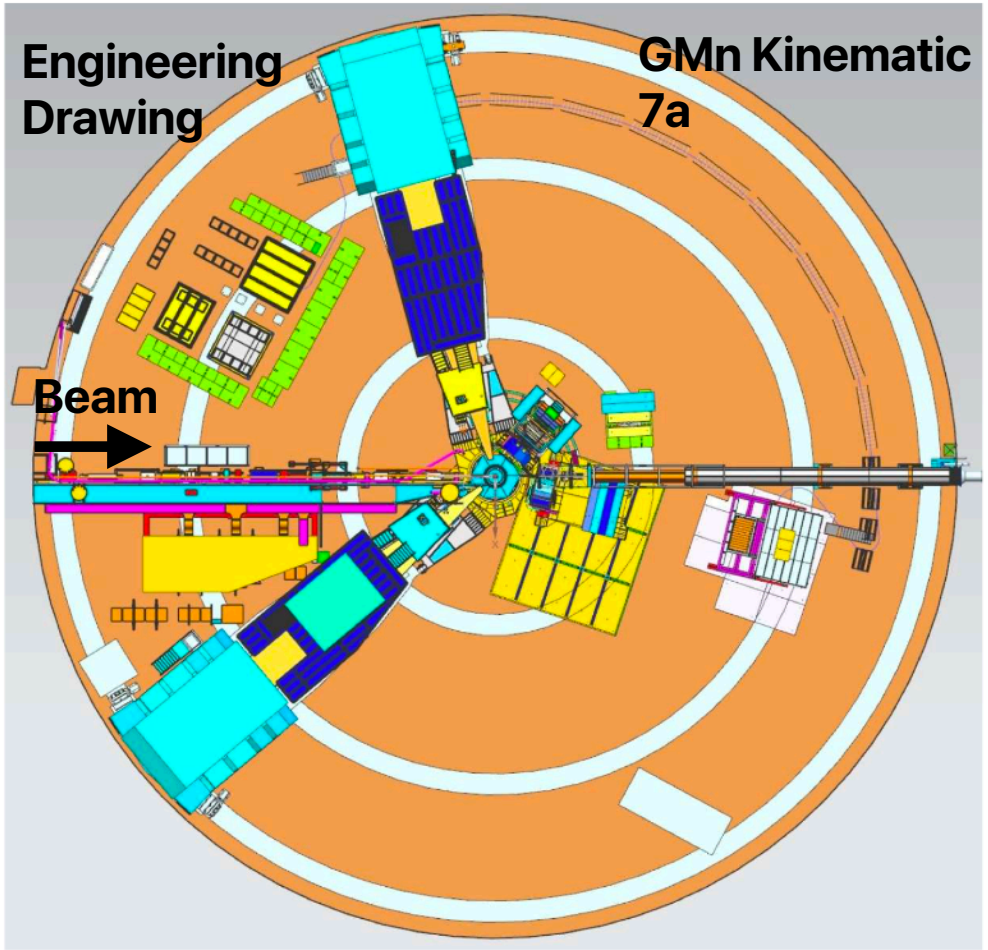
GMn																					
	Conf #		1		2		3		4		5		6		7		8		9		10		11		12		13		14	
	Beam E	GeV	3.74		3.74		3.74		5.99		5.99		5.99		7.95		7.95		7.95		9.91		9.91		9.91		4.01		4.01	
	Beam I	uA	19.2		30.9		35.1		24		30		54		30		30		52.9		30		30		55.4		19.2		30.9		34.5
radiator	Element																													
	Thickness	mg/cm²																												
	dist. to pivot	m																												
	Z																													
	A																													
expt. Tgt	Element		D		Al		H		D		Al		H		D		Al		H		D		Al		H		D		Al		H
	Thickness	mg/cm²	2435		935		1062		2435		935		1062		2435		935		1062		2435		935		1062		2435		935	
	dist. to pivot	m	0		0		0		0		0		0		0		0		0		0		0		0		0		0	
	Z		1		13		1		1		13		1		1		13		1		1		13		1		1		13	
	A		2		27		1		2		27		1		2		27		1		2		27		1		2		27	
Tgt window	Element		Al				Al		Al				Al		Al				Al		Al				Al		Al				Al
	Thickness	mg/cm²	83				83		83				83		83				83		83				83		83				
	dist. to pivot	m	0				0		0				0		0				0		0				0		0				
	Z		13				13		13				13		13				13		13				13		13				
	A		27				27		27				27		27				27		27				27		27				
Critical Window	radius	cm	13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8		13.8
	dist. to pivot	m	5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10		5.10
Time	Run time	hours	30		7		21		60		10		20		36		8		17		100		8		13		30		7		
	(% eff)	days	1.25		0.29		0.88		2.5		0.42		0.83		3		0.17		0.71		4.17		0.17		0.54		1.25		0.29		
Notes																														

... and similar for GEn-RP, nTPE, WAPP

2021 Update: Dose in GEM Electronics Bunker

- Updated g4sbs with latest geometry of the bunker (drawings from Chris Soova)
- Silicon volume: 101.6 x 101.6 x 2.54 cm^3
- Setting up to run on the farm for Q^2 = 11 GeV^2
  - E = 9.91 GeV, I = 60 μA
  - SBS at 13.3°, BB at 48°





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