FEL Dump Worksheet George Biallas 2/4/98

- This work sheet calculates the burn through times for the FEL Dumps per the available information on 2/4/98 and is derived from a worksheet by Mark Wiseman.
- The information derived is used to generate the FEL MPS Requirements Matrix
- Additional comments, and documentation are provided in the Bibliography at the botton of the sheet
- All Time to Melt calculations assume no LCW cooling and are within the +-1 Sigma Volume
- Numbers in bold are input points upon which other numbers depend
- Single Failures with times to shut off in the tens of milisec. are most significant.

Constants:

Copper Density	gr/cm^3	8.9
Copper Specific Heat	J/gr/K	0.385
Melt Temp Of Copper	C	1080

0G Dump (Injector Tune Up)

Notes
1. From analysis by B. Yunn
2. Assumed to be 2 ∑ Radius

		Expanders & Raster on	Loss of Central Expander	Loss of **10** % Current Center Expander	Loss of Raster	Loss of **20** % Raster Current	Loss of Both Expanders & Raster
Beam Energy	MeV	10	10	10	10	10	10
Beam Current	mA	5	5	5	5	5	5
Reduction in beam spot from central expander at above drop in current (Note 1)	%	NA	NA	20	NA	NA	NA
Center Expander Quad (MQG0G02) Current (Note 1)	A	1.5	0	1.35	1.5	1.5	1.35
1 Sigma	cm	**1.4**	0.4	1.25	1.4	1.4	0.4
Radius of Circular Raster (Note 2)	cm	**2.8**	2.8	2.80	0	2.24	0
Outer Radius of Rastered +1 ∑ Circle	cm	4.2	3.2	4.0522	1.4	3.64	0.4
Inner Radius of Rastered -1 ∑ Circle	cm	1.4	2.4	1.5478	NA	0.84	NA
+-3∑ Rastered Spot Dia.	cm	14	8	13.11	8.4	12.88	2.4
ID of dump at Face	cm	19.68	19.68	19.68	19.68	19.68	19.68
Centering Tolerance +-	cm	2.8	5.8	3.3	5.6	3.4	8.6
Penetration Dpth	cm	0.3	0.3	0.3	0.3	0.3	0.3
% Absorbed in Pen. Depth	%	100	100.00	100.00	100.00	100.00	100.00
Angle of Dump Face to Beam	deg.	30	30	30	30	30	30
Area of +-1∑ on Dump Face	cm^2	98.52	28.15	88.12	12.32	78.82	1.01
Total Beam Power	kW	50	50	50	50	50	50
Vol. of Copper	cm^3	29.56	8.44	26.44	3.69	23.64	0.30
Mass of copper	gr	263.05	75.16	235.28	32.88	210.44	2.68
Percent of Power in +-2∑	%	68.00	68.00	68.00	68.00	68.00	68.00
Beam Power in volume	kW	34.00	34.00	34.00	34.00	34.00	34.00
Rate of Temp. Rise	K/sec	336	1175	375	2686	420	32901
Time To Melt	sec	**3.22**	**0.92**	**2.88**	**0.40**	**2.57**	**0.03**
Recommended shut off time from particular failure	sec		**0.092**	**0.288**	**0.040**	**0.257**	**0.003**
Recommended shut off time from LCW failure	sec	**0.32**					

Raster to Dump Face	cm	165.3
Raster Angle from CL	Rad	0.01694
Raster Angle from CL	Deg	0.97043
Field Integral	G-cm	564.953
G-cm/amp	G-cm/A	252
Current Required for Raster	A	2.24188

2G First Light Dump				Minimum Defocus				
		Normal Defocus & Rasters on	Normal Defocus Loss of 2 Rasters	Both Rasters on	Loose V. Raster	Loss of **10** % Vert. Raster	Loose H. Raster	Loss of **10** % Horiz. Raster
Beam Energy	MeV	**42**	42	42	42	42	42	42
Beam Current	mA	**1.1**	1.1	1.1	1.1	1.1	1.1	1.1
Penetration Depth	cm	**1.33**	1.33	1.33	1.33	1.33	1.33	1.33
% Absorbed in Pen. Depth	%	**60**	60	60	60	60	60	60
Total Beam Power	kW	46.2	46.2	46.2	46.2	46.2	46.2	46.2
1 Sigma Vertical	cm	**0.22**	0.22	**0.06**	0.06	0.06	0.06	0.06
Radius of Vertical Raster	cm	**3.5**	0	3.5	0	3.15	3.5	3.5
Vert. Raster + 2 Sigma	cm	7.44	0.44	7.12	0.12	6.42	7.12	7.12
+-3∑ Rastered Height	cm	8.32	1.32	7.36	0.36	6.66	7.36	7.36
Percent of Power in 2 ∑	%	**68.00**	68.00	68.00	68.00	68.00	68.00	68.00
1 Sigma Horizontal	cm	**0.22**	0.22	**0.06**	0.06	0.06	0.06	0.06
Radius of Horizontal Raster	cm	**3.5**	0	3.5	3.5	3.5	0	3.15
Horizontal. Raster + 2 Sigma	cm	7.44	0.44	7.12	7.12	7.12	0.12	6.42
+-3∑ Rastered Width	cm	8.32	1.32	7.36	7.36	7.36	0.36	6.66
+-3∑ Rastered Diagnal	cm	11.8	1.9	10.4	7.4	9.9	7.4	9.9
+-3∑ Rastered Diagnal	in	4.6	0.7	4.1	2.9	3.9	2.9	3.9
Greatest angle of Beam to Dump Face	deg.	20	10	20	10	10	10	10
2 ∑ Area @ Dump face	cm^2	161.84	1.11	148.22	4.92	263.24	4.92	263.24
Vol. of Copper	cm^3	215.25	1.48	197.13	6.54	350.10	6.54	350.10
Mass of copper	gr	1915.73	13.20	1754.48	58.24	3115.91	58.24	3115.91
Beam Power in volume	kW	18.85	18.85	18.85	18.85	18.85	18.85	18.85
Rate of Temp. Rise	K/sec	26	3710	28	841	16	841	16
Time To Melt (1)	sec	**42.26**	**0.29**	**38.70**	**1.28**	**68.73**	**1.28**	**68.73**
Recommended shut off time	sec		**0.0291**	**3.8702**	**0.1285**	**6.8733**	**0.1285**	**6.8733**
Shut off time from LCW failure	sec	**4.23**						
Vertical Raster Frequency	Hz	**37**						
Compare to 1/4 Vertical Raster Period	sec	**0.0068**					**0.0068**	
Horizontal Raster Frequency	Hz	**600**						
Compare to 1/4 Horizontal Raster Period	sec	**0.0004**			**0.0004**			