**D-ZERO
CALORIMETER
MULTIPLAN**

S. J. WINTERCORN

D- Zero Engineering Note 3740.000-EN-40

JUNE 15, 1987; Rev. N

CALORIMETER MULTIPLAN (E), May 26, 1987, REV. N

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	10	11	12	13	14	15	16	17	18
1	SIGNAL	READOUT	AVERAGE	RAD LGTH	ABS LGTH	SIGNAL	READOUT	TOT. CELL	MODULE
2	CELL DEPTH	CELL DEPTH	DENSITY	/IN., NORM	/IN., NORM	CELL COUNT	CELL COUNT	COUNT	ARRAY GAP
3									
4	0.3421	0.408	0.2707	2.888	0.106	13	7	20	?
5	0.4600	0.526	0.3676	4.131	0.137	44	6	50	?
6	2.0540	2.120	0.2935	1.596	0.154	7	2	9	?
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16									
17	0.3881	0.000	0.2459	2.561	0.099	20	0	20	?
18	0.5360	0.000	0.3242	3.564	0.125	64	0	64	?
19	2.1300	0.000	0.2852	1.543	0.150	15	0	15	?
20	0.4600	0.526	0.3676	4.131	0.137	56	4	60	0.393
21	2.0540	2.120	0.2935	1.596	0.154	12	2	14	0.393
22	2.0540	2.120	0.2935	1.596	0.154	20	3	23	?
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D-Zero Calorimeter Multiplan

Introduction:

This short report explains the parameters, and their basis, of the D-Zero calorimeter multiplan spread sheet. MacIntosh Multiplan worksheets have been found to be a valuable asset to the D-Zero design effort. The spread sheet contains parameters (constants) and results that come from the parameters. The full effect of changes in D-Zero calorimeter parameters can be calculated quite easily with Multiplan. When a change in a parameter is made, any results that pertain to that parameter automatically change also. This report will explain how some of the unobvious results were obtained.

Parameter Explanations:

Radiation and Absorption Lengths- The values were derived from ref. 1 for all materials except stainless steel. These values are the quotient of the radiation length and the density and the nuclear interaction length and the density respectively. Refer to ref. 2 for stainless steel values.

Unit Cell Depth- The unit cell depth is equal to the sum of the depths of the plate, the G-10 board and twice the argon gap.

Radiation Length per Inch- The unit cell depth divided by the sum of the products of the plate depth and its radiation length, the argon depth and its radiation length and the G-10 board depth and its radiation length.

Lambda per Inch- The unit cell depth divided by the sum of the products of the plate depth and its absorption length, the argon depth and its absorption length and the G-10 board depth and its absorption length.

Average Density- The average density of each module is the sum of the products of the plate density and depth, the G-10 board density and depth and twice the argon density and depth, divided by the unit cell depth. See ref. 3 for the alloy.

Cell Count– The cell count is equal to the number of absorber plates for CC and is equal to the total number of plates in each module (including end and support plates) less one for EC.

Module Array Gap– Space between each module in its array.

Inner, Outer Radii– Since the modules are trapezoidal in shape, the inner and outer radii for EC are the points of tangency between the bases of the trapezoid and the annular spaces that the bases create. **For MH the outer radius is an average because of its shape.** For CC, the outer radius is the inner radius plus the product of the cell count and the cell depth plus other plate, board depths and accumulated tolerances.

Module IR, OR Lengths– Average plate lengths for CC. EC IR and OR lengths are the sum of the front end plate cell, other plate depths, the product of the plate count and the cell depth, and a massless cell where applicable.

Rad. and Abs. Lengths, Normal– For CC, this value is the product of the radiation or absorption length/inch and the difference between the outer and inner radii. For EC, except the leakage module, this value is the product of the radiation or absorption length/inch and the average of the module radii lengths. For EC leakage, this value is an average; the product of the radiation or absorption length/inch, and half of the module diagonal length. Note that that normal is not a unique definition for the EC leakage module.

Module Theta– Theta is the module angle in radians.

Unit Cell Area– For CC, the unit cell area is the product the average plate width and the module length. For EC EM, the unit cell area is the average area. The area for the rest of EC is the area of each module shape.

Total Cell Area– The total cell area is the product of the unit cell area and the cell count.

Plate Volume, avg.– The volume of the average plate in the module if different, or the actual volume if the same.

Plate Weight, avg.– The weight of the average plate in the module if different, or the actual weight if the same.

Module Volume- The module volume is the product of the area of the face of each module and its respective length

Module Volume Displaced- The module volume less the product of the total number of argon gaps per module and the unit cell area.

Dry Weight per Module- This value is the sum of **all** plate and board weights.

Est. C6 Radius- The root mean square of the module inner and outer radii.

Sub-assembly Weight- The product of the module weight and the number of module

Operating Weight- The liquid argon weight added to the sub-assembly weight.

***Modules Actual-** This value is the number of modules in the operating calorimeter.

TB/Spare Modules- Test beam and spare modules. These only affect the plate costs, they do not affect operating plate weights.

Plate Yield- This is an estimated value, based on most current experience.

Plate Cost per lb.-(Estimated fabrication price, \$ per lb.) + (billet cost, \$ per lb.)(1/yield) for DU and UA, \$1.80 est. for Cu.

Plate Cost- The product of the absorber plate weight and the (finished) plate cost per lb for **all** modules.

Other Information:

1. Density = 18.5 g/cc for U/1.7% plates, see ref. 3.
2. Density = 1.4 g/cc for Liquid Argon
3. Density = 1.7 g/cc for G-10
4. Density = 19.0 g/cc for Electromagnetic plates
5. Absorption length = 1.0278(Uranium absorption length)
for Fine Hadronic sections.
6. Normal Radiation and Absorption lengths mean normal to the plates.
7. SI version also included in this report.

Revisions:

D; April 28, 1986- Cell counts for IFH, ICH, MFH, MCH, OCH changed. Definition for cell count added to text. Some dimensional revisions were made also. Massless cell added to MFH and OCH modules (6-10 board, 2 argon gaps, 1/16" Al plate).

E; May 8, 1986- Changes were made according to the new CC spread sheet from Peter Kroon. Addition of cell area and total cell area columns.

F,G,H; August 19, 1986- The EC OCH module plate material was changed to copper, its cell count was changed to 24 and its board depth was changed to 44 mils. The average plate weights and volumes and estimated inner and outer structure weights were added. The EC vessel weights were recalculated and the CC EM section cell count was changed to 20.

J; August 25, 1986- The EC EM, IFH and ICH board depths were changed to 90 mils.

K; September 10, 1986- Equation for average plate weight changed consequently changing the average plate volume.

L; October 10, 1986- A better module and average plate weight were calculated. CC coarse hadronic cell count was changed to 10. Operating weight, actual module quantity and test beam/spare module columns added to the spreadsheet.

M; November 18, 1986- Cu plate depths changed to 1.83". CC OH and EC OH cell counts changed to 9 and 23 respectively.

N; May 26, 1987- General revision. Also, columns for the number of readout cells and readout boards, readout cell depths, module array gaps, inner vessel volumes, and liquid argon volumes added.

References

1. "Particle Properties Data Book," American Institute of Physics, April, 1984, p. 118, 119
2. Cooper, W. E., "Stainless Steel Absorption and Radiation Lengths", D-Zero Engineering Note 3740.000-EN-41, Jan., 1986.
3. Private Communication (Jan 30, 1985) from Sharon Bokan, a Rocky Flats metallurgist, and Mel Lundberg, MSC (quoting Oak Ridge Y12 sources) to George T Mulholland.
4. "Standard Handbook for Mechanical Engineers", edited by Baumeister and Marks, McGraw-Hill Book Co., 1967.

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	10	11	12	13	14	15	16	17	18
1	SIGNAL	READOUT	AVERAGE	RAD LGTH	ABS LGTH	SIGNAL	READOUT	TOTAL	MODULE
2	CELL DEPTH	CELL DEPTH	DENSITY	/M., NORM	/M., NORM	CEL COUNT	CELL COUNT	CELL COUNT	ARRAY GAP
3									
4	0.0086896	0.010366	7589.90	113.68	4.1595506	13	7	20	?
5	0.011684	0.0133604	10307.87	161.64	5.4162506	44	6	50	?
6	0.0521716	0.053848	8266.30	62.82	6.0611301	7	2	9	?
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17	0.009858	0	6893.40	100.82	3.89	20	0	20	?
18	0.0136144	0	9089.25	139.45	4.91	64	0	65	?
19	0.054102	0	8032.49	60.77	5.92	15	0	16	?
20	0.011684	0.0133604	10307.87	161.64	5.41	56	4	60	0.01
21	0.0521716	0.053848	8266.30	62.82	6.07	12	2	14	0.01
22	0.0521716	0.053848	8266.30	62.82	6.07	20	3	23	?
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