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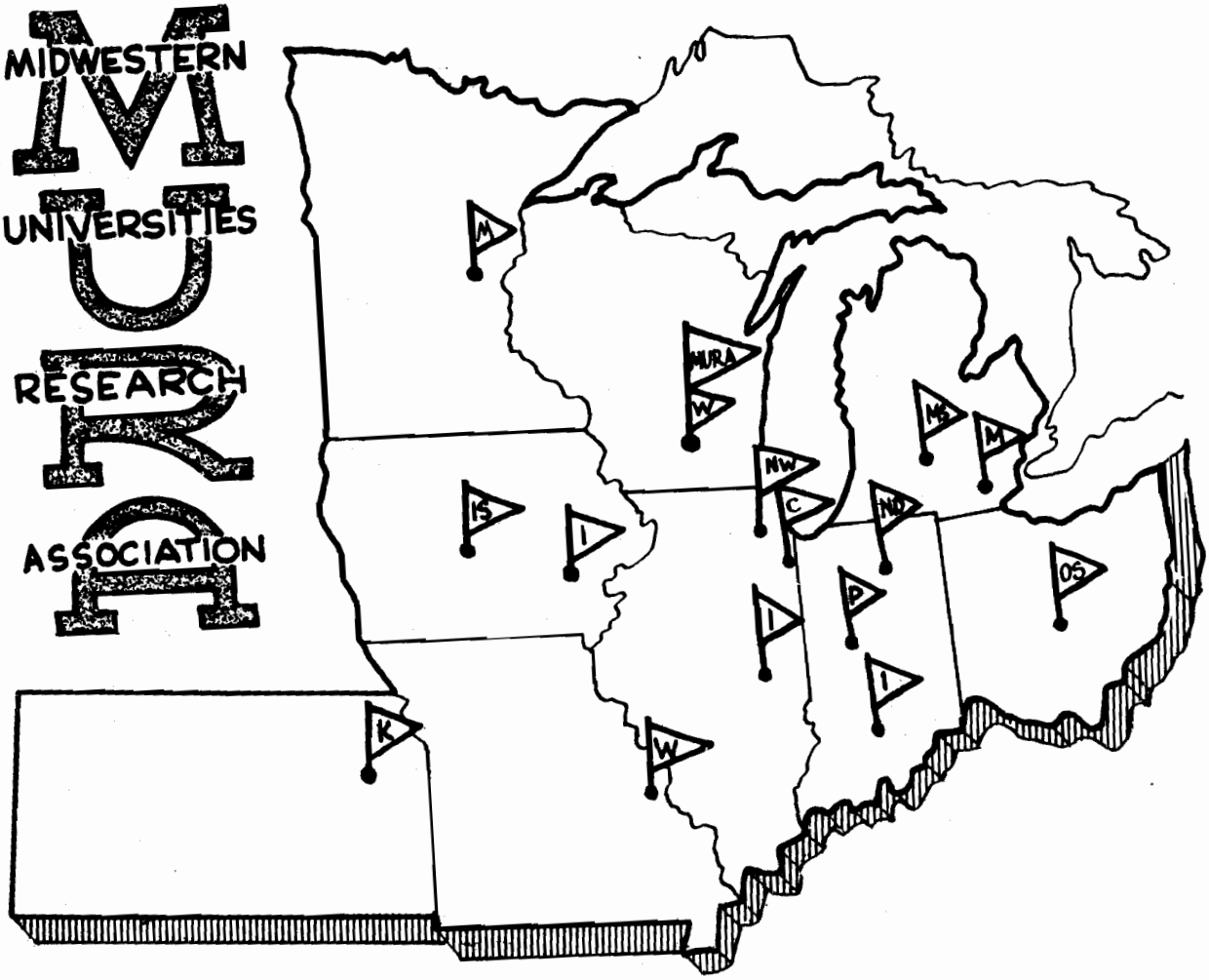

REPORT KEFUNCO

(Program 206)
July, 1958

NUMBER 415

(IBM Program)
Internal

KEFUNCO

(Program 206)

Brandt Kehoe

This program arose from a memorandum of June 30, 1958 from Don Swenson to Melvin Storm.

The program computes certain functions, described below, of particles of known kinetic energies, in accelerators of known operating parameters. It prints the parameters and then lists the kinetic energies, T, with the values of the computed functions appropriate to them.

The parameters required are: the rest energy of the particle, E_o; a reference energy E'; an equivalent radius defined by $R' = \frac{L'}{2\pi}$ where L' is the length of the orbit for a particle of energy E'; the accelerating voltage, V; the harmonic number, h; and the mean field index, k. These parameters are loaded into the machine with a set of kinetic energies or instructions for computing such a set. The functions computed from this information are:

1. $\beta = \frac{\sqrt{E^2 - E_o^2}}{E}$, the velocity of the particle in units of c, where $E = T + E_o$; and $c = 2.99793 \times 10^8$ meters/second.

2. $R = R' \left[\frac{E^2 - E_o^2}{(E')^2 - E_o^2}\right]^{\frac{1}{2k+2}}$, the equivalent orbit radius;

3. $\omega = \frac{\beta c}{2\pi R}$, the revolution frequency;

4. $K = \frac{(k+1)E_o^2 - E^2}{(k+1)(E^2 - E_o^2)} = \frac{E}{\omega}\frac{d\omega}{dE}$

5. $A = \frac{8}{\omega}\left[\frac{2VE}{\pi h |K|}\right]^{\frac{1}{2}}$, the bucket area in W - ϕ space;

6. $\nu_p = \omega\left[\frac{h|K|V}{2\pi E}\right]^{\frac{1}{2}}$, the frequency of phase oscillation;

7. $W = \frac{R}{c}\left(\frac{k+1}{k+2}\right)\left[E^2 - E_o^2\right]^{\frac{1}{2}} = \int_{E_o}^{E} \frac{dE}{\omega}$;

8. $\gamma = \frac{E}{E_o}$; and a set of products of β and γ:
$\beta\gamma$, γ^2, β^2, $1/\gamma$, $1/\gamma^2$, $\beta\gamma^2$.

The program uses the SHARE #2 print board.

UNITS

As indicated on the agendum sheet, the energy may be scaled to any convenient power of 10 electron volts (e.g., expressed in Mev or Gev) if the rf voltage is similarly scaled. The radius is expressed in meters. With the energy in 10^{α} ev, and the voltage in 10^{α} volts, the output units are R in meters, ω and ν_p in megacycles, and A and W in 10^{α} ev-seconds. ω is listed as "FREQ" on the output to avoid confusion with angular frequency.

CALCULATED INPUT

The program is designed to accept T's in three forms:

a. A list of T's in monotonic increasing order.

b. T's computed by the program in the form of an arithmetic progression:

$$T_i = T_{i-1} + \Delta T = T_o + i \Delta T.$$

For this input T_o is given and any two of the three quantities: ΔT, T_f, and N, where N is the desired number of T's to be computed in this fashion. The program generates the T_i up to and including the value of i for which

$$T_{i-1} < T_f \leqslant T_i.$$

Because of rounding error in non-significant digits, one more T may be computed than intended, in order to satisfy this requirement.

c. T's computed by the program in the form of a geometric progression:

$$T_i = T_{i-1}\, 10^{\Delta T} = T_o\, 10^{i \Delta T}.$$

Conditions on input and computation are similar to those for type b.

Either type b <u>or</u> type c input may be combined with type a. The program will order the listed and computed T's into a single montonic sequence for the output.

Operating parameters are not destroyed by the program and need not be reloaded if they are to be used again in succeeding runs of a series.

INPUT

The program and data are loaded in the following order: The program deck which includes a loader (MU LBL3) and a transition card to 1000_8; operating parameters; data for type b or c input, if any; listed (type a) T's; and "END INPUT" card, described on agendum sheet; operating parameters to be changed; etc.

SENSE SWITCHES

SS #1. Normally down. If up, the program halts on an HPR between each line of print at 1361_8 or 1546_8. Push START to proceed.

SS #2. Normally down. If up, the program transfers to read new cards. It is tested immediately following SS #1. If such a transfer is desired, put SS #1 and SS #2 up. On first stop, press START button, on second, put switches down and then press START.

SS #3. Normally down. If up, the program will stop on an HTR (1023_8) at the end of calculations and print, but before reading new data. Push START, or if machine is reset, transfer manually to 1023_8 to proceed.

TIME

The program time depends primarily on print time and requires roughly two seconds for each value of T used.

KEFUNCO AGENDUM SHEET
(Program 206)

OPERATING PARAMETERS

Parameter	Address	Value n	Value exp	Remarks
IDENT	2016		6	η = X.XXYYYY XXX = User's No. YYYY = Run No.
E_o	2017			Energies should be loaded in units of 10^{α} ev, where α is an arbitrary integer. Output values will be in corresponding units.
E'	2018			
R'	2019			Expressed in meters
V	2020			Expressed in 10^{α} volts
h	2021			Dimensionless.
k	2022			Dimensionless

CONSTANT DECREMENT T's ENTER T_o AND ANY TWO OF REMAINING THREE

T_o	1034			Energies in 10^{α} ev
ΔT	1035			
T_f	1036			
N	2080			Integer Expressed in Floating Point

EXPONENTIAL DECREMENT T's ENTER T_o AND ANY TWO OF REMAINING THREE

T_o	1037			T_o, T_f in 10^{α} ev.
ΔT	1038			ΔT - Dimensionless
T_f	1039			
N	2080			Integer Expressed in Floating Point

The program will handle either of the above sets of calculated T's and the given T's on the next page.

TABLE OF GIVEN T's

Parameter	Address	Value n	exp	Parameter	Address	Value n	exp
T_1	1040			T_{26}	1065		
T_2	1041			T_{27}	1066		
T_3	1042			T_{28}	1067		
T_4	1043			T_{29}	1068		
T_5	1044			T_{30}	1069		
T_6	1045			T_{31}	1070		
T_7	1046			T_{32}	1071		
T_8	1047			T_{33}	1072		
T_9	1048			T_{34}	1073		
T_{10}	1049			T_{35}	1074		
T_{11}	1050			T_{36}	1075		
T_{12}	1051			T_{37}	1076		
T_{13}	1052			T_{38}	1077		
T_{14}	1053			T_{39}	1078		
T_{15}	1054			T_{40}	1079		
T_{16}	1055			T_{41}	1080		
T_{17}	1056			T_{42}	1081		
T_{18}	1057			T_{43}	1082		
T_{19}	1058			T_{44}	1083		
T_{20}	1059			T_{45}	1084		
T_{21}	1060			T_{46}	1085		
T_{22}	1061			T_{47}	1086		
T_{23}	1062			T_{48}	1087		
T_{24}	1063			T_{49}	1088		
T_{25}	1064			T_{50}	1089		

This program will handle up to 110 kinetic energies in Table form, and up to 200 values total.

MU RFD2 is used for input.

The last card in the T input should be followed by a card which is blank except for "END INPUT" punched in columns 37 - 45.