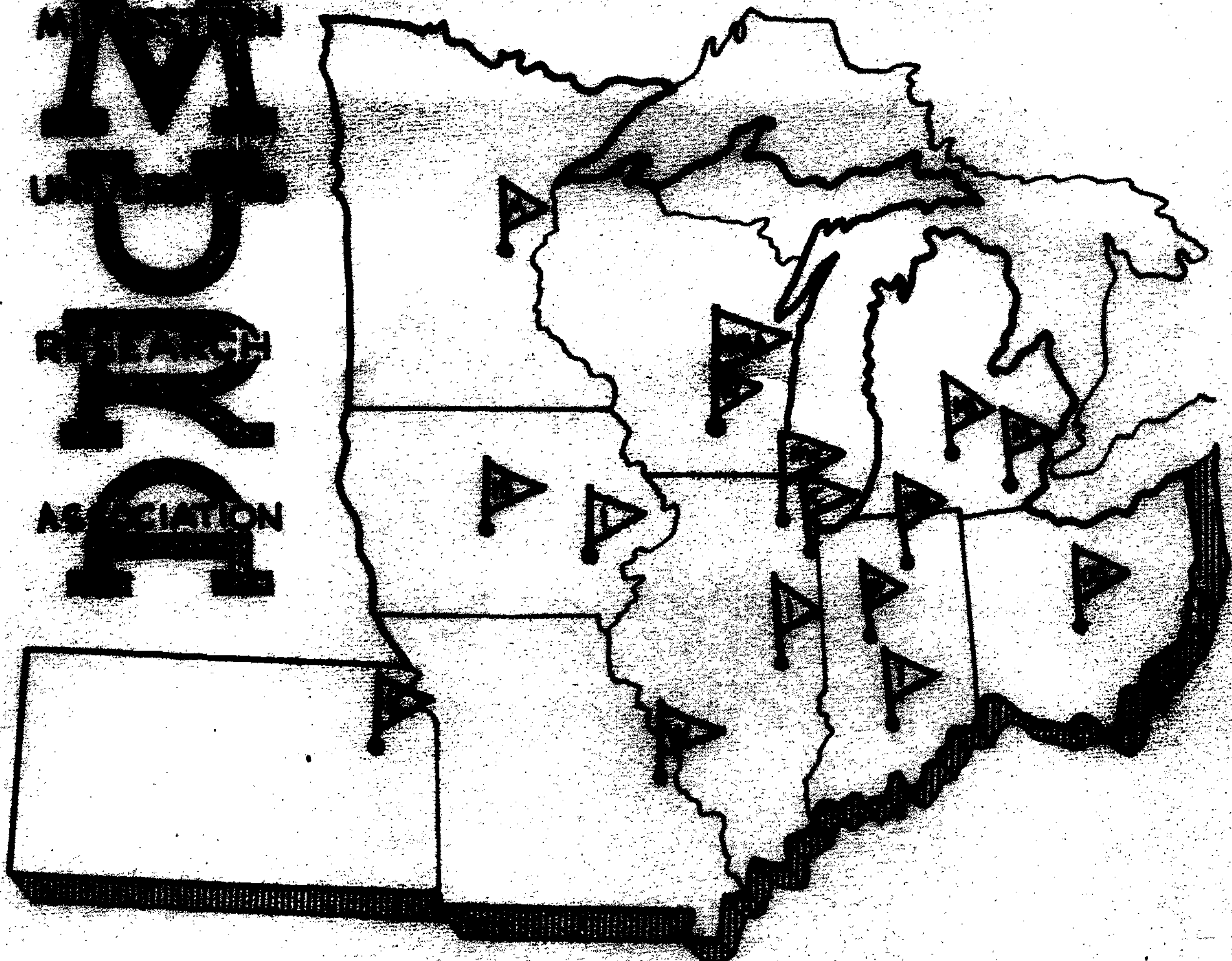


REPORT ILL TEMPERED FIVE

Cyclotron Overwrite #1
(Program 197)
August, 1958

NUMBER 428

IBM Program
Internal

ILL TEMPERED FIVE
Cyclotron Overwrite #1
(Program 197)

Elizabeth Z. Chapman

The purpose of this overwrite is to simulate the energy gain by a particle in a cyclotron. The quantity P, the total mechanical momentum of a particle, appears directly in the ILL TEMPERED FIVE equations of motion. The energy gain is simulated by adding amounts ΔP_i to P at intervals specified by the user. The user specifies an energy increment ΔE_i and the program calculates P_i from

$$E_i = E_{i-1} + \Delta E_i$$
$$P_i = \sqrt{E_i^2 - E_o^2 + P_o^2}$$

where units are used where c = 1.

The user specifies up to 50 sets of quantities N_{R_i} and ΔE_i, E_o, P_o and a larger periodicity N_B. At the beginning of the N_{R_i}th Runge-Kutta step, the overwrite calculates P_i and replaces P_{i-1} with this value. P_i and E_i are printed at this time with the line label of 30000 + i. The program continues through the sequence of sets until it reaches step N_B, when the N_R counter is reset to zero so that the whole incrementing process repeats.

P has been put into the equations of motion in such a way that the circle of expansion does not change with P.

ILL TEMPERED FIVE
Cyclotron Overwrite #1

Initial Print Format

	Line #	Col 1	Col. 2	Col. 3	Col. 4	Col. 5
	46	E_o				
I	47	N_B				
I	48	N_{R_1}	N_{R_2}	N_{R_3}	N_{R_4}	N_{R_5}
	49	ΔE_1	ΔE_2	ΔE_3	ΔE_4	ΔE_5
I	50	N_{R_6}	N_{R_7}	N_{R_8}	N_{R_9}	$N_{R_{10}}$
	51	ΔE_6	ΔE_7	ΔE_8	ΔE_9	ΔE_{10}
	.					
	.					
	.					
I	66	$N_{R_{46}}$	$N_{R_{47}}$	$N_{R_{48}}$	$N_{R_{49}}$	$N_{R_{50}}$
	67	ΔE_{46}	ΔE_{47}	ΔE_{48}	ΔE_{49}	ΔE_{50}

ILL TEMPERED FIVE
Cyclotron Overwrite #1
(Program 197)

To be attached by staples to the front of an ILL TEMPERED FIVE (Program 175) Agendum.

Parameter	Address	Value (INTEGERS)	Parameter	Address	Value n	Value exp (FLOATING POINT NUMBERS)
N_B	180		E_o	301		
N_{R_1}	302		ΔE_1	352		
N_{R_2}	303		ΔE_2	353		
N_{R_3}	304		ΔE_3	354		
N_{R_4}	305		ΔE_4	355		
N_{R_5}	306		ΔE_5	356		
N_{R_6}	307		ΔE_6	357		
N_{R_7}	308		ΔE_7	358		
N_{R_8}	309		ΔE_8	359		
N_{R_9}	310		ΔE_9	360		
$N_{R_{10}}$	311		ΔE_{10}	361		
$N_{R_{11}}$	312		ΔE_{11}	362		
$N_{R_{12}}$	313		ΔE_{12}	363		
$N_{R_{13}}$	314		ΔE_{13}	364		
$N_{R_{14}}$	315		ΔE_{14}	365		
$N_{R_{15}}$	316		ΔE_{15}	366		
$N_{R_{16}}$	317		ΔE_{16}	367		
$N_{R_{17}}$	318		ΔE_{17}	368		
$N_{R_{18}}$	319		ΔE_{18}	369		
$N_{R_{19}}$	320		ΔE_{19}	370		
$N_{R_{20}}$	321		ΔE_{20}	371		

NOTE: If additional N_{R_i} and ΔE_i (up to i = 50) are desired, attach another sheet. Addresses are consecutive.
Enter P_o as P on the ILL TEMPERED FIVE Agendum.

November 3, 1958

MEMORANDUM

TO: Computer Users

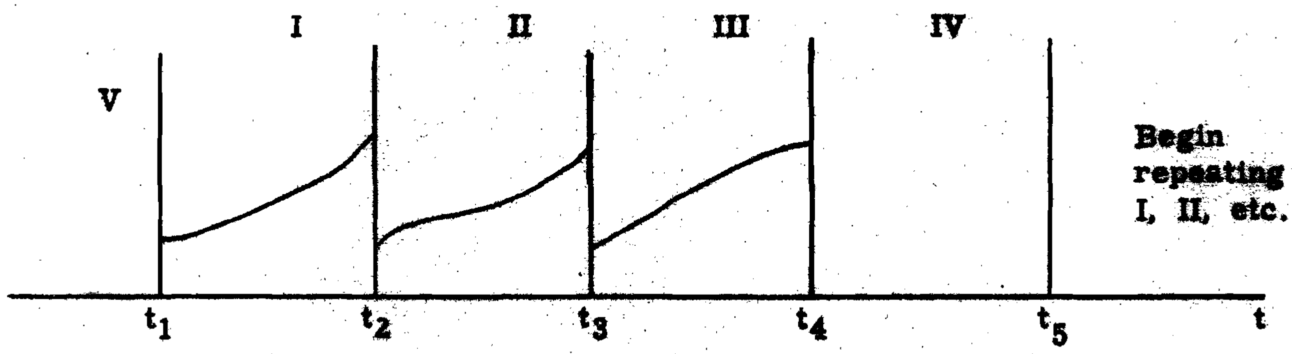
FROM: Jess Anderson

SUBJECT: Computer Program - TTT

The TTT and TTT Scope Programs have been augmented as described below. This memo should be attached securely to and become an integral part of the full write-ups of both programs.

A voltage type 4 ($\chi_1 = 4$, cf. page 3 of the main write-up) has been provided.

If $\chi_1 = 4$, V (t) will have the form



where

$$10^4 V_I = \frac{a_I + b_I\left(\frac{t' - t_1}{\tau_I}\right) + c_I\left(\frac{t' - t_1}{\tau_I}\right)^2 + d_I\left(\frac{t' - t_1}{\tau_I}\right)^3 + e_I\left(\frac{t' - t_1}{\tau_I}\right)^4}{f_I + g_I\left(\frac{t' - t_1}{\tau_I}\right) + h_I\left(\frac{t' - t_1}{\tau_I}\right)^2 + i_I\left(\frac{t' - t_1}{\tau_I}\right)^3 + j_I\left(\frac{t' - t_1}{\tau_I}\right)^4}$$

$$10^4 V_{II} = \frac{a_{II} + b_{II}\left(\frac{t' - t_2}{\tau_{II}}\right) + c_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^2 + d_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^3 + e_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^4}{f_{II} + g_{II}\left(\frac{t' - t_2}{\tau_{II}}\right) + h_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^2 + i_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^3 + j_{II}\left(\frac{t' - t_2}{\tau_{II}}\right)^4}$$

$$10^4 V_{III} = \frac{a_{III} + b_{III}\left(\frac{t' - t_3}{\tau_{III}}\right) + c_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^2 + d_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^3 + e_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^4}{f_{III} + g_{III}\left(\frac{t' - t_3}{\tau_{III}}\right) + h_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^2 + i_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^3 + j_{III}\left(\frac{t' - t_3}{\tau_{III}}\right)^4}$$

$$10^4 V_{IV} = 0.$$

Here

$$t' = t - t_F < t_5 - t_1$$

$$t_F = n\,(t_5 - t_1),\ n \text{ an integer.}$$

The restrictions

$$\tau_I > t_2 - t_1$$

$$\tau_{II} > t_3 - t_2$$

$\tau_{III} > t_4 - t_3$ <u>must</u> be observed.

The values must be such that $10^4\ V < 1$ and all quantities entered on the SENARIO AGENDUM SHEET are less than 1.

The data are given by the following set of identified entries just following the GAP entry on the SENARIO AGENDUM SHEET.

TYPE	VALUE	COMPONENT
1	t_5	
2	$t_5 - t_4$	
3	$t_4 - t_3$	
4	$t_3 - t_2$	
5	$t_2 - t_1$	
6	τ_I	
7	a_I	
8	b_I	
9	c_I	
10	d_I	
11	e_I	
12	f_I	
13	g_I	
14	h_I	
15	i_I	
16	j_I	
17	τ_{II}	
18	a_{II}	
19	b_{II}	
20	c_{II}	
21	d_{II}	
22	e_{II}	
23	f_{II}	
24	g_{II}	
25	h_{II}	
26	i_{II}	
27	j_{II}	

28	τ_{III}
29	a_{III}
30	b_{III}
31	c_{III}
32	d_{III}
33	e_{III}
34	f_{III}
35	g_{III}
36	h_{III}
37	i_{III}
38	j_{III}

Some of the time differences may be zero; any quantity which is not pertinent (i.e., is zero) may be omitted, except that card 38 (j_{III}) must be present and must be last.

Note that the time origin $t = 0$ can be at any place on the above graph. The value of t_5 serves to locate the phase of the voltage variation with respect to the origin once the latter has been chosen.

Each run through the machine can be given an initial time t_o (which need not be zero). However, once chosen, the initial time, the time origin, and the time phase of all time varying components must be consistent.