# CALLING SIMULT

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November 1976

Plasma Studies

University of Wisconsin

PLP 702

SIMULT is a simulation program that calculates time dependent, spatially averaged properties of plasmas confined in either the small or large toroidal octupole. (See PLP 607.) A version of SIMULT has been written as a subroutine and stored on tape at MACC so that anyone can use it by calling it from a simple program. Future refinements to SIMULT will be made in such a way that the calling program remains unchanged, but will result in execution of the most recent version of SIMULT. This will insure that all users are using the same (and presumably the best) version of SIMULT. It also facilitates interactive use of SIMULT, and saves in card reading and compilation costs.

In calling SIMULT, the user must specify five options and 21 parameters. SIMULT will print and graph the results if requested, and return to the calling program a 27 x 101 matrix of results along with maximum (or minimum) values of seven of the plasma properties and the times at which each maximum occurs. The calling sequence is as follows:

CALL SIMULT (IOPT, P, VAL, VALM)

where IOPT and P are matrices of values that must be defined prior to calling SIMULT and VAL and VALM are matrices into which SIMULT returns the results of its calculation. The calling program need not do anything with VAL and VALM.

The currently available options are as follows:

IOPT (1) is for auxiliary heating. Let IOPT(1) = 0 for no auxiliary heating, IOPT(1) = 1 for ohmic heating (B-toroidal), IOPT(1) = 2 for ICRH, or IOPT(1) = 4 for supplementary ECRH. To combine several auxiliary heating sources, just add the appropriate values (i.e., IOPT(1) = 5 would be ECRH + ohmic heating, etc.)

IOPT(2) = 1 for small octupole, or 2 for large octupole.

IOPT(3) = 0 for no crowbarred B-poloidal (damped half sine wave), or 1 for a passively crowbarred B-poloidal.

IOPT(4) = 0 if no printing of results is desired, 1 for table of results only, 2 for graph of results only, or 3 for both table and graph.

IOPT(5) = 0 (reserved for future use).

The parameters that must be specified are as follows:

P(1) = peak poloidal magnetic field at outer wall midplane in kgauss.

P(2) = initial $H_2$ filling pressure in units of $10^{-5}$ Torr (this pressure is ~ 2.3 times the pressure read on a Bayard Alpert gauge.)

P(3) = obstacle area (supports + probes, etc) in $cm^2$.

P(4) = peak primary microwave ECRH power in watts. (These microwaves are assumed to be powered from B-poloidal.)

P(5) = frequency in GHz of the above microwaves.

P(6) = unloaded Q of the toroidal vacuum cavity at the above frequency.

P(7) = pumping speed in ℓ/sec.

P(8) = half-sine period of B-poloidal in sec (also duration of computation).

P(9) = time after beginning of poloidal field at which the ECRH is abruptly turned off.

P(10) = power in watts of additional primary cw microwave source at the same frequency as above.

When using ohmic heating (B-toroidal), the following values must be specified (otherwise zero will suffice):

P(11) = peak toroidal magnetic field on minor axis in kgauss.

P(12) = time in seconds after the start of the poloidal field at which the toroidal field is turned on.

When using ICRH, the following values must be specified (otherwise zero will suffice):

P(13) = ICRH frequency in MHz.

P(14) = time in seconds after $B_p$ at which the ICRH pulse begins.

P(15) = time in seconds after $B_p$ at which the ICRH pulse ends.

P(16) = initial zero-to-peak single turn hoop voltage in kV.

When using supplementary ECRH, the following values must be specified (Otherwise zero will suffice):

P(17) = time in seconds after $B_p$ at which the ECRH begins.

P(18) = time in seconds after $B_p$ at which the ECRH pulse ends.

P(19) = frequency of the supplementary ECRH in GHz.

P(20) = power of the supplementary ECRH in watts.

P(21) = Unloaded Q of the toroidal vacuum cavity at the above frequency.

SIMULT returns to the calling program a 27 x 101 matrix, VAL (I,J) where J is 101 times evenly spaced from the beginning to the end of the poloidal field pulse, and I is one of the following:

I = 1: time in seconds after start of $B_p$

2: spatially averaged particle density in units of $10^9$ $cm^{-3}$

3: spatially averaged electron temperature in eV

4: spatially averaged ion temperature in eV

5: neutral density in units of $10^9$ $cm^{-3}$

6: poloidal field strength at outer wall, midplane in kgauss

7: primary ECRH power in watts

8: spatially averaged ion saturation current density to a Langmuir probe biased to -45 V ($mA/cm^2$)

9: ionization rate ($10^9$ $cm^{-3}$/sec)

10: particle diffusion rate ($10^9$ $cm^{-3}$/sec)

11: obstacle loss rate ($10^9$ $cm^{-3}$/sec)

12: particle loss rate by field decay ($10^9$ $cm^{-3}$/sec)

13: particle loss rate by finite ion gyroradius ($10^9$ $cm^{-3}$/sec)

14: particle loss rate by recombination ($10^9$ $cm^{-3}$/sec)

15: electron heating rate by primary ECRH ($10^9$ eV-$cm^{-3}$/sec)

16: electron energy loss (or ion heating) by electron-ion collisions ($10^9$ eV-$cm^{-3}$/sec)

17: electron energy loss by excitation of neutrals ($10^9$ eV-$cm^{-3}$/sec)

18: electron energy loss by bremsstrahlung ($10^9$ eV-$cm^{-3}$/sec)

19: electron energy loss by synchrotron radiation ($10^9$ eV-$cm^{-3}$/sec)

20: electron energy loss by particle transport ($10^9$ eV-$cm^{-3}$/sec)

21: electron heating by ohmic heating ($10^9$ eV-$cm^{-3}$/sec)

22: electron heating by auxiliary ECRH ($10^9$ eV-$cm^{-3}$/sec)

23: ion energy loss by charge exchange ($10^9$ eV-$cm^{-3}$/sec)

24: ion energy loss by charge exchange ($10^9$ eV-$cm^{-3}$/sec)

25: ion heating by finite temperature walls ($10^9$ eV-$cm^{-3}$/sec)

26: ion energy loss by elastic neutral collisions ($10^9$ eV-$cm^{-3}$/sec)

27: ion heating by ICRH ($10^9$ eV-$cm^{-3}$/sec)

In addition, the following values are returned:

VALM(1,1) = maximum density ($10^9$ $cm^{-3}$)

VALM(2,1) = maximum electron temperature (eV)

VALM(3,1) = maximum ion temperature (eV)

VALM(4,1) = minimum neutral density ($10^9$ $cm^{-3}$)

VALM(5,1) = maximum poloidal field (kG)

VALM(6,1) = maximum primary ECRH power (watts)

VALM(7,1) = maximum ion saturation current density (mA/$cm^2$)

VALM(I,2) for I = 1 to 7 will contain the time (in seconds) at which VALM(I,1) occurred. A sample calling program with typical values for the small octupole is shown on the following page.

```
@RUN  SPROTT,2980,4126810219,1M
@ASG,T TEMP.
@ASG,TH 20.,T,U5709
@COPY,G 20.,TEMP.
@FREE 20.
@FOR,IS TEMP.MAIN,.MAIN
      DIMENSION IOPT(5),P(21),VAL(27,101),VALM(7,2)
      IOPT(1)=1
      IOPT(2)=1
      IOPT(3)=0
      IOPT(4)=3
      IOPT(5)=0
      P(1)=0.88
      P(2)=2.3
      P(3)=90.0
      P(4)=5000.0
      P(5)=2.45
      P(6)=2000.0
      P(7)=1000.0
      P(8)=0.005
      P(9)=0.0035
      P(10)=50.0
      P(11)=1.25
      P(12)=0.0035
      P(13)=2.0
      P(14)=0.005
      P(15)=0.006
      P(16)=40.0
      P(17)=0.004
      P(18)=0.005
      P(19)=9.0
      P(20)=2.0E4
      P(21)=3000.0
      CALL SIMULT(IOPT,P,VAL,VALM)
      END
@MAP,IXN
 IN TEMP.MAIN,.SIMULT,.OHMIC,.HICRH,.HECRH
@XQT
```