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PUFF-TFT/PC

A Material Response Computer Code for PC Computer

The **PUFF-TFT/PC** code has now been updated (Version 5.0 and 6.c) to allow modeling of sample responses to sudden energy loading (e.g., X rays or Lasers) for arbitrary starting temperatures. Problems can be run for any initial temperature, both elevated and, most importantly, for cryogenic conditions. Updates have also been made in the stress response for the "thermal- only" mode, especially for the cool-down stresses after plastic flow. Likewise, the code tracks material properties (yielding, shear module, spall strengths) for cryogenic conditions.

The code amendments have been done in a "transparent" manner for the user, requiring the minimum of input parameter changes. To active this, the code maintains the existing convention of:

Enthalpy = 0.0 cal/g at temperature = 25 C

and temperature continues to be in degrees centigrade. Consequently, for that equal to 25 ^{0}C, the code will start with a non-zero enthalpy. For T > 25 ^{0}C, this initial enthalpy will be positive, whereas for T < 25 ^{0}C, the enthalpy is negative.

The previous code version did not distinguish between "dose" (the added energy due to X rays, thermal flow, etc.) and "enthalpy." This was appropriate, since both terms initialized with a common value of zero. The new code makes the distinction, since dose still starts from zero enthalpy.

The "transparent" amendments are such that the user continues to use the existing database for such parameters as melt energy, vapor energy, and latent heats. Likewise, for T > 25 ^{0}C, the existing polynomial coefficients to describe specific heats, enthalpies, and conductivities are maintained.

The code was written for the Air Force Weapon Laboratory (AFWL) primarily to allow evaluation of thin-layer stack response to X-ray deposition resulting in one dimensional (1-D) strain stress response. The code takes into account the X-ray generation of secondary cascade particles (photoelectrons, Auger electrons and fluorescent photons) using a cascade routine, and incorporates a thermal condition routine allowing the effects of rapid thermal diffusivity to be included.

The output of the X-ray/cascade/thermal routine is used as input to an updated version of the PUFF74 hydrodynamic code, which includes hydrodynamic, elasto-plastic, porous and dispersive material responses in a fully-coupled manner, and also accounts for simple phase changes.

The formulation of differential equations follows either Eulerian or Lagrangian descriptions. The Eulerian description is a spatial description; while the Lagrangian is a material description. In an Eulerian framework, all grid points, and consequently cell boundaries, remain fixed with time. Mass, momentum, and energy flow across cell boundaries. In a Lagrangian description, the grid points are attached to the material and move with the material. In this formulation, mass within a cell is invariant, but the volume of the cell may change with time because of expansion or compression, of the materials.

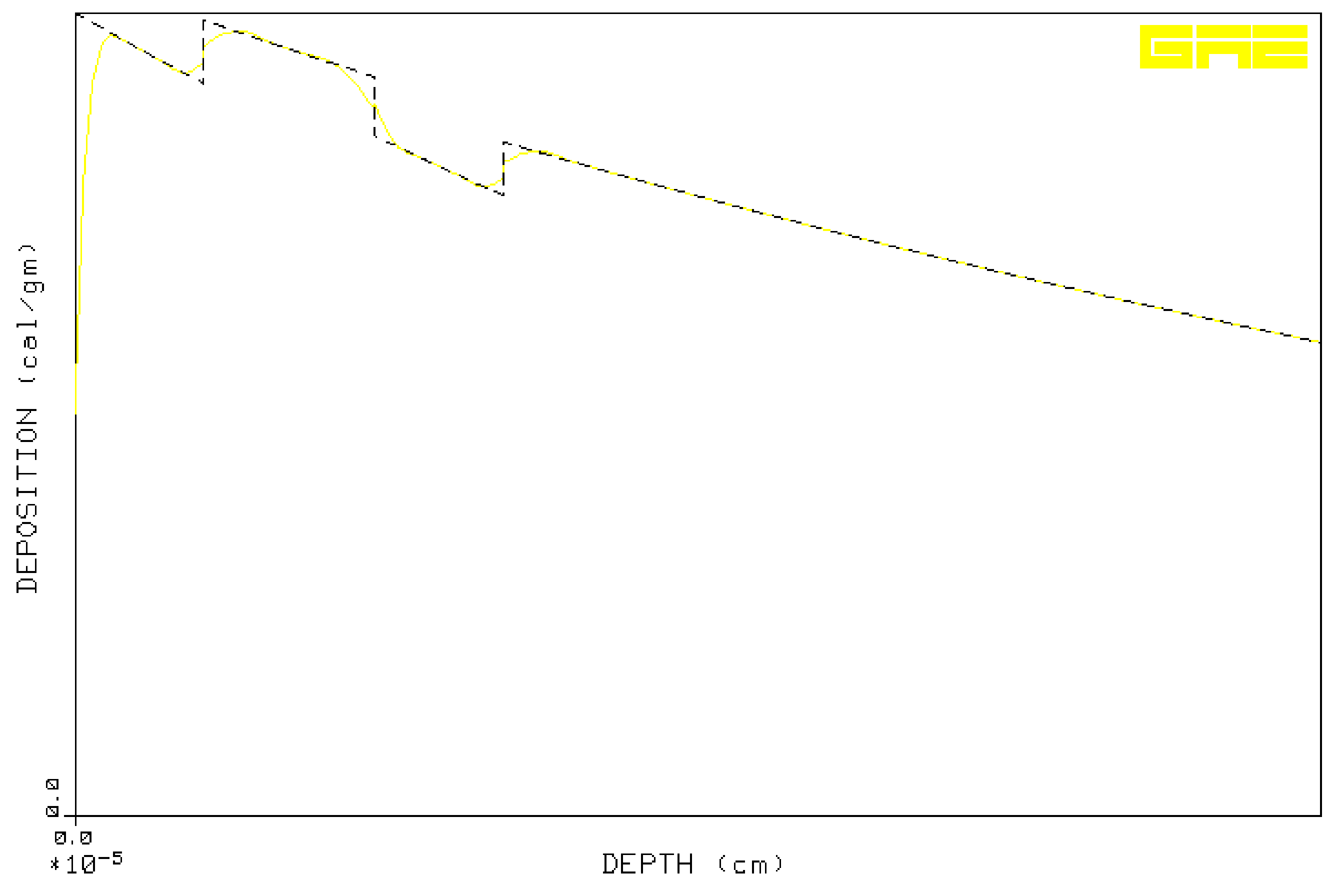
The PUFF-TFT code calculates stress wave formation and propagation by numerical integration of the conservation equations in a one-dimensional Lagrangian coordinate system. The TFT package accounts for the effects of dose enhancement due to the transport of secondary particles with ranges comparable to the thickness of the thin material layers and thermal conduction between thin material layers. The se two modifications (among others) more accurately portray the degree of energy sharing between thin layers, thereby modifying the expected energy depositions based on normal x-ray interactions and possibly altering the anticipated thermo-mechanical response of the medium.

The PUFF74 code, originally developed in the mid-sixties, has undergone a number of revisions to become a flexible material response code that includes the effects of material strength, porosity, and fracture for both homogeneous and composite materials. The code calculates stress wave formation and propagation by numerical integration of the conservation equations in a one-dimensional Lagrangian coordinate system. In addition to the hydrodynamic equation of state, which is required for all materials, the code contains an elastic-plastic model for strength effects, a P-α porosity model for treating irreversible compaction, and four models for treating strain-rate dependent or dispersive effects.

Galaxy Advanced Engineering, Inc. (GAE) has taken steps to produce the PC version, (i. e., **PUFF-TFT/PC**). Currently the program is operating on WINDOW/PC or 100% compatibles under PC/DOS or MS/Windows95/98/2000/XP/ME and NT operating system. The program uses the Universal Graphics Language Library for PC/Windows to handle the plotting capability of this code. Please refer to the following page for some output graphics example. To order this code, please contact us at (650) 740-3244.

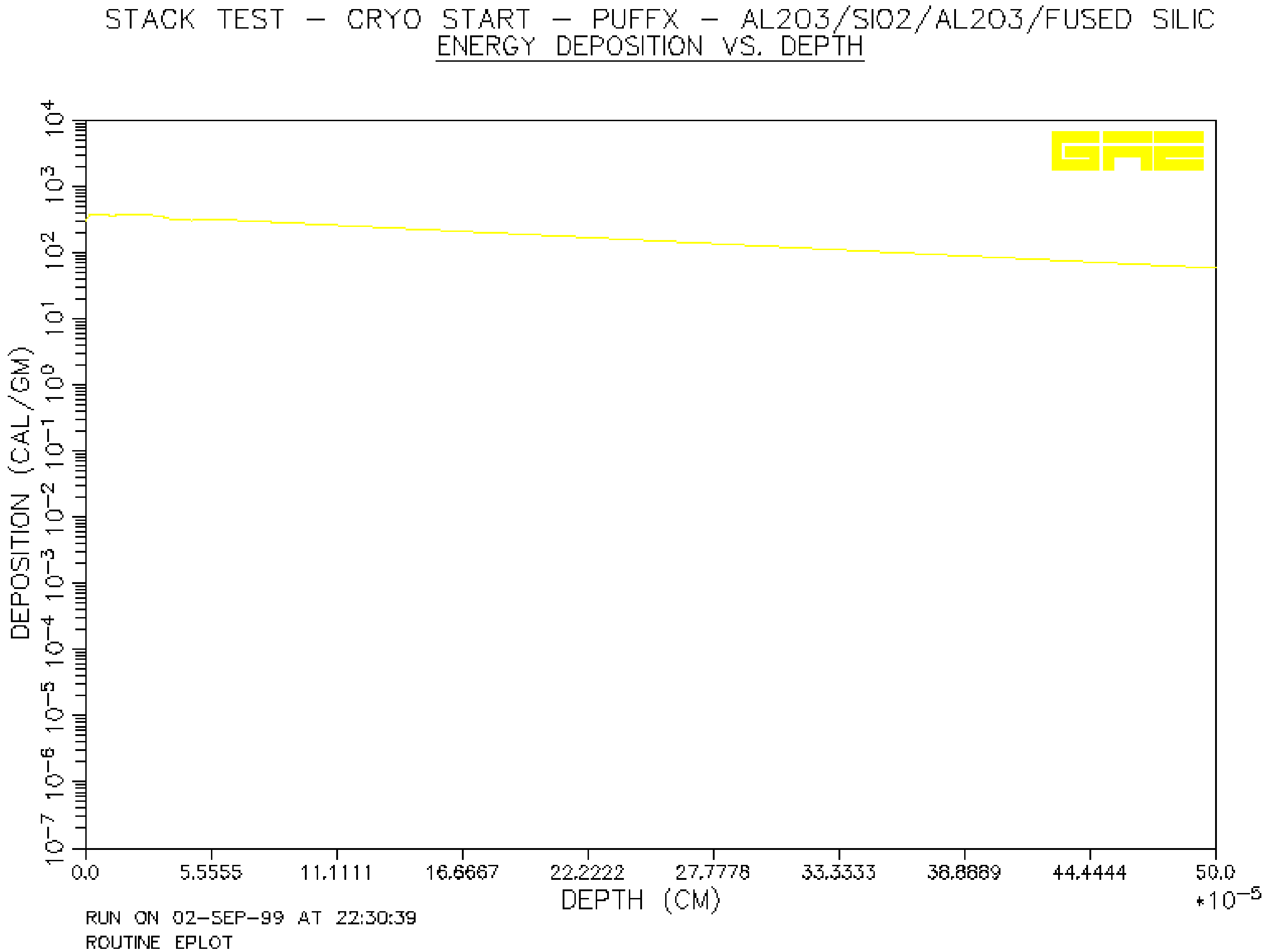
STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

CUMULATIVE DOSE VS DEPTH



RUN ON 02-SEP-99 AT 22:30:39

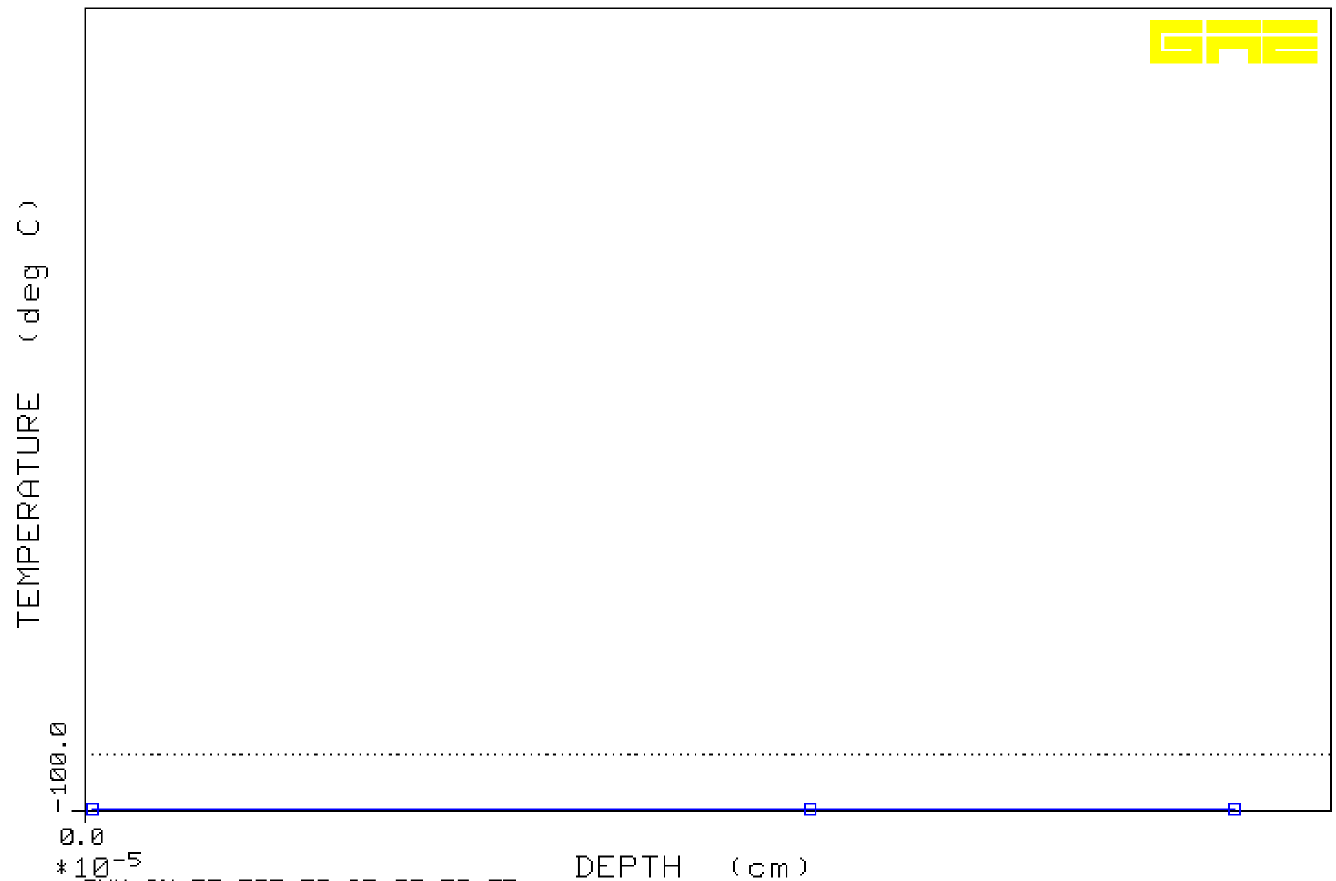
ROUTINE PLTDEP


STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC
ENERGY DEPOSITION VS. DEPTH
DEPOSITION (CAL/GM)
10^4 10^3 10^2 10^1 10^0 10^-1 10^-2 10^-3 10^-4 10^-5 10^-6 10^-7
0.0 5.5555 11.1111 16.6667 22.2222 27.7778 33.3333 38.8889 44.4444 50.0
DEPTH (CM)
*10^-5
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE EPLOT

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

TEMPERATURE vs. DEPTH

TIME: 0.1046740E-10 SEC



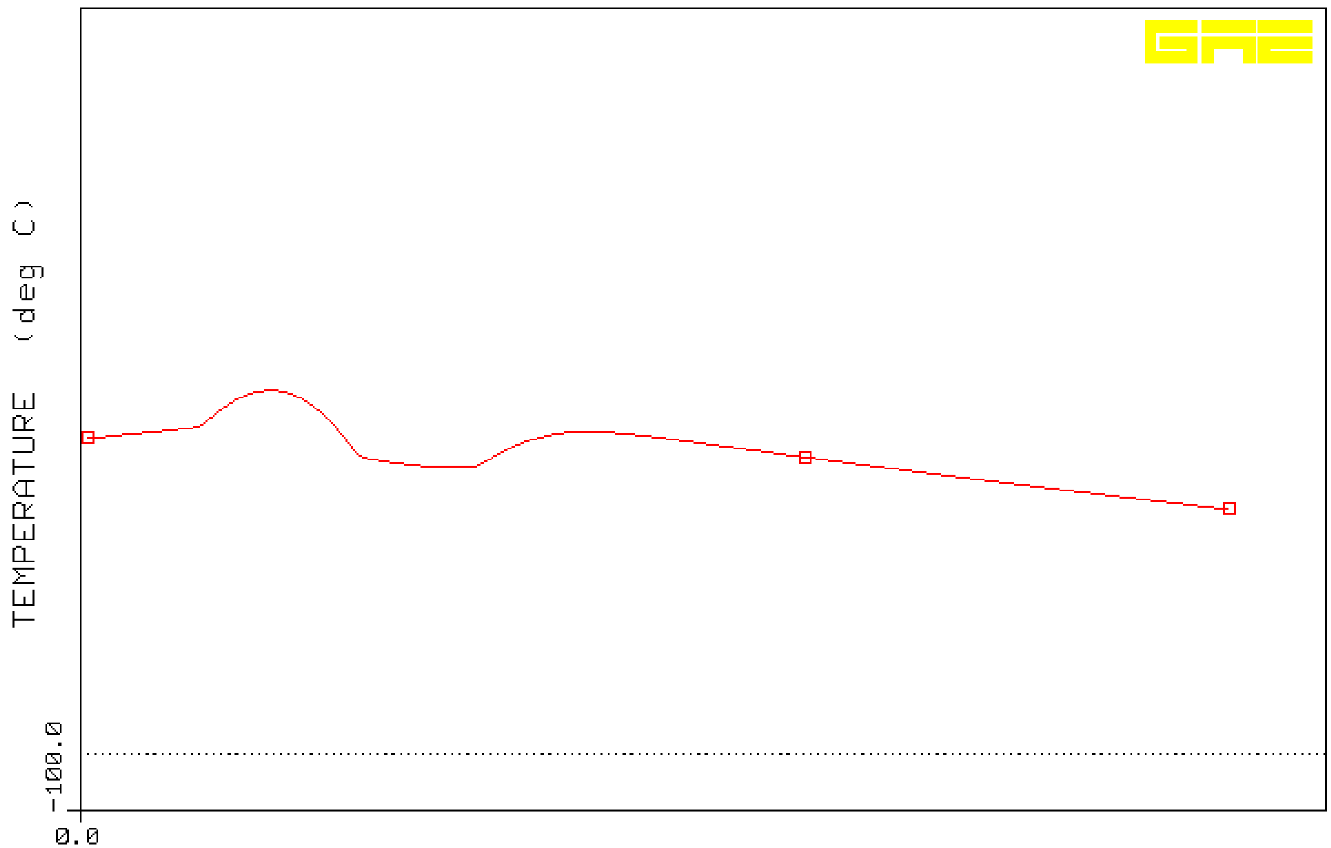
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

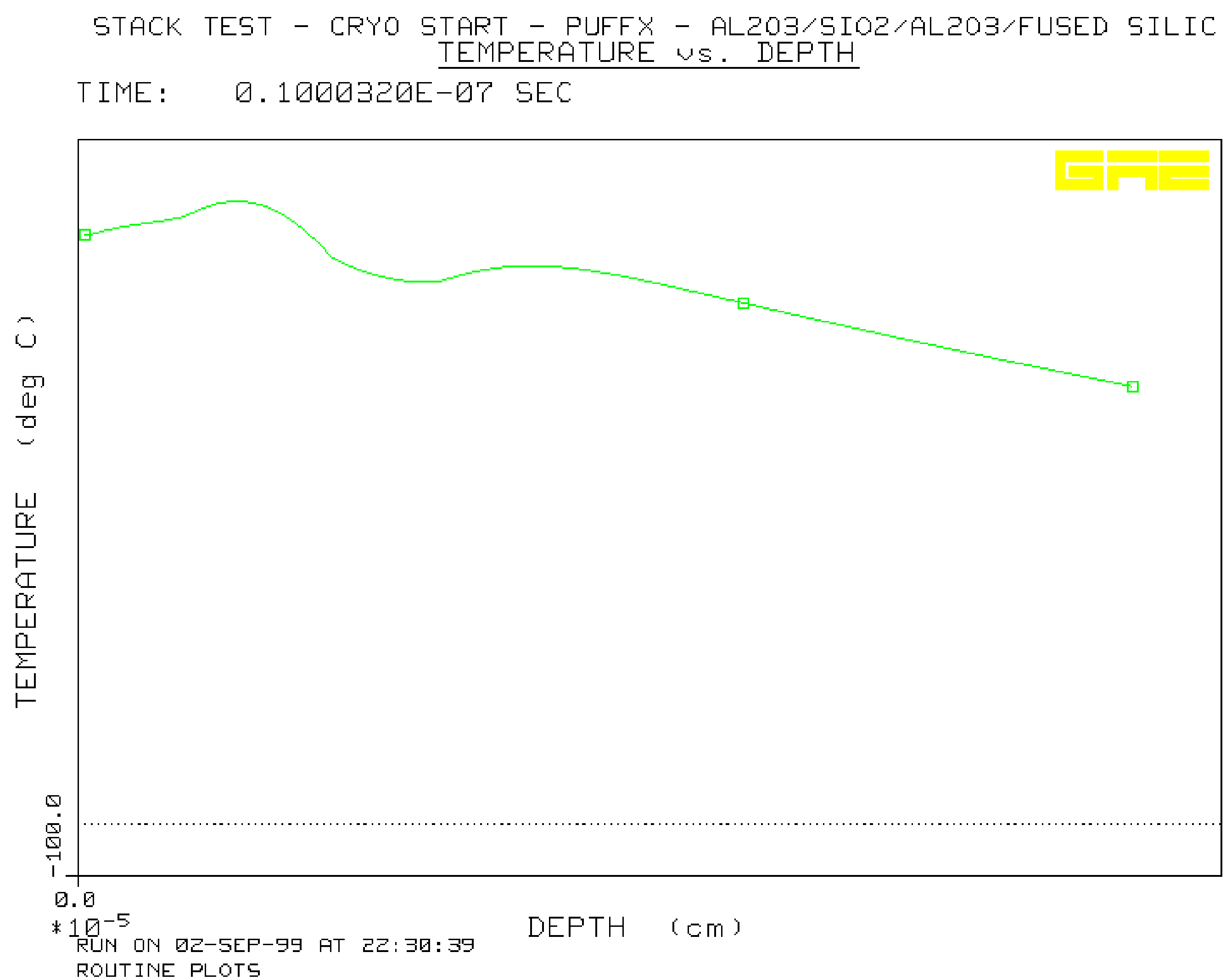
TEMPERATURE vs. DEPTH

TIME: 0.5003202E-08 SEC



RUN ON 02-SEP-99 AT 22:30:39

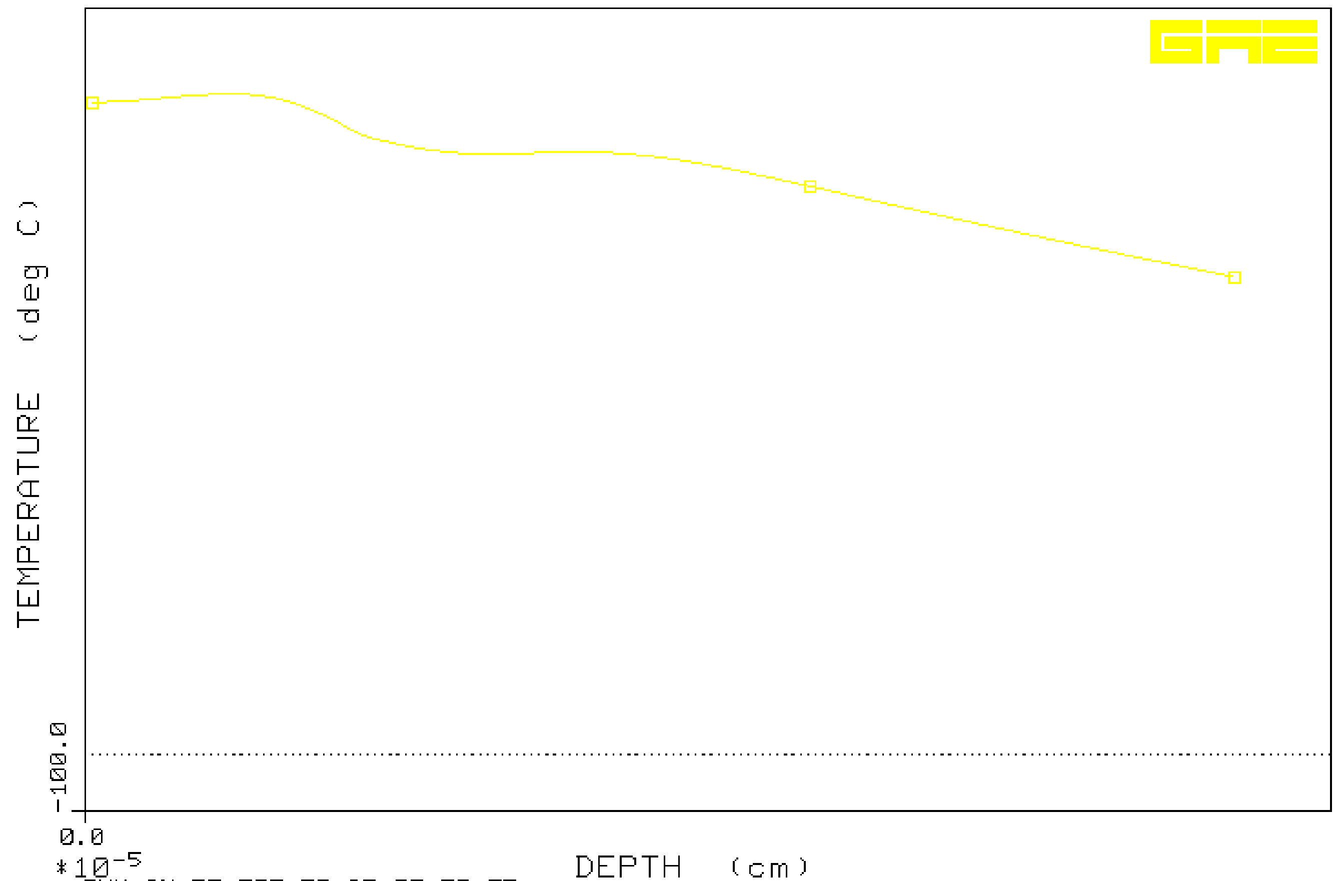
ROUTINE PLOTS


STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC
TEMPERATURE vs. DEPTH
TIME: 0.1000320E-07 SEC
TEMPERATURE (deg C)
-100.0
0.0
*10^-5
DEPTH (cm)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

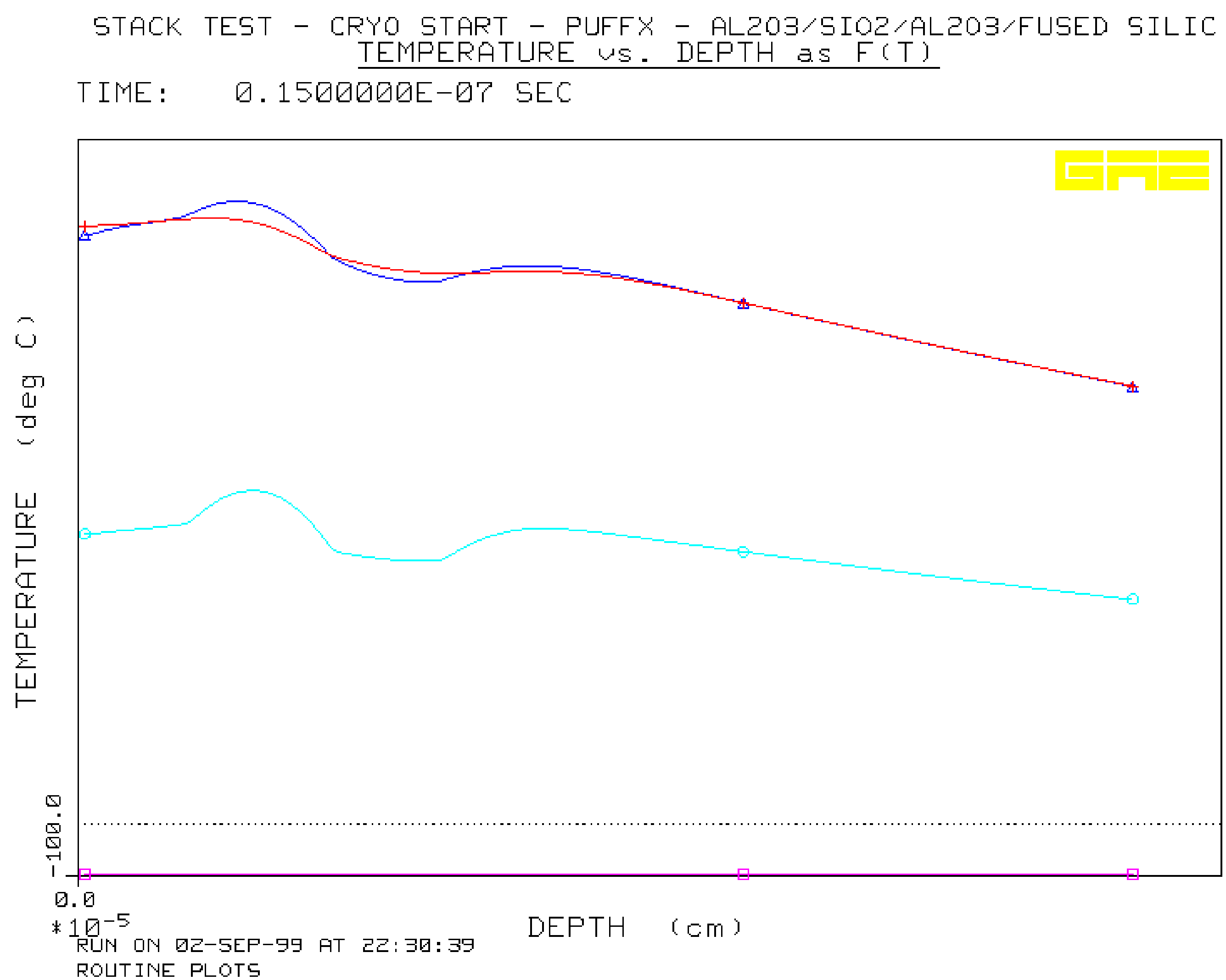
TEMPERATURE vs. DEPTH

TIME: 0.1500000E-07 SEC



RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

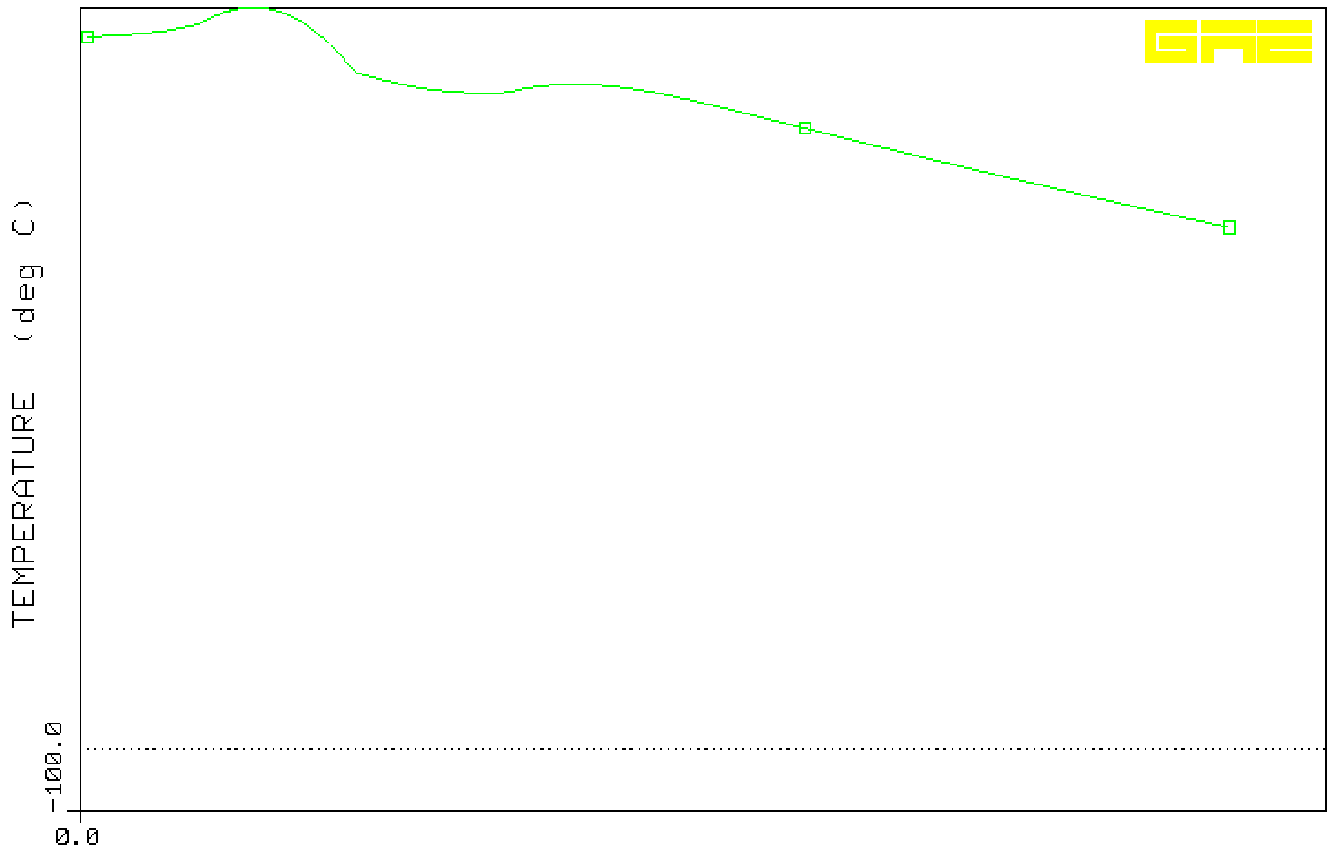


STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC
TEMPERATURE vs. DEPTH as F(T)
TIME: 0.1500000E-07 SEC
TEMPERATURE (deg C)
-100.0
0.0
*10-5
DEPTH (cm)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

MAXIMUM TEMPERATURE vs. DEPTH

TIME: 0.1500000E-07 SEC



RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

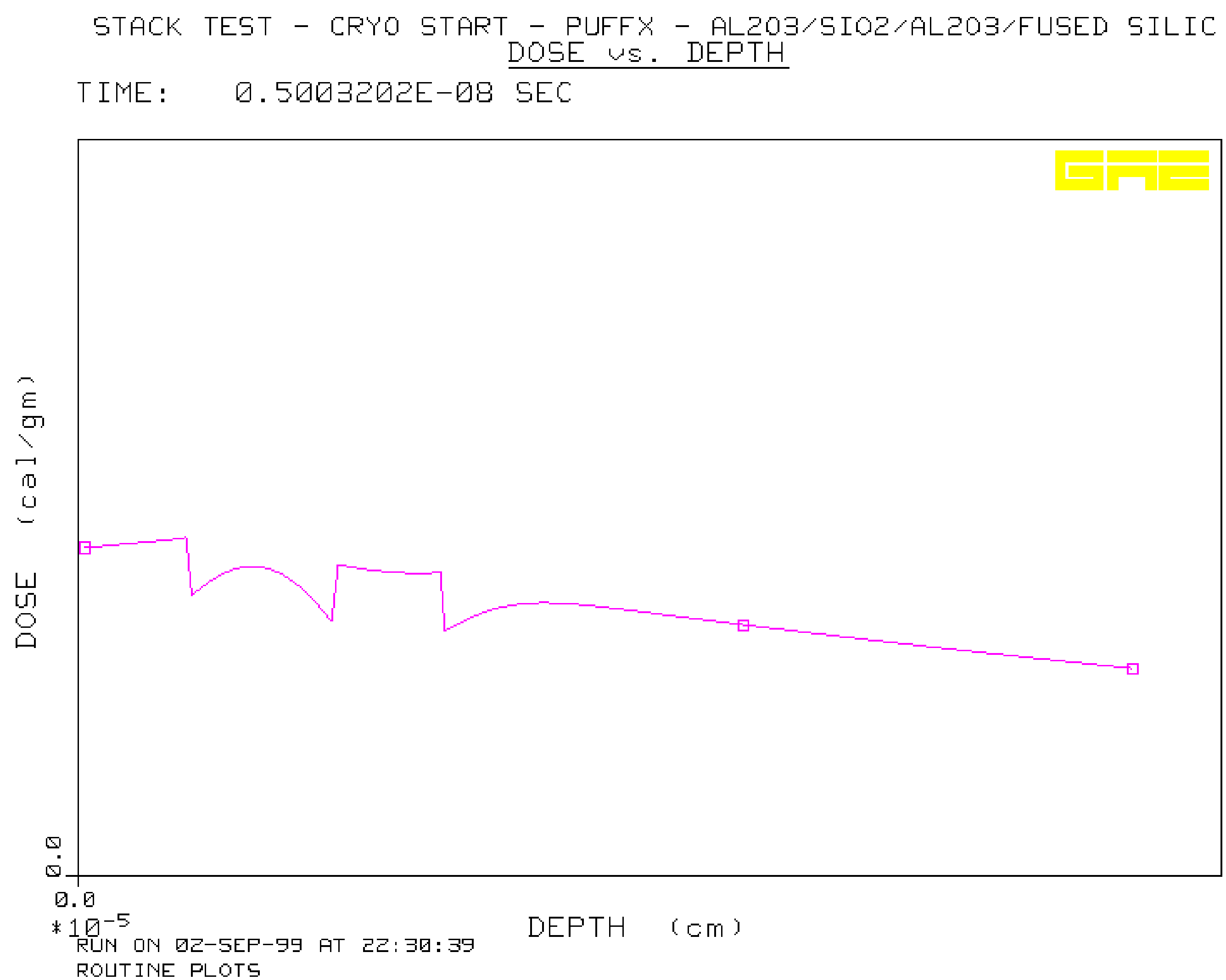
STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

DOSE vs. DEPTH

TIME: 0.1046740E-10 SEC

RUN ON 02-SEP-99 AT 22:30:39

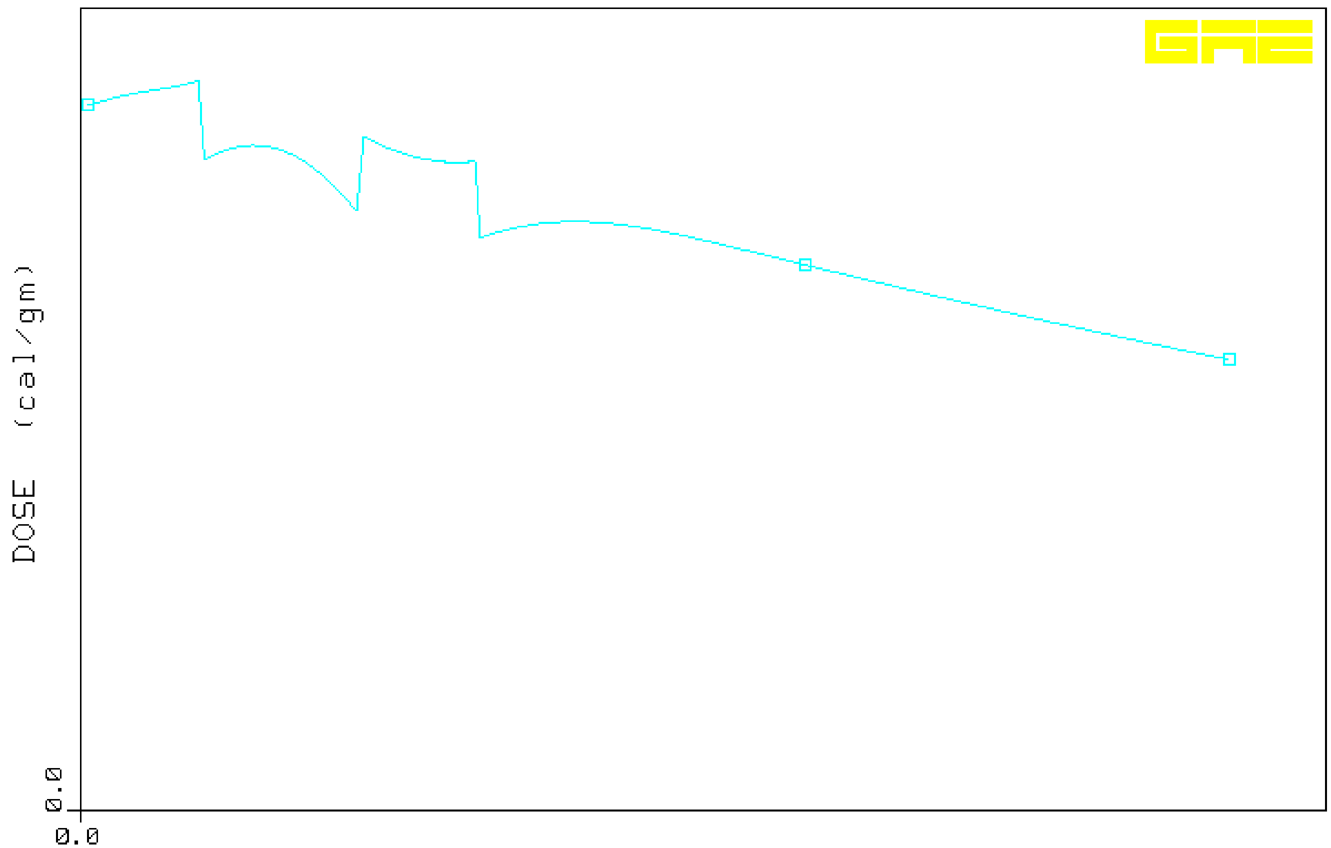
ROUTINE PLOTS


STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC
DOSE vs. DEPTH
TIME: 0.5003202E-08 SEC
DOSE (cal/gm)
0.0
0.0
*10^-5
DEPTH (cm)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

DOSE vs. DEPTH

TIME: 0.1000320E-07 SEC



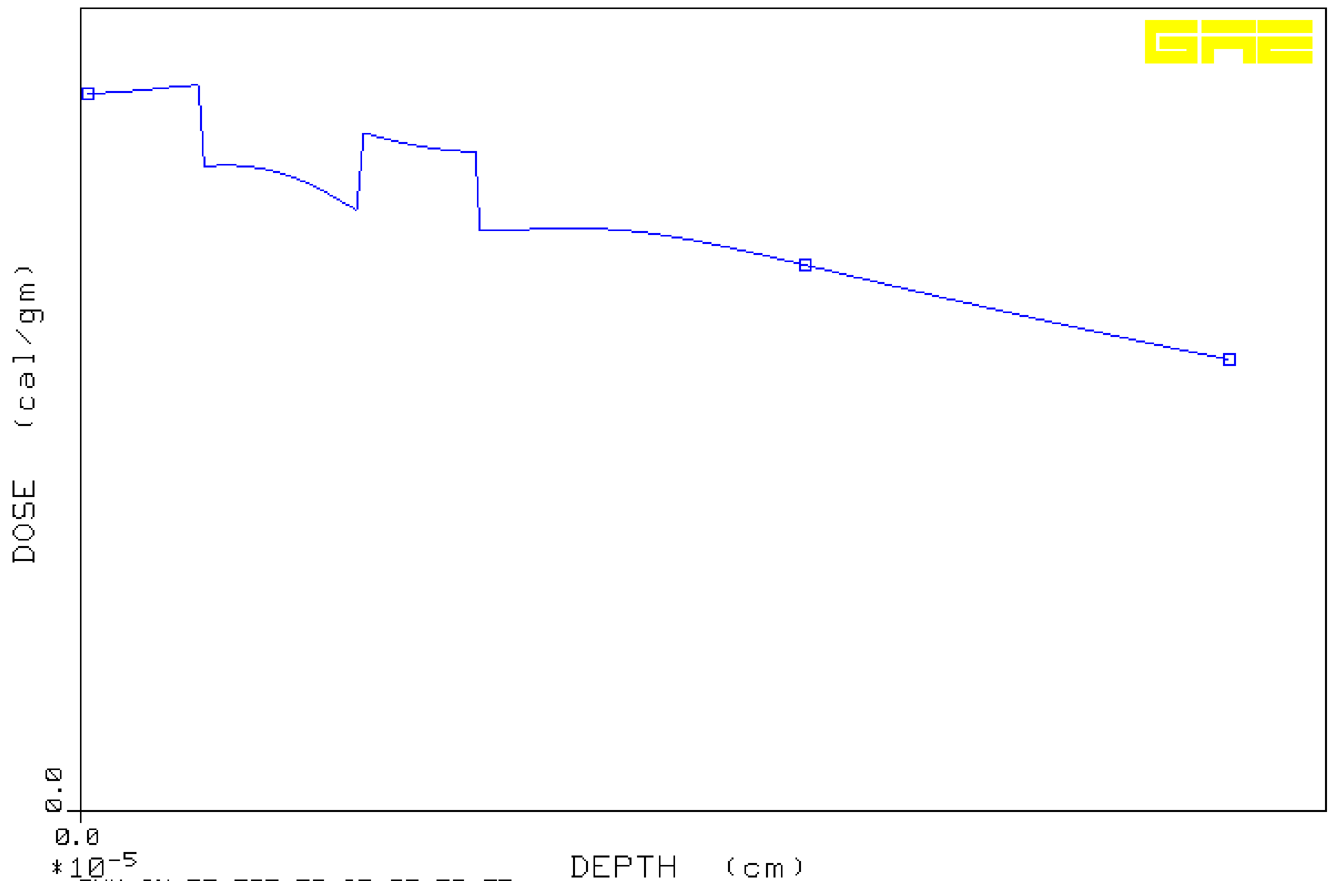
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

DOSE vs. DEPTH

TIME: 0.1500000E-07 SEC

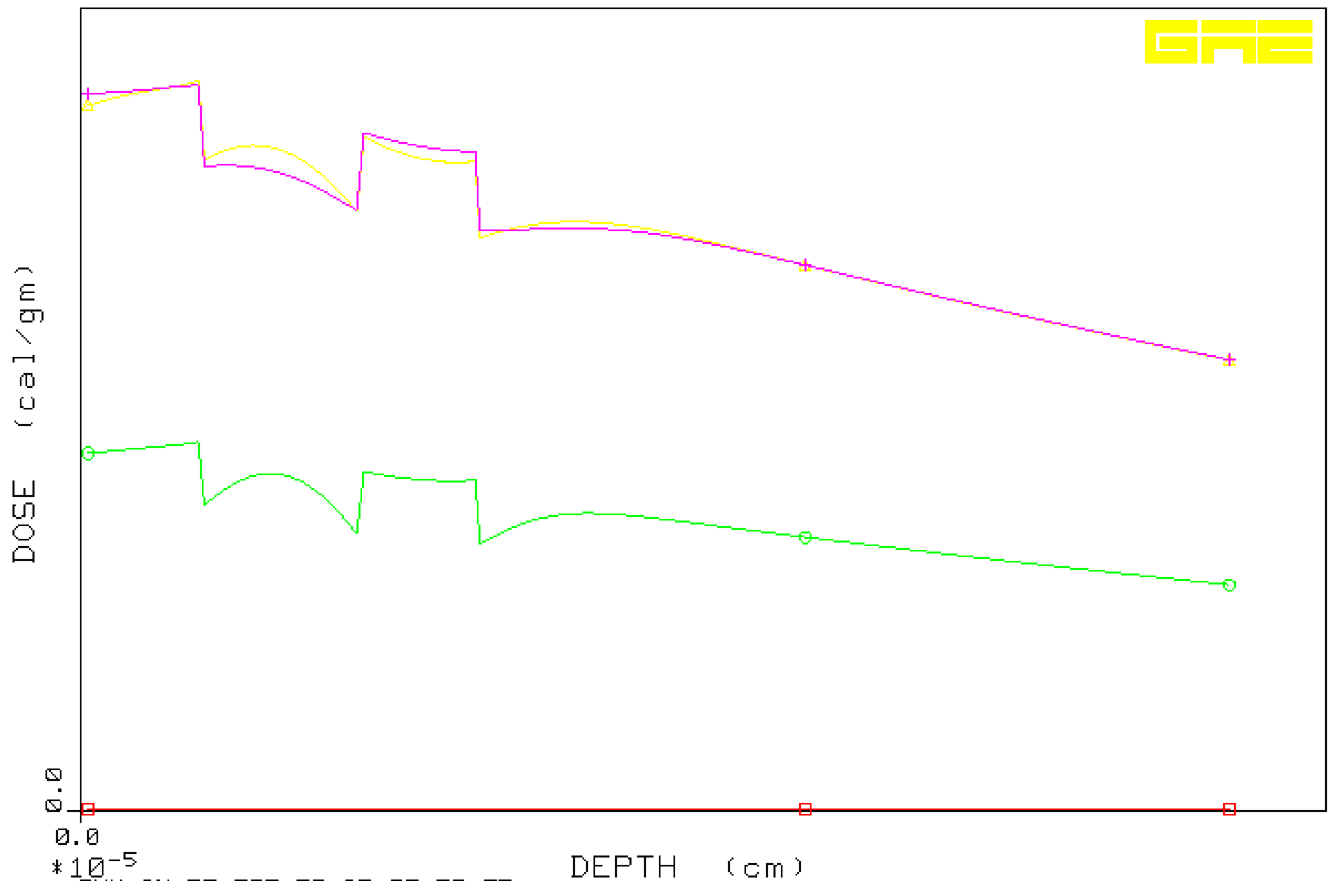


RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

DOSE vs. DEPTH AS F(T)

TIME: 0.1500000E-07 SEC



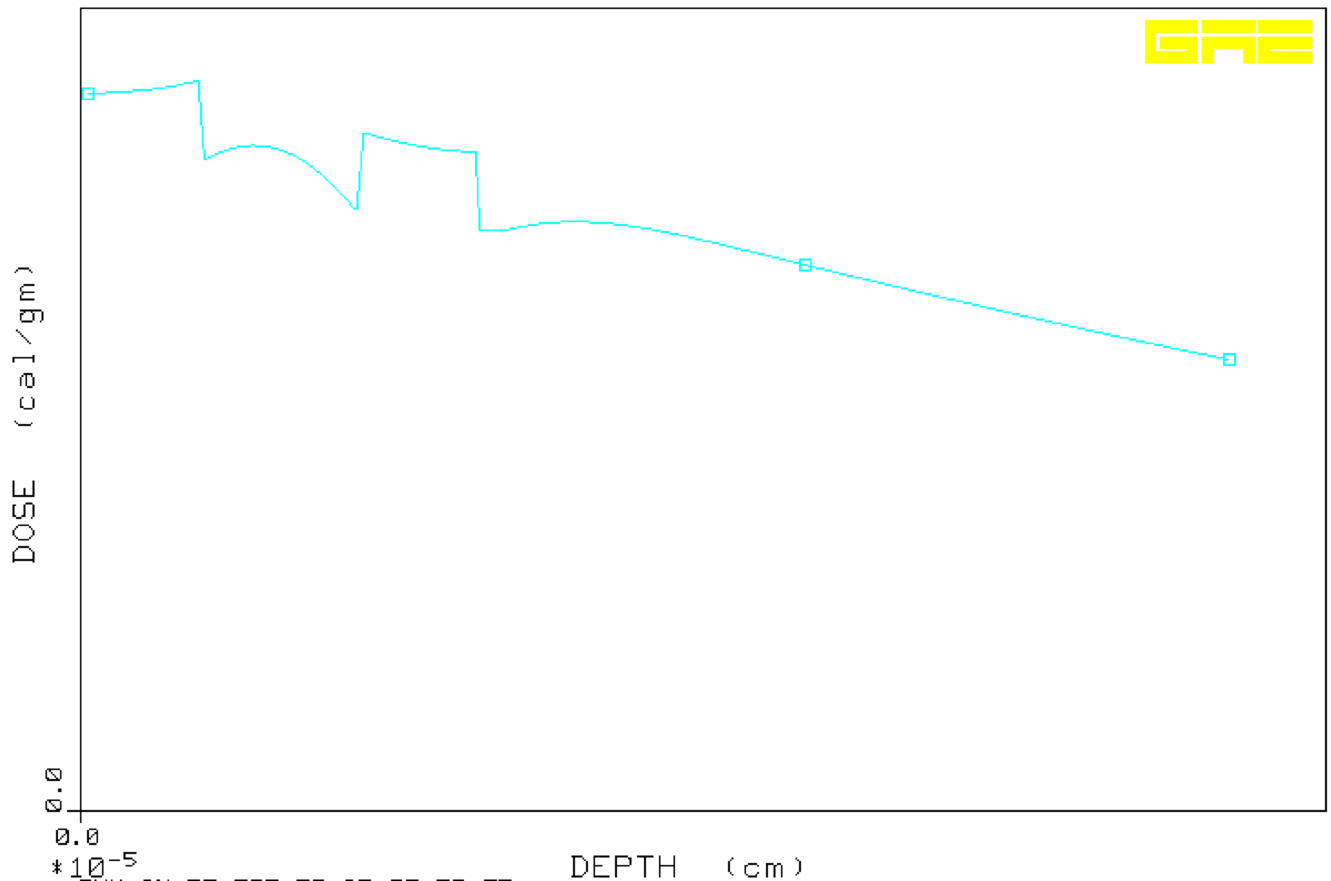
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

MAXIMUM DOSE vs. DEPTH

TIME: 0.1500000E-07 SEC



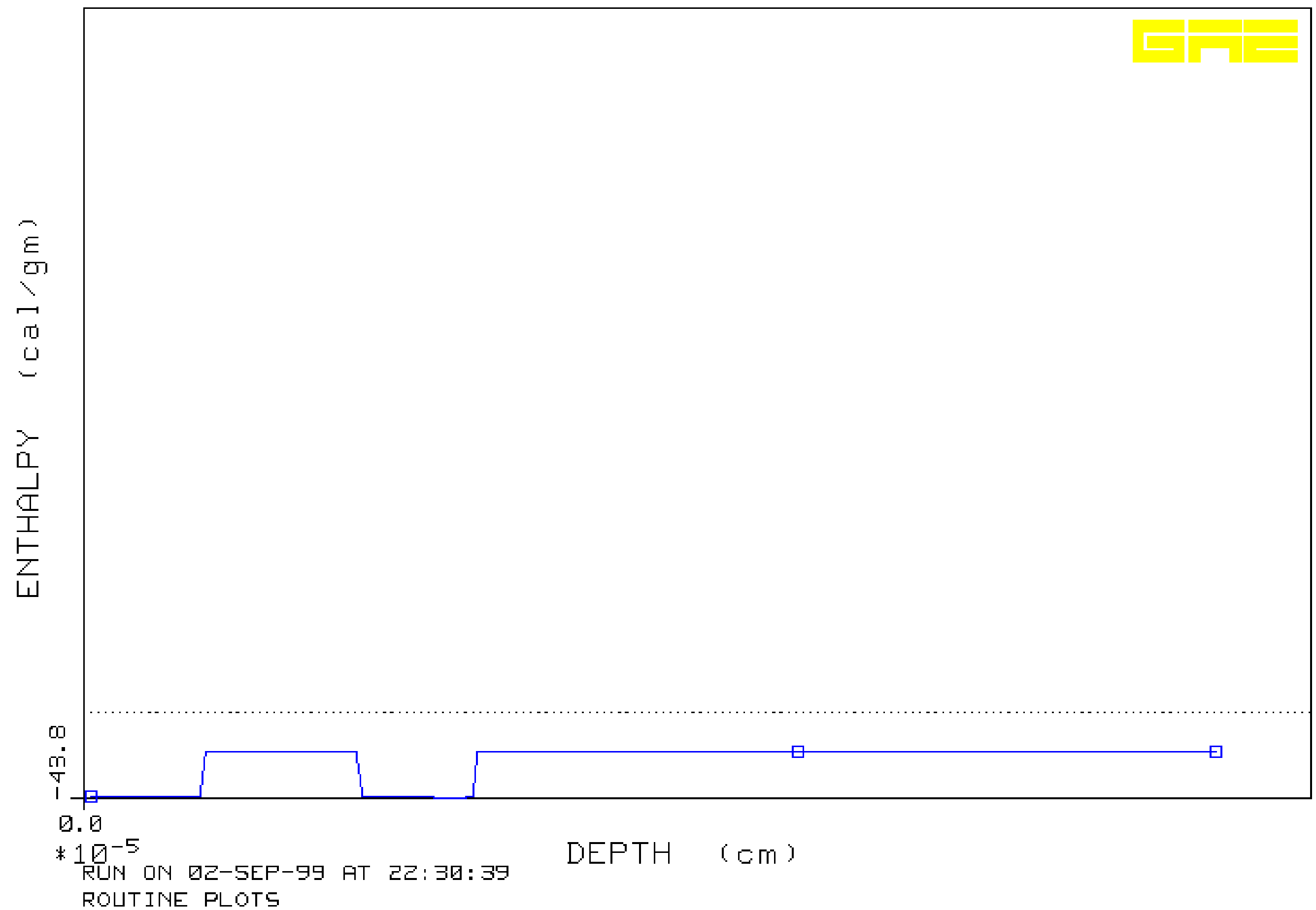
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

ENTHALPY vs. DEPTH

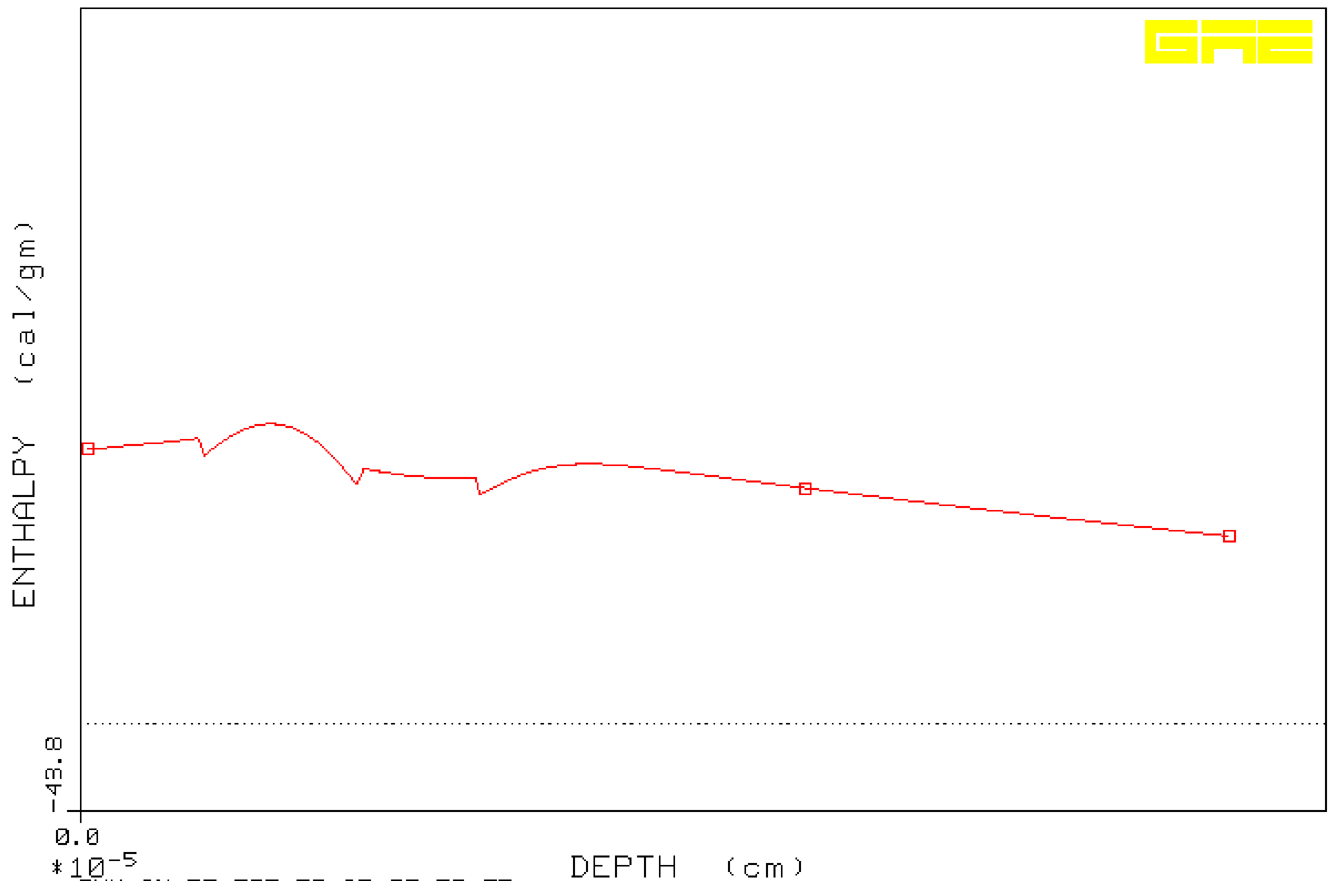
TIME: 0.1046740E-10 SEC



STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

ENTHALPY vs. DEPTH

TIME: 0.5003202E-08 SEC

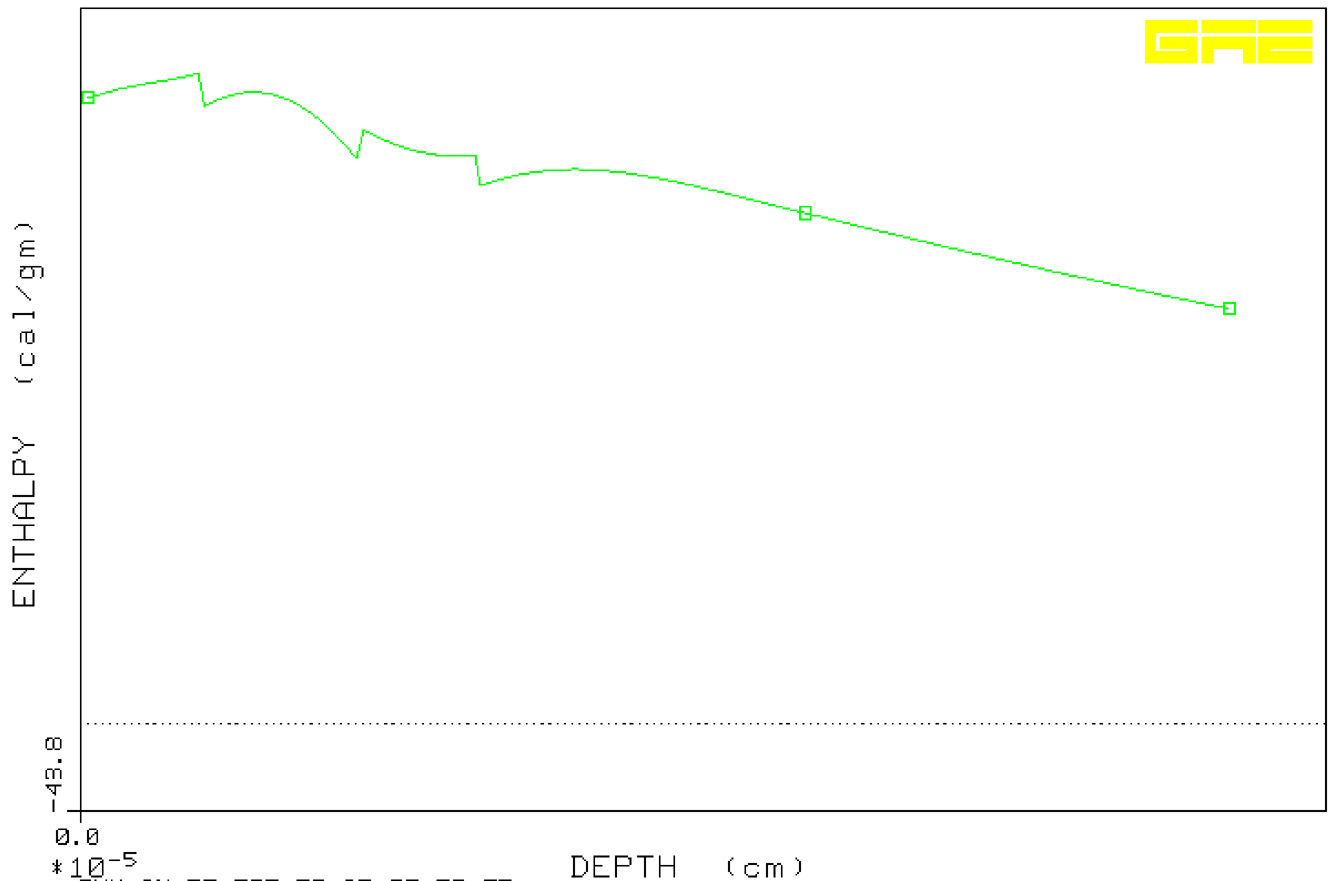


RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

ENTHALPY vs. DEPTH

TIME: 0.1000320E-07 SEC



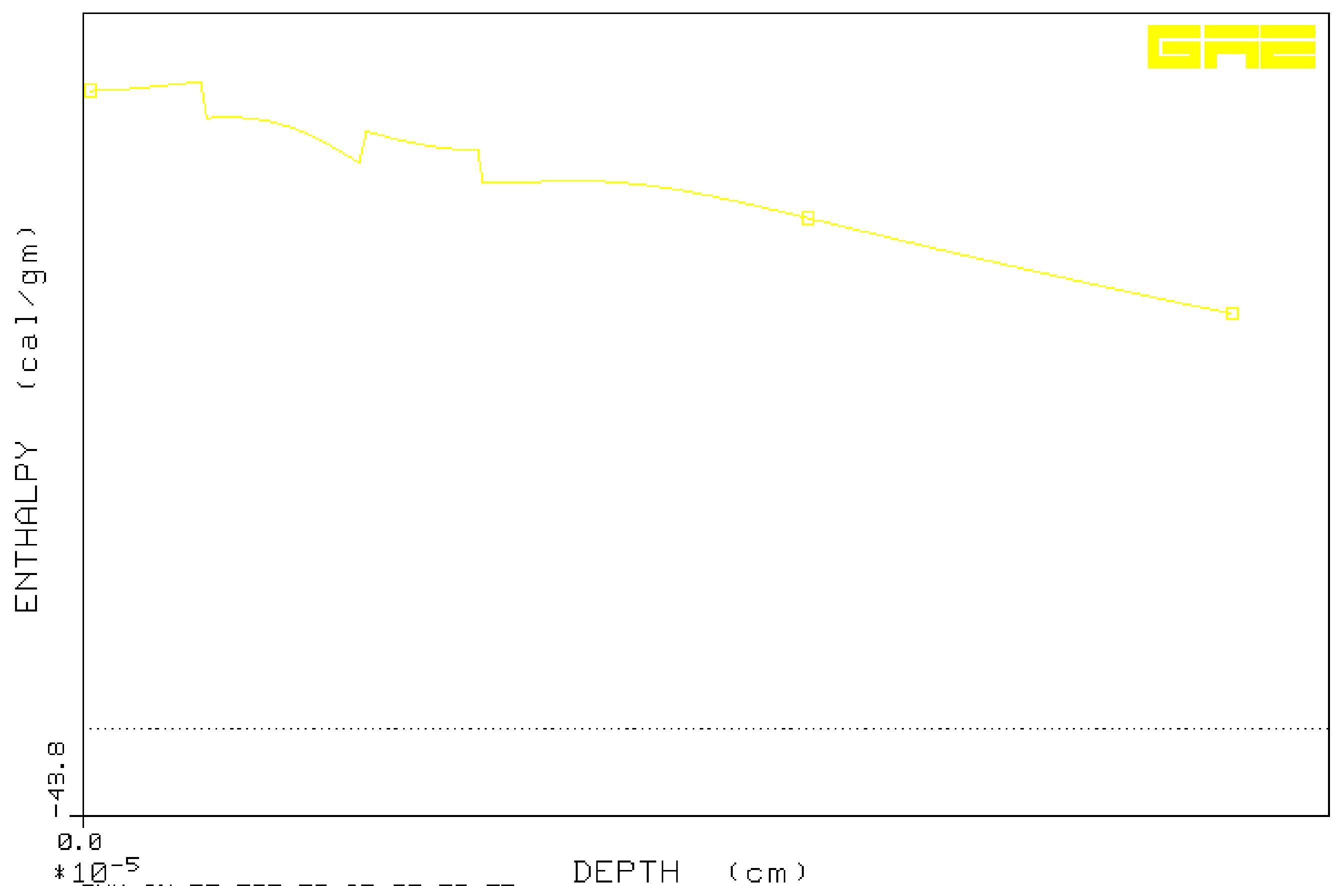
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

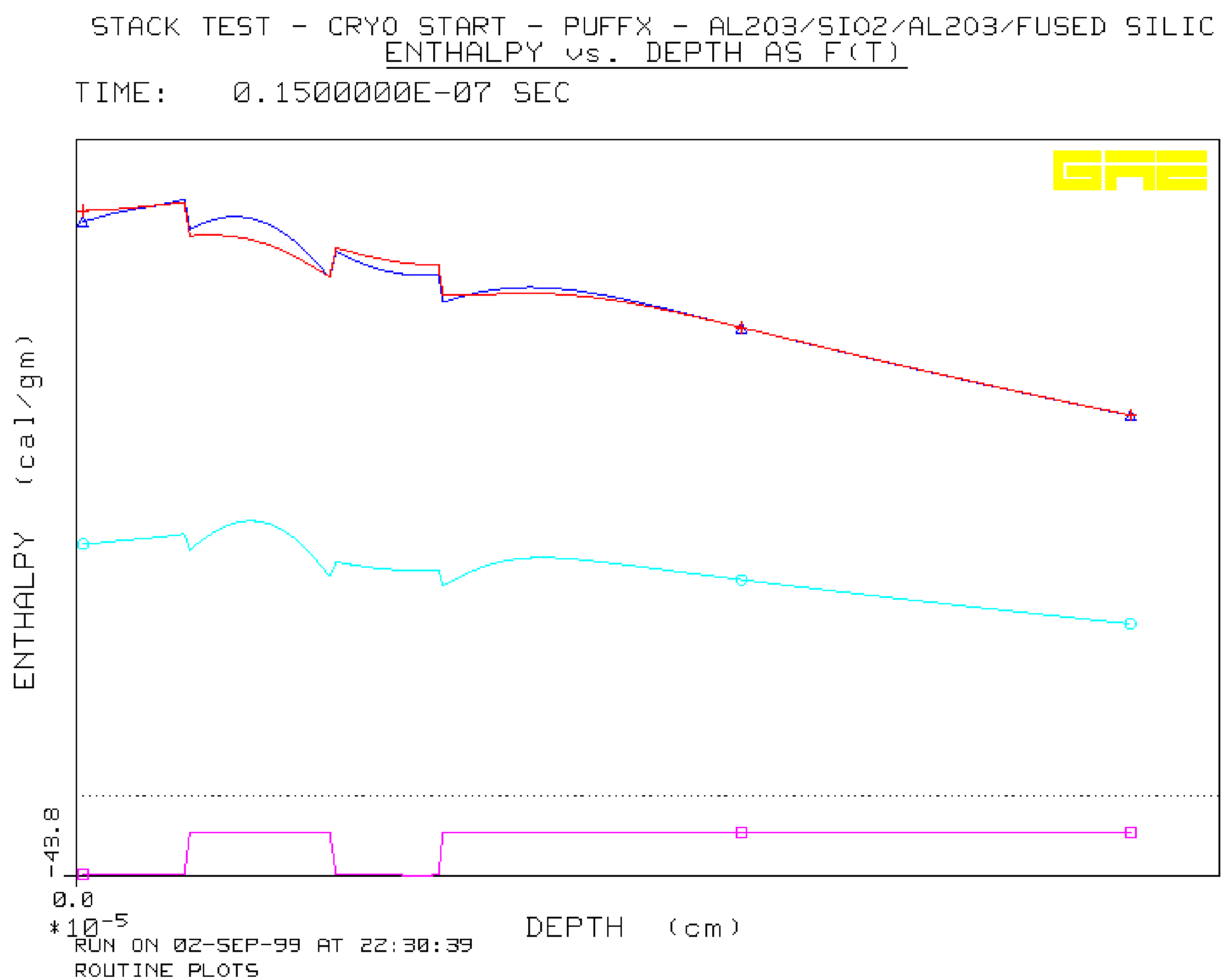
ENTHALPY vs. DEPTH

TIME: 0.1500000E-07 SEC



RUN ON 02-SEP-99 AT 22:30:39

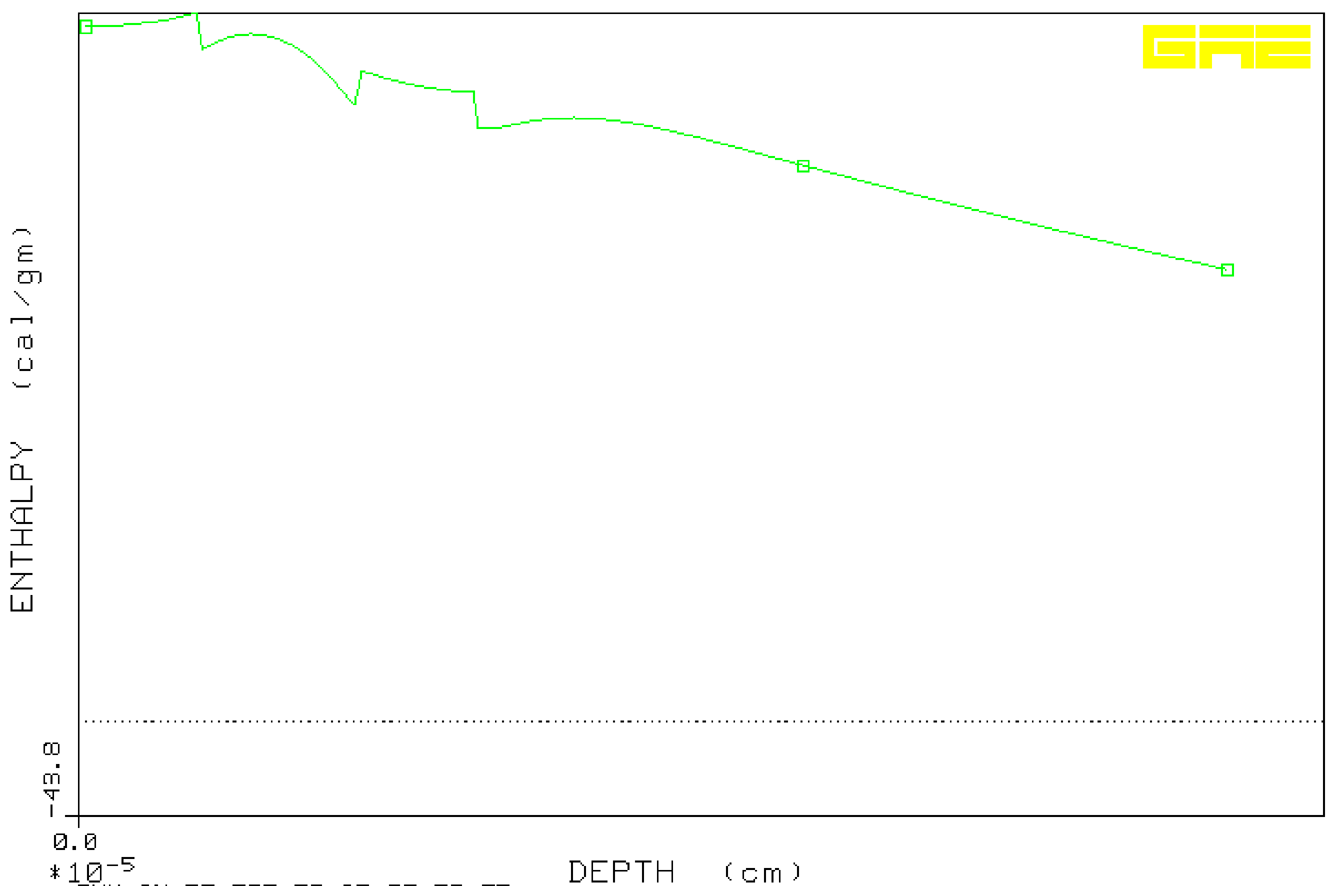
ROUTINE PLOTS


STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC
ENTHALPY vs. DEPTH AS F(T)
TIME: 0.1500000E-07 SEC
ENTHALPY (cal/gm)
-43.8
0.0
*10^-5
DEPTH (cm)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL203/SIO2/AL203/FUSED SILIC

MAXIMUM ENTHALPY vs. DEPTH

TIME: 0.1500000E-07 SEC



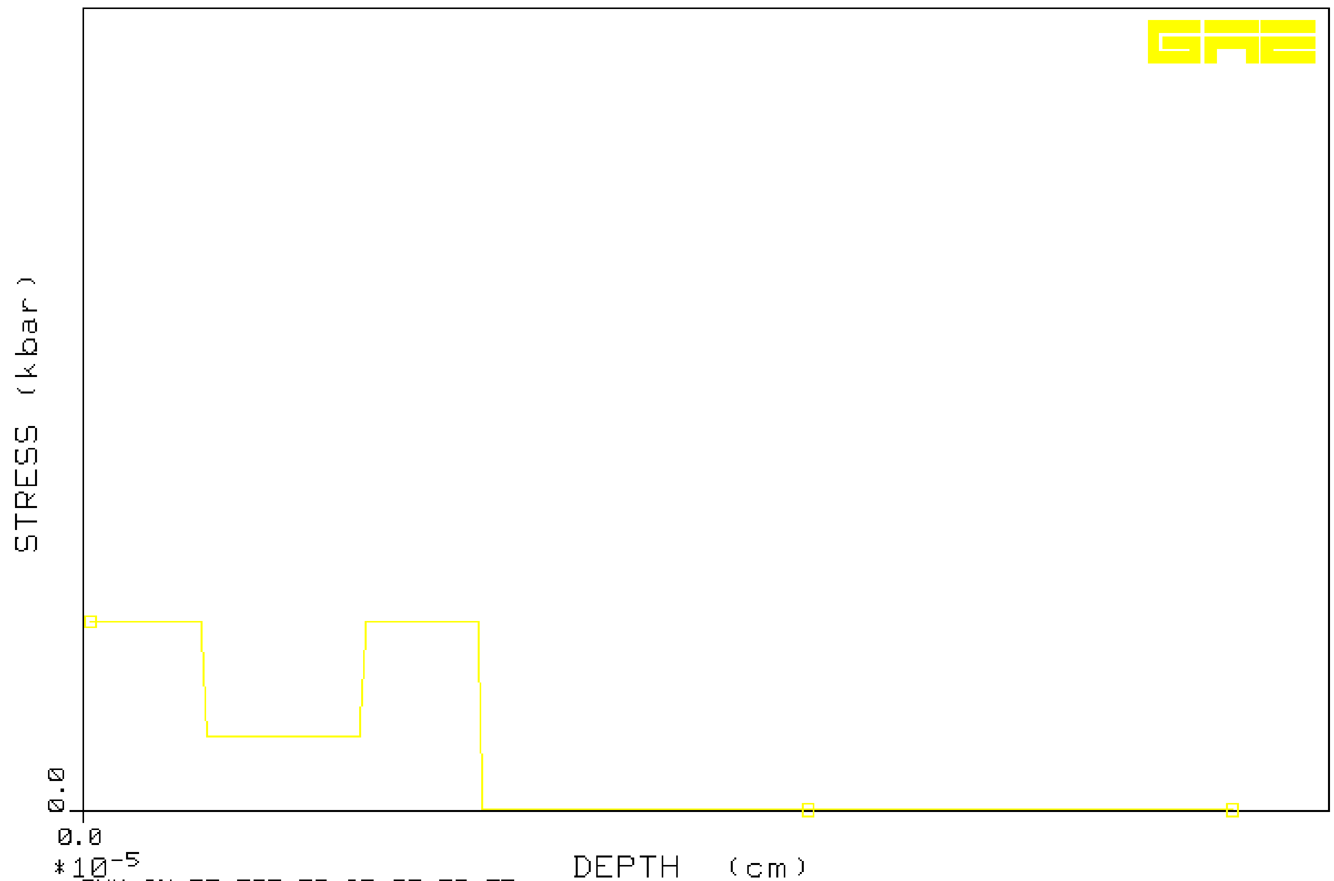
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

LATERAL STRESS vs. DEPTH

TIME: 0.1046740E-10 SEC



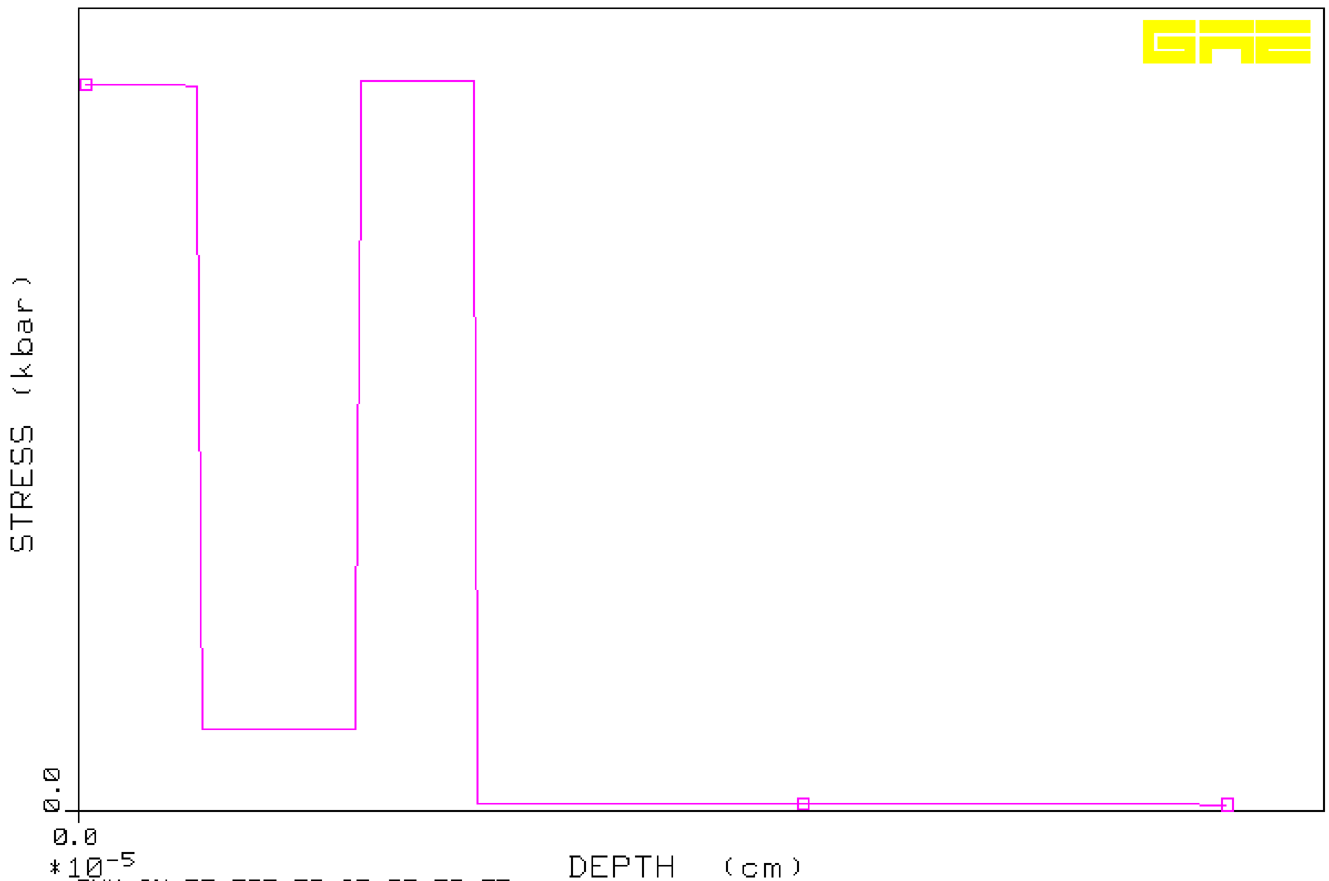
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

LATERAL STRESS vs. DEPTH

TIME: 0.5003202E-08 SEC



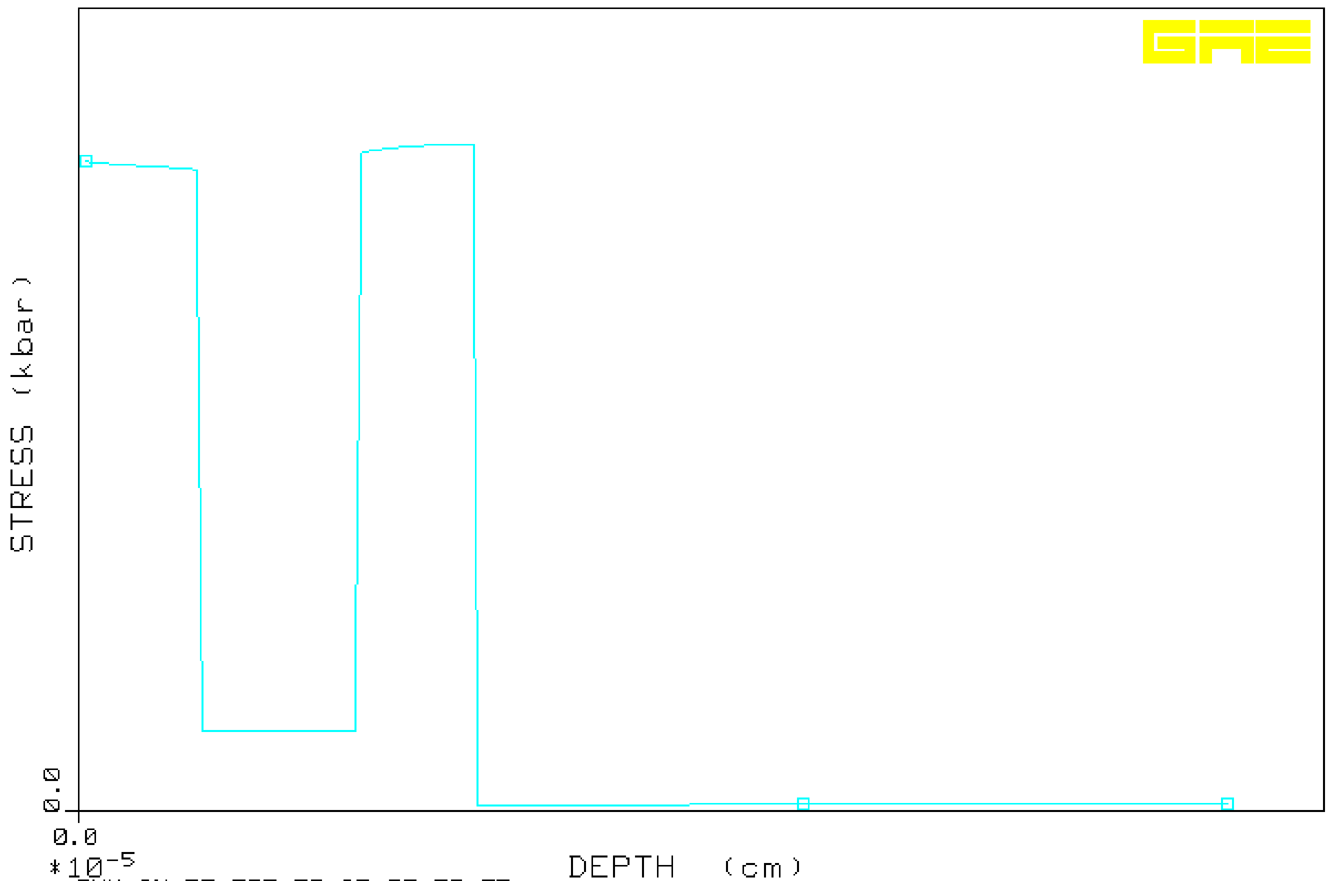
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

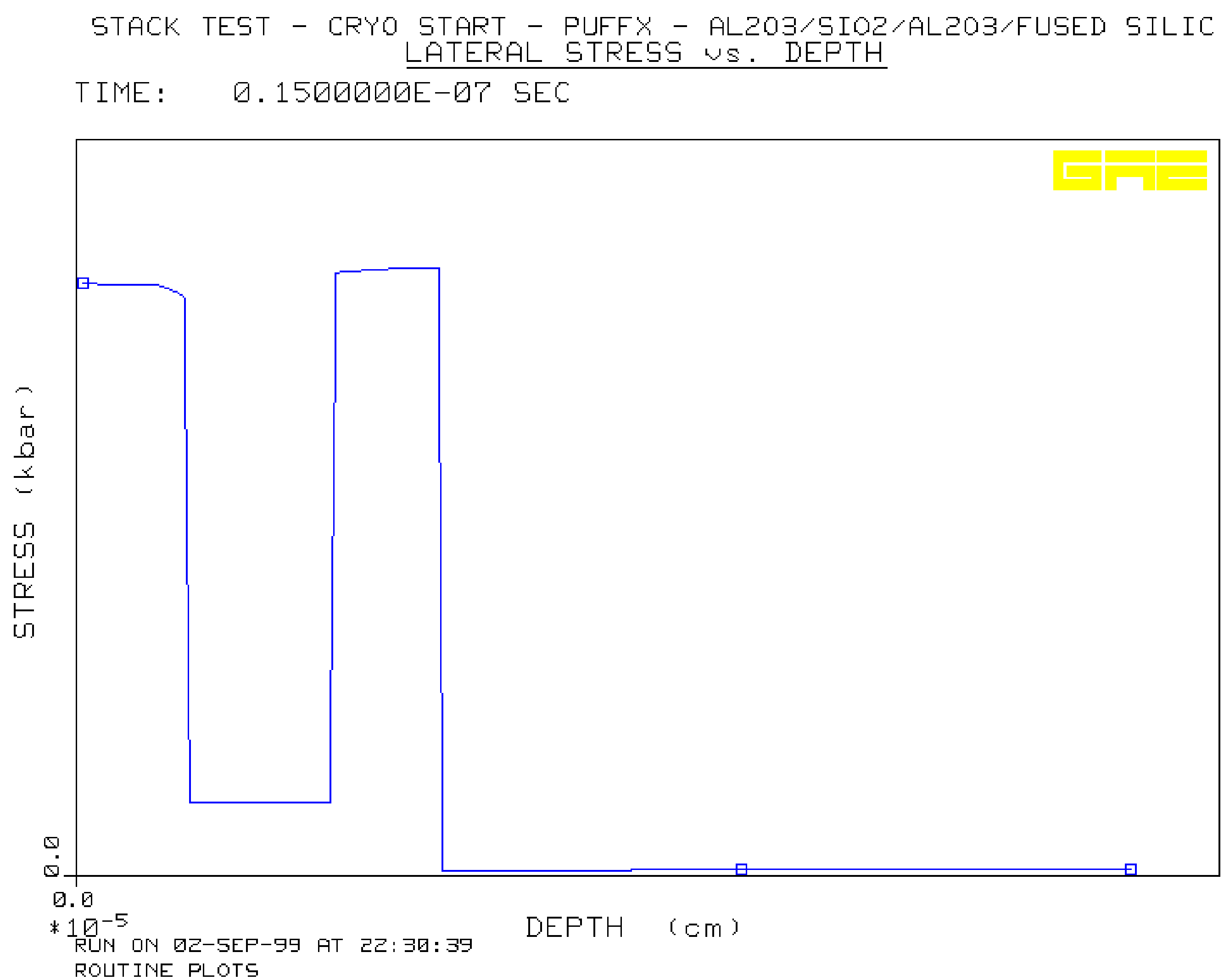
LATERAL STRESS vs. DEPTH

TIME: 0.1000320E-07 SEC



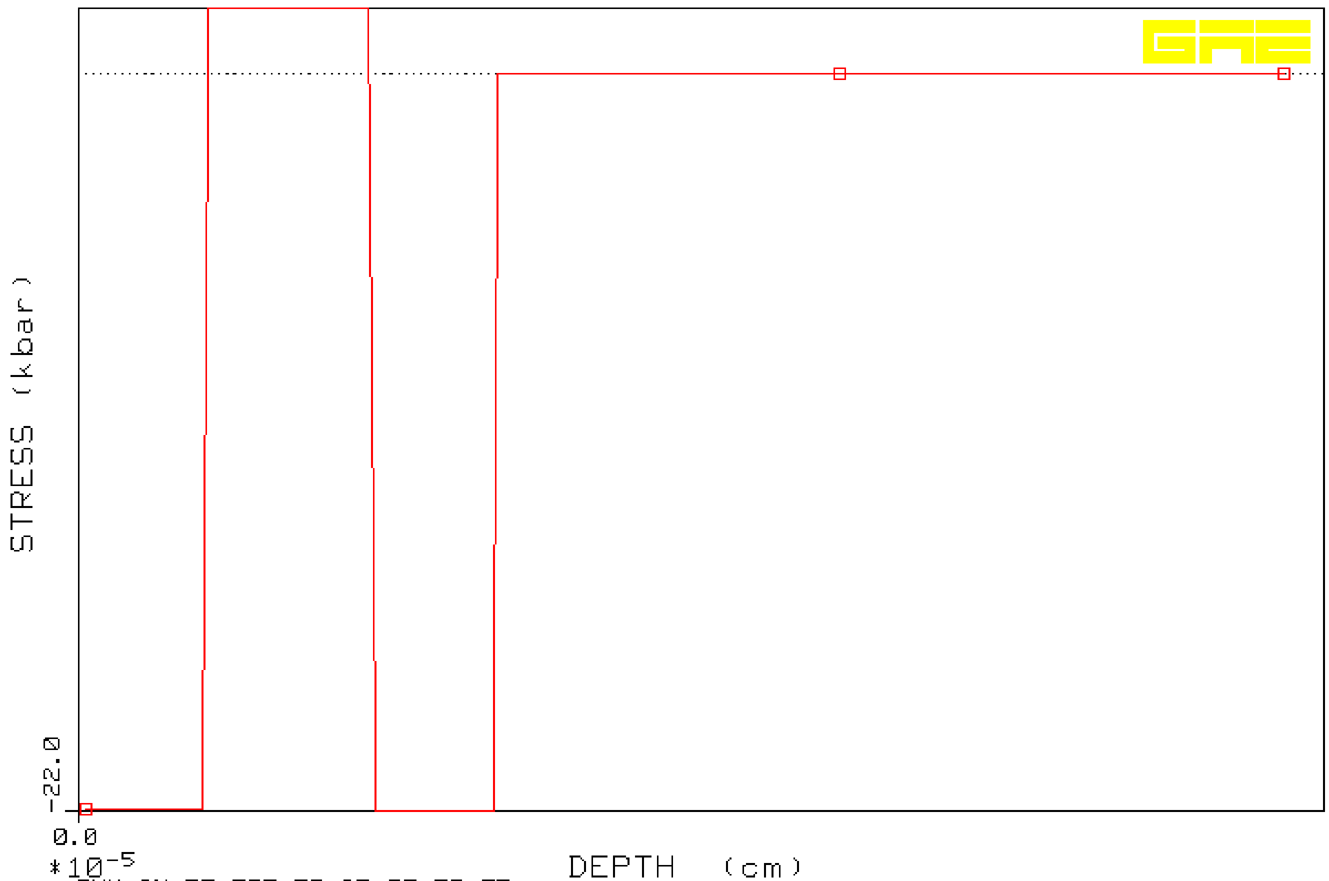
RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS


STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC
LATERAL STRESS vs. DEPTH
TIME: 0.1500000E-07 SEC
STRESS (kbar)
0.0
0.0
*10-5
DEPTH (cm)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE PLOTS

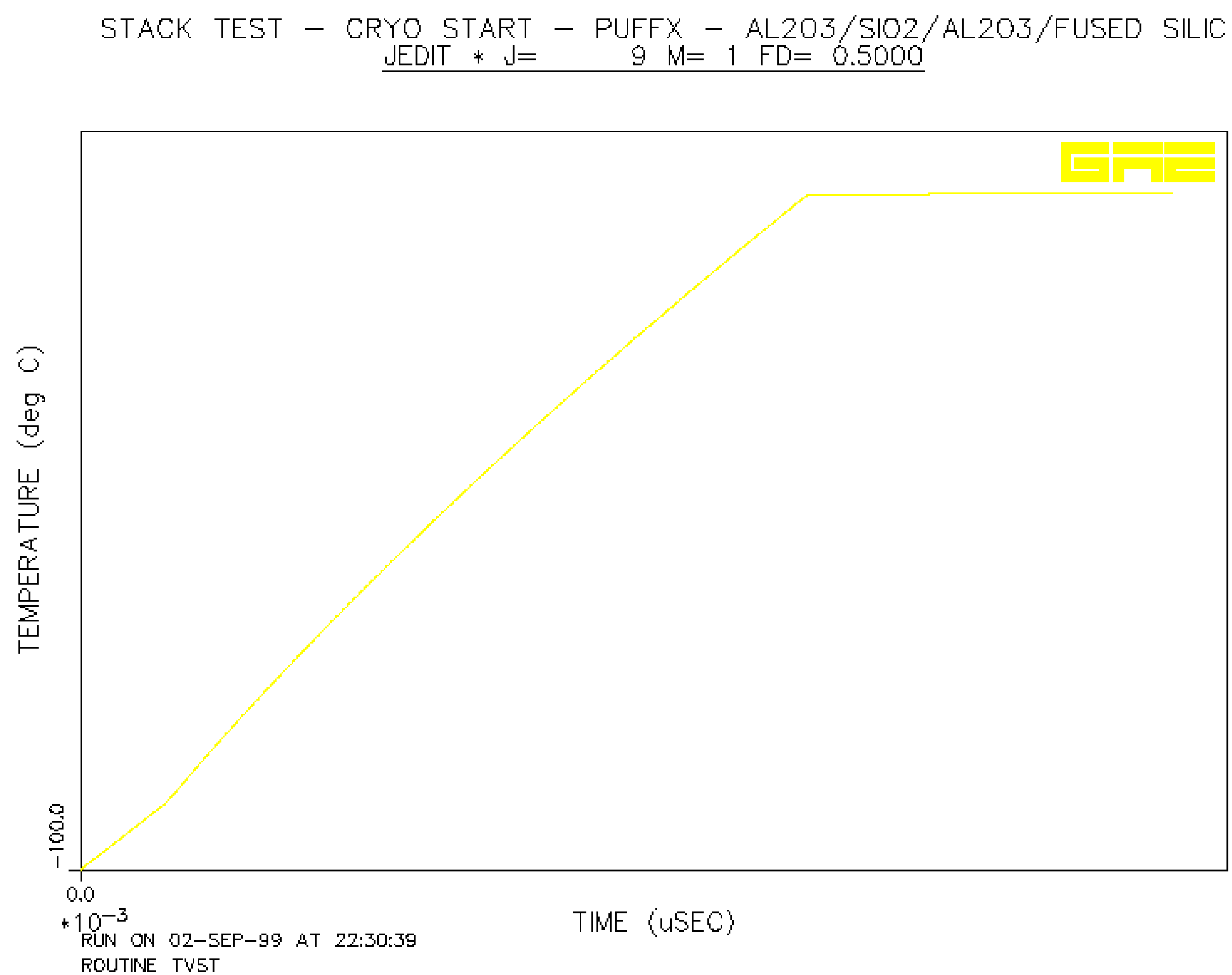
STACK TEST - CRYO START - PUFFX - AL2O3/SIO2/AL2O3/FUSED SILIC

ULTIMATE LATERAL STRESS vs. DEPTH

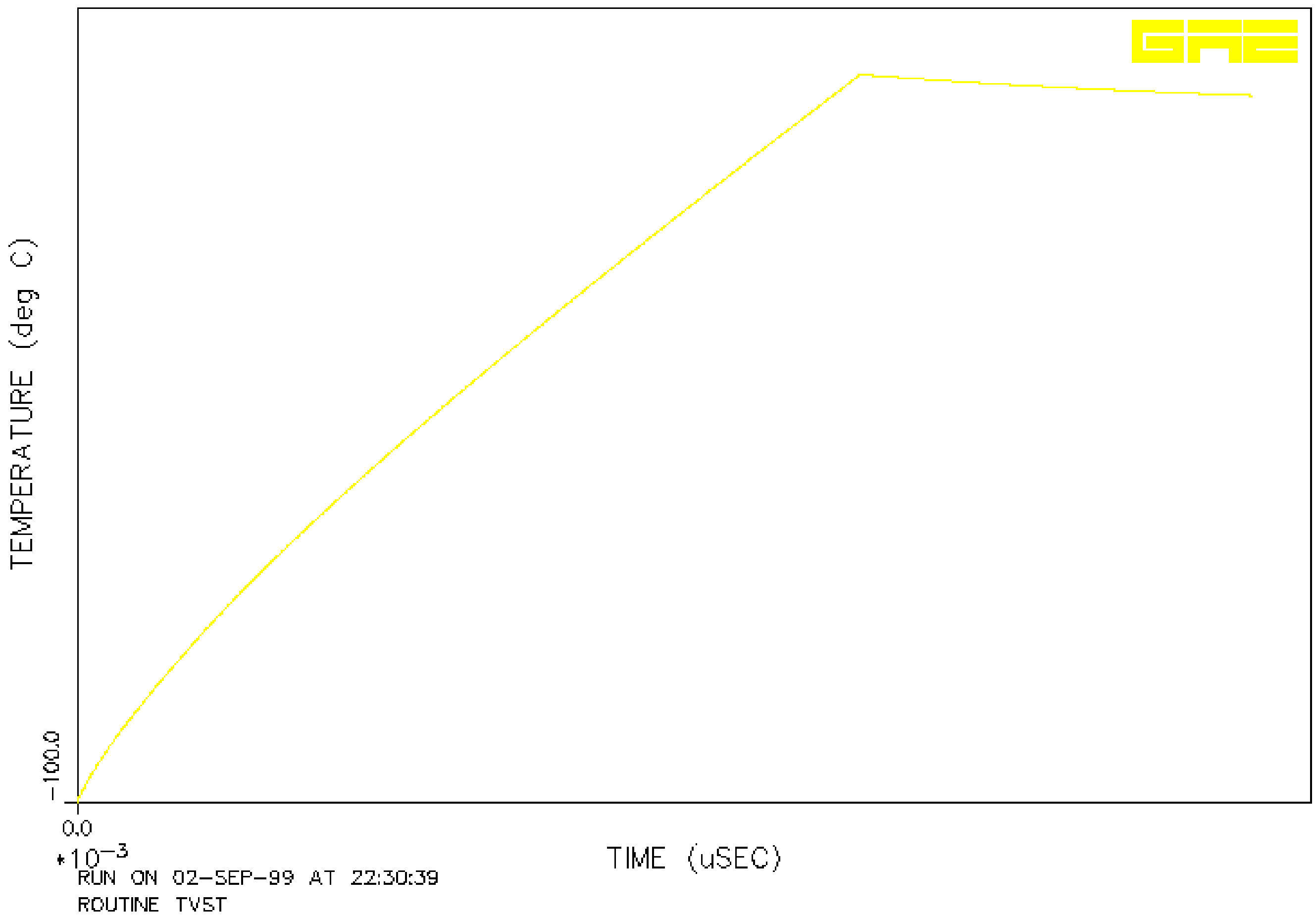


RUN ON 02-SEP-99 AT 22:30:39

ROUTINE PLOTS

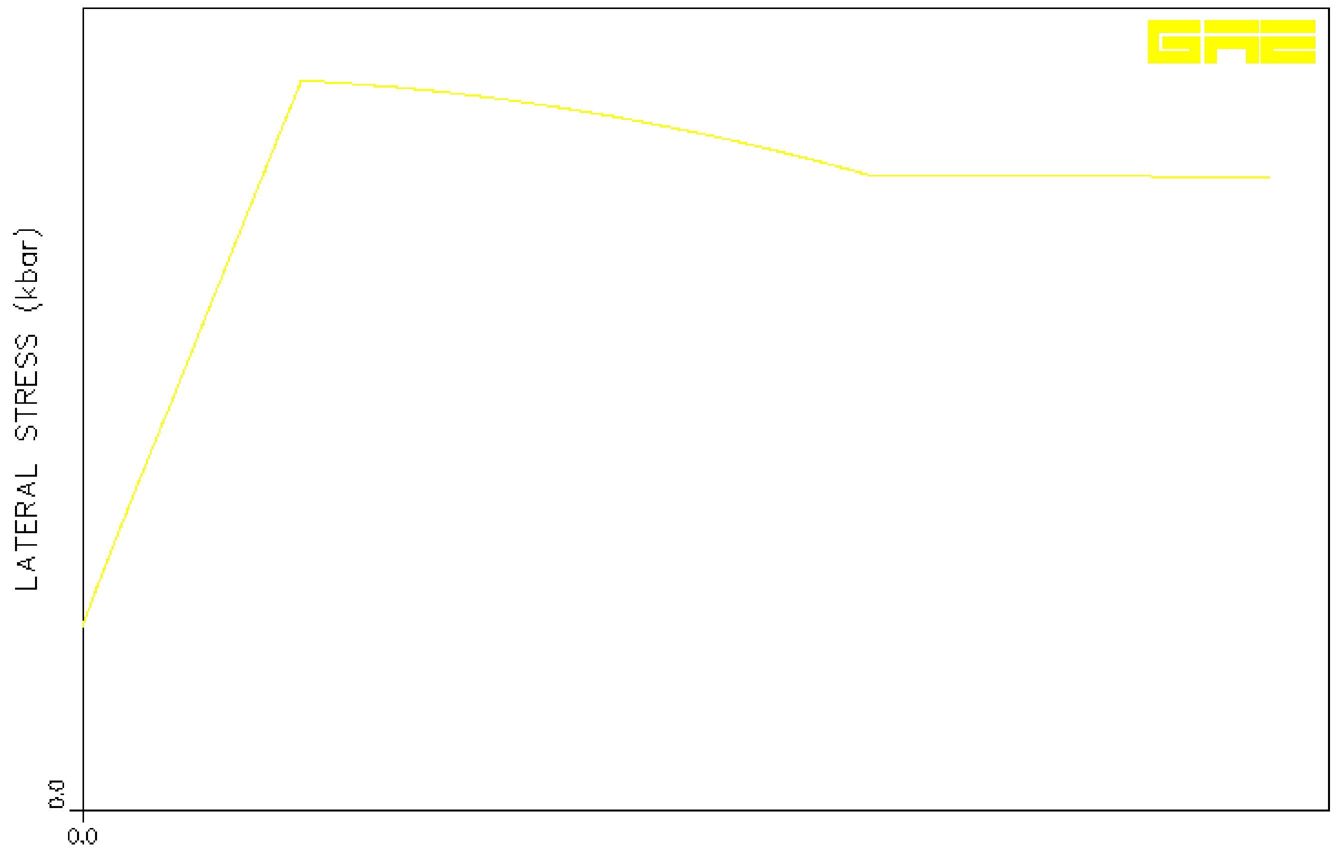

STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC
JEDIT * J= 9 M= 1 FD= 0.5000
TEMPERATURE (deg C)
-100.0
0.0
*10^-3
TIME (uSEC)
RUN ON 02-SEP-99 AT 22:30:39
ROUTINE TVST

STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC
JEDIT * J= 26 M= 2 FD= 0.5000



STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC

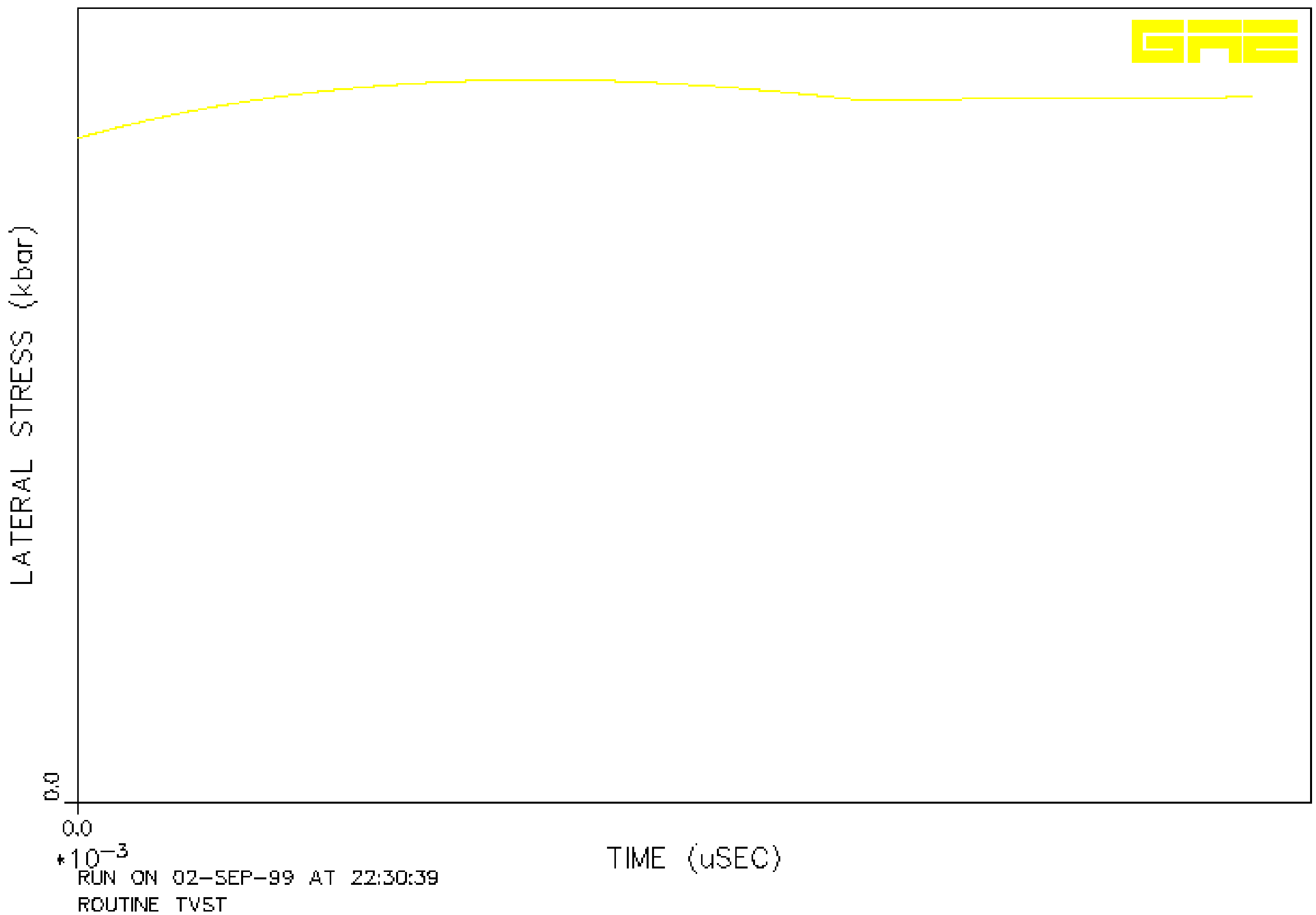
JEDIT * J= 9 M= 1 FD= 0.5000



RUN ON 02-SEP-99 AT 22:30:39

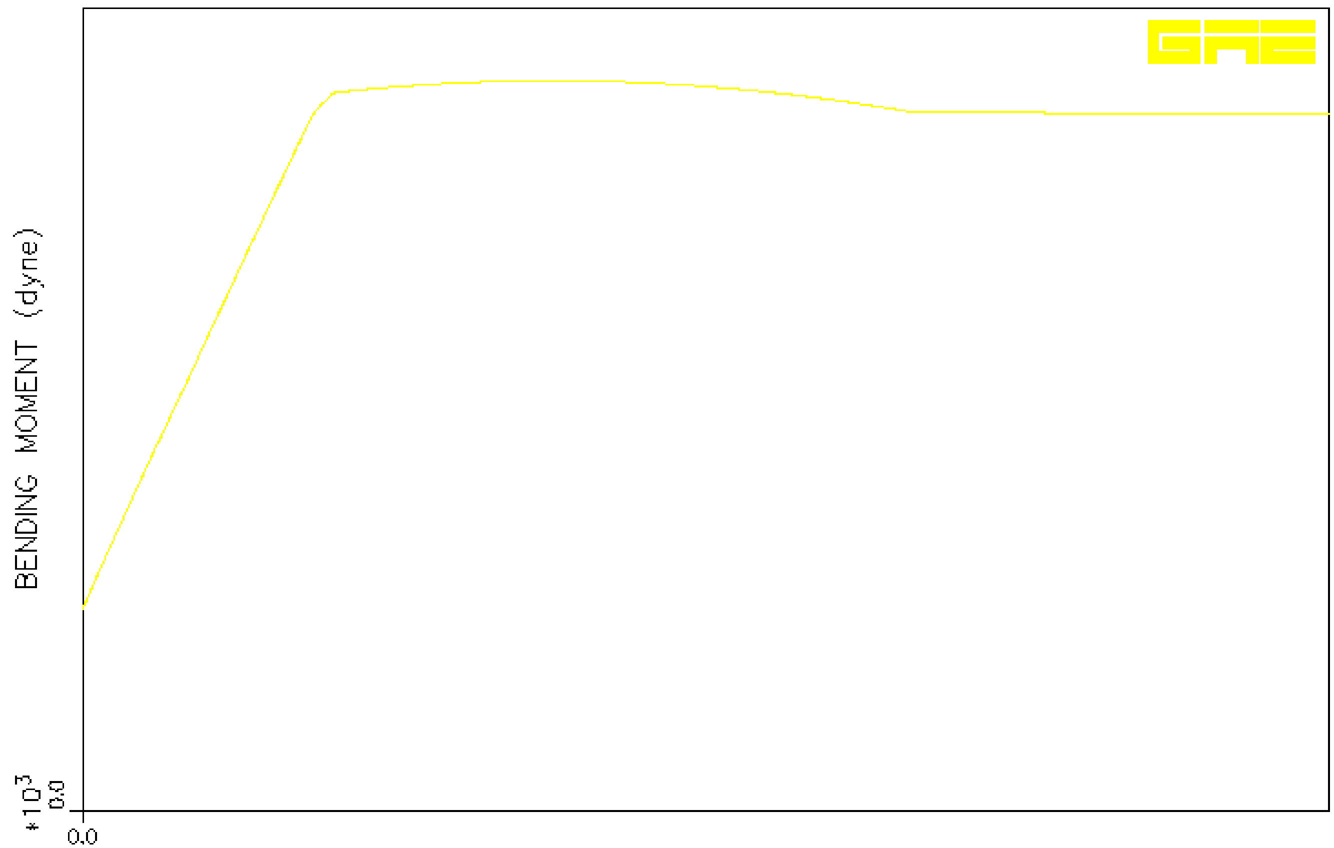
ROUTINE TVST

STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC
JEDIT * J= 26 M= 2 FD= 0.5000



STACK TEST – CRYO START – PUFFX – AL2O3/SIO2/AL2O3/FUSED SILIC

BENDING MOMENT vs. TIME



RUN ON 02-SEP-99 AT 22:30:39

ROUTINE TVST