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RFTS Automation Script

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U.S. DEPARTMENT OF ENERGY

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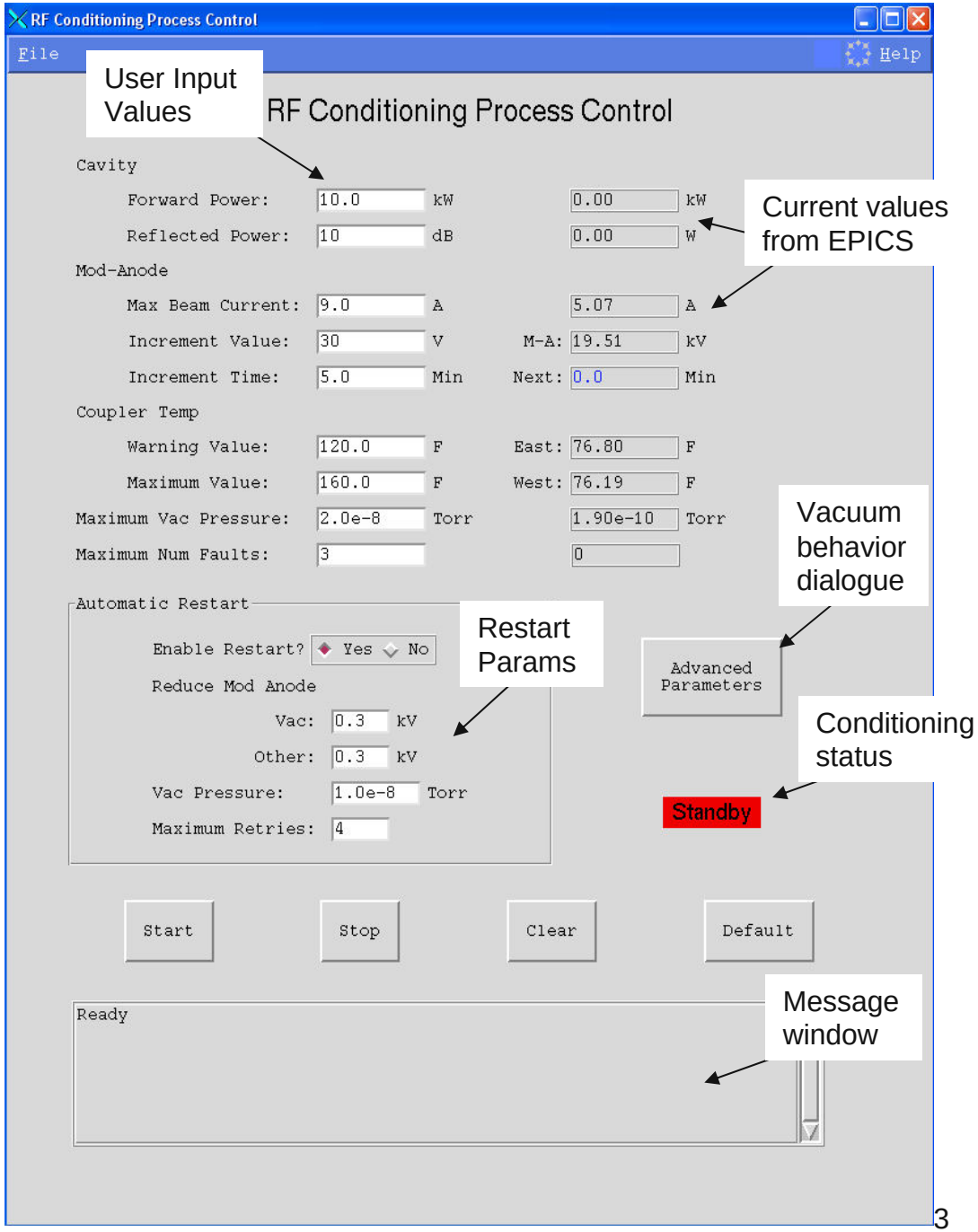
RFTS Conditioning Script

- Intended to eliminate the need for constant supervision of the test stand.
- Designed to be easy to use with few user inputs and limited oversight.
- Conditioning program can be activated after the cavity is setup, pumped down, and at least 5 kW of forward power is present in the cavity (automatic tuning).
- Program is designed primarily to ensure the safety of the test stand and components under test.
  - Secondary function of automation script is to condition components!
  - Hardware errors and communication errors are constantly evaluated.
  - RF parameters of the components in the RFTS are evaluated against user inputs and known limits.
- Programming method and protocols were modeled after existing APS scripts.
  - Tcl/Tk programming language
  - Communication with hardware is performed via channel access and EPICS
  - Communication errors with EPICS are “caught” and resolved before conditioning continues.

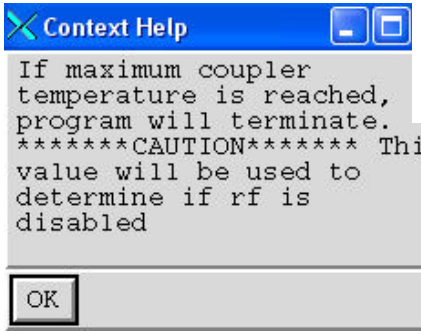
GUI Overview

- Left column of GUI has fields for user input.
- Right column shows values read from EPICS and from the conditioning program
- User inputs include cavity power, mod-anode increment values, coupler temperature, and maximum allowable vacuum pressure.
- Automatic restart is grayed out unless it is activated by selecting the proper radio button.
- Buttons perform following tasks:
  - “Start” the conditioning program,
  - “Stop” the conditioning program
  - “Clear” the message window
  - Set the user inputs to their “Default” values.

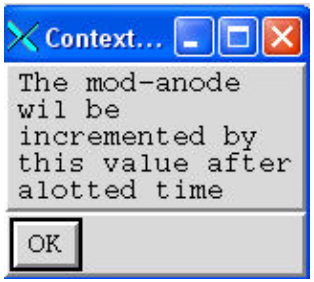


GUI Help and Message Window

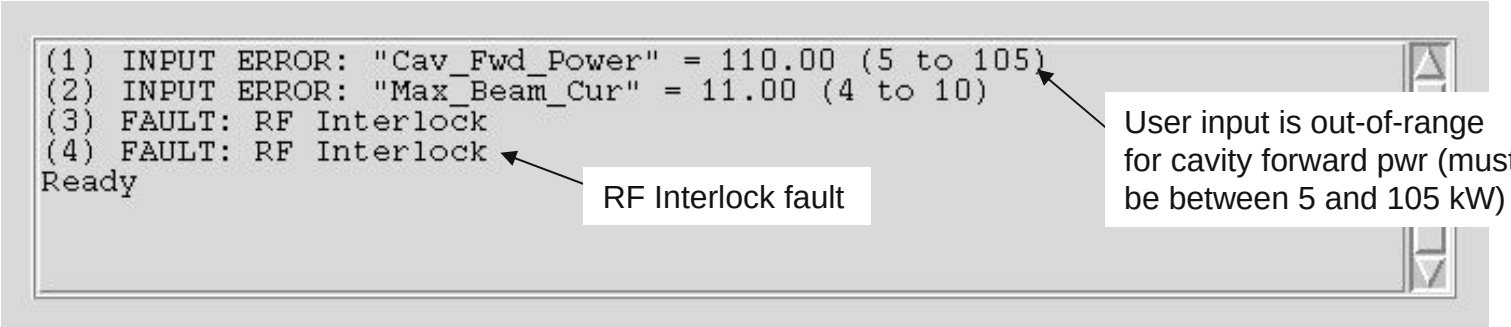
- Help messages are available by dbl clicking the right mouse button over the field.
- Comprehensive help messages are available for all user inputs.
- Help messages are intended to give general information and tips for entering values.
- Message window displays the error status for user inputs, hardware limits, interlocks, etc
- Messages that are relevant to the conditioning process are displayed such as unusual vacuum behavior, coupler temperature, restart status, etc
- Message window numbers its output to demarcate messages



"Coupler Temp Maximum Value" help text

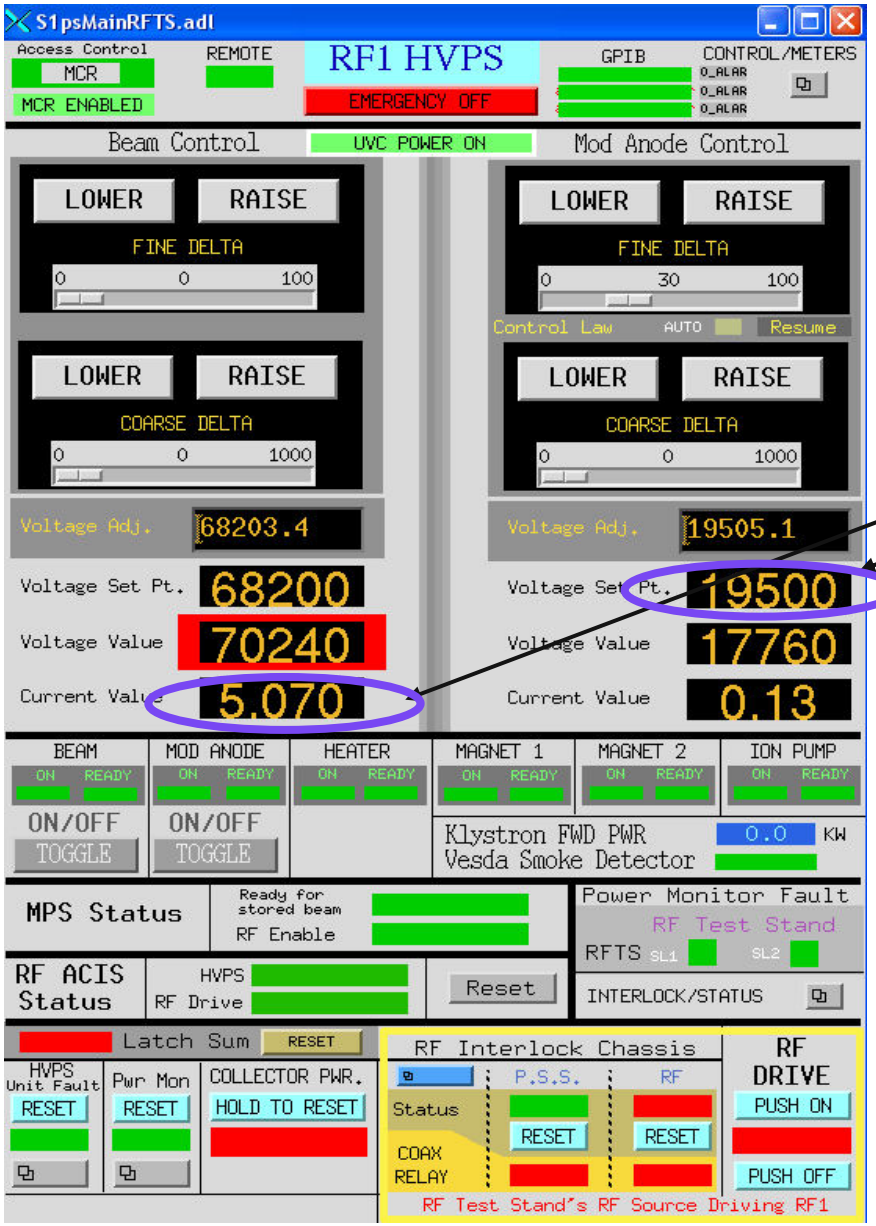


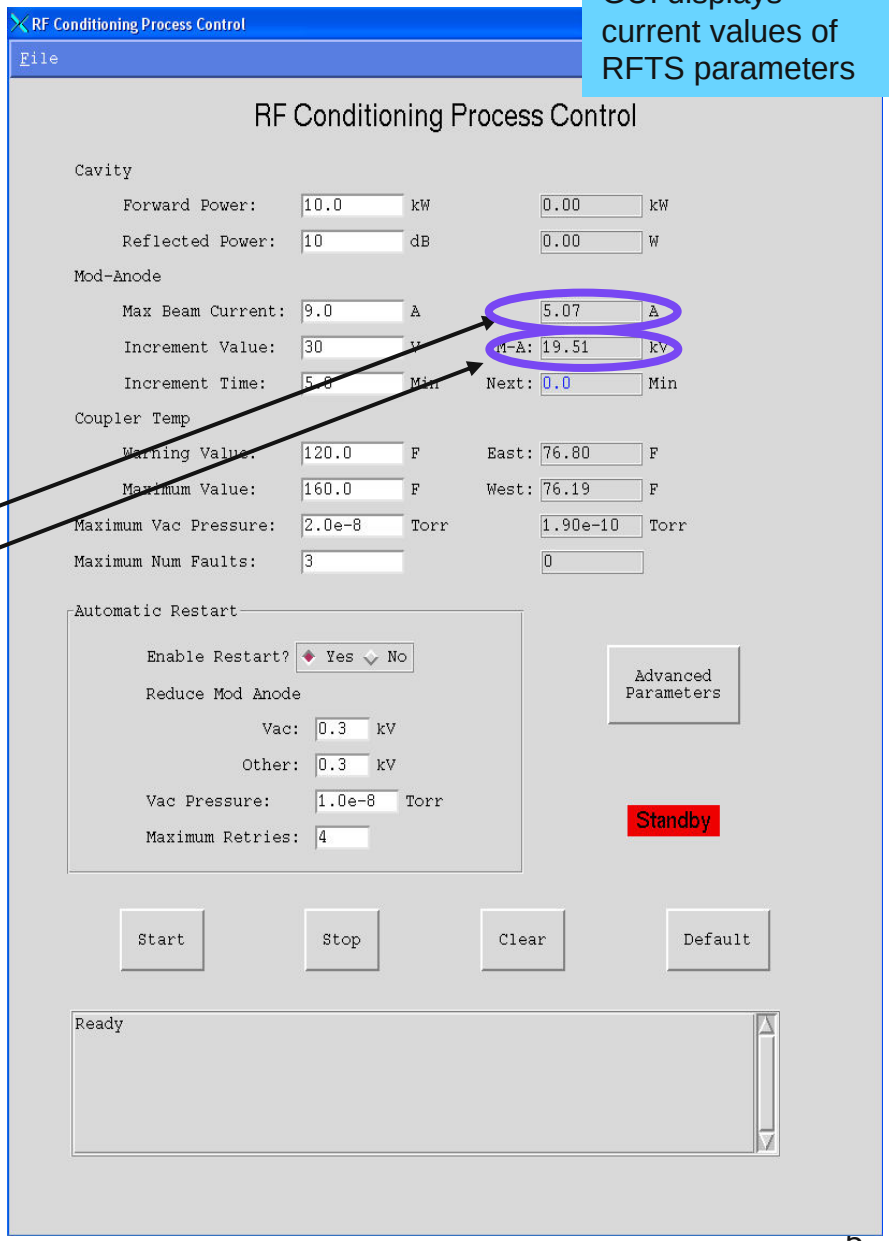
"Mod-Anode Increment Value" help text



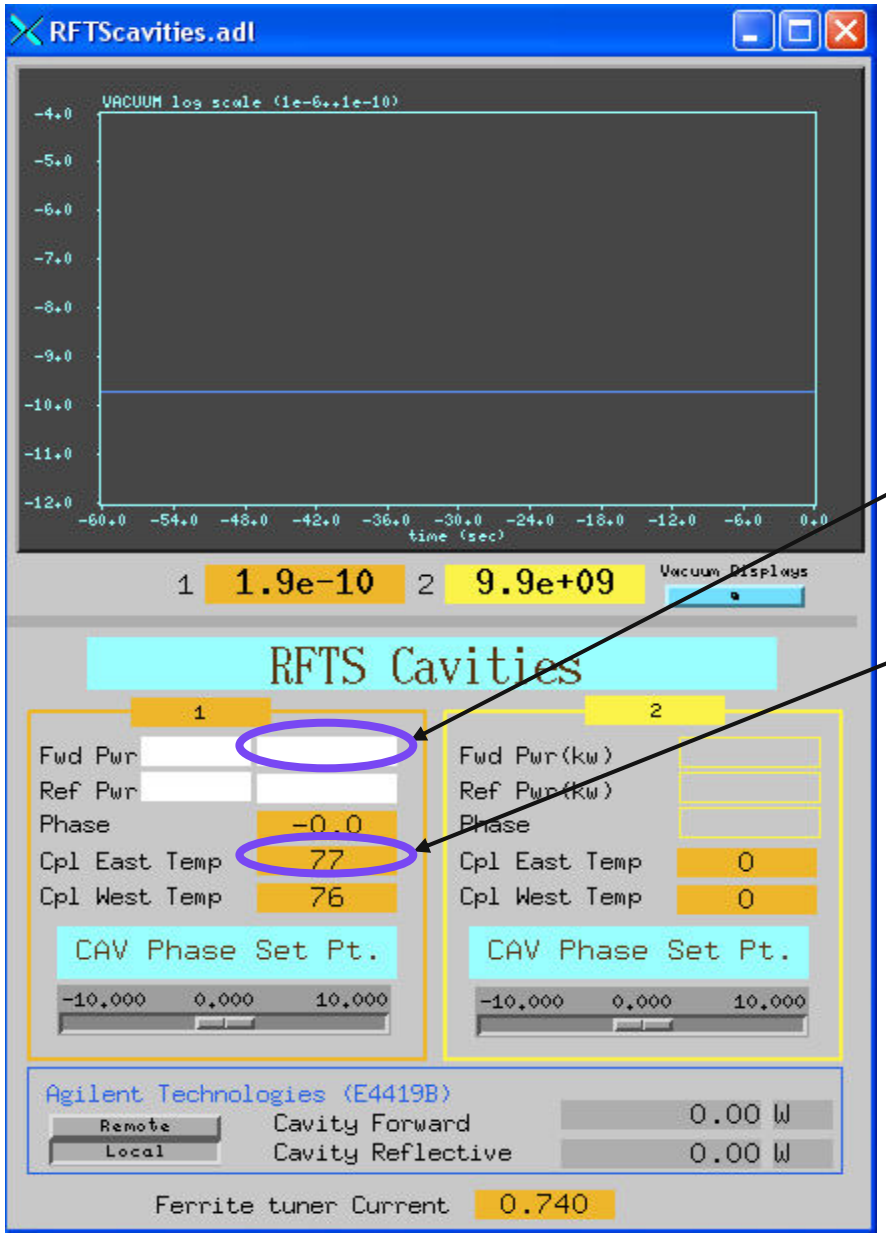
Main Conditioning Windows (I)

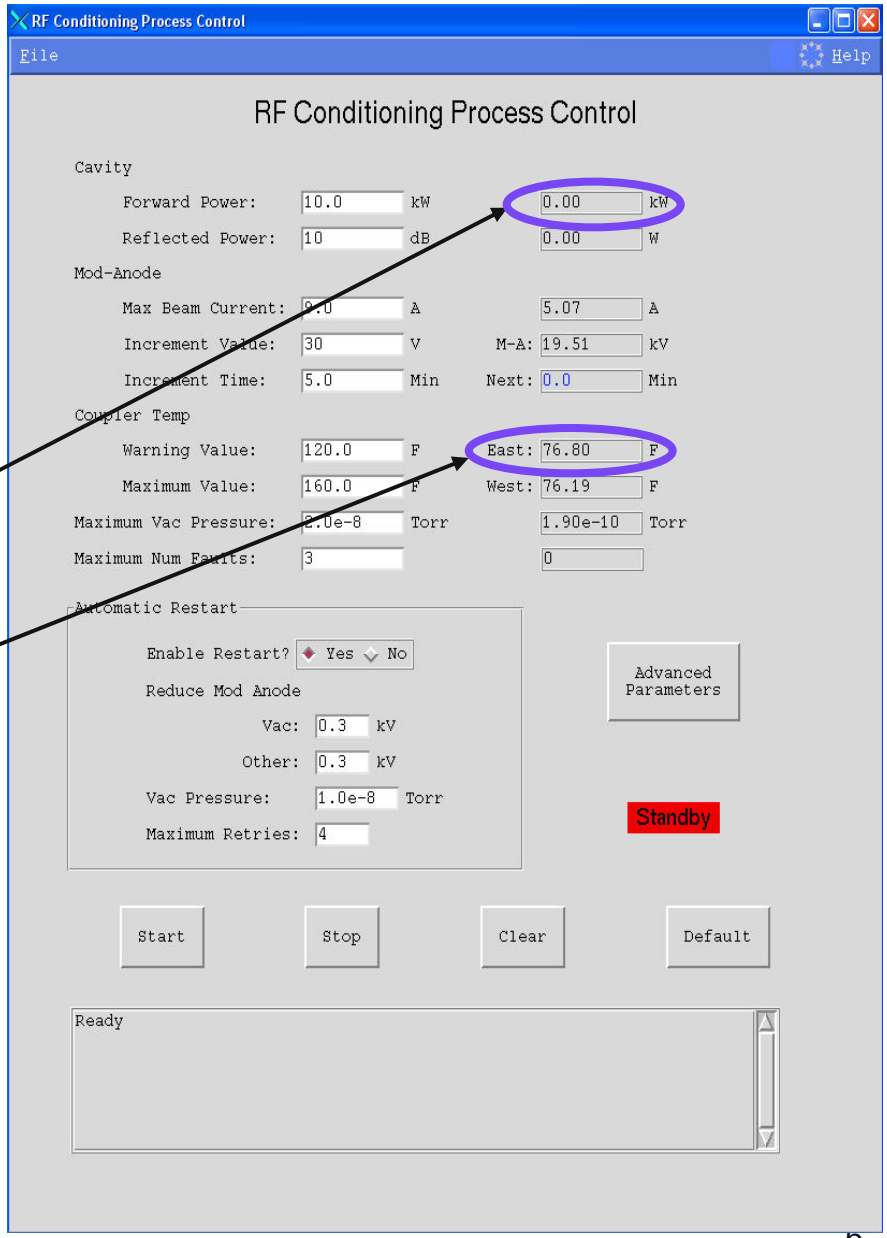
GUI displays current values of RFTS parameters





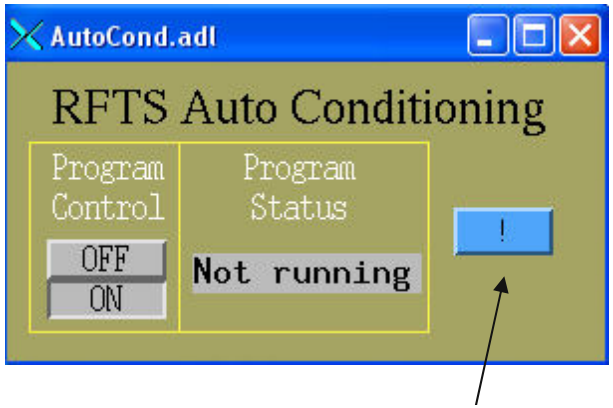
Main Conditioning Windows (II)





EPICS Master Control

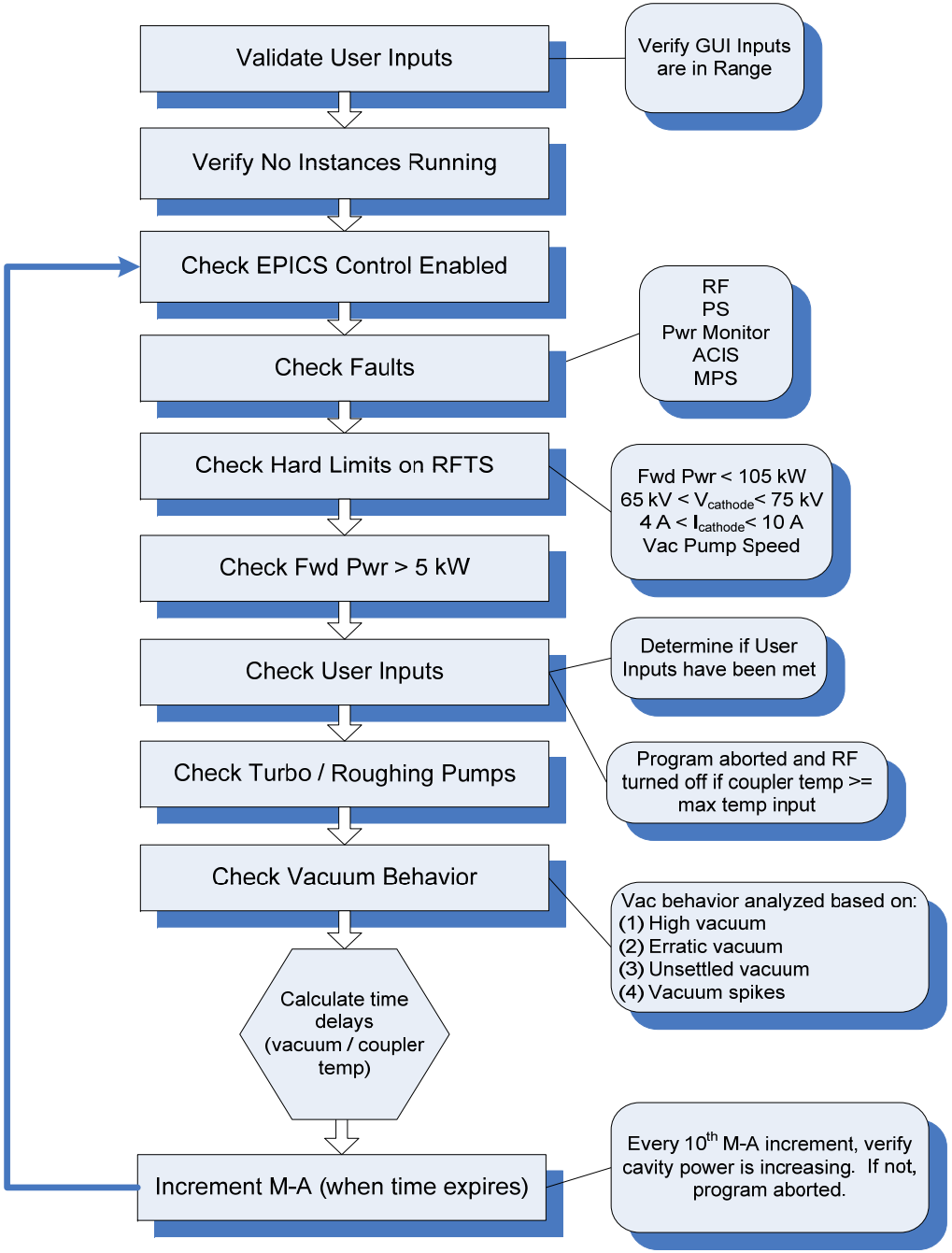
- Conditioning GUI is started from EPICS screen (“!”)
- “Program Status” shows whether a conditioning script is executing.
- When the “Start” button is pressed in the GUI, the “Program Status” changes to “Running”
- If “Program Status” is “Running”, then no other conditioning scripts are permitted to execute. However, there is no limit to the number of GUI’s that may be opened.
- “Program Control” controls whether ANY conditioning script can be running.
- If “Program Control” is “OFF”, then no script can run. In fact, any running scripts are terminated.



Opens auto conditioning GUI

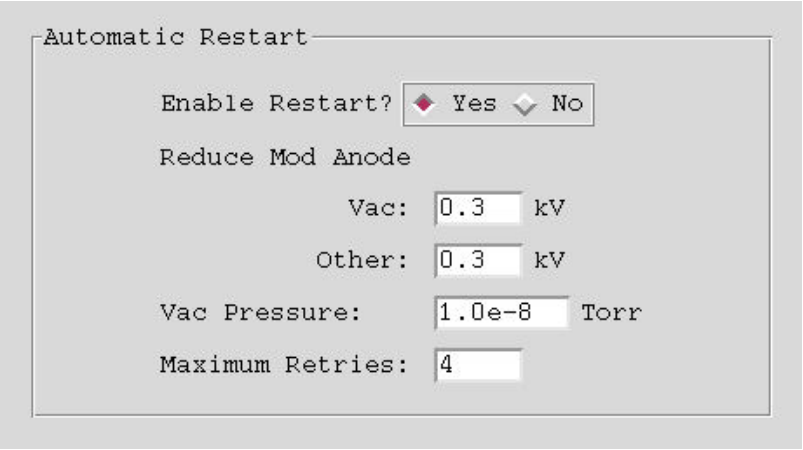
Conditioning Logic Flow

- Conditioning script is activated when the “Start” button is selected.
- Conditioning can be aborted by selecting “Stop”, by terminating the GUI, or turning off EPICS “Program Control”.
- Multiple GUI’s can be opened, but only one GUI can activate the conditioning program.
- Conditioning script constantly evaluates communication with EPICS.
- EPICS has master control of ALL instances of program.
  - Deny program execution
  - Abort any instance of conditioning script



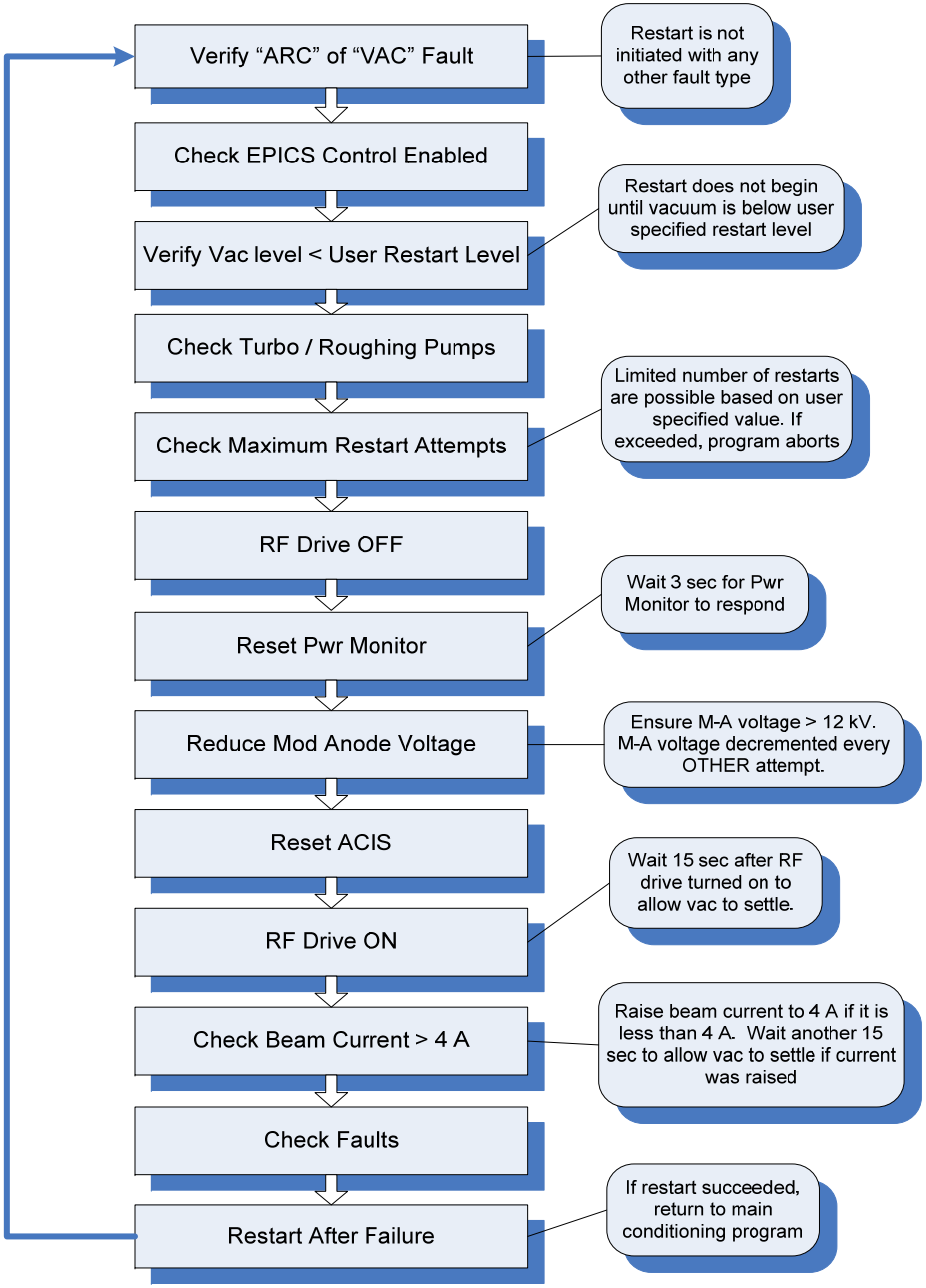
Restart RFTS

- Conditioning program can automatically restart after certain types of faults.
- Program can recover from a klystron arc, circulator internal / load / out arc, and vacuum faults
- Restart is activated by selecting the “Yes” radio button in the “Automatic Restart” GUI frame.
- Restart is initiated when the conditioning program determines that a fault is recoverable and automatic restart is enabled
- During a restart, the program reduces the mod anode voltage by a user specified amount.
- Mod anode is reduced by the quantity in the (1) “Vac:” field in the event of a vacuum fault, and (2) “Other:” field in the event of an arc.
- A restart is not initiated until the vacuum pressure is below “Vac Pressure”.



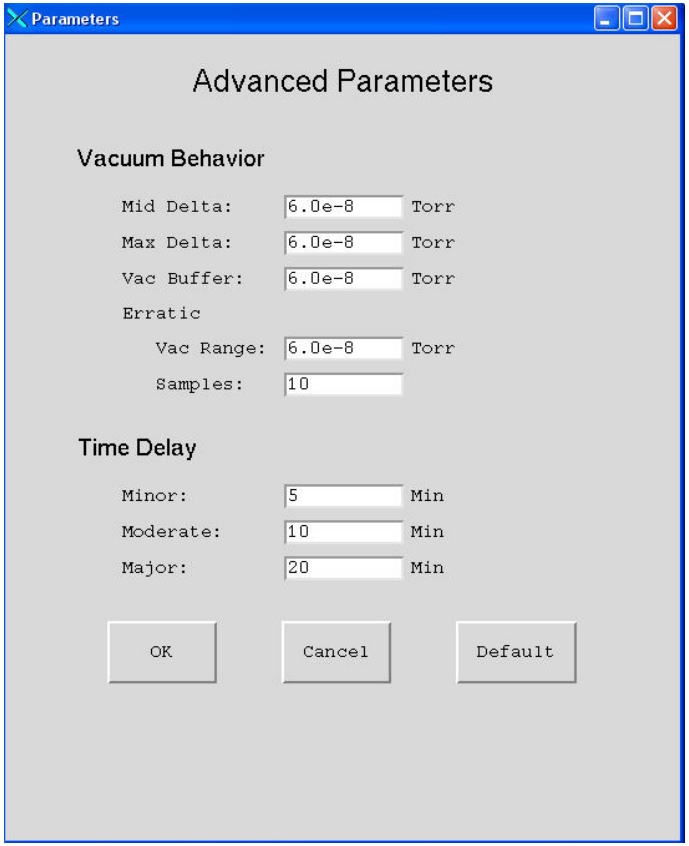
Restart Logic Flow

- Restart is initiated when a recoverable fault occurs and automatic restart is enabled.
- If power supply is off due to the fault, restart is aborted and the conditioning program is terminated.
- Restart algorithm shuts off the rf drive and resets the power monitor and ACIS.
- Mod-anode is lowered by user input value, but not below 8 kV.
- RFTS is restarted by using the RF drive.
- If beam current drops below 4 A, the current is increased until > 4 A. No further mod-anode decrements are permitted.



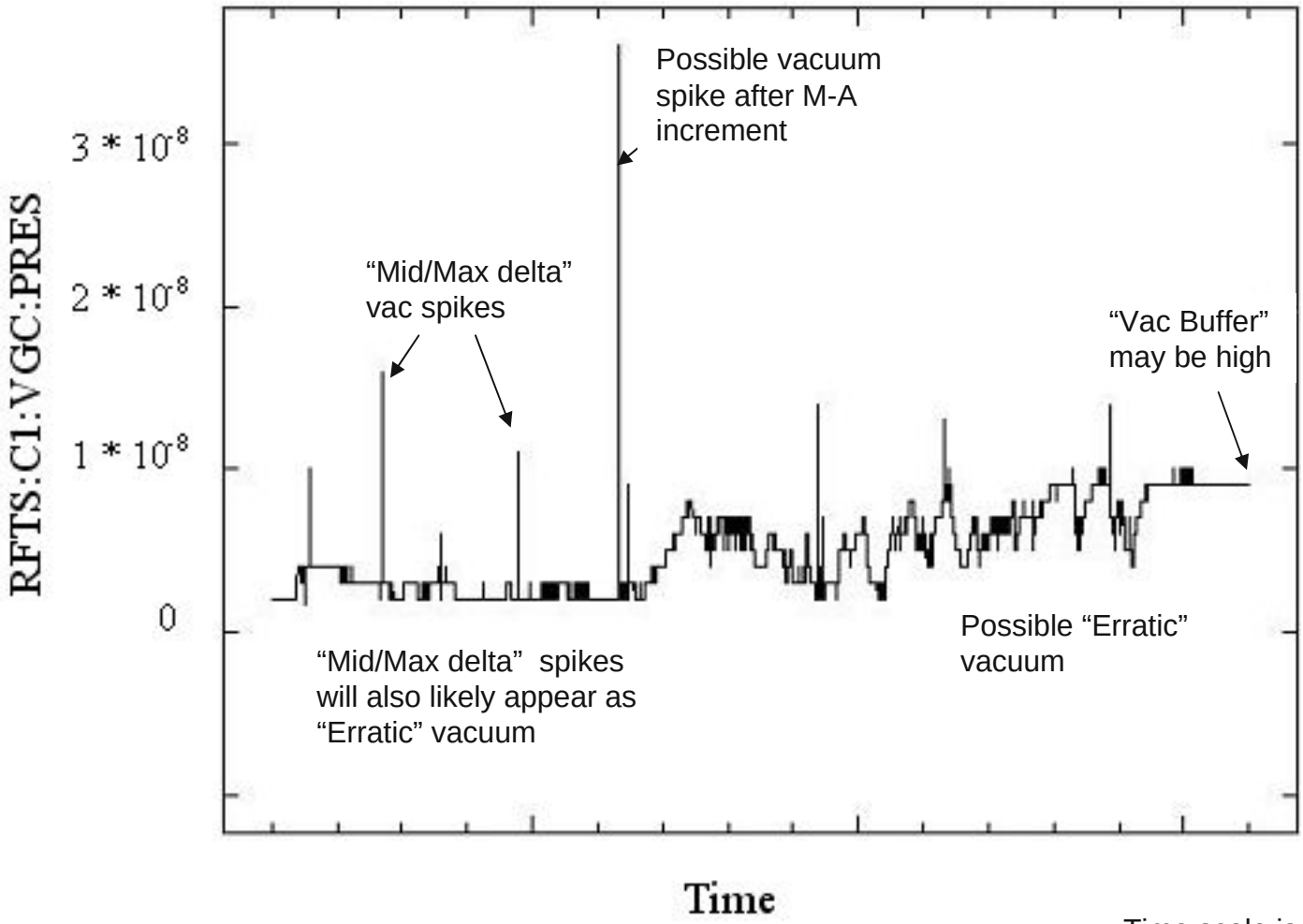
Advanced Parameters GUI

- "Advanced Parameters" sets the values used for vacuum behavior monitoring, as well as time delays that will be imposed on the "Mod-Anode Increment Time" in the main GUI.
- "Advanced Parameters" user inputs are not used to set error ranges. It defines and categorizes vac behavior and sets time delays.
- "Mid/Max Delta" is the maximum allowable difference in the vacuum from one sample (data input from EPICS) to the next.
- "Vac Buffer" is the maximum allowable increase in vacuum pressure from just before the M-A was incremented to just before the next increment.
- "Erratic" vacuum is defined as vacuum whose deviation from one vac sample to another over a number of samples ("Samples") exceeds "Vac Range"
- Time delays are used when conditions are not suitable for the mod-anode to be incremented.
- Conditions producing time delays range from minor to major. Actual delay lengths are user-defined.



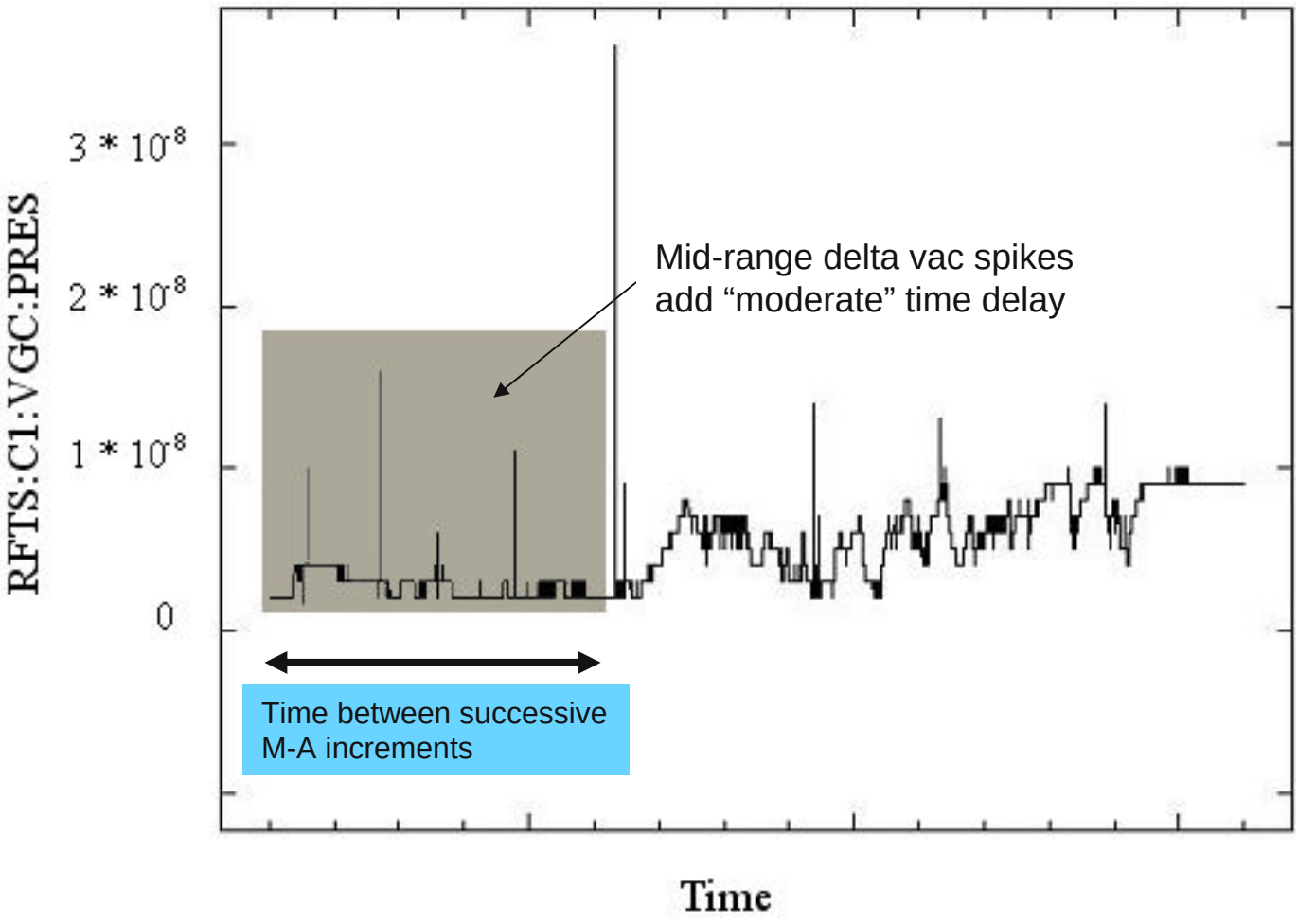
Warning	Time Delay
Mid Delta	Moderate
Max Delta	Major
Vac Buffer	Minor
Erratic Vacuum	Moderate
High Vacuum	Major
Coupler Temp Warning	Major

Vacuum Behavior Overview

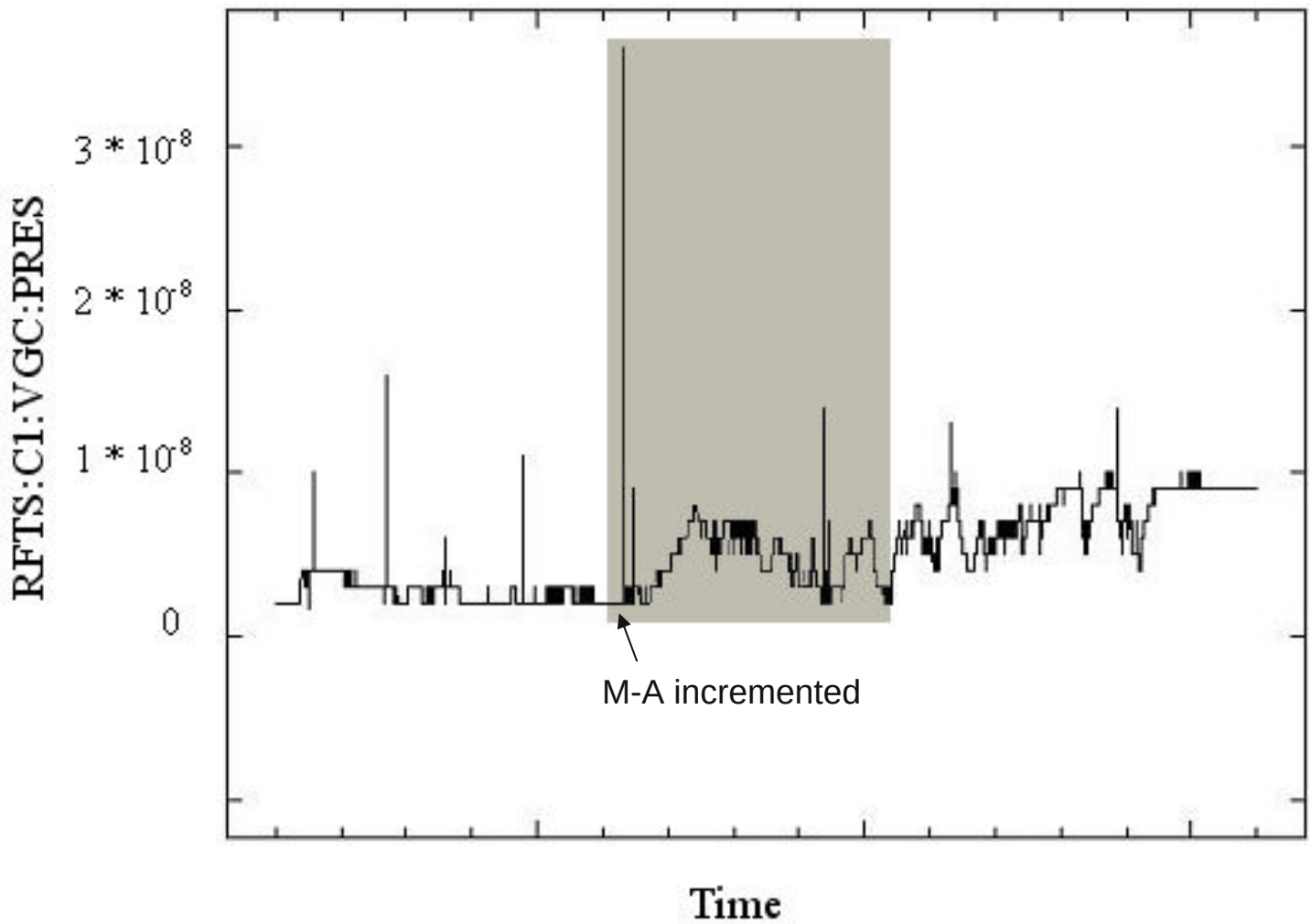


Time scale is compressed so typical vacuum behavior is not necessarily visible

Time-Frame I

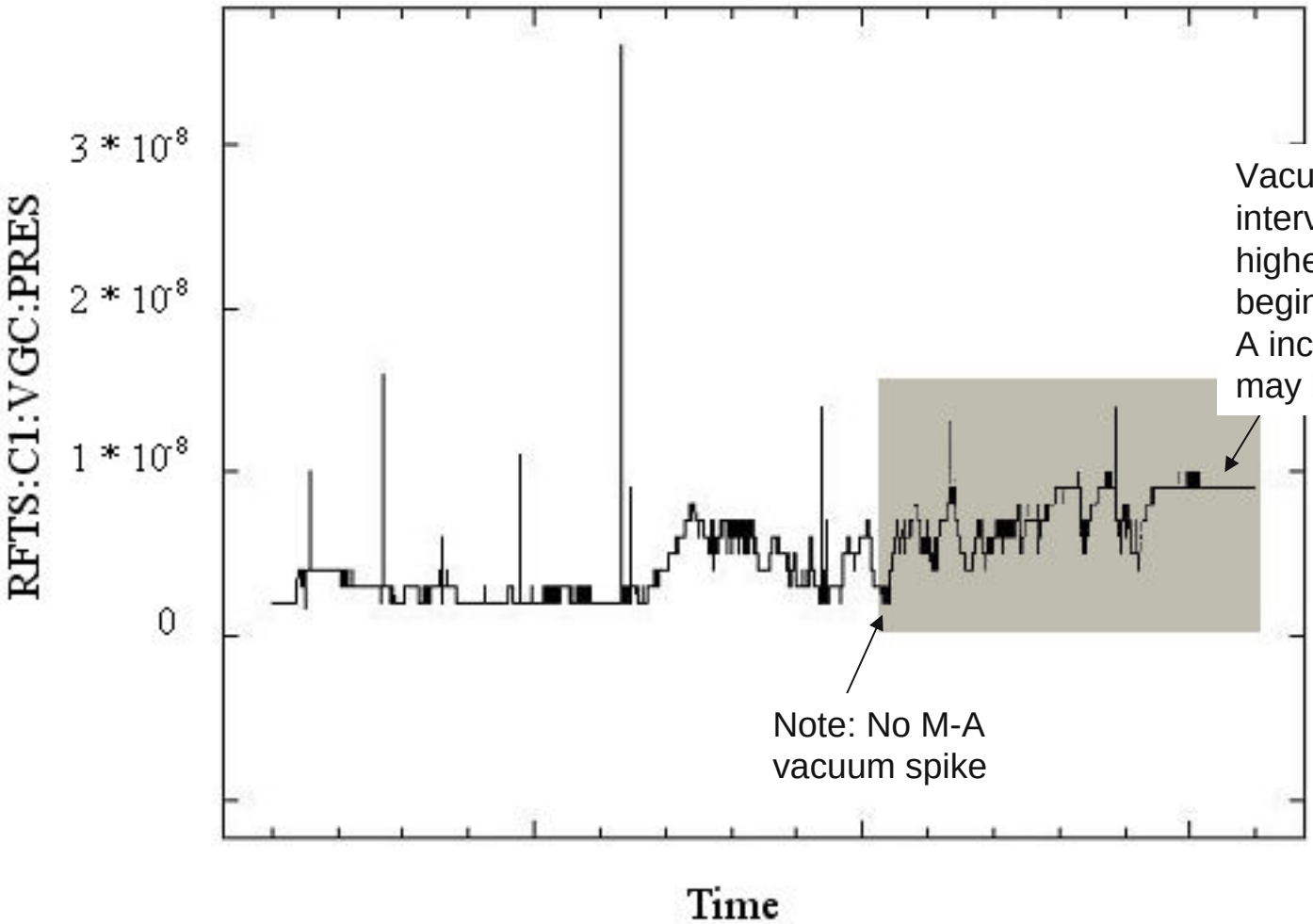

RFTS:C1:VGC:PRES
3 * 10^8
2 * 10^8
1 * 10^8
0
Time
Mid-range delta vac spikes add “moderate” time delay
Time between successive M-A increments

Time-Frame II



Conditioning script waits for a number of seconds (currently 5s) before it evaluates the vacuum behavior. As a result, the M-A vacuum spike does NOT introduce a time delay (assuming the spike duration < 5s)

Time-Frame III



Vacuum at end of interval is somewhat higher than at the beginning, so the M-A increment time may be extended.

Note: No M-A vacuum spike