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Test Platform MkII -- Internal Memo

This document seeks to establish design guidelines for the creation of a second intermediate test platform (MkII). The first test platform (MkI), which had been in use for over a year, was a completely analog Gow Mac 350 that had its original tungsten coil detectors replaced with the diode detectors developed during the last year of work with Dr. Senter. No other changes were made to the instrument. While generally acceptable for proof of concept, the MkI prototype suffers from a few significant drawbacks:

1. A lack of precision temperature control. Setting the temperature on the MkI and allowing it to reach thermal equilibrium can take between 1 and 5 hours.

2. A lack of thermal protection. The diode detectors have an absolute maximum temperature rating of about 150 degrees C, and the solder in the detector prototype melts at about 180 degrees C. It is very difficult to ensure that the maximum temperature is not exceeded using the analog TRIAC controls installed on the instrument.

3. Inaccurate temperature monitoring. Even if the analog TRIAC controls were ‘set and forget’, the analog thermocouple monitoring circuitry that displays the temperature to the user is not trustworthy. This compounds the problems listed in (1) and (2).

4. An excess of electronic and mechanical parts that do not accurately reflect the vision of the project going forward. Extra regulators, gas routing equipment, and vestigial amplifier circuitry are all present within the MkI test platform, making it difficult to work on when changes need to be made. Additionally, hazardous glass fiber insulation is not compatible with the final vision of the project.

These shortcomings, particularly those related to temperature control, recently caused the diode assembly to overheat and destroy the prototype detector. Because rebuilding the detector module already requires a complete disassembly of the test platform, this is a convenient time to fix the problems listed above and prevent them from causing problems later.

Though none of these problems are currently imposing a hard limit on the progress being made, implementing the changes proposed here will dramatically increase testing efficiency and will represent a significant step forward toward the development of an independent instrument.

MkII Minimum Absolute Maximum Ratings

Parameter	Value
Column Temperature (deg C)	200 C
Detector Temperature (deg C)	170 C
Detector bias current (mA)	150 mA
Sample Volume (uL)	10 uL
Negative Amplifier Rail (V)	-15 V
Column Temperature Error (deg C)	-10 C to +10 C

General MkII Design Requirements

1. Use three TRIAC PWM based controller boards to set the temperature using software.
    a. Verify that power ratings are being observed.

2. Finished device should observe industry standard grounding and safety practices.
    a. Grounded frame (earth ground).
    b. Power connections with voltages greater than those used to bias the amplifiers must be housed in an insulating enclosure and kept off of the desk (no exposed 120 VAC wires).
    c. Temperature control system can only fail to form an open-circuit.

3. The device should be able to run column temperature profiles such as the one shown in Figure 1.

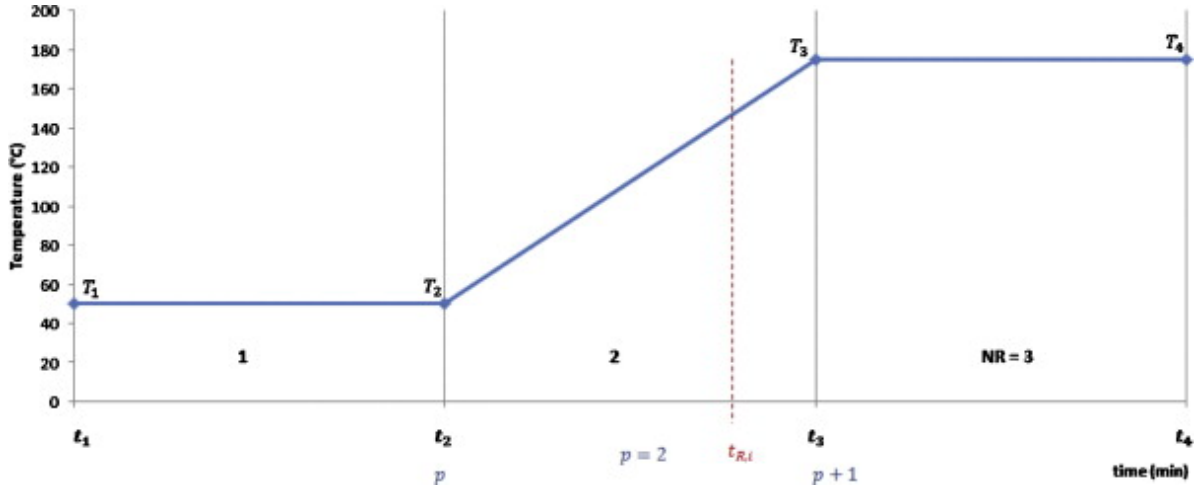

Figure 1: An example GC column temperature profile.

4. The MkII should allow ‘set and forget’ temperature control using feedback from thermocouples (or similar temperature-sensing hardware).

5. The MkII detector biasing will be accomplished using an external constant current. Proper connections for this should be available to minimize clutter and confusion.

6. A new type of reusable insulation that does not require gloves should be used instead of the traditional glass fiber mats. This will greatly simplify detector adjustments and will make future modifications much less hazardous.

Heating Element Control

1. Thermal protection
    a. Absolute maximum temperature of 170 degrees C to protect the column and detector circuits

2. Feedback loop to prevent over-temperature conditions
    a. Basic thermocouples are currently installed in the instrument. These may not be sufficiently accurate. As described in the Absolute Maximum Ratings section, the temperature in the column and injector must be resolvable to within 10 degrees of the set temperature.

3. All heating circuitry should be routed through a NO (normally open) relay to prevent control system failures from failing in the ON position.
    a. Relay is an open circuit when a control voltage is not applied to it.

4. Temperature ramping is only required for the column. All other heaters can be controlled using ‘set and forget’ PID control systems. The two injector port cartridge heaters should be connected in parallel and controlled by the same TRIAC board.

User Interface and Control

1. Control of the system should be configurable using either digital data entry (temperature ramp profiles) or analog control knobs presented to the user on the front panel.

2. A display of some kind should show the current temperature of the column, detector, and injector ports.

Amplifier Board Interface

1. Because work on the amplifier board is still ongoing, access to the diode detector lines should be fast and simple.

2. The amplifier should be biased using -12V and +12V to ensure sufficient output swing during testing.