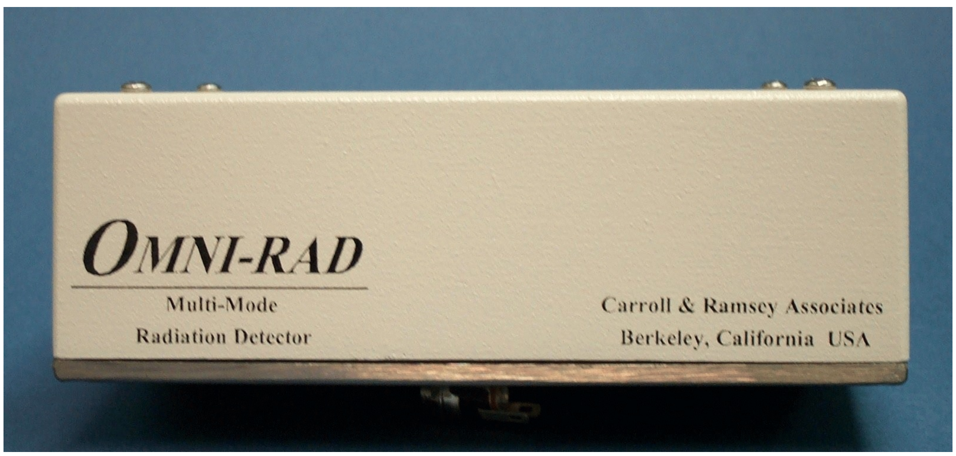
Carroll & Ramsey Instruments *613 Skysail Ln. Fort Collins, CO 80525*

Ph. (510) 847-4213 *E-mail: <sales@cr-instruments.com>* *<www.cr-instruments.com>*

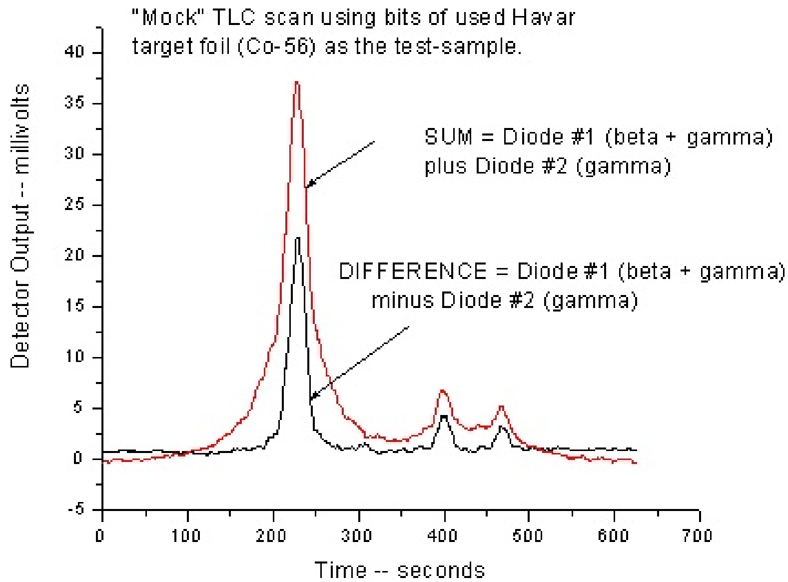
EZ-SCAN tm

A compact , bench-top scanner / detector system for thin-layer chromatography !

This system from Carroll & Ramsey Instruments incorporates ***OMNI-RAD*** ® -- a versatile, PIN-diode-based detector module for scanning TLC plates which have been 'spotted' with compounds labeled with commonly-used medical and research isotopes, including low-energy gamma emitters such as ^{125}I or ^{99m}Tc, positron-emitters such as ^{18}F, or beta (-) emitters such as ^{131}I.



Beta Detection: In beta (or positron) mode the detector module utilizes anti-parallel (opposed-polarity), back-to-back, 1 sq. cm. PIN-diodes mounted behind a 3 mm wide x 15 mm long aperture in a 1/4" (6 mm) thick lead plate which is centered over the scanning bed. The diode which is closest to the TLC plate responds to both beta's and gamma's emitted from the sample; the second diode, which is "shadowed" by the first diode, responds only to gamma's emitted from the sample. By electronically subtracting the second (gamma) signal from the first (beta plus gamma) signal, we have a composite detector which, in effect, responds to beta's only, providing excellent spatial resolution for beta $^{+}$ (positron) or beta $^{(-)}$ emitters, but without the need for bulky lead shielding -- even in the presence of an intense gamma background. The effectiveness of the concept is illustrated in the 'Mock" TLC scan shown below, where the sample under test (^{56}Co) emits both positrons (E_{max} = 1.459 MeV) as well as intensely penetrating gamma rays (846, 1240, 1760, 2600 KeV, 3260 KeV and others).



Gamma Detection: In this mode, the signals from the two detector diodes are summed instead of subtracted. Spatial resolution for low-energy gamma-emitters (~140 KeV max.) is provided by a 3 mm wide slot cut in the 1/4" thick lead bottom plate.

Mechanical: The ***EZ-SCAN***tm bed travels over 20 cm. A removable sample holder accommodates TLC plates up to 20 cm long. The scanner is compact: The chassis base is only 12" wide x 8" deep x 3.5" high. The scanning bed extends 4" to the left of the base at the beginning of a scan, and 4" to the right of the base at the conclusion of a full (20 cm) scan.

The scan speed is commensurate with the filter (integration) time-constant incorporated within the built-in detector pre-amplifier, and is pre-set at the factory: 20 cm travel in 10 minutes (plus or minus 10 seconds).

A terminal strip on the back of the scanner base provides auxiliary contact closures to ground ("start" and "stop") for use in conjunction with an external data recording device. ***Press the small push-button switch to the left of the scan-control selector switch when you wish to initiate data collection.*** Each time the scan-control selector switch is actuated to stop the bed – or if the bed reaches a pre-set limit position – a momentary (~1second) closure occurs at the 'stop' terminal. These terminals are intended to be used only with low-voltage, low-current, digital logic-type control signals of 12 V or less, behind a resistance of 1000 ohms or more.

The PIN diode detector & amplifier module puts out an analog signal at the 'beta' terminal (0-5 V) which is connected to the user's chart-recorder, or to a computer-based chromatography data-acquisition system such as PeakSimpletm.

Operating Environment The operating voltage for the scanner bed (North American version) is 110 VAC, 50 / 60 Hz. The detector module is powered by a 5 VDC regulated power supply built into the scanner chassis. Fuse is 3AG style, 0.25A 'slow-blow'. Always use correct fuse.

Caution!

Servicing of the scanner chassis should be done only by qualified personnel. Do not open the chassis box before unplugging the system from the AC mains.

The system is intended for indoor use in a controlled-climate, laboratory environment consistent with normal user / operator personal comfort. The system components and system wiring must not be in close proximity to any flame, heating element, or exposed electrical terminals. The system and its components should be protected from contact with solvents or volatile or corrosive reagents.

Unpacking and Assembly Open the package with care, being sure to not discard any small components, cables, etc. Verify that the unit has not been damaged in shipment. Look for any obvious loose or broken pieces. If there is evidence of damage in transit, notify the freight carrier and contact Carroll & Ramsey Associates for instructions for return shipment, if required.

Be sure all the parts are present:
EZ-SCAN Scanning Bed
OMIN-RAD Detector Module
sample holders
AC Power cord
Low-Voltage Detector Power cord
Combo Signal Output Cable (6 ft coax cable) + Data Acquisition 'start' cable (Dionex)

Place the scanner chassis base in a convenient location on the laboratory bench; plug the power cord into the mating receptacle on the rear of the chassis base and into a nearby 110 VAC power main. The unit is protected by a “3AG” style fuse on the rear panel (0.25 ampere ‘slow-blow’) and is intended to be ‘On’ all the time for best detector stability. There is no ‘On-Off’ power switch; the unit draws only 4 - 5 watts when the scan bed is not actuated.

Verify that the scan bed operates properly by cycling the scan-control switch through all of its positions: “fast rev”, “off”, “scan”, and “fast fwd”. Verify proper operation of the left- and right-hand limit switches; the scan bed should stop when the bed extends ~4" from the respective sides on the left-most and right-most extremes of bed travel.

The normal scan speed is pre-set at the factory at 2 cm per minute (20 cm in 10 minutes). The scanning bed is driven by a stepper motor which is coupled through a gear-reduction mechanism. The drive motor is deliberately torque-limited to prevent damage in case of limit-switch malfunction or mechanical interference. During a routine scan, the stepper motor drive system will normally emit a soft “thumping” sound. During fast forward and fast reverse, the step rate is high enough so that the sound of the bed motion actuator resembles a medium-pitched “hum”.

Place the detector module into its rectangular cut-out on the top of the scanner base with the detector slot facing downward and the connectors facing toward the rear. Insert a connector on either end of the small (approx. 8" long) +5VDC power cable into the receptacle marked “detector pwr” on the rear of the chassis base. Also insert the connector on the other end of the cable into the corresponding receptacle marked “+5V” on the rear of the detector module. After unpacking and assembly, allow the system to equilibrate thermally within the environment of the laboratory and, after powering up, allow the detector to warm up for at least ½ hour before proceeding further.

<u>Baseline Offset</u> Next, check that the “beta” detector baseline signal offset is acceptably low: Connect the (+) lead from a sensitive digital voltmeter (or computer data acquisition system) to the pin jack adjacent to the “beta” BNC receptacle on the rear of the detector module. The meter or data acquisition system should be capable of reading signals in the sub-millivolt range. Connect the (-) lead to the outside shell (ground) on an adjacent BNC coax receptacle.

Be sure there is no radioactive material close to the TLC scanner. Verify that the signal reads between + and - 1 mV or less. If the signal amplitude is more than + or - 1 mV then, using a thin jeweler’s screwdriver, ***slowly and carefully*** adjust the trim potentiometer which is closest to the rear (connector side) situated on top of the module (accessible through a small hole) for a reading as close to ‘zero’ as practical. Make adjustments in small steps; due to the long filter time constant on the detector amplifier, it may take some time for the output signal to ‘catch up’ after each adjustment.

Move the (+) meter lead to the tip jack which is adjacent to the “gamma” BNC connector, and see that the signal amplitude there is also between + and - 1 mV or less. If not, ***slowly and carefully*** adjust the trim potentiometer which is closest to the ***front*** of the detector module (away from the connectors) for a reading as close to ‘zero’ as practical. Move the (+) voltmeter lead back to the “beta” tip-jack connection and once again fine-trim the potentiometer closest to the rear. Repeat the trim adjustment for the “gamma” connector, alternating back and forth between the two adjustments a few more times until both signals are as close to ‘zero’ as practical. Finally, verify that the ‘Beta’ (difference) and ‘Gamma’ (sum) signals on the respective BNC coax connectors are each less than + or - 5 mV.

After initial set-up, this adjustment should not have to be repeated, assuming the unit is left ***on*** in a reasonably stable, climate-controlled laboratory environment. However, some drift and variation with time and with changes in ambient temperature – a few mV plus and minus – is normal and inevitable.

Finally, connect the "beta" or "gamma" signal (whichever is appropriate for your application and present use) to the chart recorder or computer data-acquisition system using a shielded coaxial-type cable equipped with BNC male connector. Auxiliary (switch-closure to ground) connections are also provided on the rear panel for remote 'start' and 'stop' of the user's data acquisition system.

<u>Sample Holders</u> Two different sample holders are provided so that ***EZ-Scan***tm can be used either with glass plates or with the thinner, plastic film-backed TLC plates. The glass-plate sample holder has shorter 'feet', thus leaving more clearance space under the detector module to accommodate the greater thickness of the glass plate.

In principle, this would also work for the thinner, plastic TLC plates, but the correct sample holder (with the tightest practical clearance) should always be used for best spatial resolution.

<u>Sample Preparation</u> The TLC plate should be centered along the axis of the sample-holder, radioactivity-side ***up***, and affixed to the smooth top of the acrylic sample-holder with a small piece of thin adhesive tape at each end, taking care not to cover the radioactivity, since even a thin layer of tape may introduce noticeable attenuation for beta or positron radiation.

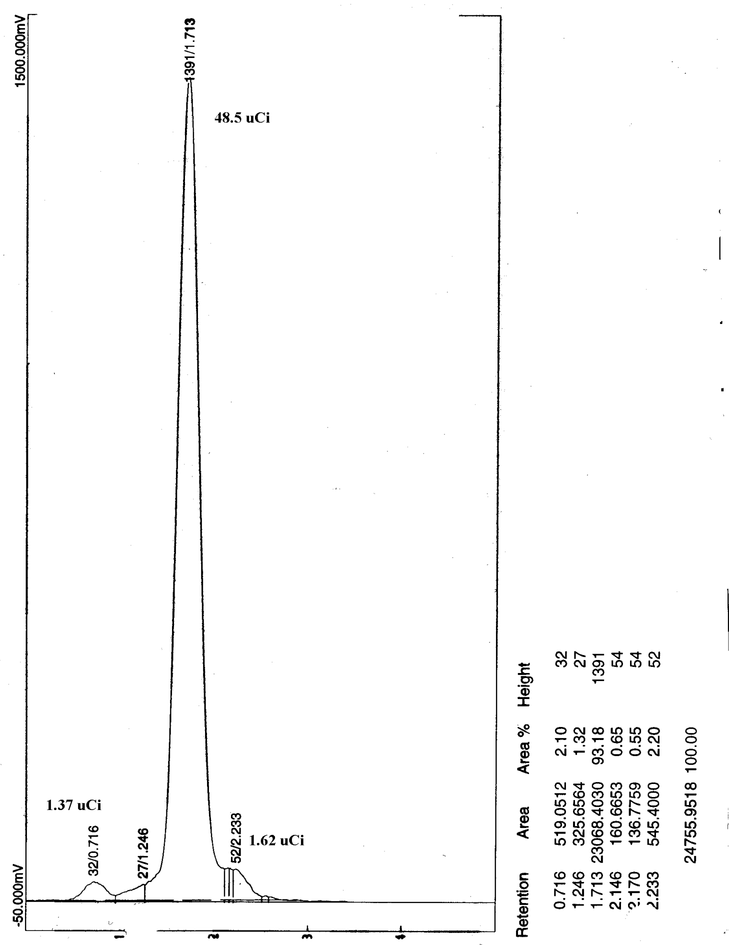
The TLC plate must lie absolutely flat -- without wrinkling or curling -- against the sample holder to avoid rubbing or mechanical interference as the sample moves past the detector aperture. The air gap between the sample and the detector aperture is deliberately made close to maintain the best possible detector spatial resolution.

Turn the scan control switch to 'Fast Rev' and run the ***EZ-SCAN*** bed all the way to the left limit. Carefully insert the sample-holder (TLC plate facing up) into the track on the scanning bed, taking care not to scrape the top of the TLC plate. Insert the sample-holder as far as it will go, until it touches the pre-set mechanical stop at the far end of the bed. The bottom of the sample-holder has small plastic feet which grip the surface of the scanning bed.

To start the scan, initiate the computer or chart-recorder, then turn the control switch to 'Scan'; the bed will begin moving at its pre-set speed. Then, if you wish to initiate data collection (assuming the data acquisition system is wired appropriately) press the small push-button switch to the left of the scan-control switch. If not stopped by the operator, the bed will run for 10 minutes (i.e., a full 20 cm scan) and then stop at the limit switch.

Many users employ only a 10 - 12 cm TLC plate; in this case the bed may be stopped manually after 5 or 6 minutes by turning the scan-control switch to 'off'. In either case, the rear panel 'stop' contact closure (if connected) can also tell the computer data acquisition system to stop.

Detector Gain The ***OMNI-RAD***^{tm} detector is intended for use with relatively high levels of gamma, beta or positron-emitting radioactivity. For example, a volume of ~1 micro-liter extracted -- without dilution -- from ~10 ml solution containing ~1 curie of ^{18}F beta+ emitting activity will contain ~100 µCi. The gain of the detector system is pre-set so that when the entire sample activity of 100 µCi is contained in a single 'spot', the peak amplitude read at the "beta" output connector on the rear of the detector module is (nominally) 1-2 volts.



System Validation As a practical matter, the simplest means of validating the EZ Scan detector system is to employ a chromatography data acquisition system which has already been independently tested and validated.

After Connecting the ***OMNI-RAD***^{tm} detector module to your data acquisition system, place several 'spots' of a relatively long-lived isotope such as ^{18}F spaced 1 cm or so apart (each spot containing a different amount of activity) on a flexible TLC slide – one that can be cut into pieces for later measurement in a dose-calibrator.

Scan the sample, record the data, and mark the various peaks on your sample slide with an appropriate number or symbol for later identification. Calculate the area under each peak in your data using your chromatography software. Cut the TLC sample into separate strips containing each of the various numbered 'spots'. Compare the software values with the corresponding values measured in the dose calibrator for each individual 'spot' (correct for half-life if necessary). This test is intended to demonstrate system linearity only: 'Absolute' calibration is generally not required since TLC measurements are usually compared against a 'reference' peak on the TLC slide under test rather than against an absolute calibration standard.

Care of Detector Module The 1/4" thick lead plate on the bottom of the OMNI-RAD detector module is coated with an 'epoxy' type enamel finish. However, the underlying lead is quite soft and will not stand up to rough treatment. It is also a bit heavy....***Don't drop it or let it come in contact with sharp objects. Handle with care!***

RF susceptibility Nuclear particle accelerators are used for the production of short-lived radio-isotopes. Such accelerators usually employ high-powered radio-frequency (RF) systems which have the potential to ‘leak’ RF energy into the environment.

The EZ-SCAN + Omni-Rad radiation detector system is widely -- and successfully -- used in PET / Radio-chemistry laboratories, which are almost always situated close to a cyclotron or similar type of ‘RF continuous wave’ nuclear particle accelerator.

However, the apparatus detects and amplifies very low-level input signals. Thus, there is a possibility that RF interference – either radiated or conducted through power or signal wiring – may occasionally cause spurious or false outputs. This may occur as a result of fast electrical transients or modulated RF signals -- for example -- from nearby digital cellular telephones or from electrically ‘noisy’ devices such as on / off (make-and-break) relay contacts, or from small ‘universal’ (AC/DC) motors often used in small electrical appliances.

For best results, RF devices such as cellular telephones and electrically ‘noisy’ equipment should not be operated in the near vicinity of sensitive radiation detection equipment (or -- for that matter – near any sensitive electronic instrumentation).

Warranty Products are warranted against defects in materials and workmanship for a period of 1 year from date of shipment. Carroll & Ramsey Instruments' (CRI’s) sole obligation for products that prove to be defective will be repair or replacement. In no event shall CRI's obligation exceed the original buyer's purchase price. CRI specifically disclaims any implied warranties or merchantability or fitness for a specific purpose, nor will CRI be liable for any indirect, incidental, or consequential damages.

This warranty does not apply to products which have been subject to mis-use such as accident, severe mechanical shock and distress, over-voltage, immersion, exposure to volatile or corrosive agents, etc. The warranty does not apply to defects due to unauthorized modification, or which have been altered in such a way as to not be capable of undergoing functional test.

Performance specifications, physical dimensions, etc. are subject to change without notice. Products sold by Carroll & Ramsey Instruments are not intended for use as critical components in medical devices or life-support devices or systems.