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PRODUCT DESCRIPTION
MODEL 1100 AUTOMATED TL/OSL SYSTEM

Note: due to the prevalence of single aliquot methods with on-system irradiation required (and the high cost of production), the high-capacity 1150 reader is no longer in production. See below for the reasons why.

FEATURES

20 sample automated glow oven
on-board computer with 19K memory
RS-232 serial interface to host computer
software control of all operating parameters
exceptionally flexible "soft machine"
single photon counting with digital dead-time correction
electronic PMT calibration with temperature compensated LED at photocathode
all major analog signals digitized
full size heating plate
1 to 25C/sec ramp rate with endpoints up to 700C
thermocouple fault alarm
hardware overtemperature interlock settable 400-700C
hardware interlocks of HV and oven power
cooling jet for fast cool down
low volume glow oven for fast evacuation
very compact, takes less than one square foot of bench space
firmware definition of control function makes updates or reconfiguration economical
hardware expansion capabilities
timer control and power for auxiliary irradiator

RECENT UPDATES

Support of quad photon counter for simultaneous detection in four wavelength ranges
Support of alpha irradiator in 770 irradiation shield/Be window
Improved light and irradiation shielding for crosstalk reduction
Increased choice of detectors include two red-response PMTs and the IRIS4 quad detector

The Daybreak model 1100, introduced in 1987, and its higher capacity sibling model 1150 (shown here), have combined the best features of the original Daybreak modular TL system with an automated 20- or 57-sample glow oven and integrated microcomputer to produce a new generation of thermoluminescence equipment. Coupled with Daybreak's classic TLAPPLIC or the new FirstLight 2.0 for Windows software, and our

extensive line of OSL exciters, alpha counters and automatic and manual sample irradiators, you have an integrated luminescence dating environment that will increase data production dramatically. Please see the Product Supplement for information about these models. The 1100-series instruments present a combination of performance and price that cannot be beaten, and has enough flexibility and expandability to ensure that it never will. All of our instruments are designed with the end user's needs in mind, based on 30 years' experience in luminescence dating research and more than 100 Daybreak systems installed throughout the world. For a large capacity OSL-optimized system, see the new 60-sample OSL-only model 2200. This system uses the same control electronics as the 1100-series, and most of the information in the present document applies to it as well

By designing our measurement systems around an embedded microcomputer, we have accomplished a number of desirable objectives. These include simplicity of hardware, flexibility, autonomy from the host computer, increased reliability, and perhaps most noticeable, a great reduction in physical size. Analog circuitry is reduced to a minimum (just the heating plate temperature control loop, vacuum gauge amplifier, and deadtime detection), and all major analog signals are digitized so that the on-board computer can assume complete control. This reduction in circuit complexity, and the use of highly complex digital and data conversion building blocks, has the effect of increased reliability due to fewer packages and interconnections and decreased size while actually increasing functionality. Compact mechanical design, and the use of high frequency switching power supplies for system and heating plate power, together with the small size of the electronics (only one sixth the printed circuit board space for the equivalent function of the original modular TL system), has led to an extraordinarily compact system size: 27 cm wide, 29 cm deep, 14 cm high, plus a 7.5 cm diameter by 23 cm high PMT housing. In doing this, we have paid considerable attention to modular construction techniques to ensure easy access for service and adjustment.

Since all control functions are implemented in firmware, with a rich set of control codes, a great degree of flexibility is possible and most future updating may be done with only a change of firmware or host computer software.

Expansion capability has been built in as well, since we fully expect future research to require greater resources. Up to 8 additional input/output ports (up to 128 input and output lines) can be added within the system architecture, and there are 3 additional analog inputs available on the board.

Physical controls have been replaced by a 'soft front panel' on the host computer. The utility TLCONSOLE is used for monitoring and exercising system operation, and includes an always-visible context-sensitive help window for sending commands. This 'front panel' display includes all status information in an easily read form. The 1100-series instruments continuously send 22-byte packets of information to the host computer for continuously monitoring operation. (For reassurance, we also put a status display panel on the instruments.) With this arrangement, even dramatic changes in system configuration may be made economically. When taking data, a simplified set of status information is displayed together with 'pushbuttons' and a real-time XY recorder-type display of data as it is received.

The sample changing mechanism of the 1100 is simple and reliable. It uses a floating sweep arm to move samples on the turntable to and from a full-size heating plate. Both flat (0.25 mm thickness and above) and dished sample disks from 0.375 inch to 1.0 cm diameter are accommodated (other diameters by special order). Fine grain and inclusion samples may both be analyzed due to the smooth motion afforded by precision DC micromotors and worm gear drive. Dynamic braking motor control ensures positional reproducibility. In the 1150, there are three such 20-sample platters in a stack. These move vertically to put the active platter on a level with the heating plate. (The sweep arm moves out of the stack to allow this movement, so one sample position per platter is lost, hence the 57-sample capacity.) In both instruments the platters are removable for loading, (A new version of the 801E beta irradiator is presently in development that will accommodate these, and with adapters, other types of platter—such

as the Risø reader's—without unloading the sample disks.) Single samples may also be measured. The small volume of the glow oven (15 cm diameter by 1 cm deep) makes for fast evacuation. The glow oven is designed for use up to 700C for brief period. As in the modular system, low heating plate power reduces cooling requirements.

Since the computer industry has been moving quickly toward increased function, lower cost, and greater diversity, we have configured the 1100 with serial interface (RS-232 at 9600 baud) for easy communication with any computer, rather than a parallel interface as was used in the original modular system.

SOME ADVANTAGES OF THE 1100 READER OVER THE COMPETITION

Full size heating plate results in exceptional temperature control. This is especially important for OSL measurements, as OSL sensitivity is dependent on sample temperature, and preheat temperature must be reproducible.

Flexibility: the 1100 can do pretty much anything (a recent project to implement negative ramps comes to mind). The timebase for OSL data acquisition is completely adjustable, and the general ramp for TL allow the data-taking scripts to describe nearly any measurement scheme imaginable.

Which brings up the new FirstLight applications software suite (see website for more information).

The operation of the system is defined primarily by its firmware, so updates to new accessories or new measurement methods is simply implemented. A flexible expansion port permits simple memory-mapped interface for new additions to the system family. This reduces the obsolescence potential. Even 15-year-old systems may be updated to the most recent configuration at minimal cost.

Four different detectors are usable interchangeably.

The alpha/beta irradiator (770 beta irradiator with two-position sample elevator, plus optional alpha source below the Be window within the evacuable space) is the most convenient means of making all the most useful methods of measurement.

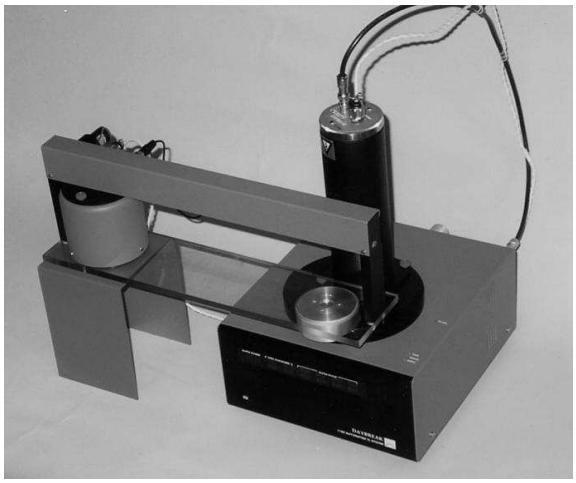
Exceptional crosstalk rejection. With the new OSL light shield that hugs the sample platter closely (inspired by the newest version of the 2200), the irradiation crosstalk is less than 0.05% dose delivered to adjacent sample positions (less than ¼ that of our competition), and the OSL crosstalk is very low (1000 seconds of full intensity blue OSL—more than 50 mW/cm2—removes less than 4% of the OSL signal of an adjacent sample. The effect on the second closest samples is not measurable. The competition does have a specification for this crosstalk)

Consistent sample elevator height (2 positions) +/- 25um contributes to irradiation precision. Our competition irradiates on the sample platter. This leads to a number of problems. First, the reproducibility of the delivered dose is compromised. Second, the crosstalk is increased. Third, any contamination of the platter with stray sample material is also exposed and will show up as an inconsistent OSL background.

Many other advantages are to be added as we think of them.

The 1100 is aimed specifically at geological dating where automation is now a virtual necessity, and is intended for use with the 801 multiple sample alpha/beta irradiator, especially where irradiation times are long. Many single aliquot techniques now in use are easier and quicker when the irradiation is done on the instrument, so that the samples need not be moved to an external irradiator. The 770 beta irradiator with a computer-controlled 'trolley' is shown here with a 1100. An optional irradiation port with a beryllium window and two-position sample elevator is available for use with this irradiator. This irradiator moves the source away from the 1100 when not needed to reduce the elevated dark count caused by close proximity of the beta source to the PMT.

The major reason why the 1150 is no longer offered: Please note that because of the platter stacking in the model 1150, the 770 may not be used with that model. It is possible to provide a special lid for the 1150 that allows irradiation of the top platter only, without a sample elevator; this degrades the exposure isolation between adjacent samples, and is not recommended except under special circumstances.



With the addition of several OSL adapters, new detector choices such as the IRIS4 quad detector (for recording data in four wavelength bands simultaneously), and the introduction of the 2000-series family of dedicated OSL reader systems, a specification supplement has been written to show our full range of instruments.

Note: *860 and 870-series OSL light sources are included for historical background only*. With the introduction of the 860-series of Xe lamp OSL light sources, with the 1100FOI fiber optic illuminator, we are able to offer both IR and visible stimulation with narrow passbands. The new lower cost 870 Halogen OSL source has proven to yield excellent power levels at narrow bandwidths, for example 20 mW/cm2 at the sample at 514 nm (34 nm passband. To complement these instruments, we have enhanced the TLAPPLIC software to simplify handling of TL and up to eight filter sets for OSL under computer control in the same batch program. (The new FirstLight 2.0 for Windows 95/98 is being released in 2001.)

Both these OSL light sources have effectively been superseded by the 1100IR/Vis all solid state OSL exciter. This is a lower cost, zero maintenance instrument, and is our recommendation for general purpose dating. This light source has been updated recently with double the number of IR LEDs for increased output. With blue LEDs (480 nm center wavelength), optical power levels in excess of 50 mW/cm^2 are possible, 30 mW/cm^2 for green LEDs (515 cm). As other wavelengths of high power LEDs become available, they may be installed, since the 'light bar' modules may be easily swapped. Maximum IR OSL power is now 100 mW/cm2. All solidstate light sources are controllable 0-100 per cent power, and may be linearly modulated. It would be possible to use an arbitrary I(t) should it prove useful, through a simple change in firmware. Papers on the "light bar' design and the various OSL light sources are available. Pulsed OSL with time domain data acquisition is in design now (early 2006), and will involve swapping the CW/MOSL controller board of the 1100IR/Vis with a pulsed current driver. Third party computer-hosted photon counting in the time domain is now available at reasonable cost, and will serve as a very flexible means of collecting data.

A new stacking design for the detector/filter/illuminator configuration is now being delivered, and all Daybreak products conform to this standard. Four thumbscrews fix the stack of components to the top lid for quick and easy disassembly (e.g., for changing of filters).

In the spring and summer of 1991 we embarked on a revision of the 1100's original mechanical and electrical design to make possible the maximum commonality of parts and assemblies between the family members, and leave enough room inside to accommodate the added mechanism of the 1150 within the same size case. We are now using smaller, lower power stainless steel solenoid valves for the purge and cooling gas supplies and the first stage vacuum (bleed) valve, and a significantly larger stainless main vacuum valve for even faster pumpdown. The gas plumbing has also been simplified by use of a manifold to make maintenance easier. The water cooling built into the original revision of the 1100 proved not to be necessary, so instead there is fan-cooled heat sinking of the heater plate conductors. Various changes to make maintenance of the changing mechanism more convenient likewise have been incorporated. The system power and heating plate power supplies have automatic voltage selection, so these systems may be plugged in anywhere in the world without alteration. The main control board used in all our systems was also improved by the addition of a second digital-to-analog converter for control of the OSL light source intensity, a separate time base oscillator, watchdog timer, and an irradiator driver. We have in mind as well some future adapters, and have attempted to make their installation in present instruments a simple task when they become available.

We were quite excited about the 1100 when we introduced it back in 1987., but to be honest, we did not consider it revolutionary It represented a distillation of the concepts pioneered by the Daybreak modular TL system and our experience gained from the more than sixty of those systems installed throughout the world. The capabilities built into these small packages are the natural result of advances in the semiconductor and computer industries in the past decade, and are a logical extension of our original system. Back in 1980, we had complete computer control of the TL system, looking forward to automation. This degree of control, together with many of the features designed into the modular system from its beginnings in 1978, has lately been touted as something new and remarkable. We've had it for years without making much noise, and will continue quietly to add features and new instruments. One thing we promise not to change is our standard of quality, reliability, and customer service, and our one-year warranty.

DETAILED SPECIFICATION

Firmware command set

The firmware architecture is that of a command-driven state machine incorporating a generalized ramp whose controller is another state machine. The actual ramping function is timer-interrupt-driven and subject to hardware and software interlocks for safety. Command codes from the host computer consist of an ASCII character (the set '@' to '-', including the upper case alphabetic characters, 32 altogether), and up to eight integer parameters (ASCII decimal strings) as required by the control function.

The general form of a command is 'c xx yy ' where c is the control character, and xx and yy are ASCII positive decimal integer strings. <Space> characters are used as delimiters, and the command string may end with any non-digit character. The basic set of commands for TL is shown below. A document describing the full command set for all our instruments is available.

Command name	Form	Parameters
Set data space	'D' xx	xx = 1-20 (C/point)
Set ramp rate	'R' xx	xx = 1-25 (C/sec)
Vacuum	'V' xx	xx = 0 (both off)

		1 (bleed on, changes to main after partial evacuation)
		2 (main on)
Purge	'P' xx	xx = 0 off
		1 on
Cool	'C' xx	xx = 0 on
		1 off
Ramp ('Go')	'G' xx	xx = 0 stop
		1 start
Preheat ('Wash')	'W' xx yy	xx = 0-700 (temperature)
		yy = preheat time (seconds)
Stage	'S' xx yy	xx = 0-700 (temperature)
		yy = stage time (seconds)
Endpoint	'E' xx yy	xx = 0-700 (temperature)
		yy = hold time (seconds)
Cool-temp ('Low')	'L' xx	xx = temperature to start ramp for BG
Send ('Query')	'Q' xx	xx = 0 current status
		1 last curve
HV	'H' xx	xx = 0 high voltage off
		1 high voltage on
Calibrate	'K' xx	xx = 0 calibrate off
		1 on
Irradiate	'I' xx yy	xx = time (seconds)
		yy=elevator position
Advance	'A' xx	xx = sample number. Advances to xx and loads sample
Home ('Base')	'B'	goes to sample 0, no load
Jump	'J' xx	goes to sample xx, no load
Reset ('Zero')	'Z'	initialize controller
Setpoint ('at')	'@' xx	xx = 0-700 (setpoint temperature)
Oven	'O' xx	xx = 0 oven off
		1 oven on

A complete set of commands for OSL, including support of multiple timebases and linear OSL intensity ramps, is also included. There is a suite of test commands for checking out all aspects of the system. Specialized commands for other accessories are added as necessary and an easy change of firmware updates the hardware. A complete description of the command language and FirstLight software are available on our web site www.daybreaknuclear.com

Generalized ramp

The 1100 ramp consists of nine stages, most of which encompass the optional preheat, stage, and hold cycles.

0: idle (ramp off, ambient temperature)
1: ramp up to preheat temperature
2: hold for preheat time
3: cool down to cool temperature (with jet)
4: ramp from ambient to stage temperature
5: hold for stage time
6: resume ramp up to end point temperature

7: end point hold time
8: cool down to cool temperature (with jet)
0: resume idle

Only stages 6, 8, and 0 are required. If preheat or stage hold time is zero, the preheat or stage portions of the ramp cycle are bypassed. The ramp rate may be changed at any time during the ramp.

Serial data format

A 44 character string is sent to the host computer every second, or every data point, whichever comes sooner. The data is transmitted in hexadecimal ASCII format, where the characters '0'..'9', 'A'..'F' map onto decimal integers 0..15.

Char 1-6 = photon count, most significant hex digit first (for multiple detector systems, like the IRIS4, this is increased to 6 characters per detector)
7-8 = data point number (corresponding temperature depends on data spacing)
9-10 = sample number (0..19). For the 1150, this is (0..59) with positions 0, 20, 40 excluded
11-12 = ramp segment or stage number (see above)
13-16 = error code (0 = OK)
17-32 = 8 8-bit ADC channels for status display
0 = TMAX (hardware-set maximum temperature)
1 = T
2 = T error
3 = vacuum gauge
4 = vacuum gauge current
5 = ramp voltage
6 = livetime duty factor (for deadtime correction)
7 = HV sense
33-40 = 32 status bits
41-43 = time since start of operation
<return>

1100-series Hardware Specifications

Temperature control sub-system

Chromel-alumel thermocouple welded to heating plate
Ice point compensation
Low-drift TC amplifier
TC-open alarm
Hardware overtemp detector and interlock settable 400-700C
Hardware and software interlock of heater power supply
Ramp rate software settable 1-25C/second
Endpoint software settable 0-700C (overridden by overtemp interlock)
Arbitrary T(t) software controlled
Fast response switching power supply for heater
1.45 inch long by 1.00 inch wide (active area) heating plate, channeled for stiffness
Analog temperature, temperature error, ramp (for checking) digitized to 8 bits

Photon counter sub-system

EMI 9235QA quartz window bialkali PMT selected for low dark count

AMP/DISC: 4 nsec risetime, 6 nsec delay time discriminator with 20-1000mV threshold. ECL differential output capable of driving 50 ohm lines
Negative high voltage (600-1600V), software enabled with hardware interlock
24-bit photon counter
Analog dead-time detector, software compensation
Temperature compensated LED photon calibration with fiber optic light guide to photocathode, software controlled
Easily changed optical filter pack, 2.00 inch diameter.
Standard pack supplied is Corning 7-59 + Schott BG-39 for TL or IROSL
Digitized HV and dead-time compensation

Glow oven

20-sample changer with 7-second cycle time
Sample form: disks flat or dished 0.010-0.060 inch thickness, 0.375-0.400 inch diameter (other sizes by special order)
Software control of atmosphere control solenoid valves
Two-stage vacuum control (bleed and main)
Heating plate cooling jet
Needle valves for control of purge and cooling jet
Thermocouple vacuum gauge with low-drift, low offset amplifier, digitized output
Low volume for fast evacuation
Expansion relief for heating plate to prevent flexure at high temperature
Purge/cooling gas fitting: 0.25 inch Swagelock
Vacuum outlet 1.0 inch tube stub for vacuum hose or 25mm ISO flange adapter

Microcontroller

2 Mhz 65F12AQ running FORTH kernel
8 kbytes RAM, 11 kbytes firmware in PROM
Very fast, compact, control code
RS-232 serial interface at 9600 baud
Expandable by 8 additional I/O ports, 3 analog inputs
Status panel to show sample position number, state of valves, sample change, HV, calibration, OSL, overtemp/TC fault, and power

Rear panel

HV: SHV connector
AMP/DISC/CAL: 7-pin Amphenol 126-series female connector
Serial port: standard DB-9 female connector
Irradiator: 9-pin Amphenol 126-series female connector
OSL: 9-pin Amphenol 126-series female connector
Reset switch
Power input: IEC standard cord set, ON/OFF switch, fuse (X2)

General

Size: 10.5 inch wide, 11.7 inch deep, 14.6 inch high overall
Weight: 17.7 lb. (7.9 kg)
Power: 115-230 VAC 50-60 Hz, 150 VA, universal input
Auxiliary irradiator control: 24V at 400 mA power available, timer output and two sensor inputs
Designed to meet UL, CSA, VDE, CE requirements