



## Accu-Gold Excel Plus

version 2.01.1975 and later

### User Guide

#### **Overview:**

'Accu-Gold Excel' is an Excel interface for Radcal's Accu-Gold measurement system. Microsoft Excel for Windows (XP and later) is required, and the interface appears as an Excel add-in. A shortcut is installed on your desktop that opens a folder containing Accu-Gold templates. (These templates are installed in the 'Program Files' folder under 'Radcal\AccuGoldExcel'.) To activate the interface, open the folder and then open one of the Excel templates provided.

#### **Installation:**

**NOTE:** Install Accu-Gold Excel *before* connecting the Accu-Gold digitizer to a USB port.

Plug the flash drive into an available USB port. (Because some USB keys are not polarized, your computer may not recognize the key; in that case rotate the key and plug it in again.)

Double-click 'setup.exe'. Follow the prompts to install Accu-Gold Excel.

#### **Supplied templates:**

The supplied templates are designed to optimize particular types of measurements. Some are more suitable for ion-chamber (10X6) measurements; others are for the multi-sensors (AGMS-D, AGMS-M and AGMS-DM) and the dose diode (DDX6). Choose the template that matches your measurement needs. The parameters used by the templates can also be changed to suit a particular application. Note that there is a template in the mA folder that provides the same capabilities as the base template, but includes input from the mA sensor (90M9 or 90M10).

#### **User templates:**

If you plan to make repeated measurements using parameter values that differ from the defaults in the supplied templates or wish to add additional worksheets with other entries, you may want to create your own templates. To do so, open a supplied template that is close to your desired configuration, run 'Modify' to activate the UserForm to set your parameters followed by 'OK', and then add any desired extra sheets. Then close and save the file with an appropriate name in any folder. If you want to convert your file to a template that remains unchanged after subsequent uses, modify its file extension in Windows Explorer from 'xls' (or 'xlsx') to 'xlt' (or 'xltn').

#### **Software updates:**

Open any template and execute Control-Shift-U. Radcal's website will be queried to determine if your software is the newest version. If it is not, you will be given the option to follow a link to the web page where setup.exe for an update is available. Follow the Software-Setup link below "Accu-Gold Excel".

The supplied templates and their description are as follows:

**AccuGold-AGMS.xlt\AccuGold-AGMSmA.xlt /AccuGold-AGMS-Dental.xlt**

Generally uses the multi-sensor (AGMS); full bandwidth; narrow pulses.

Threshold for determining start of measurement = 10 ppm of full-scale<sup>1</sup>; except 10 ppm for dental.

Used for low-level signals.<sup>2</sup> Dental (Type Code 1) eliminates the pre-heat region, if present, for exposure-width, pulse-count, dose-rate and kVp measurements.

**AccuGold-LowDoseAGMS.xlt\AccuGold-LowDoseAGMSmA.xlt**

This file has a very-low trigger level (80 nGy/s) and will measure dose rates down to about 150 nGy/s with a minimum total dose of about 150 nGy using the diagnostic multi-sensor.

To avoid noise triggers, the filter time constant for the start trigger is set to 51 ms. This file may not trigger properly with very-narrow pulses. In that case use AccuGold-AGMS.xlt, which has a trigger threshold that is 12-times larger and an 0.8-ms filter.

**AccuGold-DoseDiode.xlt\AccuGold-DoseDiodeMA.xlt**

Dose Diode (DDX6) only; full bandwidth; wider pulses; 30-ms start-trigger time constant.

Threshold for determining start of measurement = 5 ppm of full-scale (FS)

Used for low-level signals.

**AccuGold-Chamber.xlt\AccuGold-ChamberMA.xlt**

Ion chamber only with rise-time correction<sup>3</sup> and 60-ms start-trigger filter.

Threshold for determining start of measurement = 5 ppm of full-scale (FS) or set by user in C54 to reduce false triggers. Used for low-level signals and pulses wide enough to trigger.

**AccuGold-ChamberAGMS.xlt\AccuGold-ChamberAGMSmA.xlt**

AGMS trigger threshold of 5 ppm FS plus ion chamber with rise-time correction; OK for narrow pulses; 0.8-ms start-threshold time constant.

**AccuGold-DiodeAGMS.xlt\AccuGold-DiodeAGMSmA.xlt**

AGMS trigger threshold of 5 ppm FS; OK for narrow pulses; 0.8-ms start-threshold time constant.

**AccuGold-AutoChamberDose.xlt\AccuGold-AutoChamberDoseMA.xlt**

Trigger threshold of 100 ppm FS or set by user in cell C54 to reduce false triggers; chamber rise-time correction; narrow pulses OK; 2-ms start-threshold time constant; larger signals.

**AccuGold-AutoDiodeDose.xlt\AccuGold-AutoDiodeDoseMA.xlt**

Trigger threshold of 25 ppm FS; narrow pulses OK; 0.6-ms start-threshold time constant; used for larger signals.

**AccuGold-General.xlt**

Full Excel interface; recommended for the average user only for alternative auxiliary inputs.

Trigger from multi-sensor with 5 ppm FS threshold. Full bandwidth; chamber rise-time corrected; OK for narrow pulses; 0.8-ms start-threshold time constant; larger signals.

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1. Full-scale (FS) refers to the dynamic range of the sensor. See the sensor specifications.

2. When measuring low-level signals, electrical interference can be important. Portable computers that are isolated from earth ground, such as those with rechargeable-battery power supplies, are susceptible to noise pickup from power-line sources. In that case, the computer should be earth-grounded using a Radcal-supplied grounding cable.

3. The chamber electrometer has a 28-ms 1/e rise-time. Compensation controlled by cells C36:C37 reduces it to near 1 ms, which will render fast pulses while including added noise.

## Using the supplied templates ----

Connect the digitizer to your computer using the USB cable. Attach your desired sensor(s), place them in the x-ray beam and open the relevant template. Excel macros must be enabled.

Hovering over a cell on the 'Data' sheet brings up a description of its parameter. (See below for details.) Click on 'Modify' to activate the User Form to make any desired parameter modifications, including selecting an anode-filter combination. Then execute Control-Shift-R or 'Start' to begin the measurement. When the cell labeled 'Measure' turns green, make an exposure.

During the exposure, measured results with units controlled by C27 are typically updated once per second and recorded in the blue-background area under 'Real-Time Outputs'. After the exposure is complete, additional information appears in the blue area under 'Post-Exposure Outputs' and, for the selected outputs, on the 'Record' sheet as well. The waveforms in I14:V65536 produced during the entire exposure are displayed on Excel charts, which can be manipulated as usual.

After an exposure is complete and before Control-Shift-R or 'Start' is executed again or Excel is closed, some of the parameters including anode-filter choice that control the Post-Exposure Outputs can be changed, and the post-exposure data will be re-analyzed after executing Control-Shift-P. Control-Shift-C clears the digitizer's USB connection, and, after Control-Shift-R or 'Start' is executed, it causes the recognition of sensor and parameter changes and permits the selections for the 'Record' sheet to change after erasing the old data. When 'Always update' has been checked on the User Form, sensor-related changes always update. See **Mode control**.

### Sensor relevance and the 'Parameters' sheet:

The outputs from sensors that are marked as irrelevant are completely ignored. The nine values in E3:M3 on the hidden 'Parameters' sheet control sensor relevance. A value of zero in one of these cells marks the associated sensor as irrelevant; any other value makes it relevant. The fractional part of the relevance entry scales the variable threshold for the stop trigger. If the zero value for a relevant sensor lies outside of the limits in rows 4 and 5, an error message occurs and operation stops. The relevance of 'D1' defines the relevance of the multi-sensor, and the relevancies of 'D2' through 'D5' are controlled automatically based on 'D1' relevance and the choice of mammo or diagnostic measurement. Any in-range thresholds listed under 'D4' are transferred to 'D1'.

### Operational sequence and triggering:

The three basic modes of operation are zero initializing, zero refining and radiation measuring. After Control-Shift-R or 'Start' is executed, the instrument begins the zero-initializing mode for determining the zero offsets. Then the instrument enters the zero-refining mode to track zero drifts. In this mode it triggers whenever any relevant start-trigger threshold is exceeded, causing radiation measurements to begin. (Pressing escape immediately exits all modes, possibly with a non-fatal error message.) While accumulating sensor data from the radiation exposure, the instrument produces its Real-Time Outputs at periodic intervals. When the exposure is complete, waveforms and other outputs under user control become available for display and storage. Then the instrument may return to the zero-initializing or zero-refining loops or to its wait state.

The value in C16 on 'Data' determines the length of the zero-initialization interval in units of 0.2-s blocks, while the value in C15 gives the length in blocks of a zero-displaying interval that precedes the start trigger. The value in C20 gives the maximum length of the zero-refining mode. A zero invokes the **Dose-only mode** as described below, and a one causes an immediate advance to the measure mode with the trigger thresholds still active (free-run mode). The value in C22 gives the maximum time in measure, while C23 gives the number of blocks in the waveform memory. (A 302-s waveform uses 1510 blocks or 124 MBytes. The sample interval is 0.1024 ms with a 1954-sample block.) The measure mode exits when the signal permanently falls below the stop threshold or its maximum time expires, which is limited to 2.45 days. This duration may exceed the memory size, causing the memory to hold the most-recent values as a circular buffer. Triggering may occur in the zero-refining or measure modes.

In order to reduce false triggers from high-frequency noise, the sensor signals that are applied to the start and stop thresholds are smoothed by independent exponential filters with time constants given in C24 and C25 in units of 0.1024-ms sample times. These filters do not affect the waveform but can delay the start and stop times for signals that are close to their thresholds. The ion-chamber rise-time correction controlled by C36 and C37 affects the trigger and the waveform.

Values on rows 6 and 7 on 'Parameters' give the start and fixed stop thresholds where  $2^{24}$  is full-scale; start thresholds above full-scale are ignored. The fractional part of the relevance entry for a given sensor produces a variable stop threshold as that fraction of the sensor's stop-filtered peak output, which slowly decays toward the local maximum and resets after a later start trigger. The stop threshold is the larger of the fixed and variable values.

The absolute value of the entry in C32 determines the number of blocks in the zero interval after the stop signal falls below the stop threshold. For positive values, a start-filtered signal during this interval above the larger of the start threshold and the last stop threshold limited to 0.01% FS will trigger a continuing measurement lasting until the stop-filtered signal again falls below the new stop threshold, after which the zero interval with a possible re-trigger repeats. The default value of 5 allows a 1-s period for re-starting the measurement after the end of a scout pulse or in pulsed fluoro. If that time is insufficient, increase C32. Negative values inhibit the re-trigger process.

For any relevant sensor, the start threshold from 'Parameters' can be replaced with the threshold in practical units such as dose rate or current in C54, as long as A54 contains the word 'Trigger' and C54 is greater than zero. If 'Parameters' specifies multiple start thresholds, the first relevant one on a fixed list is used. Dose rates use the units of C27, and the fixed stop threshold is replaced with 1/3 of this value. For the multi-sensor, the resolution is 1 nGy/s or 100 nR/s, with maximum values of 2.147 Gy/s or 214.7 R/s; exceeding these values causes an error message. If Dynalyzer kV at the auxiliary input defines the start threshold, a non-zero C54 can specify it in kV, and the fixed stop threshold becomes 90% of this value. If A54 contains '%', then a non-zero value in C54 will be interpreted as a percentage of full-scale for any relevant sensor; otherwise it is ignored. The 'Modify' User Form provides a convenient way to set these thresholds.

#### **Dose-only mode:**

When C20 on 'Data' is zero, Accu-Gold will enter the measure mode almost immediately after zeroing is complete with trigger thresholds disabled unless C54 contains a positive value. In order to accumulate dose from the multi-sensor when kV and filtration cannot be measured (usually because signal levels and dose rate are too small), this dose-only mode causes Accu-Gold to accumulate dose that is not corrected for kV and filtration and is accurate to about +/-10%. Dose accumulation continues until you press escape or the time from the value in C22 has passed.

If C54 contains a positive value, it sets a start threshold in units of A54 for the threshold selected on 'Parameters' as usual and enables normal triggering. The trigger source can be the multi-sensor, ion chamber, dose diode, Dynalyzer or mA probe. Set the C54 threshold to accommodate your measurement needs, being aware of the possibility of false triggers. A typical low-level diagnostic threshold using **AccuGold-DoseOnlyAGMS.xlt** is 0.08 (80 nGy/s), with mammo at 0.5 (500 nGy/s). This template applies to diagnostic measurements and assumes exposures of at least five seconds. It can also be used for mammo after selecting the proper anode-filter combination and increasing the value in C54. Use 'Modify' and the User Form. For the AGMS+ with other templates dose-only mode occurs automatically for dose rates below noise thresholds.

#### **Use with ion chambers:**

Whenever an ion chamber is relevant and the digitizer is first plugged into the USB and then Control-Shift-R or 'Start' is executed, a message indicating that the chamber zero is out of range may appear; respond by clicking OK. After a few such messages or the chamber is changed, a 60-s delay starts, during which the chamber and its bias should stabilize. During this stabilization period the status bar and the value in G3 show the remaining time in the 60-s period. If you are not interested in low-level measurements, you can shorten this period by pressing Escape.

For 1 in C28, measured temperature appears in C29, with a fixed pressure manually entered into C30. For 2, measured pressure is in C30, with a fixed temperature manually entered into C29. For 3, both are measured and appear in C29 and C30, which turn blue for in-range values and red for out-of-range values. Yellow indicates manual entry.

The 10A96 adapter supports 10X5 chambers, with F40 showing '10A96'. For a missing chamber, a related error message appears, and the chamber volume in F41 becomes 'Chamber ID Error'.

The ion-chamber signal first enters an electrometer with a  $1/e$  rise-time near 27.7 ms, which smooths the waveform and the trigger signals. If the value in C36 equals this time constant and only if C37 is positive, a digital filter reduces this rise-time to a value based on C37, where a value of 3 gives a response time near 2 ms. Faster chamber responses increase high-frequency noise.

### **Making and storing repeated measurements on the 'Record' sheet:**

A 1 in column C on 'Record' next to a listed output causes that output to be recorded in a selected row starting in column D. If the C column is 2 for a rate, its Real-Time Output applies. If the row-selecting cell is empty, the value in C1 defines the number of exposures that are made without needing to execute Control-Shift-R or 'Start' repeatedly; pressing Escape exits this process. If C2 is less than 1, repeated measurements overwrite the first one; otherwise they use subsequent rows. If C2 is either 0 or 1, re-zeroing between repeated exposures is skipped; otherwise zeroing is repeated. For the minimum delay between measurements, set C15, C20 and C32 on 'Data' to 1 to avoid zero refining and filling long zero buffers. See the 'Modify' User Form.

### **Real-time outputs:**

In the measure mode the Real-Time Outputs update at intervals given by the number of blocks in C26 (typically 5). E14 shows the time from the start-trigger block to the end of the update block; E28 gives the total number of re-triggers. E17:E18 show total dose so far and dose rate for the diode; E19:E20 show that for the ion chamber. E15:E16 refer to the auxiliary input, E21:E22 refer to the mA probe and E23:E27 apply to the AGMS. Average rates equal the sums over the update interval divided by its length, except that for two or more pulse leading edges in the interval the measurement of dose rate for the dose diode, the ion chamber and AGMS synchronizes to these edges. The waveform buffer, including kV and AGMS dose rate, is updated for each interval

After the measure mode ends, the 'RT Width' in E14 includes the time from the beginning of the start-trigger block to the end of the trailing-zero blocks, and the 'Trig. Width' gives the time from the start trigger to the stop trigger, after correcting for the stop-filter time constant. If the chamber is the trigger source, a further correction allows for its slower rise time, including the effect of its correction not being activated. Totals for dose, auxiliary inputs and the number of re-triggers use the entire interval of the 'RT Width', whereas kV, filtration, HVL and mAs use the time between the start and stop triggers. Rates use these totals divided by the corrected 'Trig Width'. An update always occurs for the last measure block to give totals for the entire exposure.

### **Waveform display and its bandwidth:**

The displayed waveform passes through a low-pass filter, followed by averaging and decimation. The absolute value of negative C39 values specifies the half-power (-3-dB) bandwidth. The filter has notches at integrally-related frequencies above its half-power cut-off and can be used to reject pick-up at line frequencies. A 18.6-Hz cut-off rejects 60 Hz and 15.56 Hz rejects 50 Hz. Positive C39 values specify the maximum number of points in the waveform and control filtering and decimation accordingly. The filtered values also provide the FWHM, which replaces the 'RT Width' in E14 after the graphs are plotted. Restrict the bandwidth to reduce noise unless you need to see high-frequency ripple or fast transients. Maximum bandwidth is 4785 Hz. A bandwidth in Hz equal to  $2238/N$  can be used to display the noise that a trigger with a filter factor of N will see.

The waveform is stored in I14:V65536, where column I gives time in s, columns J through R give sensor outputs as row 1 on 'Parameters', columns S and T are kV and dose rate from the AGMS, and columns U and V give the FFT spectrum. The signed value in C44 gives the waveform

beginning in seconds with respect to either the time of the start trigger or the stop trigger based on whether 'start' or 'stop' is in A44. Similarly signed values in C45 give the time of its end based on A45. If the number of graphed data points exceeds 65,523, the decimation increases to reduce the number of points below this value. The measure memory must contain the raw waveform.

If C55 is one, up to 6 graphs are created for all relevant outputs. Other positive values use binary encoding to select a restricted set of graphs. In these graphs the region of interest is in green, with the rest of the waveform being red. The charts are erased and re-created after each exposure. If C55 is zero, any existing charts will be left unchanged and can be defined manually.

### **Regions of Interest and post-exposure outputs:**

The Post-Exposure Outputs show the results from two user-selected regions of interest. The first region defined by C40 and C41 applies to the auxiliary input, the ion chamber, the dose diode and mA probe. The second defined by C42 and C43 involves the multi-sensor. These regions can exclude atypical parts of the exposure. For example, they can exclude scout pulses for mammo machines or distorted outputs at either edge of the exposure waveform. (The default exclusion is 5 ms on both edges.) The template '**AccuGold-AGMS-Dental.xlt**' provides an automatic setting of the multi-sensor region of interest to exclude any detected pre-heat region in the measurement of width, number of pulses, dose rate and kVp. See **Using the dental template**.

The values in C40 and C42 give the beginnings in seconds of the regions of interest with respect to either the time of the start trigger or the stop trigger depending on whether 'start' or 'stop' is in A40 and A42 respectively. Similarly values in C41 and C43 give the times of their ends depending on A41 and A43. These values can have either sign. When the beginning refers to a positive delay from the start trigger and the end refers to a negative delay preceding the stop trigger, the length of the region of interest is constrained to be equal to at least 50% of the trigger width and for exposures less than 40 ms is the lesser of the trigger width or 20 ms.

Columns J and M refer to the first region of interest and provide values for its width, number of pulses, pulse rate, mA, dose rate, dose per pulse and dose per mAs. When two or more distinct leading edges of pulses in a pulsating waveform are present, the measurement of pulse rate, dose per pulse and average pulse width may be synchronized to the pulse leading edges. If M11 contains -3, the synchronization is turned off. If it is -2, then only the diode is used, and -1 uses only the chamber. These values are remembered from one exposure to the next unless you change the value or the file is closed. If M11 contains zero or a positive number, then both the chamber and the diode can control the synchronization, with the diode being preferred as long as it is relevant. When applicable, M11 shows the average pulse width as ms-D or ms-C, with M5 giving the peak dose rate for the diode and M10 for the chamber.

Columns P and S refer to the second region of interest and provide values for its width, average kV, kVp, PPV, filtration, HVL, dose rate, dose per pulse, dose per mAs and pulse-repetition rate. When at least two distinct leading pulse edges of the D1 output are present, the measurements of pulse rate, dose per pulse and average pulse width are synchronized to these leading edges.

For pulse detection a 5-sample exponential filter is continuously applied to the selected sensor's signal and 2/3 of its maximum value provides the pulse-start threshold. When the sensor's signal exceeds this threshold, the threshold is reset to a low value and a pulse is counted during the region of interest. The threshold then rises to 1/3 of the maximum of the filtered signal minus a noise-related offset. When the signal falls below this threshold, its value without the offset is doubled to form the start threshold for the next pulse. For small AGMS values and all chamber and dose-diode values the filtered signal is used for comparisons to the thresholds.

To select the regions of interest after viewing the waveforms, place the cursor on the graph to get time values and enter the desired start and stop times in C40:C43. Executing Control-Shift-P will re-analyze the data with the new values until a new exposure is measured or Excel is closed. The 'Modify' routine with the User Form can be used to set or revise the regions of interest.

**Combo mode:**

The combo mode supports the Hologic Dimensions mammographic x-ray machine, which makes two or three exposures with different anode-filter combinations within a composite exposure. The template **AccuGoldCombo-Hologic.xlt** analyzes all of these separate exposures in one pass and provides AGMS+ or chamber outputs on the sheet 'Results' for each one that is present. These outputs for the exposure excluding scout pulses consist of dose, dose rate, width and number of pulses and also for the AGMS kVaverage and HVL. The outputs also include total dose, average dose rate and width for the composite exposure including scout pulses. The selected anode-filter combinations for this template are W/AI, W/Rh and W/Cu in that order, as specified along with the indices for special calibrations in C58:C63 on the hidden 'Data' sheet. The value in C64 defines a time in seconds that exceeds the width of the scout pulses and the maximum spacing between pulses within any separate exposure but is less than the minimum gap between these exposures. The number of blocks in C32 must exceed the maximum gap between exposures.

**Measuring kVp and PPV versus Average kV:**

Accu-Gold uses a FFT routine to determine the peak value of the ripple and outputs this value as kVp in S3. A weighted average of the waveform generates the practical-peak-voltage (PPV) output in S4. These outputs are useful for older generators that have ripple at multiples of the 50- or 60-Hz line frequency or that otherwise use frequencies less than the 4.8-kHz bandwidth of the measurement. Modern high-frequency generators produce nearly flat waveforms, and average kV provides a better measurement of the generator's output because of its reduced sensitivity to noise. A 1 in C47 turns off the kVp calculation and a 0 turns off kVp and PPV.

**The 'Modify' routine and the User Form:**

Pressing the 'Modify' button on 'Data' or executing Control-Shift-M causes the User Form that allows the setting of most of the above parameters to appear. Exit this form back to 'Data' with either 'Cancel' or 'OK', which can also be chosen with the 'Enter' key. For 'Cancel' the User Form inputs are ignored, and no changes are made to the Excel file. For 'OK' or 'Enter' changes on the User Form are recorded in the Excel file, which can be stored as a new template. Once various selections are made, those that are no longer possible are disabled or blanked. To run 'Modify' a digitizer connected to your desired sensors must be available to Accu-Gold Excel.

**Converter overloads and out-of-range measurements:**

For converter overloads the related cells turn red, with the post-exposure outputs also showing 'O/L'. AGMS overloads inhibit kV and dose-rate graphs. If the computed kV or filtration reaches its limit value, its real-time output becomes 'MIN' or 'MAX', with the limited post-exposure outputs displaying red. Limited kV values block kV graphs. HVL, kV for limited filtration only and filtration for limited kV only turn yellow to indicate reduced accuracy. Because AGMS dose depends only weakly on kV and filtration, AGMS dose values are left unchanged with added errors of up to 6%.

**Mean glandular dose:**

For the mammo anode-filter combinations of MoMo, MoRh, RhRh, WAg, WRh and WAI, the ratio of mean glandular dose to total dose is computed over industry-defined ranges of kV and HVL using polynomial fits to factors for a breast thickness of 4.2 cm and a 50/50 glandularity. This ratio multiplies the total dose in E26 on 'Data' giving mean glandular dose in E52 and in an output on 'Record'. Error messages appear if the measured HVL and/or kV are outside of the defined range. If the chosen anode-filter combination is not one of the above values, no output appears in E52.

**Mode control:**

The value in C14 controls operation when the exposure is complete. For a value of 0, agHost.dll and the USB link to the digitizer remain open, and parameters are not updated at the beginning of the next measurement. If the value is -3, then the parameters including temperature and pressure are updated at the next measurement. For Control-Shift-C or some errors, the USB link is closed, and parameters are always updated at the next measurement. If the value in C14 is 1, then the link and the DLL are always closed, releasing the working memory and flushing all stored values as though Excel had been closed. Other values in C14 are for factory testing only.

**Choice of Dose Units and Dose-Area Product (DAP) for Ion Chambers:**

The choice of Grays or Roentgens for dose units and the selection of DAP can be made on the 'Modify' user form under Units to define integer values in C27 on 'Data'. Even values select Grays with odd values for Roentgens. Choosing DAP to multiply dose by the area of the chamber adds 4 to C27, but DAP is computed only if the chamber supports it. Putting 2 or 3 into C27 invokes a test mode, where the chamber, dose-diode and PDC units become coulombs but the other units are unchanged. The DAP check box is only visible if the chamber is relevant and C27 is not 2 or 3.

**Multi-sensor calibrations:**

The Mammo Multi-Sensor (AGMS-M+) and the Combined Multi-Sensor (AGMS-DM+) are calibrated for Lorad/Hologic Mo/Mo and Mo/Rh; GE DMR Mo/Mo, Mo/Rh, Rh/Cu and Rh/Rh; and Selenia W/Rh, W/Ag and W/AI. The compression paddle is assumed to be used. The AGMS-DM+ and AGMS-D+ are calibrated for diagnostic machines with W/AI. The plus sensors operate only with the AGDM+ digitizer. The drop-down list in cell C31 gives the anode-filter combination, and the default "WAI-Diag" must be selected to use diagnostic calibrations.

For situations that are not covered by one of the 10 above-listed standard calibrations, corrections may be applied to kV, dose and HVL from the AGMS based on coefficients indexed by C56 on 'Data' using a related anode-filter combination. In order to choose one of these corrections, open the User Form with 'Modify' and proceed to the 'Special Calibrations' section. There select one of the five listed manufactures of x-ray machines or 'Other' if your desired one is not listed. Then view the drop-down list below the option buttons to see the machine types of this manufacturer for which corrections exist. You must select one type for this mode to continue. Then the proper anode-filter combination and index will be automatically selected. To cancel using the Special Calibrations select the 'None' button.

Calibration tables for the old AGMS-D and AGMS-M multi-sensors and the data for the Special Calibrations are stored in the macro file. For the AGMS-D sensor C31 is not used. The new plus sensors contain the calibration tables within a flash memory in the multi-sensor.

**Macro-file details:**

The macros that interface with the Accu-Gold are contained in the file AccuGoldExcelMacro.xls. For software versions 1.13.4360 and later this file is stored in the Windows System folder (SysWOW64) and is accessible from anywhere on your computer. When the operational file is opened, macros as a part of it open the macro file and run it to establish communication with the Accu-Gold digitizer. If the operational file has been moved to a location where the macro file is no longer available, you will see an error message when the file opens. To avoid this error message when the operational file has been moved after data accumulation is complete, you will be asked at the time of closing of the operational file with the macro file still present if you want to keep the auto-activation feature. If you no longer wish to add Accu-Gold data to this workbook, answer "No". Then subsequent openings of this file will not generate the error message or run the macro file. If you change your mind and want to use Accu-Gold again with this workbook, open it and then open the macro file in Excel; the macros will automatically activate.



### Using the dental template (Type Code 1) ----

The template '**AccuGold-AGMS-Dental.xlt**' handles the output of dental x-ray machines that may have an initial low-dose-rate pre-heat region and variable kVp during a subsequent period. Proper selection of the AGMS region of interest can exclude the pre-heat region in the measurement of width, number of pulses, dose rate and kVp, with total dose still including the entire exposure. Positive fractional values in C40 cause the region of interest to begin automatically at that fraction of the peak output of the trigger source, which is usually D1 or dose rate; a value of zero or less applies the normal specification for the start of the region of interest. A positive value in C41 defines the fraction of the region that is excluded from the kVp measurement and is limited to 0.8. Negative values specify the exclusion in seconds such that at least 25 ms are not excluded.

### Using the light meter (Type Code 2) ----

The special template **AccuGold-LightMeter.xlt** supports operation with the light meter, which must be plugged into the auxiliary input to the digitizer. The base unit of the light meter contains a photo-diode that can be exposed to ambient light through an optical filter, which simulates the spectral response of the human eye, in order to measure illuminance in lx. An adapter with a 1:1 relay lens can be screwed onto the base unit above the photo-diode for the measurement of luminance in cd/m<sup>2</sup> through an aperture with a 10-mm diameter. Whenever Control-Shift-R is executed, the existence of the adapter is queried, and the right units are automatically selected.

A normally-open push-button switch in the light-meter base unit causes its output to fall to the zero level even while exposed to light, and this state is present during the zeroing modes. In order to make a measurement, depress the push-button to close the switch when the Measure cell turns green and observe the real-time 'Aux Rate' output. Then adjust the placement of the meter such that it is located where you desire to measure the luminance or the illuminance. When you are at the proper location and the reading steadies, release the push-button. The resulting sudden drop in the auxiliary output then causes the template to record the last real-time output whose signals, after stop-threshold filtering, continuously exceed the adaptive stop threshold. (The light-meter template uses a special three-block [0.6-s] update rate for the real-time outputs.) This procedure may be repeated many times as re-triggers extend the measurement, resulting in many recorded values in cell E51 and below that also appear in subsequent columns on a single row on the 'Record' sheet with the proper units in the last column. (See 'Making repeated measurements'.) The measuring mode ends when the output remains below its re-trigger threshold for 30 blocks or 6 s; changing the value in C32 varies this number. The default start threshold is 0.0001% of full scale or about 0.05 in light units, but, if C54 is not blank, its value sets this threshold, which can be raised to avoid false triggers unless low light levels are being measured.

### Using the DAPCheckPlus (Type Code 3) ----

The DAPCheckPlus (PDC) must be plugged into the auxiliary input of the digitizer using the supplied cable. Then the special template **AccuGold-DAPCheckPlus.xlt** supports the measurement of dose-area product (DAP) and its rate in radiation per minute. In most other aspects this template is similar to **AccuGold-Chamber.xlt**. Older versions of the DAPCheckPlus that plug into both the ion-chamber and the auxiliary inputs are also supported.

### Using voltage-based auxiliary inputs ----

The adapters for input voltage (AGVM) and Dynalyzer kV (AGKV) may also be connected to the AGDM+ digitizer, and their outputs can be displayed using customized versions of **AccuGold-General.xlt**. The standard input adapters measure 0 to +5 V or 0 to -5 V, and the standard Dynalyzer adapter, which is internal to the Dynalyzer IV, connects to its A+C output to measure 0 to 150 kV. To activate these measurements, unhide the 'Parameters' sheet of **AccuGold-General.xlt** and place a 1 in cell I3. The other settings on this sheet, including the relevance values of the third row, depend on the desired sensors that you want to combine with the auxiliary

output; currently the sheet requires all sensors after changing I3. After providing your inputs to this sheet, you should hide it once again. Alternatively activate the User Form with 'Modify' and simply choose your desired relevant sensors including the Dynalyzer. Then save these choices with 'OK'.

The adapter EPROM automatically chooses the correct units for the auxiliary outputs. Control inputs in column 'C' on the 'Record' sheet determine what will be displayed on that sheet including the auxiliary outputs.

When the voltage-input or Dynalyzer-voltage adapters are connected to the auxiliary input, an option exists to use a fixed voltage referred to the A/D-converter input for the zero-offset correction instead of determining this voltage with the auto-zero routine at the beginning of each measurement sequence. This property accommodates cases where the value just before the measurement does not represent the desired offset. The value in C34 on 'Data' controls this zero-offset correction. If C34 contains non-numeric characters including blank, then normal auto-zero is performed at the beginning of each measurement. For numeric entries, their value is used directly as the fixed zero offset in volts at the A/D converter until changed by the user. This offset can be measured at the output test point on the adapter.

For the special case where C34 contains precisely zero (not blank), the first operation after pressing Control-Shift-R or 'Start' will provide a brief measurement of the auxiliary output only, and this value will be entered into C34 for subsequent use as the fixed zero offset. If at the time of this measurement your input to the adapter represents the proper zero value, then subtracting the value in C34 will provide the correct offset correction. Because C34 will no longer contain exactly zero, subsequent measurements will use the fixed offset as above. You can repeat this process by changing C34 back to zero. The 'Auto Zero' check box and the list box below it allow the 'Modify' routine with the User Form to be used to control these modes.

If the mode bit from the voltage-input adapter is high, the sign of the displayed output is reversed to accommodate adapters that invert their input signal (e.g. 0 to -5 V). For the Dynalyzer IV with a built-in 90M9-type interface its output enters the digitizer's mA input to show anode current.

For the AGKV and Dynalyzer IV, the PPV and kVp outputs of the Fourier-Transform algorithm are available depending on the value in C47. The units digit in this cell controls these outputs for the multi-sensors, and the tens digit refers to the Dynalyzer. 0x is average kV only in J5; 1x is PPV in J4 and average kV in J5; 2x is average kV in E16, PPV in J4 and kVp in J5; and 3x outputs kVp in J4 with average kV in J5 without PPV. Here 'average kV' refers to the average value from the first region of interest. Or use the check boxes in the 'kV Analysis' section of the User Form for these selections.

## Off-line data storage and analysis ----

When the accumulation and processing of data from the digitizer is complete, you may automatically store waveform data with its associated calibration and control values in three files on the hard drive. A53 defines the path to the storage location of these disk files, and C52 has a suffix number to define the files uniquely; a value less than one inhibits file storage. If A53 contains "Default", the path to the operational file is used if it is defined, that is if the operational file is not a template or its direct clone. Until data have been erased, Control-Shift-W stores the data manually.

The template **ReanalyzeAccuGold.xlt** analyzes the above disk files without the digitizer being present after executing Control-Shift-A. A53 defines the path to the storage location of the disk files, and C52 has a suffix number to define the files uniquely. If A53 contains "Default", the path to the operational file is used if it is defined. The values in the yellow cells in the template can be changed, allowing the analysis of the data using different values.

## Recording the digitizer output and playing it back ----

This feature is only intended for the sophisticated user. Because the default installation does not provide a control file, this feature is disabled until the user performs the following procedure.

Provision has been made in agHost.dll for writing the binary data received from the digitizer over the USB to a file on the hard drive and then at a later time reading those data back into the processing stream for re-analysis. Because this interception of the digitizer data occurs at the beginning of the data processing in agHost.dll, which supports various user interfaces including Accu-Gold Excel and Accu-Gold 2, the operation of these interfaces and effects of changing parameters or algorithms can be compared using the same input data. The writing of data to the disk file does not interfere with the analysis of those data at the time that they were generated.

The operation of this feature is under the control of the file C:\AGname.txt that the user must create on the root directory of the C drive and populate as follows. (If the root directory is protected, use C:\AGDMdata\AGname.txt instead of a root entry; any such file in the root takes precedence.) The first line, which is limited to 98 characters, contains the path and name of the data file in which the digitizer output is to be stored. For example, it could be C:\\Program Files (x86)\\Radcal\\AGstore.txt; note that the backslashes in the path are doubled to avoid confusion with escape sequences in the "C" language. If the second line contains the single character 'w', agHost.dll will write the digitizer data into the specified file, which will be created if it does not exist and otherwise cleared. If that character is 'r', the data will be read from the file if it exists and the message "Using recorded data." appears; otherwise an error message occurs. For any other characters including blank this feature is turned off, as is also the case when the control file cannot be found. The control file can remain open while operation is proceeding but must be saved before any changes can take effect.

The analysis of the outputs from the digitizer depends on the calibration that is associated with it and its relevant sensors. If different hardware is used to re-analyze these outputs, the results generally will be different because of the variations in calibration factors. To overcome this problem the 'w' in the control file also causes the writing to the beginning of the disk file of calibration factors consisting of those for the digitizer and its sensors and of those for the multi-sensor. Then when data is read using 'r' in the control file, the stored calibrations replace the current ones. In order to allow the user to continue to use some or all of the current calibrations, a two-bit integer with a value of 0 to 3 can follow the 'r' and cause a stored calibration to be ignored. If bit 0 (LSbit) is a one, the stored digitizer and sensor calibration is ignored; and a one in the ones bit (MSbit) ignores the calibration from the AGMS. All combinations of ones and zeros for two bits are allowed. If an 'o' follows the 'w' for data recording, the storing of the calibrations is omitted. Current calibrations replace any missing stored calibrations.

A read or a write only occurs once after each call to the agHost.dll CmndState function, which is involved in the update of parameters and is always called at start up or in response to Control-Shift-C. (See **Mode control**.) When Control-Shift-R or 'Start' begins each measurement sequence in Accu-Gold Excel, a 1 or -3 in C14 on 'Data' causes CmndState to be called between measurements, allowing a read or write for the next measurement. A 'w' in the control file for these cases causes overwrites of the previously-recorded data and the last recording remains. To avoid these overwrites either remove the 'w' in the control file or re-name the disk file before starting the next measurement. If C1 on 'Record' is greater than one or C14 is zero, multiple measurements will be made without calling CmndState between them. In that case only the first measurement in the sequence will experience a read or write. (Note that this mode is typical for Accu-Gold 2, which will need to be stopped and restarted to allow the next read or write.)

The read-write process occurs once per 0.2-s block containing 60,574 bytes. All data bytes are involved, starting with initialize and continuing through the end of measure. For long exposures or long waits in refine the data file can have a size in the 100-megabyte range. Most modern computers have disk sizes that are large compared to these values; no extra RAM is needed.

## Common Error Messages:

Cannot find AccuGoldExcelMacro.xls:

The macros did not load because the security settings prevented it. See 'Enable Macros.pdf' in the Manuals folder.

The macro file with its path and name does not exist:

The indicated file is not in the Windows System folder with the indicated path.

Driver failed to open:

Windows did not load the driver, probably because the digitizer is not connected. C3 turns rose.

Driver not found:

The drivers were not installed during setup. The color of cell C3 turns rose. Call tech support.

A relevant sensor was not found:

Sensors that were needed for this template were not connected. Cells in D35:D48 containing a sensor name and S/N turn red for the missing sensors; green shows that a sensor is connected.

A relevant zero value is out of range:

A measured zero value is outside of specified limits. A sensor was exposed to radiation during the zero interval or is defective. The zero-value cell for the responsible sensor(s) in J12:R12 turns red.

Insufficient dose signal:

The width of the waveform that is specified in cells C40 and C41 is too small. Change these values to include more of the waveform or increase the width of the exposure pulse. Triggering from a brief noise transient can also cause this error.

Insufficient kV signal:

The width of the waveform that is specified in cells C42 and C43 is too small. Change these values to include more of the waveform or increase the width of the exposure pulse. Triggering from a brief noise transient can also cause this error.

Insufficient valid points for FFT kVp:

The width of the waveform that is specified in cells C42 and C43 is too small for a valid kVp output. Change these values to include more of the waveform or increase the width and/or the intensity of the exposure pulse. Triggering from a brief noise transient can also cause this error. The selected part of the waveform can be too narrow or too small for a valid kVp measurement but still wide enough and large enough to measure average kV and dose.

Post analysis requires stored data from digitizer:

The change in parameters cannot be applied to the current data. Make a new measurement.

The exposure was made too soon:

An insufficient number of blocks was accumulated in Zero Initialize and Zero Refine to fill the zero buffer. Wait until the Measure cell turns green before making an exposure.

A light meter is not connected:

The light-meter template is being used without connecting a light meter to the auxiliary input.

A PDC is not connected:

The DAPCheck template is being used without connecting a DAPCheck to the auxiliary input.

for use with: Accu-Gold+ / Rapid-Gold+

**ACCU-GOLD+**



**RAPID-GOLD+**



### SPECIFICATIONS / TECHNICAL DATA:

All specifications subject to change.

TYPE		Anode / Filter	Tube	kV $\pm 2\%$ or $\pm 0.7\text{kV}$ whichever is greater	Filt (um)	hvl (mm Al) $\pm 10\%$ or $\pm 0.05$ mm Al whichever is greater
Rad/Fluoro Dental /Mammo (AGMS-DM+) ***	Mammo (AGMS-M+) *	Mo/Mo	General	21-49	16-44	0.21-0.50
		Mo/Rh	General	21-49	6-42	0.18-0.56
		Mo/Mo	GE	22-48	16-44	0.24-0.51
		Mo/Rh	GE	22-48	6-42	0.20-0.56
		Rh/Rh	GE	25-48	12-80	0.27-0.78
		W/Ag	General	20-40	12-80	0.17-0.78
		W/Rh	General	20-40	12-78	0.17-0.69
		W/Al	General	20-50	300-3030	0.16-1.96
	Rad/Fluoro/Dental (AGMS-D+)	W/Al	General	40-160	2-24 mm	1.3-13.5**
				50-160	25-40 mm	
Rad/Fluoro/Dental (AGMS-D+) and Mammo (AGMS-M+)		Dose†		Dose Rate / Pulse Rate†		Time
		80 nGy – >100 Gy, $\pm 5\%$ (9.1 $\mu\text{R}$ – >11 kR, $\pm 5\%$ )		80 nGy/s – 200 mGy/s, $\pm 5\%$ (0.55 mR/min – 1.4 kR/min, $\pm 5\%$ ) 1 - 120 pulses/s Pulse Length: 1.0ms-300s		1 ms – 300 s $\pm 0.1\%$ or 0.2 ms

\* GE Healthcare Senographe Pristina Calibration is  $\pm 5\%$ , Rh/Ag, Mo/Cu, Rh/Cu and IQST beam quality.

\*\* or  $\pm 0.2$  mm Al whichever is greater

\*\*\* For AGMS-D+ and AGMS-DM+ Dose & Dose Rate measurements below 80 nGy, select model DDX6-WL Solid State Dose Sensor or model 10X6-60 ion chamber.

† Auto corrected to within  $\pm 2\%$  for 1.5 mm to 40 mm Al total filtration.

#### Reference conditions

**Mammo:** 2.2 mm thick polycarbonate compression paddle in beam for all measurements (kVp, dose, hvl). Calibrated using large focal spot.

**Rad/Fluoro/Dental:** 12° Tungsten anode.

#### Size

35.6 mm x 20.0 mm x 11.8 mm

#### Reference point

Round marking 1 cm diameter  
midline – 3.2 mm from top surface.

#### Working temperature range

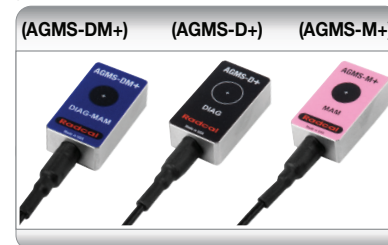
15°C - 35°C (Storage: 0°C / 32°F - 60°C / 140°F)

#### Humidity

< 80 % (without condensation)

#### Pressure

700 hPa – 1060 hPa



for use with: Accu-Gold+ / Accu-Dose+

**ACCUGOLD+**



**ACCUDOSE+**



### 10X6-6

#### General Purpose In Beam Chamber

A well documented wide dynamic range chamber with many dose and rate applications. Also recommended for measuring exposure time in Auto Dose mode.



### 10X6-6M

#### Dedicated Mammography Chamber

A world standard for mammography, ready for any mammographic tube track-filter combination. Extraordinary flat energy response over 10 - 40 keV has been documented in technical papers and makes corrections unnecessary. Also recommended for measuring exposure time in Auto Dose mode.



### 10X6-10

#### General Purpose In Beam Chamber

This 10cc multi-purpose ion chamber is suitable for measuring R&F as well fluoro. It's small size (5cm diameter x 1cm thick), excellent energy response and x-ray transparency makes it ideal for those difficult measurements where space is at a minimum.



### 10X6-60/60E

#### Service and Image Intensifier Chamber

The dynamic range and thin profile is ideal for Input Dose at the Image Intensifier, High dose rates encountered in Fluoroscopy and Cine, spot film devices & other special procedures. Additionally, the -60E (extended) chamber's increased sensitivity at lower energies turns the chamber into a "Universal" detector, covering mammography through R&F and beyond.



### 10X6-3CT

#### Computed Tomography Dose Index (CTDI) and DWP or DLP Chamber

Although designed specifically for CT X-ray beam measurements, either free-in-air or mounted in a head or body phantom, it can be used for DWP and DLP applications such as Dental x-ray measurements, due to the chambers excellent energy and partial volume response as well as uniformity along its entire 10 cm active length.



### 10X6-180

#### Leakage and Low Level Measurements Chamber

Designed for leakage measurements. Cross-section of 100 cm<sup>2</sup> and volume of 180 cm<sup>3</sup>. Also for very low dose to image receptor.



### 10X6-1800

#### Radiation Protection Chamber

For low-level radiation measurements such as shielding leakage, irradiator and environmental. Unlike typical survey meters, the 1800 cm<sup>3</sup> volume chamber offers improved accuracy over a wider dynamic range.



### 10X6-0.18

#### High Dose Rate Chamber

For in-beam measurements of high-intensity gamma radiation. Gamma irradiators and beam type irradiators. The fully guarded chamber is mounted at the end of a 3 m low noise triax cable.



### 10X6-0.6

#### High Dose Rate Chamber

This high dose rate chamber provides an excellent response at therapy and other high energy, high dose rate applications. The fully guarded chamber is mounted at the end of a 12 m low noise triax cable. Can be used with or without build up cap depending upon the application.



### 10X6-0.6CT

#### Modern Wide Beam Multi-Slice CT Chamber

0.6cc thimble chamber as described in the AAPM Report No. 111 "Comprehensive Methodology for the Evaluation of Radiation Dose in X-ray Computed Tomography." Ideal for dose measurements in modern wide beam multi-slice CT. Calibrated using X-rays @ 150 kVp, Phantom adapter included.



for use with: Accu-Gold+ / Accu-Dose+

**ACCUGOLD+**



**ACCUDOSE+**



### SPECIFICATIONS / TECHNICAL DATA:

All specifications subject to change.

CHAMBERS	10x6-6		10x6-6M		10x6-10 <sup>1</sup>		10X6-60/60E		10x6-3CT *		10x6-180		10x6-1800		10x6-0.18		10X6-0.6/0.6CT	
<b>Min Rate</b>	2 µR/s	20 nGy/s	2 µR/s	20 nGy/s	2 µR/s	20 nGy/s	200 nR/s	2.0 nGy/s	2 µR/s	20 nGy/s	100 nR/s	1 nGy/s	5 nR/s	50 pGy/s	50 µR/s	500 nGy/s	20 µR/s	200 nGy/s
<b>Max Rate</b>	17 R/s	149 mGy/s	10 R/s	88 mGy/s	17 R/s	149 mGy/s	2 R/s	19 mGy/s	40 R/s	350 mGy/s	0.6 R/s	4.9 mGy/s	18 mR/s	0.2 mGy/s	720 R/s	6.31 Gy/s	133 R/s	1.17 Gy/s
<b>Min Dose</b>	10 µR	100 nGy	10 µR	100 nGy	10 µR	100 nGy	1 µR	10 nGy	20 µR	200 nGy	200 nR	2 nGy	20 nR	200 pGy	200 µR	2 µGy	100 µR	1 µGy
<b>Max Dose</b>	59 kR	516 Gy	59 kR	516 Gy	59 kR	516 Gy	5.9 kR	52 Gy	118 kR	1 kGy	2.0 kR	17 Gy	196 R	1.7 Gy	2 MR	17 kGy	589 kR	5 kGy
<b>Cine Specifications</b>	0.1 µR/f - >1 R/f 1 nGy/f - >10 mGy/f		N/A		0.1 µR/f ->1 R/f 1 nGy/fr -> 10 mGy/f		0.01 µR/f ->100 mR/f 0.1 nGy/f ->1.0 mGy/f		N/A		N/A		N/A		N/A		N/A	
<b>Calibration Accuracy</b>	±4% using X-rays @ 60kVp and 2.8 mm AL HVL		±4% using X-rays @ 30kVp and 0.50 mm AL HVL		±5% using X-rays @ 150 kVp & 10.2 mm Al hvl		-60 ±4% using X-rays @ 150kVp and 10.2 mm AL HVL	-60E ±4% using X-rays @ 50kVp and 0.88 mm AL HVL	±4% using X-rays @ 150kVp and 10.2 mm AL HVL		±4% using X-rays @ 150kVp and 10.2 mm AL HVL		±4% using X-rays @ 150kVp and 10.2 mm AL HVL		±4% @ <sup>60</sup> Co		0.6 ±4% @ <sup>60</sup> Co	0.6CT ±4% using x-rays @ 150 kVp and 10.2mm Al HVL
<b>Exposure Rate Dependence</b>	±5%, 0.4 mR/s to 80 R/s, up to 500 R/s for 50 us pulses		±5%, 0.02 R/min to 600 R/min		±5%, 0.4 mR/s to 80 R/s, up to 500 R/s for 50 us pulses		±5%, 2 mR/min to 199 R/min		±2%, 2mR/s to 40 R/s		±5%, 20 mR/hr to 2000 R/hr		+0%, -5%, 0.1 mR/hr to 20R/hr, -10% to 65 R/hr		±2%, 3 mR/s to 720 R/s		±2%, 10 mR/s to 100 R/s	
<b>Energy Dependence</b>	±5%, 30 keV to 1.33 MeV (with build-up material)		±5%, 10 keV to 40 keV		±5%, 1.5 mm Al to 15 mm Al hvl		-60 ±5% 20 keV to 1.33 MeV (with build-up material)	-60E ±5% 0.2 mm Al HVL to 1.33 MeV (with build-up material)	±5%, 3 to 20 mm AL HVL		±5%, 30 keV to 1.33 MeV (with build up material)		±5%, 33 keV to 1.33 MeV (with build up material)		±5%, 45 keV to 1.33 MeV		0.6 ±5%, 40 keV to 1.33 MeV (with build up cap)	0.6CT ±5% 3 to 20 mm Al HVL
<b>Active Length / Area</b>	27.6 mm		N/A		N/A		N/A		100 mm		100 cm <sup>2</sup> **		165 mm		8.1 mm		19.7 mm	
<b>Construction</b>	Polycarbonate walls and electrode; conductive graphite interior coating; 6 cm <sup>3</sup> active volume; 0.05kg		0.7 mg/cm <sup>2</sup> metalized polyester window; polyacetal exterior; 6cm <sup>3</sup> active volume; 0.08kg		Polycarbonate walls and electrode. Conductive graphite exterior coating. 10.3 cm <sup>3</sup> active volume. 1.5m low noise triax cable. 0.05kg		Polycarbonate walls; conductive graphite exterior coating; 60 cm <sup>3</sup> active volume, 0.5 m low-noise triax cable; 0.13kg		C552 air-equivalent walls and electrode; polyacetal exterior cap; 3 cm <sup>3</sup> active volume; 1.5m, low noise triax cable; 0.11kg		Polycarbonate walls and electrode; conductive graphite exterior coating; 180 cm <sup>3</sup> active volume; 0.11kg		Polycarbonate walls and electrode; conductive graphite exterior coating; 1800 cm <sup>3</sup> active volume; 0.54 kg		C552 air-equivalent walls and electrode; polyacetal exterior cap, 0.18 cm <sup>3</sup> active volume, 3m triax cable		C552 air-equivalent walls and electrode; polyacetal exterior cap, 0.6 cm <sup>3</sup> active volume, 0.6 12m triax cable	

Calibration Accuracy ± 4 %, Energy Dependence ± 5 %. Plug-and-play. \* **Uniformity Along Length & Partial Volume Exposure** ±5%, to within 0.25 cm of chamber ends for a constant volume slice. Active length of 10 cm.

<sup>1</sup>Specifications apply when used with Accu-series control unit. \*\* **Complies with CFR 21**

### DDX6-WL

Diagnostic range  
(Low dose rates)



for use with: Accu-Gold+ / Rapid-Gold+ / Accu-Dose+

**ACCUGOLD+**

**RAPIDGOLD+**

**ACCUDOSE+**

#### SPECIFICATIONS / TECHNICAL DATA:

All specifications subject to change.

SENSORS:	DDX6-WL	
Min Rate:	50 nR/s	500 pGy/s
Max Rate:	0.65 R/s	5.7mGy/s
Min Dose:	200 nR	2 nGy
Max Dose:	1.8 kR	15 Gy
Accuracy:	±5% using X-rays @ 80kVp with 2.5 mm Al total filtration (IEC 61267 RQR-6)	
Energy dependence:	± 5% from 50 kVp to 120 kVp at 2.5 mm Al	
Filtration dependence:	+10% to -5% from 2.5 mm Al to 23 mm Al	