



The **AZTEC 3** Gold & Uranium Analyser



The **AZTEC 3** gold & uranium analyser is a unique automated assaying system capable of:

- ◆ Providing precise, reliable and rapid analyses to support responsive decision making
- ◆ Raising the productivity of your laboratory or mine
- ◆ Reducing assay unit costs by up to 70%
- ◆ Reducing the potential dangers of lead pollution and high temperature furnace operations inherent with traditional fire assay techniques.

Since its introduction to gold mining in 1987, the **AZTEC** has achieved great success in South Africa, and has become an invaluable tool to the assay laboratory. The growing number of users benefiting from this proven technology include:

- ◆ Eastplats Platinum Mine in North West.
- ◆ Performance Laboratory (Rand Uranium).
- ◆ Goldfields Mining Company, Carltonville, South Africa.

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Applications

X-ray fluorescence is a well established, and widely used technique for the elemental analysis of materials. However, the suitability of the technique is dependent upon the concentrations of the elements being measured. In particular, the X-ray fluorescence based instrumentation operating at photon energies below 35keV, is unable to provide sufficiently precise and rapid analyses for the extremely low concentrations of elements such as gold and platinum found in commercially viable ores. The innovative, and leading edge high energy K X-ray fluorescence (KXRF) technology of the **AZTEC 3** analyser breaks through that barrier, and provides an instrumental technique capable of revolutionising the traditional fire assay techniques for these precious metals. Designed in conjunction with the major gold mining companies, and employing the latest in electronic and computing technologies, the **AZTEC 3** incorporates a number of major technological advances arising from several years of intensive research.

Users of the **AZTEC** have discovered that its benefits and features make it well suited to numerous applications in gold mining and mineral processing. The most common of these are:

Exploration

- ◆ Screening of geological and exploration samples to separate out those that demand either longer **AZTEC** analysis or more expensive fire assay.

Mining

- ◆ Grade control samples for mining control and ore reserve evaluation.
- ◆ Checks on assays to swiftly verify unexpected results or provide rapid support for key management decisions.

Mill/Plant Operations

- ◆ Conveyor belt sample analyses for ore accounting and operational control purposes.
- ◆ Gold bearing carbon samples for control of the carbon-in-pulp process. Samples only require drying, and can be analysed to precisions of the order of 5% in under a minute.
- ◆ Gold plant or mill head samples for process monitoring and gold accounting.

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Benefits

The **AZTEC**'s application of high energy K X-ray fluorescence overcomes many of the recognised deficiencies of the traditional, and well known, fire assay and low energy X-ray fluorescence technologies. The benefits that the **AZTEC** can provide to both mining and commercial assay laboratories are considerable.

- 1 Accurate, precise, reliable and rapid assaying of powdered ore samples. **AZTEC** is capable of analysing ore grades in the range 0.01g/t to 10,000g/t, but is best suited to grades of 0.5g/t and higher. A substantial body of experimental evidence demonstrates the **AZTEC** to be at least as accurate and reliable as fire assay. Specific advantages over the traditional assay procedures include:
 - ◆ The direct measurement of gold as opposed to bullion concentration, saving the costs of expensive silver parting techniques.
 - ◆ The lower potential for error due to human intervention in the assay process.
 - ◆ Reduced sampling error from analysing at least 50g to 60g of sample.
 - ◆ Reduced errors from mineralogical and matrix element effects .

- 2 The **AZTEC** is an automated, high throughput, cost effective analytical instrument requiring little space and the minimum of attention and supervision. Throughput and unit cost are governed by the specific application. As a guide, the standard **AZTEC 3.1** configuration is able to analyse a sample to a precision of 0.3g/t in around 100 seconds, and is rated to perform approximately 1,250* analyses per day to this level of precision. (*Applicable to ores with low mercury content.)

- 3 X-ray analysis provides environmental and health advantages by eliminating the significant dangers from lead pollution inherent in fire assay. Other potential pollution hazards of fire assay also eliminated include those of mercury and arsenic, driven off from the sample during heating, and boron and fluoride compounds, present in the fluxing reagents.

- 4 The **AZTEC** power consumption of 7kW is a small fraction of that required for fire assay furnaces. The health hazards and unpleasant working environment associated with high temperature furnace operations are also eliminated.
- 5 Highly flexible in meeting changing operating conditions. Samples can be analysed to any selected level of precision by varying the analysis time, so trading off throughput against level of confidence. Routine analyses can readily be interrupted for urgent assays with minimal disruption to the laboratory.
- 6 Sample preparation is simple and inexpensive. No costly chemical reagents, consumable items or processing are required. Samples are presented to the X-rays in plastic tubes as dry powders, ground to less than 100µm. No pressing of powders is required.
- 7 Operation of the **AZTEC** is simple and training of new operators requires only 2 to 3 days.
- 8 “Lost” assays are eliminated due to the non-destructive nature of the process and automatic, user defined, quality control of sample loading and instrument stability is incorporated into the operating software.
- 9 The instrument configuration can be customised to meet specific customer requirements regarding speed, precision and price. Instrument configurations can also be easily upgraded to suit changing circumstances.
- 10 The **AZTEC** can be integrated both into a wider automated network of equipment, and into computerised laboratory and mine information management systems.

Principal of Operation

The **AZTEC 3** uses the well known energy dispersive X-ray fluorescence technique to measure the concentrations of gold, uranium and other high atomic number elements. In contrast to traditional low energy X-ray spectrometer systems, the **AZTEC** excites the high energy K X-rays of the relevant elements. By virtue of using the more penetrating higher energy photons, sample preparation is simplified and sampling errors significantly reduced. Interference effects from other elements are measured and corrected for, ensuring that their effects are minimised.

Sample preparation consists simply of grinding the dry sample to less than 100µm, and filling an 84cm³ sample tube. This provides about 100g of sample. Sample tubes are loaded into magazines which are then inserted into the instrument. Sample tubes are automatically taken from their magazines, in turn, by a robot and inserted into the X-ray chamber. Approximately 50g to 60g of sample is irradiated by a primary X-ray beam to promote the secondary fluorescence. The resultant X-rays are detected and processed by an innovative proprietary system of solid state detectors and electronics. No residual radiation remains in the samples and they can be safely analysed further by **AZTEC** or other analytical techniques.

Data processing and control is effected by a personal computer employing the Windows™ operating system. Operation of the instrument is straightforward, and training of operators takes typically two to three days. The operational software is designed to be user friendly and allows considerable flexibility in:

- ◆ How individual samples or batches of samples are registered for analysis
- ◆ Specifying the analytical parameters for samples or sample batches
- ◆ Specifying the automatic quality control systems required

Operation is designed to be continuous over a 24 hour period. No time is lost for calibration, as this takes place automatically while samples are being changed. Fault diagnosis is computerised and data-logged to facilitate maintenance and minimise down-time.

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The statistics of X-ray counting means that, the longer the counting period adopted, the better the absolute precision of a single measurement. This relationship allows the user to trade off precision against instrument throughput according to the sample type and the specific information requirements. Figure 1 illustrates the relationship for the standard **AZTEC 3.1** configuration*. Further flexibility in throughput is available by analysing sample batches, either to an absolute level of precision, or to a selected percentage precision. The typical specification for Uranium at the indicated daily throughput below in figure 1, achieves a standard deviation of 10ppm in low levels and 20ppm at higher levels of uranium oxide at a counting time of 100 seconds.

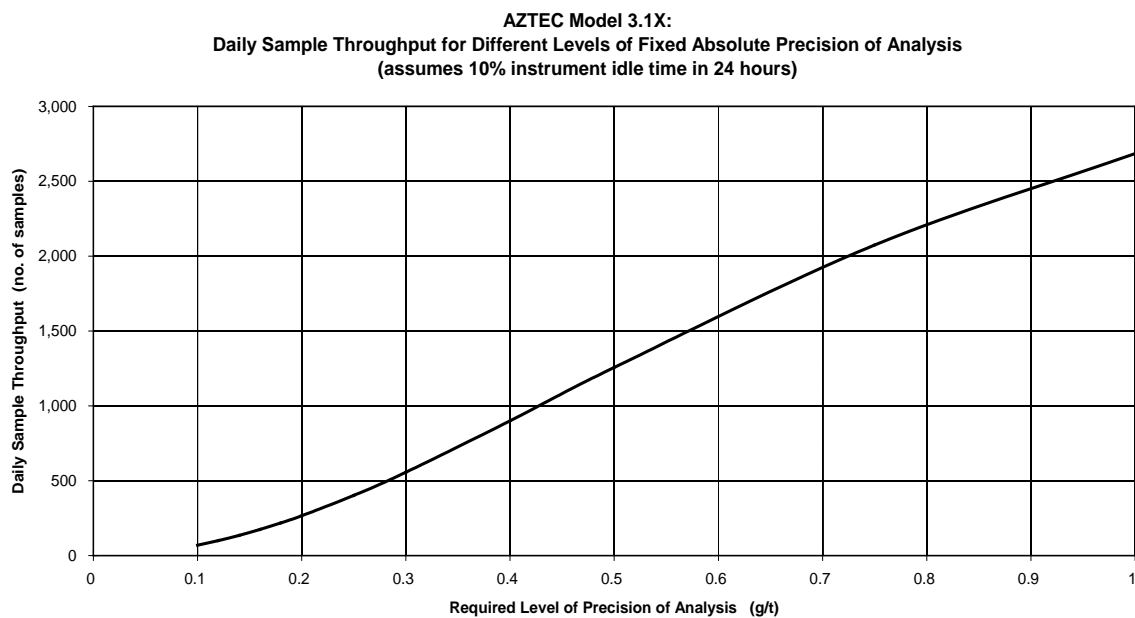
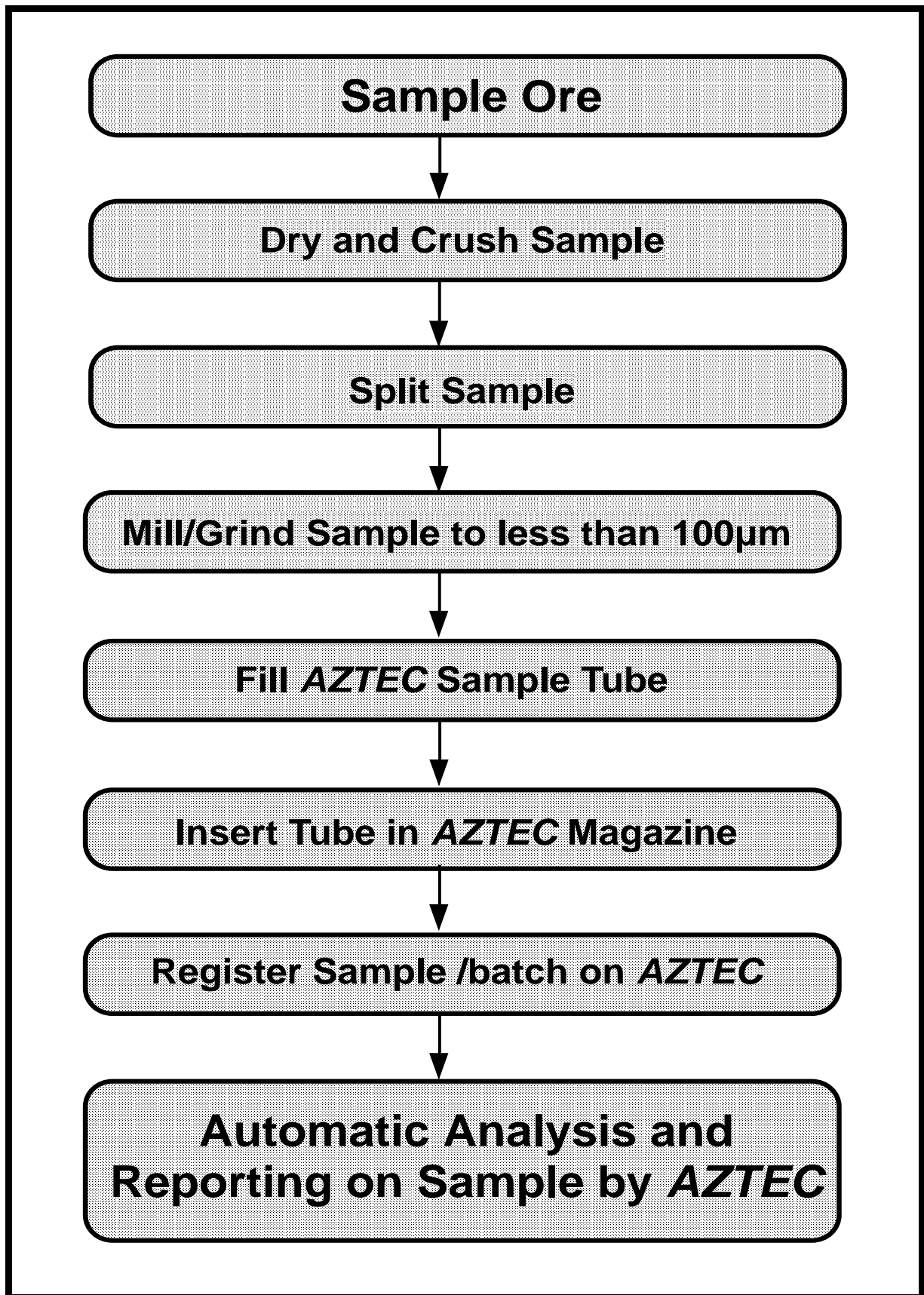


Figure 1

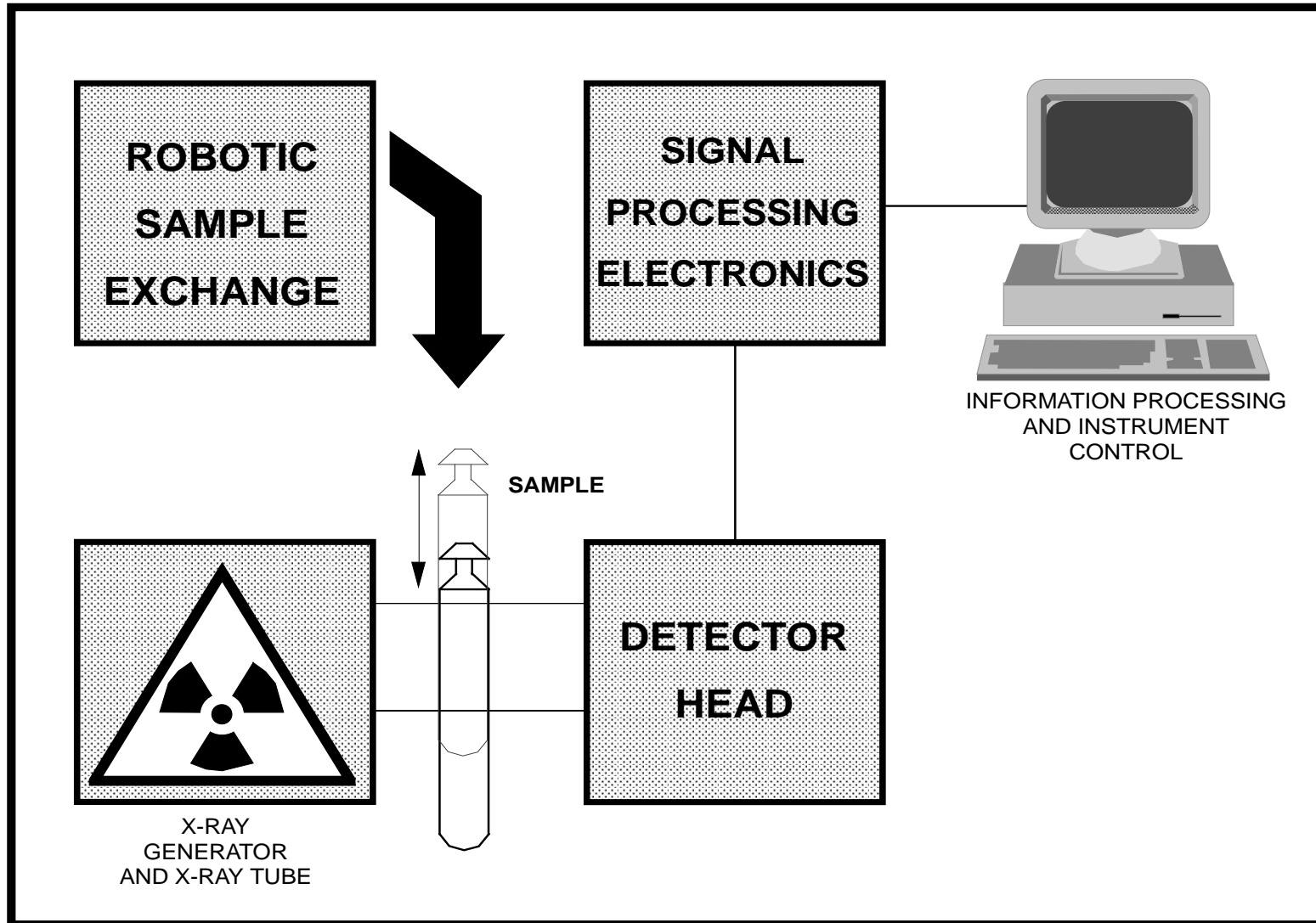
By specification of a suitable X-ray detector configuration, the **AZTEC** can be customised to the particular needs of the user. Higher configuration systems will provide a given level of analytical precision in a shorter analysis time, allowing users to either increase the throughput of the instrument, or analyse samples to a higher level of confidence. Chromatech Services (Pty) Ltd can provide guidance in the selection of an appropriate configuration.

(*Applicable to ores with low mercury content.)



System Description

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Figure 2

The **AZTEC** hardware consists of the five modules shown in Figure 2:

- ◆ *Sample transport module*:- comprising automatic sample changing robotics with a capacity for up to 792 samples.
- ◆ *Sample X-ray module*:- incorporating an X-ray generator, and 160kV tungsten anode X-ray tube and chiller unit.
- ◆ *Signal (X-ray) detector module*:- comprising pure germanium solid state detectors housed in a vacuum and cooled by either liquid nitrogen, or a helium based cryo-electric cooling system.
- ◆ *Signal processing module*:- leading edge pulse shaping and counting electronics housed in a temperature stabilised cabinet.
- ◆ *Data processing module*:- an IBM compatible PC, Super VGA colour monitor and inkjet printer.

Installation and Technical Support

The installation is carried out by Chromatech Services (Pty) Ltd. The instrument typically requires a floor area of at least 7m by 4.5m, and should be housed in an air conditioned, dust free environment.

To protect the instrument from fluctuations in the supply, power is provided from a 7 KVA Uninterruptible Power Supply with battery back up of about 15 minutes. An option is the inclusion of an emergency, diesel driven, DC generator to avoid shutting down the instrument during a mains power failure.

Chromatech Services (Pty) Ltd offers a 12 month parts warranty on the instrument, with the exception of the X-ray tube and computer, which carry the manufacturer's warranty.

Beyond the initial 12 month period Chromatech Services (Pty) Ltd offers a separate maintenance contract for parts and labour. Servicing is assisted by the comprehensive fault diagnostic data logging system built into the operating software. Access to the diagnostic data base for fault finding and repair can be performed remotely by Chromatech Services (Pty) Ltd via a modem link. This same link can enable Chromatech Services (Pty) Ltd to provide a service of remote monitoring of the instrument's performance, and inexpensive upgrading of the operating and control software.

New Developments In The K X-ray Fluorescence Analysis Of Mining Samples

Research and development is underway to extend the K X-ray technology to the analysis of other high atomic number elements. A version for the analysis of platinum samples has been thoroughly tested on a range of customer samples and is now available.

Specifications for AZTEC 3.1 Gold Analyser

Technique:

X-ray fluorescence using K X-rays for the simultaneous measurement of the gold and uranium content of powdered ore samples.

X-ray Detector Head Unit:

X-ray detector head unit containing innovative, high resolution, solid state detectors, cooled with liquid nitrogen to give optimised signal/background ratio.

Signal Processing Electronics:

Rack mounted Euro-card format for ease of servicing. Temperature stabilised to eliminate variations in results due to the effect of ambient temperature changes on the electronic components.

Sample Exchange:

The capacity of the extended 9 dock configuration is 792 samples. Each dock holds one magazine capable of containing 88 samples in an 8 × 11 array.

X-ray Module:

160kV HV Generator and X-ray tube with water chiller.

Power Supply:

7kVA single phase uninterruptible power supply, with a nominal 20 minute battery back up at full load, fed from 220/110 VAC ± 10%, 50/60Hz single phase supply.

Computer:

Latest specification IBM compatible P.C. with SVGA monitor and inkjet printer. The **AZTEC** operating and control system employs the Windows™ operating environment.

Range:

Gold 0 - 10 000ppm Uranium 0 - 20 000ppm

Analytical Precision (one standard deviation) and Sample Throughput (fixed time counting):

Gold: (low mercury content ores)

Nominal Precision (ppm)	Nominal Counting Time (seconds)	Nominal Daily Instrument Throughput
0.5	50	1 250 samples per day
0.4	70	900 samples per day
0.3	120	560 samples per day
0.2	270	270 samples per day
0.1	1100	70 samples per day

Accuracy/Bias (excluding interference effects):

Gold: Zero bias (100 000s count) better than 0.03ppm
 sensitivity accuracy (100 000s count) better than 1% of gold value

[Chromatech Services (Pty) Ltd reserve the right to change these specifications at any time, without notice.]

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