

Introducing the First Own ABX Clinical Chemistry System : the Pentra 400

Result of Cooperation within the HORIBA Group

Georges Ferrandi, Christophe Fudaly, Olivier Magnin, Stéphane Rougale

Abstract

The medical diagnostic market always demands faster results, high precision and sensitivity, complete secure systems and more flexibility while controlling costs. Clinical Chemistry represents a big part of that market and is even more price sensitive than the other areas. ABX has designed the Pentra 400, a new kind of Clinical Chemistry system in partnership with other companies within the HORIBA group. The Pentra 400 is a random access bench top clinical chemistry analyzer with high productivity, high level of analytical capabilities and unique flexibility for this range of analyzer. The types of tests that are performed vary from routine Clinical Chemistry to more specific tests like HbA1c, DATs, TDMs, up to research testing. By combining its high standards with unique flexibility, it also opens various application capabilities for future test needs.

1 Introduction

The In Vitro Diagnostics world market represented a turnover of some 22.7 billions Euro in 2001 : 7% in Hematology, 35% in Clinical Chemistry, (e.g. glucose, cholesterol, sodium, potassium, hepatic and cardiac enzymes), 28% in Immuno-chemistry,(e.g. Drug testing, Hormone, tumor markers, allergy tests), and 30 % for other Analyses like Infectious disease, Microbiology...

ABX Diagnostics, European leader in the Hematology field, decided in 1998 to diversify its offer and propose a Clinical Chemistry/ Immuno-chemistry solution to its Hematology customers. In Clinical Chemistry and Immuno-chemistry, reagents represent about 86% of the total market revenue while analysers represent only 14%. The systems are often sold on a reagent rental basis. ABX decided to launch not only an instrument but a complete system including analyzer, reagents, calibrators and controls.

We will take a closer look at the instrument first - the Pentra 400 (Fig.1) - and then develop the reagent menu.



Fig.1 The Clinical Chemistry System Pentra 400

2 Pentra 400 General Description

The Pentra 400 has the following features.

- The analytical part of the Pentra 400 is designed to have a throughput of up to 300 tests/hour in colorimetry (a cycle every 12 seconds for a measurement at 15 wavelengths).
- The ISE module throughput is 180 tests/hour.
- The combined throughput of the system is then up to 420 tests/hour.
- The reagent tray with 52 positions (44 refrigerated) provides high autonomy .
- The laser bar code reader enables reagent management (lot number, test quantities, shelf life).

The split view of the Pentra 400 is shown in Fig.2.

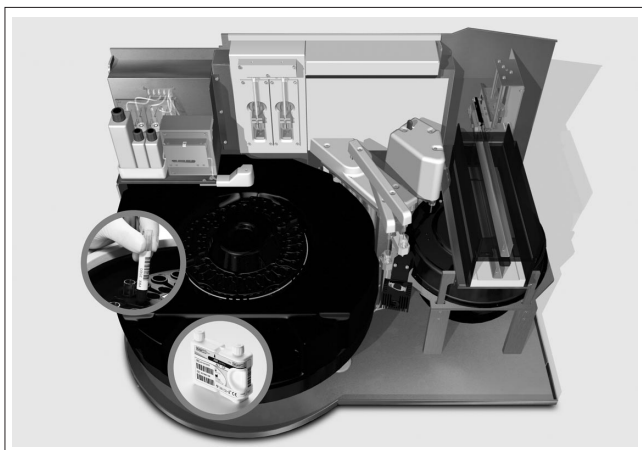


Fig.2 Pentra 400 Split View

A reagent needle (including pre-heating, level and clot detection) dispenses the desired quantity of reagent/buffer in the reaction cuvette. Simultaneously, the sample needle (with level and shock detection) either aspirates sample on sample tray or other reagent and then dispenses it in the same cuvette.

This sample tray holds 6 racks of 10 samples, it is equipped with a laser bar code reader for identification and a tube detector for size detection. With the Pentra 400, not only continuous loading is possible but the shape of the sample rack provides maximum sample handling flexibility (5mL, 10mL primary tubes and cups are accommodated on the same rack).

Once the sample and reagent are dispensed in the cuvette, a mixing palette provides proper homogenization for optimized chemical reaction results.

The reaction tray holds 6 segments of 12 reaction cuvettes at a controlled temperature of 37 °C. To complete the system, a segment handler, consisting of 2 racks of 30 segments each (for new and used segments), automatically changes segments when needed. This cuvette changer provides over 2 hour autonomy.

3 Pentra 400 Optical System Co-developed with Jobin Yvon

Biochemistry analyzers are predominantly based on the use of the photometry principle: samples to be analyzed and reagents are mixed, parallel measurement of light absorbed at selected wavelengths (up to 15th) is then performed. Depending on the chosen reagent, measurement of absorbed light at a specific wavelength is

used to monitor clinical parameters. The optical bench is considered as the analyzer core unit as most of the results originate from this light absorbance measurement.

The optical system was specified for high measurement sensitivity and low maintenance (Fig.3). Two optical functions are distinguished in the Pentra 400 optical system: light source and shaping system (where white light is emitted and taken to the sample to be analyzed), spectral unit (where wavelength selection is carried out)

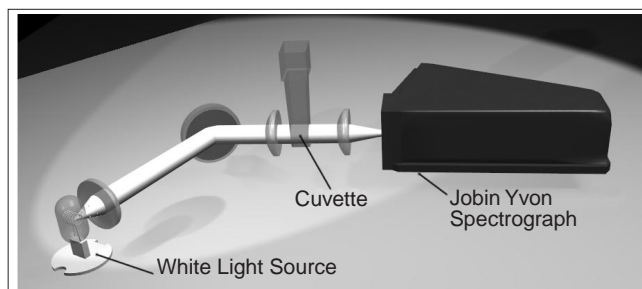


Fig.3 Pentra 400 Optical System Overview

Regarding the first part, ABX chose to develop a custom tungsten-halogen white light source which gives high luminous efficiency in a compact package. A precision socket allows lamp replacements without any alignment step. The following optics was designed to turn emitted white light beams geometry into a shape adapted to optical absorbance measurements.

The spectrograph unit can be seen as the second optical function of the total optical set-up (Fig.4).

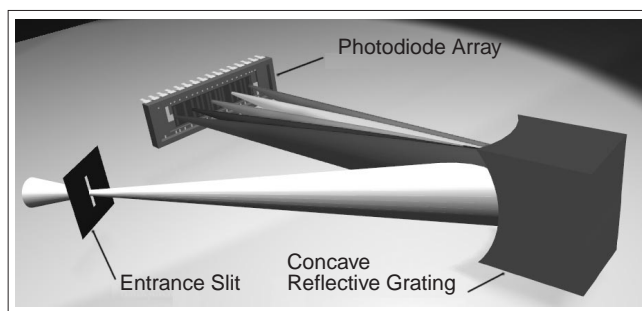


Fig.4 Concave Reflective Grating Spectrograph

This optical system, which spreads incoming white light into its primary colors, is a critical part. It was designed in close collaboration with the diffraction gratings manufacturer Jobin Yvon. Since the goal was to design a compact and rugged spectrophotometer, a concave reflective grating was retained. The need for high sensitivity photometric measurements led to the choice of Jobin Yvon holographic grating technology. This grating fabrication process dramatically reduces stray light and ensures a high optical signal to noise ratio.

As a result, from the close relation between ABX and Jobin Yvon, has emerged the heart of the Pentra 400 analyzer : the 15 wavelength high precision spectrophotometer.

4 ISE Module

Co-developed with HORIBA Medical Division in Kyoto

This optional module was designed by HORIBA based on ABX specifications. HORIBA has wide experience in this field with the SERA-520 and manufacturing of electrochemical micro sensors. HORIBA medical division developed: Electronics, Software, Electrodes, Reagents, ABX developed: mechanical parts and final assembly.

The ISE module is integrated in the Pentra 400, for simultaneous determination of Sodium, Potassium and Chloride on serum (direct method) and urine (indirect method). The ISE module is shown in Fig.5.

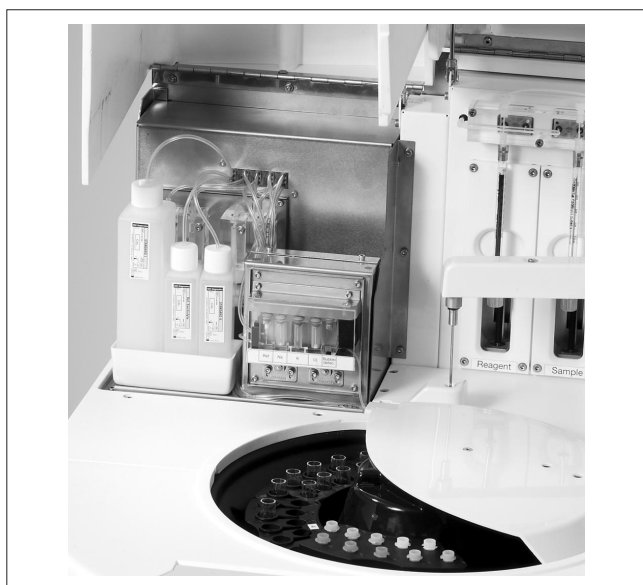


Fig.5 ISE Module

This module is completely independent. It consists of four electrodes: Na, K, Cl and one for reference and uses three reagents. It automatically runs calibration at regular time intervals and sends results to the Pentra 400.

The sample needle brings 50 µl of serum to the cup, that are then transferred to the electrodes. Samples are separated by small air gaps that are sensor detected to assure good positioning of the samples at the electrodes. Sample pre-dilution is automatically performed when using urine samples. After 60 seconds (on serum) results are sent to the Pentra 400.

5 Interactive Touch Screen Interface

With its touch screen monitor the Pentra 400 uses cutting-edge technology in a user-friendly format. Real time visualization of ongoing analyses and management of reagents are performed from a single screen that provides live instrument, reagent and sample status information.

This software includes an integrated validation station with automatic or manual validation of patient results.

It also allows our customers to develop their own applications applied to various fields: medical diagnostic field, detergent manufacturing and food engineering.

The interactive touch screen interface is shown in Fig.6.



Fig.6 Interactive Touch Screen Interface

6 Pentra 400 Reagent Menu

The Pentra 400 was designed to target primarily the two market segments: Routine and Dedicated market

Routine Market demands easy to use and highly secure systems. The Pentra 400 was defined as the system able to perform over 95% of the parameters of the middle-size laboratories on a single workstation.

ABX provides the reagents and corresponding applications to most of these parameters in convenient cassette packaging (Fig.7). This means that our customers get complete support on the use of these reagents.



Fig.7 ABX Cassettes

Dedicated Market which include: Diabetes monitoring, Drugs of Abuse testing, Therapeutic Drug Monitoring, Research and industry applications, demands very flexible systems with high quality results.

If ABX does not provide the type of reagent and application needed, cooperation could be provided as a service to the development of new applications and use them on Reagent Racks (Fig.8).



Fig.8 Reagent Racks

With customized Open channels, up to 3 reagents + 7 diluents per method, sample volume ranging from 2 to 380 μ L and reagent volume from 2 to 600 μ L, Antigen excess check, Pentra 400 users can thus develop their own specific applications with a maximum flexibility.

7 Conclusion

Pentra 400 is a good example of successful co-operation within the Horiba group (ABX/Jobin Yvon/HORIBA Medical Division) where each company has contributed with its specific knowledge and expertise. The challenge of designing the Pentra 400 was to match the needs of the customers; quality of results, security and productivity of the system. Continuous development of new applications will allow to expand the possibilities of such a system in the future. We strongly feel that this product will allow to make further contributions to the field of medical treatment.



Georges Ferrandi

ABX S.A.
Marketing Department
Biochemistry Product Manager



Christophe Fudaly

ABX S.A.
Development Department
Project Manager



Olivier Magnin

ABX S.A.
Development Department
Optics Department Manager



Stéphane Rougale

ABX S.A.
Marketing Department
Biochemistry Product Manager