THYROID UPTAKE MEASUREMENT SYSTEM

Nguyen Duc Tuan, Nguyen Thi Bao My and Nguyen Van Sy

Institute for Nuclear Science and Technology, VAEC, Vietnam.

ABSTRACT: The NED-UP.M7 (Fig.1.) is a complete thyroid uptake and analysis system specifically designed for nuclear medicine. Capable of performing a full range of studies this system provides fast, accurate results for Uptake Studies. The heart of the NED-UP.M7 is a microprocessor-controlled 2048 channel Compact Multi-Channel Analyzer, coupled to a 2" x 2" NaI(Tl) detector with a USB personal computer interface. The system offers simple, straight-forward operation using pre-programmed isotopes, and menudriven prompts to guide the user step by step through each procedure. The pre-programmed radionuclides include I-123, I-125, I-131, Tc-99m and Cs-137. The user-defined radionuclides also allow for isotope identification while the printer provides hard copy printouts for patient and department record keeping. The included software program running on PC (Windows XP-based) is a user friendly program with menudriven and graphic interface for easy controlling the system and managing measurement results of patient on Excel standard form.

Fig. 1:

1. Introduction

In vivo measurement techniques are the most direct and widely used approach for assessing the burden of iodine radioisotopes within the body. The *in vivo* measurement of these radioisotopes within the body is performed with various radiation detectors and associated electronic devices that are collectively known as *in vivo* thyroid monitors or whole body counters, depending on the body site of interest. These radiation detectors commonly utilize sodium iodide (NaI), hyperpure germanium, and organic liquid scintillation detectors to measure the gamma rays and x-rays emitted from ^{125}I and ^{131}I. Applying this technique, the purpose of the project is to design and construct a PC-based compact multichannel analyzer system using NaI scintillation detector for performing, interpreting and reporting the results of thyroid uptake measurements.

2. Results

The hardware configuration of the thyroid uptake measurement system is described on figure 2 block diagram, consisting of three main parts which have specifications as follows.

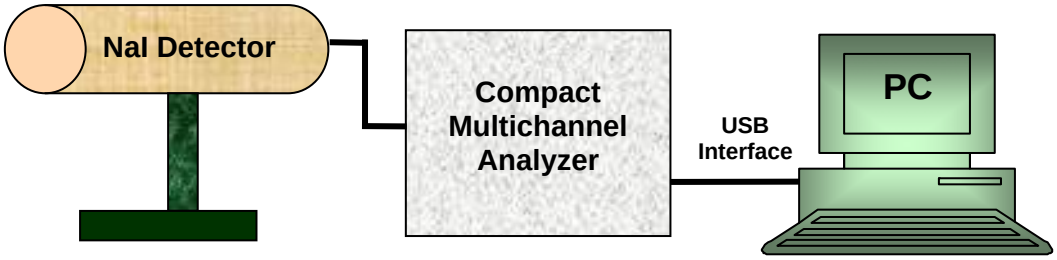

Fig. 2: System Block Diagram

- ***Computer:*** PC for Windows® XP with P4, 3 GHz processor, 512 megabyte RAM, 40g HD, 48x CD-RW.

- ***Probe Detector:*** 2" x 2" Nal (T1) integral line scintillation detector with tube base.

- ***Compact Multi-Channel Analyzer (Fig. 3):***

Resolution: 2048 channels

Spectral Resolution: FWHM 8% (Cs-137)

Maximum Count Rate: 100,000 cps

Connectors: Signal (BNC); high voltage (MHV)

Power Supply: 220V AC

Detector High Voltage Adjustment: H.V. adjustable, uses 10uCi Cs-137 as the calibration source.

Windows Application Programs: Thyroid Uptake, CD-ROM package

Pre-programmed Radionuclides: I-123, I-131, Tc-99m, Cs-137.

Uptake Stand:

Dimensions: 42" l x 31" w x 62" h (106.7 x 78.7 x 157.5 cm)

Collimated Shield: Flat field collimator meeting IAEA specifications

Lead Shielding Collimator: 1" thick (2.5 cm)

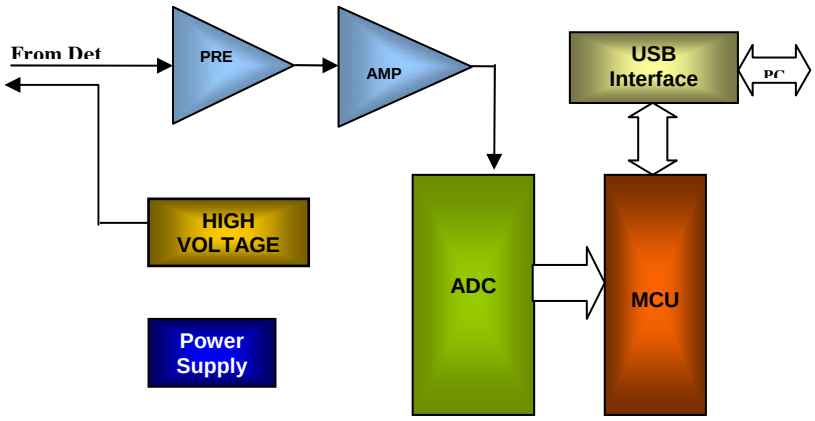

Fig. 3: Block Diagram of Compact Multichannel Analyzer

The software program provides fast, dedicated modules which cover all necessary procedures for QA-QC and uptake measurement as functions of **Energy Calibration** (use of Cs-137 reference source)**, Chi-Square Test, Uptake Measurement** and **Excel Output Standard Form** of results as described on figures 4, 5, 6, 7, 8.

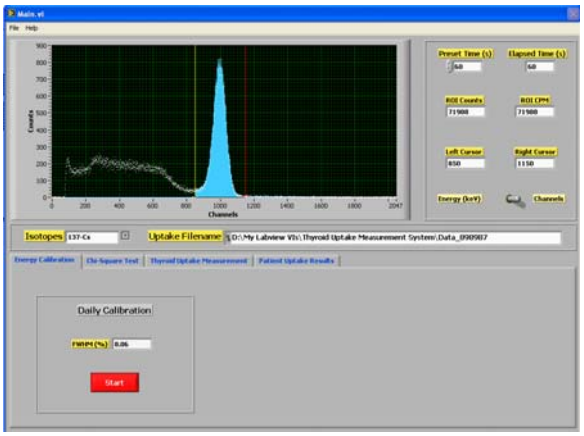

Fig. 4: Calibration function

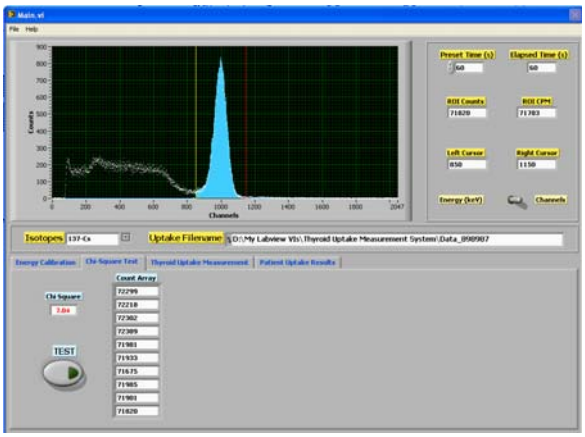

Fig. 5: Chi-Square Test Function

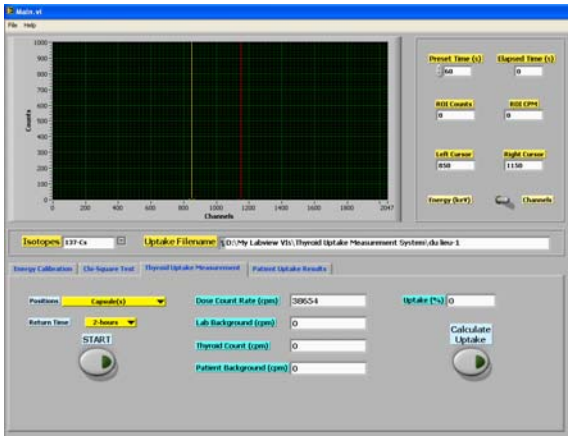

Fig. 6: Thyroid Uptake Measurement Function

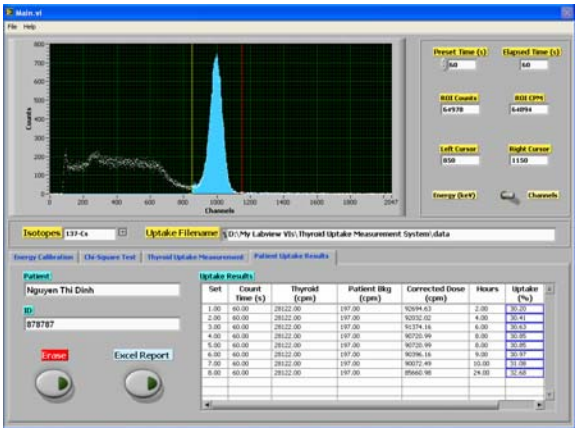

Fig. 7: Patient Uptake Results Function

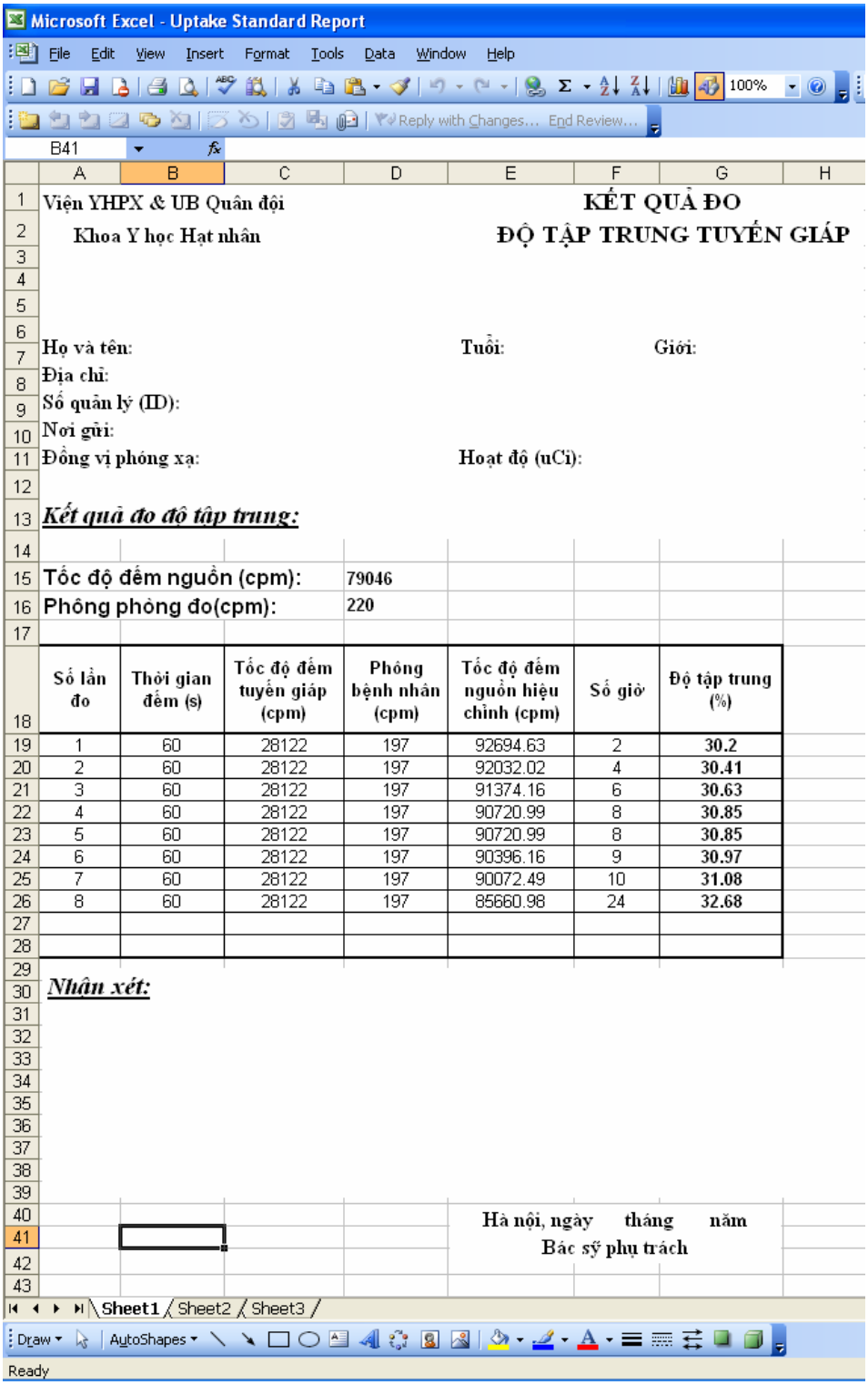

Fig. 8: Excel Standard Output Form for Patient Results

In addition, the prepared procedures with detailed protocols for regular quality control cover the function of its counting circuits, energy calibration, energy resolution, sensitivity, counting precision, linearity of energy response, background count rate, linearity of activity response and preset analyzer facilities, listed on the table below.

Test No.	Test	Reference	Acceptance	Frequency in routine testing		
				Daily	*Weekly*	*Half-yearly*
1	Channel-energy calibration	**x**	**x**	**x**		
2	Energy resolution (%FWHM)	**x**	**x**			**x**
3	Sensitivity	**x**	**x**		**x**	
4	Counting precision (Chi-Square)	**x**	**x**		**x**	
5	Linearity of energy response	**x**	**x**			**x**
6	Intergral background count rate	**x**	**x**		**x**	
7	Linearity of activity response	**x**	**x**			**x**

Test Schedule for Uptake Measurement System

3. Conclusion

All the hardware system and included software are designed and manufactured completely on the framework of the project. The thyroid uptake measurement system has been put into operation successfully as test experiment for 4 months at Military Institute of Medical Radiology and Oncology in Hanoi. The system has been used for uptake measurement in diagnostics and therapy on thousands of patients. In addition, beside the detector imported from foreign manufacturers, all the remained parts of electronics of the system and software are made and developed by ourselves as domestic products with low cost. These are extremely significant and possible in widely supplying for national nuclear medical applications.

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