THE NEW EFFECTIVE GASEOUS DETECTOR FOR DIGITAL SCANNING RADIOGRAPHY

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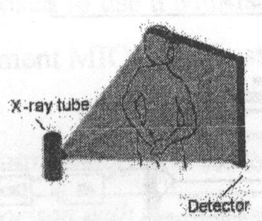
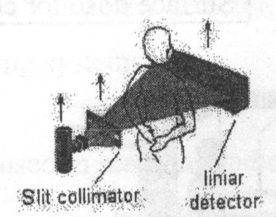
Introduction

Scientific discoveries and technological inventions have created new possibilities and breakthroughs in medical diagnostics. The classic example is the discovery of X-rays by W.C Roentgen, one hundred years ago. The applications and commercial success of new methods depends mainly on three factors: characteristics, functional capability and cost. All of them determine the commercial success of new technology in the market.

Background

All existing digital systems used in projection radiography could be divided into two basic classes. The digital systems using two-dimensional detectors are related to one class, and systems with one-dimensional detectors and using scanning method are related to the other class. Obviously, both systems have advantages and disadvantages. Most essential are submitted in the table below:

Two-dimensional detectors	*One-dimensional detectors and scanning method*
	
<u>Disadvantages</u>	<u>Advantages</u>
• Manufacturing of digital detectors requires high level of technology, therefore they are very expensive • Background due to scattering radiation • The fixed size of image (length) • Presence geometrical magnification in both directions	• It is quite easily to produce one dimensional detector having high parameters and its production could be cheaper • Low level of noise due to absence of scattering radiation • The length of image can be arbitrary • Absence of distortion in vertical direction • Opportunity to operate in direct counting mode • Systems with one-dimensional detectors can be used in CT-mode

Advantages	Disadvantages
• Short image acquisition time (0.1 sec)	• Rather big image acquisition time (2.5-5 sec)

In the Western Europe, United States and Japan two-dimensional detectors are widely used. In Russia many different scanning systems were developed and used in hospitals. Besides, most of used medical devices intended for prophylactic examinations are obsolete. At the present moment it is necessary approximately 6000 devices for prophylactic examinations of chest organs (against TB). Therefore, using of cheap systems with high parameters and low patient irradiation dose is very important due to wide spreading of tuberculosis in Russia.

In 1985 the first scanning system with Multi Wire Proportional Chamber (MWPC) operating in a counting mode was created. The principle of operation MWPC is described in detail in the paper [1]. Here we just present a schematic view of the Low Dose digital Radiography Device (LDRD) "Siberia" (fig 1.) and MWPC (fig 2). Also the parameters of last modification of LDRD "Siberia" with MWPC are represented in the table 1:

Table 1. Main parameters of the LDRD "Siberia" with MWPC.

The number of elements of detector	640
Dimension of element, mm	0.6
The width of detector, mm	384
Resolution, lp/mm	0.8
Efficiency, %	30
Contrast sensitivity, %	1.5
Dynamic range	130
Scanning speed, sm /sec	4
Surface dose for chest image, mR	3-5

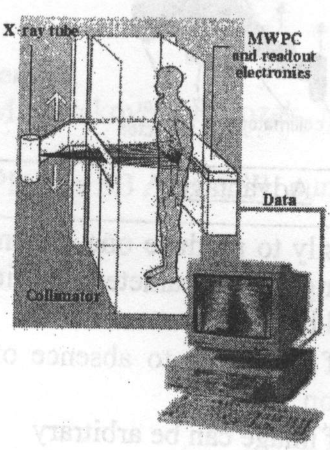


Fig 1. The installation for medical radiography

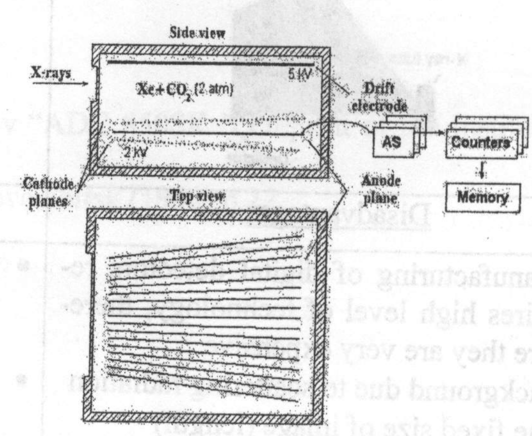


Fig 2. The multi wire proportional chamber.

In 1996 the Ministry of Health of Russia recommended the device for mass production and applications in medical practice. Now we have all allowing documents of Russian Ministry of Health.

About eighty devices are in operation in Russia at this time. They were produced by three plants (Orel, Sverdlovsk, Berdsk) and INP (Novosibirsk). The license for production was sold to China (Beijing). They have produced and installed in hospitals ten devices.

With growing of the number of the operational devices the experience of the lacks and defects of MWPC was collected. We faced with problem of low reliability of system. At that time the development of a new detector operating on the other principles was started. Under development special attention was paid to eliminate following lacks and defects:

- Detector ageing under radiation.
- Low scanning speed caused by low counting rate of MWPC.
- Inconveniences caused by necessity of changing gas in detector at least once per year.
- Electronics is very expensive and complicated due to counting mode.
- Relatively low space resolution.

It was proposed to use a Multistrip Ionisation Chamber (MIC) as a new detector. We think, that at present moment MIC is the best among detectors for scanning systems.

Comparison of MIC with different detector types used in scanning radiography.

In comparison with solid-state semiconductors, MIC:	*In comparison with sandwich "scintillator plus photodiode", MIC:*	*In comparison with MWPC in a counting mode, MIC:*
• High radioresistance. • More cheaper.	• Has no intermediate transformation of energy of γ-quantum [γ→charge] instead of [γ→light→charge] with the additional losses of energy. • Much better signal to noise ration (~10 times). • Uniform sensitive length without of dead zones • Much better shape of the channel. • Better radioresistance. • Better dynamic range (2-3 times)	• Has better spatial resolution • Has better dynamic range (3 times). • Has better contrast sensitivity. • Has better efficiency (2-3 times). • Has unlimited counting rate (possible to increase the scanning speed), • Much more high reliability • Electronics is very simple and cheap.

In 1999 development of MIC was completed. At the present the factory "Vostok" in Novosibirsk produces MIC for INP. We complete it with electronics, power supplies and software and sell these detectors to three factories in Russia and China.

The principle of MIC operation is described in detail in the paper [1]. Here we just present schematic view of MIC (fig 3) and parameters of LDRD "Siberia" with MIC, which represented in the table 2:

Table 2. Parameters of LDRD "Siberia" with MIC.

The number of elements of detector	1024
Dimension of element, mm	0.4
Dimension of element in a patient's body, mm	0.35x0.35
Width of image, mm	410
Scanning time (for chest)	5
Resolution, lp/mm	1.25
Efficiency, %	70
Contrast sensitivity, %	1
Dynamic range	480
Effective dose for chest image, mR	3-5

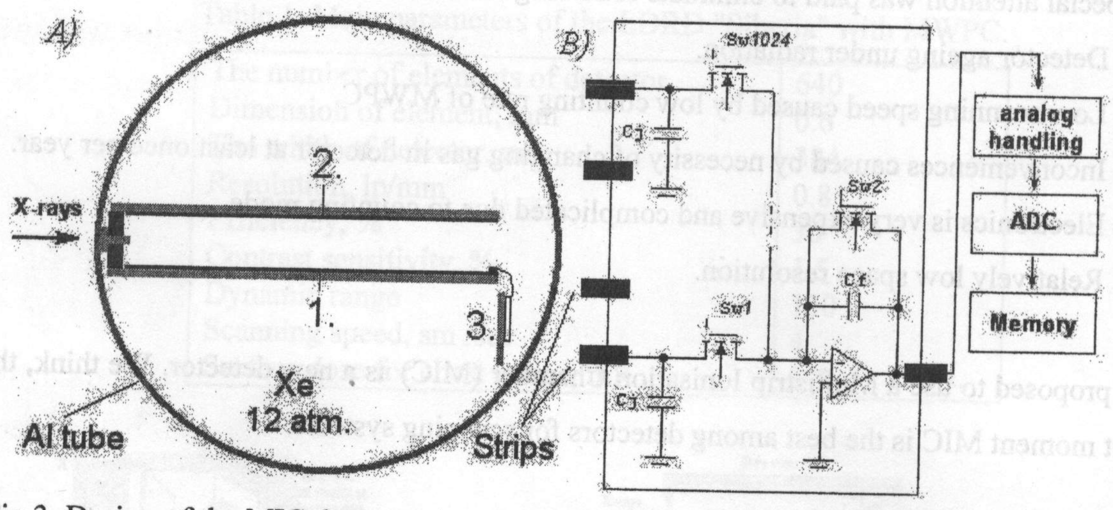


Fig 3. Design of the MIC detector: 1 – signal electrode, 2 – drift electrode, 3- electronics.

Experience of using LDRD with MIC detector:

BINP medical department	12 months
Krasnokamensk (Chita region)	7 months
Central hospital SB RAS, Novosibirsk	3 months
Orel	6 months
Berdsk	3 months
China hospitals (4 devices)	1-3 months

References

1. E.A. Babichev et all., Nuclear instruments and methods in Physics Research A 419 (1998) 290-294