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PARALLEL ENCODERS FOR PIXEL DETECTORS

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I. Introduction

Silicon integration pixel detectors having thousands and more pixels with amplifiers-shapers have been constructed. There arises the problem of fast coordinate encoding X_i (i = 1,2,3...t) of fired pixels and generation of fast pulses according to given criteria,e.g. for the multiplicity of fired pixels t. Comparators are used to determine fired pixels in the pixel detector having 32x32 pixels [1]. However, only the edges of the coordinates X_{max} and y_{max}, X_{min} and y_{min} are encoded. A priority encoder is used in a more complicated pixel detector [2]. It should be noted that delays in logic circuits increase for a large number of registration channels n and, in addition, t synchropulses are required for data readout. Therefore there is a complicated problem to provide a minimum delay time T_d and small power consumption in the circuits of data transformation and processing for a large number of registration channels, and multiplicity t. To all appearances, not a traditional solution of this problem is needed. As shown [3], for t << n the algebraic coding theory can be used for effective data compression registered in one-dimensional detectors, e.g. in MWPC. As a consequence, a new class of parallel encoders which encode t > 1 signals in parallel has been suggested. The author has described [4] the method of constructing such parallel encoders and circuits for a fast calculation of the coordinates of fired position-sensitive sources on the basis of the algebraic coding theory. New results on the use of the method of syndrome coding for the construction of a new type of parallel encoders, majority coincidence and coordinate processors for high energy physics experiments are given [5]. The use of the algebraic coding theory allows fast tracking processors to be constructed [6].

The aim of this paper is to show that the algebraic coding theory can be successfully used for data processing registered in pixel detectors. The use of this theory results in the development of an effective conception of data processing on the basis of fast dataway logic.

2. Parallel encoding of the multiplicity of signals in pixel detectors.

For the reason which will be clear later on we assume that the detector contains $n = 2^m - 1 = k \times k$ pixels, arranged in the two-dimensional plane X,Y, and $m > 2$. As an example, fig. 1 presents a simplified block-diagram of the pixel detector having 49 pixels ($k = 7$). The following two cases are possible. 1. There is no preliminary encoding of fired pixels, and a bit word is read out in a computer. But in real experiments it is necessary to generate a fast signal about multiplicity $t \leqslant 2$. For this reason information should be encoded. The simplest and the most economical method based on shift registers has a very long transformation time, in particular for large n. The use of the syndrome coding method allows one to obtain a high speed and to optimize the number of circuits for given t simultaneously.

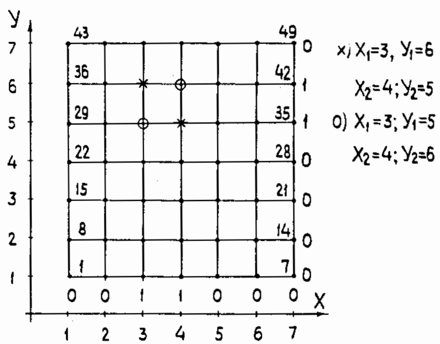

Fig. 1. Schematic image of the pixel detector containing 49 pixels. * - and o - events.

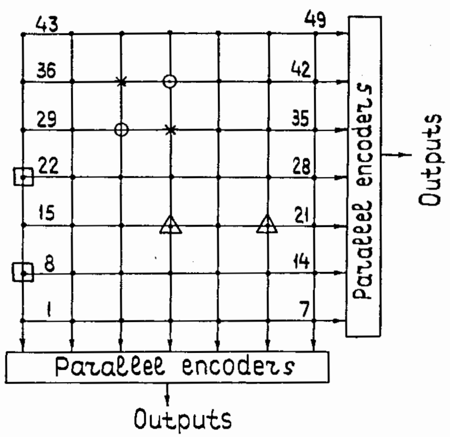

Fig. 2. Schematic image of the pixel detector with parallel encoders for each row and column. *, o, □ and Δ - events.

For simplicity let t be 2. Assume that the pixels with coordinates $X_1 = 3$, $Y_1 = 6$ and $X_2 = 4$, $Y_2 = 5$ are fired at one instant time and the pixels with coordinates $X_1 = 3$, $Y_1 = 5$ and $X_2 = 4$, $Y_2 = 6$ at the other one. As seen from fig. 1 when data are read out from the X and Y registers (not shown in the figure), there appear ambiguities of the coordinates of the fired pixels because in the both cases we have equal codes 0011000 and 0000110. This is the reason why preliminary encoding is needed. There are two approaches if the syndrome coding method is used: 1. the use of separate encoders for each row and column and 2. the use of one encoder for all n registration channel. Let us consider the first case. As known [1-5], accordihg to the syndrome coding method, for the construction of a parallel encoder it is necessary, first of all, to construct a coding matrix which is similar to the parity check matrix of the t correcting BCH-

code. So, for $t = 2$ and $m = 3$ we have the coding matrix $H_{7,2}$:

Pixels number in row or column

$$
\begin{matrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{matrix}
\quad H_{7,2} = \left| \begin{matrix} a^0 & a^0 \\ a^1 & a^3 \\ a^2 & a^6 \\ a^3 & a^2 \\ a^4 & a^5 \\ a^5 & a^1 \\ a^6 & a^4 \end{matrix} \right|
\longrightarrow
\left| \begin{matrix} 100 & 100 \\ 010 & 110 \\ 001 & 101 \\ 110 & 001 \\ 011 & 111 \\ 111 & 010 \\ 101 & 011 \end{matrix} \right|
$$

$$
\begin{matrix} \downarrow & \downarrow \\ S_1 & S_3 \end{matrix}
$$

The Galois field GF (2^3) elements generated by an irreducible polynomial $X^3 + X + 1$ are presented in the first column of the matrix $H_{7,2}$: $a^0 = 100$, $a^1 = 010$, $a^2 = 011$, $a^3 = 110$, $a^4 = 011$, $a^5 = 111$, $a^6 = 101$ and $a^7 = a^0 = 100$ because the Galois field is cyclic. Besides, the field element a^1 is supposed to be the root of this polynomial so that $a^3 = a^1 + a^0$ mod. 2. There are cubes of the corresponding elements in the second column. The coding matrix $H_{7,2}$ is shown to be the same for all rows and columns, and therefore the encoder in fig. 2 is the same for fig. 3. Using such a scheme, all possible combinations of two fired pixels can be unambiguously encoded. It is unnecessary to check all possible codes because this statement is based on the well-known theorem of t correcting BCH-code decoding [8]. As shown in fig. 2, without encoding we have the following combinations of codes on condition that data are read out from the register, and enumeration N_i ($i = 1,2,..7$) of pixels in the corresponding rows and columns is executed from left to right and from bottom upwards.

Table 1

Combinations of unitary binary codes for separate coding rows and columns

	Unitary codes															
	X coordinate								Y coordinate							
No. of	*	*	0	0	□	□	Δ	Δ	*	*	0	0	□	□	Δ	Δ
pixels	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1
4	1	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0
5	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
6	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

From table 1 it follows that all combinations of fired pixels, as could be expected, are different.

So, as shown in fig.3, if a priority encoder is used, we get diffe-

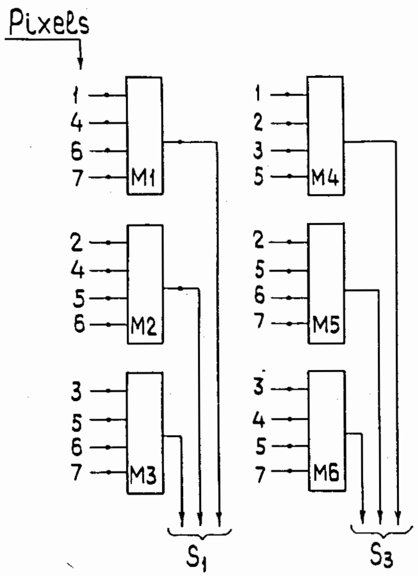

Fig.3. Scheme of the parallel encoder for one row (column). t = 2 and n = 7.

rent natural binary codes for four separate events. However, for large n the use of priority encoders for encoding a unitary code to a natural one becomes ineffective due to large delays, and, in addition, synchropulses are required far data readout. The frequency of these pulses also depends on the number of pixels, n. If the method of syndrome coding is used, the encoding of fired pixels in pixel detectors is executed with the aid of combinatinal circuits (without memory elements), and a register and synchropulses are not needed. Let us consider our example for two cases. 1. Encoding is separately executed for each row and column. 2. A general encoder is used for all n pixels. Consider table 2.

Table 2

Encoding of the position of fired pixels by the syndrome coding method

	Coordinate X							Coordinate Y							
	*	*	o	o	□	□	△	*	*	o	o	□	△	△	
$S_1 \rightarrow$	a^2	a^3	a^2	a^3	a^0	a^0	a^2	a^5	a^4	a^4	a^5	a^0	a^2	a^2	
$S_3 \rightarrow$	a^6	a^2	a^6	a^2	a^0	a^0	a^4	a^1	a^5	a^5	a^1	a^5	a^6	a^6	

Using the method of syndrome coding, a unitary binary code is encoded to a cyclic code or to the Galois field elements. Moreover the result equals the row of the $H_{7,2}$ matrix when there is one unit in a row or in a column of the pixel detectors. In the case of two events the result is equal to the modulo 2 of two corresponding rows of the $H_{3,2}$ matrix. For example, two pixels denoted as ^ are fired in the third row at positions 4 and 6, i.e. a^3 and a^5. In the general case we have the following relation between the coordinates X_i and Newton's symmetric power functions S_j

$$S_j = \sum_{i=1}^{t} X_i^j \;, \quad i = 1,2,3 \ldots 2t-1, \; j = 1,\, 3,\, 5 \ldots . \qquad (1)$$

As $S_1 = X_1 + X_2$ and $S_3 = X_1^3 + X_2^3$ for $t = 2$, we have

$$+\begin{array}{c} a^3 \\ \underline{a^5} \\ a^2 \end{array} \quad \begin{array}{c} a^2 \\ \underline{a^1} \\ a^4 \end{array} \;\longrightarrow\; +\begin{array}{c} 110 \\ \underline{111} \\ 001 \end{array} \quad \begin{array}{c} 001 \\ \underline{010} \\ 011 \end{array}$$

Here and below the sign "+" is the modulo 2 sum. Thus, the syndrome code $S_1 = a^2$ and $S_3 = a^4$. Instead of a unitary 7-bit position code 001010 we obtain a 6-bit cyclic code $S_1 = 001$ and $S_3 = 011$ which carries information on the coordinates the fired pixels X_1 and X_2 and multiplicity t. The rules of Galois field algebra can be used.

Let us examine the second case. All 49 pixels are numbered from 1 to 49. As in the previous example, each pixel has its amplifier-shaper of logic pulses. The outputs of the encoders are connected to a parallel encoders having 49 inputs as shown in fig. 4. Suppose that two pixels are fired simultaneously. In order to draw up a principal scheme of the parallel encoder, it is necessary to construct a coding matrix corresponding to the parity check matrix of the BCH-code which corrects two mistakes with the following parameters: $m = 6$, $n = 2^6 - 1 = 63$ and $t = 2$. For clear reasons the coding matrix given below has 50 rows although a scheme of parallel encoder for 63 inputs can be constructed without a substantial increase of parity checkers. As S_1 and S_3 are the $GF(2^6)$ Galois field elements, they can be presented as a polynomial of the 6-th power

$$S_1 = S_{10}a^0 + S_{11}a^1 + S_{12}a^2 + S_{13}a^3 + S_{14}a^4 + S_{15}\,a^5$$
$$S_3 = S_{30}a^0 + S_{31}a^1 + S_{32}a^2 + S_{33}a^3 + S_{34}\,a^4 + S_{35}a^5, \qquad (2)$$

where $a^0 - a^6$ are linearly independent elements of this field. For example, $a^0 = 100000$, $a^1 = 010000$ and so on, $a^5 = 0000001$, $S_{10} - S_{15}$ and $S_{30} - S_{35}$ are the coefficients which can be equal to one or zero depending on the elements. It is assumed that Galois field is generated over the irreducible polynomial of the 6-th power $X^6 + X + X^0$ and the element a^1 is the root of this polynomial. So, $a^6 = a^1 + a^0$, $a^7 = a^2 + a^1$ and so on. A block-diagram of the parallel encoder having 49 inputs is presented in fig. 4. All designations of fig. 2 are left here. A principal scheme of the parallel encoder is given by the position of units in the rows of the coding matrix $H_{50,2}$. As would be expected, the syndrome code is equal to 12 bits for $t = 2$ and $n = 49$. So for the events marked * we have

$$S_1 = \begin{array}{c} 101001 \\ \underline{001101} \\ 100100 \end{array} = a^{32} \qquad S_3 = \begin{array}{c} 110011 \\ \underline{101100} \\ 011111 \end{array} = a^{57}$$

As supposed in the BCH-coding theory, for $t \leqslant 3$ the coding matrix should comprise at least three columns which include the Galois field elements

Coding matrix $H_{50,2}$

No. of pixels	$GF(2^6)$ elements	Cubes of these elements	No. of pixels	$GF(2^6)$ elements	Cubes of these elements
1	100000	100000	26	010001	101000
2	010000	000100	27	101000	000101
3	001000	110000	28	011100	111100
4	000100	000110	29	001110	110111
5	000010	101000	30	000111	100010
6	000001	000101	31	110011	011100
7	110000	111100	* 32	101001	110011
8	011000	110111	33	100100	010010
9	001100	100010	34	010010	011010
10	000110	011100	35	001001	011011
11	000011	110011	36	110100	010111
12	110001	010110	37	011010	100110
13	101000	011010	* 38	001101	101100
14	010100	011011	39	110110	110101
15	001010	010111	40	011011	111010
16	000101	100110	41	111101	011111
17	110010	101100	42	101110	100111
18	011001	110101	43	010111	100000
19	111100	111010	44	111011	000100
20	011110	011111	45	101101	110000
21	001111	100111	46	100110	000011
22	110111	100000	47	010011	101000
23	101011	000100	48	111001	000101
24	100101	110000	49	101100	111100
25	100010	000011	50	010110	110111

raised to the 1-st, 3-d and 5 th power. We need the value of S_5 for the events designated as * in one of the examples considered below:

$S_5 = (a^{31})^5 + (a^{37})^5 = a^{2x63}a^{29} + a^{2x63}a^{59} = a^{29} + a^{59} = a^{12}$.

Figure 5 presents a principal scheme used to calculate one component of S_{10} of vector S_1. It is not difficult to note that 12 similar schemes are required to calculate codes S_1 and S_3. As parity checkers are used to calculate the syndrome code, a simultaneous encoding of two coordinates is executed fastly and synchropulses are not needed. If the two considered methods of encoding the coordinates of fired pixels are compared, the second method is more preferable from the viewpoint of data compression and the number of circuits because in the first method rows and columns are coded separately.

3. Event selection by multiplicity

The important property of the BCH-code syndrome is to carry information on the multiplicity and coordinates of particle interactions. The algorithm of a majority coincidence circuit is based on the property of the L_t matrix [8,9]. The txt matrix

$$L_t = \begin{vmatrix} S_1 & 1 & 0 & 0 & 0\dots\dots 0 \\ S_3 & S_1^2 & S_1 & 1 & 0\dots\dots 0 \\ S_5 & S_1^4 & S_3 & S_1^2 & 1\dots\dots 0 \\ \dots & \dots & \dots & \dots & \dots \\ S_{2t-1} & S_{2t-2} & S_{2t-3} & S_{2t-4} & S_{2t-5}\ S_t \end{vmatrix}$$

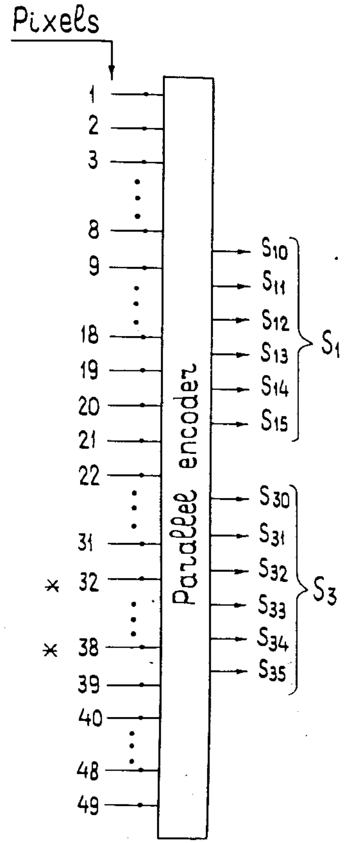

Fig.4. Block-diagramm of the parallel encoder for n = 49 and t = t.

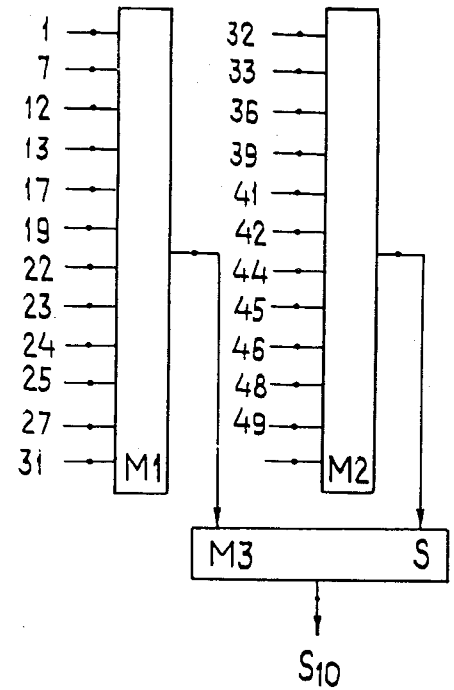

Fig.5. Principal scheme for the calculation of one component S_{10} of vector S_1.

is nonsingular if Newton's symmetrical functions S_j depend on t or t + 1 of different Galois field elements and it is singular if the functions S_j depend on a smaller number of different Galois field elements than t-1. Thus, to determine t, the determinant L_t should be calculated. The expressions for the matrix determinant in the Galois field for t = 1 - 3 take the form

t	det L_t
1	S_1
2	$S^3 + S_3$
3	$S_1^6 + S_1^3 S_3 + S_3^2 + S_1 S_5$

(3).

In accord with the example, we have $\det L_1 = S_1 = a^{32} = 100100 \neq 0$,

$\det L_2 = (a^{32})^3 + a^{57} = a^{63} a^{33} + a^{57} = a^0 a^{33} + a^{57} \neq 0$.

$\det L_3 = a^{192} + a^{96} a^{57} + a^{114} + a^{32} a^{12} = a^{189} a^3 + a^{63} a^{27} + a^{51} + a^{32} a^{12} =$

$= a^3 + a^{27} + a^{51} + a^{44} = 0$.

Substituting the binary equivalents of the Galois field elements and taking the modulo 2 sum of them, we get

$$\begin{array}{r} 000100 \\ +\ 011100 \\ +\ 110101 \\ +\ 101101 \\ \hline 000000 = \det L_3. \end{array}$$

These and other investigations show that the majority of operations in the Galois field is performed simpler and faster by virtue of the fact it is finite [10]. There are two methods of hardware realization of algebraic operations in this field. 1. Use of PROMs or PLAs. However, the use of this method for large n is ineffective, and, in addition, signal delays increase. 2. Use of conventional combinational logic in the basis AND and modulo 2 adders (EXCLUSIVE OR). As noted in [11], the synthesis of logical circuits in such a basis has many advantages over that of the basis NOR-AND in connection with the development of regular structures of the matrix type with the aid of integral technology. It has turned out objectively that hardware realization of different operations over the Galois field $GF(2^m)$ is faster and simpler with the help of AND logical elements and modulo 2 adders. To turn to this basis, it is necessary to present expression (2) in the following form

$\det L_1 = S_1 = a^0 S_{10} + a^1 S_{11} + a^2 S_{12} + a^3 S_{13} + a^4 S_{14} + a^5 S_{15}$.

$\det L_2 = (S_1^3 + S_3) = a^0 S_{10} + a^1 S_{11} + a^2 S_{12} + a^3 S_{13} + a^4 S_{14} + a^5 S_{15})^3 +$

$+ (a^0 S_{30} + a^1 S_{31} + a^2 S_{32} + a^3 S_{33} + a^4 S_{34} + a^5 S_{35})$.

It should be noted that multiplication of polynomials in the Galois field $GF(2^m)$ is performed as multiplication of usual polynomials but modulo m - 1 [11]. Besides, like terms are grouped by modulo 2 . For example, $2S_{10} = 0$. Since the element a^1 is assumed to be the root of the polynomial $X^6 + X + 1$ $(1 = a^0)$, then $a^6 = a^1 + 1$ and $a^7 = a^2 + a^1$ and so on. $a^{12} = a^7 + a^6 =$

$= a^2 + a^1 + a^1 + a^0 = a^0 + a^2 = 101000$. That is why those product terms which power is larger than 6 are resolved into basis elements (in more detail see [7, 10]). After power raising grouping like terms and resolving the remaining terms into basis elements, we get

$S_{10}^3 = S_{10} + S_{12} + S_{14} + S_{10}S_{13} + S_{13}S_{15} + S_{11}S_{14} + S_{13}S_{14} + S_{11}S_{15} + S_{12}S_{15}$,

$S_{11}^3 = S_{12} + S_{10}S_{11} + S_{10}S_{13} + S_{11}S_{13} + S_{12}S_{13} + S_{13}S_{14} + S_{14}S_{15}$,

$S_{12}^3 = S_{14} + S_{10}S_{12} + S_{11}S_{13} + S_{12}S_{14} + S_{12}S_{15} + S_{14}S_{15}$,

$S_{13}^3 = S_{11} + S_{13} + S_{15} + S_{11}S_{14} + S_{12}S_{13} + S_{12}S_{14} + S_{12}S_{15} + S_{13}S_{14} + S_{14}S_{15} +$
$+ S_{10}S_{13} + S_{10}S_{14}$,

$S_{14}^3 = S_{13} + S_{15} + S_{10}S_{12} + S_{10}S_{14} + S_{10}S_{15} + S_{11}S_{12} + S_{11}S_{14} + S_{12}S_{14} +$
$+ S_{12}S_{15}$,

$S_{15}^3 = S_{15} + S_{11}S_{12} + S_{11}S_{13} + S_{11}S_{15} + S_{12}S_{14} + S_{12}S_{15}$ (4).

From (4) and (2) we obtain the following brief description of $\det L_2 =$ $\det L_{20} + \det L_{21} + \det L_{22} + \det L_{23} + \det L_{24} + \det L_{25}$

$$\begin{aligned} \det L_{20} &= S_{10}^3 + S_{30} \\ \det L_{21} &= S_{11}^3 + S_{31} \\ \det L_{22} &= S_{12}^3 + S_{32} \\ \det L_{23} &= S_{13}^3 + S_{33} \\ \det L_{24} &= S_{14}^3 + S_{34} \\ \det L_{25} &= S_{15}^3 + S_{35} \end{aligned} \qquad (5)$$

Figure. 6 gives a principal scheme used to transform the syndrome code $S_1 S_3$ to the binary coordinates X_1 and X_2 and a device (MCC) for selecting two events on condition that t < 2. To use PROMs and PLMs for direct transformation of the Galois field elements to a natural binary code needed to perform arithmetic and algebraic operations on these codes, we have some difficulties for large n and t.However, more economical methods are known to calculate the coordinates of fired pixels at t $\leq$ 5 [12,13]. Peterson's [8] or Chien's [14] sequential [14] methods can be used for t > 5. As it follows from (4) for the calculation of the determinant $\det L_2$, it is necessary to have a coincidence matrix which consists of logical AND elements with two inputs, six parity checkers and a small number of logical elements AND and OR. For the condition t $\leq$ 3, it is also necessary to add circuits for the calculation of $\det L_3$. For this purpose parity checkers and a certain number of AND elements with three and four inputs are required. For instance, to calculate the product $S_1^3 S_3$, logical elements AND having three and four inputs are needed. Such coincidence matrices can be made using integral technology, and their number can be counted by a computer.

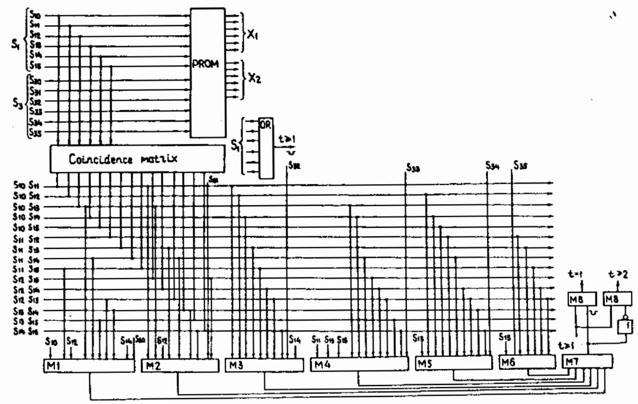

Fig.6. Principal scheme of the majority coincidence circuit and of the coordinate encoder for t < 2 . M1 - M7 - MC10160., M8 - MC10102.

The speed of MCC T_d for rather large t and n can be calculated from the expression

$$T_d = 2T_p + 3T_{and},$$

where T_p is the delay of a parity checker and T_{and} the delay of an AND element. If ECL-logic is used, then T_d does not exceed 15 ns. Thus, for the construction of a processor device for pixel detectors according to the syndrome coding method, it is necessary to perform the following procedures [9].

1. AN irreducible polynomial of the m-th power is taken from the tables of [8], and $2^m - 1$ nonzero elements of $GF(2^m)$ are calculated. For m = 4 - 10 the following polynomials can be recommended: $X^4 + X + 1$, $X^5 + X^2 + X + 1$, $X^6 + X + 1$, $X^7 + X^3 + 1$, $X^8 + X^4 + X^3 + X^2 + 1$, $X^9 + X^4 + 1$ and $X^{10} + X^3 + 1$.
2. The parity check matrix (coding matrix) $H_{n,t}$ is constructed for given t < n/2. The number of columns in the matrix should be t.
3. The Galois field elements in the matrix $H^T_{n,t}$ are substituted by their binary equivalents.
4. Determinants up to the t-th order are calculated by a computer.
5. The operations needed to calculate the determinants are performed over the Galois field elements presented as polynomials of the m - 1 power. As a result, we get Boolean's relations which are simply realized in the AND and EXCLUSIVE OR basis.
6. A principal scheme of MCC is conctructed according to the Boolean expressions.

Output 1 = $detL_1 \vee detL_2 \vee detL_3 \vee ... \vee detL_j \vee ... \vee detL_t \geqslant 1$
Output 2 = $detL_2 \vee detL_3 \vee ... \vee detL_j \vee ... \vee detL_t \geqslant 2$
....
Output j = $detL_j \vee ... \vee detL_t \geqslant j$
Output t = $detL_t \geqslant t$.

It should be noted (and it is of importance) that t-1 schemes of parallel counters can be constructed by adding a not complicated combinational circuit (fig.6). It is clear that an analytical calculation on a computer should be used for t >4 [15].

Let us return to our example. It is not difficult to calculate that for t = 1 $S_1 = a^{31} = 101001$, i.e. $S_{10} = S_{12} = S_{13} = 1$ and $S_{11} = S_{12} = S_{14} = 0$. Then $S_3 = a^{30} = 110011$, i.e $S_{30} = S_{31} = S_{34} = S_{35} = 1$ and $S_{32} = S_{33} = 0$. One can verify that $detL_1 = S_1 = 0$, but $detL_2 = 0$. In this case the logical element AND (see fig. 6) is open, and the signals t > 1 and t = 1 are generated at the outputs. The signals $t \geqslant 1$ and $t \geqslant 2$ are formed for t =2. It should be stressed that the modulo 2 operation which needs the inversion of signals was used in the above examples as in algebraic coding theory. As shown in [16], inversion can be excluded if the effective superposition code developed by the author is used. In this case there is no need to form signals in duration and in amplitude because the syndrome codes are calculated with the aid of amplifiers-shapers.Moreover, the coding of light signals can be executed using light mixers. However, all theorems used in the algebraic theory of BCH-codes are partically inapplicable to this code.

Conclusion

From the above examples it is clear that the use of the syndrome coding method for data processing registered in pixel detectors has a number of advantages over conventional methods based on intuition and not on strict analytical calculations.

1. The compression of data registered in pixel detectors ($K_c = n/t\log_2 n$) takes plase for large n. For example K_c = 1023 = 32 for n = 1023 and t = 3.
2. As the syndrome code carries information both on the coordinates and on the number of fired pixels, the multiplicity t and the coordinates of fired pixels can be fastly determined using parallel calculation methods such as table ones (PROMs and PLAs) and standard fast circuits.
3. For large n and t analytical calculations on computers can be used in order to get the Boolean expressions which describe complicated devices exactly. In other words, the process of construction of very large integrated circuits can be automated using the suggested methods.
4. As the Galois algebra is modular in nature, it is possible to construct detectors and associated processor devices by the modular method.

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Никитюк Н.М. E10-91-161

Параллельные шифраторы для двумерных детекторов

Описывается новый метод шифрации и определения множественности сигналов, зарегистрированных в двумерных детекторах. Данный метод базируется на теории алгебраического кодирования и позволяет оптимизировать количество необходимых логических схем. Координаты и множественность сработавших позиционно-чувствительных детекторов определяются параллельно и без использования синхроимпульсов. Приводится схема параллельного шифратора, содержащего 49 входов для множественности сигналов t = 2.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

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Parallel Encoders for Pixel Detectors

A new method of fast encoding and determining the multiplicity and coordinates of fired pixels is described. This method based on the method of syndrome coding allows one optimize logic circuits. The coordinate and multiplicity t of fired pixels are encoded and determined in parallel and without synchropulses. As syndrome coding method is based on the algebraic coding theory for a large number of pixels n and multiplicity t, analytical calculations on computers can be used to construct parallel encoders and majority coincidence circuits (MCC). A specific example construction of parallel encoders and MCC for n = 49 and t = 2 is given.

The investigation has been performed at the Laboratory of High Energies, JINR.

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