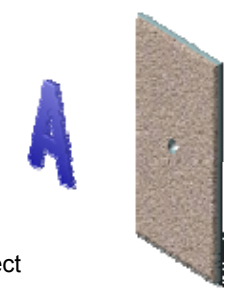
OPTIMIZATION OF THE FLAT MULTI-PINHOLE CODED APERTURES FOR THE SINGLE-PHOTON EMISSION COMPUTER TOMOGRAPHY

M.A.Antakov

Moscow Institute of Electronic Technology (MIET)

1

The obscura-chamber for a source of optical radiation



Flat radiating object

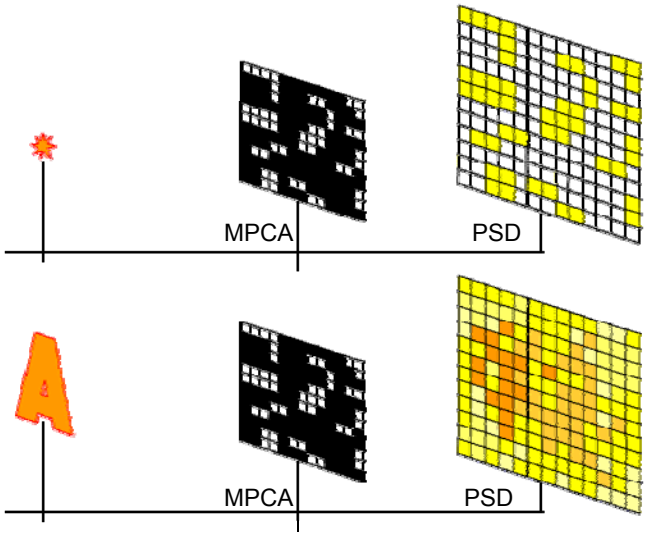
The opaque plate with a small hole (pinhole)

Position sensitive detector (PSD)

Volume radiating object

2

Multi-pinhole coded aperture (MPCA)

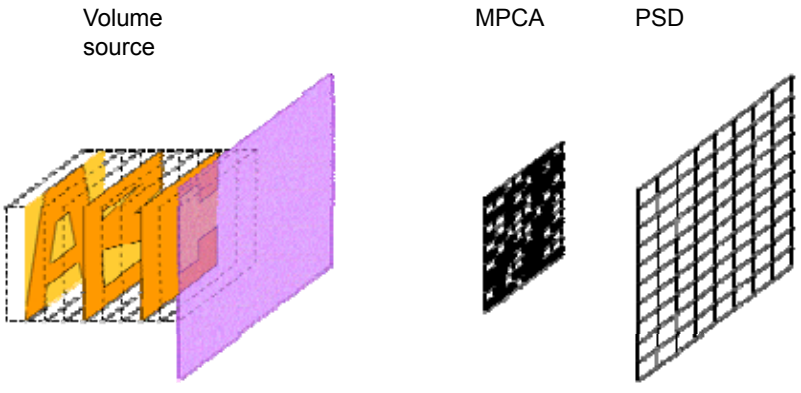


The shade on a detector is a copy of the coded aperture. Decoding is required

The shade on a detector represents more difficult picture

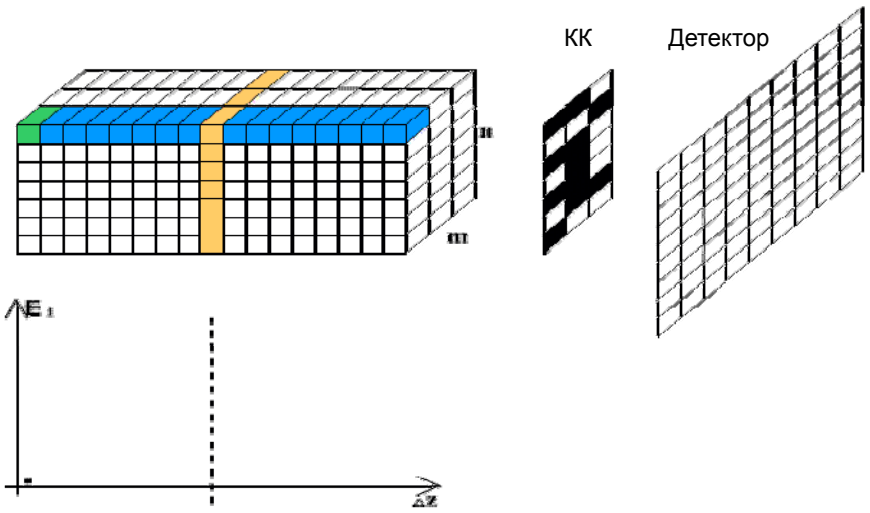
3

Focal planes method



4

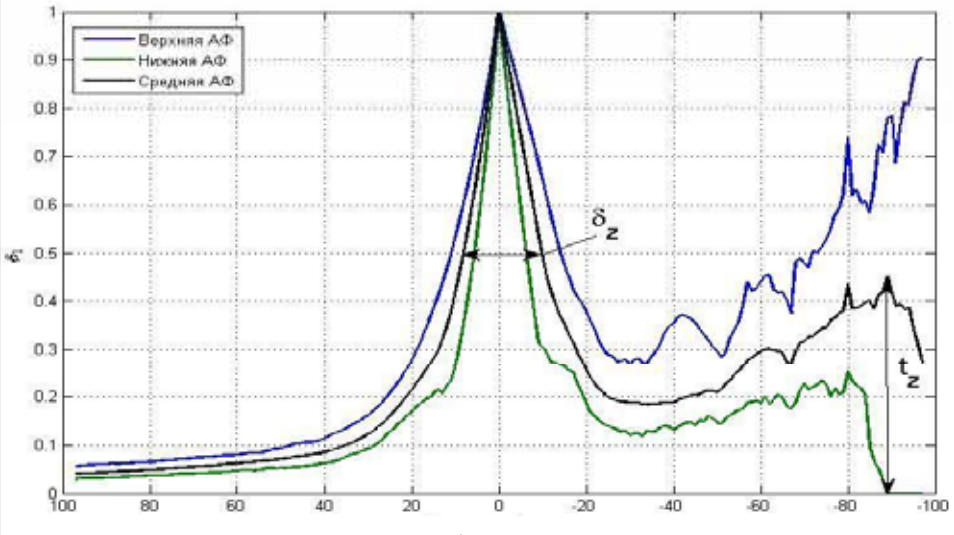
Construction of the point spread function (PSF) of coded aperture



5

PSF of the coded aperture

PSF of the coded aperture with the 20X20 dimension constructed with the line-by-line method



6

Classical pseudo-random sequences (PRS)

PRS is any line in (0,1)-matrix-circulant satisfying a condition: $\hat{A}\hat{A}^T = (k-\lambda)\hat{I} + \lambda\hat{J}$

$\hat{I}$ *is a unit diagonal matrix*
$\hat{J}$ *is a square matrix consisting only of ones*
k *and* λ *are the integers*

Considered all 2D-tables, satisfying conditions: $7 \le m,n \le 50$ *and* $|m-n| \le 43$

Number such (0,1)-tables — **4768** **(actually 546)**
Among them:
- on the basis of classical ($k \le \frac{v+1}{2}$) — **987**
- on the basis of associated ($k > \frac{v+1}{2}$) — **987**
- on the basis of degenerated ($k = v-1$) — **4222 (can't be used)**

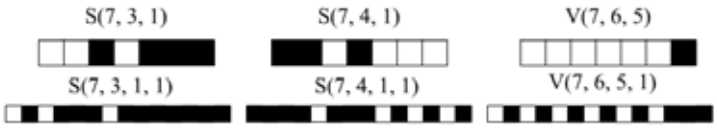
The main disadvantage is a limited choice of an average transparency k/v

7

The extended pseudo-random sequences (EPRS)

Construction EPRS on the basis of:

classical PRS | associated PRS | degenerated PRS



The number of 2-D tables constructed on the basis of 1-D EPRS is equal to **44205**

Among them:
- On a basis of classical PRS is equal to **8030**
- On a basis of associated PRS is equal to **6348**
- On a basis of degenerated PRS is equal to **34247**

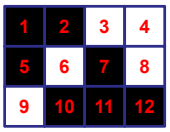
Wide choice of an average transparency : $0.0002 \le k/v \le 0.5$

8

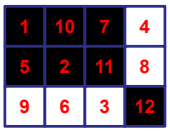
Construction methods

On the basis of **one** PRS:

Line-by-line method:

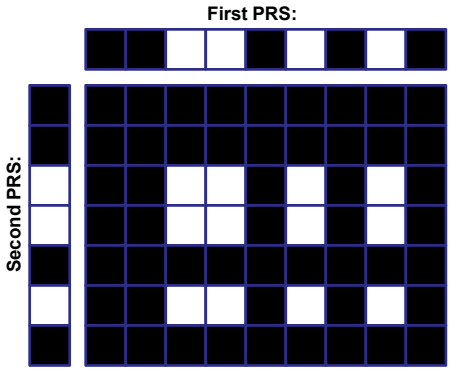


Diagonal method:



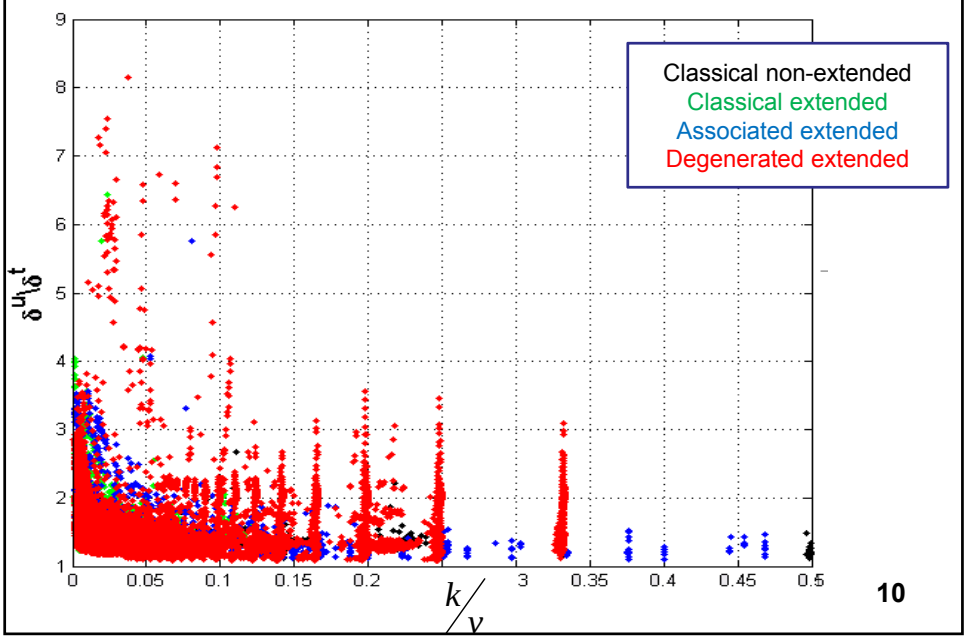
On the basis of **two** PRS:

Self-supported method:



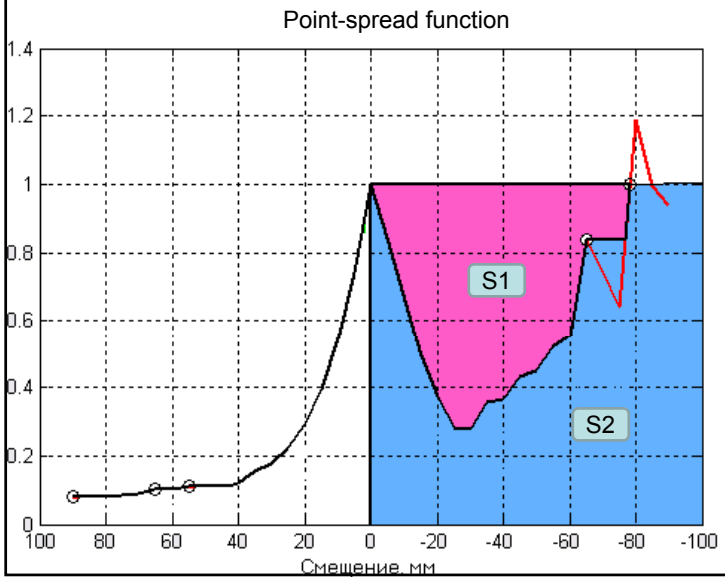
9

The normalized depth resolution



10

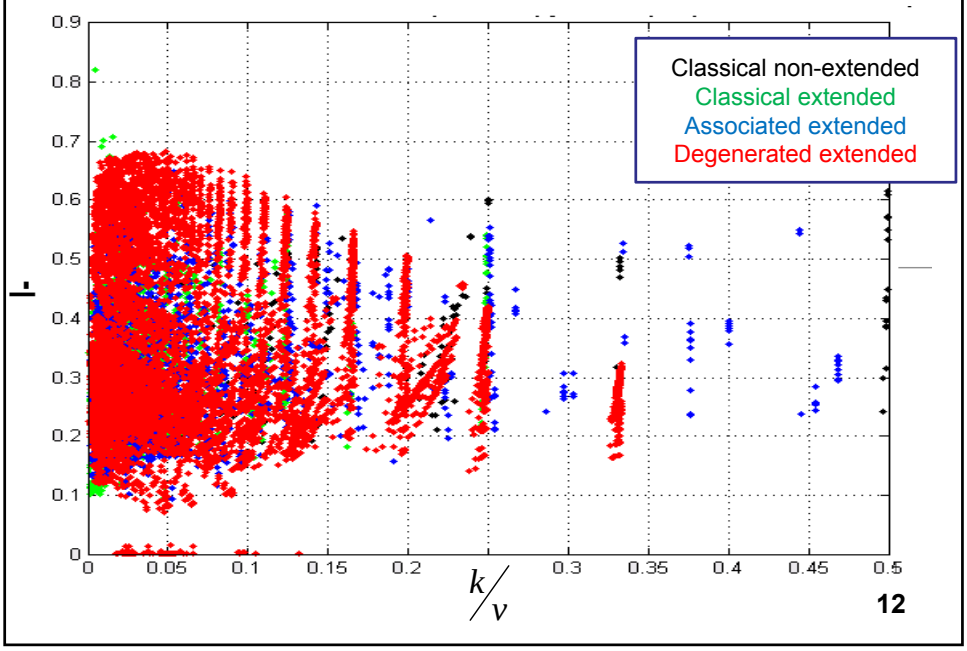
Criterion of the integral contribution



$$I = \frac{S1}{S1 + S2}$$

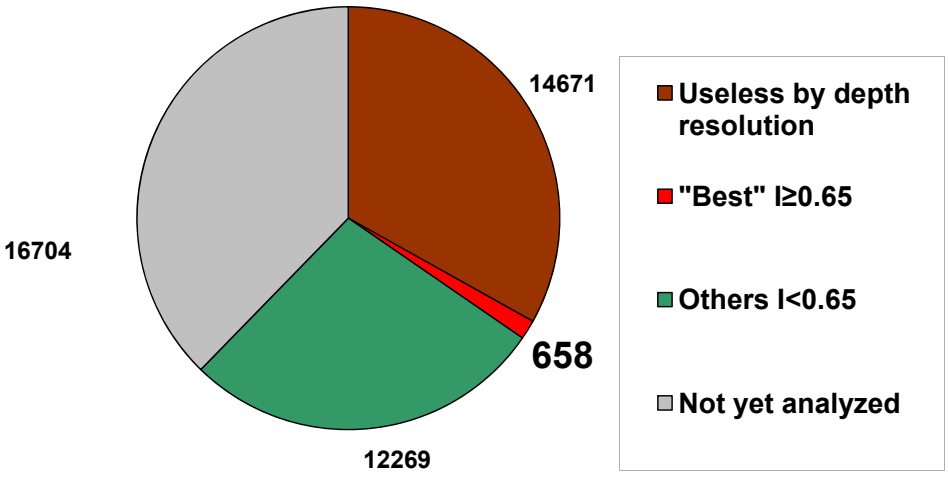
11

Criterion of the integral contribution



12

All 2-D tables



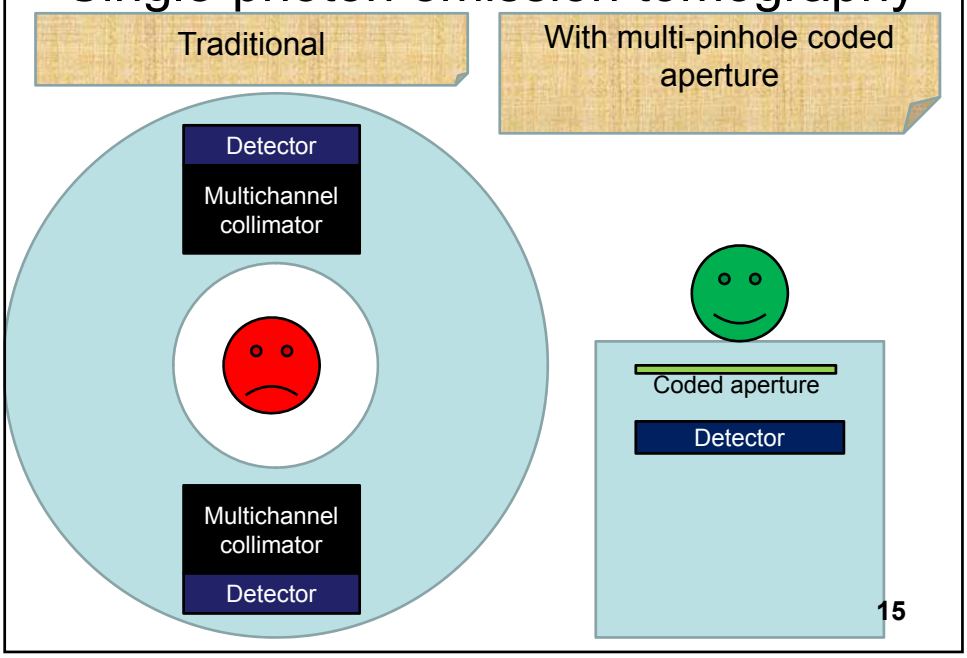
13

Main results

1. 658 coded apertures with good PSF had been selected by the criterion of the integral contribution from 27598 possible coded apertures.
2. The majority (609 from 658) of coded apertures with good PSF are constructed with the line-by-line method. The others are constructed with the diagonal method. There are no apertures with the good PSF, constructed by the self-supported method.
3. From 658 coded apertures with good PSF only 25 are constructed on the basis of non-extended classical PRS, the others are constructed on the basis of EPSR, obtained from degenerated PRS.

14

Single-photon emission tomography



Thank you for your attention

16