Application of Nuclear Physics Methods for Identification of Complex Chemical Substances

Project DVIN

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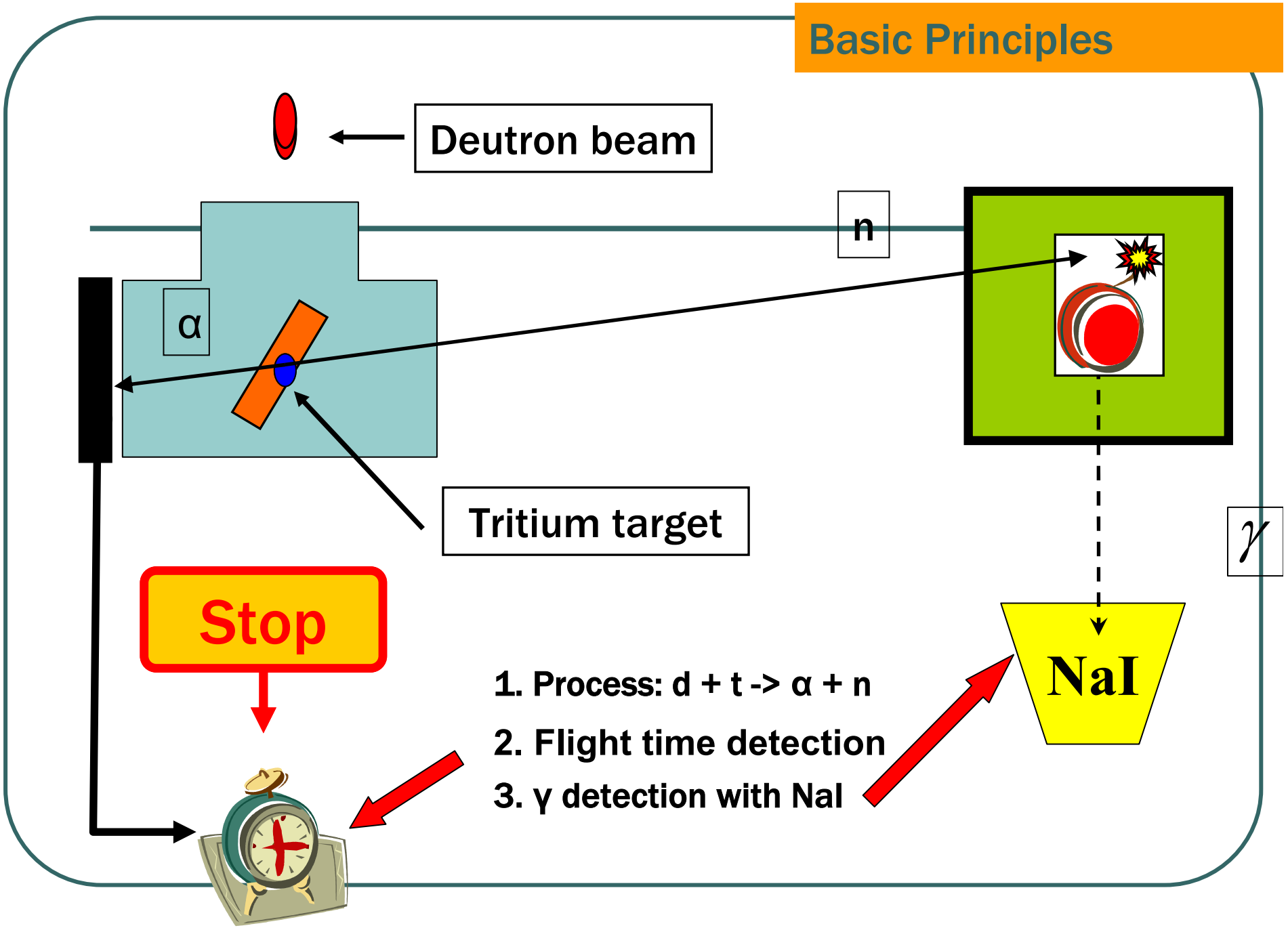
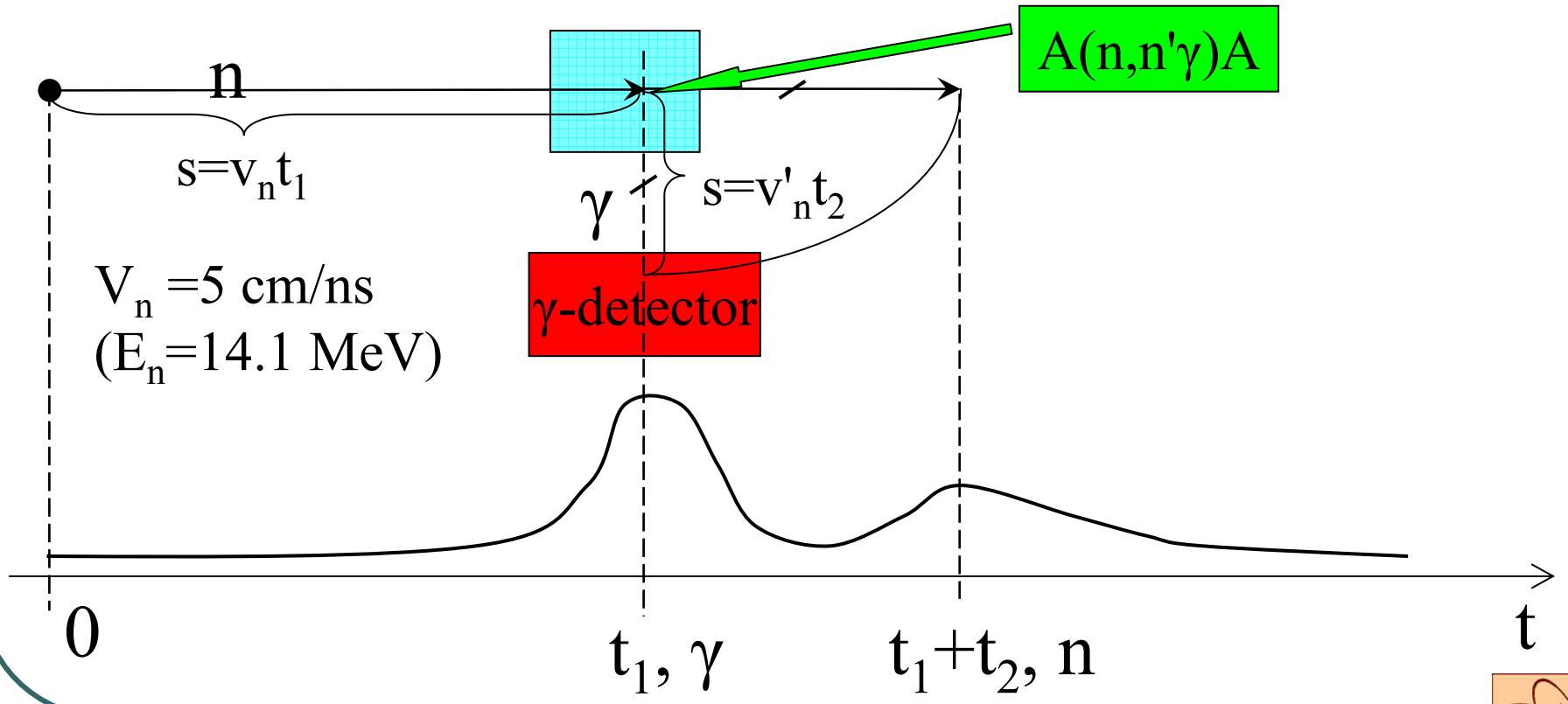
Project history

- 1998, Rochester Conference, Vancouver
  B.Maglich, API method
  V.G.Kadyshevsky
- 1999, “Aspect” , R@D for Customs
- 2003, “ Aspect” , mobile prototype for Customs
- 2005, stationary detector

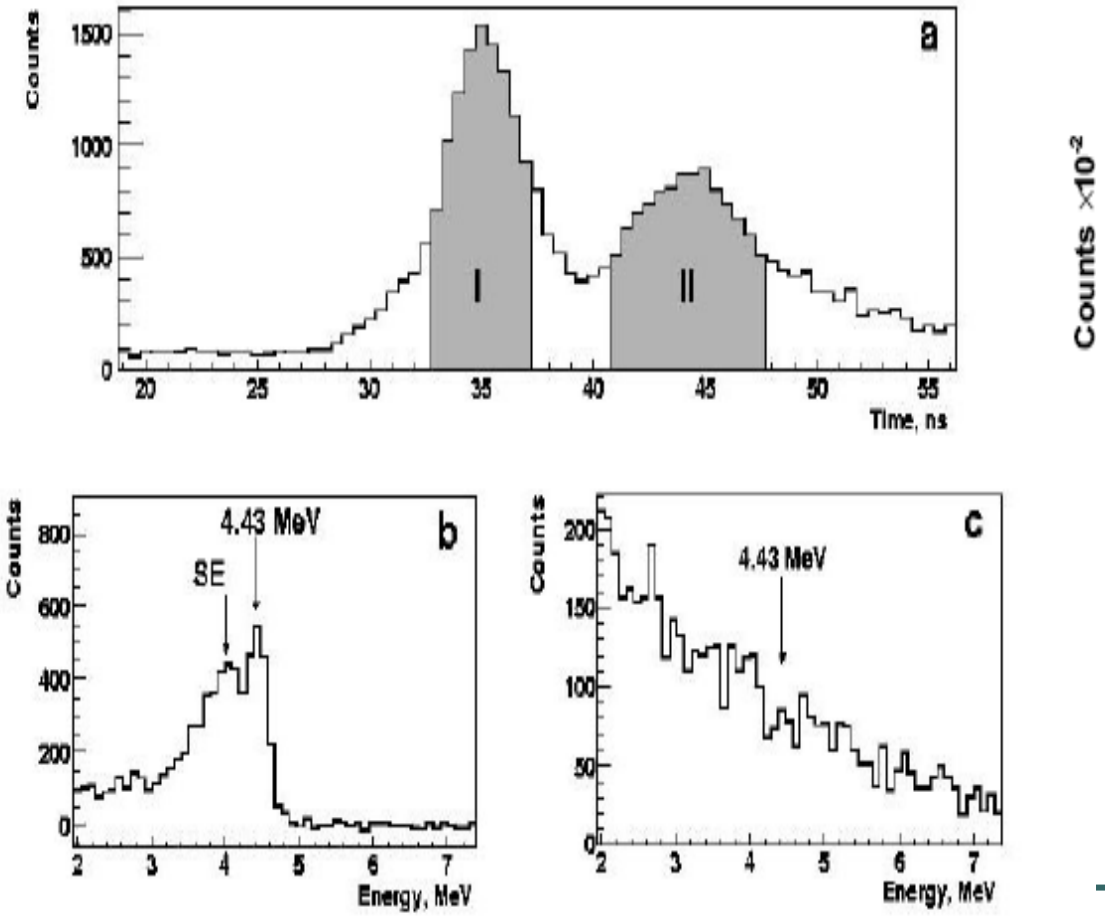
Basic Principles



Time distribution



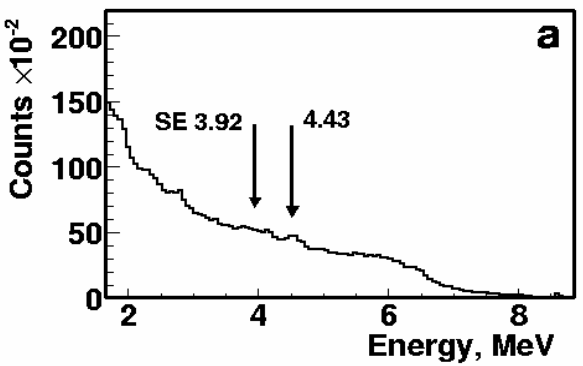
Energy spectra in different time intervals

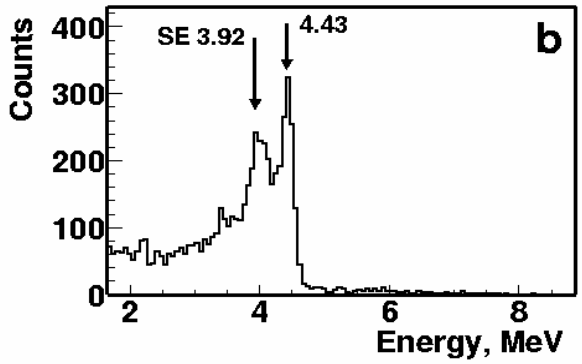


Possibility of scanning in depth

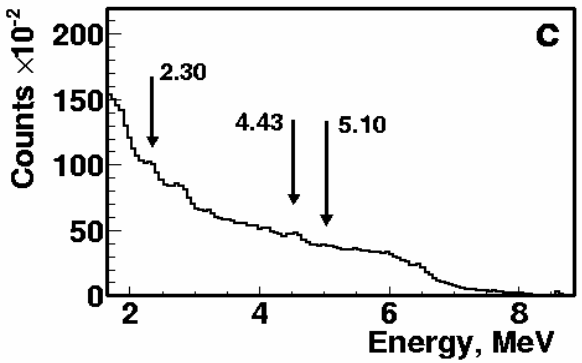
Reliability of hidden substance detection

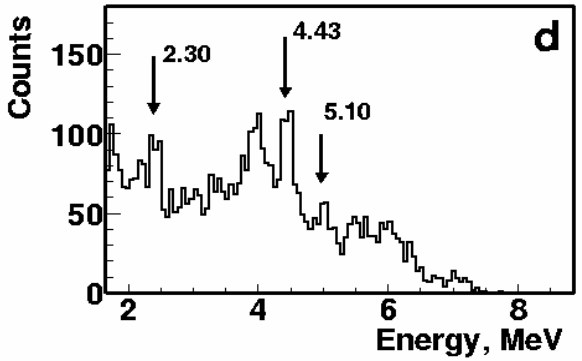
$E_\gamma(^{12}C) = 4.43$ MeV, $E_\gamma(^{14}N) = 5.1$ MeV, $E_\gamma(^{16}O) = 6.13$ MeV





⇐ ^{12}C

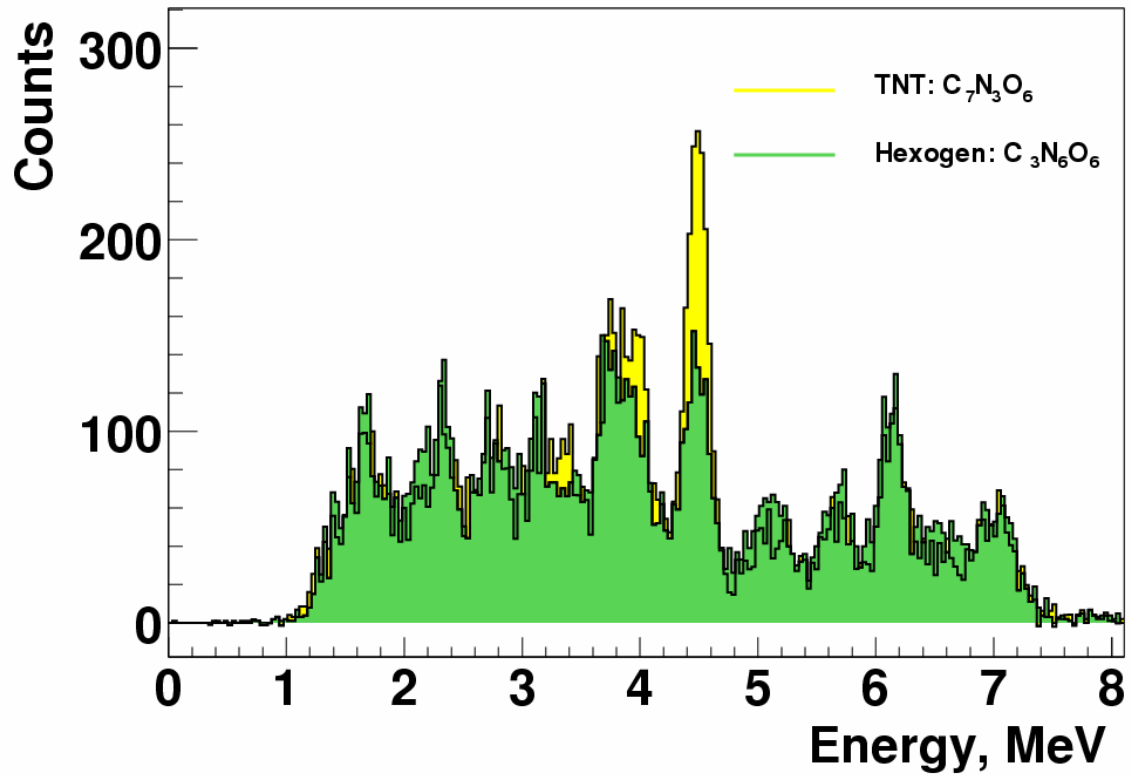




⇐ melamine ($C_3H_6N_6$)

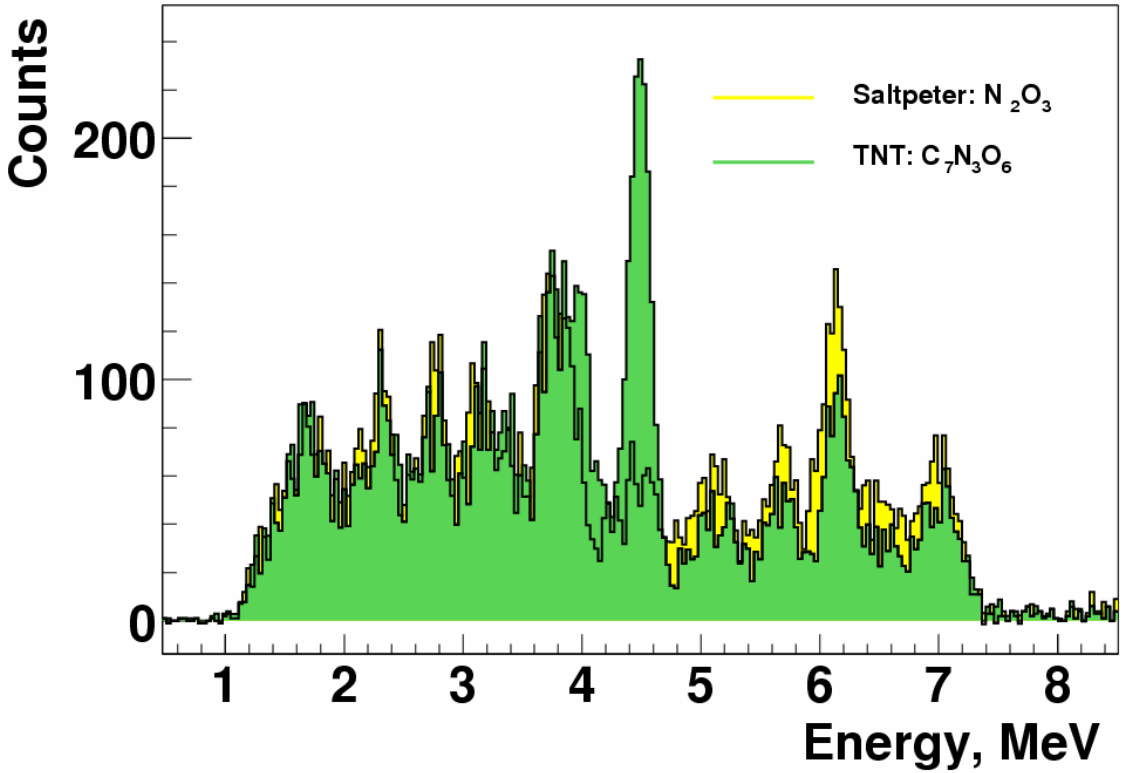
Signal/background ratio is better than 200

Идентификация вещества – по спектрам γ-квантов



Тротил ($C_7N_3O_6$) и гексоген ($C_3N_6O_6$)

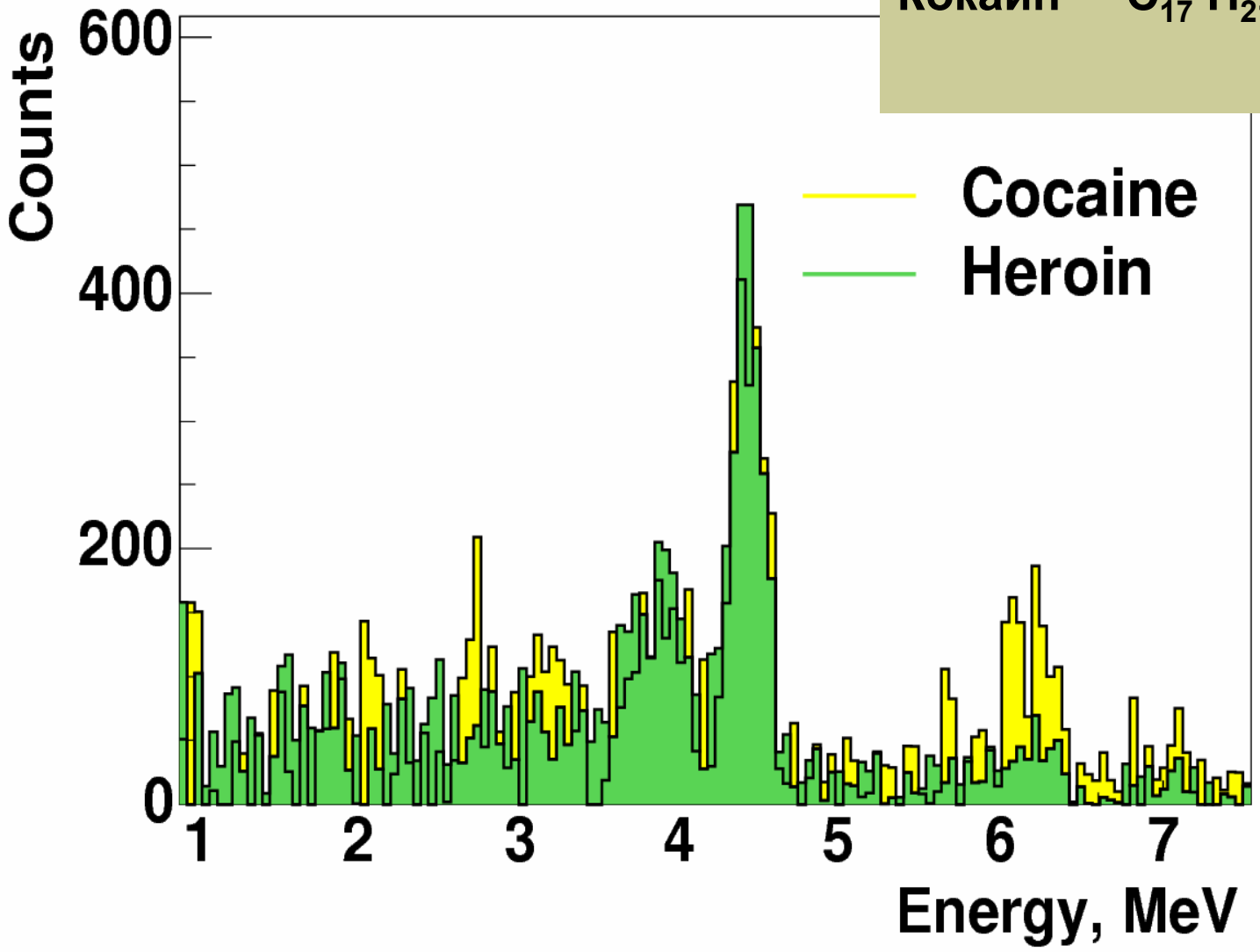
Спектры γ-квантов

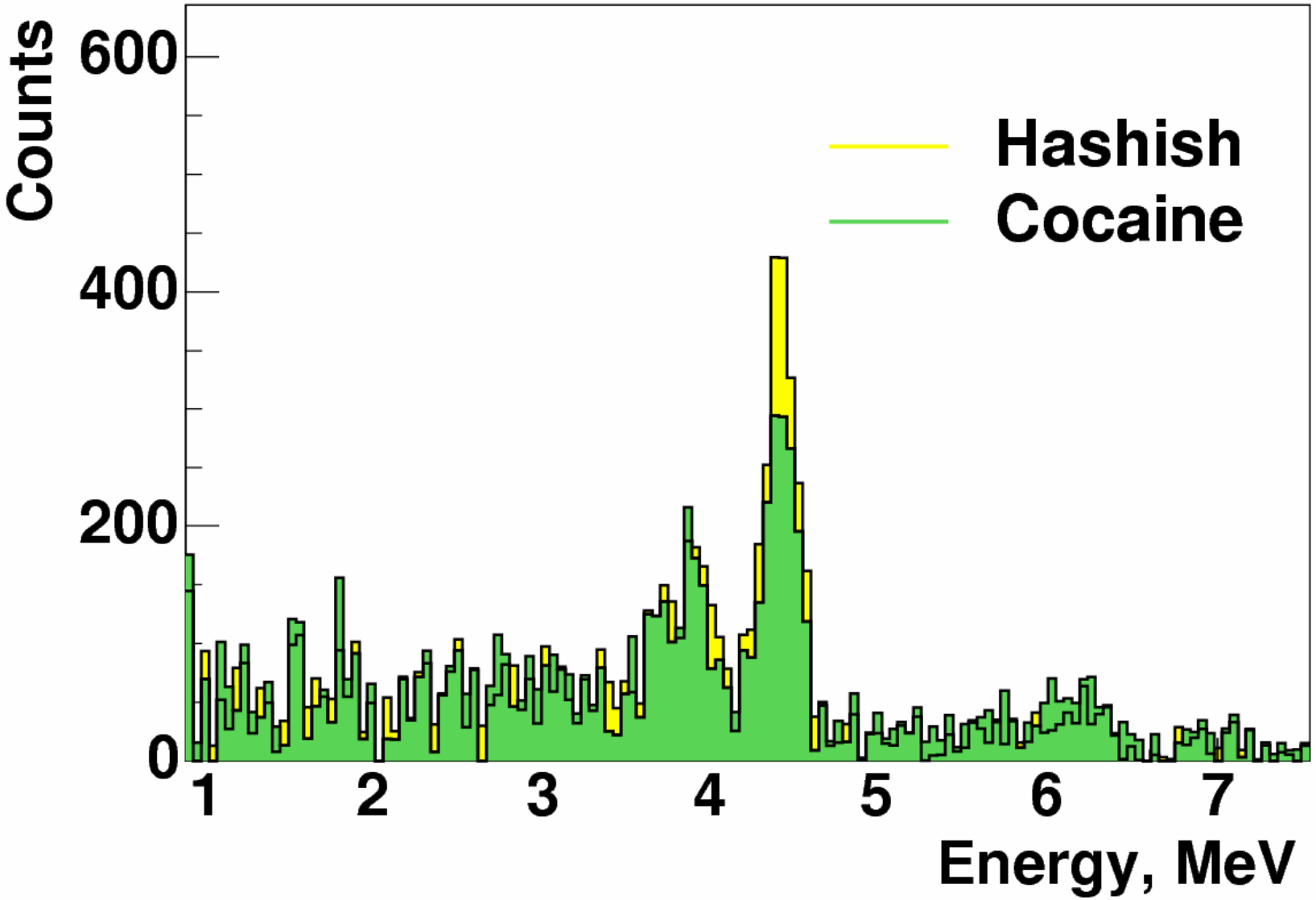


Селитра (N_2O_3) и тротил ($C_7N_3O_6$)

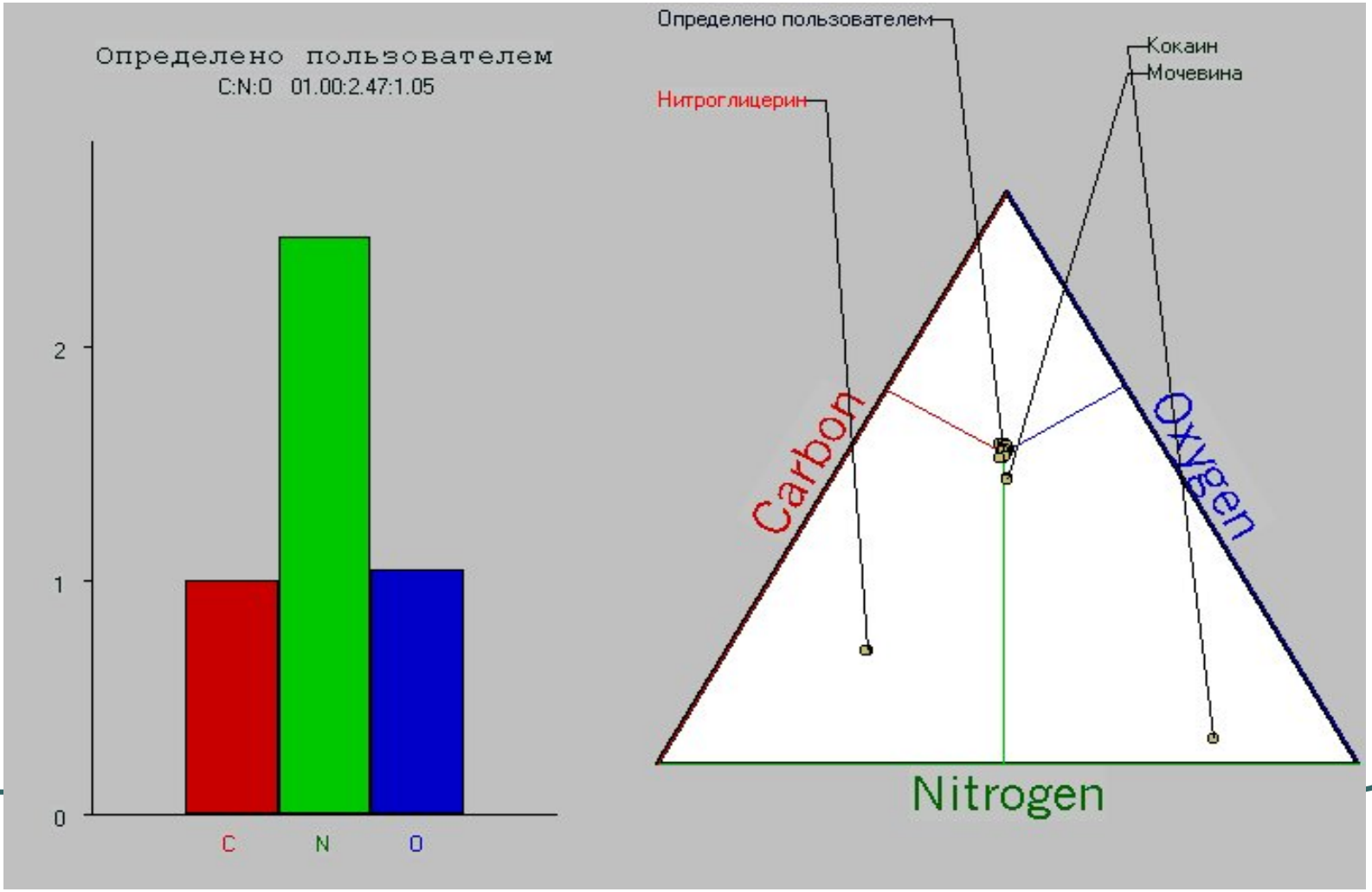
Героин – $C_{19}H_{17}O_5N$

Кокаин – $C_{17}H_{21}O_4N$

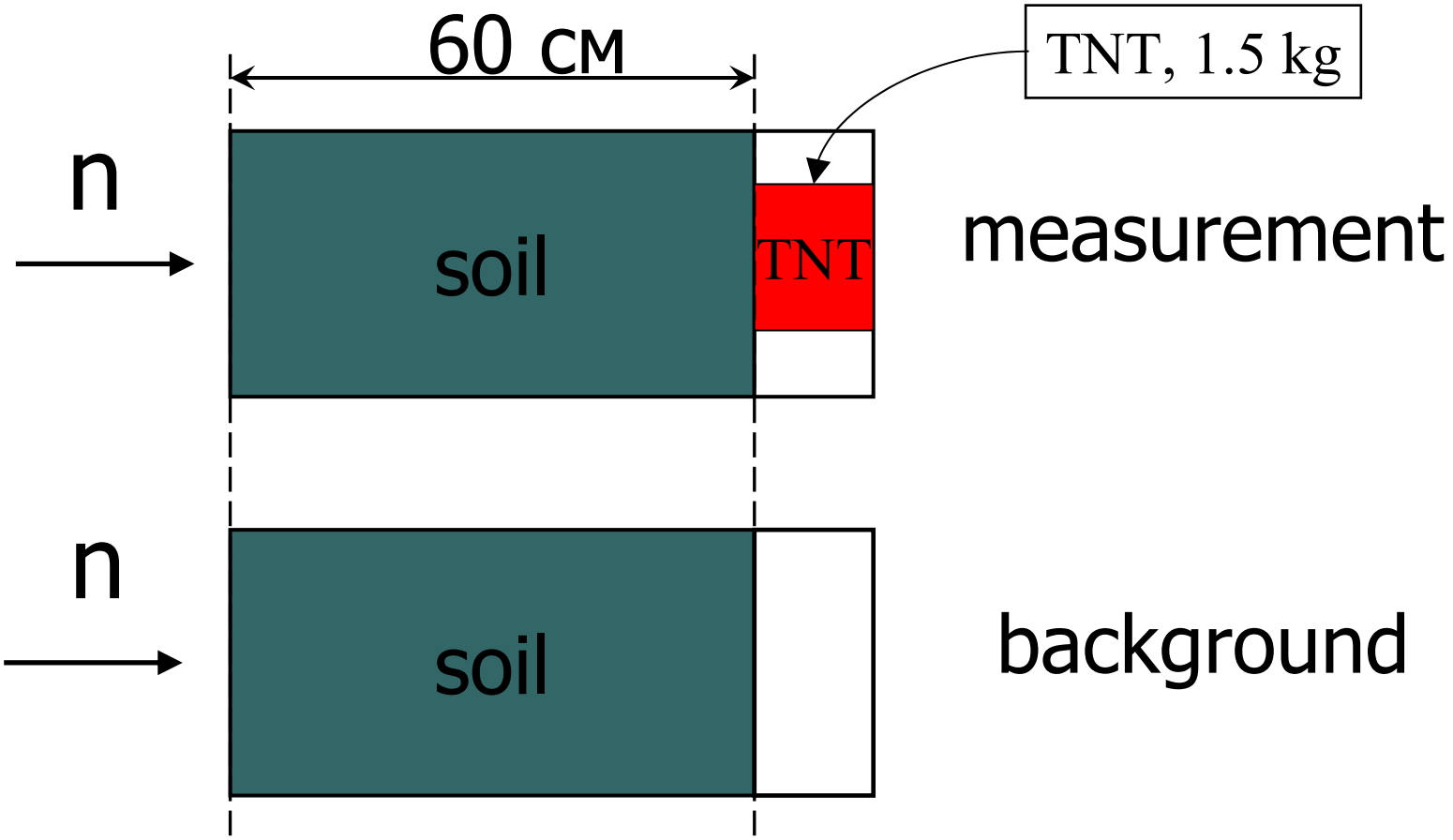


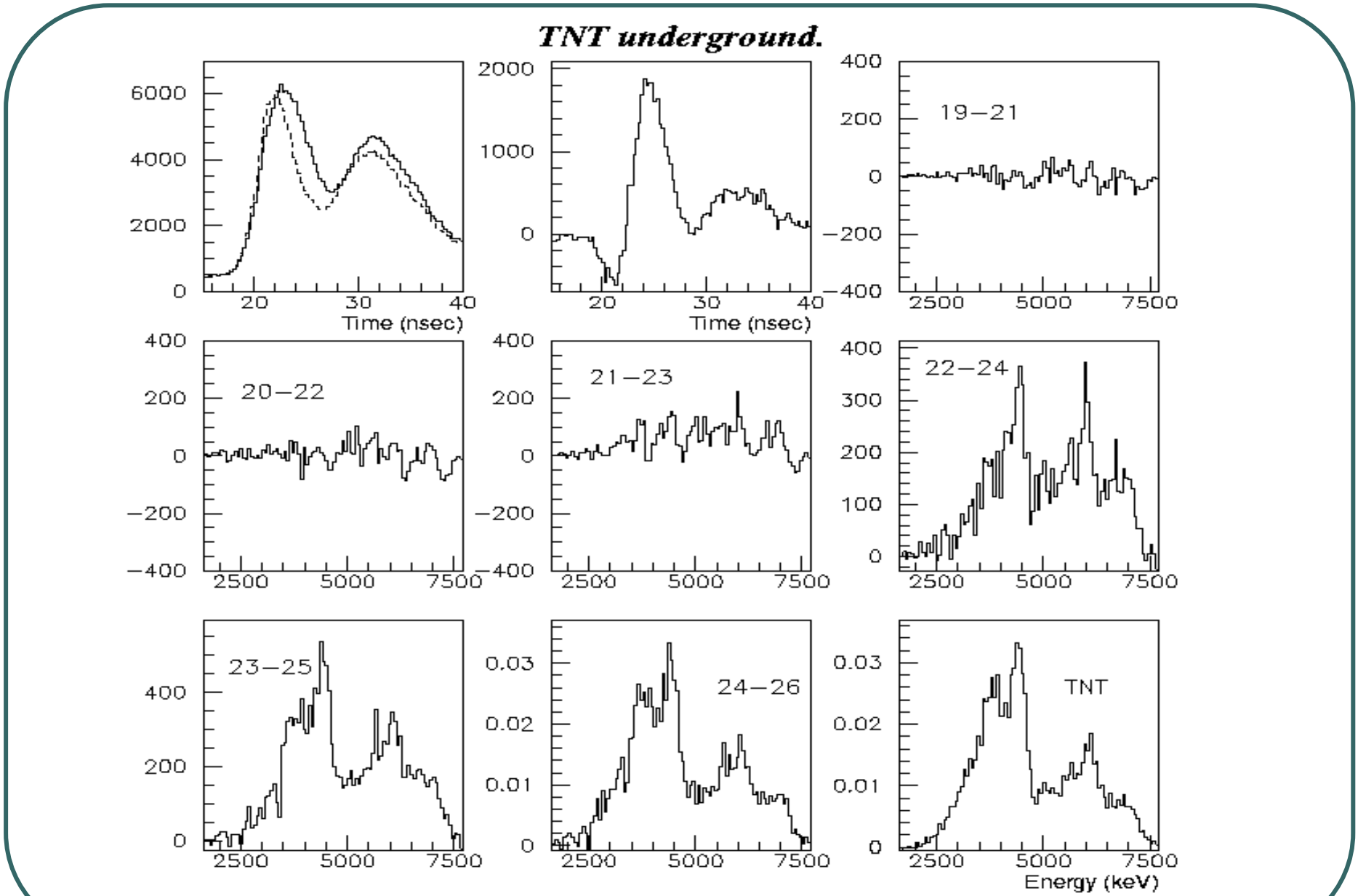

Counts
600
400
200
0
1
2
3
4
5
6
7
Energy, MeV
Hashish
Cocaine

Urea: CN_2O

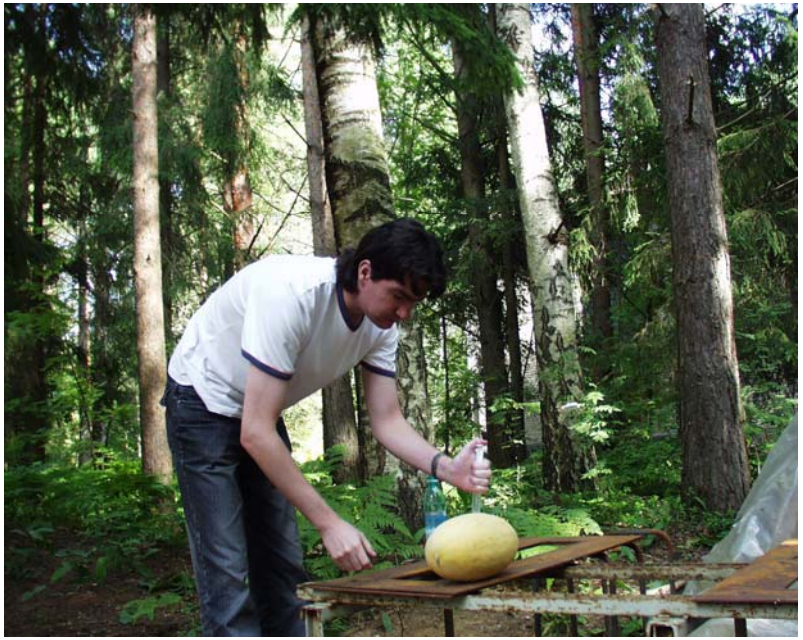

Определено пользователем
C:N:O 01.00:2.47:1.05
2
1
0
C
N
O
Определено пользователем
Кокаин
Мочевина
Нитроглицерин
Carbon
Oxygen
Nitrogen

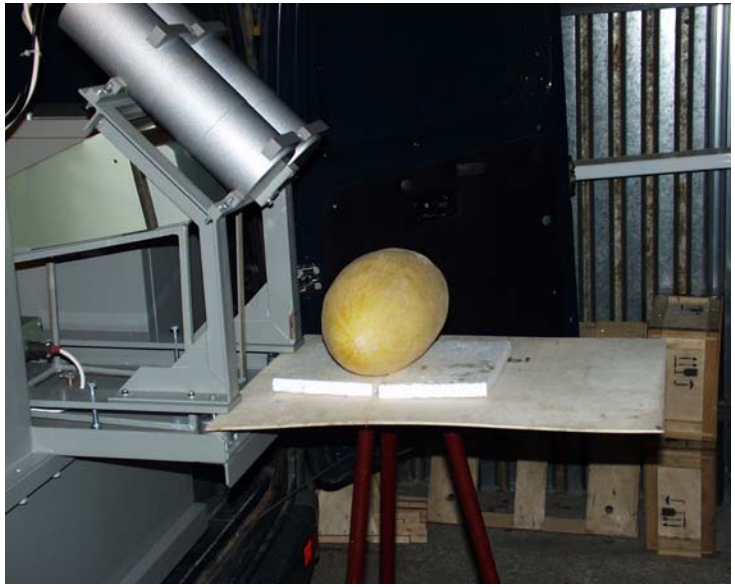
TNT in soil

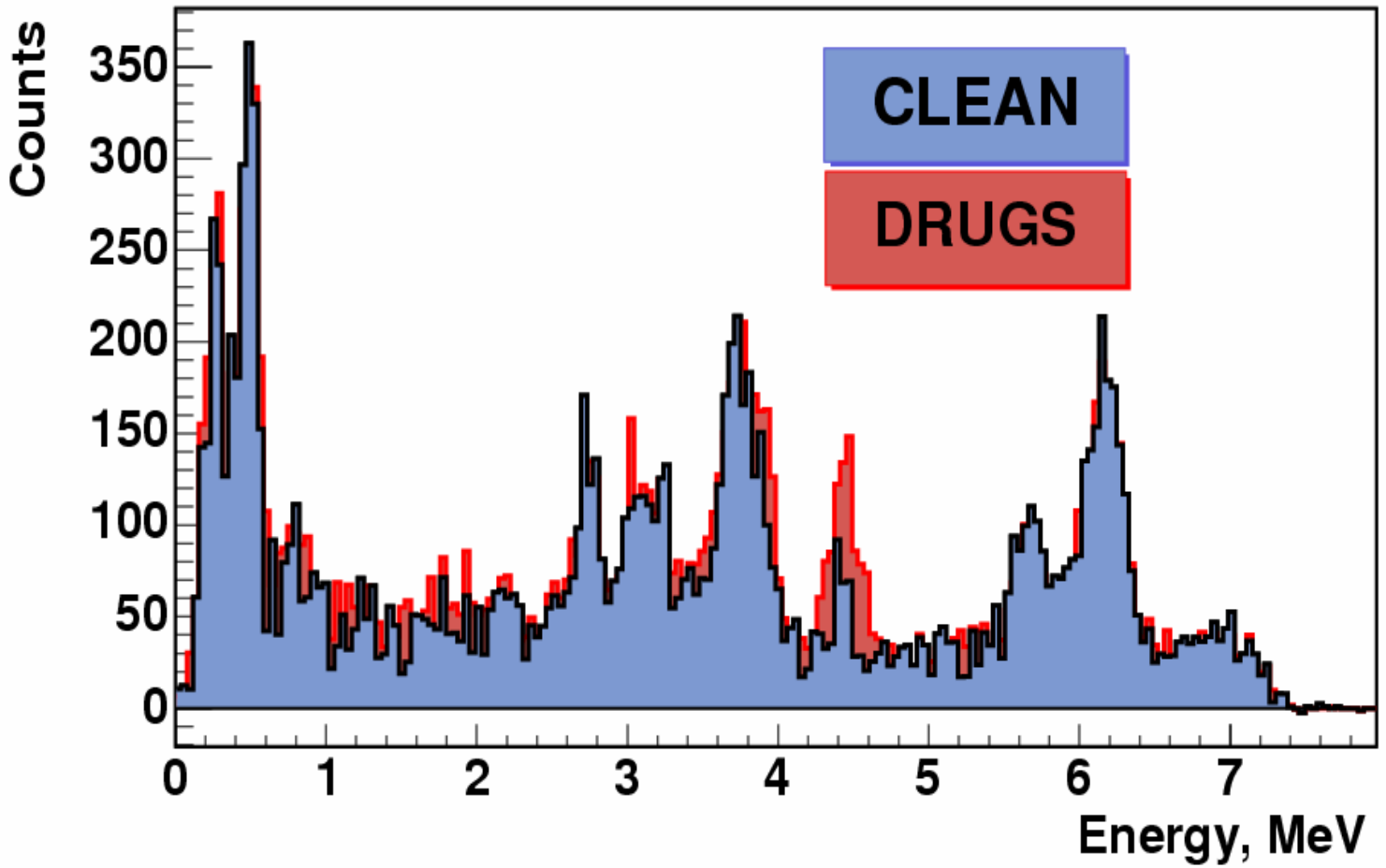



TNT underground.
Time (nsec)
Time (nsec)
19−21
20−22
21−23
22−24
23−25
24−26
TNT
Energy (keV)

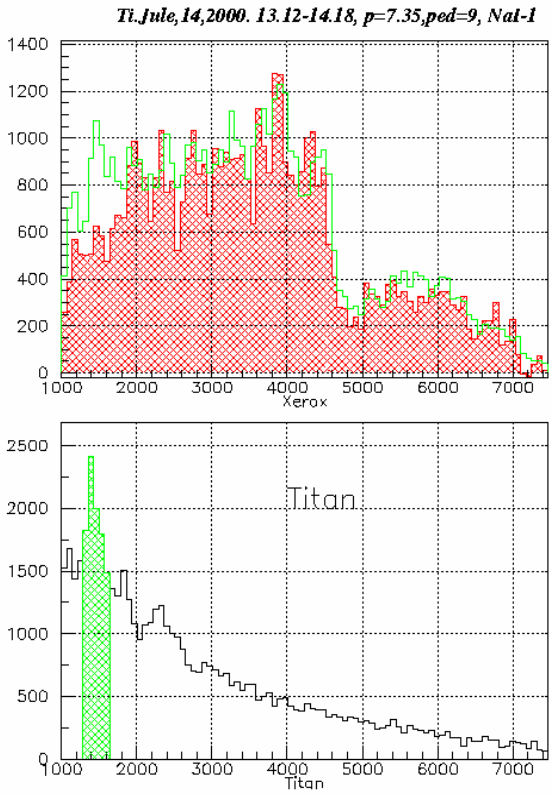
Melon in benzene






Counts
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
Energy, MeV
CLEAN
DRUGS

Идентификация долларов

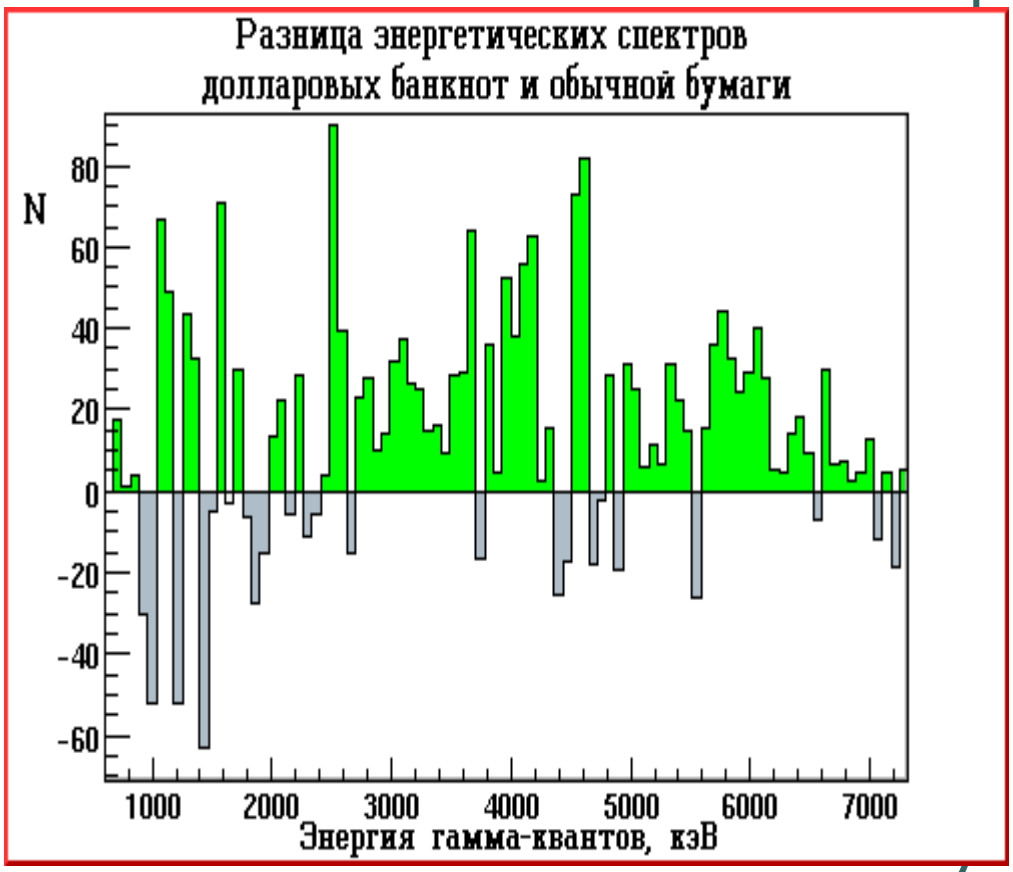


Элемент	Доллар	Бумага
C	41%	47%
H	6%	6%
O	46%	46%
S	-	0.11%
Пепел	7%	0.65%

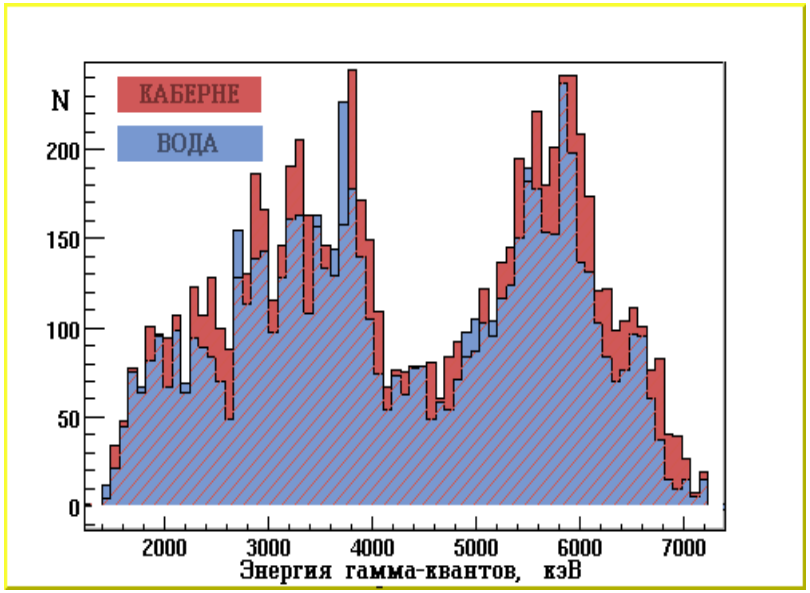
Основной элемент пепла :

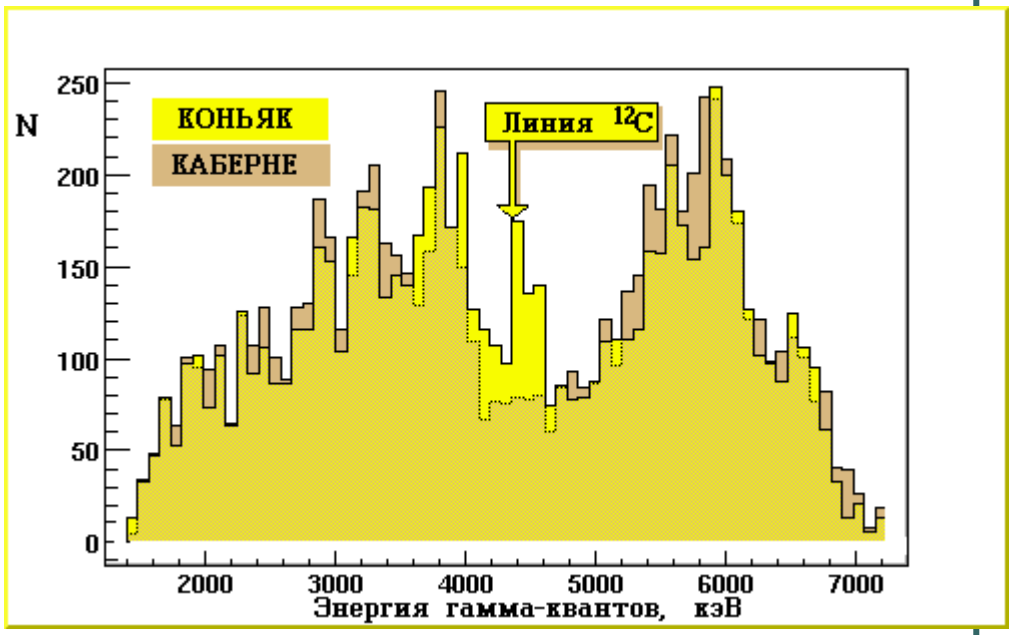
- Титан: 63%

Результат опытов:доллары



Каберне/коньяк





Portable neutron generator

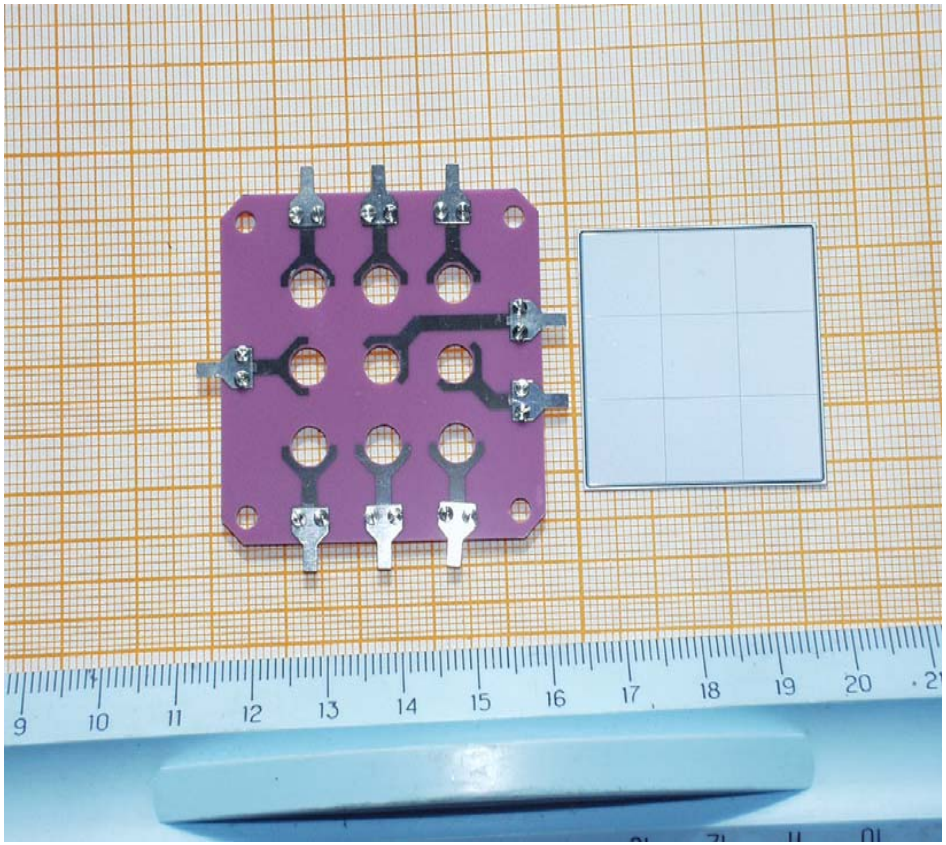
Five different types of PHG made by VNIIA (Moscow) have been tested

Neutron intensity:

$I = (1\text{-}10)\cdot 10^{7}\ c^{-1}$

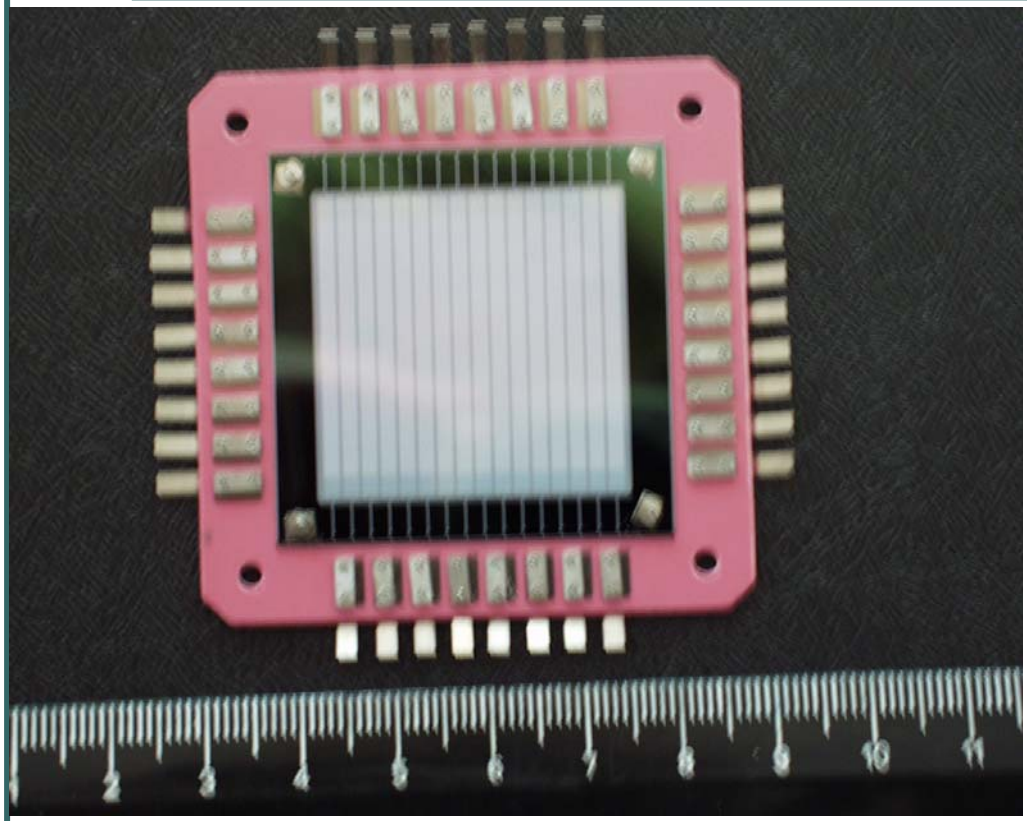
Operation time: up to 650 hours.

α-detector on 9 channels



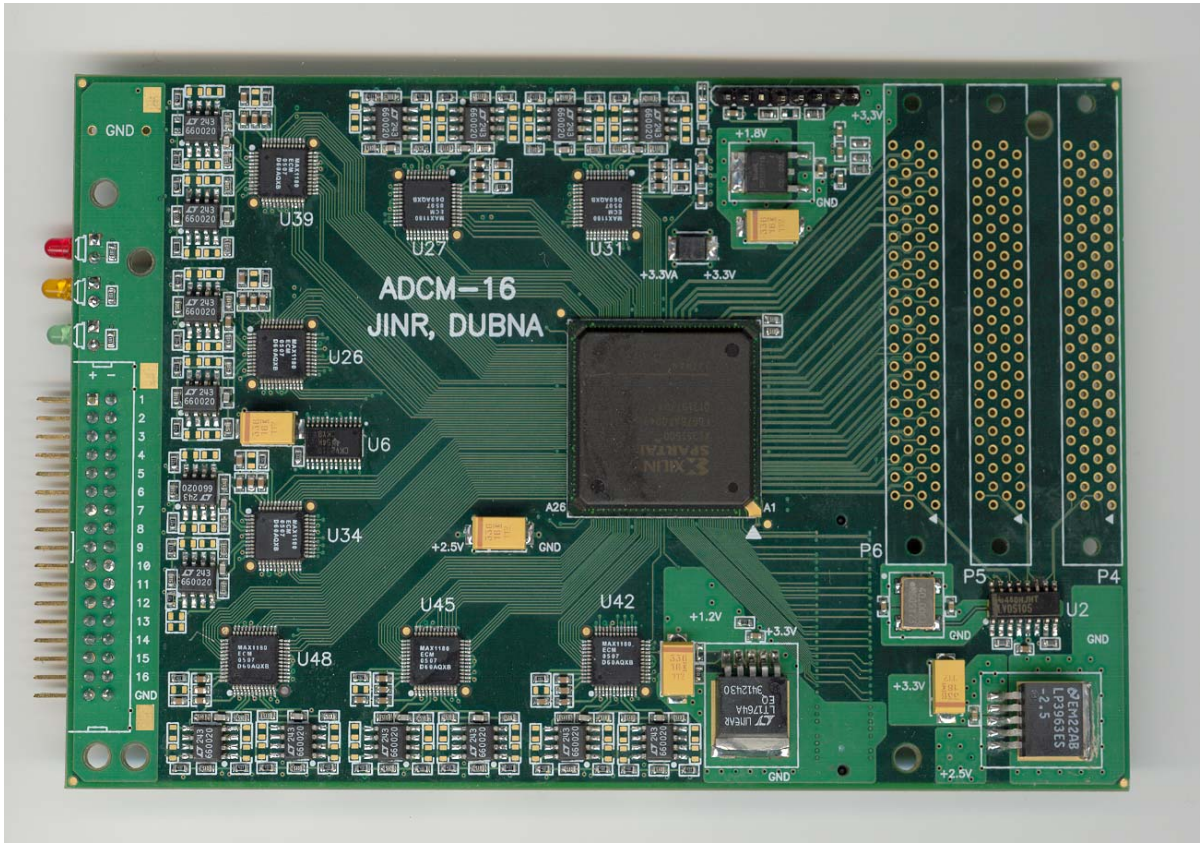
- Different types of α-detectors have been constructed and tested
- 9 cells10x10 mm^2

Развитие технической базы-2



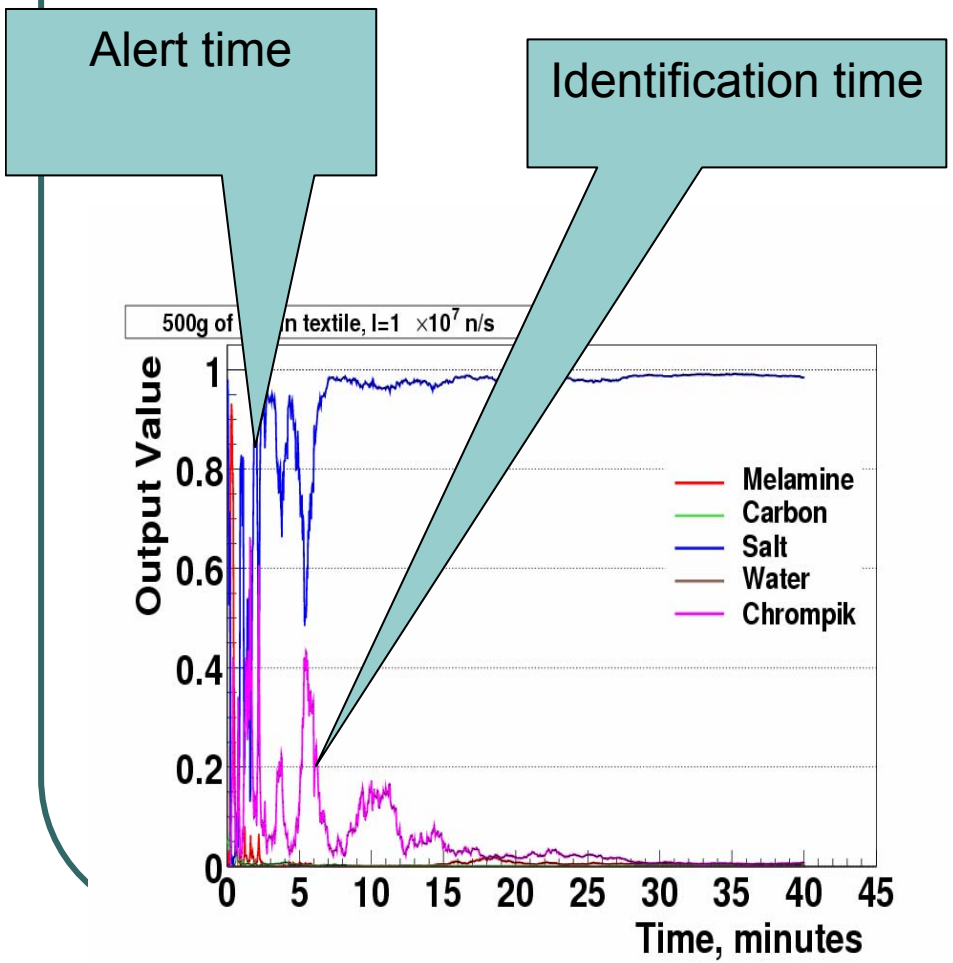
- α- детектор на 64-канала
- Размер пикселя – 4x4 мм^2
- 4 кратное уменьшение минимальной массы

DAQ electronics



- PCI-card for 16 α- γ-channels has been developed

Identification of hidden substances by neural networks



- Neural net output

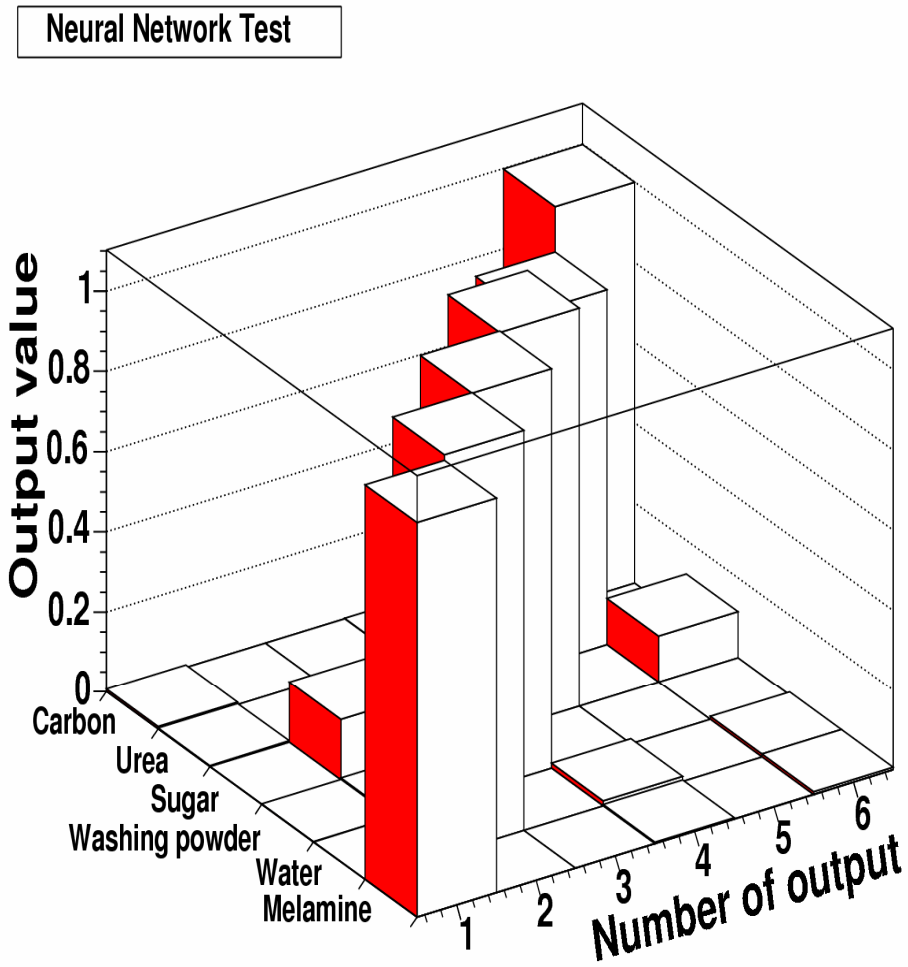
P > 0.8 – alert time

- Identification time

P >0.8 for one substance

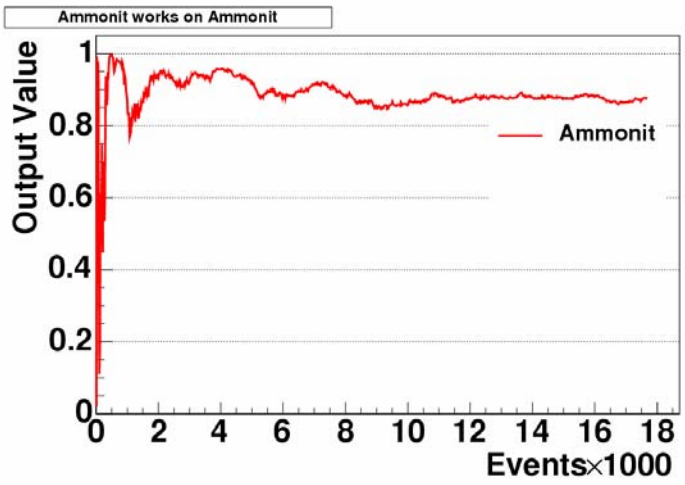
P <0.2 – for all other substances

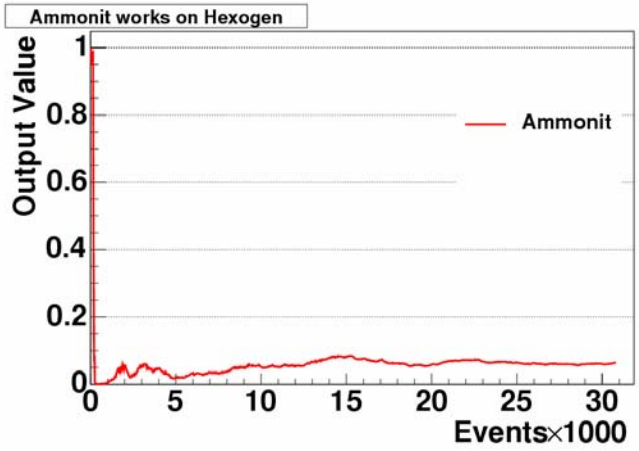
Identification of the hidden substance



The test of the neuron net performance. Along Y axis the number of interrogated substance is plotted. The results is the corresponding identification probability. It is plotted on Z axis.

Распознавание ВВ





- Изучена идентификация различных ВВ:

ТНТ, ТЭН, тетрил, гексоген, гранулит, аммонит, А-IX-1, А-IX-2, ПВВ-12А

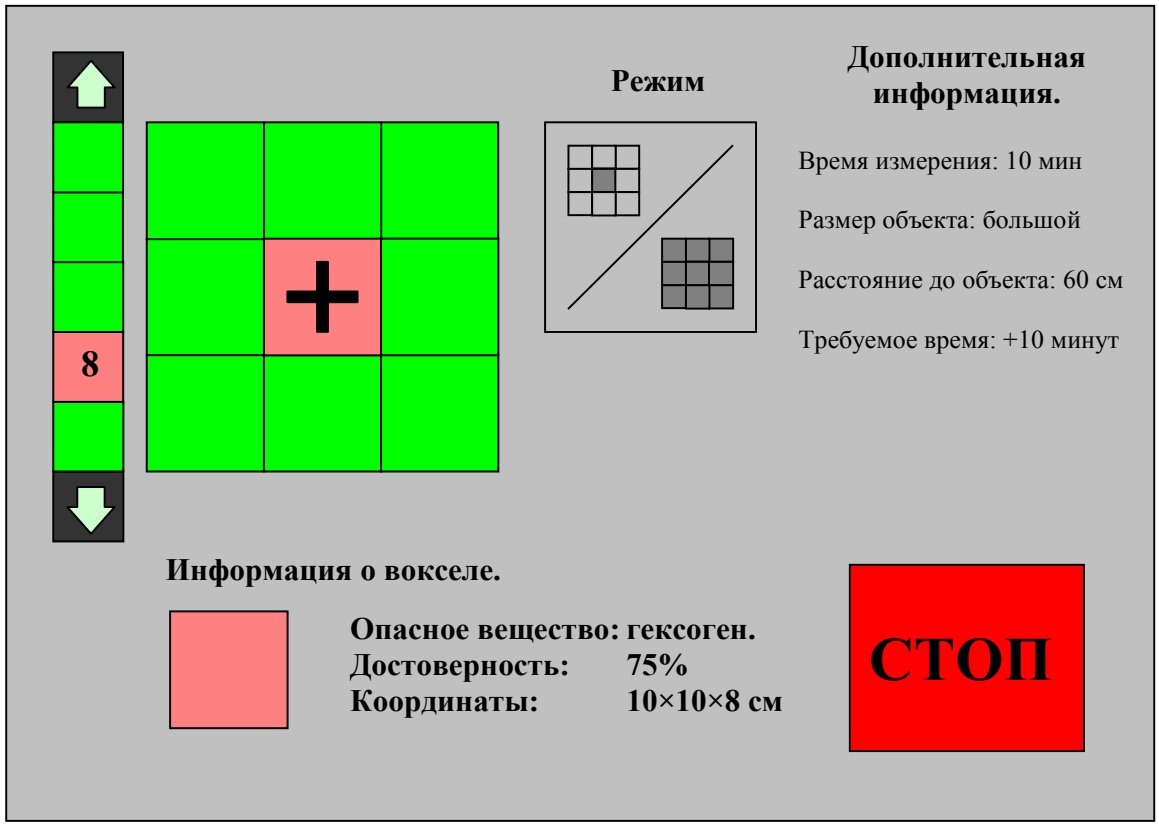
- А-IX-1 – гексоген + 5% связующего вещества

  А-IX-2 – гексоген + 20% алюминиевой пудры

- Сеть отличает А-IX-2 от

А-IX-1 или от гексогена

Users interface

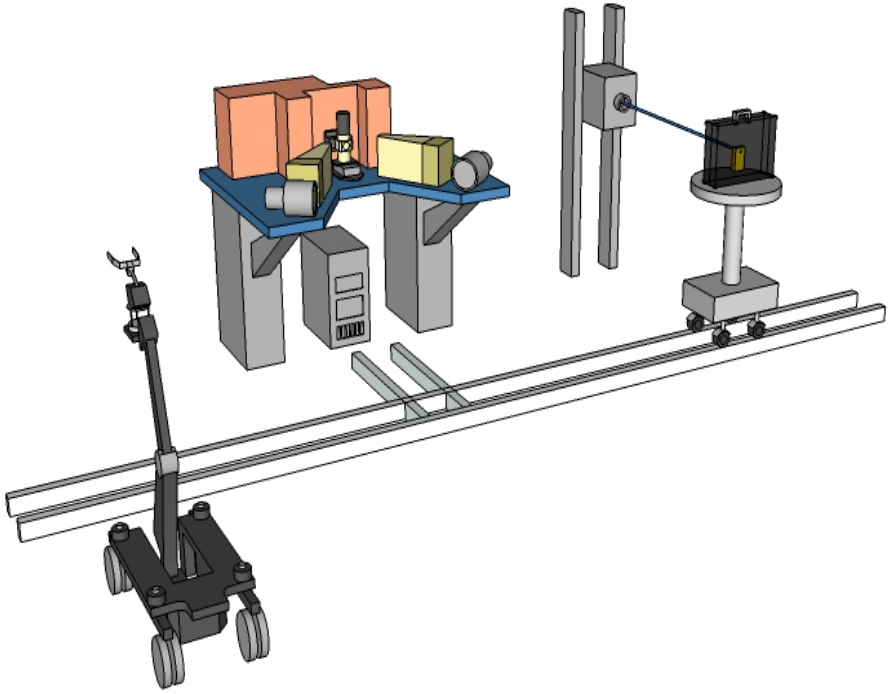


Identification procedure is without operator

Collaboration with SPC “Aspect”

- Mobile prototype for Customs was constructed
- Work on prototype for large containers inspection is under way

Стационарная установка



- Работа по целеуказанию
- Целеуказание рентгеновский интроскоп

Stationary detector

Main advantages of the Associated Particle Imaging method

- Sensitivity to the C:N:O:Cl:Fe:Al…. composition of the substance
- Determination of the 3-D coordinates of hidden object
- Large penetration capability – up to 1-1.5 m
- Good conditions for the hidden substance identification. S/B=200 times higher then in traditional neutron activation analysis.
- Identification procedure is without an operator

Summary:

- The application of the Tagged Neutrons Method was tested successfully.
- Main components of the detector have been created.
- First prototypes have been constructed and tested in lab conditions.
- Useful tool, complimentary to the existing arsenal of devices.