OBSERVATION OF THE E(38)-BOSON

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Abstract

The first results of the search for the E(38)-boson [1] are presented.

The search was conducted in the effective mass spectra of photon pairs produced in the d(2.0 GeV/n) + C, d(3.0 GeV/n) + Cu and p(4.6 GeV) + C reactions.

The experimental data was obtained at internal beams of the JINR Nuclotron.

[1]. E. van Beveren and G. Rupp. arXiv:1202.1739; 1204.3287.

-------- Исходное сообщение --------
Тема: ArXiv:1203.4198
Дата: Thu, 17 May 2012 19:04:52 +0100
От: eef@teor.fis.uc.pt
Кому: Khachik Abraamyan <abraam@sunhe.jinr.ru>
Копия: George Rupp <george@ist.utl.pt>

Dear Dr. Khachik Abraamyan and collaborators,

It was a pleasant surprise to read your article on "Resonance structure in diphoton and two-neutral-pion systems in Deuterium-Carbon interactions" ArXiv:1203.4198.

I am sorry that I did not come across your 2006 work nucl-ex/0607027 before today.

Your result is spectacular as it does not seem to fit into any type of model for strong interactions and worth to offer you my congratulations.

Do you yourself have an explanation for the resonance at 360 MeV?

Actually, I was browsing in Google through data for diphotons where I found your work. **The reason is that I myself and my collaborator George Rupp are interested in diphoton data from 30 to 50 MeV** (see arXiv:1202.1739 and arXiv:1204.3287).

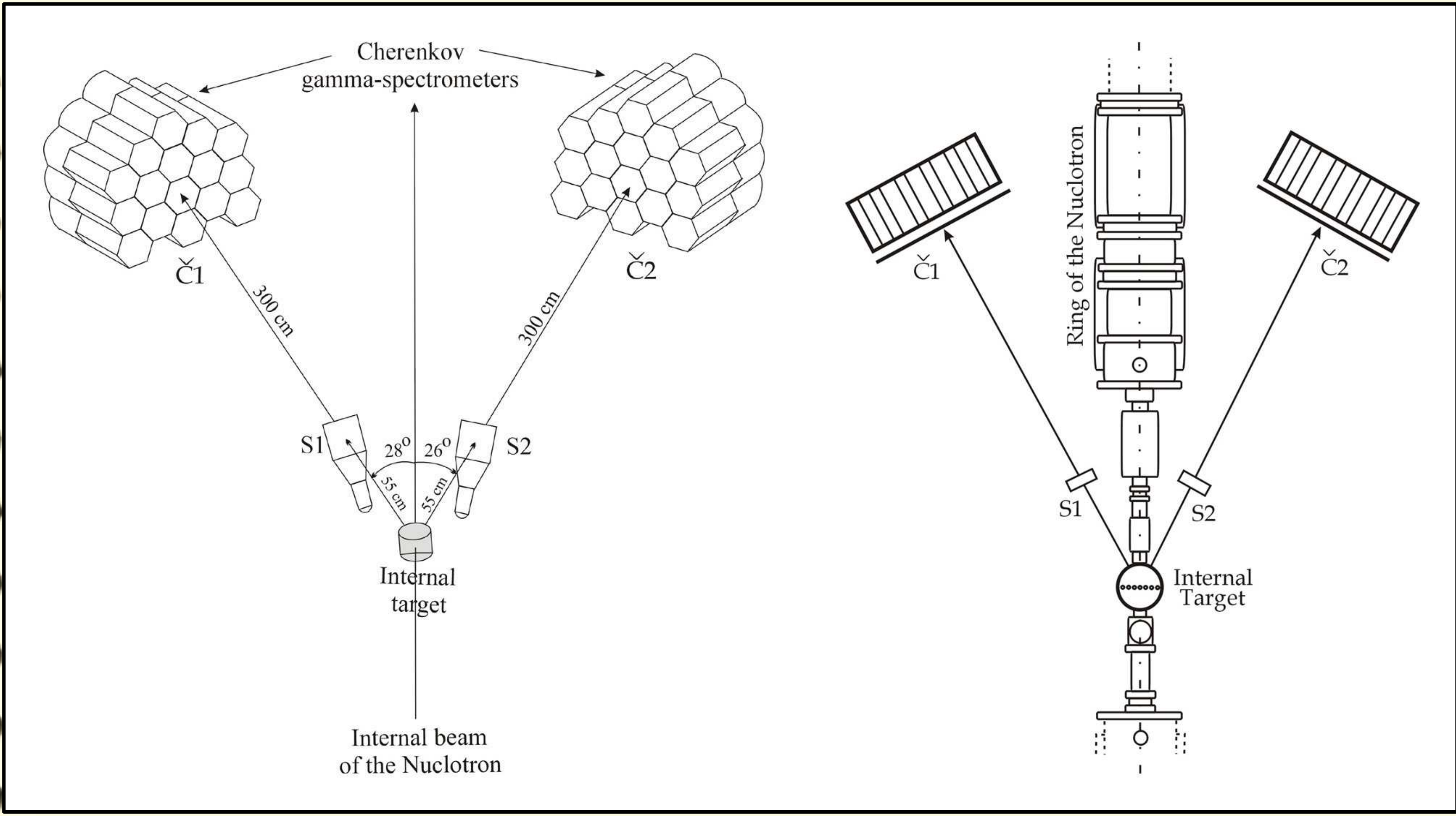
Unfortunately, your lower limit is 100 MeV, but I wonder
whether that is a limitation of your setup at the JINR Nuclotron,
or that it could be lowered to 30 MeV.

Kind regards,
Eef van Beveren

The plan of the report

- The experiment.
- First results.
- Check of the observed peak.
- Data simulation.
- Conclusion, outlook.

PHOTON-2 setup on internal beams of the NUCLOTRON



EXPERIMENT

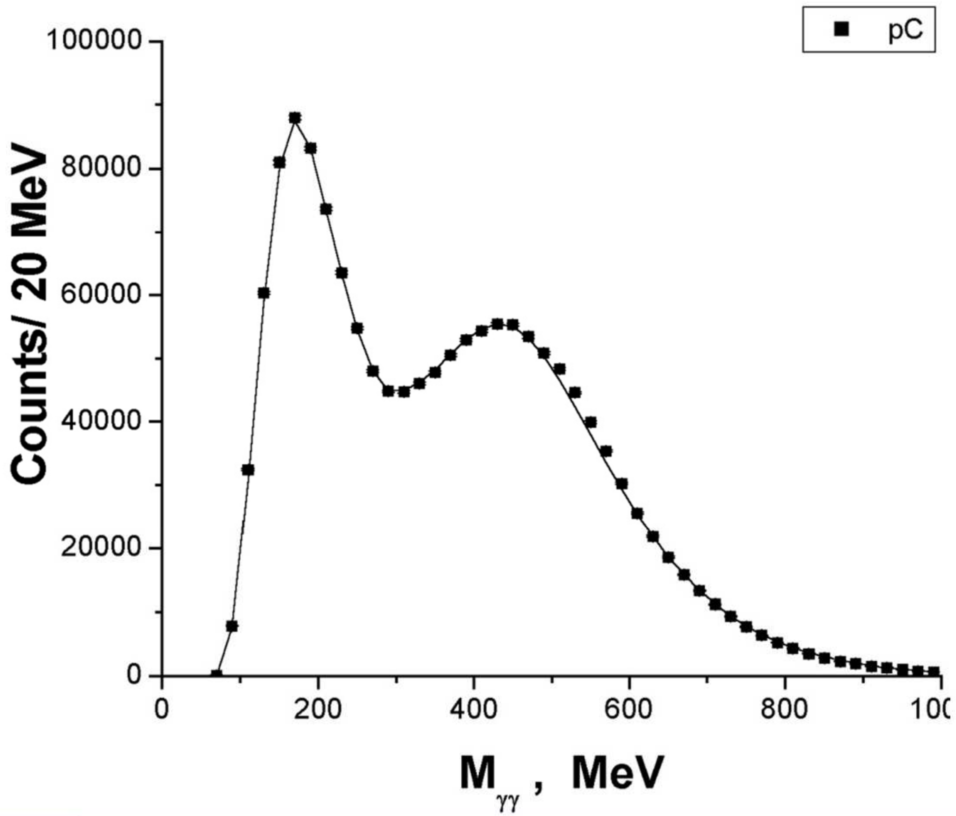
The data acquisition of production of neutral mesons and γ-quanta in *d*C interactions has been carried out with internal beams of the JINR Nuclotron.

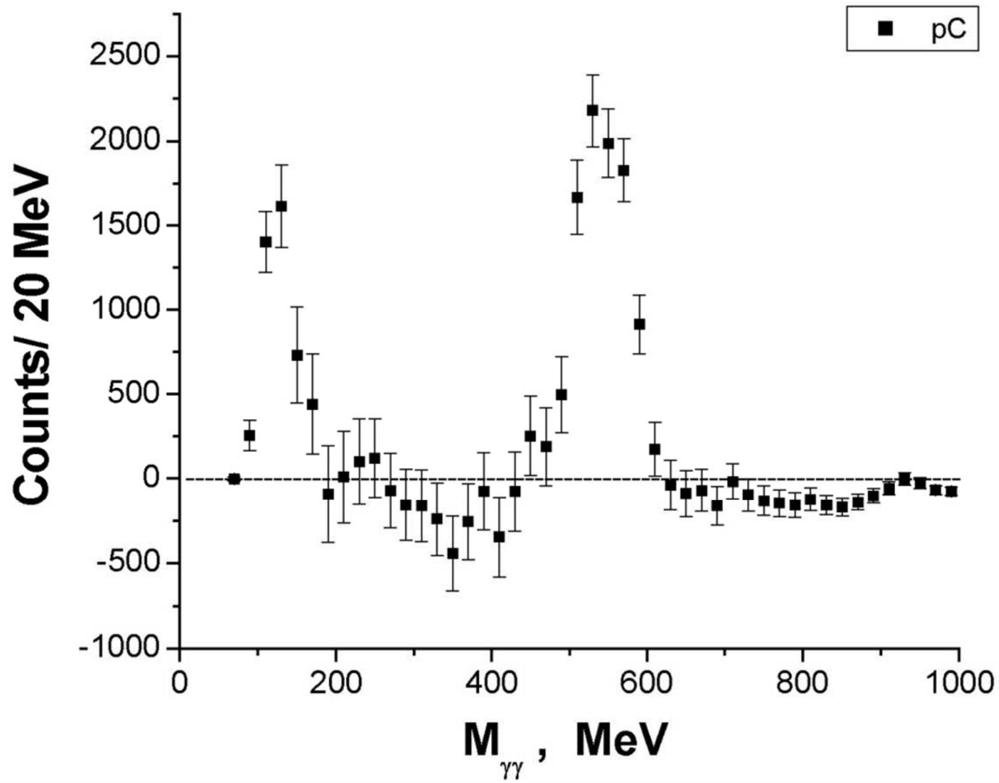
The PHOTON-2 setup includes 32 γ-spectrometers of lead glass. The modules of the γ-spectrometer are assembled into two arms of 16 units. These modules in each arm are divided into two groups of 8 units. The output signals in each group are summed up linearly and after discrimination by amplitude are used in fast triggering. In this experiment, the discriminator threshold was at the level of 0.4 GeV. Triggering takes place when there is a coincidence of signals from two or more groups from different arms. (The block-scheme of electronic equipment is in sl. № 44.)

Detailed description of the experiments is in:

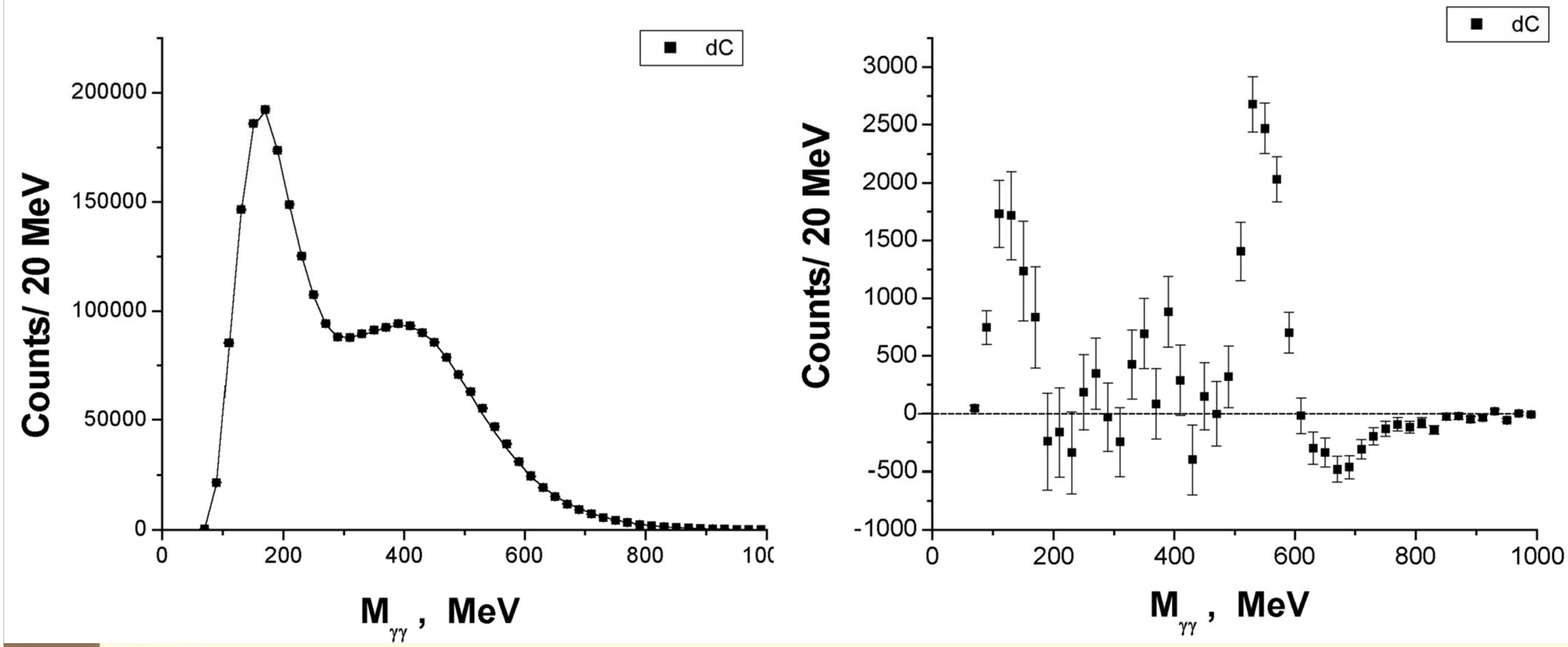
Kh. U. Abraamyan et al., Phys. Rev. C ***80****, 034001 (2009); arXiv:0806.2790.*

Invariant mass distributions of γγ pairs without (left) and with (right) the background subtraction. The reaction p(5.5 Gev/c)+C, minimal cuts: Eγ ≥ 50 MeV





Invariant mass distributions of γγ pairs without (left) and with (right) the background subtraction. The reaction d(5.5 Gev/c)+C, minimal cuts: Eγ ≥ 50 MeV.



First results of the search for the E(38)-boson

To search for a 38 MeV boson we have analyzed the effective masses of pairs of photons produced in *p*C, *d*C and *d*Cu interactions.

To search for a signal from the E(38)-boson we have analyzed photon pairs detected in the same arm of the spectrometer (sl. №5). Below are the first results of this analysis for photons that detected in the Right arm (situated at an angle of 26°).

The selection criteria

(1) the number of detected photons in the Right arm of the spectrometer, $N\gamma \geq 2$;

(2) the energies of photons, $E\gamma \geq 50;200$ MeV;

(3) the summed energy in real and random events ≤ 0.7; 0.75 GeV.

(4) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.997$; 0.994.

The so-called event mixing method was used to estimate the combinatorial background: combinations of γ-quanta were sampled randomly from different events.

I. d(3 GeV/n)+Cu

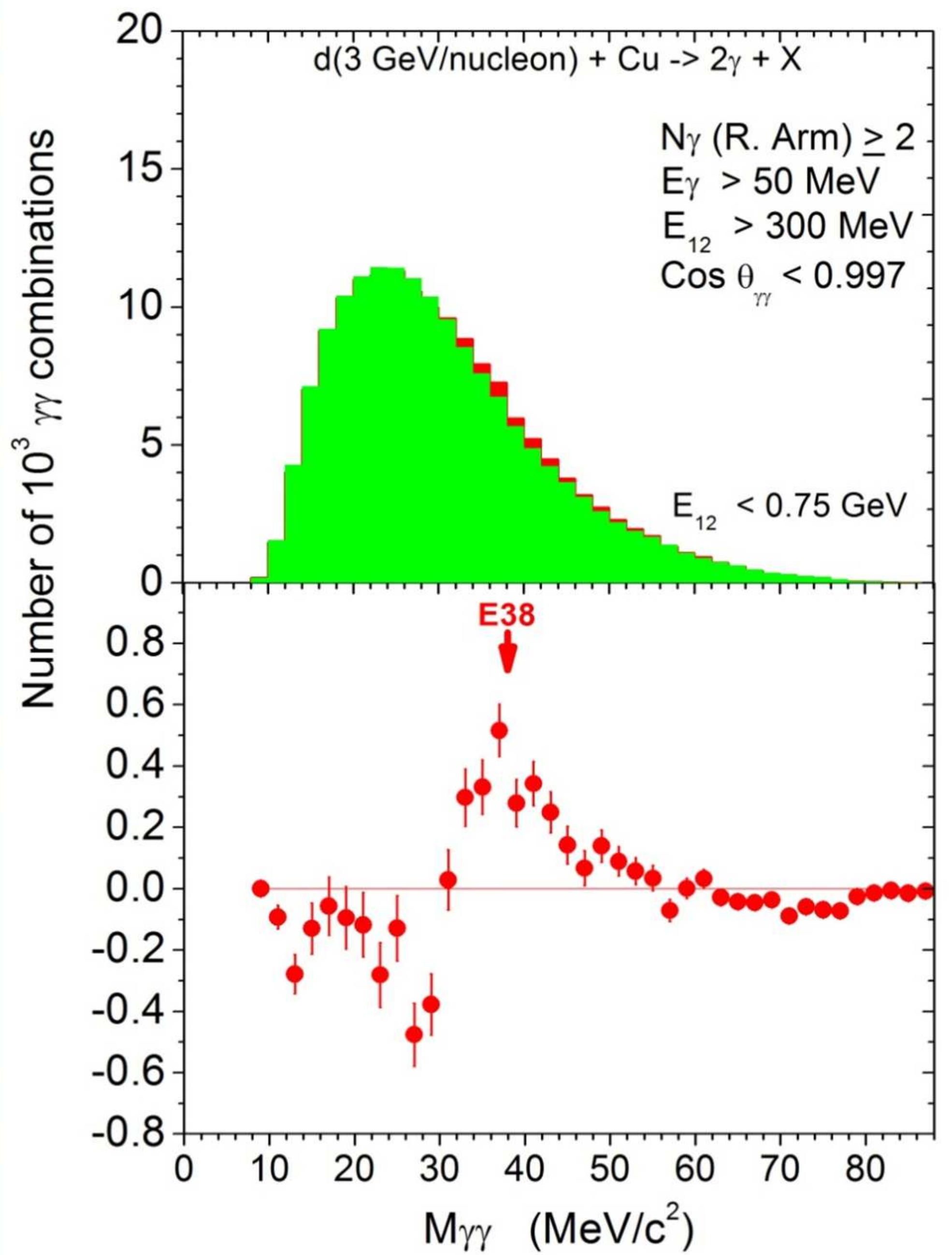
1) Soft selection criteria:

(i) the energies of photons, Eγ > 50 MeV,

(ii) the sum of the energies of two photons, $300 < E_{12} < 750$ MэB,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma} < 0.997$.

1(a): **The background is normalized to the total pair number.**



I. d(3 GeV/n)+Cu

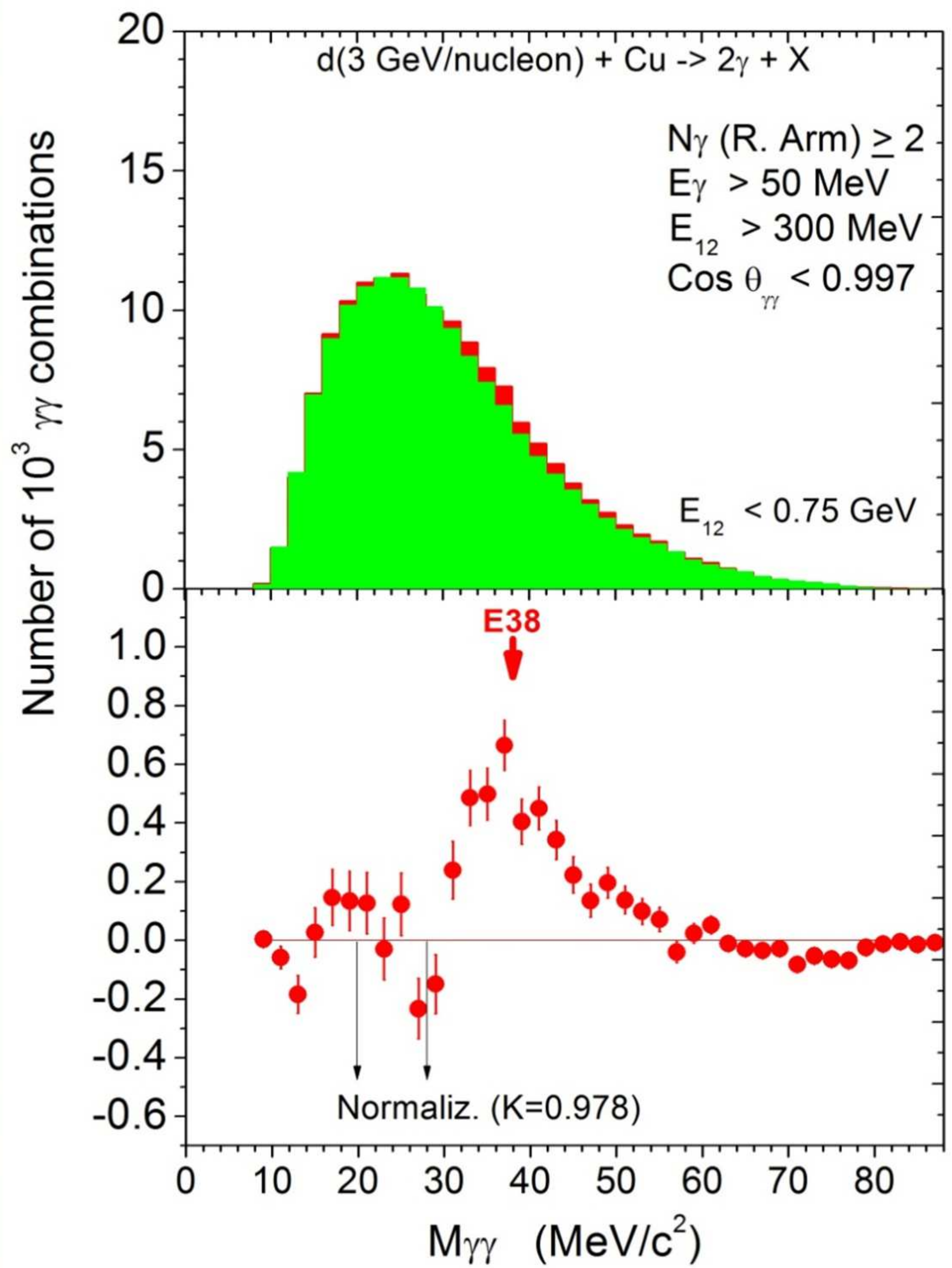
1) Soft selection criteria:

(i) the energies of photons, $E\gamma > 50$ MeV,

(ii) the sum of the energies of two photons, $300 < E_{12} < 750$ MэВ,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.997$.

1(b): **The background is normalized to the number of pairs in a range (20; 28) MeV.**



I. d(3 GeV/n)+Cu

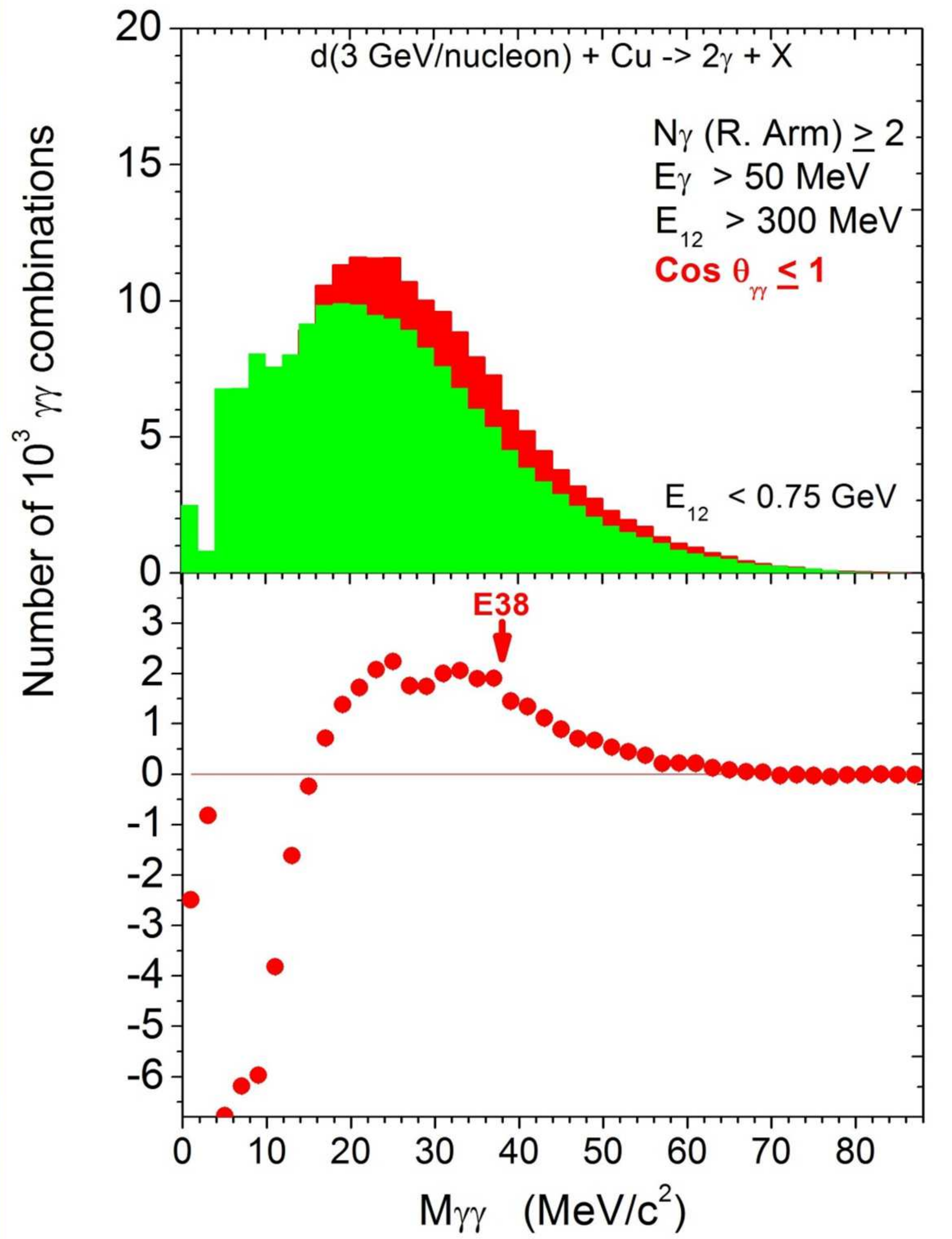
1) Soft selection criteria:

(i) the energies of photons, Eγ > 50 MeV,

(ii) the sum of the energies of two photons, 300 < E_{12} < 750 MэB,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma} \leq 1$.

The background is normalized to the total pair number.



I. d(3 GeV/n)+Cu

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(i) the energies of photons, Eγ > 50 MeV,

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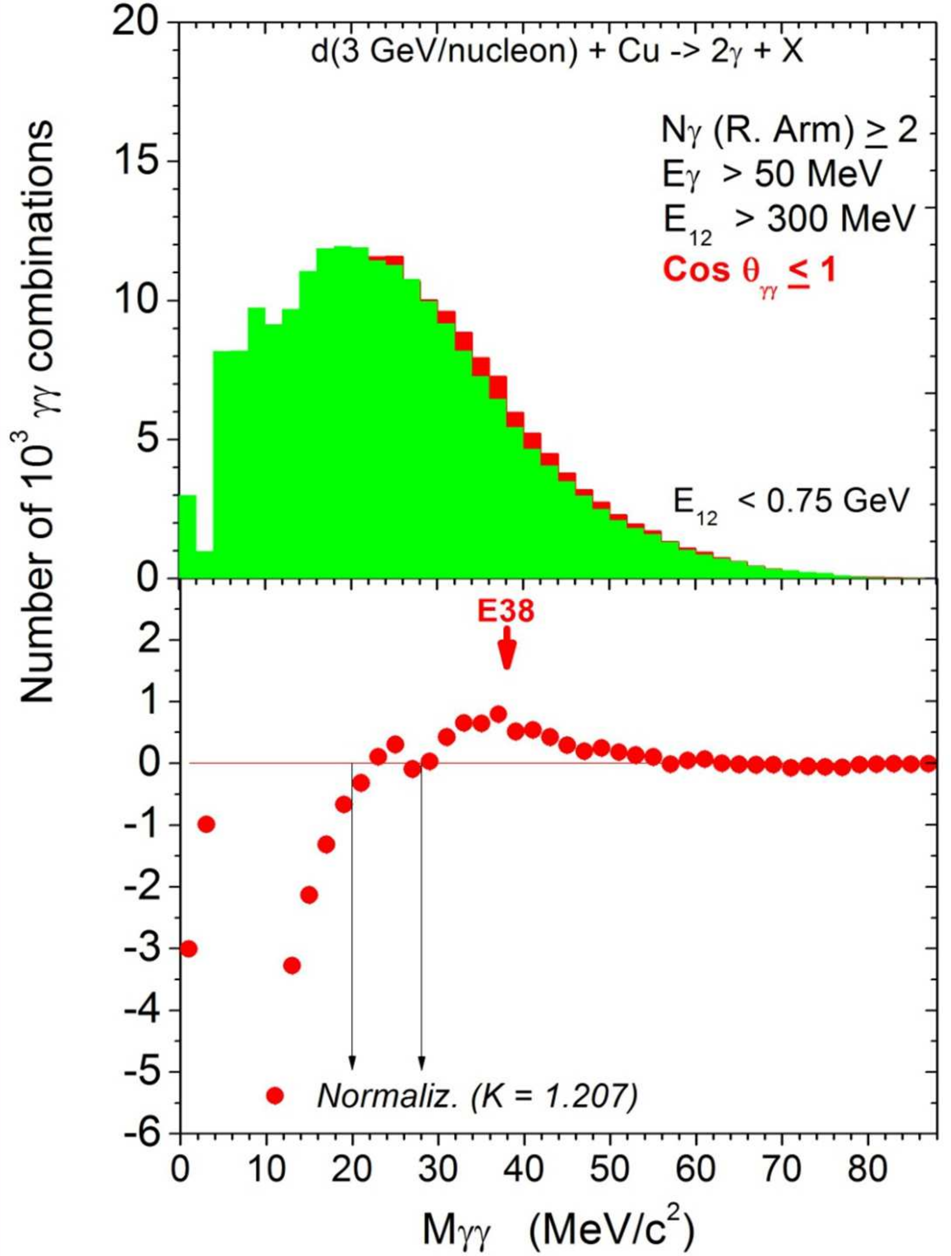
The background is normalized to the number of pairs in a range (20; 28) MeV



I. d(3 GeV/n)+Cu

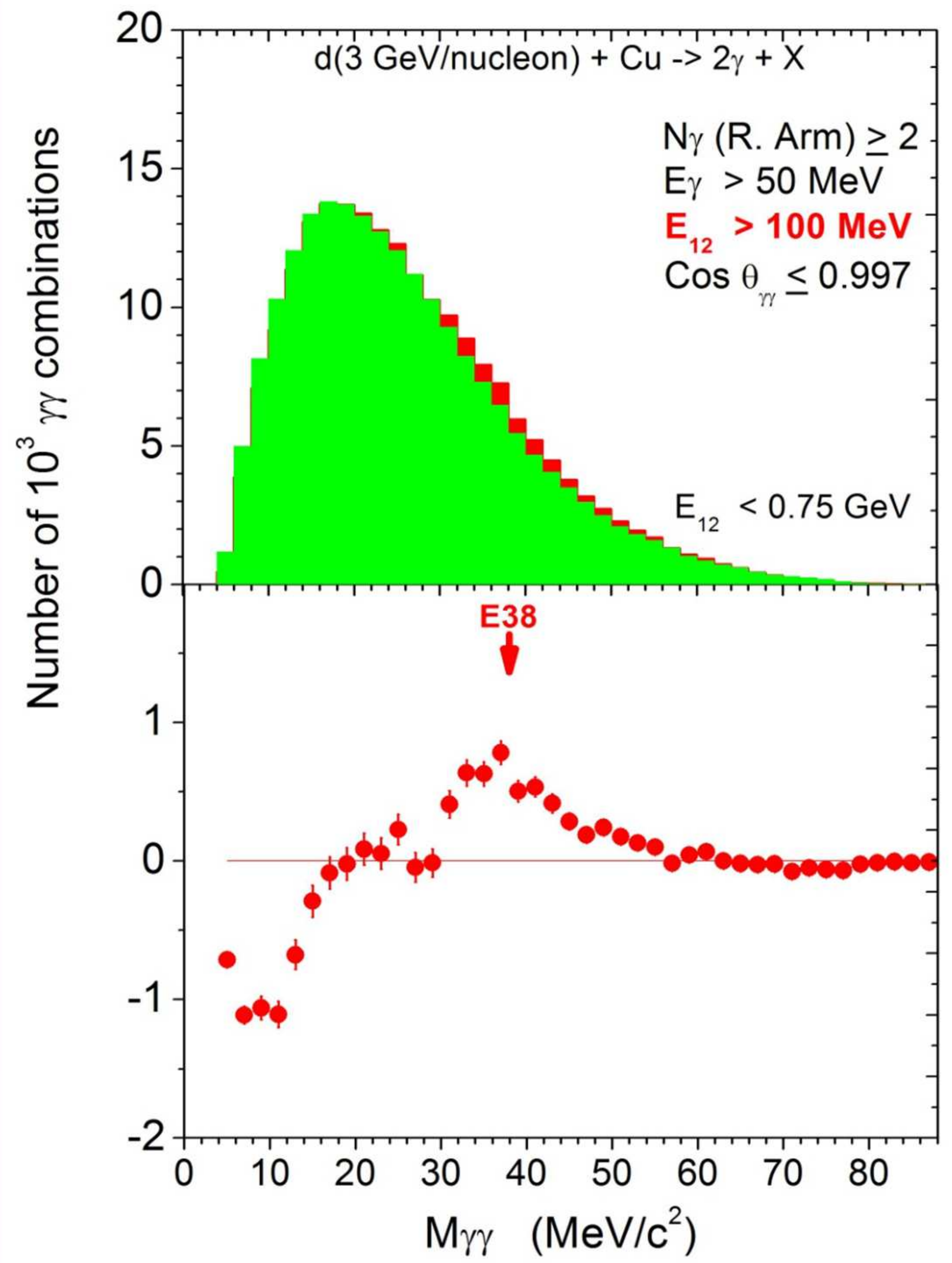
1) Soft selection criteria:

(i) the energies of photons, $E\gamma > 50$ MeV,

(ii) the sum of the energies of two photons, **100** $< E_{12} <$ 750 MэВ,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.997$.

The background is normalized to the total pair number.



I. d(3 GeV/n)+Cu

1) Soft selection criteria:

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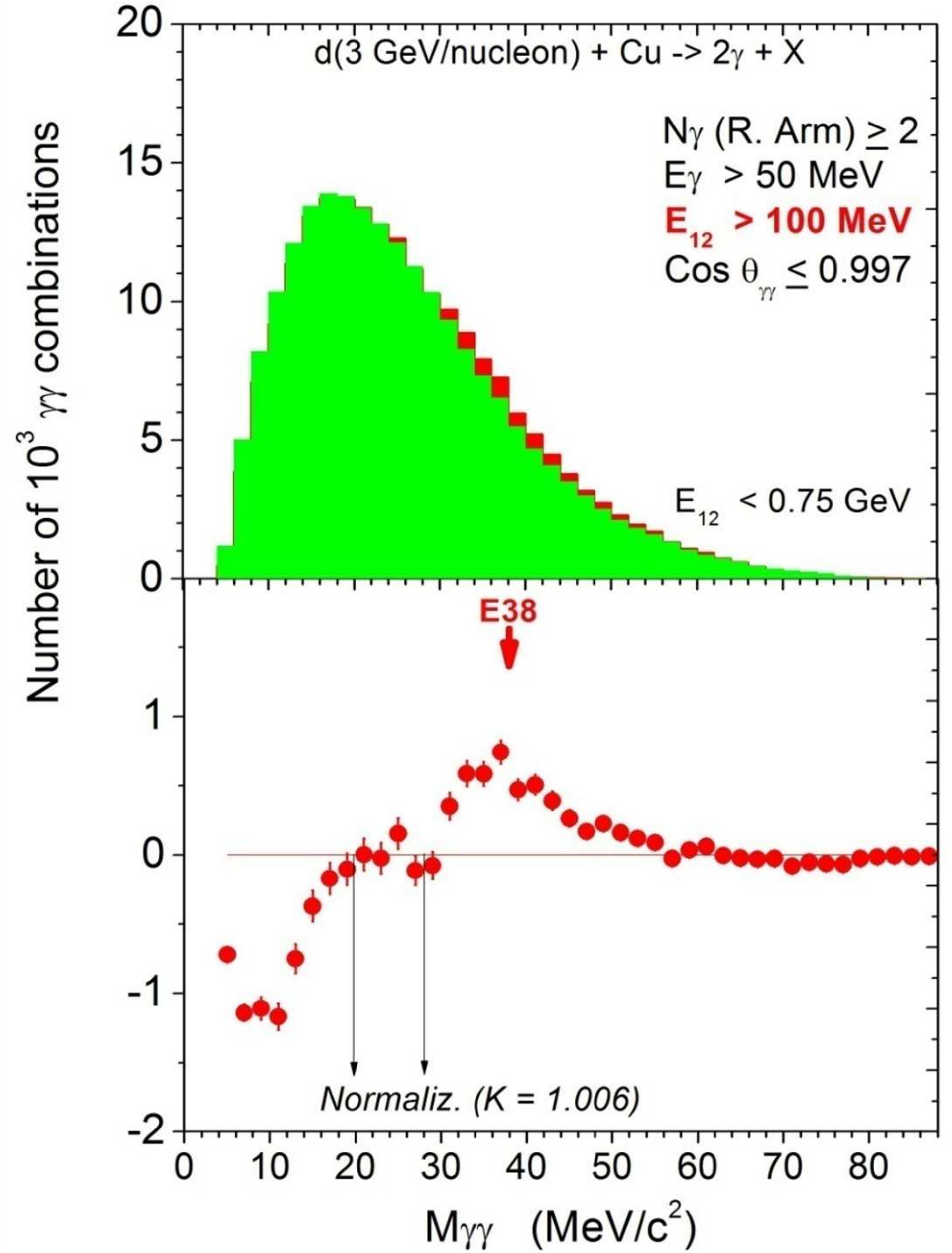
(ii) the sum of the energies of two photons, **100** $< E_{12} <$ 750 MэB,

(iii) opening angles of photons, $\cos \theta_{\gamma\gamma} < 0.997$.

The background is normalized to the number of pairs in a range (20; 28) MeV.



I. d(3 GeV/n)+Cu

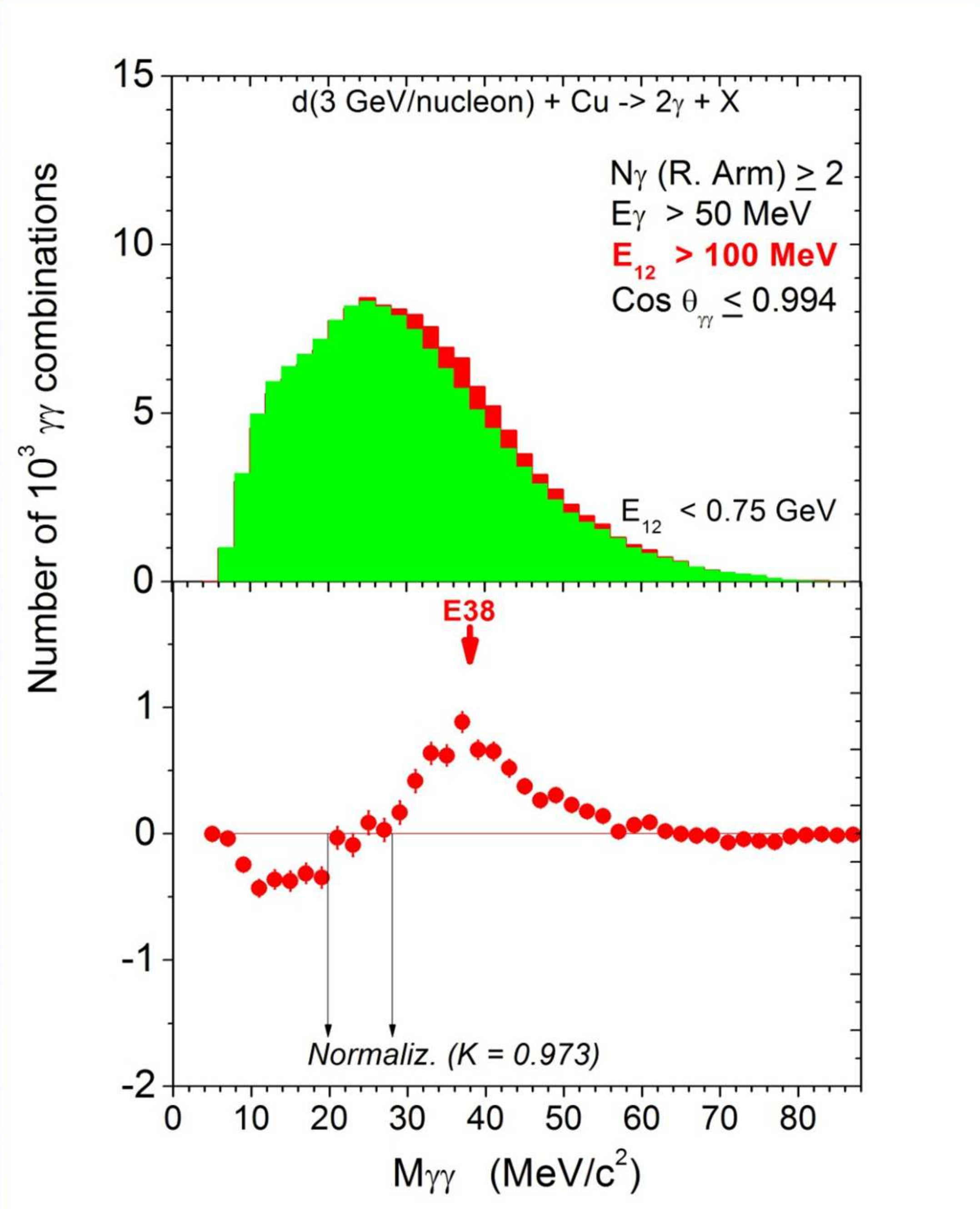
1) Soft selection criteria:

(i) the energies of photons, Eγ > 50 MeV,

(ii) the sum of the energies of two photons, **100** < E_{12} < 750 MэВ,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma}$ < **0.994**.

The background is normalized to the number of pairs in a range (20; 28) MeV.



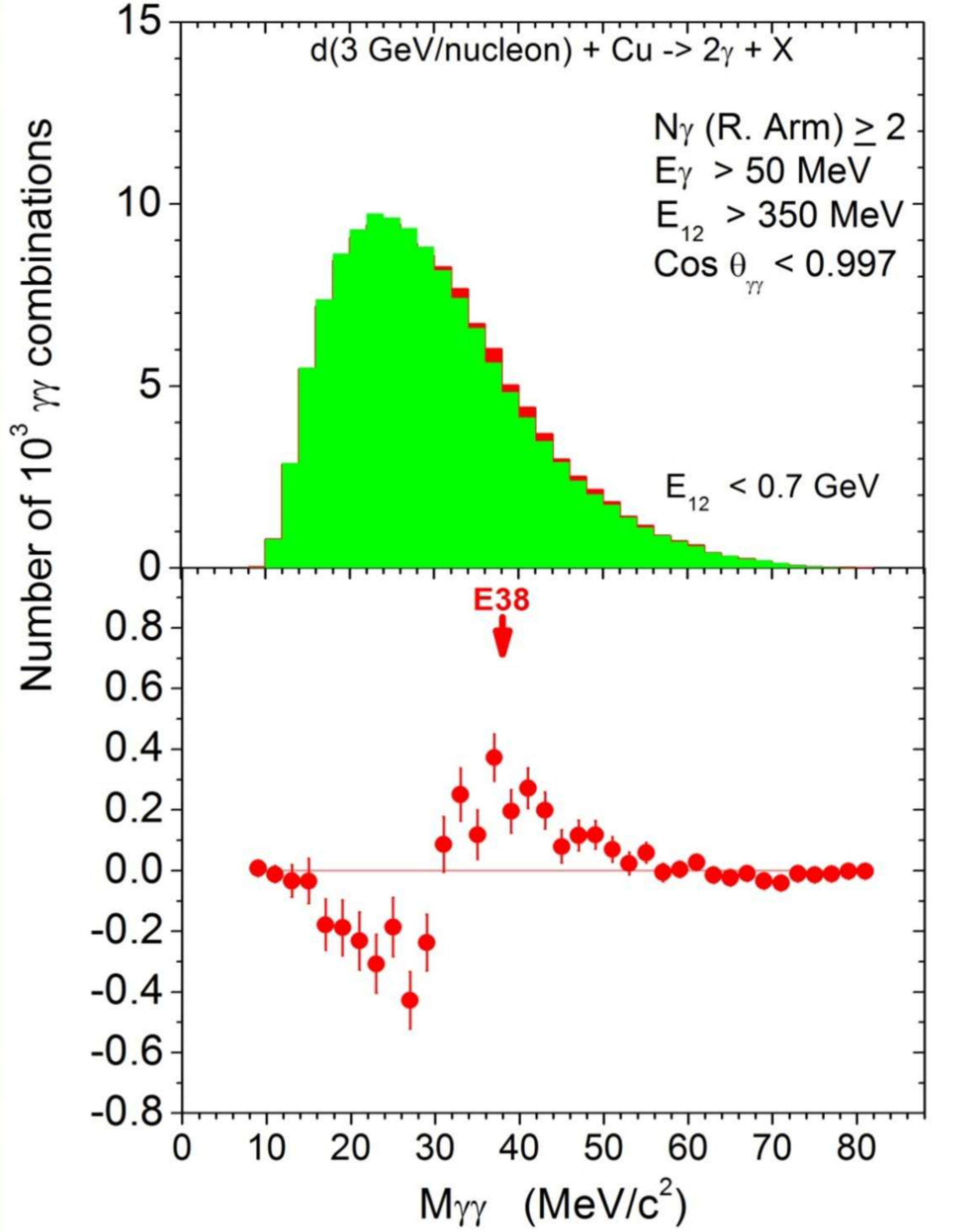
2) Another levels of sum of the energies:

(i) the energies of photons, Eγ > 50 MeV,

(ii) the sum of the energies of two photons, 350 < E_{12} < 700 MэB,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma}$ < 0.997.

2(a): **The background is normalized to the total pair number.**



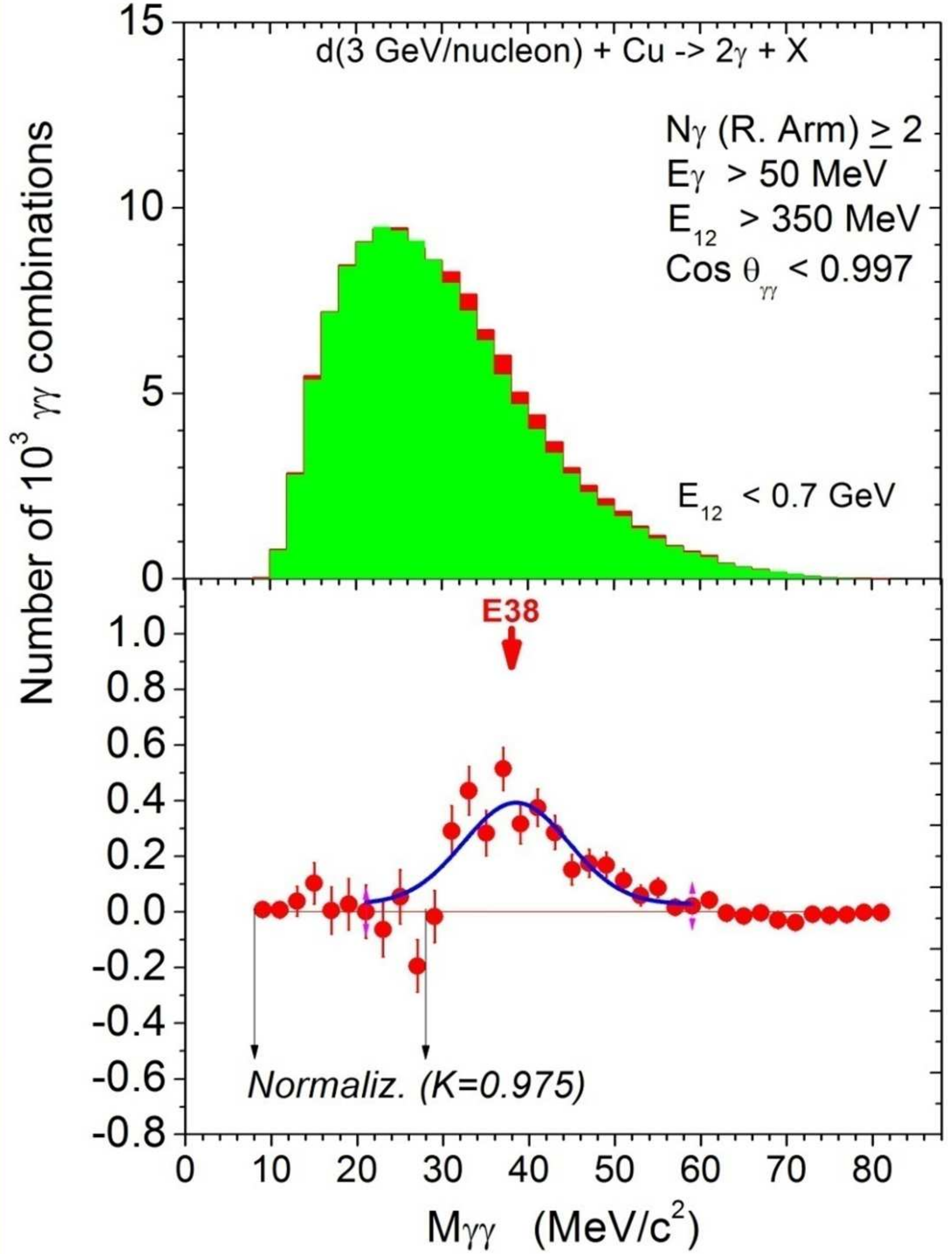
2) Another levels of sum of the energies:

(i) the energies of photons, $E\gamma > 50$ MeV,

(ii) the sum of the energies of two photons, $350 < E_{12} < 700$ MэВ,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.997$.

2(b): **The background is normalized to the number of pairs in a range M< 28 MeV.**



The parameter values in the Gaussian approximation

Model	Gauss	
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)	
Reduced Chi-Sqr	1.84691	
Adj. R-Square	0.72145	
	Value	Standard Error
y0	0.02916	0.02557
xc	38.4935	1.02639
w	12.27429	2.35025
A	5.59649	1.18853
sigma	6.13714	1.17513
FWHM	14.45187	2.76721
Height	0.3638	0.052

I. d(3 GeV/n)+Cu

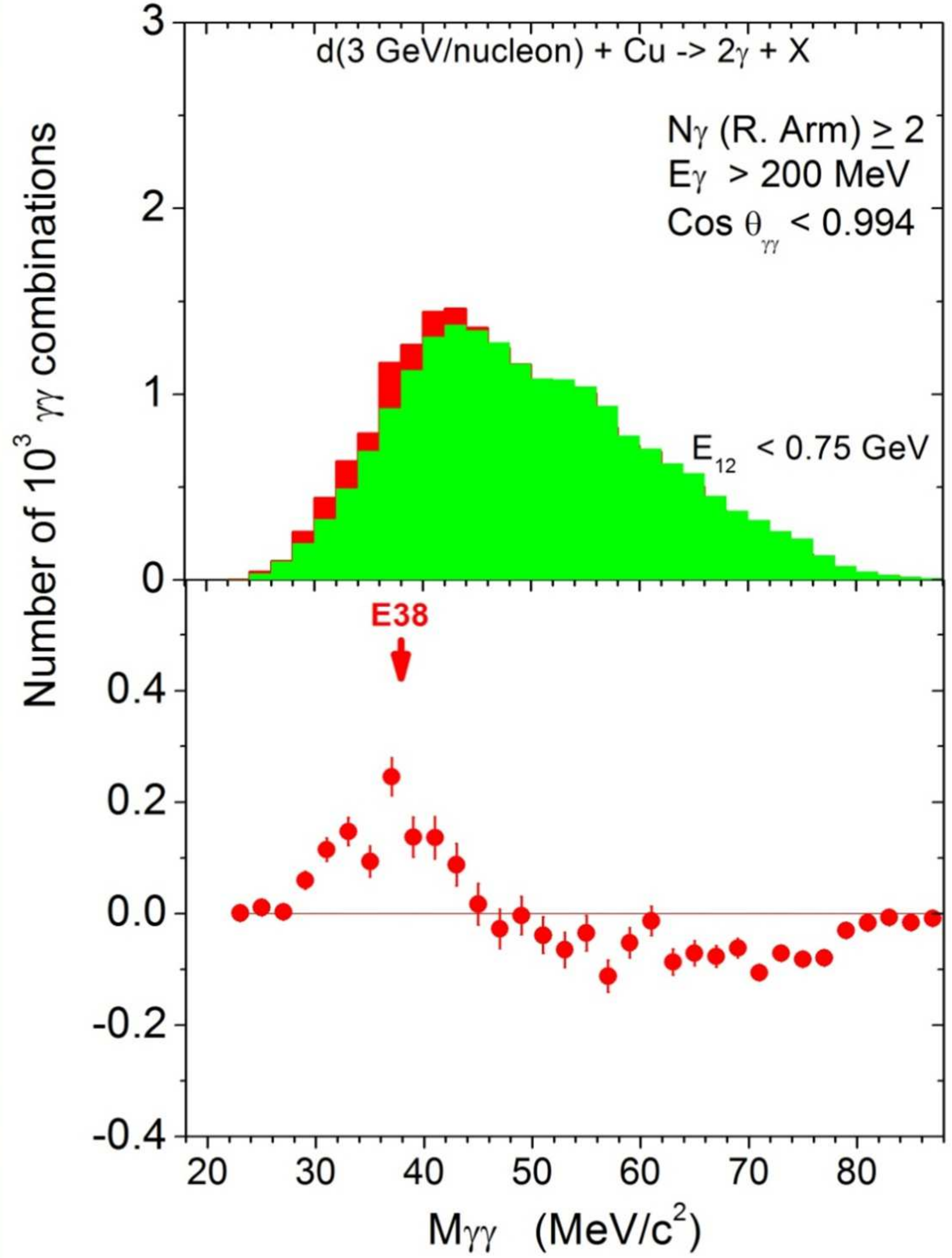
3) Harder criteria of photon selection:

(i) the energies of photons, Eγ > 200 MeV,

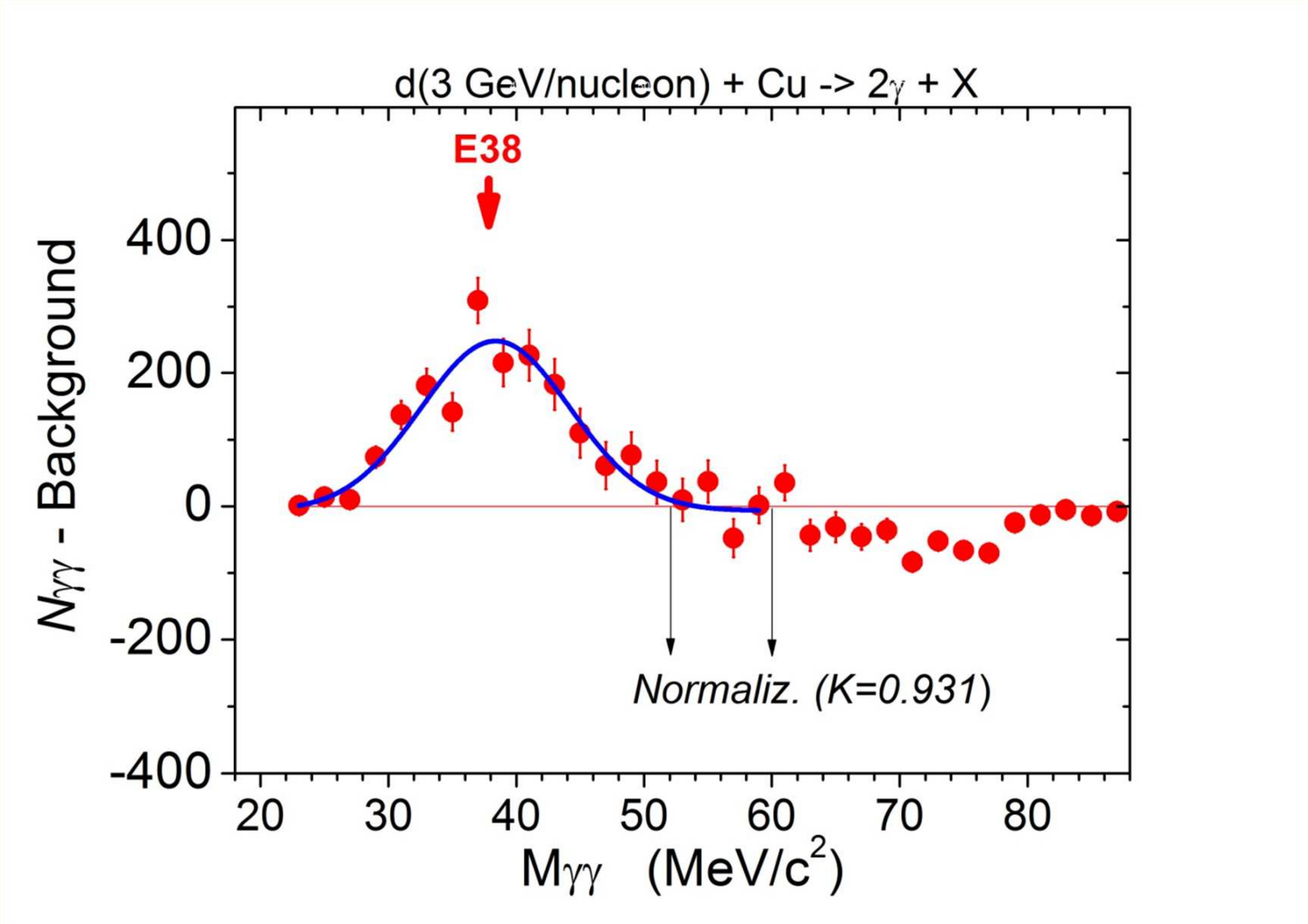
(ii) the sum of the energies of two photons, 400 < E_{12} < 750 MэВ,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma}$ < 0.994.

3(a): **The background is normalized to the total pair number.**



3(b). The same spectrum after the background subtraction. The background is normalized to the number of pairs in a range (52; 60) MeV.



The parameter values in the Gaussian approximation

- **Model Gauss**
- **Equation y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)**
- **Reduced Chi-Sqr 1.58751**
- **Adj. R-Square 0.91188**

	Value	Standard Error
y0	-6.47137	5.40144
xc	38.38166	0.53758
w	11.63691	1.11396
A	3708.89197	365.91194
sigma	5.81846	0.55698
FWHM	13.70142	1.31159
Height	254.3001	20.44404

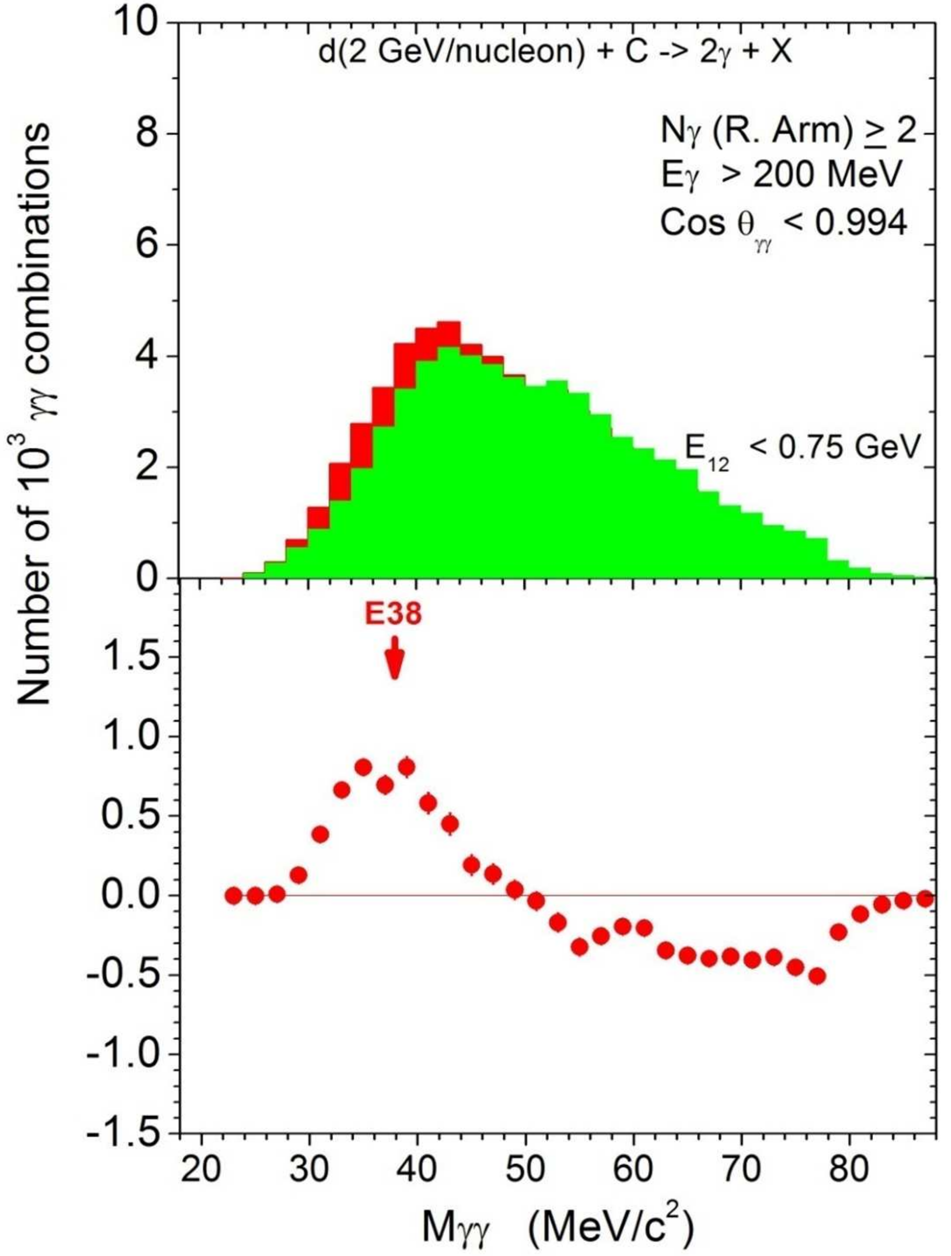
II. The same for the **d(2 GeV/n)+C** reaction :

(i) the energies of photons, Eγ > 200 MeV,

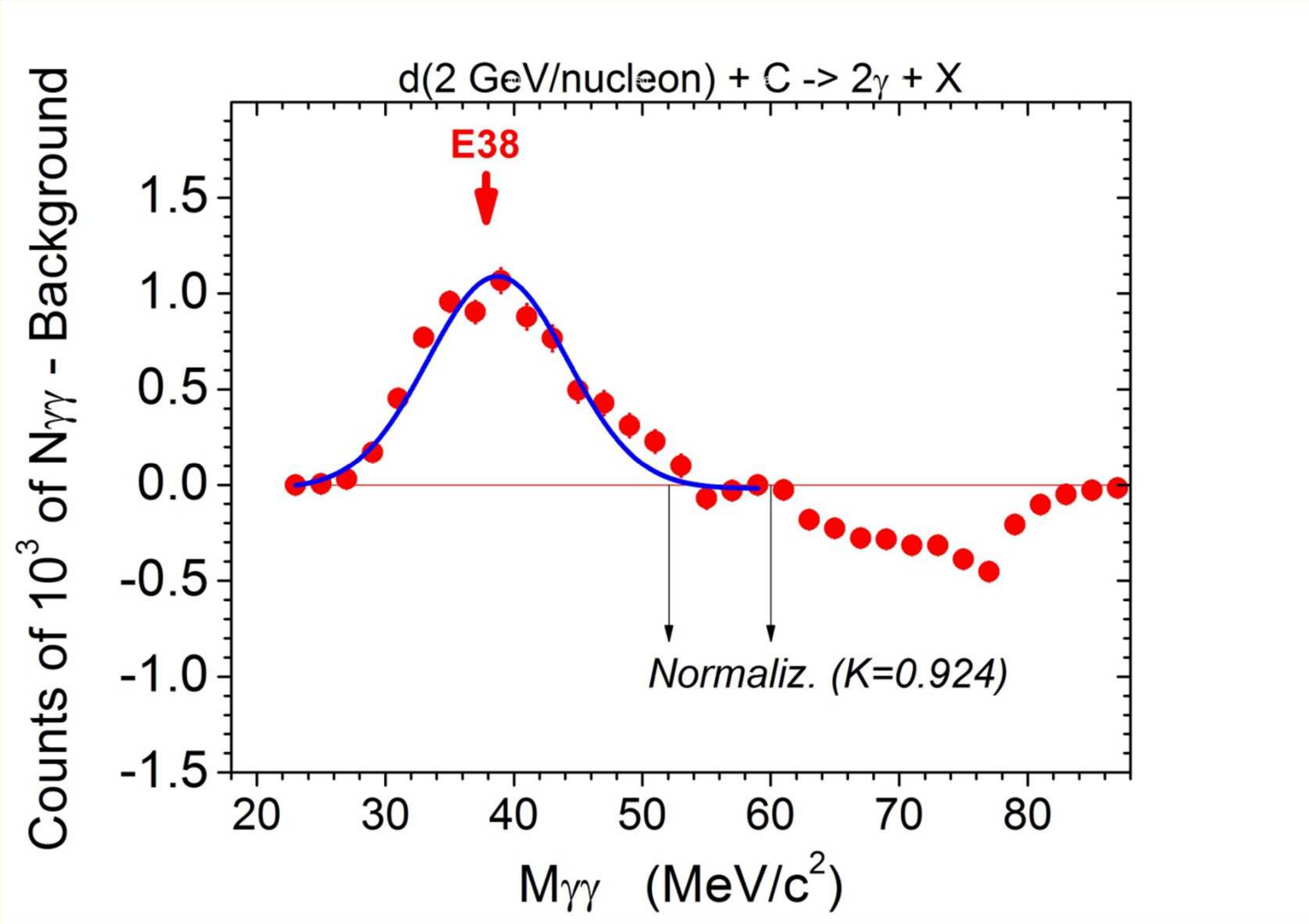
(ii) the sum of the energies of two photons, 400 < E_{12} < 750 MэВ,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma}$ < 0.994.

4(a): **The background is normalized to the total pair number.**



4(b). The same spectrum after the background subtraction. The background is normalized to the number of pairs in a range (52; 60) MeV.



The parameter values in the Gaussian approximation

Model	Gauss	
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)	
Reduced Chi-Sqr	4.3887	
Adj. R-Square	0.95555	
	Value	Standard Error
y0	-0.01890	0.00815
xc	38.74343	0.36009
w	10.87834	0.65543
A	15.10837	0.92977
sigma	5.439170	0.32772
FWHM	12.80827	0.77171
Height	1.108140	0.06538

I. d(3 GeV/n)+Cu

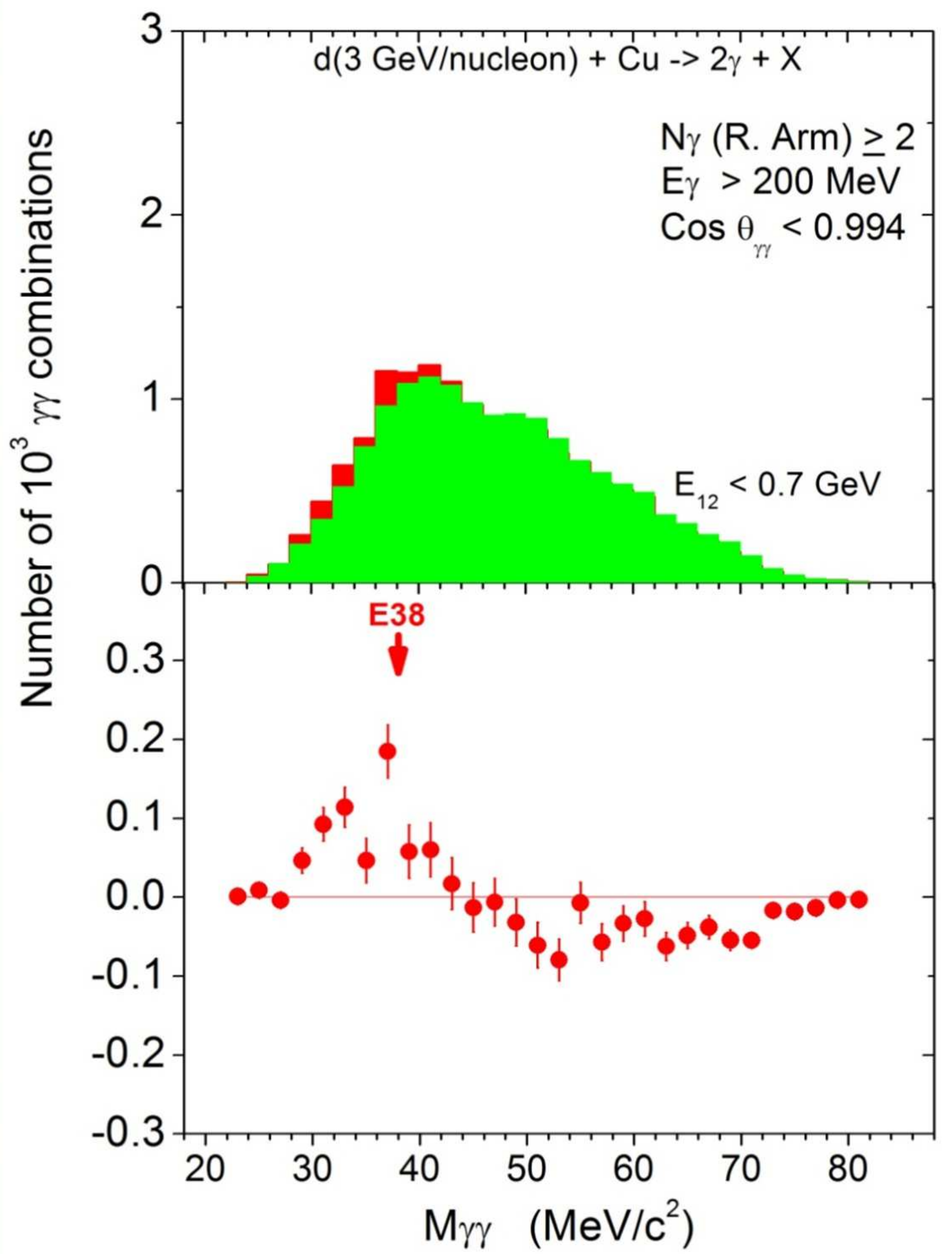
4) Harder cut of pair energies:

(i) the energies of photons, $E\gamma > 200$ MeV,

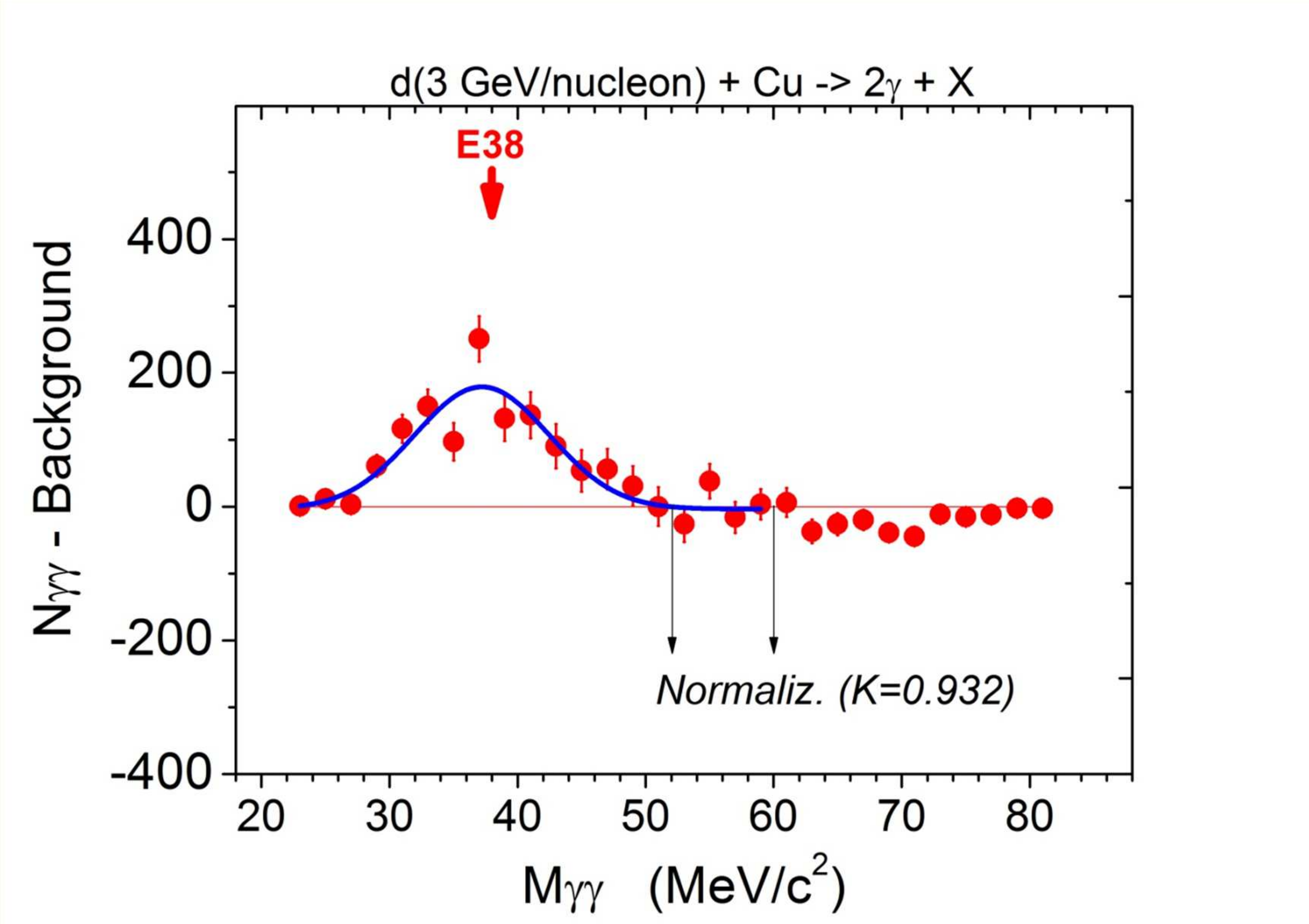
(ii) the sum of the energies of two photons, $400 < E_{12} < 700$ MэB,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.994$.

5(a): **The background is normalized to the total pair number.**



5(b). The same spectrum after the background subtraction. The background is normalized to the number of pairs in a range (52; 60) MeV.



The parameter values in the Gaussian approximation

Model	Gauss	
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)	
Reduced Chi-Sqr	1.58093	
Adj. R-Square	0.84778	
	Value	Standard Error
y0	-3.44853	4.68366
xc	37.21531	0.64489
w	10.51329	1.30923
A	2401.89065	306.17727
sigma	5.25664	0.65461
FWHM	12.37845	1.5415
Height	182.28658	20.07458

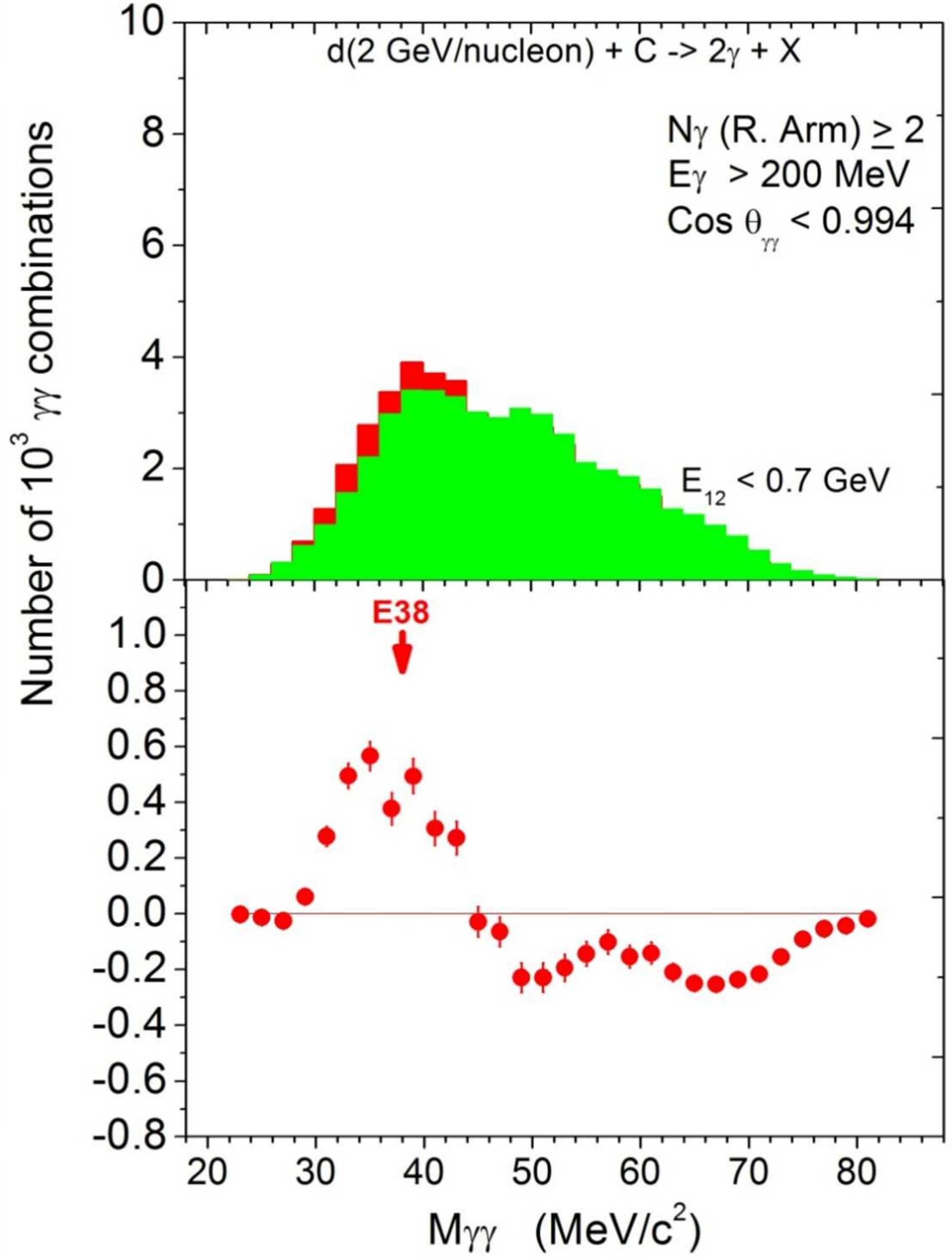
II. The same for the **d(2 GeV/n)+C** reaction

(i) the energies of photons, $E\gamma > 200$ MeV,

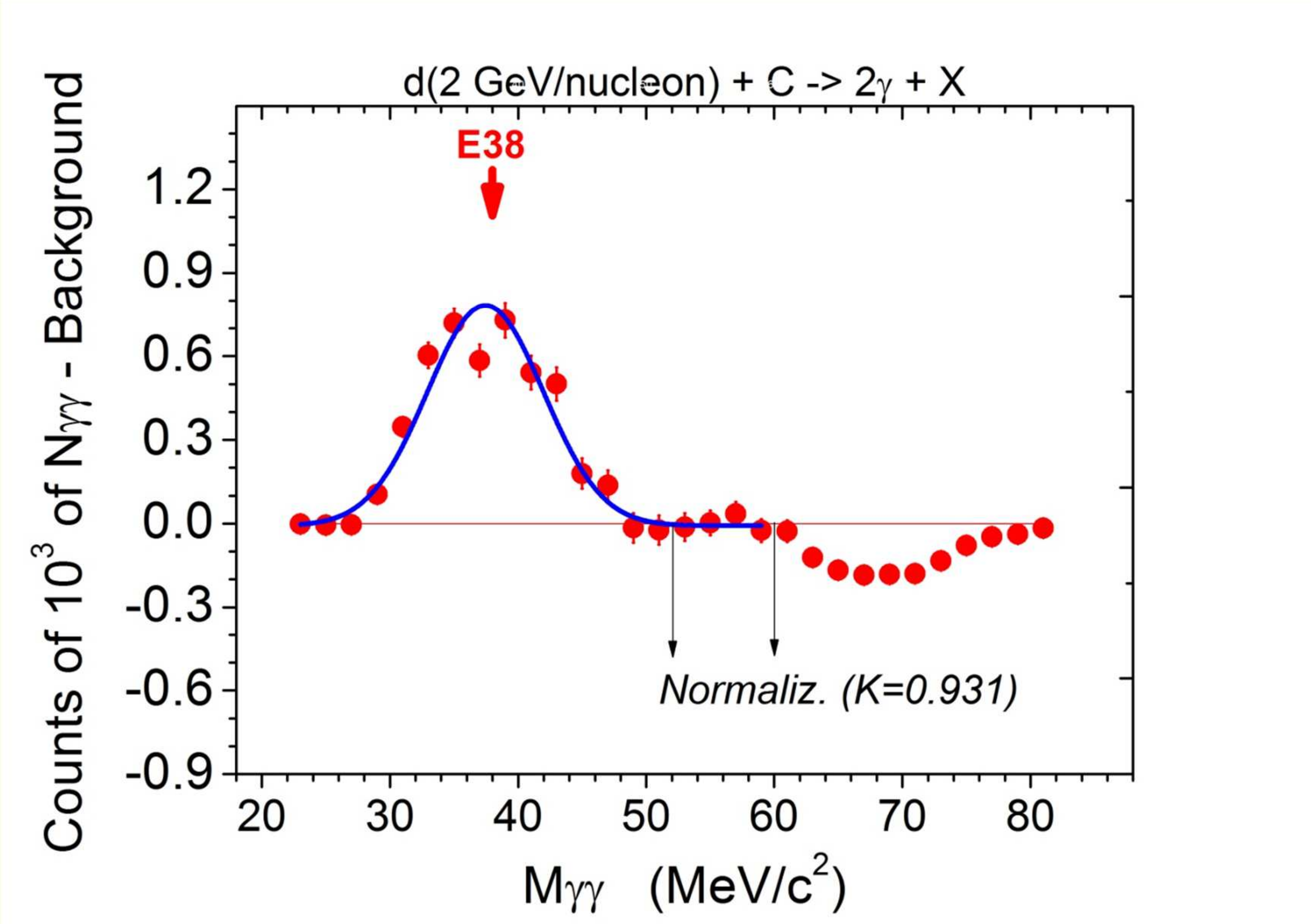
(ii) the sum of the energies of two photons, $400 < E_{12} < 700$ MэВ,

(iii) opening angles of photons, Cos $\theta_{\gamma\gamma} < 0.994$.

6(a): **The background is normalized to the total pair number.**



6(b). The same spectrum after the background subtraction. The background is normalized to the number of pairs in a range (52; 60) MeV.



The parameter values in the Gaussian approximation

- Model Gauss
- Equation y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)
- Reduced Chi-Sqr 2.97201
- Adj. R-Square 0.93912

	Value	Standard Error
y0	-0.00749	0.00404
xc	37.44908	0.35209
w	9.06737	0.61384
A	8.97991	0.61823
sigma	4.53369	0.30692
FWHM	10.67601	0.72275
Height	0.79019	0.05629

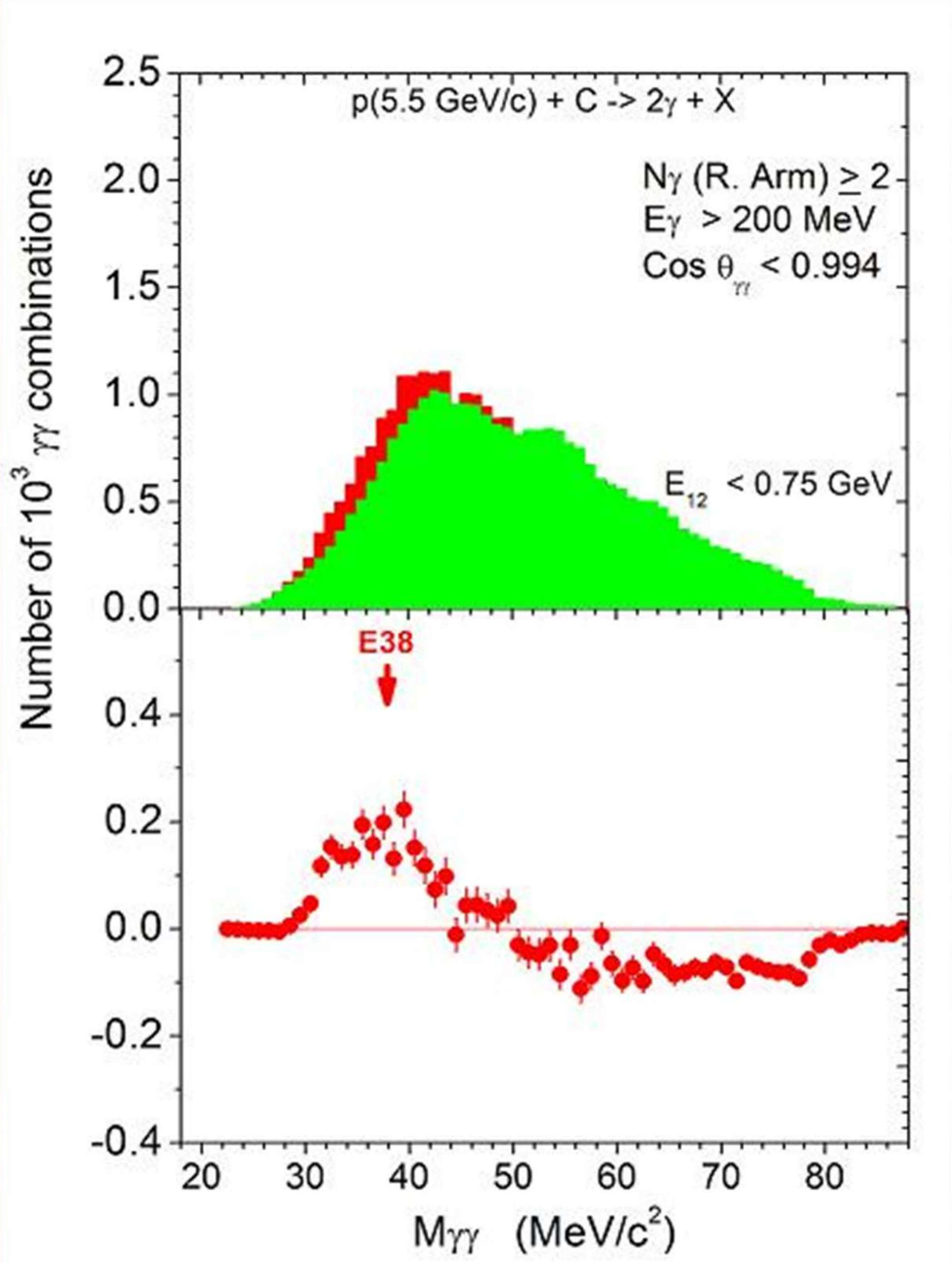
III. The same for the **p(4.6 GeV)+C** reaction

(i) the energies of photons, Eγ > 200 MeV,

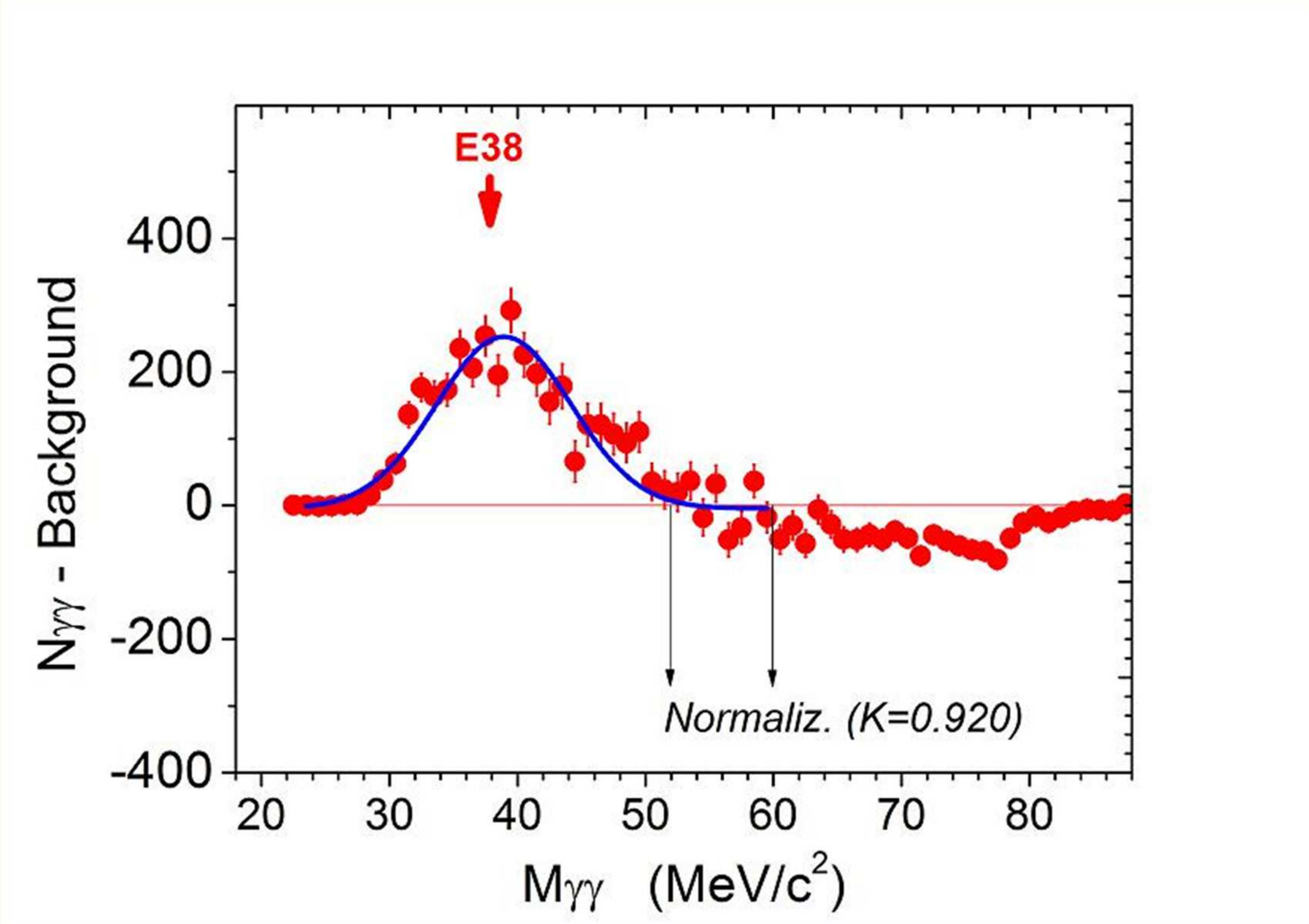
(ii) the sum of the energies of two photons,
$400 < E_{12} < 750$ MэВ,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.994$.

7(a): **The background is normalized to the total pair number.**



7(b). The same spectrum after the background subtraction. The background is normalized to the number of pairs in a range (52; 60) MeV.



The parameter values in the Gaussian approximation

Model	Gauss	
Equation	y=y0 + (A/(w*sqrt(PI/2)))*exp(-2*((x-xc)/w)^2)	
Reduced Chi-Sqr	2.08756	
Adj. R-Square	0.90461	
	Value	Standard Error
y0	-0.00488	0.00241
xc	38.92991	0.36477
w	10.51775	0.67541
A	3.39499	0.22285
sigma	5.25887	0.3377
FWHM	12.3837	0.79523
Height	0.25755	0.01603

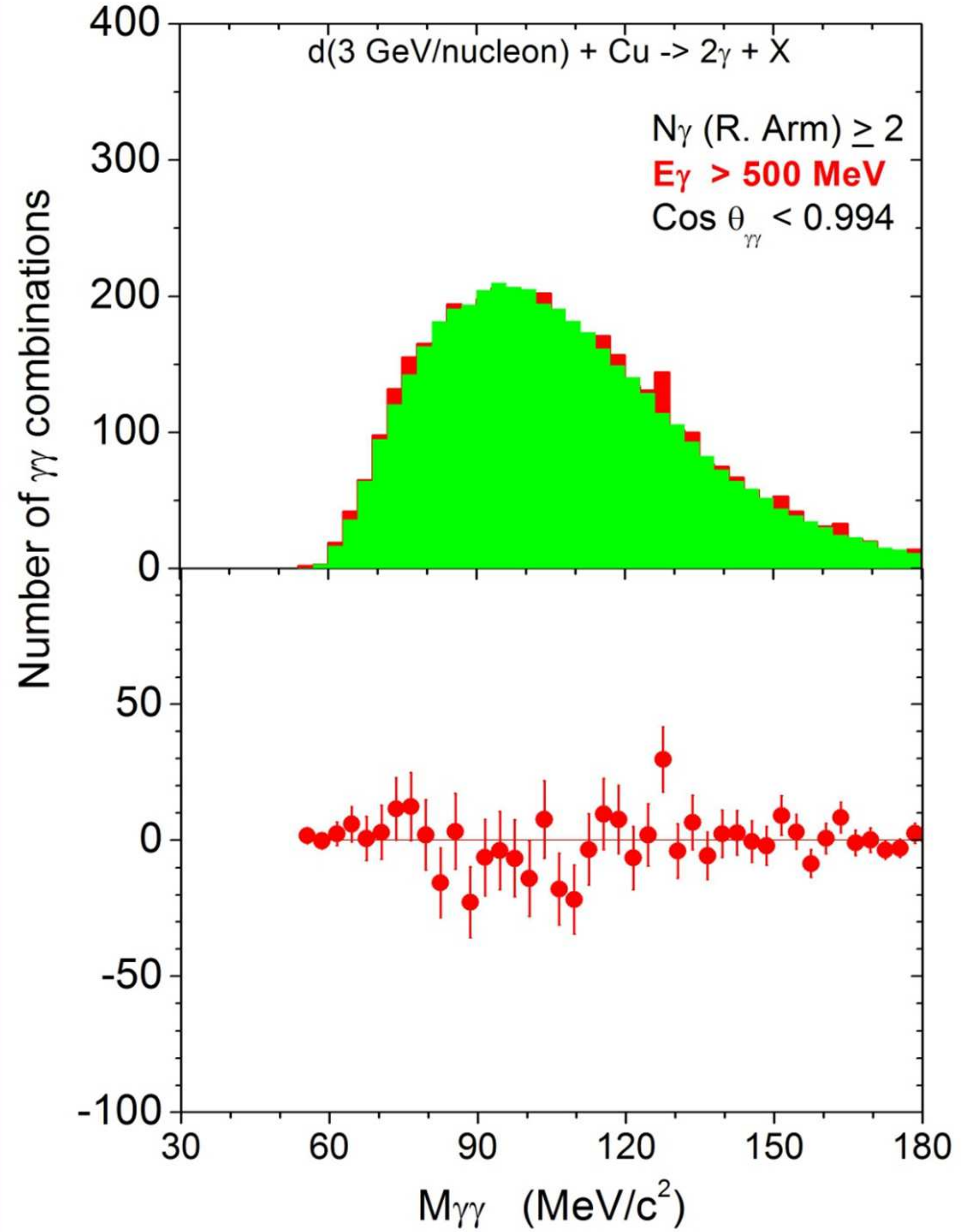
I. d(3 GeV/n)+Cu

5) Harder criteria of photon selection:

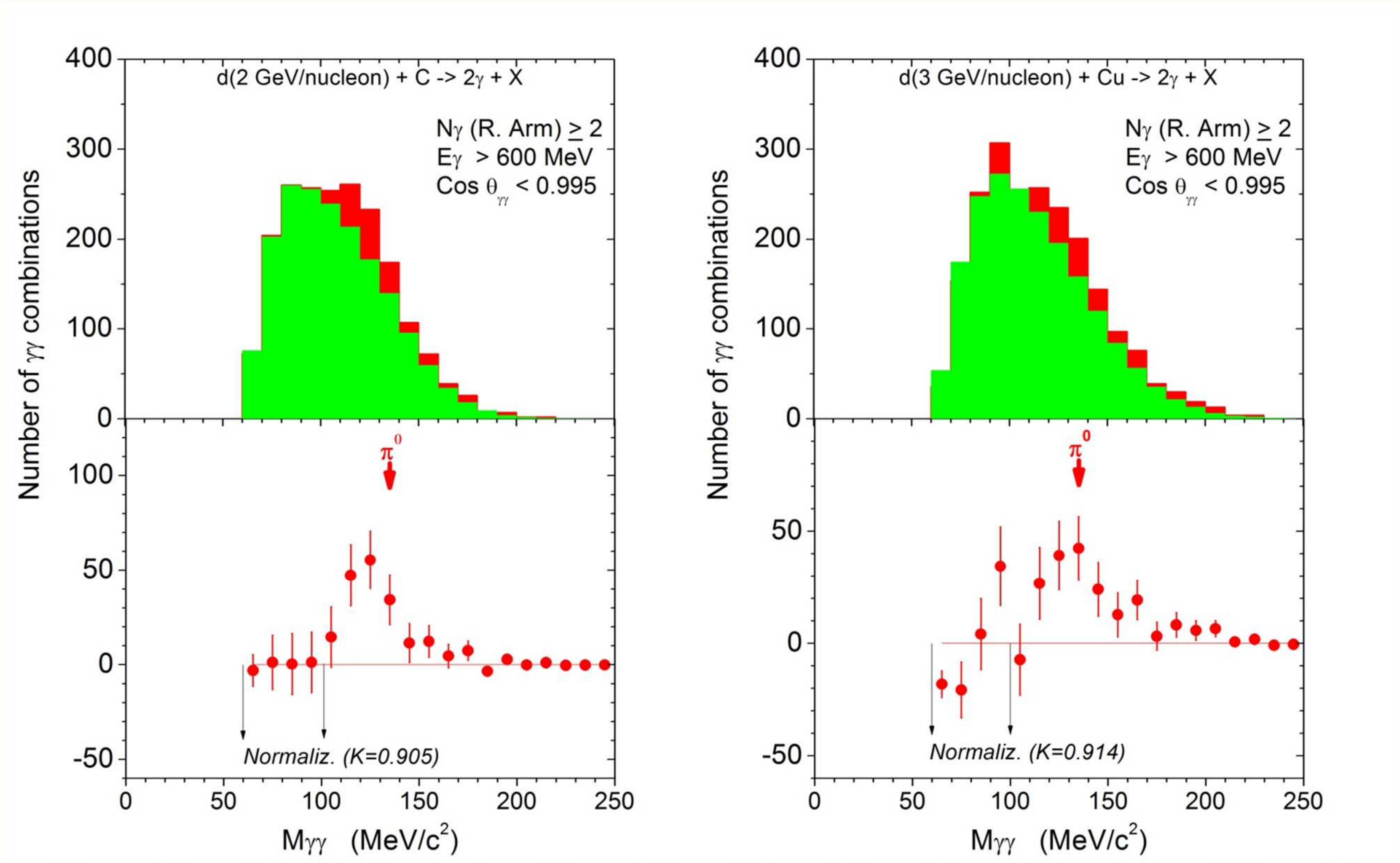
(i) the energies of photons, $E\gamma > 500$ MeV,

(iii) opening angles of photons, $\cos\theta_{\gamma\gamma} < 0.994$.

The background is normalized to the total pair number.



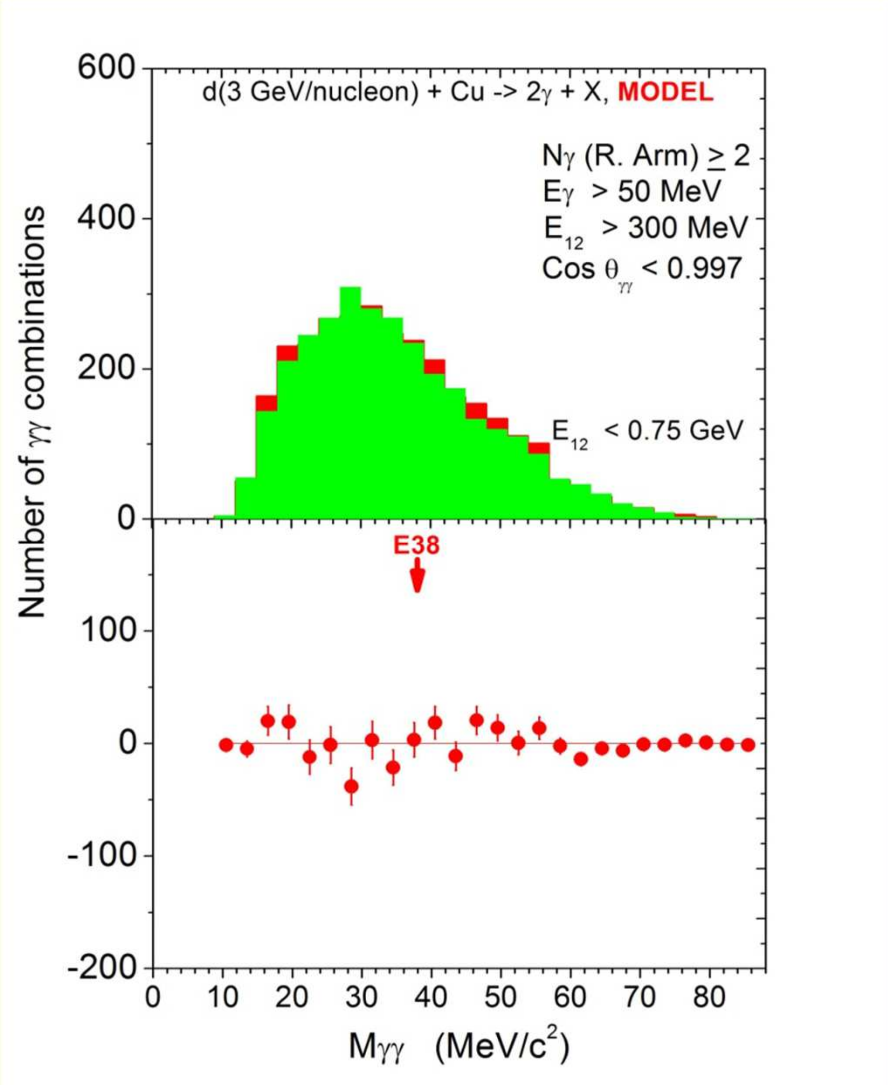
The invariant mass distributions of γγ pairs in the right arm of the spectrometer in the reaction d+C (left) and d+Cu (right).



Data simulation

- To simulate *p*C-, *d*C- and *d*Cu- reactions we used a two-phases transport code [*K.K. Gudima et al. LANL Report LA-UR-01-6804, Los Alamos, 2001*]
- The following γ-decay channels are taken into account:
- ✓ the direct decays of $\boldsymbol{\pi^o, \eta, \acute{\eta}}$ hadrons into two $\boldsymbol{\gamma}$'s;
- ✓ $\boldsymbol{\omega \rightarrow \pi^o\gamma}$;
- ✓ $\boldsymbol{\Delta \rightarrow N\gamma}$;
- ✓ the Dalitz decays of $\boldsymbol{\eta \rightarrow \pi\pi\gamma}$, $\boldsymbol{\eta \rightarrow \gamma ee}$, $\boldsymbol{\pi^o \rightarrow \gamma ee}$;
- ✓ $\boldsymbol{\acute{\eta} \rightarrow \rho^o\gamma}$, $\boldsymbol{\Sigma \rightarrow \Lambda\gamma}$,
- ✓ the $\boldsymbol{\pi}N$ and *NN*-bremsstrahlung.

The invariant mass distributions of γγ pairs selected from above described procedure (see sl.№11) for simulated *d*(3 GeV/n)+Cu data in the real conditions of the experiment.



Conclusion

- **Thus, there is a signal at ~ 38 MeV/c^2 in spectra of diphotons in *d*+C and *d*+Cu reactions, as well as in the reaction *p*+C. The data simulation shows, that, practically, there are no systematic errors in event mixing background.**
- **Position of the signal from π^0 mesons shows, that the uncertainty in the position of the E(38)-signal does not exceed 3 MeV.**
- New experiments are required to be carried out under conditions appropriate for registration of pairs of two photons within the invariant mass interval of 30-50 MeV. Some scanning in the beam energy and mass will clarify the effect.

Re: Fwd[2]: Your article arXiv:1208.3829, Observation of the E(38)-boson
От кого:
Chris Austin <chris@chrisaustin.info>
Кому:
Khachik Abraamyan <abraam@bk.ru>
1 сентября 2012, 00:33
Dear Dr Abraamyan,

Thank your very much for your reply. My first news report on your paper was published a few days ago, (with no figures):
http://www.science20.com/crawler_superland/unexpected_new_light_boson-93215

I am preparing another report, that goes into the event mixing method of measuring the background, which I'll try to post this weekend.

I have also submitted an article to arXiv that estimates the coupling constant g of the E(38) to the light quarks from your measurements, assuming that the E(38) is produced in a bremsstrahlung-like manner and decays only to two photons. I found g \sim 10^{-4}. The article is scheduled to appear on Monday in hep-ph, and in the meantime the pdf is at **http://chrisaustin.info/lightquarke38.pdf**

Best regards,
Chris Austin

>
> I am preparing a brief report on your article arXiv:1208.3829, Observation of the E(38)-boson, to be published in my Science 2.0 column **http://www.science20.com/blog/4844**. I would like to reproduce 2 figures from your article, Fig. 2(b) and Fig. 4(a), with full attribution to your article. Would this be all right?

Тема:comments on new boson
Дата:Sun, 26 Aug 2012 09:24:41 +0200
От:jarekk <jarekk@karol.imp.gda.pl>
Кому:<abraam@sunhe.jinr.ru>

Dear Prof. Kh.U. Abraamyan

I have read **"Russians find new Particle, E(38) at 38 MeV" on interactions.org 21 August 2012,** where comments on your observations are present.
This observation is very interesting and potentially can fit to description of elementary particles by means of vacuum medium mechanics.
I develop vacuum medium mechanics in order to provide theory constructed on basis of more extended system of fundamental notions than the Standard Modal has. In particular within vacuum medium machanics electron and neutrino can be in unstable bounded state.
…
Thereby, M=38MeV is encouraging for considerations of such a concept. Your results follow from collision of heavier objects interpreted within vacuum medium mechanics as composition of stable electrons, positrons and neutrina. No quarks is considered. We could expect that within such collided media electron and single neutrino can be forced to create short living bounded state. Let us also note that I interpret the boson discovered at CERN and suggested that this is the Higgs boson as a phenomenon on the path leading to disintegration of three-positron proton. I suggest also that whole discussion on the Higgs boson manifests difficulties in theoretical physics following from too poor system of fundamental notions related to the Standard Model. In my opinion crisis in theoretical physics is serious. It is also my opinion that we should construct entirely new theory starting from better defined system of fundamental notions. I suppose that my work "Vacuum medium mechanics as a way towards constructing fundamental and universal theories" could be interesting for you. I am interested in your comments on my work.

Yours sincerely,
Jarosław Kaczmarek

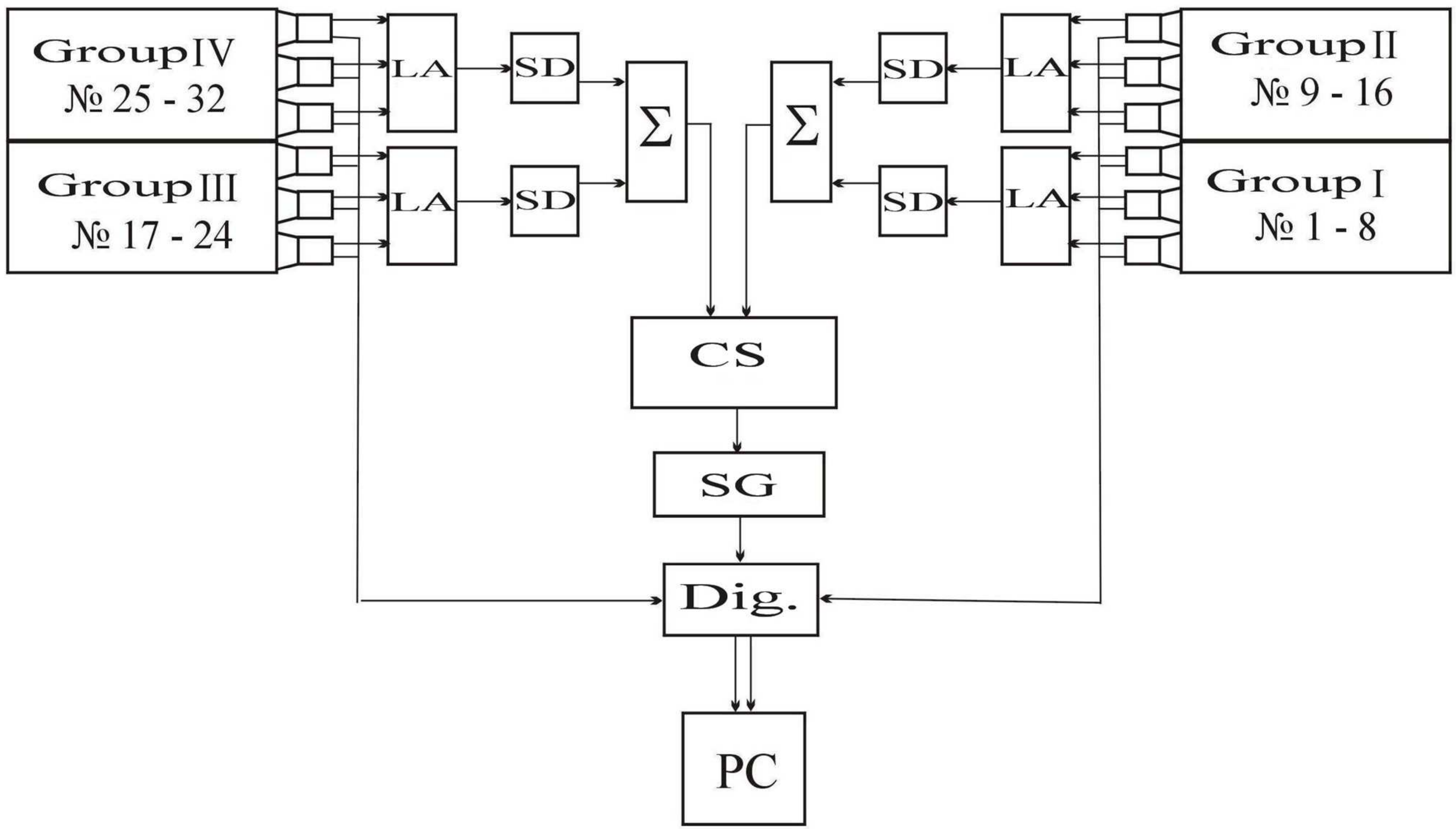
Doc. dr hab. inż. Jarosław Kaczmarek
Institute of Fluid-Flow Machinery Polish Academy of Sciences ul. J.Fiszera 14, 80-952 Gdańsk POLAND

Thank you for attention!

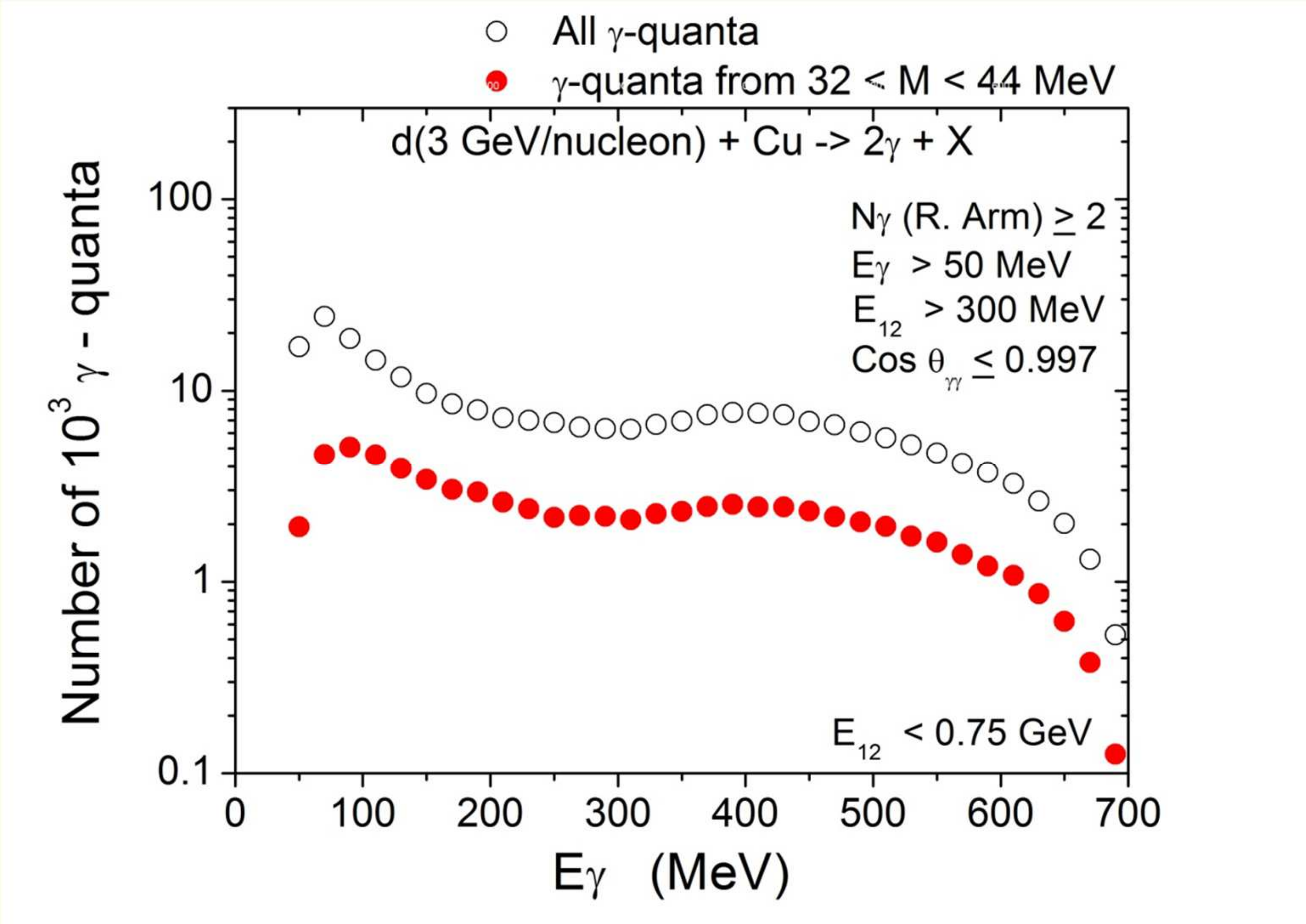
For more details see:

arXiv:1208.3829

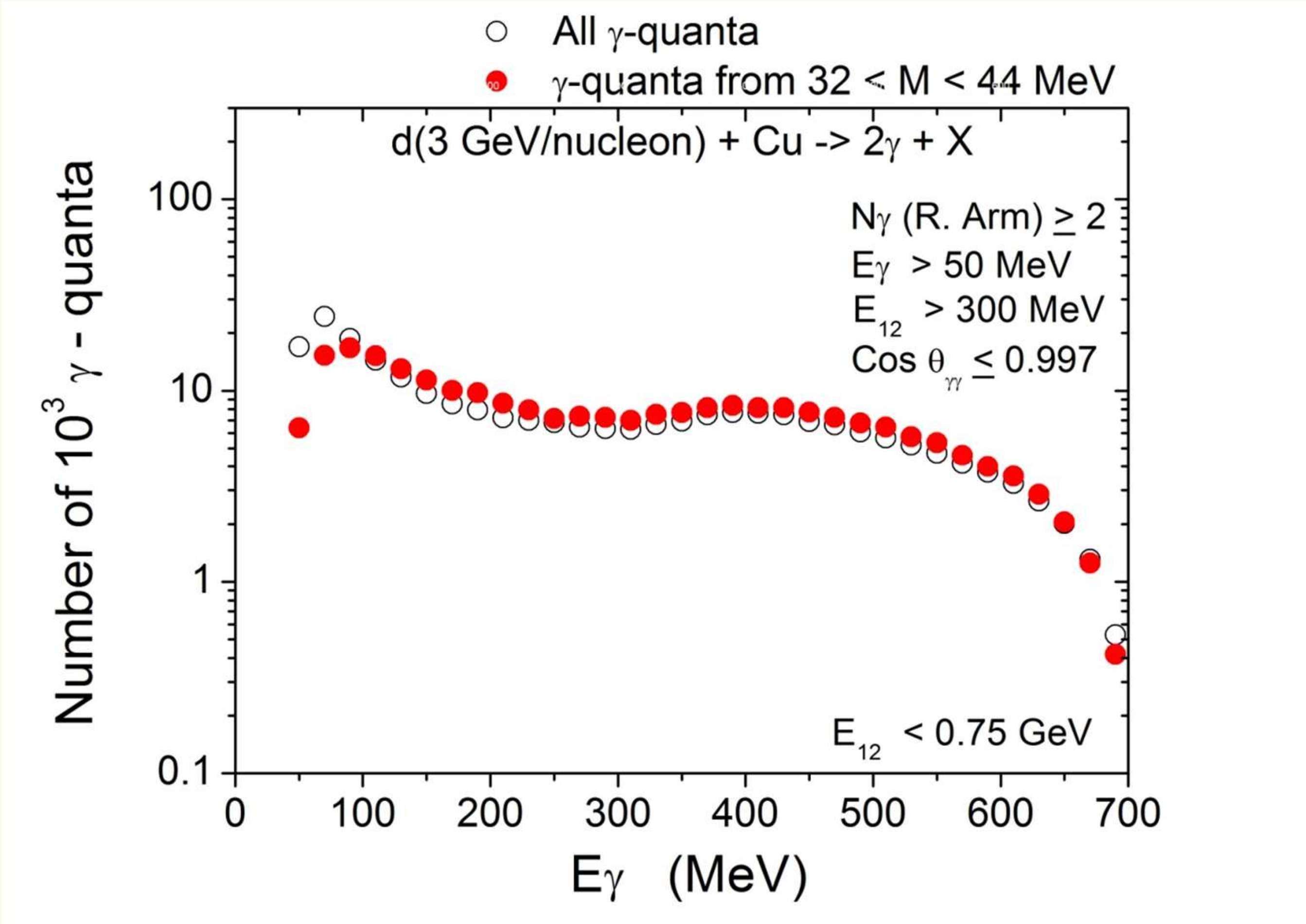
The block-scheme of electronic equipment



The energy distributions of γ-quanta in the spectrum (sl. №11) (without normalization)



The energy distributions of γ-quanta in the spectrum (sl. №11) (after normalization)



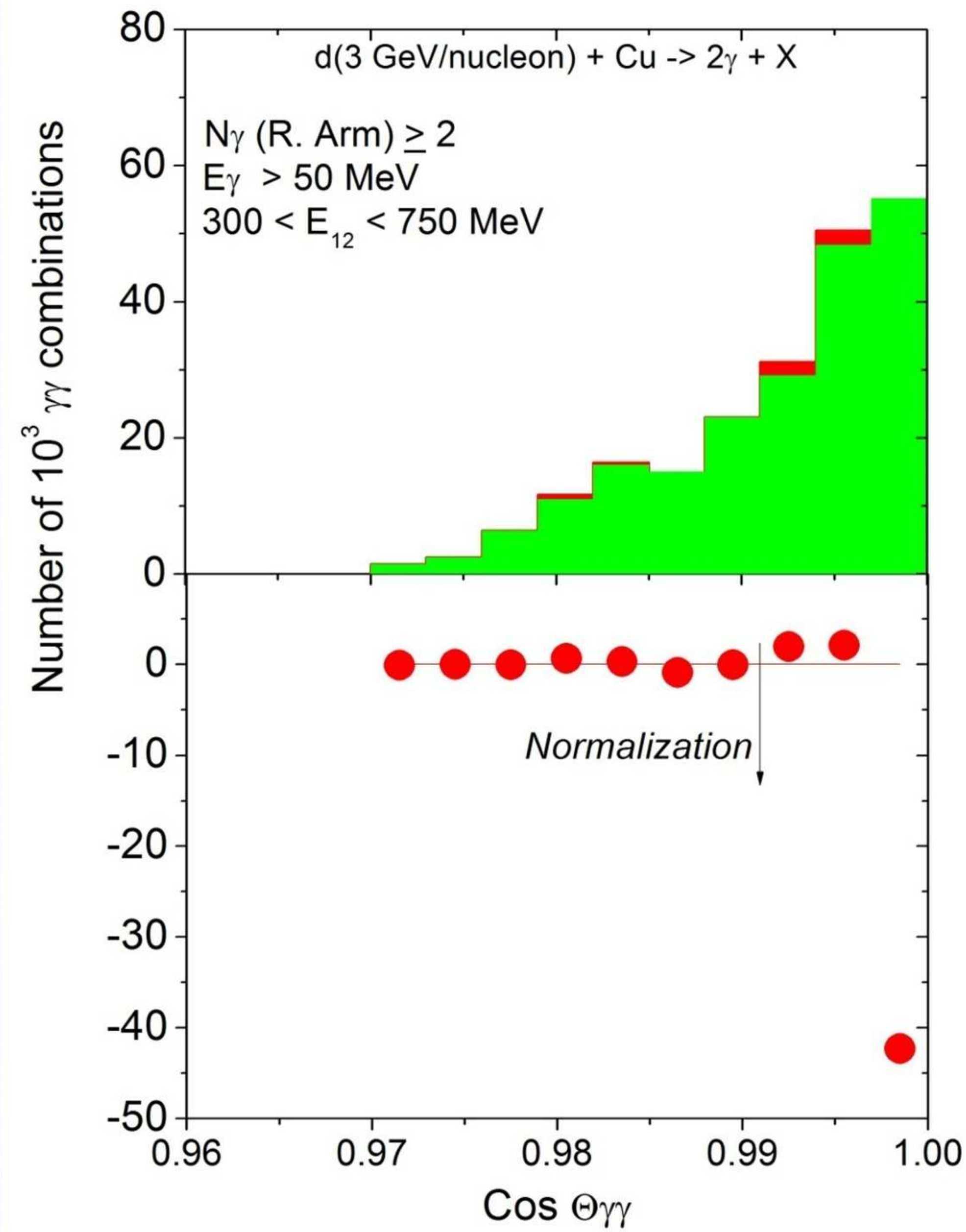
I. d(3 GeV/n)+Cu

1) Soft selection criteria:

(i) the energies of photons, Eγ > 50 MeV,

(ii) the sum of the energies of two photons, $300 < E_{12} < 750$ MэB,

The background is normalized to the number of pairs in a range Cos Θγγ < 0.991.

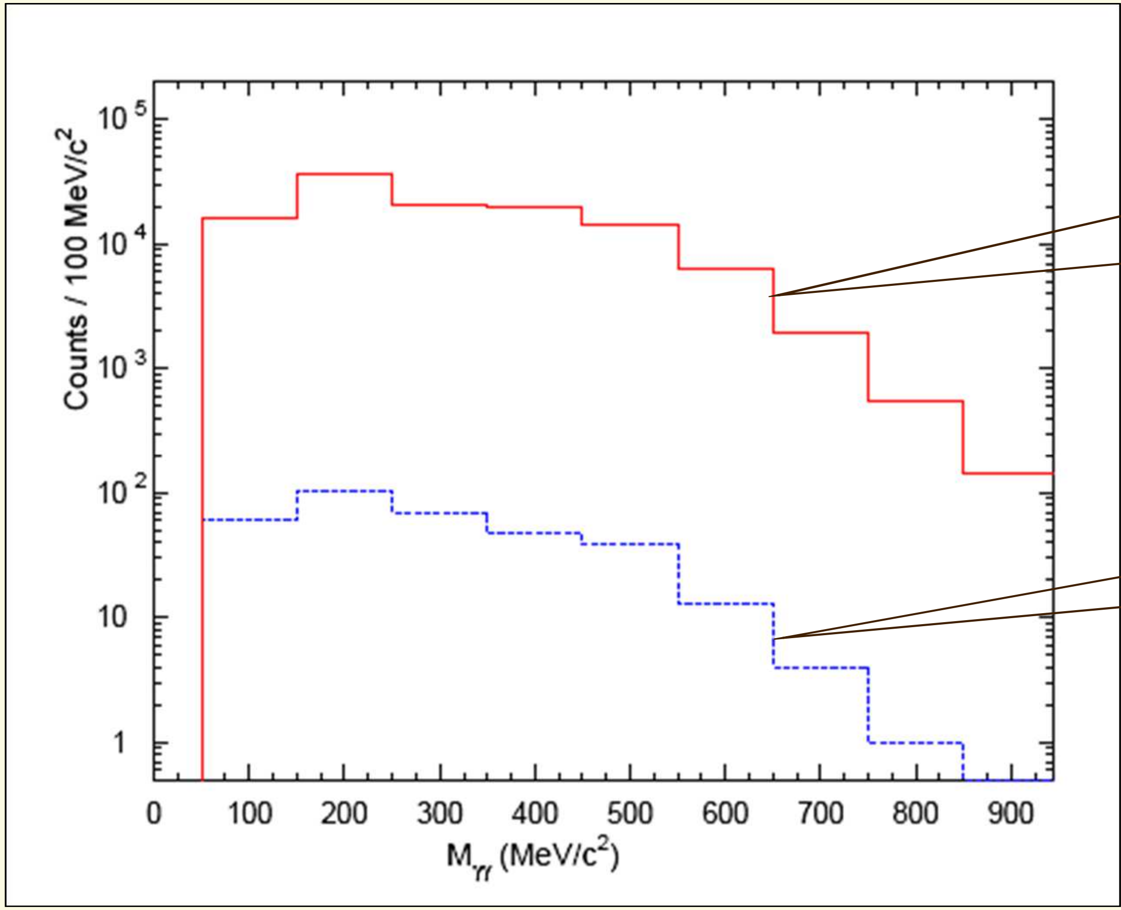


Check of the observed effect

The dominant part of background comes from the $\pi^o \to \gamma\gamma$ *decay. Other sources of background are charged particles as well as neutrons and particles from a general background in the accelerator hall.*

1. The contribution of the general background in the experimental hall was estimated from the measurements with empty target: this source contributes less than 1% and is quite smoothly distributed with respect to $M\gamma\gamma$.
2. Contributions of the given sources were estimated by special measurements with and without veto-detectors $S1$ and $S2$ and by comparison of data obtained at different beam intensities. The total contribution of above sources is less than **10%** and becomes negligible (< **1%**) after subtraction of event mixing background.

Invariant mass distributions of γγ pairs in two different runs of measurement under condition $E\gamma \geq 50$ MeV: with the empty target (dashed histogram) and with the internal carbon target (solid histogram) in the reaction $dC \rightarrow \gamma + \gamma + X$ at 2.75 GeV/c per nucleon.



With the internal carbon target

Without target