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FEATURES OF DATA PROCESSING OF AN EXPERIMENT ON STUDYING PROTON-PROTON CORRELATIONS IN THE d + ^{1}H → p + p + n REACTION

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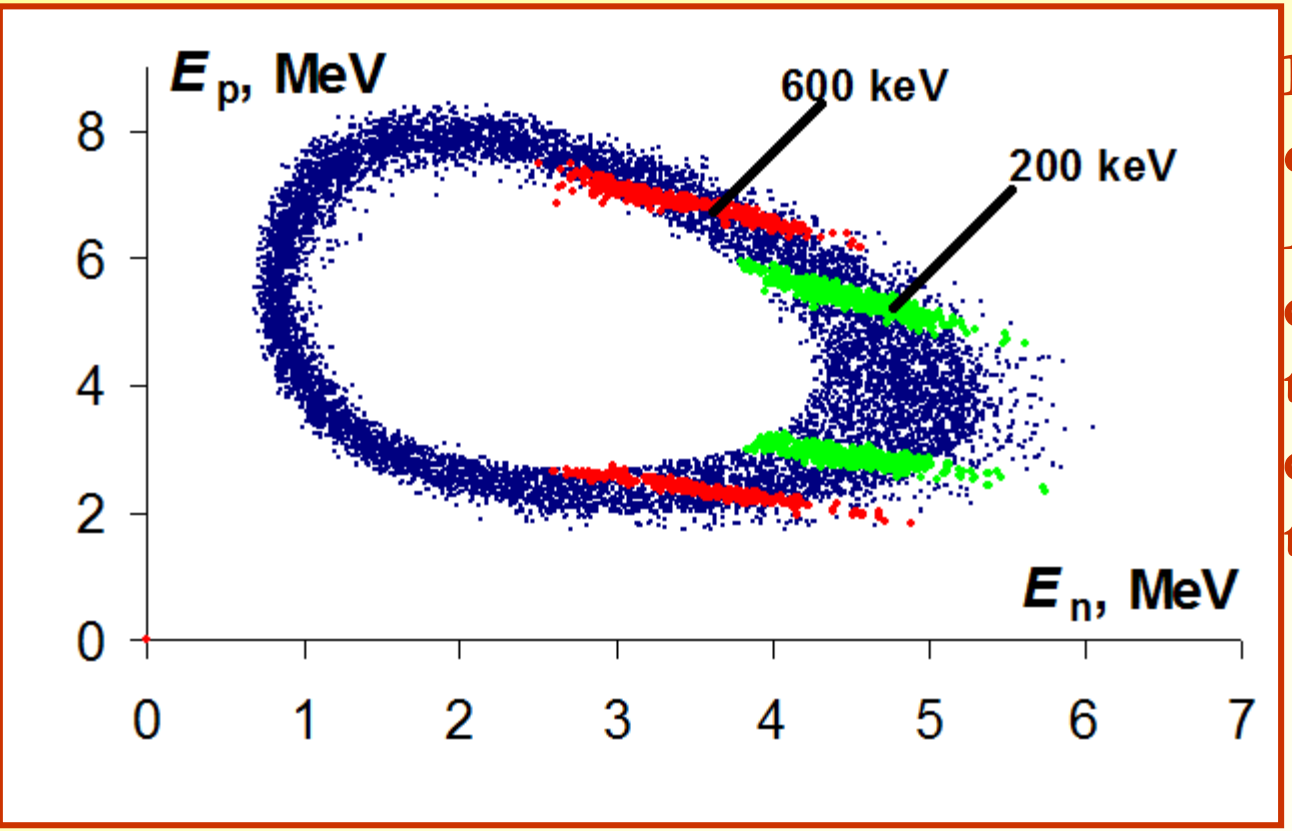
Measuring a_{pp} and E_{pp} in different reactions

- One of the manifestations of the CSB effect is the difference between the scattering lengths a_{pp} and a_{nn}. The scattering length a_{pp} is measured in *pp*-scattering reaction. The scattering length ann is measured in the reactions $d + {}^2\mathrm{H} \rightarrow (pp) + (nn)$ and $n + d \rightarrow (nn) + p$ with 3 and 4 particles in the final state.
- The value of the scattering length extracted in reactions with three or more particles in the final state can be influenced by the interaction of the *NN*-pair with other particles.
- The scattering length app can also be measured in the reactions $d + {}^2\mathrm{H} \rightarrow (pp) + (nn)$ and $d + {}^1\mathrm{H} \rightarrow (pp) + \mathrm{n}$, and the result may differ from that obtained in pp-scattering.
- **The aim of this work is to study the effect of 3*N*-forces on the extracted value of the virtual pp-state energy (E_{pp}) related to the *pp*-scattering length.**

Kinematic simulation of the $d + {}^1\mathrm{H} \rightarrow (pp) + n$ reaction: the first stage

- At the first stage, the two-particle reaction $\boldsymbol{d + {}^1\mathrm{H} \rightarrow (pp) + n}$ is simulated with a deuteron beam energy of 15 MeV.
- The mass of the two-proton system is $\boldsymbol{m_{2p} = 2m_p + E_{pp}}$.
- In the simulation, the sought value of the virtual level energy was taken in a wide range $\boldsymbol{Epp}$ **= 0.2 - 0.6 MeV**.
- The optimal angles of neutron emission **(38° ± 2°)** and pp-system **(–18° ± 1.5°)**, corresponding to the maximum possible proton energies in the experiment were determined.

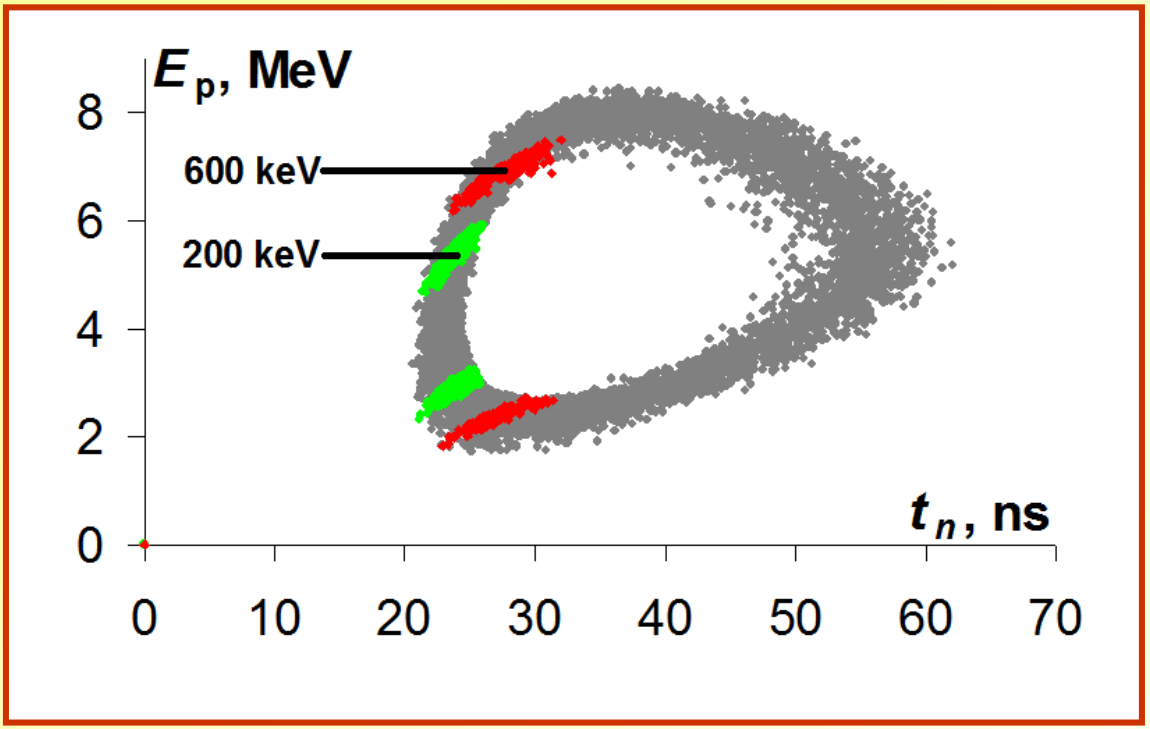
Kinematic simulation of the $d + {}^1\mathrm{H} \rightarrow (pp) + n$ reaction: the second stage



Designations: blue color - events without E_{pp} selection; green – events corresponding to E_{pp} = 200 keV; red - events corresponding to E_{pp} = 600 keV.

E_p – the energy of one of the protons from $d + {}^1\mathrm{H} \rightarrow p + p + n$; E_n – the energy of a neutron from the reaction $d + {}^1\mathrm{H} \rightarrow p + p + n$.

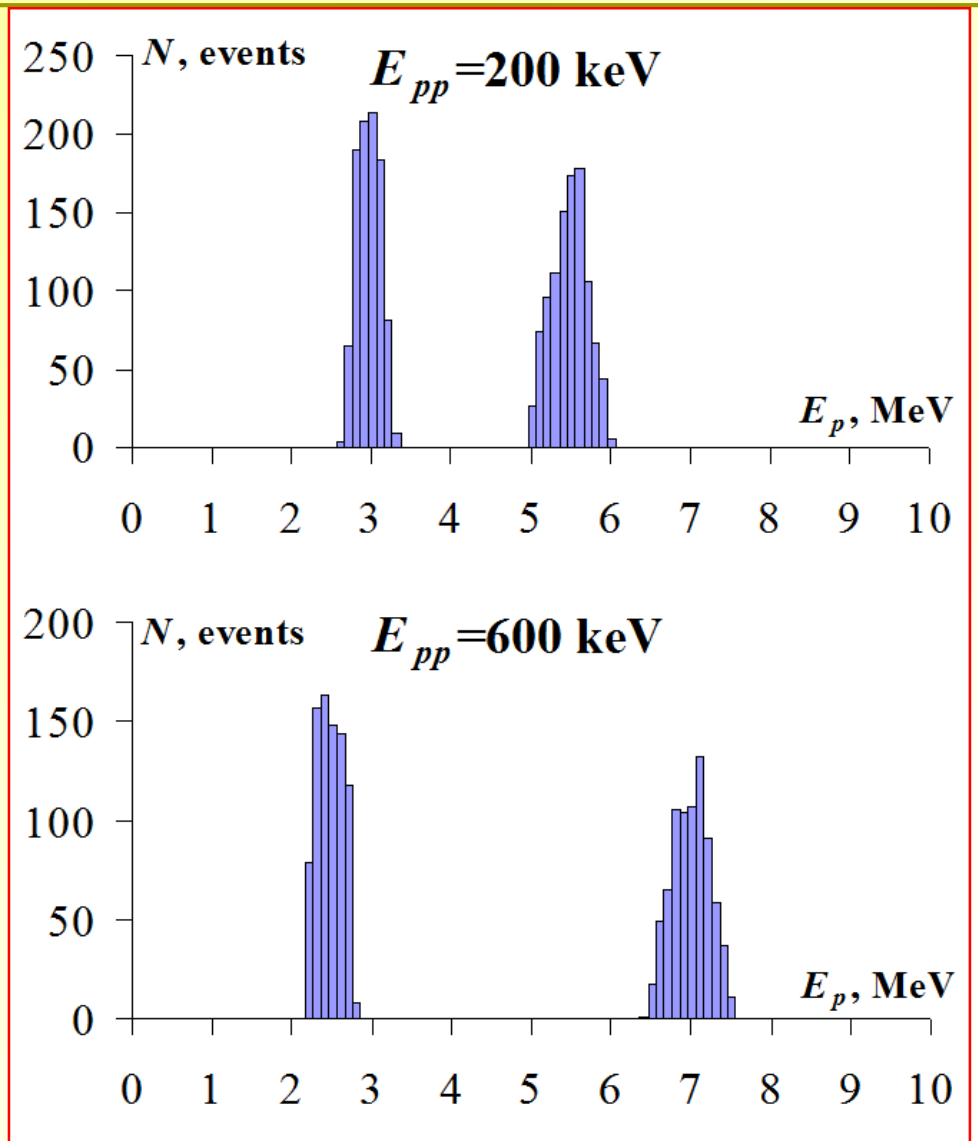
Diagram E_p-t_n. Time of flight t_n depends on E_n



Designations: grey color - events without E_{pp} selection; green – events corresponding to E_{pp} = 200 keV; red - events corresponding to E_{pp} = 600 keV.

E_p – the energy of one of the protons from $d + {}^1\mathrm{H} \rightarrow p + p + n$; E_n – the energy of a neutron from the reaction $\mathrm{d} + {}^1\mathrm{H} \rightarrow p + p + n$.

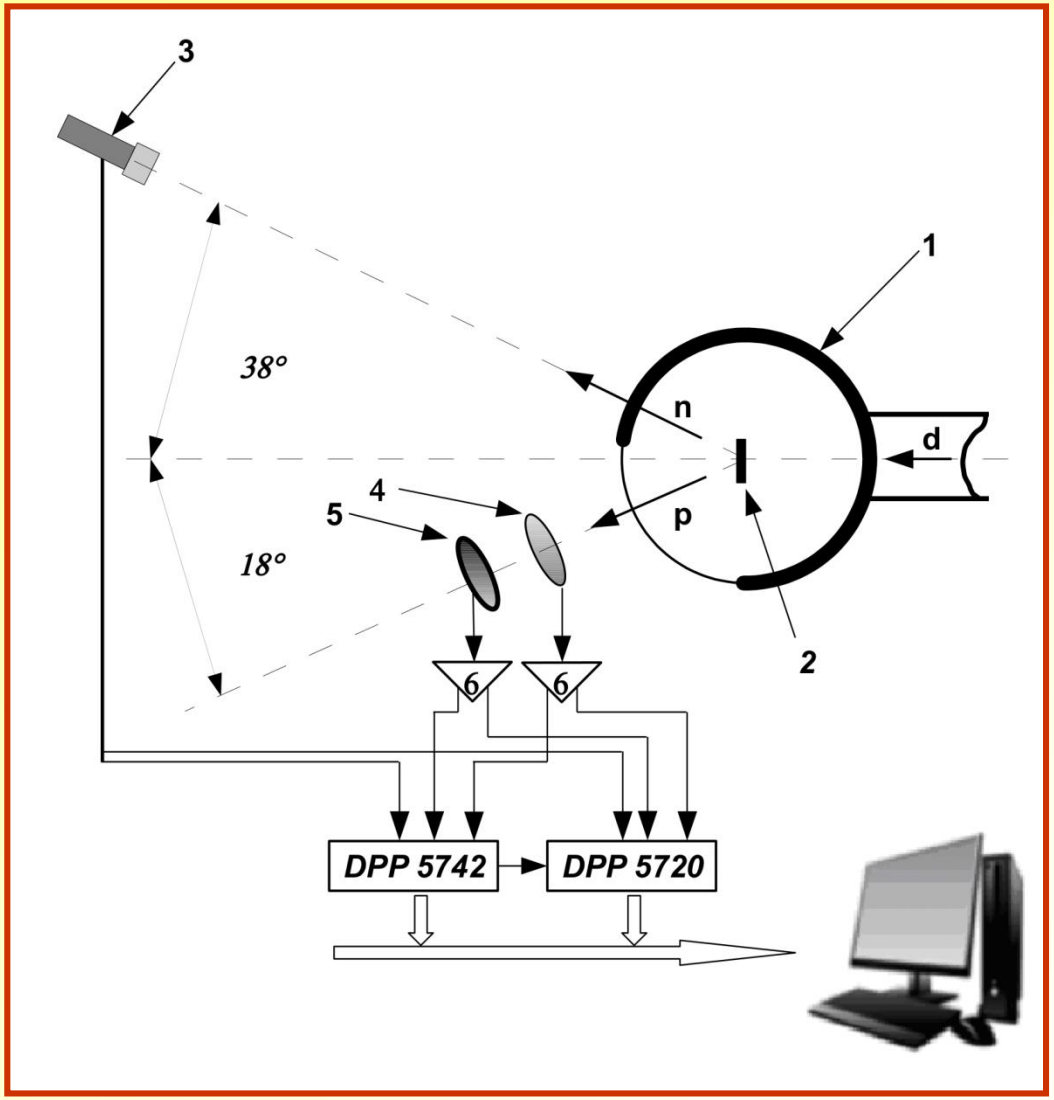
Proton energy spectra for different E_{pp} (300 and 600 keV) after separation of background events



Experimental parameters obtained by simulation of the $d + {}^{1}\mathrm{H} \rightarrow p + p + n$ reaction

- Proton registration angle: 18° ± 2.5°.
- Proton energy measurement range: 0.5 - 8 MeV.
- Measurement range for ΔE: 0.24 - 0.78 MeV.
- Neutron registration angle: 38° ± 2°.
- The shape of the proton energy spectrum makes it possible to determine the value of E_{pp}.
- Available for research E_{pp} range: 200-600 keV (based on experimental conditions and simulation results).

Experimental setup for registration of charged particles and neutrons in the $d + {}^1\mathrm{H} \rightarrow p + p + n$ reaction



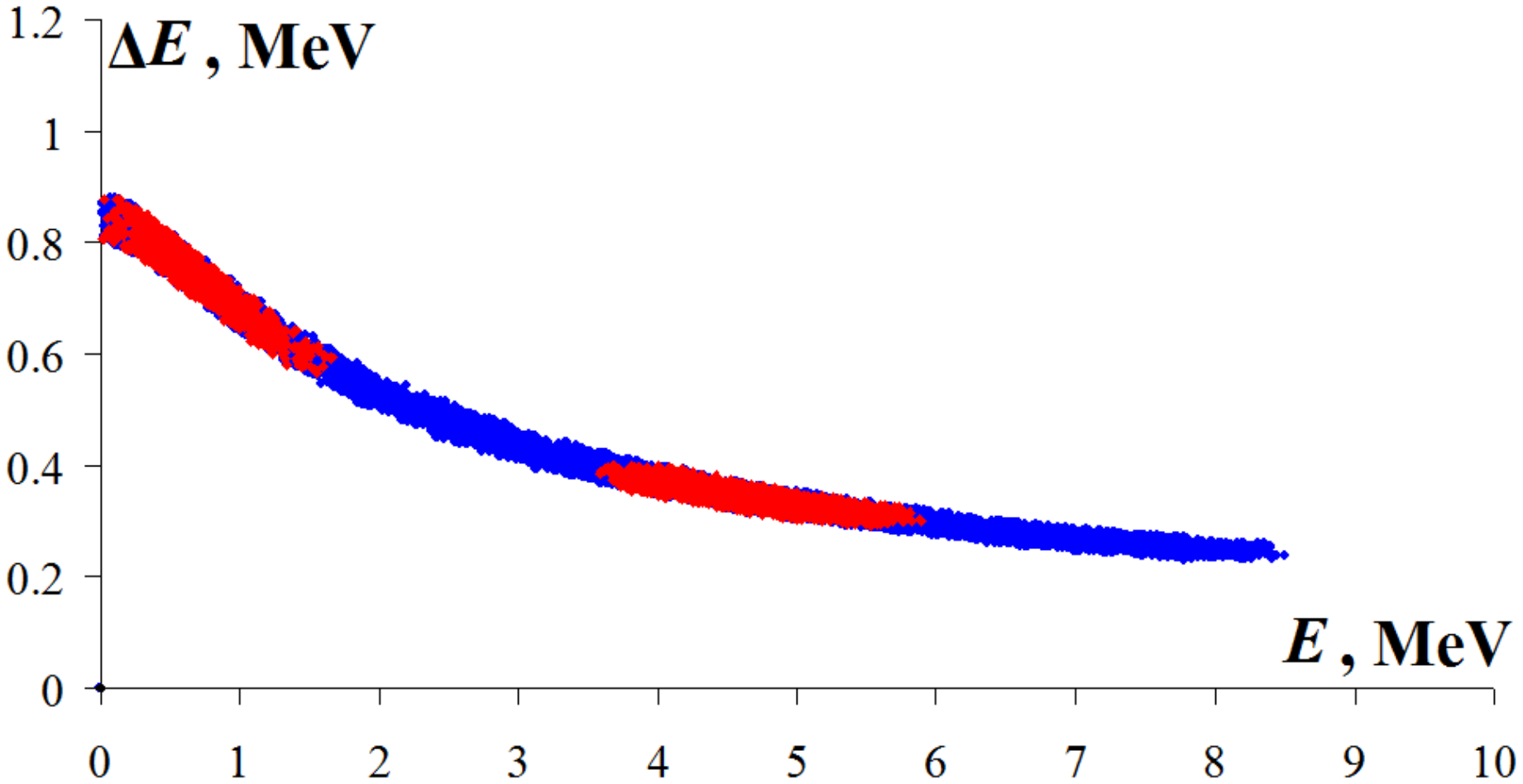
1 - vacuum scattering chamber,
2 - target CH_2,
3 - a neutron detector,
4 - silicon ΔE-detector (25 μm),
5 - E-detector,
6 - acquisition system, including preamplifiers, amplifiers, and digital pulse processors DPP 5742 and DPP 5720.

Simulation of ionization loss of protons in the ΔE-E-system

The thicknesses of the layers of matter through which protons pass:

Target (CH_2)	30	μm
Film_1 (Lexan)	20	μm
Air_1	22,5	mm
ΔE detector (Si)	24	μm
Air_2	10	мм
E1 detector (Si)	500	μm

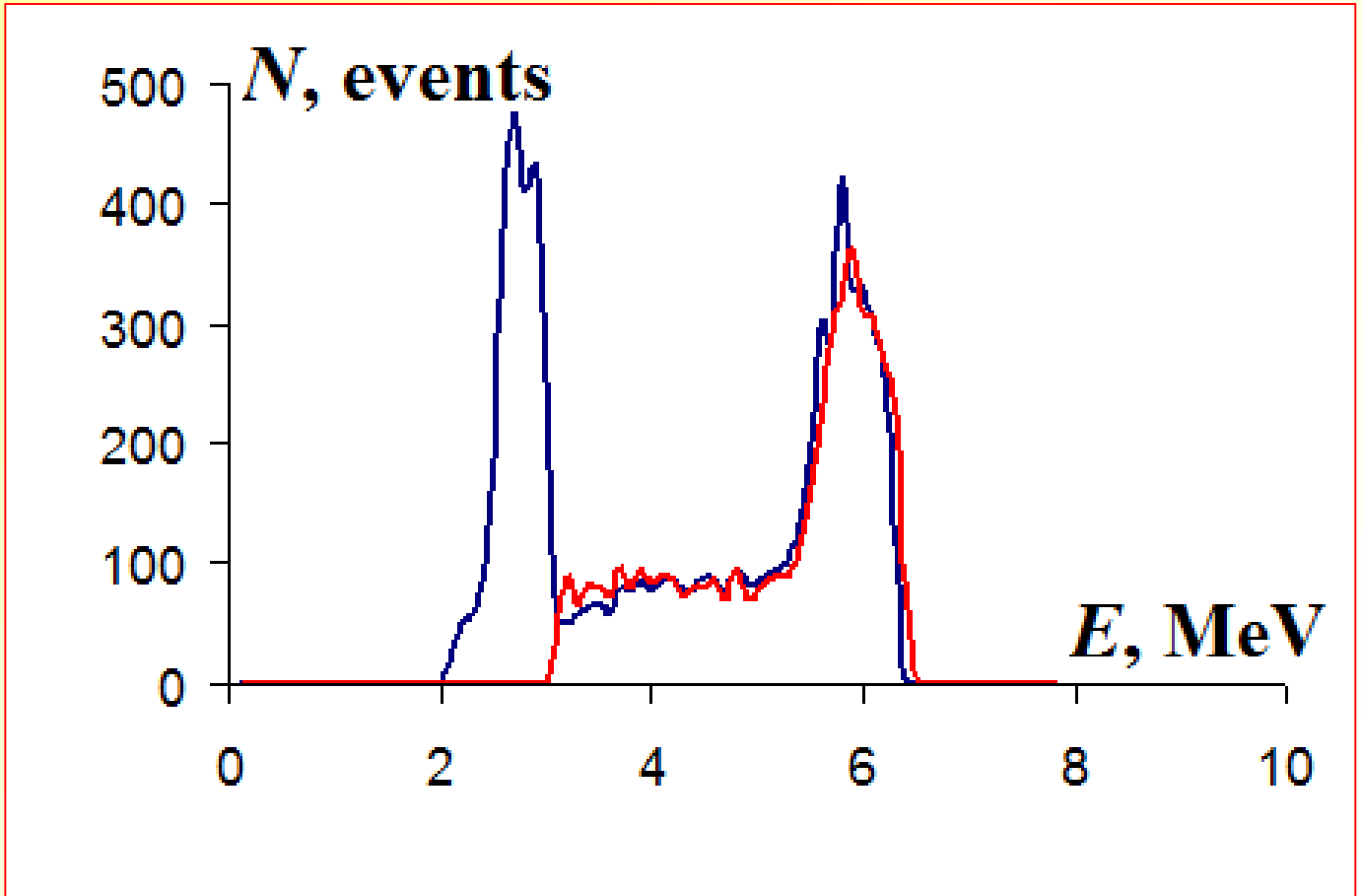
Simulation of ionization loss of protons in the ΔE-E-system



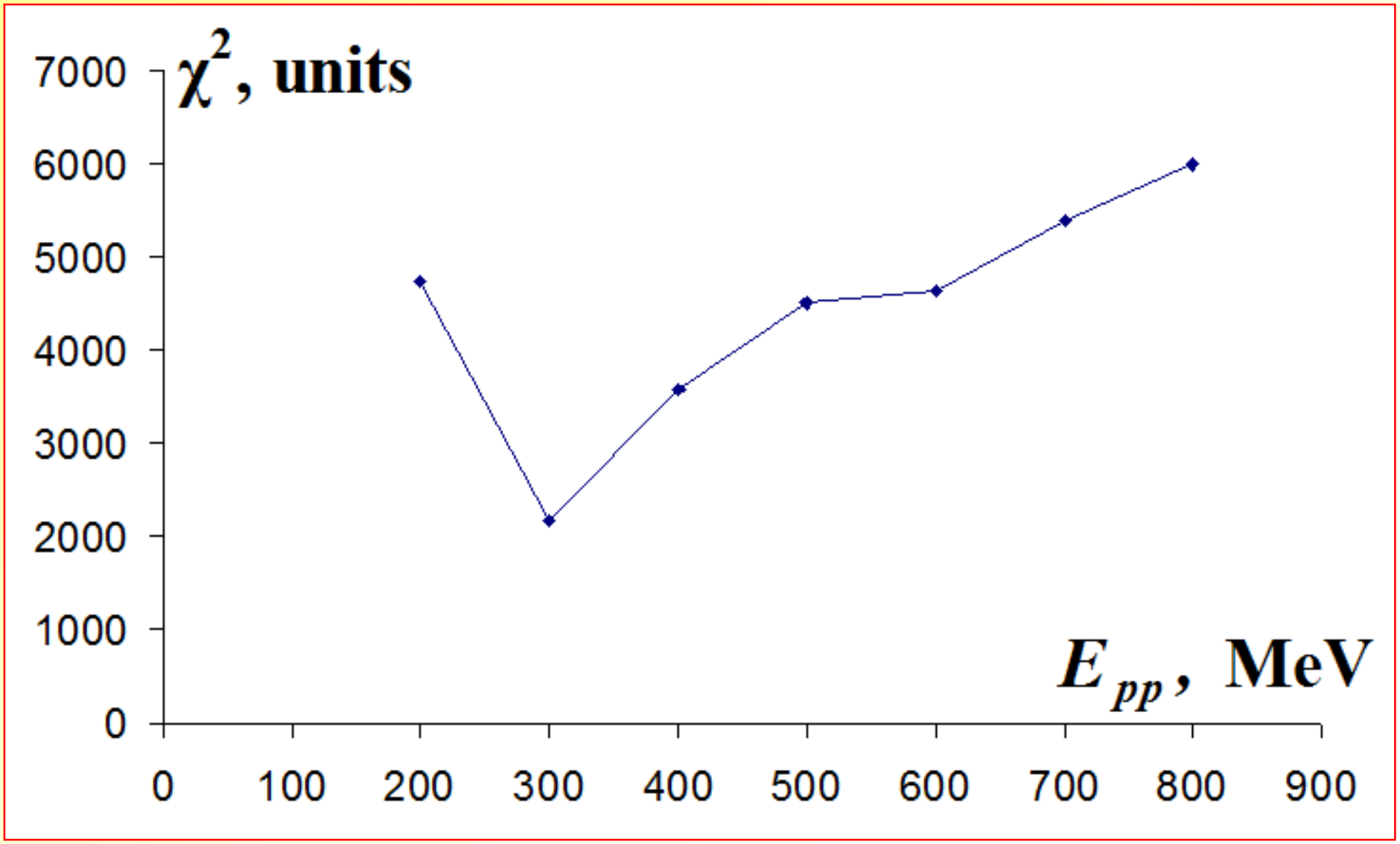
Designations: blue color - events corresponding to the passing of protons with energies in the range of 0.5 - 8 MeV; red color - events corresponding to $Epp = 300$ keV $\pm$ 50 keV.

Recovering the spectrum after the passing of protons through the ΔE-E -system

Recovery is carried out according to the formula $E_0 = f(\Delta E + E)$.



Usage of the χ^2 method in the case of the recovered proton spectrum



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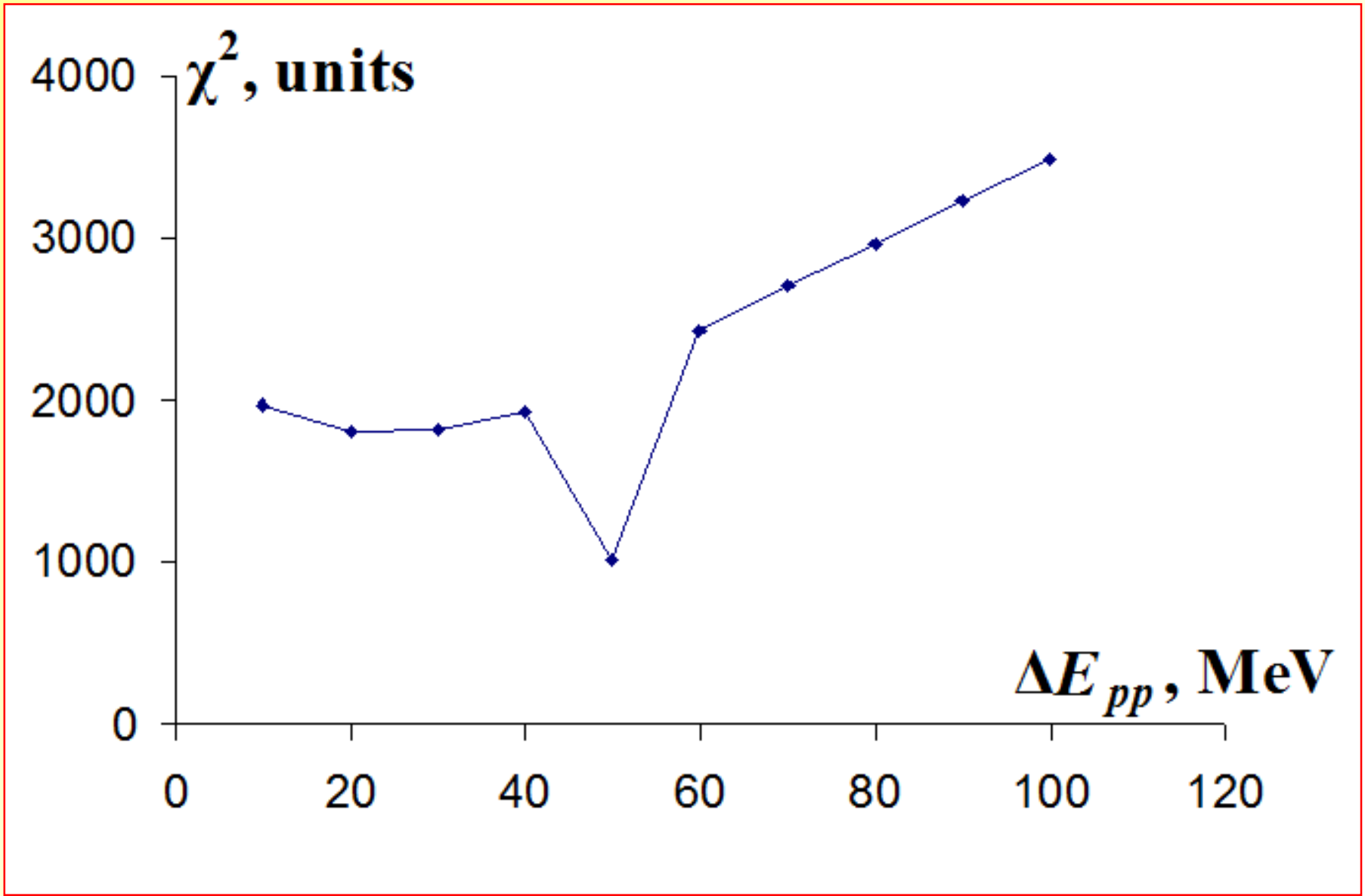

Conclusion

- The results of kinematic simulation showed that analysis of the shape of the proton spectrum under certain experimental parameters can give information on E_{pp}.
- Optimal parameters of the experiment have been determined.
- The simulation of the passing of charged particles through the substance of the detectors (silicon), as well as through the layers of other substances present in the detecting system has been carried out.
- The procedure of extracting the energy of the virtual pp-state using the $\chi 2$ minimum method was considered.

Thank you for your attention!