

# INVESTIGATION OF THE dp-NON-MESONIC BREAKUP REACTION AT 300-500MeV AT NUCLOTRON



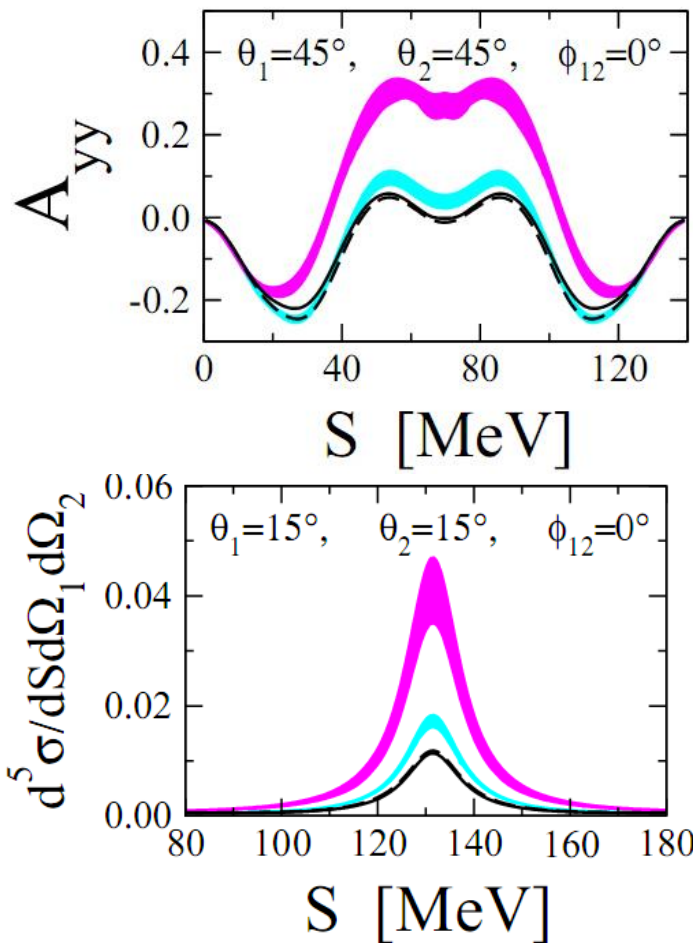
**Piyadin S.M. et al.**

**The XXII International Baldin Seminar  
on High Energy Physics Problems  
Dubna, Russia, September 15-20, 2014**

The purpose of this experimental program is to obtain the information about spin – dependent part of the  $3NF$  from two processes:

1. dp-elastic scattering;
2. dp-breakup with registration of two protons at energy  $300 - 500 \text{ MeV}$ .

# dp breakup reaction.



This slide presents tensor analyzing power  $A_{yy}$  (top) and differential cross section in selected breakup configurations at 200 MeV (bottom).

- The light shaded band (blue) contains the theoretical predictions based on CD-Bonn, AV18, Nijm I, II and Nijm 93.
- The darker band (magenta) represents predictions when these NN forces are combined with the TM 3NF.
- The solid line is for AV18+Urbana IX and the dashed line for CD Bonn+TM

One can see that the inclusion of 3NF have great impact on the values of analyzing power and cross section.

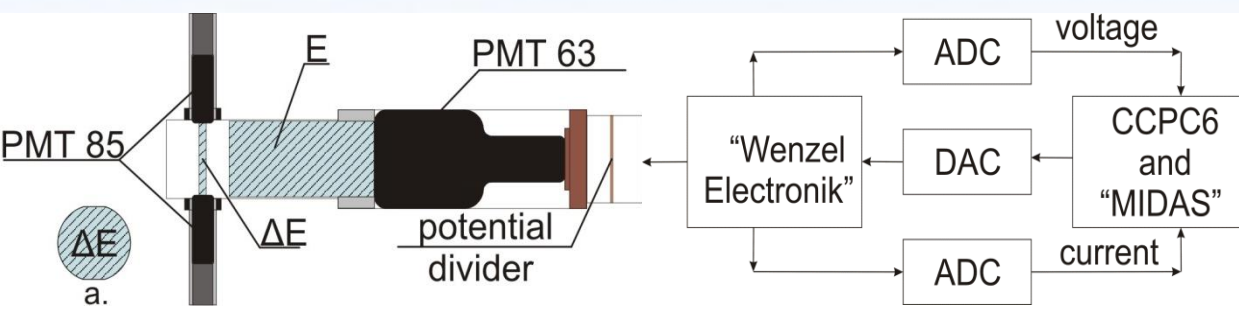
$\Theta_1$  – polar angle of the 1-st proton.

$\Theta_2$  – polar angle of the 2-nd proton.

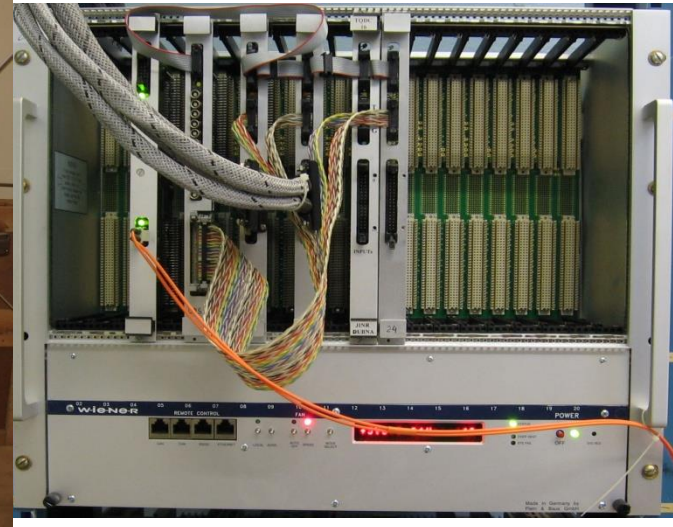
$S$  – arc length along the kinematical curve.

$\Phi_{12}$  – azimuth angle with respect to the horizontal plane.

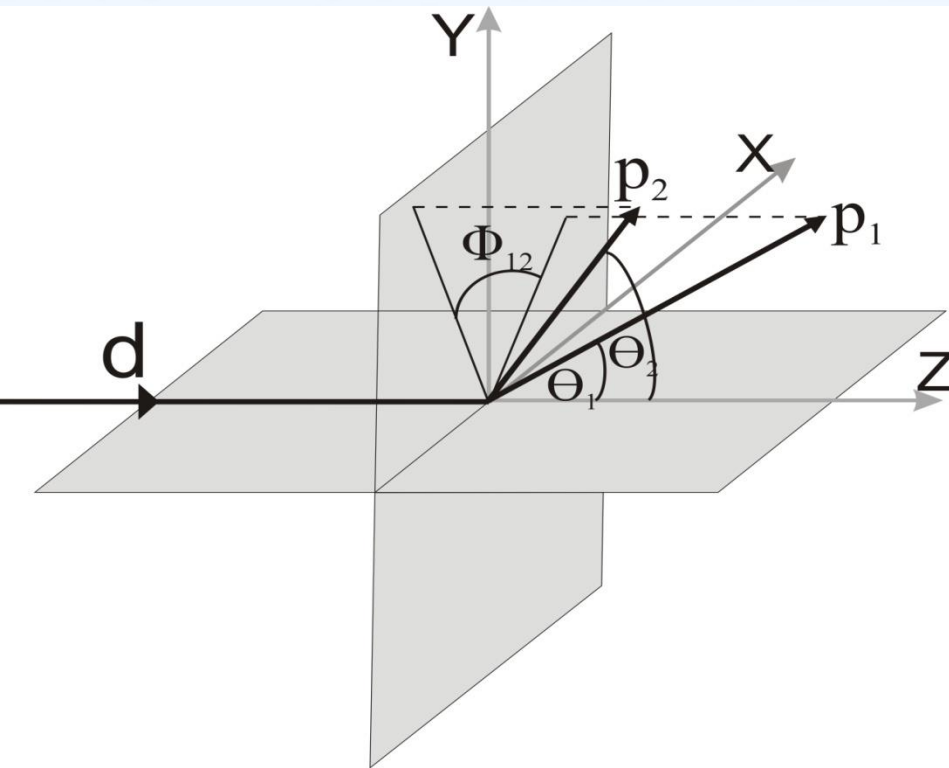
# Detection system for dp-breakup.



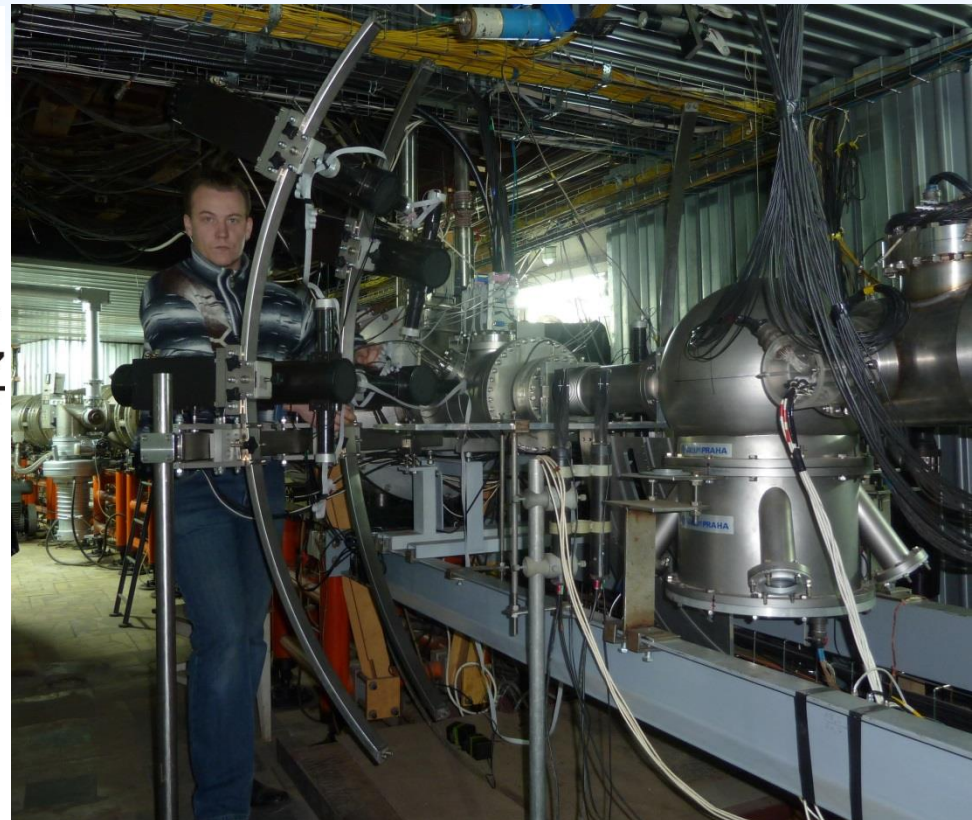
$\Theta$  ( $12^\circ$ ,  $45^\circ$ )  
 $\Phi$  ( $0^\circ$ ,  $360^\circ$ )  
 Space angle of the detector  $4.6^\circ$ .



# Setup of the experiment at Internal Target Station.

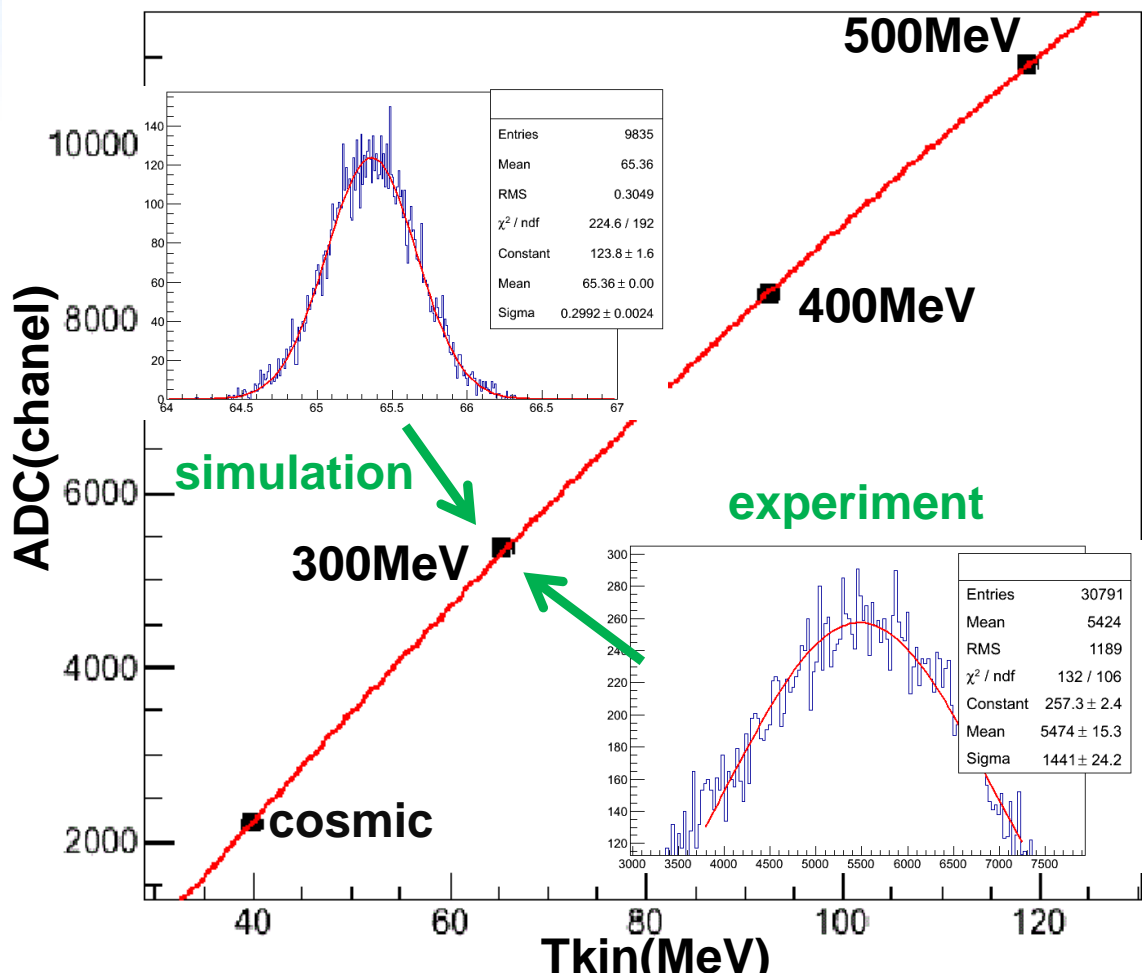


Detection angles for registration  
of two protons



The position of the detectors  
at Internal Target Station at Nuclotron

# The calibration of E scintillation detectors



## Results calibration E-scintillator:

1. Cosmic muons;
2. pp-quasi elastic: for 1 pairs 90° cms, for 2 pairs 110° cms;
3. dp-elastic scattering for 87° cms.

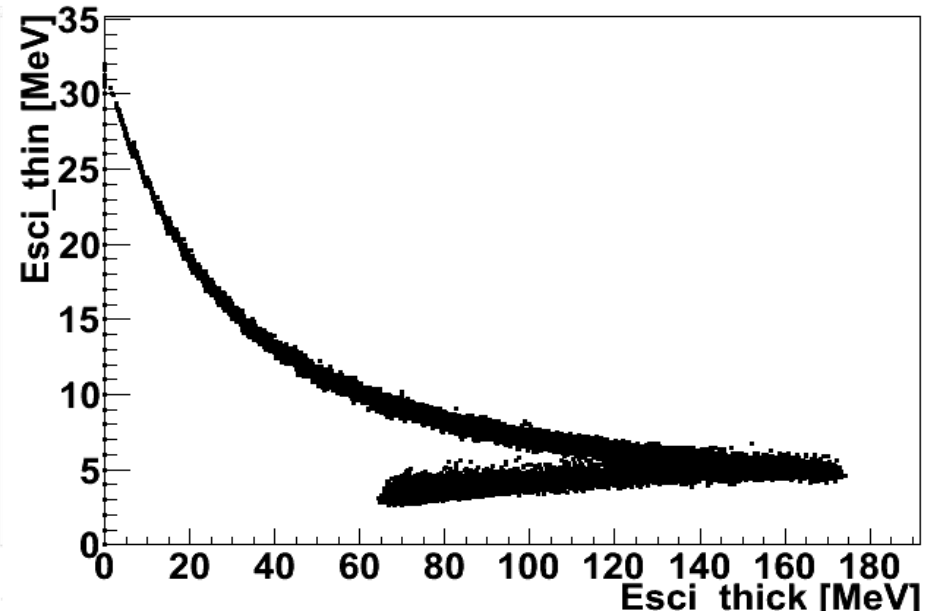
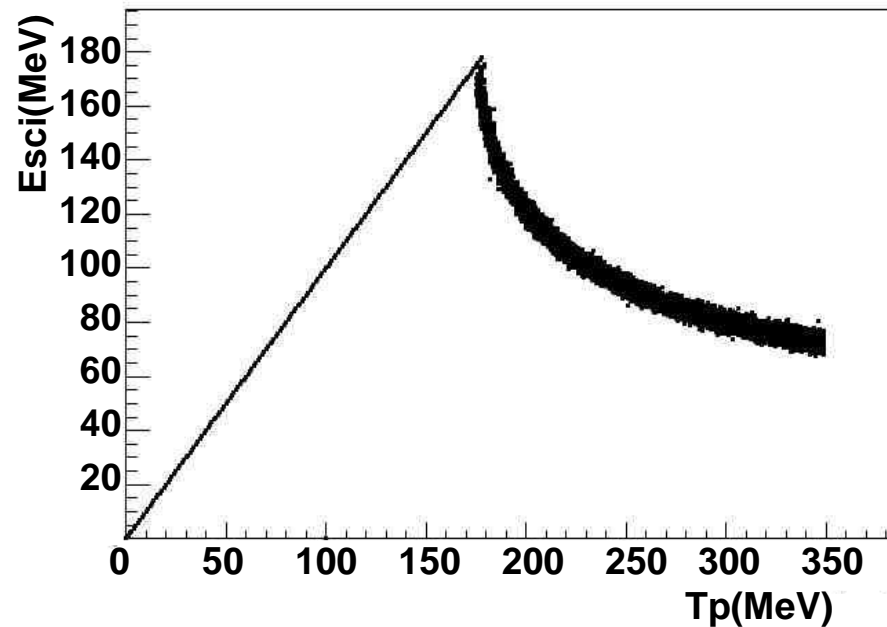
Also the calibration for  $\Delta E$  scintillation detectors were obtained.

$$E_{det} = E + (\Delta E_1 + \Delta E_2)/2$$

# Simulation of the dp-ppn reaction

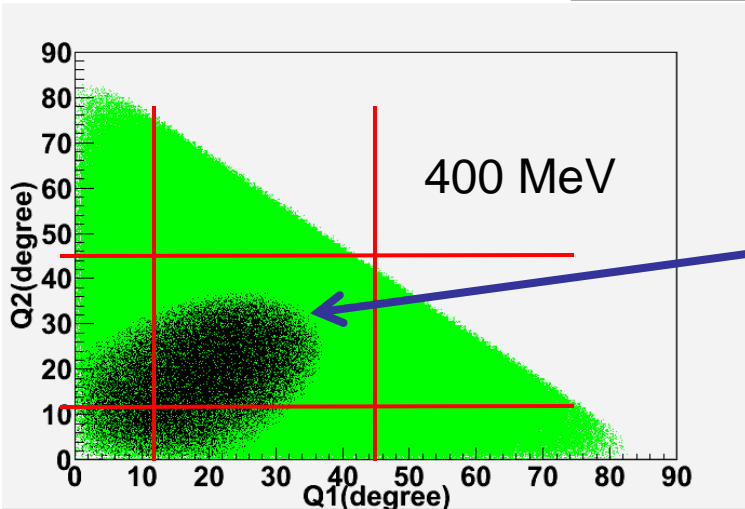
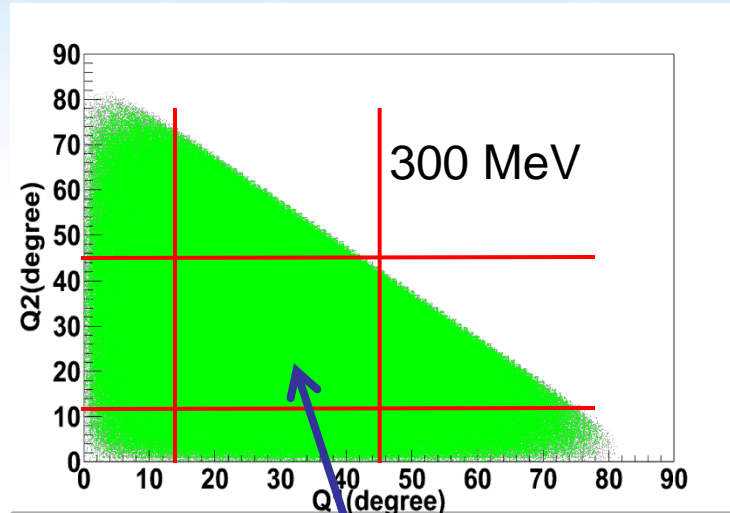


21.0cm scintillator

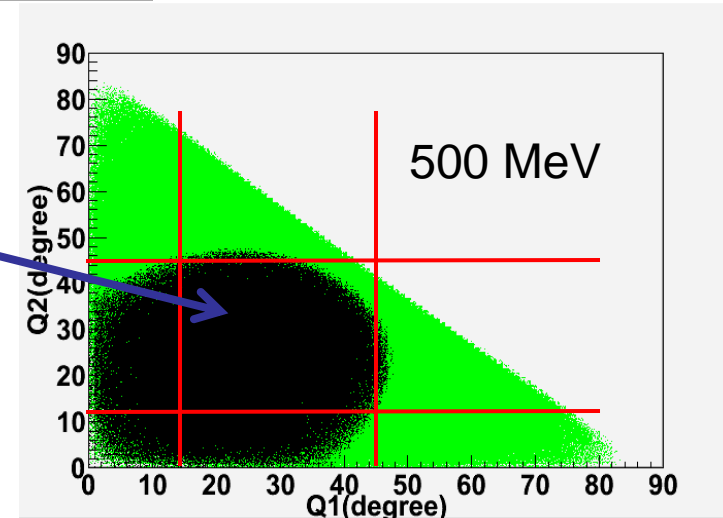


Energy losses of protons when passing through scintillator

# Acceptance of the setup for coplanar geometry.

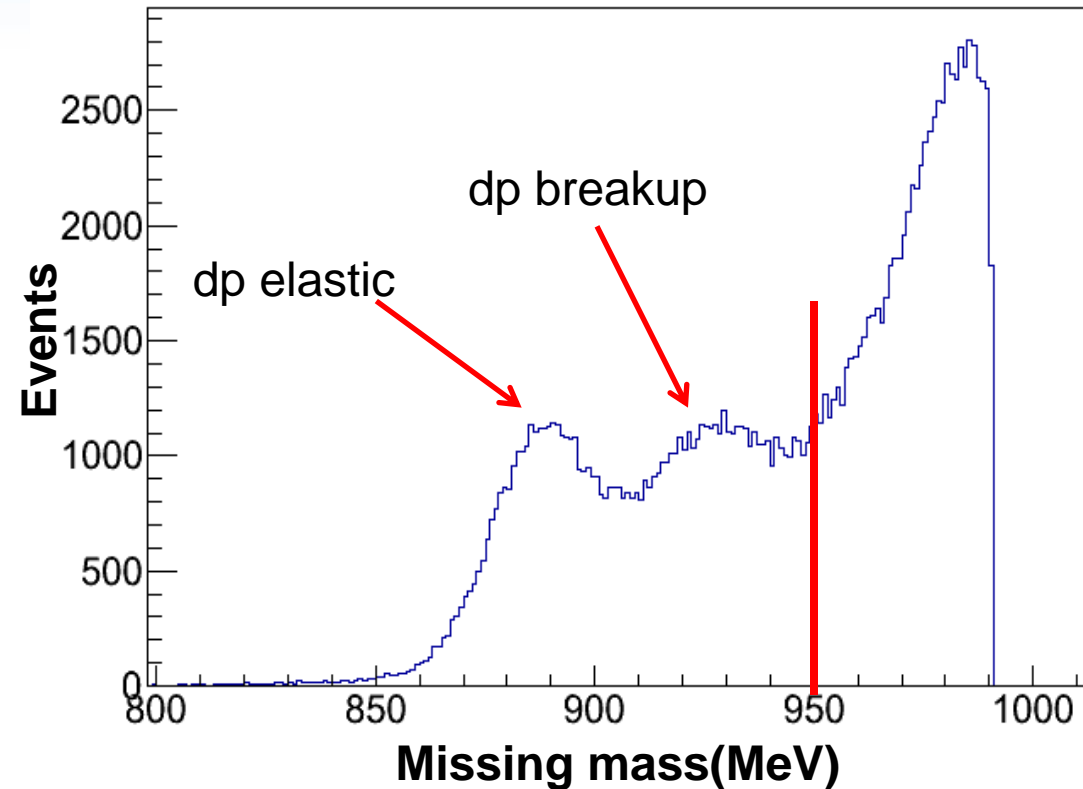


Acceptance  
of the setup





# Experiment to study of dp breakup.



**The missing mass spectrum.**

Deuteron energy: 400 MeV.

Configuration:  $\Theta_1=25^\circ, \Theta_2=43.6^\circ,$   
 $\phi_{12}=178.5^\circ$

dp-elastic scattering: 87° cms

Energy deuteron: 229.7 MeV

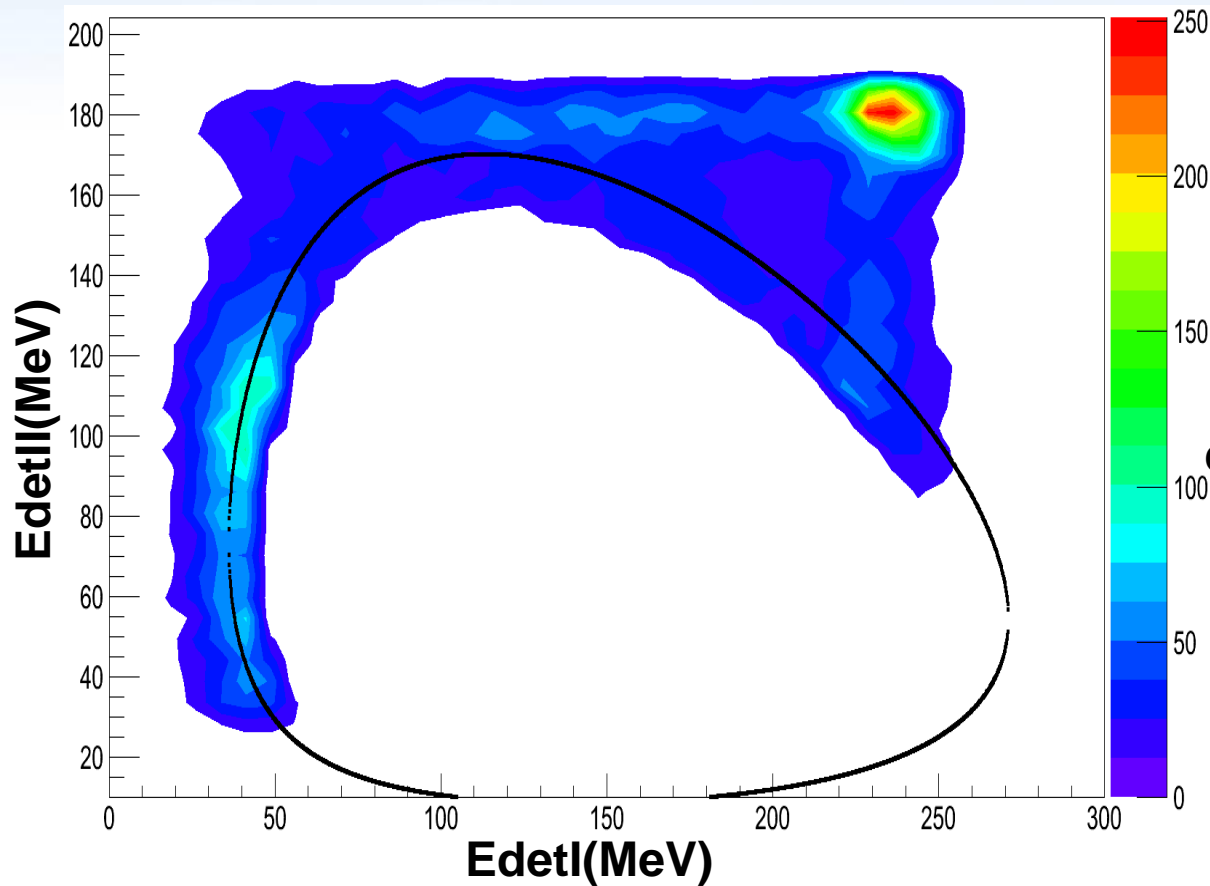
Energy proton: 170.32 MeV

Cut on missing mass:

1. dp-elastic & dp-breakup:  
< 950 MeV

2. dp-breakup:  
940 MeV  $\pm$  10 MeV

# Experiment data for dp breakup.



**Correlation of the two energies with the cut on missing mass.**

Deuteron energy: 400 MeV.

Configuration:  $\Theta_1=25^\circ$ ,  $\Theta_2=43.6^\circ$ ,  
 $\varphi_{12}=178.5^\circ$

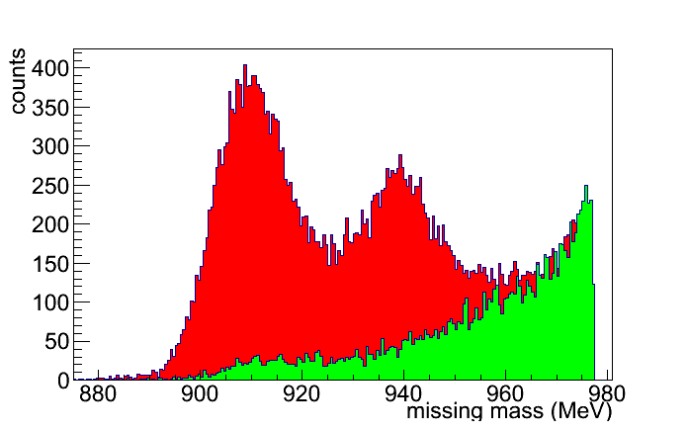
dp-elastic scattering: 87° cms

Energy deuteron: 229.7 MeV

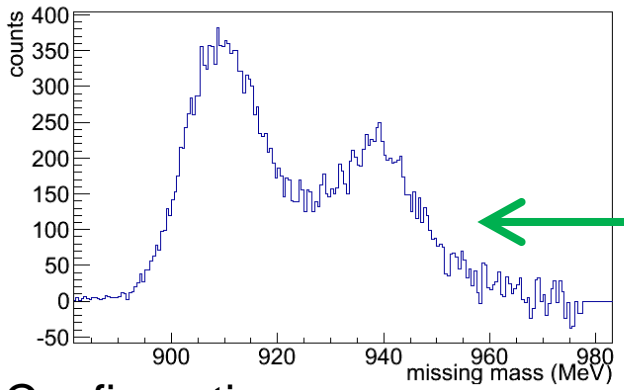
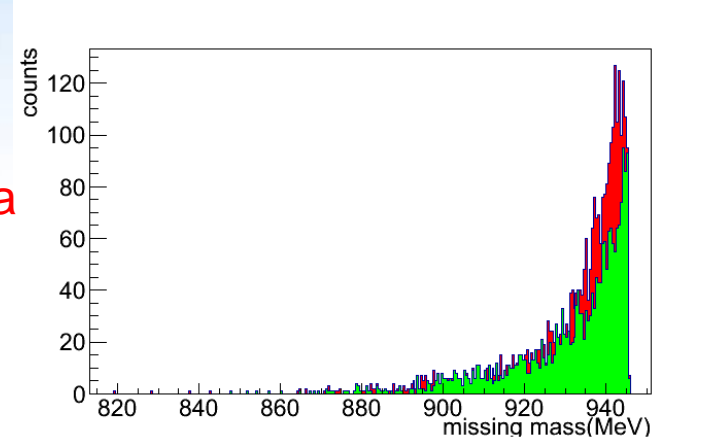
Energy proton: 170.32 MeV

**Black curve – kinematic locus for dp-breakup reaction.**

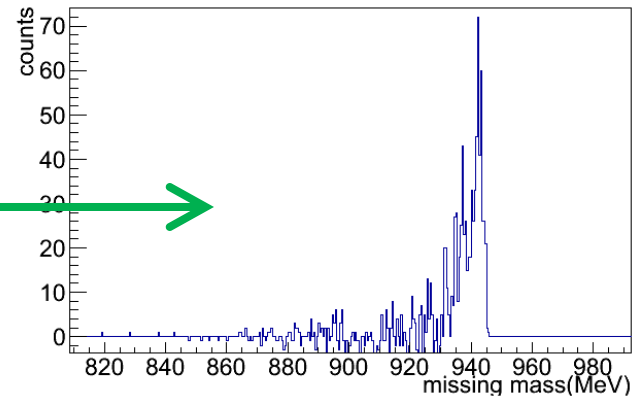
# CH<sub>2</sub>-C<sup>12</sup> subtraction



Deuteron energy:  
300 MeV.  
CH<sub>2</sub> – red color spectra  
C<sup>12</sup> – green color



← Results CH<sub>2</sub>-C<sup>12</sup> →



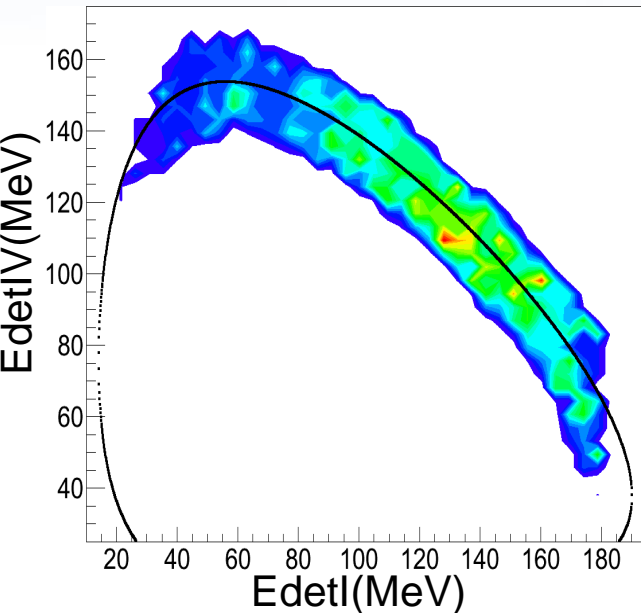
Configuration:  
 $\Theta_1=25.2^\circ, \Theta_2=43.9^\circ, \phi_{12}=178.5^\circ$   
dp-elastic scattering: 87<sup>0</sup> cms

Configuration:  
 $\Theta_1=33.9^\circ, \Theta_2=43.9^\circ, \phi_{12}=133.8^\circ$

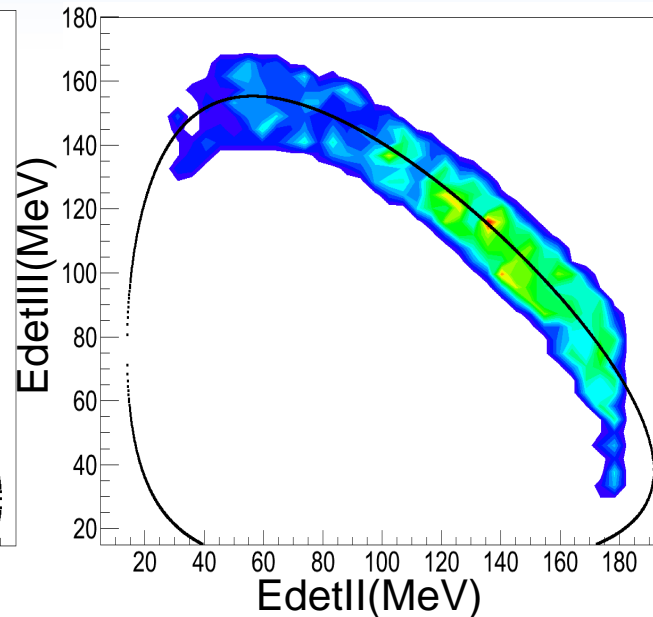
# The deuteron energy 300 MeV.



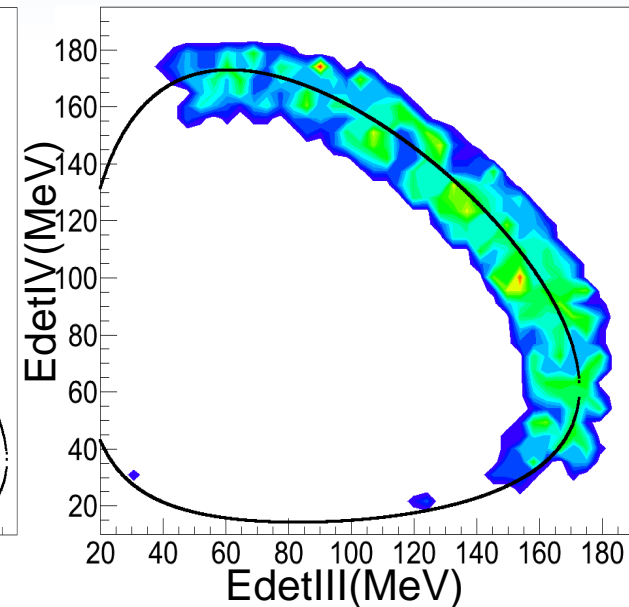
$$\Theta_1 = 25.2^\circ, \Theta_4 = 33.9^\circ, \\ \varphi_{14} = 135.3^\circ$$



$$\Theta_2 = 25.2^\circ, \Theta_3 = 33.9^\circ, \\ \varphi_{23} = 133.5^\circ$$



$$\Theta_3 = 33.9^\circ, \Theta_4 = 33.9^\circ, \\ \varphi_{34} = 180^\circ$$

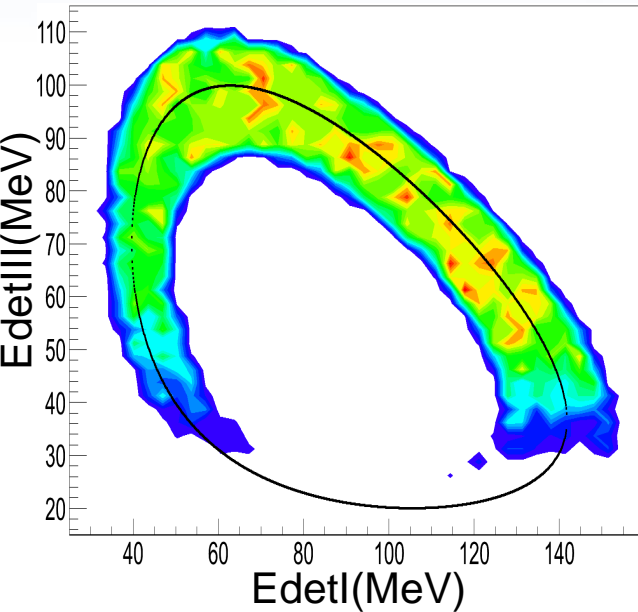


Correlations of the proton energies with the cut on missing mass ( $940 \text{ MeV} \pm 10 \text{ MeV}$ ) of deuteron energy 300 MeV.

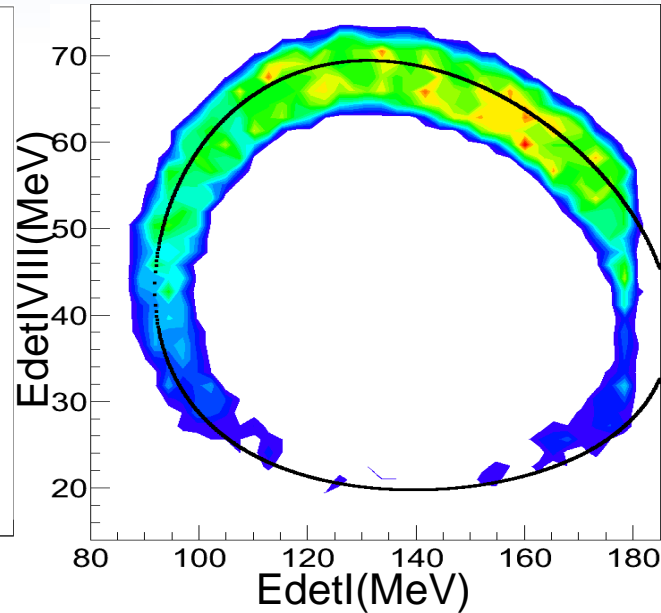
# The deuteron energy 400 MeV.

**DSS** structure  
deuteron

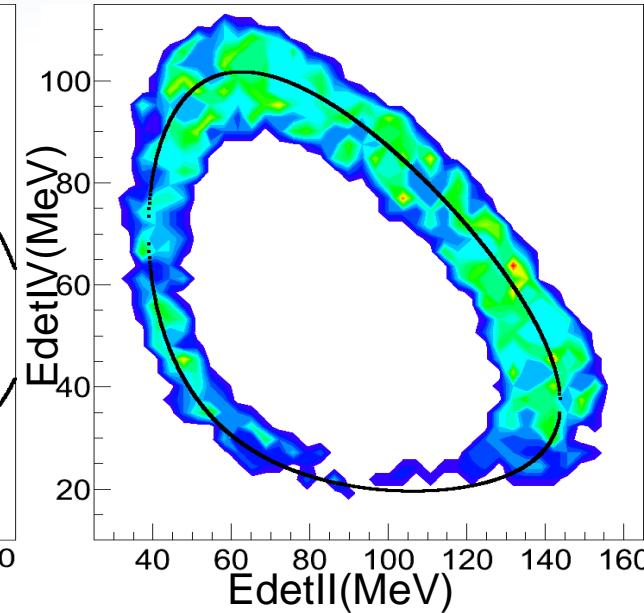
$$\Theta_1 = 25^\circ, \Theta_3 = 33.7^\circ, \\ \varphi_{13} = 44.6^\circ$$



$$\Theta_1 = 25.2^\circ, \Theta_8 = 53.6^\circ, \\ \varphi_{18} = 135.5^\circ$$



$$\Theta_2 = 25^\circ, \Theta_4 = 33.7^\circ, \\ \varphi_{24} = 46.5^\circ$$

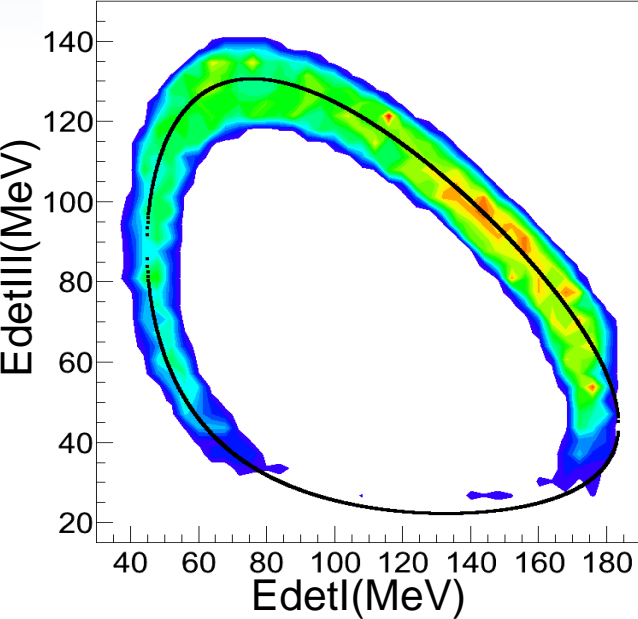


Correlations of the proton energies with the cut on missing mass ( $940\text{MeV} \pm 10\text{MeV}$ ) of deuteron energy 400 MeV.

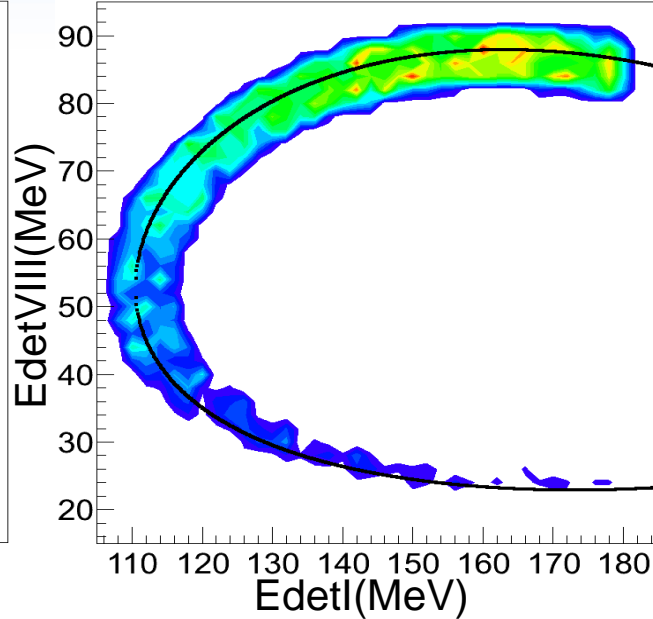
# The deuteron energy 500 MeV.

**DSS** structure  
with  
deuteron

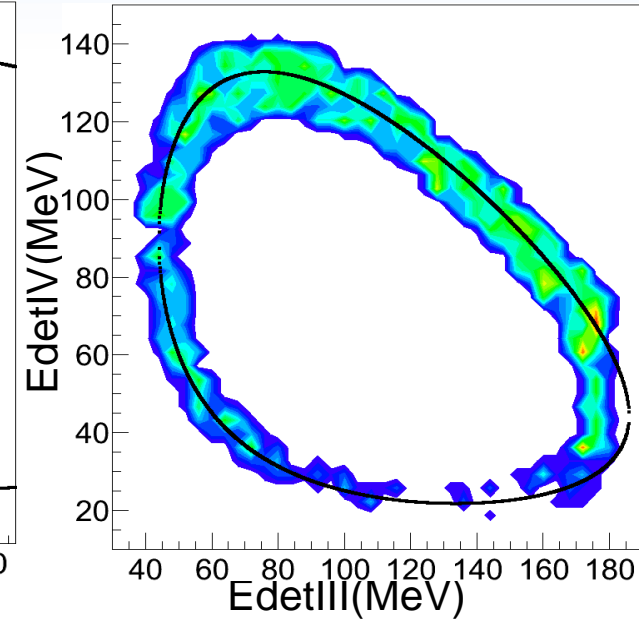
$$\Theta_1 = 24.7^\circ, \Theta_3 = 33.3^\circ, \\ \varphi_{13} = 44.6^\circ$$



$$\Theta_1 = 24.7^\circ, \Theta_8 = 53.3^\circ, \\ \varphi_{18} = 135.4^\circ$$



$$\Theta_2 = 24.7^\circ, \Theta_4 = 33.3^\circ, \\ \varphi_{24} = 46.5^\circ$$



Correlations of the proton energies with the cut on missing mass ( $940\text{MeV} \pm 10\text{MeV}$ ) of deuteron energy 500 MeV.

# Conclusion.



- The preliminary results for  $dp \rightarrow ppn$  reaction at 300-500 MeV for different geometry at Internal Target Station at Nuclotron are obtained.
- The procedure of selection of events relating to  $dp$  – breakup reaction is established.
- The setup on the study of deuteron non-mesonic breakup reaction was put into operation.



**THANK YOU  
FOR THE  
ATTENTION!**