Strokovsky E.A.

Run 54 of the Nuclotron (total duration: ≈1008 hours)

10.02.2017 – 24.03.2017

Run 54 of the Nuclotron (10.02.2017 – 24.03.2017):

1. ***Works with SPI:***
   - ***Data taking (to complete measurements started in the run 53):***
     - ***DSS project***
     - ***ALPOM-2 project***
   - ***Accelerator physics: acceleration of polarized protons in the Nuclotron.***

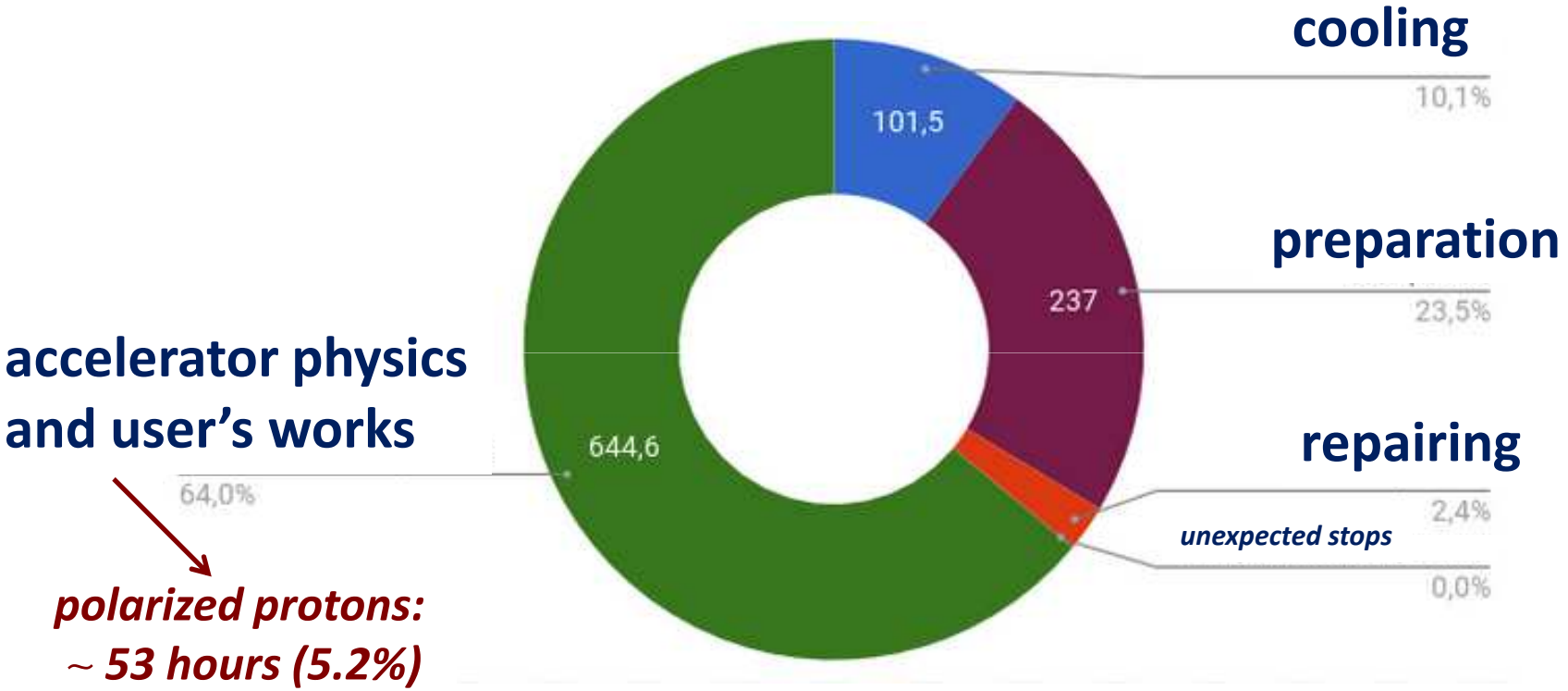
2. ***Works with the Laser Source (nuclear beams: C and Li)***
   - ***Carbon beam***
     - ***BM@N: start of data taking for commissioning (and R&D for other users)***
   - ***7Li beam***
     - ***HyperNIS: start of data taking for commissioning (and R&D for other users)***

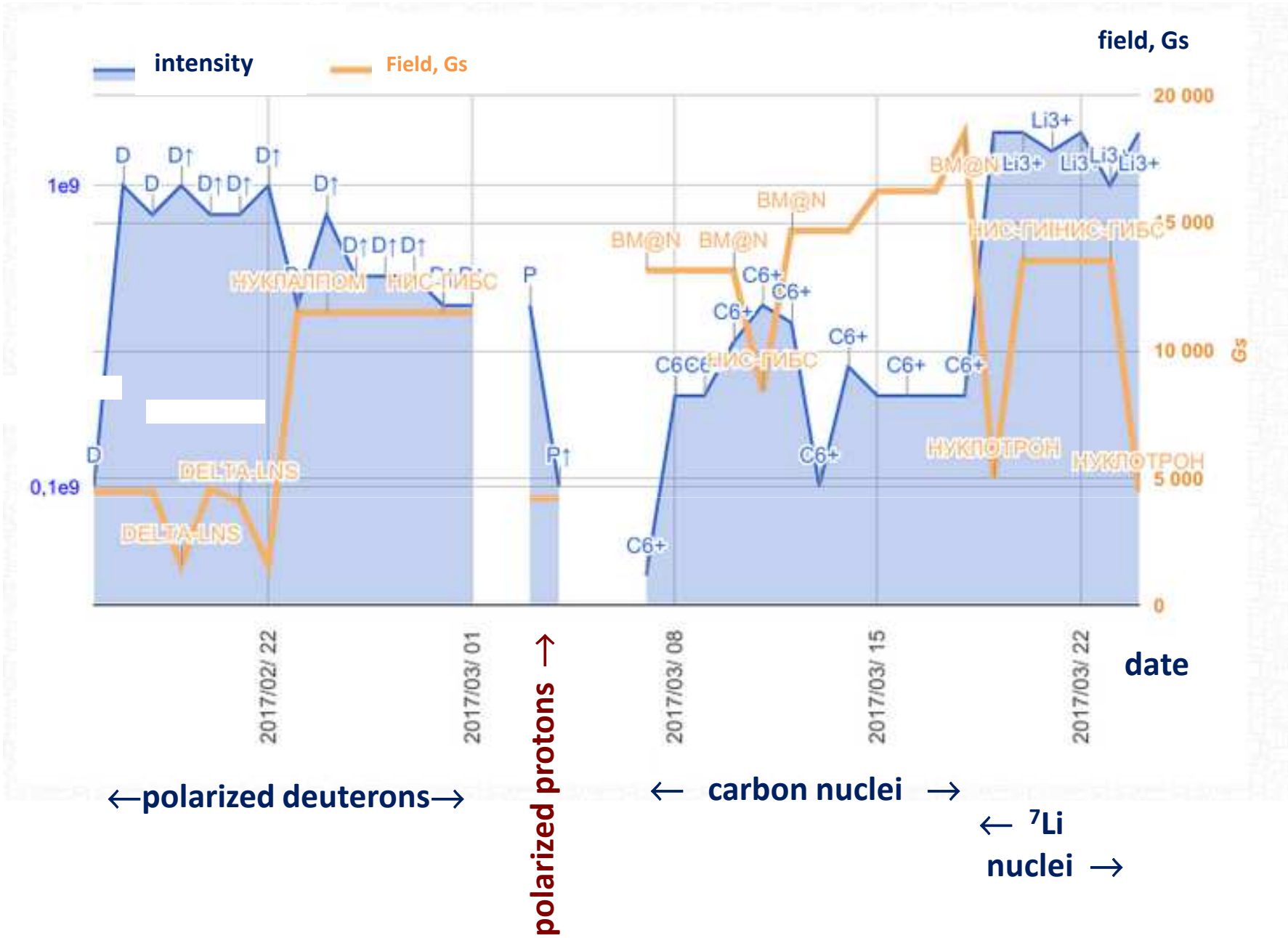
All the works are included in the JINR topical plan.

In parasitic mode: **R&D works for accelerator physics and other approved projects (SCAN-3 etc.) at MARUSYA setup.**

Run 54 of the Nuclotron (10.02.2017 – 24.03.2017)

The total run duration: ≈1008 hours




field, Gs
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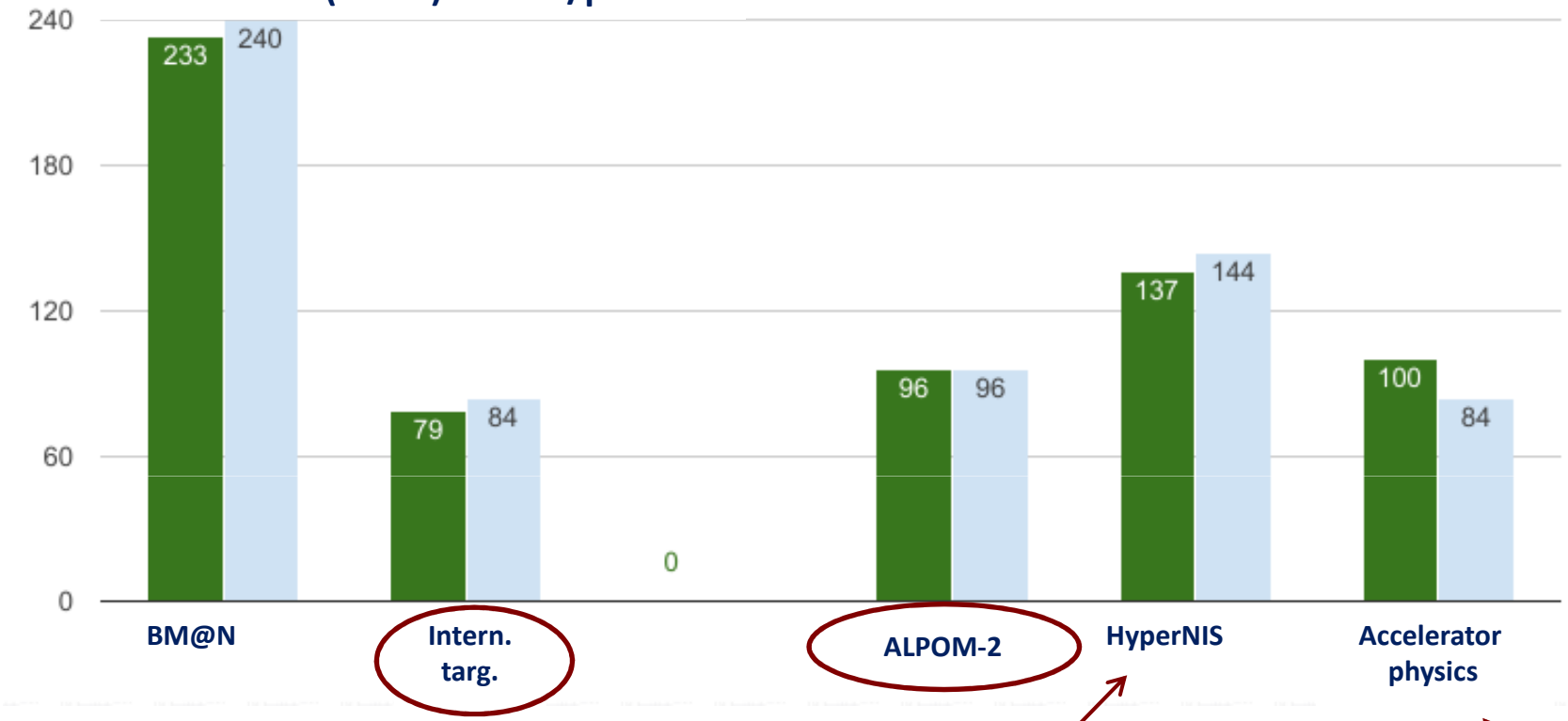
Gs
D
D↑
P
P↑
C6+
Li3+
BM@N
НУКЛАЛПОМ
НИС-ГИБС
DELTA-LNS
НУКЛОТРОН
2017/02/ 22
2017/03/ 01
2017/03/ 08
2017/03/ 15
2017/03/ 22
date
←polarized deuterons→
polarized protons →
← carbon nuclei →
← 7Li nuclei →

Use of beam (hours): in fact/planned



including R&D for other users

including polarized protons and polarimetry of *d* and *p*

In general, users are satisfied by the machine work.

BM@N results will be presented in the talk by M.Kapishin;

results from ALPOM-2 and DSS projects will be presented at the DSPIN-2017 Conference;

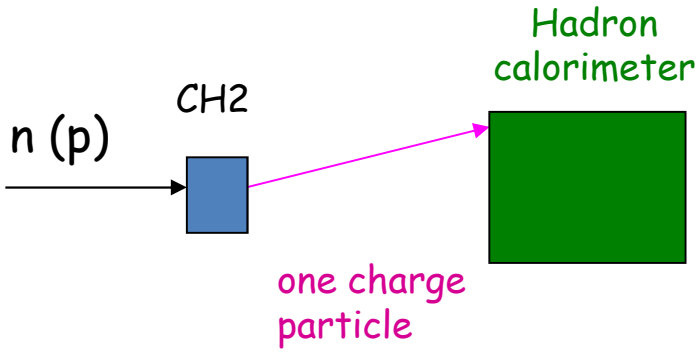
Some results about beam polarization (in the run 54): few next slides.

(all the data are still preliminary, data analysis is going on)

ALPOM-2 in runs 53 and 54:

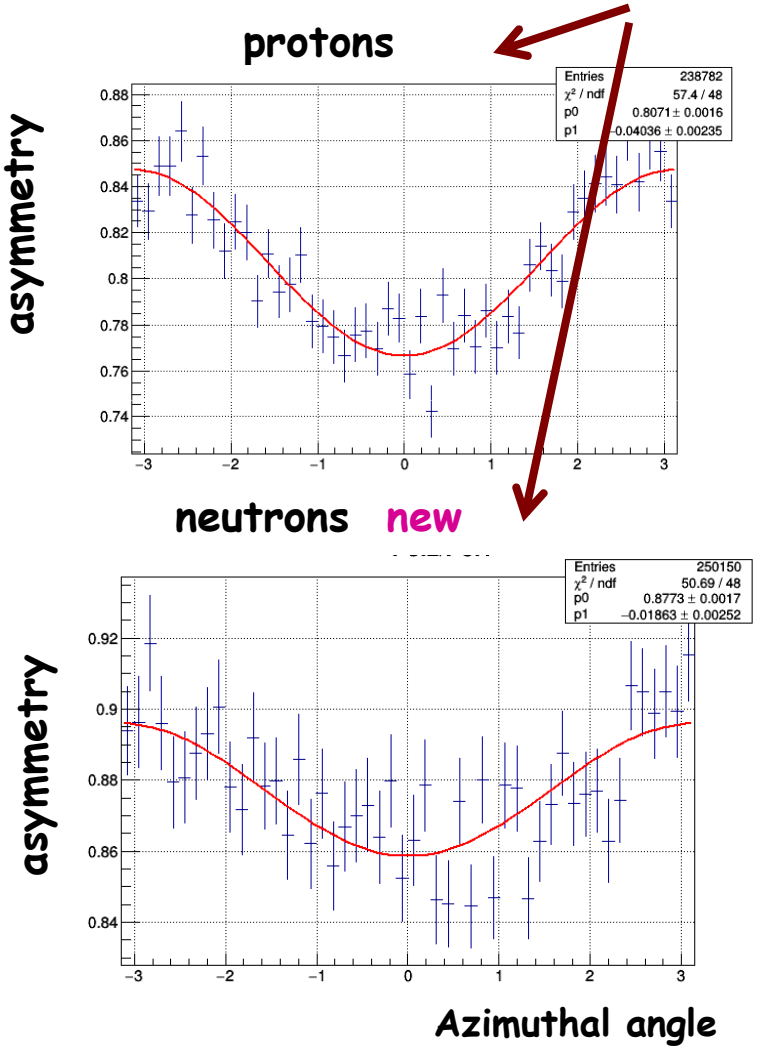
reminder *(from N.M.Piskunov)*

Measurement of analyzing powers for the reaction p + CH2 up to 7.5 GeV/c and n + CH up to 4.5 GeV/c at the Nuclotron



JINR-Slovakia-USA-France-United Kingdom

(From the run 53)



(From N.M.Piskunov)

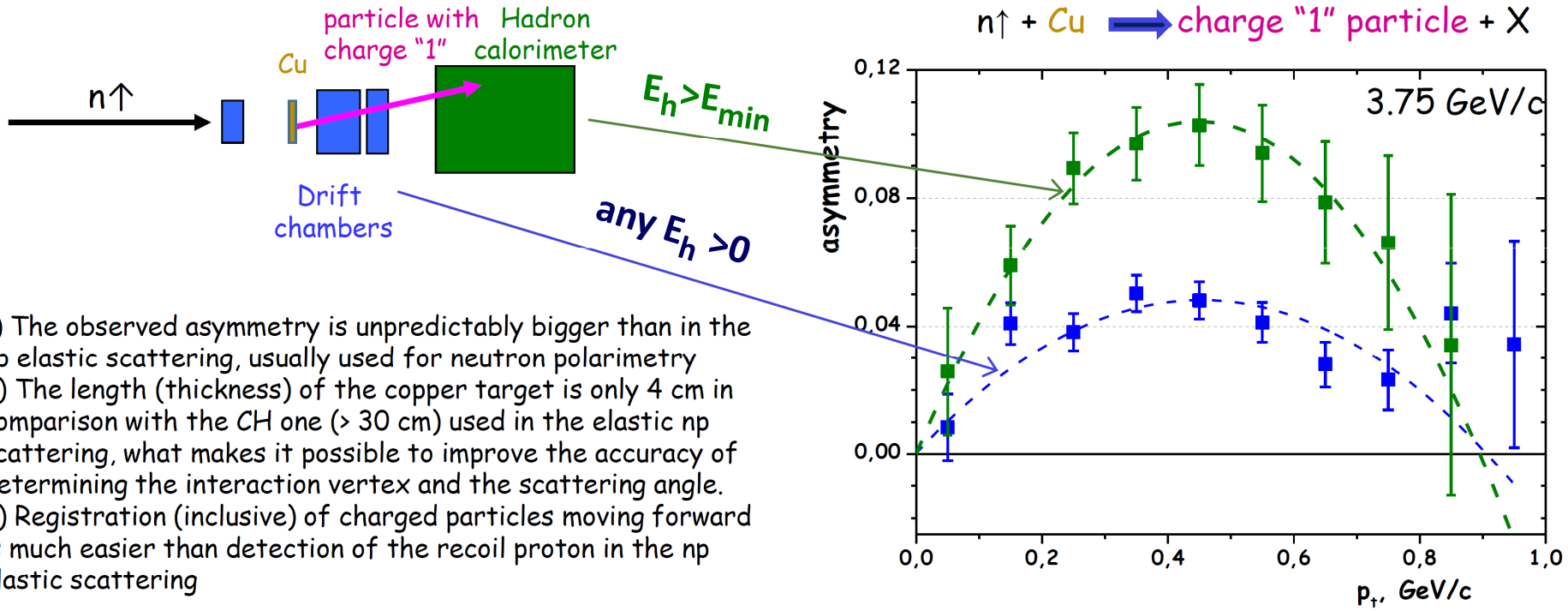
ALPOM-2 in the run 54:

new

unique result, observed at first time in the world:

Measurement of analyzing powers for the reaction p + CH2 up to 7.5 GeV/c and n + CH up to 4.5 GeV/c at the Nuclotron (ALPOM2 proposal)

JINR-Slovakia-USA-France-United Kingdom



1) The observed asymmetry is unpredictably bigger than in the np elastic scattering, usually used for neutron polarimetry
2) The length (thickness) of the copper target is only 4 cm in comparison with the CH one (> 30 cm) used in the elastic np scattering, what makes it possible to improve the accuracy of determining the interaction vertex and the scattering angle.
3) Registration (inclusive) of charged particles moving forward is much easier than detection of the recoil proton in the np elastic scattering

The inverse reaction p+Cu (W), with detection of a neutron in the forward direction by a hadron calorimeter, can be used for measurements of the proton polarization at the NICA collider.

SPI performance for deuterons was investigated. In particlular, the tuning of the SPI in the "tensor" mode was studied (using polarimetry at the Internal Target Station for monitoring of the tensor polarization of deuterons) and value of Pzz ≈ -1.5 was observed.

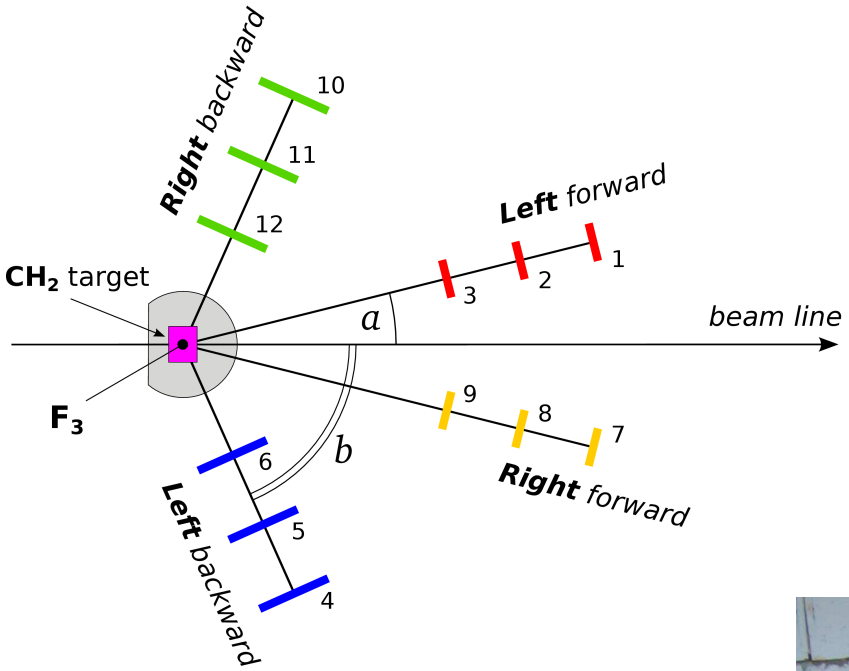
The capability of the Nuclotron to accelerate polarized protons was investigated at first time in JINR.

Polarization of the internal beam of polarized protons was measured at 500 MeV.

Polarimeter at the extracted beam (F3 focus):
Polarization of extracted polarized protons was seen at the level of |P|≈(0.1÷0.15) at T_p = 1 and 2 GeV (kinetic energy) (very preliminary estimation!).

Polarimeter at the extracted beam (F3 focus)

reminder



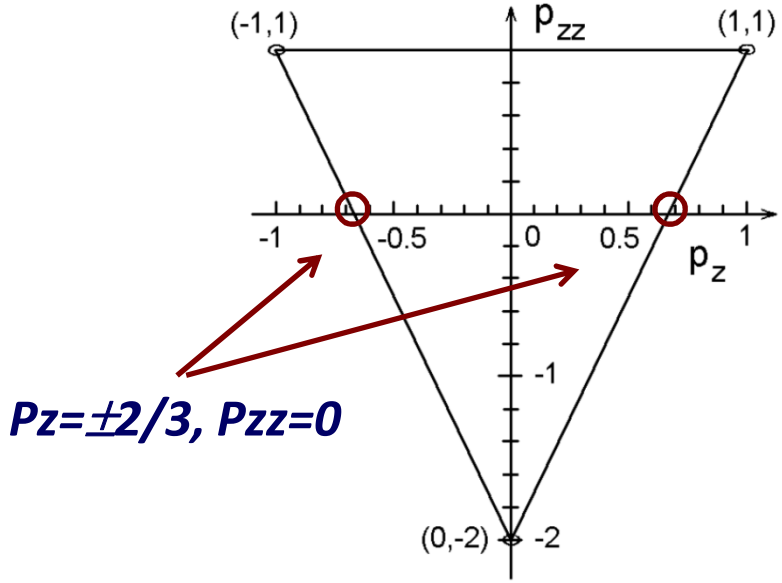
beam

Polarimeter at the extracted beam (F3 focus)

Deuteron beam momentum: 7.5 GeV/c

(preliminary, Nuclotron run 54)

RUNs	Tar	$P_z(+)$	$P_z(-)$
35–62	CH_2	$+0.642 \pm 0.008$	-0.508 ± 0.007
63–69	CH_2	$+0.644 \pm 0.011$	-0.497 ± 0.009
71–78	CH_2	$+0.656 \pm 0.012$	-0.519 ± 0.01
80–89	CH_2	$+0.648 \pm 0.011$	-0.522 ± 0.009
90–141	CH_2	$+0.632 \pm 0.008$	-0.515 ± 0.007
152–164	CH_2	$+0.746 \pm 0.01$	-0.567 ± 0.009

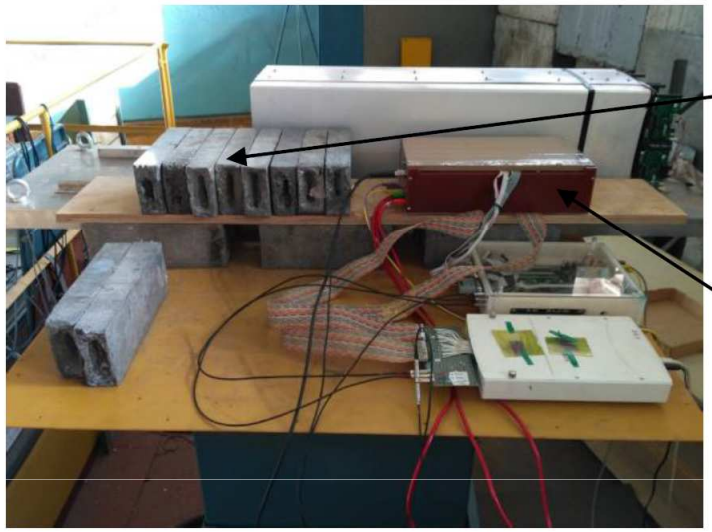


Pz=±2/3, Pzz=0

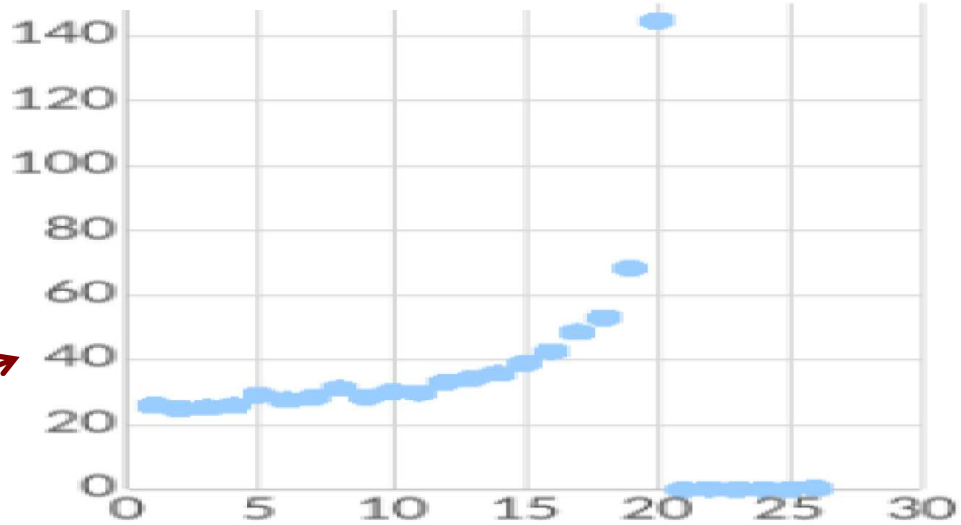
Few R&D results

"NUCLEON-2" project: tests of the Si-Calorimeter prototype (26 layers, thickness of the layer ≈1 mm)

Carbon beam, T≈2 GeV/nucl.



Signal amplitude (mV) in the layer

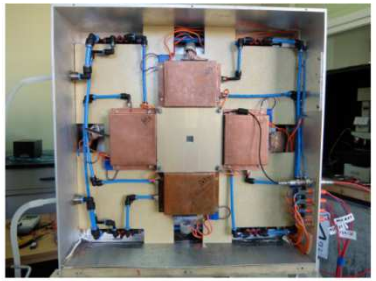


Example of event with detected Bragg peak (carbon beam)

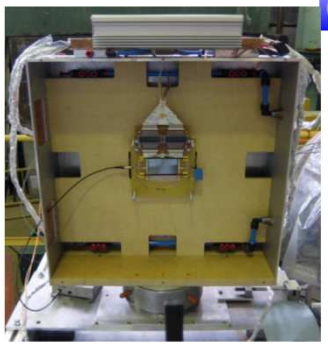
Next beam test of the microstrip detectors (STS) for BM@N and CBM

Test setup

- One STS test station
- Trigger system based on two scintillators counters
- 3 FEBs with nXYTER v.2.0 ASIC
- SysCore v.2 based readout
- Online Analysis based on DABC & Go4



Test station with "baby" sensor



Test station with CBM06C4-DM

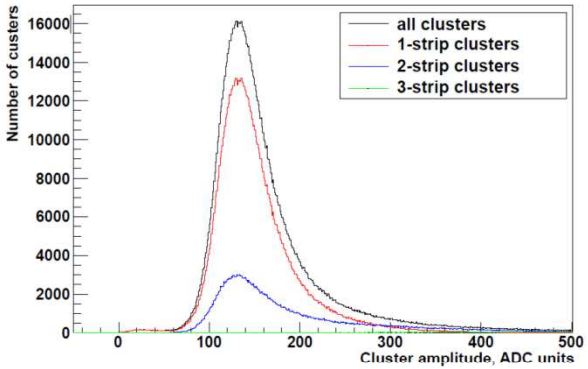
Two types of demonstrators were tested:

- With "baby" sensor Hamamatsu
- With CBM06C4-DM by CiS

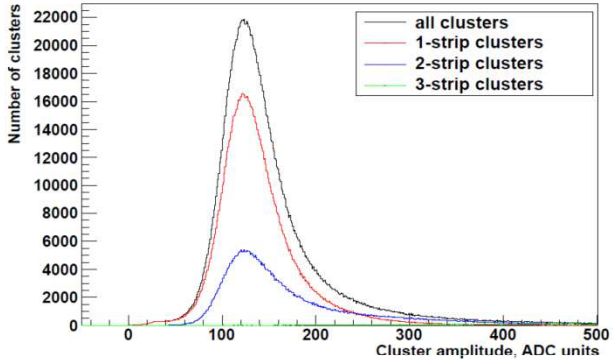
red – p-side
blue – n-side

Next beam test of the microstrip detectors (STS) for BM@N and CBM

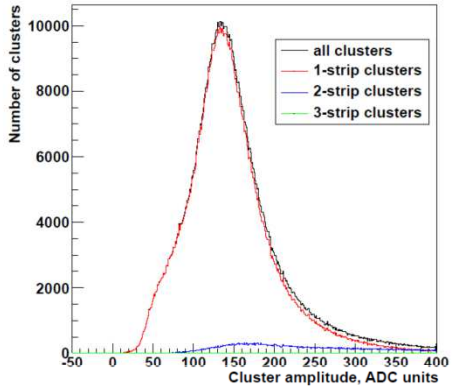
Clusters amplitudes measured with the *d* beam



Clusters amplitudes on the **P side** of baby sensor



Clusters amplitudes on the **N side** of baby sensor

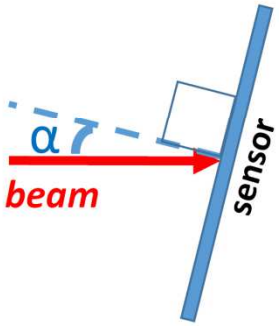


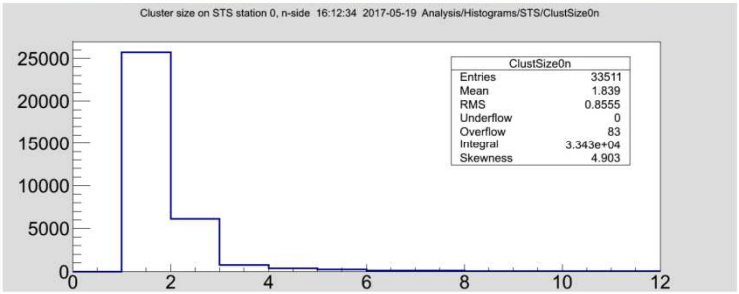
Clusters amplitudes on the **P side** of CBM06C4-DM sensor

Areas with no masked and noisy channels was selected.
Coincidence with trigger was applied

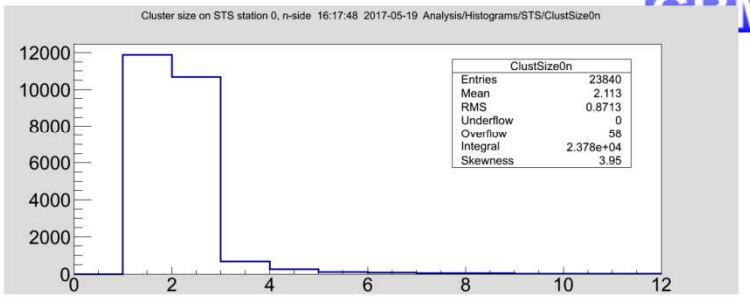
Deficiency of 2-strip clusters for the CBM06C4-DM is due to high value of comp. threshold (reg 18 val 42)

Cluster size dependence on the angle

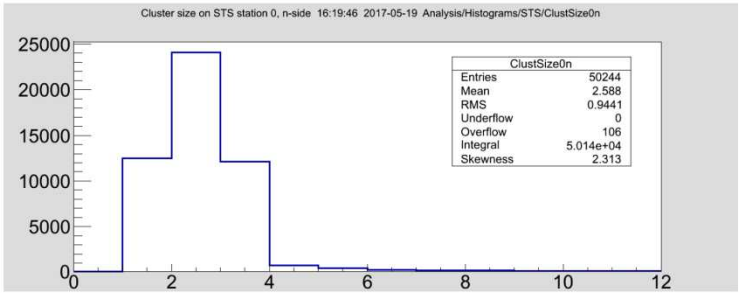




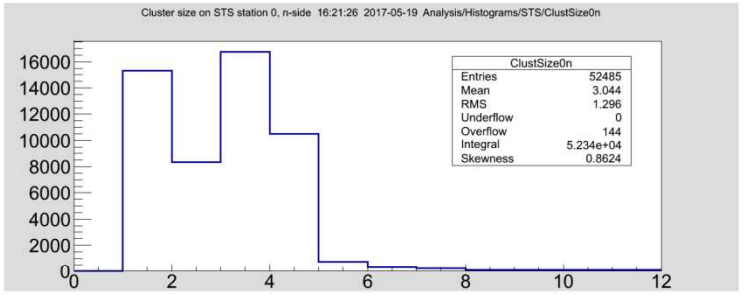
$Cluster\ size\ for\ \alpha = 0^{\circ}$



$Cluster\ size\ for\ \alpha = 9^{\circ}$



$Cluster\ size\ for\ \alpha = 19^{\circ}$



$Cluster\ size\ for\ \alpha = 27^{\circ}$

• New physical results were obtained, important for intermediate energy polarimetry of neutrons (above pion production threshold) .

• JINR has restored (in 2016, run 53) polarized deuteron beam with kinetic energies up to 5 GeV/nucleon;

❑ ***now, at first time, JINR has also the relativistic polarized proton beam, accelerated in the Nuclotron.***

This is the most important result of the run 54 for external users, taking into account that

accelerated polarized proton beams of intermediate energies do not exist at other world centers at present.

❖ ***The acceleration of polarized protons in the Nuclotron is very important result for the NICA project as well…***