The BM@N experiment at JINR: status and physics program
Outline

1. Motivation
2. Detector geometry
   ✓ Spatial resolution: MC vs Exp.
   ✓ Momentum resolution: MC vs Exp.
   ✓ Λ reconstruction: MC vs Exp.
4. Summary & Plans
✓ **In A+A collisions** at Nuclotron energies:
Opening thresholds for strange and multi-strange hyperon production

→ strangeness at threshold

✓ **In p+p, p+n, p+A collisions:**
hadron production in elementary **reactions** and \textit{\textquoteleft}cold\textquoteleft\ **nuclear matter** as \textit{\textquoteleft}reference\textquoteleft\ to pin down nuclear effects
In heavy-ion reactions: production of hypernuclei through coalescence of $\Lambda$ with light fragments enhanced at high baryon densities.

Maximal yield predicted for $\sqrt{s}=4-5A$ GeV (stat. model) (interplay of $\Lambda$ and light nuclei excitation function).

→ BM@N energy range is suited for the search of hypernuclei.
Detector geometry

**BM@N setup:**

- ✓ Central tracker (GEM+Si) inside analyzing magnet to reconstruct AA interactions
- ✓ Outer tracker (DCH, CPC) behind magnet to link central tracks to ToF detectors
- ✓ ToF system based on mRPC and T0 detectors to identify hadrons and light nucleus
- ✓ ZDC calorimeter to measure centrality of AA collisions and form trigger
- ✓ Detectors to form T0, L1 centrality trigger and beam monitors
- ✓ Electromagnetic calorimeter for γ,e+e-

**BM@N advantage:** large aperture magnet (~1 m gap between poles)

- → fill aperture with coordinate detectors which sustain high multiplicities of particles
- → divide detectors for particle identification to “near to magnet” and “far from magnet” to measure particles with low as well as high momentum (p > 1-2 GeV/c)
- → fill distance between magnet and “far” detectors with coordinate detectors
Technical run in December 2016

BM@N set-up used in the deuteron run.

Example of an event reconstruction in the central tracker.
Technical run in December 2016

2 big GEMs

tests of Big GEM

ZDC

Si detector

ECAL

DCH-1

ToF-400

On behalf of the BM@N collaboration  VBLHEP, JINR, Dubna, Russia  ICPPA-2017
Data set

**Magnetic field:** 1600 A (0.79 T)

**Events:** 7M (0.76M with Λ candidates)

**Beam / Target:** d / Cu, $E_{kin} = 4$ AGeV

**Beam / Target:** d / CH$_2$, $E_{kin} = 4$ AGeV

**Beam / Target:** d / C, $E_{kin} = 4$ AGeV

**Gas in GEM:** Ar + Isobuthan

**GEM position from target:** 51-86-116-151-181-216 cm
GEM hit residuals without mag. field

✓ X residual of 2-nd station for straight lines (tracks) defined by hit combinations on stations 1 and 3.
✓ An assumption of the same resolution of all three stations leads from the 156 um residual to $\sigma = 127$ um resolution. ($\sigma_x = \sigma_\Delta / \sqrt{1.5} = 156/ \sqrt{1.5} = 127$ um)
✓ Averaged positions of deuteron beam with $E_{kin} = 4\ \text{AGeV}$ reconstructed in 6 GEM planes at different values of magnetic field.

✓ Opposite electric field direction in consecutive GEM planes.
GEM hit residuals in mag. Field 0.79 T

GEM hit residuals for exp. data.

GEM hit residuals for MC simulation with Garfield parametrization.

Mag. field 0.79 T
Gas mixture  Ar+ Isobuthan

On behalf of the BM@N collaboration  VBLHEP, JINR, Dubna, Russia  ICPPA-2017
Momentum resolution: Exp. vs MC

✓ Momentum resolution for deuteron beam of 9.7 GeV/c ~9%.

✓ Momentum resolution for proton spectators with momentum of 4.85 GeV ~6%.

✓ Momentum resolution from MC as function of particle momentum.

✓ MC results reproduce exp. data for spectator protons and deuteron beam.
**Signal event topology defined selection criteria:**

- relatively large distance of closest approach (DCA) to primary vertex of decay products
- small track-to-track separation in decay vertex
- relatively large decay length of mother particle

Λ signal width of 3 MeV and background level is reproduced by MC simulation.

**Event topology:**

- PV – primary vertex
- \(V_0\) – vertex of hyperon decay
- dca – distance of the closest approach
- path – decay length
BM@N experiment is in starting phase of its operation and has recorded first experimental data with deuteron beam of 4 AGeV.

Minimum bias interactions of deuteron beam with different targets were analyzed with aim to reconstruct tracks, primary and secondary vertexes using central GEM tracking detectors.

Spatial, momentum and primary vertex resolution of GEM tracker are reproduced by Monte Carlo simulation.

Signal of Λ-hyperon is reconstructed in proton-pion invariant mass spectrum.

To improve vertex and momentum resolution and reduce background under Λ-hyperon signal, additional planes of GEM detectors and a set of silicon detectors in front of GEM tracking detectors will be implemented.

BM@N set-up will extend continuously to adapt its performance for measurements of interactions of heavier ion beams with targets.
Thank you for attention!
## $K_S^0$ simulation: MC-2015 vs MC-2017

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<thead>
<tr>
<th></th>
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<th>MC-2017</th>
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<td><strong>GEM position from target:</strong></td>
<td>30-45-60-80-100-130 cm</td>
<td>51-86-116-151-181-216 cm</td>
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<td><strong>$K_S^0$:</strong></td>
<td>28229 (gen) / 2500 (rec)</td>
<td>19020 (gen) / 167 (rec)</td>
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<td><strong>Eff. Rec.</strong></td>
<td><strong>8.9%</strong></td>
<td><strong>0.8%</strong></td>
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<td><strong>Magnetic field</strong></td>
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<td>Magnetic field B = <strong>0.7</strong> T</td>
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On behalf of the BM@N collaboration

VBLHEP, JINR, Dubna, Russia

ICPPA-2017
### Λ simulation: MC-2015 vs MC-2017

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<td>Λ: 11933 (gen) / 2359 (rec)</td>
<td>Λ: 43432 (gen) / 1832 (rec)</td>
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<td>Eff. Rec. = 19.8%</td>
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