Simulation of hadron calorimeter for SRC at BM@N

SPEAKER:

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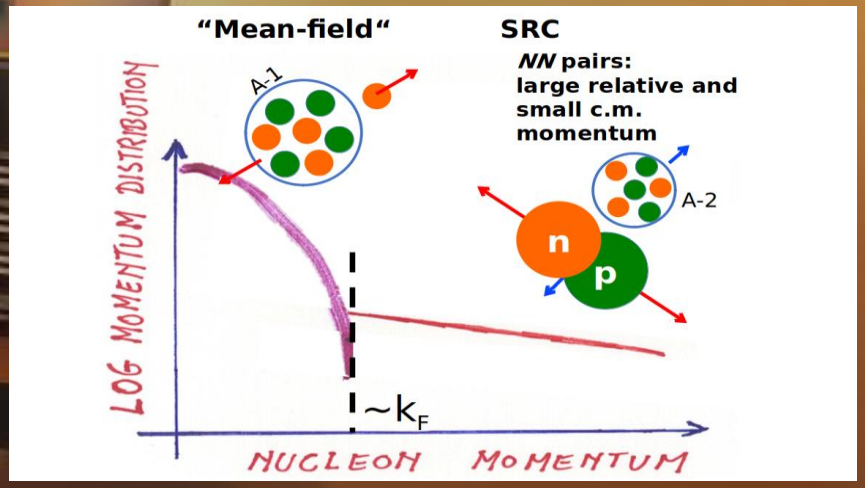
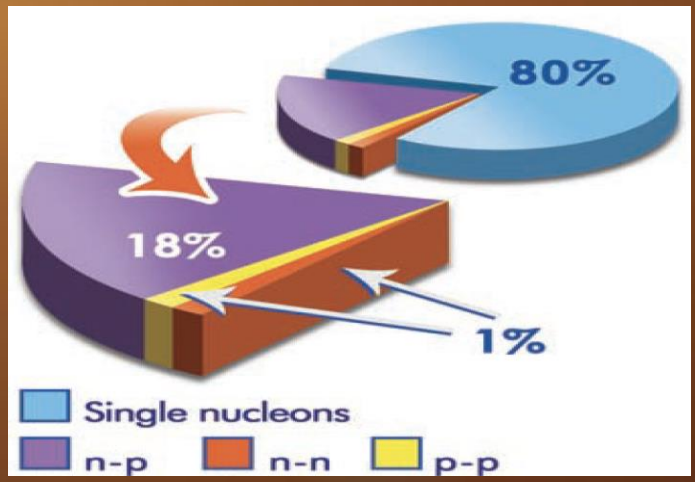
Alushta, 2020

Short Range Correlations (SRC)

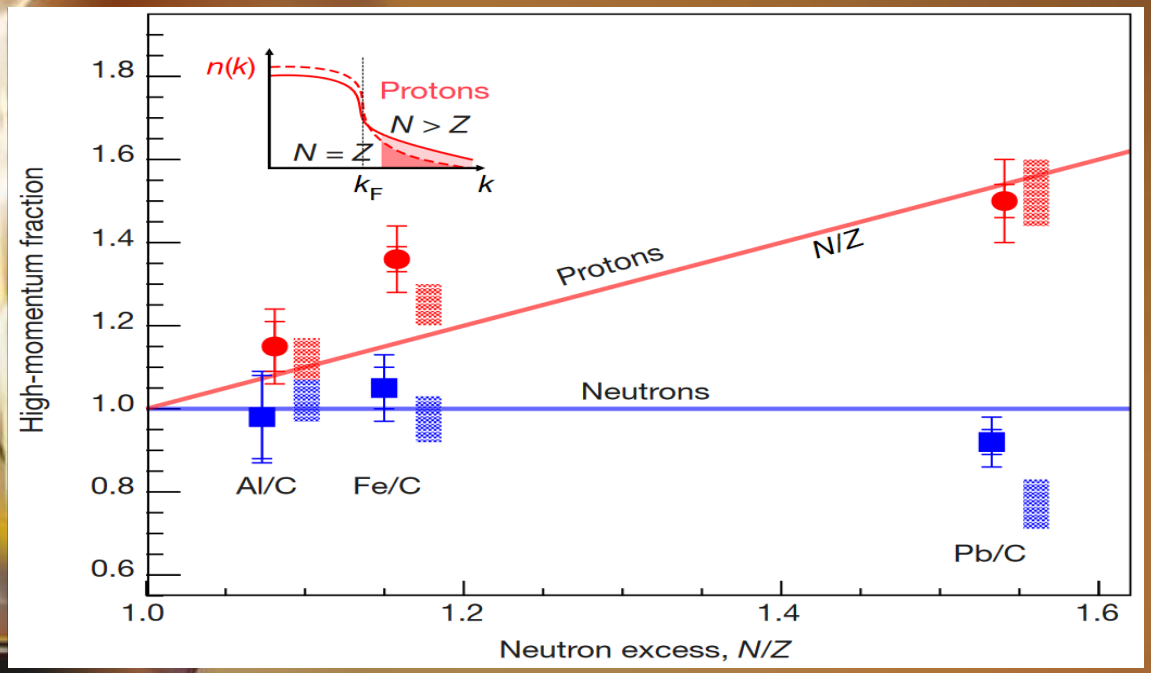
prof. Mark Strickman (born 1949)

prof. Leonid Frankfurt (born 1938)





Consequence of n-p dominance



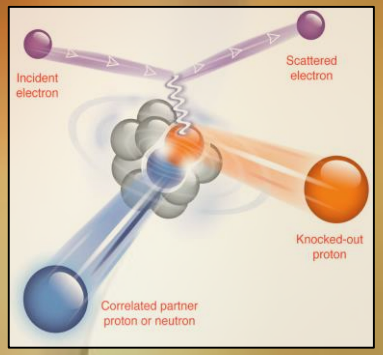
Fraction of correlated protons / neutrons grow / saturate with neutron excess

-> protons “speed up“

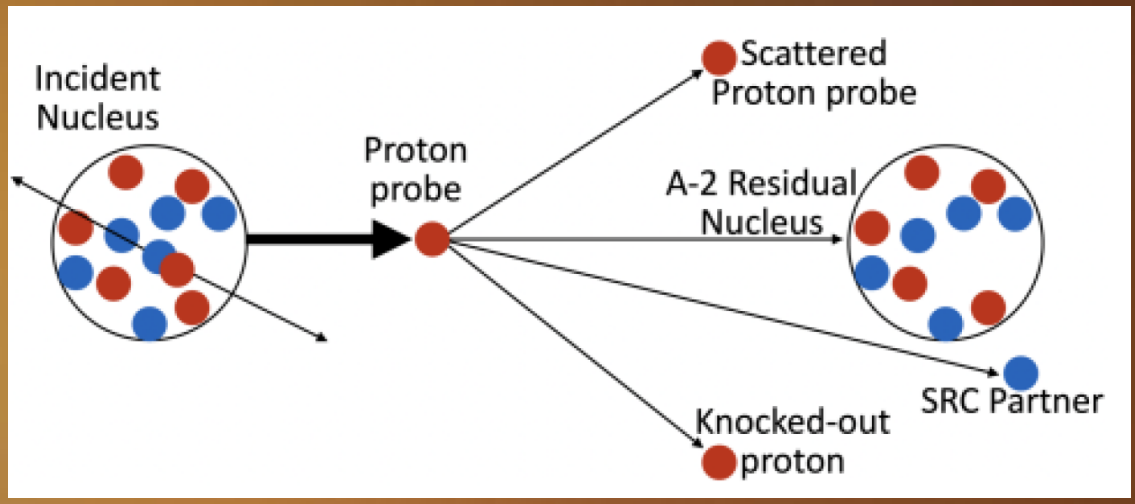
Key to Neutron stars

Inverse kinematics

Normal kinematics



Inverse kinematics



Inverse kinematics

- ✓ higher cross-section
- ✓ p_{miss}, p_{recoil}
- ✓ fragment ID + p_{A-2}

Reaction: *A* (*p*,2*pN*) *A*-2

NICA (Nuclotron based Ion Collider fAcility)

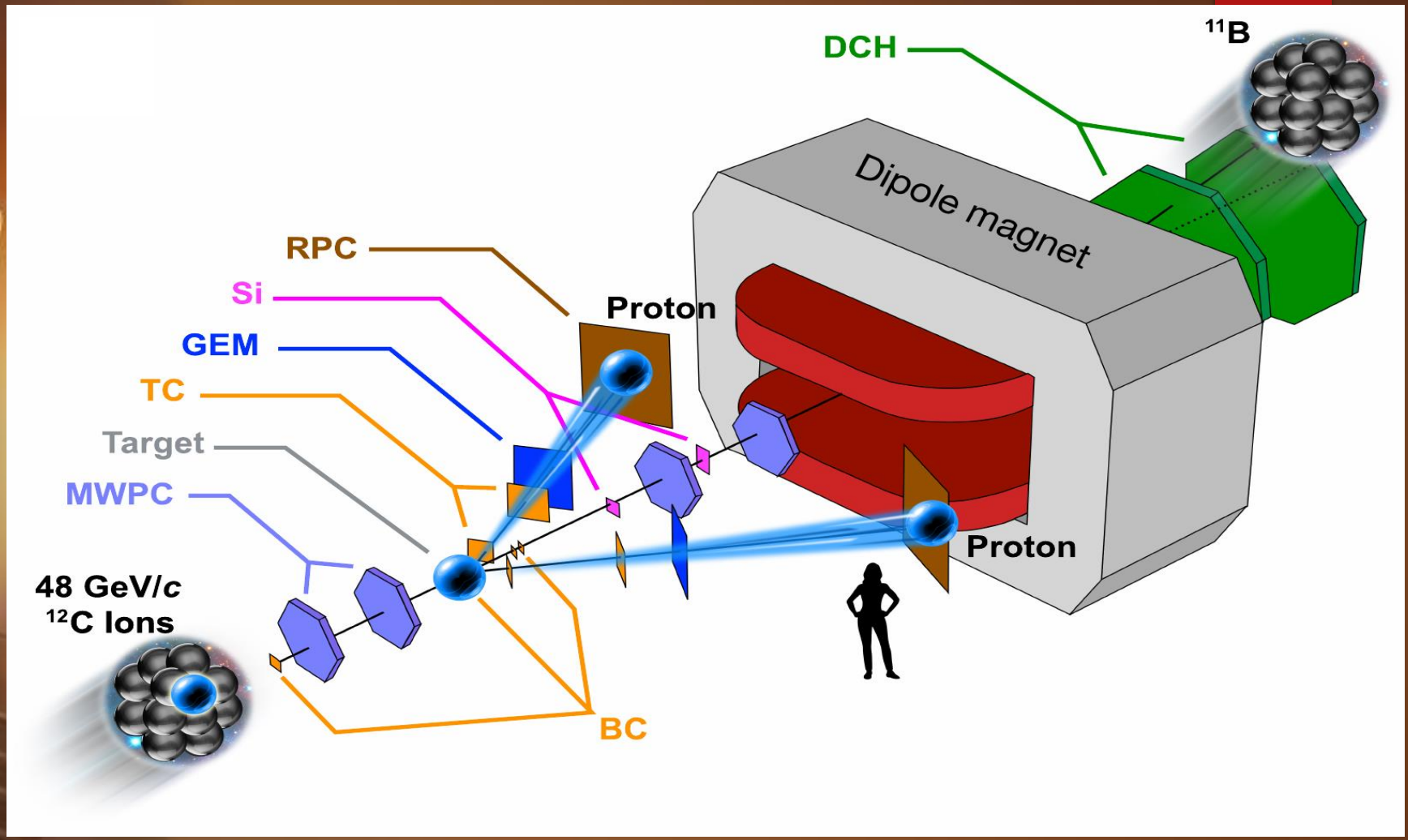
NICA - is a new accelerator complex, which is being created on the basis of JINR (Dubna) with the aim of studying the properties of dense baryonic matter and quark-gluon plasma.

Energy up to 11 GeV / nucleon

BM@N (Baryonic Matter at Nuclotron) is the first active experiment of the NICA complex with a fixed target that studies the production of strange particles in heavy ion collisions at beam energies from 2 to 6 GeV.

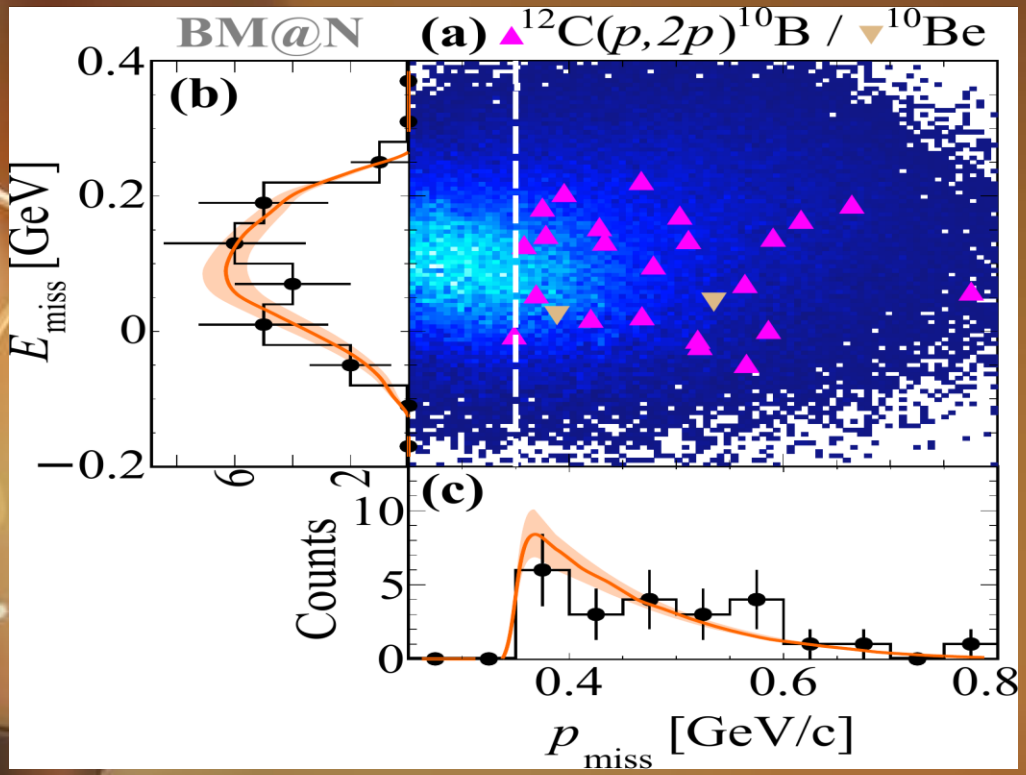
BM@N has been collecting data since 2015.

Experimental setup for SRC at BM@N



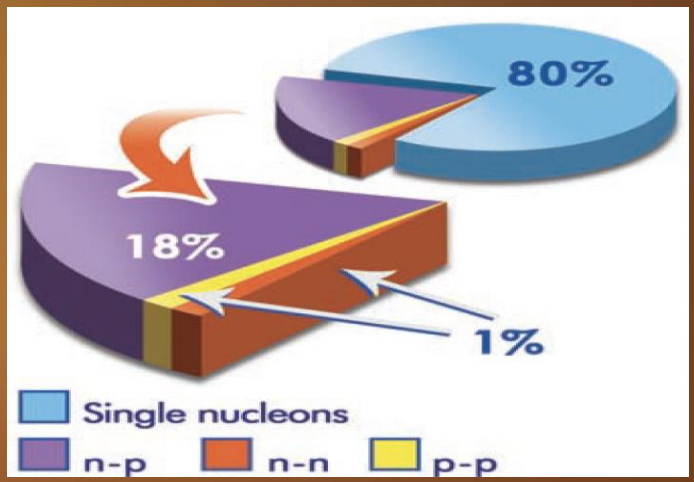
Carbon Beam (4GeV/c/nucleon)
Liquid hydrogen target

Results from first physical run



23 np pairs
2 pp pair

-> *np* dominance



+ proton-proton opening angle
Guided by simulation

Factorization evidence

Factorization of nuclear many-body wave function:

A-2 ←

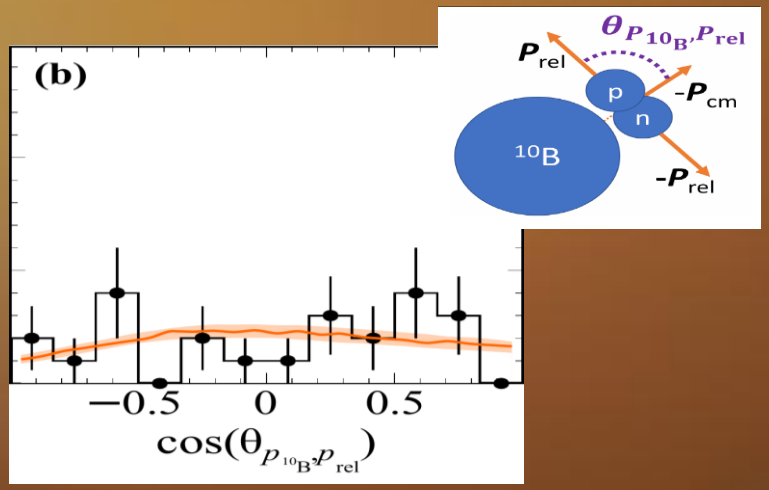
$$n^{A}_{\alpha,NN}(Q,q) = \tilde{C}^{A}_{\alpha,NN}(Q) \times |\tilde{\varphi}^{\alpha}_{NN}(q)|^2$$

universal

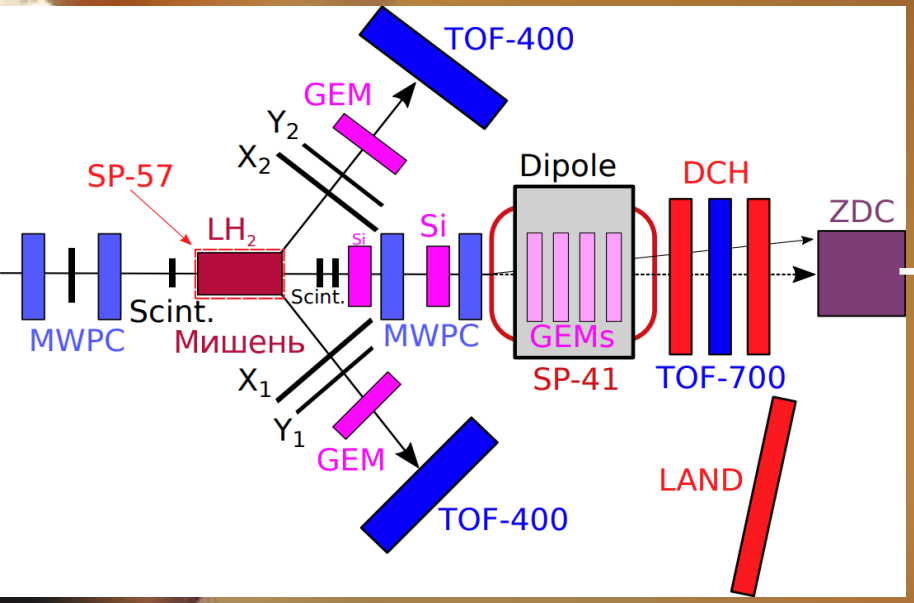
small c.m. motion ~ A-2

strongly correlated pair [universal 2-body]

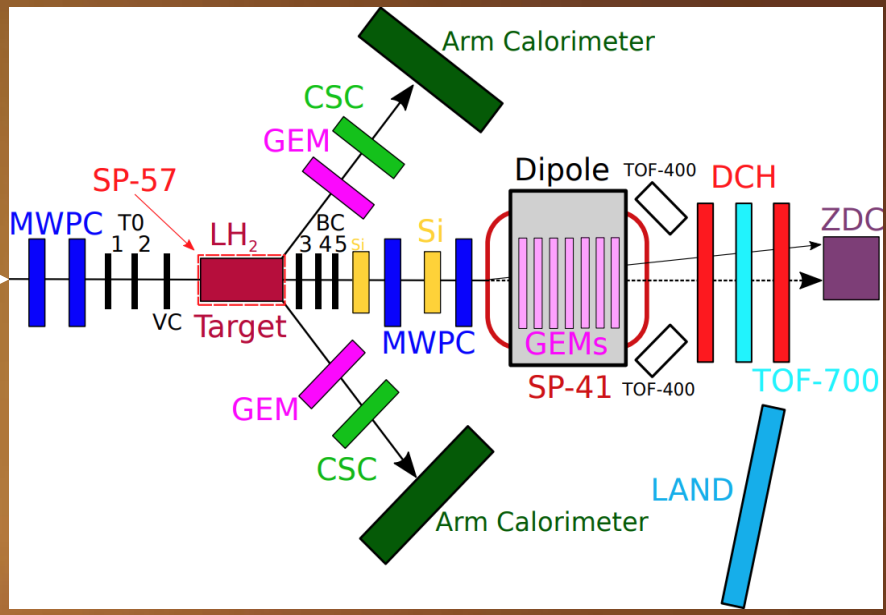
Rooted in theories, e.g. Generaized Contact Formalism



Next run (2021) preparation



2018 configuration



2021 conceptual configuration

Hadron calorimeter

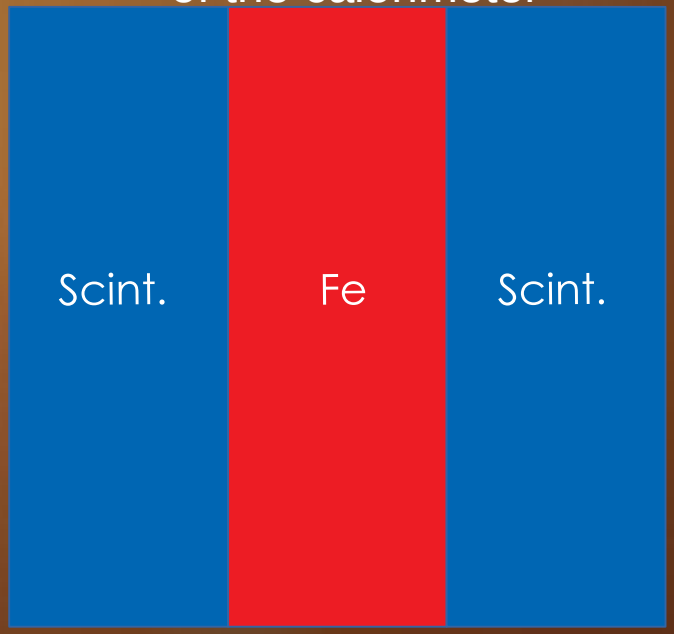
Expected energy of knocked-out protons (2 GeV) =>
Expected velocity of of knocked-out protons (0.9**β)** =>
Expected time of 5m flight of knocked-out protons (18.5 ns).

The main background is pions. One of the tasks of the calorimeter is Proton/Pion separation:

- The first scintillator layer will separate P/Pi by Time of flight. The time resolustion will be about 80ps.

- The second scintillator layer will separate P/Pi with the same velocity by Energy losses

Conceptual design of the calorimeter

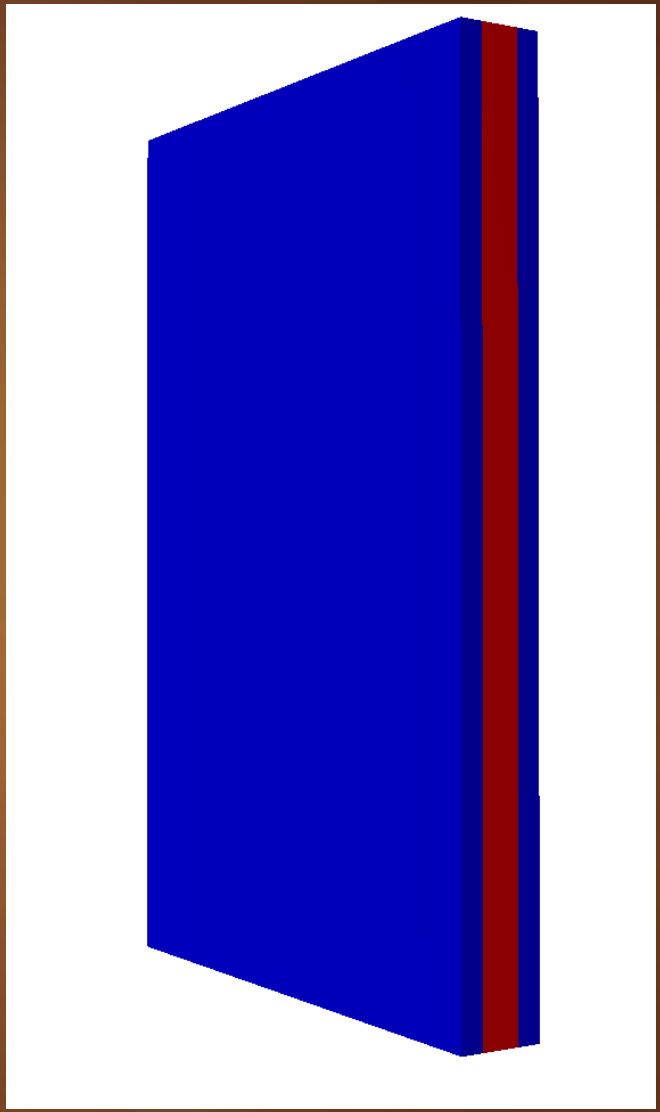


Simulation

- **Input data**

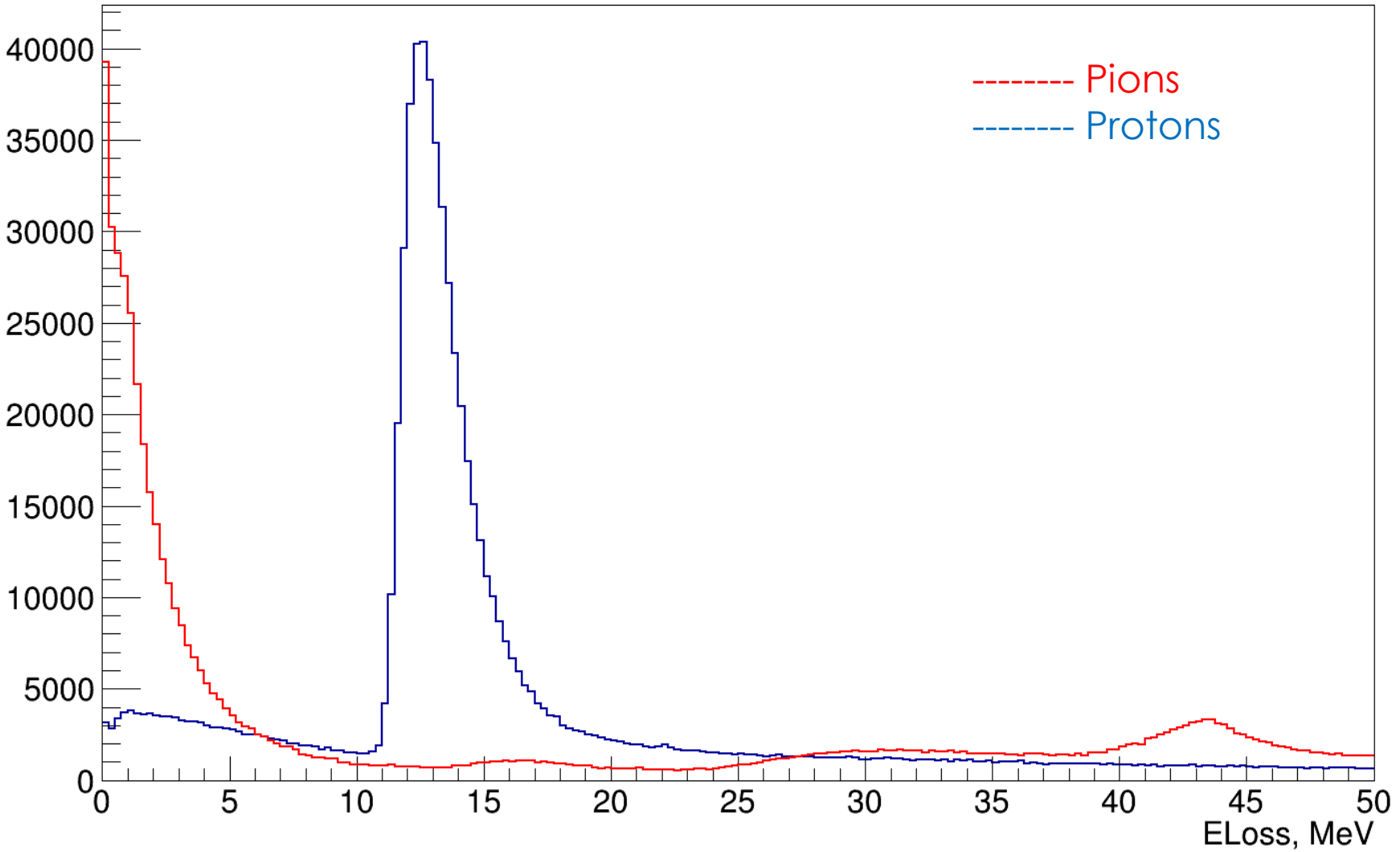
- **Geant4 simulation parameters:**
- Protons (2 GeV) or pions (0.3 GeV) (the same velocity)
- Beam is perpendicular to XY calorimeter plane

- **Geometry parameters:**
- Calorimeter size: 150*230*22 cm^3
- 2 layers of iron and 3 layers of scintillator
- Iron layer thickness: 10 cm
- Scintillator layer thickness: 6 cm



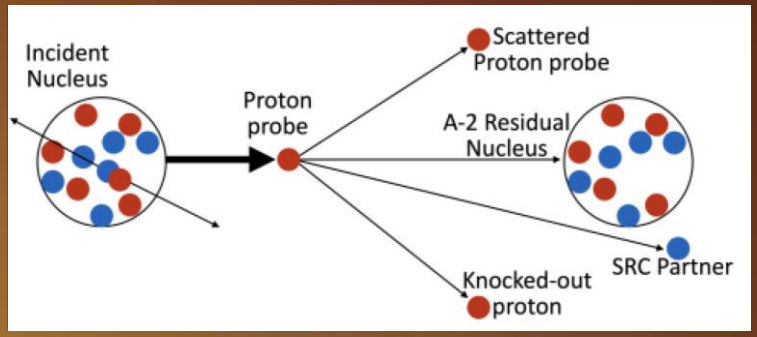
Calorimeter geometry

P/Pi separation in the 2nd scintillator layer

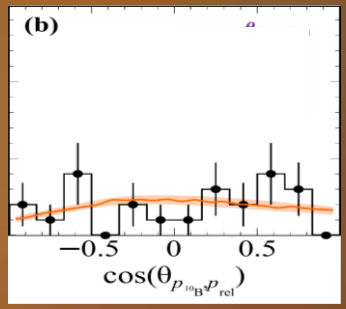


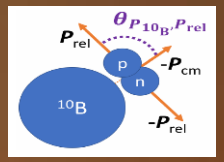
Conclusion

-The studing SRC at BM@N opens possibilities for new experiments by internal nuclear structure studing.



-The results of first physics run gives experimental evidance for factorization of nuclear many-body wave function.





-The possibility of P/Pi separation using Hadron calorimeter was shown