NUCLEAR EMULSIONS DETECTOR: PROJECTS FOR NEW MEASUREMENTS



A. Alexandrov, V. Boccia, A. Di Crescenzo, G. De Lellis, G. Galati, A. Iuliano, <u>A. Lauria</u>, M. C. Montesi, A. Pastore, V. Tioukov

Università di Napoli "Federico II", INFN Napoli, Università di Bari, INFN Bari

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BEAM Target	¹⁶ O 200 MeV/n	¹⁶ O 400 MeV/n	¹² C 700 MeV/n
Carbon	GSI1	GSI3	GSI5
Polyethyle ne	GSI2	GSI4	GSI6

- Complete the acquisition for the cross section measurements with ¹²C at 200 and 400 MeV/n on double target (C and C₂H₄)
 - \bullet Same geometry adopted in 2019 for ^{16}O at 200 and 400 MeV/n at GSI
 - Where and when: at CNAO, in 2023

- 2) Study of the **direct kinematic geometry** with **protons up to 250 MeV** on nuclear nanometric emulsions
 - Where and when: at CNAO, Autumn 2022

¹²C beam: The emulsion spectrometer structure



¹²C beam: experimental set-up





¹²C beam: The emulsion chamber



same boxes if possible (depending on the film size) Emulsions chamber:
plastic material (ABS)
3D printer
0.8-1.0 cm thickness
5x5 cm² window

▶ 14.1x21.0-23.0 x11.6 cm³

MonteCarlo simulations

- Further MC simulations will be done to characterize the interaction of ¹²C beam on C and C₂H₄ targets
- Study the angolar and energy distribution of fragments to optimise the number of layers in each section

Measurements with direct kinematic approach: the idea

- The main experimental difficulty for a direct measurement of target fragmentation induced by a proton beam is the short range of produced fragments (≤100 µm)
- In usual configurations, so short fragments do not exit the target: we propose to use the Emulsion Cloud Chamber (ECC) technique, in a configuration where the target and the tracking device coincide
- We will use a novel kind of nuclear emulsion, called Nano Imaging Tracker (NIT^{(1),(2)}), with grains at the nanometric scale that allows us to detect path lengths shorter than 100 nm
- The project has been proposed for a PRIN by three research units: Bari, Naples, INFN (LNGS)

(1) Asada, T. et al. The development of a super-fine-grained nuclear emulsion. Prog. Theor. Exp. Phys. 6, (2017)
 (2) Alexandrov, A. et al. Super-resolution high-speed optical microscopy for fully automated readout of metallic nanoparticles. Sci. Reports 10, 18773 (2020)

Direct kinematic approach: the experimental set up



Direct kinematic approach: preliminary MC simulation



Preliminary MC simulation: fragment's track lengths



- Difficulty in producing (payment) and delivering emulsions from Russia
- Emulsions for Carbon exposure at CNAO to be produced in Nagoya (Japan), need to discuss with Sato-san and the group
- NIT emulsions (about 1.2 m²) will be produced at the Gran Sasso facility by ourselves

Dark room facility at Gran Sasso underground laboratory



THANKS