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# Preliminary Progress of Dark Matter Exploration with RPCs-based Muon Scattering Imaging System

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## Abstract

Evidence of dark matter's existence has been found through cosmological observations. However, there is no experiment which has directly detected any form of dark matter particle until now. Since muons are one of the competitive candidates for dark matter research, we plan to use the free cosmic-ray muons interacting with dark matter, to trace possible interaction between dark matter and muons, as illustrated in Fig. 1. When the possible interaction occurs, the information from this scattering can be recorded by muon scattering tomography system, allowing us to infer parameters of dark matter.

## Preliminary Result

Resistive Plate Chamber(RPC) is a gas detector, which is sensitive to muons. So we built a muon tomography system with a sensitive volume of 203mm*203mm*500mm using 4 RPCs, the structure of which is shown as Fig. 2. We conducted a experiment by our muon scattering tomography system for two months, capturing the angular distribution of cosmic ray muon scattering in air. Simultaneously, we created a GEANT4 simulation of our system with the same size, material, and other settings, and simulated the cosmic ray muon scattering in air. A comparison (as shown in Fig. 3) showed more large-angle scattering events in the experiment than those in the simulation. This suggests that muon scattering processes in space and materials still require further analysis.

## Future Plan

Next, we plan to eliminate the interference from air scattering for dark matter exploration. We will add vacuum chambers between each RPC (as shown in Fig. 4) to upgrade the detection system to vacuum mode. In the future, we aim to further reduce background to enhance the detection sensitivity of this method.

**Please stay tuned for more details on Yu Xudong's report on Sunday morning!**

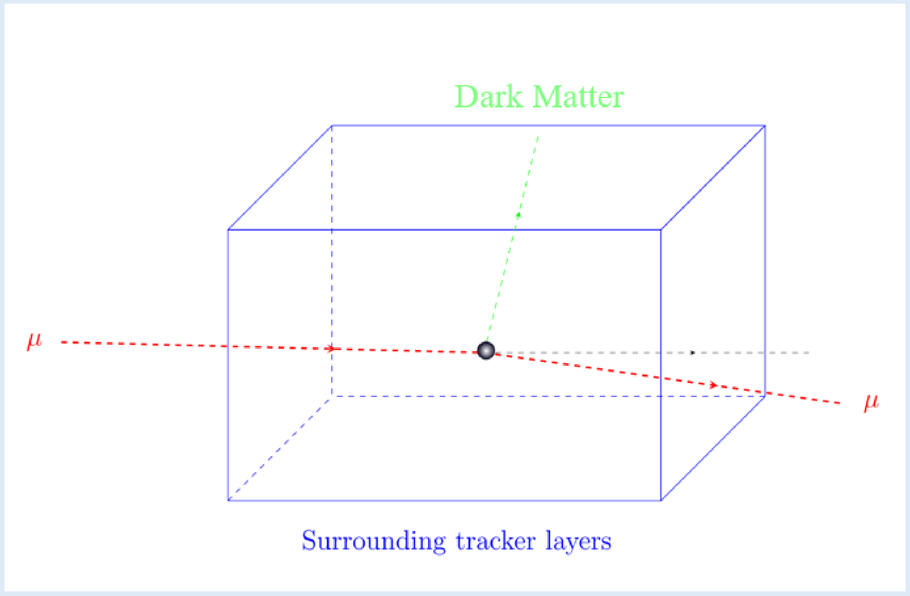


Fig. 1. Scattering Model between Muon and Dark Matter[1]

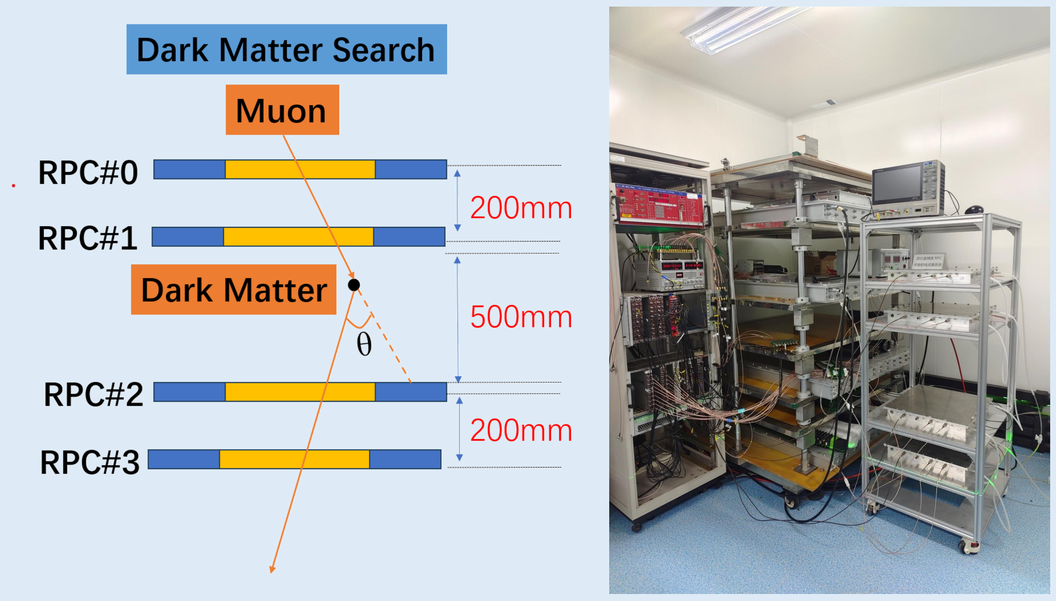


Fig. 2. RPCs-based Muon Scattering Imaging system in PKU[1, 2]

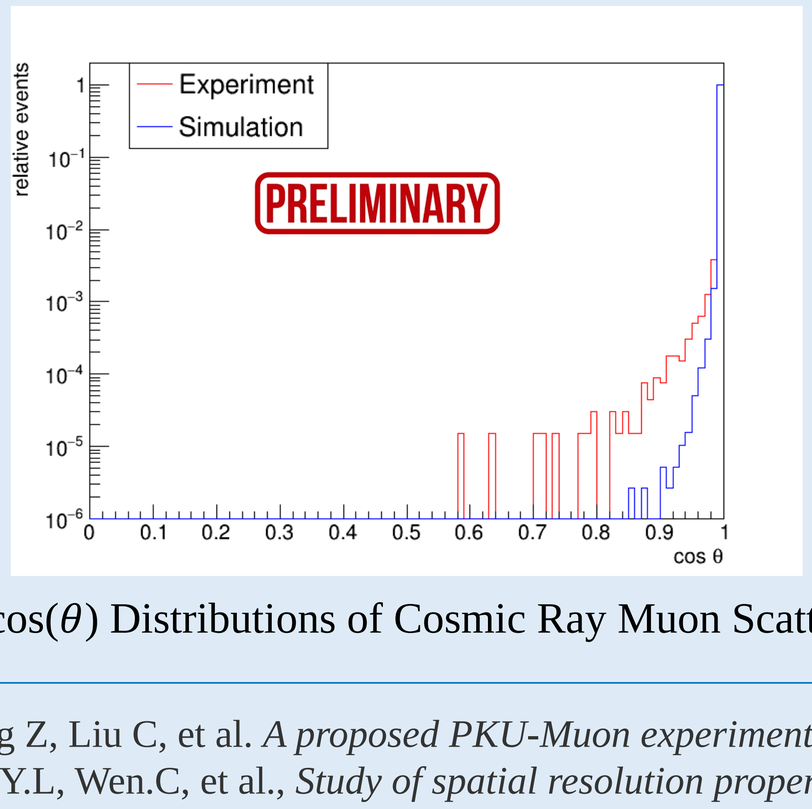


Fig. 3. The cos($\theta$) Distributions of Cosmic Ray Muon Scattering in Air

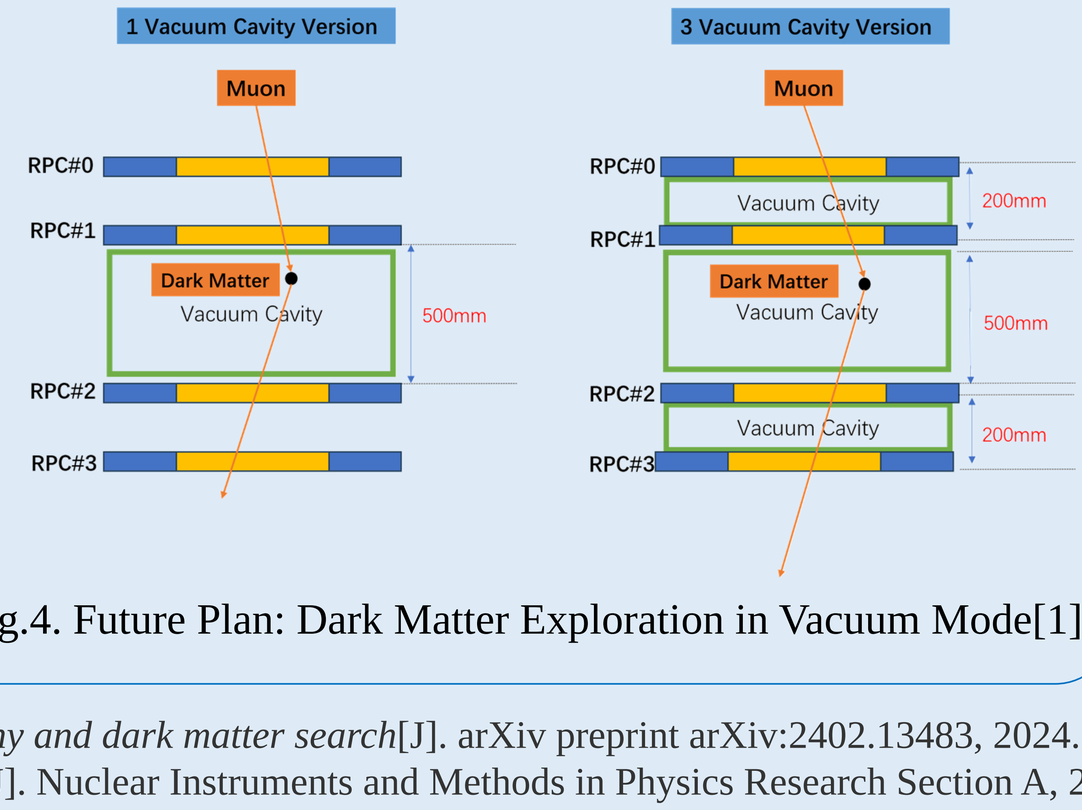


Fig.4. Future Plan: Dark Matter Exploration in Vacuum Mode[1]

[1] Yu X, Wang Z, Liu C, et al. *A proposed PKU-Muon experiment for muon tomography and dark matter search*[J]. arXiv preprint arXiv:2402.13483, 2024.
[2] Li.Q.T, Ye.Y.L, Wen.C, et al., *Study of spatial resolution properties of a glass RPC*[J]. Nuclear Instruments and Methods in Physics Research Section A, 2012, **663**(1): 22-25.