Contribution ID: **59** Type: **Poster**

Water Cherenkov Detectors in Precision Agriculture: A Novel Approach for High-Resolution Soil Moisture Monitoring

Monday, September 15, 2025 3:50 PM (1 hour)

Water Cherenkov Detectors (WCDs), traditionally employed in particle physics to detect cosmic rays, are now being repurposed for a groundbreaking application: precision soil moisture monitoring via neutron sensing. This method offers distinct advantages over conventional neutron probes, including possible enhanced sensitivity to low moisture levels and the ability to cover larger soil volumes without direct subsurface intrusion. This study evaluates the feasibility of WCDs for agricultural neutron hydrometry, addressing key challenges such as background noise suppression and data interpretation in heterogeneous soils. We present experimental results from controlled condition measurements in an environment that emulates wet and dry soil conditions, and, on the other hand, a Monte Carlo simulation using a model in Geant 4 with an atmospheric neutron spectrum to relate the change in the signal due to soil moisture differences.
By bridging particle physics and agronomy, WCDs could improve the current state of soil moisture monitoring, offering a non-invasive, scalable, and highly accurate alternative for optimizing water use in crops. Further research is needed to refine cost efficiency and adaptability to diverse soil types, but the preliminary findings suggest a transformative role for this technology in sustainable farming.

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Session Classification: Poster Session

Track Classification: Technological aspects and applications of Cherenkov light detectors