Quarknet Summer Experience: A Week at the Forefront of Physics

Our team had an incredible week diving deep into the world of particle and condensed matter physics. From witnessing detector components for CERN being assembled to learning about the fascinating world of super-cooled materials, we experienced firsthand the cutting-edge research that is shaping our understanding of the universe.

Monday, May 27, 2025: A Look Inside Detector Upgrades

Our week began at the Advanced Particle Detector Lab, where we had the unique opportunity to sit in on an upgrade meeting. We joined faculty and students in reviewing critical data from the ongoing production of detector modules. The discussion covered everything from the performance of individual modules to the importance of maintaining precise temperature and atmospheric pressure conditions within the clean room, a factor essential for reliable manufacturing.

Following the meeting, we suited up and entered the clean room itself. We witnessed a significant milestone: the first simultaneous "dry-run" assembly of four modules, utilizing both the left and right sides of the gantry system. This was a fantastic look into the intricate engineering and quality control required for these complex instruments. The day concluded with a demonstration from Dr. Chris Madrid, who meticulously tested a module's electrical current across a voltage range of 600-900 mV in a low-humidity environment to ensure its stability and performance.

Tuesday, May 28, 2025: Building for the Future with the DREAM Calorimeter

The focus shifted to the future of particle detection with an update on the High Granularity Dual-Readout (DREAM) calorimeter. This

next-generation detector is being developed for future experiments at CERN. We learned how its 750 two-meter-long fibers, bundled in copper, will use fast silicon photomultipliers to achieve remarkable time segmentation on the order of 10 picoseconds. This will allow physicists to reconstruct particle interaction events in precise 5 cm segments, simultaneously capturing both Cherenkov radiation and scintillation for a more complete picture.

Putting our knowledge into practice, we spent the afternoon constructing a large, light-tight tent. This enclosure is crucial for housing the DREAM calorimeter during overnight testing runs, using cosmic-ray muons to calibrate and validate the detector's performance.

Thursday, May 30, 2025: Exploring Emergent Properties in Condensed Matter

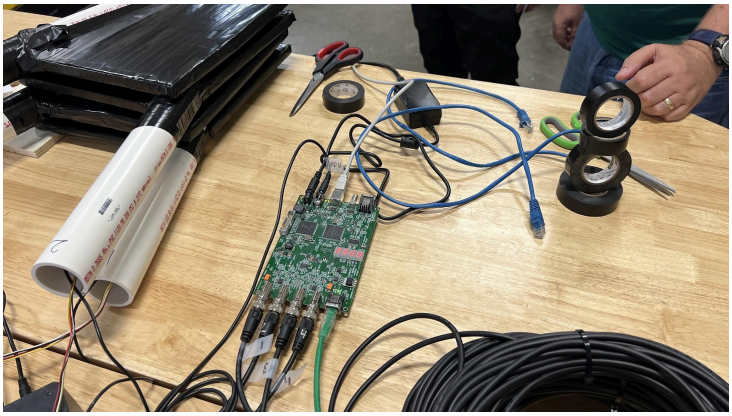
To round out the week, Dr. Yun Suk Eo delivered a fascinating presentation on condensed matter physics and the concept of emergent properties. He detailed the theory behind the 4-terminal measurement technique, which is vital for accurately determining a material's electrical resistance under the extreme conditions of ultra-low temperatures and low voltages.

Dr. Eo then guided us to his lab for a live demonstration, where we observed resistance readings of a material cooled to an incredible 2.000 K. His postdoctoral researcher and graduate student explained

their meticulous process for crystal preparation. This involved sealing materials inside quartz capsules and heating them to approximately 700 K for weeks at a time—a patient process required to grow the perfect crystals needed for their experiments.

Wednesday, June 4 & Friday, June 6, 2025: Muon Detector Relocation and Setup

Work continued as we relocated the muon detector to a new home at Frenship High School. These days were dedicated to the careful restructuring, setup, and maintenance required to ensure the detector was fully operational in its new environment. This move is an exciting step in bringing particle physics research directly into the high school setting, allowing students to engage with real, functioning scientific equipment.




SAFETY
FIRST
WEAR
GOGGLES