Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **102** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

Pulse Shape Discrimination in DEAP-3600

Thursday 10 June 2021 16:00 (10 minutes)

DEAP-3600 is a sensitive single-phase liquid-argon detector of non-baryonic dark matter at SNOLAB. WIMP-nucleon scattering is distinguished from electromagnetic events by pulse shape discrimination (PSD) in the argon. Nuclear recoils, which have high ionization density, preferentially excite a singlet argon dimer state which decays via VUV emission in nanoseconds. Electromagnetic events, which have low ionization density, preferentially excite a triplet state which decays with a time constant of 1.445 microseconds. This difference allows for excellent separation of the two classes of events.

The liquid argon in DEAP-3600 is contained in a 85cm-radius acrylic sphere that is coated on the inside with 1,1,4,4-tetraphenyl-1,3-butadiene (TPB) which is as a wavelength shifter, efficiently absorbing the VUV light and re-emitting in the blue. The blue light travels through the acrylic vessel and acrylic light guides to 255 Hamamatsu R5912 HQE PMTs.

The pulse shapes and therefore the PSD is complicated by instrumental effects including the presence of long-lived states of TPB and PMT effects including late pulsing, after pulsing, and dark noise. Recent studies of the pulse shape and PSD will be discussed including the effect of removal of PMT effects in events before applying the PSD algorithms. Two PSD algorithms are discussed: 1) a prompt-fraction parameter and 2) a likelihood estimator. A comparison will be given.

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Session Classification: R3-7 Machine learning in HEP & Novel reconstruction techniques II (PPD) / Apprentissage automatique en PHE et nouvelles techniques de reconstruction II (PPD)

Track Classification: Particle Physics / Physique des particules (PPD)