Improving LArTPC Performance with Photo-Ionizing Dopants

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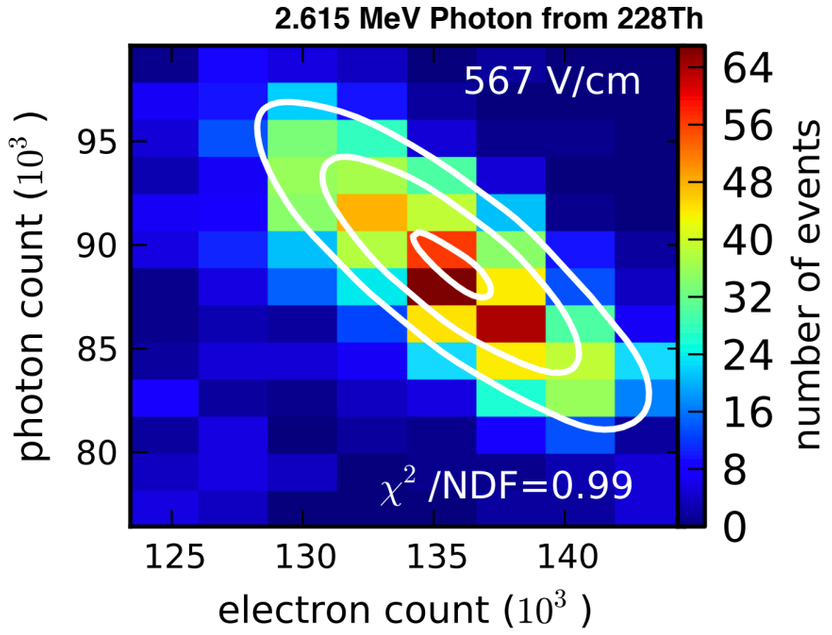
- **(LXe/LAr)TPC Issue:**
  MeV-scale energy deposits exhibit a strong anti-correlation between the light and charge signals
  - Addressed by utilizing a *precise* light measurement to augment the charge measurement (EXO-200, LArIAT)
  - Large photo-cathode coverage can be challenging and expensive in massive LArTPCs
- **Concept:** Use photo-ionizing dopants to convert light into charge
  - Chemical that is ionized by scintillation light
  - Breaks anti-correlation and enable a more precise ionization-only energy measurement

Historical Context: Originally proposed for LAr calorimeters(*) and tested in a 3-ton ICARUS TPC

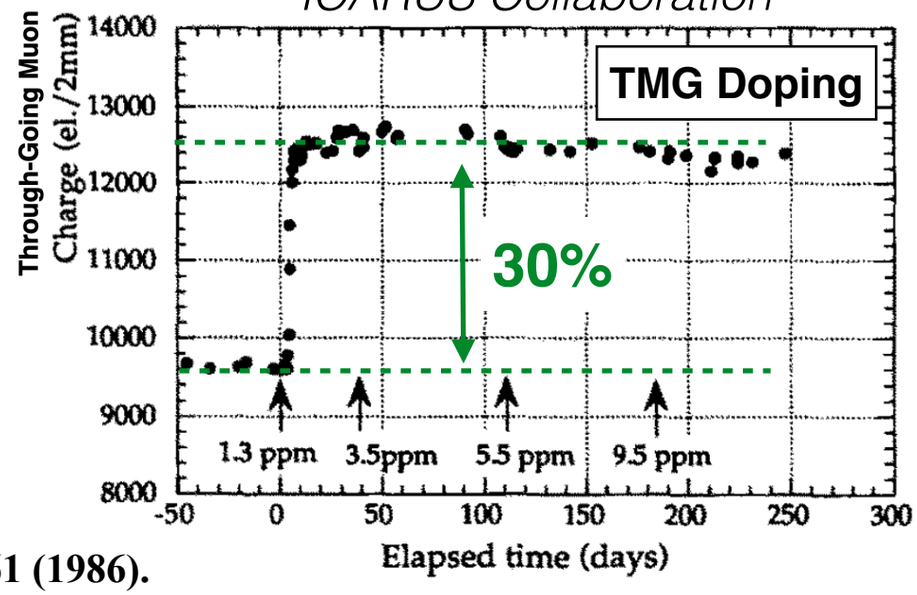
PRC 101, 065501 (2020)

EXO-200 Collaboration



Nucl. Instrum. Methods. Phys. Res. B 355, 660 (1995).

ICARUS Collaboration



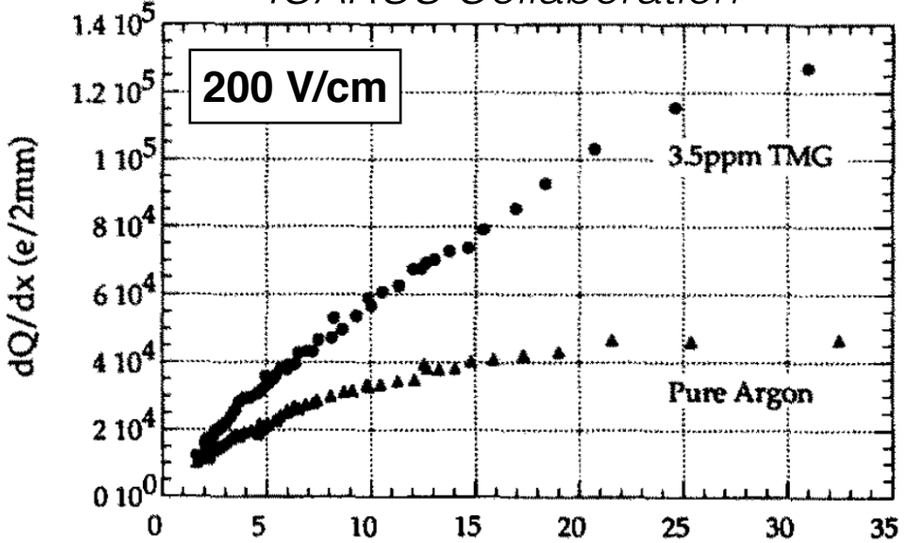
(*) D. F. Anderson, Nucl. Instrum. Methods. Phys. Res. B 245, 361 (1986).

Benefits and Challenges

- The conversion of light to charge comes with a number of benefits
  - Breaks anti-correlation of light and charge
  - Move from isotropic light to directional charge
  - Creates a more linear detector response when large amounts of energy are deposited

Nucl. Instrum. Methods. Phys. Res. B 355, 660 (1995).

ICARUS Collaboration



- Without light one needs to establish the T0 using aspects of the charge
  - One method for doing this would be to leverage the diffusion of the charge to estimate the origin of the charge in the drift direction
  - Already demonstrated in 35-ton experiment **(T. K. Warburton, PhD Thesis)**