Neutrino and Dark Matter Detection: Preliminary Hardware Studies

The CLEAN collaboration

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Introduction to CLEAN

⇒ **Cryogenic**

⇒ **Low**

⇒ **Energy**

⇒ **Astrophysics**

⇒ **Noble Gasses**

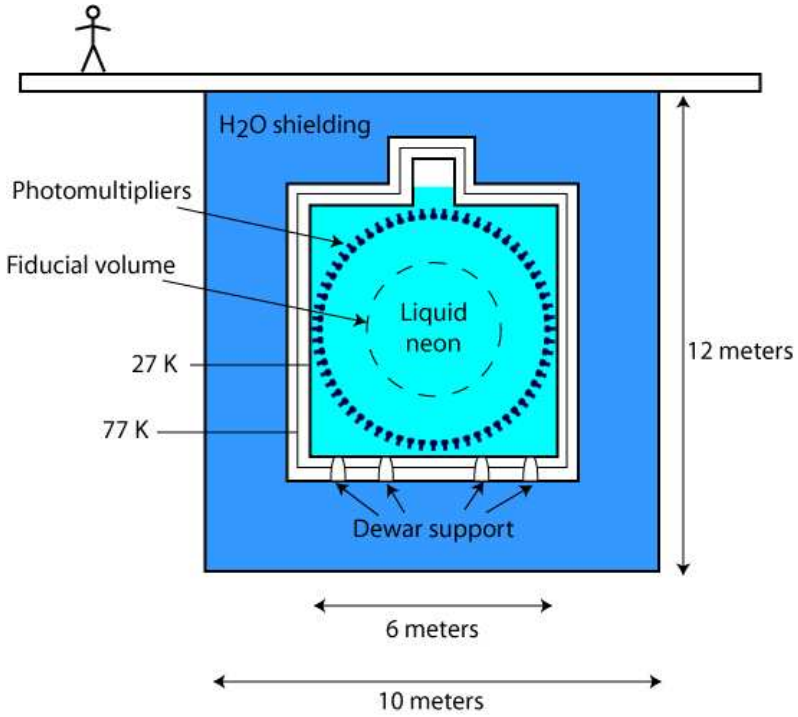
Neutrino-electron scattering events:

$$\nu + e^- \rightarrow \nu + e^-$$

WIMP-nucleus scattering events:

$$\chi + \mathrm{Ne} \rightarrow \chi + \mathrm{Ne}$$

Proposed CLEAN detector

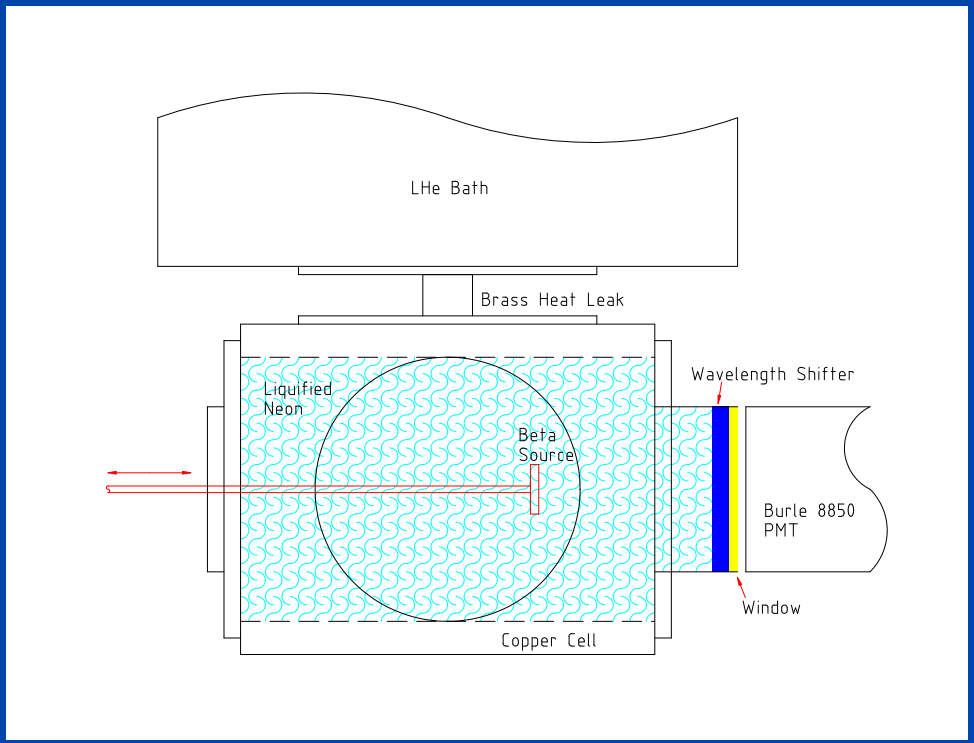


- ≈ 135 tonnes liquid neon
- ≈ 2000 PMTs
- ≈ 40 kEV threshold

Advantages of Neon:

- No long lived radioactive isotopes
- Purified with cold traps
- Relatively inexpensive
- Transparent to own scintillation light
- Liquid denser than liquid Helium
- Excellent pulse shape discrimination

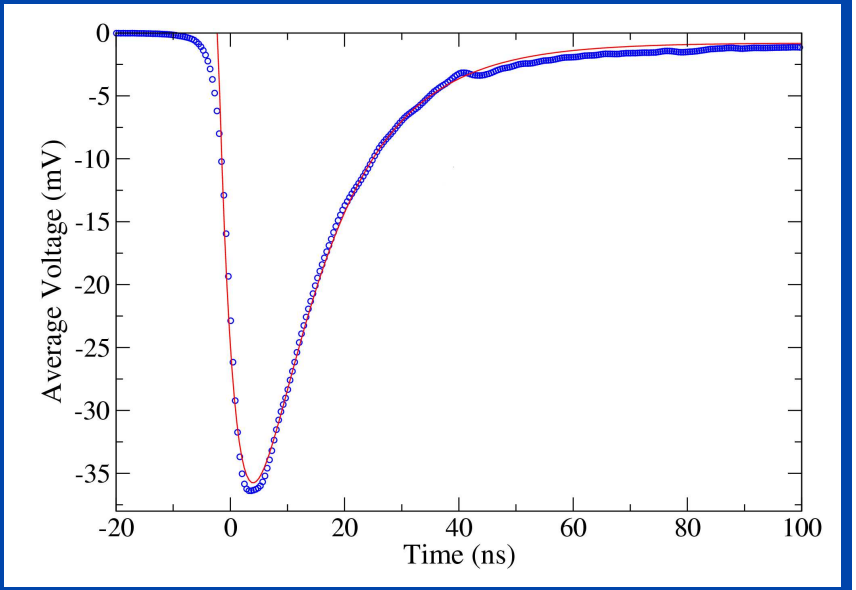
Neon Scintillation Properties



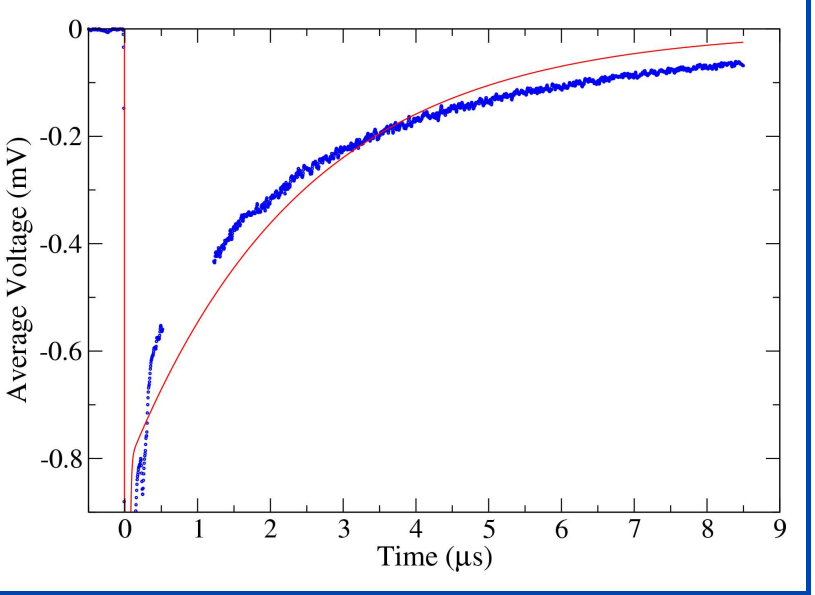
- Liquid He cooled
- Room temperature PMT
- $\approx$ 350ml of liquid neon
- Measured time constants

Liquid neon scintillation time constants

Singlet regime, $\tau_s = 12.8ns$



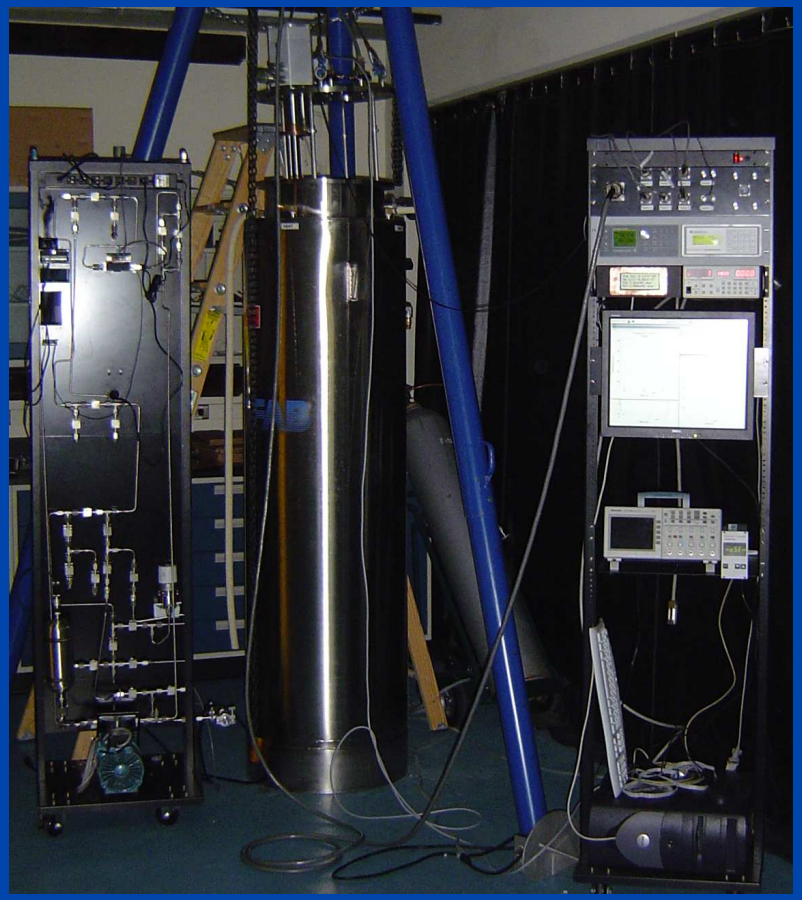
Triplet regime, $\tau_l = 2.4\mu s$

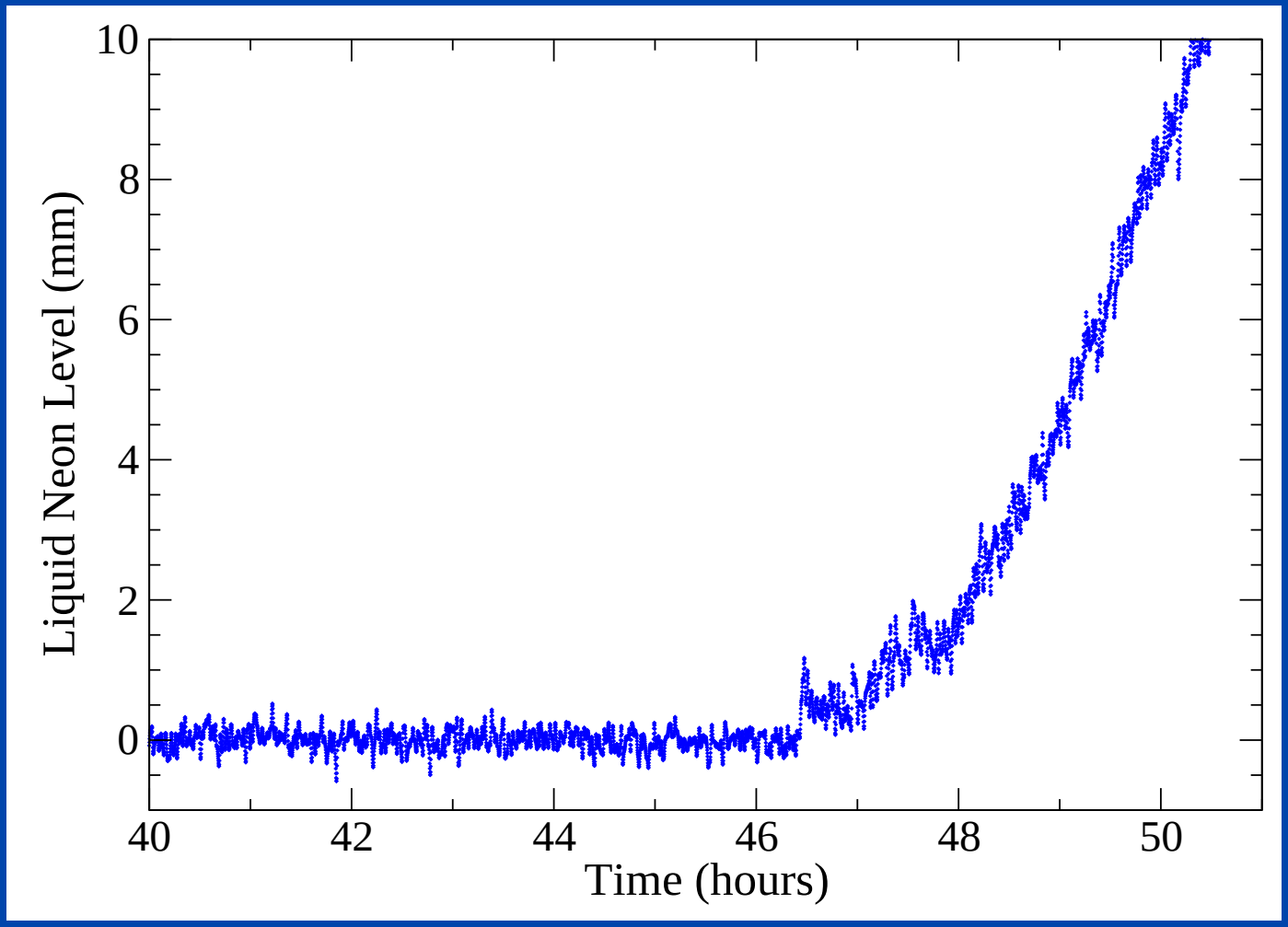


Triplet/singlet ≈ 2.8

Expect $\times 20$ reduction for nuclear recoils

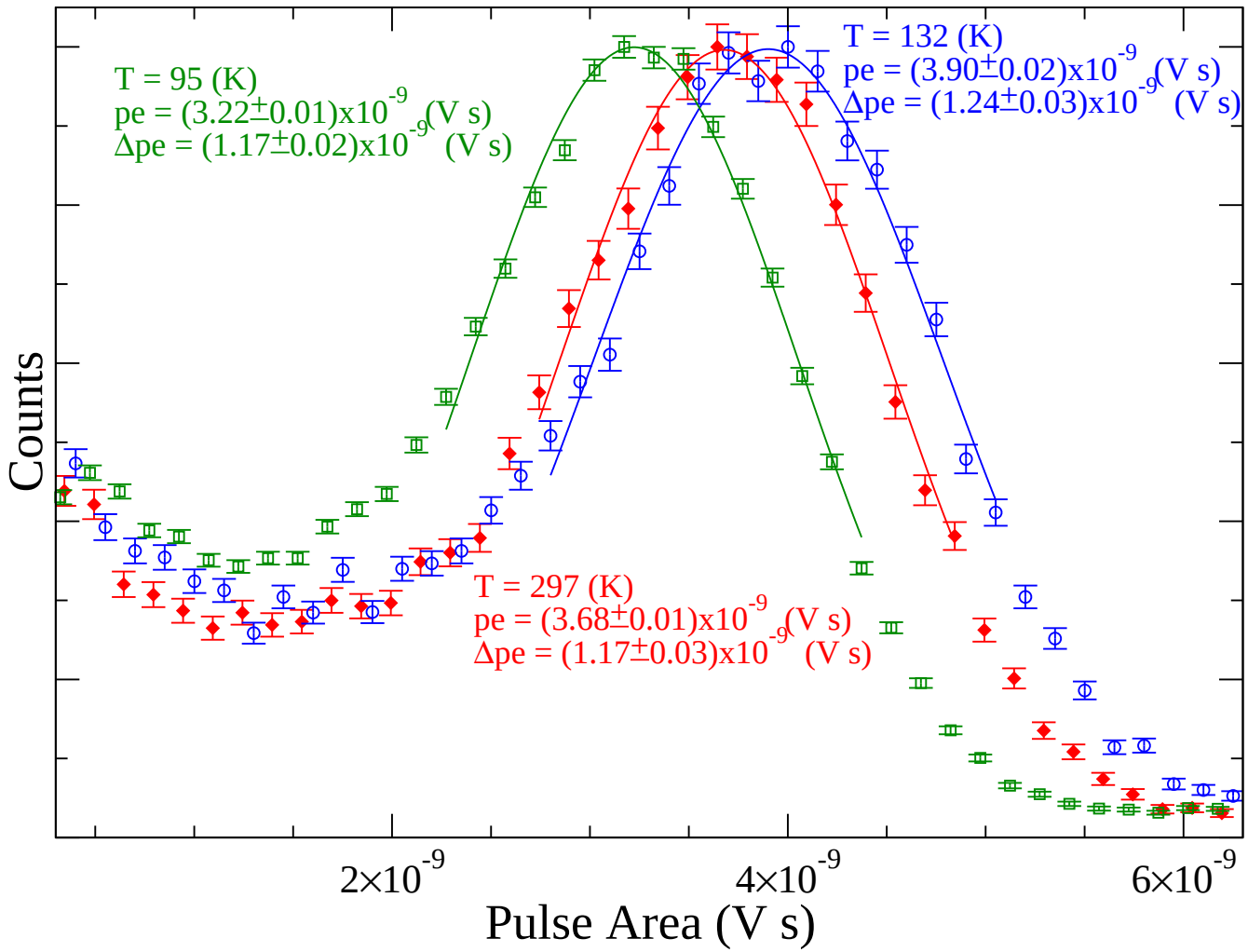
Low Temperature PMT Testing




Liquid Neon Level (mm)
10
8
6
4
2
0
40
42
44
46
48
50
Time (hours)

Single Photoelectron Peaks

Electron Tubes D746B



Conclusions

- Neon appears to be an excellent scintillation medium for both neutrino and WIMP detection
- Preliminary R+D is moving forward quickly

Actively working on

⇒ PMTs immersed in liquid neon

⇒ Neon purification and assay

⇒ Time dependence and attenuation length measurements in purified neon for α's, β's and neutrons