Development of the experiment on first observation of elastic coherent neutrino-nucleus scattering with liquid argon

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Plan

• Motivation
  • Coherent elastic neutrino-nucleus scattering (CEvNS)
  • Benefits of different working substances usage for CEvNS registration
  • LAr detector for CEvNS registration: CENNS-10

• ITEP Test Chamber

• Investigation of different type of WLS
  • NOL, TPB
  • Volume-distributed WLS (Xe-dopant)

• Conclusion
Motivation

• CEvNS is predicted by Standard Model, but still no experimental observation

• A lot of groups working on this problem all over the world

• Different type of detecting substance allow to determine parameters of this process
Motivation

CENNS-10

- CENNS-10 is LAr detector made by IU group @ SNS, Oak Ridge, USA
- Two PMTs: R5912
- Current WLS technology: acrylic + tetraphenyl butadiene (TPB)
- Upgrading... New WLS techniques?
ITEP Test chamber

Thermocontrol

Gas

Vacuum or N₂

PMT
LAr
sample
LN₂ bath

Gas

Vacuum or N₂

PMT
LAr
sample
LN₂ bath

Vacuum or N₂

PMT
LAr
sample
LN₂ bath
ITEP Test Chamber & scheme of measurements

ORTEC 927
Multichannel analyser

ORTEC 570 Amplifier
Digital oscilloscope
(1 GHz)

Base

PMT

LAr
diam 35 mm

33.3 mm
30 mm

diam 22 mm

WLS

α source

$^{241}$Am

ORTEC 927 Base

PMT FEU-181 MELZ (Moscow)
VUV-sensitive: MgF$_2$ window multialkali photocathod
Can operate at cold (down to LN$_2$ temp.)
NOL & TPB investigation

- Enikolopov inst. developed new type of WLS called “Nanostructured organosilicon luminophore” (NOL).
- NOL has several types with different absorption spectrum
- A lot of measurements have already been done, but...
- We need some additional tests (first of all comparing test with TPB) before presenting our results

NOL1: T-Ph-Ph-T (T-thiophene; Ph-phenyl)

- PMT FEU-181 (Russia)
- Photocathode – S20

λ, nm

k, l·mol⁻¹·cm⁻¹

S3~190 nm
S2~270 nm
S1~350 nm

absorption
emission
Volume-distributed WLS

- Xe-dopant in LAr works like distributed WLS

- The amount of collected light increasing with Xe concentration

- Two Xe dopants:
  - $14^{+5}_{-3}$ ppmv
  - $24^{+9}_{-5}$ ppmv

- For 14 ppmv mixture one can obtain 4 times more light then for pure Ar
Volume-distributed WLS

- Still can distinguish fast and slow components!
- Light output from Ar to Xe depends on Xe concentration
- Mixture is stable! In long run (for 24 ppmv mixture): 32 hours of continuous running with average temperature ~86K (practically stable) (Xe melting point is 161,3 K)
Conclusion

• We are conducting R&D on different types of WLS for LAr detectors
• Different characteristics of volume-distributed WLS (Xe-doping) were experimentally investigated
• We have shown stability of LAr+Xe mixture and possibility of usage this type of WLS
• A lot of things in our ToDo list:
  • NOL & TPB tests
  • Further LAr+Xe investigation (Precise concentration, gamma-source...)
This work was supported by RFBR grant: 16-32-00691 мол_а «My first grant»
Thank you for your attention!
NOL-results

NO WLS

LXe, T = 57.6 a.u.

Entries: 1500
Mean: 840
RMS: 374

NOL-3a, min. glass

LXe, NOL-3a, T = 60.4 a.u.

Entries: 500
Mean: 45.29
RMS: 23.79

NOL-1 FS glass

No data for LXe.

LAr, T = 26.3 a.u.

Entries: 1250
Mean: 596.6
RMS: 294

LAr, T = 26.3 a.u.

Entries: 400
Mean: 100.5
RMS: 96.5

LAr, T = 26.3 a.u.

Entries: 200
Mean: 43.35
RMS: 18.28