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

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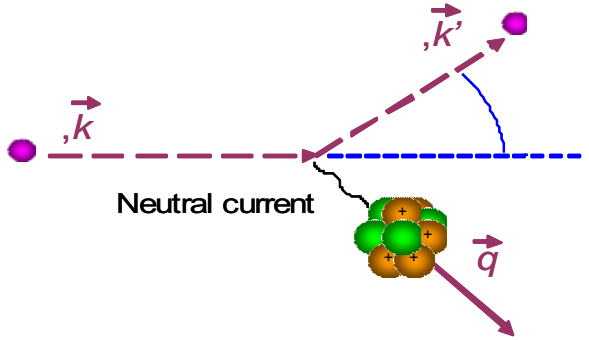
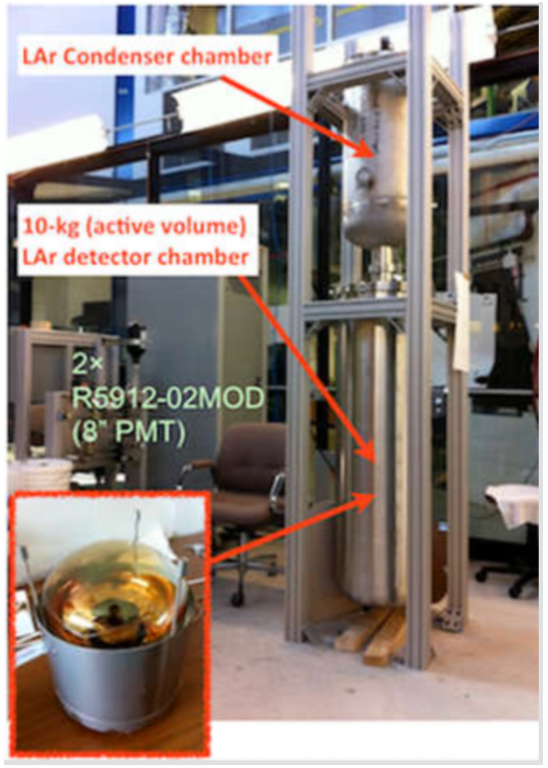
Plan

- 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

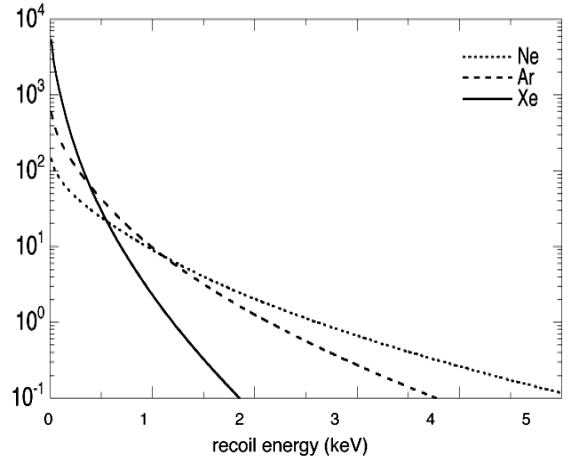
Motivation



- 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



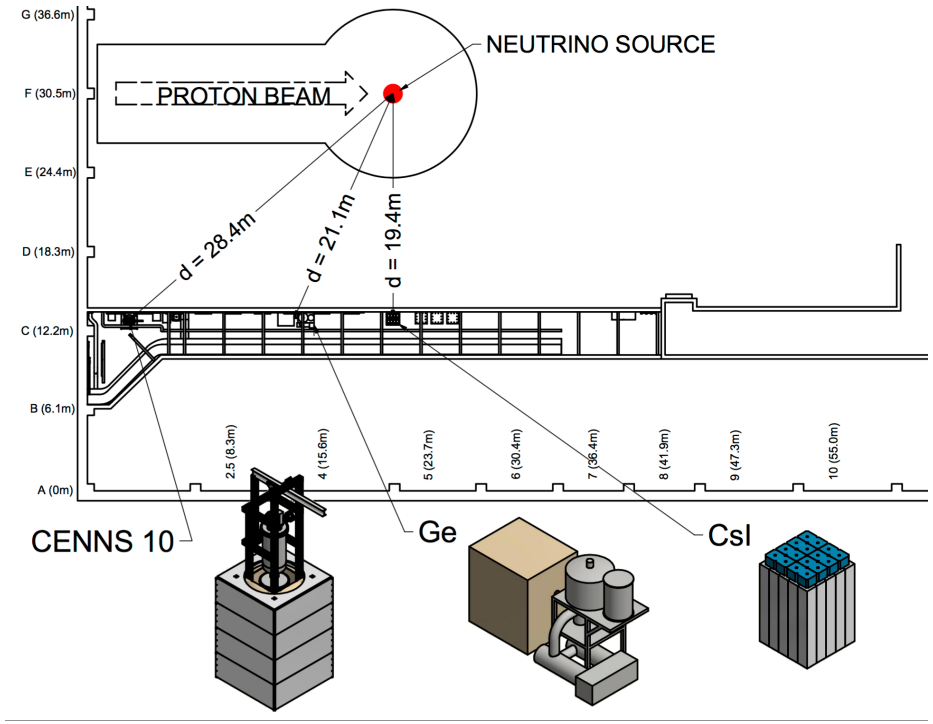
$$\sigma_{\text{elastic}} = \frac{G_F^2}{4\pi} N^2 E_\nu^2$$
$$\approx 0.4 \times 10^{-44}\,\text{cm}^2 A^2 E_\nu(\text{MeV})^2$$

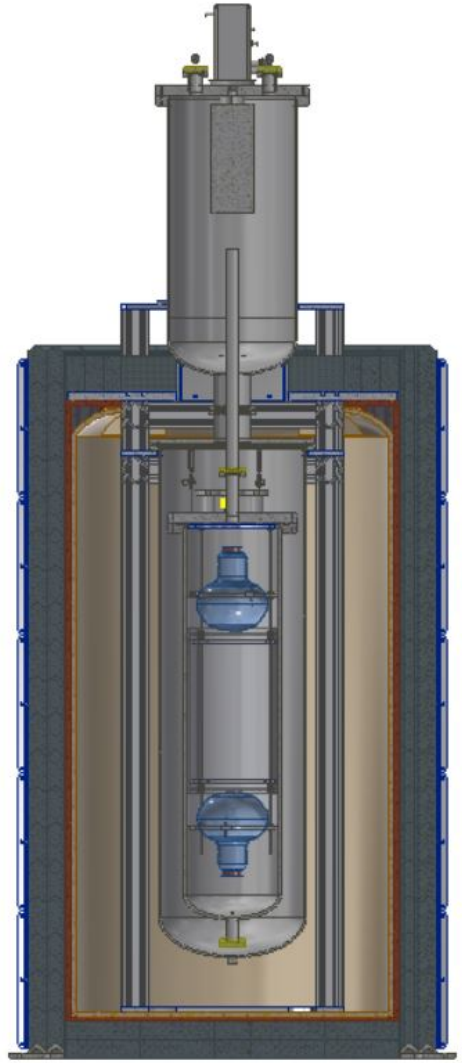


P. S. Barbeau, J. I. Collar, J. Miyamoto, and I. Shipsey
IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 50, NO. 5, OCTOBER 2003

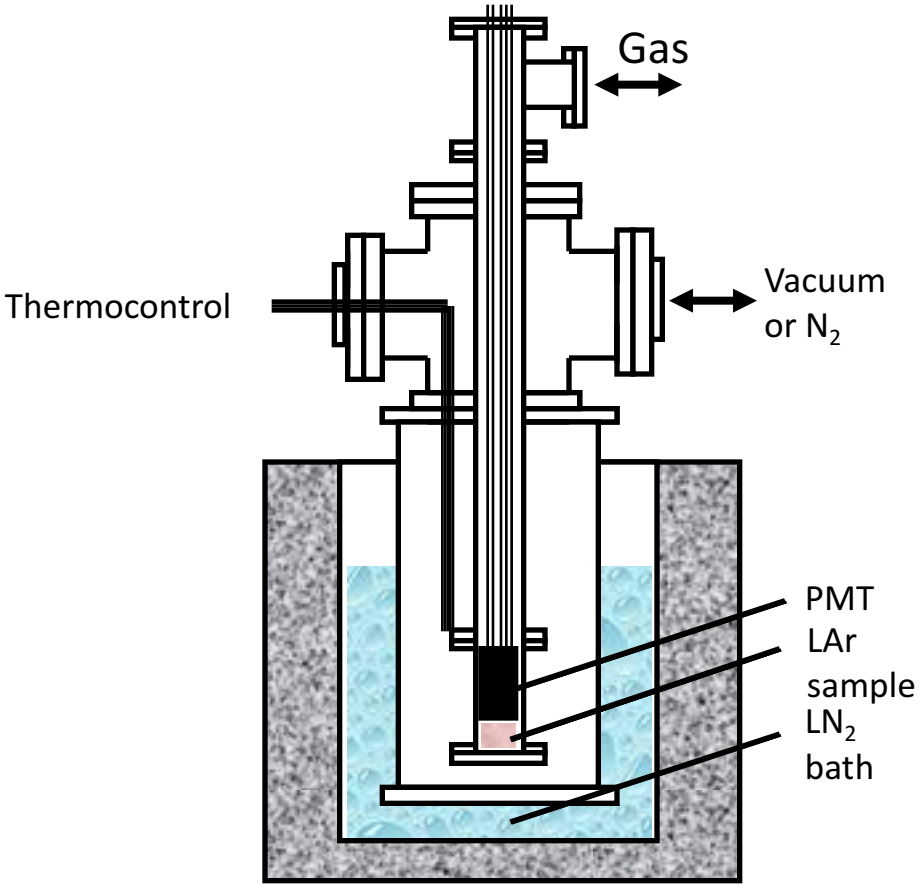
Motivation CENNS-10

- 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 techiques?

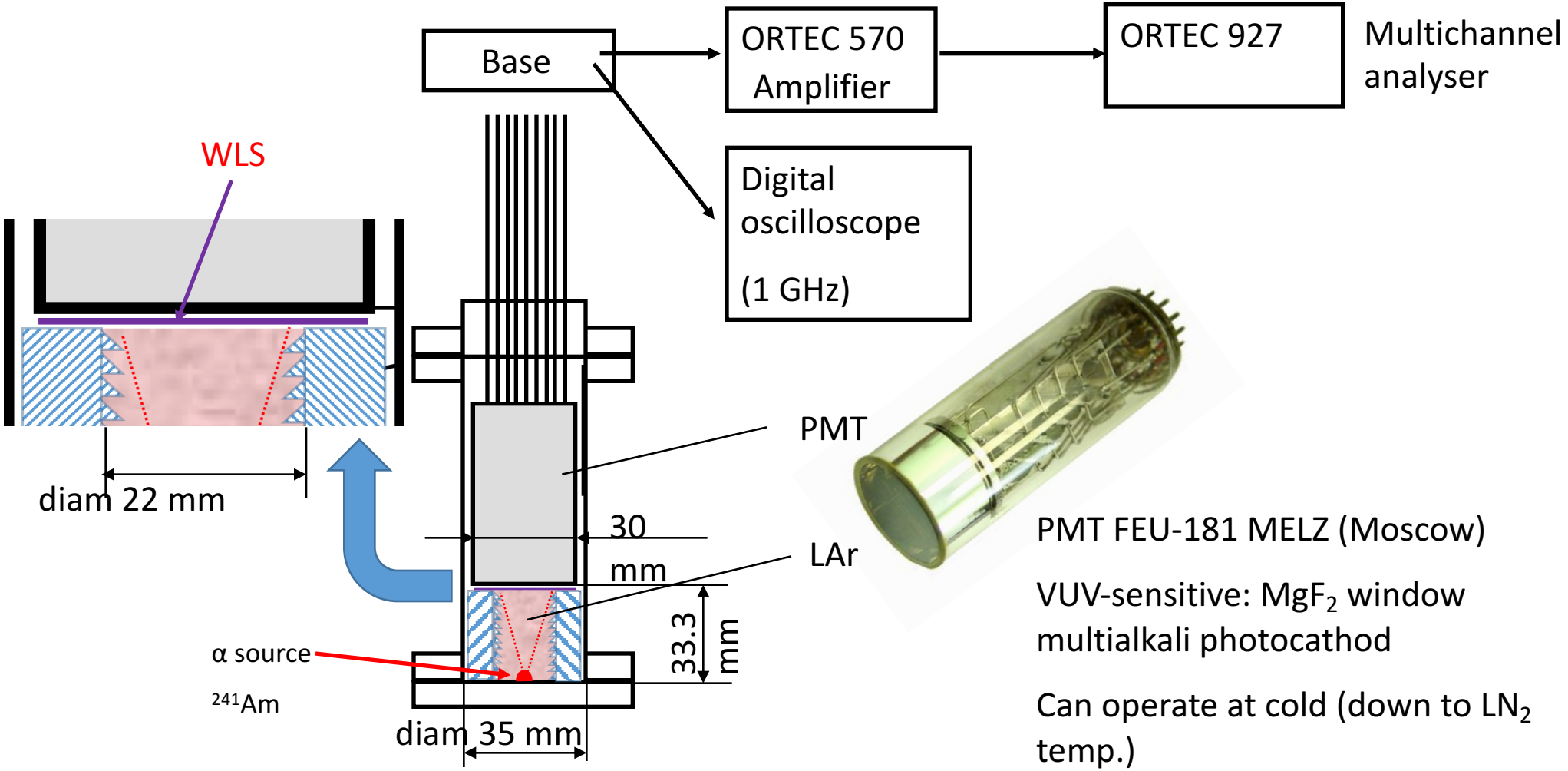




ITEP Test chamber



ITEP Test Chamber & scheme of measurements



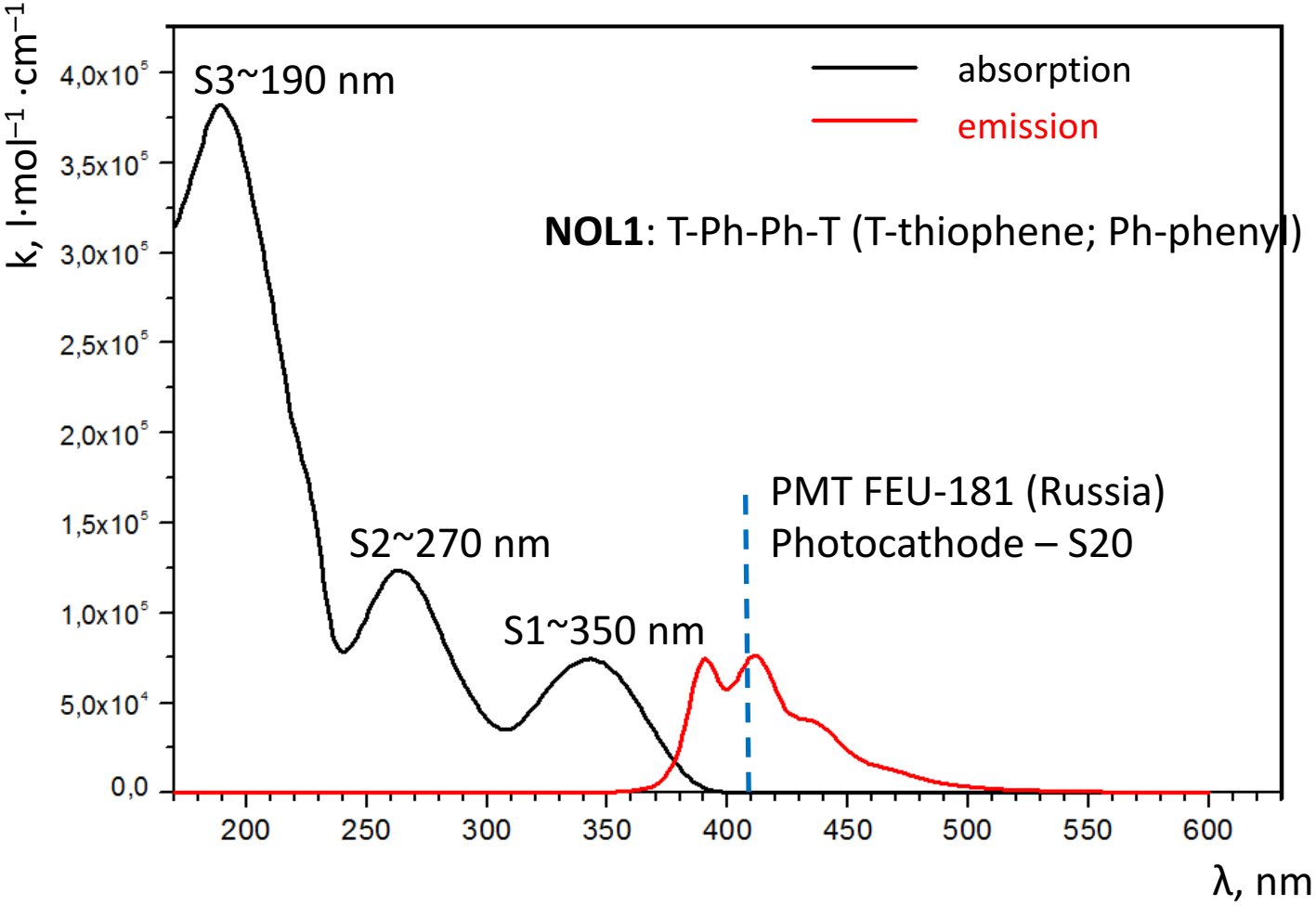
PMT FEU-181 MELZ (Moscow)

VUV-sensitive: MgF_2 window multialkali photocathod

Can operate at cold (down to LN_2 temp.)

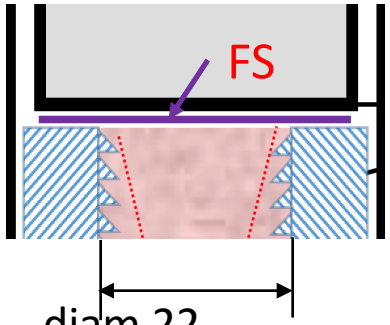
NOL & TPB investigation

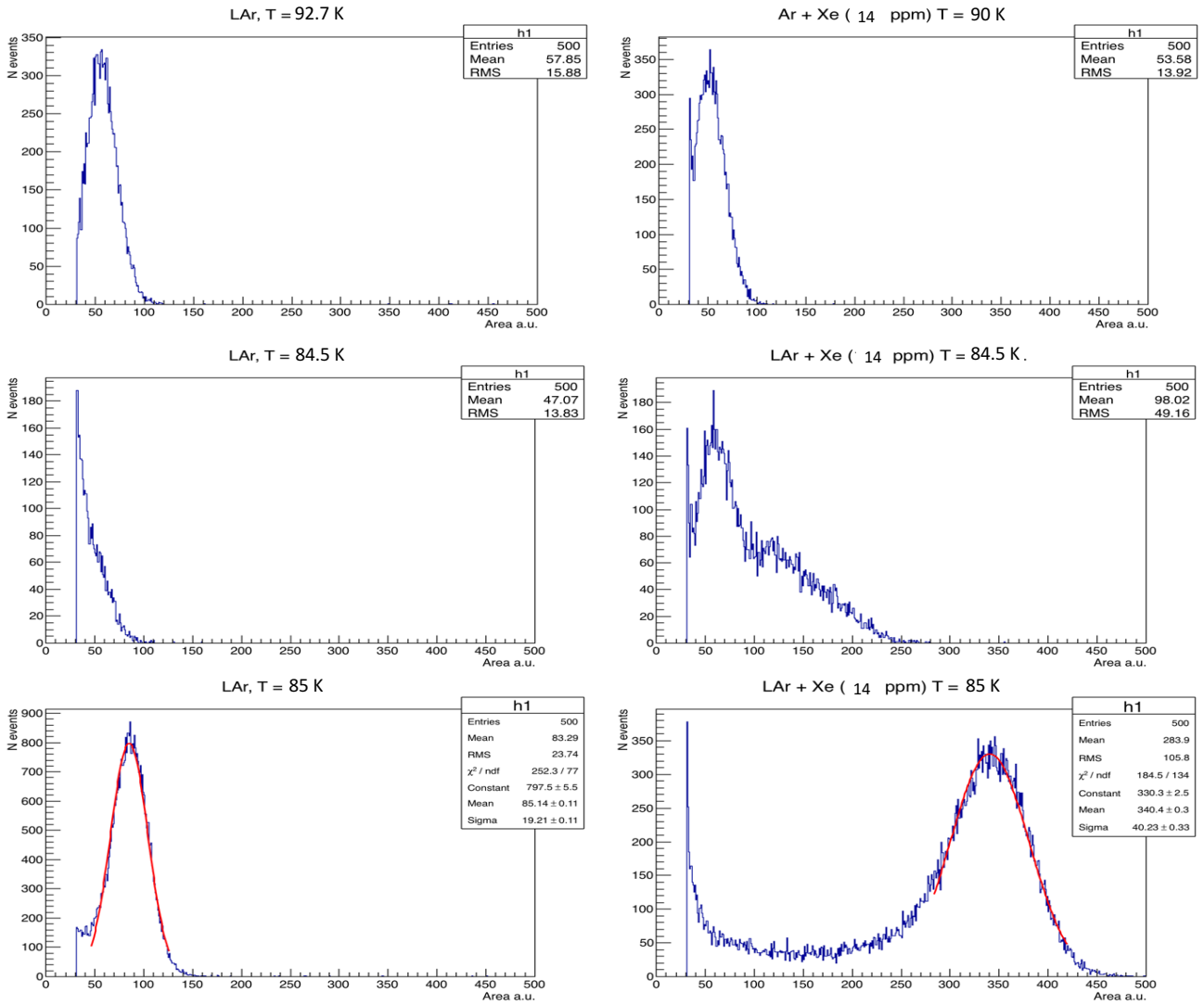
- Enikolopov inst. developed new type of WLS called “Nanostructured organosilicon luminophore” (NOL) *T. Yu. Starikova et al J. Mater. Chem. C, 2016,4, 4699-4708*
- NOL has several types with different absorption spectrum
- A lot of measurements have already been done, but…
- We need some additional tests (first of all comparing test with TPB) before presenting our results



Volume-distributed WLS

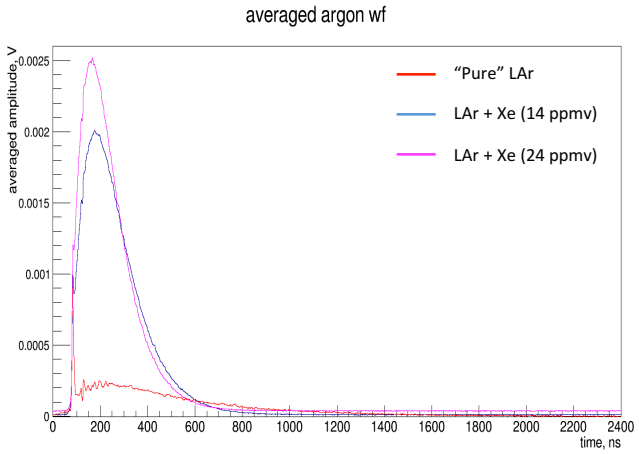
- Xe-dopant in LAr works like distributed WLS
  O. Cheshnovsky, B. Raz, J. Jortner, J. Chem. Phys. 57 (1972) 4628.
- The amount of collected light increasing with Xe concentration
  A. Neumeier, et al., Nucl. Instrum. Meth. A 800, 70-81 (2015)
- Two Xe dopants:
  - 14^{+5}_{-3} ppmv
  - 24^{+9}_{-5} ppmv
- For 14 ppmv mixture one can obtain 4 times more light then for pure Ar

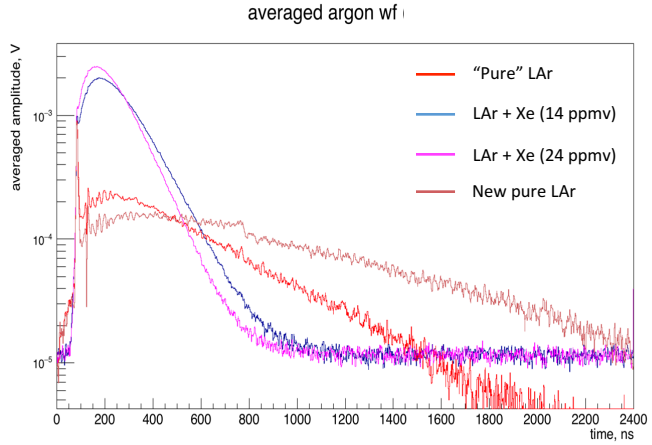


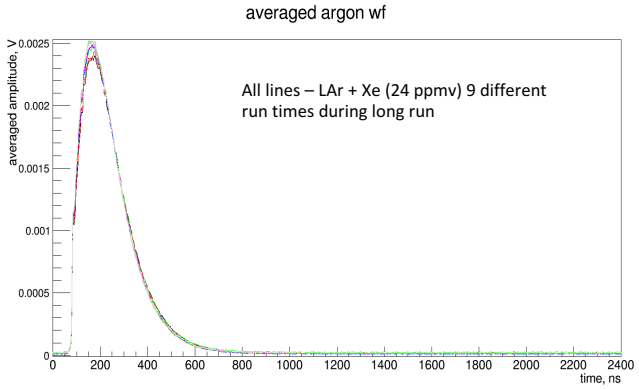


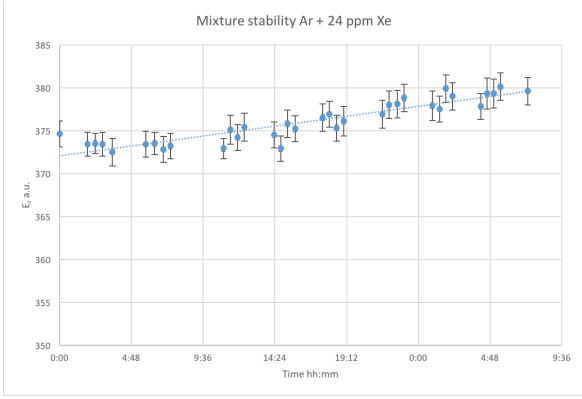
Volume-distributed WLS

- 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…)

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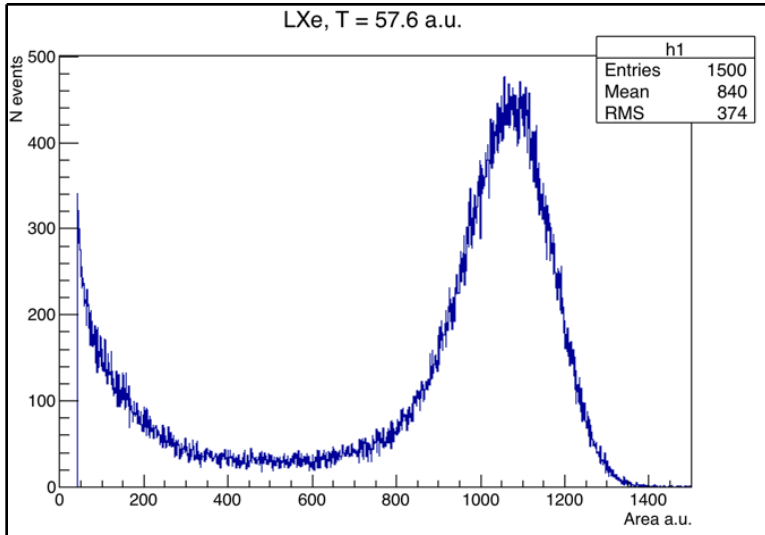
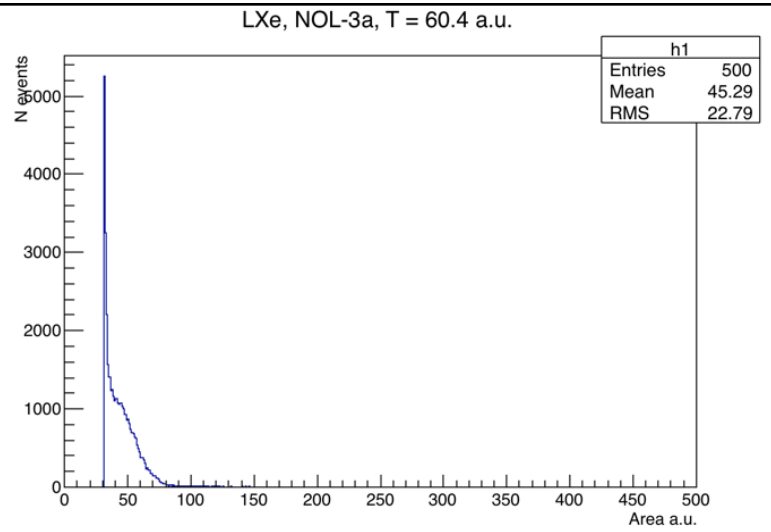
16-32-00691 мол_а «My first grant»

Thank you for your attention!

NOL-results

РОССИЙСКИЙ ЭМИССИОННЫЙ ДЕТЕКТОР

	NO WLS	NOL-3a, min. glass	NOL-1 FS glass
LXe			No data for LXe.
LAr