Measurement of the electroluminescence yield in two-phase argon

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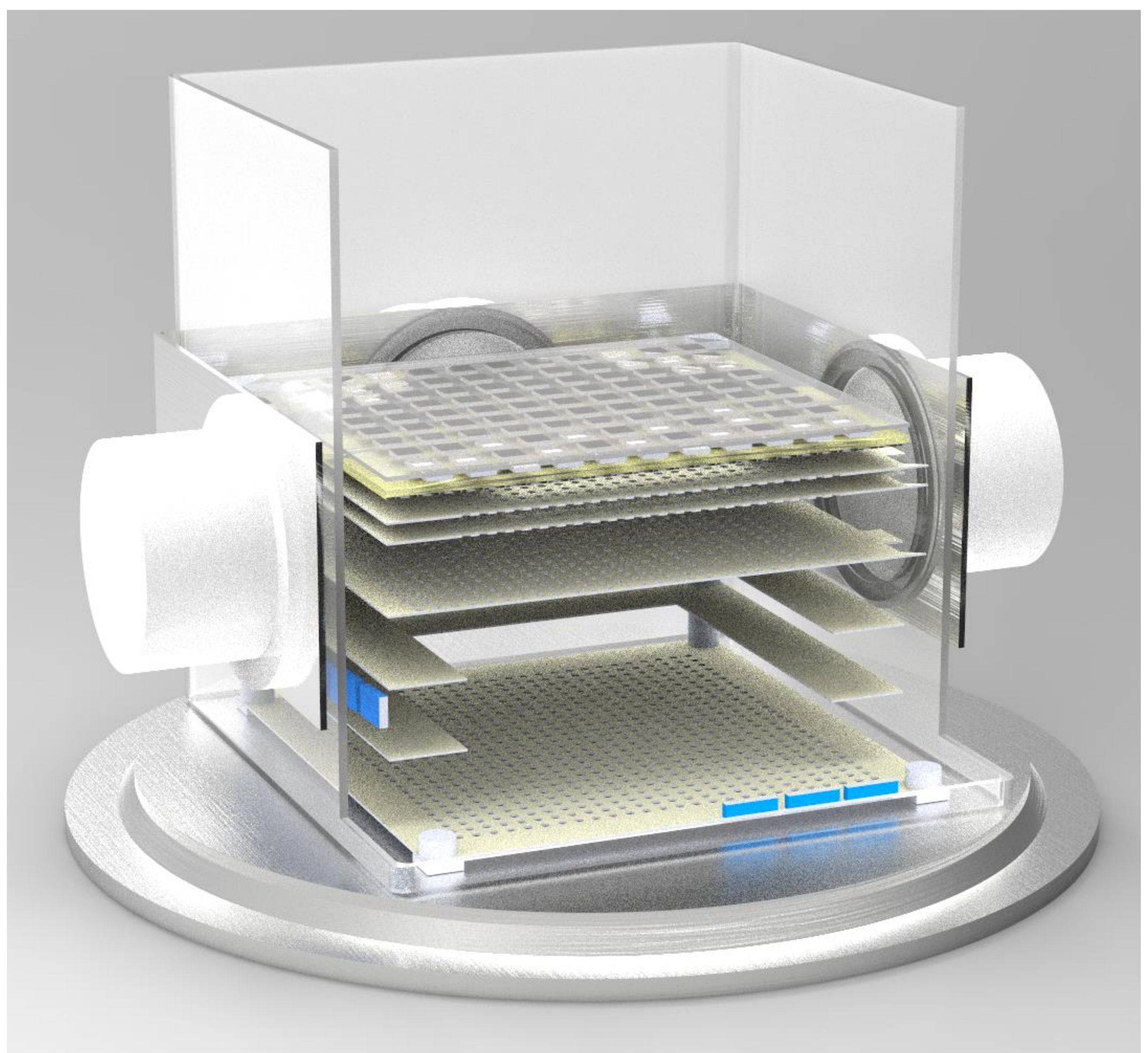
Introduction

New results, concerning the measurement of the proportional electroluminescence (EL) yield in Ar with minor (11±2 ppm) admixture of N_2 are presented. The measurements were performed with two-phase Cryogenic Avalanche Detector (CRAD) with EL gap located directly above the liquid-gas interface. The EL gap was optically read out by cryogenic PMTs and a matrix of SiPMs.

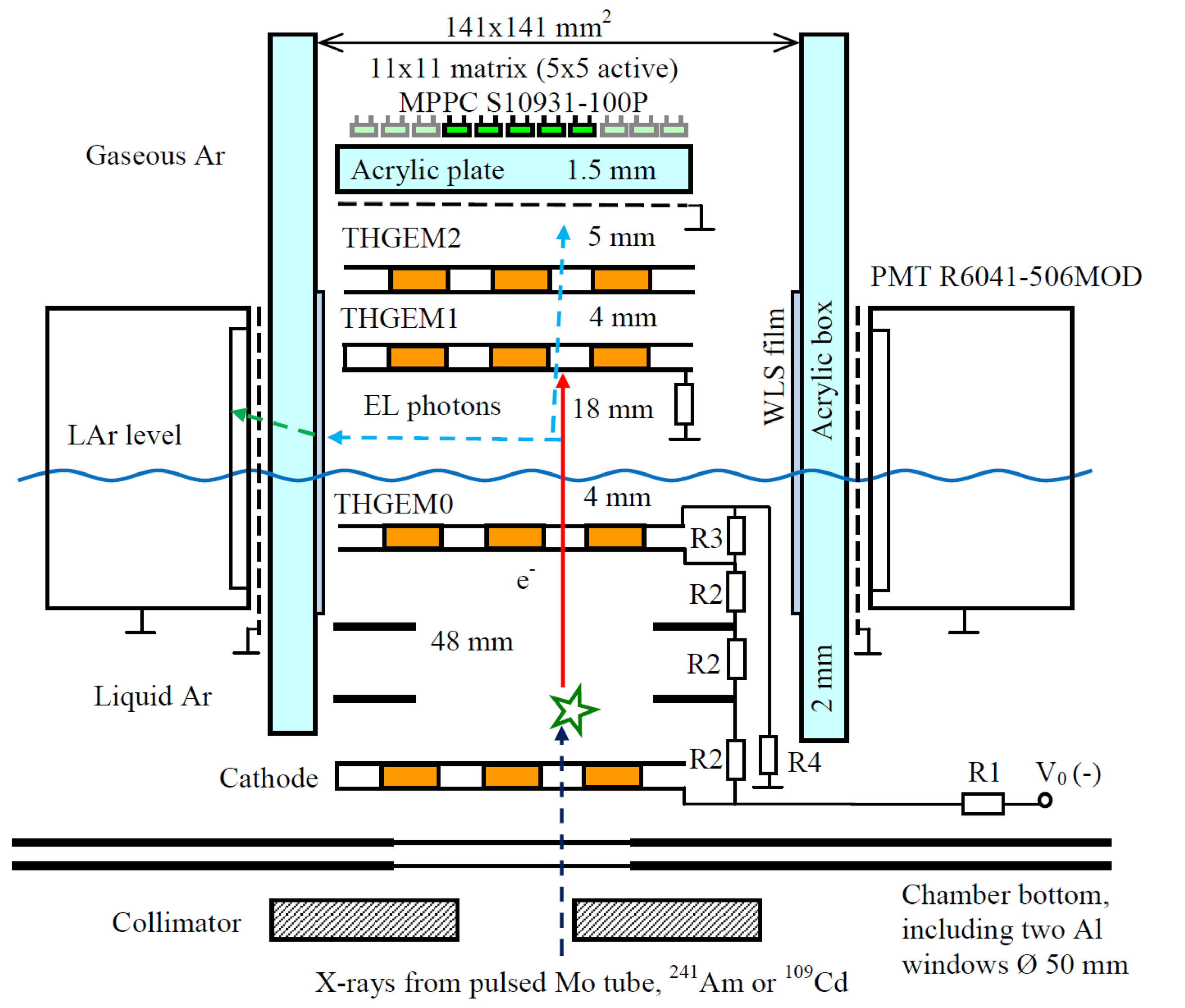
Experimental setup



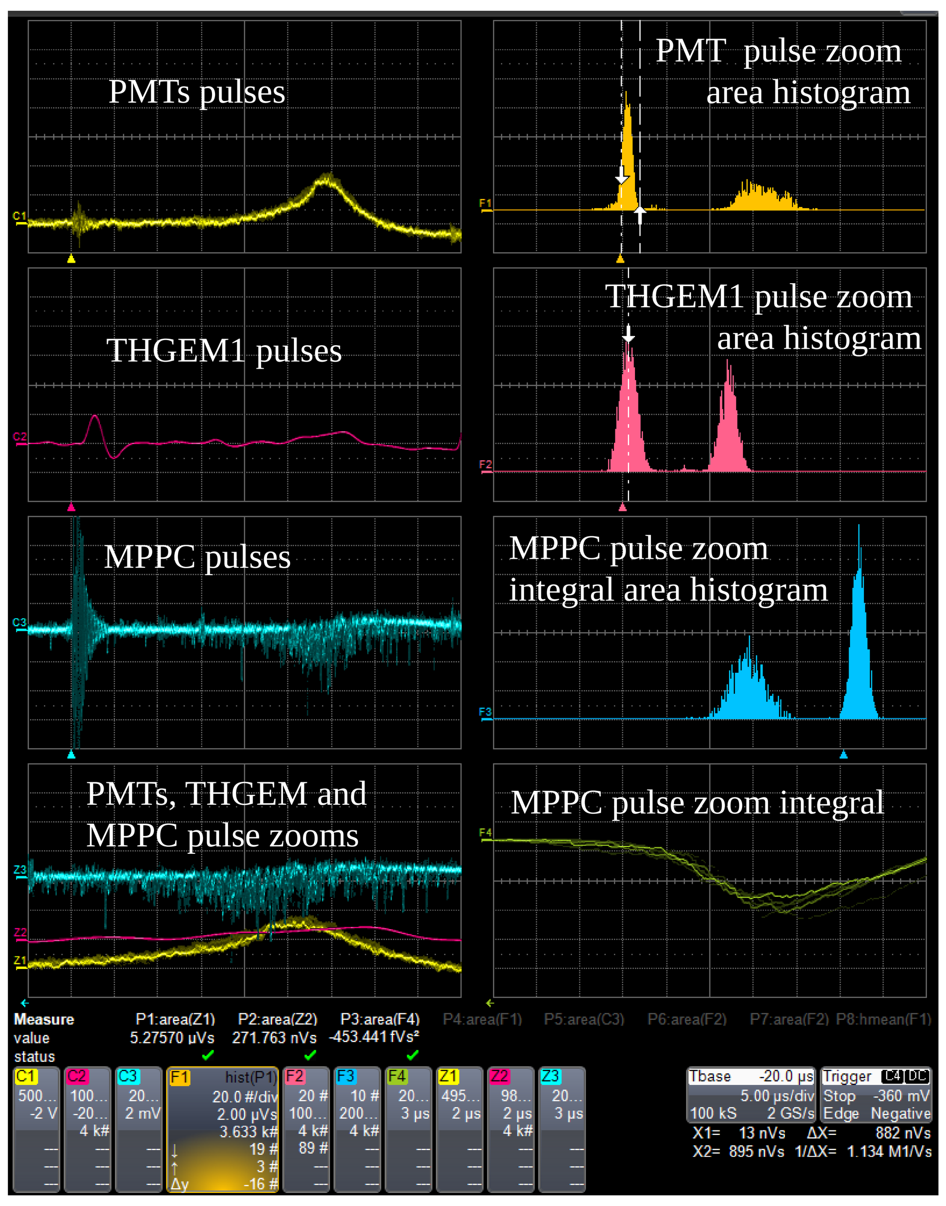
Cryogenic Avalanche Detector (CRAD):

- **9 liters cryogenic chamber with X-ray windows**
- **~2.5 liter of liquid Ar**
- **N_2 content 11 ppm±2 ppm**

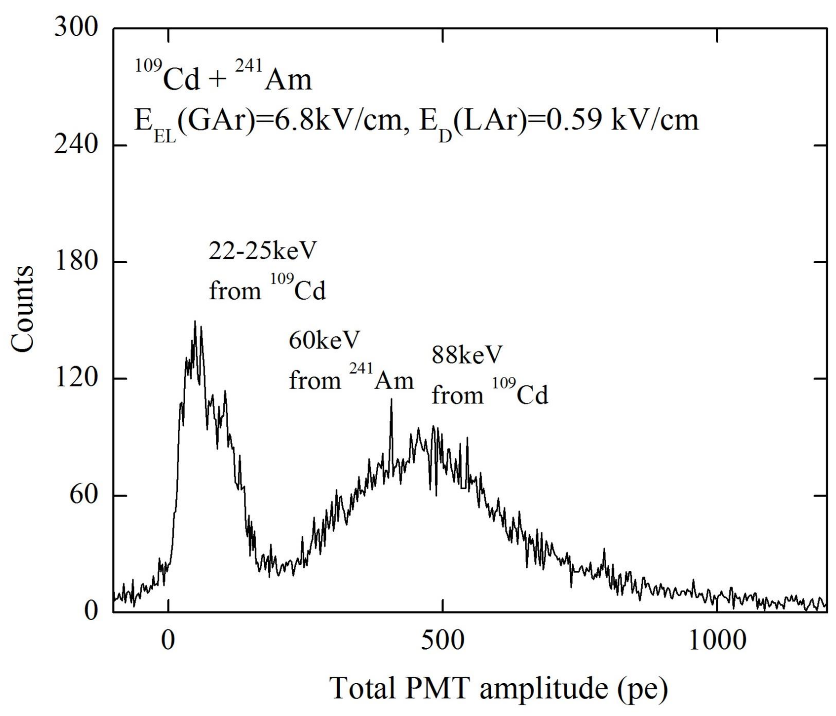
- **Electroluminescence (EL) gap (18 mm thick)**
- **4 cryogenic PMTs R6041-506MOD with WLS (TPB)**
- **2THGEM assembly (10x10 cm²)**
- **11x11 (5x5 active) matrix of SiPMs (of S10931-100P type, 6x6 mm² active area)**



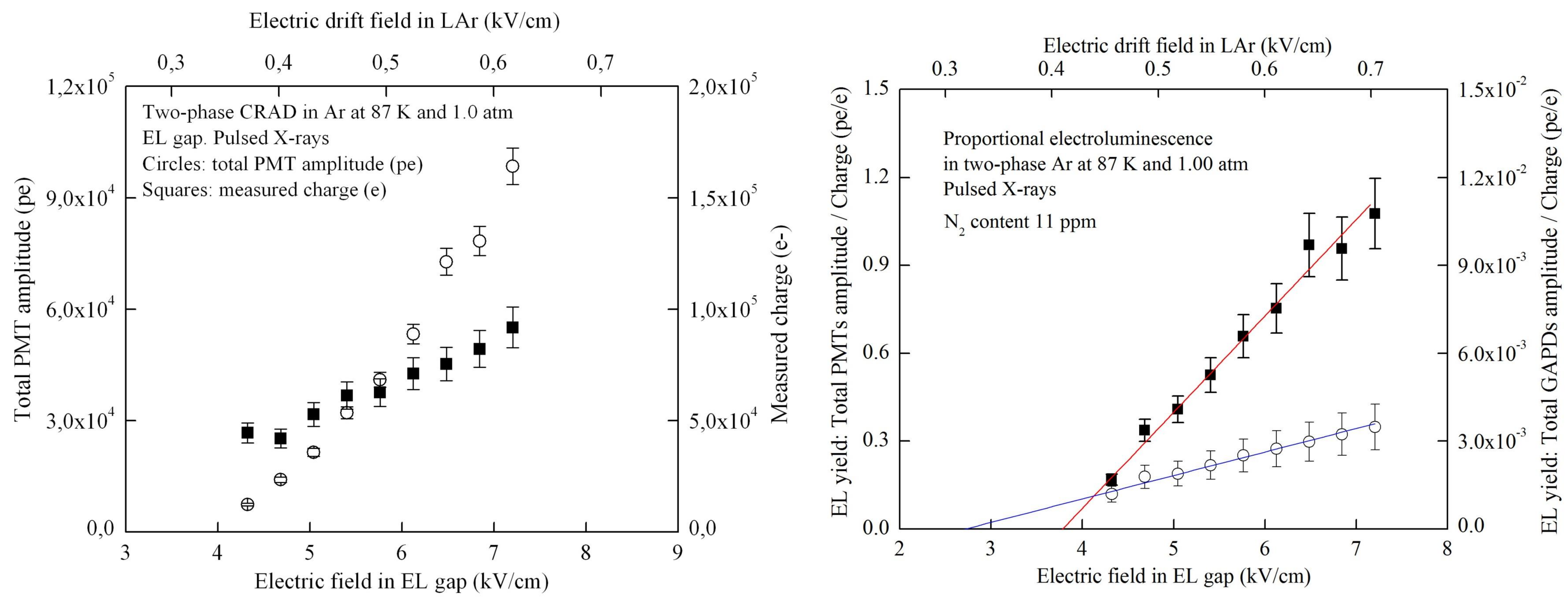
Results



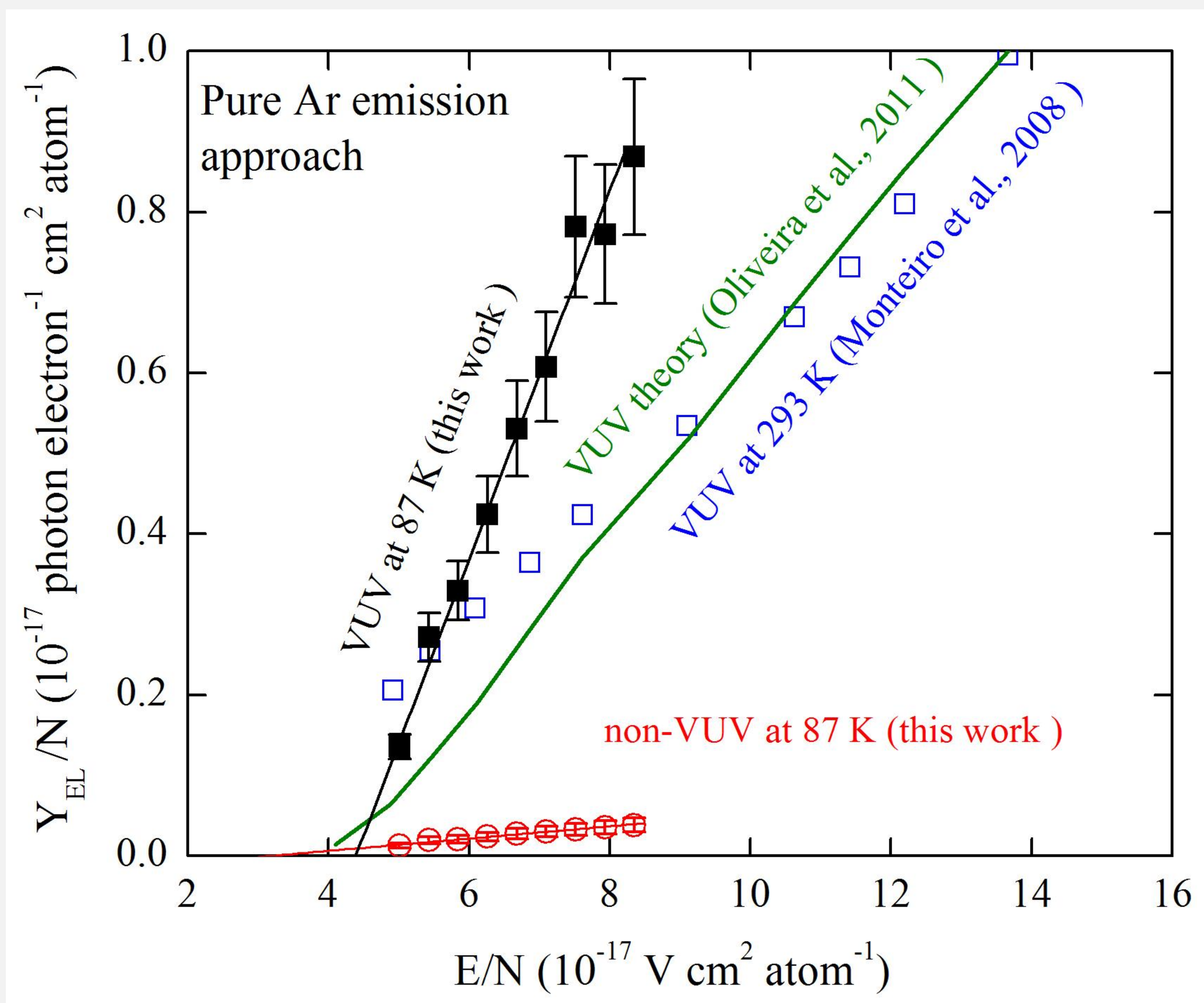
Typical picture of event: signals from the EL gap, namely the total optical signal from the PMTs, the charge signal from the THGEM1 and the optical signal from the MPPC, theirs zooms and histograms, obtained by calculation zooms areas.
Signals are induced by pulsed X-rays with the energy of 30-40 keV absorbed in liquid Ar, at an electric field of 6.8 kV/cm in the EL gap and 0.59 kV/cm in the drift region. Note that the ionization electron drift time, equal to the distance between the trigger indicated by a triangle and the PMT pulse peak, is about 31 µs.



Amplitude distribution of the total PMT signal from the EL gap at an electric field of 6.8 kV/cm in the EL gap and 0.59 kV/cm in the drift region, under irradiation with X-rays from ^{109}Cd+^{241}Am radioactive source.
V_{PMT} =700V



Left figure shows the PMT amplitude in number of pe (circles) and charge in number of electrons (squares) as a function of the electric field in the EL gap. Right figure shows EL gap yield measured using PMT (squares) and SiPM (circles) signals as a function of the electric field in the EL gap.



Reduced electroluminescence yield as a function of the reduced electric field in the VUV (Ar emission) and in non-VUV (modeled as N_2 2PS emission), determined in this work in gaseous Ar, in the two-phase mode at a temperature of 87 K and pressure of 1.00 atm. For comparison, the yields in gaseous Ar in the VUV obtained experimentally at 273 K (Monteiro et al.) and theoretically (Oliveira et al.) are presented.

Conclusions

1. **We continued a series of measurements of the EL yield in two-phase Ar, doped with a minor admixture of N_2.**
2. **We confirm the excess of the EL yield measured in experiment with respect to the theory, of about a factor of 2-3.**
3. **The contribution of non-VUV photons to the EL yield, measured with SiPM, amounted to about 5%.**
4. **Accordingly this EL excess cannot be explained by the N_2 emission contribution, in contrast to our previous interpretation of the data of 2015.**
5. **Resolving this problem is in progress.**

References

1. A. Buzulutskov, 2017 arXiv:1702.03612 p1-6
2. A. Bondar et al., 2017 NIM A845 206-209
3. A. Bondar et al., 2015 EPL 112 19001-p1-6