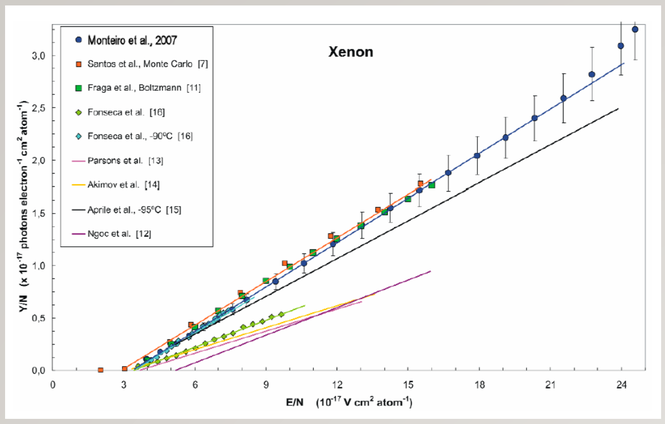
NEUTRAL BREMSSTRAHLUNG SCINTILLATION EMISSION IN XENON OPTICAL TPCS

Cristina M.B. Monteiro* (*cristinam@uc.pt)

LIBPhys, Physics Department, University of Coimbra, Portugal

On behalf of the NEXT collaboration

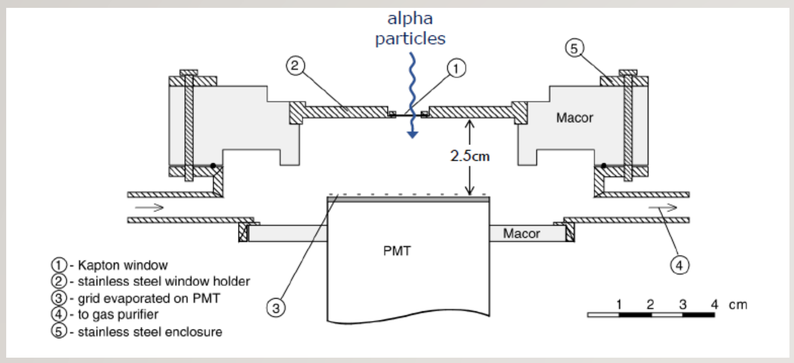
ELECTROLUMINESCENCE IN XENON

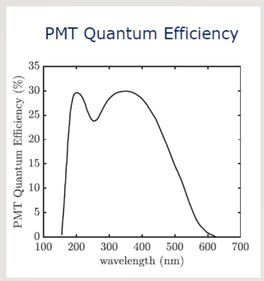


INTRODUCTION

We present evidence of non-excimer-based secondary scintillation in gaseous xenon, obtained using both the NEXT-White TPC and a dedicated setup. Detailed comparison with first-principle calculations allows us to assign this scintillation mechanism to neutral bremsstrahlung (NBrS), a process that has been referred to exist in xenon, but hitherto forgotten. For photon emission below 1000 nm, the NBrS yield increases from about 10^{-2} photon/e-/cm/bar for reduced electric field values of 50 V/cm/bar to above $3x10^{-1}$ photon/e-/cm/bar at 500 V/cm/bar. For pressure-reduced electric field values above 1.5 kV/cm/bar, as typically employed for EL, it is estimated that NBrS is present with an intensity around 1 photon/e-/cm/bar, about two orders of magnitude lower than conventional EL. Despite fainter than EL, our calculations reveal that NBrS can interfere, in either gas or liquid phase, with the ability to distinguish and/or precisely measure low primary-scintillation signals (S1). These backgrounds originate specially in the 'buffer' and 'veto' regions. Furthermore, we show that this new source of light emission opens up a viable path towards obtaining S2 signals for discrimination purposes in future single-phase liquid TPCs for neutrino and dark matter physics, with estimated yields of about 20-50 photons/e-/cm.

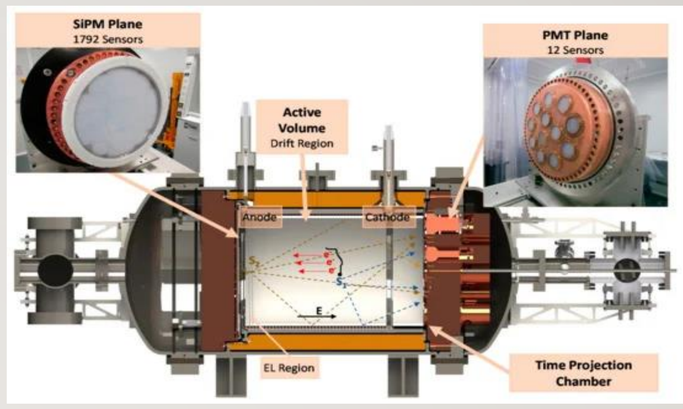
STUDIES IN XE: DRIFTLESS GPSC





- Dedicated setup: GPSC without drift-region
- 25-mm scintillation gap
- PMT: 52-mm diameter; spectral sensitivity: 155-625 nm
- Gas in a closed circuit, continuously purified by hot getters, SAES st707
- Xenon gas @ 1.24 bar
- Incident radiation: alpha particles from a collimated ^{241}Am source
- Mean energy deposition: 1.7 MeV; mean penetration depth: 2.6 mm

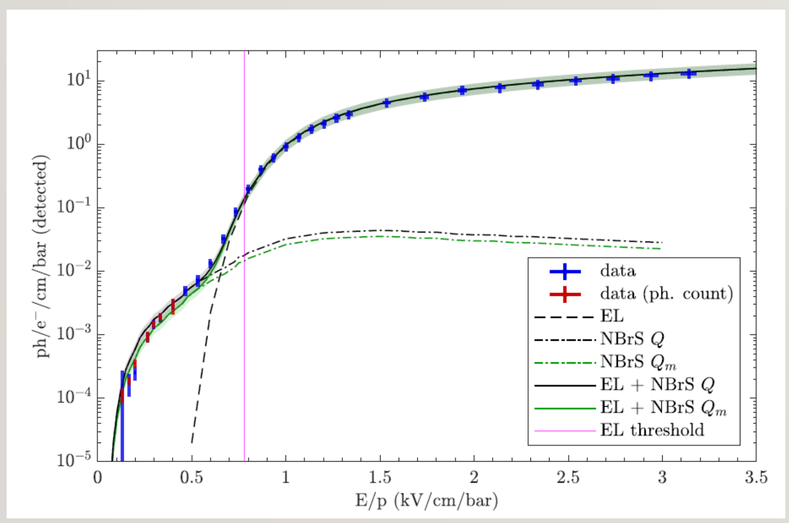
DETECTOR NEXT- WHITE (NEW)



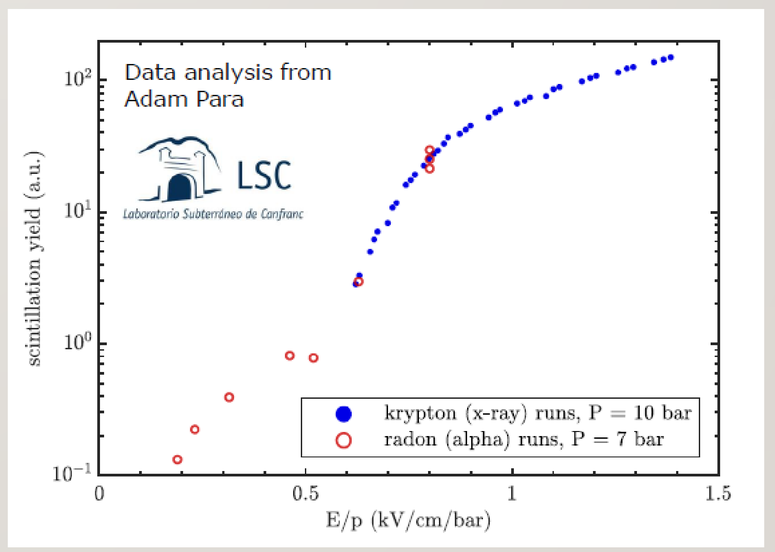
- 5 kg high-pressure xenon;
- Signal readout comprises 2 planes:
- 1) a plane of PMTs for energy measurement (S2, but also S1 start-of-event);
- 2) a SiPM tracking plane for offline topological event analysis and filtering.
- Xenon in a closed system, purified by a hot getter;
- Ionisation signal amplification : electroluminescence (EL gap ~ 6 mm);

NEUTRAL BREMSSTRAHLUNG IN XENON

IN GPSC - CONTROLLED CONDITIONS



IN NEXT-WHITE (NEW) TPC



CONCLUSIONS

- We present **unambiguous identification** of NBrS scintillation in Xe, supported by a predictive theoretical model;
- We have shown NBrS in NEXT-White, at present the largest optical HPXe-TPC in operation,
- We studied NBrS in a dedicated setup and implemented a robust theoretical model for NBrS,
- There is a significant photon emission in the range of 150-600 nm at electric fields well below the EL threshold detectable with standard sensors,
- The subthreshold emission is not based on excimer formation, since it is not quenched as ordinary EL emission,
- For EL-fields > 1 kV/cm/bar the NBrS contribution to secondary scintillation is <1%,
- BUT: it will be seen in the TPC buffer regions in the gas phase, between the high voltage electrode and the ground electrodes shielding the PMT planes,
- AND: relevant in a range of E/p values extending from those applied for secondary scintillation (1 kV/cm/bar) to typical drift fields of 100 V/cm/bar and down to the thermal limit (~ E/p = 10 V/cm/bar in pure Xe at room temperature).