

Development of single phase liquid xenon TPCs for future dark matter search

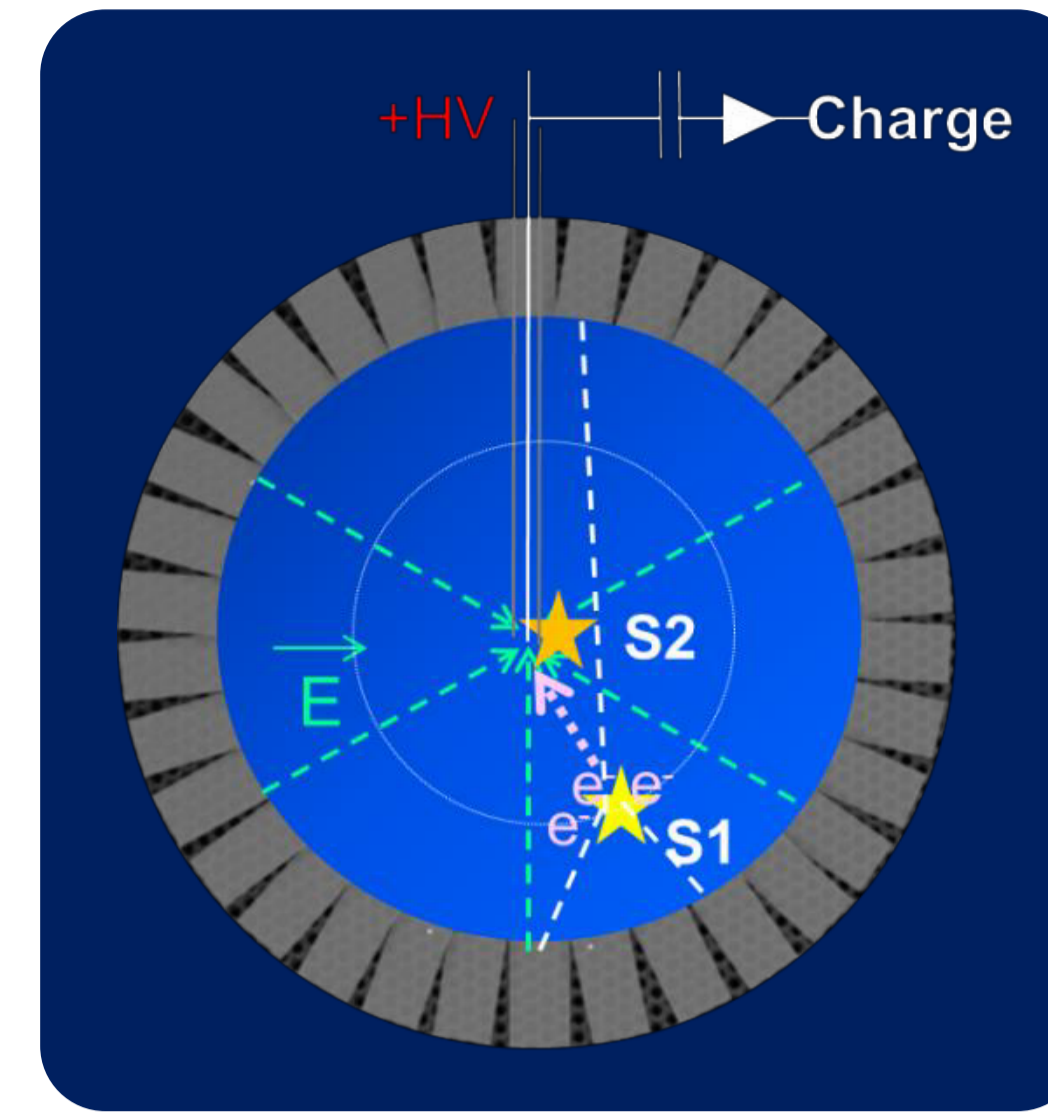
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Introduction

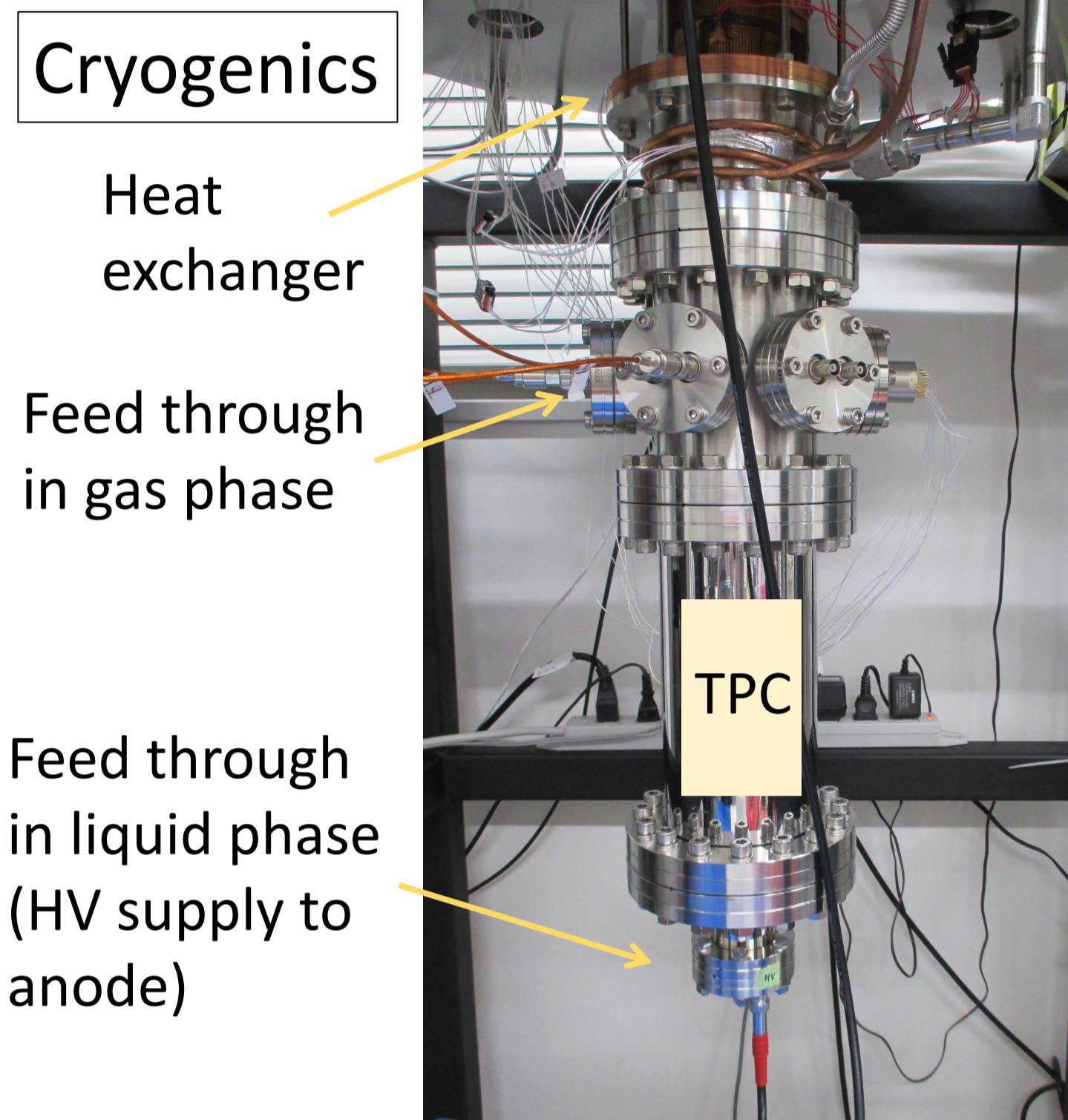
In direct dark matter search experiments, there are two types of detectors using liquid xenon(LXe), LXe scintillator (XMASS) and two phase TPC (XENON, LUX). TPCs could give good position reconstruction and also they can identify nuclear recoil signals and electronic recoil signals. For all that, we are developing a single phase LXe TPC in order to make it in a spherical shape which can utilize the effective shelf shielding of LXe and are free from the control of the liquid level.

For the spherical TPC, we have made a small test chamber of LXe. As a first step, we have investigated the property of S2 in LXe using thin anode wire. Currently, we are developing various electrodes for the central anode of the spherical TPC.

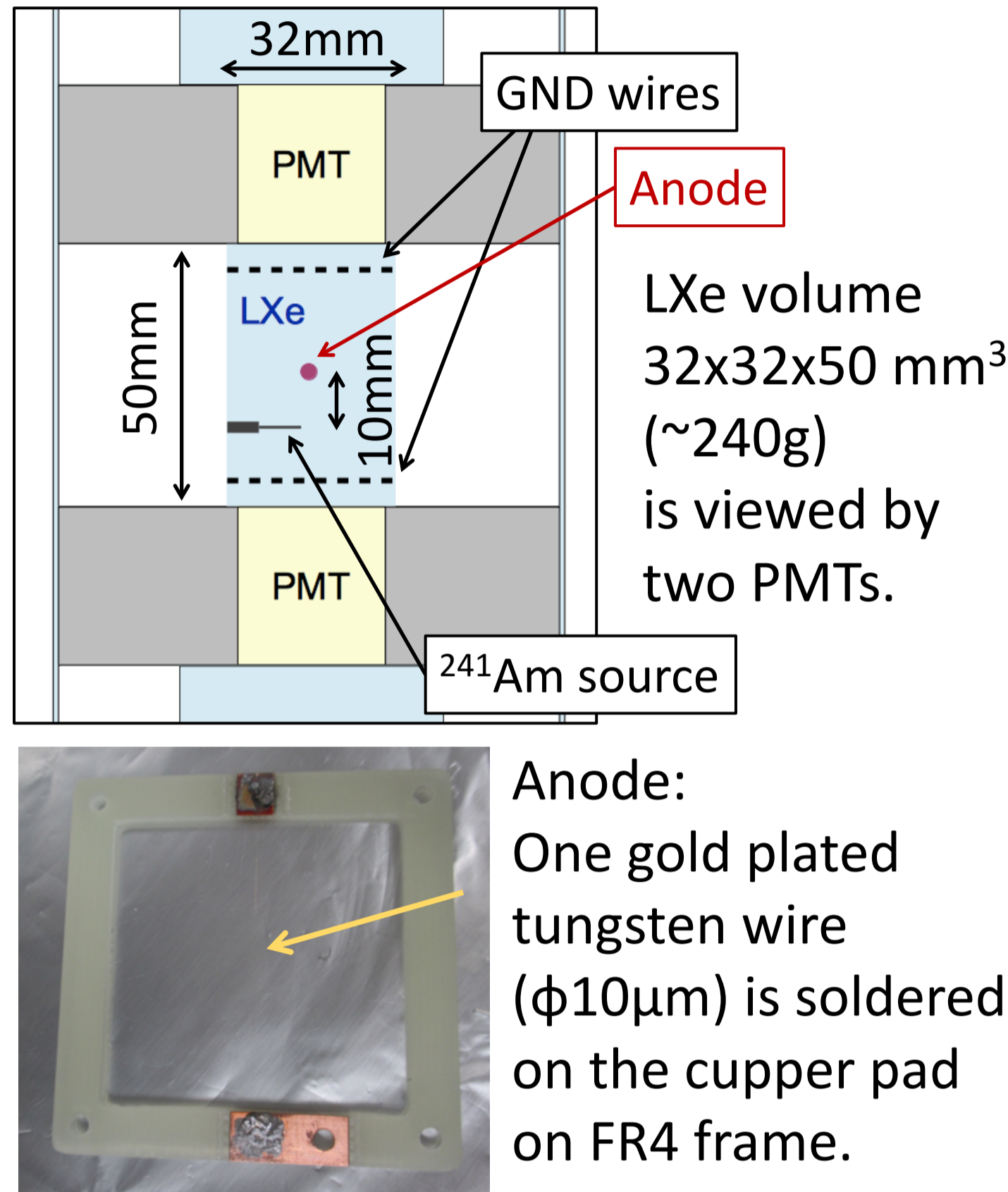
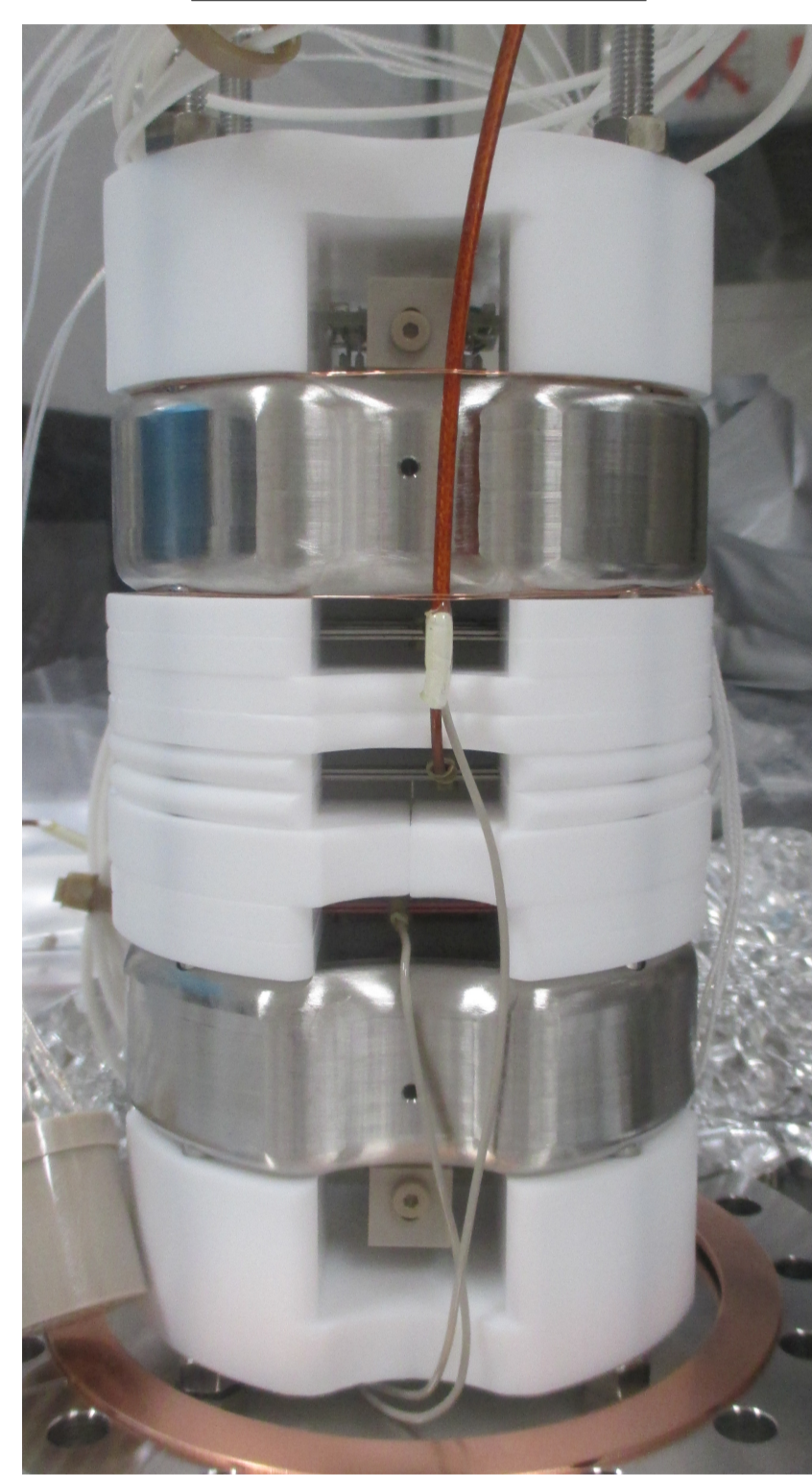


Schematic of spherical TPC. By applying electric field, ionized electrons drift towards the anode placed at the center of the detector. S2 is generated around the center anode through the charge amplifications or proportional scintillation.

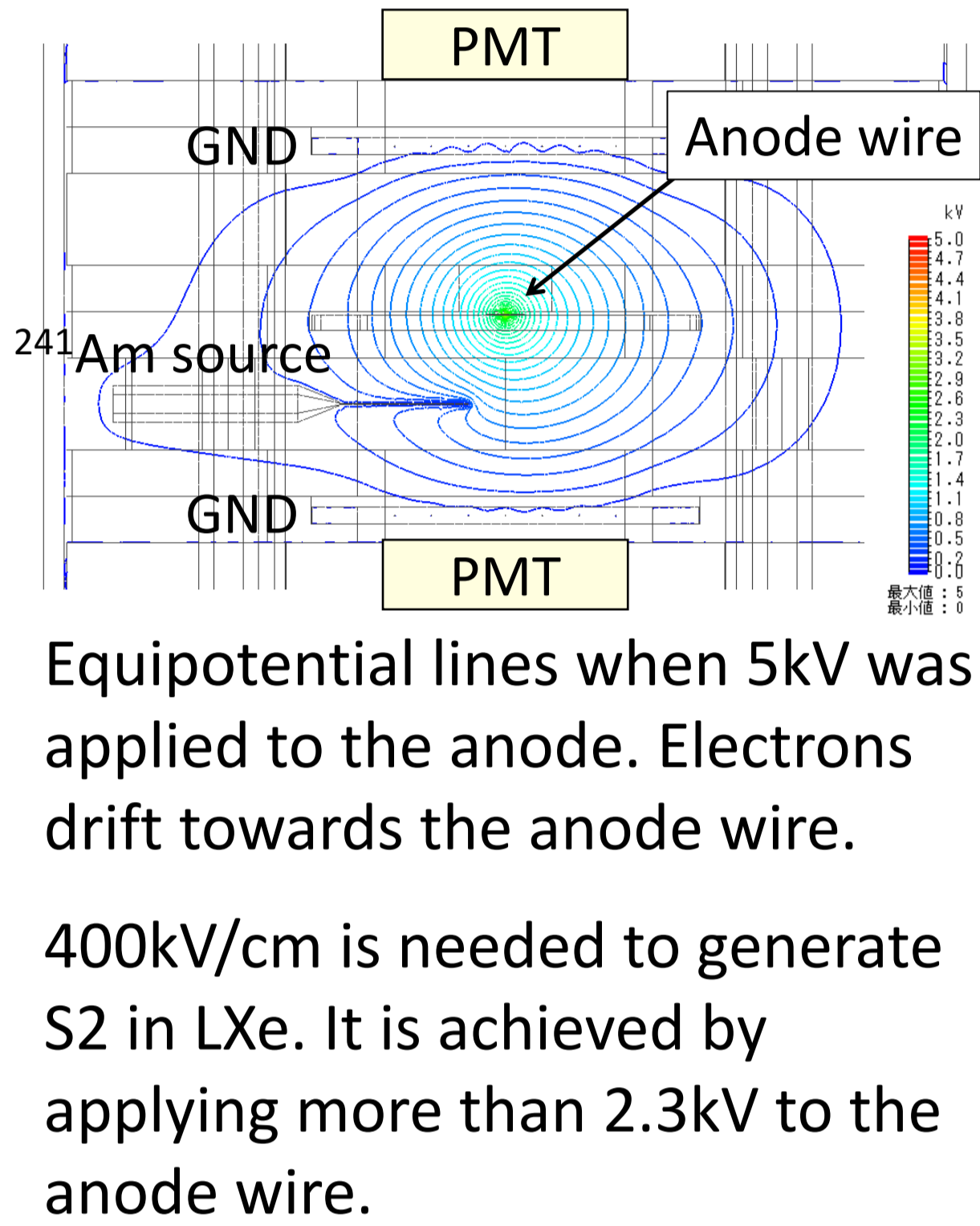
Experimental setup



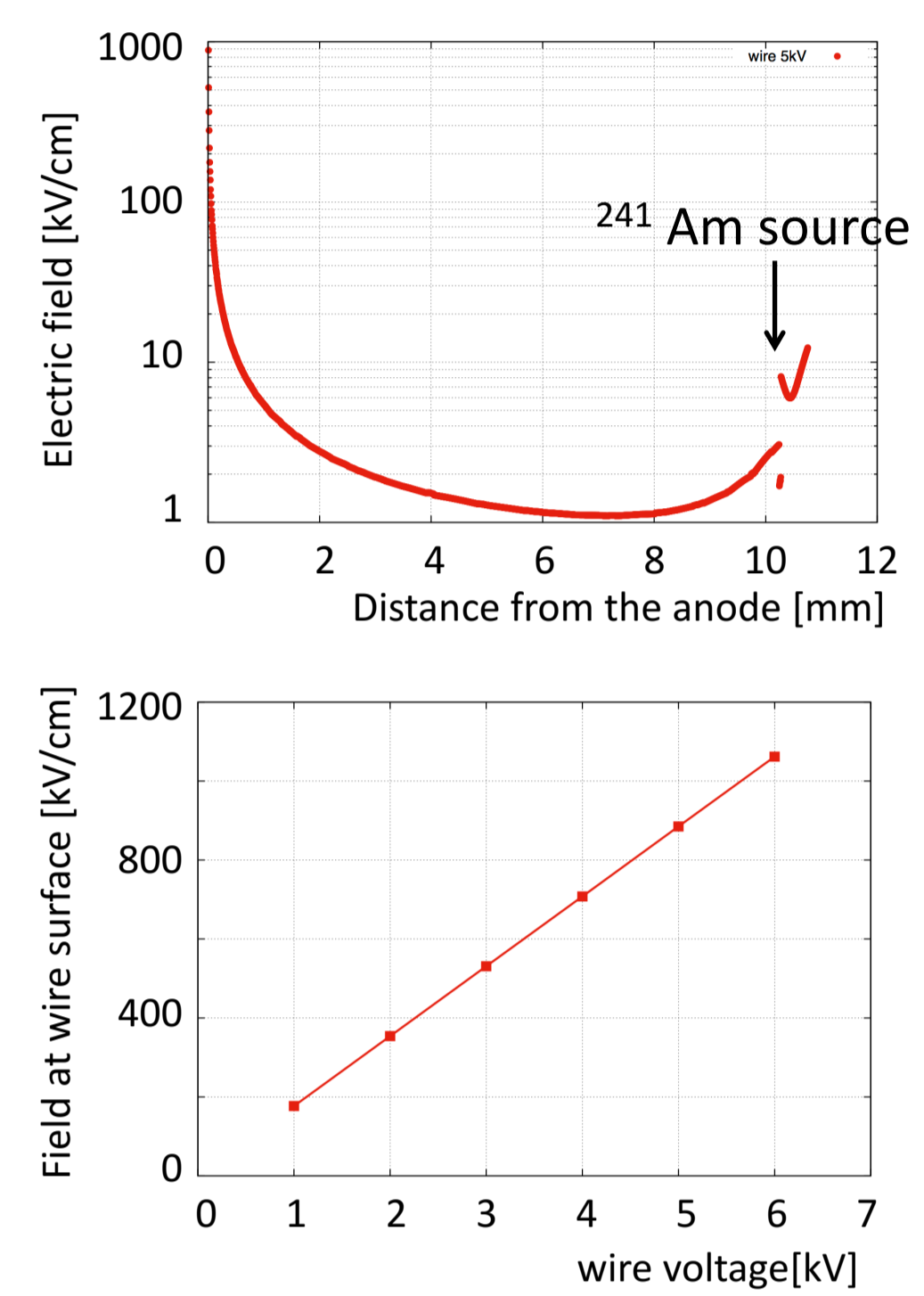
TPC setup



Electric field simulation



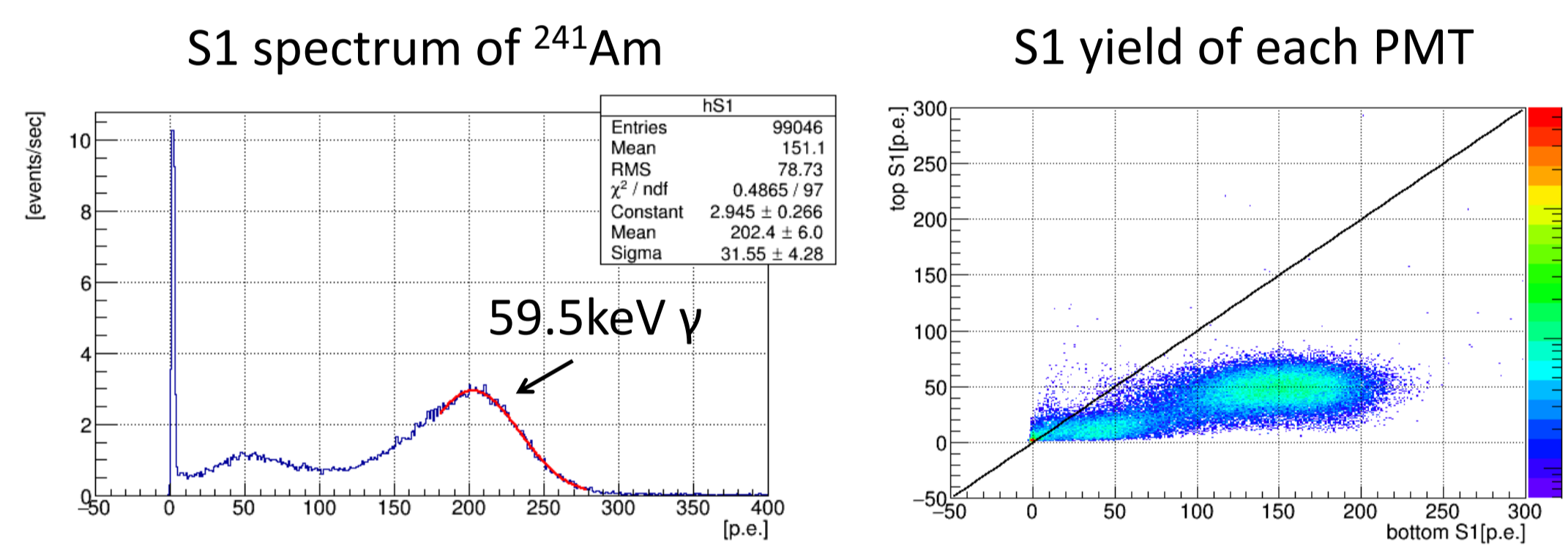
by FEMTET



Results

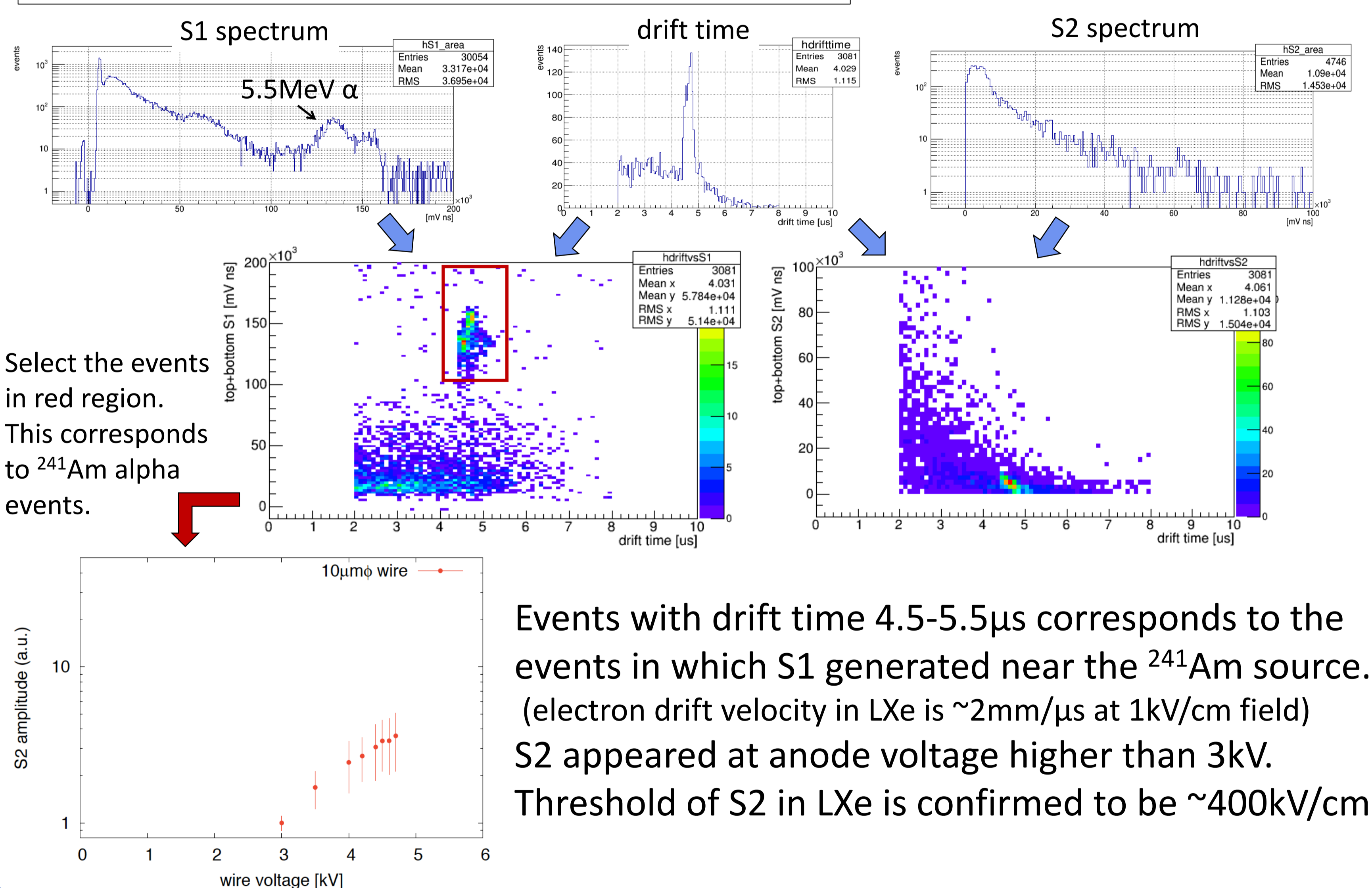
(1) S1 from ²⁴¹Am source

59.5keV gamma ray was used for calibration. Light yield of S1 was 3.4 ± 0.1 p.e./keV.

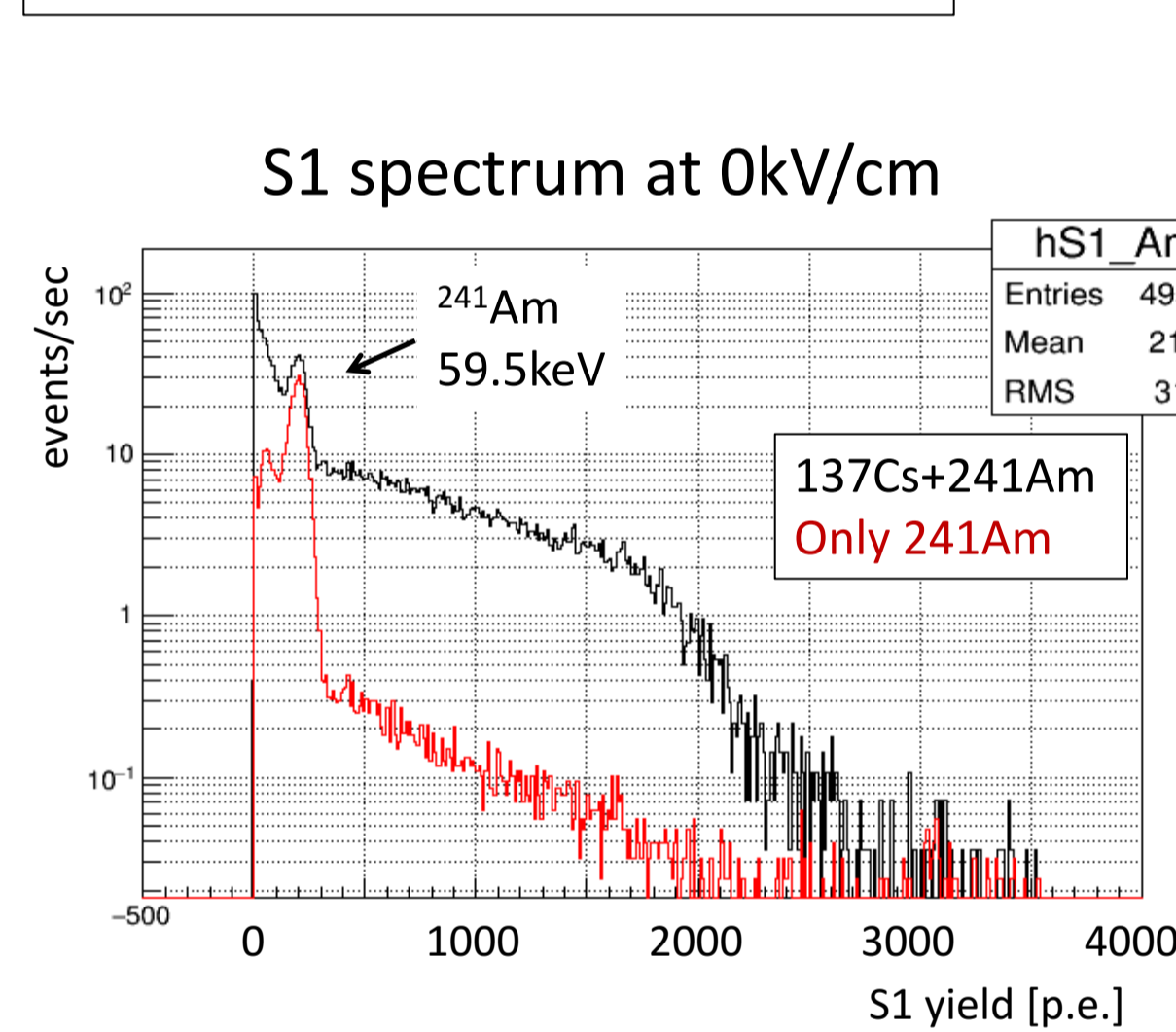


(2) S2 originated from ²⁴¹Am 5.5MeV alpha

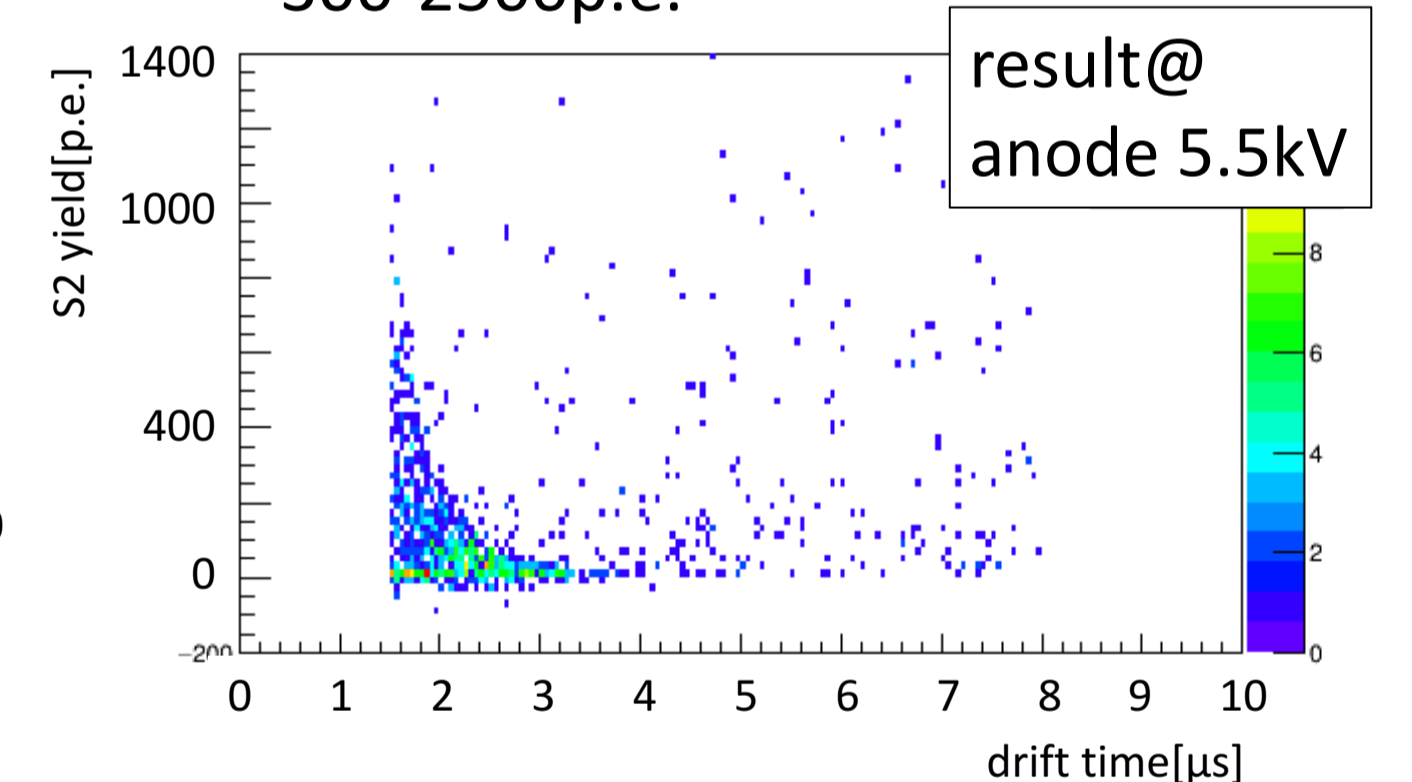
result @ anode 4.9kV



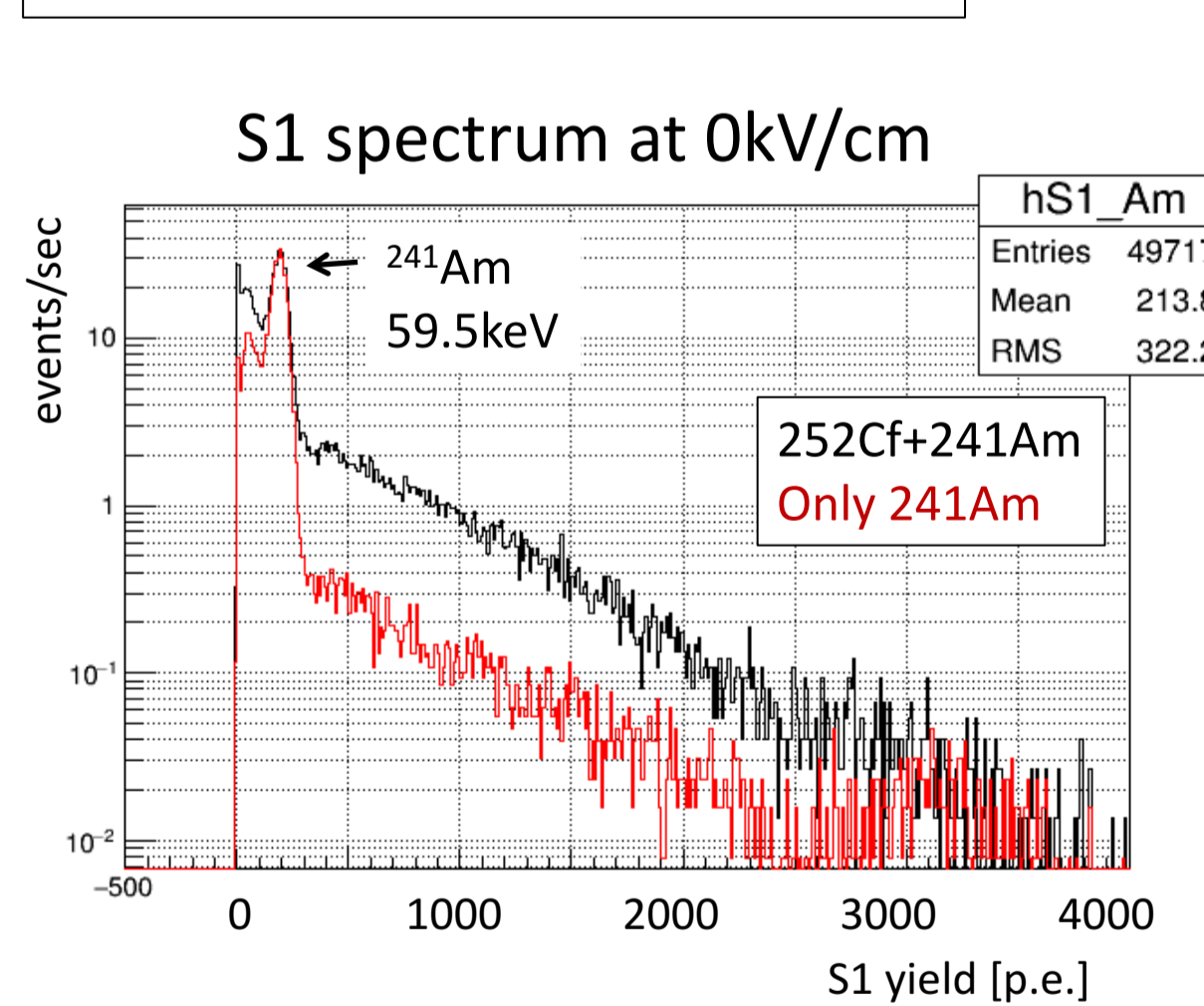
(3) ¹³⁷Cs irradiation



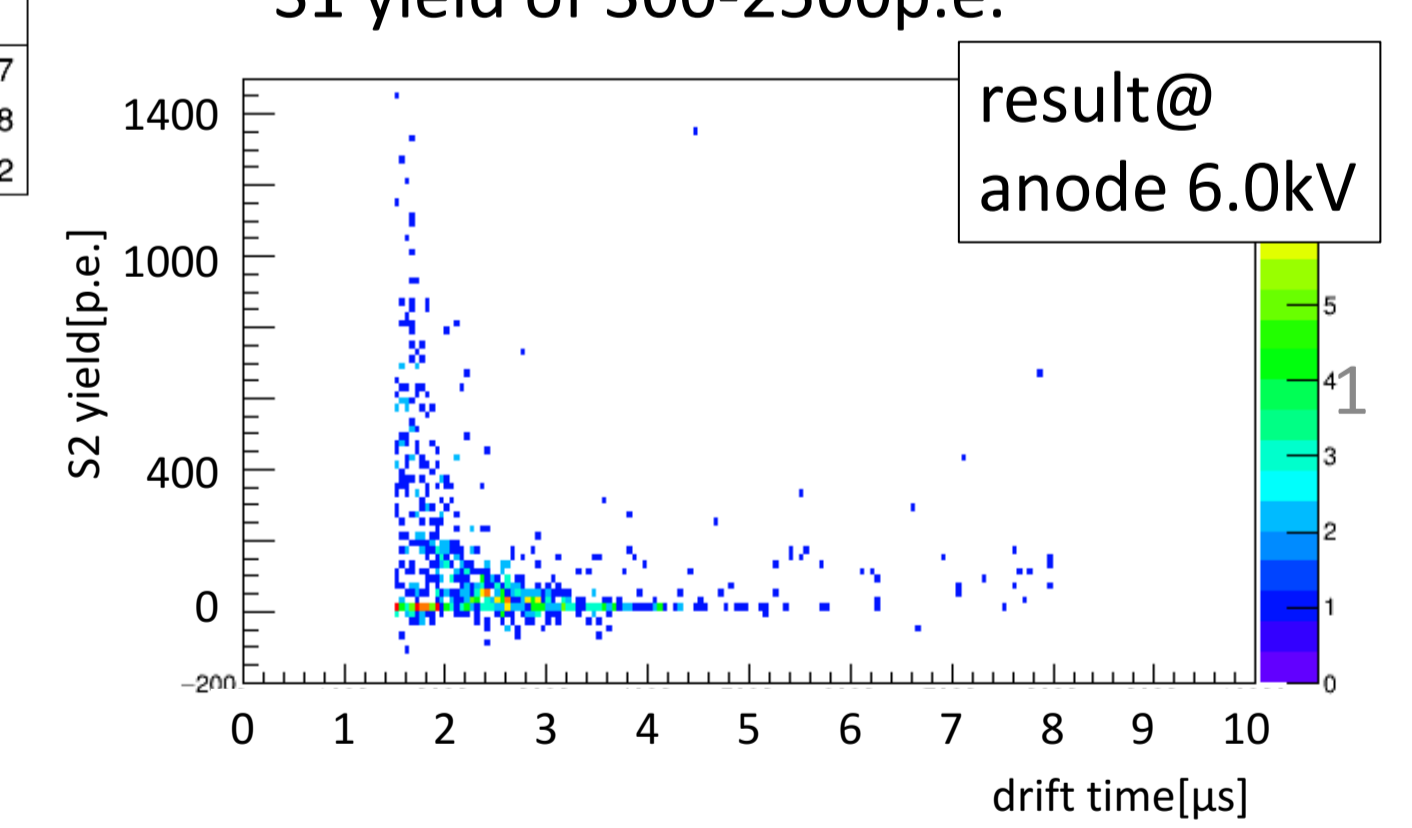
S2 generated events with S1 yield of 300-2500p.e.



(4) ²⁵²Cf irradiation



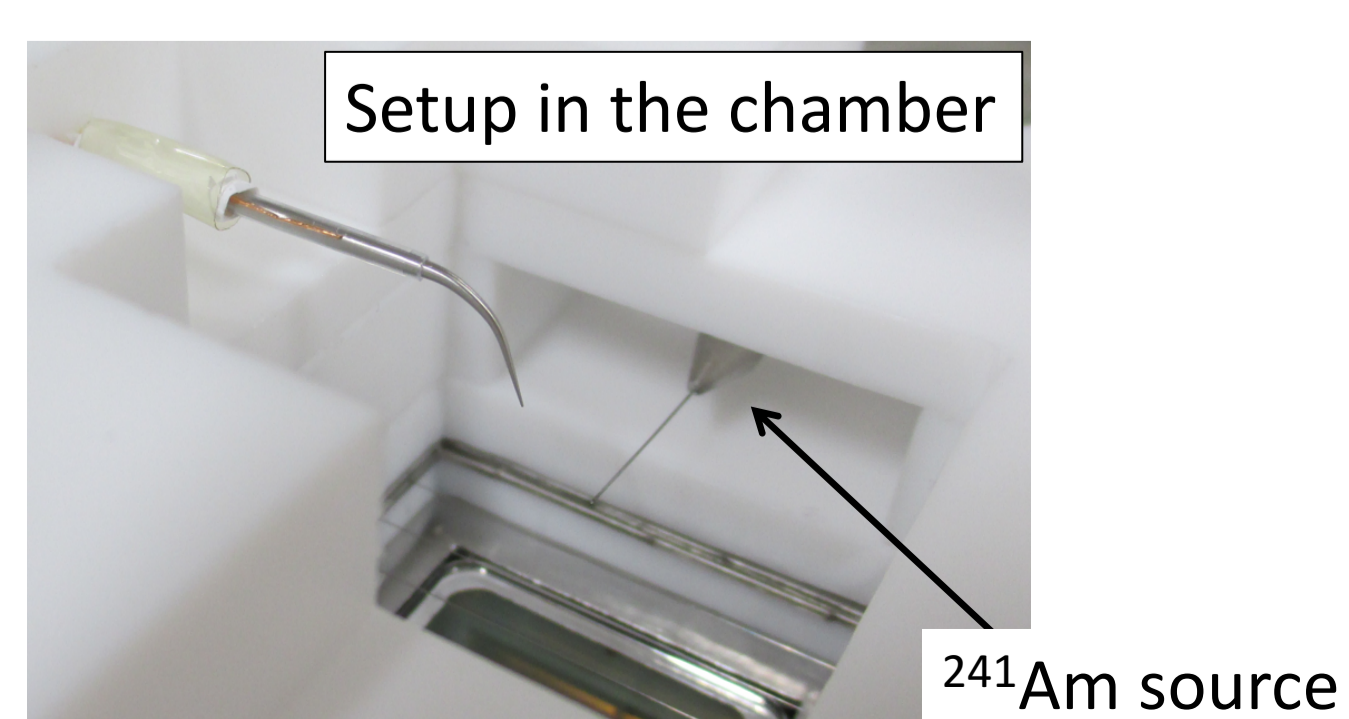
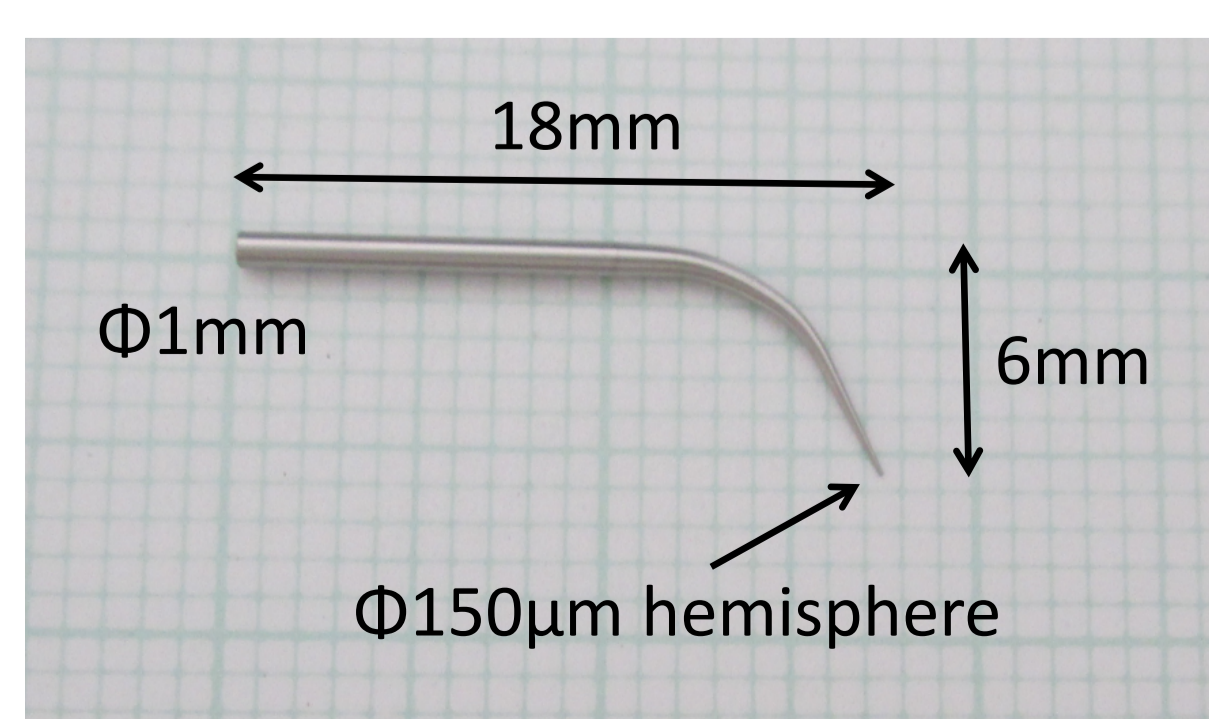
S2 generated events with S1 yield of 300-2500p.e.



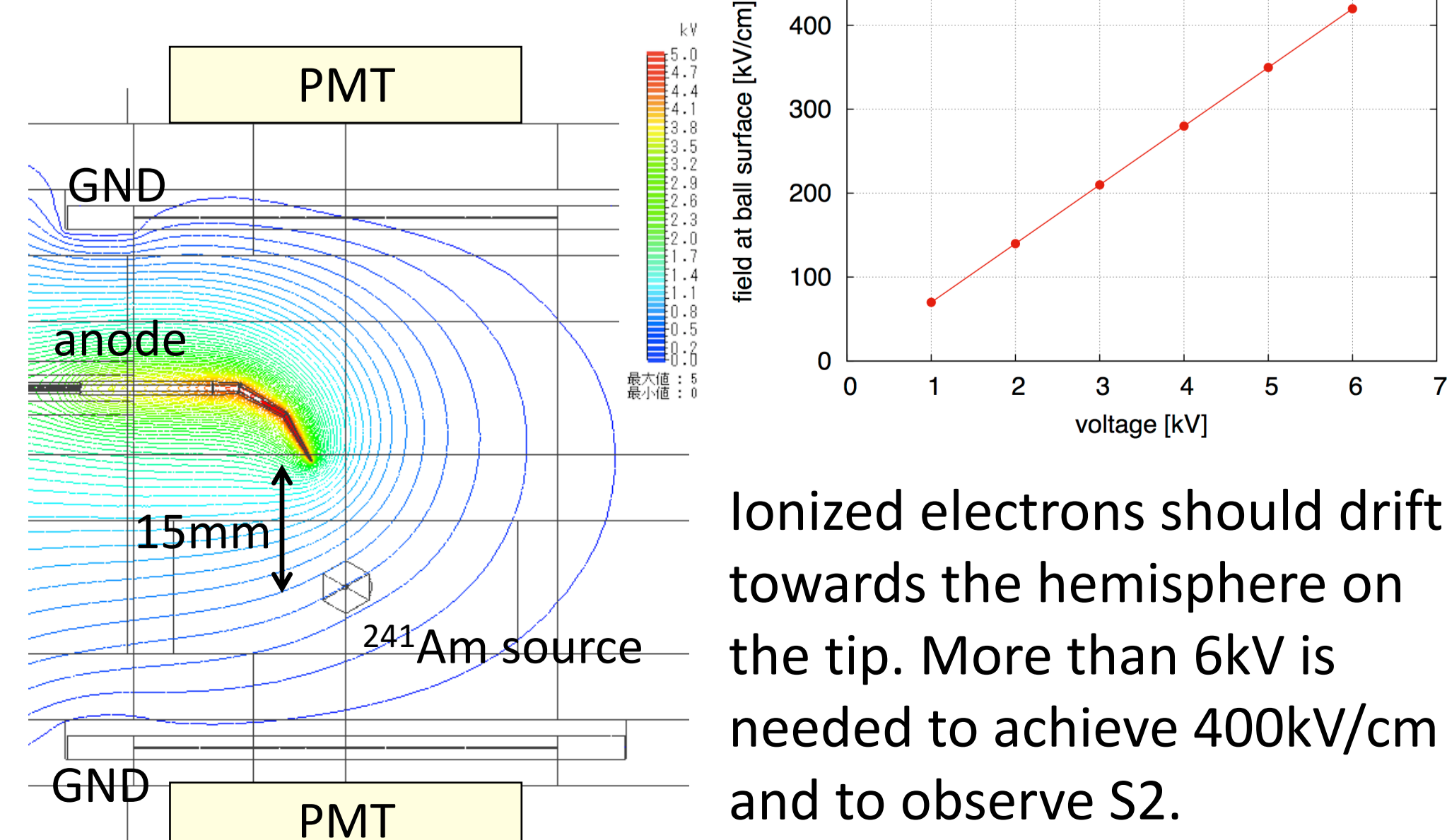
S2 originated from ¹³⁷Cs source and ²⁵²Cf source were observed. Most of the S2 generated events have drift time shorter than 3μs. These events corresponds to the events which S1 occurred near the anode wire.

Needle-shaped anode

For a spherical TPC, we need to set the anode at the center of the detector. Instead of the wire, we developed a needle-shaped anode to achieve strong electric field at the needle tip.



Electric field simulation



We are going to test "echinus" shaped anodes to make a high enough and more uniform electric field so that the electrons near the wall of the detector can be collected to the center.

