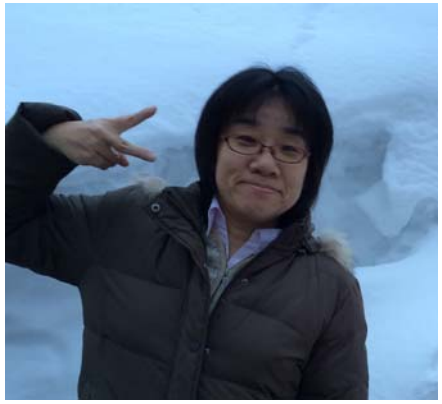
# AXELプロジェクト

**A.K.Ichikawa, Kyoto university**

**for the AXEL collaboration**

# AXEL group



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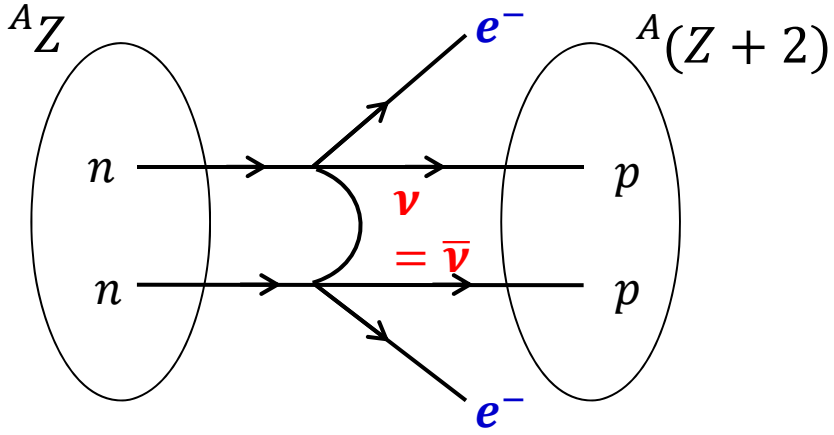
# neutrino-less double-beta ($0\nu\beta\beta$) decay

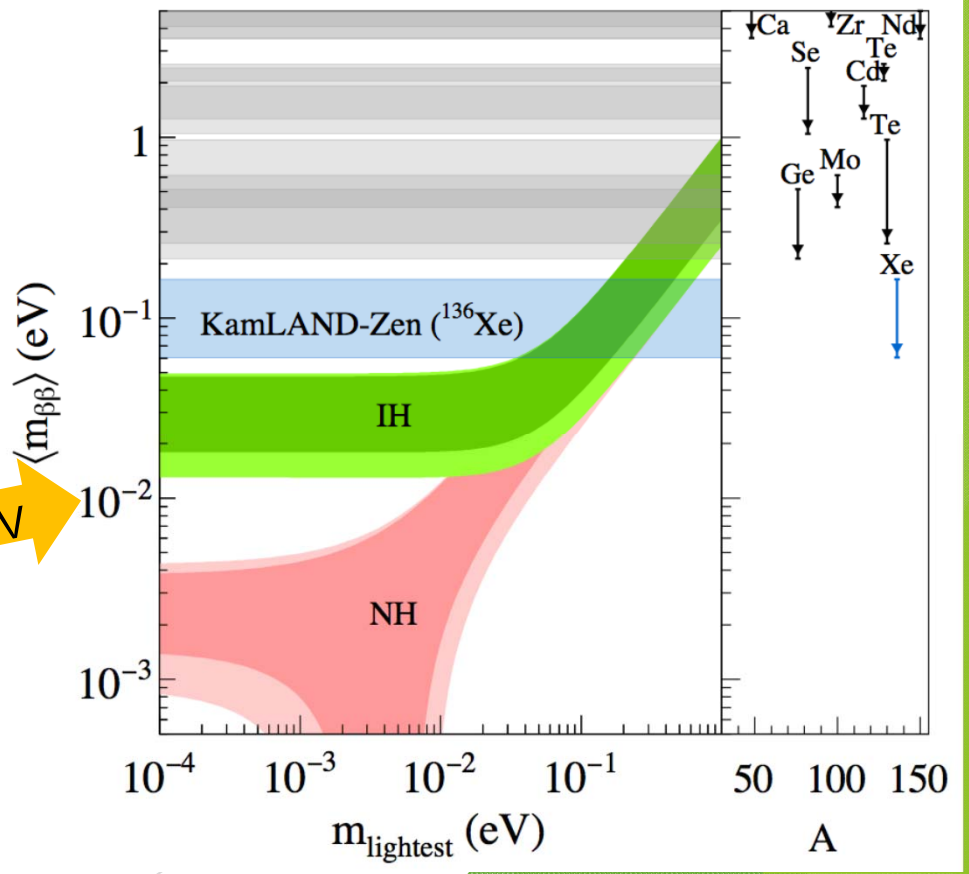



- happens if neutrino is its own anti-particle (Majorana type) and has Mojorana mass components.
- Next generation experiments are aiming to cover here, but…

  Life time $\propto m_{\beta\beta}^{-2}$

Need > 1 ton double-beta nuclei

J.Shirai, Neutrino2016

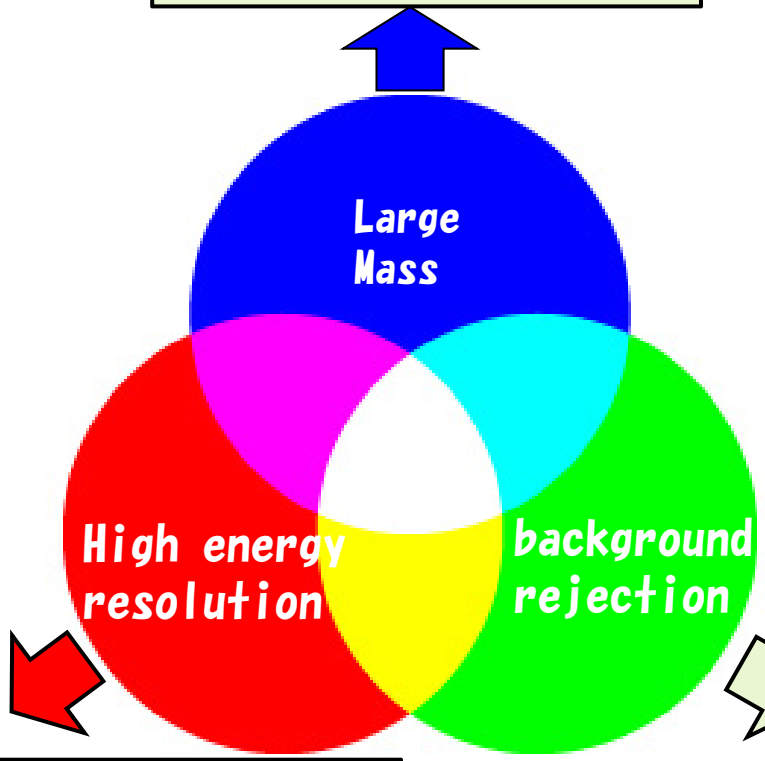


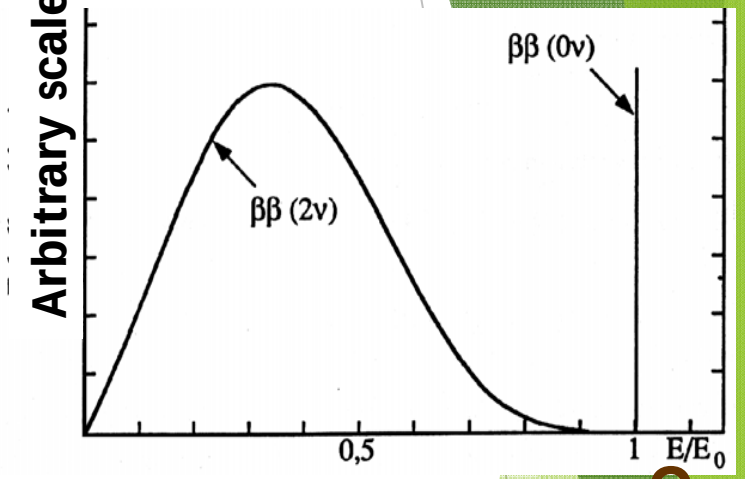
# Keys for $0\nu\beta\beta$ decay search and our approach

$^{136}Xe$

abundance : 8.9%

$Q_{\beta\beta} = 2.48$ MeV




Semiconductors, bolometers and

Ionization of noble gas!

tracking detectors

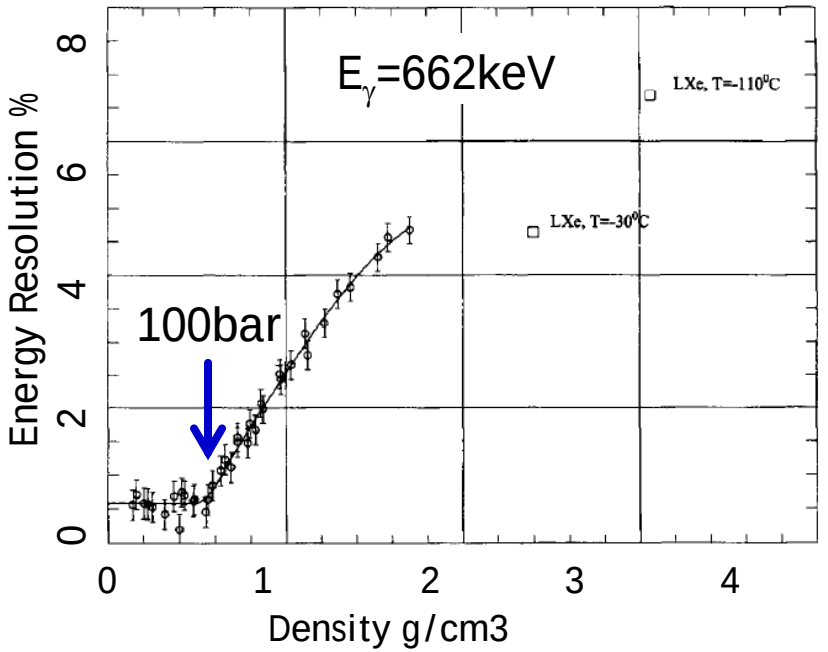
# High Energy resolution by Xenon proportional scintillation mode (Electroluminescence from ionization electrons)

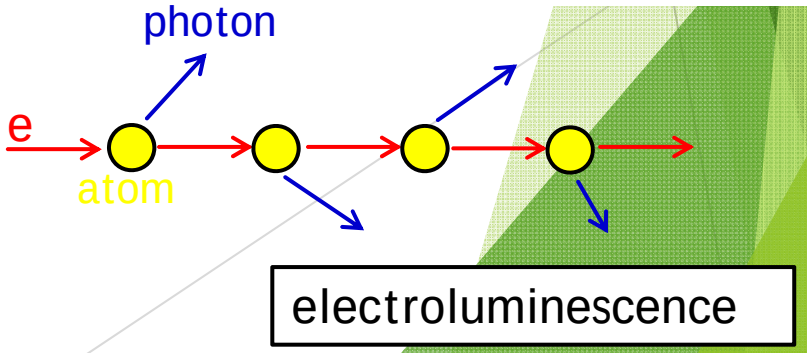
- W-value 21.5 eV, Fano factor<0.17
  - → 0.29%(FWHM)@2.48MeV
  - → comparable to semi-conductors!

  c.f. Ge 0.2%, EXO ~3%, KamLand-Zen ~9%
- At higher density, energy resolution becomes worse.
  - → reject liquid option.
- Proportional Scintillation mode using electroluminescence lights
  - linear process →Good linearity and stability
  - #photons ∝ voltage drop rather than the field strength.

There is already pioneering work by D.Nygren and the NEXT collaboration

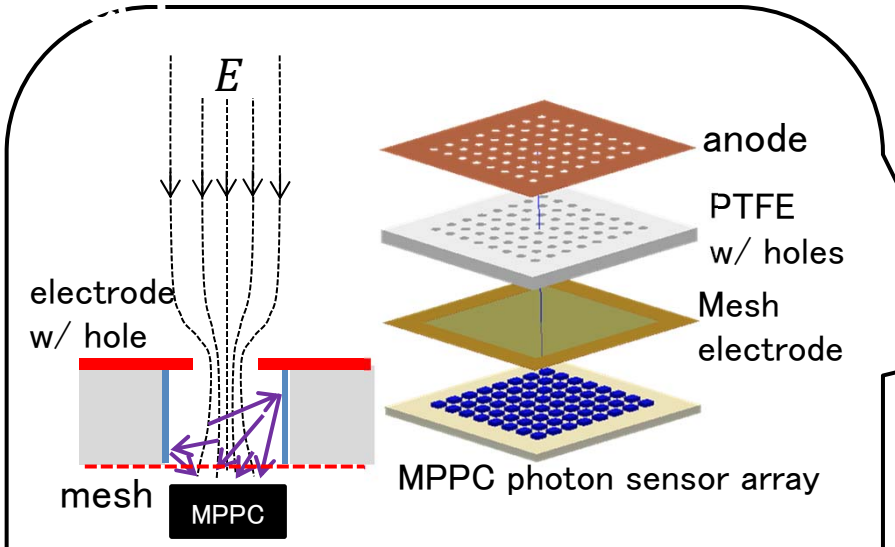
A. Bolotnikov, B. Ramsey Nucl. Instr. And Meth. A396(1997) 360

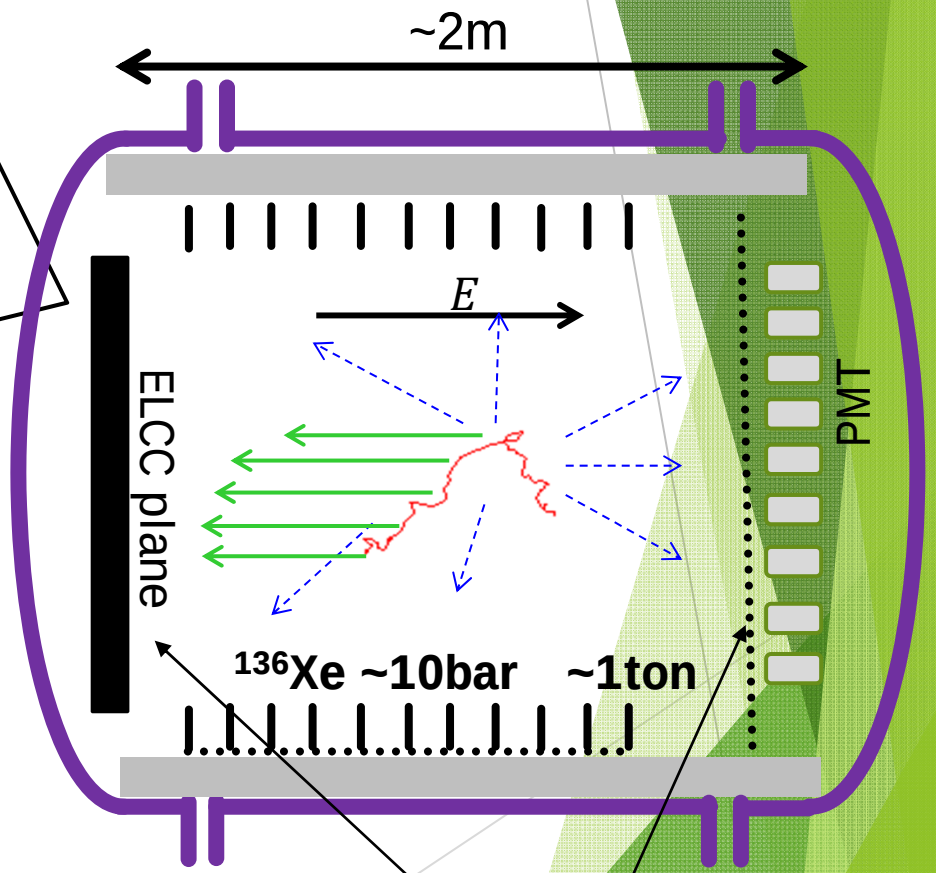


# What we propose in the AXEL project

## Electro luminescence light collection cell

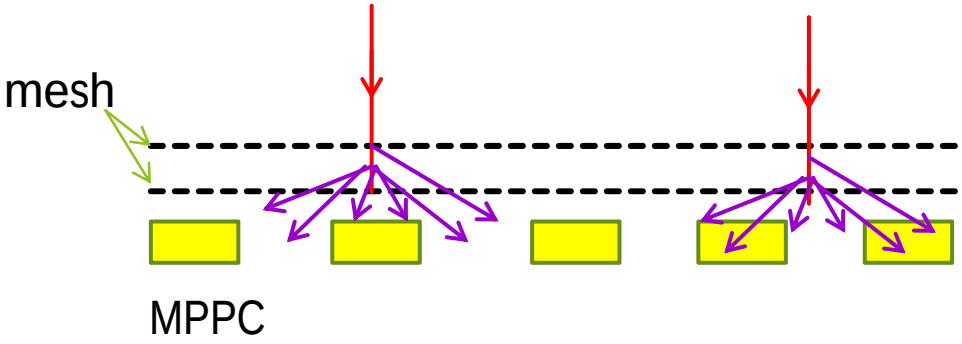


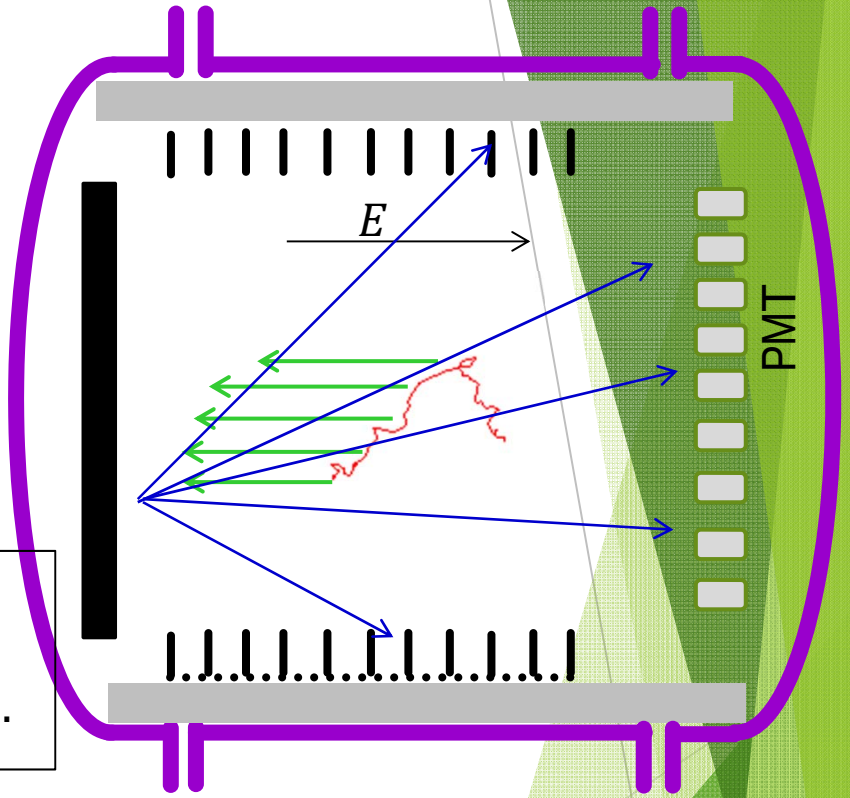

High energy resolution
(goal: <0.5%(FWHM))

Background rejection by event topology

# Why ELCC?



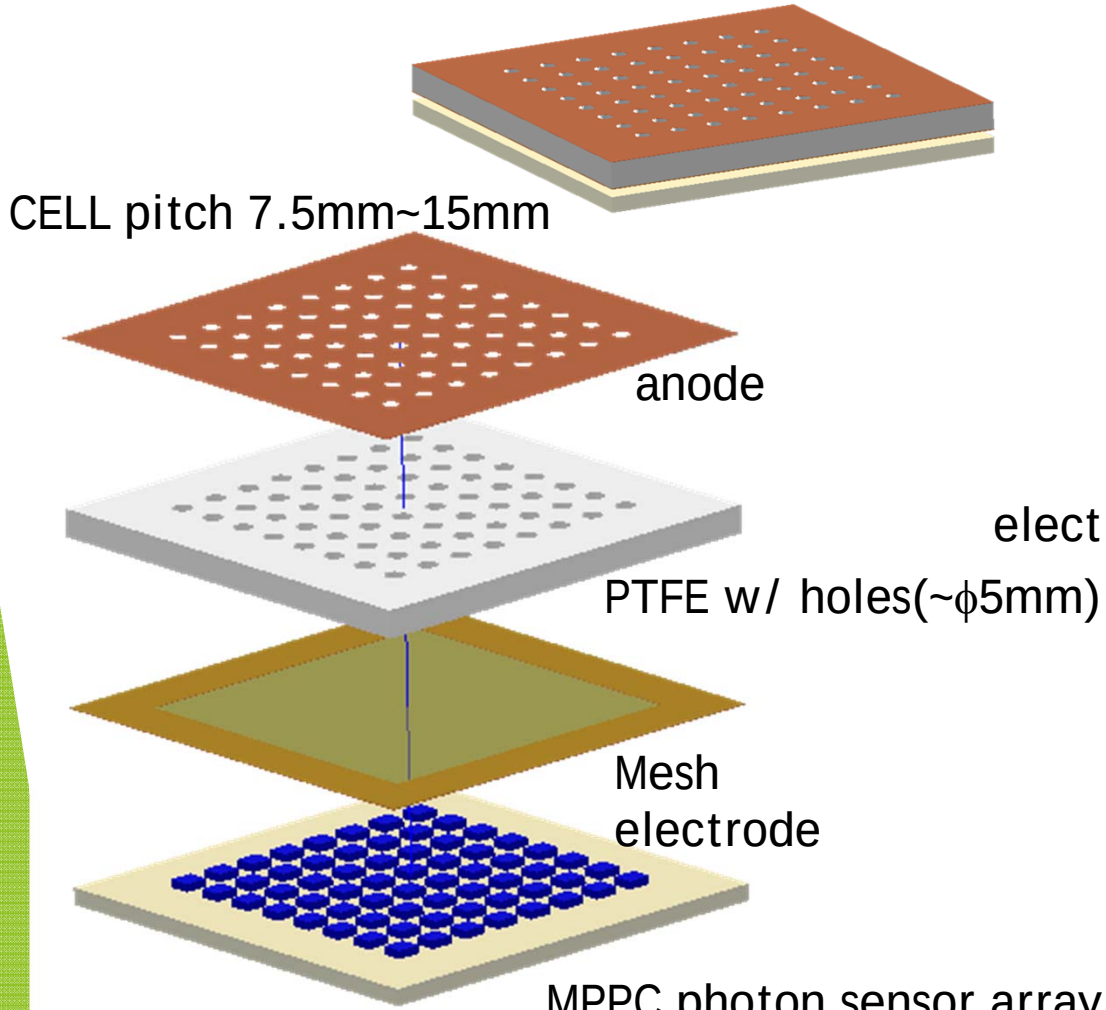

Case : sensors are placed very close to meshes.

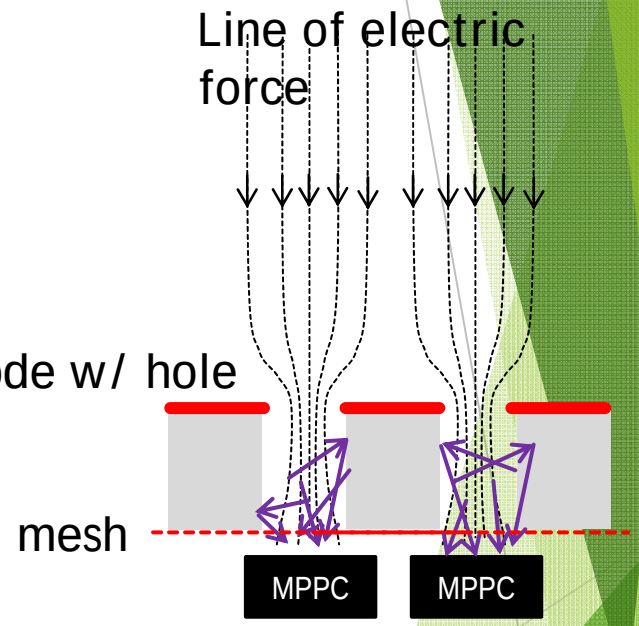



Case : sensors are placed far end to meshes.

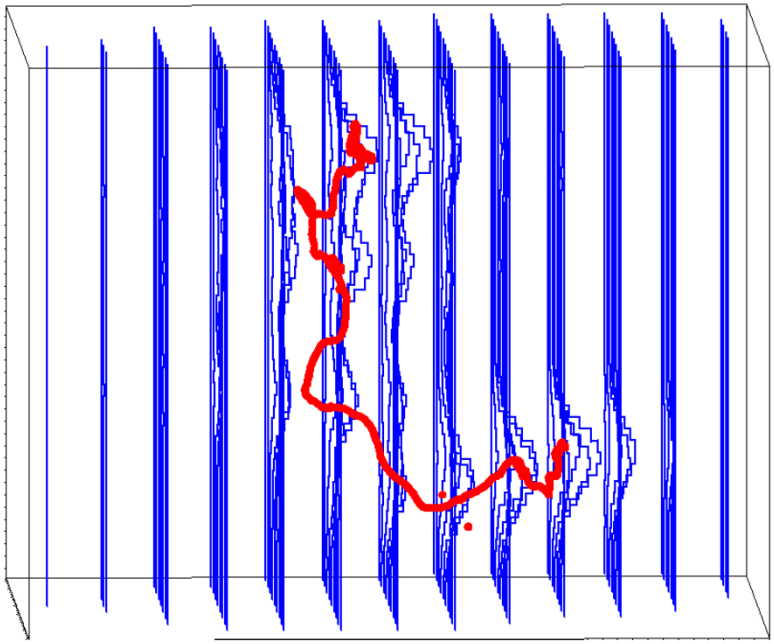
Usually, photo sensor arrays and meshes are used.
Then acceptance to EL photon changes depending on the EL gen. position. $\rightarrow$ worsen energy resolution

# ELCC
## -ElectroLuminescence Light Collection Cell -




- Uniform response in wide area
- extendable to large size with the rigid structure

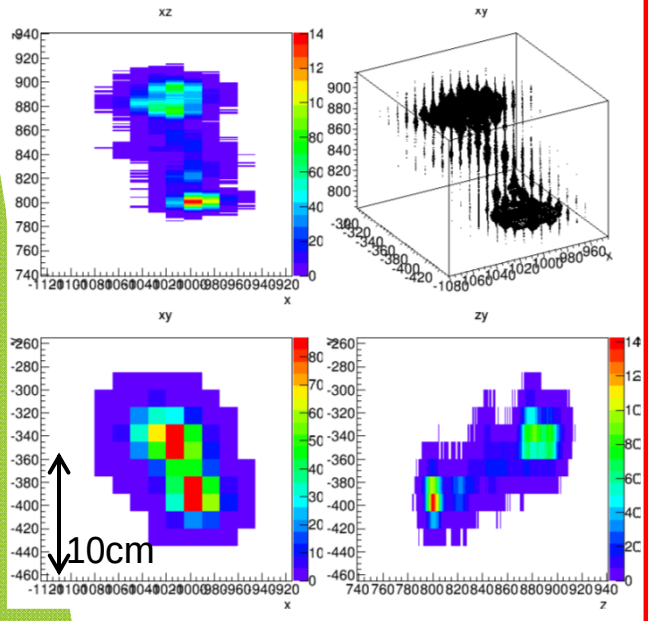


# AXEL
## -Expected event topologies-

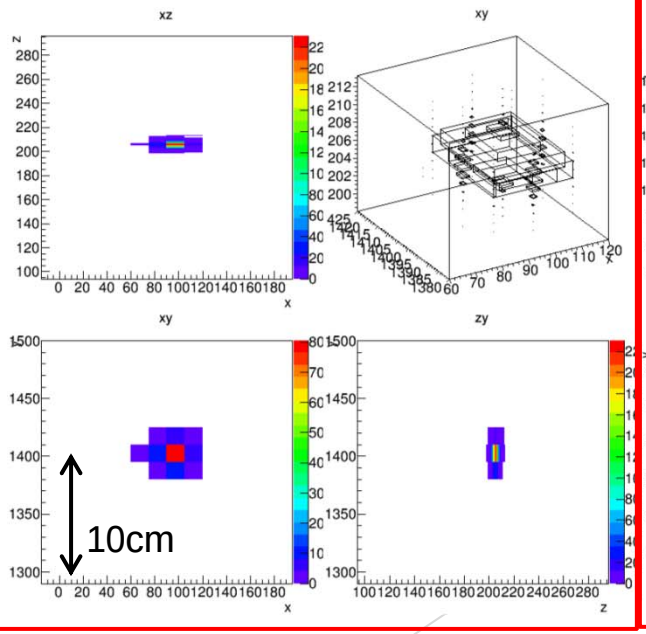
simulation

10atm, 15mm pitch, 1μs sampling (~1mm)

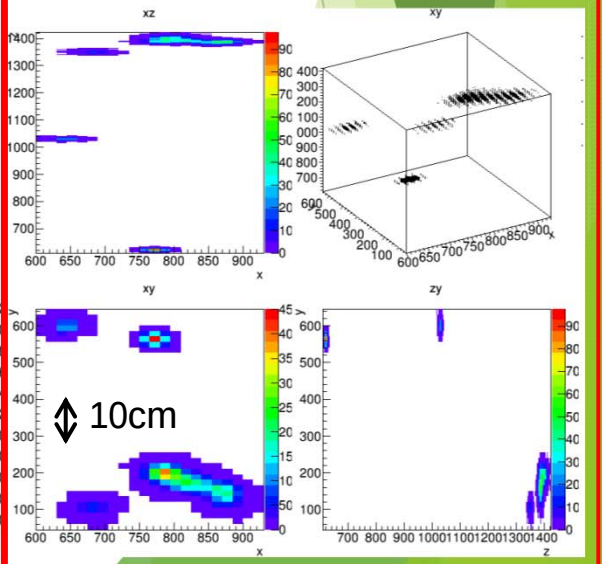
### 0νββ




### α

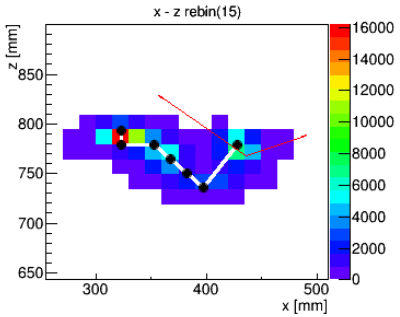


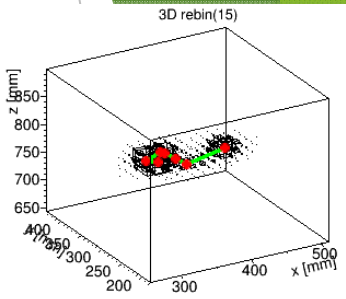

### Compton γ

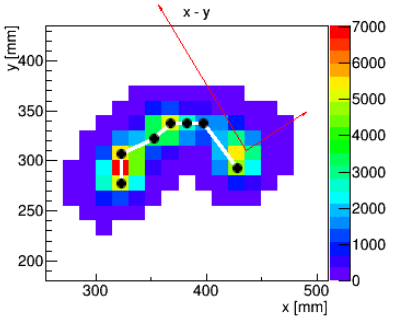


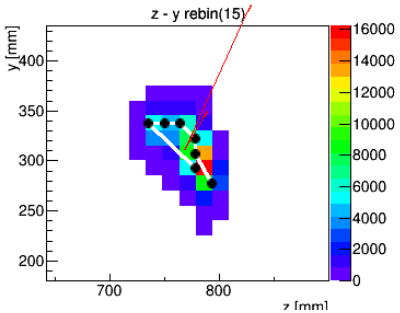
# (very) rough sensitivity estimation for 1-ton detector

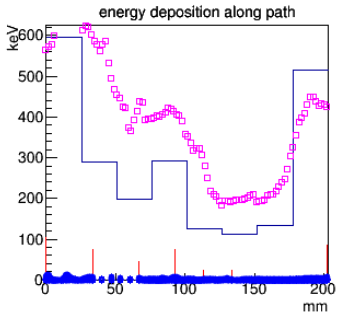
- 10bar 1ton enriched $^{136}$Xe
- Signal
  - ✓ a few events/year @ $m_{\beta\beta}$=20meV
    - 79% contained in fiducial volume
    - 49% after clustering
    - 22% after blob-recognition
- Background
  - ✓ Only $^{214}$Bi considered now. (cannot be separated by *E*)
  - ✓ 10 ton low background(3ppb) material
    - 12k evts/yr in fiducial
    - 75 evts/yr after clustering
    - 7 evts/yr w/ blob-recognition
  - ✓ considering thin vessel in pressurized wator
    - 0.1 evts/yr



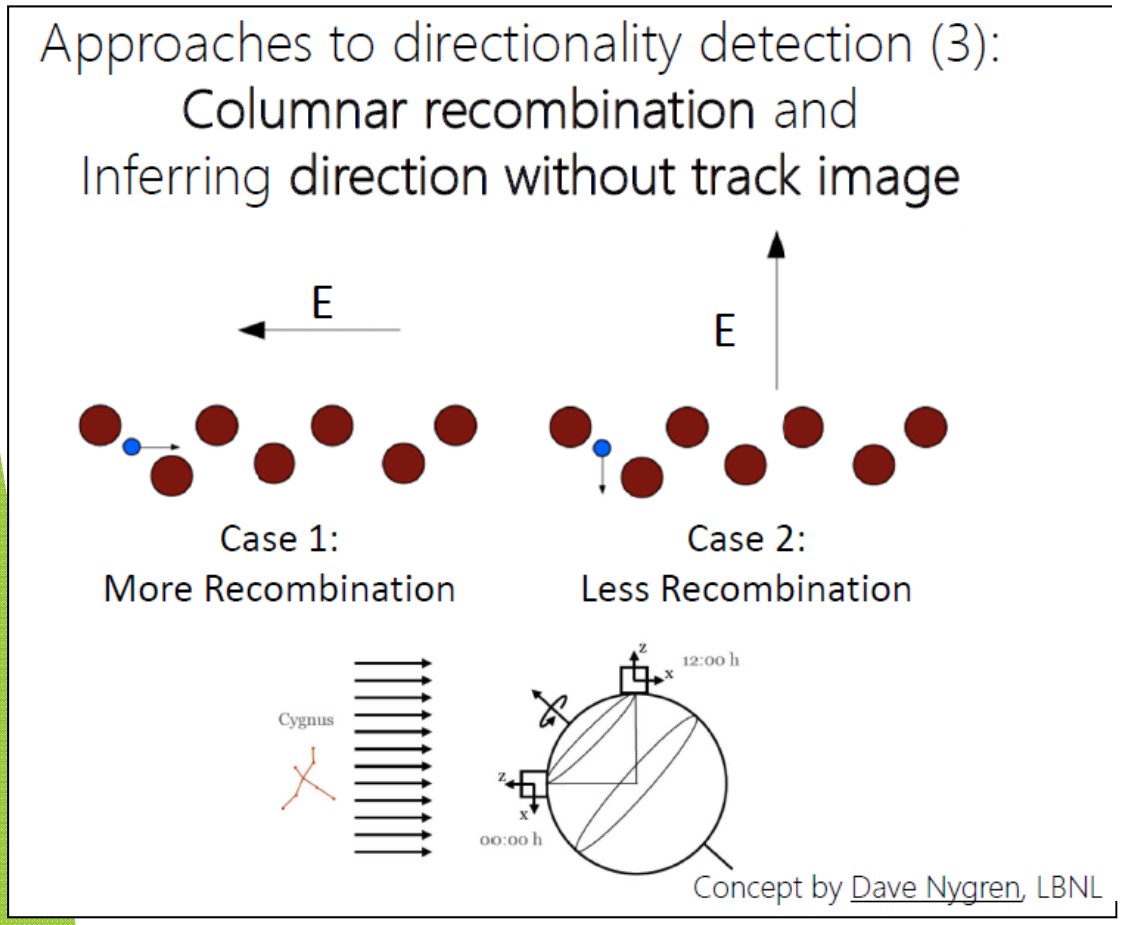




Recognition of track with a blob at both ends. (algorithm optimization still in progress)

柱状再結合で暗黒物質探索をしよう！

だくアクセル

Dark AXEL




- Measure recombination rate by comparing scintillation yield and ionization yield
- Observed in Xe+TMA for $\alpha$ (D.C.Herrera et al. 2015 Proc. of Sci. TIP2014 057), but scintillation suppressed.
- 別の方法を模索中
  - 磁場をかけたがうまくいかなかった。今は、別の方法でデータ取得中

# comments & timeline

- ELCCの原理検証は、かなりできた。
- 近々の課題
  - 高電圧をてなづける
  - コストダウン
  - 次の予算獲得
- スケジュールの目標
  - 2017-2017: 180L検出器　キセノン量 8.6kg @ 9気圧, 1146ch

    1.8MeVで性能実証
  - 2017?~2020?：2,000L検出器 phase 0, キセノン量 100kg@9気圧,約6,000ch
  - 2020? -：2,000L検出器に136Xeを入れて世界記録更新を目指す
  - 202? -　1トン検出器製作に着手。
- 20 meV、そしてその先に行くには、もう一ひねり必要。
  - いくつかアイデアはあり。ただし、もちろんstraight forwardではない。が、なんとか、もう一アイデアものにしたい。