Magnetic tracking detector **DCBA** /**MTD** for neutrinoless double beta decay experiments

DCBA: **D**rift **C**hamber **B**eta-ray **A**nalyzer
MTD: **M**agnetic **T**racking **D**etector (temporary)

Nobuhiro ISHIHARA (KEK) for the DCBA collaboration

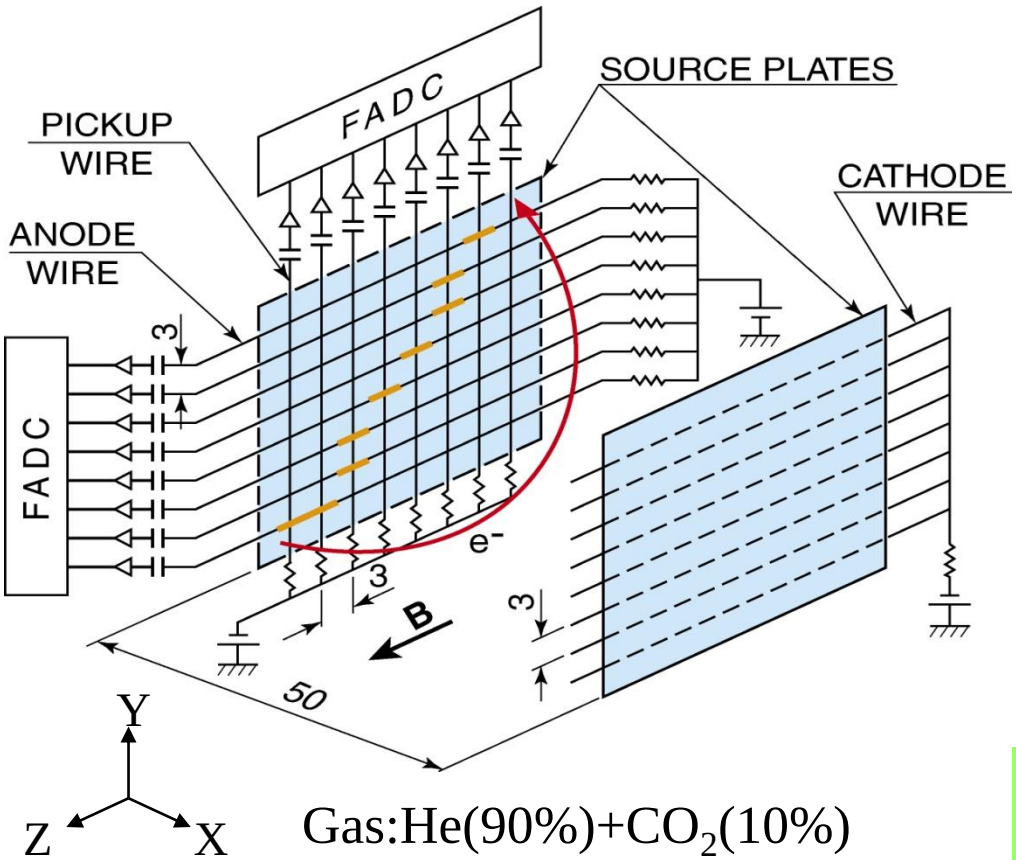
Contents

Introduction

- DCBA: R$D program for neutrinoless DBD experiments
- DCBA-T2
  (i) 2 drift chambers with 6mm wire pitch
  (ii) Decay source: ^{100}Mo in natural Mo commercially available
  (iii) Conventional solenoid magnet of 0.8 kG maximum
- DCBA-T3
  (i) 12 drift chambers with 3 mm wire pitch
  (ii) Decay source : ^{150}Nd in nat. Nd_2O_3 plates developed at KEK
  (iii) Superconducting solenoid magnet of 3 kG maximum
- MTD (temporary name)
  (i) Future plan technically based on DCBA
  (ii) Decay source : ^{150}Nd of 10(nat.)-200(enr.) mol in 1 module
  (iii) Permanent name will be given by a new collaboration.

Magnetic Tracking Detector

Principle of electron detection



Gas:He(90%)+CO_2(10%)

Momentum Acceptance

p(MeV/c)=0.3r(cm)B(kG)

$B \approx 2$ kG

2 cm < r < 5 cm

⇓

1.2 MeV/c < p < 3 MeV/c

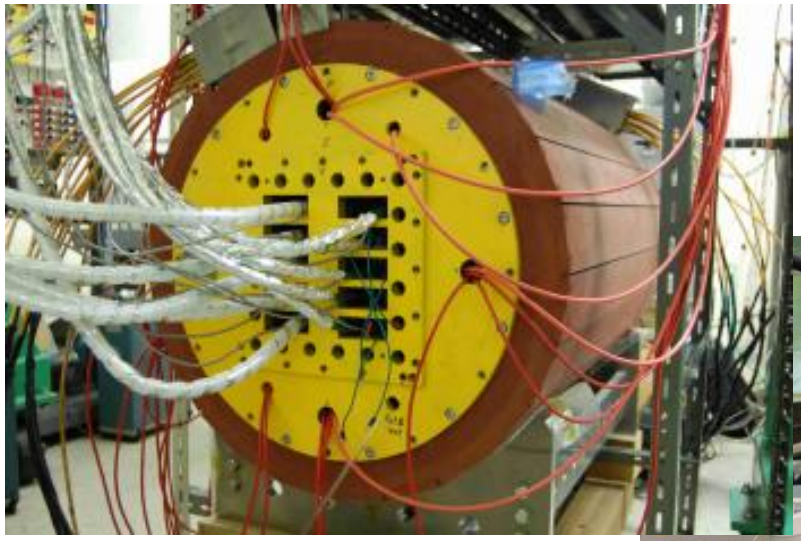
Energy Acceptance for e^-

0.8 MeV < T < 2.5 MeV

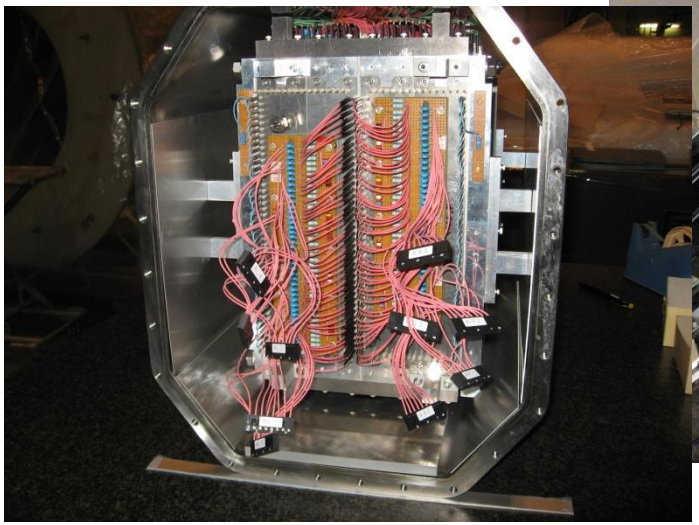
α is automatically rejected

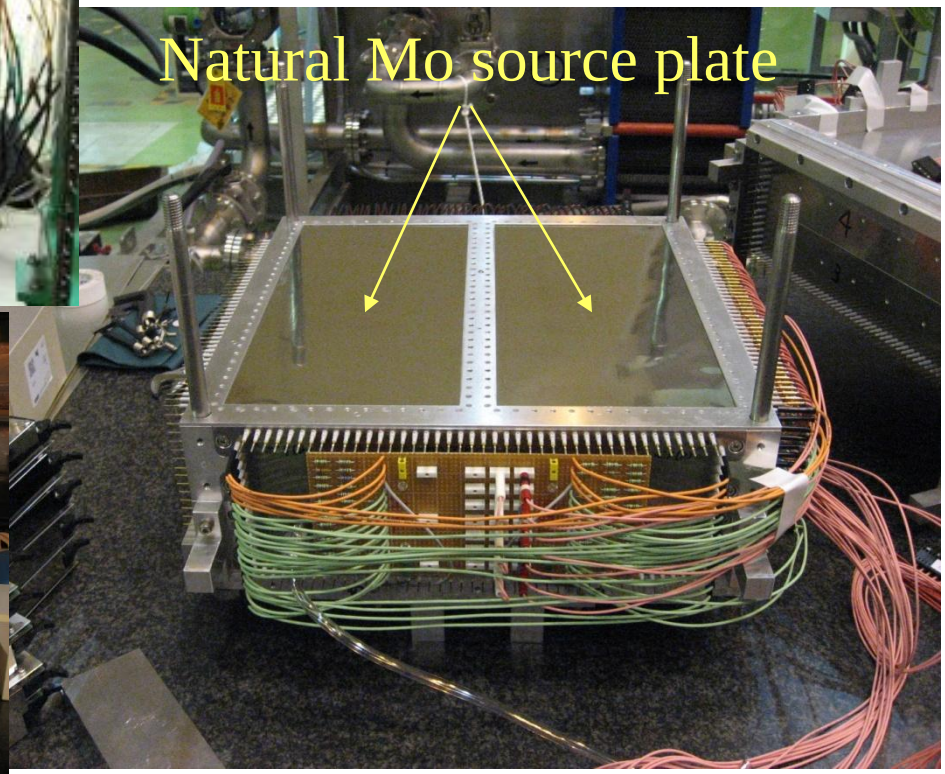
T=1 MeV → $p \approx$ 87 MeV/c

DCBA-T2 with natural Mo source



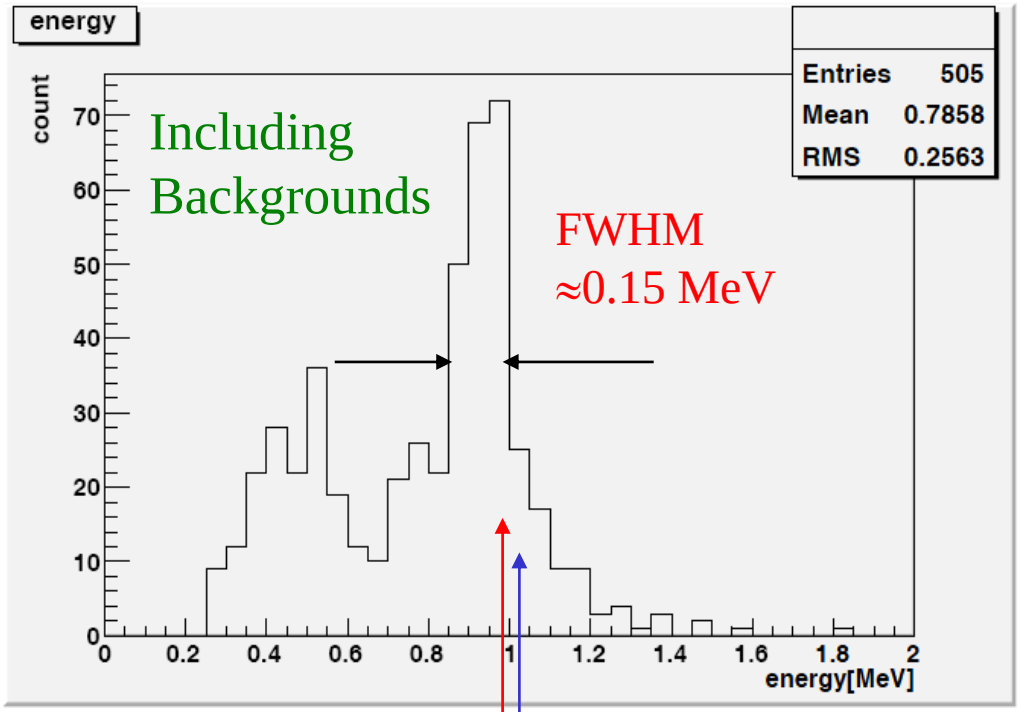
9.6% ^{100}Mo
45 mg/cm^2 thick plate
0.03 mol ^{100}Mo



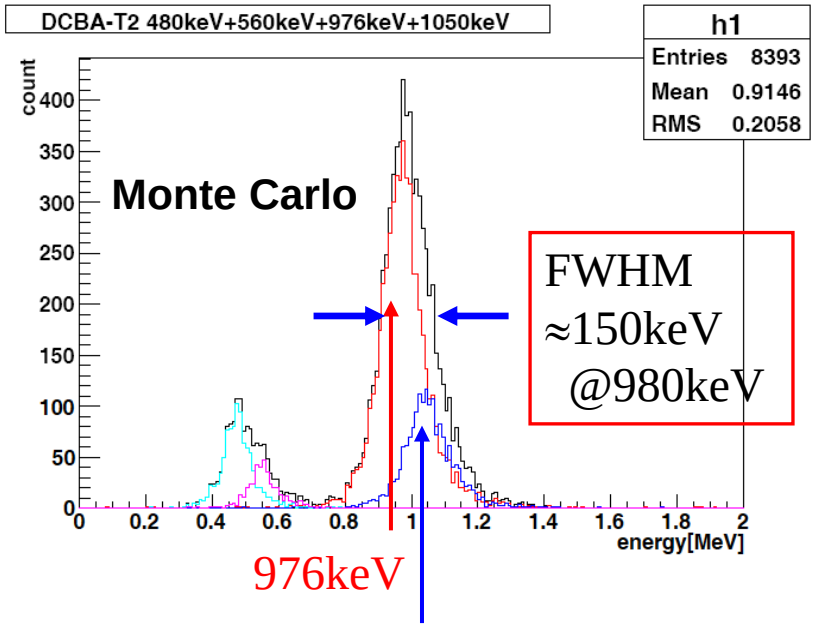


Energy resolution of DCBA-T2

Energy spectra of internal conversion electrons from ^{207}Bi



0.98 1.05
(7 : 2.4)



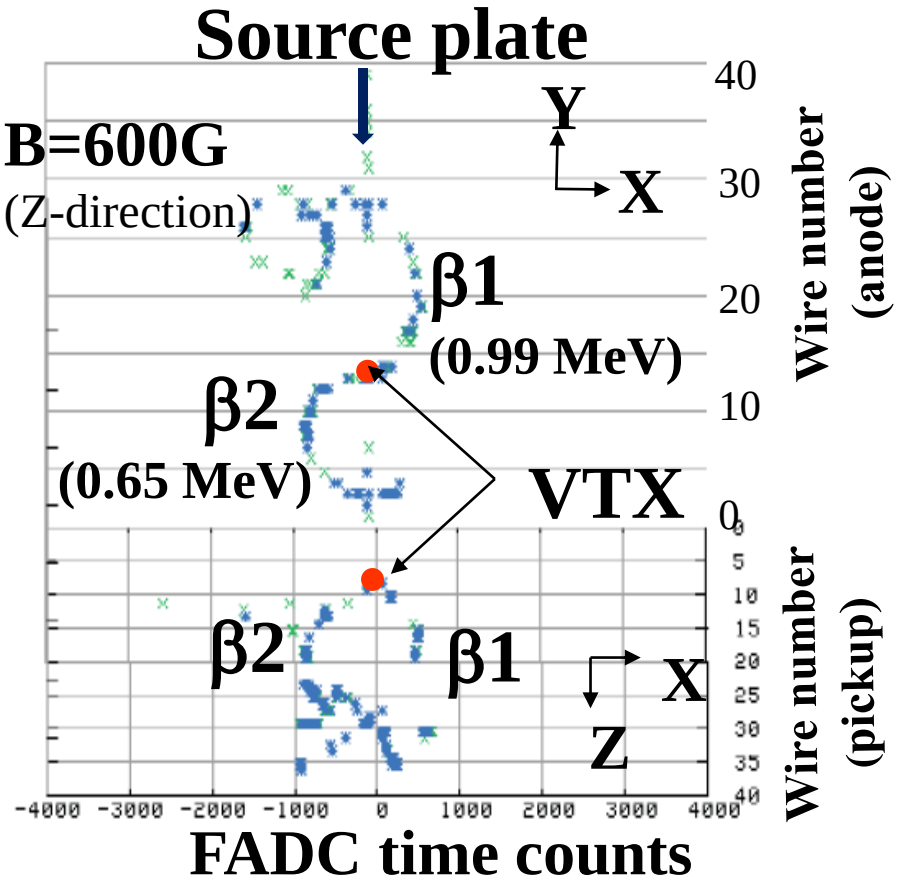
976keV

1050keV

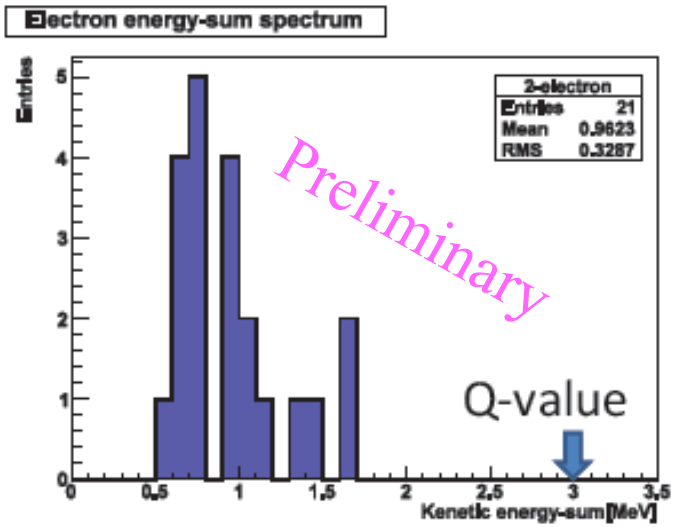
Chamber conditions
He(90%)+CO_2(10%) 1atm
B=0.8 kG
Wire pitch=6 mm

DCBA -T2

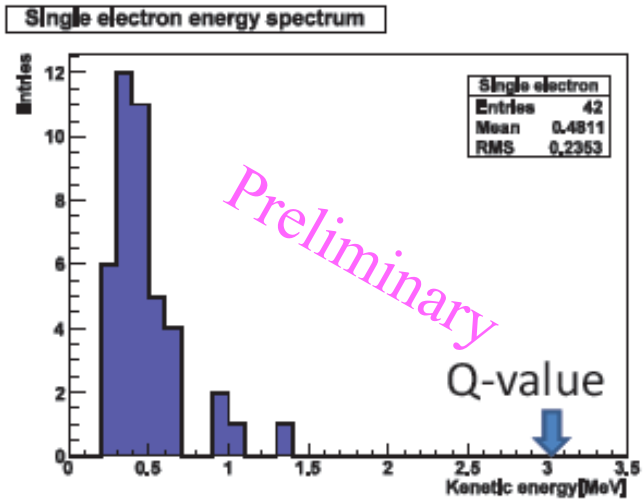
Example of 2νββ candidates from ^{100}Mo



Energy spectra



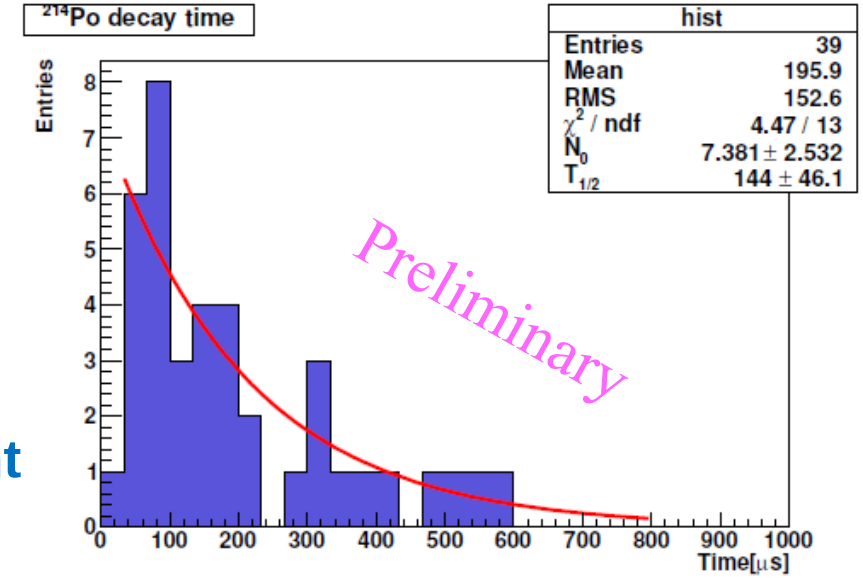
Energy sum of two electrons



Single electron energy

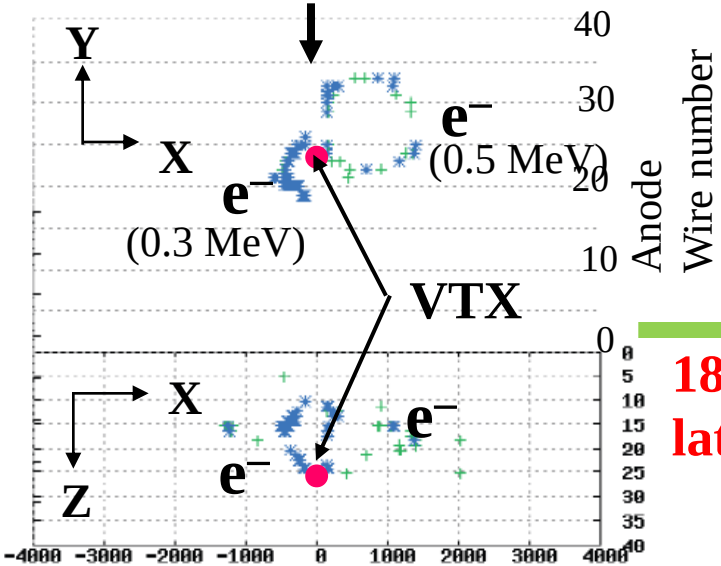
Decay time distribution of ^{214}Po

obtained by detecting a two- or single-electron event followed by an alpha ray



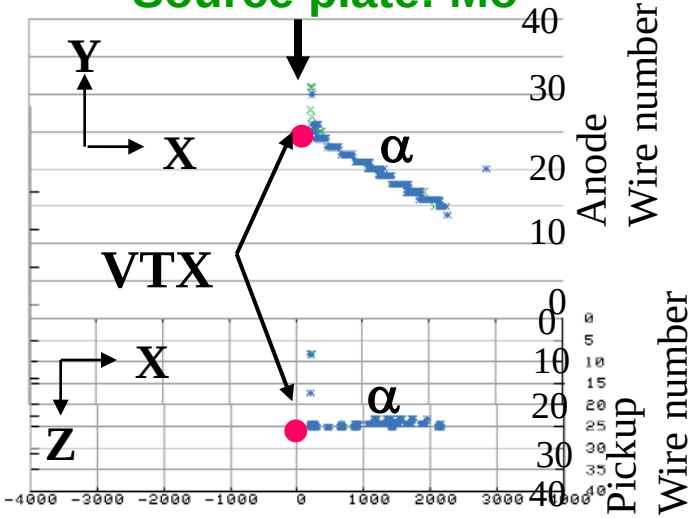
Example of a two-electron event

Source plate: Mo



186 μs later

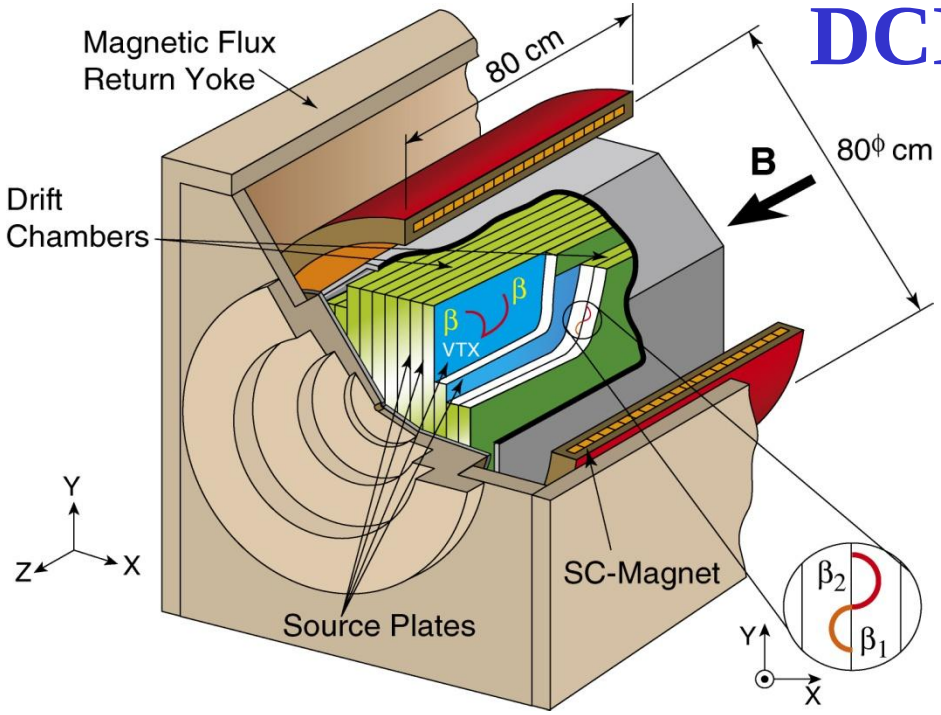
Source plate: Mo

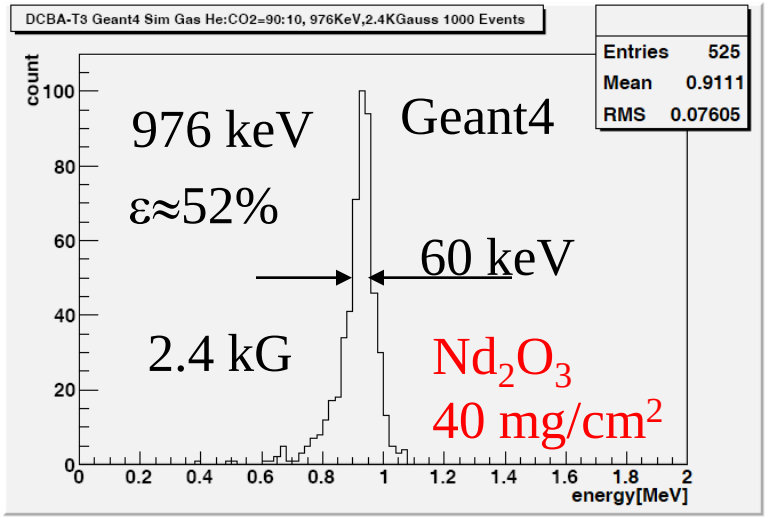


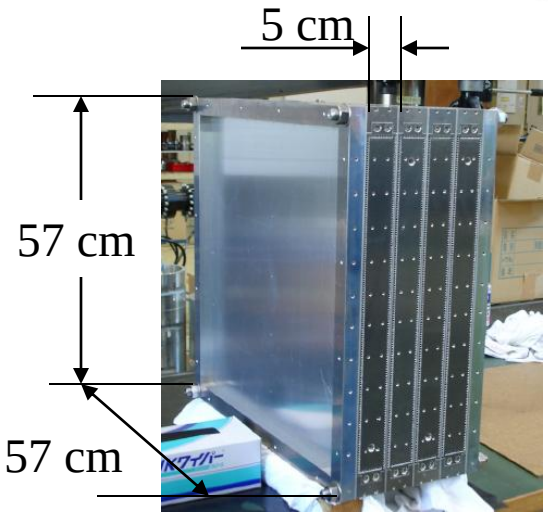
^{214}Bi β decay to ^{214}Po + Compton e^-

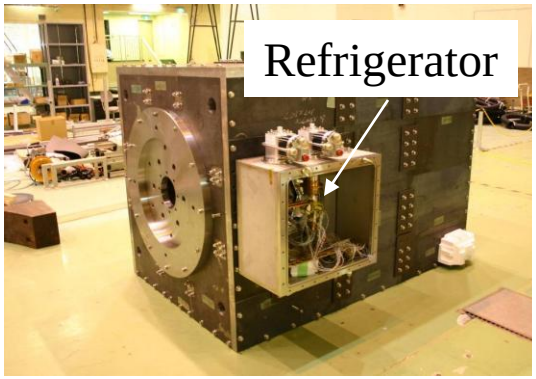
α Decay of ^{214}Po at the same VTX

DCBA-T3 (under construction)

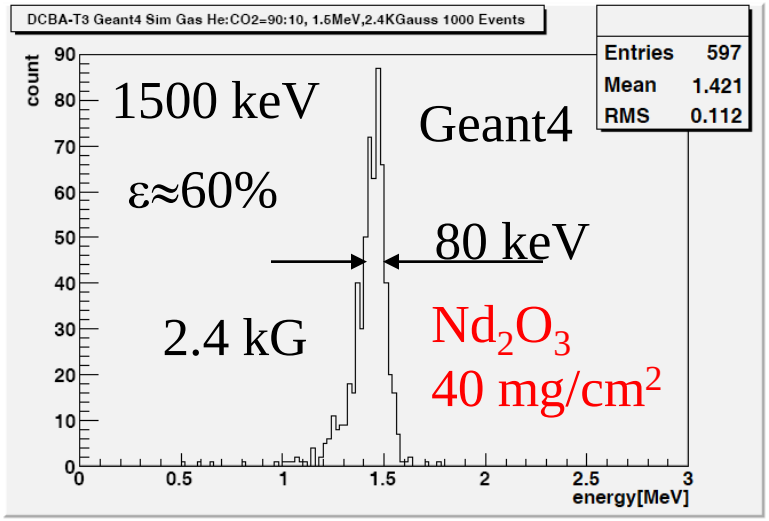




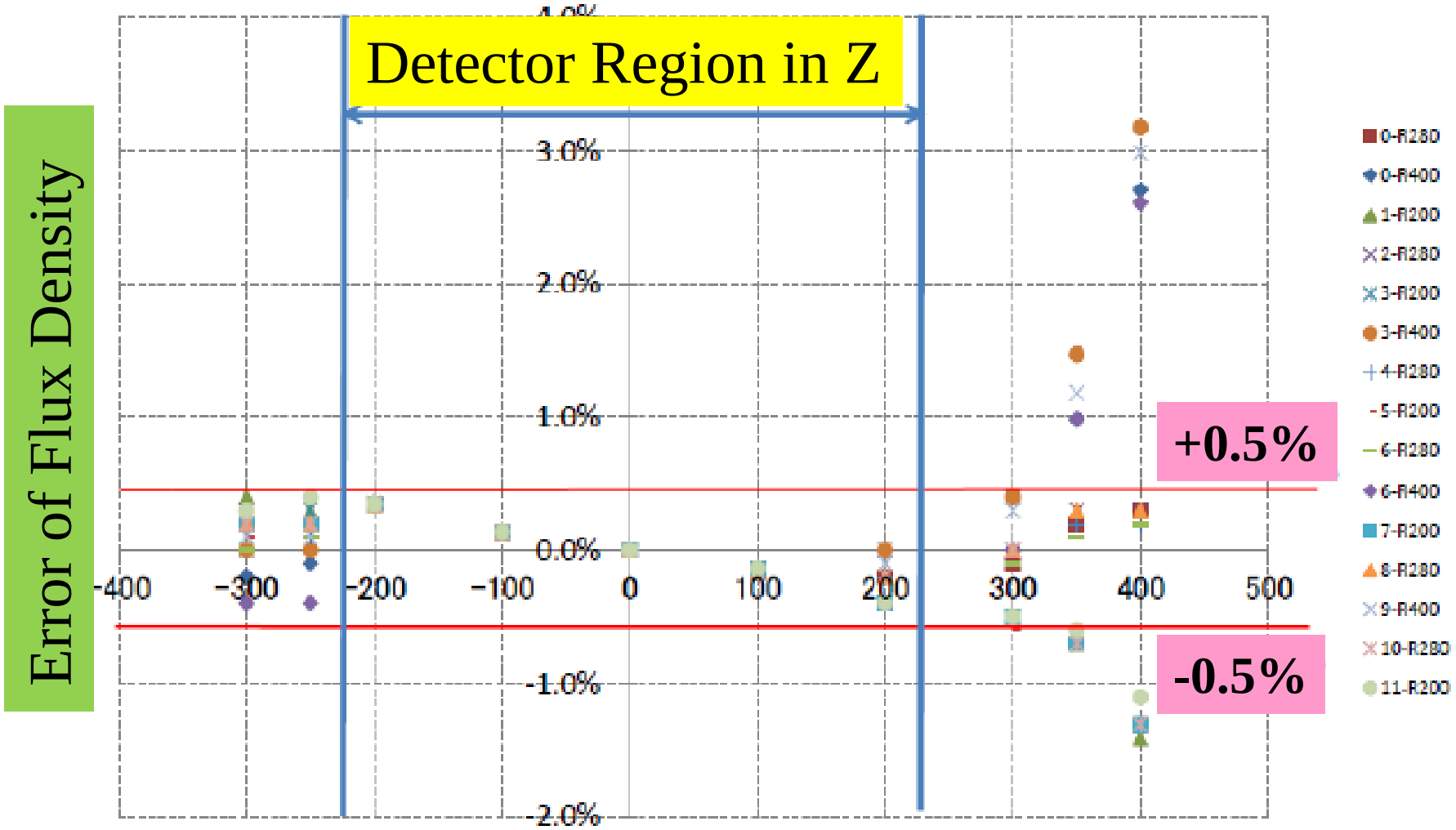




SC-magnet

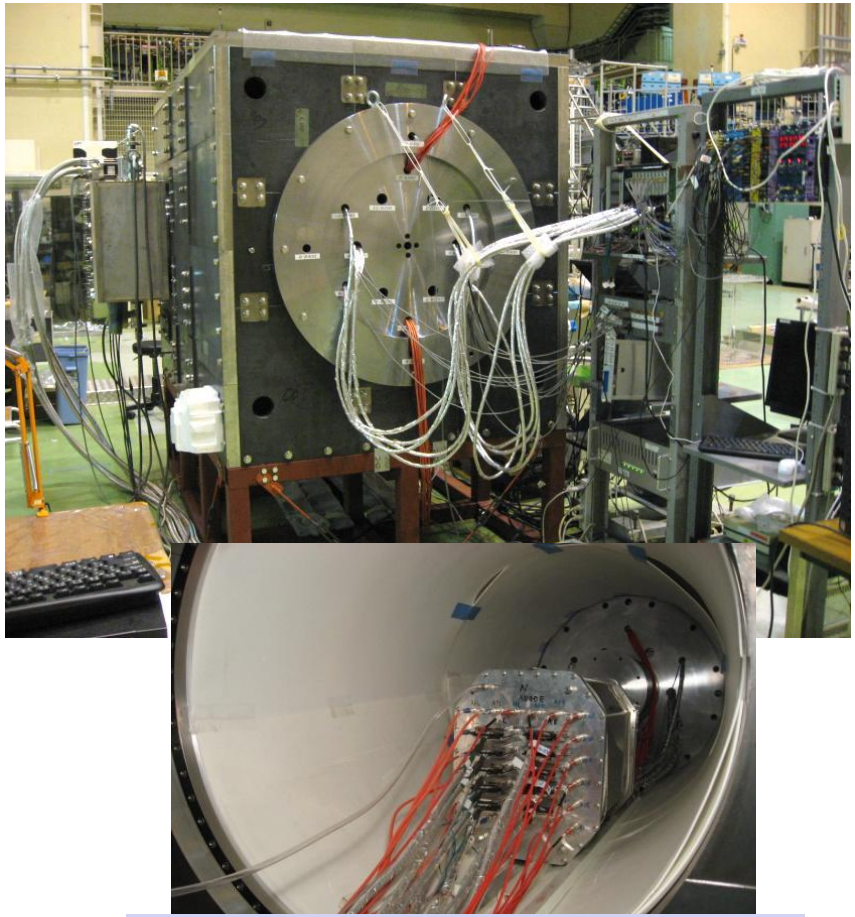


Magnetic Field Uniformity of DCBA-T3



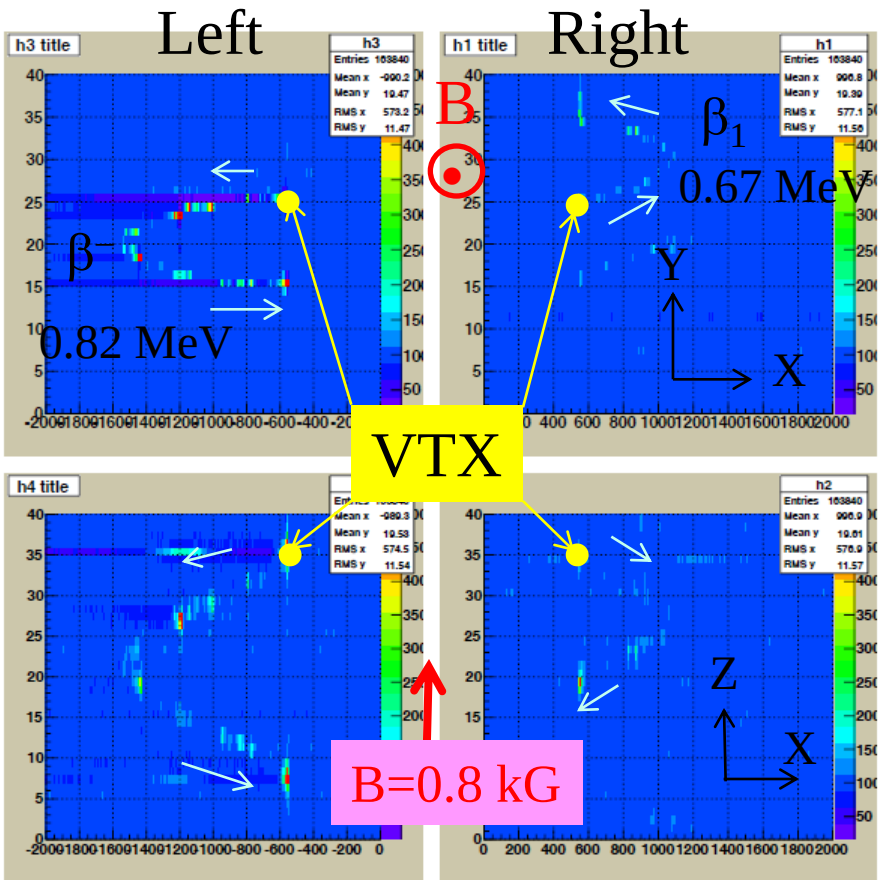
DCBA-T2.5

T2 Chamber + T3 Superconducting Solenoid Magnet



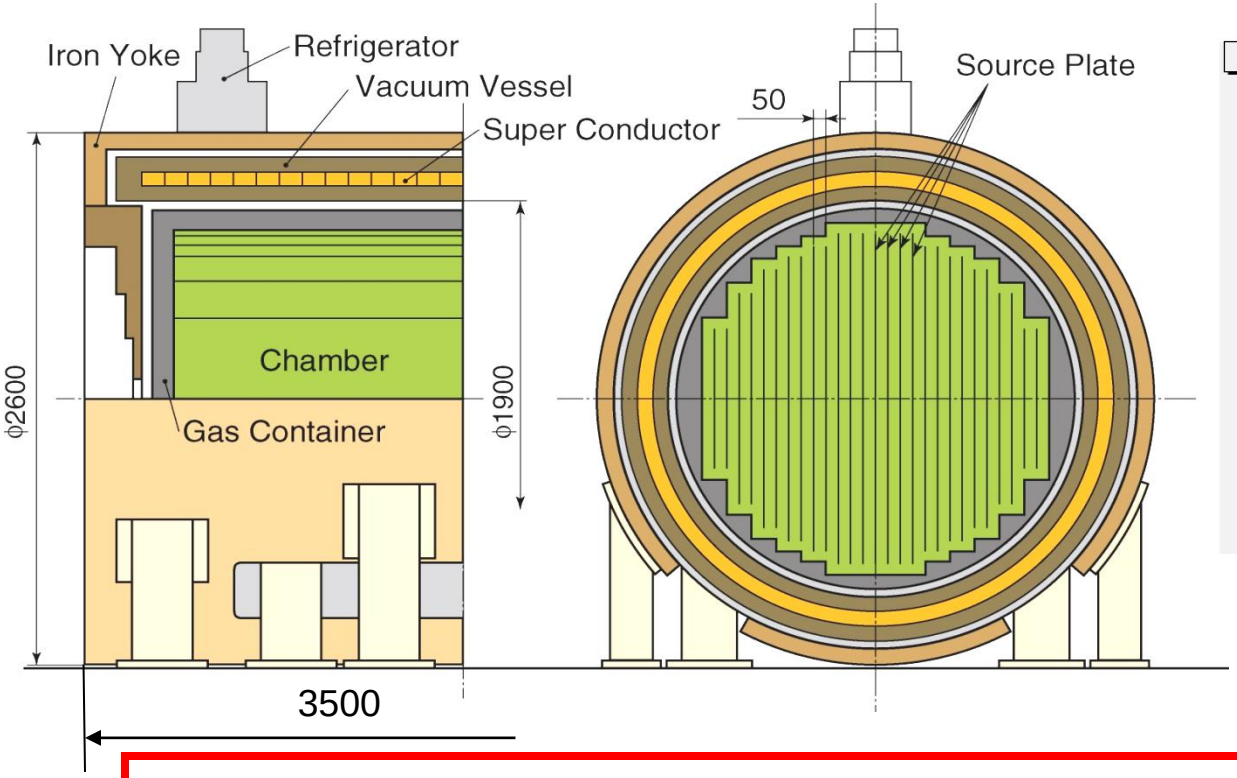
DCBA-T2 Chamber installed into the DCBA-T3 SC-Magnet

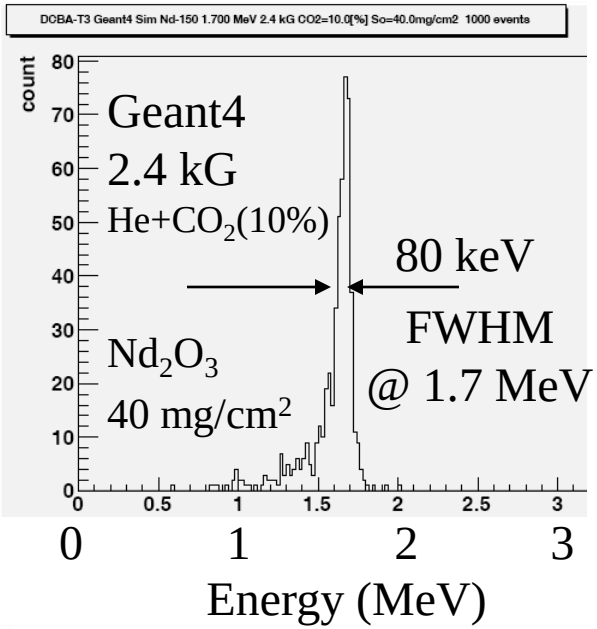
$2\nu\beta\beta$ event candidate from ^{100}Mo (9.6%)



MTD (Magnetic Tracking Detector: temporary name) module after DCBA

Chamber cell : the same as DCBA-T3, Source plate: 80 m^2/module
Thickness: 40 mg/cm^2, Source weight: 32 kg/module





Expected Energy Resolution $$\frac{\mathrm{FWHM}(E_{sum}) = \sqrt{2} \times 80\mathrm{keV}}{Q_{\mathrm{Nd\text{-}150}}(3370\mathrm{keV})} \approx 3.4\%$$

Conclusions

1. Magnetic tracking detector is a momentum analyzer for studying neutrinoless double beta decay.
2. DCBA is the R&D project followed by a future plan MTD.
3. DCBA-T2 has taken $2\nu\beta\beta$ candidates from natural Mo source plates. DCBA-T2.5 consisting of the T2 chamber and T3 magnet is in operation at KEK.
4. DCBA-T3 chamber accommodating natural Nd is under construction for improving energy resolution.
5. Several ten modules of MTD will make it possible to investigate the effective neutrino mass down to 50 meV.
6. We have applied funds to JSPS Grant-in-Aid for a MTD module.