

"Double Beta Decay and Neutrinos" (DBD11), Osaka Japan

Present Status of the DCBA Experiment



H. Iwase (KEK)
on behalf of the DCBA collaboration

Double beta decay experiments

Scintillation/Calorimetry (source = detector)

ionization

COBRA (^{130}Te , ^{116}Cd , etc.)
Majorana(^{76}Ge)
GERDA(^{76}Ge)

scintillation

CANDLES(^{48}Ca)
XMASS(^{136}Xe)
KamLAND-Zen(^{136}Xe)
SNO+(^{150}Nd)

bolometry

CUORE(^{130}Te)

ionization+scintillation

EXO(^{136}Xe)

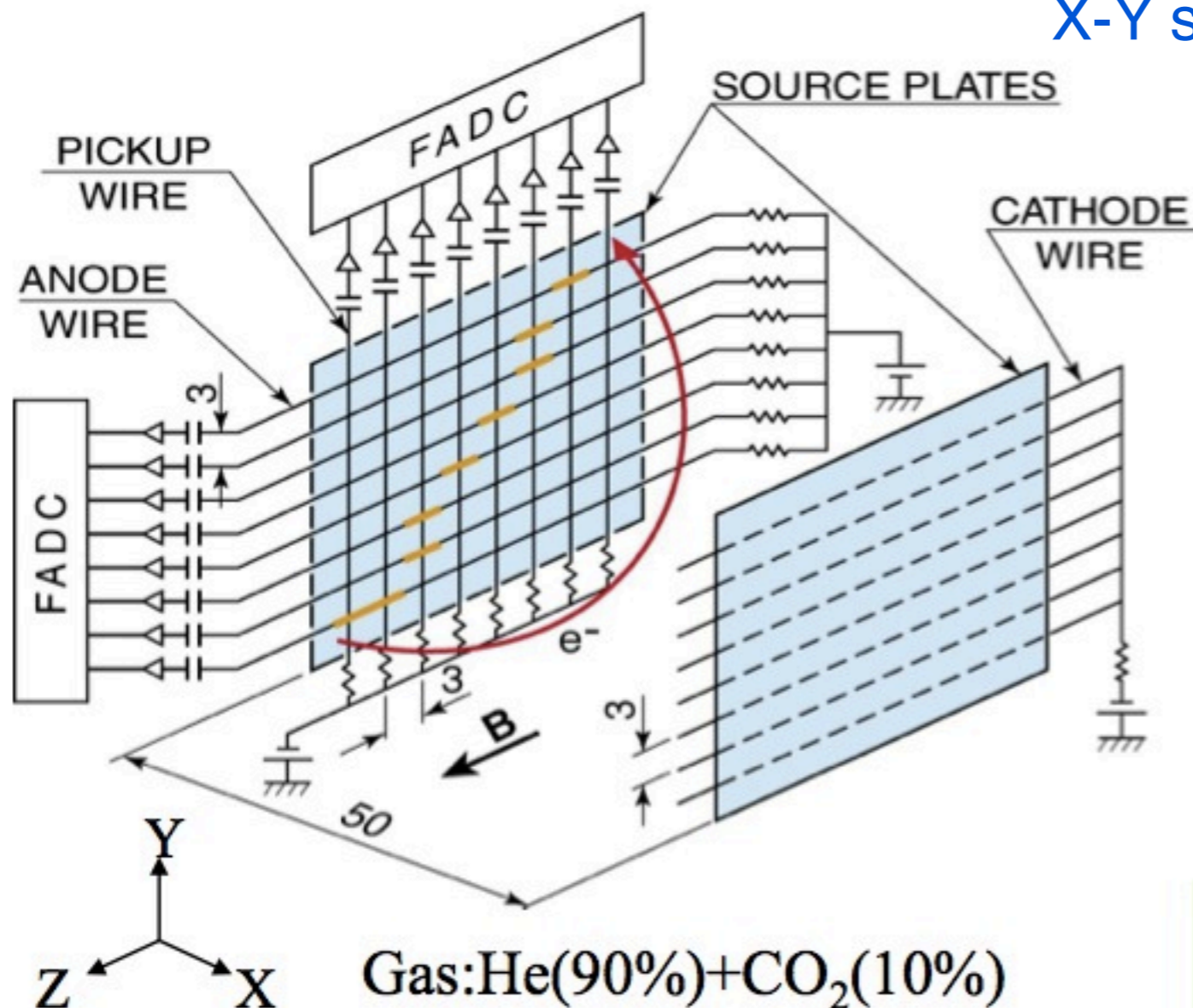
Combination (source \neq detector)

NEMO3 (^{100}Mo , ^{82}Se , ^{150}Nd , etc.)
Super NEMO (^{100}Mo , ^{82}Se , ^{150}Nd , etc.)

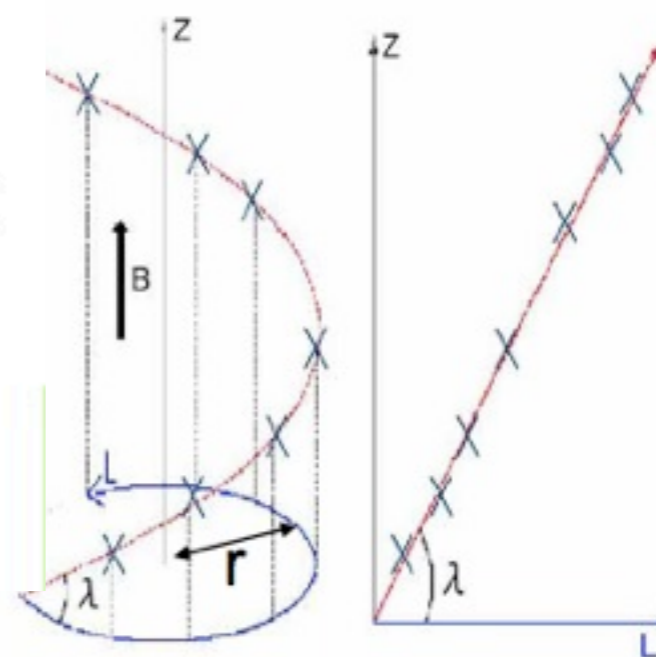
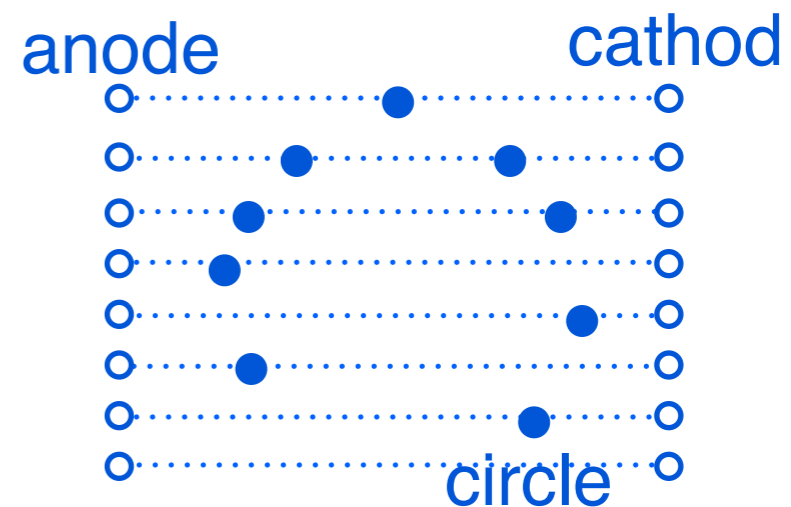
Tracking (source \neq detector)

DCBA (^{100}Mo , ^{150}Nd , etc.)

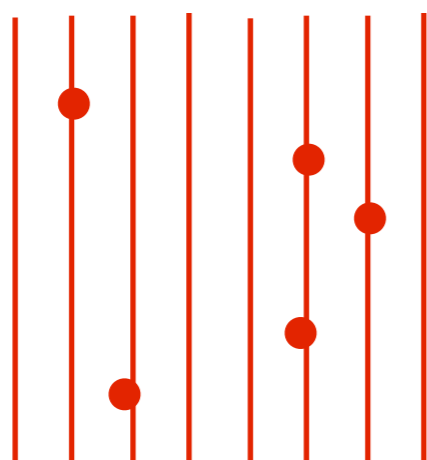
DCBA method



X-Y surface



pickup
Y-Z surface

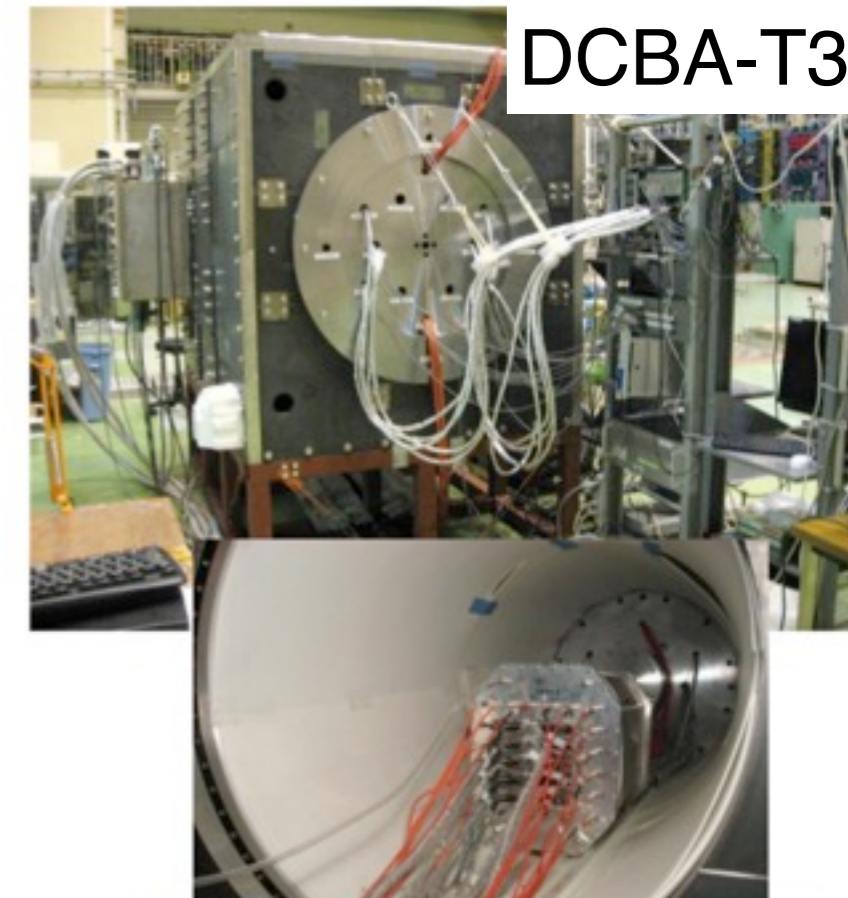
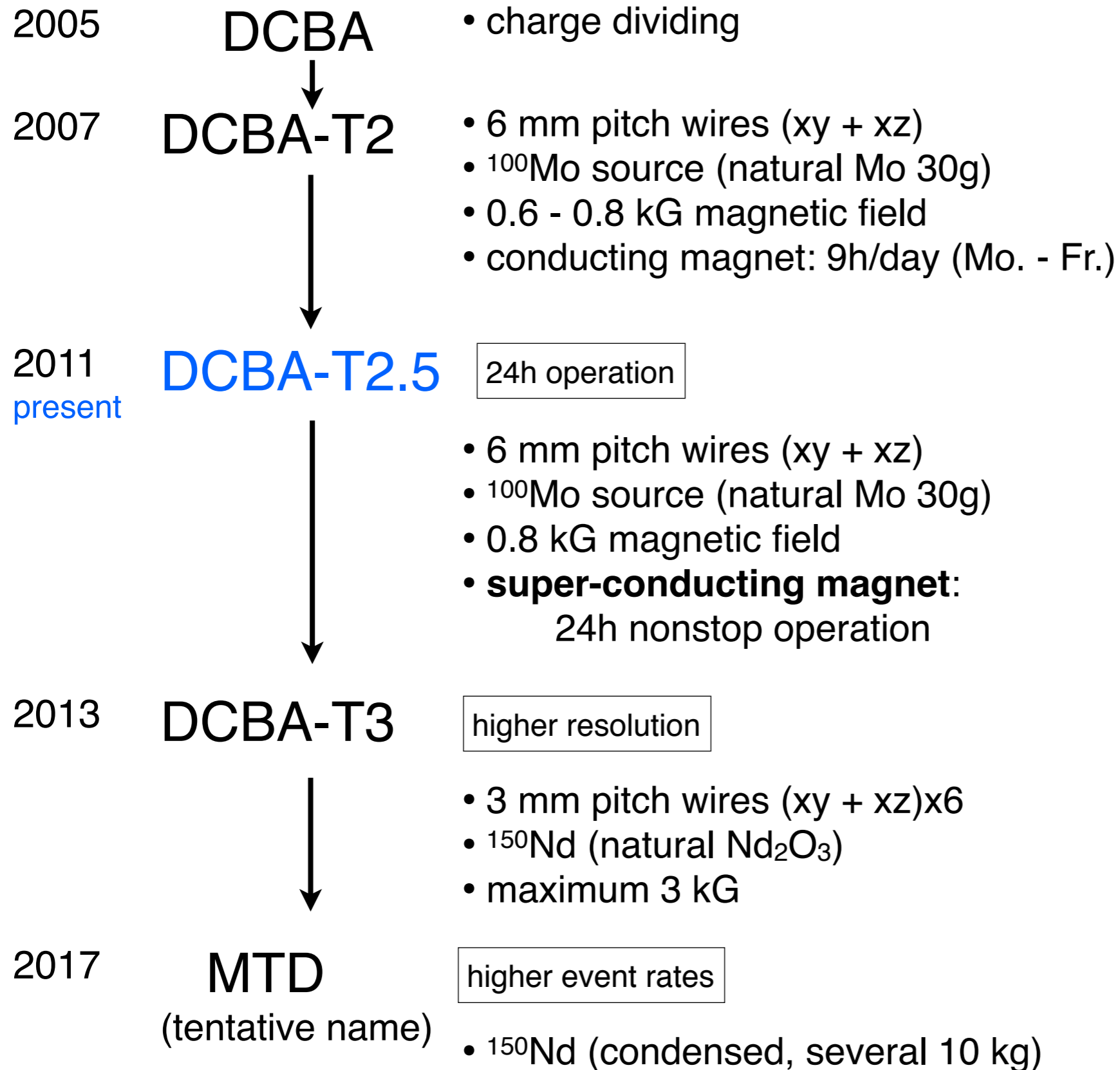


cosine curve

$$p \cos \lambda = 0.3rB, T = \sqrt{p^2 + m_e^2} - m_e$$

p (MeV/c) momentum, **T** (MeV) k. energy, **r** (cm) radius, **m_e** (MeV/c²) rest mass of e⁻, **B** (kG) magnetic flux density, **λ** pitch angle

DCBA experiment



DCBA-T2-detector
in T3 (=T2.5)

DCBA T-2 results

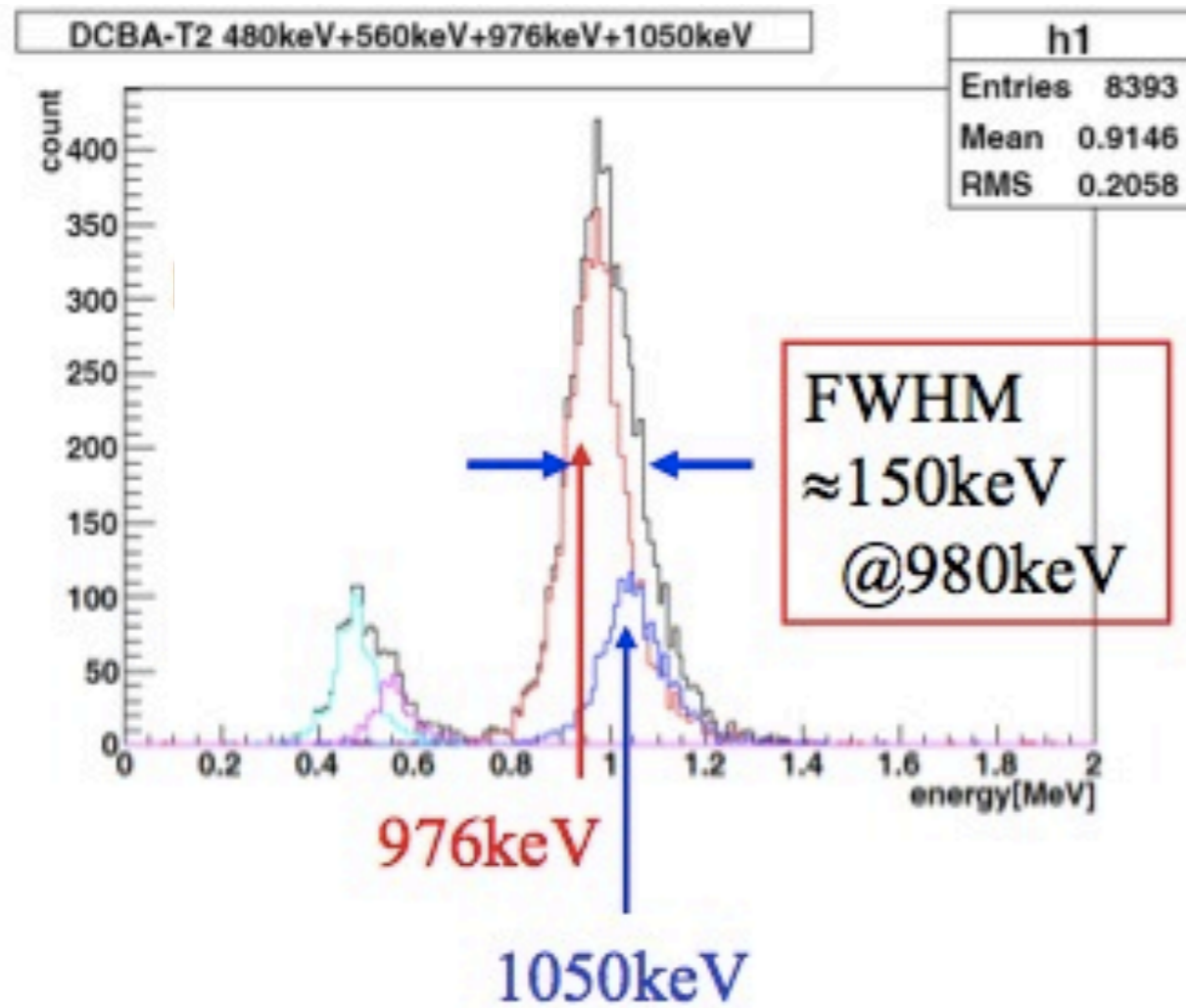


Energy resolution of DCBA T-2

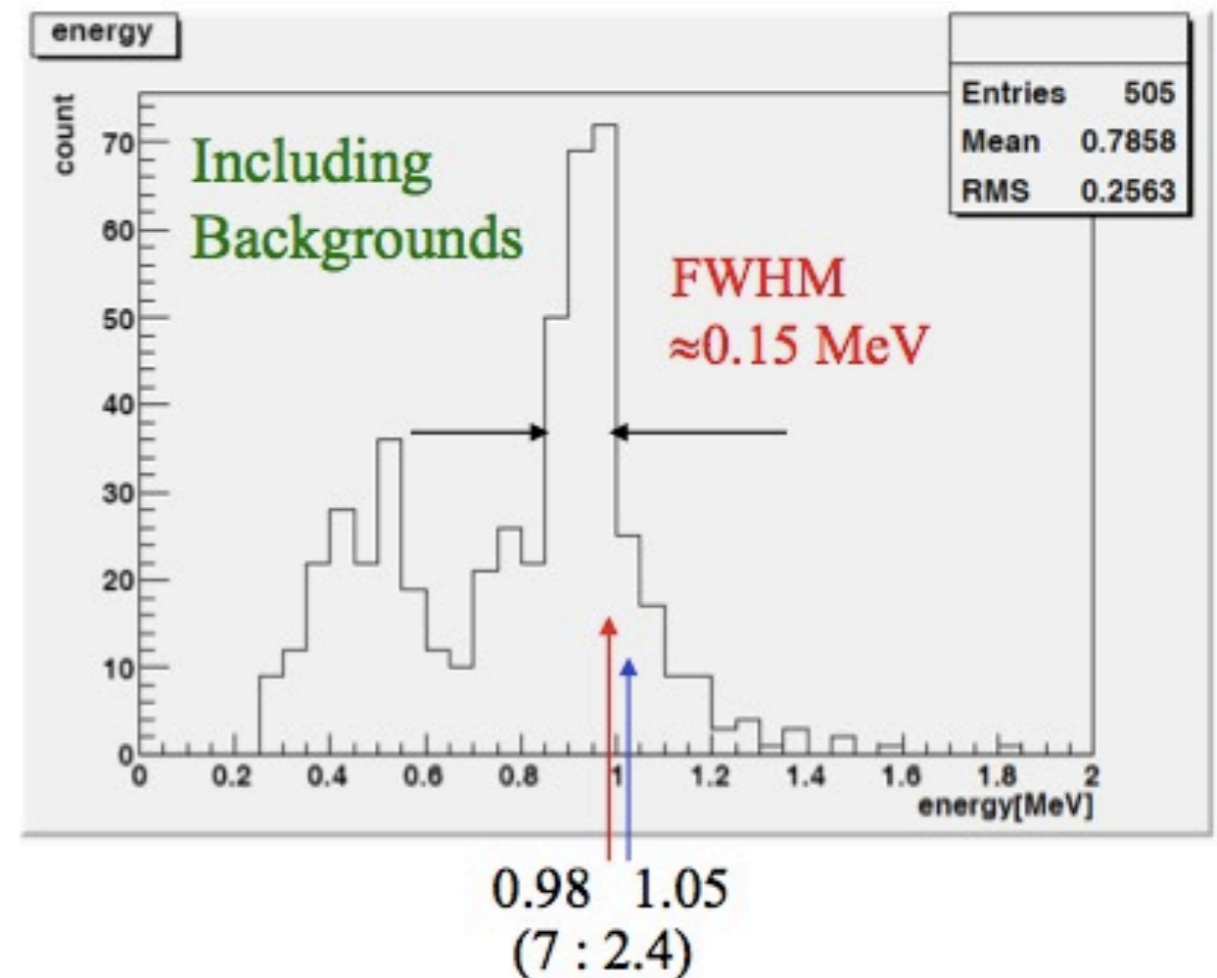
Energy spectra of internal conversion electrons

0.48 (1.5%), 0.56 (0.6%), 0.98 (7.0%) and 1.05 MeV (2.4%) from ^{207}Bi

MC



Measurement

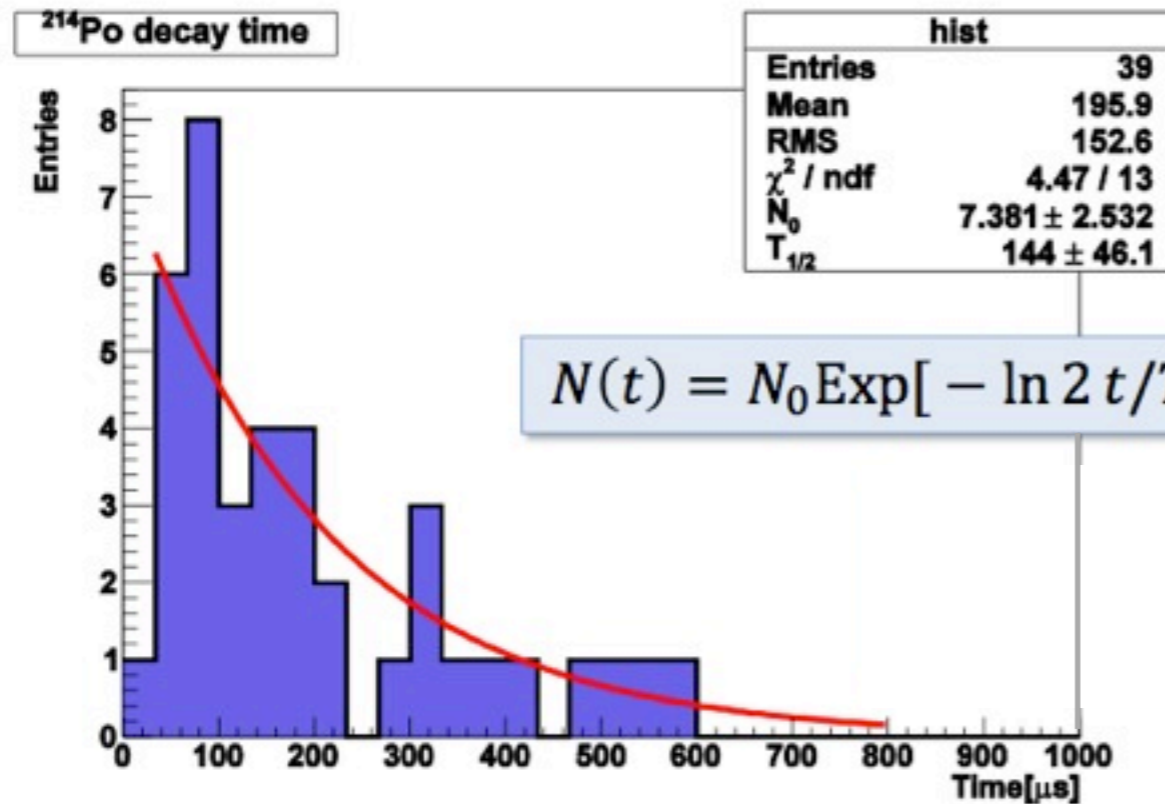
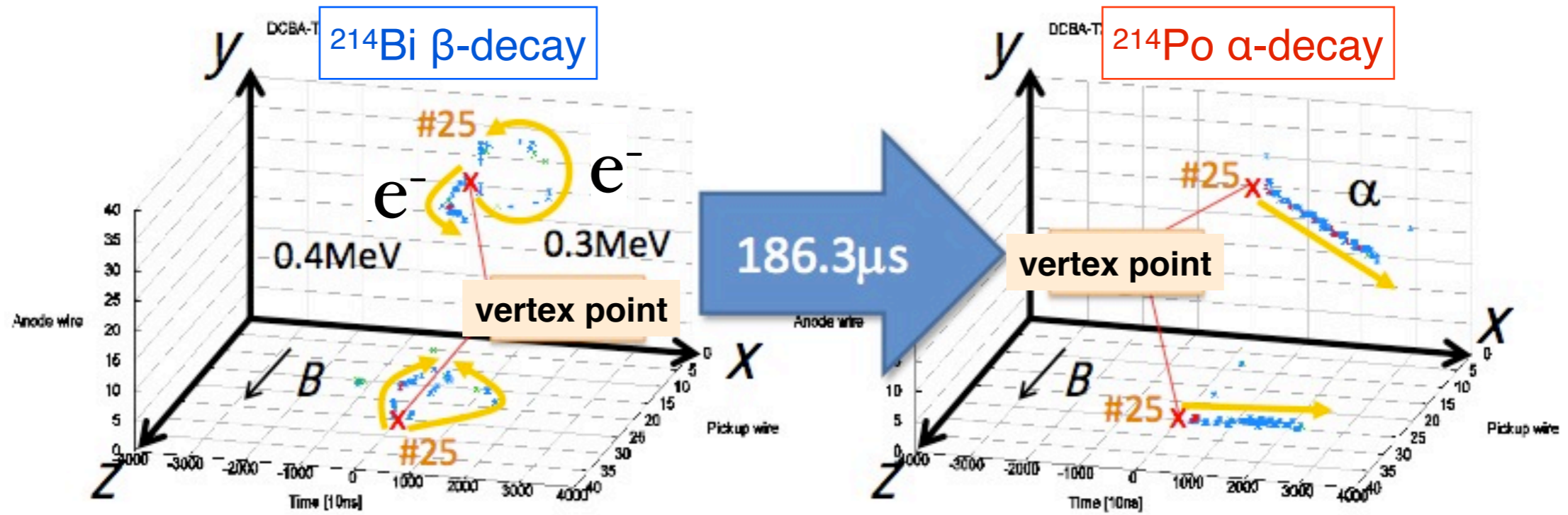


chamber conditions

- He (90%) + CO_2 (10%) 1 atm
- $B = 0.8\text{ kG}$
- wire pitch = 6 mm

^{214}Po half-life measurement by T-2

^{214}Bi β -decay \rightarrow ^{214}Po α -decay detection and the ^{214}Po half-life



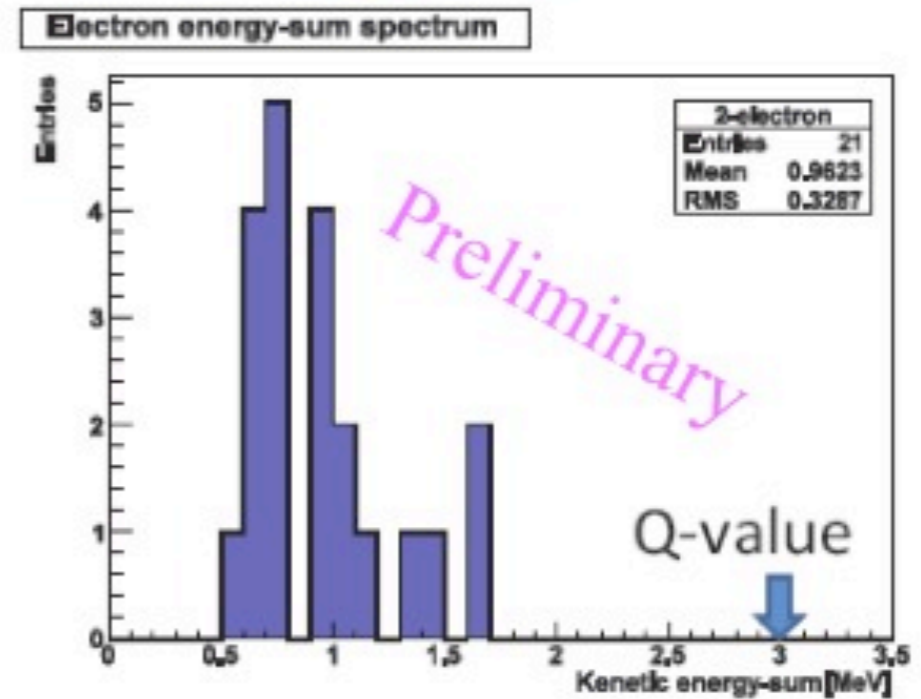
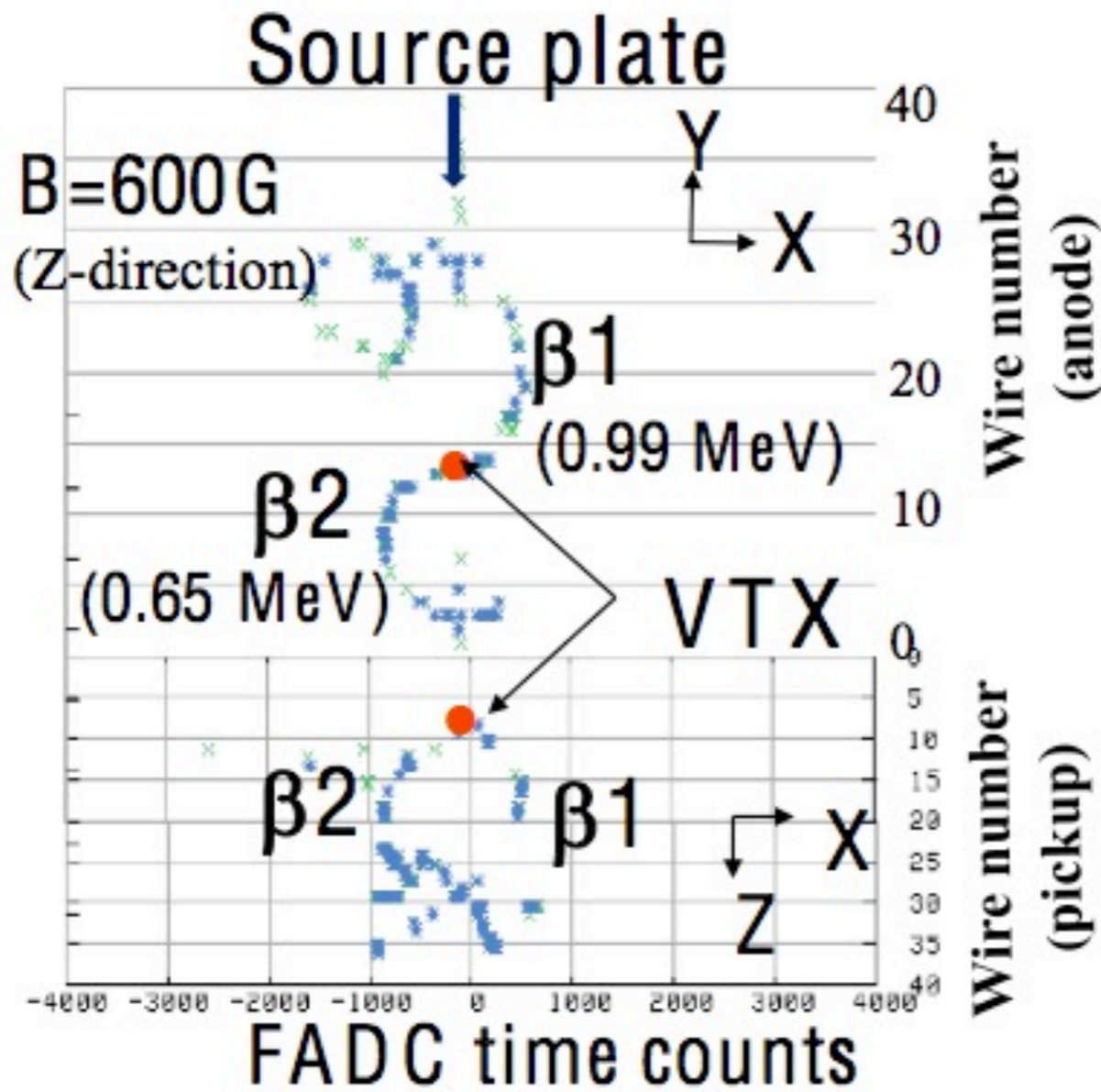
^{214}Po half-life

$$T_{1/2} = 144 \pm 46 \mu\text{s}$$

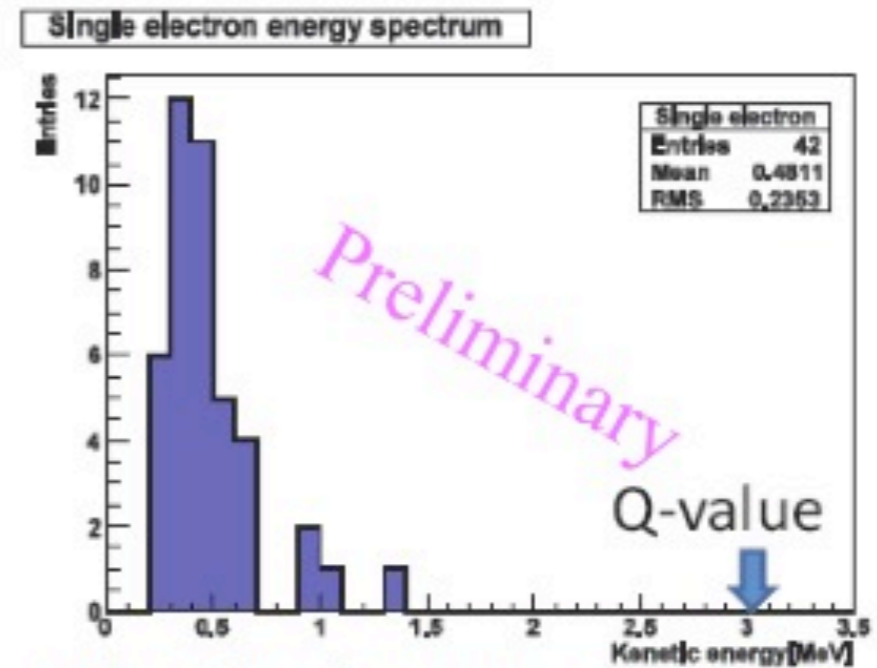
(ref. $164.3 \mu\text{s}$)

DCBA T-2 result

Example of $2\nu\beta\beta$ candidates from ^{100}Mo

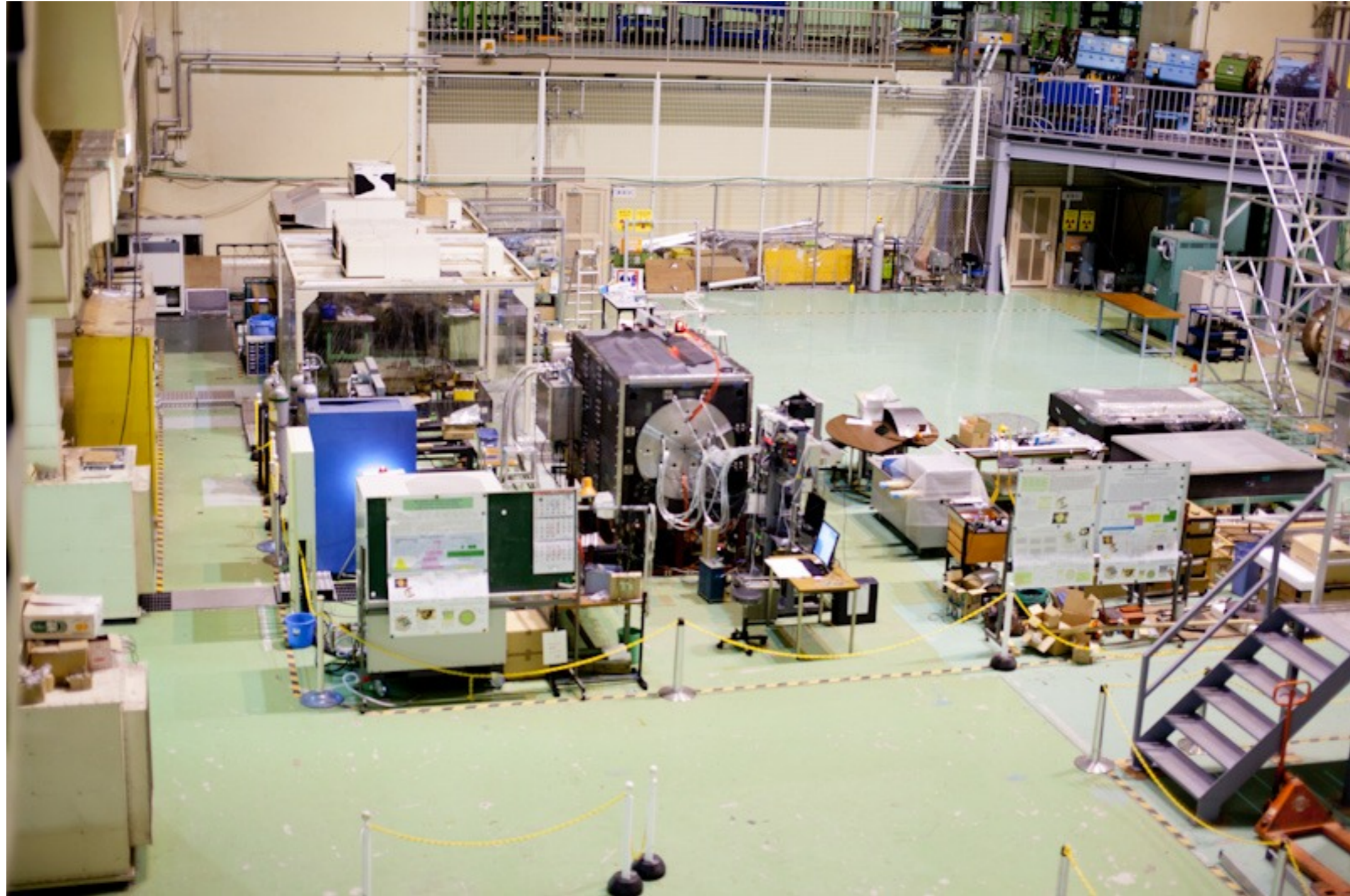


Energy sum of two electrons



Single electron energy

DCBA T-3

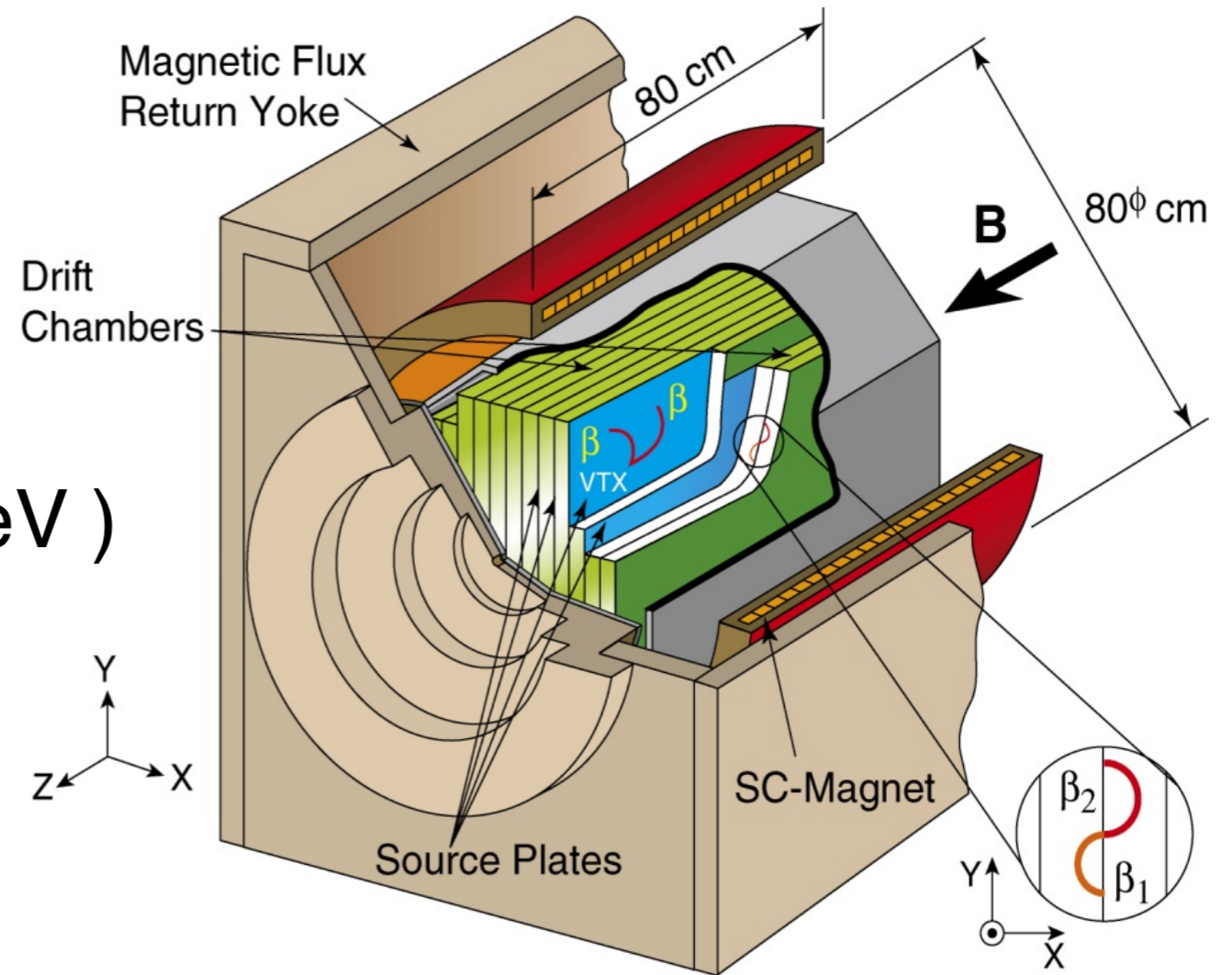


Super conducting magnet for T-3

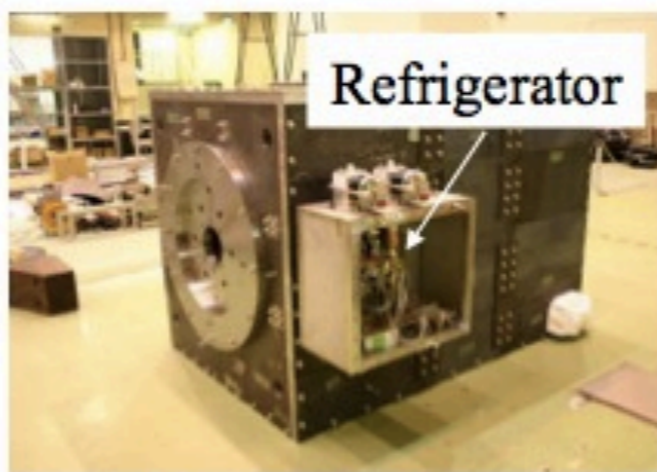
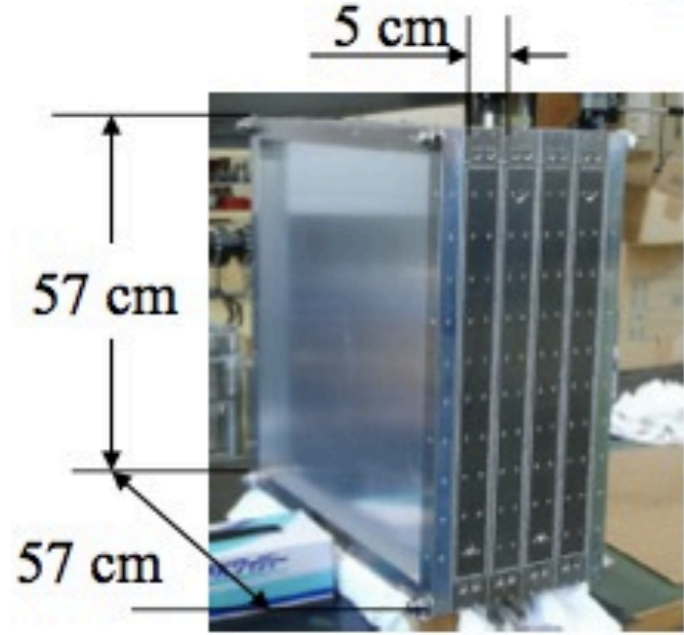
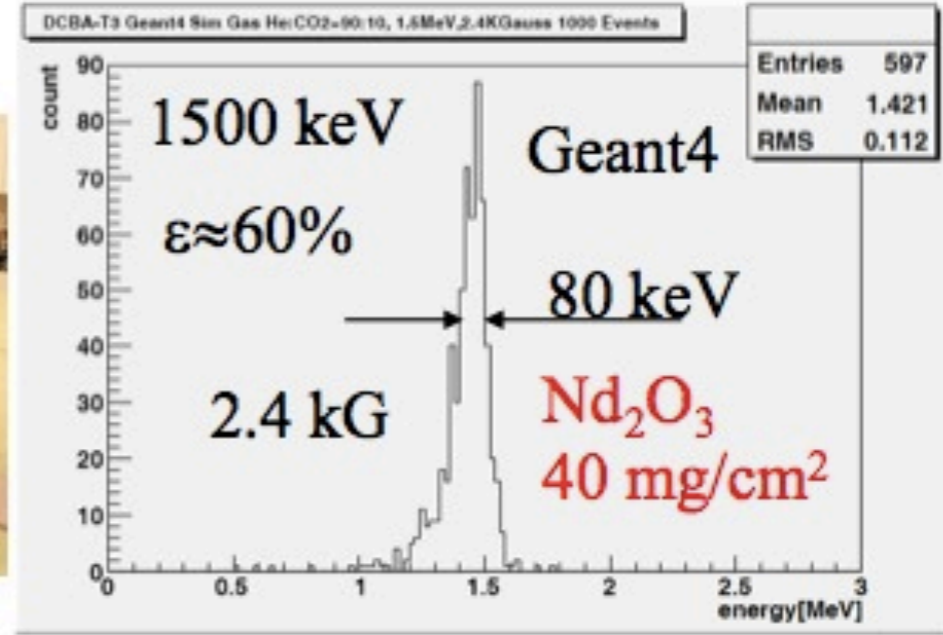
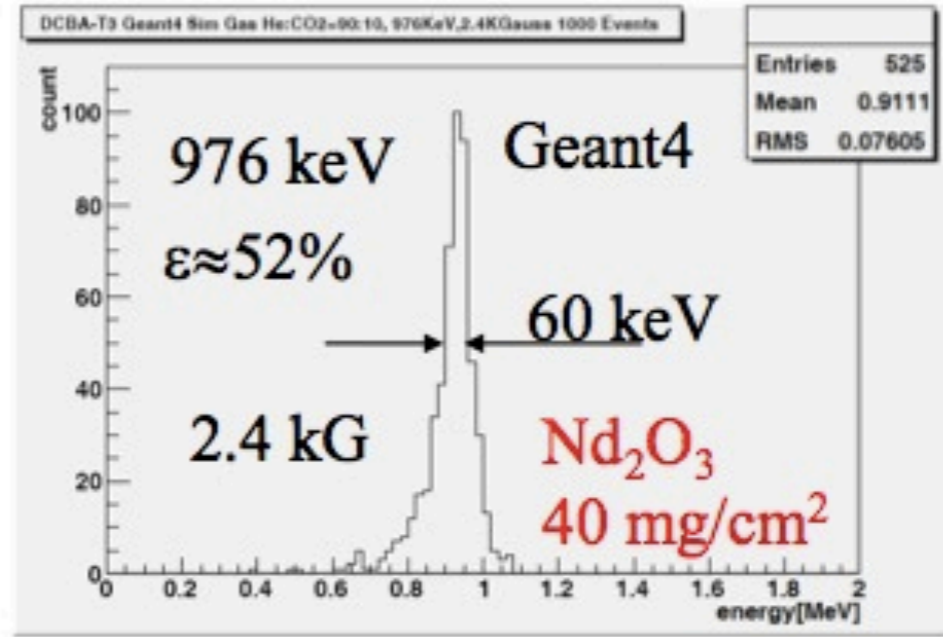
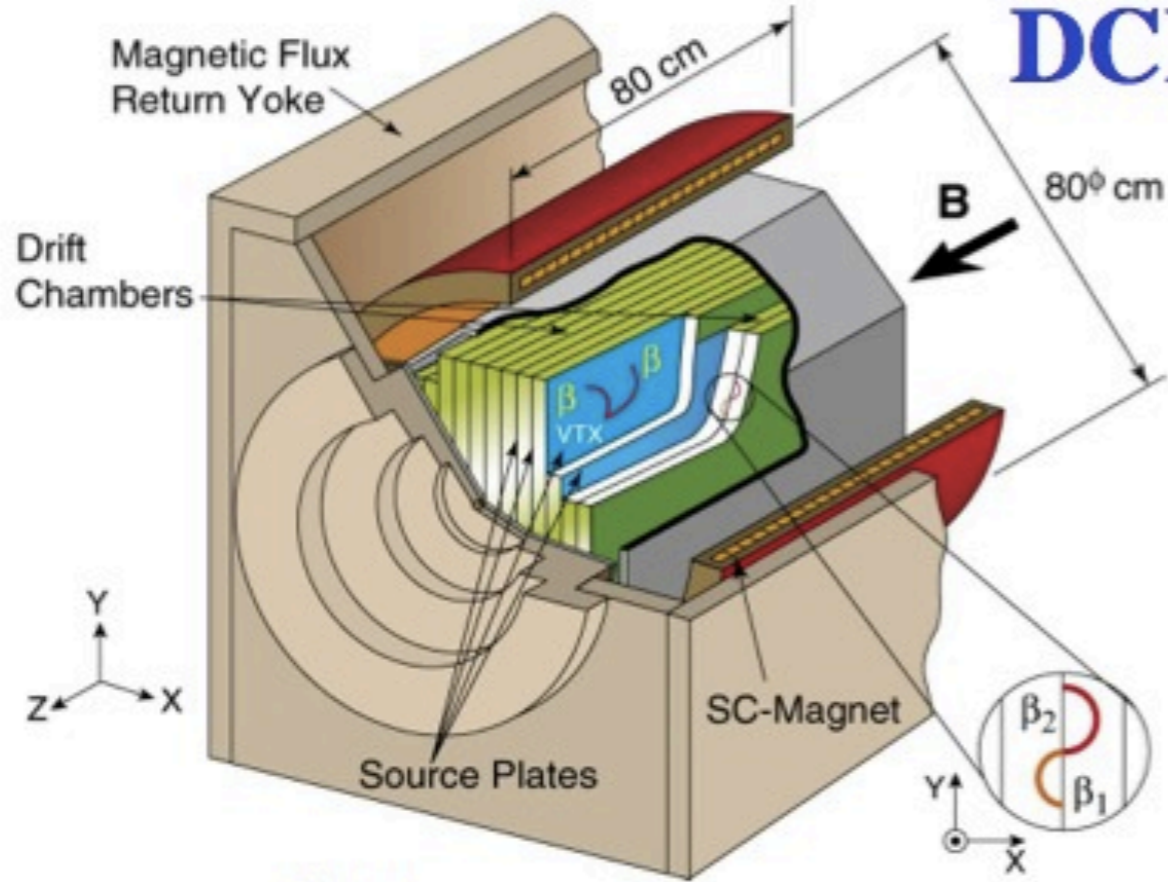
- coolant-less
- GM refrigerator

for DCBA T-3

- $B = 0.2 \text{ T} \pm 0.5\%$ ($\Delta E \sim 80 \text{ keV}$)
- $\phi 600\text{mm} \times L600\text{mm}$

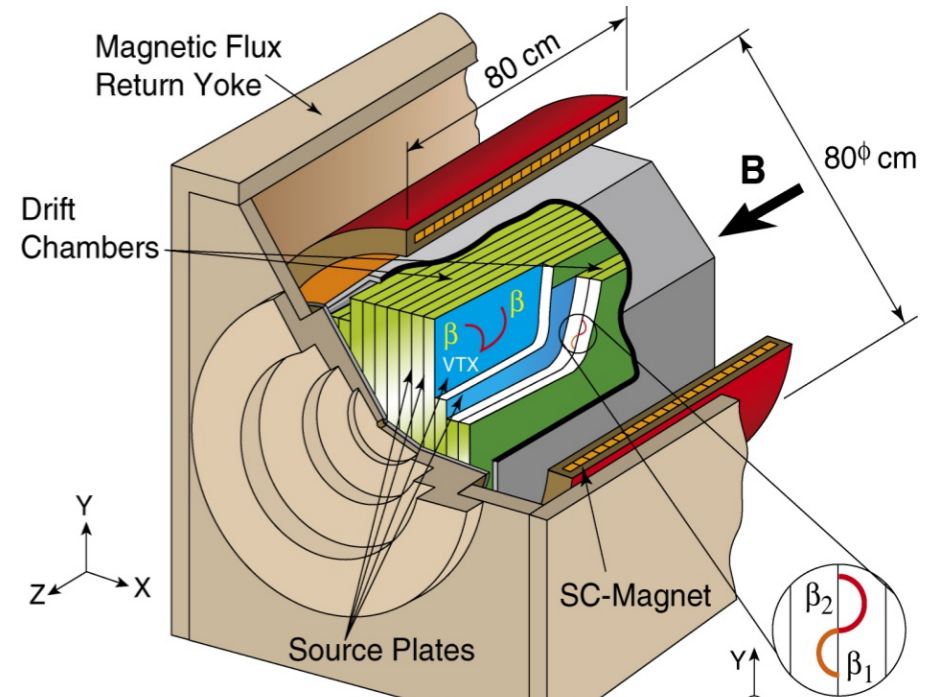
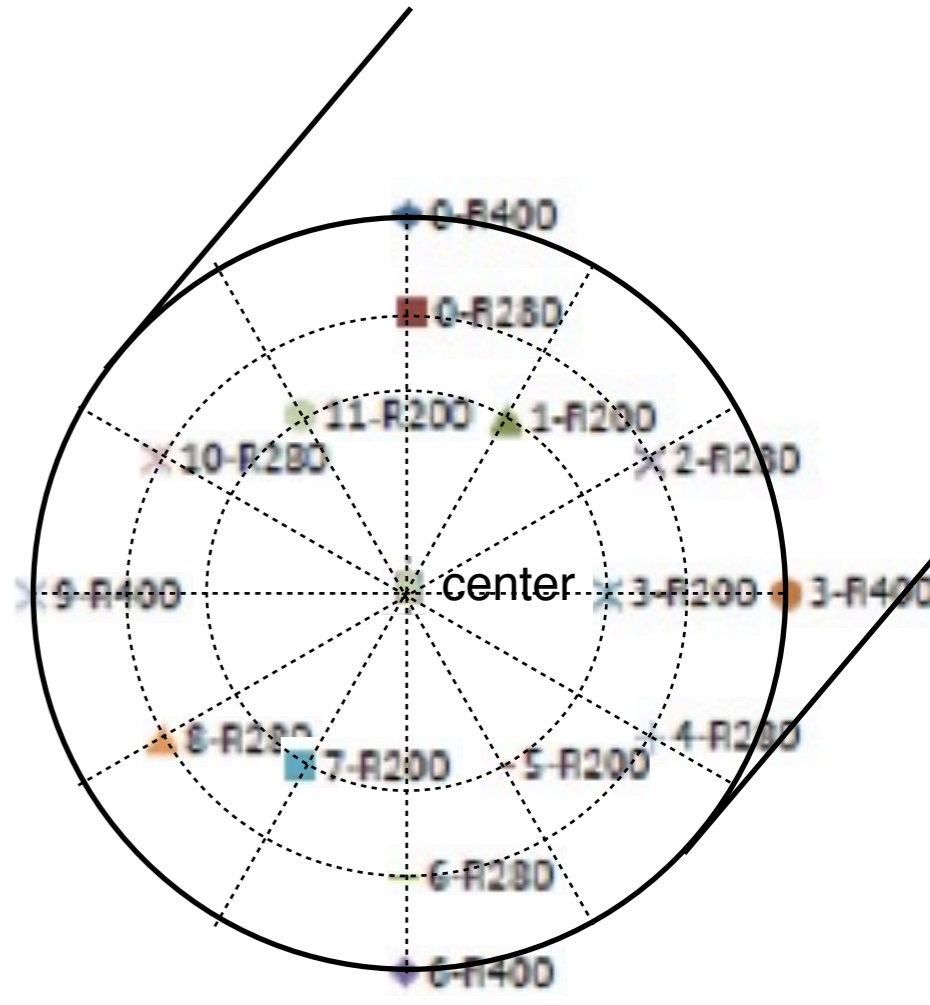
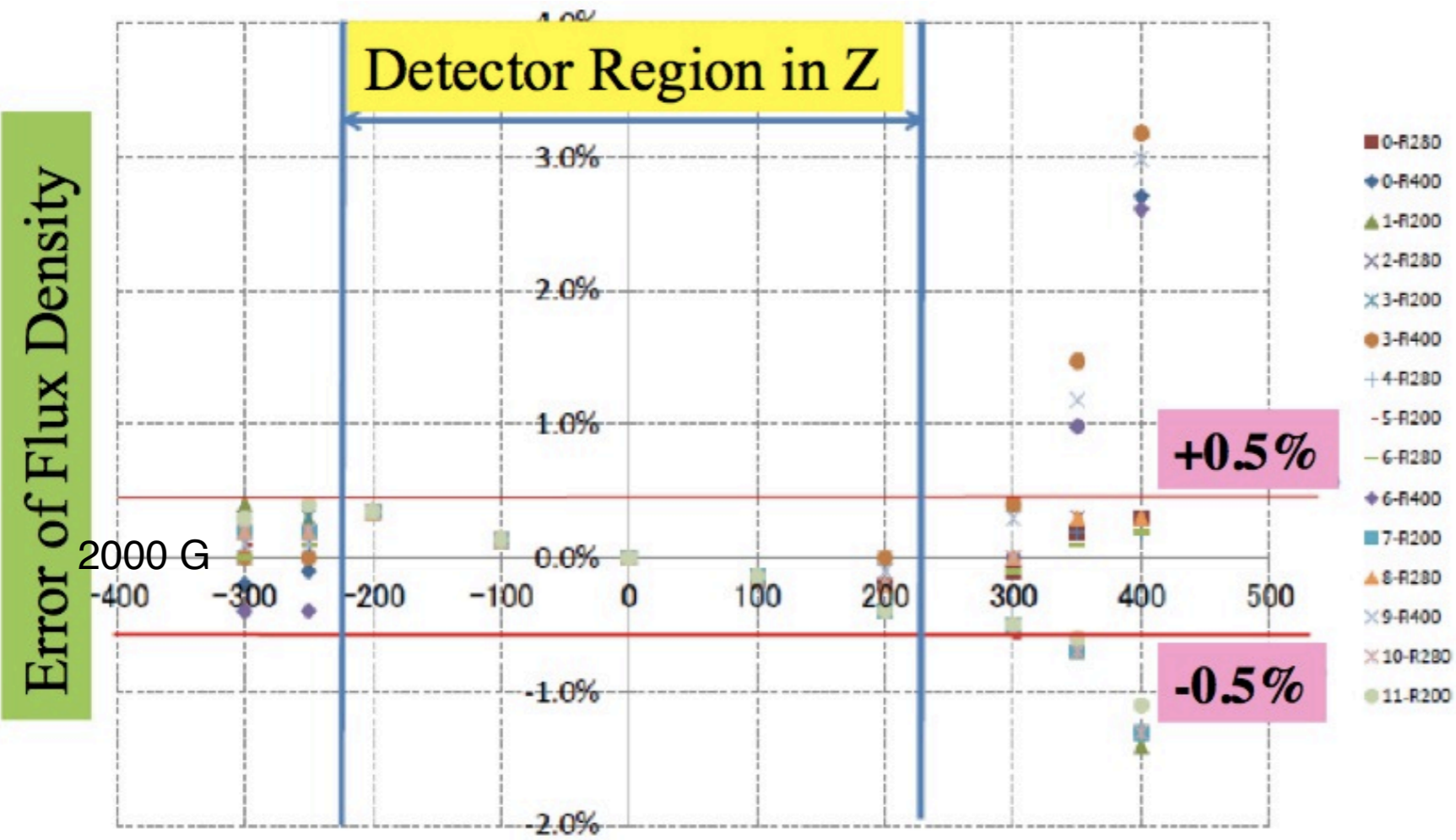


DCBA-T3 (under construction)

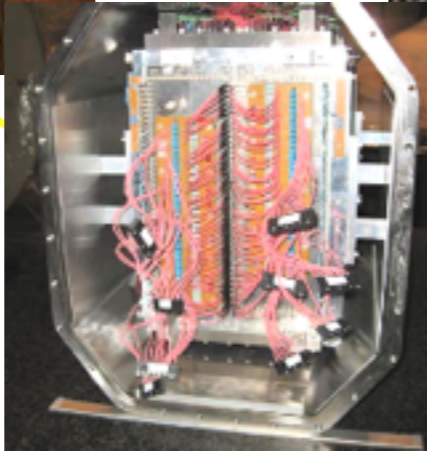
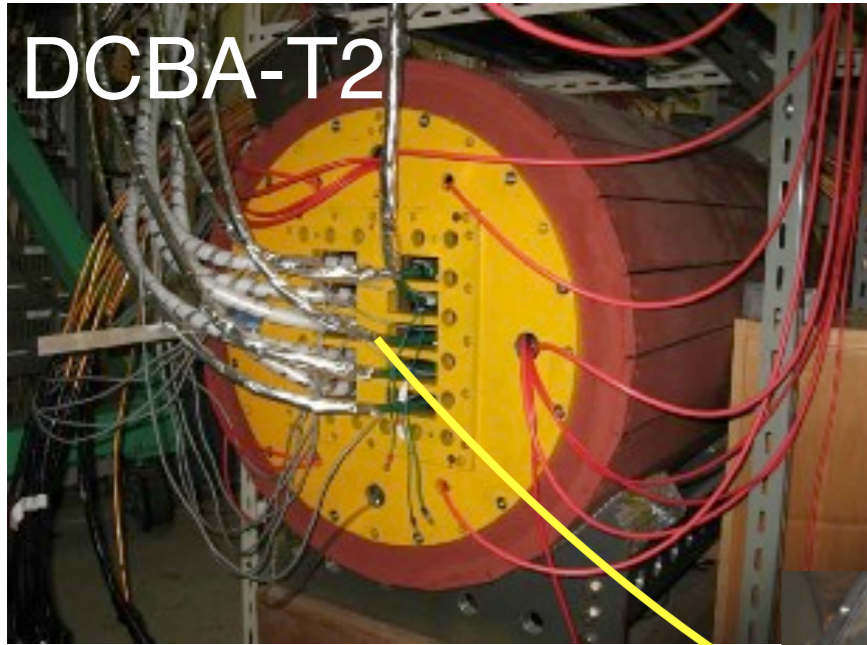


SC-magnet

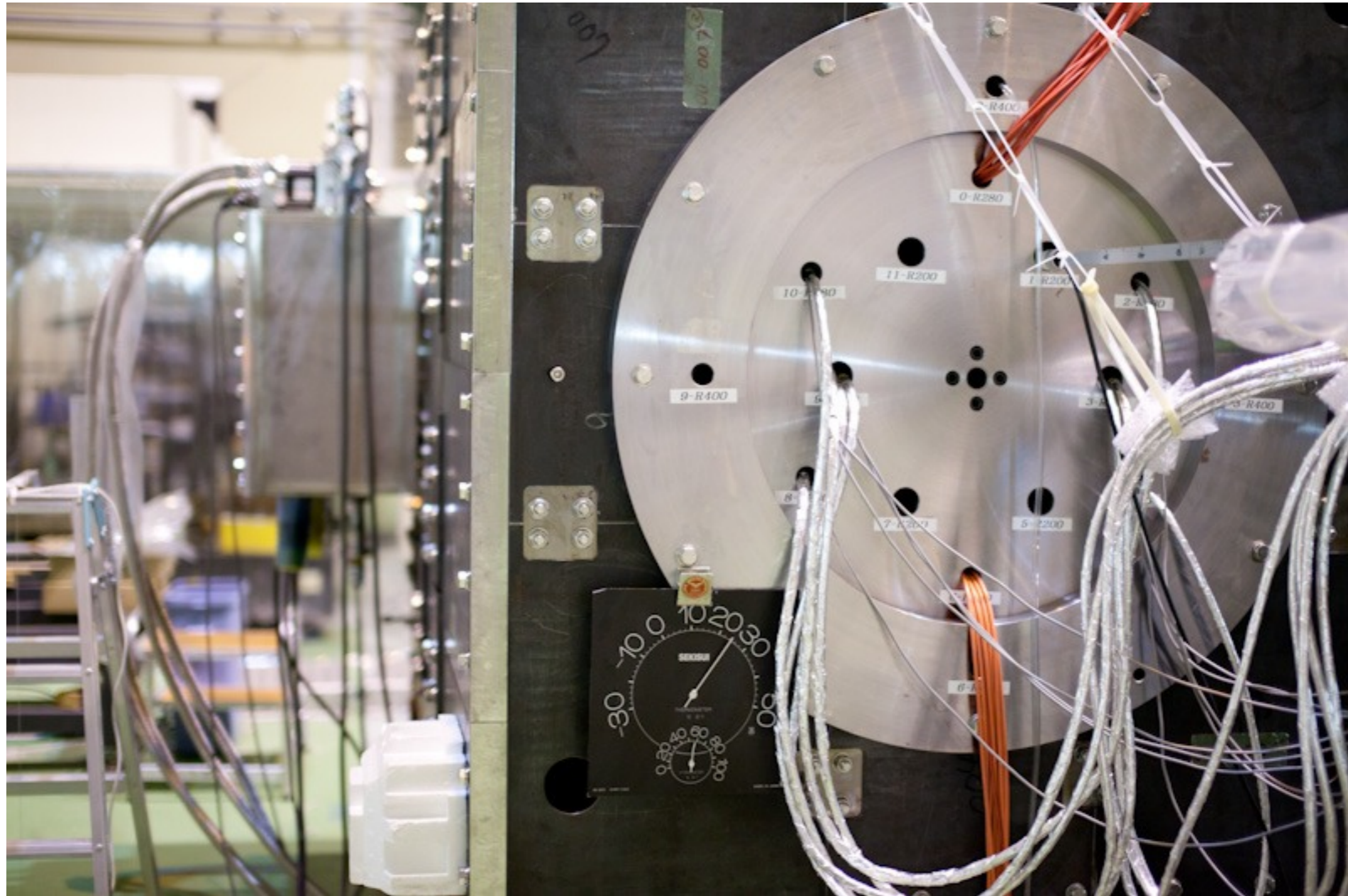
Magnetic field uniformity of DCBA-T3



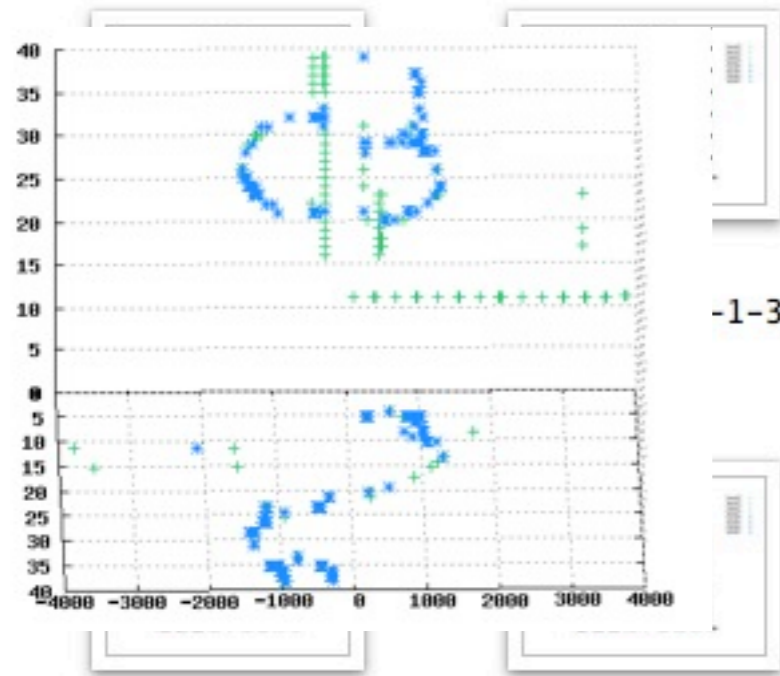
DCBA T-2.5



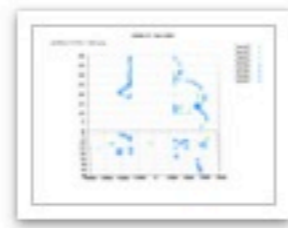
present result of DCBA T-2.5



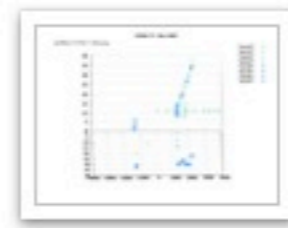
DCBA T-2.5 events



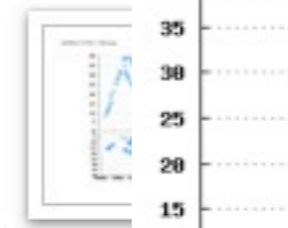
-1-3d1



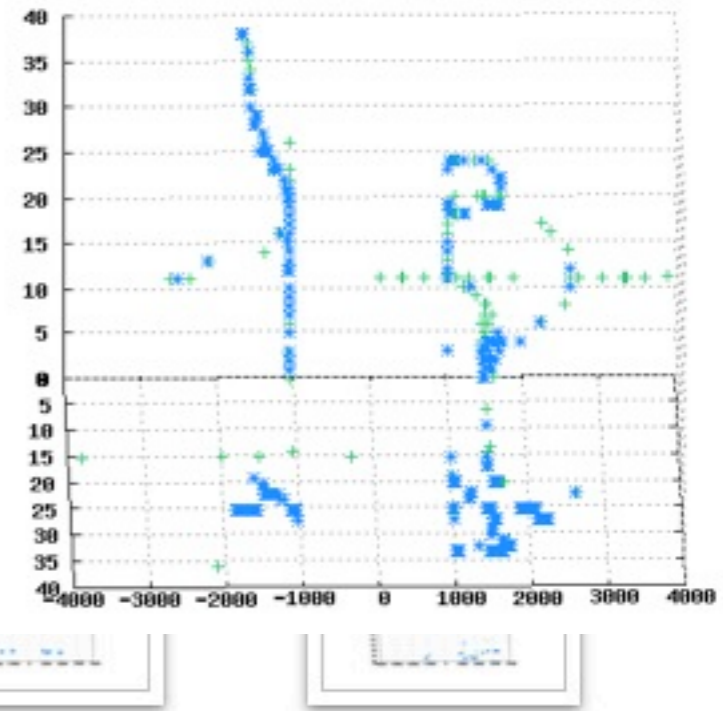
plotfiles110702-1-3d2
.png



plotfiles110702-1-3d3
.png



plotfiles110702-1-3d7



plotfiles110702-1-3d1
2.png

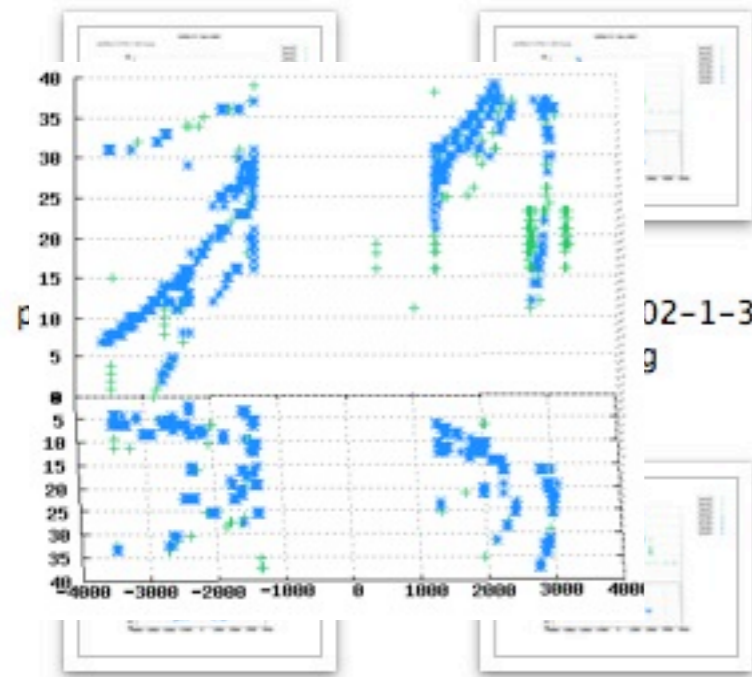
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plotfiles110702-1-3d8
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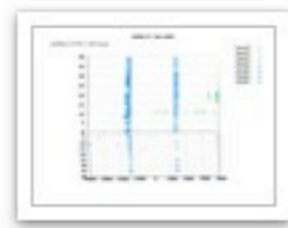
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plotfiles110702-1-3d1
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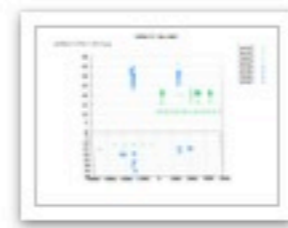
plotfiles110702-1-3d1
1.png



02-1-3d1
g



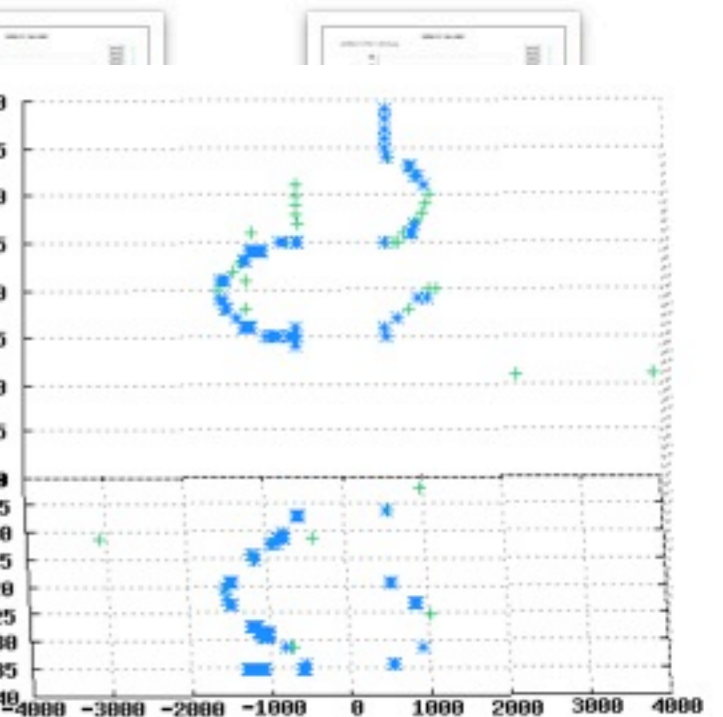
plotfiles110702-1-3d1
6.png



plotfiles110702-1-3d1
7.png



plotfiles



plotfiles110702-1-3d2
6.png

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1.png

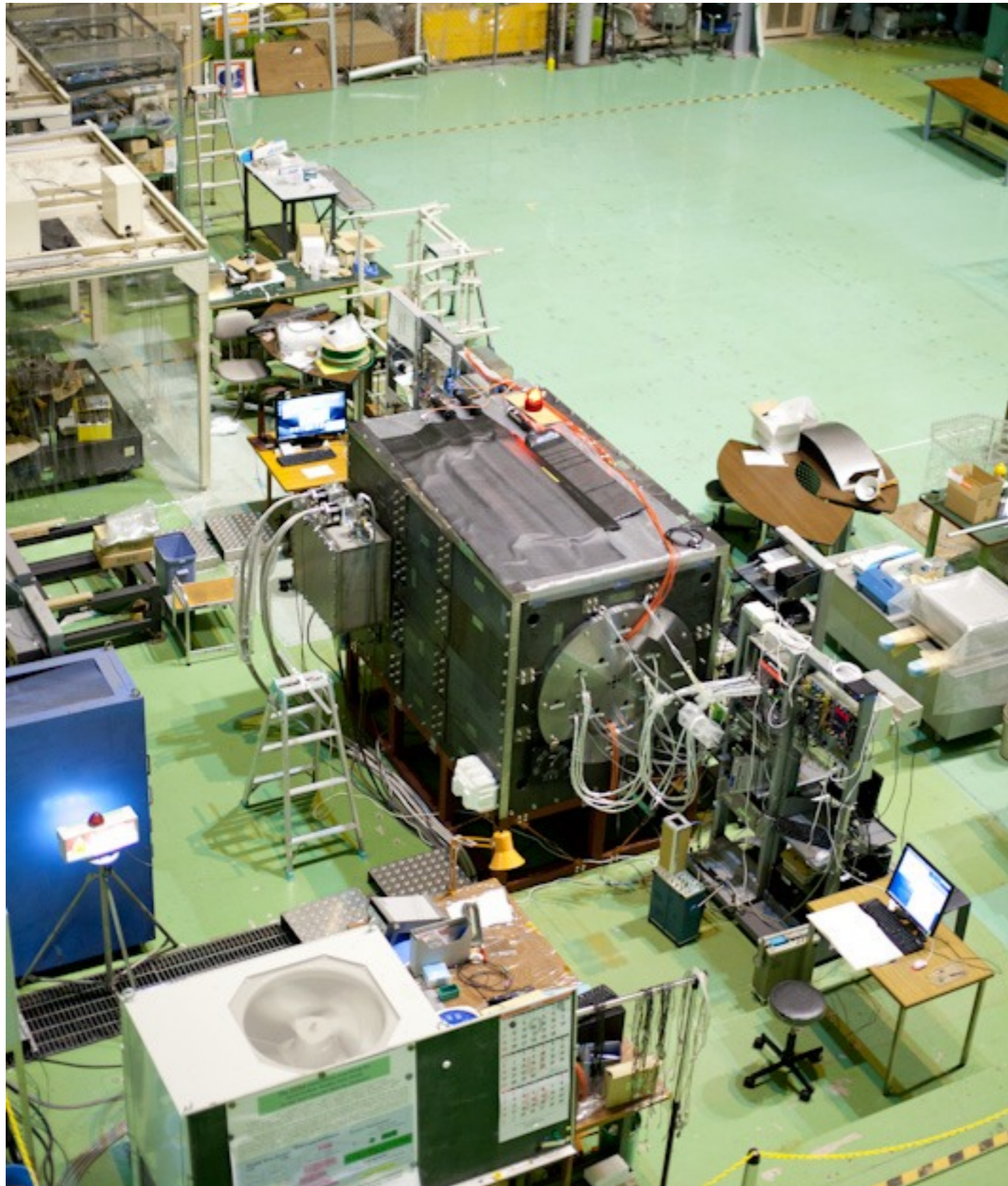
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2.png

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3.png

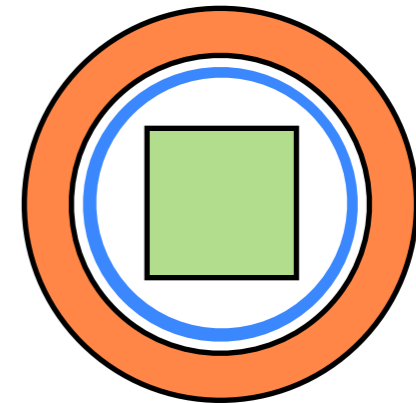
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4.png

plotfiles110702-1-3d2
5.png

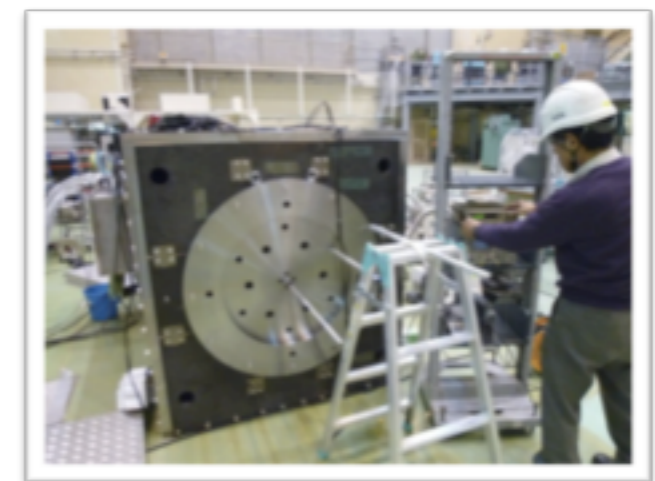
against noise events



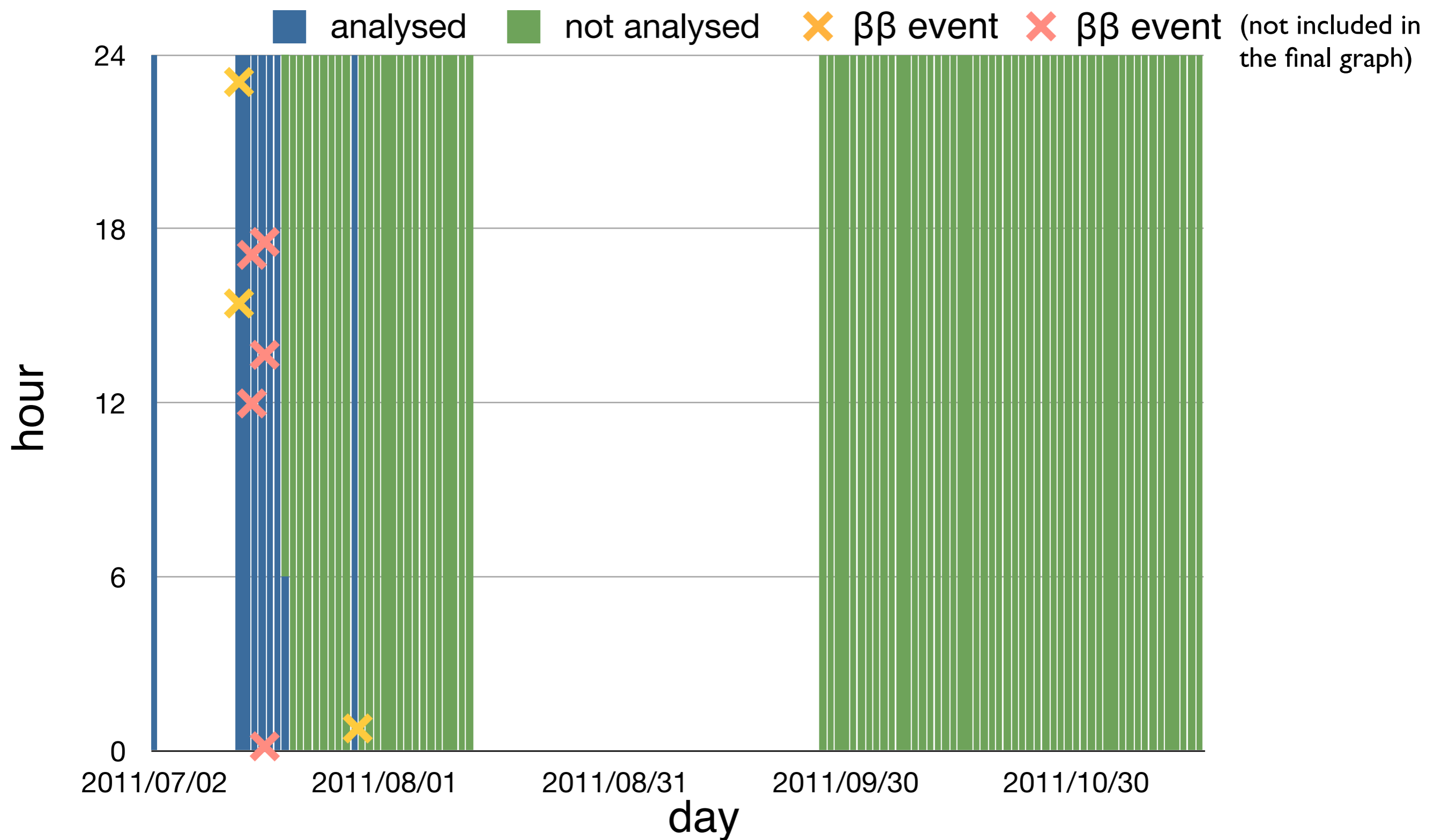
- > additional veto counter
whole veto counter
inside the magnet



- > move to underground

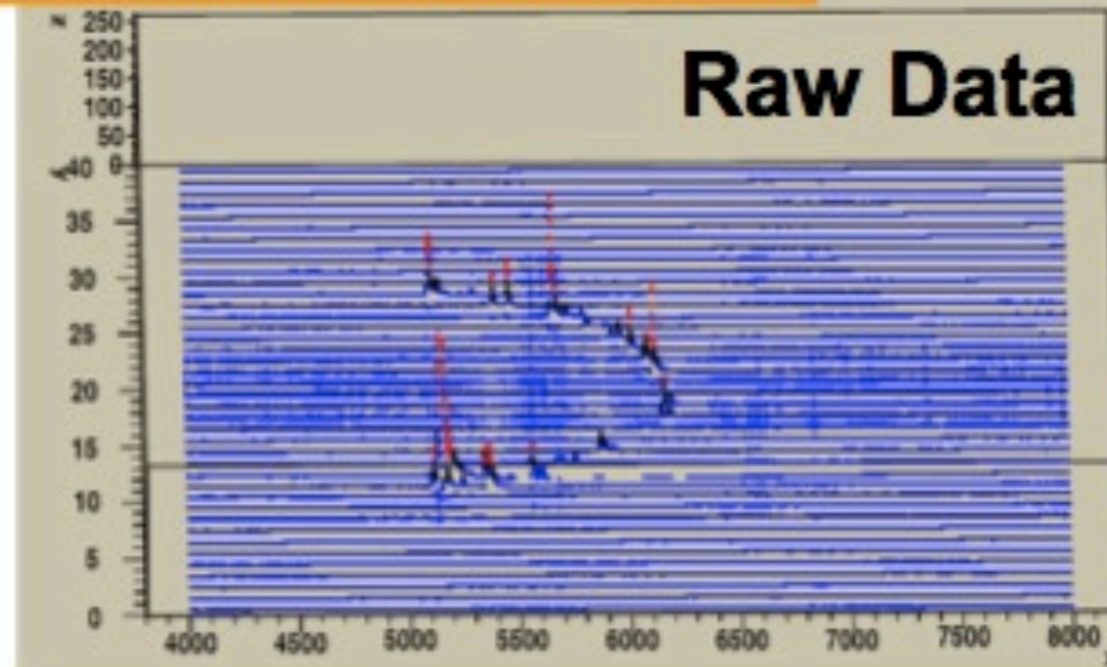


recent DCBA time table & $\beta\beta$ events

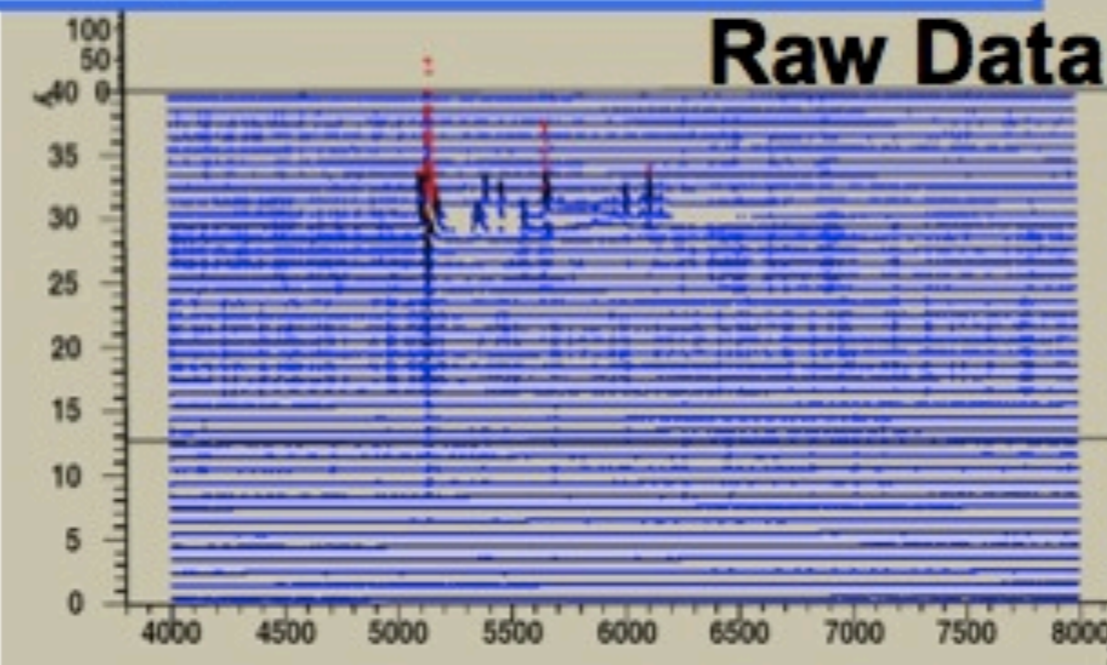


DCBA data analysis - raw data

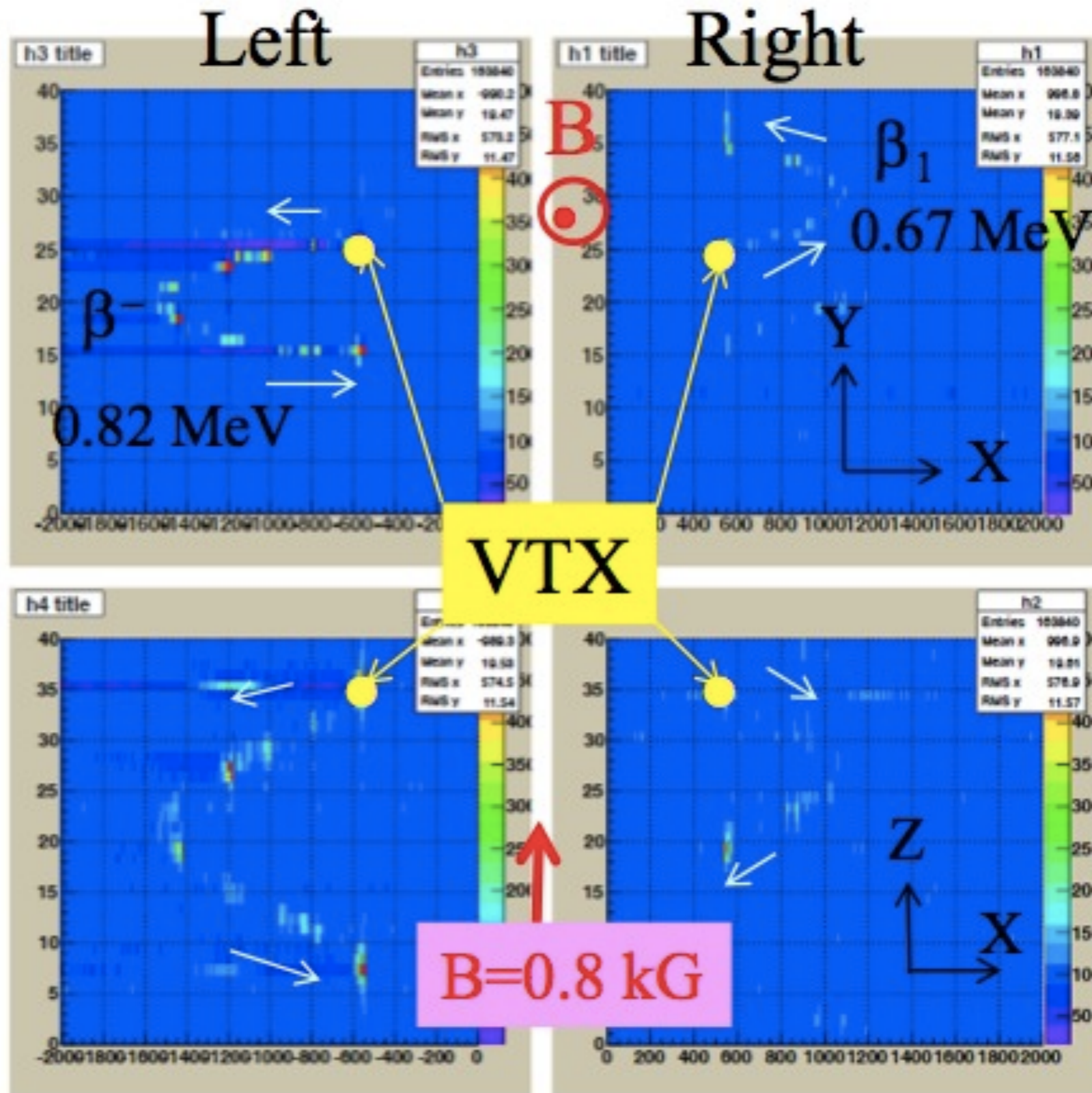
X-Y surface



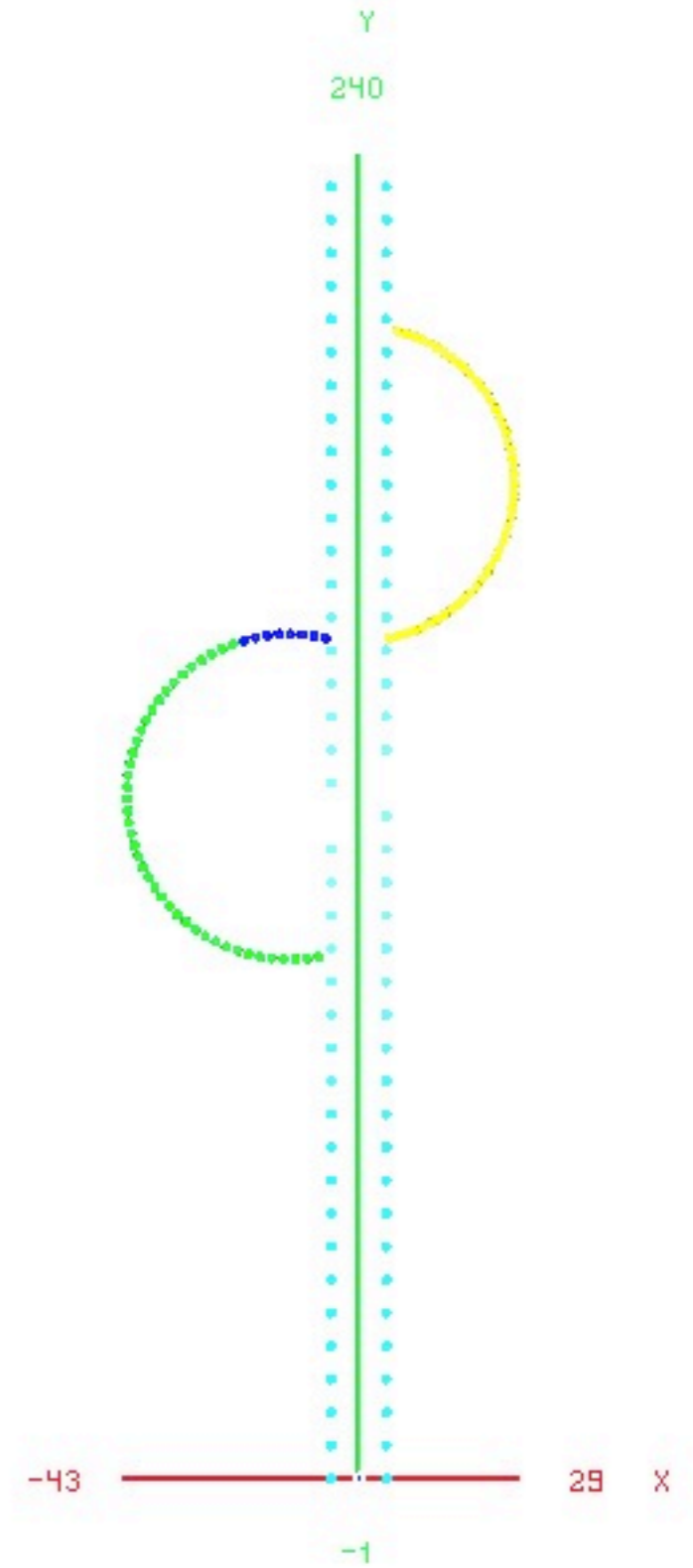
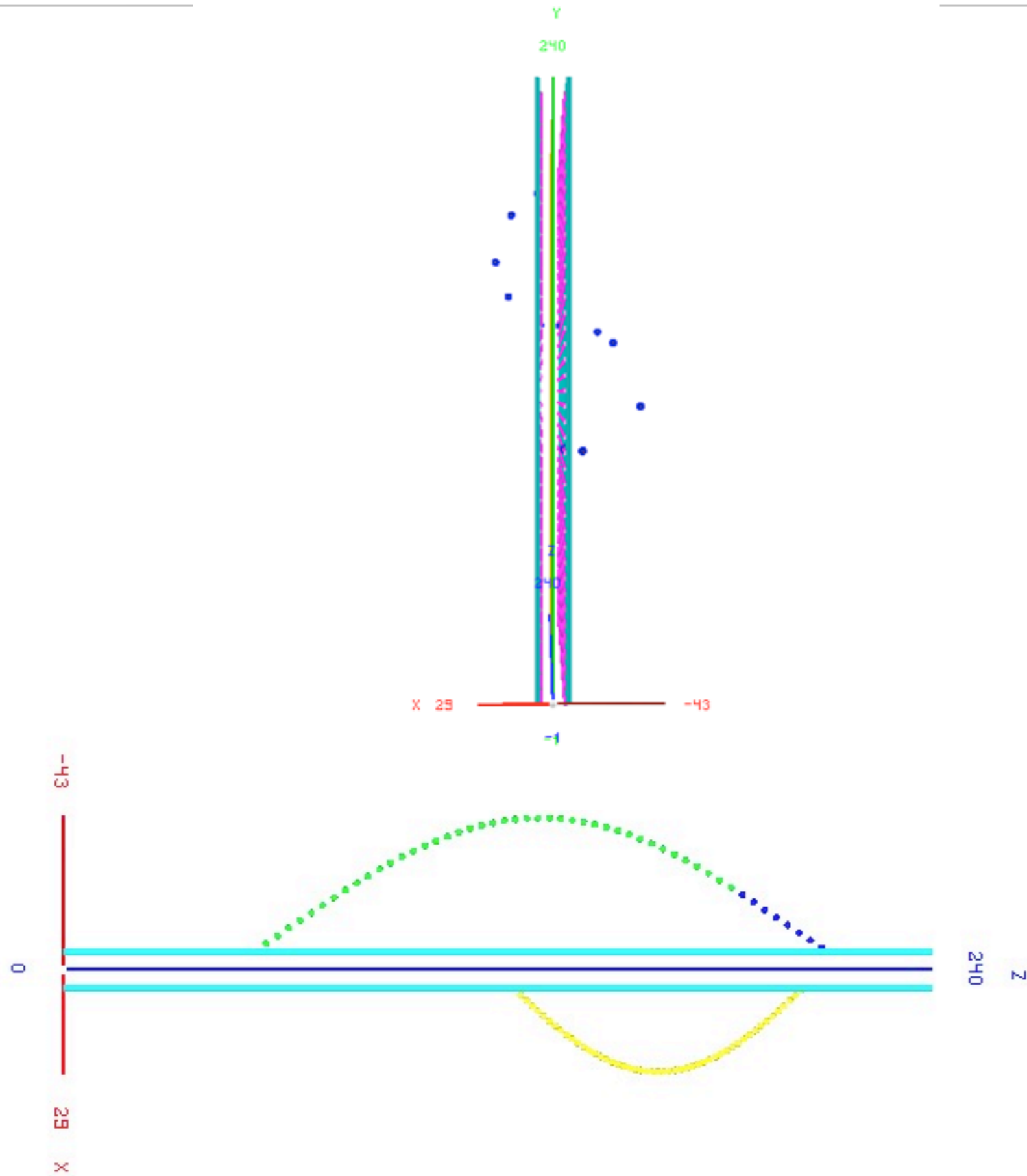
X-Z surface



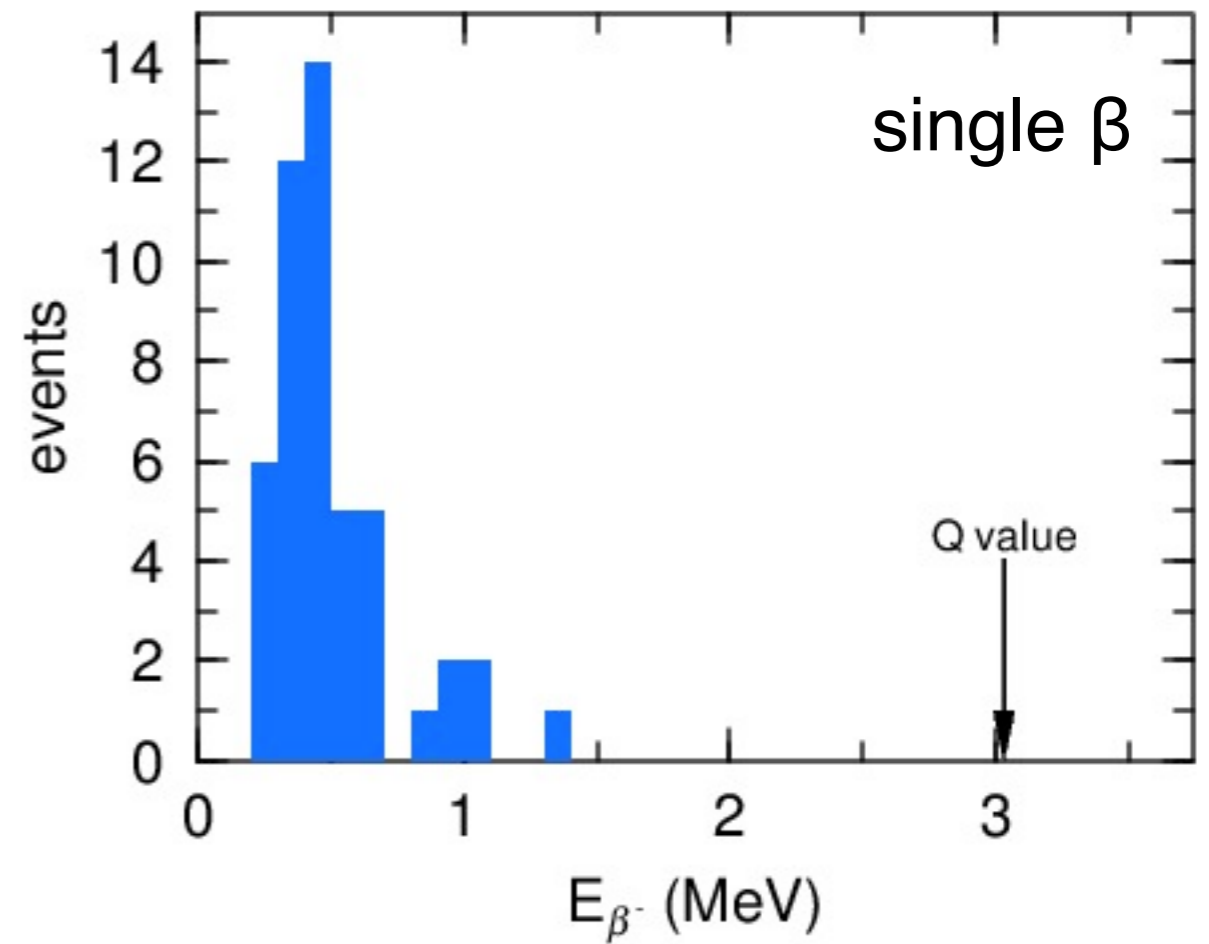
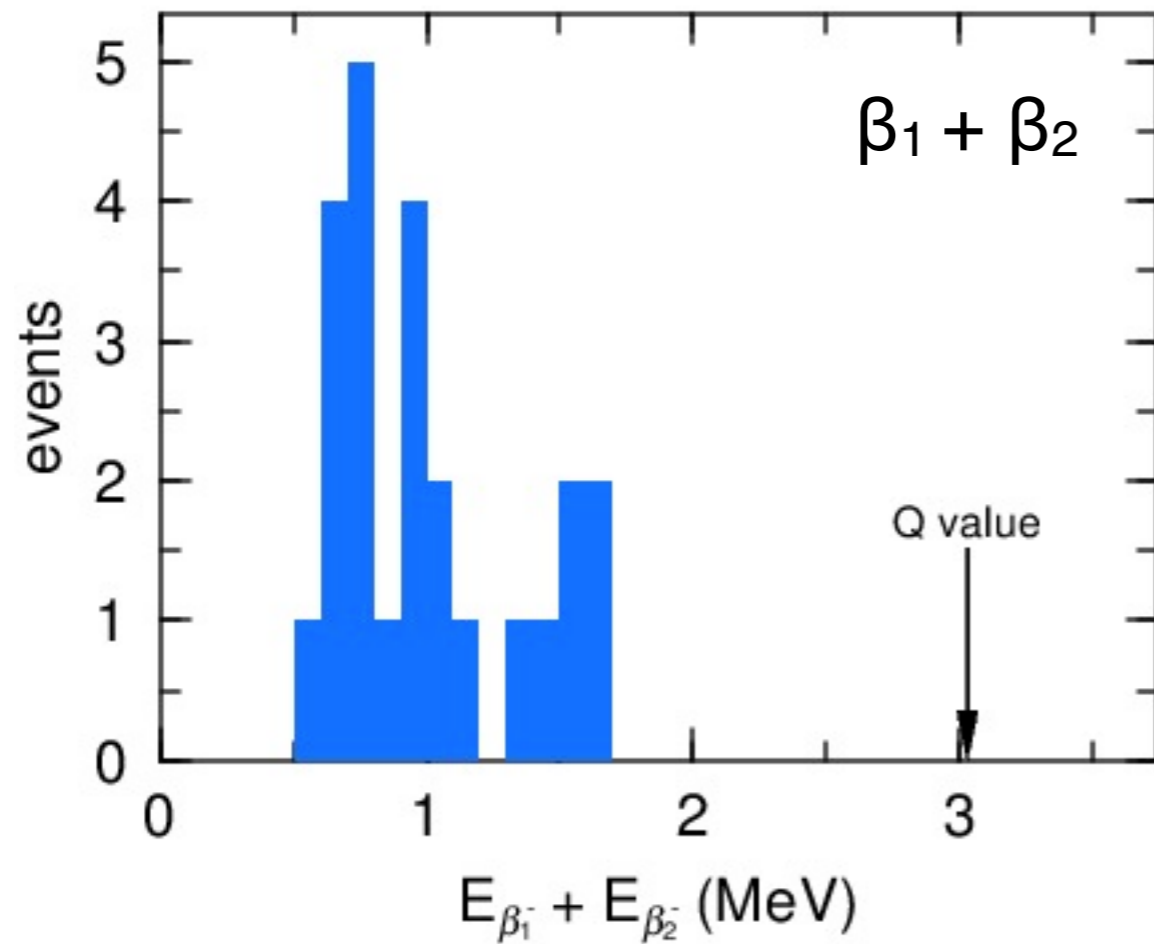
DCBA data analysis



DCBA data analysis

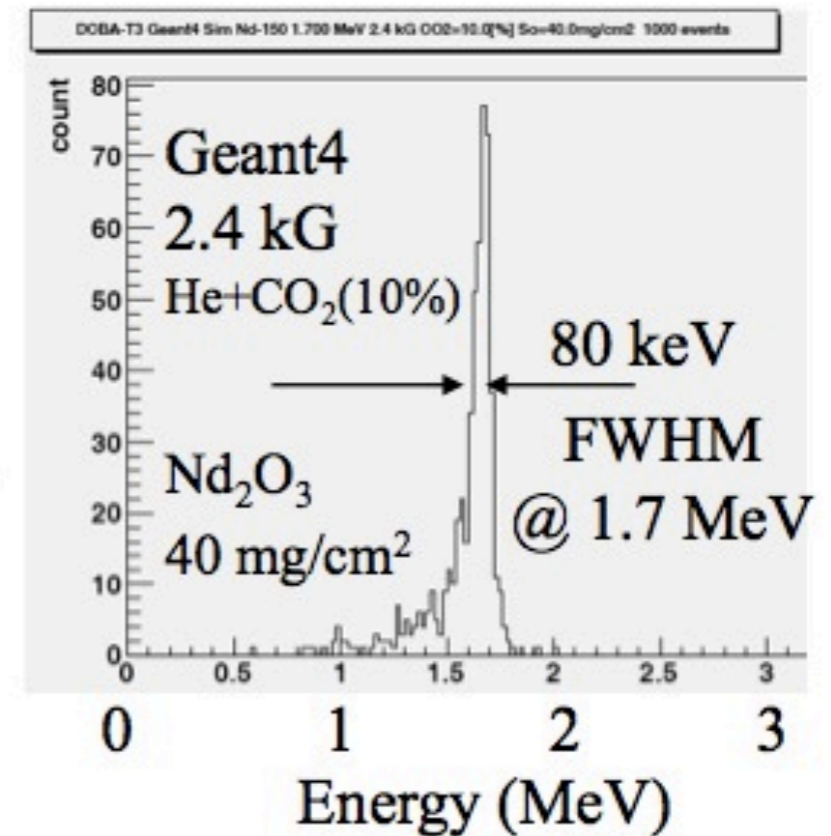
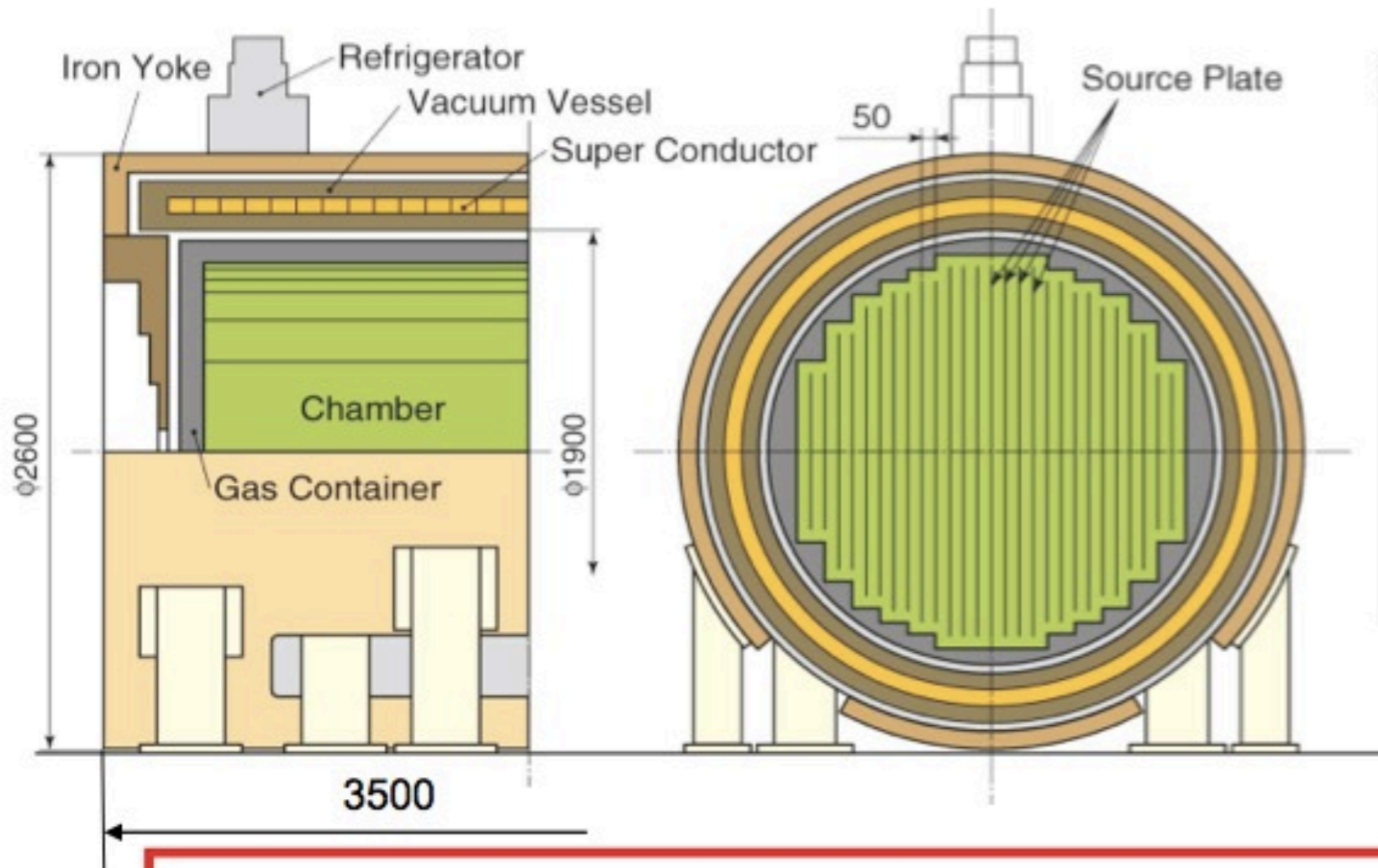


DCBA (T-2 + T-2.5) ^{100}Mo $\beta\beta$ results



MTD - the next DCBA

Chamber cell : the same as DCBA-T3, Source plate: 80 m²/module
 Thickness: 40 mg/cm², Source weight: 32 kg/module 27 source plates

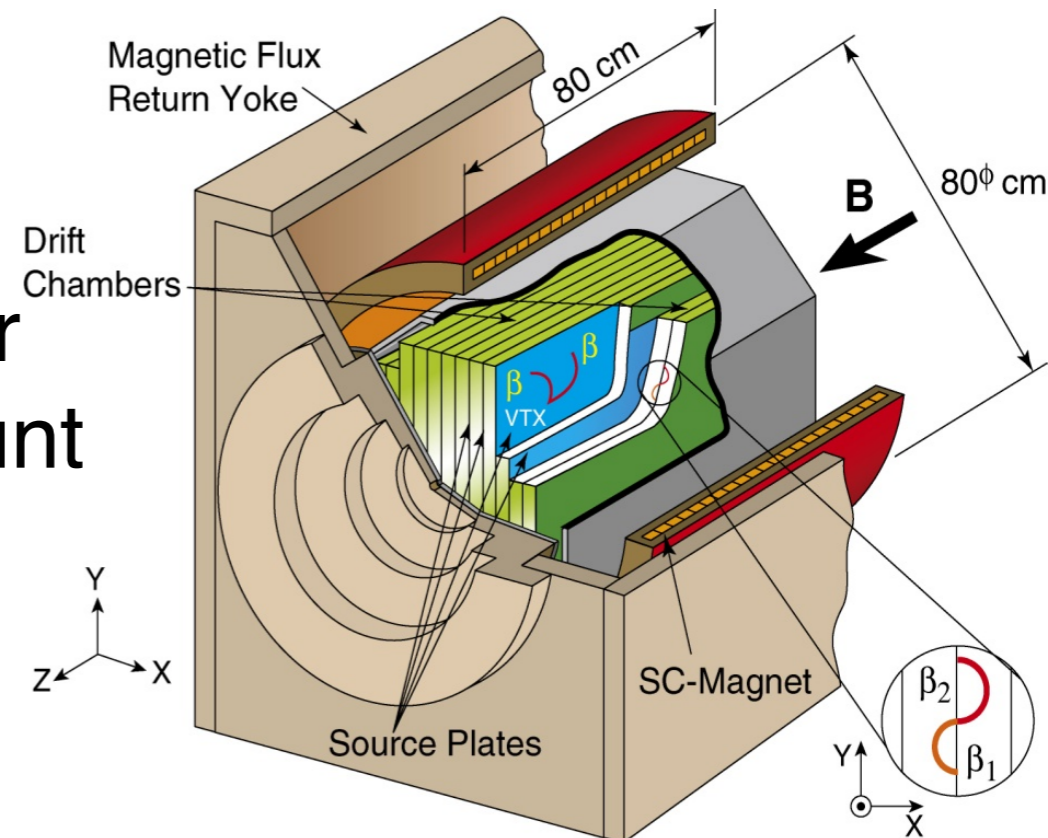


Expected Energy Resolution

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

Summary

- DCBA $\beta\beta$ -decay data taking was started by T-2
- 21 $2\nu\beta\beta$ candidate events found by T-2
- DCBA-T3 super conducting magnet was finished
- T-2 chamber in T-3 s.c. magnet (T-2.5) is in operation
- 24h data taking
- T-3 is under development for higher energy resolution and source amount



recent DCBA time table & $\beta\beta$ events

