KAON09

CsI calorimeter and low power PMT base for K^{0}TO experiment

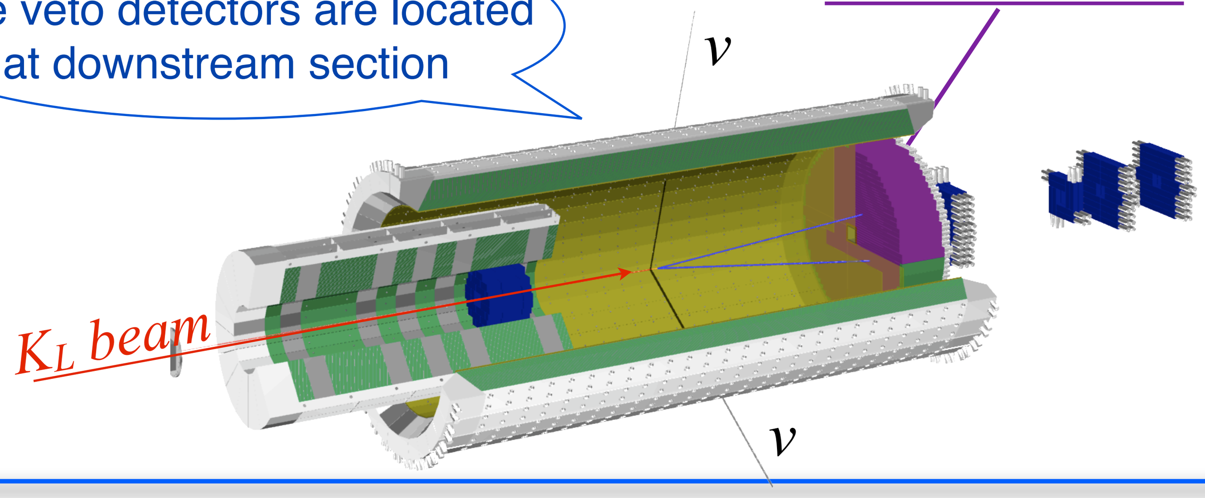
Takahiko Masuda for the J-PARC E14 K^{O}TO Collaboration, Kyoto University (JAPAN)

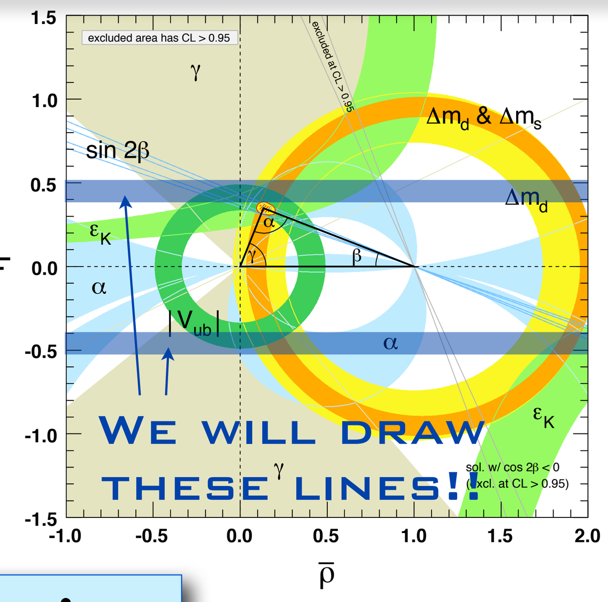
Introduction of K^{0}TO experiment

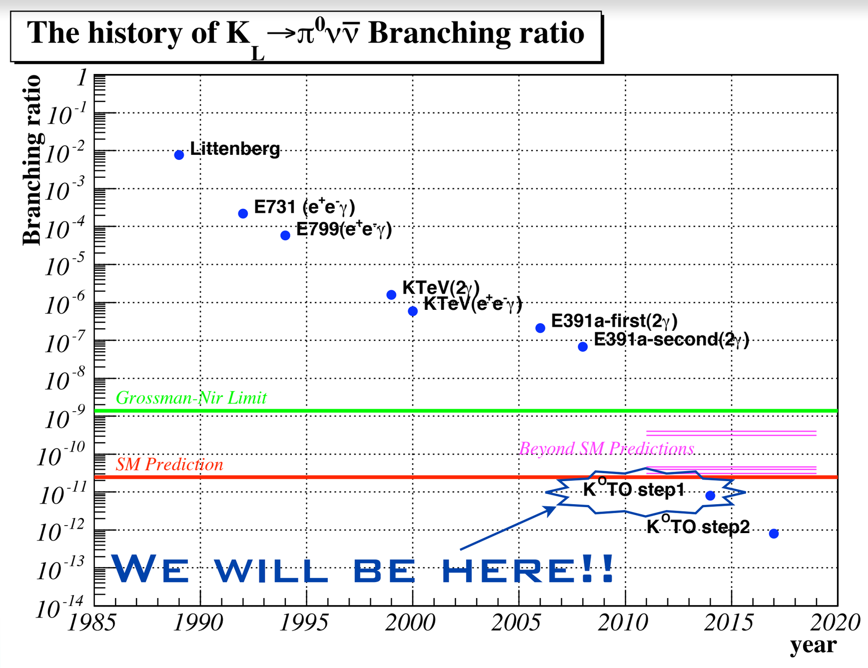
What is K^{0}TO (K^0 at TOkai) experiment?

- Discovery of $K^0_L \rightarrow \pi^0 \nu\bar{\nu}$ decay event
- Precise determination of CP violation parameter η with small theoretical error
- Start in late 2011, at J-PARC (TOKAI, JAPAN)

More veto detectors are located at downstream section







Detectors & Signal selection

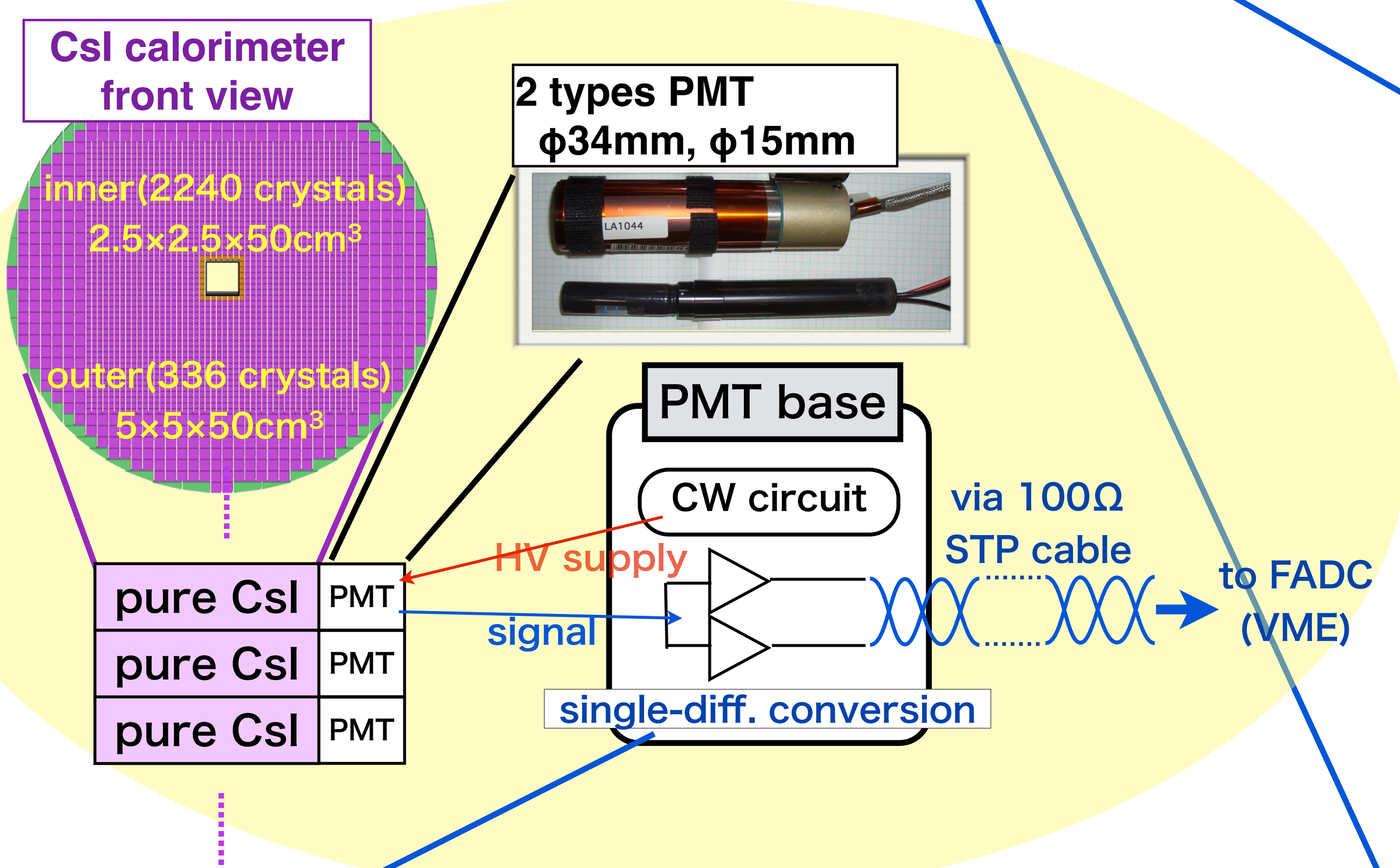
- There are only 2 gammas from π^0 decay (neutrino cannot be detected)
- Energy & positions of 2 gammas are measured by CsI calorimeter to reconstruct π^0 vertex
- Veto detectors covering all solid angle confirm that there is nothing else
- Detectors are put in vacuum (~0.1Pa) to suppress back ground

CsI calorimeter overview

- CsI calorimeter consists of about 2600 pure CsI crystals (2 types) and is located in vacuum
- Fine segmentation makes gamma separation easier
- PMT measures each CsI scintillation light
- PMT signal pulse is amplified and converted to differential for noiseless transmission

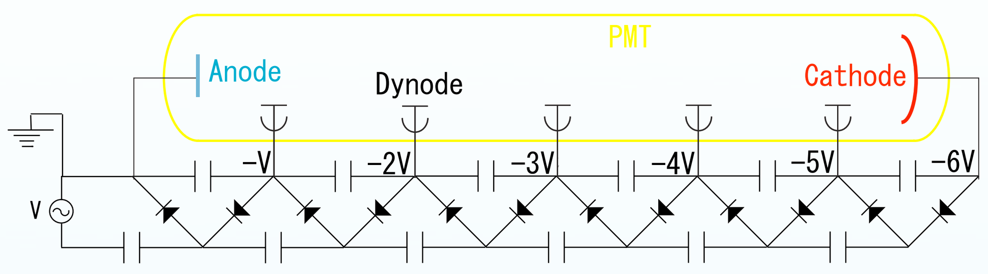
Requirements for each channels

Energy range	1MeV ~ 1.3GeV
Linearity	± 5%
Single counting rate	120kHz



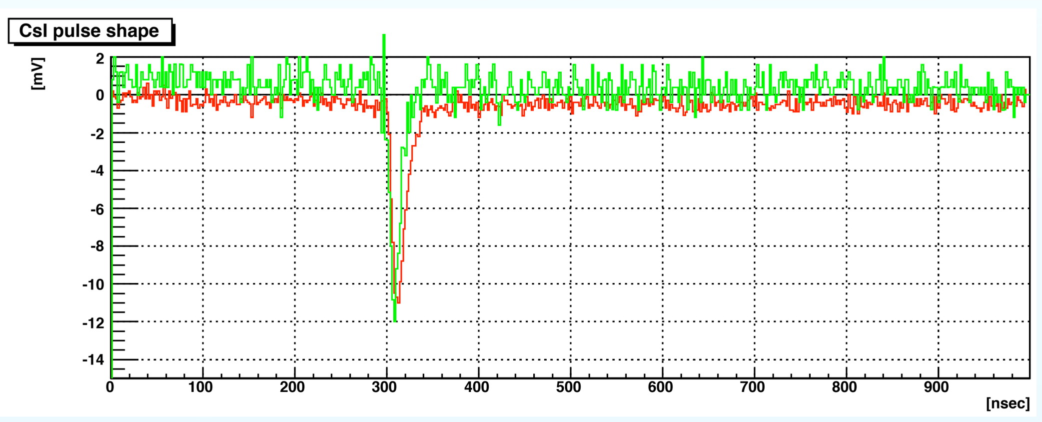
New PMT base

- There is heat problem caused by operation in vacuum using normal resistor-divided base. We must reduce PMT base power consumption to suppress heat. That is why I planed to use Cockcroft-Walton circuit as PMT base.



Cockcroft-Walton

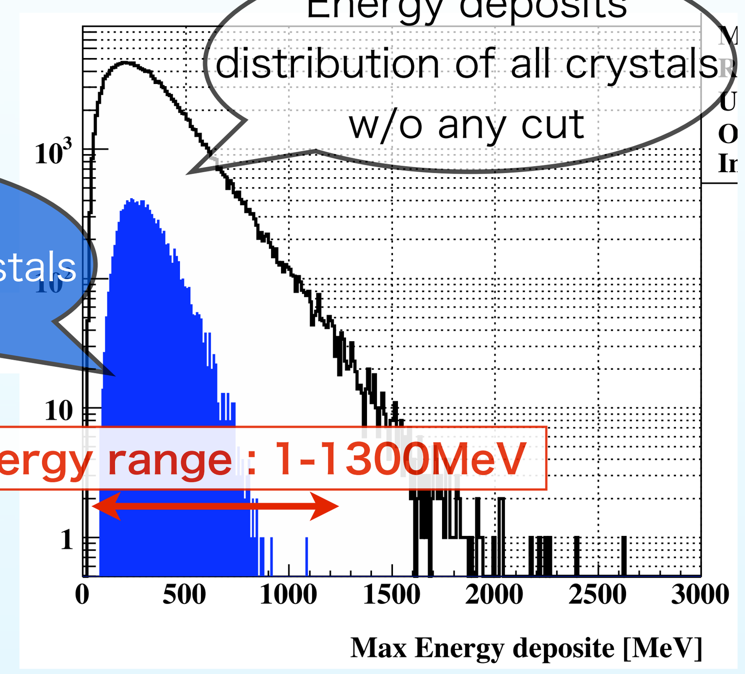
- PMT gain is too small (~5000 typ.) to measure 1MeV. To solve this problem, I added preamp into base which is High-speed, Low-power, differential output. Right figure shows cosmic ray pulse from CsI crystal amplified by the preamp.



	Previous	New
Power	700mW/ch	CW : 60mW/ch Preamp : 90mW/ch
Gain	5000	340000 (charge equivalent)

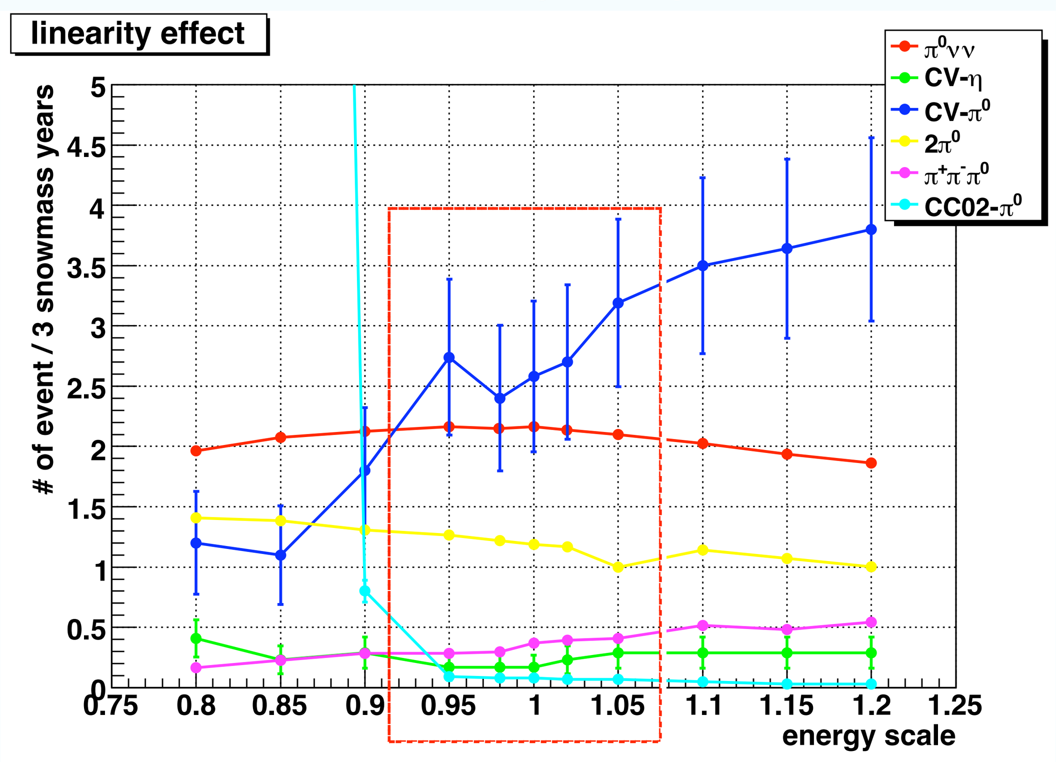
Energy range

CsI must measure almost all gammas from the decay $K^0_L \rightarrow \pi^0\nu\nu$. I simulated their energy distribution crystal by crystal, and decided 1-1300MeV as a requirement energy range of CsI calorimeter with a redundancy at some level.



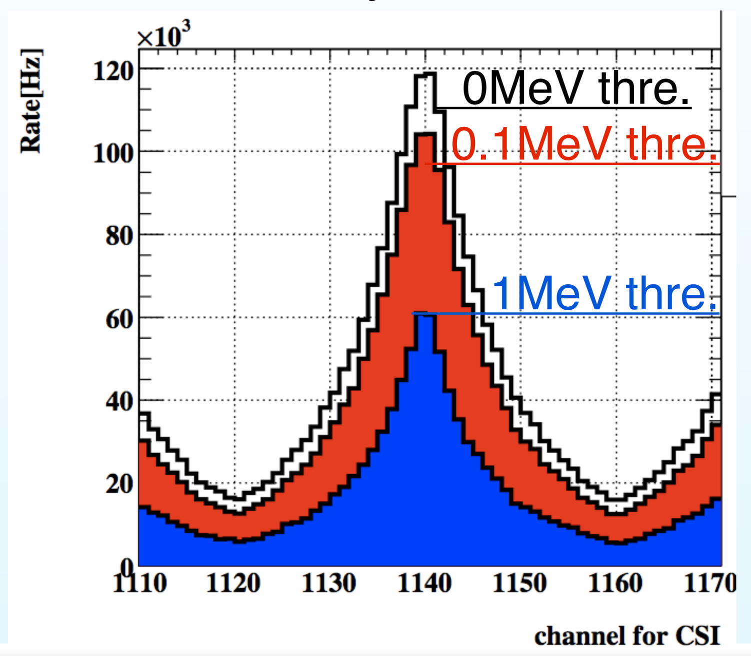
Linearity

Linearity of CsI calorimeter affects S/N ratio directly. I simulated the quantitative evaluation of S/N variation. Lower figure shows it. Horizontal axis is energy miss scale parameter and vertical axis is numbers of events of $K_L^0 \rightarrow \pi^0\nu\nu$ and major B.G.s. Outside of red box, 2 B.G.s increase. I decided Linearity acceptable value is ±5%.



Single counting rate

K_L^0 beam is enough thin to avoid hitting CsI directly, so single counting rate is enough few. Hottest crystal which is located nearby beam hole is only 120kHz.



Right figure shows single counting rate vs. crystal. Around 1140ch crystals are located nearby beam hole.

Requirements of CsI calorimeter were fixed and our new PMT base can decrease power to 150mW with enough gain, using CW circuit and internal preamp. We'll do mass production in JFY2010.