

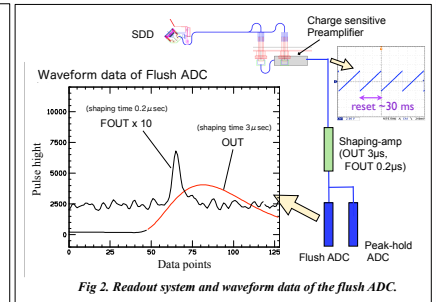
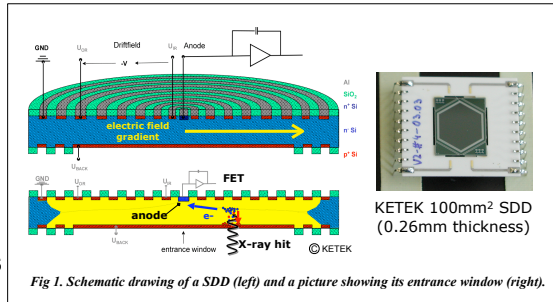
Silicon Drift Detectors for the Precision Spectroscopy of Kaonic Helium $3d \rightarrow 2p$ X-rays

Abstract

The strong-interaction shift of $3d \rightarrow 2p$ x-rays of kaonic helium atoms was measured with a statistical accuracy of ~ 2 eV using silicon drift x-ray detectors (SDDs) by the KEK-PS E570 collaboration. This precision was realized by using recently developed SDDs. The SDDs are characterized by: **1)** the low output capacitance which is almost independent of the active area, **2)** the thin active layer. The low output capacitance brings benefits of much better resolution than conventional photodiodes, and the thin active layer reduces the continuum background caused by the soft-Compton process.

1. Silicon Drift Detector "SDD"

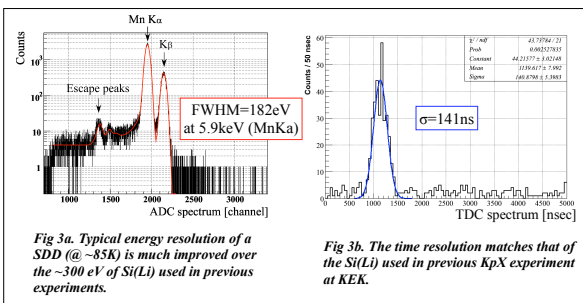
• Silicon drift detector is a semiconductor x-ray detector. Its charge collection mechanism shown in Fig.1 makes it possible to keep the anode size very small. This results in a **small detector capacitance** and a good energy resolution as well as its **large effective area**. In addition, the small anode permits a reduction of the active layer thickness which helps to **reduce continuum background** caused by the soft-Compton process.



• The readout system using a charge sensitive preamplifier and the typical signal pulse measured by the flush ADC are shown in Fig.2.

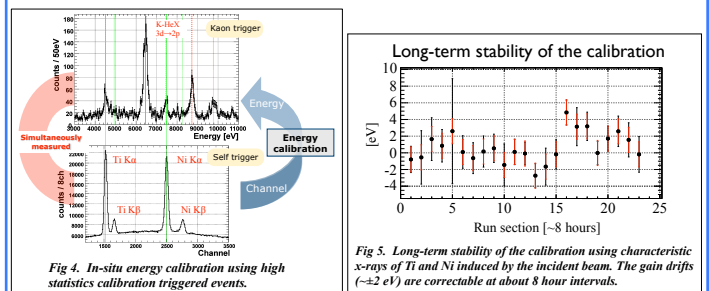
2. Energy and time resolution of the SDD used in the E570 experiment

- The typical energy resolution at 85 K is **182 eV (FWHM) at 5.9 keV** (Mn K-alpha x-ray), which corresponds to the energy resolution of 185 eV (FWHM) at the kaonic helium $3d \rightarrow 2p$ transition energy (Fig.3a).
- The time resolution is **~ 140 ns** (Fig.3b).



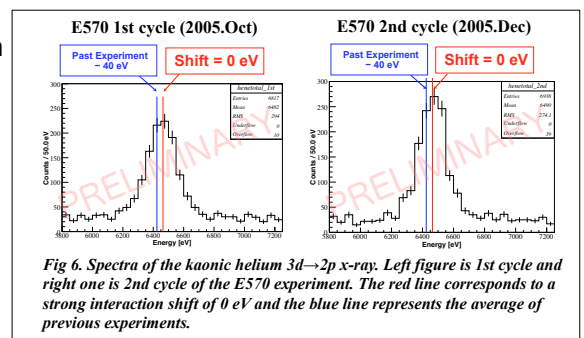
3. Energy calibration and its stability

- In-beam energy calibration was realized by the **interpolation method using Ti and Ni characteristic x-rays** which were simultaneously measured with the kaonic helium x-rays (Fig.4).
- The long-term stability was ensured in Fig.5, **gain drifts of the SDD are correctable at 8 hour intervals**.



4. Preliminary results of the E570 experiment

- Preliminary results are shown in Fig.6, the peak of the kaonic helium $3d \rightarrow 2p$ x-ray is shown close up. The past experimental shift results (-40 eV) which has been known as "the kaonic helium puzzle" were clearly rejected.
- In total, **about 1500 events** were accumulated after fiducial volume cuts were applied. The statistical error of the shift is estimated to be $\sigma \sim 2$ eV.
- The systematic error estimation is now in progress.



Summary

The strong-interaction shift of $3d \rightarrow 2p$ x-rays of kaonic helium atoms was measured with a statistical accuracy of ~ 2 eV using the SDDs. The past experimental results which have been known as "the kaonic helium puzzle" were clearly rejected.