IX International Conference on Hypernuclear and Strange Particle Physics, 10-14 October 2006

A superfluid helium target for precision spectroscopy of kaonic helium 3d → 2p X-rays

Masami Iio for KEK-PS E570 collaboration
Nishina Center for Accelerator-Based Science, RIKEN

Interaction of a negative kaon with a nucleon in nuclear medium is important to understand the possibility of the kaon condensation in high density nuclear matter. Measurement of the kaonic atom X-rays is a good probe to determine this interaction. However, experimental values of the strong interaction shift of the kaonic helium have had very large deviation from those calculated theoretically and more precise data have been awaited (kaonic helium puzzle). The purpose of KEK-PS E570 experiment is to determine the kaonic helium level shift with a precision of ~2eV by spectroscopy of 3d → 2p X-rays.

Last orbit energy level shift and width of kaonic atoms

Reference : C.J Batty, E. Friedman, A. Gal Phys. Rep. 287 (1997) 385-445

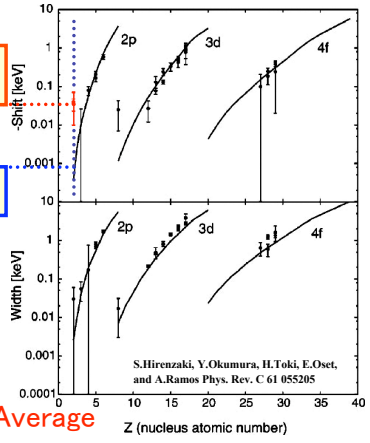
Experimental values: ~40eV
Very large repulsive shift !

Theoretical values: ~0.2eV
Calculation from chiral unitary + optical model

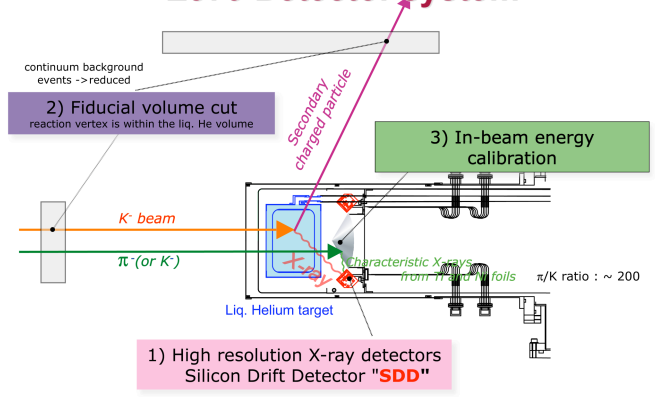
< Experimental values >

ΔE_{2p} (eV) Shift	Γ_{2p} (eV) Width
-41 ± 33	–
-35 ± 12	30 ± 30
-50 ± 12	100 ± 40
-43 ± 8	55 ± 34

Average



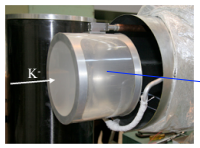
E570 Detector system

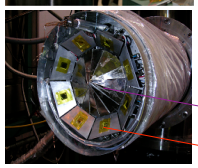


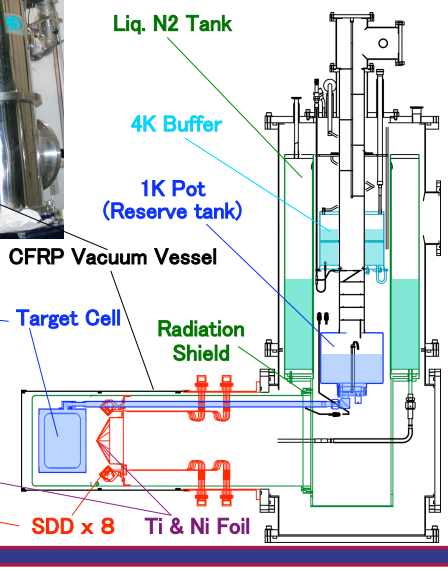
E570 Target Requirements

- **Attenuation of the kaonic helium X-rays**
  - > SDDs were installed inside the target system
  - > Windows of the target cell : Mylar of thickness 75 mm
    (Using superfluid helium of low vapor pressure)
- **Resolution of reaction vertex for fiducial volume cuts**
  - > Windows of Radiation shield : Au of thickness 0.1 mm
  - > The vacuum vessel : CFRP of thickness 1 mm

E570 LHe Ⅱ Target



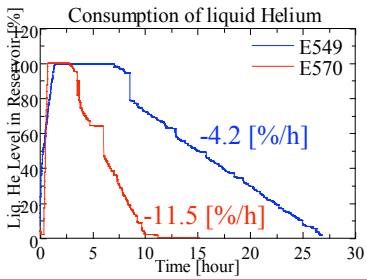




Performance of the E570 LHe Ⅱ Target

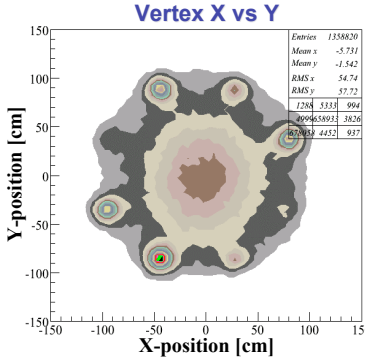
The temperature of each SDD was kept at ~85 K during the experimental period by heat conduction through the radiation shield which was cooled by liquid nitrogen. The heat load which can be estimated from evaporation rate of liquid helium in the reserve tank was 0.48 W and consumption of the liquid helium was about 100 ℓ/day. Although the heat load increased ~3 times higher than E549 condition, the target cryostat could cool down the target cell at 1.4 K and keep helium as superfluid.

	E549	E570
Heat load to 1K part	0.16 W	0.48 W
He consumption	45 ℓ/day	100 ℓ/day
Target Cell temperature	1.25 K	1.40 K
Pressure in the 1K pot	1.0 Torr	3.0 Torr



Vertex image of the target cell and SDDs

Vertex X vs Y



Vertex Z vs Y