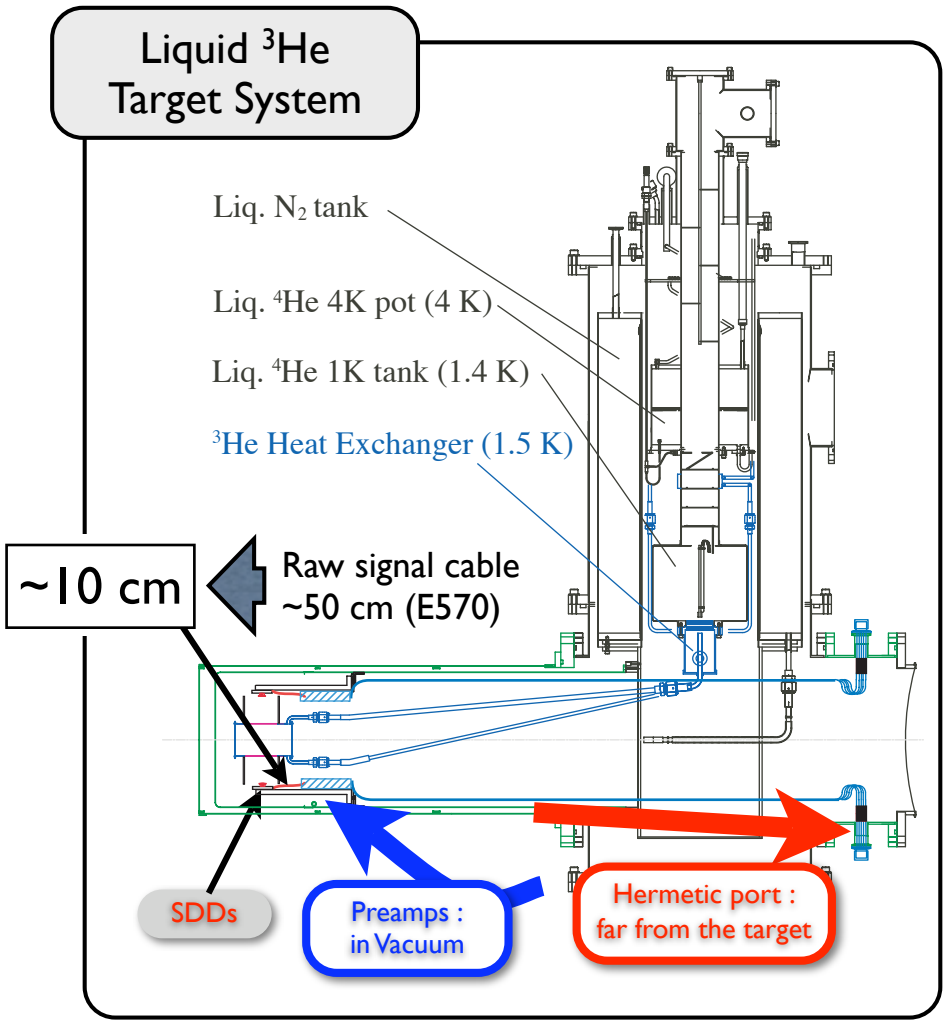
Operation check of the SDD preamplifier in vacuum and low-temperature condition (II)



E17 requirements

short cables and near preamp

low temperature operation (LN2 cooling with heater)

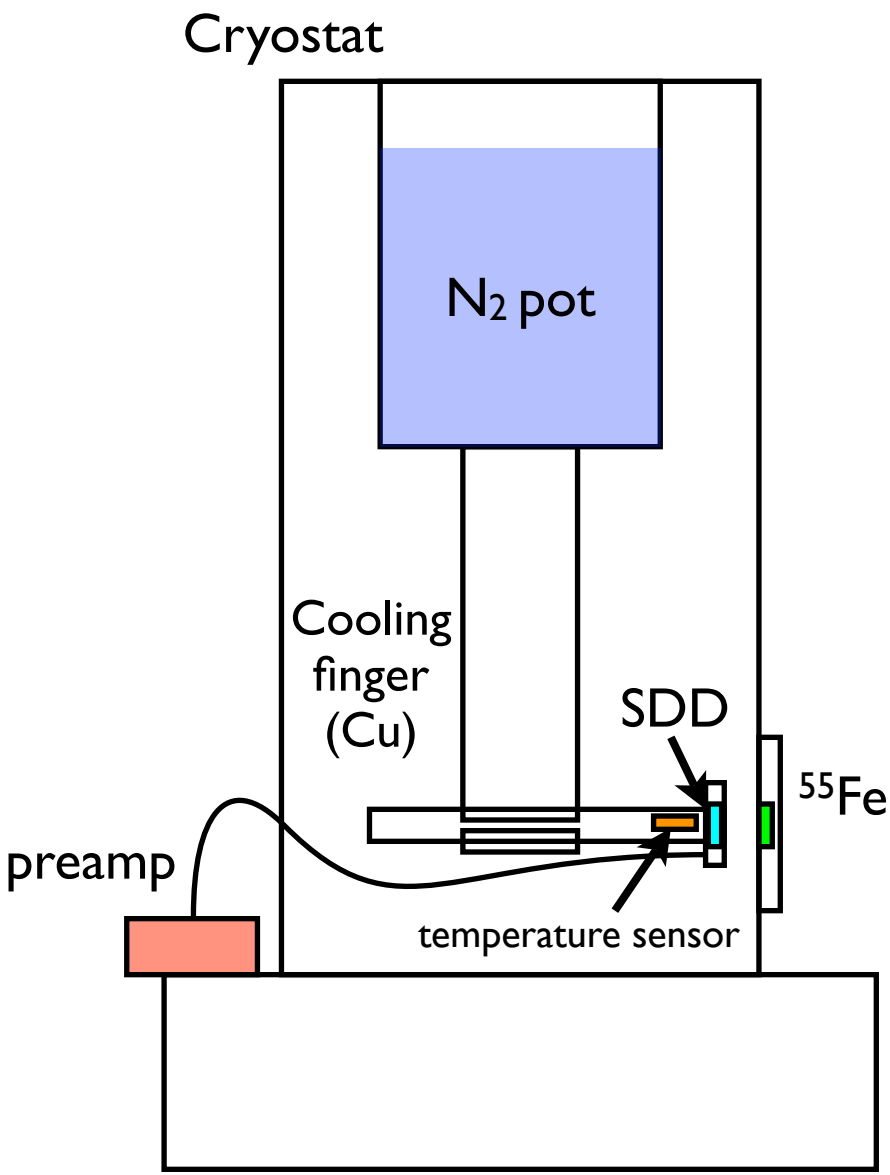
low heat consumption for LHe3 target operation

test bench @ KEK

Checking the preamp operation
in vacuum,
short cables
and LN2 cooling with a heater

Hideyuki Tatsuno 2007/Aug/6th

1. preamp outside vacuum vessel

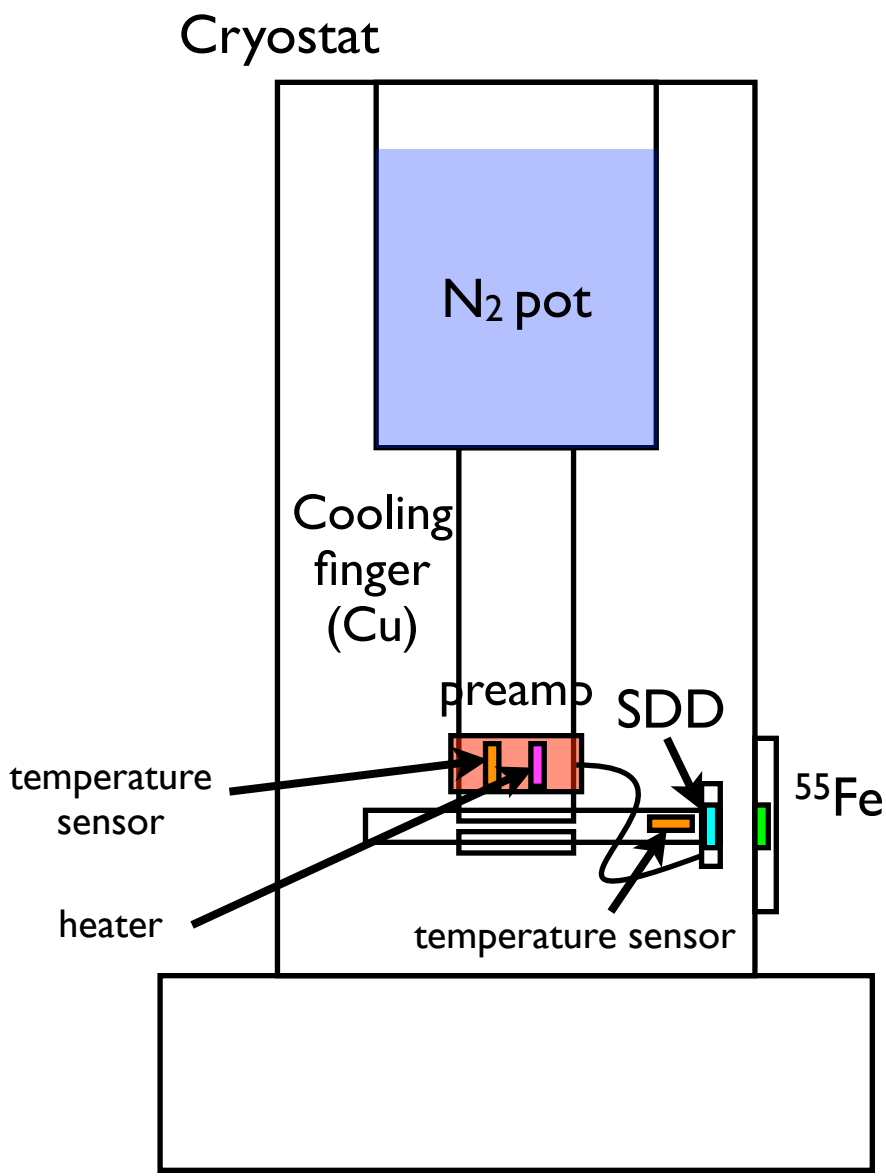


Normal condition
(same as E570 test bench)

- SDD chip : S/N:V2-6-03.02 (SDD #10)
  which was installed on #1 port of the SDD folder at 2nd cycle
- Temperature at SDD : 97 K

Good energy resolution
~ 180 eV (FWHM) at 5.9 keV

2. preamp inside vacuum vessel



- same SDD
- same preamp (without modifying the settings ... reset and substrate voltage)

- Temperature at preamp : 150 K with heater (64.6% 30W)
- Temperature at SDD : 99 K

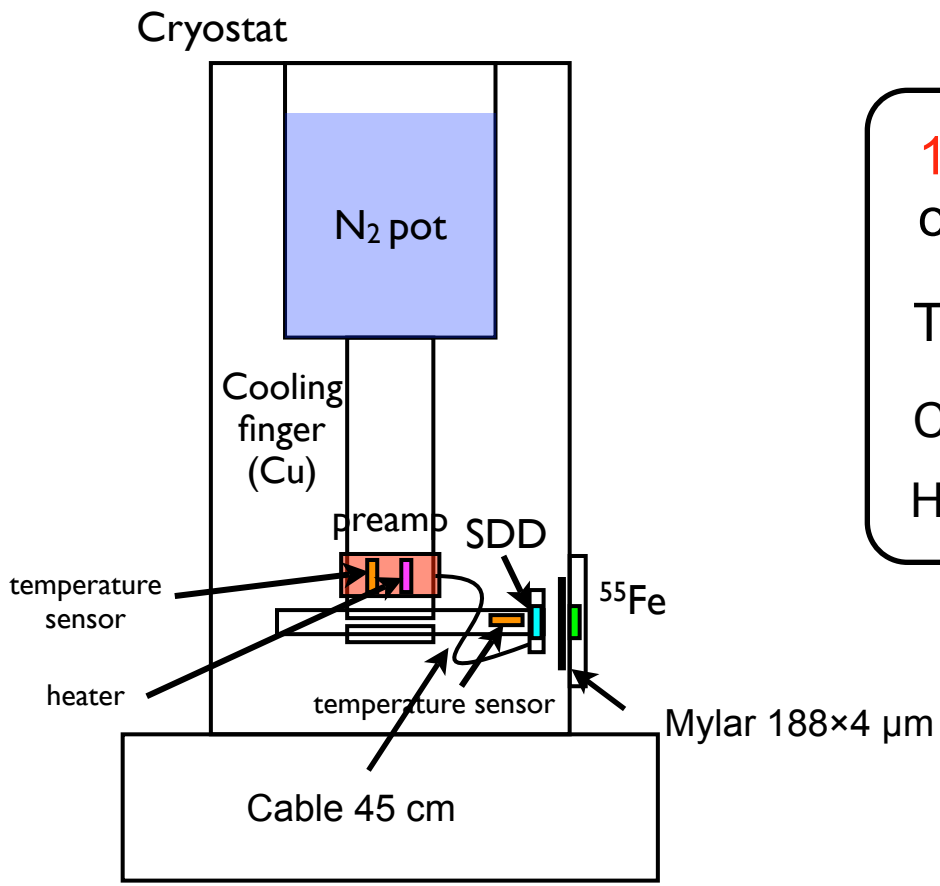
healthy signal output only for 5 minutes...

Due to GND disconnection caused by heat shrinkage of its solder.

3. preamp inside vacuum vessel (II)

Repaired the preamp

Same setup → but the temperature equilibrium was changed ! (unknown)
Maximum point of preamp temperature was 120.8 K



Operated condition

120.0 K at preamp with heater 91.9% of 30W (SDD and preamp ON)

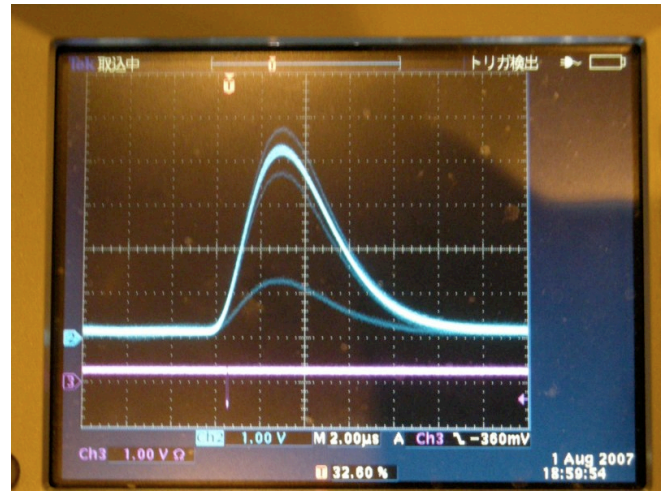
Temperature at SDD: 102.0 K

Cable length from SDD to preamp: 45 cm

Heat consumption: 1.1 W

Good working at 120 K !!
→ took data for 1 hour

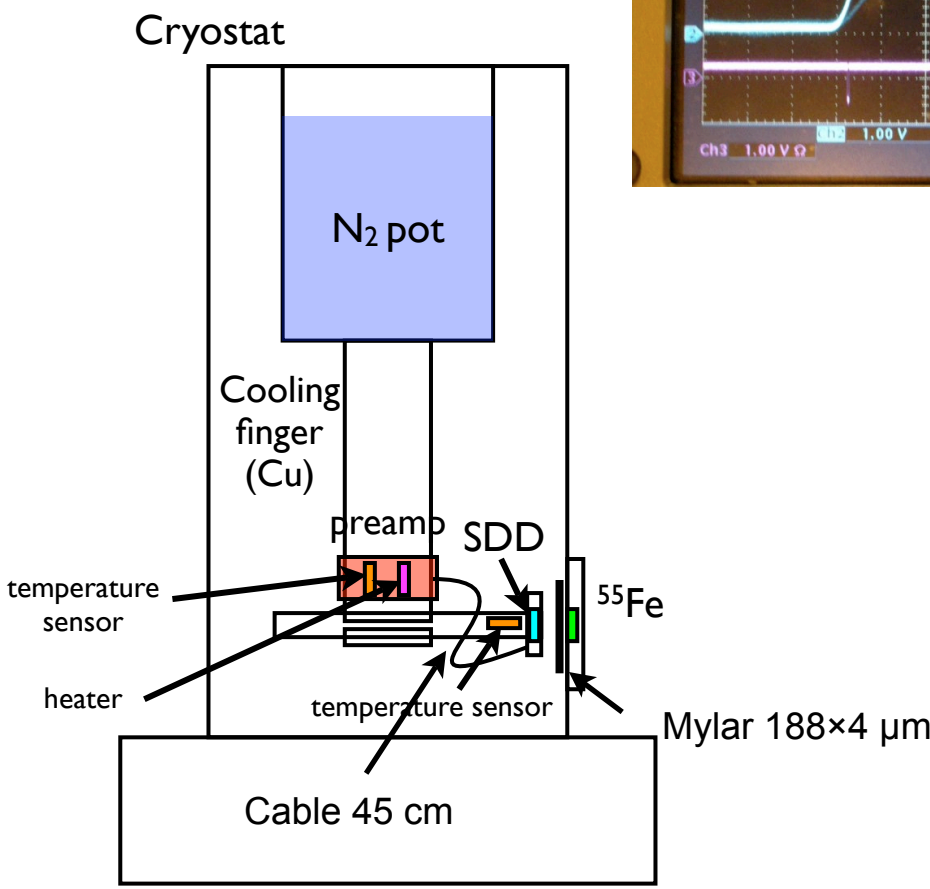
3. preamp inside vacuum vessel (II)

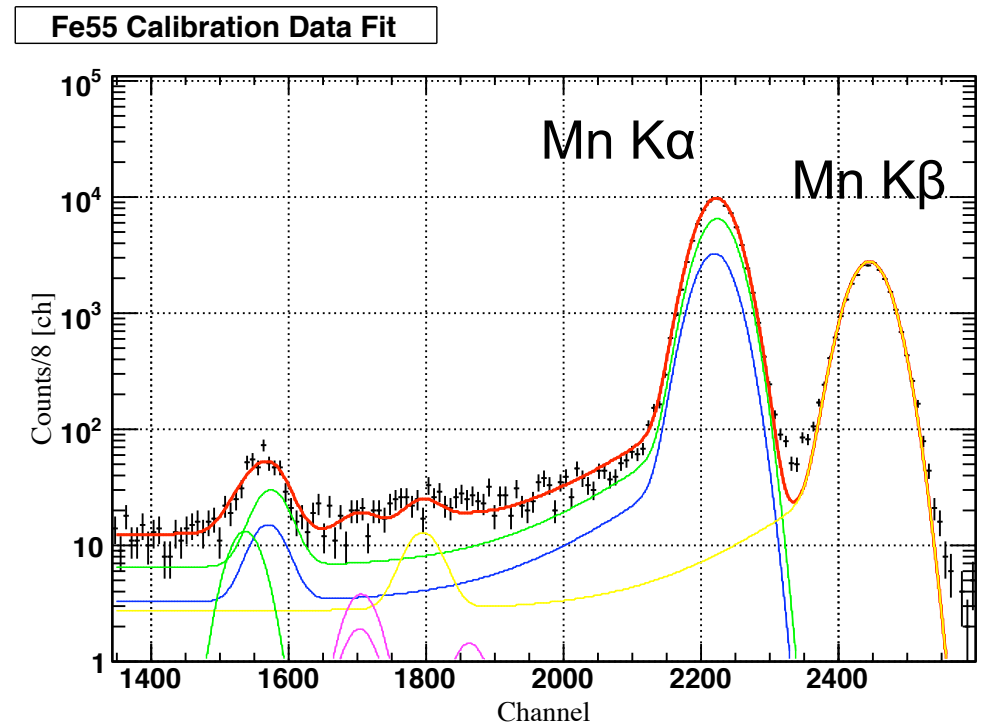


Data taking: 1 hour

SDD hit rate: 46 Hz

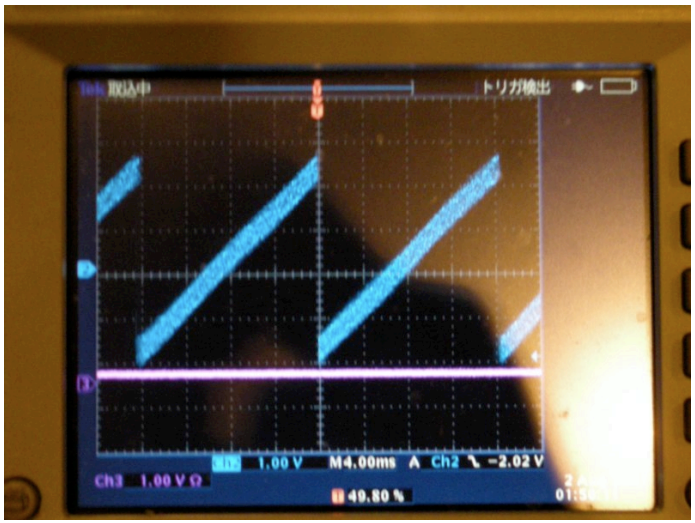
Energy resolution: 173 eV at MnKα1

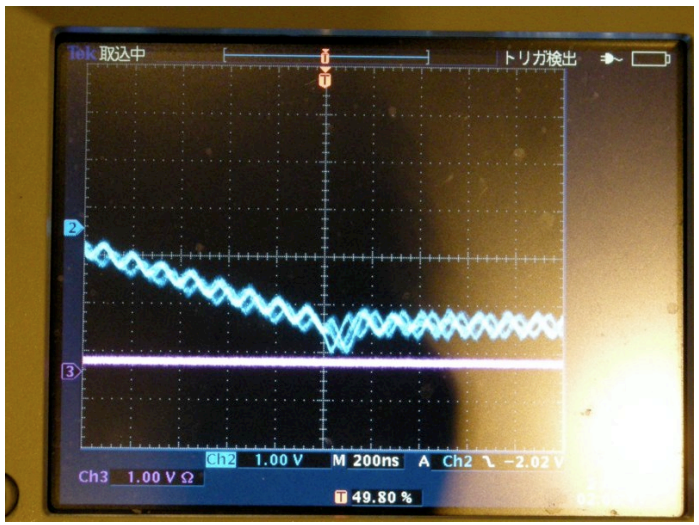




Good working at 120 K

→ Decreased the preamp temperature from 120 K to 110 K

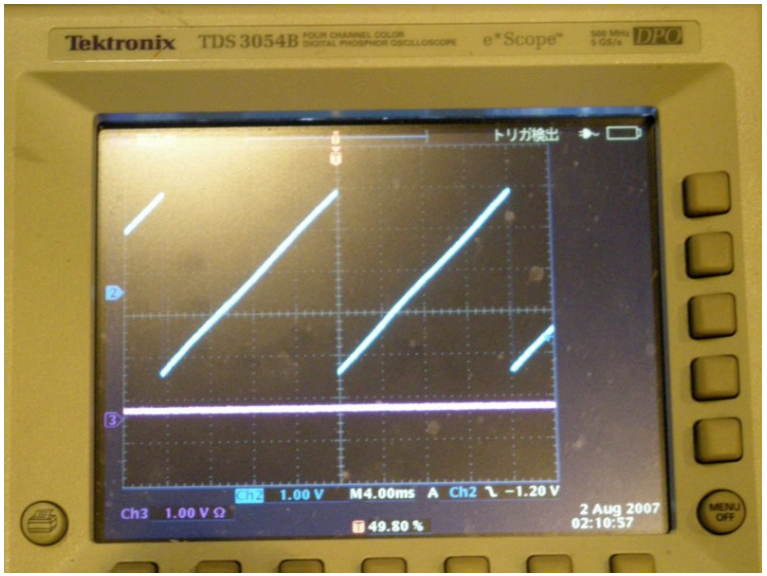


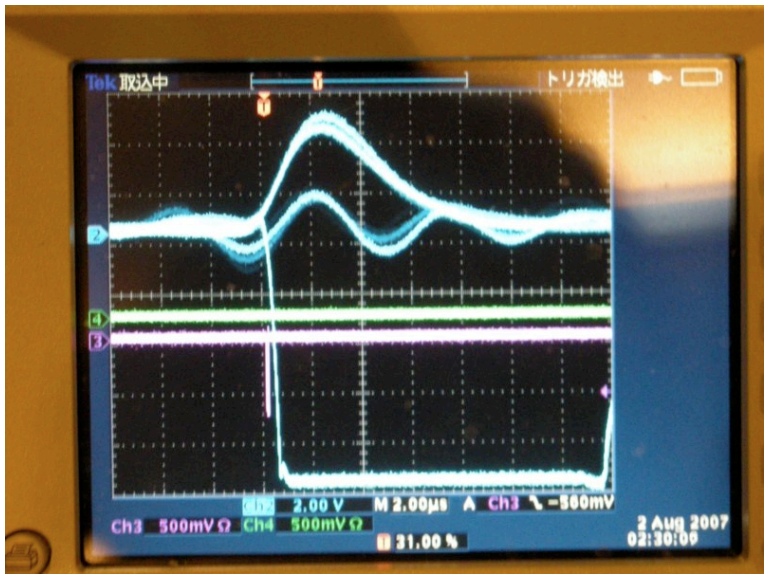


But then ...

High frequency noise (~10 MHz) appeared suddenly !

Preamp output was very unstable and never could reproduce the stable signal, even if its temperature was set the previous point 110 K again.





Turned off SDD and preamp
→ Turn on them again at 120 K

Oscillation disappeared but still noisy !

Impossible to take data ...

Phenomenon

Stable working at 120 K (preamp)

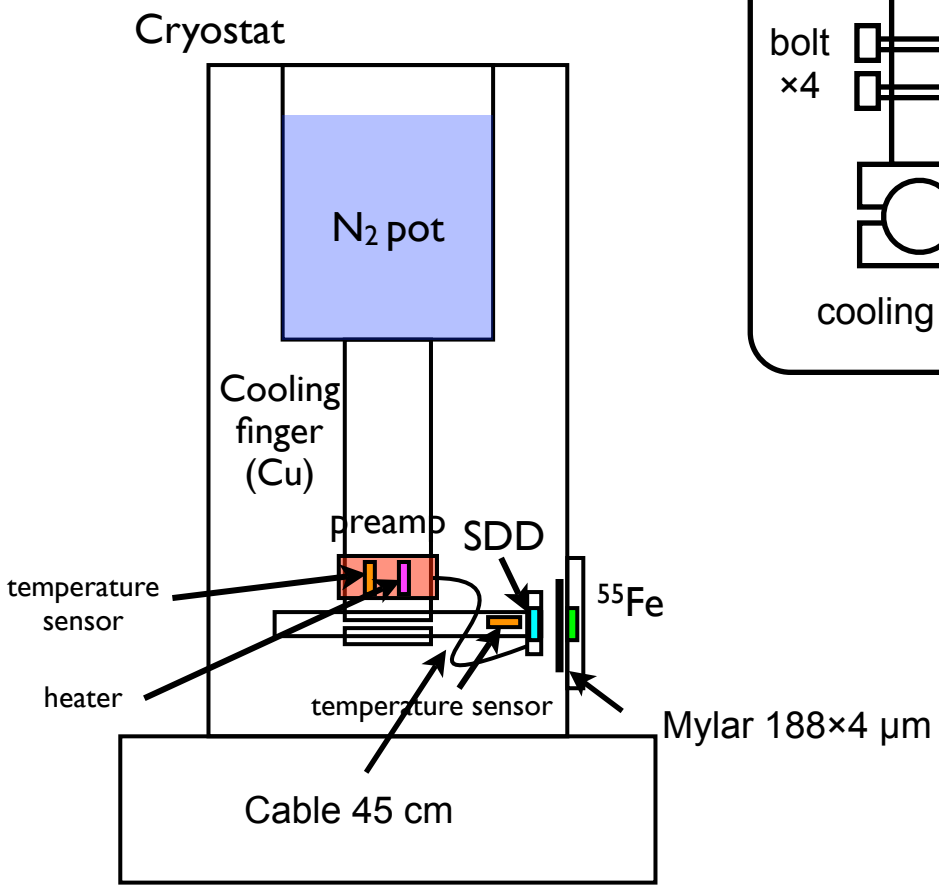
→ *Changed only preamp temperature*

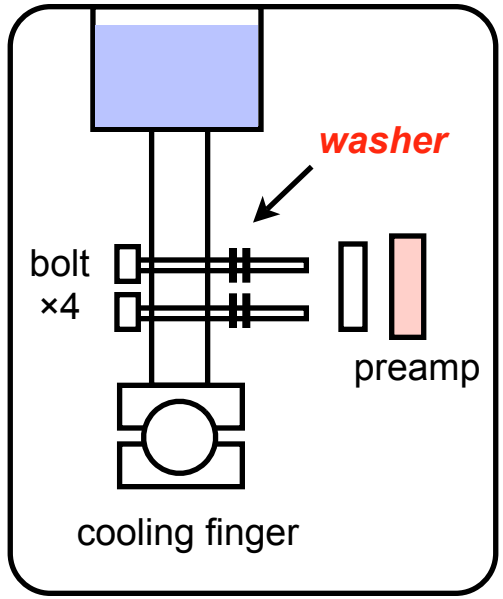
→ *Oscillation and noise appeared*

What happened ... ?

Check again on higher temperature condition ...

4. preamp inside vacuum vessel (III)





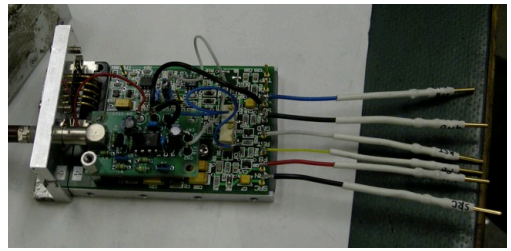
Decreased thermal conductance to the preamp using washers

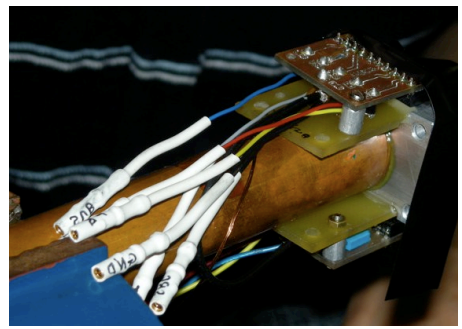
Still noisy at 134.9 K

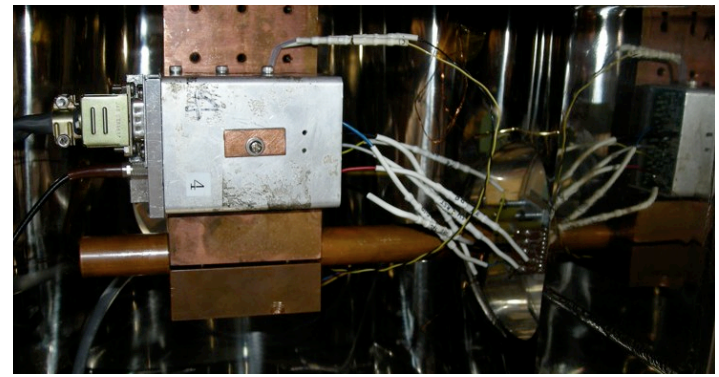
(SDD: 107.4 K)

Could not reproduce the stable signal !

5. preamp inside vacuum vessel (IV)







Removed the washers and shorted the cable length from 45 cm to 15 cm

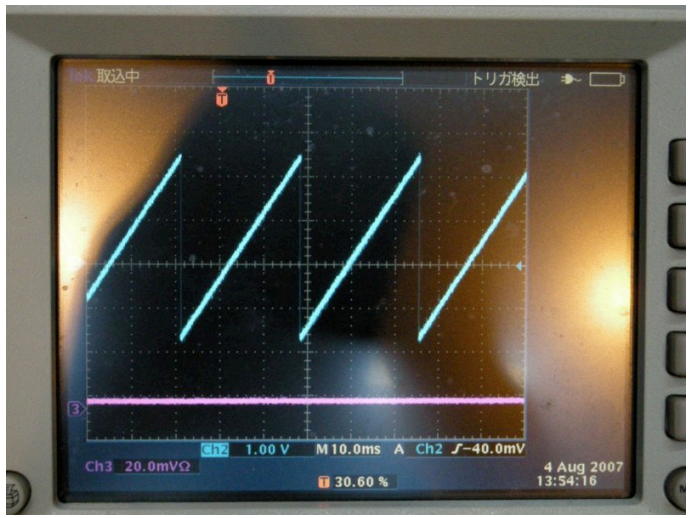
low cable capacitance → low noise ?

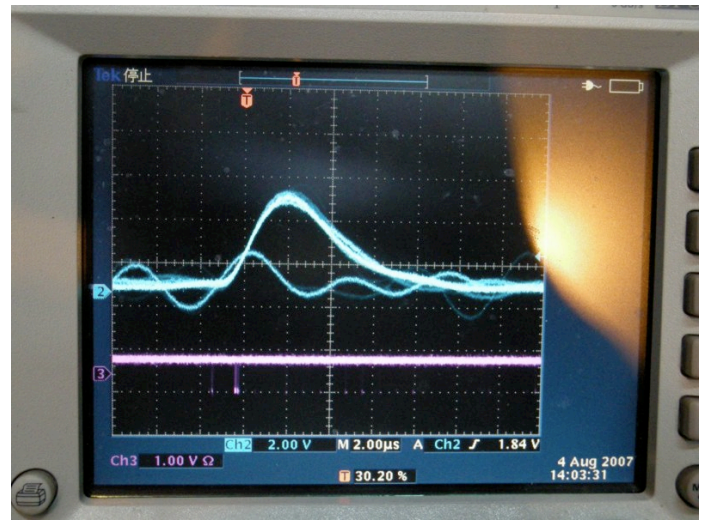
110.0 K at preamp with heater 92.1% of 30W (SDD and preamp ON)

Temperature at SDD: 101.8 K

Cable length from SDD to preamp: 15 cm

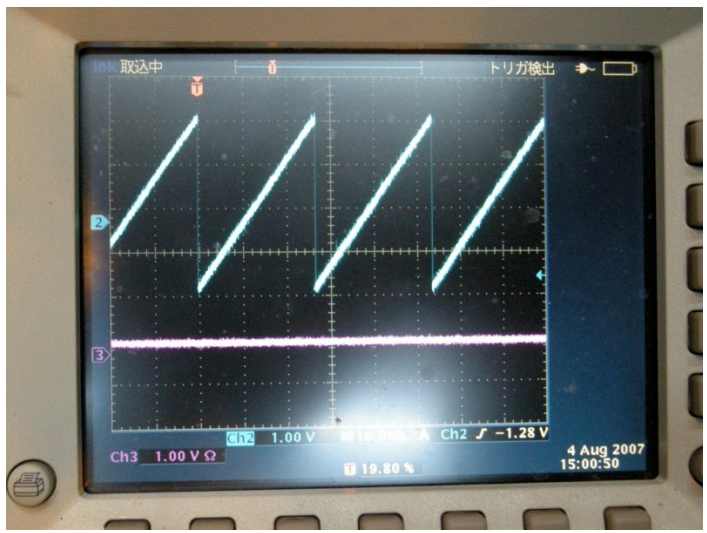
5. preamp inside vacuum vessel (IV)

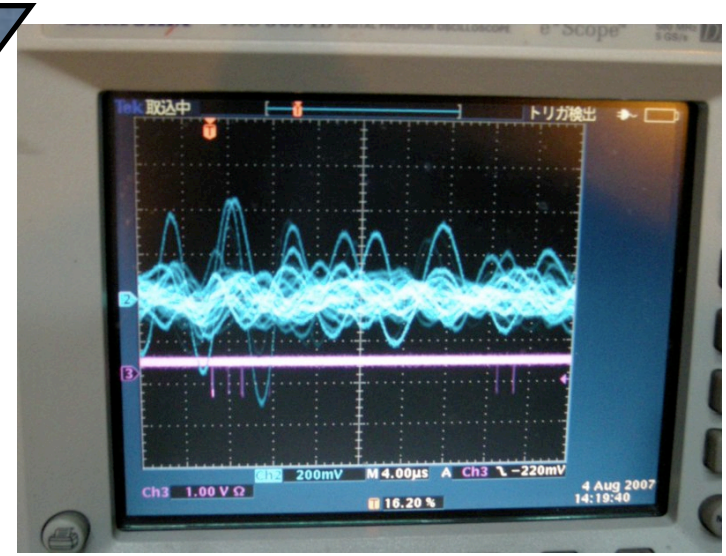




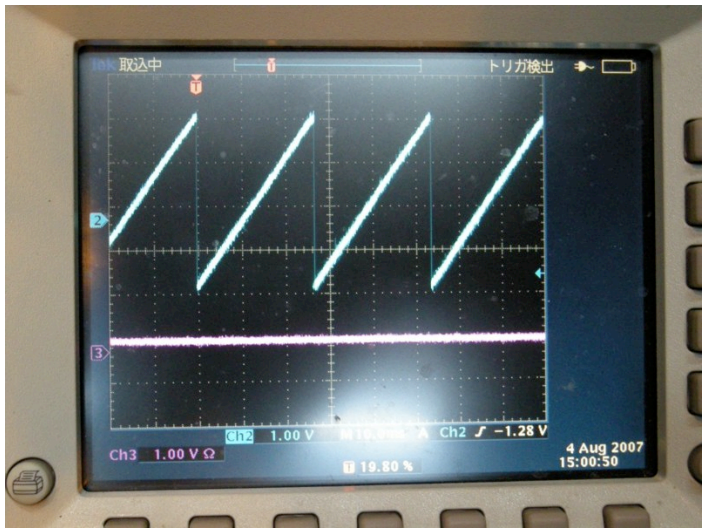
Still noisy

and unstable ...



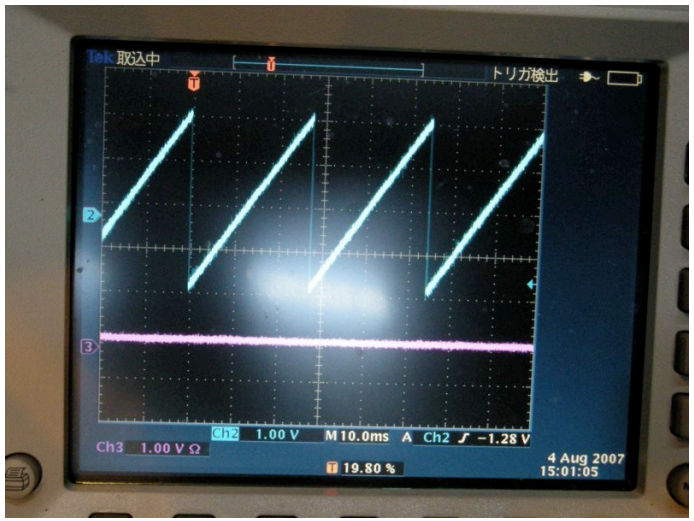


5. preamp inside vacuum vessel (IV)



Still noisy, but it did not have strong temperature dependence

110.0 K



Preamp was alive even at 88.0 K

88.0 K

Possibility 1

Noisy from beginning on these low temperature conditions, and the first stable operation was a semi-stable position ?

Local heating (thermal noise) or loose GND in the cryostat ?

Possibility 2

The preamp deteriorated due to LN2 cooling and heater heating.

Measures to be taken

Make new preamplifiers toward stable low-energy operation

(Stable data taking must be difficult using the current preamps, I think.)