8. LOW LEVEL ALPHA BETA COUNTING SYSTEM

This system has a gas proportional counter(GPC) with one through gas flow chamber. The presently used GPC system consists of two detectors: sample measuring GPC and a plastic guard (veto) to prevent or reduce cosmic radiation interference. The thicknesses of the detectors are about 1 cm. Moreover sample detector (GPC) is not possible to discriminate alpha and beta particles perfectly. Therefore, this system cannot be used as a spectrometer. The discrimination of alpha and beta particles is not related to only their energies but also it is mainly due to their ionisation which they are different from each other at the same energy. As is well known, for instance, alpha particles cause more ionisation than beta particles, thus leading to create more electrical charge for alpha particle than that of beta particle. For example, the energy deposited in the gas counter by beta particles is around 60-70 keV whereas the energy deposited by alpha particles is around 600-700 keV.

If the low X-ray energies of about 2-10 keV that can emit various samples are reached to gas medium, these low energy X-rays can easily be attenuated on the counter having P-10 gas (90%Ar+10%CH_4) and they are detected as if they are beta particles by the measuring system. At the same time many of alpha emitting radioisotope can also emits x-rays in this energy range. So correction factors should be used for both alpha and beta emitting samples. In fact, the inert gases Xe, Kr heavier than Ar is more preferentially used for X-ray detection by the sealed GPC detectors

At the same time the energy resolution of the detector can be worsened due to the inherent property in which negative ions can be produced by capturing an electro negative molecules such as O_2 . Therefore the detector shall isolated from air medium in such way that the primary gas and secondary gas molecules can be sealed in a tube or the gas mixtures (such as P-10) are continuously flowed in the chamber. This requires a gas bottles for feeding into a plastic hose through the inlet of the proportional counter. In some measuring systems gas GPC is isolated in a chamber and in other systems, the gas mixture is continuously circulating through one or more than two detectors(2,4, 8,16, .. detectors) by gas distribution system at the same inlet pressure. Although the isolated GPC systems seem to be more useful, however microscopic gas leakage makes their shorter useful life. In the present experiment, once through gas flow proportional counter will be used for sake of simplicity With the use of these systems, first air is filled the chamber, hence it should be cleaned for a while by purging P-10 operating gas because air has electro negative property due to it oxygen content. For this reason, after turning on the system, the user should wait for, at least 20-30 s gas cleaning procedure before high voltage is applied to the detector. Normally note that the detector purge light is off and take an advice from the instruction manual.

Operating Principles Of The System

System has different responses to different radiation types. The particles emitted from the radioactive source placed on sample tray are seen firstly by sample detector. There is a thin aluminium layer between guard detector and sample detector. Because of this, alpha and beta particles from the source placed under sample detector's window cannot reach guard detector. The preamplifier in the system, amplifies the amplitude of the pulse occurred from the absorbed α, β or γ radiation. Then this long tailed pulse obtained from the preamplifier and amplifier is transformed it to a Gauss shaped sharp pulse. This pulse height is proportional to

the ion pair number obtained in the detector. During simultaneous α and β counting, the produced pulse amplitude of alpha particles is 9 V, whereas the produced pulse height is 0.7 V for beta articles. This amplitude difference between alpha and beta pulse height allows to count alpha and beta particles in two different channels with a single channel analyser. These channels are obtained by putting low level discriminator (LLD) and a window (ΔE) to the pulse height analyser. With use of LLD, a minimum pulse height can be determined as a threshold. The possible pulses under a specific level(i.e., LLD) are assumed to be noise and other low energy interactions and that signal is extracted from the alpha and beta channels.

The window width, ΔE will be set in a such way that the pulses caused by beta particles (P) are placed in the voltage range of LLD ≤ P ≤ LLD+ ΔE. Every P pulse meets this condition from the amplifier causes a logic pulse via single channel analyzer. These logic pulses correspond to beta particles and they are collected in the B channel of the counter. Other pulses which meets the condition of P > LLD+ ΔE correspond to alpha particles and they are collected at A channel of the counter.
As mentioned above, the main role of the guard detector is to avoid the cosmic rays and detectible low energy X- and gamma rays that can contribute to A and B channel counts. Guard detector is connected to the pre-amplifier, amplifier, single channel analyzer and logic shaping and delaying components. Guard detector sends a specific pulse to the shaping and delaying component only if its amplitude is higher than the LLD level. This component generates a large pulse of 11 μs for every pulse reaches to it. The role of this pulse is to blockage A and B channel during this time period. By this way, the measuring system can prevent the background count at alpha and beta channels.

PROCEDURE

First gather the necessary information about the present modules from the instruction manuals. Then check all signal connections, look at the detector position and operate the whole NIM system.

1. Turn on the NIM bin.
2. Turn on the gas from the appropriate gas bottles.
3. Check that the gas inlet pressure is 0.3 SCFH (ft^3 / hr) by observing pressure gauage

Warning: If the gas pressure exceeds the value, the very thin window material can be torn or deformed by being puffed up/inflating hubs, thus causing the detector failure

4. Check the high voltage (it should be zero) and switch on the high voltage switch.
5. Make the following adjustments and presents on th front panel of the NIM modules

A) Model 2015 Amp/TSCA (Sample Channel)

Coarse Gain : 4 (80μg/cm^2 increase to 16 with the window)
Fine Gain :0,00
Input Polarity : Positive
LLD :0,10 (for only alpha counting)
0,10 (for only beta counting- 80μg/cm^2 lower to 0.08 with the window)
0,06 (for simultaneous alpha and beta count)
ΔE :0,00 (for only alpha counting)
10,0 (for only beta counting)
1,00 (for simultaneous alpha and beta count)
(Rear Panel) ΔE Range :10 Volt

B) Model 2015 Amp/TSCA (Guard Channel)

Coarse Gain : 32
Fine gain :0,00
Input Polarity : Positive
LLD :0,06
ΔE :10,0
(Rear Panel) ΔE Range : 10 Volt

C) Model 2055 Logic Shaper and Delay

Input Polarity : Positive
X1 / x10 :x10
Delay :11,0 μs

D) Model 1790 Universal Counter/Timer

0,1 MIN / 0,1 SEC :Either position
SINGLE / RECYCLE :Single
CHANNEL A PRESCALER :Out
CHANNEL B PRESET :Time
CHANNEL A PRESCALER :Out
CHANNEL B PRESET :Out
CHANNEL A PRINT :Both
CHANNEL B PRINT :In

Channel A , for α	P>LLD+ΔE		
Channel B , for β	LLD<P<LLD+ΔE		
A for only alpha:	P>0,1+0	➔	P>0,1
B for only beta:	0,1<P<0,1+10	➔	0,1<P<10,1
For both α and β	A: P>0,06+1	➔	P>1,06
	B: 0,06<P<0,06+1	➔	0,06<P<1,06

The following steps should be completed before sample counting

1. Set the detector voltage a suitable value for the count. (alpha only, beta only or for alpha and beta together)
2. Place the source on the sample tray and place in to the detector (The active face of source should placed upward to correspond to the window of the detector).
3. In order to preset the time duration, use the switch on channel A. For example, for the counting period of 20 s, you should the notation ($Nx10^M$), that is, N=2 and M=2 is chosen.
4. Reset the system and start the acquisition. Channel A gives counts of alpha particles and channel B gives counts of beta particles.