Effect of sodium salicylate (SS) on the determination of Pb-210/Bi-210 by Cerenkov counting

Wang Yadong, Song Lijuan, Dai Xiongxin
China Institute for Radiation protection, China

Outline

- Introduction
- Preliminary tests with SS
- What causes the increase of efficiency
- Conclusions

Introduction

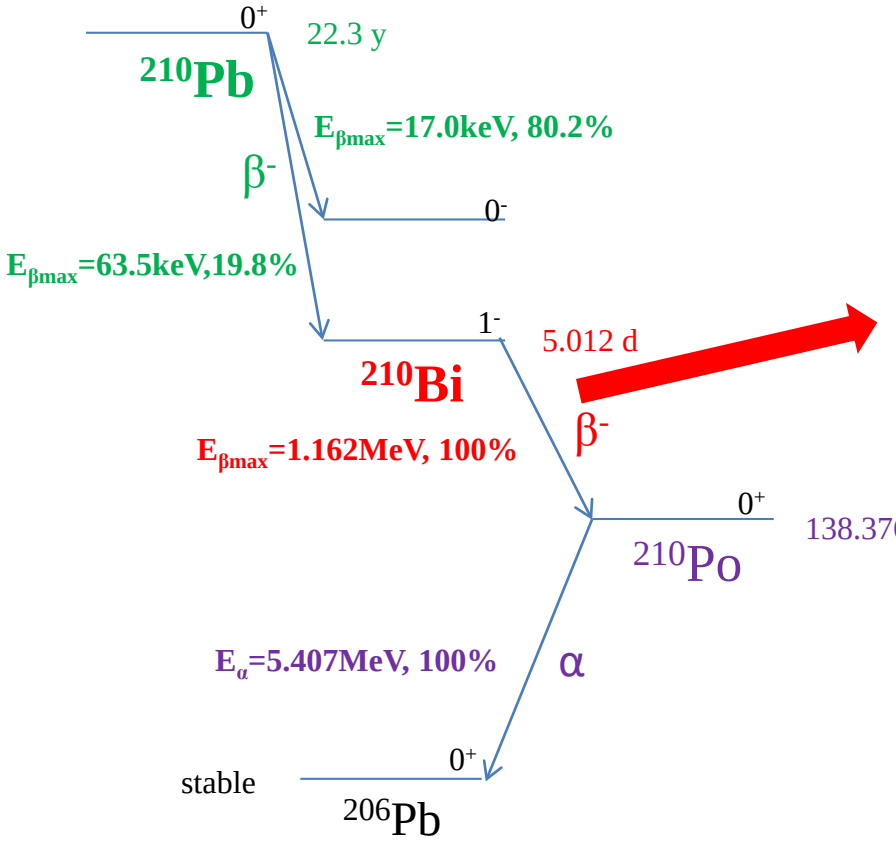


Fig 1 Simplified decay chain of Pb-210

- Cerenkov counting
- The threshold energy for beta: **0.263Mev** (refractive index =1.33)

- **Advantages**
- An natural discriminator of high-energy beta from low-energy beta and alpha
- No cocktail mixing with samples
- Could be used further after counting

Introduction

- **Cerenkov light of Bi-210**
- Cerenkov efficiency :

  lower than **20%**
- $E_{\beta average}$=**0.389Mev**
- A large proportion of Cerenkov light lie in UV region

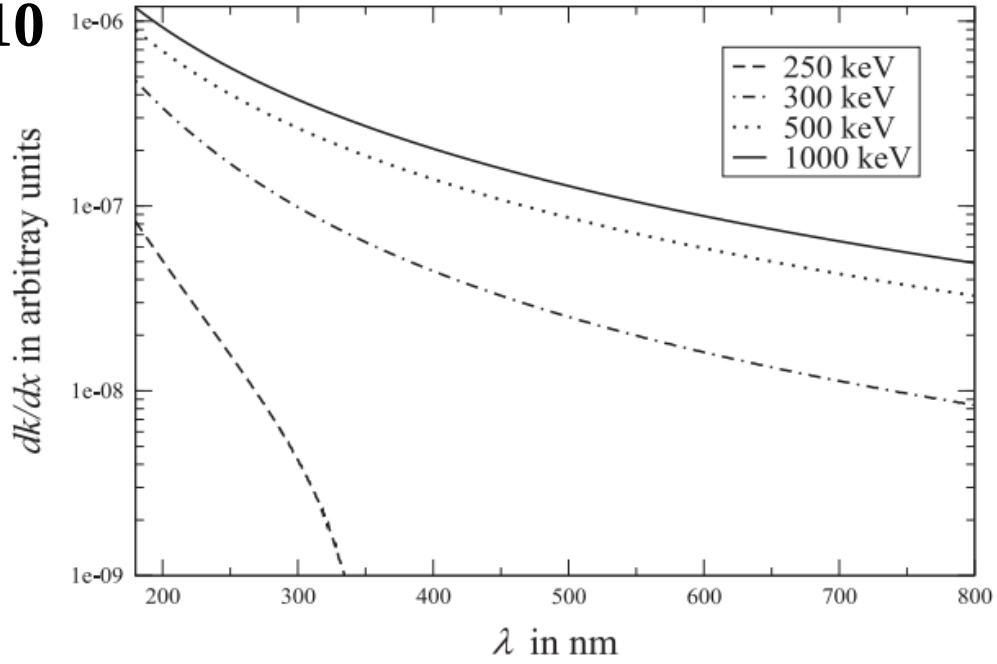
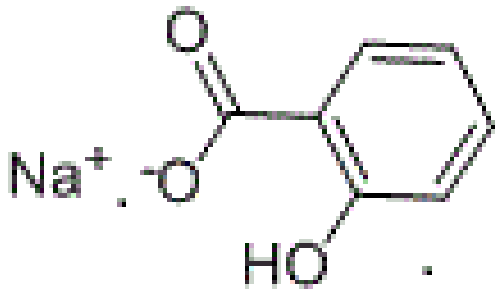


Fig 2 Spectra of Cerenkov light created in water for various electron energies

- **Wavelength shifting**
- Sodium salicylate



- Solubility :1000g/L (20°C)
- Absorption spectrum: **85.0~350.0** nm
- Fluorescence spectrum: around **425.0** nm

Preliminary tests with SS

- Experimental
- Spiked with **Pb-210 standard**

(Pb-210,**Bi-210** and **Po-210** are in equilibrium)

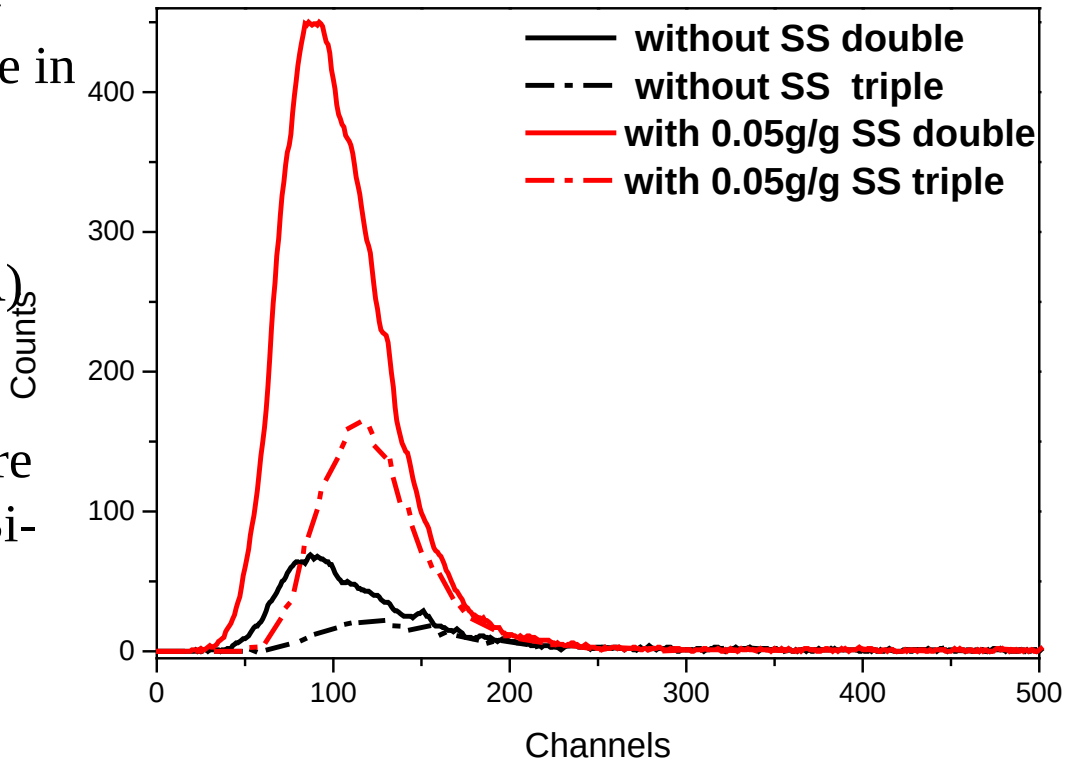
- Instrument : Hidex 300SL

(with 3 PMTs enabling TDCR)

- Results
- Assuming that all the pulses are caused by Cerenkov light of Bi-210
- Detection efficiency:

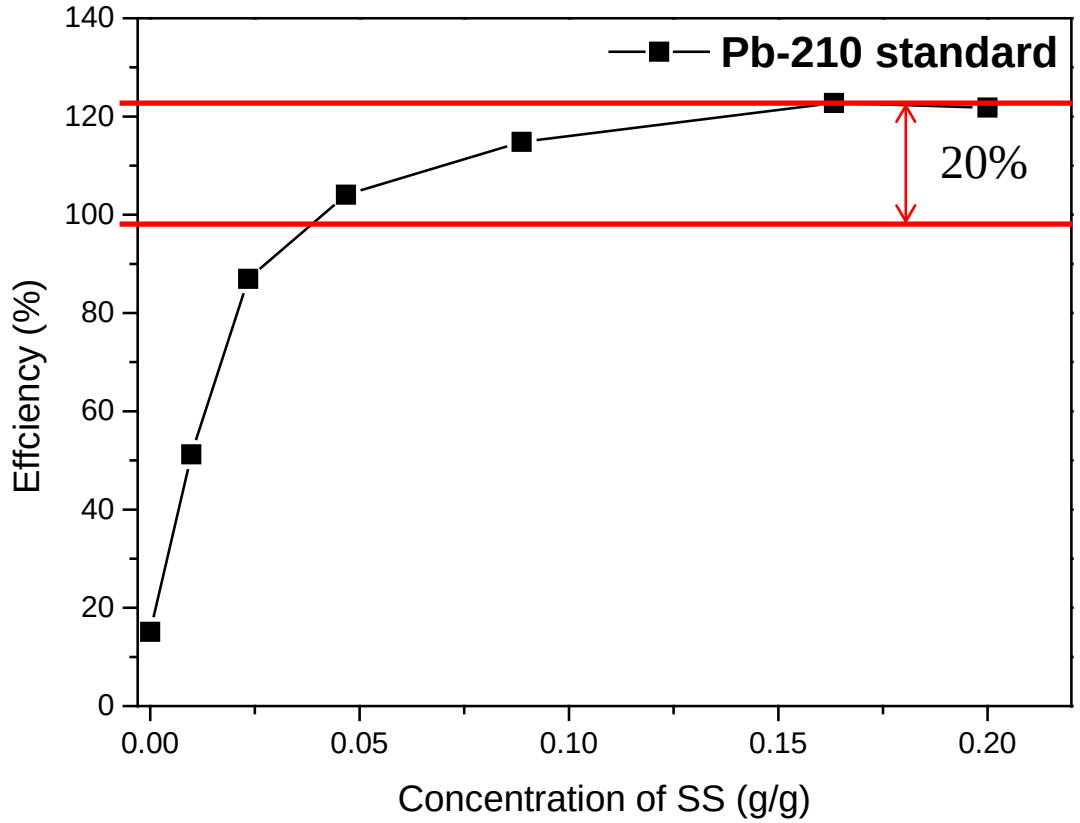
without SS, **15.1%**

with 0.05g/g SS,**100.3%**



Preliminary tests with SS

- Screening the concentrations of SS for the best



It was unexpected

Po-210 and Pb-210 might produce scintillation light.

What causes the increase of efficiency

- **Scintillation?**
- **Experiment preparation**

I. Separation of Bi-210 and Po-210 by Sr-resin

Calibration by LSC using UG AB:

a)TDCR, b) decay curve of Bi-210

Both Bi-210 and Po-210 were purified well

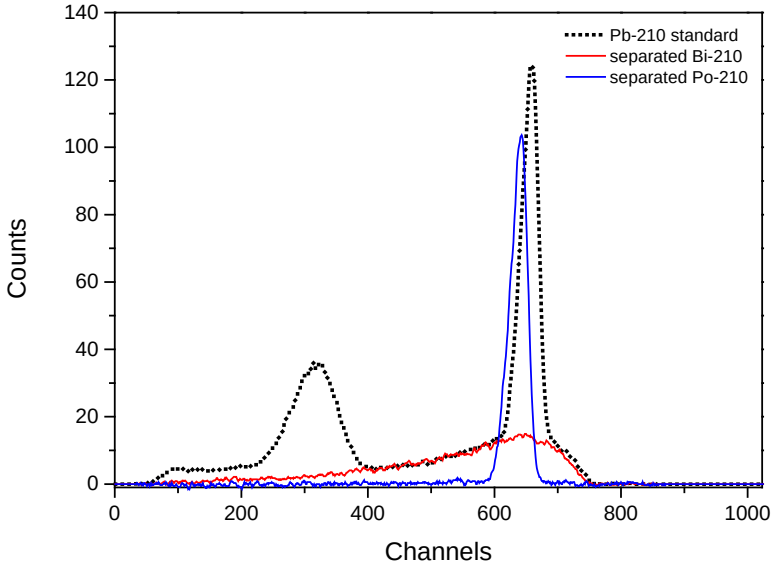
II. Simplifying experiment

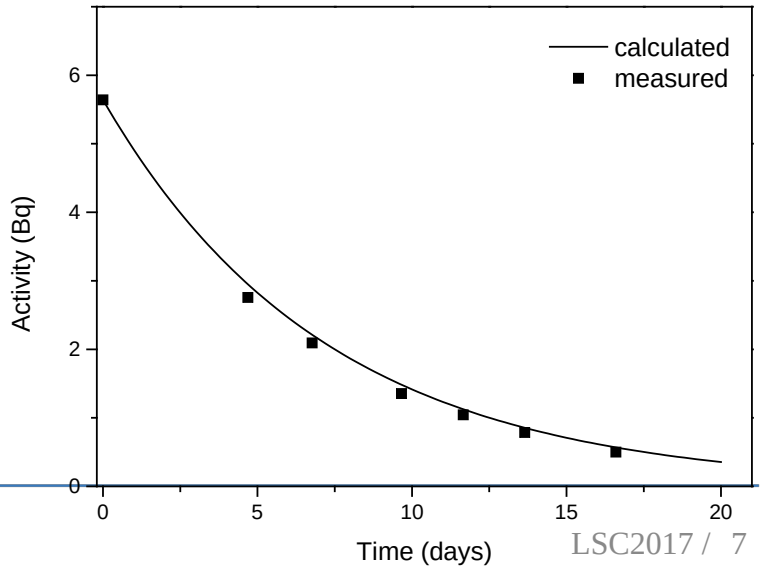
Ni-63 as alternative of Pb-210

Ni-63: $E_{\beta max}$=0.067Mev

$E_{\beta average}$=0.017Mev

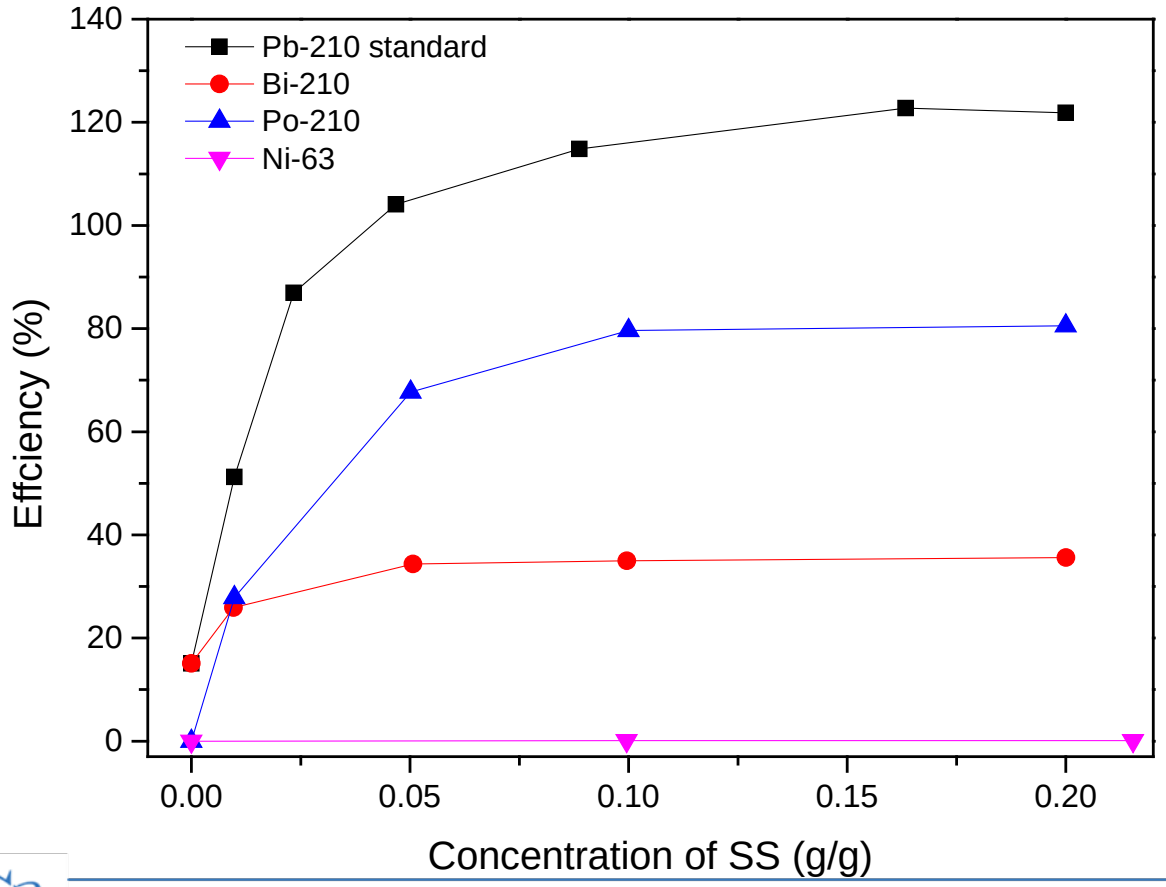
Daughter: stable Cu-63





What causes the increase of efficiency

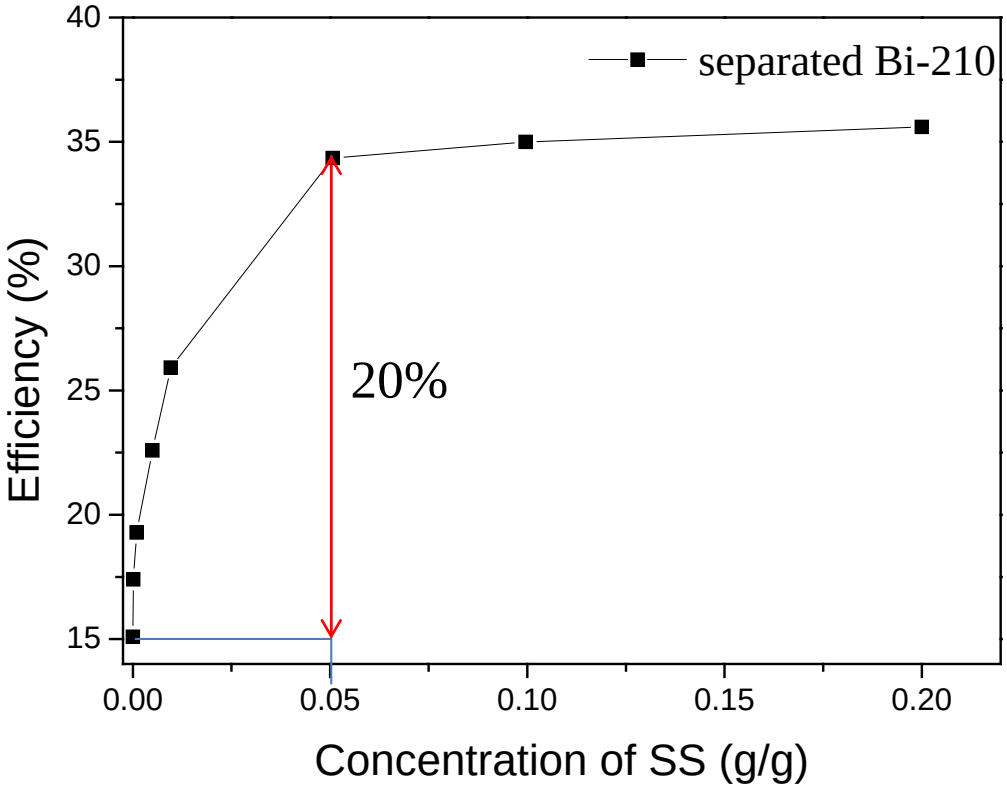
- **Scintillation !**



- The efficiency of Pb-210 standard (with Bi-210 and Po-210 in equilibrium) is equal to the sum of Bi-210 and Po-210
- **The efficiency of Po-210 is high because of scintillation**
- **The efficiency of Bi-210 reaches 35%**
- **The efficiency of Ni-63 (Pb-210) is almost zero**

What causes the increase of efficiency

- The increased efficiency of Bi-210



The increased efficiency of Bi-210 by adding SS might be caused by three possibilities,

a) scintillation

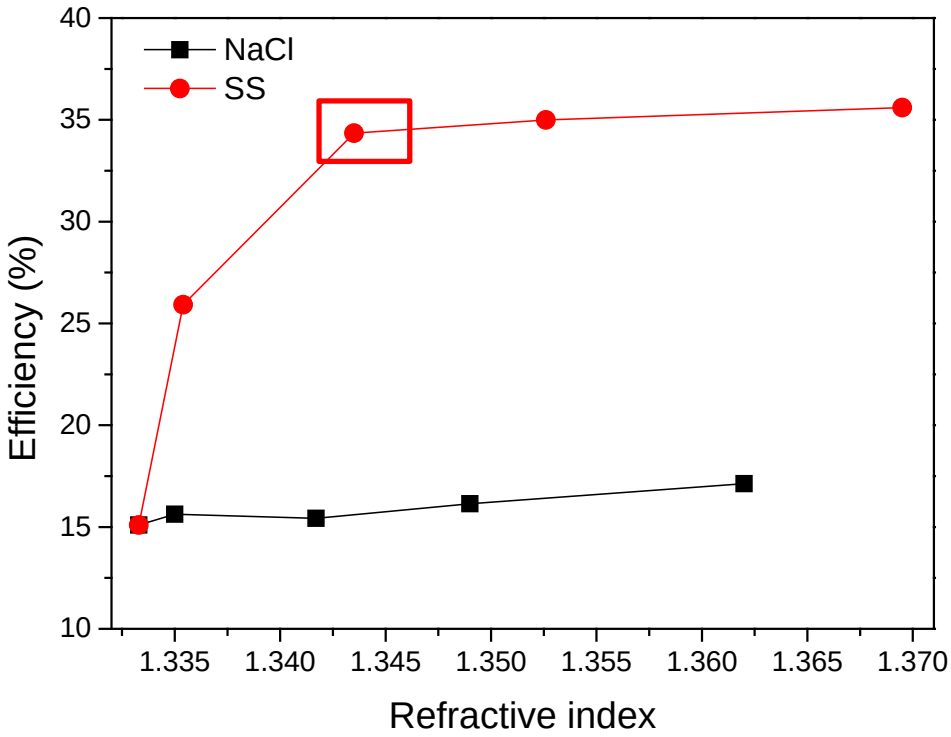
b) wavelength shifting the Cerenkov light

c) refractive index

Refractive index ?

Refractive index of SS and NaCl solutions

Concentration (g/g)	Refractive index	
	SS	NaCl
0	1.3333	1.3333
0.010	1.3354	1.3350
0.047	1.3435	1.3417
0.089	1.3526	1.3490
0.163	1.3695	1.3620



- The increase of refractive index by adding SS is **not** mainly contributed to the increase of efficiency.

Conclusions

- Sodium salicylate acts as a scintillator and produce scintillation light by alpha particles;
- The increased efficiency of Bi-210 by SS is not mainly due to the increase of refractive index;
- Both wavelength shifting and scintillation light from SS may be contributed to the increase of efficiency for Bi-210 and need to be demonstrated further.

Thank you for your attention