

**Qualitative and semi-quantitative
analysis method of surface contamination
by measuring liquid scintillation counter
with plastic scintillator**

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Key Words of this study

1. **Identification** of radionuclides
2. **Measurement** by liquid scintillation counter (**LSC**) **without liquid scintillator**
3. **Plastic scintillator (PS)** for smear method
4. **Ecology** and economy

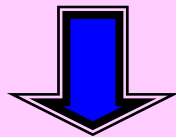
Necessity of contamination check

- Unsealed radionuclides are unexpectedly inhaled to the users' body when contamination occurred.

(Risk of internal exposure)

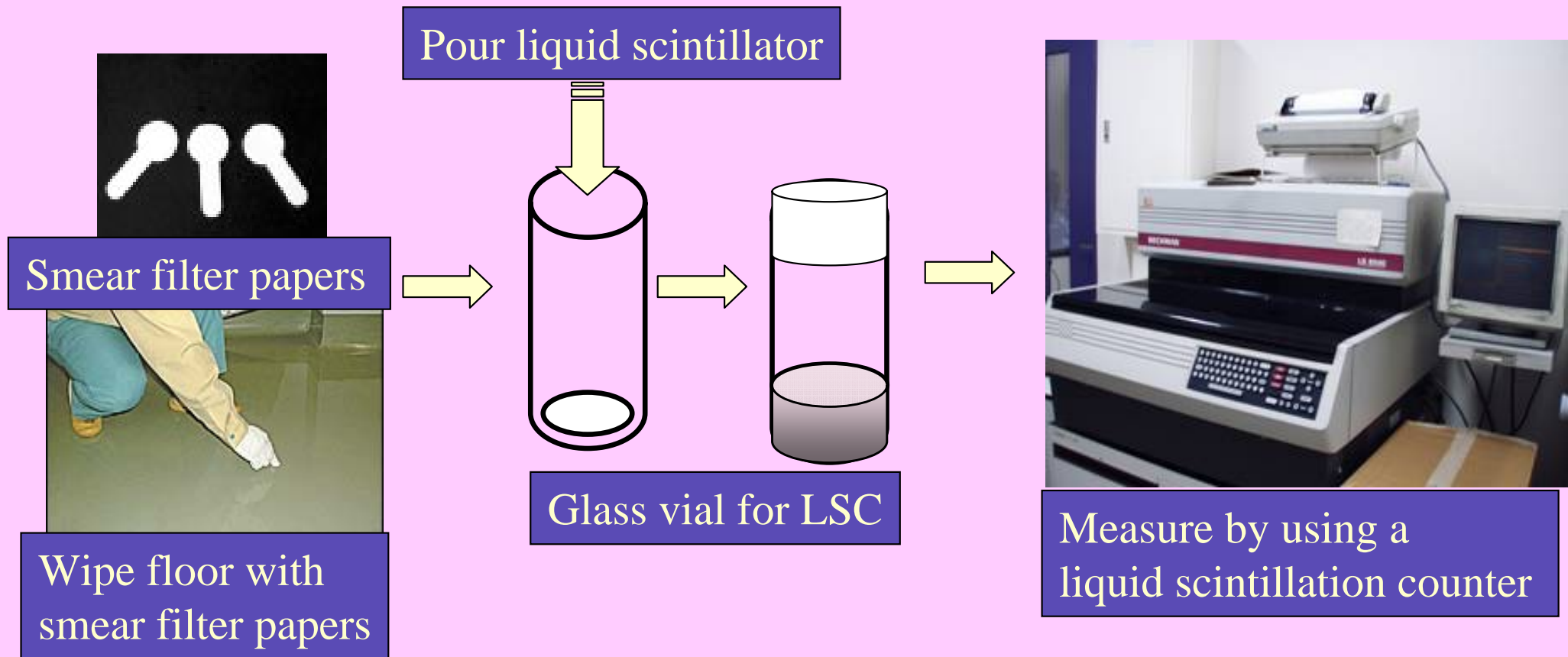
- When someplace or someone contaminated, the contamination is possibly spread to other place or other person.

(Risk of external exposure)



- So, routinely contamination check, more than every month, is necessary.

A conventional wipe method for removable contamination



However, there are mainly 3 issues in the conventional contamination check method.

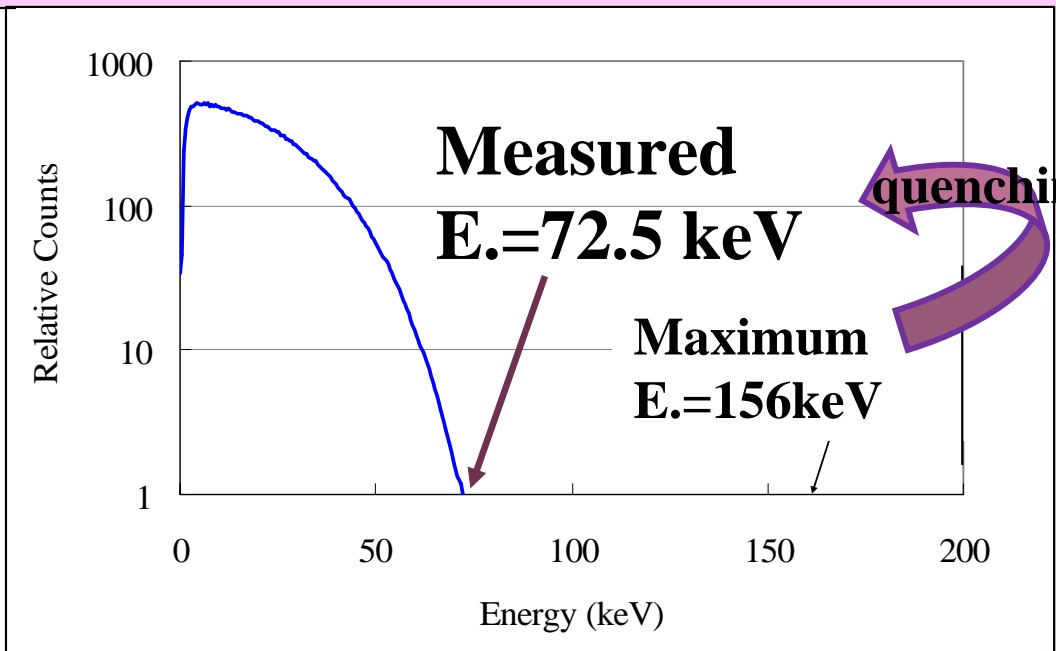
Three issues

- 1. Identification of radionuclides is difficult.**
- 2. Postprocessing of radioactive waste is required after contamination check.**
- 3. There are many unknown factors in wipe method.**

Issue of conventional wipe method-1

ISOTOPE1: ^3H (0-20 keV)
 ISOTOPE2 : ^{14}C (20-200 keV)
 WIDE OPEN WINDOW (200-2000keV)

Sample	H#	CPM	%ERROR	DPM	EFF
1	104.7	3H	141.00	16.84	120.34
...					
		^{14}C	323.00	11.13	437.98 ...
		WIDE	531.00	8.68	



2 87.9
 Measurement result of the Beckman LSC6500

^{14}C with liquid scintillator of ACS-2

Identification of ^{14}C and ^{35}S , which maximum energies are very near, is impossible by LSC with liquid scintillator, because the quenching are always occurred and the quenching level is different in each sample.

Issue of conventional wipe method-2

- ❑ Some postprocessing is necessary because the liquid scintillator which is used for measurement become the radioactive waste.



- ❑ Use of liquid scintillator for contamination check is no good for our environment and health because of use of organic solvents.
- ❑ Use of liquid scintillator is waste of our budgets which purchase the liquid scintillator and do away with wastes.

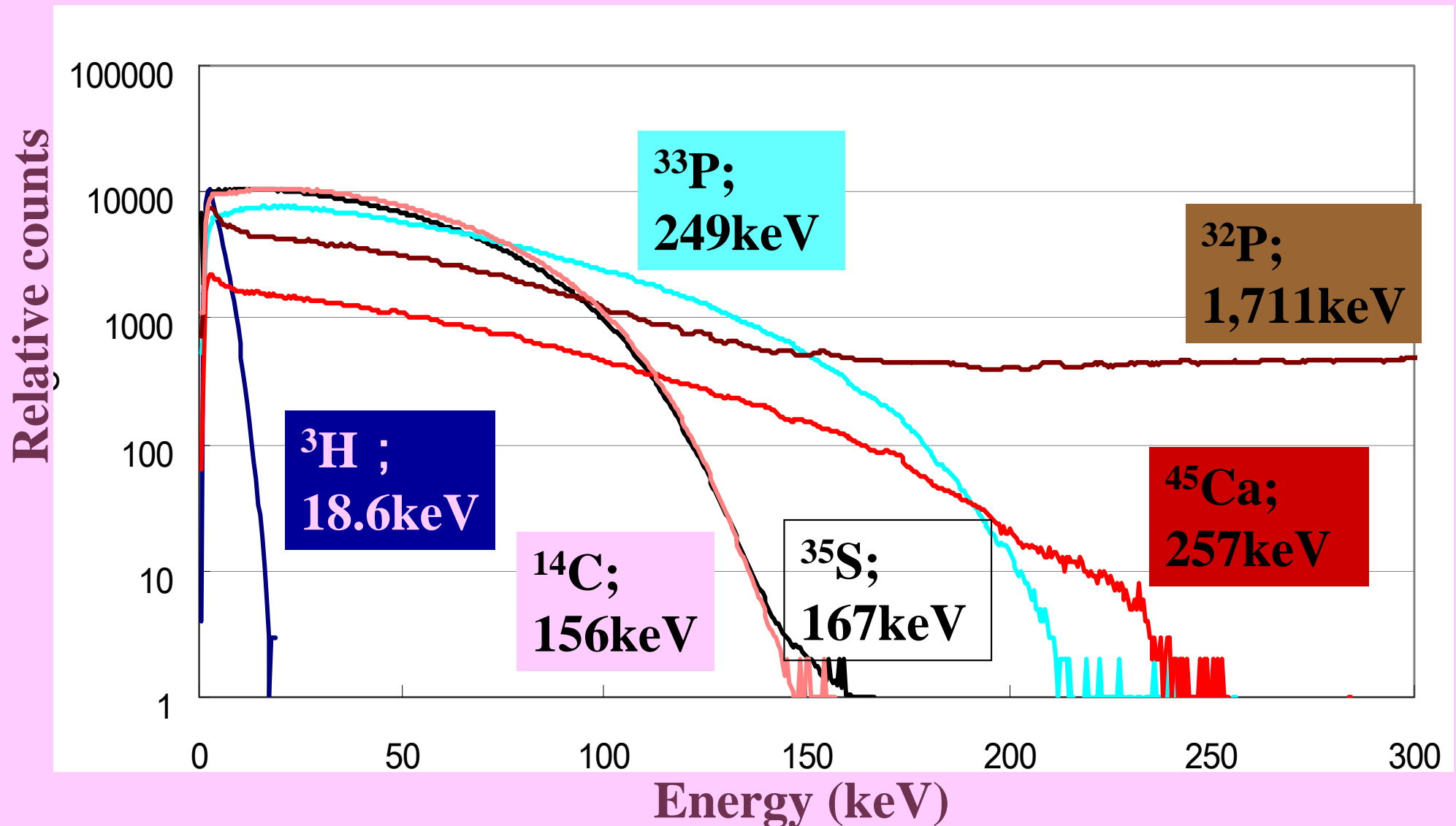
Issue of conventional wipe method-3

- ❑ There are many unknown factors in wipe method.
- ❑ Especially, a wipe efficiency is different in each case and cannot make it uniformity.

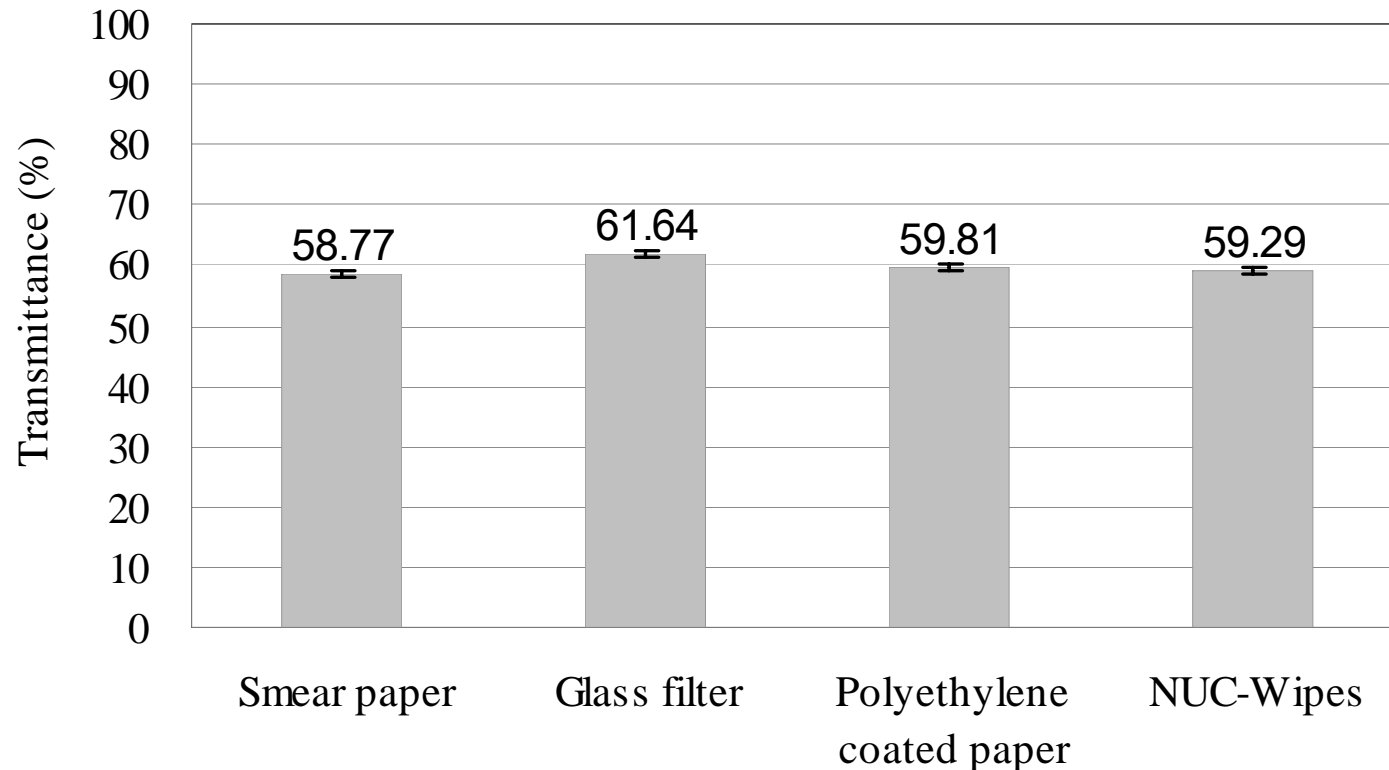
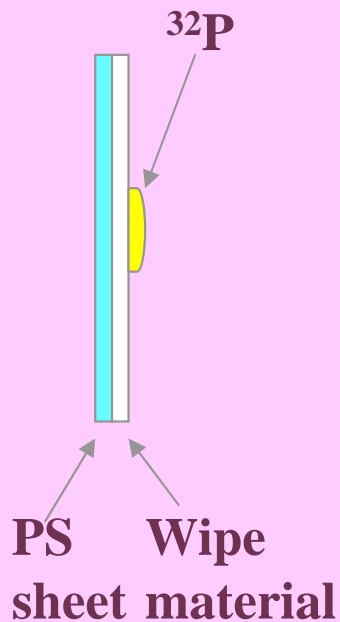


- ❑ Some equipments like robots are invented by some researchers to get the same wipe pressure, however, it does not become common equipment.

Spectra of beta-nuclides measured with plastic scintillator at LSC-2008



Transmission of fluorescence through wipe materials



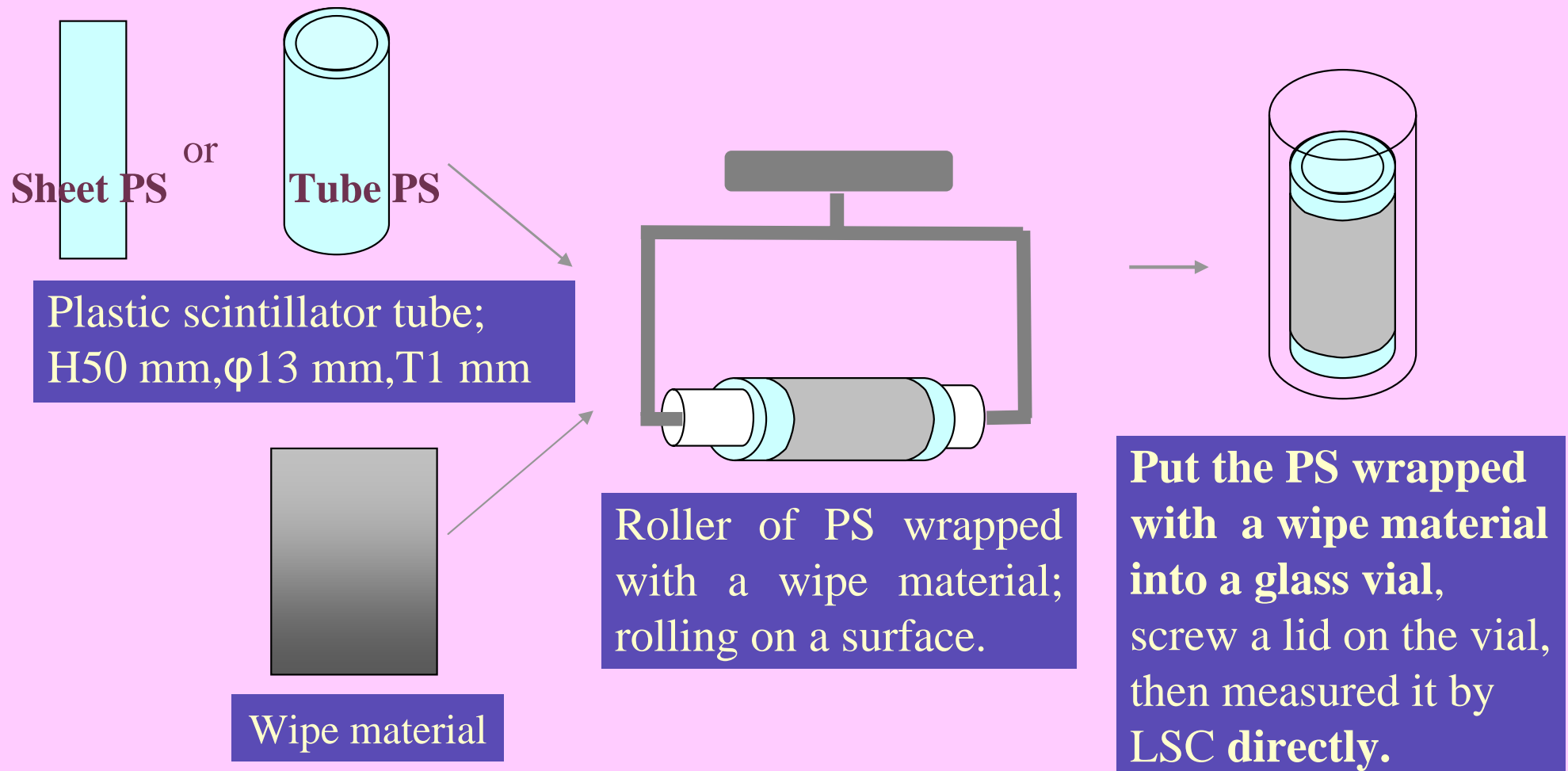
Transmittance rate (%) of 4 kinds of wipe materials.

Each wipe material wrapped a 0.5 mm thickness PS sheet and ^{32}P of 5 μL was put on it, dried, then measured by counting with the coincidence method of LSC.

Purpose

To establish a new surface contamination check method by using liquid scintillation counter with plastic scintillator (PS).

Instruments and method (Kit for wipe)



- ❑ Methionine labeled with ^3H , ^{14}C , ^{35}S , γ -ATP labeled with ^{32}P and $^{45}\text{CaCO}_3$ (Amersham Biosciences)
- ❑ Wipe materials; a conventional smear filter paper (ADVANTEC No. 63), a glass filter (Whatman GF/C No. 1,822 021), a polyethylene coated paper (TECHNOL TH-E8401), a NUC-WIPE (National Diagnostics; NW-300)

Result-1

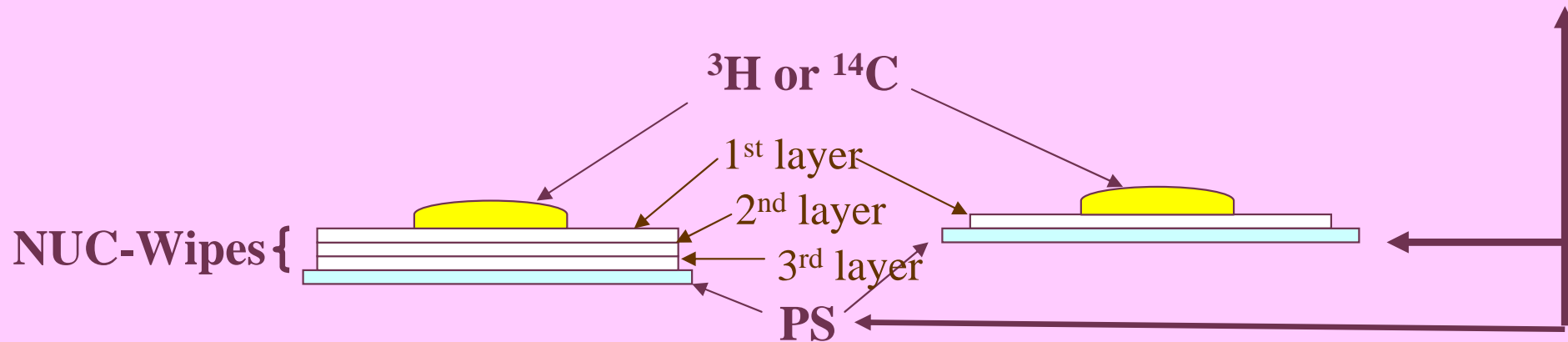
Measurement efficiency

Nuclide	$E_{\max}^{-\beta}$ (keV)	Efficiency* (%)			
		Smear paper	Glass filter	Polyethylene coated paper	NUC- Wipes
^3H	18.6	0.2 ± 0.03	0.5 ± 0.06	0.01 ± 0.002	3 ± 0.5
^{14}C	156	3 ± 0.3	15 ± 1.6	5 ± 0.2	20 ± 0.6
^{35}S	167	4 ± 0.3	15 ± 2.8	6 ± 0.3	23 ± 4.8
^{45}Ca	257	6 ± 1.5	31 ± 0.8	15 ± 0.4	30 ± 3.4
^{32}P	1,710	54 ± 1.6	50 ± 9.3	55 ± 0.8	65 ± 6.5

*; 50 μL solution of each nuclide

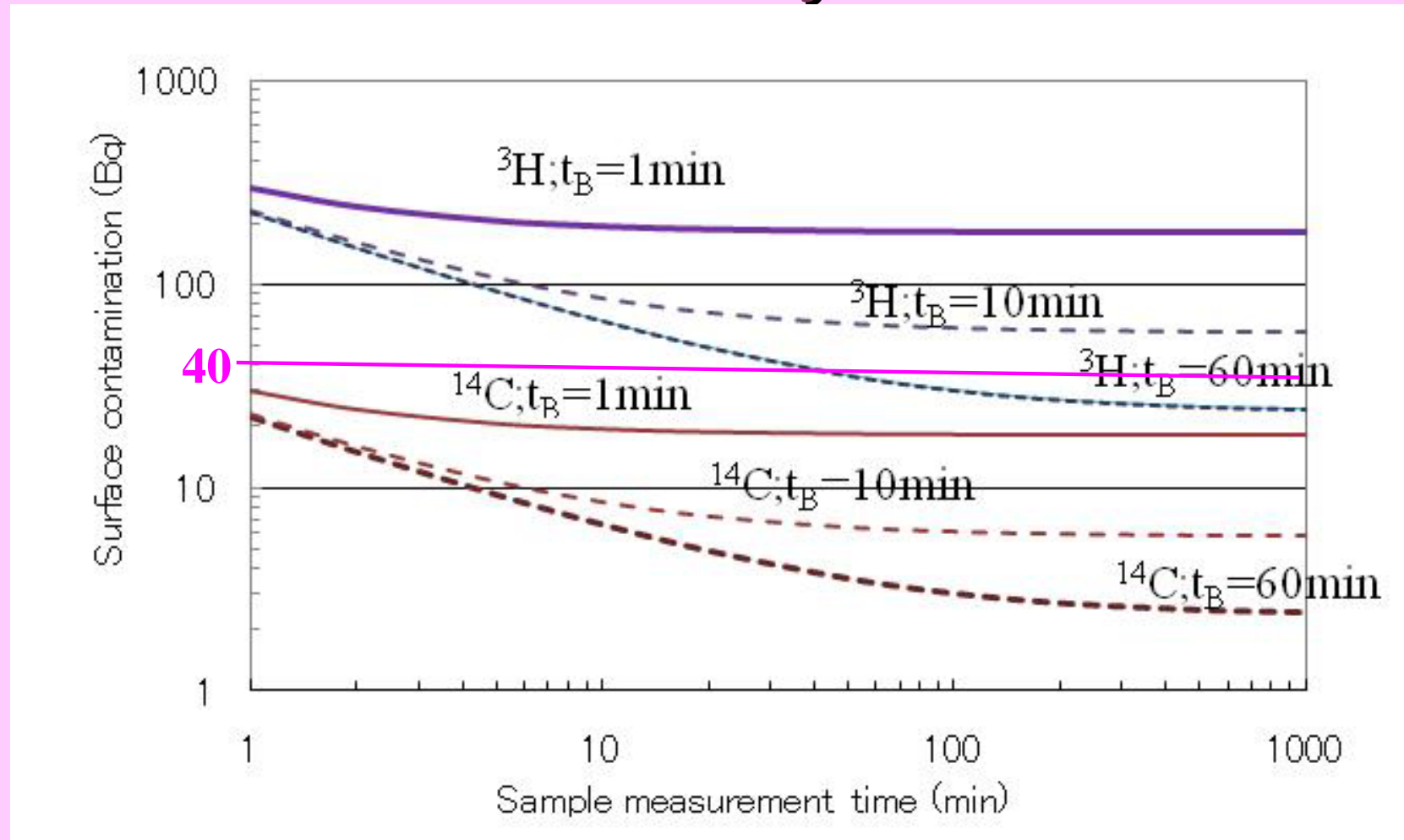
Possibility of reuse of PS

Nuclides	Counting ratios of NUC-Wipes (%)			
	1 st layer	2 nd layer	3 rd layer	PS
³ H	71.3 ± 1.2	0.09 ± 0.08	0.03 ± 0.02	BG
¹⁴ C	95.7 ± 1.2	0.07 ± 0.09	0.02 ± 0.01	BG



Result-3

Detection limit by the roller PS



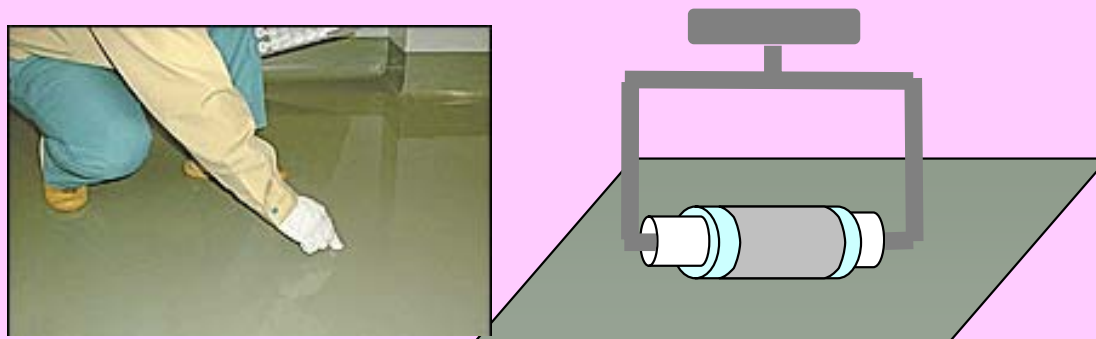
$$n_D = k^2/2[1/t_S + \{1/t_S^2 + 4n_B/k^2(1/t_S + 1/t_B)\}^{1/2}]$$

$$LA_D = n_D/a/\epsilon/60$$

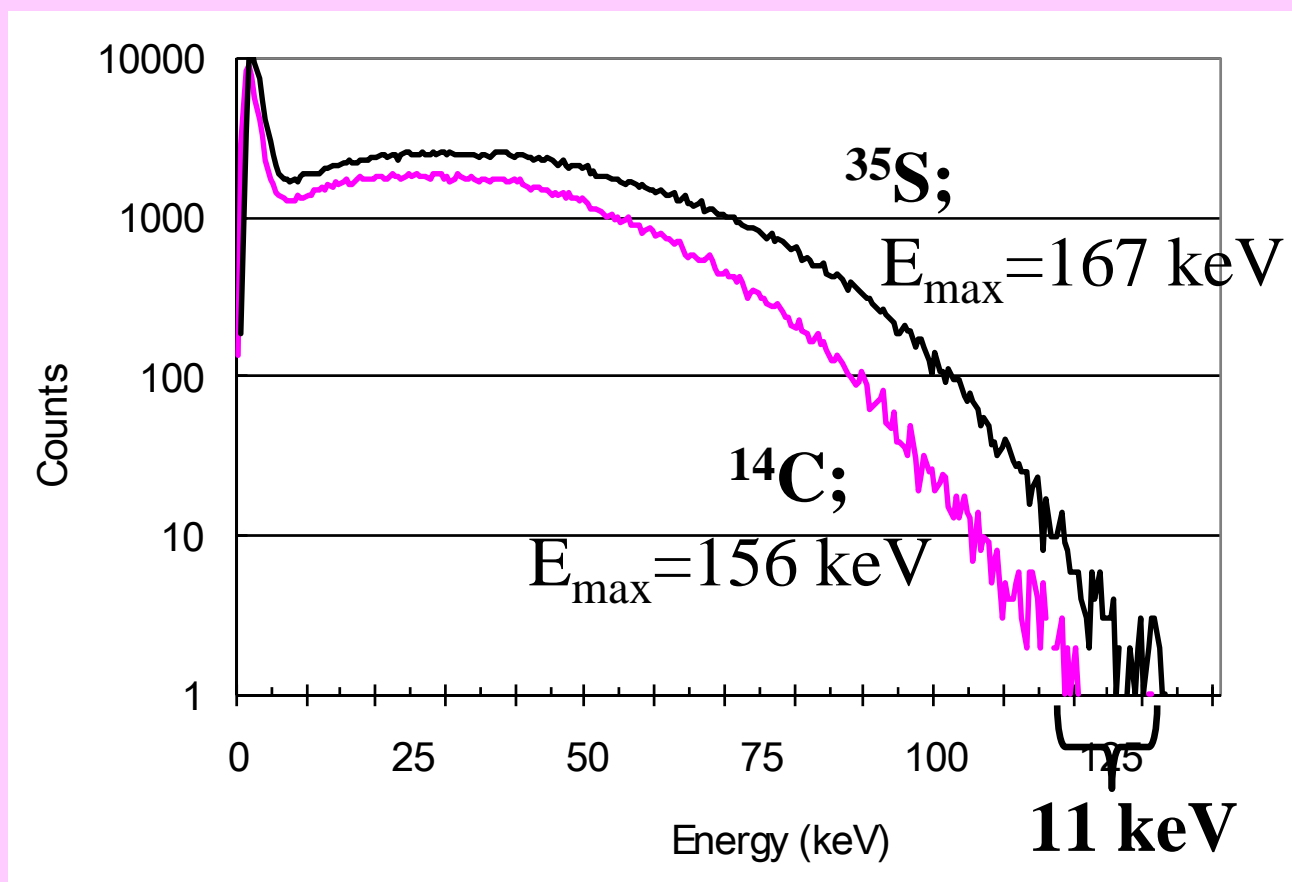
Example of wipe efficiencies

Nuclides	Wipe efficiencies * of NUC-Wipes (%)	
	Manual	Roller
^3H	15.7 ± 4.1	14.4 ± 0.6
^{14}C	20.6 ± 7.0	12.9 ± 1.2

*; 100 μL solution of each nuclide



Spectra of ^{14}C and ^{35}S measured with PS



By Tri-Carb3170
TR/SL

^{14}C and ^{35}S on plastic scintillator wrapped with NUC-Wipes were identified by their shapes and the difference of the end-points of spectra.

Summary

1. **Plastic scintillator (PS)** was able to use for the removable contamination check. (The fluorescence that emitted in PS passed through the wipe materials.)
2. **Identification** of low energy beta-nuclides (^{14}C , ^{35}S and so on) is possible with PS wrapped by NUC-Wipes.(resolution of issue 1)
3. The PS contamination check method **never need liquid scintillator**, so the postprocessing of liquid scintillator is unnecessary. (resolution of issue 2)
4. The standard deviation of wipe efficiencies were low when used **the roller-type PS**. (resolution of issue 3)
5. **The PS can be used repeatedly.**

Conclusion

The roller method using plastic scintillator is useful for removable contamination check and it can identify the radionuclides.

The PS method is ecology and economy.



Thank you for your attention !!