

# Response to radioactive material detected by radiation portal monitors

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# Objective of RPM (Radiation Portal Monitor)

Imported cargo and goods

**Blocking of illegal  
radioactive material**

**Flow Checking of natural  
radiation material**

Prevention for public from unnecessary exposure

# Monitoring Target

## ■ Artificial radioactive material / contaminated scrap

Smoke detector



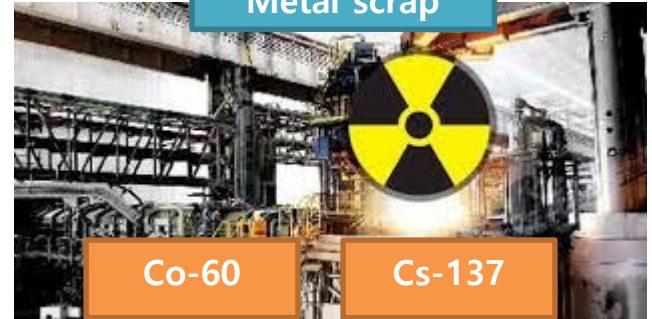
Am-241

Gauges



Cs-137

Metal scrap



Co-60

Cs-137

## ■ Natural radioactive material

Marble



K-40  
Ra-226  
U-238

Salt



K-40

Wool



K-40  
Ra-226

Tire



Ra-226

Gems



U-238

Dental ceramic



K-40  
Th-232  
U-238



# Legal Basis

## Act on Protective Action Guidelines Against Radiation in the Natural Environment

### Installation, etc. of Monitors at Airports and Harbors (Article 19)

- The NSSC shall install and operate radiation monitors at airports and harbors
- An airport operator and a person who operates harbor facilities(hereafter operator) shall cooperate with the NSSC in installing monitors
- NSSC may entrust to operate monitors installed

## Enforcement Decree of Act on Protective Action Guidelines Against Radiation in the Natural Environment

### Entrustment of Operation of Monitors (Article 13)

- Verification of radiation levels and radioactive nuclides of target cargo
- Classification, isolation and temporary storage of suspicious materials detected
- Routine inspection such as checking the normal operation of monitors



# Legal Basis

## Act on Protective Action Guidelines Against Radiation in the Natural Environment

### Operation & Maintenance of Monitor (Article 20-2)

- Operator shall obey the guidance for operation and maintenance of monitor
- NSSC may order operator to fulfill the necessary measures for operation and maintenance of monitor according to guidance

### Detection and Analysis of Suspicious Materials (Article 21)

- When operator detects matter whose radioactive concentration exceeds or is suspected to exceed limits he/she shall report to NSSC
  - detection date, place, owner, radiation level, nuclide, exported nation, imported company etc.

### Investigation and Analysis (Article 23)

- NSSC shall establish and implement annual investigation plans for the current status of operation and maintenance of monitor

### Development of Education Programs (Article 26-2)

- Operator shall complete education for operation of monitor and measures to suspected material provided by NSSC

# RPMs at Harbor/Airport

- Korea has been operating at **major international harbor/airport** since 2012  
(by Act on Protective Action Guidelines against Radiation in Living Environment)
- Now, more than **100 RPMs** have been operating at major harbors and airports

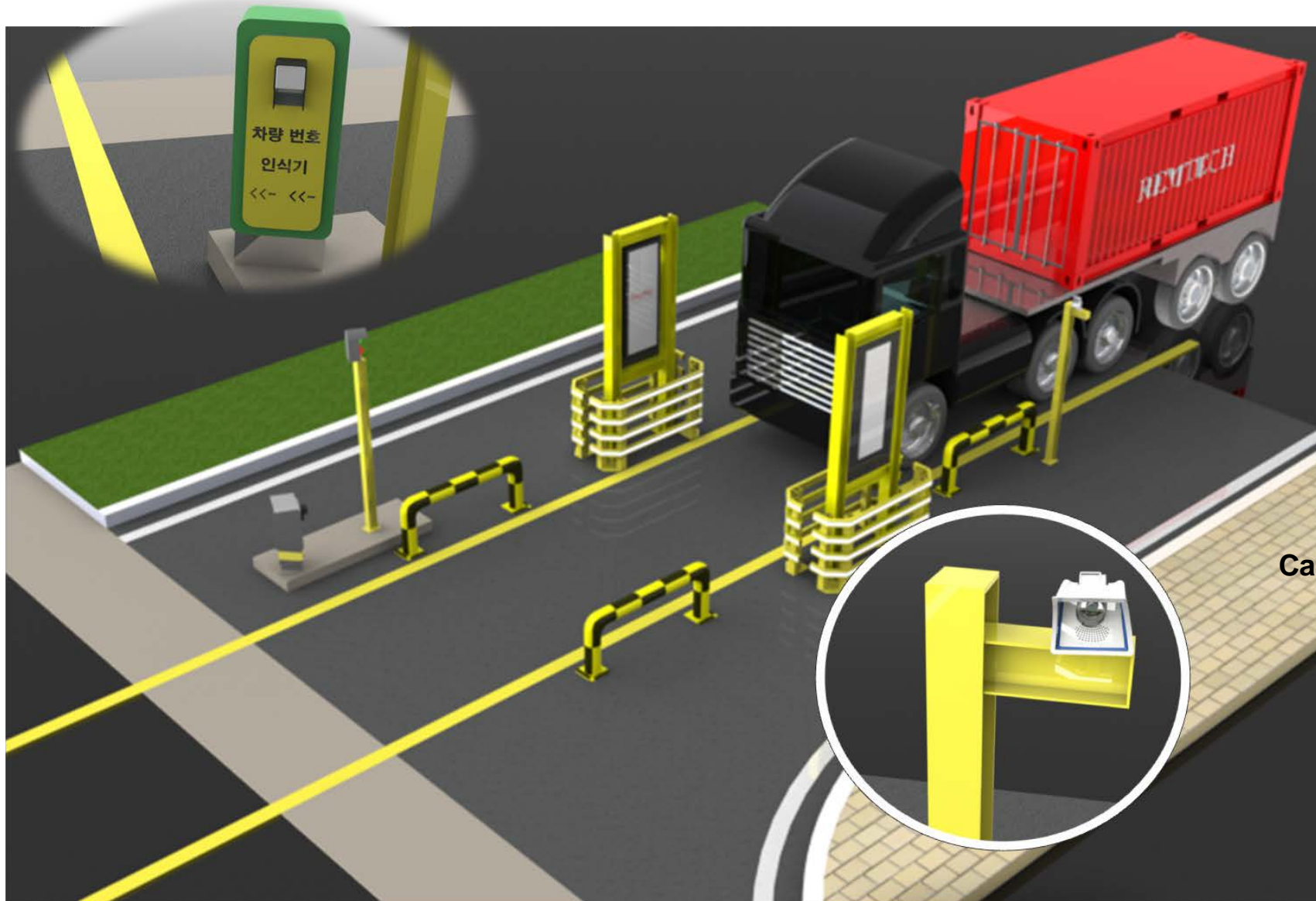




# RPM system at Seaports

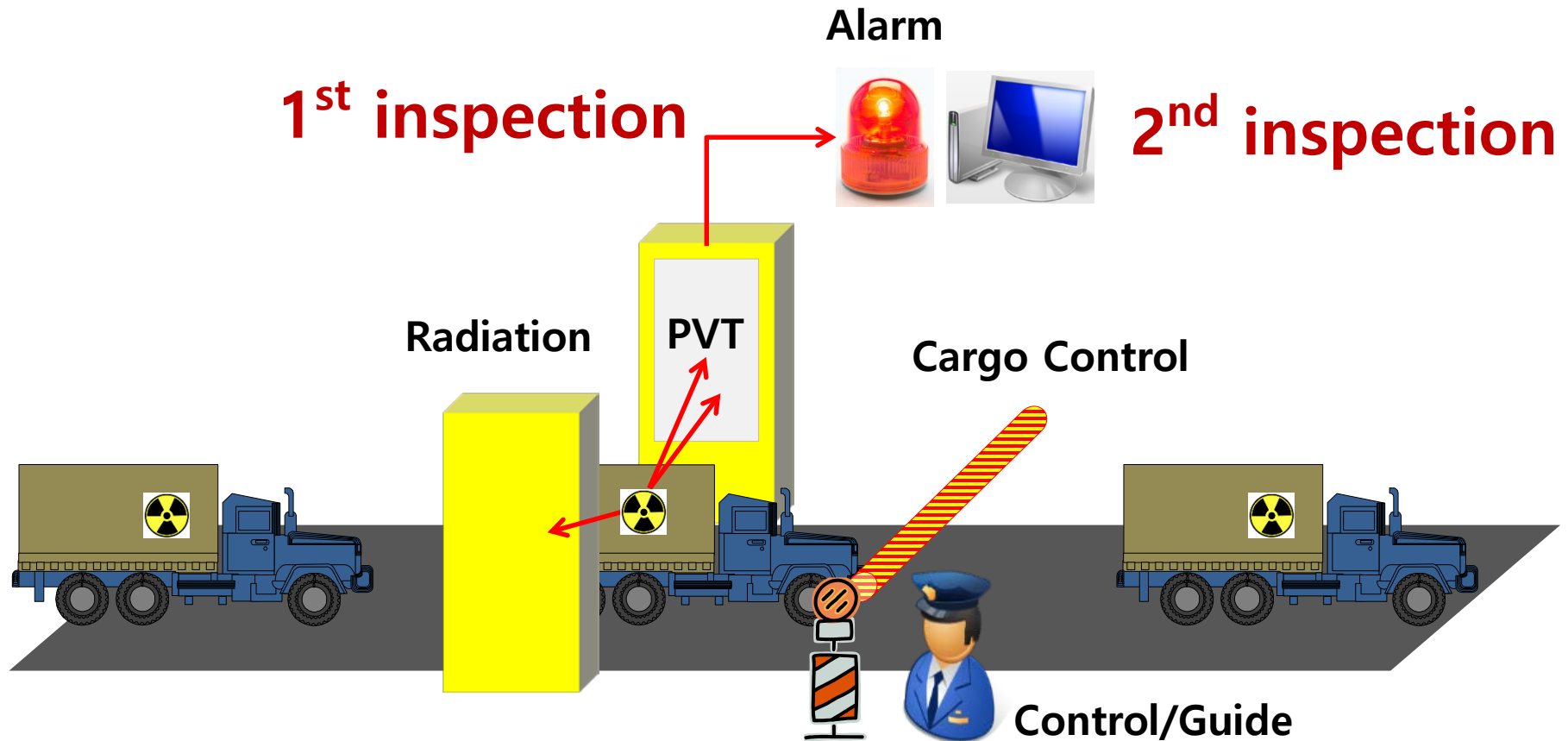
CAR number recognizer

RPM



Camera

# RPM system Concept





# RPM system Concept



# RPM Operation Software



[Thermo, Remtech]



[Ludlum, Neosiskorea]

# Alarm Message

Left, Right side Detection of Artificial Cs-137!!

## Daily Statistics

107

No.  
cars

17

1<sup>st</sup> level

3

2<sup>nd</sup> level

1

3<sup>rd</sup> level

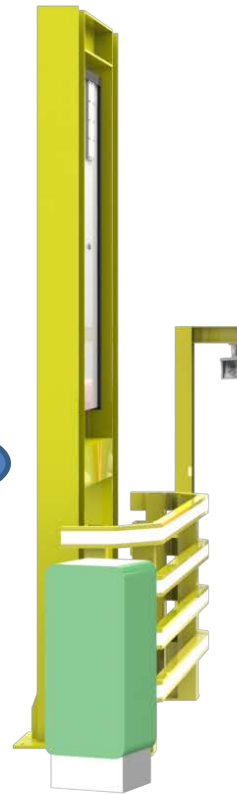
<Photo of cargo>



Container No.



Left



Right



<Recent data>

Time	Speed	Registered No.
2013-12-09 13:45:12	13Km/h	전남 130어1956

# Alarm Report

## □ 감지신호 발생 정보

발생 일시	2014-08-20 11:48	경보종류	조사준위
항만/부두/관문명	부산신항 현대 #6	감시기번호	1
차량번호	00가0000	입출차구분	출차
차량속도	13 km/h	차량길이	10 m
보안운영사	현대부산신항만	연락처	051-290-1797

## □ 화물정보

화물 형태	<input checked="" type="checkbox"/> 컨테이너(20피트) <input type="checkbox"/> 컨테이너(40피트) <input type="checkbox"/> 일반화물		
내용물	TILES PORCELAIN TILE	컨테이너번호	XINU 1086463 AP24 3895608
운송기사	(소속) 021이노 (성명) 권용래 (핸드폰) 010-9898-7094 (사무실)		
선사	(업체명) APL (전화) 620-0912	포어더/운송사	(업체명) ACE (전화) 611-5906
보세창고	(업체명) (전화)	수입업체	(업체명) (전화)
직전출항지		수입국	
비고	부산 99사 2873		

## □ 2차검색결과

방사선량률 (화물에서의 이격거리)	배경준위 (5 m 이격)	μSv/h ~ μSv/h
	화물주변 (1 m 이격)	μSv/h ~ μSv/h
	화물표면 (10 cm 이격)	μSv/h ~ μSv/h 100 μSv/h 이상 이면, 격리 조치 후 즉시 유선보고
검출핵종	천연 : <input type="checkbox"/> K-40 <input type="checkbox"/> Ra-226 <input type="checkbox"/> Th-232 <input type="checkbox"/> U-235 <input type="checkbox"/> U-238 인공 : <input type="checkbox"/> Co-60 <input type="checkbox"/> Cs-137 <input type="checkbox"/> 기타 ( )	

< Basic inform >  
time, level, car No.  
(automatic print)

< Cargo inform. >  
cargo, driver, owner

< 2<sup>nd</sup> inspection >  
identified nuclide,  
dose-rate



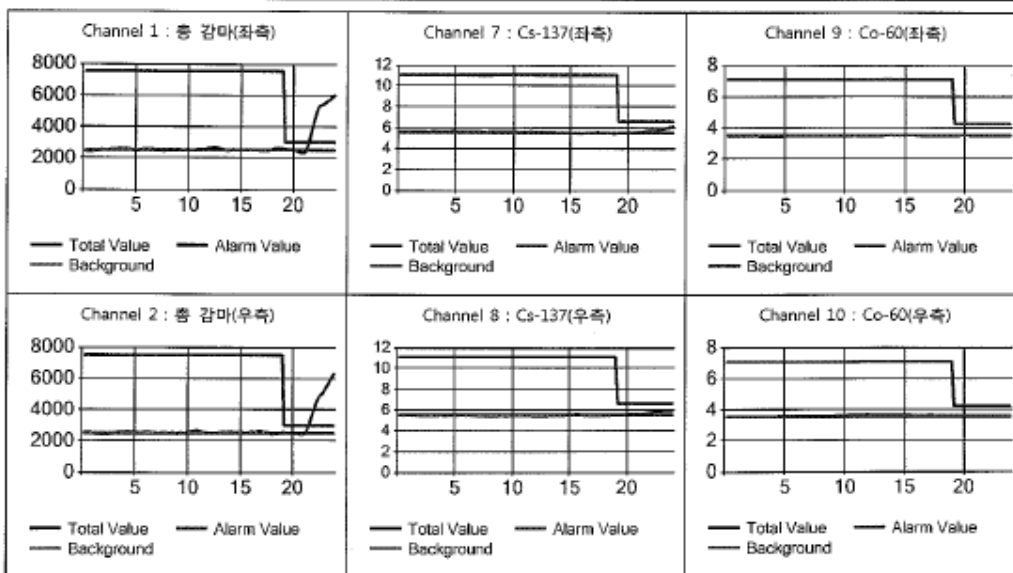
# Alarm Report

## □ 감지신호 발생 채널 정보

Alarm date : 2014-08-20 오전 11:47:19						
No	Channel Name		Total Value	Background	Net	Net_rel.
1	A 총 감마(좌측)	[cps]	6031	2532	3499	138%
2	A 총 감마(우측)	[cps]	6313	2494	3819	153%
7	Cs-137(좌측)		6.15	5.54	0.61	11%
8	Cs-137(우측)		5.99	5.55	0.44	8%
9	Co-60(좌측)		3.52	3.55	-0.03	-1%
10	Co-60(우측)		3.61	3.54	0.07	2%

< Detection data >

count-rate by channel



< Data graph >

count-rate as time

## □ 화물/차량 사진

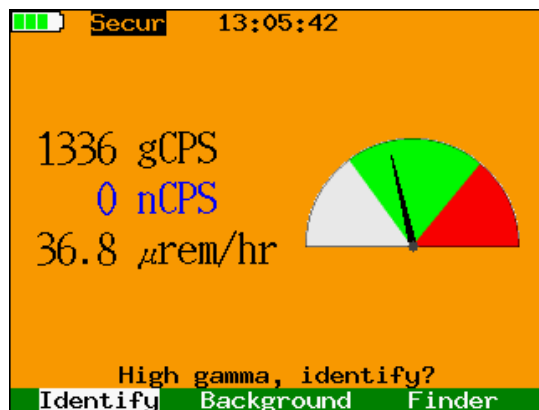
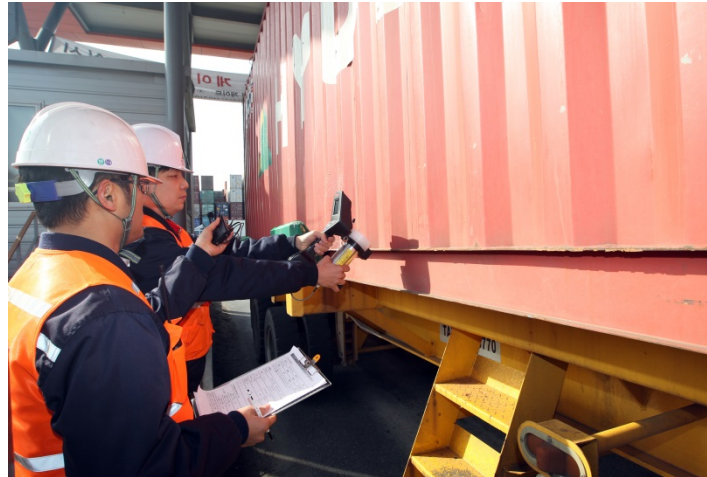


< Cargo photo >

check of container No.

# 2<sup>nd</sup> Inspection Procedure

- 2<sup>nd</sup> Inspection : Nuclide Identification
  - find high dose-rate location
  - **nuclide identification**



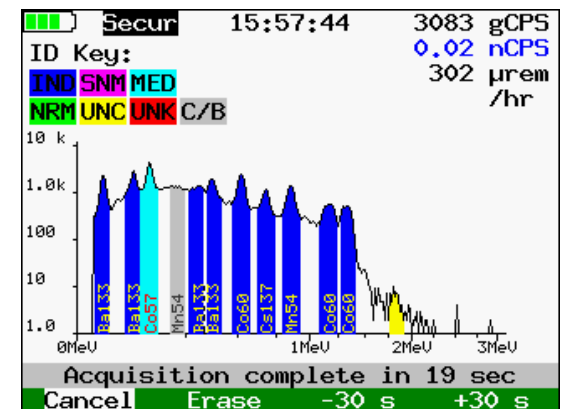
15:58:09

Analysis Report # 48

Nuclide	Class	Conf
Cobalt-60	IND	81%
Barium-133	IND	99%
Cesium-137	IND	66%
Manganese-54	IND	89%
Cobalt-57	MED	63%

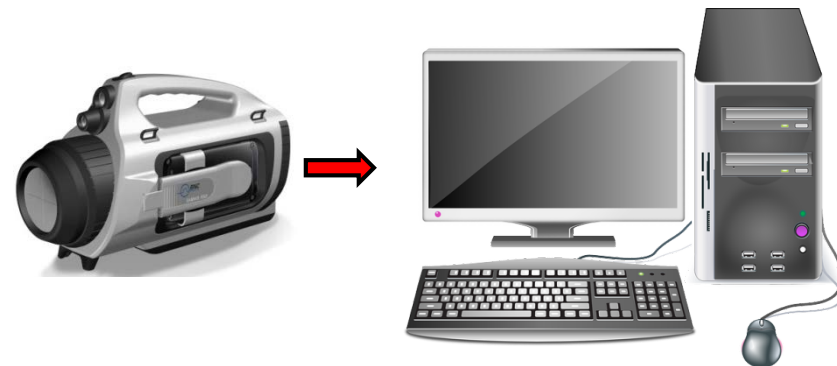
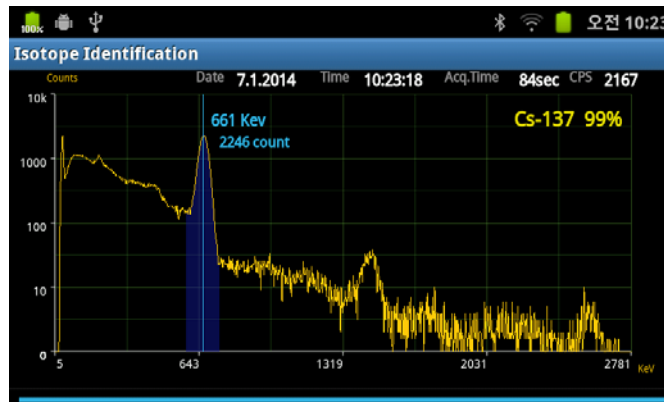
Acq Date:	11-Apr-2014
Type:	MANUAL ID
Live Time:	60.0 sec
Dose Rate:	278.8 $\mu$ rem/hr
Gamma cprt:	2843.3 CPS
Neut cprt:	0.03 CPS





# Reach back system for operators

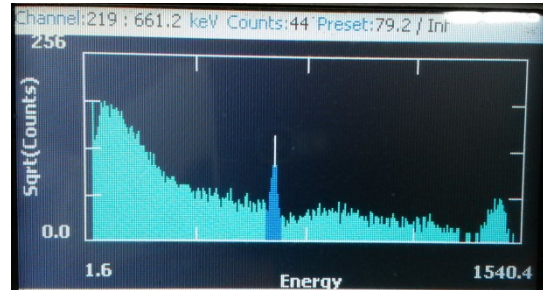
- Reach back system
  - **Nuclide identification** from spectrum analysis is very difficult
  - Even trained operator, needs of **the guidance from experts**.
- Nuclide identifier with mobile network
  - 3'x3' NaI(Tl) detector **linked with network** smart-phone.
  - The operator can send the spectrum to the KINS
  - KINS experts analyze the received data and guide to the operator



# RPM detection (Real Alarm)

## ■ BELLARUS PINE KILN DRY SAWN

- 2016. 4.11, Cs-137, 0.24uSv/h, ~ 600Bq/kg, scheduled for return



Nuclide	Type	Corr(%)
Cs-137	industrial	92.700

0.24  $\mu$ Sv/h

## ■ Aluminum Scrap

- 2016. 4.29, Ra-226, 0.7uSv/h, from Libya
- 2016. 4.13, Cs-137, 0.16uSv/h from Japan



Identification	SS1
gamma channel	0.093 $\mu$ Sv/h
AGE: 1.1	
Cs-137	Industrial

# RPM detection (Real Alarm)

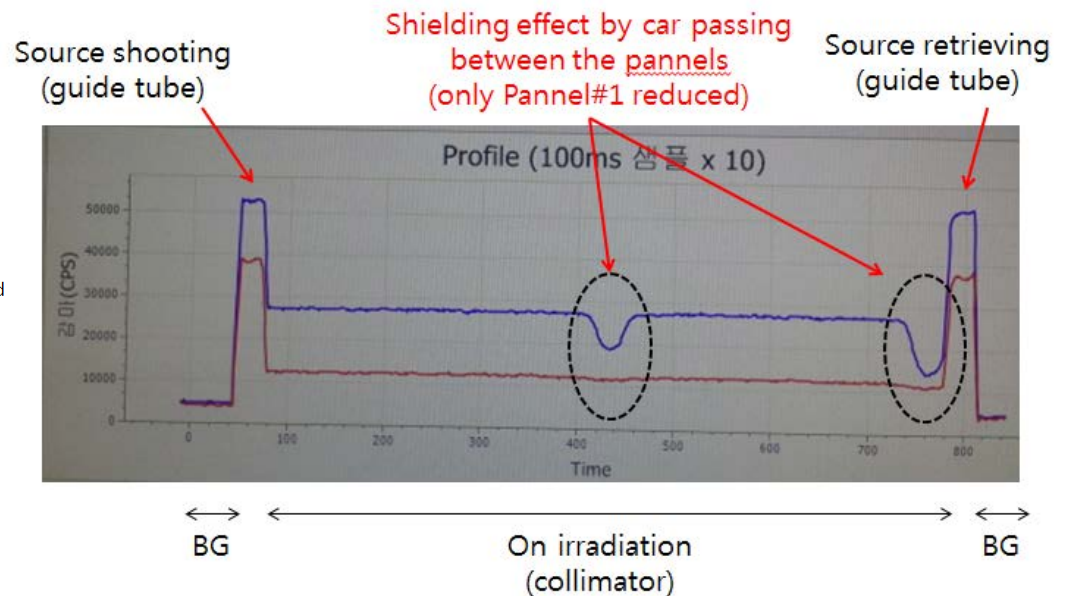
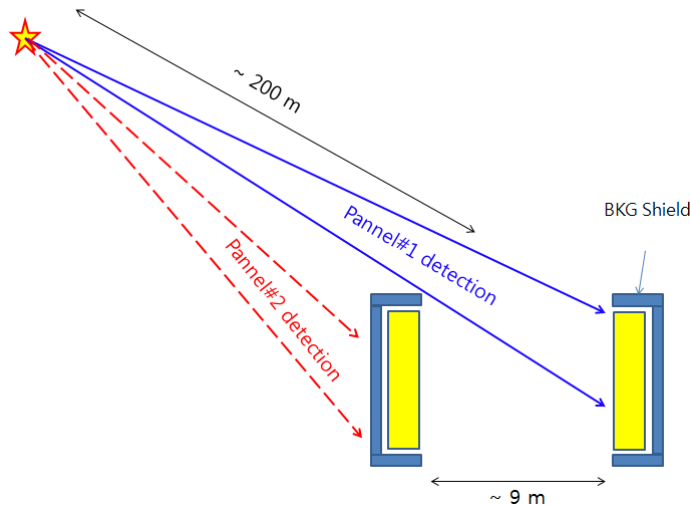
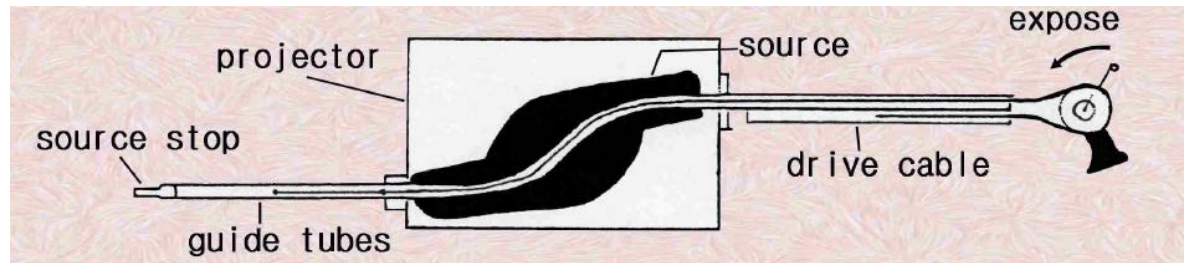
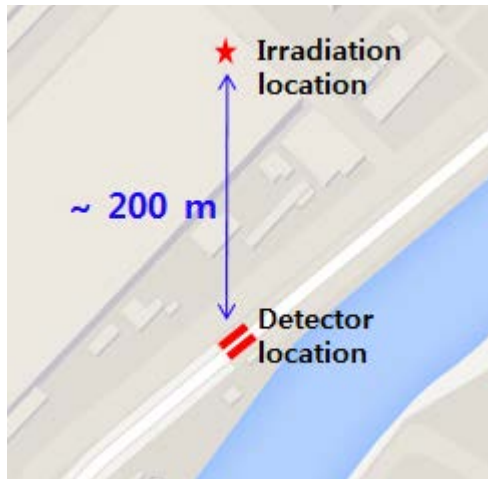
- NORMs : Ra-226, Th-232
- Monazite





# RPM detection (False Alarm)

- Continuous alarm without cargo
  - NDT irradiation work nearby site



# Training for RPM operators

## ■ Basic Training

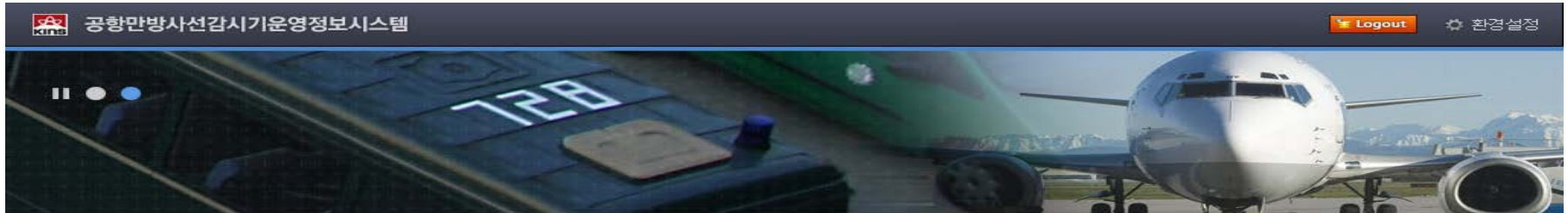
- Initial education : basic operation of device etc.
- Periodic education : operation, response & report etc.

## ■ Intensive Training Course (Train the trainers)

- KINS trained **representative guards / managers** from local seaports
- The trainers **trained local officers**



# RPMnet



공항만방사선감시기운영정보시스템

Logout

환경설정

## ▶ 공항만방사선감시기운영정보

광양항	마산항	목포항	부산항
울산항	인천항	평택항	포항항

## ▶ 공지사항

더보기

감시기 운영 복구 (부산감천항 중앙부두)

박창수 2014-11-26

감시기 운영 일시 중지 (부산 감천항 중앙부두)

박창수 2014-11-19

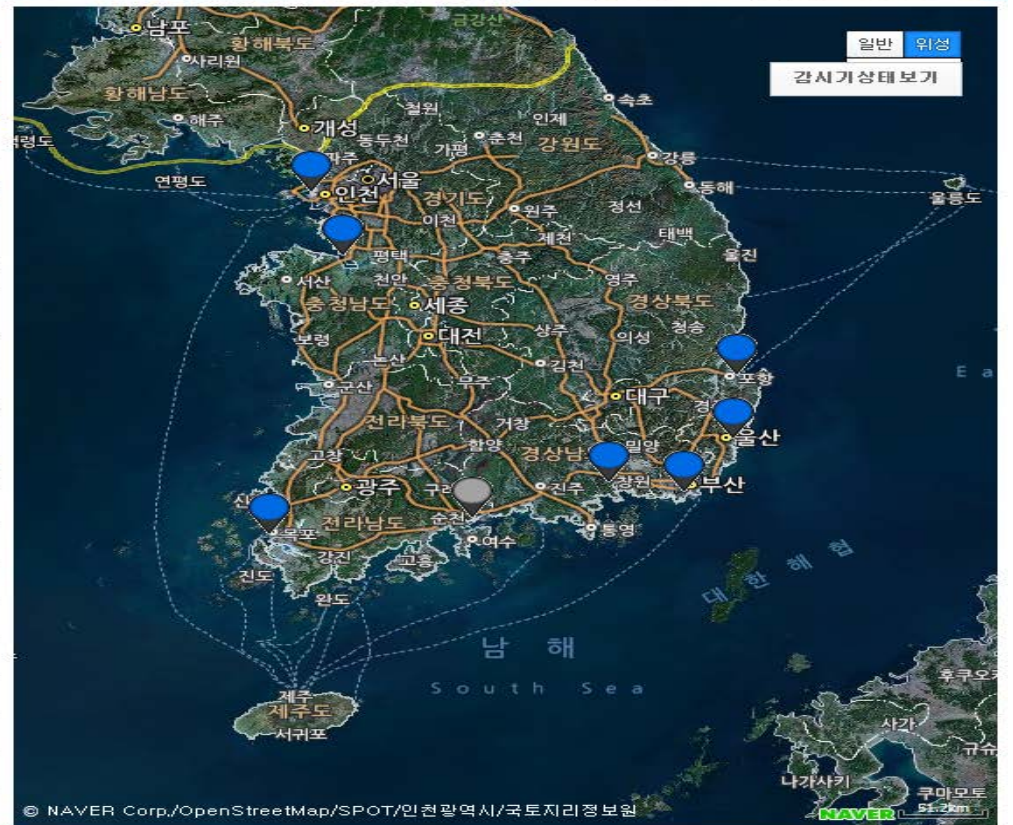
감시기 운영 복구 (부산감천항 YK부두)

박창수 2014-08-25

## ▶ 최근경보

더보기

발생일	감시기	감지신호구분	조치
2016-01-20 19:26:17	한진터미널#6	감지준위	미접수
2016-01-20 16:33:08	한진터미널#6	감지준위	미접수
2016-01-20 16:10:33	한진터미널#6	감지준위	미접수
2016-01-20 15:18:02	신항 1부두 #2	감지준위	미접수
2016-01-20 15:01:57	신항 1부두 #2	감지준위	미접수
2016-01-20 15:01:12	신항 1부두 #2	감지준위	미접수
2016-01-20 14:58:02	신항 1부두 #2	감지준위	미접수
2016-01-20 13:57:52	신항 1부두 #2	감지준위	미접수

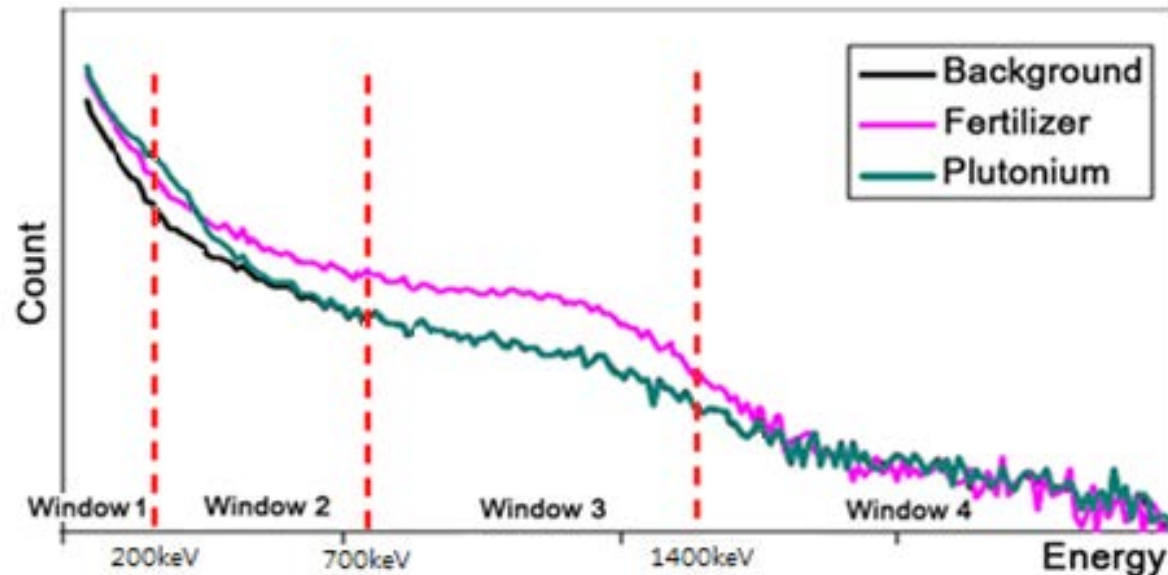




# KINS developed Algorithm

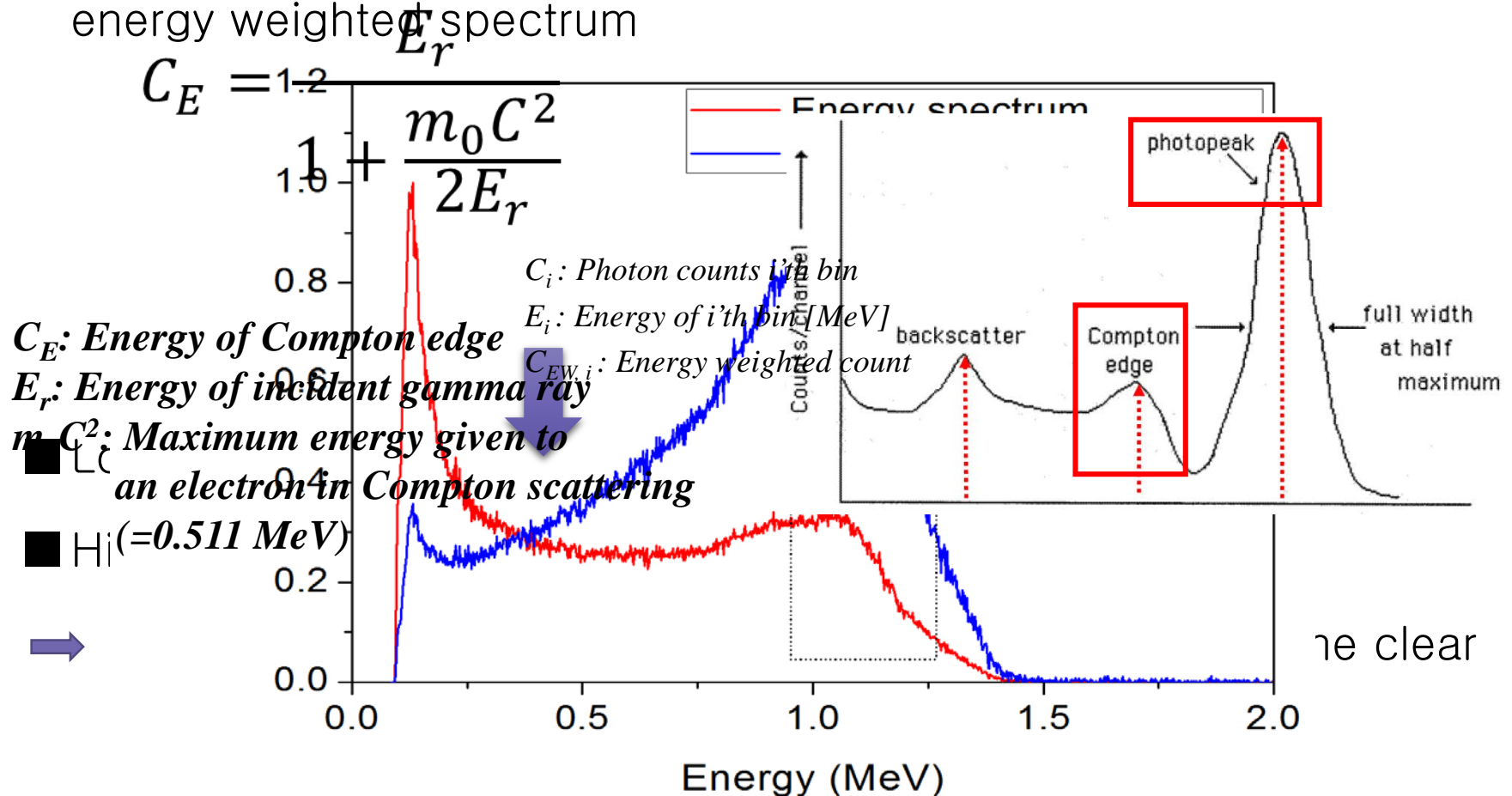
## □ Energy window

- The radioisotopes are roughly determined with ratio between the windows
- It is difficult to discriminate radionuclides emitting gamma-rays with similar energies
- ex.  $^{137}\text{Cs} - ^{214}\text{Bi}$  (0.66 / 0.61 MeV),  
 $^{60}\text{Co} - ^{40}\text{K}$  (1.17, 1.33 / 1.46 MeV)

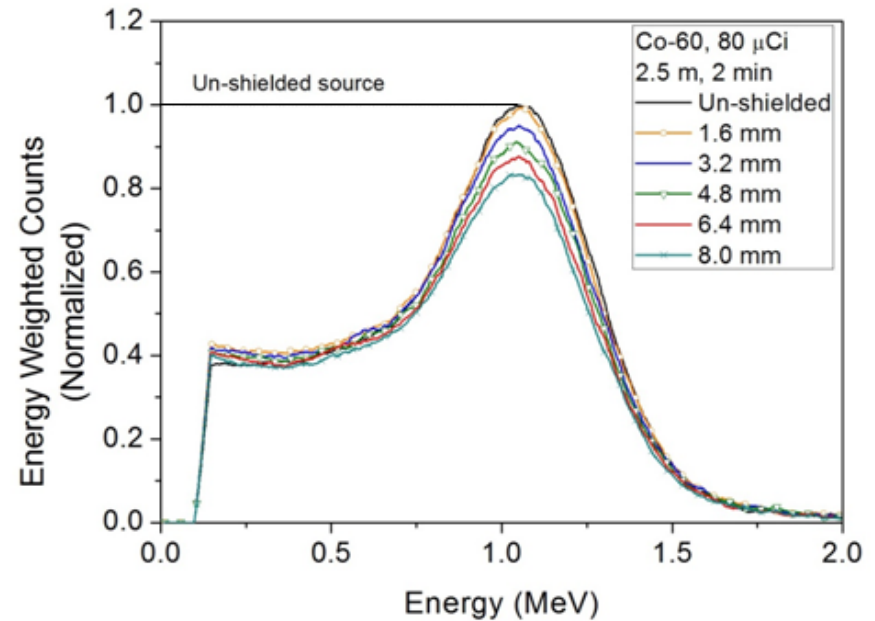
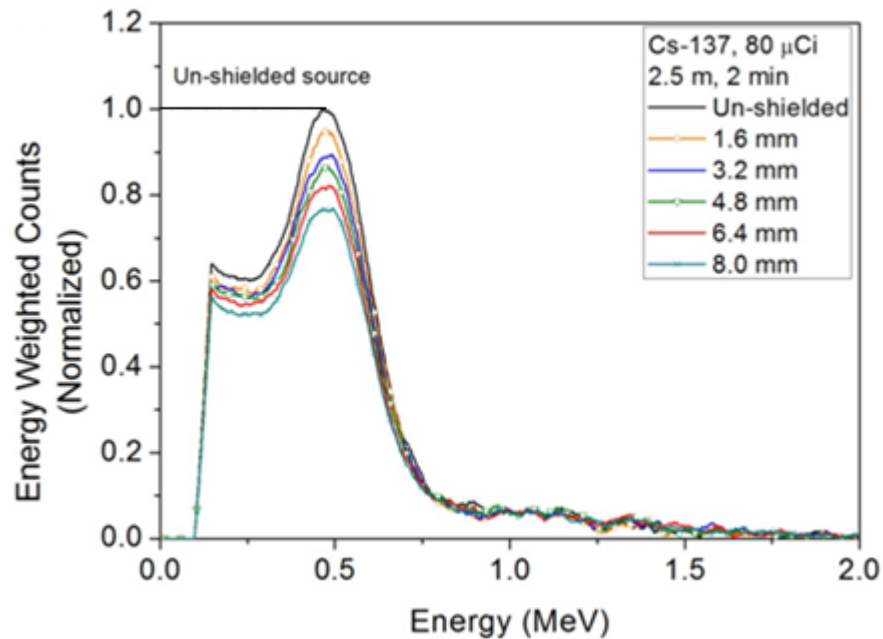


# KINS developed Algorithm

- Through the energy weighted algorithm, the counts per channel are multiplied with the energy of each channel and it leads to the energy weighted spectrum



# KINS developed Algorithm



Energy weighted algorithm is valid on the shielded source

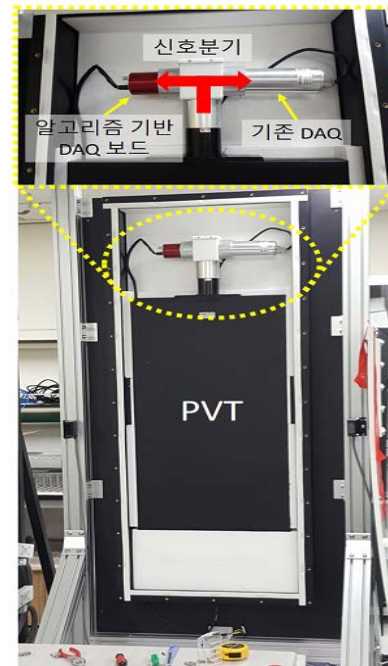
# International Cooperation

- ❑ Joint test on KINS algorithm with DOE and its affiliated organization(PNNL, ORNL, etc.)
- ❑ Participation in IAEA CRP(Coordinated Research Project)



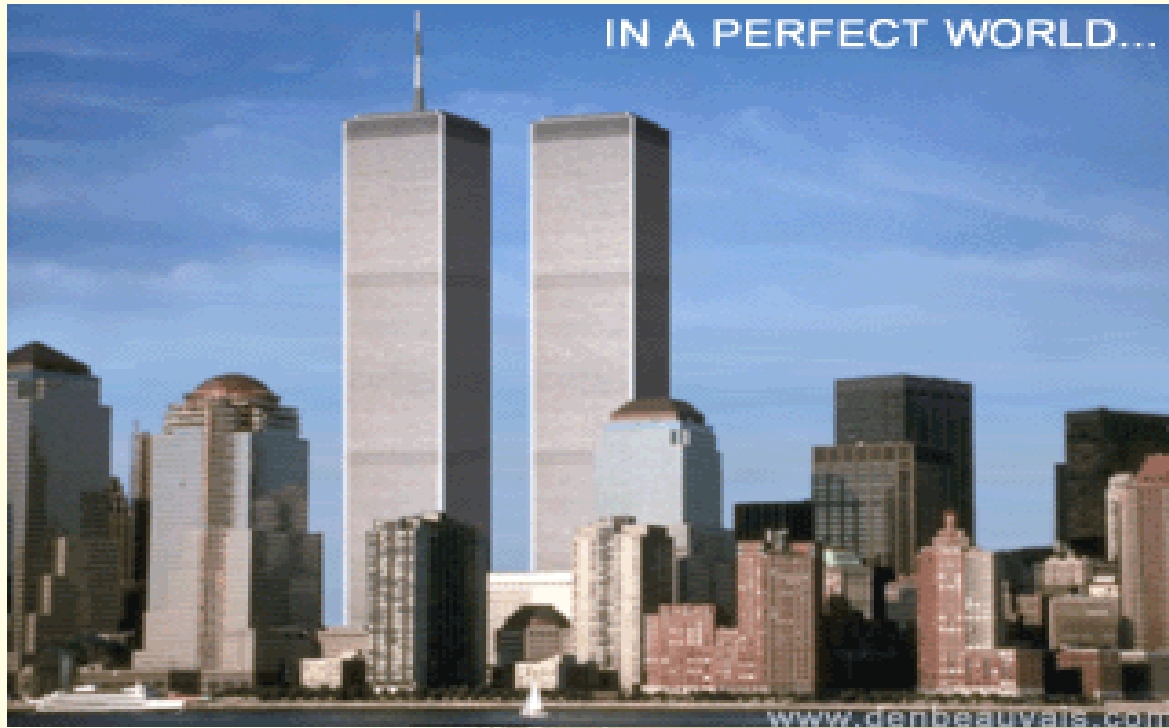
# Future Plan

- ❑ Development of the RPM operation software loaded with KINS algorism
- ❑ Sustainable development on KINS algorism from Energy Window to Peak Window
- ❑ Joint test and evaluation with DOE and its affiliated organization
- ❑ Development of RPM maintenance methodology : condition-based and predictive





IN A PERFECT WORLD...



**KINS**

**Thank you very much**