



Chinese Academy of Customs Administration



# Application of Radiation Detection Technology to Facilitate the Safe and Secure Trade by Detecting R/N and Other Contraband

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*Yongming Hou  
China Customs Radiation Detection Training Center  
Chinese Academy of Customs Administration*





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**Fireworks and Firecrackers Detection**





## Research Background

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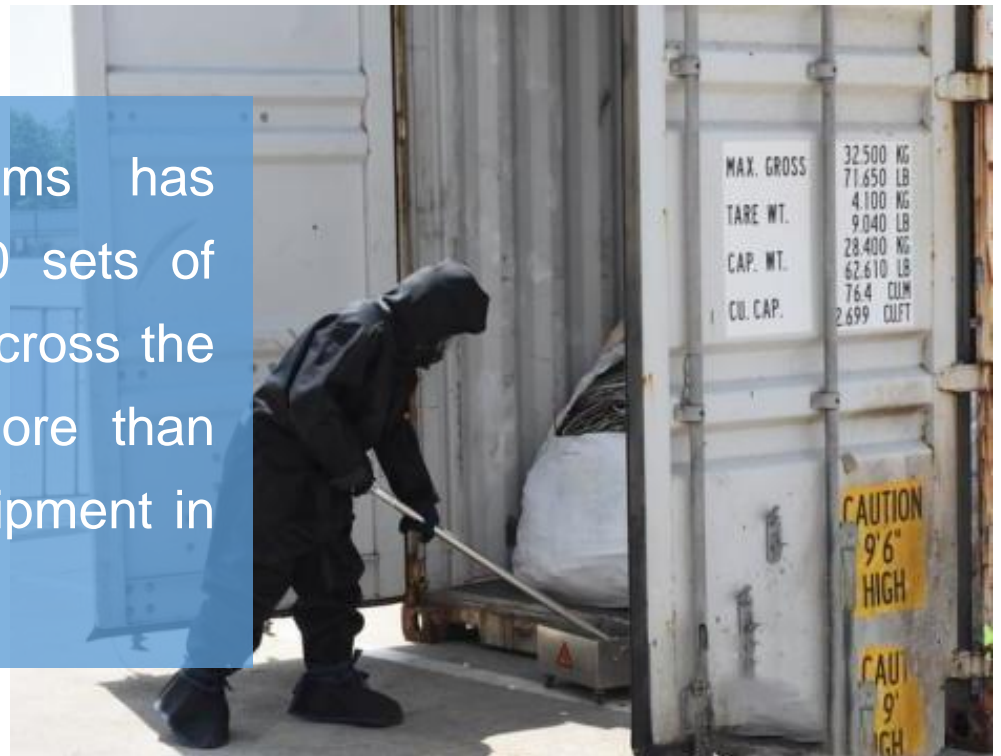
According to the statistics of the International Atomic Energy Agency, at present, more than **11000** radiation portal monitors(RPMs) has been deployed at border locations around the world.





## Research Background

By 2021, China Customs has equipped more than 2000 sets of RPM equipment at ports across the country, accounting for more than 18% of the total RPM equipment in the world.





## Research Background



RPMs Equiped at border ports





## Research Background

### Traditional Application Scenarios

The large-scale deployment of RPM equipment worldwide has played an important role in combating the illegal trafficking of nuclear and other radioactive materials.

Nuclear Material

Radioactive Materials

Radiation Sources

Radiative Wastes and Pollutions





## Research Background

### New Application Scenarios

Radiation Detection can play the advantages of non-invasive detection in fighting against illegal crimes such as false declaration and concealment, as well as in the supervision of explosives and contraband.





## Research Background




Fireworks and firecrackers (contain small amount of radioactivity) seized by China customs through radiation detection







## Research Background



Although trade facilitation is critical to economic prosperity, it has to be balanced against the need to ensure the safety and security of the supply chain by detecting, preventing, and deterring illicit trafficking of R/N, CBRN and other contraband items.



## Research Background



**IAEA**

International Atomic Energy Agency

--To apply the benefits/capabilities of RPMs to advance the overall use of nuclear detection technologies for safe and secure trades, the IAEA proposed a coordinated research programme(CRP) in 2019.

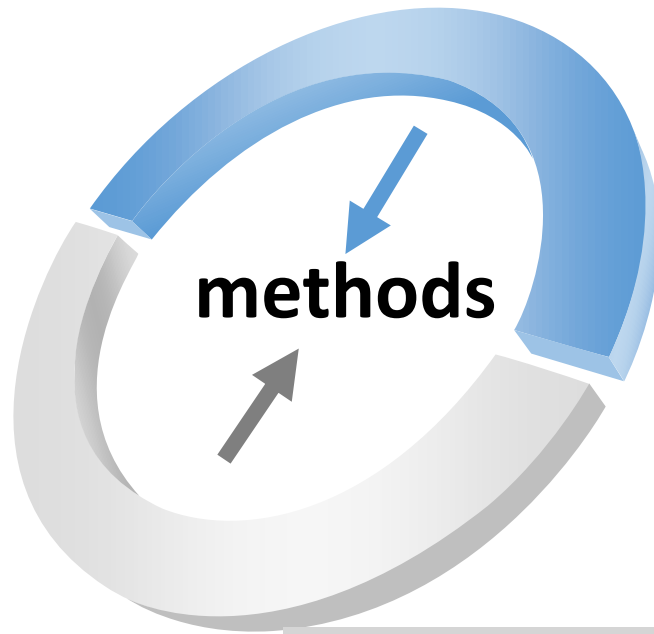
--China Customs radiation Detection Training Center and the China Institute of Atomic Energy jointly participated in the CRP. The research, entitled with “Develop advanced techniques for trade verification and anomaly detection using data generated from radiation detection systems” has approved by IAEA.





## Methods

Qualitative analysis



The research methods to detect contraband using radiation technology includes qualitative and quantitative analysis. The purpose of the analysis is to determine if the response of RPM “matches” the expectation for the declared commodity.

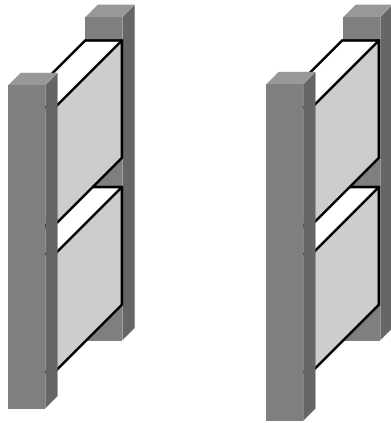
quantitative analysis





## Methods

### Qualitative Analysis



schematic diagram of RPM equipped with large size gamma ray detector

There are mainly the following situations:

---Radioactivity is detected in goods that should not contain radioactivity.

---No radioactivity was detected in the declared radioactive cargo.

---The nuclide identification result is inconsistent with the cargo.



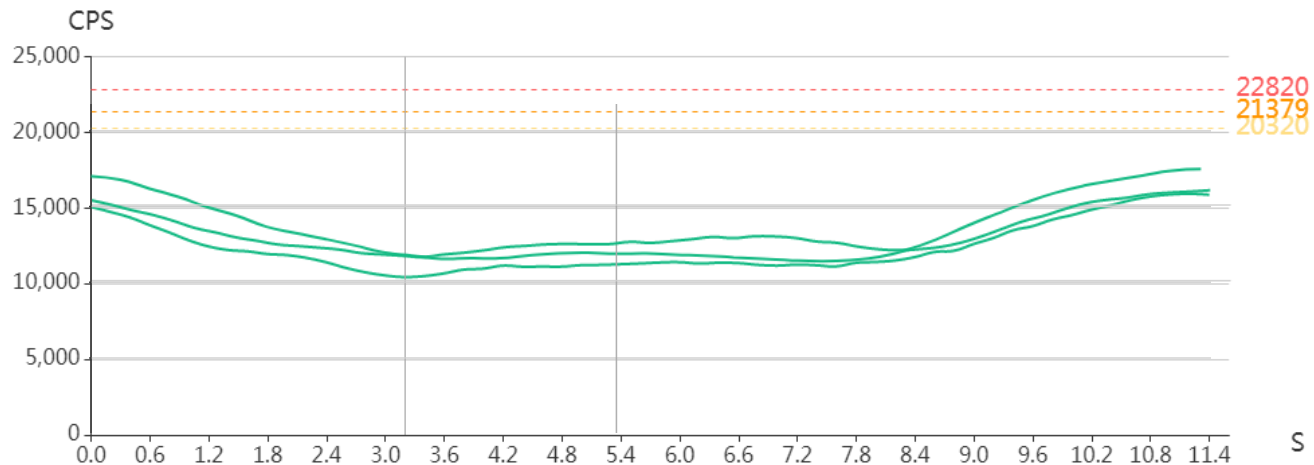


## Methods

### Quantitative Analysis

--statistical data of cargo radioactivity

--baseline suppression of radioactivity







## Fireworks and Firecrackers Detection

---Class 1 dangerous goods

---must comply with the relevant regulations on the transportation and storage of flammable and explosive dangerous goods

---specific border ports

---the world's largest produce and export

---"closing the container with the tail cargo" smuggling





## Fireworks and Firecrackers Detection

### Radioactivity in Firworks and Fircrackers



black powder

75% potassium nitrate

15% charcoal

10% sulfur

Potassium nitrate is rich in potassium, which contains natural radionuclide **K-40**, accounting for about **0.011%**.





## Fireworks and Firecrackers Detection

---The detection data used in this paper is from a batch of smuggled fireworks and firecrackers seized by the Chinese Customs.

---The cargo weighs 20.1 tons, and the declared product name is stainless steel shelf.

---In fact, the declared stainless steel shelves are only at the end of the container, and most of the internal space of the container is loaded with fireworks and firecrackers.

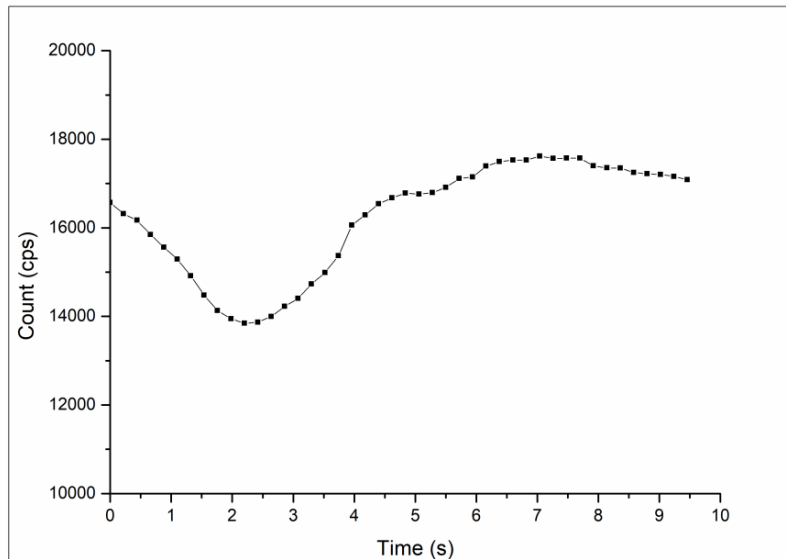




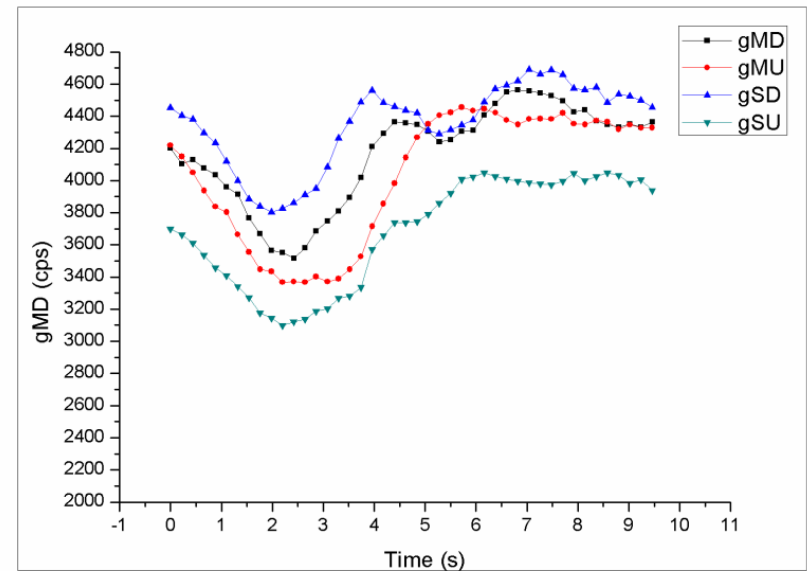


# Fireworks and Firecrackers Detection

## Qualitative analysis of detection results



radiation detection curve of fireworks and firecrackers



radiation count rate measured by four detectors of the RPM





## Fireworks and Firecrackers Detection

### Quantitative analysis of detection results

radiation detection data of fireworks and the detection results of perlite (radioactive goods) and non-radioactive goods

Type of goods	Background counting rate ( $s^{-1}$ )	Minimum counting rate detected ( $s^{-1}$ )	Maximum counting rate detected ( $s^{-1}$ )	Baseline suppression rate (%)	Counting rate net increasing (%)
fireworks	16571	13844	17618	16.5%	6.3%
perlite	14306	13996	30886	2.1%	115.9%
non-radioactive goods	15367	10195	15875	33.7%	3.3%





## Fireworks and Firecrackers Detection

### Quantitative analysis of detection results

- The radiation net increase rate of fireworks and firecrackers is 6.3%, compared with 3.3% for non-radioactive cargo and 115.9% for perlite
- The radioactive intensity of fireworks and firecrackers is far less than perlite.
- Alarm threshold is a key factor.
- Only when the alarm threshold is set very low can the 6.3% count increase trigger the device alarm.





## Conclusions

01

The radiation detection technology represented by RPM can conduct rapid radioactive detection on the inspected goods and articles without affecting the normal circulation of trade, and has played an important role in the customs nuclear security supervision.

02

Radiation detection technology can play an active role in the detection of prohibited and restricted commodities. This has been proved in the detection of fireworks smuggling.

03

Using radiation detection technology detect the prohibited articles in a certain way, relying on the highly intelligent and automatic analysis function of the RPM, which is also the most lacking function of such equipment at present.





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***THANKS FOR YOUR ATTENTION***

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