Peltier-cooling-type High Performance Cloud Chamber

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Problems in Conventional Cloud Chambers

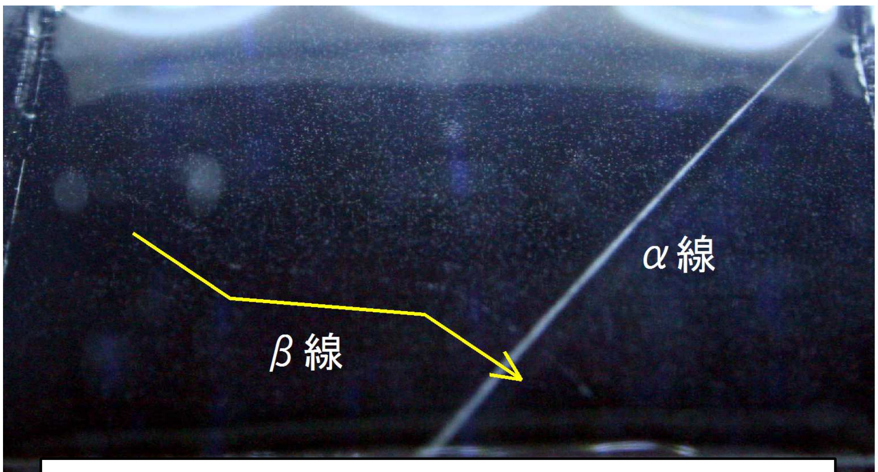
- Needs preparation and resupply dry-ice
- Hard to long time continuing presentation
- Requires several minutes to start observation
- Radiation tracks are not observed under bad weather condition
- Limited to just observation of alpha-rays track

Features of this products

- Dry-ice Free!
- Clear track observation and Stable long time
- Oservation of not only alpha-rays tracks, but also beta-rays tracks, and furthermore, delta-rays tracks arisen from gamma rays.

→ Intuitively radiological education of the difference in interaction with materials from a kind of radiation-rays

- Cheap price from parts on the consumer market

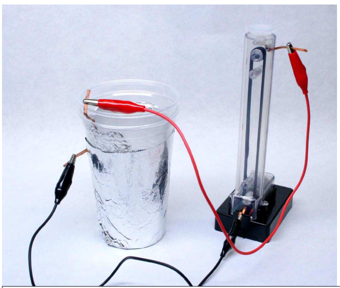


Comparison of alpha- and beta-ray track

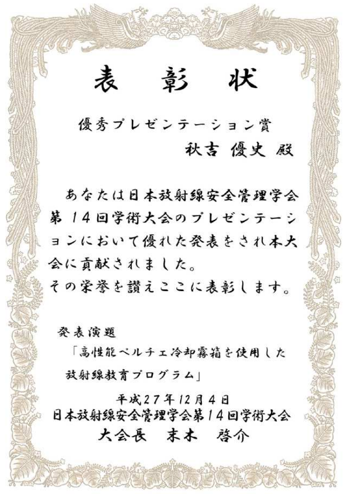
Main Unit

Main unit and a connection cable

Cockcroft-Walton type HV Unit



Van de Graaff type HV unit



表彰状

優秀プレゼンテーション賞
秋吉 優史 殿

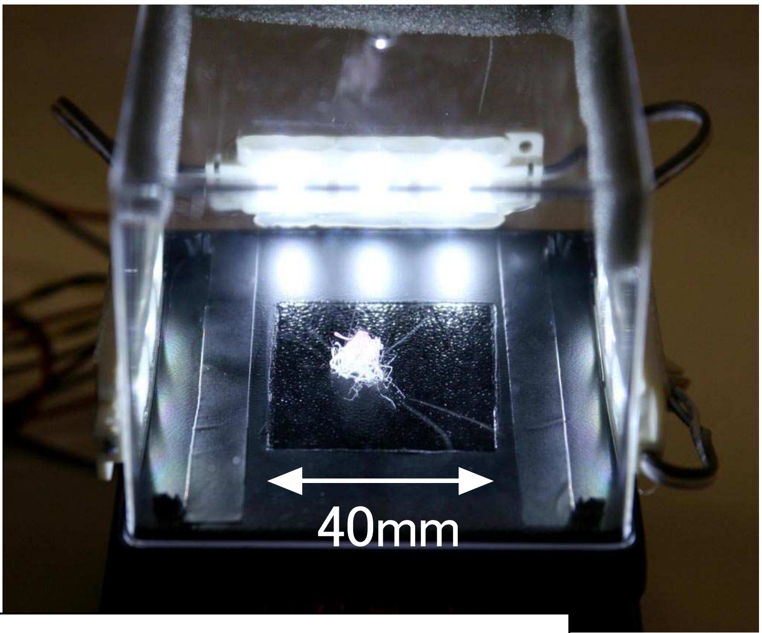
あなたは日本放射線安全管理学会第14回学術大会のプレゼンテーションにおいて優れた発表をされ本大会に貢献されました。
その栄誉を讃えここに表彰します。

発表演題
「高性能ペルチェ冷却霧箱を使用した放射線教育プログラム」

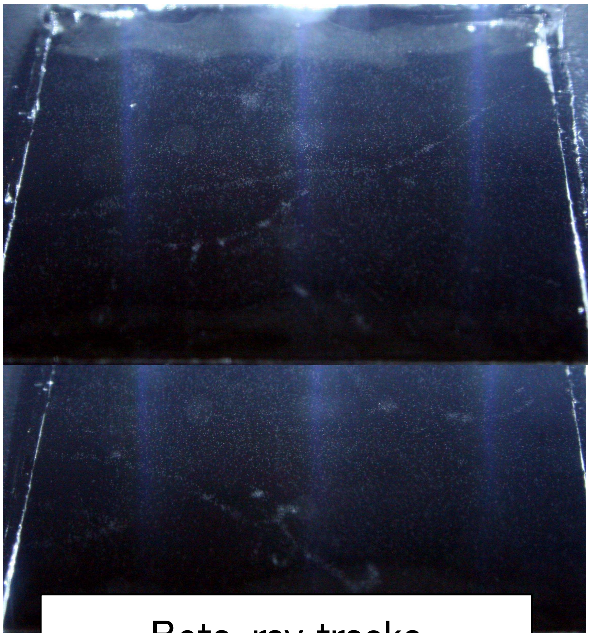
平成27年12月4日
日本放射線安全管理学会第14回学術大会
大会長 末木 啓介

A presentation related to this products won the presentation prize at the Japanese Society of Radiation Safety Management.

This equipment consists of the main unit into which Peltier devices, an air cooling heat-sink, and LED lightings were packed compactly, and the high-voltage unit. High-intensity LED lighting enable us to observe tracks in the bright room. Although the power supply of 12V/5V is required, it can obtain using the ATX power supply taken out from old PC. Cockcroft type HV unit that can be operated continuously is usually attached, while these high-voltage unit acan be used for a stusy of an accelerator, so it is also possible for you to choose a Van de Graaff type as short-time training.



The operation illustrate of the equipment(Alpha-ray tracks)



Beta-ray tracks

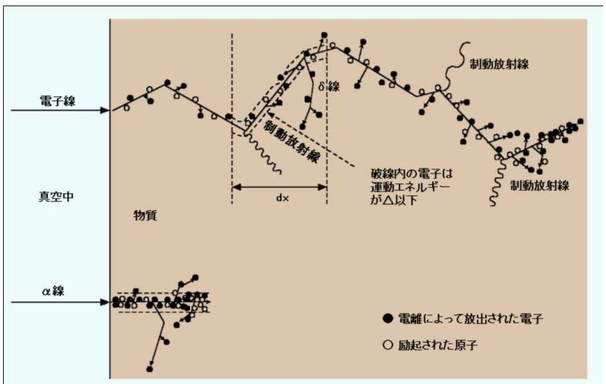
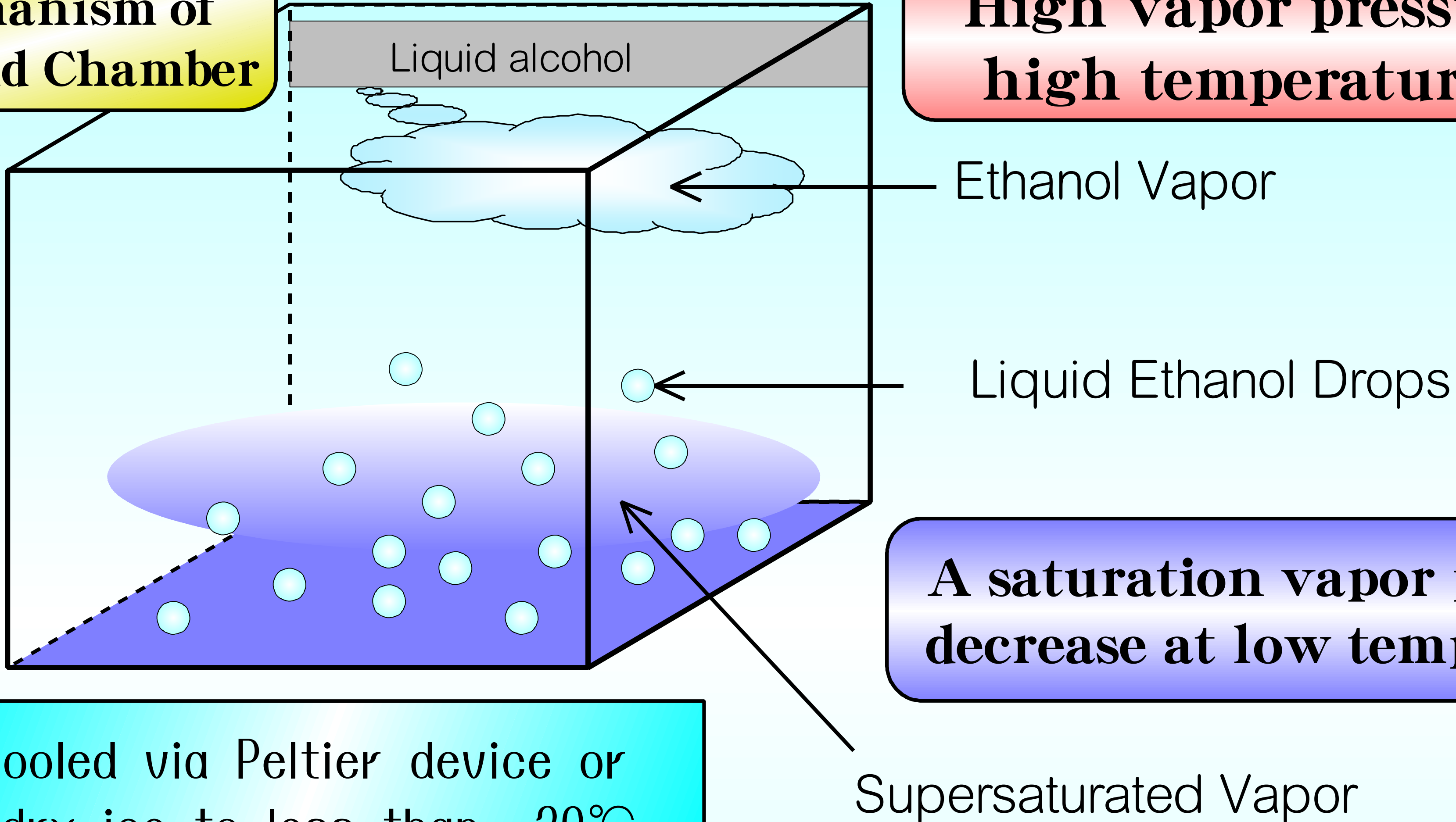


図1 荷電粒子と物質の相互作用

[出典]江藤秀雄ほか：放射線防護、丸善(1982年12月)、p.54

Observation of radiations using conventional cloud chambers were limited to only alpha-ray tracks and had many restrictions. While this Peltier-cooling-type high performance cloud chamber enable us to observe **very clear radiation tracks** in a few tens of seconds after a power supply even under a bad weather condition, of cause **without dry ices**. The technical features such as clearing assorted ions in air using HV-unit, high-intensity LED illuminations and the fabric of the chamber enable us to **observe beta-ray tracks**. Not only simple observation of alpha-ray tracks, but also compare with beta-rays track or a **delta-ray tracks arisen from gamma rays** enables us to perform far deep radiological education related to interactions of radiations and materials.

Mechanism of a Cloud Chamber



High vapor pressure at high temperature

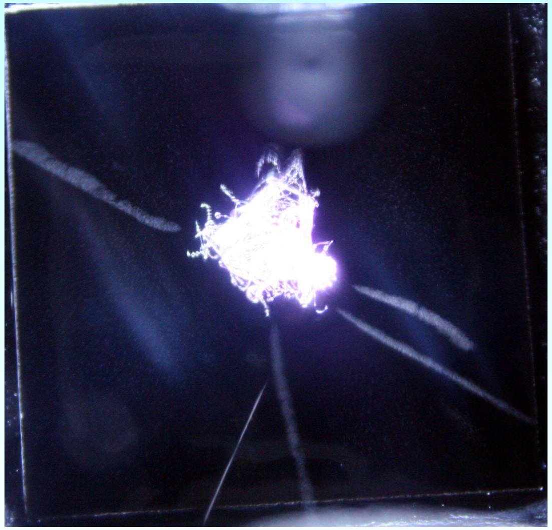
A saturation vapor pressure decrease at low temperature

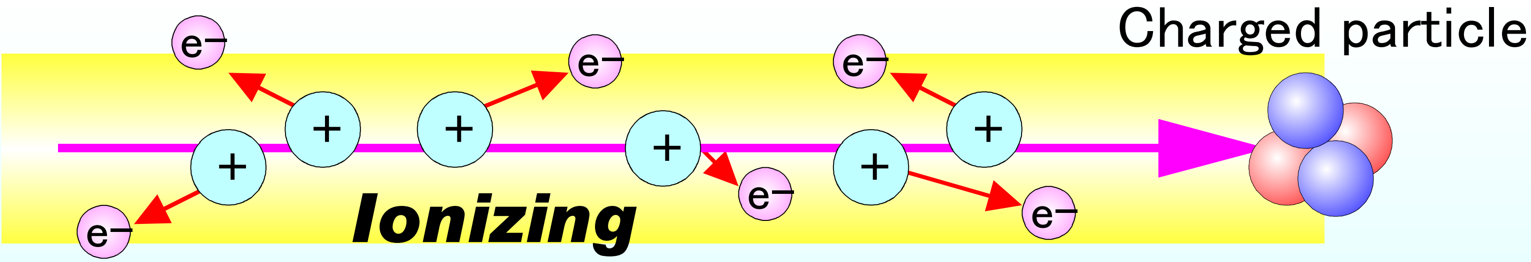
Cooled via Peltier device or dry ice to less than −20℃

At room temperature, vapor pressure of ethanol is relatively high. This ethanol vapor getting cold at bottom of the chamber, and then a saturated vapor pressure decrease and the vapor comes to supersaturated condition. At this condition, small stimulation makes the supersaturated vapor to tiny liquid drops.

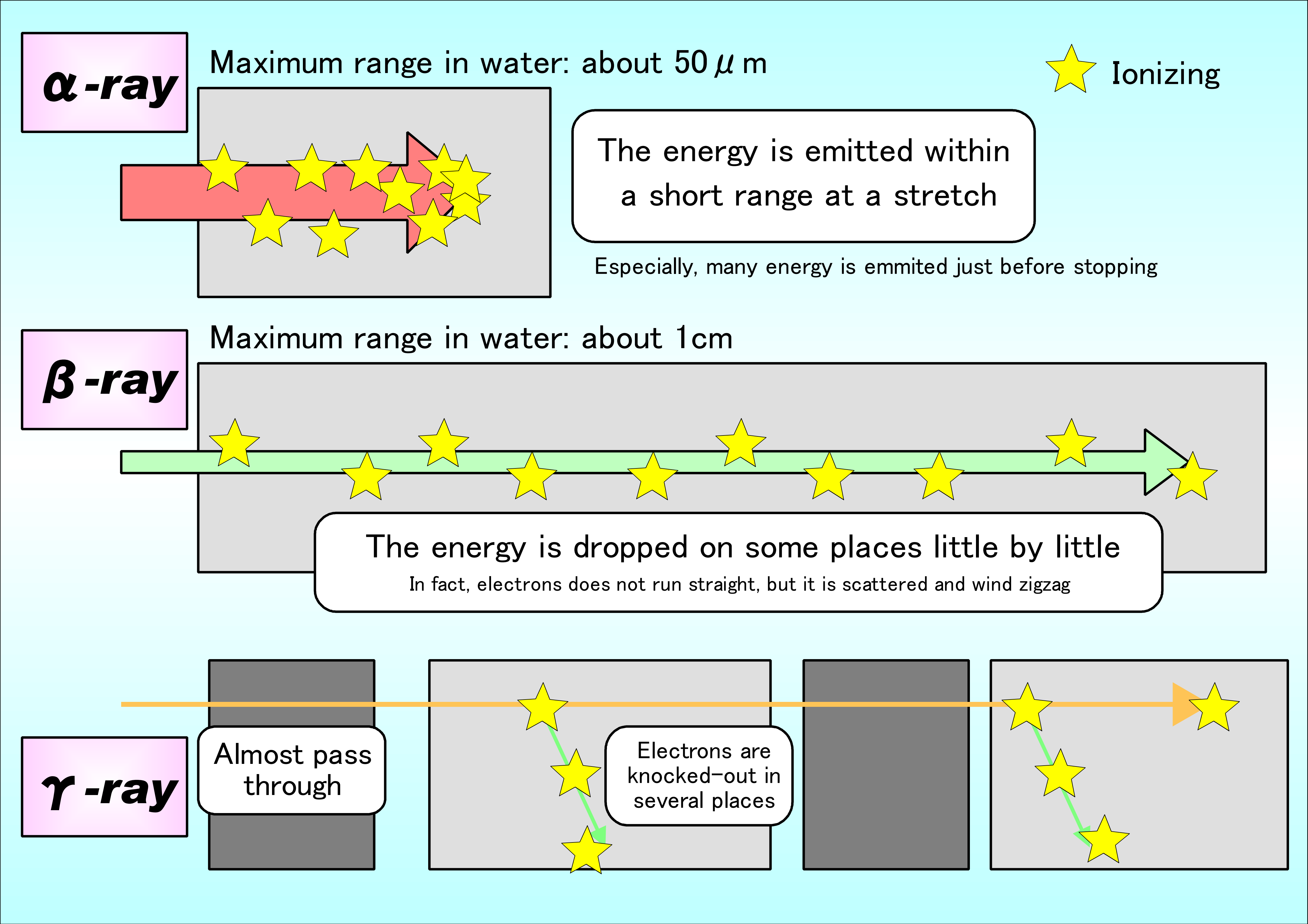
Why we can observe radiation tracks as white stripes?

When a charged particle runs in air, it knock-out many electrons from atoms in air, and many pair of plus-ion and minus-ions are generated (Ionizing). These ions in the supersaturated ethanol vapor, it nucleate tiny liquid drops (Ethanol molecular have polarity and pulled to the ions). Along the ionizing radiation path, a lot of tiny drops nucleated in a row. This is why we can observe radiation tracks as white stripes.





The radiated alpha-particles and electrons are too small to see, and furthermore, the speed of the particles does not catch up with a super-high-speed camera. However, the tracks remain in the air and we can observe it. This is the same as the jet stream in the sky. After an airplane flies, a jet stream can be seen remain for a while. A jet stream is created in the high altitude cold sky where water vapor from the sea come to super saturation, and then the exhaust gas from the engine of the airplane stimulate it to nucleate tiny drop of liquid water, i.e., clouds.

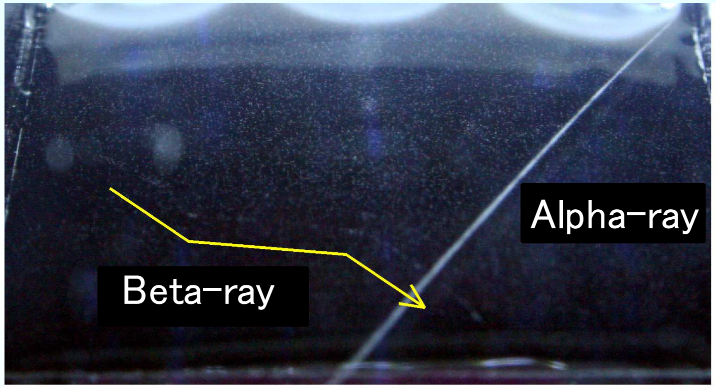

α-ray
Maximum range in water: about 50μm
Ionizing
The energy is emitted within a short range at a stretch
Especially, many energy is emmited just before stopping
β-ray
Maximum range in water: about 1cm
The energy is dropped on some places little by little
In fact, electrons does not run straight, but it is scattered and wind zigzag
γ-ray
Almost pass through
Electrons are knocked-out in several places

Radiation Weighting factor

Effective dose (Sv) = Σ Absorbed dose(Gy) × Radiation Weighting Factor × Organization Weighting Factor

→ α-Ray: 20, β、γ-Ray: 1

Refrects the different interaction behavior



*For Japanese weigh 60kg

Internal Radioactive Nuclide		Effective Dose per one year	
K-40: 4,000Bq	→	170 μSv/year	β・γ-Rays
Po-210: 20Bq	→	800 μSv/year	α-Rays

Radon and it's doughters radiate alpha-rays → 1.26mSv/year averaged in the world
In Japan: Many people live in wooden house → 0.48mSv/year