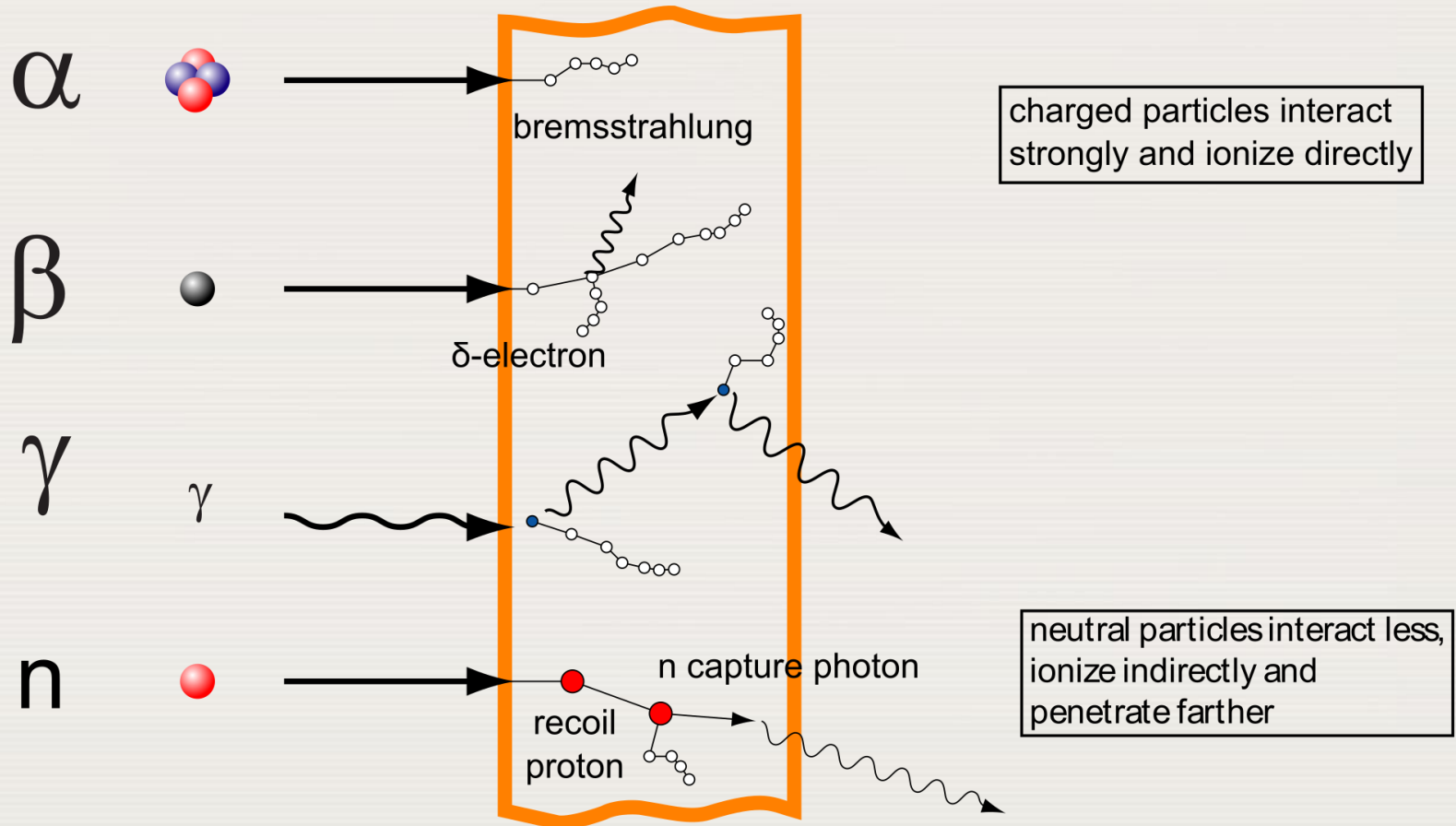


Radiological Safety



Ionizing Radiation

Interaction of ionizing radiation with matter



Effects of Ionizing Radiation

- Deterministic and Stochastic

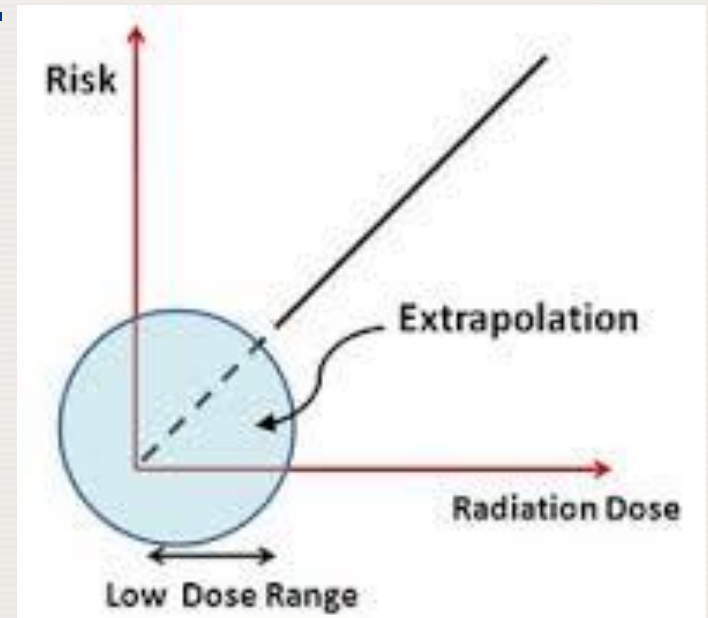
Type of Effect	Description	Threshold	Dose Increase	Example of Effect
Deterministic	High dose rate, short time (for example accident scenario)	Yes (see table)	Increase in Severity (no change in potential)	Skin burn, ARS, death
Stochastic	Low dose rate, long time (for example routine work)	No???	Increase in Potential (no change in severity)	Cancer, Hereditary effects

Deterministic Effects

Dose (whole body irradiation)	Effects
< 0.25 Sv	No clinically recognizable damage
0.25 Sv	Decrease in white blood cells
0.5 Sv	Increasing destruction of the leukocyte-forming organs (causing decreasing resistance to infection)
1 Sv	Marked changes in the blood picture (decrease in the leukocytes and neutrophils)
2 Sv	Nausea and other symptoms
5 Sv	Damage to the gastrointestinal tract causing bleeding and $\approx 50\%$ death
10 Sv	Destruction of the neurological system and $\approx 100\%$ death within 24 h

Stochastic Effects

- 4% – 5% increase per Sv for cancer compared with 25% to 30% natural occurrence rate for cancer
- Linear No Threshold or....
- Latest studies indicate that there may be a threshold at ~ 200mSv to 500mSv (lifetime dose)



Realistic Numbers

typical background

0.1 $\mu\text{Sv/h}$ or 1 mSv/y or 80 mSv/life

legal limits for public exposure from artificial sources

1 mSv/y

during our activities we will limit the dose rate

< 0.5 $\mu\text{Sv/h}$ for $\sim 30 \text{ min} \times 2$

total dose from the activity $\sim 0.5 \mu\text{Sv}$

7-hour flight $\sim 0.05 \text{ mSv}$

Radiological Safety

- Radiation is all around us. When working with radiation, as with any other hazard, if treated with respect the risks can be mitigated.
- Two mains hazards when working with radiation, internal and external (more later).



Radiological Safety – Internal Hazard

- Radioactive Contamination is defined as radioactive material where it is not wanted.



Route into the body	Mitigation
Inhalation	Ventilation (including fume hoods & glove-boxes). Respiratory protection.
Ingestion	Restrictions on eating and drinking in certain areas. Personal hygiene.
Absorption through intact skin	Care with certain materials for example tritium.
Via open wounds	Seek RP advice prior to working with any wound. Immediately report any cuts, puncture wounds or abrasions.

Radiological Safety – External Hazard

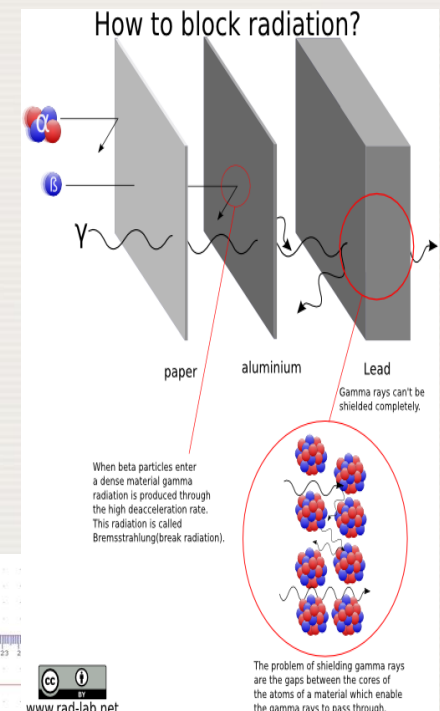
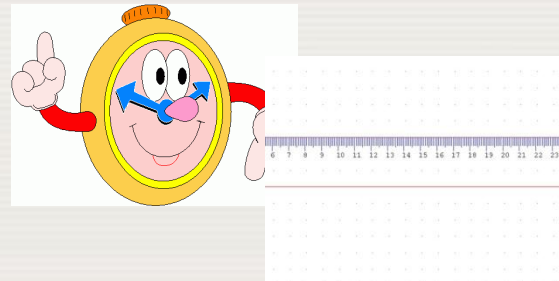
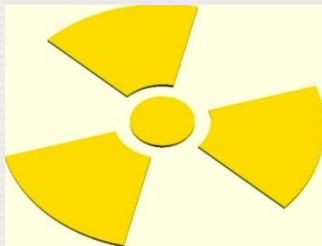
- Material emitting radiation outside the body

Mitigation method

Time – the less time you are exposed to the material, the lower your radiation dose will be.

Distance – the further away you are from the material, the lower your radiation dose will be.

Shielding – if shielding can be used to reduce the intensity of the radiation from the material, the lower your radiation dose will be.



ALARA - As Low As Reasonably Achievable

Minimize Exposure

A. Distance

Doubling the distance between your body and the radiation source will divide the radiation shielding exposure by a factor of 4.

B. Time

Good planning needed to minimize your time of radiation exposure.

C. Shielding

Shielding is necessary to protect against radiation.