Radioactive Contamination

Monitoring Methods

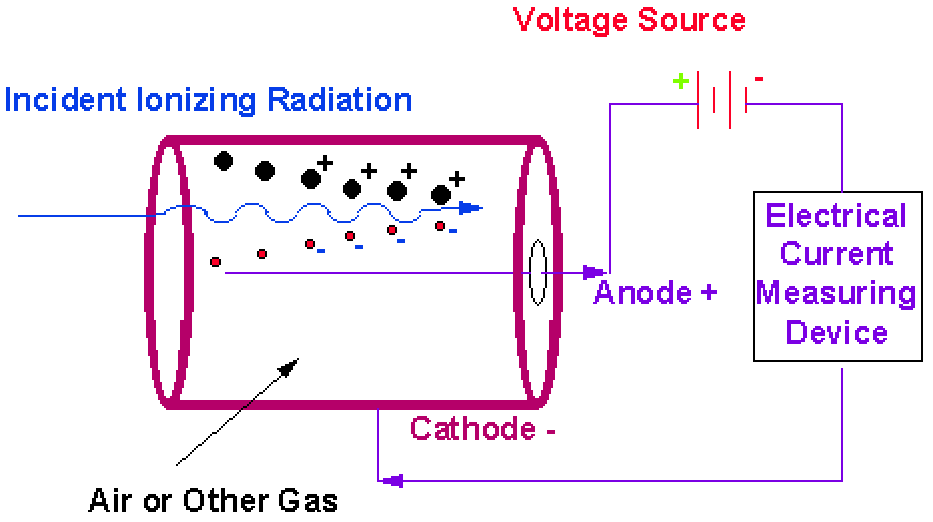
Two Methods

- Hand-held monitor
  - Usually a Mini-Instruments mini-monitor
  - Geiger-Muller and solid scintillation detectors
- Wipe test
  - Liquid scintillation counting

Standard Mini-Monitor

Type E/S Probes

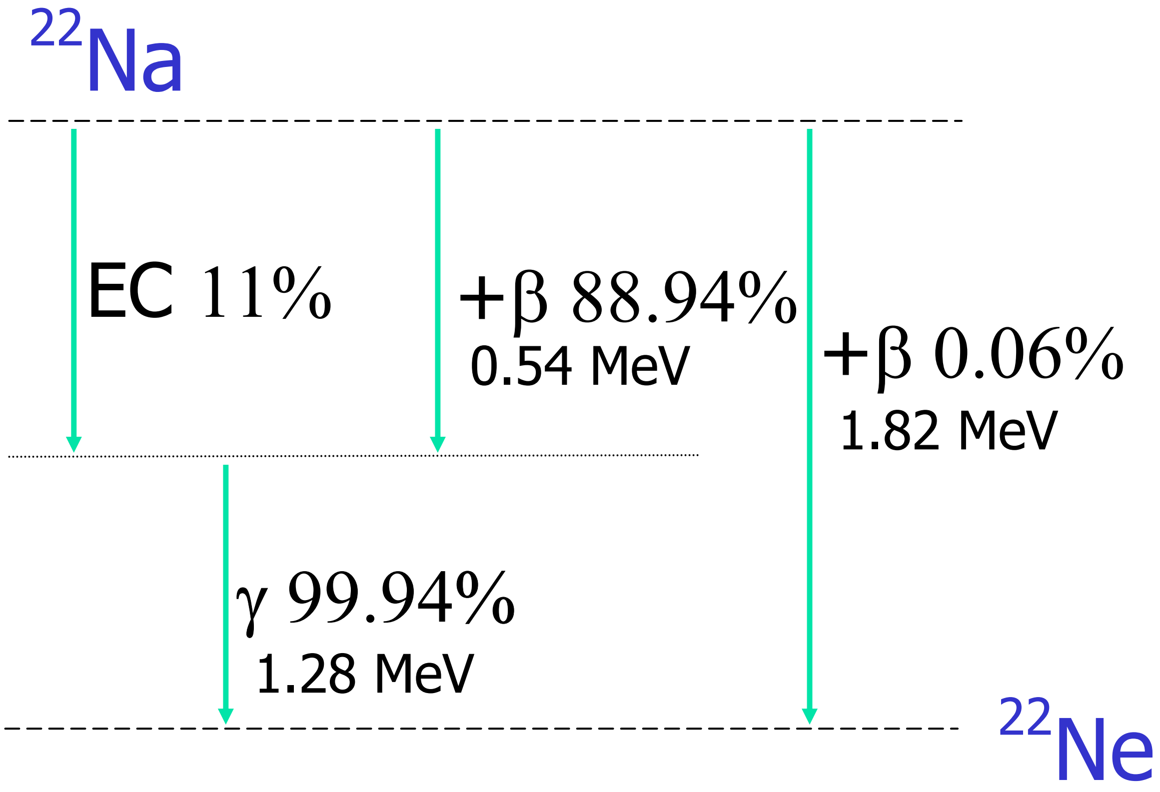
- Primarily used to detect β radiation
- Geiger-Muller (GM) detectors



Type E/S Probes

E	$6cm^2$ end-window. Background = ~0.25cps. Used for hard β, e.g. ^{32}P, ^{36}Cl. Will detect soft β, e.g. ^{14}C, ^{35}S, ^{33}P, ^{45}Ca, but EP15 is preferred. Will not detect **very** weak β, e.g. ^{3}H. Sensitive to γ, X and α.
EP15	Twice as sensitive as type E. $15cm^2$ end-window. Background = ~0.5cps Used for hard β, e.g. ^{32}P, ^{36}Cl. Especially good for soft β, e.g. ^{14}C, ^{35}S, ^{33}P, ^{45}Ca, except ^{3}H. Also sensitive to γ and X. OK for α > 3Mev.
S/SL	Open grille on one side. Background = ~1cps. Used for hard β, e.g. ^{32}P, ^{36}Cl. Not suitable for soft β, e.g ^{3}H, ^{14}C, ^{35}S, ^{33}P, ^{45}Ca. Suitable for β/γ emitters such as ^{22}Na.

^{22}Na Decay Scheme

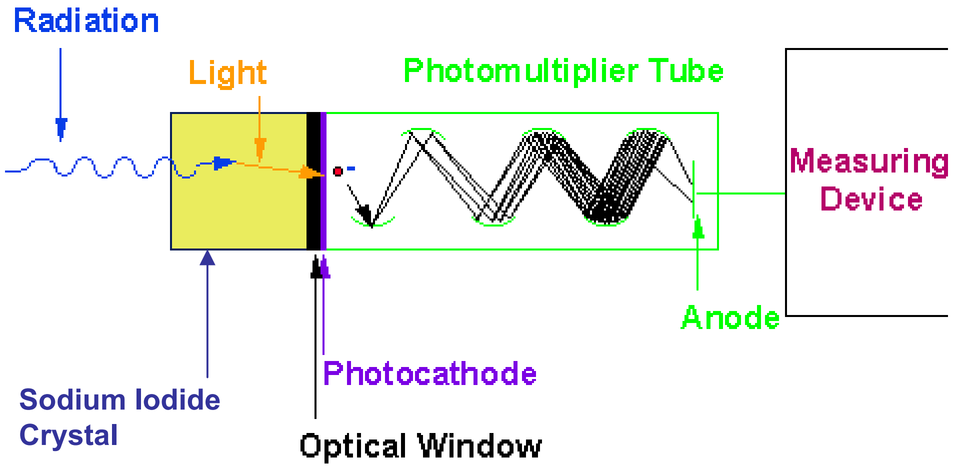


β Energies

	Isotope	β E_{max}	
	3H	0.019	Not detectable by mini-monitor
Soft β	14C	0.156	EP15
	35S	0.167	
	33P	0.249	
	45Ca	0.257	
Hard β	36Cl	0.710	E or S/SL
	32P	1.711	

Type 42/44 Probes

- Used to detect γ and x-ray radiation
- All NaI solid scintillation detectors



Type 42/44 Probes

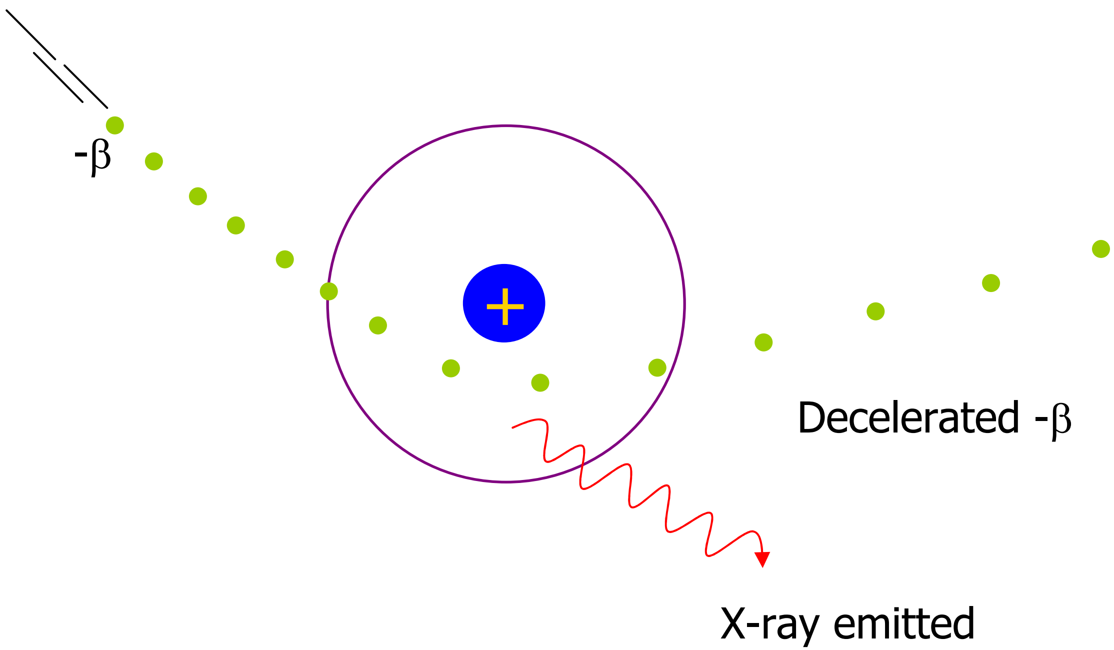
42A	0.05mm thick aluminium end window. 23mm diam, 1mm thick crystal. Background = 1.5 to 3 cps. Used for low intensity γ/x, 10 to 150 KeV.
42B	0.25mm thick beryllium end window. Much better detection efficiency at energies < 10 KeV. Used for low intensity γ/x, 5 to 150 KeV.
44A	0.05mm thick aluminium end window. 32mm diam, 2.5mm thick crystal. Background higher than Type 42 but much better efficiency above 40KeV. Used for wider range of γ/x, 10 to 500+ KeV.
44B	0.25mm thick beryllium end window. Much better detection efficiency at energies < 10 KeV. Used for wider range of γ/x, 5 to 500+ KeV.

Detector Efficiency

- % Efficiency = cps/dps * 100
- Determined by
  - Geometry
  - Absorption in air and end window
  - Intrinsic efficiency of the detector

Bremsstrahlung

Braking radiation



Using a Mini-Monitor

- Check
  - Next test date
  - Probe type
  - Battery strength
- Remove end-window cap
- Check
  - Speaker is on
  - Background reading
  - Response to check source

Monitoring Protocol

- Note date and type of monitor/probe used
- Note background cps
- Monitor slowly and methodically
- Hold the probe ~1cm above the surface
  - Take care not to contaminate the end of the probe!
- Record
  - cps if > background
  - zero if cps = background

Dealing with Contamination

- Establish the extent & demarcate area
- Attempt to decontaminate
- Continue until all loose contamination has been removed
- Re-monitor area
- If bound contamination remains and presents a significant external radiation hazard, shield it

Wipe Testing

- More laborious than mini-monitoring
- Essential for tritium
- Employs liquid scintillation counting
- Low efficiency
  - Usually only 10% of loose contamination in picked up
  - Subject to quenching
- Qualitative rather quantitative

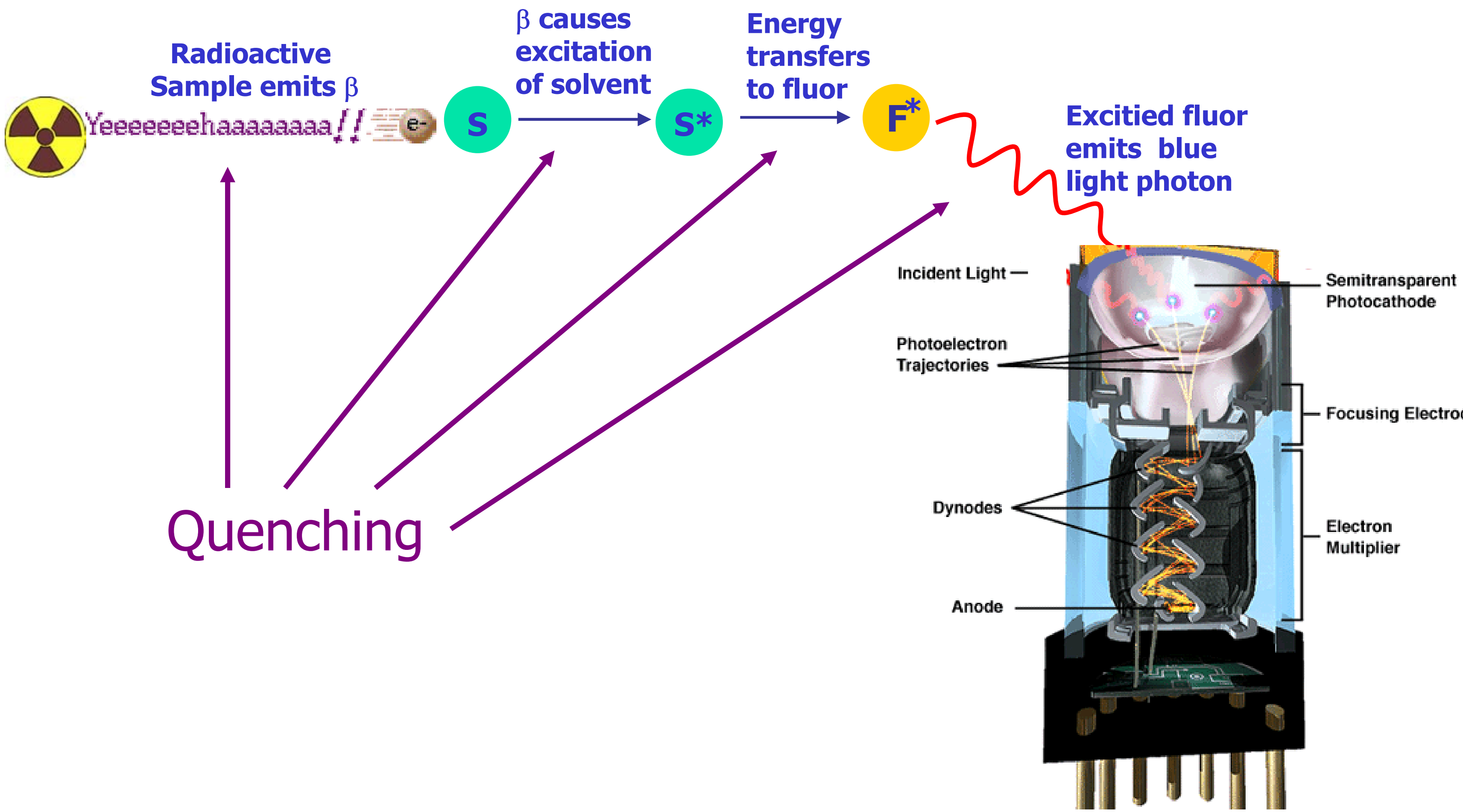
Possible Protocol

- Label counting vials (on cap not side)
- Use EtOH soaked filter disc, held in forceps
- Swab 10 x 10cm area (if possible)
- Work from the perimeter inwards
- Transfer disc to counting vial
- Take background wipe from an area never used for radioactive work, e.g. office bench
- Add 10ml of scintillation cocktail to each vial
- Shake well
- Count for 5 min on scintillation counter
  - Parameters will depend upon type of counter
- Any result 2x background is positive
  - Decontaminate and re-test until no loose contamination is detected

Alternative Methods

- Use a cotton-bud for very small areas
  - Break off into a microfuge tube
  - Add 150μl of scint fluid
- Use 2.5 diameter filter disc
  - Insert vertically into minivial
  - Add 0.5ml of scint fluid
  - Tilt carefully to completely wet filter
  - Insert into counter so disc faces detector

Liquid Scintillation Counting



Quenching

- Photon – β is absorbed
- Chemical – blocks slovent/fluor transfer
- Optical
  - Inside vial - colour quenching
  - Residue on outside of vial

- Other phenomena that interfere with LSC
  - Chemiluminescence
  - Static electricity