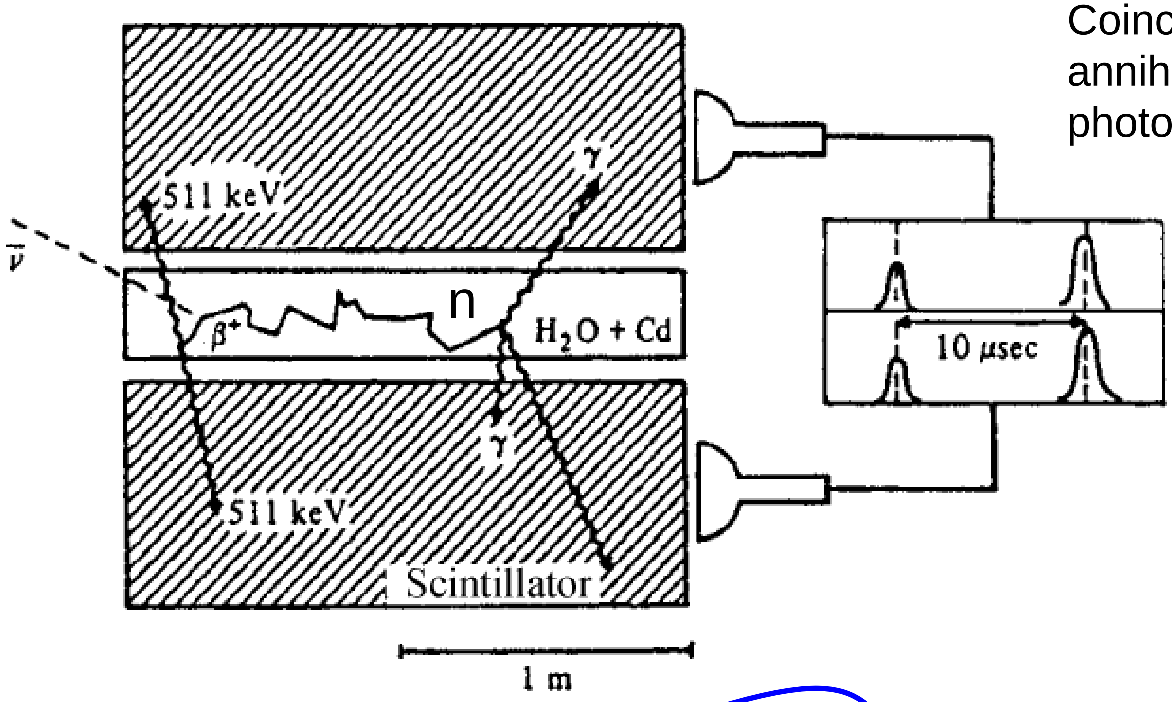
Neutrino Discovery

Cowan & Reines, 1956 (Nobel prize 1995)



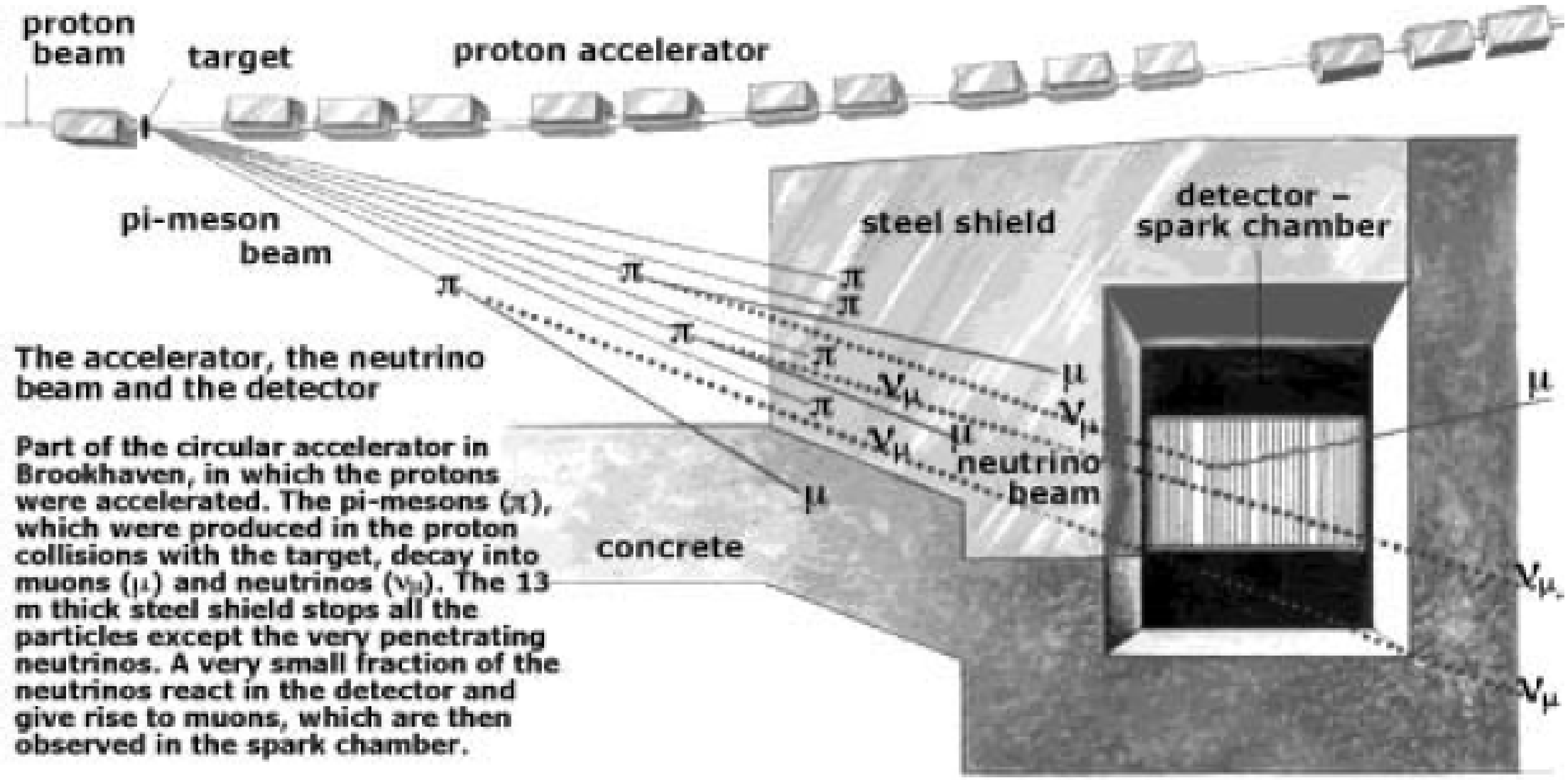
Coincidence between annihilation photons and photons from n capture

$$\bar{\nu}_e + p \rightarrow e^+ + n$$

$$^{113}\mathrm{Cd}(n,\gamma)^{114}\mathrm{Cd}$$

Project Poltergeist & Herr Auge

Electron and Muon Neutrino



The accelerator, the neutrino beam and the detector

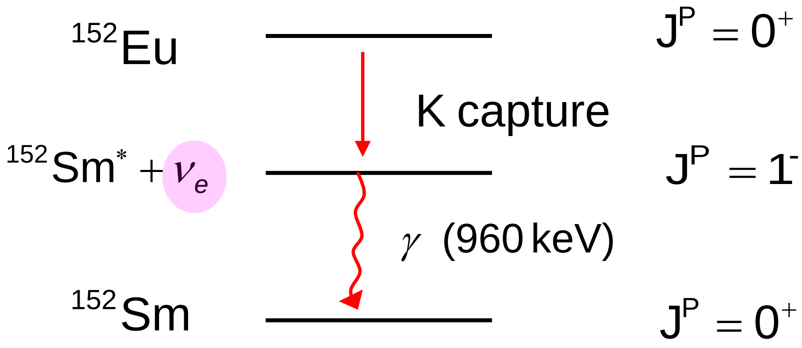
Part of the circular accelerator in Brookhaven, in which the protons were accelerated. The pi-mesons (π), which were produced in the proton collisions with the target, decay into muons (μ) and neutrinos (ν_μ). The 13 m thick steel shield stops all the particles except the very penetrating neutrinos. A very small fraction of the neutrinos react in the detector and give rise to muons, which are then observed in the spark chamber.

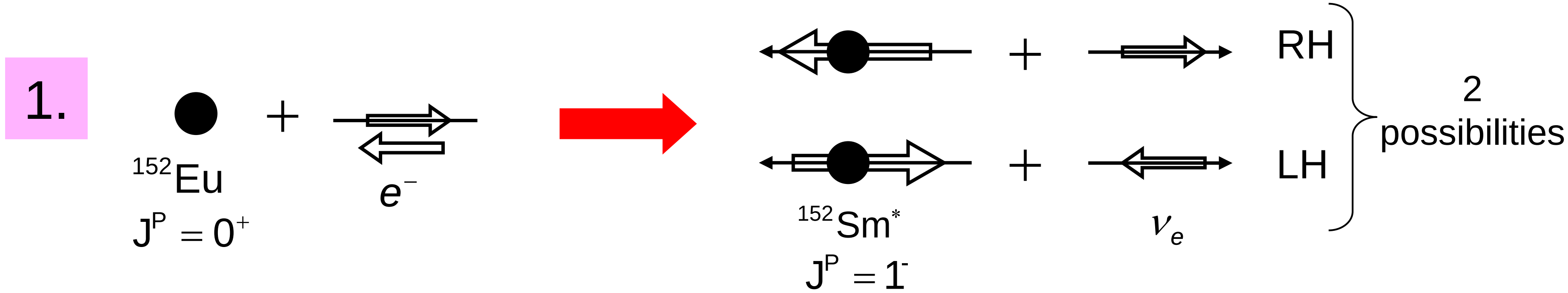
Neutrino Helicity

M.Goldhaber (1957)

$$^{152}Eu + e^- \rightarrow \ ^{152}Sm^* + \nu_e$$

$$E_\nu \approx 950\,KeV$$

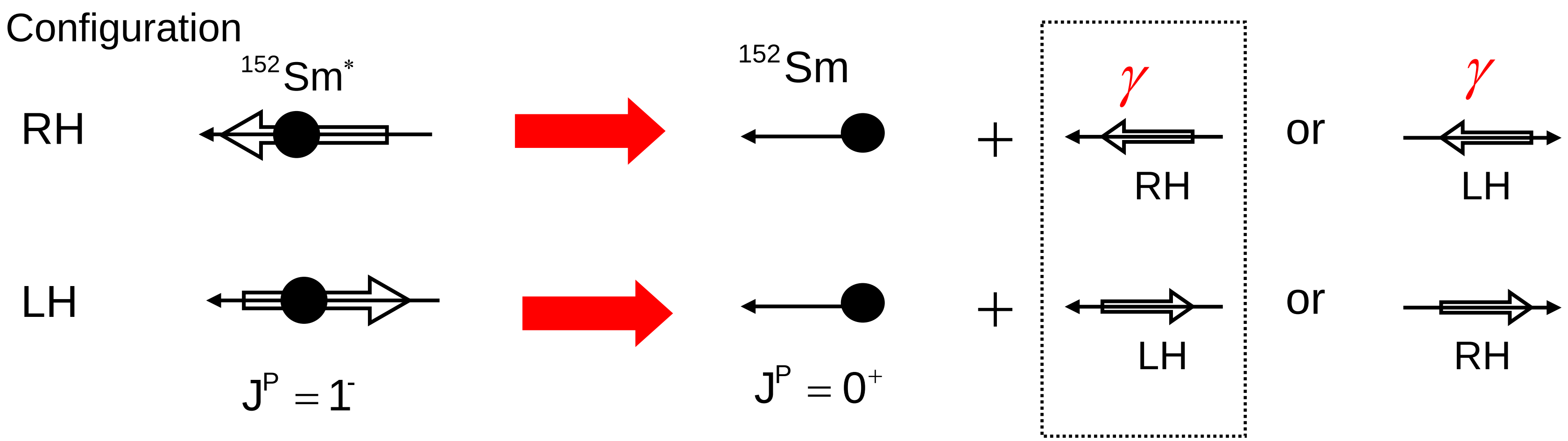




Sm undergoes is small **recoil (p_{recoil} =950 KeV)**. Because of angular momentum conservation Spin J=1 of Sm* is opposite to neutrino spin. Important: **neutrino helicity is transferred to the Sm nucleous.**

Neutrino Helicity

2. γ emission: $^{152}\mathrm{Sm}^*(J^P = 1^-) \rightarrow {}^{152}\mathrm{Sm}(J^P = 0^+) + \gamma$



Photons along the Sm recoil direction carry the polarization of the Sm* nucleus

- How to select photons along the recoil direction ? $\Rightarrow$ 3
- How to determine the polarization of these photons ? $\Rightarrow$ 4

Neutrino Helicity

3. Resonant photon scattering: $\gamma + {}^{152}\text{Sm} \rightarrow {}^{152}\text{Sm}^* \rightarrow {}^{152}\text{Sm} + \gamma$

4.

Determination of the photon polarization

Exploit that the transmission index through magnetized iron is polarization dependent:
<u>Compton scattering in magnetized iron</u>

$$P_\gamma = -0.66 \pm 0.14$$ (expect. 0.75)