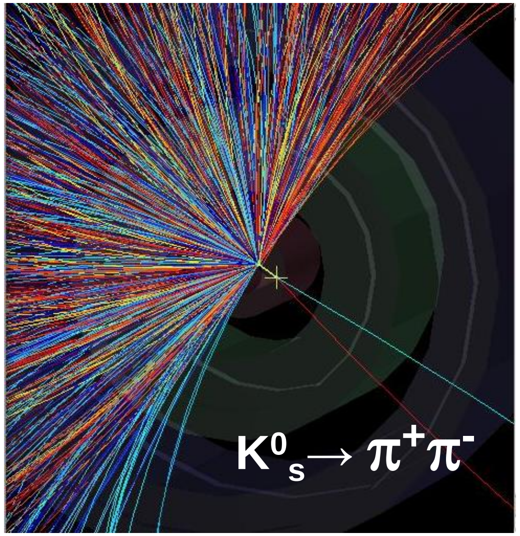
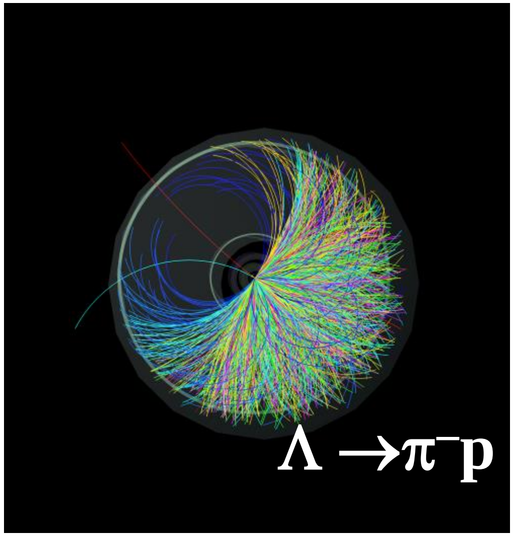
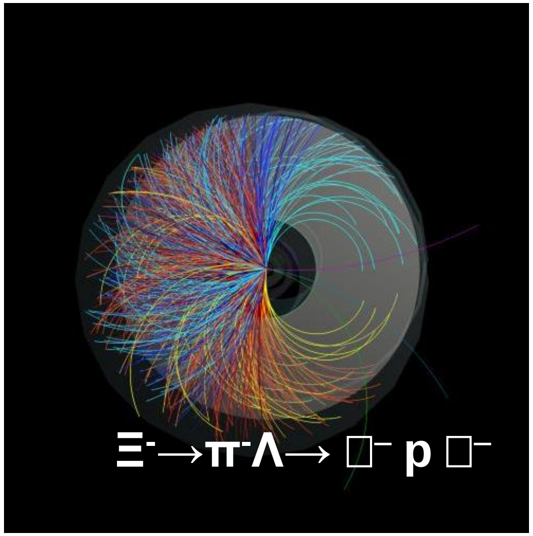
# Looking for strange particles in ALICE

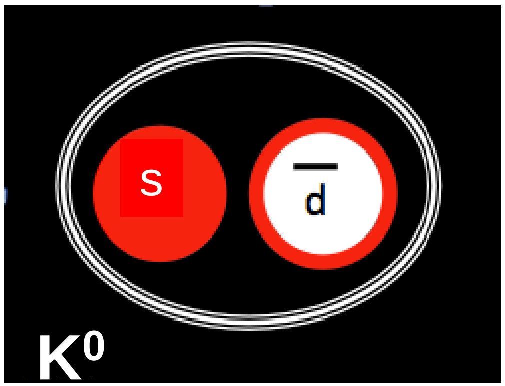


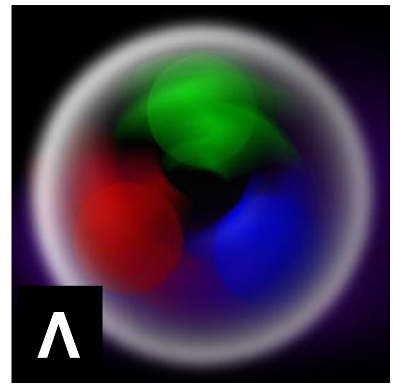
# What are strange particles ?

meson




$d\bar{s}$, $\bar{d}s$

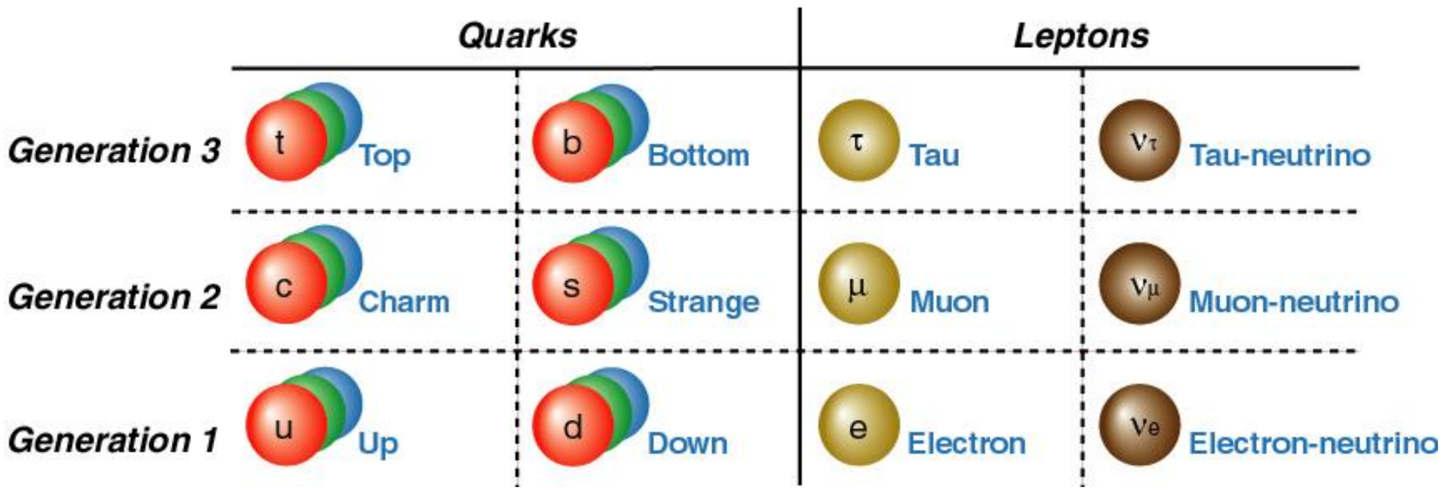
baryon




uds

hadrons (baryons or mesons) containing at least one strange (s) quark

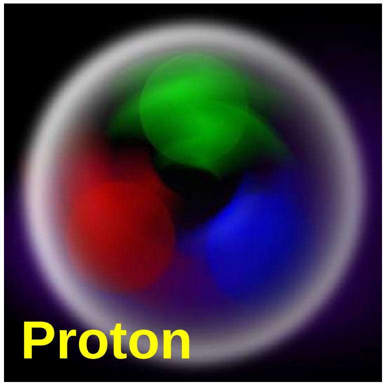
# Today's periodic system of the fundamental building blocks



# Quark Confinement

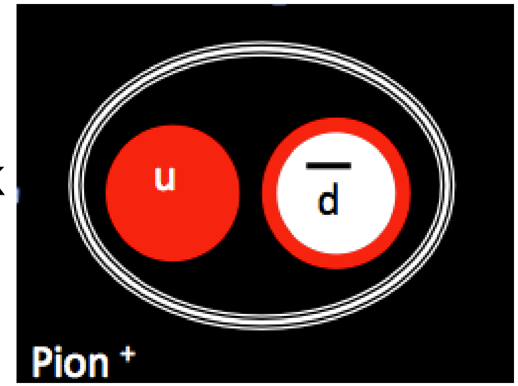
## Quarks can not exist free in nature

## They can only exist bound inside hadrons




baryons consisting of 3 quarks

mesons consisting of a quark and an anti-quark




**Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$**

**Baryons are fermionic hadrons.**

**These are a few of the many types of baryons.**

| Symbol | Name | Quark content | Electric charge | Mass GeV/$c^2$ | Spin |
|---|---|---|---|---|---|
| **p** | proton | **uud** | 1 | 0.938 | 1/2 |
| $\bar{\mathbf{p}}$ | antiproton | $\bar{\mathbf{u}}\bar{\mathbf{u}}\bar{\mathbf{d}}$ | –1 | 0.938 | 1/2 |
| **n** | neutron | **udd** | 0 | 0.940 | 1/2 |
| **Λ** | lambda | **uds** | 0 | 1.116 | 1/2 |
| $\Omega^-$ | omega | **sss** | –1 | 1.672 | 3/2 |

**Mesons $q\bar{q}$**

**Mesons are bosonic hadrons**

**These are a few of the many types of mesons.**

| Symbol | Name | Quark content | Electric charge | Mass GeV/$c^2$ | Spin |
|---|---|---|---|---|---|
| $\pi^+$ | pion | $\mathbf{u}\bar{\mathbf{d}}$ | +1 | 0.140 | 0 |
| $\mathbf{K}^-$ | kaon | $\mathbf{s}\bar{\mathbf{u}}$ | –1 | 0.494 | 0 |
| $\rho^+$ | rho | $\mathbf{u}\bar{\mathbf{d}}$ | +1 | 0.776 | 1 |
| $B^0$ | B-zero | $\mathbf{d}\bar{\mathbf{b}}$ | 0 | 5.279 | 0 |
| $\eta_c$ | eta-c | $\mathbf{c}\bar{\mathbf{c}}$ | 0 | 2.980 | 0 |

We will be looking for neutral strange particles, which travel some distance (mm or cm) from the point of production (collision point) before they decay into two oppositely charged particles

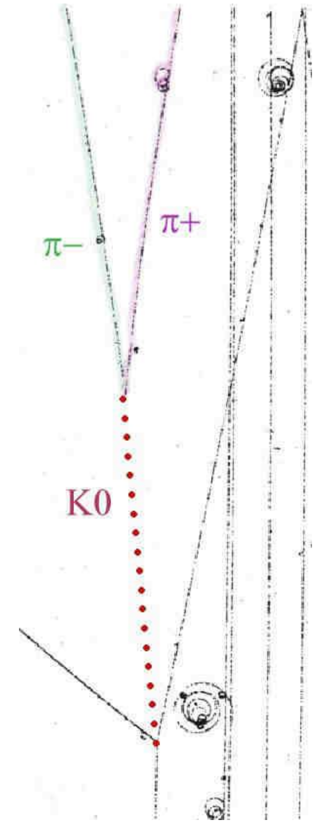
$K^0_s \rightarrow \pi^+\pi^-$

τ = 0.89 x10$^{-10}$ s
cτ = 3x10$^{10}$ cm s$^{-1}$ x8.9x10$^{-11}$ s
2.67 cm from the point of interaction

$\Lambda \rightarrow \pi^- p$

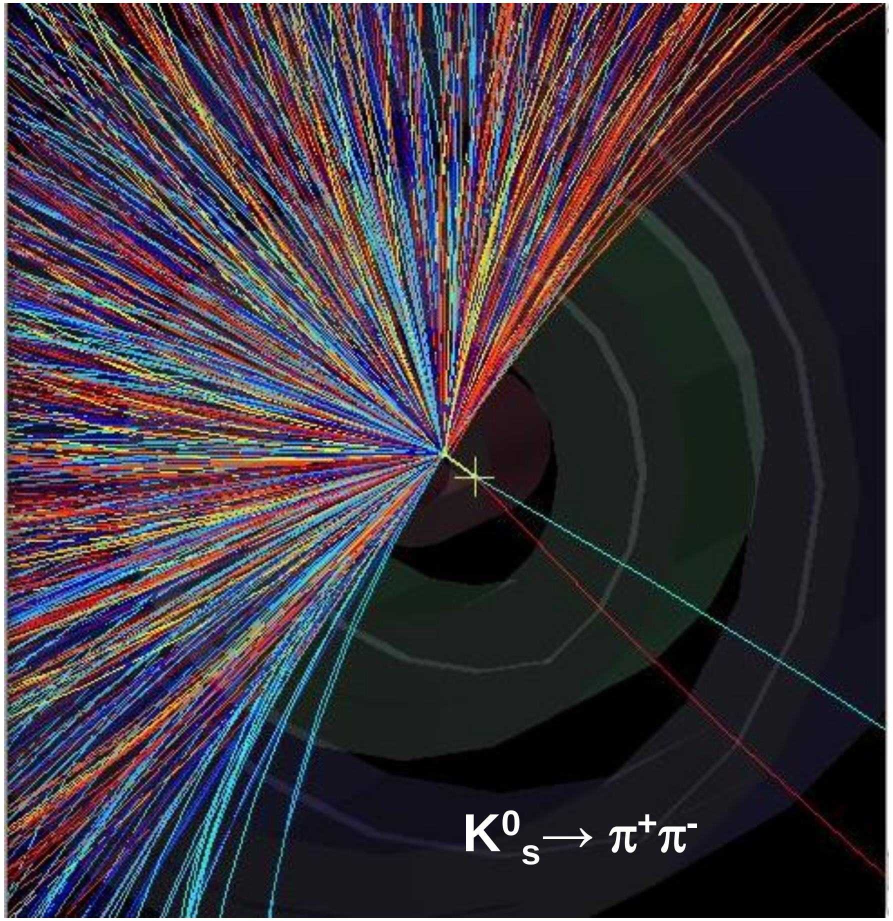
$\bar{\Lambda} \rightarrow \pi^+ \bar{p}$

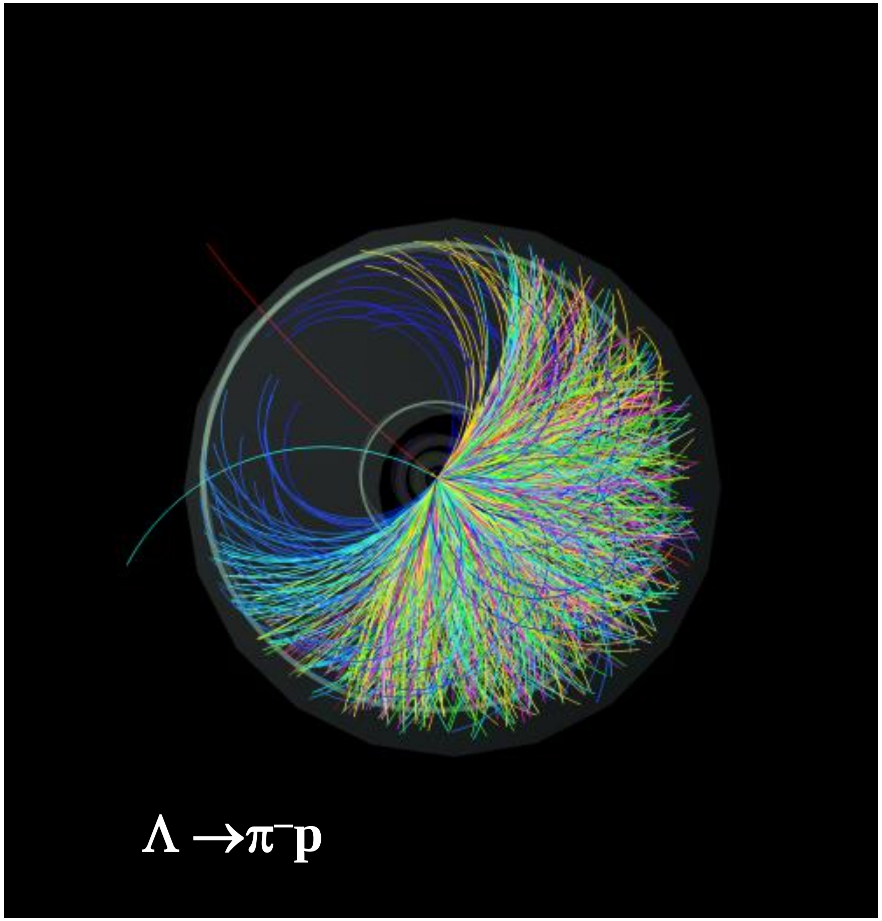
τ = 2.6 x10$^{-10}$ s
cτ = 3x10$^{10}$ cm s$^{-1}$ x2.6x10$^{-10}$ s
7.2 cm distance from the point of interaction




Weak decays : strangeness is not conserved

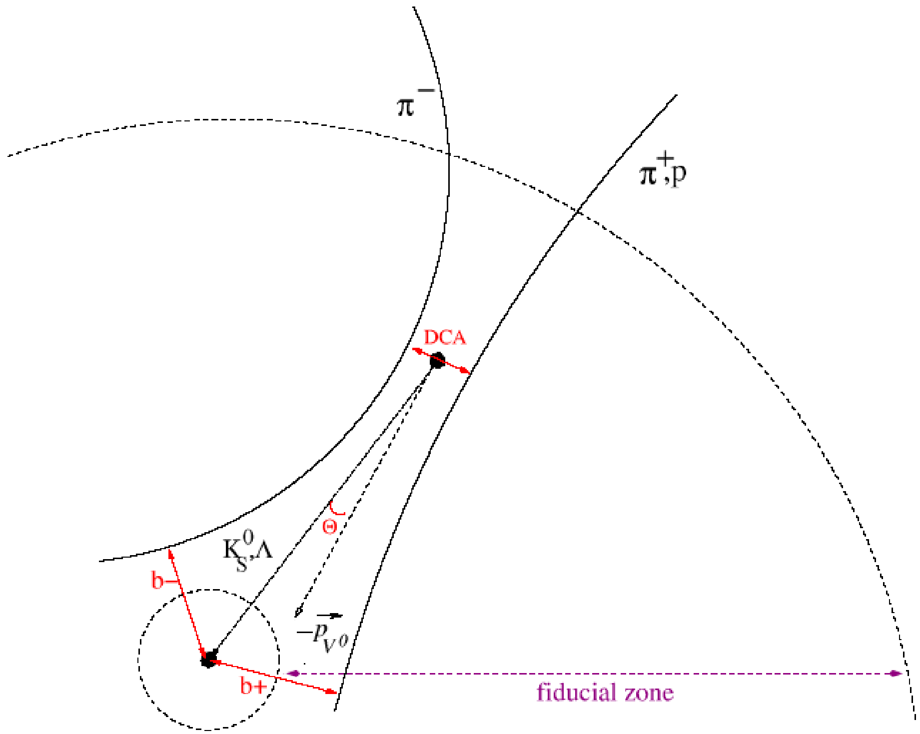
# How do we find V0s ?



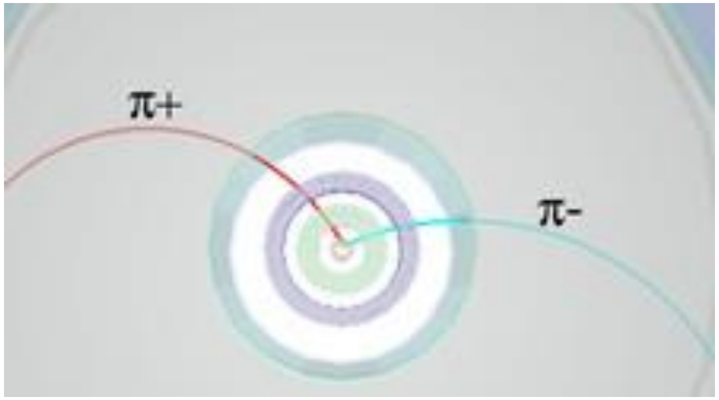

We look for two opposite tracks, having the same origin, which is not the interaction (collision) point

# How do we find V0s ?

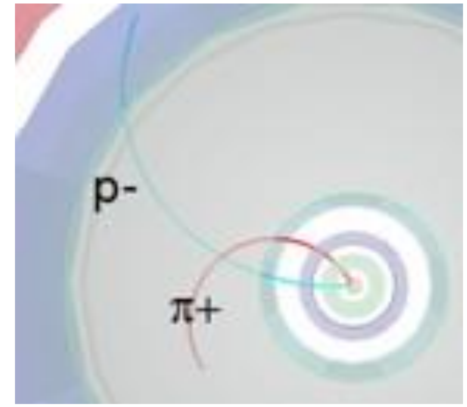



We look for two opposite tracks, having the same origin, which is not the interaction (collision) point

# How do we identify each V0?





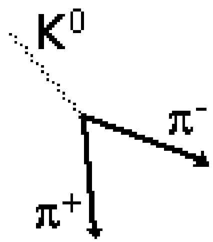



$K^0_s \rightarrow \pi^+\pi^-$

$\Lambda \rightarrow \pi^- p^+$

anti $\Lambda \rightarrow p^{-}$□$^{+}$

$K^0 \rightarrow \pi^+ + \pi^-$



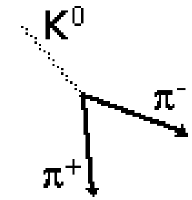

V0 decay :
a neutral particle (no track) gives suddenly two tracks

**Identify V0s from the decay topology**

$P = Q \cdot B \cdot R$
P momentum
Q electric charge
B magnetic field
R radius of curvature

# How do we identify each V0?

$K^0 \rightarrow \pi^+ + \pi^-$




**Calculate the (invariant) mass**

Energy conservation $E = E_1+E_2$

Momentum conservation $\mathbf{p} = \mathbf{p}_1+\mathbf{p}_2$

Total energy $E^2 = p^2c^2 + m^2c^4$

c=1 $E^2 = p^2 + m^2$

$E = E_1+E_2$ $E_1^2 = p_1^2 + m_1^2$ $E_2^2 = p_2^2 + m_2^2$

$E^2 = p^2 + m^2$ $m^2 = E^2 - p^2 =(E_1+E_2)^2 -(p_1+p_2)^2 = m_1^2 + m_2^2 +2E_1E_2 - 2\,\mathbf{p}_1 . \mathbf{p}_2$

**Calculate the mass of the initial particle from the values of the mass and the momentum of the final particles**

Particle Identification (done by a number of PID detectors) ⇒ $m_1$ $m_2$

Radius of curvature of the particle tracks due to magnetic field ⇒ $p_1$ $p_2$

P=Q·B·R (P momentum, Q electric charge, R radius of curvature, B magnetic field)