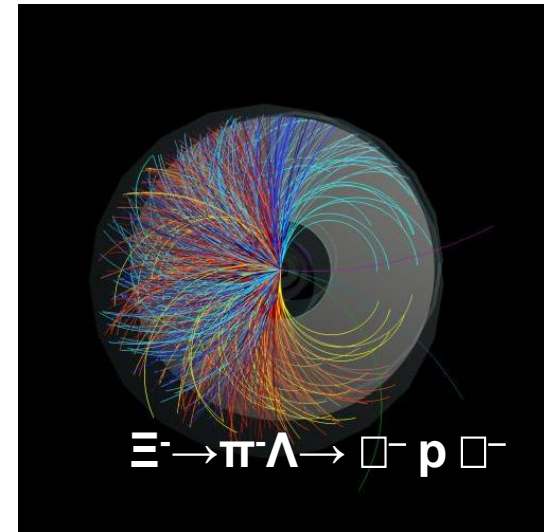
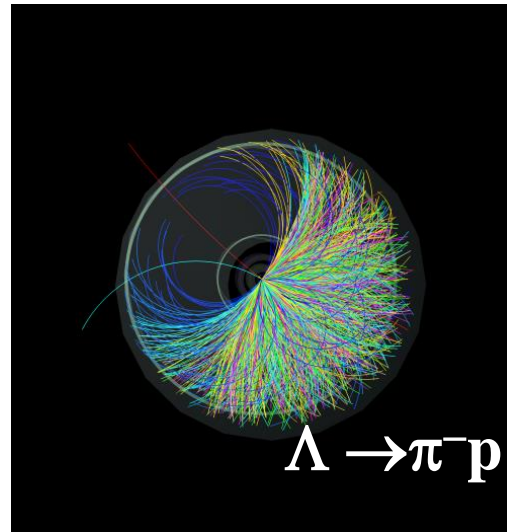
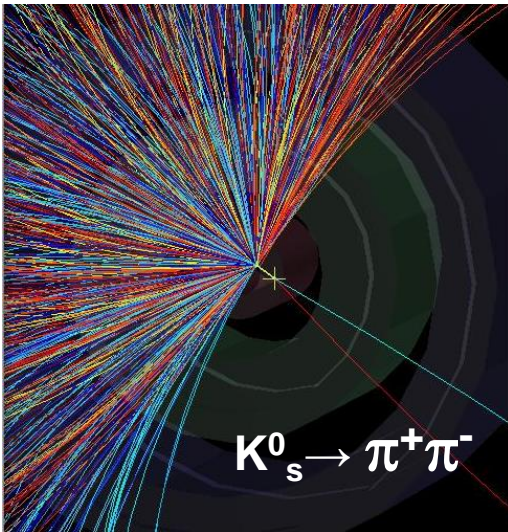
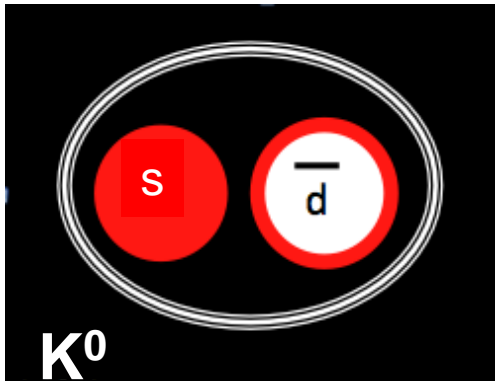


# Looking for strange particles in ALICE



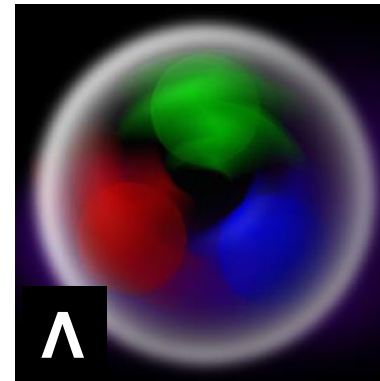
# What are strange particles ?

meson



$\bar{d}s, ds$













baryon



uds

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

## Today's periodic system of the fundamental building blocks

	<i>Quarks</i>		<i>Leptons</i>	
<i>Generation 3</i>	 <b>t</b> Top	 <b>b</b> Bottom	 <b>τ</b> Tau	 <b>ν<sub>τ</sub></b> Tau-neutrino
<i>Generation 2</i>	 <b>c</b> Charm	 <b>s</b> Strange	 <b>μ</b> Muon	 <b>ν<sub>μ</sub></b> Muon-neutrino
<i>Generation 1</i>	 <b>u</b> Up	 <b>d</b> Down	 <b>e</b> Electron	 <b>ν<sub>e</sub></b> Electron-neutrino

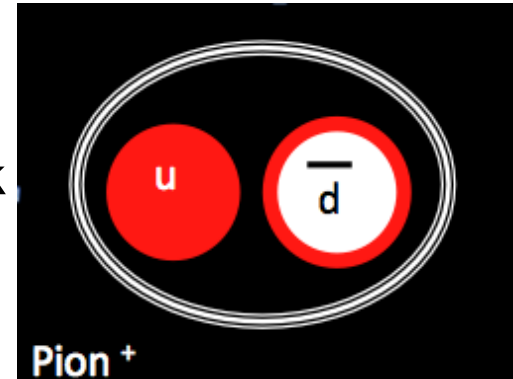
# Quark Confinement

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 $\text{GeV}/c^2$	Spin
<b>p</b>	proton	<b>uud</b>	1	0.938	1/2
<b><math>\bar{p}</math></b>	antiproton	<b><math>\bar{u}\bar{u}\bar{d}</math></b>	-1	0.938	1/2
<b>n</b>	neutron	<b>udd</b>	0	0.940	1/2
<b><math>\Lambda</math></b>	lambda	<b>uds</b>	0	1.116	1/2
<b><math>\Omega^-</math></b>	omega	<b>sss</b>	-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 $\text{GeV}/c^2$	Spin
<b><math>\pi^+</math></b>	pion	<b><math>u\bar{d}</math></b>	+1	0.140	0
<b><math>K^-</math></b>	kaon	<b><math>s\bar{u}</math></b>	-1	0.494	0
<b><math>\rho^+</math></b>	rho	<b><math>u\bar{d}</math></b>	+1	0.776	1
<b><math>B^0</math></b>	B-zero	<b><math>d\bar{b}</math></b>	0	5.279	0
<b><math>\eta_c</math></b>	eta-c	<b><math>c\bar{c}</math></b>	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**

$$K_s^0 \rightarrow \pi^+ \pi^- \quad \tau = 0.89 \times 10^{-10} \text{ s}$$

$$c\tau = 3 \times 10^{10} \text{ cm s}^{-1} \times 8.9 \times 10^{-11} \text{ s}$$

2.67 cm from the point of interaction

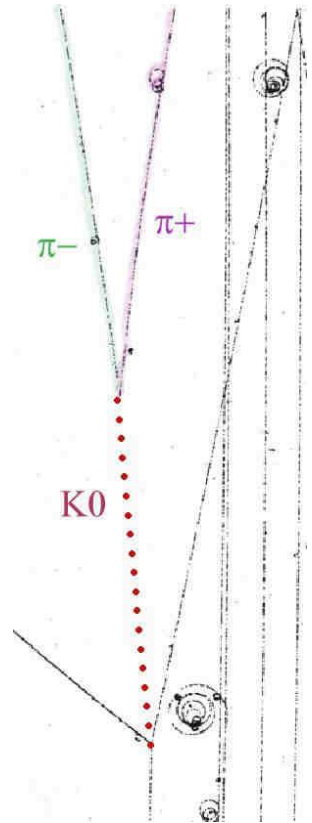
$$\Lambda \rightarrow \pi^- p \quad \tau = 2.6 \times 10^{-10} \text{ s}$$

$$c\tau = 3 \times 10^{10} \text{ cm s}^{-1} \times 2.6 \times 10^{-10} \text{ s}$$

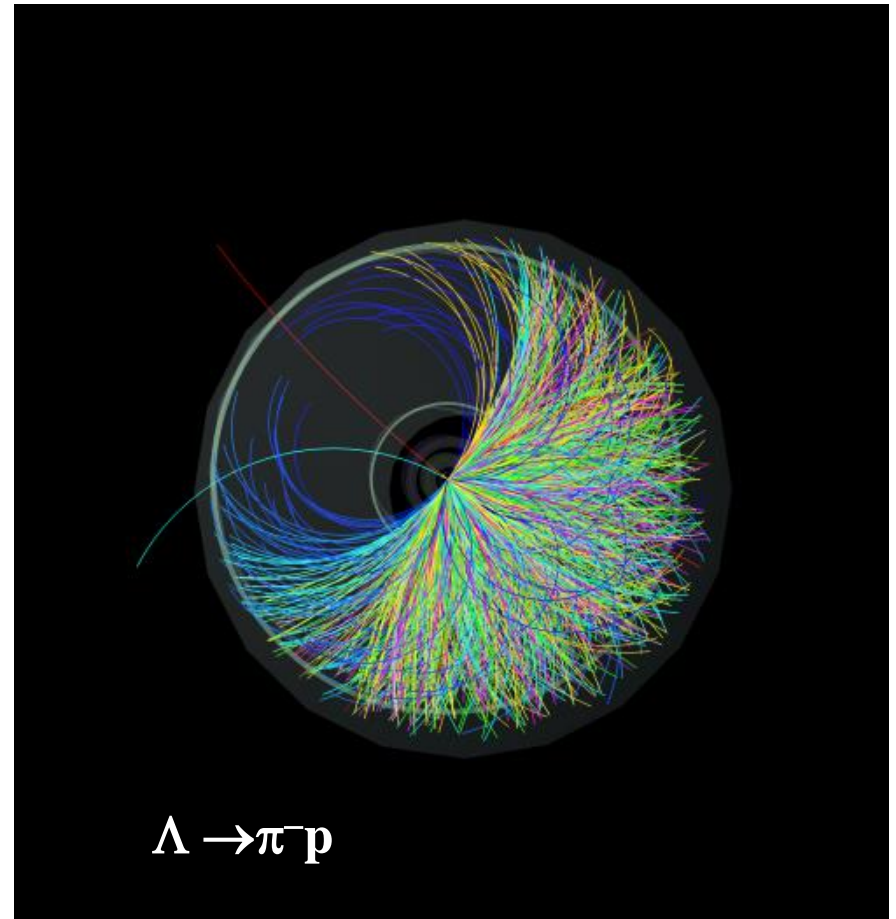
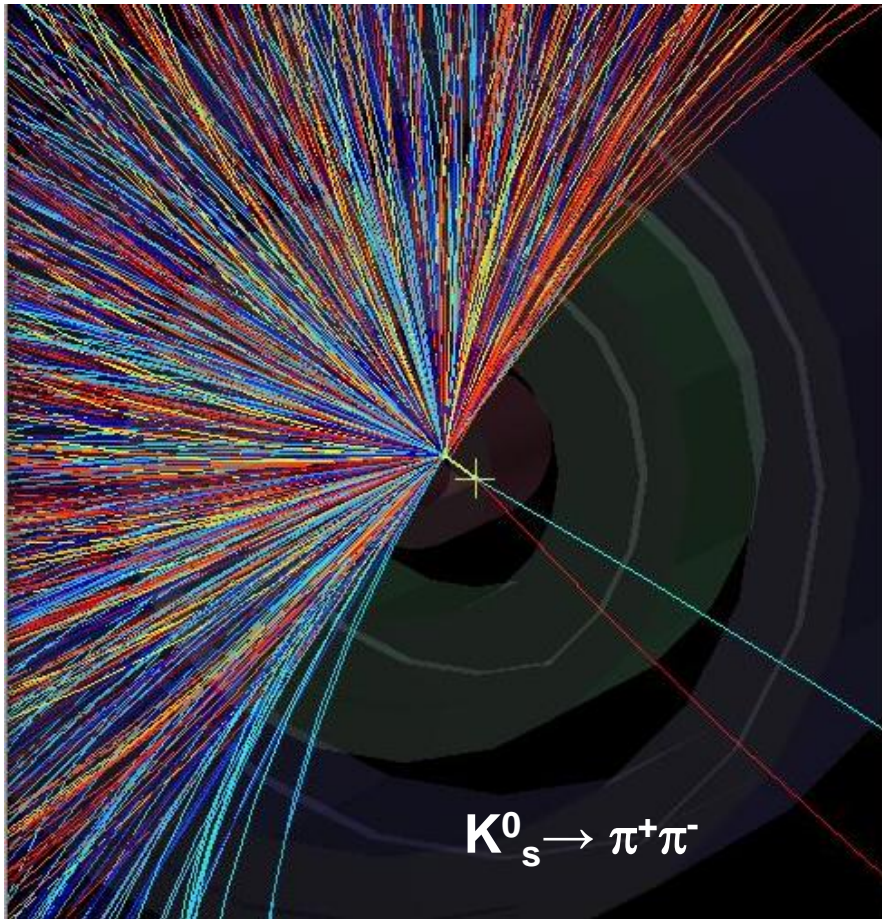
7.2 cm distance from the point of interaction

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

Weak decays : strangeness is not conserved

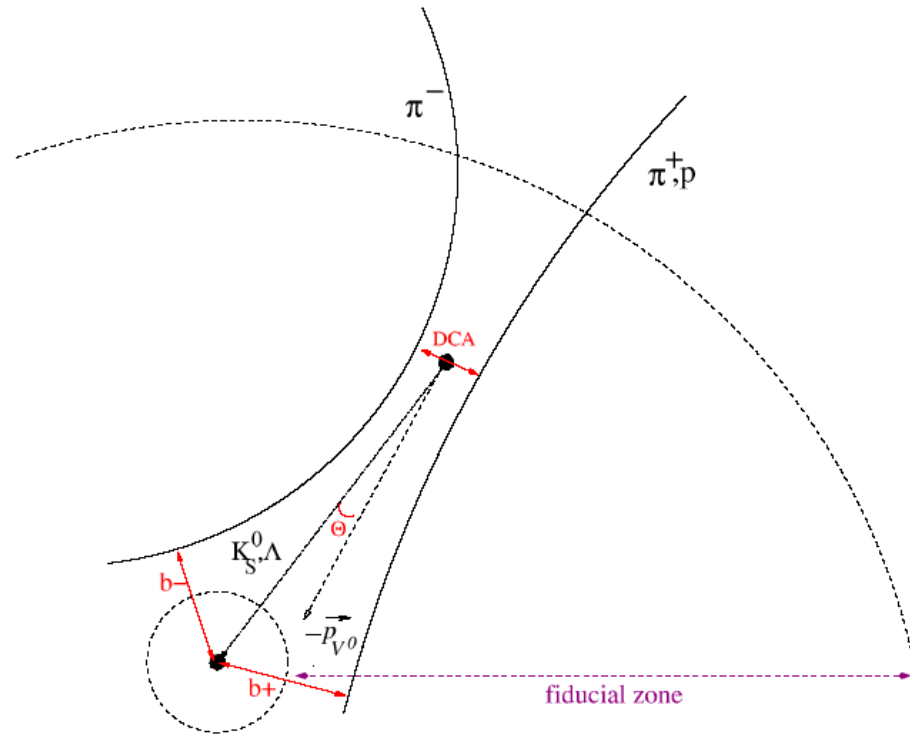


## How do we find V0s ?



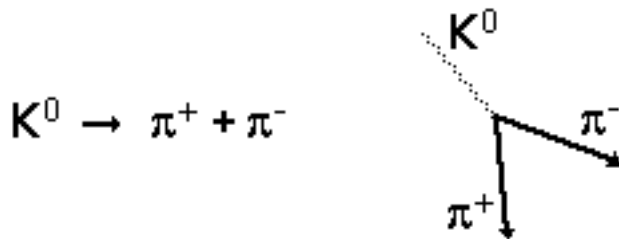
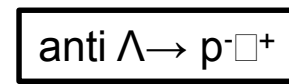
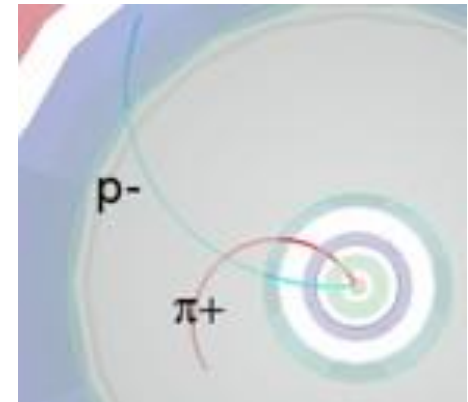
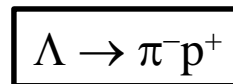
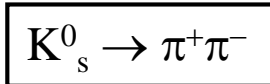
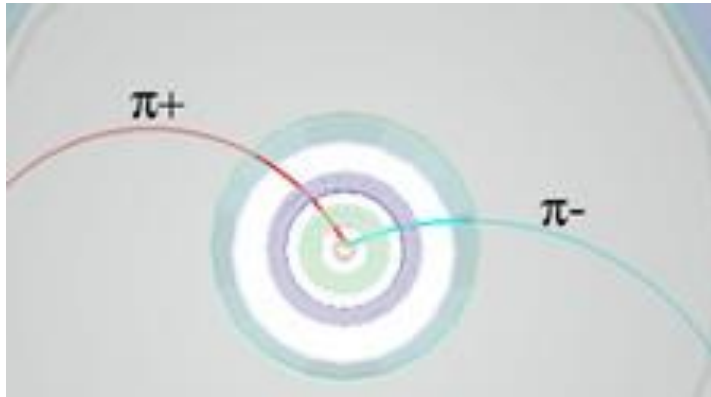
We look for two opposite tracks, having the same origin, which is not the interaction (collision) point

# 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?



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

$$P = Q \cdot B \cdot R$$

P momentum

Q electric charge

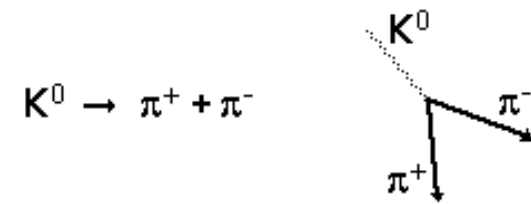
B magnetic field

R radius of curvature

**Identify V0s from the decay topology**



# How do we identify each V0?



## Calculate the (invariant) mass

Energy conservation

$$E = E_1 + E_2$$

Momentum conservation

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

Total energy

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

$c=1$

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

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

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

## 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)  $\Rightarrow m_1 m_2$

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

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