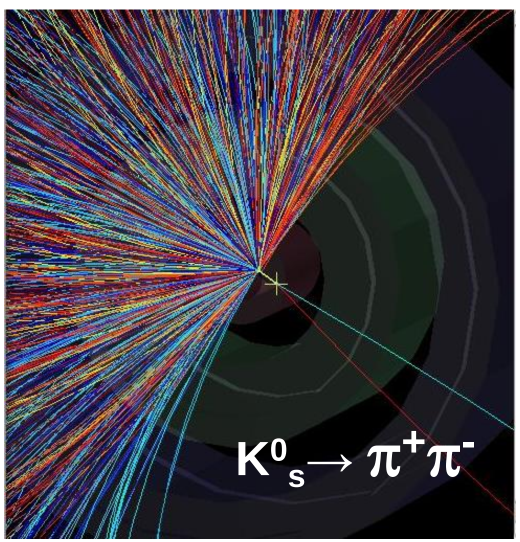
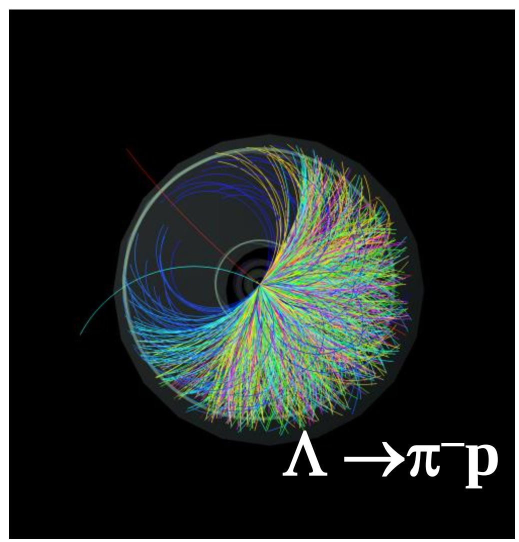
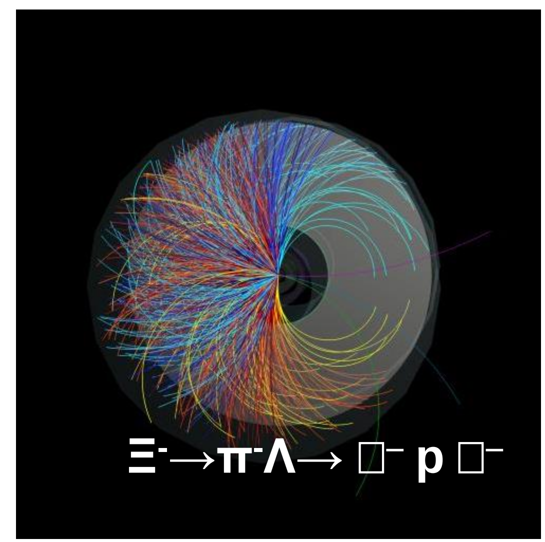
Looking for strange particles in ALICE

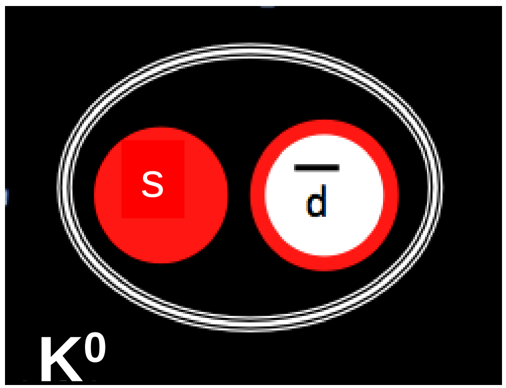






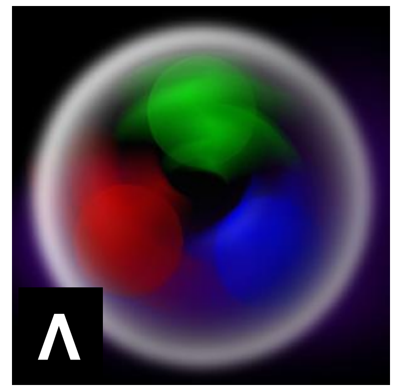
What are strange particles ?

meson



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

baryon



uds

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

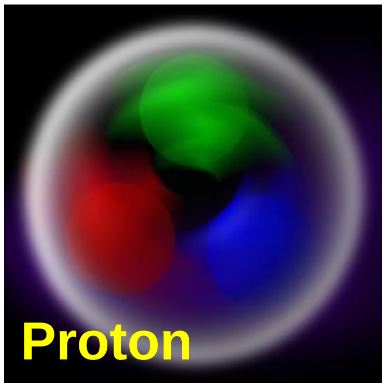
Today's periodic system of the fundamental building blocks

	Quarks		*Leptons*	
Generation 3	t Top	b Bottom	τ Tau	ν_τ Tau-neutrino
Generation 2	c Charm	s Strange	μ Muon	ν_μ Muon-neutrino
Generation 1	u Up	d Down	e Electron	ν_e Electron-neutrino

Quark Confinement

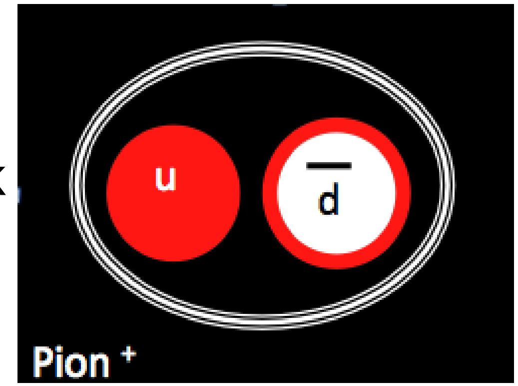
Quarks can not exist free in nature

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 GeV/c^2	Spin
p	proton	uud	1	0.938	1/2
$\bar{p}$	antiproton	$\bar{u}\bar{u}\bar{d}$	–1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	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
π^+	pion	$u\bar{d}$	+1	0.140	0
K^-	kaon	$s\bar{u}$	–1	0.494	0
ρ^+	rho	$u\bar{d}$	+1	0.776	1
B^0	B-zero	$d\bar{b}$	0	5.279	0
η_c	eta-c	$c\bar{c}$	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

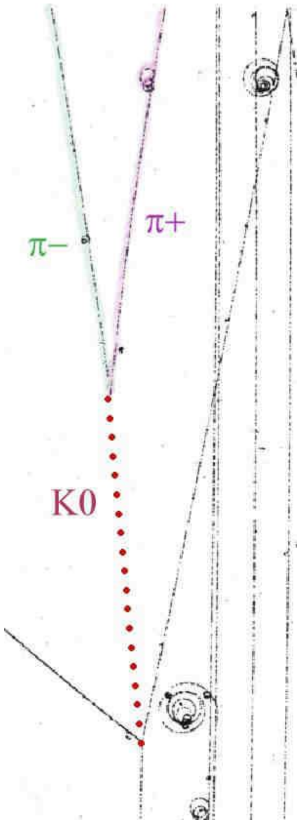
$K^0_s \to \pi^+\pi^-$

$\tau = 0.89 \times 10^{-10}$ s
$c\tau = 3 \times 10^{10}$ cm $s^{-1} \times 8.9 \times 10^{-11}$ s
2.67 cm from the point of interaction

$\Lambda \to \pi^- p$

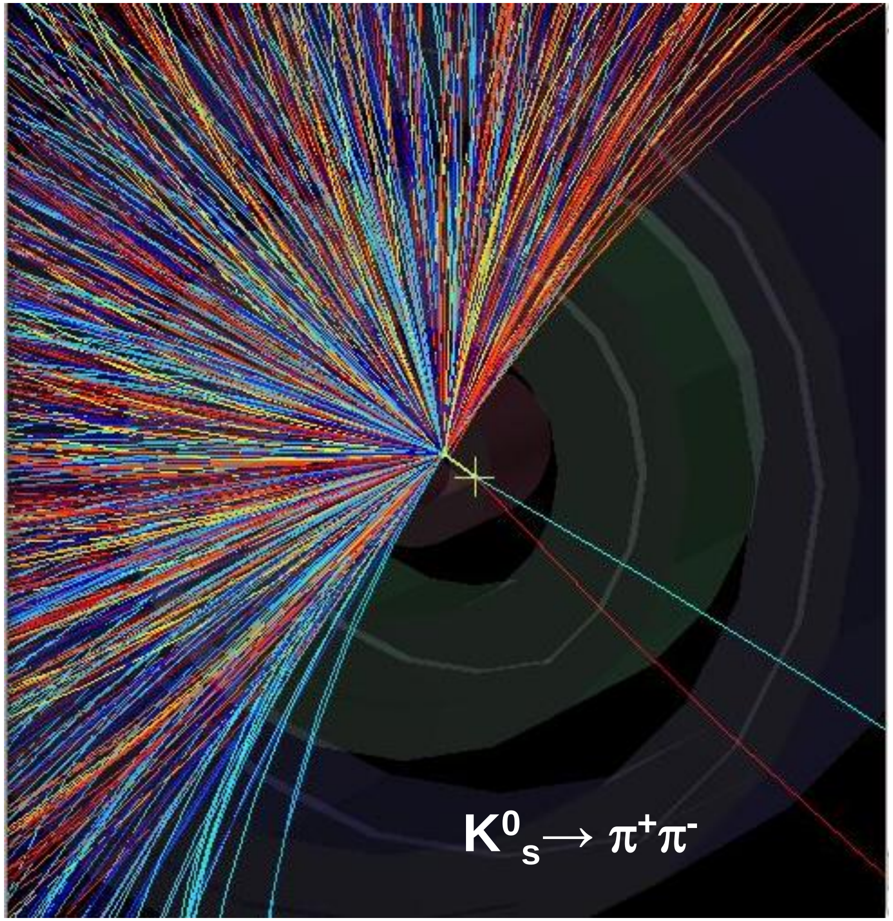
$\tau = 2.6 \times 10^{-10}$ s
$c\tau = 3 \times 10^{10}$ cm $s^{-1} \times 2.6 \times 10^{-10}$ s
7.2 cm distance from the point of interaction

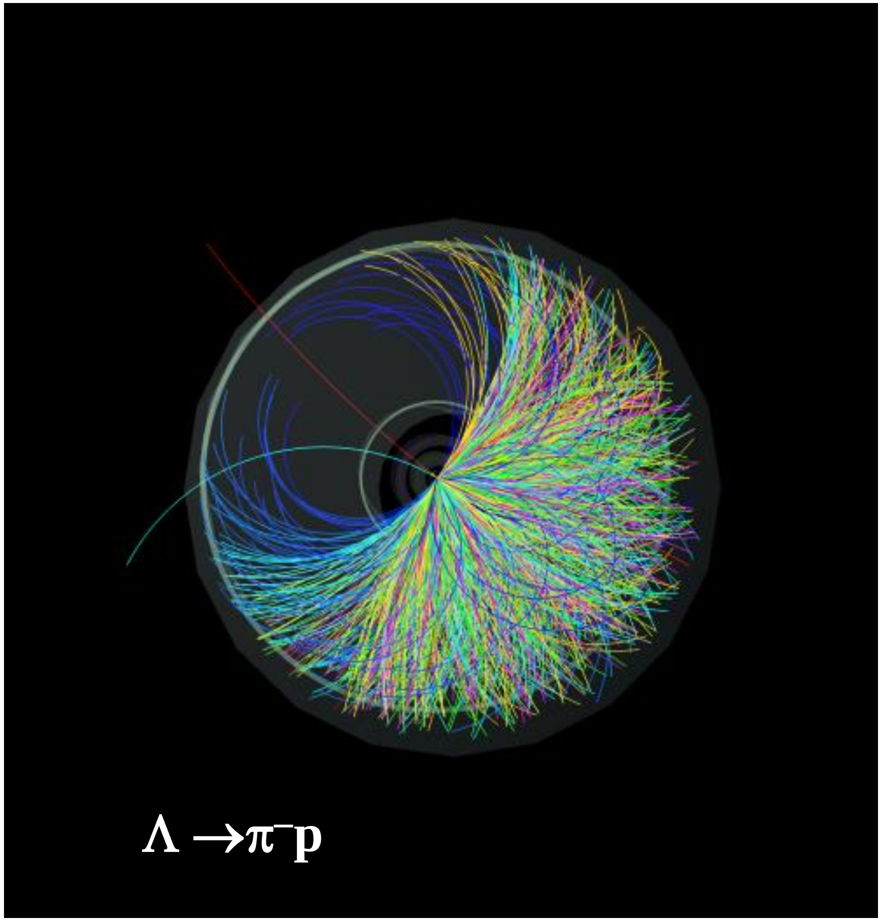
$\bar{\Lambda} \to \pi^+ \bar{p}$



Weak decays : strangeness is not conserved

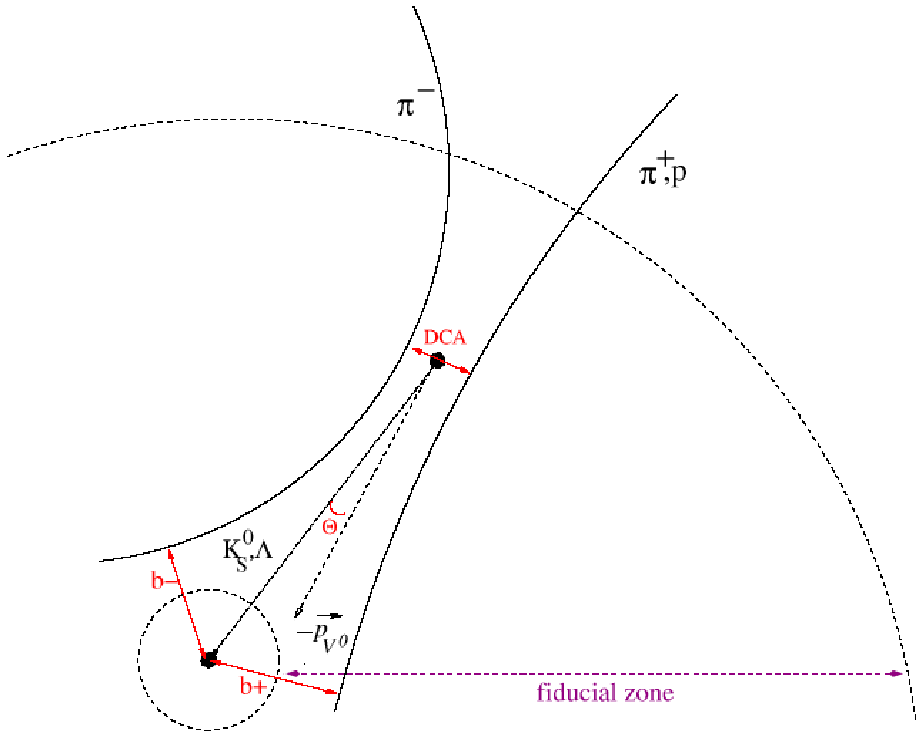
How do we find V0s ?





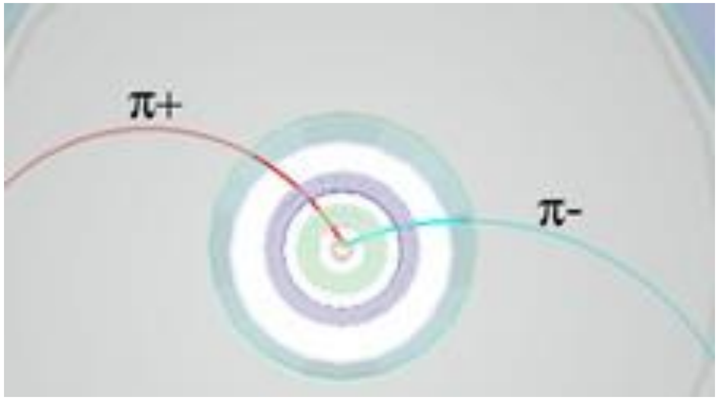
We look for two opposite tracks, having the same origin, which is not the interaction (collision) point

How do we find V0s ?



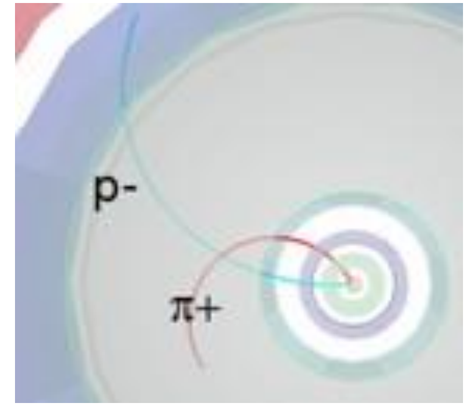
We look for two opposite tracks, having the same origin, which is not the interaction (collision) point

How do we identify each V0?



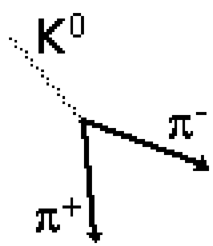
$K^0_s \rightarrow \pi^+\pi^-$

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



anti $\Lambda \rightarrow p^-$□$^+$

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



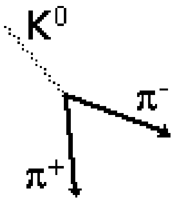
V0 decay :
a neutral particle (no track) gives suddenly two tracks

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) $\Rightarrow$ m_1 m_2

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

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