PH3520 / Particle Physics

Autumn term 2011 – week 7

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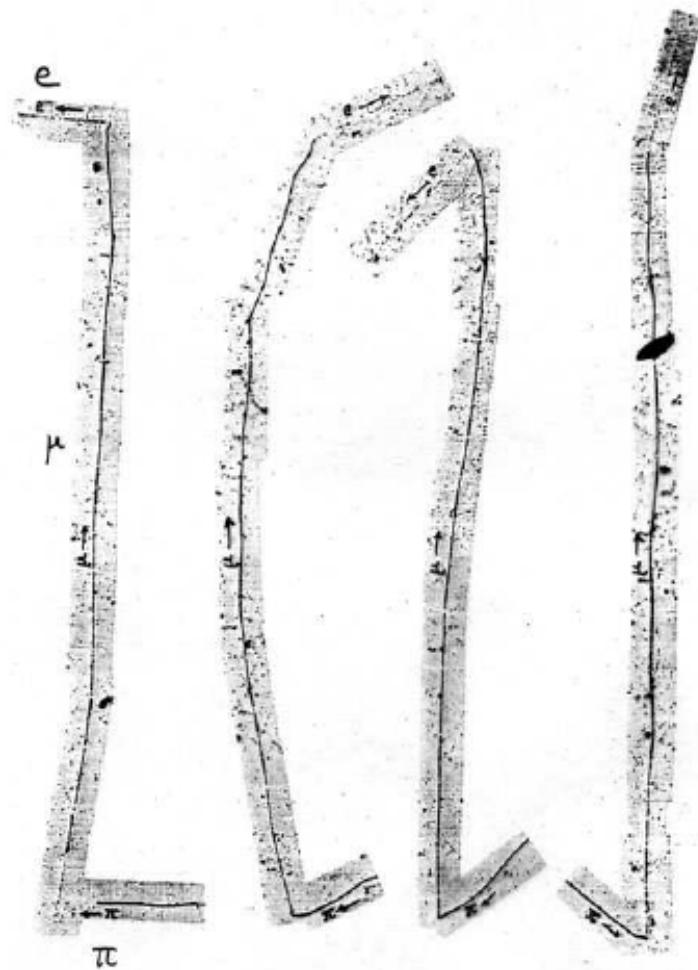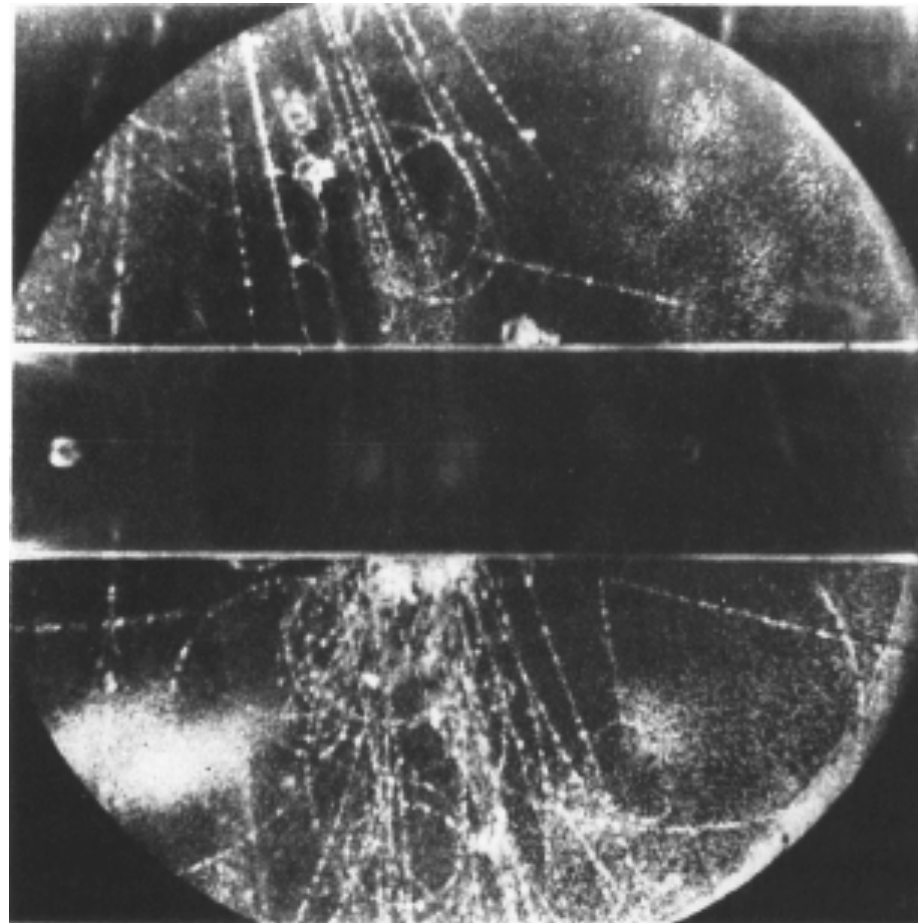
Discovery of the pion

Figure 7.2: Emulsion photographs showing the decay chain $\pi \rightarrow \mu \rightarrow e$ [37].

C.F. Powell, P.H. Fowler and D.H. Perkins, *The study of elementary particles by the photographic method*, Pergamon, New York, 1959.
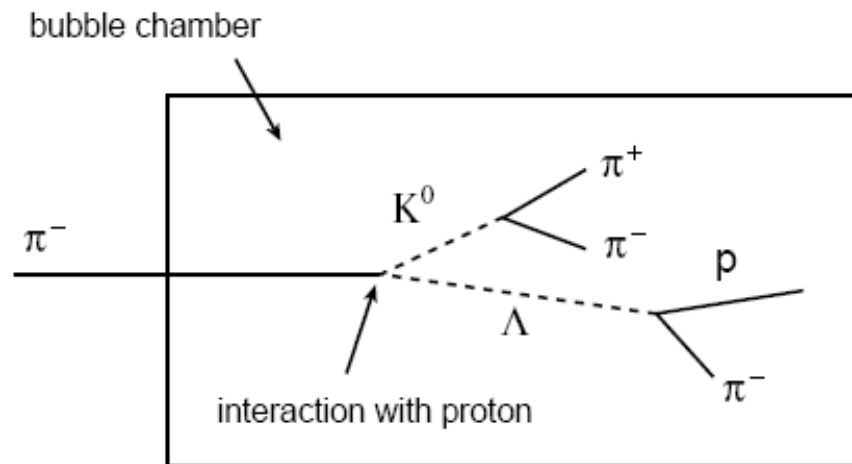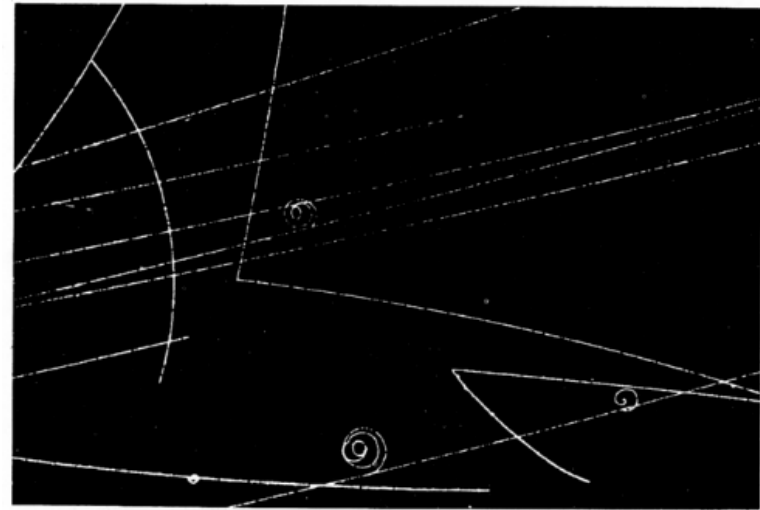
Discovery of the kaon

G.D. Rochester and C.C. Butler, Nature **160** (1947) 855.
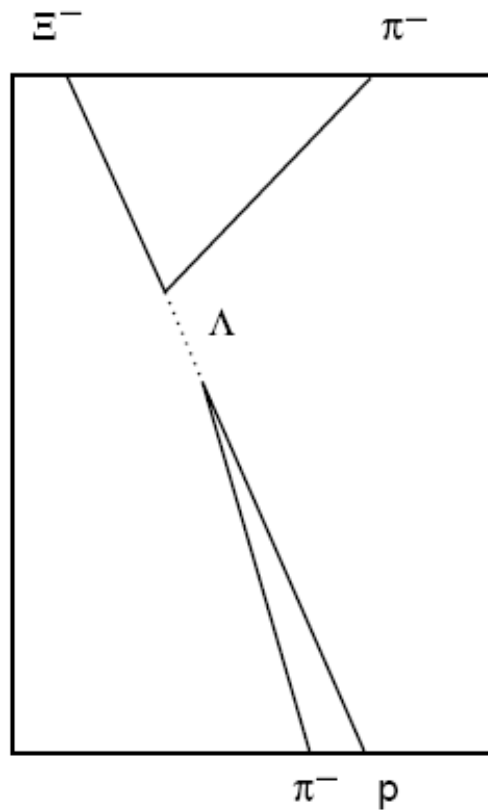
Singly strange baryon: the Λ

$\pi^- p \rightarrow K^0 \Lambda$ in the Berkeley 72-inch bubble chamber
imglib.lbl.gov/ImgLib

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Doubly strange baryon: the Ξ^-

R. Armenteros *et al.*, Phil. Mag. **43** (1952) 597.

E.W. Cowan, Phys. Rev. **94** (1954) 161.

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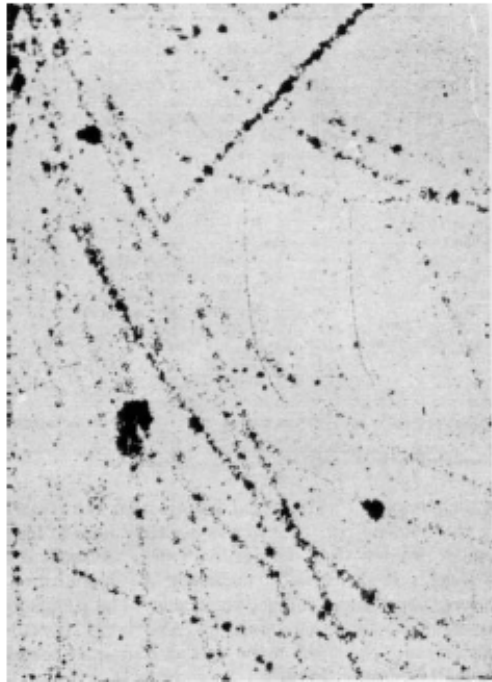
Triply strange baryon: the Ω^-

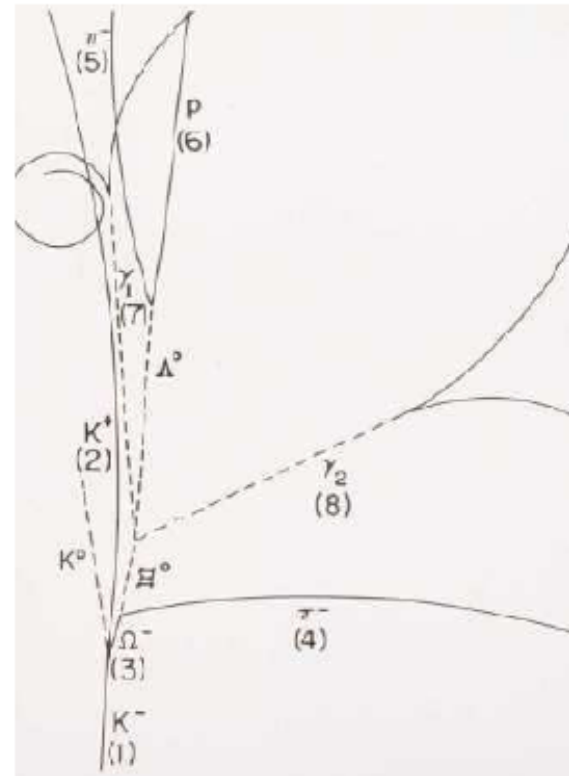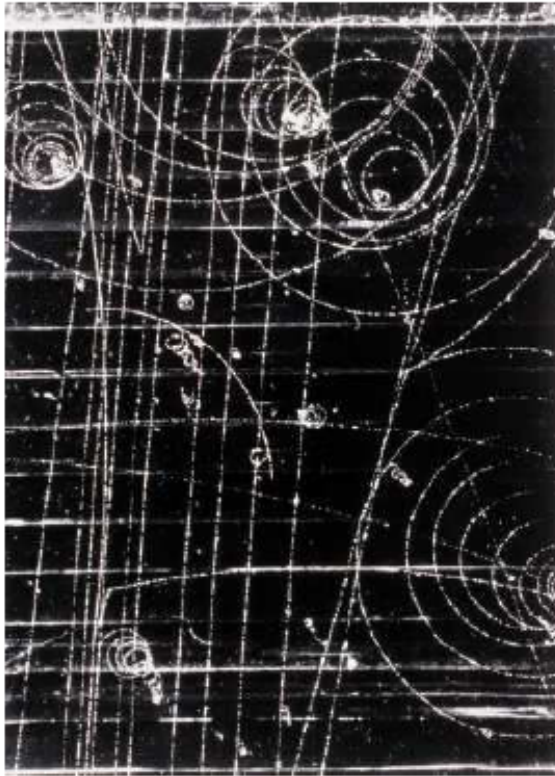V.E. Barnes *et al.*, Phys. Rev. Lett. **12** (1964) 204.

Figure 7.10: The bubble chamber photograph (left) and its interpretation (right) showing the first identified Ω^- baryon [42].

Strange hadrons

Table 7.1: Hadrons containing at least one s quark combined with u or d quarks [6].

particle	quarks	mass (MeV)	τ (s)	$c\tau$
K_S^0	$d\bar{s}, s\bar{d}$	497.7	0.893×10^{-10}	2.68 cm
K_L^0	$d\bar{s}, s\bar{d}$	497.7	5.17×10^{-8}	15.5 m
K^+, K^-	$u\bar{s}, s\bar{u}$	493.7	1.24×10^{-8}	3.71 m
Λ	uds	1115.7	2.63×10^{-10}	7.89 cm
Σ^+	uus	1189.4	0.799×10^{-10}	2.40 cm
Σ^0	uds	1192.6	7.4×10^{-20}	2.22×10^{-11} m
Σ^-	dds	1197.4	1.48×10^{-10}	4.43 cm
Ξ^0	uss	1314.9	2.90×10^{-10}	8.71 cm
Ξ^-	dss	1321.3	1.64×10^{-10}	4.91 cm
Ω^-	sss	1672.5	0.822×10^{-10}	2.46 cm

Hadron resonances

$$\pi^- p \to \pi^- p$$
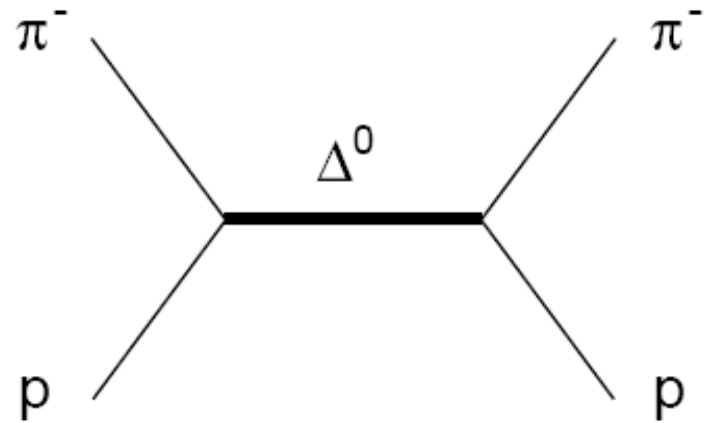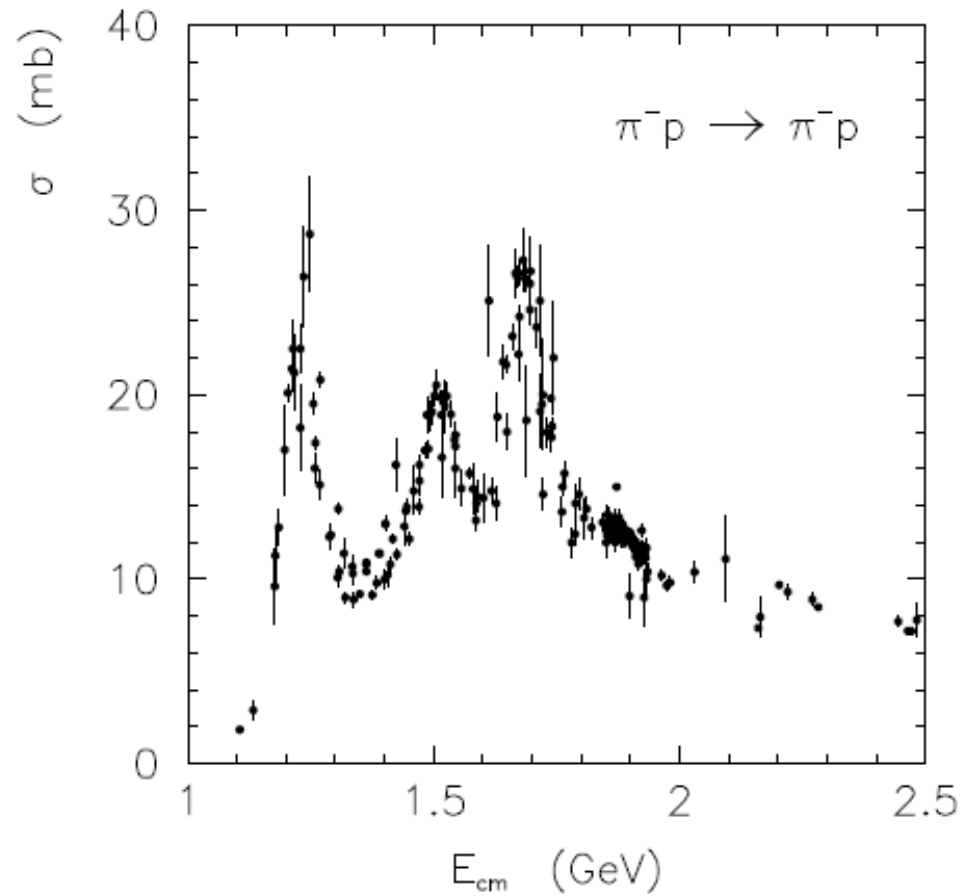
Resonance production in Z decay

$e^+ e^- \rightarrow$ hadrons at $E_{cm} = M_Z$ produces ~dozen 10 π^+, 10 π^-

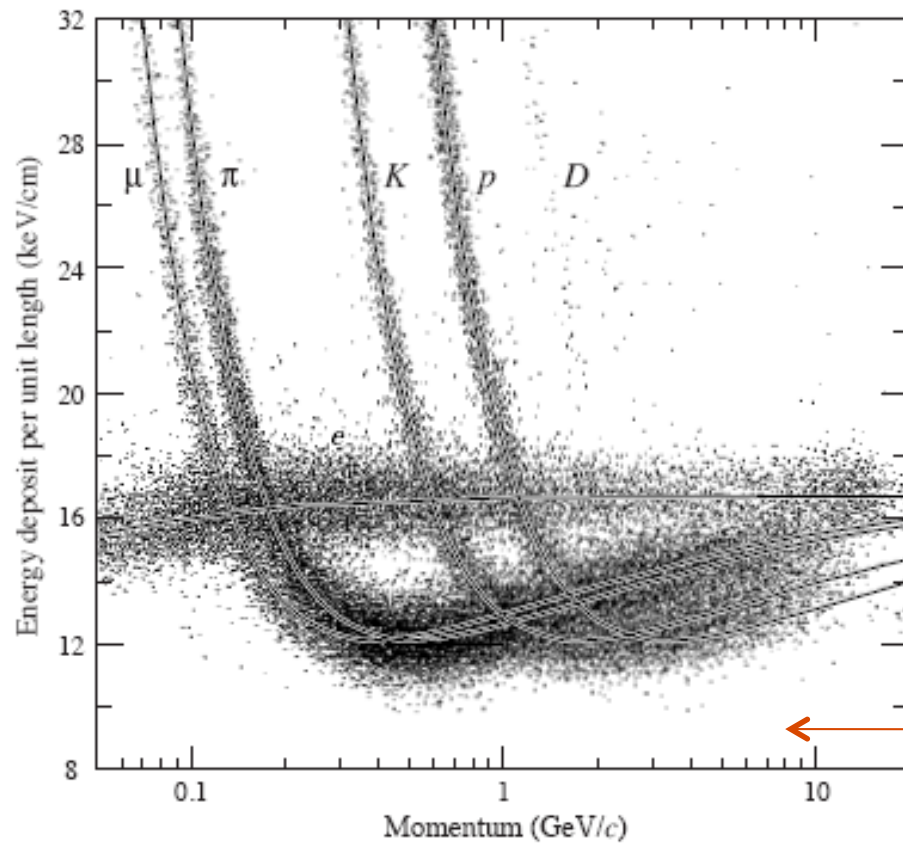Calculate $m_{\pi\pi}$ for all $\pi^+\pi^-$ pairs and enter in histogram

ρ^0
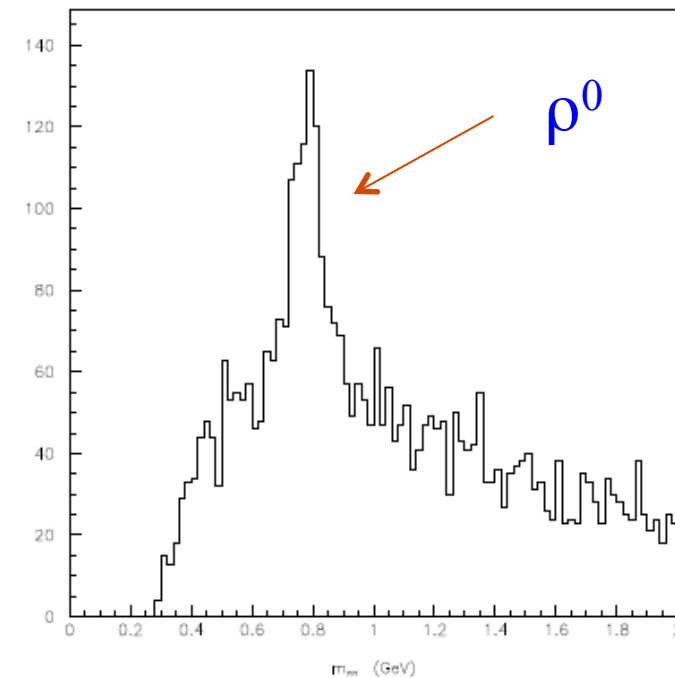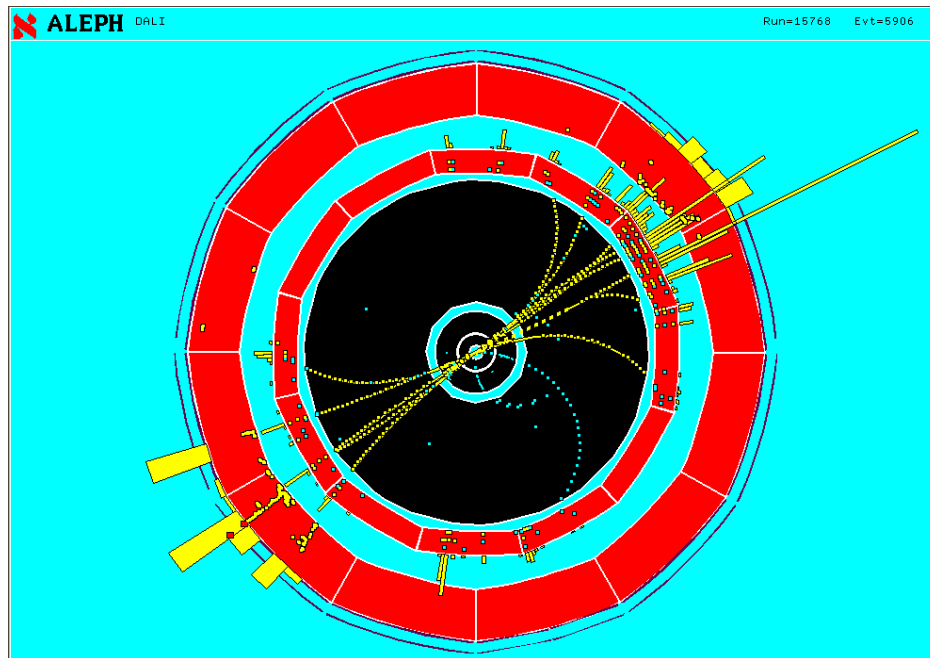
Summary of hadron resonances

Table 7.2: Some hadron resonances and their properties [6].

particle	quarks	J^P	mass (MeV)	Γ (MeV)
ρ^0	$u\bar{u}, d\bar{d}$	1^-	770	150
$\rho^\pm$	$u\bar{d}, d\bar{u}$	1^-	770	150
ω	$u\bar{u}, d\bar{d}$	1^-	782	8.4
$K^{*\pm}$	$s\bar{u}, u\bar{s}$	1^-	892	51
K^{*0}	$d\bar{s}$	1^-	896	50
ϕ	$s\bar{s}$	1^-	1020	4.4
Δ^{++}	uuu	$3/2^+$	1230	120
Δ^+	uud	$3/2^+$	1230	120
Δ^0	udd	$3/2^+$	1230	120
Δ^-	ddd	$3/2^+$	1230	120
Σ^{*+}	uus	$3/2^+$	1383	36
Σ^{*0}	uds	$3/2^+$	1384	36
Σ^{*-}	dds	$3/2^+$	1387	39

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Search for free quarks

Charge 1/3 or 2/3 particles would have a minimum ionization rate (dE/dx) 1/9 or 4/9 that of a unit charge particle.