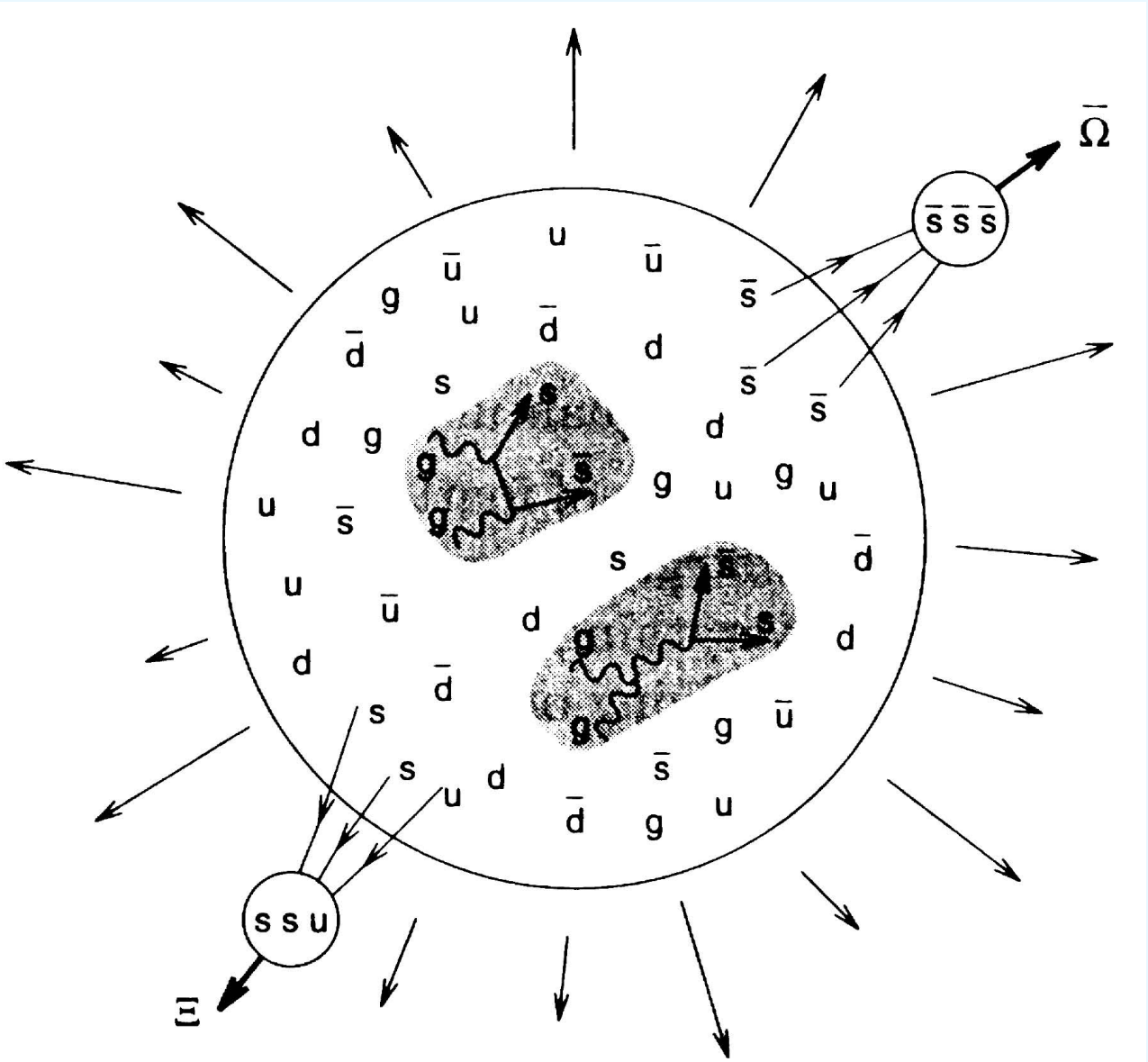
Strangeness Production

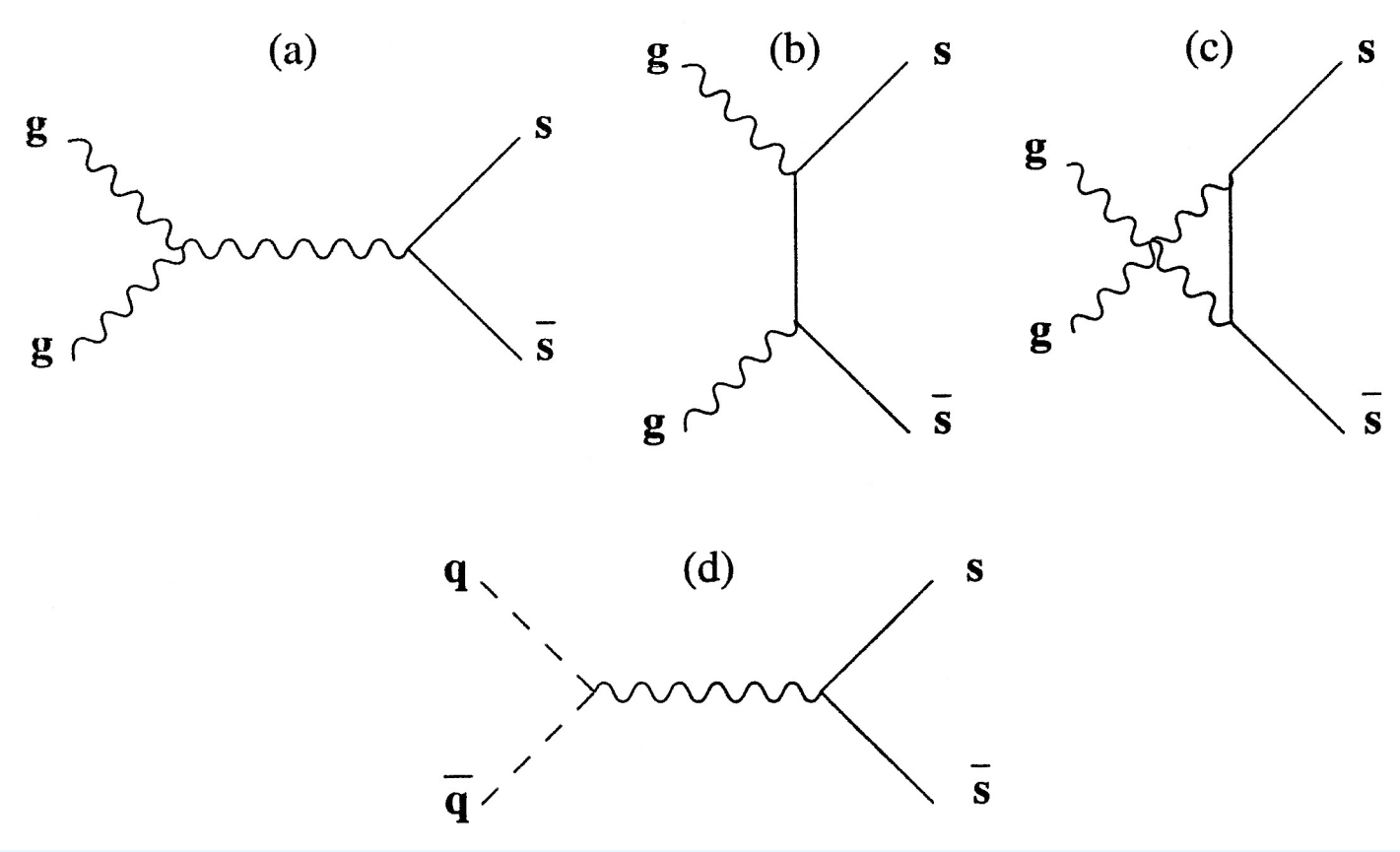
. Koch, B. Müller, J. Rafelski (1986). "Strangeness in relativistic heavy ion collisions". Physics Reports 142 (4): 167. Bibcode: 1986PhR...142..167K. doi:10.1016/0370-1573(86)90096-7.

Strangeness Production

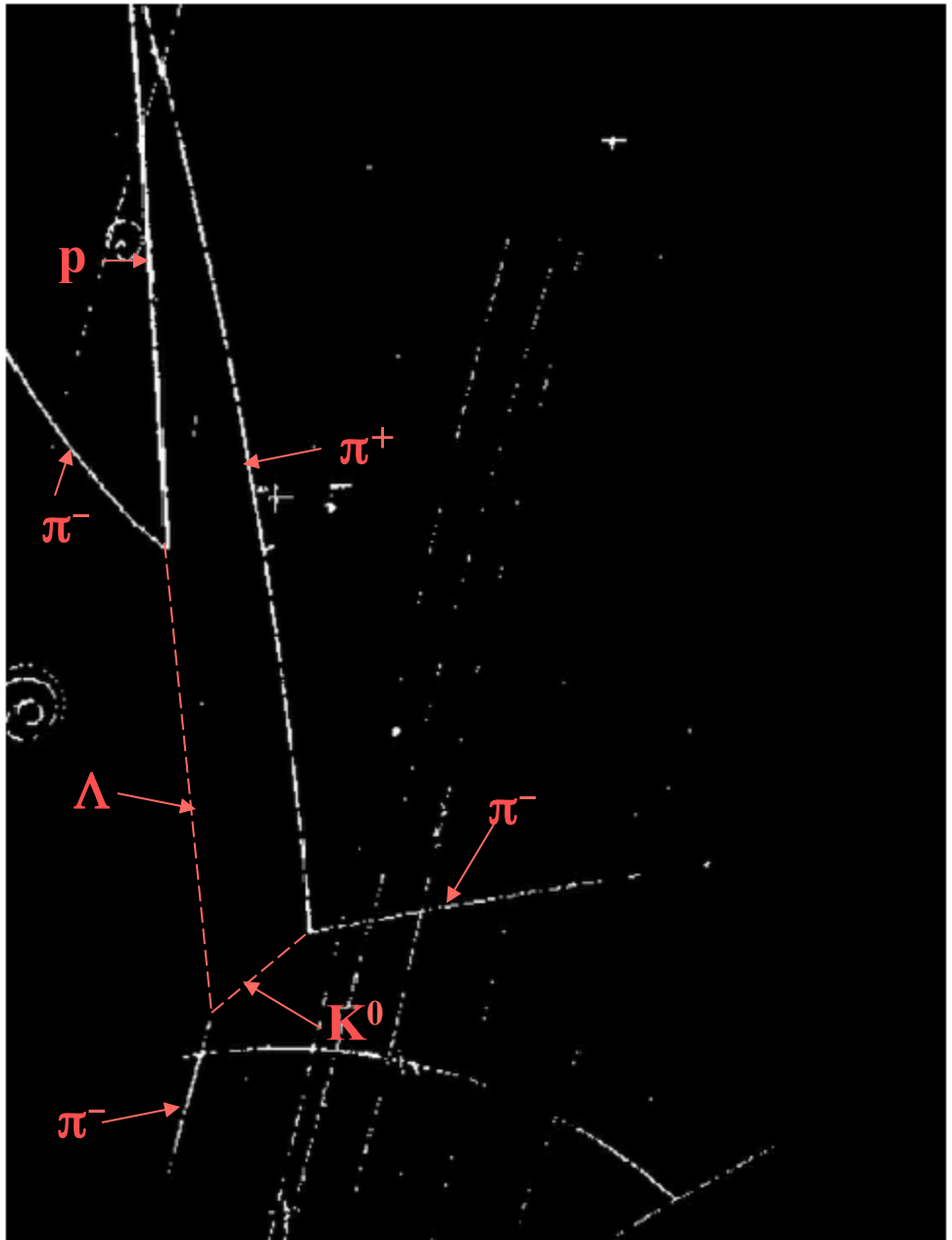
$T_c \sim m_s$



Strangeness production in QGP



Associate Production



$$\begin{array}{lcccccc} & \pi^- p & \rightarrow & K^0 \Lambda & & \\ S & 0 \quad 0 & & +1 & -1 & \end{array}$$

Strangeness enhancement

- General arguments for enhancement:
  1. Lower energy threshold

$T_{QGP} > T_C \sim m_s = 150$ MeV

$$q + \bar{q} \rightarrow s + \bar{s} \qquad E_{thres} = 2m_s \approx 300 \text{ MeV}$$
$$g + g \rightarrow s + \bar{s}$$

$$\pi + \mathrm{N} \rightarrow \Lambda + K \qquad E_{thres} \approx 530 \text{ MeV}$$
$$K + \pi \rightarrow \bar{\Lambda} + \mathrm{N} \qquad E_{thres} \approx 1420 \text{ MeV}$$

Note that strangeness is conserved in the strong interaction

  2. Larger production cross-section

$$\sigma_{QGP}(s\bar{s}) > \sigma_{HG}(s\bar{s})$$

Strange particles with charged decay modes

$\mathrm{K}^{\pm} = (u\bar{s}, \bar{u}s) \rightarrow \mu^{\pm}\nu_{\mu}$ (64%, 3.7m)

$\mathrm{K}^{0}_{s} = (d\bar{s} + \bar{d}s) \rightarrow \pi^{+}\pi^{-}$ (69%, 2.7cm)

$\phi = (s\bar{s}) \rightarrow \mathrm{K}^{+}\mathrm{K}^{-}$ (49%, n/a)

$\Lambda = (uds) \rightarrow p\pi^{-}$ (64%, 7.9cm)

$\Xi^{-} = (dss) \rightarrow \Lambda\pi^{-}$ (100%, 4.9cm)

$\Omega^{-} = (sss) \rightarrow \Lambda\mathrm{K}^{-}$ (68%, 2.5cm)

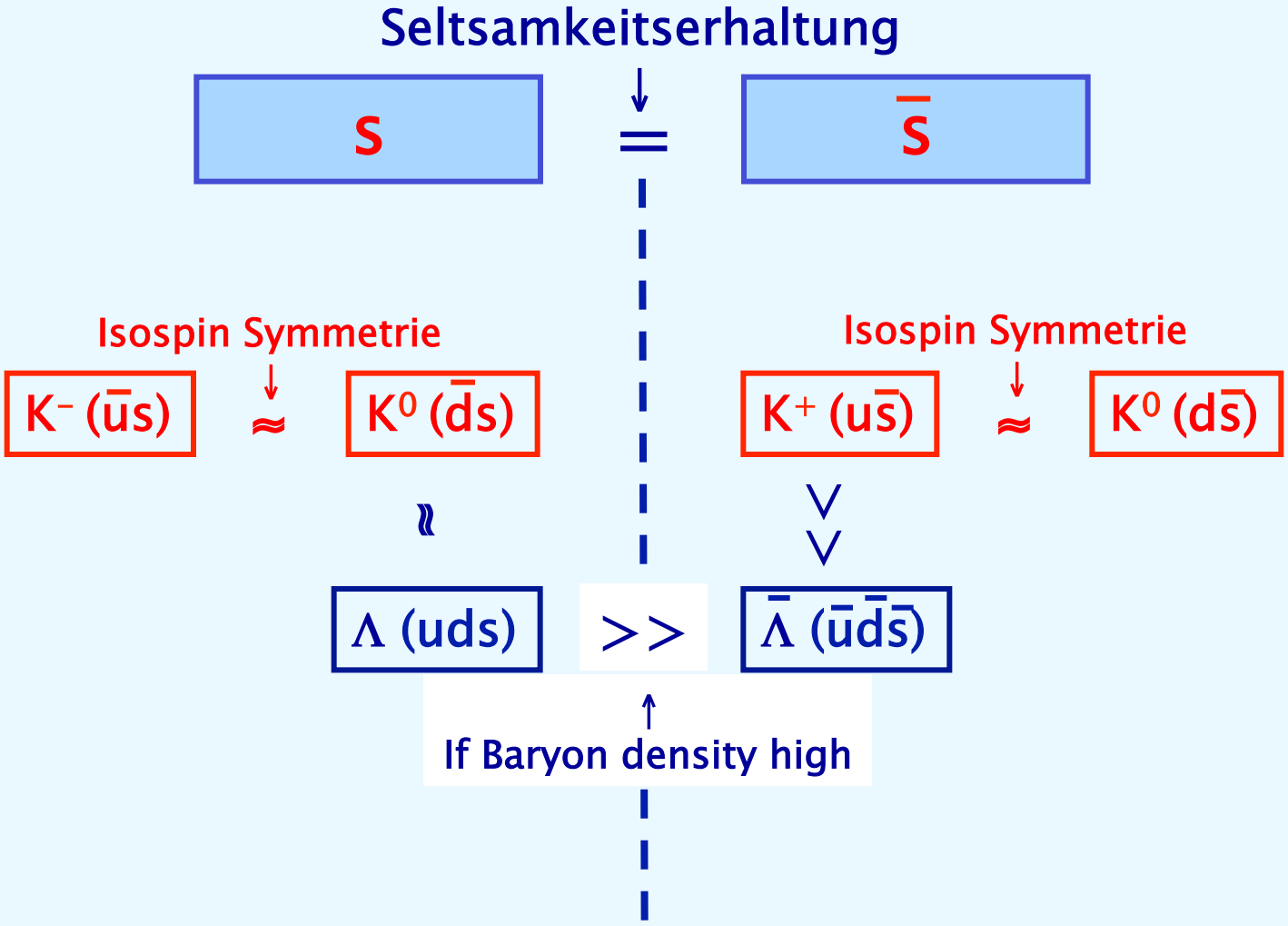
+ resonances

Enhancement is expected to be more pronounced for multi-strange baryons and their anti-particles

Strangeness Particles

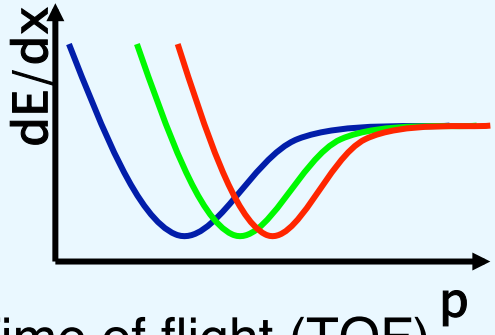
Particle	Quarks	S	$I(J^P)$	Mass (MeV/c^2)	Decay particles	B.R. (%)	$c\tau$ (cm)
K^+ (K^-)	$u\bar{s}$ ($\bar{u}s$)	+1 (-1)	$\frac{1}{2}(0^-)$	493.677	$\mu^+\nu_\mu$ ($\mu^-\bar{\nu}_\mu$)	63.55	371.2
K^0_S	$d\bar{s}$, $s\bar{d}$	—	$\frac{1}{2}(0^-)$	497.614	$\pi^+\,\pi^-$	69.2	2.68
ϕ	$s\bar{s}$	0	$0(1^-)$	1019.455	$\mathrm{K}^+\,\mathrm{K}^-$	48.9	4.63×10^{-12}
					$\mathrm{e}^+\,\mathrm{e}^-$	2.95×10^{-2}	
					$\mu^+\mu^-$	2.87×10^{-2}	
Λ ($\bar{\Lambda}$)	uds ($\bar{u}\bar{d}\bar{s}$)	-1 (+1)	$0(\frac{1}{2}^+)$	1115.683	$\mathrm{p}\,\pi^-$ ($\bar{\mathrm{p}}\,\pi^+$)	63.9	7.89
Ξ^- ($\bar{\Xi}^+$)	dss ($\bar{d}\bar{s}\bar{s}$)	-2 (+2)	$\frac{1}{2}(\frac{1}{2}^+)$	1321.71	$\Lambda\,\pi^-$ ($\bar{\Lambda}\,\pi^+$)	99.887	4.91
Ω^- ($\bar{\Omega}^+$)	sss ($\bar{s}\bar{s}\bar{s}$)	-3 (+3)	$0(\frac{3}{2}^+)$	1672.45	$\Lambda\,\mathrm{K}^-$ ($\bar{\Lambda}\,\mathrm{K}^+$)	67.8	2.46

Contributions to strangenss in A+A

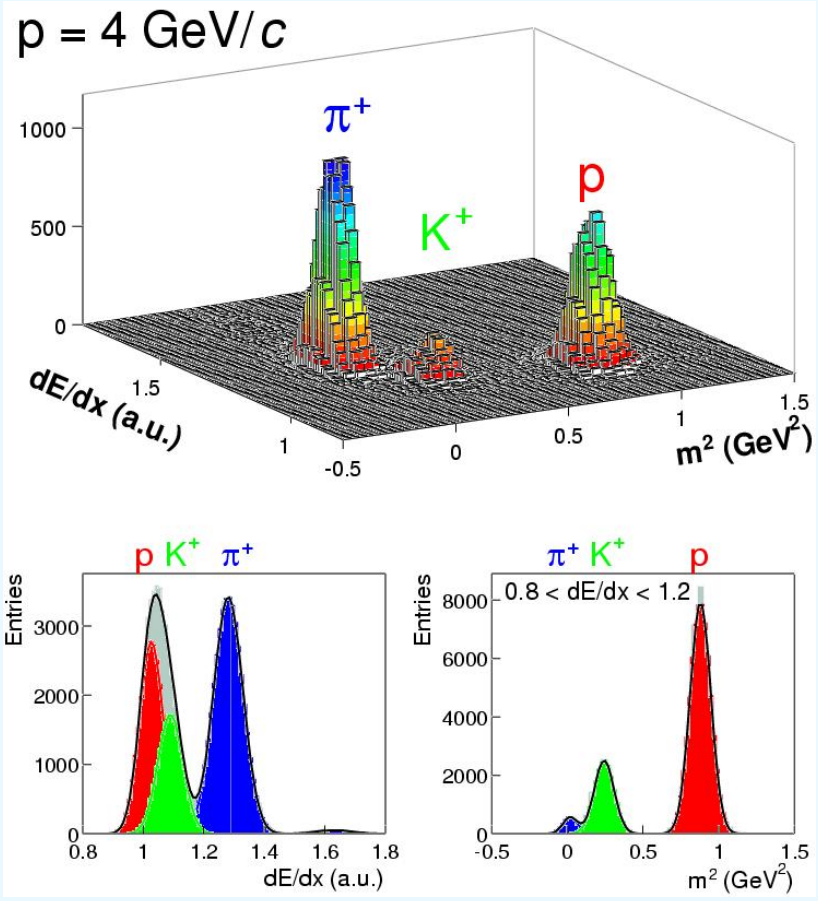


Identification of changed particles

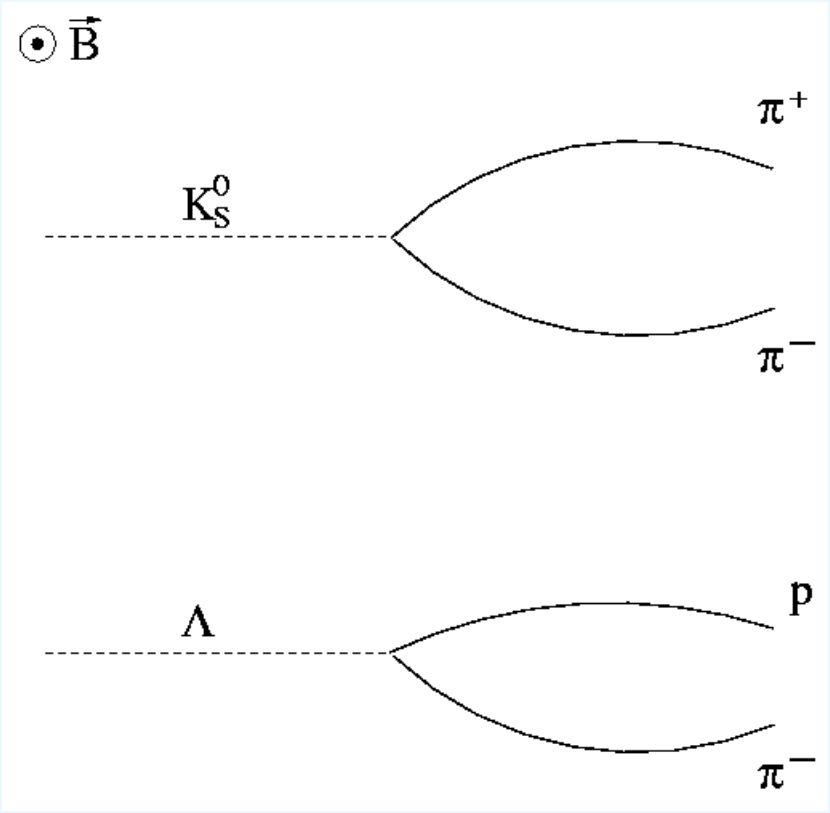
- Energie-loss dE/dx in TPC
  - resolution 3-4%
  - Bethe-Bloch curves

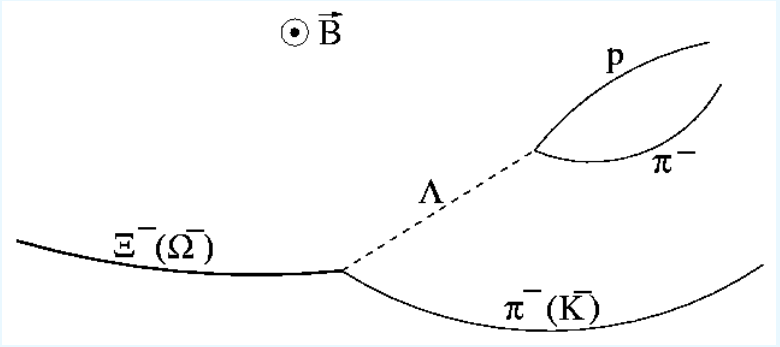


- Time of flight (TOF)
  - resolution 60 ps

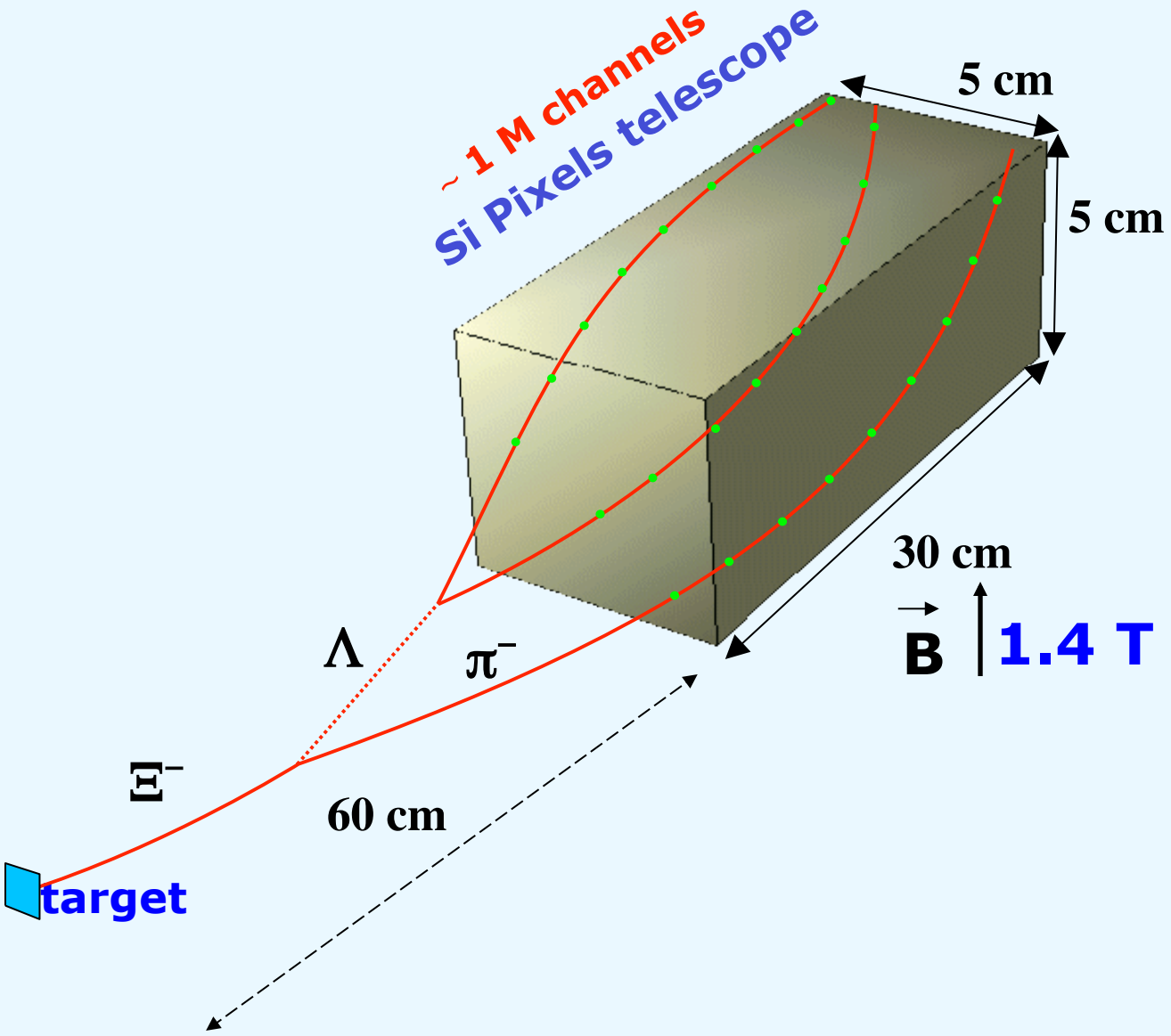


V^0 Topologie

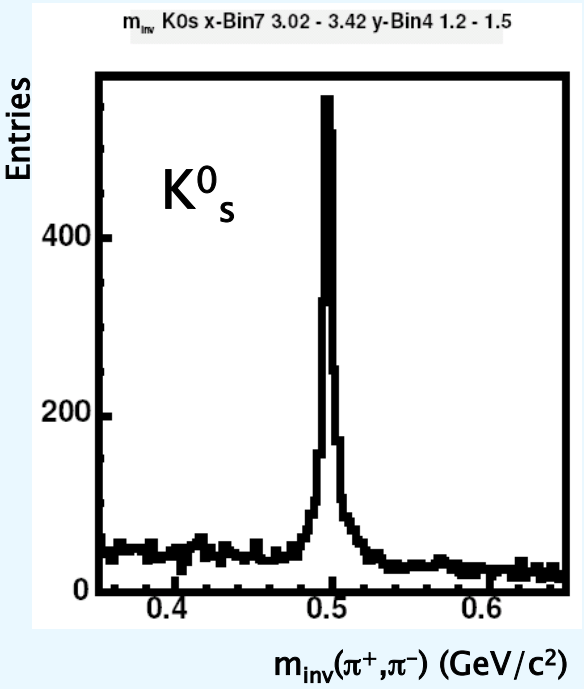


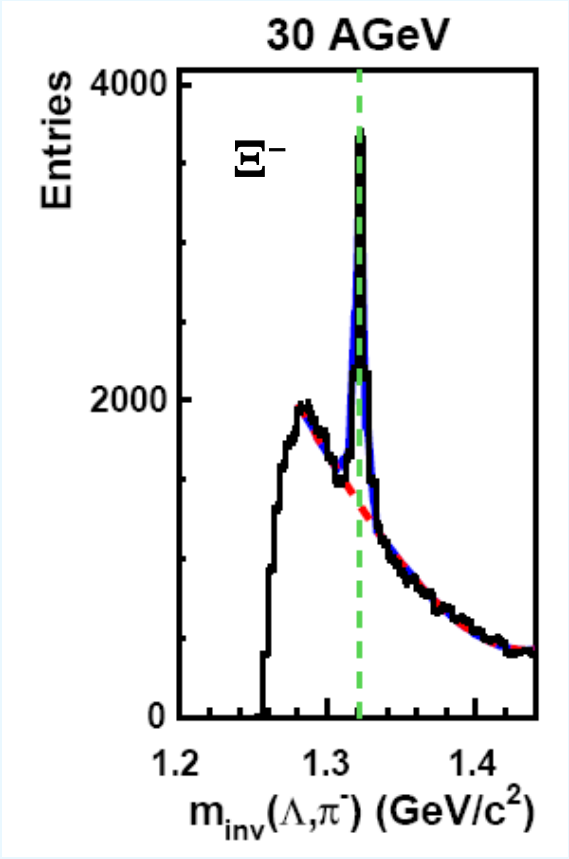


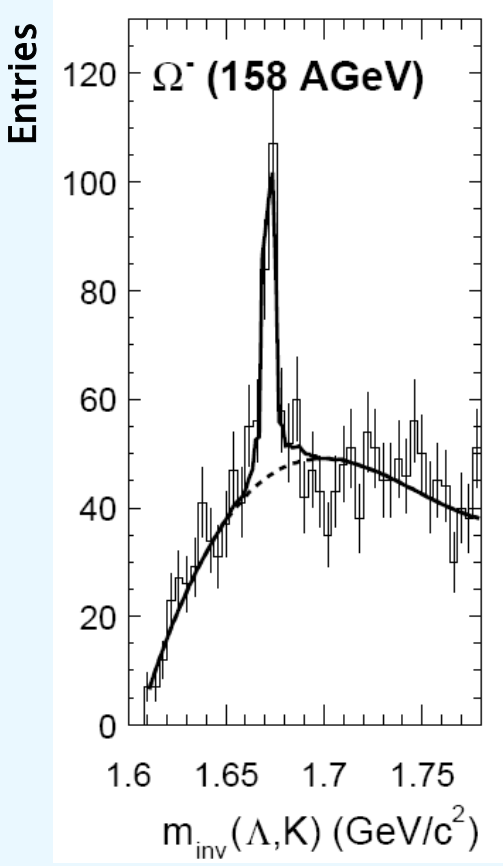
Reconstruction of strangeness caring hadrons in in NA57



Invariant mass reconstruction (K^0_s, Ξ^-, Ω^-)







NA49