UPPSALA UNIVERSITET

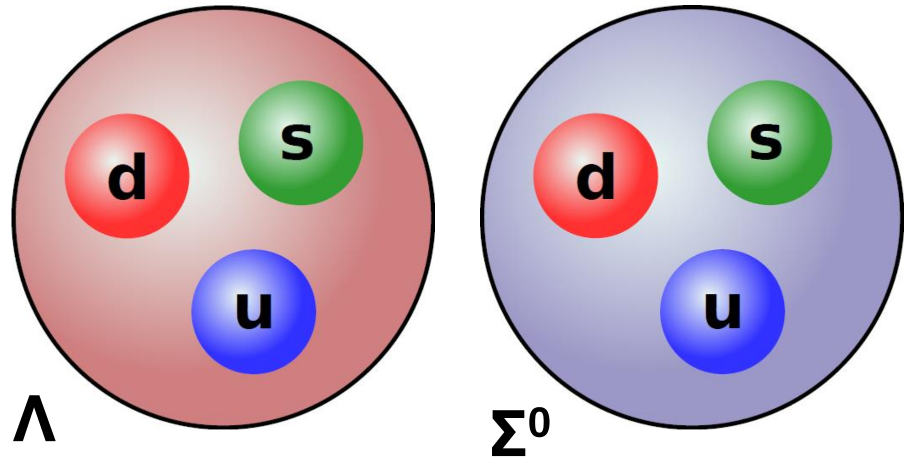
Hyperon Spin Physics and the GEM's

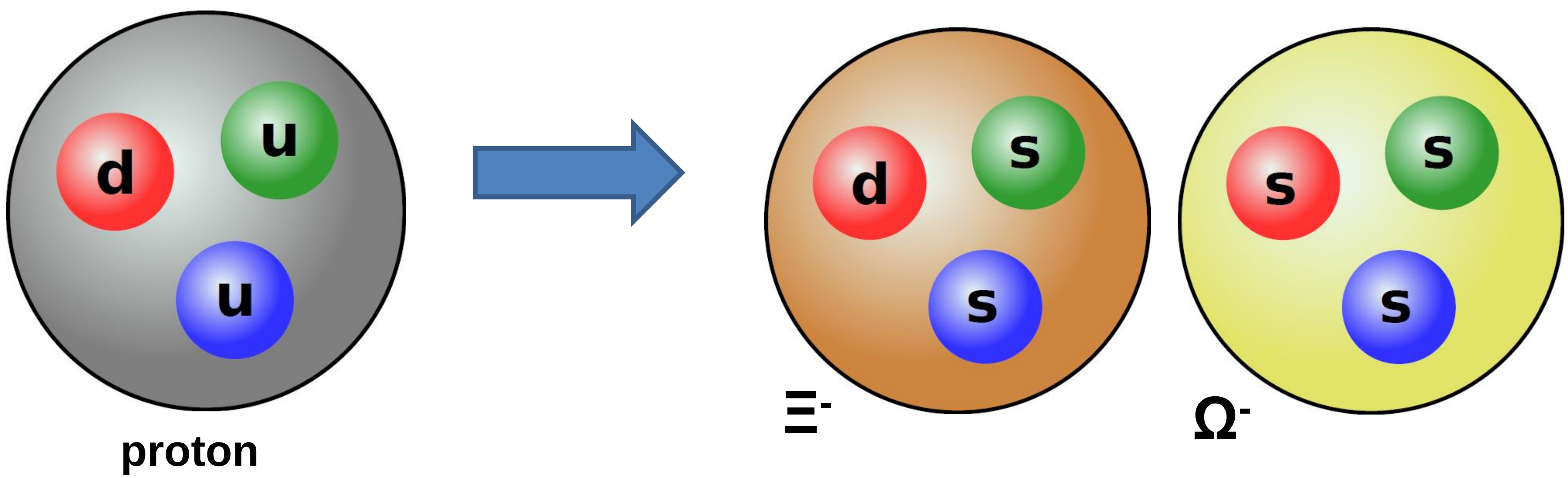
Karin Schönning, Uppsala University,
on behalf of the Hyperon Physics Working Group, PANDA

PANDA Collaboration Meeting, Sep. 14th 2016,
Mainz, Germany

Key question in hyperon physics:

What happens if we replace one of the light quarks in the proton with one - or many - heavier quark(s)?

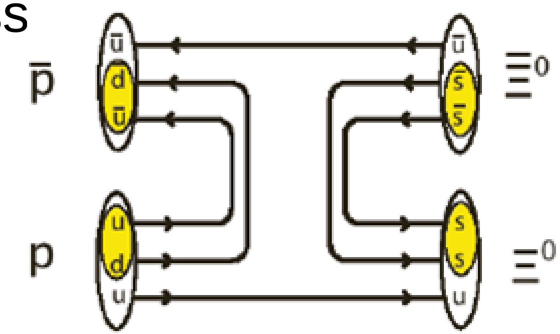


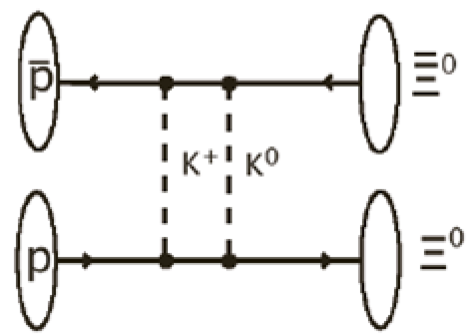


Introduction

- Light quark (*u, d*) systems:
  - Relevant degrees of freedom are hadrons.

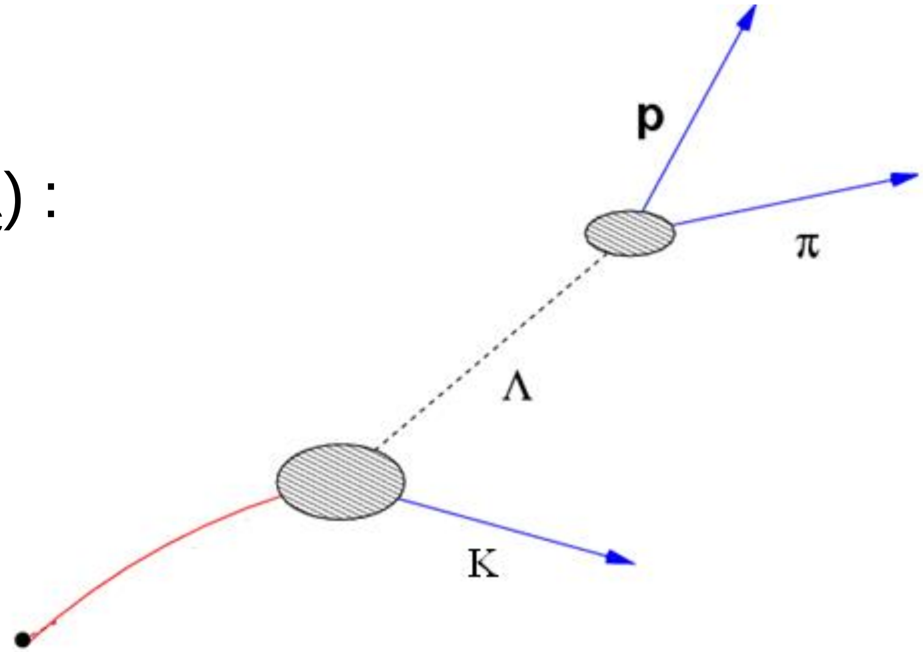
- Systems with strangeness
  - Scale: $m_s \approx 100$ MeV ~ $\Lambda_{QCD} \approx 200$ MeV.
  - Relevant degrees of freedom?
  - **Probes QCD in the intermediate domain.**





- Systems with charm
  - Scale: $m_c \approx 1300$ MeV.
  - Quark and gluon degrees of freedom more relevant.

Spin observables in $\bar{p}p \rightarrow \bar{Y}Y$

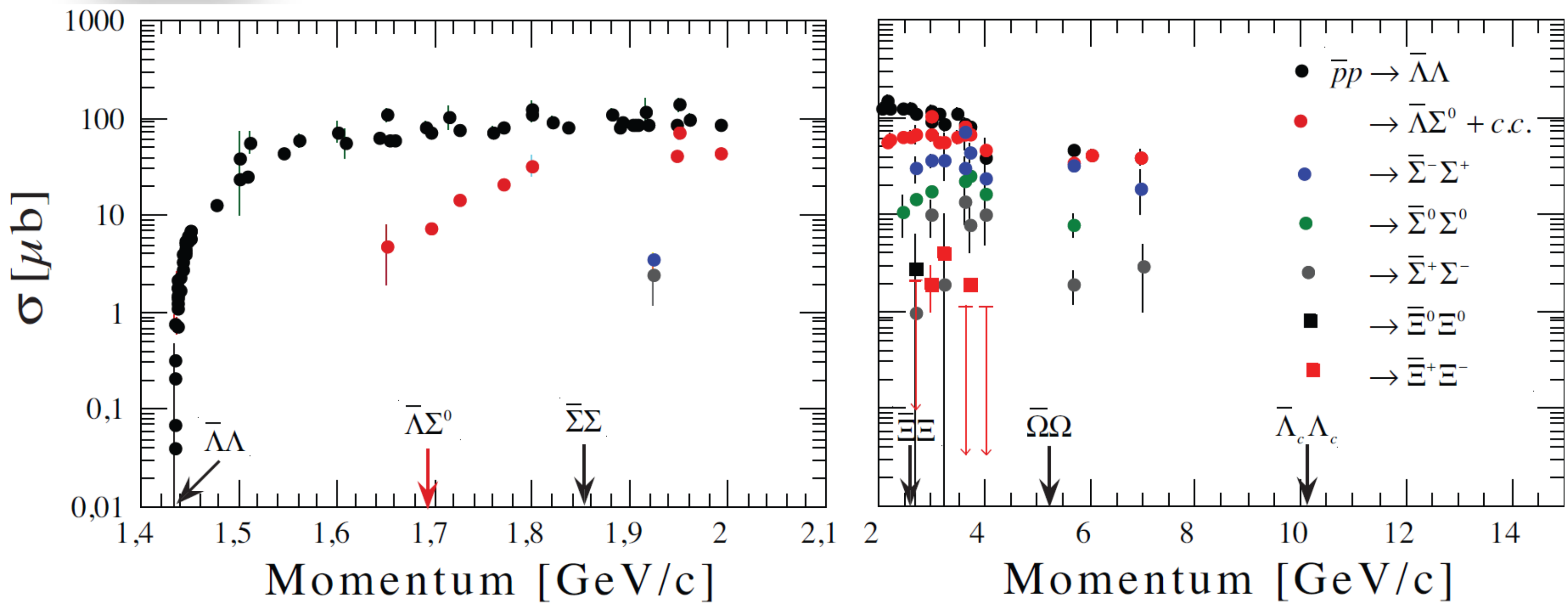


- Spin $\frac{1}{2}$ hyperons (Λ, Ξ, Λ_c) :
  - Polarisation.
  - Spin correlations.

- Spin $\frac{3}{2}$ hyperons into spin $\frac{1}{2}$ hyperons ($\Omega \rightarrow \Lambda K$):
  - 7 polarisation parameters.

Spin observables are powerful tools in testing models.

Previous measurements of $\bar{p}p \rightarrow \bar{Y}Y$

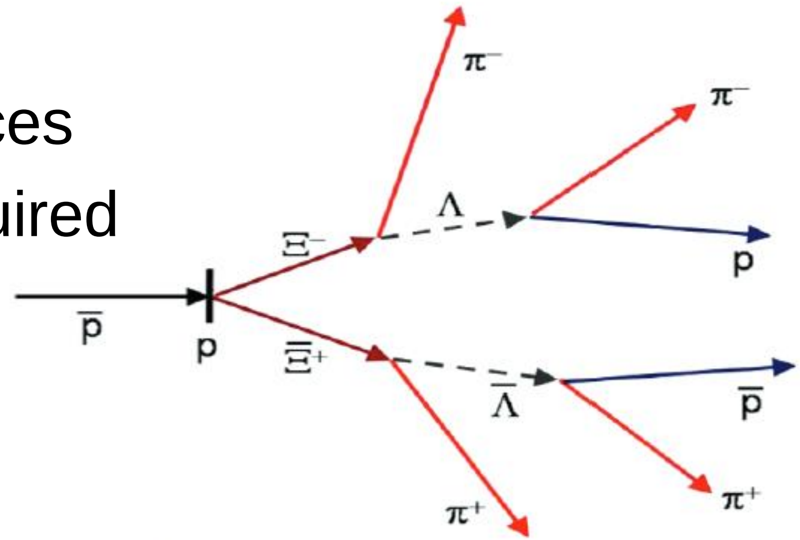


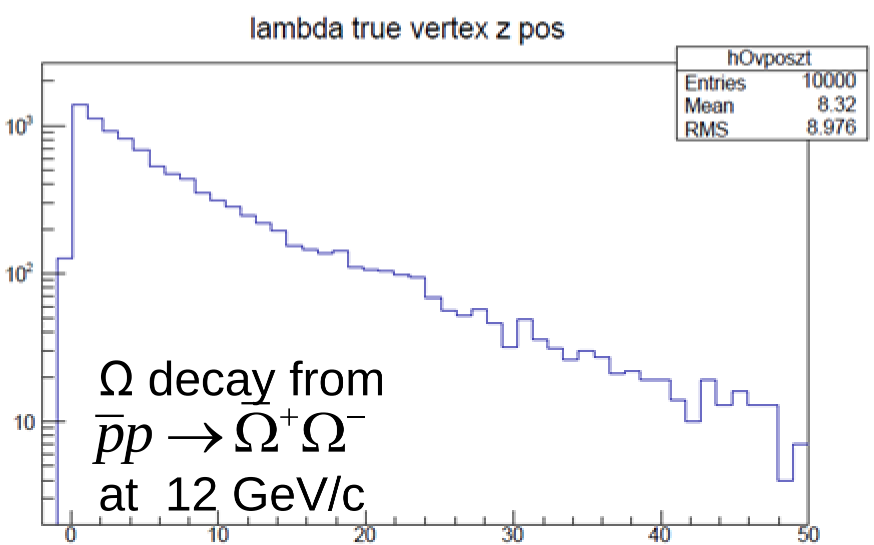
- A lot of data on $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ near threshold, mainly from PS185 at LEAR*.
- Very scarce data bank above 4 GeV.
- Only a few bubble chamber events on $\bar{p}p \rightarrow \bar{\Xi}\Xi$
- No data on $\bar{p}p \rightarrow \bar{\Omega}\Omega$ nor $\bar{p}p \rightarrow \bar{\Lambda}_c\Lambda_c$

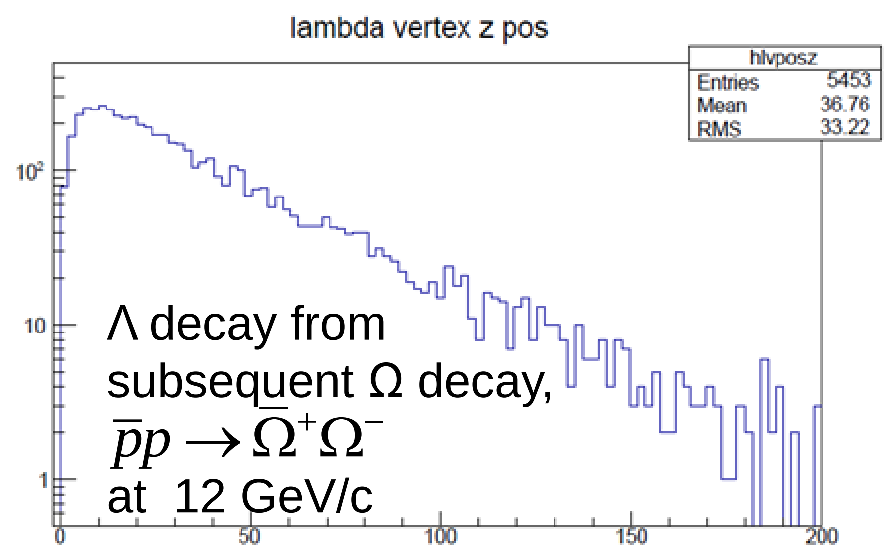
* See *e.g.* T. Johansson, AIP Conf. Proc. Of LEAP 2003, p. 95.

Requirements for hyperon physics

- Weak decay → displaced vertices
  → good spacial resolution required
- Many final state particles (4-6).







UPPSALA UNIVERSITET

Simulations for the scrutiny 2014

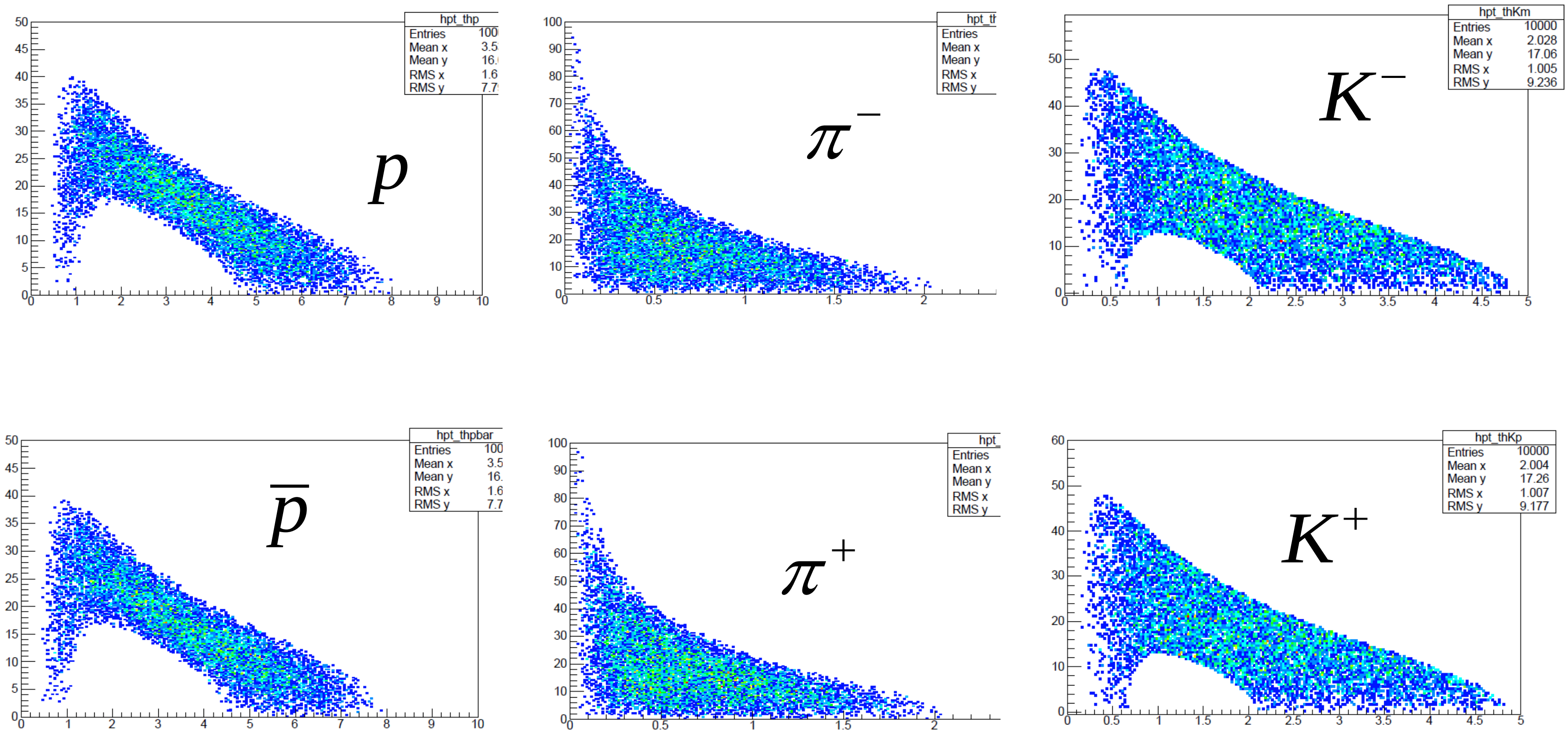
- Ideal pattern recognition.
- Ideal PID.
- Channels:
  - Single strange $\bar{p}p \to \bar{\Lambda}\Lambda$ at 1.64 GeV/c.
  - Double strange $\bar{p}p \to \bar{\Xi}\Xi$ at 4 GeV/c.
  - Triple strange $\bar{p}p \to \bar{\Omega}\Omega$ at 12 GeV/c.

- Forward peaking Λ angular distributions.
- Isotropic Ξ and Ω distributions.

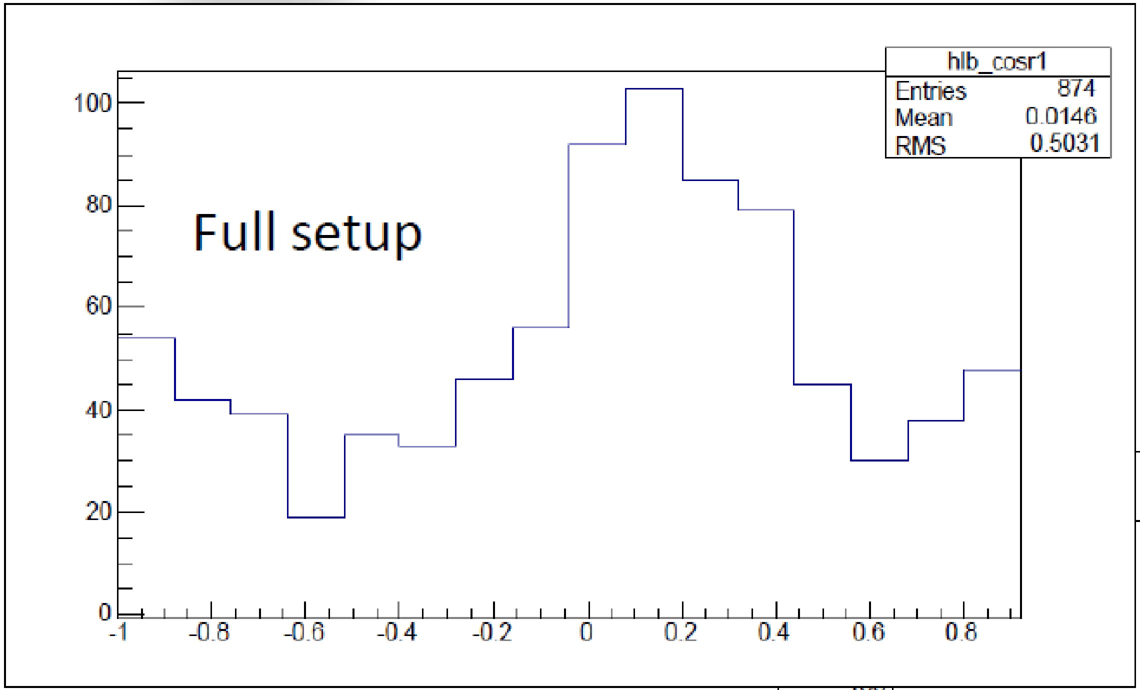
UPPSALA UNIVERSITET

$\bar{p}p \rightarrow \bar{\Lambda}\Lambda$	σ = 64 μb		Required # events: > 40000
Setup	ε (%)	L (pb^{-1})	Hours with 10^{31} $cm^{-2}s^{-1}$
Full	23	0.017	0.18
No FTS	12	0.032	0.35
No MVD/GEM	0.3	1.27	14
$\bar{p}p \rightarrow \bar{\Xi}\Xi$	σ = 2 μb		Required # events: > 10000
Setup	ε (%)	L (pb^{-1})	Hours with 10^{31} $cm^{-2}s^{-1}$
Full	10	0.12	3.4
No FTS	3.4	0.36	10
No MVD/GEM	0.01	122	3400
$\bar{p}p \rightarrow \bar{\Omega}\Omega$	(σ = 2 nb)		Required # events: > 1000
Setup	ε (%)	L (pb^{-1})	Days with 10^{31} $cm^{-2}s^{-1}$
Full	8.3	32	36
No FTS	2.9	91	105
No MVD/GEM	0.05	5280	6110

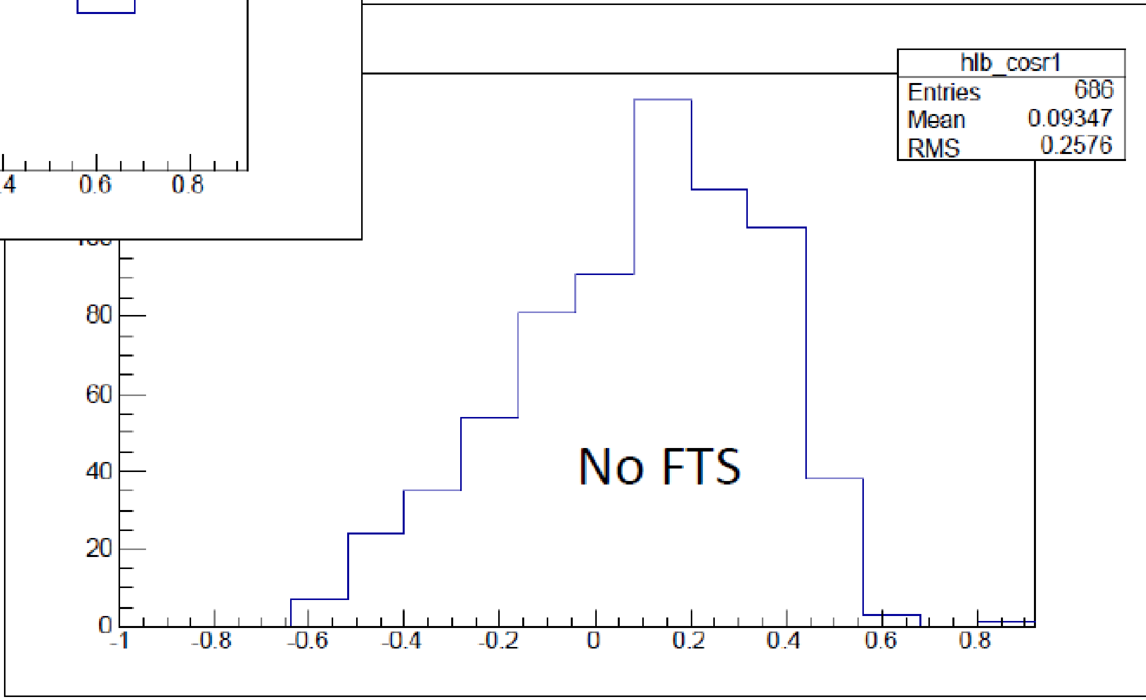
Phase space of $\bar{p}p \to \bar{\Omega}\Omega$ at 12 GeV/c



Acceptance as a function of $\cos\theta_{\Omega bar}$

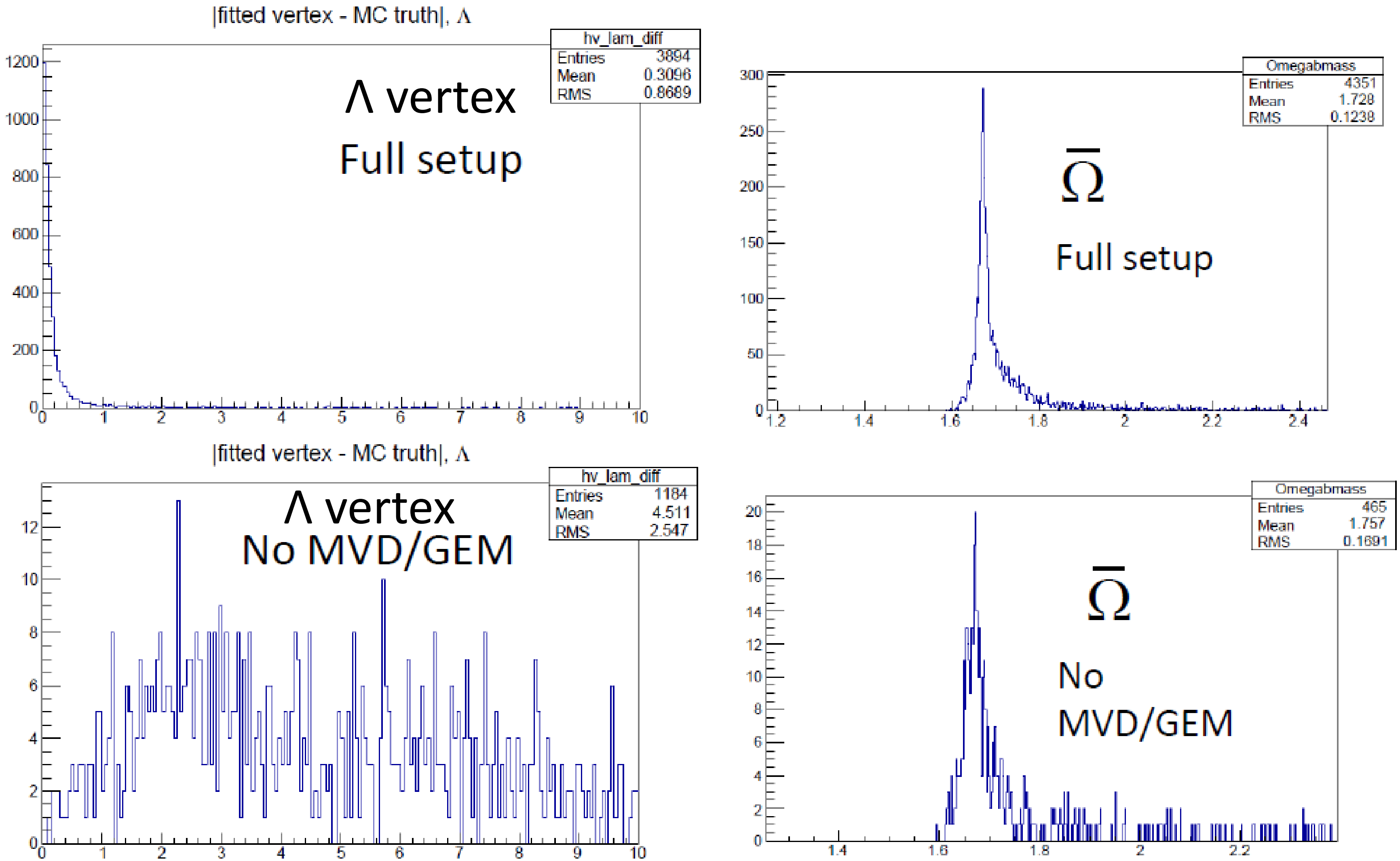


Without the FTS, large parts of the $\cos\theta_{\Omega}$ have zero acceptance.



Arbitrary units, flat generated distribution

Vertex- and mass resolution



UPPSALA UNIVERSITET

Summary

- Strangeness production probes the strong interaction in the confinement domain.
- Spin observables are powerful in testing models.
- PANDA is the perfect experiment for strangeness production – when the full setup is available.
- Simulations performed in 2014 for the scrutiny.
- No FTS: efficiency reduced by 1/3.
- No MVD/GEM: very poor results.

UPPSALA UNIVERSITET

Thanks for your attention!