CENTRALITY DEPENDENCE OF STRANGE BARYON YIELDS IN Pb–Pb COLLISIONS

Presented by Ladislav Šándor
Institute of Experimental Physics, Košice

for the NA57 collaboration

Physics motivation: why (multi)strange particles ?

- Enhanced production of strange baryons predicted in a quark-gluon plasma (QGP) scenario of high energy heavy-ion collisions (J. Rafelski, B. Müller - 1982)
- the (anti)hyperon enhancement is expected to increase with the strangeness content of particle (statistical hadronization)
- More generally: data on multi-strange hyperons and antihyperons - an important benchmark for microscopic models which attempt a comprehensive description of hadron abundances in nucleus-nucleus collisions

Strangeness enhancement

or the absence of strangeness suppression

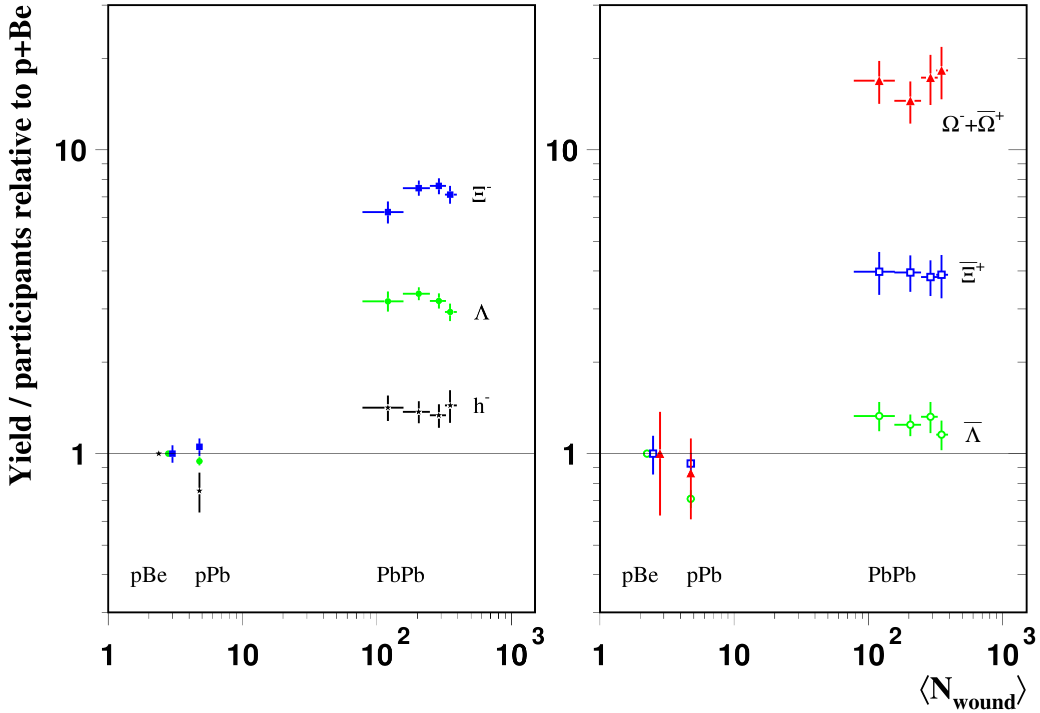
If a QGP is formed:

- **gluons are copiously emitted. Then quark pairs are produced:** $\mathrm{gg} \rightarrow \mathrm{q\overline{q}}$
- **partial restoration of chiral symmetry ($\mathbf{m}_s \simeq$ 150 MeV), $\mathrm{s\overline{s}}$ production much less disfavoured wrt $\mathrm{u\overline{u}}$, $\mathrm{d\overline{d}}$**
- **in a baryon rich environment $\mathrm{s\overline{s}}$ production is additionally favoured by Pauli blocking**
- **equilibration time comparable with the duration of ion collision (a few fm/c)**
- **multistrange baryons are easily produced and their abundance should go up along with that of all other particles**

In the hadronic fireball:

- **a strangeness enhancement could also be obtained as a result of particle reinteractions, but the approach to equilibrium would be limited: high threshold energies, long equilibration time ($\simeq 100\ \mathrm{fm}/c$)**
- **production of multistrange baryons and especially antibaryons is particularly disfavoured (e.g.: $\overline{\Omega}^{+}$ threshold $\simeq$ 3.3 GeV)**
- **the abundances of multistrange baryons would lag behind those of lighter particles, and would not reach saturation during the interaction time**

WA97 results on strangeness enhancement



160 A GeV/c WA97 data at midrapidity ($|y - y_{\mathrm{cm}}| < 0.5$)
exhibit the enhancement in Pb–Pb with respect to p–A collisions
increasing with the strangeness content of particle (QGP prediction)

see: http://wa97.web.cern.ch/WA97/

The NA57 experiment

Successor of the WA97 experiment, similar layout, significant upgrade

Aim: search for the onset of the enhancement in two directions:

- extended centrality range down to $N_{wound} \simeq 50$ (at 160 A GeV/c)
- lower beam momentum: 40 A GeV/c

Status of experiment:

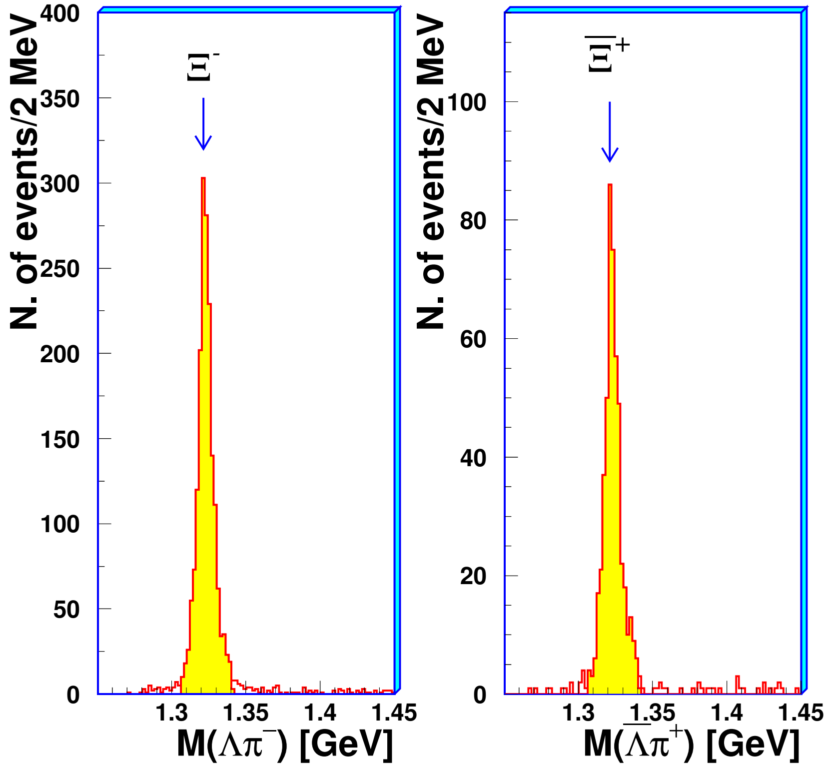
- 40 A GeV/c: Pb–Pb data taken in 1999 (290 Mevents),
  p–Be reference data taking to be completed this summer
- 160 A GeV/c: Pb–Pb data taken in two runs - 1998, 2000
  1998 run (230 Mevents) - analysis in course,
  2000 run (230 Mevents) - event reconstruction in progress
  Note: we need full 1998 + 2000 statistics for Ω !

Pb–Pb 1998 data analysis

- started with Ξ^- and $\overline{\Xi}^+$: statistics large enough to study the centrality dependence down to $N_{wound} \simeq 50$

- major effort on checks (20-30% difference with WA97)

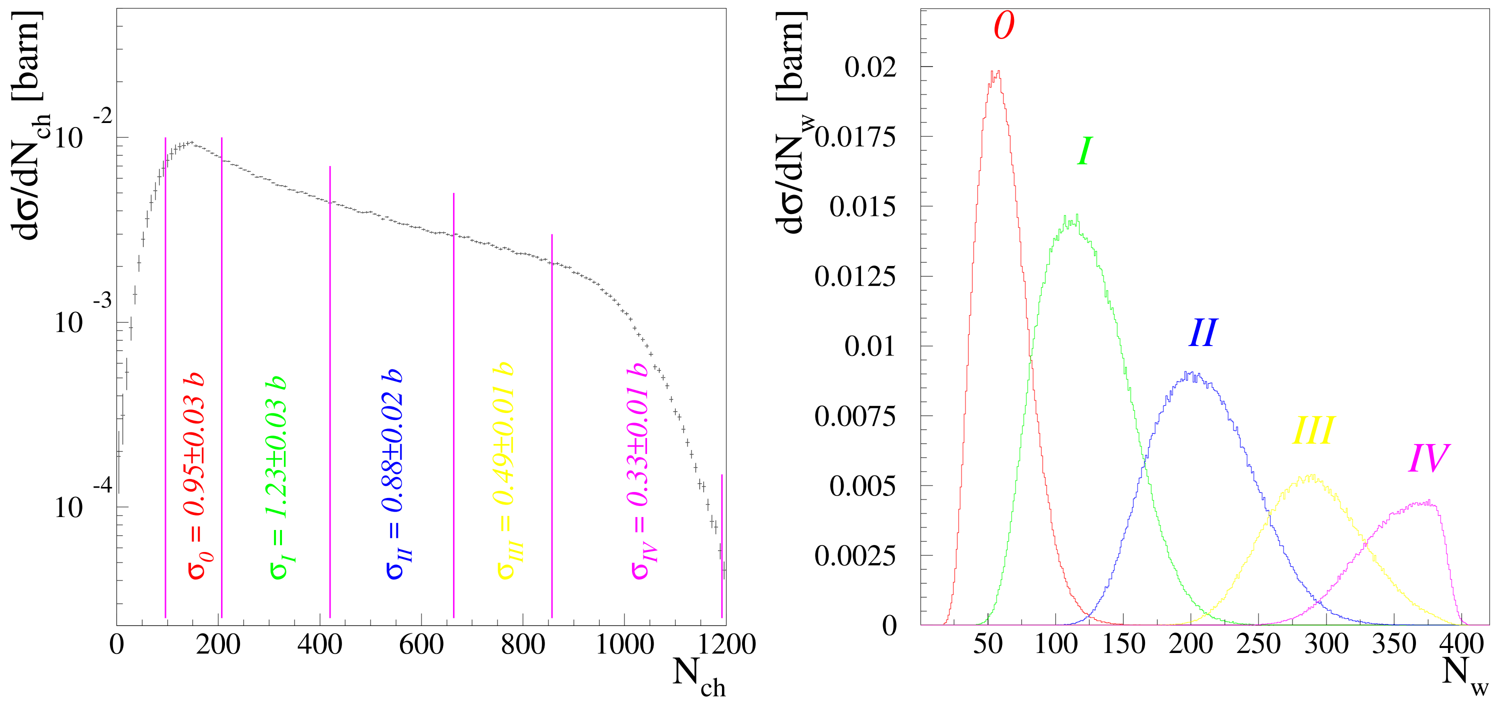
- Λ and $\overline{\Lambda}$ analysis in progress



Selected Ξ^- and $\overline{\Xi}^+$ signals

Centrality estimate

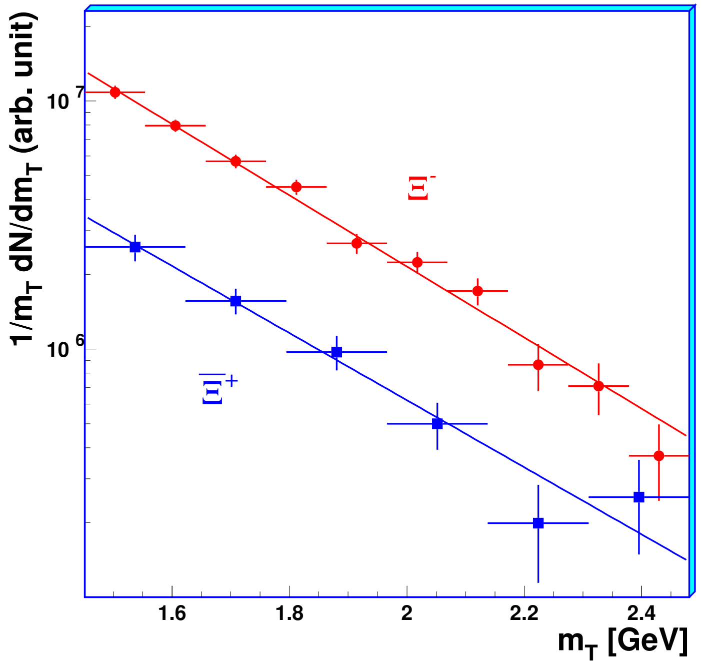
Centrality selection on basis of charged particle multiplicity measurement
Five centrality classes, bins I – IV same as for WA97

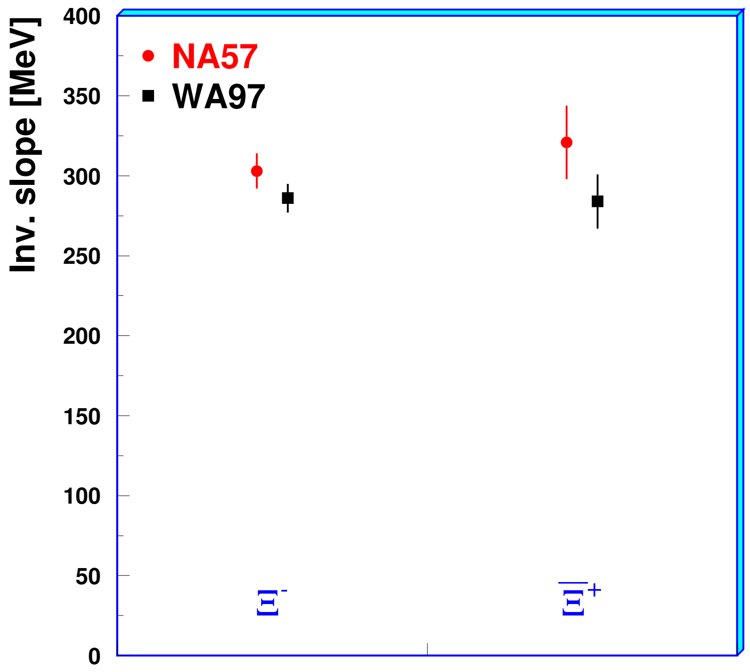


Number of wounded nucleons N_{wound} from Xsections for each class (Glauber)

Most peripheral NA57 centrality bin 0 $\rightarrow \langle N_{wound} \rangle = 62$

Transverse mass spectra, inverse slopes

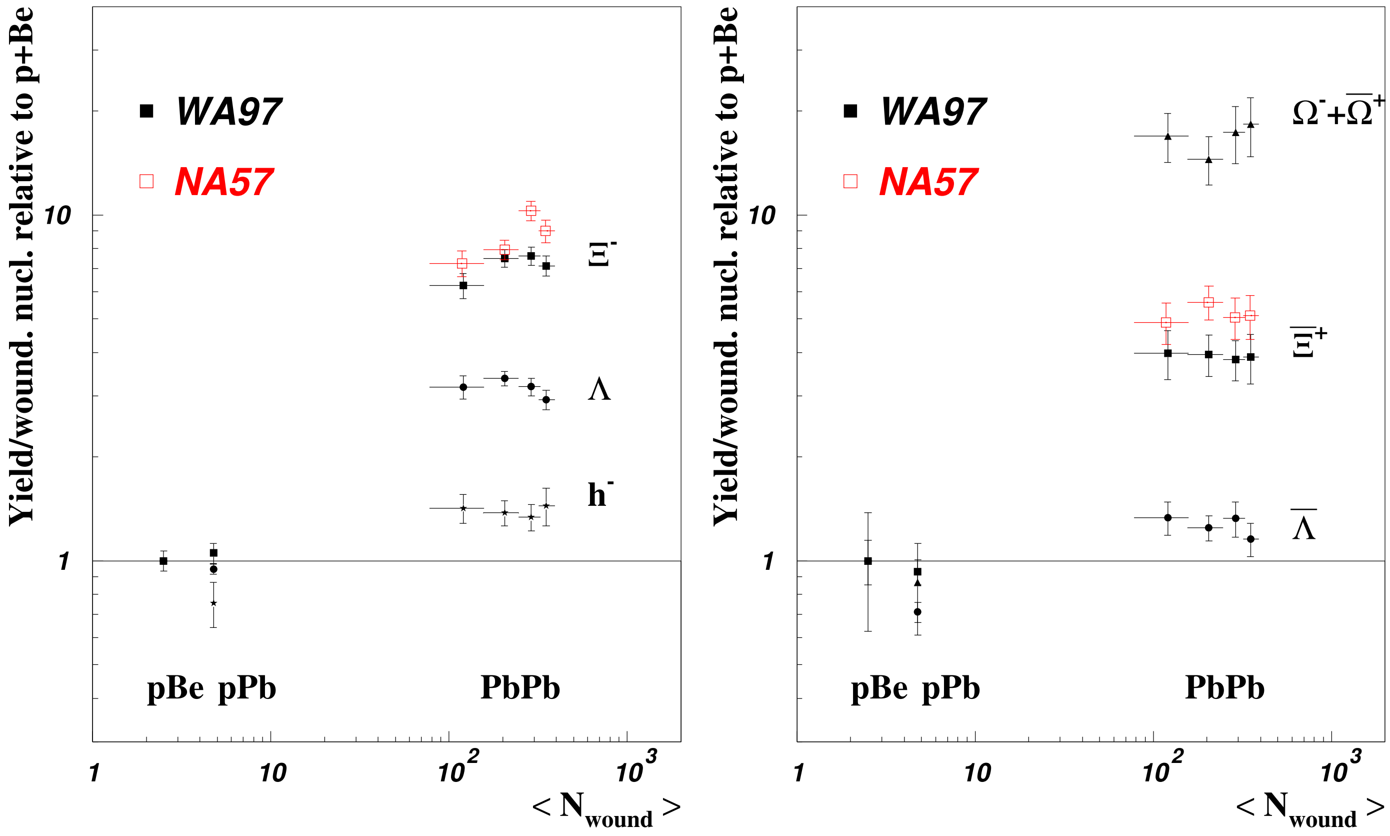




No significant centrality depencence of T

NA57 inverse slopes compatible with WA97

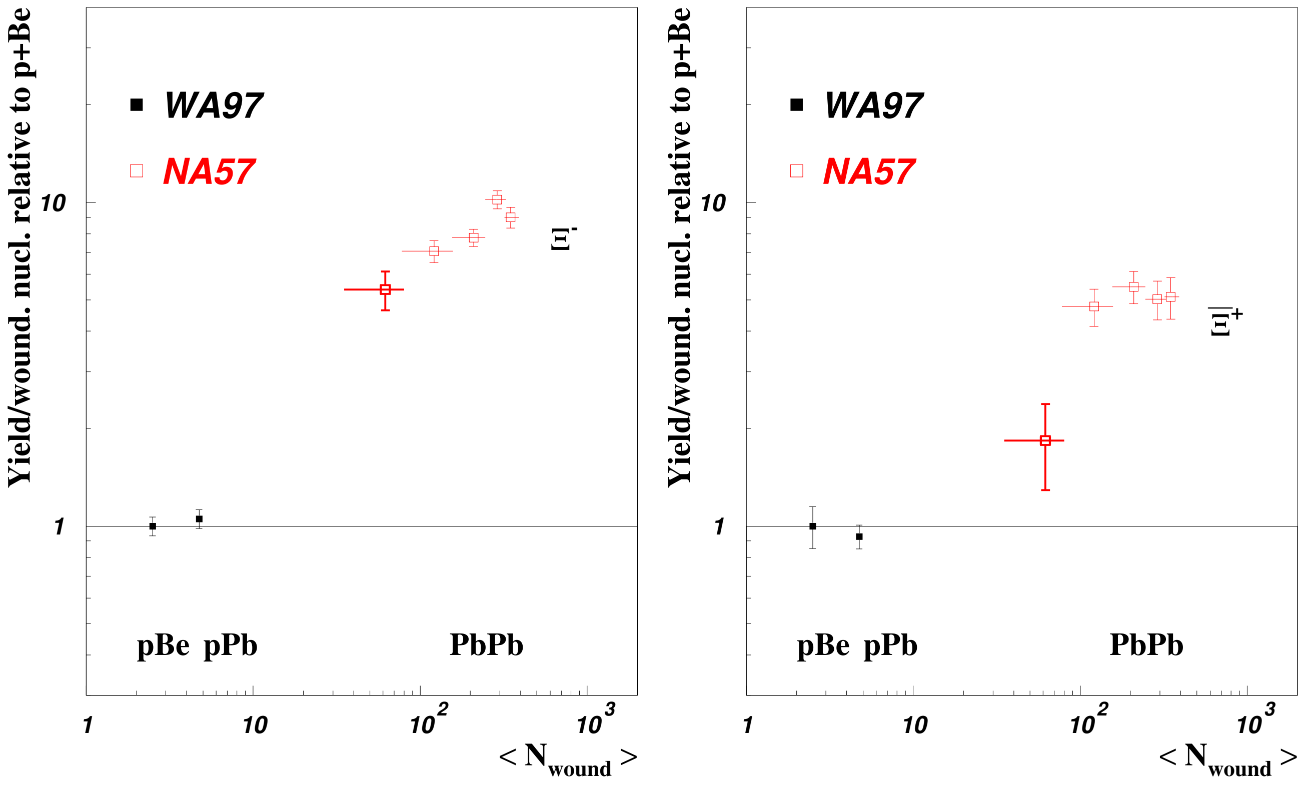
NA57 yields in WA97 centrality range



Ξ^- and $\overline{\Xi}^+$ yields larger by 20-30% with respect to WA97

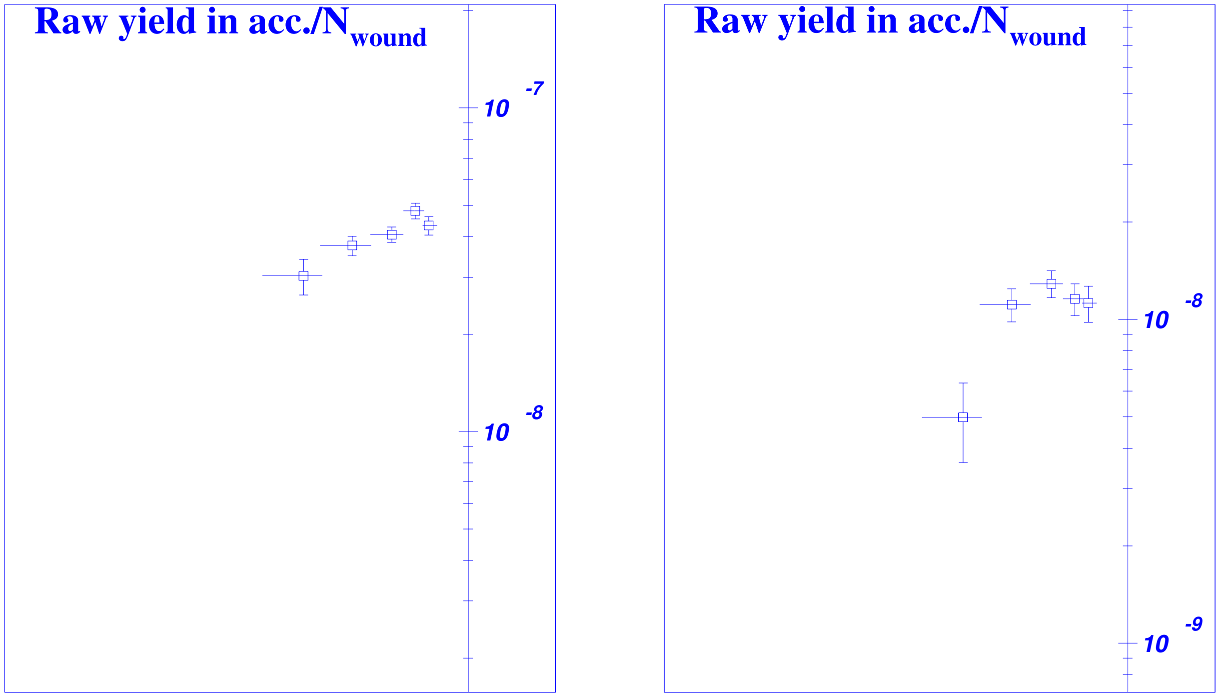
Reasons for this difference being investigated

NA57 Ξ yields per participant

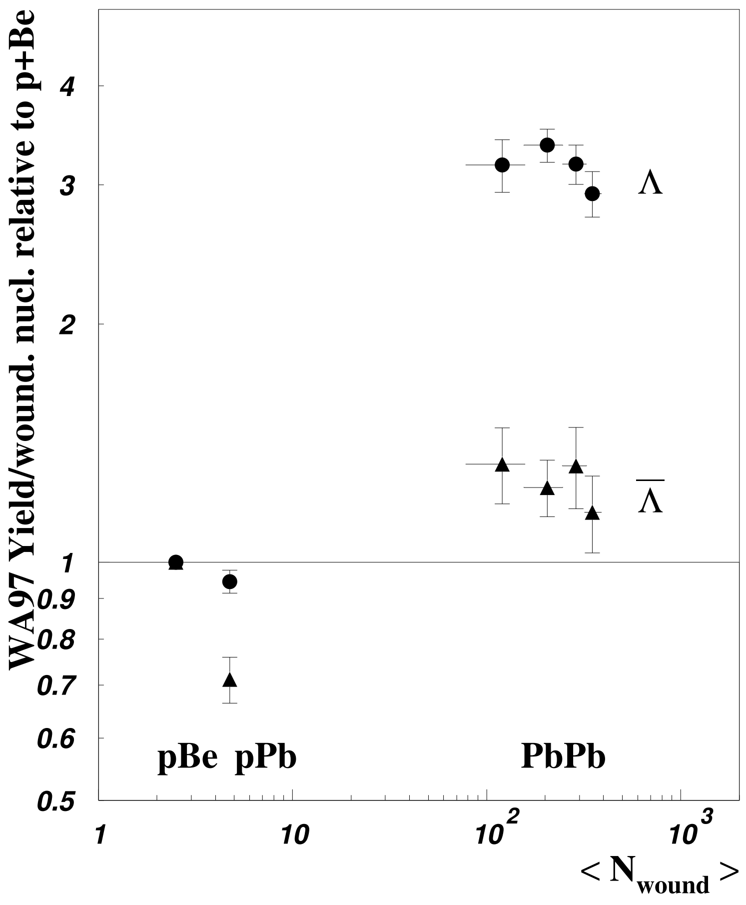


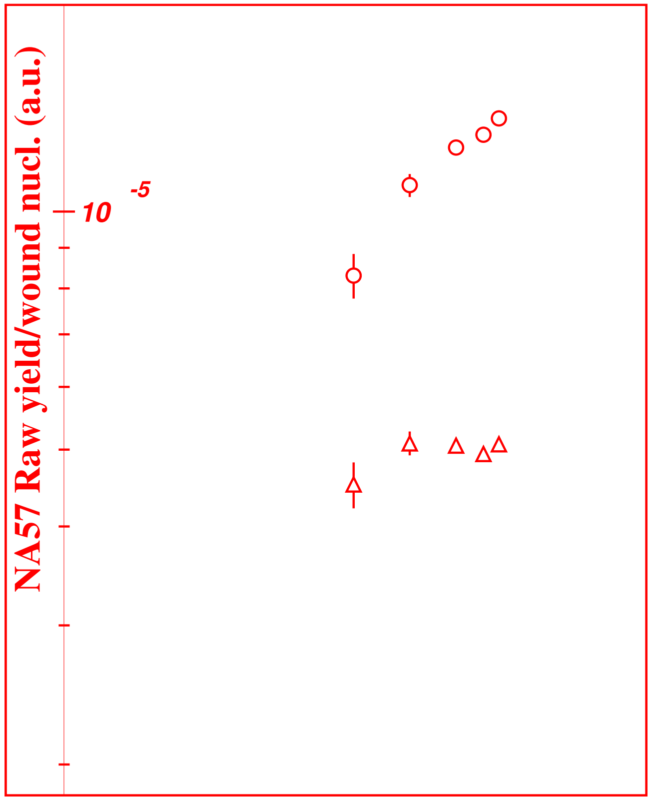
Decrease of yields both for Ξ^- and for $\overline{\Xi}^+$ when going from bin I to bin 0

3.5 σ effect for $\overline{\Xi}^+$. Onset of enhancement ?


Raw yield in acc./N wound
10 -7
10 -8
Raw yield in acc./N wound
10 -8
10 -9

Λ yields per participant





Before going on to final analysis (correction calculations)
the WA97/NA57 difference must be understood

Summary and outlook

- Yields per participant decrease in low centrality region (bin 0) both for Ξ^- and $\overline{\Xi}^+$ (3.5 σ effect for $\overline{\Xi}^+$)
- Λ ($\overline{\Lambda}$) raw yields suggest similar centrality behaviour as for Ξ^- ($\overline{\Xi}^+$)
- Indication of onset of enhancenents warrants further investigation of the transition region (low number of wounded nucleons)

What next ?

- finalize the NA57 vs WA97 comparison
- corrected Λ (1998 data)
- Ω^-, $\overline{\Omega}^+$, doubled statistics for Ξ^-, $\overline{\Xi}^+$ (2000 data)
- analysis of 40 A GeV/c data (Ξ, Λ)
- possible request for a run (2002-3) using existing NA57 set-up with intermediate mass beam