

Should we test strangeness conservation?



The Standard Model of Particle Physics (S.M.)

- Strong interaction is flavor blind. Thus it cannot change flavor!
Its time scale is 10^{-22} s.
- Weak interaction can change flavor.
Its time scale is $\sim 10^{-11}$ s.

On the other hand there must be “something” beyond this “standard model”! (to explain dark matter, neutrino masses, ...)

Beyond S.M.

- Maybe there are rare flavor changing interactions with time scales between those of weak and strong interactions?
Should we check?
- Two arguments:
 - There is no measurement of an upper limit for strangeness conservation violation (to my knowledge)! And what is not measured is not known!!
 - Isospin (quark flavor) symmetry is violated in strong interactions (see below).

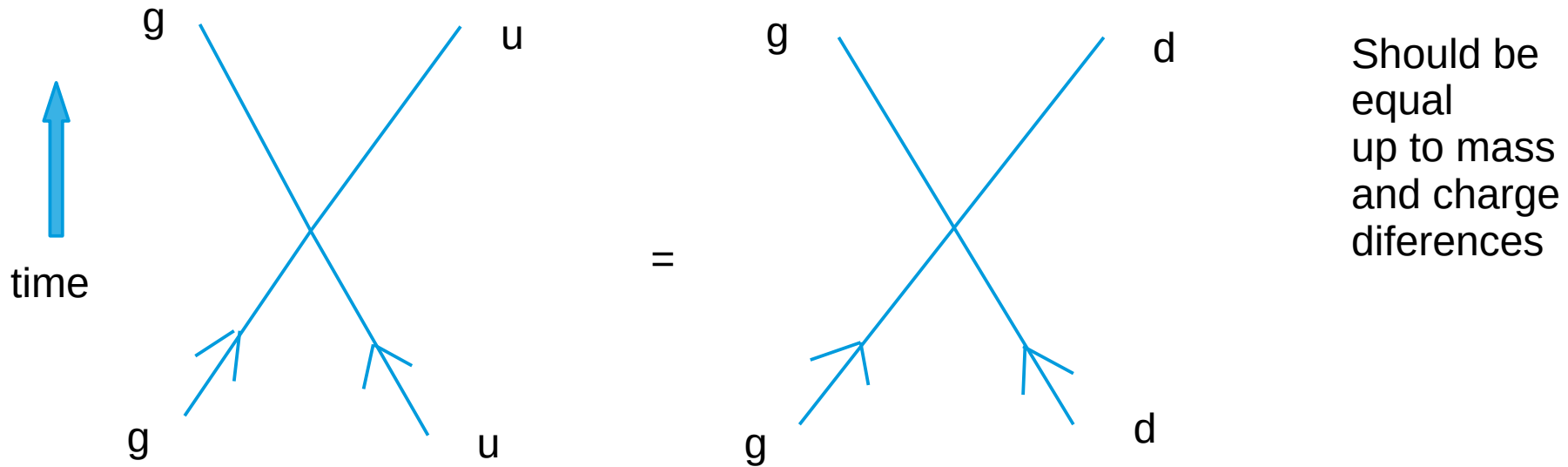
Question: Is a measurement of the upper limit worth a publication?

Is a measurement of the upper limit worth a publication?

- The answer depends on:
 - The achievable value of the upper limit.
 - Number of recorded events, number of events with strange particles
 - The effort to determine the upper limit.
 - Analysis steps, particle ID.
 - Effort to determine the upper limit.
 - Unknowns ...
- ... your belief in strangeness (flavor) conservation....

More on flavor and strong interactions

S.I. is flavor blind \Leftrightarrow isospin symmetry



Should be equal
up to mass
and charge
differences

Isospin symmetry violation

$$(u\bar{s} + \bar{u}s)/(d\bar{s} + \bar{d}s) = (K^+ + K^-)/(K^0 + \bar{K}^0) = (K^+ + K^-)/2K_s^0$$

Should be ~ 1 in isospin symmetric collision systems

Experiment $\sim 1.13 \pm 0.03$ (4.7σ) (Ar+Sc @ $\sqrt{s} \sim 10$ GeV)

Ref.: Nature Comm. 16, 2849(2025) (NA61)

This finding was “present” since 20 years in experimental nuclear collision data but never published because of the prejudice that the ratio should be unity (and analysis problems! see backup).

Isospin symmetry violation:

Do we have to rethink “Strong Interaction”?

(but there are attempts to explain “1.13” within the S.M.)

If yes, is flavor conservation affected?

Is there an experimental upper limit for strangeness conservation at shorter than weak interaction time scales?

No!! (no published or unpublished result found!)

How to (measurement of the upper limit)?

Search for $p+p \Rightarrow$ proton + lambda + π^+

Optimize

- find a data set with large number of recorded events,
- choose elementary reaction with maximum number of Lambdas,
- choose events with at least one proton and a lambda in the final state and check for missing mass compatible with pion mass.

My proposal

Analyse high statistics p+p interactions for p L pi+ final states.

- Select events with one or more positively charged tracks and a V0.
- Select one positively charged track, assume it is proton, assume that the V0 is Lambda. Plot the missing mass ($MM(p,L)$) and look for entries below 300 MeV/c² (to differentiate between pp>p L K+ and pp>p L pi+).

(Select another positively charged track, assume it is a proton, assume that the V0 is Lambda. Plot the missing mass ($MM(p,L)$) and look for entries below 300 MeV/c²)

If there are no events with $MM(p,L) < 300 \text{ MeV/c}^2$, the job is essentially done. Only the estimate of an upper limit would be needed to publish the result.

My proposal cont.

If there are events with $MM(p,L) < 300 \text{ MeV}/c^2$, then much more effort has to be invested:

- V0 opening angle cut (removal of gamma conversion),
- proton ID, lambda ID,
- kinematical fit !?
- Caution: K^+ decay $\Rightarrow \mu^+ + \nu$ may fake a π^+ !

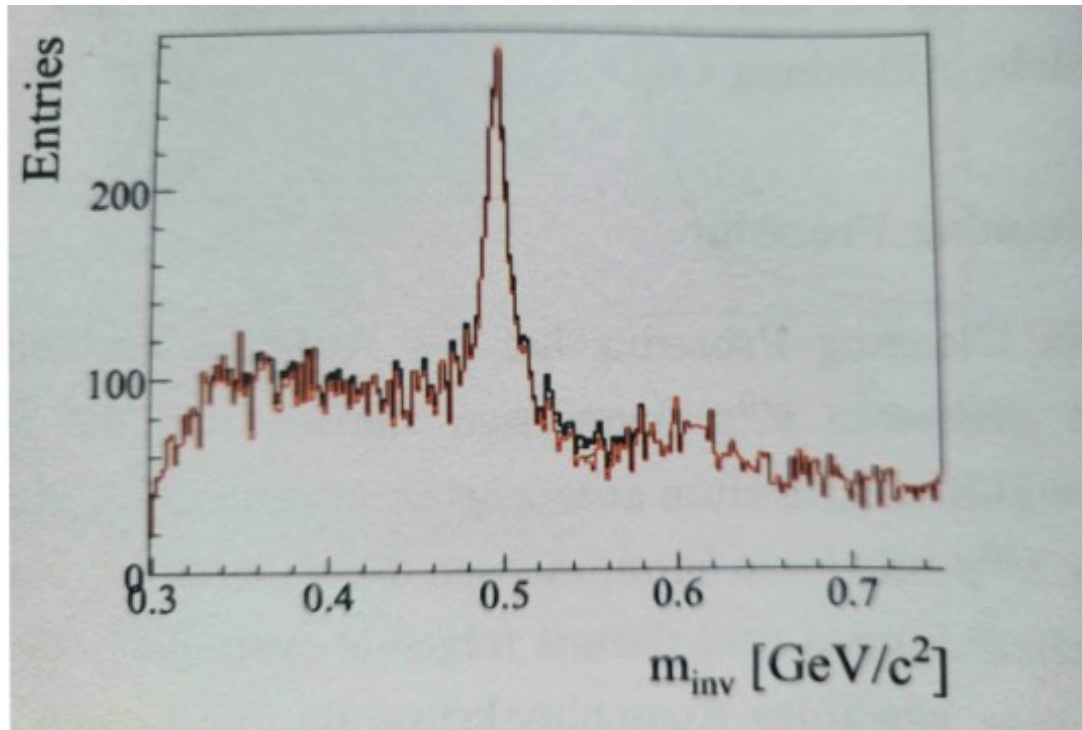
“until no entries remain”!

Backup on K^0_s analyses (isospin symmetry viol.)

- NA49 had more than 4 theses on K^0_s production in Pb+Pb collisions, the results of which were never published, because of either unstable or “too small” results!
- Similar problems were present in other early Pb+Pb analyses by other collaborations.
- NA61 studied smaller systems (e.g. Ar+Sc) with stable results.

My suspicion: correlated background in π^+/π^- invariant mass distributions in high multiplicity events (probably from Ξ^-).

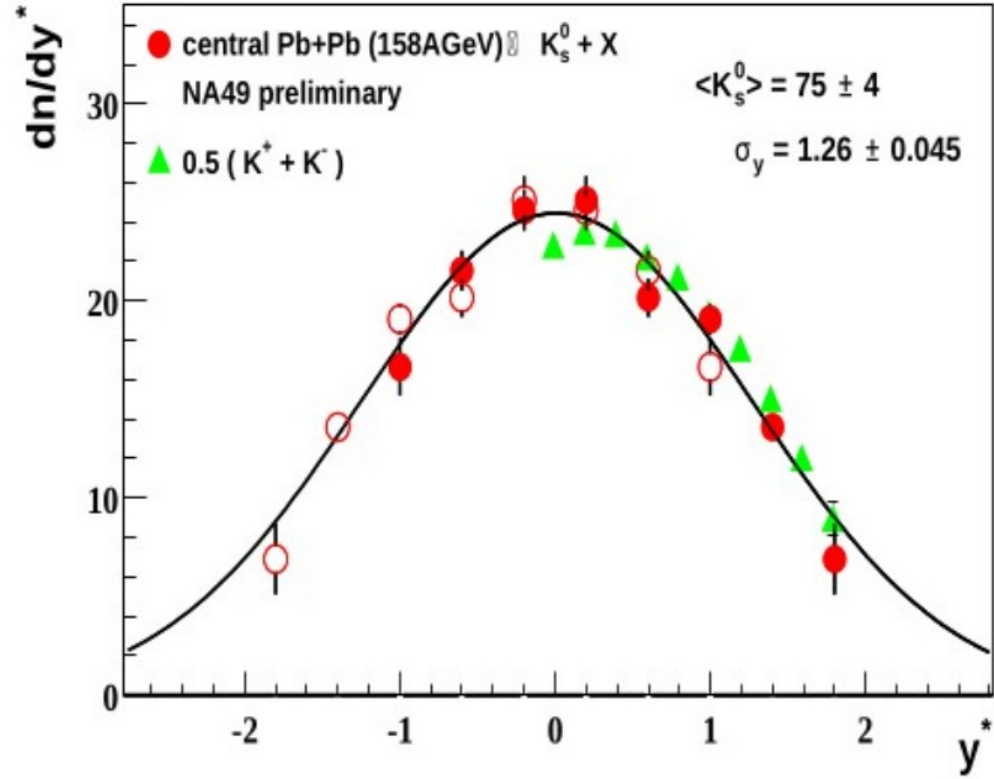
From Book's thesis



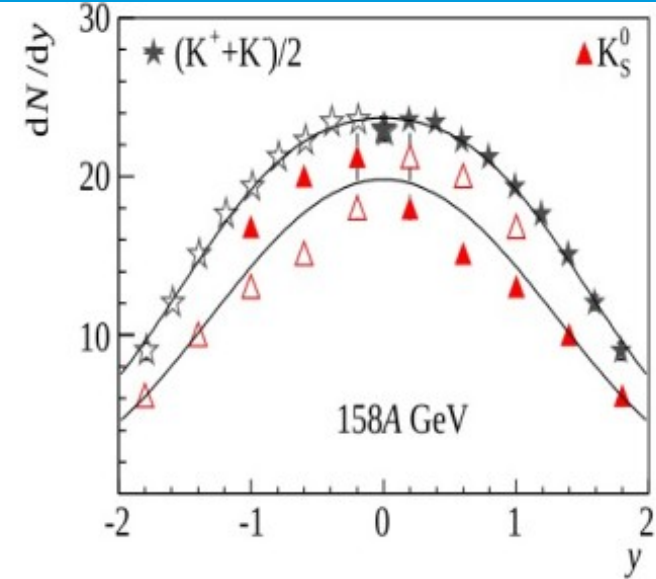
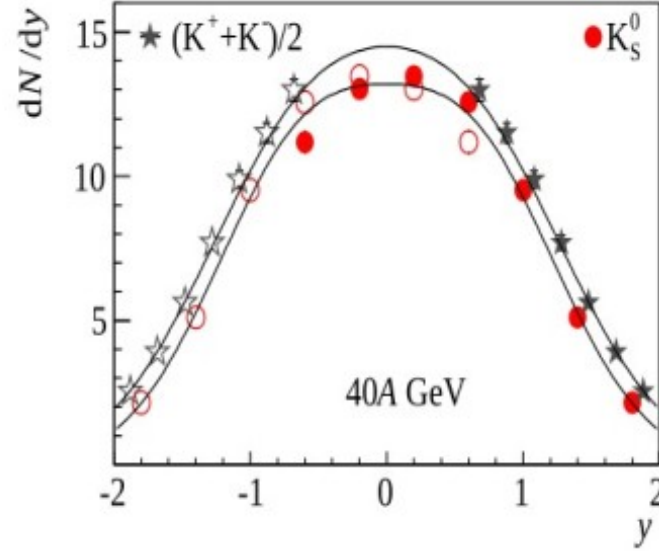
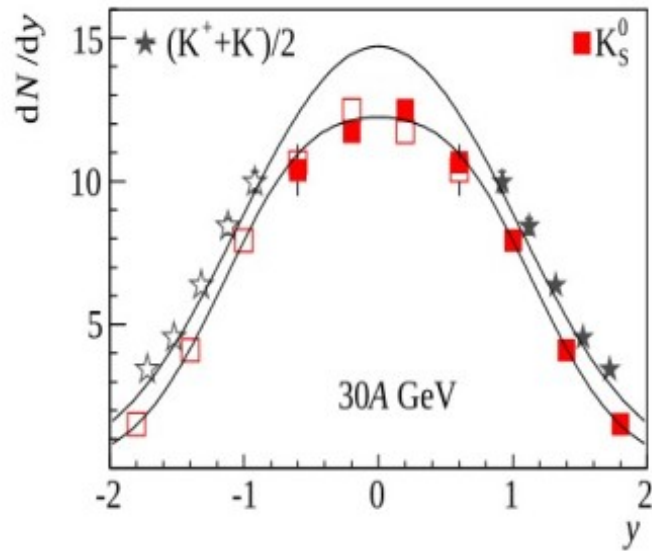
- Note the bump on the right of the K0 signal.

Thesis A. Mischke

K0 by NA57
 $dn/dy(y=0) = 27$



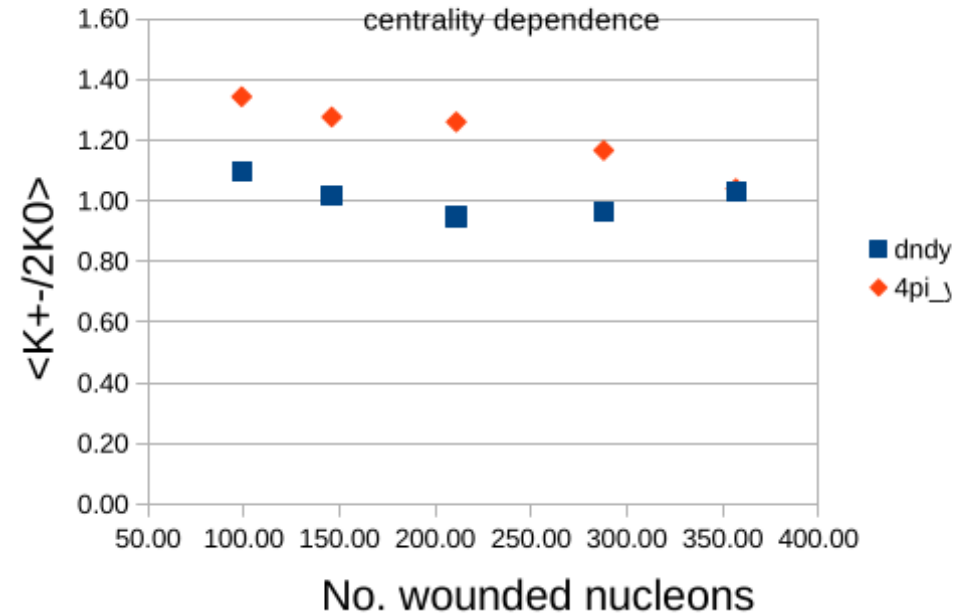
Thesis C. Strabel



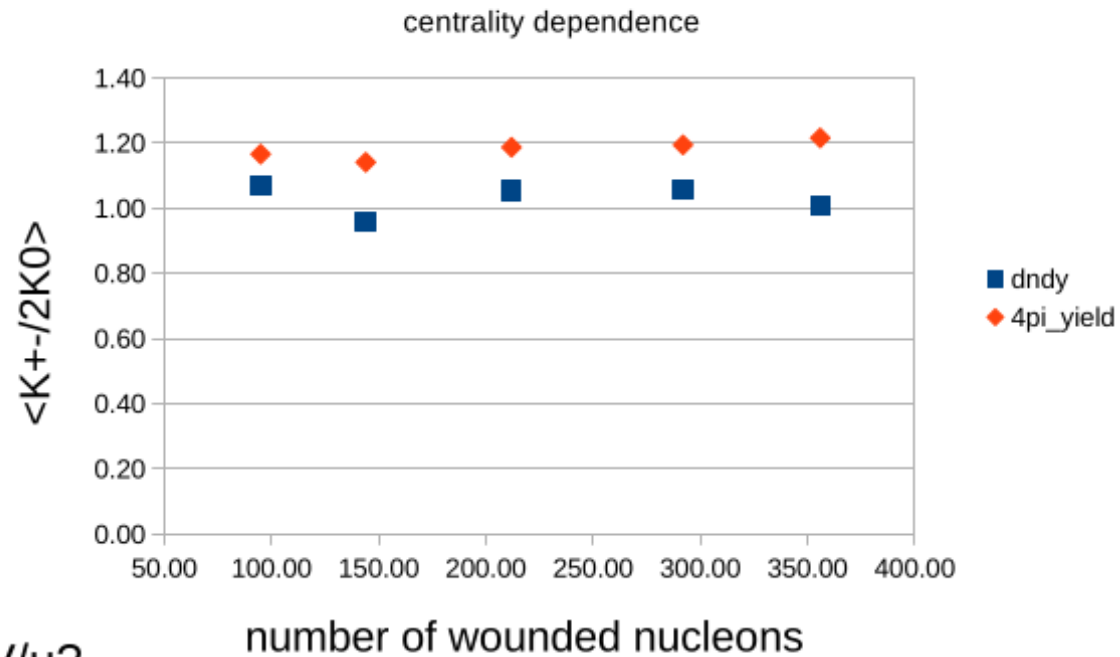
More charged than neutral kaons at all energies!
Asymmetry with respect to midrapidity at 158 GeV/u.
Too many K^0 below midrapidity at 158 GeV/u?

The “last word” from NA49 on K^0_s (J. Book thesis)

Charged to neutral kaon ratio at 158 GeV/u



Charged to neutral kaon ratio at 40 GeV/u



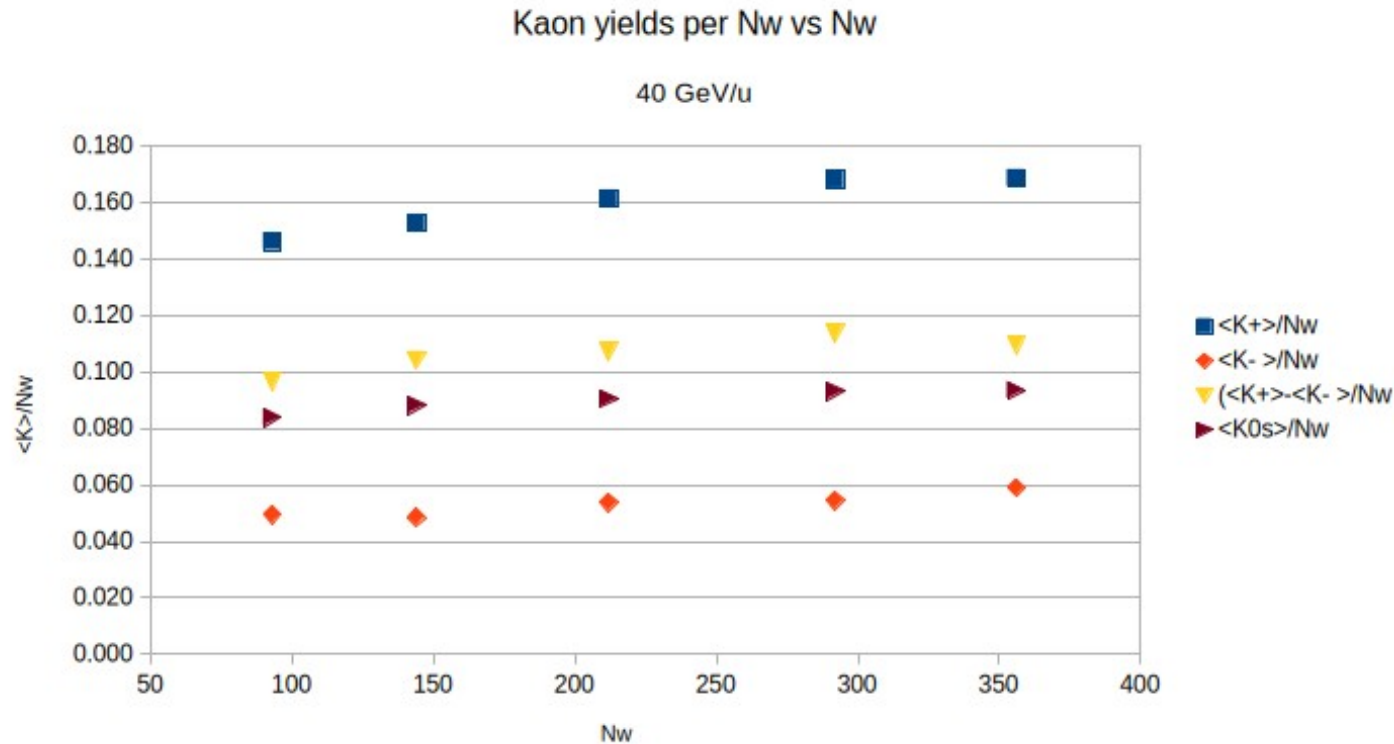
What is the problem of the data at 158 GeV/u?

Why do the ratios decrease with centrality?

Different centrality selection for K^+ and K^0 in peripheral collisions?

unpublished!

Kaon yields per Nw vs Nw at 40 GeV/u



Note increase of normalized kaon yields with centrality except for central collisions

Thank you