Polarized p-A and Inclusive Lambda Polarization experiments at the AGS

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p-A@RHIC Workshop
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Outline

- Asymmetry in Inclusive Pion Production at the AGS
- Issues with intended production from a carbon target
- The experimental set up and results
- Lambda polarization measurement at the AGS
- Comparison from p-A production
- Summary

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Asymmetry in Inclusive Pion Production

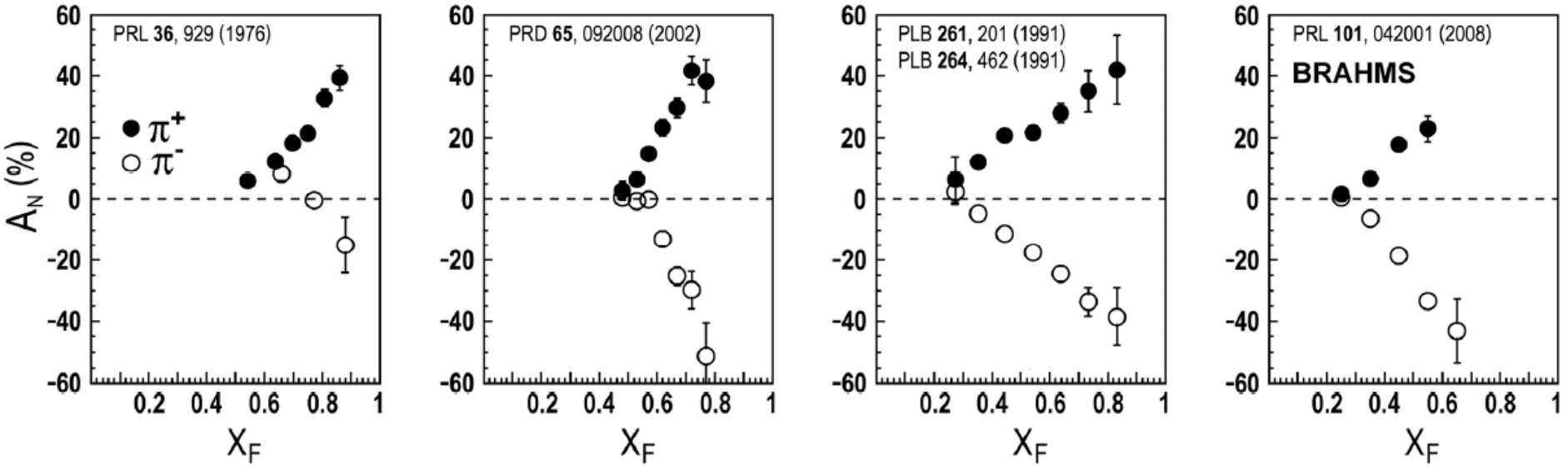
BRAHMS

ANL
√s=4.9 GeV

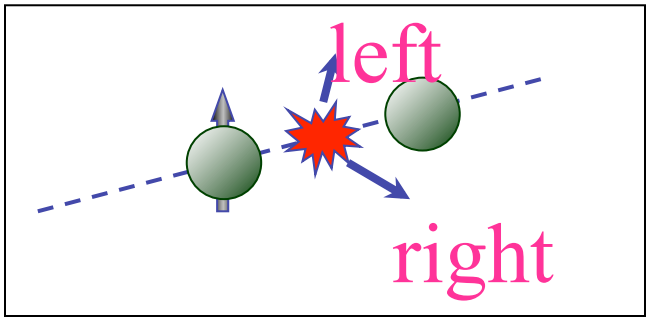
BNL
√s=6.6 GeV

FNAL
√s=19.4 GeV

RHIC
√s=62.4 GeV



$$x_F = 2p_{long} / \sqrt{s}$$



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C. Aidala's compilation

The measurement at the AGS

- The impetus was RHIC polarimetry
- The choice polarimeter then was inclusive pion production
- From E704, the expected asymmteries for our design was 15%
- The only target that would withstand beam heating was carbon
- The question, are we likely to experience a diluted asymmetry?
- An RBRC theory workshop and the assumption was Yes!
- This prompted an experimental verification

The Theoretical Argument Boris Kopeliovich hep-ph/9801414

- Agues that inclusive production follows the Cronin effect being proportional to A^{α} with $\alpha > 1$ due to qualitatively multiple interactions / rescatterings in the nucleus and increases with higher transverse momentum
- The apparent larger pt is a result of distributed over many interactions with lower momentum transfer
- Assuming a carbon nuclear density of 0.33 fm^{-2} he calculates the mean no. of parton scattering ~ 2 or half the effective p_t
- Since the asymmetry is linear with p_t he expected $A_N/2$ at p_t=1 GeV/c

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Yesterday: Yuri's odderon >> a dilution in p-A

Feng no dilution at $p_t >> Q^2$

AGS E925 Experiment

PHYSICAL REVIEW D, VOLUME 65, 092008

Measurement of analyzing powers of π^+ and π^- produced on a hydrogen and a carbon target with a 22-GeV/c incident polarized proton beam

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(E925 Collaboration)
(Received 11 September 2001; published 20 May 2002)

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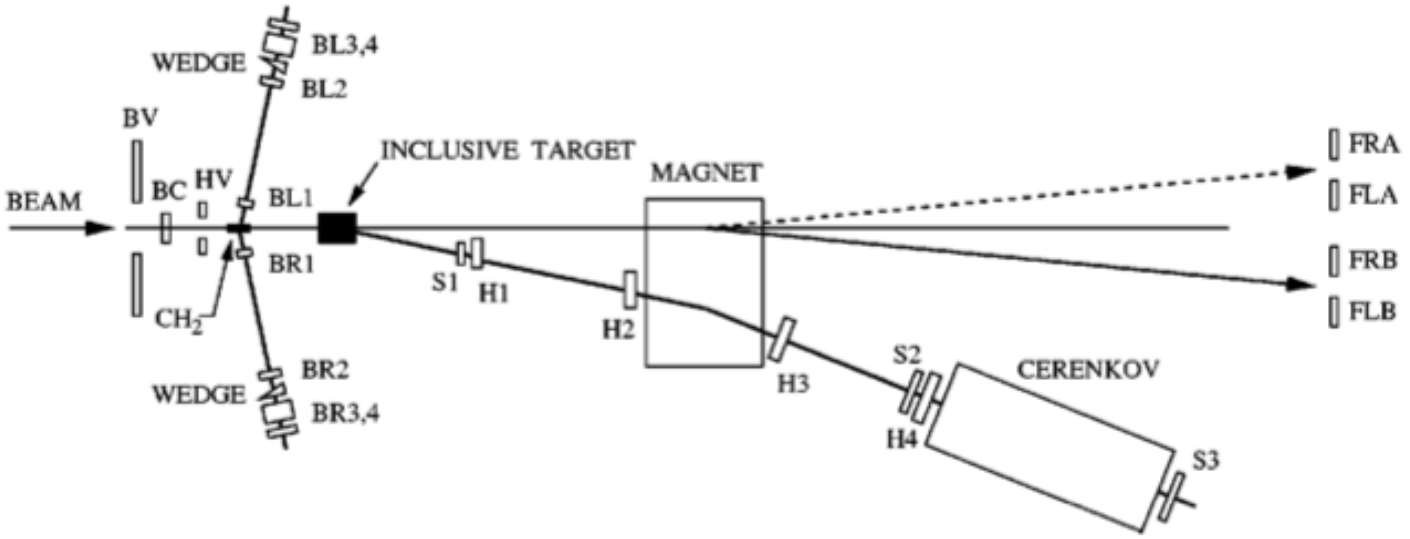
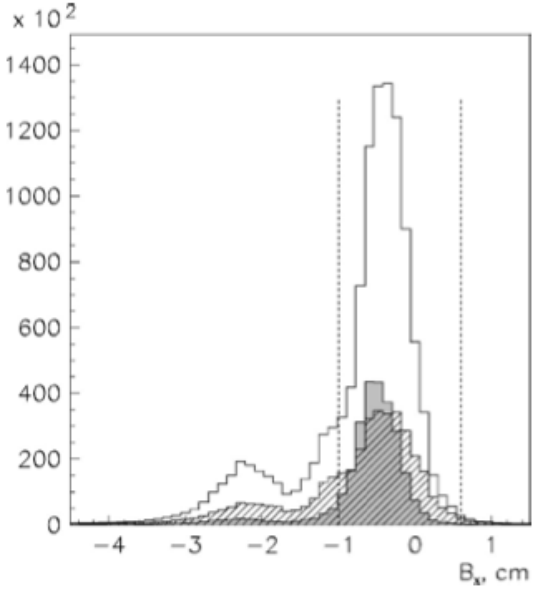
AGS E925



- A single arm spectrometer to identify all charged particles
- Three targets: Hydrogen, Carbon, CH_2
- Strong coupling between x_F and p_T



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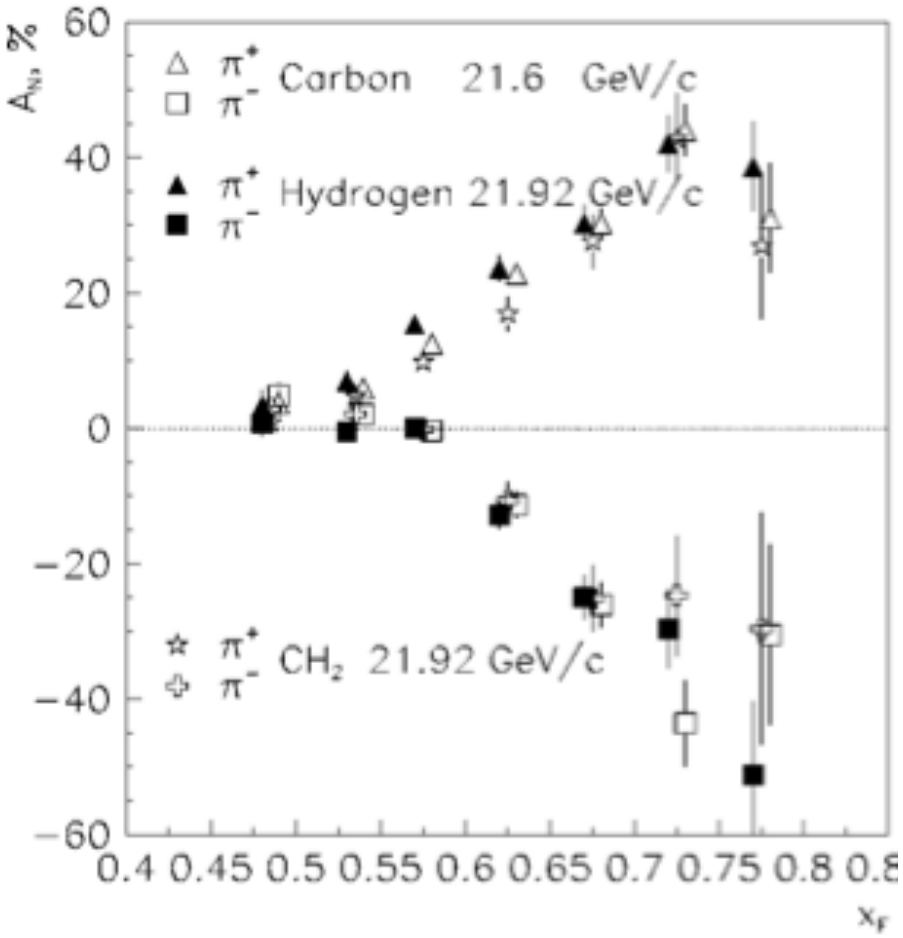
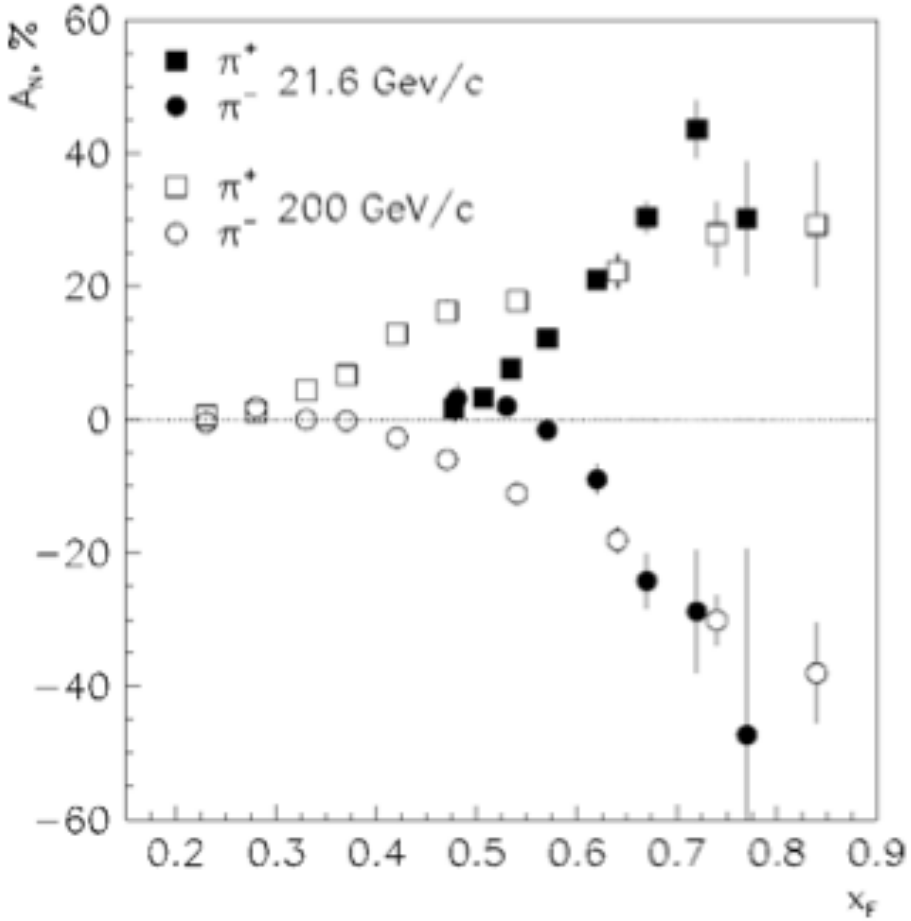
A_N in pion production

$x_F > 0.45$ and $0.6 < p_T < 1.2$ GeV/c





No difference between hydrogen and carbon targets

Will this persist for larger A targets?

Discernable change with beam energy

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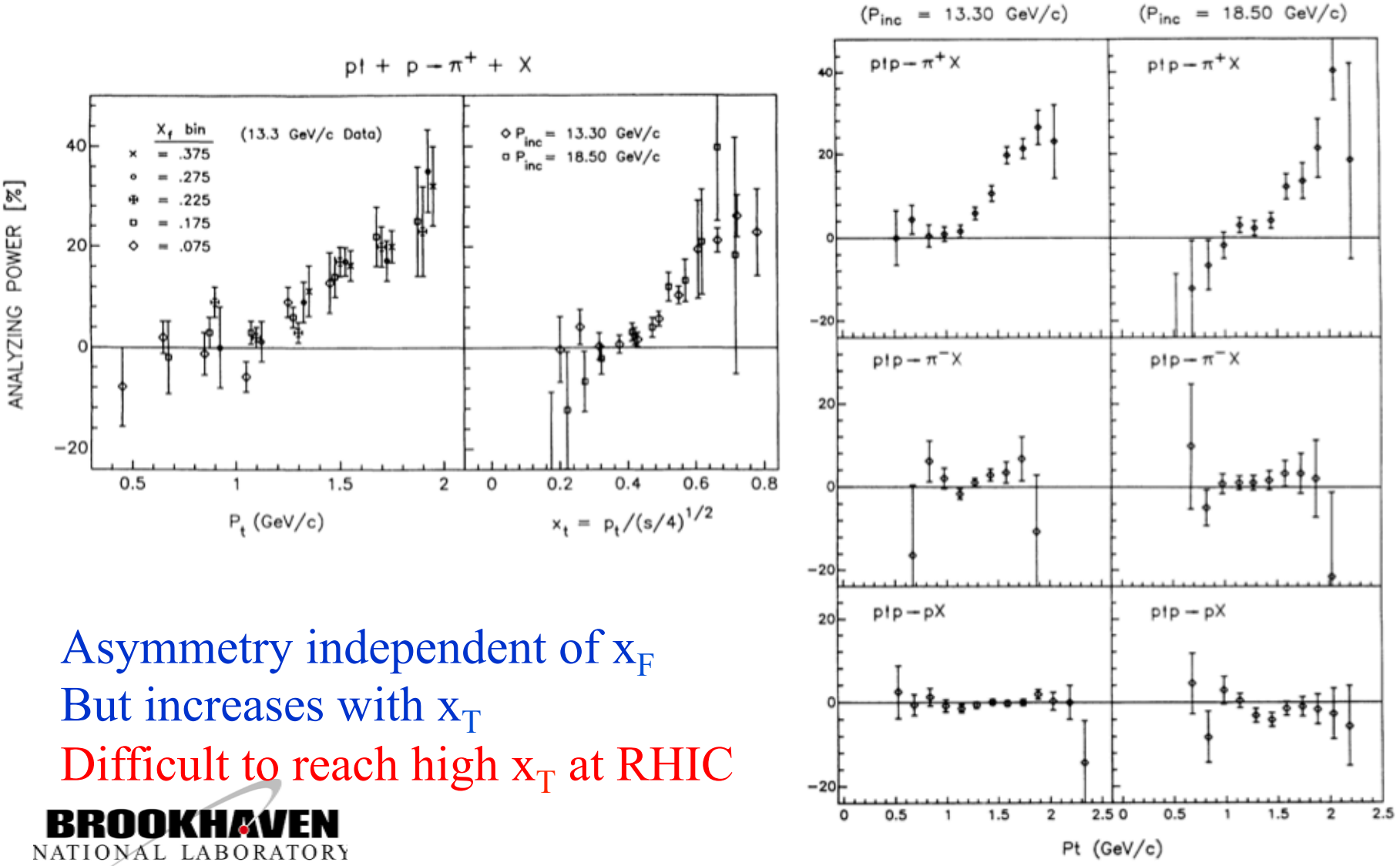
Another measurement from the AGS PRL 64, 925 (1990)



Asymmetry independent of x_F

But increases with x_T

Difficult to reach high x_T at RHIC

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Summary of the AGS pion asymmetries

- Large asymmetries in charged forward pion production are observed similar to those at the ZGS and Fermilab

- Large asymmetries observed at large angles and large x_T in π^+ at but not in π^- or protons.

- The AGS data from hydrogen, CH_2, and Carbon targets do not support the notion of dilution of asymmetry with higher A

- It is possible that dilution will appear at higher A
  polarized p-A at RHIC is the venue

Lambda Polarization measurement at the AGS

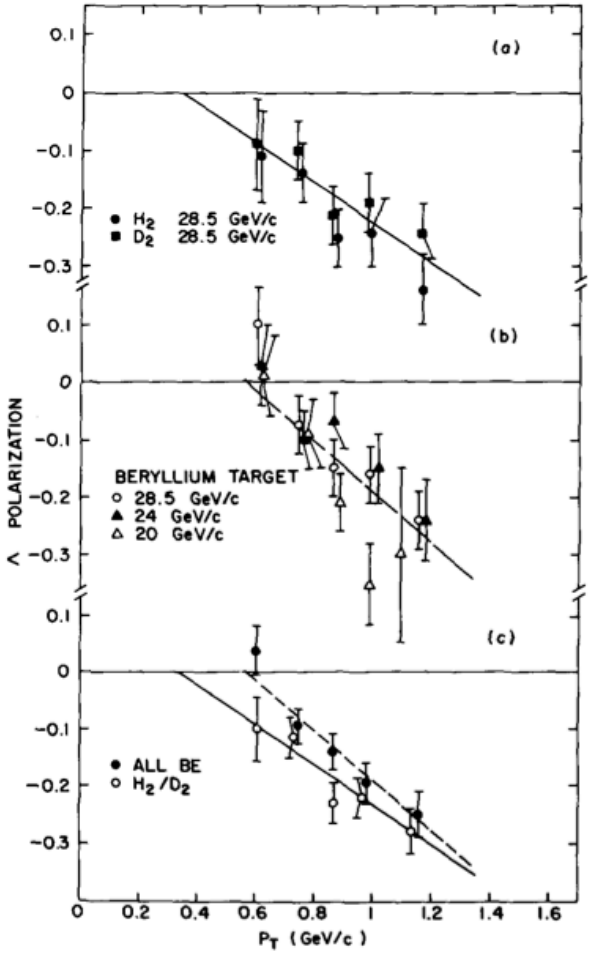
- Earlier Lambda polarization measurements at Fermilab were carried out primarily with Beryllium targets

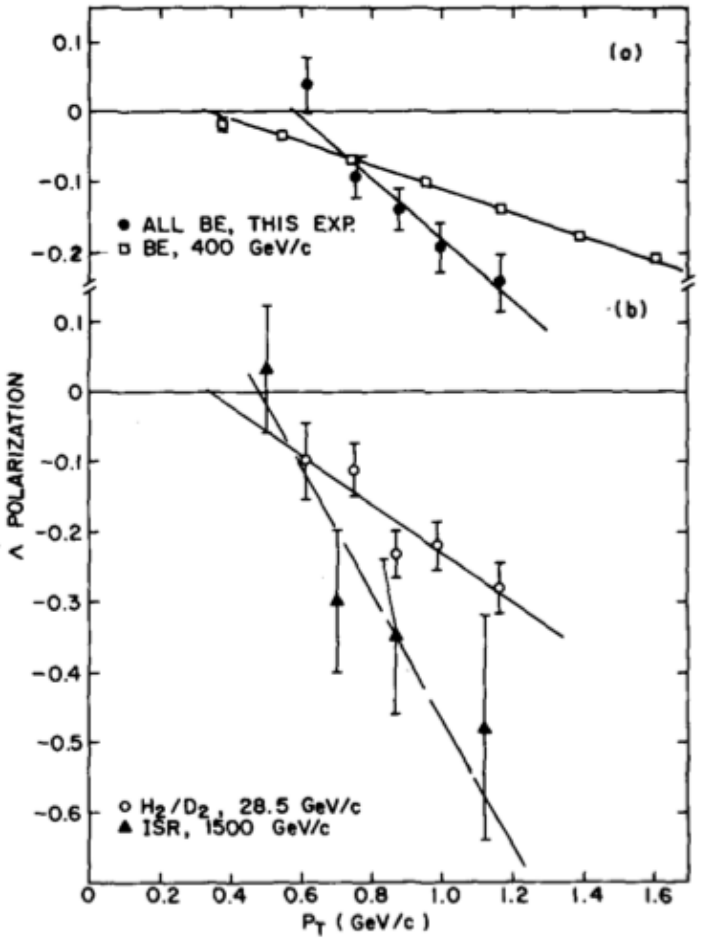
- While Λ's and Ξ^0's were polarized, anti lambdas and protons were not.
- Could this be a result of some nuclear effect?

- The AGS experiment sought to study Lambda polarization from hydrogen, deuterium, and beryllium targets

- Data collected at incident beam momenta 20, 24, and 28.5 GeV/c

Lambda Polarization





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Polarization seen in hydrogen, not a nuclear effect

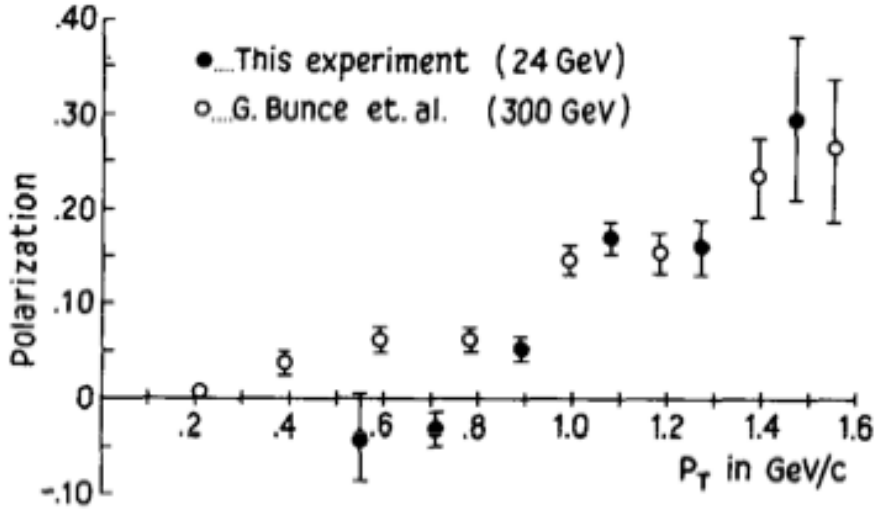
Possible nuclear dependence? Be lower than H_2/D_2

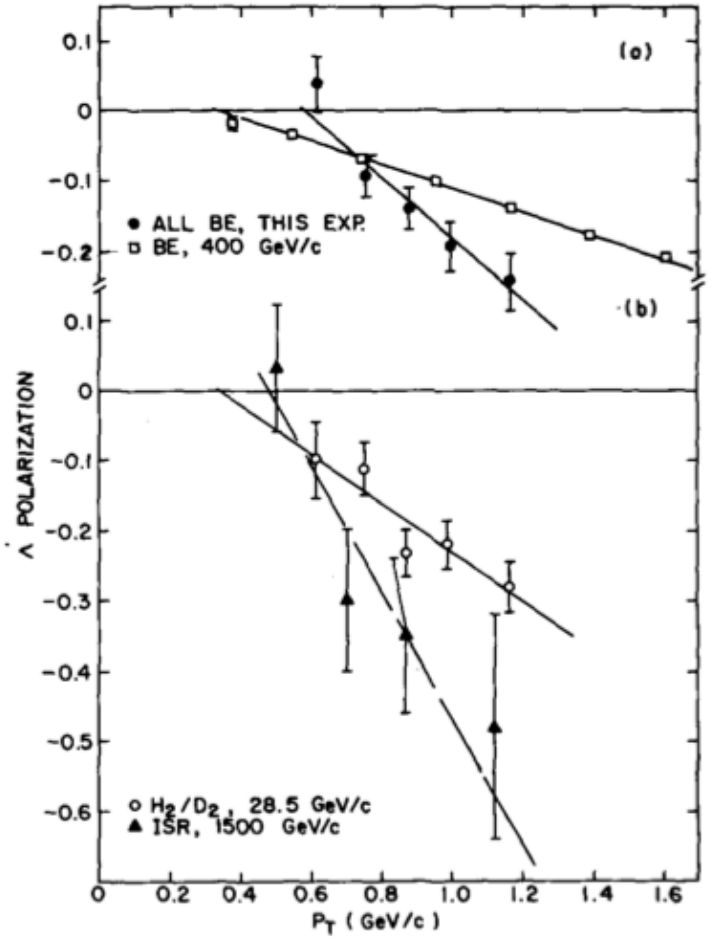
Strong energy dependence

Lambda polarization Cont'd

p-A dependence was further inferred by comparing the AGS Measurement to one that at CERN at 24 GeV with platinum target. At the same p_T the polarization in diluted

K. Heller et al. phys. Lett. 68 (1977) 480





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Further work at the AGS M. Sullivan et al. PRD 36 (1987) 674

At this stage there was no distinction made between directly
Produced Λ and those that come from Σ -> Λ + γ decays.
If Σ are polarized their daughter Λ could retain 1/3 the polarization
implying higher polarization for direct lambda

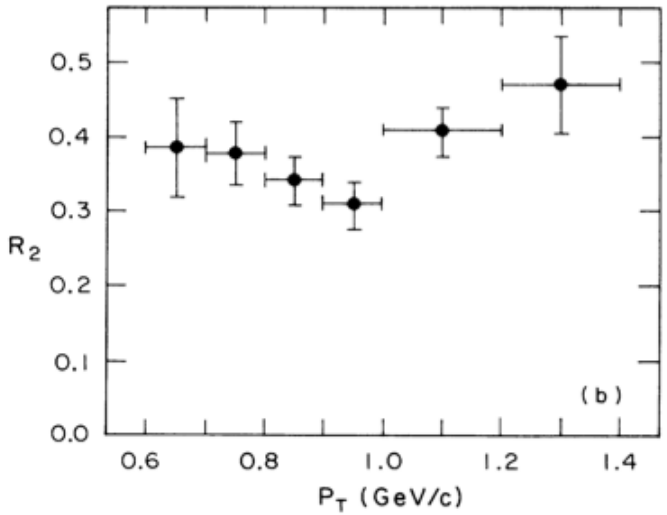

FIG. 12. R_2, the ratio of Σ^0 inclusive production to directly produced Λ^0 production, is shown vs (a) p, the momentum of the produced particle and (b) p_T, the transverse momentum of the produced particle. The errors are statistical only.

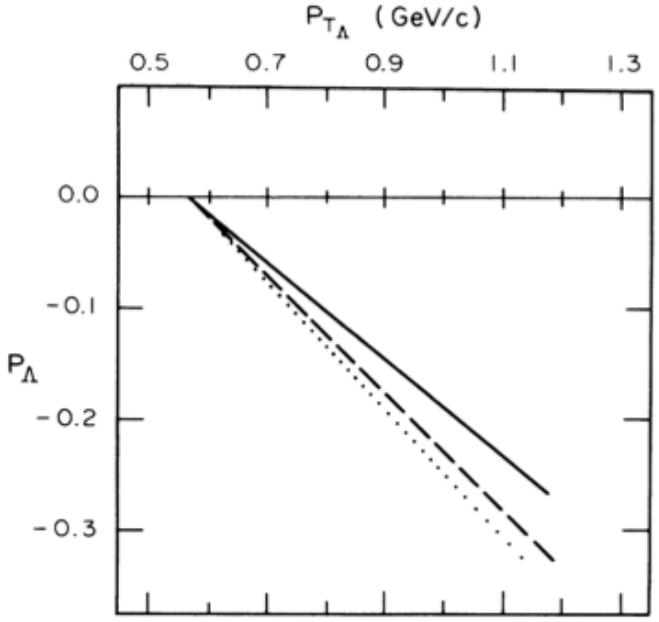

FIG. 13. The effect of this measurement on a previous Λ^0 polarization experiment. The solid line is the fit to the polarization data determined in Ref. 3. The dashed line results if Σ^0 polarization is equal and opposite to that of the observed Λ^0 polarization. The dotted line results if the Σ^0 are produced unpolarized.

Summary of Lambda polarization p-A

- Hyperon polarization is well established with measurements at FNAL, the CERN PS and ISR, and the AGS
- The measured polarization seems to be diluted with higher A
- Studies on spin transfer from polarized beams to hyperons
  COMPASS and HERMES w/ muon and electron beams
  E704 at Fermilab and STAR (Sichtermann's presentation)
- Polarized p-A at RHIC provides a good opportunity for such systematic studies