Forward Backward Asymmetry for Λ, Ξ and Ω baryons

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D0 Detector

Tracking & Muon System

- Scintillator counters and drift tubes
- Thick calorimeter and iron toroids

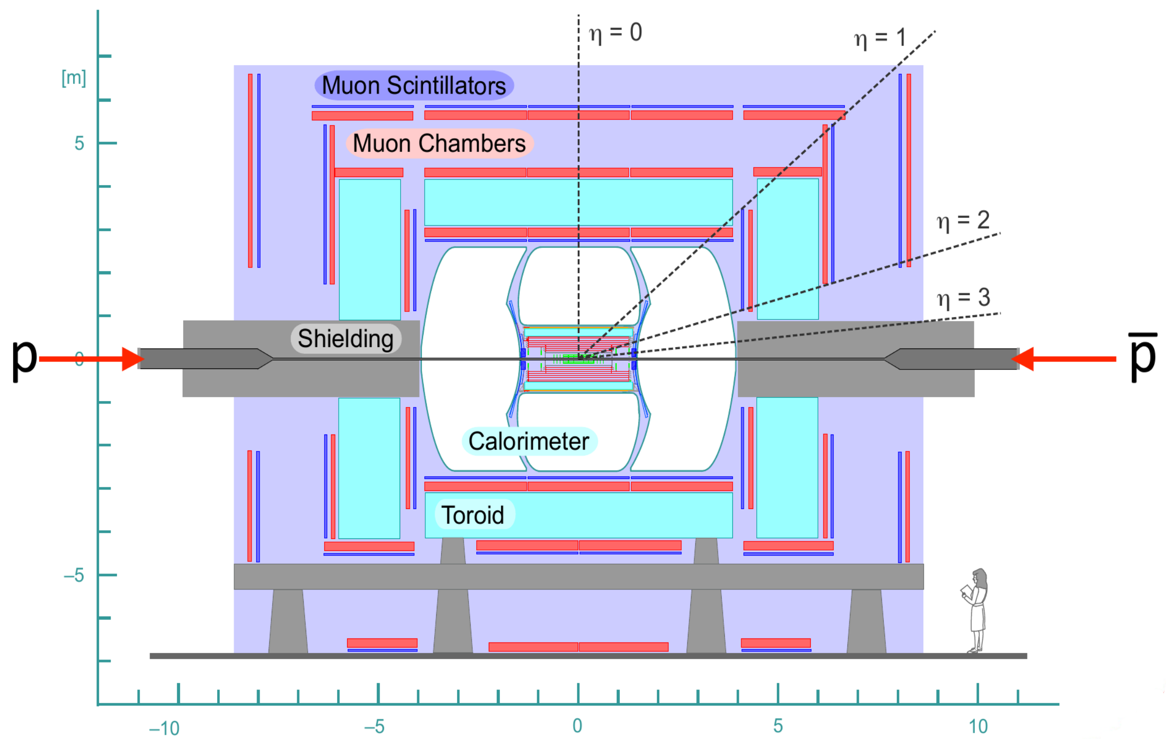
Excellent muon triggering and ID

- Silicon Microstrip Tracker

Excellent vertex resolution

- Central Fiber Tracker

Good mass resolution



Excellent for B physics with muons

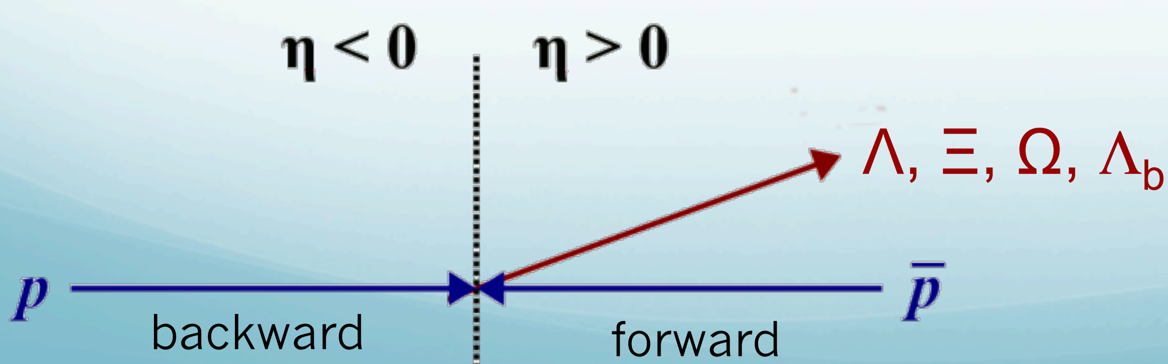
Forward-backward asymmetries of $\Lambda, \bar{\Lambda}$ at $\sqrt{s}$=1.96 TeV

The DØ detector is well suited to measure forward-backward asymmetries A_{FB}:

- Initial state is $p\bar{p}$ (CP symmetric)
- The solenoid and toroid magnetic fields are reversed periodically (canceling many important systematics)

For many measurements, no other experiment has comparable sensitivity

Search for Violation of CPT and Lorentz invariance in B^0_s meson oscillations	Phys. Rev. Lett. 115, 161601 (2015)
Measurement of the direct CP-violating parameter $A_{CP}(D^+ \to K^- \pi^+ \pi^+)$	Phys. Rev. D 90, 111102(R) (2014)
Measurement of the direct CP-violating charge asymmetry in $D_s^{\pm} \to \varphi \pi^{\pm}$	Phys. Rev. Lett. 112, 111804 (2014)
Study of CP-violating charge asymmetries of single muons and like-sign dimuons in $p\bar{p}$ collisions	Phys. Rev. D 89, 012002 (2014)



$$A_{FB} \equiv \frac{N_F - N_B}{N_F + N_B}$$

Directions reversed for antiparticles

Phys. Rev. D93, 032002 (2016)

Forward-backward asymmetry of (Λ, $\bar{\Lambda}$)

Illustrates common method used in all of these analyses

- "Forward":

Forward Λ have longitudinal momentum in the p direction
Forward $\bar{\Lambda}$ have longitudinal momentum in the $\bar{p}$ direction

- Forward-backward asymmetry in a bin of |y|: $A_{FB} \equiv \frac{N_F - N_B}{N_F + N_B}$

\# of reconstructed Λ plus $\bar{\Lambda}$ or K_S with p_T > 2.0 GeV in each data set

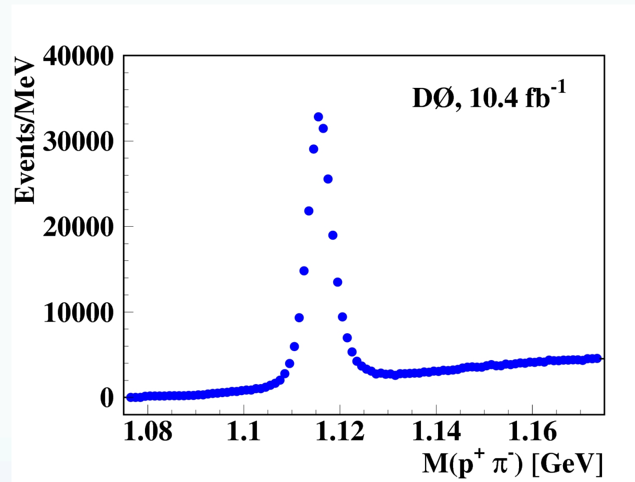
Data set

	Data set	Number of events
Signal	(i) $p\bar{p} \to \Lambda(\bar{\Lambda})X$	5.85×10^5
	(ii) $p\bar{p} \to J/\psi\Lambda(\bar{\Lambda})X$	2.50×10^5
	(iii) $p\bar{p} \to \mu^{\pm}\Lambda(\bar{\Lambda})X$	1.15×10^7
Control channel	(i) $p\bar{p} \to K_S X$	2.33×10^6
	(ii) $p\bar{p} \to J/\psi K_S X$	6.55×10^5
	(iii) $p\bar{p} \to \mu^{\pm} K_S X$	5.34×10^7

Forward-backward asymmetry of (Λ, $\bar{\Lambda}$)

• Count Λ and $\bar{\Lambda}$ candidates in a signal region and subtract background determined from two sidebands.

• Weighting data by luminosity and magnet polarities cancels detector geometric effects.



• The double difference*

$$A'_{FB} = \frac{N_F(\Lambda) - N_B(\Lambda) + N_F(\bar{\Lambda}) - N_B(\bar{\Lambda})}{N_F(\Lambda) + N_B(\Lambda) + N_F(\bar{\Lambda}) + N_B(\bar{\Lambda})}$$

cancels 1st order contributions of two detector effects:
$A_{\Lambda\bar{\Lambda}}$: relative difference of efficiencies for Λ and $\bar{\Lambda}$ and
A_{NS} : relative difference of efficiencies of the north and south sections of the DØ detector (the $\bar{p}$ beam propagates north).

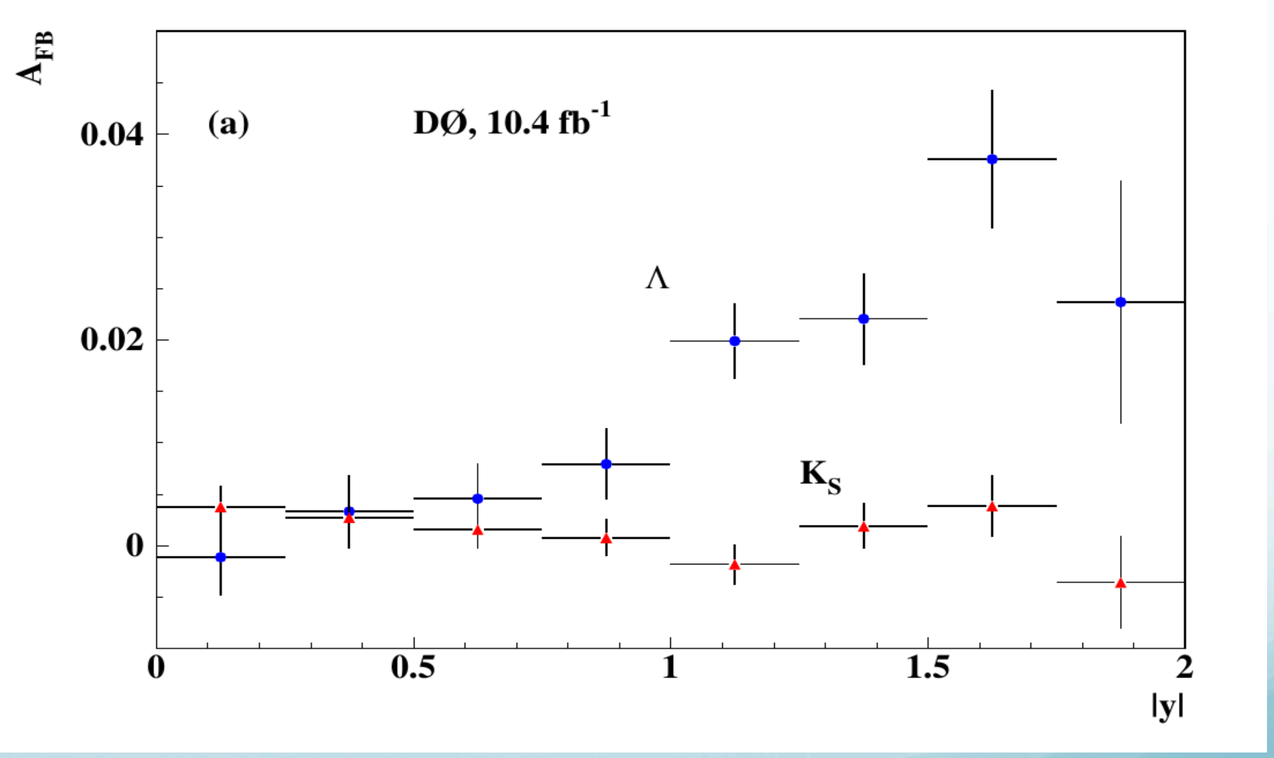
*primed quantities are “raw” asymmetries

Forward-backward asymmetry $\Lambda,\bar{\Lambda}$

A_{FB}=0 for $p\bar{p} \Rightarrow K_sX$, because $K_s \Rightarrow \pi^+\pi^-$ does not distinguish its parent K^0 or $\bar{K}^0$
Used to verify no additional corrections from north-south asymmetries

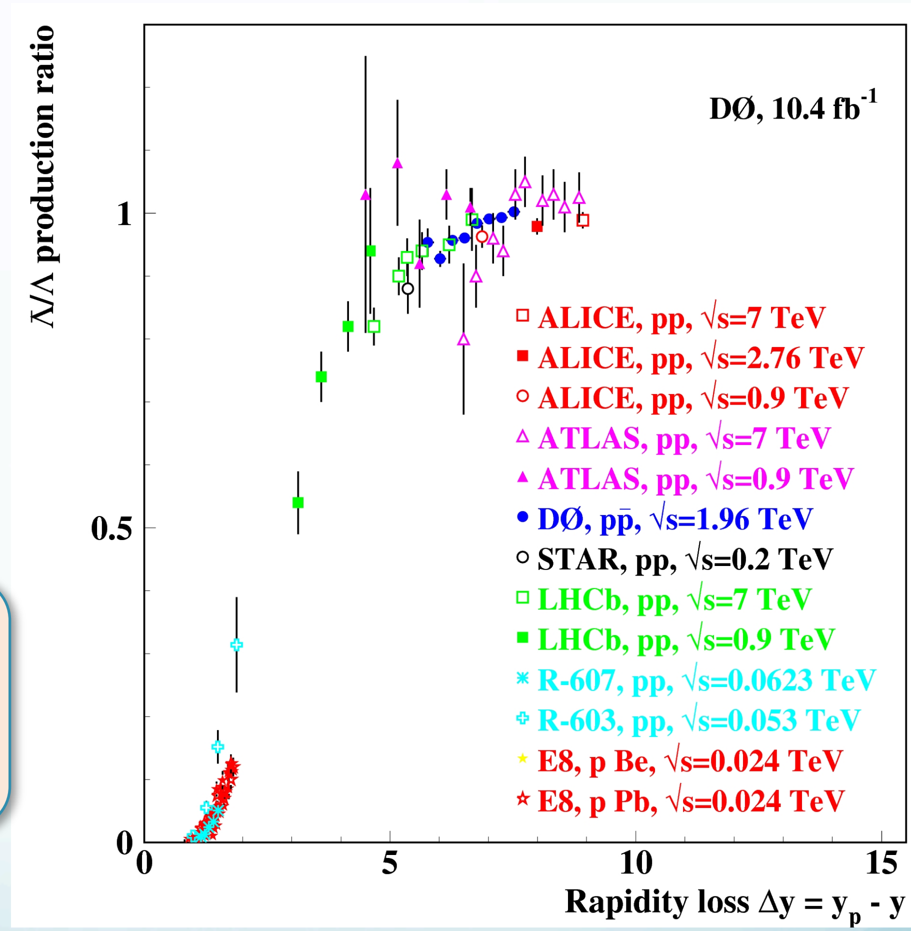
P_T>2 GeV

Asymmetry A_{FB}
$p\bar{p} \Rightarrow \Lambda(\bar{\Lambda})$ X
and
control sample with K_s



Forward-backward asymmetry $\Lambda,\bar{\Lambda}$

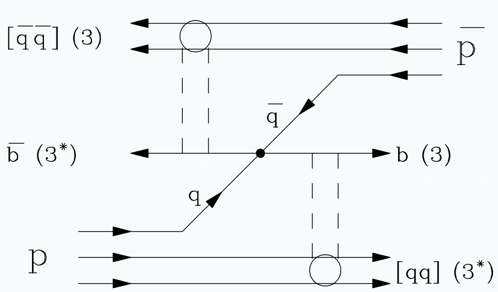
Comparing $\bar{\Lambda}/\Lambda$ production ratio $(1-A_{FB})/(1+A_{FB})$ to a wide range of proton scattering experiments



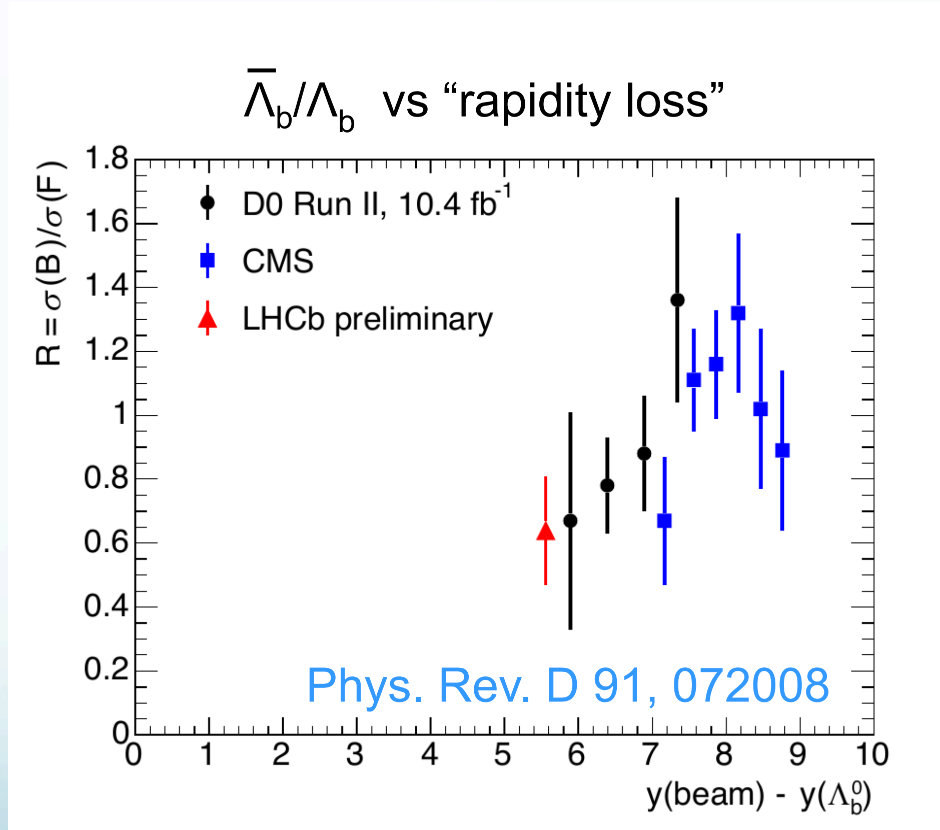
Production ratio is an approximately universal function of rapidity loss and does not depend significantly on √s, or target p, $\bar{p}$, Be or Pb

Forward-backward asymmetry $\Lambda_b, \bar{\Lambda}_b$

Results supports view that bottom quark produced in the scattering can coalesce with a ud diquark remnant of the beam particle to produce a lambda



"String drag" effect proposed by J. Rosner

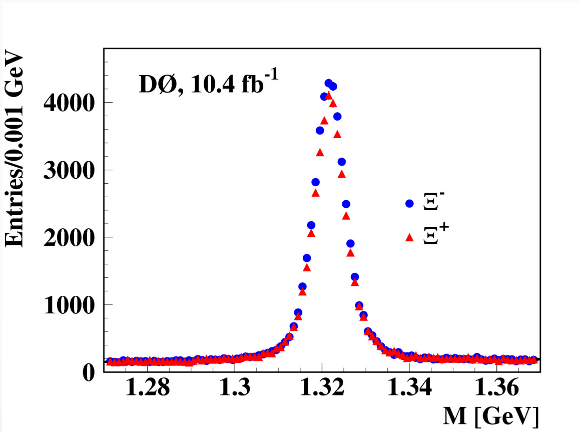


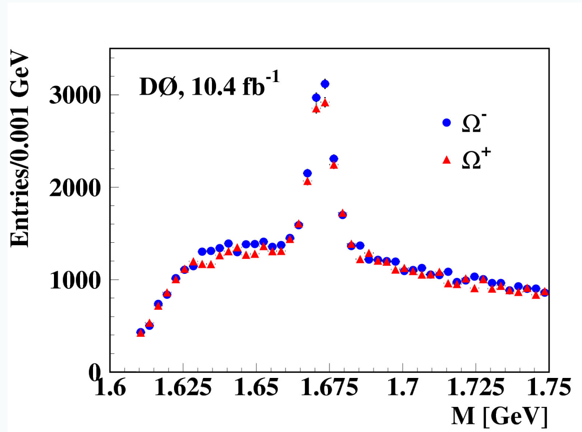
PRD 93 112001 (2016)

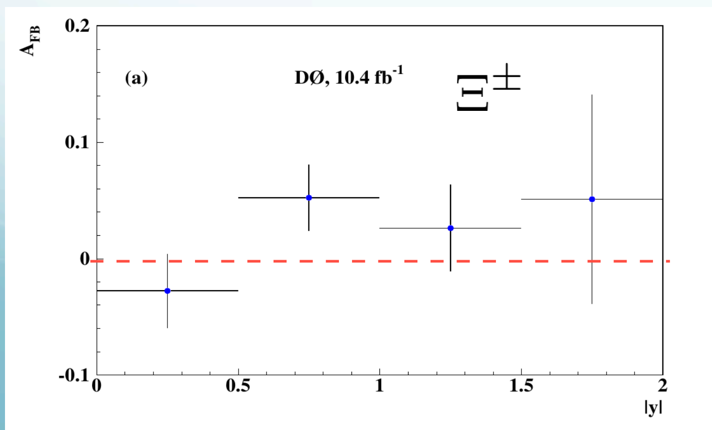
A_{FB} for $\Xi^{\pm}$ and $\Omega^{\pm}$

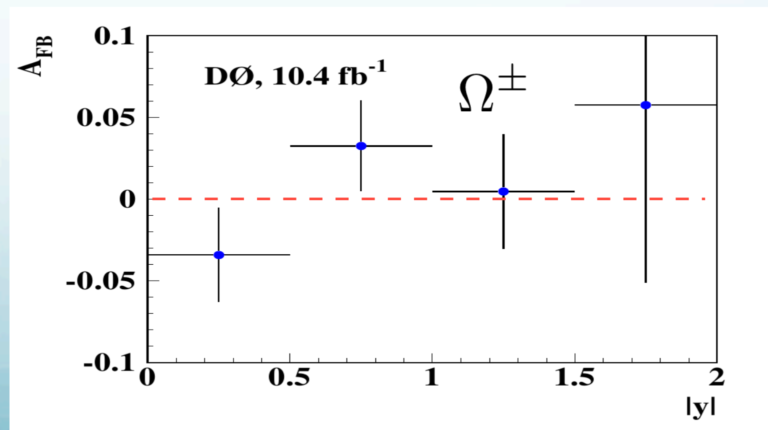
If hypothesis correct, expect $A_{FB}>0$ for Λ, $\Lambda_c^{\pm}$ and $\Lambda_b^{\pm}$ and $A_{FB}\sim 0$ for $B^{\pm}$, $\Xi^{\pm}$, and $\Omega^{\pm}$ since these particles do not share a diquark with the proton

$A_{FB}(B^{\pm})$= [-0.24 ± 0.41(stat) ± 0.19 (syst)]% PRL 114, 051803 (2015)









A_{FB} Summary

Results consistent with hypothesis that strange or bottom quark produced in scattering can coalesce with a ud diquark remnant of the beam to produce a Λ

For particles that do not share a diquark with the proton
A_{FB} consistent with 0 for $B^{\pm}$, $\Xi^{\pm}$ and $\Omega^{\pm}$