Λ Fragmentation Functions

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Fragmentation Functions 2018

February 22, 2018

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Outline

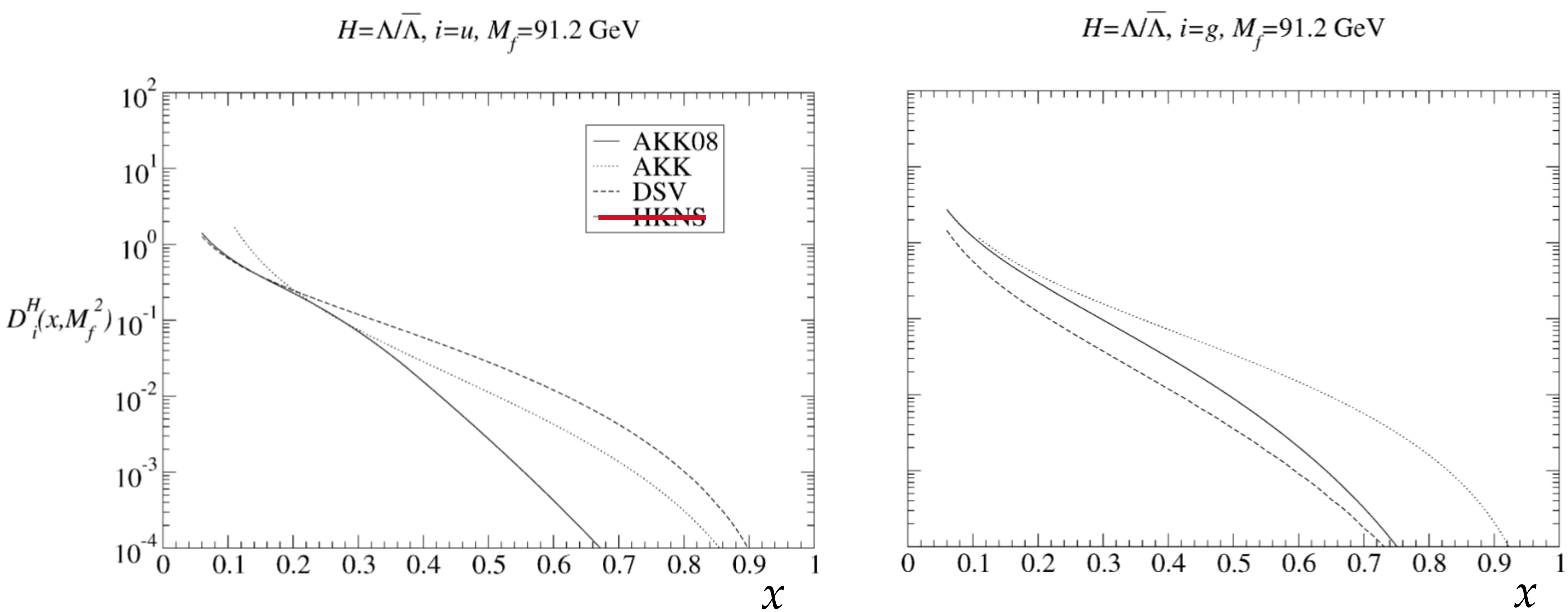
- Unpolarized Λ Fragmentation Functions - brief intro
- Polarizing Λ Fragmentation Functions:
    - Conclusions from existing data of $p\,p \to \Lambda^{\uparrow}\,X$ and $e^+\,e^- \to \Lambda^{\uparrow}\,h\,X$
    - Tests in $p\,p \to \Lambda^{\uparrow}$ jet X at midrapidity & application in $p\,A \to \Lambda^{\uparrow}\,X$ at forward rapidity (small x)
- D_{LL} (G_1) & D_{NN} (H_1)

Unpolarized Λ FF

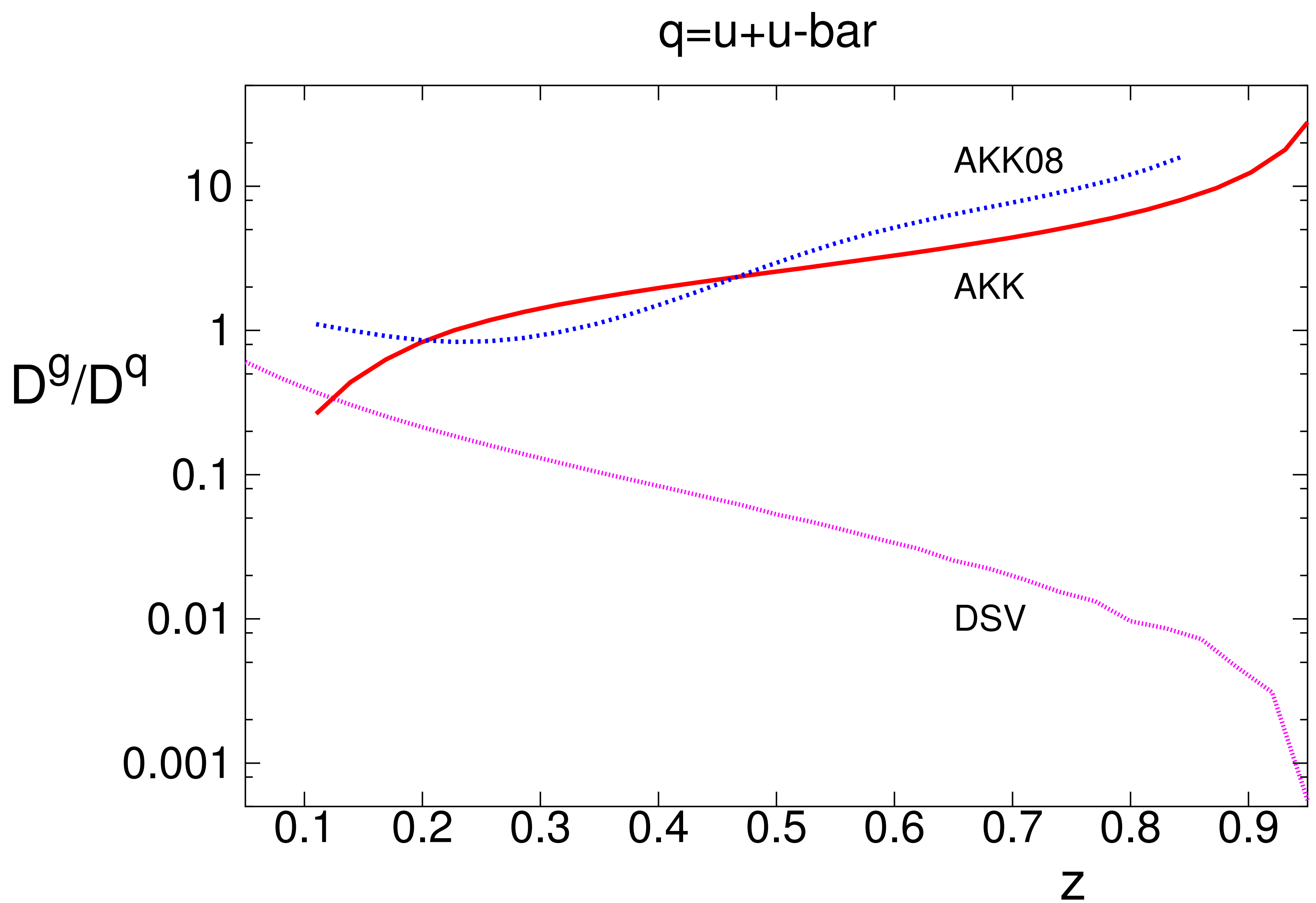
Unpolarized Λ fragmentation functions

Unpolarized Λ FFs have been extracted by various groups:

- De Florian, Stratmann, Vogelsang [DSV] (PRD 57 (1998) 5811) [e^+e^- data & SU(3) sym]
- Indumathi, Mani, Rastogi [IMR] (PRD 58 (1998) 094014) [e^+e^- data & SU(3) breaking]
- Boros, Londergan, Thomas [BLT] (PRD 62 (2000) 014007) [e^+e^- data & SU(3) breaking]
- Albino, Kniehl, Kramer [AKK] (NPB 734 (2006) 50) [e^+e^- data & flavour separation]
- AKK update [AKK08] (NPB 803 (2008) 42) [including RHIC & CDF data]



Role of g → Λ X



$D_1^g / D_1^{u+\bar{u}}$ at LO

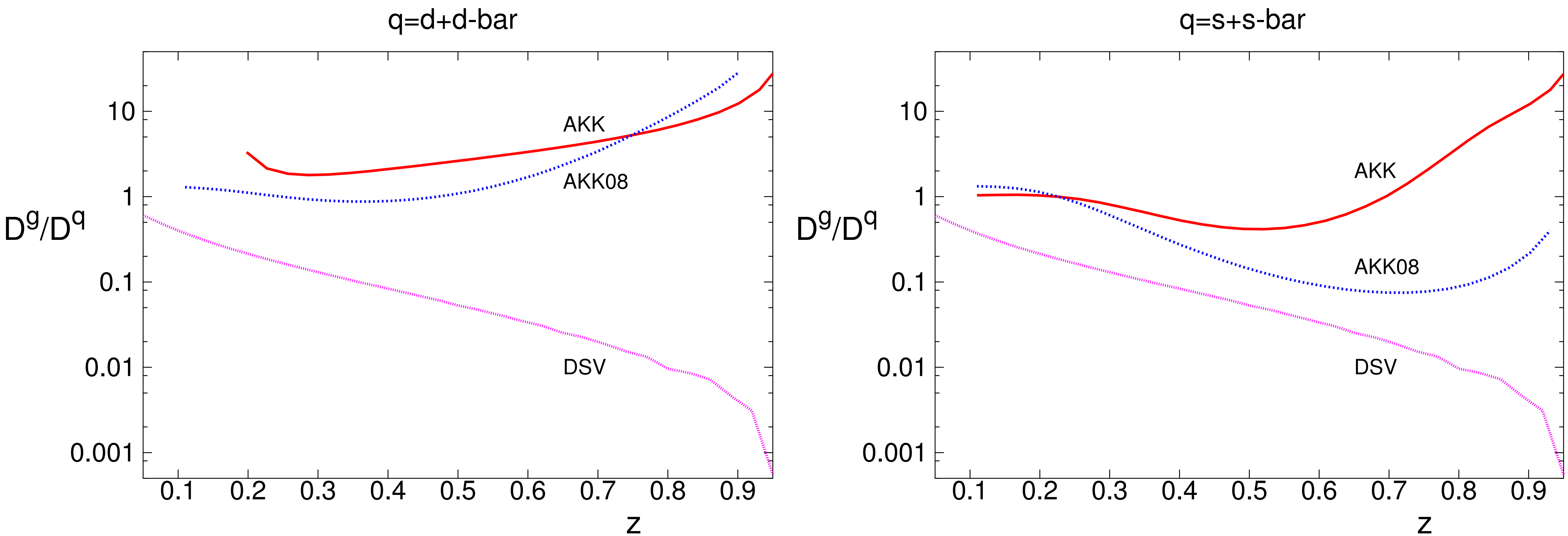
Q = 10 GeV

De Florian, Stratmann, Vogelsang [DSV] (PRD 57 (1998) 5811) (e^+e^- data only)

Albino, Kniehl, Kramer [AKK] (NPB 734 (2006) 50) (STAR data motivated gluon FF)

AKK update [AKK08] (NPB 803 (2008) 42) (STAR & CDF data including in fit)

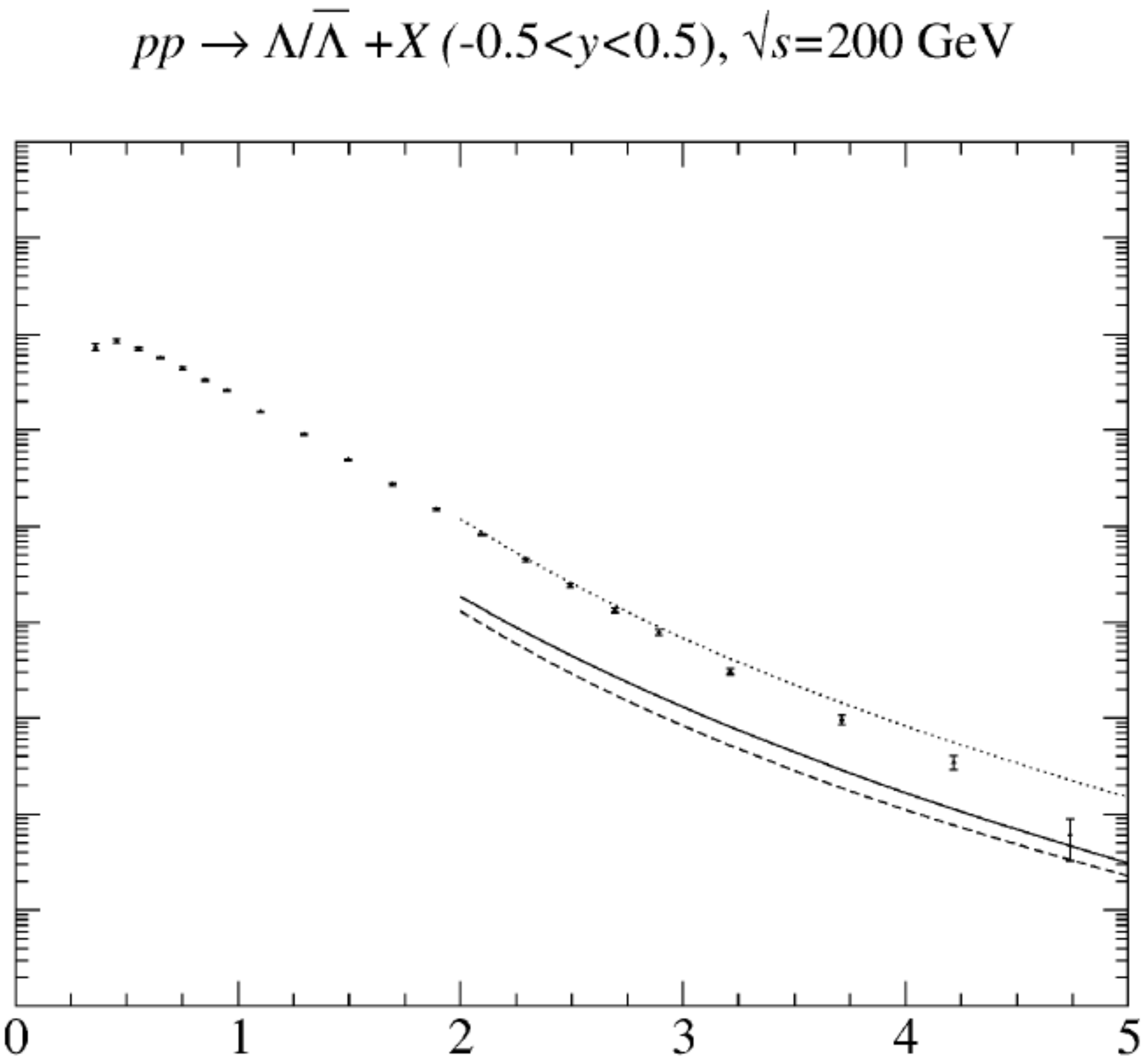
Role of g → Λ X



Fits of D_1 to only $e^+e^- \rightarrow \Lambda X$ data not very sensitive to $g \rightarrow \Lambda X$

AKK08 that includes RHIC and CDF data turns out to be also problematic

Λ fragmentation function problem



p_T distribution

solid: AKK08

dotted: AKK

dashed: DSV

data: STAR

"a possible inconsistency between the pp and e^+e^- reaction data for Λ/Λ production"

AKK, NPB 803 (2008) 42

Polarizing Λ FF

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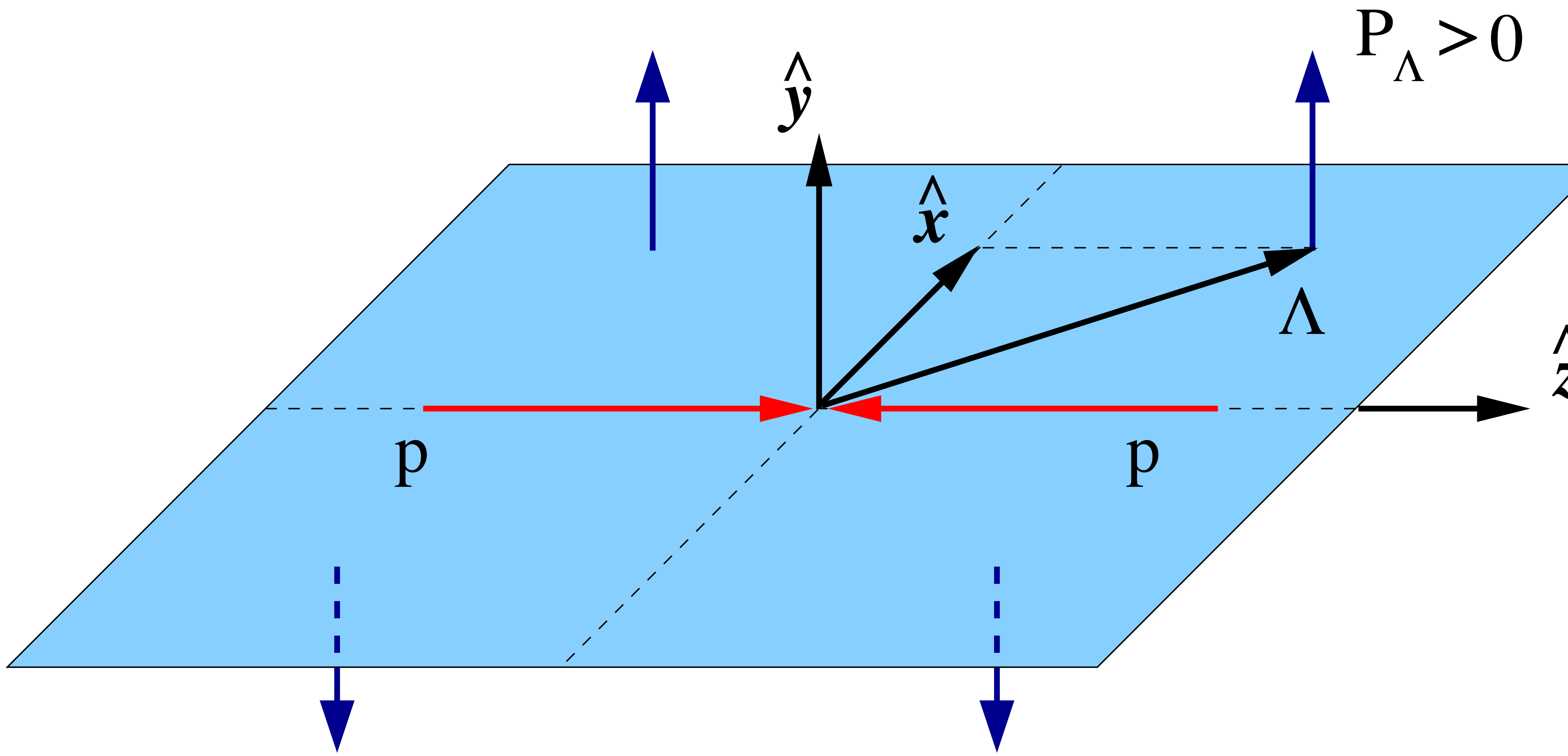
past & present

Transverse Λ polarization in unpolarized scattering

Large asymmetries have been observed in $p + p \to \Lambda^{\uparrow} + X$

G. Bunce *et al.*, PRL 36 (1976) 1113

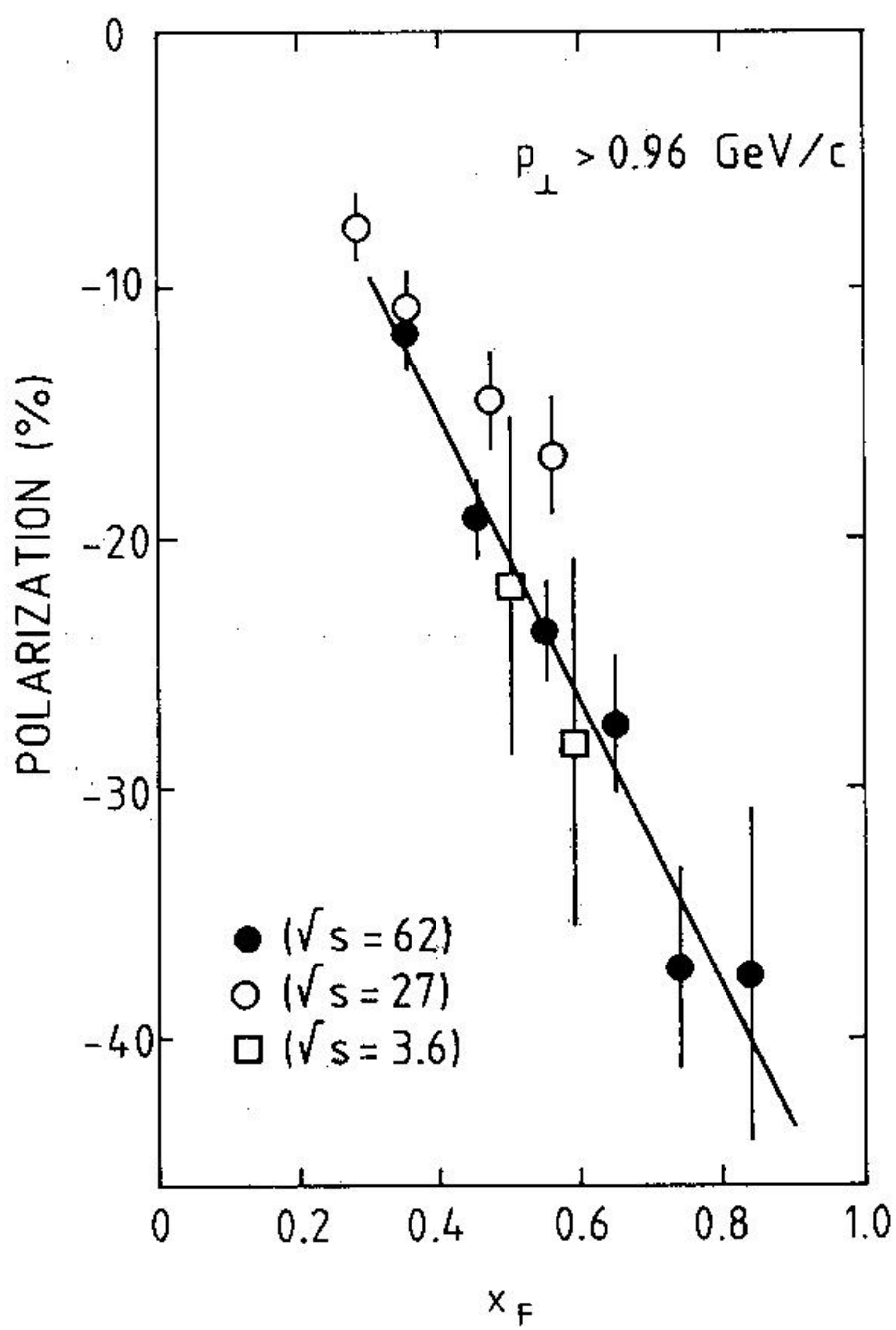


Blue arrows indicate the direction of positive transverse (w.r.t. production plane) polarization P_Λ, in the four quadrants

For symmetry reasons P_Λ=0 at midrapidity in pp collisions in the c.o.m. $P_\Lambda(-x_F) = -P_\Lambda(x_F)$ does not automatically apply in pA collisions or in fixed target experiments

pp data - x_F dependence

P_Λ turns out to be negative



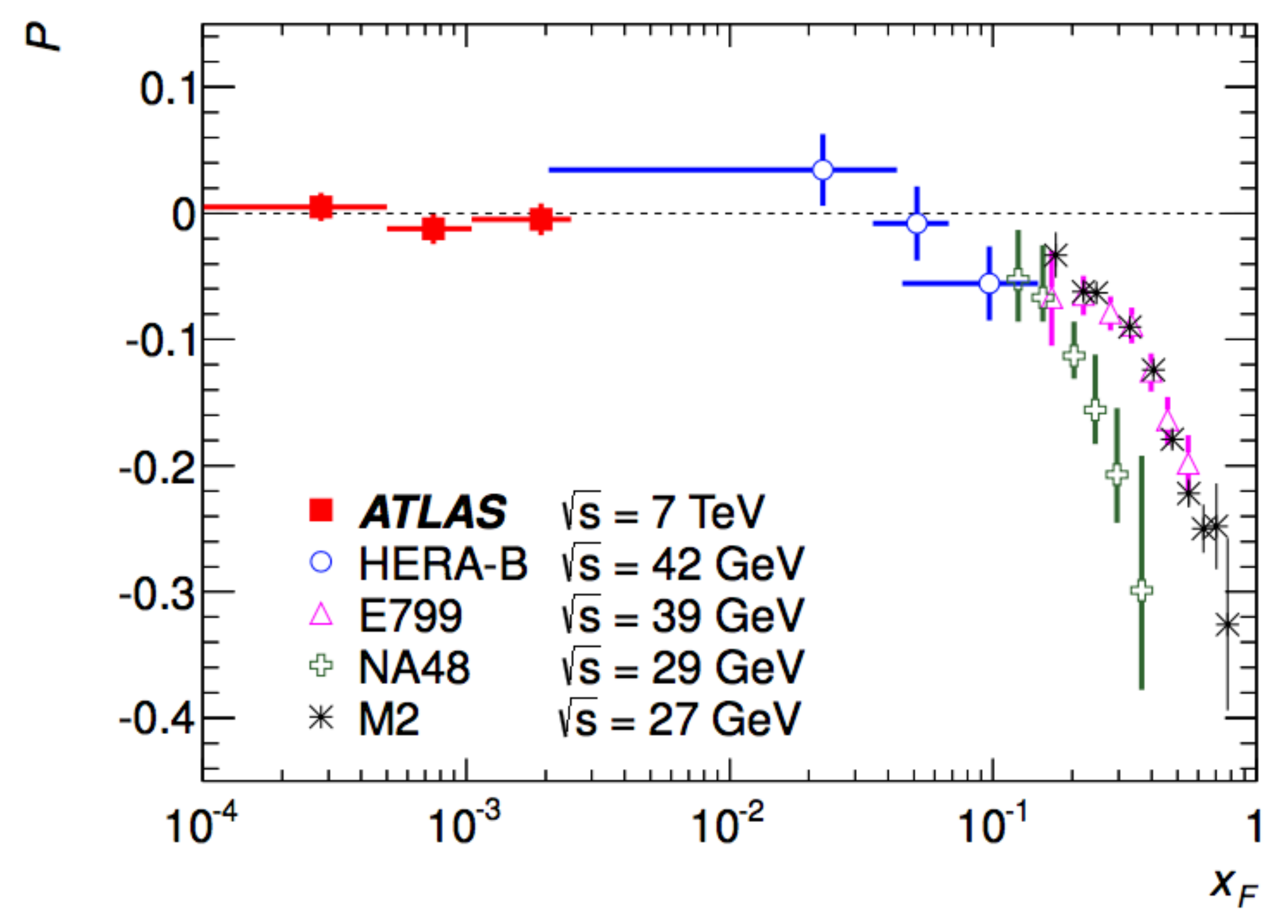
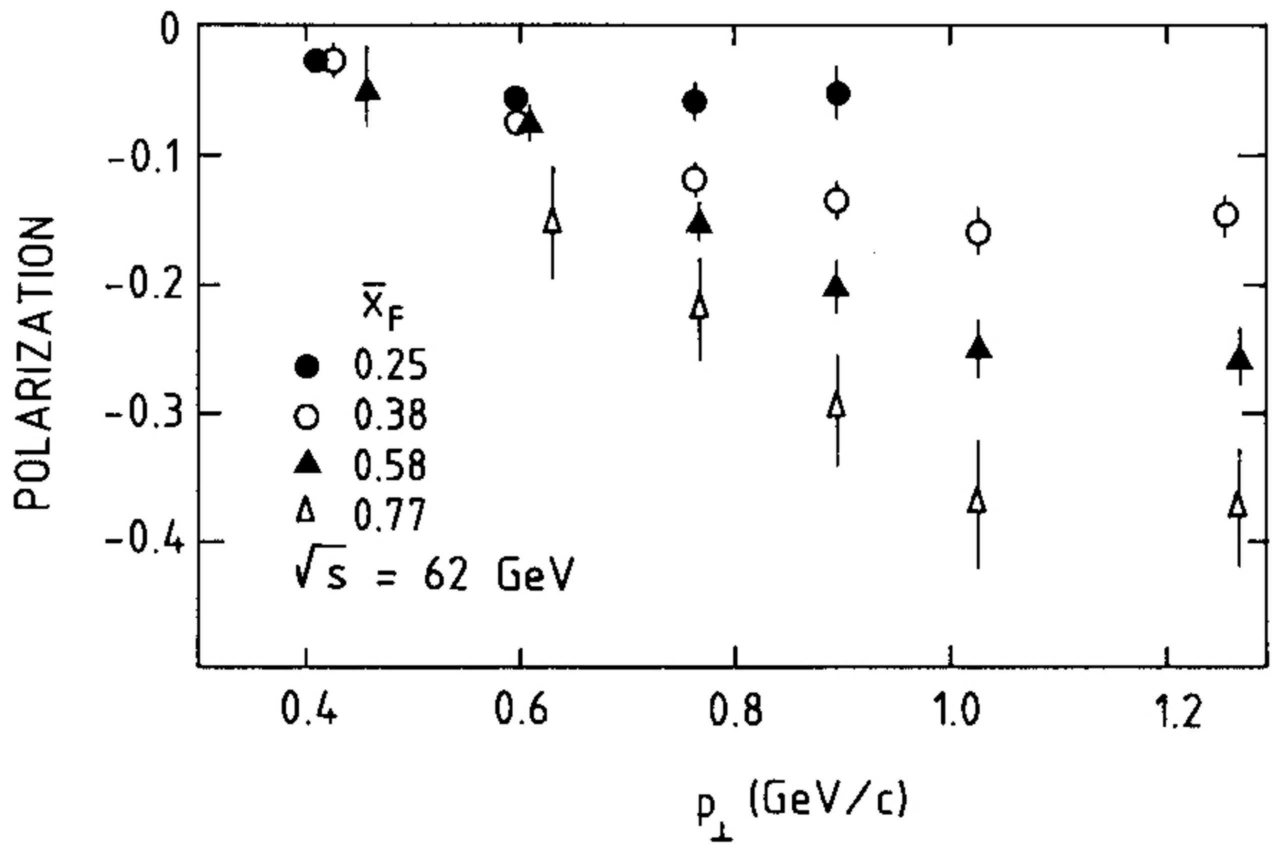


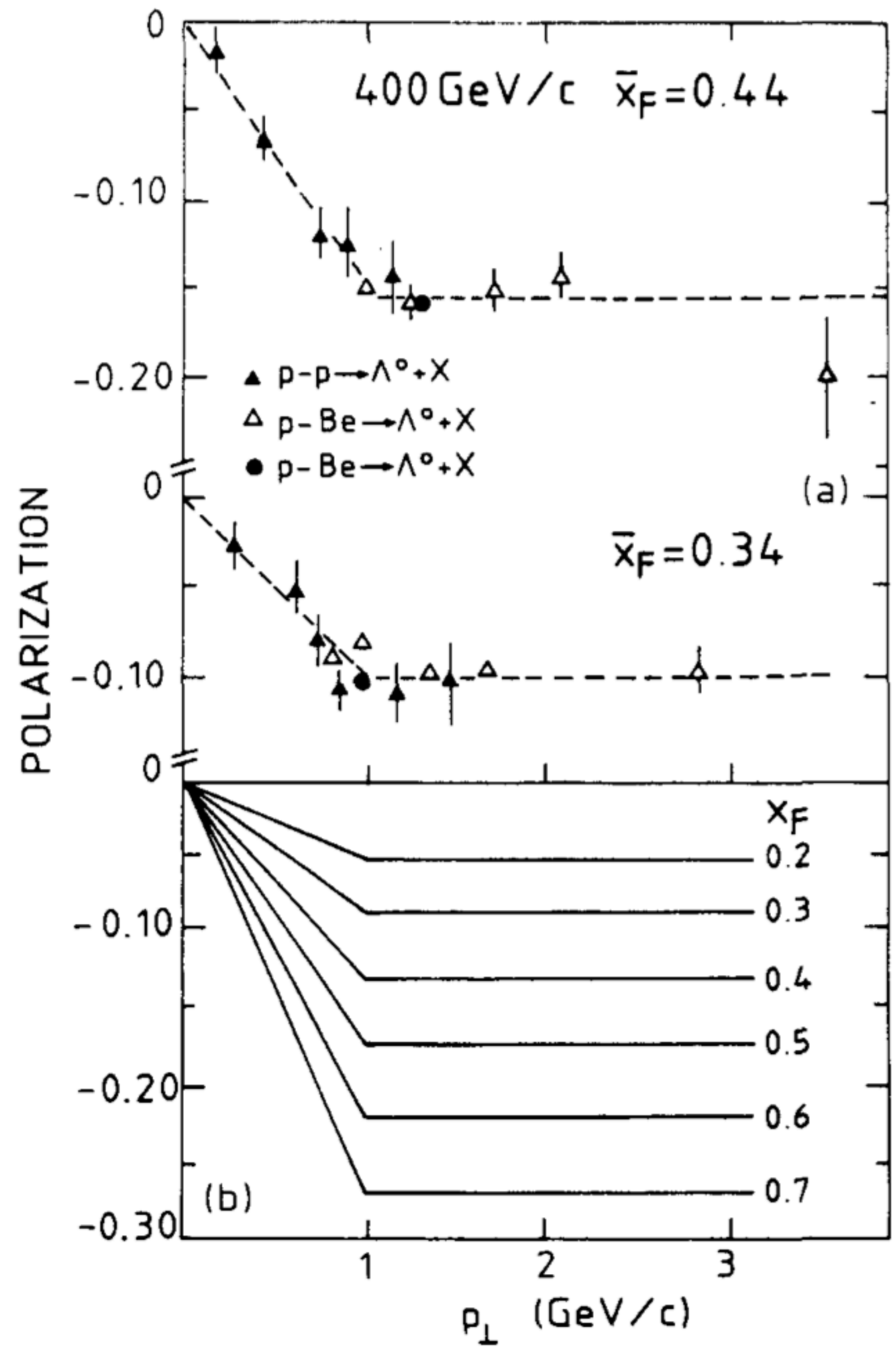
FIG. 8. The Λ transverse polarization measured by ATLAS compared to measurements from lower center-of-mass energy experiments. HERA-B data are taken from Ref. [5], NA48 from Ref. [4], E799 data from Ref. [3], and M2 from Ref. [2]. The HERA-B results are transformed to positive values of x_F using Eq. (1).

ATLAS Collab, Phys.Rev. D91 (2015) 032004

Eq. (1): $P(-x_F) = -P(x_F)$ applied to the fixed target experiment HERA-B for pC and pW

pp data - p_T dependence

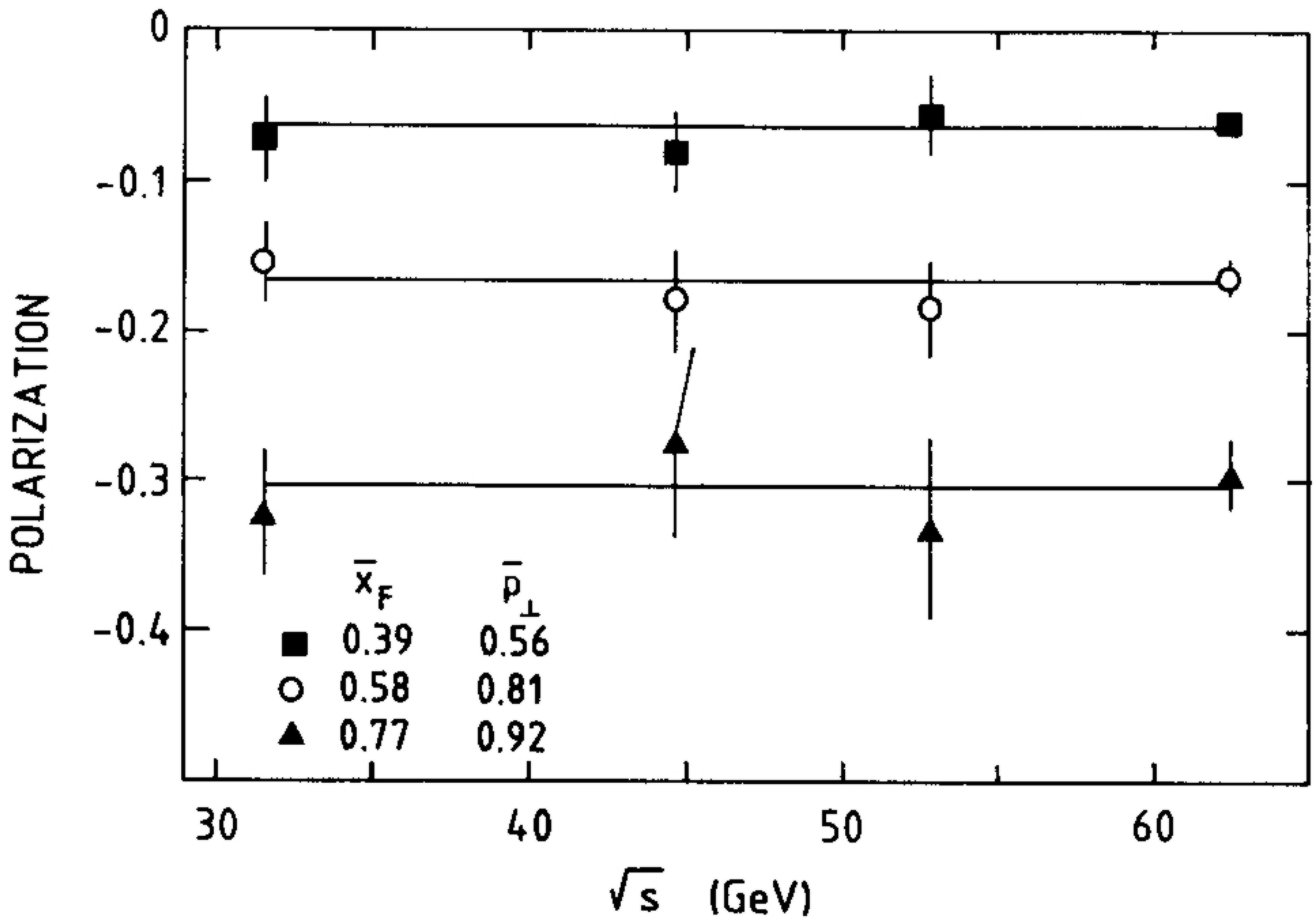




For p_T above 1 GeV/c P_Λ becomes flat

(measured up to $p_T \sim 4$ GeV/c)

pp data - √s (in)dependence



Comprehensive review of data by A.D. Panagiotou (Int.J.Mod.Phys.A 5 (1990) 1197)

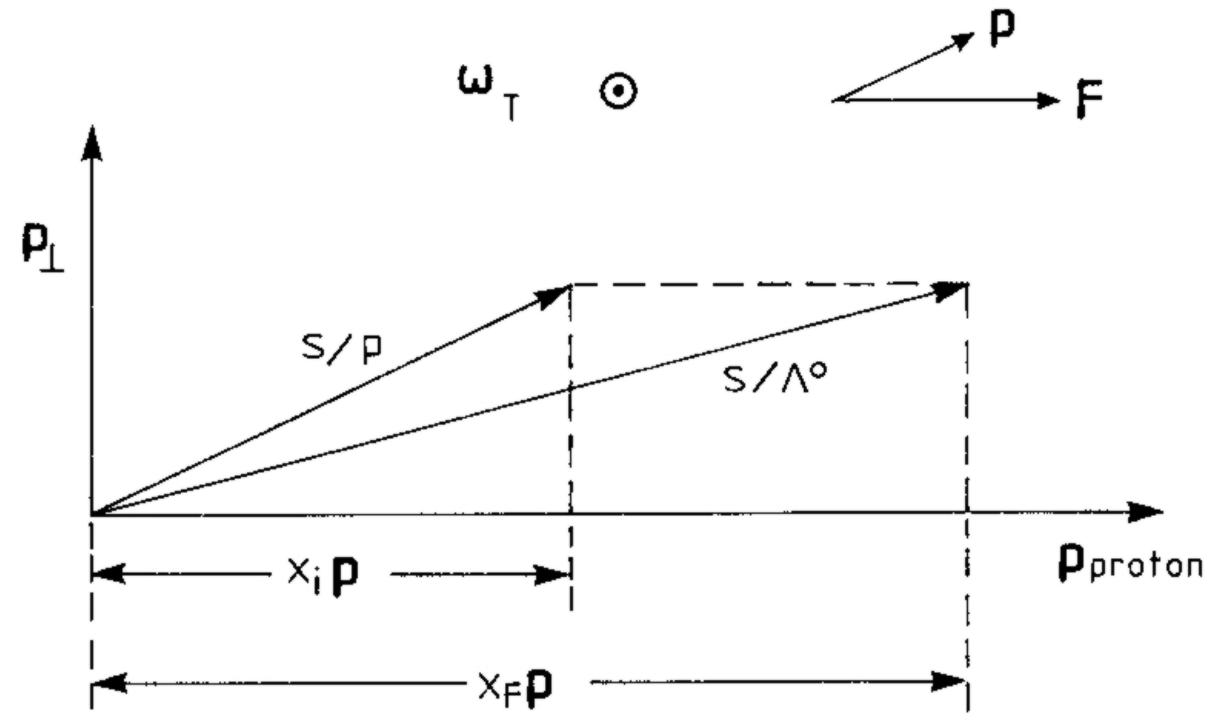
Theoretical considerations

Most models give only qualitative descriptions of the data for $p_T \sim 1 - 2$ GeV/c

J. Felix, Mod.Phys.Lett.A 14 (1999) 827-842

E.g. the DeGrand-Miettinen model (based on recombination of a ud diquark from the proton and an s quark from the sea; spin-orbit coupling creates the polarization)

PRD 23 (1981) 1227 & 24 (1981) 2419



P_Λ stays large at least until the highest measured $p_T \sim 4$ GeV/c

For large p_T perturbative QCD and collinear factorization should apply

pQCD conserves helicity, which leads to $P_\Lambda \sim \alpha_s m_q/\sqrt{\hat{s}}$ (= small)

Kane, Pumplin & Repko, PRL 41 (1978) 1689

Collinear factorization

Consider for example the $qg \to qg$ subprocess

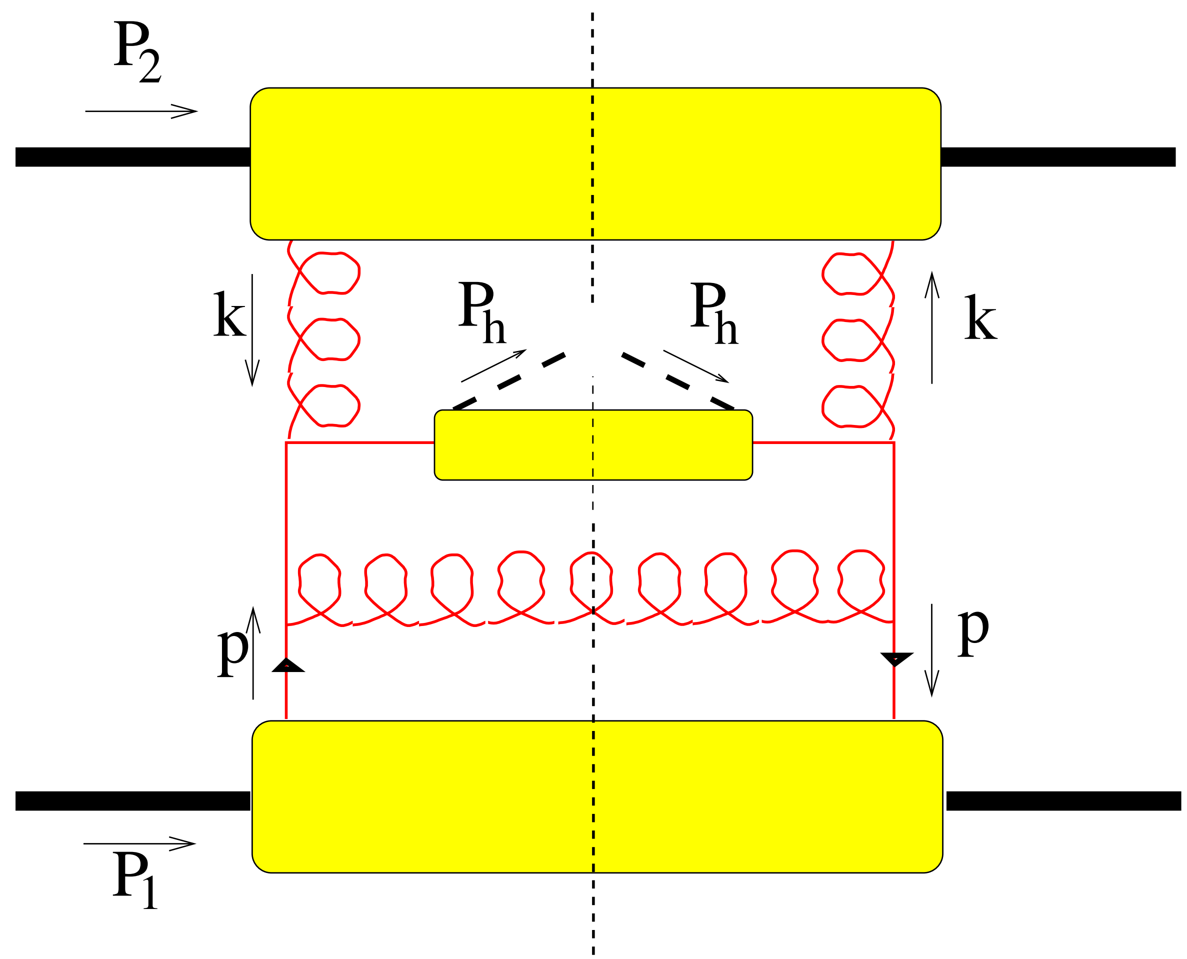
$$\sigma \sim q(x_1) \otimes g(x_2) \otimes \sigma_{qg\to qg} \otimes D_{\Lambda/q}(z)$$

$q(x_1)$ = quark density

$g(x_2)$ = gluon density

$D_{\Lambda/q}(z)$ = Λ fragmentation function

$$P_\Lambda \sim q(x_1) \otimes g(x_2) \otimes \sigma_{q\,g\to q\,g} \otimes \,?$$



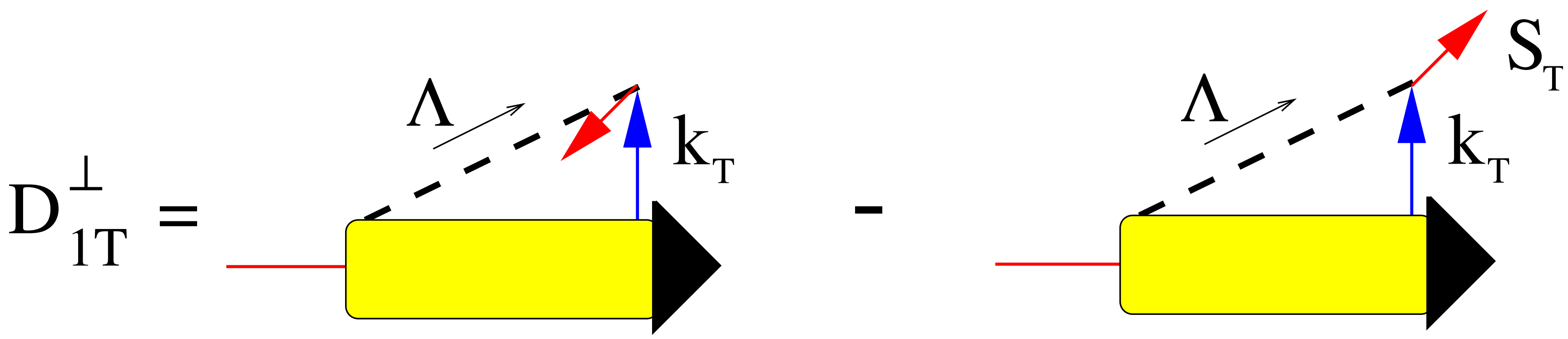
No leading twist collinear fragmentation function exists for $q \to \Lambda^\uparrow X$

(due to symmetry reasons)

It would be necessarily higher twist, which leads to a fall-off as $1/p_T$

Noncollinear factorization

Dropping the requirement of collinear factorization, does allow for a solution



- Transverse momentum dependent: $D_{1T}^{\perp}(z, k_T)$
- A nonperturbative $k_T \times S_T$ dependence in the fragmentation process
- Allowed by the symmetries (parity and time reversal)

Λ polarization arises in the fragmentation of an unpolarized quark

Mauro Anselmino suggested the name "polarizing fragmentation function"

However, $p + p \to \Lambda^{\uparrow} + X$ is not TMD factorizing (like $p^{\uparrow}p \to \pi X$)

Nevertheless, reasonable functions were obtained

Polarizing fragmentation functions

$D_{1T}^{\perp}$ has been extracted from fixed target p + p(Be) → $\Lambda^{\uparrow}(\bar{\Lambda}^{\uparrow})$ + X data

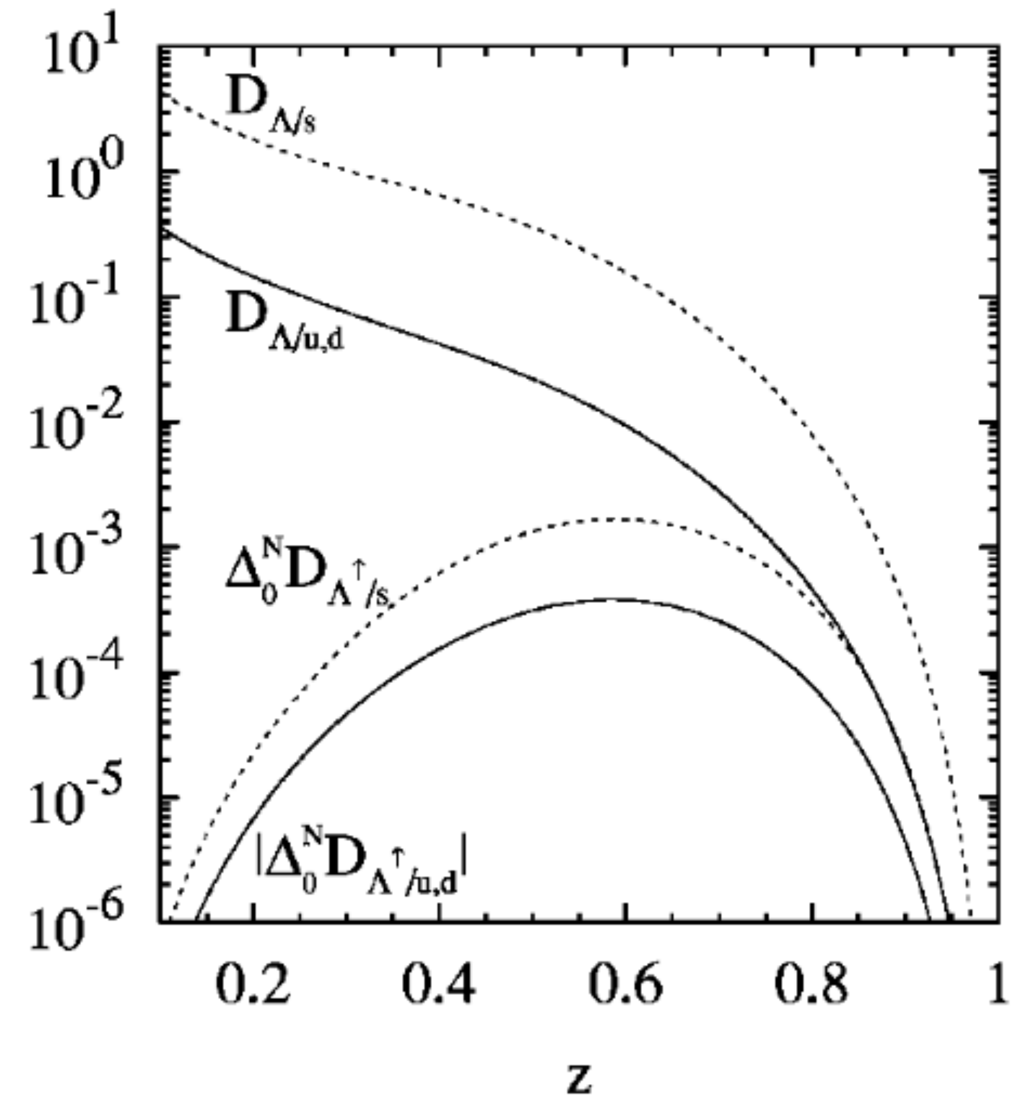
Anselmino, D.B., D'Alesio & Murgia, PRD 63 (2001) 054029

Using unpolarized FF by Indumathi, Mani, Rastogi:

PRD 58 (1998) 094014

Includes SU(3) breaking

$$\Delta_0^N D_{\Lambda^{\uparrow}/q} \sim \langle k_{\perp} \rangle \; D_{1T}^{\perp}(z, \langle k_{\perp} \rangle)$$



Resulting $D_{1T}^{\perp}$ has opposite signs for u, d versus s quarks; the latter is larger

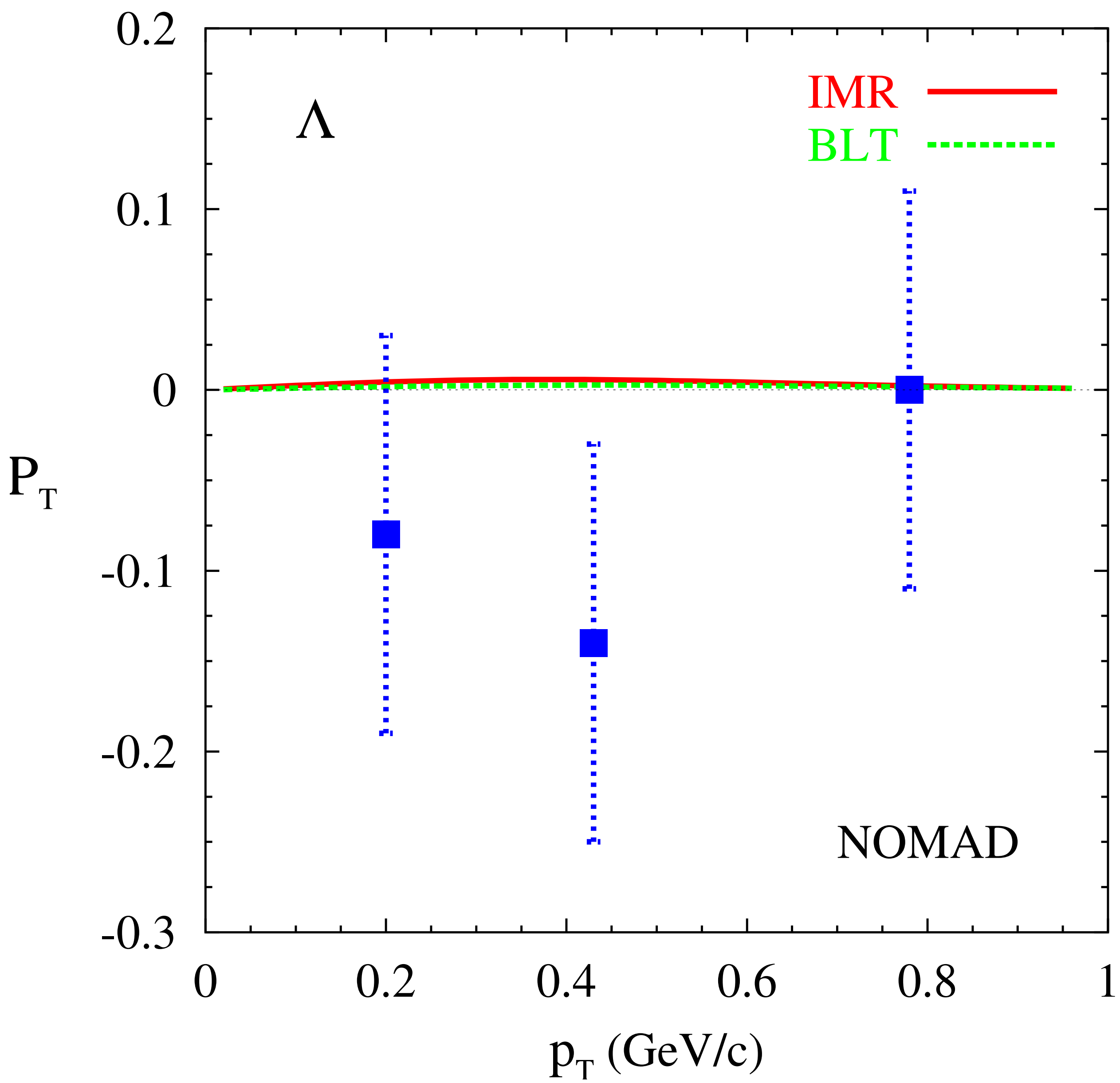
This leads to cancellations in order that $P_{\bar{\Lambda}} \approx 0$

Extraction done under the restriction of $p_T > 1$ GeV/c to exclude the soft regime

Predictions for SIDIS

Semi-inclusive DIS: ep → e' $\Lambda^{\uparrow}$ X (NC) and ν_{μ} p → $\mu\Lambda^{\uparrow}$ X (CC)

Anselmino, D.B., D'Alesio & Murgia, PRD 65 (2002) 114014



Only available SIDIS data in the current fragmentation region was on $\nu_{\mu}p \to \mu\Lambda^{\uparrow}X$

Astier et al., NOMAD Collab., NPB 588 (2000) 3

Data and curves are for:

$< x_F >= 0.21$ & $< z_h >= 0.34$

$< Q^2 > = 9$ GeV^2

Newer SIDIS data

The ZEUS Collaboration: Measurement of K_S^0, Λ and $\bar{\Lambda}$ production at HERA

	Polarization (%)		
	High-Q^2 DIS	Low-Q^2 DIS	Photoproduction
Λ	$-1.3 \pm 4.3(\text{stat.})^{+4.0}_{-0.8}(\text{syst.})$	$-4.0 \pm 5.3(\text{stat.})^{+4.7}_{-4.0}(\text{syst.})$	$-2.4 \pm 2.2(\text{stat.})$
$\bar{\Lambda}$	$-2.2 \pm 4.2(\text{stat.})^{+2.4}_{-1.3}(\text{syst.})$	$-8.5 \pm 5.5(\text{stat.})^{+4.7}_{-2.1}(\text{syst.})$	$-5.8 \pm 2.2(\text{stat.})$
K_S^0	$-1.5 \pm 1.1(\text{stat.})$	$-0.05 \pm 1.5(\text{stat.})$	$-0.5 \pm 0.2(\text{stat.})$

Table 1. The transverse polarization values for Λ and $\bar{\Lambda}$, expressed here in %, in the high-Q^2 DIS ($Q^2 > 25$ GeV^2 and $0.02 < y < 0.95$), low-Q^2 DIS ($5 < Q^2 < 25$ GeV^2 and $0.02 < y < 0.95$), and photoproduction ($Q^2 < 1$ GeV^2, $0.2 < y < 0.85$ and with two jets $E_T^{\text{jet}} > 5$ GeV and $|\eta^{\text{jet}}| < 2.4$) samples. Only Λ and $\bar{\Lambda}$ in the range $0.6 < P_T^{\text{LAB}} < 2.5$ GeV and $|\eta^{\text{LAB}}| < 1.2$ are considered. The statistical error is quoted for all samples, together with the systematic uncertainty associated with the measurement for the high-Q^2 and low-Q^2 samples. A similar systematic uncertainty is expected for the photoproduction sample. Also shown, as a test of any systematic effect, are the polarization values obtained by investigating the angular distribution of the higher-momentum π from K_S^0 decays

ZEUS Collab., Eur. Phys. J. C 51 (2007) 1

Other ep data are either in the target fragmentation region or for quasi-real production (E665, HERMES)

Polarizing FFs from e^+e^-

ELSEVIER

Nuclear Physics B 504 (1997) 345–380

NUCLEAR PHYSICS B

Asymmetries in polarized hadron production in e^+e^- annihilation up to order $1/Q$

D. Boer[a], R. Jakob[a], P.J. Mulders[a,b]

$$\frac{d\sigma^O(e^+e^-\to hX)}{d\Omega\, dz_h} = \frac{3\alpha^2}{Q^2}\sum_{a,\bar a} e_a{}^2 \Big\{ A(y)\, D_1^a(z_h) + C(y)D(y)\,|S_{hT}|\sin(\phi_{S_h})\,\frac{2M_h}{Q}\,\frac{D_T^a(z_h)}{z_h}\Big\} \qquad (80)$$

← Λ polarization in $e^+e^- \to \Lambda^\uparrow X$ is twist-3

$$\frac{d\sigma(e^+e^-\to h\text{ jet }X)}{d\Omega\, dz_h\, d^2\boldsymbol{q}_T} = \frac{3\alpha^2}{Q^2} z_h^2 \sum_{a,\bar a} e_a{}^2 \Big\{ A(y)\Big[D_1^a(z_h, z_h^2 Q_T^2) + |S_{hT}|\sin(\phi_h-\phi_{S_1})\,\frac{Q_T}{M_h}\, D_{1T}^{\perp a}(z_h, z_h^2 Q_T^2)\Big]$$

← in $e^+e^- \to (\Lambda^\uparrow \text{ jet})\, X$ it is not power suppressed

Λ polarization in e^+e^-

OPAL data $Q=M_Z$

Eur.Phys.J C2 (1998) 49

Transverse polarization compatible with zero at the ~3 percent level

Table 6. Measured transverse polarization of Λ baryons as a function of p_T (the transverse momentum of the Λ measured relative to the event thrust axis). The first error is statistical, the second systematic

p_T (GeV/c)	P_T^Λ (%)
< 0.3	$-1.8 \pm 3.1 \pm 1.0$
$0.3 - 0.6$	$0.4 \pm 1.8 \pm 0.7$
$0.6 - 0.9$	$1.0 \pm 1.9 \pm 0.7$
$0.9 - 1.2$	$0.8 \pm 2.2 \pm 0.6$
$1.2 - 1.5$	$0.0 \pm 2.7 \pm 0.6$
> 1.5	$1.8 \pm 1.6 \pm 0.5$
> 0.3	$0.9 \pm 0.9 \pm 0.3$
> 0.6	$1.1 \pm 1.0 \pm 0.4$

This measurement is closer to $e^+e^- \to (\Lambda^\uparrow \text{ jet})\, X$ than to $e^+e^- \to \Lambda^\uparrow X$

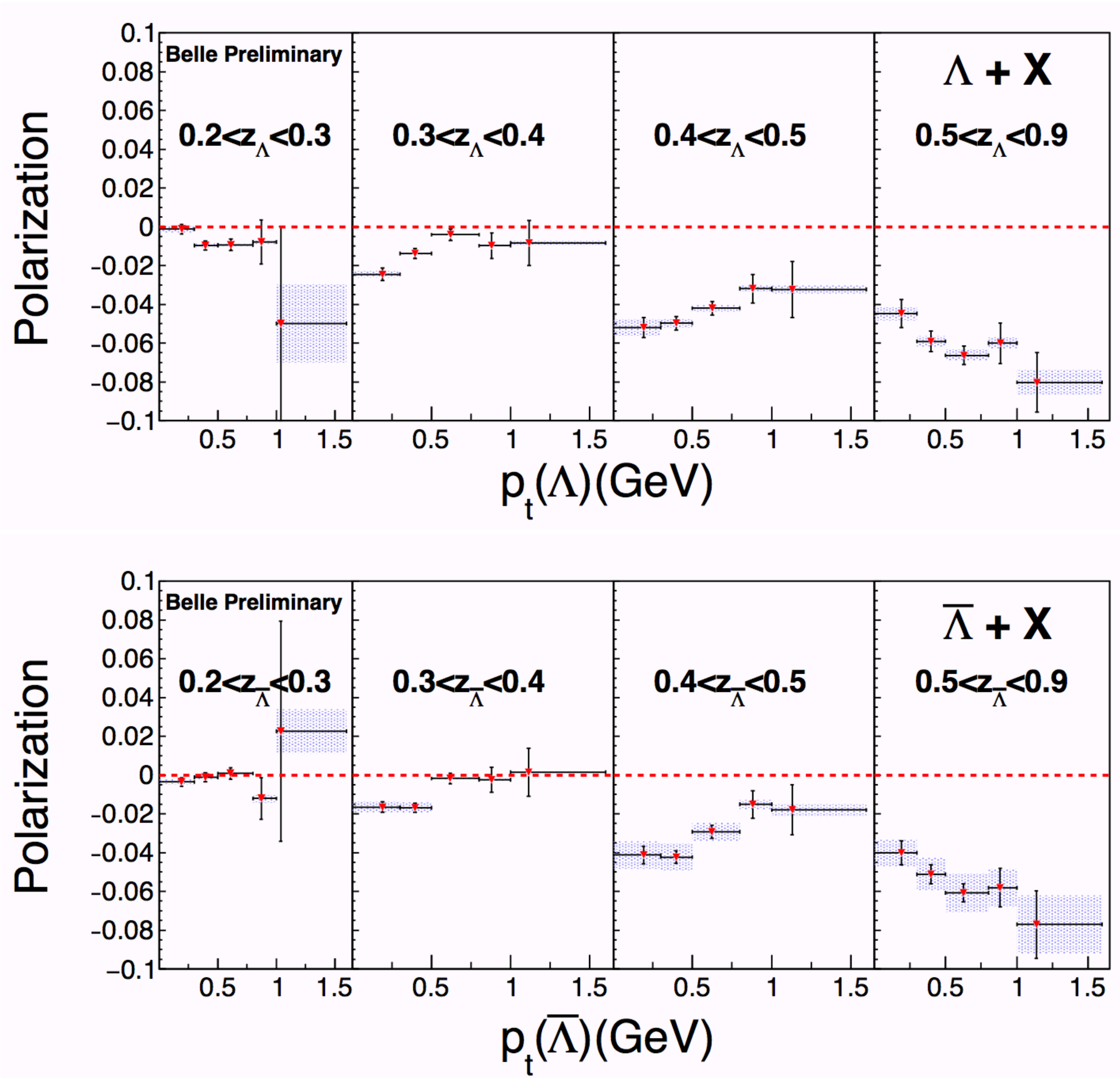
Twist-3 description applies to collinear factorization for p_T integrated case

Schlegel at Transversity 2018 (in collab with Gamberg, Kang, Pitonyak & Yoshida)

TMD evolution of observables with a single k_T-odd function is approx $1/\sqrt{Q}$

Belle polarization is then expected to be $\sqrt{(91.2/10.6)} \approx 3$ times larger than OPAL data (for z integrated)

Λ polarization in e^+e^-



p_T w.r.t. thrust axis

BELLE Collaboration arXiv:1611.06648

Again: this is closer to $e^+e^- \to (\Lambda^\uparrow \text{ jet})\, X$ than to $e^+e^- \to \Lambda^\uparrow X$

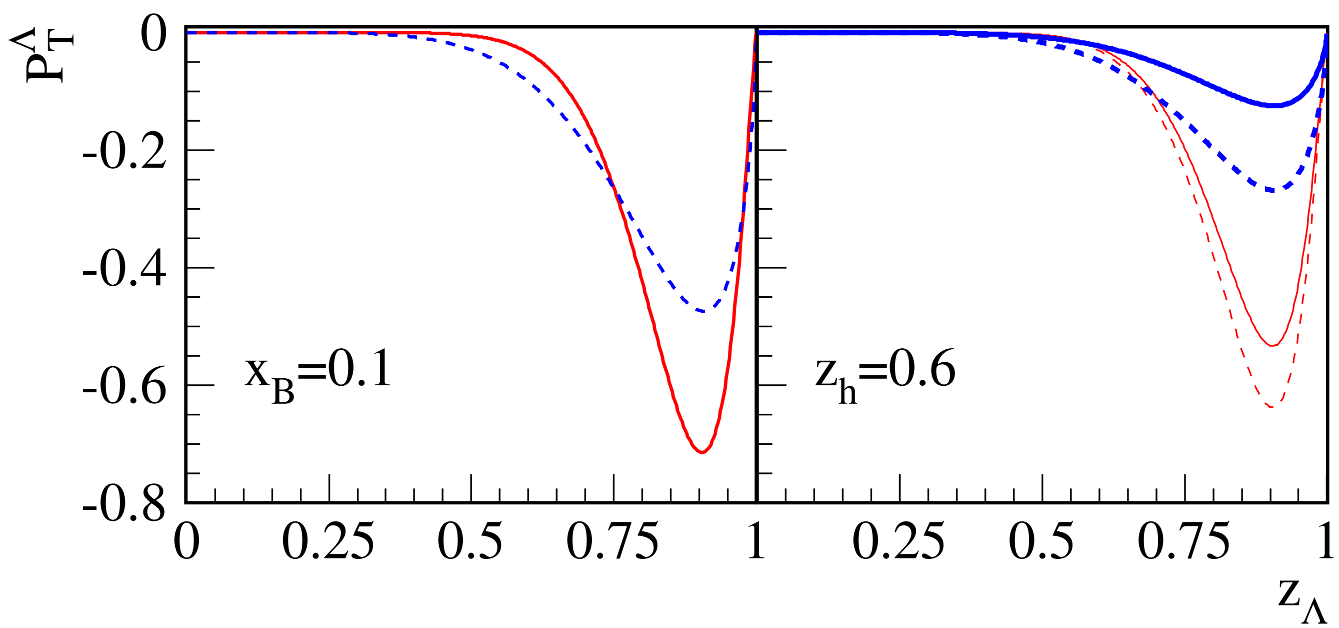
As expected anti-Λ is similar to Λ, unlike the pp case

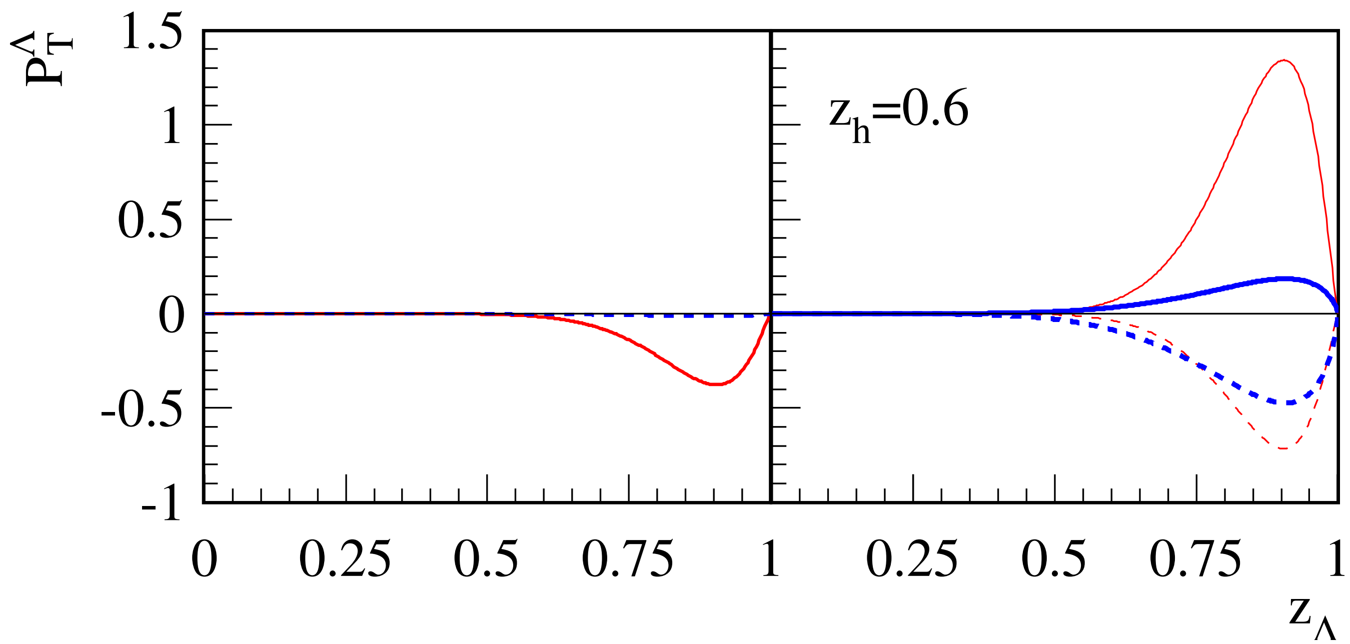
Associated production

$e^+e^- \to \Lambda^\uparrow X$ is very sensitive to cancellations between u, d and s contributions

It is better to study Λ produces in association with a π or K

This allows for flavor selection





D.B., Kang, Vogelsang, Yuan, PRL 2010

Fig 1: SIDIS, SU(3)-symmetric (solid) and broken (dashed) spin-averaged FFs

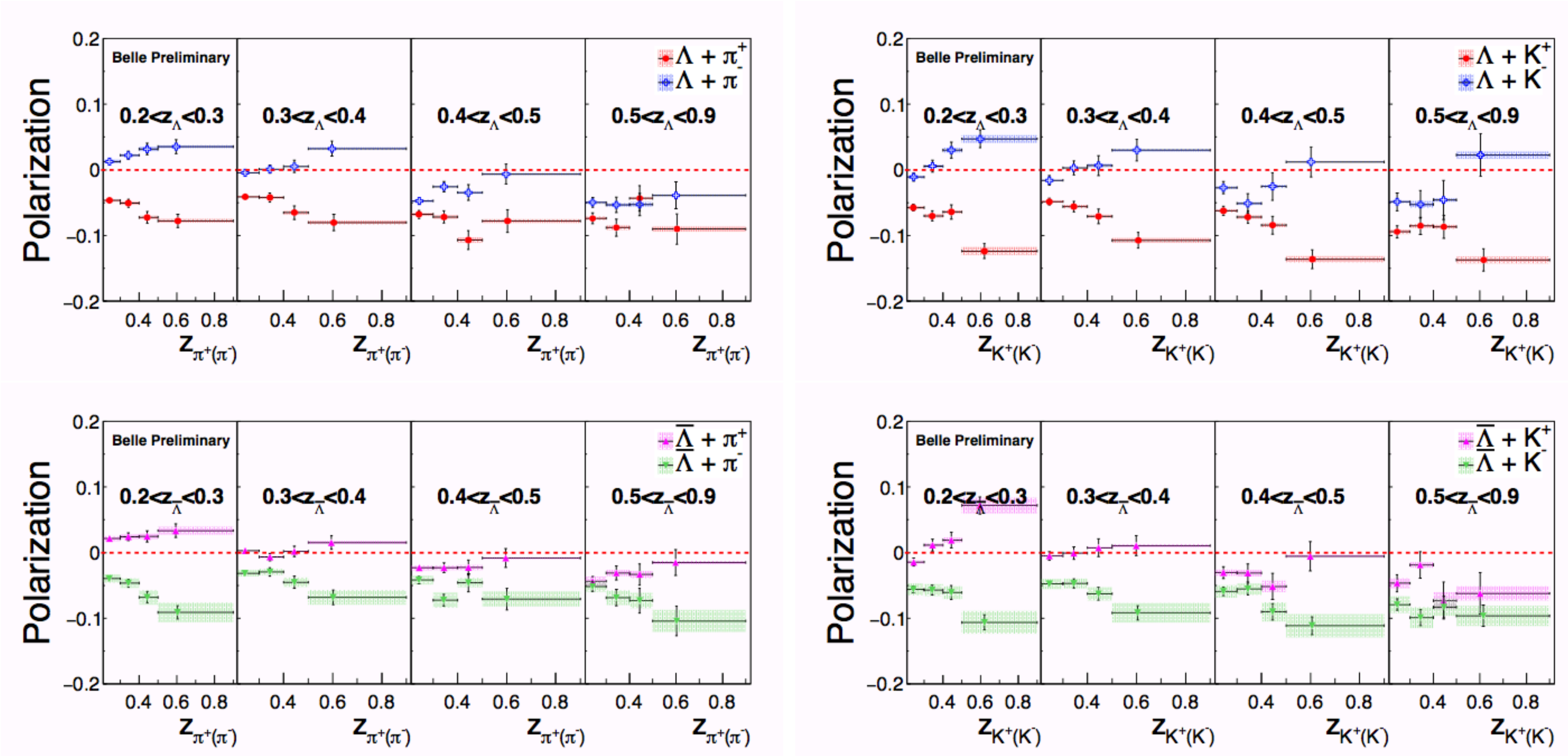
Fig 2: $e^+e^- \to \pi^\pm + \Lambda^\uparrow + X$, SU(3)-symmetric (thin) and broken (thick), solid/dashed is $\pi^\pm$

Fig 3: $e^+e^- \to$ jet $+ \Lambda^\uparrow + X$, SU(3)-symmetric (solid) and broken (dashed) spin-averaged FFs

Fig 4: $e^+e^- \to K^\pm + \Lambda^\uparrow + X$, SU(3)-symmetric (thin) and broken (thick), solid/dashed is $K^\pm$

Comparison to $ep \to e'\Lambda^\uparrow X$ can be used to test universality of $D_{1T}^\perp$

Associated production at Belle



BELLE Collaboration, arXiv:1611.06648

Data does not follow our expectations, e.g. for π^+ larger polarization than for π^-

Needs to be looked into

Polarizing Λ FF

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future

Using high energy hadron colliders

Validity of factorized description depends on a proper cross section description

This requires data at higher energies and higher p_T

Available data is from experiments with $\sqrt{s} \leq 62$ GeV, requiring large K factors

Why no $\Lambda^\uparrow$ data from high energy hadron colliders, such as RHIC or Tevatron?

Capabilities to measure Λ polarization via $\Lambda \to p\,\pi^-$ are usually restricted to the midrapidity region, where the degree of transverse polarization is very small

$P_\Lambda = 0$ at $\eta=0$ in pp collisions in cms

Alternative: consider jet+Λ production: $p\,p \to (\Lambda^\uparrow \text{jet})\ \text{jet}\ X$

Such an asymmetry does not need to vanish at $\eta = 0$

D.B., Bomhof, Hwang & Mulders, PLB 659 (2008) 127; D.B., arXiv:0907.1610

In fact, for $E_{jet}/\sqrt{s} \ll 1$ (easily valid at LHC) and universal FFs, one can study

$p\,p \to (\Lambda^\uparrow \text{jet})\ X$

D.B., arXiv:1007.3145

Jet+Λ production

Consider two jets, with momenta K_j and $K_{j'}$, such that $K_j \cdot K_{j'} = O(\hat{s})$

The Λ is part of one of the two jets, and has momentum K_Λ and polarization S_Λ

An asymmetry can arise that is proportional to: $\epsilon_{\mu\nu\alpha\beta} K_j^\mu K_{j'}^\nu K_\Lambda^\alpha S_\Lambda^\beta$

In principle, it is not power suppressed and it does not need to vanish at $\eta = 0$

In the center of mass frame of the two jets the asymmetry is of the form:

$$\mathrm{SSA} = \frac{d\sigma(+\boldsymbol{S}_\Lambda) - d\sigma(-\boldsymbol{S}_\Lambda)}{d\sigma(+\boldsymbol{S}_\Lambda) + d\sigma(-\boldsymbol{S}_\Lambda)} = \frac{\hat{\boldsymbol{K}}_j \cdot (\boldsymbol{K}_\Lambda \times \boldsymbol{S}_\Lambda)}{z\, M_\Lambda} \frac{d\sigma_T}{d\sigma_U}$$

$d\sigma_T / d\sigma_U$ depends on $D_{1T}^\perp$

For further details see D.B., Bomhof, Hwang & Mulders, PLB 659 (2008) 127

Considered in hybrid factorization approach (assumption that initial partonic k_T distribution hardly affects the relative momentum of the Λ w.r.t. its jet for large jet transverse momentum)

Jet+Λ production

The process p p → ($\Lambda^{\uparrow}$jet) jet X can be studied at RHIC and LHC

For instance, ALICE can measure Λ's over a wide p_T range,
in a typical yearly run at least up to 16 GeV/c

Rapidity coverage of ALICE: $-0.9 \leq \eta \leq +0.9$

For jet rapidities in this kinematic region, the cross section is dominated by gluon-gluon (gg→gg) scattering, if gluons fragmenting into Λ's are as important as quarks

This leads to

$$\frac{d\sigma_T}{d\sigma_U} \approx \frac{D_{1T}^{\perp\, g}(z, K_{\Lambda\, T}^2)}{D_1^g(z, K_{\Lambda\, T}^2)}$$

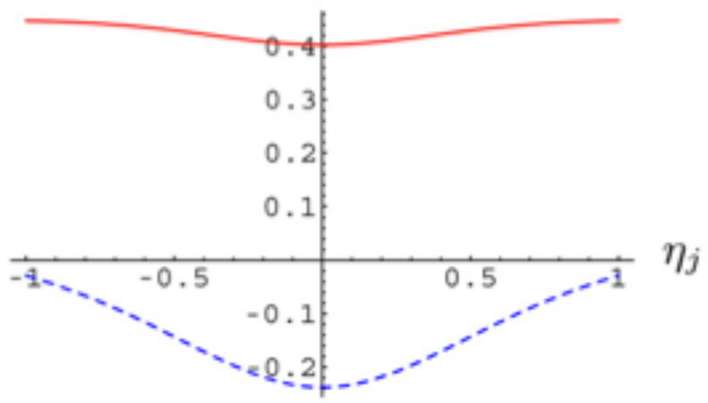
No model or fit for $D_{1T}^{\perp g}$ is available yet, so no predictions can be made yet

Recall that the fit of $D_{1T}^{\perp}$ to pp→$\Lambda^{\uparrow}$X data is not sensitive to g→ΛX

Jet+Λ production at the LHC

If it happens that $D_{1T}^{\perp g} \ll D_{1T}^{\perp q}$, then one finds for $\eta_{j'} \approx -\eta_j$ ($x \equiv x_1 \approx x_2$)

$$\frac{d\sigma_T}{d\sigma_U} \approx \frac{\sum_q f_1^q(x) D_{1T}^{\perp q}(z, K_{\Lambda T}^2)}{\sum_q f_1^q(x)(D_1^q(z, K_{\Lambda T}^2) + D_1^g(z, K_{\Lambda T}^2)) + f_1^g(x) D_1^g(z, K_{\Lambda T}^2)/0.8}$$

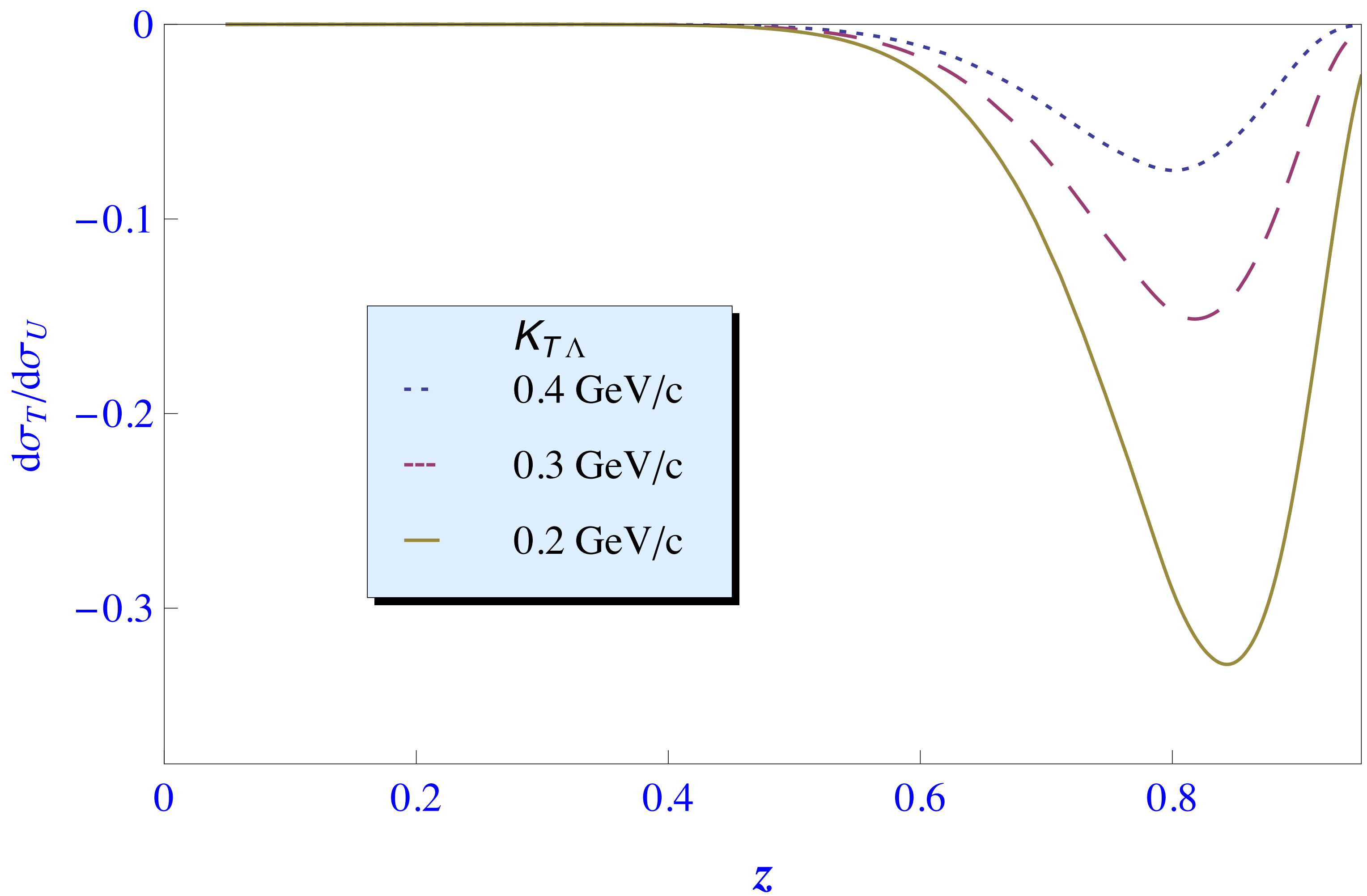


This includes also in the denominator the qg → qg subprocess

Will use extracted ratios for $D_{1T}^{\perp q}/D_{1T}^{\perp q}$ with DSV & IMR which have $D_1^g \ll D_1^q$

Expected to yield qualitative estimates only

Jet+Λ production at the LHC



using DSV

$\eta_j, \eta_{j'} = 0$

$|K_{\perp j}|, |K_{\perp j'}| = 70$ GeV

The asymmetry exceeds -1 for smaller $K_{T\Lambda}$ at large z, hence is overestimated

Hardly any asymmetry at smaller z due to fit to low energy data

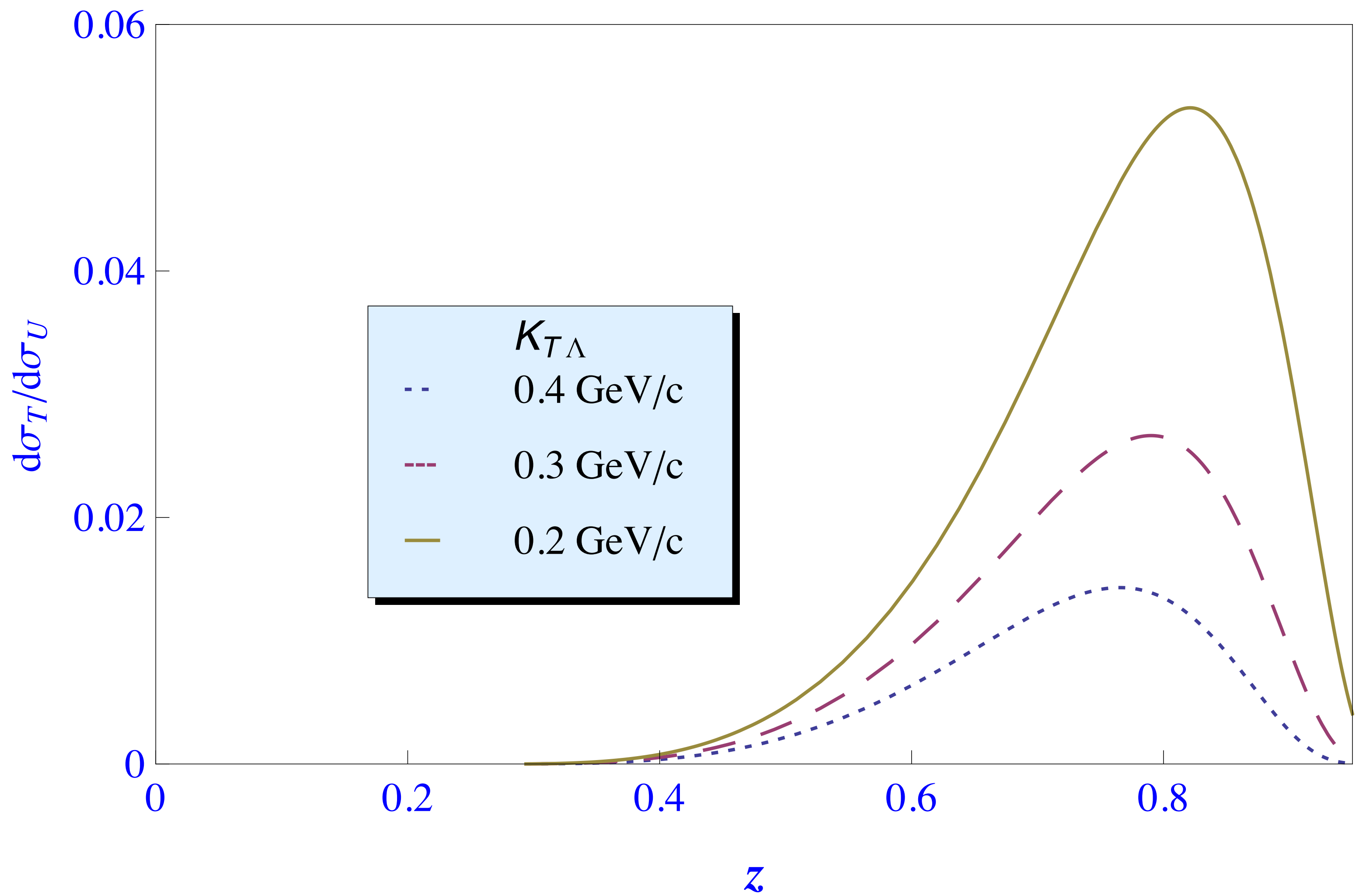
Need not be realistic at high energies

D.B., arXiv:1007.3145

Jet+Λ production at the LHC

$D_{1T}^{\perp}$ extracted using SU(3) breaking unpolarized FFs [IMR] yields very different result

Indumathi et al., PRD 58 (1998) 094014



Asymmetry is very sensitive to the cancellation between u, d and s contributions

D.B., arXiv:1007.3145

Universality of $D_{1T}^{\perp}$

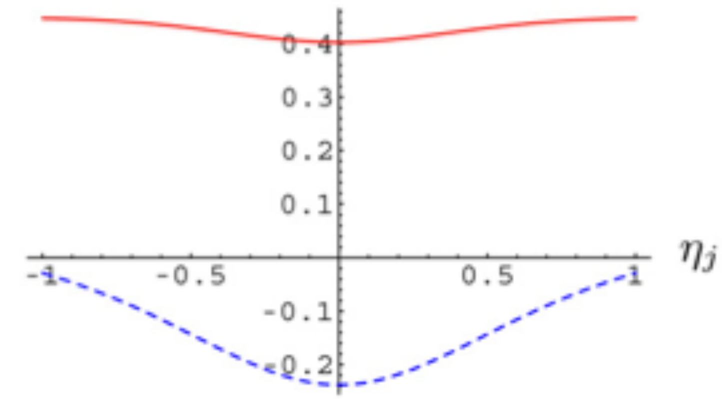
p p → ($\Lambda^{\uparrow}$jet) jet X allows a test of universality at RHIC and LHC through $\hat{t}/\hat{s}$ dependence, but not too distinctive

$$a_g(y) = \frac{d\hat{\sigma}_{gg\to[g]g}}{d\hat{\sigma}_{gg\to gg}}$$

$$a_q(y) = \frac{d\hat{\sigma}_{qg\to[q]g}}{d\hat{\sigma}_{qg\to qg}}$$

$$b(y) = \frac{d\hat{\sigma}_{qg\to qg}}{d\hat{\sigma}_{gg\to gg}} =$$

$b(y)+b(1-y)$ (solid line) and $b(y)a_q(y)+b(1-y)a_q(1-y)$



Comparing e^+e^- and ep seems more promising

Assuming universality of $D_{1T}^{\perp}$ one can consider p p → ($\Lambda^{\uparrow}$jet) X if $E_{jet}/\sqrt{s} \ll 1$

D.B., 1007.3145

The away-side jet is then not needed, allowing to study a rather simple *asymmetry in the lab frame* $\propto K_j \cdot (K_\Lambda \times S_\Lambda)$ with analyzing power:

$$\frac{\int \frac{dy}{y} \sum_q \left(f^{qg} + f^{gq}\right) d\hat{\sigma}_{qg} D_{1T}^{\perp\, q}}{\int \frac{dy}{y} \left[\sum_q \left(f^{qg} + f^{gq}\right) d\hat{\sigma}_{qg} \left(D_1^q + D_1^g\right) + f^{gg} d\hat{\sigma}_{gg} D_1^g\right]}$$

$$f^{ab} \equiv x_1 f_1^a(x_1) x_2 f_1^b(x_2),\; d\hat{\sigma}_{ab} \equiv d\hat{\sigma}_{ab\to ab}(y) + d\hat{\sigma}_{ab\to ab}(1-y) \text{ with } y = -\hat{t}/\hat{s}$$

Forward rapidity data

Λ polarization is also very interesting in p A reactions at very high $\sqrt{s}$, large A and η

In this kinematic regime of small x, saturation of the gluon density is expected

The saturation scale Q_s and even its evolution with x could be probed in this way

D.B. & Dumitru, PLB 556 (2003) 33; D.B., Utermann & Wessels, PLB 671 (2009) 91

However, in the forward direction often protons cannot be identified, which hampers the measurement of Λ polarization

None of the existing data is in the saturation regime

Suggestion: use neutral decays $\Lambda \to n\, \pi^0$ (B.R. 1/3) to measure Λ polarization at forward rapidities

Cork et al., PR 120 (1960) 1000; Olsen et al., PRL 24 (1970) 843

Hadron production in the saturation regime

The cross section of forward hadron production in the (near-)saturation regime:

pdf $\otimes$ dipole cross section $\otimes$ FF

Dumitru & Jalilian-Marian, PRL 89 (2002) 022301

Since $D_{1T}^{\perp}$ is k_T-odd, it essentially probes the derivative of the dipole cross section

At transverse momenta of $O(Q_s)$ the dipole cross section changes most

This leads to a Q_s-dependent peak in the Λ polarization

First demonstrated for the McLerran-Venugopalan model, which has constant Q_s

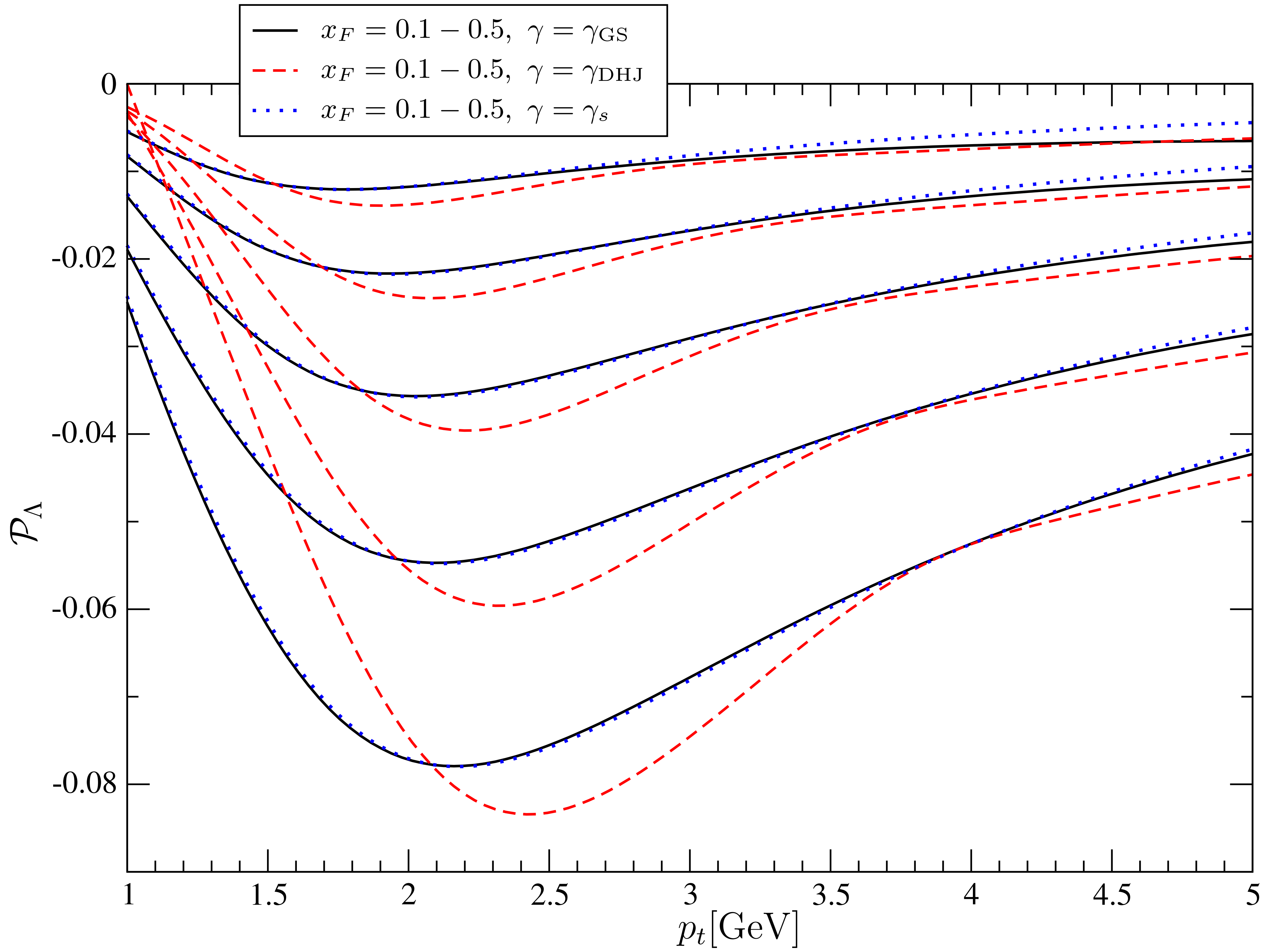
D.B. & Dumitru, PLB 556 (2003) 33

For an x-dependent Q_s it is a priori not clear whether this signature remains

But various CGC models lead to same conclusion about peak of Λ polarization:

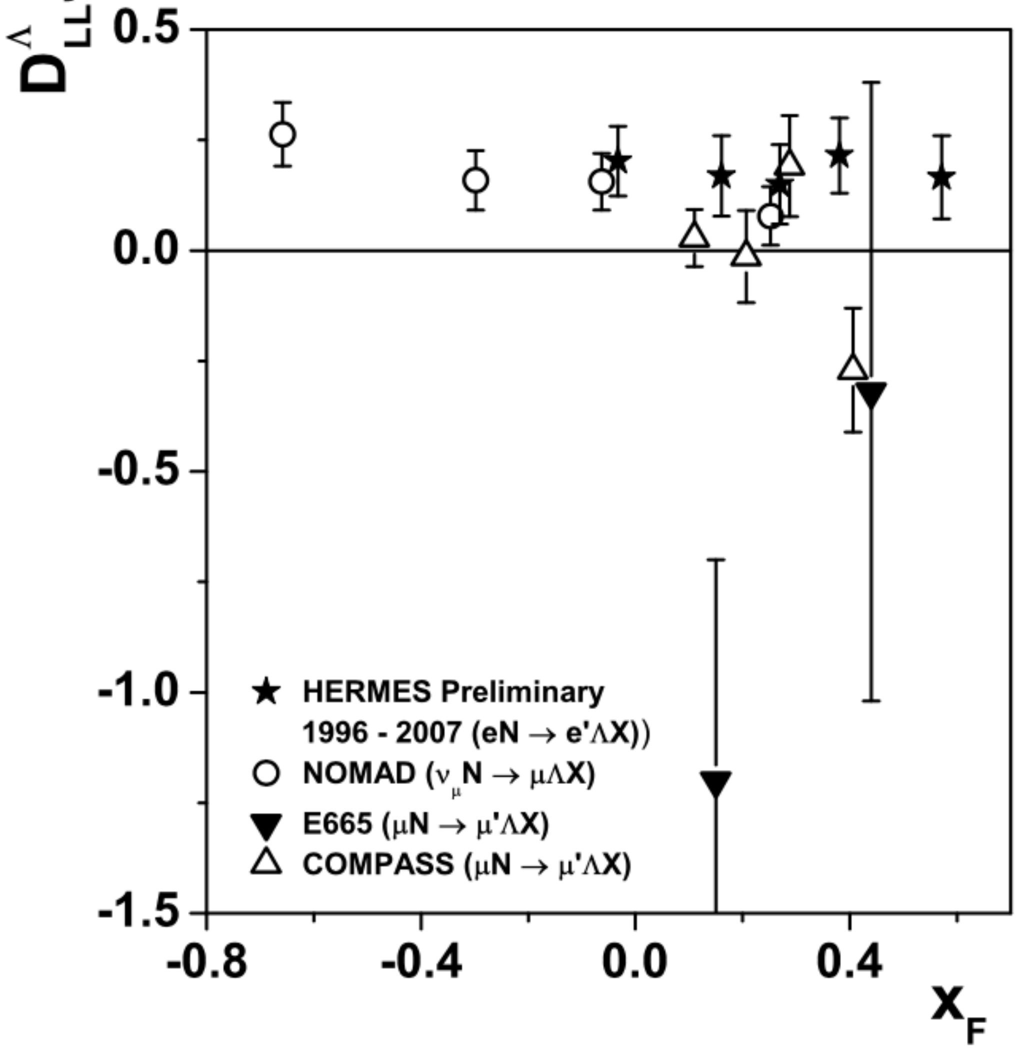
Its x_F dependence is to very good approximation the x dependence of Q_s!

Λ polarization in $p + Pb \to \Lambda^{\uparrow} + X$ at $\sqrt{s} = 8.8$ TeV

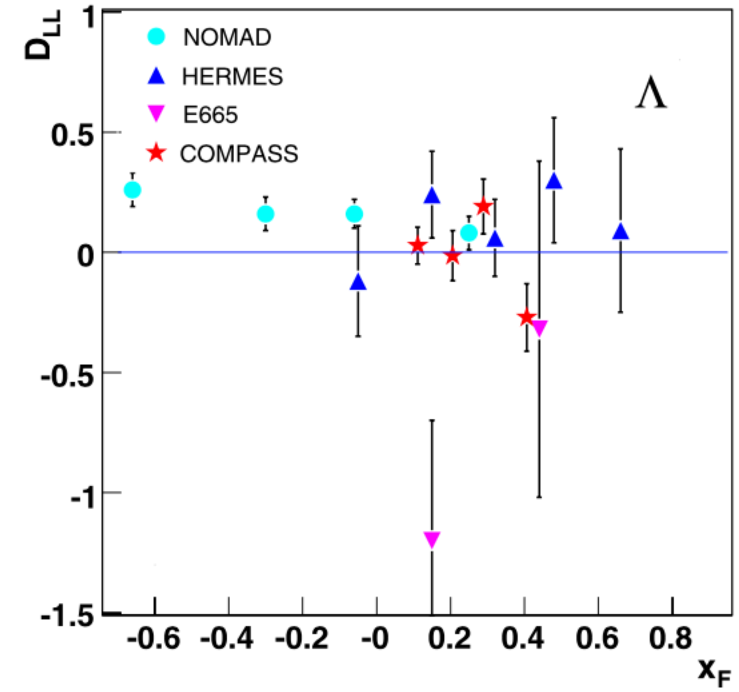


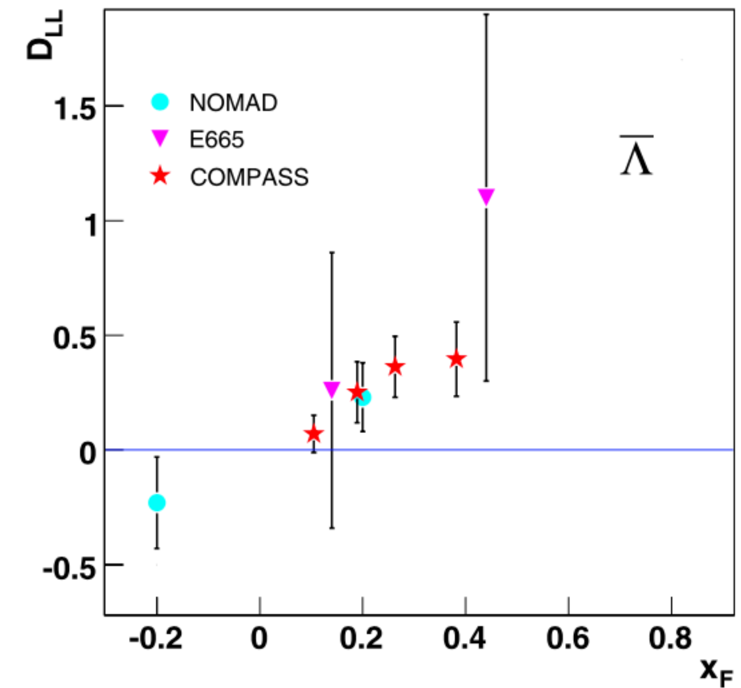
D.B., Utermann & Wessels, PLB 671 (2009) 91

D_{LL}

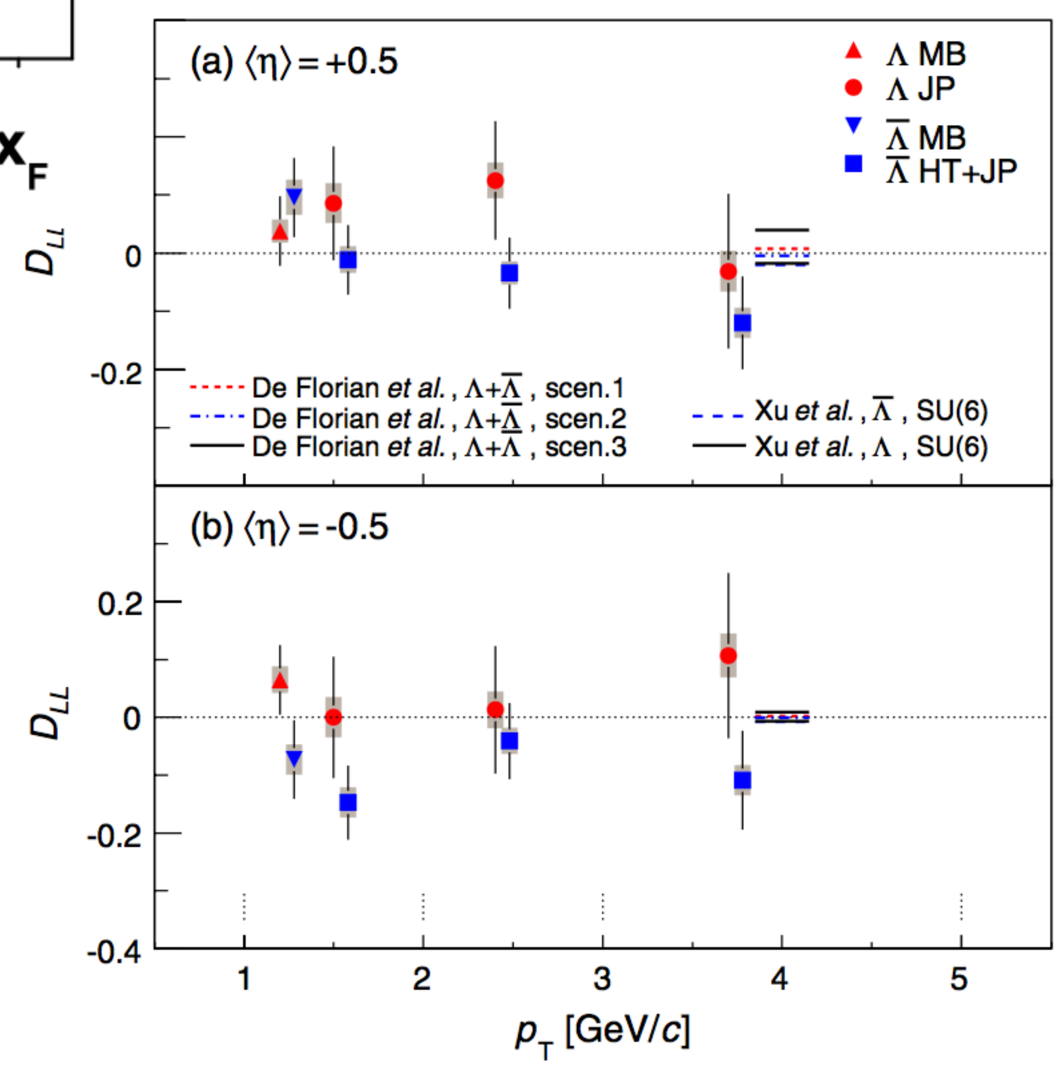


HERMES@SPIN2010





COMPASS, EPJC 2009



STAR, PRD 2009

D_{NN} in SIDIS ($\mu p^{\uparrow} \rightarrow \mu \Lambda^{\uparrow} X$)

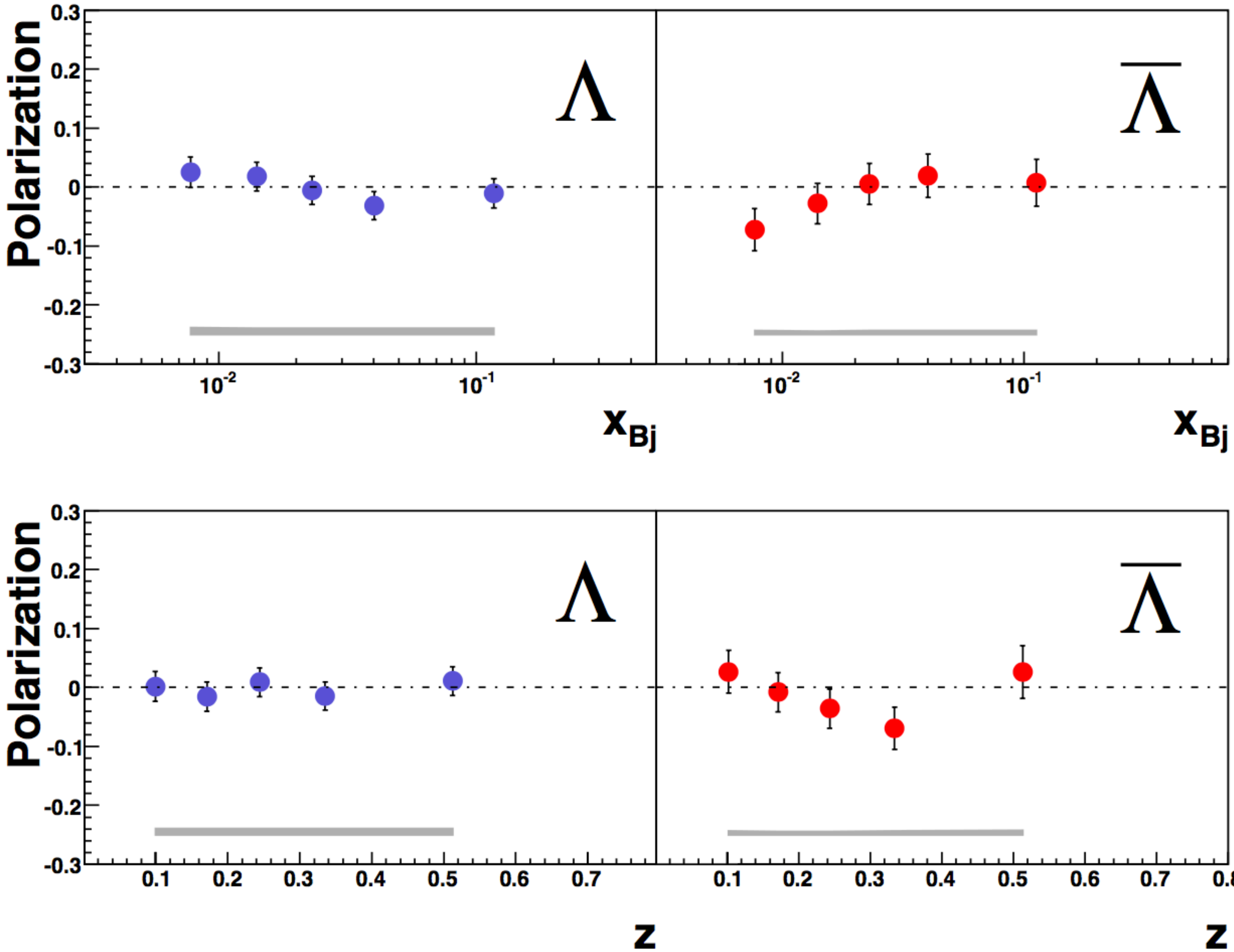
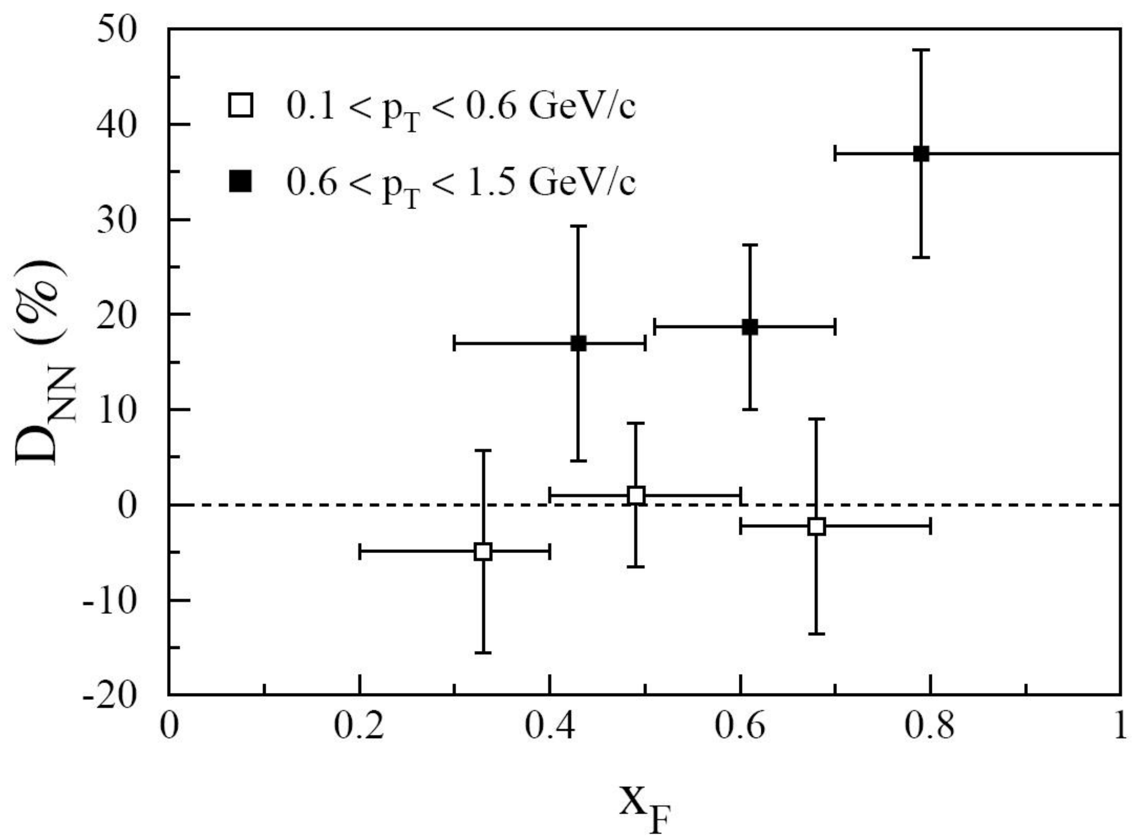


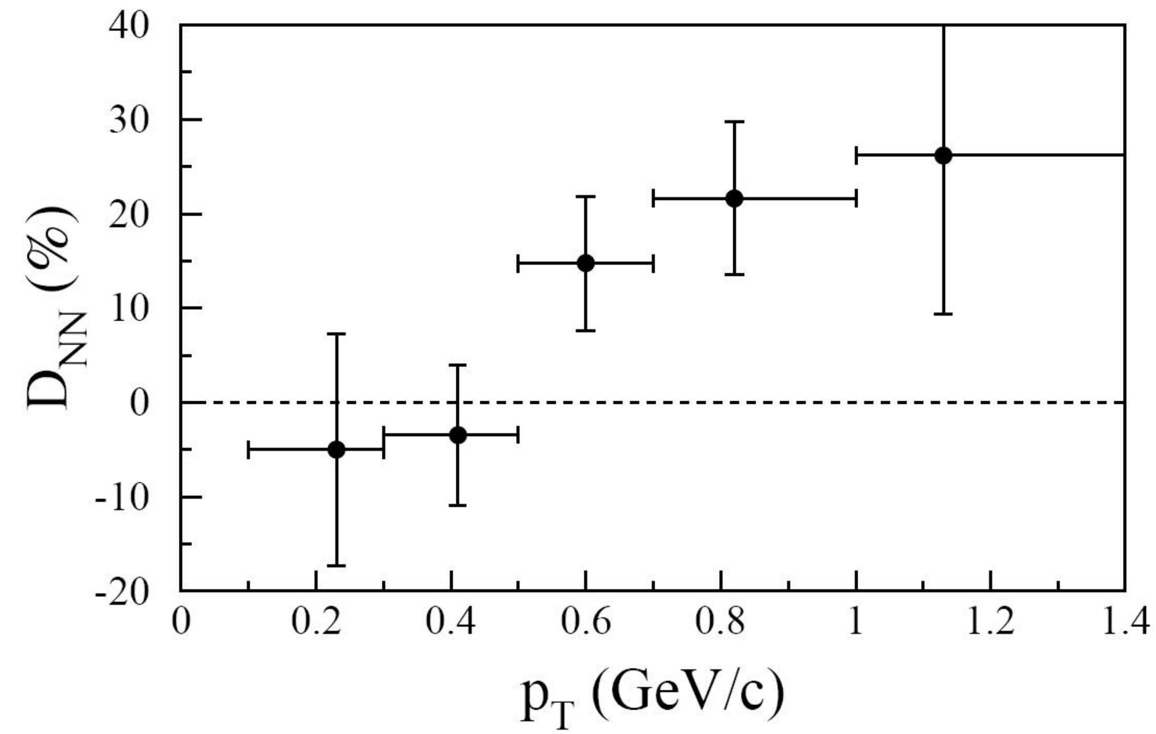
Figure 6.3: Λ and $\overline{\Lambda}$ polarizations with statistical errors as a function of x_{Bj} and z in the 2007 COMPASS data on a transversely polarized proton target with $Q^2 > 1$ (GeV/c)^2 and $0.1 < y < 0.9$. The lower band shows the upper limit of the systematic error, estimated by the pulls distribution of false polarizations (same as Fig. 5.15).

T. Negrini, COMPASS, PhD thesis, 2009

Likely implies small $H_1^{u,d}(z)$ and/or small $h_1^s(x)$ in the measured range

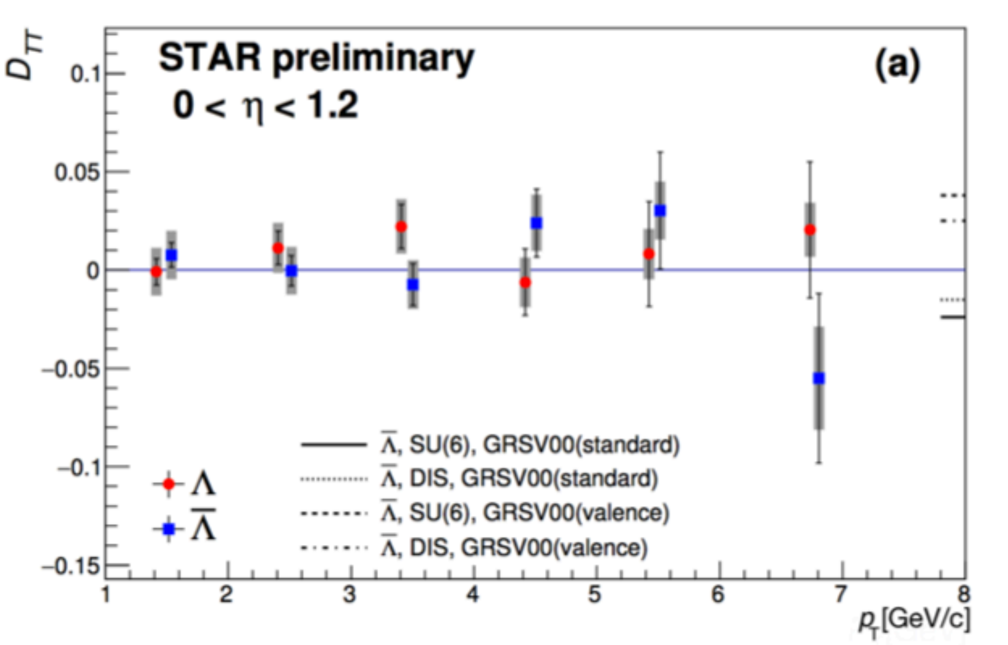
D_{NN} in pp

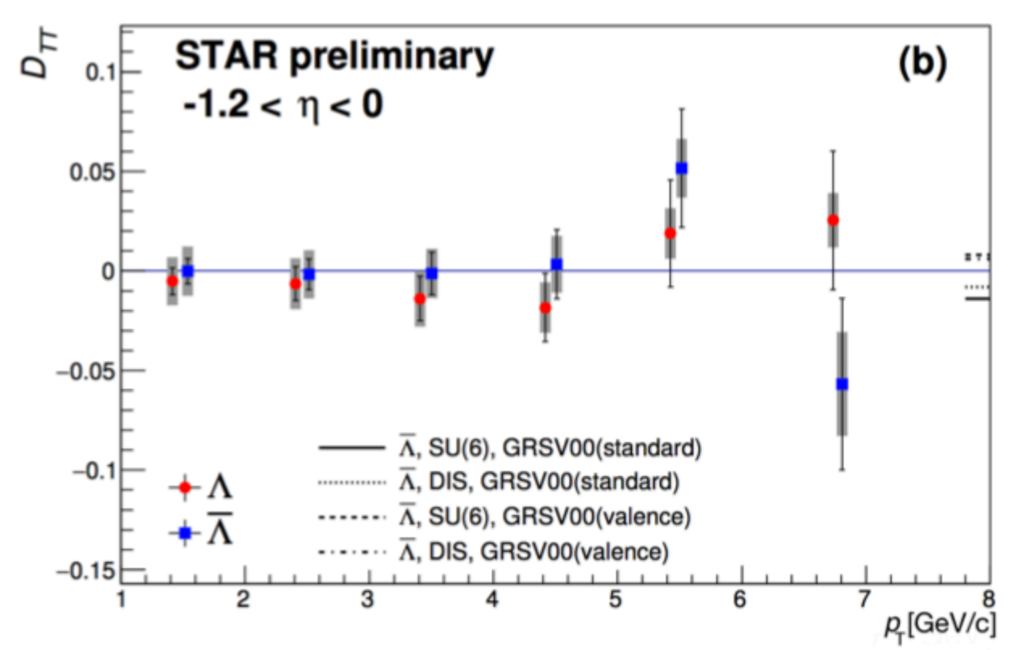




E704 Collaboration, Bravar et al., PRL 78 (1997) 4003

At E704 ($\sqrt{s} \approx 20$ GeV) not $h_1 H_1$ (factorization is doubtful at low $p_T < 1.5$ GeV)





STAR Collab., PoS DIS2017 (2018) 225

Conclusions

Open issues

- Λ FFs are not yet fitted with data from LHC. AKK08's observation of "a possible inconsistency between the pp and e^+e^- reaction data" not yet solved
- More SIDIS $\Lambda^\uparrow$ data is needed & comparison to ZEUS data needs to be made
- Evolution from BELLE to LEP might work regarding magnitude, to be checked
- Systematics of associated production at BELLE needs to be understood still
- Nonzero $D_{1T}^{\perp}$ ⇒ unsuppressed $K_j \cdot (K_\Lambda \times S_\Lambda)$ asymmetry in $pp \to (\Lambda^\uparrow \text{jet})\, X$ at midrapidity, not yet experimentally studied, may clarify the role of gluons
- The k_T-odd nature of $D_{1T}^{\perp}$ can be of use to small-x physics: x_F dependence of the peak of Λ polarization directly probes the x dependence of Q_s
  In principle possible at LHC (at RHIC the peak is likely at too low p_T)
- Still not clear from D_{NN} whether transversity FF is sizable