

Strange quark suppression from a simultaneous MC analysis of parton distribution and fragmentation functions

Nobuo Sato

ODU/JLab

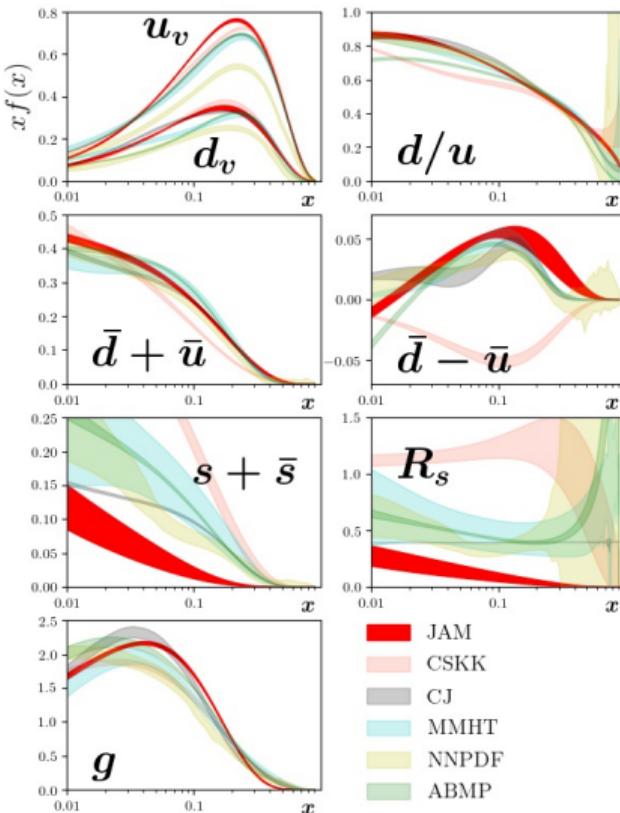
The 11th Circum-Pan-Pacific Symposium
on High Energy Spin Physics
Miyazaki, Japan

In collaboration with:

Carlota Andres, Jake Ethier,
Wally Melnitchouk

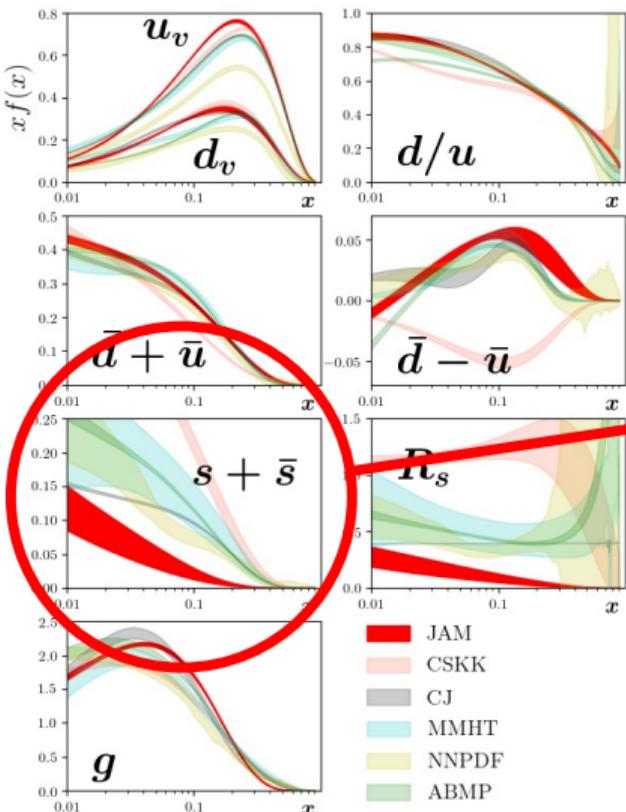


New JAM19: simultaneous PDF & FF(π, K) extraction

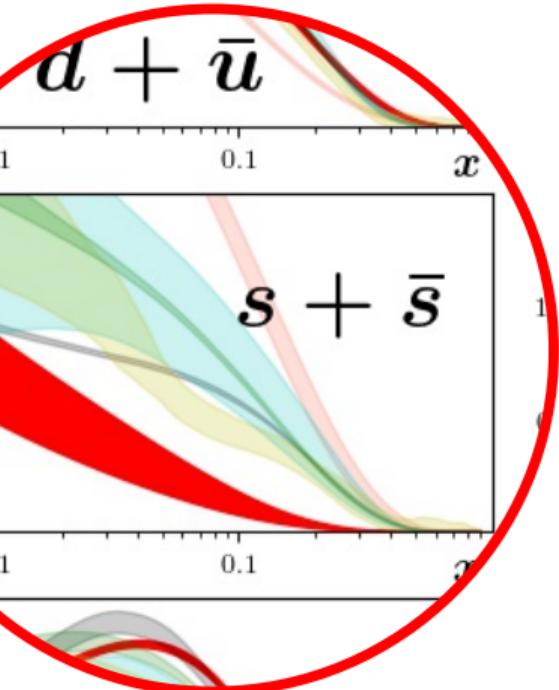


- ✓ DIS (p, d)
- ✓ DY (pp, pd)
- ✓ SIA (π^\pm, K^\pm)
- ✓ SIDIS (π^\pm, K^\pm)

New JAM19: simultaneous PDF & FF(π, K) extraction

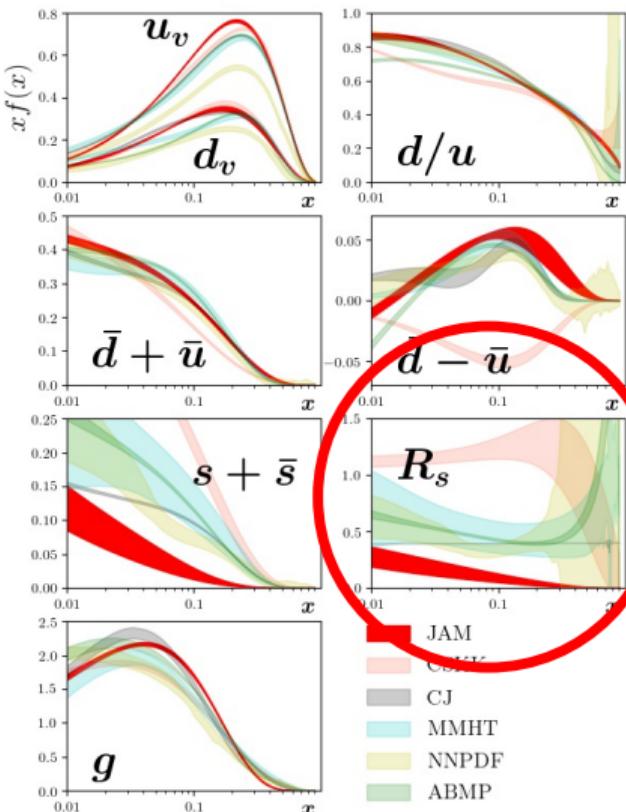


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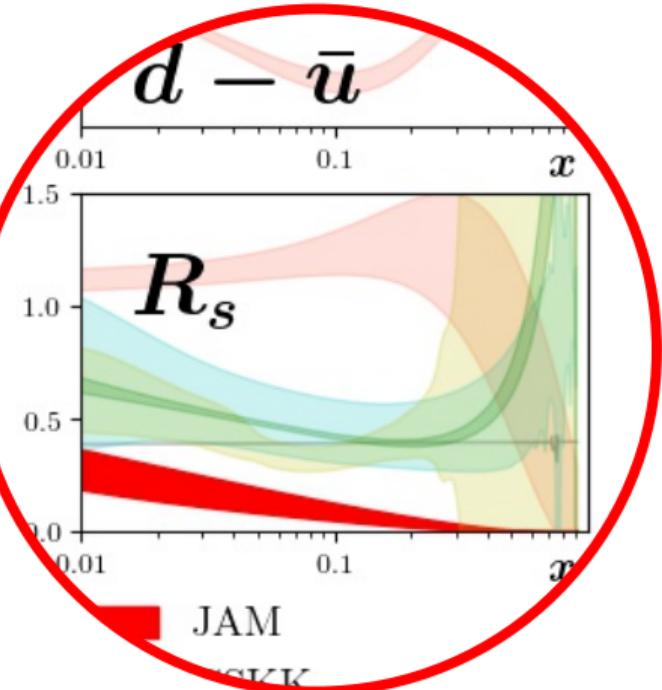


Strong strange suppression

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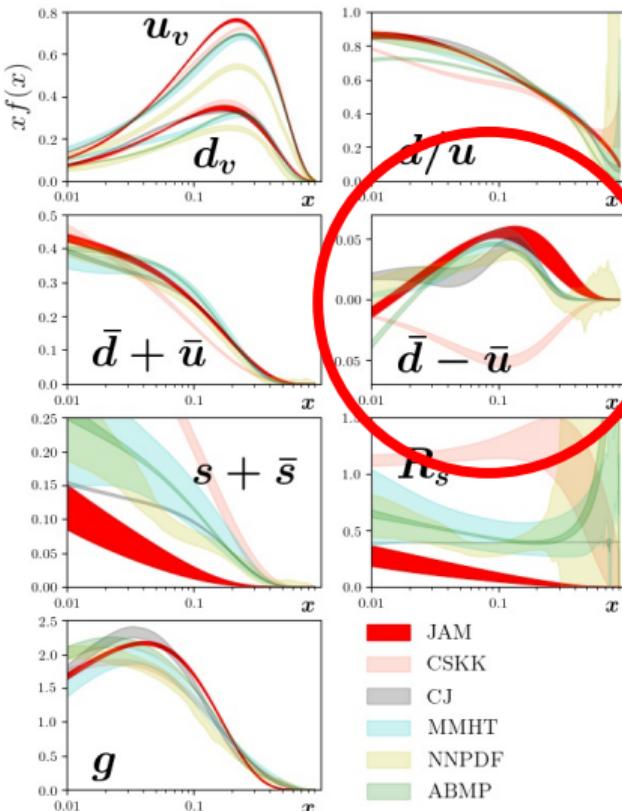


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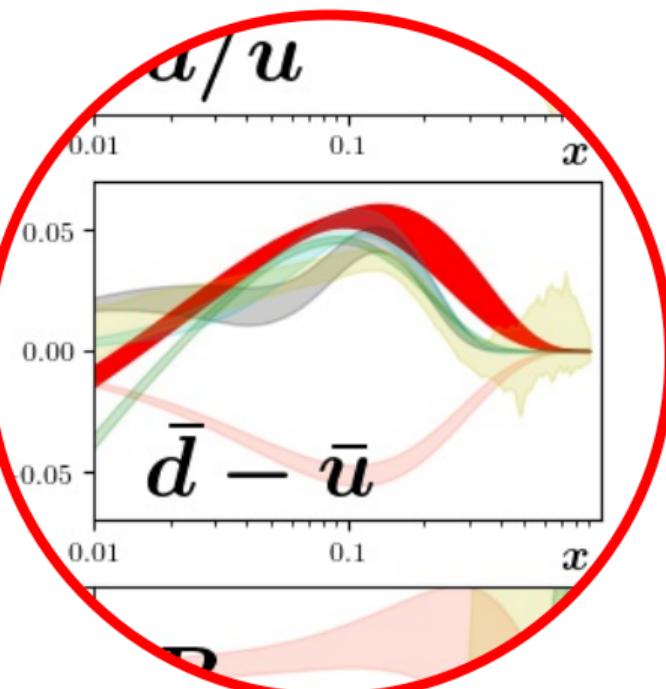
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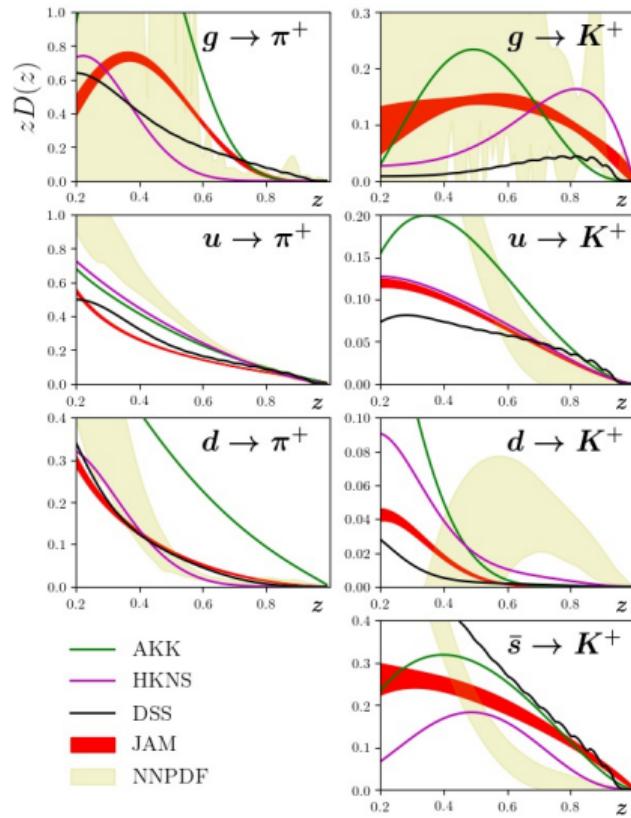


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Large $\bar{d} - \bar{u}$

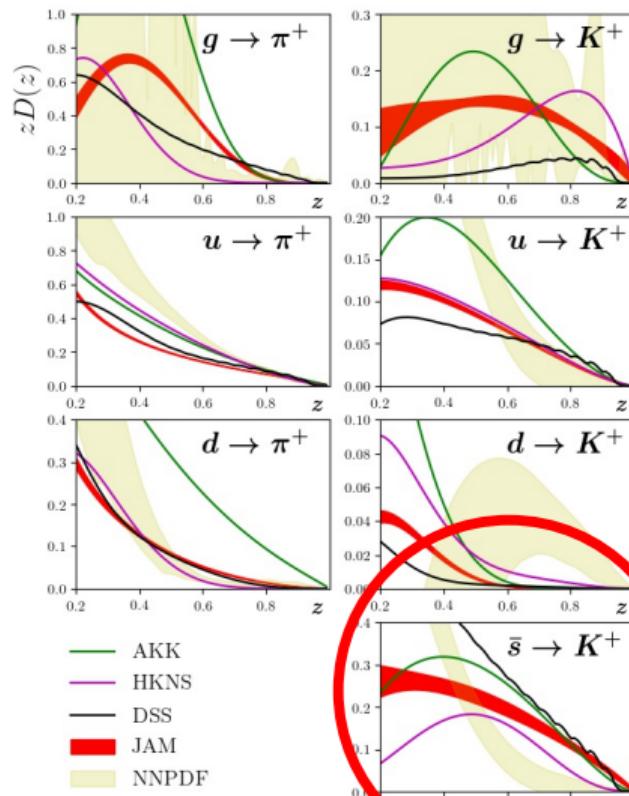


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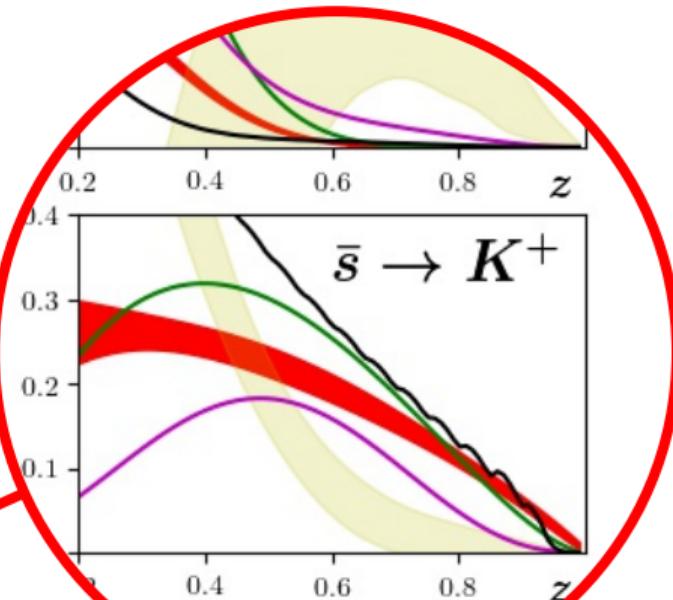
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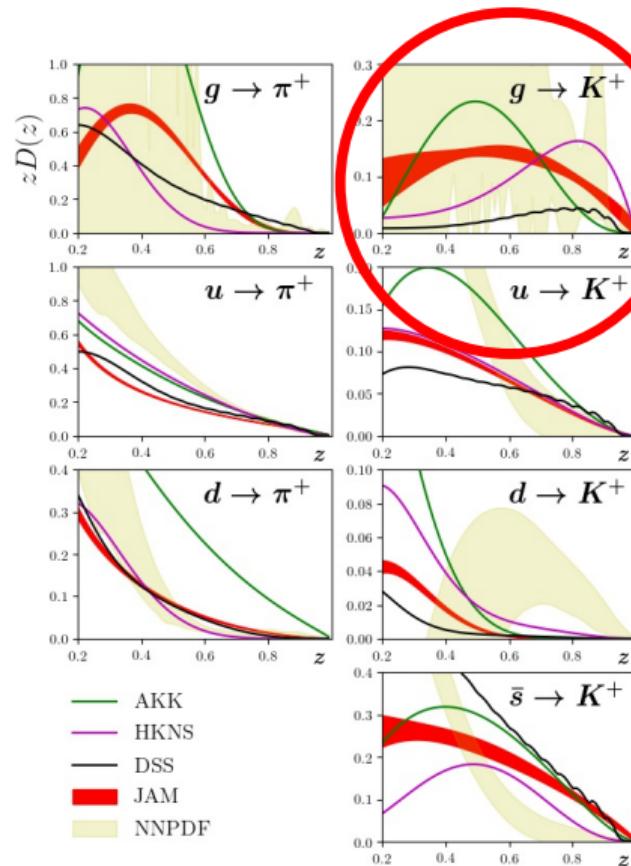


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Large $\bar{s} \rightarrow K^+$



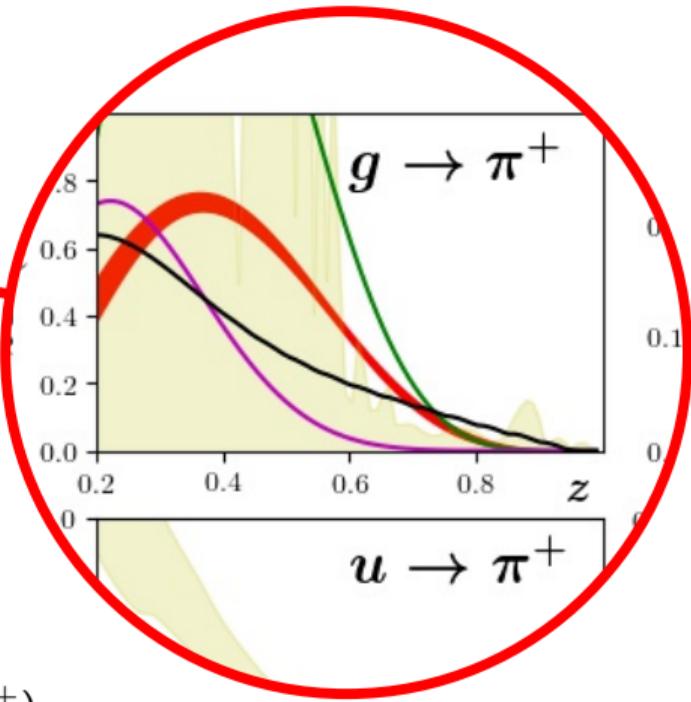
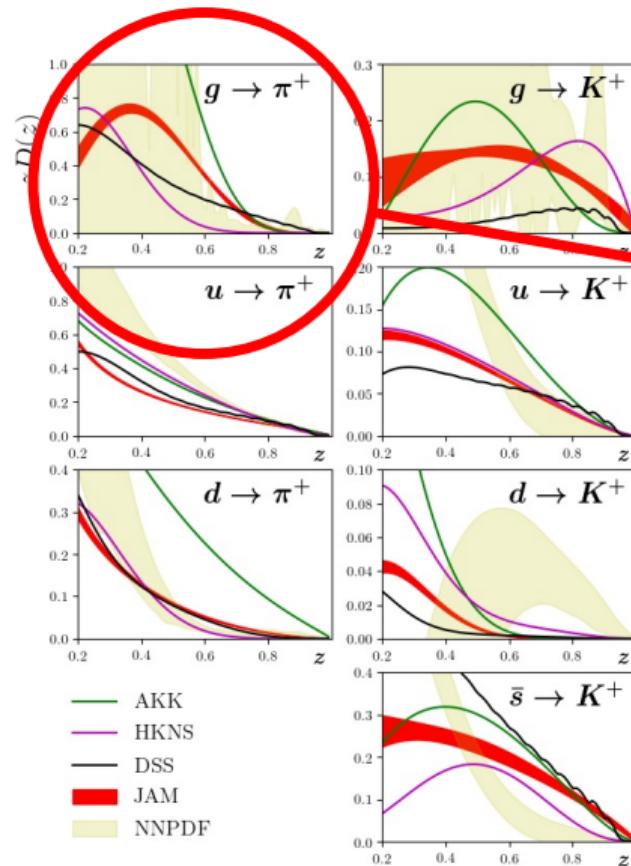
New JAM19: simultaneous PDF & FF(π, K) extraction



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Constraints on $g \rightarrow K^+$

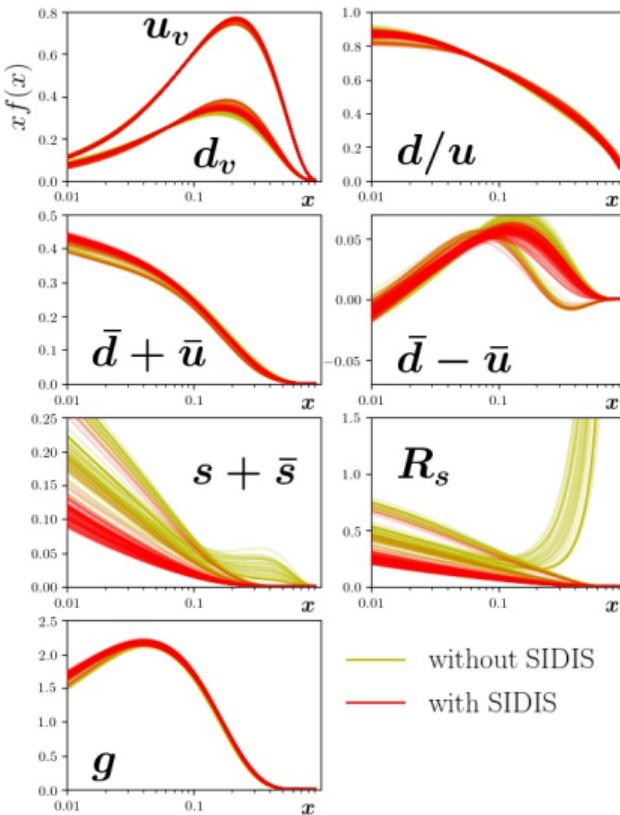
New JAM19: simultaneous PDF & FF(π, K) extraction



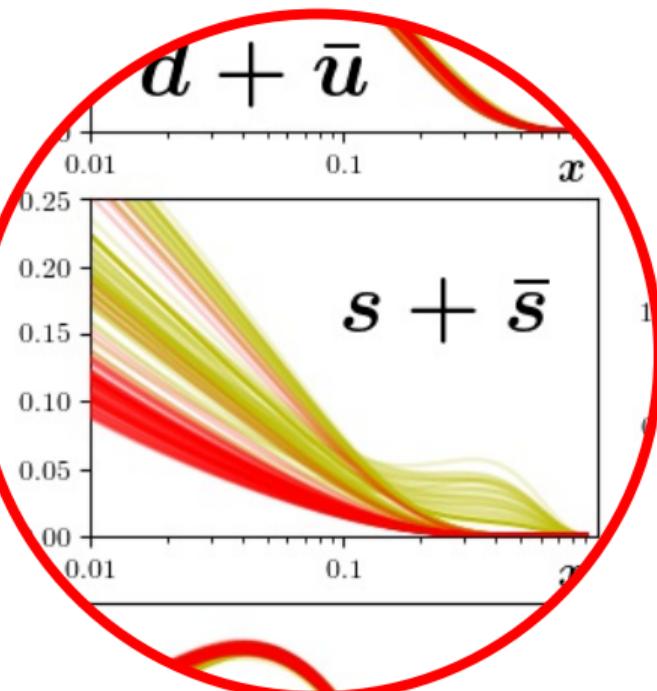
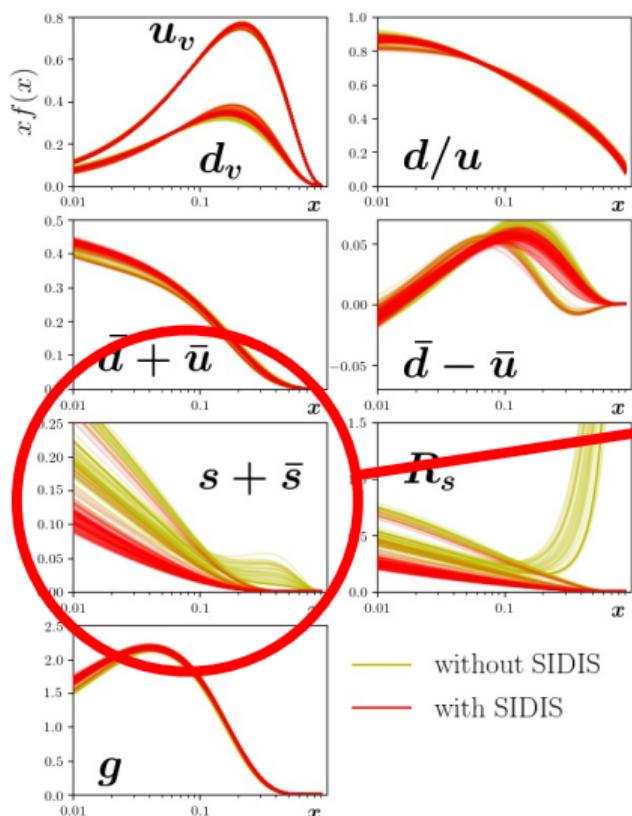
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Constraints on $g \rightarrow \pi^+$

New JAM19: impact of SIDIS data on PDFs

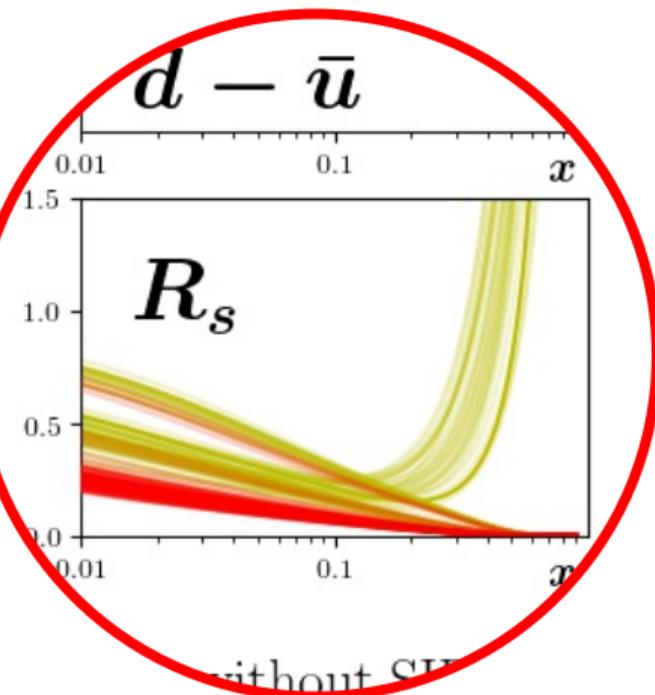
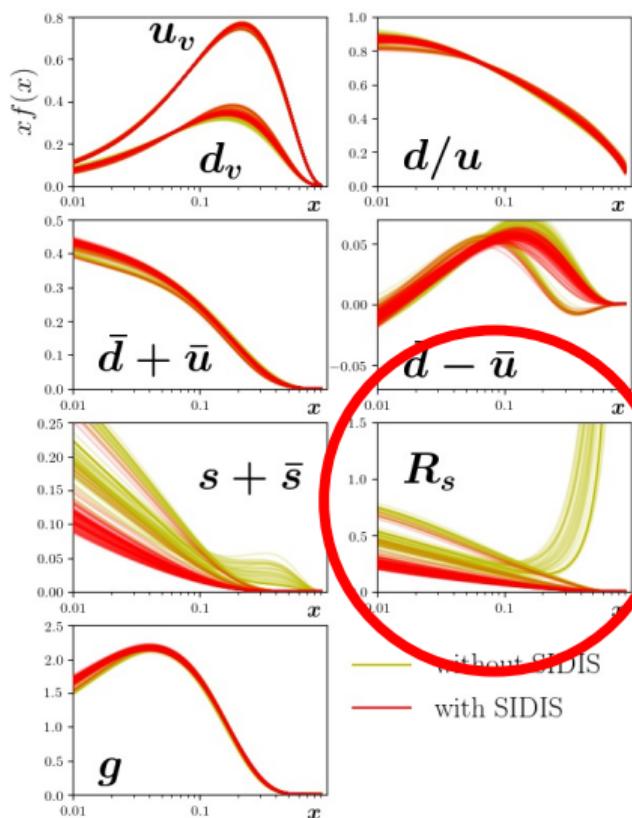


New JAM19: impact of SIDIS data on PDFs



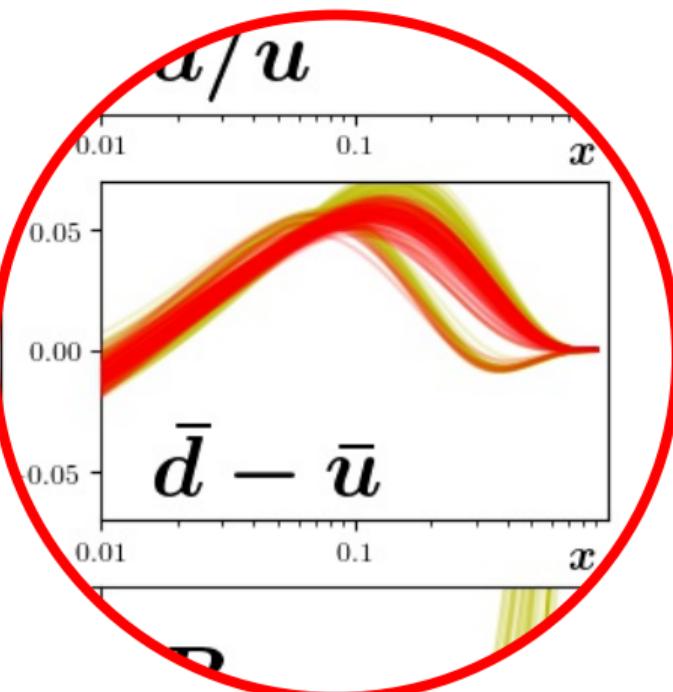
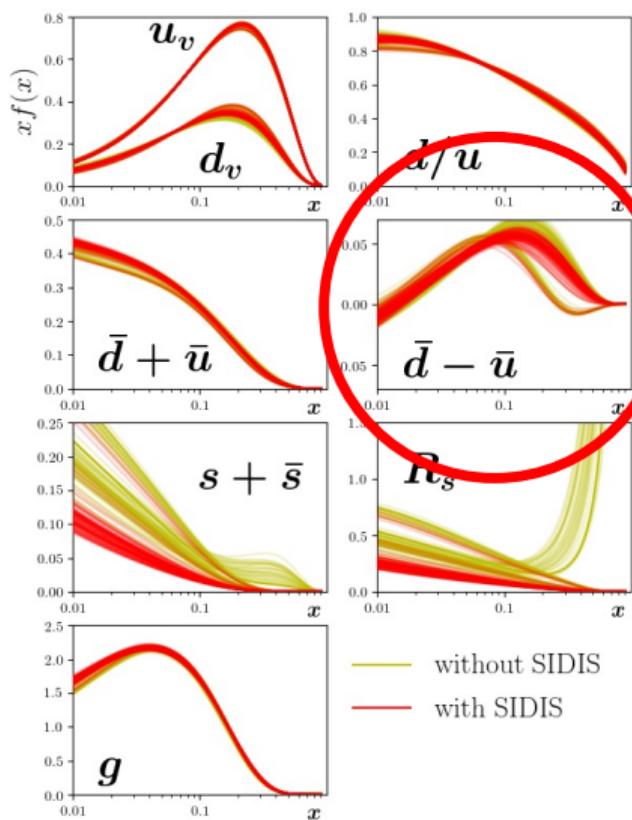
Strong strange suppression

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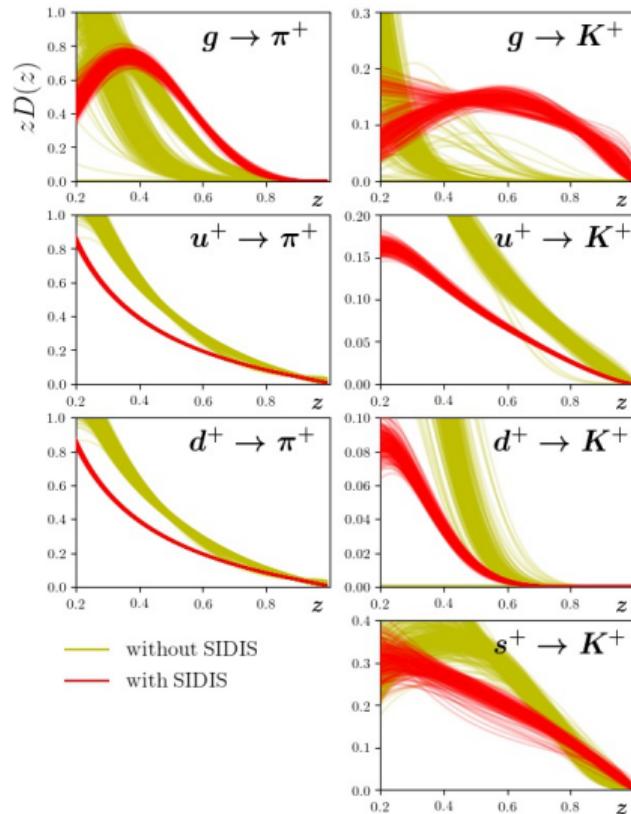
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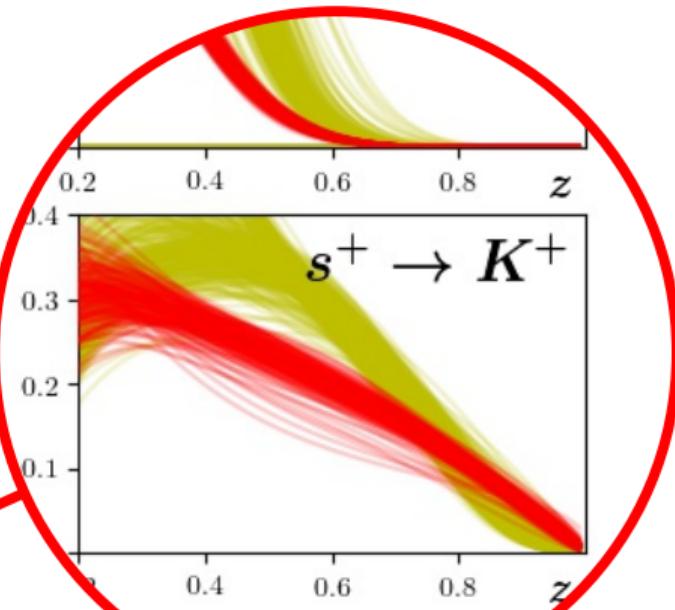
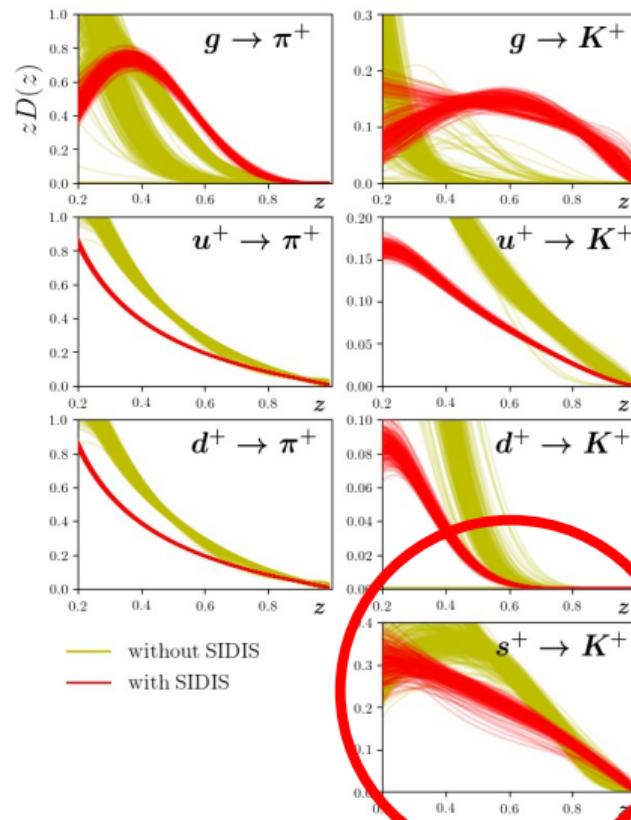


Large $\bar{d} - \bar{u}$

New JAM19: impact of SIDIS data on FFs

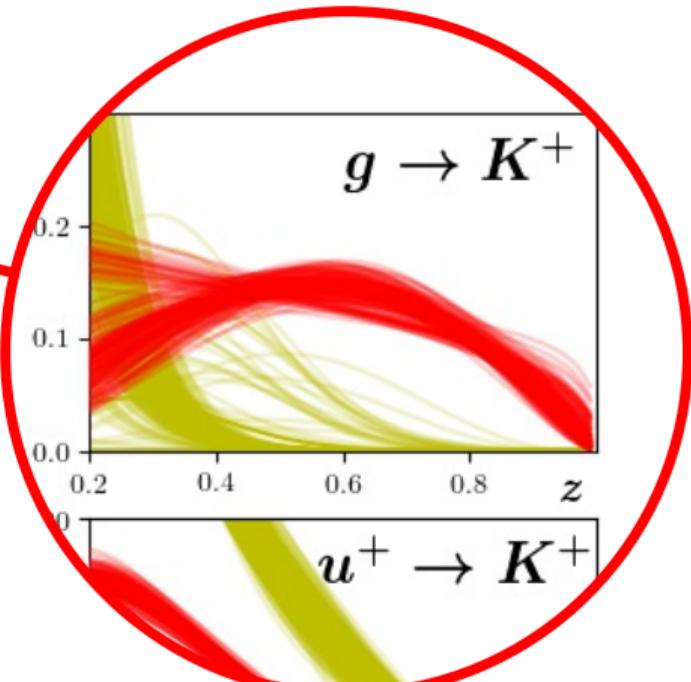
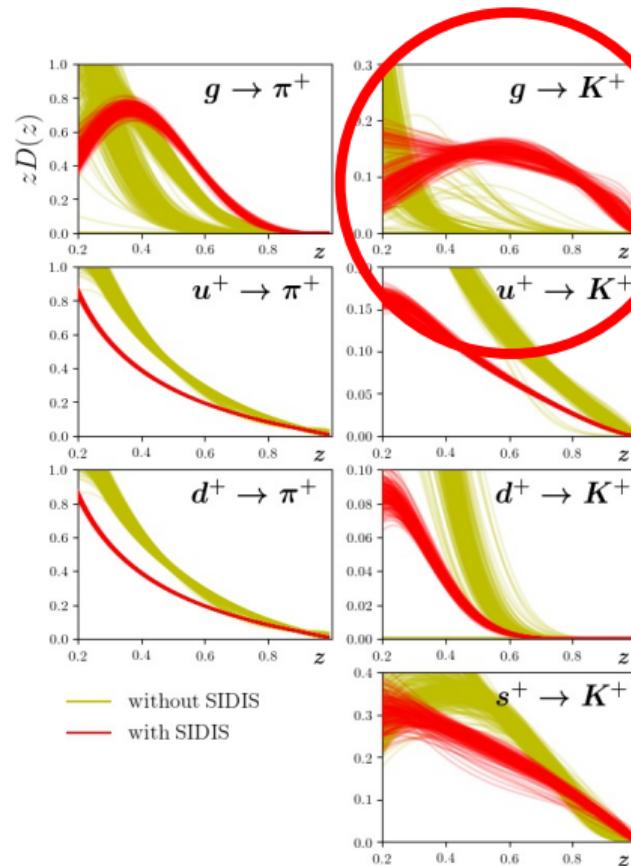


New JAM19: impact of SIDIS data on FFs



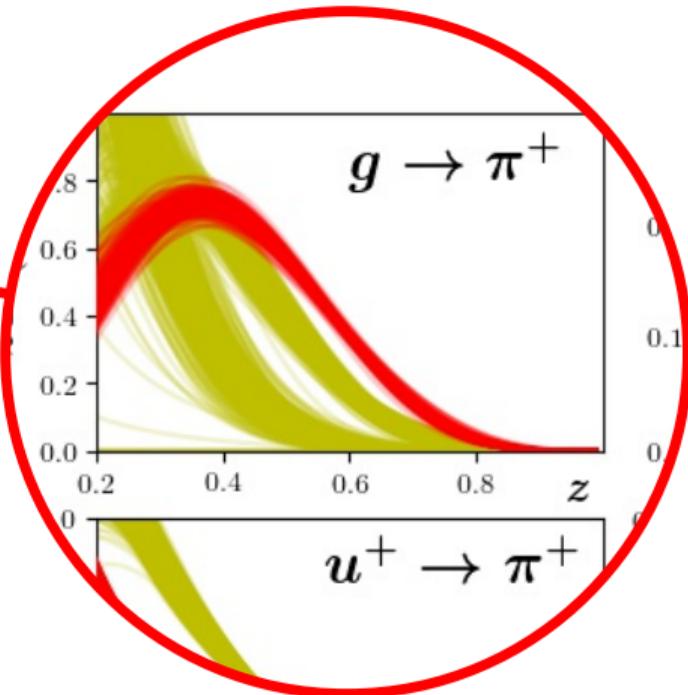
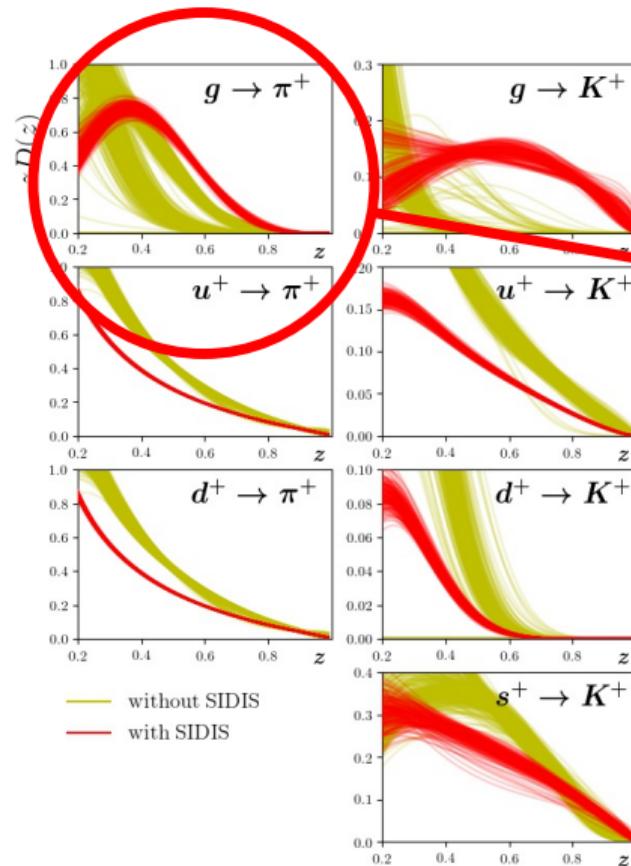
Constraints on $\bar{s} \rightarrow K^+$

New JAM19: impact of SIDIS data on FFs



Constraints on $g \rightarrow K^+$

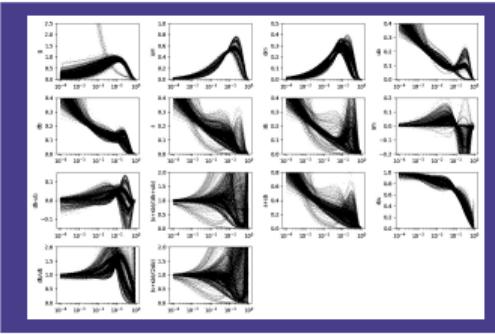
New JAM19: impact of SIDIS data on FFs



Constraints on $g \rightarrow \pi^+$

JAM19 multi-step strategy

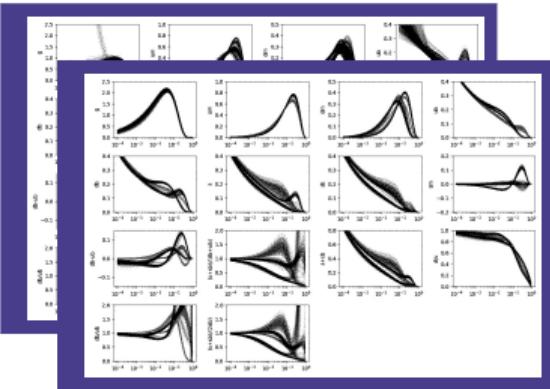
PDFs



+DIS (No HERA)

JAM19 multi-step strategy

PDFs

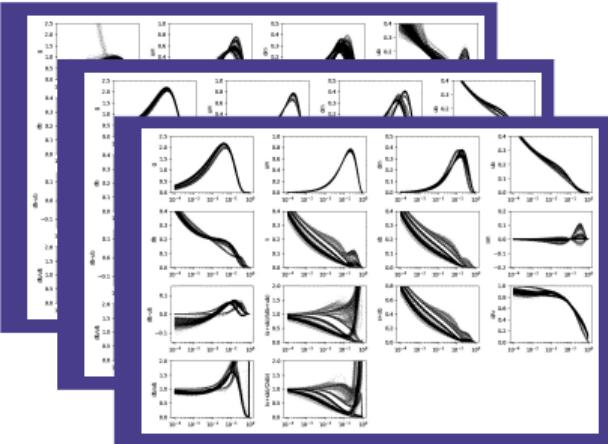


+DIS (No HERA)

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JAM19 multi-step strategy

PDFs



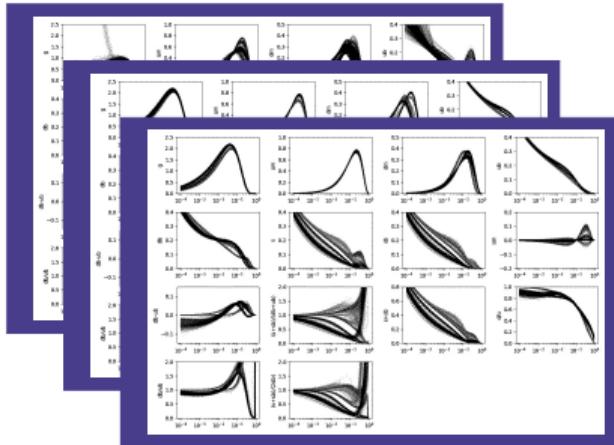
+DIS (No HERA)

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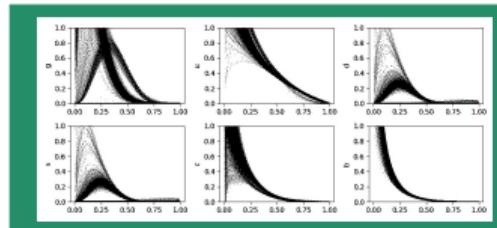
+DY

JAM19 multi-step strategy

PDFs

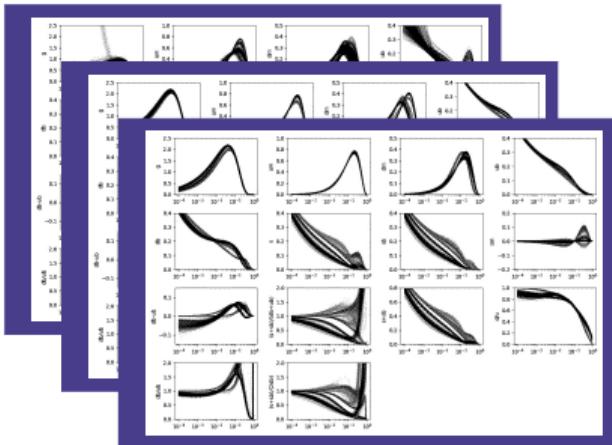


pion FFs



JAM19 multi-step strategy

PDFs

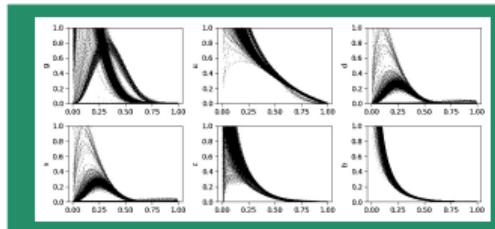


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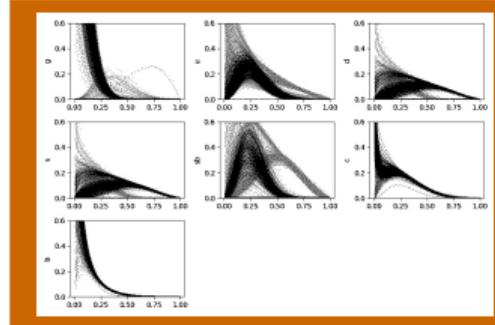
+DY

pion FFs



+SIA pions

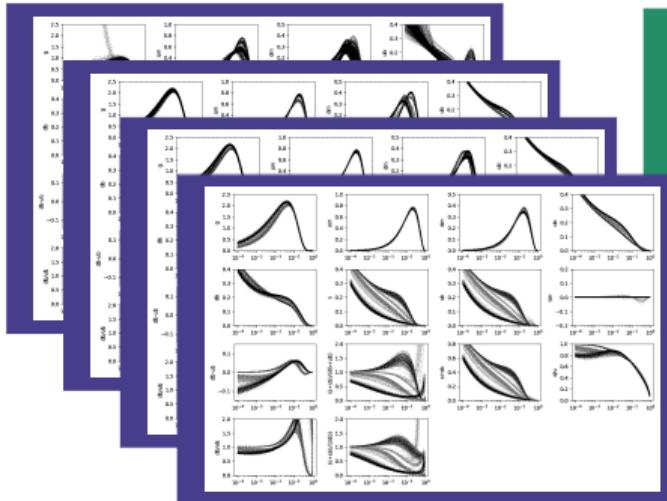
kaon FFs



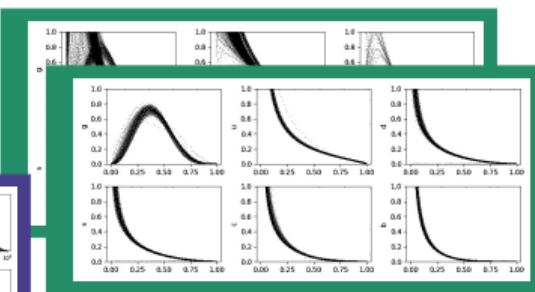
+SIA kaons

JAM19 multi-step strategy

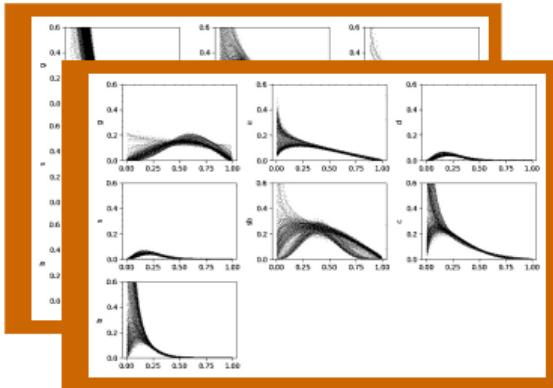
PDFs



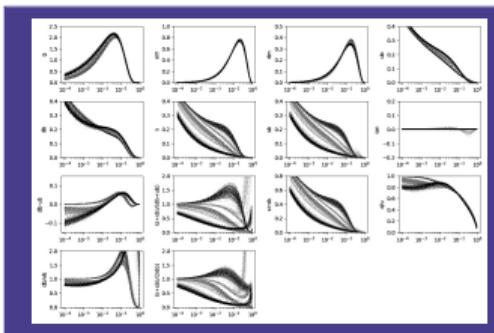
pion FFs



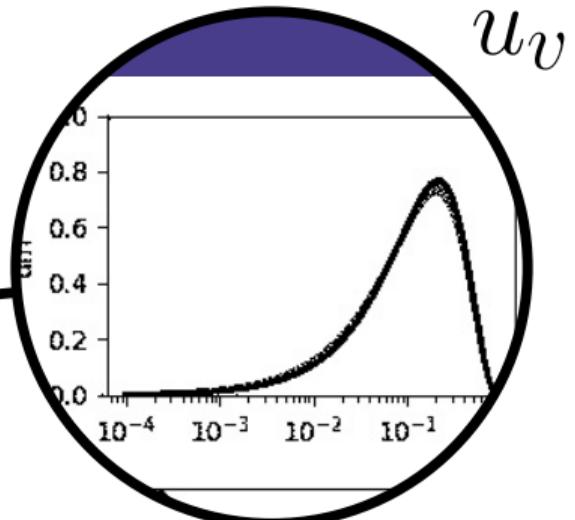
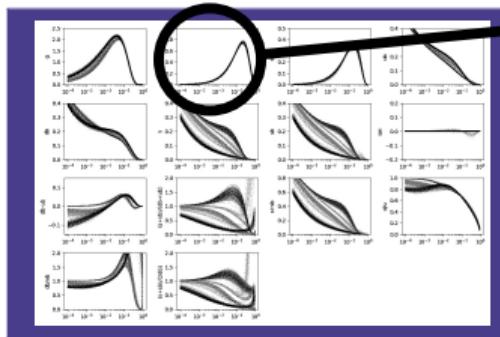
kaon FFs



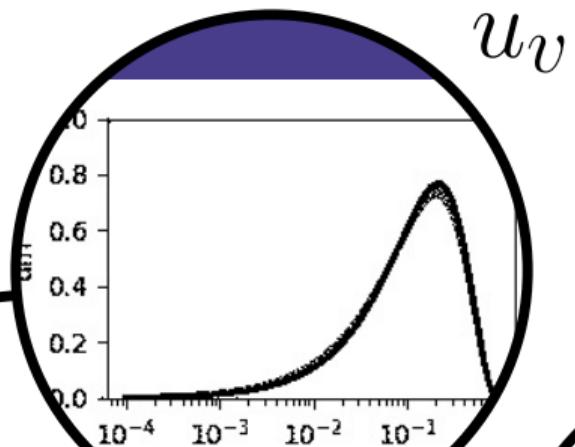
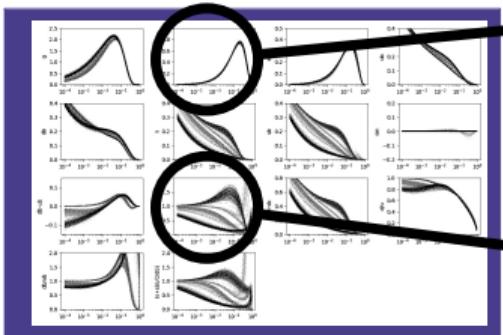
Discriminating multiple solutions



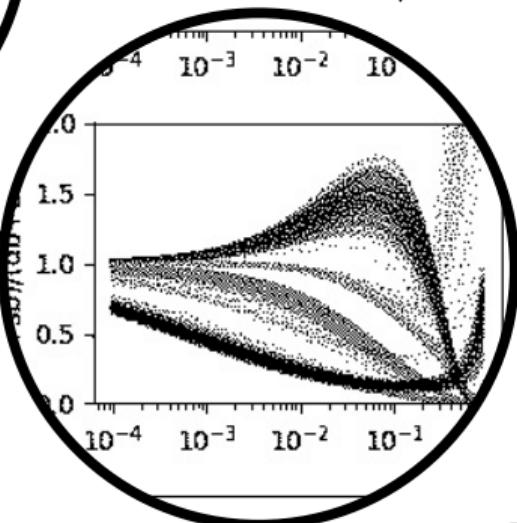
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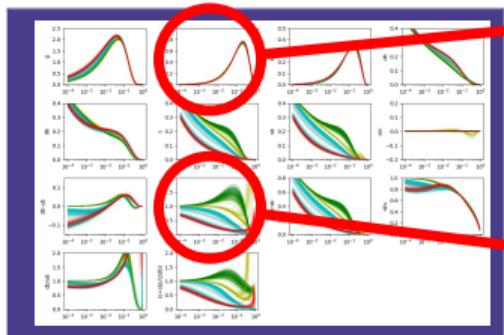
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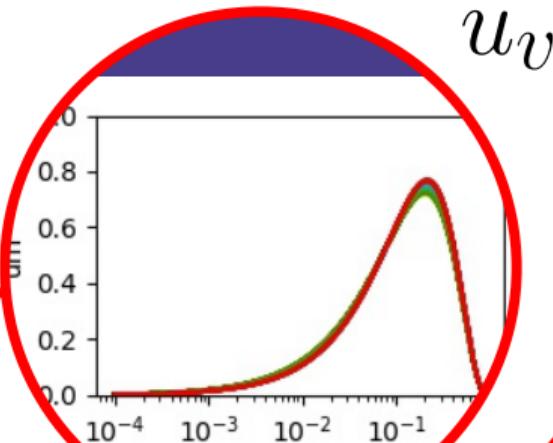
$$R_S = \frac{s+\bar{s}}{d+\bar{u}}$$



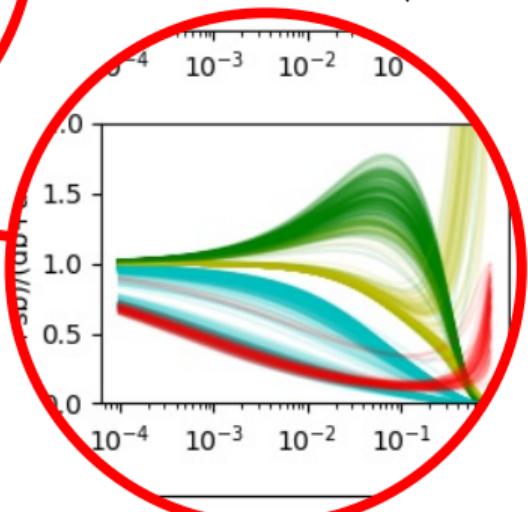
Discriminating multiple solutions



***k*-means clustering**

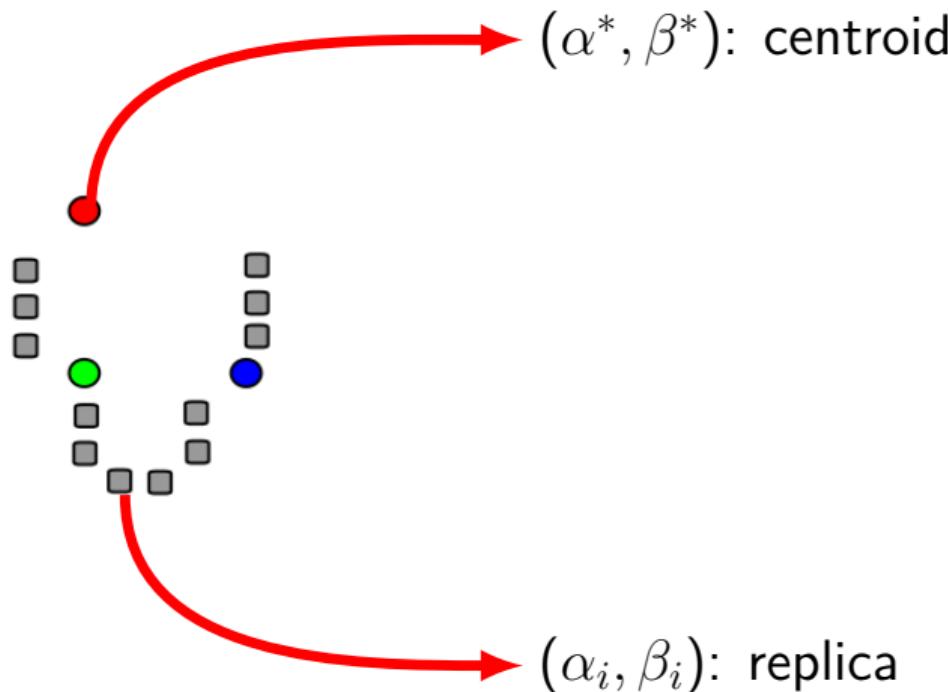


$$R_s = \frac{s+\bar{s}}{d+\bar{u}}$$



k-means clustering: 2D example (α, β)

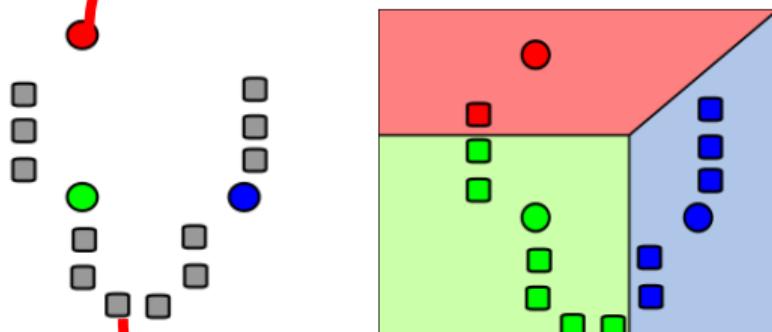
e.g. $f(x) = x^\alpha(1 - x)^\beta$



k -means clustering: 2D example (α, β)

e.g. $f(x) = x^\alpha(1 - x)^\beta$

(α^*, β^*) : centroid



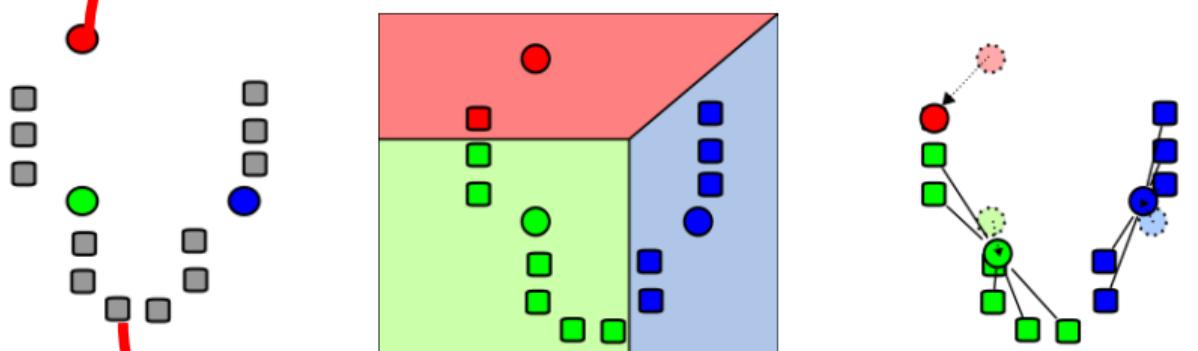
define clusters

(α_i, β_i) : replica

k -means clustering: 2D example (α, β)

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(α^*, β^*) : centroid

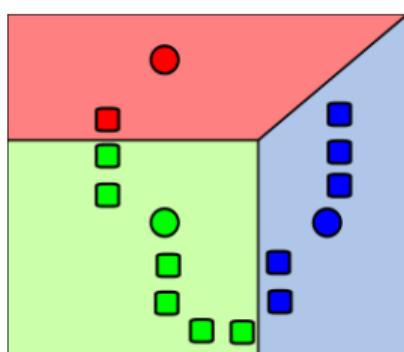
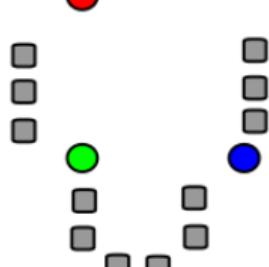


(α_i, β_i) : replica

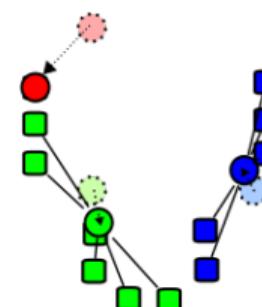
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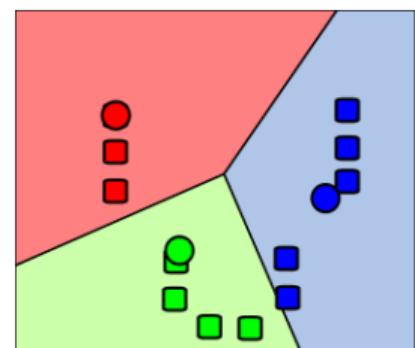
(α^*, β^*) : centroid



define clusters



adjust centroids

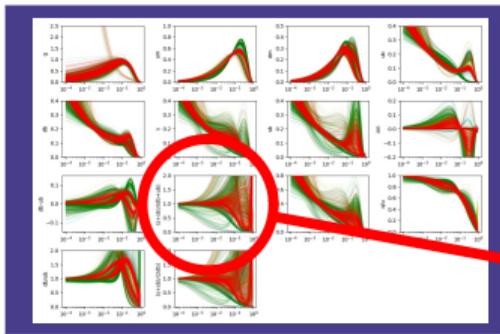


get new clusters

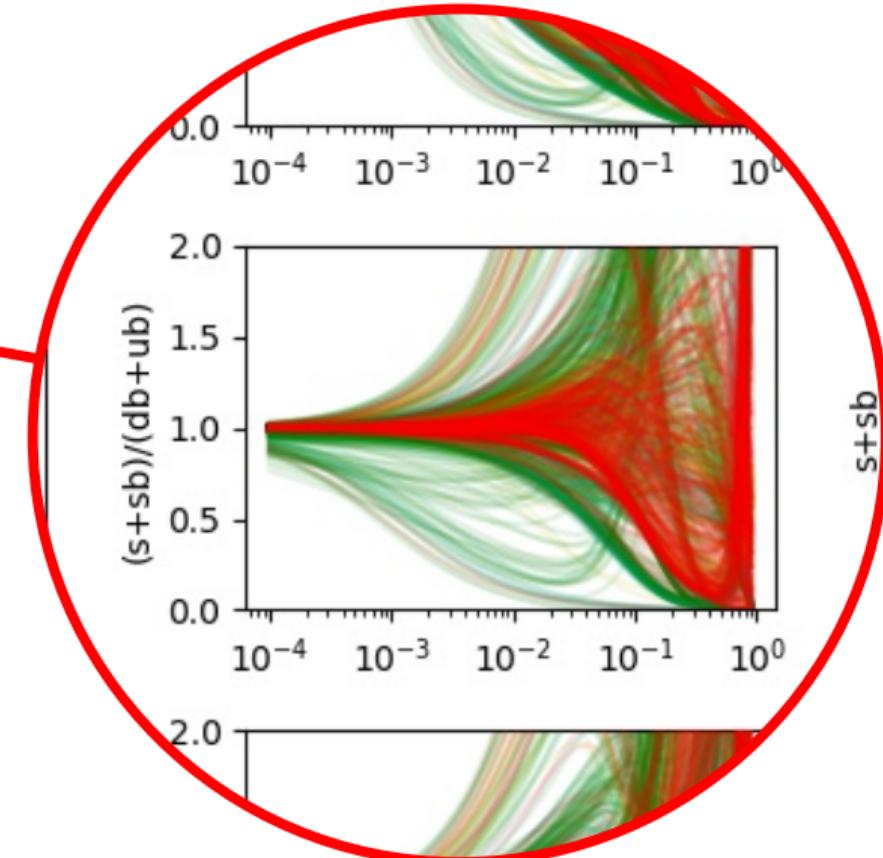
(α_i, β_i) : replica

Constraints on R_s

PDFs

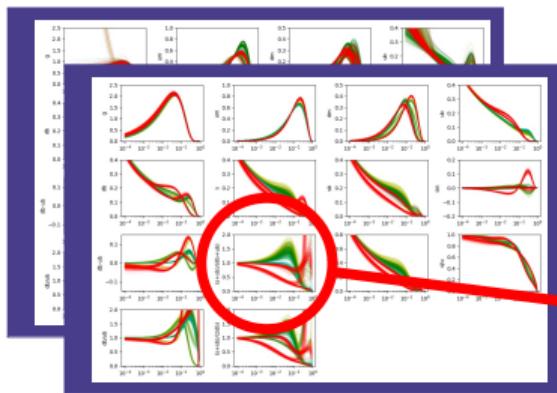


+DIS (No HERA)

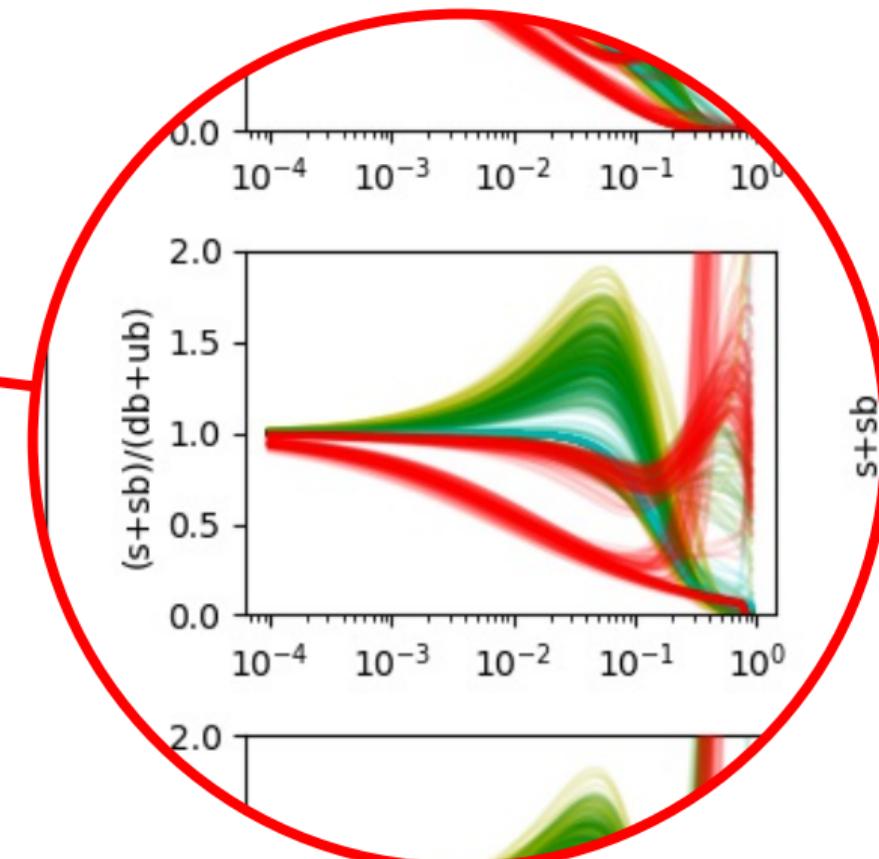


Constraints on R_s

PDFs

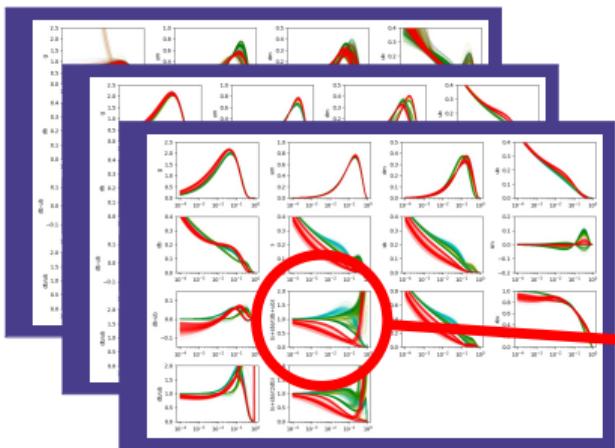


+DIS (No HERA)
+DIS HERA

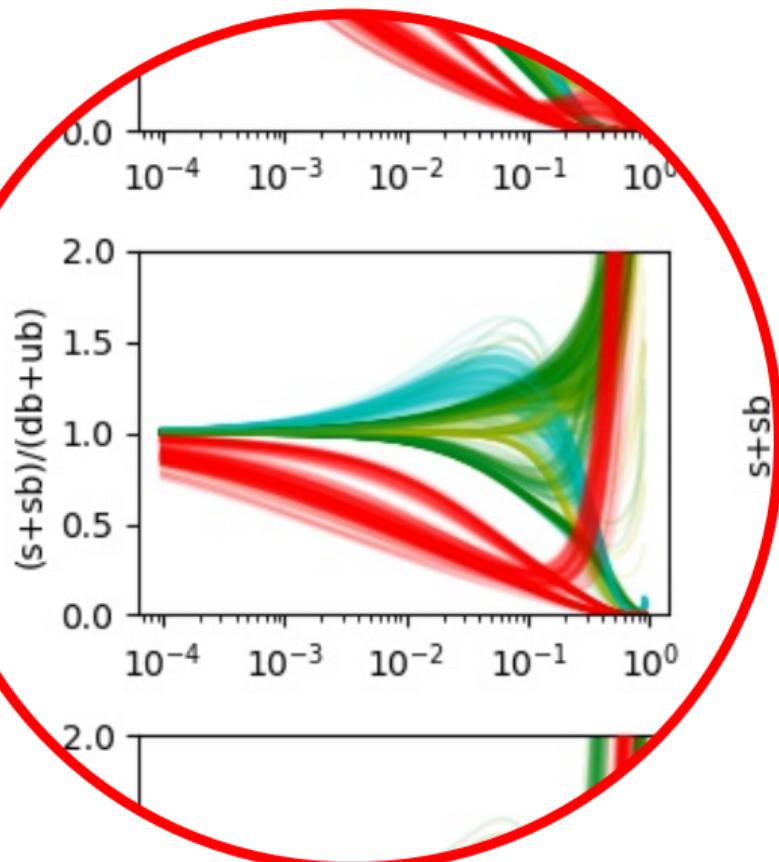


Constraints on R_s

PDFs

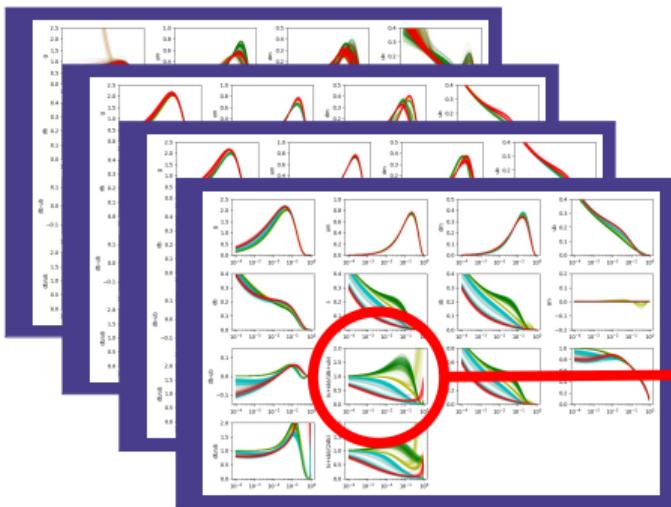


- +DIS (No HERA)
- +DIS HERA
- +DY



Constraints on R_s

PDFs

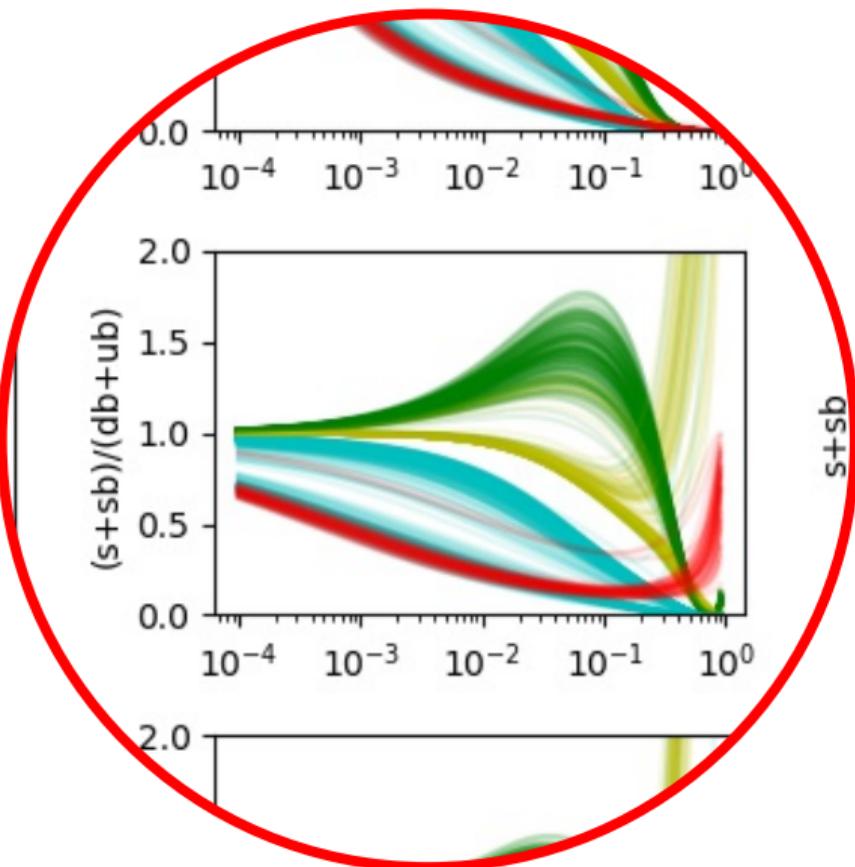


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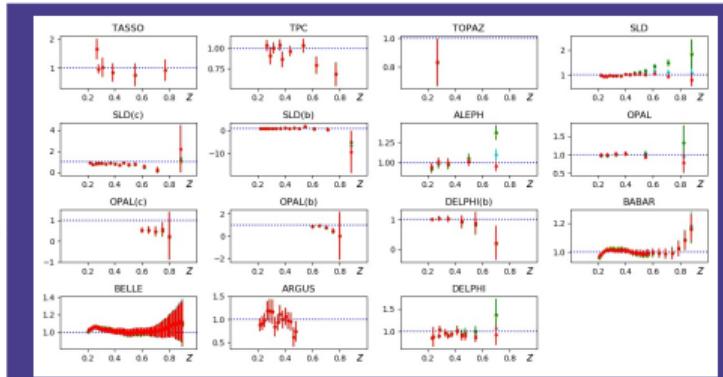
+DY

+SIA + SIDIS



SIA Kaon (\pm) data

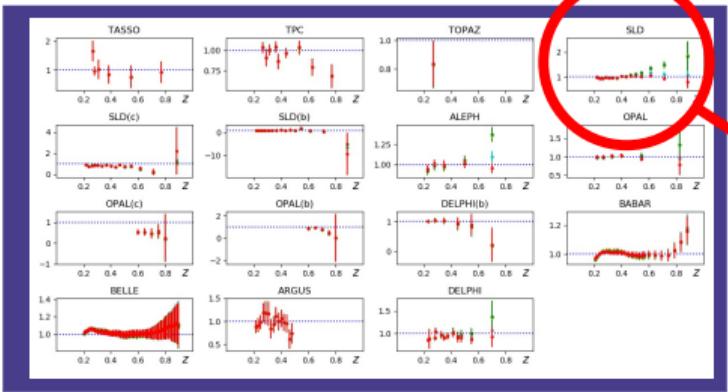
Data/theory



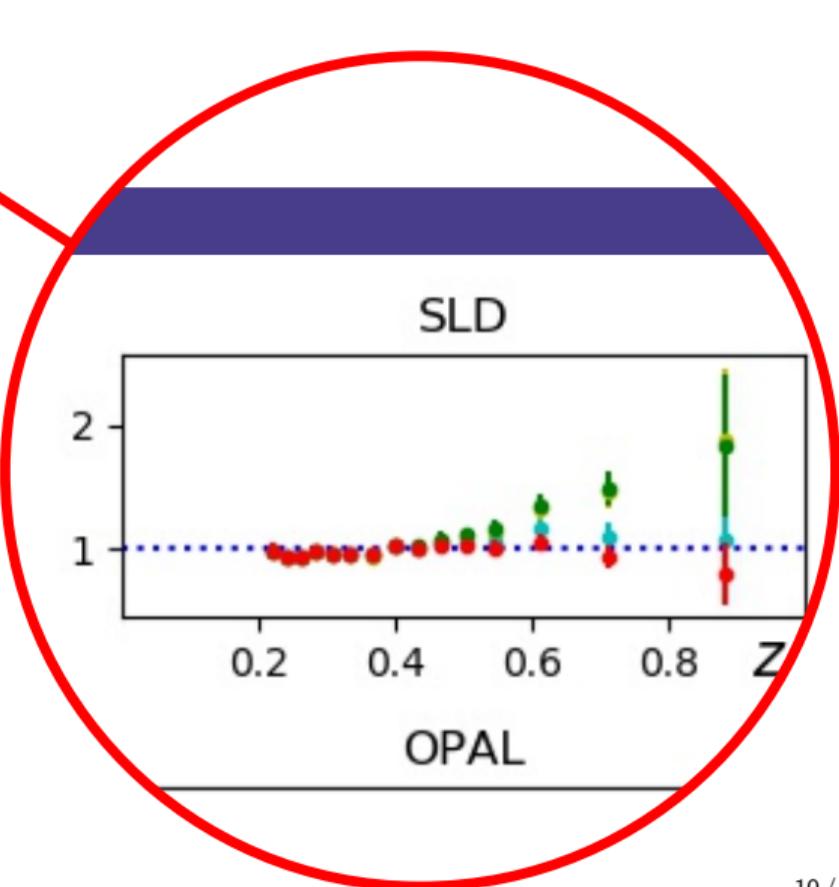
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SIA Kaon (\pm) data

Data/theory

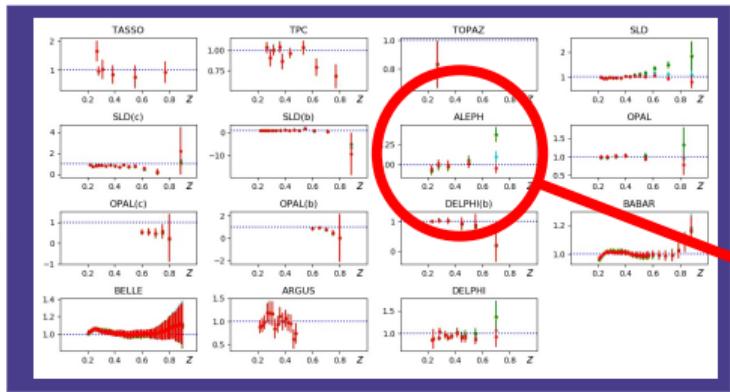


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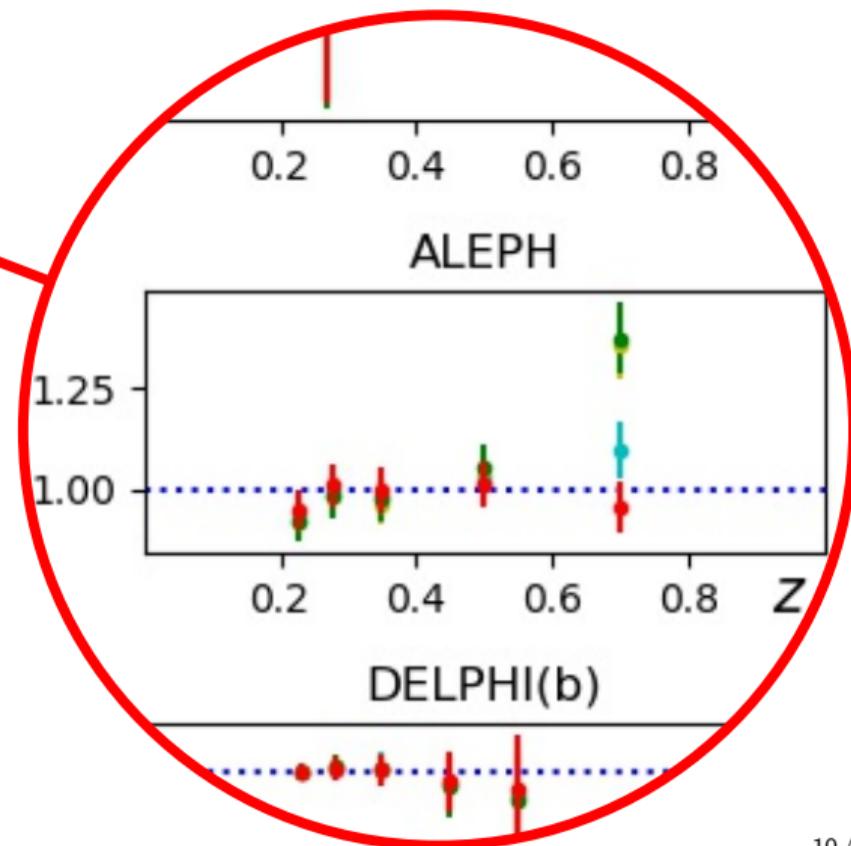


SIA Kaon (\pm) data

Data/theory

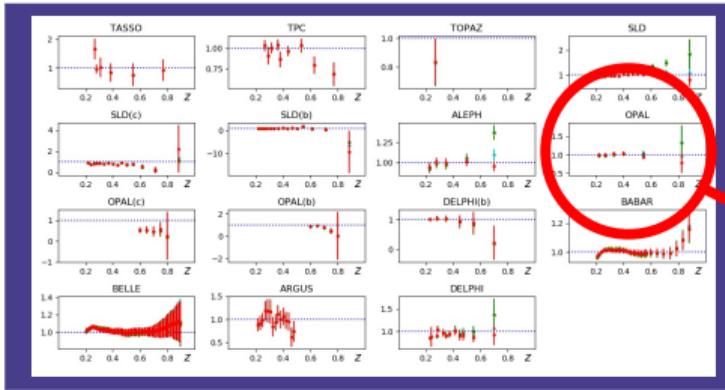


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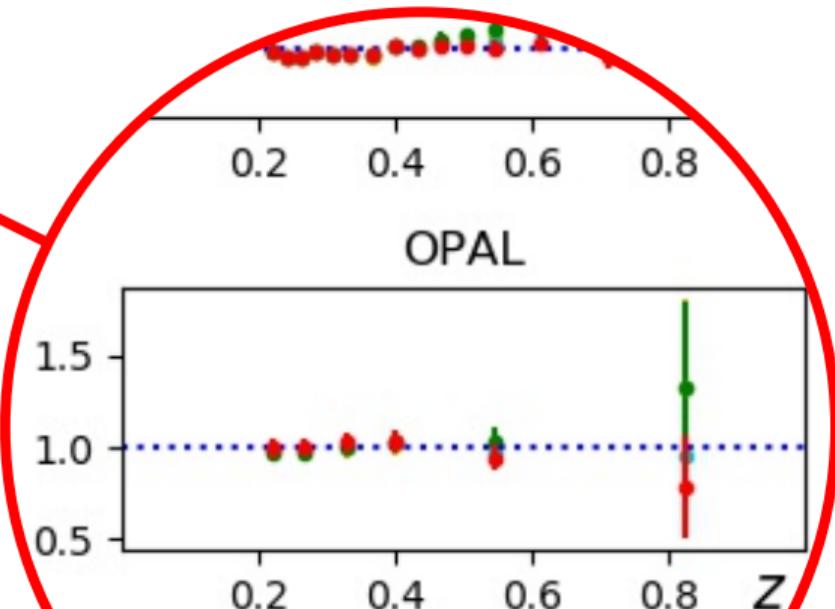


SIA Kaon (\pm) data

Data/theory



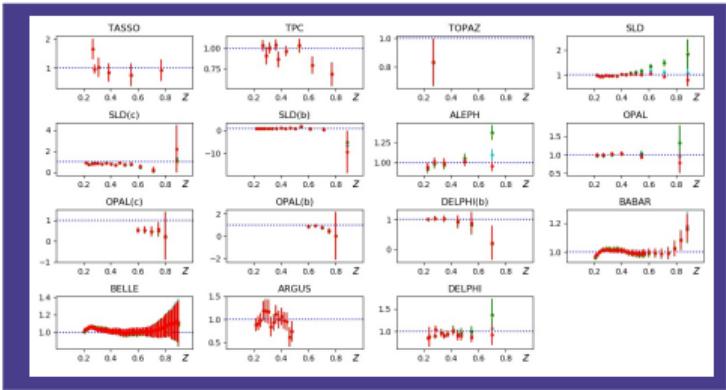
Z



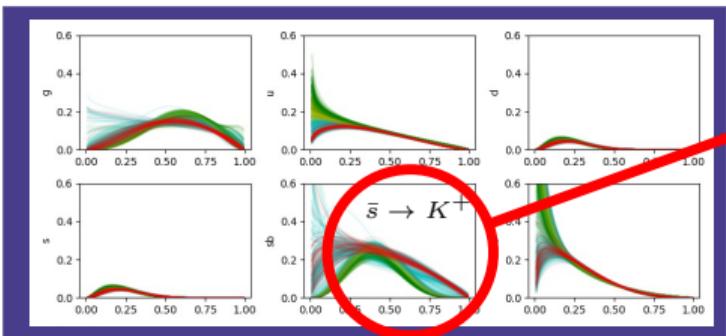
BABAR

SIA Kaon (\pm) data

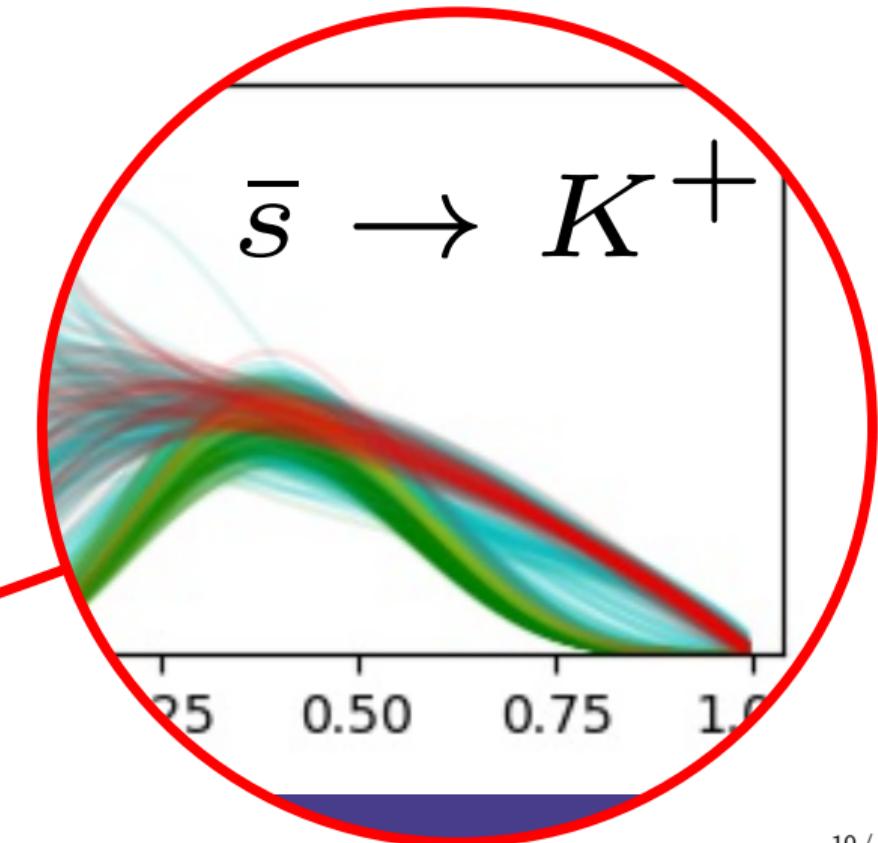
Data/theory



zD_K^+

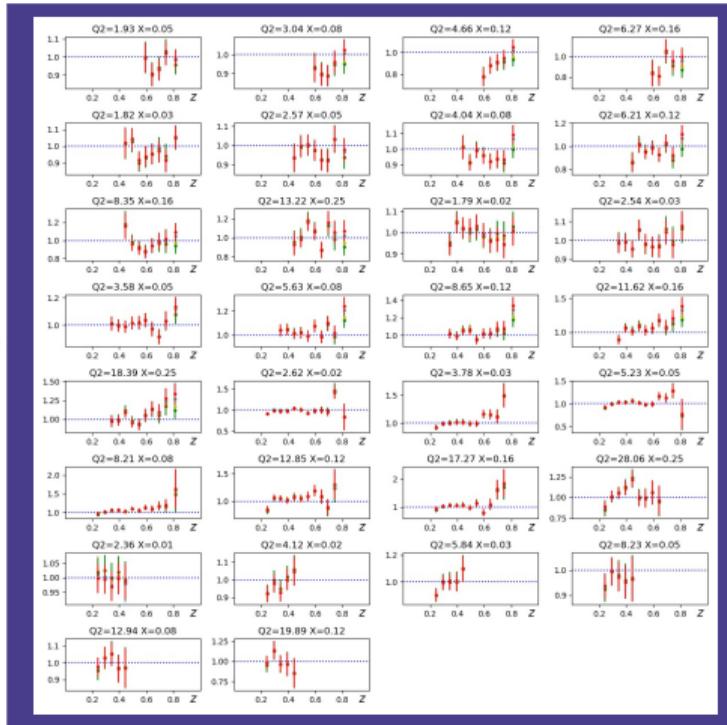


Z



SIDIS Kaon (+) data

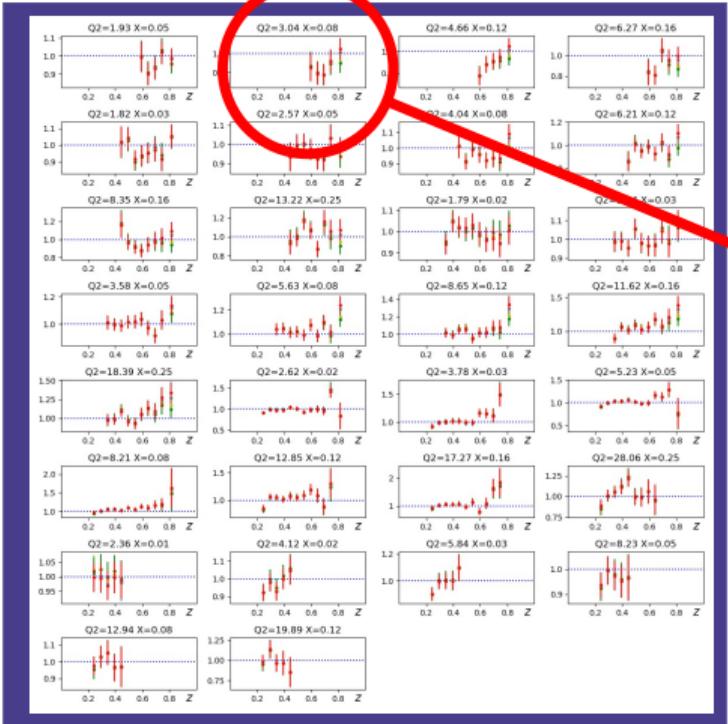
Data/theory



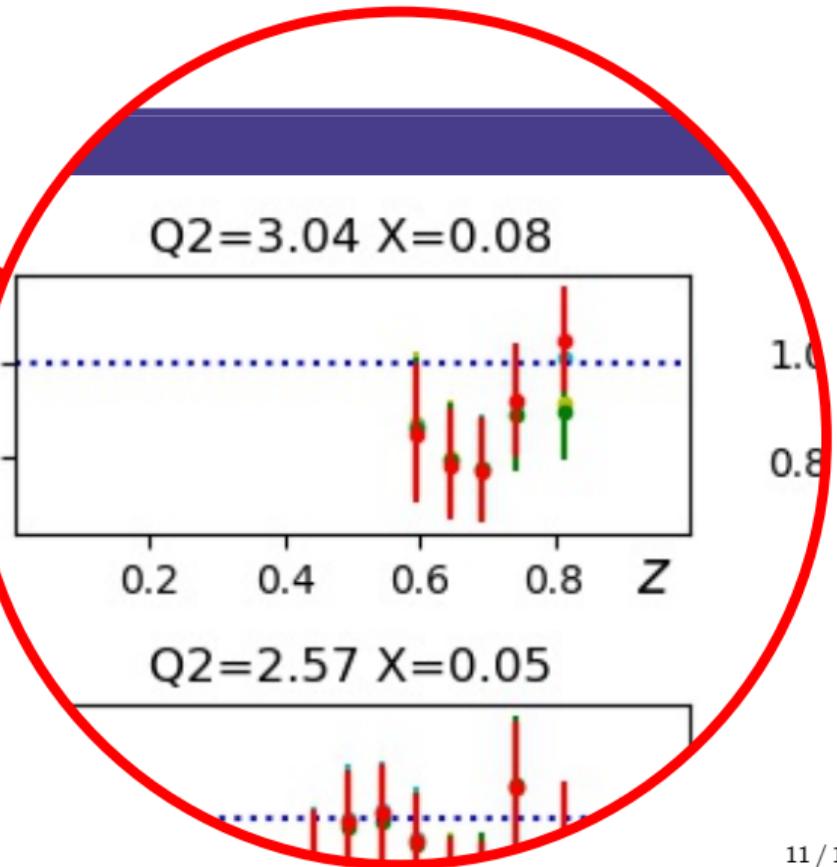
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SIDIS Kaon (+) data

Data/theory

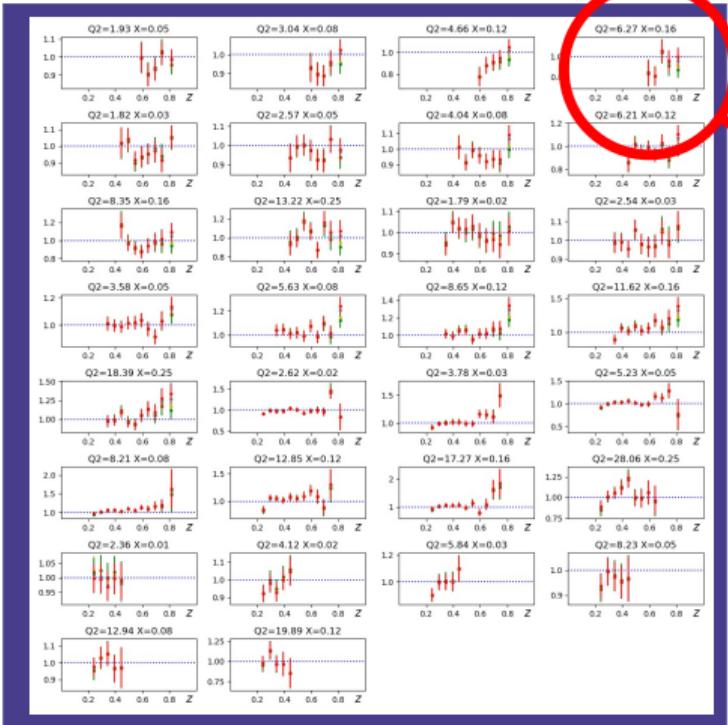


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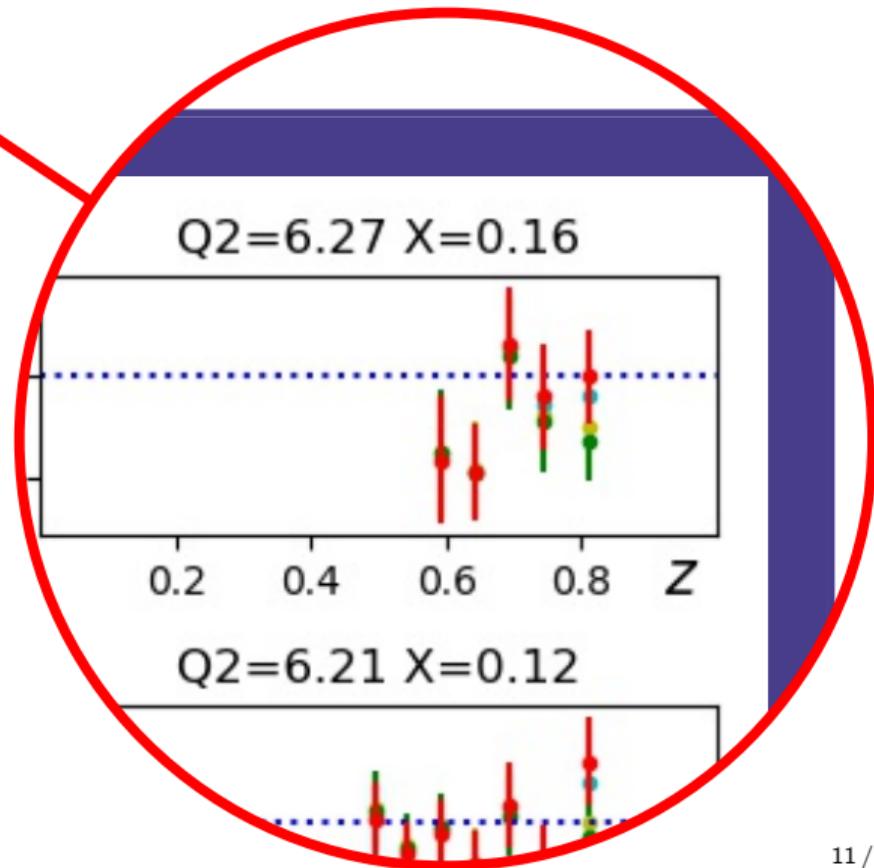


SIDIS Kaon (+) data

Data/theory

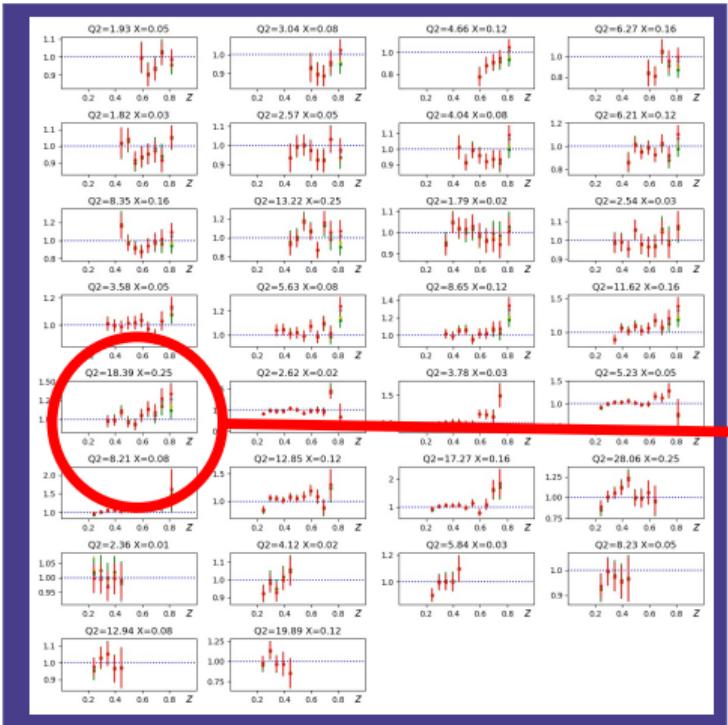


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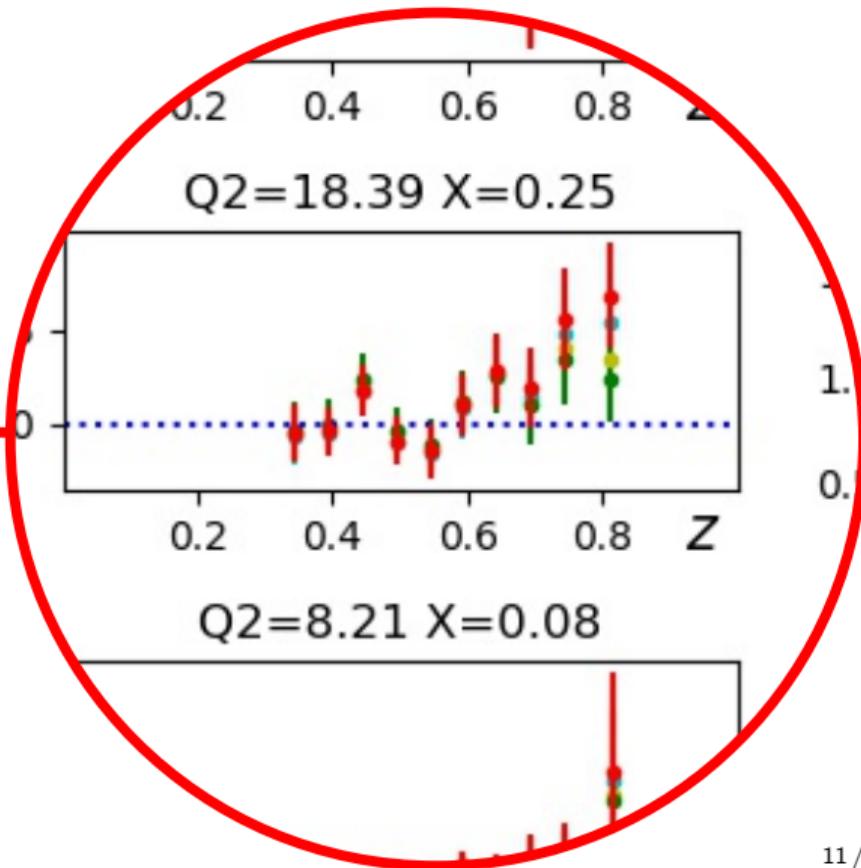


SIDIS Kaon (+) data

Data/theory

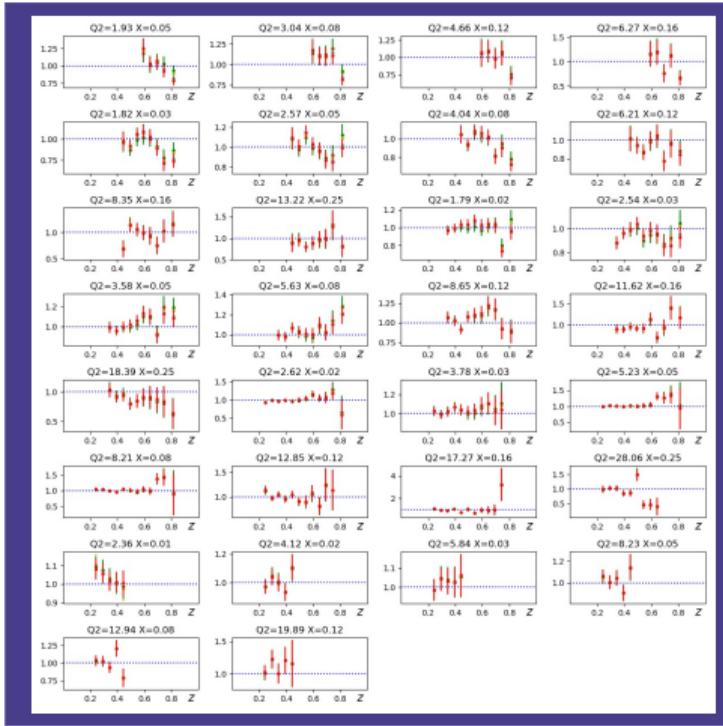


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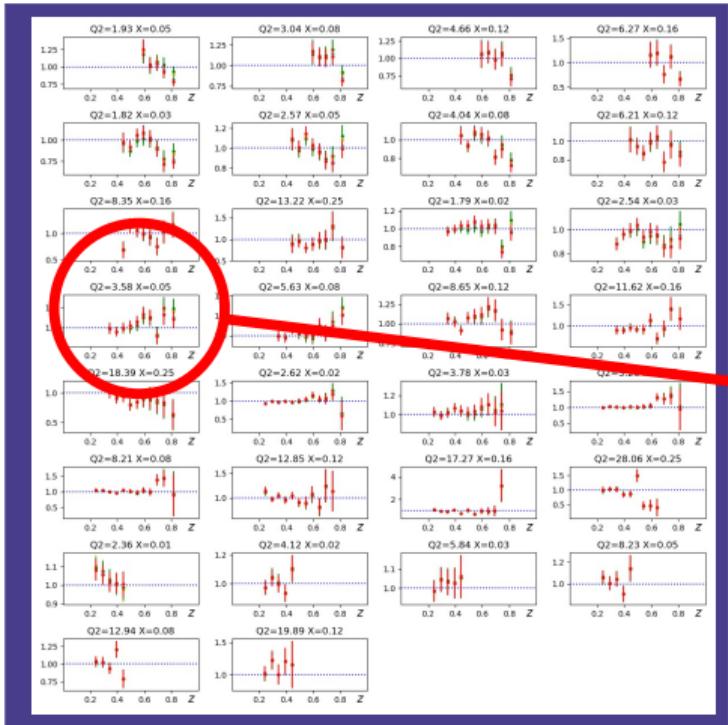
Data/theory



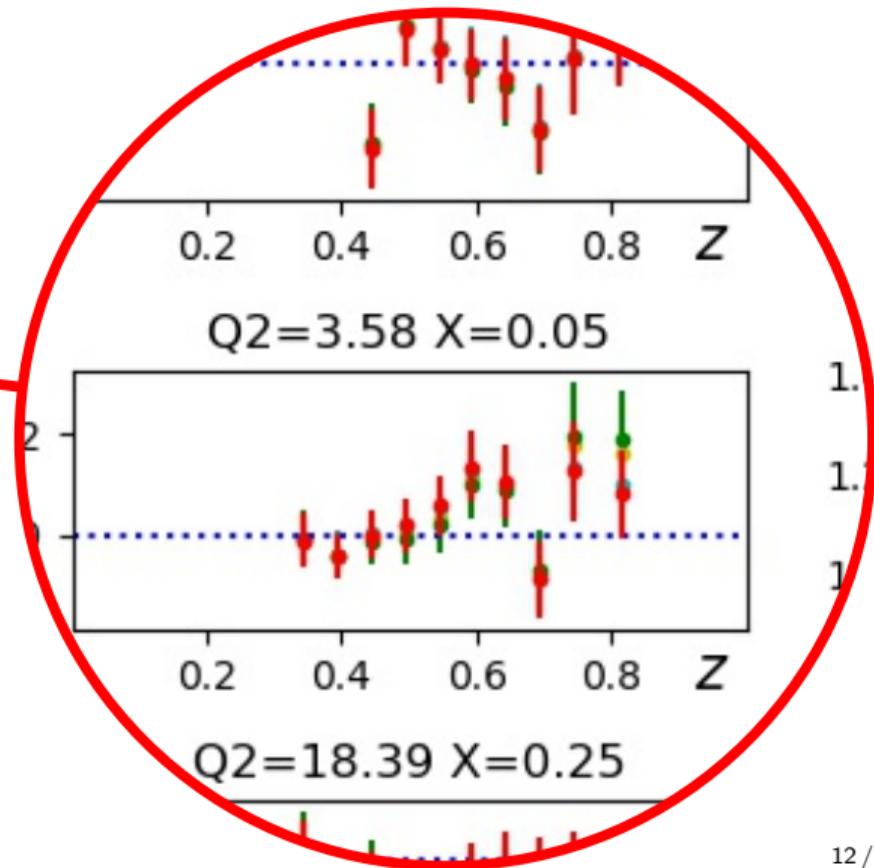
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SIDIS Kaon (-) data

Data/theory

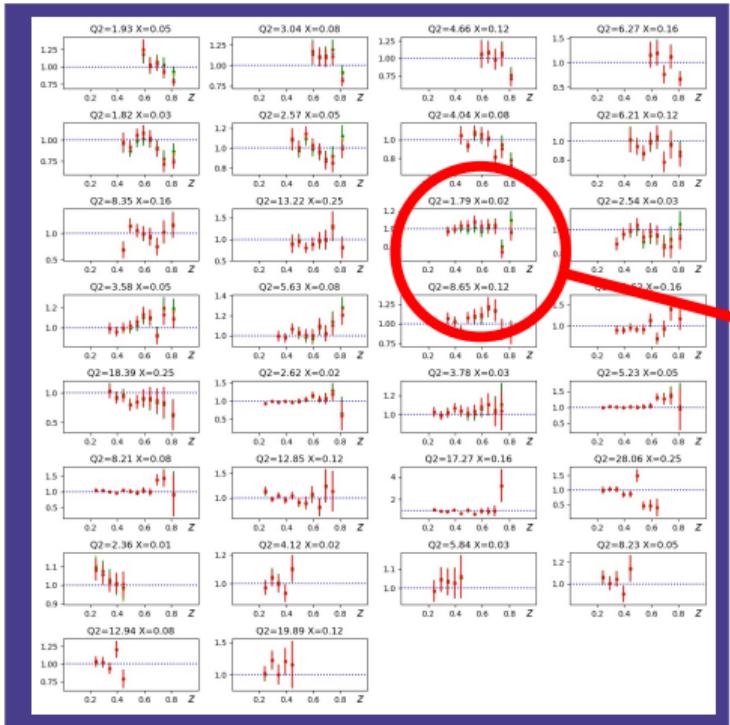


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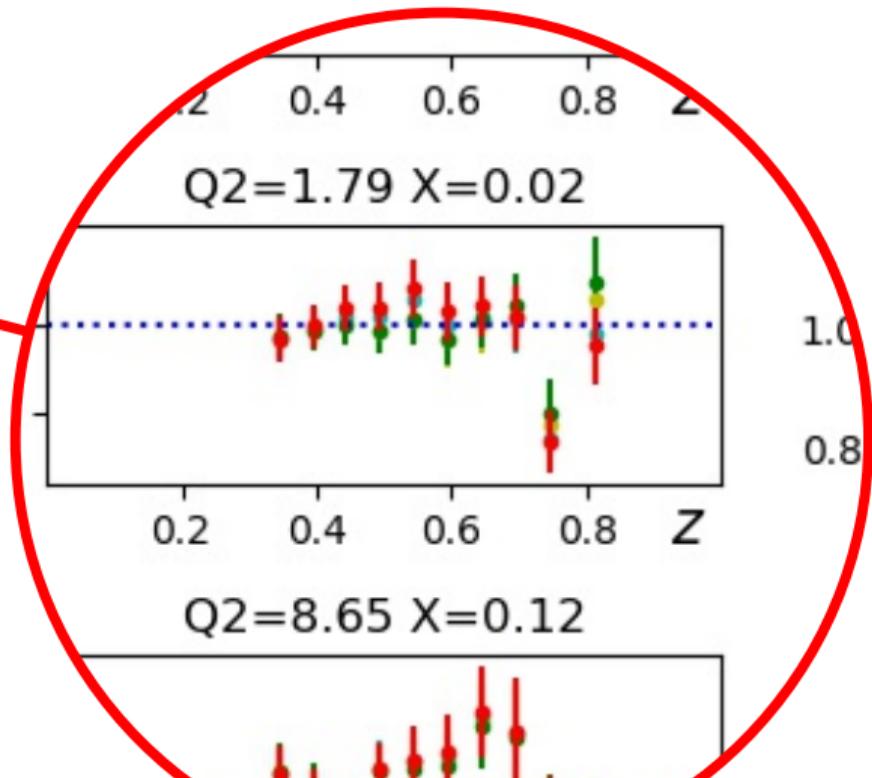


SIDIS Kaon (-) data

Data/theory



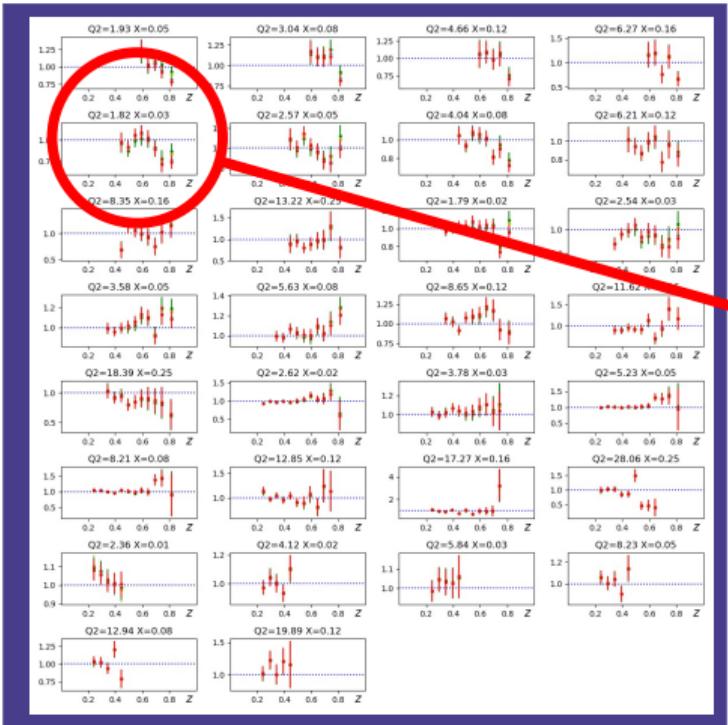
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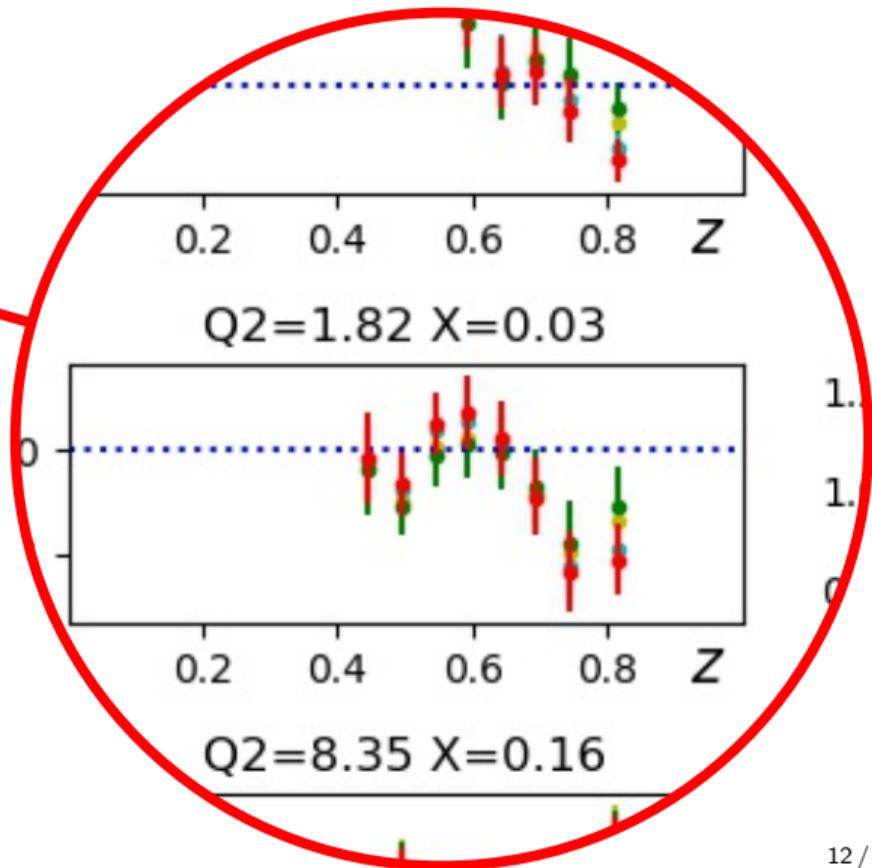
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SIDIS Kaon (-) data

Data/theory



Z

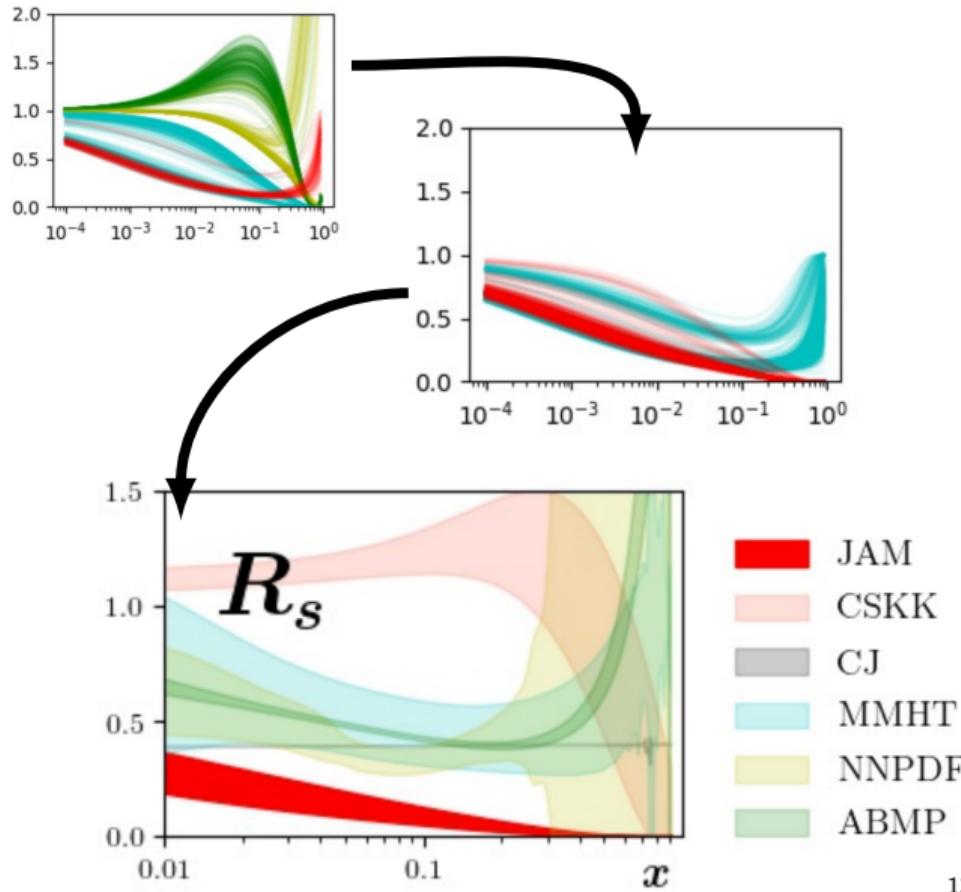


JAM19 sample selection criteria

- Apply k-mean clustering
- Classify clusters by increasing order in “extended” reduced Chi²

$$\frac{\chi^2}{N_{\text{tot}}} + \sum_{\text{exp}} \frac{\chi^2_{\text{exp}}}{N_{\text{exp}}}$$

- Perform a new sampling with flat priors around best cluster



Summary and outlook

■ New JAM19 PDF & FF combined analysis

- data: DIS, SIDIS, DY, SIA
- JAM19 methodology: MC (multi-steps), k -means, extended reduce Chi2
- Strong suppression of nucleon strange PDF

■ Future

- Inclusion of jets
- Inclusion of Tevatron W/lepton asymmetry
- Inclusion of LHC W/Z and W+c data