

Drell-Yan and J/ψ with RF-separated beams

Kaon Structure

RF-separated beams for AMBER - Kick Off Meeting

Outlook

- ✓ Priority measurements
- ✓ Kaon structure - available data
- ✓ Drell-Yan measurement
- ✓ J/psi measurement
- ✓ J/psi measurement - impact on production mechanisms
- ✓ Summary

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Disclaimer:

This is not an extensive talk - I will briefly draw your attention to the main experimental goals of the Drell-Yan and J/psi measurements

Physics with high-intensity kaon and anti-proton beams

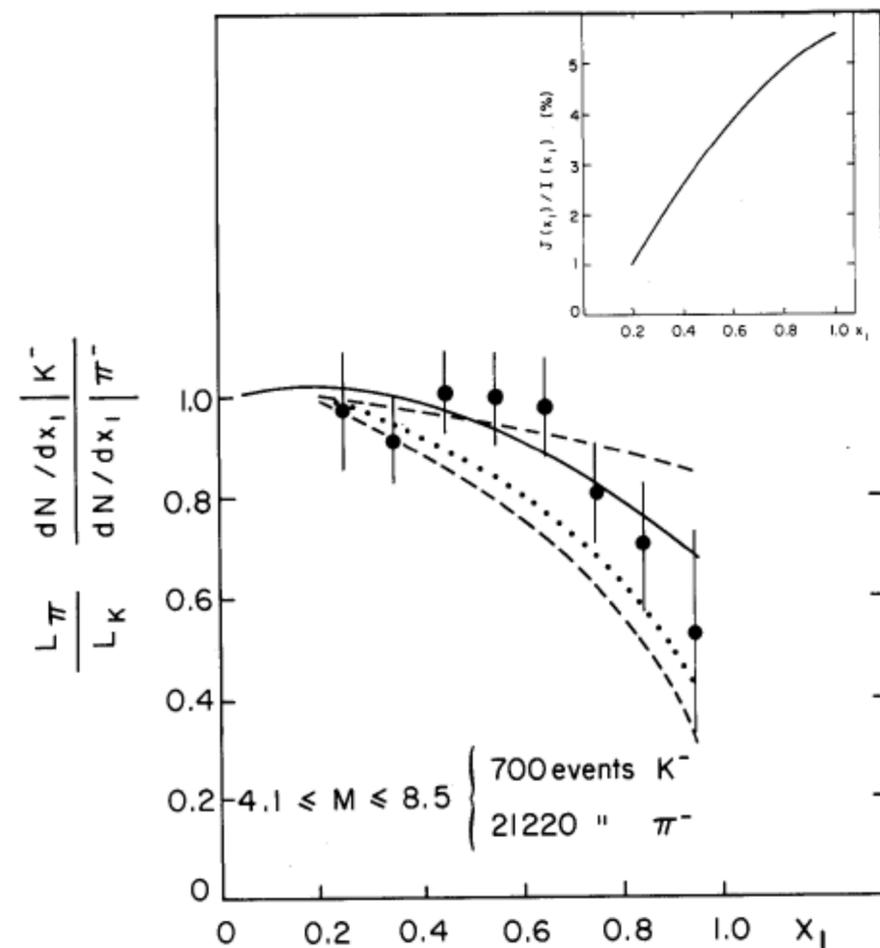
- **Unique opportunity to study the kaon structure:** our priority
 - valence and sea structure with Drell-Yan lepton pair production
 - valence and gluon structure with J/psi production
 - gluon structure also with prompt photons (dedicated run) → see Alexey talk

- **proton structure:** to be considered as an extension of the programme
 - Combined with transversely polarised target allows us to probe the transverse degrees of freedom of the proton with no dependence on the pion (as in COMPASS)

more details on Letter of Intent
[CERN-SPSC-2019-003 ; SPSC-I-250](#)

Kaon Structure - available data

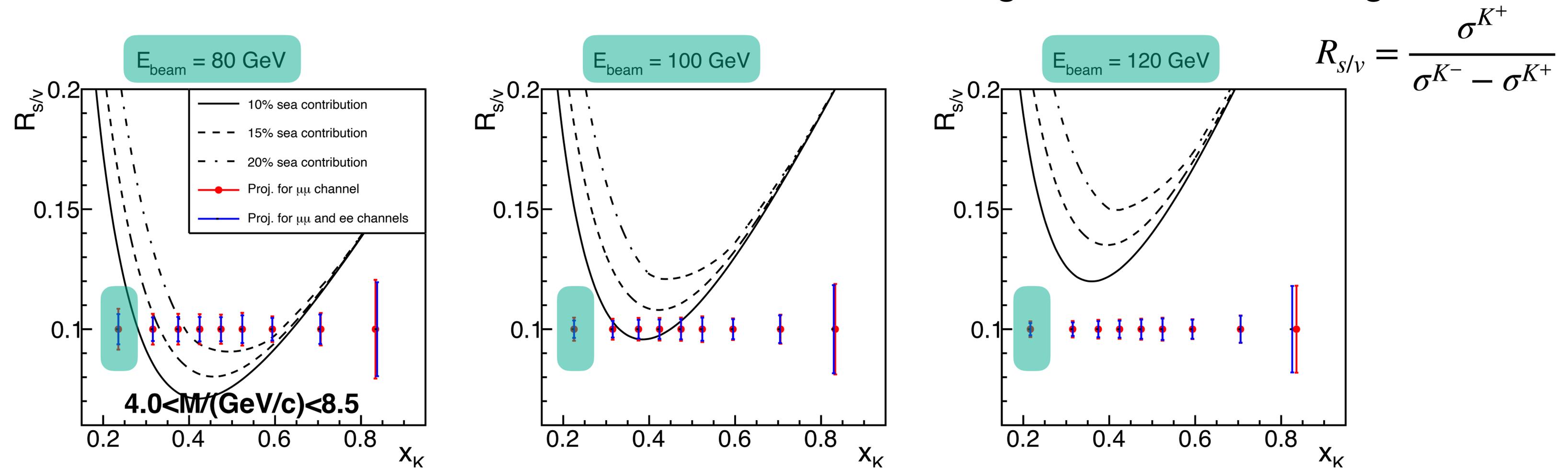
[NA3: PLB 93 \(1980\) 354](#)



- **kaon structure:**
 - Only 700 events from NA3
 - The kaon valence distributions are nearly unknown
 - There is no data on kaon sea and gluon content

Drell-Yan measurement

- Kaon valence PDF - can be addressed with the negative kaon beam
- Kaon sea PDF - can be addressed when combining the two beam charges



Higher beam energies allow to access lower x values with a better precision

J/psi measurement

- Model independent access to the kaon PDF

$$\begin{aligned}
 K^- (\bar{u}s) + p(uud) &\propto gg + \underbrace{\left[\bar{u}_v^K u_v^p \right]}_{\text{val-val}} + \underbrace{\left[\bar{u}_v^K u_s^p + s_v^K s_s^p \right]}_{\text{val-sea}} + \underbrace{\left[\bar{u}_s^K u_v^p \right]}_{\text{sea-val}} + \underbrace{\left[\bar{u}_s^K u_s^p + u_s^K \bar{u}_s^p + s_s^K \bar{s}_s^p + \bar{s}_s^K s_s^p \right]}_{\text{sea-sea}} \\
 K^+ (u\bar{s}) + p(uud) &\propto gg + \left[\text{---} \right] + \underbrace{\left[u_v^K \bar{u}_s^p + \bar{s}_v^K s_s^p \right]}_{\text{val-sea}} + \underbrace{\left[\bar{u}_s^K u_v^p \right]}_{\text{sea-val}} + \underbrace{\left[\bar{u}_s^K u_s^p + u_s^K \bar{u}_s^p + s_s^K \bar{s}_s^p + \bar{s}_s^K s_s^p \right]}_{\text{sea-sea}}
 \end{aligned}$$

$$\sigma(K^-) - \sigma(K^+) \propto \bar{u}_v^K u_v^p \quad \leftarrow \text{only val-val}$$

J/psi measurement

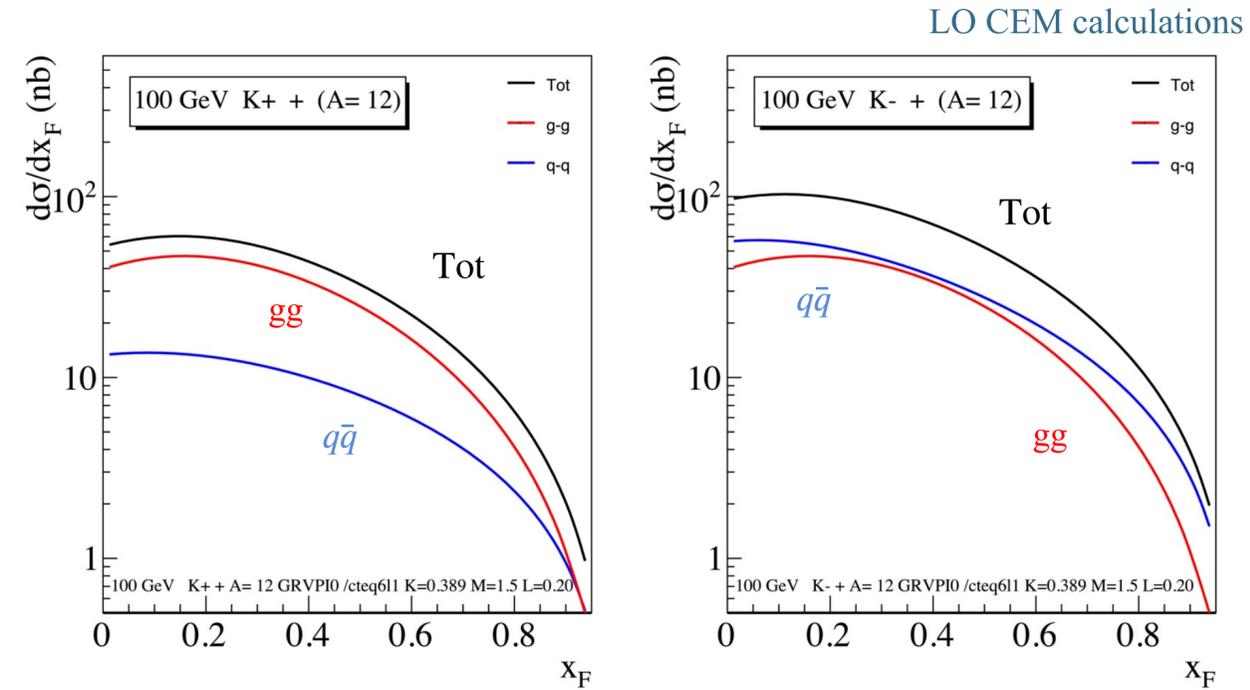
- Model independent access to the kaon PDF

$$\begin{aligned}
 K^- (\bar{u}s) + p(uud) &\propto gg + \underbrace{[\bar{u}_v^K u_v^p]}_{\text{val-val}} + \underbrace{[\bar{u}_v^K u_s^p + s_v^K s_s^p]}_{\text{val-sea}} + \underbrace{[\bar{u}_s^K u_v^p]}_{\text{sea-val}} + \underbrace{[\bar{u}_s^K u_s^p + u_s^K \bar{u}_s^p + s_s^K \bar{s}_s^p + \bar{s}_s^K s_s^p]}_{\text{sea-sea}} \\
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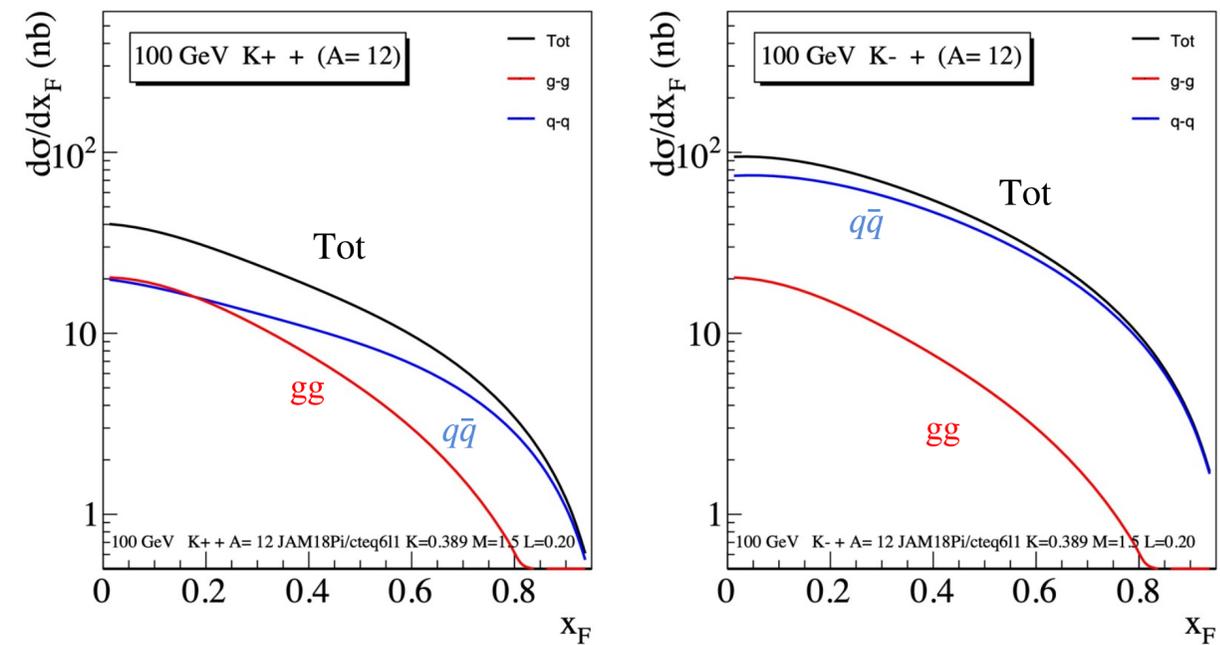
$$\sigma(K^-) - \sigma(K^+) \propto \bar{u}_v^K u_v^p \quad \leftarrow \text{only val-val}$$

- Kaon valence PDF - new and unique, high-statistics measurement with J/psi (can be compared with Drell-Yan)
- Kaon gluon PDF - can be determined if the valence term is well known

J/psi measurement - impact on production mechanisms



PDF: from GRV (pion)

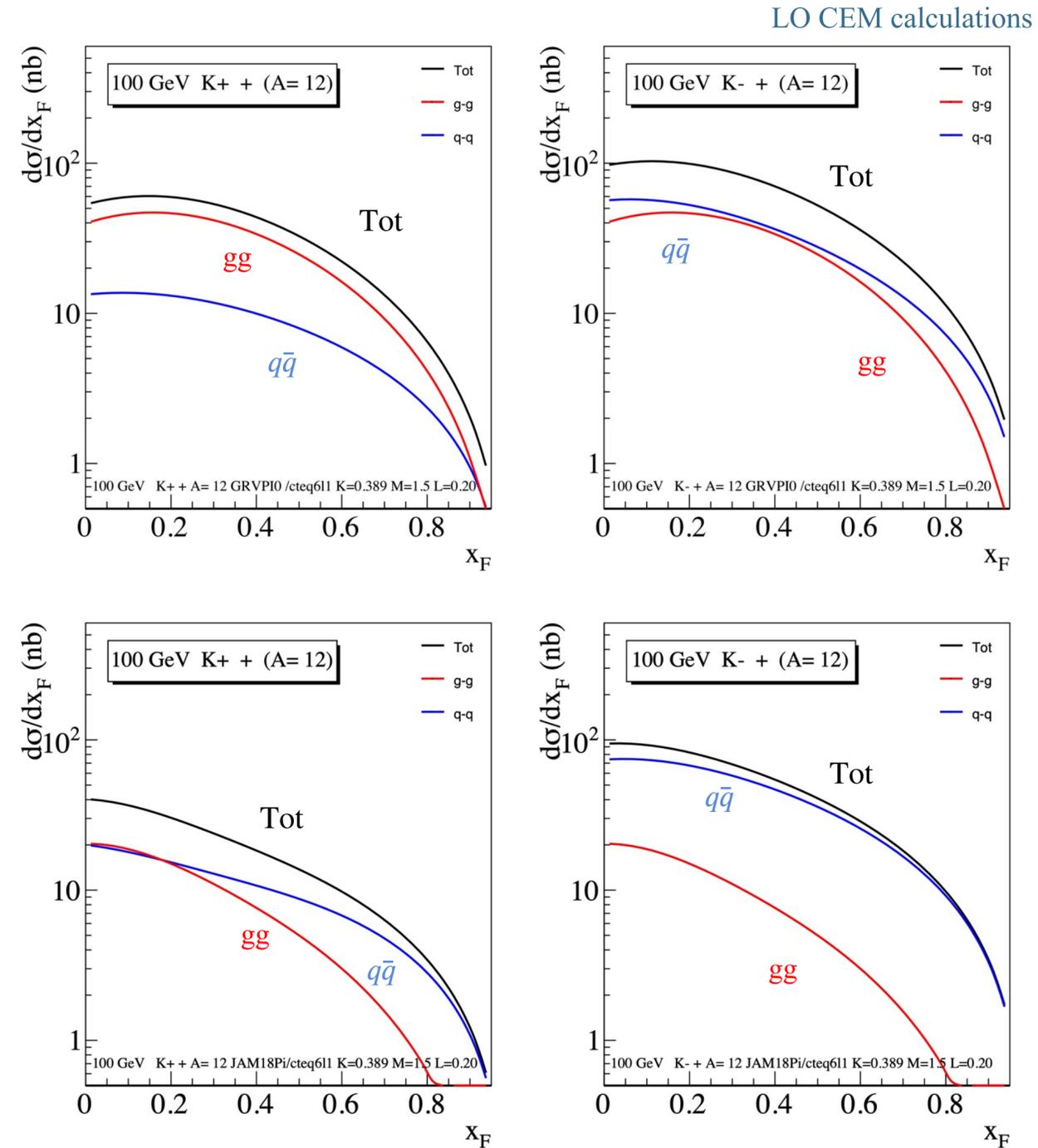


PDF: from JAM (pion)

strong dependence on the kaon PDF parametrisation

J/psi measurement - impact on production mechanisms

- The difference between the two kaon charges is sensitive to the **valence only**
- Opportunity to study the J/psi **production mechanism** (gg versus qqbar)
- Possibility to access the **gluon structure** of the kaon
- For 80 GeV beam energy, we expect around 300k events for each kaon charge (factor 100 more than NA3)



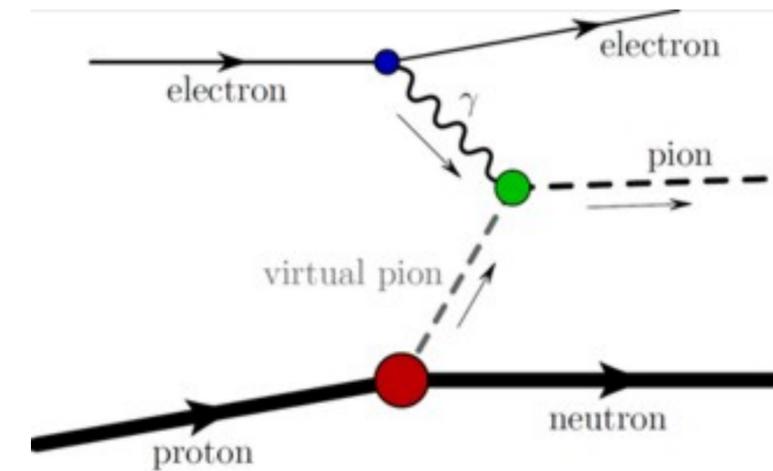
PDF: from GRV (pion)

PDF: from JAM (pion)

strong dependence on the **kaon PDF parametrisation**

Kaon structure from other experiments

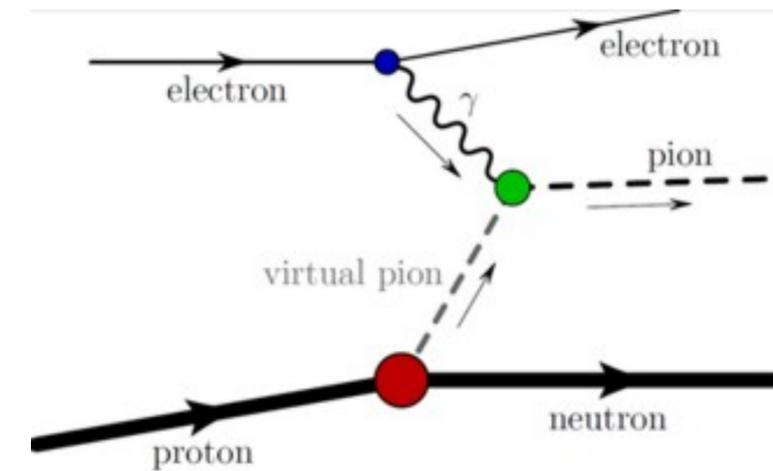
- At **JLab** and **EIC** - possibility to study the kaon structure through the Sullivan process (based on the meson-cloud model)
- At **J-PARC** - possibility to measure the kaon structure using a kaon beam of around 15 GeV and an intensity of up to 10^6



Sullivan process

Kaon structure from other experiments

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Sullivan process

Uniqueness

Kaon induced Drell-Yan measurement as planned in **AMBER** is the most direct way to access the Kaon structure

Summary

- The **main priority** for the AMBER phase II Drell-Yan/Charmonium programme with RF-separated beams is the measurement of the **kaon induced cross-section** with the two kaon charges
- **Drell-Yan** data allows the determination of the **valence and sea structure** of the kaon
- **J/psi** data allows the determination of the **valence and gluon structure** of the kaon
- The **complete kaon structure** (valence/sea/gluon) can be for the **first time** addressed with a good precision in **AMBER**

Thank you for your attention