Hadron structure measurements at the M2 beamline at CERN

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on behalf of the AMBER collaboration

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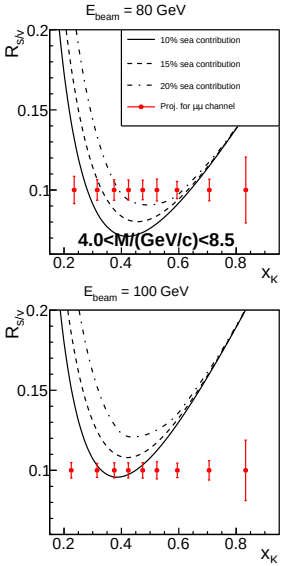
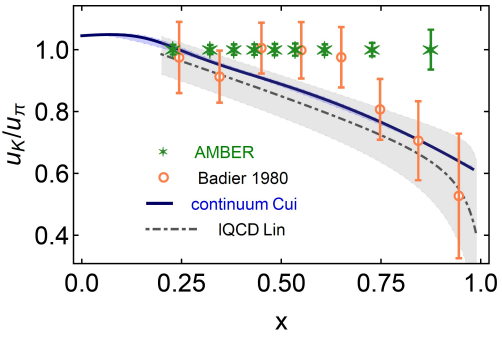
Perceiving the emergence of hadron mass

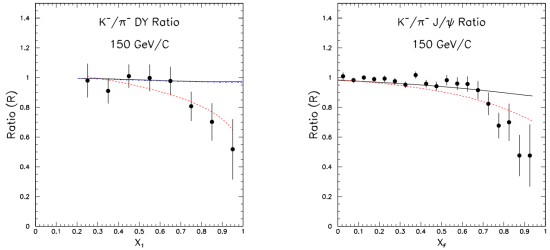
Projections for valence/sea separation for Kaons

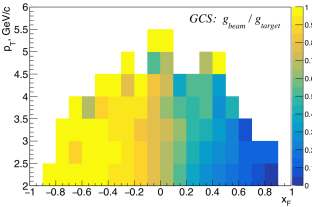


- **Map valence and sea content in the kaons**:
  $R_{s/v} = \frac{\sigma^{K^+C}}{\sigma^{K^-C} - \sigma^{K^+C}}$, Londergan, *et al.* PLB 380 (1996)
- Assuming the intensity for K^+ and K^-: $2 \times 10^7\ s^{-1}$



Complementarity between measurements and setups

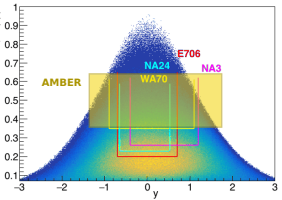




Charmonia and prompt photon production

$\Rightarrow$covering different phase-space

Determine the gluon content in the Kaon



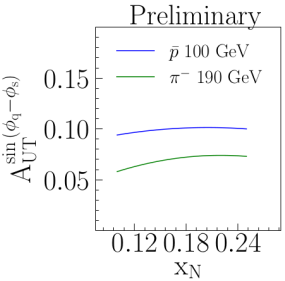
Open spectrometer $\rightarrow$ access to ψ' and χ_c states

- Extensive study of charmonia production mechanisms
- Additional input for gluon PDF in the Kaons

Anti-proton with a RF separated beam

Possibility to study valence proton TMD PDFs in a model free way

J. Terry, EHM 03/12/2020



- cross-sections for $\bar{p}$ induced-DY at 120 GeV $\sim \pi^-$ induced-DY at 190 GeV
- Combined statistics from $\mu^+\mu^-$ and e^+e^- channels $\sim$ 2 years of COMPASS-II data taking
- With active absorber: better acceptance in θ_{CS}

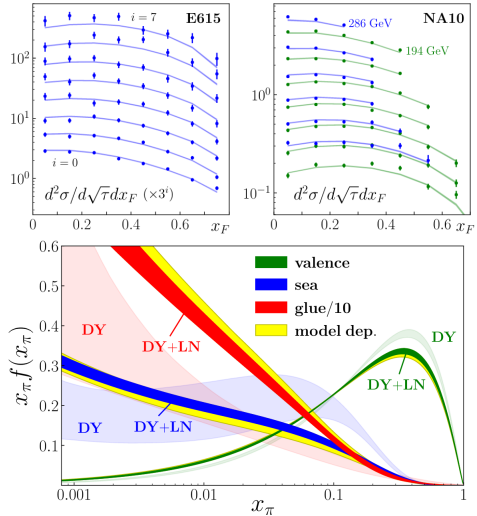
Experiment	Target type	Beam type	Beam intensity (part/sec)	Beam energy (GeV)	DY mass (GeV/c^2)	DY events $\mu^+\mu^-$	DY events e^+e^-
This exp.	110cm NH_3	$\bar{p}$	3.5×10^7	100	4.0 – 8.5	28,000	21,000
				120	4.0 – 8.5	40,000	27,300
				140	4.0 – 8.5	52,000	32,500

Outlook:

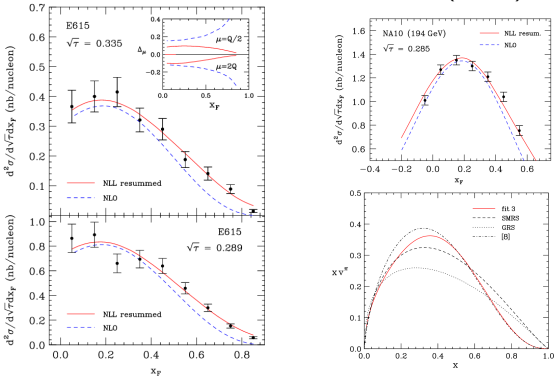
- AMBER can perform key measurement to determine the structure of the Kaon
- Proton structure will not be left over and studies of TMD PDFs are foreseen

E615, NA10 data and large x behaviour

P.C. Barry, *et al.*, arXiv:1804.01965



M. Aicher, *et al.*, PRL 105 252003 (2010)



Experimental side: $\sigma_{x_F} \sim 0.03$: $\frac{\sigma}{dx_F d\sqrt{\tau}}$ ✓, F_π^v ✗

→ migration effect can be present

Theory side: NLL cannot be neglected

Need for new data with precise evaluation of uncertainties

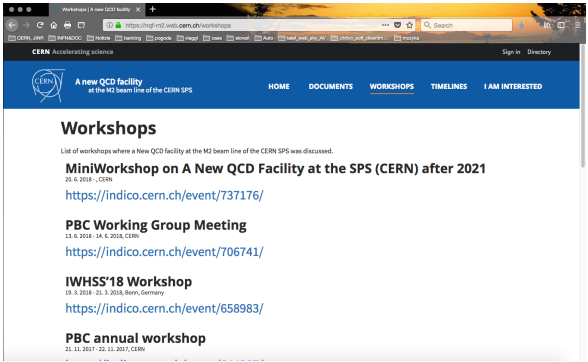
State of the art of the theory

BACKUP

A new QCD facility

- Letter of Intent
  arXiv:1808.00848
  DY, Spectroscopy, muon-p elastics scattering, ...

- A web page



New ideas and collaborators are welcome

Proposal available

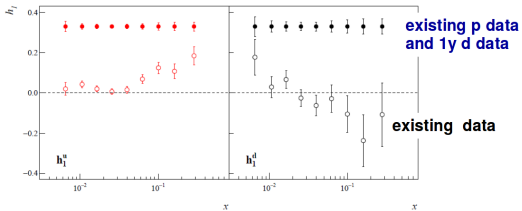
Anti-proton beam: Synergy DY and SIDIS

Additional insight with $\bar{\boldsymbol{p}}$ on Boer Mulders (private exchange with Andreas Metz)

- Transversity modulation less affected by QCD radiative effects
- Smooth matching between TMD approach and QCD

$\rightarrow$ Extract transversity from SIDIS $A_{UT}^{sin(\phi_h+\phi_S)} \propto \boldsymbol{h_{1,p}^q} \otimes H_{1q}^{\perp h}$ measurements

u and d quark Transversity PDFs



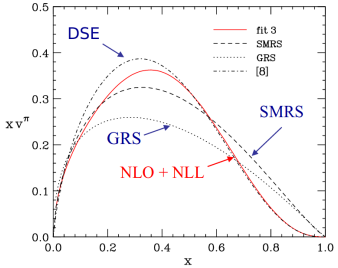
- Use DY measured $A^{sin(2\phi-\phi_S)} \propto \boldsymbol{h_{1,h}^{\perp q}} \otimes \boldsymbol{h_{1,p}^q}$ and SIDIS transversity knowledge

Obtain Boer-Mulders $\boldsymbol{h_1^{\perp q}}$ for **proton and meson with antiproton and meson beams**

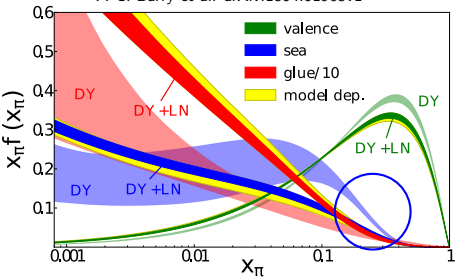
Complementary to SIDIS, where Cahn effects can be difficult to disentangle from Boer-Mulders effects

Renewed interest in pion structure

Phys. Rev. Lett. 105, 252003 (2010)



P. C. Barry *et al.* arXiv:1804.01965v1



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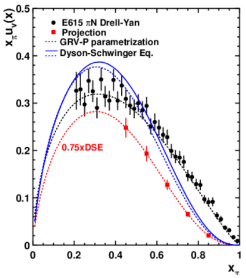

- Agreement between DSE and fit to E615 data at NLO+NLL
- First extraction of PDFs with Hera data (DIS with leading neutron)
- Foreseen measurement of Tagged DIS at JLab and at EIC

Aim for direct data in the circled area

Pion induced Drell-Yan statistics for 2 years

Experiment	Target type	Beam energy (GeV)	Beam type	Beam intensity (part/sec)	DY mass (GeV/c^2)	DY events
E615	20cm **W**	252	π^+ π^-	17.6×10^7 18.6×10^7	4.05 – 8.55	5,000 30,000
NA3	30cm H_2	200	π^+ π^-	2.0×10^7 3.0×10^7	4.1 – 8.5	40 121
	6cm **Pt**	200	π^+ π^-	2.0×10^7 3.0×10^7	4.2 – 8.5	1,767 4,961
NA10	120cm D_2	286 140	π^-	65×10^7	4.2 – 8.5 4.35 – 8.5	7,800 3,200
	12cm W	286 140	π^-	65×10^7	4.2 – 8.5 4.35 – 8.5	49,600 29,300
COMPASS 2015 COMPASS 2018	110cm NH_3	190	π^-	7.0×10^7	4.3 – 8.5	35,000 45,000
This exp	100cm **C**	190	π^+	1.7×10^7	4.3 – 8.5 3.8 – 8.5	**23,000** 37,000
		190	π^-	6.8×10^7	4.3 – 8.5 3.8 – 8.5	22,000 34,000
	24cm W	190	π^+	0.2×10^7	4.3 – 8.5 3.8 – 8.5	7,000 11,000
		190	π^-	1.0×10^7	4.3 – 8.5 3.8 – 8.5	6,000 9,000

Use of lighter and isoscalar target as compared to past experiments