Drell-Yan measurements with π, K and $\bar{p}$ beams

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on behalf of the COMPASS Collaboration

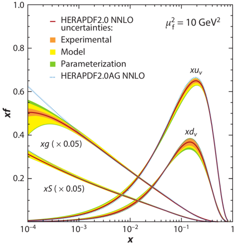
University of Illinois at Urbana-Champaign

IWHSS 2017 - Cortona.
April 3^{rd}-5^{th}

Outline

What do we know about hadron structure

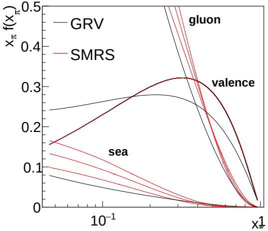
Proton:



- Valence: well known
- Sea: well known
- Gluons: well known

Best known particle thanks to Hera and LHC

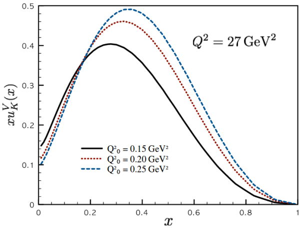
Pion:



- Valence: roughly known
- Sea: coarse bound
- Gluons: barely constrained
- First moments calculated on lattice

State of the proton in 80's

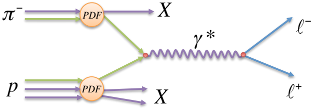
Kaon:



- Valence: unconstrained
- Sea: unknown
- Gluons: unknown
- No moments calculated on lattice

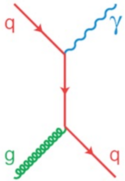
How to access meson structure

Drell-Yan:



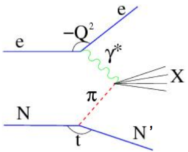
- 90's: NA3, NA10, E615
- 10's: COMPASS-II
- 20's: COMPASS++

Prompt photon productions:



- 90's NA24, W70
- 20's COMPASS++

DIS with leading N:



- 90's: H1, ZEUS
- 10's: JLAB TDIS
- 30's: EIC

ECT workshop (Nov. 6-10, 2017): Dilepton Productions with Meson and Antiproton Beams

Argonne Workshop on π and K structure at an Electron-Ion Collider, June, 1-2, 2017

Evolution of knowledge on pion structure

Group	Year	Set	Q_0^2 (GeV^2)	Factorization scheme	Model	Data	N_f	$\Lambda_{\overline{\text{MS}}}^{N_f=4}$ (MeV)
ABFKW	1989	NLO	2.00	$\overline{\text{MS}}$	$v^\pi = \gamma X$, DY	WA70, NA24	4	229
					s^π = DY	NA3		
					$g^\pi = \gamma X$, MSR	WA70, NA24		
SMRS	1992	10%	4.00	$\overline{\text{MS}}$	v^π = DY	NA10, E615	4	190
		15%			s^π = DY	NA3		
		20%			$g^\pi = \gamma X$, MSR	WA70		
GRV	1992	LO	0.25	LO	v^π = ABFKW	WA70, NA24	6	200
		NLO	0.30	$\overline{\text{MS}}$	$s^\pi = 0$			
					g^π = MSR			
GRSc	1999	LO	0.26	LO	v^π = DY, MSR	NA10, E615	3	204
		NLO	0.40	$\overline{\text{MS}}$	$s^\pi = (v^\pi/v^p)s^p$	H1, ZEUS		299
					$g^\pi = (v^\pi/v^p)g^p$	H1, ZEUS		

MSR with reasonable bounds

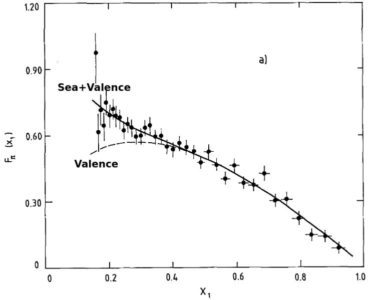
M. Klasen JPG: Nucl. Part. Phys. 28, 2002

- Pion structure is not fully constrained
- Momentum Sum Rule (MSR) provides important constraint
- Limited data, no new data for > 20 years

Status on pion sea

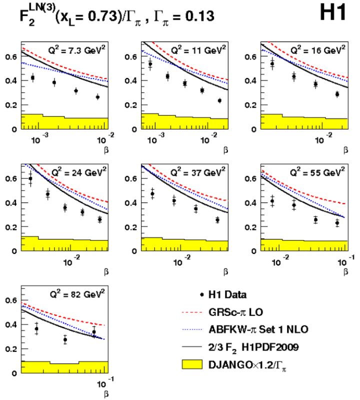
Drell-Yan NA3

Badier *et al.*, Z. Phys. C18, 1983



- $\pi^- - Pt$ 200 GeV: 4.7k events
- $\pi^+ - Pt$ 200 GeV: 1.7k events
- Very few events for π^+ beam

DIS with di-jet and leading neutron



Aaron *et al.*, Eur. Phys. J. C68, 2010

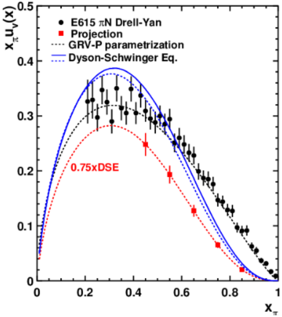
- Wide x coverage
- Estimates of pion flux introduce strong model dependence

Renewed interest in meson structure

Tagged DIS at JLAB

- Same approach as H1 and Zeus: Sullivan process
- Complement to Drell-Yan measurement at high x
- Caveat: Model dependent
  unknown pion flux $\rightarrow$ normalization to DY at $x = 0.5$
- Checks of the pion-cloud model

PR12-15-006

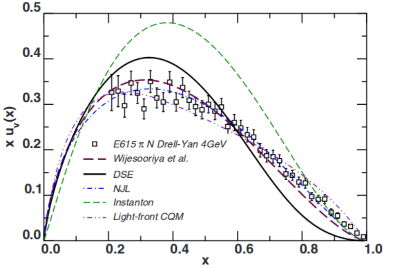


Meson structure at EIC

- DIS on pion and kaon cloud surrounding the proton R. Holt *et al.* Rev. Mod. Phys. 82, 2010

Status of the pion valence quark distribution

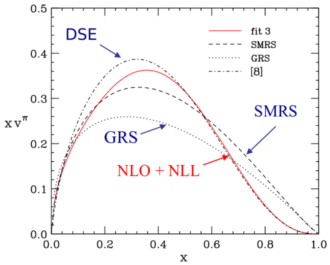
- Several models compatible with empirical data
- Disagreement between fitted PDFs from data and DSE



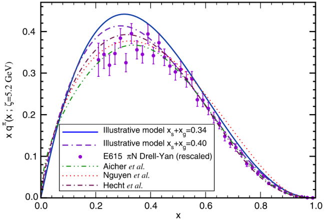
Holt and Roberts, Rev. Mod. Phys. 82, 2991 (2010).

Status of the pion valence quark distribution

- Recent reanalysis at NLL
- Agreement restored between DSE and data
- Caveat: Only valence quark distributions are fitted in NLL
- Sea and gluon from GRS
- Scarce sea quark sensitive data ($x < 0.4$)



Aicher *et al.* PRL 105, 252003, 2010



L. Chang *et al.* PLB 420, 2014

Pion valence-sea separation in Drell-Yan

With π^+ and π^- beam with isoscalar target (D for instance):

$$\sigma(\pi^+ d) \propto \frac{4}{9}[u^\pi \cdot (\bar{u}_s^p + \bar{d}_s^p)] + \frac{4}{9}[\bar{u}_s^\pi \cdot (u^p + d^p)] + \frac{1}{9}[\bar{d}^\pi \cdot (d^p + u^p)] + \frac{1}{9}[d_s^\pi \cdot (\bar{d}_s^p + \bar{u}_s^p)]$$

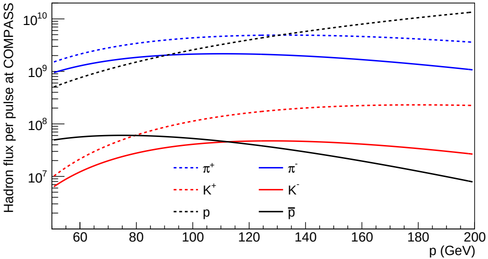
$$\sigma(\pi^- d) \propto \frac{4}{9}[u_s^\pi \cdot (\bar{u}_s^p + \bar{d}_s^p)] + \frac{4}{9}[\bar{u}^\pi \cdot (u^p + d^p)] + \frac{1}{9}[\bar{d}_s^\pi \cdot (d^p + u^p)] + \frac{1}{9}[d^\pi \cdot (\bar{d}_s^p + \bar{u}_s^p)]$$

- Assumption:
  - Charge conjugation and SU(2)$_f$ for valence: $u_v^{\pi^+} = \bar{u}_v^{\pi^-} = \bar{d}_v^{\pi^+} = d_v^{\pi^+}$
  - Charge conjugation and SU(3)$_f$ for sea: $u_s^{\pi^+} = \bar{u}_s^{\pi^-} = u_s^{\pi^-} = \bar{u}_s^{\pi^+} = \bar{d}_s^{\pi^+} = d_s^{\pi^+} = \bar{d}_s^{\pi^-} = d_s^{\pi^+} = s_s^{\pi^+} = s_s^{\pi^-} = \bar{s}_s^{\pi^+} = \bar{s}_s^{\pi^-}$
- Two linear combinations
  - Only valence sensitive: $\Sigma_v^{\pi D} = -\sigma^{\pi^+ D} + \sigma^{\pi^- D} \propto \frac{1}{3} u_v^\pi (u_v^p + d_v^p)$
  - Sea sensitive: $\Sigma_s^{\pi D} = 4\sigma^{\pi^+ D} - \sigma^{\pi^- D}$

M2 beam line at CERN

Assuming $2 \cdot 10^{13}$ppp on production target

- Unique high intensity meson beams
- Fair sharing between π^+ and p for positive beams around 120 GeV
- Potential for antiproton and kaon studies



Example around 120 GeV:

- $\approx 2{\times}10^8$ $\pi^-/\pi^+/p$ per second for $\approx$ 10s before collimators.
- $\approx 6{\times}10^7$ $K^+/K^-/\bar{p}$ per second for $\approx$ 10s before collimators.

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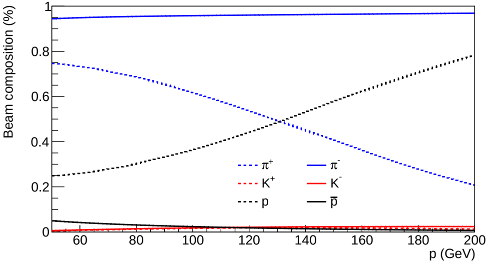
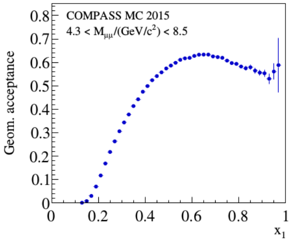


Example around 120 GeV:

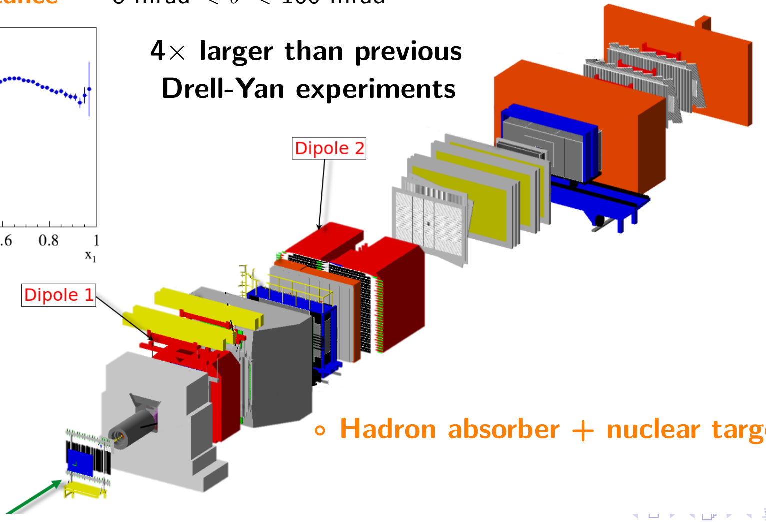
- $\approx 2{\times}10^8\ \pi^-/\pi^+/p$ per second for $\approx$ 10s before collimators.
- $\approx 6{\times}10^7\ K^+/K^-/\bar{p}$ per second for $\approx$ 10s before collimators.
- After collimators and radio-protection limit: Beam mostly composed of π^- or p/π^+

Apparatus: use COMPASS spectrometer for initial simulation studies

- **Large acceptance** $8 \text{ mrad} < \theta < 160 \text{ mrad}$



4× larger than previous Drell-Yan experiments

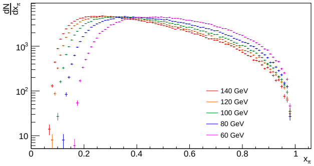


- **Hadron absorber + nuclear targets**

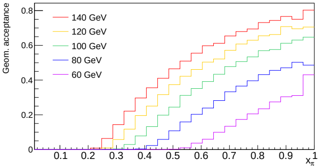
Trade-off energy, intensity *vs.* cross-section, acceptance

Case studies: Impact of the lower beam energy on the current acceptance

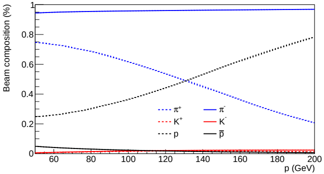
π-induced DY cross-section



Geometric acceptance

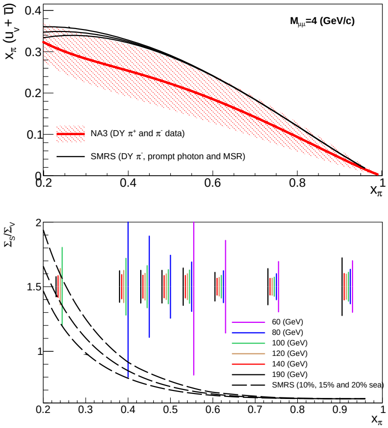


Beam composition



- Acceptance significantly impacted by lowering the beam energy
- Optimize the apparatus to minimize acceptance losses
- Beam Identification essential

Initial results: Sensitivity to valence/sea separation in the pion



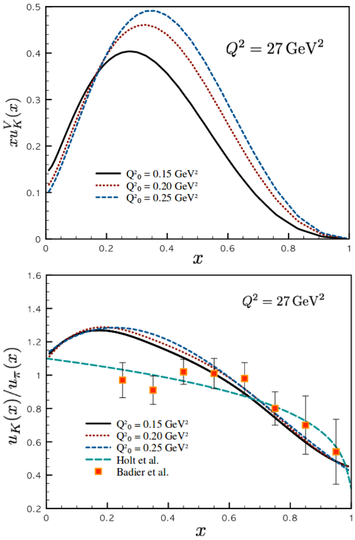
- SMRS and NA3 extractions are compatible
- Large uncertainties from "direct sea" measurement
- Projection for current COMPASS acceptance
- 140 days of π^+ with C target with $2{\cdot}10^{13}$ppp
- 10% statistical uncertainty in the first bin ($0.01<x<0.35$) for 190 GeV
- Integrated over x: best energy 140 GeV
- Potential gain with improved acceptance at 140 GeV and 120 GeV

Kaon structure status

Sole measurement from NA3
K^--W : 700 events

- Sensitive to $SU(3)_f$ breaking
- Mostly only model predictions
  Illustration for Nambu-Jona-Lasinio (Chiral effective theory)
- No predictions from lattice - waiting for data!

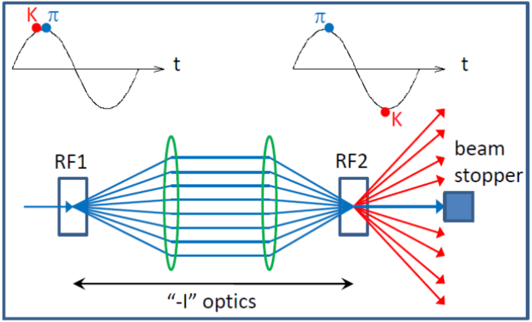
How to improve the situation?



S-i. Nam PRD 86, 074005, 2012

Unique opportunities with RF separated beam

- Deflection with 2 cavities
- Relative phase = 0 → dump
- Deflection of wanted particle given by $\Delta\phi \approx \frac{\pi f L}{c} \frac{m_w^2 - m_u^2}{p^2}$

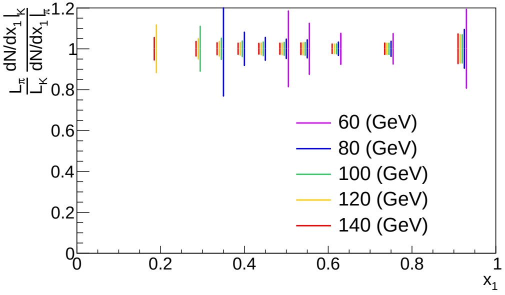


To keep good separation, L should increase as p^2 → limits the beam momentum

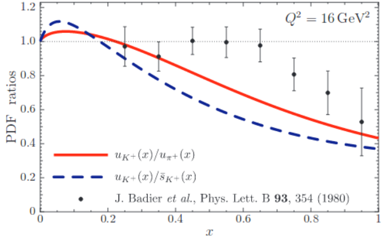
Preliminary beam flux expectations for $2 \cdot 10^{13}$ppp:
$K^-/\bar{p}$: $\approx 1\times10^7$ particles per second for $\approx$ 10s
Enhancement by a factor of 50 compared to current beam

See talk from Johannes Bernhard on Monday

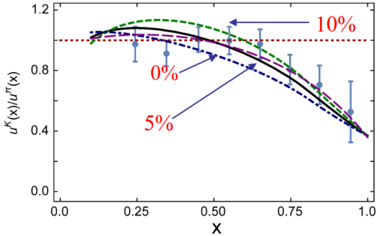
Initial results: Projections for valence for Kaons



P.T.P. Hutauruk *et al.*, PRC 94 035201, 2016

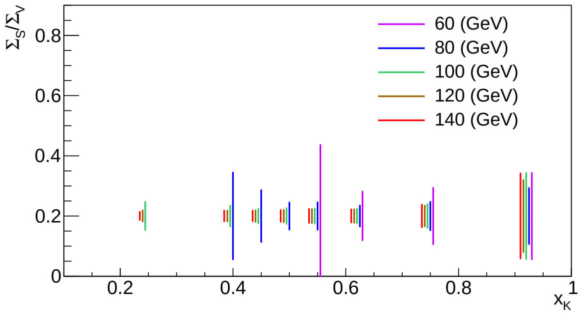


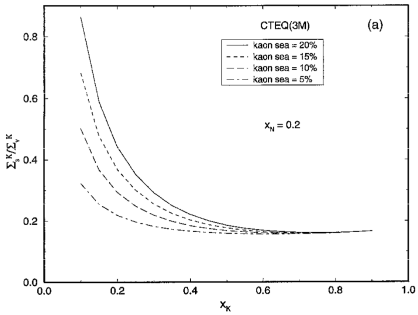
C. Chen *et al.*, PRD 93 074021, 2016



- 3% statistical uncertainty
- 140 days of K^- with W target
- Obvious improvement in statistics
- Some insight on the gluon content according to Chen Chen *et al.*

Initial results: Projections for valence/sea separation for Kaons

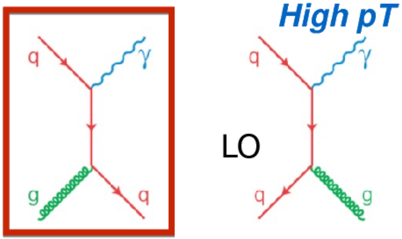


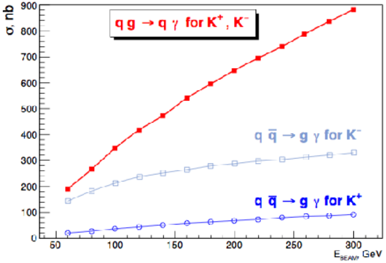


- 3% statistical uncertainty
- Additional 140 days and K^+ with C target
- Unique measurement of sea in kaons
- Also sensitivity to valence strangeness

Gluon structure of Kaons with prompt photons

At the moment there is no experimental data on G(x) of kaon!





$$d\sigma_{AB} = \sum_{a,b=q,\bar{q},g} \int dx_a dx_b f_a^A(x_a,\mu^2) f_b^B(x_b,\mu^2) d\sigma_{ab\to\gamma X}(x_a,x_b,\mu^2).$$

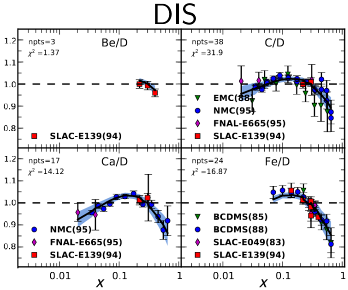
Thanks to A. Guskov

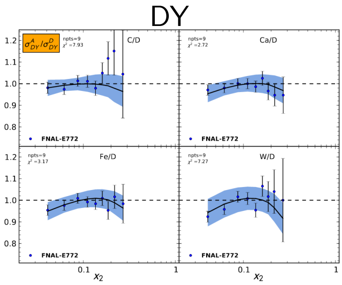
K^+ beam of 100+ GeV/c and nuclear target

High aperture system of 3 precise electromagnetic calorimeters

First observation of kaon-induced prompt photons, first measurement of kaon G(x)

Nuclear effect in hadron structure





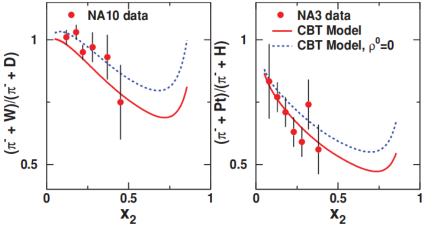
- Insight on QCD in many body systems
- Difference in anti-shadowing region ($0.1 < x < 0.2$)
  Enhancement visible in DIS *vs.* Mild increase in DY
  $\rightarrow$ sea-valence effect?
  $\rightarrow$ flavor dependence?

Nuclear effect

Iso-vector ρ^0 mean field generated in $Z \neq N$ nuclei can modify nucleon's u and d PDFs differently

- NA10 π on W favor flavor independence
- NA3 π on Pt favor flavor dependence
- Meson induced Drell-Yan process tags flavor

D. Dutta *et al.*, PRC 83 042201 2011



Precise pions and kaons DY measurements can provide unique constraints

- $\pi^- A/\pi^- D \approx u^A/u^d$
- $\pi^+ A/\pi^- D \approx d^A/4u^d$
- $K^- A/K^- D \approx u^A/u^d$
- $K^+ A/K^- D \approx (4\bar{u}^A + s^A)/u^d$

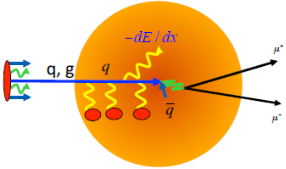
Requires only nuclear target, no additional beam time

Parton energy loss

Drell-Yan measurements on nuclei can provide constraints on parton energy loss

See talk from Francois Arleo on Tuesday

- Multiple scattering of incoming quark in large nuclei
- No energy loss in the final state



Two possible signatures:

- $\sigma^{A}_{DY}/\sigma^{D}_{DY} \searrow$ at large x_1:
  Softer x_1^A compared to x_1^p
- $< p_T^2 >$ broadening:
  Additional $k_\perp$ acquired from g scattering

Important input to understand collision system in heavy ion collisions
Fixed target kinematic especially suited

Unpolarised Drell-Yan angular dependencies

$$\frac{dN}{d\Omega} = \frac{3}{4\pi}\frac{1}{\lambda+3}\left(1+\lambda\cos^2(\theta)+\mu\sin(2\theta)\cos(\phi)+\frac{\nu}{2}\sin^2(\theta)\cos(2\phi)\right)$$

In naive Drell-Yan model, no k_T and no QCD processes involving gluons:

$$\lambda = 1,\ \ \mu = 0,\ \ \nu = 0$$

The Lam-Tung relation, derived from the fermionic nature of quarks, predicts:

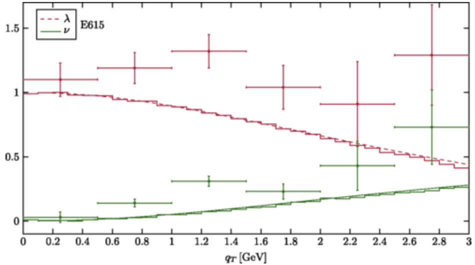
$$1 - \lambda - 2\nu = 0$$

Analog of DIS Callan-Gross relation for Drell-Yan

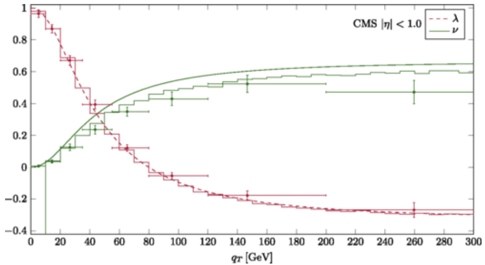
C.S. Lam and W.K. Tung, Phys. Rev. D 18, 2447 (1978)

QCD Lam-Tung relation

E615 PRD 39, 92 (1989)



CMS PLB 750, 154 (2015)



- Recent evidence in terms of QCD: radiative effects describe well data at large q_T
  - J.-C. Peng *et al.* PLB 758, 384 (2016)
  - M. Lambertsen and W. Vogelsang PRD93, 114013 (2016)
- Boer Mulders expected at low q_T $\rightarrow$ fixed target regime
- To single out Boer Mulders effects very precise data are necessary

Synergy DY *vs* SIDIS

DY:					SIDIS:			
$A_{UU}^{\cos(2\phi)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1,p}^{\perp q}$	Boer-Mulders	$A_{UU}^{\cos(2\phi_h)}$	$\propto h_{1,p}^{\perp q}$	$\otimes$	$H_{1q}^{\perp h}$
$A_{UT}^{\sin(\phi_S)}$	$\propto f_{1,h}^{q}$	$\otimes$	$f_{1T,p}^{\perp q}$	Sivers	$A_{UT}^{\sin(\phi_h-\phi_S)}$	$\propto f_{1T,p}^{\perp q}$	$\otimes$	D_{1q}^{h}
$A_{UT}^{\sin(2\phi-\phi_S)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1,p}^{q}$	Transversity	$A_{UT}^{\sin(\phi_h+\phi_S)}$	$\propto h_{1,p}^{q}$	$\otimes$	$H_{1q}^{\perp h}$
$A_{UT}^{\sin(2\phi+\phi_S)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1T,p}^{\perp q}$	Pretzelosity	$A_{UT}^{\sin(3\phi_h-\phi_S)}$	$\propto h_{1T,p}^{\perp q}$	$\otimes$	$H_{1q}^{\perp h}$

TMD PDFs are **universal** but
final state interaction (SIDIS) *vs.* initial state interaction (DY) $\rightarrow$ **Sign flip** for naive T-odd TMD PDFs

$$f_{1T}^{\perp q}\,|_{SIDIS} = -f_{1T}^{\perp q}\,|_{DY}$$
$$h_{1}^{\perp q}\,|_{SIDIS} = -h_{1}^{\perp q}\,|_{DY}$$

Crucial test of TMD framework in QCD

See talk from Marcia Quaresma on Tuesday

Synergy DY *vs* SIDIS

DY:					SIDIS:			
$A_{UU}^{\cos(2\phi)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1,p}^{\perp q}$	Boer-Mulders	$A_{UU}^{\cos(2\phi_h)}$	$\propto h_{1,p}^{\perp q}$	$\otimes$	$H_{1q}^{\perp h}$
$A_{UT}^{\sin(\phi_S)}$	$\propto f_{1,h}^{q}$	$\otimes$	$f_{1T,p}^{\perp q}$	Sivers	$A_{UT}^{\sin(\phi_h-\phi_S)}$	$\propto f_{1T,p}^{\perp q}$	$\otimes$	D_{1q}^{h}
$A_{UT}^{\sin(2\phi-\phi_S)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1,p}^{q}$	Transversity	$A_{UT}^{\sin(\phi_h+\phi_S)}$	$\propto h_{1,p}^{q}$	$\otimes$	$H_{1q}^{\perp h}$
$A_{UT}^{\sin(2\phi+\phi_S)}$	$\propto h_{1,h}^{\perp q}$	$\otimes$	$h_{1T,p}^{\perp q}$	Pretzelosity	$A_{UT}^{\sin(3\phi_h-\phi_S)}$	$\propto h_{1T,p}^{\perp q}$	$\otimes$	$H_{1q}^{\perp h}$

Additional insight with $\bar{p}$ on Boer Mulders

- Transversity modulation less affected by QCD effects

→ Extract transversity from SIDIS $A_{UT}^{sin(\phi_h+\phi_S)}$ measurements

- Use DY measured $A^{sin(2\phi-\phi_S)}$ and SIDIS transversity knowledge

→ Obtain Boer-Mulders, $h_{1,p}^{\perp q}$, for proton

Unpolarised DY present/future experiment landscape

M. Diehl, J. Pawlowski, G. Schnell at Physics beyond collider working group, CERN, March 2017

- J-Parc: polarized DY program "in stasis"
  (30 or even 50 GeV proton beam)
  "near-term" (2020~), 20 GeV pi- beam fixed-target program
  possibility for <10 GeV pion/kaon/(anti-)proton beam
- PANDA@FAIR (under construction); 2025++
  $\sqrt{s}$ = 5.5 GeV; valence quarks because of anti-proton beam
- SPASCHARM @ IHEP 20xx ?
  40-70 (100?) GeV proton beam on (pol.) fixed-target
  secondary hadron beams & tertiary polarized (anti)protons

- E906 (FNAL) proton on proton at 120 GeV dedicated to sea quarks in proton

No competitors in our kinematic domain, complementary measurements

Polarised DY present/future experiment landscape

D. Kikola *et al.* arXiv:1702.01543

Experiment	particles	beam energy (GeV)	$\sqrt{s}$ (GeV)	$x^{\uparrow}$	$\mathcal{L}$ (cm^{-2}s^{-1})	$\mathcal{P}_{\rm eff}$	$\mathcal{F}$ (cm^{-2}s^{-1})
AFTER@LHCb	$p + p^{\uparrow}$	7000	115	$0.05 \div 0.95$	$1 \cdot 10^{33}$	80%	$6.4 \cdot 10^{32}$
AFTER@LHCb	$p + {}^{3}\mathrm{He}^{\uparrow}$	7000	115	$0.05 \div 0.95$	$2.5 \cdot 10^{32}$	23%	$1.4 \cdot 10^{31}$
AFTER@ALICE$_{\mu}$	$p + p^{\uparrow}$	7000	115	$0.1 \div 0.3$	$2.5 \cdot 10^{31}$	80%	$1.6 \cdot 10^{31}$
COMPASS (CERN)	$\pi^{\pm} + p^{\uparrow}$	190	19	$0.2 \div 0.3$	$2 \cdot 10^{33}$	18%	$6.5 \cdot 10^{31}$
PHENIX/STAR (RHIC)	$p^{\uparrow} + p^{\uparrow}$	collider	510	$0.05 \div 0.1$	$2 \cdot 10^{32}$	50%	$5.0 \cdot 10^{31}$
E1039 (FNAL)	$p + p^{\uparrow}$	120	15	$0.1 \div 0.45$	$4 \cdot 10^{35}$	15%	$9.0 \cdot 10^{33}$
E1027 (FNAL)	$p^{\uparrow} + p$	120	15	$0.35 \div 0.9$	$2 \cdot 10^{35}$	60%	$7.2 \cdot 10^{34}$
NICA (JINR)	$p^{\uparrow} + p$	collider	26	$0.1 \div 0.8$	$1 \cdot 10^{32}$	70%	$4.9 \cdot 10^{31}$
fsPHENIX (RHIC)	$p^{\uparrow} + p^{\uparrow}$	collider	200	$0.1 \div 0.5$	$8 \cdot 10^{31}$	60%	$2.9 \cdot 10^{31}$
fsPHENIX (RHIC)	$p^{\uparrow} + p^{\uparrow}$	collider	510	$0.05 \div 0.6$	$6 \cdot 10^{32}$	50%	$1.5 \cdot 10^{32}$
PANDA (GSI)	$\bar{p} + p^{\uparrow}$	15	5.5	$0.2 \div 0.4$	$2 \cdot 10^{32}$	20%	$8.0 \cdot 10^{30}$

No competitors with $\bar{p}$ or meson beams, complementary picture

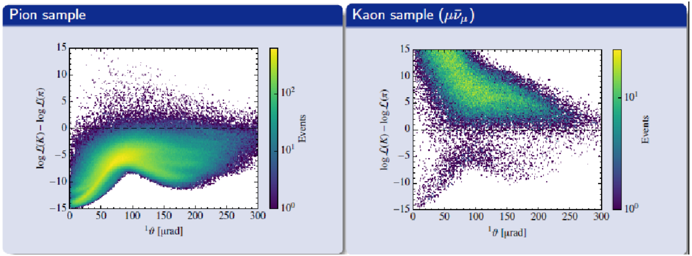
Instrumentation requirements

With RF separated beam the abundance of a given particle species will be about 50%

Excellent beam PID is essential

Illustration CEDAR performances with 190 GeV beam with $2 \cdot 10^7$ particles/spill

π K



π Eff.= 0.998 & Impurity = 0.018 K/$\bar{p}$ Eff.=0.88/0.96 & Impurity = 0.025/0.07

Comparable or even superior beam tagging should be available for 10 times higher flux

Target and Vertex detector

Target:

- Choice of target matches physics objectives
- Studies: LH_2, $LD_2/C/NH_3$ + different A nuclear targets

→ Several targets in beam line: Optimization of beam time

Vertex:

- High intensity incoming hadron beam (up to 10^8/s)
- Resulting very high multiplicities requires high performance vertex detectors
- Necessity for precise evaluation and room for "innovative technologies"
  - → Very fast timing -low mass- high position resolution detectors
  - → *R&D* required

Large angle spectrometer:

- Optimize large angle spectrometer
- Increase acceptance of upstream spectrometer
  - → *R&D* required

Conclusions

Unique and precise new measurements with a RF separated beam

- Pion and kaon structure including valence sea separation
- Precise test of Lam Tung relation
- Cold nuclear matter effects

- Requirement for RF separated, ongoing
- Evaluation apparatus design, ongoing

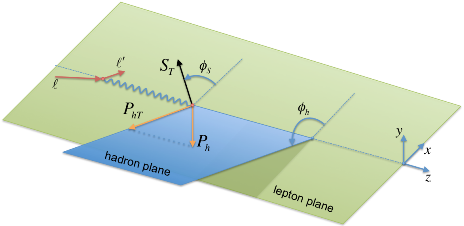
New collaborators are welcome

BACKUP

Drell-Yan and SIDIS cross-section modulations

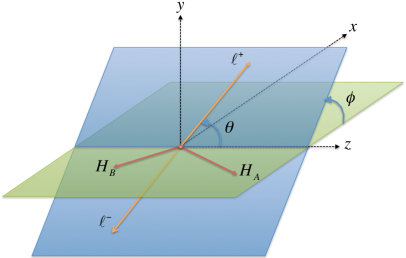
SIDIS:

$$\frac{d\sigma}{dxdydzd\phi_S d\phi_h dP_{hT}^2} \overset{LO}{=} \frac{\alpha^2}{xyQ^2}\frac{y^2}{2(1-\epsilon)}\left(1\frac{\gamma^2}{2x}\right)\hat{\sigma_U}\Big\{1+\epsilon A_{UU}^{\cos(2\phi_h)}\cos(2\phi_h)$$
$$+S_T\left[A_{UT}^{\sin(\phi_h-\phi_S)}\sin(\phi_h-\phi_S)+\epsilon A_{UT}^{\sin(\phi_h+\phi_S)}\sin(\phi_h-\phi_S)\right.$$
$$\left.+\epsilon A_{UT}^{\sin(3\phi_h-\phi_S)}\sin(3\phi_h-\phi_S)\right]$$
$$+S_T P_l\left[\sqrt{1-\epsilon^2}\cos(\phi_h-\phi_S)A_{LT}^{\cos\phi_h-\phi_S}\right]\Big\}$$



DY:

$$\frac{d\sigma}{d^4qd\Omega} \overset{LO}{=} \frac{\alpha^2}{Fq^2}\hat{\sigma_U}\Big\{\left(1+\cos^2(\theta)+\sin^2(\theta)A_{UU}^{\cos(2\phi)}\cos(2\phi)\right)$$
$$+S_T\Big[(1+\cos^2(\theta))A_{UT}^{\sin(\phi_S)}\sin(\phi_S)$$
$$+\sin^2(\theta)\left(A_{UT}^{\sin(2\phi+\phi_S)}\sin(2\phi+\phi_S)+A_{UT}^{\sin(2\phi-\phi_S)}\sin(2\phi-\phi_S)\right)\Big]\Big\}$$

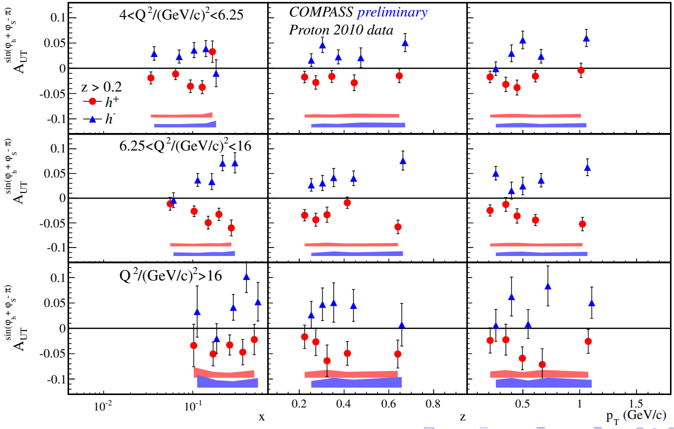


SIDIS Transversity in DY Q^2 ranges

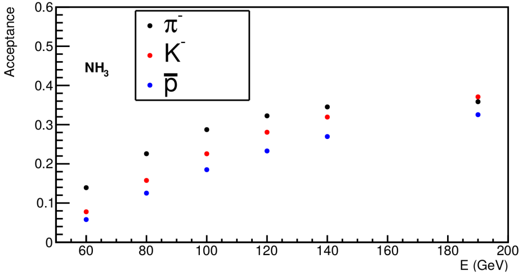
$h_{1,p}^q$: correlation between transversely polarised quark in a transversely polarised nucleon

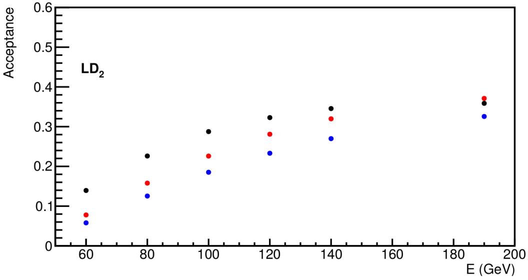
$$A_{UT}^{sin(\phi_h+\phi_S)} \propto h_{1,p}^q \otimes H_{1q}^{\perp h}$$

- Sizable in all Q^2 range
- Azymuthal modulation have opposite sign for h^+ & h^-



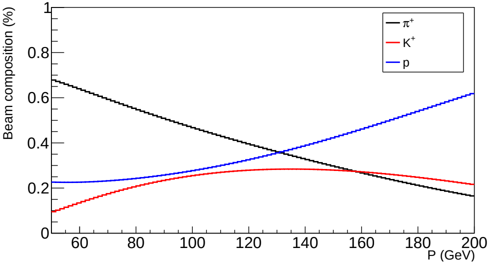
COMPASS like acceptance as a function of beam energy

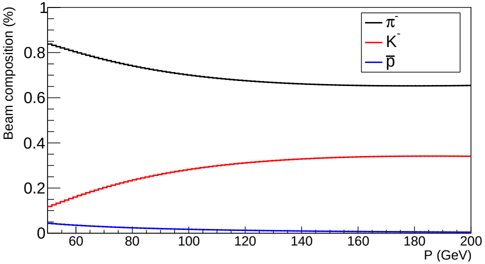




Assumption for K physics case studies

Assuming for the moment: $2 \cdot 10^{13}$ ppp on production target
Assuming for the moment: 3/63/3 % of pions/kaons/protons pass the dump





Assumption for K physics case studies

Assuming for the moment: $2 \cdot 10^{13}$ ppp on production target
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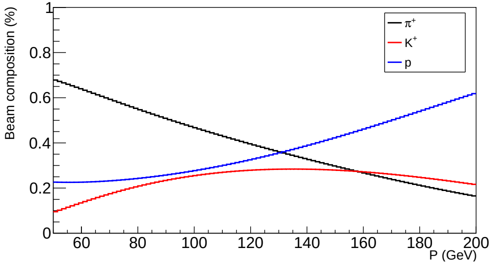
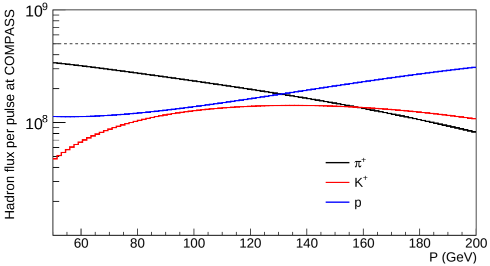
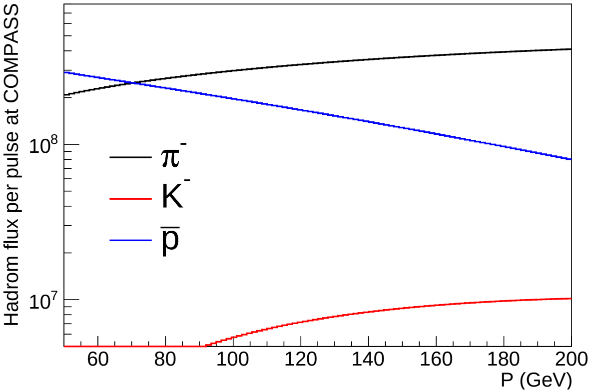




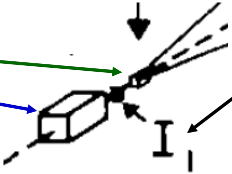
Assumption for $\bar{p}$ physics case studies

Assuming for the moment: $2 \cdot 10^{13}$ ppp on production target
Assuming for the moment: 3/3/80 % of pions/kaons/protons pass the dump



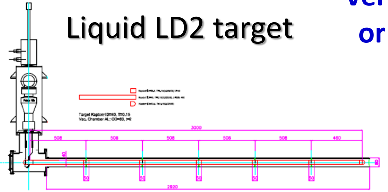
Targets and Vertex Detector(s)

NA3 Drell-Yan targets
-> 6cm Platinum
-> 30cm LH2

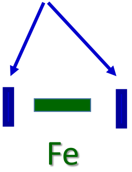


I_1 is a **Cherenkov** which flags interactions in the LH2 target

Liquid LD2 target



Vertex Detector or Ĉ counter



Hadron Absorber