



Status and plans of the COMPASS Experiment



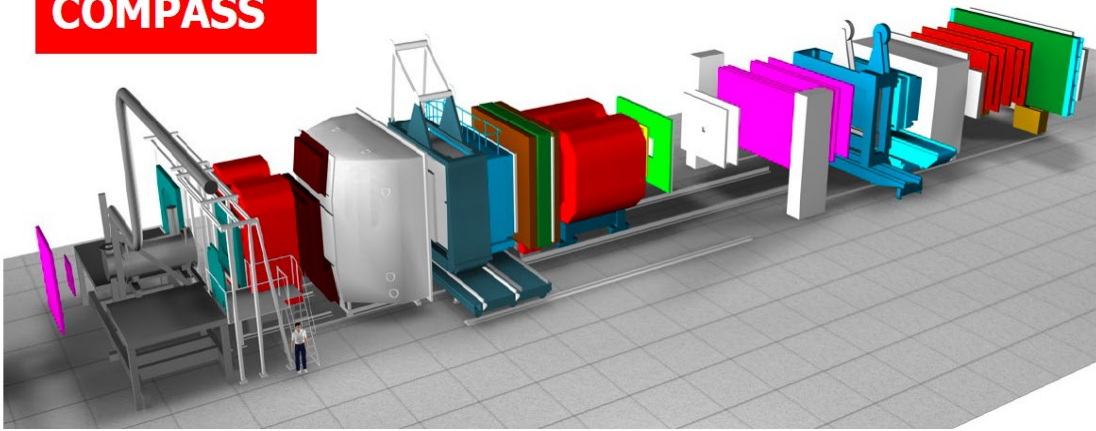
Fulvio Tassarotto (CERN and INFN Trieste) on behalf of the COMPASS Collaboration

COmmon Muon Proton Apparatus for Structure and Spectroscopy













1. Introduction
2. Hadron data analysis
3. DVCS and DVMP data analysis
4. SIDIS data analysis and TMDs
5. Dell-Yan data analysis
6. Preparation for the transversely polarised deuteron run



COMPASS



> 200 physicists, 24 Institutions, 13 Countries

	Дубна (LPP and LNP), Москва (INR, LPI, State University), Протвино		Bochum, Bonn (ISKP & PI), Erlangen, Freiburg, Mainz, München TU	
	Warsaw (NCBJ), Warsaw (TU) Warsaw (U)	CERN		USA (UIUC)
	Praha (CU/CTU) Liberec (TU) Brno (ISI-ASCR)		Yamagata	
	Calcutta (Matriviani)		Lisboa/Aveiro	Saclay
	Taipei (AS)		Tel Aviv	Torino (University, INFN), Trieste (University, INFN)

2002	nucleon structure with	160 GeV μ	L&T	polarised deuteron target
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2005	<i>CERN accelerators shut down</i>			
2006	nucleon structure with	160 GeV μ	L	polarised deuteron target
2007	nucleon structure with	160 GeV μ	L&T	polarised proton target
2008	<i>hadron spectroscopy</i>			
2009	<i>hadron spectroscopy</i>			
2010	nucleon structure with	160 GeV μ	T	polarised proton target
2011	nucleon structure with	190 GeV μ	L	polarised proton target
2012	Primakoff & DVCS / SIDIS test			
2013	<i>CERN accelerators shut down</i>			
2014	Test beam Drell-Yan process with π beam and T polarised proton target			
2015	Drell-Yan process with π beam and T polarised proton target			
2016	DVCS / SIDIS with μ beam and unpolarised proton target			
2017	DVCS / SIDIS with μ beam and unpolarised proton target			
2018	Drell-Yan process with π beam and T polarised proton target			
2021	nucleon structure with 160 GeV μ T polarized deuteron target			



COMPASS main active analyses



Channel	Status	Details
Hadron data		
Measurement of chiral anomaly in $\pi^- \gamma \rightarrow \pi^- \pi^0$	update	study of systematic effects
Measurement of chiral dynamics in $\pi^- \gamma \rightarrow \pi^- \pi^0$	update	study of systematic effects
Triangle singularity as the origin of the $a_1(1420)$ in $\pi^- p \rightarrow \pi^- \pi^- \pi^+ p$	final	will be submitted to PRL PRD method paper in drafting stage
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Exclusive reactions with 2012 data		
DVCS cross section and t -slope	final	PLB 793 (2019) 188-194
π^0 cross section t and ϕ dependence	final	PLB 805 (10 June 2020) 135454
SDME for exclusive ω	final	paper almost finished
SDME for exclusive ρ	almost final	paper to be written
SDME for exclusive ϕ	ongoing	analysis done but not cross checked
Exclusive reactions with 2016-17 data		
DVCS cross section and t -slope	new	ongoing
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pion and kaon multiplicities	ongoing	2016/17 data
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Transverse spin and TMD analyses

Other P_T -weighted transverse spin asymmetries (SIDIS 2010 data)	new	ongoing
MultiD analysis of transverse spin asymmetries (SIDIS 2010 data)	update	ongoing
Measurement of g_2^p (SIDIS 2010 data)	update	ongoing
TMD transverse and longitudinal spin asymmetries (SIDIS 2007, 2010, 2011 data)	update	paper being written
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Drell-Yan and Charmonium analyses		
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Drell-Yan and Charmonium angular dependence	ongoing	systematics study
Drell-Yan and Charmonium left-right spin asymmetries	ongoing	
Neural network methods for Drell-Yan process selection	new	ongoing
Beam particle identification analysis	new	ongoing

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2008-2009 data taking, 190 GeV/c hadron beam on a hydrogen target.

COMPASS has performed the most comprehensive analysis of isovector resonances decaying into $\eta\pi$, $\eta'\pi$, or $\pi^-\pi^-\pi^+$ final states.

kinematic range: $0.1 < t' < 1.0$ (GeV/c)²

$\pi^-\pi^-\pi^+$ diffractively produced on a solid-lead and a proton target

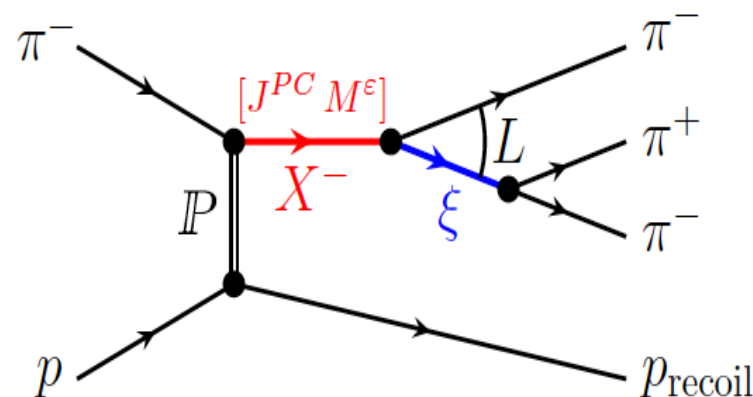
PRD 95 (2017) 032004, PRD 98 (2018) 092003

3π data sample: $\sim 50 \times 10^6$ exclusive events – factor 10 to 100 with respect to previous experiment.

Detailed description of the PWA method and the results from this analysis have been published.

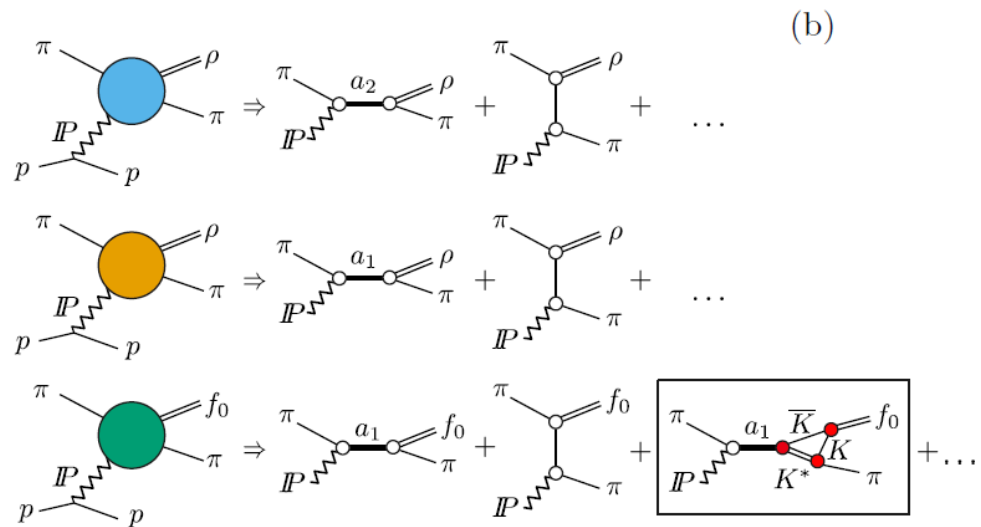
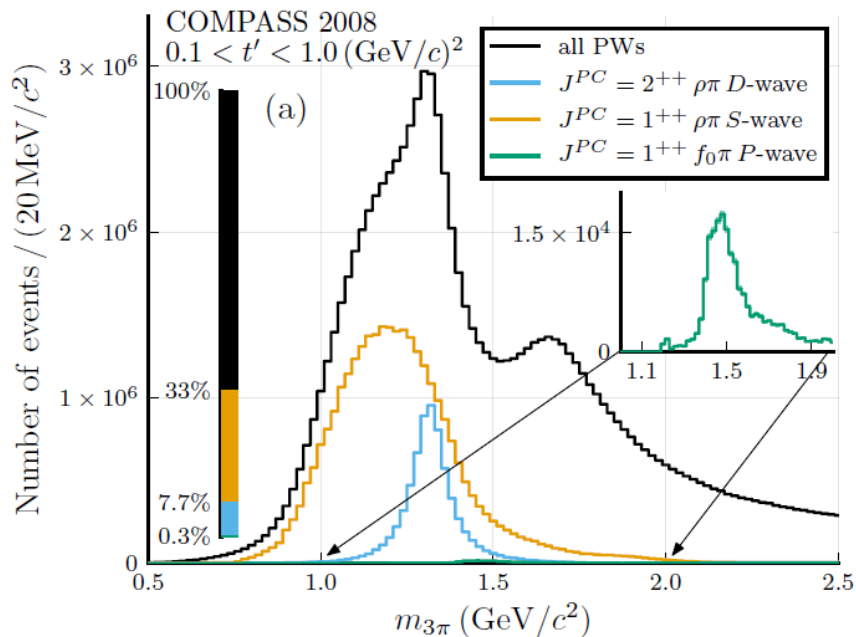
Collaboration with Joint Physics Analysis Center (JPAC)

**New ongoing analysis, improved event reconstruction and selection, including 2009 data
→ factor 2.5 in exclusive 3π events**



PWA of the reaction $\pi^- + p \rightarrow \pi^- \pi^- \pi^+ + p$

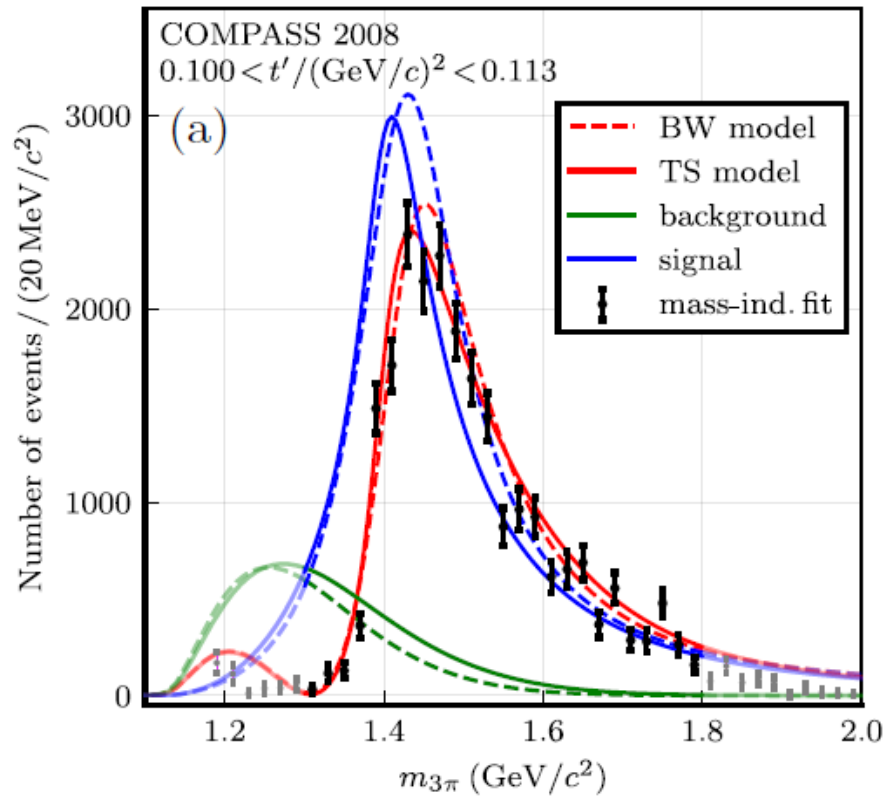
Resonance-like signal, $a_1(1420)$, found in the $f_0(980) \pi$ P 1^{++} partial wave, [PRL 115, 082001 \(2015\)](#) not fitting into the $q\bar{q}$ scheme of ordinary mesons
 Interpretations: tetraquark, molecule-like, etc.



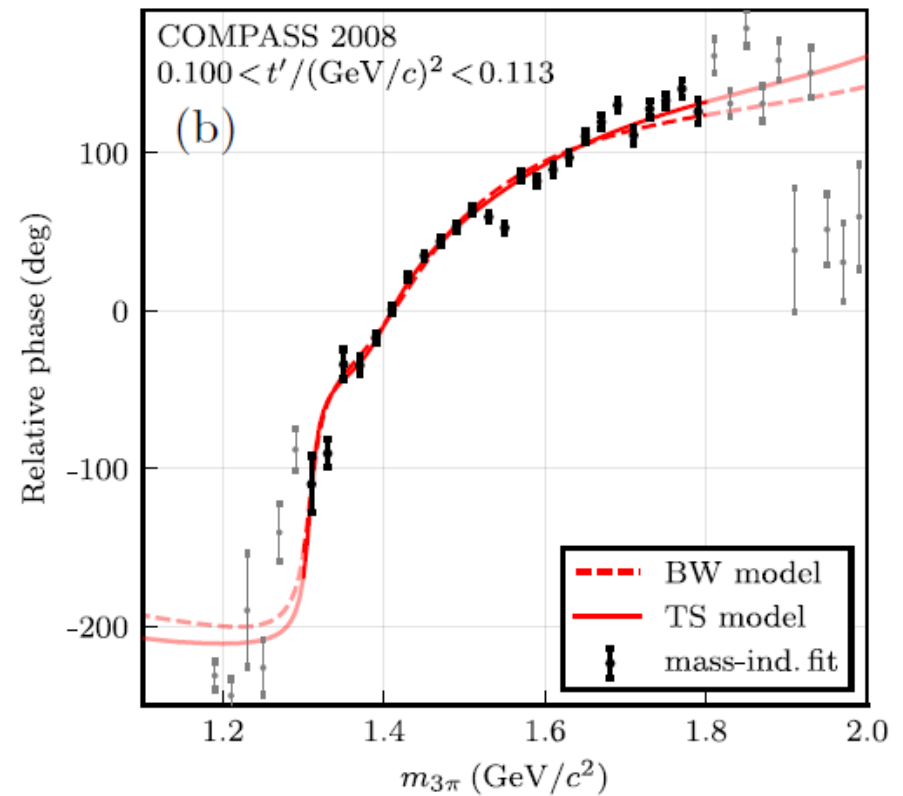
Kinematic effect (triangle singularity) in the decay of $a_1(1260)$ into $K^*(892) \bar{K} + c.c.$, and rescattering of the \bar{K} with the K from the K^* decay into the observed $f_0(980)$

The Triangle Singularity (TS) model is fitted to our partial-wave data.
 Less parameters than the resonance hypothesis (BW).
 TS fit has slightly better quality \rightarrow no need for an additional resonance.

Intensity of the $1^{++}0^+$ $f_0\pi$ P -wave

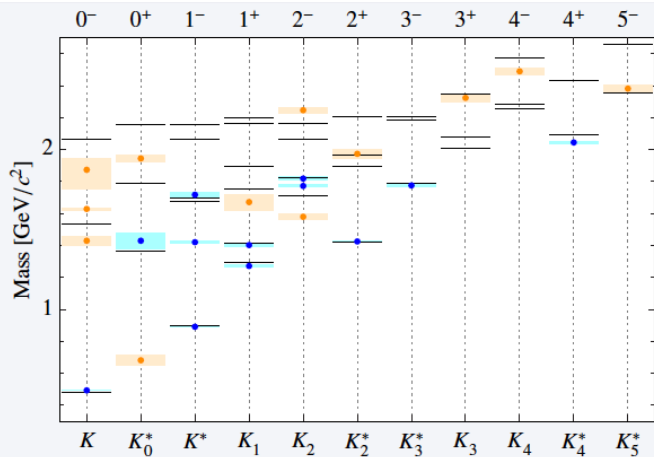


Interference of $1^{++}0^+$ ($f_0\pi P - \rho\pi S$)



The article is ready to be submitted to PRL.

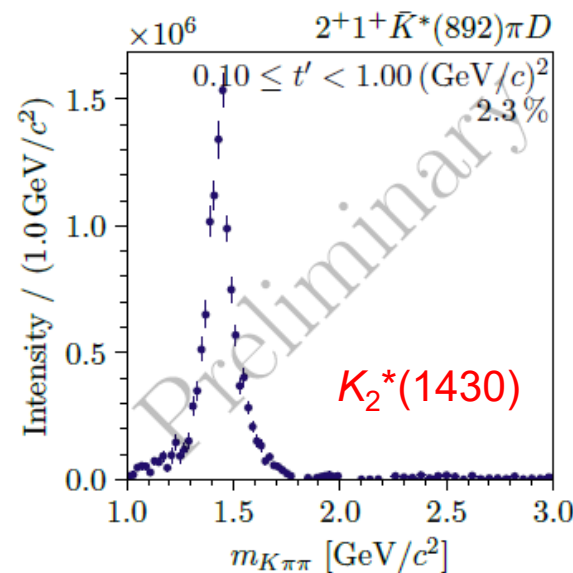
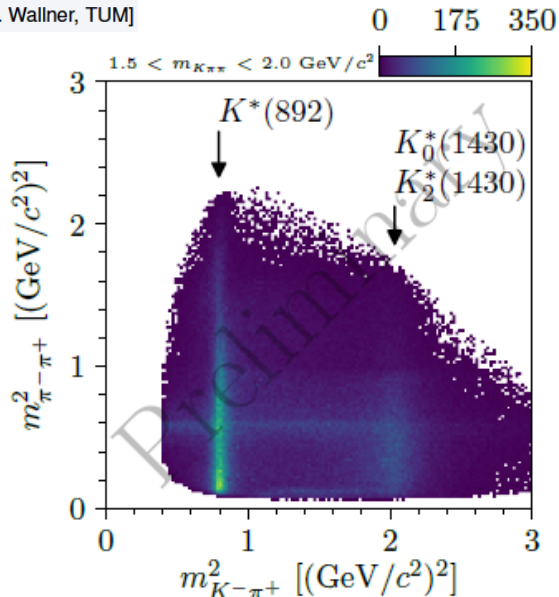
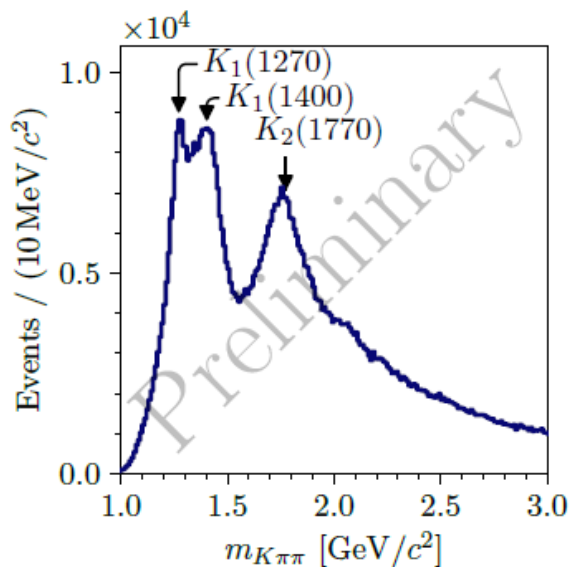
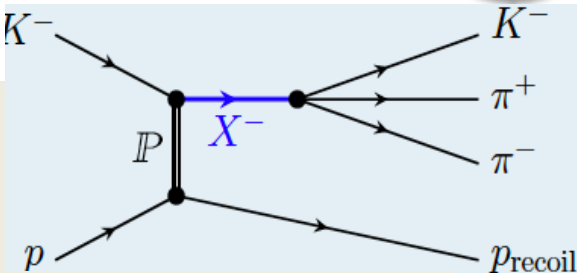
The PDG lists 25 kaon states, 12 of which need confirmation.



[Courtesy S. Wallner, TUM]

2.4% K⁻ in the 190 GeV/c negative hadron beam.
(CEDAR)

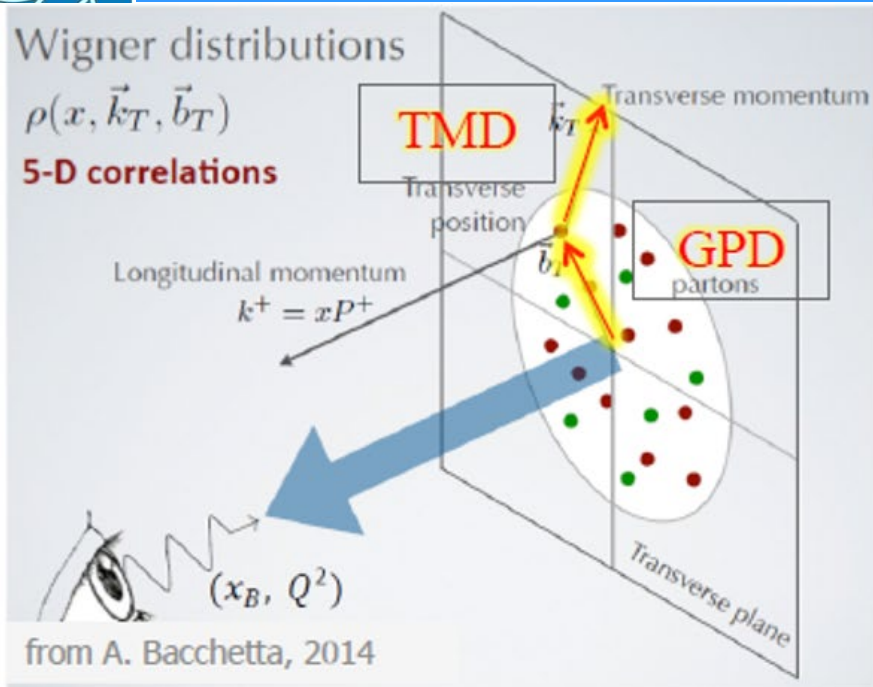
We have 720 000 exclusive K⁻ π⁻ π⁺ events in the range 1:0 < m_{Kππ} < 3:0 GeV/c² and 0:1 < t' < 1:0 (GeV/c)².



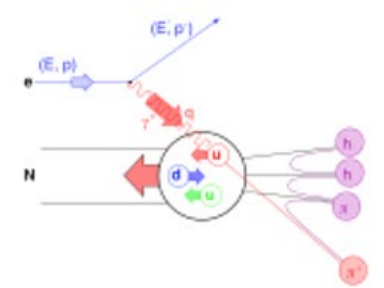
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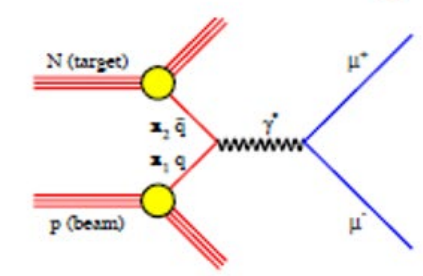
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Semi-Inclusive DIS



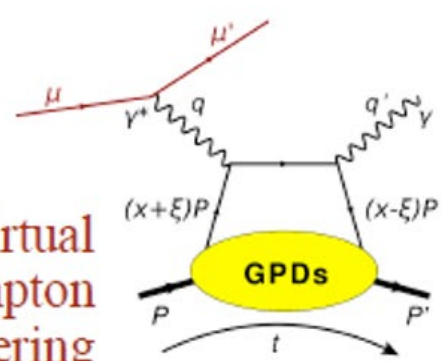
Drell-Yan process



Transversity Momentum Distributions: **TMD** (x, k_T):
 probe the **transverse parton momentum** dependence

Generalized Parton Distributions : **GPD** (x, b_T):
 probe the **transverse parton distance** dependence

Deeply Virtual
 Compton
 Scattering



COMPASS explores the multi dimensional structure of the nucleon both in momentum and in configuration space, via SIDIS, D-Y and DVCS

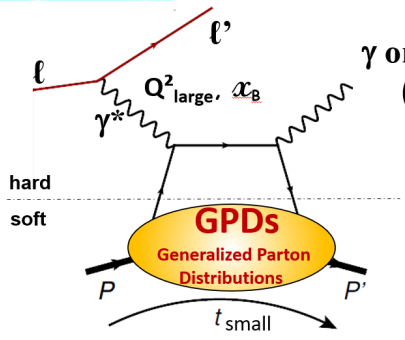


Exclusive π^0 production on unpolarised proton



COMPASS 2012 data

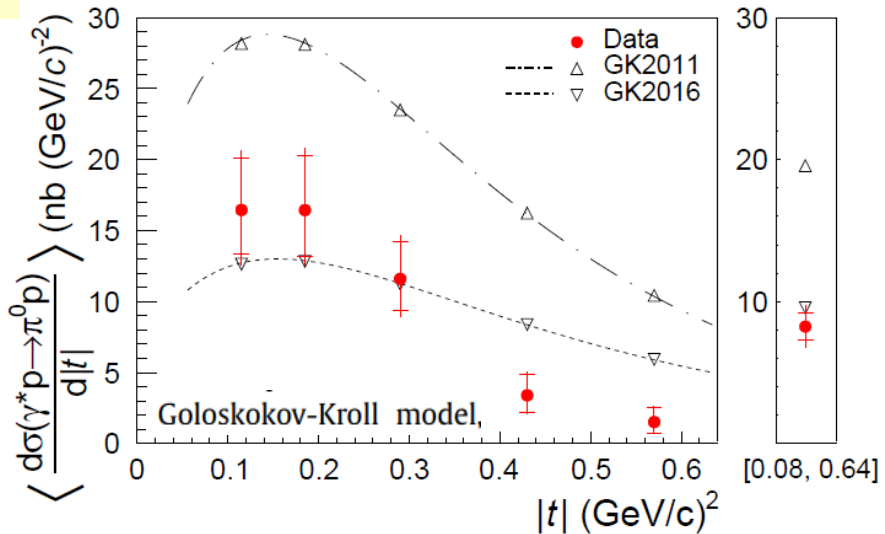
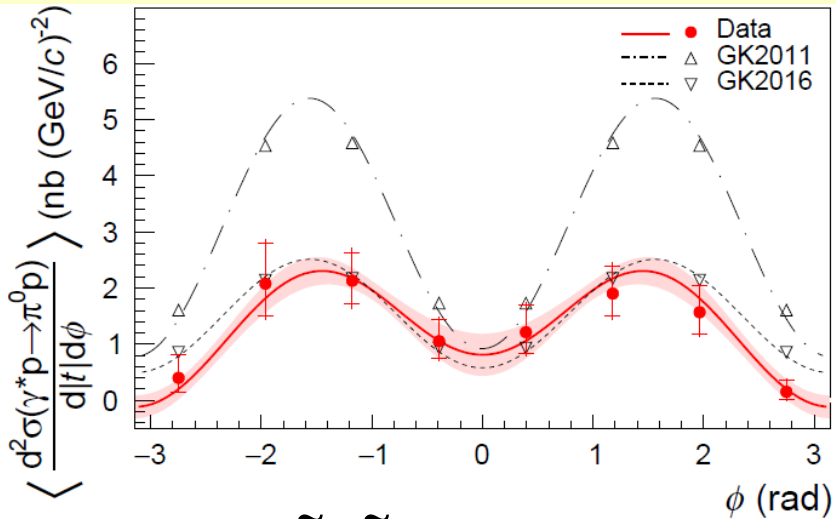
$$\mu p \rightarrow \mu \pi^0 p$$



4 chiral-even GPDs $H, E, \tilde{H}, \tilde{E}$
 4 chiral-odd GPDs H_T, \bar{E}_T, \dots
 called also transversity GPDs

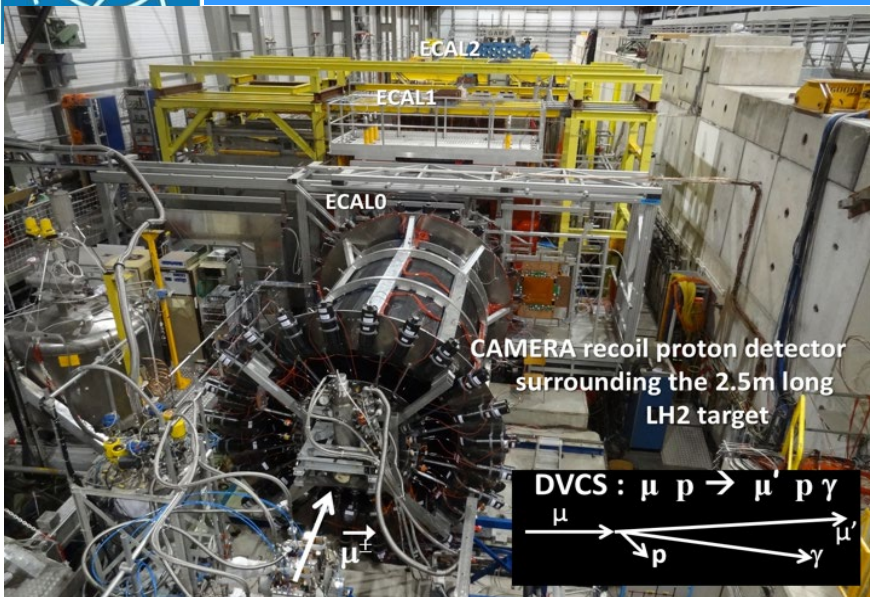
$$\frac{d^2\sigma}{dt d\phi_\pi} = \frac{1}{2\pi} \left[\left(\frac{d\sigma_T}{dt} + \epsilon \frac{d\sigma_L}{dt} \right) + \epsilon \cos 2\phi_\pi \frac{d\sigma_{TT}}{dt} + \sqrt{2\epsilon(1+\epsilon)} \cos \phi_\pi \frac{d\sigma_{LT}}{dt} \right]$$

PLB 805 (2020)135454, hep-ex/1903.12030



σ_L depends on \tilde{H}, \tilde{E} : leading twist contribution \rightarrow should be dominant.
 surprisingly $\sigma_T, \sigma_{TT}, \sigma_{LT}$ involving also H_T and \bar{E}_T are found to be large

DVCS cross sections published: **PLB 793 (2019) 188**; SDMEs for ω, ρ and ϕ well advanced.

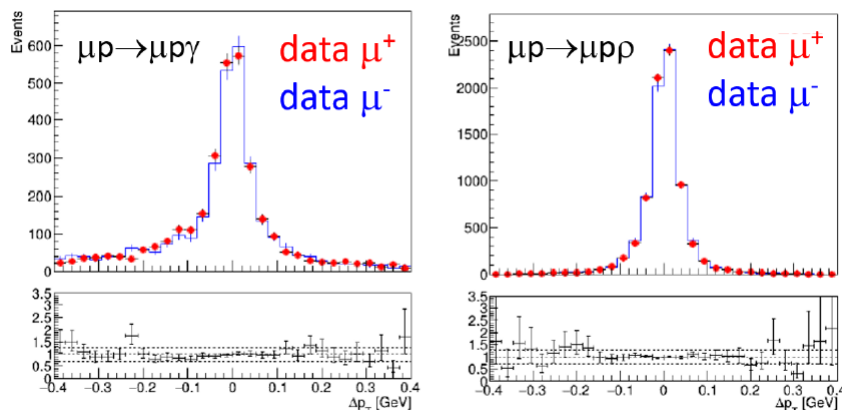


COMPASS 2016-2017 data

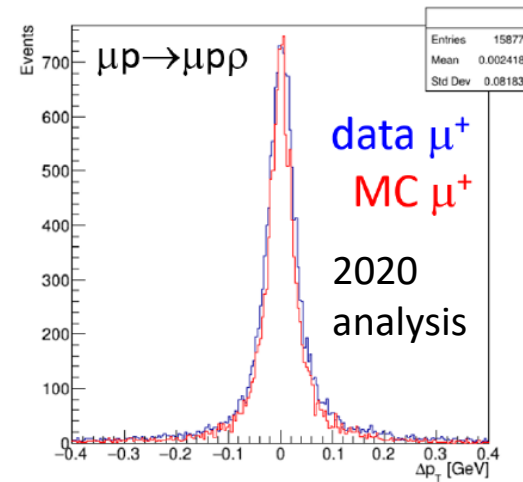
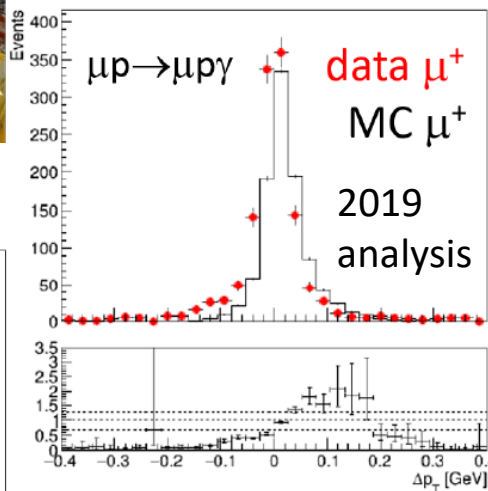
$$\Delta P_T = |P_T^{CAMERA}| - |P_T^{spectro}|$$

Comparison μ^+ data and MC

Comparison μ^+ and μ^- data



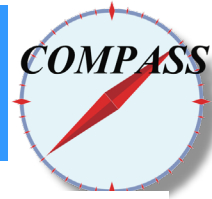
μ^- distributions normalized to the μ^+ luminosity
good agreement between μ^- and μ^+ distributions



MC: TGEANT with HEPGEN++ generators. Improvement of calibration of the ToF recoil proton detector CAMERA.



Drell-Yan and charmonium data analyses



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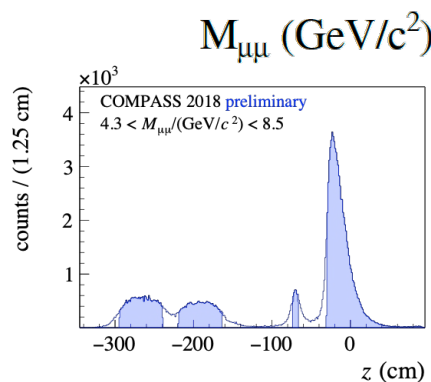
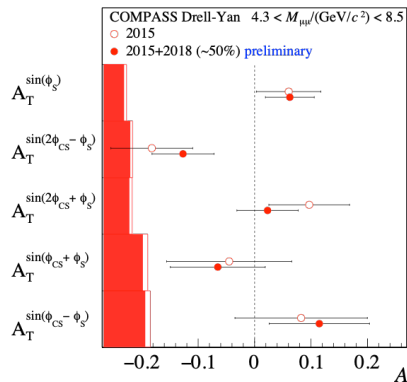
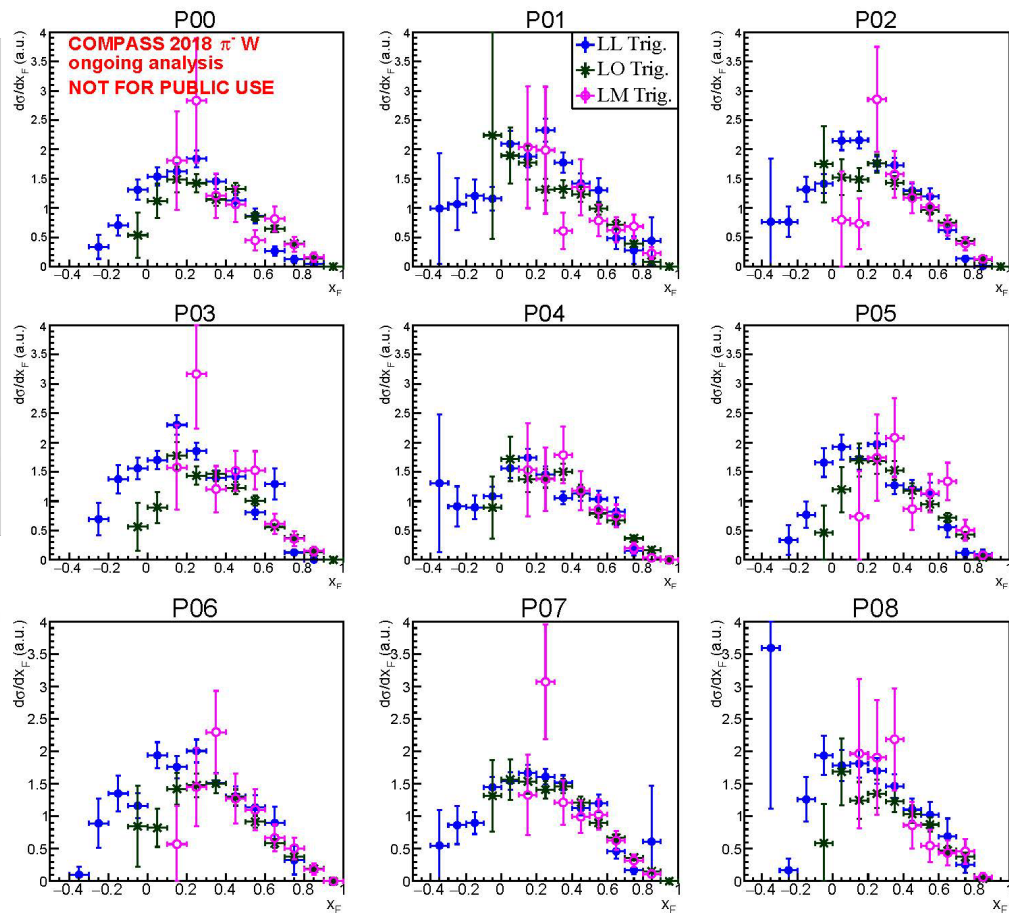
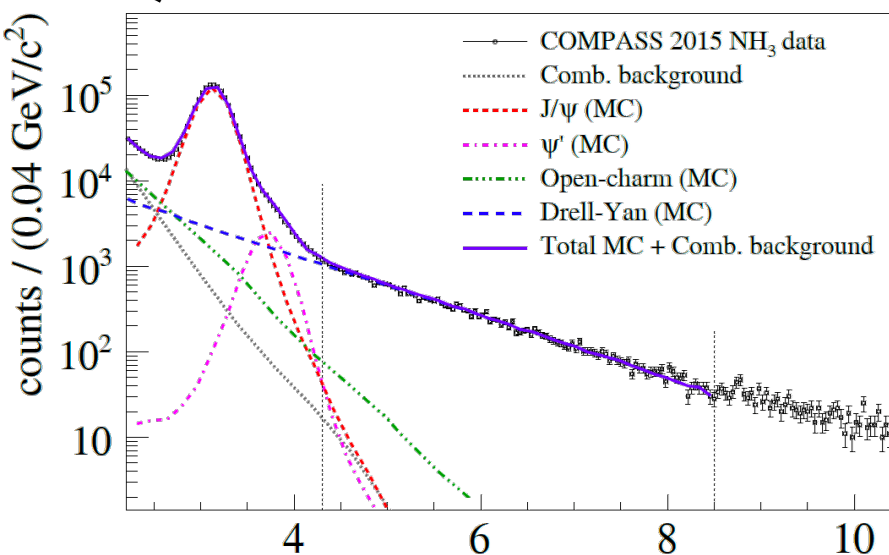
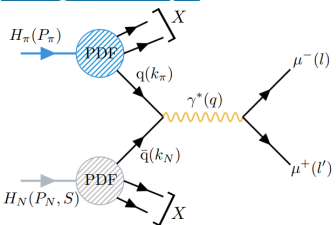
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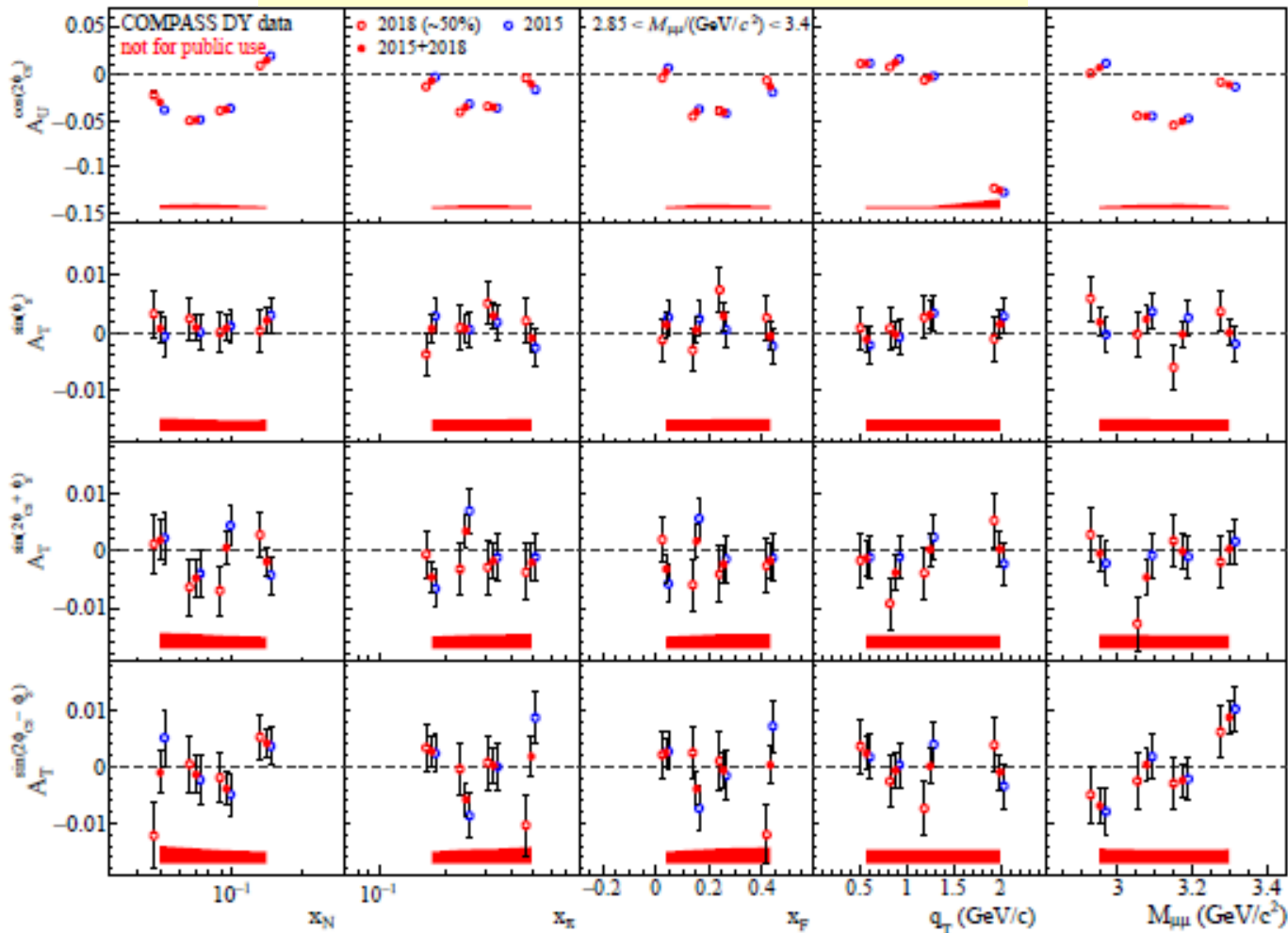
2018 Drell-Yan event distributions in x_F for W



25 weeks data taking (May – November), PT reversal: \sim once/week \rightarrow 9 periods of 2-3 weeks
 1.8 PB of data. Production campaign at Blue Waters supercomputer system (NCSA, USA).
 Challenge: control of systematics. Sophisticated procedures to equalize the acceptance conditions between the subperiods of opposite polarisation within a period.

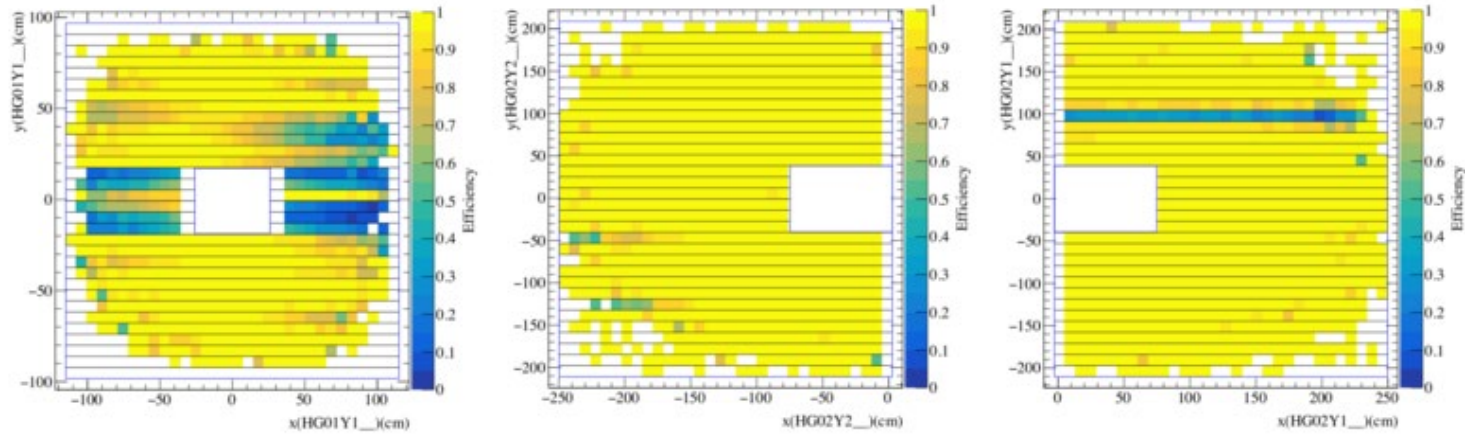


COMPASS 2015 + 50% 2018 data



contribution to J/ψ production mechanism study: $q\bar{q}$ (PLB 770 (2019) 302) unfavored
could provide bound to gluon Sivvers function

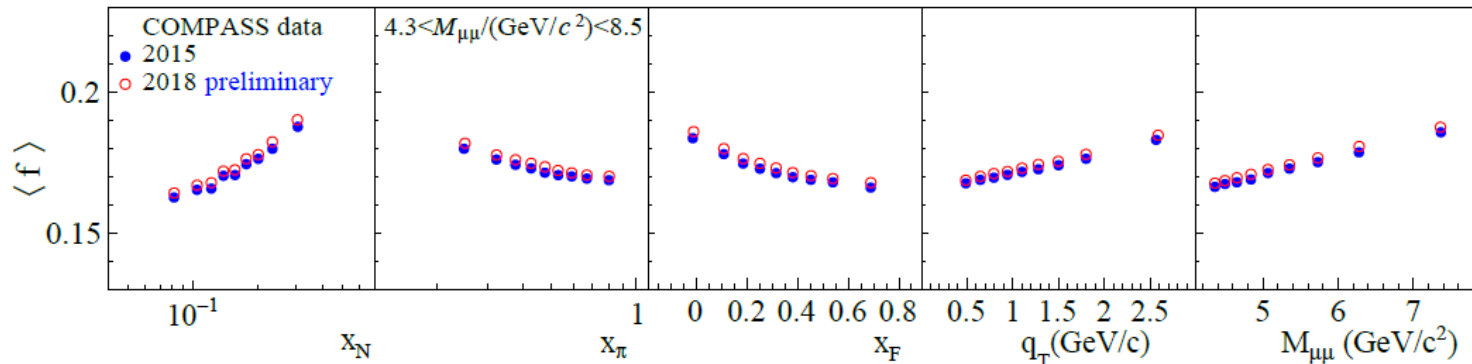
Trigger hodoscopes inefficiencies studied using a “calorimeter trigger”



Large statistics → Bidimensional detailed maps of the measured efficiencies for each period.
 2D eff. maps used for simulation and analysis of the data → improved data – MC comparison.

$$f = \frac{n_H \sigma_{\pi^-H}^{DY}}{n_H \sigma_{\pi^-H}^{DY} + \sum_A n_A \sigma_{\pi^-A}^{DY}}$$

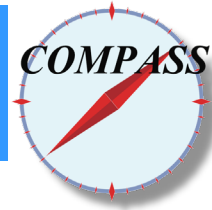
kinematic dependence studied using MCFM (NNLO);
 pdf nuclear effects from nCTEQ15



contributes with 8% to the systematic error



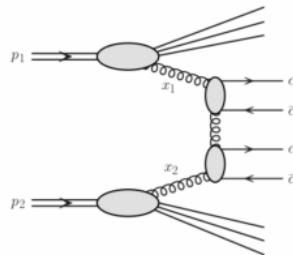
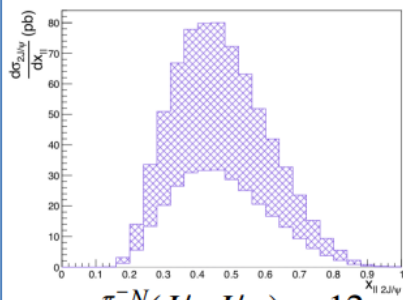
Double J/ψ production cross-section



Observed by NA3 ~40 y ago.

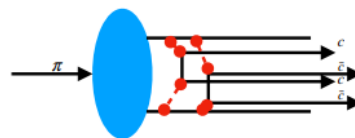
Phys. Lett. 120B (1983) 237

Single Parton Scattering



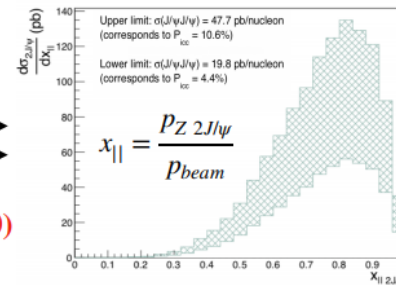
$$\sigma_{SPS}^{\pi^- N}(J/\psi J/\psi) \approx 12 - 29 \text{ pb/nucleon}$$

Intrinsic charm of pion (S.Brodsky) ($|d\bar{u}c\bar{c}c\bar{c}\rangle$ Fock component)

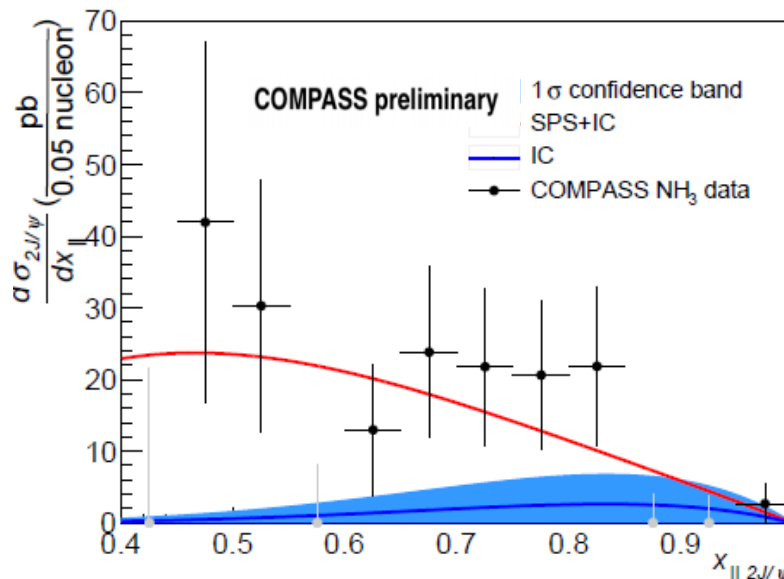
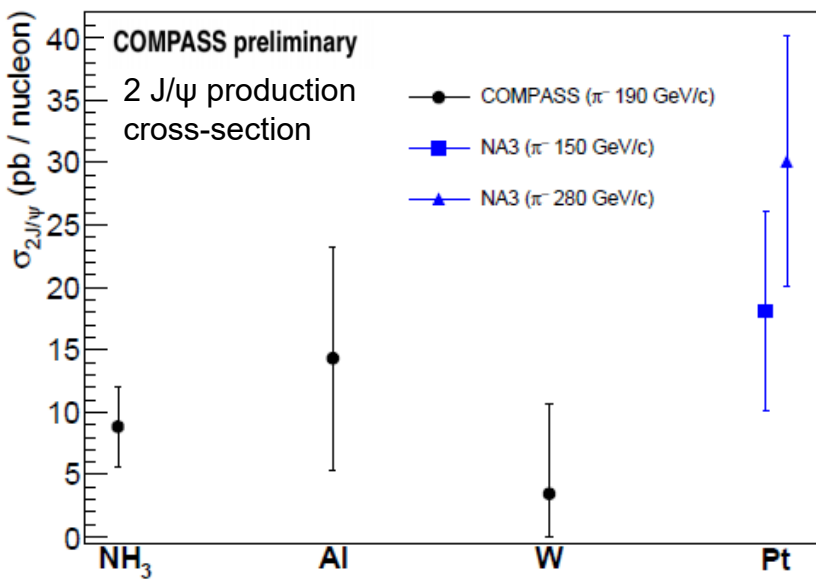


Phys. Lett. B 93, 451 (1980)

$$\sigma_{IC}^{\pi^- N}(J/\psi J/\psi) \approx 19.8 - 47.7 \text{ pb/nucleon}$$



$$x_{||} = \frac{PZ_{2J/\psi}}{P_{beam}}$$



COMPASS preliminary results are in better agreement with SPS than with IC production mechanism

$$x_{||} = \frac{PZ_{2J/\psi}}{P_{beam}}$$

Article in preparation



COMPASS main analyses



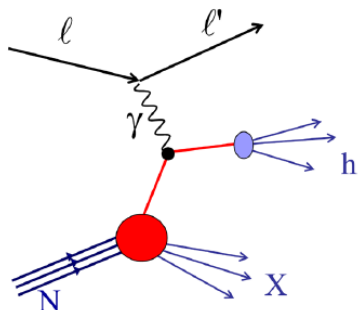
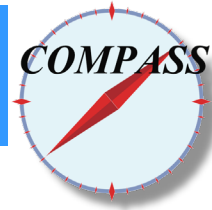
Channel	Status	Details
Hadron data		
Measurement of chiral anomaly in $\pi^- \gamma \rightarrow \pi^- \pi^0$	update	study of systematic effects
Measurement of chiral dynamics in $\pi^- \gamma \rightarrow \pi^- \pi^0$	update	study of systematic effects
Triangle singularity as the origin of the $a_1(1420)$ in $\pi^- p \rightarrow \pi^- \pi^- \pi^+ p$	final	will be submitted to PRL PRD method paper in drafting stage
Study of excited kaons in $K^- p \rightarrow K^- \pi^- \pi^+ p$	update	preliminary results from PWA
Study of non-resonant processes in $\pi^- p \rightarrow \pi^- \eta^{(\prime)} p$	update	fit of double-Regge models at large $m_{\eta^{(\prime)}\pi}$ improvements of data sample and MC
Study of non-resonant processes in $\pi^- p \rightarrow \pi^- \pi^- \pi^+ p$	new	fit of multi-Regge models at large $m_{3\pi}$ improvements of data sample and MC
Exclusive reactions with 2012 data		
DVCS cross section and t -slope	final	PLB 793 (2019) 188-194
π^0 cross section t and ϕ dependence	final	PLB 805 (10 June 2020) 135454
SDME for exclusive ω	final	paper almost finished
SDME for exclusive ρ	almost final	paper to be written
SDME for exclusive ϕ	ongoing	analysis done but not cross checked
Exclusive reactions with 2016-17 data		
DVCS cross section and t -slope	new	ongoing
π^0 cross section t and ϕ dependence	new	ongoing
J/ψ cross section	new	ongoing
Multiplicities		
p/p and K^-/K^+ multiplicity ratio	final	2006 data, submitted to PLB
pion and kaon multiplicities	ongoing	2016/17 data
p/p and K^-/K^+ multiplicity ratio	new	2016/17 data

Transverse spin and TMD analyses

Other P_T -weighted transverse spin asymmetries (SIDIS 2010 data)	new	ongoing
MultiD analysis of transverse spin asymmetries (SIDIS 2010 data)	update	ongoing
Measurement of g_2^p (SIDIS 2010 data)	update	ongoing
TMD transverse and longitudinal spin asymmetries (SIDIS 2007, 2010, 2011 data)	update	paper being written
Transversity induced $\Lambda/\bar{\Lambda}$ polarisation (SIDIS 2010 data)	final	paper being written
Exclusive processes contribution to azimuthal asymmetries in SIDIS on unpolarised deuteron	final	NPB 956 (2020) 115039
Azimuthal asymmetries in SIDIS on unpolarised proton data (2016/17)	update	ongoing
P_T distributions in SIDIS on unpolarised proton data (2016/17)	update	ongoing
Drell-Yan and Charmonium analyses		
Drell-Yan transverse spin asymmetries in 2018 data	ongoing	data being processed
Transverse spin asymmetries in J/ψ mass range	ongoing	
Double J/ψ production cross section	final	paper being written
Drell-Yan cross section and nuclear dependent effects	ongoing	being cross-checked
Drell-Yan and Charmonium angular dependence	ongoing	systematics study
Drell-Yan and Charmonium left-right spin asymmetries	ongoing	
Neural network methods for Drell-Yan process selection	new	ongoing
Beam particle identification analysis	new	ongoing

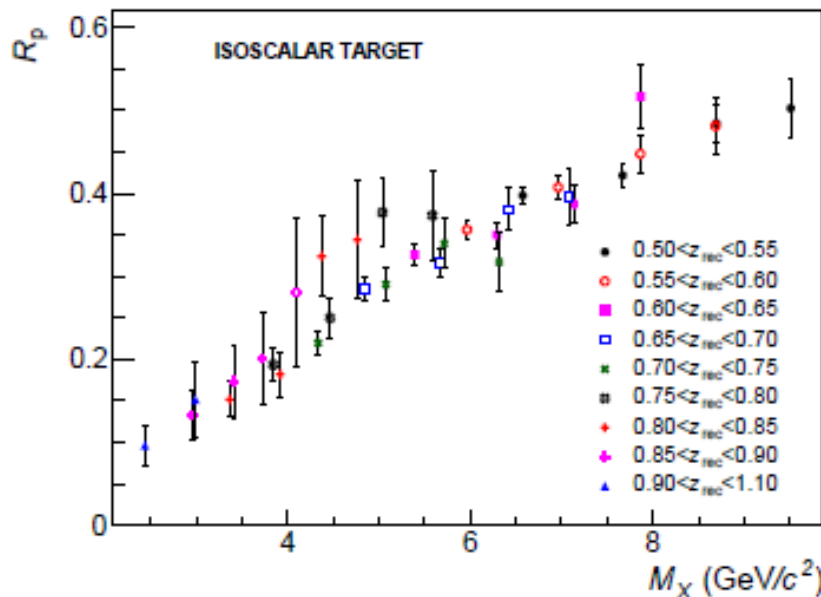
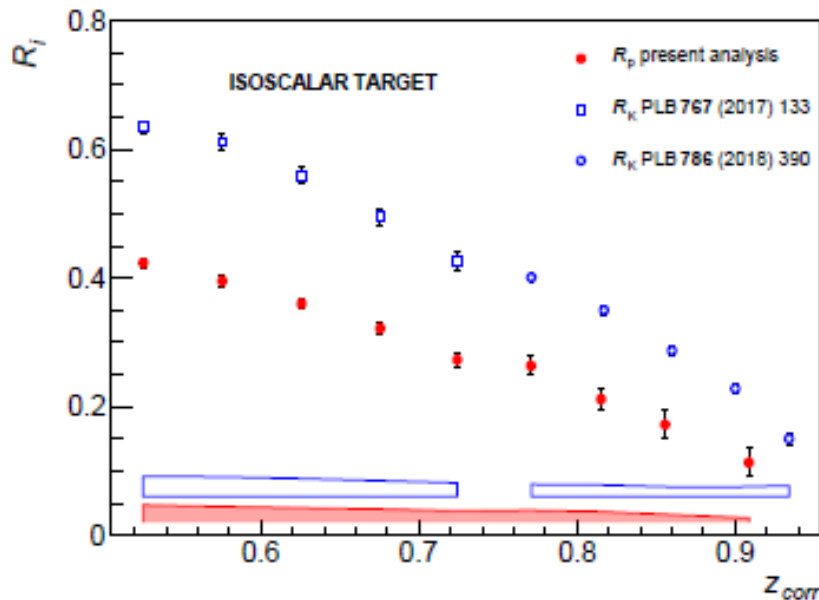


SIDIS hadron multiplicity ratios at high z



$$\frac{dN^h}{dN^{\text{DIS}}} \propto \sum_q e_q^2 q D_q^h$$

K^- over K^+ multiplicity ratios published: PLB 786 (2018) 390



p -bar over p below prediction over the full z range

Proton ratios paper: CERN-EP/2020-041, accepted by PLB

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Drell-Yan and Charmonium left-right spin asymmetries	ongoing	
Neural network methods for Drell-Yan process selection	new	ongoing
Beam particle identification analysis	new	ongoing

14 independent azimuthal modulations: all measured by COMPASS

$$\frac{d\sigma}{dx dy d\psi dz d\phi_h dP_{h\perp}^2} =$$

$$\frac{\alpha^2}{xyQ^2} \frac{y^2}{2(1-\varepsilon)} \left(1 + \frac{\gamma^2}{2x}\right) \left\{ F_{UU,T} + \varepsilon F_{UU,L} + \sqrt{2\varepsilon(1+\varepsilon)} \cos\phi_h F_{UU}^{\cos\phi_h} \right.$$

$$+ \varepsilon \cos(2\phi_h) F_{UU}^{\cos 2\phi_h} + \lambda_e \sqrt{2\varepsilon(1-\varepsilon)} \sin\phi_h F_{LU}^{\sin\phi_h}$$

$$+ S_{\parallel} \left[\sqrt{2\varepsilon(1+\varepsilon)} \sin\phi_h F_{UL}^{\sin\phi_h} + \varepsilon \sin(2\phi_h) F_{UL}^{\sin 2\phi_h} \right] + S_{\parallel} \lambda_e \left[\sqrt{1-\varepsilon^2} F_{LL} + \sqrt{2\varepsilon(1-\varepsilon)} \cos\phi_h F_{LL}^{\cos\phi_h} \right]$$

$$+ |S_{\perp}| \left[\frac{f_{1T}^{\perp} D_1}{\sin(\phi_h - \phi_S)} \left(F_{UT,T}^{\sin(\phi_h - \phi_S)} + \varepsilon F_{UT,L}^{\sin(\phi_h - \phi_S)} \right) \right.$$

$$+ \varepsilon \frac{h_{1T}^{\perp} H_1^{\perp}}{\sin(\phi_h + \phi_S)} F_{UT}^{\sin(\phi_h + \phi_S)} + \varepsilon \frac{h_{1T}^{\perp} H_1^{\perp}}{\sin(3\phi_h - \phi_S)} F_{UT}^{\sin(3\phi_h - \phi_S)}$$

$$\left. + \sqrt{2\varepsilon(1+\varepsilon)} \sin\phi_S h_{1T}^{\perp} F_{UT}^{\sin\phi_S} + \sqrt{2\varepsilon(1+\varepsilon)} \sin(2\phi_h - \phi_S) F_{UT}^{\sin(2\phi_h - \phi_S)} \right]$$

$$+ |S_{\perp}| \lambda_e \left[\sqrt{1-\varepsilon^2} \frac{g_{1T} D_1}{\cos(\phi_h - \phi_S)} F_{LT}^{\cos(\phi_h - \phi_S)} + \sqrt{2\varepsilon(1-\varepsilon)} \cos\phi_S F_{LT}^{\cos\phi_S} \right.$$

$$\left. + \sqrt{2\varepsilon(1-\varepsilon)} \cos(2\phi_h - \phi_S) F_{LT}^{\cos(2\phi_h - \phi_S)} \right\},$$

nucleon polarisation

	U	L	T
U	f_1		f_{1T}^{\perp}
L		g_1	g_{1T}
T	h_1^{\perp}	h_{1L}^{\perp}	$h_1 h_{1T}^{\perp}$

quark polarisation

Collins and Sivers asymmetries published since several years

PRL 94 (2005) 202002, NP B765 (2007) 31, PLB 673 (2009) 127, PLB 692 (2010) 240, PLB 713 (2012) 10, PLB 717 (2012) 376, PLB 717 (2012) 383, PLB 744 (2015) 250, PLB 753 (2016) 406, PBL 770 (2017) 138, PLB 772 (2017) 854



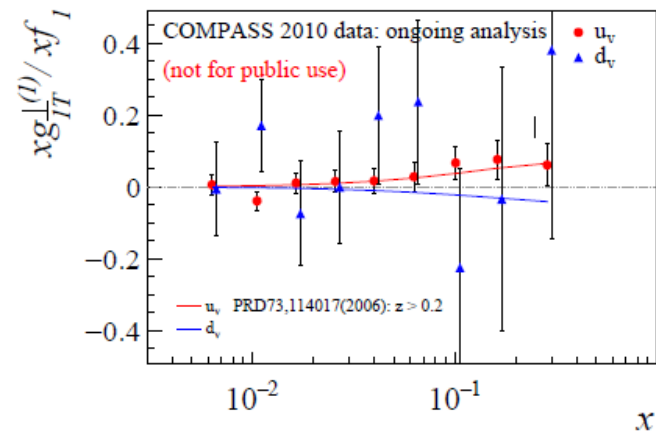
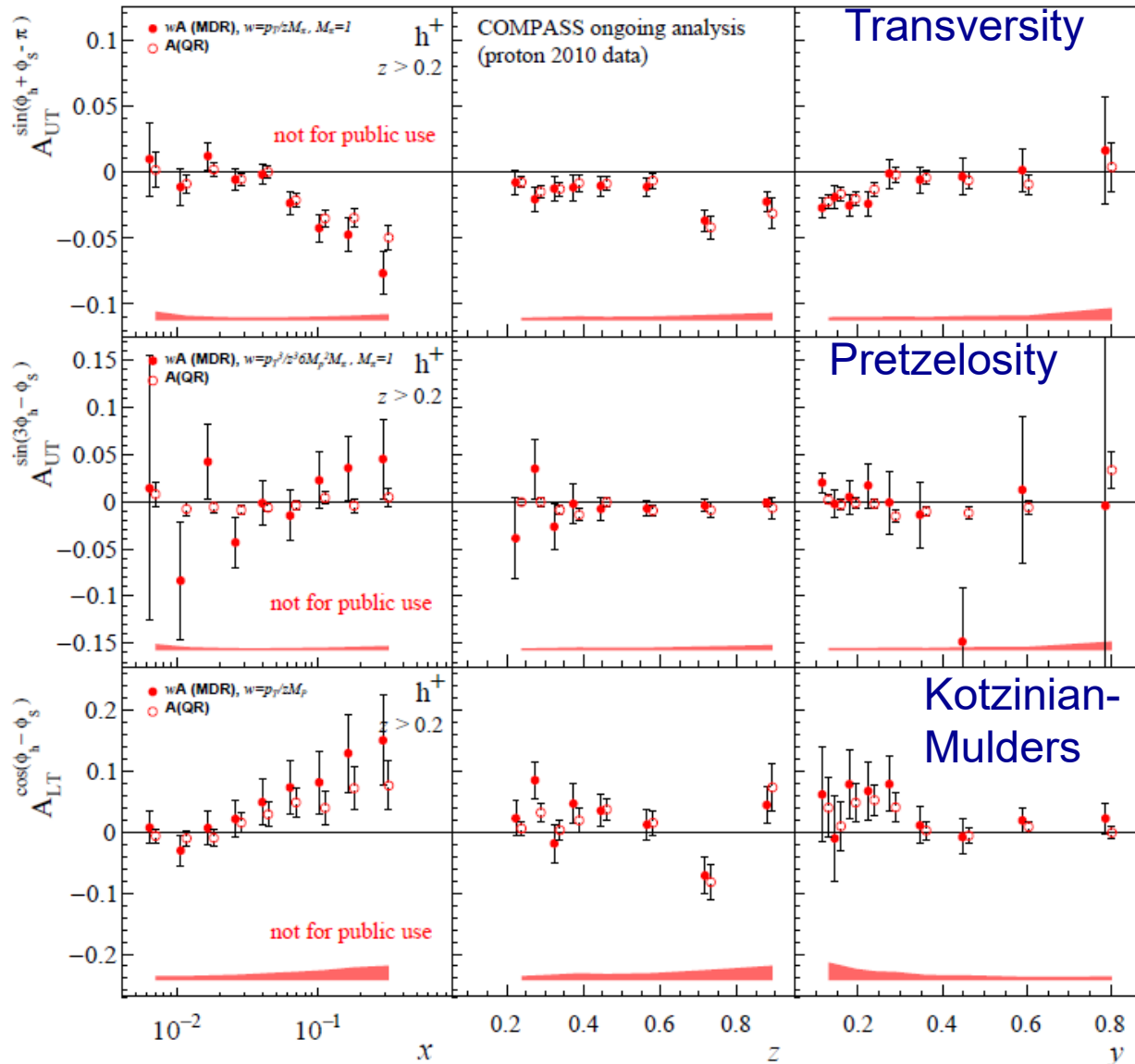
p_T weighted transverse spin asymmetries



Asymmetries obtained by weighting the spin-dependent part of the cross-section with powers of p^h_T .

- allow simpler extraction of moments of pdfs.
- Sivers: published.
- Collins and Kotzinian-Mulders: $\neq 0$ at large x

Sivers already published: NPB 940 (2019) 34





Transversity induced Λ and $\bar{\Lambda}$ polarisation

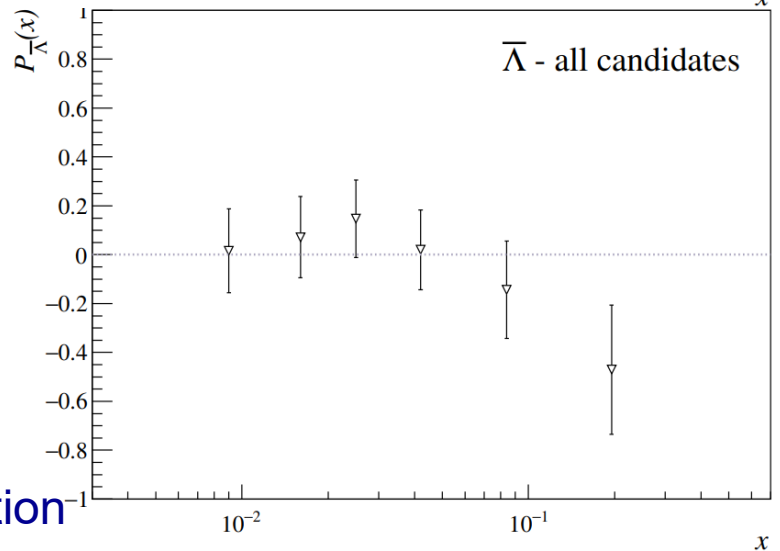
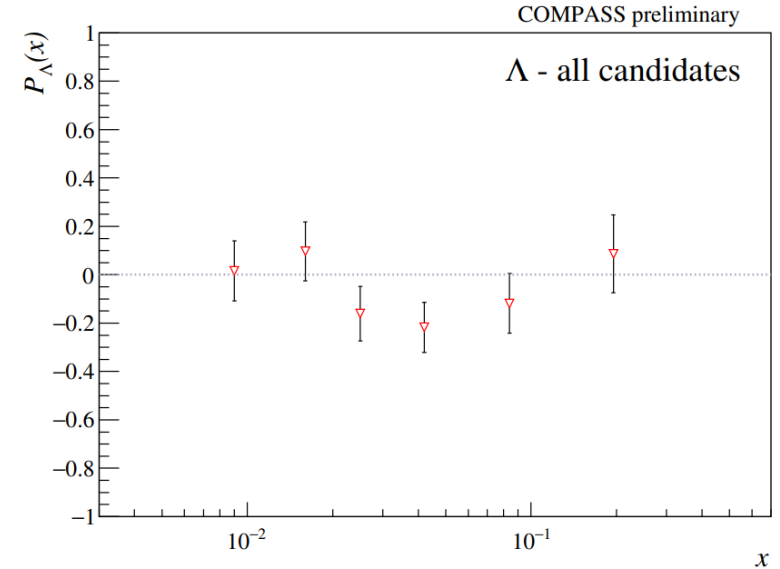
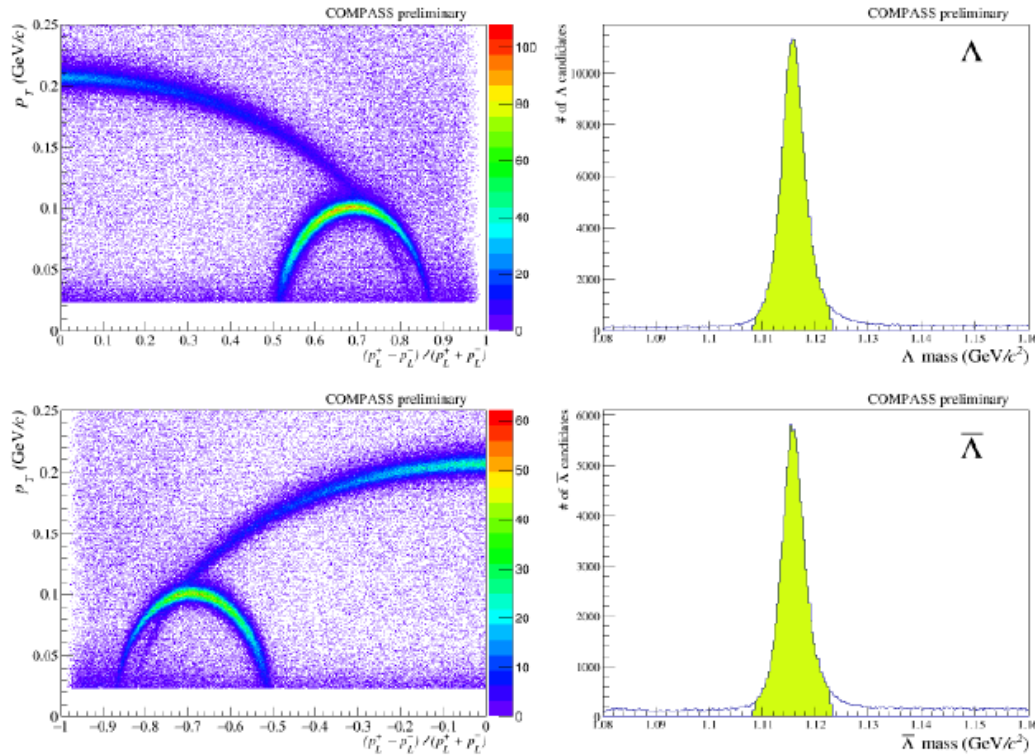


measured for the first time

Polarisation of fragmenting quark (transversity)

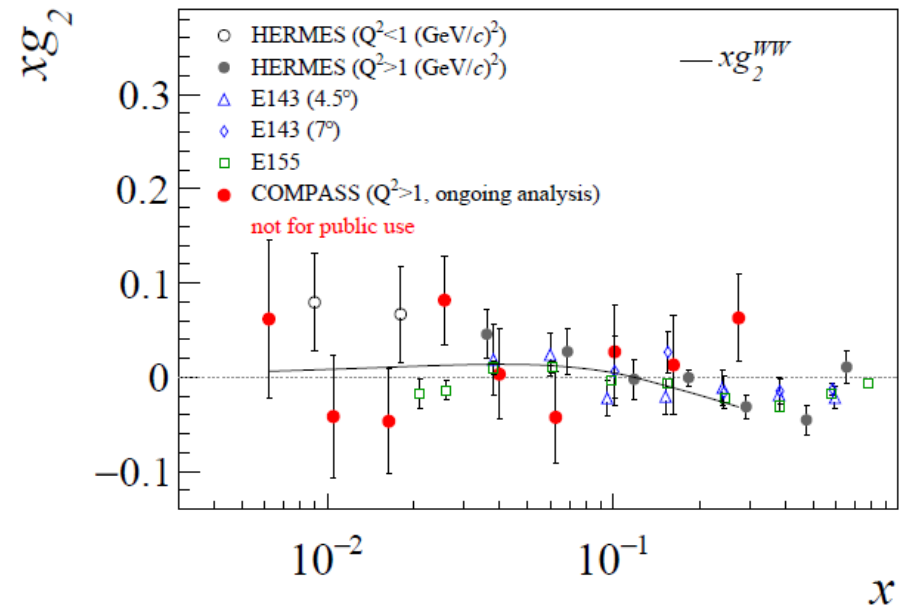
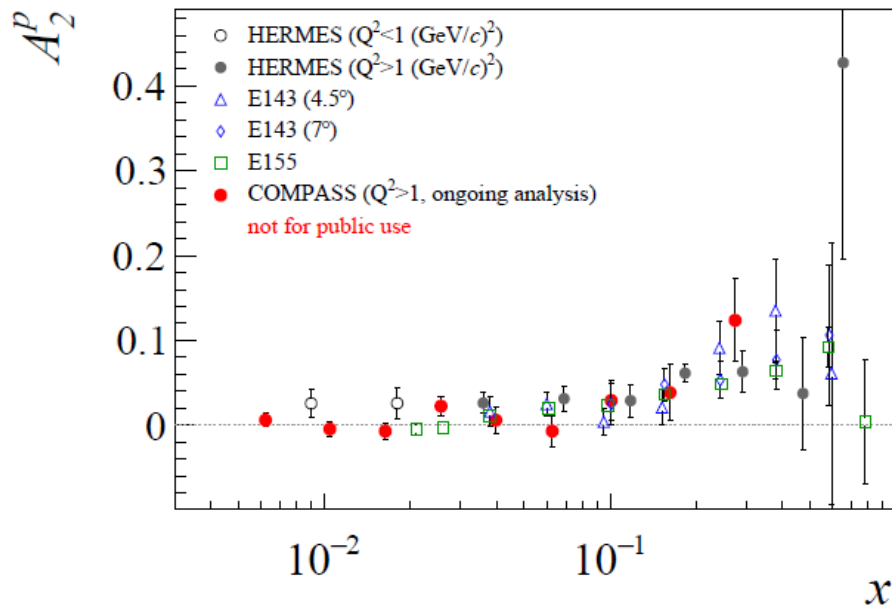
$\rightarrow \Lambda$ polarisation via the FF $H_1^{\Lambda/q}$

$\Lambda \rightarrow p\pi^-$ self-analysing: angular asymmetry of the decay p

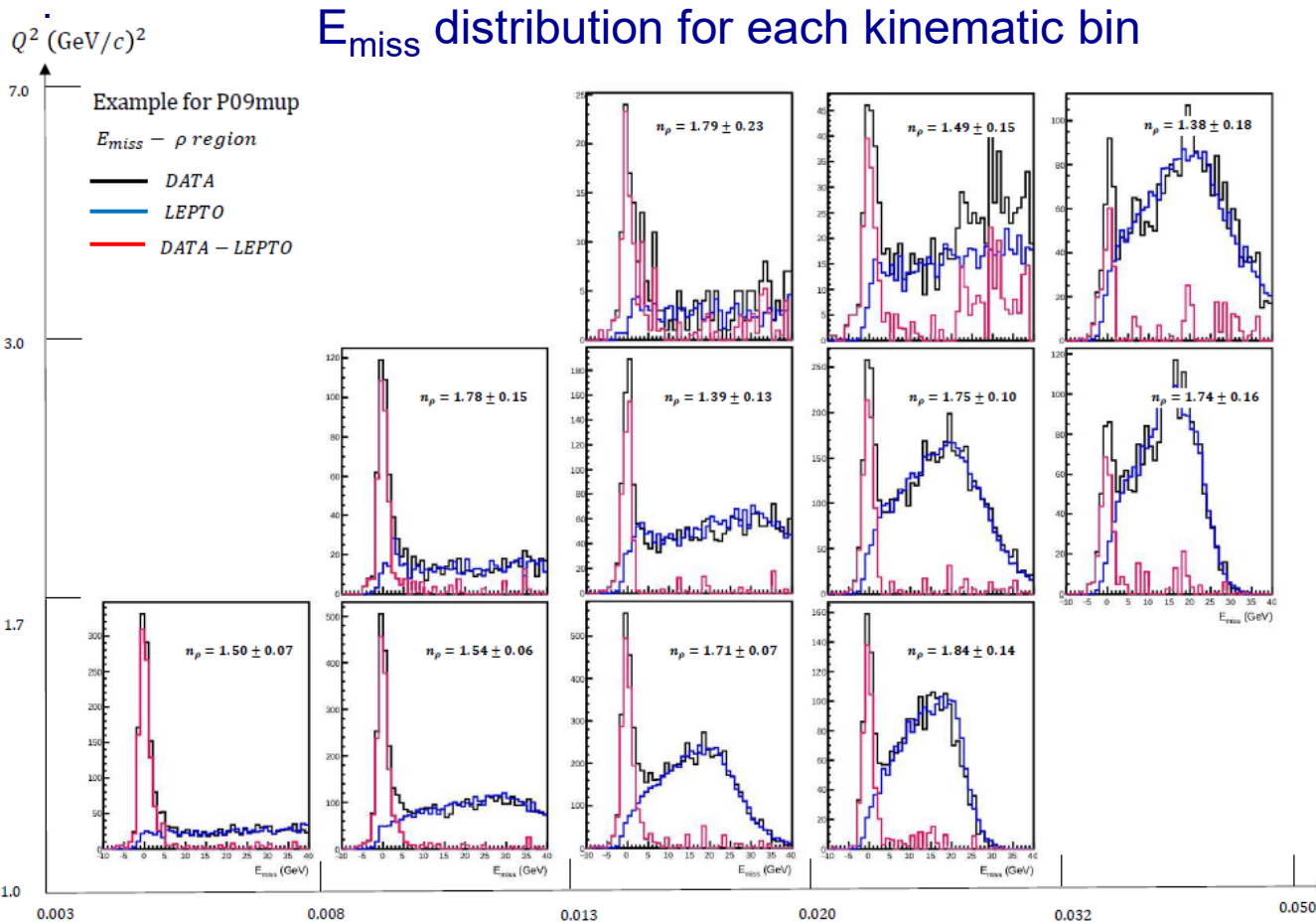


paper almost ready for circulation in the Collaboration

The spin dependent structure function g_2 is studied in both DIS ($Q^2 > 1 \text{ GeV}^2/c^2$) and low Q^2 regions. COMPASS results are unique in the low x range



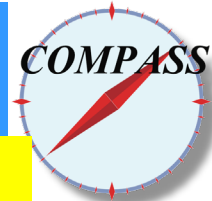
Exclusive hadrons, produced by the decay of exclusive mesons contaminate the SIDIS sample. They exhibit large azimuthal modulations which bias the results of the measured azimuthal asymmetries [NPB956(2020)115039]



2016/17 data analysis:
new subtraction strategy

- does not rely on the knowledge of cross sections
- the contribution of exclusive hadrons is subtracted from the measured azimuthal distributions before correcting them for the acceptance and fitting them to extract the amplitudes

→ better control of systematics.



Published in 2018 - 2019

- Search for muoproduction of $X(3872)$ at COMPASS and indication of a new state $\tilde{X}(3872)$ **PLB 783 (2018) 334**
- New analysis of DR tensor resonances measured at the COMPASS experiment **PLB 779 (2018) 464**
- Transverse-momentum-dependent multiplicities of charged hadrons in muondeuteron deep inelastic scattering **PRD 97 (2018) 032006**
- Longitudinal double-spin asymmetry A_1^p and spin dependent structure function g_1^p of the proton at small values of x and Q^2 **PLB 781 (2018) 464**
- Azimuthal asymmetries of charged hadrons produced in high-energy muon scattering off longitudinally polarised deuterons **EPJC78 (2018) 952**
- K^- over K^+ multiplicity ratio for kaons produced in DIS with a large fraction of the virtual-photon energy **PLB 786 (2018) 390**
- Transverse extension of partons in the proton probed by deeply virtual compton scattering **PLB 793 (2019) 188**
- Light isovector resonances in $\pi^- p \rightarrow \pi^- \pi^- \pi^+ p$ at 190 GeV/c. **PRD 98 (2018) 092003**
- Measurement of P_T -weighted Sivers asymmetries in leptonproduction of hadrons. **NPB 940 (2019) 34**

Published in 2020 or ongoing

- Measurement of the cross section for hard exclusive π^0 leptonproduction. **PLB 805 (2020) 135454**
- Exclusive processes contribution to the measured SIDIS azimuthal asymmetries. **NPB 956 (2020) 115039**
- Antiproton over proton and K^- over K^+ multiplicity ratios at high z in DIS. **Accepted by PLB CERN-EP/2020-041**
- A Triangle Singularity as the origin of the $a_1(1420)$. **Ready for submission to PRL**
- Transversity and Lambda polarization in polarized SIDIS
- Study of double J/ψ production
- Target transverse-polarization-dependent azimuthal asymmetries in muon-proton SIDIS
- Target longitudinal-polarization-dependent azimuthal asymmetries in muon-proton
- SDMEs in Exclusive omega meson muoproduction at COMPASS .
- Measurement of q_T -weighted transverse-spin-dependent azimuthal asymmetries in the Drell-Yan process.
- Properties of the exotic meson $\pi_1(1600)$ with $J^{PC}=1^{-+}$ and its decay into $\rho(770)\pi$
- Multidimensional transverse-polarization-dependent azimuthal asymmetries in muon-proton SIDIS



Run 2021: SIDIS on transv. pol. deuterons



Approved by SPSC and RB in 2018

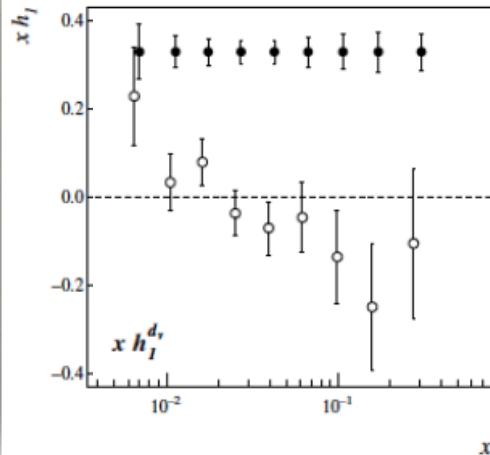
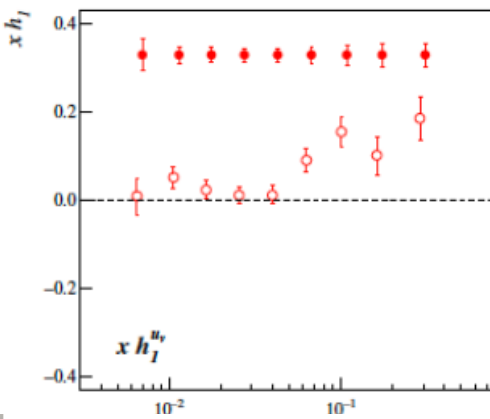
150 days of good μ beam (in 2021)

important for the evaluation of the nucleon tensor charge

estimated impact of the 2021 run on the tensor charge:

$\Omega_x: 0.008 \div 0.210$

	$\delta_u = \int_{\Omega_x} dx h_1^{uv}(x)$	$\delta_d = \int_{\Omega_x} dx h_1^d(x)$	$g_T = \delta_u - \delta_d$
present	0.201 ± 0.032	-0.189 ± 0.108	0.390 ± 0.087
projected	0.201 ± 0.019	-0.189 ± 0.040	0.390 ± 0.044

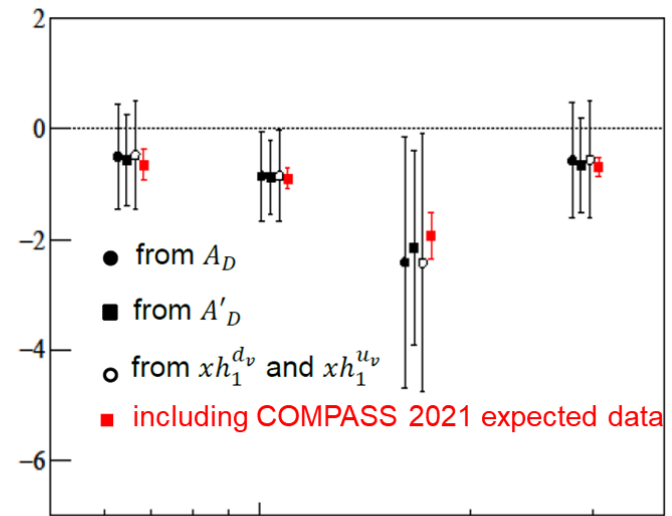


Difference asymmetries including future deuteron results

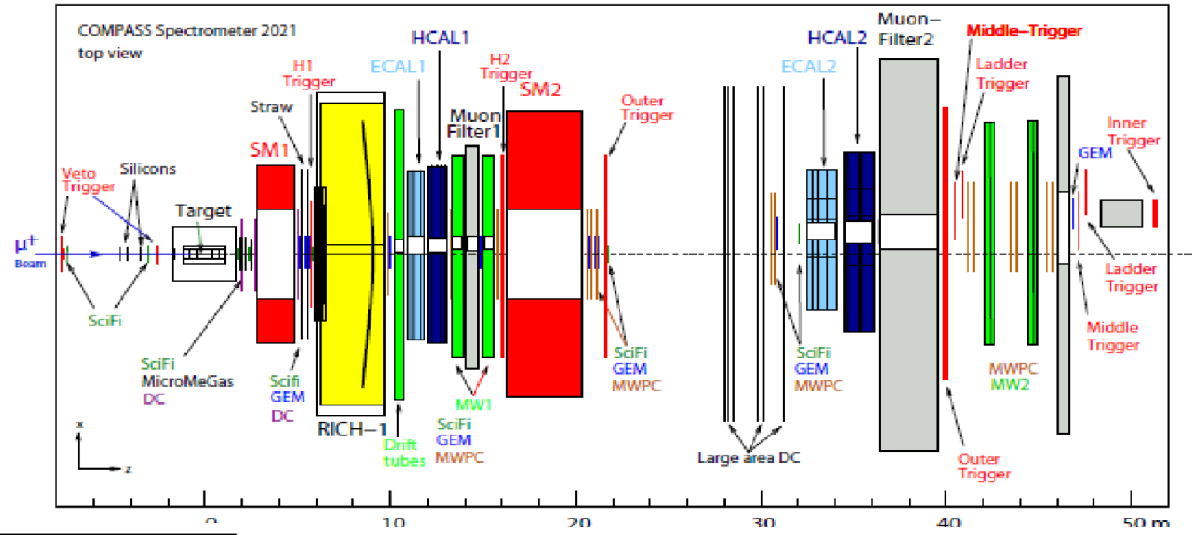
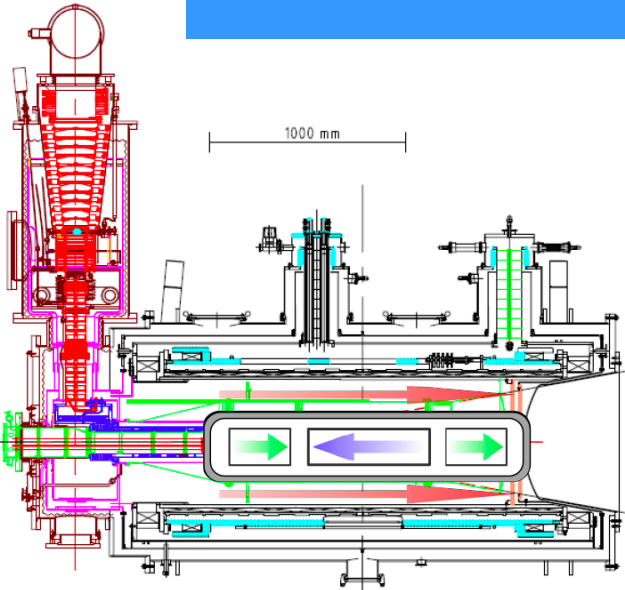
$$A_{D,t} = \frac{\sigma_{C,t}^+ - \sigma_{C,t}^-}{\sigma_{0,t}^+ + \sigma_{0,t}^-} \rightarrow \frac{xh_1^{d_v}}{xh_1^{u_v}}$$

Black points: extraction from published data using two definitions of difference asymmetries;
 Open squares: Ratio of pdfs from standard extraction

A. Martin et al. PRD 91 (2015)



$$\sigma_r = 0.43 \rightarrow \sigma_r = 0.11$$



Detector	Ready	Interventions foreseen before commissioning
BMS	✓	Minimal hardware intervention.
Silicon Trackers	✓	Tracker stations to be remounted, vacuum system to be restarted and nitrogen cooling system to be tested.
Polarised Target	✓	Missing diode gun and vacuum pump, Helium pumps to be maintained, magnet Control Safety System to be restarted and commissioned at room temperature, Polarized target to be commissioned in cold mode, new microwave generator to be tested.
Scintillating Fibres	✓	SciFi stations to be remounted, new threshold loading system to be installed, HV supply system to be replaced.
Trigger and Veto hodoscopes	✓	All hodoscopes ready except H1 to be disassembled and refurbished, new H1 structural support to be installed.
Micromegas	✓	HV and LV PSU to be exchanged.
GEM Trackers	✓	Two complete new station to be produced, mounted and installed, HV PSU to be replaced. All other stations ready
Drift Chambers	✓	DC4 detector assembling to be finalised, transported and re-installed. DC0, DC1 and DC5 ready.
Straw Drift Chambers	✓	Minimal hardware intervention.

Detector	Ready	Interventions foreseen before commissioning
RICH	✓	C_4F_{10} radiator gas to be cleaned; new MWPC HV system to be installed and integrated in the COMPASS DCS. New provider CH_4 purity to be validated. FEE cooling system completion.
RICH-WALL	✓	RICH WALL MDT to be tested and repaired, detector to be re-assembled and reinstalled.
ECAL1-ECAL2	✓	LED monitoring system to be produced and installed for ECAL1.
HCAL1-HCAL2	✓	Detector nearly ready, minimal hardware interventions.
MWPCs	✓	Repair of the damaged detector Mylar windows to be performed, HV PSU to be replaced. New FEE electronic to be installed for one detector.
Muon Walls	✓	HV PSU to be replaced.
W45	✓	HV PSU to be replaced.
DAQ HW	✓	New spare cross-point switch in production, Hardware to be commissioned during dry run.
DAQ SW	✓	New DAQ software and library to be tested and debugged during the dry run
DCS	✓	New HW to be integrated in the DCS system, dedicated DCS tests to be performed.

COMPASS Target area changeover almost complete. PT system platform installed.



The Magnet Safety Control System has been upgraded



New microwave cavity built.



Magnet Control Safety System commissioning plan

SEP	SEP	SEP	SEP	OCT	OCT	OCT	OCT
Precooling with LN2		He cooling	MSS Tests	Sol. Dip. Test	Stability Test	Field Rotat. Test	Warm up

the PT commissioning is a major effort (COMPASS, CRG, EP-DT, CV)

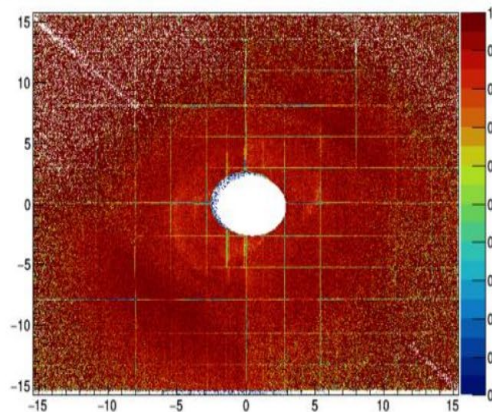
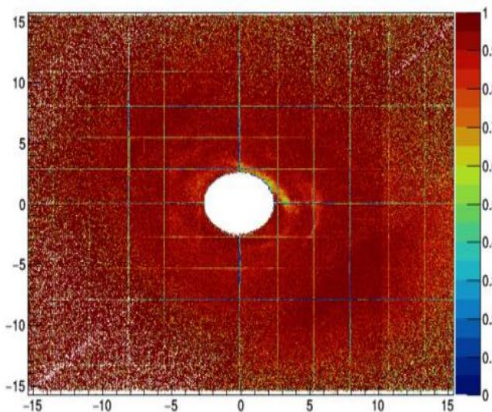
Efficiency maps for GEM 07 in 2015 and 2018

Building of two new detectors

GM07V1__: Efficiency (6σ) = 90.0303 %

2015

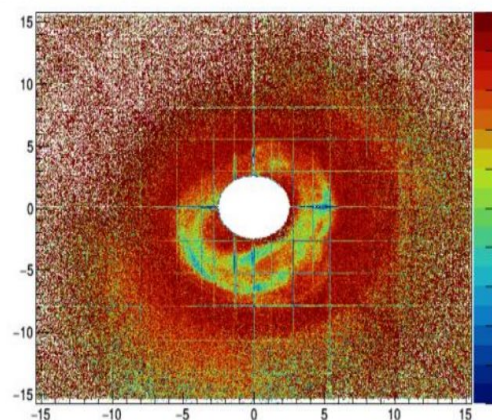
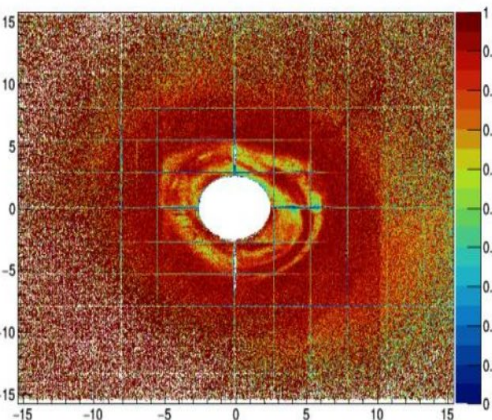
GM08U1__: Efficiency (6σ) = 88.2021 %



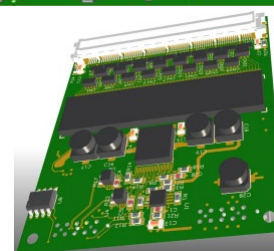
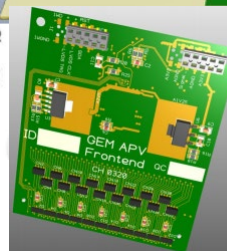
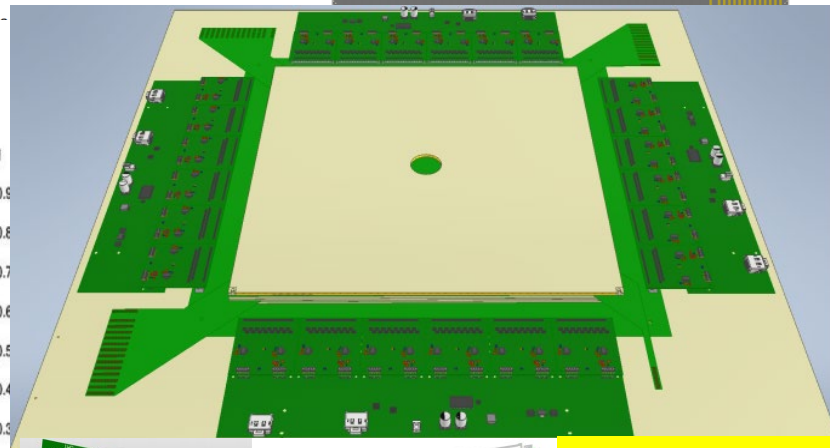
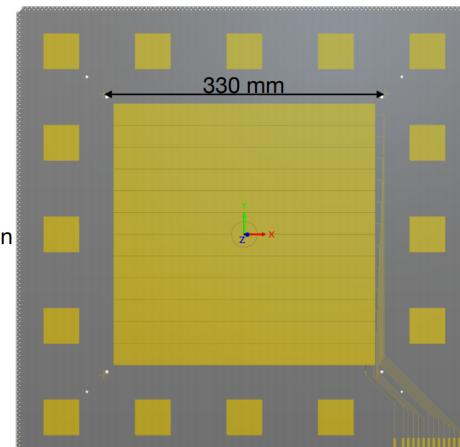
GM07V1__: Efficiency (6σ) = 79.3938 %

2018

GM08U1__: Efficiency (6σ) = 73.7945 %



- Triple GEM stack
- Foils segmented on one side: 12 sectors + centre
- All tracks guided through one corner with coverlay protection
- Foils rotated by 90 degree
- Cu thickness reduced
- Silver connections (Via)



new GEM foils, new mechanics, new readout boards, etc.



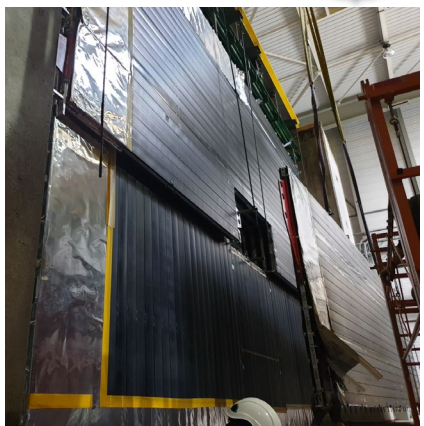
DC4 repair



MWPC repair



RW refurbishing



DC5 repair



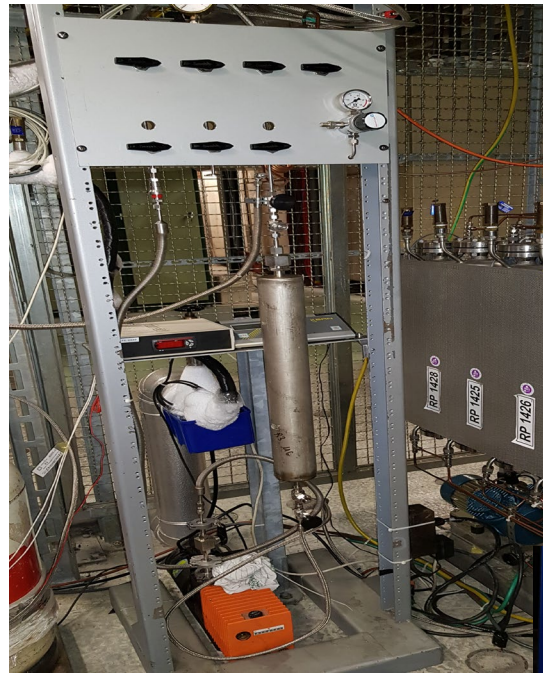
Delays due to Covid-19 outbreak → but it is possible to recover them

H1 scintillator slabs showing signs of deformation

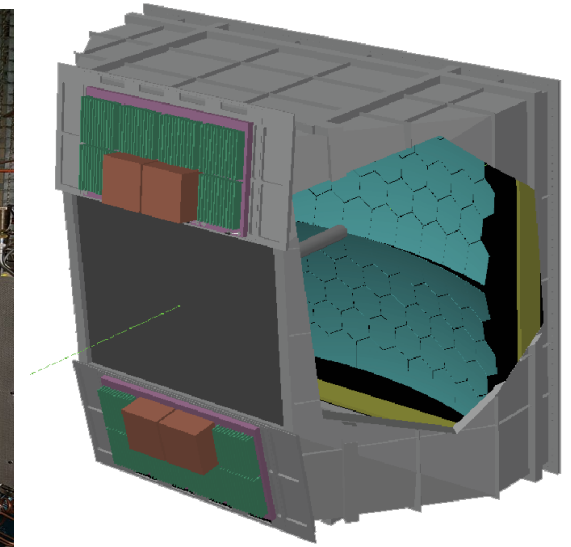


Refurbishing foreseen

RICH maintenance and gas system refurbishing



The missing RICH radiator gas (650 kg C_4F_{10}) has been purchased from F2 Chemicals



It will require long, delicate gas cleaning work

- The COMPASS Experiment is very active on the analysis of the collected data
- Important progress on all research lines: Spectroscopy, GPDs, SIDIS and Drell-Yan
- The Polarised Target and the spectrometer preparations are well advanced
- Despite the delay caused by the Covid-19 outbreak whenever the muon beam will come COMPASS will be ready to use it