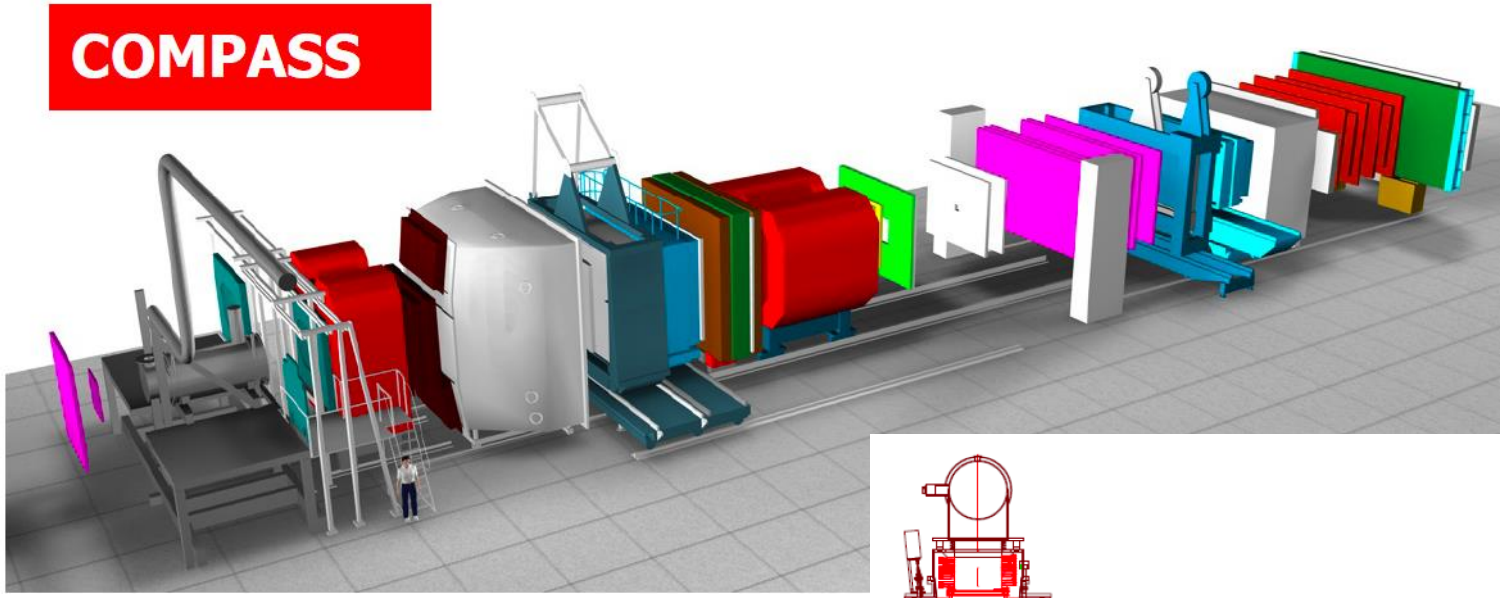
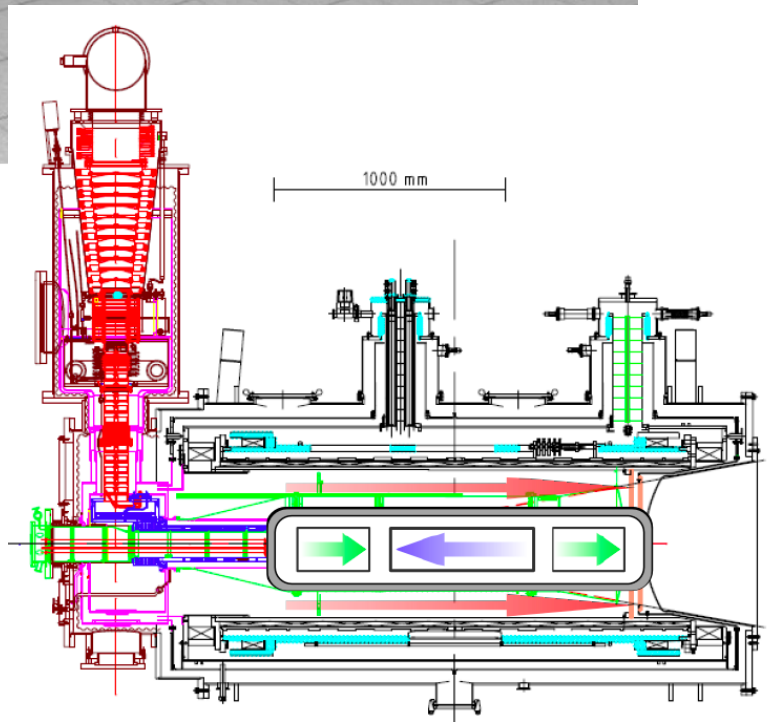
Outline

1. **Fixed target QCD facility**
2. **Beyond 2020 Workshop**
3. **COMPASS short term plan**
   - Short term plan proposal
4. **FixetTargetQcdFacility Long term plan**
   - Preamble
   - Letter of Intent
   - Existing hadron/muon beam
   - RF separated beam
   - Drell-Yan
   - Spectroscopy
   - Prompt Photons
   - Kaon polarizability
5. **Summary**

Materials are provided by: C. Roberts, V. Andrieux, M. Chiosso, C. Riedl, B. Grube, J. Friedrich, A. Guskov….

COMPASS Spectrometer at SPS M2 beam line (CERN)





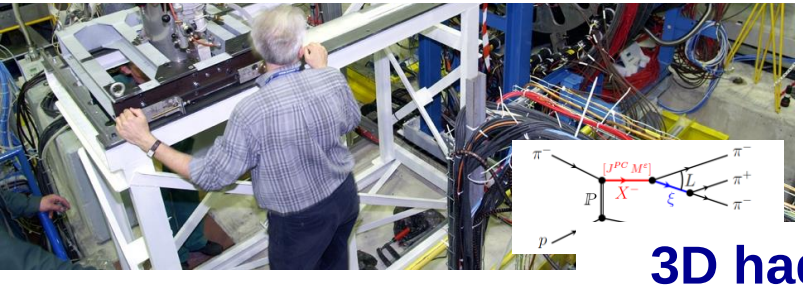
Universal and flexible apparatus.

Most important features of the two-stage COMPASS Spectrometer:

1. Muon, electron or hadron beams with the momentum range 20-250 GeV and intensities up to 10^8 particles per second
2. Solid state polarised targets (NH_3 or ^6LiD) as well as liquid hydrogen target and nuclear targets
3. Advanced tracking (350 planes) and powerful PiD systems (Muon Walls, Calorimeters, RICH), new DAQ

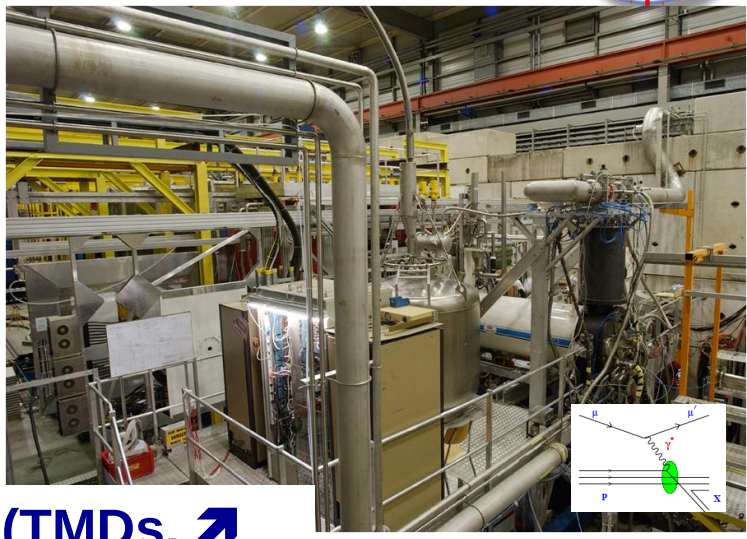
COMPASS QCD facility at SPS M2 beam line (CERN) (secondary hadron and lepton beams)

Exotic state, chiral dynamics



Hadron Spectroscopy &

COMPASS-I
1997-2011

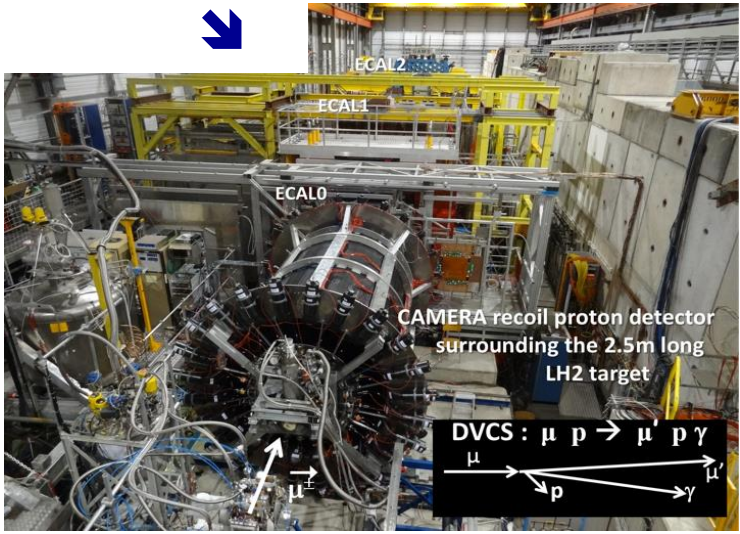


sed SIDIS

3D hadron structure (TMDs, GPDs), spin decomposition

Polarised Drell-Yan

COMPASS-II
2012-2018



DVCS (GPDs) + unp. SIDIS

Beyond 2020 dedicated Workshop

This week – regular annual COMPASS Workshop (IWHSS'16 Kloster Seeon)

COMPASS beyond 2020 Workshop

21 Mar 2016, 08:05 → 22 Mar 2016, 17:10 Europe/Zurich

222-R-001 (CERN)

Description The goal of the workshop is to explore hadron physics opportunities for fixed-target COMPASS-like experiments at CERN beyond 2020 (CERN Long Shutdown 2 2019-2020). The programme comprises

- Reviews of the various physics domains: TMDs, GPDs, FFs, spectroscopy, exotics, tests of ChPT, astrophysics

- Reviews of physics results expected in the next 10 years from major labs around the world

- Good attendance (>100 physicists), large interest
- 11 "outside" review talks – Jefferson Lab, RHIC, Fermilab, KEK (Japan) BEPC II (IHEP, Beijing), NICA (JINR, Dubna), CERN (After, LHCb), GSI (Panda), J-PARC (Japan), EIC – China;
- 7 COMPASS talks (chronol.) – SIDIS, GPDs, Chiral Dynamics, astrophysics (dark matter), Drell-Yan, hadron spectroscopy;
- 2 "round-table"-like discussions on possible future with hadron and muon beams;
- Outcome of the Workshop:
    - RF Separated antiproton/kaon beam would provide a unique opportunity for future fixed target COMPASS-like program at CERN
    - Existing muon and hadron beam allows to enrich current COMPASS program by doing unique or first class measurements of exclusive processes, SIDIS and Drell-Yan

Short term COMPASS future

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN–SPSC–2017–XXX
SPSC-X-XXX
October 2, 2017

d-Quark Transversity

and

Proton Radius

Addendum to the COMPASS-II Proposal

The COMPASS Collaboration
and
PNPI

v2.1 3.10.2017 9:17

034 / SPSC-P-340-ADD-1

Long term FixedTargetQcdFacility future plans

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

November 16, 2017

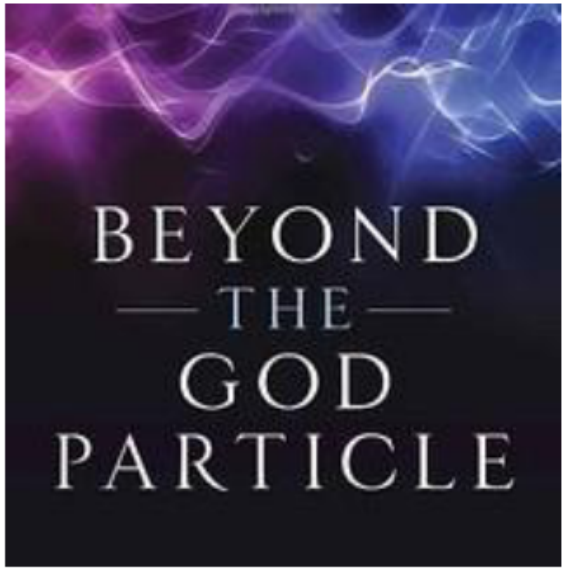
Letter of Intent: Fixed-Target Experiment at M2 Beamline beyond 2020

QCD Preamble

Overture

- LHC has NOT found the "God Particle"
  because the Higgs boson is NOT the origin of mass
  - Higgs-boson only produces a little bit of mass
  - Higgs-generated mass-scales explain neither the proton's mass nor the pion's (*near*-)masslessness
  - Hence LHC has, as yet, taught us very little about
    - Origin Nature Structure

    of the nuclei whose existence support the Cosmos



- Strong interaction sector of the Standard Model, *i.e.* QCD, is the key to understanding the
  origin, existence and properties
  of (almost) all known matter

- Answers are in sight
  - Theoretical tools are reaching point where sound QCD predictions can be made
  - New facilities – in operation or being planned – can validate those predictions

LoI is open for new ideas/proponents

A.) RF separated kaon and anti-proton beam:
- 1. Hadron spectroscopy ✓
- 2. Drell-Yan physics ✓
- 3. Primakoff with kaon beam
- 4. Direct Photons with kaon ✓
- 5. RF separated beam

B.) Standard muon beam:
- 1. DVCS with trans. polarised proton target
- 2. Elastic muon proton scattering ✓

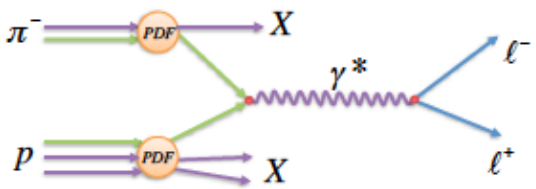
C.) Standard hadron beam:
- 1. Polarised/Unpolarised DY with various targets ✓
- 2. Absolute cross-section measurements p + He -> pbar X ✓
- 3. Hadron spectroscopy with antiprotons

D.) Spectrometer upgrades – hardware

For the moment it is ~50 pages long document

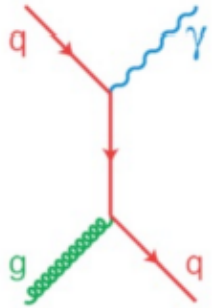
Existing hadron beam
We learned very little so far about meson structure

Drell-Yan:



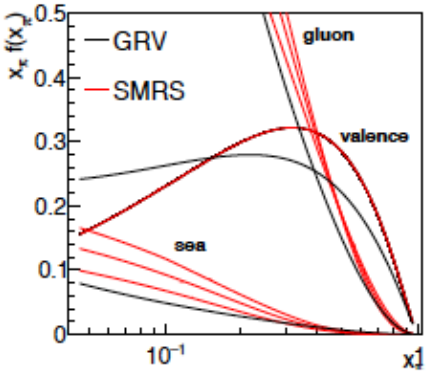
- 90's: NA3, NA10, E615
- 10's: COMPASS-II
- 20's: New Experiment

Prompt photon production:



- 90's NA24, W70
- 20's New experiment

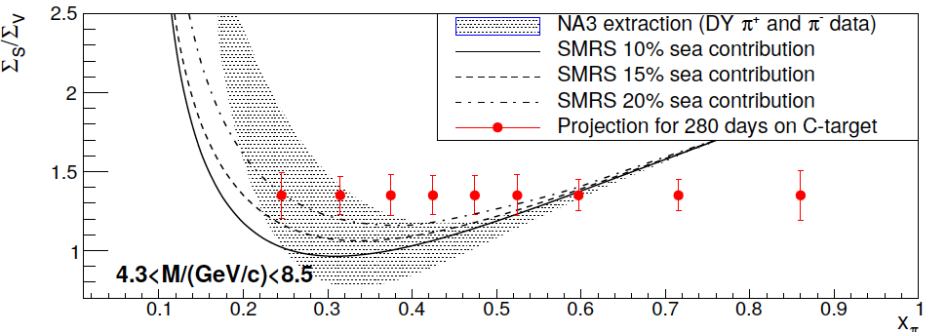
Pion PDFs

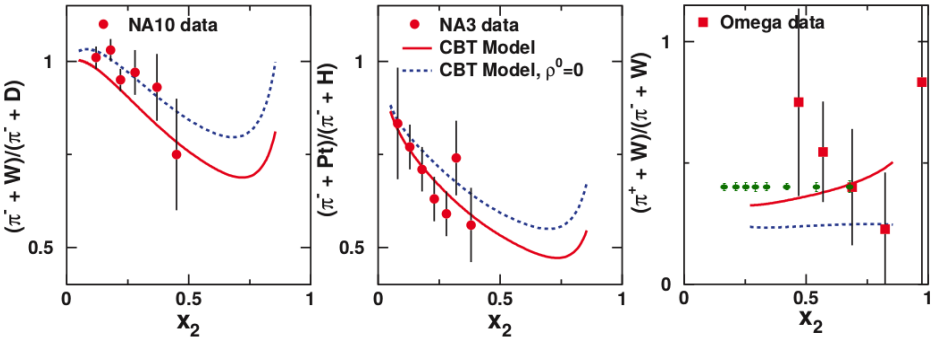


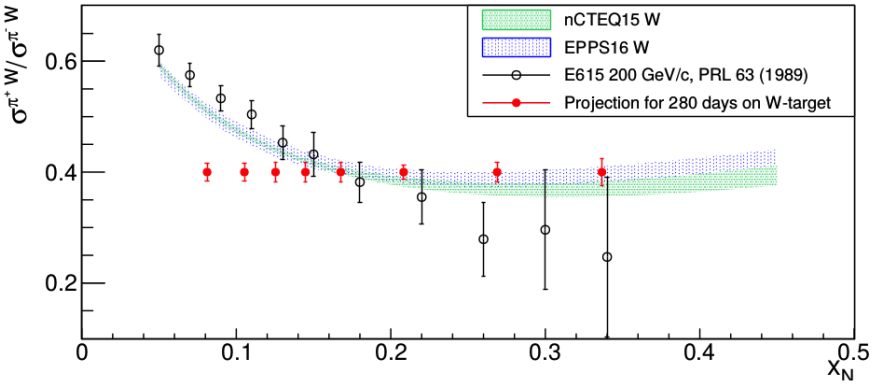
- Valence/sea: Drell-Yan
- Gluons: Prompt photons

Current knowledge on Pion structure is mostly coming from those two processes:
Can we improve? can we extend to the Kaon case?

Existing hadron beam
Drell-Yan

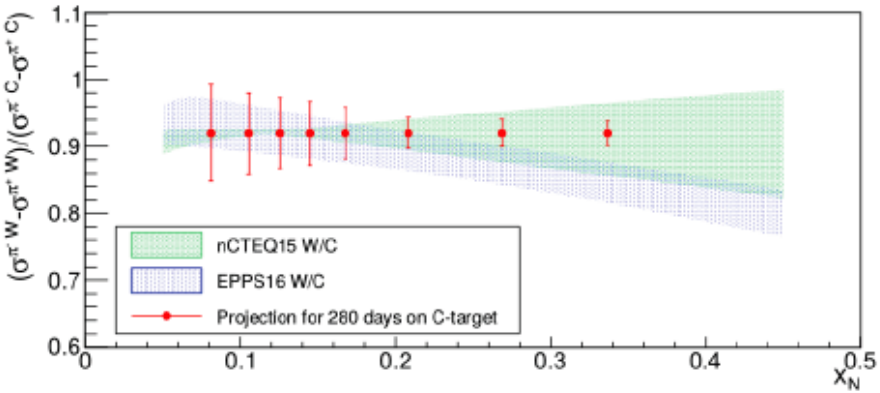






- Statistical uncertainties projections for COMPASS-like experiment (1 or 2 years of running depending on beam intensity: 7×10^7 or 1.4×10^8 /s)
- Time sharing 1:10 h^-/h^+ beam

1. sea/valence ratio in pion
2. EMC effect pion projectile (red - flavour dep.)
3. Nuclear PDFs (existing DY data already in)
4. Nuclear PDFs (valence)



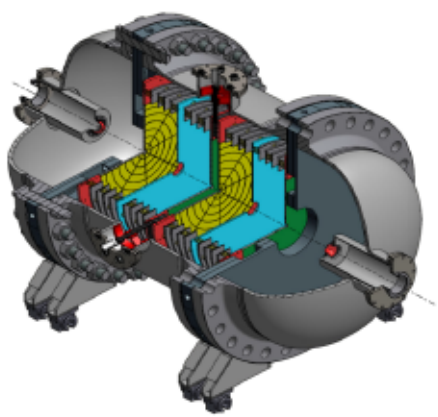
Existing muon beam:

Proton radius measurement in elastic mu-p scattering

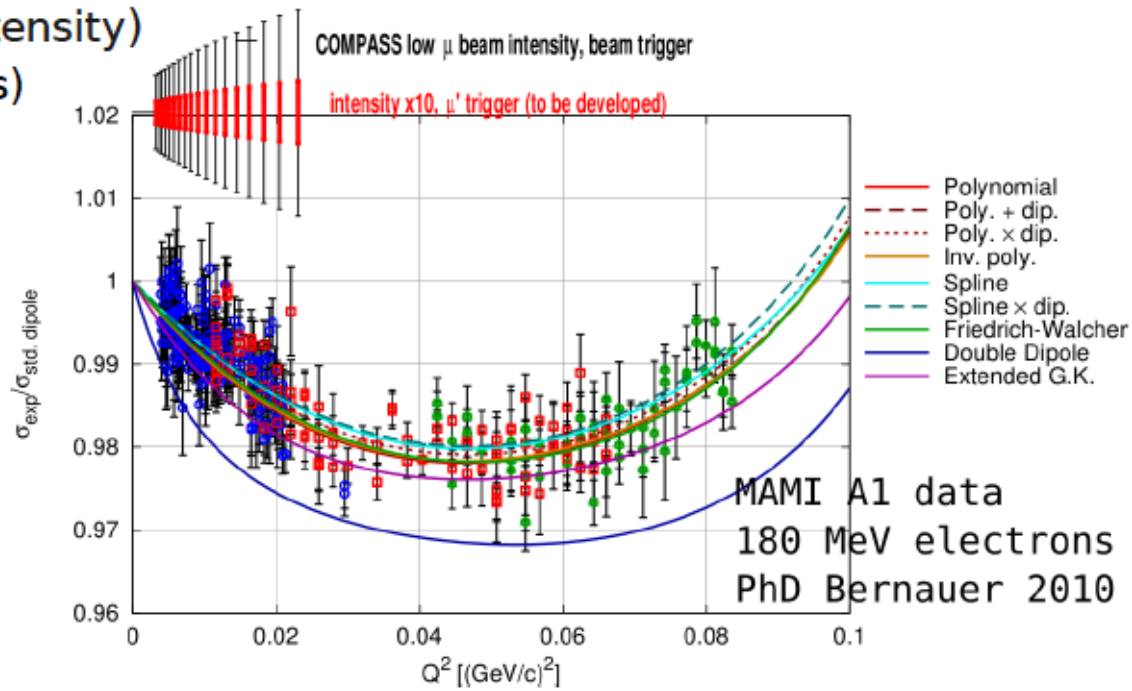
- 100 GeV SPS muon beam (M2)
- Hydrogen high-pressure active TPC target cell (PNPI development)
- Measure the cross-section (shape) over broad Q^2 range 10^{-4} … 10^{-1}
- From 10^{-3} … $2*10^{-2}$ fit the proton radius (slope of electric form factor)
  - Precision 0.03 fm with conservative beam trigger (0.5% beam intensity)
  - Goal: 0.01 fm (from 180 days) trigger concept to be solved

unique because…

- muon beam requires a factor 10 smaller radiative corrections than e^- beams (vs. Mainz, Jlab)
- high-energy muon beam, very small scattering angles: practically no Coulomb correction (vs. MUSE)
- *best systematics control*

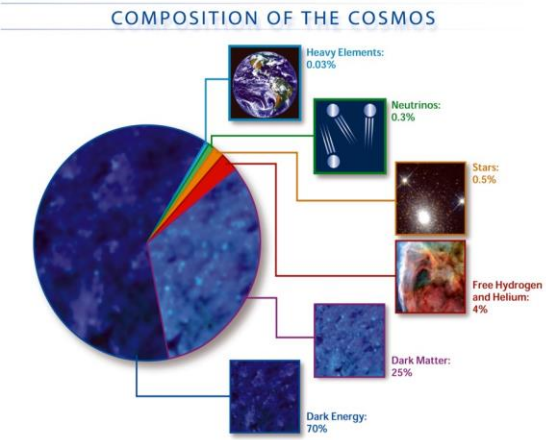


IKAR active target cell
A. Vorobyev, St. Petersburg



Search for Dark Matter

Absolute cross section measurement p+He--> pbar+X



-New AMS(2) data – the antiparticle flux is well known now (few % pres.) (http://dx.doi.org/10.1103/PhysRevLett.117.091103)

- Two type of processes contribute – SM interactions (proton on the ISM with the production for example antiprotons in the f.s.) and contribution from dark particle – antiparticle annihilation;

- In order to detect a possible excess in the antiparticles flux a good knowledge of inclusive cross sections of p-He interaction with antiparticles in the f.s. is a must, currently the typical precision is of 30-50%.

COMPASS++ from a few tens of GeV/c up to 250 GeV/c, in the pseudorapidity range 2.4 < h < 8.

We performed simulation with TGEANT (GEANT4 based COMPASS MC), using FLUKA generator or the internal TGEANT generator:

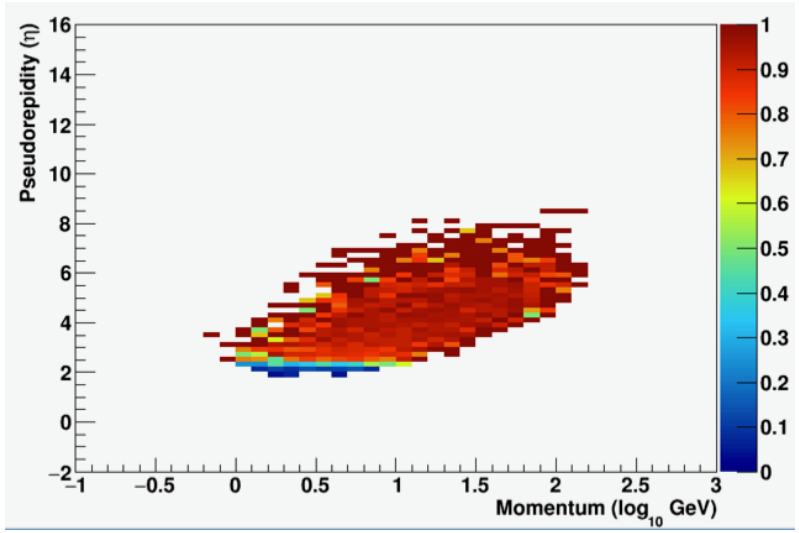
2009 COMPASS hadron setup, 190 GeV beam.

New tCOMPASS associated members for this project:

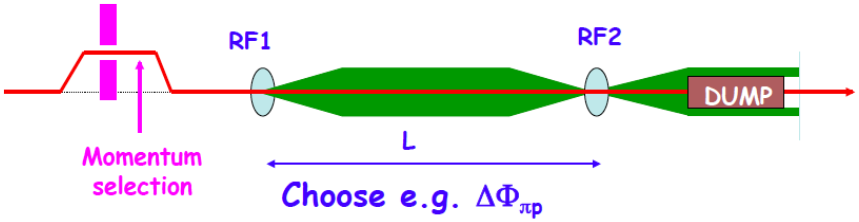
AMS: Paolo Zuccon (MIT), Nicolò Masi (Bologna)

Theoretical Physicist: Fiorenza Donato (Torino)

Goal is to measure the double differential (momentum and pseudorapidity) anti-p cross production from p+p and p+He at different proton momenta (50, 100, 190, 250 GeV/c).



RF separated antiproton/kaon beam



$\Delta\Phi = 2\pi\,(L\,f\,/\,c)\,(\beta_1^{-1} - \beta_2^{-1})$ with $\beta_1^{-1} - \beta_2^{-1} = (m_1^2 - m_2^2)/2p^2$

"Normal" h^- beam composition:
~97% (π) ~2.5%(K) ~0.5% (pbar)

Assumptions:

– 8×10^7 antiprotons for 10^{13} ppp (10 seconds) (optimistic estimate by Lau Gatignon);
– we assume here 4×10^{13} protons.

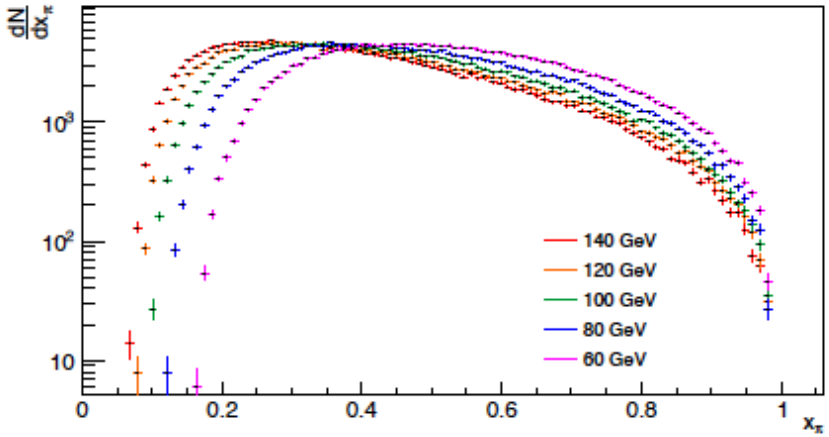
Antiprotons RF separated beam: 3.2×10^7 /s - Gain is a factor of 50 compared to the standard h^- beam for Drell-Yan experiment (~1% of h^- beam 6×10^7 /s dominated by π^-)

Using the same assumption for RF separated kaon beam, possible kaon beam intensity is 8×10^6 /s - Gain is a factor of 80 compared to to the standard "spectroscopy" h^- beam

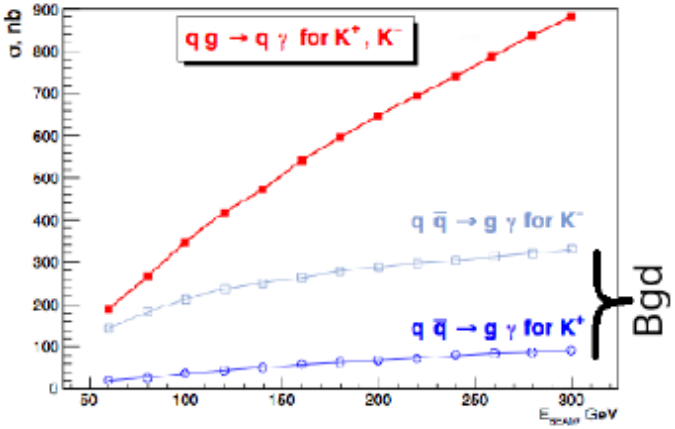
High intensity RF separated beam will provide unique opportunities for Hadron Spectroscopy and Drell-Yan physics

RF separated hadron beam
Meson structure study in DY and PP processes

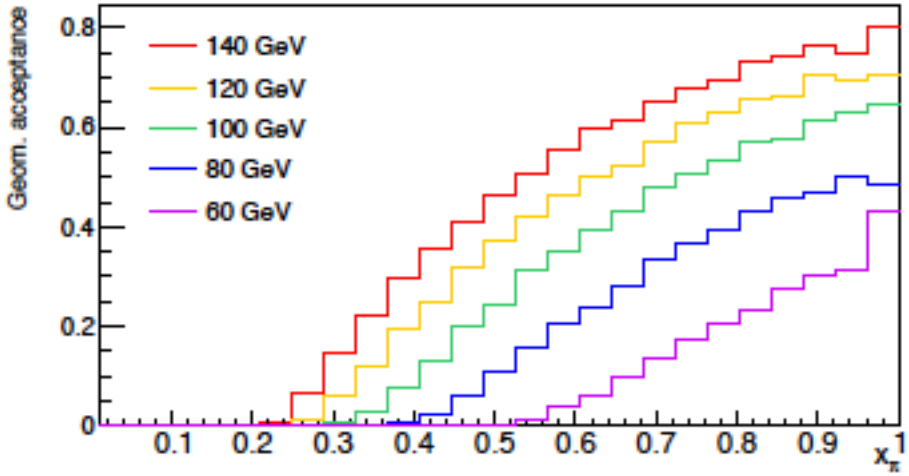
DY cross-section



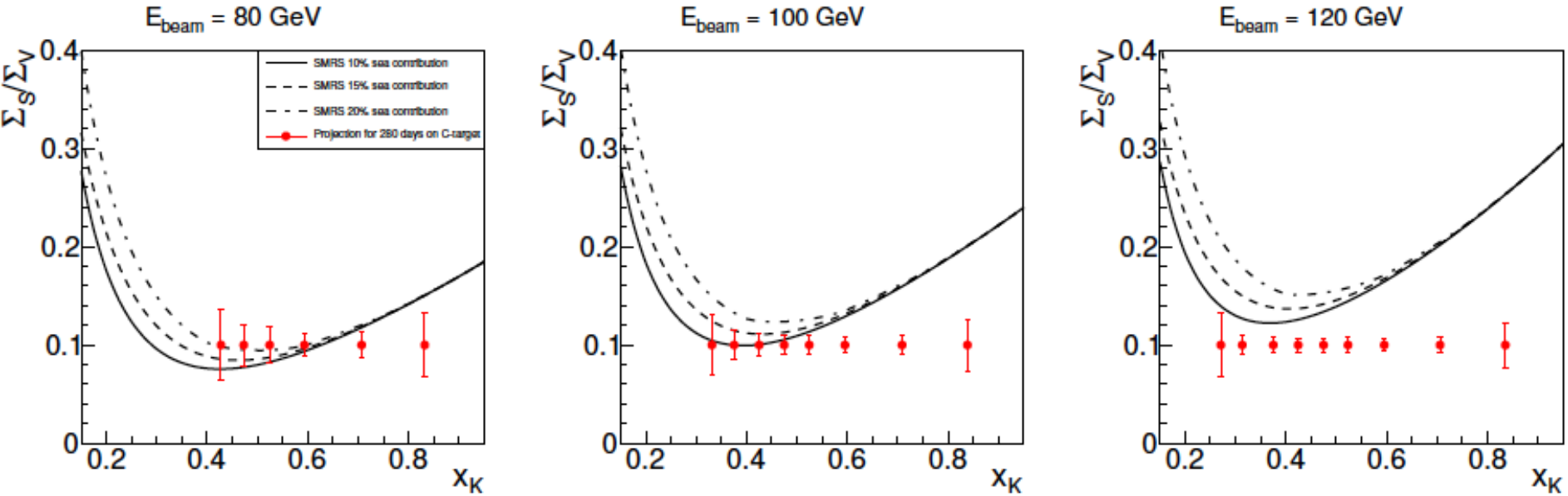
Prompt photon cross-section



Highest possible beam momentum is Essential for both Drell-Yan and Prompt Photons program

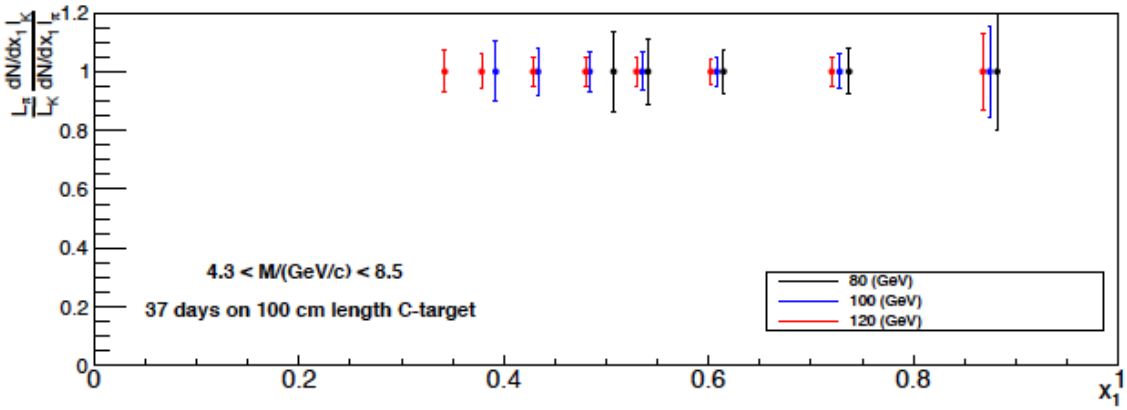


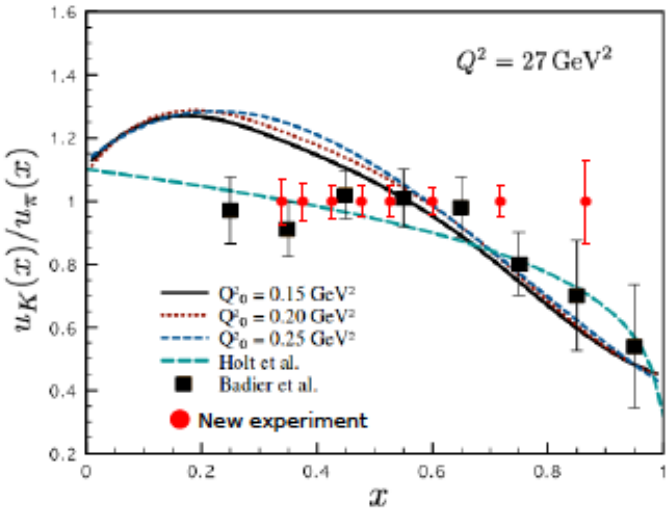
RF separated hadron beam
Meson structure study in DY and PP processes
Projection for valence/sea quarks separation in Kaon



- First measurement of sea in Kaon
- There is still a room for optimization
- Assumed K^+/K^- beam intensity $2x10^7$ /s
- 280 days of running

RF separated hadron beam
Meson structure study in DY and PP processes
Valence u-quark quarks in Kaon compared to pion





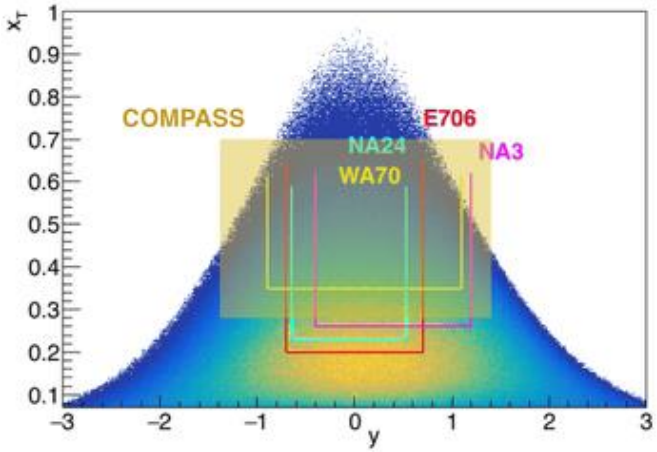
Experiment	Beam type (GeV)	Intensity (/s)	Target	DY events
NA3	K^- (150)	0.25×10^7	Pt	688
	K^- (200)	0.93×10^7		90
	K^+ (200)	0.22×10^7		170
This exp	K^- (80)	1.9×10^7	C	593
	K^- (100)	2.3×10^7		1,800
	K^- (120)	2.5×10^7		3,600
This exp	K^+ (80)	1.7×10^7	C	482
	K^+ (100)	2.1×10^7		1,700
	K^+ (120)	2.3×10^7		3,700

- Statistics with 280 days with a sharing K^-:K^+ $\sim$ 1:7
- Purity of the beam is around 30%, can it be better?
- Obvious gain in intensity with RF separated beam compared to NA3

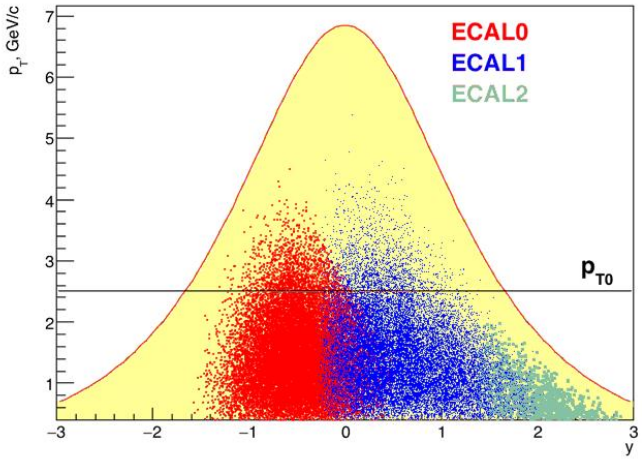
RF separated hadron beam
Meson structure study in DY and PP processes

At the moment there is no experimental information about gluon contribution in kaon. Calculations based on Dyson-Schwinger equations predict 6 times smaller contribution at hadronic scale in respect to pion (Phys. Rev. D93 (7) (2016) 074021)

Pythia-based MC simulation for prompt photons production was used for preliminary estimation of kinematic range accessible at COMPASS. It was compared with corresponding ranges accessible by previous experiments with pion beams.



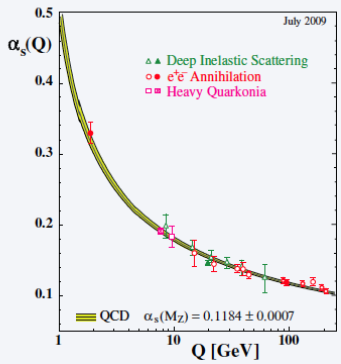
Full MC simulation for prompt photons and minimum bias events was performed for K+ beam of 100 GeV/c and the COMPASS setup configuration of 2017 DVCS run. Possibilities to identify signal and reject background were tested. Some optimization of the setup from point of the material budget was tested.



NO competitors

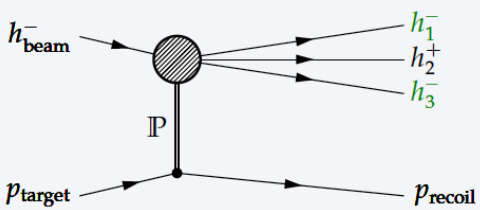
RF separated hadron beam
Strange sector meson spectroscopy with Kaon beam

- Binding of quarks and gluons into hadrons governed by low-energy (long-distance) regime of QCD
- Least understood aspect of QCD
  - Perturbation expansion in α_s not applicable
  - Revert to models or numerical simulation of QCD (lattice QCD)
- Details of binding related to hadron masses
  - Only small fraction of proton mass explained by Higgs mechanism $\Rightarrow$ most generated dynamically



Hadrons reflect workings of QCD at low energies

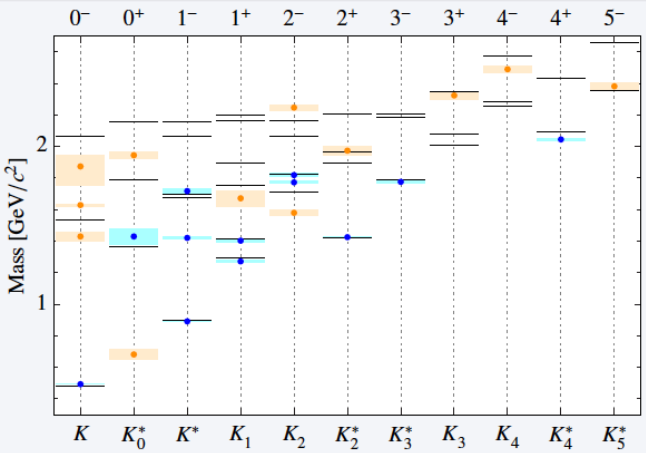
Measurement of **hadron spectra** and **hadron decays** gives valuable input to theory and phenomenology



- Diffractive production of excited kaon states X^- that decay into $K^-\pi^+\pi^-$
- Beam-particle ID via Cherenkov detectors (CEDARs)
  - Ca. 50× more π^- than K^- in beam
- Final-state PID via RICH detector
  - Distinguish K^- from π^- over wide momentum range

PDG 2016: 25 kaon states below 3.1 GeV/c^2

- Only 12 kaon states in summary table, 13 need confirmation
- Many predicted quark-model states still missing
- Some hints for supernumerous states



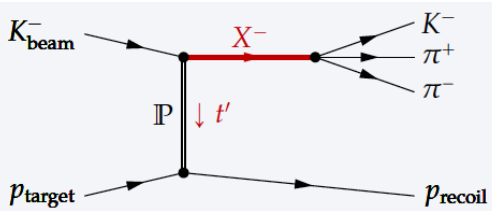
[Courtesy S. Wallner, TUM]

Boris Grube, TU München | Hadron Spectroscopy with Kaon Beam

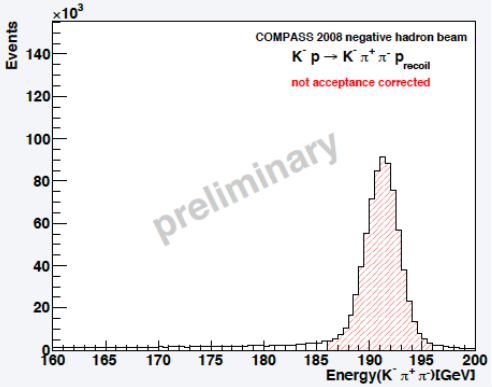
Many kaon states need confirmation

- Little progress in the past
  - Most PDG entries more than 30 years old
  - Since 1990 only 4 kaon states added to PDG (only 1 to summary table)

RF separated hadron beam
Strange sector meson spectroscopy with Kaon beam



- From 2008 data taking campaign
- 270 000 events
- $0.07 < t' < 0.7\,(\mathrm{GeV}/c)^2$
- Exclusivity ensured by measuring recoil proton
  - Also suppresses target excitations



Work in progress: improving analysis

- Improved beam PID + data sample from 2009 run
  $\Rightarrow$ ca. 8×10^5 $K^-\pi^+\pi^-$ events
  $\Rightarrow$ world's largest data set (4× WA03)
- Improved PWA model $\Rightarrow$ clearer resonance signals
- Resonance-model fit $\Rightarrow$ extraction of $K^-\pi^+\pi^-$ resonances and their parameters

Future program

- *Goal:* collect 10 to 20 $\times 10^6$ $K^-\pi^+\pi^-$ events using high-intensity RF-separated kaon beam
  - Would exceed any existing data sample by at least factor 10
  - *High physics potential:* rewrite PDG for kaon states above 1.5 GeV/c^2 (like LASS and WA03 did 30 year ago)
  - Precision study of $K\pi$ S-wave
- Requires experimental setup with uniform acceptance over wide kinematic range (including PID and calorimeters)
- No direct competitors

Measurement of kaon Compton scattering via the Primakoff effect and an RF separated beam for determination of the kaon polarisability, and kaon-photon induced strange meson production

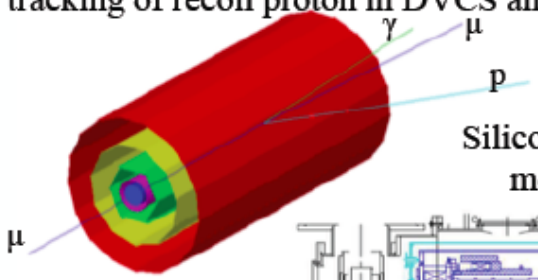
QCD facility – future fixed target experiment at M2
Spectrometer upgrades

- **New type of FEE and trigger logic compatible with trigger-less readout**
  - FPGA-based TDC with time resolution down to 100 ps (iFTDC)
- Higher trigger rates: **90-200 kHz** (factor of 2.5-5)
- Digital trigger
- First tests in 2018

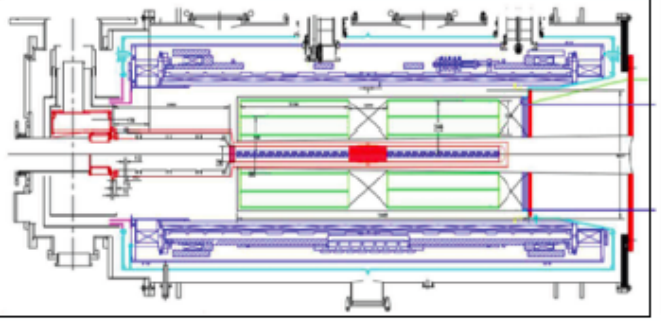
General upgrades of COMPASS-II apparatus:
- New large-size **PixelGEMs**
- **GEMs** or **Micromegas** to replace aging MWPCs
- High-aperture "**RICH0**" for some programs, p < 10-15 GeV?

Could be Large-Area Picosecond Photo-Detectors based on micro-channel plates with time resolution < 50 ps, spatial resolution ~ 0.5 mm. LAPPD™ by IncomInc.
- High-rate-capable **CEDARs** for beam PID for all hadron programs.

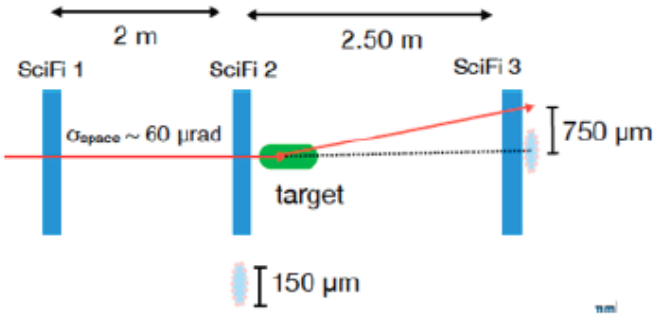
GPD E: 3-layer silicon detector at very low temperature for tracking of recoil proton in DVCS and PID via dE/dx.



Silicon detector inside existing modified target magnet.



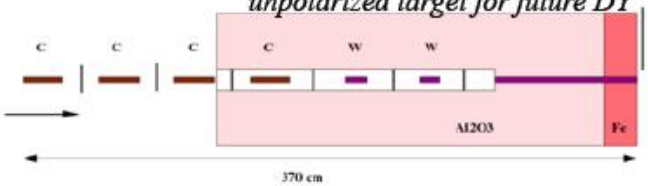
Proton radius:
- **High-pressure active TPC target or hydrogen tube** surrounded by SciFi, 4-8 layers with U/V projections
- **SciFi trigger system** on scattered muon
- Silicon trackers



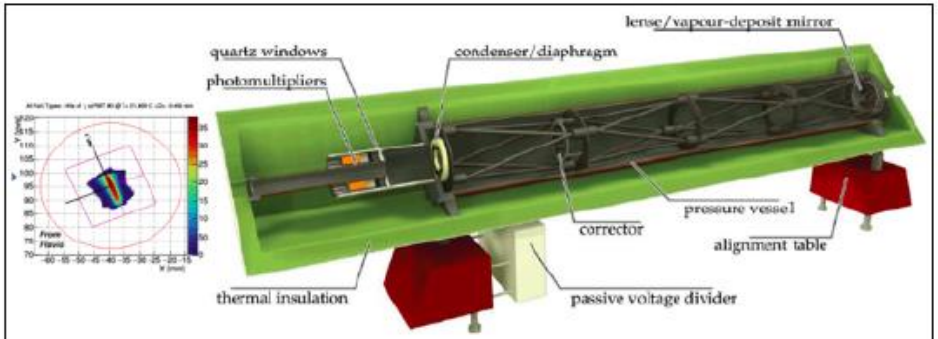
QCD facility – future fixed target experiment at M2
Spectrometer upgrades

Drell-Yan general:
- High-purity and efficiency di-muon trigger
- Dedicated precise luminosity measurement
- Dedicated vertex-detection system
- Beam trackers

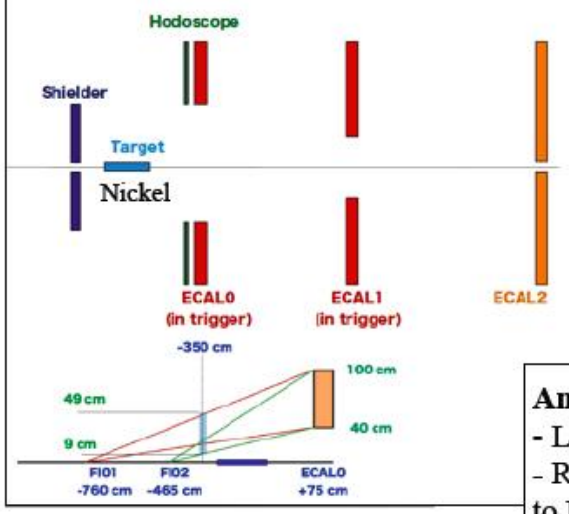
unpolarized target for future DY



Drell-Yan RF separated beams:
- Due to lower beam energy, need wide aperture ± 200 mrad
- High-rate and high-multiplicity capability
- Active absorber (magnetic field, calorimetry?)
- TPCs?
- GEMs?

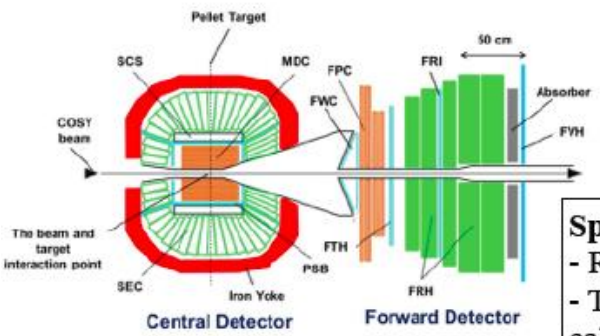


CEDAR upgrade 2018



Prompt Photons
- Shielder (20-30cm steel) upstream of target
- New hodoscope upstream of ECal0
- Transparent setup

Anti-matter cross section
- LH2 and LHe targets
- RICH0 for lower momentum to ID anti-protons?



WASA detector with target spectrometer

Spectroscopy with low-anergy anti-p:
- RICH & CEDAR, RICH0 for low p?
- Target spectrometer (tracking, barrel calorimeter) similar to WASA

Spectroscopy with high-energy K—:
- RICH & CEDAR
- Uniform acceptance, ECals
- Good vertexing
- Recoil TOF detector

Summary

- “Beyond 2020” workshop (CERN, March 2016) and IWHSS (Cortona, Italy, April 2017) ➔ success, strong interest in the hadron physics community

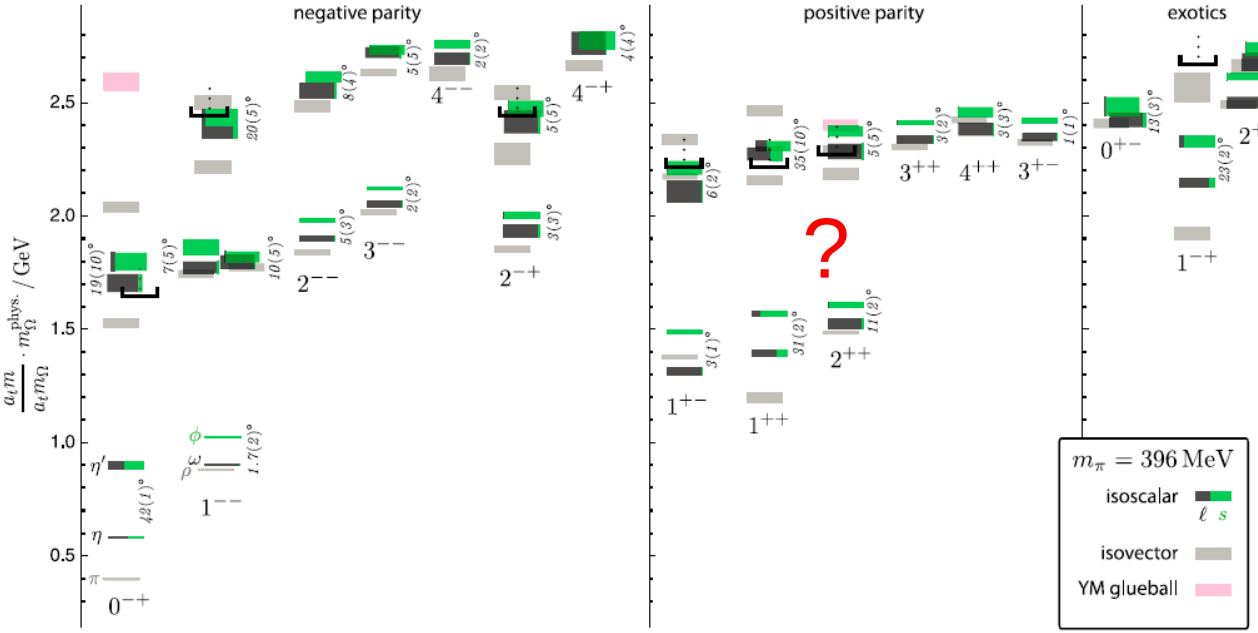
- RF separated antiproton/kaon beam will provide unique opportunity for meson spectroscopy and meson structure study

- Existing muon and hadron beams allows to enrich current COMPASS program

Thank you!

RF separated beam – Hadron spectroscopy (i)

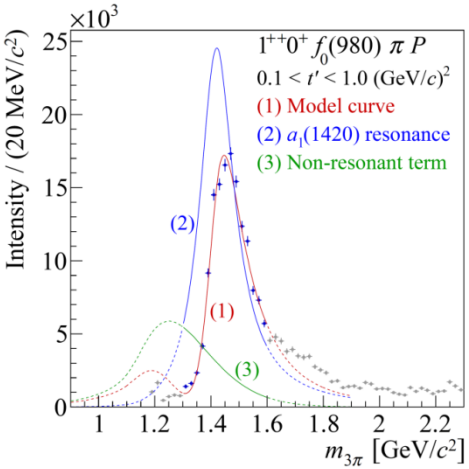
Light Meson Sector & COMPASS contribution



3π data sample ~50x10^6 exclusive events – factor 10 to 100 to previous experiment

Good illustration or our potential is a discovery of a new axial-vector meson $a_1(1420)$ in $1^{++}0^+$ $f_0(980)\pi$ P wave (PRL).

COMPASS: $a_1(1420)$



It is shown that we have elaborated adequate methods to cope with huge statistics and produced nice results

[C. Adolph et al., COMPASS, PRL 115, 082001 (2015)]

RF separated beam – Hadron spectroscopy (ii)

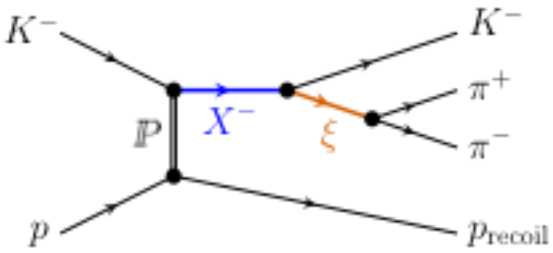
Light and Strange Meson Spectrum

RF separated kaon beam ~ 8 x 10^6 /s, beam momentum ~100 GeV

What can we contribute as COMPASS?

- State-of-the-art high-resolution spectrometer with full PID
- Advanced analysis techniques being developed in the light-quark sector

Method to be used: Kaon beam diffraction scattering on LH_2 and thin nuclear targets



- Goal: ~10 larger data sample than existing worldwide what would make possible to have similar to pion diffraction wave set: 88 waves in 11 t′ bins;
- COMPASS could rewrite PDG tables for strange mesons
- Extend studies of chiral dynamics to strange sector

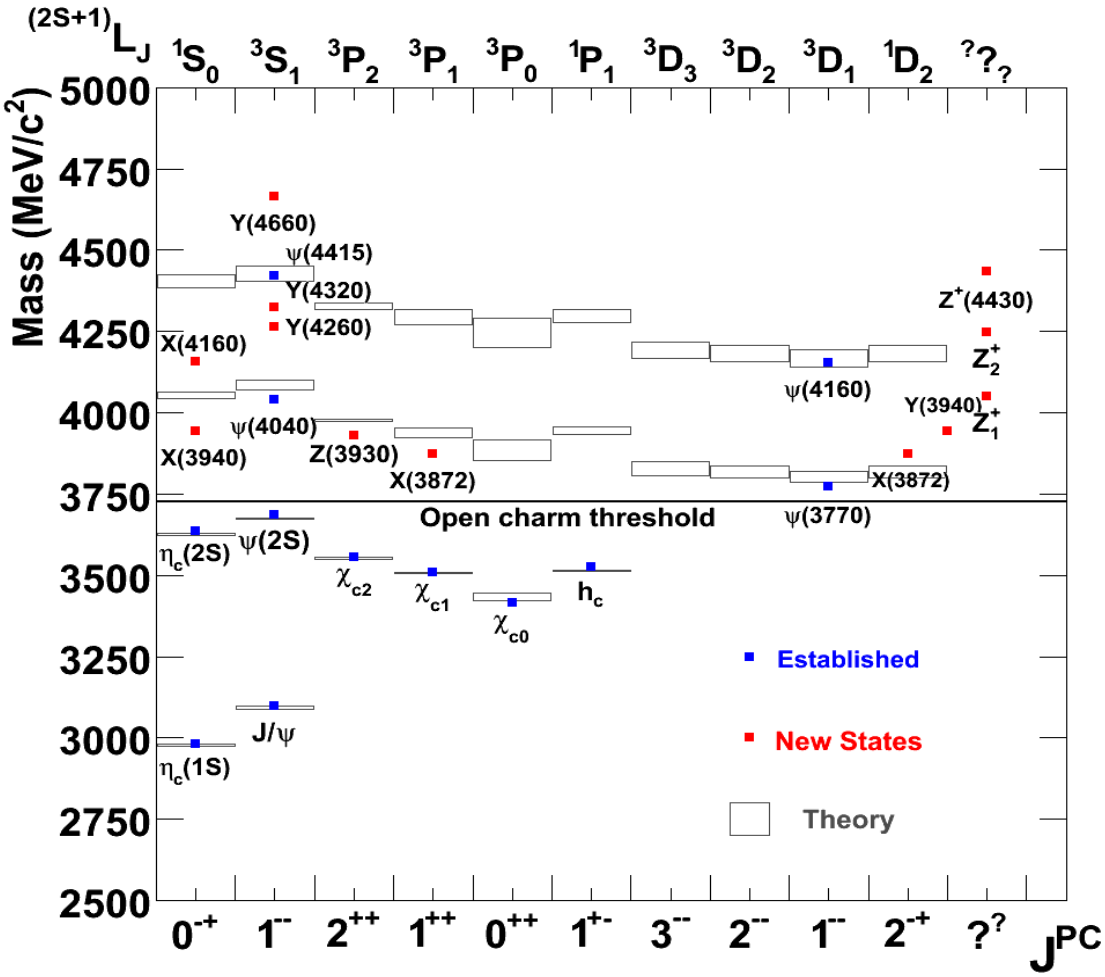
No real competitors

JParc - ~10^5 /s, low momenta kaons

JLab - ~10^4 /s, K^0 long beam, lower momenta

Unique opportunity

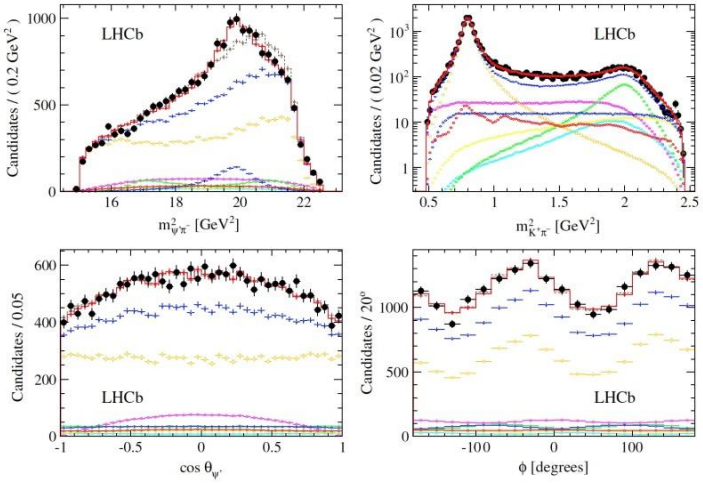
RF separated beam – Hadron spectroscopy (iii)
Charmonium spectra



[V. Santoro, Hadron 2015]

- Many new (narrow) states discovered in recent years
- Assignment not clear
- Some definitively not charmonium-like

LHCb: $Z(4430)^-$: 13.9 σ



[LHCb, PRL 112, 222002 (2014)]

Existing hadron beam
Drell-Yan

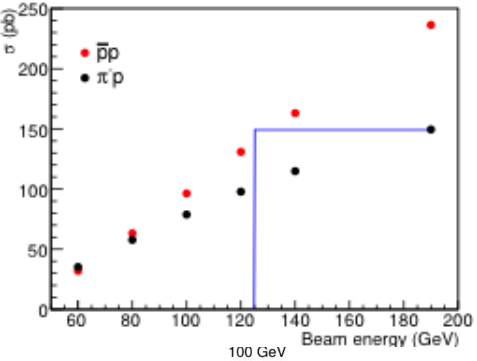
Expected statistics

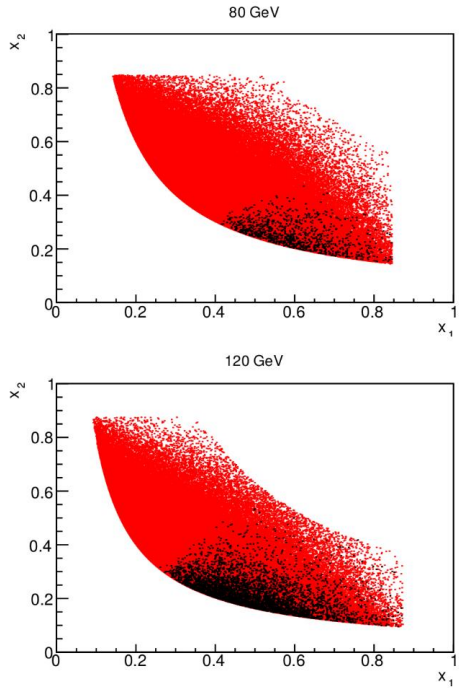
Experiment	Beam type (GeV)	Beam intensity (part/sec)	Target type	DY mass (GeV/c^2)	DY events
E615	π^+ 252	17.6×10^7	20cm W	4.05 – 8.55	**5,000**
E615	π^- 252	18.6×10^7	20cm W	4.05 – 8.55	30,000
NA3	π^+ 200	2.0×10^7	30cm H_2	4.1 – 8.5	**40**
NA3	π^- 200	3.0×10^7	30cm H_2	4.1 – 8.5	121
NA3	π^+ 200	2.0×10^7	6cm Pt	4.2 – 8.5	**1,767**
NA3	π^- 200	3.0×10^7	6cm Pt	4.2 – 8.5	4,961
NA10	π^- 286	65×10^7	120cm D_2	4.2 – 8.5	7,800
NA10	π^- 140	65×10^7	120cm D_2	4.35 – 8.5	3,200
NA10	π^- 286	65×10^7	12cm W	4.2 – 8.5	49,600
NA10	π^- 140	65×10^7	12cm W	4.35 – 8.5	29,300
COMPASS 2015	π^- 190	7.0×10^7	110cm NH_3	4.3 – 8.5	35,000
COMPASS 2018	π^- 190	7.0×10^7	110cm NH_3	4.3 – 8.5	52,000
This exp*	π^+ 190	1.7×10^7	100cm C	4.3 – 8.5	**23,000**
This exp*	π^- 190	6.8×10^7	100cm C	4.3 – 8.5	22,000
This exp*	π^+ 190	0.2×10^7	24cm W	4.3 – 8.5	**7,000**
This exp*	π^- 190	1.0×10^7	24cm W	4.3 – 8.5	6,000

Conservative estimates:

- with current beam intensities and RP limits: 7×10^7/s total beam flux
- and a super-cyle: 1 spill every 26s
- exploitable spills (stability beam and apparatus, analysis cut): 65%
- CEDARs: 90% efficiency

RF separated beam - Drell-Yan antiproton-induced Drell-Yan





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

Beam (GeV)	$I_{\bar{p}}$ (10^7/s)	Acc.
$\bar{p}$ (80)	3.2	6%
$\bar{p}$ (100)	2.7	11%
$\bar{p}$ (120)	2.3	15%

- cross-sections for *pbar induced-DY at 120 GeV and π− induced-DY at 190 GeV*
- Apparatus with pol. target does not meet specs imposed by the new beam energy
- Necessity to squeeze the apparatus

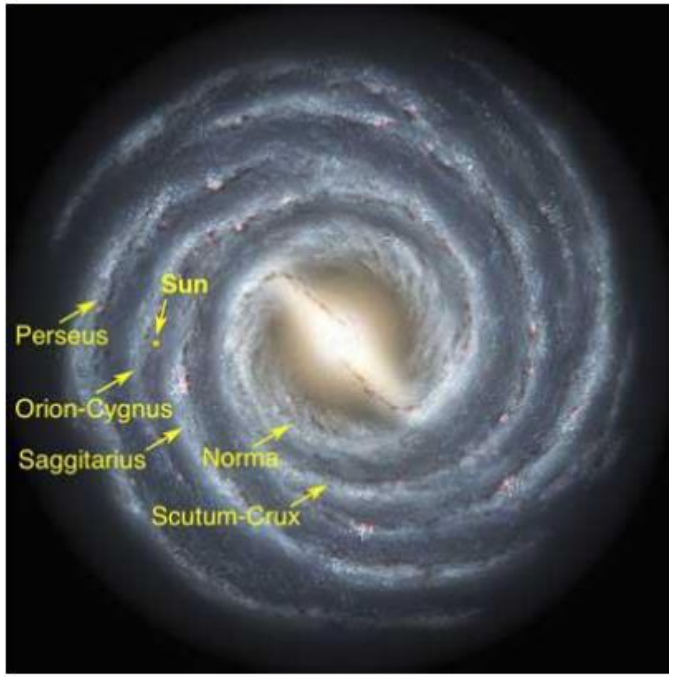
No competitors, unique data

QCD Preamble

Emergent Phenomena in the Standard Model

Existence of the Universe as we know it depends critically on following empirical facts:

- Proton is massive, *i.e.* the mass-scale for strong interactions is vastly different to that of electromagnetism
- Proton is absolutely stable, despite being a composite object constituted from three valence quarks
- Pion is unnaturally light (but not massless), despite being a strongly interacting composite object built from a valence-quark and valence antiquark



Emergence: low-level rules producing high-level phenomena, with enormous apparent complexity

Running/planed Drell-Yan experiments, COMPASS (π^- beam on $\mathbf{p}^\uparrow$) – unique experiment

Experiment	Particles	Energy (GeV)	x_b or x_t	Luminosity ($cm^{-2}\,s^{-1}$)		P_b or P_t (f)	rFOM#	Timeline
COMPASS (CERN)	$\pi^\pm + p^\uparrow$	190 GeV $\sqrt{s} = 19$	$x_t = 0.1 – 0.3$	2×10^{33}	0.14	$P_t = 80\%$ f = 0.22	1.0×10^{-3}	2014-2015, 2018
PANDA (GSI)	pbar + $p^\uparrow$	15 GeV $\sqrt{s} = 5.5$	$x_t = 0.2 – 0.4$	2×10^{32}	0.07	$P_t = 90\%$ f = 0.22	1.1×10^{-4}	>2025
AFTER	$p^\uparrow + p$	7 TeV $\sqrt{s} = 120$	$x_b = 0.1 – 0.9$	2×10^{32}	0.06	$P_b = 100\%$?	2.3×10^{-5}	>2020
NICA (JINR)	$p^\uparrow + p$	collider $\sqrt{s} = 26$	$x_b = 0.1 – 0.8$	1×10^{32}	0.04	$P_b = 70\%$	6.8×10^{-5}	>2023
PHENIX/STAR (RHIC)	$p^\uparrow + p^\uparrow$	collider $\sqrt{s} = 510$	$x_b = 0.05 – 0.1$	2×10^{32}	0.08	$P_b = 60\%$	1.0×10^{-3}	>2018
fsPHENIX (RHIC)	$p^\uparrow + p^\uparrow$	$\sqrt{s} = 200$ $\sqrt{s} = 510$	$x_b = 0.1 – 0.5$ $x_b = 0.05 – 0.6$	8×10^{31} 6×10^{32}	0.08	$P_b = 60\%$ $P_b = 50\%$	4.0×10^{-4} 2.1×10^{-3}	>2021
SeaQuest (FNAL: E-906)	p + p	120 GeV $\sqrt{s} = 15$	$x_b = 0.35 – 0.9$ $x_t = 0.1 – 0.45$	3.4×10^{35}	---	---	---	2012 - 2017
Pol tgt DY‡ (FNAL: E-1039)	$p + p^\uparrow$	120 GeV $\sqrt{s} = 15$	$x_t = 0.1 – 0.45$	4.4×10^{35}	0 – 0.2*	$P_t = 85\%$ f = 0.176	0.15	2018-2019
Pol beam DY§ (FNAL: E-1027)	$p^\uparrow + p$	120 GeV $\sqrt{s} = 15$	$x_b = 0.35 – 0.9$	2×10^{35}	0.04	$P_b = 60\%$	1	2020

‡ *8 cm NH_3 target* / § *L= 1×10^{36} $cm^{-2}\,s^{-1}$ (LH_2 tgt limited)* / *L= 2×10^{35} $cm^{-2}\,s^{-1}$ (10% of MI beam limited)*

**not constrained by SIDIS data* / # rFOM = relative lumi * P^2 * f^2 wrt E-1027 (f=1 for pol p beams, f=0.22 for π^- beam on NH_3)

Existing hadron beam

pbar production cross-section for Dark Matter Search

experimental accuracy of the order of a few % achieved by **AMS-02** on CR pbar flux and pbar/p flux ratio **(http://dx.doi.org/10.1103/PhysRevLett.117.091103)**
The large uncertainty on the production cross sections - the dominant limiting factor.
precise **p+p → pbar+X** and **p+He → pbar+X** cross-section data are needed
(proton beam kinetic energy **from 10 GeV to 6 TeV and a pseudorapidity η ranging from 2 to almost 8**)

COMPASS++ from a few tens of GeV/c up to 250 GeV/c, in the pseudorapidity range $2.4 < \eta < 8$.
We performed simulation with TGEANT (GEANT4 based COMPASS MC), using FLUKA generator or the internal TGEANT generator:
2009 COMPASS hadron setup was simulated with 190 GeV/c proton beam on 40 cm long Liquid H2 target or Liquid He target
New three COMPASS associated members for this project:
AMS: Paolo Zuccon (MIT), Nicolò Masi (University of Bologna and INFN)
Theoretical Physicist: Fiorenza Donato (University of Torino and INFN)

Goal is to measure the double differential (momentum and pseudorapidity) anti-p cross production from p+p and p+He at different proton momenta (50, 100, 190, 250 GeV/c).

With minimum bias trigger setup and a beam intensity of 5 x 10^5 p/s , assuming a conservative anti-proton identification efficiency of 70% and a double differential cross section with 20 bins in momentum and pseudorapidity, we could reach a statistical error of 1% for a given beam proton momentum in a few hours of data taking