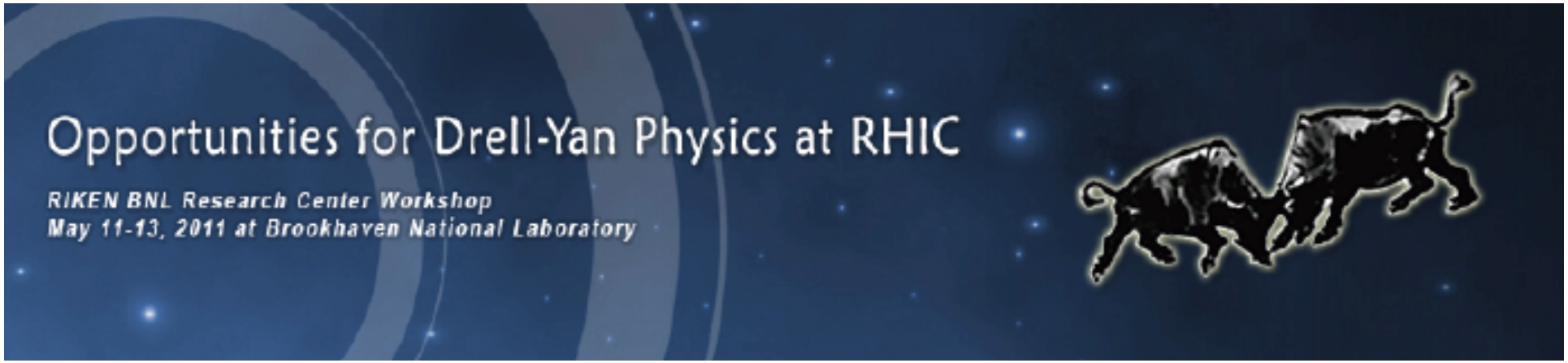
Forthcoming Drell-Yan experiment at COMPASS



Oleg Denisov
INFN section of Turin
For the COMPASS collaboration
12.05.2011

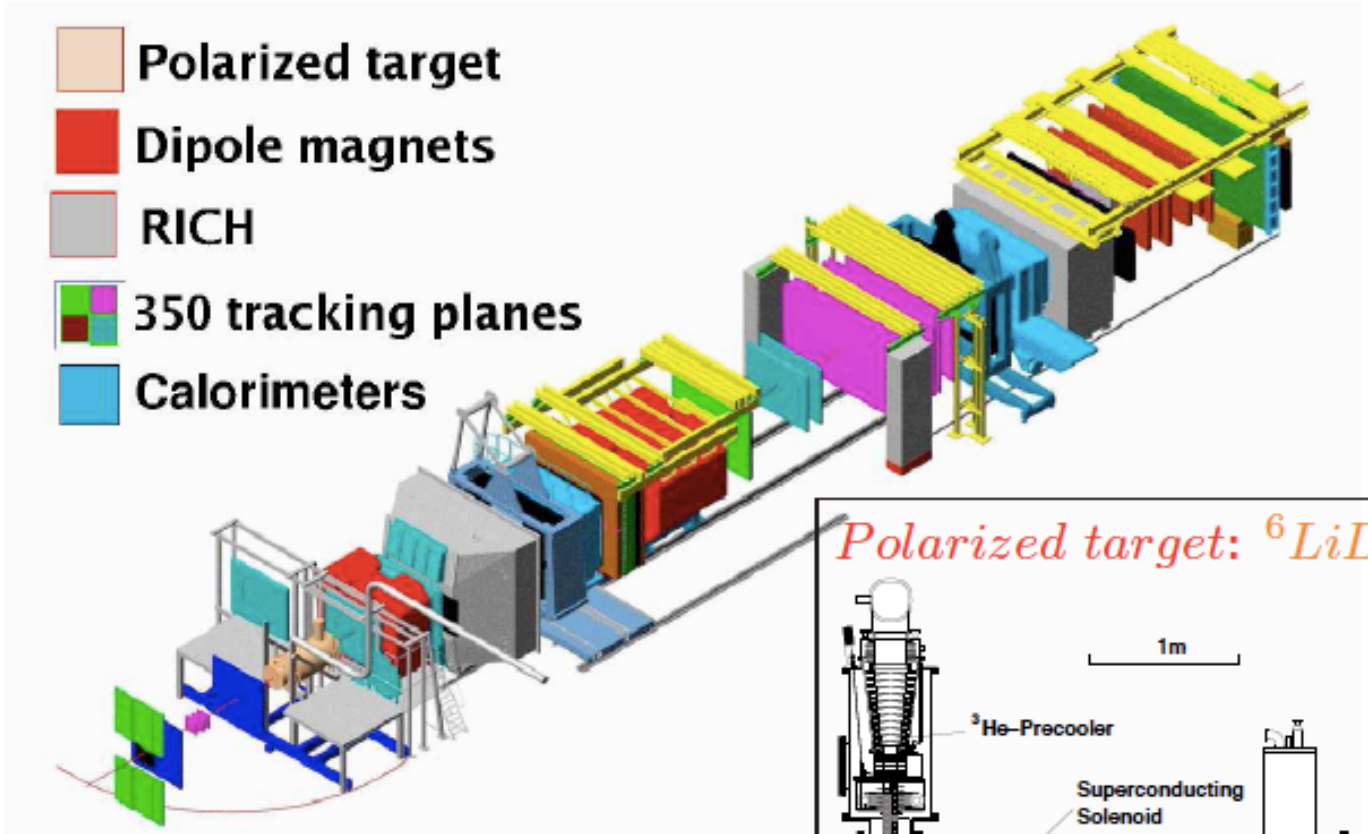
Outline

- COMPASS I ➔ COMPASS-II
- Drell-Yan, polarised case
- Transversity & TMDs (single transversally polarised DY, this workshop – George Sterman, Gunar, Mauro,….):
  - Proton description at LO
  - Proton spin ➔ quark orbital angular momentum
  - TMDs factorisation and universality – crucial test of modern QCD
- Unpolarised pion Drell-Yan (Paul Reimer and Jen-Chieh Peng)
- TMDs study – choice of kinematic domain
- Polarised DY@COMPASS
  - Set-up
  - Kinematics & Projections
  - Beam test
  - Upgrades & Timelines
- Some conclusions

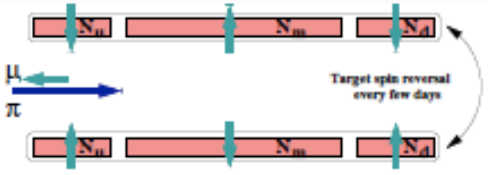
COMPASS facility at CERN (SPS)

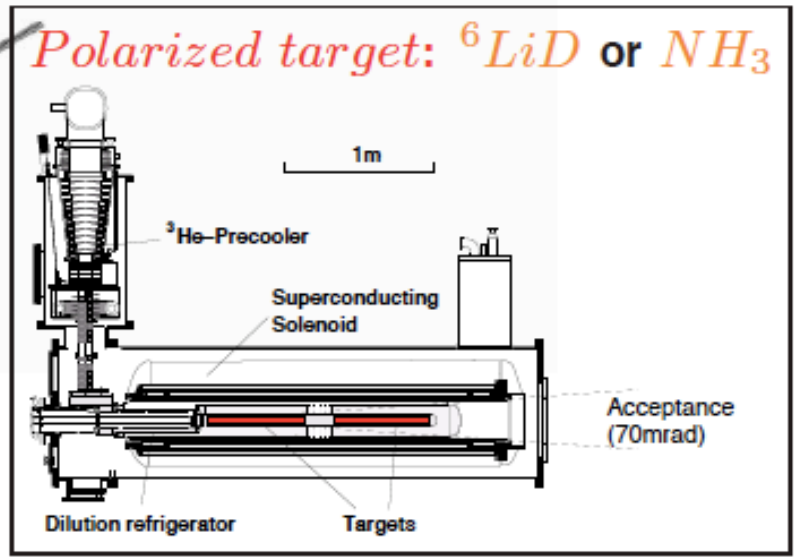
COmmon Muon Proton Apparatus for Structure and Spectroscopy

COMPASS facility at CERN



μ or π beam





COMPASS-II (New Physics) a piece of history

- COMPASS is very sophisticated, universal and flexible facility ➔ Physics beyong SIDIS and hadron spectroscopy is possible:
  - Unique COMPASS Polarised Target
  - Both hadron and lepton beams
  - Easy-accessable spectrometer components
- All that all together has generated new physics proposals with COMPASS – DVCS(GPDs) and polarised DY:
  - For the first time these ideas (GPD and DY) were reported at the Villars SPSC meeting in September 2004
  - Since then (DY part) 3 International Workshops (Torino, Dubna, CERN), > 40 COMPASS DY subgroup meetings, 3 Beam Tests, > 20 presentations at the international Conferences….
- The COMPASS-II proposal was submitted to the CERN SPSC on May 17th 2010
- Approved by the CERN research board on December 1st 2010, 1 year for Drell-Yan and 2 years for GPDs in the time interval between two LHC shutdowns.
- April 7th – the Collaboration took a decision to run first the DY program and then DVCS (GPDs) program – we will start in 2013 (beam test) and in 2014 we will have a full year of DY data taking.

COMPASS-II: a Facility to study QCD (SPSC,CERN)

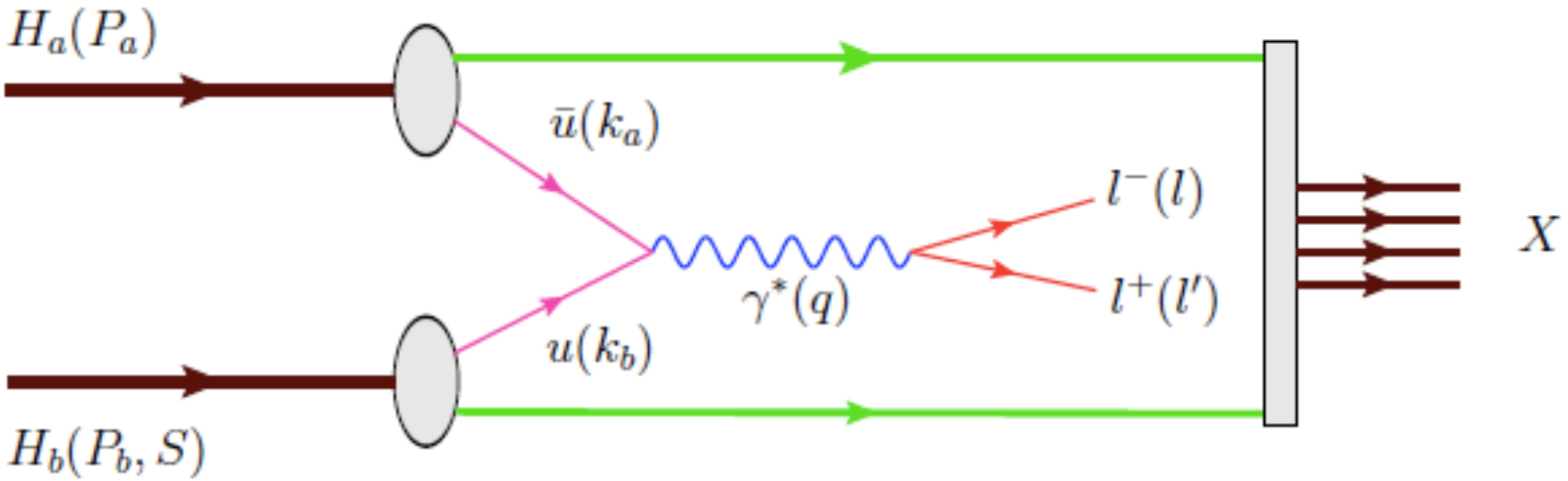
COMMON
MUON and
PROTON
APPARATUS for
STRUCTURE and
SPECTROSCOPY

Long Term Plans for at least 5 years (starting in 2012)

- ✓ Primakoff with π, K beam ➔ Test of Chiral Perturb. theory
- ✓ DVCS & DVMP with μ beams ➔ Transv. Spatial Distrib. with GPDs
- ✓ SIDIS (with GPD prog.) ➔ Strange PDF and Transv. Mom. dep. PDFs
- ✓ Drell-Yan with π beams ➔ Transverse Momentum dependent PDFs

O. Denisov (INFN Torino) - DY, J. Friedrich (TU Munich) - Primakoff, N. d'Hose (CEA Saclay) - GPD
for the COMPASS Collaboration

Drell-Yan Kinematics



$P_{a(b)}$	the momentum of the beam (target) hadron,
$s = (P_a + P_b)^2$,	the total centre-of-mass energy squared,
$x_{a(b)} = q^2/(2P_{a(b)} \cdot q)$,	the momentum fraction carried by a parton from $H_{a(b)}$,
$x_F = x_a - x_b$,	the Feynman variable,
$M^2_{\mu\mu} = Q^2 = q^2 = s\ x_a\ x_b$,	the invariant mass squared of the dimuon,
$\mathbf{k}_{Ta(b)}$	the transverse component of the quark momentum,
$\mathbf{q}_T = \mathbf{P}_T = \mathbf{k}_{Ta} + \mathbf{k}_{Tb}$	the transverse component of the momentum of the virtual photon.

Drell-Yan cross-section – general (full) angular distribution

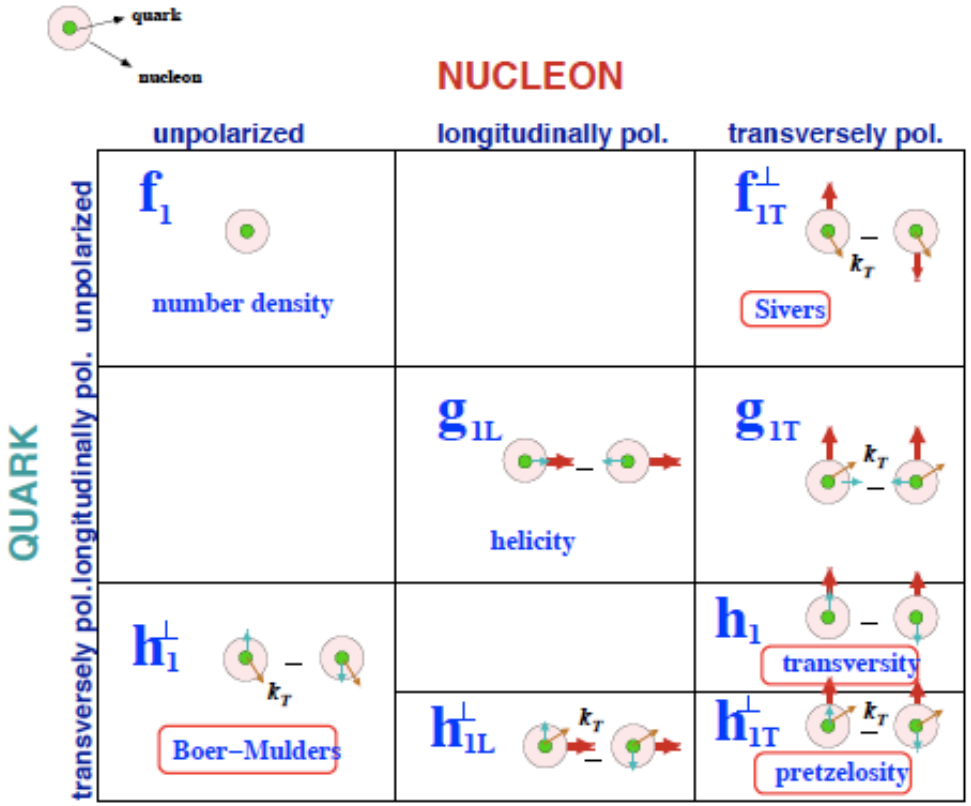
2008: S. Arnold, (Ruhr U., Bochum) , A. Metz, (Temple U.) , M. Schlegel, (Jefferson Lab)
Phys.Rev.D79:034005,2009, e-Print: **arXiv:0809.2262**

$$
\begin{aligned}
\frac{d\sigma}{d^4q\,d\Omega} &= \frac{\alpha_{em}^2}{F\,q^2}\times \\
&\Big\{\Big((1+\cos^2\theta)\,F_{UU}^1 + (1-\cos^2\theta)\,F_{UU}^2 + \sin 2\theta\cos\phi\,F_{UU}^{\cos\phi} + \sin^2\theta\cos 2\phi\,F_{UU}^{\cos 2\phi}\Big) \\
&+ S_{aL}\Big(\sin 2\theta\sin\phi\,F_{LU}^{\sin\phi} + \sin^2\theta\sin 2\phi\,F_{LU}^{\sin 2\phi}\Big) \\
&+ S_{bL}\Big(\sin 2\theta\sin\phi\,F_{UL}^{\sin\phi} + \sin^2\theta\sin 2\phi\,F_{UL}^{\sin 2\phi}\Big) \\
&+ |\vec{S}_{aT}|\Big[\sin\phi_a\Big((1+\cos^2\theta)\,F_{TU}^1 + (1-\cos^2\theta)\,F_{TU}^2 + \sin 2\theta\cos\phi\,F_{TU}^{\cos\phi} + \sin^2\theta\cos 2\phi\,F_{TU}^{\cos 2\phi}\Big) \\
&\qquad + \cos\phi_a\Big(\sin 2\theta\sin\phi\,F_{TU}^{\sin\phi} + \sin^2\theta\sin 2\phi\,F_{TU}^{\sin 2\phi}\Big)\Big] \\
&+ |\vec{S}_{bT}|\Big[\sin\phi_b\Big((1+\cos^2\theta)\,F_{UT}^1 + (1-\cos^2\theta)\,F_{UT}^2 + \sin 2\theta\cos\phi\,F_{UT}^{\cos\phi} + \sin^2\theta\cos 2\phi\,F_{UT}^{\cos 2\phi}\Big) \\
&\qquad + \cos\phi_b\Big(\sin 2\theta\sin\phi\,F_{UT}^{\sin\phi} + \sin^2\theta\sin 2\phi\,F_{UT}^{\sin 2\phi}\Big)\Big] \\
&+ S_{aL}\,S_{bL}\Big((1+\cos^2\theta)\,F_{LL}^1 + (1-\cos^2\theta)\,F_{LL}^2 + \sin 2\theta\cos\phi\,F_{LL}^{\cos\phi} + \sin^2\theta\cos 2\phi\,F_{LL}^{\cos 2\phi}\Big)
\end{aligned}
$$

Leading Order PDFs

At leading order, 3 PDFs are needed to describe the structure of the nucleon in the collinear approximation.

But if one takes into account also the quarks intrinsic transverse momentum k_T, 8 PDFs are needed:



Single-polarised DY cross-section: Leading order QCD parton model

At LO the general expression of the DY cross-section simplifies to (Aram Kotzinian) :

$$\begin{aligned}\frac{d\sigma^{LO}}{d^4q\,d\Omega} &= \frac{\alpha_{em}^2}{F\,q^2}\hat{\sigma}_U^{LO}\Big\{\Big(1 + D^{LO}_{[\sin^2\theta]}\,A_U^{\cos 2\phi}\cos 2\phi\Big) \\ &+ S_L D^{LO}_{[\sin^2\theta]}\,A_L^{\sin 2\phi}\sin 2\phi \\ &+ |\vec{S}_T|\Big[A_T^{\sin\phi_S}\sin\phi_S + D^{LO}_{[\sin^2\theta]}\Big(A_T^{\sin(2\phi+\phi_S)}\sin(2\phi+\phi_S) \\ &+ A_T^{\sin(2\phi-\phi_S)}\sin(2\phi-\phi_S)\Big)\Big]\Big\},\end{aligned}$$

Thus the measurement of 4 asymmetries (modulations in the DY cross-section):

- $A_U^{\cos 2\phi}$ gives access to the Boer-Mulders functions of the incoming hadrons,
- $A_T^{\sin\phi_S}$ – to the Sivers function of the target nucleon,
- $A_T^{\sin(2\phi+\phi_S)}$ – to the Boer-Mulders functions of the beam hadron and to $h_{1T}^{\perp}$, the pretzelosity function of the target nucleon,
- $A_T^{\sin(2\phi-\phi_S)}$ – to the Boer-Mulders functions of the beam hadron and h_1, the transversity function of the target nucleon.

TMDs universality SIDIS←→DY

The time-reversal odd character of the Sivers and Boer-Mulders PDFs lead to the prediction of a sign change when accessed from SIDIS or from Drell-Yan processes:

↪ Check the predictions:

$$f_{1T}^{\perp}(DY) = -f_{1T}^{\perp}(SIDIS)$$

$$h_1^{\perp}(DY) = -h_1^{\perp}(SIDIS)$$

Its experimental confirmation is considered a crucial test of non-perturbative QCD.

Universality test includes not only the sing-reversal character of the TMDs but also the comparison of the amplitude as well as the shape of the corresponding TMDs

Sivers, Boer-Mulders functions SIDIS ←→ DY

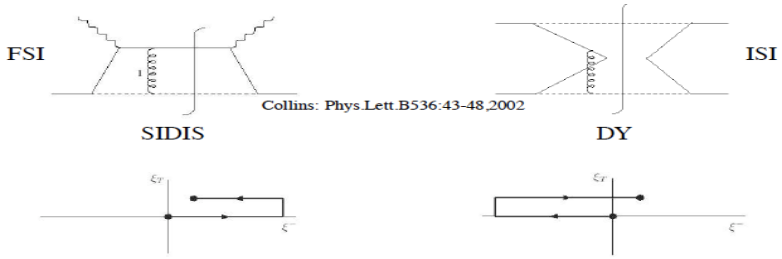
QCD

$\sigma_h \cong \sigma_p \times PDF$

QCD factorization, valid for hard processes only (Q, q_T are large)

Cross-sections are gauge-invariant objects, to provide the gauge invariance of the PDFs the gauge-link was introduced (intrinsic feature of PDF). The presence of gauge-link provides the possibility of existence of non-zero T-odd TMD PDFs

Direction of the gauge-link of the k_T dependent PDF is process-dependent (gauge-link is resummation of all collinear soft gluons) and it changes to the opposite in SIDIS wrt DY



Sivers and Boer-Mulders functions are T-odd, and to provide the time-invariance they change the sign in SIDIS wrt DY due to the opposite direction of the gauge-link

$$f_{1T}^{\perp}(x,\mathbf{k}_T)\Big|_{SIDIS} = -f_{1T}^{\perp}(x,\mathbf{k}_T)\Big|_{DY}$$

$$h_1^{\perp}(x,\mathbf{k}_T)\Big|_{SIDIS} = -h_1^{\perp}(x,\mathbf{k}_T)\Big|_{DY}$$

J.C. Collins, Phys. Lett. B536 (2002) 43

J. Collins, talk at LIGHT CONE 2008

SIDIS←→DY – QCD test

Andreas Metz (Trento-TMD'2010):

Sign reversal of the Sivers function

- Prediction based on operator definition (Collins, 2002)

$$f_{1T}^{\perp}\big|_{DY} = -\, f_{1T}^{\perp}\big|_{DIS}$$

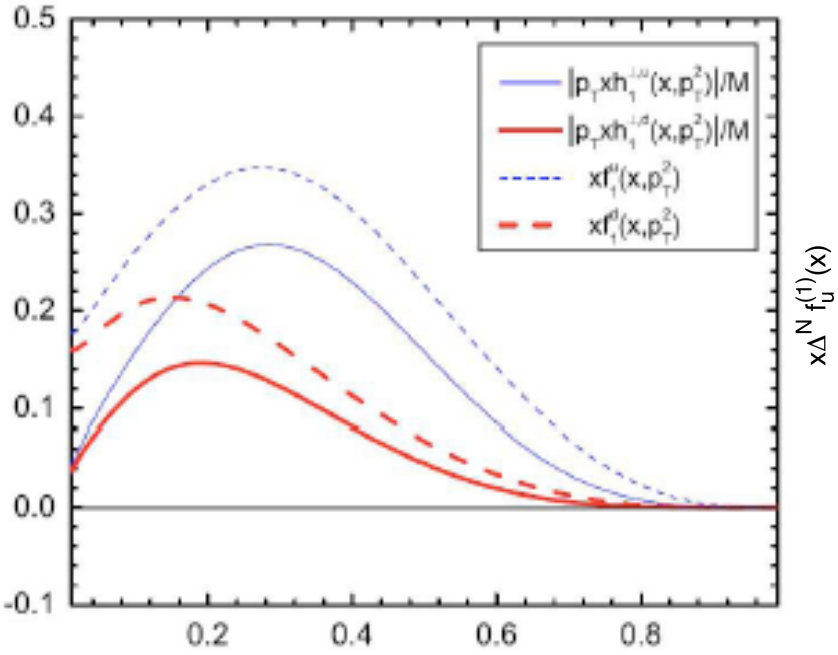
- What if sign reversal of $f_{1T}^{\perp}$ is not confirmed by experiment ?
  - Would not imply that QCD is wrong
  - Would imply that SSAs not understood in QCD
  - Problem with TMD-factorization
  - Problem with resummation of large logarithms
    - → Resummation relevant if more than one scale present
    - → CSS resummation in Drell-Yan (Collins, Soper, Sterman, 1985); resum logarithms of the type

$$\alpha_s^k \ln^{2k} \frac{\vec{Q}_T^2}{Q^2}$$

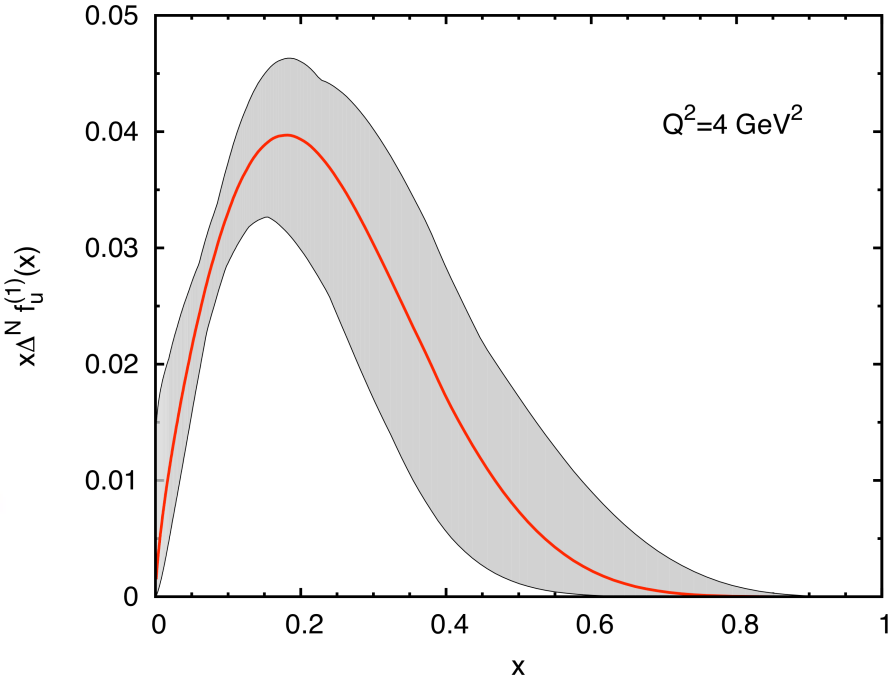
→ Has also implications for Fermilab and LHC physics

Some indications for the future Drell-Yan experiments

1. TMD PDFs – ALL are sizable in the valence quark region



- Boer-Mulder function for u and d quarks as extracted from $p + D$ data from Zhang *et al Phys. Rev.* D77,0504011]



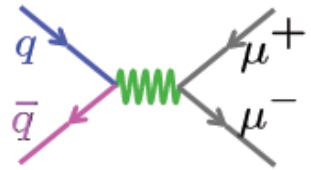
Sivers effect in Drell-Yan processes.
M. Anselmino, M. Boglione U. D'Alesio,
S. Melis, F. Murgia, A. Prokudin
Published in Phys.Rev.D79:054010, 2009

2. $\Lambda_{QCD} < p_T < Q$: - P_T should be small (~ 1 GeV), can be generated by intrinsic motion of quarks and/or by soft gluon emission. This is the region where TMD formalism applies.

Unpolarised Drell-Yan ➔ Paul Reimer seminar at Torino 13/04/2011

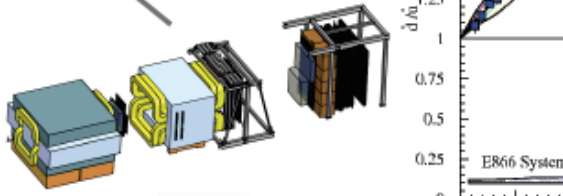
What can we learn with unpolarized Drell-Yan?

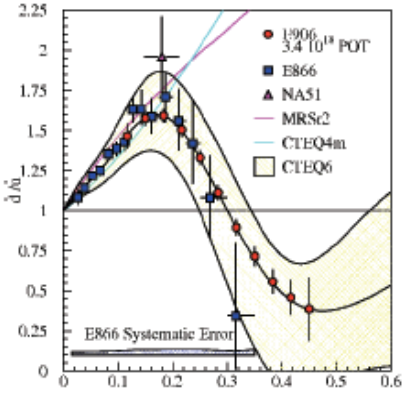
Paul E. Reimer
Physics Division
Argonne National Laboratory
13 April 2011

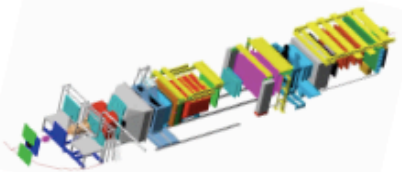


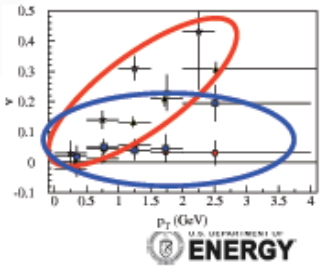
- **Proton** induced Drell-Yan
  - Sea of the proton and of nuclei
  - High-x valence distributions
  - Partonic energy loss in cold nuclear matter
- Pion (and Kaon) induced Drell-Yan
  - EMC effect
  - Valence structure of the pion and kaon
  - Transverse Structure & QCD via angular distributions
  - Sea of the pion?

$$Q_\pi^{sea} \equiv \int_0^1 x q_\pi^{sea}(x) dx = 0.01$$









This work is supported in part by the U.S. Department of Energy, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357.

We need very much unpolarised DY data to run successful polarised DY experiment

Why Drell-Yan @ COMPASS

1. Large angular acceptance spectrometer
2. SPS M2 secondary beams with the intensity up to 10^8 particles per second
3. Transversely polarized solid state proton target with a large relaxation time and high polarization, when going to spin frozen mode;
4. a detection system designed to stand relatively high particle fluxes;
5. a Data Acquisition System (DAQ) that can handle large amounts of data at large trigger rates;
6. The dedicated muon trigger system

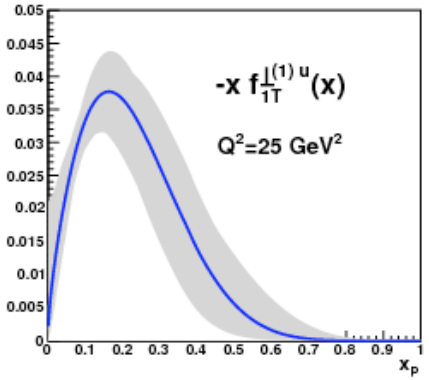
For the moment we consider two step DY program:

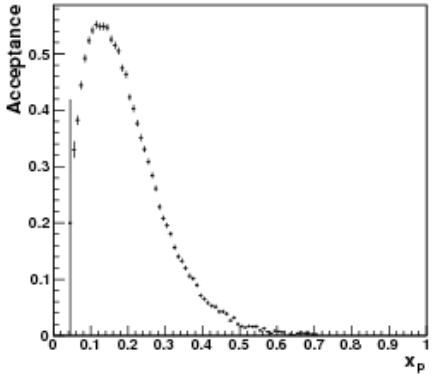
- The program with high intensity pion beam
- The program with Radio Frequency separated antiproton beam

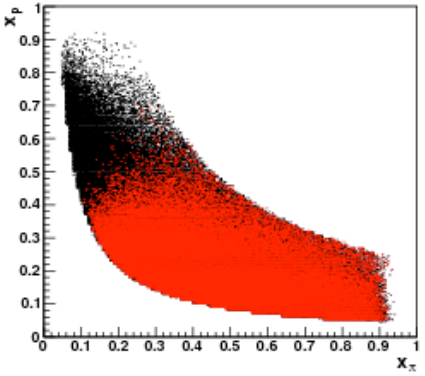
DY@COMPASS – kinematics - valence quark range

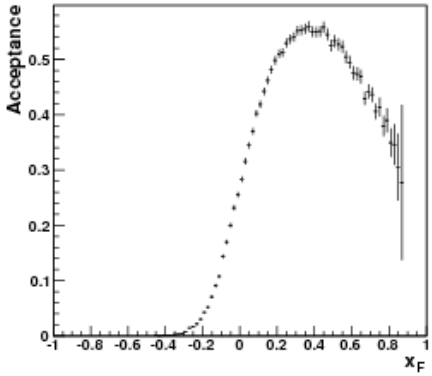
$\pi^- p \rightarrow \mu^- \mu X$ (190 GeV pion beam)

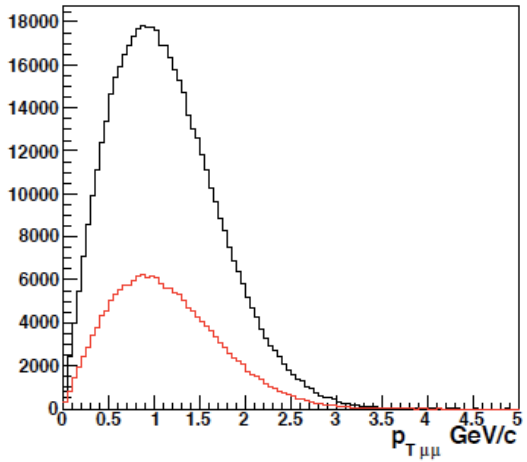
- In our case ($\pi^- p \rightarrow \mu^- \mu X$) contribution from valence quarks is dominant
- In COMPASS kinematics u-ubar dominance
- $\langle P_T \rangle \sim 1$GeV – TMDs induced effects expected to be dominant with respect to the higher QCD corrections





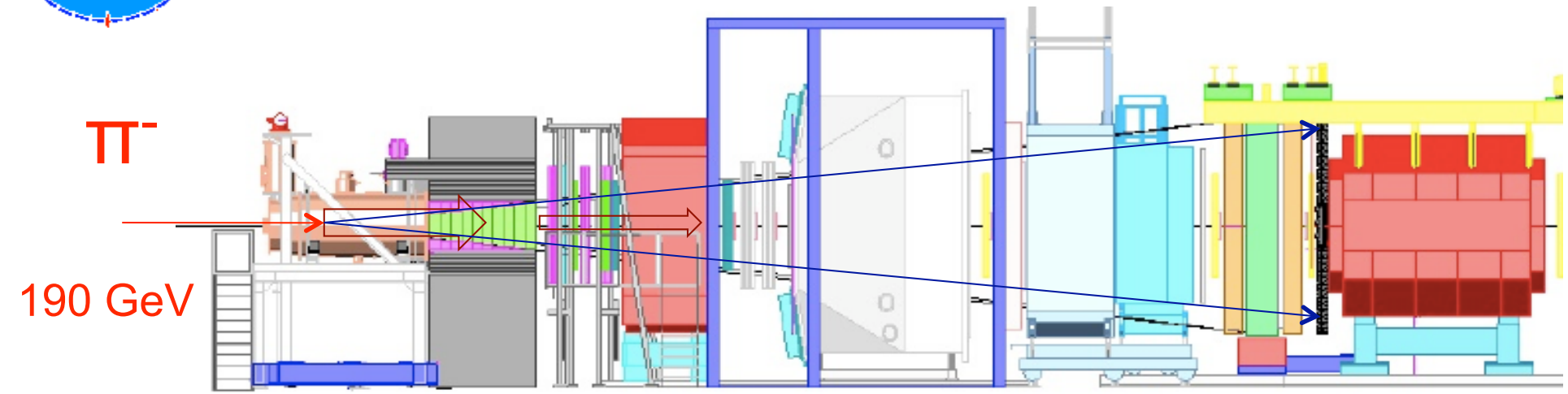






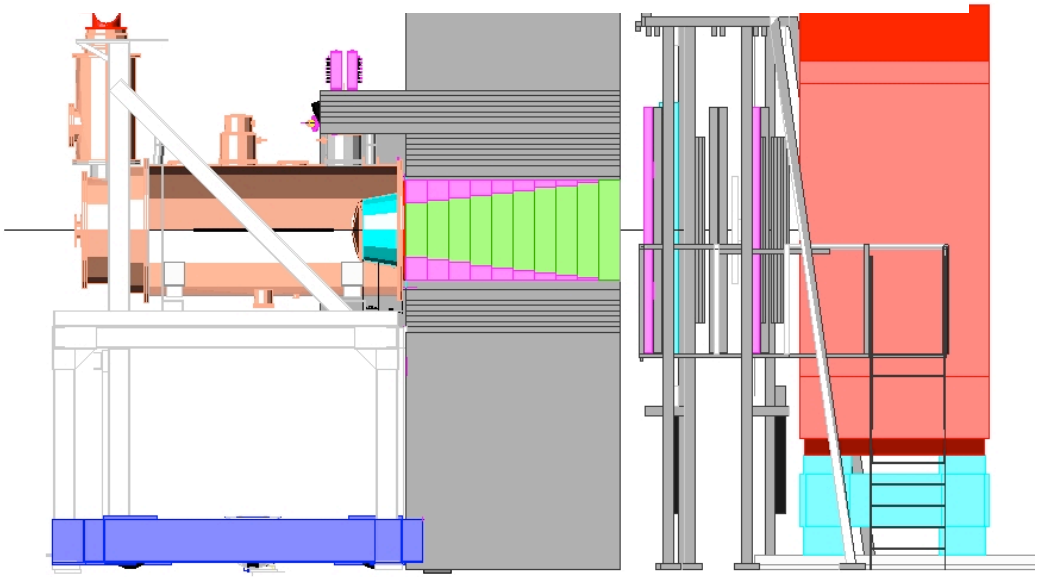
DY@COMPASS - set-up

$\pi^- p^\uparrow \rightarrow \mu^- \mu X$

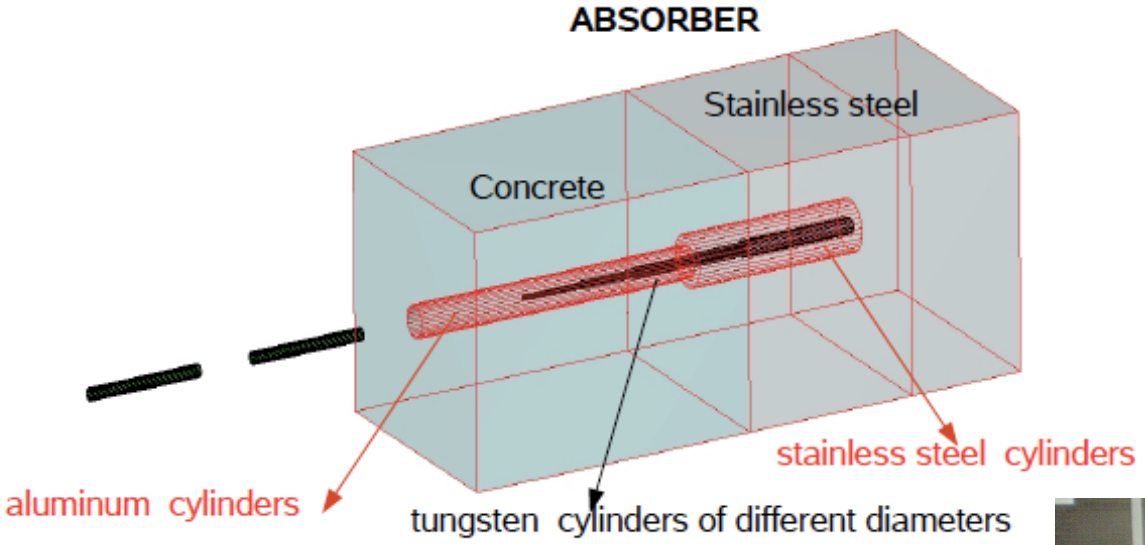


Key elements:

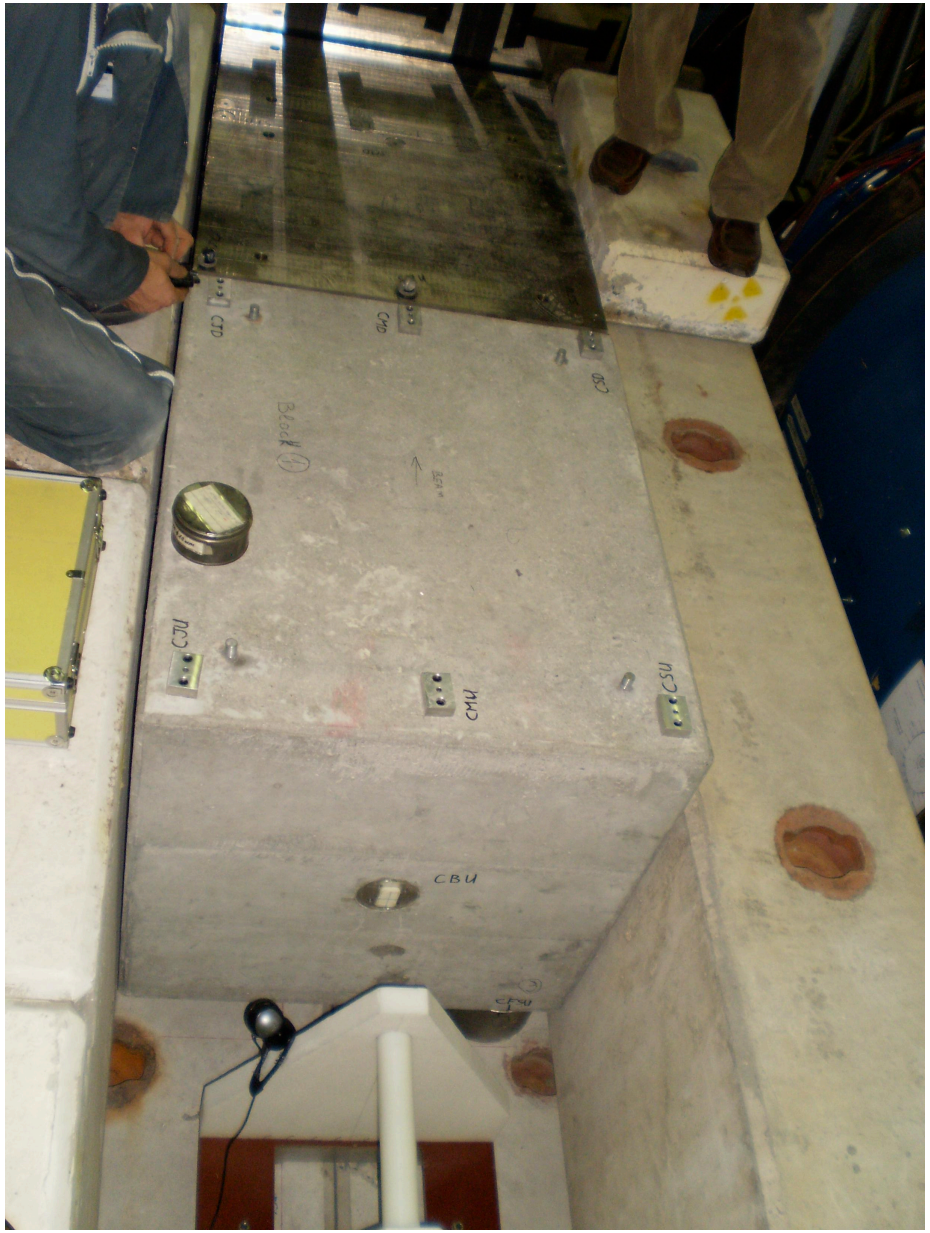
1. COMPASS PT
2. Tracking system (both LAS abs SAS) and beam telescope in front of PT
3. Muon trigger (in LAS is of particular importance - 60% of the DY acceptance)
4. RICH1, Calorimetry – also important to reduce the background (the hadron flux downstream of the hadron absorber ~ 10 higher then muon flux)



DY Feasibility@COMPASS: Beam Test 2009 – the most important in a row of three beam tests 2007-2009



DY Feasibility@COMPASS
Beam Test 2009 (with hadron absorber III)



Radiation in the experimental area, detector occupancies and J/Psi yeild:

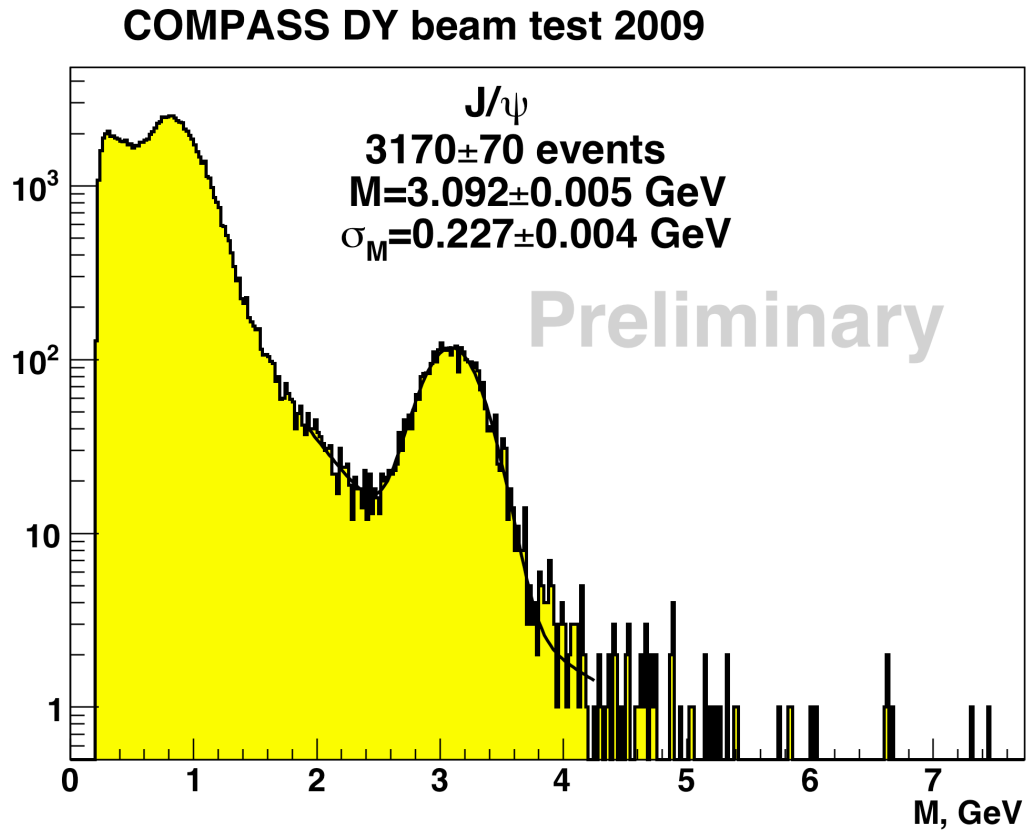
Everything as expected

17-05-2011

Oleg Denisov

DY@COMPASS - feasibility - Signal

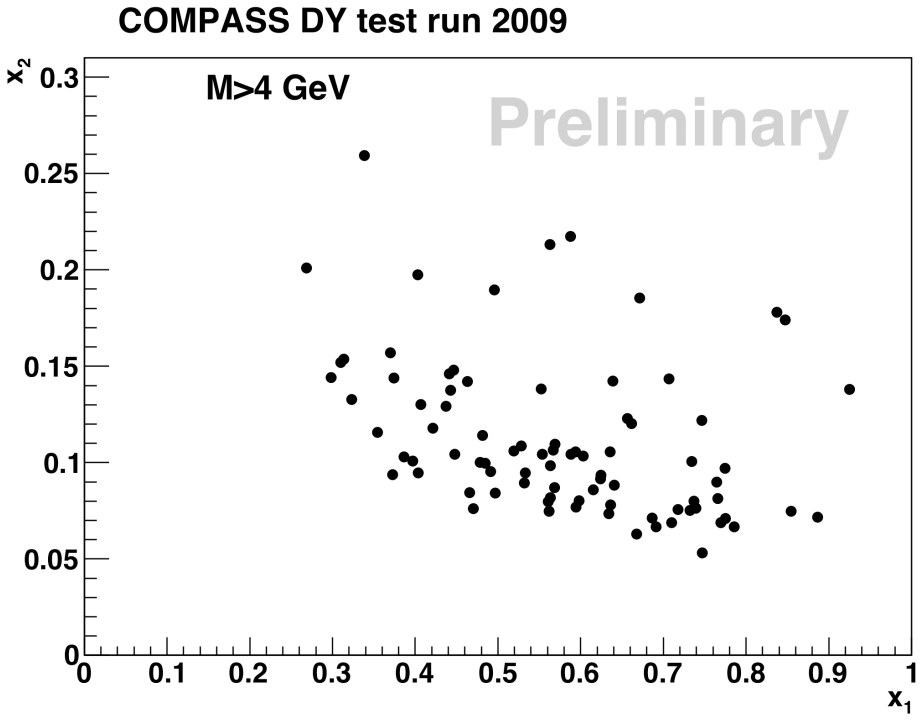
- Expected according to the proposal J/Psi and Drell-Yan yields: 3600±600 and 110±22 (normalized to 2009 beam flux ~3.7 x 10^{11})
- Measured in 2009 beam test J/Psi yield is 3170±70, and DY yield is 84±10

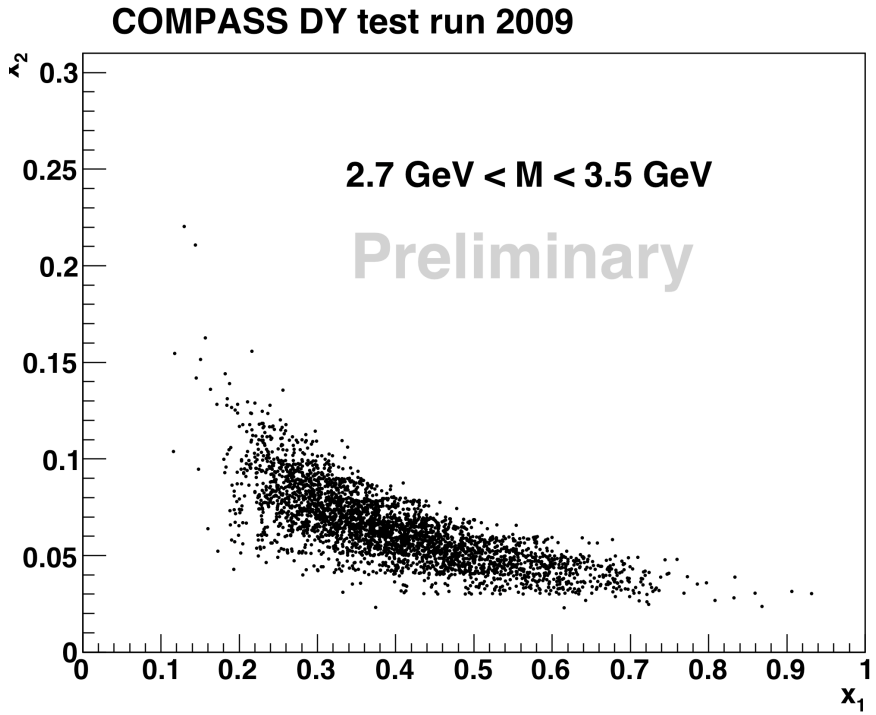


DY@COMPASS - feasibility – Kinematics I

- Valence quark range for both J/Psi and DY

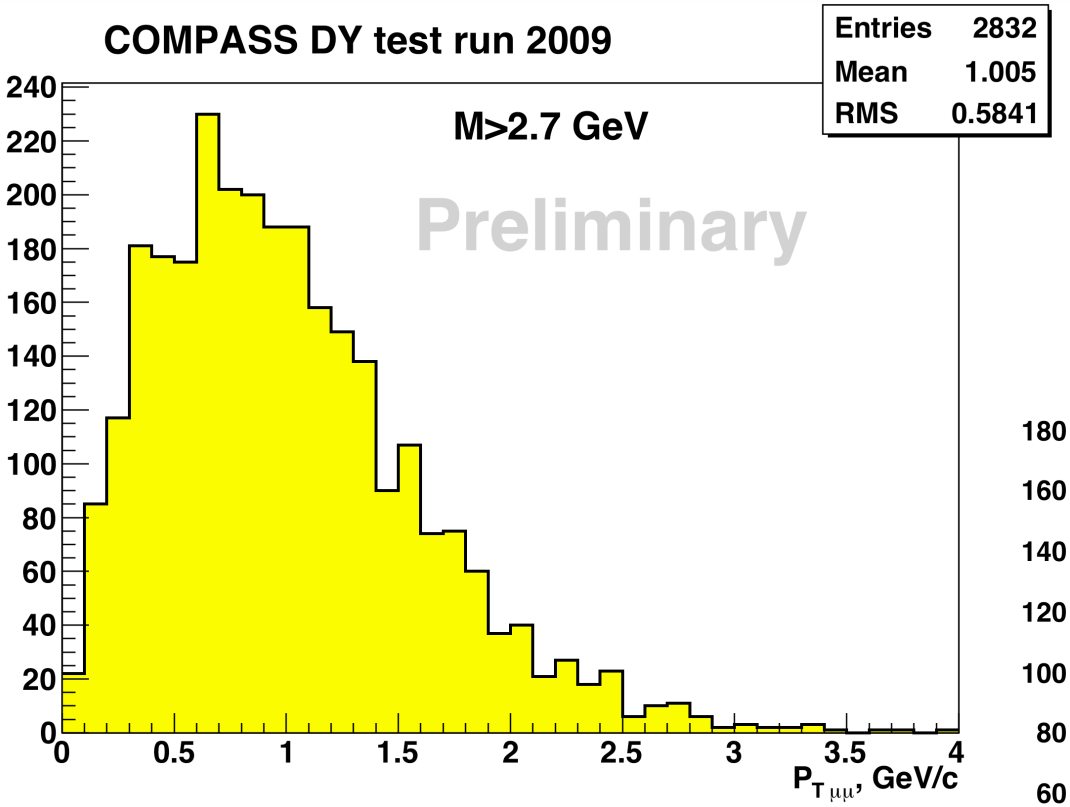
$$x_1 = \frac{Q^2}{P_1 q},$$
$$x_2 = \frac{Q^2}{P_2 q},$$
$$x_f = x_1 - x_2,$$

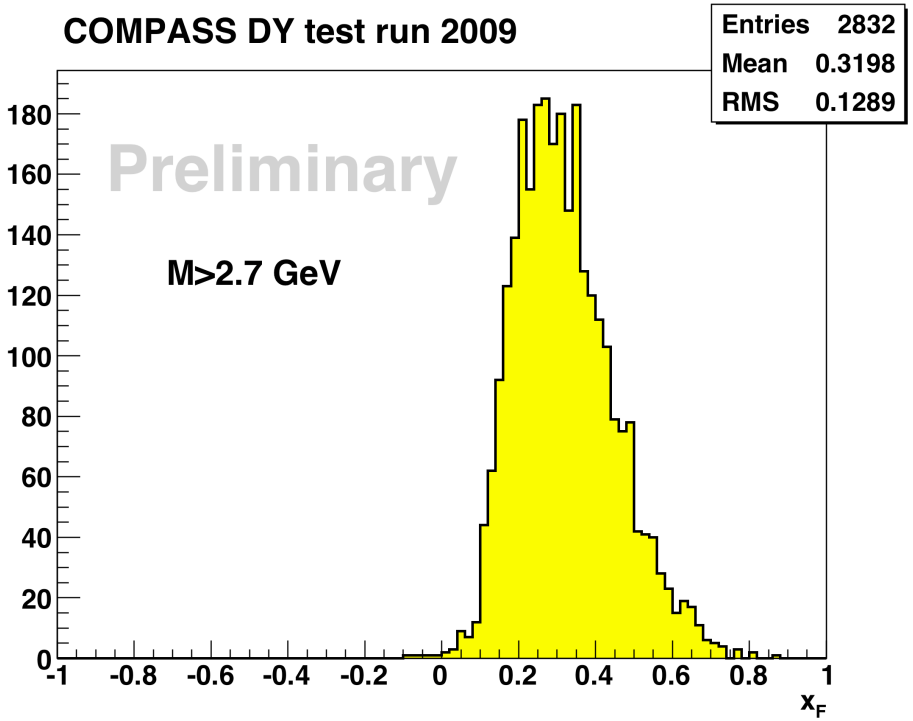




DY@COMPASS - feasibility – Kinematics II

q_T and x_F ranges





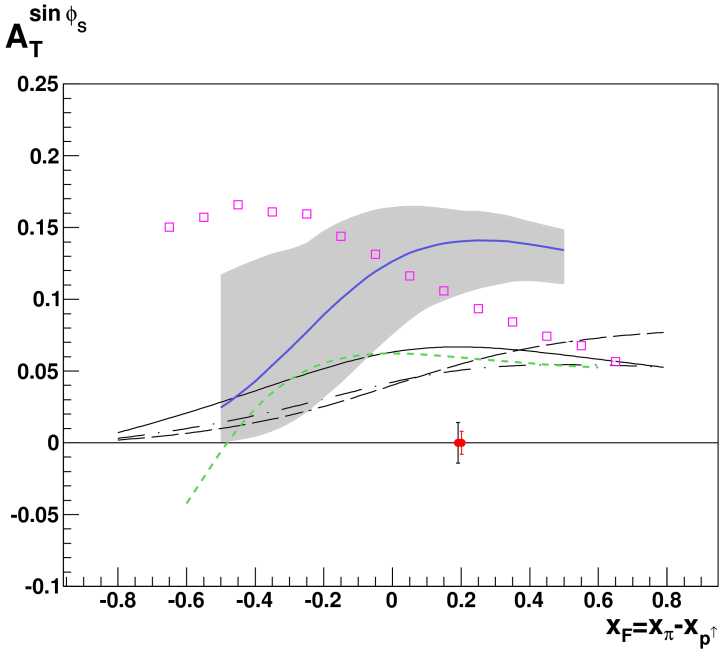
DY@COMPASS projections I

With a beam intensity $I_{beam} = 6 \times 10^7$ particles/second, a luminosity of $L = 1.7 \times 10^{33}\ cm^{-2}s^{-1}$ can be obtained.

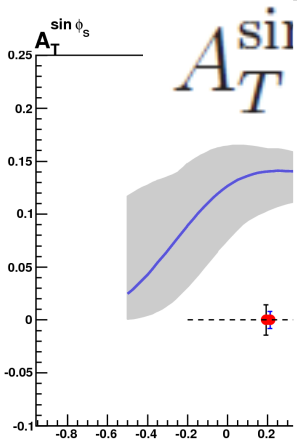
↪ Assuming 2 years of data-taking, one can collect > 200000 DY events in the region $4 < M_{\mu\mu} < 9.$ GeV/c^2.

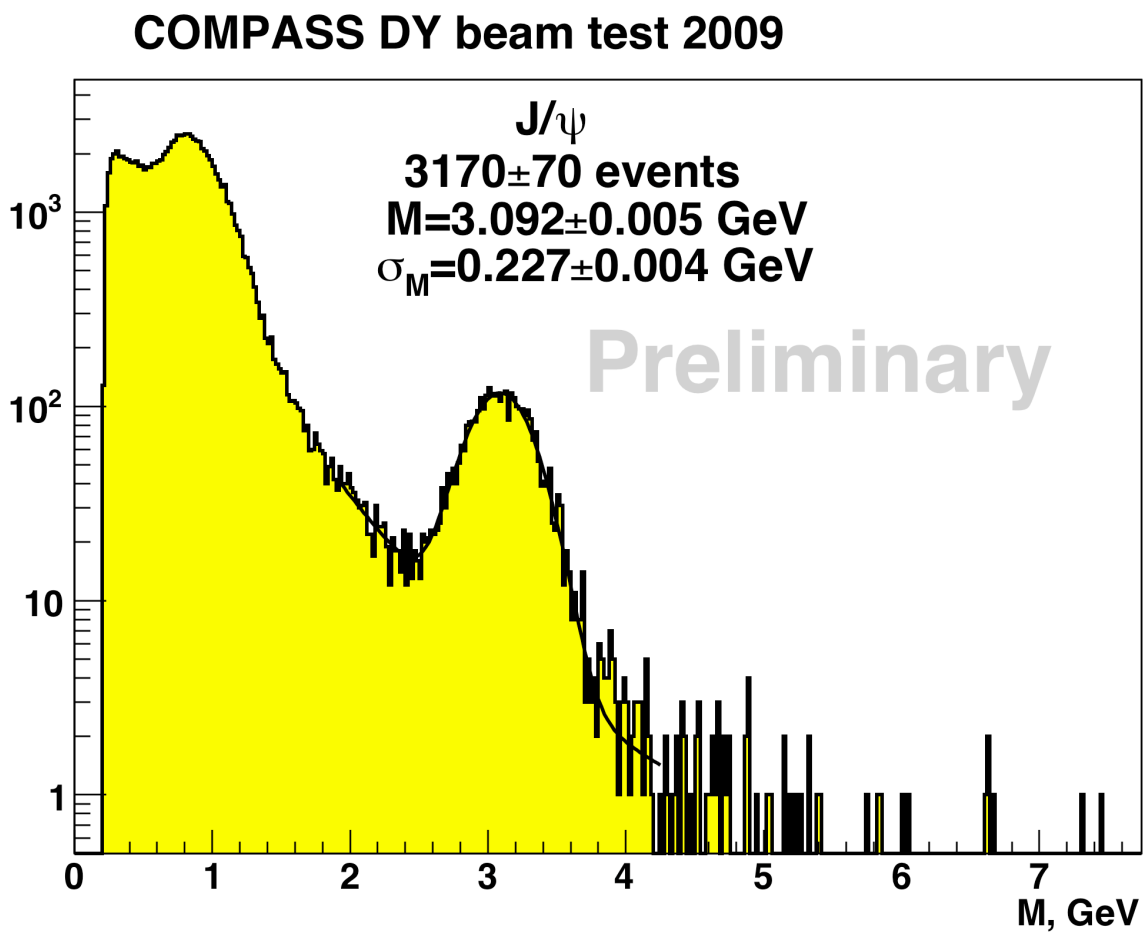
Predictions for the Sivers asymmetry in the COMPASS phase-space, for the mass region $4. < M < 9.$ GeV/c^2, compared to the expected statistical errors of the measurement:

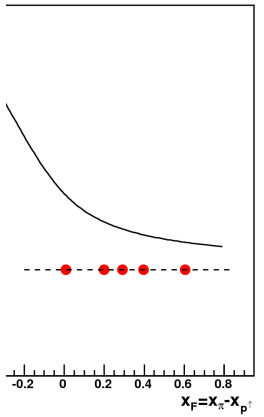
– solid and dashed: Efremov et al, PLB612(2005)233;
– dot-dashed: Collins et al, PRD73(2006)014021;
– solid, dot-dashed: Anselmino et al, PRD79(2009)054010;
– boxes: Bianconi et al, PRD73(2006)114002;
– short-dashed: Bacchetta et al, PRD78(2008)074010.

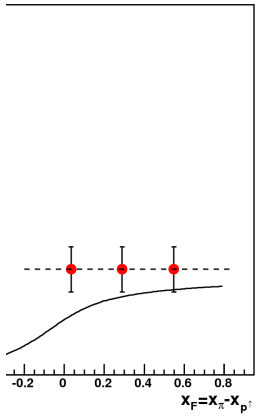


DY@COMPASS projections II





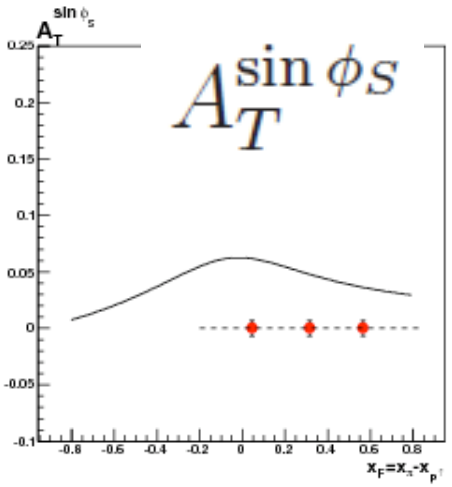


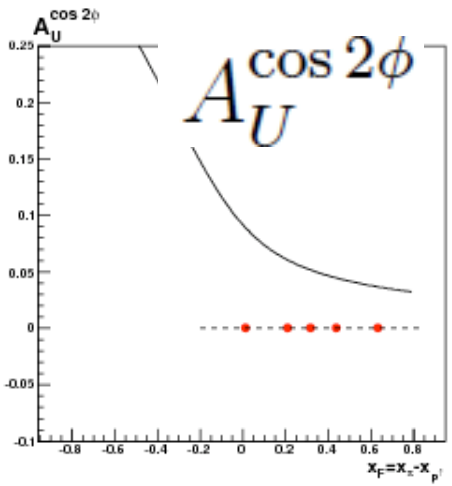


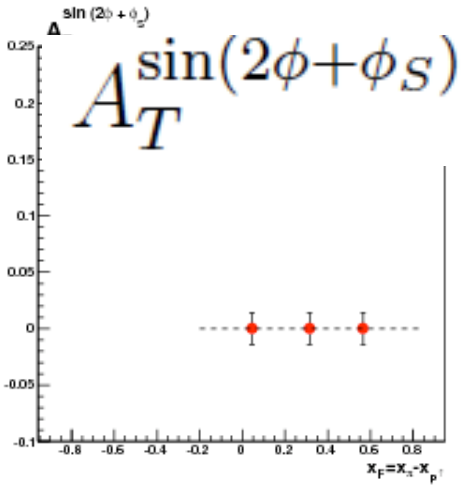
$(\mathrm{HMR})\colon 4. \leq M_{\mu\mu} \leq 9.\ \mathrm{GeV}/c^2 \quad (\mathrm{IMR})\colon 2.0 \leq M_{\mu\mu} \leq 2.5\ \mathrm{GeV}/c^2$

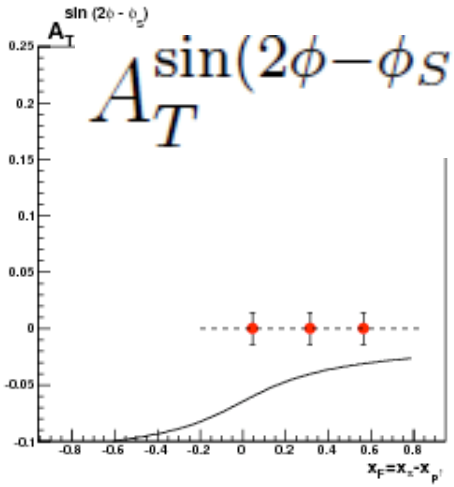
DY@COMPASS projections III

J/ψ region: $2.9 \leq M_{\mu\mu} \leq 3.2\ \mathrm{GeV/c^2}$





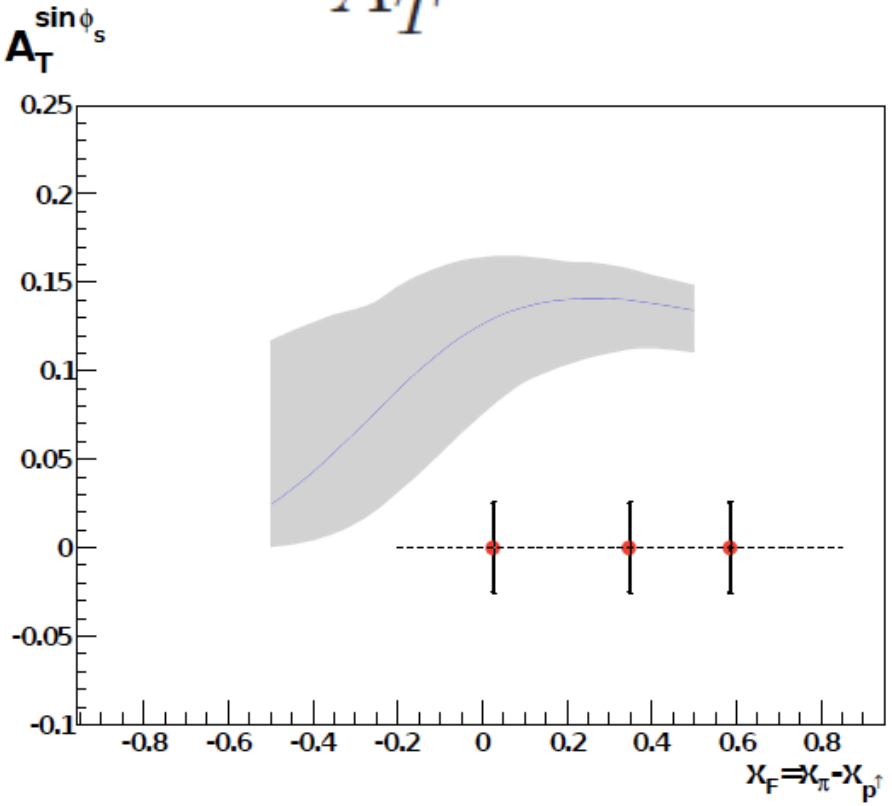




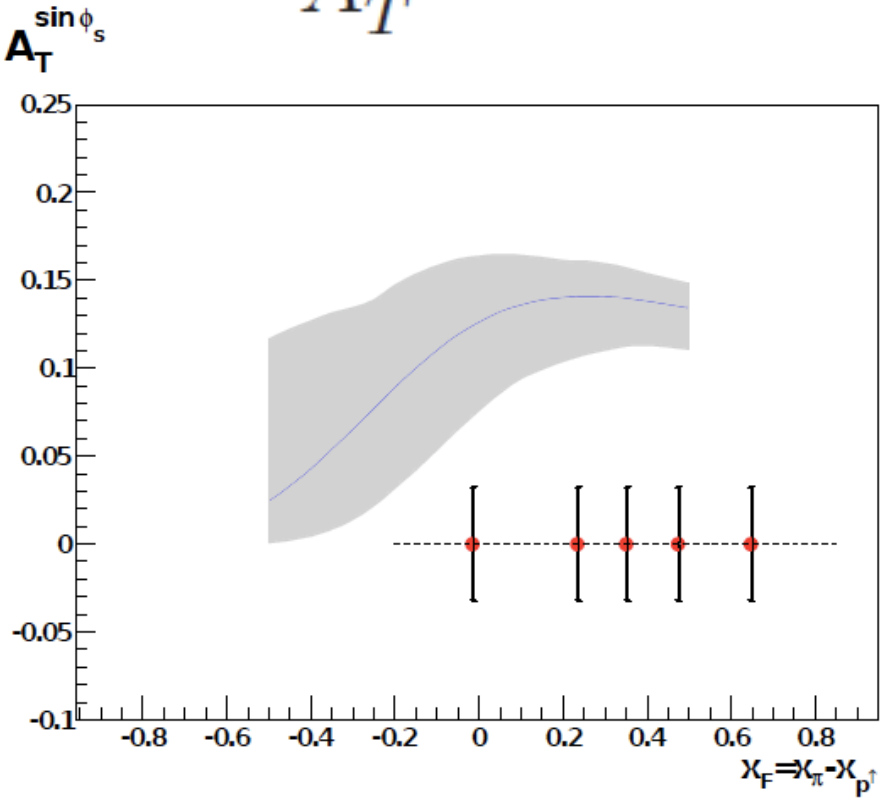
DY@COMPASS projections IV

$$(\mathrm{HMR}):\ 4. \leq M_{\mu\mu} \leq 9.\ \mathrm{GeV}/c^2$$

$A_T^{\sin\phi_S}$



$A_T^{\sin\phi_S}$



DY@COMPASS - set-up

$\pi^- p^\uparrow \rightarrow \mu^- \mu X$

The main characteristics of the future Drell-Yan experiment:

1. Small cross section ➔ High intensity hadron beam (up to 10^9 pions per spill) on the COMPASS PT

2. High intensity hadron beam on thick target ➔
    1. Hadron absorber to stop secondary particles flux
    2. Beam plug to stop the non interacted beam
    3. Radioprotection shielding around to protect things and people
    4. High-rate-capable radiation hard beam telescope

3. Hadron absorber + shielding ➔ PT has to be moved by 2.2 meters upstream

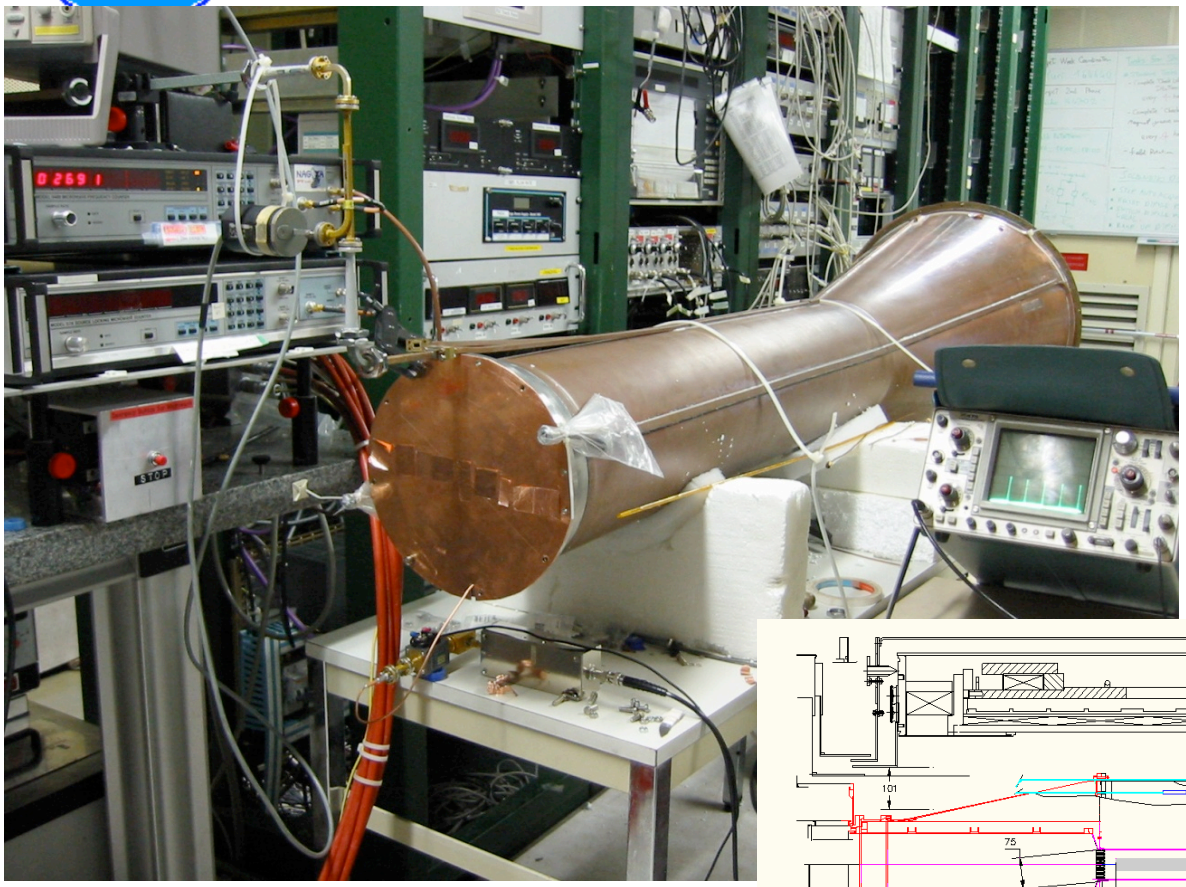
4. LAS dominates in the acceptance ➔The performance of the LAS tracking system must be improved and muon trigger in LAS has to be well tuned.

5. Hadron absorber ➔ vertex detector is very welcome to improve cell-to-cell separation

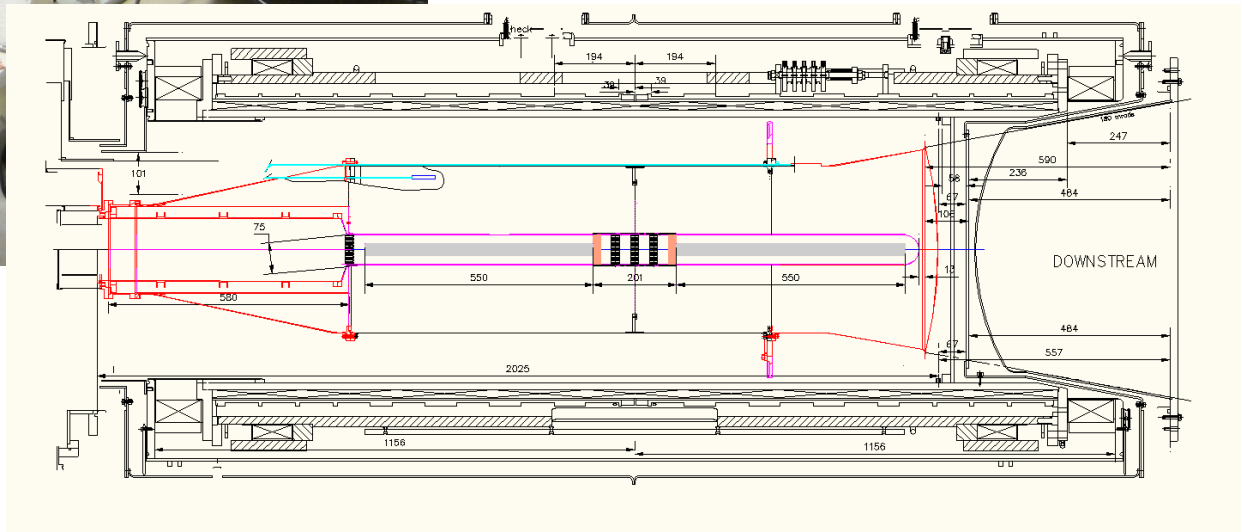
COMPASS-II DY list of upgrades

- COMPASS Polarised target:
  - New target holder (2x55 cm, 20 cm gap)
  - Old/modified Micro-Wave cavity (2 cells target)
  - PT Pump system refurbishing
- COMPASS PT has to be moved by ~2.2 meters upstream in order to release a space for the Hadron Absorber
- Hadron absorber (Alumina Al_2O_3) and beam plug (tungsten)
- Radio-Protection screen (stainless steel & borated polyeth.)
- New SciFi-based beam telescope
- H1 trigger hodoscope modification (central hole size adjustment)
- New vertex detector (SciFi based)
- New Large Area tracking station in the LAS
- Additional trigger hodoscope?

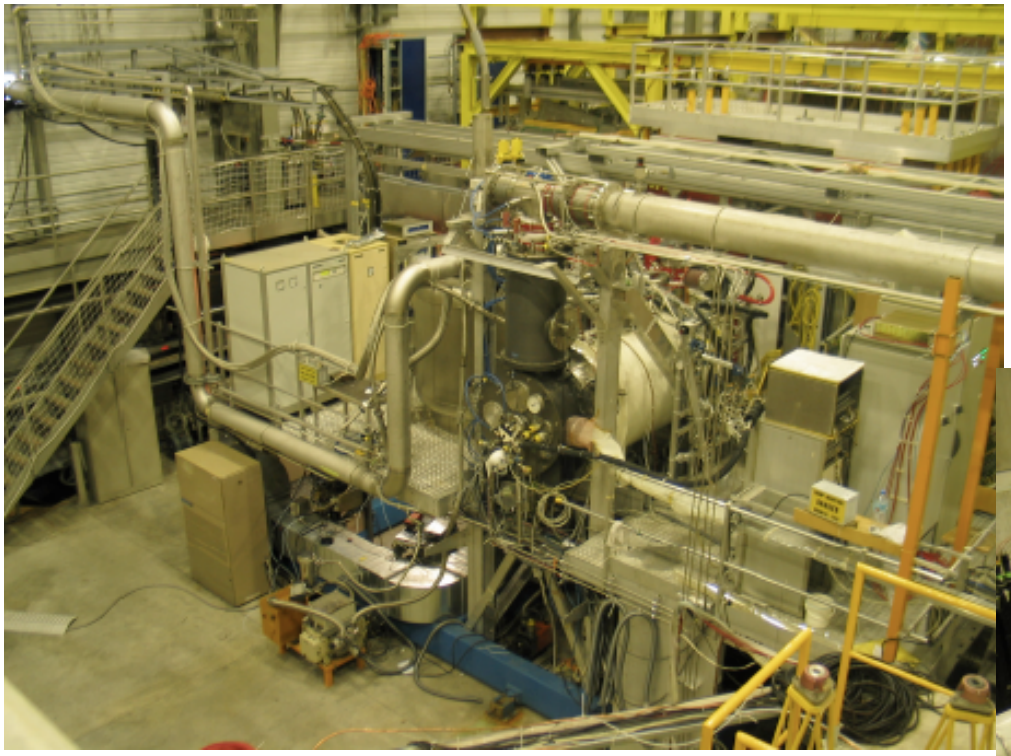
Polarised Target (mw cavity)

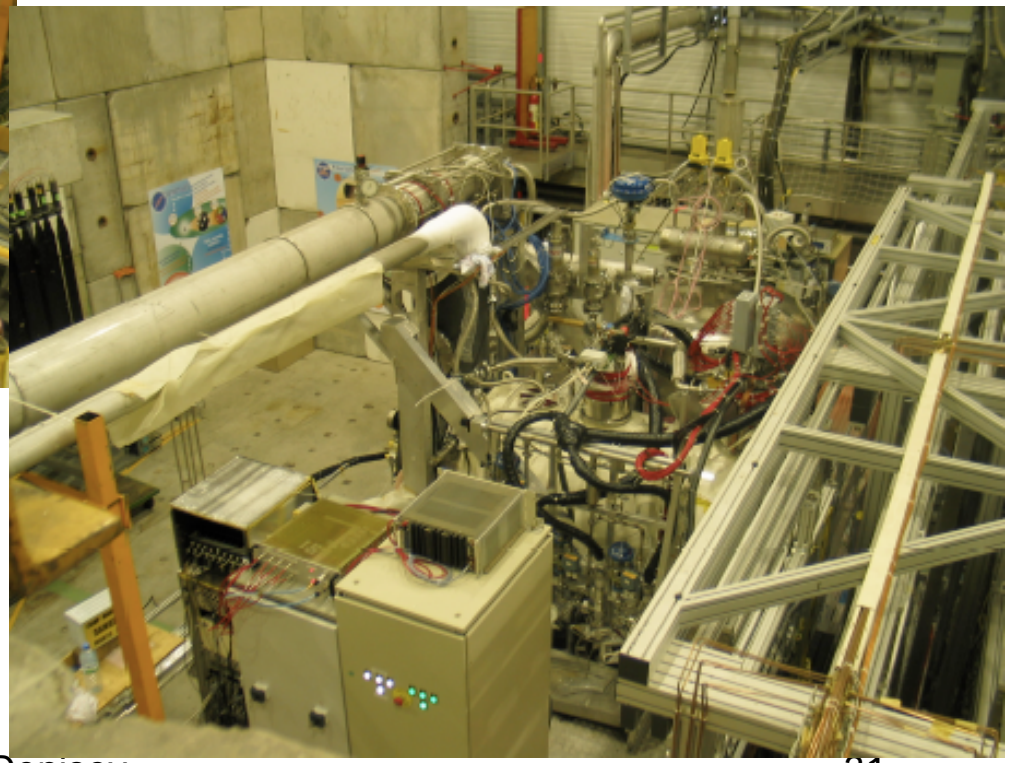


1. Modified standard OD cavity (3 cells)
2. Use old SMC 2 cell cavity (needs new support system in OD magnet)



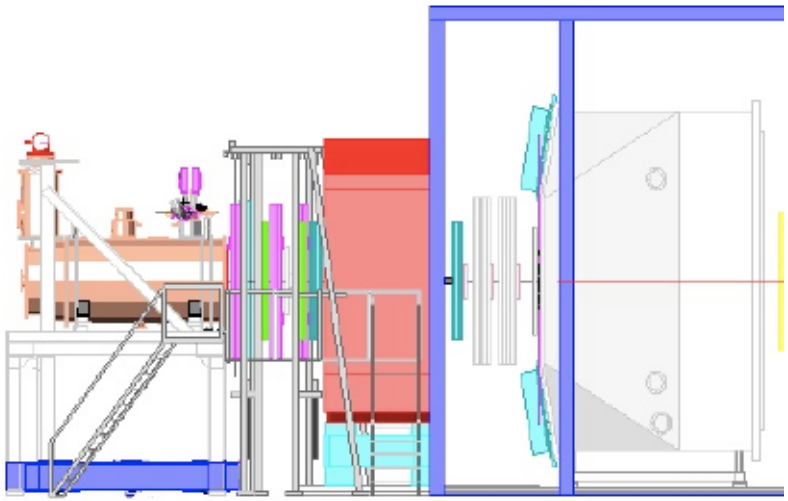
PT movement

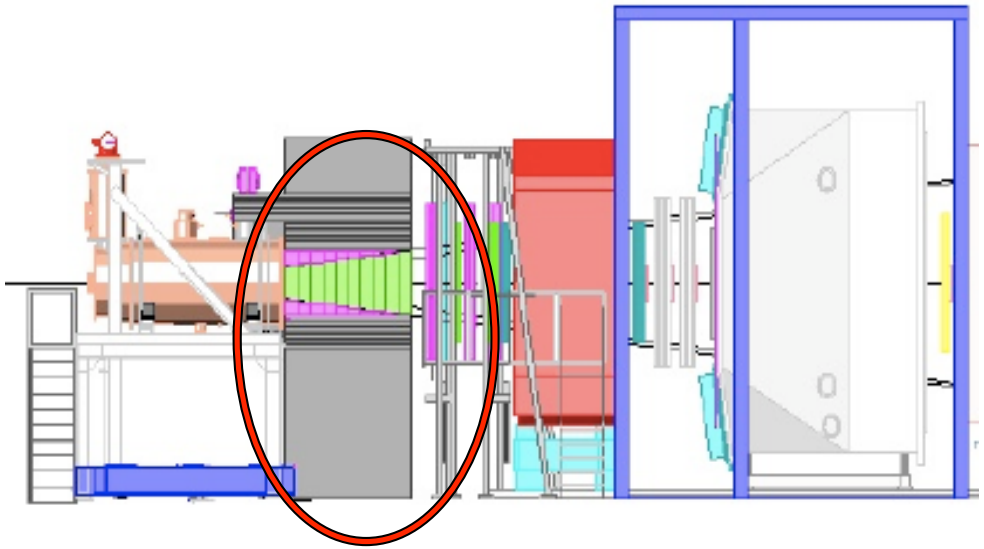


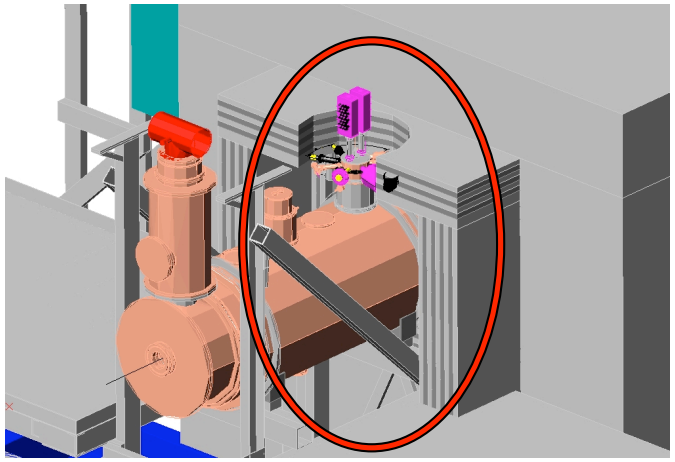


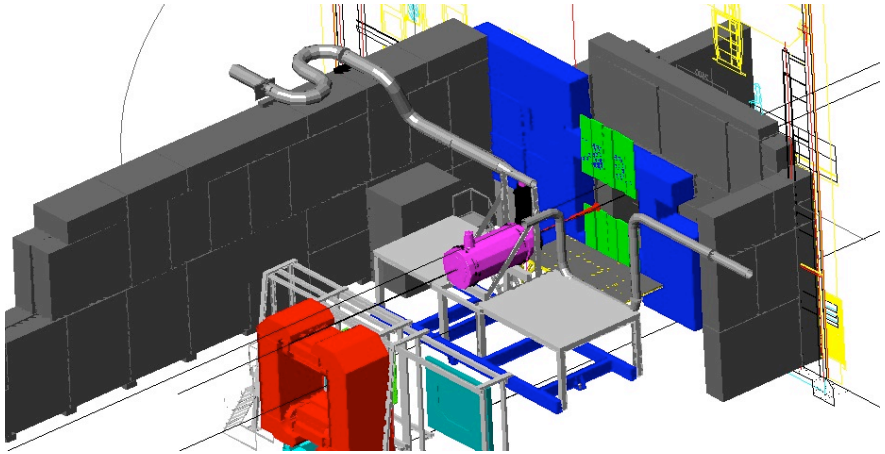
PT movement

Second step is the Drell-Yan set-up drawings production ➔ will be done by the beginning of May

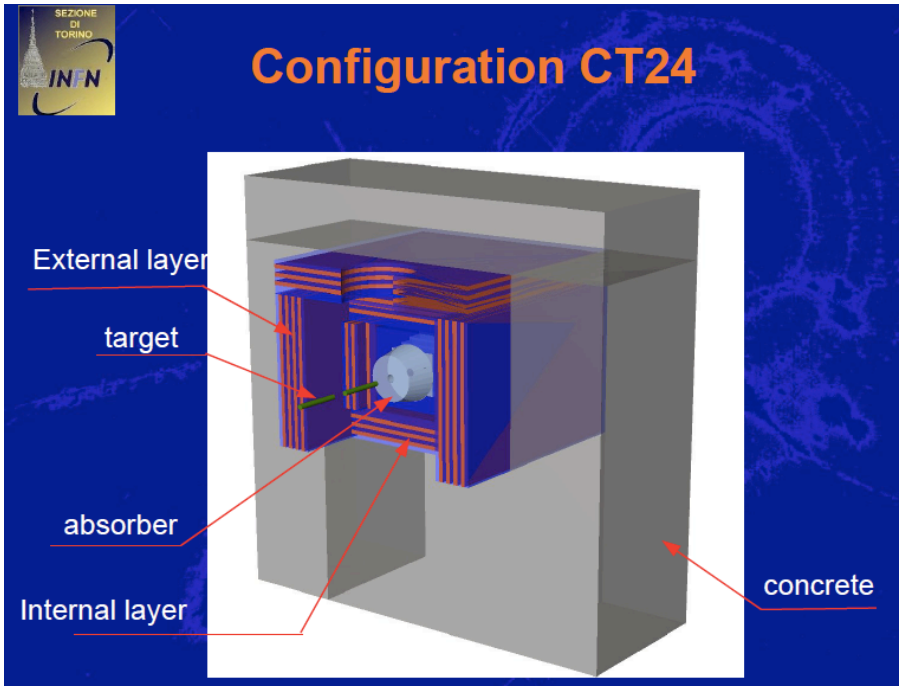






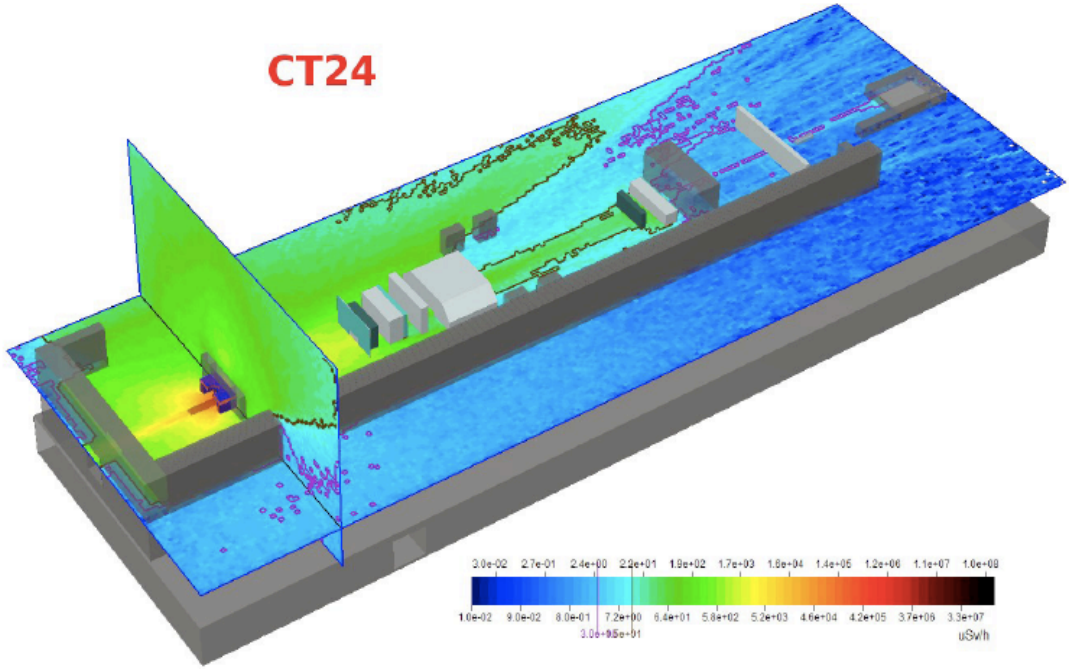


Hadron absorber & beam plug



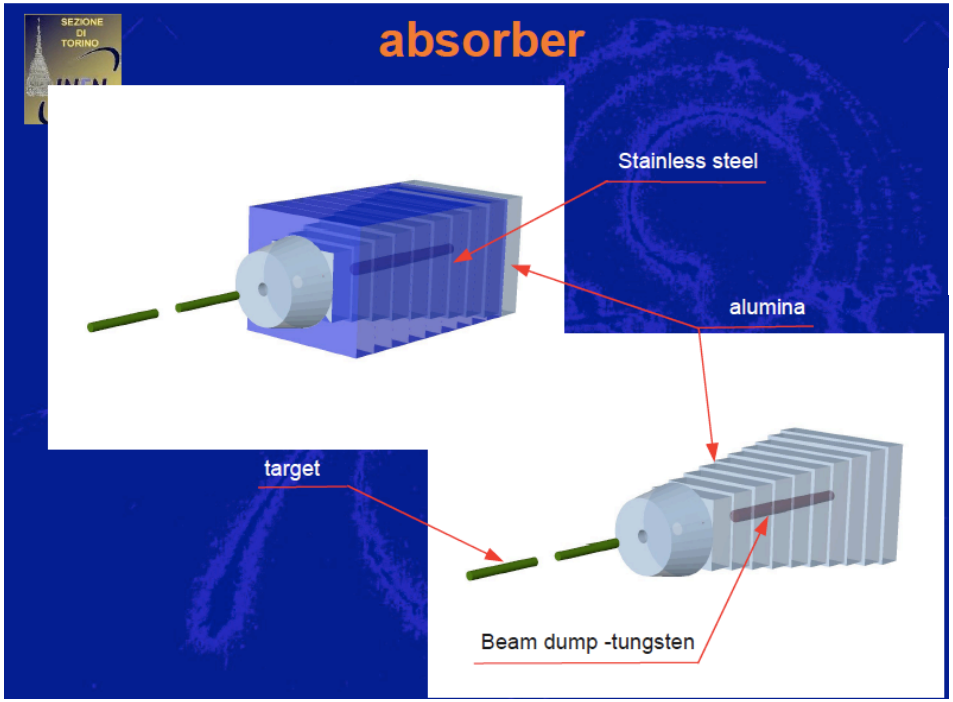
Purpose:

1. To stop the non-interacted beam
2. To spot secondary hadron flux to avoid spectrometer illumination
3. To protect people and things from the irradiation
4. Very COMPACT and TRANSPARENT



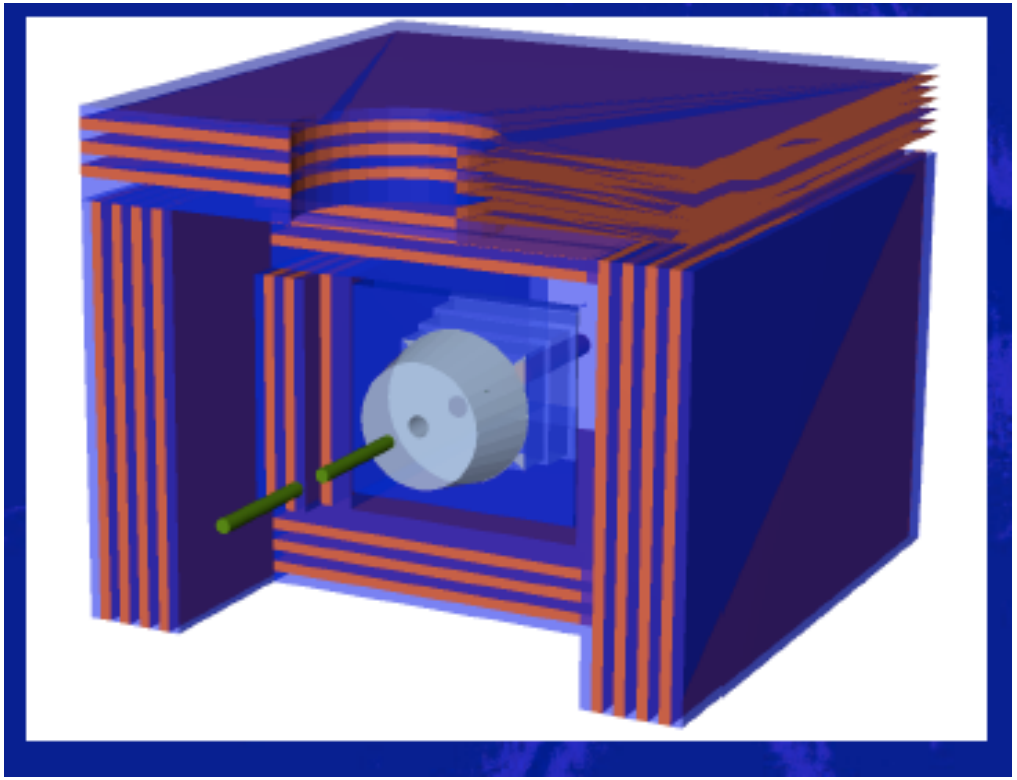
RP issue – approved by CERN RP for the maximal possible beam intensity 10^9 pions per spill and super cycle duration 33,6 s, flat top 10 s.

Hadron absorber & beam plug



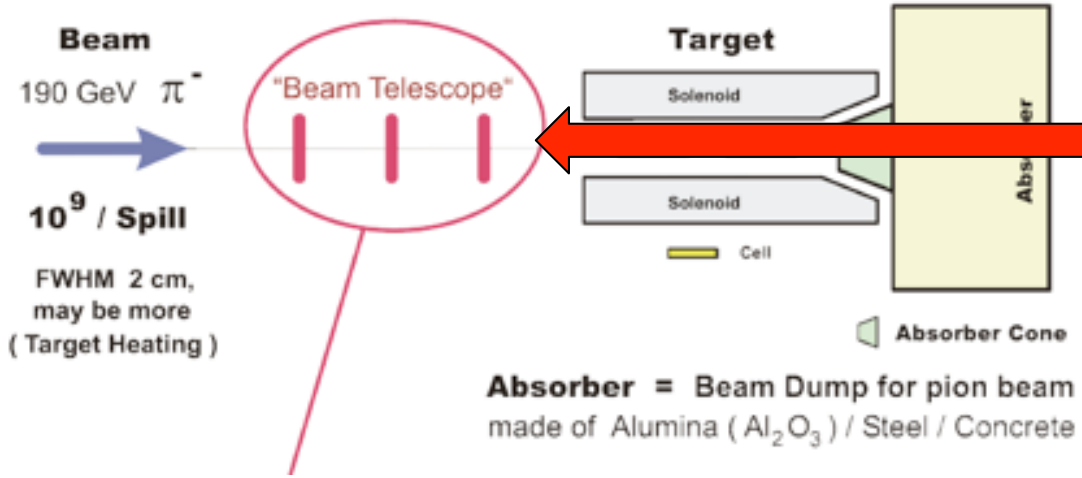
Al_2O_3 – ideal material, very good ratio X/λ

	X_0 [g/cm²]	ρ [g/cm³]	λ_{int} (π) [g/cm²]
Concrete	26,60	2,30	126,6
Alumina	27,94	3,97	129,3
Stainless Steel	13,94	7,90	160,9
Carbon	42,7	2,27	117,8



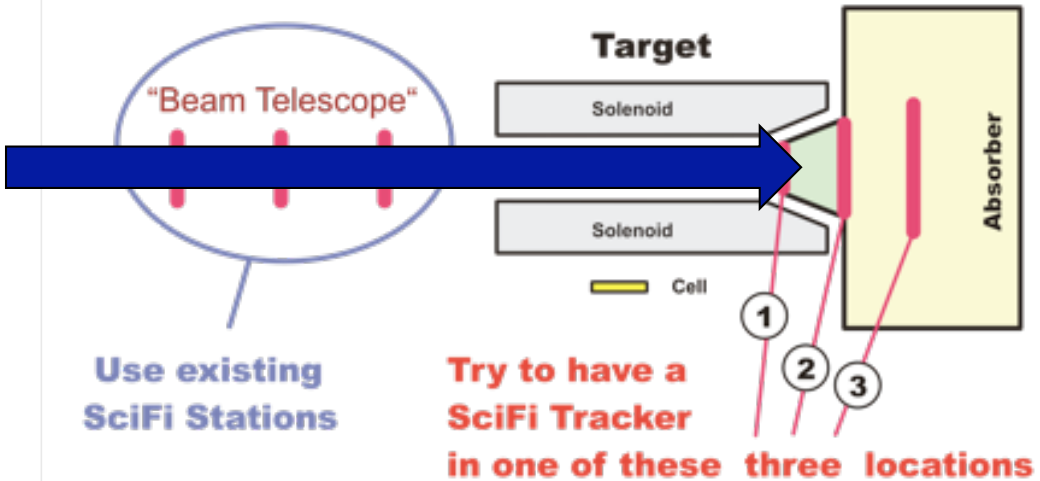
Must be compatible with the PT platform and the access to the PT instrumentation has to be provided

NEW SciFi telescope & vertex detector



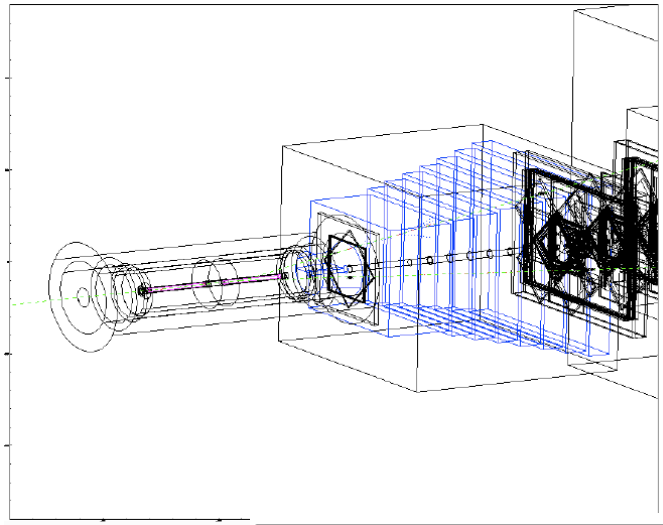
MUST

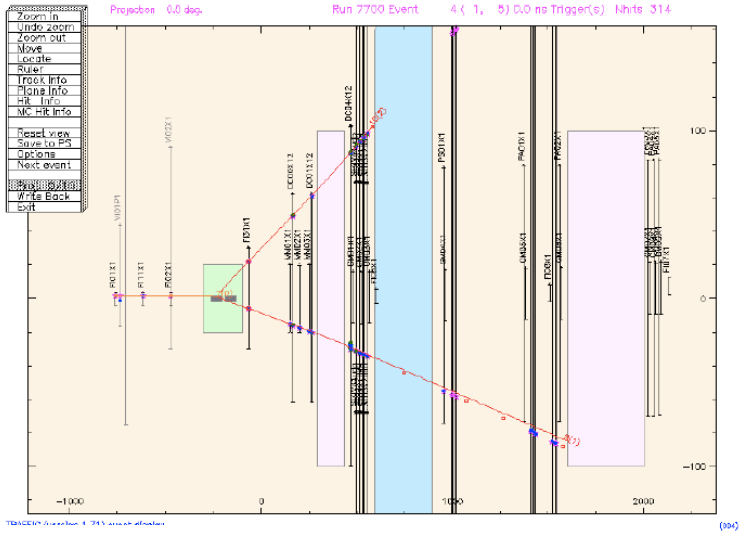
Very important



NEW Sci-Fi telescope & vertex detector

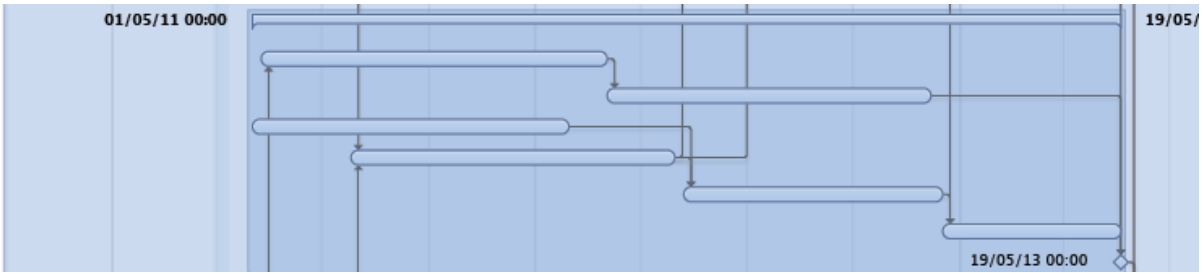
Very important but we can start without





Geometry	$\sigma_{\Delta M}$ (MeV/c^2)	$\sigma_{\Delta V_z}$ (cm)	$\sigma_{\Delta V_x}$ (cm)	$\sigma_{\Delta\phi}$ (mrad)	in target (z)	in target (z & r)
Solo Al_2O_3	172	6.3	0.09	64	89.0%	73.6%
Telescopio fascio	174	6.2	0.1	57	89.3%	74.3%
Vtx det 10 cm	142	3.2	0.08	52	92.6%	78.3%
Vtx det 15 cm	134	2.2	0.08	51	93.8%	79.7%
Vtx det 20 cm	132	2.0	0.08	50	94.6%	80.6%
Vtx det 60 cm	128	1.8	0.07	50	95.8%	82.2%

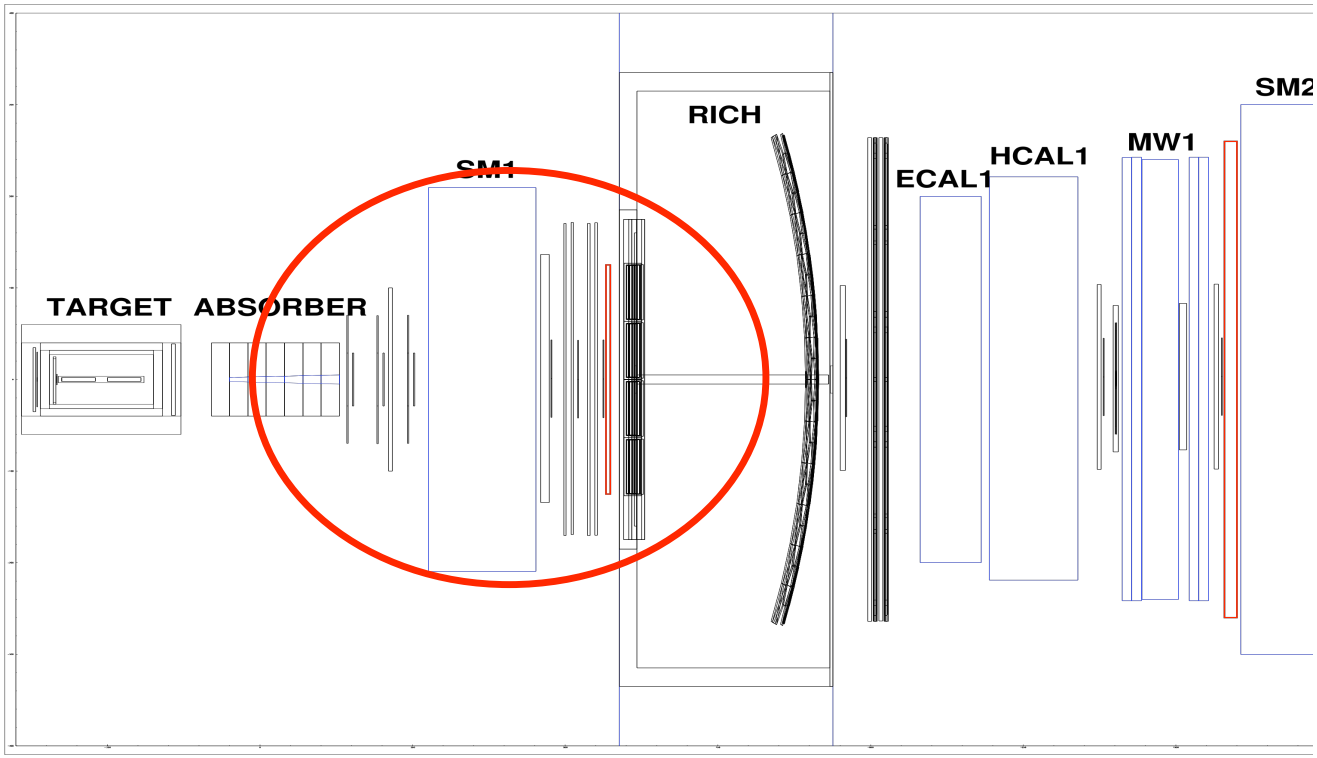
15) Beam telescope (SciFi's)	107s	**01/05/11 00:00**	
• 16) Design of the mechanical structure for beam telescope	42s 4g 1h	08/05/11 00:00	
• 17) Production of new detectors for the beam telescope	40s	01/03/12 00:00	
• 18) Feasibility study Vertex detector	39s 1h	01/05/11 00:00	
• 19) Conceptual design HA+Vertex detector	40s	24/07/11 00:00	
• 20) Design of the mechanics for the vertex detector	32s 1h	06/05/12 00:00	
• 21) Production of the new stations and design of the support	21s 6g 23h	16/12/12 00:00	
◆ 22) Test assembly with absorber		19/05/13 00:00	



Tracking Station in LAS

Drell-Yan muon pairs at COMPASS kinematics:

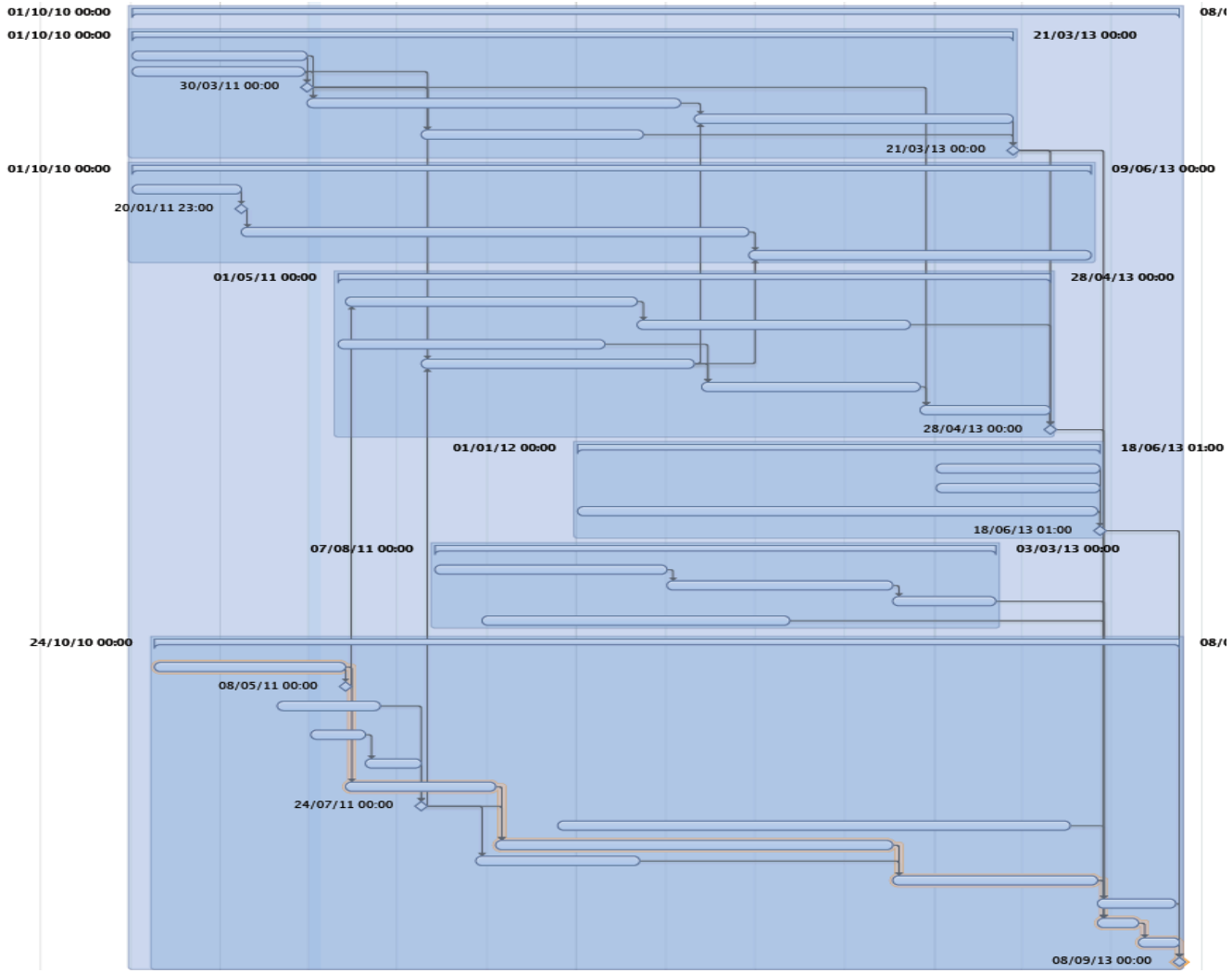
1. 60% both muons stays in LAS
2. 36% 1 muon in LAS and another in SAS



COMPASS-II DY preparation timelines: no show stopper

08/09/2013 – Drell-Yan experiment is ready for beam

1)	**Drell–Yan program upgrades**	153s 2g	**01/10/10 00:00**
2)	**Hadron absorber (HA)**	128s 6g 1h	**01/10/10 00:00**
3)	Hadron absorber MC study	25s 5g	01/10/10 00:00
4)	Hadron absorber RP opimiziation	25s 2g	01/10/10 00:00
5)	Concept design of the absorber		30/03/11 00:00
6)	Design of the absorber	54s 4g	30/03/11 00:00
7)	Absorber production	46s 4g 1h	29/04/12 00:00
8)	HA support stucture design	32s 4g 1h	24/07/11 00:00
9)	Test assembling HA+support		21/03/13 00:00
10)	**Radiorptection shieldings**	140s 2g	**01/10/10 00:00**
11)	Monte Carlo oprimisation	16s	01/10/10 00:00
12)	Decision on the concept of the shielding		20/01/11 23:00
13)	R/P shielding design + support stucture design	74s 2g	20/01/11 23:00
14)	R/P shielding + support production	50s	24/06/12 00:00
15)	**Beam telescope (SciFi's)**	104s	**01/05/11 00:00**
16)	Design of the mechanical structure for beam telescope	42s 4g 1h	08/05/11 00:00
17)	Production of new detectors for the beam telescope	40s	01/03/12 00:00
18)	Feasibility study Vertex detector	39s 1h	01/05/11 00:00
19)	Conceptual design HA+Vertex detector	40s	24/07/11 00:00
20)	Design of the mechanics for the vertex detector	32s 1h	06/05/12 00:00
21)	Production of the new stations and design of the support	18s 6g 23h	16/12/12 00:00
22)	Test assembly with absorber		28/04/13 00:00
23)	**Trigger system modification**	76s 2g	**01/01/12 00:00**
24)	H1 modification (central hole)	24s	01/01/13 00:00
25)	Trigger configuration/logic modufucation	24s	01/01/13 00:00
26)	??? Additional trigger hodoscope (extentions to the existing)??	75s 6g 23h	01/01/12 00:00
27)	Trigger system ready		18/06/13 01:00
28)	**Polarised Target modification**	82s 1h	**07/08/11 00:00**
29)	Microwave cavity design	34s	07/08/11 00:00
30)	Microwave cavity construction	33s 1h	01/04/12 00:00
31)	Microwave cavity test	15s	18/11/12 00:00
32)	Target holder design and construction	45s	25/09/11 00:00
33)	**Target region modification**	150s	**24/10/10 00:00**
34)	Lay–out of the DY experiment (upstream part)	28s	24/10/10 00:00
35)	Preliminary lay–out fixed		08/05/11 00:00
36)	Access to the are (doors etc.) – discussion with CERN (Lau)	14s 6g 23h	27/02/11 00:00
37)	Study of the radiation influence on the sensitive elements PT + electronics	8s	03/04/11 00:00
38)	Optimisation of the sensitive elepent positioning in the area	8s	29/05/11 00:00
39)	Plan for the PT infrastructure modification (piping etc.)	22s	08/05/11 00:00
40)	Final DY lay–out		24/07/11 00:00
41)	PT pump system refurbishing	74s 6g 23h	11/12/11 00:00
42)	PT Infrastructure modification	58s 1h	09/10/11 00:00
43)	PT platform modification	24s	18/09/11 00:00
44)	PT movement + infrastructure assembling	29s 6g 23h	18/11/12 00:00
45)	PT cooling down and test polarisation	11s 2g 22h	16/06/13 00:00
46)	HA installation	6s	16/06/13 00:00
47)	Radioprotection shielding installation	6s	28/07/13 00:00
48)	Ready for data taking		08/09/13 00:00



COMPASS Running until 2016 III

Decision by the Collaboration (F.K. slide):

2014-2016

Tentative schedule

2012	Primakoff	18 weeks
	GPDs	6 weeks
2014	Drell-Yan	
2015	GPDs	
2016	GPDs	

End of 2013 – short DY test very desirable

2013 Long shut down necessary for PT mouvement and installation

→ Agreed upon

COMPASS: Summary

- Pion and, later probably antiproton beams (50-200 GeV)
- Drell-Yan process dominated by the contribution from the valence quarks (both beam and target), $\tau = x_1 x_2 = Q^2/s \cong 0.05 \div 0.3$
- Solid state polarised targets, NH_3 and ^6LD, in case of hydrogen target
- Statistical error on single spin asymmetries after one year of running is on the level 1÷2%
- The proposal was recommended by SPSC for approval on September 29th. The initial recommendation is for 3 years (likely 2013-2015). The SPSC also proposes a schedule of two years GPD and one year DY.
- Proposal is approved by the CERN Research Board on December 1st 2010.
- During the last Collaboration meeting the decision is taken by the Collaboration to run first Drell-Yan experiment (2013 ➔ 2014) and then DVCS program.
- Looking at the huge activity in the field a lot of new DY data is just behind the corner