First results on the longitudinal double spin asymmetry A_1^p and g_1^p from the 2011 COMPASS data

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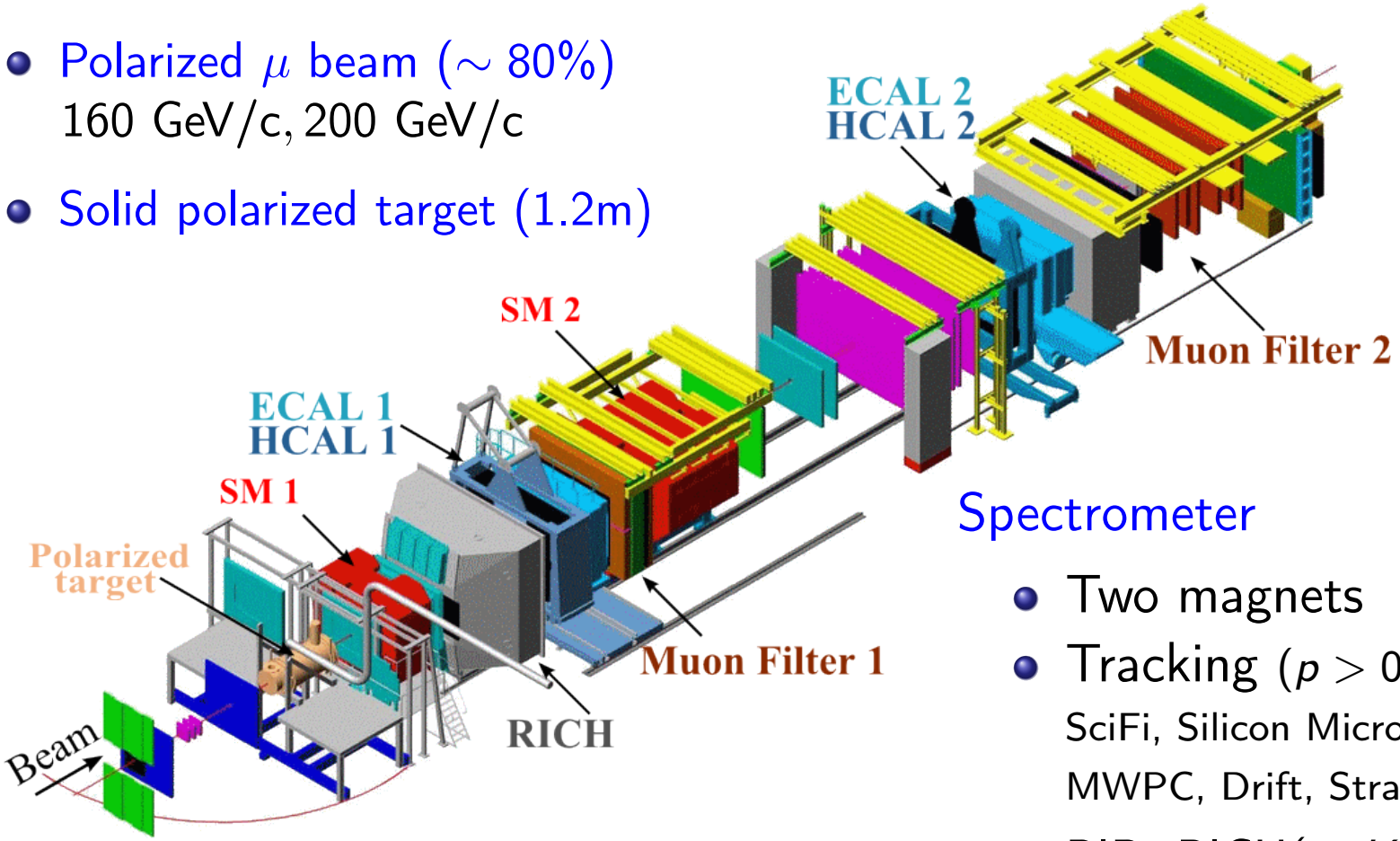
COMPASS @ CERN

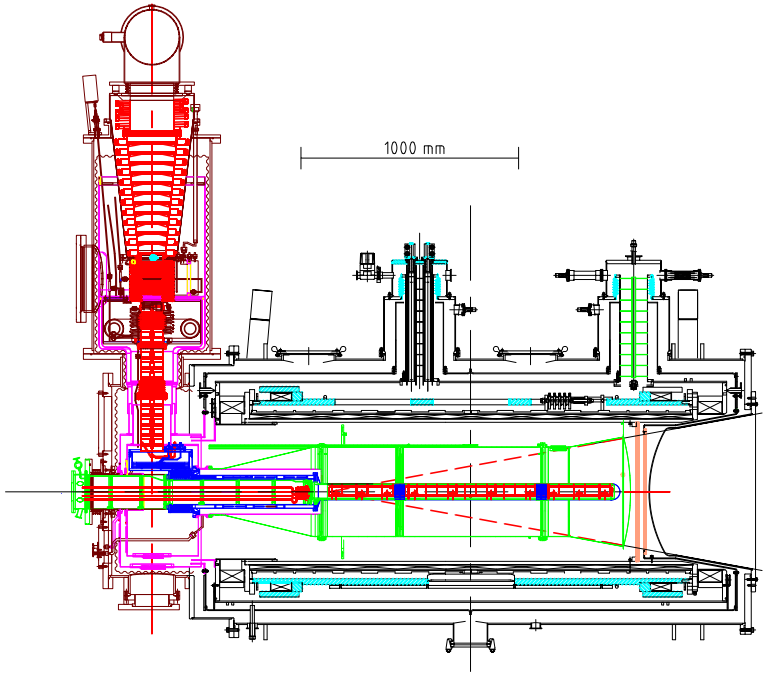
- M2 beamline
- Polarized μ beam ($\sim 80\%$)
  160 GeV/c, 200 GeV/c
- Solid polarized target (1.2m)

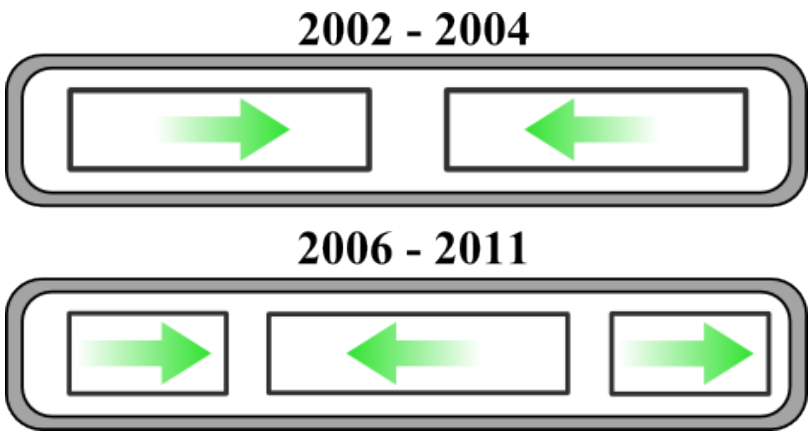


Spectrometer

- Two magnets
- Tracking ($p > 0.5$ GeV/c)
  SciFi, Silicon MicroMega, Gem
  MWPC, Drift, Straws, Driftubes
- PID: RICH(π, K, p)
  ECAL, HCAL, muon filters

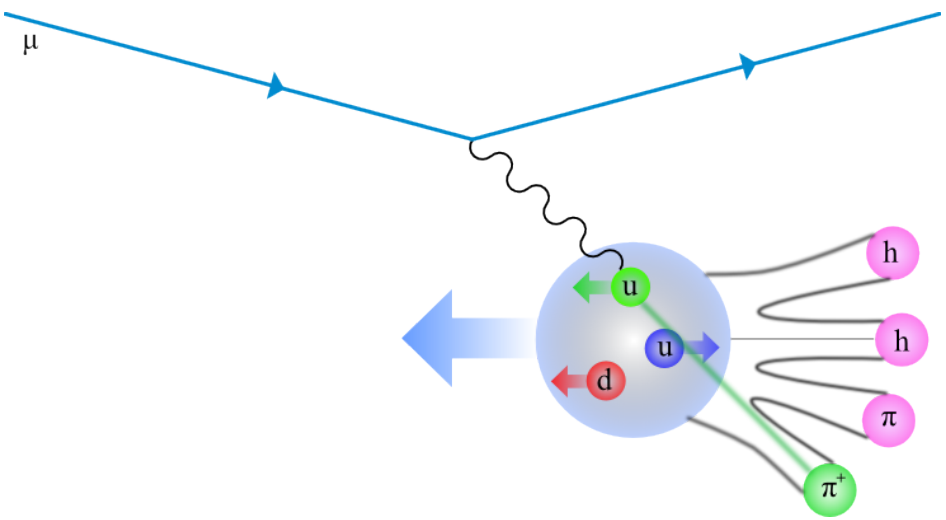
Polarized target





- Upgrade of the target system in 2005
- Three target cells, oppositely polarized
- 180 mrad geometrical acceptance
- Regular polarization reversals by field rotation
- NH_3 (Longitudinal proton polarization: $\sim 90\%$)

Deep Inelastic Scattering

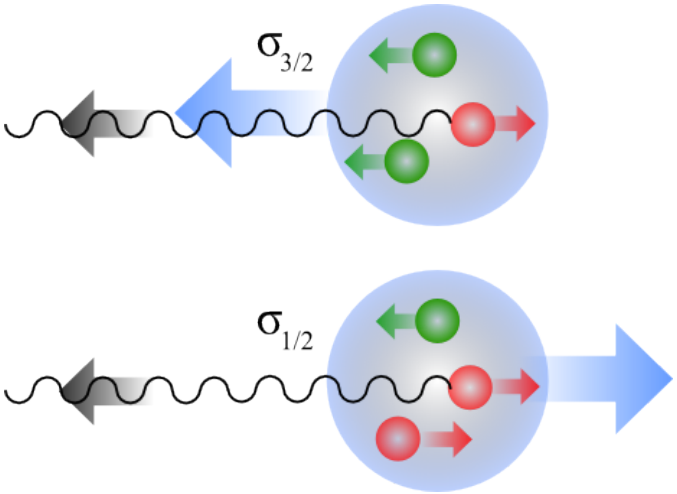


- 4-momentum of the virtual photon: $q = k - k'$
- Energy of the virtual photon: $\nu = \frac{Pq}{M} \overset{\text{lab}}{=} E - E'$
- $Q^2 = -q^2 \overset{\text{lab}}{\approx} 4EE' \sin^2 \frac{\theta}{2}$
- Bjorken scaling variable: $x \overset{\text{lab}}{=} \frac{Q^2}{2M\nu}$
- $y \overset{\text{lab}}{=} \frac{\nu}{E}$

Inclusive cross section:

$$\frac{\mathrm{d}^2\sigma}{\mathrm{d}\Omega \mathrm{d}E'} \sim \underbrace{c_1 F_1(x, Q^2) + c_2 F_2(x, Q^2)}_{\text{spin independent}} + \underbrace{c_3 g_1(x, Q^2) + c_4 g_2(x, Q^2)}_{\text{spin dependent}}$$

Polarized Deep Inelastic Scattering



- Absorption of polarized photons
  $\sigma_{1/2} \sim q^+$
  $\sigma_{3/2} \sim q^-$
- $q(x) = q(x)^+ + q(x)^-$
  $\Delta q(x) = q(x)^+ - q(x)^-$

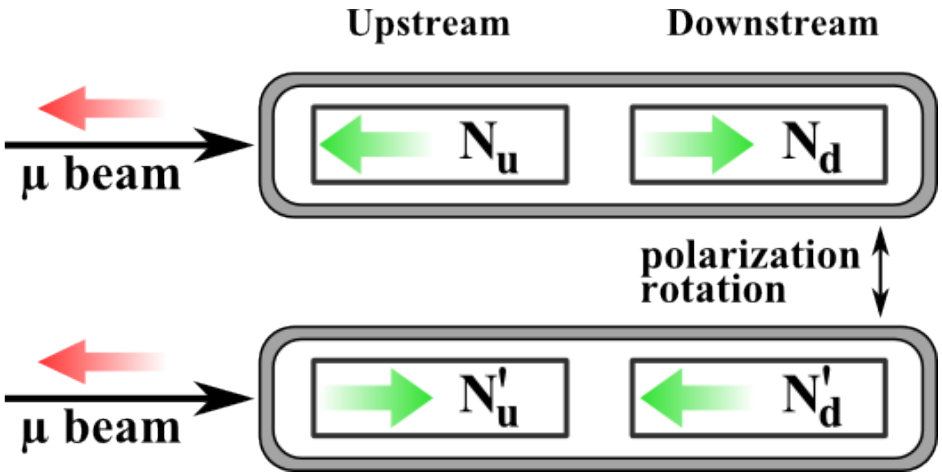
- Photon nucleon asymmetry

$$A_1(x, Q^2) = \frac{\sigma_{1/2} - \sigma_{3/2}}{\sigma_{1/2} + \sigma_{3/2}} \approx \frac{\sum_q e_q^2 (q(x)^+ - q(x)^-)}{\sum_q e_q^2 (q(x)^+ + q(x)^-)} = \frac{g_1(x, Q^2)}{F_1(x, Q^2)}$$

- Spin structure function

$$g_1(x, Q^2) = \frac{1}{2} \sum_q e_q^2 \Delta q(x) = A_1(x, Q^2) \cdot \frac{F_2(x, Q^2)}{2x(1 + R(x, Q^2))}$$

Method



- Aim:
  $A = \frac{\sigma^{\Uparrow\downarrow} - \sigma^{\Uparrow\uparrow}}{\sigma^{\Uparrow\downarrow} + \sigma^{\Uparrow\uparrow}}$
- Measured:
  $A_{exp} = \frac{N_u - N_d}{N_u + N_d}$
- Needed:
  - Flux cancellation
  - Acceptance cancellation
    $\rightarrow$ Polarization rotation
    $\rightarrow$ 3 target cells
- $A_{exp} = A \cdot P_B \cdot P_T \cdot f$

- Averaging:

$$A_{exp} = \frac{A + A'}{2} = \frac{1}{2}\left(\frac{N_u - N_d}{N_u + N_d} + \frac{N'_u - N'_d}{N'_u + N'_d}\right)$$

2011 Data

2007 and 2011 data taking

- Target: NH_3
- Increased beam energy
  160 GeV $\rightarrow$ 200 GeV
- Higher Q^2
- Smaller x_{Bj}

Improve results on

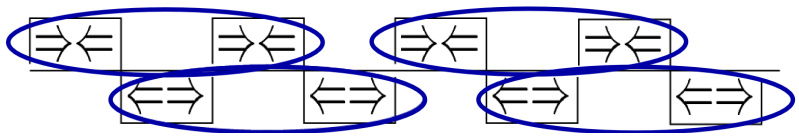
- Bjorken sum rule (systematic error)
- QCD fit
- Flavor asymmetry

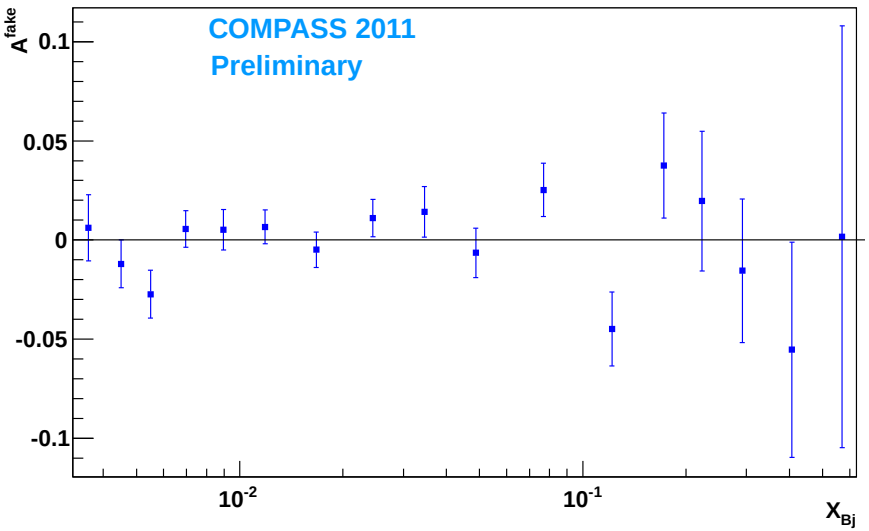
Event selection

- Kinematic cuts:
  - $Q^2 > 1$ (GeV/c)^2
  - $0.1 < y < 0.9$ remove radiative events
- $0.0025(0.0040) < x < 0.7$
- Extrapolated beam track crosses all target cells
  $\rightarrow$ Flux cancellation

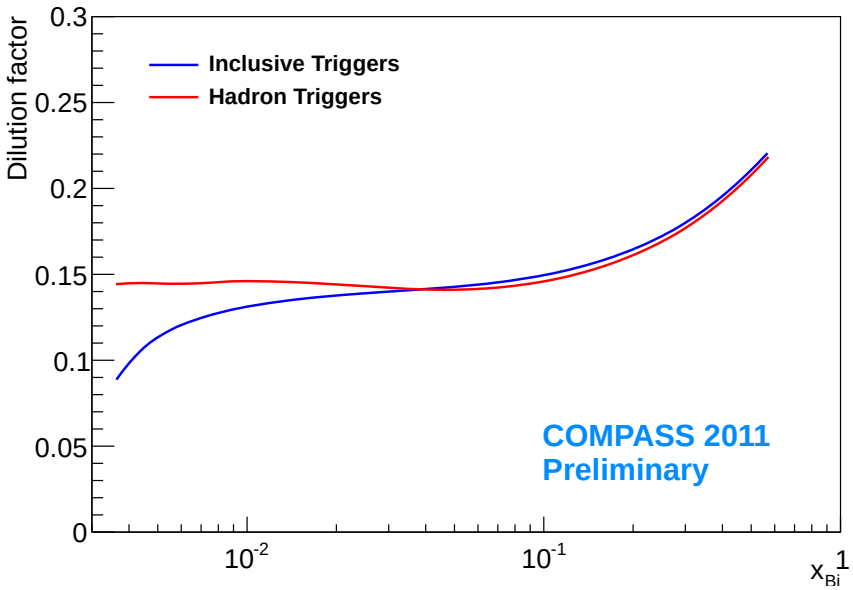
Systematic studies

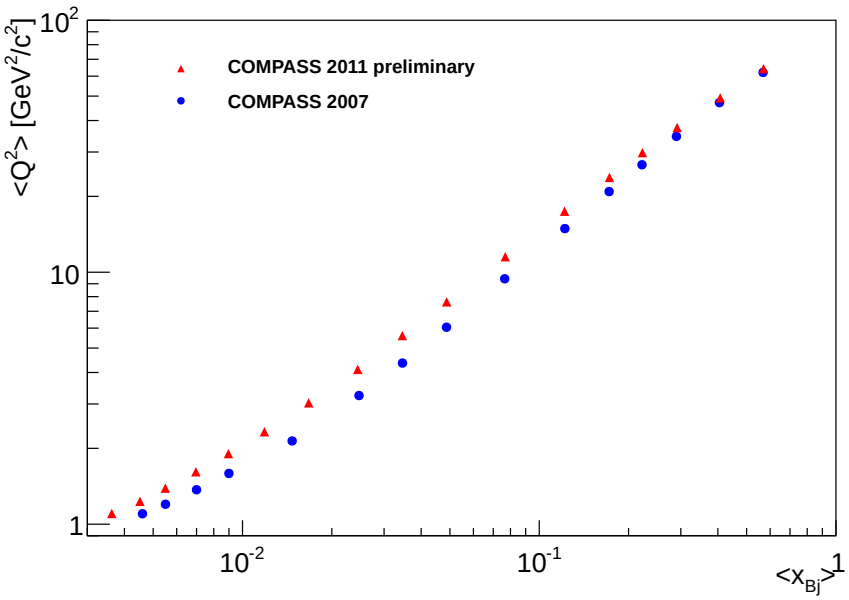
- Determination of the exact target position
- Checking the data quality
  $\rightarrow$ e.g. Influence of small detector movements, detector problems,...
- Most important contribution to the systematic error
  $\rightarrow$ False asymmetries
  - Microwave reversal
  - Fake configuration (same spin orientation)

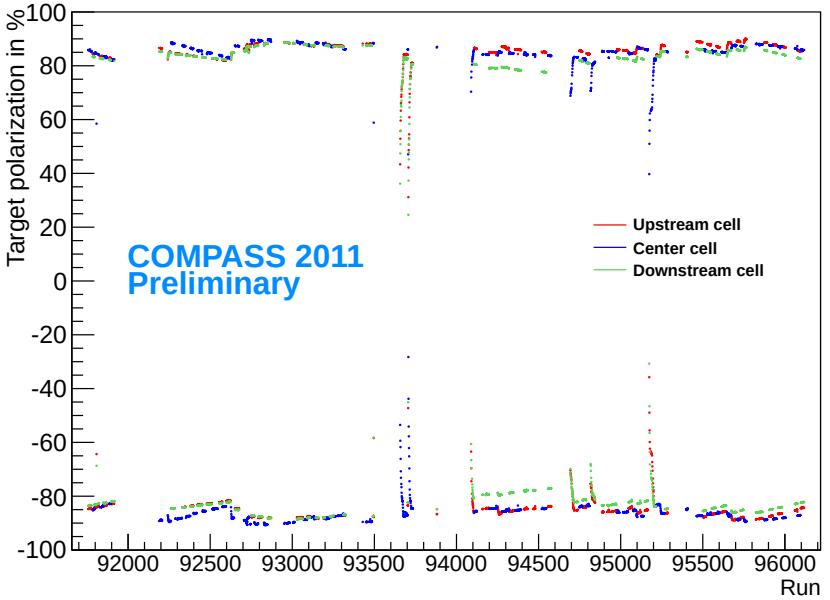




2011 results

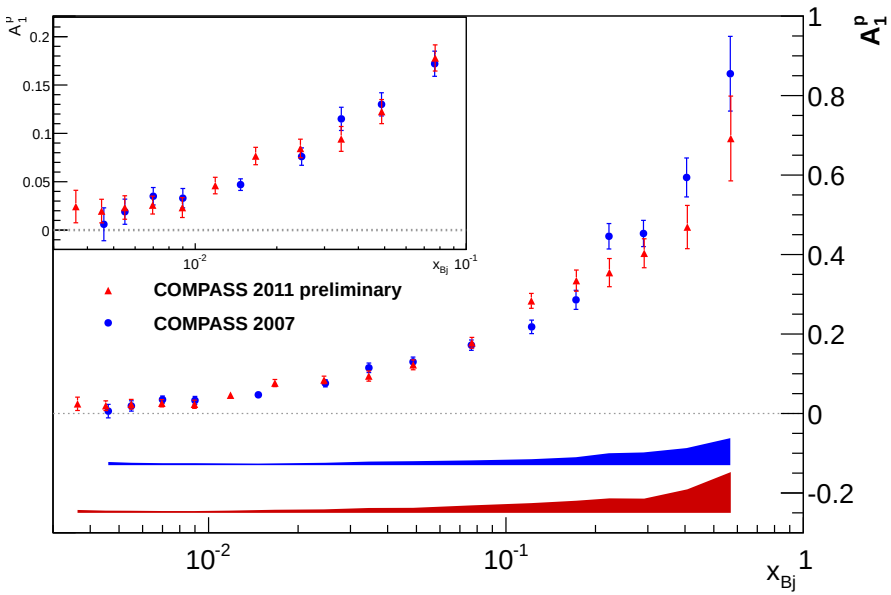


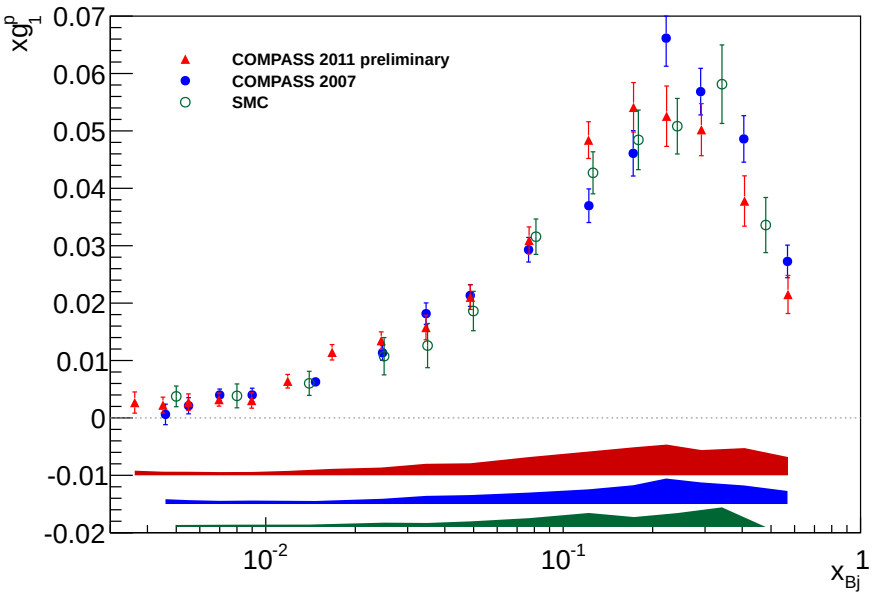




- $78 \cdot 10^6$ Events
- Dilution factor includes radiative corrections
- Higher Q^2 in 2011
- Field reversals

2011 results





- Good agreement between COMPASS 2011/07 and SMC
- 2011: Small ^{14}N corrections missing
- $g_1^p(x, Q^2) = \frac{F_2^p(x,Q^2)}{2x(1+R(x,Q^2))} A_1^p$
- F_2^p parameterization from SMC
- Same parameterization for R as in depolarization factor

Summary and Outlook

- New measurement at 200 GeV/c
- Measurement of A_1^p and g_1^p
  - New value at small x
  - 2011 data improve the precision of the COMPASS results
- Outlook
  - Identified hadron asymmetry
  - Include our results in a NLO pQCD fit
  - Improve the results on the test of the Bjorken sum rule