Spin-Spin correlations in top dilepton channel

J. Antoš, A. Beretvas, Y.-C. Chen

Spin-Spin correlations from pragmatic point of view

Basic formula

$$\frac{1}{\sigma}\frac{d\sigma^2}{d\cos\theta_+ d\cos\theta_-} = \frac{1}{4}(1 - C\cdot\cos(\theta_+)\cos(\theta_-))$$

Derived formulas

$$\frac{1}{\sigma}\frac{d\sigma}{dz} = -1/2\cdot(1 - C\cdot z)\cdot ln(|z|)$$

$z=\cos(\theta_+).\cos(\theta_-)$

$$\frac{-1}{ln(|z|)}\frac{1}{\sigma}\frac{d\sigma}{dz} = 1/2\cdot(1 - C\cdot z)$$

$$C = \frac{N_+ - N_-}{N_+ + N_-} \qquad C=4\cdot\frac{N_{op}-N_s}{N_{op}+N_s} \qquad C=-9\langle z\rangle$$

Frame and theoretical expectations

Beam frame I (Parke – Mahlon)
Beam frame || (Bernreuther et al.)

Helicity frame - lab. → ZMF → t rest frame

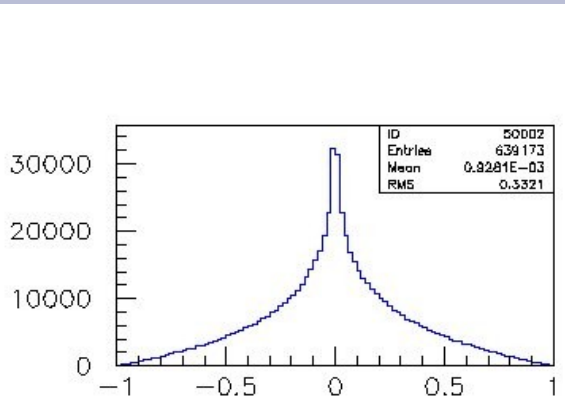
In NLO SM calculations

$C_{beamII} = 0.777$

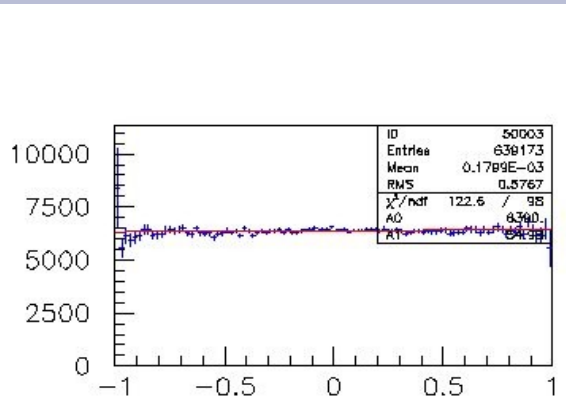
$C_{hel} = -0.352$

Test of formulas on Toy MC samples

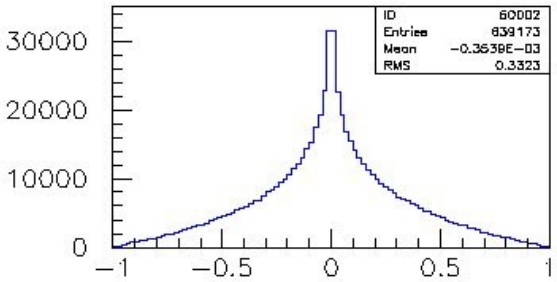
Standard Pythia



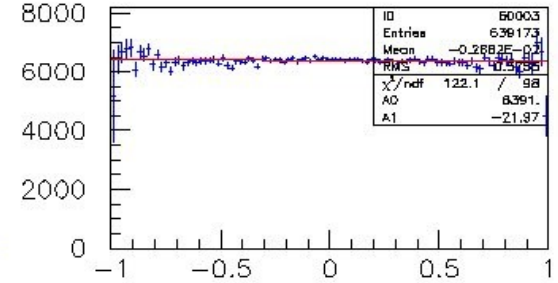
ideal beam PMccst1*cst2



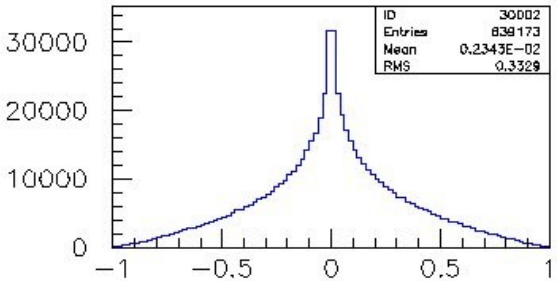
ideal beam PM ccst1*cst2 inversely weighted



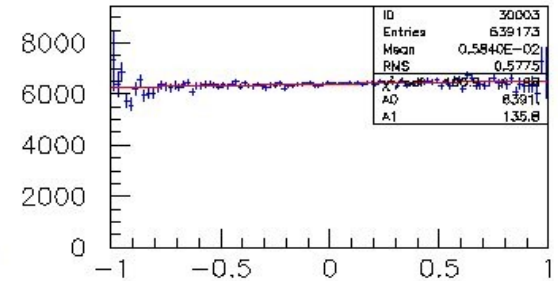
ideal beam BB ccst1*cst2



ideal beam BB ccst1*cst2 inversely weighted



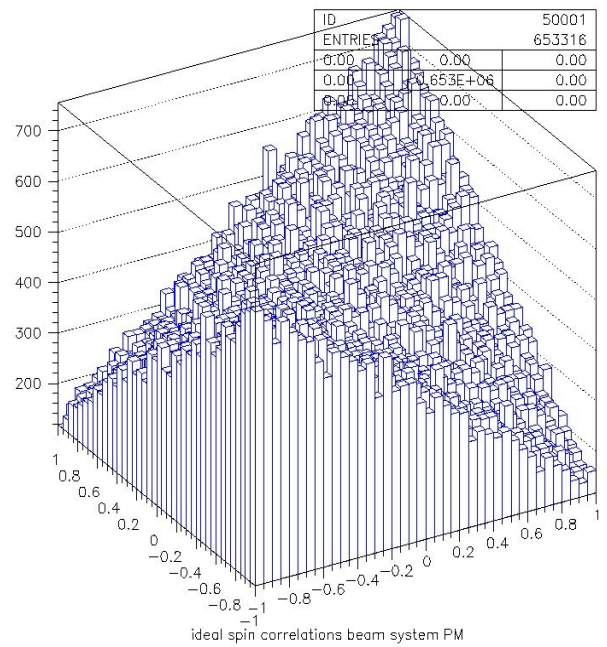
helicity ccst1*cst2

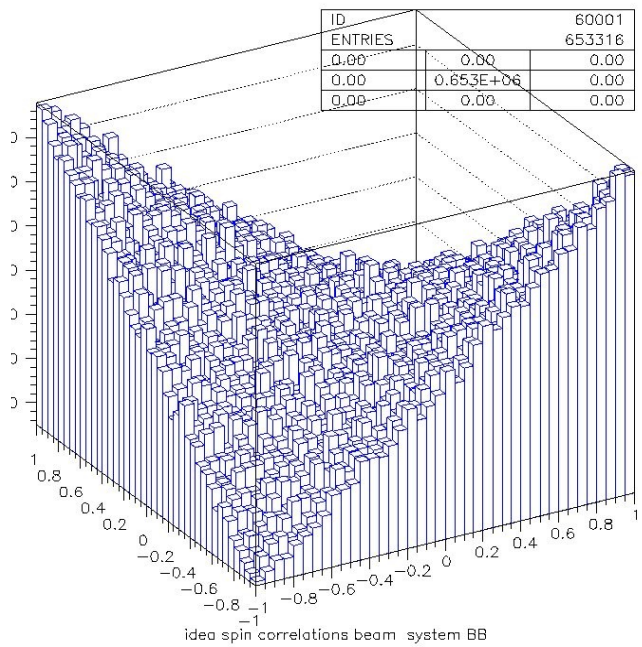


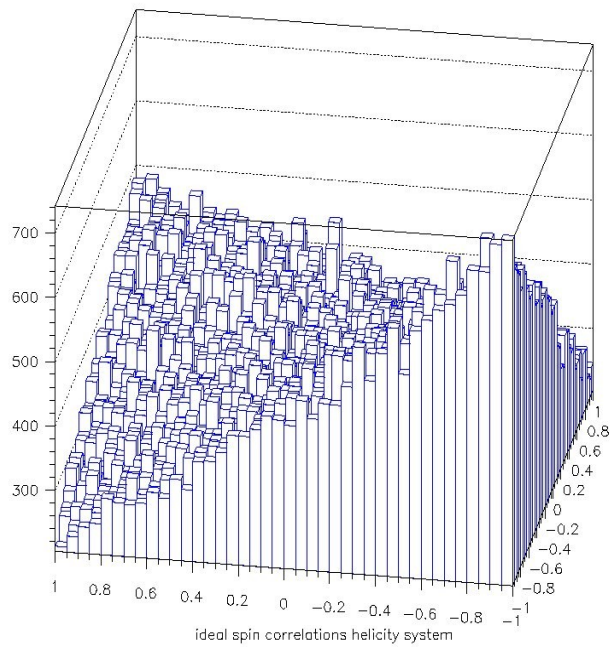
helicity ccst1*cst2 inversely weighted

Test of formulas on Toy MC samples

(TopRex)





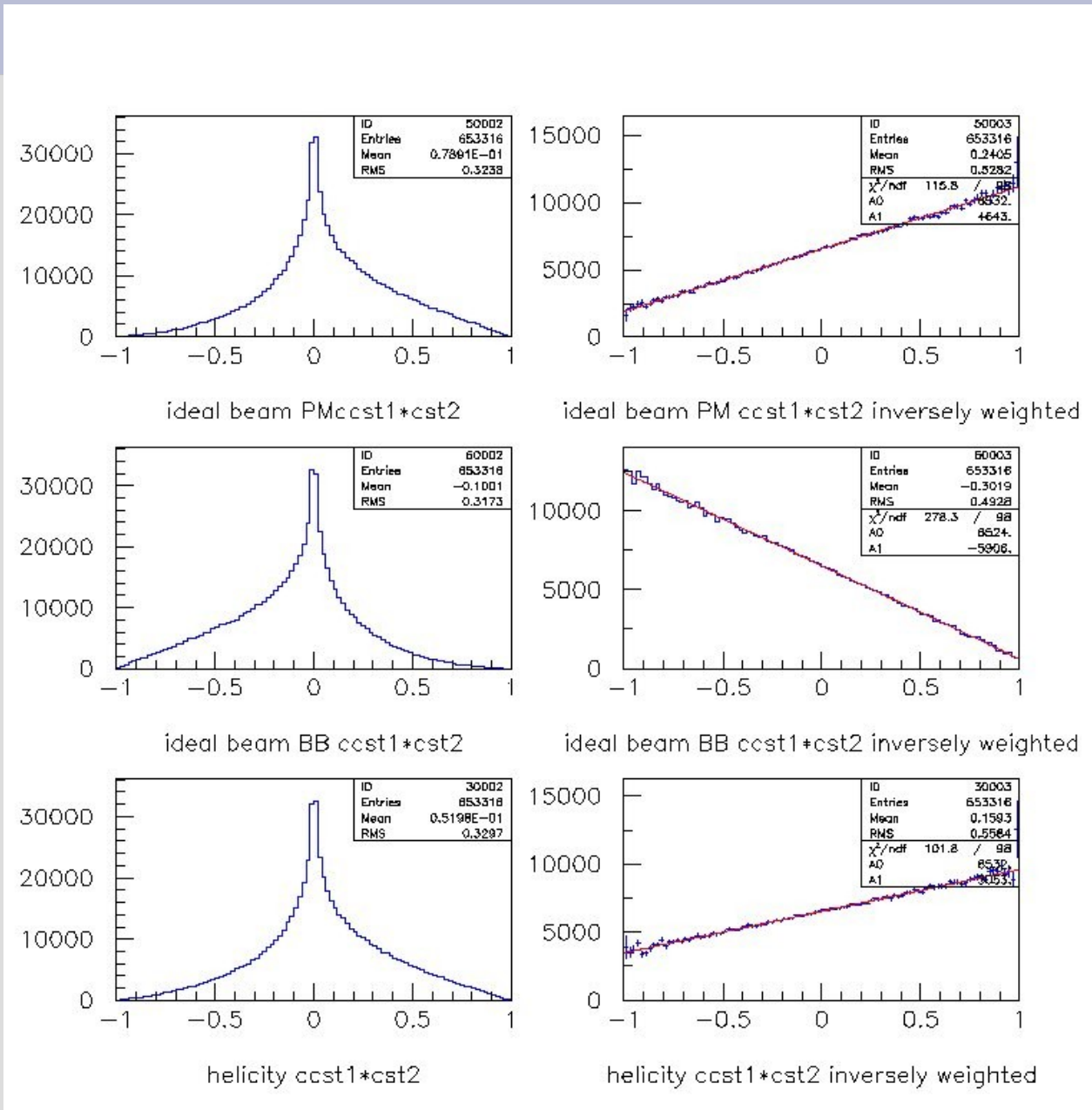


TopRex cont.

C_{beamI}=-0.711±0.004

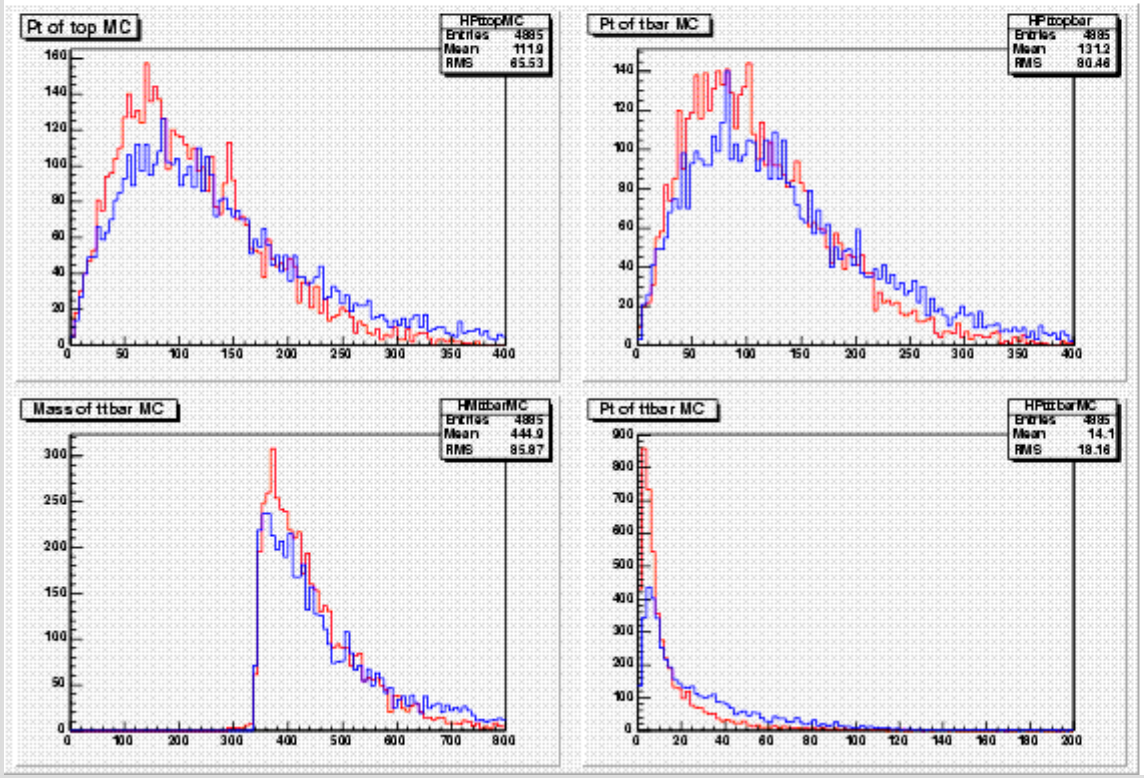
C_{beamII}=0.904±0.004

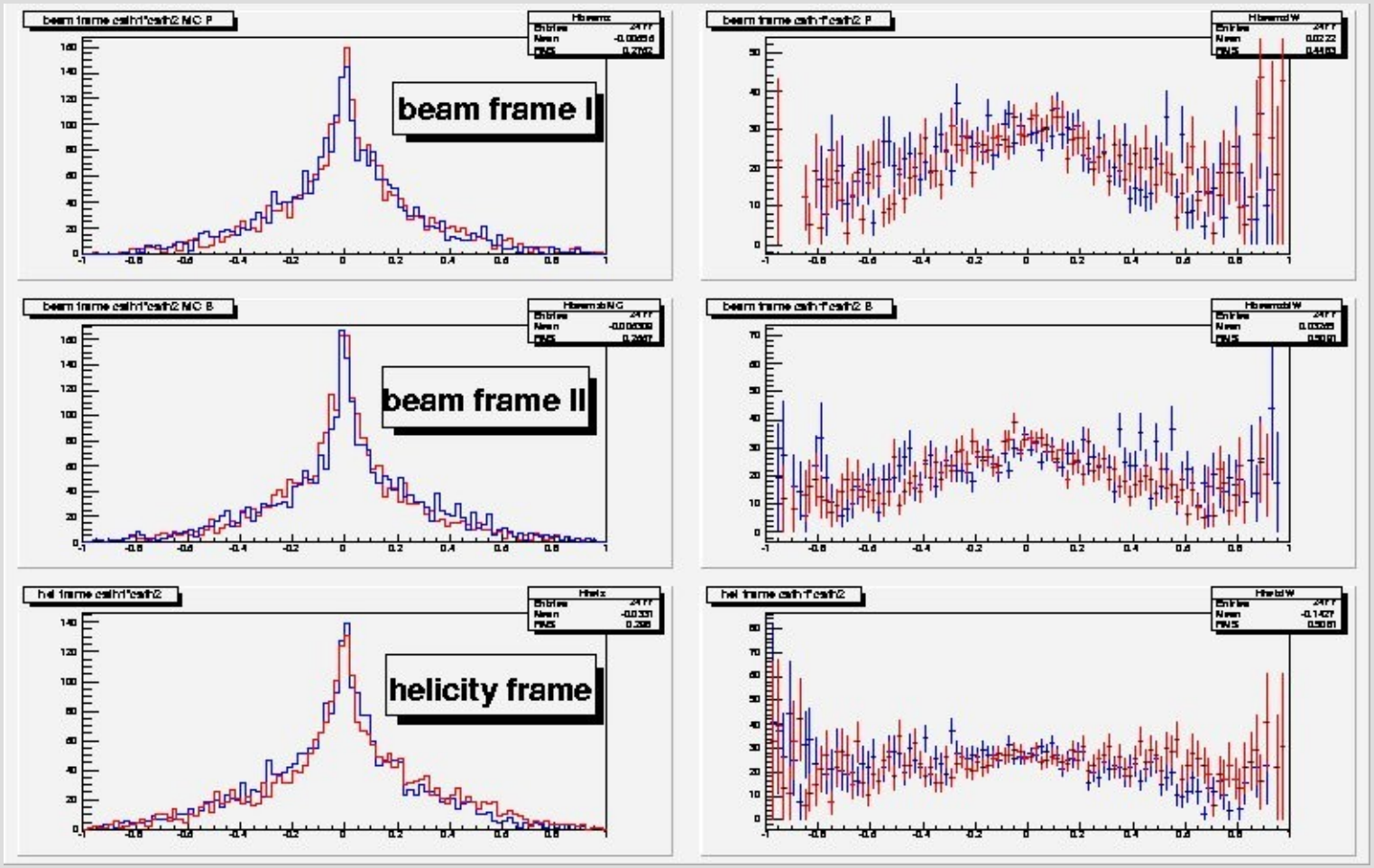
C_{hel} =0.467±0.004



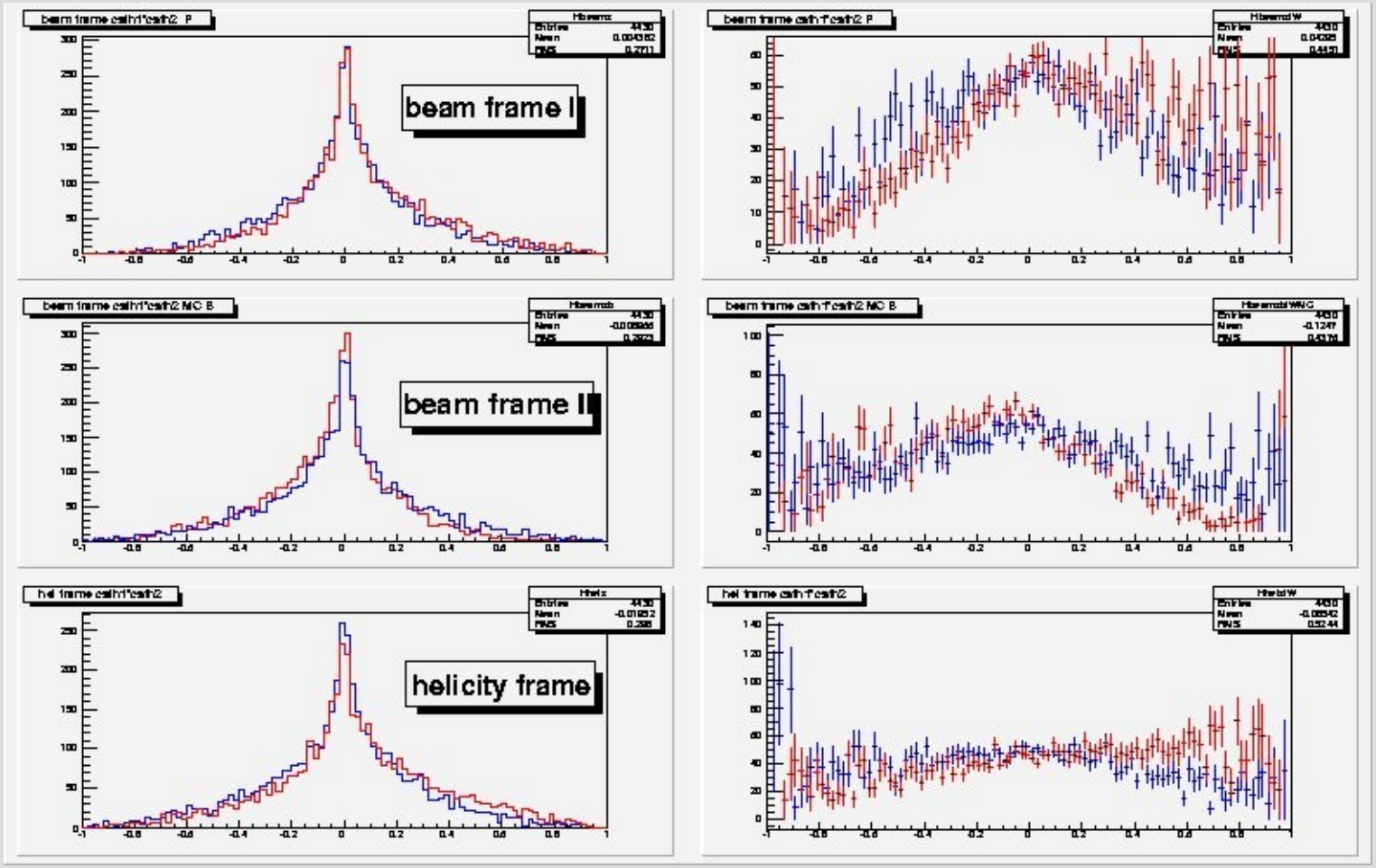
Realistic MC sample (Pythia)

A comparison of original and reconstructed selected top variables

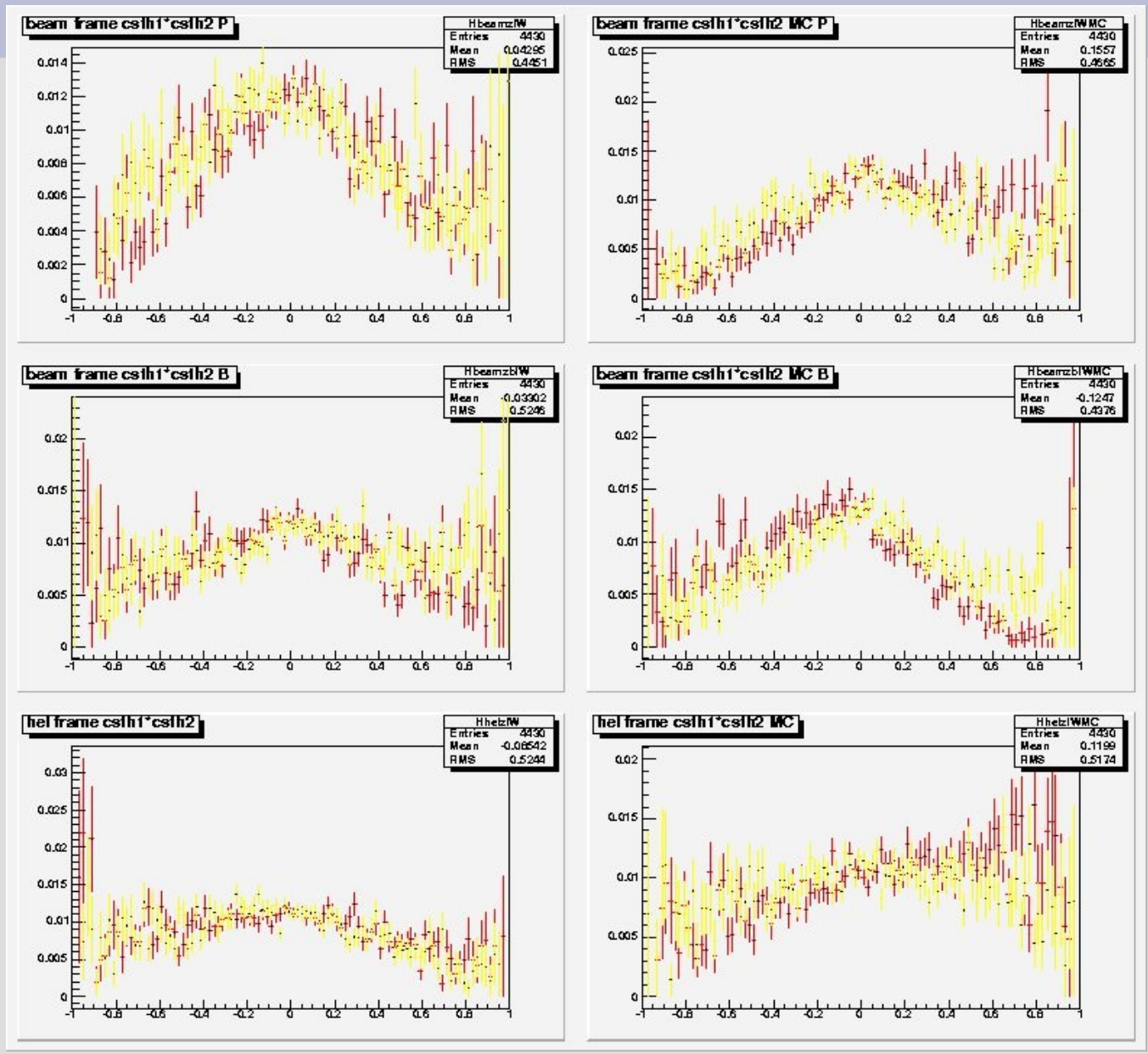



beam frame I
beam frame II
helicity frame

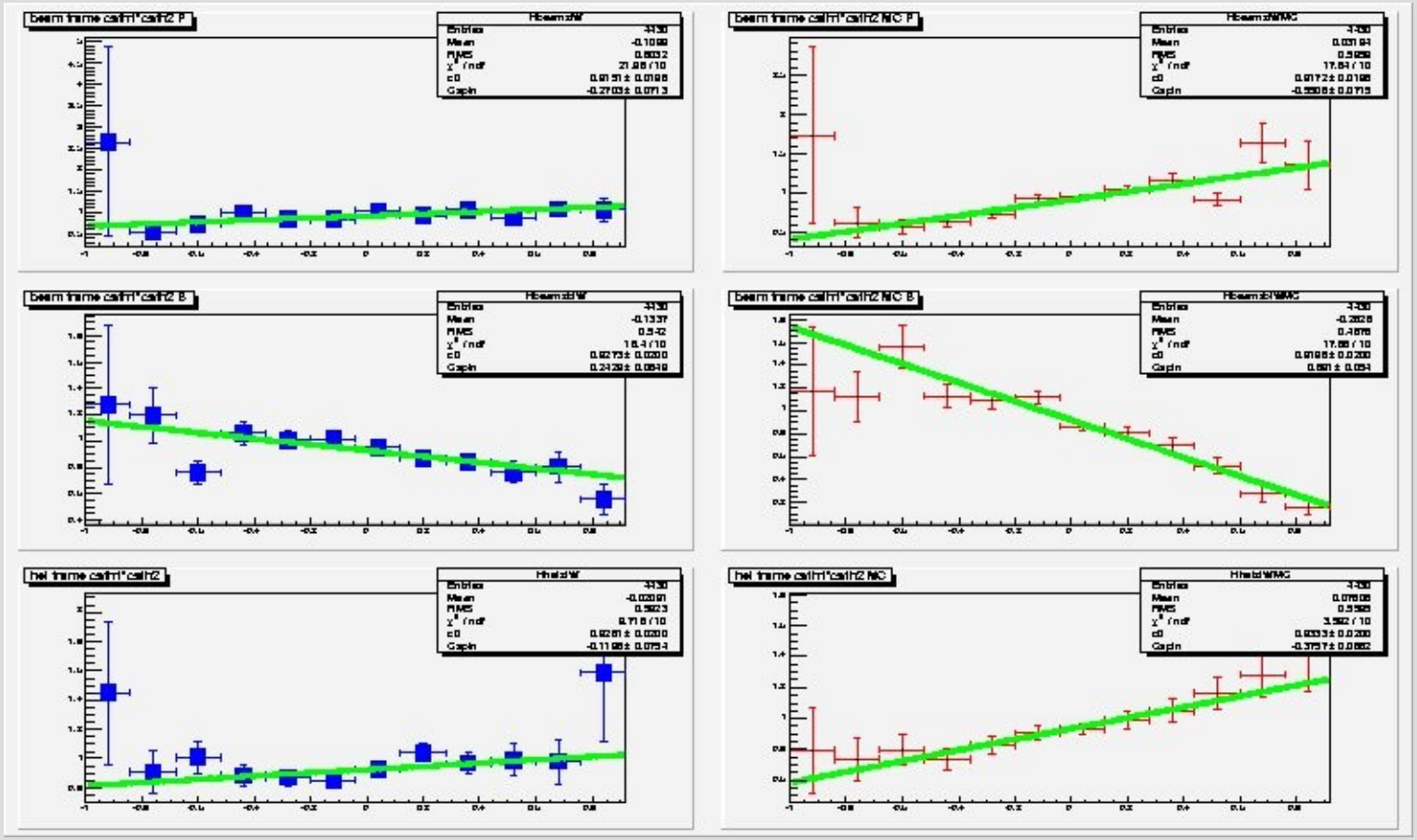
Realistic MC sample (Herwig)



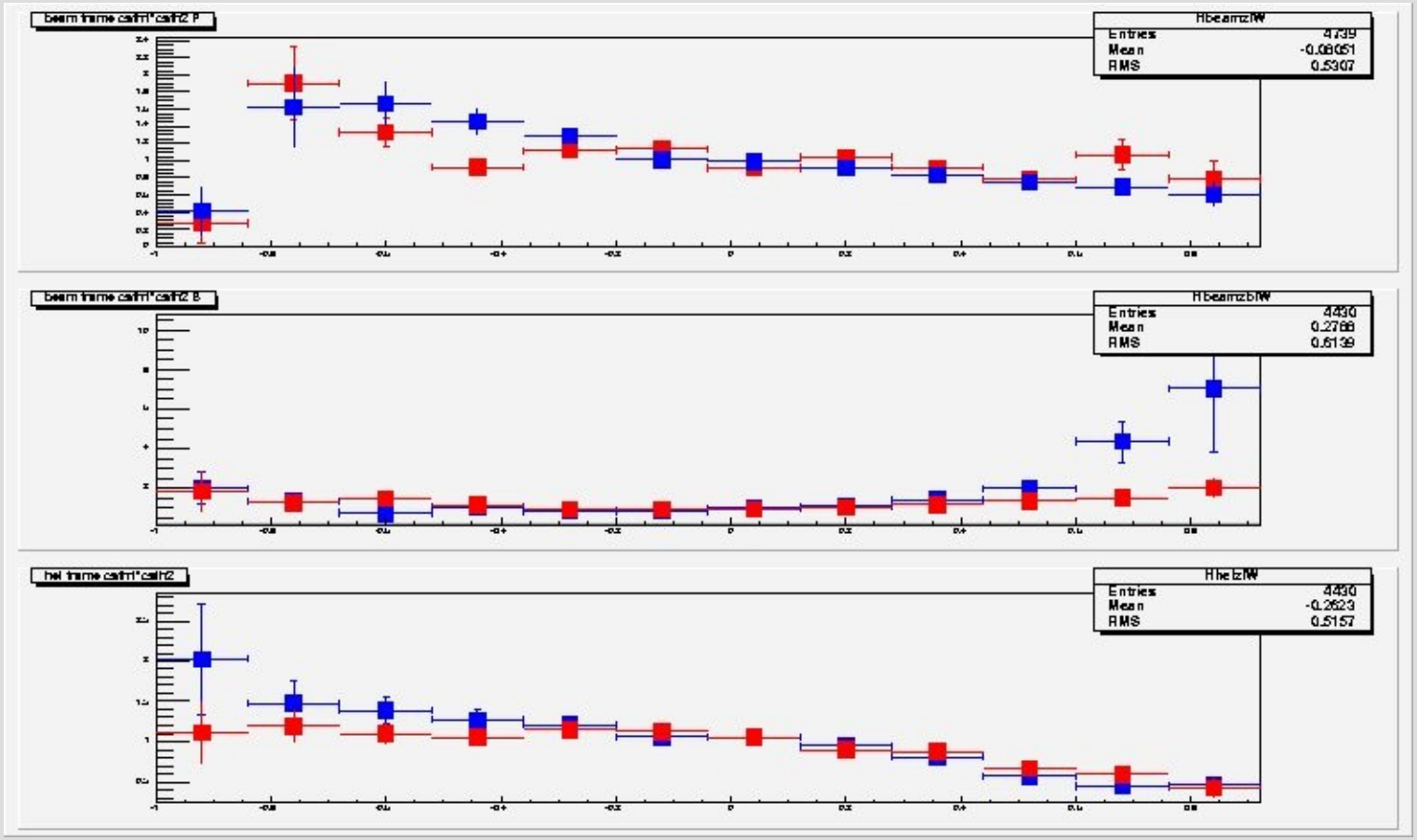
Herwig spin ON/OFF



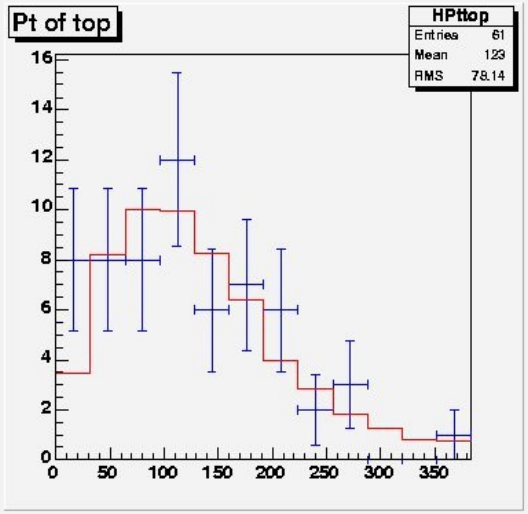
Herwig ratio spin ON/OFF

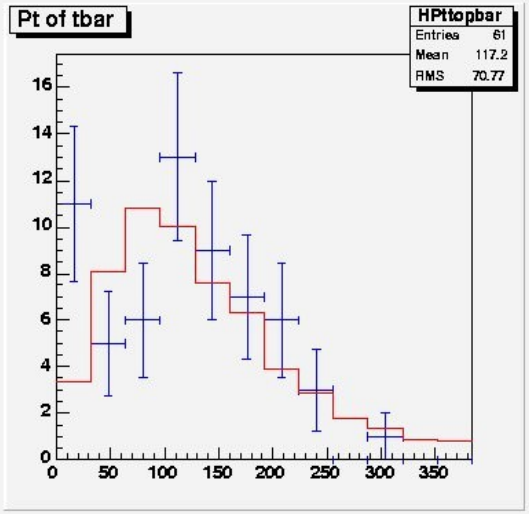


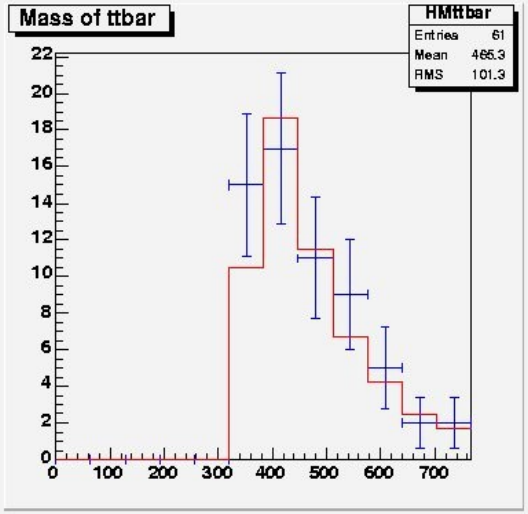
Herwig ratio gen/rec

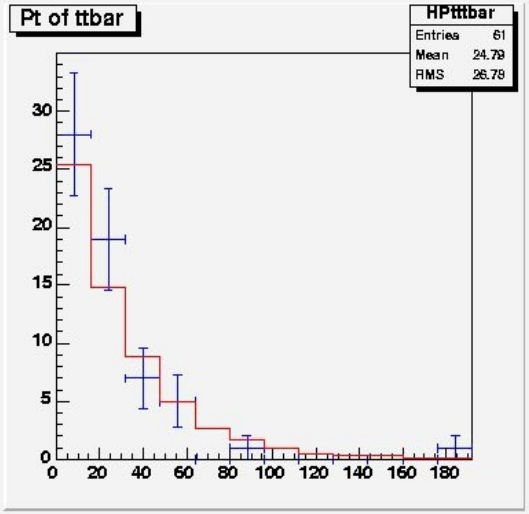


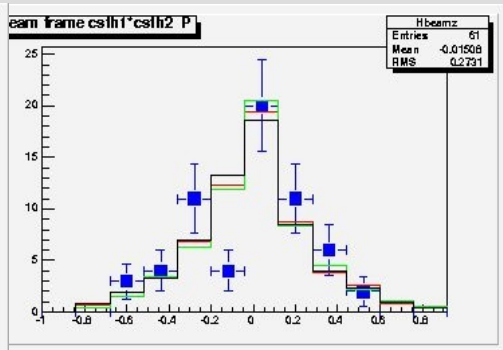
Determination of spin-spin corr. In Data

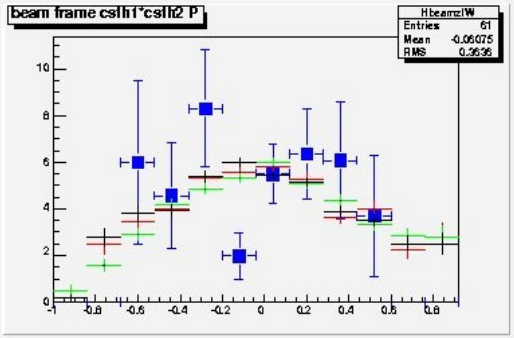


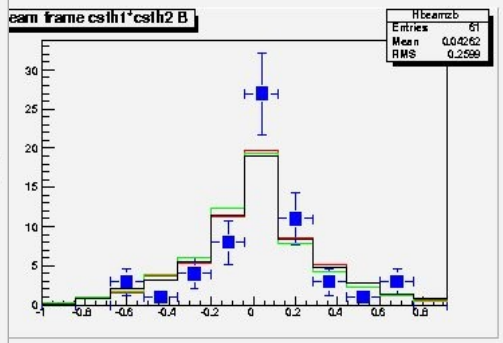


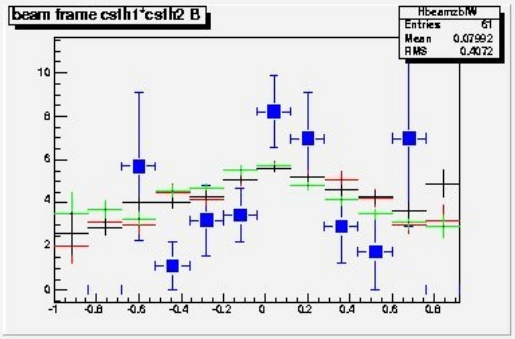


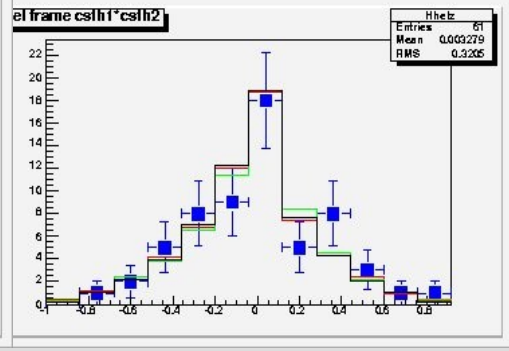


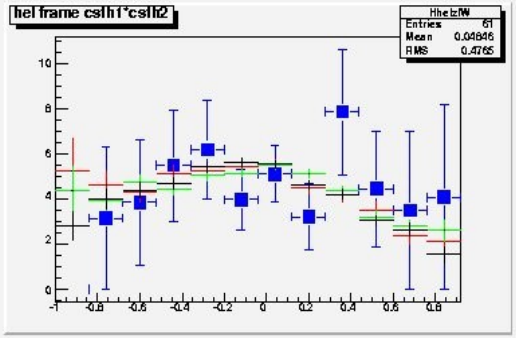








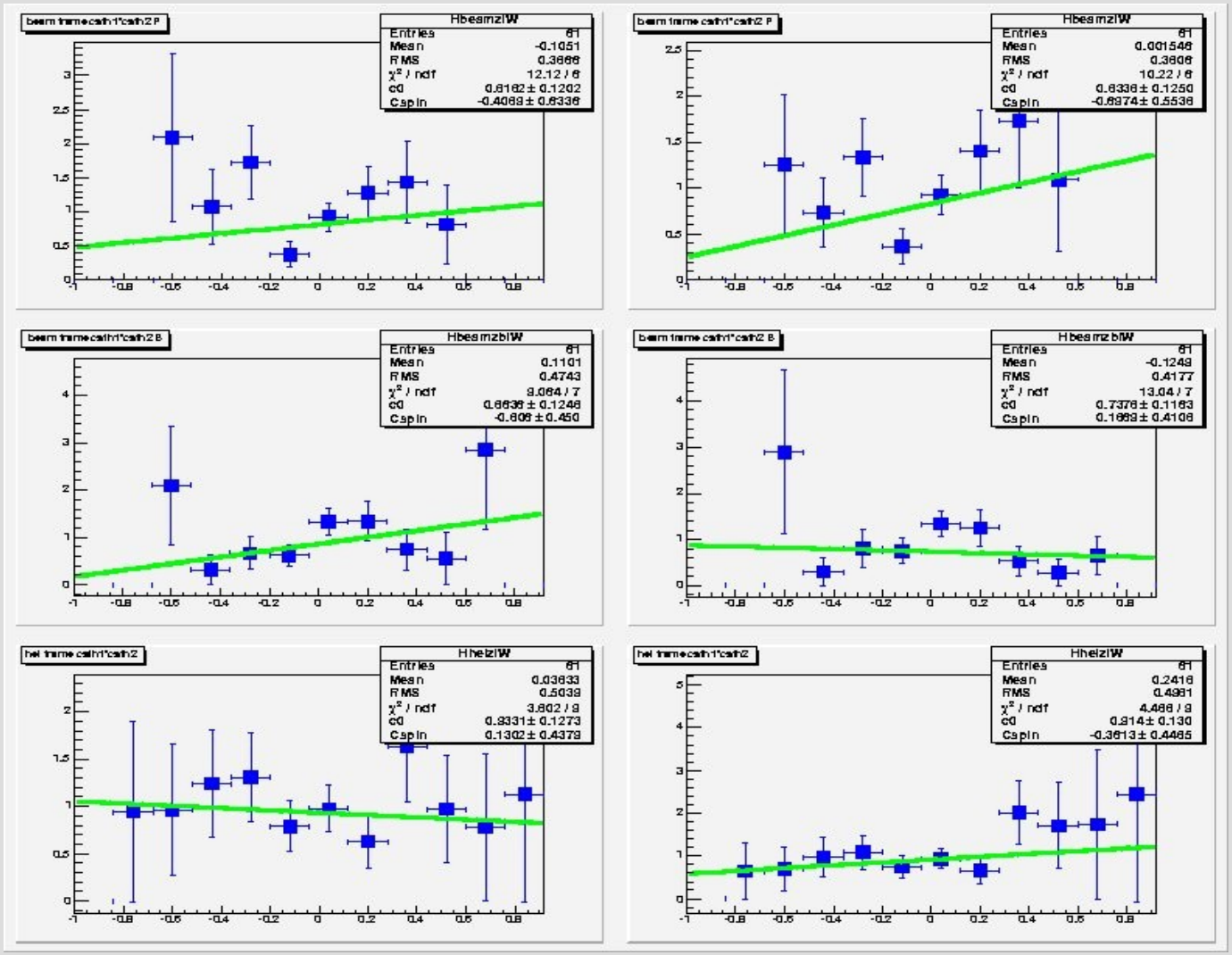




Determination of spin-spin corr. In Data

$$f_{Data}^{true}(z) = \frac{f_{Data}^{rec}(z)}{2 \cdot f_{MCoff}^{rec}(z)}$$

$$f_{Data}^{true}(z) = \frac{f_{Data}^{rec}(z) \cdot f_{MCon}^{hepg}(z)}{2 \cdot f_{MCon}^{rec}(z) \cdot f_{MCoff}^{hepg}(z)}$$



Conclussion

Result	C_{beamI}	C_{beamII}	$C_{helicity}$
Theor. NLO	–	0.777	-0.352
Reconstr. I	-0.4 ± 0.6	-0.81 ± 0.45	0.13 ± 0.44
Reconstr. II	-0.7 ± 0.55	0.19 ± 0.41	-0.34 ± 0.45

Results at 1.9 fb^{-1} integrated luminosity are consistent with both SM expected or 0 correlation coefficient For discrimination between these two options is a significant increase of statistics neccessary.

Background and systematic errors have not been taken into account in the present analysis