Exclusive study of deuteron electrodisintegration near threshold

(E08-008 update)

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16 December 2009

Why do we study deuteron electro disintegration

Deuteron is the simplest nuclear system.

Deuteron offers a unique opportunity to examine subnuclear degrees of freedom.

An important tool to explore the two-nucleon system and its electromagnetic properties.

Exclusive measurement offers more detailed information on the structure functions($f_{\mu\mu'}$).

Limited number of partial waves for FSI.

General formula

$$\frac{d^3\sigma}{dE_1 d\Omega_e d\Omega_p} = C_n(\rho_{00}f_{00} + \rho_{11}f_{11} + \rho_{01}f_{01}cos\phi_p + \rho_{-11}f_{-11}cos2\phi_p + h\rho'_{-11}f'_{-11}sin\phi_p)$$

$$C_n = \frac{\alpha}{6\pi^2}\frac{E_1}{EQ^4}$$

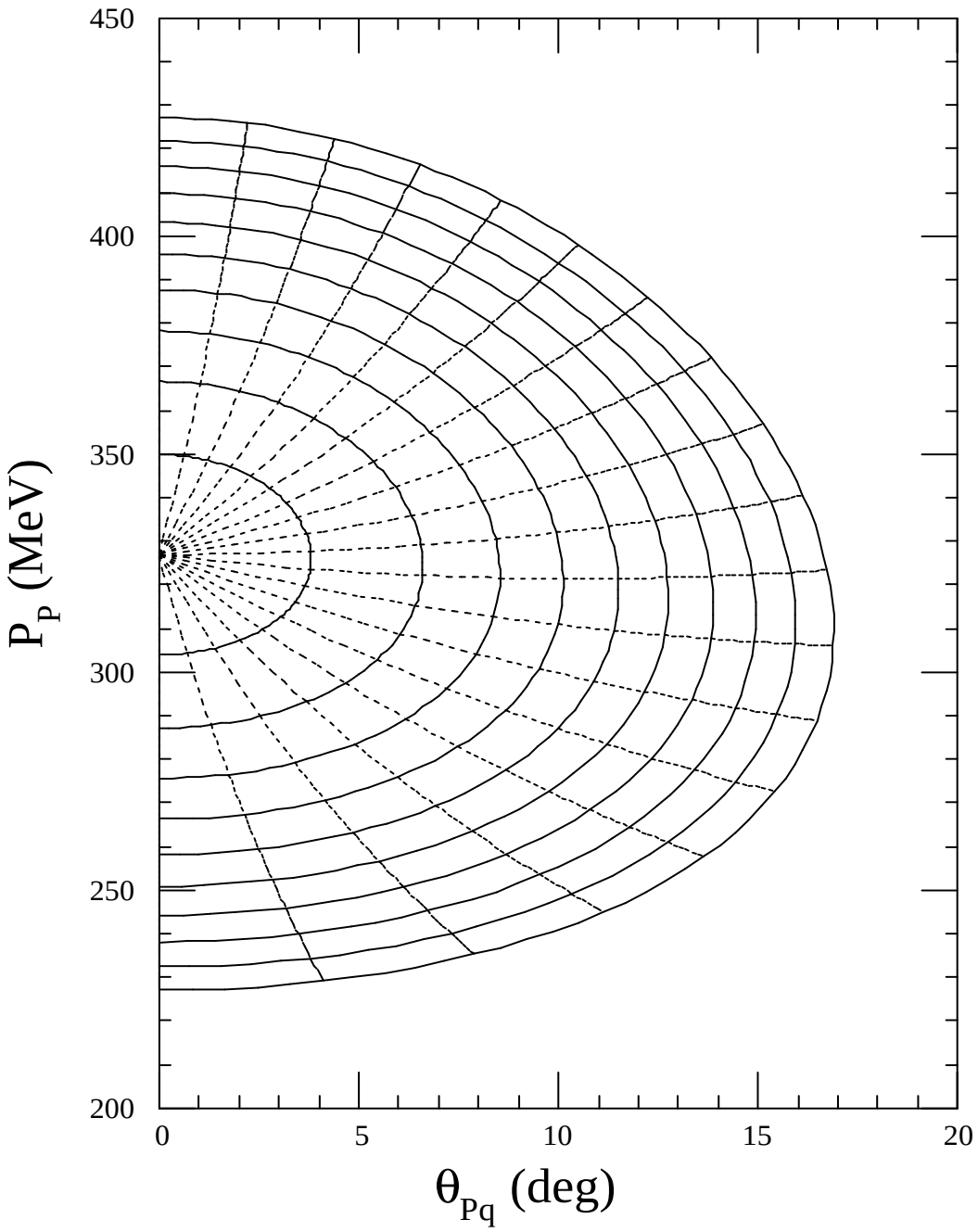
$$\rho_{\mu\mu'}(Q^2, \nu, \theta_e)$$

$f_{\mu\mu'}(Q^2, W, \theta_p)$ structure functions:
f_{00} longitudinal,
f_{11} transverse,
f_{01} longitudinal-transverse,
f_{-11} transverse-transverse,
f'_{01} the fifth due to beam polarization.

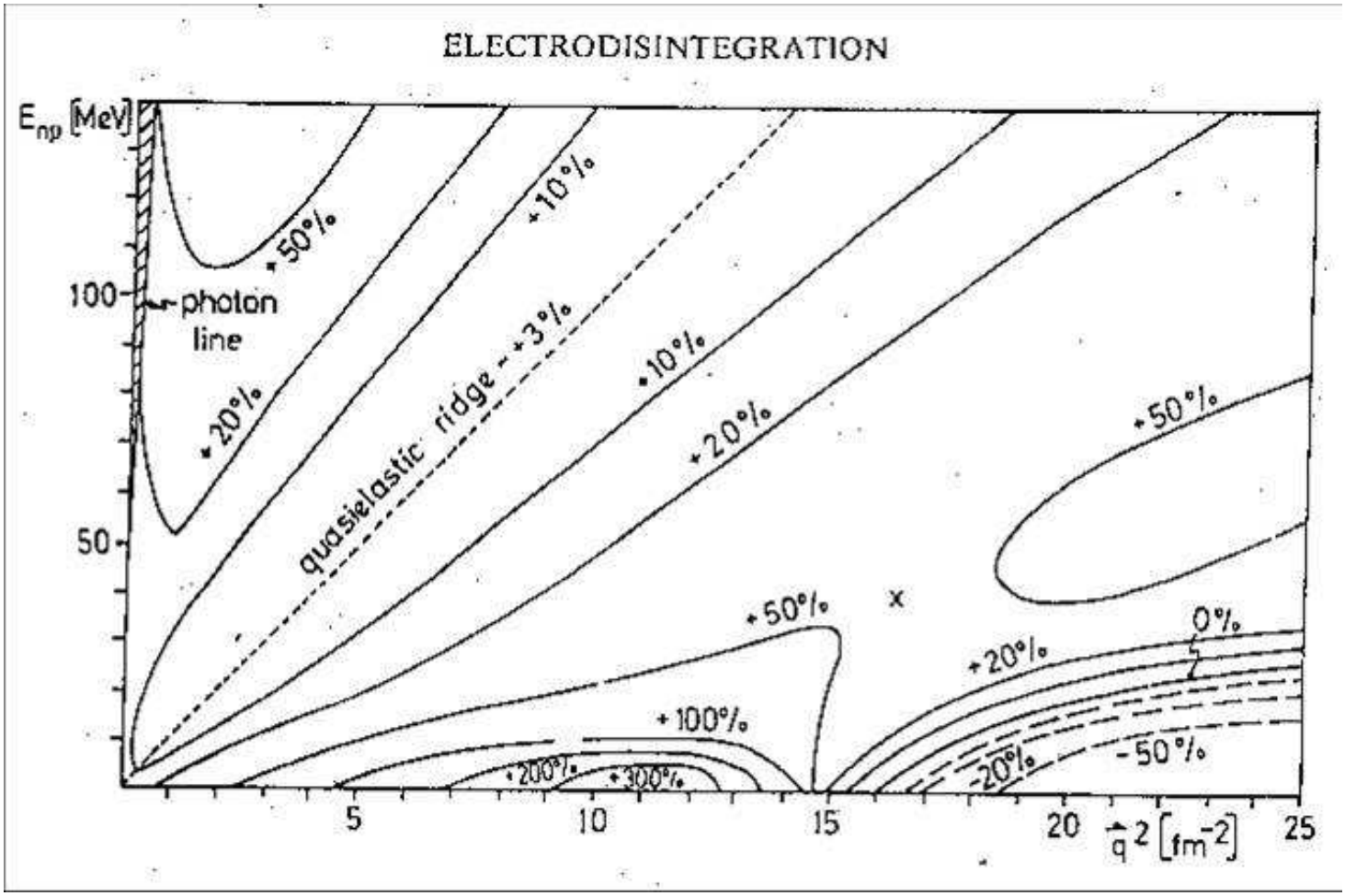
Kinematic setting

E (MeV)	θ_e (deg.)	Q^2 (fm^{-2})	θ_R (deg.)
2250	16.9	10.68	71.4

Phase space distribution



At this setting, $q_3^2 = 11 fm^{-2}$ where meson exchange effect is maximized.



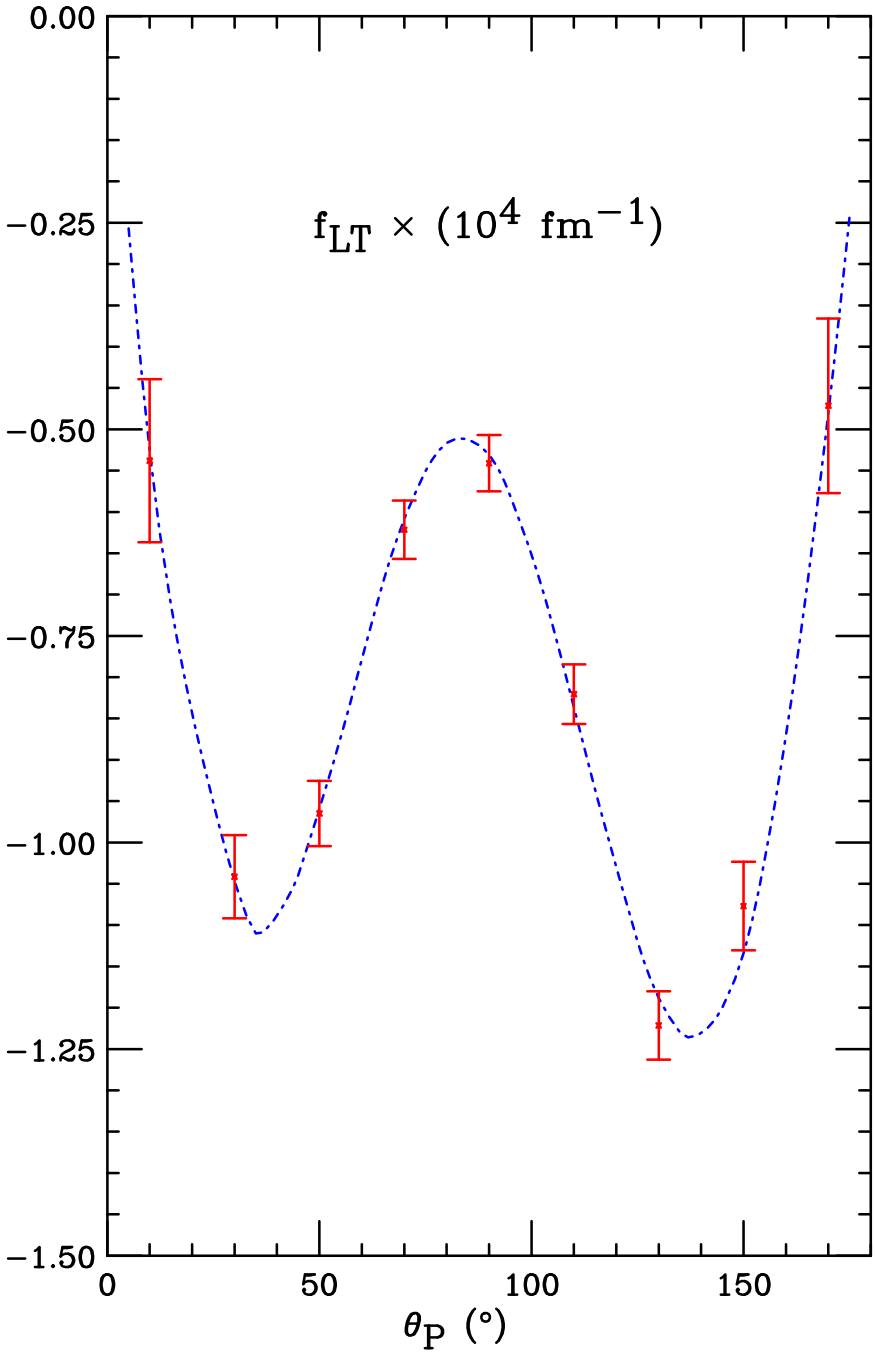
Experment part I
HRS-BIGBITE combination.

To measure structure functions in

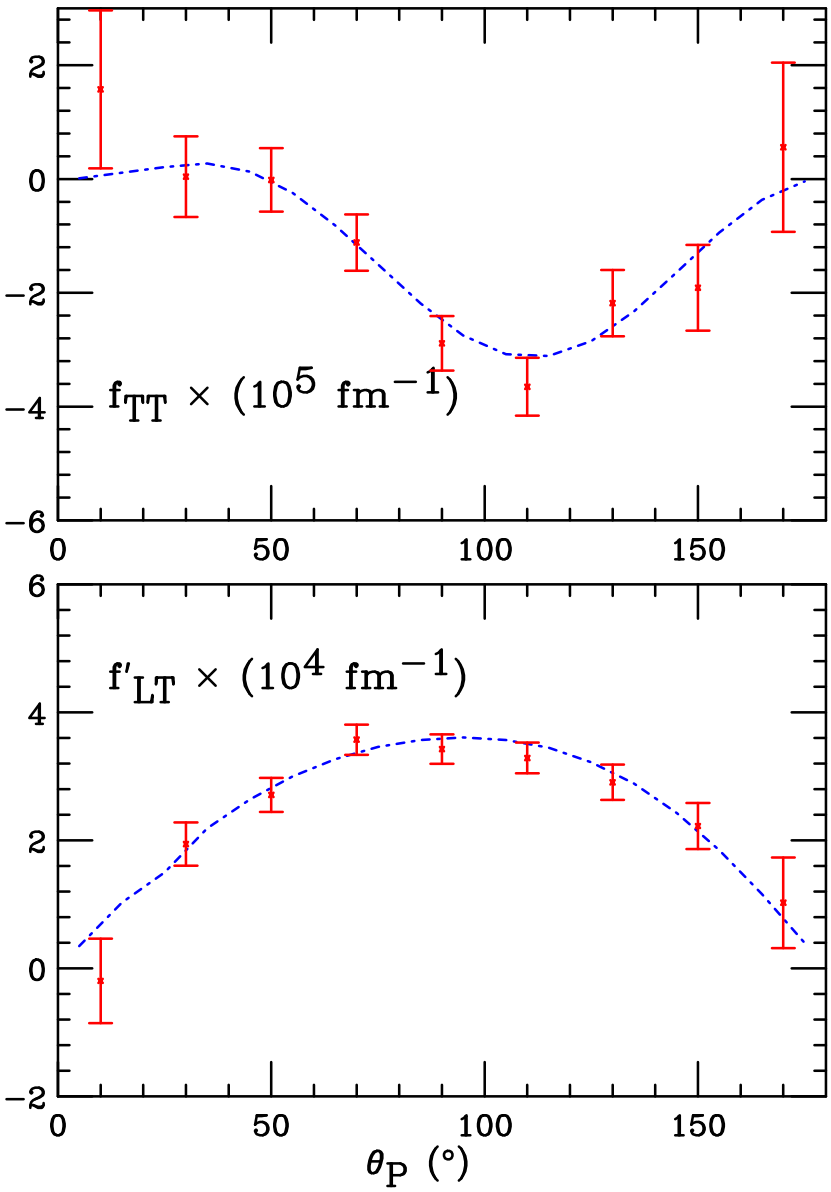
$$d(\vec{e}, e'p)n$$

$f_{00} + f_{11}$, f_{01}, f_{-11}, and f'_{01}.

Projected result of f_{LT}



Projected result of f_{TT} and f'_{LT}



Experment part II

HRS-HRS/FPP combination.

to measure proton polarization, P'_x and P'_z in

$$d(\vec{e}, e'\vec{p})n$$

.

Event projection on electrom arm in 10 hours

E_{np} (MeV)	Q^2 (fm^{-2})	ν (MeV)	θ_r (deg)	count (M)
0.5	10.68	113.41	71.7	12.9
1.5	10.69	114.36	71.6	11.6
2.5	10.69	115.32	71.5	11.1
3.5	10.68	116.27	71.4	10.8
4.5	10.68	117.23	71.3	10.6
5.5	10.67	118.18	71.3	10.6
6.5	10.67	119.13	71.2	10.7
7.5	10.67	120.09	71.1	10.8
8.5	10.66	121.05	71.0	11.0
9.5	10.66	122.00	70.9	11.3

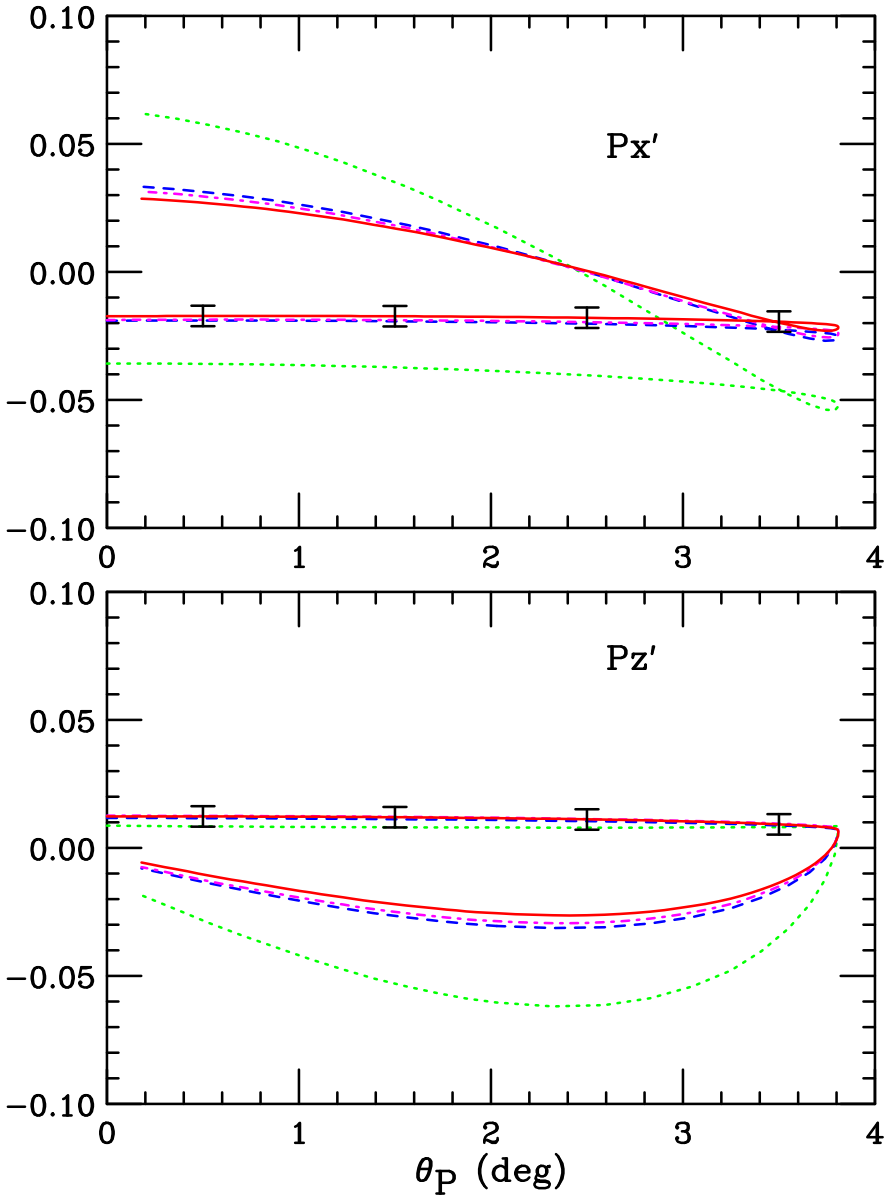
Projected precision

Θ_{FPP} (deg.)	A_c	σ_{Ac}	σ_i
7	0.1430	0.0100	0.0027
11	0.1770	0.0080	0.0021
15	0.1800	0.0080	0.0021
19	0.1900	0.0090	0.0020
23	0.1860	0.0110	0.0020
27	0.2060	0.0150	0.0018
31	0.2610	0.0200	0.0015
35	0.3200	0.0260	0.0012
39	0.3710	0.0310	0.0010

For $\Delta E_{np} = 2\ MeV$ and $\Delta\theta_P = 2$ deg,
$\sigma\,(P_{x'}\ or\ P_{z'}) \approx 0.004$

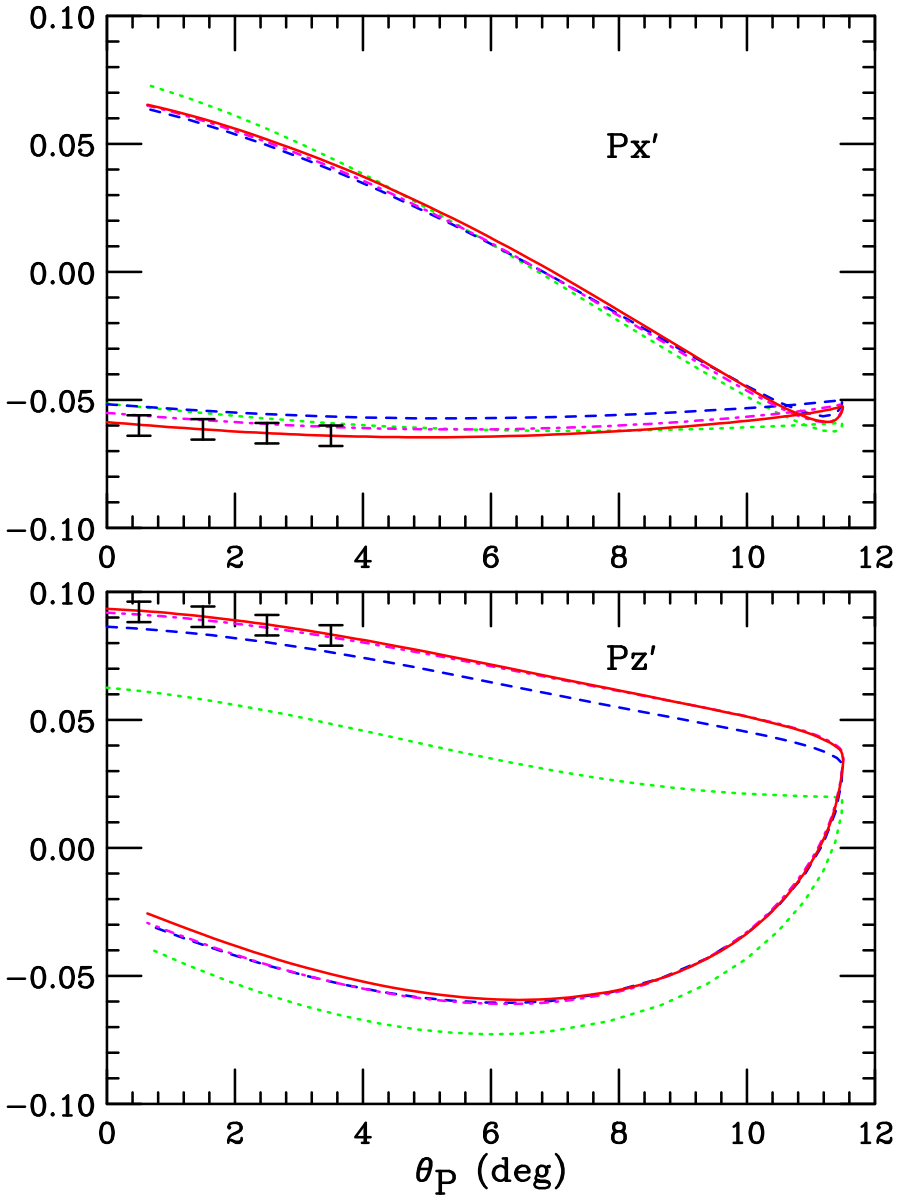
Proton polarization at E_{np}=0.5 MeV (Arenhövel)

dotted green-normal, dashed blue-MEC, dotted-dashes magenta-MEC+IC, solid red-full calculation.



Proton polarization at E_{np}=4.5 MeV (Arenhövel)

dotted green-normal, dashed blue-MEC, dotted-dashes magenta-MEC+IC, solid red-full calculation.



Beam time

	E (MeV)	θ_{HRS} (deg.)	θ_{BB} (deg.)	time (day)
part I	2250 2250	16.9 16.9	66.4 76.4	5 5
	E (MeV)	θ_{HRS} (deg.)	θ_{FPP} (deg.)	time (day)
part II	2250	16.9	71.4	5
set up				5
total				20

Summary

E08-008 will be an out-of-plane measurement of deuteron electrodisintegration with HRS's and BigBite using 25 days of beam time. It will provide the first systematic measurement of all the structure functions over a broad range of COM angles at $Q^2 = 10.68 fm^{-2}$ and threshold. Predictions of MEC's, IC's, FSI's, and relativistic corrections will be tested using the various observables.

The results will provide for the first time the proton polarization with good precision in this kinematic region.