09/20/12

(Vorwey Zhi Liu's Thesis)

$$\sigma(h, P_z, P_{zz}) \equiv \frac{d\sigma}{d\Omega}(h, P_z, P_{zz}) = \Sigma + h \cdot \Delta$$

Asymmetry:

$$A = \frac{\sigma(+h, P_z, P_{zz}) - \sigma(-h, P_z, P_{zz})}{\sigma(+h, P_z, P_{zz}) + \sigma(-h, P_z, P_{zz})} =$$

$$= \frac{\cancel{\Sigma} + h\Delta - (\cancel{\Sigma} - h\Delta)}{\Sigma + \cancel{h\Delta} + \Sigma - \cancel{h\Delta}} = \frac{h \cdot \Delta}{\Sigma}$$

$$\Sigma = \frac{d\sigma}{d\Omega} \cdot [1 + \Gamma] \; ; \quad \Delta = \frac{d\sigma}{d\Omega} \cdot \Lambda$$

$$A = \frac{h \cdot \cancel{\frac{d\sigma}{d\Omega}} \cdot \Lambda}{\cancel{\frac{d\sigma}{d\Omega}} \cdot [1 + \Gamma]} = h \cdot \frac{\Lambda}{[1 + \Gamma]}$$

$$\Lambda = P_z \cdot \left[\frac{\sqrt{3}}{\sqrt{2}} \cdot \cos\theta^* \, T^e_{10} - \sqrt{3} \cdot \sin\theta^* \cdot \cos\phi^* \, T^e_{11} \right]$$

$$\Gamma = P_{zz} \cdot \left[\frac{1}{\sqrt{2}} P_2^0(\cos\theta^*) T_{20} - \frac{1}{\sqrt{3}} P_2^1(\cos\theta^*) \cos\phi^* \cdot T_{21} + \frac{1}{2\sqrt{3}} \cdot P_2^2(\cos\theta^*) \cos 2\phi^* T_{22} \right] =$$

$$= P_{zz} \left[\frac{1}{\sqrt{2}} \cdot \frac{1}{2} \cdot (3\cos^2\theta^* - 1) T_{20} - \right.$$

$$- \frac{1}{\sqrt{3}} \cdot \frac{\cancel{3}\,\sqrt{3}}{2} \underbrace{(2\cos\theta^* \sin\theta^*)}^{\sin 2\theta^*} \cos\phi^* T_{21} +$$

$$\left. + \frac{1}{2\cancel{\sqrt{3}}} \cdot \cancel{3}\,\sqrt{3} \cdot \sin^2\theta^* \cdot \cos(2\phi^*) T_{22} \right] =$$

$$= \frac{P_{zz}}{2} \left[\frac{3\cos^2\theta^* - 1}{\sqrt{2}} \cdot T_{20} - \sqrt{3} \cdot \sin 2\theta^* \cos\phi^* T_{21} + \sqrt{3} \sin^2\theta^* \cos(2\phi^*) T_{22} \right]$$

$$\boxed{\begin{aligned} P_z &= n_+ - n_- \\ P_{zz} &= 1 - 3 n_0 \end{aligned}}$$

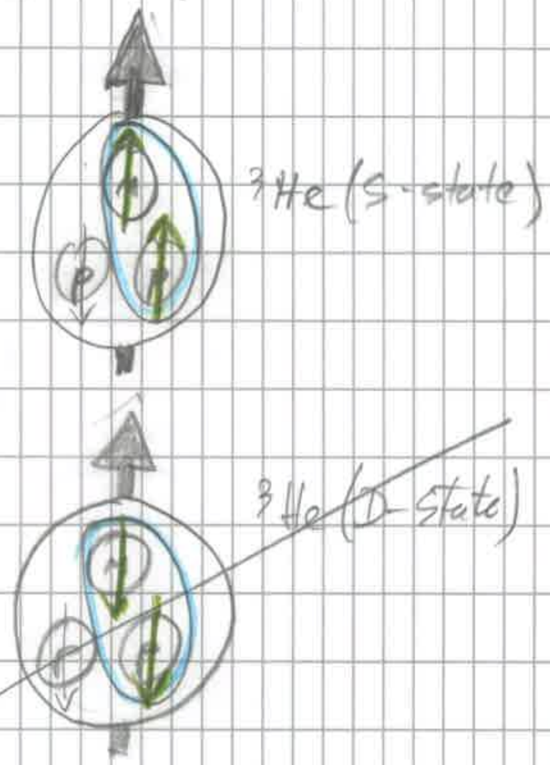
$(\cos\theta^*)$ according to ZLZ: In ^3He, d already

$\Big]_z$ = [?] only vector polarization, meaning, that

can not be found in n_0 state. So:

$n_+, n_- \neq 0$, $\underline{n_0 = 0}$. Ergo:

$+$ $P_{zz} = 1$;



$\doteq P_{^3He} \cdot \frac{2}{3}$

The same reason as ($\cos\varphi^* T_{21}$ for the proton case)

$$1\ GeV/c = \frac{1}{1.957 \cdot 10^{-16}\ m} = \frac{5.1098 \cdot \cancel{10^{15}}}{\cancel{10^{15}}\ fm} =$$

$$= \frac{5.1098}{fm} \Rightarrow \left[\frac{1}{fm}\right] = \frac{1}{5.1098}\ GeV/c =$$

$$= \underline{0.1957\ GeV/c}$$

Chapter 3

Overview of the Experiment

The experiment described in this thesis is the first experiment performed at the internal-target facility of NIKHEF. The experimental setup allows the measurement of the $(e,e'p)$ and $(e,e'd)$ reactions for tensor-polarized deuterium. In this chapter an overview of the experiment is given, together with its major design considerations. We give a general discussion of the kinematics, the electron storage ring and the principle of the internal target. In order to optimize the detection system, a Monte Carlo code was written which is briefly described in section 3.2. Furthermore, the results of a study of the spatial distribution of the stored electron beam are presented in section 3.3. In section 3.4 the design considerations for the polarized deuterium target will be discussed. A detailed description of the polarized source, internal target, polarimeters and detection system will be given in the next chapters.

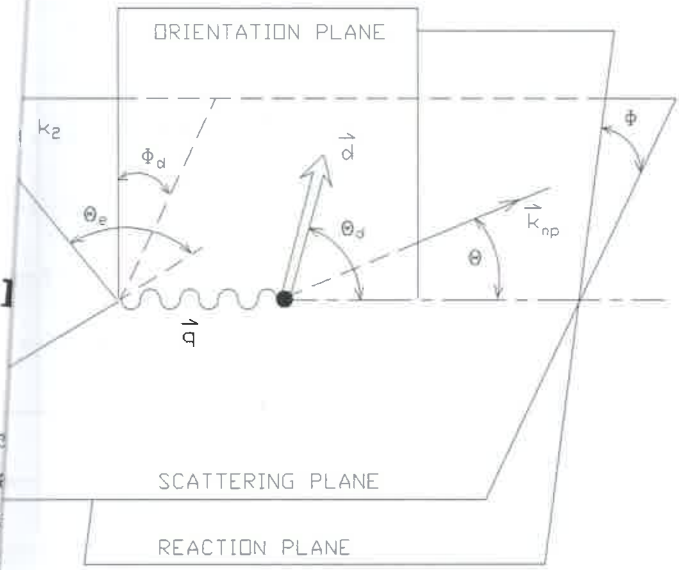
3.1 Description of the Experiment

3.1.1 Planned measurements

The goal of our experiment was to measure the spin-dependent observables for both $^2\vec{\vec{\mathrm{H}}}(e,e'd)$ elastic and $^2\vec{\vec{\mathrm{H}}}(e,e'p)$ quasi-elastic scattering over a large kinematic range. The general expression of the cross section for polarized deuteron electro-disintegration has the following form [6]:

$$\begin{aligned}\sigma = \sigma_0\Big[\, 1 \;&+\; \sqrt{3}\,P_z \sin\theta_d \sin\phi_d\, iT_{11} + \frac{1}{\sqrt{2}}\,P_{zz}\left(\frac{3\cos^2\theta_d - 1}{2}\,T_{20}\right.\\ &-\left.\sqrt{\frac{3}{2}}\,\sin 2\theta_d\,\cos\phi_d\,T_{21} + \sqrt{\frac{3}{2}}\,\sin^2\theta_d\,\cos 2\phi_d\,T_{22}\right)\Big]\,. \end{aligned} \tag{3.1}$$

Here, σ_0 is the unpolarized cross section, P_z and P_{zz} are the degree of vector and tensor polarization defined as $P_z = n_+ - n_-$ and $P_{zz} = 1 - 3n_0$, where n_+, n_0, and n_- are



y of exclusive electron-deuteron scattering with polarized elec- ron target. The relative $n-p$ momentum is denoted by $\vec{k}_{np}$ and ϕ and the deuteron orientation axis by $\vec{d}$ characterized by

of the final np relative momentum with respect to the photon rmine the polarization orientation in the same coordinate system. helicity and $P_1^d = P_{10}^d = \sqrt{\frac{3}{2}}(n_+ - n_-)$, $P_2^d = P_{20}^d = \frac{1}{\sqrt{2}}(1 - 3n_0)$ tensor polarizations of the deuteron. erical components of the virtual-photon density matrix. In a the z-axis parallel to $\vec{q}$ and the y-axis parallel to $\vec{e} \times \vec{e}'$, they can

$$\rho_L = Q_\mu^2 \frac{\xi^2}{2\eta} \tag{2.70}$$

$$\rho_T = \frac{1}{2} Q_\mu^2 (1 + \frac{\xi}{2\eta}) \tag{2.71}$$

$$\rho_{LT} = Q_\mu^2 \frac{\xi}{\eta} \sqrt{(\xi + \eta)/8} \tag{2.72}$$

$$\rho_{TT} = Q_\mu^2 \frac{\xi}{4\eta} \tag{2.73}$$

$$\rho'_{LT} = \frac{1}{2} Q_\mu^2 \xi \sqrt{2\eta} \tag{2.74}$$

$$\rho'_T = \frac{1}{2} Q_\mu^2 \sqrt{(\xi + \eta)/\eta}, \tag{2.75}$$

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ew of the Experime

scribed in this thesis is the first experiment pe KHEF. The experimental setup allows the mea ns for tensor-polarized deuterium. In this cha , together with its major design consideratio nematics, the electron storage ring and the p ptimize the detection system, a Monte Carlo in section 3.2. Furthermore, the results of ored electron beam are presented in section for the polarized deuterium target will be larized source, internal target, polarimeters ext chapters.

ion of the Experiment

neasurements

iment was to measure the spin-dependent $(e, e'p)$ quasi-elastic scattering over a large e cross section for polarized deuteron elec

$$\sqrt{3}\, P_z \sin\theta_d \sin\phi_d\, iT_{11} + \frac{1}{\sqrt{2}} P_{zz} \left(3\cos^2 \right.$$

$$\sqrt{\frac{3}{2}} \sin 2\theta_d \cos\phi_d\, T_{21} + \sqrt{\frac{3}{2}} \sin^2\theta_d \cos 2\phi$$

d cross section, P_z and P_{zz} are the degree $= n_+ - n_-$ and $P_{zz} = 1 - 3n_0$, where

where f is usually called the recoil factor

$$f = 1 + \frac{2E_e}{M_d}\sin^2\frac{\theta_e}{2}. \tag{2.23}$$

We define Q, related to the space-like four-momentum q transferred from the electron to the target nucleus, by

$$Q^2 = -q_\mu^2 = 4\frac{E_e^2}{f}\sin^2\frac{\theta_e}{2}. \tag{2.24}$$

For completeness, the kinetic energy and the angle of the recoil deuteron with respect to the incident electron are given below:

$$T_d = E_e - E_{e'} = \frac{Q^2}{2M_d}, \tag{2.25}$$

$$\sin^2\theta_d = \frac{\cos^2(\theta_e/2)}{f + (T_d/M_d)^2\sin^2(\theta_e/2)}. \tag{2.26}$$

The general features of e-d scattering have been investigated by many authors [53, 54]. By using the first Born approximation (one-photon exchange approximation) and imposing Lorentz and gauge invariance, the differential cross section can be written as

$$\frac{d\sigma}{d\Omega} = \frac{1}{f}(\frac{d\sigma}{d\Omega})_{\mathrm{Mott}}S, \tag{2.27}$$

where

$$(\frac{d\sigma}{d\Omega})_{\mathrm{Mott}} = \frac{\alpha^2\cos^2(\theta_e/2)}{4E_e^2\sin^4(\theta_e/2)} \tag{2.28}$$

describes the scattering of an electron from a point-like spinless particle (α is the fine structure constant), and

$$S = A(Q^2) + B(Q^2)\tan^2\frac{\theta_e}{2}, \tag{2.29}$$

originates from the electromagnetic structure of the deuteron. As a consequence of parity and time-reversal invariance, the structure functions A and B are in turn given by three elementary electromagnetic form factors:

$$A(Q^2) = G_C^2(Q^2) + \frac{8}{9}\eta^2 G_Q^2(Q^2) + \frac{2}{3}\eta G_M^2(Q^2), \tag{2.30}$$

$$B(Q^2) = \frac{4}{3}\eta(1+\eta)G_M^2(Q^2) \tag{2.31}$$

with $\eta = Q^2/4M_d^2$.

If a target with vector polarization P_z and tensor polarization P_{zz} is used in conjunction with an ultra-relativistic beam of polarized electrons with helicity h, then the cross section takes the following form [3, 55, 56]

$$\begin{aligned}
\frac{d\sigma}{d\Omega}(P_z, P_{zz}, h) &= \Sigma + h\Delta \\
\Sigma &= \frac{d\sigma}{d\Omega}[1+\Gamma] \\
\Gamma &= P_{zz}[\frac{1}{\sqrt{2}}P_2^0(\cos\theta_d)T_{20}(Q,\theta_e) - \frac{1}{\sqrt{3}}P_2^1(\cos\theta_d)\cos\phi_d T_{21}(Q,\theta_e) \\
&\qquad + \frac{1}{2\sqrt{3}}P_2^2(\cos\theta_d)\cos 2\phi_d T_{22}(Q,\theta_e)] \\
\Delta &= \frac{d\sigma}{d\Omega}P_z[\frac{\sqrt{3}}{\sqrt{2}}\cos\theta_d T_{10}^e(Q,\theta_e) - \sqrt{3}\sin\theta_d)\cos\phi_d T_{11}^e(Q,\theta_e)], \qquad (2.32)
\end{aligned}$$

where the notation has been chosen such that the connection with the Madison Convention [57] is made explicit. The responses T_{ij} can be expressed in terms of the three form factors

$$\begin{aligned}
T_{20} &= -\frac{1}{\sqrt{2}S}[\frac{8}{3}\eta G_C G_Q + \frac{8}{9}\eta^2 G_Q^2 + \frac{1}{3}\eta[1+2(1+\eta)\tan^2\frac{\theta_e}{2}]G_M^2] && (2.33) \\
T_{21} &= +\frac{2}{\sqrt{3}S}\eta[\eta + \eta^2\sin^2\frac{\theta_e}{2}]^{1/2}G_M G_Q \sec\frac{\theta_e}{2} && (2.34) \\
T_{22} &= -\frac{1}{2\sqrt{3}S}\eta G_M^2 \quad \frac{2}{3} && (2.35) \\
T_{10}^e &= \sqrt{\frac{3}{2}}\frac{2}{3S}\eta[(1+\eta)(1+\eta\sin^2\frac{\theta_e}{2})]^{1/2}G_M^2\sec\frac{\theta_e}{2}\tan\frac{\theta_e}{2} && (2.36) \\
T_{11}^e &= \frac{\sqrt{3}\,4}{2S\,3}[\eta(1+\eta)]^{1/2}G_M(G_C + \frac{1}{3}\eta G_Q)\tan\frac{\theta_e}{2}, && (2.37)
\end{aligned}$$

where the suffix e in T_{10}^e and T_{11}^e denotes that polarized electron beam is required. This notation is chosen to avoid confusion with the case of the deuteron vector analyzing power using an unpolarized electron beam. In the one-photon exchange approximation of electron-deuteron scattering, and as a result of time-reversal invariance, the deuteron vector analyzing power is identically zero when using an unpolarized electron beam [58].

The angles θ_d and ϕ_d specify the quantization axis of the target with respect to the three-momentum transfer as shown in Fig. 2.7 . The associate Legendre polynomials, sometimes expressed as d-functions, multiplying the rank-two responses are

$$\begin{aligned}
P_2^0 &= d_{00}^2 = \frac{3}{2}\cos^2\theta_d - \frac{1}{2} && (2.38) \\
P_2^1 &= -\sqrt{6}d_{10}^2 = 3\cos\theta_d\sin\theta_d && (2.39) \\
P_2^2 &= 2\sqrt{6}d_{20}^2 = 3\sin^2\theta_d. && (2.40)
\end{aligned}$$

Subject: RE: Elastic Deuteron Asymmetry
From: Zilu Zhou <zzhou2@slb.com>
Date: 12/19/2011 04:21 PM
To: Miha Mihovilovic <miha.mihovilovic@ijs.si>
CC: Simon Sirca <simon.sirca@fmf.uni-lj.si>

Miha,

Sorry for a late reply. Weekend always busy...

Before we start, I have to warn you that trying to treat He3(e,e'd)p as if it is a vector polarized deuteron and then get Aed for elastic asymmetry would be a mistake. Aed elastic is almost near zero as I showed on page 21 in my thesis, which is completely different from e-p elastic.
The vector asymmetry in He3(e,ed)p does not come from e-d elstic, but rather with the Faddeev calculation including He3 ground state properties and isospin reaction process. These interferences cannot be simplified in a intuitive picture like a e-d elastic asymmetry. Whileas He3(e,e'p)d or two-body break-up, the isospin interference is negligible, then the e-p elastic picture stands. Then the simplicity prevails, as we have discussed.

Now back to the Pz and Pzz calculation:
In Deuteron, this is exact complication. I have both Pz and Pzz equations on page 34, or equivalent in some of the publications. For both, there are always dilutions from the n0 state, as you said. So, strictly speaking, all the Pz measurements from many experiments were wrong without measuring the n0 state. But everybody did use unpolarized averages in the dominator as a short -cut. This was also one of the arguments that one has to study tensor polarization, in my thesis on page 45.

Other than this, everything is straight forward with the equations on page 34, or page 48. For polarized he3, you have + and - states, and then if deuteron is 100% following the he3 polarization, Pz is 100%.
For Pzz, since you do not have n0 state, then it is fixed at +1, 100%. There is no -2 100% in your case.

Hope this helps. Good luck. Let me know if you have more questions.

Zilu

-----Original Message-----
From: Miha Mihovilovic [mailto:miha.mihovilovic@ijs.si]
Sent: Friday, December 16, 2011 11:45 AM
To: Zilu Zhou
Cc: Simon Sirca
Subject: Elastic Deuteron Asymmetry

Dear Zilu,

I have few questions regarding my asymmetry analysis at low missing momenta (that we discusses on Monday), and would like to ask you for your help.

I am trying to calculate double polarized asymmetry for elastic scattering of electrons on deuterium. I am using formalism from your thesis (chapter 2). Unfortunately I do not know, how to properly consider polarization of the deuterium target in my asymmetry expression. It has a following form:

```
Aelastic  = Pz *(helicity dependent part of the cross section)/
                (sigma0*[1 + Pzz*(helicity independent part)])
```

Here Pz and Pzz are vector and tensor polarizations of the target. If my target would have 100% polarization, what do I need to consider for Pz and Pzz? Is it possible to take the tensor part out of the equation or do I need to consider it properly?

Simon and I also examined Passchier's paper with hopes to find an answer to this question (although it is not about elastic scattering). In that experiment you were also using vector-polarized deuterium. Unfortunately , we were not able to reproduce formula 3 (which shows how to calculate AVed from the measured asymmetry) from the expression (2) for the cross-section. In the paper you get very simple relation:

```
A = h*P1d*AVed
```

In our calculation we always got an additional tensor term in the denominator. We assumed that in the experiment you were changing vector-polarization but keeping tensor-polarization fixed the whole time. Is this true? The only way that we were able to reproduce formula in Passchier's paper was to consider two additional terms in the denominator with only tensor polarization (vector polarization = 0).

Is it enough to measure asymmetry at only one tensor polarization and just flipping vector-polarization, in order to extract AVed, or do you need measurements at two different tensor polarizations?

Thank you very much for all your help and suggestions.

Sincerely,
Miha

Subject: RE: Deuteron FF parameterization
From: Ball Jacques <jacques.ball@cea.fr>
Date: 12/16/2011 11:56 AM
To: Miha Mihovilovic <miha.mihovilovic@ijs.si>

Dear Miha,

Thank you for the interest in our past work. The information you asked for can be found at the following web page :
http://irfu.cea.fr/Sphn/T20/Parametrisations/

best regards

Jacques Ball

Irfu / SPhN
CEA, Centre de Saclay
F-91191 Gif-sur-Yvette
Tel : 33 1 69-08-87-19
Mail : jacques.ball@cea.fr
Webpage : http://irfu.cea.fr/Sphn/Phocea/Vie_des_labos
/Ast/ast_groupe.php?id_groupe=495

-----Message d'origine-----
De : Miha Mihovilovic [mailto:miha.mihovilovic@ijs.si]
Envoyé : vendredi 16 décembre 2011 11:18
À : Ball Jacques
Cc : jball@jlab.org; miham@jlab.org; Simon Sirca
Objet : Deuteron FF parameterization

Dear prof. Ball,

I am a PhD student in Hall A working on the analysis for the E05-102 experiment. In my analysis I am trying to determine asymmetry for the elastic electron-deuteron scattering. To calculate this asymmetry I need to know deuteron form-factors. For the parameterization of the form-factors I would like to use one of the parameterizations from your paper (Eur. Phys. J. A 7, 421 (2000)).

I would like to ask you, if you could send me parameters, that you considered in your fits.

Sincerely,
Miha Mihovilovic

Paramétrisations

The results of the Parameterization I and II, detailed in our article, "Phenomenology of the deuteron electromagnetic form factors" (European Physical Journal A, vol 7 (2000) 421), which were worked out with the World data set are updated on this page.

Parameterization I

$$Gx(Q^2)=Gx(0)[1-(Q/Qx(0))^2][1+\sum_{i=1}^{5} ax(i)Q^{(2i)}]^{(-1)}$$

with x = c, q, m and Q in Fm^{-1}

Gc		Gq		Gm	
Qc(0)	4.21	Qq(0)	8.1	Qm(0)	7.37
ac(1)	6.740E-01	aq(1)	8.796E-01	am(1)	5.804E-01
ac(2)	2.246E-02	aq(2)	-5.656E-02	am(2)	8.701E-02
ac(3)	9.806E-03	aq(3)	1.933E-02	am(3)	-3.624E-03
ac(4)	-2.709E-04	aq(4)	-6.734E-04	am(4)	3.448E-04
ac(5)	3.793E-06	aq(5)	9.438E-06	am(5)	-2.818E-06

$G_c(0) = 1.$

$G_q(0) = 25.83$

$G_M(0) = 1.714$

To see the full results listing of the form factors , click here : Parameterization I

Parameterization II

The notations are those used by Kobushkin and Syamtomov in "Deuteron electromagnetic form factors in the transitional region between nucleon-meson and quark gluons pictures" (Phys. At. Nucl 58, 1477, (1995)).

a(i) (fm^{-2})	b(i) (fm^{-1})	c(i)	$\alpha^2(i)$ (fm^{-2})	$\beta^2(i)$ (fm^{-2})	$\gamma^2(i)$ (fm^{-2})
1.57057	0.07043	-0.16577	1.52501	43.67795	1.87055
12.23792	0.14443	0.27557	8.75139	30.05435	14.95683
-42.04576	-0.27343	-0.05382	15.97777	16.43075	28.04312
27.92014	0.05856	-0.05598	23.20415	2.80716	41.12940

$\mu^{(\alpha)} = 240.86\ MeV/c$ $\mu^{(\beta)} = 29.138\ MeV/c$ $\mu^{(\gamma)} = 426.93\ MeV/c$ $\delta = 898.52\ MeV/c$

To see the full results listing of the form factors , click here : Parameterization II

back to t20 home page

Opomba: Danes dne 09/21/12 mi je [illegible] prvič pokazala svoje tongue. Nikoli [illegible] mi [illegible] [illegible] na [illegible]! [illegible] [illegible] [illegible] lahko [illegible] [illegible]!

(3He)

09/21/12

$$|J=\tfrac{1}{2}, m_j=\tfrac{1}{2}\rangle_{^3He} = \sqrt{\tfrac{2}{3}}\,|1,1\rangle_d\,|\tfrac{1}{2}\ -\tfrac{1}{2}\rangle_p$$

$$-\sqrt{\tfrac{1}{3}}\,|1,0\rangle_d\,|\tfrac{1}{2},+\tfrac{1}{2}\rangle_p$$

Tukaj ni dvojke, ker je celotni [illegible] spin. Hvaležni [illegible] predznak.

$$P_d = {}_{^3He}\langle \tfrac{1}{2}\ \tfrac{1}{2}|\, \mathbb{1}\,\sigma_z^{(d)}, P_{^3He}\, |\tfrac{1}{2}\ \tfrac{1}{2}\rangle =$$

$$= \left(\sqrt{\tfrac{2}{3}}\langle 1,1|\langle \tfrac{1}{2},-\tfrac{1}{2}| - \sqrt{\tfrac{1}{3}}\langle 1,0|\langle \tfrac{1}{2},+\tfrac{1}{2}|\right) P_{^3He}\ \cdot$$

$$\left(\sqrt{\tfrac{2}{3}}\cdot \mathbb{1}\cdot |1,1\rangle\,|\tfrac{1}{2},-\tfrac{1}{2}\rangle - \sqrt{\tfrac{1}{3}}\cdot 0\right) =$$

$$= \tfrac{2}{3}$$

TO-DO:

+ Preveri na ostalih podatkih, če analiza res štima.

+ Poglej kaj se najbolj [illegible] [illegible] elektronih. Kateri kvantni [illegible] je najbolj vzbujen?

```
ThE: 12.5,  Th*: 68.2544,  Ph*: 8.53774e-07
Gc(0.27063 GeV**2) = 0.0617677
Gq(0.27063 GeV**2) = 2.3764
Gm(0.27063 GeV**2) = 0.166093
A(0.27063 GeV**2) = 0.00602567
B(0.27063 GeV**2) = 0.000721013
T20(0.27063 GeV**2, 70deg) = -1.07945
T21(0.27063 GeV**2, 70deg) = 0.233359
T22(0.27063 GeV**2, 70deg) = -0.0240091
T10(0.27063 GeV**2, 70deg) = 0.0587881
T11(0.27063 GeV**2, 70deg) = 0.182052
LongAsymmetry: ThE: 10.5,  Th*: 71.5778,  Ph*: 0, Q2: 0.192864,  AL: -0.0212088
TransAsymmetry: ThE: 10.5,  Th*: 161.578,  Ph*: 0, Q2: 0.192864,  AT: -0.0193912
---------------------------------------------------------------------------
LongAsymmetry: ThE: 11,  Th*: 70.7393,  Ph*: 0, Q2: 0.211177,  AL: -0.0228927
TransAsymmetry: ThE: 11,  Th*: 160.739,  Ph*: 0, Q2: 0.211177,  AT: -0.0233552
---------------------------------------------------------------------------
LongAsymmetry: ThE: 11.5,  Th*: 69.9058,  Ph*: 0, Q2: 0.23025,  AL: -0.024564
TransAsymmetry: ThE: 11.5,  Th*: 159.906,  Ph*: 0, Q2: 0.23025,  AT: -0.0276787
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12,  Th*: 69.0774,  Ph*: 0, Q2: 0.250072,  AL: -0.0261893
TransAsymmetry: ThE: 12,  Th*: 159.077,  Ph*: 0, Q2: 0.250072,  AT: -0.0321579
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12.5,  Th*: 68.2544,  Ph*: 8.53774e-07, Q2: 0.27063,  AL: -0.0277243
TransAsymmetry: ThE: 12.5,  Th*: 158.254,  Ph*: 0, Q2: 0.27063,  AT: -0.0364951
---------------------------------------------------------------------------
LongAsymmetry: ThE: 13,  Th*: 67.4367,  Ph*: 0, Q2: 0.291914,  AL: -0.0291125
TransAsymmetry: ThE: 13,  Th*: 157.437,  Ph*: 0, Q2: 0.291914,  AT: -0.040332
---------------------------------------------------------------------------
LongAsymmetry: ThE: 13.5,  Th*: 66.6246,  Ph*: 0, Q2: 0.313909,  AL: -0.0302837
TransAsymmetry: ThE: 13.5,  Th*: 156.625,  Ph*: 8.53774e-07, Q2: 0.313909,  AT: -0.043315
---------------------------------------------------------------------------
```

Pol. = 2/3

09/24/12

For 12.5° data

Longitudinal: $\frac{-0.03116 + (-0.0252685)}{2} =$

$= -0.028214 \pm 0.002946$

Transverse: $\frac{-0.045172 + (-0.0295947)}{2} =$

$= -0.037383 \pm 0.00779$

```
ThE: 12.5,  Th*: 68.2544,  Ph*: 8.53774e-07
Gc(0.27063 GeV**2) = 0.0617677
Gq(0.27063 GeV**2) = 2.3764
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T10(0.27063 GeV**2, 70deg) = 0.0587881
T11(0.27063 GeV**2, 70deg) = 0.182052
********Point ThE: 10,  Eprime: 2.37886 is out of acceptance!
LongAsymmetry: ThE: 10,  Eprime: 2.37886,  Th*: 72.4212,  Ph*: 0, Q2: 0.175324,  AL: -0.0195369
TransAsymmetry: ThE: 10,  Eprime: 2.37886,  Th*: 162.421,  Ph*: 0, Q2: 0.175324,  AT: -0.0158946
------------------------------------------------------------------------------
********Point ThE: 10.2857,  Eprime: 2.37622 is out of acceptance!
LongAsymmetry: ThE: 10.2857,  Eprime: 2.37622,  Th*: 71.9387,  Ph*: 0, Q2: 0.185252,  AL: -0.0204897
TransAsymmetry: ThE: 10.2857,  Eprime: 2.37622,  Th*: 161.939,  Ph*: 0, Q2: 0.185252,  AT: -0.0178321
------------------------------------------------------------------------------
********Point ThE: 10.5714,  Eprime: 2.3735 is out of acceptance!
LongAsymmetry: ThE: 10.5714,  Eprime: 2.3735,  Th*: 71.4577,  Ph*: 0, Q2: 0.195433,  AL: -0.0214491
TransAsymmetry: ThE: 10.5714,  Eprime: 2.3735,  Th*: 161.458,  Ph*: 8.53774e-07, Q2: 0.195433,  AT: 
-0.0199304
------------------------------------------------------------------------------
********Point ThE: 10.8571,  Eprime: 2.37072 is out of acceptance!
LongAsymmetry: ThE: 10.8571,  Eprime: 2.37072,  Th*: 70.9784,  Ph*: 0, Q2: 0.205866,  AL: -0.0224117
TransAsymmetry: ThE: 10.8571,  Eprime: 2.37072,  Th*: 160.978,  Ph*: 0, Q2: 0.205866,  AT: -0.0221796
------------------------------------------------------------------------------
********Point ThE: 11.1429,  Eprime: 2.36787 is out of acceptance!
LongAsymmetry: ThE: 11.1429,  Eprime: 2.36787,  Th*: 70.5007,  Ph*: 0, Q2: 0.216549,  AL: -0.0233728
TransAsymmetry: ThE: 11.1429,  Eprime: 2.36787,  Th*: 160.501,  Ph*: 0, Q2: 0.216549,  AT: -0.0245609
------------------------------------------------------------------------------
********Point ThE: 11.4286,  Eprime: 2.36496 is out of acceptance!
LongAsymmetry: ThE: 11.4286,  Eprime: 2.36496,  Th*: 70.0246,  Ph*: 0, Q2: 0.227479,  AL: -0.0243272
TransAsymmetry: ThE: 11.4286,  Eprime: 2.36496,  Th*: 160.025,  Ph*: 0, Q2: 0.227479,  AT: -0.0270457
------------------------------------------------------------------------------
********Point ThE: 11.7143,  Eprime: 2.36198 is out of acceptance!
LongAsymmetry: ThE: 11.7143,  Eprime: 2.36198,  Th*: 69.5502,  Ph*: 0, Q2: 0.238654,  AL: -0.0252685
TransAsymmetry: ThE: 11.7143,  Eprime: 2.36198,  Th*: 159.55,  Ph*: 0, Q2: 0.238654,  AT: -0.0295947
------------------------------------------------------------------------------
LongAsymmetry: ThE: 12,  Eprime: 2.35894,  Th*: 69.0774,  Ph*: 0, Q2: 0.250072,  AL: -0.0261893
TransAsymmetry: ThE: 12,  Eprime: 2.35894,  Th*: 159.077,  Ph*: 0, Q2: 0.250072,  AT: -0.0321579
------------------------------------------------------------------------------
LongAsymmetry: ThE: 12.2857,  Eprime: 2.35583,  Th*: 68.6065,  Ph*: 0, Q2: 0.26173,  AL: -0.0270808
TransAsymmetry: ThE: 12.2857,  Eprime: 2.35583,  Th*: 158.606,  Ph*: 0, Q2: 0.26173,  AT: -0.0346759
------------------------------------------------------------------------------
LongAsymmetry: ThE: 12.5714,  Eprime: 2.35266,  Th*: 68.1372,  Ph*: 0, Q2: 0.273627,  AL: -0.027933
TransAsymmetry: ThE: 12.5714,  Eprime: 2.35266,  Th*: 158.137,  Ph*: 0, Q2: 0.273627,  AT: -0.0370825
------------------------------------------------------------------------------
LongAsymmetry: ThE: 12.8571,  Eprime: 2.34942,  Th*: 67.6698,  Ph*: 0, Q2: 0.28576,  AL: -0.0287346
TransAsymmetry: ThE: 12.8571,  Eprime: 2.34942,  Th*: 157.67,  Ph*: 0, Q2: 0.28576,  AT: -0.0393083
------------------------------------------------------------------------------
LongAsymmetry: ThE: 13.1429,  Eprime: 2.34613,  Th*: 67.2041,  Ph*: 0, Q2: 0.298126,  AL: -0.0294727
TransAsymmetry: ThE: 13.1429,  Eprime: 2.34613,  Th*: 157.204,  Ph*: 0, Q2: 0.298126,  AT: -0.0412855
------------------------------------------------------------------------------
LongAsymmetry: ThE: 13.4286,  Eprime: 2.34277,  Th*: 66.7403,  Ph*: 0, Q2: 0.310723,  AL: -0.0301327
TransAsymmetry: ThE: 13.4286,  Eprime: 2.34277,  Th*: 156.74,  Ph*: 0, Q2: 0.310723,  AT: -0.0429528
------------------------------------------------------------------------------
LongAsymmetry: ThE: 13.7143,  Eprime: 2.33935,  Th*: 66.2783,  Ph*: 0, Q2: 0.32355,  AL: -0.0306989
TransAsymmetry: ThE: 13.7143,  Eprime: 2.33935,  Th*: 156.278,  Ph*: 0, Q2: 0.32355,  AT: -0.04426
------------------------------------------------------------------------------
LongAsymmetry: ThE: 14,  Eprime: 2.33587,  Th*: 65.8181,  Ph*: 0, Q2: 0.336602,  AL: -0.0311538
TransAsymmetry: ThE: 14,  Eprime: 2.33587,  Th*: 155.818,  Ph*: 8.53774e-07, Q2: 0.336602,  AT: -0.0451719
```

Minimum!

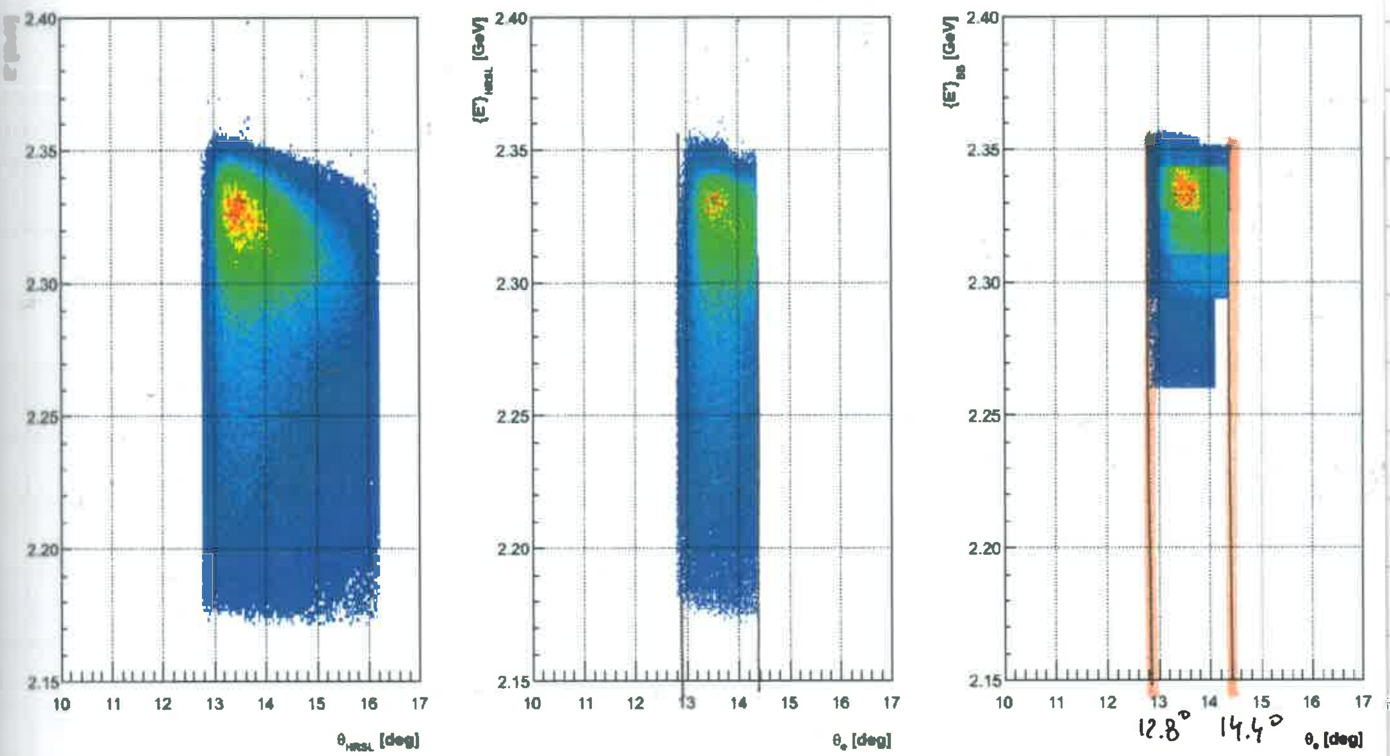
Maximum!

Popravi, ker gre enostavno do 14.5°

```
ThE: 12.5,  Th*: 68.2544,  Ph*: 8.53774e-07
Gc(0.27063 GeV**2) = 0.0617677
Gq(0.27063 GeV**2) = 2.3764
Gm(0.27063 GeV**2) = 0.166093
A(0.27063 GeV**2) = 0.00602567
B(0.27063 GeV**2) = 0.000721013
T20(0.27063 GeV**2, 70deg) = -1.07945
T21(0.27063 GeV**2, 70deg) = 0.233359
T22(0.27063 GeV**2, 70deg) = -0.0240091
T10(0.27063 GeV**2, 70deg) = 0.0587881
T11(0.27063 GeV**2, 70deg) = 0.182052
********Point ThE: 10,  Eprime: 2.37886 is out of acceptance!
LongAsymmetry: ThE: 10,  Eprime: 2.37886,  Th*: 72.4212,  Ph*: 0, Q2: 0.175324,  AL: -0.0195369
TransAsymmetry: ThE: 10,  Eprime: 2.37886,  Th*: 162.421,  Ph*: 0, Q2: 0.175324,  AT: -0.0158946
---------------------------------------------------------------------------
********Point ThE: 10.2941,  Eprime: 2.37614 is out of acceptance!
LongAsymmetry: ThE: 10.2941,  Eprime: 2.37614,  Th*: 71.9245,  Ph*: 0, Q2: 0.185547,  AL: -0.0205178
TransAsymmetry: ThE: 10.2941,  Eprime: 2.37614,  Th*: 161.925,  Ph*: 0, Q2: 0.185547,  AT: -0.0178915
---------------------------------------------------------------------------
********Point ThE: 10.5882,  Eprime: 2.37334 is out of acceptance!
LongAsymmetry: ThE: 10.5882,  Eprime: 2.37334,  Th*: 71.4295,  Ph*: 0, Q2: 0.19604,  AL: -0.0215057
TransAsymmetry: ThE: 10.5882,  Eprime: 2.37334,  Th*: 161.43,  Ph*: 0, Q2: 0.19604,  AT: -0.0200587
---------------------------------------------------------------------------
********Point ThE: 10.8824,  Eprime: 2.37047 is out of acceptance!
LongAsymmetry: ThE: 10.8824,  Eprime: 2.37047,  Th*: 70.9362,  Ph*: 0, Q2: 0.206799,  AL: -0.0224966
TransAsymmetry: ThE: 10.8824,  Eprime: 2.37047,  Th*: 160.936,  Ph*: 8.53774e-07, Q2: 0.206799,  AT:
-0.0223847
---------------------------------------------------------------------------
********Point ThE: 11.1765,  Eprime: 2.36753 is out of acceptance!
LongAsymmetry: ThE: 11.1765,  Eprime: 2.36753,  Th*: 70.4446,  Ph*: 0, Q2: 0.217822,  AL: -0.0234856
TransAsymmetry: ThE: 11.1765,  Eprime: 2.36753,  Th*: 160.445,  Ph*: 0, Q2: 0.217822,  AT: -0.0248485
---------------------------------------------------------------------------
********Point ThE: 11.4706,  Eprime: 2.36452 is out of acceptance!
LongAsymmetry: ThE: 11.4706,  Eprime: 2.36452,  Th*: 69.9547,  Ph*: 0, Q2: 0.229107,  AL: -0.0244666
TransAsymmetry: ThE: 11.4706,  Eprime: 2.36452,  Th*: 159.955,  Ph*: 0, Q2: 0.229107,  AT: -0.0274176
---------------------------------------------------------------------------
********Point ThE: 11.7647,  Eprime: 2.36145 is out of acceptance!
LongAsymmetry: ThE: 11.7647,  Eprime: 2.36145,  Th*: 69.4666,  Ph*: 8.53774e-07, Q2: 0.240651,  AL:
-0.0254327
TransAsymmetry: ThE: 11.7647,  Eprime: 2.36145,  Th*: 159.467,  Ph*: 8.53774e-07, Q2: 0.240651,  AT:
-0.0300476
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12.0588,  Eprime: 2.3583,  Th*: 68.9803,  Ph*: 0, Q2: 0.252452,  AL: -0.0263755
TransAsymmetry: ThE: 12.0588,  Eprime: 2.3583,  Th*: 158.98,  Ph*: 0, Q2: 0.252452,  AT: -0.0326821
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12.3529,  Eprime: 2.35509,  Th*: 68.4959,  Ph*: 8.53774e-07, Q2: 0.264508,  AL:
-0.0272852
TransAsymmetry: ThE: 12.3529,  Eprime: 2.35509,  Th*: 158.496,  Ph*: 0, Q2: 0.264508,  AT: -0.0352548
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12.6471,  Eprime: 2.35181,  Th*: 68.0133,  Ph*: 0, Q2: 0.276816,  AL: -0.0281507
TransAsymmetry: ThE: 12.6471,  Eprime: 2.35181,  Th*: 158.013,  Ph*: 0, Q2: 0.276816,  AT: -0.0376922
---------------------------------------------------------------------------
LongAsymmetry: ThE: 12.9412,  Eprime: 2.34846,  Th*: 67.5326,  Ph*: 0, Q2: 0.289373,  AL: -0.0289589
TransAsymmetry: ThE: 12.9412,  Eprime: 2.34846,  Th*: 157.533,  Ph*: 0, Q2: 0.289373,  AT: -0.0399186
---------------------------------------------------------------------------
LongAsymmetry: ThE: 13.2353,  Eprime: 2.34505,  Th*: 67.0538,  Ph*: 0, Q2: 0.302176,  AL: -0.0296955
TransAsymmetry: ThE: 13.2353,  Eprime: 2.34505,  Th*: 157.054,  Ph*: 0, Q2: 0.302176,  AT: -0.0418615
---------------------------------------------------------------------------
LongAsymmetry: ThE: 13.5294,  Eprime: 2.34157,  Th*: 66.577,  Ph*: 8.53774e-07, Q2: 0.315224,  AL:
-0.0303441
TransAsymmetry: ThE: 13.5294,  Eprime: 2.34157,  Th*: 156.577,  Ph*: 0, Q2: 0.315224,  AT: -0.0434574
---------------------------------------------------------------------------
LongAsymmetry: ThE: 13.8235,  Eprime: 2.33803,  Th*: 66.1021,  Ph*: 0, Q2: 0.328514,  AL: -0.0308869
TransAsymmetry: ThE: 13.8235,  Eprime: 2.33803,  Th*: 156.102,  Ph*: 0, Q2: 0.328514,  AT: -0.0446568
---------------------------------------------------------------------------
LongAsymmetry: ThE: 14.1176,  Eprime: 2.33442,  Th*: 65.6292,  Ph*: 0, Q2: 0.342042,  AL: -0.0313045
TransAsymmetry: ThE: 14.1176,  Eprime: 2.33442,  Th*: 155.629,  Ph*: 0, Q2: 0.342042,  AT: -0.0454276
```

```
LongAsymmetry: ThE: 14.4118,  Eprime: 2.33075,  Th*: 65.1582,  Ph*: 0, Q2: 0.355806,  AL: -0.0315759
TransAsymmetry: ThE: 14.4118,  Eprime: 2.33075,  Th*: 155.158,  Ph*: 0, Q2: 0.355806,  AT: -0.0457568
-----------------------------------------------------------------------------------------------------
LongAsymmetry: ThE: 14.7059,  Eprime: 2.32702,  Th*: 64.6893,  Ph*: 0, Q2: 0.369803,  AL: -0.0316795
TransAsymmetry: ThE: 14.7059,  Eprime: 2.32702,  Th*: 154.689,  Ph*: 0, Q2: 0.369803,  AT: -0.04565
-----------------------------------------------------------------------------------------------------
LongAsymmetry: ThE: 15,  Eprime: 2.32323,  Th*: 64.2224,  Ph*: 0, Q2: 0.384031,  AL: -0.0315926
TransAsymmetry: ThE: 15,  Eprime: 2.32323,  Th*: 154.222,  Ph*: 0, Q2: 0.384031,  AT: -0.0451288
-----------------------------------------------------------------------------------------------------
```

Sedaj določimo še mejne točke za 14.5° data:



Longitudinal: $A_L^e = \dfrac{-0.02896 - 0.031576}{2} = \underline{\underline{-0.0303 \pm 0.0013}}$

Transverse: $A_T^e = \dfrac{-0.039919 - 0.04576}{2} = \underline{\underline{-0.04284 \pm 0.00292}}$