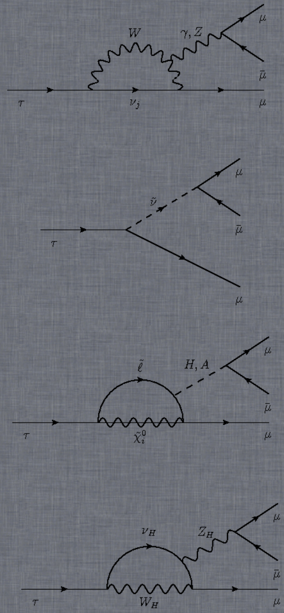
Updates on activities.

Marcin Chrząszcz[1,2] , Nicola Serra[1]

[1] University of Zurich , [2] Institute of Nuclear Physics, Krakow,

May 23, 2014

University of Zurich[UZH]

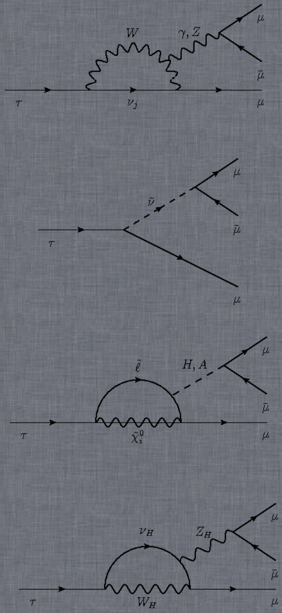


Introduction

MM without unfolding

MM with unfolding

S-wave measurements



Reminder

- last time I shown the preliminary results of analysing the TOY MC.
- Found couple of bugs, and bias in fitting.
- Today will give the final numbers.

MM results without unfolding.

- This hasn't change at all from last time.
- For details on extraction of the signal moments from the mixsampel(bck+sig) see my previous presentation: Link
- I am tired of putting $\mathcal{O}(10^2)$ plots in the presentations
- All pull plots are here: Link
- Fits to mass here: Link
- Summarizing table in the next slide.
- HEADS UP: tables are small, I attached the bigger version in separate file.

MM without unfolding results

Mean of the pull							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	$-0.015 \pm 0.027(0.6)$	$0.057 \pm 0.027(2.1)$	$-0.018 \pm 0.028(0.6)$	$0.046 \pm 0.027(1.7)$	$0.021 \pm 0.027(0.8)$	$-0.0082 \pm 0.028(0.3)$	$0.0098 \pm 0.026(0.4)$
1	$0.031 \pm 0.029(1.1)$	$0.026 \pm 0.027(1.0)$	$-0.016 \pm 0.029(0.6)$	$0.013 \pm 0.028(0.5)$	$-0.091 \pm 0.028(3.3)$	$-0.053 \pm 0.027(2.0)$	$0.0078 \pm 0.028(2.8)$
2	$-0.052 \pm 0.027(1.9)$	$-0.0031 \pm 0.027(0.1)$	$-0.041 \pm 0.029(0.5)$	$-0.039 \pm 0.027(1.4)$	$-0.012 \pm 0.027(0.4)$	$-0.048 \pm 0.026(1.8)$	$0.023 \pm 0.029(0.8)$
3	$-0.035 \pm 0.027(1.3)$	$0.013 \pm 0.027(0.5)$	$0.0047 \pm 0.028(0.2)$	$-0.042 \pm 0.028(1.5)$	$0.044 \pm 0.028(1.6)$	$0.019 \pm 0.028(0.7)$	$-0.03 \pm 0.029(1.0)$
4	$0.049 \pm 0.027(1.8)$	$-0.021 \pm 0.028(0.8)$	$0.0025 \pm 0.029(0.1)$	$0.025 \pm 0.027(0.9)$	$0.045 \pm 0.028(1.6)$	$-0.035 \pm 0.027(1.3)$	$0.057 \pm 0.026(2.2)$
5	$0.014 \pm 0.029(0.5)$	$-0.018 \pm 0.027(0.7)$	$0.013 \pm 0.028(0.5)$	$-0.009 \pm 0.028(0.3)$	$0.029 \pm 0.027(1.1)$	$-0.021 \pm 0.028(0.8)$	$0.043 \pm 0.028(1.5)$
6	$0.012 \pm 0.029(0.4)$	$-0.0021 \pm 0.029(0.1)$	$-0.01 \pm 0.028(0.4)$	$0.0098 \pm 0.028(0.3)$	$0.0014 \pm 0.028(0.1)$	$-0.00054 \pm 0.029(1.0)$	$-0.031 \pm 0.026(1.3)$
7	$0.15 \pm 0.027(5.6)$	$-0.24 \pm 0.028(18)$	$-0.32 \pm 0.027(12)$	$1.6 \pm 0.027(60)$	$0.37 \pm 0.028(13)$	$-0.15 \pm 0.027(60)$	$0.016 \pm 0.028(0.6)$
8	$0.017 \pm 0.027(0.6)$	$-0.039 \pm 0.028(1.4)$	$-0.01 \pm 0.027(0.4)$	$0.023 \pm 0.028(0.8)$	$0.011 \pm 0.029(0.4)$	$-0.015 \pm 0.027(0.6)$	$-0.022 \pm 0.028(0.8)$
9	$0.042 \pm 0.028(1,5)$	$0.00059 \pm 0.026(0.1)$	$0.024 \pm 0.026(0.9)$	$0.034 \pm 0.027(1.3)$	$-0.021 \pm 0.027(0.8)$	$-0.082 \pm 0.027(3.0)$	$-0.016 \pm 0.027(0.6)$
10	$0.013 \pm 0.026(0.5)$	$-0.038 \pm 0.027(1.4)$	$-0.027 \pm 0.027(1.0)$	$-0.04 \pm 0.028(1.4)$	$-0.028 \pm 0.029(1.0)$	$0.037 \pm 0.028(1.3)$	$-0.024 \pm 0.028(0.9)$
11	$0.092 \pm 0.027(3.4)$	$0.0068 \pm 0.028(0.2)$	$-0.076 \pm 0.027(2.8)$	$-0.029 \pm 0.028(1.0)$	$-0.025 \pm 0.028(0.9)$	$-0.018 \pm 0.027(0.7)$	$-0.03 \pm 0.027(1.1)$

Everything better then I hoped :)

M.Chrząszcz, N.Serra 2014

MM without unfolding results

Sigma of the pull							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	$0.96 \pm 0.02(2.1)$	$0.95 \pm 0.02(2.7)$	$0.97 \pm 0.022(1.5)$	$0.97 \pm 0.021(1.2)$	$0.95 \pm 0.023(2.2)$	$0.98 \pm 0.023(0.93)$	$0.94 \pm 0.021(2.9)$
1	$1 \pm 0.025(-0.37)$	$0.97 \pm 0.022(1.4)$	$1 \pm 0.024(-0.57)$	$0.97 \pm 0.023(1.4)$	$0.99 \pm 0.023(0.44)$	$0.97 \pm 0.021(1.7)$	$0.98 \pm 0.022(1.1)$
2	$0.94 \pm 0.022(2.7)$	$0.96 \pm 0.021(1.7)$	$1 \pm 0.023(0.021)$	$0.95 \pm 0.022(2.2)$	$0.96 \pm 0.023(2)$	$0.95 \pm 0.021(2.5)$	$1 \pm 0.025(-0.84)$
3	$0.95 \pm 0.022(2.1)$	$0.96 \pm 0.022(1.6)$	$0.98 \pm 0.021(0.83)$	$0.99 \pm 0.021(0.55)$	$0.97 \pm 0.023(1.2)$	$0.98 \pm 0.023(0.74)$	$1 \pm 0.022(-0.024)$
4	$0.96 \pm 0.023(1.8)$	$0.98 \pm 0.022(1.1)$	$1 \pm 0.023(-0.79)$	$0.94 \pm 0.023(2.4)$	$0.96 \pm 0.024(1.6)$	$0.95 \pm 0.021(2.2)$	$0.94 \pm 0.021(2.9)$
5	$1 \pm 0.023(-0.3)$	$0.95 \pm 0.022(2.1)$	$1 \pm 0.021(0.13)$	$0.98 \pm 0.021(0.9)$	$0.95 \pm 0.023(2.1)$	$0.98 \pm 0.021(1.1)$	$0.99 \pm 0.022(0.65)$
6	$1 \pm 0.025(-0.33)$	$1 \pm 0.023(-0.41)$	$0.97 \pm 0.023(1.2)$	$0.99 \pm 0.022(0.26)$	$0.98 \pm 0.023(0.78)$	$0.99 \pm 0.024(0.58)$	$0.93 \pm 0.02(3.4)$
7	$0.95 \pm 0.021(2.3)$	$0.97 \pm 0.022(1.3)$	$0.95 \pm 0.022(2.3)$	$0.95 \pm 0.023(2.1)$	$0.97 \pm 0.022(1.4)$	$0.93 \pm 0.022(3.3)$	$0.99 \pm 0.023(0.53)$
8	$0.94 \pm 0.022(2.9)$	$0.99 \pm 0.024(0.21)$	$0.96 \pm 0.021(1.9)$	$1 \pm 0.024(0.014)$	$1 \pm 0.023(-0.0078)$	$0.96 \pm 0.022(1.8)$	$0.95 \pm 0.023(2)$
9	$0.98 \pm 0.023(1)$	$0.91 \pm 0.021(4.2)$	$0.91 \pm 0.02(4.4)$	$0.95 \pm 0.022(2.4)$	$0.95 \pm 0.022(2.1)$	$0.95 \pm 0.022(2.4)$	$0.97 \pm 0.022(1.5)$
10	$0.92 \pm 0.021(3.8)$	$0.95 \pm 0.023(2.3)$	$0.96 \pm 0.021(2.1)$	$0.98 \pm 0.023(0.9)$	$1 \pm 0.023(-0.24)$	$0.97 \pm 0.023(1.4)$	$1 \pm 0.025(0.067)$
11	$0.97 \pm 0.021(1.5)$	$0.98 \pm 0.022(1.1)$	$0.95 \pm 0.02(2.6)$	$0.96 \pm 0.024(1.8)$	$0.98 \pm 0.023(1.1)$	$0.96 \pm 0.022(1.7)$	$0.96 \pm 0.021(1.8)$

Everything better then I hoped :)

M.Chrząszcz, N.Serra 2014

MM with unfolding results

Mean of the pull							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	$-0.022 \pm 0.028(-0.8)$	$0.071 \pm 0.026(2.7)$	$-0.05 \pm 0.028(-1.8)$	$0.059 \pm 0.029(2)$	$0.022 \pm 0.027(0.8)$	$-0.059 \pm 0.027(-2.2)$	$0.031 \pm 0.026(1.2)$
1	$-0.0075 \pm 0.027(-0.3)$	$0.015 \pm 0.026(0.6)$	$-0.072 \pm 0.027(-2.6)$	$-0.15 \pm 0.03(-5.1)$	$-0.066 \pm 0.028(-2.4)$	$-0.046 \pm 0.027(-1.7)$	$0.0051 \pm 0.027(0.2)$
2	$-0.02 \pm 0.027(-0.7)$	$-0.01 \pm 0.028(-0.4)$	$0.04 \pm 0.027(1.5)$	$-0.15 \pm 0.028(-5.5)$	$-0.059 \pm 0.027(-2.1)$	$0.0086 \pm 0.028(0.3)$	$-0.024 \pm 0.03(-0.9)$
3	$-0.029 \pm 0.027(-1.1)$	$-0.065 \pm 0.027(-2.4)$	$0.12 \pm 0.026(4.5)$	$-0.059 \pm 0.028(-2.1)$	$0.018 \pm 0.027(0.7)$	$0.021 \pm 0.027(0.8)$	$-0.04 \pm 0.028(-1.5)$
4	$-0.033 \pm 0.027(-1.3)$	$-0.065 \pm 0.027(-2.4)$	$0.13 \pm 0.027(4.9)$	$0.05 \pm 0.027(1.9)$	$-0.035 \pm 0.026(-1.3)$	$-0.023 \pm 0.027(-0.8)$	$0.053 \pm 0.027(2)$
5	$0.033 \pm 0.026(1.3)$	$-0.095 \pm 0.026(-3.6)$	$0.16 \pm 0.027(5.8)$	$0.043 \pm 0.028(1.5)$	$-0.0014 \pm 0.028(-0.1)$	$-0.007 \pm 0.027(-0.3)$	$0.045 \pm 0.027(1.7)$
6	$-0.008 \pm 0.028(-0.3)$	$-0.1 \pm 0.028(-3.6)$	$0.16 \pm 0.03(5.8)$	$0.16 \pm 0.03(6)$	$0.045 \pm 0.03(1.7)$	$0.0056 \pm 0.027(0.2)$	$0.009 \pm 0.03(0.3)$
8	$0.058 \pm 0.027(2.2)$	$-0.12 \pm 0.027(-4.3)$	$0.049 \pm 0.03(1.9)$	$0.15 \pm 0.03(5.5)$	$-0.045 \pm 0.03(-1.7)$	$0.018 \pm 0.03(0.7)$	$-0.019 \pm 0.03(-0.7)$
9	$0.043 \pm 0.03(1.6)$	$-0.037 \pm 0.03(-1.3)$	$0.091 \pm 0.03(3.4)$	$0.15 \pm 0.03(5.4)$	$-0.035 \pm 0.03(-1.3)$	$-0.04 \pm 0.03(-1.6)$	$-0.049 \pm 0.03(-1.7)$
10	$0.0053 \pm 0.03(0.19)$	$-0.043 \pm 0.03(-1.6)$	$0.051 \pm 0.03(1.9)$	$0.068 \pm 0.03(2.5)$	$-0.009 \pm 0.03(-0.3)$	$0.018 \pm 0.03(0.7)$	$-0.021 \pm 0.03(-0.8)$
11	$0.088 \pm 0.03(3.1)$	$-0.1 \pm 0.03(-3.4)$	$0.036 \pm 0.03(1.3)$	$0.084 \pm 0.03(3)$	$-0.049 \pm 0.03(-1.7)$	$0.015 \pm 0.03(0.5)$	$-0.019 \pm 0.03(-0.7)$

Aristotle:

Hope is the dream of a waking man.

But I like the moments dream!

Pull plots: Link

MM with unfolding results

Sigma of the pull							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	$0.98 \pm 0.02(0.78)$	$0.95 \pm 0.019(2.5)$	$1 \pm 0.021(-0.53)$	$1 \pm 0.024(-1.5)$	$0.96 \pm 0.022(1.8)$	$0.99 \pm 0.021(0.49)$	$0.95 \pm 0.019(2.7)$
1	$0.97 \pm 0.021(1.4)$	$0.95 \pm 0.018(2.6)$	$0.96 \pm 0.02(1.8)$	$1.1 \pm 0.023(-2.2)$	$1 \pm 0.021(-0.82)$	$1 \pm 0.022(0.034)$	$0.97 \pm 0.019(1.4)$
2	$0.97 \pm 0.021(1.5)$	$1 \pm 0.02(-0.0053)$	$0.99 \pm 0.019(0.56)$	$1 \pm 0.021(0.029)$	$1 \pm 0.022(-0.028)$	$1 \pm 0.02(-0.47)$	$0.96 \pm 0.019(1.9)$
3	$0.97 \pm 0.019(1.5)$	$0.97 \pm 0.023(1.5)$	$0.95 \pm 0.018(3)$	$1 \pm 0.021(-0.15)$	$0.99 \pm 0.022(0.49)$	$0.98 \pm 0.021(1.1)$	$1 \pm 0.021(0.11)$
4	$0.96 \pm 0.018(2)$	$0.96 \pm 0.019(2)$	$0.98 \pm 0.021(0.92)$	$0.98 \pm 0.02(1.1)$	$0.94 \pm 0.02(2.8)$	$0.99 \pm 0.023(0.46)$	$0.98 \pm 0.021(0.89)$
5	$0.96 \pm 0.019(2.3)$	$0.96 \pm 0.019(2.3)$	$0.98 \pm 0.021(0.71)$	$1 \pm 0.022(-0.72)$	$1 \pm 0.021(-0.028)$	$0.98 \pm 0.021(1)$	$0.97 \pm 0.019(1.4)$
6	$1 \pm 0.022(-0.13)$	$1 \pm 0.02(0.12)$	$0.98 \pm 0.021(0.95)$	$0.96 \pm 0.019(2.2)$	$0.95 \pm 0.019(2.9)$	$0.98 \pm 0.021(1.1)$	$0.98 \pm 0.02(0.76)$
7	$0.99 \pm 0.021(0.71)$	$0.98 \pm 0.02(0.76)$	$0.95 \pm 0.019(2.5)$	$0.97 \pm 0.02(1.3)$	$1 \pm 0.022(-1.1)$	$1 \pm 0.021(-0.58)$	$0.99 \pm 0.019(0.66)$
8	$0.95 \pm 0.02(2.3)$	$0.99 \pm 0.021(0.26)$	$0.95 \pm 0.019(2.5)$	$0.98 \pm 0.019(0.98)$	$0.94 \pm 0.019(2.9)$	$0.98 \pm 0.021(1.1)$	$0.97 \pm 0.019(1.6)$
9	$0.97 \pm 0.02(1.7)$	$0.99 \pm 0.02(0.36)$	$0.98 \pm 0.02(0.81)$	$1 \pm 0.023(-0.93)$	$0.96 \pm 0.019(2.1)$	$0.93 \pm 0.019(3.7)$	$1 \pm 0.022(-0.15)$
10	$1 \pm 0.02(-0.0027)$	$0.99 \pm 0.022(0.5)$	$1 \pm 0.022(0.051)$	$0.98 \pm 0.02(1)$	$0.99 \pm 0.02(0.31)$	$0.98 \pm 0.02(0.86)$	$0.99 \pm 0.02(0.64)$
11	$1 \pm 0.023(-1.6)$	$1.1 \pm 0.022(-3)$	$1.1 \pm 0.02(-2.5)$	$1 \pm 0.021(-1.3)$	$1 \pm 0.022(-1.9)$	$1 \pm 0.021(-2)$	$1 \pm 0.02(-0.77)$

Sigmas are ok!

MM without unfolding - DEBUGGING

Where things can go wrong?

- Signal moments with weights are wrong?
- Background moments are wrong.

Good that there aren't many possibilities :P

M.Chrząszcz, N.Serra 2014

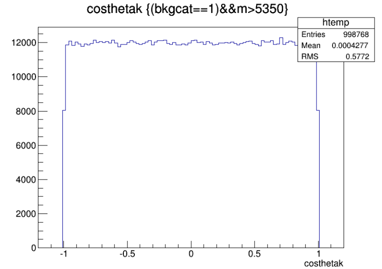
DEBUGGING: signal only

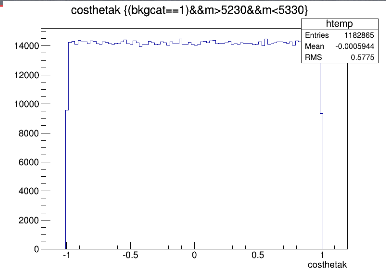
Mean of the pull							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	$-0.043 \pm 0.027(-1.6)$	$0.051 \pm 0.027(1.9)$	$0.048 \pm 0.028(1.7)$	$0.13 \pm 0.028(4.6)$	$0.022 \pm 0.028(0.8)$	$-0.036 \pm 0.027(-1.3)$	$0.01 \pm 0.027(0.4$
1	$-0.036 \pm 0.027(-1.3)$	$-0.03 \pm 0.028(-1.1)$	$-0.022 \pm 0.026(-0.8)$	$-0.019 \pm 0.029(-0.7)$	$-0.068 \pm 0.028(-2.4)$	$-0.022 \pm 0.027(-0.8)$	$0.0043 \pm 0.026($
2	$-0.044 \pm 0.027(-1.6)$	$-8.8e-05 \pm 0.028(-0.0)$	$0.035 \pm 0.027(1.3)$	$-0.018 \pm 0.027(-0.7)$	$-0.04 \pm 0.028(-1.4)$	$0.00 \pm 0.029(0.0)$	$-0.04 \pm 0.028(-$
3	$-0.037 \pm 0.027(-1.4)$	$0.0043 \pm 0.027(0.2)$	$-0.055 \pm 0.027(-2)$	$-0.0083 \pm 0.028(-0.3)$	$0.046 \pm 0.027(1.7)$	$0.0086 \pm 0.026(0.3)$	$-0.049 \pm 0.027($
4	$-0.015 \pm 0.027(-0.5)$	$-0.03 \pm 0.027(-1.1)$	$-0.029 \pm 0.027(-1.1)$	$0.013 \pm 0.028(0.5)$	$-0.031 \pm 0.027(-1.2)$	$0.0078 \pm 0.028(0.3)$	$0.064 \pm 0.026(2.$
5	$0.066 \pm 0.027(2.5)$	$-0.021 \pm 0.026(-0.8)$	$-0.072 \pm 0.028(-2.6)$	$-0.031 \pm 0.028(-1.1)$	$-0.0037 \pm 0.028(-0.1)$	$0.0033 \pm 0.025(0.1)$	$0.024 \pm 0.026(0.$
6	$-0.018 \pm 0.027(-0.6)$	$-0.026 \pm 0.028(-0.9)$	$0.013 \pm 0.028(0.5)$	$0.05 \pm 0.028(1.8)$	$0.054 \pm 0.026(2.1)$	$-0.013 \pm 0.026(-0.5)$	$0.0048 \pm 0.028($
8	$0.033 \pm 0.026(1.3)$	$-0.033 \pm 0.028(-1.2)$	$-0.021 \pm 0.027(-0.8)$	$0.0038 \pm 0.028(0.1)$	$-0.062 \pm 0.027(-2.3)$	$0.026 \pm 0.027(1.0)$	-0.0032 ± 0.027
9	$-0.045 \pm 0.027(-1.6)$	$-0.0082 \pm 0.028(-0.3)$	$0.018 \pm 0.027(0.7)$	$0.02 \pm 0.026(0.8)$	$-0.029 \pm 0.026(-1.1)$	$0.012 \pm 0.025(0.5)$	$-0.015 \pm 0.026($
10	$-0.0041 \pm 0.027(-0.2)$	$-0.033 \pm 0.028(-1.2)$	$0.0066 \pm 0.027(0.3)$	$-0.059 \pm 0.026(-2.2)$	$-0.025 \pm 0.028(-0.9)$	$0.0099 \pm 0.028(0.4)$	$-0.015 \pm 0.028($
11	$-0.0021 \pm 0.027(-0.1)$	$-0.064 \pm 0.029(-2.2)$	$-0.034 \pm 0.028(-1.2)$	$-0.03 \pm 0.028(-1.1)$	$-0.045 \pm 0.028(-1.6)$	$0.011 \pm 0.028(0.4)$	$-0.031 \pm 0.028($

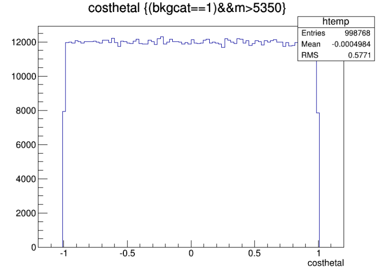
This looks very ok!
Pull plots: Link

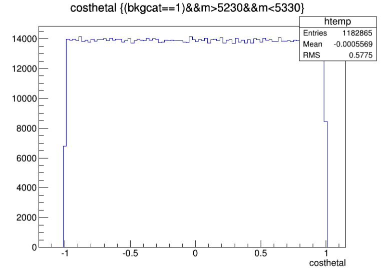
M.Chrząszcz, N.Serra 2014

MM background: folded



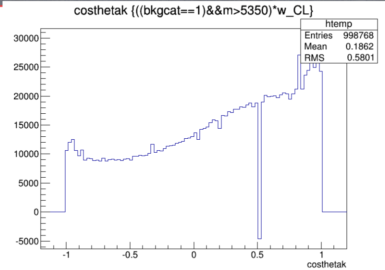


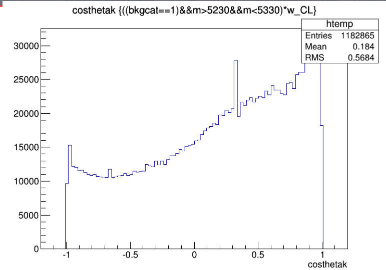


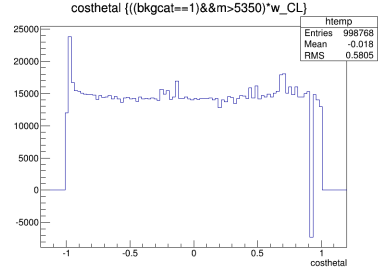


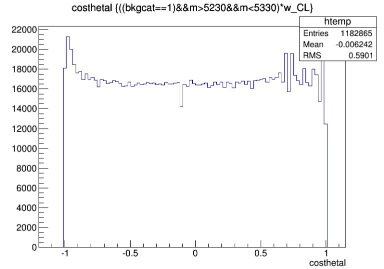
M.Chrząszcz, N.Serra 2014

MM background unfolded









M.Chrząszcz, N.Serra 2014

Error summary

Error on S_x							
q^2	S_3	S_4	S_5	S_{6s}	S_{6c}	S_7	S_8
0	0.064	0.071	0.056	0.094	0.057	0.071	0.063
1	0.089	0.11	0.098	0.098	0.1	0.11	0.089
2	0.091	0.11	0.11	0.086	0.11	0.12	0.091
3	0.096	0.12	0.11	0.084	0.11	0.12	0.0954
4	0.091	0.11	0.11	0.077	0.11	0.11	0.091
5	0.092	0.11	0.1	0.077	0.1	0.11	0.092
6	0.088	0.1	0.097	0.073	0.1	0.1	0.089
7	0.076	0.088	0.082	0.063	0.086	0.09	0.076
8	0.075	0.083	0.073	0.067	0.081	0.088	0.075
9	0.077	0.089	0.076	0.07	0.083	0.091	0.077
10	0.09	0.1	0.087	0.084	0.095	0.1	0.091
11	0.12	0.13	0.11	0.13	0.12	0.14	0.12

M.Chrząszcz, N.Serra 2014

Summary

- There is a mass dependence on the unfolding!
- What we are seeing with slightly high pull distribution is the negative weights.
- Taking this effect into account everything in agreement!
- In terms of MM I consider official TOYMC done(unless some one spoted a mistake :))

M.Chrząszcz, N.Serra 2014

Nest steps

- Need to estimate the impact of s-wave on MM.
- I did the math, which looks promising.
- Everything in next slides.

S-wave in PDF

Reminder:

$$\frac{d^4\Gamma}{dq^2 dcos\theta_k dcos\theta_l d\phi} = \frac{9}{32\pi}(J_{1s}sin^2\theta_k + J_{1c}cos^2\theta_k + (J_{2s}sin^2\theta_k + J_{2c}cos^2)cos2\theta_l + J_3 sin^2\theta_k sin^2\theta_l cos2\phi + J_4 sin2\theta_k sin\theta_l cos\phi + J_5 sin2\theta_k sin\theta_l cos\phi + (J_{6s}sin^2\theta_k + J_{6c}cos^2\theta_k)cos\theta_l + J_7 sin2\theta_k sin\theta_l sin\phi + J_8 sin2\theta_k sin2\theta_l sinphi + J_9 sin^2\theta_k sin^2\theta_l sin2\phi) \quad (1)$$

Let's add a very discussing things that keeps us awake at night:

$$W_s = \frac{1}{4\pi}(2I_{1a}sin^2\theta_l + 2I_{1b}sin^2\theta_l cos\theta_k + I_4 sin\theta_k sin2\theta_l cos\phi + I_5 sin\theta_k sin\theta_l cos\phi + I_7 sin\theta_k sin\theta_l + sin\phi + I_8 sin\theta_k sin2\theta_l sin\phi) \quad (2)$$

M.Chrząszcz, N.Serra 2014

S-wave in PDF

$$PDF_{total} = PDF_{\mathrm{K}^*}(1 - F_s) + PDF_{s-wave} \quad (3)$$

This means that every moment will be exactly the same but multiplied by $(1 - F_s)$. Example:

$\frac{8S_3}{25} \rightarrow \frac{8S_3}{25}(1 - F_s)$

- From this ones seems strait forward that s-wave has a linear impact on S_x measurements.
- S-wave always tries to make the S_x smaller in terms of absolute value.
- The stronger bonds we can put on F_s the smaller the error.
- The interference terms in eq.2 are completely decoupled from anything so we can measure it without any problem and it is for free.

S-wave in PDF

- Problem is that F_l and F_s mix(not orthogonal.
- Easy to calculate the moments:

$$M_{F_l} = (\frac{2}{135})(54 + 27F_l(-1 + F_s) + 2F_s(-27 + 80\pi)) \quad (4)$$

$$M_{F_s} = \frac{1}{45}(27 - 9F_l(-1 + F_s) + F_s(-27 + 128\pi)) \quad (5)$$

This is not linear unfortunately, but still can be solved quite easy:

$$F_l = \frac{-18 + 15M_{F_l} + 10M_{F_s}}{-34 + 15M_{F_l} + 30M_{F_s}} \quad (6)$$

$$F_s = \frac{135(-2 + M_{F_l} + 2M_{F_s})}{270 - 135M_{F_l} - 270M_{F_s} - 1088\pi + 480M_{F_l}\pi + 960M_{F_s}\pi} \quad (7)$$

M.Chrząszcz, N.Serra 2014

S-wave sensitivity

- Will investigate how much sensitivity we have using this method using toyMC.
- The better we do the smaller the systematic so it's definitely worth looking into!