

New Results for KKMC-hh with Dizet 6.45

S.A. Yost

The Citadel

March 27, 2020

KKMC-hh is a collaboration with S. Jadach, B.F.L. Ward and Z. Wąs.

Computational resources provided by IFJ-PAN, Kraków.

KKMC-hh with Dizet 6.45

- The EW corrections in KKMC-hh have been upgraded to Dizet 6.45. We will present some comparisons between Dizet 6.21 and 6.45 and plots made with the new binning.
- Elżbieta has verified that the input and output parameters match her tables.
- An 8G event run is close to finished – I have analyzed 2G events from it for today.
- The A_4 definition used here is $\frac{8}{3} A_{FB}$ calculated in the full phase space. Plots with the definition $A_{FB} = \langle \cos \theta \rangle$ could be made if desired.

Standard Model Parameters

DIZET6.45 uses a scheme $(\alpha(0)v_0)$ with input parameters $G_\mu, \alpha(0), M_Z$. The other EW parameters are then calculated. M_W is calculated with EW corrections. Apart from the top, quark masses are not used by DIZET. The others are parameters for generating ISR in KKMC-hh.

$1/\alpha(0)$	137.035999139	$\alpha_s(M_Z)$	0.1201789	
$1/\alpha(M_Z)$	128.950302560	$\alpha_s(m_t)$	0.1094	
G_F	$1.1663787 \times 10^{-5} \text{ GeV}^{-2}$	$\sin^2(\theta_W)$	0.22340108	
M_Z	91.1876 GeV	$\sin^2(\theta_W)_{\text{eff}}$	0.23149900	
Γ_Z	2.4953785 GeV			
M_W	80.3589356 GeV	m_d	4.7 MeV	Red: input
Γ_W	2.0898823 GeV	m_u	2.2 MeV	Blue: output
M_H	125 GeV	m_s	150 MeV	
m_e	510.998928 keV	m_c	4.6 GeV	
m_μ	105.658389 MeV	m_b	1.2 GeV	
m_τ	1.777 GeV	m_t	173.0 GeV	(corrected)

Available Results

- Our tabulated results all include a dilepton mass cut in all cases:
 $60 \text{ GeV} < M_{ll} < 150 \text{ GeV}$.
- The following table shows only A_4 calculated from A_{FB} in the full phase space without fermion cuts. These use a 2G event sample.
- We also calculated A_{FB} with lepton cuts $P_T > 25 \text{ GeV}$, $|\eta| < 2.5$ on both muons but did not include this in the tables.
- All results use NNPDF3.1 NLO and include FSR corrections.
- After the table, we will show 7G event distributions for A_{FB} and A_4 with 1 GeV binning for the full range $60 \text{ GeV} < M_{ll} < 150 \text{ GeV}$.

Comparisons of A_4 for Old and New Dizet

$A_4 = \frac{8}{3}A_{FB}$ is calculated in the full phases space with complete (KKMC best) photonic corrections.

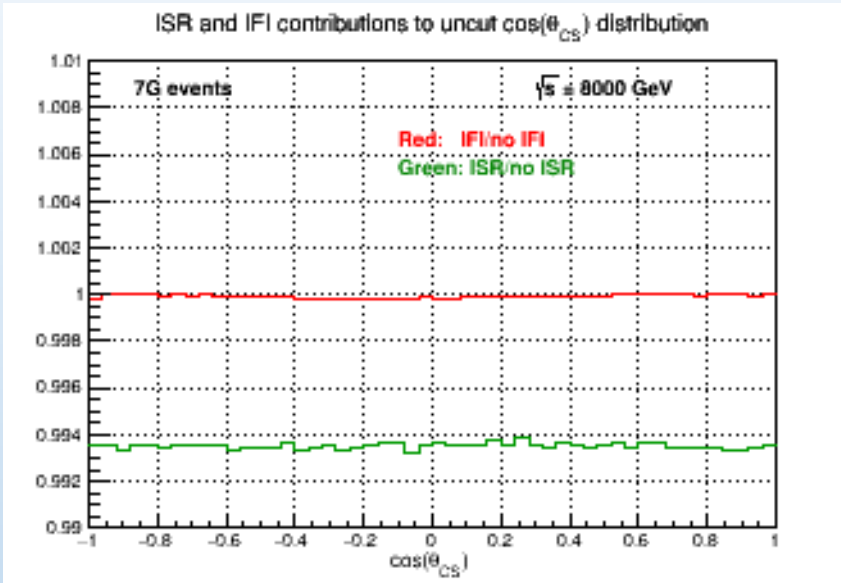
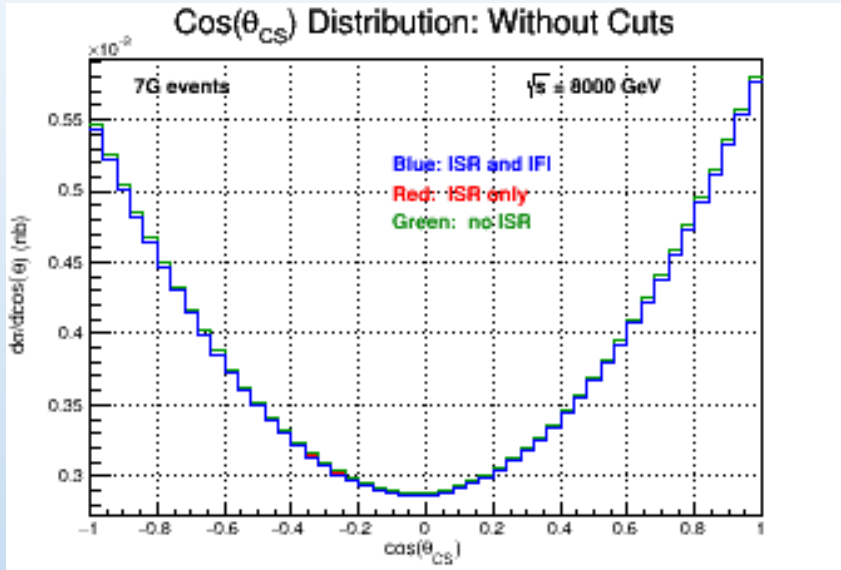
ΔISR is the difference in A_{FB} with ISR on minus ISR off, with IFI off in both cases.

ΔIFI is the difference in A_4 with IFI on minus IFI off.

These numbers are based on analyzing a 2G event sample.

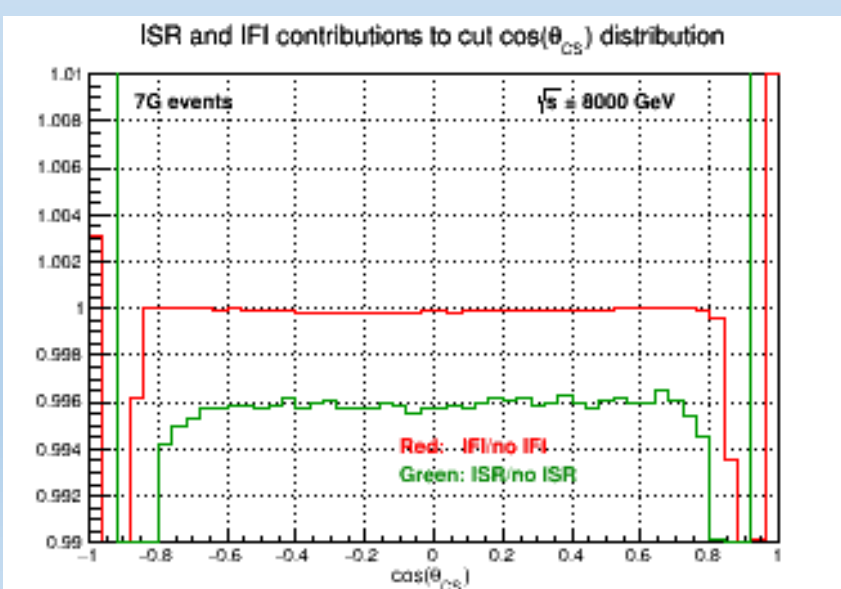
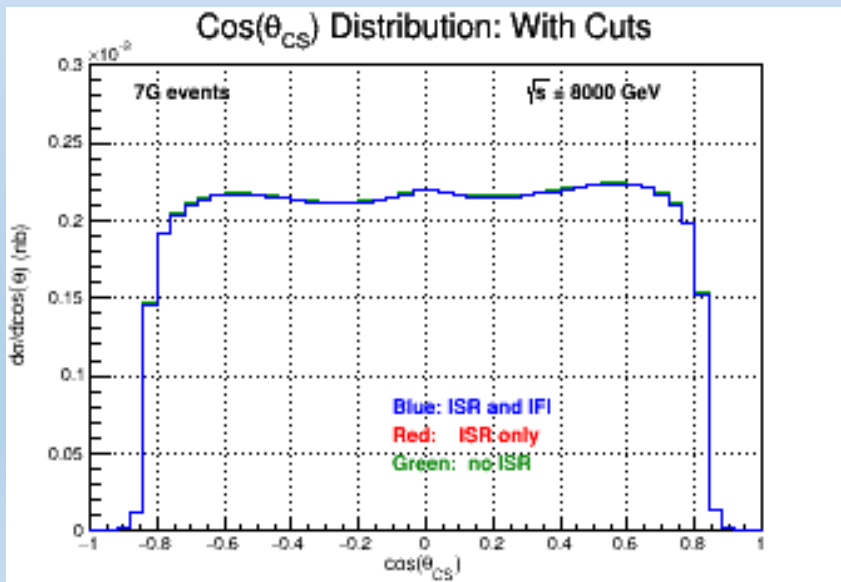
	DIZET	$60 < M_{ll} < 81$	$81 < M_{ll} < 101$	$101 < M_{ll} < 150$	$60 < M_{ll} < 120$	$89 < M_{ll} < 93$
A_4 (best)	6.45	$-0.28445(8)$	$0.07711(4)$	$0.57446(9)$	$0.05583(3)$	$0.08235(6)$
	6.21	$-0.29020(8)$	$0.07692(4)$	$0.58284(9)$	$0.05514(3)$	$0.08232(6)$
ΔISR	6.45	$(-3.3 \pm 1.1) \times 10^{-4}$	$(0.1 \pm 5.0) \times 10^{-5}$	$-(7.6 \pm 1.7) \times 10^{-4}$	$-(4.2 \pm 4.5) \times 10^{-5}$	$-(7.8 \pm 7.5) \times 10^{-5}$
	6.21	$(-4.5 \pm 1.5) \times 10^{-4}$	$(3.3 \pm 5.0) \times 10^{-5}$	$-(6.0 \pm 1.7) \times 10^{-4}$	$-(1.4 \pm 4.5) \times 10^{-5}$	$(0.4 \pm 7.5) \times 10^{-5}$
ΔIFI	6.45	$(5.8 \pm 1.3) \times 10^{-4}$	$(2.8 \pm 0.3) \times 10^{-4}$	$-(6.12 \pm 0.07) \times 10^{-3}$	$(1.3 \pm 0.3) \times 10^{-4}$	$(1.4 \pm 0.4) \times 10^{-5}$
	6.21	$(4.5 \pm 1.0) \times 10^{-4}$	$(3.2 \pm 0.5) \times 10^{-4}$	$-(6.12 \pm 0.07) \times 10^{-3}$	$(1.4 \pm 0.3) \times 10^{-4}$	$(1.9 \pm 0.4) \times 10^{-5}$

ISR and IFI contributions to CS angle distribution



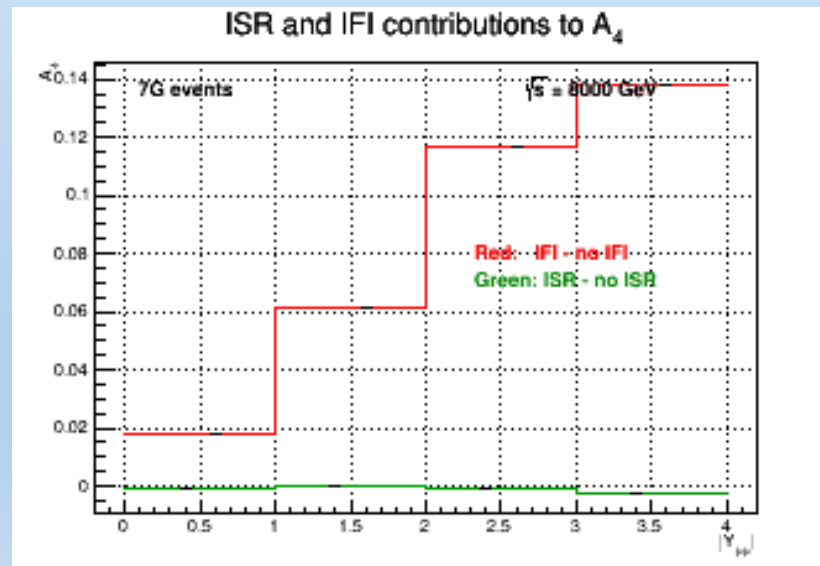
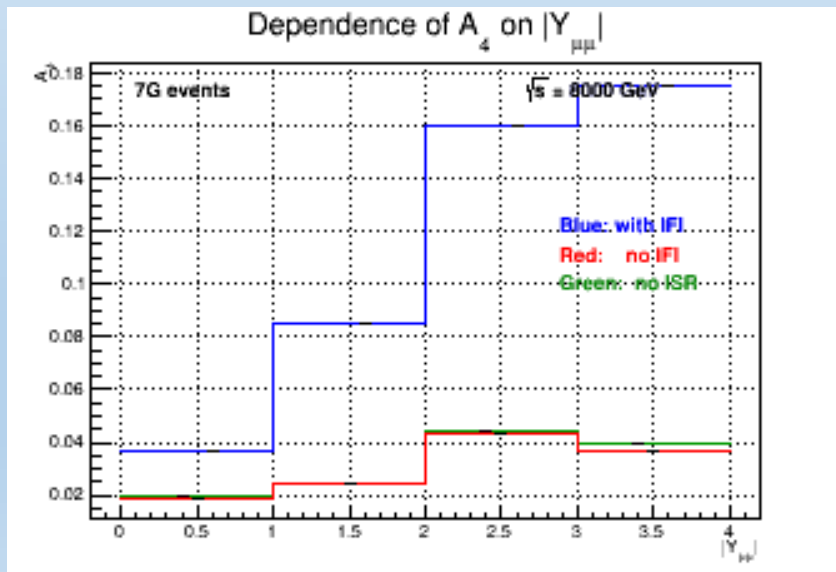
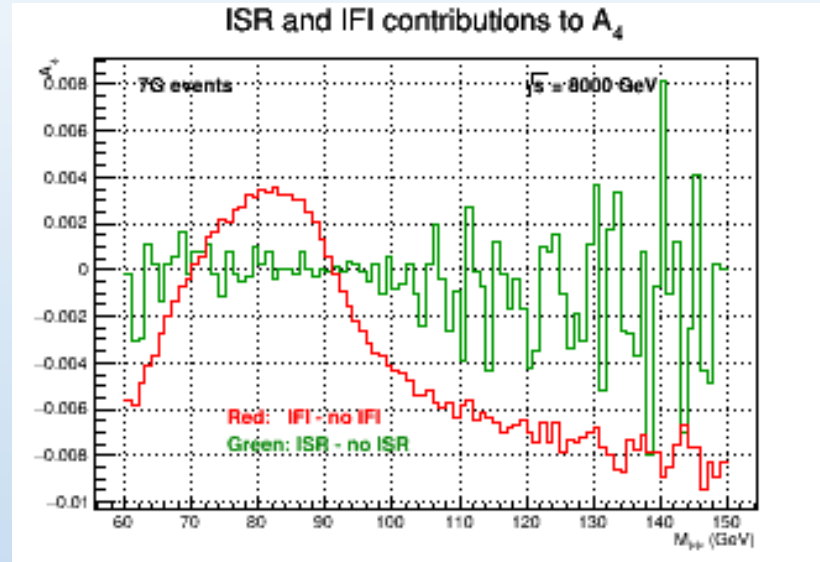
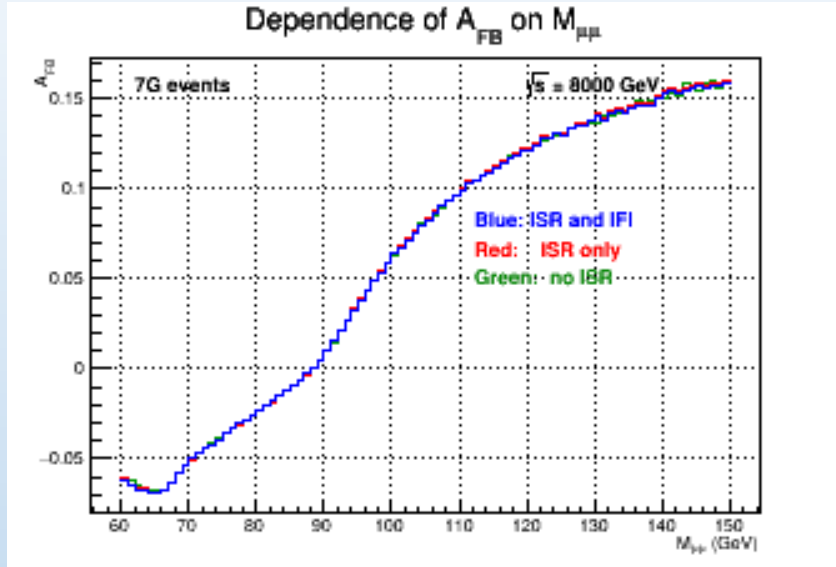
**Without Lepton Cuts
(used for A_4)**

The IFI contributions are magnified by 10.



**With Lepton Cuts
(used for A_{FB})**

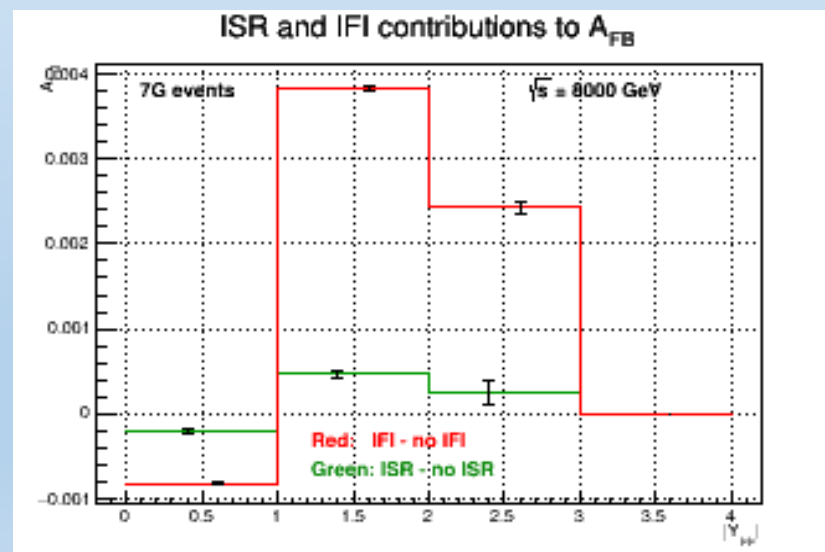
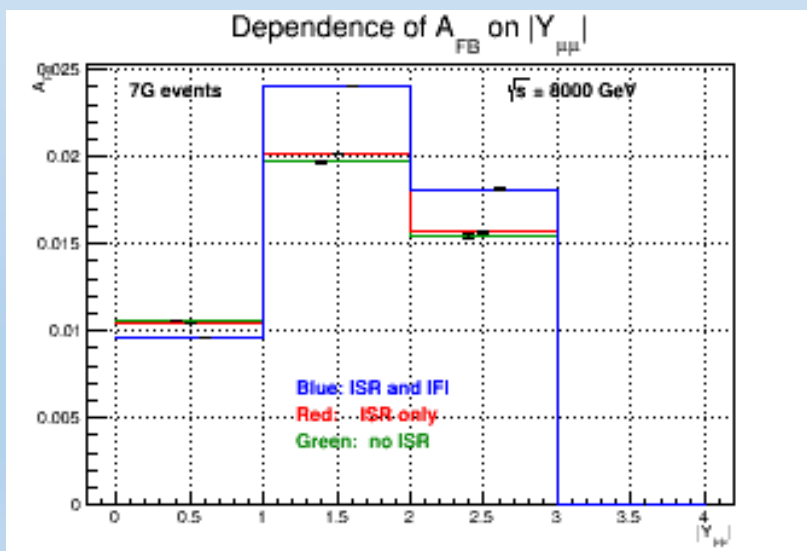
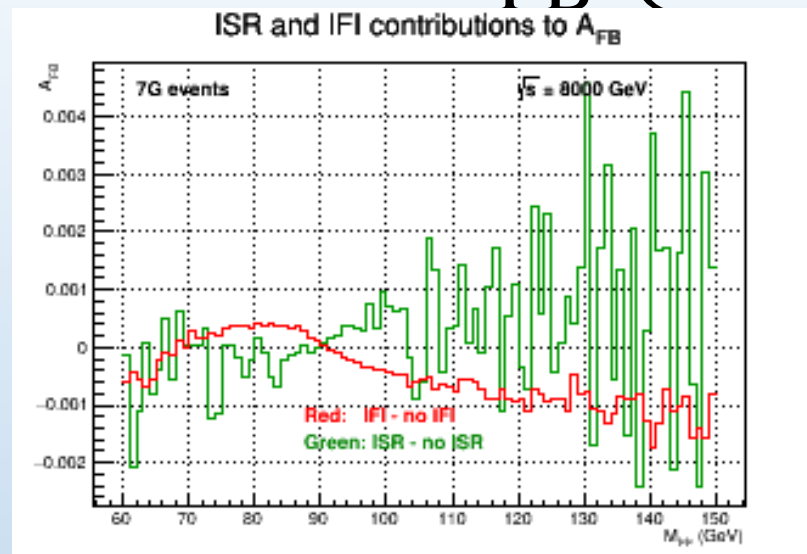
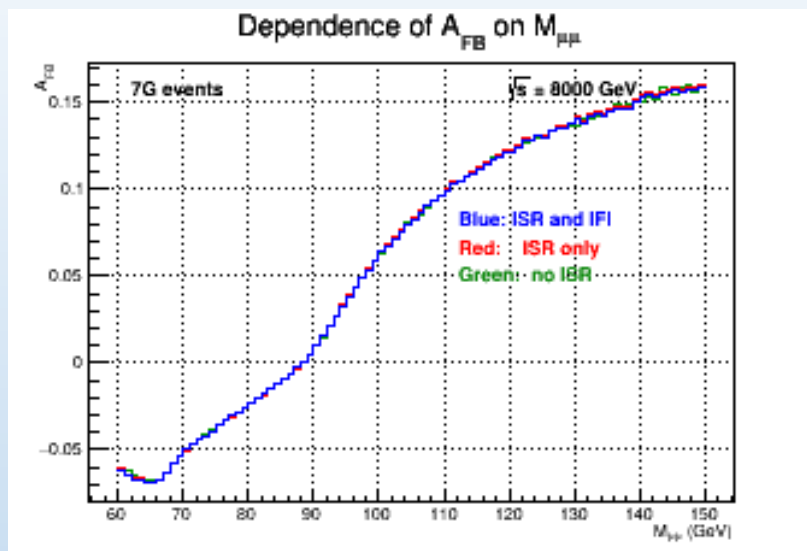
ISR and contributions to A_4 ($\frac{8}{3} A_{FB}$, no lepton cuts)



The ISR and IFI contributions to A_4 are shown here. IFI appears to have more structure in the pole region, but more statistics will be useful for the ISR contribution.

When binned in Y , the ISR contribution is much smaller than IFI.

ISR and IFI contributions to A_{FB} (with lepton cuts)



These plots show A_{FB} calculated with the lepton cuts. When binned in M_{ll} , the IFI contribution is typically below 1 per mil.

The errors on the ISR contribution are still relatively large, but the effect appears to be comparable to IFI.

Again, ISR is usually smaller than IFI when binned in Y .

Other Available Results

Not all of the results from the latest run have been analyzed yet.

The binned A_4 and A_{FB} plots are based on 7G events – essentially the complete sample.

The tables and $\cos(\theta_{CS})$ histogram were based on the first 2G events in the sample.

Runs were also done with FSR off as well (no radiation), and with the complete photonic corrections together with a HERWIG parton shower.

KKMC-hh was not designed to run without DIZET, but an experimental run was done with it off and an attempt at using a G_μ input scheme. If this was successful, some results may be shown in the future to compare that to DIZET as well. If not, more work may be needed to completely back DIZET out of the KKMC calculations.