Recent developments with DIZET

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ZFITTER

ZFITTER

is a Fortran package for the evaluation of radiative corrections (quantum corrections), as predicted in the Standard Model of elementary particles, to a variety of observable quantities, notably those related to the Z-boson resonance peak.

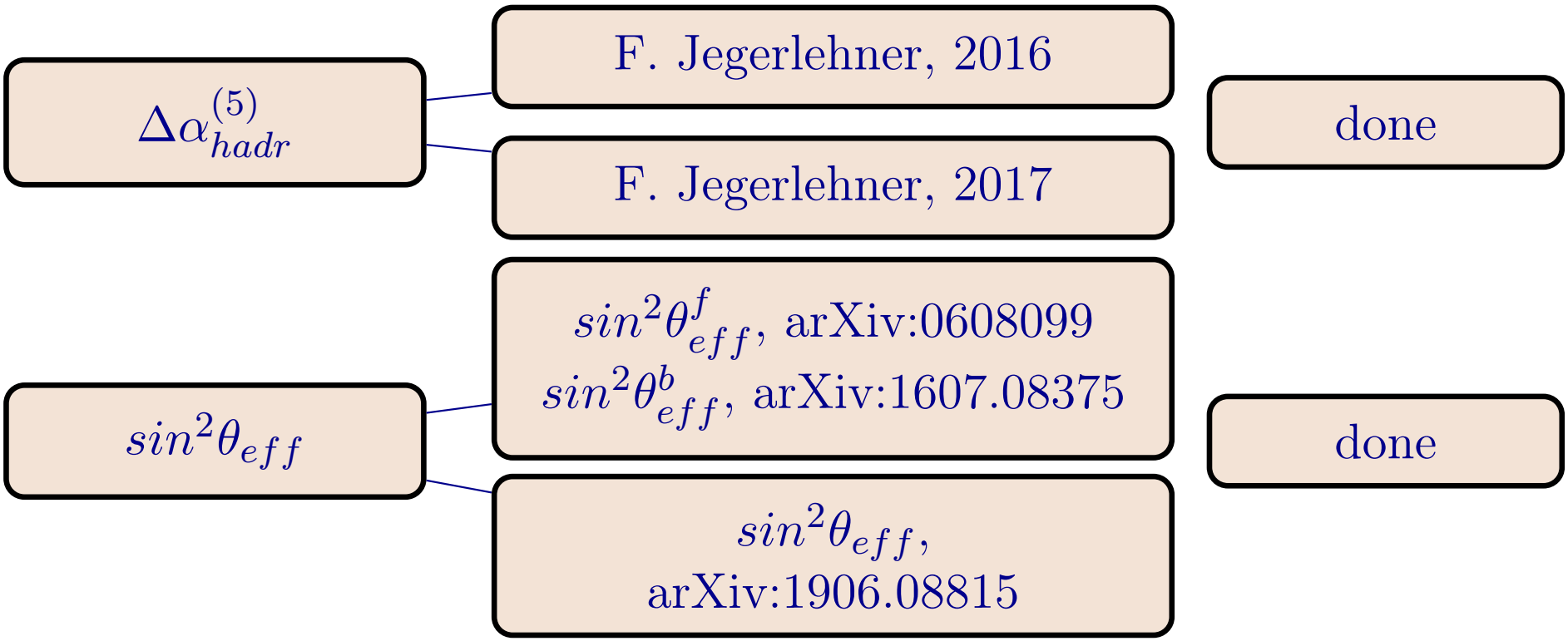
The homepage of the **ZFITTER** project and collaboration is http://sanc.jinr.ru/users/zfitter/

DIZET

The Fortran package **DIZET**, a library for the calculation of electroweak radiative corrections, is part of the **ZFITTER** distribution. It can also be used in a standalone mode.

KKMC uses **DIZET** library for the calculation of higher order corrections in the electroweak/QCD Standard Model.

DIZET v 6.45


$\Delta\alpha^{(5)}_{hadr}$
F. Jegerlehner, 2016
F. Jegerlehner, 2017
done
$sin^2\theta_{eff}$
$sin^2\theta^f_{eff}$, arXiv:0608099
$sin^2\theta^b_{eff}$, arXiv:1607.08375
$sin^2\theta_{eff}$,
arXiv:1906.08815
done

DIZET v 6.45, hadr5

We introduce new options for the flag IHVP:

IHVP	Realization	Result at M_Z
1	Jegerlehner(1995)	2.8039e-2
4	Jegerlehner(2016)	2.7586e-2
5	Jegerlehner(2019)	2.7604e-2

In preparation to arXiv:1905.05078 Fred update hadr5n17.f code.
So now IHVP=5 – Hadronic vacuum polarization using Jegerlehner 2017 public code with 2019 years update.

Note: Jegerlehner(2019) code provides statistical and systematic errors estimation.

DIZET v 6.45, $sin^2\theta_{eff}$

We introduce new option for the flag IAMT4:

IAMT4	Description
6	$sin^2\theta^{lept}_{eff}$ with fermionic two-loop correction by Awramik, Czakon, Freitas, Weiglein (april 2004)
7	$sin^2\theta^{f}_{eff}$ & $sin^2\theta^{b}_{eff}$ with complete two-loop correction according arXiv:hep-ph/0608099 & arXiv:1607.08375
8	$sin^2\theta_{eff}$ with complete two-loop correction according arXiv:1906.08815

DIZET v 6.45, $sin^2\theta_{eff}$

We use for comparison M_Z=91.1876 GeV, M_H=125.10 GeV, m_t=172.9 GeV and α_s=0.1181

Channel	$sin^2\theta_{eff}$		
	IAMT4=6	IAMT4=7	IAMT4=8
$\nu, \bar{\nu}$	0.231307	0.231311	0.231276
$e+, e-$	0.231688	0.231688	0.231657
$\mu+, \mu-$	0.231688	0.231688	0.231657
$\tau+, \tau-$	0.231688	0.231688	0.231657
$u, \bar{u}$	0.231582	0.231575	0.231551
$d, \bar{d}$	0.231454	0.231463	0.231424
$c, \bar{c}$	0.231582	0.231575	0.231551
$s, \bar{s}$	0.231454	0.231463	0.231424
$b, \bar{b}$	0.233131	0.232893	0.232893

DIZET v 6.45, Impact of improvements

We compare results obtained using old and new best setups of DIZET:

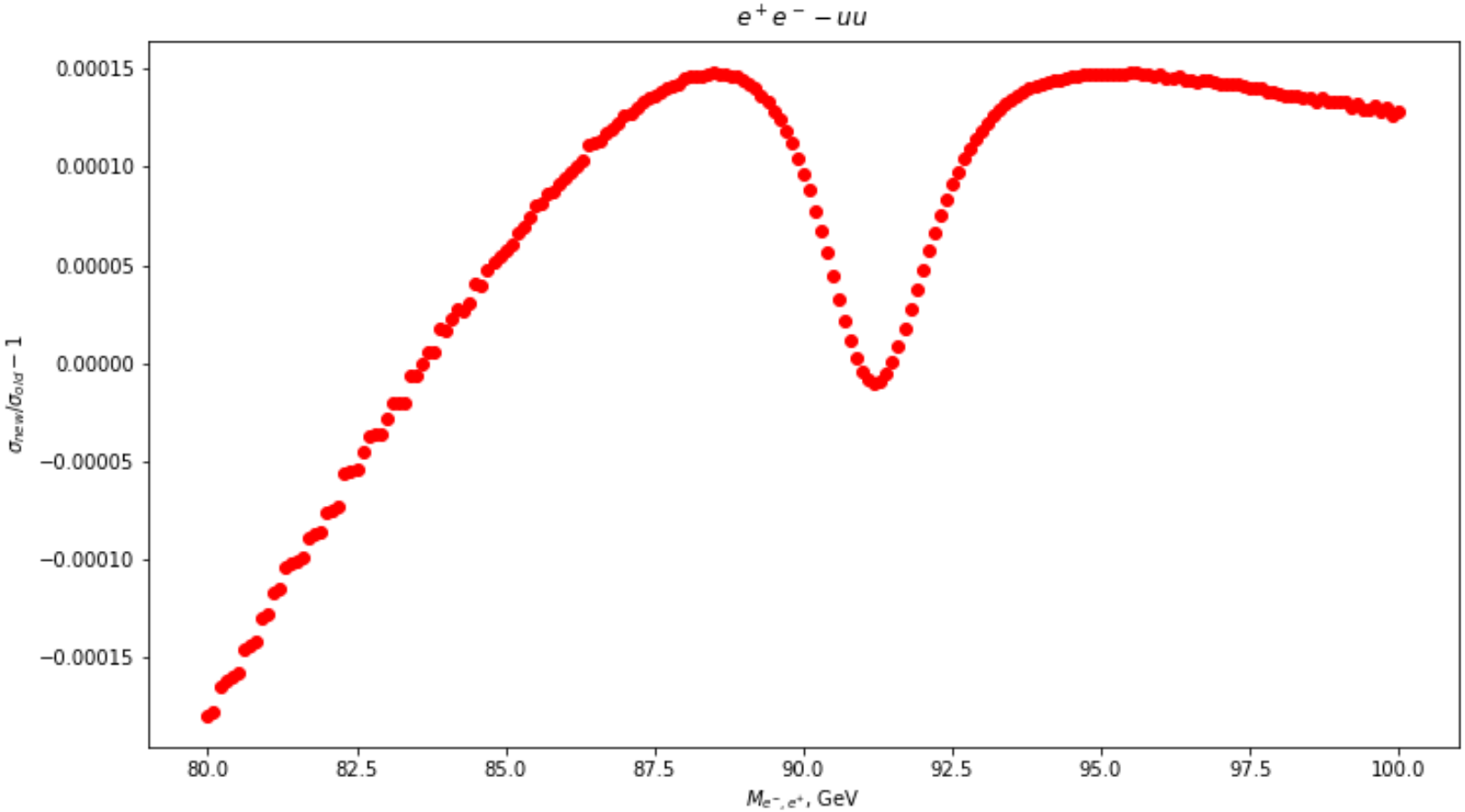
New best options:

IHVP=5
IAMT4=8

Old best options:

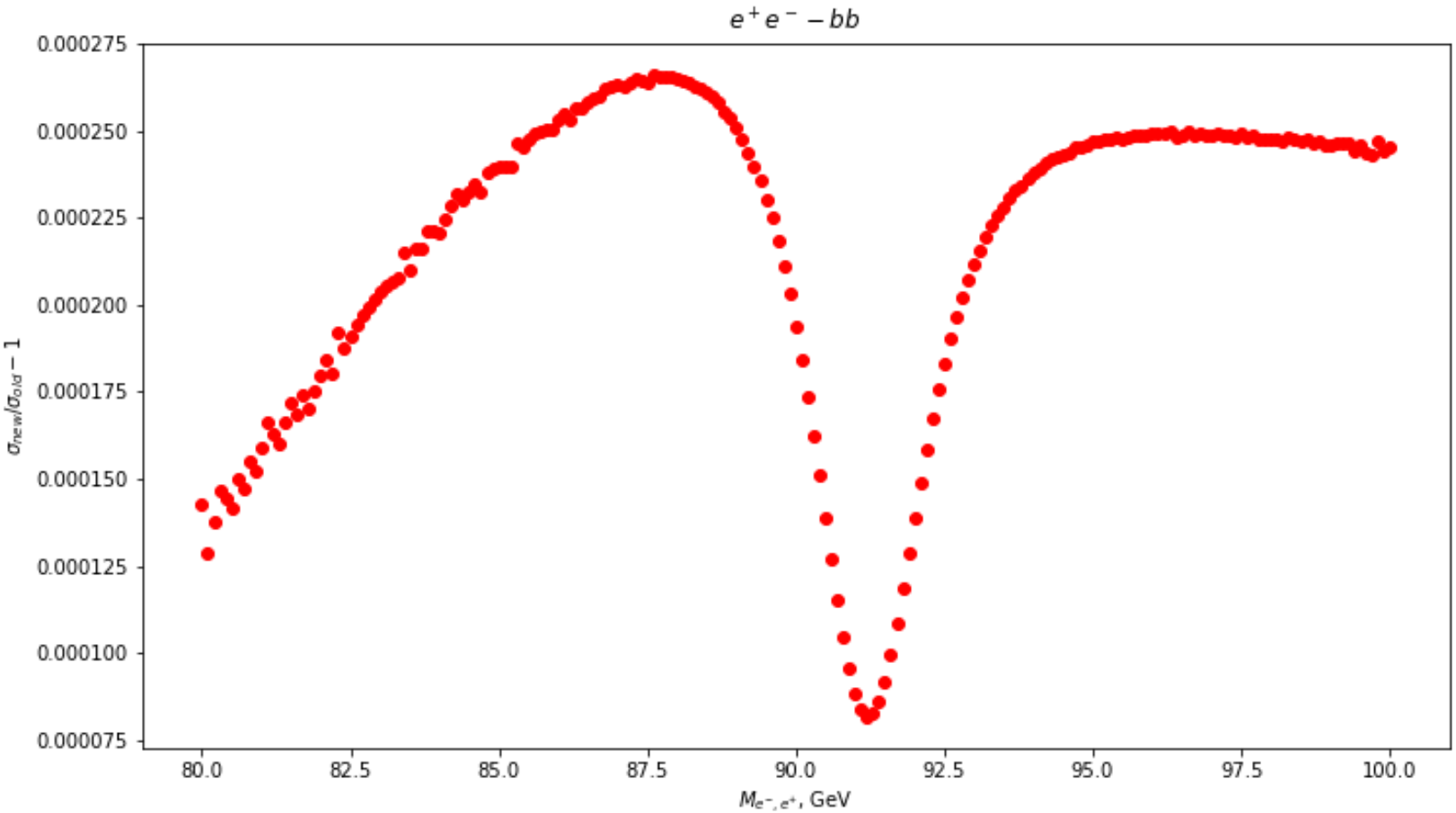
IHVP=1
IAMT4=6

DIZET v 6.45, Impact on Z-shape



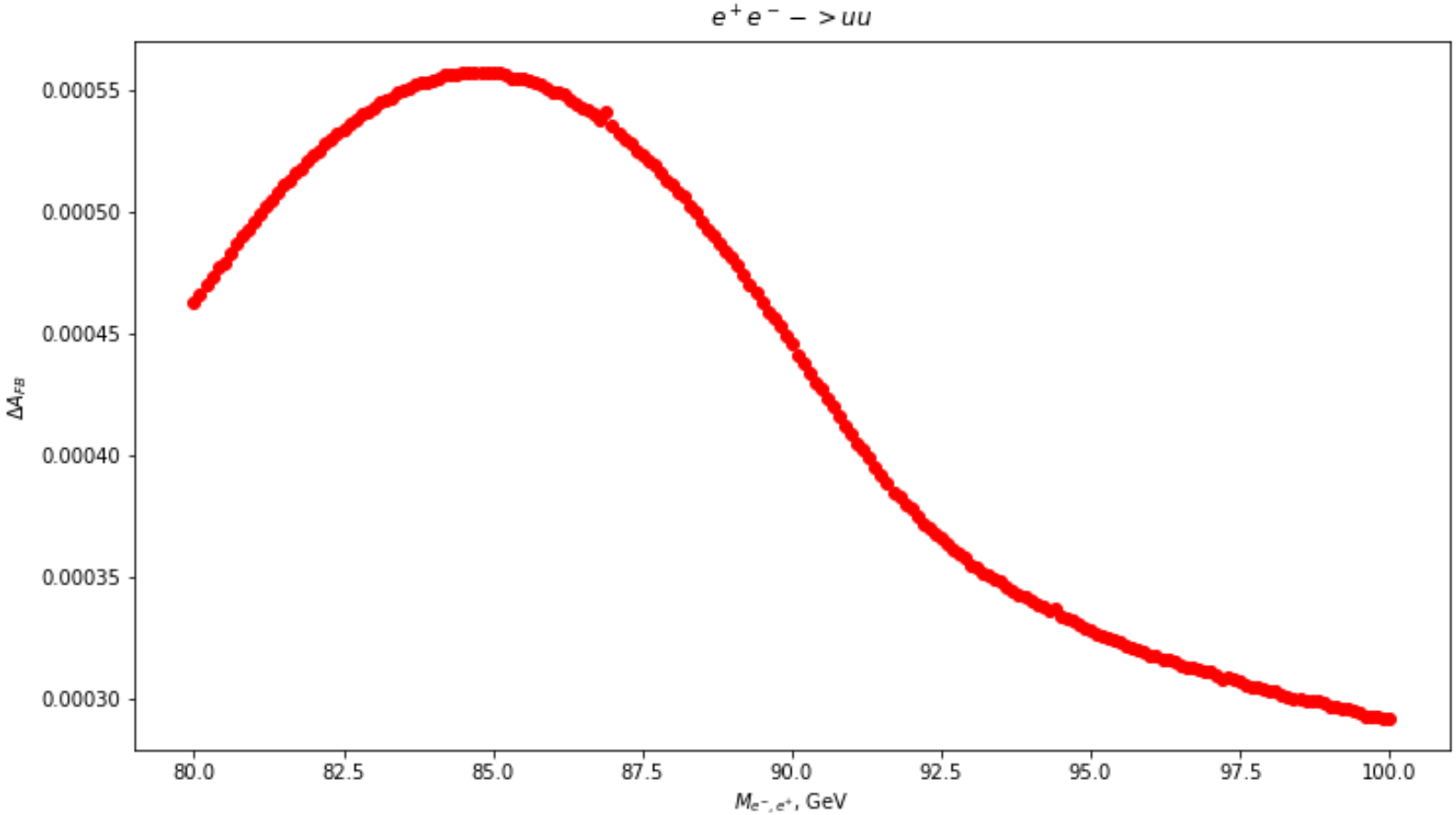
$\sigma_{new}/\sigma_{old} - 1$, channel $e^+e^- \to u\bar{u}$

DIZET v 6.45, Impact on Z-shape



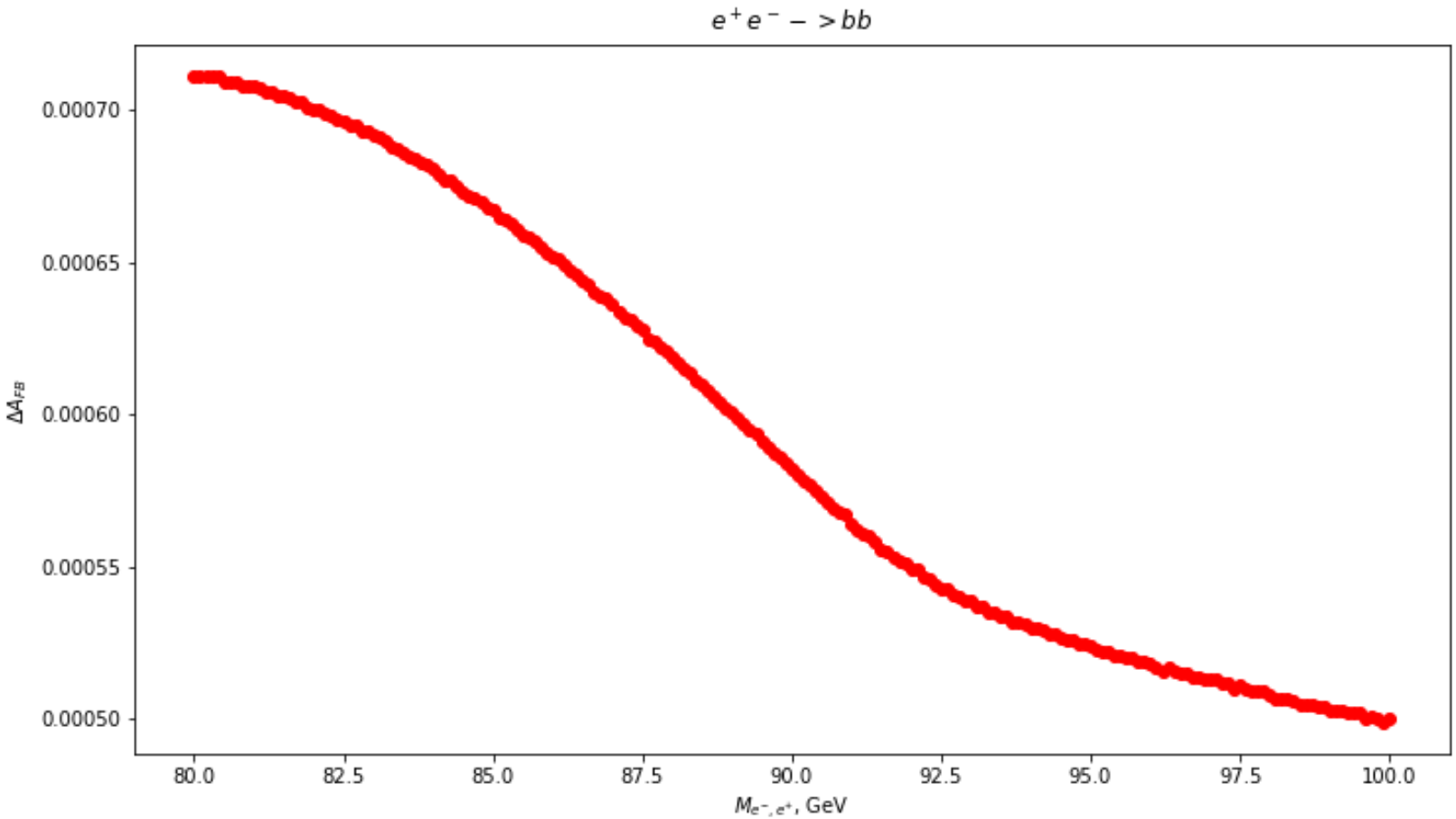
$\sigma_{new}/\sigma_{old} - 1$, channel $e^+e^- \to b\bar{b}$

DIZET v 6.45, Impact on AFB



$\mathrm{AFB}_{new} - \mathrm{AFB}_{old}$, channel $e^+e^- \to u\bar{u}$

DIZET v 6.45, Impact on AFB



$\mathrm{AFB}_{new} - \mathrm{AFB}_{old}$, channel $e^+e^- \to b\bar{b}$

In preparation to DIZET v 7.00

1) Implementation of the results from paper **'Electroweak pseudo-observables and Z-boson form factors at two-loop accuracy'** of Ievgen Dubovyk, Ayres Freitas, Janusz Gluza, Tord Riemann and Johann Usovitsch (arXiv:1906.08815), which provides complete fitting formula for **Z-boson decay widths**, **branching ratios** and **cross-section**.

2) Implementation of new electroweak schemes:
(G_f, M_Z, M_W), $(G_f, \sin\theta_{eff}, M_Z)$.

In preparation to DIZET v 7.00

It also provides an opportunity to calculate EWPO order by order!

Form fact.	Born	$\mathcal{O}(\alpha)$	$\mathcal{O}(\alpha\alpha_s)$	$\mathcal{O}(\alpha_t\alpha_s^2,\ \alpha_t\alpha_s^3,$ $\alpha_t^2\alpha_s,\ \alpha_t^3)$	$\mathcal{O}(N_f^2\alpha^2,\ N_f\alpha^2)$	$\mathcal{O}(\alpha_{bos}^2)$
F_V^ℓ $[10^{-5}]$	77.63	−59.86	0.31	−0.09	1.88	0.24
F_A^ℓ $[10^{-5}]$	3426.43	19.32	−1.12	−0.92	1.62	0.28
$F_{V,A}^\nu$ $[10^{-5}]$	3426.43	28.36	−1.16	−0.93	2.81	0.21
$F_V^{u,c}$ $[10^{-5}]$	644.45	−129.87	−1.36	−0.73	−6.26	0.19
$F_A^{u,c}$ $[10^{-5}]$	3426.43	21.54	−1.13	−0.93	2.28	0.27
$F_V^{d,s}$ $[10^{-5}]$	1760.71	−100.64	−1.15	−1.01	−6.24	0.19
$F_A^{d,s}$ $[10^{-5}]$	3426.43	24.56	−2.21	−0.93	2.10	0.25
F_V^b $[10^{-5}]$	1760.71	−133.08	−1.58	−0.95	−7.68	0.86
F_A^b $[10^{-5}]$	3426.43	−21.45	−0.85	−0.87	−0.62	1.01

In preparation to DIZET v 7.00

Order by order calculation of $sin^2\theta_{eff}$:

Channel	$sin^2\theta_{eff}$			
	Born	$+\mathcal{O}(\alpha)$	$+\mathcal{O}(\alpha\alpha_s)$	full
$b,\bar{b}$	0.212550	0.231648	0.231835	0.232877