ISR*FSR Interference from $\mathcal{KK}$ MC generator

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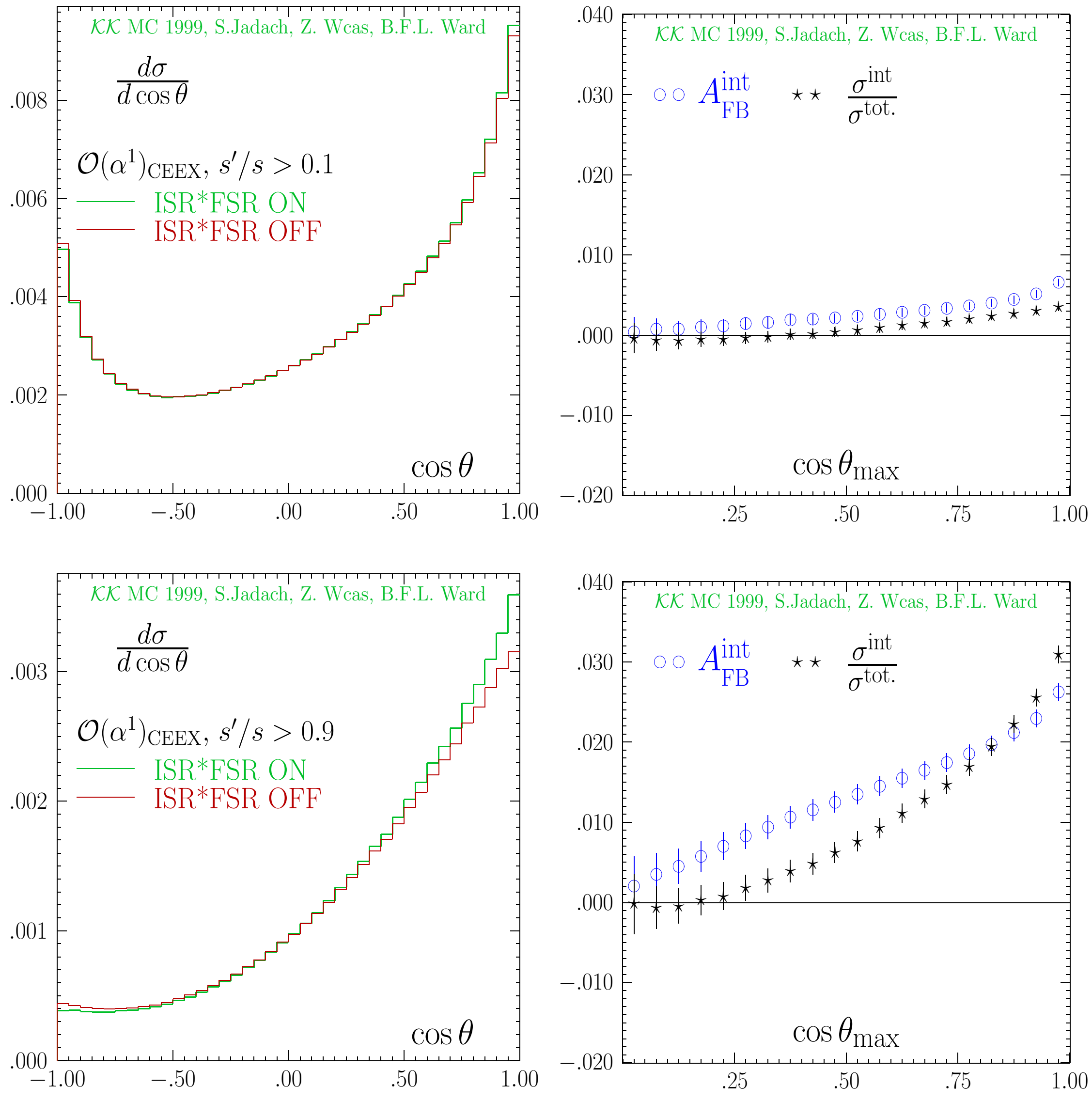
QUESTIONS:

- **How big is ISR*FSR Interference in σ_{tot} and A_{FB}?**
- **Do we know it at $\mathcal{O}(\alpha^1)$?**
- **Do we know it beyond $\mathcal{O}(\alpha^1)$?**
- **How sensitive it is to cut-off changes?**
- **Conclusions**

For $\mathcal{KK}$ MC check `http://home.cern.ch/~jadach`

ISR*FSR interf. in angular distribution

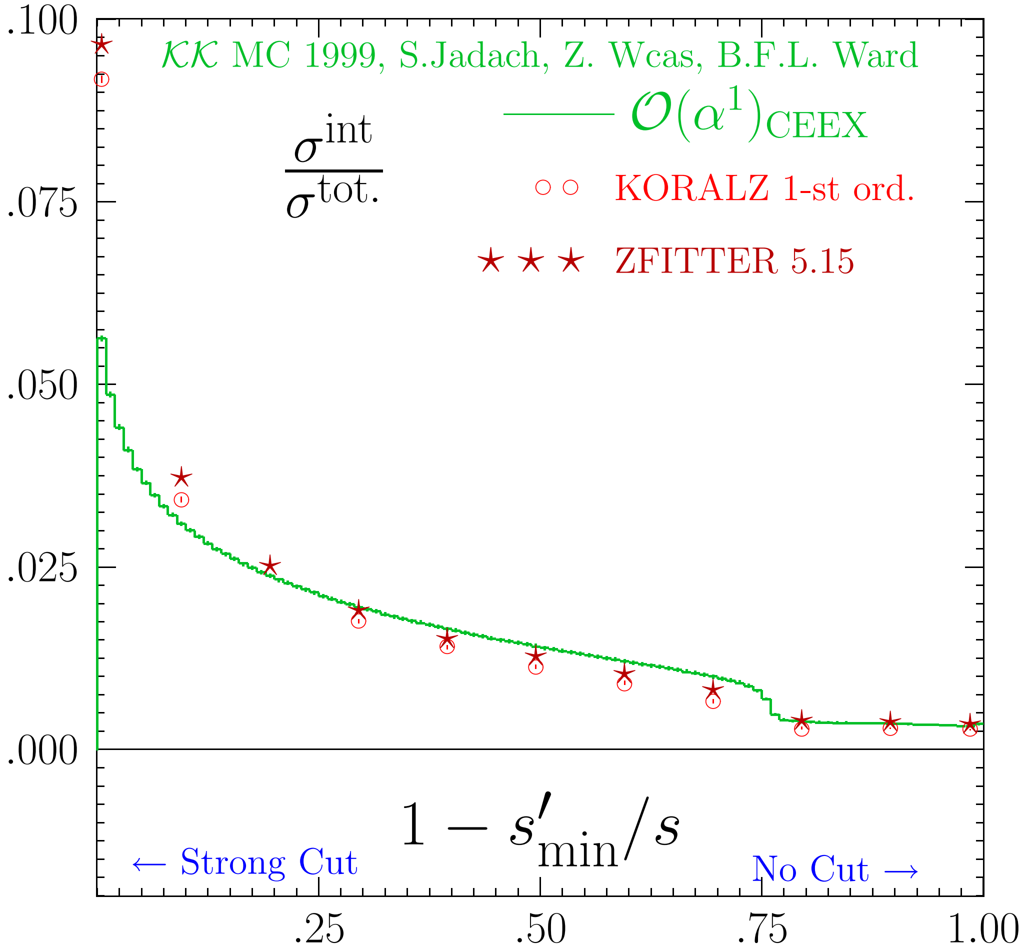
The influence of ISR*FSR interference at 189GeV. The energy cut is on s'/s, where $s' = m^2_{f\bar{f}}$. The angular cut is $|\cos\theta| < \cos\theta_{\max}$ Scattering angle is $\theta = \theta^\bullet$. [Angle $\theta^\bullet$ is defined in Phys. Rev. **D41**, 1425 (1990)]



DESY

ISR*FSR in σ, cut-off dependence

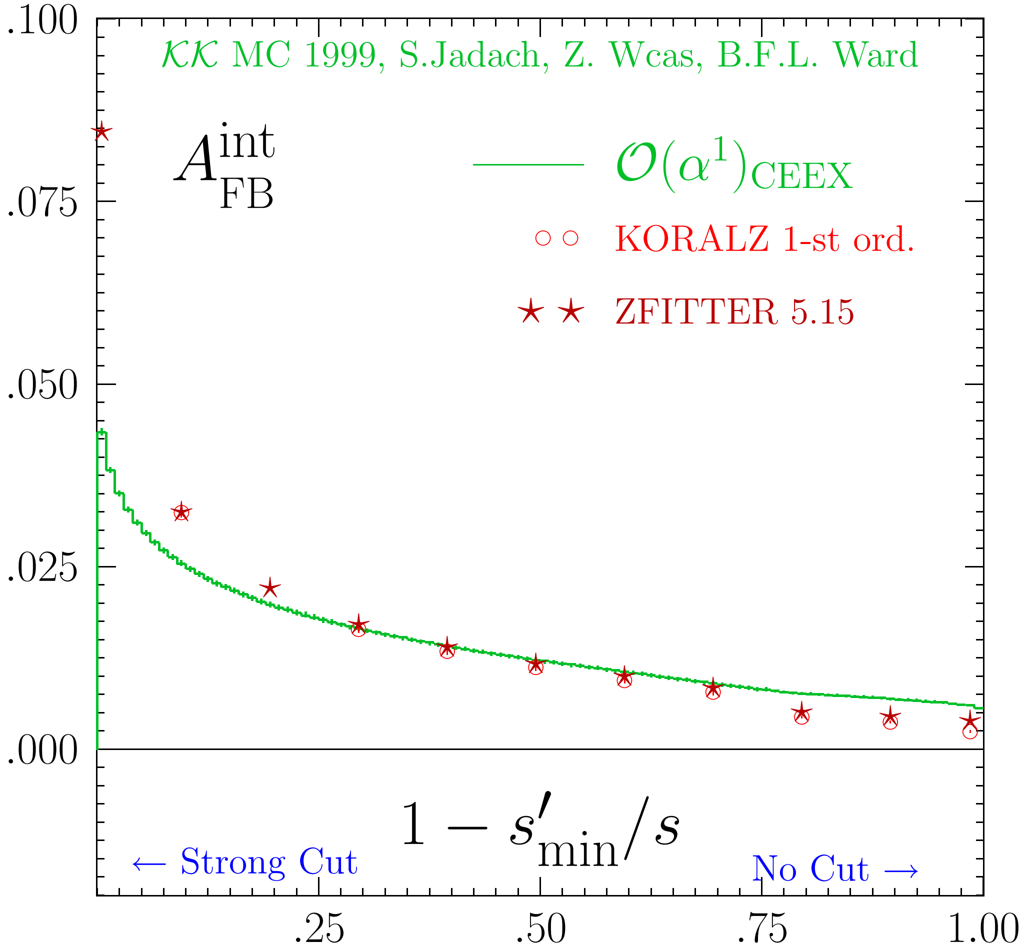
The ISR*FSR interference correction to $\sigma(s'_{\min})$ at 189GeV. No cut in $\cos\theta^{\bullet}$. From $\mathcal{KK}$ M.C. with $\mathcal{O}(\alpha^1)_{\rm CEEX}$ exponentiation at the amplitude level.



DESY

ISR*FSR in A_{FB}, energy cut-off study

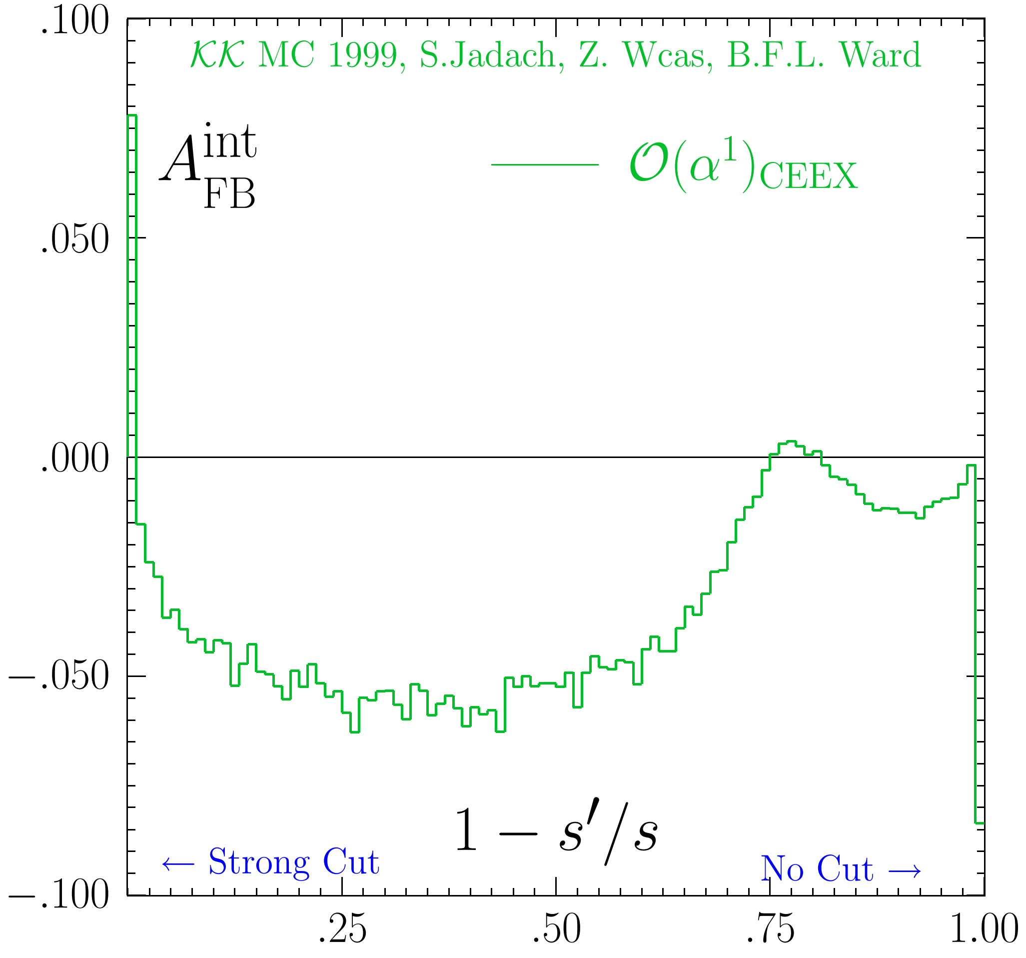
The ISR*FSR interference correction to A_{FB} at 189GeV. No cut in $\cos\theta^{\bullet}$. From $\mathcal{KK}$ M.C. with $\mathcal{O}(\alpha^1)_{\rm CEEX}$ exponentiation at the amplitude level.



DESY

ISR*FSR in A_{FB}, energy cut-off study

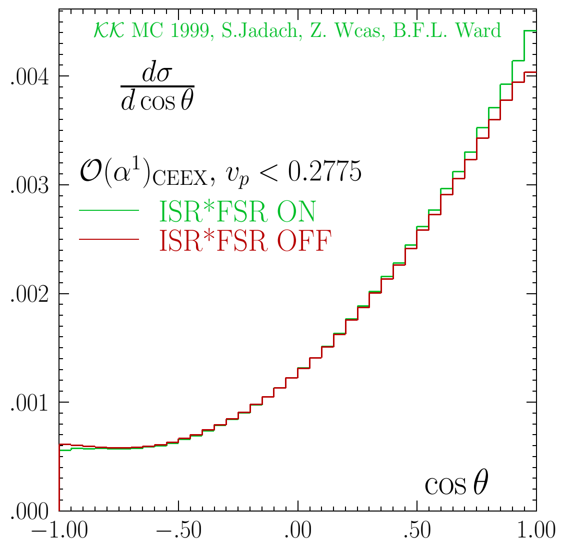
Bin-per-bin s'-dependence of A_{FB}
– the ISR*FSR interference contribution at 189GeV.
Results from $\mathcal{KK}$ M.C. with $\mathcal{O}(\alpha^1)_{\rm CEEX}$
exponentiation at the amplitude level.
No cut in $\cos\theta^\bullet$.

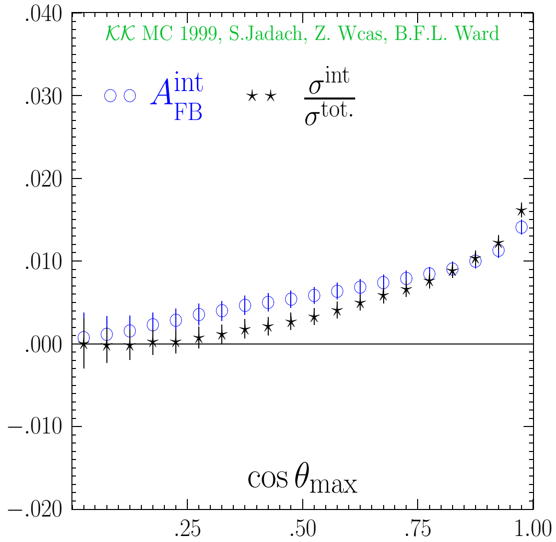


DESY

ISR*FSR interf. Realistic acceptance

The influence of ISR*FSR interference at 189GeV. The energy cut is on $v_p = 1 - Q^2_{Aleph}/s$, where Q^2_{Aleph} is s-channel propagator variable of ALEPH. The angular cut is $|\cos\theta| < \cos\theta_{\max}$ Scattering angle is $\theta = \theta^{\bullet}$. [Angle $\theta^{\bullet}$ is defined in Phys. Rev. **D41**, 1425 (1990)]





DESY

ISR*FSR interf. Realistic acceptance

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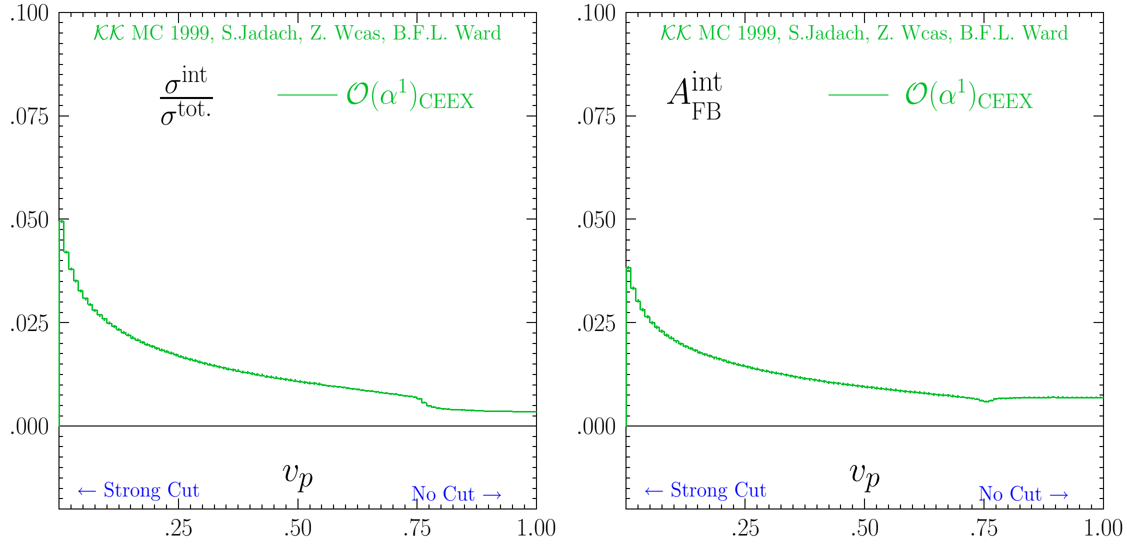
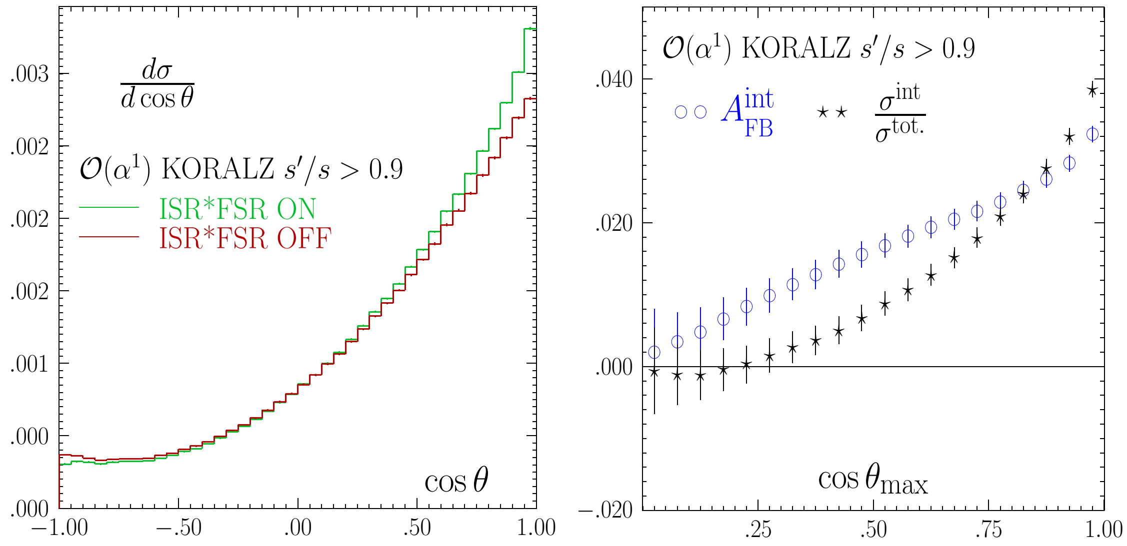


DESY

ISR*FSR interf. KORALZ 1-st order

The influence of ISR*FSR interference at 189GeV. The energy cut is on s'/s, where $s' = m^2_{f\bar{f}}$. The angular cut is $|\cos\theta| < \cos\theta_{\max}$ Scattering angle is $\theta = \theta^{\bullet}$. [Angle $\theta^{\bullet}$ is defined in Phys. Rev. **D41**, 1425 (1990)]



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Appendix: $\mathcal{KK}$ versus our older MC's and plans

Feature	KORALB	KORALZ	$\mathcal{KK}$ now	$\mathcal{KK}$ 2000
ISR	$\alpha + \alpha L$	$(\alpha + \alpha L + \alpha^2 L^2)_{\rm exp}$	$(\ldots + \alpha^3 L^3)_{\rm exp}$	$(\ldots + \alpha^3 L^3)_{\rm exp}$
FSR	$\alpha + \alpha L$	$(\alpha + \alpha L + \alpha^2 L^2)_{\rm exp}$	$(\ldots + \alpha^2 L^2)_{\rm exp}$	$(\ldots + \alpha^3 L^3)_{\rm exp}$
ISR*FSR interf.	$\alpha + \alpha L$	$\alpha + \alpha L$, no exp.	$(\alpha + \alpha L)_{\rm exp}$	$(\alpha + \alpha L)_{\rm exp}$
Exponentiation	NONE	for $\vert M(p_i)\vert^2$	for $M(p_i)$	for $M(p_i)$
Exact m.el. for real photons	up to 1	1, 2coll.	1, 2coll, 3coll.	up to 3
El-Weak	No Z-reson.	YES	YES	YES
Beam polar.	long+trans.	longit.	long+trans.	long+trans.
τ polar.	long+trans.	longit.	long+trans.	long+trans.
Hadronization	—	Yes	Yes	Yes
τ decay	Yes	Yes	Yes	Yes
Inclusive mode	—	No	Yes	Yes
Beamstrahlung	—	No	Yes	Yes
beam spread	—	No	Yes	Yes
$\nu\nu$ channel	—	Yes	No	Yes
ee channel	—	No	No	Yes
tt channel	—	No	No	???
WW channel	—	No	No	???

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Conclusions

$\mathcal{KK}$ Monte Carlo and KORALZ answers on ISR*FSR Interference:

- **For typical exp. energy cut 0.3 ISR*FSR int. is about 1.5% in σ_{tot} and A_{FB}.**
- **For energy cut 0.1 it is twice bigger.**
- **The cut $|\cos\theta < 0.9$ makes it 25% smaller.**
- **The $\mathcal{O}(\alpha^1)$ ISR*FSR int. is under total controll using KORALZ and $\mathcal{KK}$ Monte Carlo for arbitrary cuts.**
- **Effects beyond $\mathcal{O}(\alpha^1)$ are negligible, (<20% of $\mathcal{O}(\alpha^1)$), except when energy cut is stronger than 0.1.**
- **ISR*FSR int. at Z radiative return is very small, as expected.**
- **Change from s' to Q^2-propagator in energy cut has no effect.**

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