Top quark studies at IFIC - Valencia

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Outline

1. **Top quark mass measurement using radiative events in the continuum.**

2. **Top quark reconstruction at high energies.**

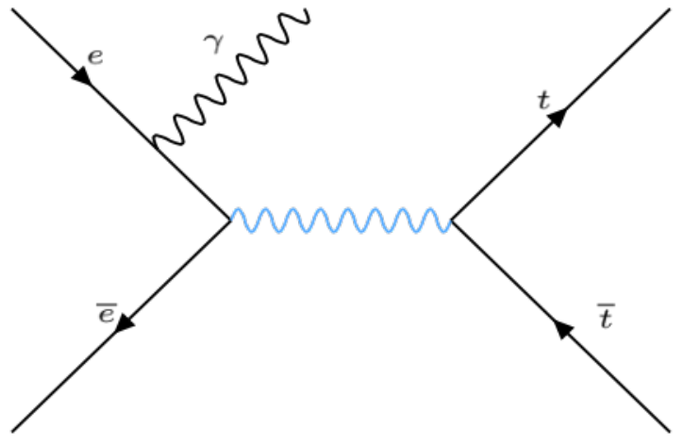
3. **Top quark couplings through an EFT.**

Top quark mass measurement using radiative events in the continuum

Top quark mass in the continuum

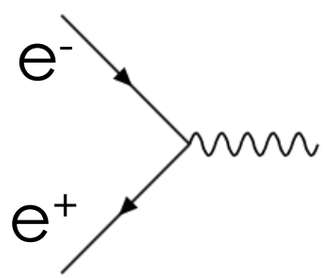
Motivation: high-precision measurement of the top-quark mass in the continuum of an e^-e^+ linear collider, complementary to the threshold measurement.

$e^-e^+ \rightarrow$ ttbar γ_{ISR}



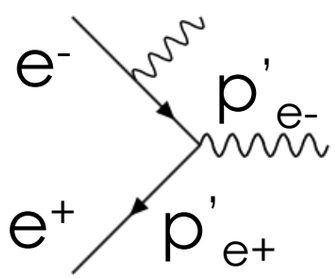
The cross section is sensitive to the scale of the interaction and m_t

$$\sigma(e^+e^- \rightarrow t\bar{t}) = f(s, m_t)$$



$$s = (p_{e^-} + p_{e^+})^2$$

$$\sigma(e^+e^- \rightarrow t\bar{t}\gamma) = f(s', m_t)$$



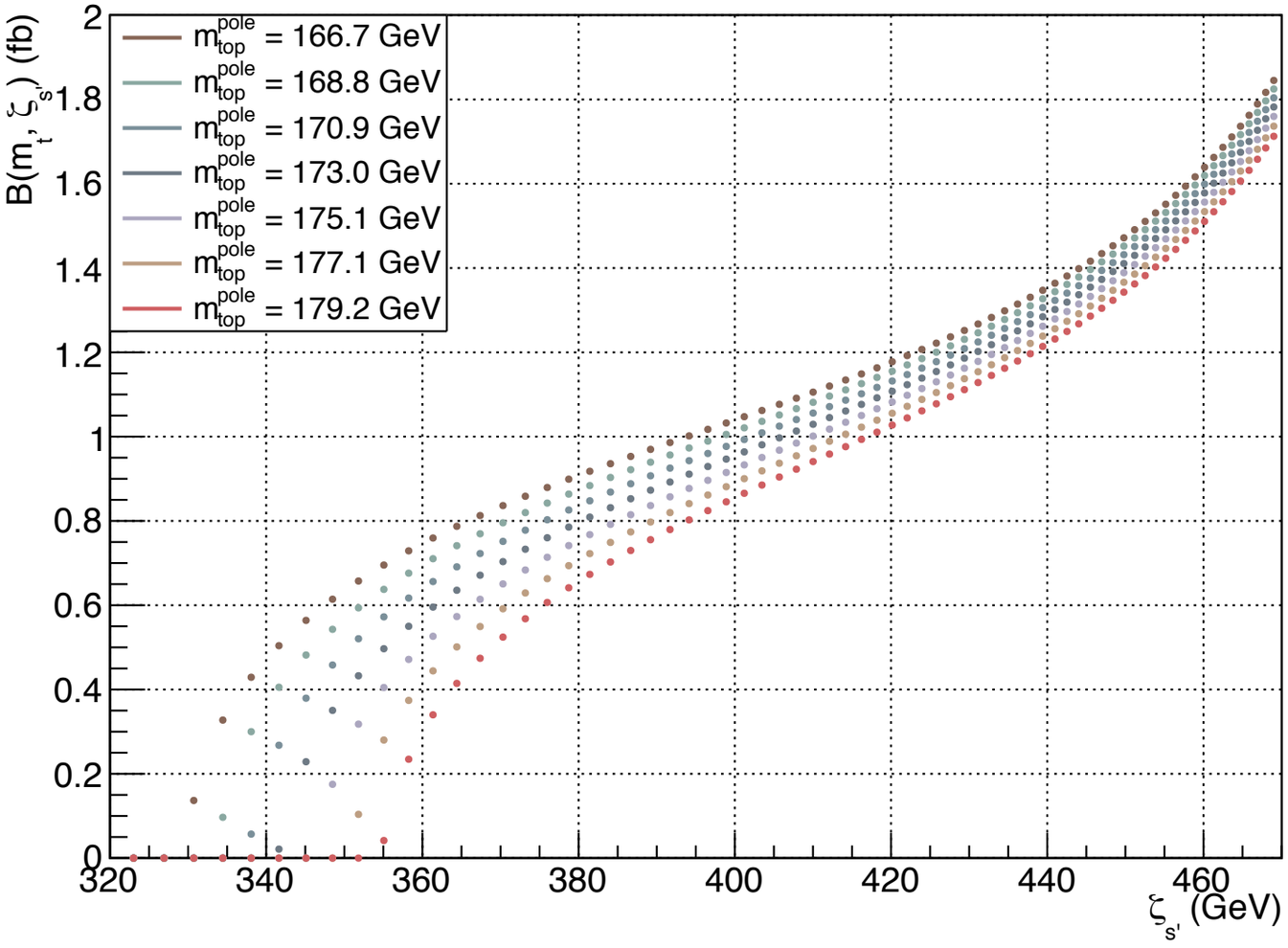
$$s' = (p'_{e^-} + p'_{e^+})^2$$

Top quark mass in the continuum

Observable: differential cross section of the ttbar pair production with a certain s' (i.e with a certain energy of the ISR photon)

$$B(m_t, \zeta_{s'}) = \frac{d\sigma_{t\bar{t}\gamma}}{d\zeta_{s'}} \longrightarrow \zeta_{s'} = \sqrt{s'}$$

$$s' = s\left(1 - \frac{2E_\gamma}{\sqrt{s}}\right)$$



Precision: depends on the measurement of the ISR photon, which can be measured with high precision

Sensitivity: the observable is more sensitive to m_t near the top production threshold

Methodology: template fitting of samples with realistic statistics to reference curves for different m_t values

Top quark mass in the continuum

Parton level study: best case scenario for different luminosities with unpolarized beams at 500 GeV

s = 500 GeV	m_t (GeV)	Δm_t (MeV)
500 fb^{-1}	173,158	155
1000 fb^{-1}	173,140	103
2600 fb^{-1}	173,133	61

Particle level study (with selection criteria and detector coverage accounted): potential of the observable for different luminosities at different s

s (GeV)	Luminosity (fb^{-1})	m_t (GeV)	Δm_t (MeV)
380	500	173,141	100
500	500	173,327	294
500	4000	173,122	100
1000	1000	173,381	639
1000	3500	173,197	388

Precisions of a hundred MeVs are within reach of the observable

Work in progress:

- A full simulation study to accomodate detector effects is on its way
- A well defined theoretical framework is being developed by A. Hoang (U. Wien) and V. Mateu (UAM)
- An optimized selection criteria has been studied
- Corrections on the luminosity spectrum of the accelerator are being investigated

Top quark reconstruction at high energies

Top reconstruction at high energies

Collaboration with P. Roloff and R. Ström (CLICdp CERN).

Reconstruction Strategy

Trimming technique: remove background.

Consists in the inclusive reconstruction of subjets inside the big boosted top jet.

+

Top tagging: distinguish tops from QCD background.

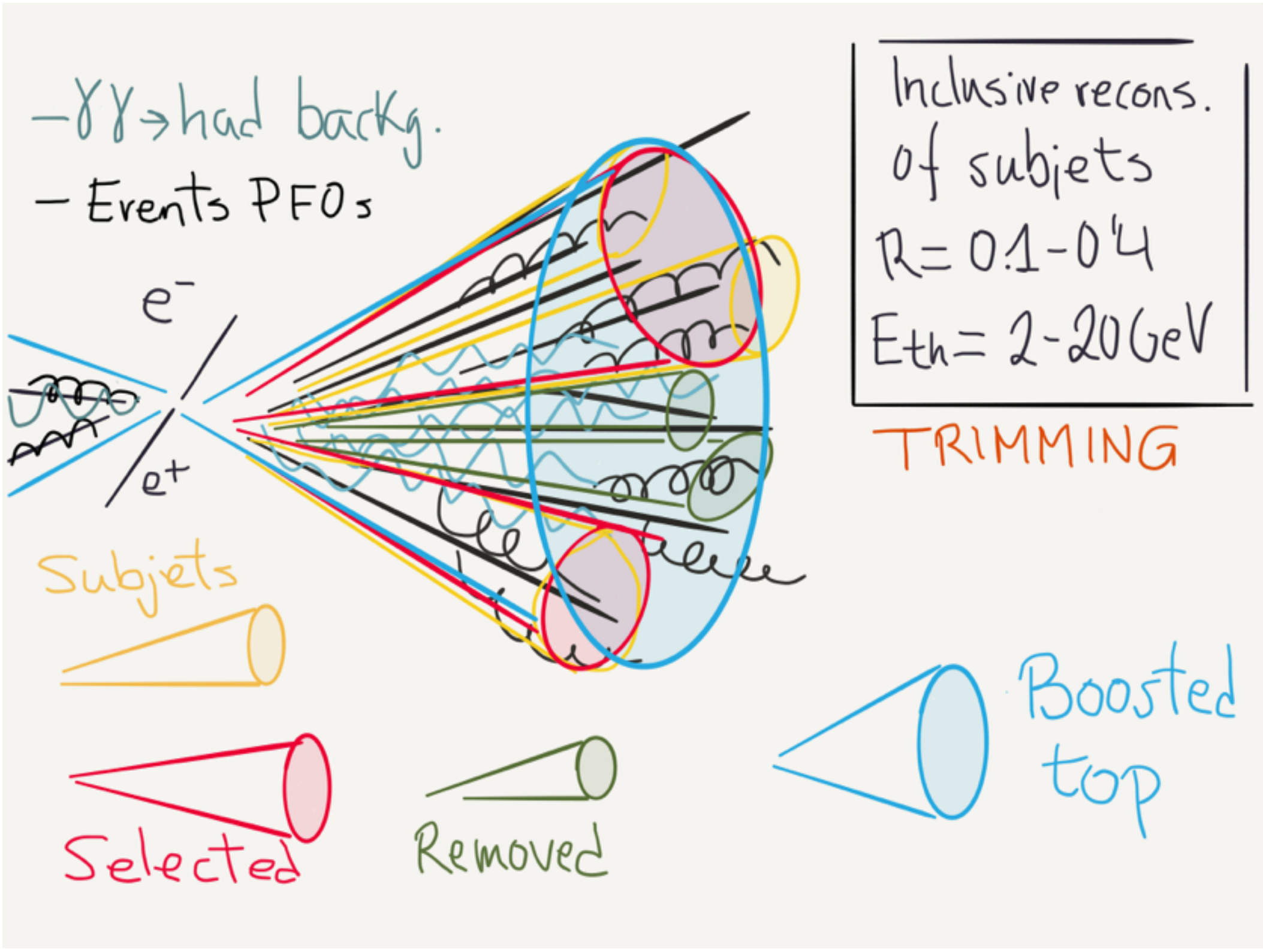
Studied Samples

6 fermion final-state samples CLIC@1.4TeV

P(e-) = -80%

Marlin processors for ILCSoft under development

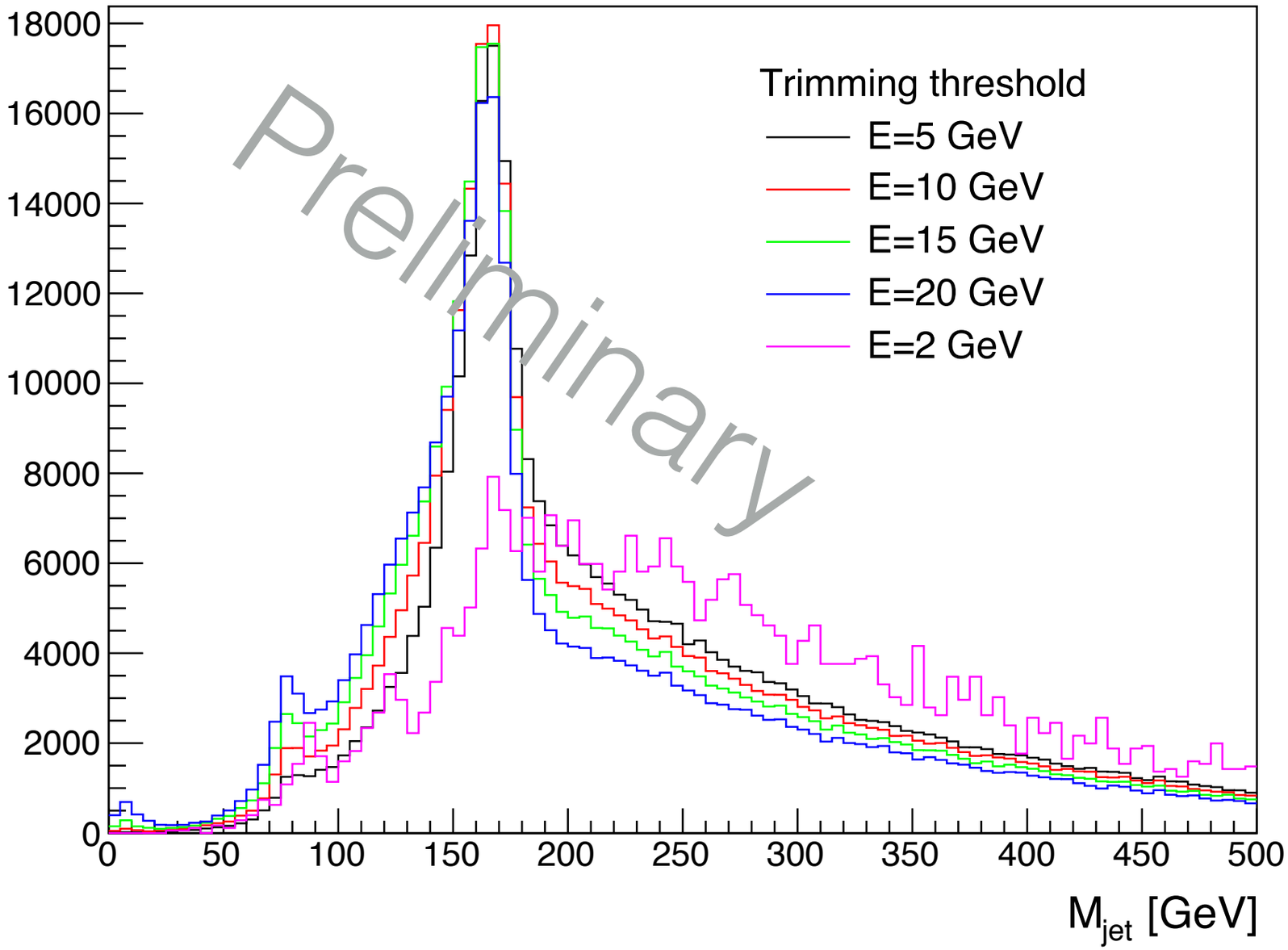
Trimming technique



Energy threshold selection

Trimming threshold impact

- Durham algorithm on smaller jets.
- R for subjets = 0.2

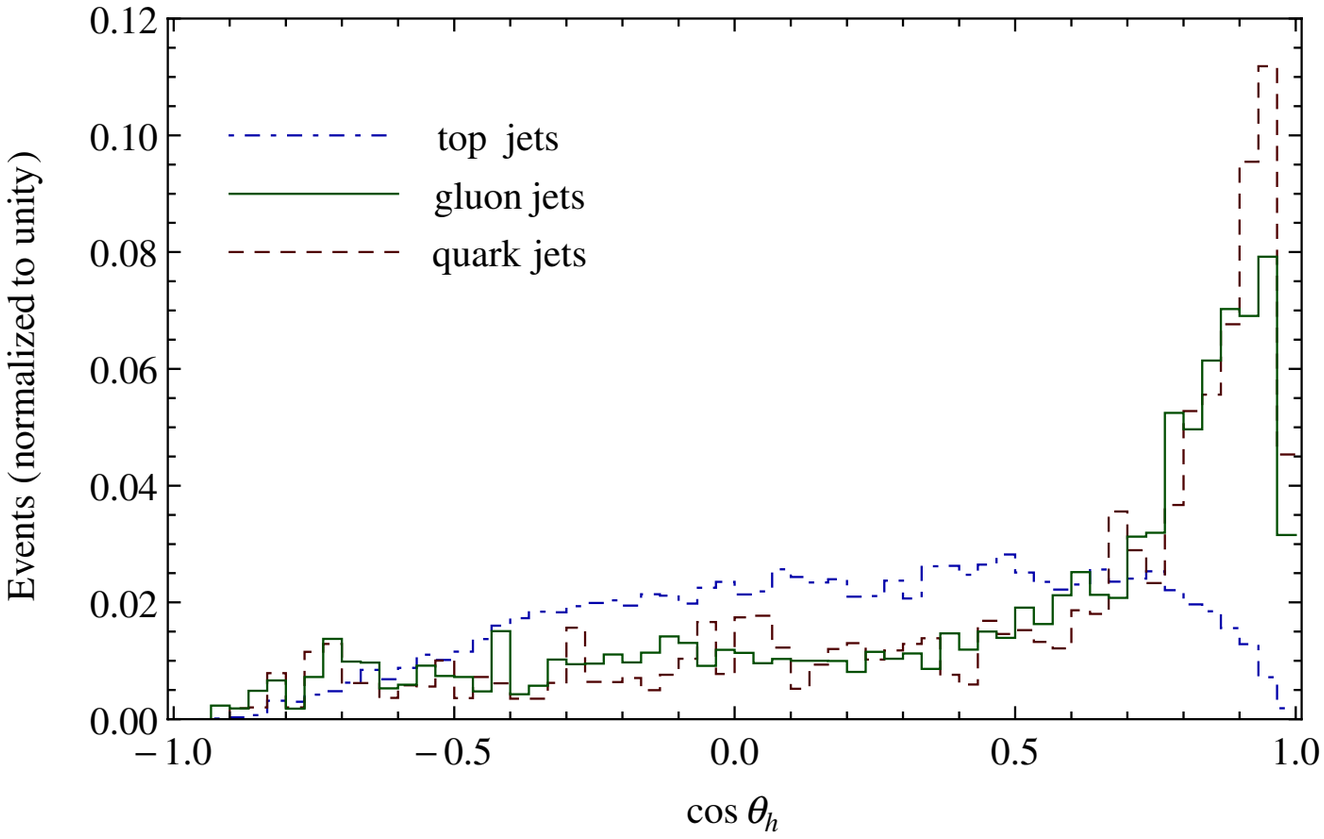


Top tagger

Based on LHC top tagging studies:

Top Tagging: A Method for Identifying Boosted Hadronically Decaying Top Quarks

Phys,Rev.Let. 101, 142001 (2008)



Semileptonic tt decays

- Lepton identification
- One b-jet tagged
- Subjet analysis
- Distinguish between 3-jets close together from QCD high-pt jets

Top quark couplings through an EFT

(based on previous work with LAL)

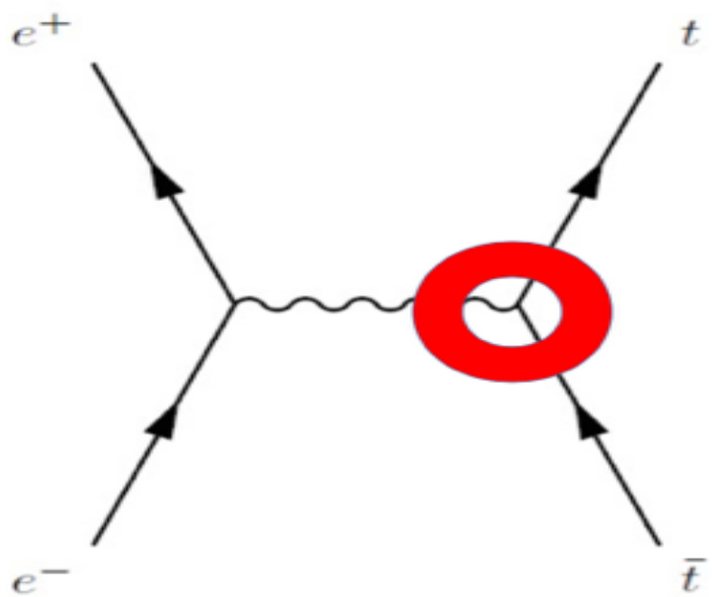
Top quark couplings - EFT

Collaboration with G. Durieux (DESY), C. Zhang (BNL).

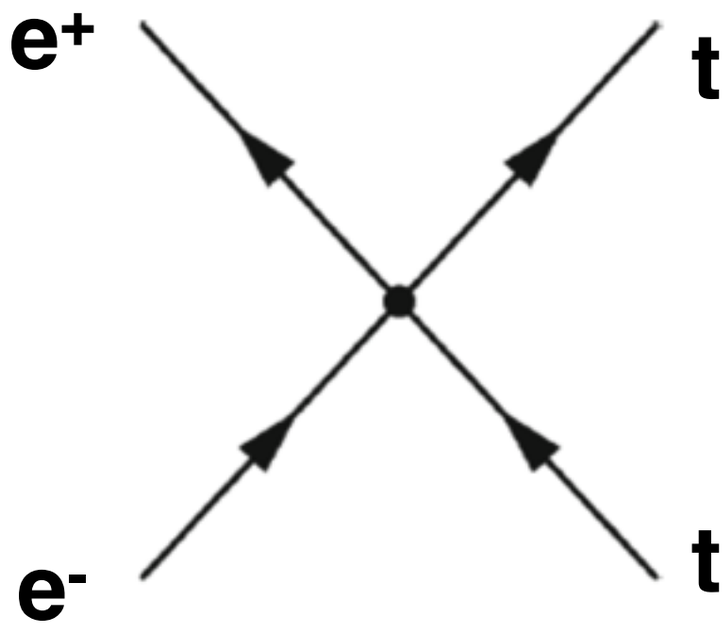
Motivation: We can **connect different physics processes with the same operators**.

$$\mathcal{L}_{eff} = \mathcal{L}_{SM} + \frac{1}{\Lambda^2}\sum_i C_i O_i + \mathcal{O}\left(\Lambda^{-4}\right)$$

Correction to vertices

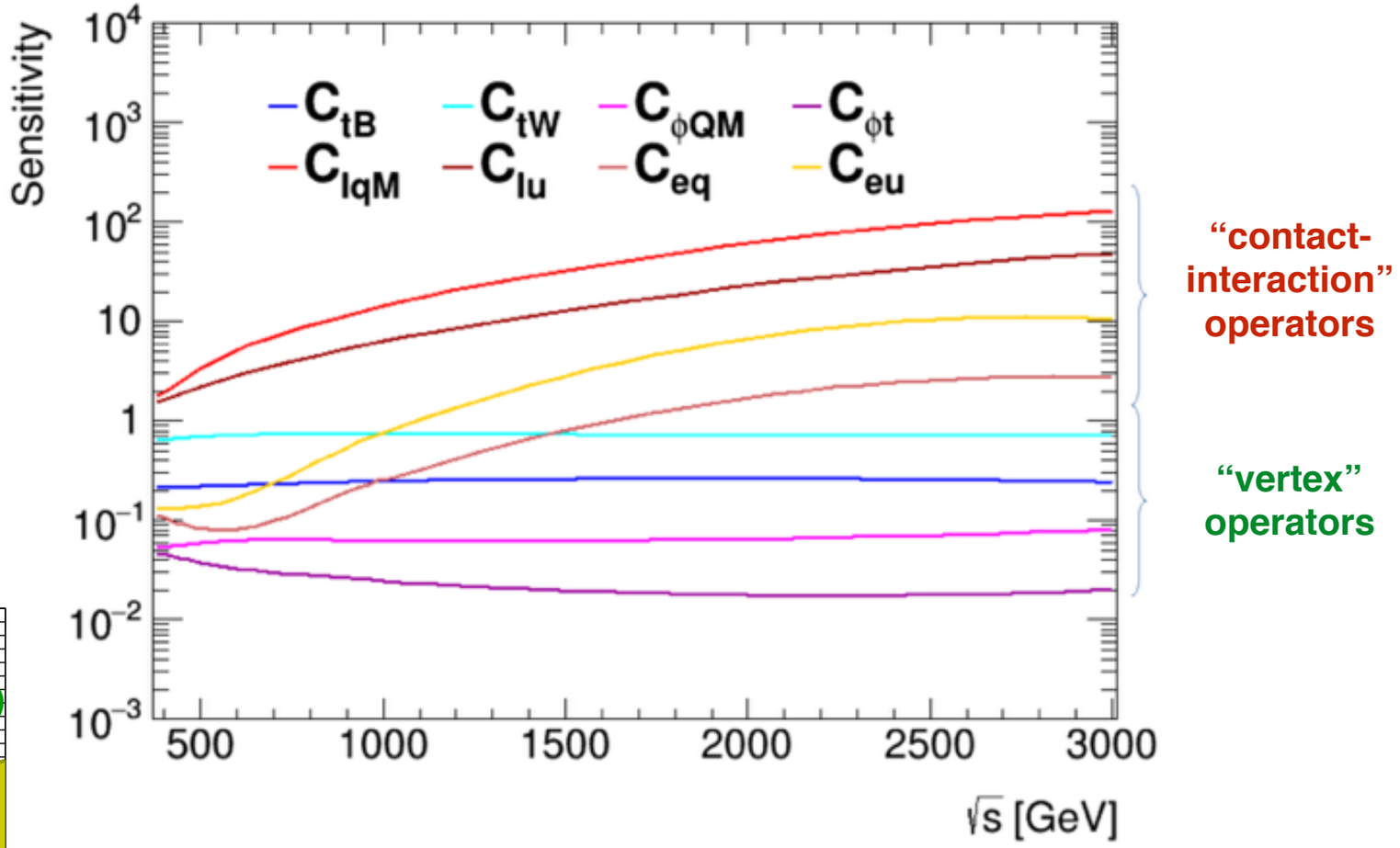


Contact interactions



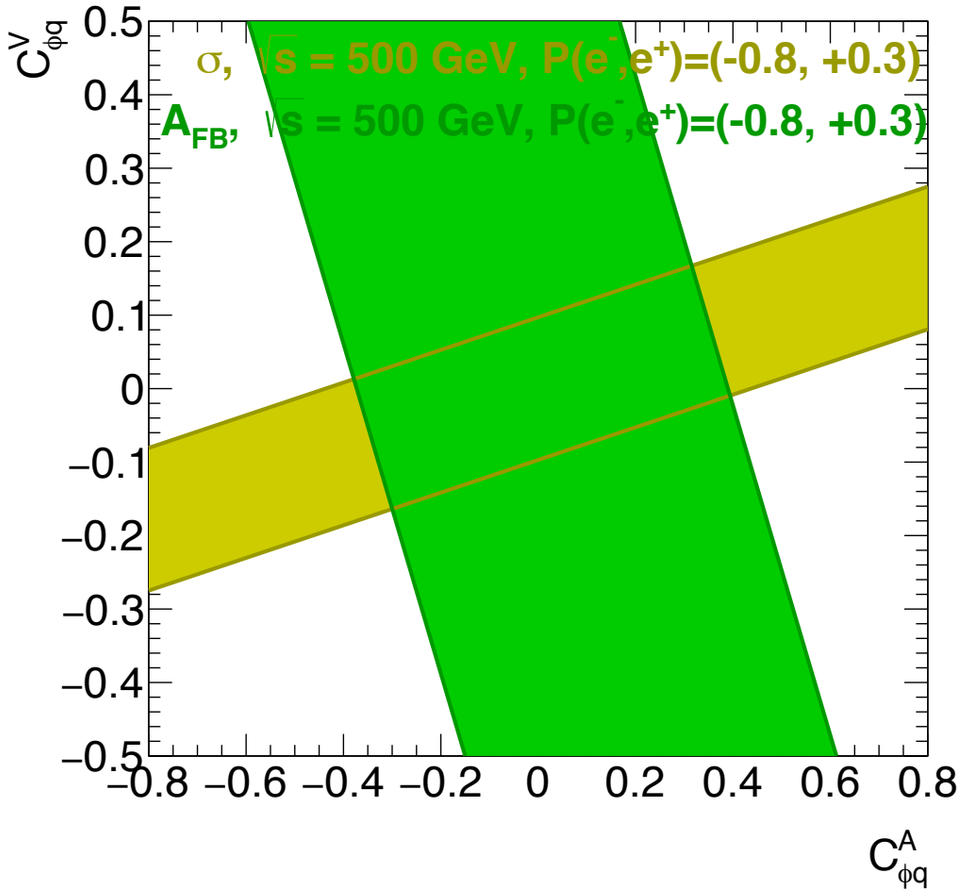
Top quark couplings - EFT

Sensitivity:
Relative change in cross-section due to non-zero operator coefficient
$\Delta\sigma\,(C) / \sigma / \Delta C$



"contact-interaction" operators

"vertex" operators

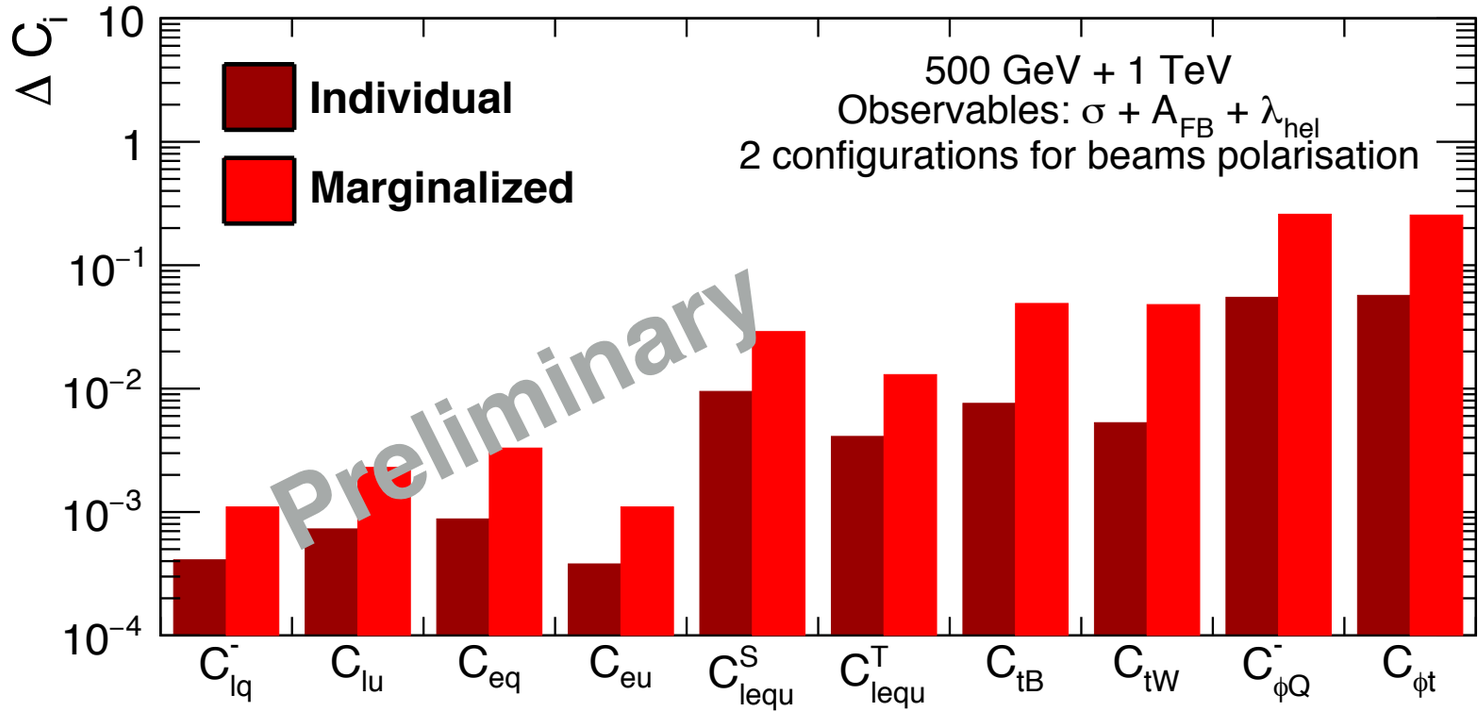


Methodology: to find complementarity between operators using different observables.

Top quark couplings - EFT

Global fit in the ILC energy program:
500 GeV + 1 TeV

We can think about a possible upgrade at 1.5 TeV or 3 TeV



Individual: *only 1 parameter floating (all the rest fixed).*
Marginalized: *all the parameters floating.*

Comparison with concrete BSM models

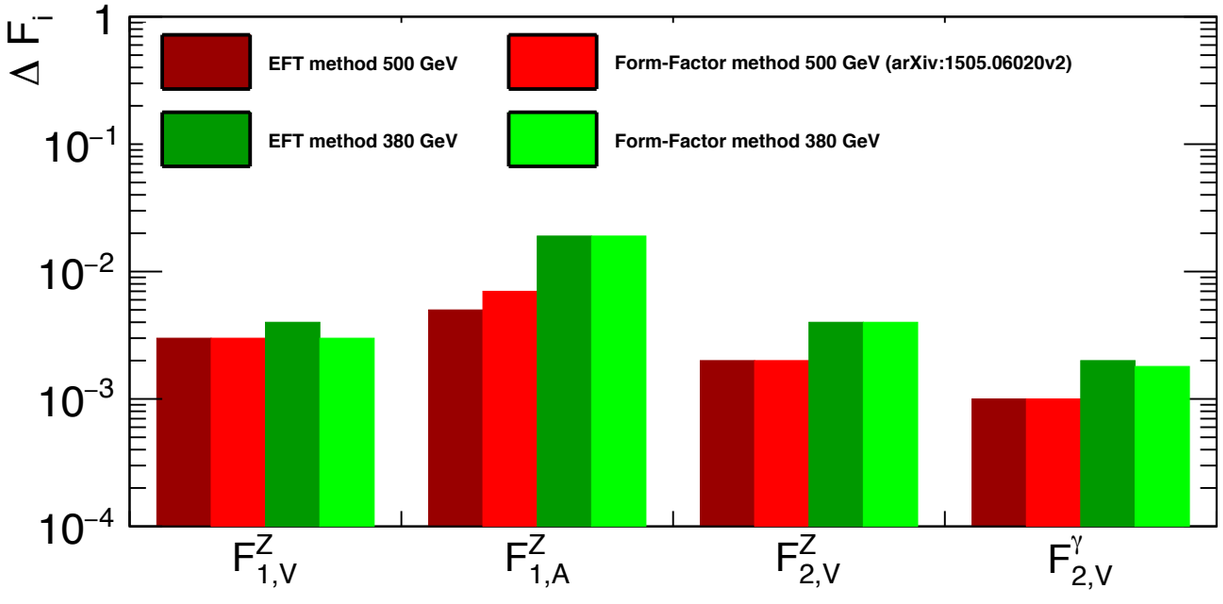
Vector-like quarks:

MU / λ > 3 TeV *(indv fit)*
MU / λ > 1.4 TeV *(marg. fit)*

R-S models - KK modes:

Mkk > 13 TeV *(indv fit)*
Mkk > 8 TeV *(marg. fit)*

Comparison with form-factors scheme



Thank you!