Update on Top FCNC Studies

O. Cakir*

Ankara University

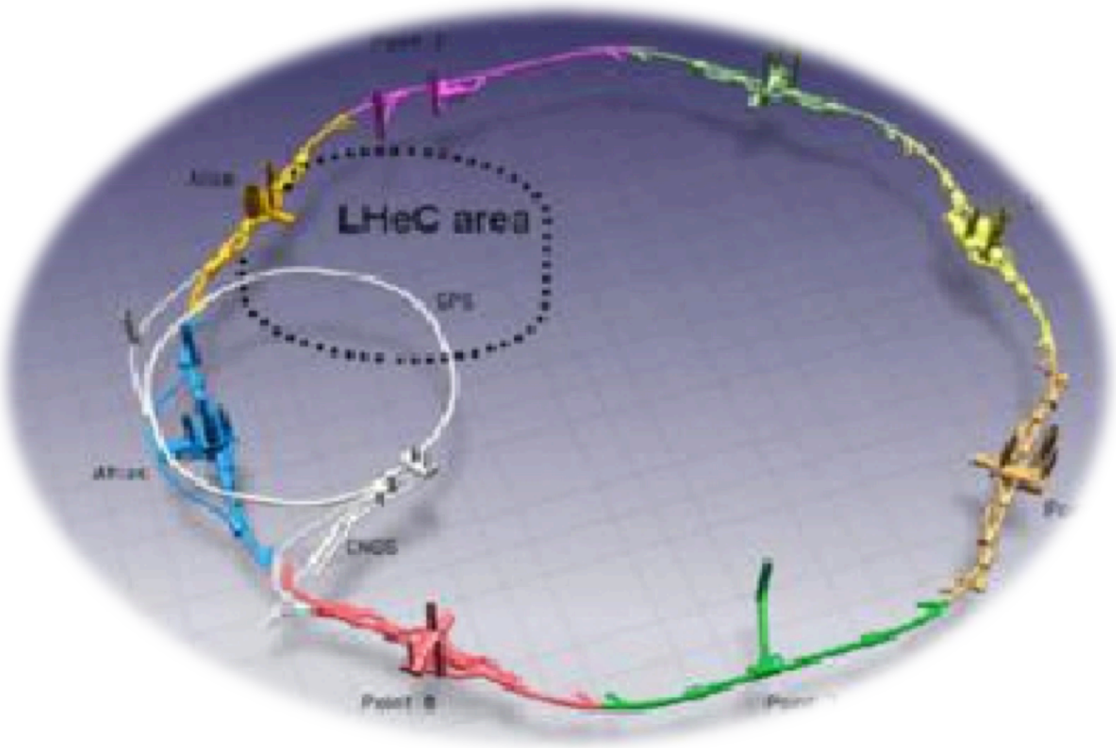
*with collaboration H.Denizli, A.Senol, I.Turk Cakir, A.Yilmaz, H.Karadeniz

BSM physics studies at ep colliders, vidyo meeting, 11 August 2017

OUTLINE

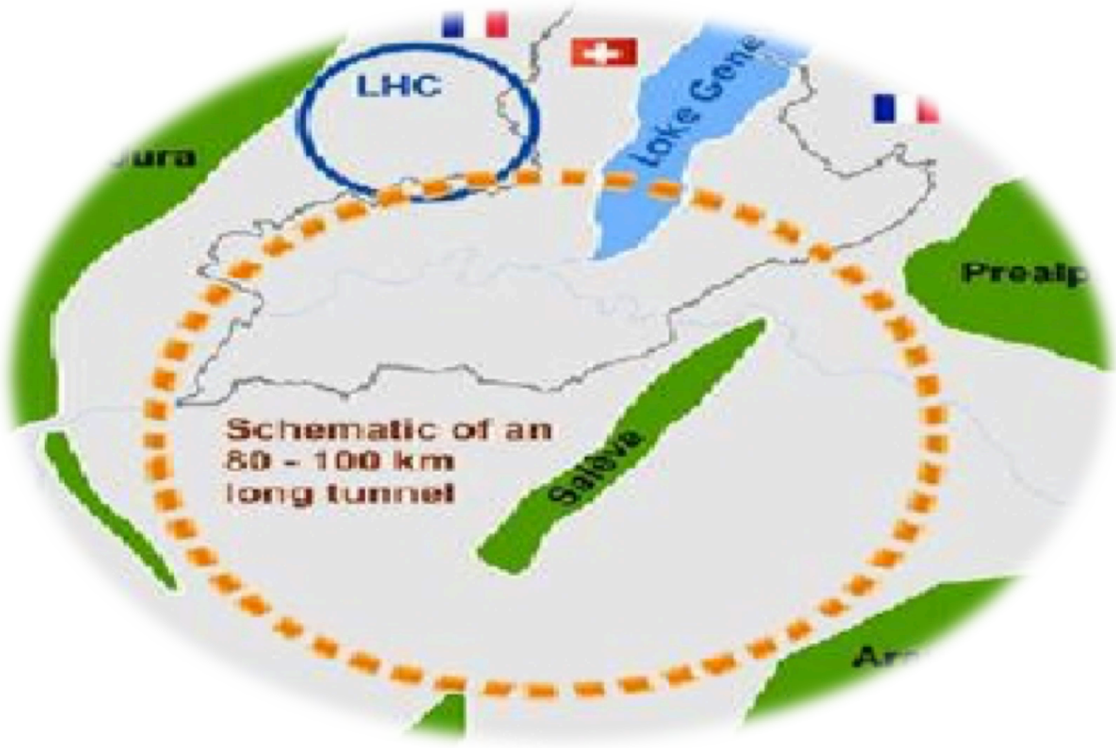
- Introduction
- Top physics at ep colliders
- Top quark FCNC interactions
- Cross sections
- Detector simulation
- Analysis
- Conclusions

FUTURE PROSPECTS OF EP COLLIDERS



LHeC

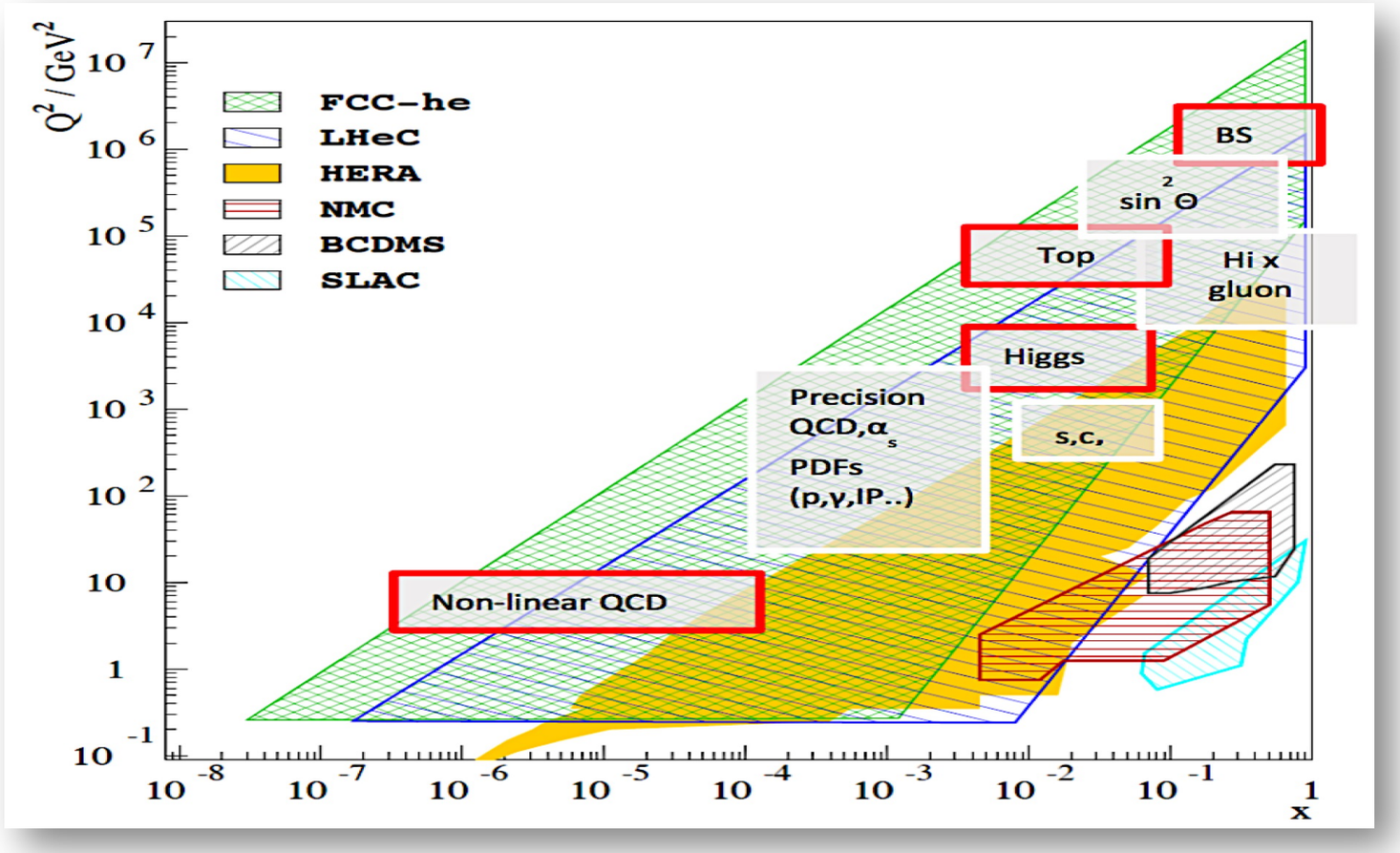
7 TeV proton of LHC and 60 GeV electron ($\sqrt{s}$ ~1.3 TeV)



FCC-he

50 TeV proton of FCC and 60 GeV electron ($\sqrt{s}$ ~ 3.5 TeV)

PHYSICS AT FUTURE EP COLLIDERS

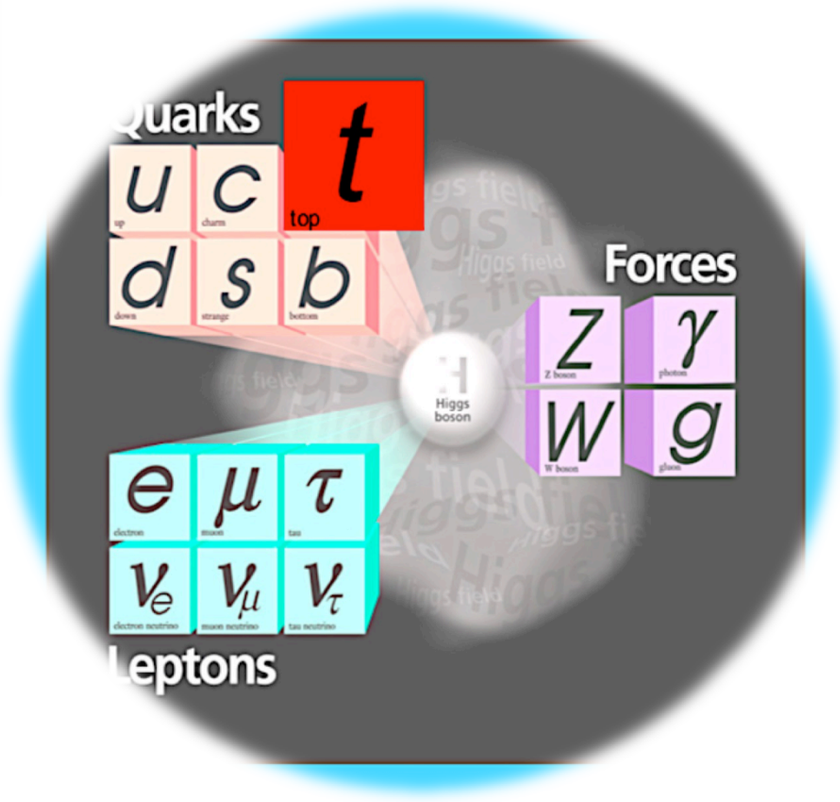


O. Bruning *et al.*, PoS EPS-HEP2015 (2015) 520

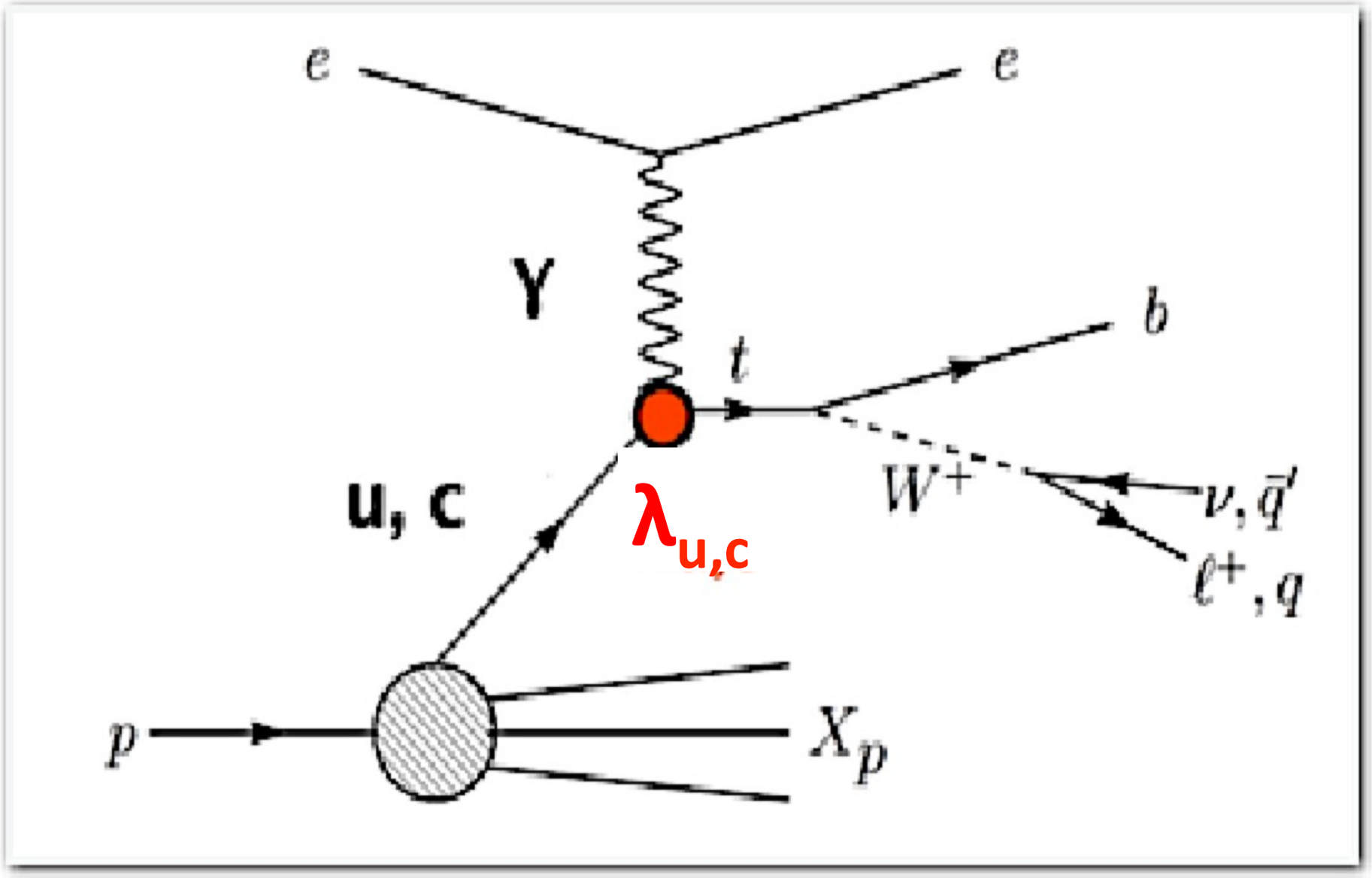
The FCC-he and LHeC compared to previous DIS experiments. The plot indicates the placement of key physics subjects in the kinematics plane of x and Q^2.

Precise measurements of couplings between SM gauge bosons and quarks and leptons are sensitive test of new physics (search for deviations), due to its large mass the top quark is expected to be the most sensitive to BSM physics.

The future ep colliders offers excellent prospects for top physics.



TOP QUARK FCNC INTERACTIONS

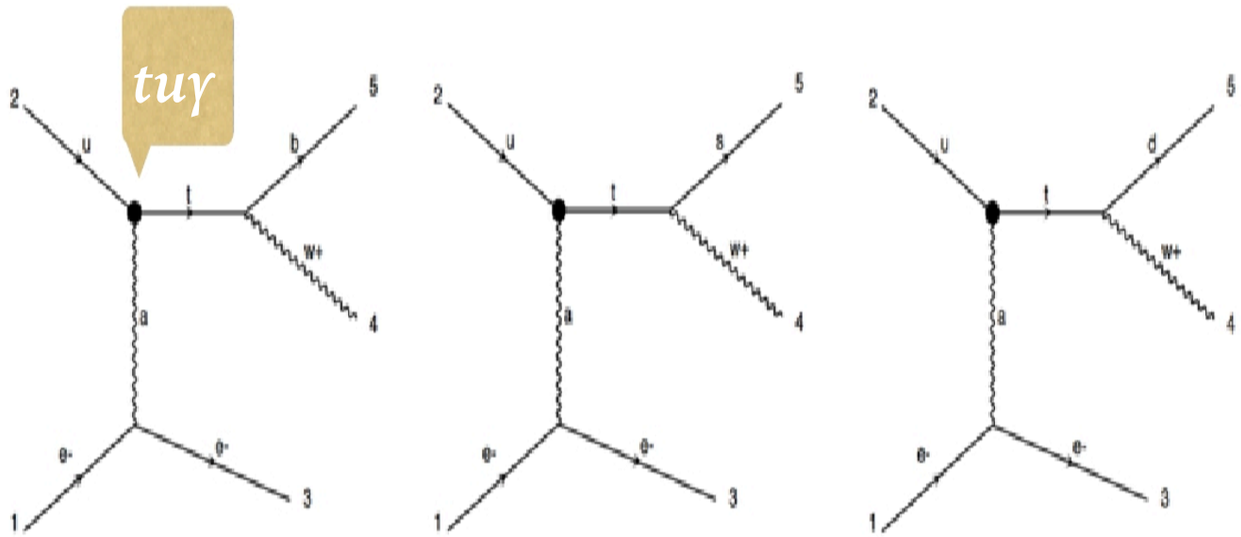


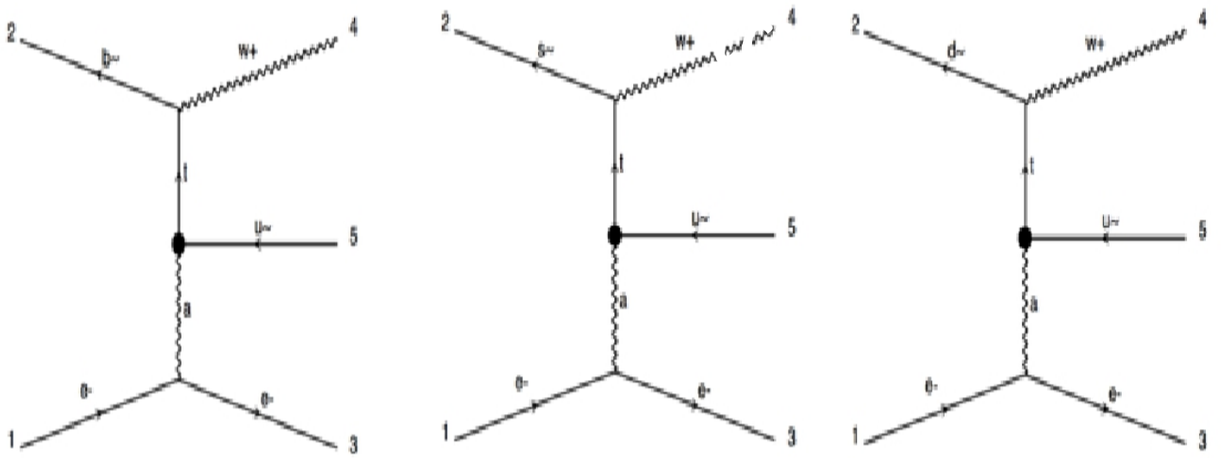
Sensitive search for FCNC couplings will constrain BSM models

CROSS SECTIONS FOR SIGNAL

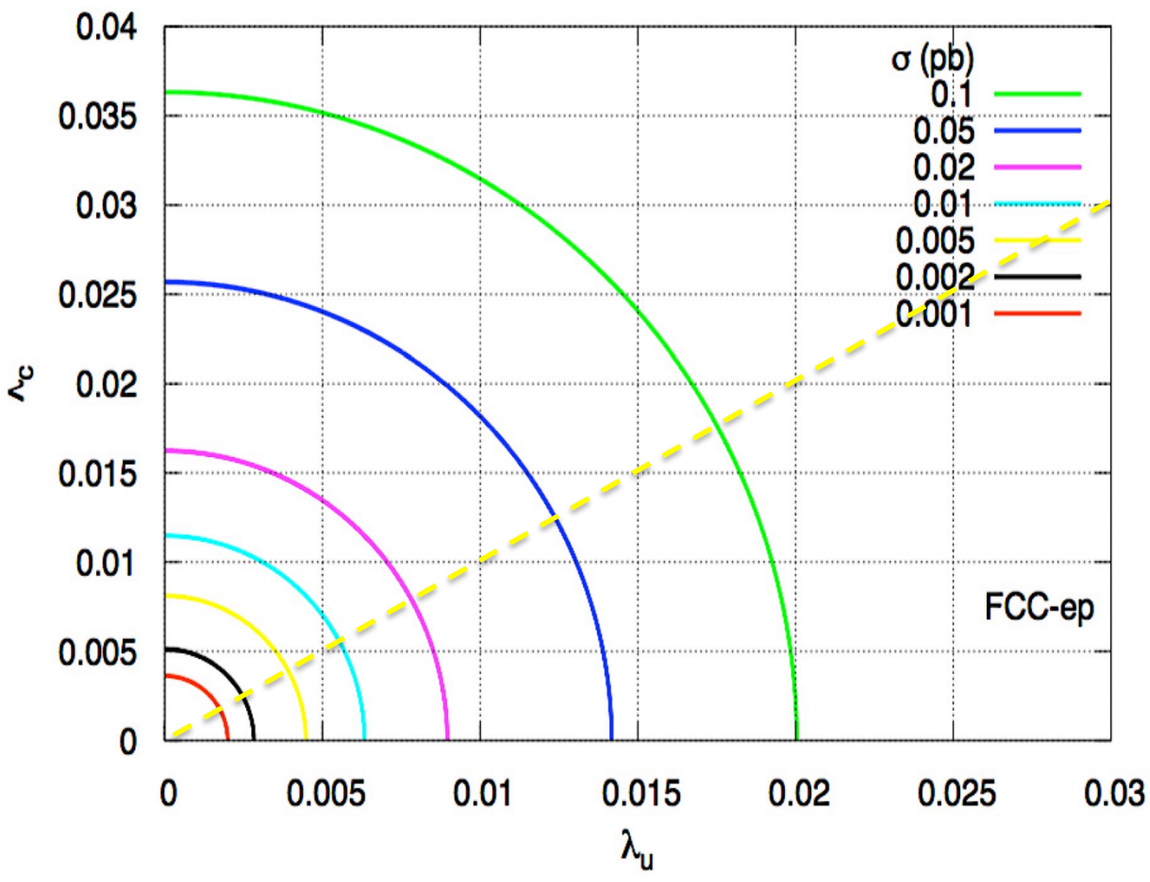
Process: e-p->e-Wq+X.

Signal cross sections at FCC-ep collider depending on FCNC tqγ couplings λ_u and λ_c within the interested range.





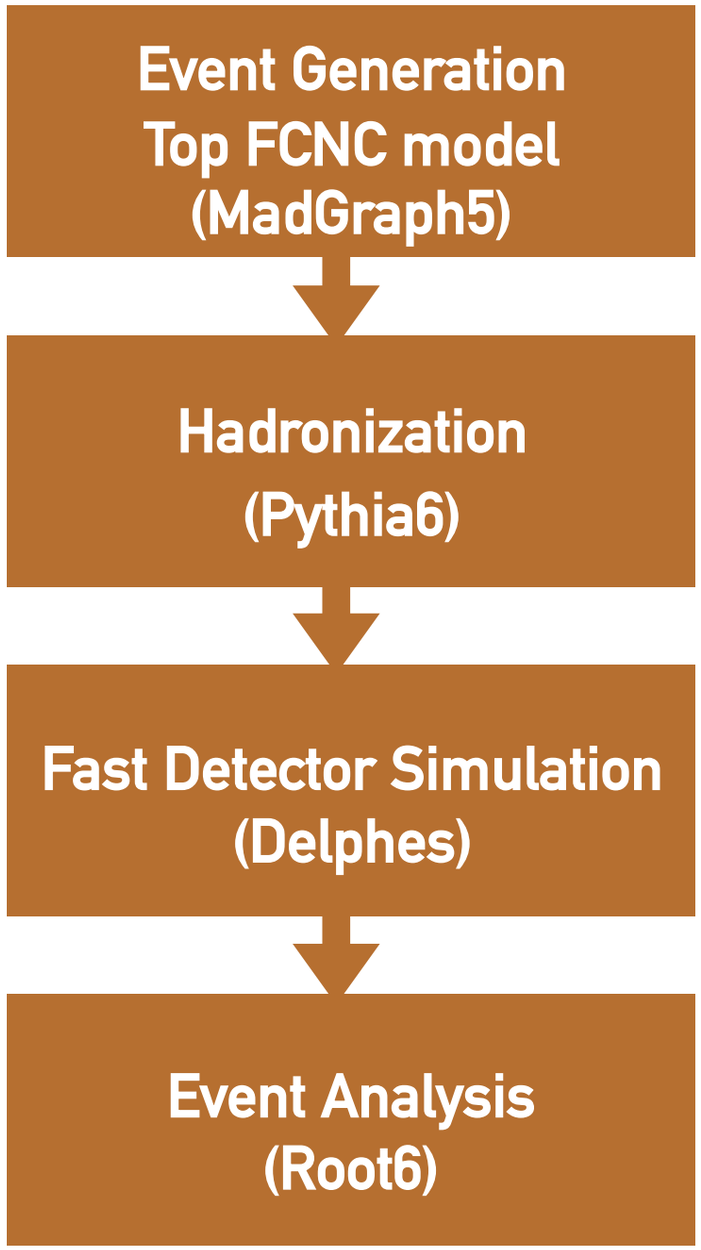
PDF: NNPDF2.3



+ similar diagrams for tcγ

(*further diagrams for process e^-p->e^-W^-q+X with the interchange q<—>q~*)

ANALYSIS FRAMEWORK

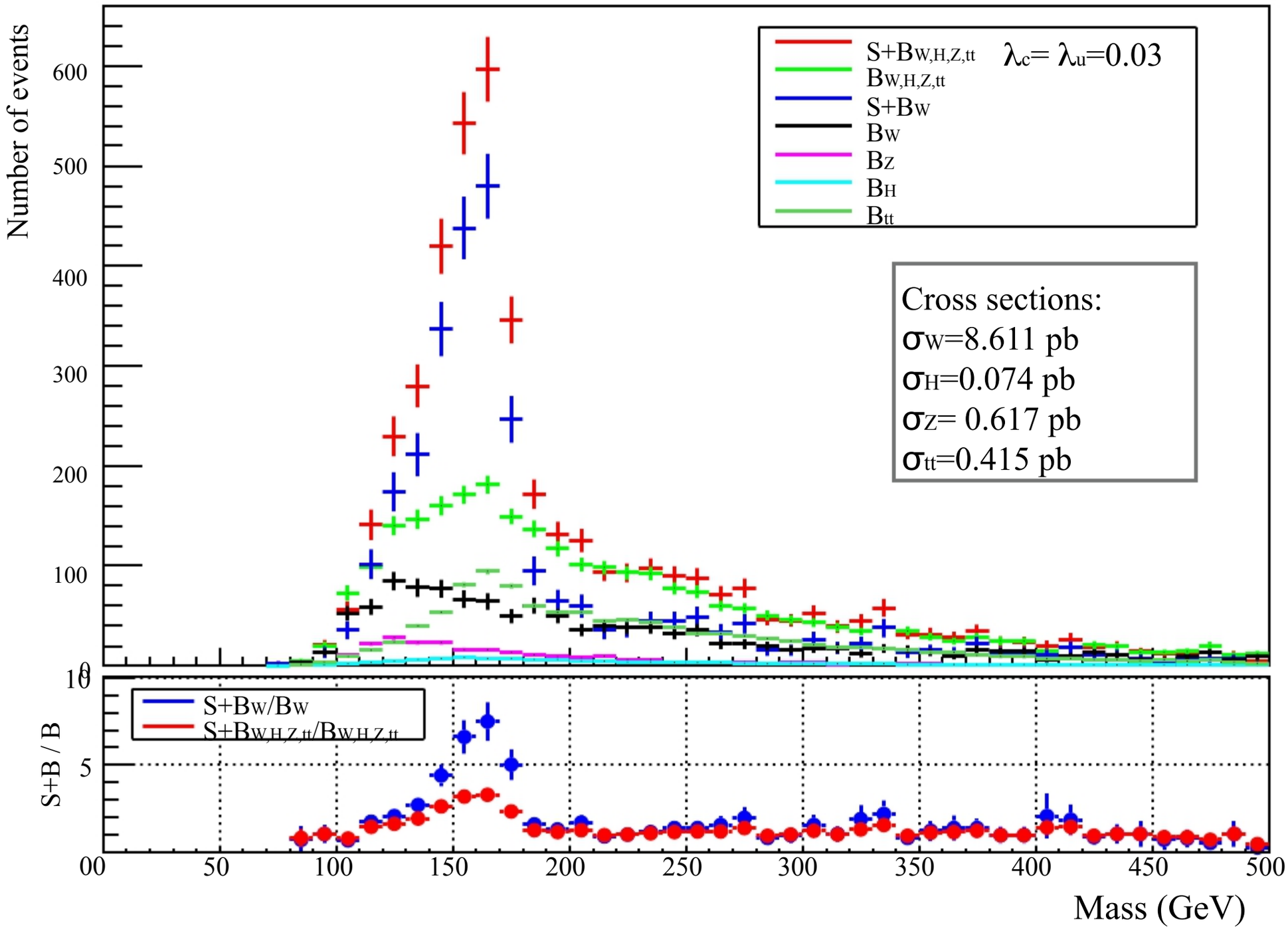


For the analysis, after pre-selection, we use the analysis cuts for further background suppression

Cut flow

Cut-0 :	at least one electron and three jets (pre-selection with default MG5 cuts)
Cut-1 :	require one of three jets as being b-tag
Cut-2 :	b-tagged jet has transverse momentum p_T>35 GeV and other jets have p_T>25 GeV, and electron has p_T>20 GeV
Cut-3 :	all jets have pseudo-rapidity -5.0<η<0 ; and electron has -2.5<η<2.5
Cut-4 :	invariant mass of two jets within 50<m_{jj}<90 GeV (for W- boson)
Cut-5 :	invariant mass of three jets (for top) between 130<m_{bjj}<200 GeV

FCC-EP: (S+B)/B AND RELEVANT BACKGROUNDS



S: $ep \rightarrow eWj$

B_W: $ep \rightarrow eWj$

B_Z: $ep \rightarrow eZj$

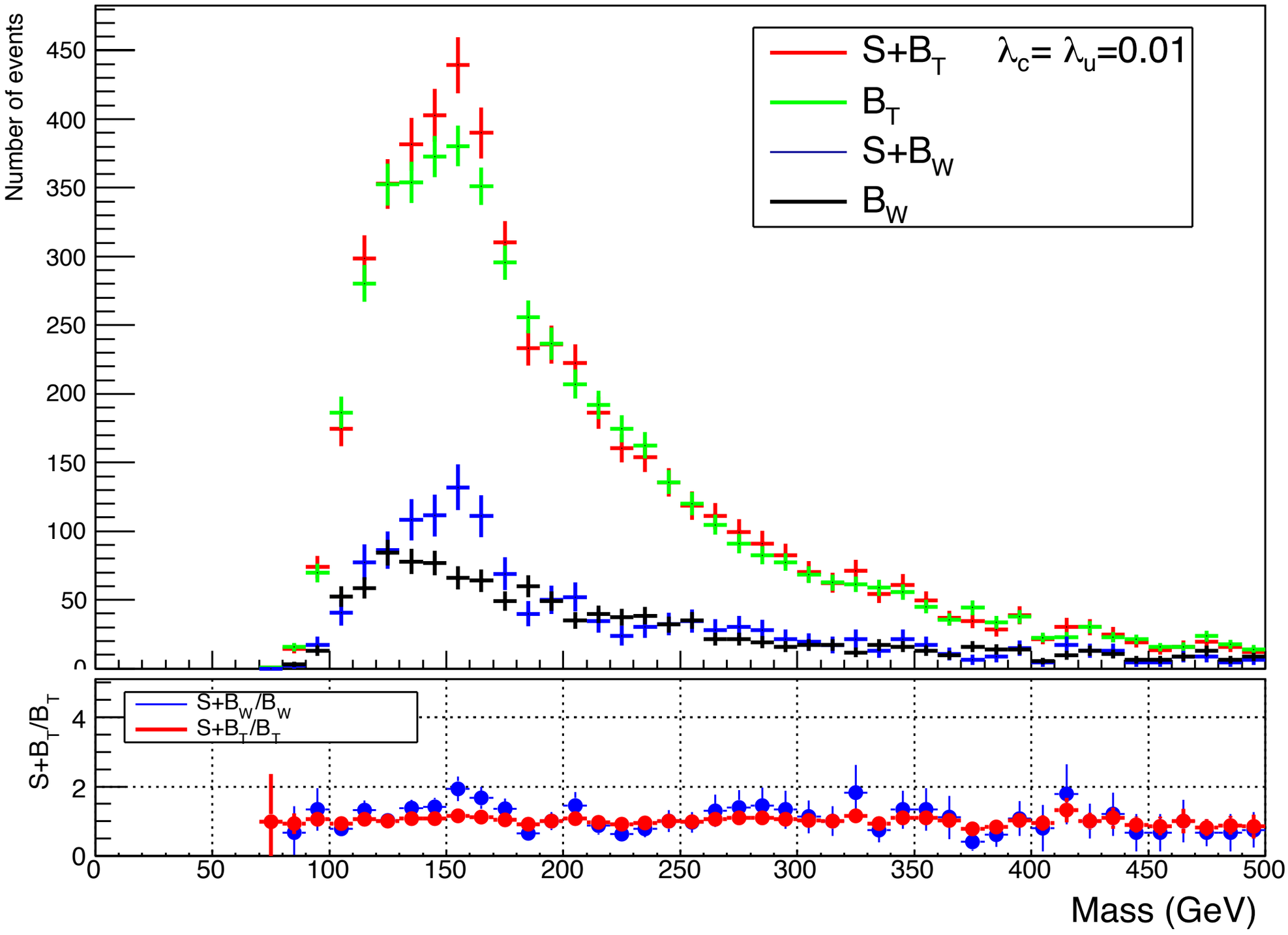
B_H: $ep \rightarrow eHj$

B_{tt}: $ep \rightarrow e\bar{t}t$

➤ *With the relevant backgrounds ($B_T = B_W + B_Z + B_H + B_{tt}$), the ratio $(S+B)/B$ are shown in figure.*

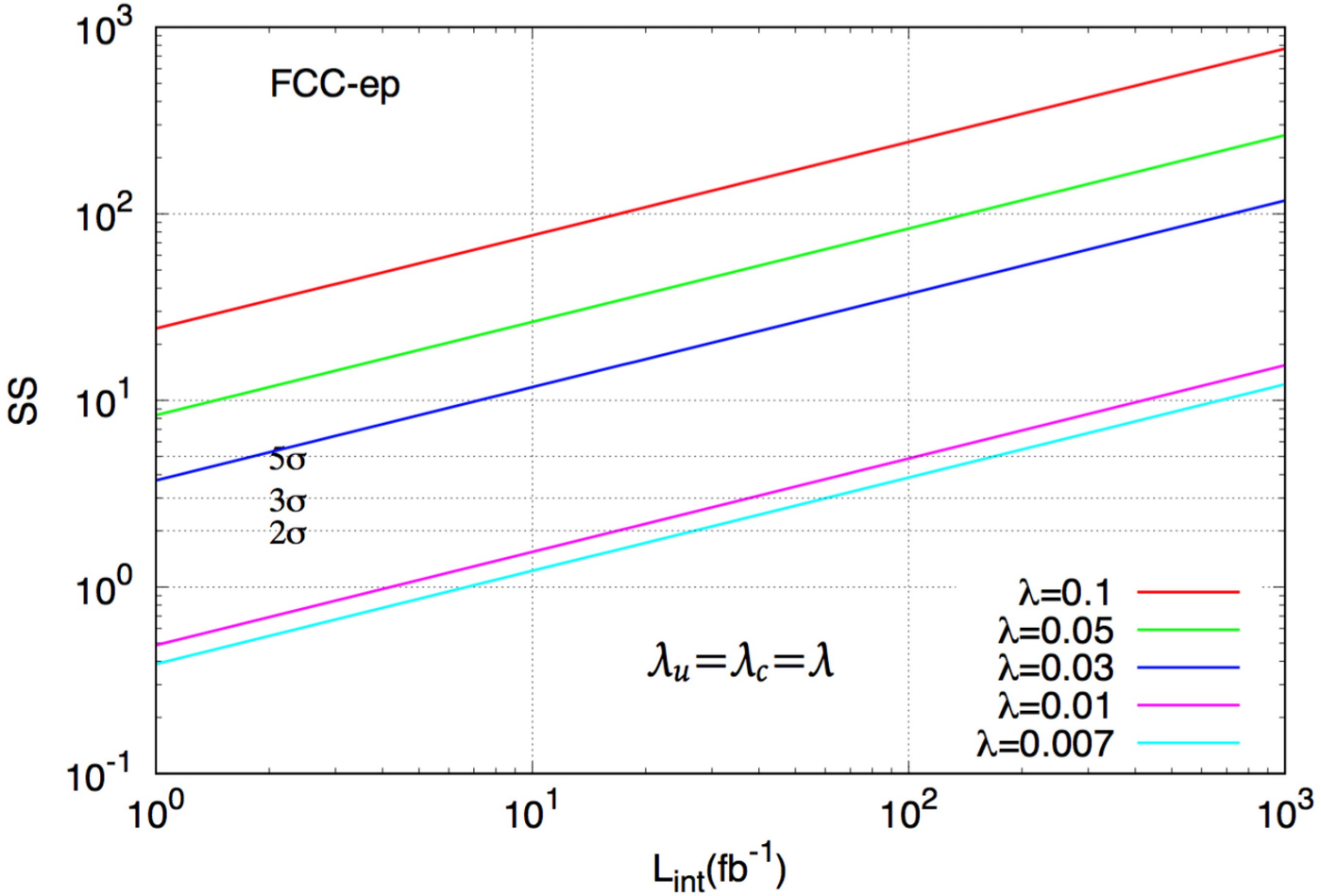
arXiv:1701.06932

FCC-EP: (S+B)/B AND RELEVANT BACKGROUNDS



FCC-EP: SS PLOT

Statistical significance $SS=\sqrt{2}[(S+B_T)\ln(1+S/B_T)-S]$ for $e^-p\to e^-+bjet+2j$ with *tqγ* FCNC interactions. Here, we assume equal coupling scenario $\lambda_u = \lambda_c = \lambda$.



All relevant backgrounds (B_T) are included,

<u>3σ significance:</u>

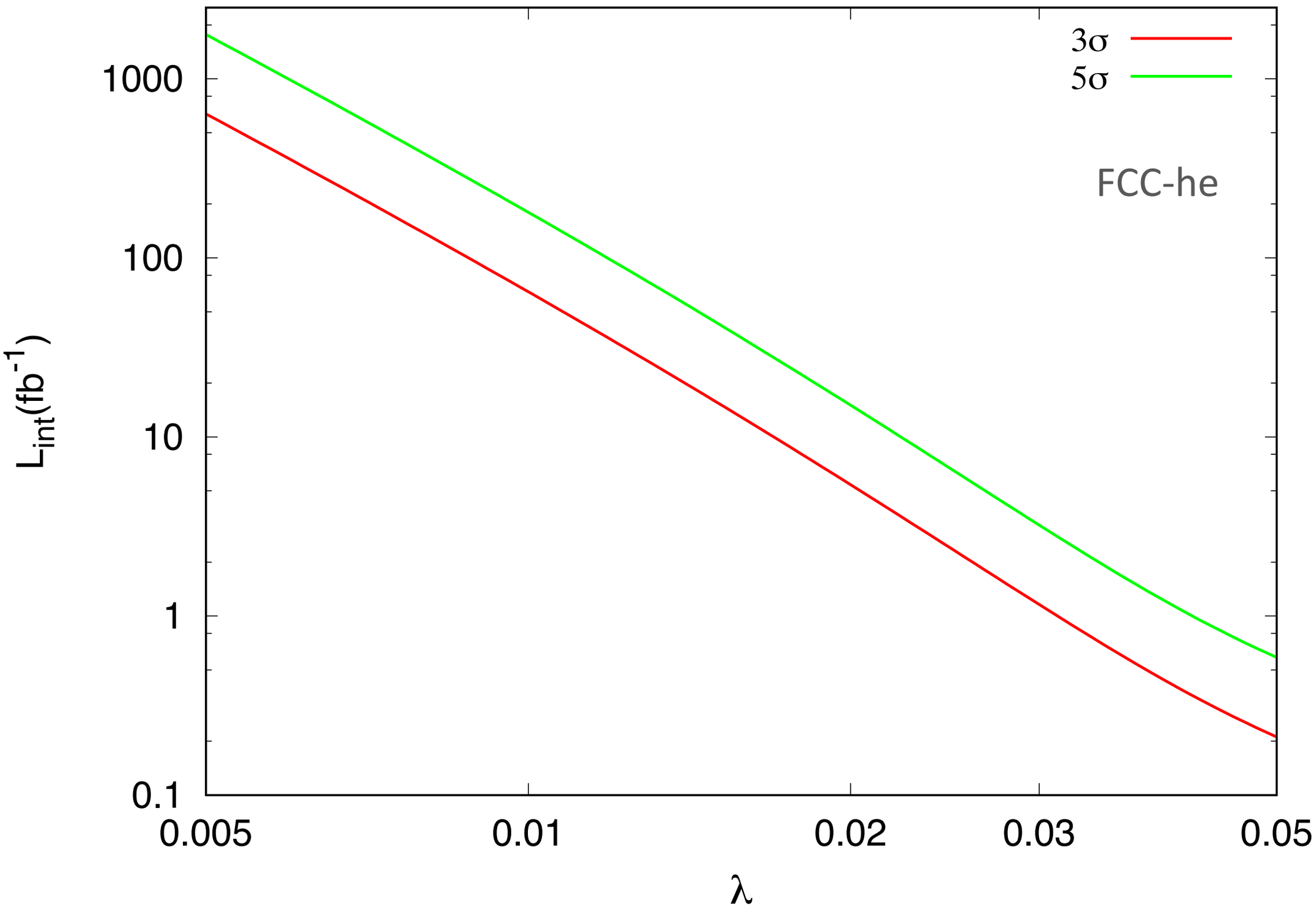
at $\lambda=0.01$ for $L_{int}=40/fb$.

* Compare with LHeC when $\lambda_q=0.01$ for $L_{int}=200/fb$.

arXiv:1705.05419

We find 3σ signal significance result to reach an upper limit λ=0.01 with integrated luminosity of 40/fb at FCC-ep. For comparision, in order to reach this coupling at LHeC we need 200/fb. This limit on the coupling can also be translated to the branching ratio $BR(t\to q\gamma)=2\times10^{-5}$.

LUMINOSITY VS COUPLING



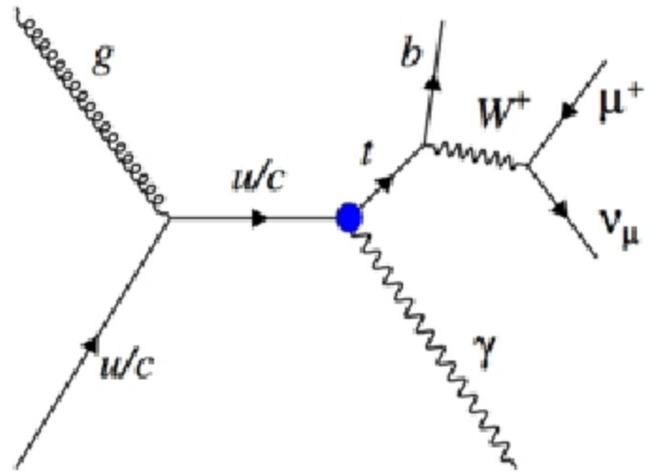
CONCLUSION

- In this talk we present a short overview of the top FCNC at the ep colliders, which has also a rich top physics programme.
- *Top FCNC tqγ couplings can be measured down to λ_q = 0.01 and it can be translated into branching ratio BR(t→qγ) = 2x10^{-5} at the FCC-eh*
- These studies have been performed with the updated Delphes detector simulation.

COMPARISON: TOP FCNC AT LHC

Based on proton-proton collisions at 8 TeV within the CMS detector at the LHC at an integrated luminosity of 19.8 fb^{-1}, the limits (95% CL) on the top quark FCNC couplings

$$\mathcal{L}_{\mathrm{eff}} = -eQ_{\mathrm{t}} \sum_{\mathrm{q=u,c}} \bar{\mathrm{q}} \frac{i\sigma^{\mu\nu} q_\nu}{\Lambda} (\kappa^{\mathrm{L}}_{\mathrm{tq}\gamma} P_{\mathrm{L}} + \kappa^{\mathrm{R}}_{\mathrm{tq}\gamma} P_{\mathrm{R}}) \mathrm{t} A_\mu + \mathrm{h.c.},$$



$BR(t \rightarrow u\gamma) = 1.7 \times 10^{-4}$

$BR(t \rightarrow c\gamma) = 2.2 \times 10^{-3}$

CMS Collab.JHEP04(2016)035

Discussion on different energy options