Precise predictions for $h^0 \to WW^*/ZZ^* \to 4f$

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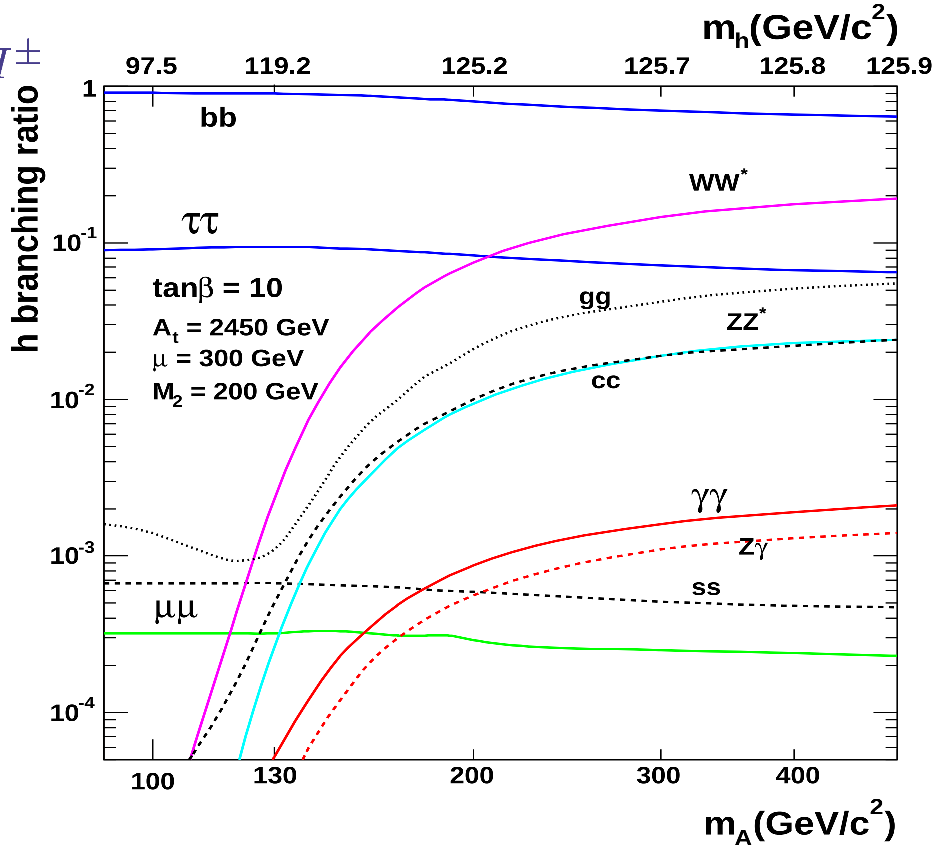
Outline

- Introduction
- Strategy of the calculation
- Numerical results
- Summary

Introduction

Higgs sector of MSSM

- 5 physical Higgs bosons, h^0, H^0, A^0 and $H^\pm$
  $M_{h^0} \leq 135$GeV
- Discovery potential of h^0
  decay channel to $b\bar{b}$ difficult in mass range below 140GeV
  BR$(h^0 \to VV^*)$ grows with M_{A^0}
  in the limit $M_{A^0} \gg M_Z$, h^0 SM-like
- precise knowledge of the channel helps
  distinguish Higgs boson of different origin
  indirect bounds on e.g. M_{A^0}
  information for distinguishing soft SUSY-breaking scenarios



R. Kinnunen et al '05

Introduction

Current results

for SM Higgs

$H \to VV$, $\mathcal{O}(\alpha)$ corrections for on-/off- shell gauge bosons

(Grau et al ’90, Kniehl ’91)

$H \to 4f$, $\mathcal{O}(\alpha)$ EW corrections available for leptonic final state

(A. Bredenstein, A. Denner, S. Dittmaier and M. M. Weber ’06)

also $\mathcal{O}(\alpha_s)$ QCD corrections for semileptonic/hadronic final states

(A. Bredenstein, A. Denner, S. Dittmaier and M. M. Weber ’06)

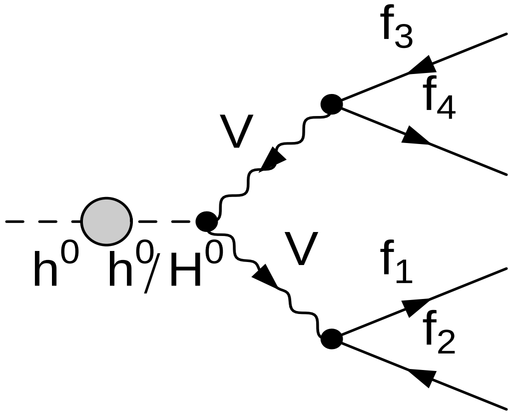
interesting to compare the results for SM/MSSM Higgs boson

for MSSM $h^0 \to VV^*$, improved tree-level results(Higgs mixing) available in FeynHiggs

In this work, as the first step, the $\mathcal{O}(\alpha)$ EW corrections to decay of h^0 to four leptons are computed

Strategy

In contrast to SM case



- beyond lowest order
  mixing between Higgs bosons
  Vertex correction to H^0VV due to
  fermion/sfermion loop
- implementation of width
  M_{h^0} below threshold, one gauge boson can be resonant
  - complex mass scheme
    implemented in SM, problem in MSSM
  - pole scheme not applicable near and below threshold region
  - factorization scheme

$$\mathcal{M}_{\text{born}} = \frac{k_V^2 - M_V^2}{k_V^2 - M_V^2 + iM_V\Gamma_V}\mathcal{M}_{\text{born}}(\Gamma_V = 0)$$

at tree level, double-counting from self-energy insertions avoided at loop level

Strategy

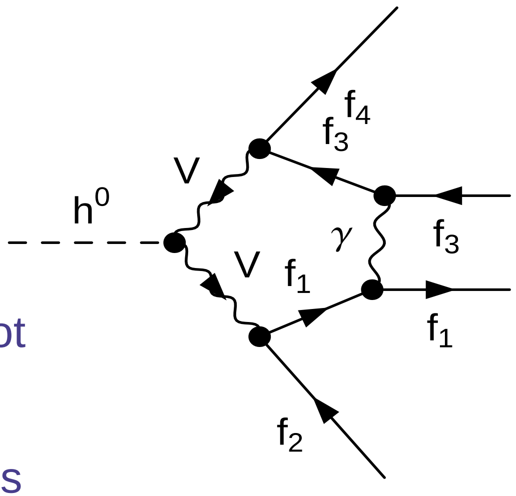
- virtual photonic corrections

  on-shell singularities occur in photonic diagrams, e.g. pentagon diagrams,

  $$\ln(k_V^2 - M_V^2) \rightarrow \ln(k_V^2 - M_V^2 + iM_V\Gamma_V)$$

  only scalar integrals contribute, replacement does not disturb gauge invariance

  analytical evaluation of soft/on-shell singular integrals

  - charged resonance

    IR/on-shell singular contributions extracted+Real

    →QED-like correction

  - neutral resonance

    photonic diagrams gauge invariant

- real photon emission

  phase space slicing/dipole subtraction

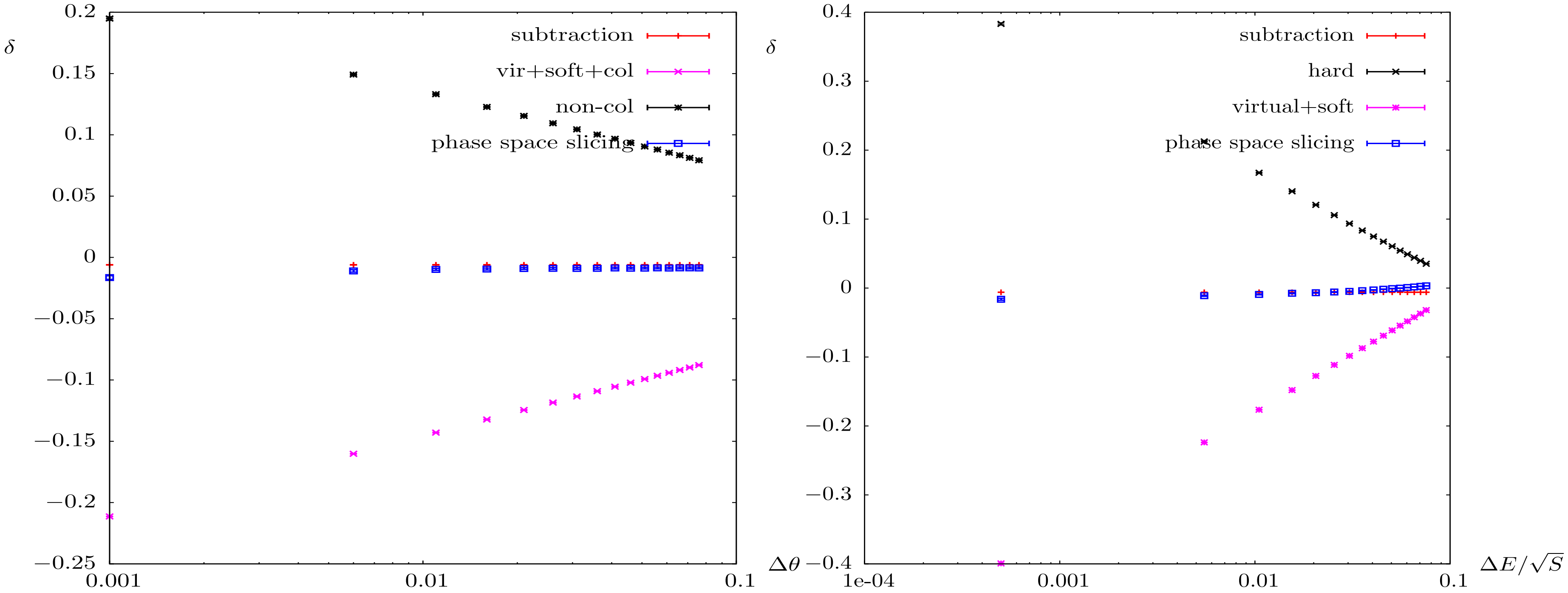
  analytical check of cancellation of soft singularities

Numerical results

QED-like correction to partial decay width of

$h^0 \to e^- \bar{\nu}_e \mu^+ \nu_\mu$

comparison of phase space slicing and subtraction

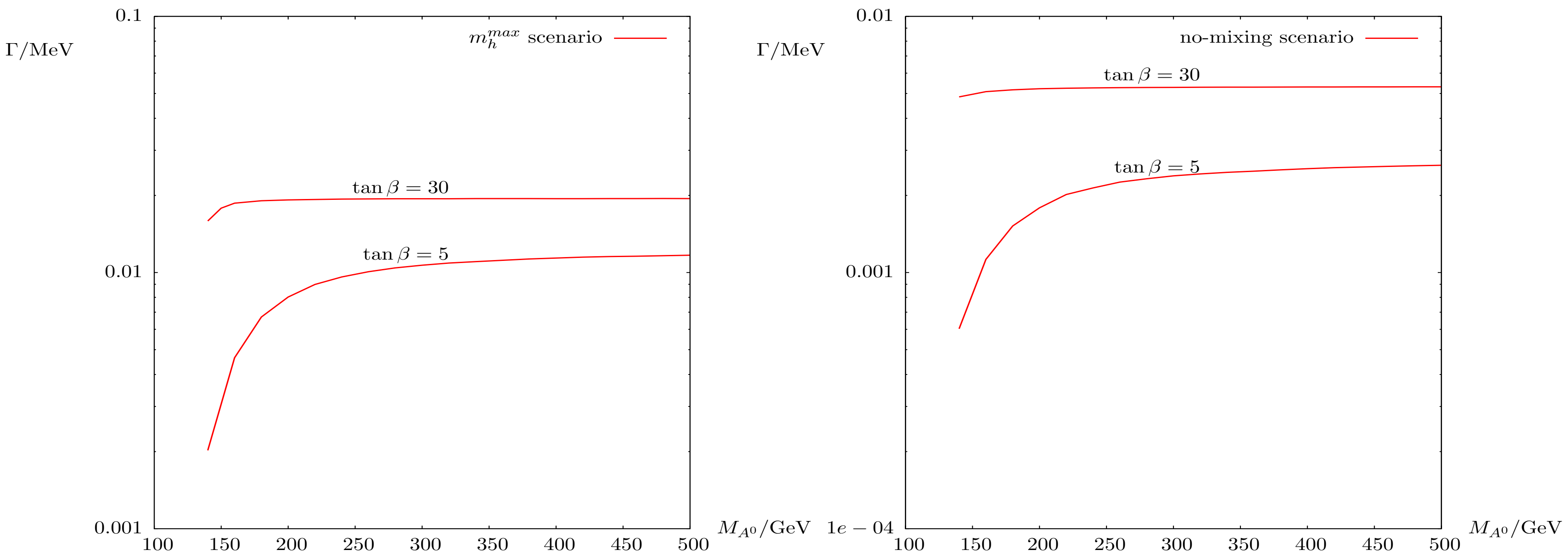


for m_h^{max} scenario, $\tan\beta = 30$, $M_{A^0} = 400$GeV

agreement between two approaches

Numerical results

partial decay width of $h^0 \to e^- \bar{\nu}_e \mu^+ \nu_\mu$

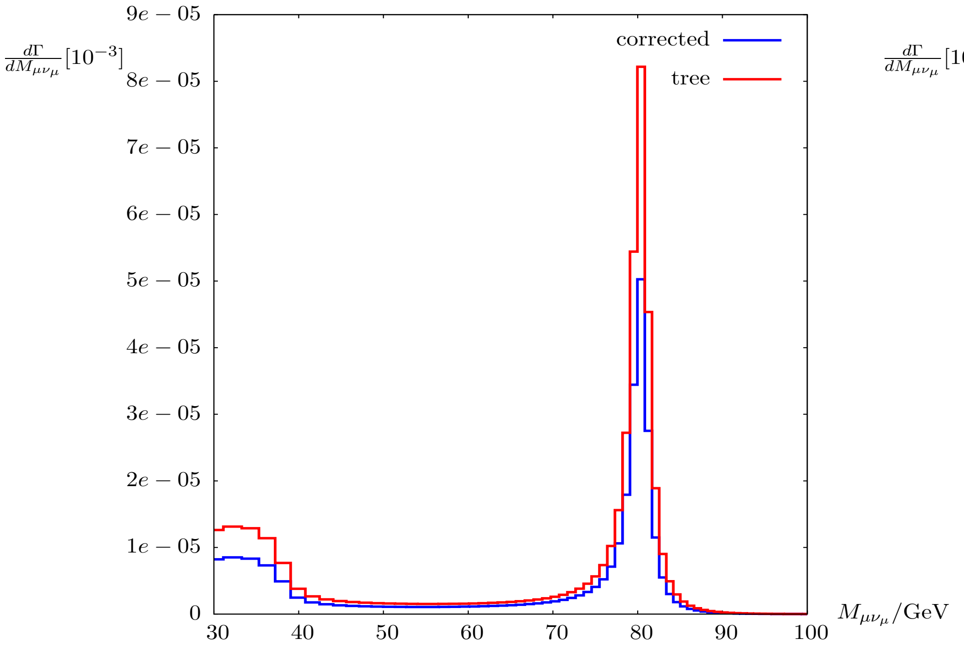


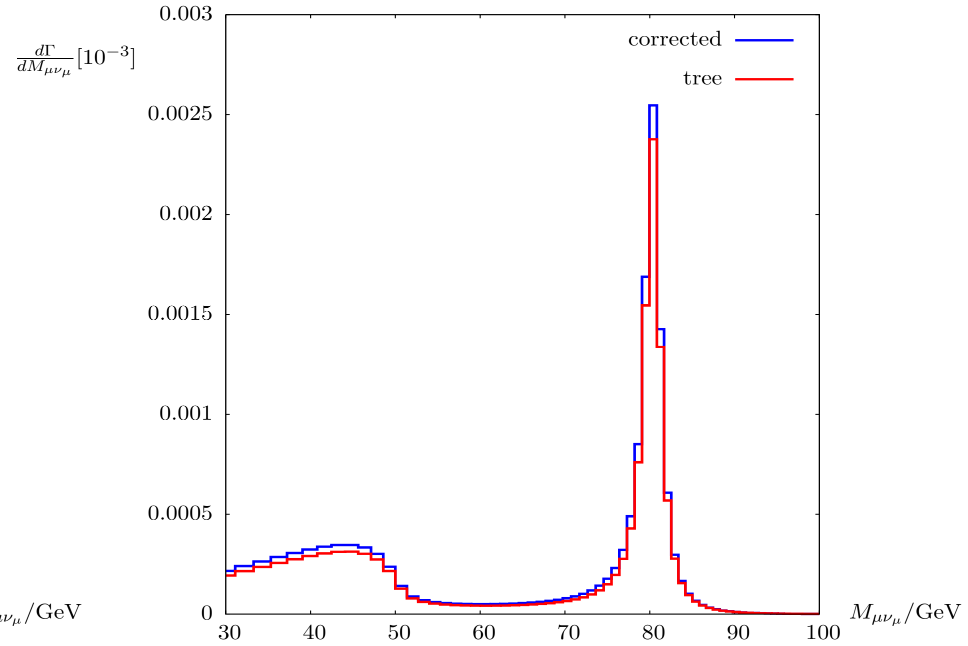
approach the value for SM Higgs of same mass for large M_{A^0},

for m_h^{max} scenario with $\tan\beta = 30$, difference $\sim 5\%$

Numerical results

invariant mass distribution of $h^0 \to e^- \bar{\nu}_e \mu^+ \nu_\mu$





for m_h^{max} scenario, with $\tan\beta = 30$, $M_{A^0} = 120/400$GeV

enhancement where the other gauge boson is resonant

mixing between Higgs bosons leads to negative corrections for the left, negligible for the right

Summary

- radiative corrections for $h^0 \to 4f$ needed for various reasons
- new features of MSSM Higgs bosons relevant
- RC can give rise to sizeable relative corrections
- to be finished; include light quarks in final state