

*ELW WG : THEORY PART
AND B FACTORIES*

Michael Spira (PSI)

Higher-order threshold corrections for single top quark production

Nikolaos Kidonakis

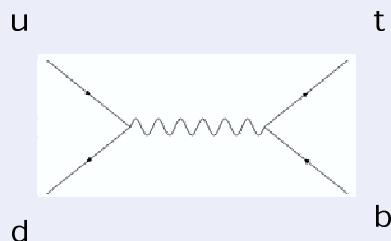
(Kennesaw State University)

- Single top production -
 t and s channels and tW production
- Threshold resummation
- NNNLO soft-gluon corrections
- Cross section at the Tevatron
- Cross section at the LHC

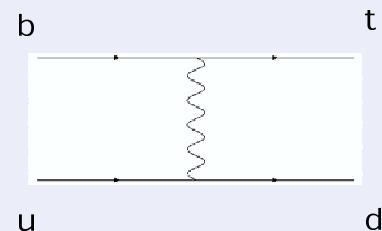
N. Kidonakis, Phys. Rev. D 74, 114012 (2006); D 75, 071501(R) (2007).

Total cross-sections

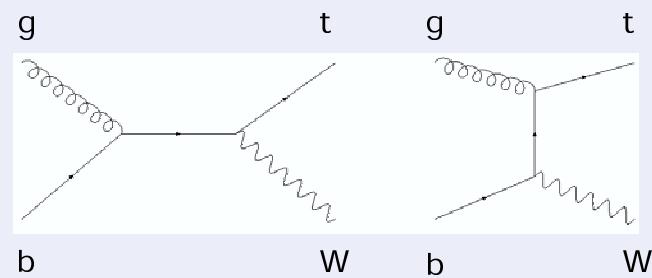
s-channel



t-channel



top-W associated production



dependence

s+t channel
 $\sigma = 4.9 \pm 1.4$ pb

Tevatron(pb)

Tevatron(pb) LHC(pb)

0.89

10

1.98

240

0.14

66

NLO soft gluon corrections

$$\frac{d^2\hat{\sigma}^{(1)}}{dt du} = F^B \frac{\alpha_s(\mu_R^2)}{\pi} \left\{ c_3 \left[\frac{\ln(s_4/m_t^2)}{s_4} \right]_+ + c_2 \left[\frac{1}{s_4} \right]_+ + c_1^\mu \delta(s_4) \right\}$$

$$c_3^{ts} = 3C_F \text{ and } c_3^{tW} = 2(C_F + C_A), c_2^s = -\frac{7}{4}C_F + 2C_F \ln \left(\frac{s(s-m_t^2)}{(t-m_t^2)(u-m_t^2)} \right) - 2C_F \ln \left(\frac{\mu_F^2}{m_t^2} \right), \dots$$

NNLO soft gluon corrections

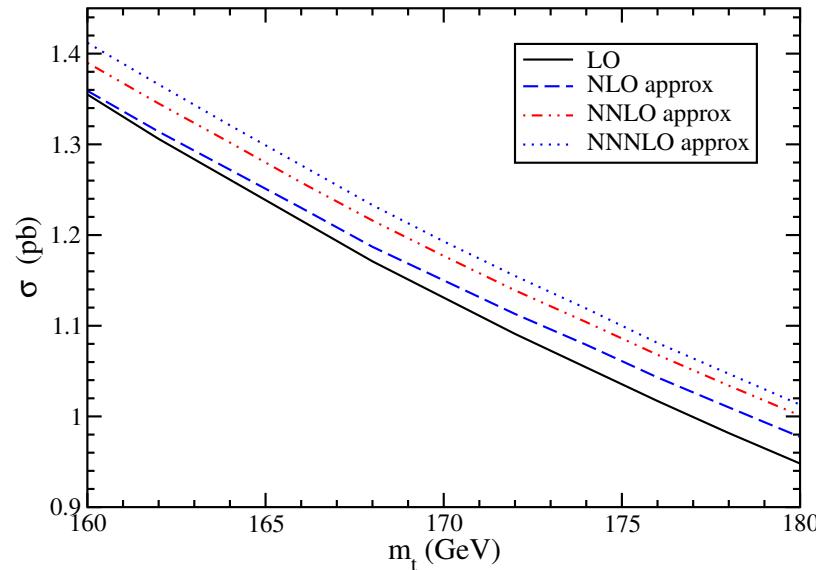
$$\frac{d^2\hat{\sigma}_{t,s}^{(2)}}{dt du} = F^B \frac{\alpha_s^2(\mu_R^2)}{\pi^2} \left\{ \frac{1}{2} c_3^2 \left[\frac{\ln^3(s_4/m_t^2)}{s_4} \right]_+ + \left[\frac{3}{2} c_3 c_2 - \frac{\beta_0}{4} c_3 + C_F \frac{\beta_0}{8} \right] \left[\frac{\ln^2(s_4/m_t^2)}{s_4} \right]_+ \dots \right\}$$

NNNLO soft gluon corrections

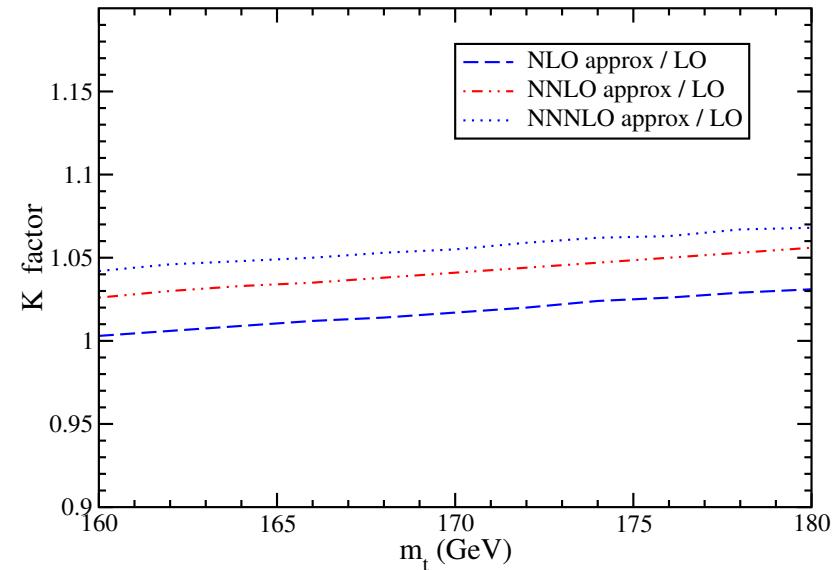
$$\frac{d^2\hat{\sigma}^{(3)}}{dt du} = F^B \frac{\alpha_s^3(\mu_R^2)}{\pi^3} \left\{ \frac{1}{8} c_3^3 \left[\frac{\ln^5(s_4/m_t^2)}{s_4} \right]_+ + \left[\frac{5}{8} c_3^2 c_2 - \frac{5}{48} \beta_0 c_3 (2c_3 - C_F) \right] \left[\frac{\ln^4(s_4/m_t^2)}{s_4} \right]_+ \dots \right\}$$

Single top production at the Tevatron - t channel

Single top at Tevatron t -channel $S^{1/2}=1.96$ TeV $\mu=m_t$



Single top at Tevatron t -channel $S^{1/2}=1.96$ TeV $\mu=m_t$



t channel	LO	NLO approx	NNLO approx	NNNLO approx
$m_t = 170$	1.131	1.150	1.177	1.193
$m_t = 172$	1.091	1.113	1.139	1.155
$m_t = 175$	1.035	1.060	1.085	1.100

Single top production at the LHC - t channel

Threshold corrections not a good approximation of full QCD corrections

Exact NLO cross section

$$\sigma_{\text{top}}^{t\text{-channel}}(m_t = 170 \text{ GeV}) = 152 \pm 5 \pm 3 \text{ pb} = 152 \pm 6 \text{ pb}$$

↑ ↑
scale pdf

$$\sigma_{\text{top}}^{t\text{-channel}}(m_t = 175 \text{ GeV}) = 146 \pm 4 \pm 3 \text{ pb} = 146 \pm 5 \text{ pb}$$

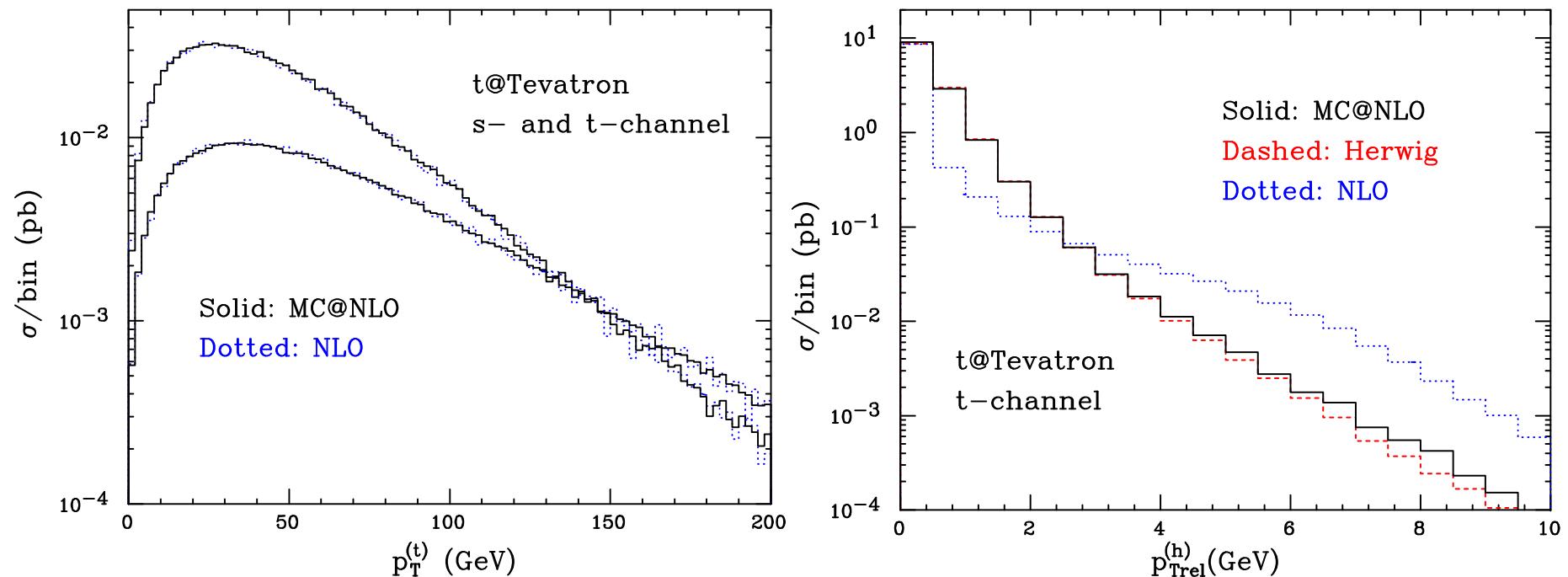
↑ ↑
scale pdf

SINGLE TOP PRODUCTION AND DECAY IN MC@NLO

Patrick Motylinski

NIKHEF

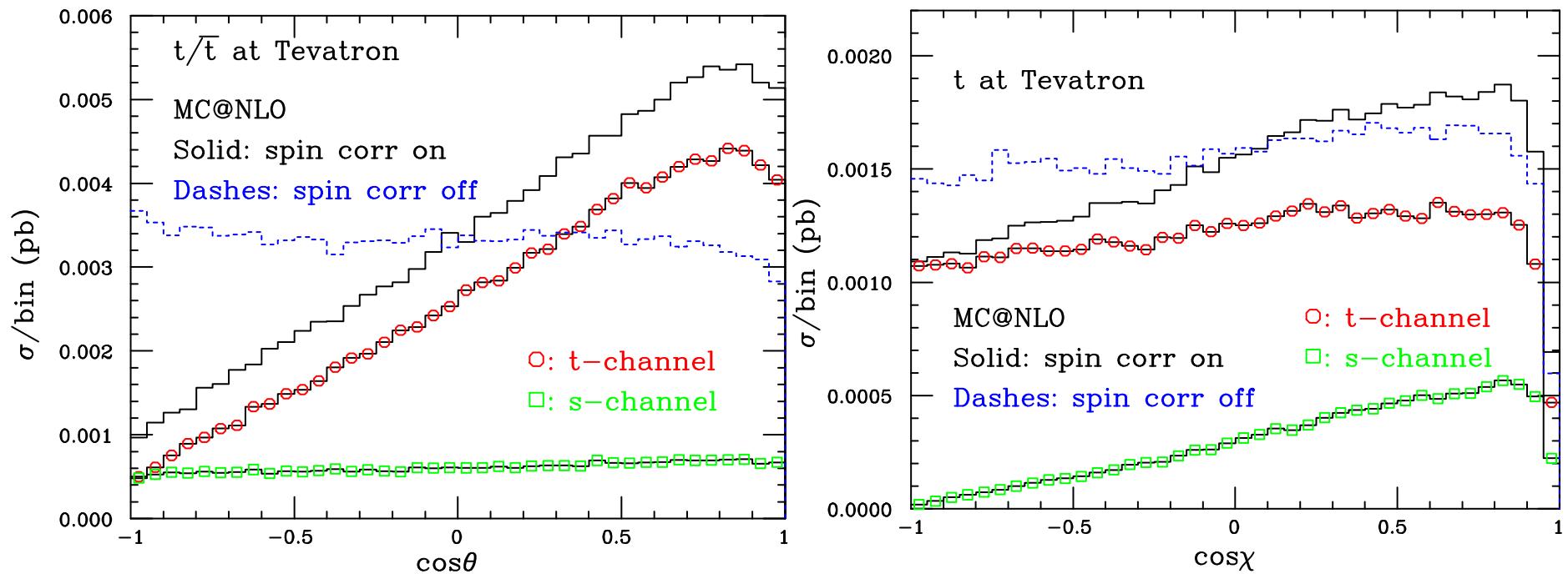
DIS Munich, April 18th, 2007



Left: p_T of the top quark

Right: p_T of particles included in the jet relative to the axis of the jet.

EFFECTS OF SPIN CORRELATIONS



where

θ is the angle between the direction of flight of the lepton (from top decay) and the hardest non- b jet

χ is the the angle between the direction of flight of the lepton (from top decay) and the anti-proton beam.

SINGLE TOP STUDIES WITH MCFM

F. Tramontano

Università di Napoli "Federico II"

and INFN sezione di Napoli

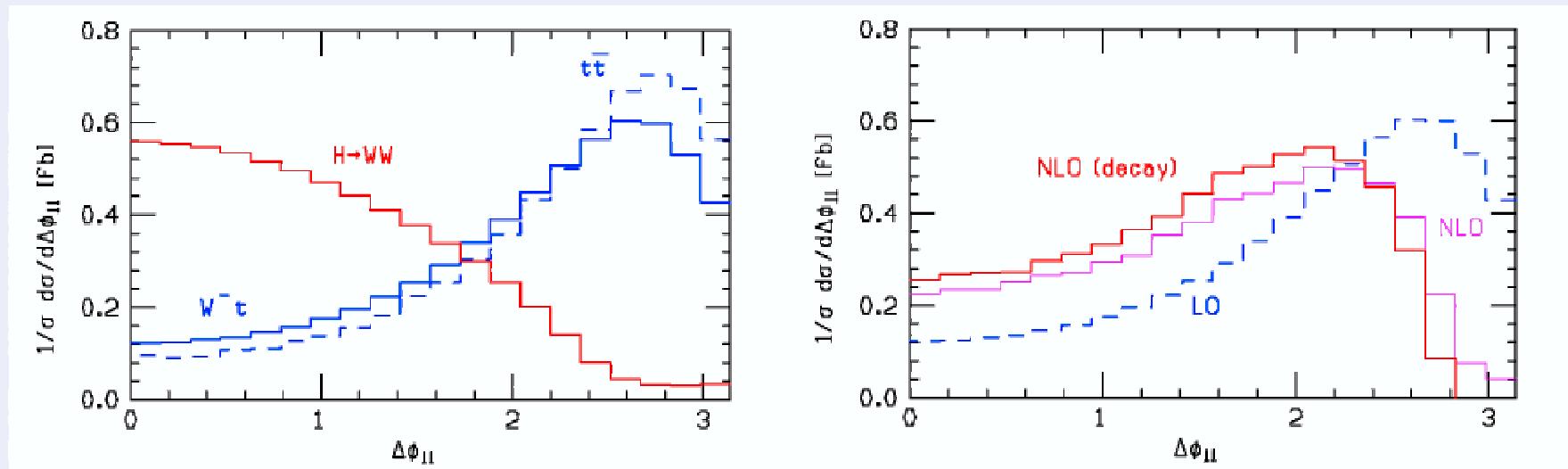
in collaboration with J. Campbell and R.K. Ellis

Munich

DIS 2007

- At the LHC the Wt channel has a total rate of 66 pb that is larger than the s -channel (10 pb)
- For $150 < m_H < 180$ Wt associated production is an important source of background for $H \rightarrow WW^*$ discovery channel
 - WW from the continuum is the main background
 - $t\bar{t}$ and Wt are large and comparable

Angle between the leptons in the transverse plane



LHC

*NLO introduce important
modification for this distribution*

Impact of new PDF sets on searches at the LHC

C.-P. Yuan

Michigan State University

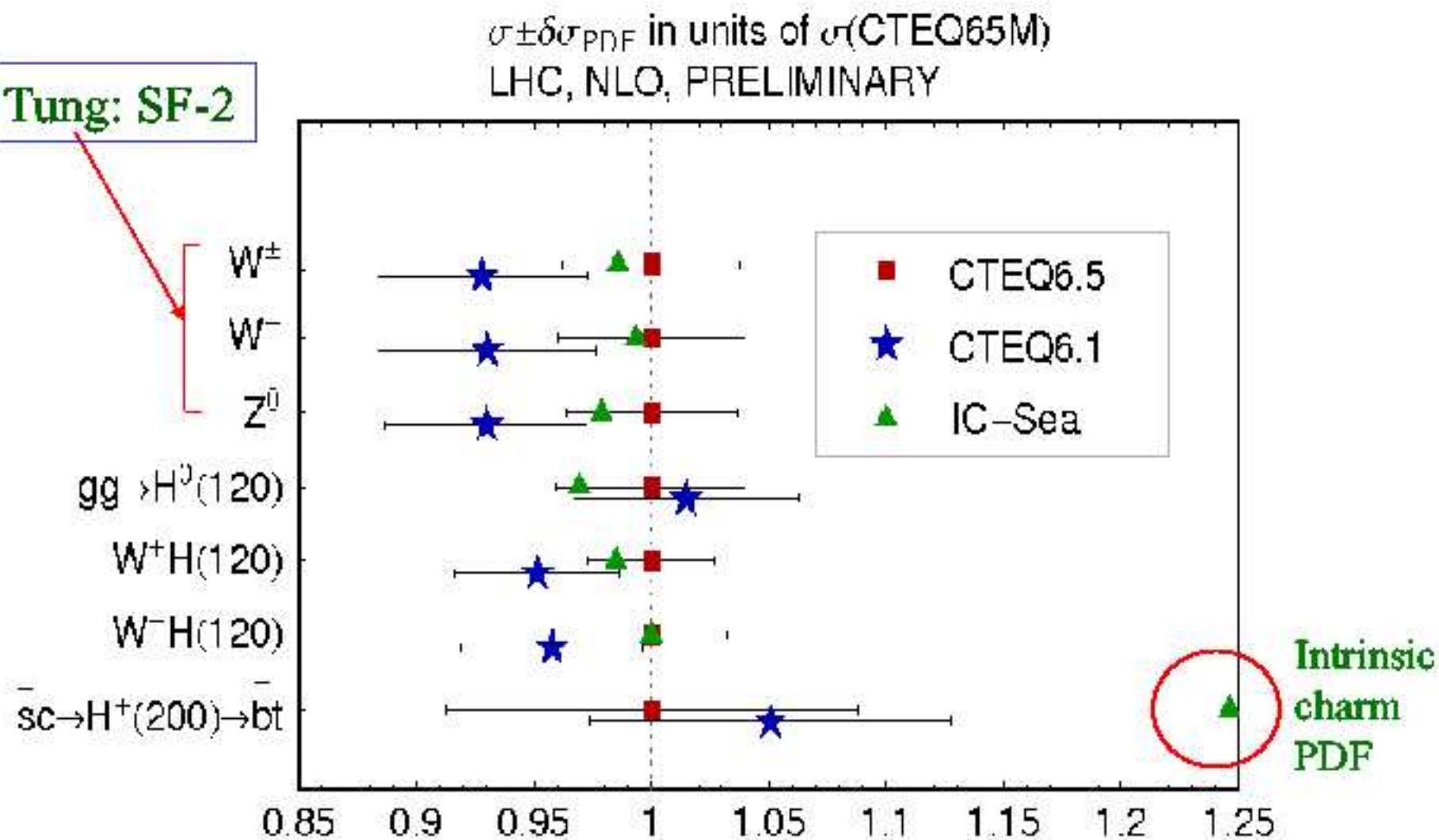
April 18, 2007 @ DIS 2007

Impact of new CTEQ6.5 (M,S,C) PDFs to

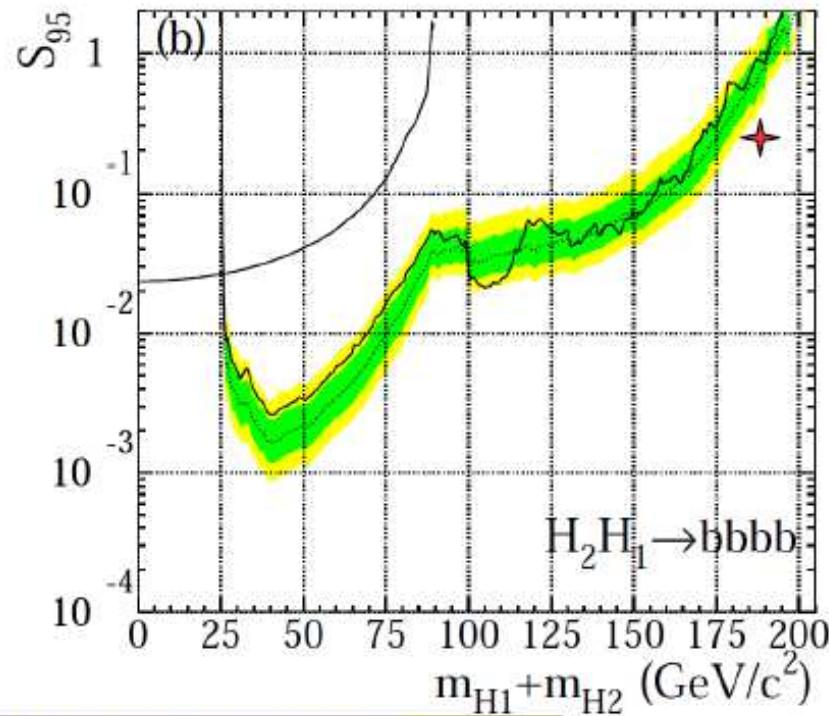
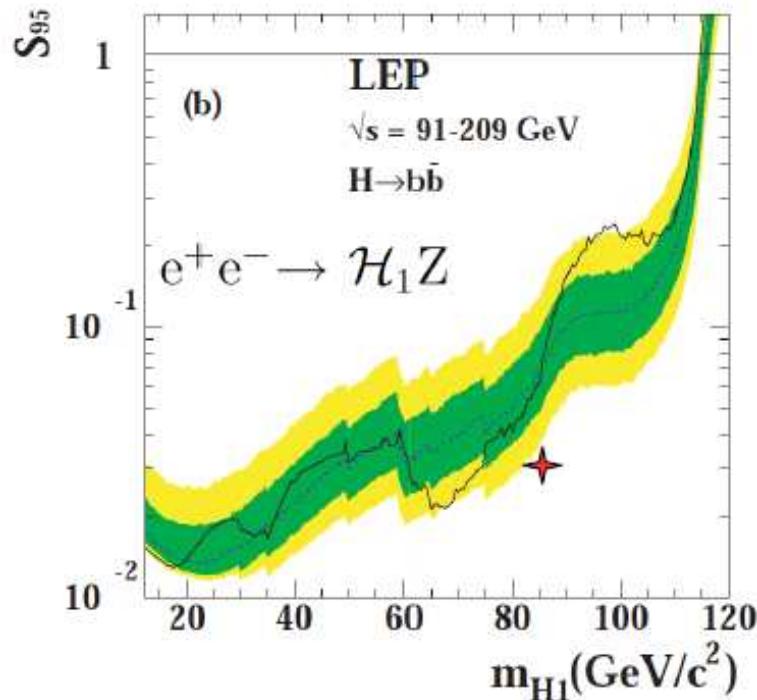
- SM processes: W , Z , top, Higgs
- hH^+ and AH^+ productions in **MSSM** (Light Higgs Scenario)
- s-channel H^+ production in **TopColor** and **MSSM**

Impact of CTEQ6.5M,S,C PDF's on σ_{tot} 's at LHC

Tung: SF-2



The LHS Sample Point (CP conserving case)



$\tan \beta$	M_H^+	μ	A_t	M_1/M_2	M_3	M_Q
40	130	600	600	100/200	300	300

$$M_h/M_A/M_H = 84/101/120 \text{ GeV}$$

$$Br(h/A/H \rightarrow b\bar{b}) = 0.71/0.70/0.62$$

$$g_{ZZh}^2 = 0.05, g_{ZZH}^2 = 0.94, M_{\chi_1^+} = 196 \text{ GeV}, M_{\tilde{t}_1} = 138 \text{ GeV}$$

$$\Delta\rho = 0.9 \times 10^{-3}, Br(b \rightarrow s\gamma) = 2.9 \times 10^{-4}$$

$$\sigma_{Zh}/\sigma_{Zh}^{exp} = 0.04, \sigma_{Ah}/\sigma_{Ah}^{exp} = 0.4$$

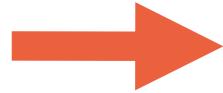
Summary

- New CTEQ6.5 (M,S,C) PDFs impact collider Phenomenology at the LHC/Tevatron
- hH^+ and AH^+ associated productions should be measured at the LHC / Tevatron



To test Light MSSM Higgs boson scenario (LHS)

- s-channel Charged Resonances in TopColor and **MSSM**



Can modify single-top production rates
and decay distributions



Ulrich Haisch
Universität Zürich

DIS 2007
Munich, April 18th 2007

How To Kill a Penguin

CMFV parameters

K - \bar{K} mixing ($|\epsilon_K|$)

$B_{d,s}$ - $\bar{B}_{d,s}$ mixing ($\Delta M_{B_{d,s}}$)

$K \rightarrow \pi\nu\bar{\nu}, \bar{B} \rightarrow X_{d,s}\nu\bar{\nu}$

$K_L \rightarrow \mu^+\mu^-, B_{d,s} \rightarrow \mu^+\mu^-$

$K_L \rightarrow \pi^0\ell^+\ell^-$

$\epsilon'/\epsilon, |\Delta S| = 1$

non-leptonic $|\Delta B| = 1$

$\bar{B} \rightarrow X_s\gamma$

$\bar{B} \rightarrow X_sg$

$\bar{B} \rightarrow X_s\ell^+\ell^-$

dominated by **Z-penguin**

$S(v)$

$S(v)$

$X(v)$

$Y(v)$

$$X(v) = C(v) + B^{\nu\nu}(v)$$

$$Y(v) = C(v) + B^{\ell\ell}(v)$$

$$Z(v) = C(v) + \frac{1}{4}D(v)$$

$Y(v), Z(v), E(v)$

$X(v), Y(v), Z(v), E(v)$

$X(v), Y(v), Z(v), E(v), E'(v)$

$D'(v), E'(v)$

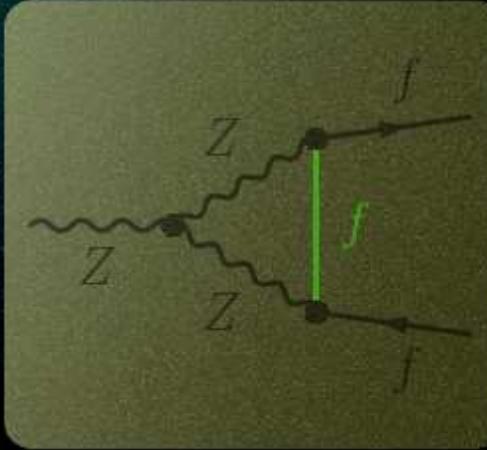
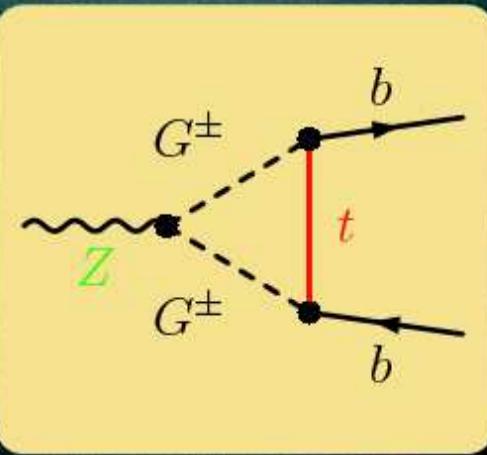
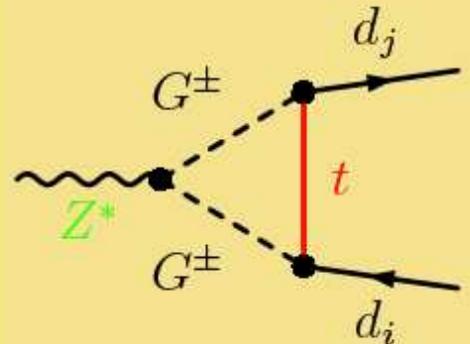
$E'(v)$

$Y(v), Z(v), E(v), D'(v), E'(v)$

drop as $\mathcal{O}(10^{-2})$

trade for $C_7^{\text{eff}}(\mu_b)$

Idea: $Z \rightarrow d_{iL} \bar{d}_{jL} \equiv Z \rightarrow b_L \bar{b}_L$



$$\Gamma_{ji} \propto V_{tj}^* V_{ti} \mathcal{C}(q^2) \bar{d}_{jL} Z d_{iL}$$

$$\delta \mathcal{C} = 1 - \frac{\text{Re } \mathcal{C}(q^2 = 0)}{\text{Re } \mathcal{C}(q^2 = M_Z^2)}$$

$Z \rightarrow d_{iL} \bar{d}_{jL}$: $\mathcal{C}(q^2 = 0)$

$Z \rightarrow b_L \bar{b}_L$: $\mathcal{C}(q^2 = M_Z^2)$

is there a general argument that shows that $\delta \mathcal{C}$ is small?

Conclusions & Outlook

- Large CMFV contributions to $Z \rightarrow d_{iL} \bar{d}_{jL}$ excluded by LEP and SLC measurements of POs R_b^0, A_b & $A_{FB}^{0,b}$
- Are there other correlations in quark sector?
 $b \rightarrow s\gamma$ vs. $b \rightarrow b\gamma^*$, ...
- Are there correlations in lepton sector assuming minimal lepton flavor violation?
 $\mu \rightarrow e\gamma$ vs. $(g-2)_\mu^*$, ...
- Despite 5 meetings @ CERN[†] interplay between flavor & collider physics largely unexplored

*these probably don't work

[†]<http://mlm.home.cern.ch/mlm/FlavLHC.html>

R.I.P. Large Destructive CMFV Z-Penguin!



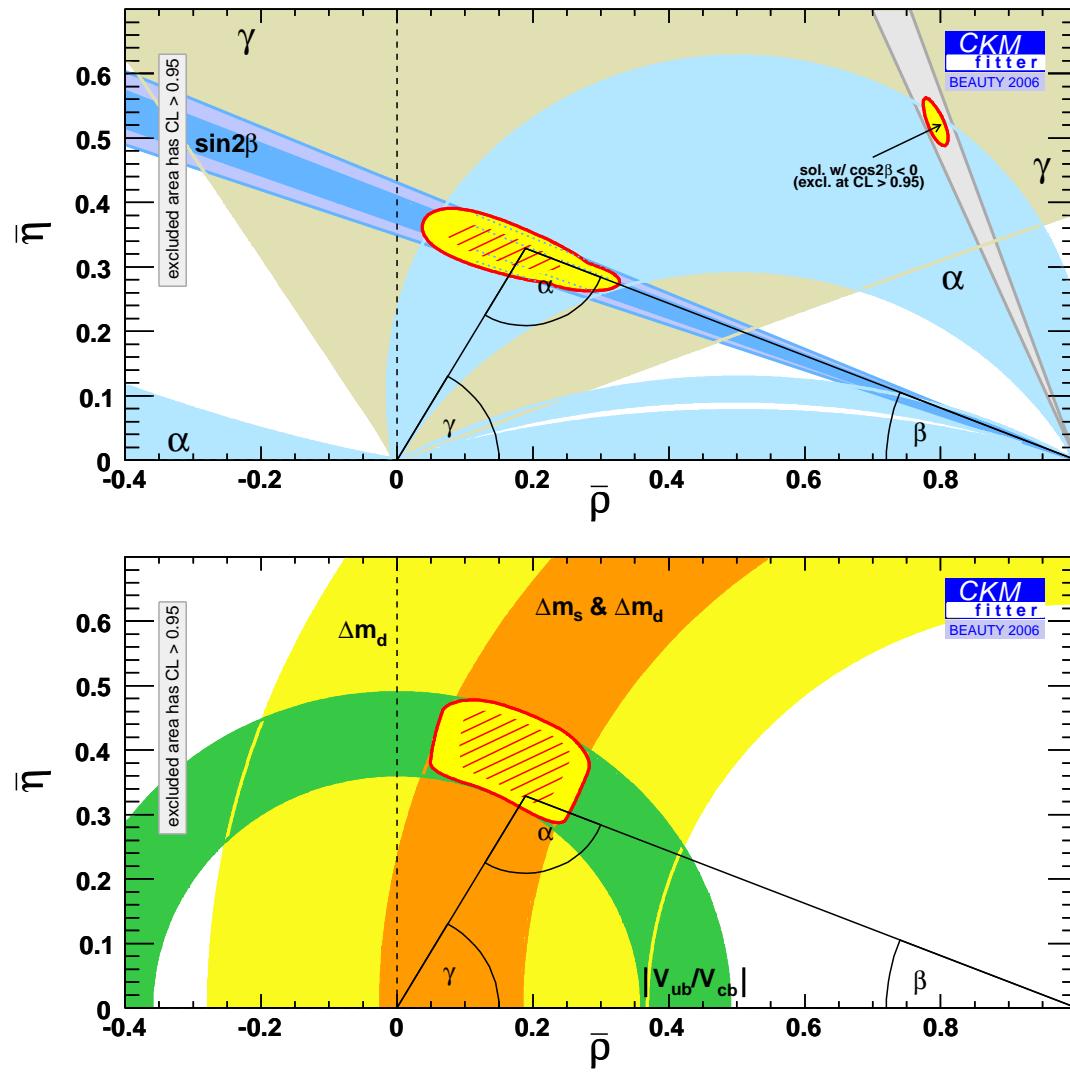
CKM sides @ B factories

XV international Workshop on DIS

München, Germany, 15-20.Apr 2007

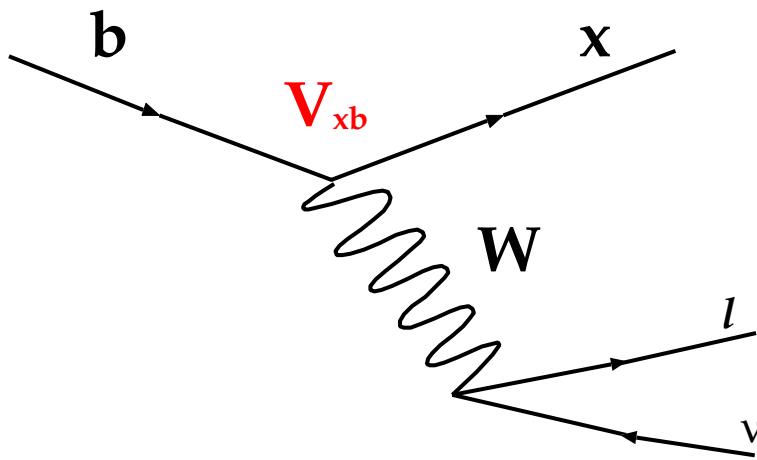
中村 勇 (Nakamura Isamu) / KEK

Introduction にかえて



- Precise Determination of $|\mathcal{V}_{ub}/\mathcal{V}_{cb}|$ is important for the test of CKM mechanism

Measurement of V_{xb}



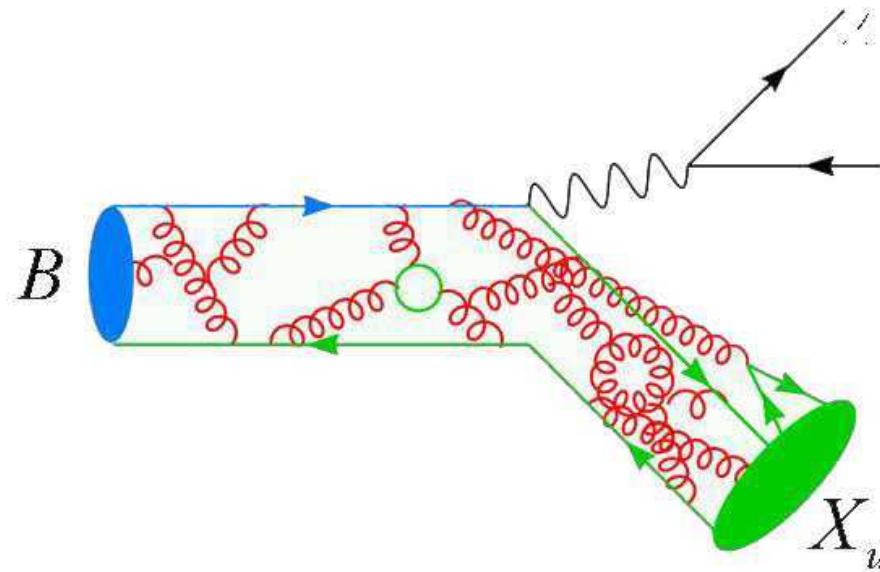
- Measurement is very straightforward, use a relation

$$\Gamma(b \rightarrow x \ell^- \bar{\nu}) = \frac{G_F^2}{192\pi^2} |V_{xb}|^2 m_b^5 \left(1 + \text{補正項}\right)$$

- Only need to count the number of $b \rightarrow x \ell^- \bar{\nu}$ events, however in reality

Measurement of V_{xb}

- In reality,



- To get 補正項, we have to know structure of B meson
 - ◊ In inclusive case
⇒ OPE, b and c quark masses
 - ◊ in exclusive case
⇒ form factors

纏め

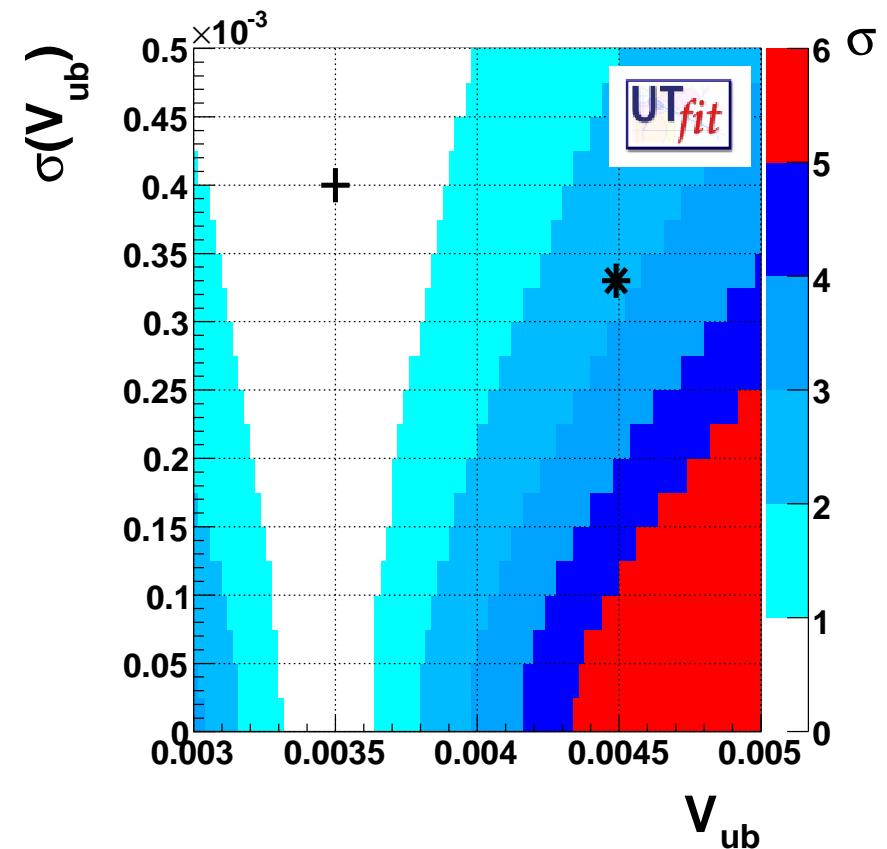
- Summary of the Measurement

	$ V_{cb} (10^{-3})$	$ V_{ub} (10^{-3})$
Exclusive	39.4 ± 1.6	4.0 ± 0.6
Inclusive	41.5 ± 0.6	4.5 ± 0.3

- Good consistency

- ◊ Different schemes
- ◊ Different Theories

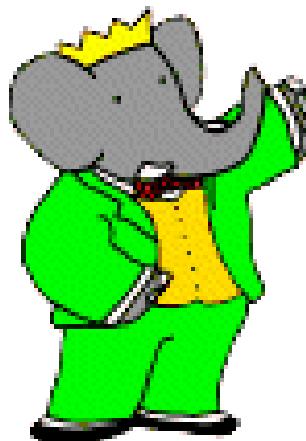
- Some says inconsistency between inclusive and exclusive $|V_{ub}|$
- Need both experimental and theoretical effort for more Precision



Measurement of CKM angles at BaBar and Belle

Nick Barlow

University of Manchester/
University of Cambridge



DIS 2007

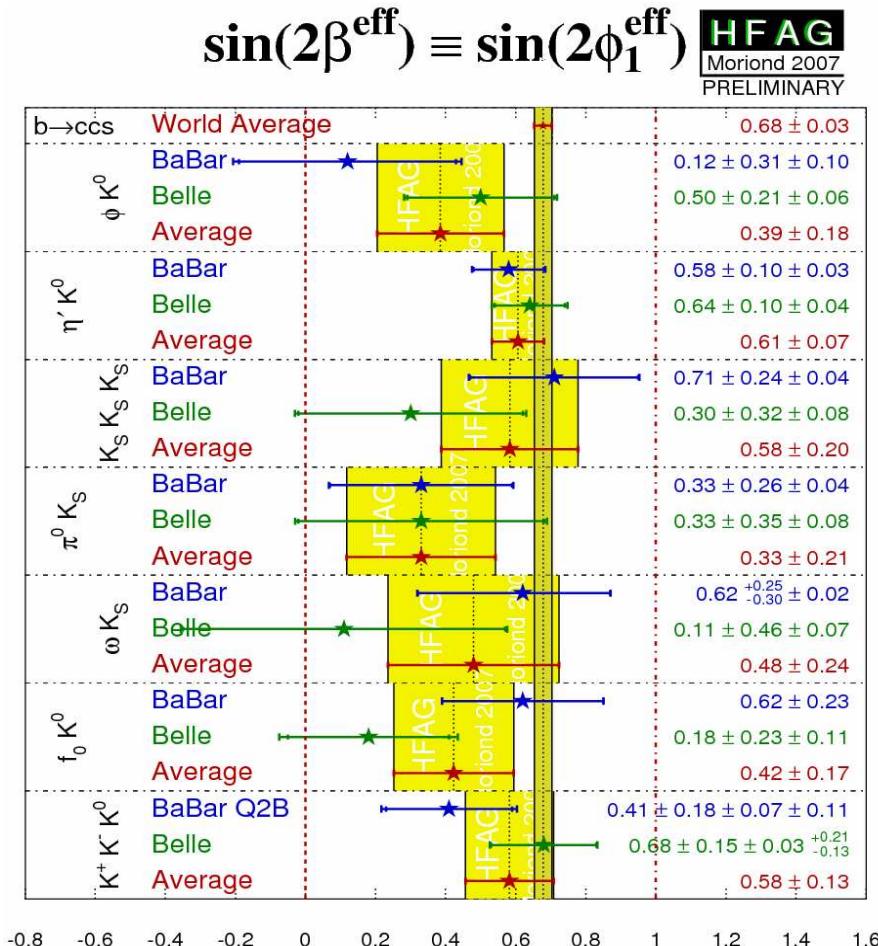


Contents

- CKM matrix and Unitarity Triangle
- Time-dependant analysis at the B factories
- Measurement of β (ϕ_1)
 - $b \rightarrow c\bar{c}s$ decays ($B \rightarrow c\bar{c} K^0$)
 - $b \rightarrow c\bar{c}d$ decays (e.g. $B \rightarrow D\bar{D}$)
 - $b \rightarrow s$ penguin-dominated decays (e.g. $B \rightarrow \phi K^0$)
- Measurement of α (ϕ_2)
 - $B \rightarrow \pi\pi$
 - $B \rightarrow \rho\rho$
- Measurement of γ (ϕ_3)
 - $B \rightarrow D\bar{K}$
- Conclusions

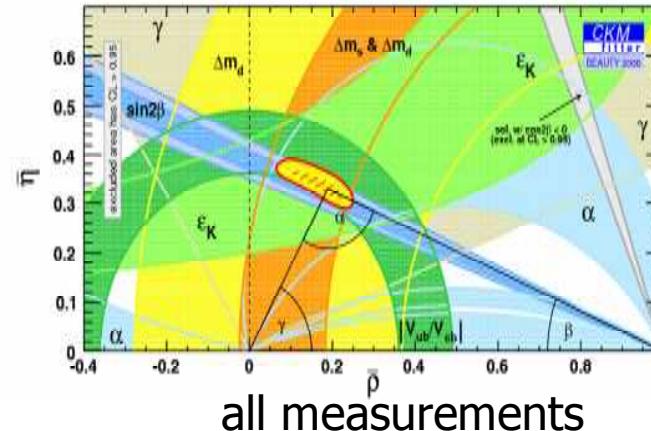
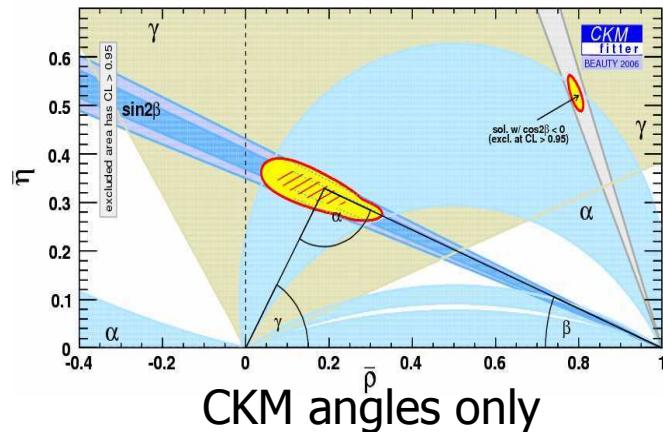
Summary of β with $b \rightarrow s$ penguins

- In general, values of $\sin 2\beta$ from penguin-dominated modes are smaller than that from $b \rightarrow c\bar{c}s$
- Some theoretical uncertainties, but these tend to lead us to expect a shift in the other direction
- Shift is not yet statistically significant, but both experiments are expected to double their data samples by summer 2008



Conclusions

- $\beta(\phi_1)$: uncertainty $\sim 1^\circ$
 - Precision measurement in $B \rightarrow$ charmonium decays
 - $b \rightarrow s$ penguins are a promising place to look for new physics
 - $\alpha(\phi_2)$: uncertainty $\sim 10^\circ$
 - B factories are just now getting sufficient data for branching fraction measurements of all $B \rightarrow \pi\pi$ and $B \rightarrow pp$ channels
 - $\gamma(\phi_3)$: uncertainty $\sim 30^\circ$
 - Used to be considered beyond the reach of B factories
 - Lots of clever phenomenology work means there is potential for some useful constraint on (ρ, η) plane by the end of the B factories





τ Physics at the B-Factories

Hisaki Hayashii

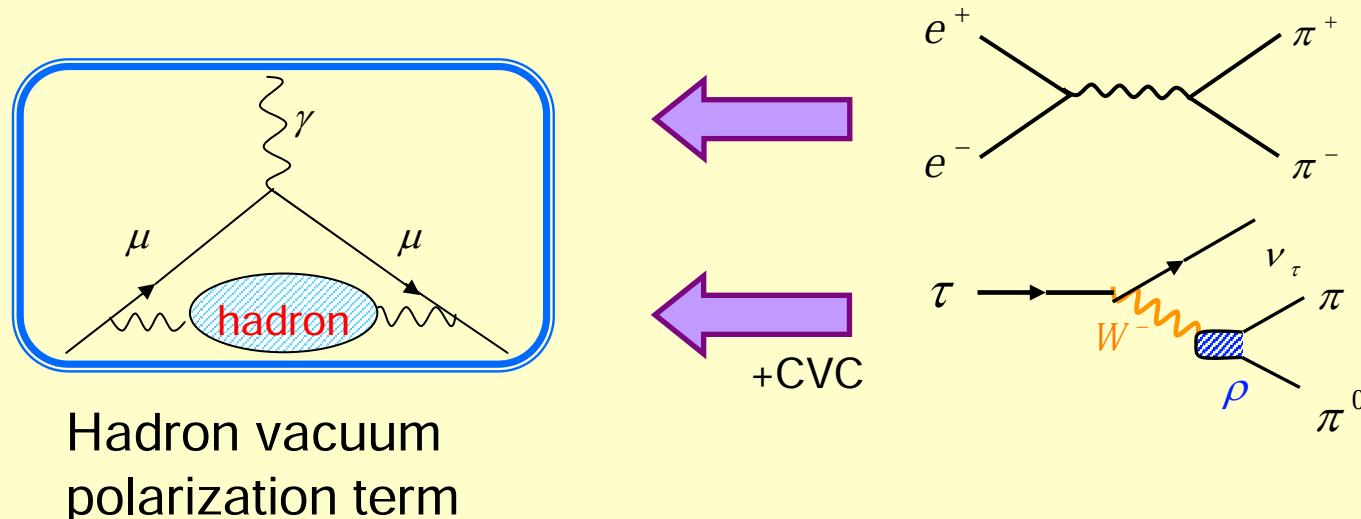
Nara, Japan

DIS07

2007/April/16-20, Munich, Germany

Motivation: $\tau^- \rightarrow \pi^-\pi^0\nu_\tau$ and $a_\mu = (g_\mu - 2)/2$

- It is known that hadronic vacuum polarization (h.v.p.) term plays an important role in the theoretical calculation of the muon anomalous magnetic moment. $a_\mu = (g_\mu - 2)/2$
- The dominant part of the h.v.p. term can be evaluated from the 2π spectral function measured with e^+e^- or τ^- -data.
- Recent data indicate that there is a systematic difference in the 2π system between e^+e^- reaction and τ^- -decays.



$a_\mu(2\pi)$ from Belle τ data

$$a_\mu(2\pi) = 457.2 \pm 1.0_{\text{SF}} \pm 2.3_{\text{BR}} \pm 2.3_{\text{SU}(2)} \times 10^{-10}$$

$$m_{\pi\pi}^2 \geq 0.25 \text{ GeV}^2$$

✓ Most precise on structure function (SF) measurement

✓ Consistent with previous τ data.

SF: structure function error, BR: Br error

SU(2):SU(2) breaking correction error

c.f.

τ and e^+e^- data are different yet

- τ (ALEPH, CLEO)

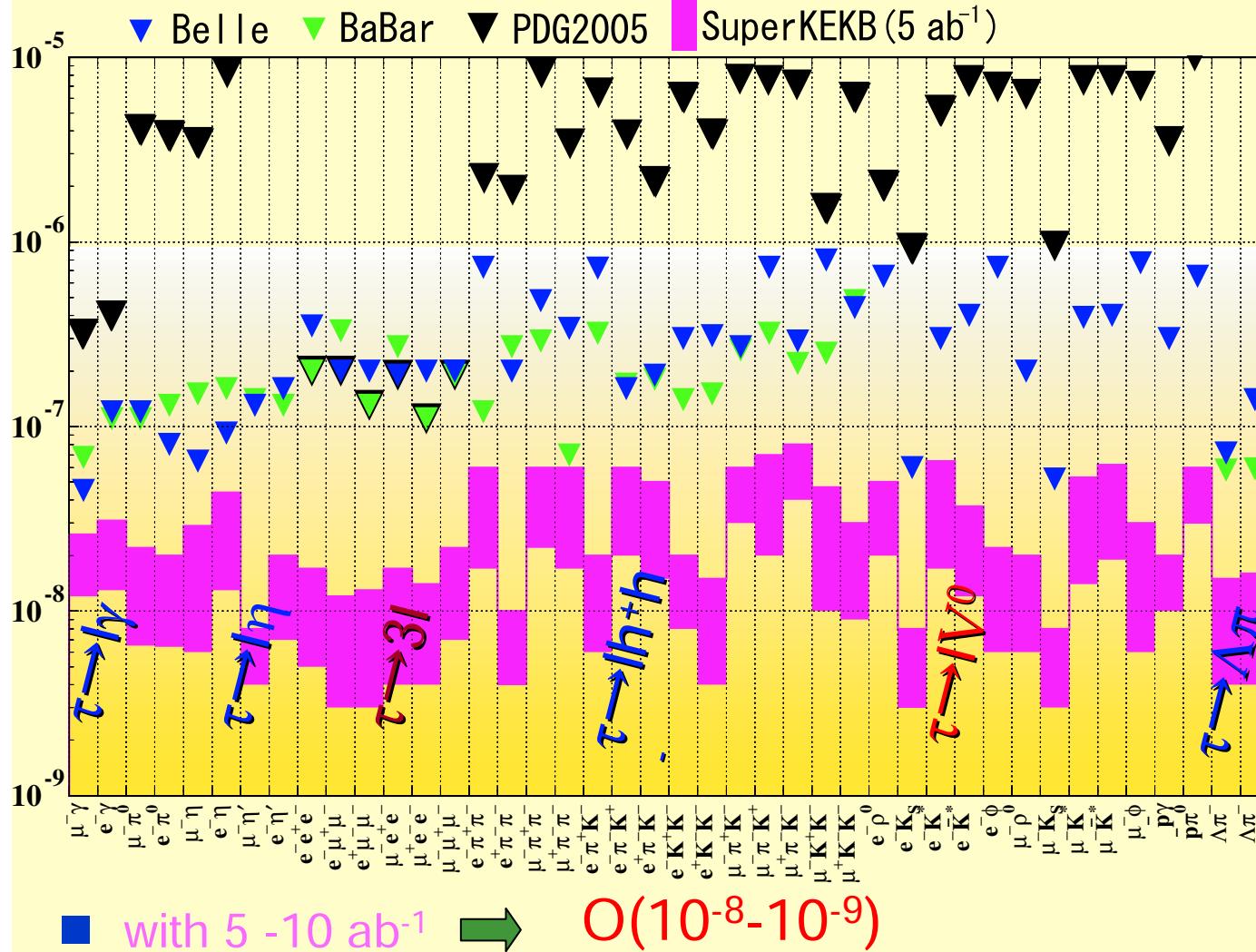
$$a_\mu(2\pi) = 464.0 \pm 2.2_{\text{SF}} \pm 2.3_{\text{BR}} \pm 2.3_{\text{SU}(2)}$$

- e^+e^- (CMD2)

Ref. Eur.Phys.C27,497(2003)

$$a_\mu(2\pi) \approx 440.8 \pm 4.9 \pm 1.6_{\text{rad}}$$

LFV searches: Summary



CLEO

Belle/Babar

Achieving $<10^{-7}$ with full sample

Super-B

■ with 5 -10 ab⁻¹

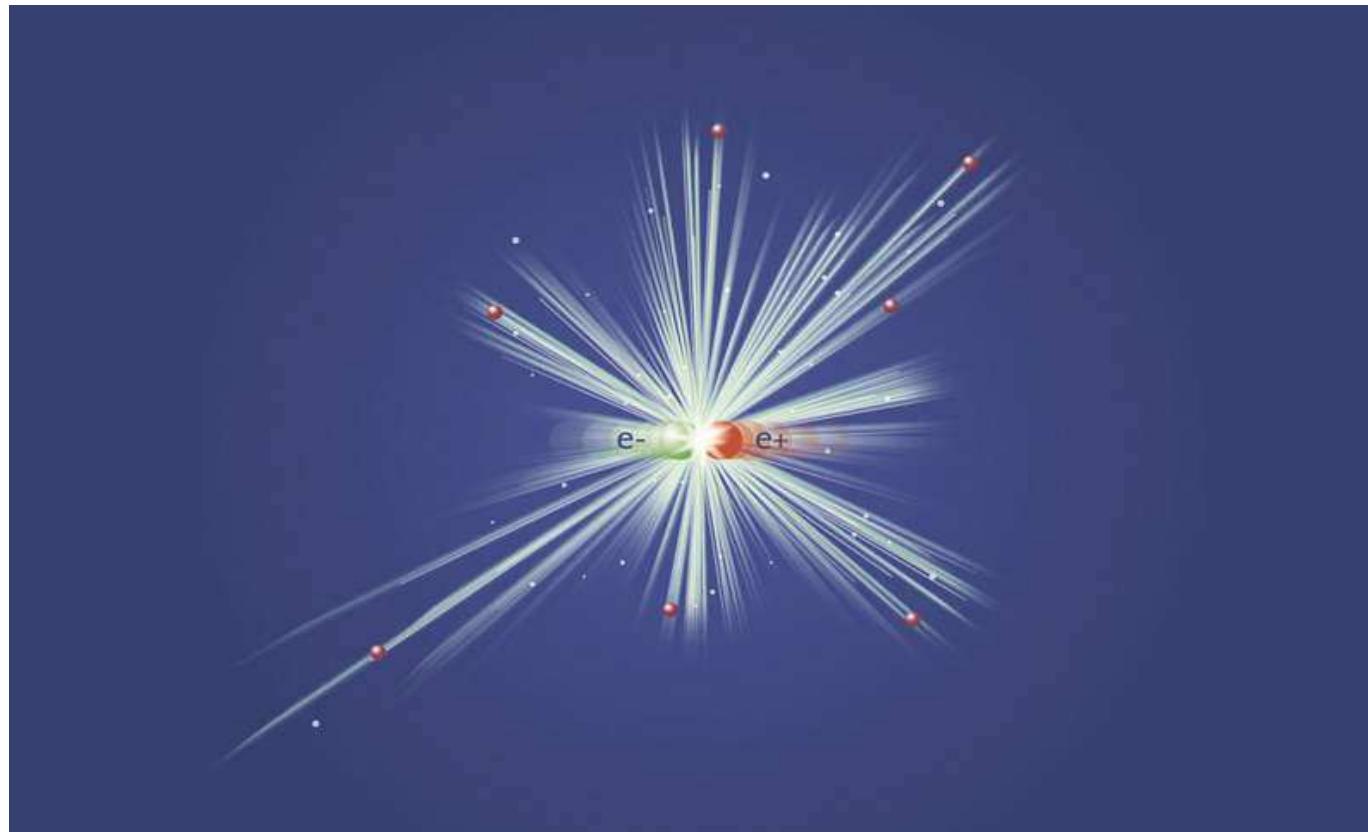
$O(10^{-8}-10^{-9})$

Summary



- B-factories (Belle & Babar) has recorded $10^9 \tau$ -decays which are now under analysis.
- Big advantage in statistical accuracy and searches for rare modes.
- Lepton universality holds. New measurements on M_τ , τ_τ .
- Upper limit on $|M_{\tau+} - M_{\tau-}|/M_\tau$ is 2.8×10^{-4} at 90% C.L.
(10 times improvement of the previous results.)
- Precise $|F_\pi|^2$ is measured in 2π decay. Problems with CVC still exist
- First observation of τ decay including ϕ – meson is made.
$$Br(\tau \rightarrow \phi K \bar{\nu}) = (4.0 \pm 0.25 \pm 0.26) \times 10^{-5}$$
Three Kaon modes are best place for neutrino-mass measurement up to 1MeV order.
- Sensitivity of LFV searches better than 10^{-7} .
The most stringent limit is
$$Br(\tau^- \rightarrow \mu^- \gamma) < 1.6 \times 10^{-8}$$
 (Belle+Babar comb.)
 - Exploring possible parameter space of New Phys.

ILC Physics Prospects



*Alexei Raspereza, MPI for Physics, Munich
DIS'07 Conference 18/04/2007 Munich*

Decay Independent Higgs Detection

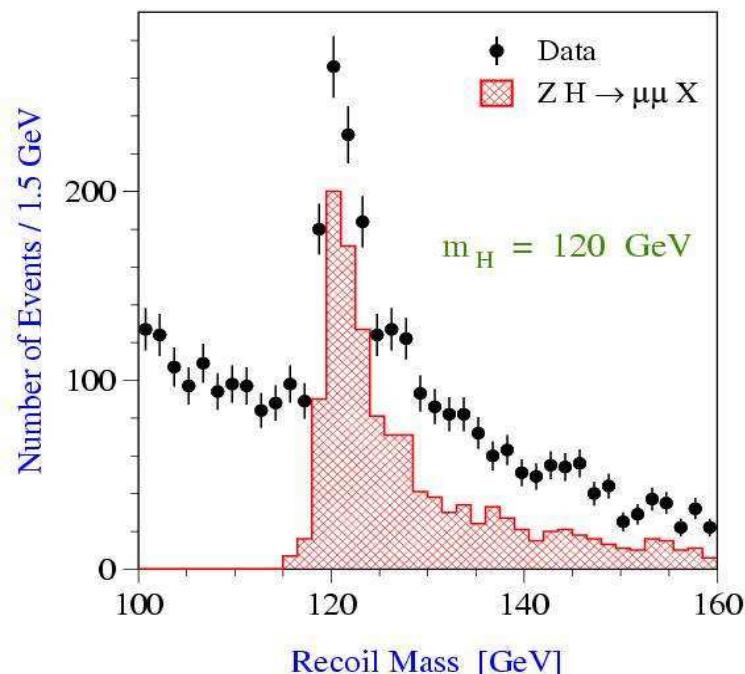
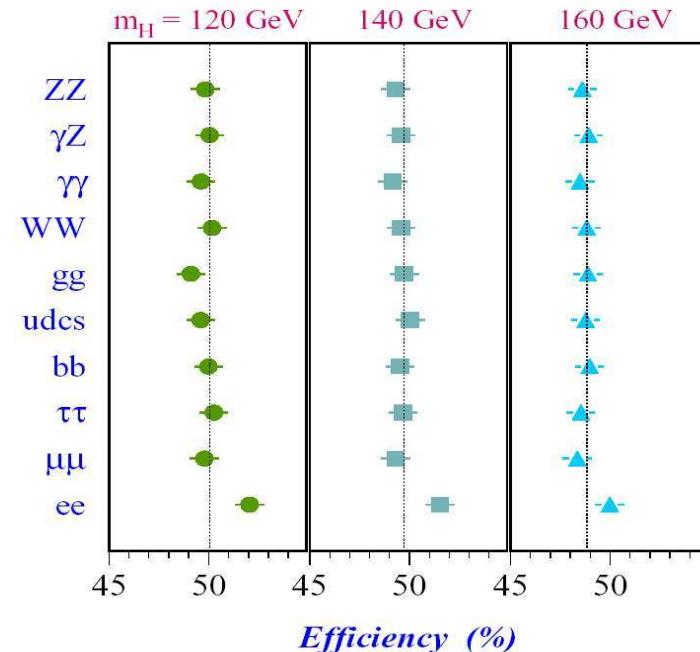
At ILC Higgs boson can be detected independent of its decay mode, even if it decays into invisible particles $H \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0$

ILC „golden“ channel : $ZH \rightarrow (ee, \mu\mu)X$

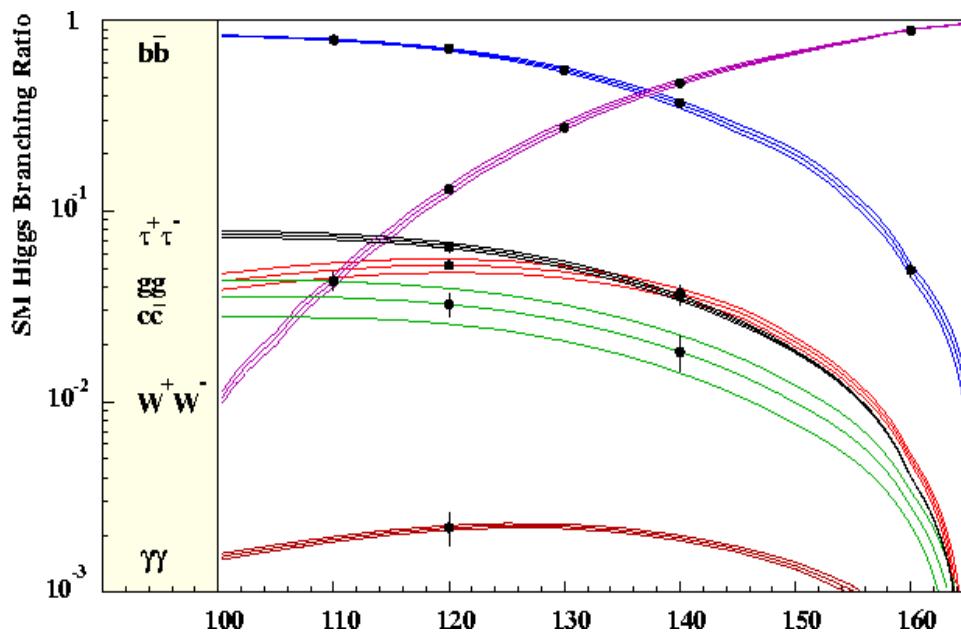
Peak in $(ee, \mu\mu)$ recoil mass spectrum

⇒ model independent extraction
of ZHH coupling $\sigma(ZH) \propto g_{HZZ}^2$

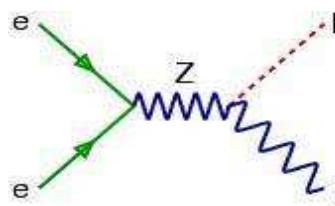
- ◆ $\sqrt{s} = 350 \text{ GeV}, L=500 \text{ fb}^{-1}$
- ⇒ $\delta\sigma/\sigma = 2.6(3.1)\% \ m_H = 120(160) \text{ GeV}$
combining $Z \rightarrow ee$ and $Z \rightarrow \mu\mu$



Higgs Couplings to SM Particles

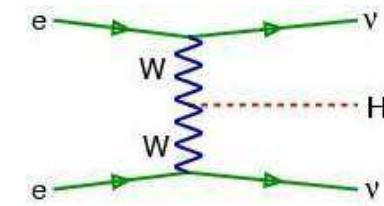


Couplings to weak bosons through production rates



$$\sigma(ZH) \propto g_{HZZ}^2$$

$$\Gamma_{ZZ}$$



$$\sigma(H\nu\nu) \propto g_{HWW}^2$$

$$\Gamma_{WW}$$

$\Delta BR/BR$	
bb	1.0%
cc	12.3%
gg	8.3%
$\tau\tau$	5.0%
WW	4.2%
$\gamma\gamma$	26%

$$\Gamma = \Gamma_{WW} / Br_{H \rightarrow WW}$$

&

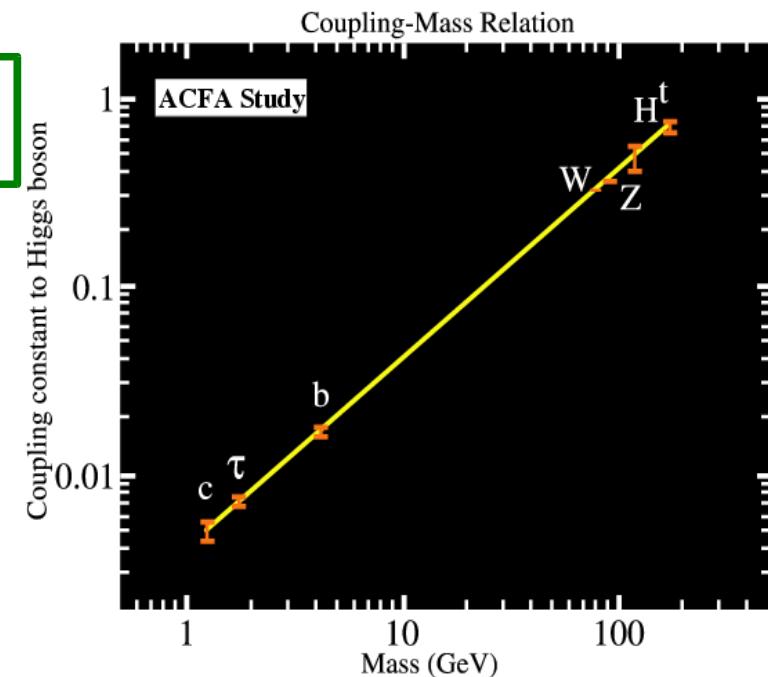
$$Br_{H \rightarrow X}$$

$$e^+e^- \rightarrow ZH$$

$\sqrt{s}=350\text{GeV}$

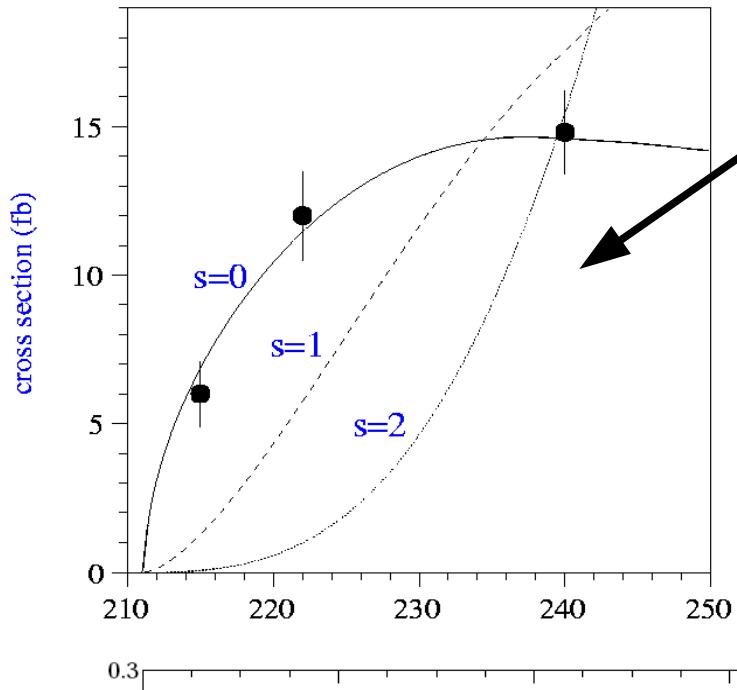
$L=500\text{fb}^{-1}$

$m_H=120\text{GeV}$

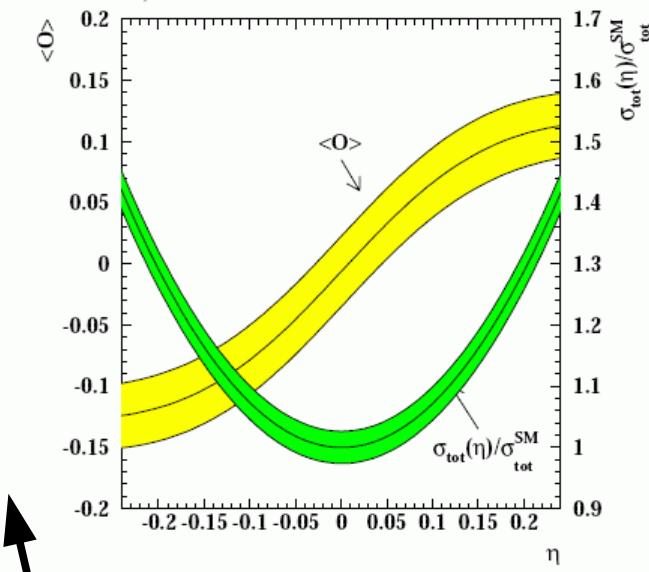
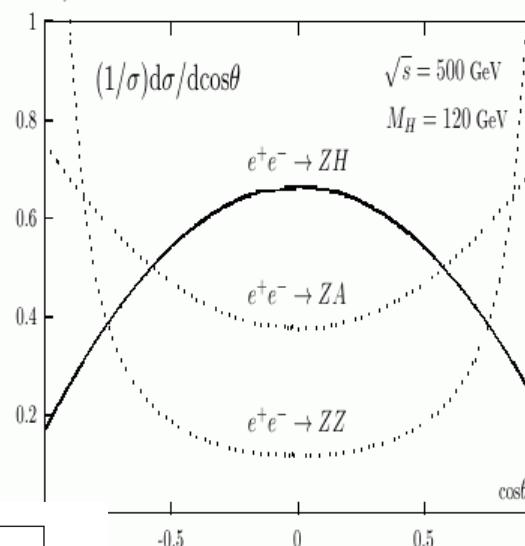


Higgs Quantum Numbers & Self-Coupling

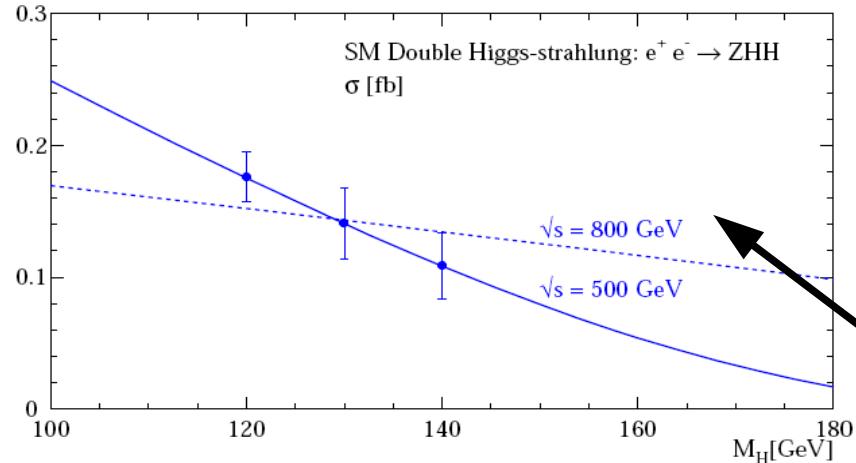
\Rightarrow complete establishment of Higgs mechanism



Higgs spin through ZH threshold scan



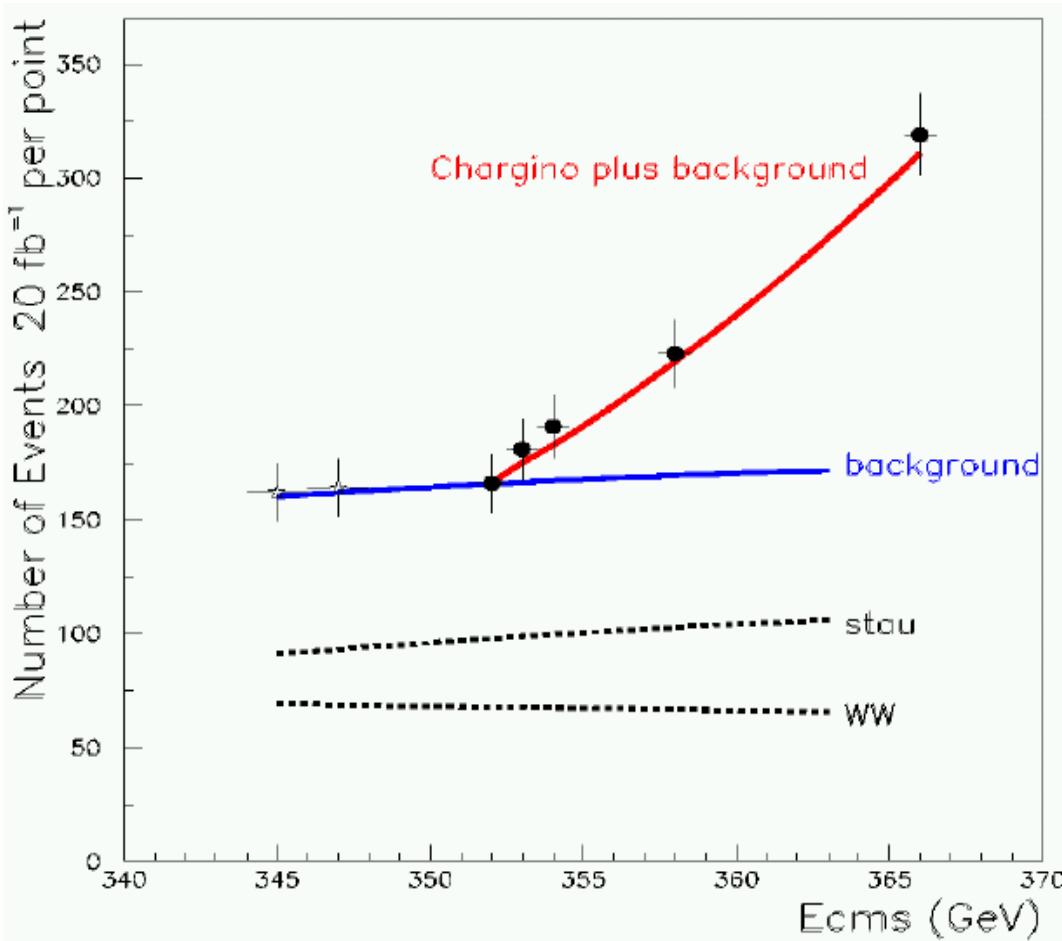
Higgs parity from ZH x-sec & angular distributions



Higgs self-couplings from ZHH & $\nu\nu HH$

Gaugino Masses

Traditional threshold scan technique



Gaugino masses
(mSUGRA SPS 1A point)

	m , GeV	δ_m , GeV
$\tilde{\chi}_1^\pm$	176.4	0.55
$\tilde{\chi}_2^\pm$	378.2	3
$\tilde{\chi}_1^0$	96.1	0.05
$\tilde{\chi}_2^0$	176.8	1.2
$\tilde{\chi}_3^0$	358.8	3–5
$\tilde{\chi}_4^0$	377.8	3–5

Threshold scan of $\tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow \tau^+ \nu_\tau \tilde{\chi}_1^0 \tau^- \bar{\nu}_\tau \tilde{\chi}_1^0$

Summary

- International Linear e^+e^- collider – next large experimental facility after LHC
- Fascinating physics is anticipated
 - Elucidating mechanism of EWSB
 - Probing New Physics (SUSY, Extra Dimensions, Extended Gauge Theories)
- Complements LHC data
- Universality of detector (from hardware side) and universality of thinking (from human side) is needed to embrace all expected and unexpected scenarios
- ILC project is global (inter-regional) effort \Rightarrow high chances for success
- Interested, intrigued? Joins us!