Physics and Optimization

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ILC Tokubetsu Suishin Kickoff Meeting @ Sendai

September 12, 2011

topics

- introduction
- activities of ILC Asia Physics Working Group
  - Higgs studies
  - BSM studies
- benchmark processes for DBD

(will *not* talk about plans beyond 2012...)

Standard Model

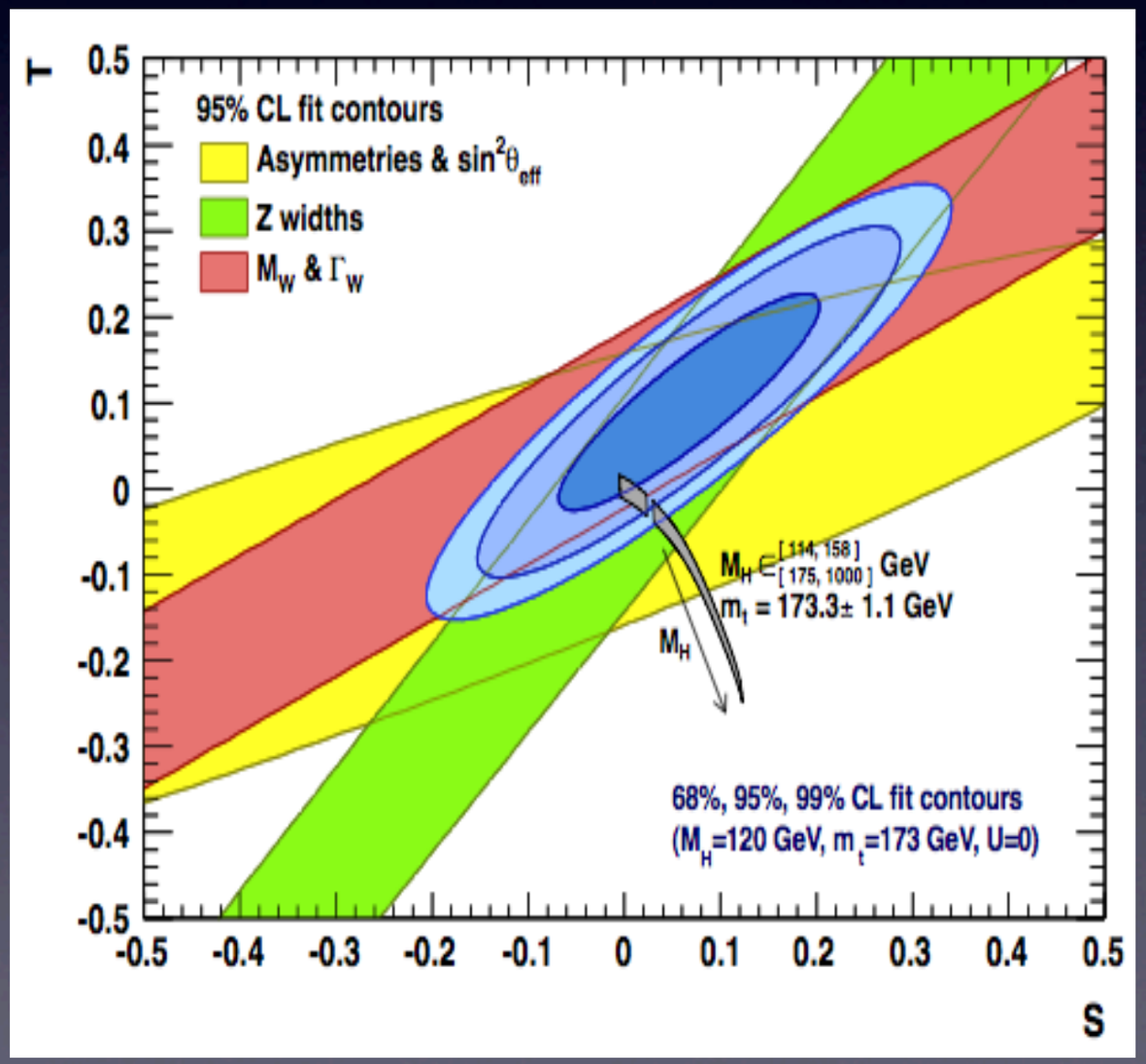
- has many free parameters
  - α, α_s, G_F
  - m_Z, m_H
  - m_t, m_b, m_c, m_s, m_d, m_u, m_τ, m_μ, m_e
  - θ_{12}, θ_{23}, θ_{31}, δ

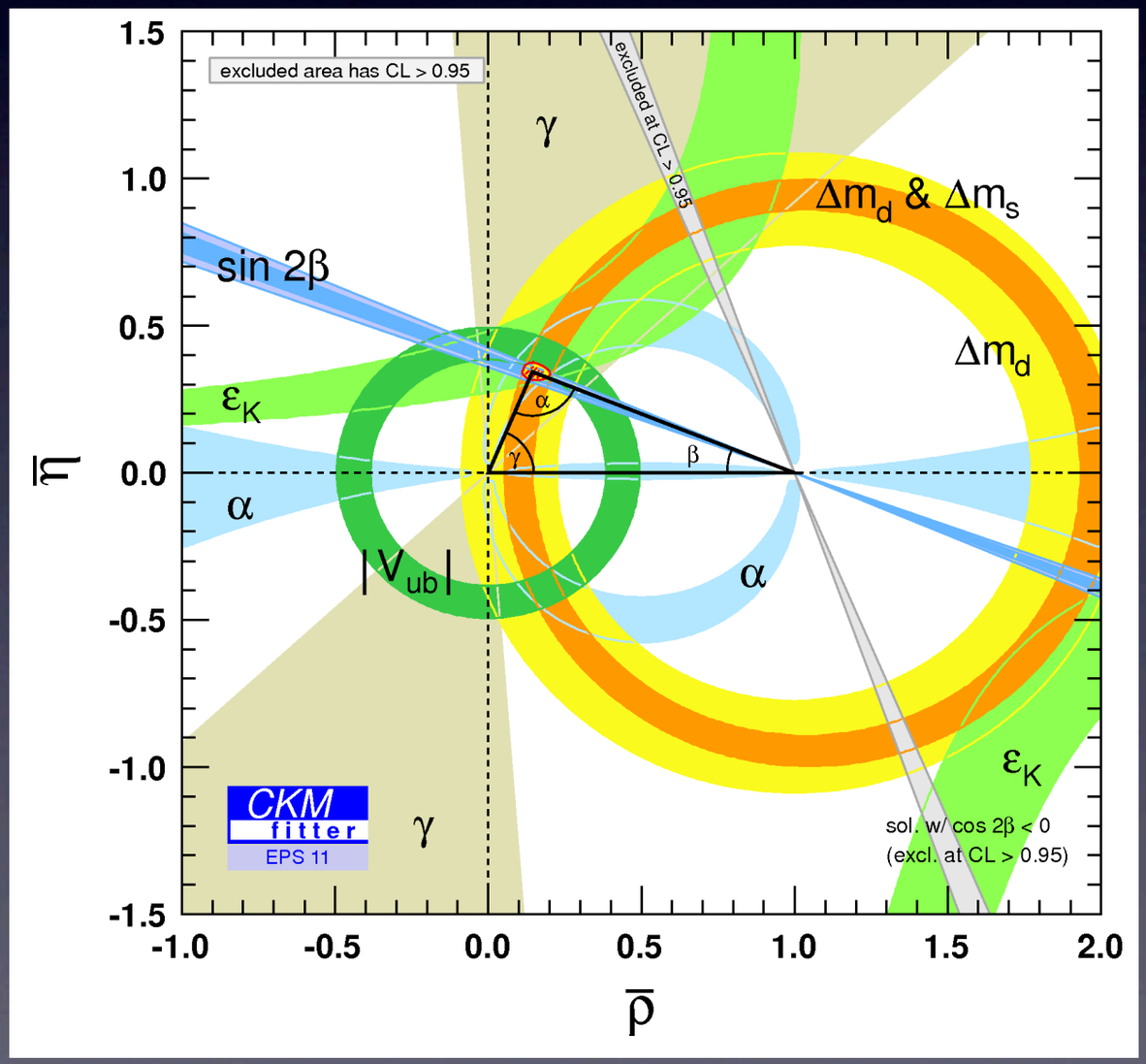
(neutrino masses & mixing parameters)

verification of SM

= over-constraining of the SM parameters

= many different measurements of the same parameters





- α, α_s, G_F
- m_Z, m_H

precision electroweak measurements (SLC, LEP, Tevatron, LHC, ...)

- m_t, m_b, m_c, m_s, m_d, m_u, m_τ, m_μ, m_e
- θ_{12}, θ_{23}, θ_{31}, δ

B factories (KEKB, PEP-II)

- α, α_s, G_F
- μ, λ

Higgs factory = ILC

- y_t, y_b, y_c, y_s, y_d, y_u, y_τ, y_μ, y_e
- θ_{12}, θ_{23}, θ_{31}, δ

B factories (KEKB, PEP-II)

Higgs studies

- many of these parameters will be *directly* measurable at the ILC:
  - Higgs self-coupling: λ
  - Yukawa couplings:
    - y_t (associated production with top pair)
    - y_b, y_c (through Higgs decays)

	$\sqrt{s}$ [GeV]	integrated luminosity	relative error	See tomorrow's talk by
λ	500	2 ab^{-1}	57%*	J. Tian
y_t	500	1 ab^{-1}	10%†	R. Yonamine
y_b	250	250 fb^{-1}	2.7%‡	H. Ono
y_c	250	250 fb^{-1}	8.7%‡	

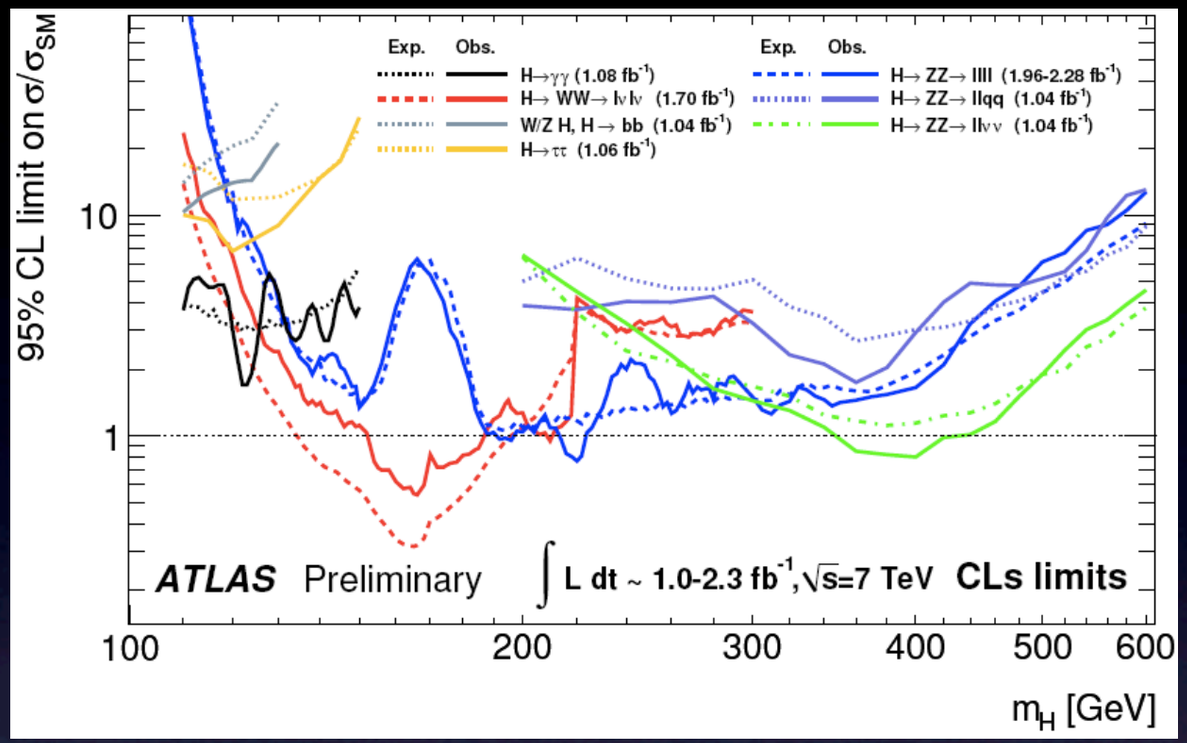
All results assume: m_H=120 GeV, beam polarization (-0.8, +0.3)

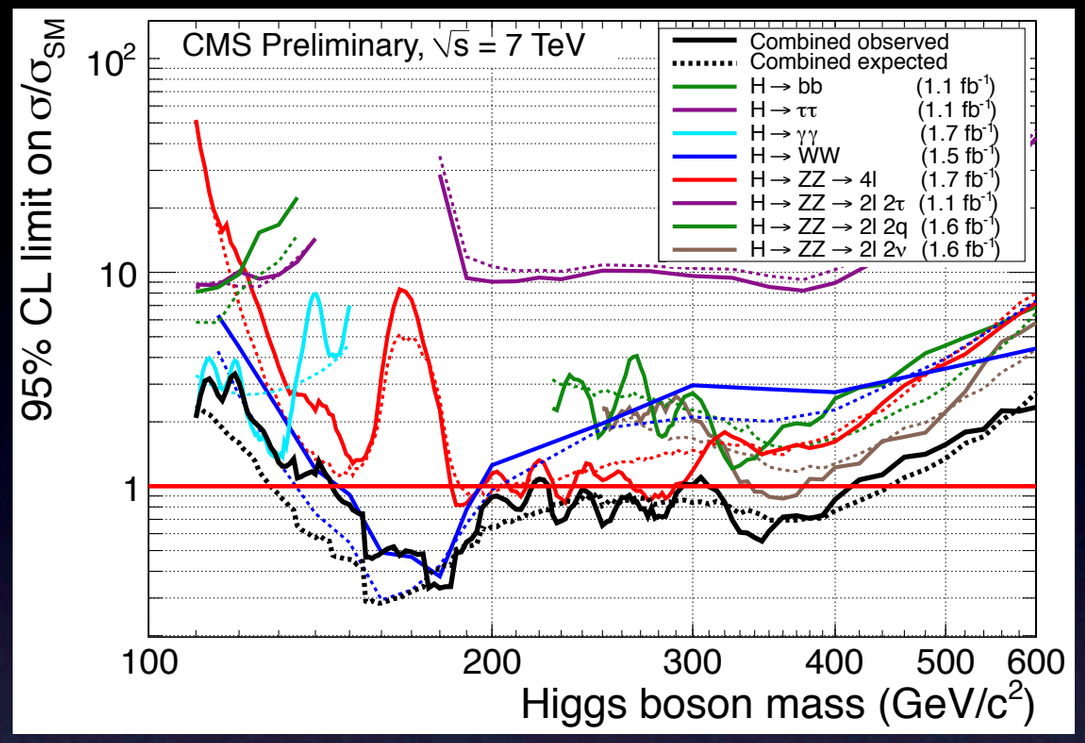
* lots of room for improvement in analysis techniques

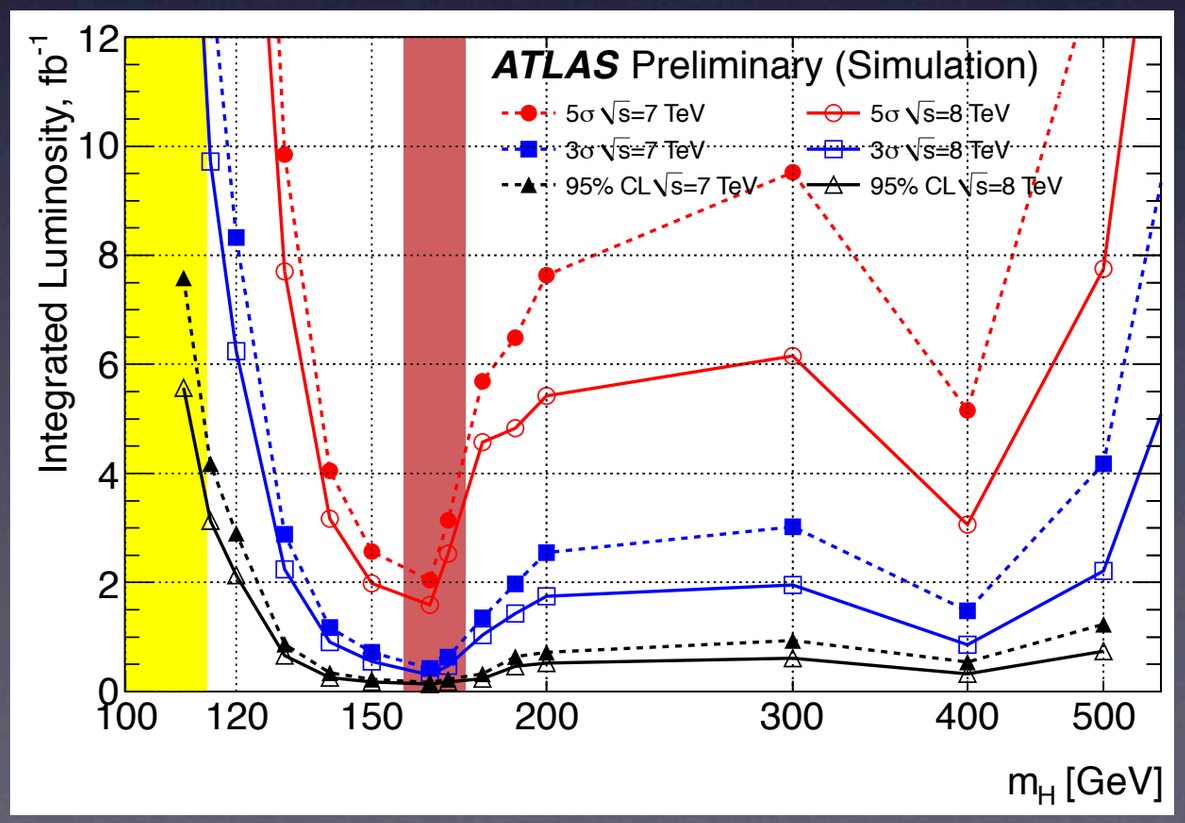
† result of fast simulation study

‡ error on branching fraction

LHC Higgs prospects

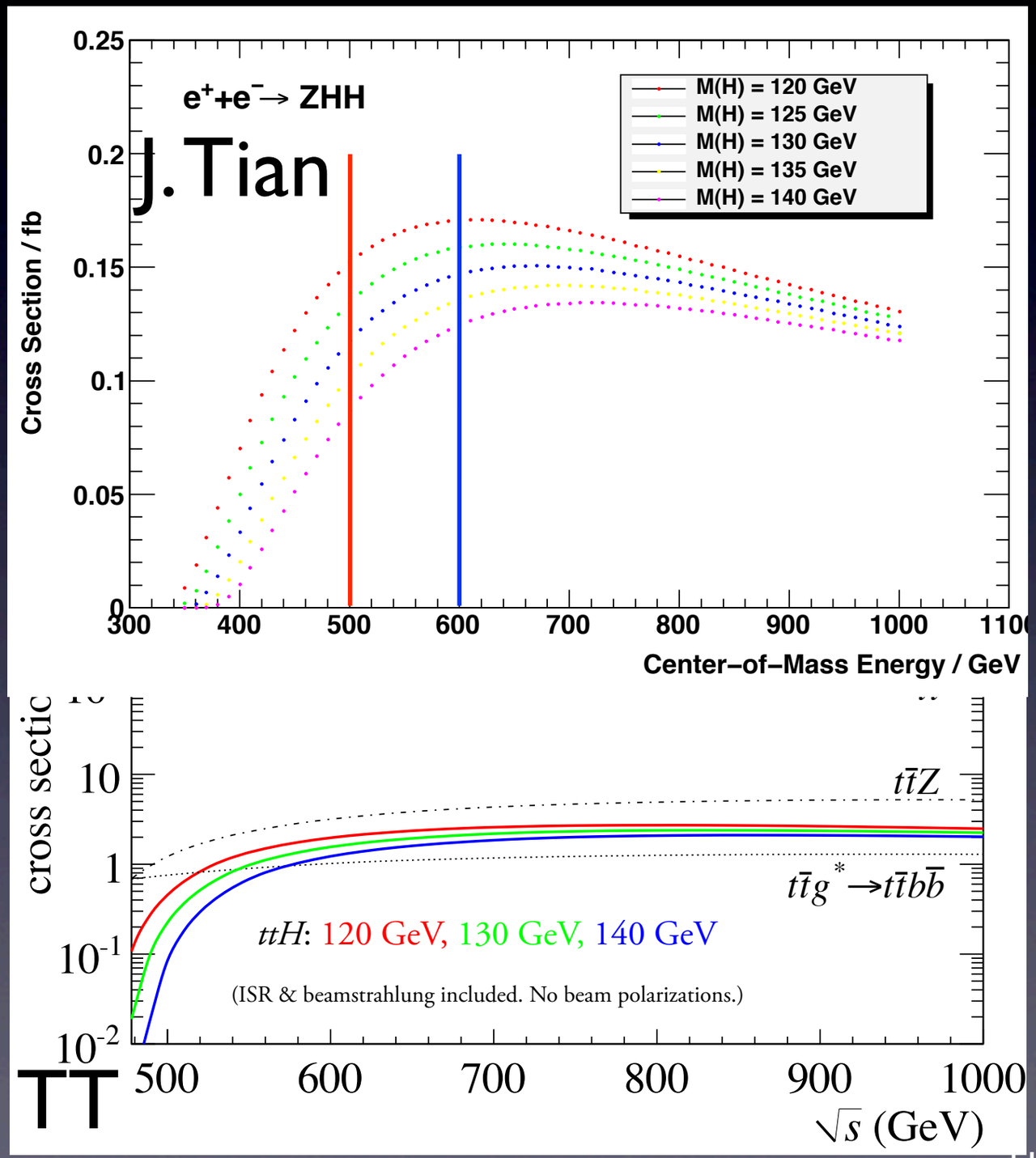


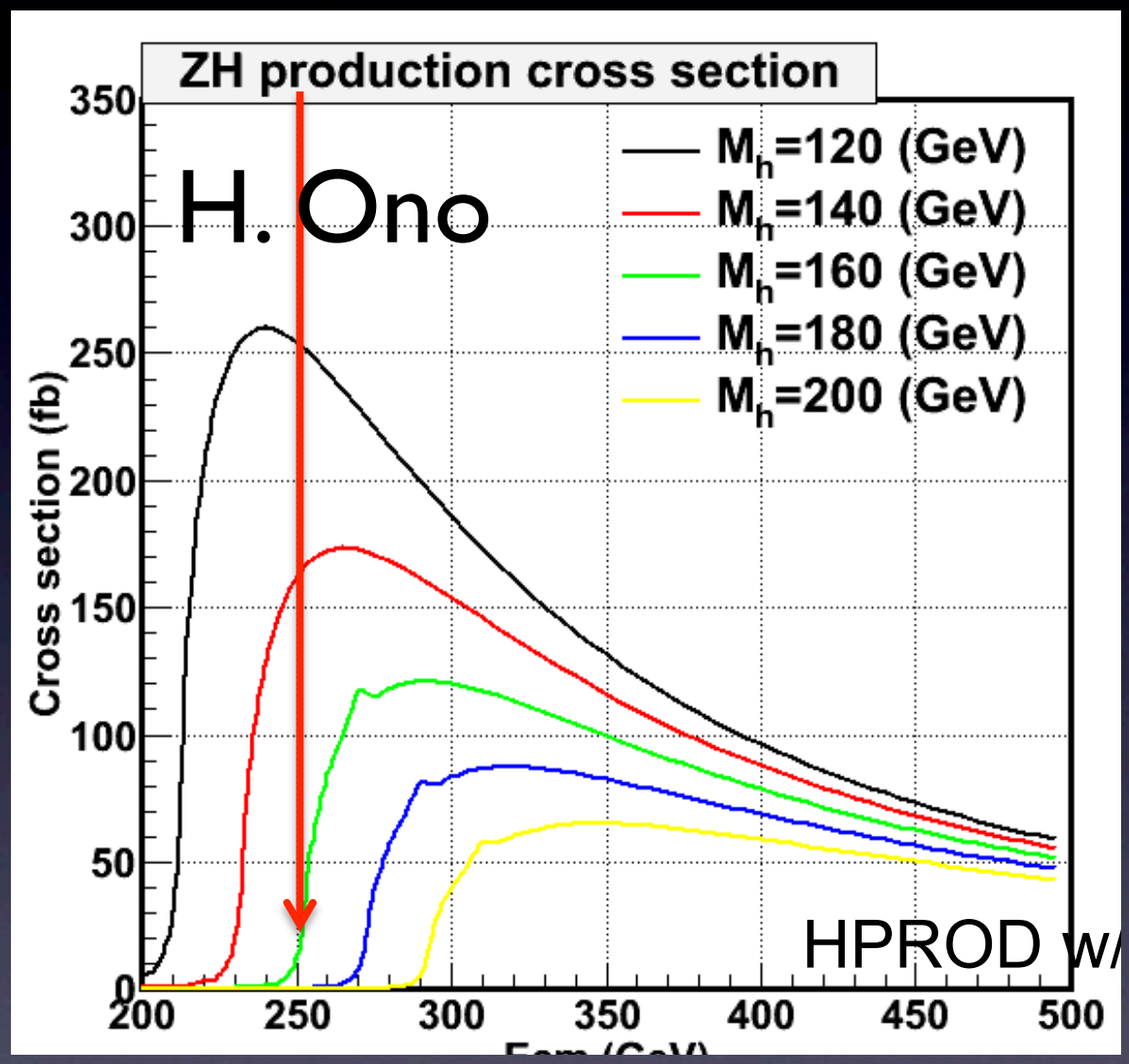




- 3σ evidence expected for m_H>120 GeV with 10 fb^{-1}
- improvement in H→bb and ττ channels highly desired for low mass region

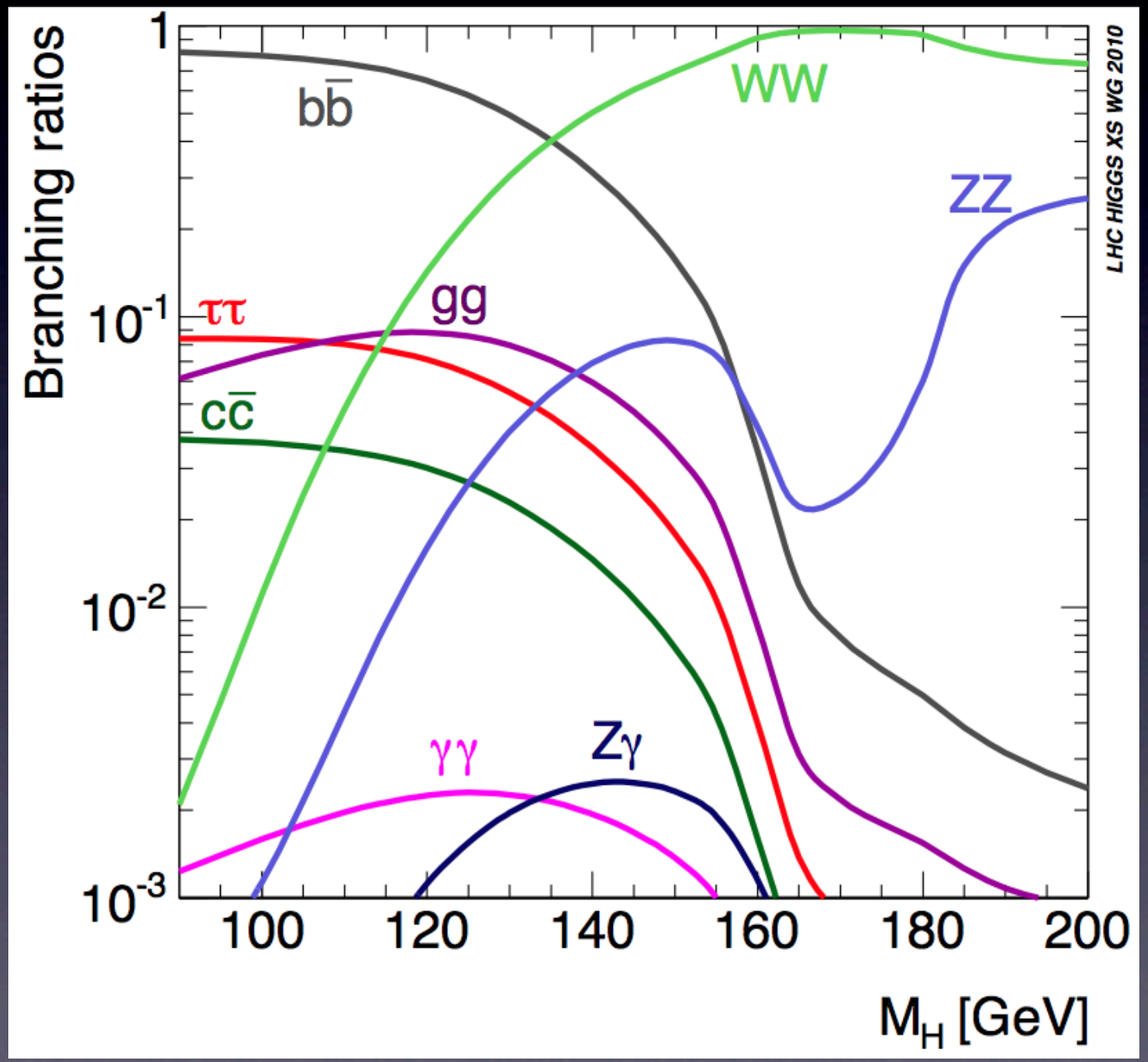
what if m_H=140 GeV?





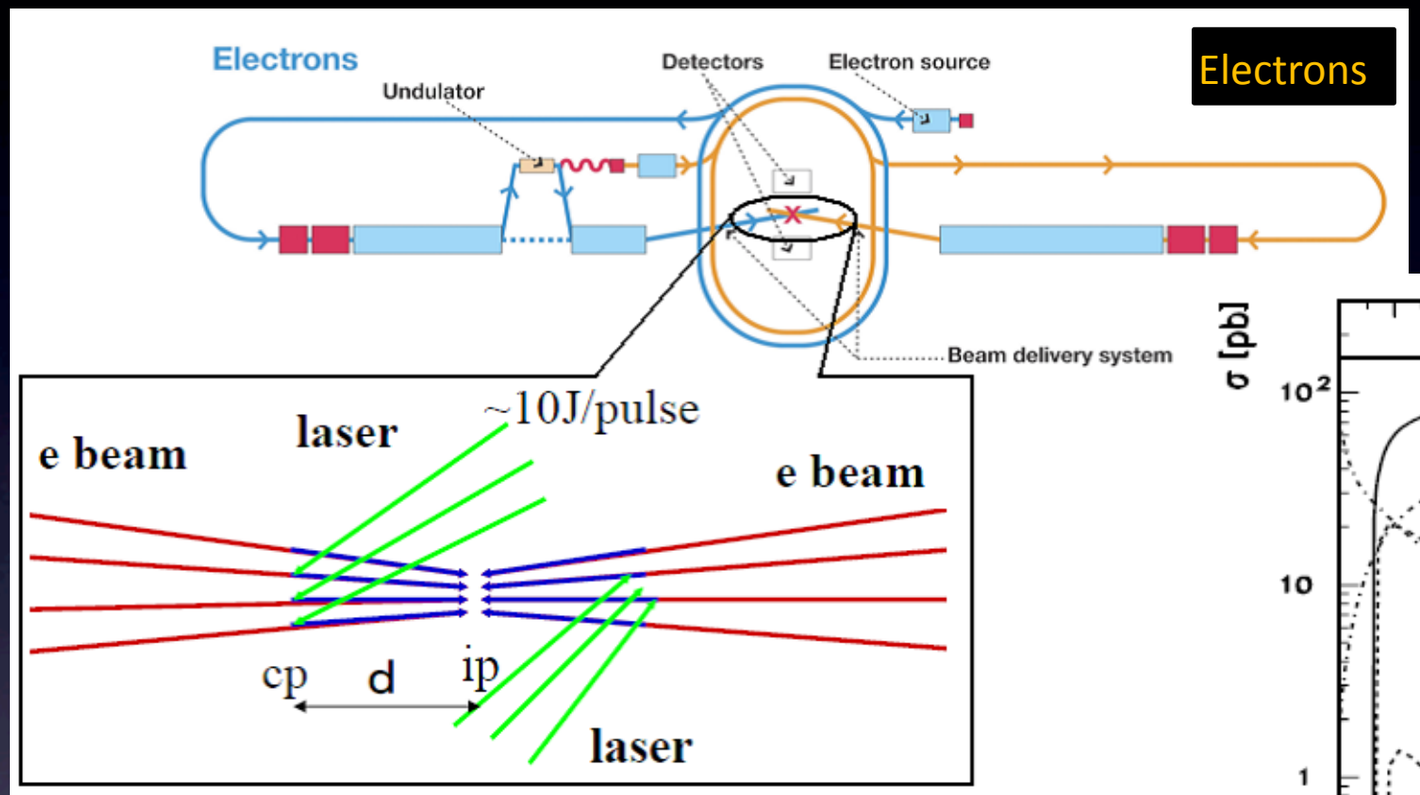
signal cross section decreases

what if m_H=140 GeV?



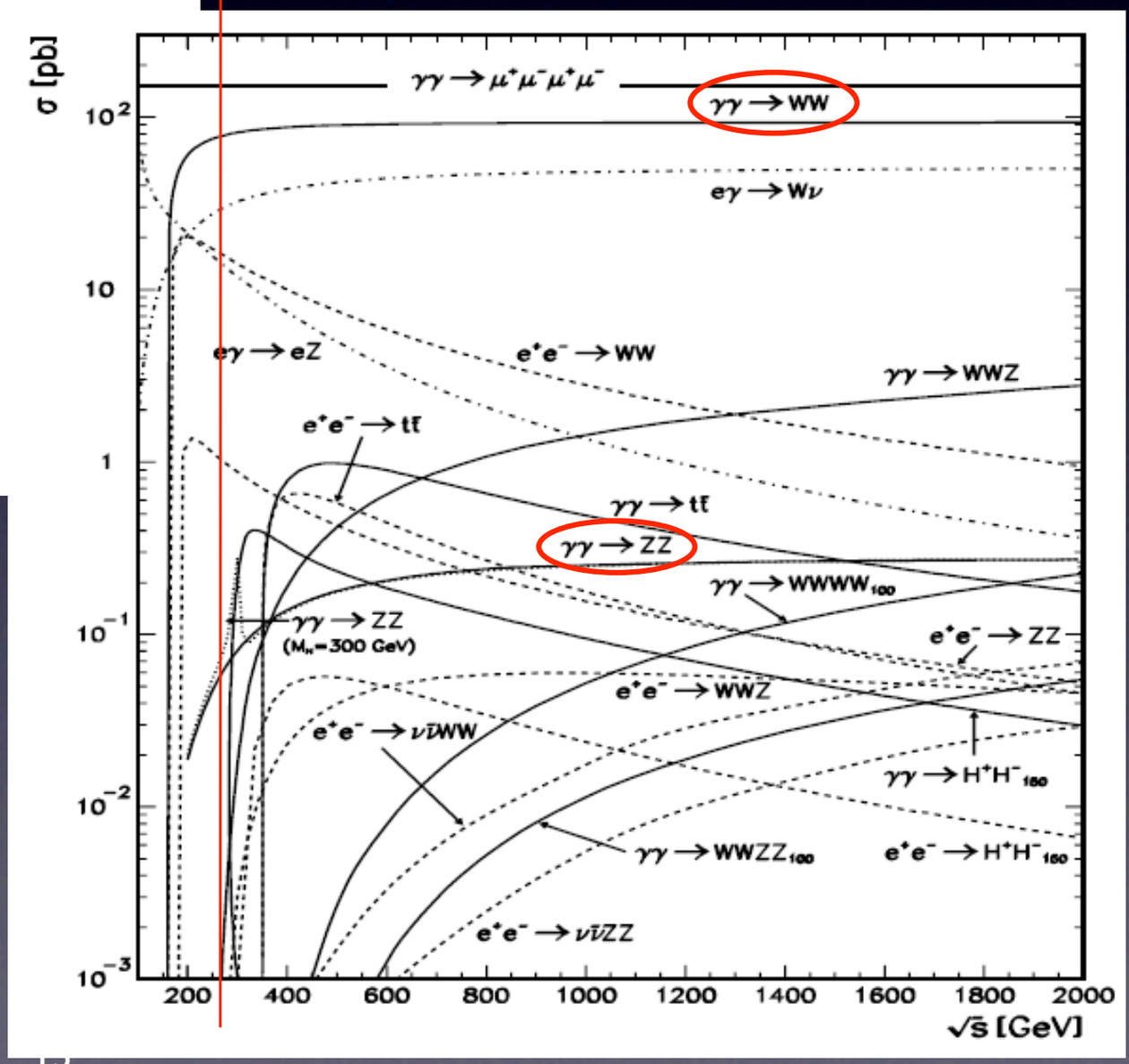
- BF(H→bb) decreases
- H→WW becomes important!
- reanalysis with m_H=140 GeV needed for robust estimate
- we will need to be prepared

Higgs self-coupling with the photon-photon collider option (S. Kawada et al.)



Electrons

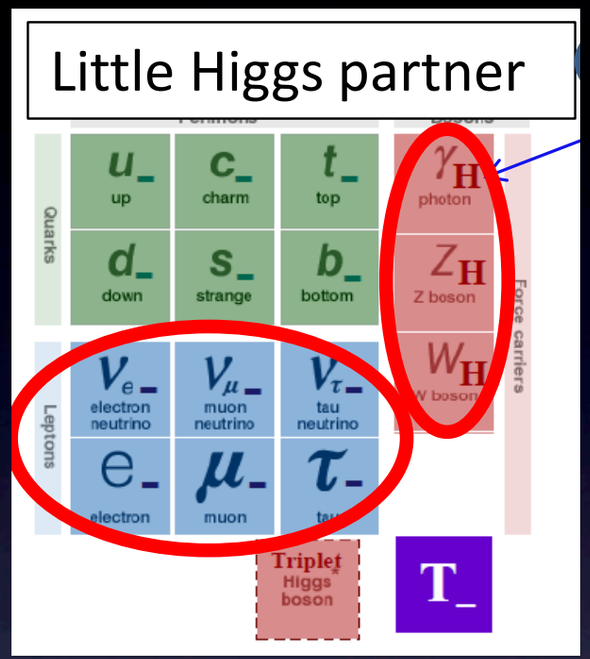
- double Higgs production accessible at lower E_{CM}
- large WW, ZZ background
- feasibility depends critically on jet clustering

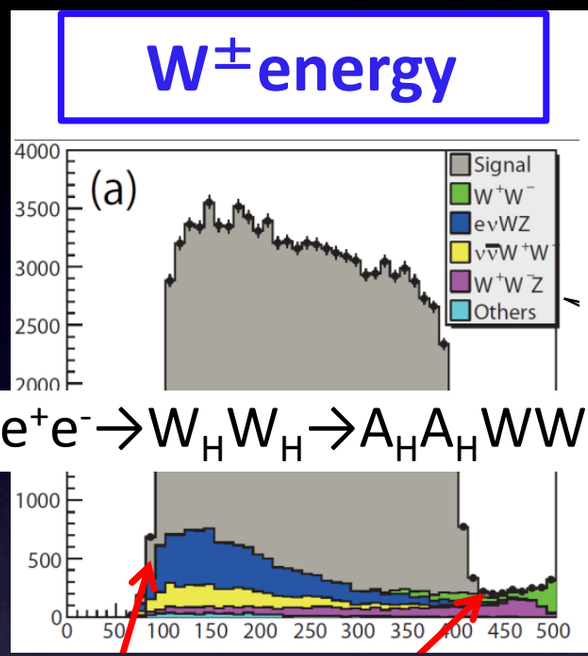


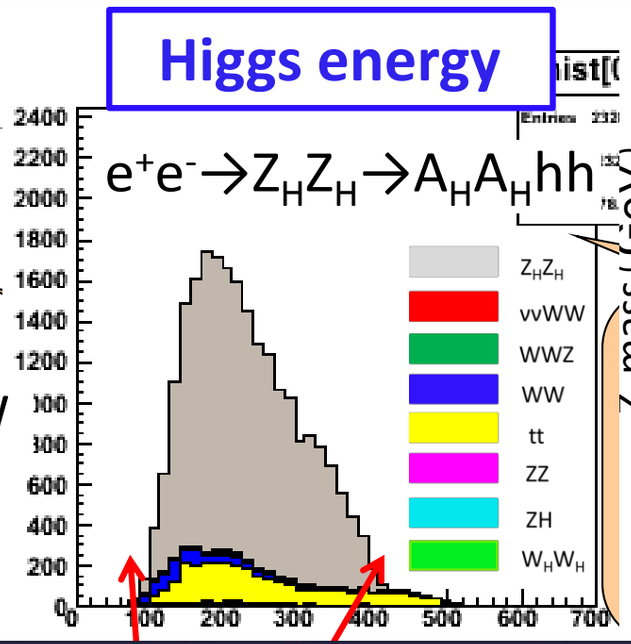
BSM studies

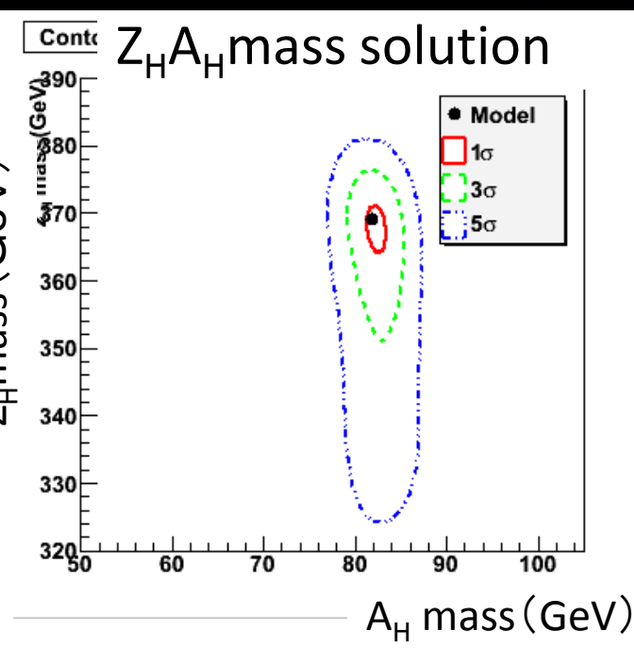
Little Higgs with T-parity
(E. Kato et al.)

E_{CM}=1 TeV









particle	mass	sensitivity
A_H	81.9(GeV)	1.3%
W_H	369(GeV)	0.20%
Z_H	368(GeV)	0.56%
e_H	410(GeV)	0.46%
ν_H	400(GeV)	0.10%

parameter	True value	Measurement accuracy
f	580(GeV)	0.16%
K	0.5	0.01%

- fast simulation study shows ILC is very sensitive to LHT particle masses & couplings

theory talk on testing Little Higgs at LHC & ILC by K. Harigaya tomorrow

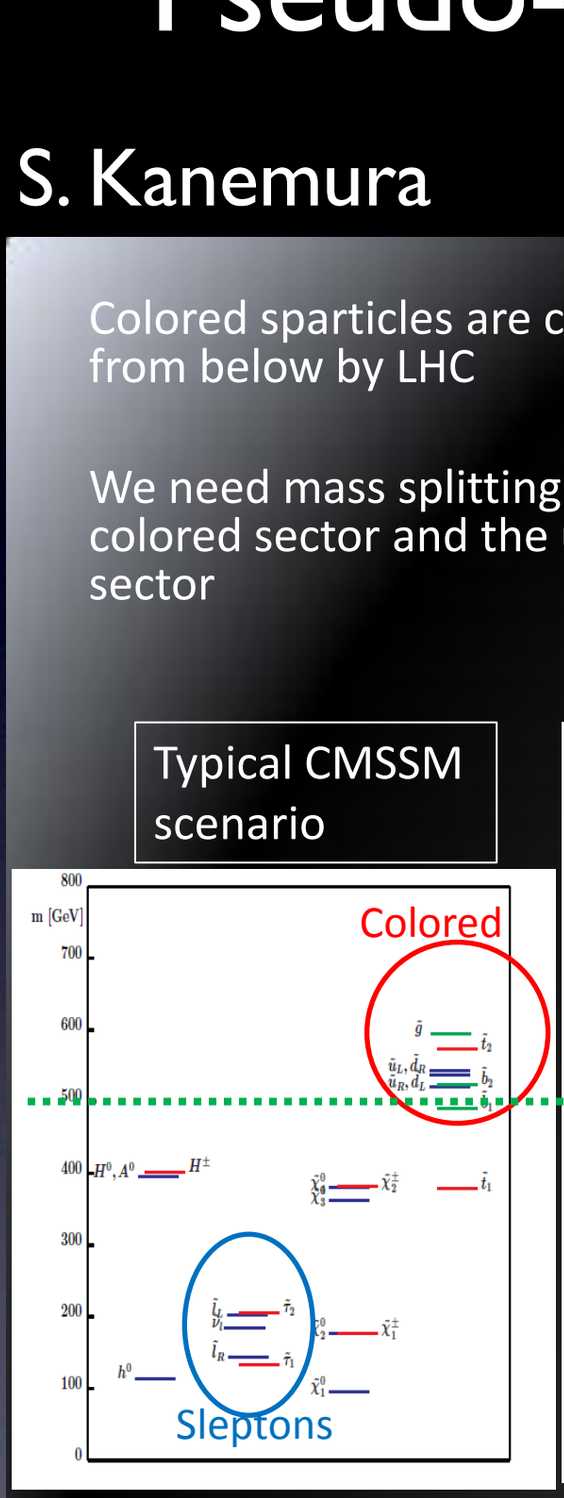
Pseudo-stable SUSY particles

S. Kanemura

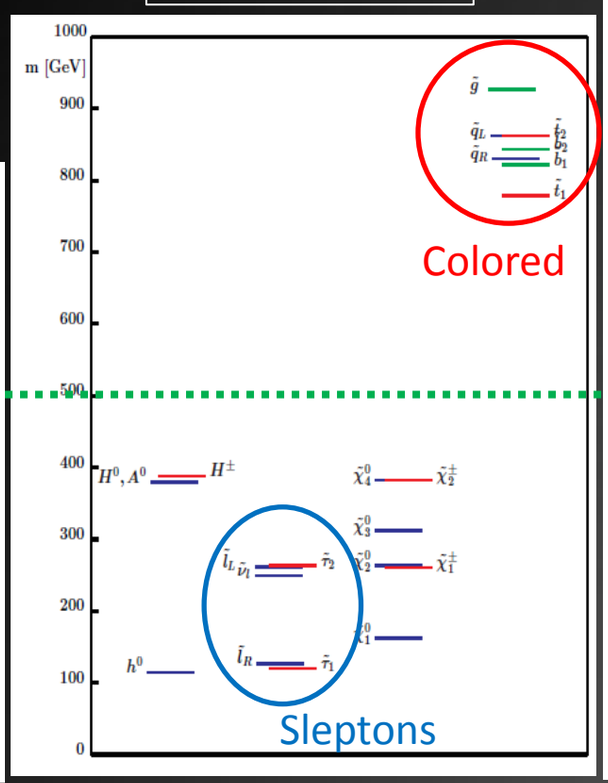
Colored sparticles are constrained from below by LHC

We need mass splitting between the colored sector and the uncolored sector

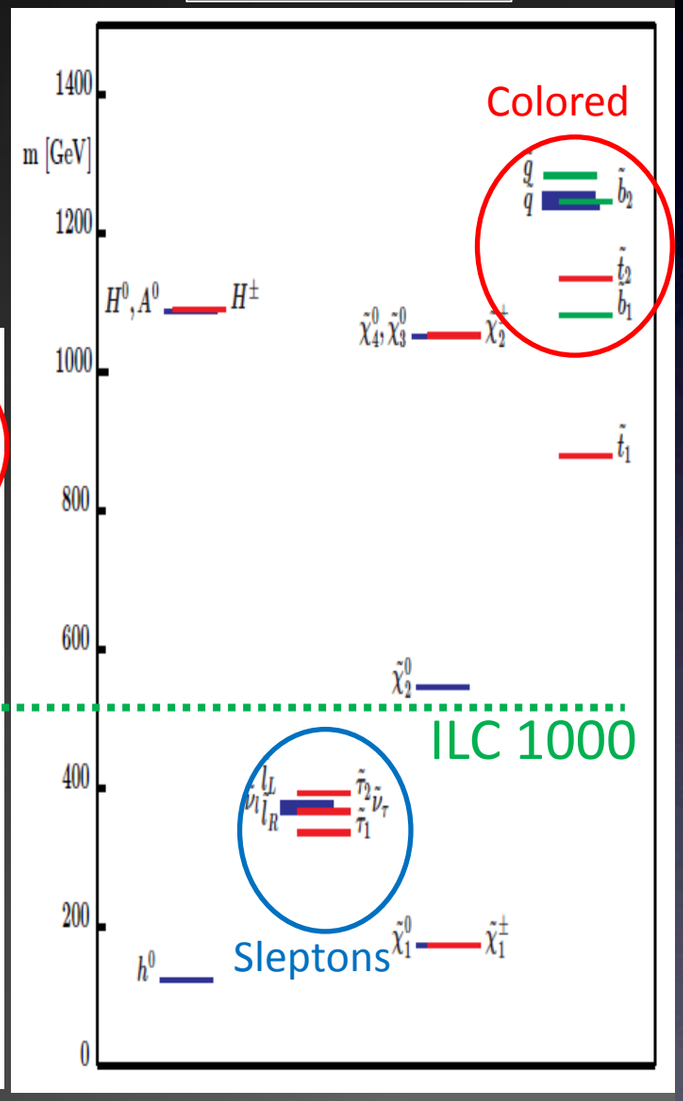
Typical CMSSM scenario



Typical GMSB scenario



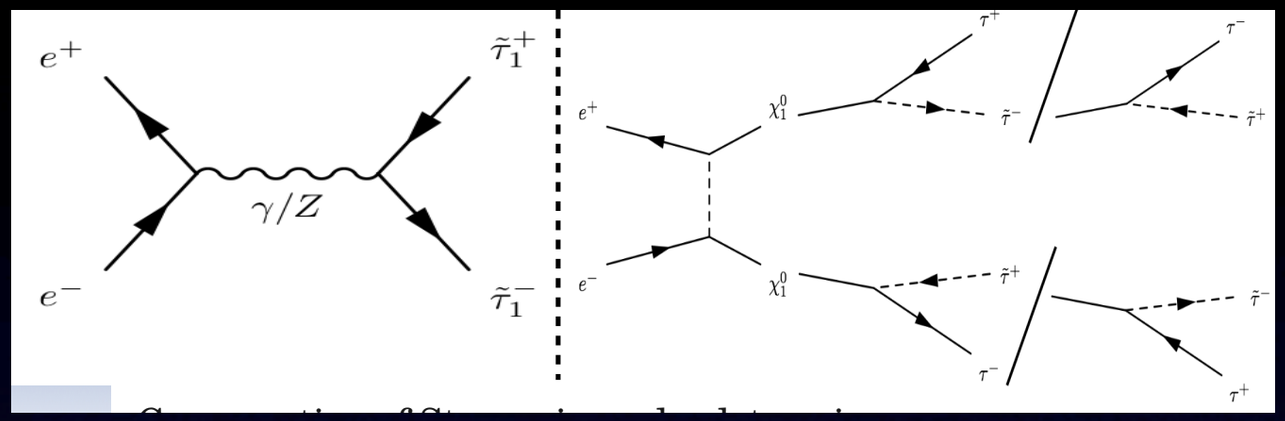
Typical AMSB scenario



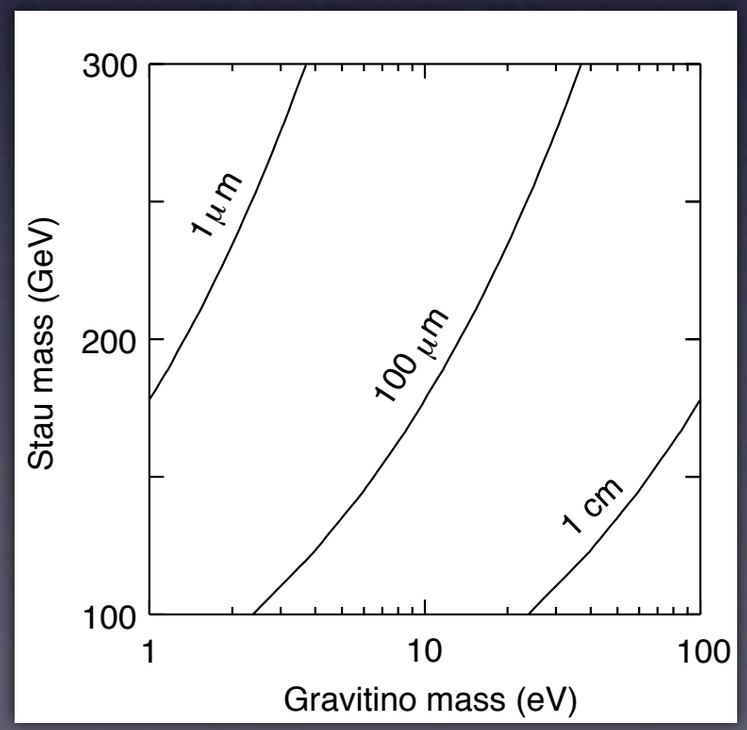
S. Heinemeyer

sleptons may be accessible at the ILC!

stau as pseudo-stable NLSP



- stau lifetime O(10cm):
  - stop the stau at HCAL to measure lifetime
  - stau mass determined from dE/dx information
    - talk by W. Yamaura tomorrow
- stau lifetime O(0.1mm):
  - measure stau lifetime by distribution of off-vertex tracks
  - determine stau mass by threshold scan/ kinematic edges
  - analysis in progress by R. Katayama



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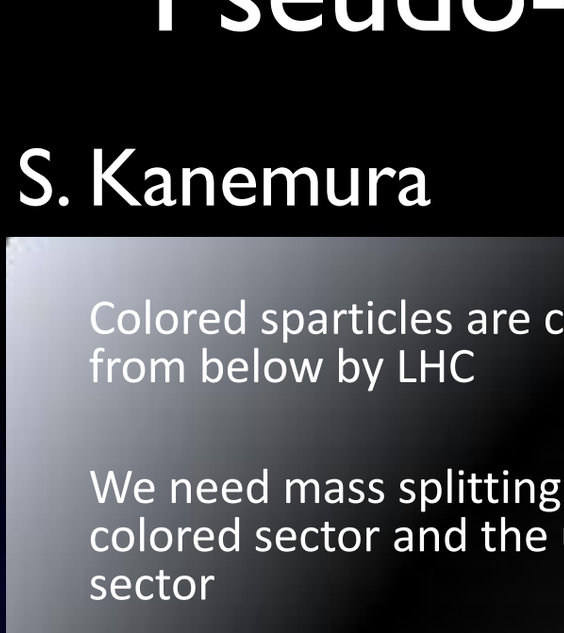

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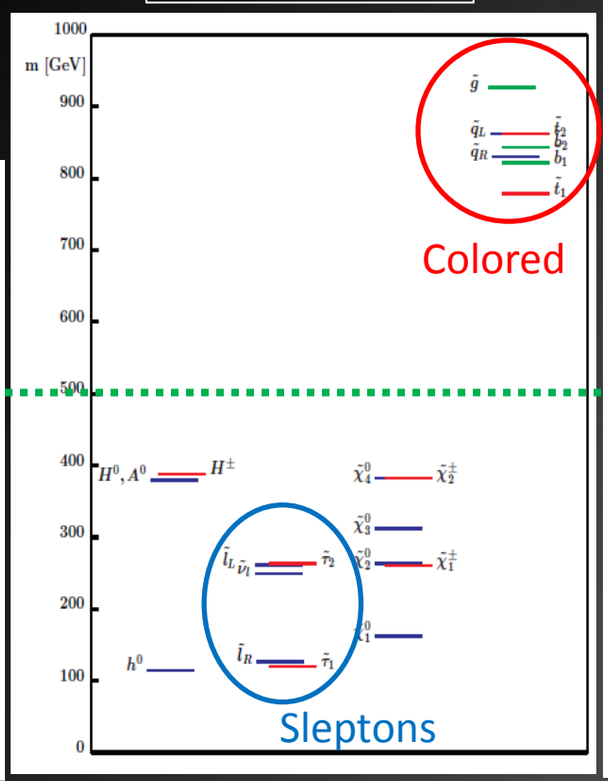

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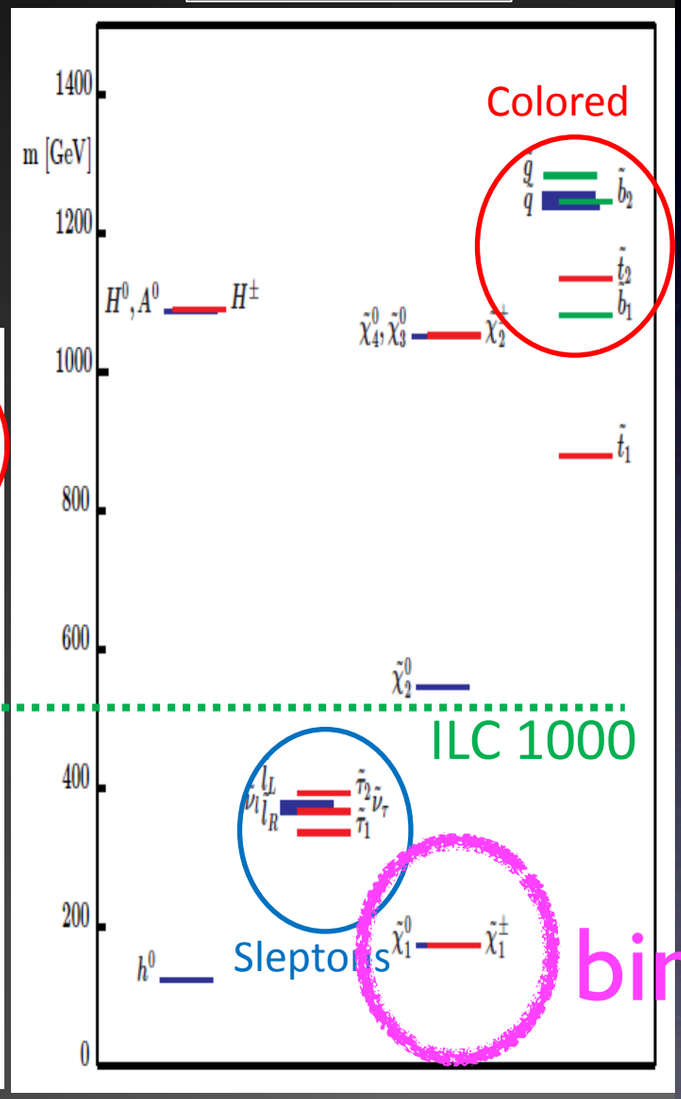

S. Heinemeyer

bino/wino

nearly degenerate gauginos may be accessible at the ILC!?

DBD benchmarks

- as part of Detailed Baseline Design (DBD) Report, the detector groups are required to study 3 processes at E_{cm}=1 TeV
  - $e^+e^- \rightarrow \nu\nu H$ with $H \rightarrow \mu\mu$, bb, cc, gg, WW^*
    - measure the branching ratios
      - to be covered by H. Ono (bb, cc, gg)
  - $e^+e^- \rightarrow W^+W^-$ with $W \rightarrow qq, l\nu$
    - measure *in situ* the left-handed polarization
    - to be covered by DESY group
  - $e^+e^- \rightarrow ttH$ with $H \rightarrow$ bb and 8 jets and 6 jets + lepton
    - measure the top Yukawa coupling
    - to be covered by R. Yonamine, TT, K. Fujii
- plus additional studies at 500 GeV e.g. ZHH, top pair, ...

papers

- "Hidden particle production at ILC" PRD 78, 015008 (2008)
- "Precision measurements of little Higgs parameters at the ILC" PRD 79, 075013 (2009)
- T. Saito et al. "Extra dimensions and seesaw neutrinos at the ILC" PRD 82, 093004 (2010)
- R. Yonamine et al. "Measuring the top Yukawa coupling at the ILC at sqrt(s) = 500 GeV" PRD 84, 014033 (2011)
- T. Saito, T. Suehara et al. "Discrimination of new physics models with the ILC" Submitted to PRD

summary

- ILC Asia Physics Working Group is actively pursuing important physics studies at the ILC with focus on Higgs and BSM
- robustly adapt analysis targets as new LHC results come in
- at the same time, many DBD benchmark studies will be covered in time for the 2012 deadline