Summary for Gamma-Gamma

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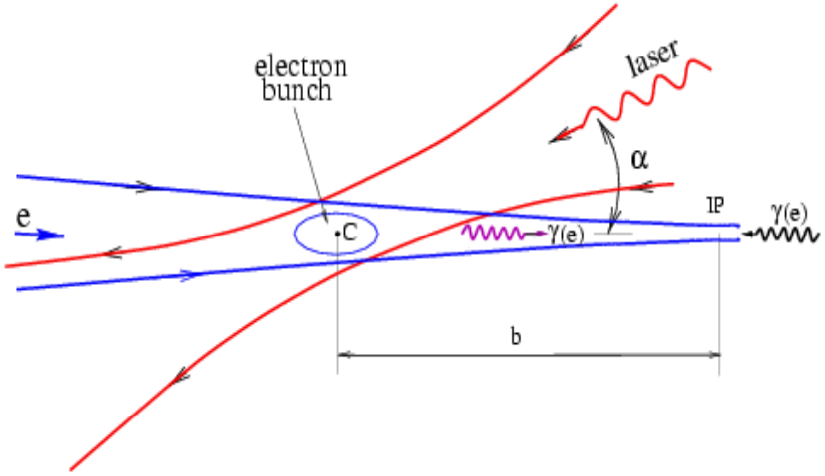
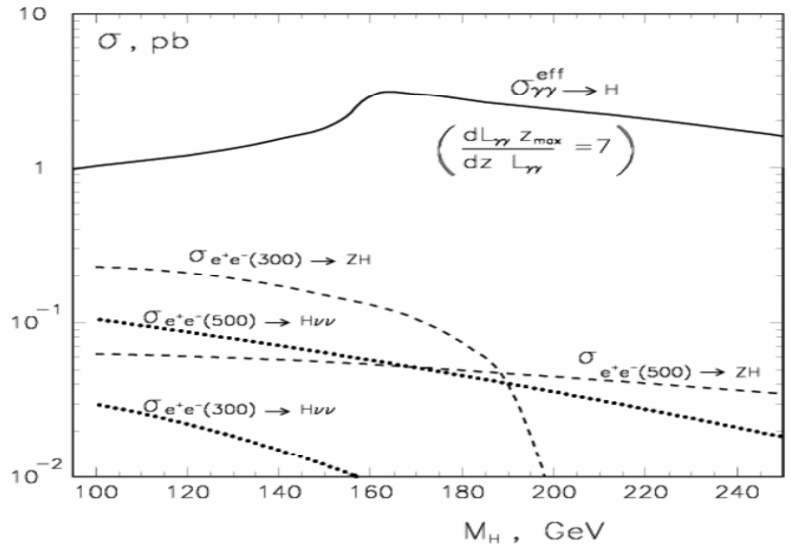
November 20, 2008
LCWS08 -- UIC, Chicago

As pointed out in the past: Photon Linear Collider (PLC) is a simple & elegant idea

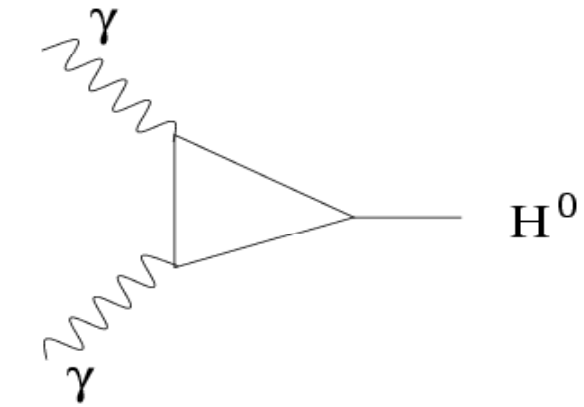


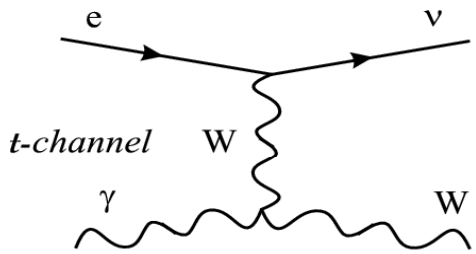


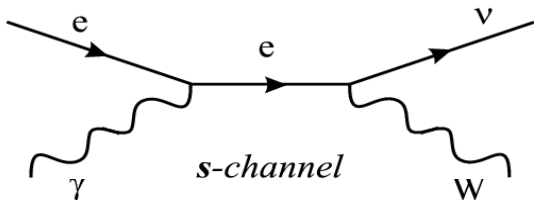
- Laser Compton interaction produces beam of high energy photons
  - **$E_\gamma < 0.8\ E_{beam}$**
- Peak has high circular polarization
  - **Linear polarization is also possible**
  - **CP studies**
- The effective cross section for processes like $\gamma\gamma \rightarrow$ h is high, compensating for the lower luminosity $L_{\gamma\gamma} \sim 0.2 L_{ee}$

- ***Recent Question: Is it cost effective to make low energy PLC, if LHC find a "light" Higgs ?***

Basic Physics Case for a Low Energy & High Energy PLC already stablish







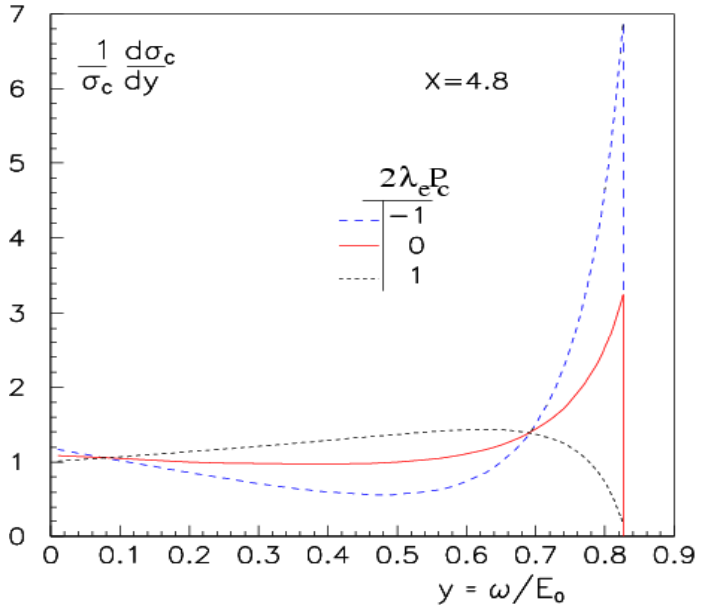
Low Energy E_{ee} ~150 GeV

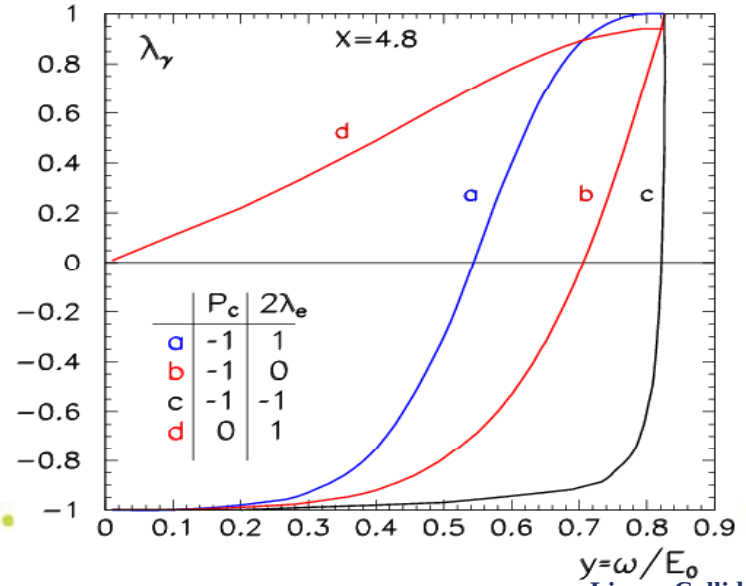
- M_h=120 GeV
  - $\Gamma_{h\to\gamma\gamma}$ **$Br_{H\to bb}$ → 2%**
- Eγ→Wν
  - **Γ_W & M_W**

High Energy

- M_A & M_H
  - **Accessible in low tan β not accessible to LHC and ILC**
  - **Turn ODD and EVEN states with linear polarization**
- Eγ→Wν
  - **Gauge coupling K_γ & λ_γ more precise than at the LHC**

PLC: Issues & Facts discussed at joint session with Beam Delivery System Group





- Polarization needed to obtain high luminosity @ $E_{\gamma\gamma}$ ~0.8 E_{ee}
  - **Damping rings needed due to high emittances of beam produced with DC photo-guns**
  - **Hope... Future RF polarized sources**
- e-e- preferred to obtained higher luminosity and suppress backgrounds
  - **Savings on cost of positron source**
- ***Question: Any difference in price between a cold & a warm 150 GeV e-e-machine?***

PLC: Issues & Facts discussed at joint session with Beam Delivery System group

- Interactions of Laser with e-beam disruptive
  - **Large crossing angle needed**
    - At small angles masking is needed to protect the detector
    - Detector performance same as for e+e- for theta>7^{o}
  - **Study needed to determine if we can used the disrupted e-beam for fast feedback … e-e- also not optimal for feedback system**

- Beam dump: γ-beam cannot be deflected therefore the energy density at the dump is large
  - **Request: proper simulation & design needed**

- Feasible laser design for both a warm and a cold machine
  - **Warm technology: 1 J in 1ps ➔ 12 MERCURY Laser**
  - **Cold Technology : optical cavity ➔ 1 MERCURY Laser**

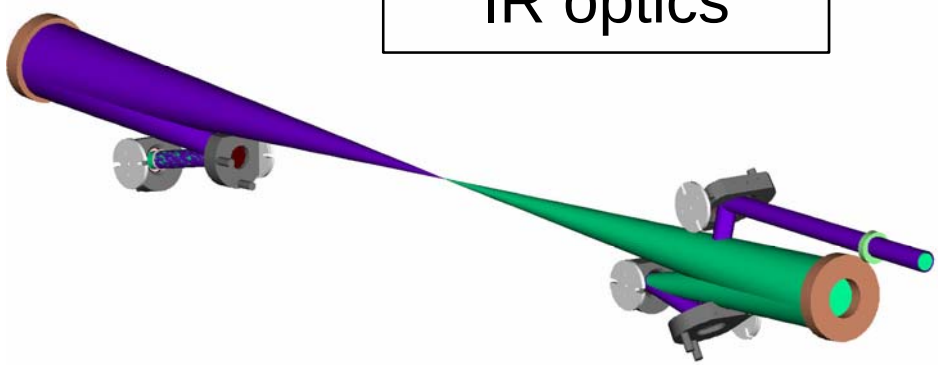
➔MERCURY Goal: 100 J, 10 Hz , 10% Efficiency, 2-10 ns , < 5X Diffraction limit , > 108 shots

Clear progress in the MERCURY laser (up to 55J @ 10Hz) … next is to adapt to our needs

➔**Warm tech: Straw-man laser for NLC presented at Snowmass 2001**

- **120 hz of 100 J macro-pulses from 12 MERCURY lasers**
- **100 J laser macro-pulse converted to train of 1 J subpulses**

IR optics

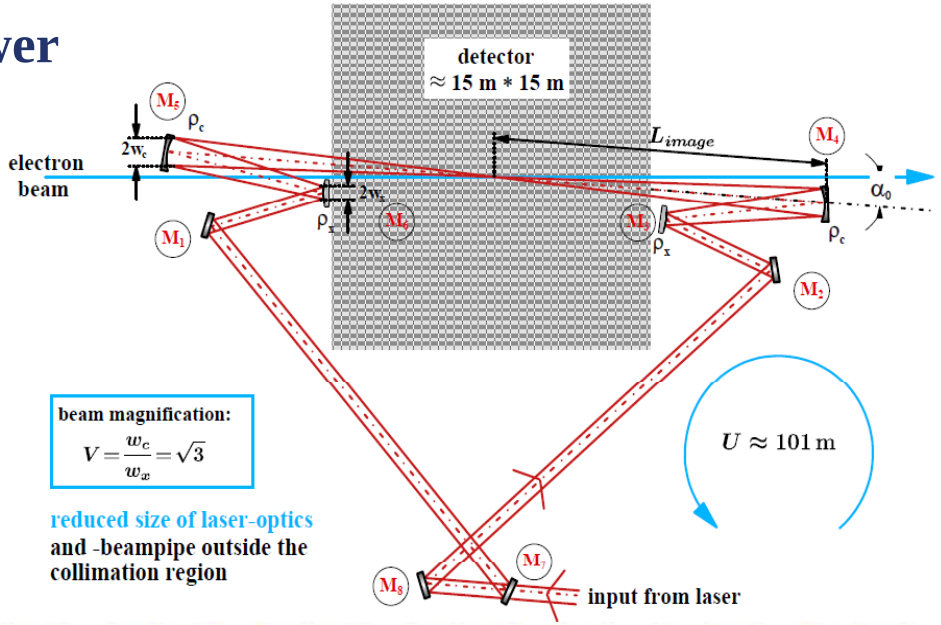


➔**Cold tech: Ideas to reduce laser power**

Pulse Stacking Cavity

Stack laser pulses on phase
to reduce peak as well as average
Power by of at least 100

Inter-bunch spacing allows possibility of Recirculation **(369 ns path length)**

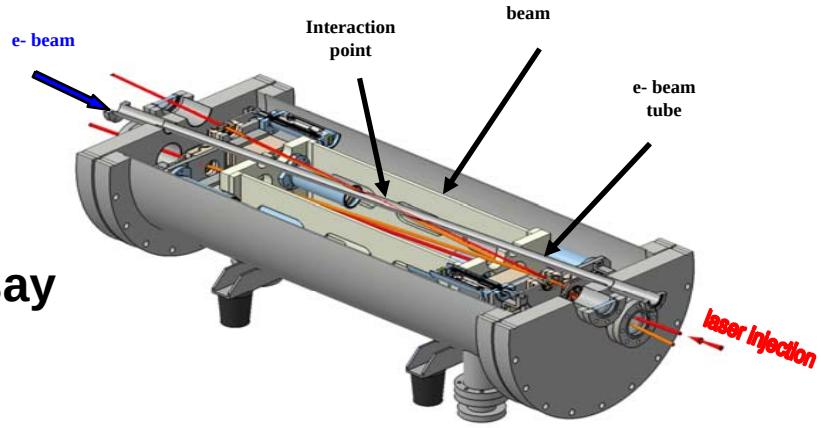


Good news: γ generation by Laser pulse stacking cavity / accelerator has been demonstrated

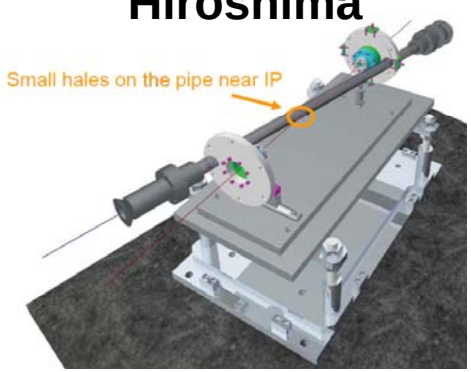
- **Polarized electron source (PosiPol)**
- **hard x ray generation (LUCX)**
- **Quantum beam project**

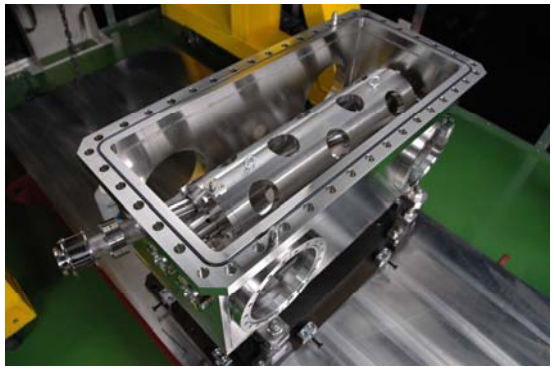
Hope basic technology including implementation with accelerator is established in next a few years.

LAL - Orsay



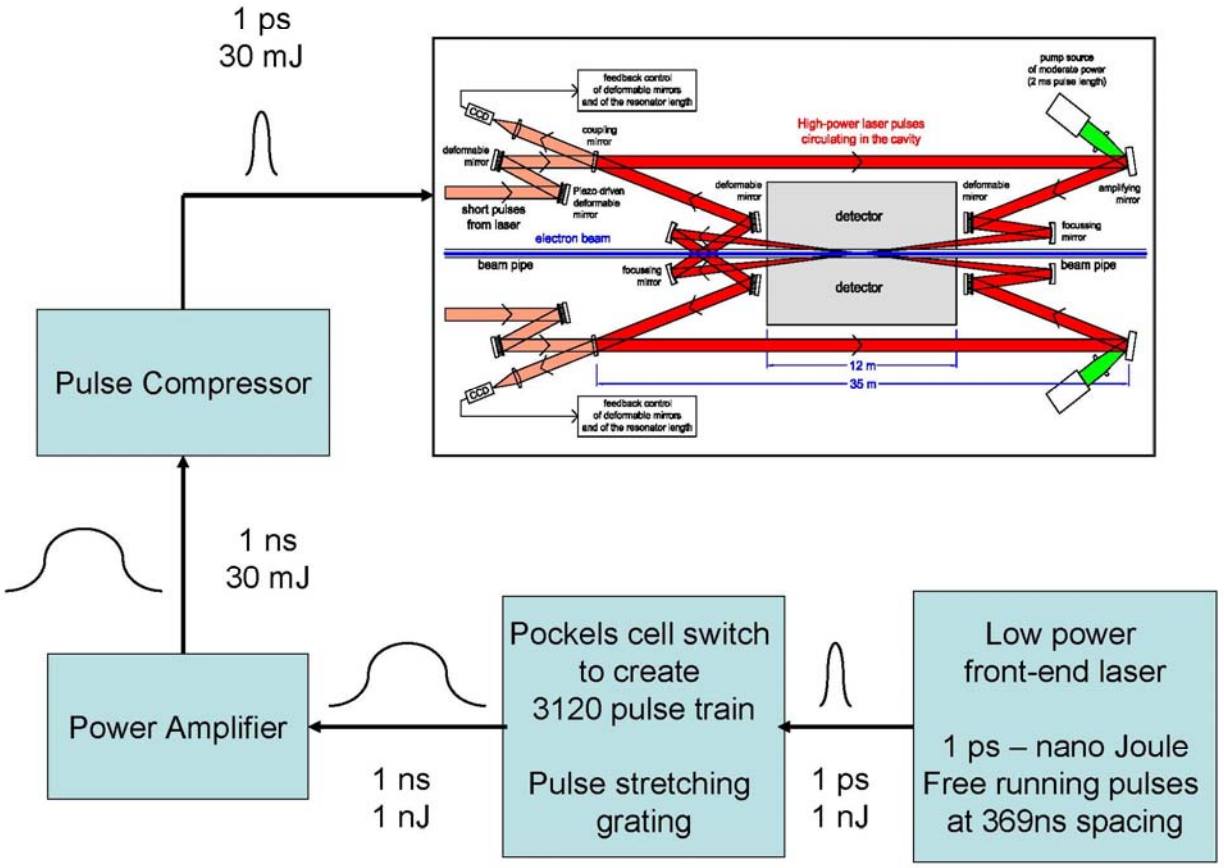
KEK - Hiroshima





Next step develop a conceptual design for a photon collider laser - LLNL

- Average power of ~500W
  - Been done before
  - But not with
    - ps pulse
    - Good wavefront quality
    - Time formatting
- In 2009 we will create a conceptual design for the laser system
  - Identify any technology limitations
  - Understand the R&D path to demonstrating a workable system

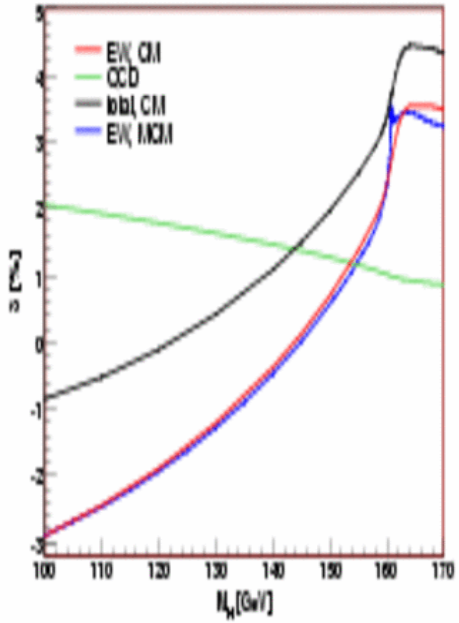


PLC could provide precise $\Gamma_{H\to\gamma\gamma}$ NLO theoretical corrections now available

EW/QCD corrections to $H \to \gamma\gamma$

$\Rightarrow$ $\Gamma_{H\to\gamma\gamma} \to 3\%$ assuming $\mathrm{Br}_{H\to b\bar{b}} \to 2-3\%$

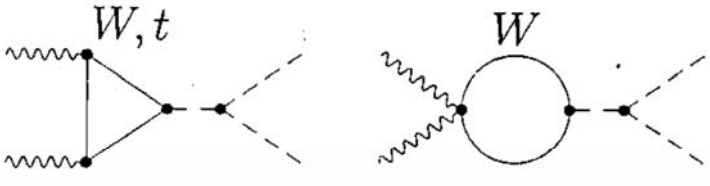
Summary of EW/QCD corrections to $H\to\gamma\gamma$ for $100\ \mathrm{GeV} < M_H < 170\ \mathrm{GeV}$



Theory side: SM radiative corrections to $\Gamma_{H\to\gamma\gamma}$ needed to match the % experimental accuracy, to distinguish between standard/non standard Higgs, to reveal possible unknown charged particles in loops

- Light Higgs, screening between QCD and EW NLO effects:
  $M_H = 120\ \mathrm{GeV} \Rightarrow \delta = -0.1\%$ → one order of magnitude less than the expected experimental accuracy at the ILC
- Heavier Higgs, enhancement between QCD and EW NLO effects: $M_H = 170\ \mathrm{GeV} \Rightarrow \delta = +4.4\%$

1st look at Higgs self coupling



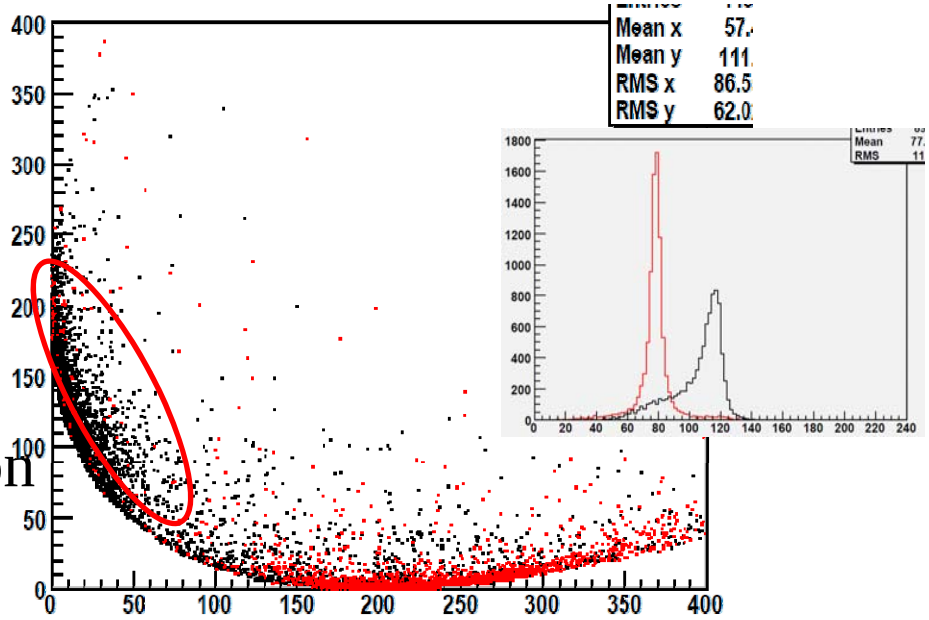
- Signal $\gamma\gamma \rightarrow h \rightarrow hh$
- Background $\gamma\gamma \rightarrow WW$

$$\lambda = \lambda^{SM}(1 + \delta\kappa)$$

jet-jet mass distribution
best combination w.r.t. χ^2

Signal ~ 0.205fb
20events@Ltot=1000fb^{-1}
~12events/year

Background ~50pb after con on
with luminosity distribution.



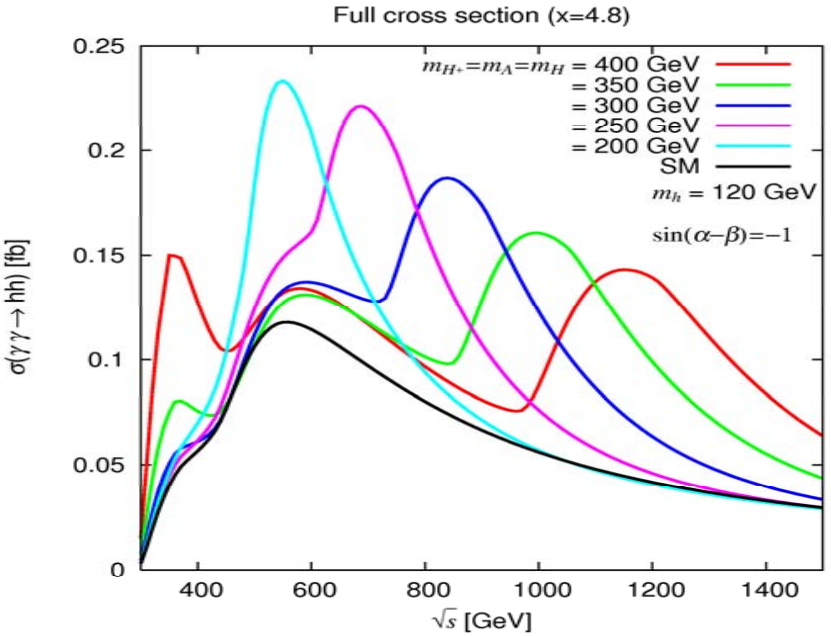
$$\chi^2_W \equiv \left(\frac{m_{ij} - m_W}{\sigma}\right)^2 + \left(\frac{m_{kl} - m_W}{\sigma}\right)^2$$

ï‡

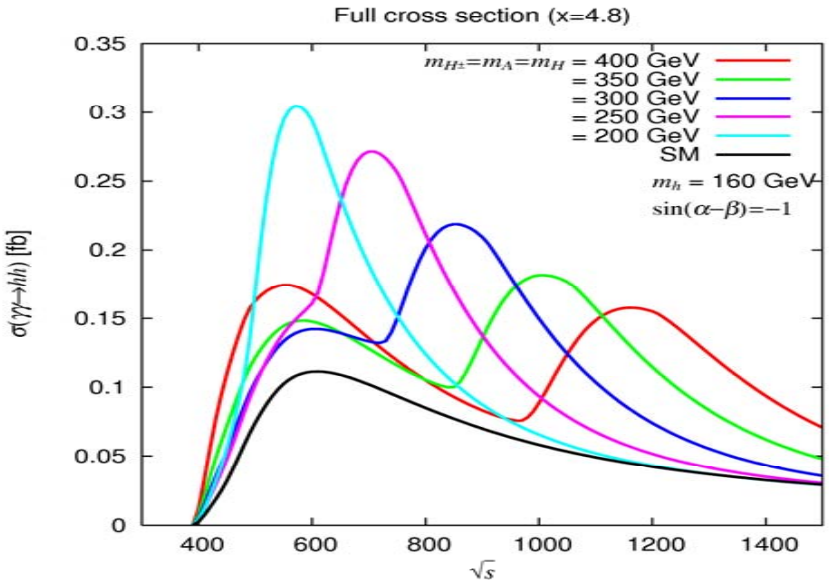
$$^2_H = \left|\frac{m_j - m_H}{ïf}\right|^2 - \left|\frac{m_k - m_H}{ïf}\right|^2$$

Higgs boson pair production at PLC in the two Higgs doublet model

$m_h = 120$ GeV



$m_h = 160$ GeV



- The cross section strongly depend on m_h m_Φ $\sqrt{s}$

	THDM $m_\Phi = 450$GeV	200GeV	SM
$\sqrt{s} = 350$GeV $m_h = 120$GeV	$\sigma \sim 0.3$fb	$\sigma \sim 0.05$fb	$\sigma \sim 0.05$fb
$\sqrt{s} = 600$GeV $m_h = 160$GeV	$\sigma \sim 0.2$fb	$\sigma \sim 0.3$fb	$\sigma \sim 0.1$fb

Conclusion

- Progress on technological issues needed to build a PLC
- Will continue to develop the program in order to respond to LHC discoveries
  - **So far, focus on light Higgs**
  - **Let's not forget SUSY capabilities of eg for sleptons and gg for charginos**
- Hope to have answers to a number of questions that need input from other subgroups by the next LCWS meeting
  - **To early to say if PLC is more cost effective and easier to built for a low energy Higgs machine E_{ee}=150 GeV**