“Higgs” Factory at the Greek-Turkish Border

Evangelos Gazis
National Technical University
Athens

ILC & more: a miniworkshop for the INFN and International community

16-17 May 2013 *Centro Volta -Villa del Grumello*

Serkant Ali CETİN
Doğuş University, Istanbul, Turkey

Evangelos N. GAZIS
National Technical University, Athens, Greece

Bora ISILDAK
OÅNzyeğin University, İstanbul, Turkey

Fatih OÅNmer İLDAY
Bilkent University, Ankara, Turkey

Konstantinos KORDAS and Chariclia PETRIDOU
Aristotle University of Thessaloniki, Thessaloniki, Greece

Yannis K. SEMERTZIDIS
Brookhaven National Laboratory, New York, USA

Saleh SULTANSOY
TOBB Economy & Technolgy University, Ankara, Turkey and
ANAS, Institute of Physics, Baku, Azerbaijan

GoÅNkhan UÅNNEL
University of California at Irvine, Irvine, USA

Konstantin ZIOUTAS
University of Patras, Patras, Greece

Outline

- **Introduction – Motivation**
  - Higgs Boson Discovery
  - Higgs Production
    1. **e+e− collider**
    2. **photon-photon collider**
    3. **a muon collider**
- **Photon-Photon Collider**
- **Electrons and Positrons vs Photons**
- **Photon Collider Specifications**
- **Greek-Turkish Proposal**
- **Conclusions**

Introduction - Motivation

The HIGGS BOSON discovery at the LHC, leads to the next step for a machine to produce in a dedicated factory for detailed studies:

1) **e+e− collider** at a center of mass of about 260 GeV to produce ZH final states

2) **photon-photon collider** at the resonance of 126 GeV (corresponding to Eee=160 GeV)

3) **a muon collider** at the resonance of 126 GeV

The 3rd requires a serious research and development effort, among other topics on the **muon cooling**, making it the least feasible at the present time.

Introduction - Motivation

The σ_Z = 0.2 pb of the Z associated Higgs production at the e +e− collider @ $\sqrt{s}$ = 260 GeV with unpolarized beams

About the same σ_H as the direct Higgs production at a polarized gamma-gamma collider.

Such a photon collider could be obtained from electron beams of 80 GeV via **Inverse Compton Scattering**. The achievable luminosities are also comparable: L =10^{33} cm^{-2} s^{-1}, as is shown in **Eur. Phys. J. C28:27-44, 2003**.

The photon-photon collider option has the advantage of the determination of the spin and CP properties of the new boson, by adjusting the polarization of the electron and laser beams

Photon – Photon Collider

An Old idea of a photon-photon collider first suggested in 1982

I.Ginzburg, G.Kotkin, V.Serbo, V.Telnov: On possibility of obtaining gamma-gamma, gamma-electron beams with high energy and luminosity, JETP Lett. 34 (1982)

and later updated for various electron machines that were planned:

V. Telnov, The Photon Collider at TESLA, NIM A472, 43-60 (2001)

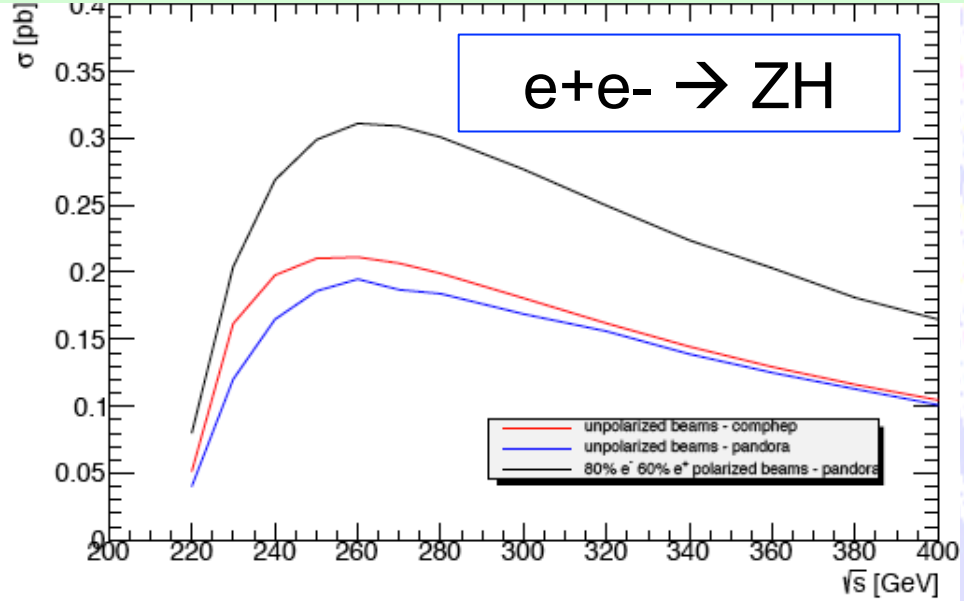
ICFA Beam DynamicsWorkshop: Accelerators for a Higgs Factory, Linear vs. Circular (HF2012), *(05 Nov 2012)*

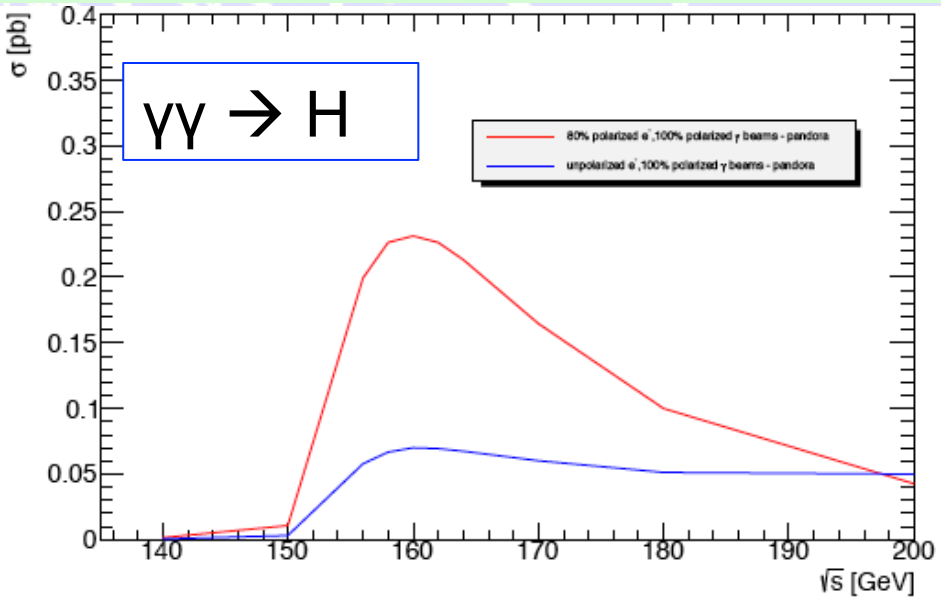
27 Talks given for Higgs Factory / 4 Talks for photon-photon collider

Electrons & Positrons vs Photons

Electron-Positron Collider	Photon-Photon Collider
1. circular or linear machine 2. re-using the positrons at the expense of a large radius of curvature to reduce the energy loss by synchrotron radiation 3. σ_{ZH} = 0.20 pb (unpolar) = 0.31 pb (polar, ~80%)	1. circular or linear machine 2. Polarized electron beams (~80%) for gammas and 100% Laser polarization, 3. σ_Z = 0.23 pb 4. Possible γe^- collisions to measure the triple gauge boson coupling WWγ

CompHEP (NIM A534, 2004, 250), PANDORA (http://www-sldnt.slac.stanford.edu/nld/new/docs/generators/pandora.htm)





Photon – Photon Collider Specifics

ACCELERATOR

An electron linac with two arcs bending in opposite directions

Simple and cheap option

Two electron linacs facing each other, 80 GeV each

Option with better performance

Both options use the CLIC technology with gradient 100 MV/m, getting electron beam energy 80 GeV in ~1.5 km length (ILC SC technology 35 MV/m)

High energy photon beam via Compton backscattering of a laser beam off the electron beam at Conversion Point (CP), prior to γγ interaction point of collisions (< 5 cm)

Photon – Photon Collider Specifics

LASER TECHNOLOGY

Highly intense ultrafast pulses

The high flux translate into large average powers, PLUS high peak powers and short pulses to maximize the interaction cross section for (inverse) Compton scattering, appears to be most feasible approach to laser-based gamma ray generation.

Three potential technology lines to achieve the desired laser parameters:

(1) Traditional solid state laser technology,
(2) thin-disk lasers,
(3) fiber lasers

In all three cases, conversion to 0.5 μm region is accomplished via second harmonic generation (SHG).

The combined system, after SHG, can offer 50 mJ/pulse with 5 J/burst at 1 kHz and 5 kW average power at 530 nm.
Pulse durations in the range of 1 ps could be targeted.

Photon – Photon Collider Specifics

Gamma-Gamma Collider Parameters

Table I: The parameters of the proposed $\gamma\gamma$ collider

Parameter	Value
Ee^- (GeV)	85 (80)
Eγ (GeV)	64
$\mathcal{L}_{\gamma\gamma}$ (10^{33} cm^{-2} s^{-1})	1 .. 10
Laser wavelength (μm)	0.53 (0.38)
repetition frequency (Hz)	same as electron beam

Photon – Photon Collider Specifics

PHYSICS POTENTIAL

a 160-GeV photon collider could provide:

1. studies on the “Higgs” properties
2. studies on the W-W-γ coupling
3. Other studies:
   - ✓ photon structure function via γe- collisions
   - ✓ gluon distribution of the photon
   - ✓ spin dependent structure function of the photon (polarization change)
   - ✓ investigation of the WWγγ quartic vertex

Photon – Photon Collider Specifics

LOCATION

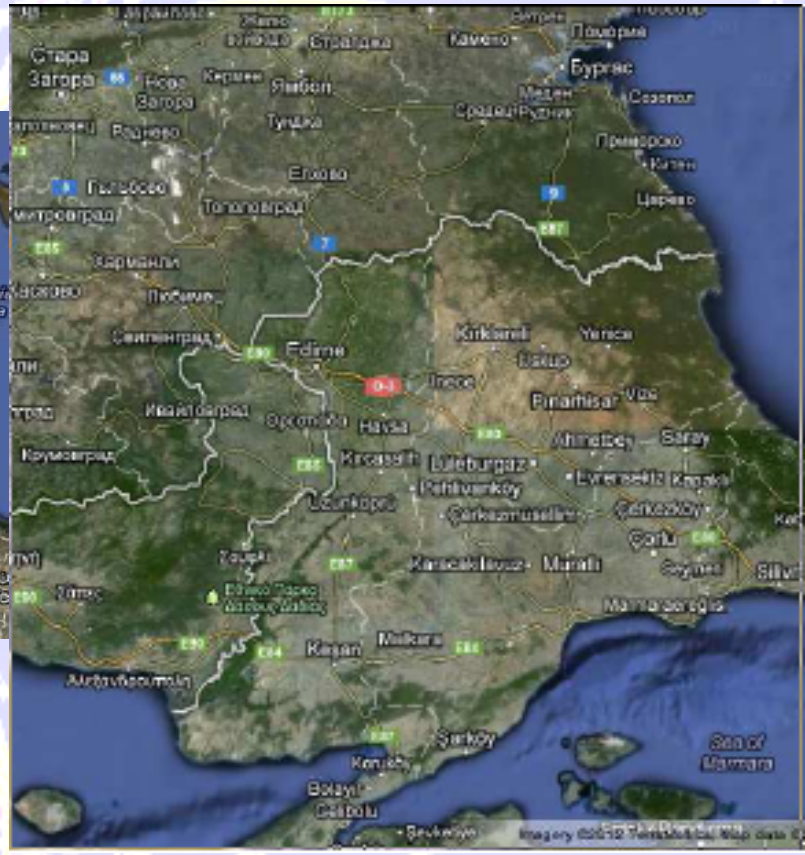
It is proposed the establishment of a regional laboratory in **Thrace** to promote the accelerator and high energy physics potential of South-East Europe, Caucasus and Middle-East.

Thrace region has a low cost of real estate, manpower and living. Therefore the overall project would require lower investments compared to a similar installation at CERN or at any other Western European location.

Additionally, the local industries would benefit from this project and the region would greatly develop, leading to an increased gross regional productivity.

Photon – Photon Collider Specifics

LOCATION



CONCLUSIONS

It is proposed a photon collider for a multitude of reasons:

1. **a detailed study of the Higgs boson**

2. **The γe^- collisions open the potential for other physics studies**

3. **the South-East Europe, Caucasus and Middle-East region (double country area: Greece-Turkey, even triple with Bulgaria), will benefit from an international scientific laboratory, inspired from the very successful CERN experience**

Epilogue

" … 'Ων έστιν γάρ ημίν τοίσί τε των φυσίων τοίσί τε των τεχνέων οργάνοις επικρατέειν, τουτέων εστίν ημίν δημιουργοίς είναι, άλλων δέ ούκ έστιν. "

Ιπποκράτης 460-370 π.Χ.

"… there, we can prevail with the help of the physical or the scientific instruments; there we, only, have the possibility to become creators. "

Hippocrates 460-370 BC