

# An X-band $e^+e^-/\gamma\gamma$ Higgs factory at KEK

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R. Belusevic: KEK Preprint 2008-33, ArXiv:0810.3187v2

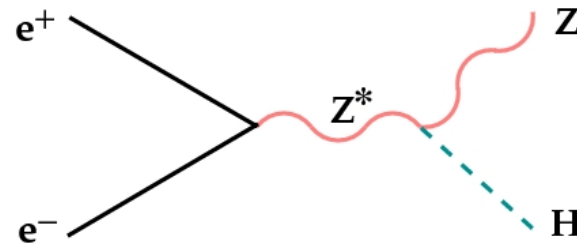
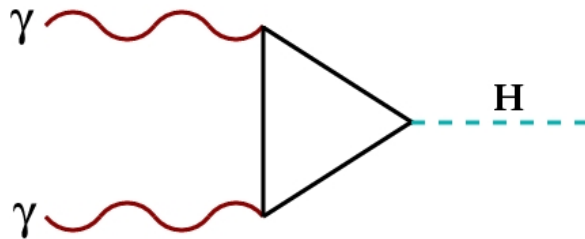
# Main characteristics of the proposed facility:

- 1 Based on **CLIC-type** cavities and the existing RF technology (XL4 klystrons, ScandiNova modulators, SLED II system)
- 2 A **two-beam scheme** could be implemented at a later stage as a test facility for CLIC
- 3 An **optical FEL** would be used to produce high-energy photon beams for a  **$\gamma\gamma$  collider**
- 4 In the **first stage** of operation ( **$e^+e^- \rightarrow Z, WW$**  and  **$\gamma\gamma \rightarrow H$** ) the proposed facility could be built within the KEK site

# Main characteristics of the proposed facility:

- 5 If the initial operational mode is with photon beams, then there is no need for an **e+ source** and a positron **DR**
- 6 With a **crossing angle** of  $\sim 25$  mrad for both  $e^+e^-$  and  $\gamma\gamma$  beams, only a single **beam dump** line would be required
- 7 For some processes, the required **CM energy** is considerably lower at the proposed facility than at an  $e^+e^-$  or  $pp$  collider
- 8 The rich set of **final states** in  $e^+e^-$  and  $\gamma\gamma$  collisions is essential for measuring all the properties of the **Higgs boson**

# Higgs production in $e^+e^-$ and $\gamma\gamma$ collisions



The following Higgs properties can be measured in these processes:

$M_H$ , spin, CP

CP violation

$\Gamma_{\gamma\gamma}\text{Br}(W^*W)$

$\Gamma_{\gamma\gamma}\text{Br}(bb)$ , ...

$M_H$ , spin, CP

H-Z coupling

$\Gamma_{\text{tot}}$

$\text{Br}(W^*W)$ ,  $\text{Br}(bb)$ , ...

Combining the two sets of measurements yields  $\Gamma_{\gamma\gamma}$ , which is a unique measure of physics beyond the Standard Model.

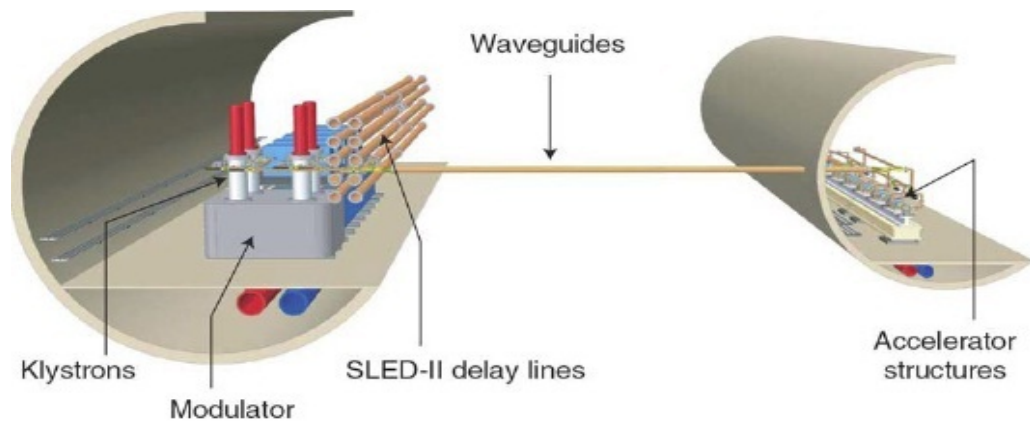
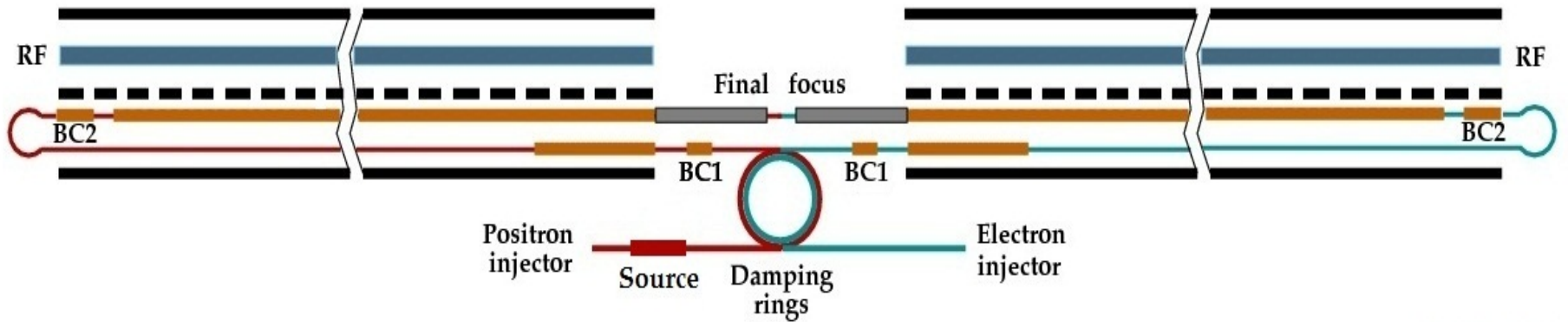
# Higgs self-coupling in $e^+e^-$ and $\gamma\gamma$ collisions

The trilinear Higgs self-coupling can be measured in the process  $\gamma\gamma \rightarrow HH$  just above the kinematic threshold of  $2M_H$  ( $E_{ee} \sim 340$  GeV), and at  $E_{ee} \sim 500$  GeV in the process  $e^+e^- \rightarrow ZHH$ .

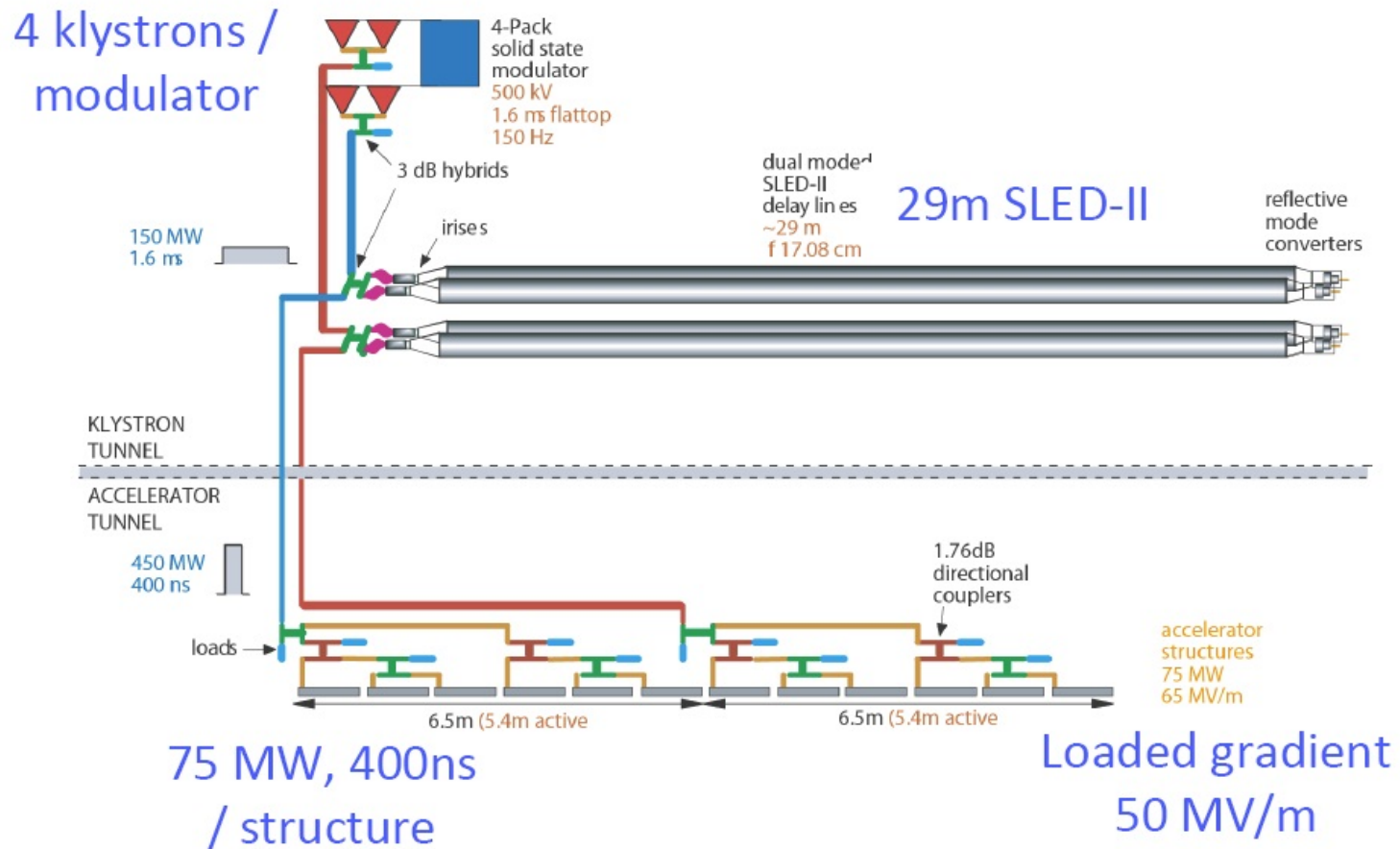
Sensitivity to the trilinear Higgs self-coupling is expected to be similar in  $e^+e^-$  and  $\gamma\gamma$  collisions. Detailed MC simulations are currently carried out at Hiroshima University and KEK (K. Fujii et al.).

R. Belusevic & G. Jikia: Phys. Rev. D **70**, 073017-1 (2004)

# Schematic layout of the collider



# GLC RF configuration



# Rough design parameters

## (1)

T. Higo

	GLC	CLIC500	CLIC	Stage 1
Total CM energy (GeV)	500	500	3000	250
Loaded accelerator gradient (MV/m)	50	80	100	85
Effective gradient (MV/m)	44			70
Linac length (km)	14.5			3.6
Klystron peak power (MW)	75			40
Klystron pulse length ( $\mu$ s)	1.6			1.0
Pulse compression ratio	4			4
Power / structure	75			52
RF pulse length	400			250
Beam current	0.86	2.2	1.2	1.2



# Rough design parameters

## (2)

T. Higo

	GLC	CLIC500	CLIC	Present
Number of particles in a bunch $10^{10}$	0.75	0.68	0.37	
Bunch spacing (ns)	1.4	0.5	0.5	
Number of bunches / train	192	354	392	
Bunch train length (ns)	267	177	196	
.....				
Wall plug power (MW)	233			
Peak luminosity ( $10^{34}$ )	2.5			
Cost				

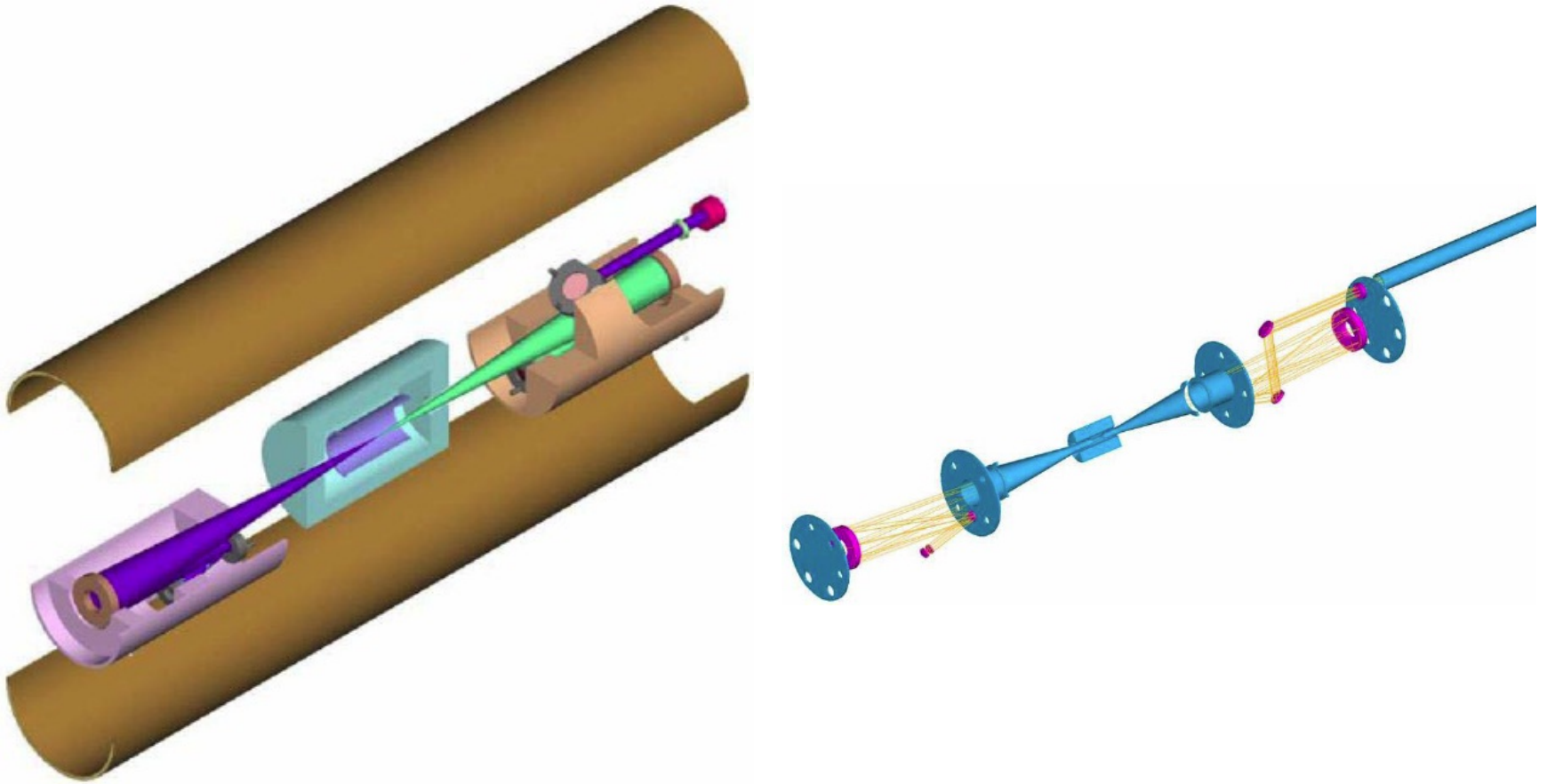
# Rough design parameters

(3)

T. Higo

	GLC	CLIC500	CLIC	Present
Modulator				
Klystron				XL4/PPM
Pulse compression				SLED II
Power delivery				Low loss WG
Acc. structure length (m)	0.6		0.25	0.25
Phase advance / cell	$5\pi/6$	$5\pi/6$	$2\pi/3$	$2\pi/3$
Structure filling time (ns)	120	50	67	67
Beam hole aperture 2a (mm)	0.21-0.15	<0.145>	<0.11>	<0.11>
Vg/c (%)	5.1 – 1.1	1.9 – 1.1	1.7 – 0.8	1.7 – 0.8

# Optics assembly at the $\gamma\gamma$ interaction region



Elements of the assembly were designed and prototyped at LLNL

## Concluding remarks:

The proposed facility would be a **highly versatile** Higgs factory.

The total length of the two linacs would be only about 3.6 km at  $E_{ee} \sim 250$  GeV.

If a **two-beam scheme** is implemented (even partially) at a later stage, the proposed X-band machine could serve as a genuine test facility for CLIC.