Full Detector Simulation of $e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$ at CLIC

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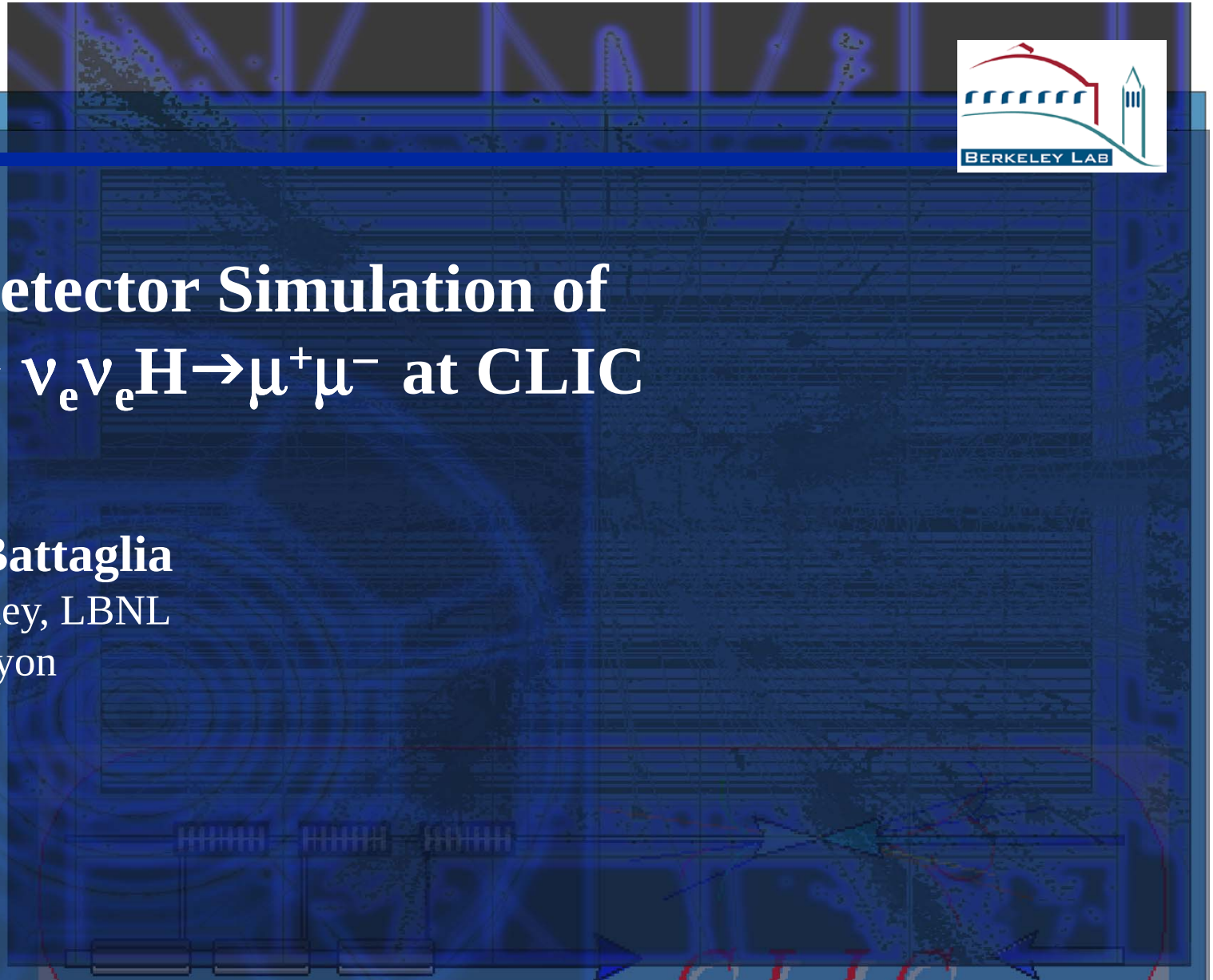

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CERN, October 15, 2008

A Detector Concept for CLIC

Several performances proposed for the CLIC detector obtained with an ILC-type detector optimised at lower energies;

SiD appears as useful concept to study details of experimentation at CLIC;

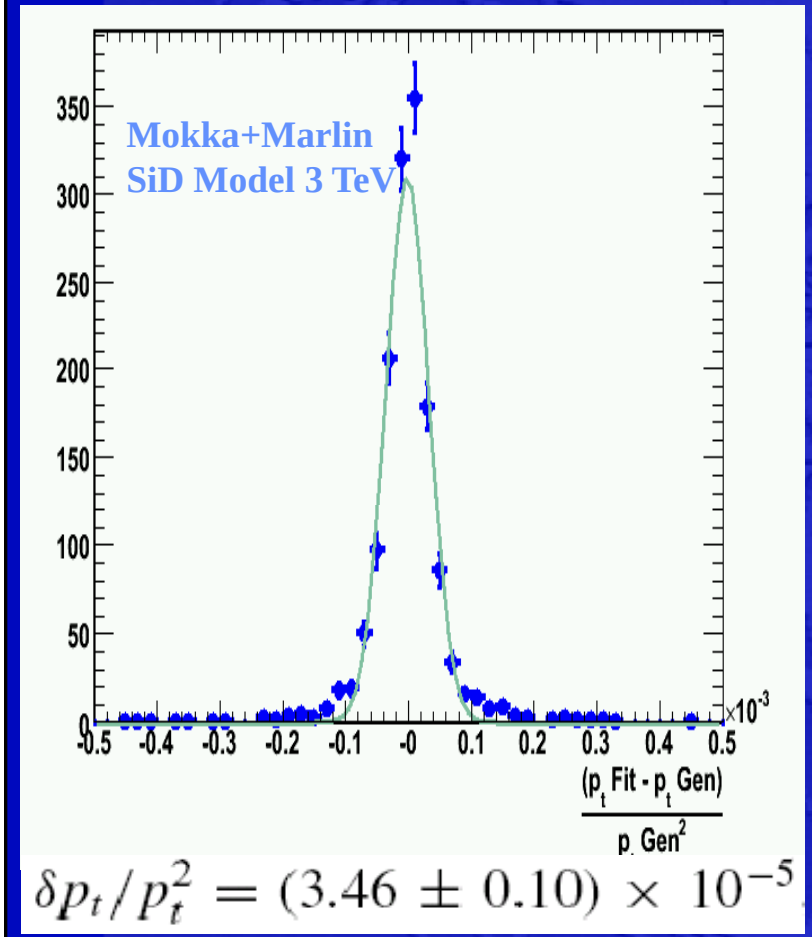
But best suited tracker technology for CLIC
(continuous 3D TPC vs 2D Si strips vs 3D Si pixels)
needs to be assessed by current study;

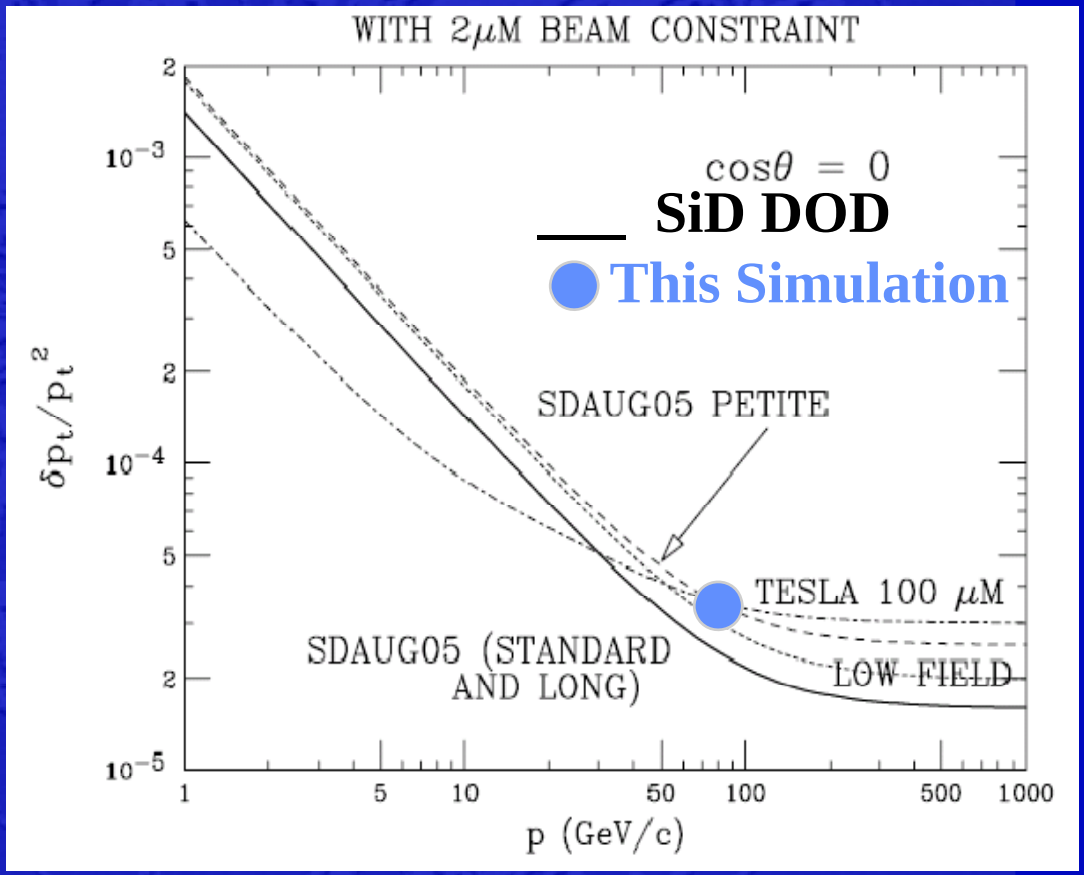
$\delta p / p^2 GeV^{-1}$	Tracker Only	All Tracker
LEP	$1.2\ 10^{-3}$	$5\ 10^{-4}$
LHC	--	$2\ 10^{-4}$
ILC	$1.5\ 10^{-4}$	$3\text{-}6\ 10^{-5}$

Is the ILC momentum resolution sufficient at CLIC energies ?

SiD G4 Simulation with MOKKA

Track reconstruction using 5-layered Si Main Tracker + Vertex Tracker;
Full PatRec and KF in Marlin C++ framework;





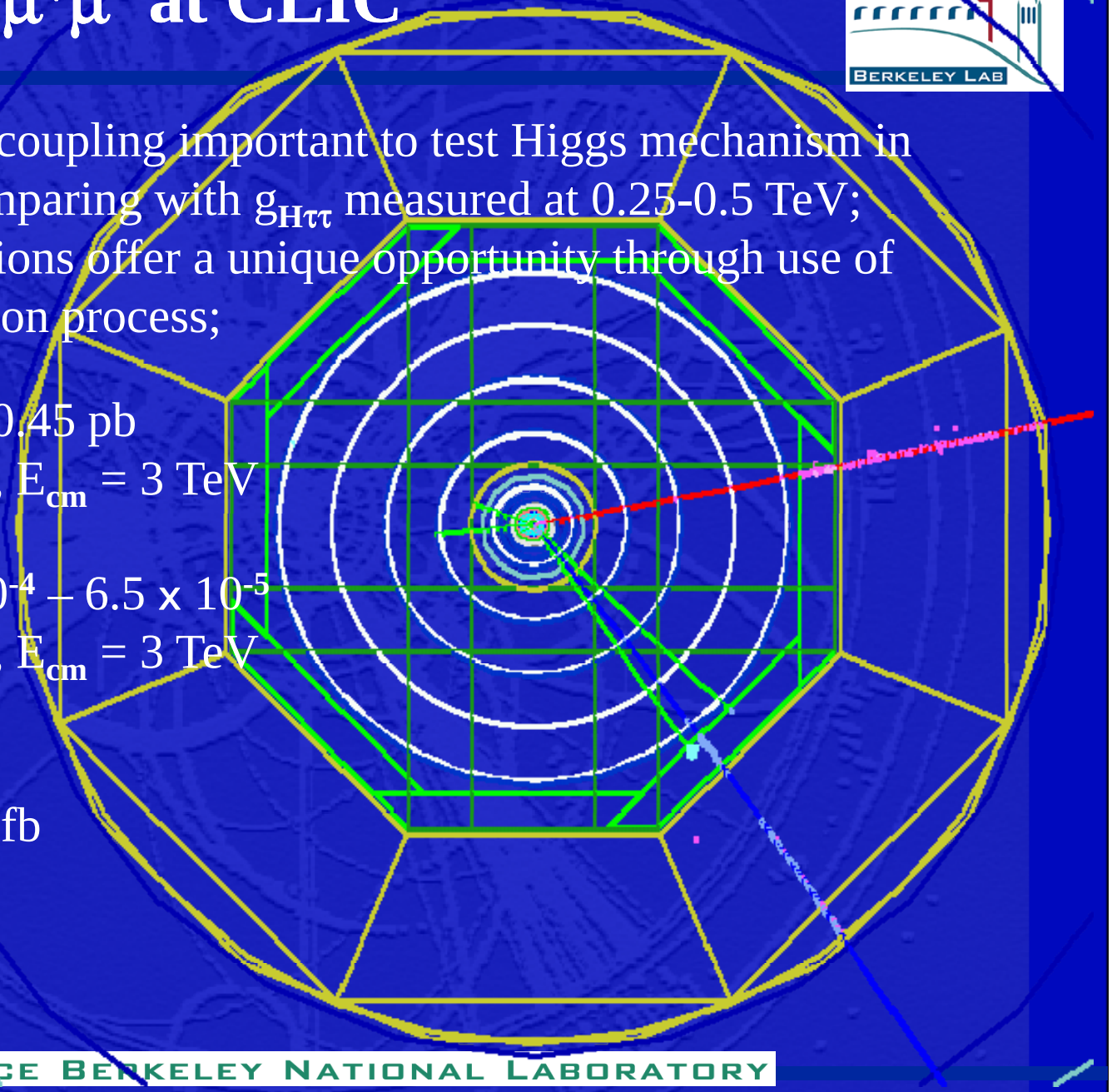
$e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$ at CLIC

Determination of $g_{H\mu\mu}$ coupling important to test Higgs mechanism in lepton sector when comparing with $g_{H\tau\tau}$ measured at 0.25-0.5 TeV; high energy e^+e^- collisions offer a unique opportunity through use of WW fusion H production process;

$\sigma(e^+e^- \rightarrow H\nu\nu) = 0.48\text{-}0.45$ pb
for M_H=120-150 GeV, E_{cm} = 3 TeV

$BR(H \rightarrow \mu\mu) = 2.6 \times 10^{-4} - 6.5 \times 10^{-5}$
for M_H=120-150 GeV, E_{cm} = 3 TeV

SM Background
$\sigma(e^+e^- \rightarrow \mu\mu\nu_l\nu_l) = 5.3$ fb



$e^+e^- \to \nu_e\nu_e H \to \mu^+\mu^-$ at LHC and ILC

LHC

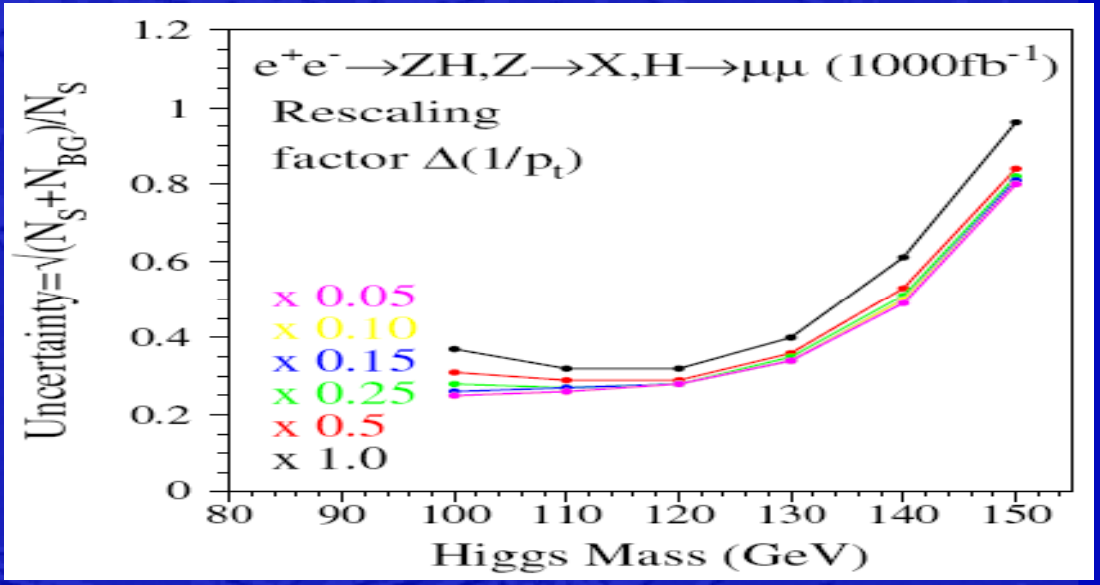
(Han, McElrath, PLB528 (2002))

m_h(GeV)	Luminosity required for 3σ observation (fb^{-1})			Significance for 300 fb^{-1}		
	W,g Combined	g fusion	W fusion	W,g Combined	g fusion	W fusion
115	238	464	489	3.37	2.41	2.35
120	227	430	482	3.45	2.51	2.37
130	267	535	532	3.18	2.25	2.25
140	531	1047	1076	2.26	1.61	1.58

TABLE II: The SM results for $h \to \mu^+\mu^-$ signal from gluon fusion and weak-boson fusion and the DY background, combining the ATLAS and CMS detectors. The cuts used are in Eqs. (4) and (5).

ILC 0.5 TeV

(Yang, Riles, ALCPG 2007)



Benchmark Analysis: $e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$

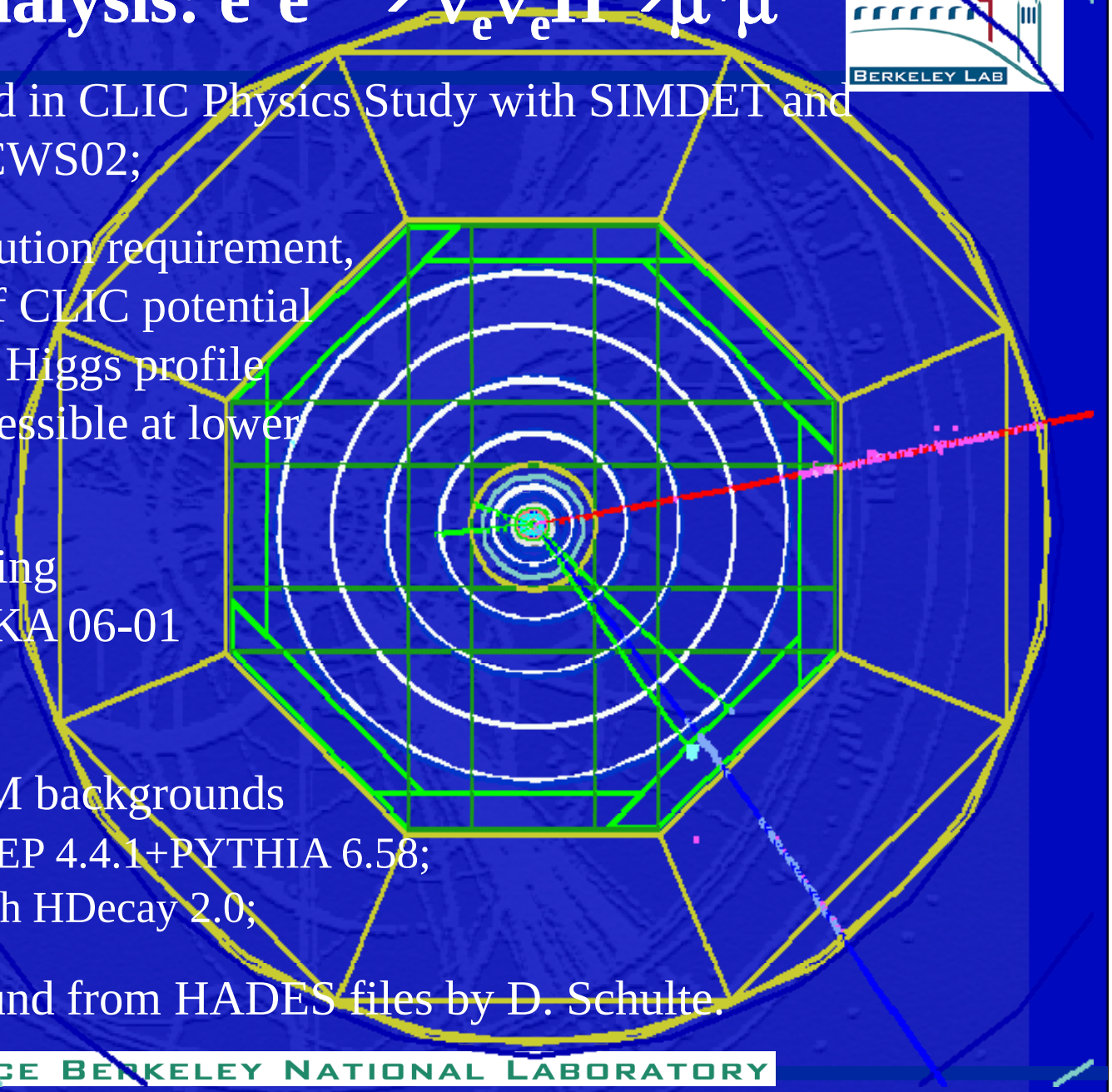
Process already studied in CLIC Physics Study with SIMDET and results presented at LCWS02;

Tests momentum resolution requirement, get realistic estimate of CLIC potential on a crucial part of the Higgs profile program not easily accessible at lower energies and LHC;

Analysis performed using SiD02 model in MOKKA 06-01 and Marlin 00.09.06;

$\mu\mu\nu_e\nu_e$ and $\mu\mu\nu_\mu\nu_\mu$ SM backgrounds generated with CompHEP 4.4.1+PYTHIA 6.58; Higgs BRs computed with HDecay 2.0;

$\gamma\gamma \rightarrow$ hadrons background from HADES files by D. Schulte.



Benchmark Analysis: $e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$

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Testing the Higgs mechanism in the lepton sector with multi-TeV e^+e^- collisions

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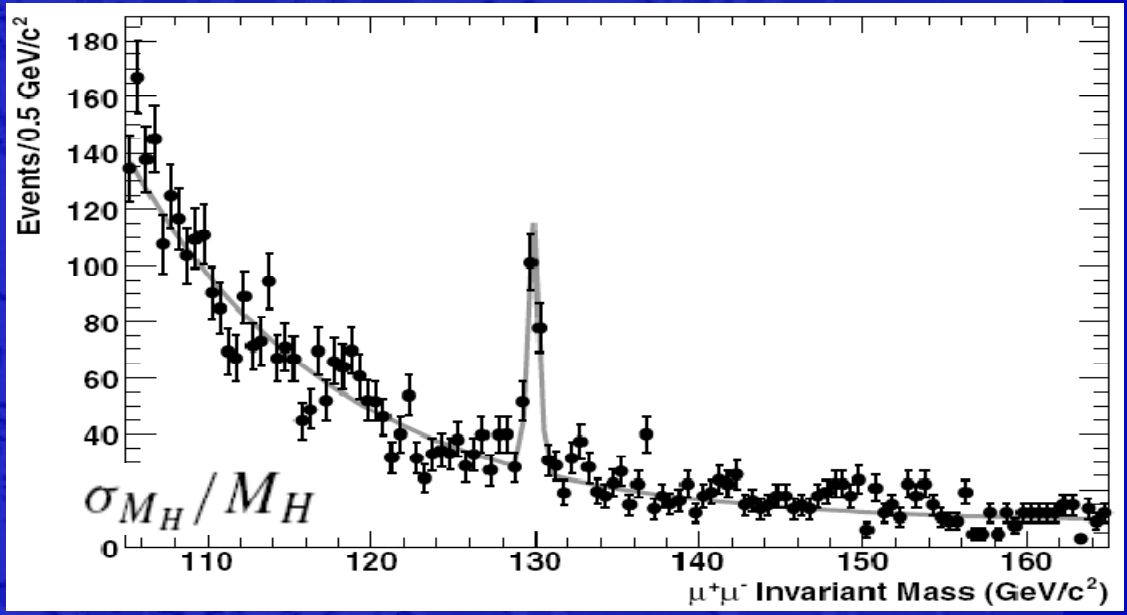
Benchmark Analysis: $e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$

σ_{M_H}/M_H = 0.0034

$\pm 2\,\sigma_{M_H}$ signal window



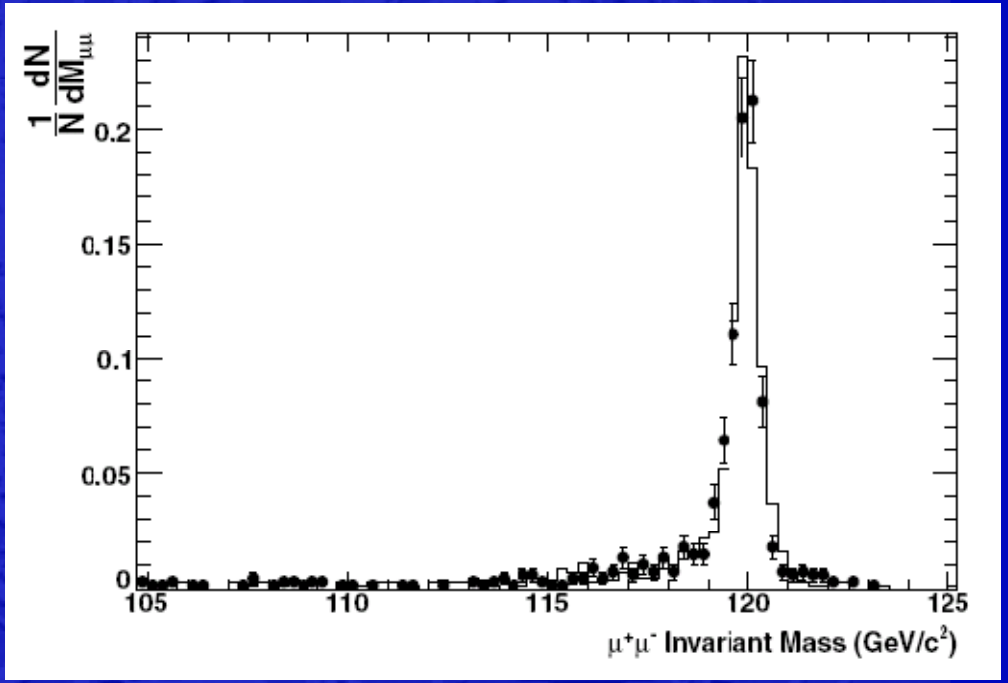
Results for 5 ab^{-1}

M_H (GeV)	Nb. signal evts.	Nb. bkg. evts.	S/$\sqrt{B}$	δBR/BR
120	229.6	161.1	18.1	0.086
130	153.1	88.1	16.3	0.101
140	103.2	64.3	12.9	0.125
150	68.1	58.1	9.5	0.160
155	68.1	58.0	5.2	0.253
160	12.1	33.0	2.1	

Benchmark Analysis: $e^+e^- \rightarrow \nu_e\nu_e H \rightarrow \mu^+\mu^-$

Test effect of overlaying
$\gamma\gamma \rightarrow$ hadron background (50 BX)

no degradation of reconstruction efficiency observed.



CLIC operating at 3 TeV and high luminosity can determine the muon Yukawa coupling $g_{H\mu\mu}$ to a statistical accuracy of 0.04-0.08 with 5 ab^{-1} of integrated luminosity and ILC-like momentum resolution.