Experience with generating SM Backgrounds for the CLIC Studies

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Some current CLIC Physics Studies

CLIC Physics studies have addressed so far event reconstruction and detector performance requirements:

Momentum resolution, beamstrahlung spectrum, beam polarisation:
e+e- → $\mu_R\mu_R$ → $\mu\mu E_{\mathbf{miss}}$ (JJB and MB; CERN-LCD-2010-005)
e+e- → $e_R e_R$, $e_R e_L$, $e_L e_L$ (JJB, MB, SB; in progress);

Unconstrained Energy resolution, di-jet mass resolution (W/Z/h separation)
e+e- → $\chi+\chi-$ → Wl $E_{\mathbf{miss}}$ (JJB, MB; in progress);

Di-jet mass resolution, kinematic fit with sqrt(s) constrain, b-tagging,
$\gamma\gamma$ → hadrons effect on event reconstruction, jet clustering algorithms:
e+e- → HA → bbbb (MB and P Ferrari; CERN-LCD-2010-006);

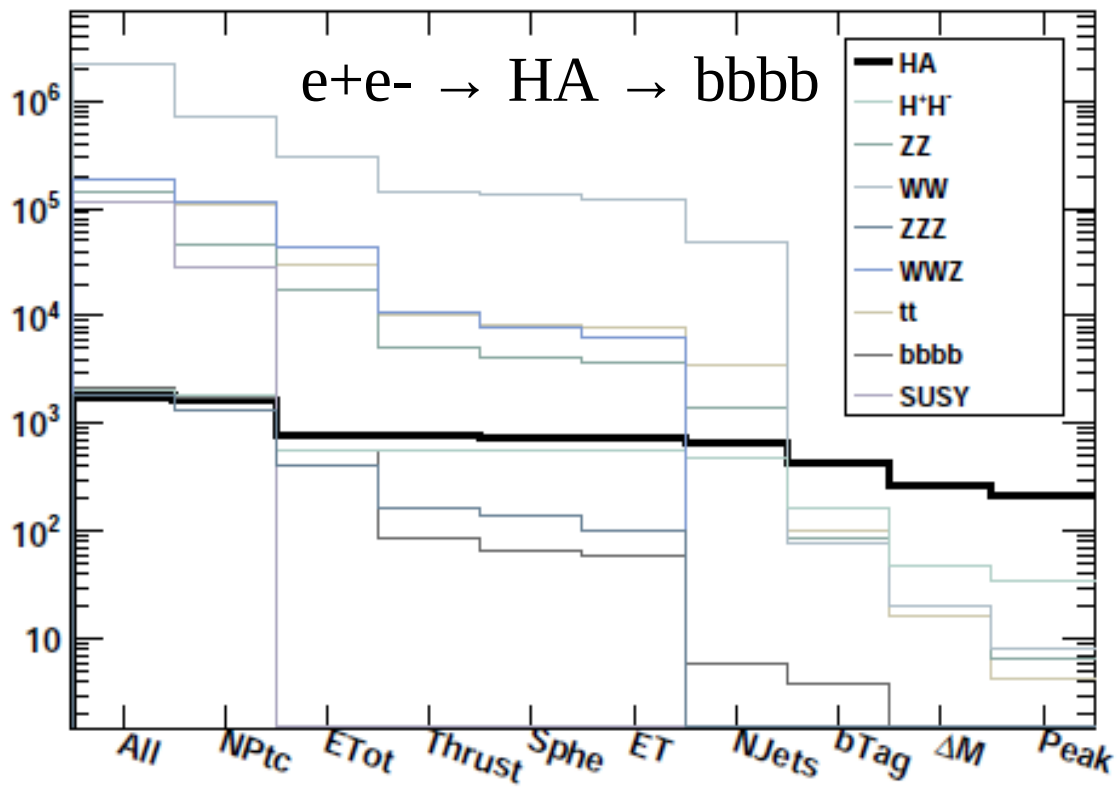
Top reconstruction, very high jet multiplicity final state, kinematic fit:
e+e- → tttt (MB and G Servant; arXiv:1005.4632 [hep-ex]);

Forward Jet reconstruction and forward b-tagging:
e+e- → $\nu\nu$H(180) → $\nu\nu$bb (WG-3; in progress)

Some current CLIC Physics Studies

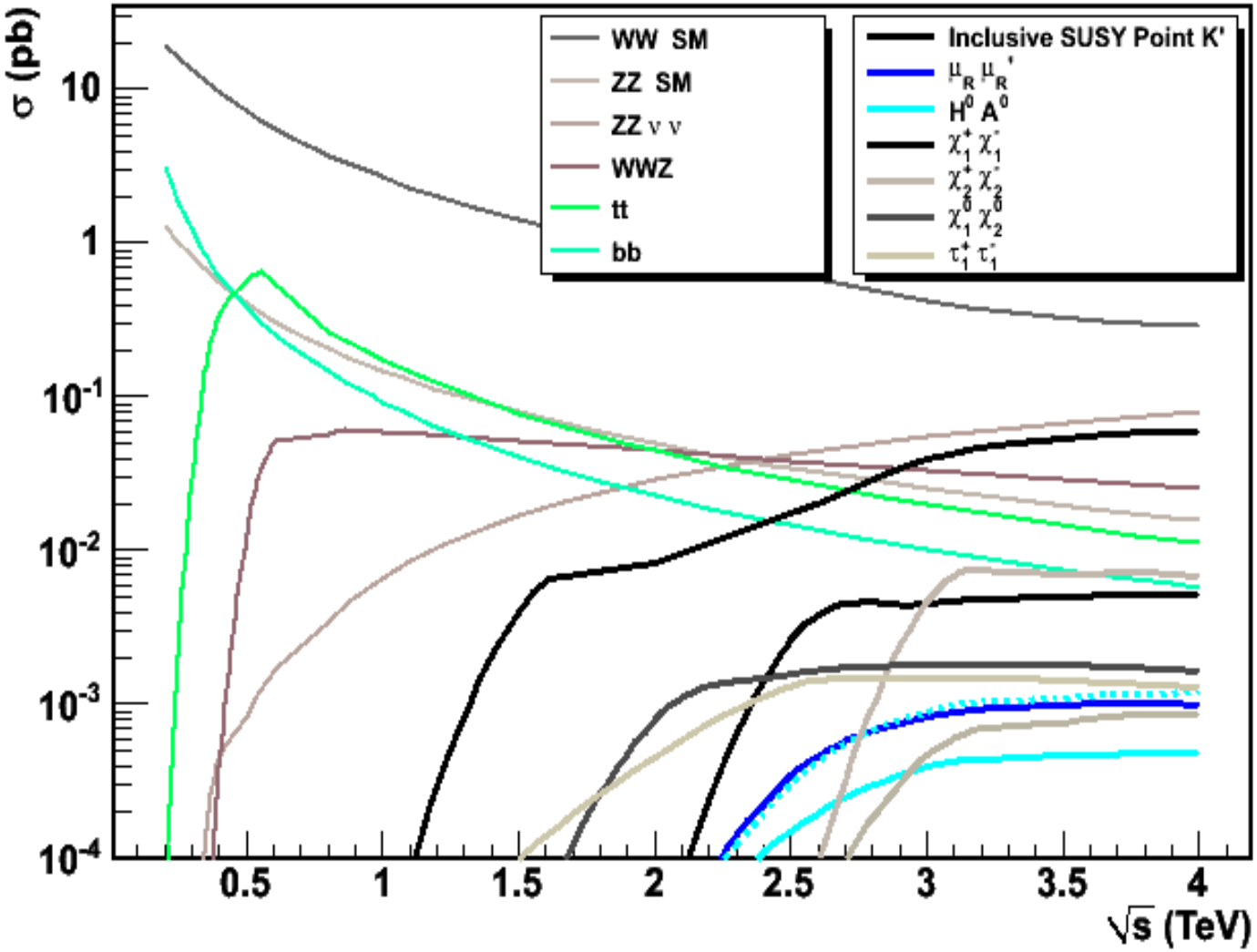
For most processes studied so far the signal is the main challenge;

At 3 TeV B/S ratios generally large: ~200 for e+e- → $\mu_R\mu_R$, ~1800 for e+e- → HA but signal of pair produced heavy particles kinematically well-separated from highly boosted SM events: background rejection by kinematical cuts, topology and flavour tagging can be factorised and used to reweight SM bkg events:



CERN-LCD-2010-006

Heavy Mass SUSY and SM Cross Sections



Generators Used for SM Backgrounds

<u>Generic SM Backgrounds</u>:
WW, ZZ, tt, ff → Pythia 6.215
WWZ, ZZZ → CompHep 4.4.0 + Pythia 6.215

<u>Analysis-specific irreducible SM bkg</u>:
bbbb, bbνν, μμνν, eeνν, tttt, ttνν
→ CompHep 4.4.0 + Pythia 6.215
(tested also WHIZARD)

<u>Two photon γγ → llee</u>
BDK (modified for DELPHI) interfaced to stdhep

~200k events fully simulated and reconstructed (Mokka_Marlin) ~30k of which with 5-40 BX of overlayed γγ → background

An example:

Data sets for $e^+e^- \rightarrow HA \rightarrow bbbb$ analysis

(CERN-LCD-2010-006)

Process	σ (fb)	Generator	Nb of Events Generated
H^0A^0	0.3	ISASUGRA 7.69+ PYTHIA 6.125	3000
Inclusive SUSY	32.5	ISASUGRA 7.69+ PYTHIA 6.125	20000
H^+H^-	0.6	ISASUGRA 7.69+ PYTHIA 6.125	3000
W^+W^-	464.9	PYTHIA 6.125	30000
Z^0Z^0	26.9	PYTHIA 6.125	15000
$t\bar{t}$	19.9	PYTHIA 6.125	15000
$b\bar{b}b\bar{b}$	0.4	CompHEP+ PYTHIA 6.125	5000
$W^+W^-Z^0$	32.8	PYTHIA 6.125	7500
$Z^0Z^0Z^0$	0.4	PYTHIA 6.125	2500

Accelerator Effects

Luminosity Spectrum:
CALYPSO interface to GUINEA PIG output in PYTHIA

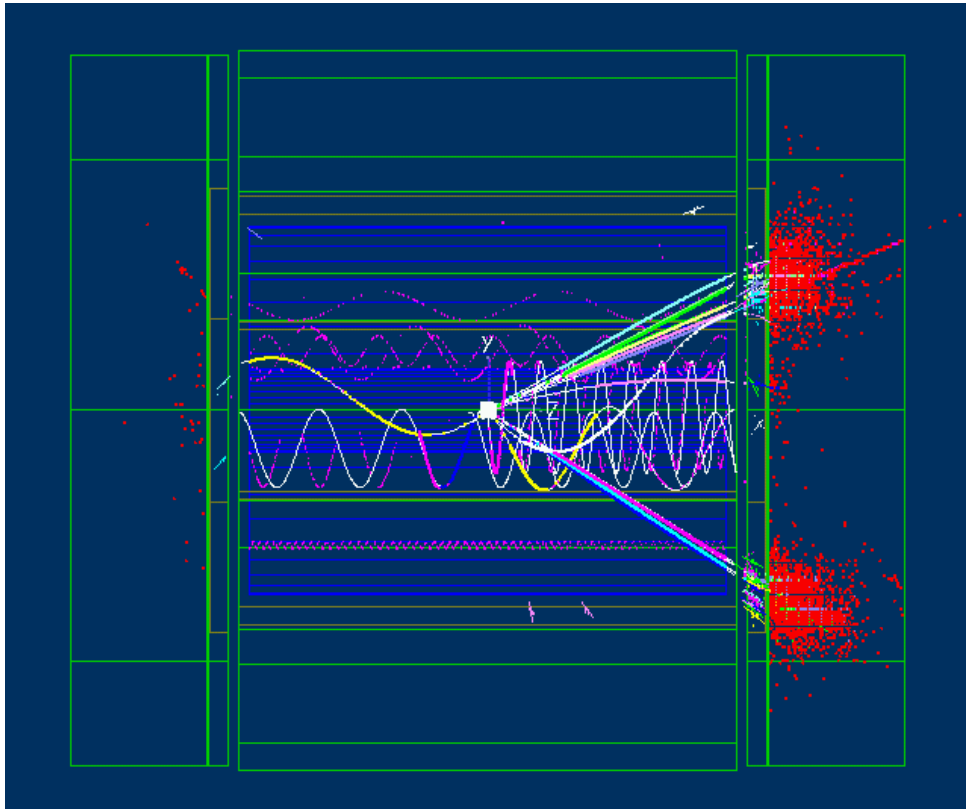
$\gamma\gamma \rightarrow$ hadrons
HADES interface to GUINEA PIG+PYTHIA output in PYTHIA
$\rightarrow$ stdhep file $\rightarrow$ Mokka $\rightarrow$ lcio file $\rightarrow$ Marlin Overlay

Incoherent Pairs
Interface to GUINEA PIG in Mokka $\rightarrow$ lcio file $\rightarrow$ MarlinOverlay

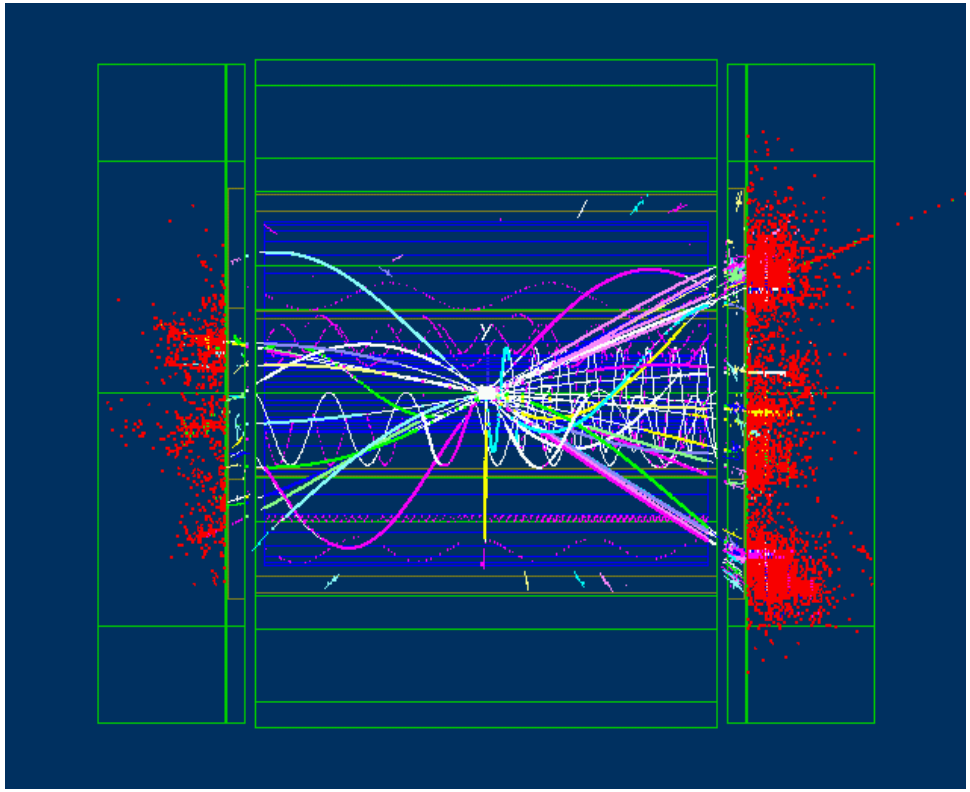
Parallel Muons
Interface to BDSIM output in PYTHIA $\rightarrow$ stdhep file $\rightarrow$ Mokka
with custom tracking plugin $\rightarrow$ lcio file $\rightarrow$ Marlin Overlay

Accelerator Effects

e+e- → ννH(180) → ννbb



e+e- only



+20 BX gg → hadrons

CLIC Experience

Important to have flexibility in generator choice but imperative to have common interface to full/fast simulation (stdhep), use same interface also for machine induced backgrounds;

Need to ensure generators are properly tuned: include LEP/SLC/B-factories engineering data on fragmentation functions, lifetimes, branching fractions, particle yields,...

Many benchmark signals have very distinctive topology and/or kinematic signature: can profit of event pre-selection in bkg data sample ($W \rightarrow l\nu$ decays, …) and weighted events in analysis;

Best strategy for SM process generation to be decided once signal benchmarks (how many, which final states ?) are agreed.