

# CLIC Benchmark Reactions: Introduction

Mark Thomson,  
University of Cambridge

## This Talk:

- ★ Purpose of Benchmark Reactions – relation to Physics Case
  - ★ The ILC Benchmarks
  - ★ Detector Issues at CLIC
  - ★ Guidelines for benchmarks for the CLIC CDR
  - ★ Timeline
-

# Purpose of Benchmarks

## Context:

### ★ CLIC CDR Volume 3: Physics and Detector

- Chapter 2: the physics case
- Chapter 3: detector requirements
- Chapter 12: detector performance

} Benchmarks

### ★ Physics Benchmarks

- Select 5 channels for **full analysis**
  - GEANT 4 detector simulation, event reco + data analysis
  - This is a significant effort, hence restrict to about 5
- Purpose: demonstrate ability “to do physics” in **CLIC experimental environment**
  - **distinct** from physics case
  - but, benchmark processes should be a sub-set of processes which form part of the physics case

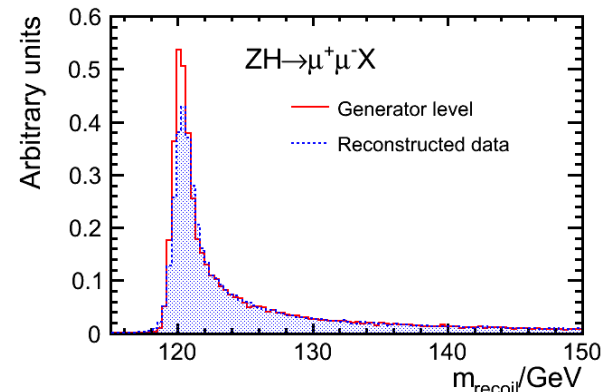
### ★ Useful to recall ILC Benchmark reactions...

# ILC Benchmarks

## ★ Higgs mass measurement from recoil mass:

$$e^+e^- \rightarrow HZ \text{ at } \sqrt{s} = 250 \text{ GeV}$$

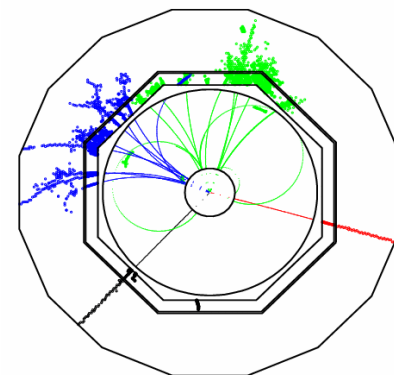
- Tests momentum resolution
- Assumed light Higgs  $m_H = 120 \text{ GeV}$



## ★ Higgs Branching fractions from

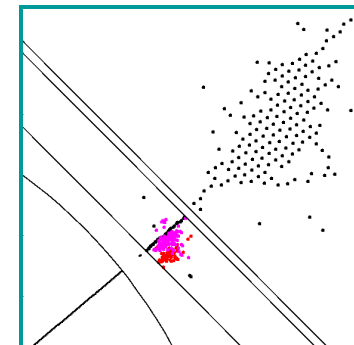
$$e^+e^- \rightarrow HZ \text{ at } \sqrt{s} = 250 \text{ GeV}$$

- In particular  $BR(H \rightarrow c\bar{c})$
- Tests flavour tagging



## ★ Tau polarization in $e^+e^- \rightarrow Z \rightarrow \tau^+\tau^-$ at $\sqrt{s} = 500 \text{ GeV}$

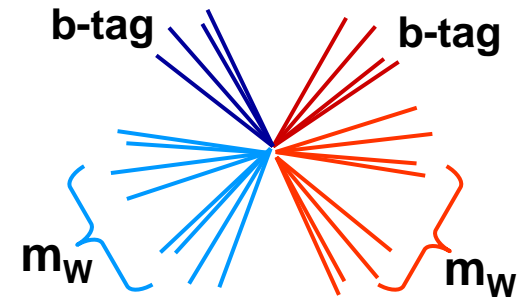
- Reconstruction of nearby particles



# ILC Benchmarks cont.

★ **Top mass and forward-backward asymmetry**  
in  $e^+e^- \rightarrow t\bar{t}$  at  $\sqrt{s} = 500\text{ GeV}$

- Tests reconstruction of multi-jet final states
- Flavour tagging
- Jet energy resolution

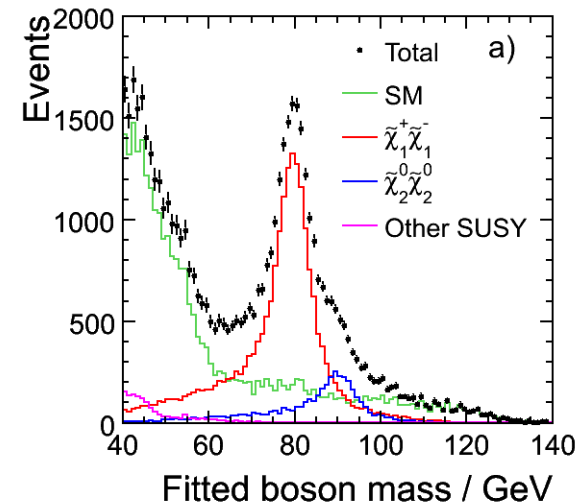


★ **Chargino/Neutralino reconstruction assuming SUSY “point 5”**

$$e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \rightarrow W^+W^- \tilde{\chi}_1^0 \tilde{\chi}_1^0 \quad \text{vs.} \quad e^+e^- \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_2^0 \rightarrow ZZ \tilde{\chi}_1^0 \tilde{\chi}_1^0$$

at  $\sqrt{s} = 500\text{ GeV}$

- Tests jet energy resolution
- Gauge boson mass reconstruction

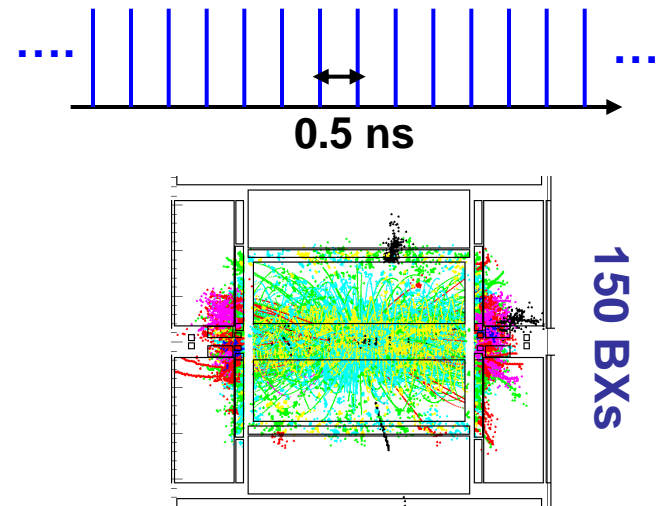


# Detector Issues at CLIC

★ **0.5 ns time structure:** detector will integrate over some number of bunch crossings

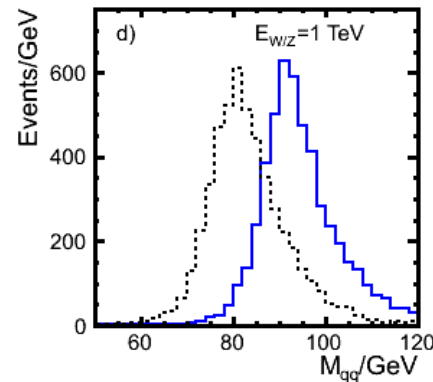
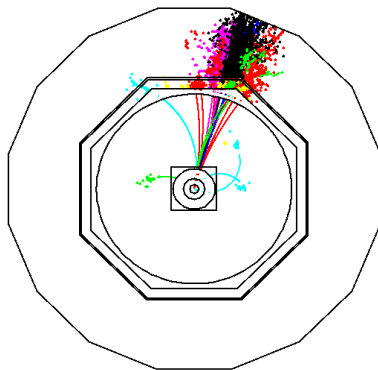
➔ Pile-up of  $\gamma\gamma \rightarrow$  hadrons

- Impact on jet finding ?
- Impact on mass reconstruction
- What timing requirements are needed?



★ **Jet energy/mass reconstruction:** challenging for  $\sim$  TeV jets

1 TeV Z



★ **High energy electron/muon reconstruction:** challenging for  $\sim$  TeV

★ **Forward jets:** challenging as background forward peaked

★ **Missing  $E_T$  reconstruction:** impact of background

# Benchmarks for CLIC CDR

Need to propose **four 3 TeV CLIC benchmark** channels

★ These should “stress” the detectors:

- high energy leptons
- reconstruction of high mass states decaying to jets
- jet physics in the forward region
- +...

Plus **one 500 GeV CLIC benchmark** channel

★ For a staged machine, compare directly with ILC performance

- ILC Higgs studies performed at 250 GeV !
- Choice probably limited to three ILC benchmarks at 500 GeV

- tau pairs
- chargino/neutralino reconstruction
- top mass reconstruction



Complex analysis

Relatively simple

## Timeline

★ Aim to have first full proposal at meeting of 19<sup>th</sup> July

- needs to be decided quickly due to simulation/reconstruction time

★ Today, discuss options

★ This week (by email) converge on a shortlist