A simulation study of heavy Higgs bosons decaying to jets at high energy regions of the ILC
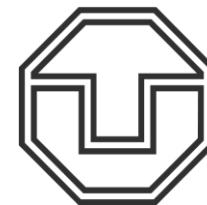
by Christian Drews

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Academic advisors: Professor Hitoshi Yamamoto (Tohoku Uni.)
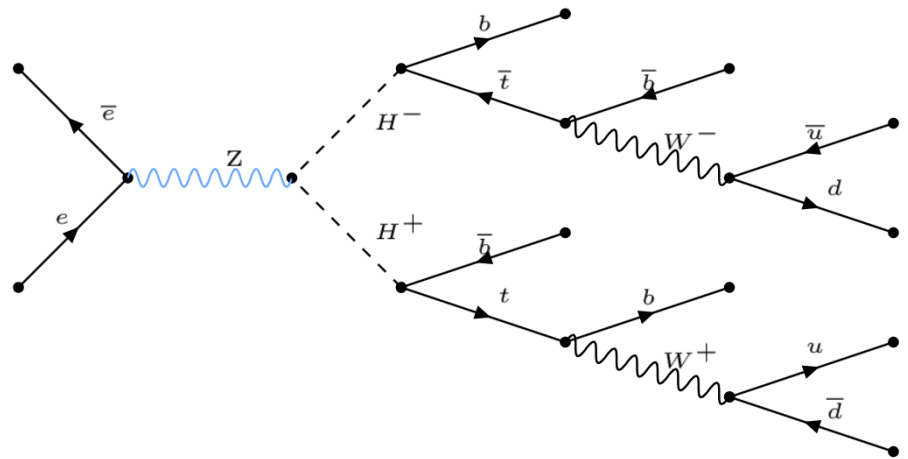Professor Arno Straessner (TU Dresden)

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Analysis Strategy

- $m_{H\pm}$ = 350 GeV
- e^+e^- -> H^+H^- -> tb tb -> Wbb Wbb $\xrightarrow{\mathrm{W}\rightarrow 2\ \mathrm{jets}}$ 8 jets
- Pairing 4 jets with lowest b tag to W mass
- Pairing 5th and 6th jet to top mass
- Pairing other jets to same invariant mass
- Background:
  - ttH/ttZ/ttg -> ttbb
  - tt -> bWbW
  - HA -> bbbb (SUSY)
- Later semi-leptonic mode will be included

Analysis Strategy - Chi^2

- Jet pairing has 40320 combinations
- With b tag consideration –> 576 combinations
- without exchanging jets from W-bosons and tob quarks -> 36 combination
- For mass measurement the mass of H$^\pm$ can not be fixed

$$\chi^2 = \left| \frac{(m_{j_1 j_2 j_3 j_4})^2 - (m_{j_5 j_6 j_7 j_8})^2}{2\sigma_{H+}^2} \right| + \left(\frac{m_{j_2 j_3 j_4} - M_t}{\sigma_t} \right)^2$$

$$+ \left(\frac{m_{j_6 j_7 j_8} - M_t}{\sigma_t} \right)^2 + \left(\frac{m_{j_3 j_4} - M_W}{\sigma_W} \right)^2 + \left(\frac{m_{j_7 j_8} - M_W}{\sigma_W} \right)^2$$
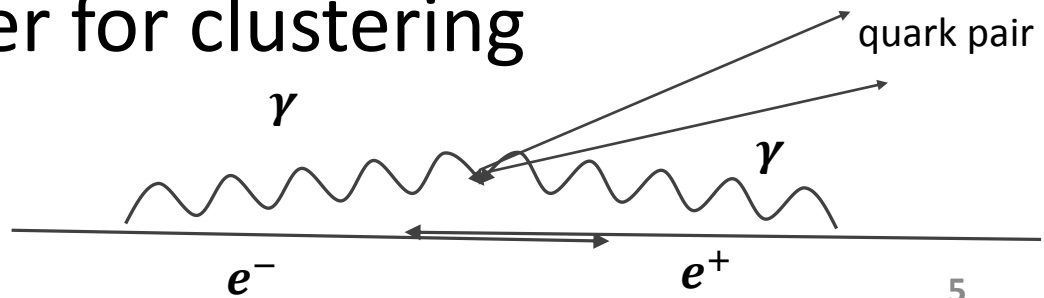
Analysis Strategy - Find R for kt-Algorithm
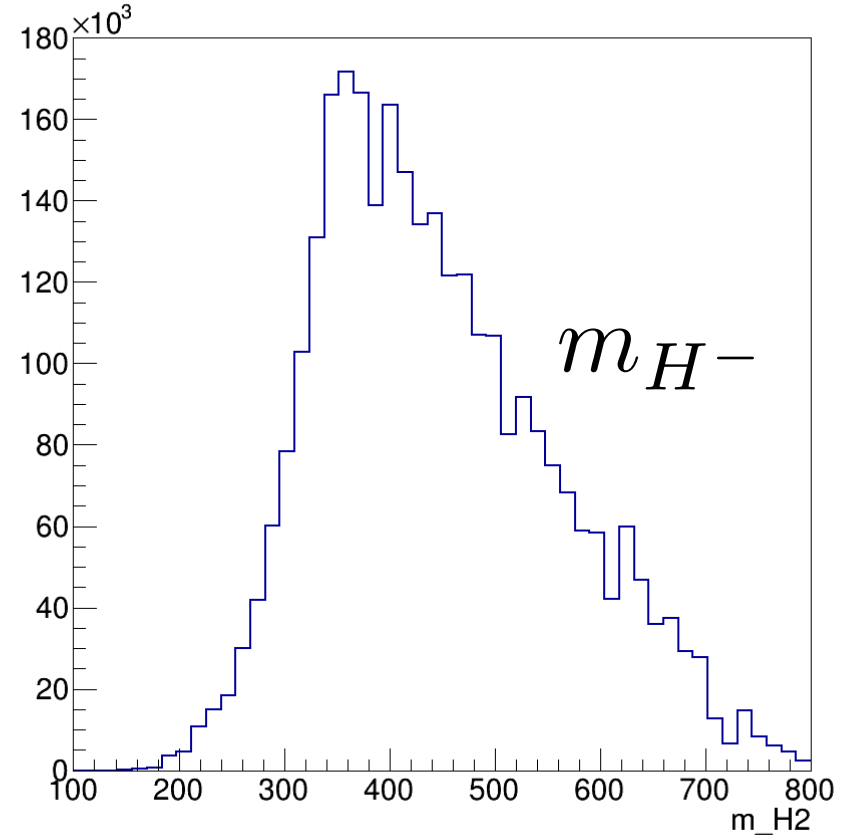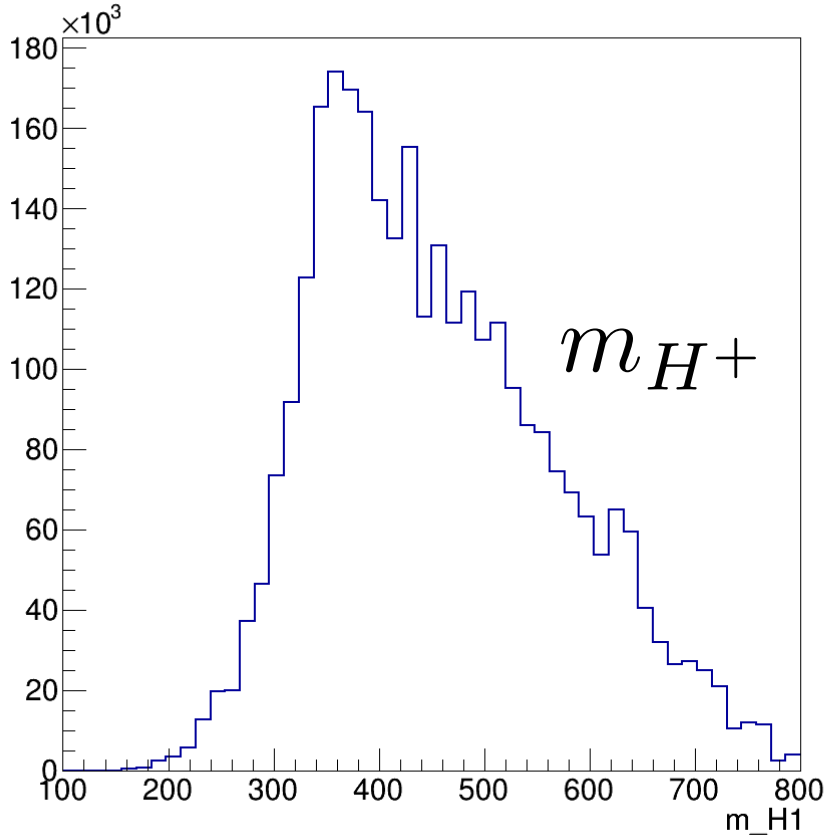
Reconstructed H$^+$ and H$^-$ mass with uncorrected clustering and chi^2 pairing

Analysis Strategy – Beam Background

- In average 1.7 beam background events per bunch crossing

- Has major influence on jet clustering

- Use kt-algorithm from fastjet package to reduce backgrond
  - R: Generalized radius of jets
  - Vary R to optimal mass resolution

- Use Satoru Jetfinder for clustering

quark pair

γ

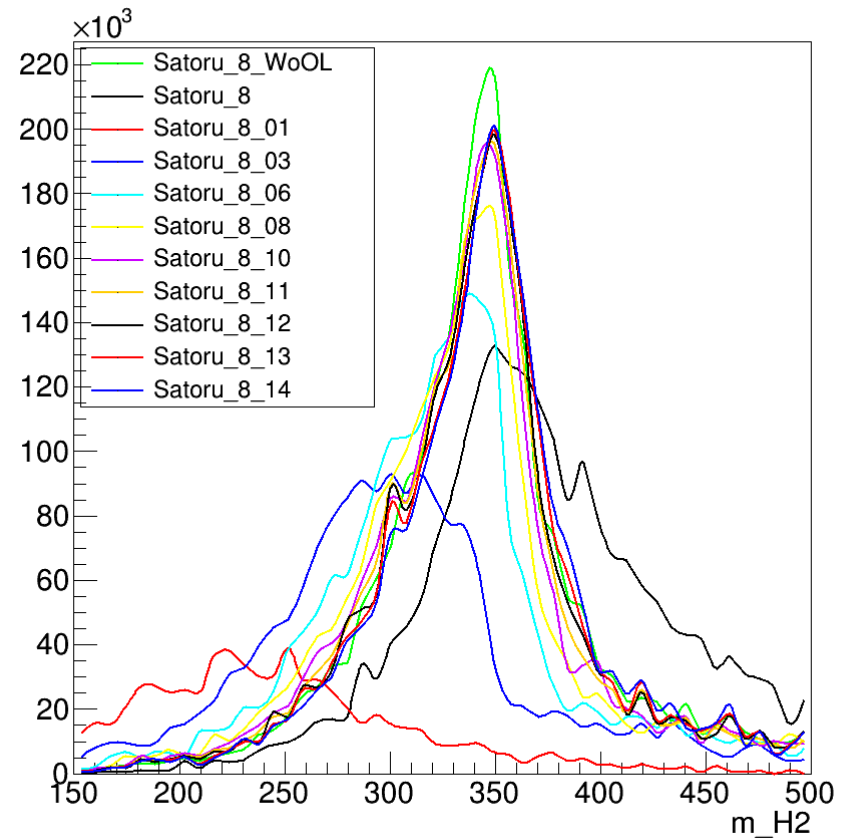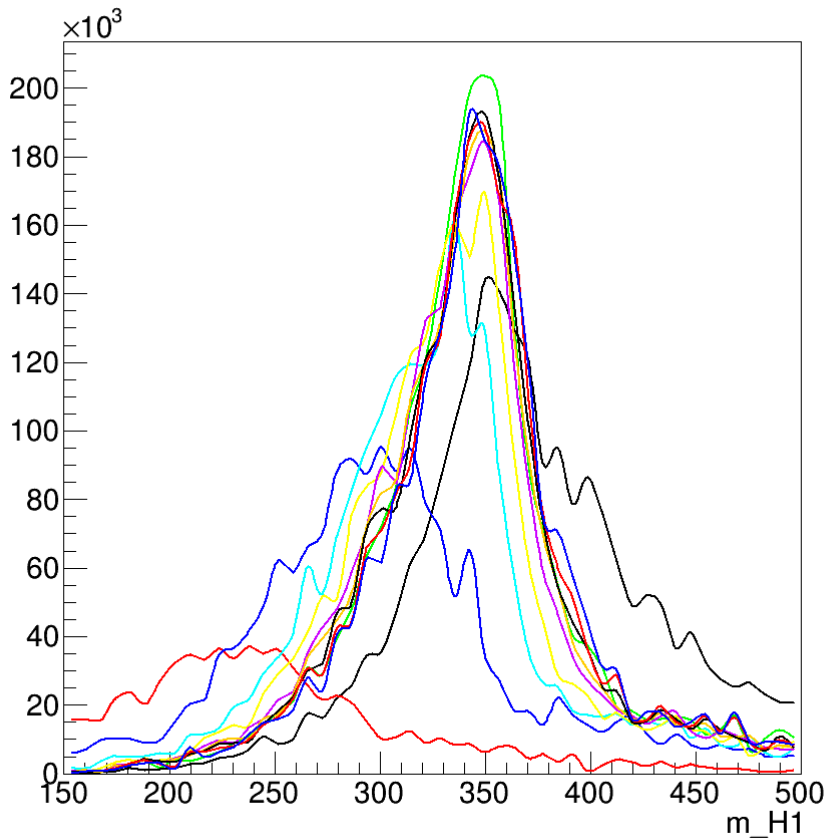γ

e^-

e^+

Analysis Strategy – kt Algorithm

- Calculate the distance between to all tracks

$$d_{ij} = \min(p_{Ti}^2, p_{Tj}^2)\frac{\Delta R_{ij}}{R}$$

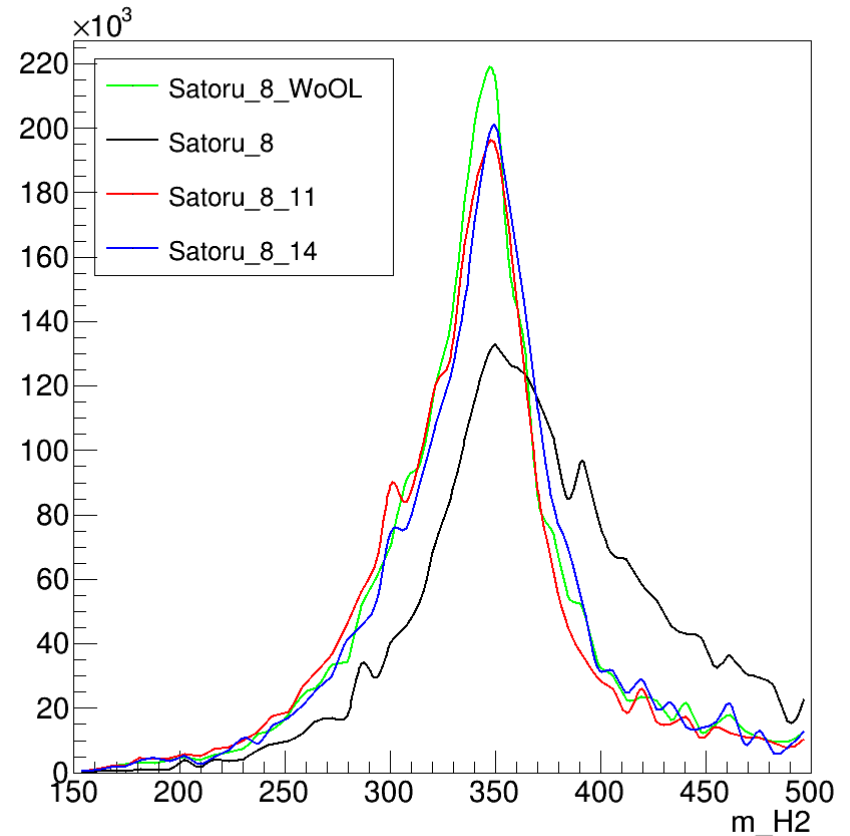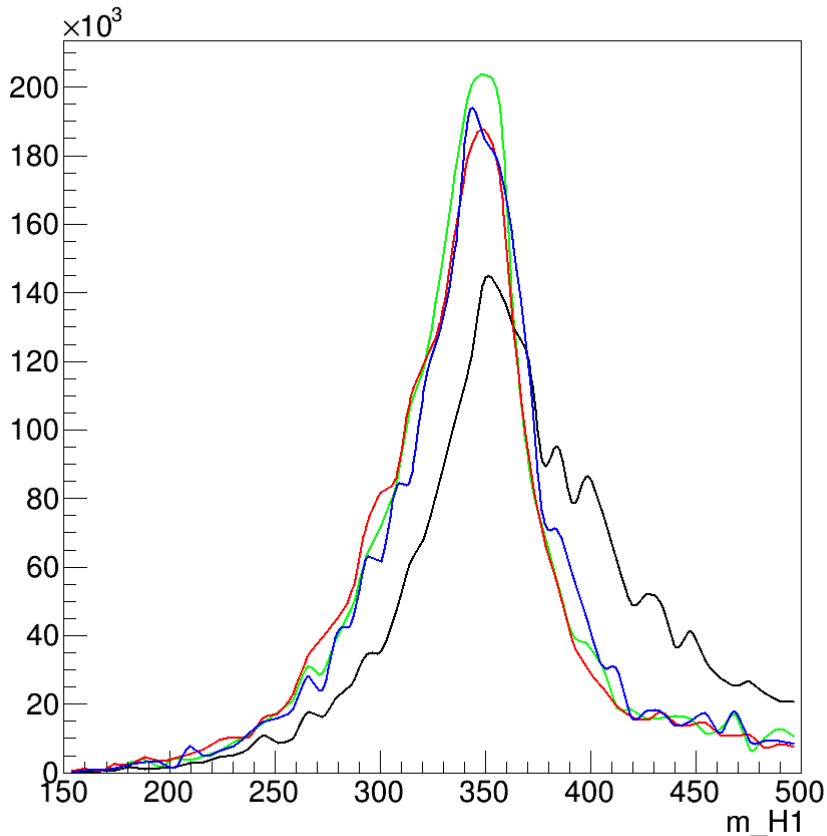with $\Delta R_{ij} = (\eta_i - \eta_j)^2 + (\phi_i - \phi_j)^2$

- Find smallest d_{ij}
- If $d_{ij} < d_{iB} = p_{Ti}^2$ merge tracks, if not remove Track i
- Continue to step one until there are only the requested number of tracks

Analysis Strategy - Find R for kt-Algorithm

Reconstructed H⁺ and H⁻ mass with realistic clustering and pairing with generator information

Analysis Strategy - Find R for kt-Algorithm

Reconstructed H$^+$ and H$^-$ mass with realistic clustering and pairing with generator information

Status

- Best R for jet clustering
  - For charged Higgs between 1.1 and 1.4 (Impact on pairing has to be studied)
  - Around 1.0 for tth samples (consistent with older study at 1TeV (R = 1.2))
- Data samples were (finally) generated successfully
- Analyses environment is set and partially tested on tth samples

Plan

- Half-time presentation on Monday
- Apply kt-algorithm on jet pairing
- Check Chi^2 Pairing with 3D display
- Include semi-leptonic mode (6 jets)
- Develop extra conditions for pairing
- Background study with cuts
- Research how to distinguish H+ and H-
- Study of CP-violation measurement

Schedule

	Apr	May	Jun	Jul	Aug	Sep	Oct
Cluster Study							
Pairing Study							
Semi-leptonic							
Background							
CP-Violation							
Writing							

Today