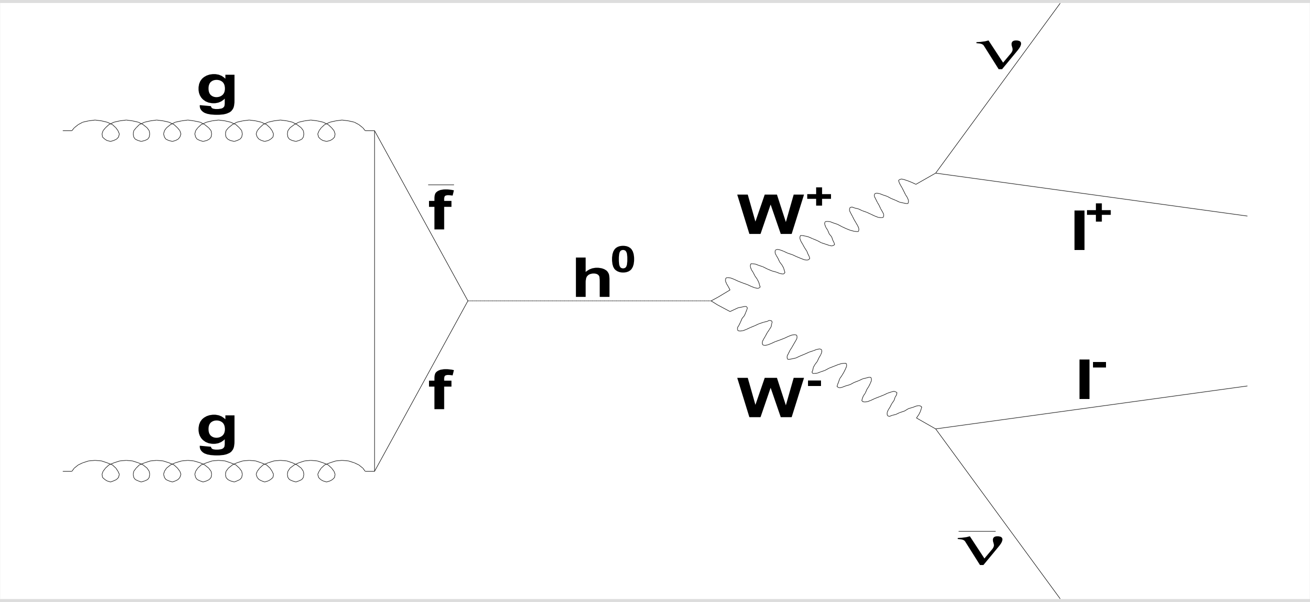
Particle Physics-II Project

Arnab K. Pal

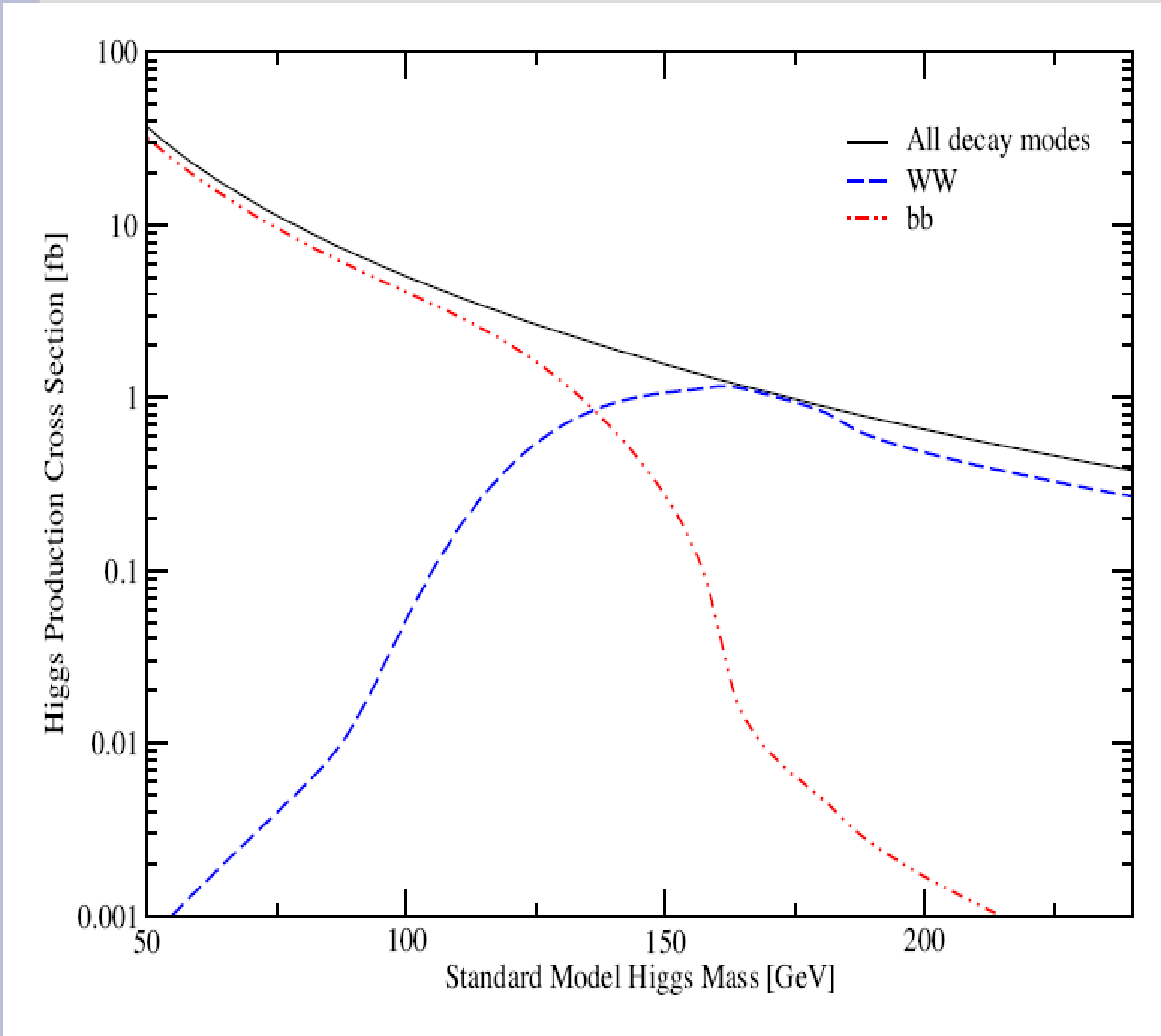
Standard Model Higgs Boson in the WW decay channel(Exclusive)



$$pp \rightarrow p + H + p \rightarrow p + WW* + p$$

Higgs is produced exclusively, the '+' sign indicates large rapidity gaps. The final state protons are intact which can detected at the FPD's.

Cross Section times the Branching ratio



- Shows the cross section for the process as a function for the M_H.
- The increasing branching ratio to WW compensates for the falling cross section.
- Peaks at the WW turn on mass ~ 160 GeV.
- At masses > 150 GeV the WW Decay mode is Primary.

Main features of the channel

- Look at the WW* decay mode, mass of which is above the 2W threshold i.e (150 – 190 GeV).
- It is attractive channel because any degradation in the mass resolution of the detectors does not affect the signal to background ratio.
- Level 1 triggering of the central detector is possible for this channel.
- The suppression of the dominant backgrounds does not depend of the mass resolution of the FPD.
- The advantages of the FPD are explicit. It gives a better resolution of the higgs mass.
- Observation of the higgs in the exclusive double tagged channel immediately establishes its quantum numbers.

Main Backgrounds

- The dominant irreducible background arises from WW continuum production, which has a cross-section times branching ratio between six and nine times larger than that of the Higgs-boson signal.
- WZ production with W ->lnu, Z -> ll and ZZ production with Z -> ll and Z->nunu also constitute a source of potentially irreducible background.
- ttbar and Wt production are the source of the largest reducible backgrounds with isolated leptons in the final state.
- Wbb and direct bb production, containing one or two leptons from semileptonic b-decays, are the dominant sources of reducible background with non-isolated leptons in the final state. These are considerably suppressed by the lepton pT-threshold cuts and by isolation cuts.
- Wbb and direct bb production, containing one or two leptons from semileptonic b-decays, are the dominant sources of reducible background with non-isolated leptons in the finalstate. These are considerably suppressed by the lepton pT-threshold cuts and by isolation cuts.
- W+jet production, where a jet is mistaken as an electron, may also be a source of significant background.

Backgrounds

Process	$\sigma \times$ BR (pb)
$WW^* \to l\nu l\nu$	4.8
$WZ/ZZ \to ll\nu + X$	1.1
$t\bar{t} \to WWb\bar{b} \to l\nu l\nu + X$	38.6
$q\,g \to W\,t \to WW\,b \to l\nu l\nu + X$	4.8
$\mathrm{W}b\bar{b} \to \mathrm{l}\nu b\bar{b} + \mathrm{X}$	82.3
W+jet(s), $p_T > 10$ GeV	19300
$b\bar{b}$ inclusive (BR not included)	500x10[6]

Basic Selection Criterion at the detector level

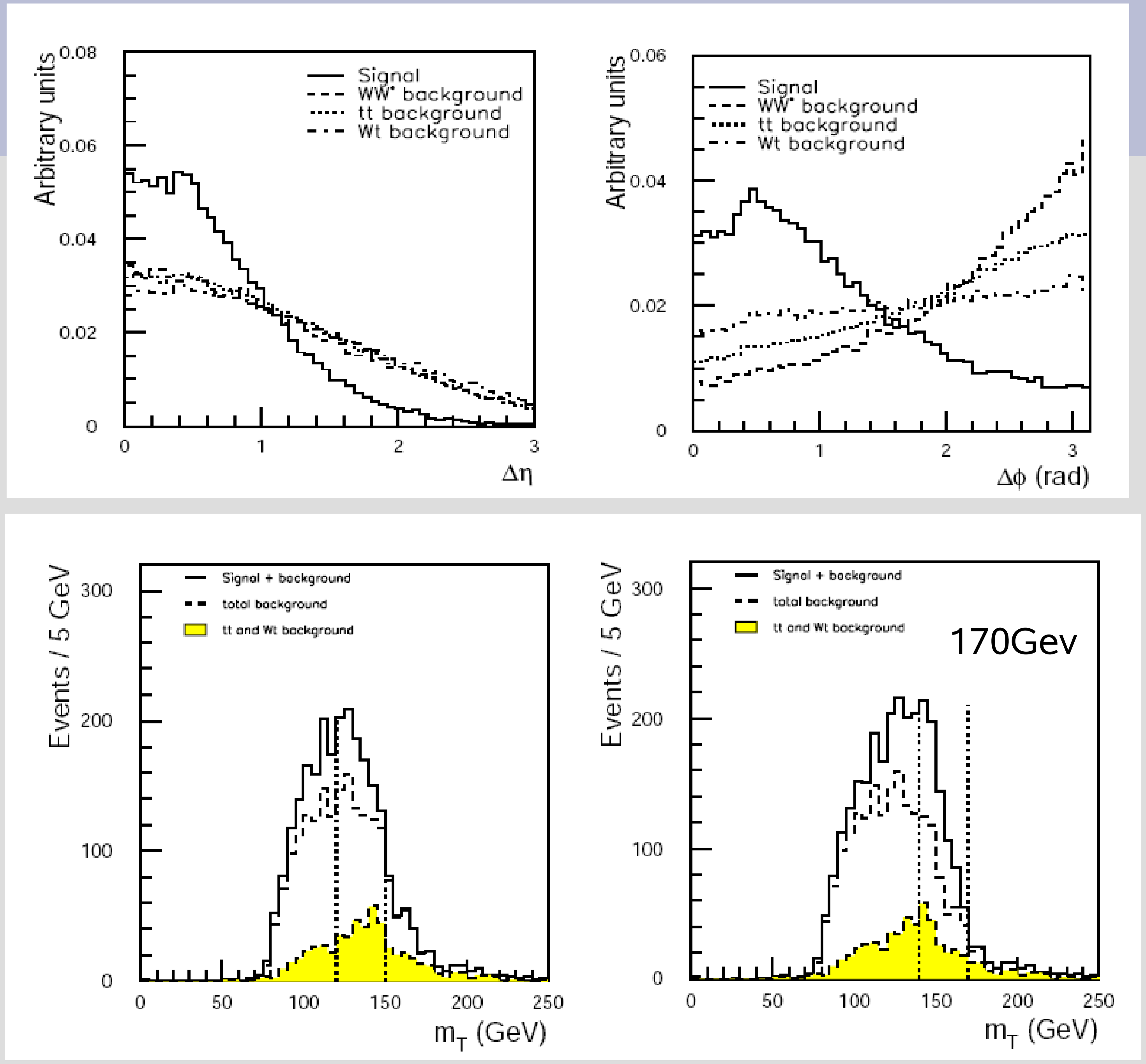
- Two isolated leptons with opposite sign are required within $|\eta| < 2.5$ and with transverse momenta, $p_T{}^1 > 20$ GeV and $p_T{}^2 > 10$ GeV. At high luminosity, the cut on the leading lepton is raised to 30 GeV for trigger purposes.
- Significant missing transverse momentum is required, $E_T{}^{miss} > 40$ GeV.
- The dilepton invariant mass is required to be smaller than 80 GeV.
- The opening angle ($\Delta\phi$) between the two leptons in the transverse plane is required to be smaller than 1.0 (measured in rad).
- The absolute value of the polar angle Θ_{ll} of the di-lepton system is required to be smaller than 0.9.
- The absolute value of the pseudorapidity difference ($\Delta\eta$) between the two leptons is required to be smaller than 1.5.

- Events with one or more jets with $p_T > 15$ GeV and $|\eta| < 3.2$ are rejected. At high luminosity, the p_T-threshold of this jet-veto cut is raised to 30 GeV.
- The transverse mass computed from the leptons and the missing transverse momentum,

$$m_T = \sqrt{2 p_T^{ll} E_T^{miss} (1 - \cos(\Delta\phi))}$$

  is required to fall in the mass window m_H - 30 GeV $< m_T < m_H$. Since the WW^* background is falling with increasing transverse mass, the lower cut value is reduced to m_H - 40 GeV for Higgs-boson masses above 170 GeV, in order to recover signal efficiency.

Initial results from TDR



Plan of Work

- Generation of the Signal Process using ExHuME.
  - Use exhume_i interface with Athena.
  - Use generator level Filters to get dilepton events.
  - Get generator level plots of variables.
- Run ATLFAST simulation on the events and compare the results and smearing of the variables due to detector simulations.
- Write code to introduce FPD.
- Get the FPD specific variables.
- Calculate the efficiency of Cuts on these variables.
- Repeat the procedure for leading background and evaluate the scenario of discovery.
- See the effect of Pile up(mult int) in the main detector and the pile up for FPD.

Current Situation

- Generation started.
  - higgs mass = 160GeV
- Implemented generator level filters.
- Got the plots of the basic variables.
- Evaluating the correctness of the generator level data and the filter.