Extraction of the VBF-Z signal

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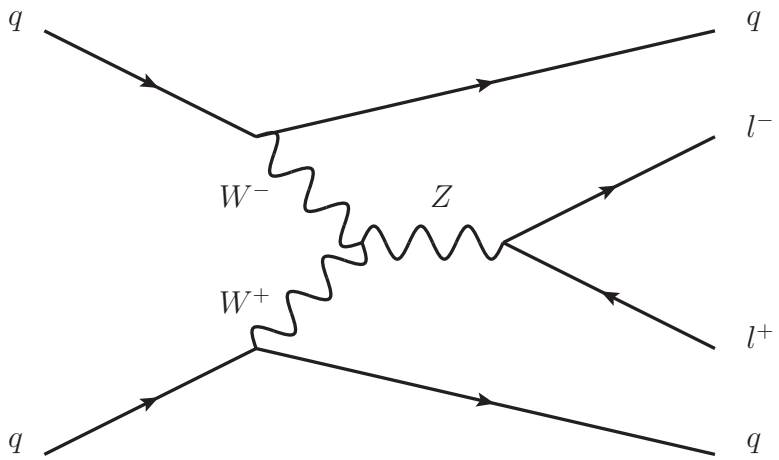
What is VBF-Z? (I)

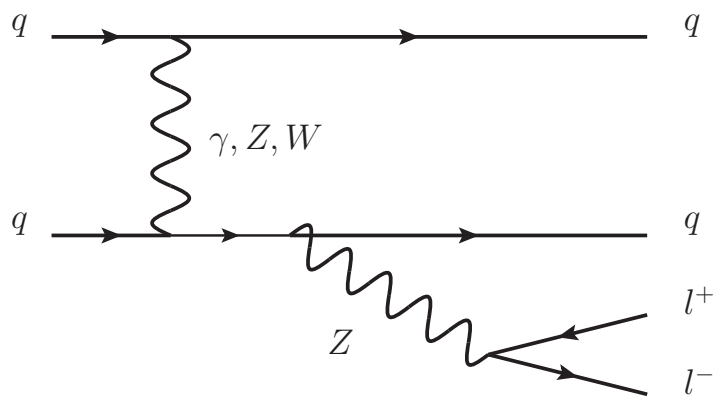
- Two jets in opposite hemispheres with large angle
  $\rightarrow$ rapidity gap
  $\rightarrow$ large invariant mass

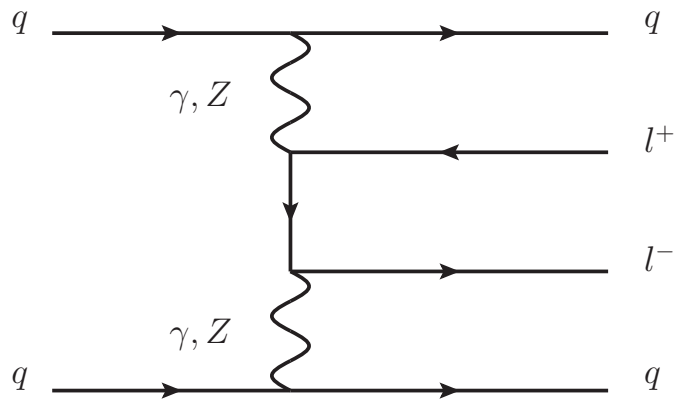


- only electroweak interaction
  $\rightarrow$ no color exchange between the quarks
  $\rightarrow$ no extra jets in the central region
- Two leptons in the central region

What is VBF-Z? (II)

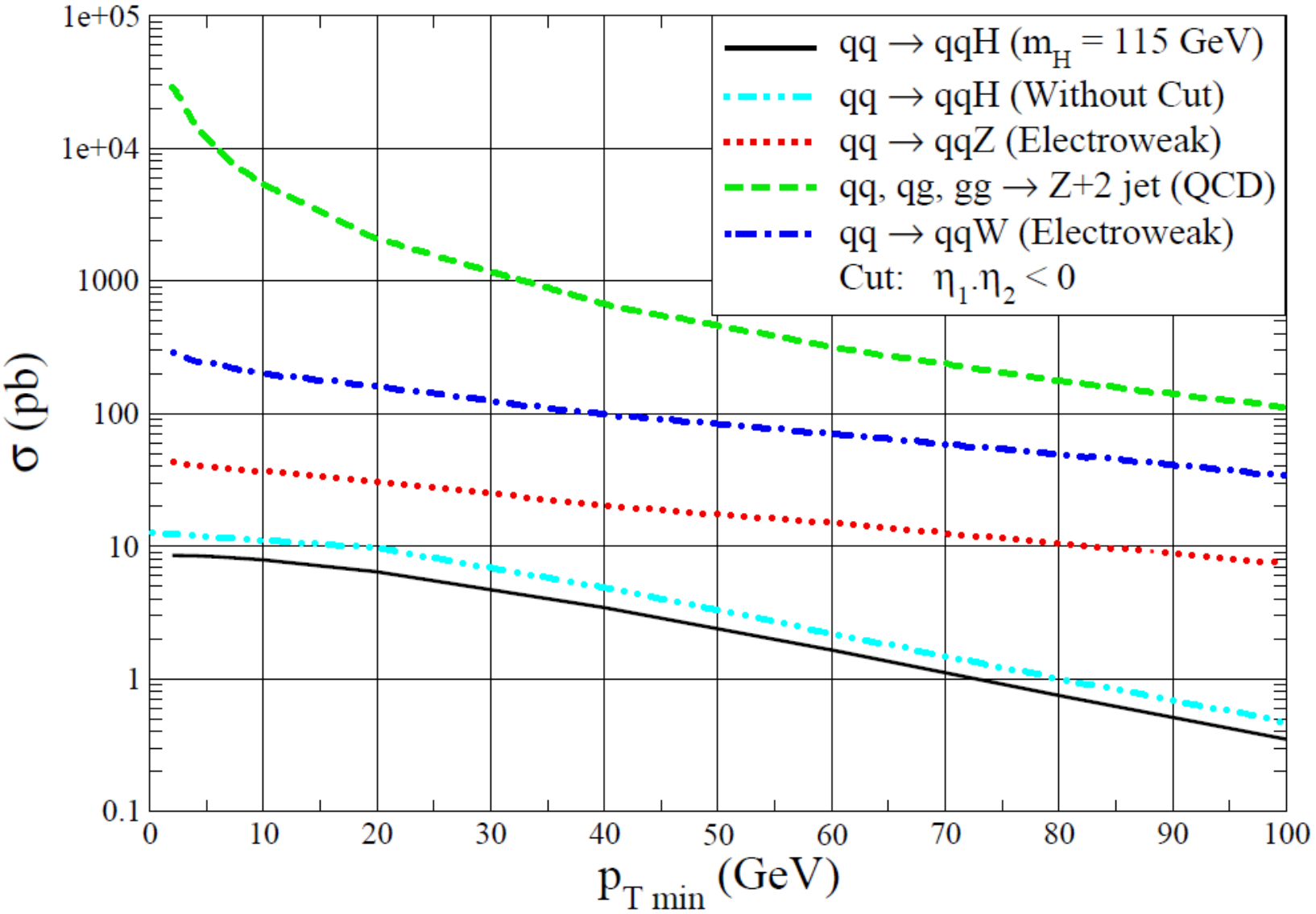
Other t-channel processes with the same initial and final state





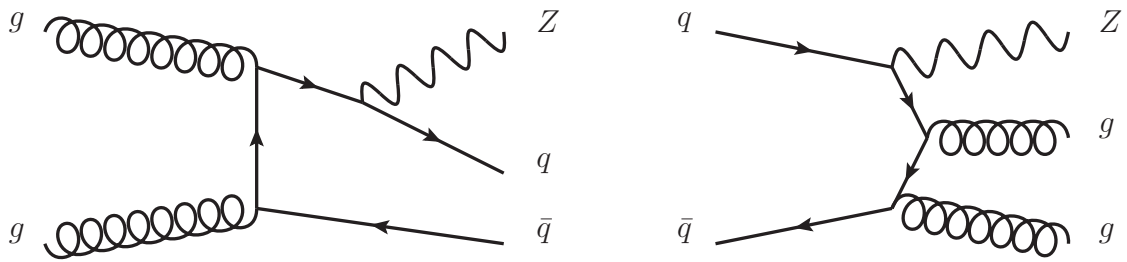
⇒ this all is VBF-Z!

Background I

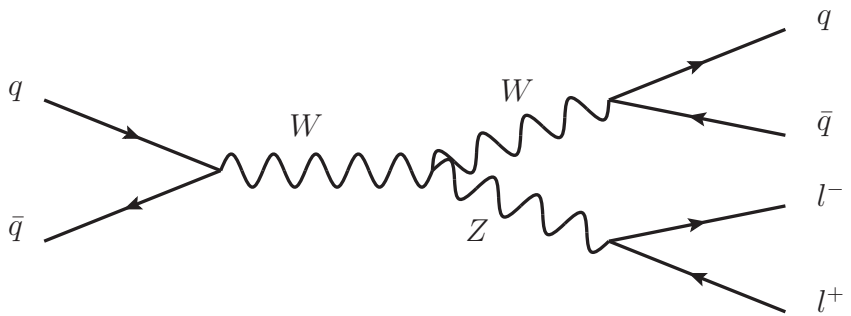


Background II

- Largest Background: QCD-Z
  (ca. 100-200 x VBF-Z)



- Also s-channel processes
  (only small fraction)



What we have done so far:

- Check if its possible to seperate VBF-Z (t-channel) from QCD-Z
- only on parton level
  - VBF-Z: VBFNLO (11294 events)
  - QCD-Z: MCFM (44080 events)
- only electron events
- with Neural Network (NeuroBayes)

basic selection:

$p_T(q)$	$> 20\,\text{GeV}$	$p_T(l)$	$> 10\,\text{GeV}$
$\lvert\eta\rvert(q)$	< 4	$\lvert\eta\rvert(l)$	< 2.5
$\Delta R(q_1, q_2)$	> 0.75	$81 < m(l_1 + l_2)$	$< 101\,\text{GeV}$

additional VBF-Cuts:

$$\begin{aligned} \eta(q_1) \times \eta(q_2) &< 0 \\ |\Delta\eta(q_1, q_2)| &> 2 \\ m(q_1 + q_2) &> 80\,\text{GeV} \end{aligned}$$

- significance: $\mathcal{S} = \frac{S}{\sqrt{S+B}}$

cut based results (10fb^{-1} parton level)

3 different selections

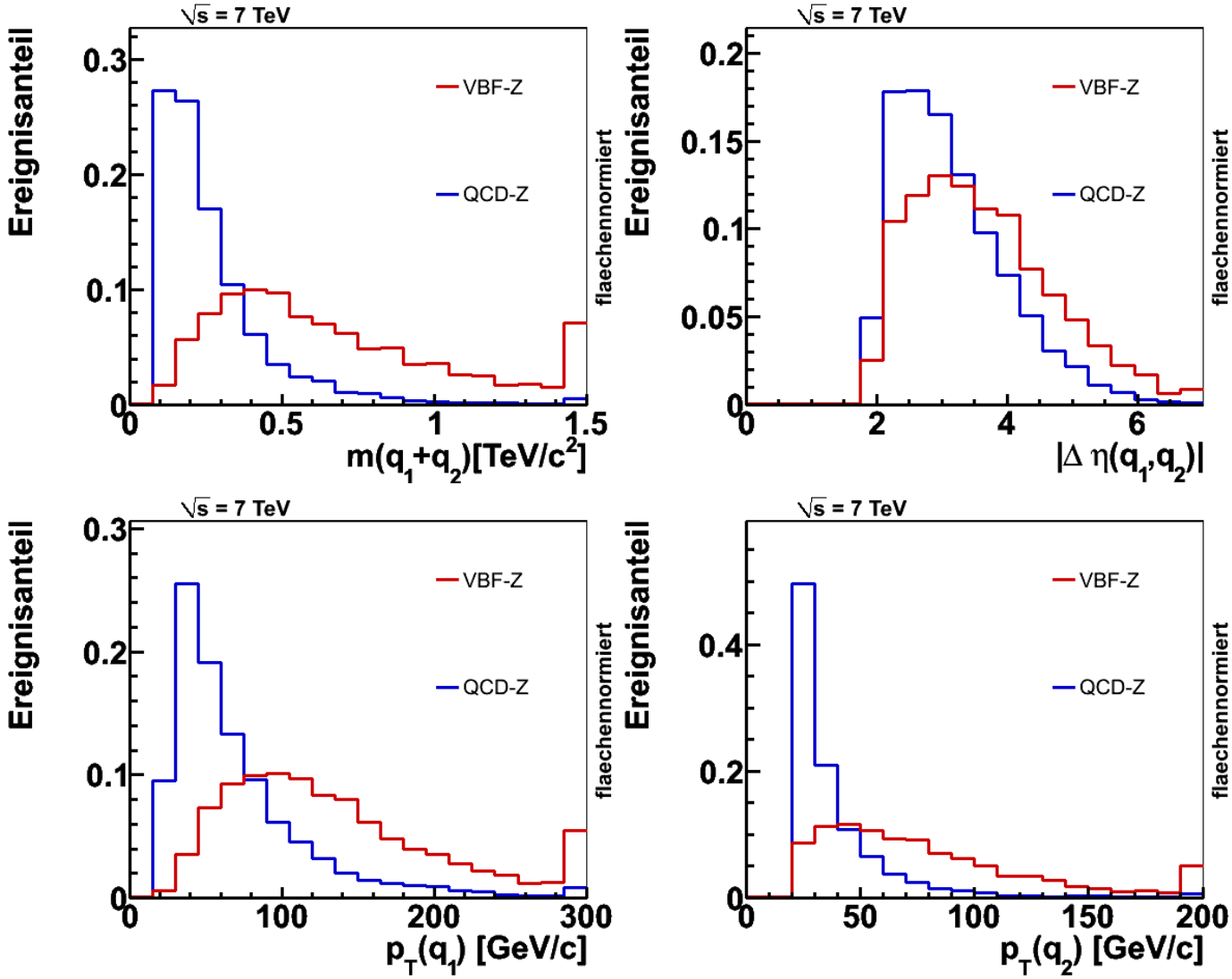
$m(q_1 + q_2)$	$> 80\,\text{GeV}$	$> 250\,\text{GeV}$	$> 660\,\text{GeV}$
$p_T(q_{max})$	$> 20\,\text{GeV}/c^2$	$> 75\,\text{GeV}/c^2$	$> 84\,\text{GeV}/c^2$
$p_T(q_{min})$	$> 20\,\text{GeV}/c^2$	$> 35\,\text{GeV}/c^2$	$> 64\,\text{GeV}/c^2$
N_{exp} VBF-Z	671	391	185
N_{exp} QCD-Z	87470	15845	2373
$\mathcal{S}$	2,3	3,0	3,7

$\Rightarrow$ use Neural Networks to improve significance

NeuroBayes

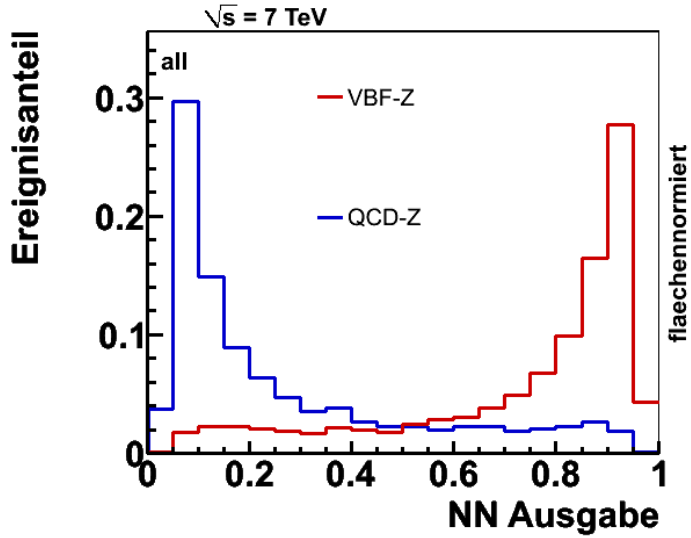
- feed-forward network with one hidden layer and one output node
- commercial program from Michael Feindt
  free license available at CERN
- extensive preprocessing of the variables to avoid overtraining
- used in ATLAS (single Top and Higgs analysis)

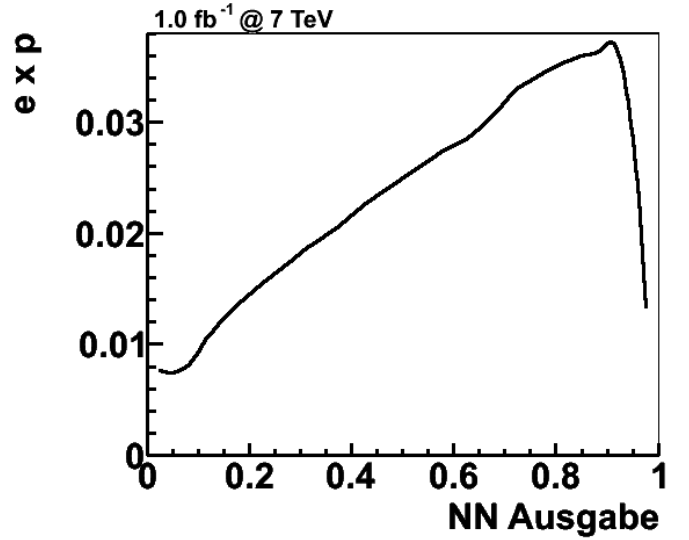
Some important Variables for NN



NN results (parton level)

- find the "best" cut on the NN output distribution
  $\rightarrow$ efficiency x purity is maximized
- significance $\approx 1.5\sigma$ $(1\,\mathrm{fb}^{-1})$
- significance $\approx 5\sigma$ $(10\,\mathrm{fb}^{-1})$





Results

- experiment-independent parton-level analysis
- trained several networks with different cuts (vary VBF-Cuts)
  $\rightarrow$low sensitivity on cuts
- significance $\approx 5\sigma$ $(10\,\mathrm{fb}^{-1})$
  $S/B \approx 200/2000$
  - only electrons
    $\rightarrow$ factor 2 for myons
  - only parton level
    $\rightarrow$ only $\approx 30\%$ efficiency for full-simulated events
    ($\approx 70\%$ efficiency for each tight-electron + acceptance)
- No systematics are applied
- How do the variables look like after showering and detector simulation?

$\Rightarrow$ hope to get $3-5\sigma$ at the end of 2012 $(10 + x\,\mathrm{fb}^{-1})$

Outlook:

Next steps:

- analyse ATLAS full-simulated EWK-Z events (Sherpa)
  $\rightarrow$ s- and t-channel
  eliminate the s-channel (cut on $m(q_1 + q_2)$)
- Compare VBFNLO and Sherpa on the parton level
- apply basic selection on the full-simulated events
  ($\rightarrow$ efficiency?)
- Compare Data and MC also for background processes

Whats needed?

- VBFNLO full-simulated signal-MC