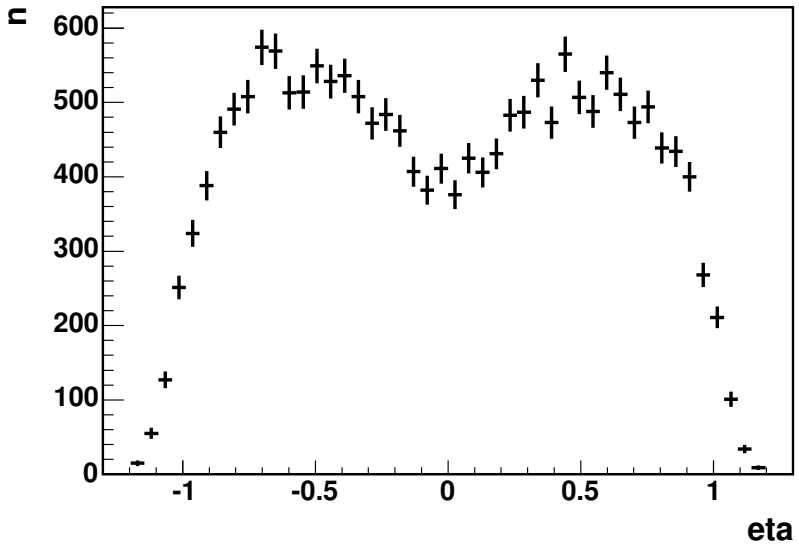
An Artifial Neural Network for Plug Electron Identification

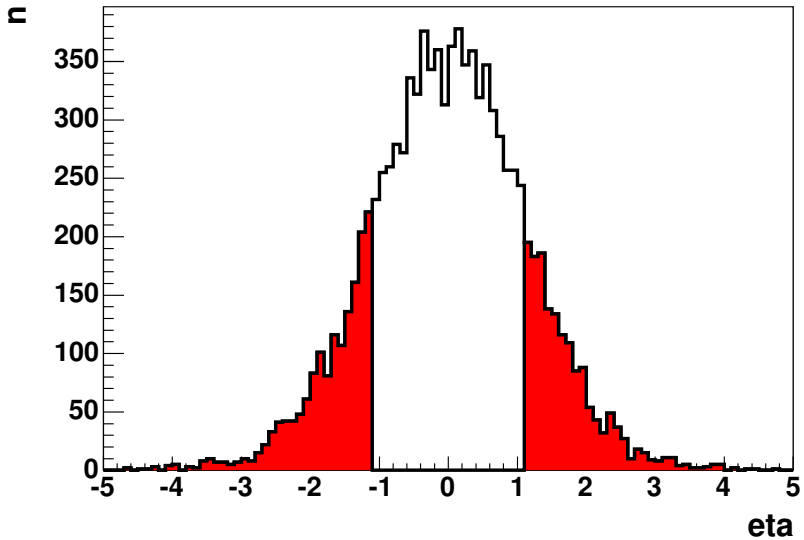
Yves Kemp, Thomas Müller, Hartmut Stadie, Wolfgang Wagner

Universität Karlsruhe

Use of plug electrons for analysis



η-distribution of electrons in 4.11 version of single top analysis
(after preselection)

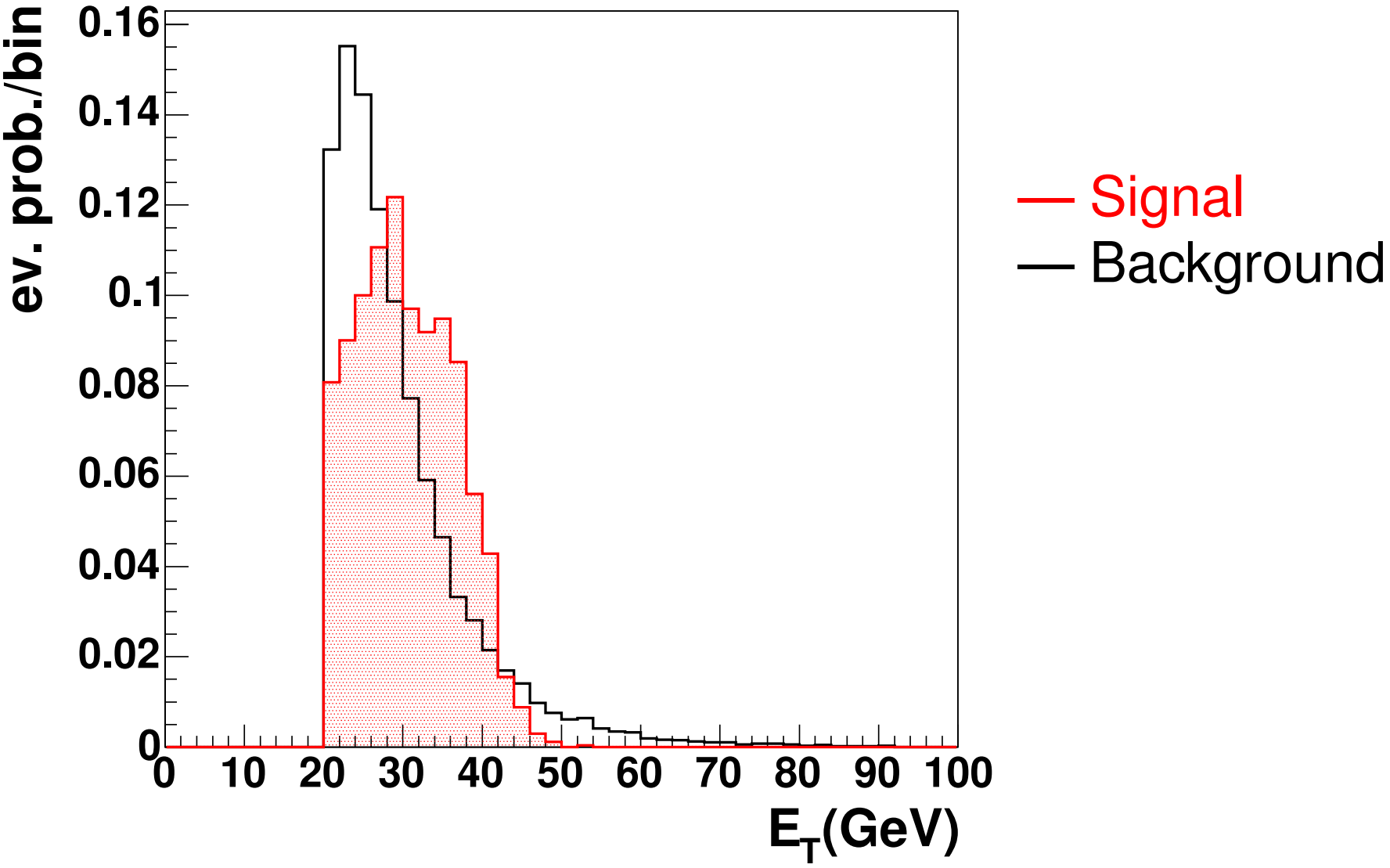


η-distribution of electrons in t-channel MC.
ca 30% with $|\eta| > 1.1$

Selection of the samples

- Signal sample:
  - 1 tight central electron with track
  - Another electron candidate in plug (Z-Candidate)
  - Cuts to be independent of trigger cuts
  - 2000 events remain
- Background sample:
  - 2 balanced jets (1 central, 1 plug)
  - Several preselection cuts
  - 30000 events remain
- Both samples taken from data! (bpel08)
  cdfsoft2 versions 4.9 and 4.11

Control plot: E_T of plug electron

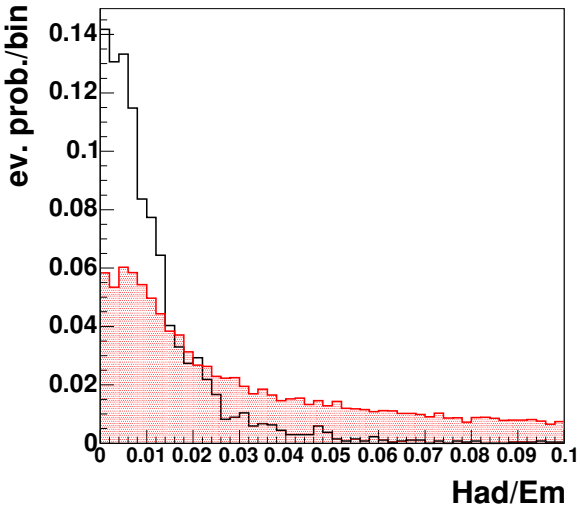


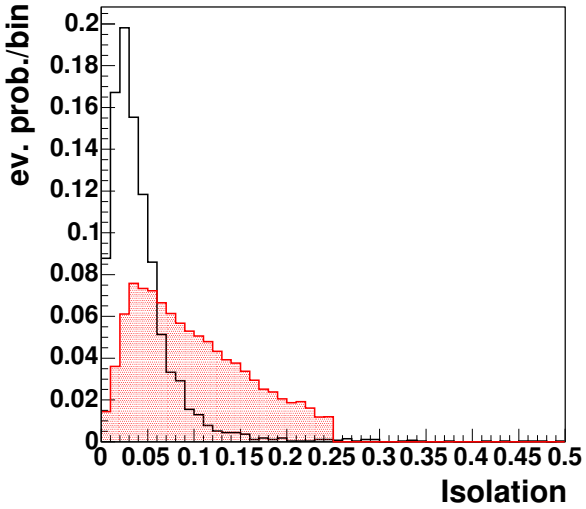
Variables for plug electron ID

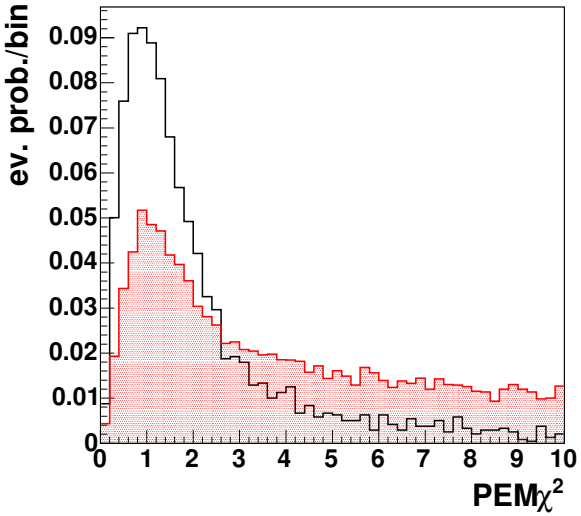
- Fiducial cut: $1.2 < |\eta| < 2.8$
- EmE$_T$
- (Phoenix-)Track

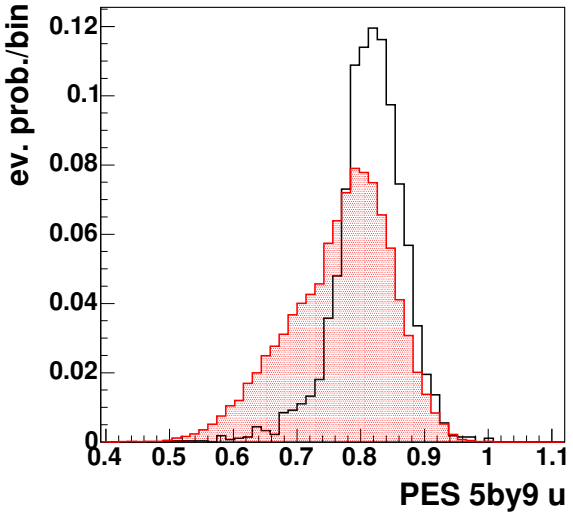
- HadE/EmE (sliding cut)
- Isolation Ratio
- PEM χ^2 (comparision with test beam data
- PES 5by9 u (Shower profile in PES in u direction)
- PES 5by9 v (Shower profile in PES in v direction)

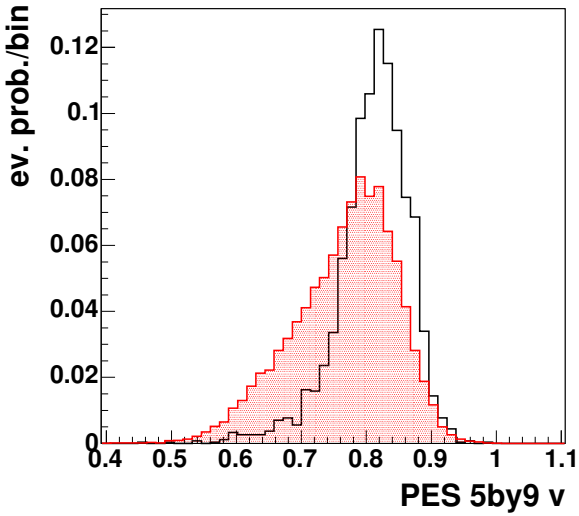
Selection variables









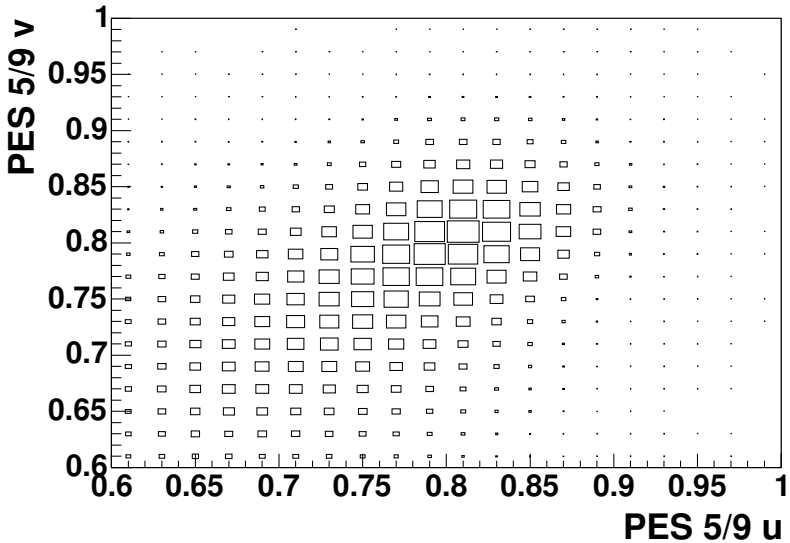


— Signal
— Background (normalized to same integral)

Correlation matrix

	Target	HadEm	Iso	PEMχ^2	PES 5/9 u	PES 5/9 v
Target	100.0	-49.4	-66.6	-64.5	43.9	43.2
HadEm		100.0	52.8	44.8	-24.8	-24.2
Iso			100.0	72.0	-38.9	-38.5
PEMχ^2				100.0	-42.8	-43.4
PES 5/9 u					100.0	45.9
PES 5/9 v						100.0

Target is -1 for background, 1 for signal



Correlation between the two PES 5/9 variables due to cross talk and geometry

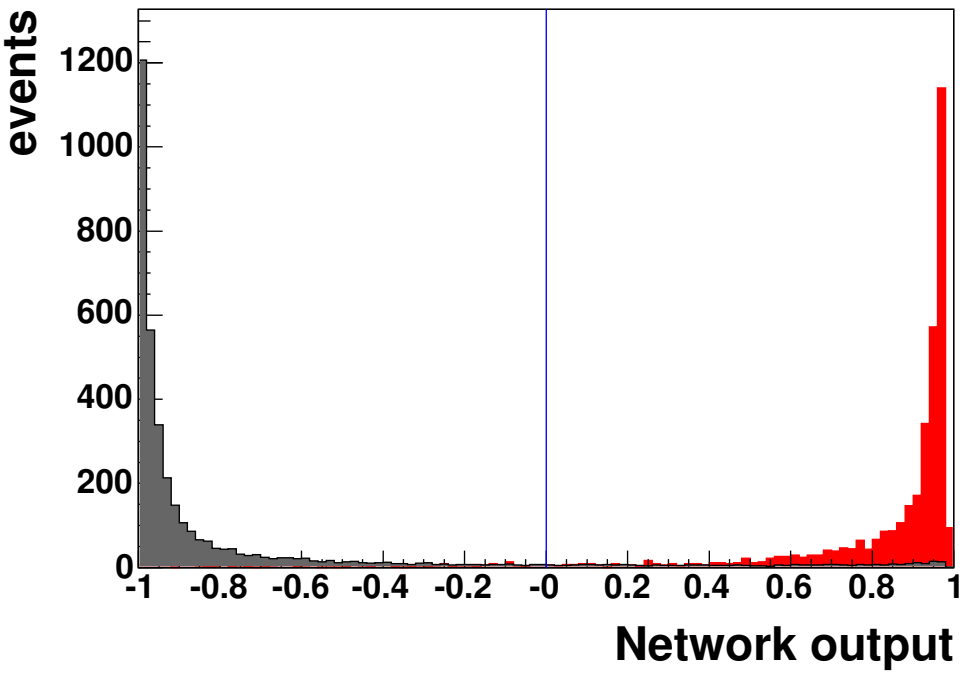
Artificial Neural Network

- 5 input variables (+ 1 bias node)

	rank	correlation σ
Had/Em	5	4.8
Isolation	1	57
PEM χ^2	3	14
PES 5/9 u	4	11
PES 5/9 v	2	20

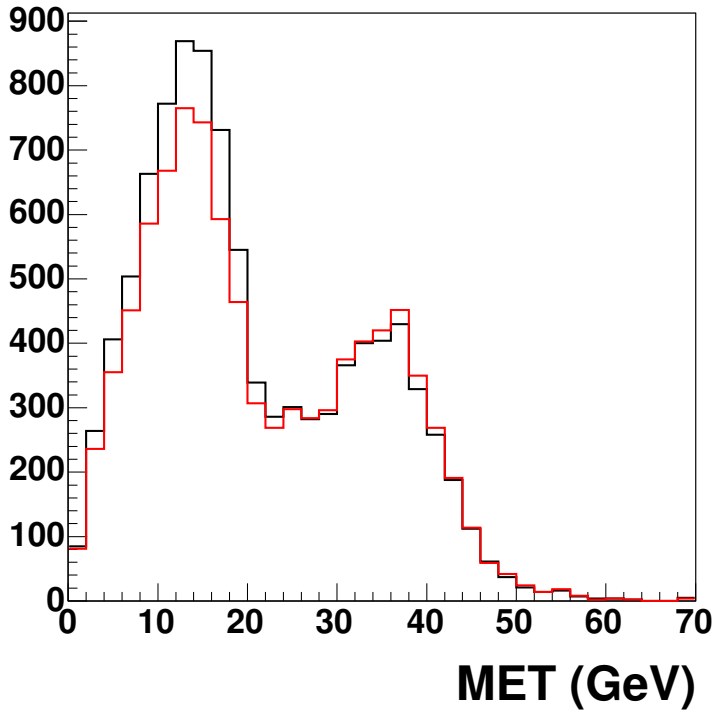
- Preprocessing of the variables
- 5 nodes in intermediate layer
- Binary classification (-1 background, 1 signal)
- 50 iterations
- NeuroBayes ANN package (see Ulrichs talk)

Artificial Neural Network results



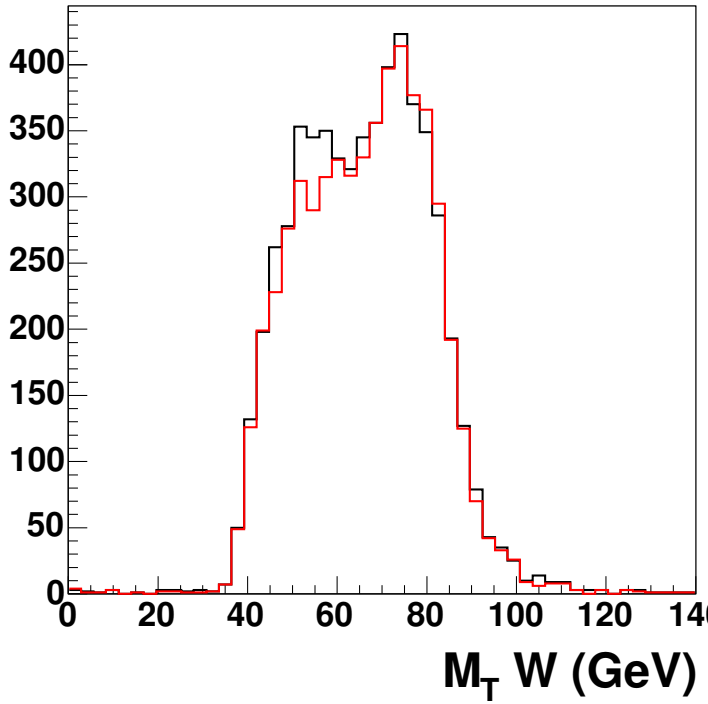
- Standard Cuts:
  - Signal efficiency 84%
  - Background eff. 5.3%
- ANN cut $>$ 0.65:
  - Same signal efficiency
  - Background eff. 3.5%
  - 34% less background
- ANN cut $>$ 0.40:
  - Same background eff.
  - Signal efficiency 91%
  - 8% more signal

Independent tests



– ANN
– cuts

sample: All events with one plug candidate + track



Missing ET

NN cut: 5679 ev. $<$ 25 GeV

standard: 6483 ev. $<$ 25 Gev

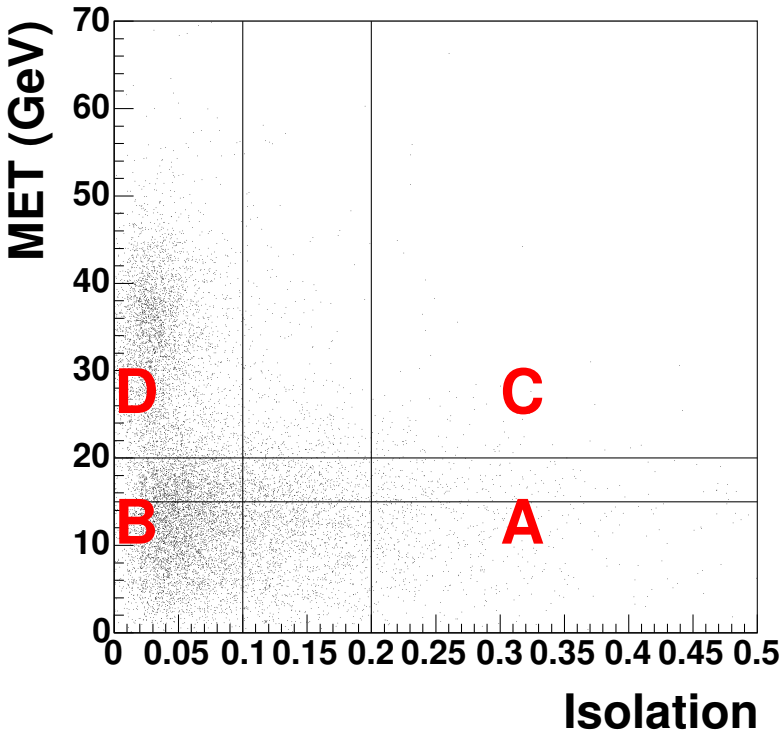
Transverse W-Mass

(MET $>$ 15 GeV)

NN cut: 5738 events

standard: 5533 events

Background estimation: 4-sector method



All standard cuts except isolation applied

A: (MET $<$ 15 GeV, Iso $>$ 0.2: 501

B: (MET $<$ 15 GeV, Iso $<$ 0.1: 4015

C: (MET $>$ 20 GeV, Iso $>$ 0.2: 106

D: (MET $>$ 20 GeV, Iso $<$ 0.1: 4156

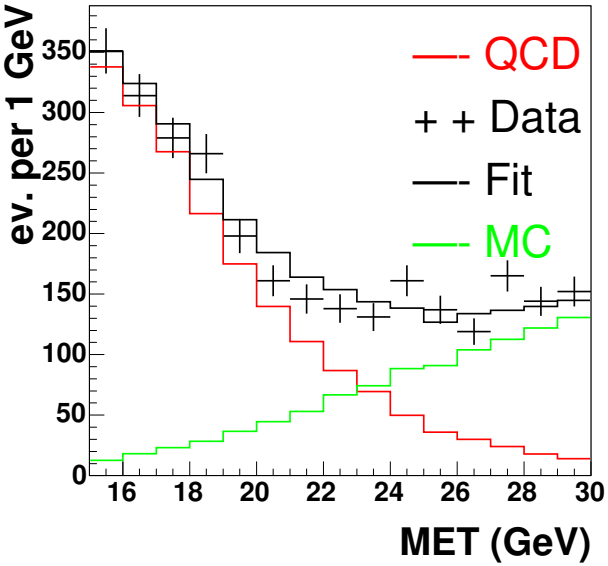
$$\Rightarrow \frac{N_{\text{QCD in D}}}{N_{\text{Total in D}}} = 20.4\%$$

This method does not work for ANN cut

sample: All events with one plug candidate + track

QCD background estimation: Fit method

Idea: Fit background and MC to data
Background: Invert ANN cut: $<$ -0.95
MC: W+jets sample
Fit: Scaling factors for background and MC, fit MET in interval 15-30 GeV



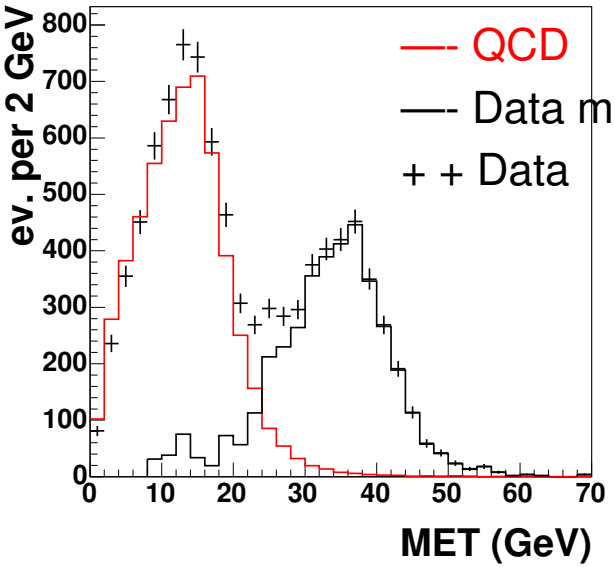
ANN $>$0.5:

$$\Rightarrow \frac{^{N}\text{QCD in MET} > 20\text{ GeV}}{^{N}\text{Total in MET} > 20\text{ GeV}} = 15.3\%$$

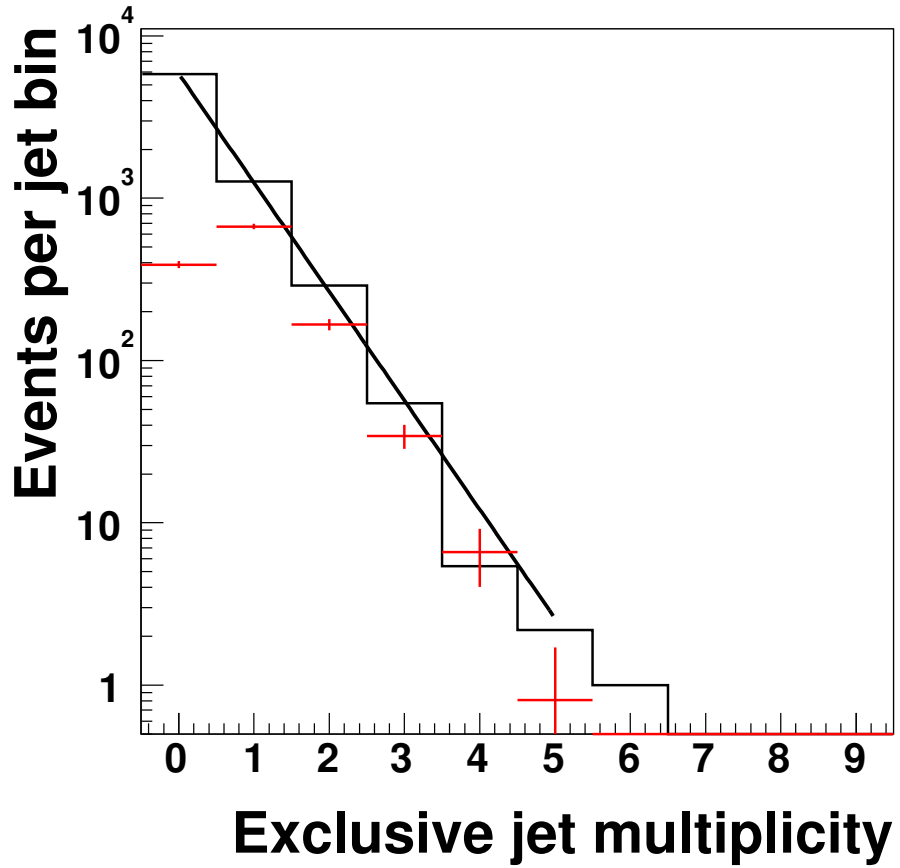
Standard Cuts:

$$\Rightarrow \frac{^{N}\text{QCD in MET} > 20\text{ GeV}}{^{N}\text{Total in MET} > 20\text{ GeV}} = 17.9\%$$

sample: All events with one plug candidate + track



Jet multiplicity



+ + QCD (ANN < -0.95)

—- Data minus QCD

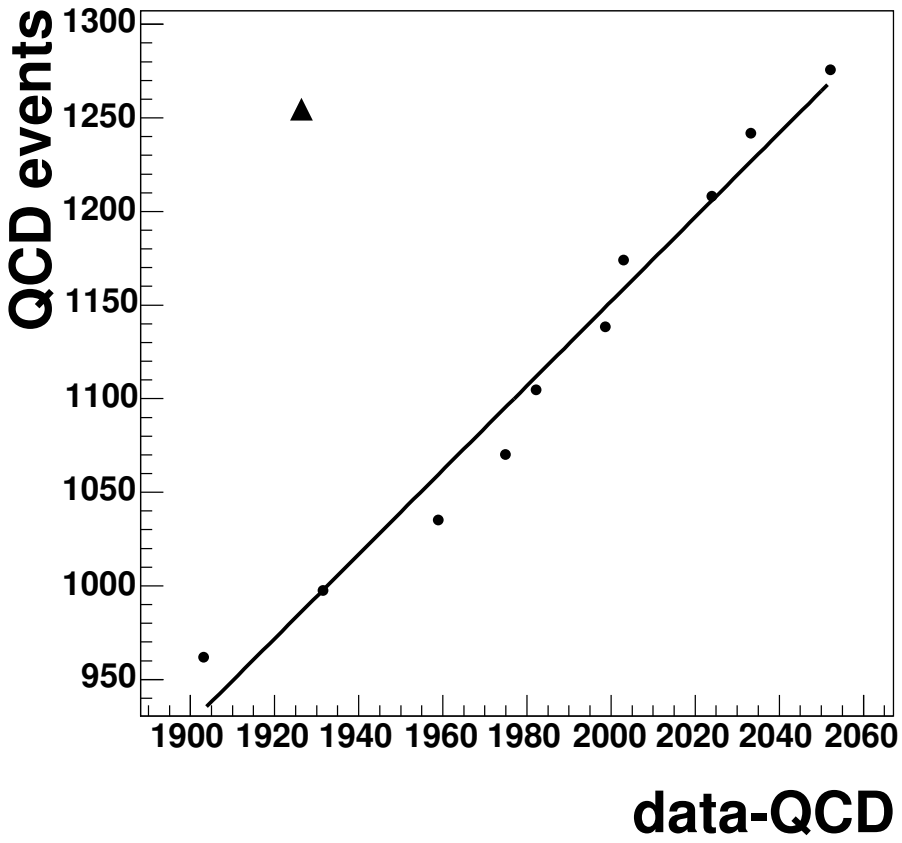
Jets	Data	QCD	Data - QCD
0	39693	2581	37112
1	7507	4204	3303
2	1976	1083	893
3	402	240	262
4	53	44	11
With CDF standard cuts			
0	37960	2990	35870
2	1926	1255	673

sample: All events with one plug candidate + track

Additional requirement: MET $>$ 20 GeV

(realistic scenario for W+jets analysis)

Exclusive 2-Jet Bin



- Varying ANN cut such that S/B or $S/\sqrt{B}$ is optimal
- $\sim$ 20% less background
- $\sim$ 5.7% more signal

Conclusion, Outlook

- Plug electrons will give better single top limit
- Identification with Artificial Neural Network useful
- $\sim$20% less background in 2-jet-bin
- $\sim$5.7% more signal in 2-jet-bin
- Plan to provide easy-to-use generic tool

- Waiting for Gen 5 plug TopNtuples
- Determine acceptance and efficiencies
- Integrate into next round of single top analysis