Detector optimization for Jet Reconstruction

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Extension of Sitges Results

- Briefly review jet facts
- Extend processes studied
- Review and extend discriminators
- Compare new NN results with Sitges cuts results

Purpose

- At high energies jets are ubiquitous.
- Nearly all event will contain jets.
- Thus, reconstructing jets is crucial.
- Set upper bound using “generator” level.
- Set lower bound using only simple calorimeter clustering.

Jets are particles!

- High mass states decay predominately to quark jets
- Use topology, mass, rapidity and event shape to identify.
- For example:
  - q → one jet
  - Color singlet(W,Z,H) → two jets
  - t → three jets

Difficulties

- Getting jet masses right:
  - Finding neutrals in calorimeter
  - Finding low energy charged particles curled up in strong solenoidal field
  - Assigning particles to correct jet.
- Getting topology right:
  - Lose a jet through jet merger
  - Gain a jet from gluon radiation

Helpful Facts

- At higher energies jets are more collimated.
  - Particle transverse momentum ~300MeV
- At higher jet energies gluon radiation is less severe due to running of α_s.
- At higher jet energies multiplicity ~ ln E.
- Strong B field separates charged particles from each other and from neutrals.

Layout of discriminator plots

udscb(qq) events are in top plot in green

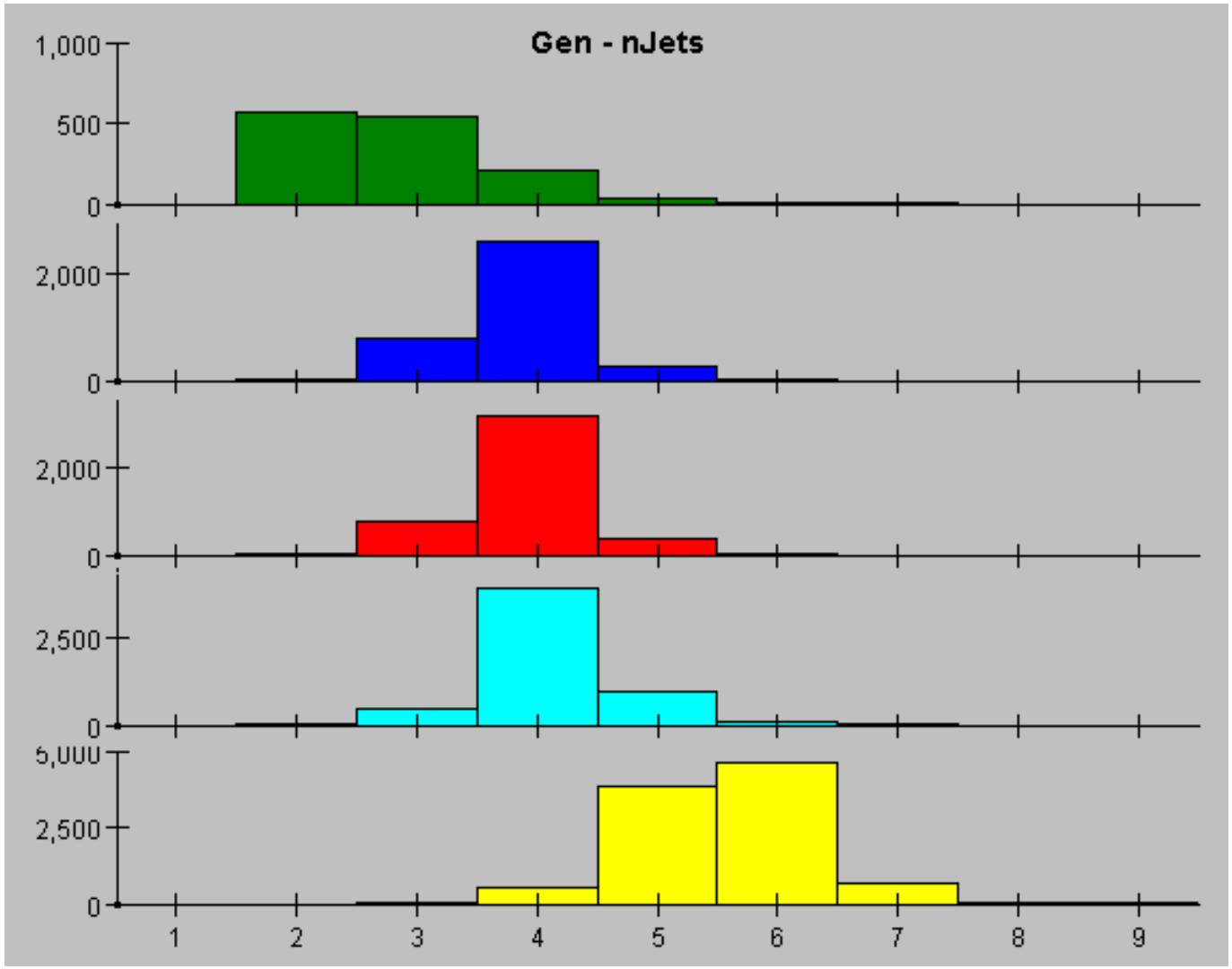
WW events are next in blue

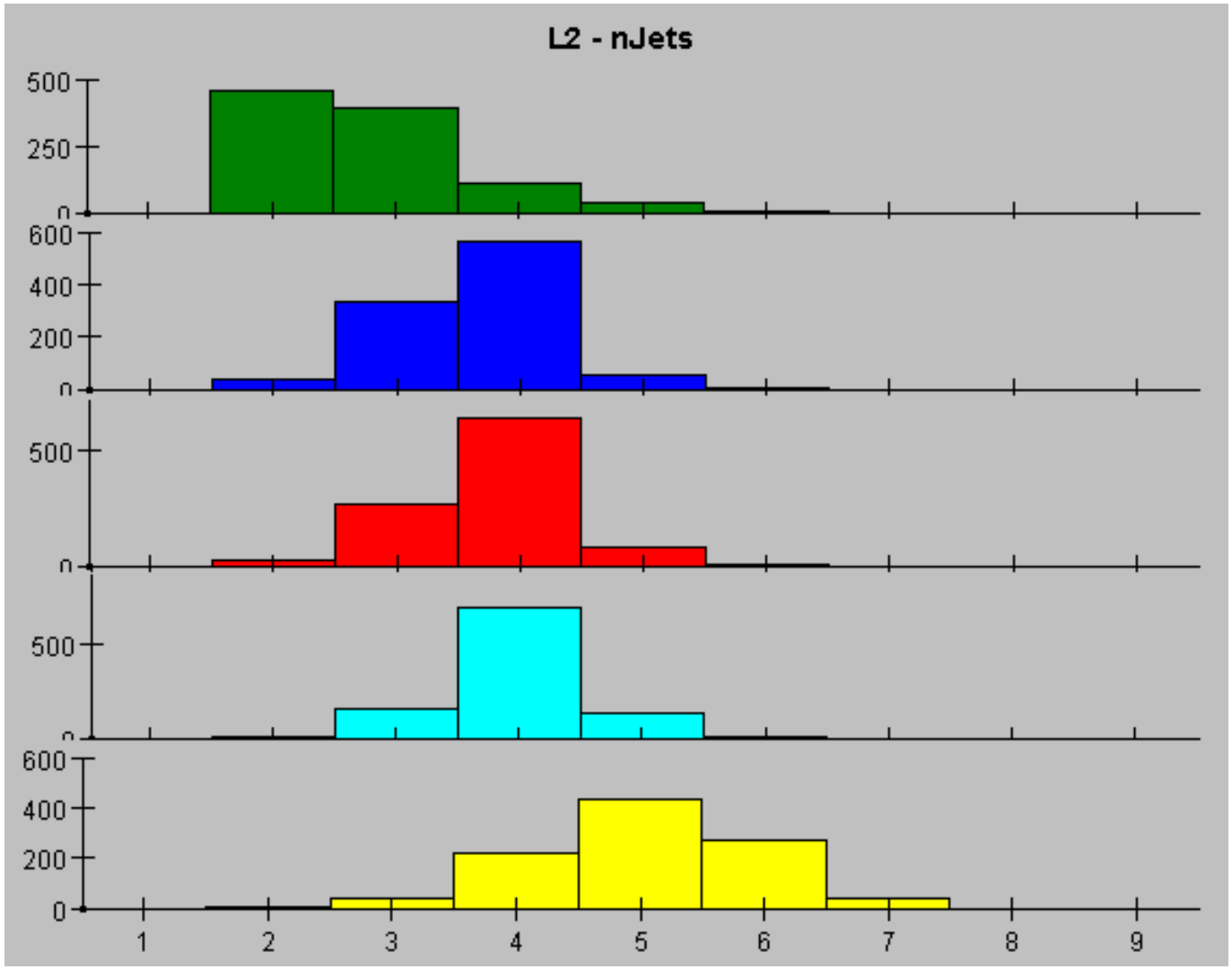
ZZ event are in the middle in red

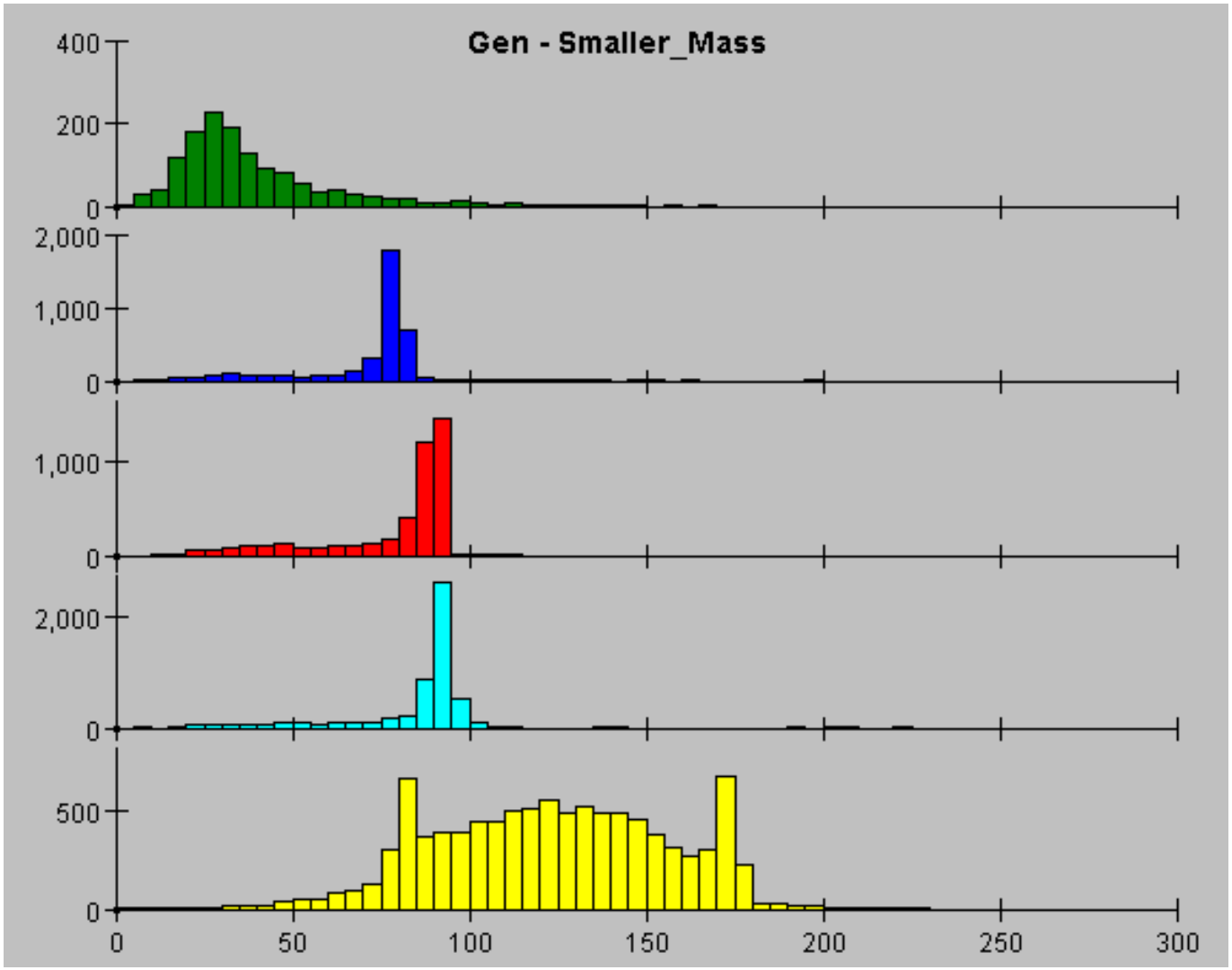
ZH events are next in cyan

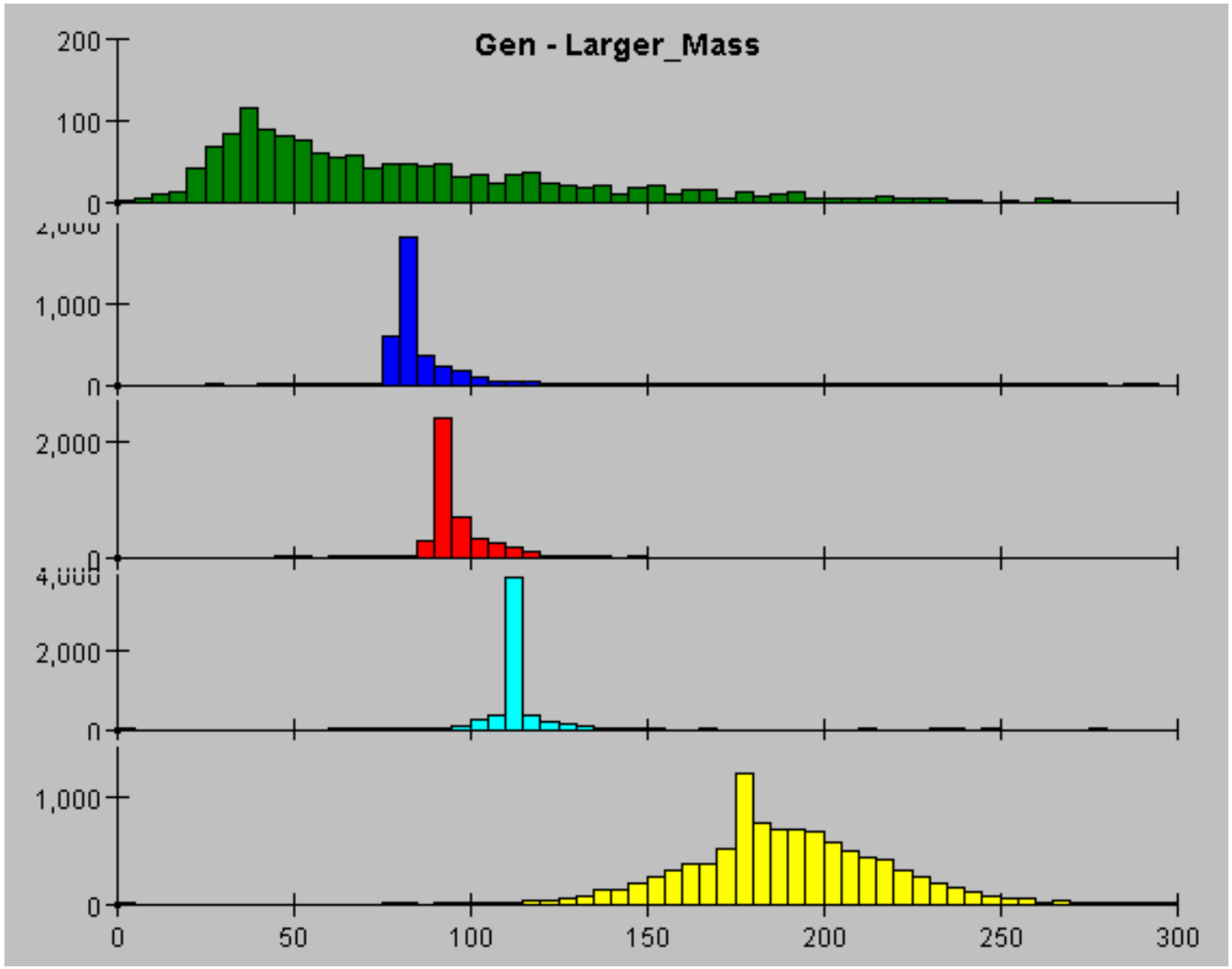
tt events are last in yellow

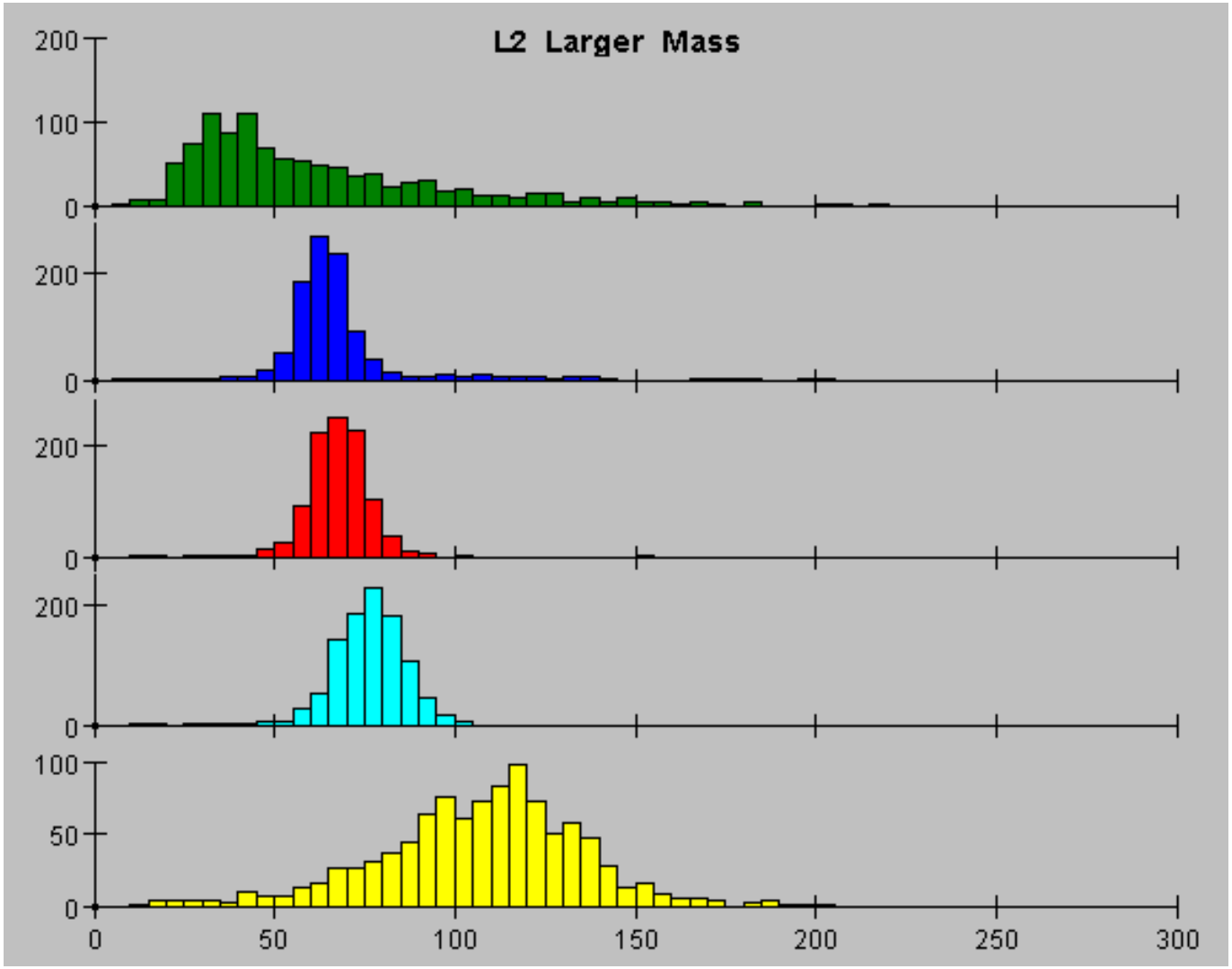
Notes: they go from light to heavy, H=114GeV

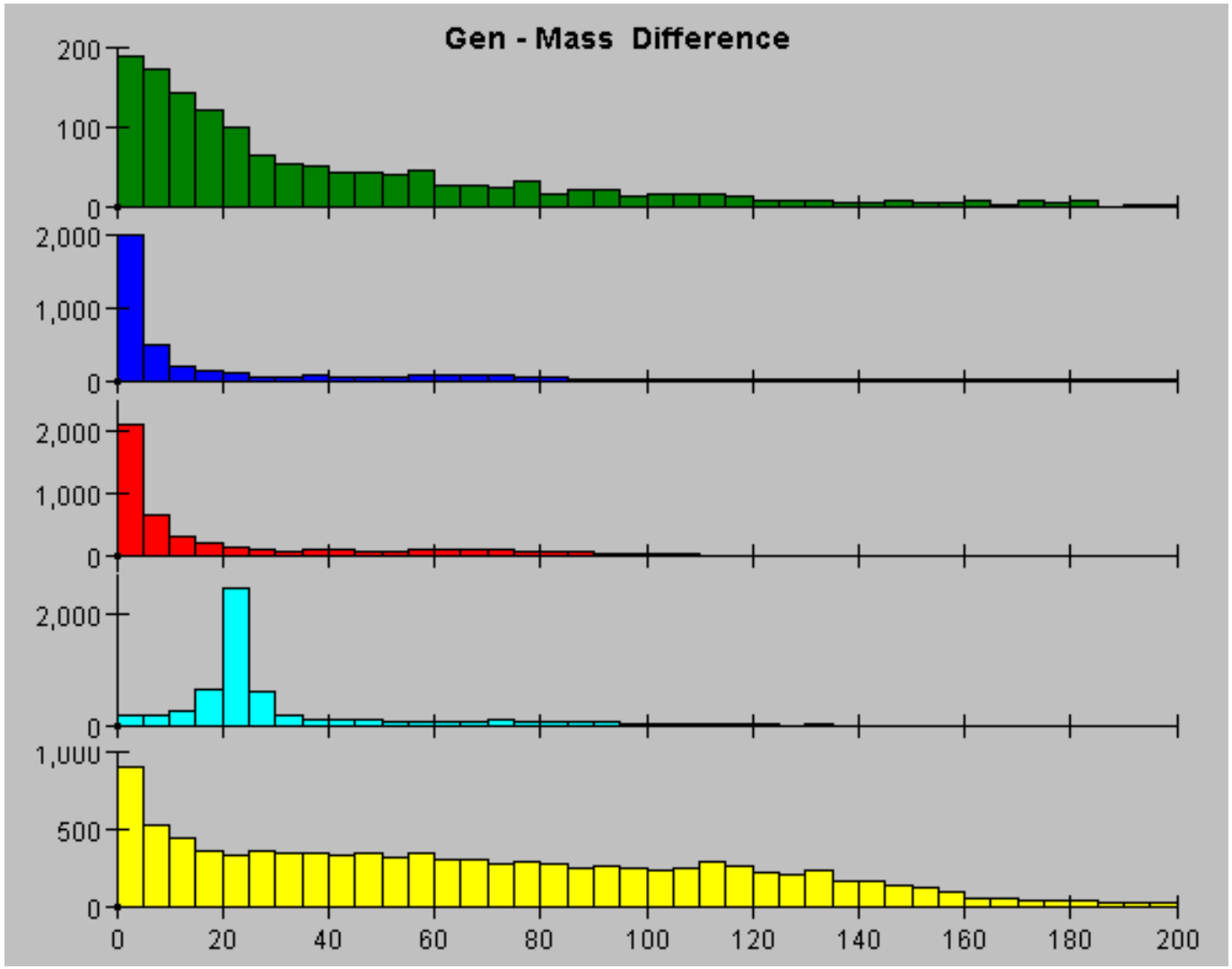

Gen - nJets
1,000
500
0
2,000
0
2,000
0
2,500
0
5,000
2,500
0
1
2
3
4
5
6
7
8
9

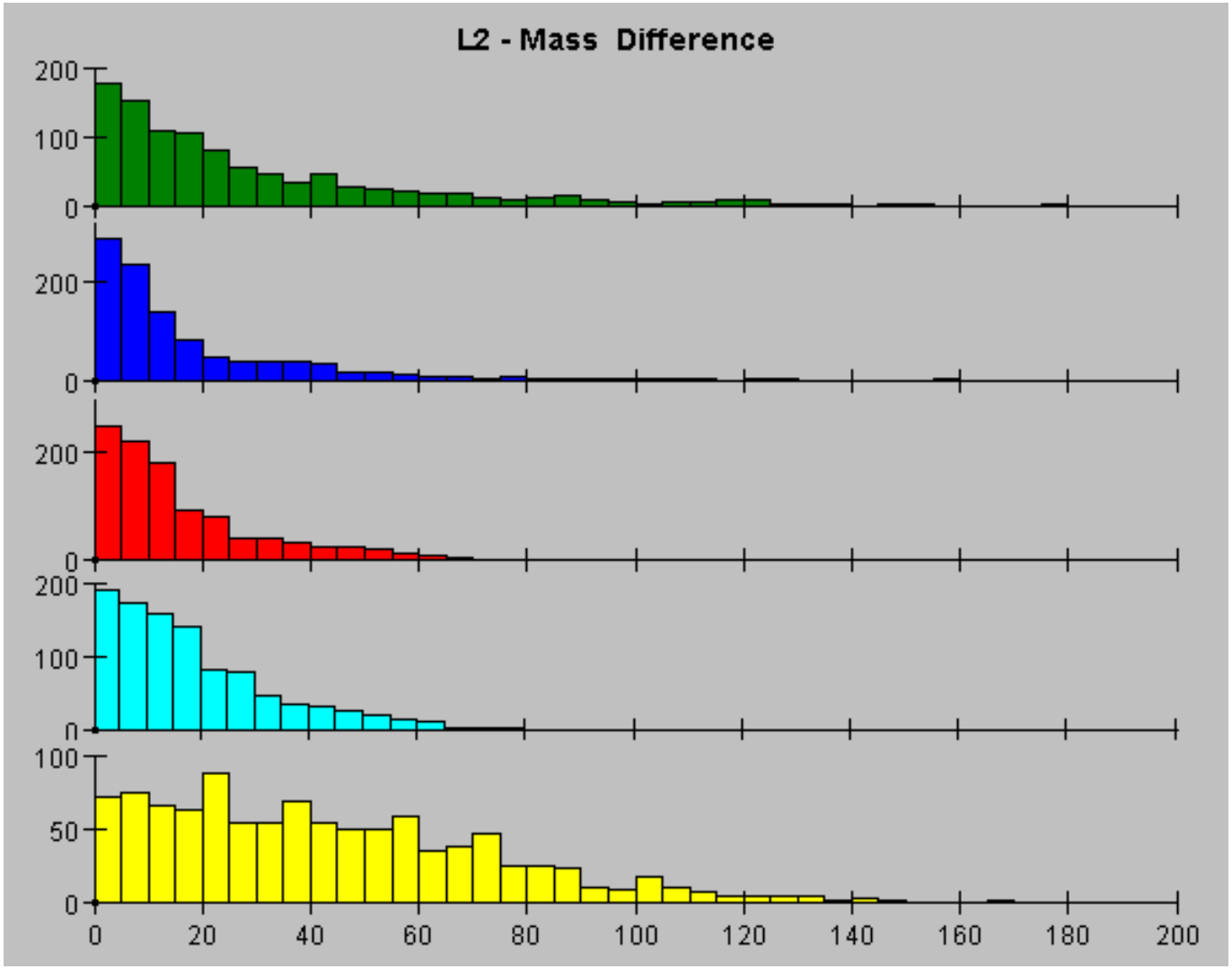

L2 - nJets
500
250
0
600
400
200
0
500
0
500
0
600
400
200
0
1
2
3
4
5
6
7
8
9

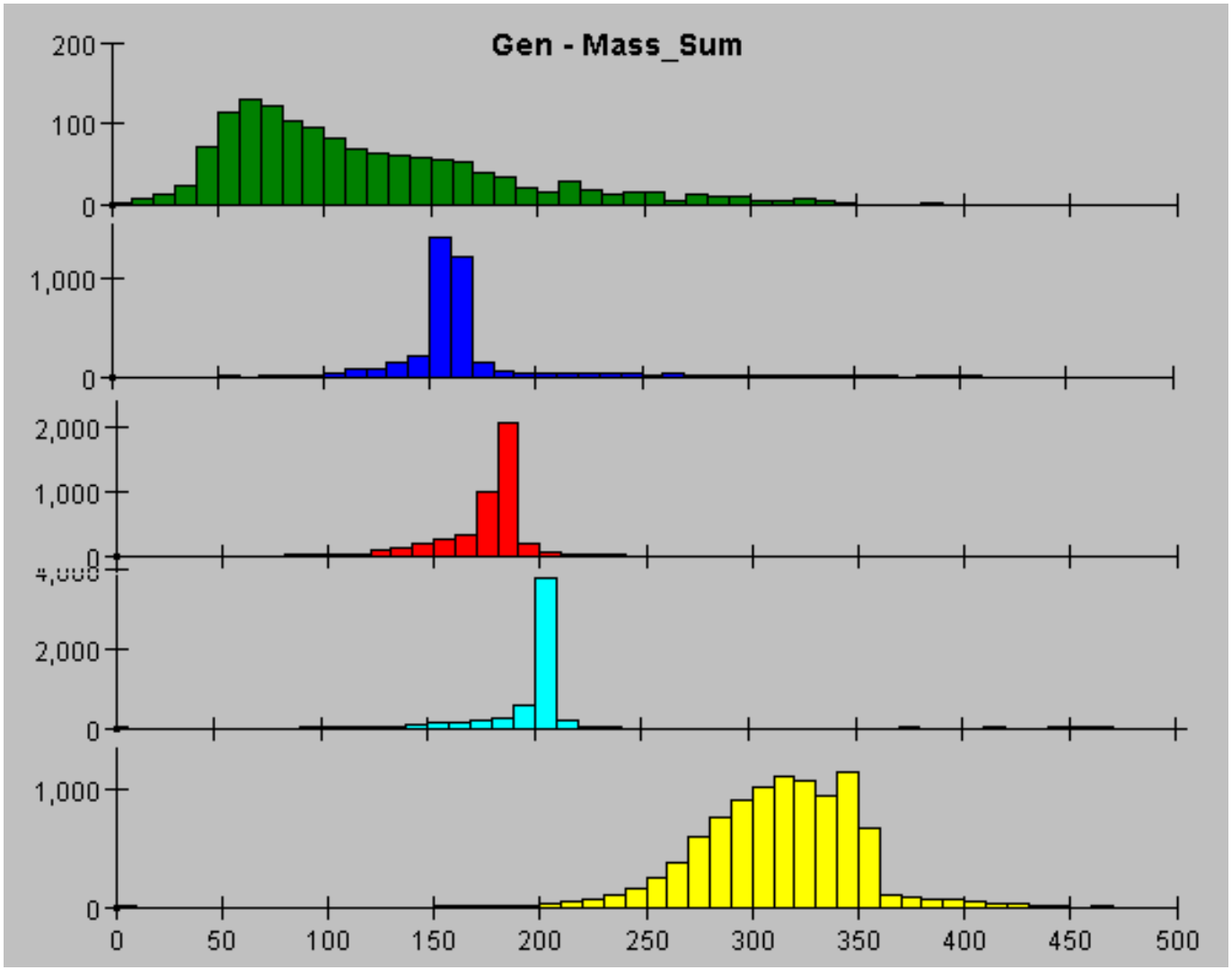

Gen - Smaller_Mass
400
200
0
2,000
1,000
0
1,000
0
2,000
0
500
0
0
50
100
150
200
250
300

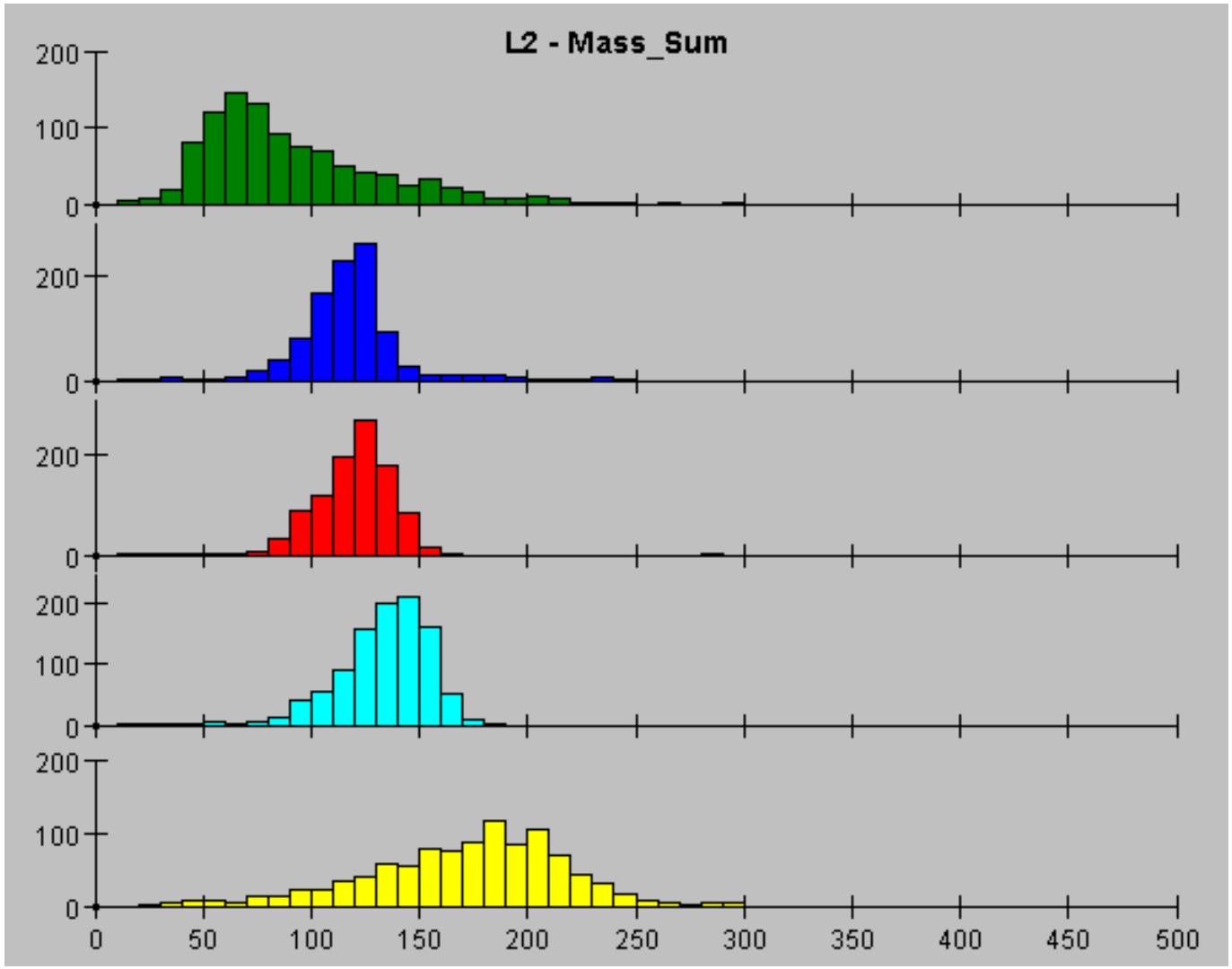

Gen - Larger_Mass
200
100
0
1,000
0
2,000
0
2,000
0
1,000
0
0
50
100
150
200
250
300

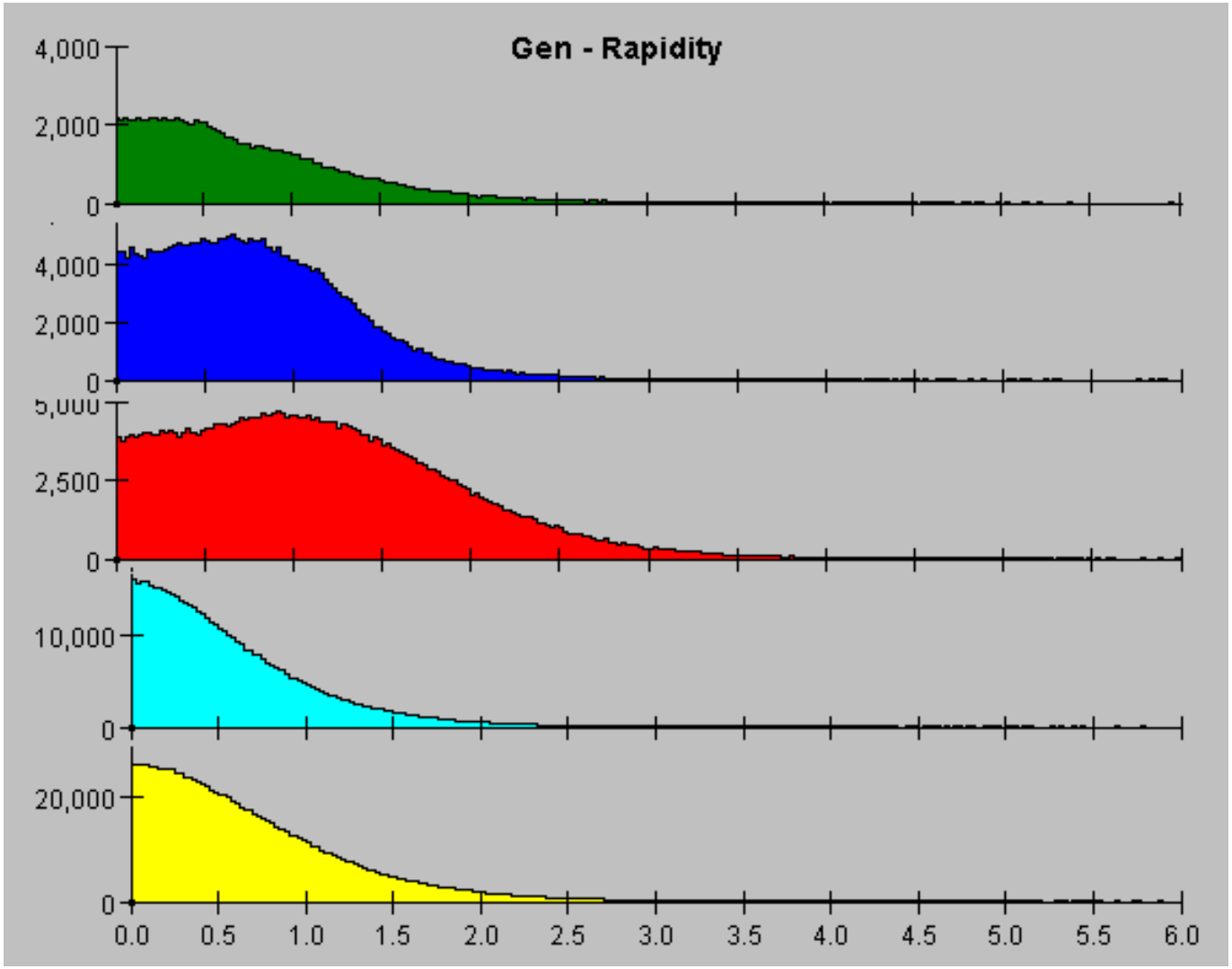

L2 Larger Mass
200
100
0
200
0
200
0
200
0
100
50
0
0
50
100
150
200
250
300

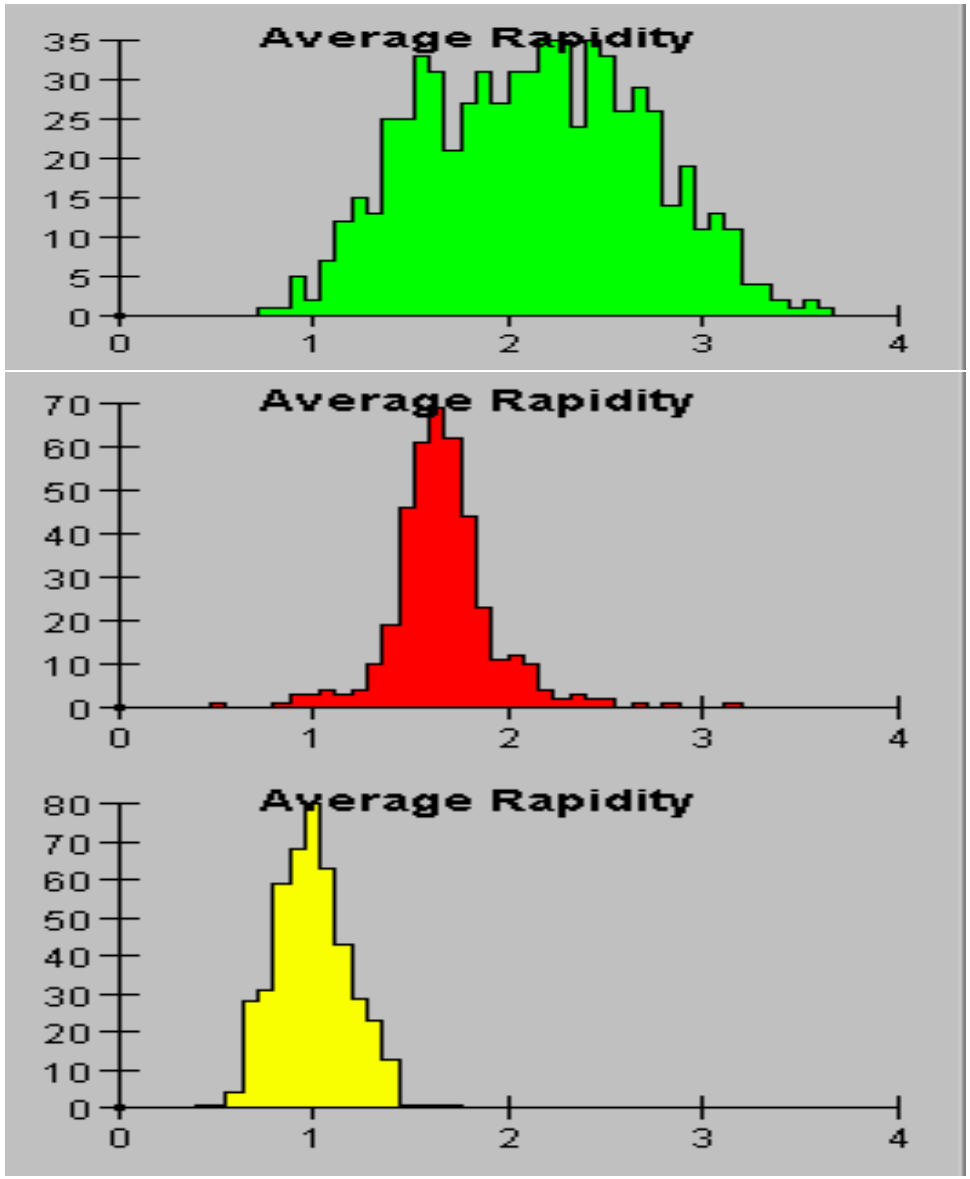

Gen - Mass Difference
200
100
0
2,000
1,000
0
2,000
1,000
0
2,000
0
1,000
500
0
0
20
40
60
80
100
120
140
160
180
200


L2 - Mass Difference
200
100
0
200
0
200
0
200
100
0
100
50
0
0
20
40
60
80
100
120
140
160
180
200

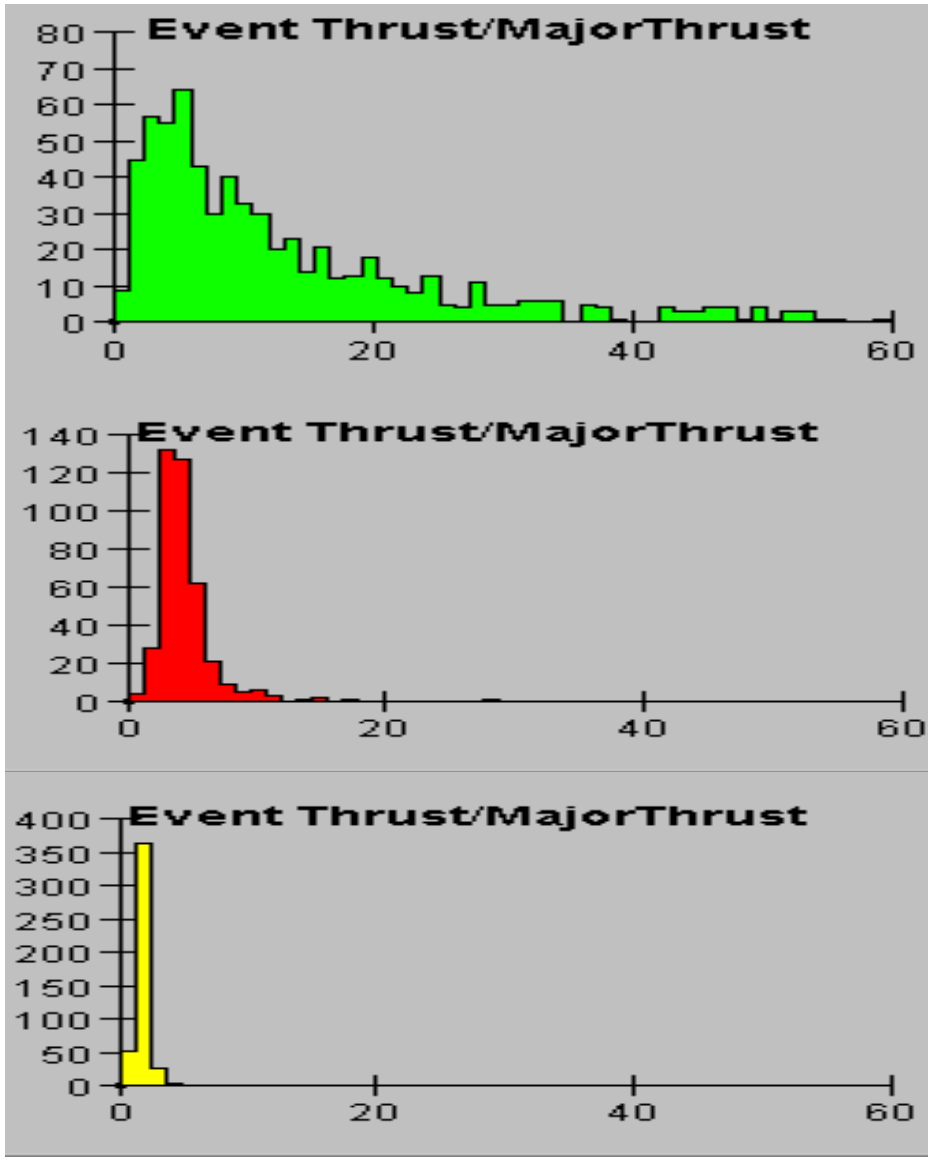

Gen - Mass_Sum
200
100
0
1,000
0
2,000
1,000
0
2,000
0
1,000
0
0
50
100
150
200
250
300
350
400
450
500


L2 - Mass_Sum
200
100
0
200
0
200
0
200
100
0
200
100
0
0
50
100
150
200
250
300
350
400
450
500


Gen - Rapidity
4,000
2,000
0
4,000
2,000
0
5,000
2,500
0
10,000
0
20,000
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0



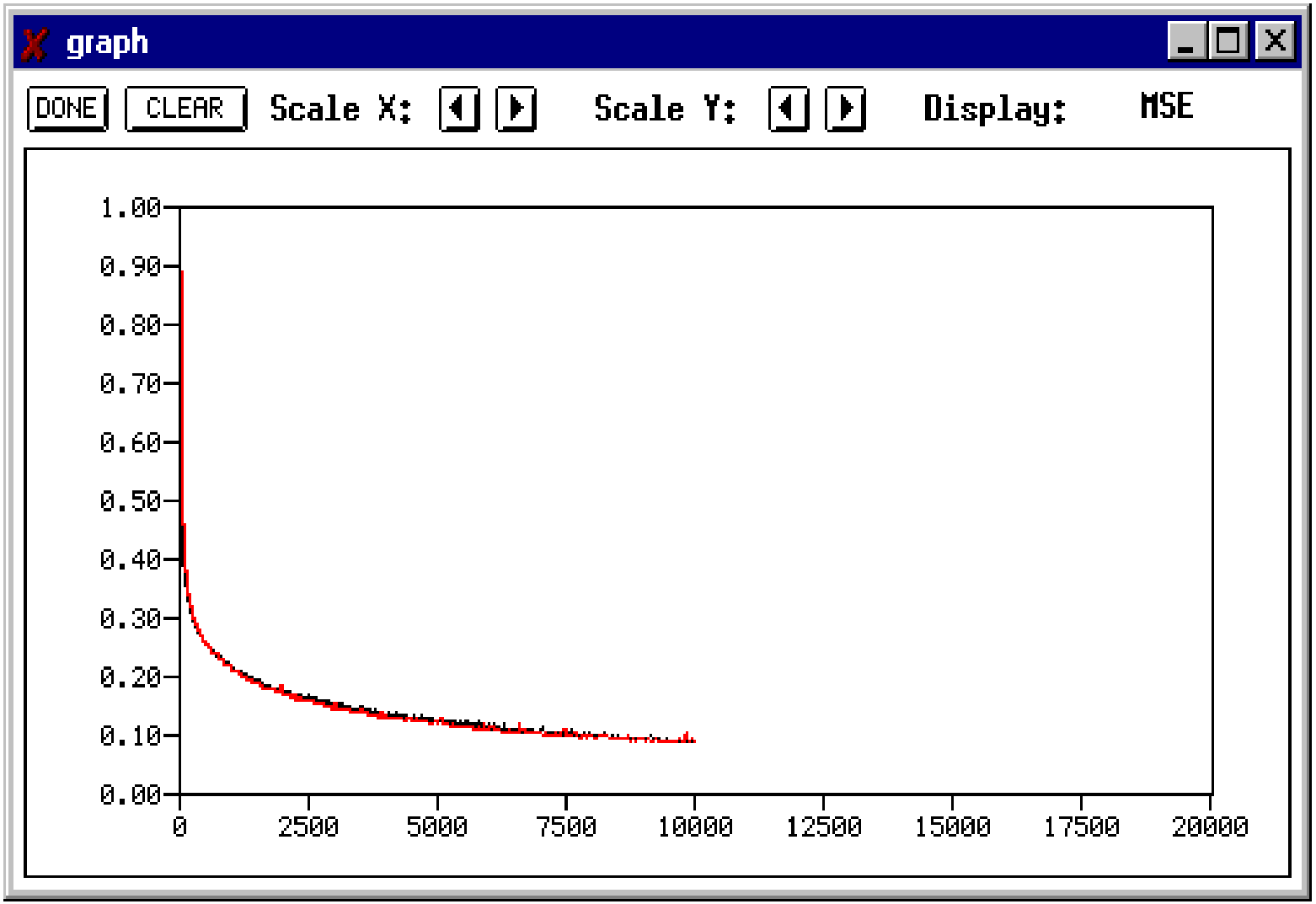
Sorry: this is an old slide, goof in new slide.


Event Thrust/MajorThrust
80
70
60
50
40
30
20
10
0
0
20
40
60
Event Thrust/MajorThrust
140
120
100
80
60
40
20
0
0
20
40
60
Event Thrust/MajorThrust
400
350
300
250
200
150
100
50
0
0
20
40
60

Sorry: ditto

Neural Net

- Stuttgart – SNNS
- Training sets:
  - Gen level 2K-5K events/process (20K total)
  - Sim level 1K events/process (5K total)
- Both validation sets:
  - 100 events/process



Gen level training graph to show there is no overtraining.

% Efficiency with NN

	Gen Level	Sim Level
qq	91	76
WW	90	66
ZZ	97	53
ZH	96	74
tt	100	86

% Efficiency with old cuts

	Gen Level	Sim Level
qq	91	89
WW	na	na
ZZ	84	63
ZH	na	na
tt	91	67

% Correct ID with NN

	Gen Level	Sim Level
qq	95	74
WW	98	60
ZZ	87	74
ZH	97	64
tt	98	86

% Correct ID with old cuts

	Gen Level	Sim Level
qq	63	70
WW	na	na
ZZ	61	6
ZH	na	na
tt	98	

Summary/Next

- Study extended to have three similar color singlet states.
- Neural net does significantly better than cuts.
- Surprisingly good results with simple calorimeter clusters only.
- Next: better clustering to improve results
- And study calorimeter design to improve results