LCFIPlus Variables

How to add a new variable

Adding a new variable must be done in code. The LCFIPlus package should be downloaded (e.g. checked out from SVN) and compiled, with appropriate environmental variables defined for Marlin.

Each variable is defined inside src/FlavorTag.cc as a class inheriting from FTAlgo. The name of the variable is defined by providing a string argument to the constructor of the parent class. The variable class should implement the process() method which performs the variable computation. One can access the jet data through the member "_jet" and the event data through "_event". The result should be stored in the member variable "_result". One can optionally implement the processEvent() method which is called once per every event. The class should be instantiated and added to the FTManager object inside the FlavorTag::init() method to make the variable known to LCFIPlus.

An example implementation of a variable is shown below.

```
// computes the number of vertices in a jet
class FtNvtx : public FTAlgo {class FtNvtx : public FTAlgo {
  public:
    FtNvtx() : FTAlgo("nvtx") {}
    void process() { _result = _jet->getVertices().size(); }
};
```

Variables defined in this way can be used as a flavor tagging variable in the XML configuration. The name of the variable identified in XML is the same as the one given as a string in the constructor of the C++ code.

List of input variables

All variables are computed for each jet. A brief explanation is given below for the variables which are defined by LCFIPlus.

name	description
trk1d0sig	d0 significance of track with highest d0 significance
trk2d0sig	d0 significance of track with second highest d0 significance
trk1z0sig	z0 significance of track with highest d0 significance (ordering by d0, not z0)
trk2z0sig	z0 significance of track with second highest d0 significance (ordering by d0, not z0)
trk1pt	transverse momentum of track with highest d0 significance
trk1pt_jete	trk1pt divided by the jet energy
trk2pt	transverse momentum of track with second highest d0 significance
trk2pt_jete	trk2pt divided by the jet energy
jprobr	joint probability in the r-phi plane using all tracks
jprobr5sigma	joint probability in the r-phi plane using all tracks having impact parameter significance exceeding 5 sigma
jprobz	joint probability in the z projection using all tracks
jprobz5sigma	joint probability in the z projection using all tracks having impact parameter significance exceeding 5 sigma
d0bprob	product of b-quark probabilities of d0 values for all tracks, using b/c/q d0 distributions
d0cprob	product of c-quark probabilities of d0 values for all tracks, using b/c/q d0 distributions
d0qprob	product of q-quark probabilities of d0 values for all tracks, using b/c/q d0 distributions
z0bprob	product of b-quark probabilities of z0 values for all tracks, using b/c/q z0 distributions
z0cprob	product of c-quark probabilities of z0 values for all tracks, using b/c/q z0 distributions
z0qprob	product of q-quark probabilities of z0 values for all tracks, using b/c/q z0 distributions
nmuon	number of identified muons
nelectron	number of identified electrons
trkmass	mass of all tracks exceeding 5 sigma significance in d0/z0 values
1vtxprob	vertex probability with all tracks associated in vertices combined
vtxlen1	decay length of the first vertex in the jet (zero if no vertex is found)
vtxlen1_jete	vtxlen1 divided by the jet energy
vtxlen2	decay length of the second vertex in the jet (zero if number of vertex is less than two)

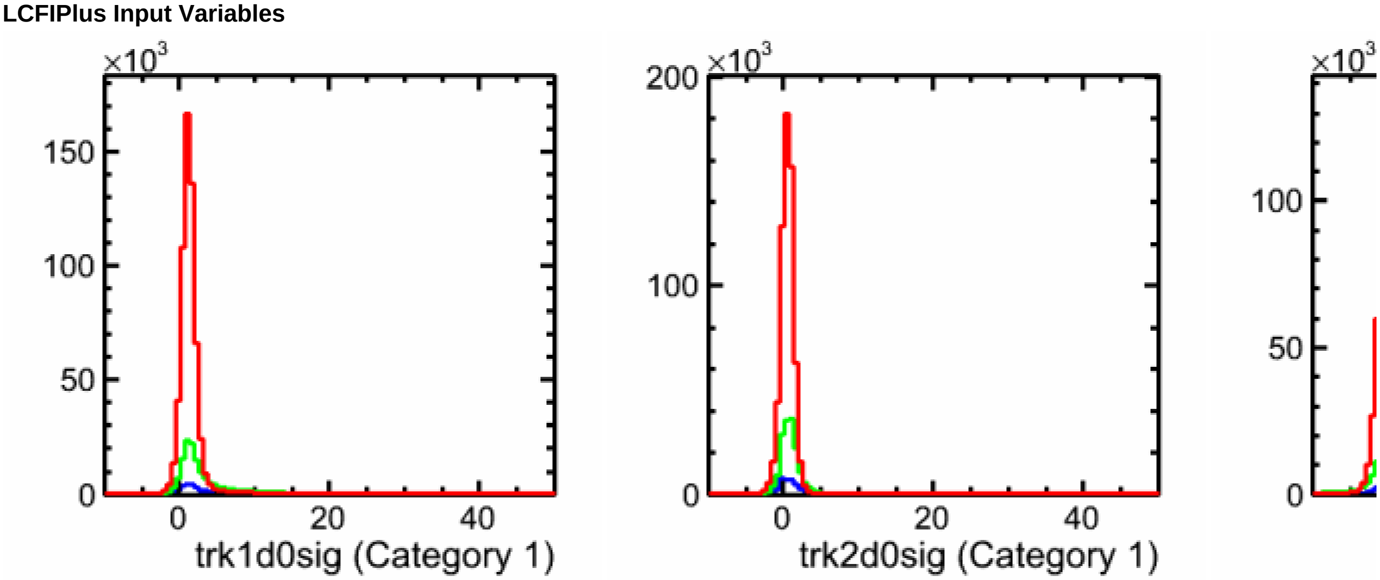
vtxlen2_jete	vtxlen2 divided by the jet energy
vtxlen12	distance between the first and second vertex (zero if number of vertex is less than two)
vtxlen12_jete	vtxlen12 divided by the jet energy
vtxsig1	decay length significance of the first vertex in the jet (zero if no vertex is found)
vtxsig1_jete	vtxsig1 divided by the jet energy
vtxsig2	decay length significance of the second vertex in the jet (zero if number of vertex is less than two)
vtxsig2_jete	vtxsig2 divided by the jet energy
vtxsig12	vtxlen12 divided by its error as computed from the sum of the covariance matrix of the first and second vertices, projected along the line connecting the two vertices
vtxsig12_jete	vtxsig12 divided by the jet energy
vtxdirang1	the angle between the momentum (computed as a vector sum of track momenta) and the displacement of the first vertex
vtxdirang1_jete	vtxdirang1 multiplied by the jet energy
vtxdirang2	the angle between the momentum (computed as a vector sum of track momenta) and the displacement of the second vertex
vtxdirang2_jete	vtxdirang2 multiplied by the jet energy
vtxmult1	number of tracks included in the first vertex (zero if no vertex is found)
vtxmult2	number of tracks included in the second vertex (zero if number of vertex is less than two)
vtxmult	number of tracks which are used to form secondary vertices (summed for all vertices)
vtxmom1	magnitude of the vector sum of the momenta of all tracks combined into the first vertex
vtxmom1_jete	vtxmom1 divided by the jet energy
vtxmom2	magnitude of the vector sum of the momenta of all tracks combined into the second vertex
vtxmom2_jete	vtxmom2 divided by the jet energy
vtxmass1	mass of the first vertex computed from the sum of track four-momenta
vtxmass2	mass of the second vertex computed from the sum of track four-momenta
vtxmass	vertex mass as computed from the sum of four momenta of all tracks forming secondary vertices
vtxmasspc	mass of the vertex with minimum pt correction allowed by the error matrices of the primary and secondary vertices
vtxprob	vertex probability; for multiple vertices, the probability P is computed as 1-P = (1-P_1)**(1-P_2)**...*(1-P_N)

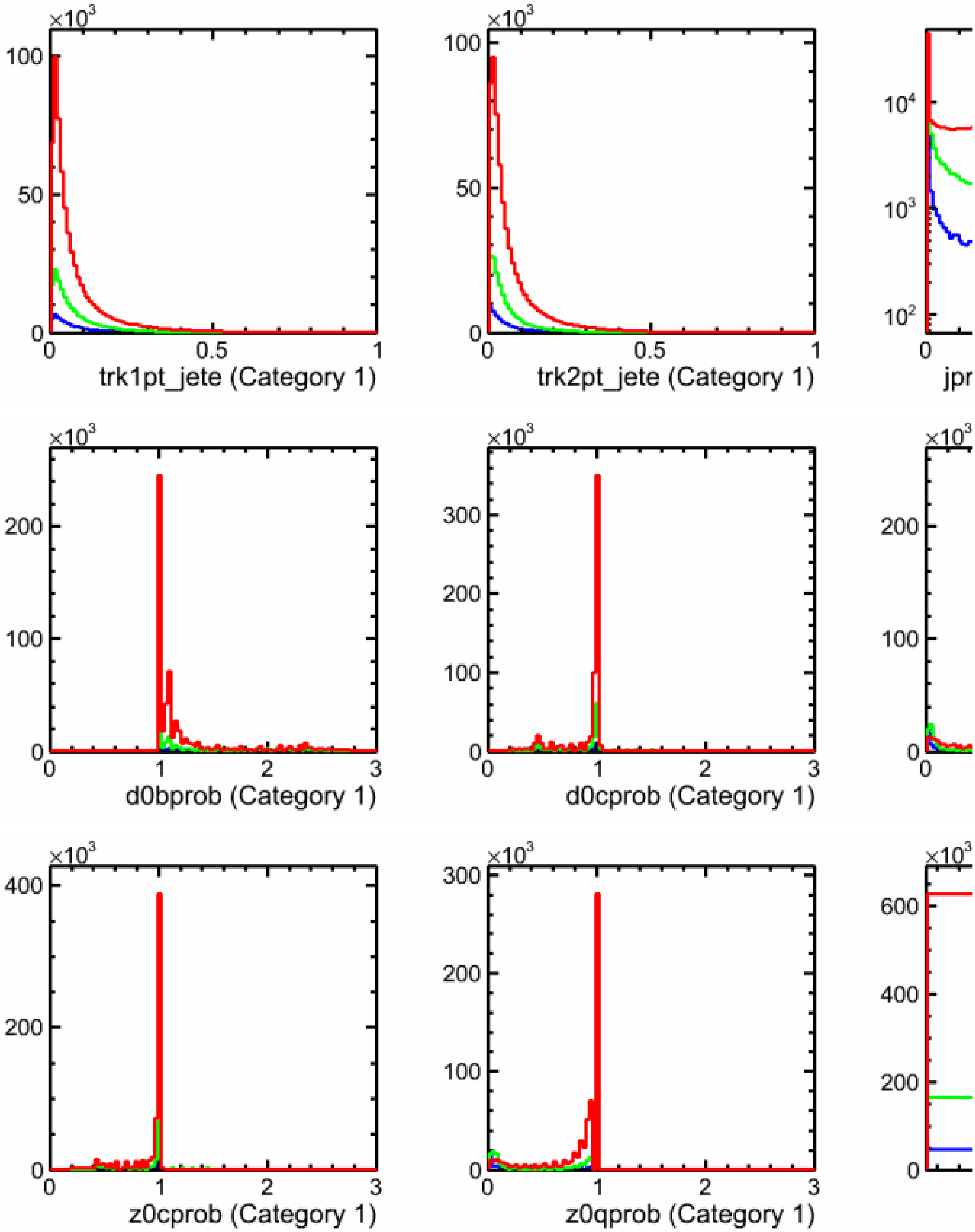
Example plots of input variables

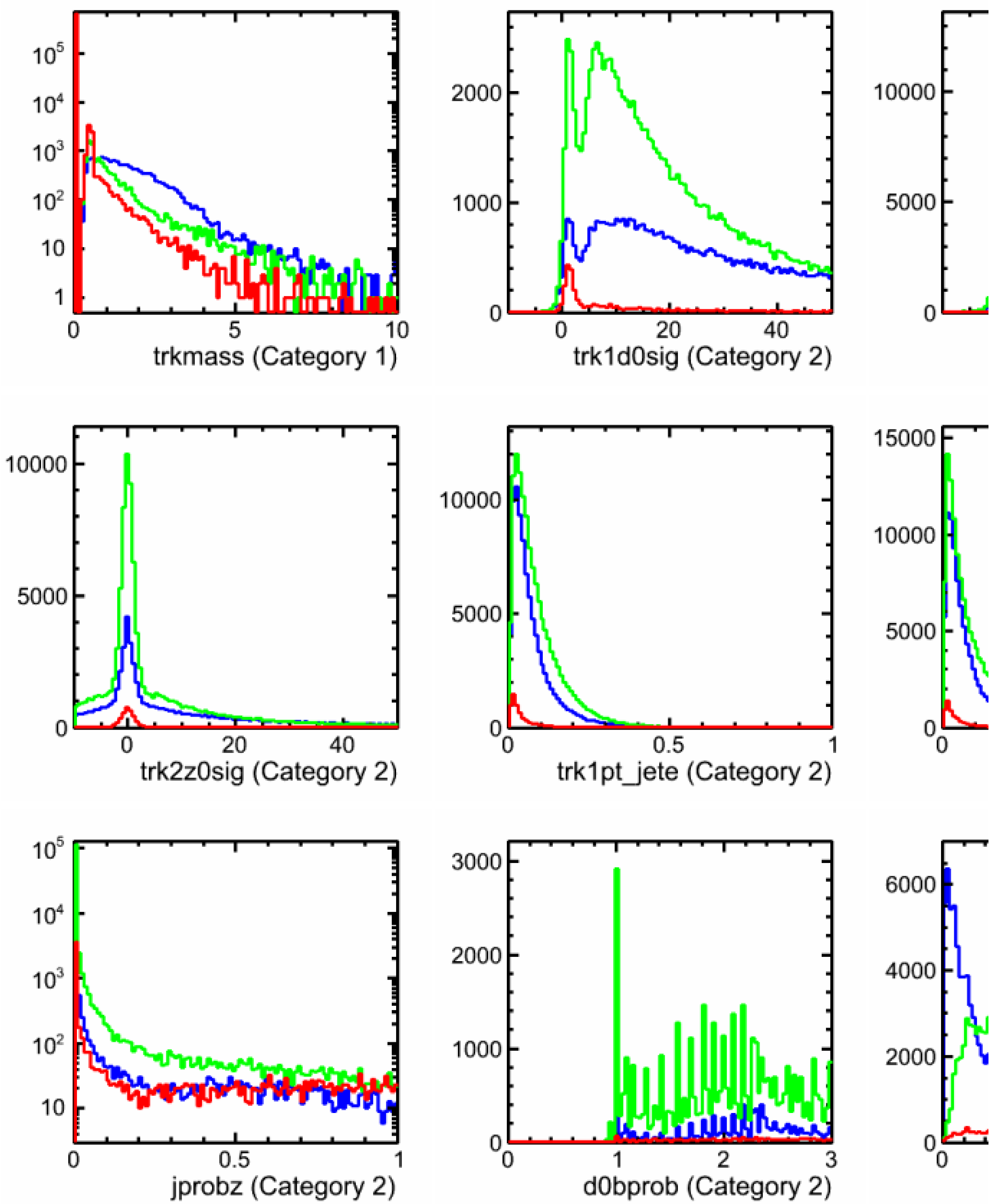
The plots below are made from 6 jet samples at 500 GeV using ILD detector simulation. They were made in the context of the DBD studies in 2012.

The color scheme is as follows: blue = b jets, green = c jets, red = uds jets.

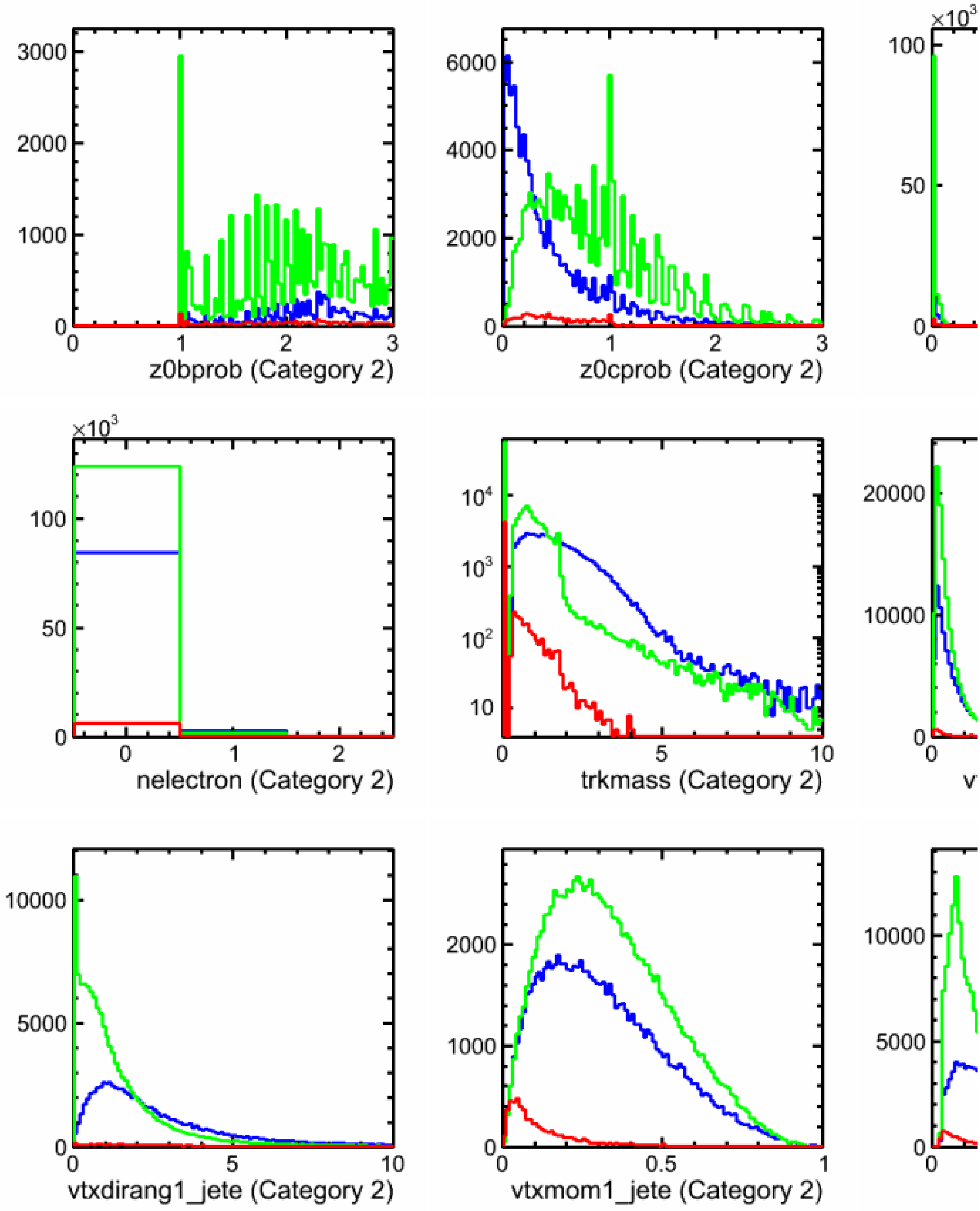
LCFIPlus Input Variables



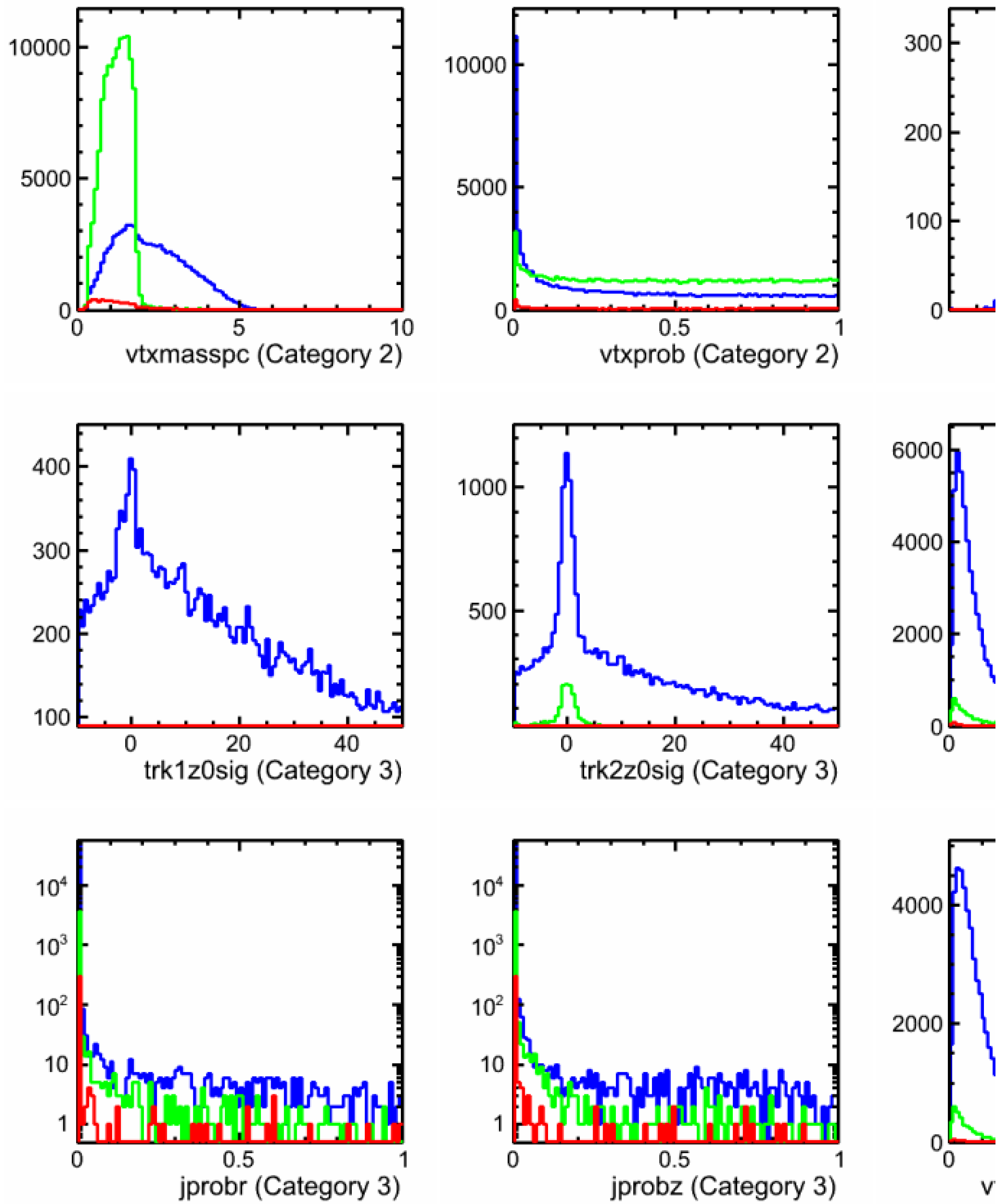

×10^3
100
50
0
0
0.5
1
trk1pt_jete (Category 1)
×10^3
100
50
0
0
0.5
1
trk2pt_jete (Category 1)
10^4
10^3
10^2
0
jpr
×10^3
200
100
0
0
1
2
3
d0bprob (Category 1)
×10^3
300
200
100
0
0
1
2
3
d0cprob (Category 1)
×10^3
200
100
0
0
×10^3
400
200
0
0
1
2
3
z0cprob (Category 1)
×10^3
300
200
100
0
0
1
2
3
z0qprob (Category 1)
×10^3
600
400
200
0



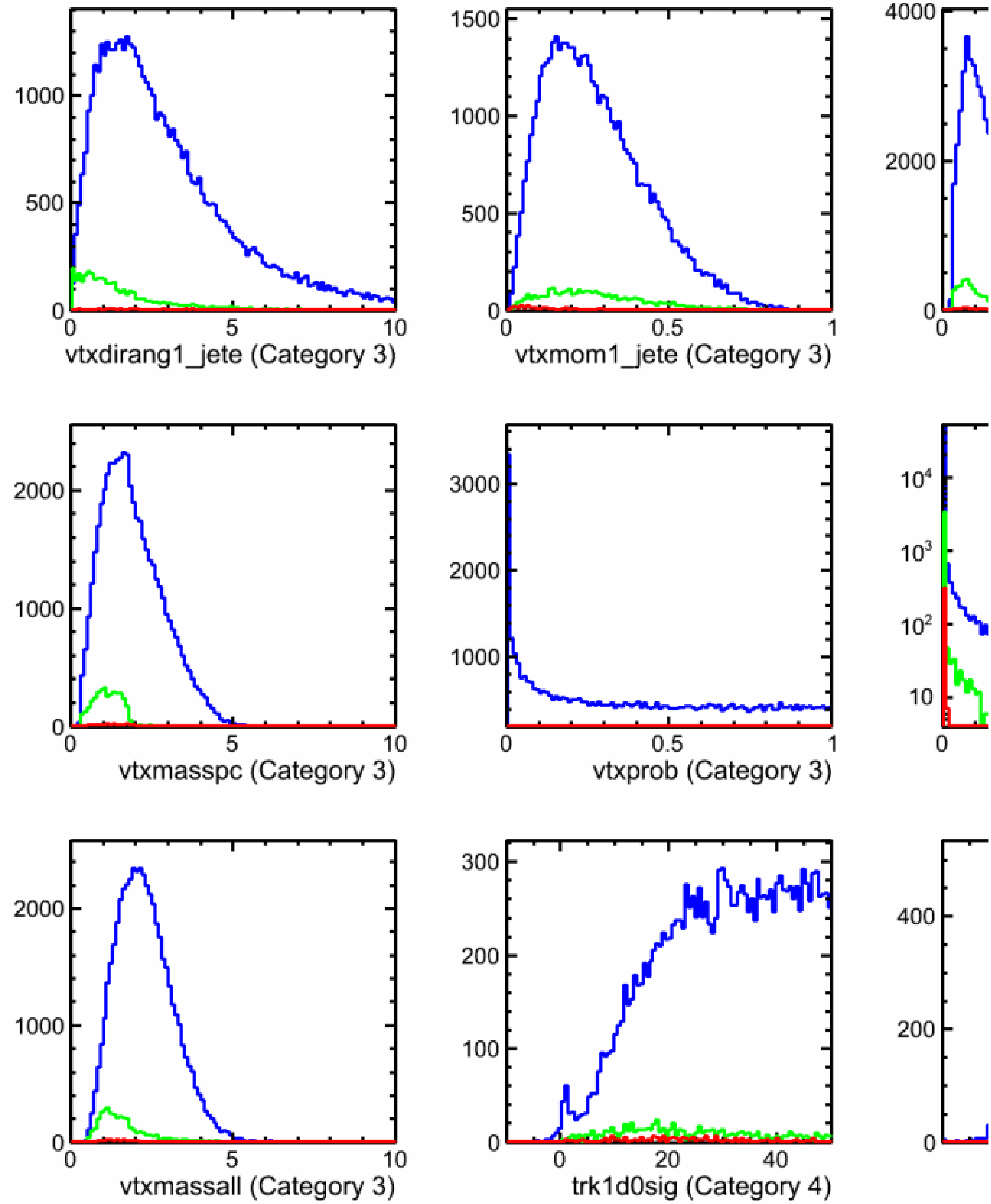
trkmass (Category 1)
trk1d0sig (Category 2)
trk2z0sig (Category 2)
trk1pt_jete (Category 2)
jprobz (Category 2)
d0bprob (Category 2)
10^5
10^4
10^3
10^2
10
1
0
5
10
2000
1000
20
40
10000
5000
15000
0.5
3000
6000
4000
2
3

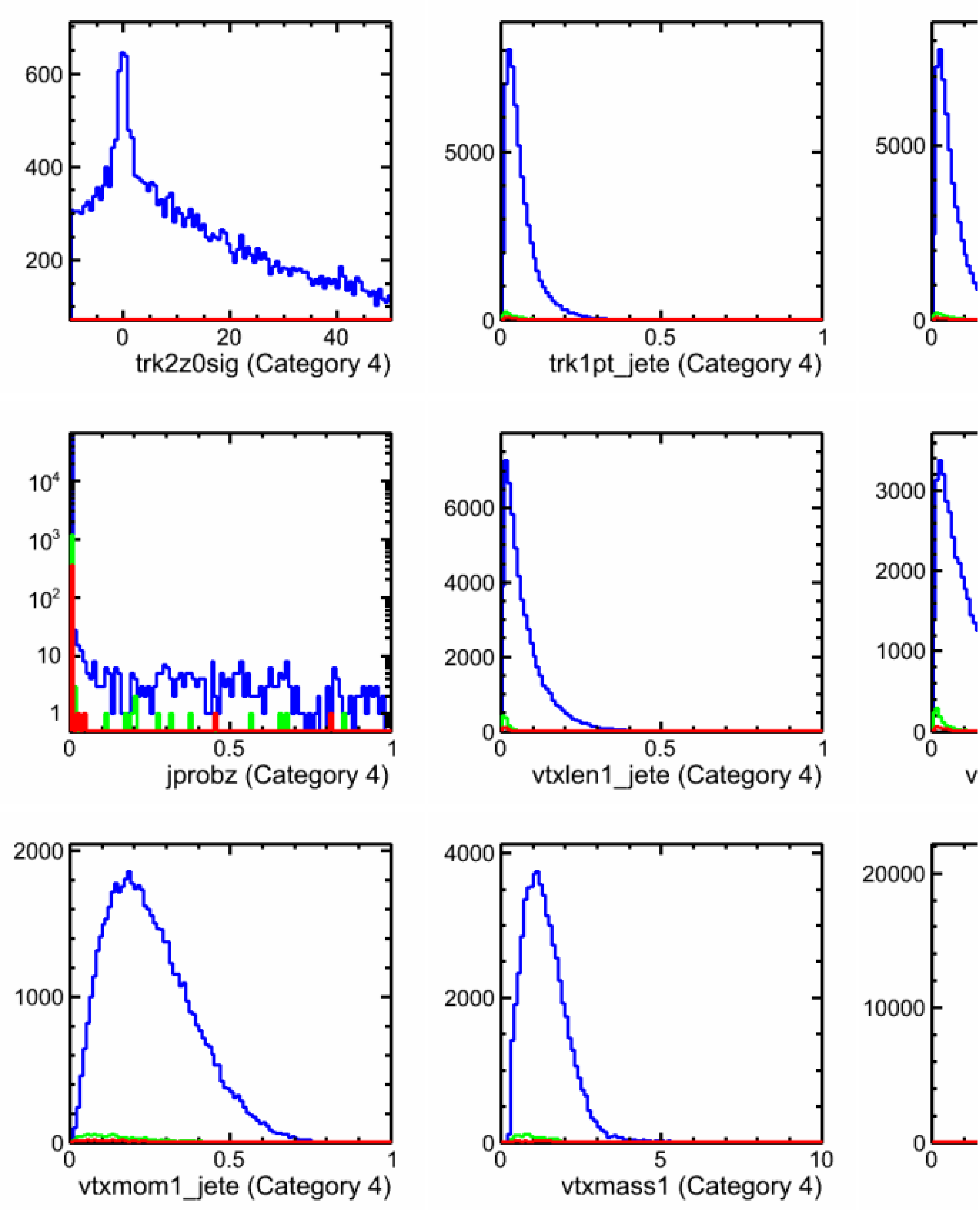


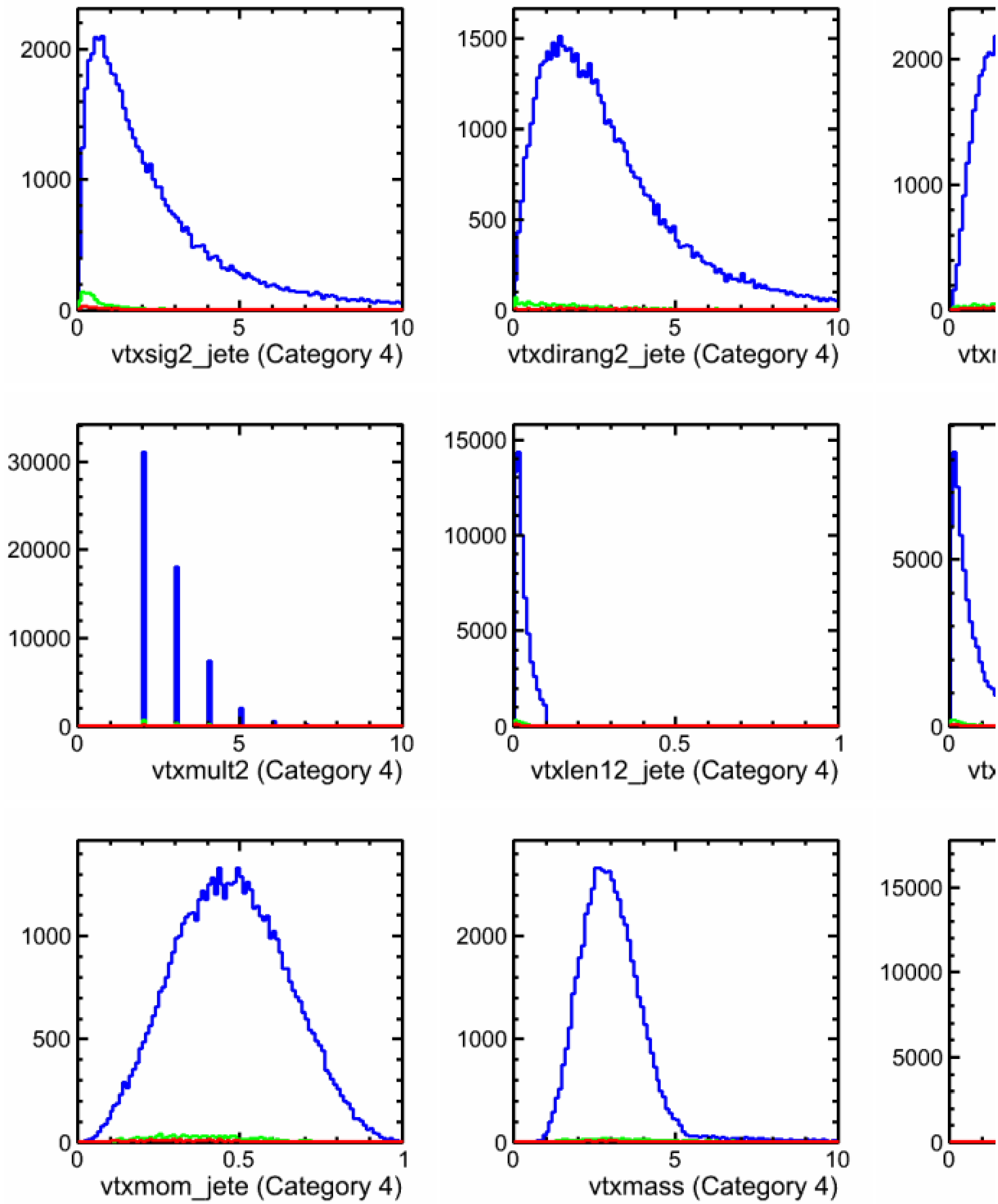
z0bprob (Category 2)
z0cprob (Category 2)
nelectron (Category 2)
trkmass (Category 2)
vtxdirang1_jete (Category 2)
vtxmom1_jete (Category 2)



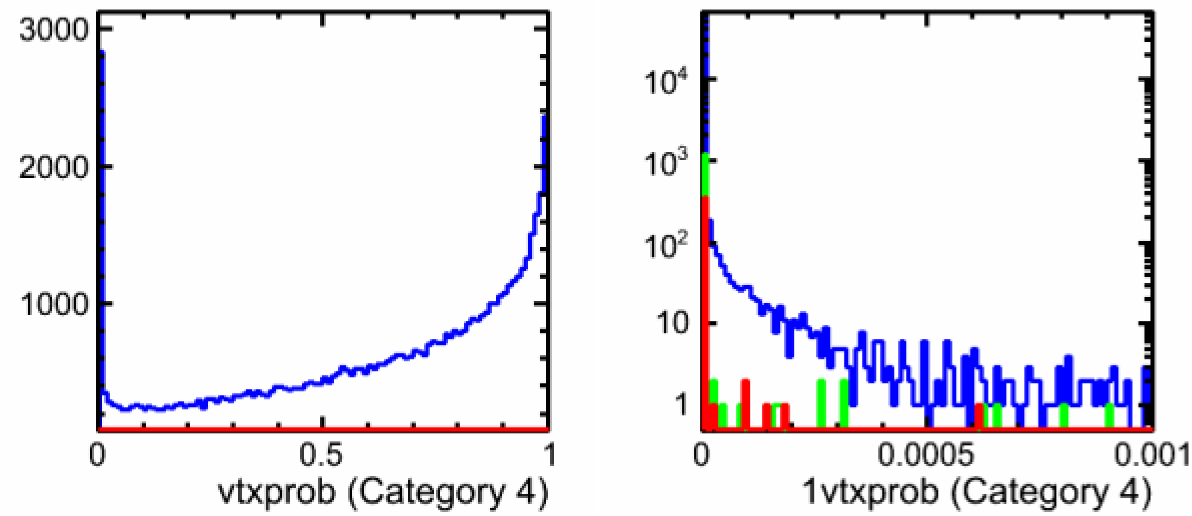
vtxmasspc (Category 2)
vtxprob (Category 2)
trk1z0sig (Category 3)
trk2z0sig (Category 3)
jprobr (Category 3)
jprobz (Category 3)


vtxdirang1_jete (Category 3)
vtxmom1_jete (Category 3)
vtxmasspc (Category 3)
vtxprob (Category 3)
vtxmassall (Category 3)
trk1d0sig (Category 4)
0
500
1000
1500
2000
3000
4000
5
10
0.5
1
20
40
100
200
300
400
10
10^2
10^3
10^4


600
400
200
0
20
40
trk2z0sig (Category 4)
5000
0
0.5
1
trk1pt_jete (Category 4)
5000
0
0
10⁴
10³
10²
10
1
0
0.5
1
jprobz (Category 4)
6000
4000
2000
0
0.5
1
vtxlen1_jete (Category 4)
3000
2000
1000
0
0
2000
1000
0
0.5
1
vtxmom1_jete (Category 4)
4000
2000
0
5
10
vtxmass1 (Category 4)
20000
10000
0
0



vtxsig2_jete (Category 4)
vtxdirang2_jete (Category 4)
vtxmult2 (Category 4)
vtxlen12_jete (Category 4)
vtxmom_jete (Category 4)
vtxmass (Category 4)



3000
2000
1000
0
0.5
1
vtxprob (Category 4)
10^4
10^3
10^2
10
1
0
0.0005
0.001
1vtxprob (Category 4)