



TOHOKU
UNIVERSITY



LCFIPlus performance test

Ryo Yonamine
Tohoku University

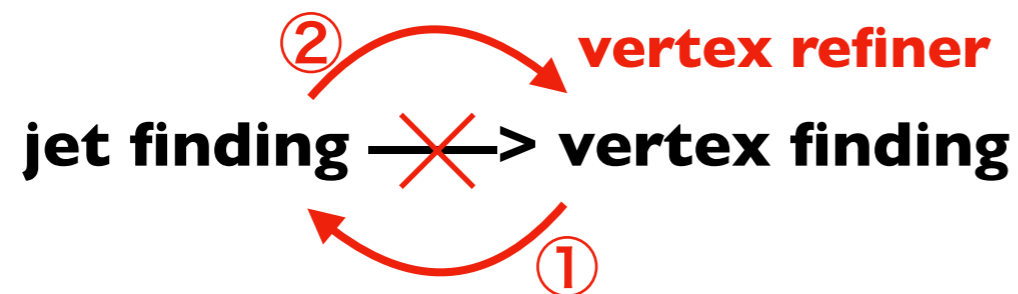
What's LCFIPlus?

❖ Jet flavour tagging tool

▶ Originated from LCFIVertex.

- . D. Bailey, et al., The LCFIVertex package: vertexing, flavour tagging and vertex charge reconstruction with an ILC vertex detector, Nucl.Instrum.Meth. A610 (2009) 573–589.

▶ Starts from vertex finding and then goes to jet finding.



Vertex refiner :

- Assign vertices to jets if necessary
- Find single track vertices (“pseudo-vtx”)
- Force two vertices

❖ **Implemented in iLCSoft but can be used in other frameworks.**

❖ **Now it is becoming the standard in LC physics.**

Urgent matter on LCFIPlus

- ❖ **iLCSoft has been intensively developed for new MC sample production.**
- ❖ **Vertexing part in LCFIPlus is common for most processes and thus it will be efficient to be done centrally.**
 - ▶ Jet clustering part in LCFIPlus is expected to run by physics analysers depending on their requirements.
- ❖ **It means the performance, especially on vertexing, must be tested before the MC production.**

News since last meeting

- ❖ **Changes on LCFIPlus for coming MC production.**
 - ▶ beam spot smearing off (p5)
 - ▶ a bug fixed (p6)
- ❖ **ttbar test sample produced**
 - ▶ requested to check the sample from the view point of vertexing.
 - ▶ flavour tagging test will come later.
 - ▶ see p7 ~

Beam spot smearing in LCFIPlus

❖ What is it for?

- ▶ In DBD era, there was not beam spot smearing (IP is always (0,0,0))
- ▶ To avoid overestimating the performance of vertex finding, LCFIPlus smeared the point to be constrained, instead of smearing IP.
- ▶ The smearing in LCFIPlus runs during vertexing.

❖ No need for next MC production

- ▶ In next MC production, IP smearing will be done before reconstruction (in detector simulation?).
- ▶ The smearing in LCFIPlus is OFF by default in v01-19-06 (and later).
- ▶ Beam size used in DBD:
 - ▶ σ_x 639e-6 mm
 - ▶ σ_y 5.7e-6 mm
 - ▶ σ_z 9.13e-2 mm

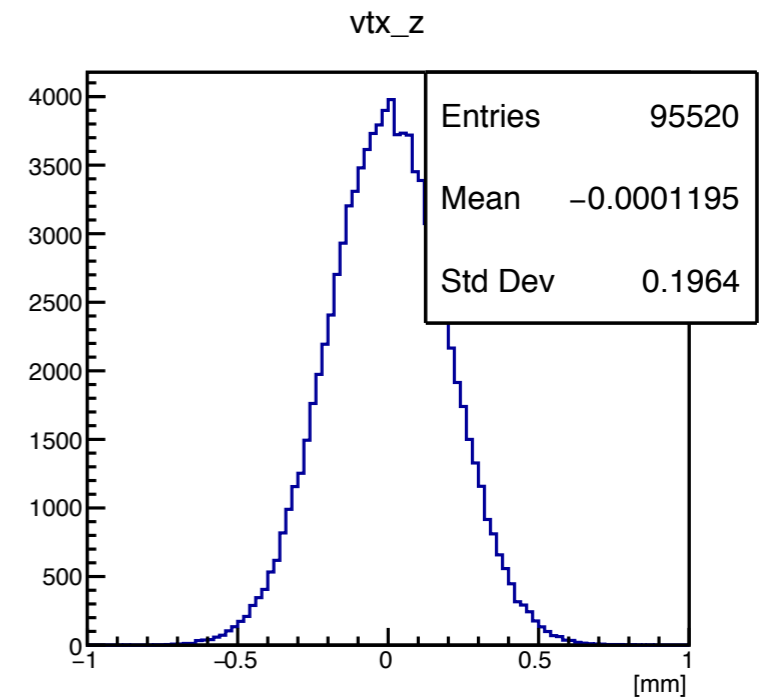
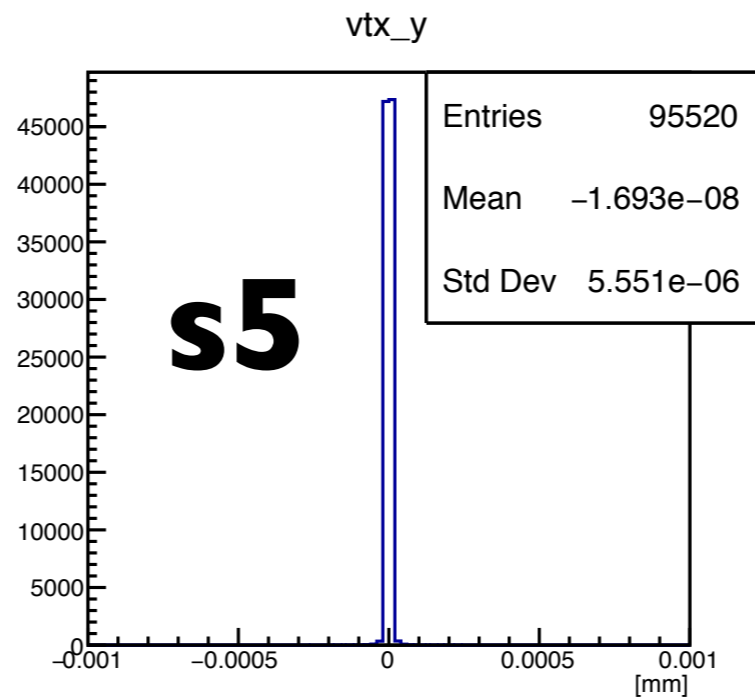
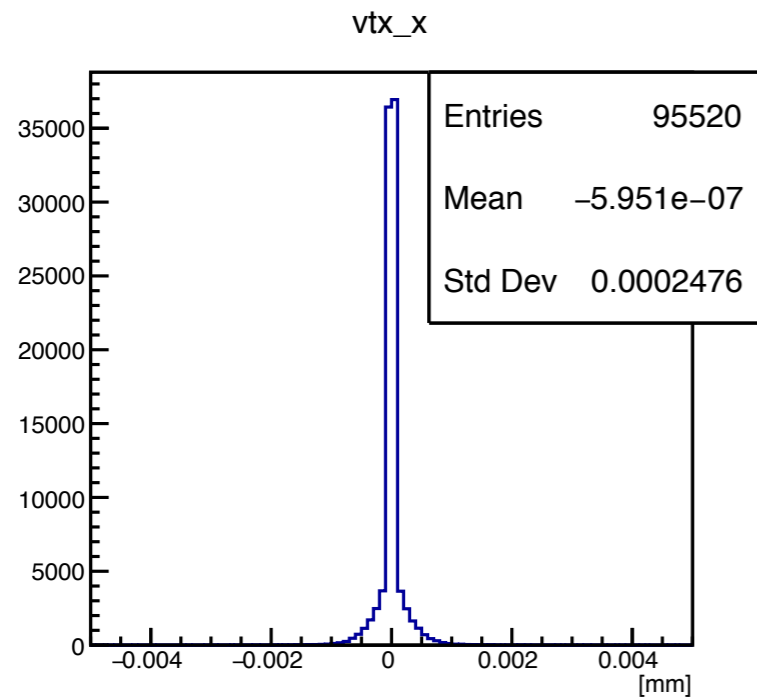
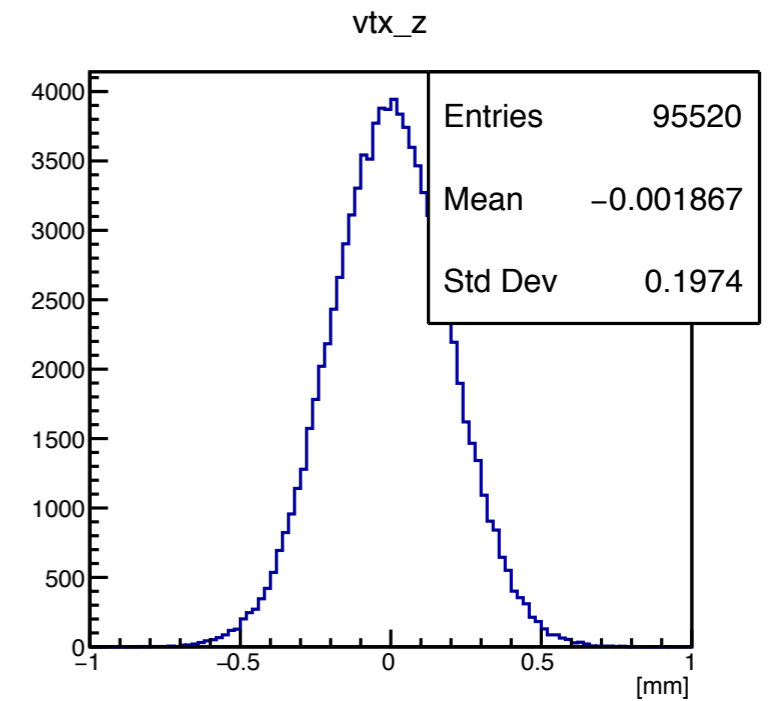
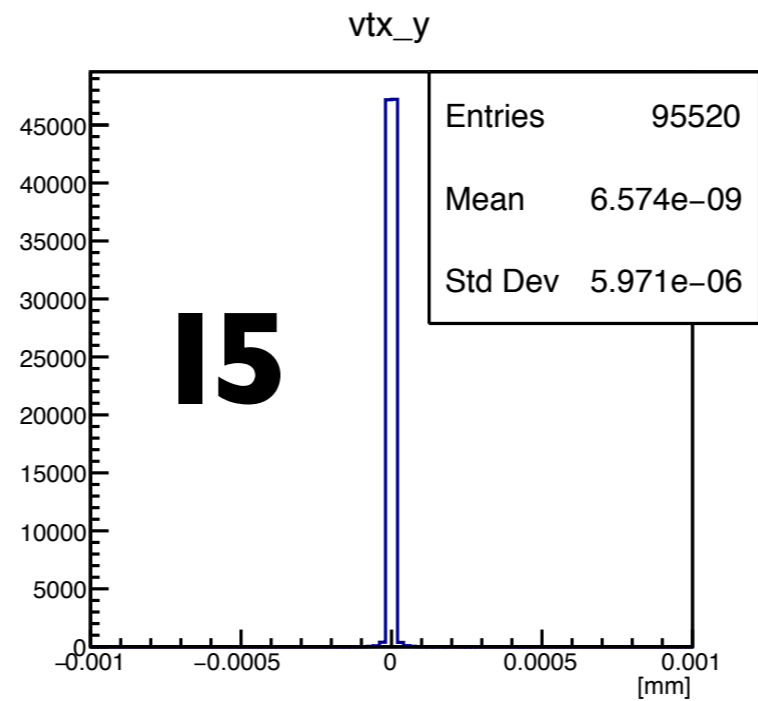
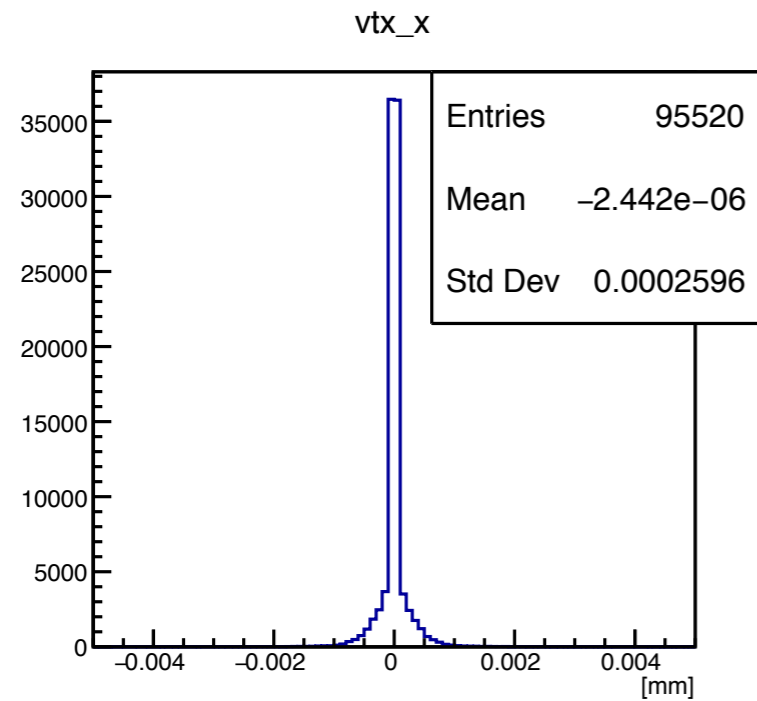
A bug related to vertex mass distribution

- ❖ **There are two energy definitions**
 - ▶ Nominal one and one dedicated for PID (introduced after DBD)
 - ▶ It turned out that if we replace the nominal one to the new one not only in PID functions but in entire code.
- ❖ **We have fixed it so that the new energy definition is used only in PID functions.**
 - ▶ This solved the major difference in flavour tagging performance between the DBD samples and the samples recently produced.

ttbar sample test

- ❖ **One of benchmarks for ILD detector performance.**
- ❖ **a small sample has been produced for check.**
 - ▶ 6f_ttbar, 500GeV
 - ▶ ILD_I5_oI_v02 and ILD_s5_oI_v02
 - ▶ Hereafter these samples are referred to as just I5 and s5.
- ❖ **Tools used in this study**
 - ▶ iLCSoft v01-19-06
 - ▶ TruthVertexFinder developed by Sviatoslav.
 - ▶ Vertex rec-mc matching = compute distance (squared) and sum over all secondary vertices ($:= \text{chi}^2$) for all combinations.
e.g. Given Rec : 3 vertices, MC : 4 vertices in a event,
 ${}^4P_3 = 24$ combinations \Rightarrow find a combination having minimum chi^2 .
- ❖ **DBD sample used as a reference**
 - ▶ In addition to the standard DBD sample, I produced new samples based on the DBD sample but re-ran vertexing with the latest LCFIPlus w/o beam spot smearing. This will be referred to as dbd_v01-19-06_newvtx.

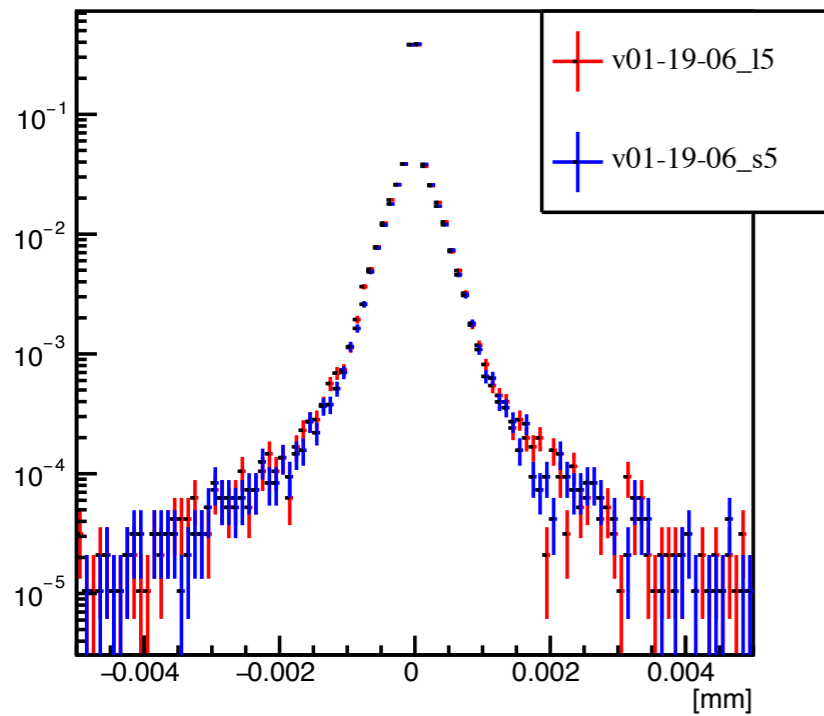
Primary vertex : position (l5 and s5)



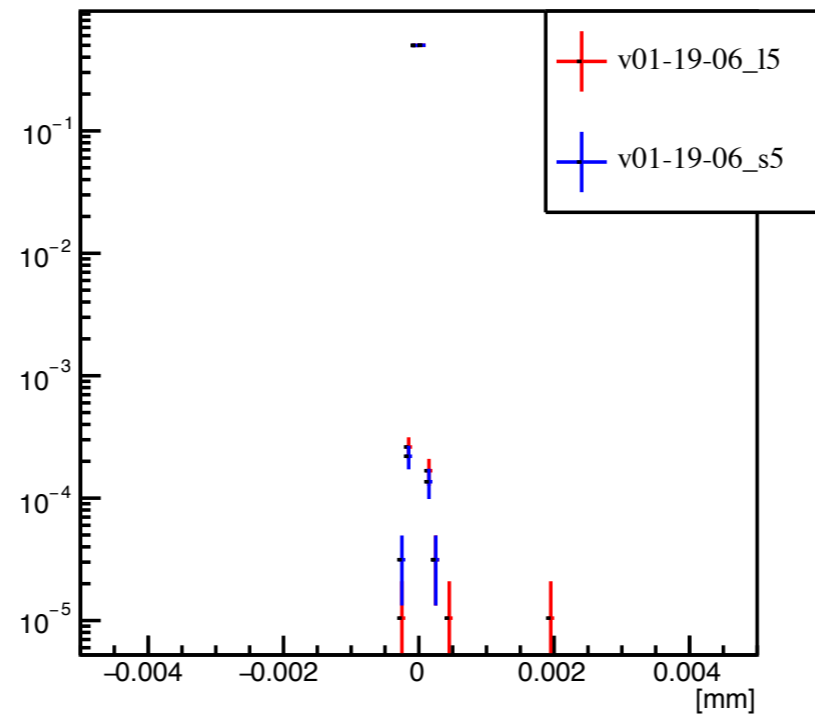
Primary vertex : position (l5 and s5)

Log scale, normalized

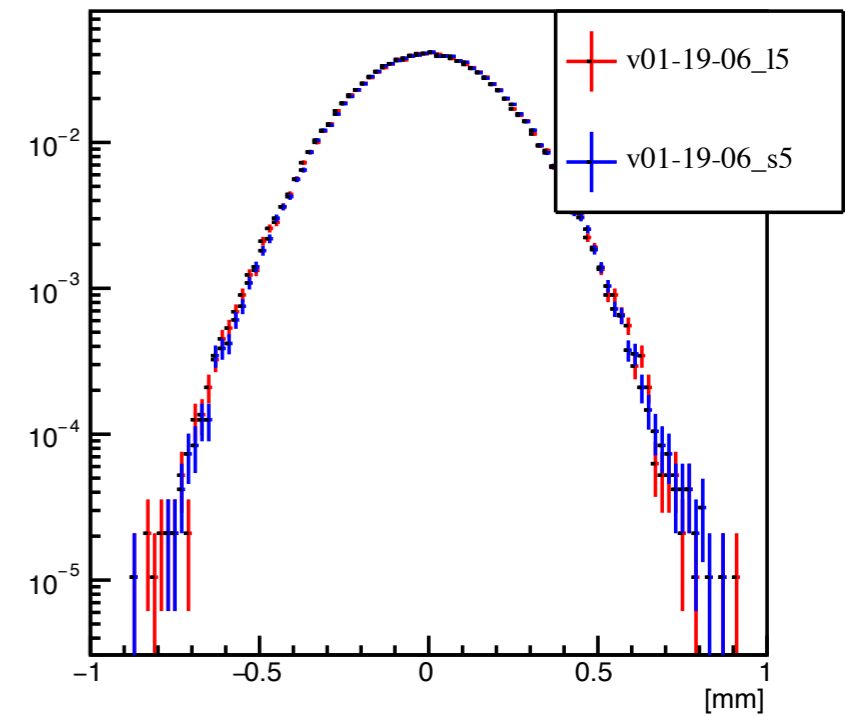
vtx_x



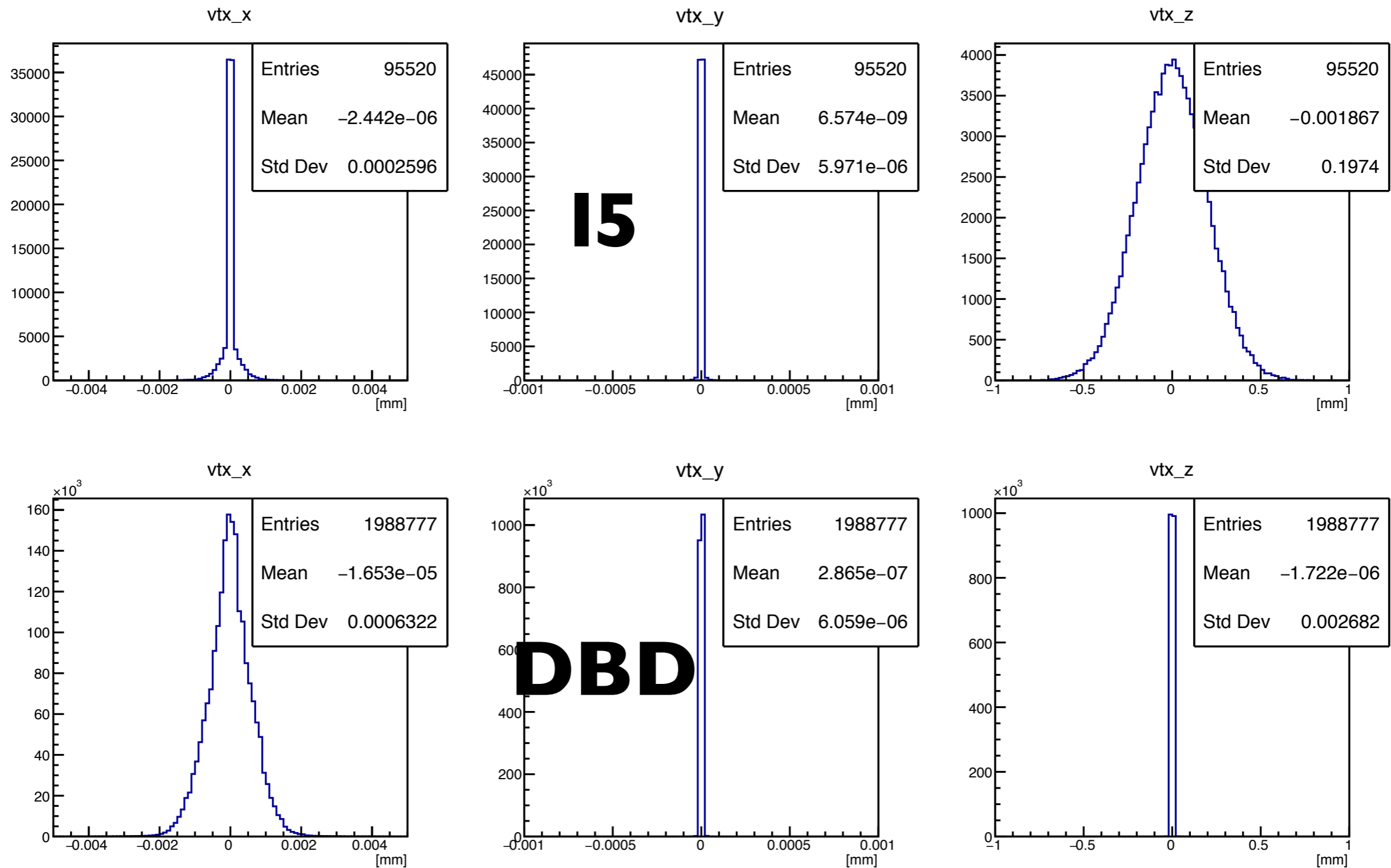
vtx_y



vtx_z



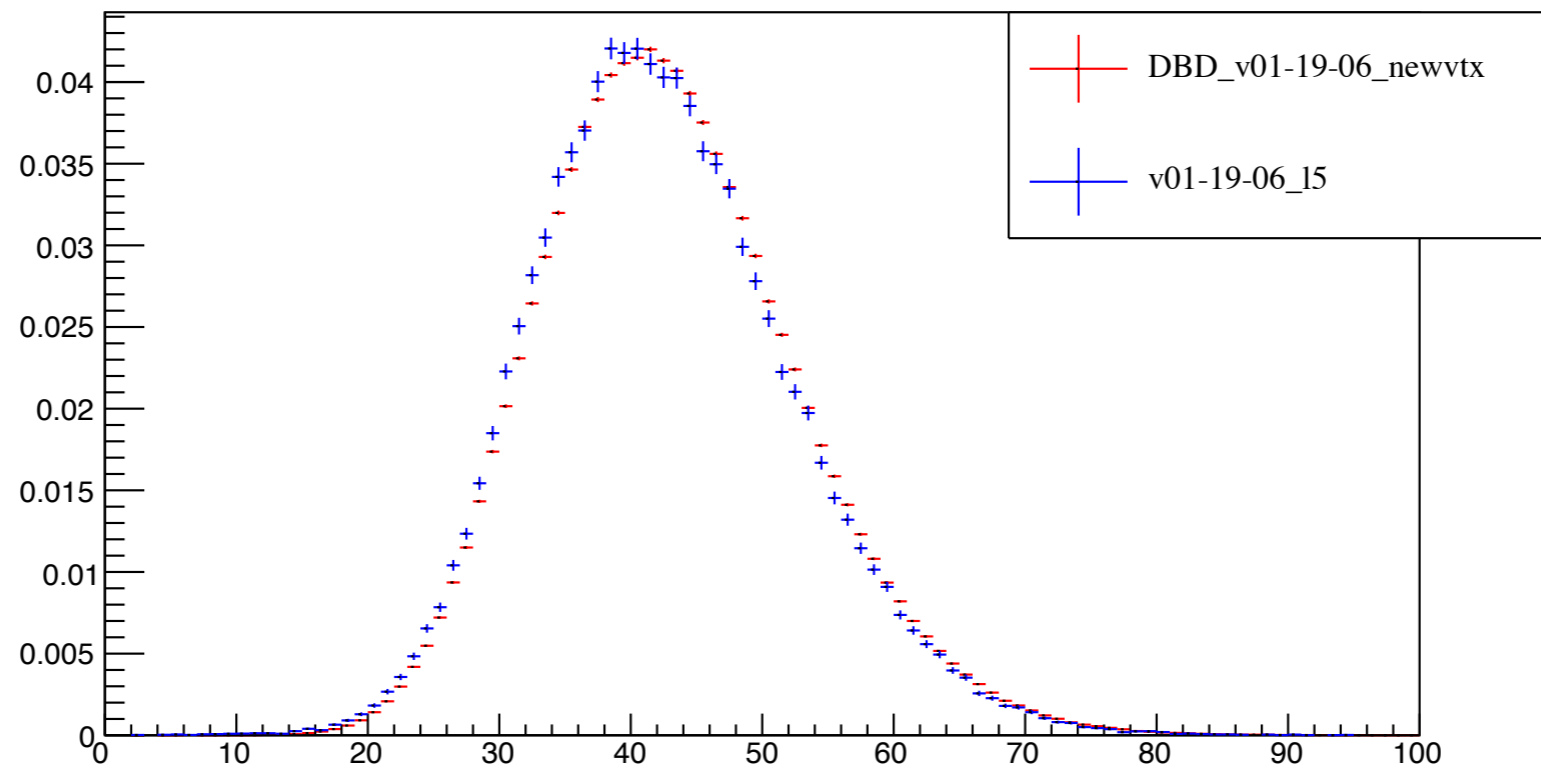
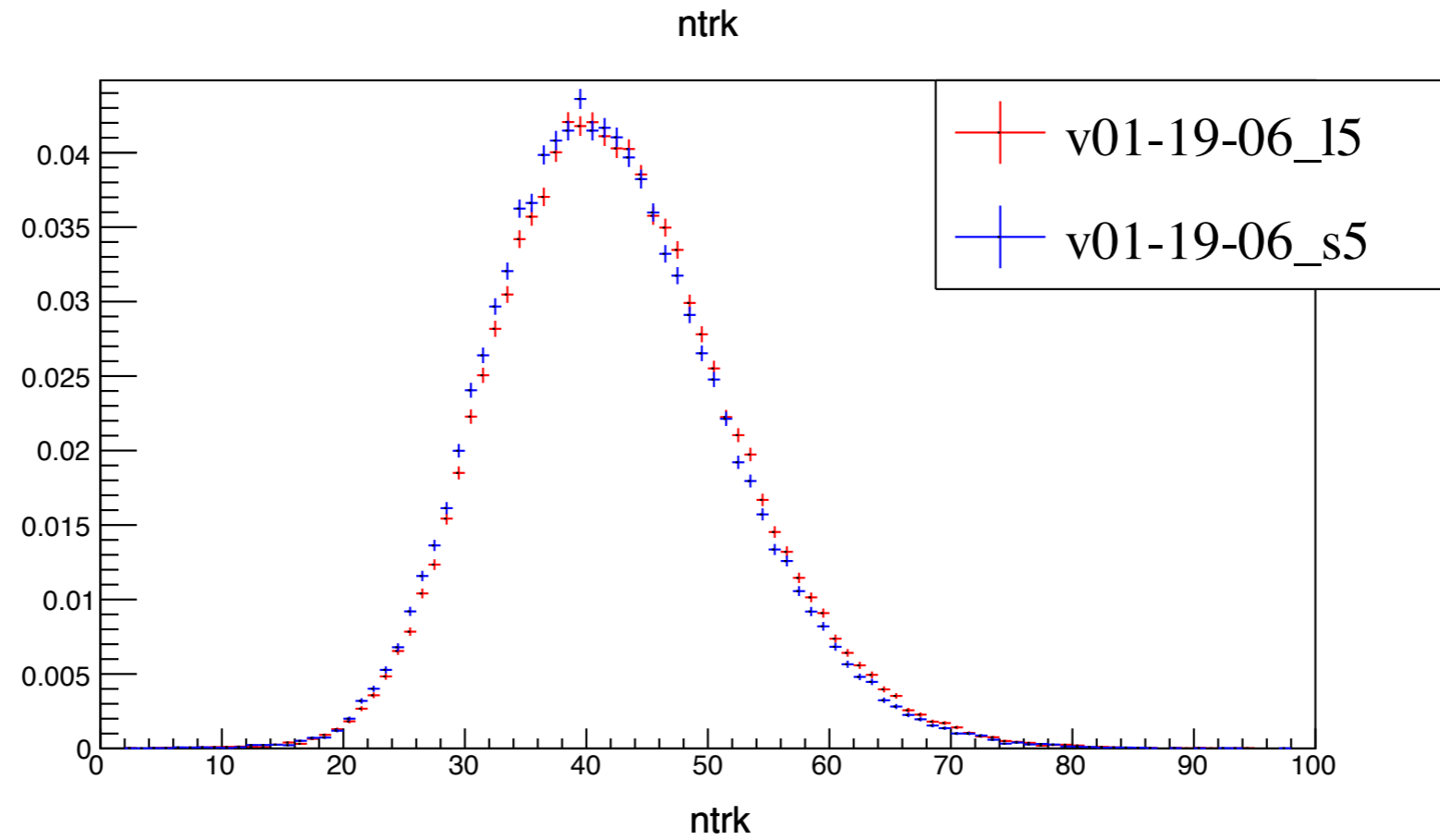
Primary vertex : position (I5 and DBD)



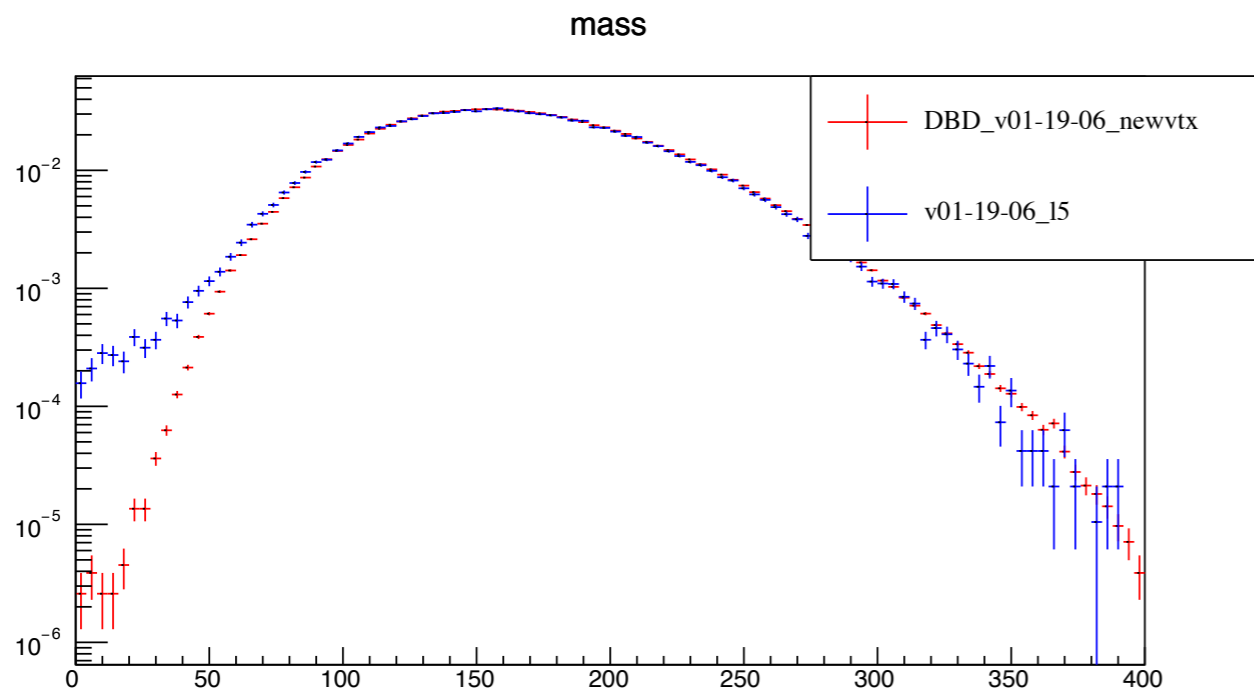
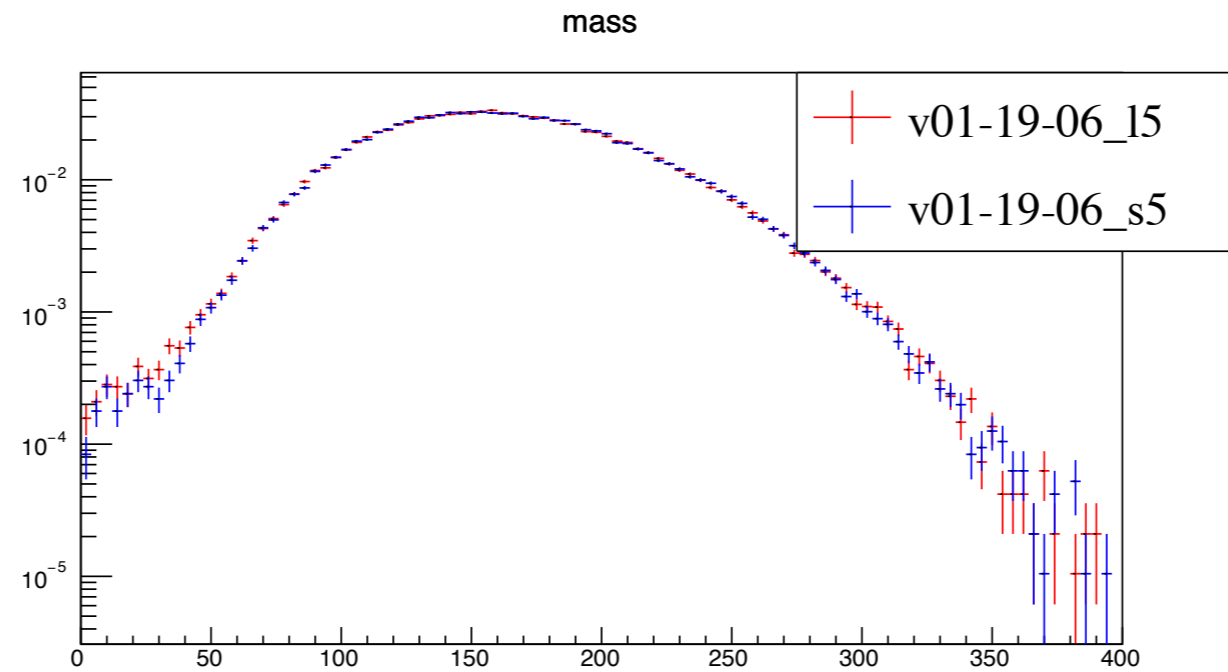
Key to understand:

- smearing in sample
- smearing in LCFIPlus

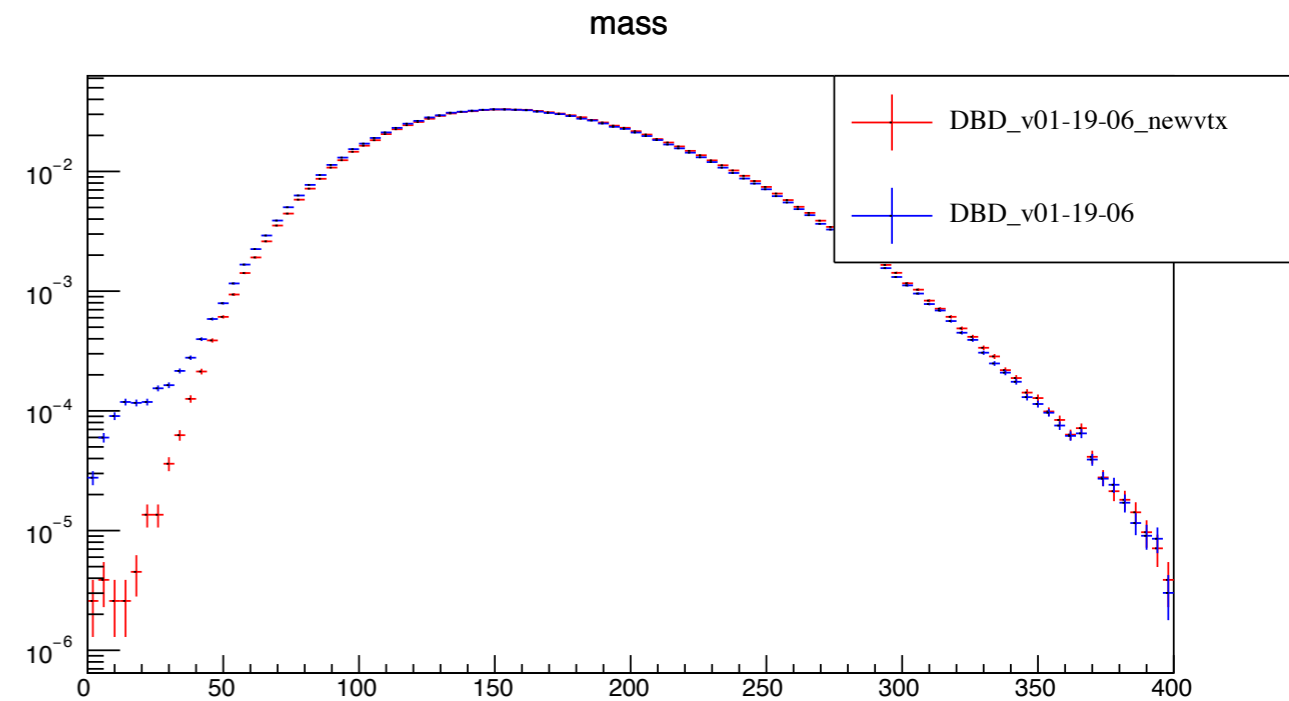
Primary vertex : # of tracks



Primary vertex : mass

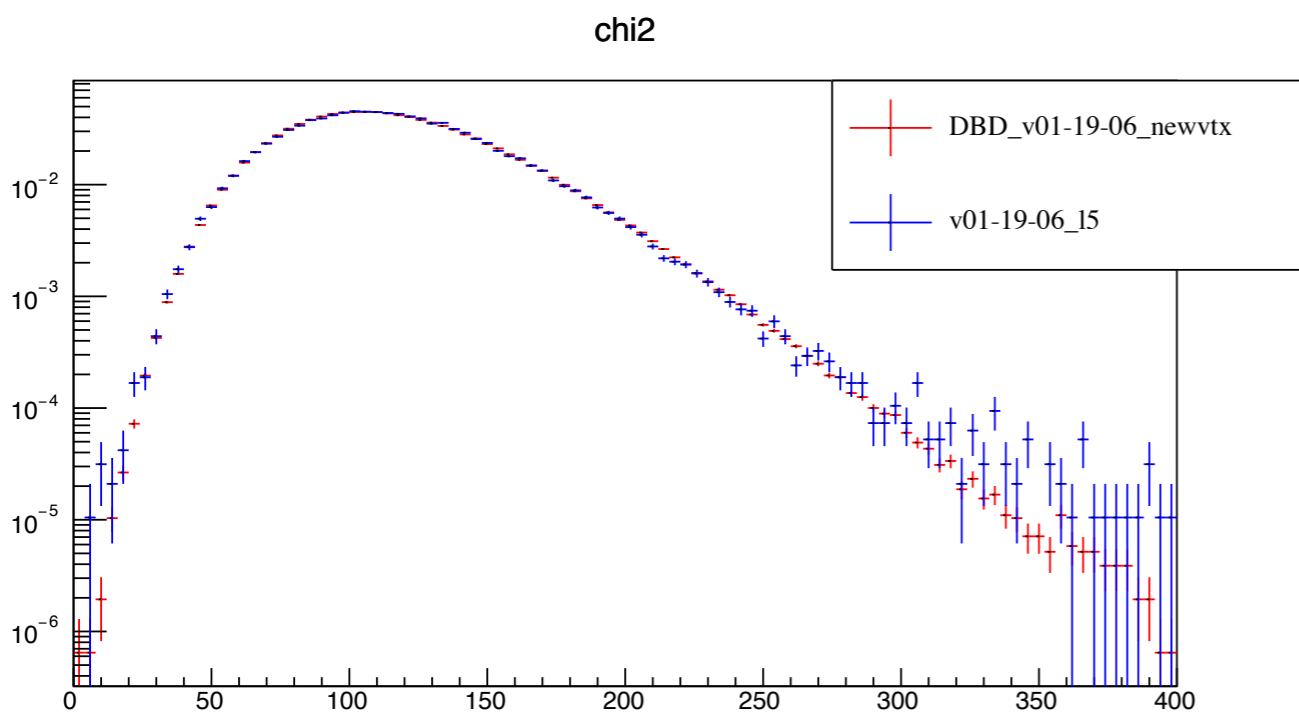
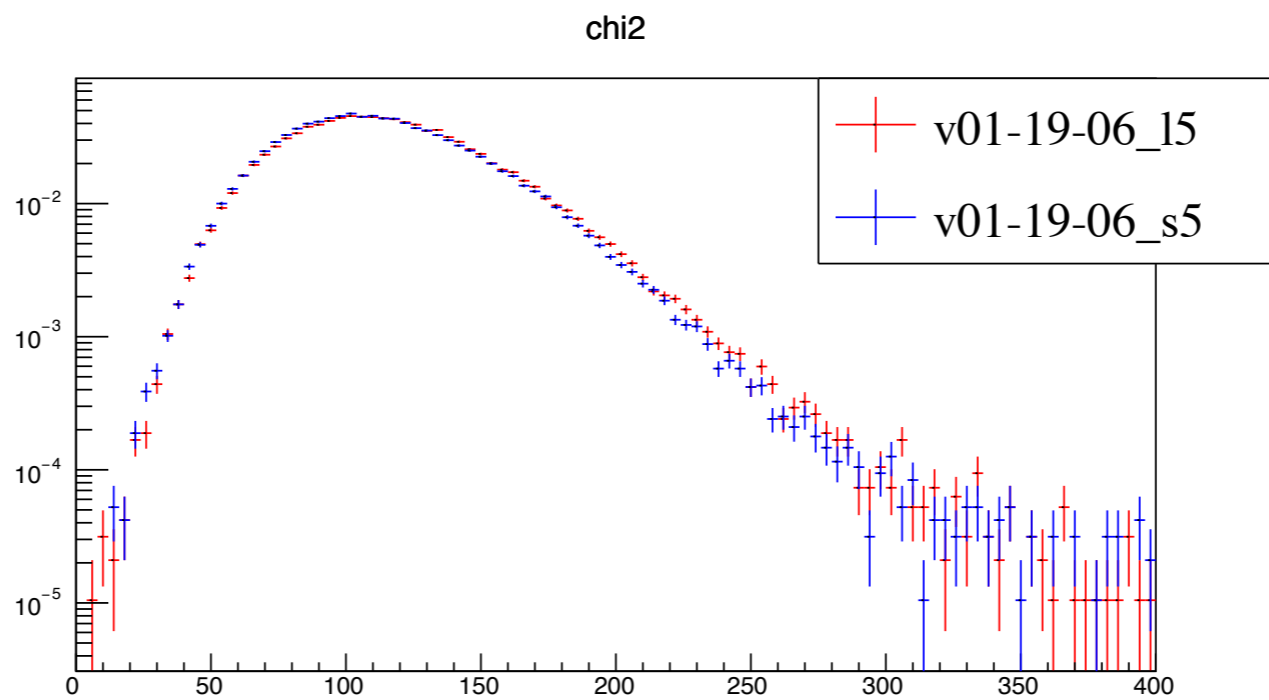


This is a sample check with same software

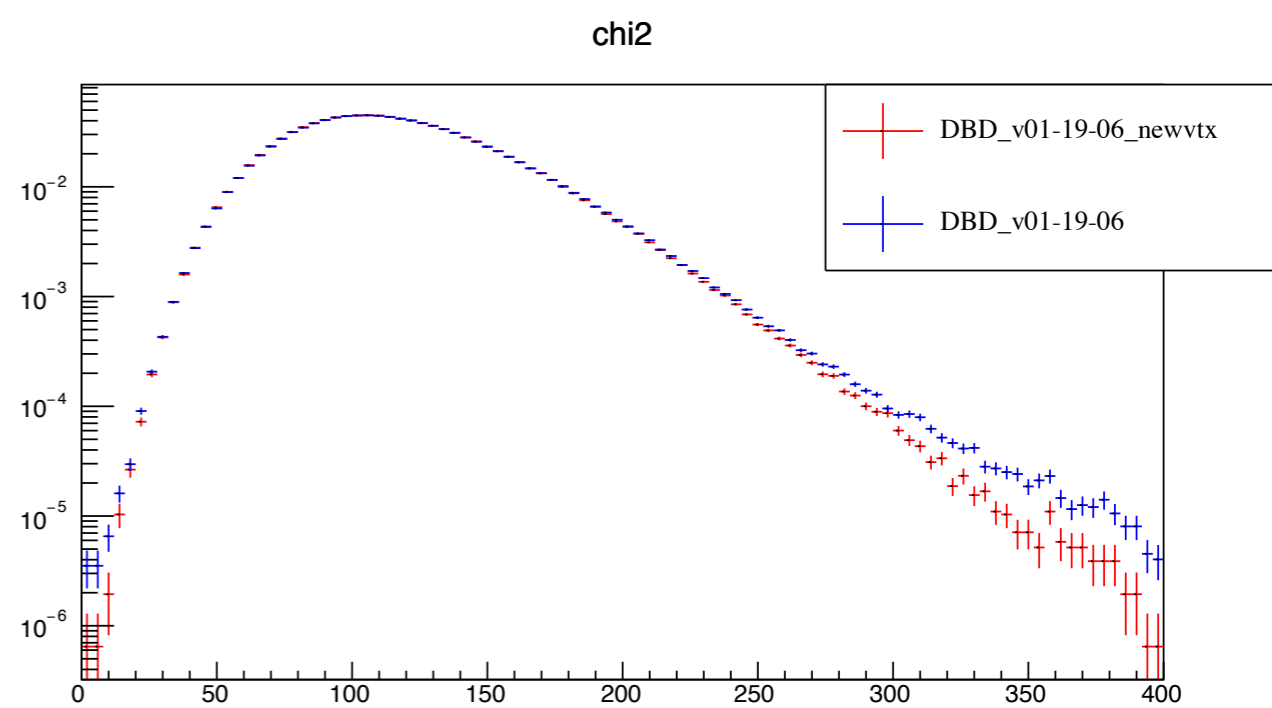


This is a software test with same sample

Primary vertex : chi2



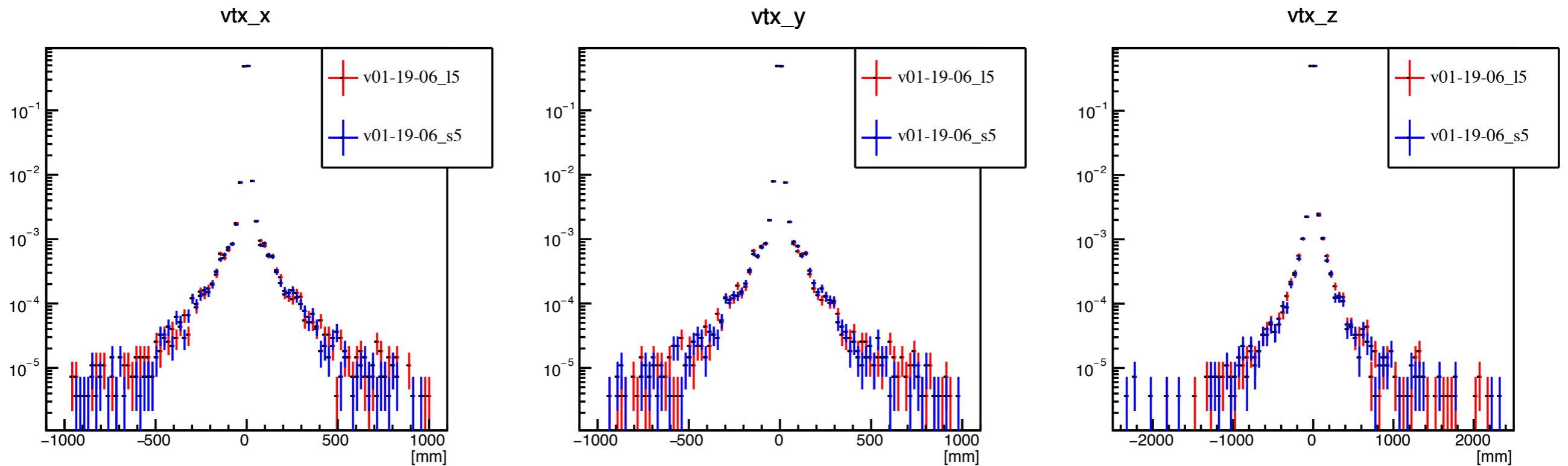
This is a sample check with same software



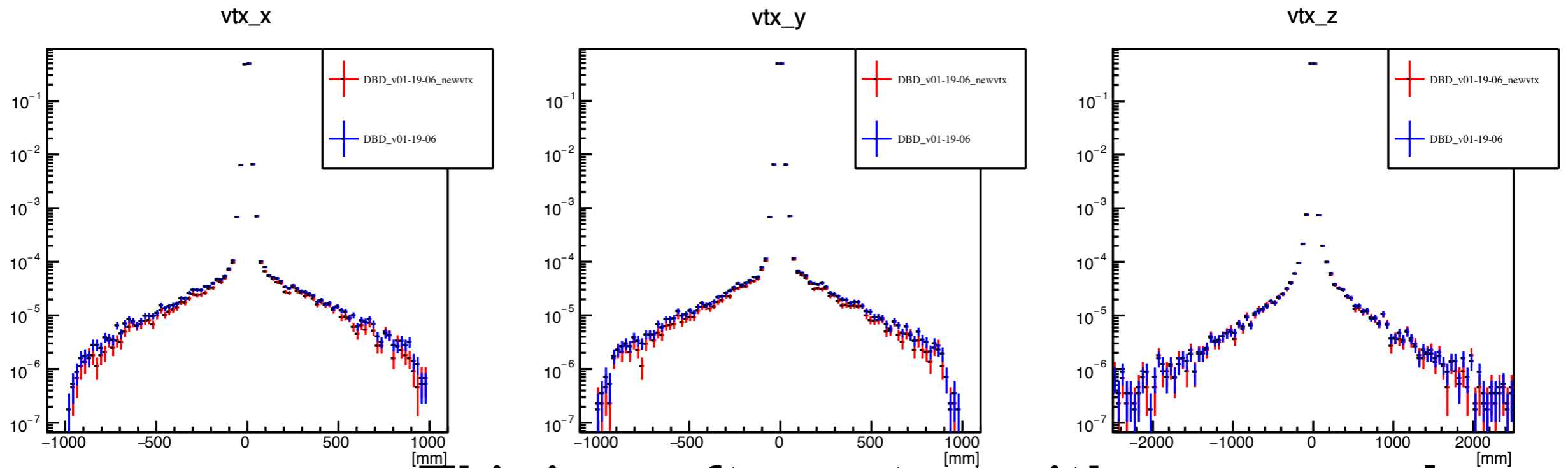
**This is a software test with same sample
New software seems to give smaller tail.**

Secondary vertex : position (l5 and s5)

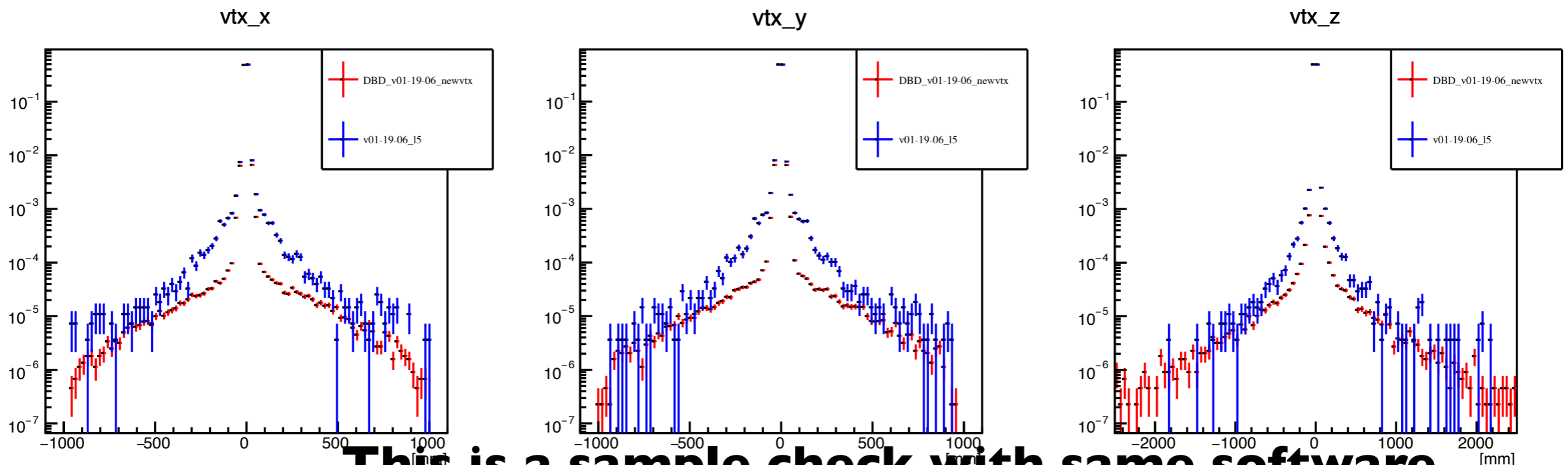
Log scale, normalized



Secondary vertex : position (I5 and DBD)



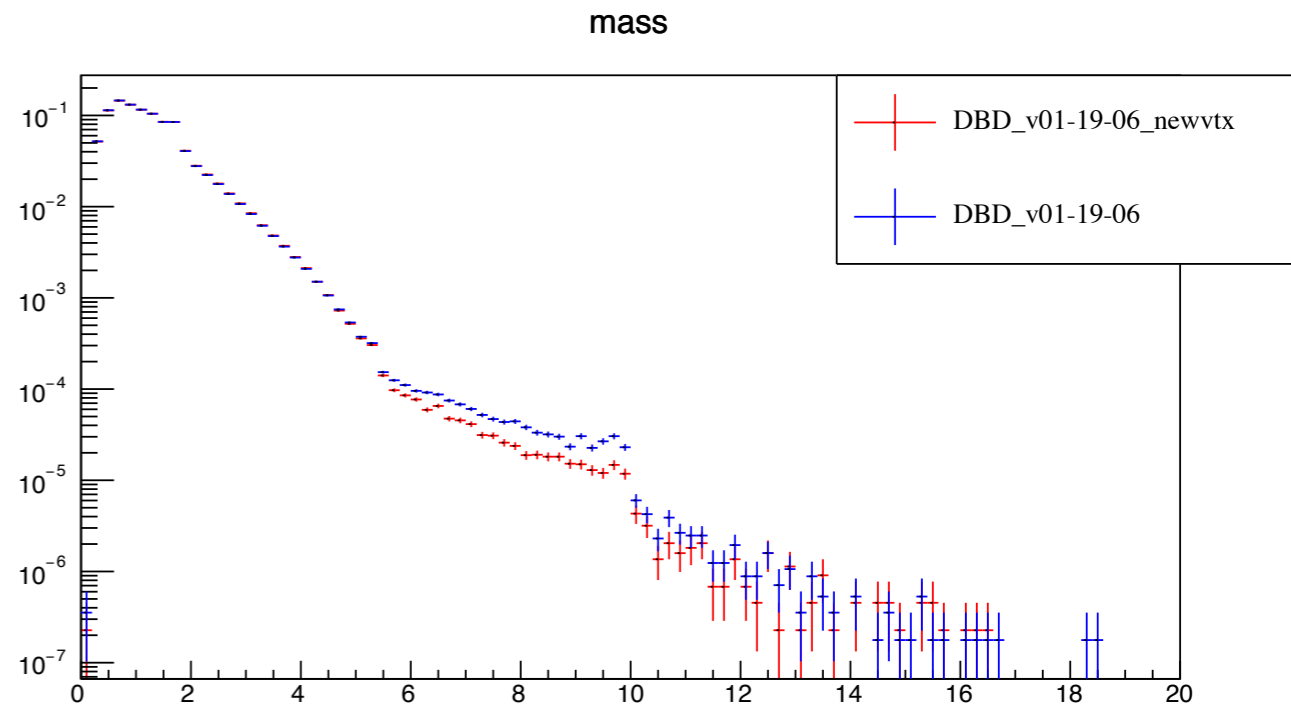
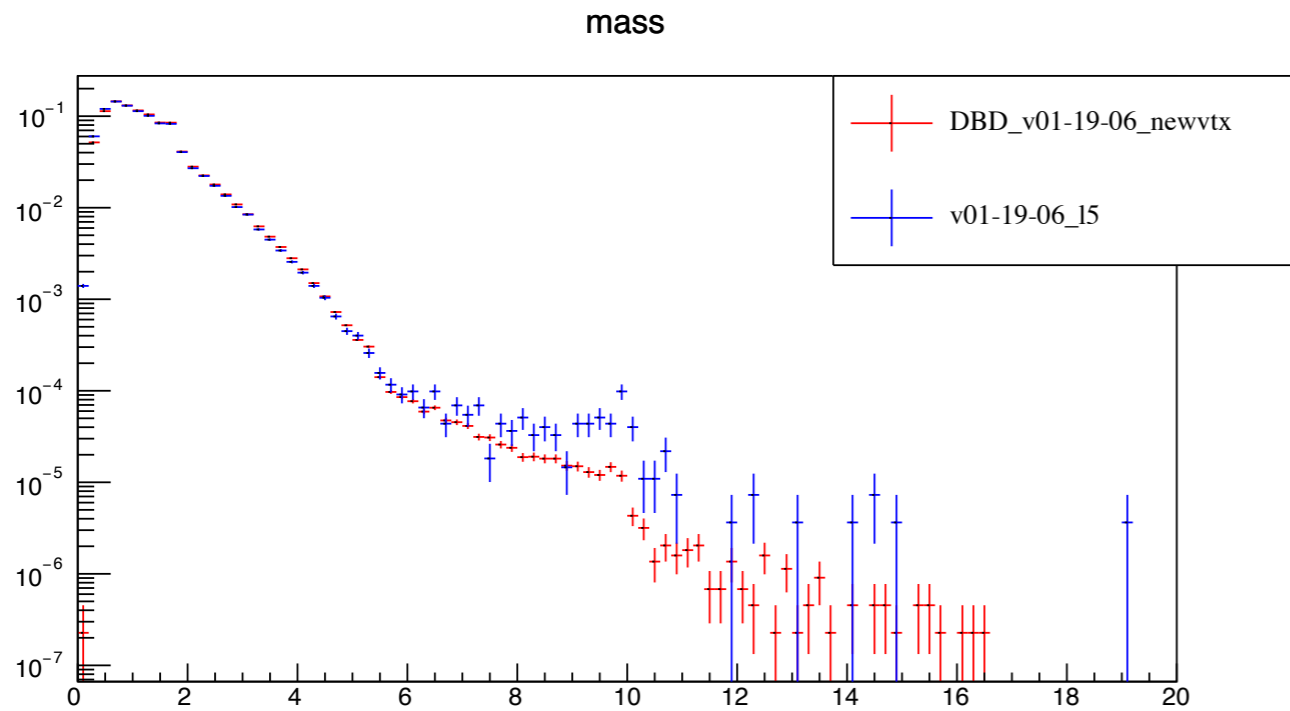
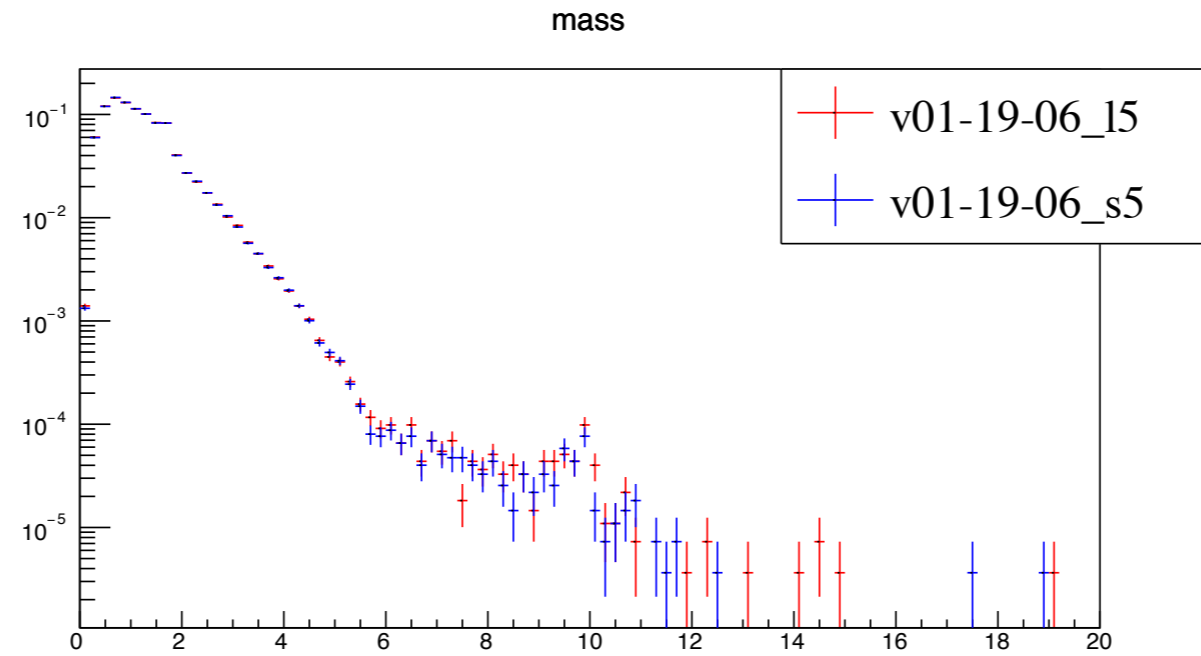
This is a software test with same sample



This is a sample check with same software

Due to beam spot smearing? (ask Akiya?).

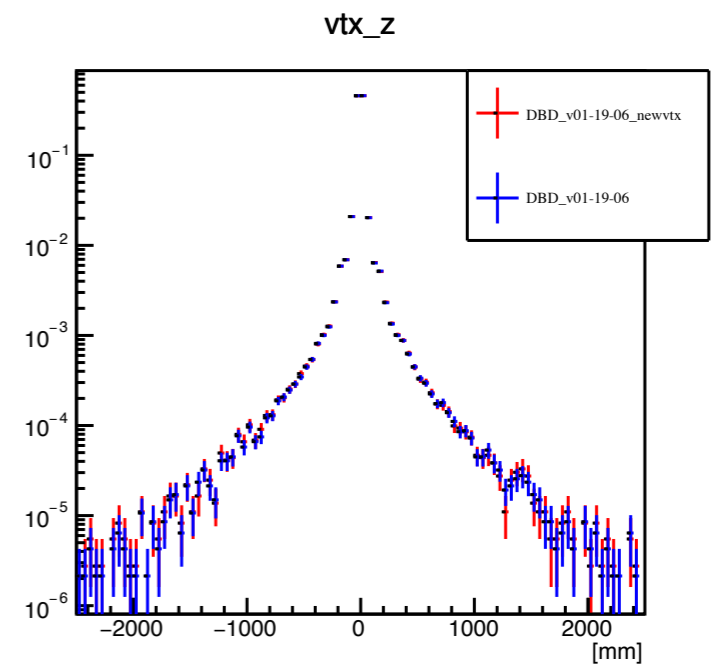
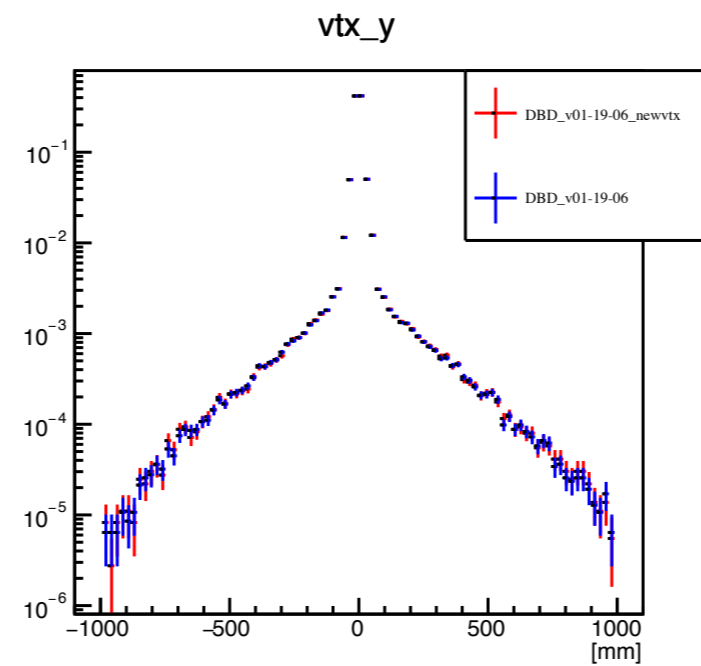
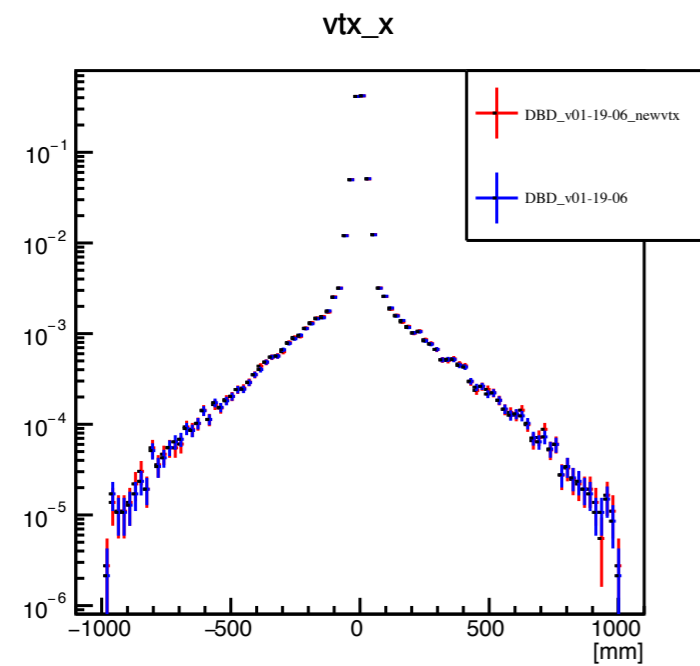
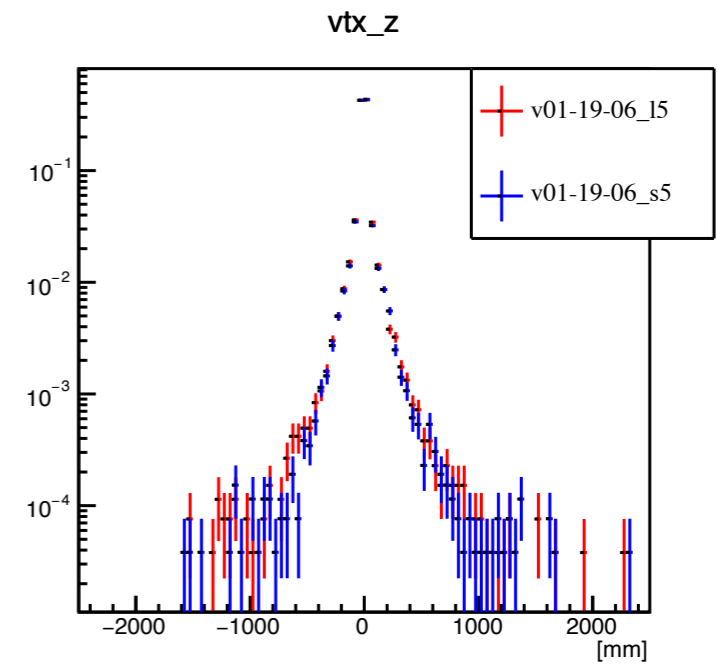
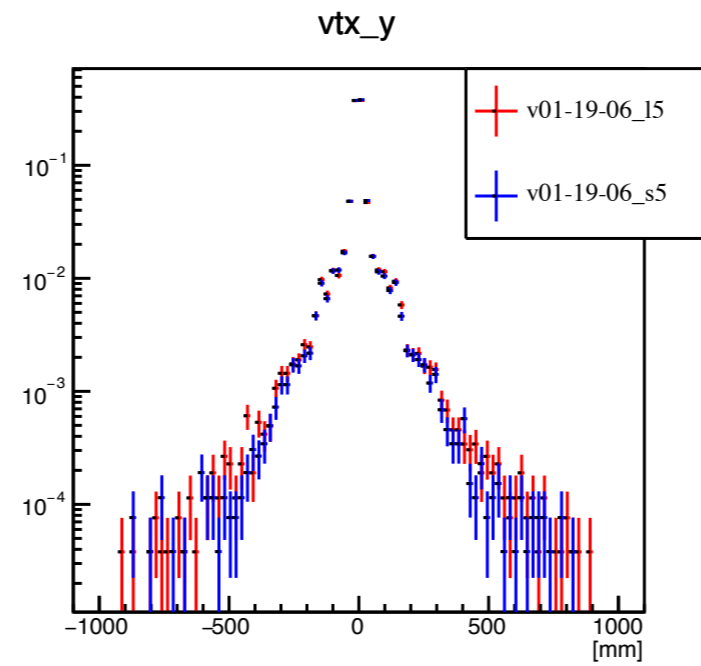
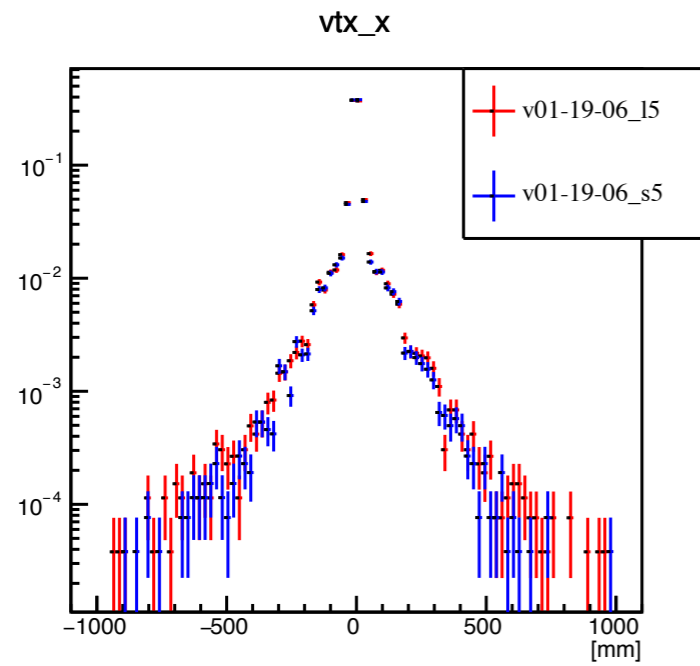
Secondary vertex : mass



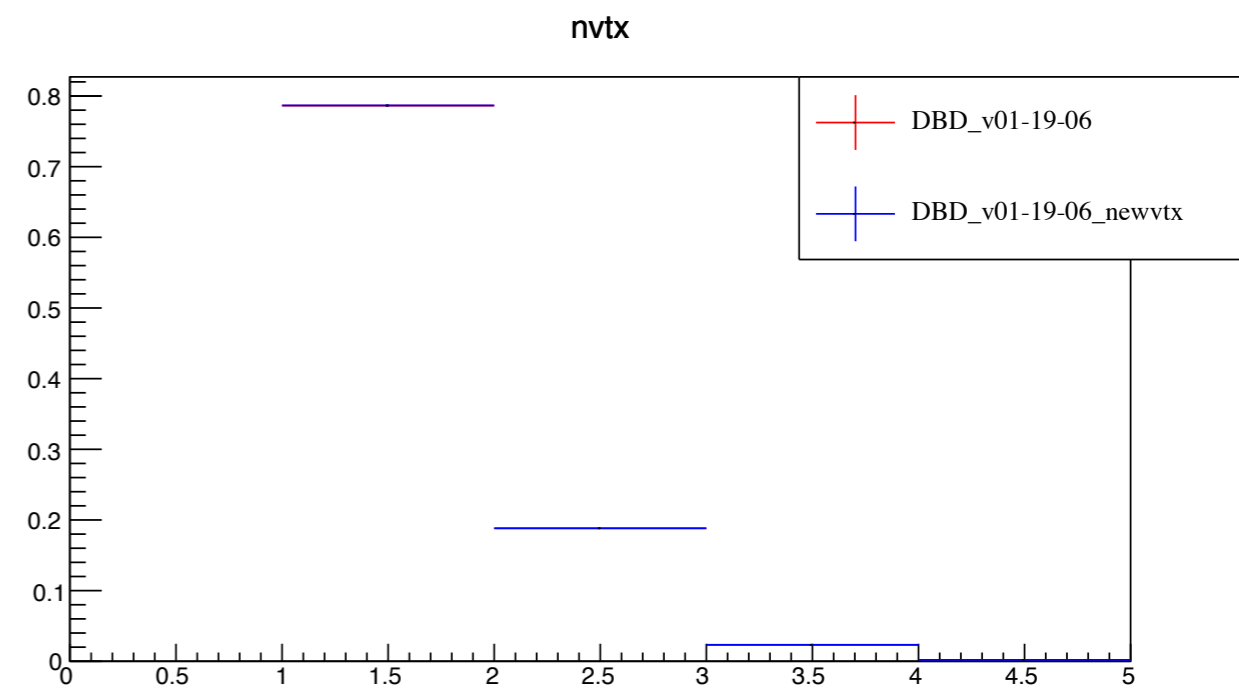
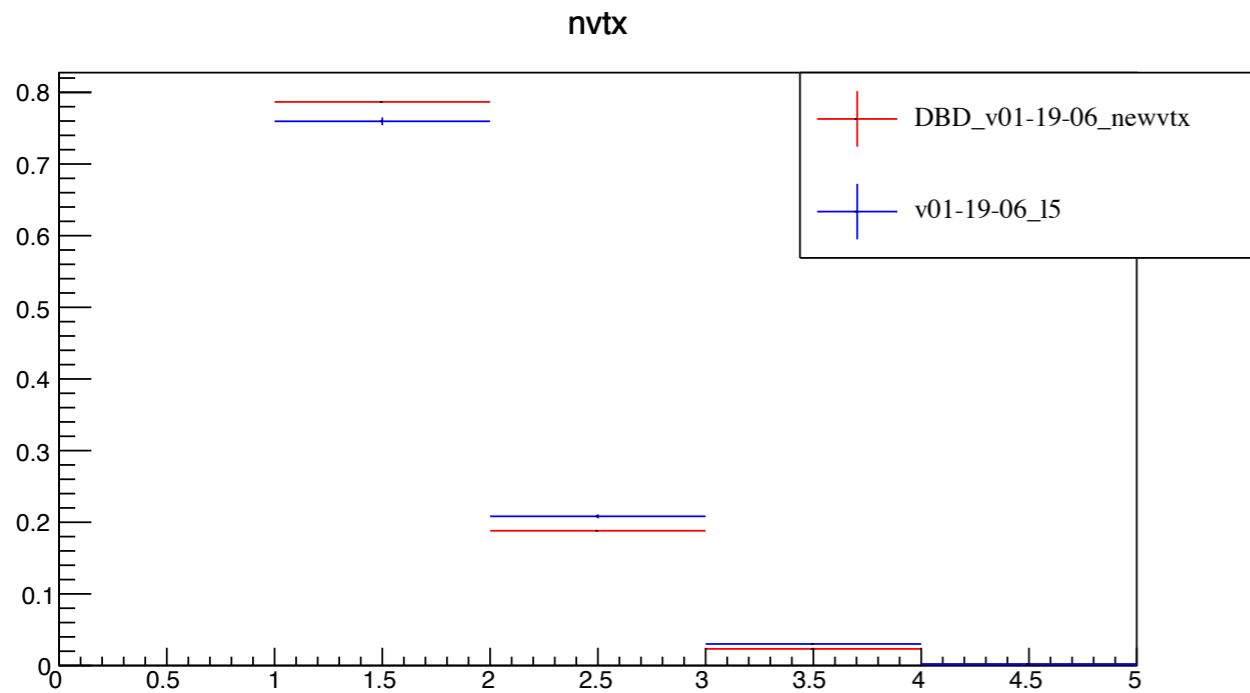
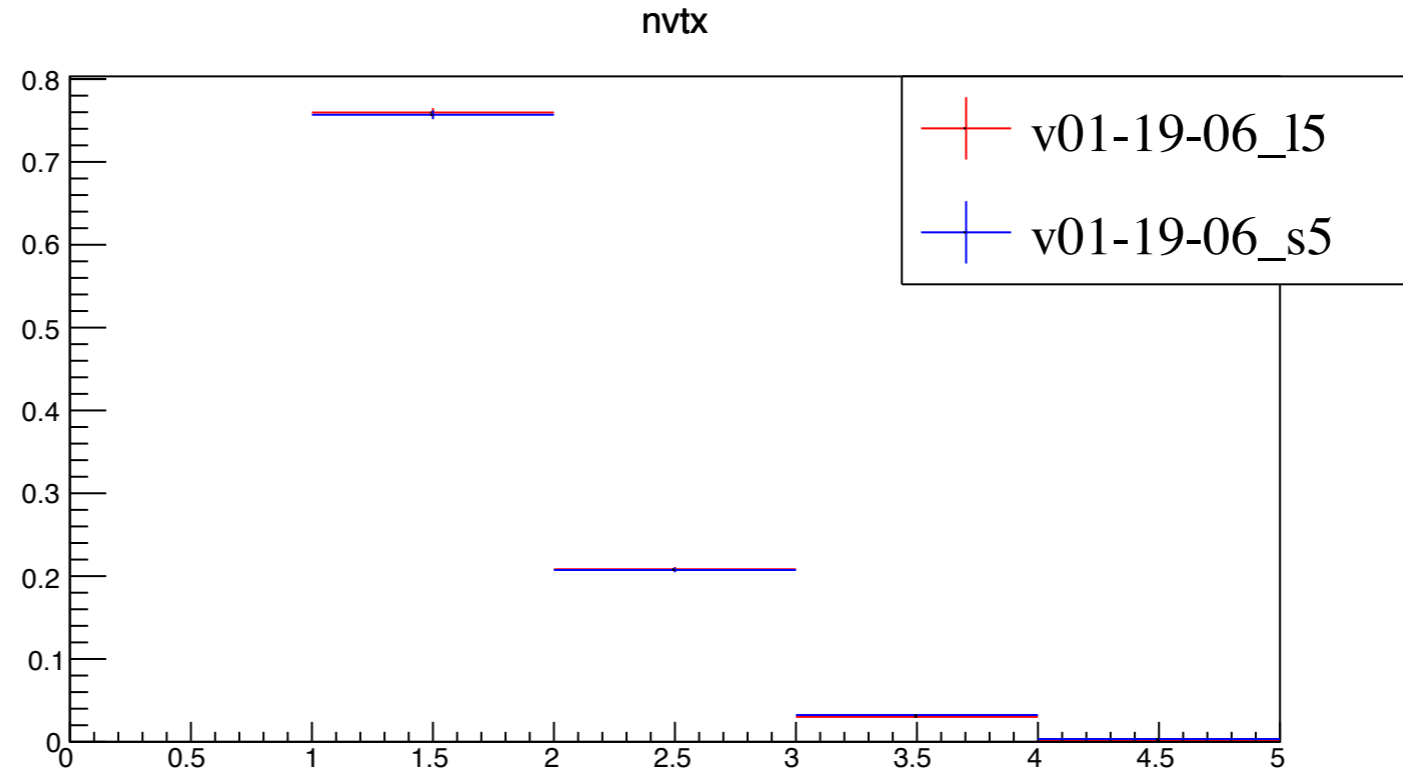
This is a sample check with same software

**This is a software test with same sample
New software seems to give smaller tail.**

V0 vertex : position



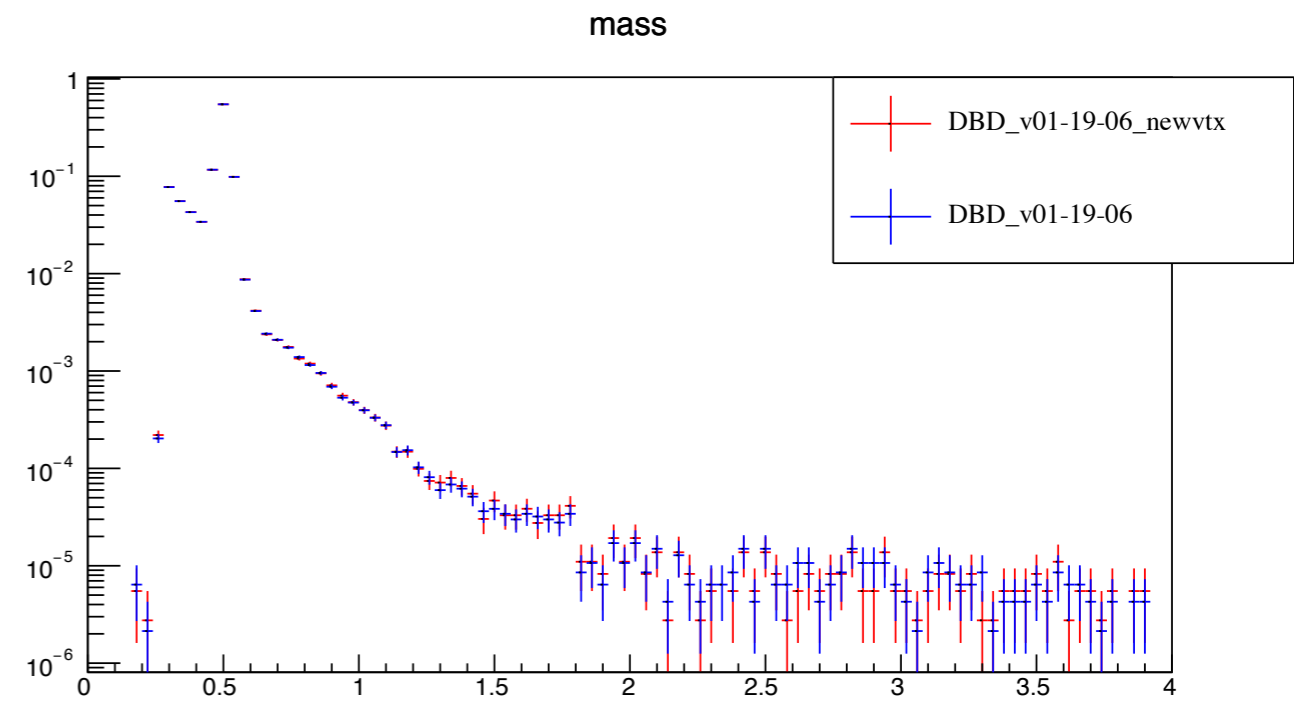
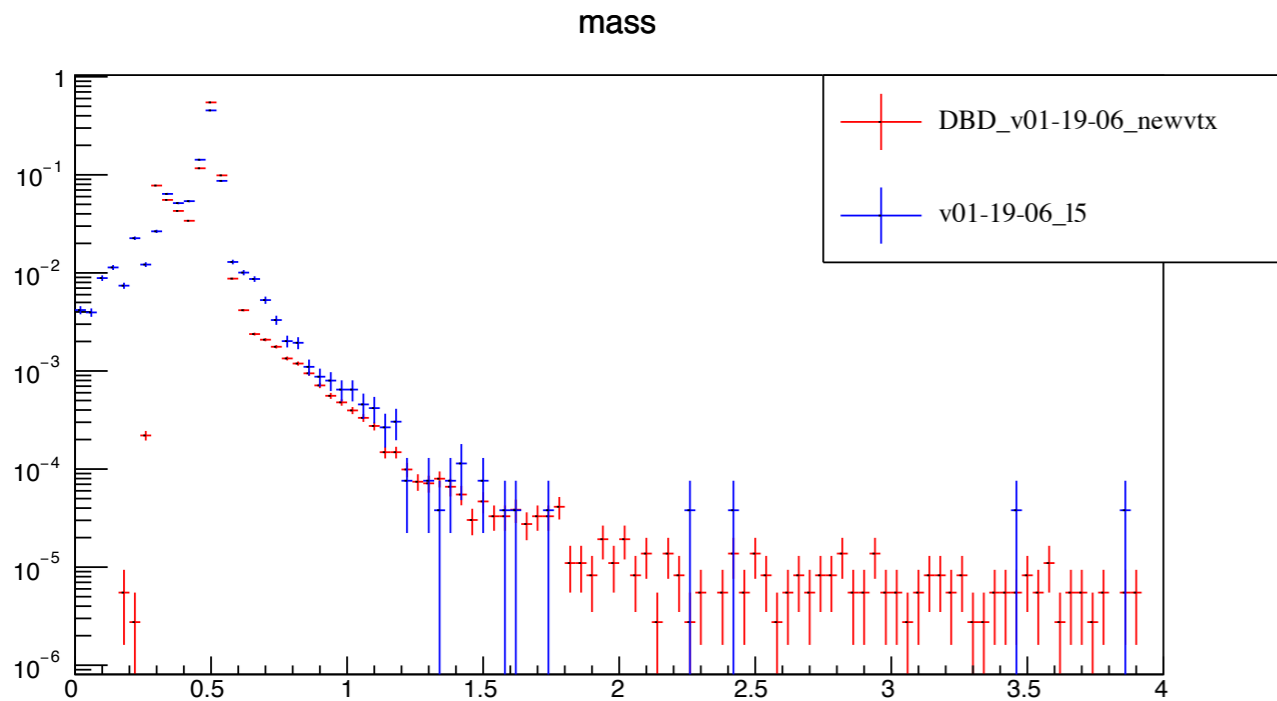
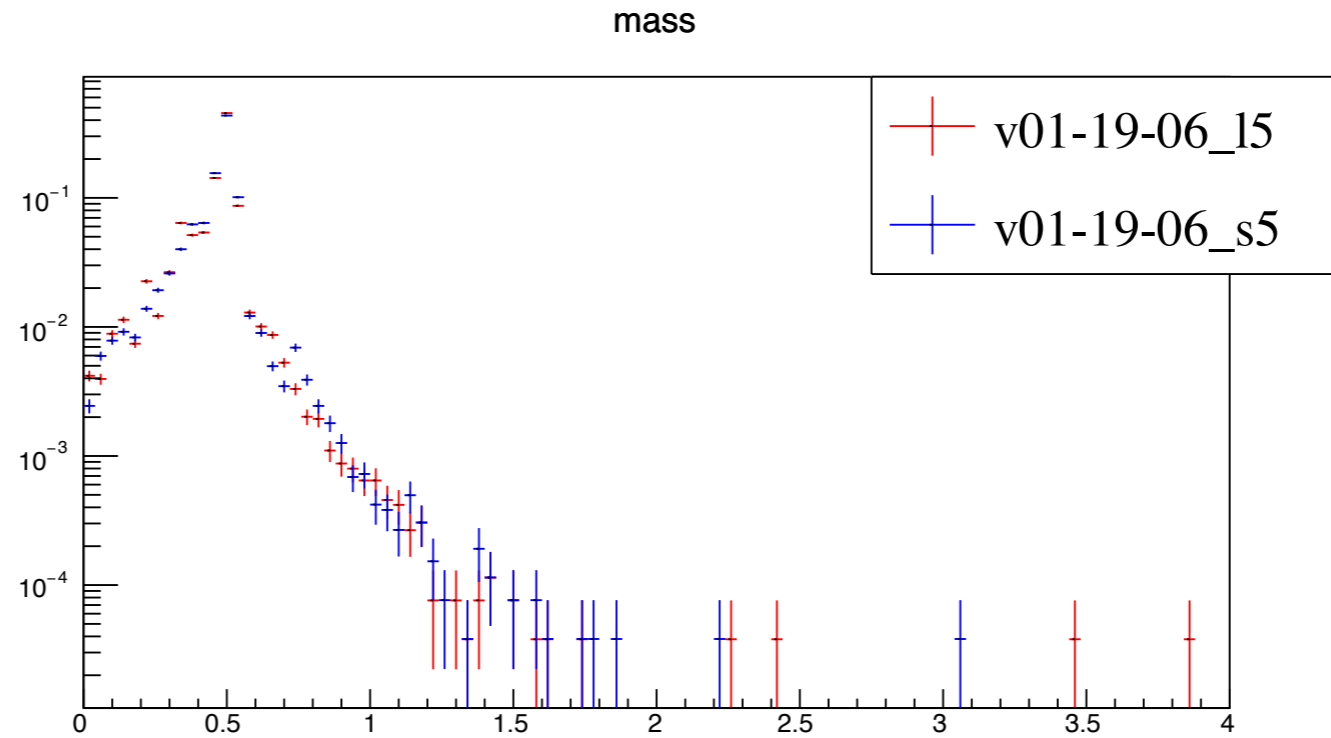
V0 vertex : # of vertices per event



This is a sample check with same software

This is a software test with same sample

V0 mass



This is a sample check with same software

This is a software test with same sample

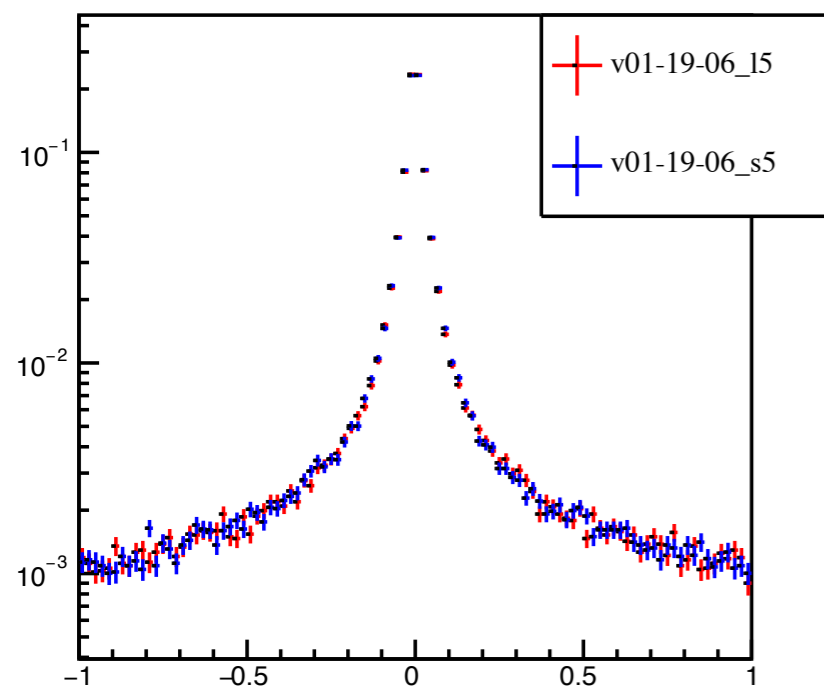
Summary

- ❖ **There were some changes in LCFIPlus for coming MC sample production.**
 - ▶ beam spot smearing
 - ▶ a bug fix related to energy definition.
- ❖ **ttbar sample tested with v01-19-06**
 - ▶ There are some difference from DBD sample but they are understood.
 - ▶ We don't see clear problem.
 - ▶ I will ask Akiya next week to clarify the difference (other than beam spot smearing) between DBD sample and the latest sample to understand the bottom plots in p15.

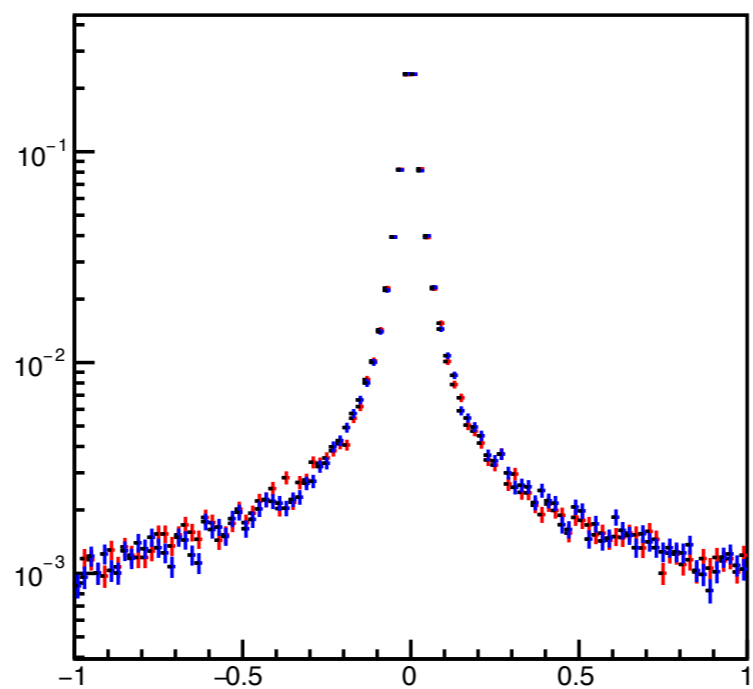
Backup

Secondary vertex : residual

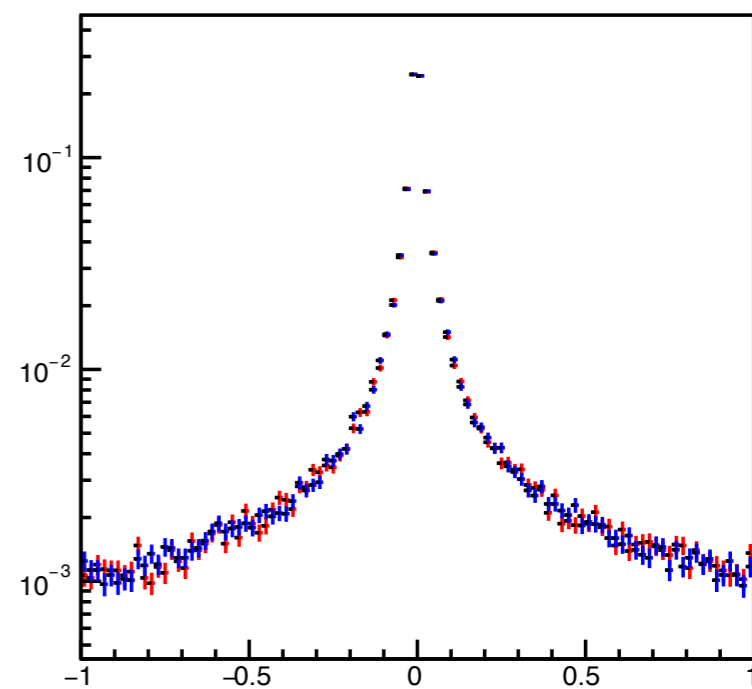
x_rec-x_mc



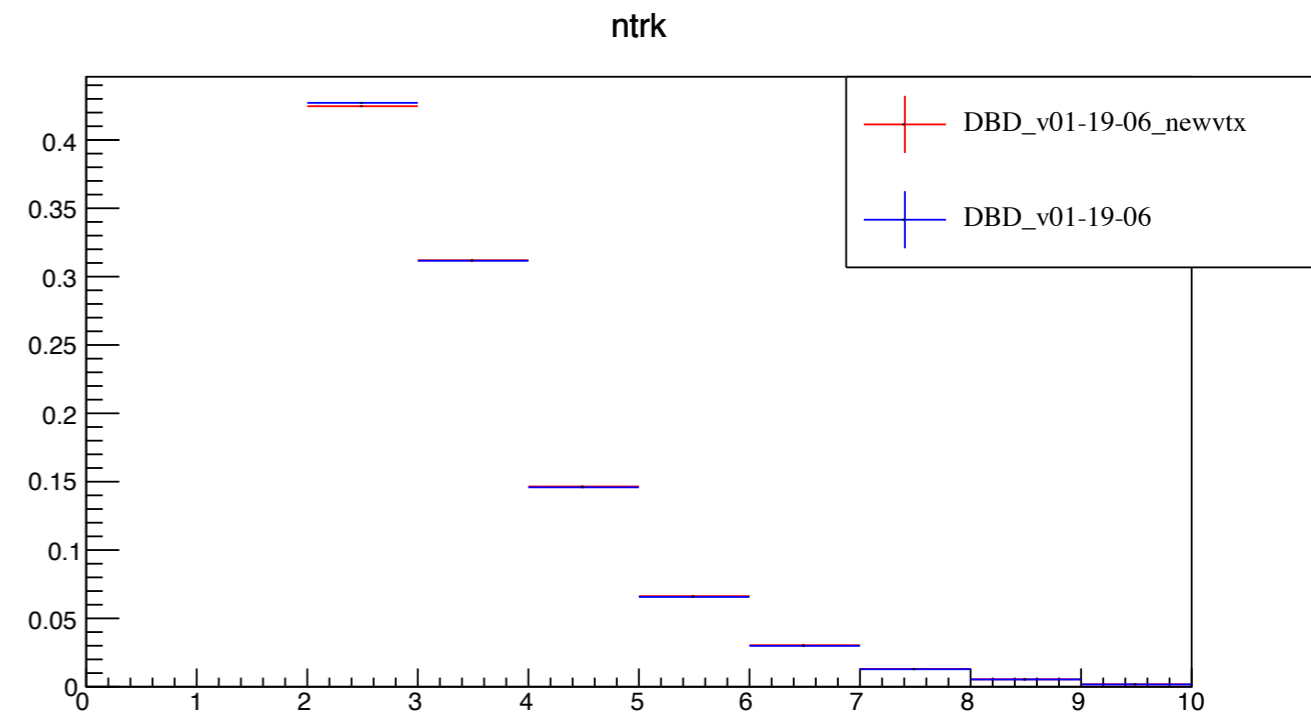
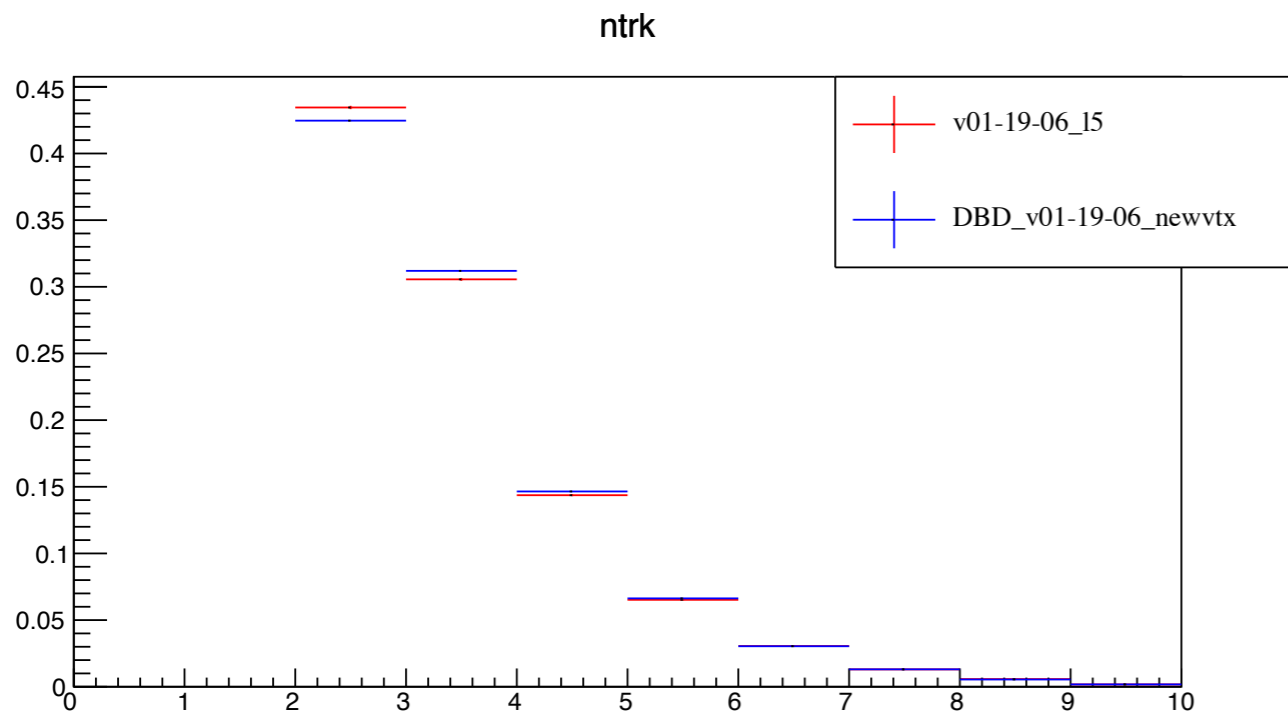
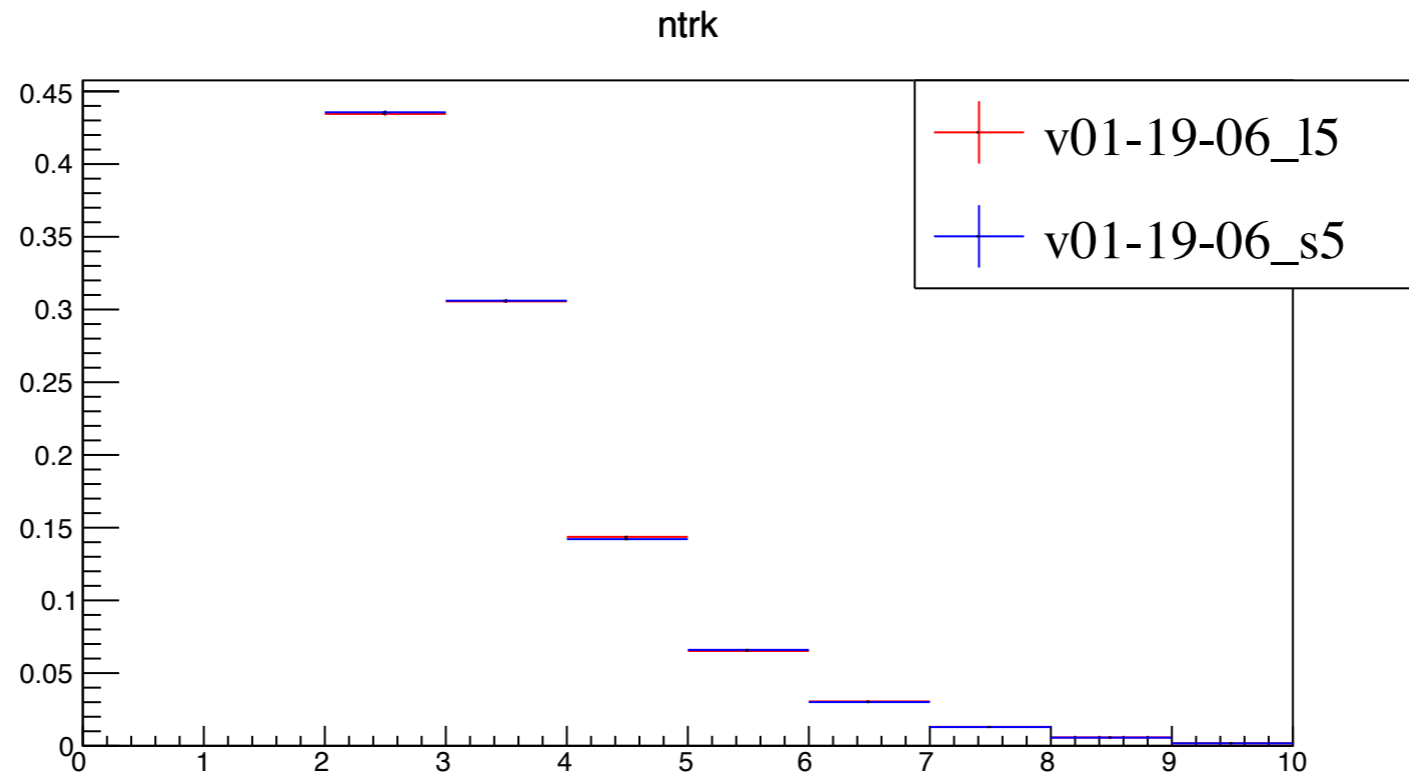
y_rec-y_mc



z_rec-z_mc



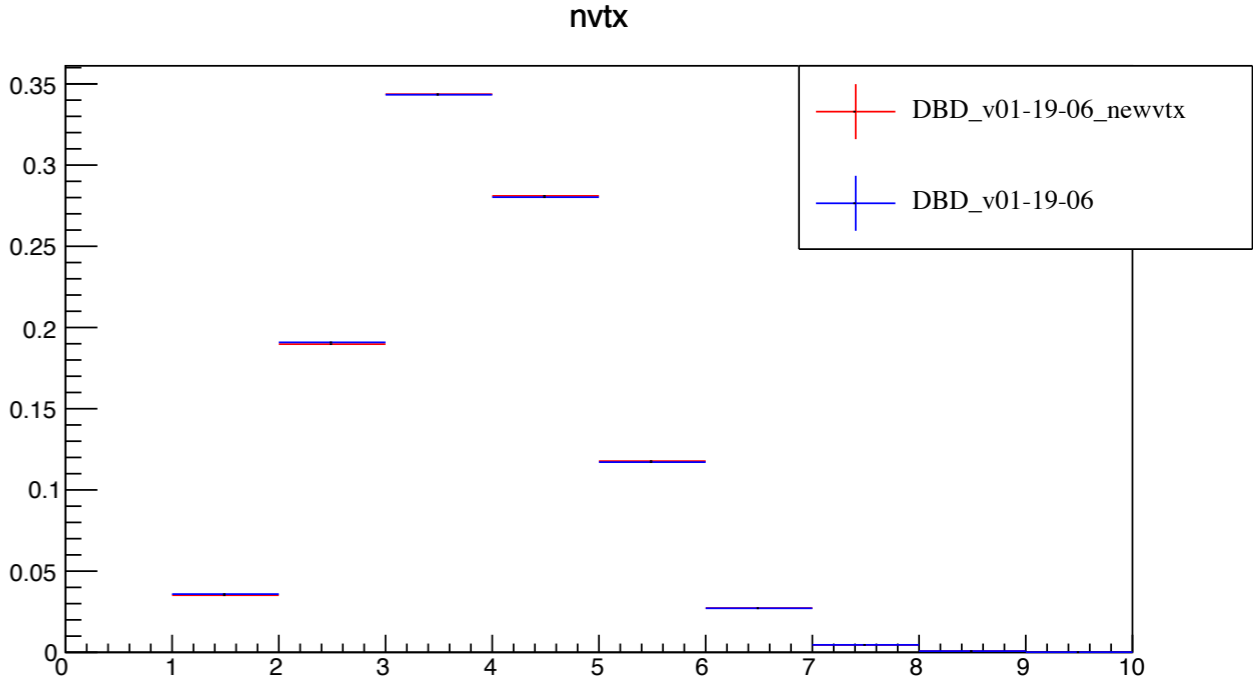
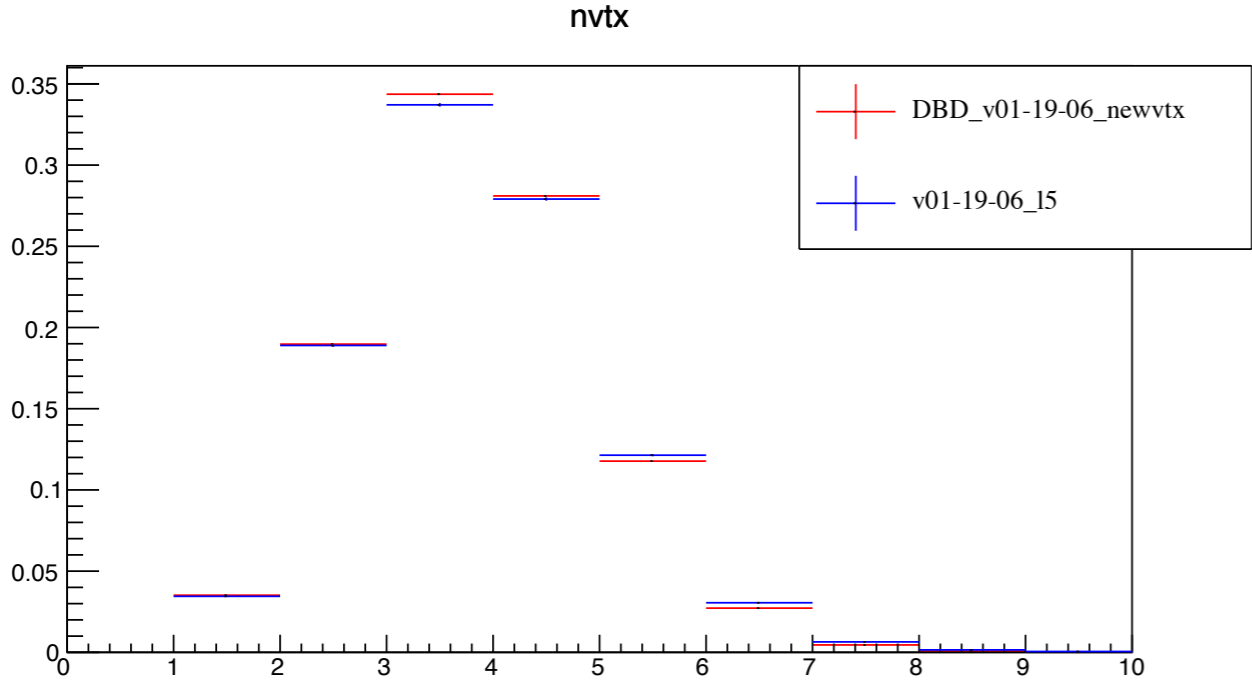
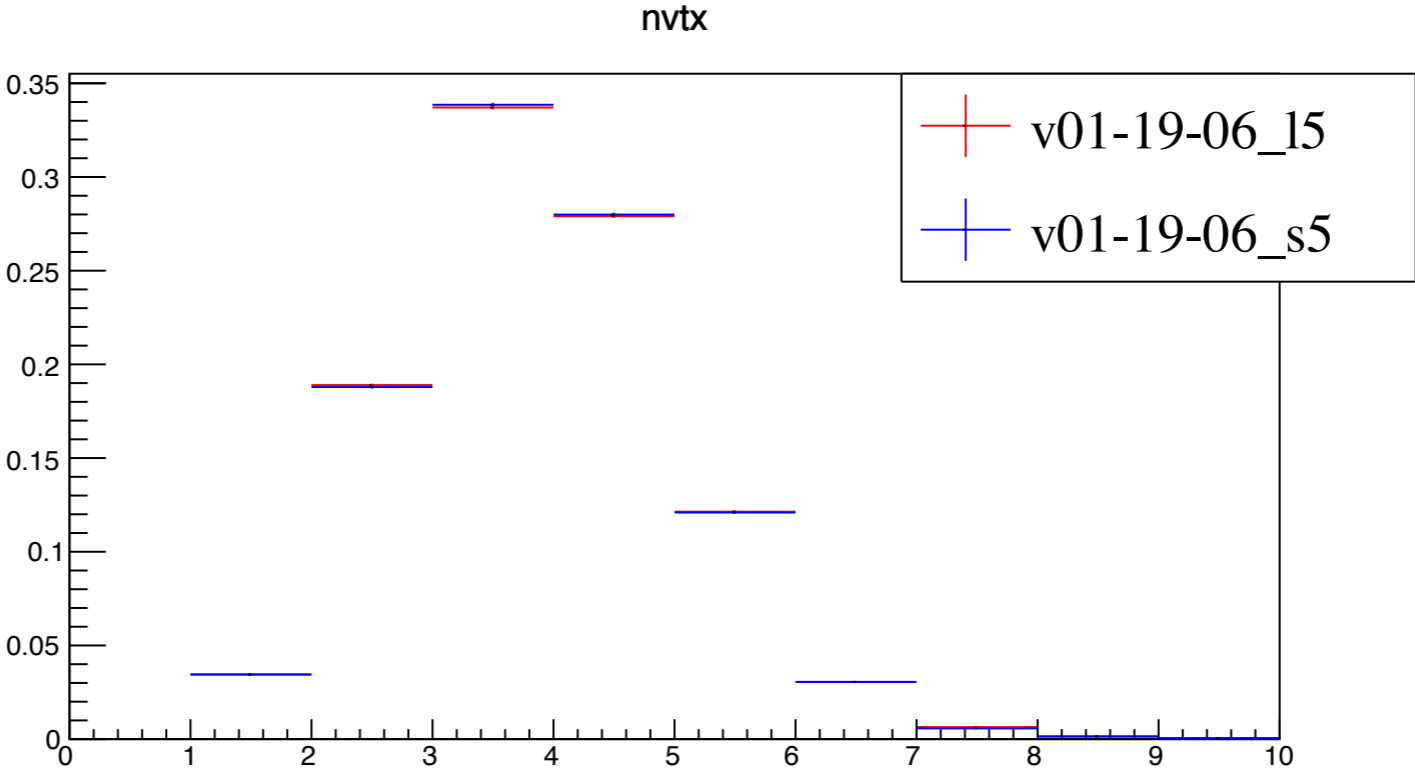
Secondary vertex : # of tracks per vertex



This is a sample check with same software

This is a software test with same sample

Secondary vertex : # of vertices per event

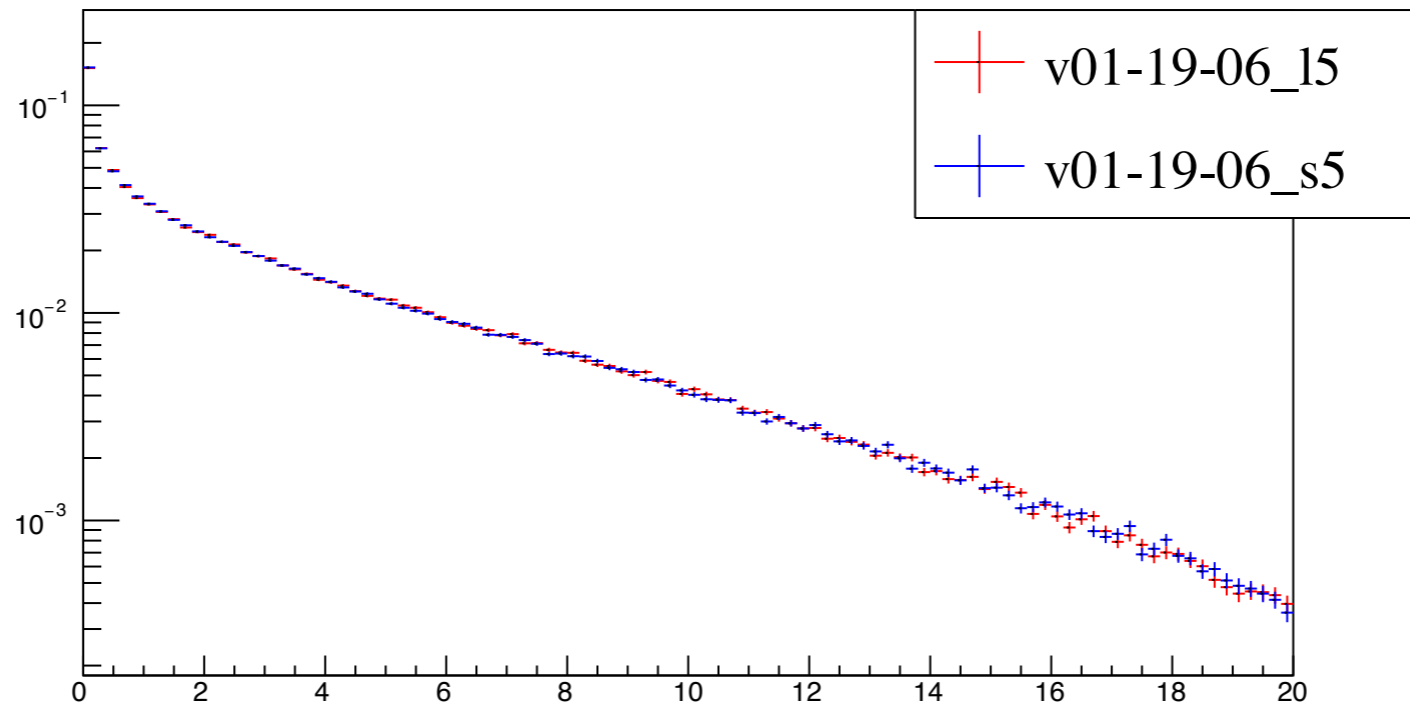


This is a sample check with same software

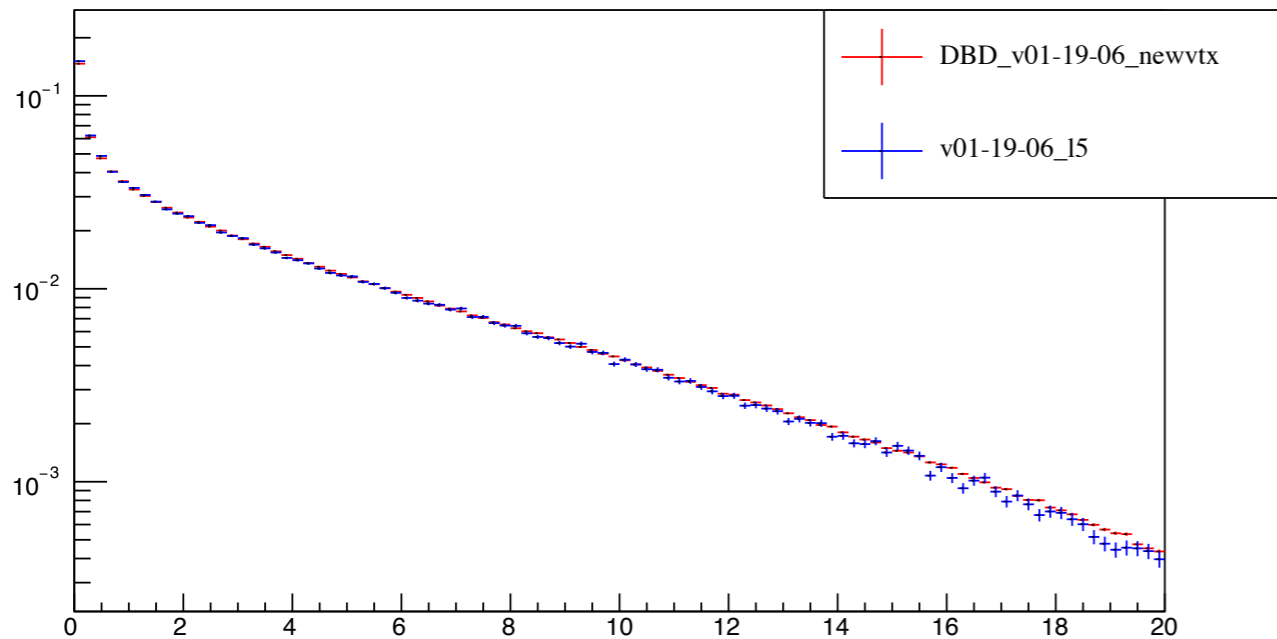
This is a software test with same sample

Secondary vertex : chi2

chi2

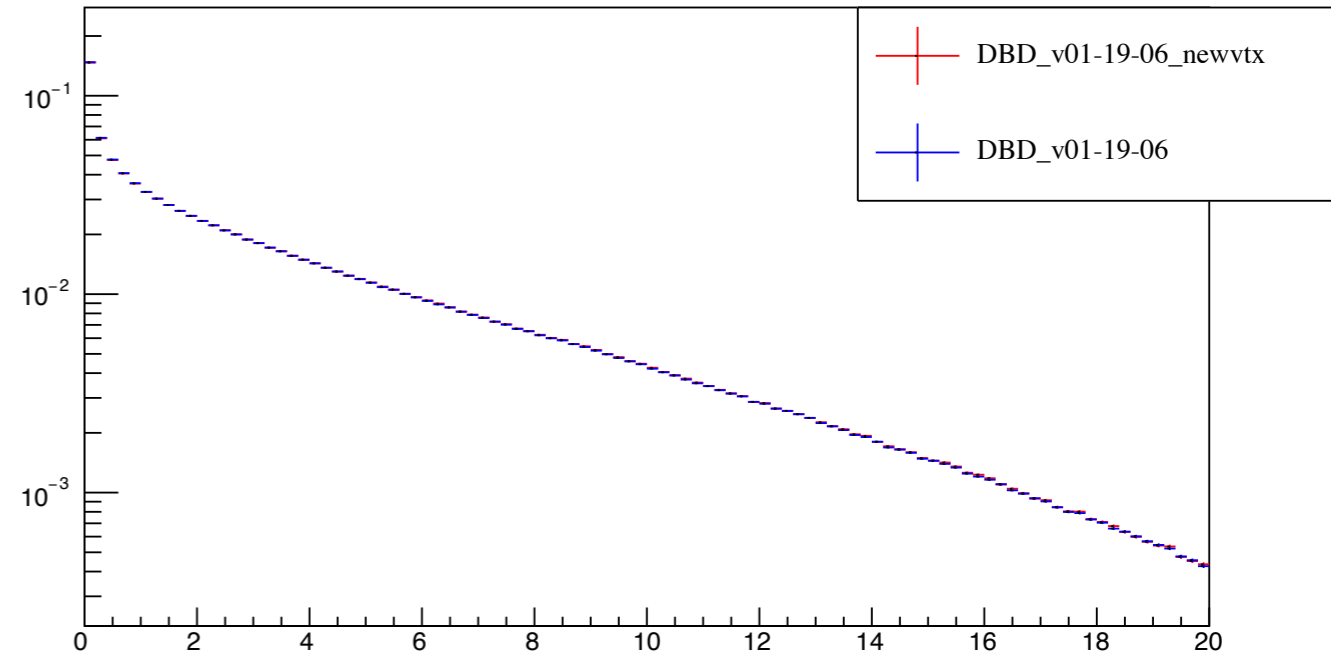


chi2



This is a sample check with same software

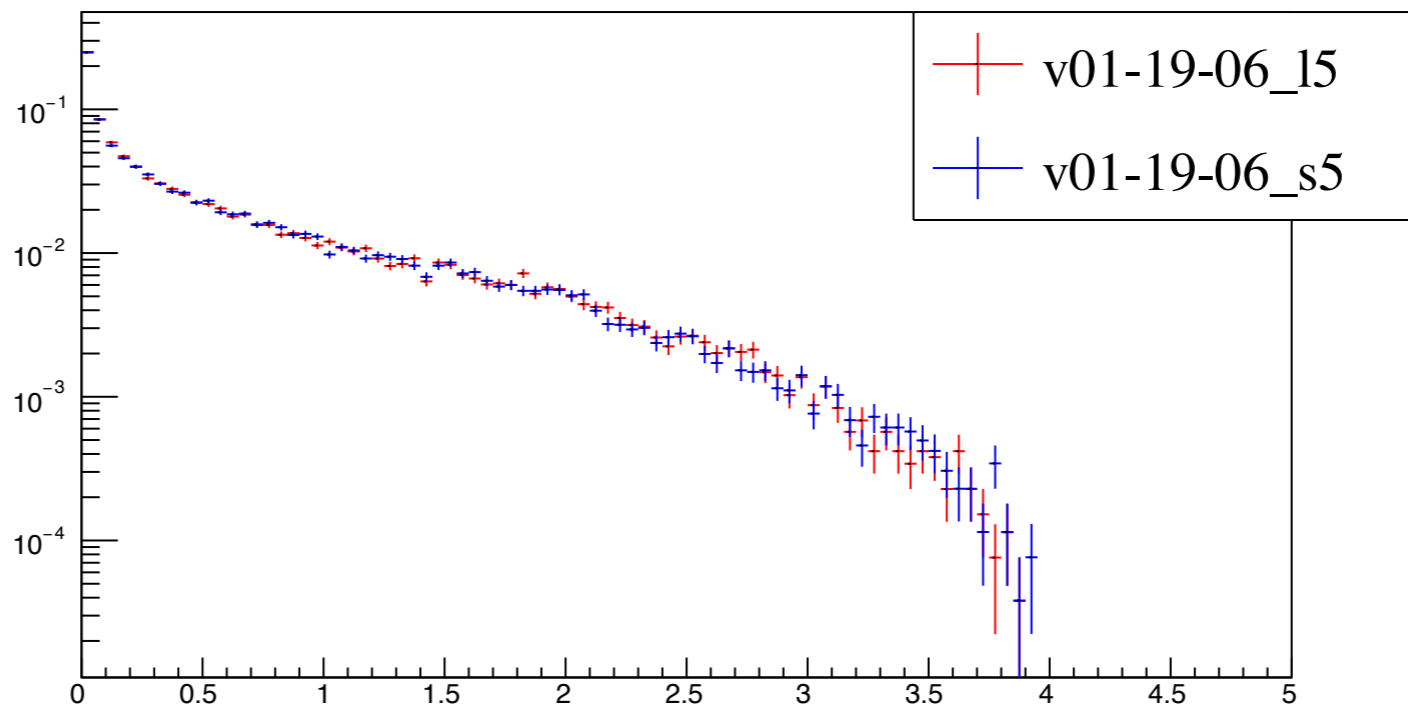
chi2



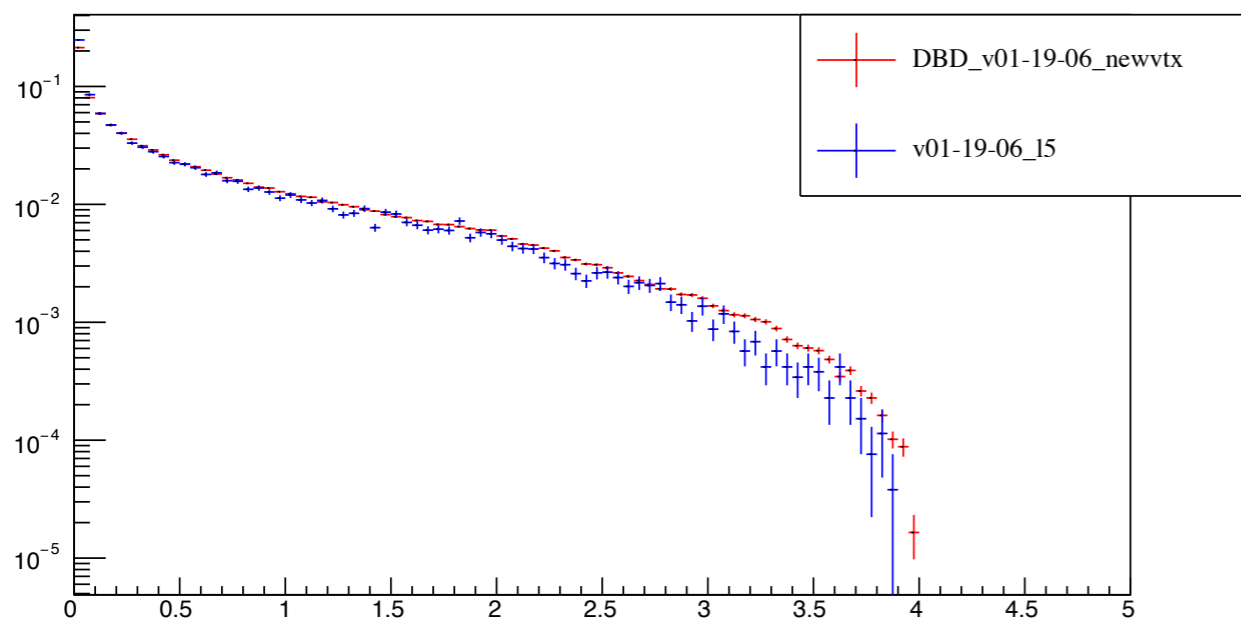
This is a software test with same sample

V0 chi2

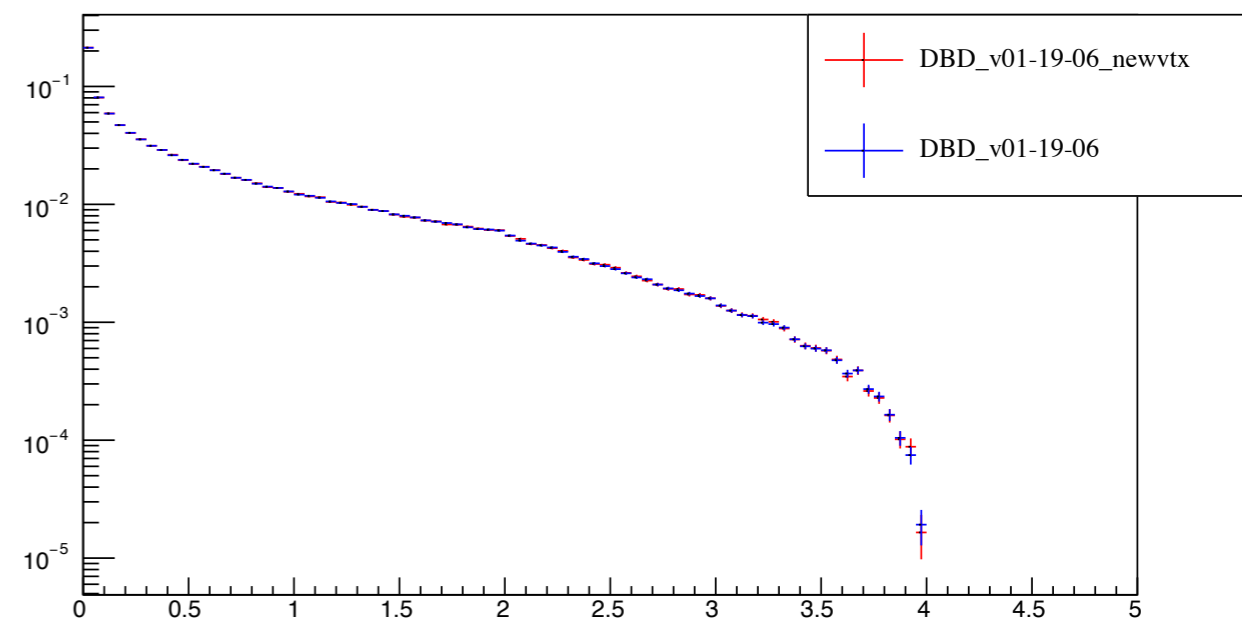
chi2



chi2



chi2



This is a sample check with same software

This is a software test with same sample