

LCFIPlus

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What's LCFIPlus?

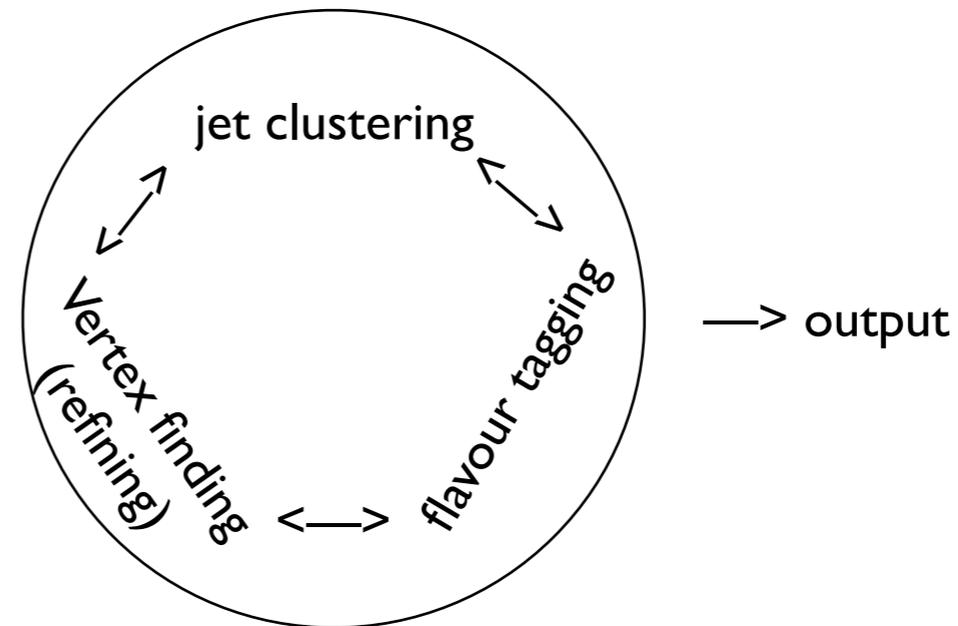
❖ A framework for jet flavour identification.

- ▶ Does vertex finding, jet clustering, and flavour tagging
- ▶ Implemented as a modular algorithm.
 - ▶ Gives flexibility to iterate or reverse the processes.

w/o LCFIPlus :

jet clustering → vertex finding → flavour tagging → output

w/ LCFIPlus :



▶ Typical flow :

“vertex finding → jet clustering → vertex refining → flavour tagging”

Typical workflow

Particle Flow Object (PFO)

LCFIPlus input

LCFIPlus

Charged particles

Neutral particles

Vertex finding

- primary vertex finding,
- secondary vertex finding,
- V0 vertex finding

Jet clustering & Vertex refiner

Jet flavour tagging

Jets with b, c probabilities

LCFIPlus output

PFO is an object created in Particle Flow Algorithm which aims for the best jet energy resolution with whole detector system.

Here, you can simply consider PFO to be something like “Best estimated reconstructed particle”.

What's LCFIPlus?

❖ History

- ▶ Originated from LCFIVertex (e.g. arXiv:0908.3019)
- ▶ LCFIPlus development was initiated by T. Suehara and T. Tanabe (~2011?).
- ▶ M. Kurata and J. Strube joined (~2015?). RY joined (~2018).

❖ Currently mostly used in LCIO framework :

- ▶ ILD
- ▶ SiD
- ▶ CLIC
- ▶ CEPC

❖ But LCFIPlus itself is designed as a standalone package.

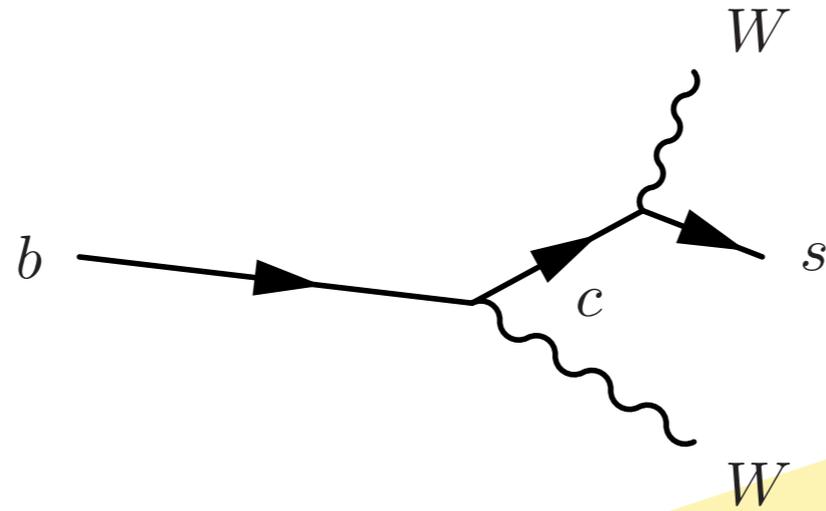
- ▶ For other data format, you need to implement a data conversion module from your data format to LCFIPlus data format.

❖ Git repository

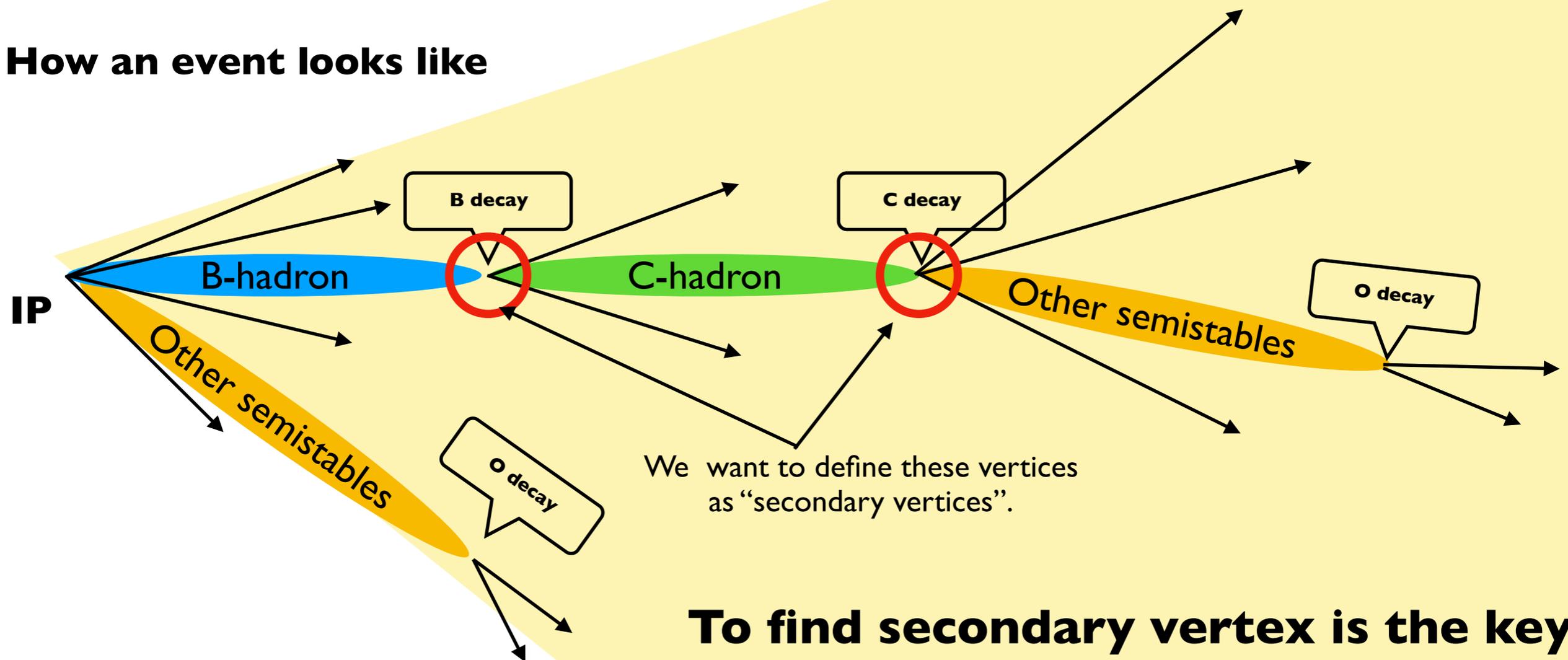
- ▶ <https://github.com/lcfiplus/LCFIPlus>
- ▶ Released v00-07.

Principle of b-tag and c-tag

Feynman diagram



How an event looks like



To find secondary vertex is the key.

Highlight of 2018 updates

The main concern this year was whether LCFIPlus works well with the new (IDR) samples as the DBD era.

- 
- Simulation/Reconstruction software (aka ilcsoft) has been renovated.**
 - w/ DD4hep (<https://dd4hep.web.cern.ch/dd4hep/>)**
 - w/ new tracking algorithms**
 - w/ IP smearing**
 - w/ bug fixes etc.**

Actual changes can be found at

<https://github.com/lcfiplus/LCFIPlus/commits/master>

Highlight of 2018 updates

❖ **ILD Ichinoseki meeting (Feb.)**

- ▶ Tested 91 GeV(2jet) sample —> Seen discrepancy between DBD and IDR.
- ▶ Turned out that there was a left-over from developments and it affected the result. —> 91 GeV sample looked fine.
- ▶ 500GeV (6jet) sample still seen discrepancy.

❖ **ALCW18 (May)**

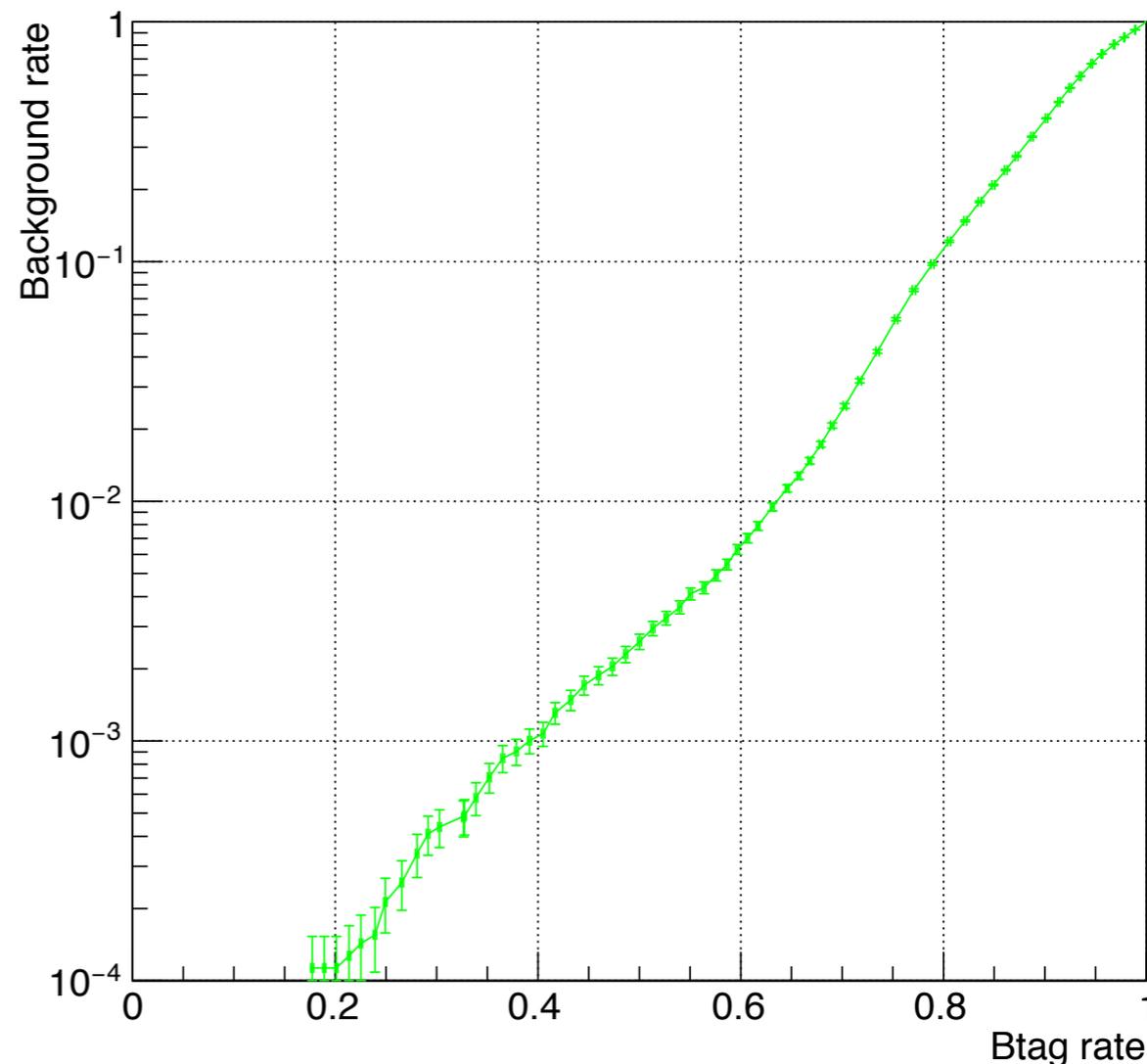
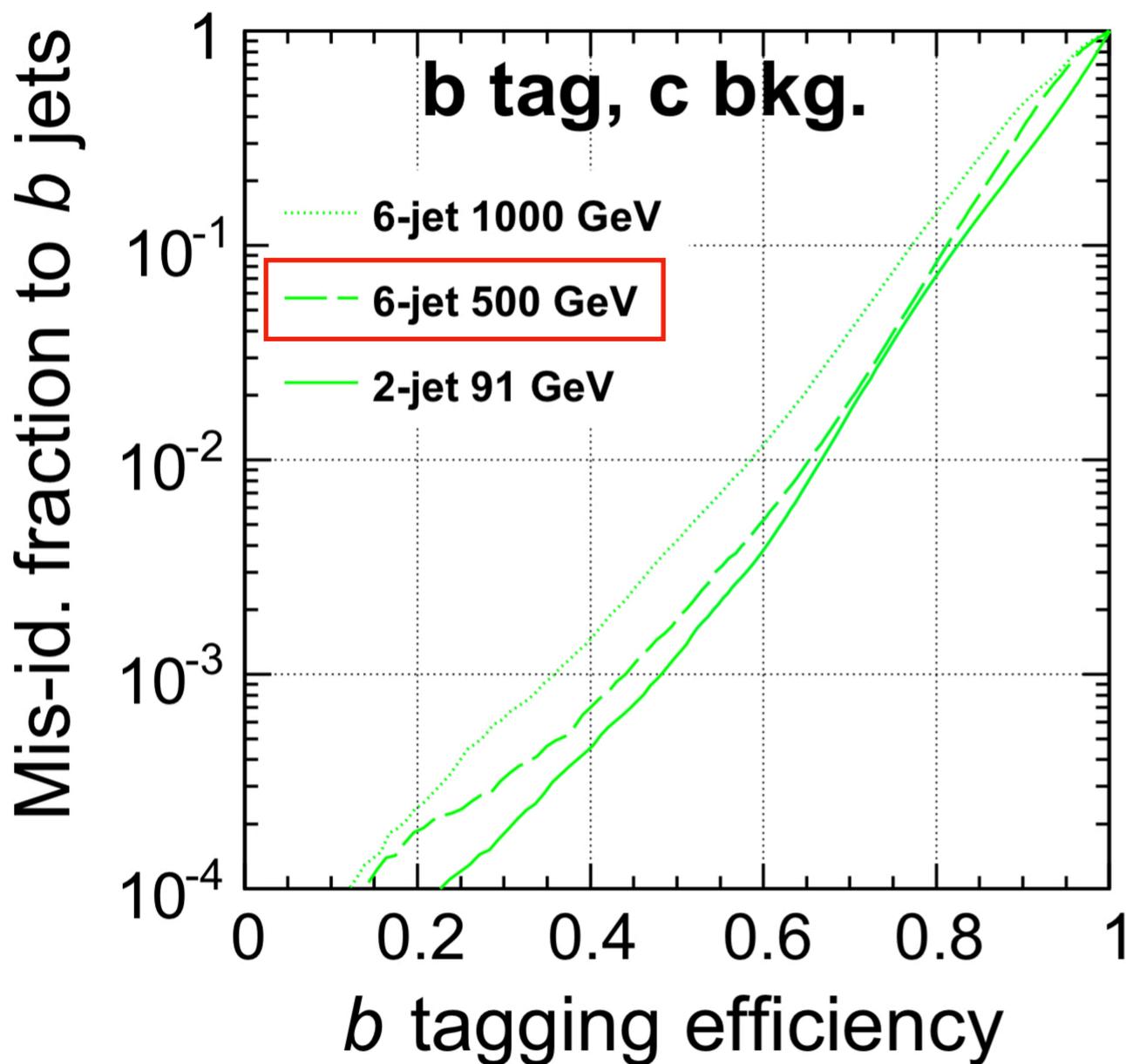
- ▶ Primary vertex fitting failures, which result in vertex position to be (0,0,0) with too-small errors, were found from time to time.
- ▶ Statistical (strange) dependency in a MVA training, which is used for the flavour identification. Turned out that the IP smearing introduced after DBD is the cause.

❖ **LCWS18 (Oct.)**

- ▶ Found the cause of the primary vertex failures and succeeded in improving the situation.
- ▶ Accommodated to IP smearing, meaning that all the part assumed the primary vertex to be (0,0,0) has been modified so that the primary vertex position found during the process to be used.
- ▶ All known issues are finally solved at Tag v00-07.

Comparison with previous result [1]

(a)

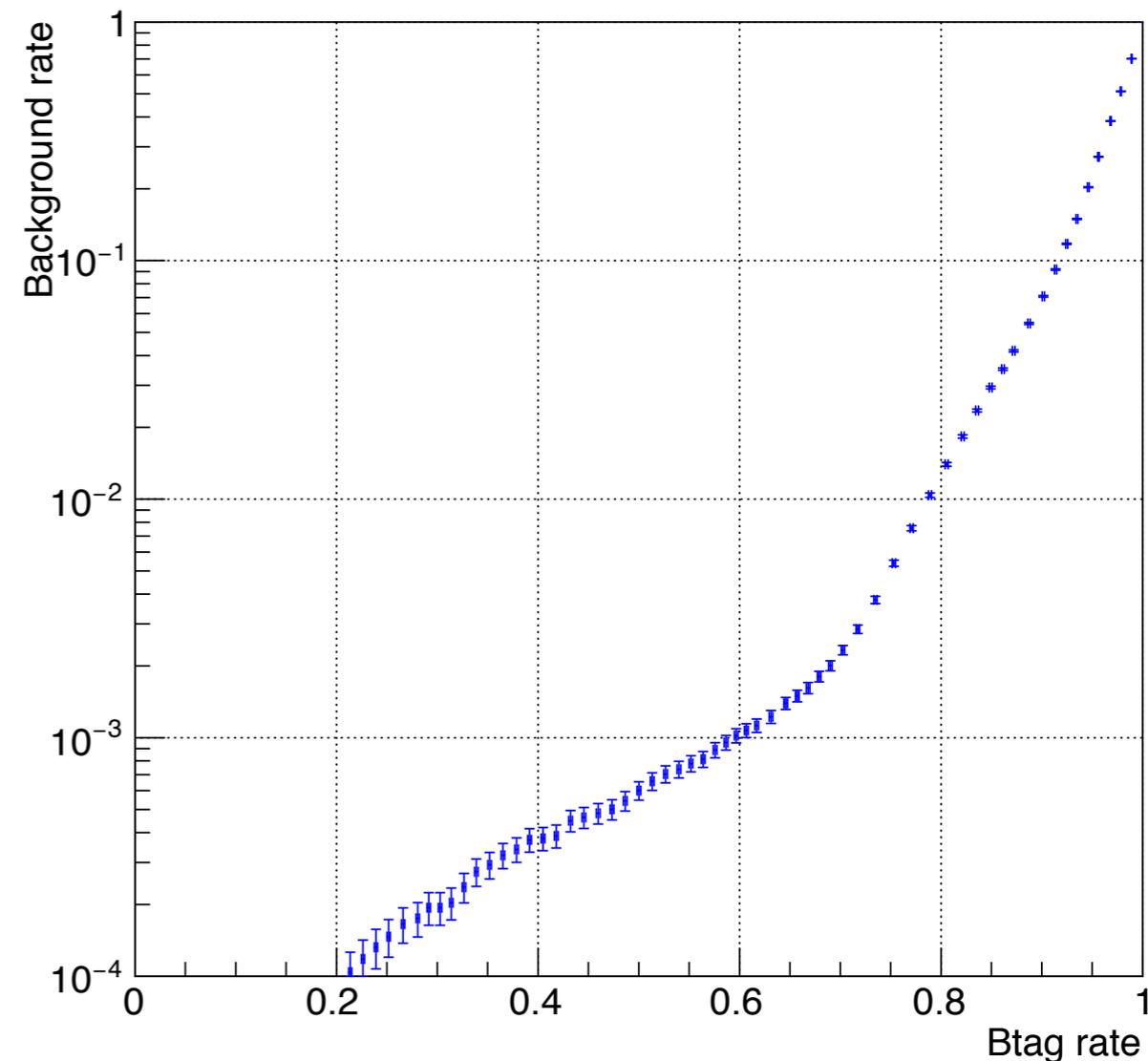
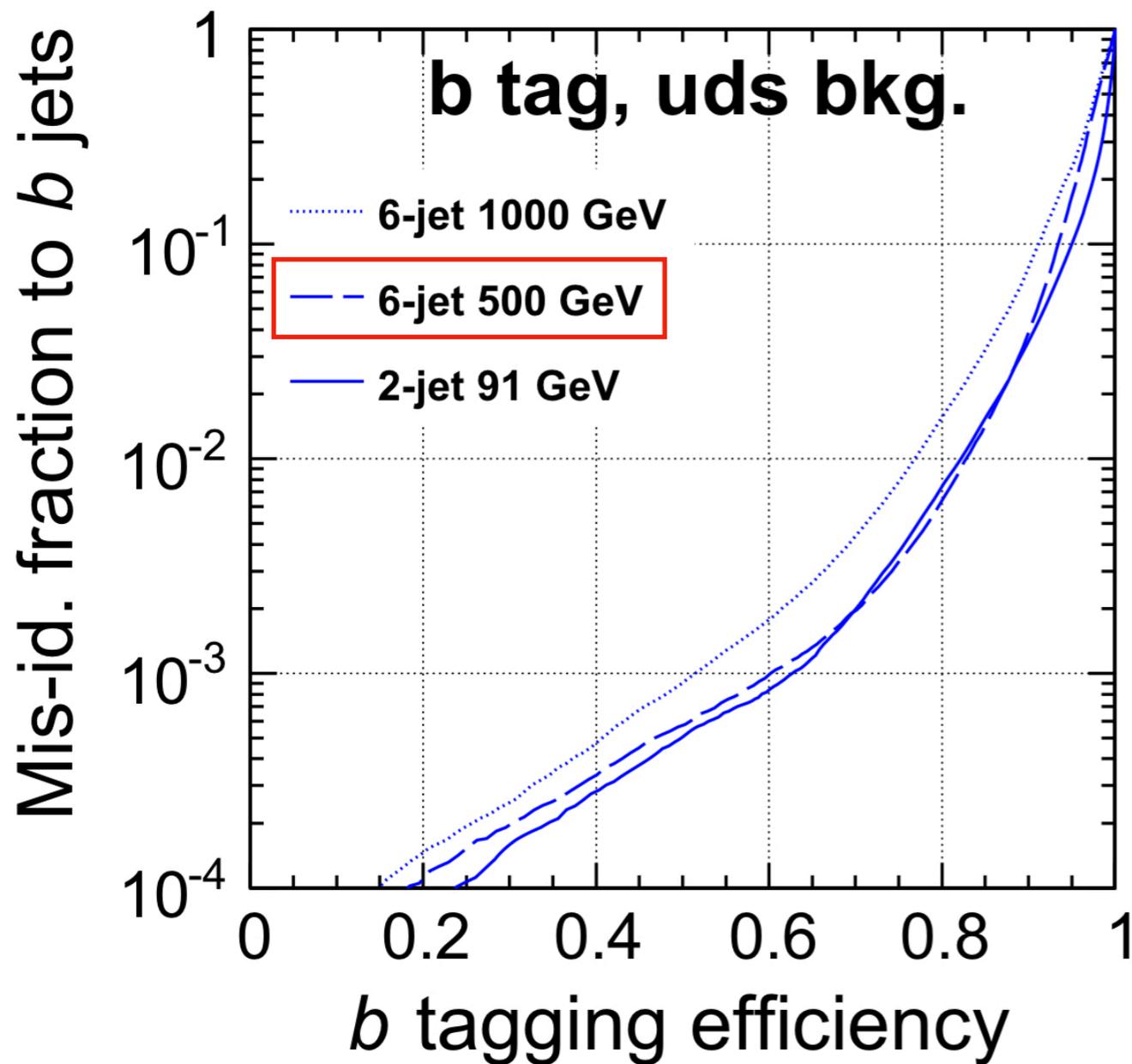


[1]: LCFIPlus: A framework for jet analysis in linear collider studies, Taikan Suehara, Tomohiko Tanabe

- DBD sample (no IP smearing, but emulated in LCFIPlus) used. $\sim 20k$ for each sample.
- Beam spot constraint (639nm, 5.7nm, 91.3um) as written in [1].
- v00-07 used. MVA param. Maxdepth=6

Consistent result.

Comparison with previous result [1]

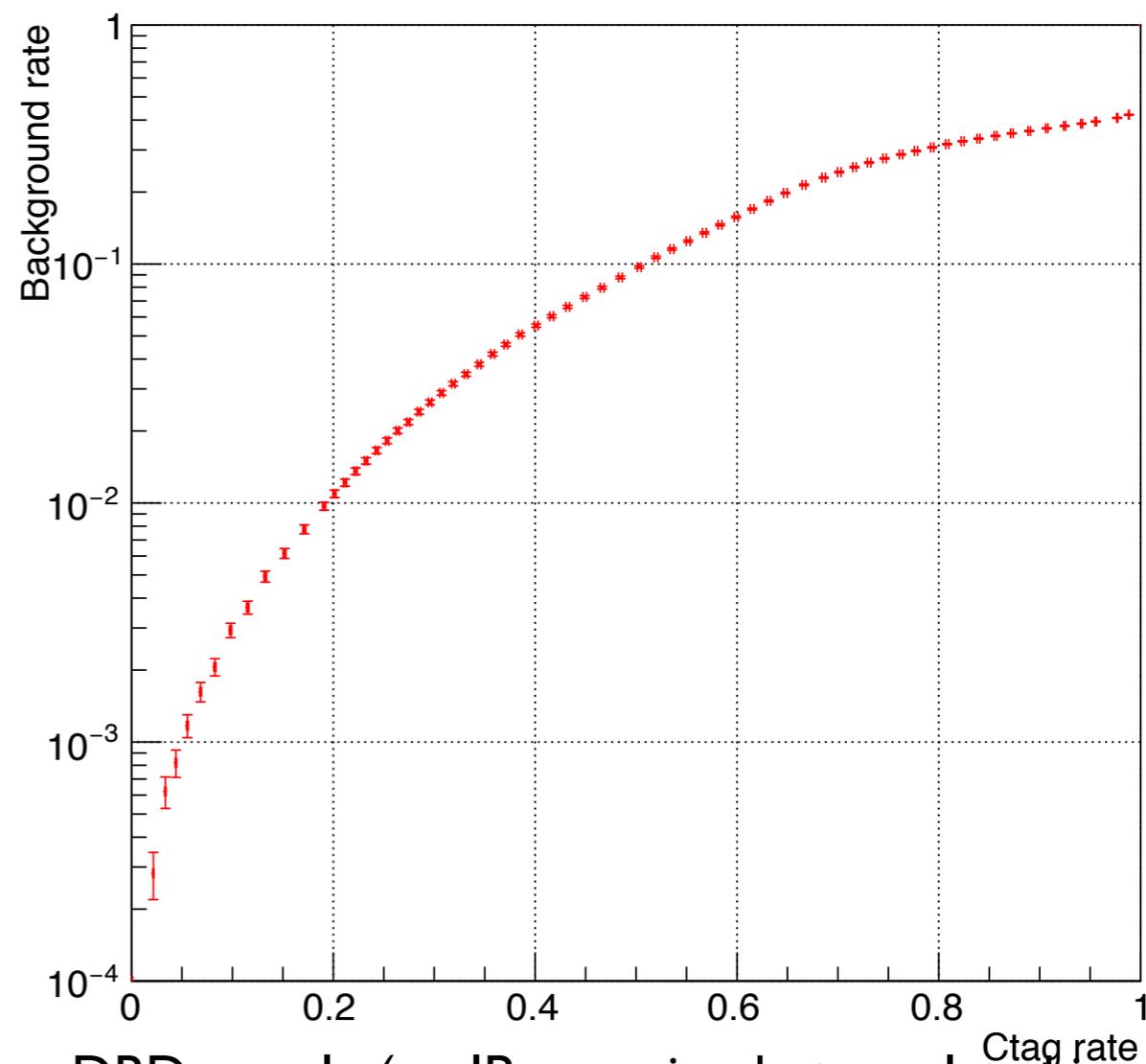
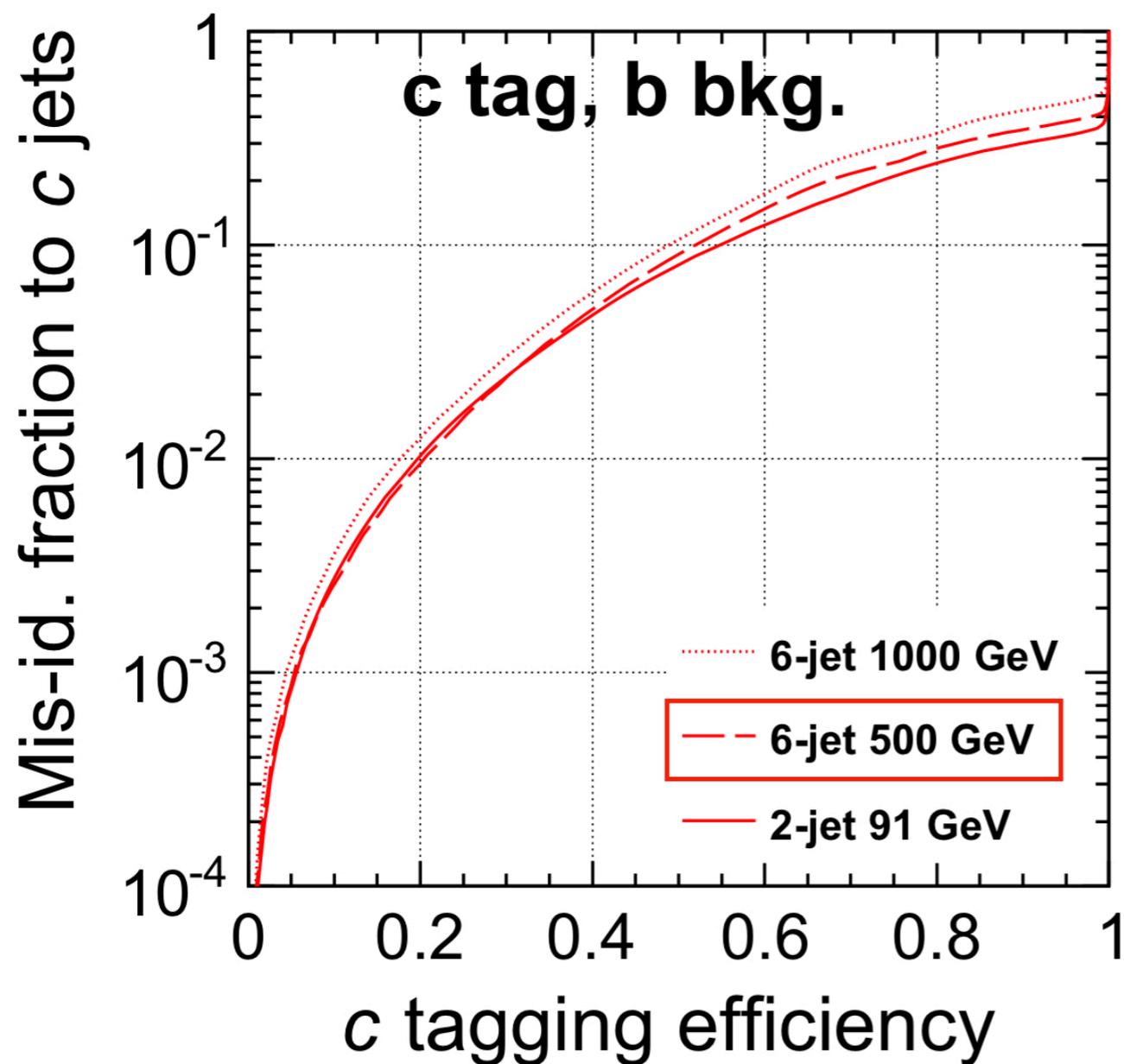


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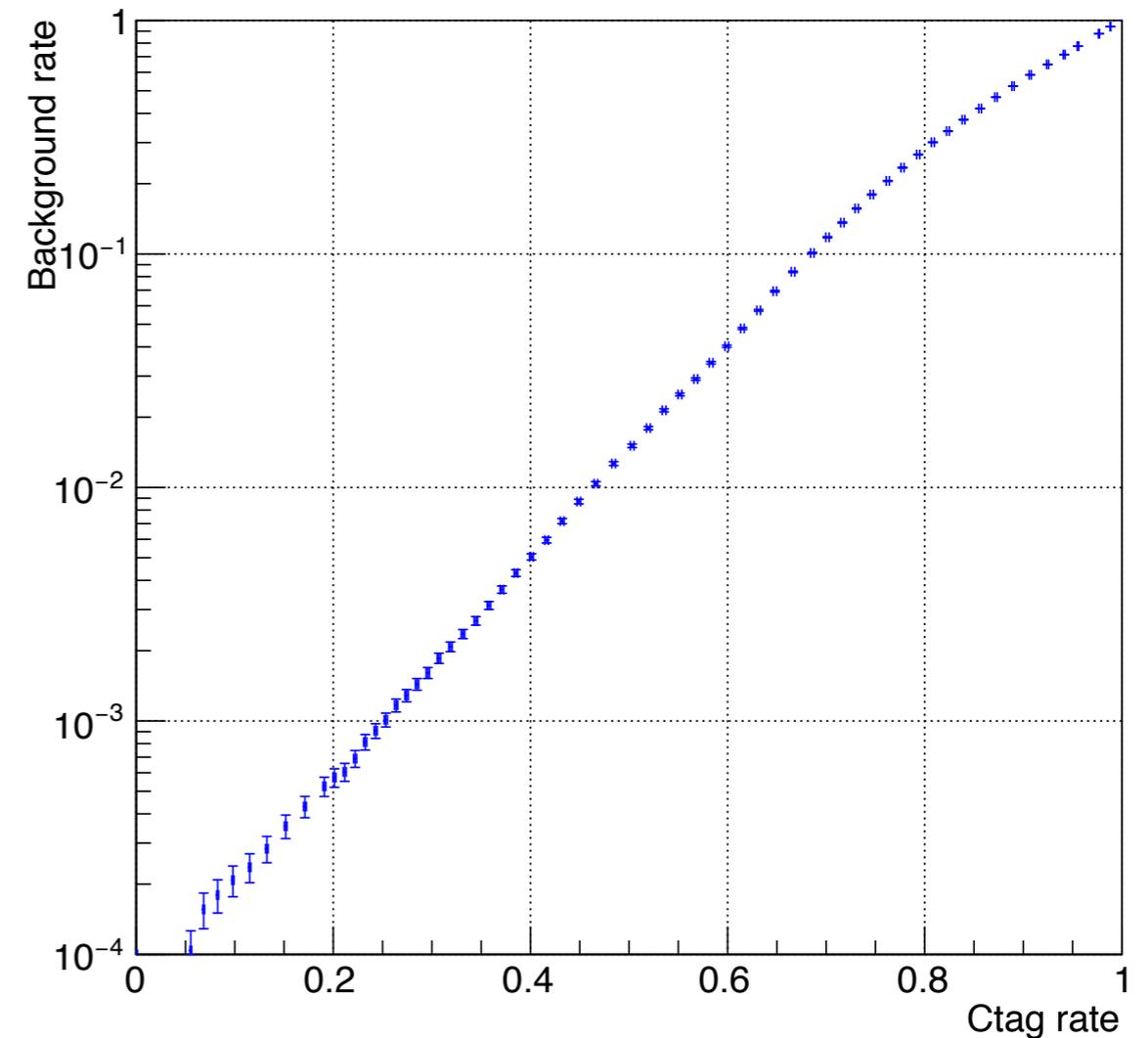
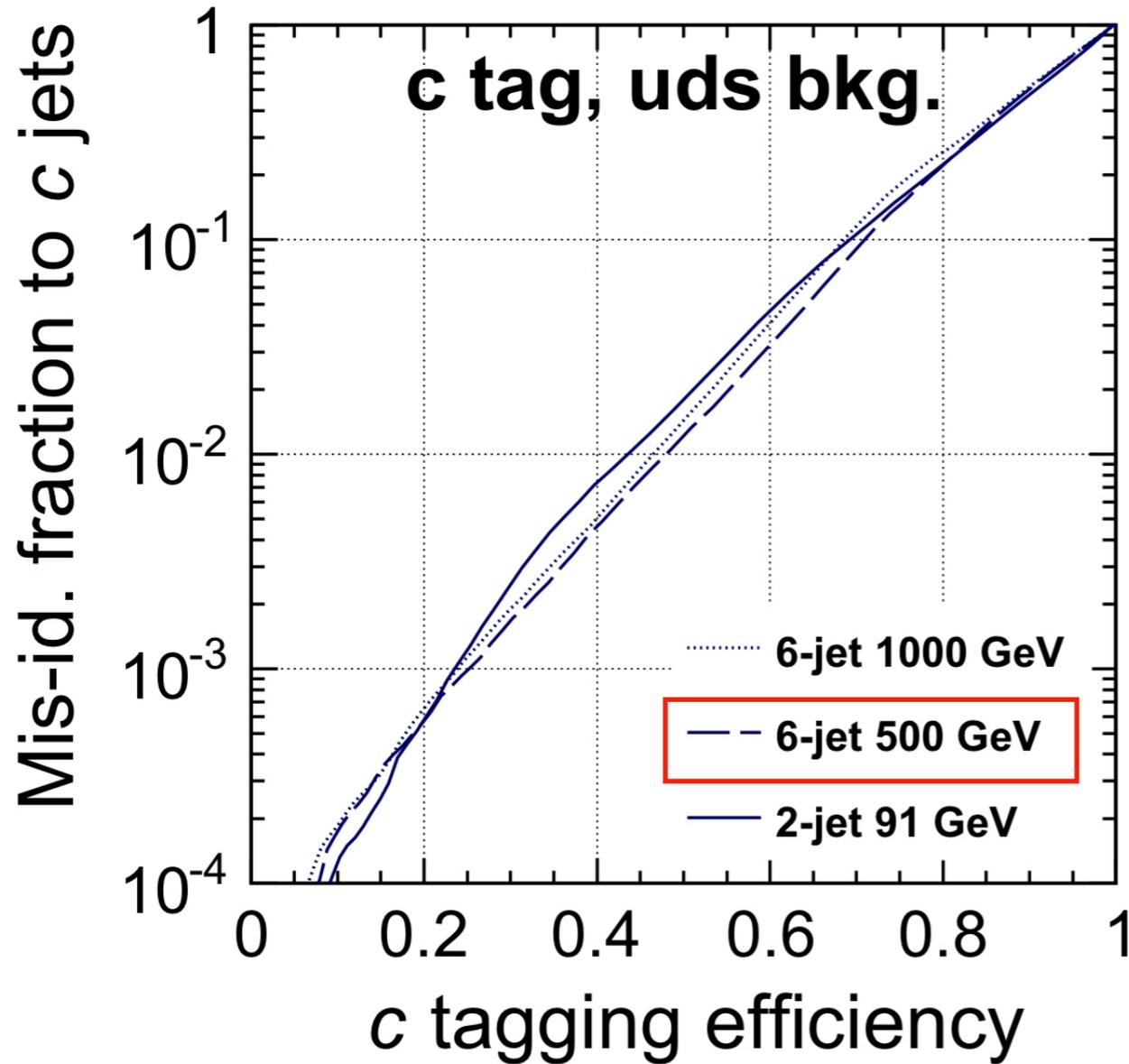


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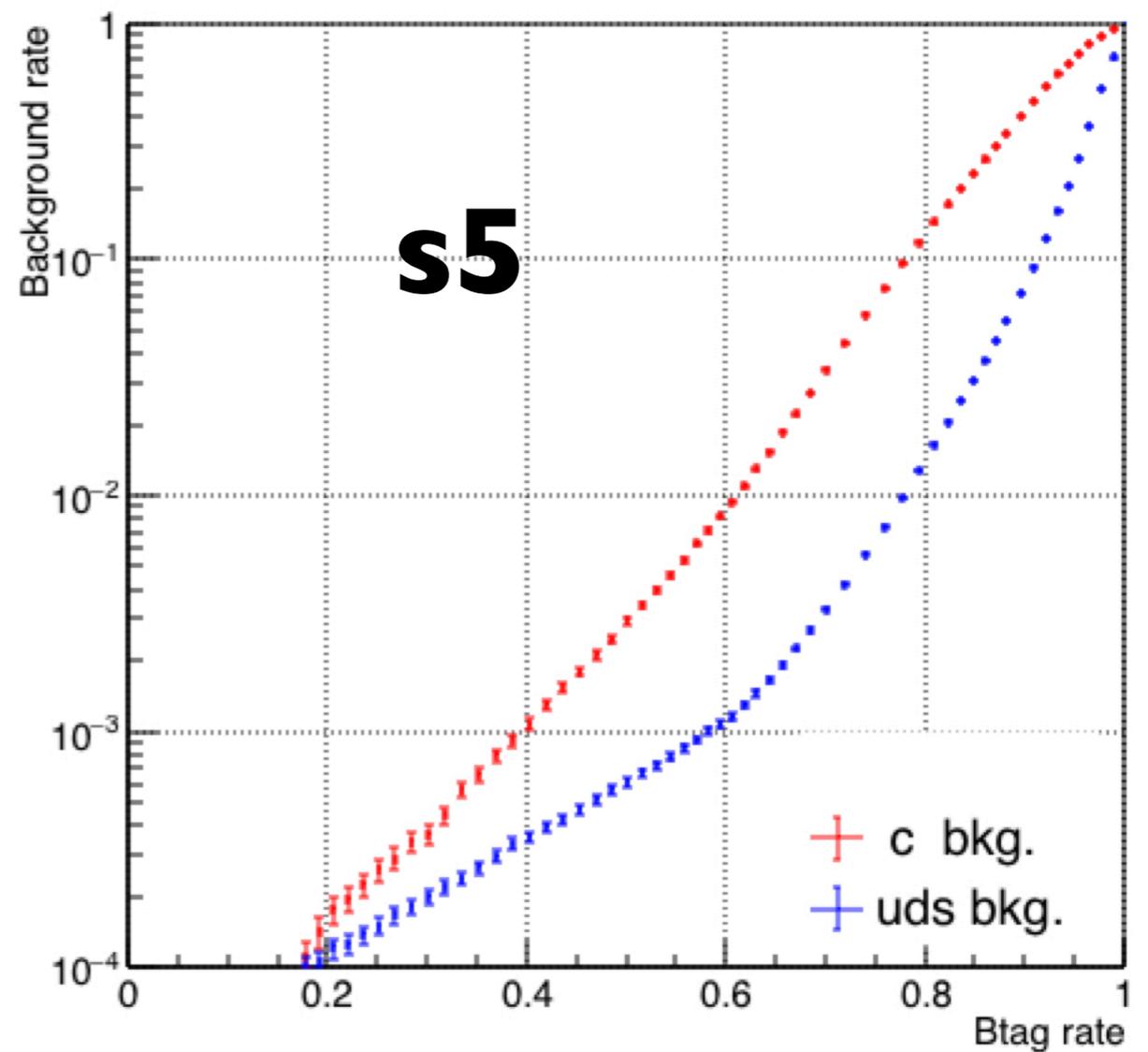
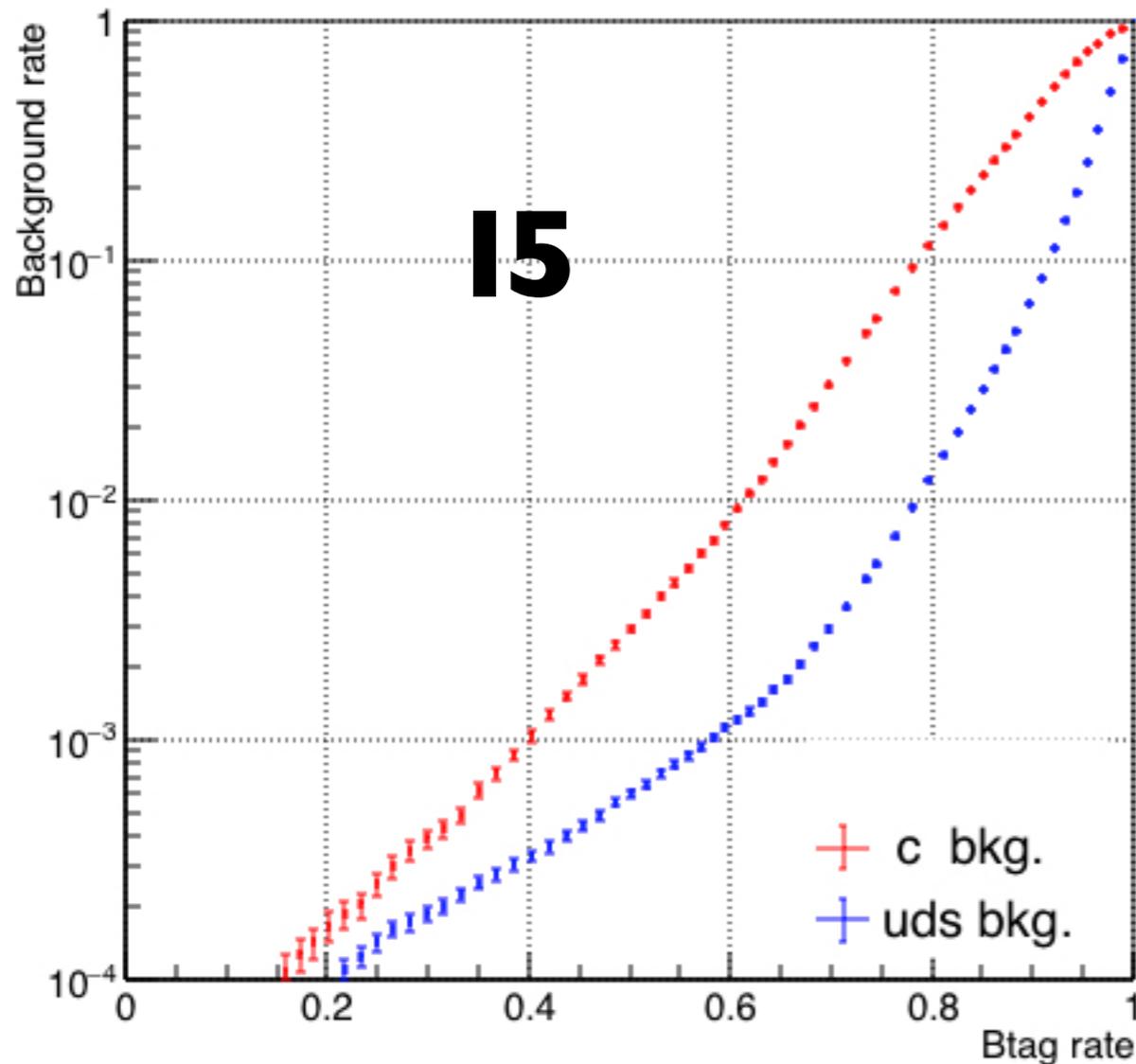
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Consistent result.

Latest result (b-tagging)

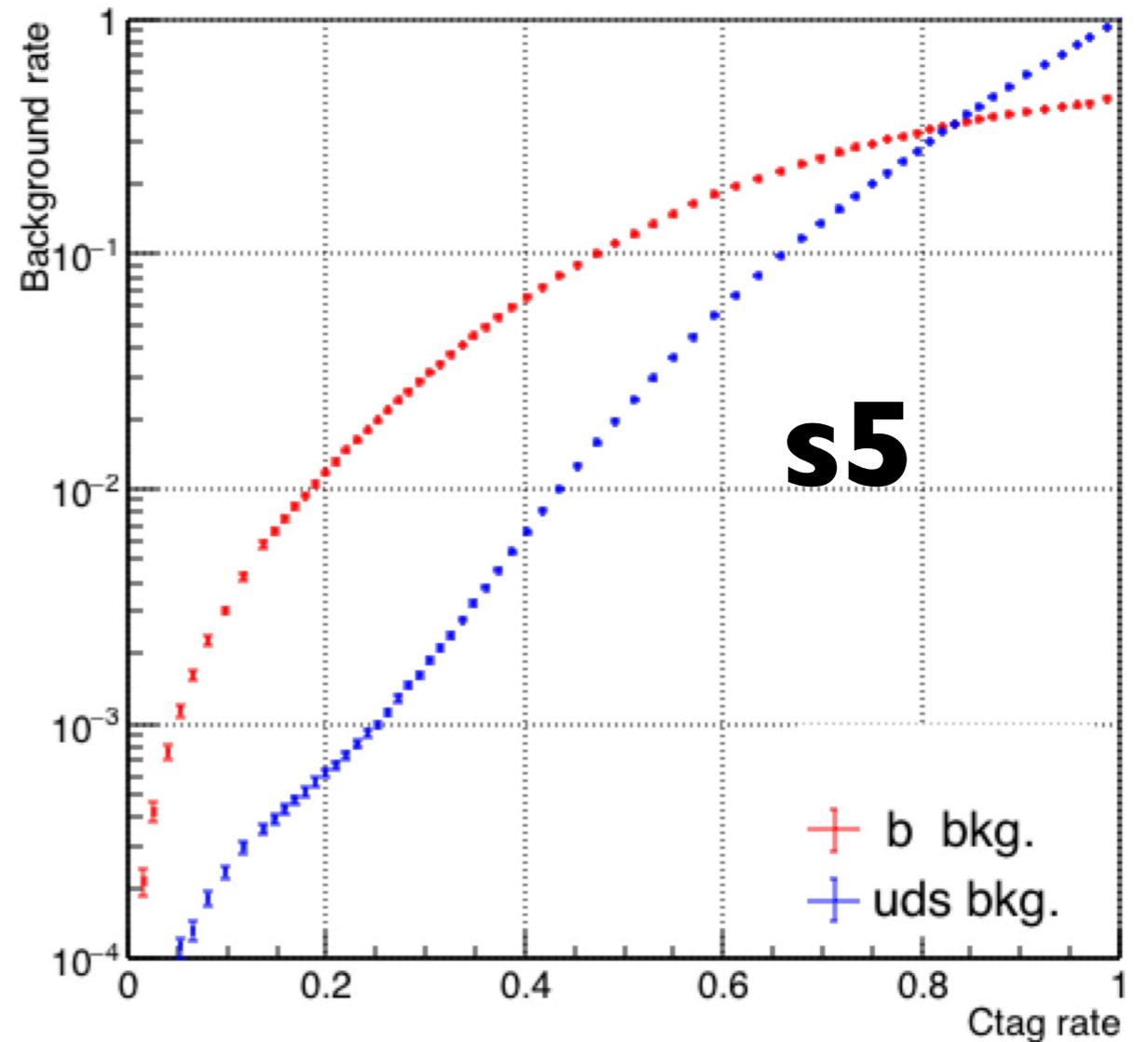
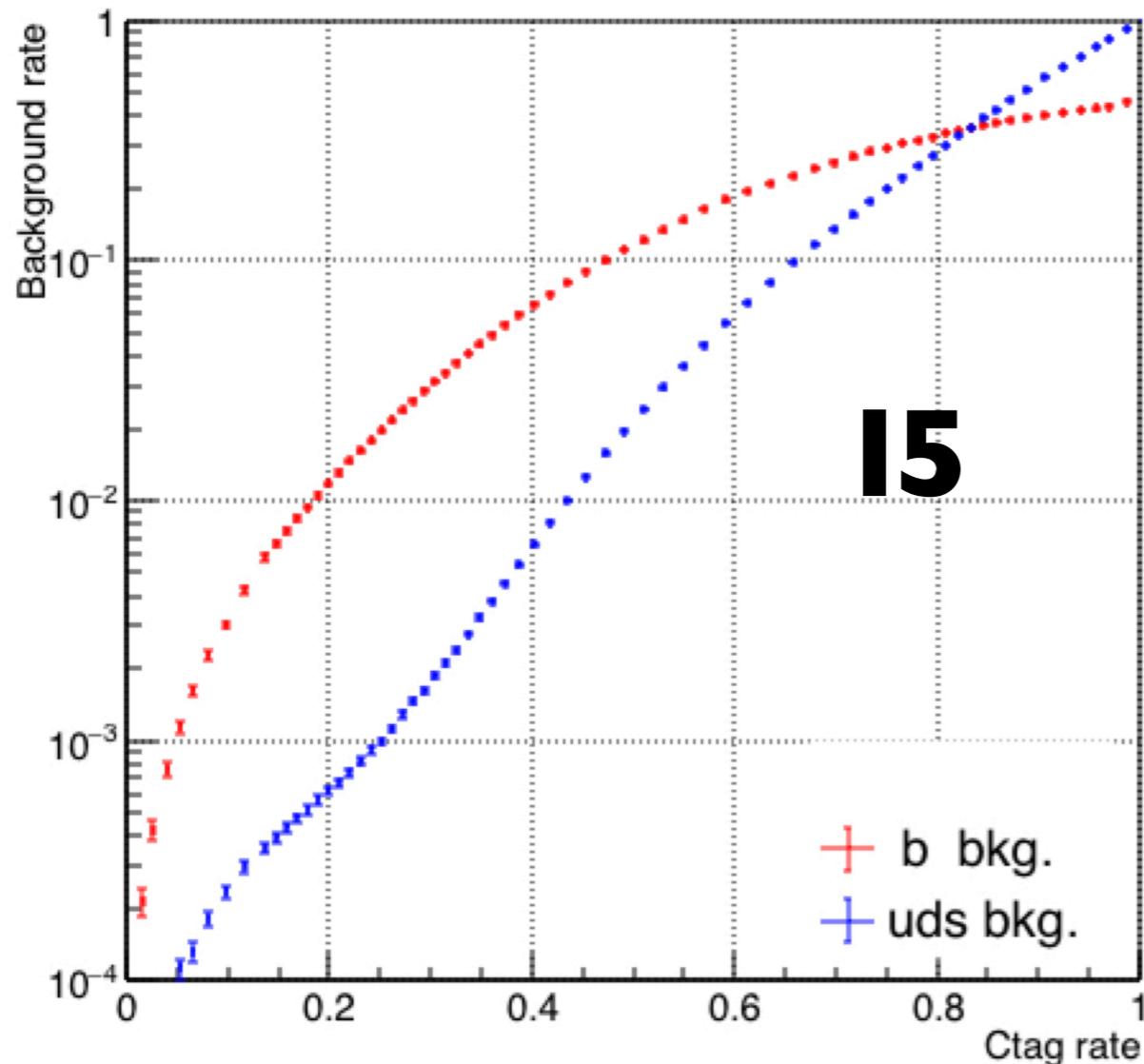
6-jets, 500 GeV, w/ IP smearing, w/ beam bkg.



- Used same software but different samples compared to the previous plots.
- No references for this new condition.

Latest result (c-tagging)

6-jets, 500 GeV, w/ IP smearing, w/ beam bkg.



- Used same software but different samples compared to the previous plots.
- No references for this new condition.

How to get this performance?

- ❖ **Unfortunately, you have to re-process vertexing on your own for the current IDR samples (unless it was processed with LCFIPlus v00-07).**
- ❖ **Use <https://github.com/ryonamin/ILDConfig/tree/example20181219/LCFIPlusConfig>**
 - ▶ MVA parameter : MaxDepth=6 used.
 - ▶ Some new MVA input variables : d0bprob2, z0bprob2, etc.
 - ▶ Reprocessed vertex collections (PrimaryVertex, BuildupVertex, V0.)
- ❖ **Don't hesitate to ask if you need help for these steps.**

Summary

- ❖ **LCFIPlus is ready for the new setup.**
 - ▶ But the recent fixes affect primary vertexing. —> Need to reprocess vertexing for existing the IDR samples.
- ❖ **LCFIPlus gives similar result as before if you use same samples as before. This check was done by using ~20k statistics.**
- ❖ **No clear difference between l5 and s5.**
- ❖ **Moving to check performance for physics samples, e.g. ttbar samples.**