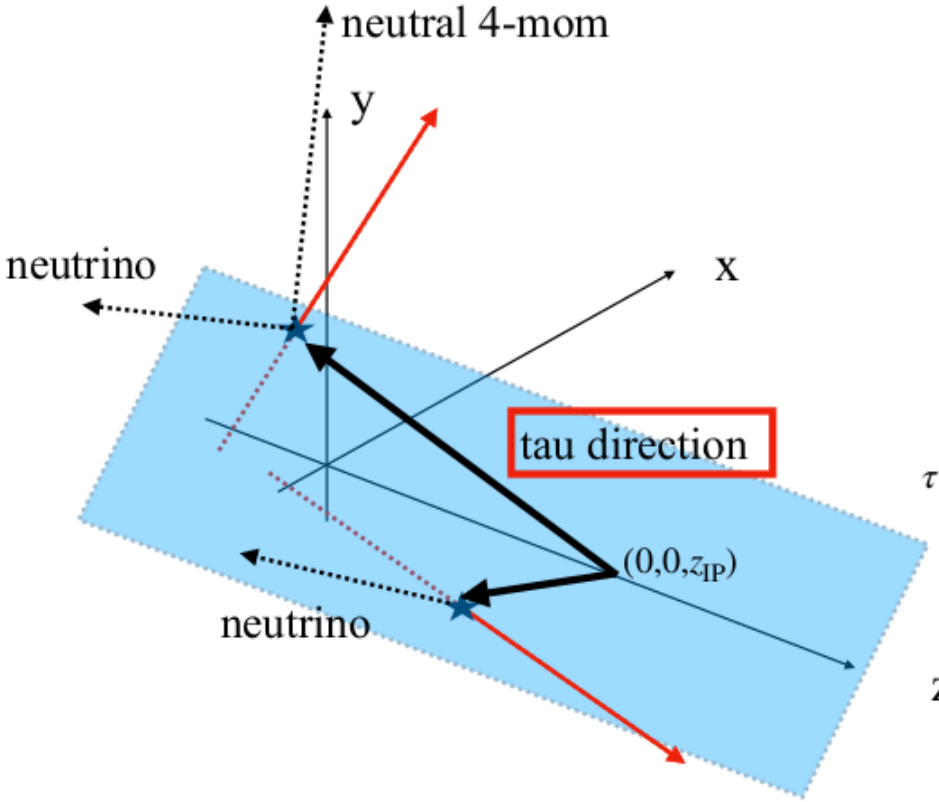
report (on Yumino-san’s tau-tau reco)

Daniel, 2022/9/29

with Yumino-san, investigating method to use
vertex detector information to reconstruct tau decays in e+ e- → tau+ tau-

τ reconstruction method



(ϕ, z_{IP}) determined tau direction

with assumptions

- $p_T^{\tau_1} = p_T^{\tau_2}$
- Single ISR photon
- E_{CM}

⇨ tau 4-momentum

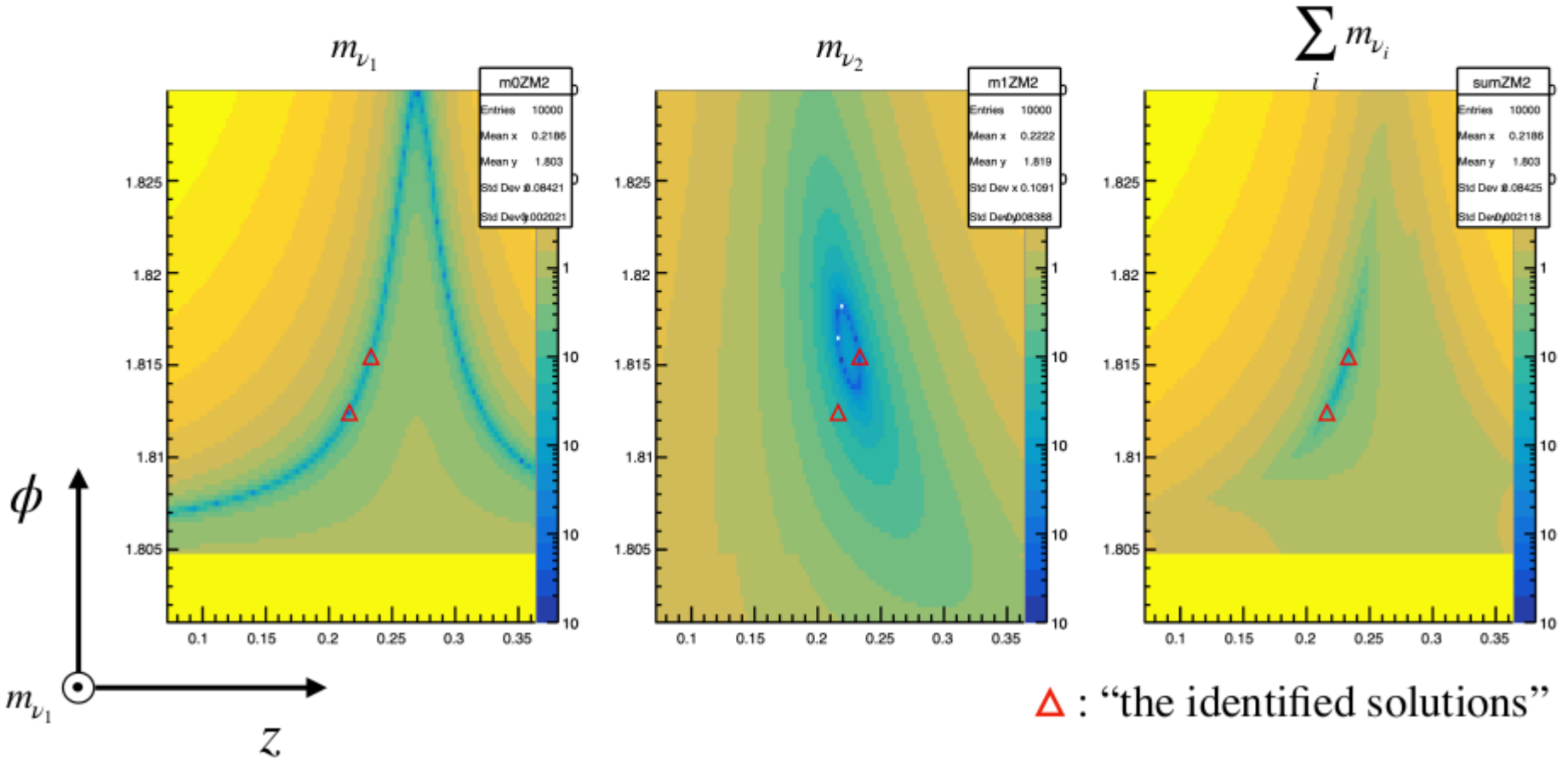
By comparing with the visible tau 4-momentum
⇨the invariant mass of the missing (neutrino)
momentum for each tau can be calculated

We choose the values of z and ϕ which result in neutrino masses closest to zero

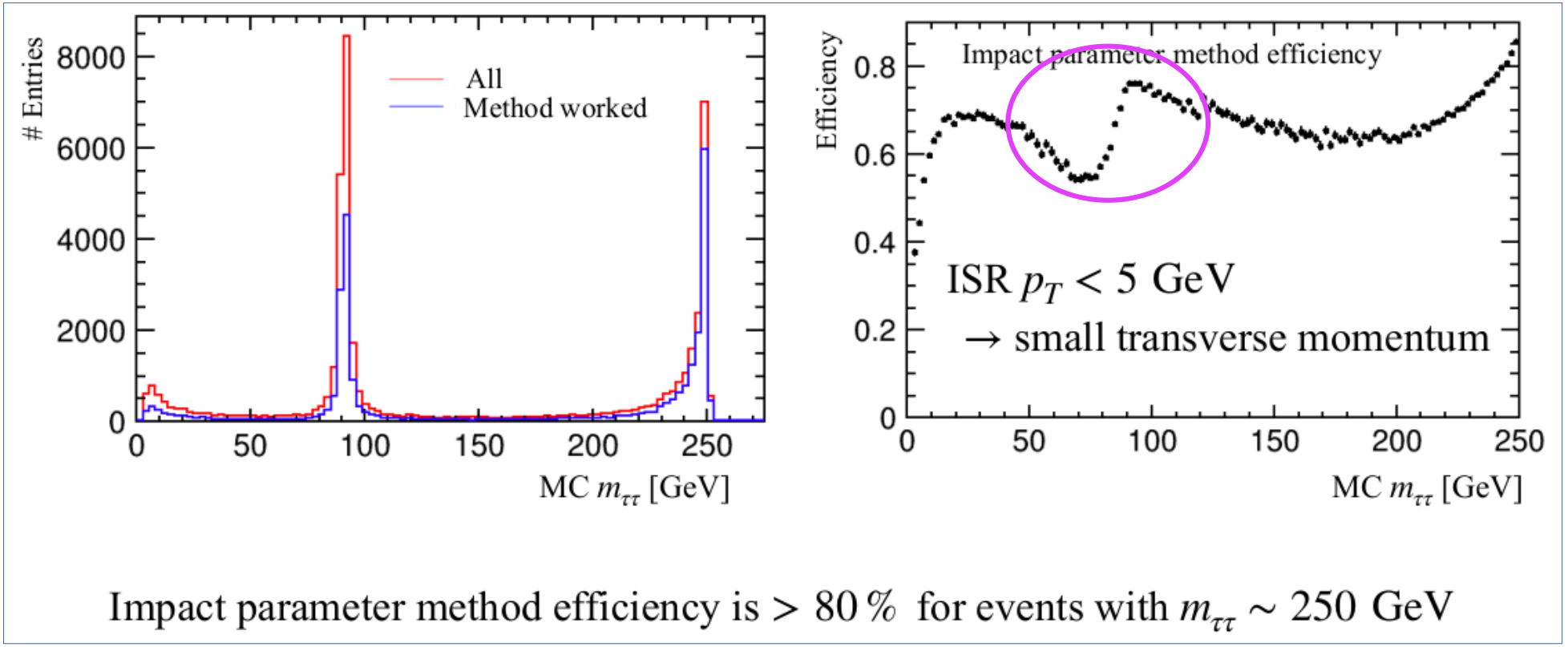
(c) Yumino

Find solutions

We choose the values of z and ϕ which result in neutrino masses closest to zero



△ : "the identified solutions"

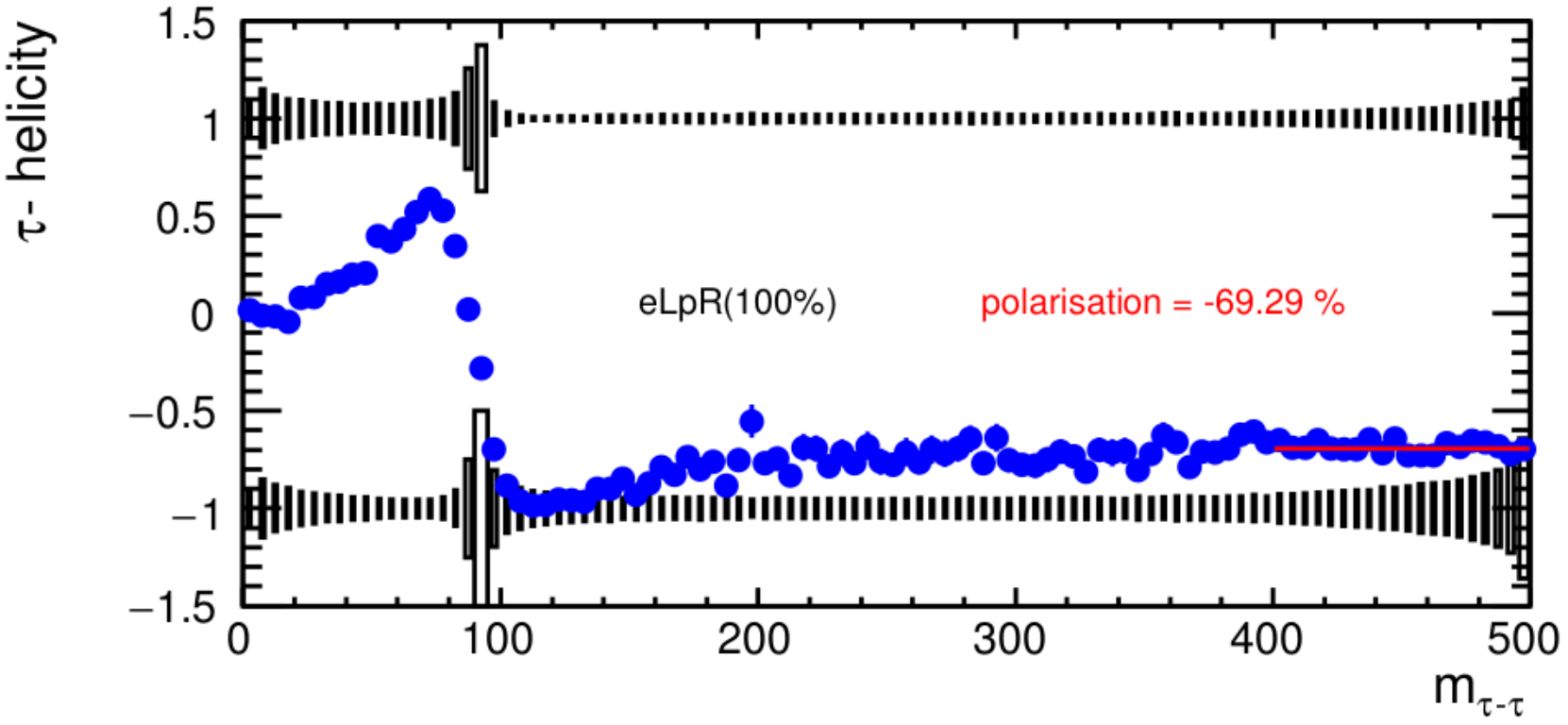


© Yumino

efficiency to find >0 solutions has interesting structure around m_Z

why?

my initial guesses → cos(th) and/or tau polarisation change as we sweep through Z resonance



maybe reconstruction efficiency depends on the tau polarisation / polarimeter we're trying to measure ?

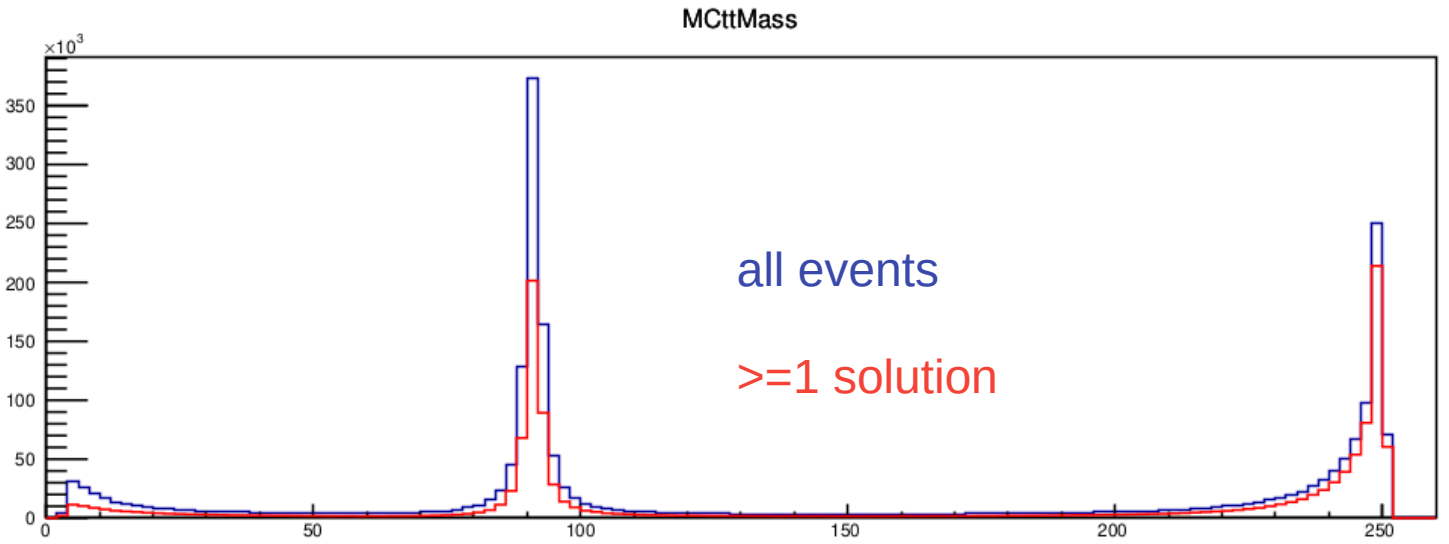
Yumino-san checked, but found no significant dependence on

* tau scattering angle cos(theta) or
* tau polarimeter

which could explain the observed variation in efficiency...

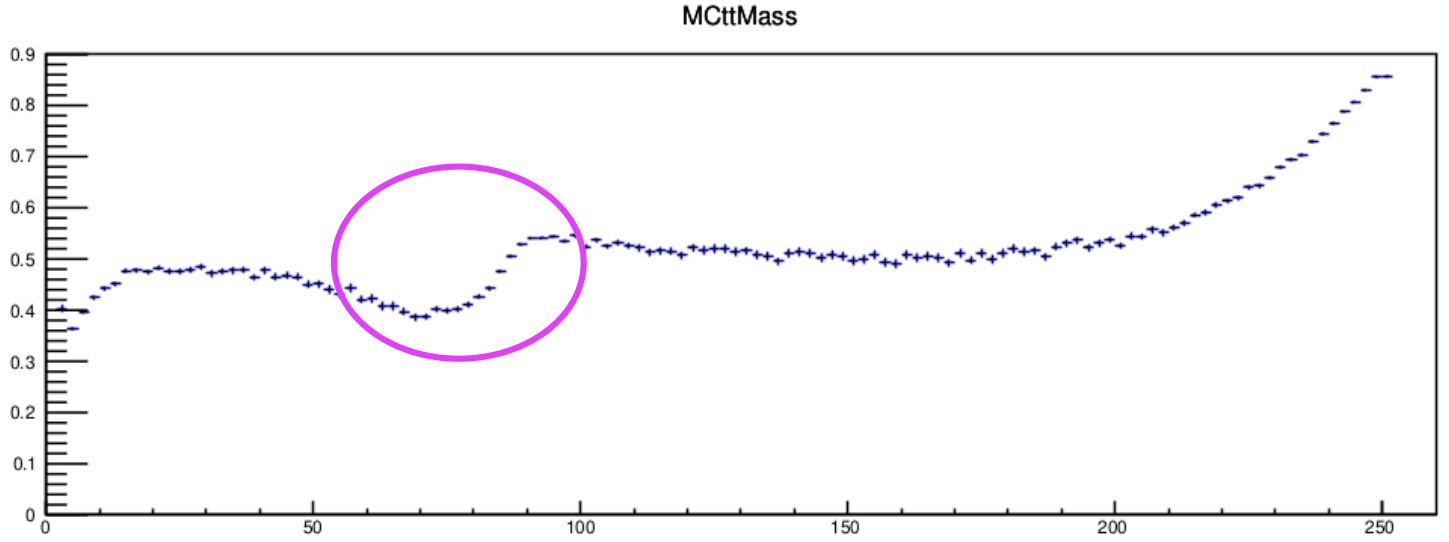
distribution of MC tau-tau invariant mass

events

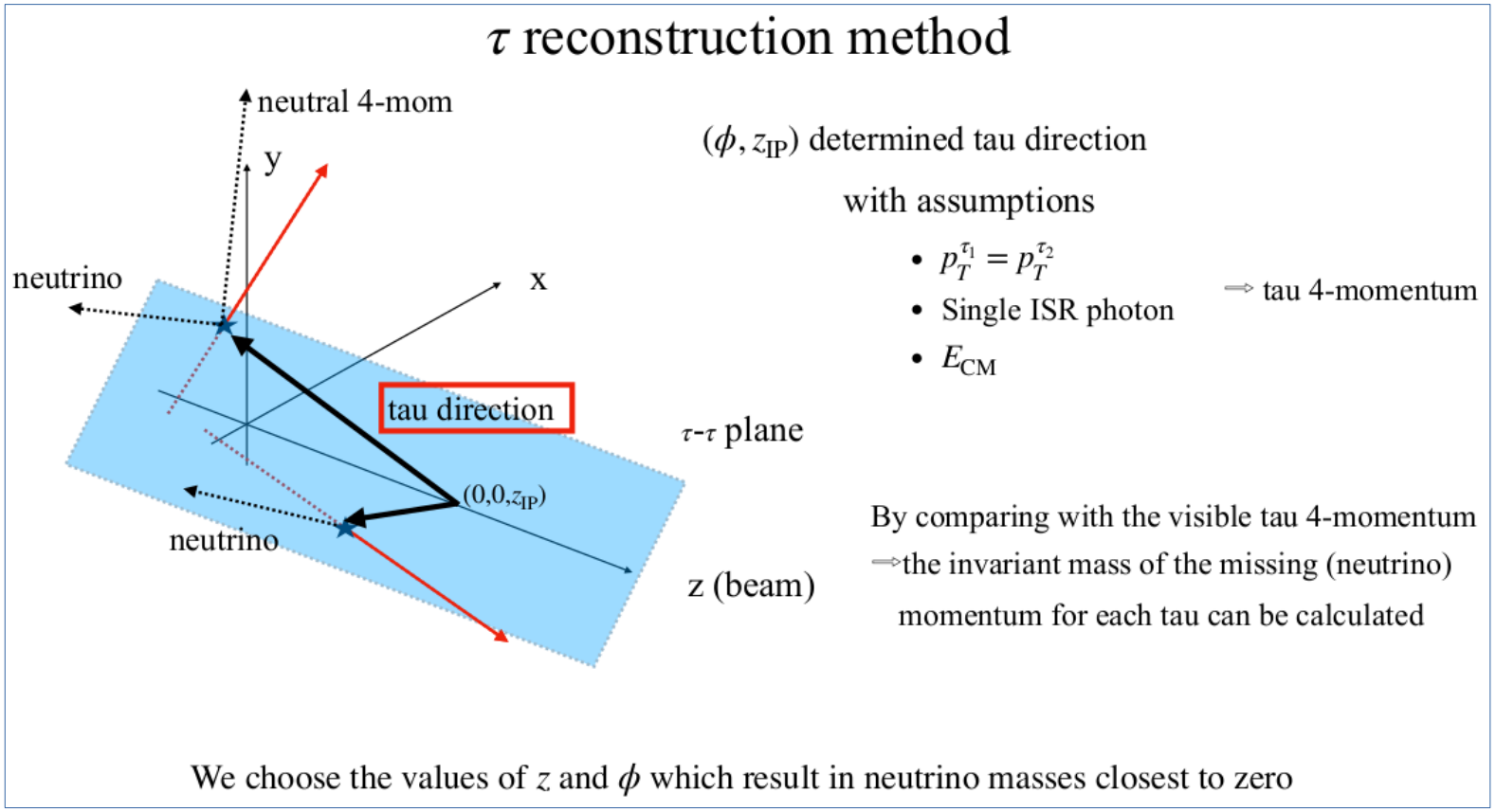


tau-tau invariant mass [GeV]

efficiency



tau-tau invariant mass



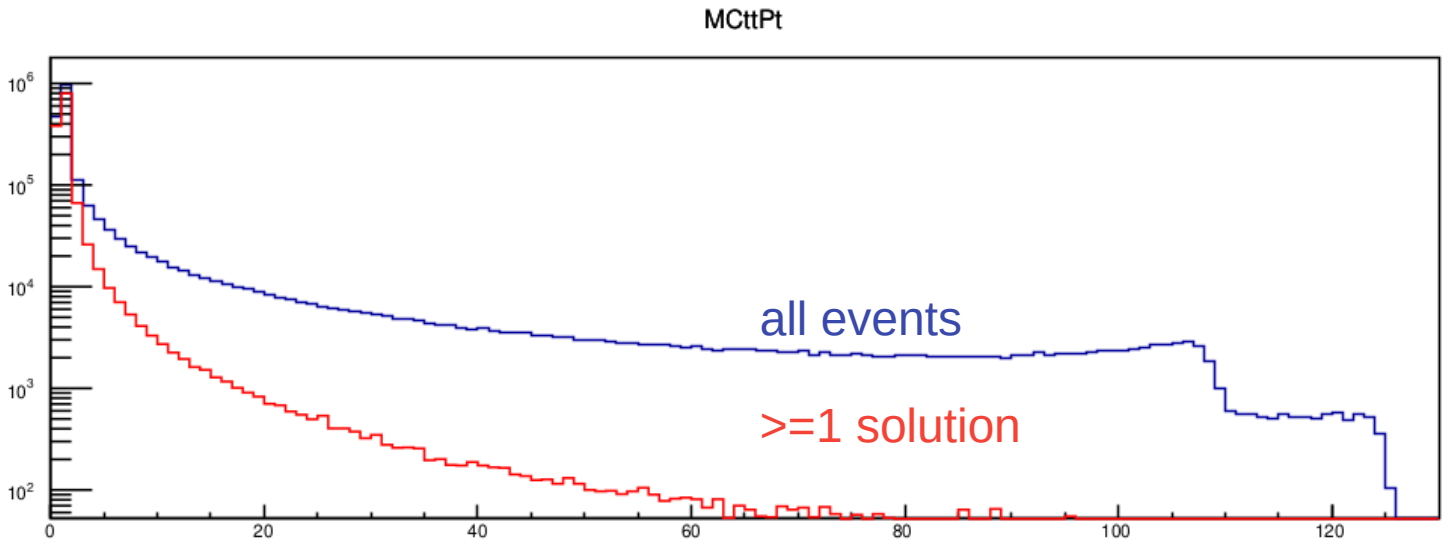
method assumes that tau-tau system has no p_T

fixed initial CM energy

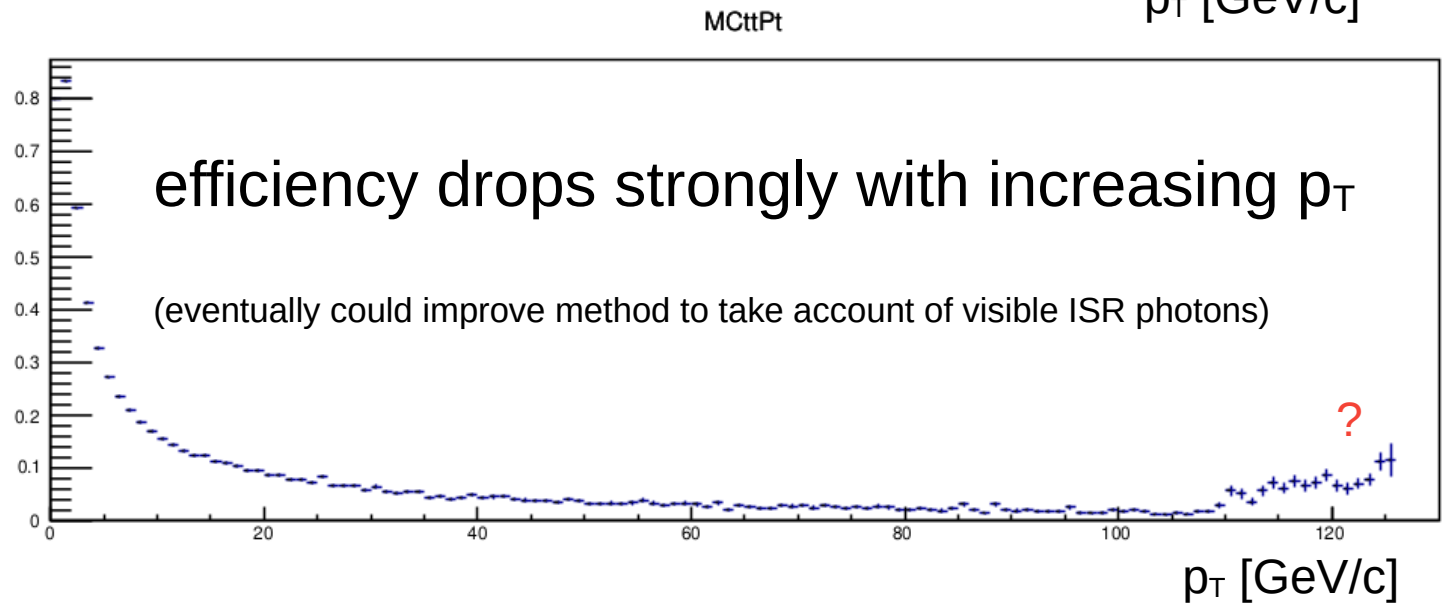
ISR/BS along only 1 beam direction

p_T of tau-tau system [MC level]

events

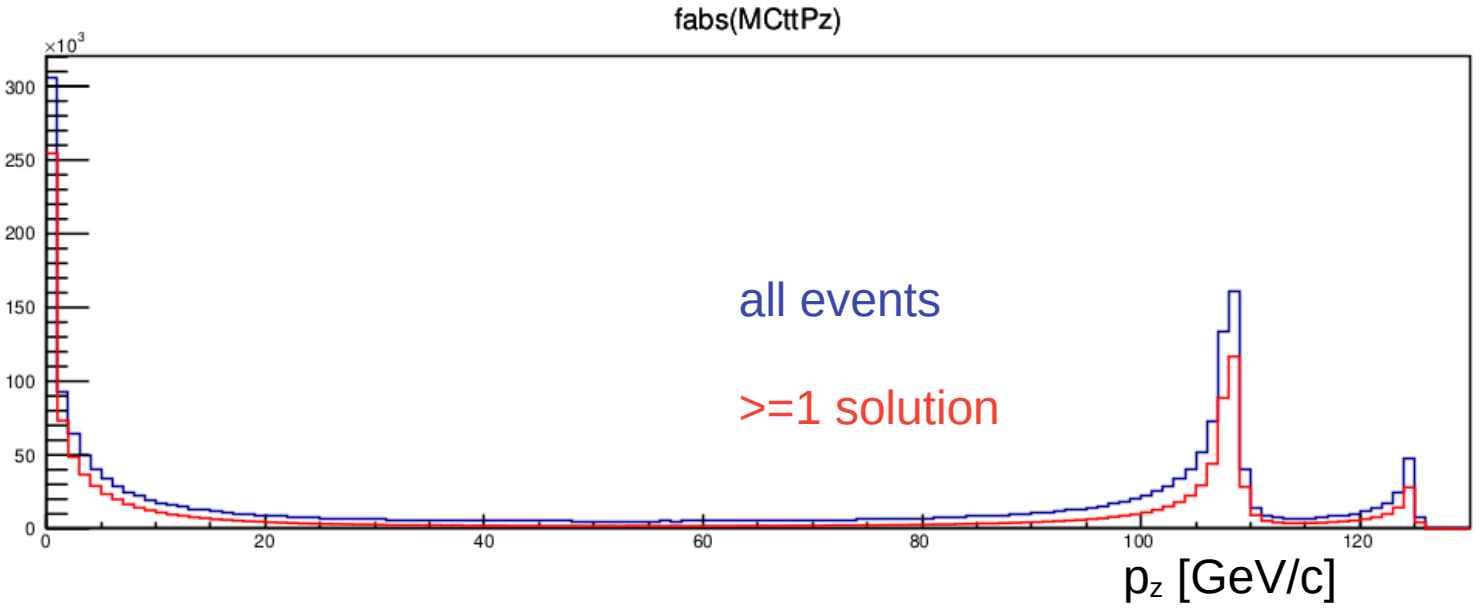


efficiency

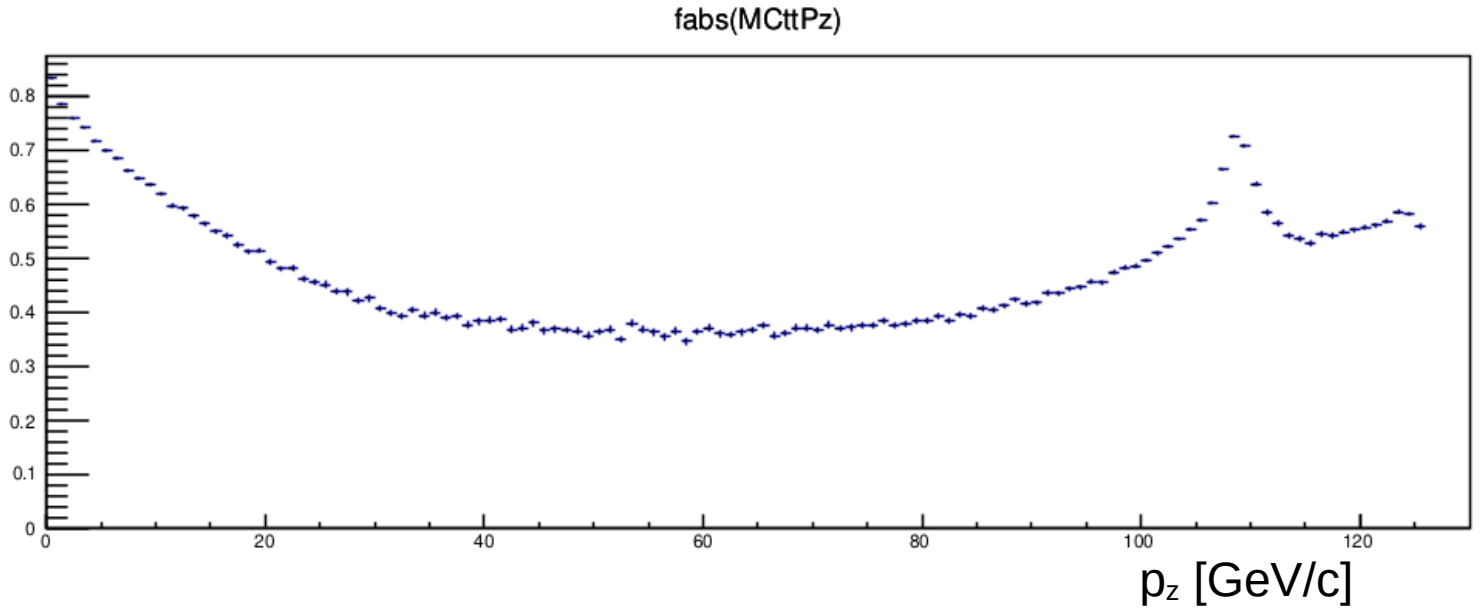


$|p_z|$ of tau-tau system [MC]

events

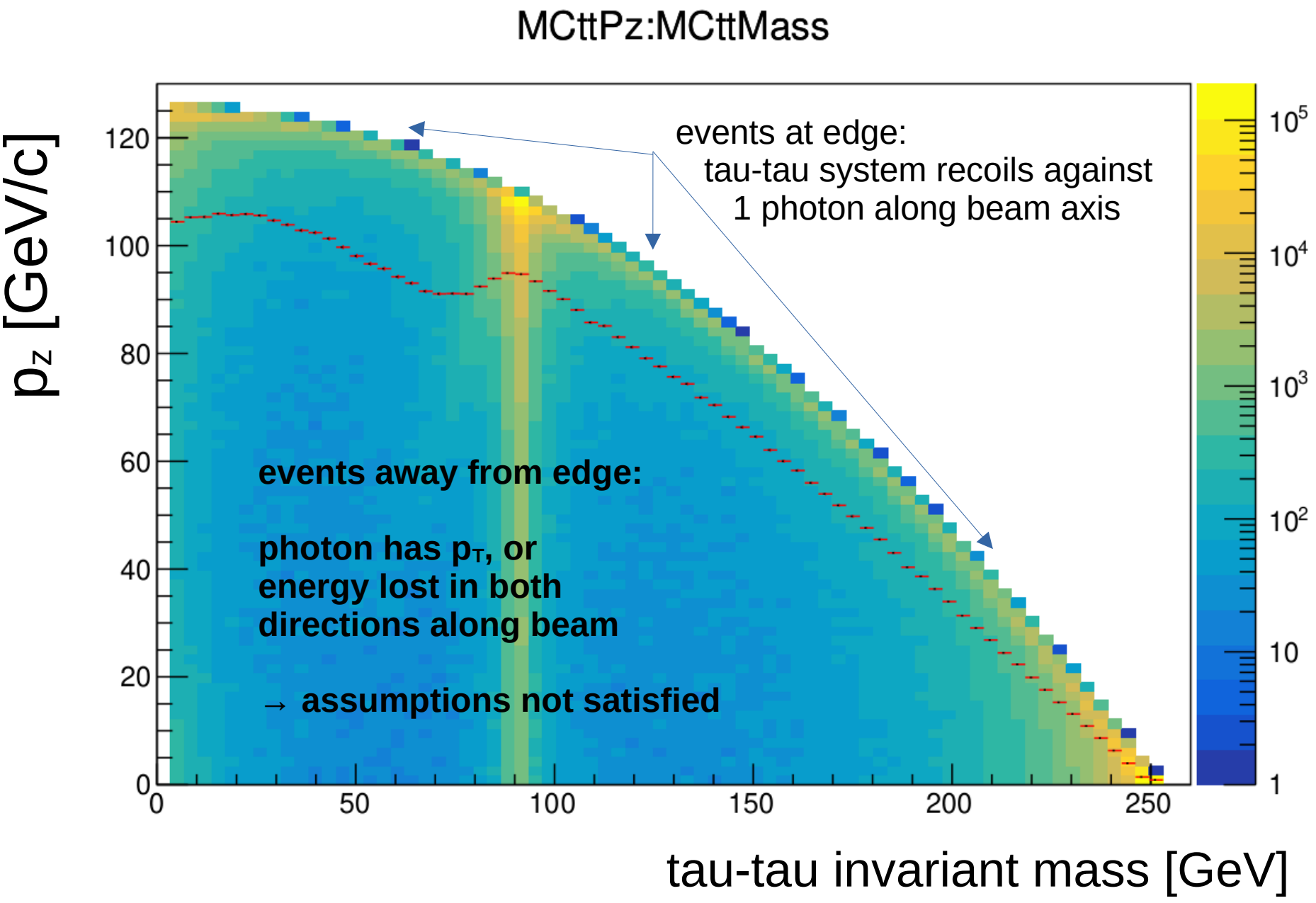


efficiency



non-trivial dependence on p_z

then I made this plot:



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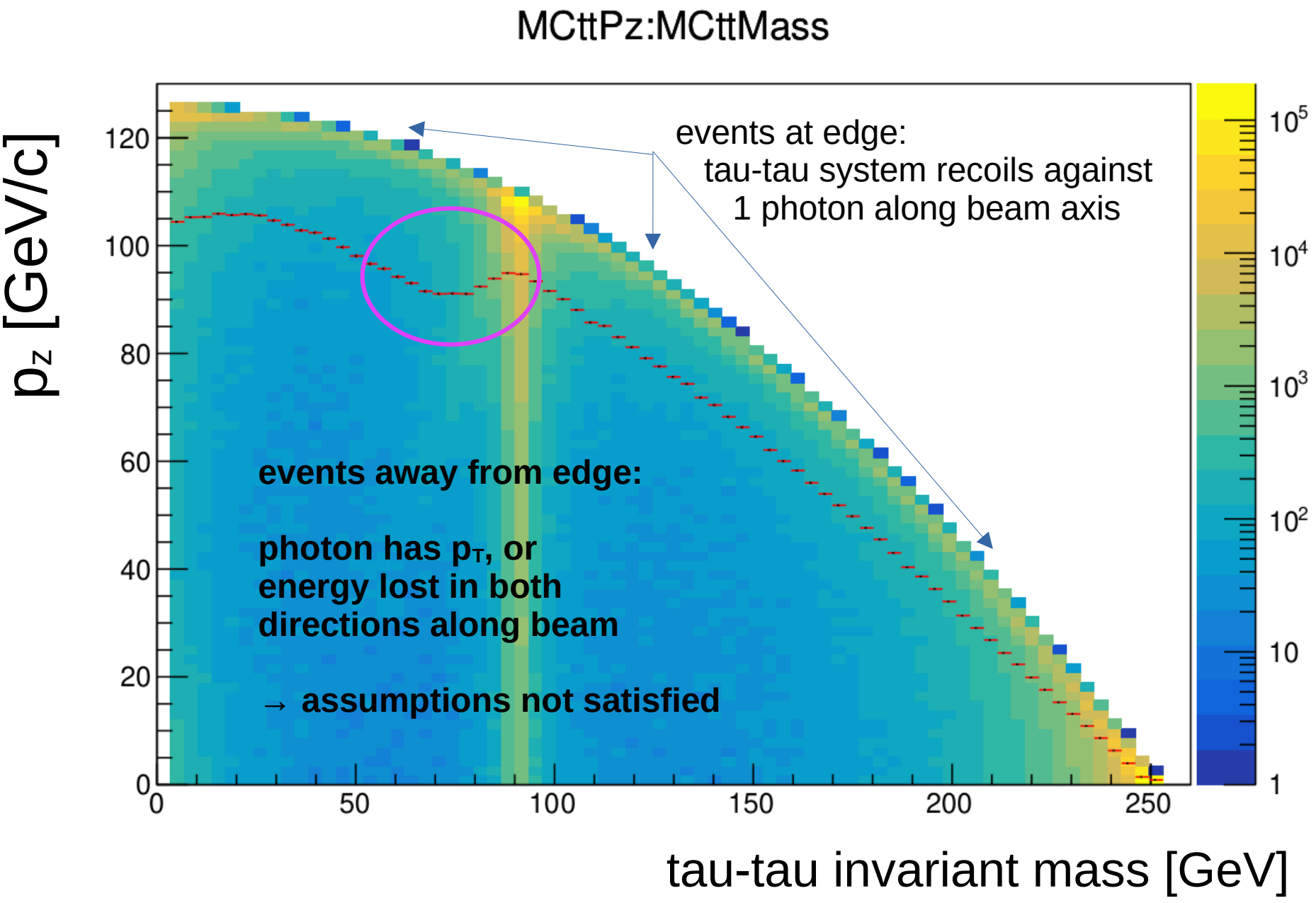
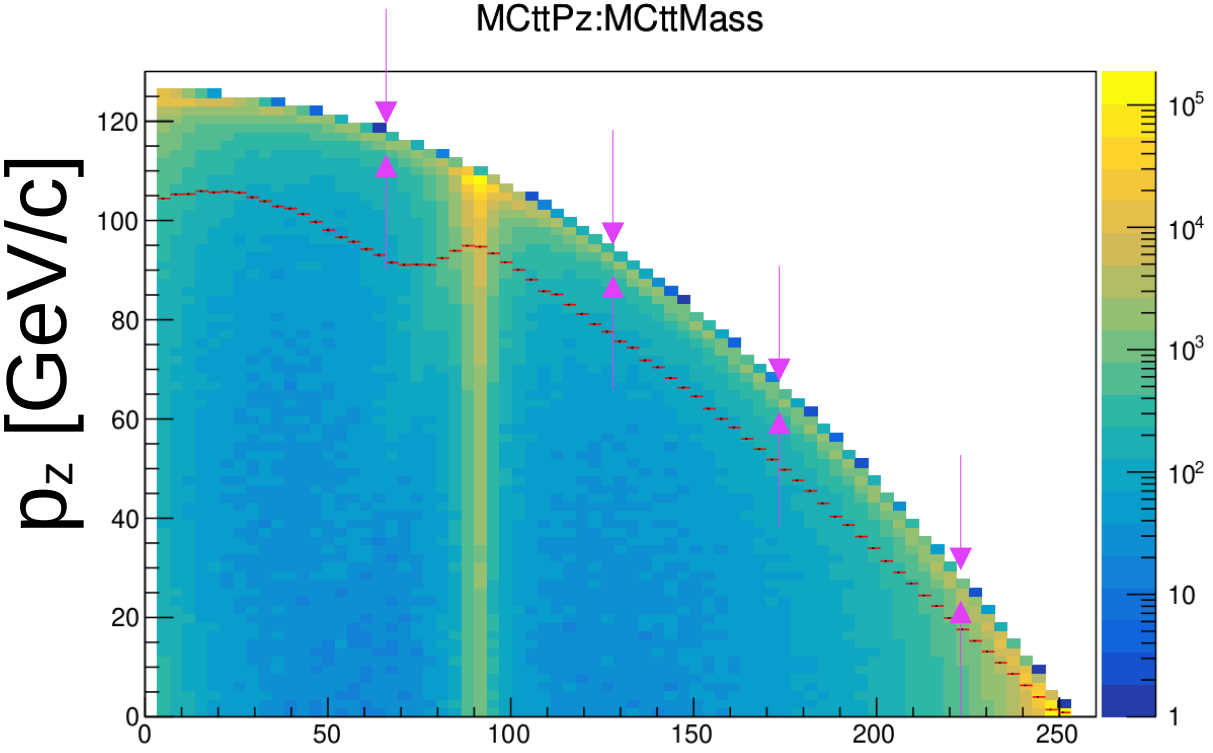
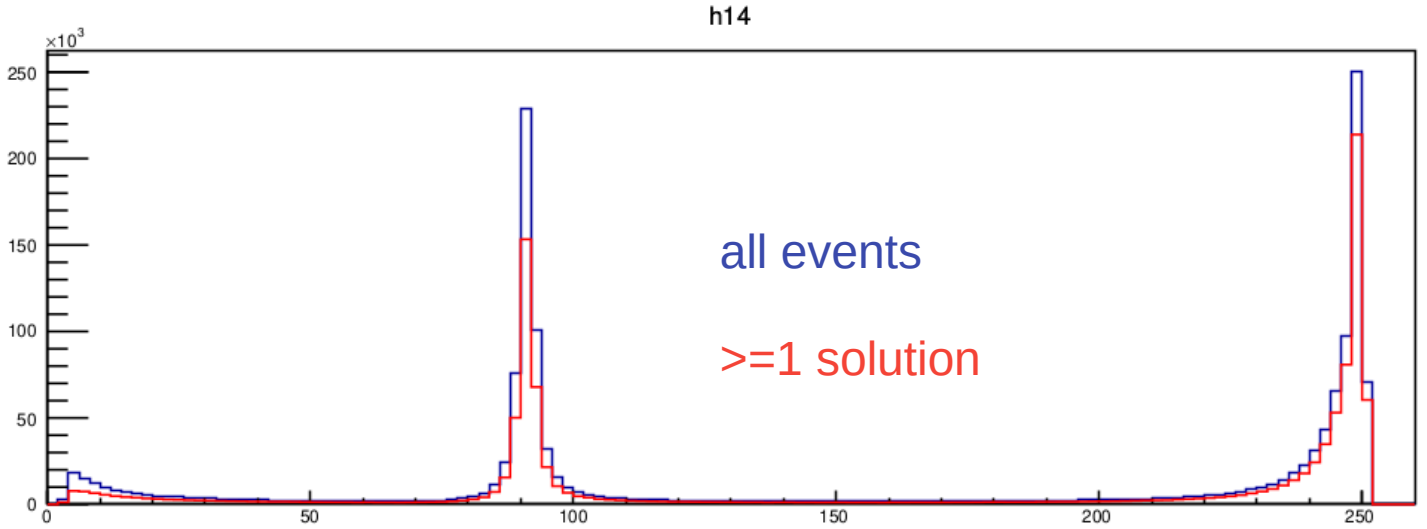




select events along the kinematic edge
(within 5 GeV of nominal position)

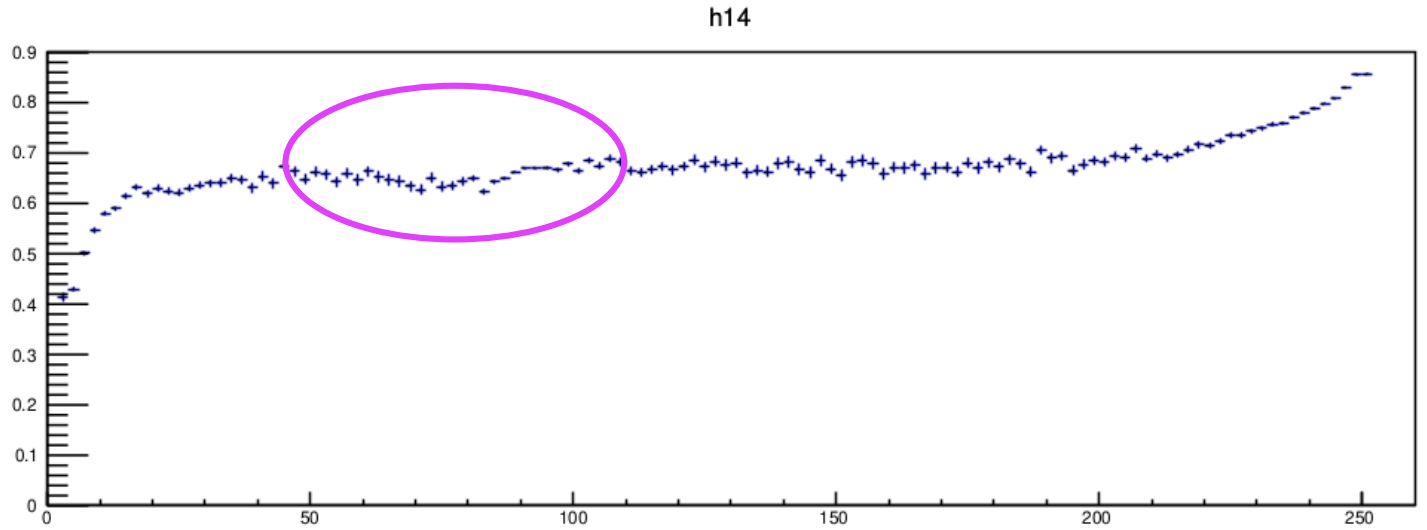
selecting events with tau-tau p_Z within 5 GeV of expected value,
assuming 1 collinear ISR photon, ECM=250 and tautau mass

events

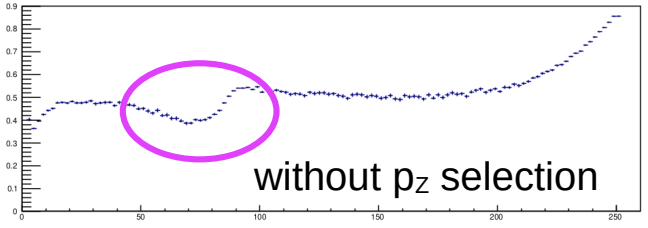


tau-tau invariant mass [GeV]

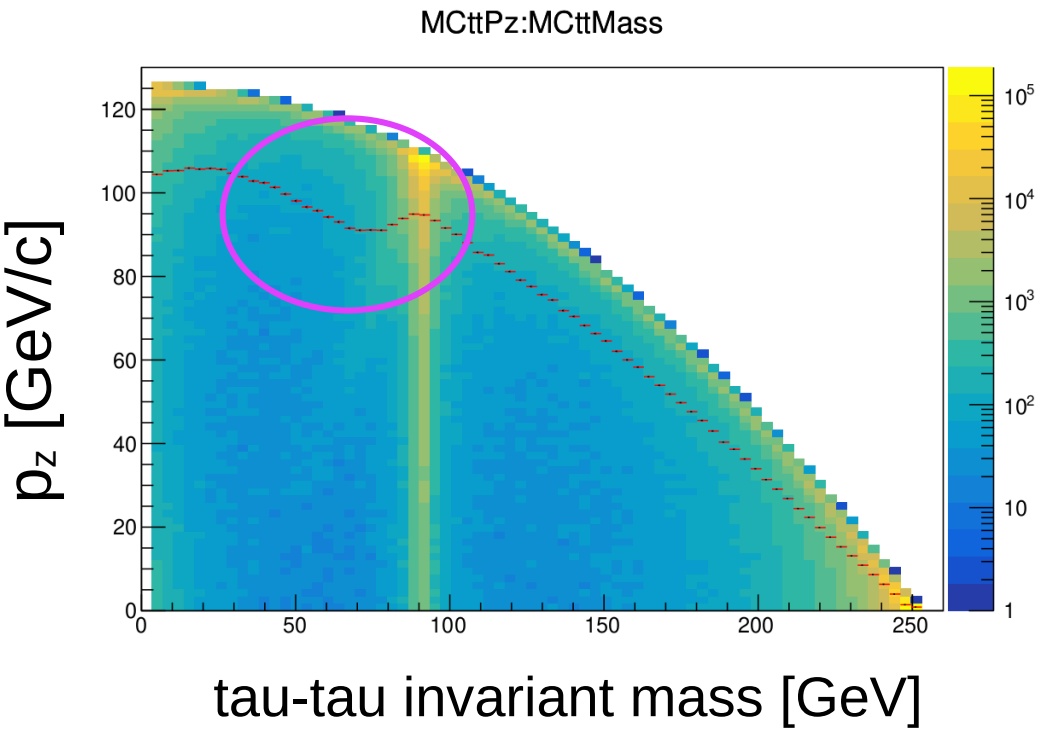
efficiency

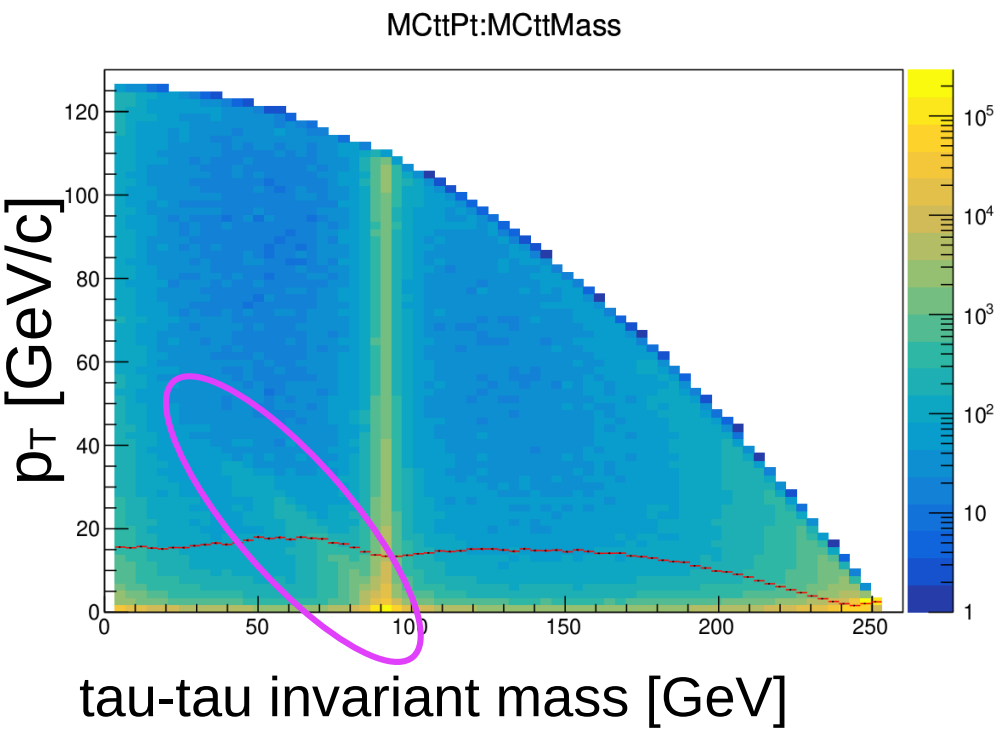


tau-tau invariant mass



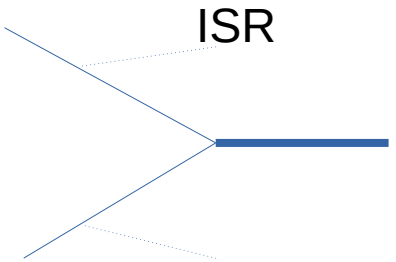
so I think this is the reason for inefficiency



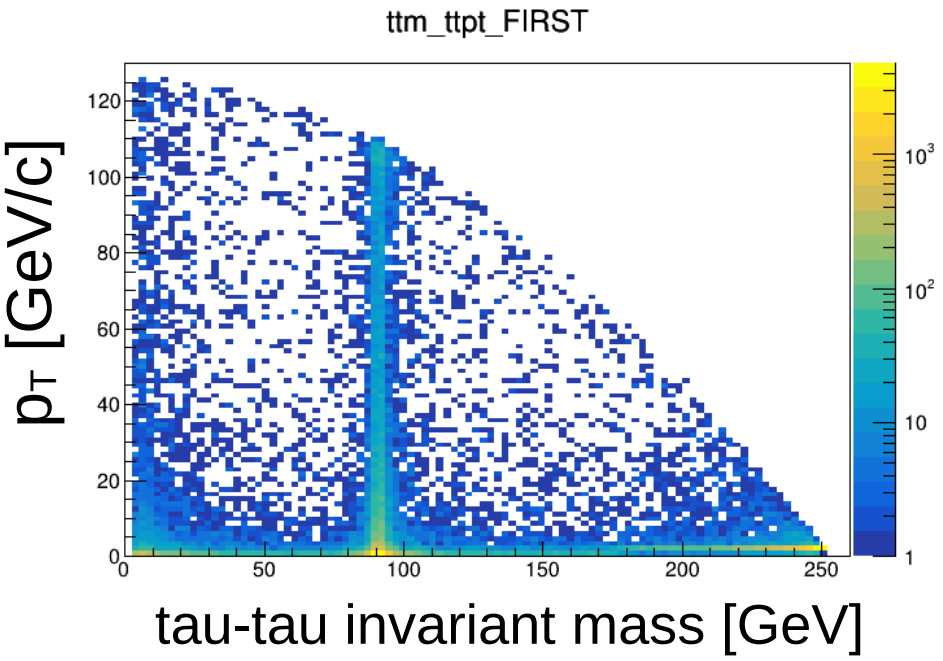


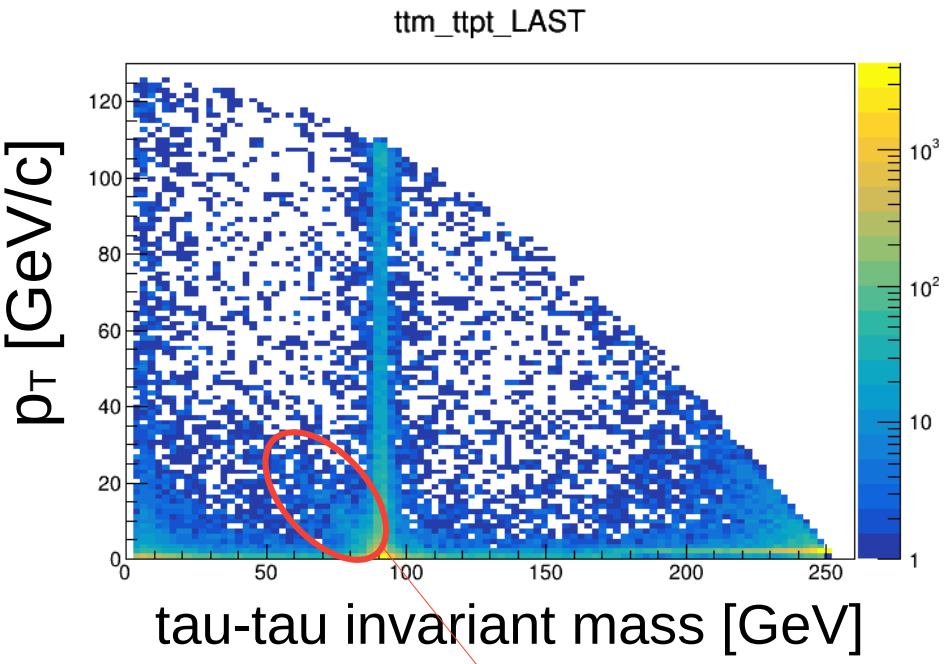
but I don't understand **why** the
average p_Z and p_T has such a strange feature
around m_Z

something to do with ISR? is it real?
or due to ISR modeling?



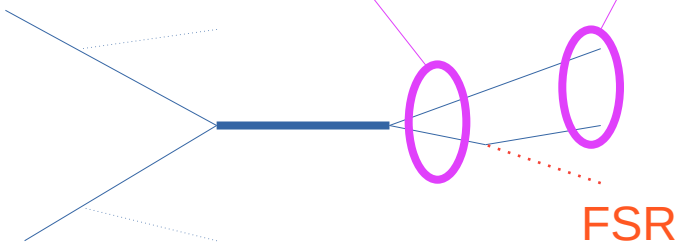
UPDATE: last night I finally understood





before FSR

after FSR



Z produced on-shell
significant FSR
→ tau-tau inv. mass < m_Z

need to think about how to deal with FSR.

if included in tau jet, tau mass constraint not satisfied

Probably not trivial, unless we can cleanly identify FSR photon → difficult…?

mystery solved !

need to think about how to deal with FSR

- try to identify and veto large-FSR events?
- try to make use of them properly?