



HF jets analysis

15.09.2020 ALICE@IFJ meeting

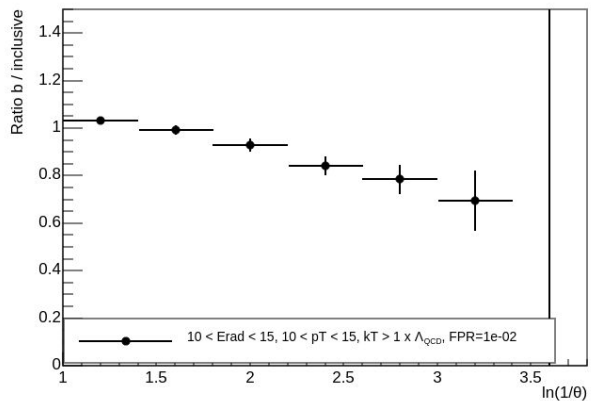
Sebastian Bysiak

Outline

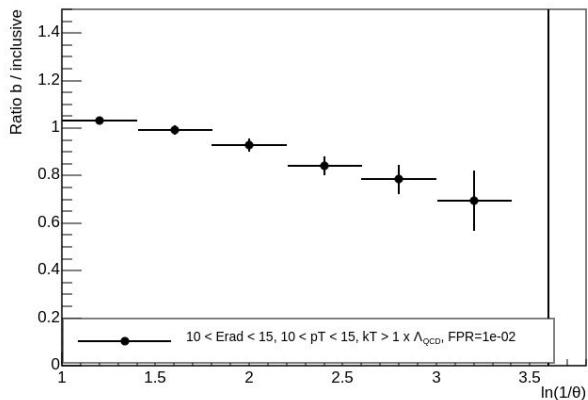


1. Dead-cone in data
2. Dead-cone in MC & bias from MC correction

$$10 < E_{\text{radiator}} < 15$$

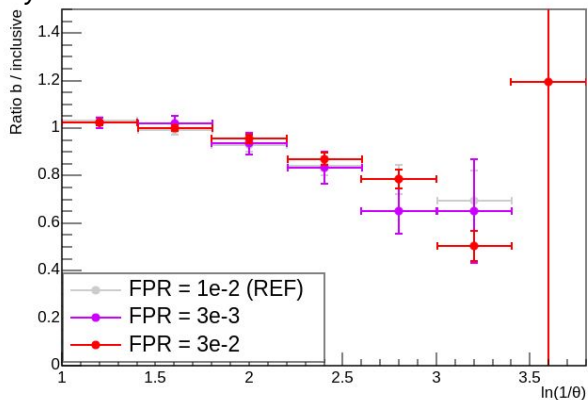


$$10 < E_{\text{radiator}} < 15$$

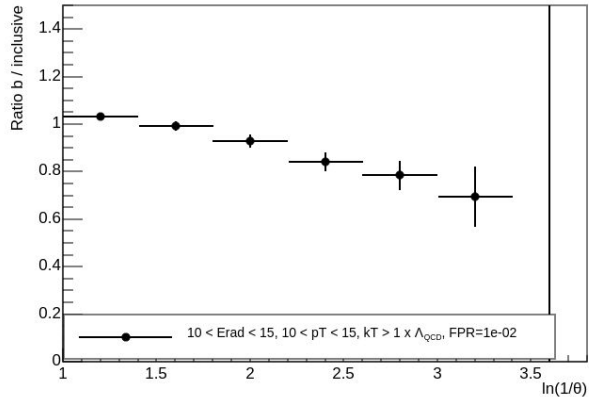


FPR
x 3
x 0.3

ideally no difference

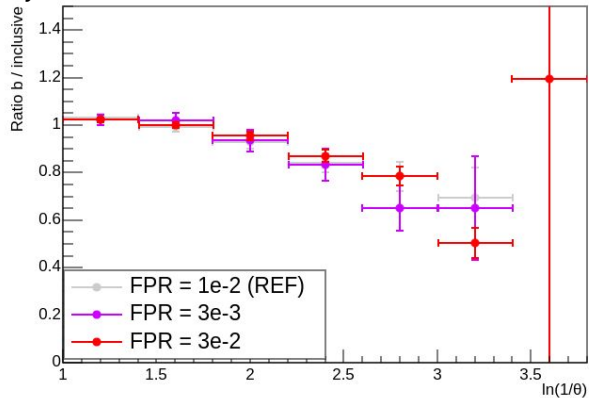


$$10 < E_{\text{radiator}} < 15$$

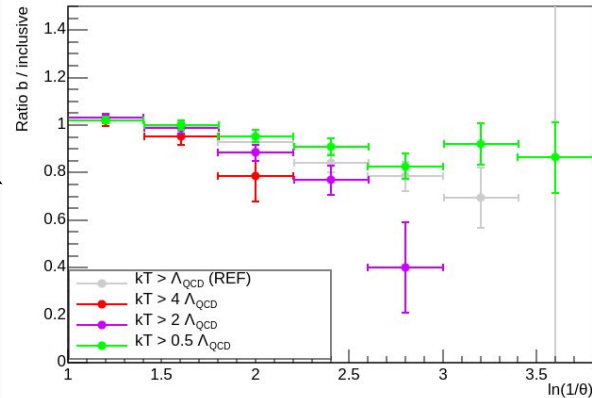


FPR
x 3
x 0.3

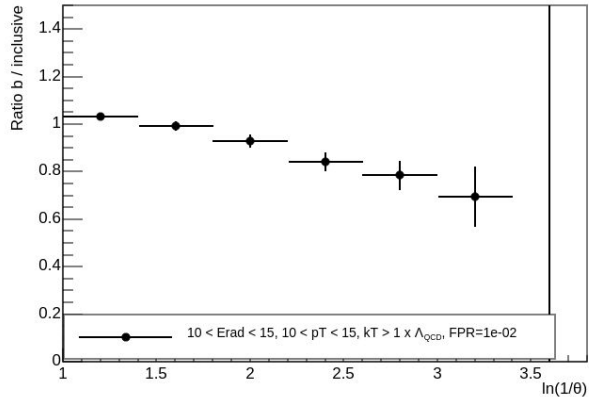
ideally no difference



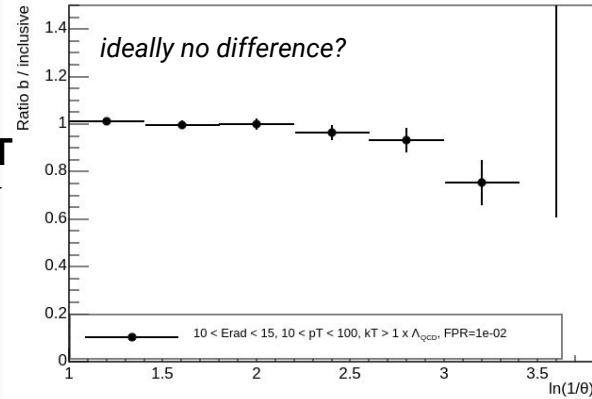
kT
x 0.5
x 2
x 4



$$10 < E_{\text{radiator}} < 15$$

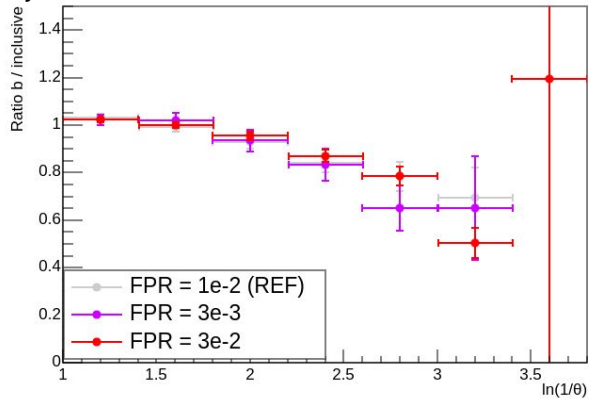


wider pT

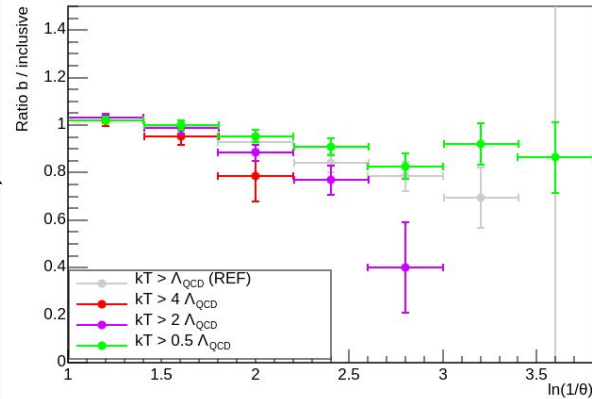


FPR
x 3
x 0.3

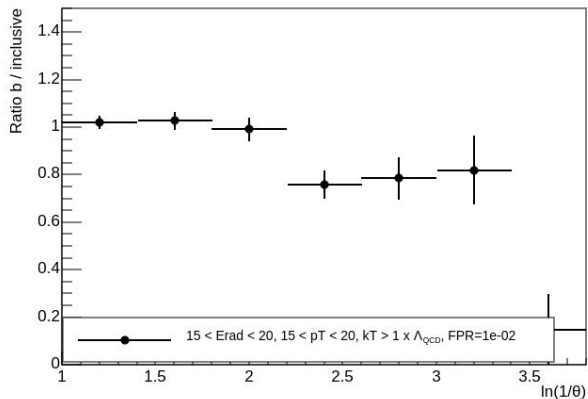
ideally no difference



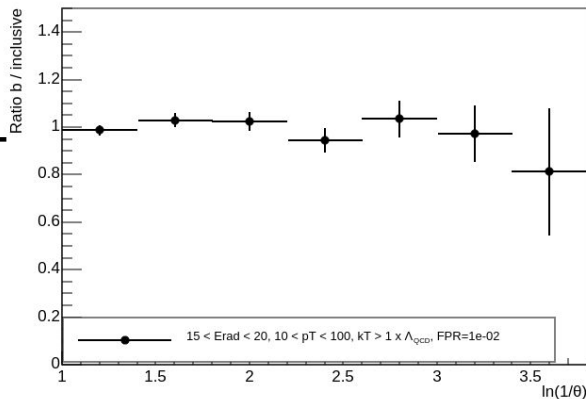
kT
x 0.5
x 2
x 4



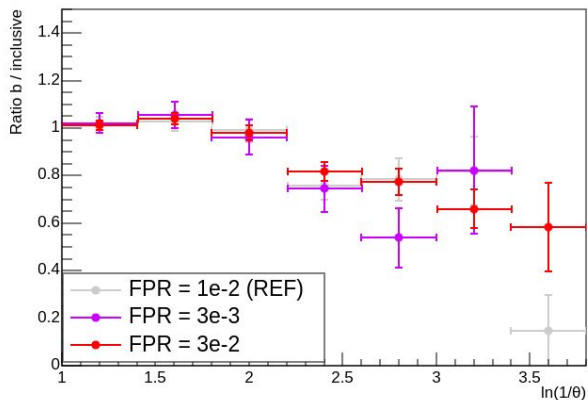
$$15 < E_{\text{radiator}} < 20$$



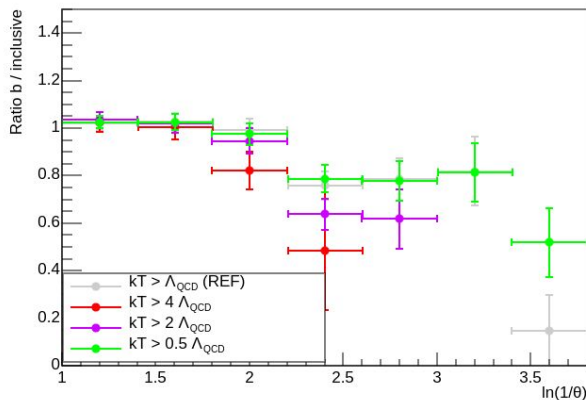
wider pT



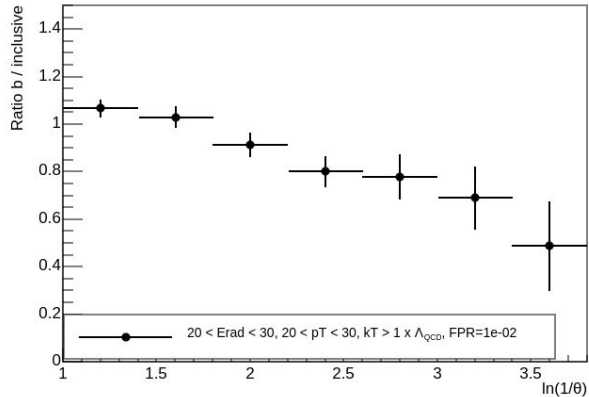
FPR
x 3
x 0.3



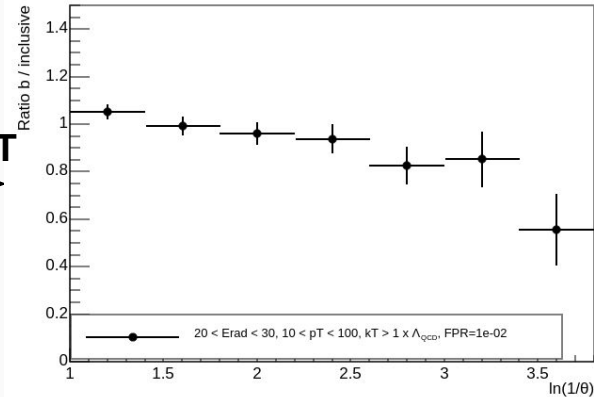
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x 0.5
x 2
x 4



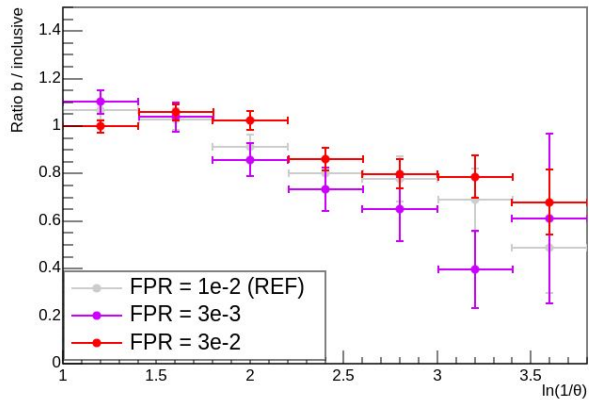
$20 < E_{\text{radiator}} < 30$



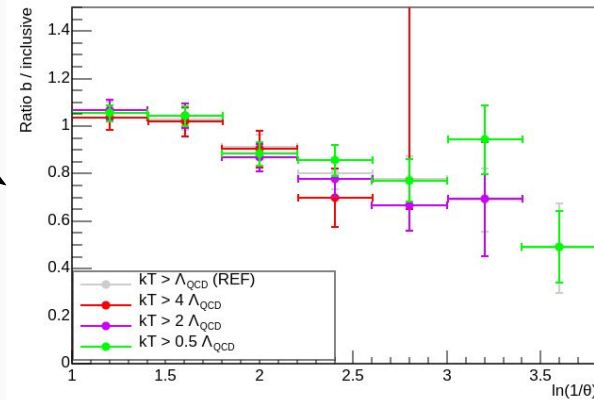
wider pT



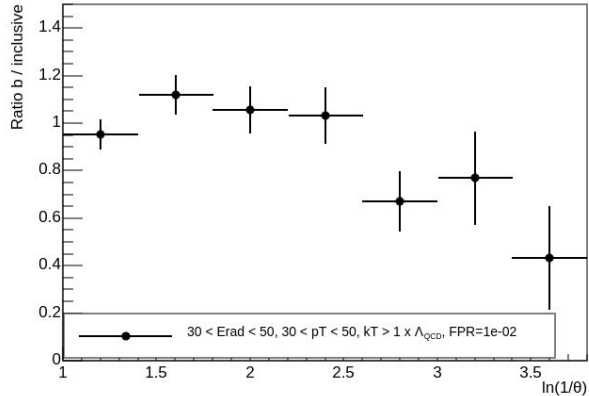
FPR
x 3
x 0.3



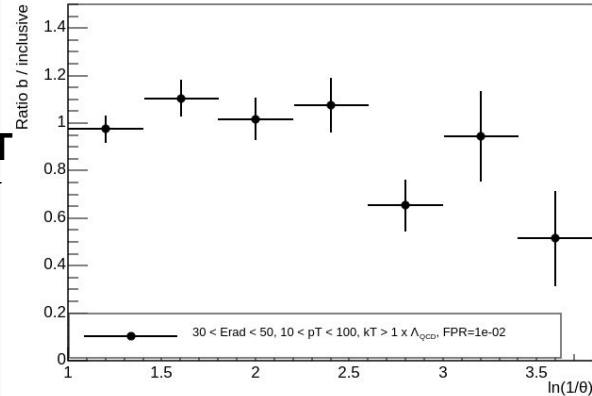
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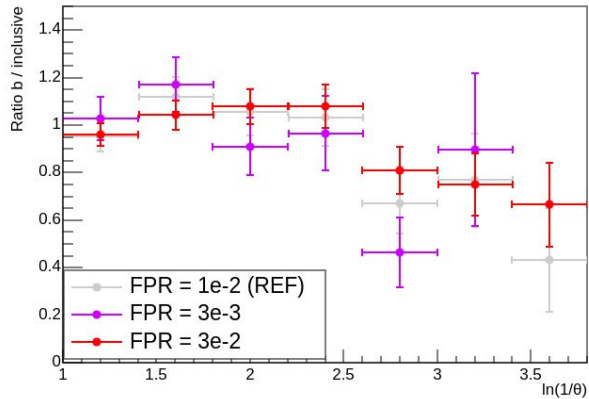
$30 < E_{\text{radiator}} < 50$



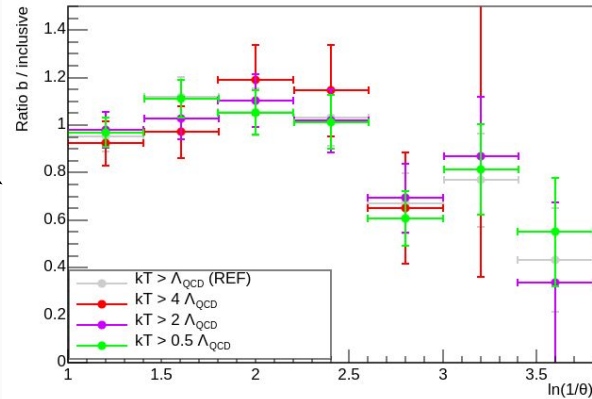
wider pT



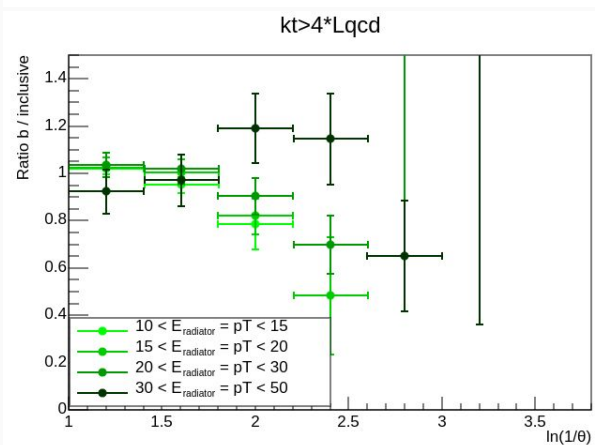
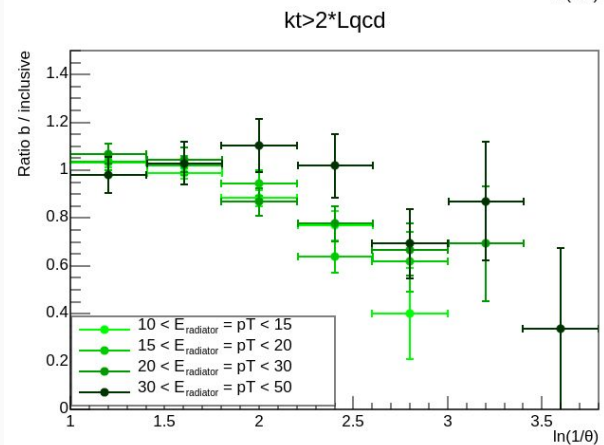
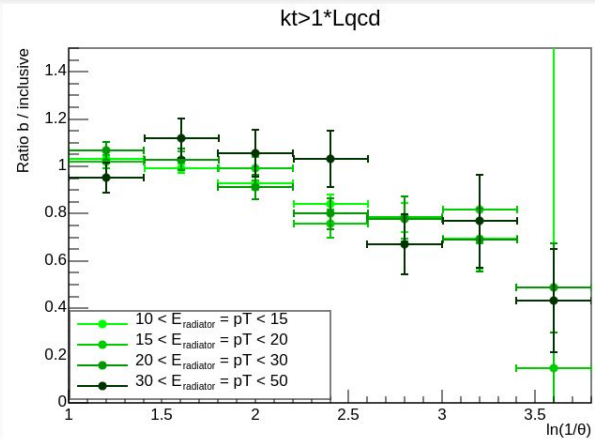
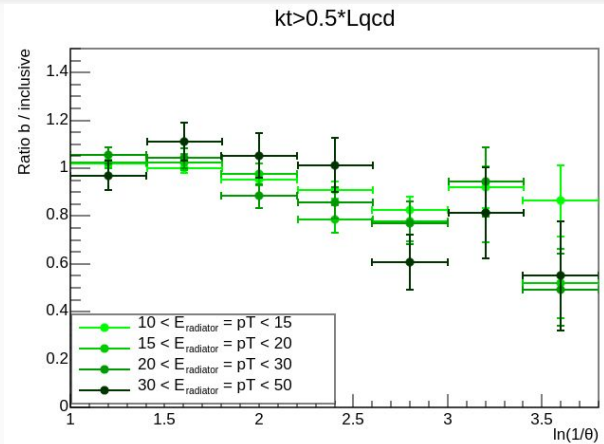
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x 0.3



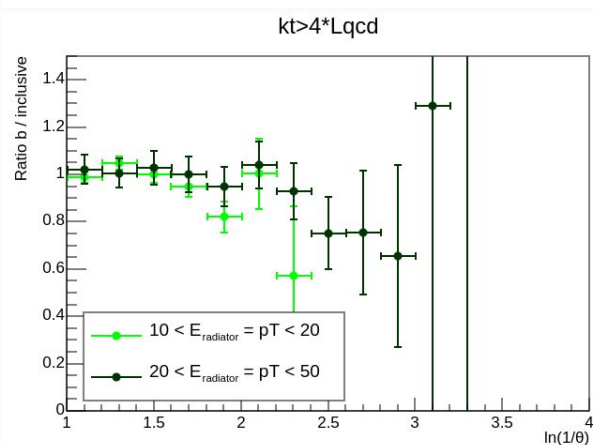
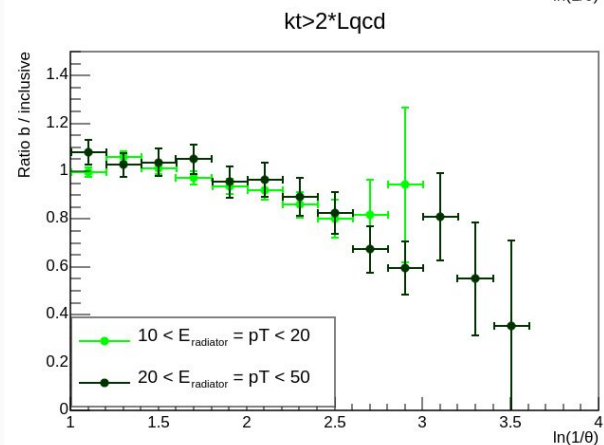
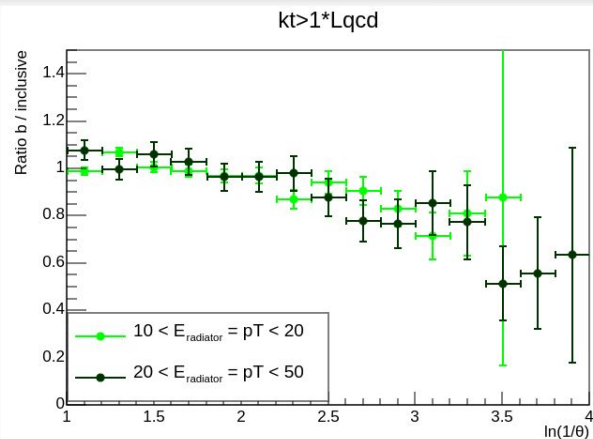
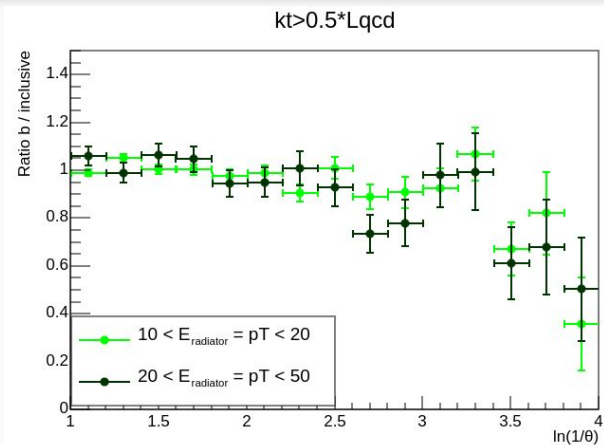
kT
x 0.5
x 2
x 4



E_{radiator} compared



E_{radiator} compared



- differences due to jet p_T
- (too large) variations due to changes of model score threshold
- kT cut works as expected
(i.e. improves quality / significance, reduces statistics)
- no systematic change with E_{rad} , besides cut-off θ

Consider random classifier, which predicts random score for each jet

Raw ratio $b_{\text{RAW}} / \text{inclusive}$ will be completely flat in data.

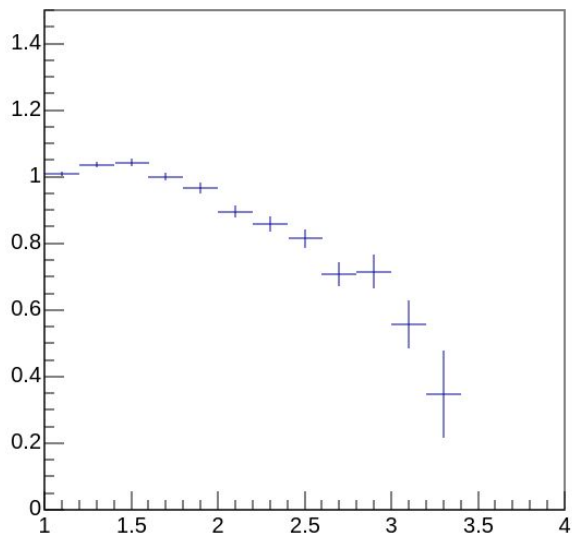
MC correction ($b_{\text{MC-true}} / b_{\text{MC-tagged}}$) will be equal to $b_{\text{MC-true}} / \text{inclusive}$

$$\begin{aligned} \text{Final ratio} &= b_{\text{RAW}} * (b_{\text{MC-true}} / b_{\text{MC-tagged}}) / \text{inclusive} = \\ &= (b_{\text{MC-true}} / \text{inclusive}) * b_{\text{RAW}} / \text{inclusive} = \\ &= b_{\text{MC-true}} / \text{inclusive} \end{aligned}$$

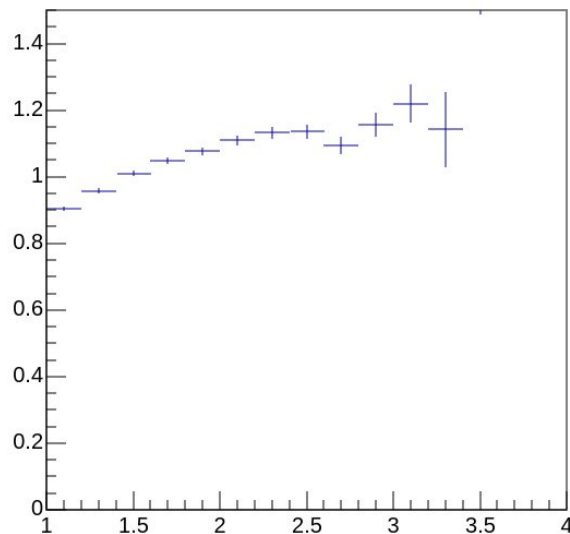
In my case contamination is $\sim 30\text{-}70\%$

PYTHIA: same E_{rad} , different jet p_T

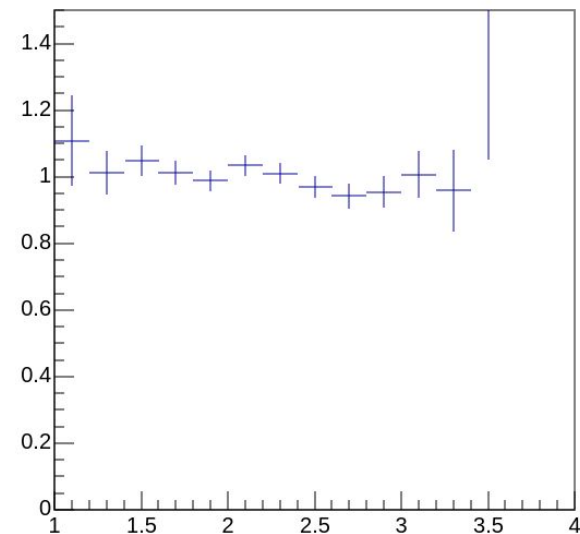
PYTHIA $p_T < 10 < \text{Jet}_T < 15$, $10 < E_{\text{rad}} < 15$, $k_T > 1 \Lambda_{\text{QCD}}$



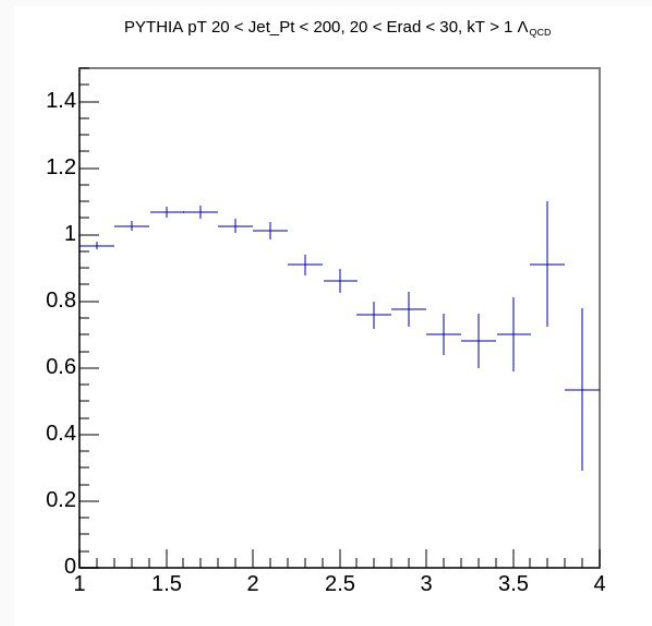
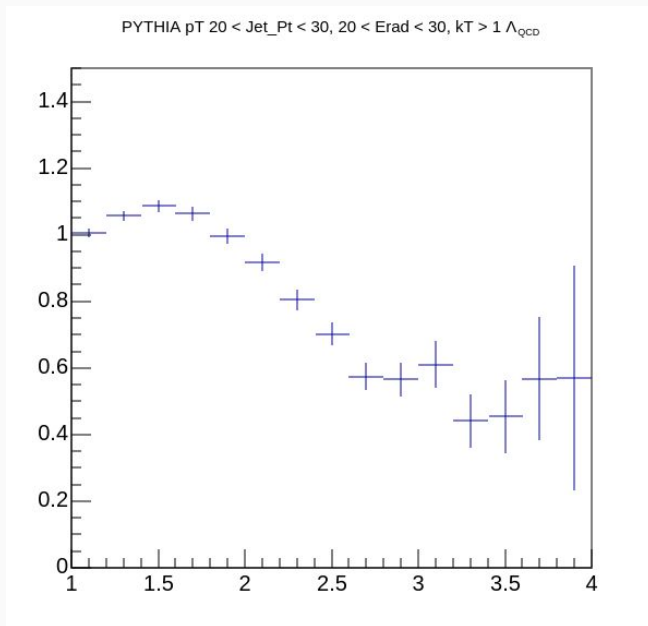
PYTHIA $p_T < 10 < \text{Jet}_T < 150$, $10 < E_{\text{rad}} < 15$, $k_T > 1 \Lambda_{\text{QCD}}$



PYTHIA $p_T < 20 < \text{Jet}_T < 150$, $10 < E_{\text{rad}} < 15$, $k_T > 1 \Lambda_{\text{QCD}}$



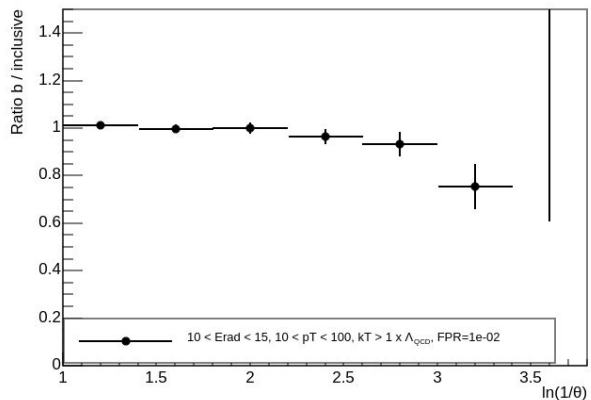
PYTHIA: same E_{rad} , different jet p_T



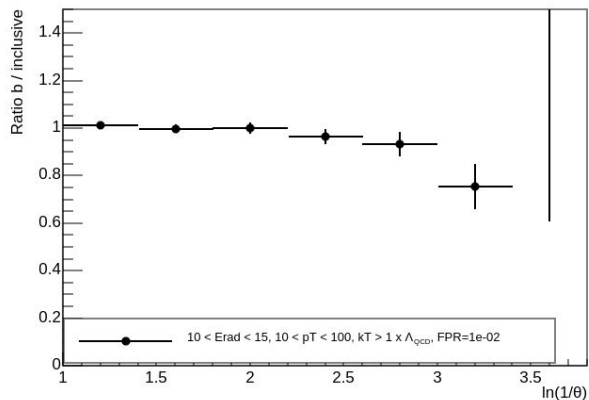
$10 < p_T < 100$



$$10 < E_{\text{radiator}} < 15$$

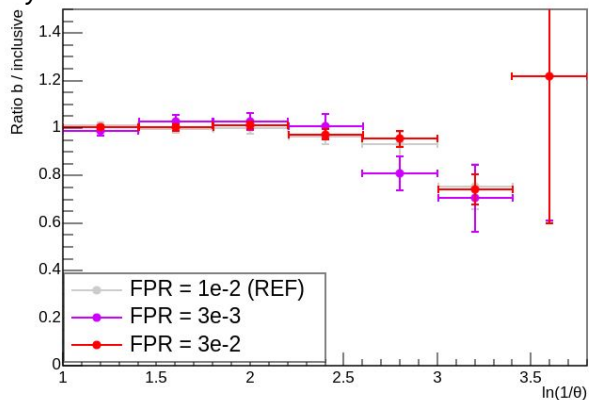


$$10 < E_{\text{radiator}} < 15$$

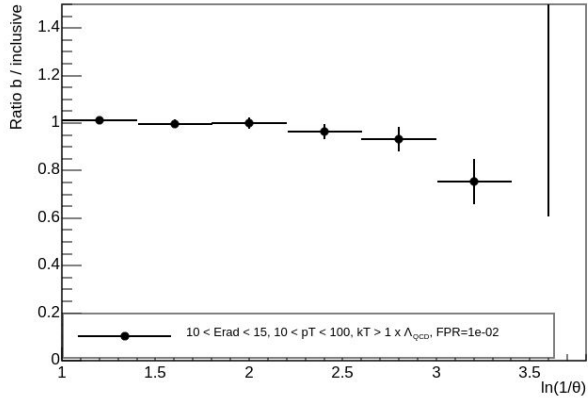


FPR
x 3
x 0.3

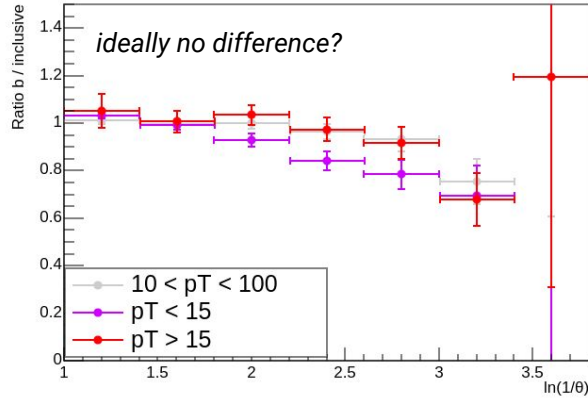
ideally no difference



$$10 < E_{\text{radiator}} < 15$$

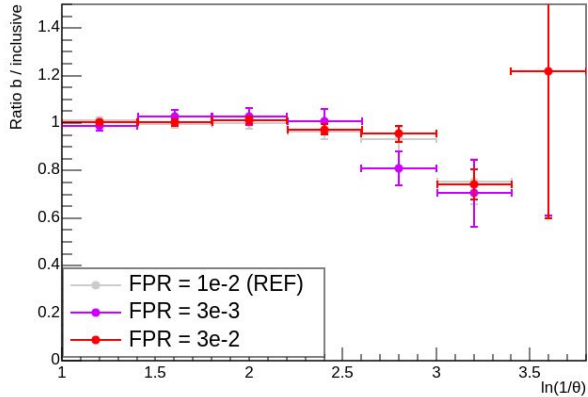


pT

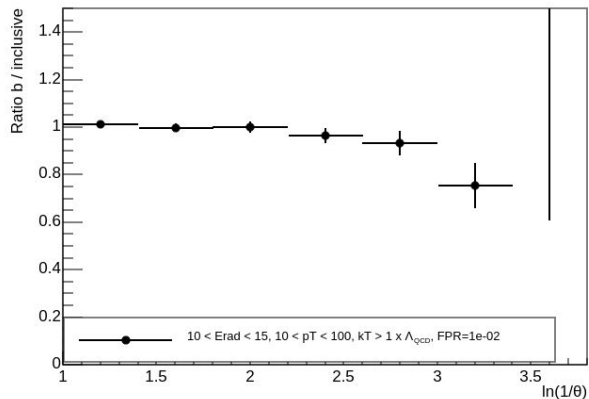


FPR
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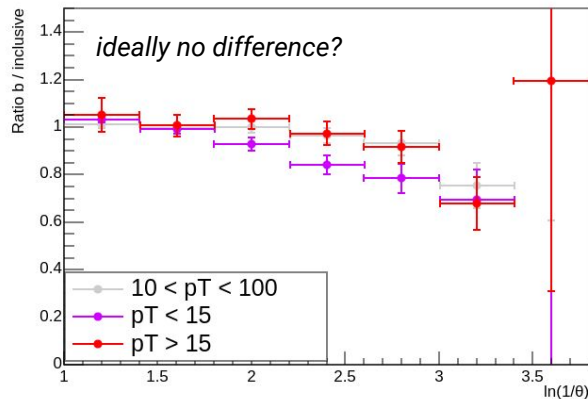
ideally no difference



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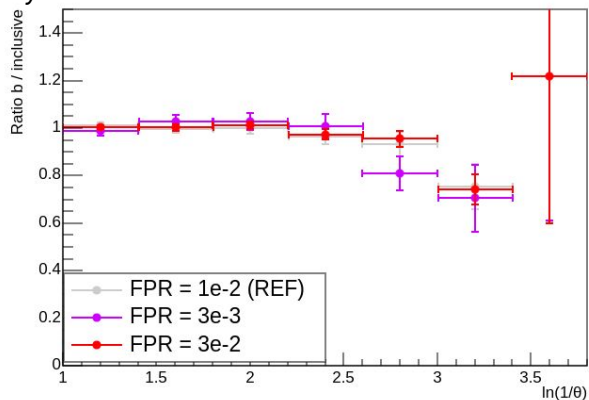


p_T

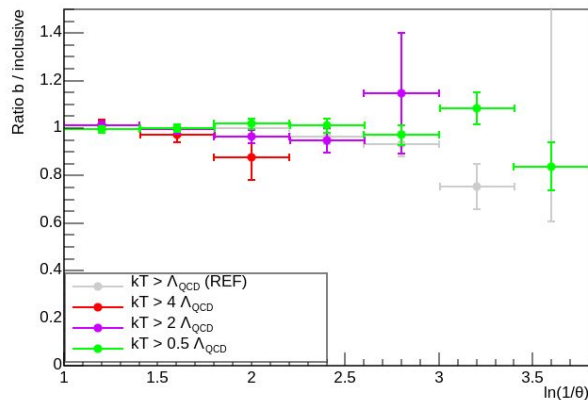


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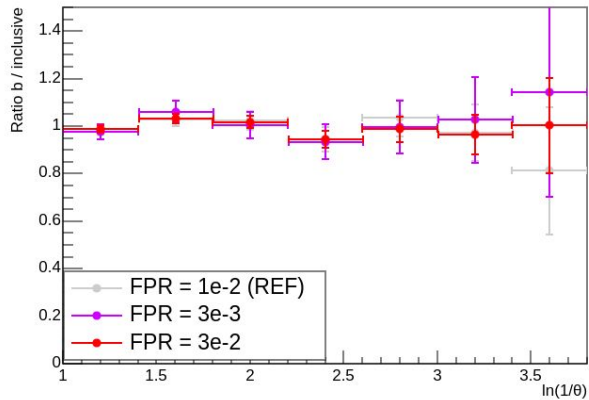
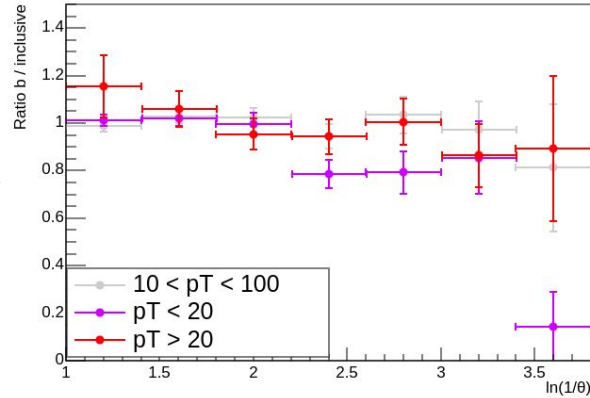
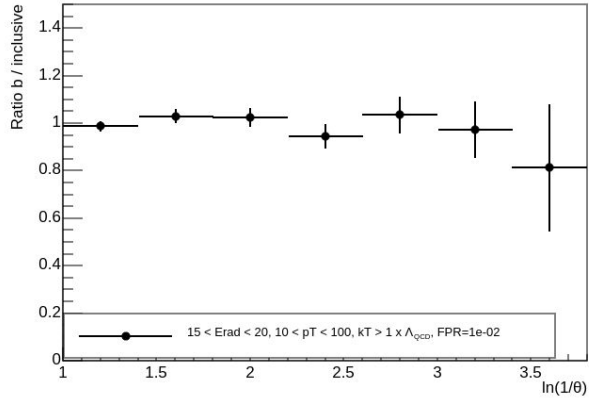
ideally no difference



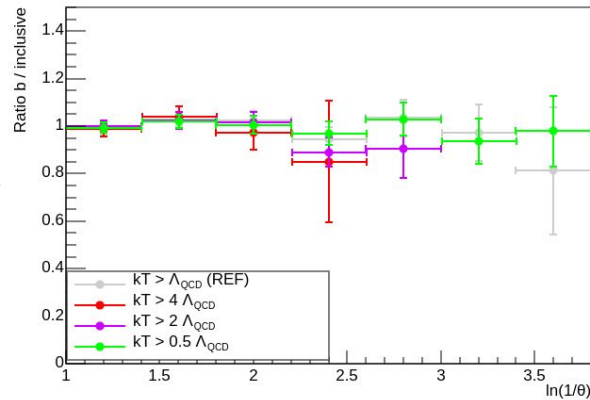
k_T
x 0.5
x 2
x 4



$$15 < E_{\text{radiator}} < 20$$



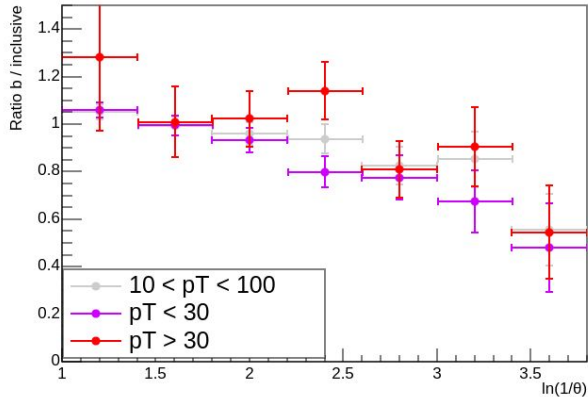
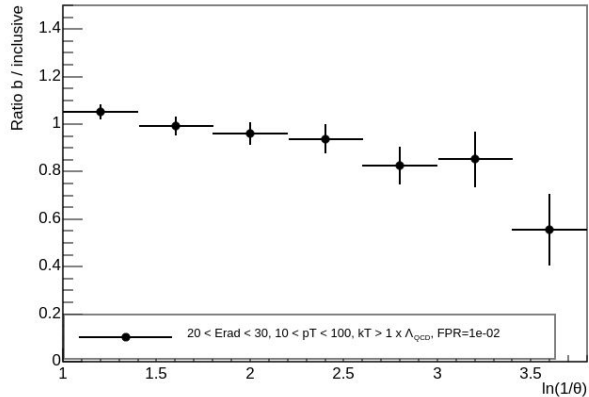
k_T
 $\times 0.5$
 $\times 2$
 $\times 4$



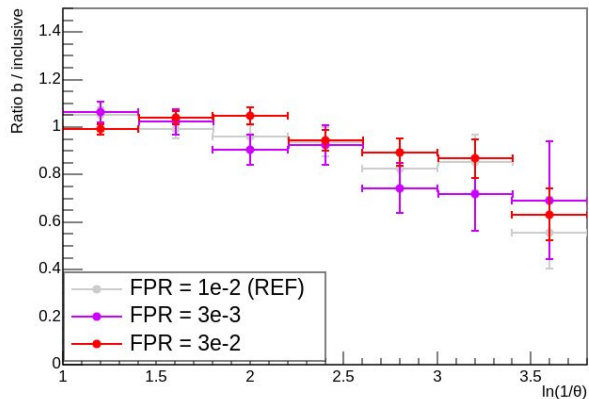
FPR
 $\times 3$
 $\times 0.3$

p_T

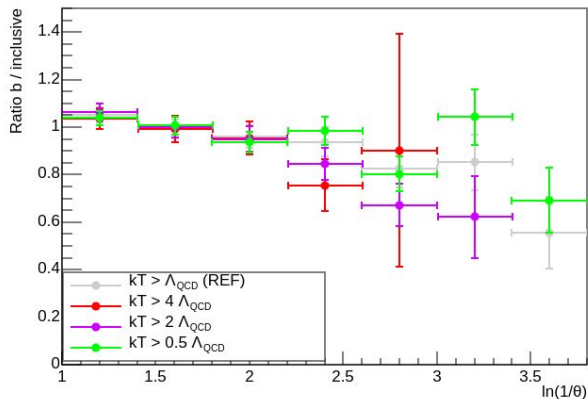
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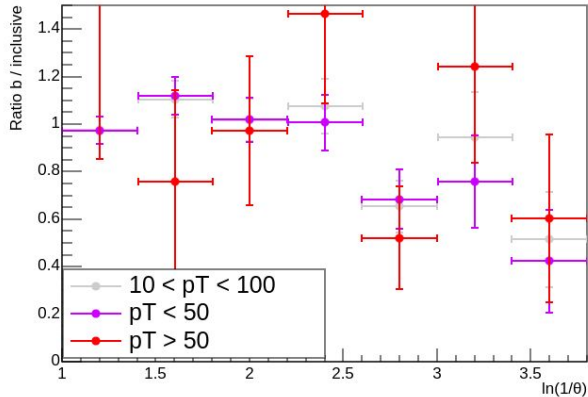
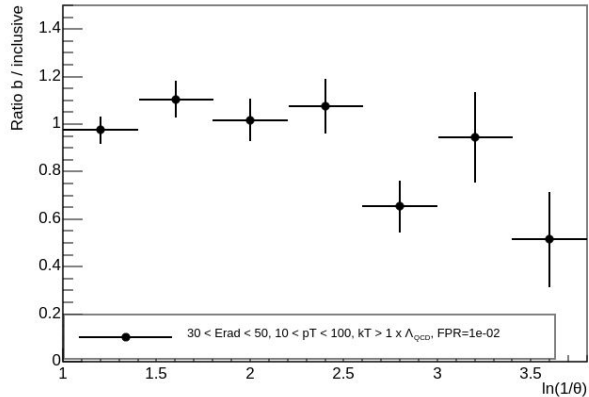


kT
 x 0.5
 x 2
 x 4

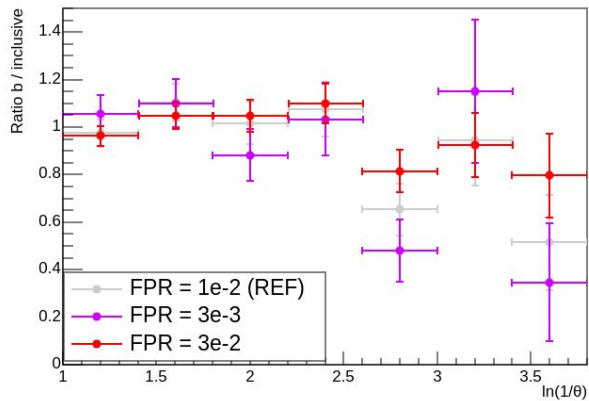


pT

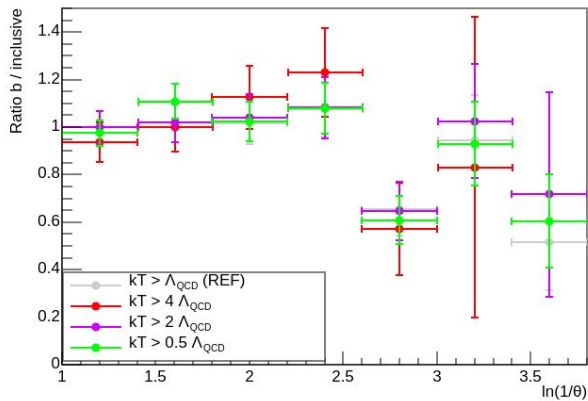
$30 < E_{\text{radiator}} < 50$

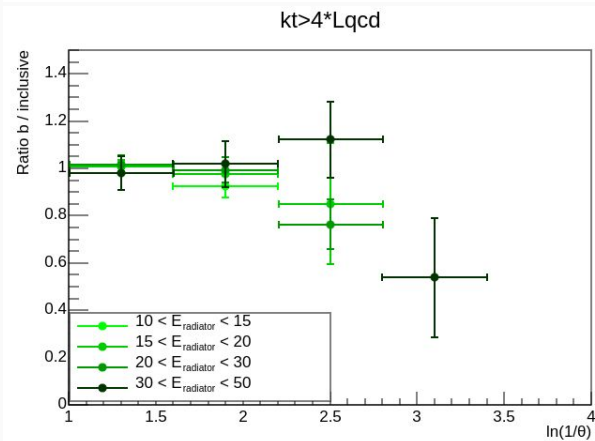
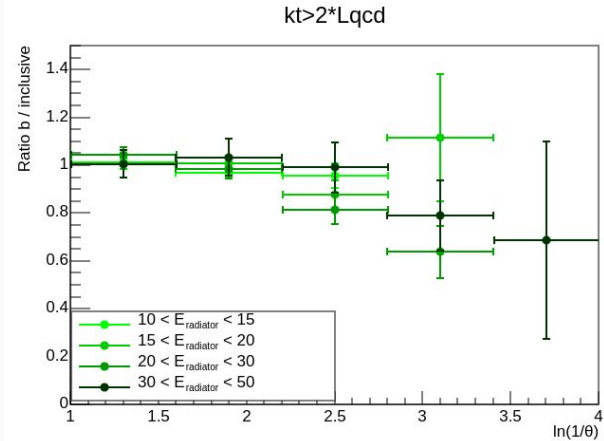
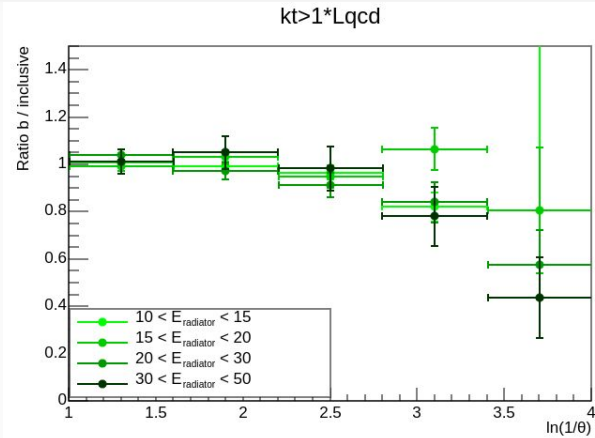
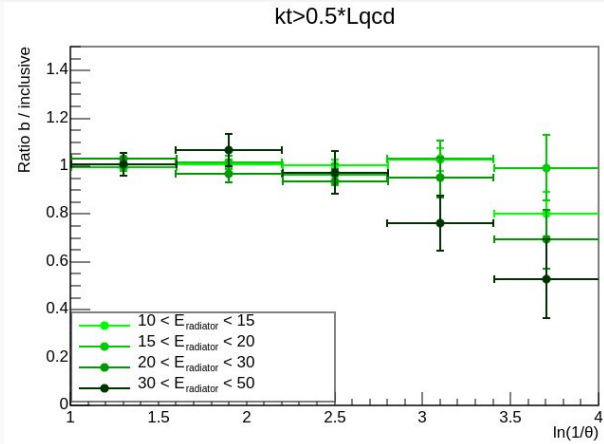


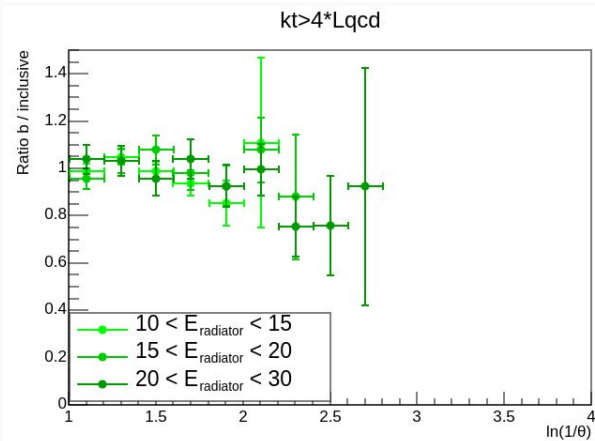
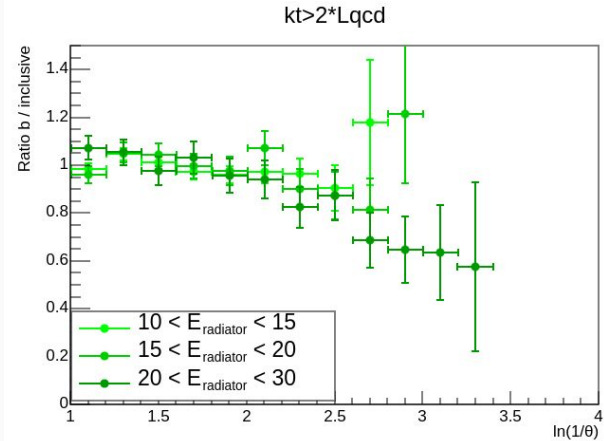
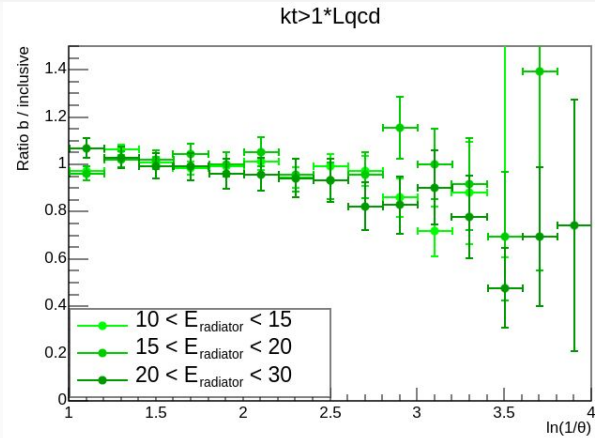
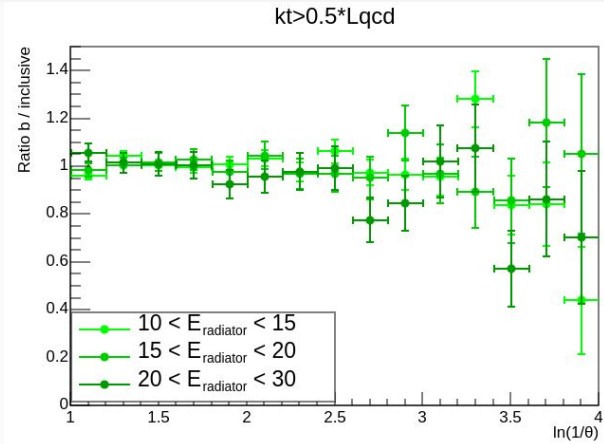
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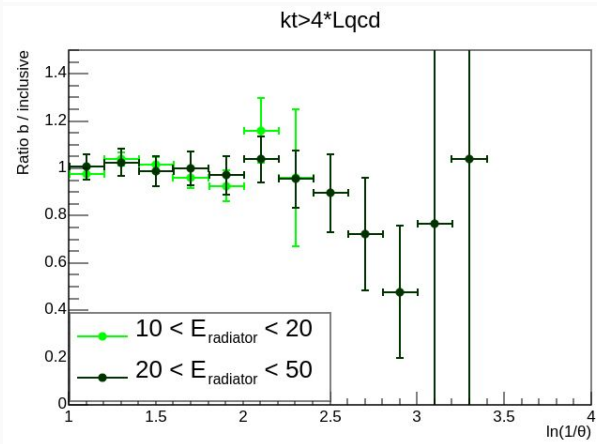
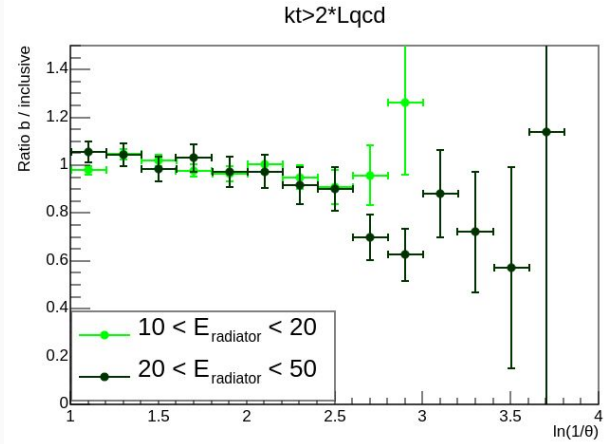
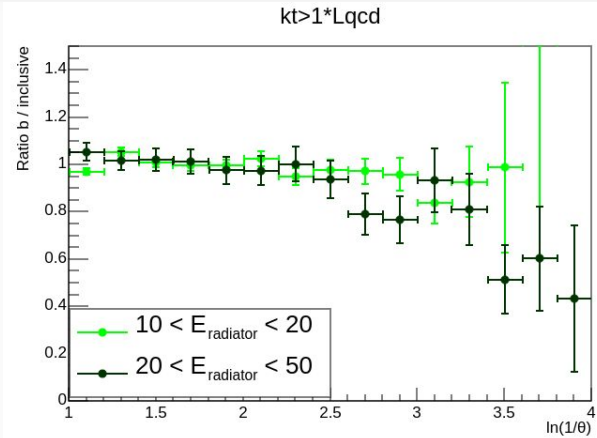
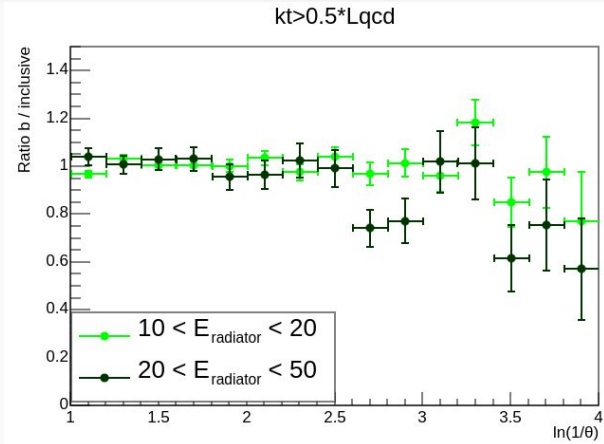


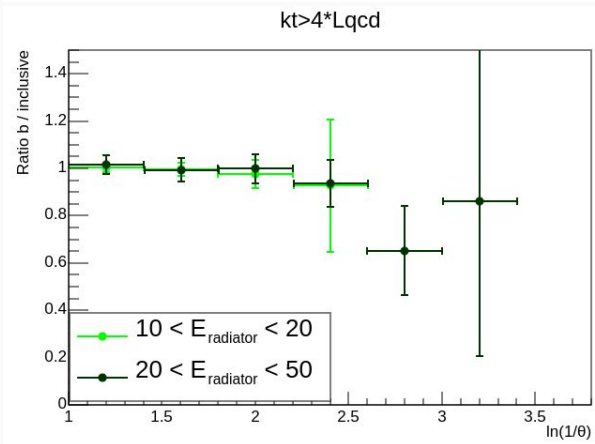
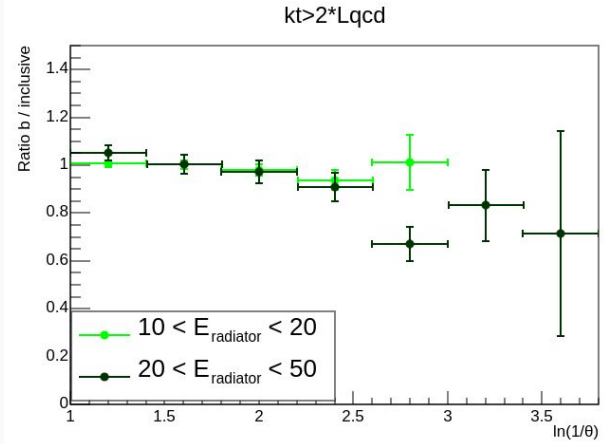
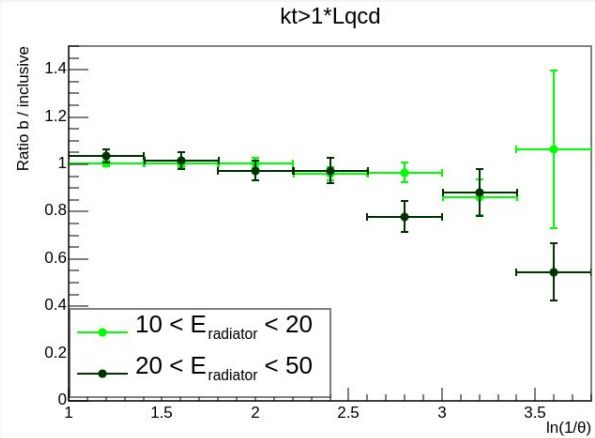
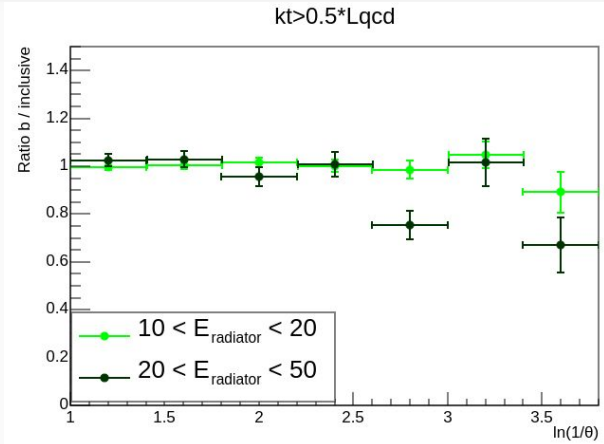
kT
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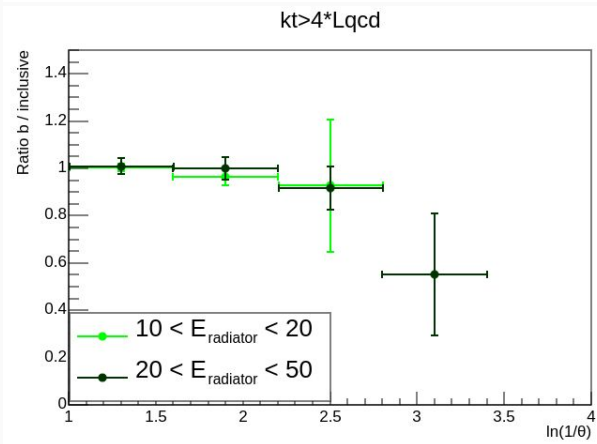
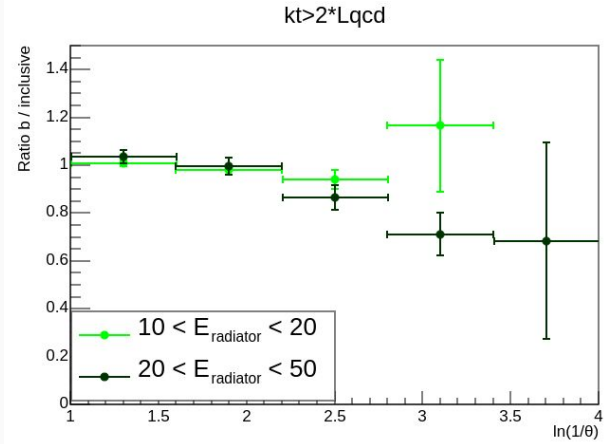
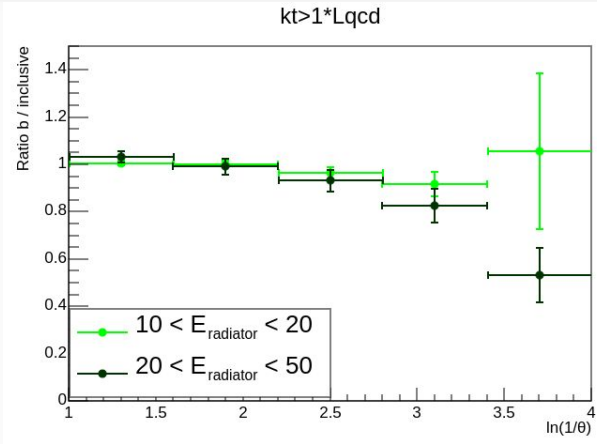
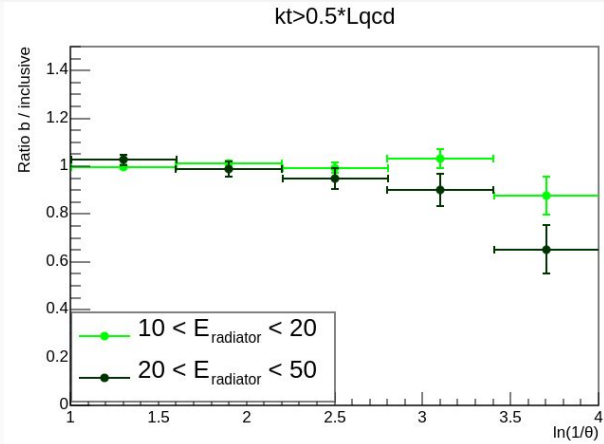










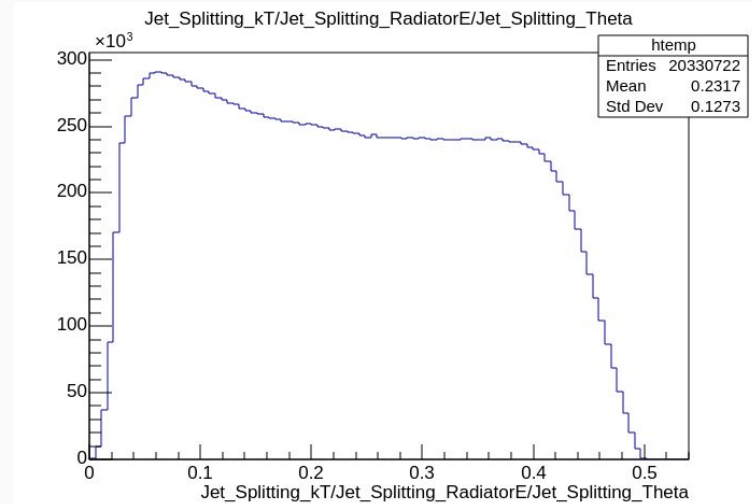
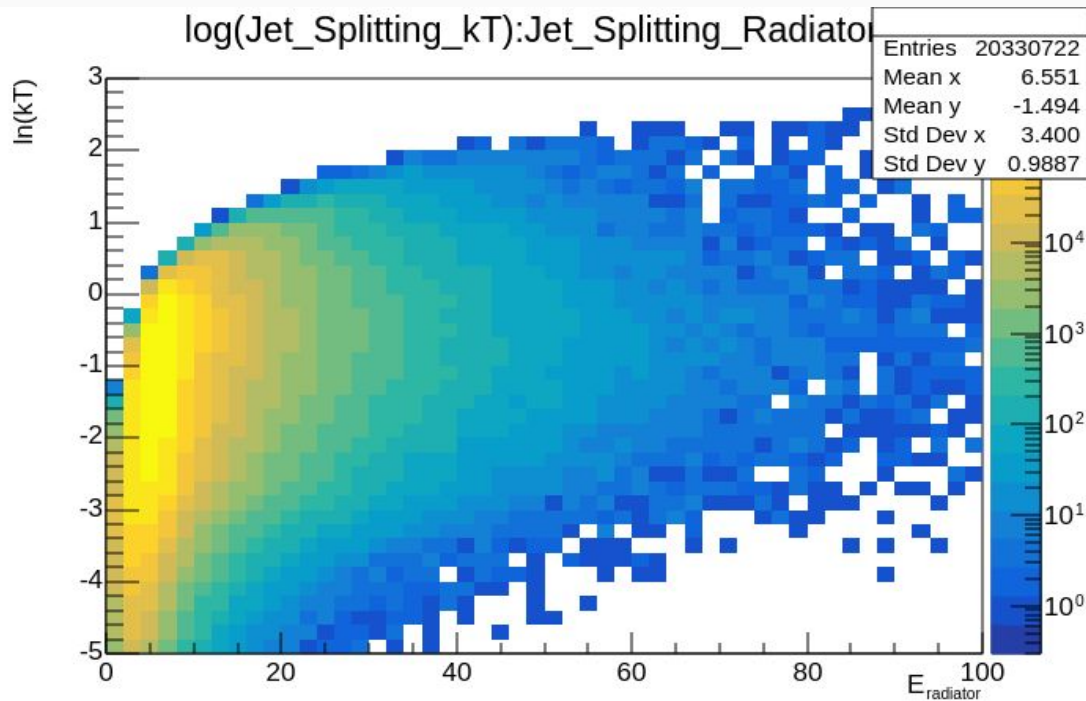


OLD

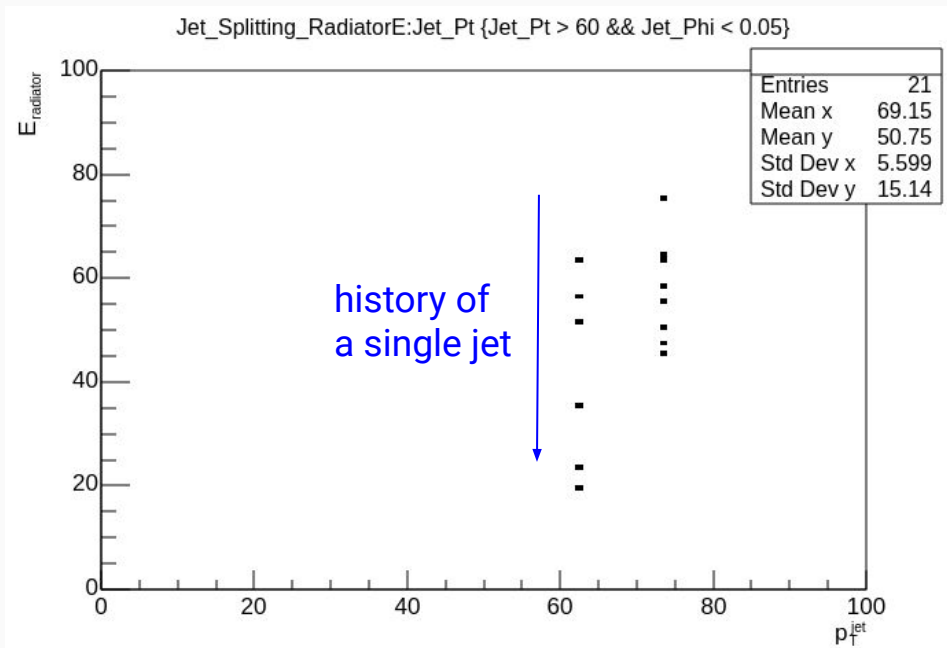
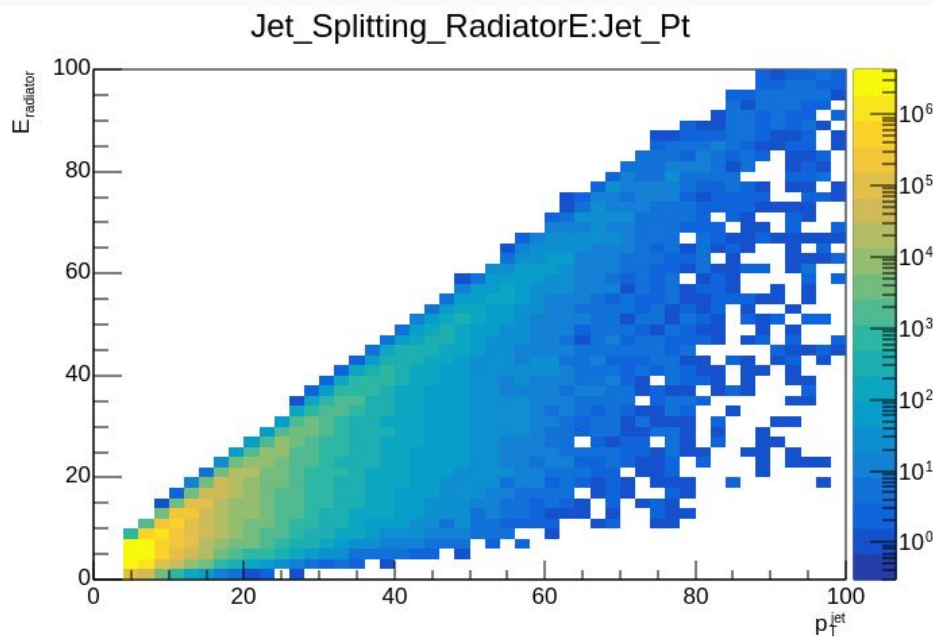


- jet p_T
 - splittings:
 - E_{rad} – emitting particle
 - θ – emission angle
 - kT – momentum of the emission transverse to emitter direction
 - z – fraction of emitter momentum carried by emission
- $$kT = E_{\text{rad}} * z * \theta$$

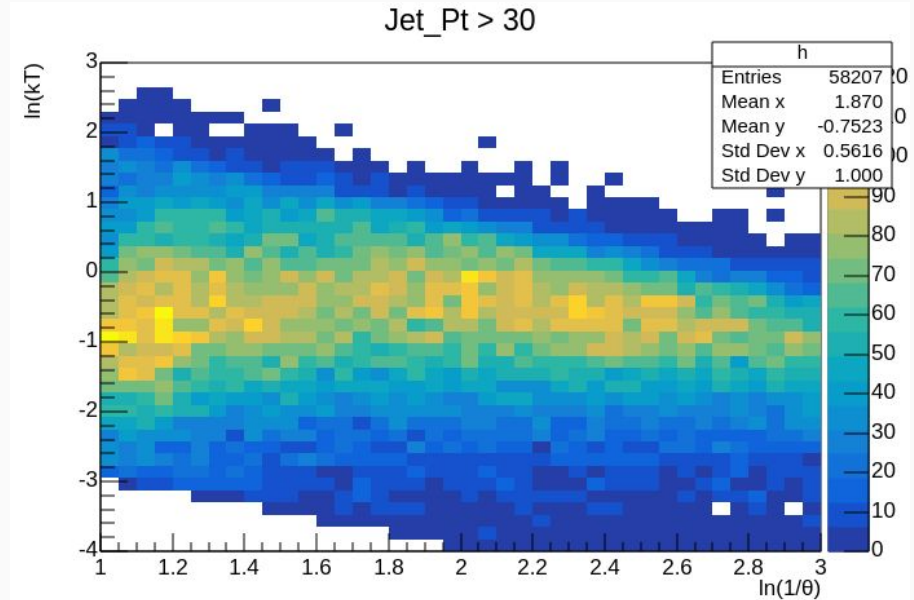
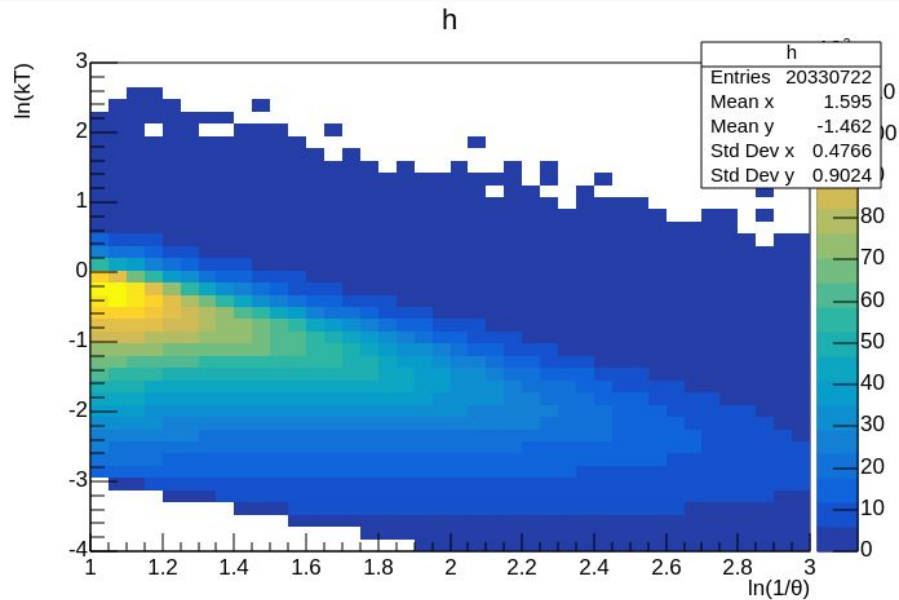
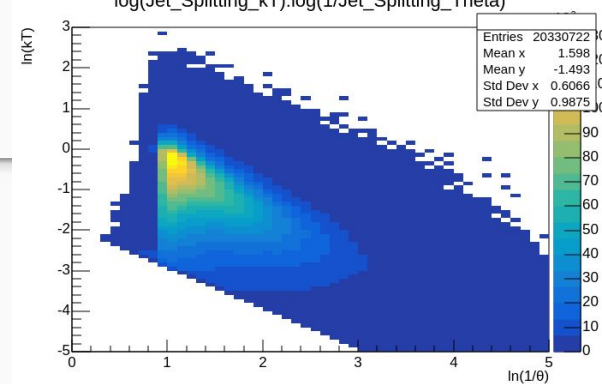
kT vs E_{rad} and z



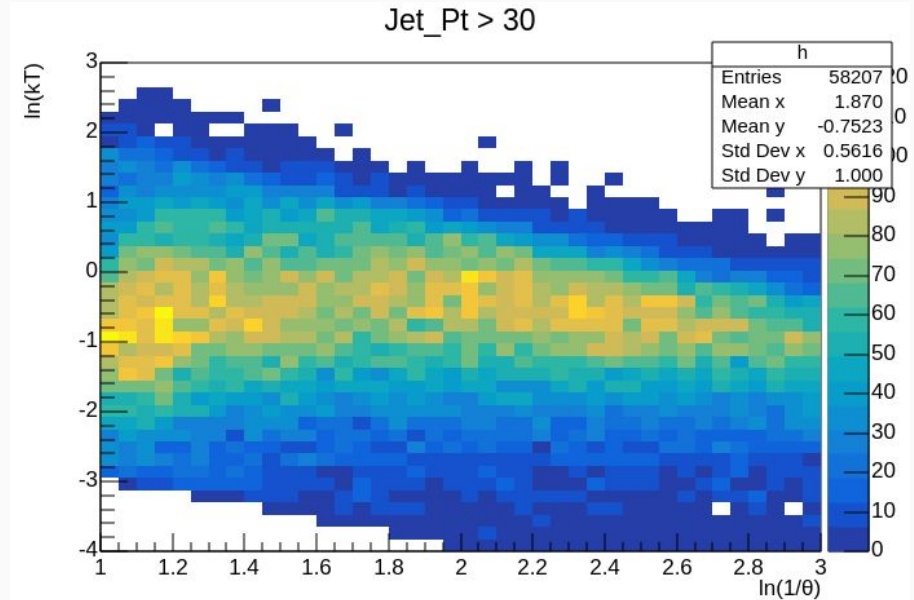
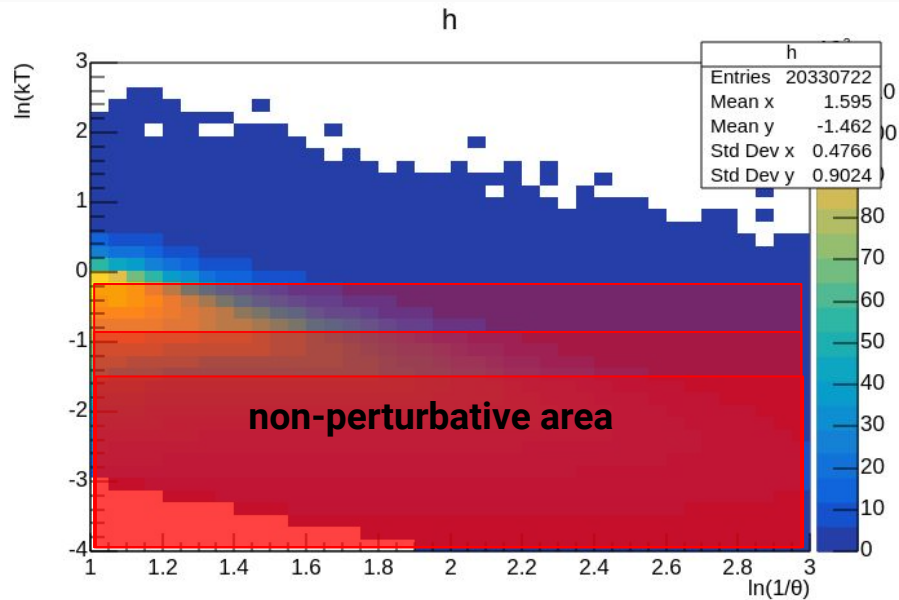
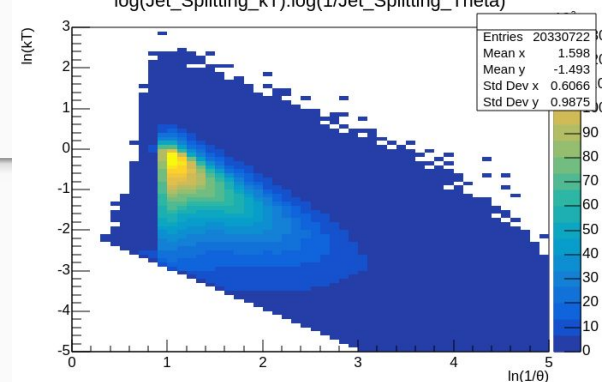
E_{rad} vs p_T



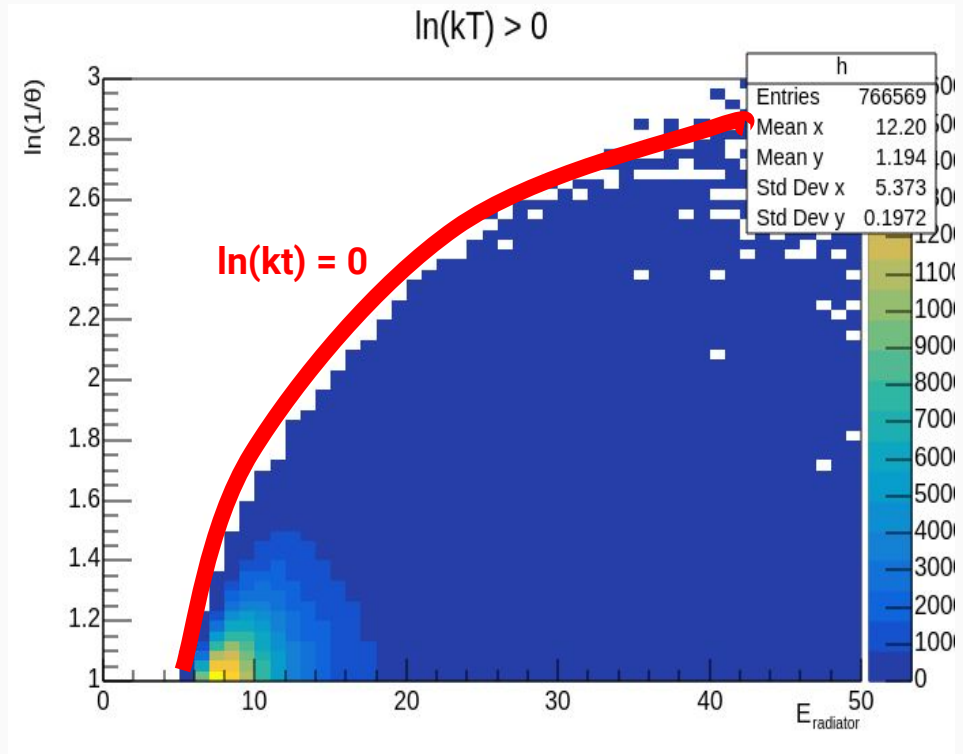
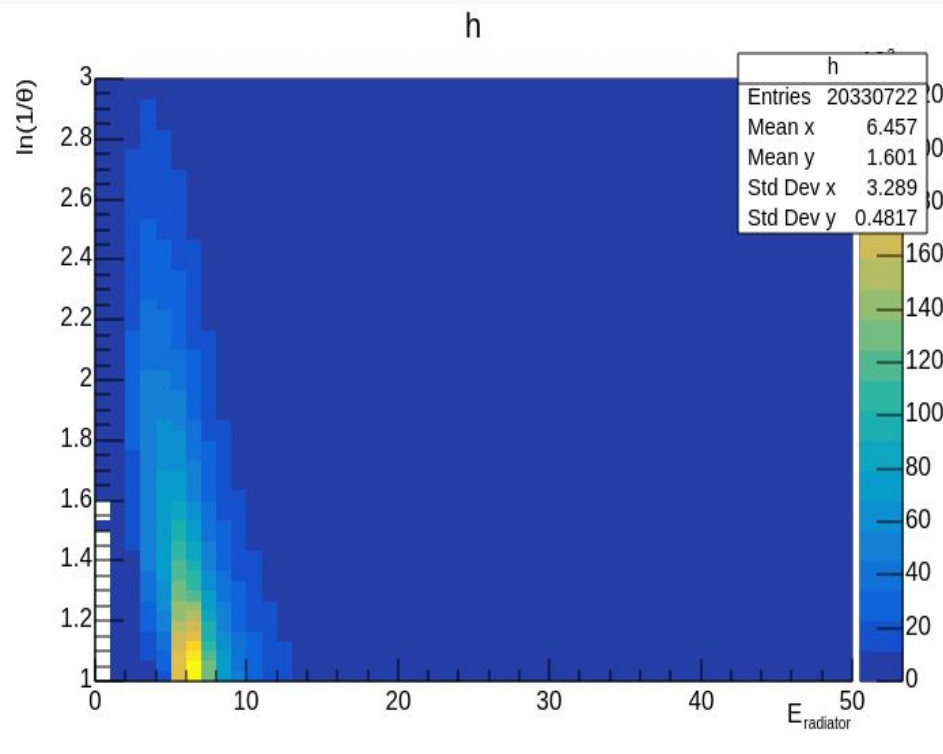
kT vs θ – “Lund Plane”



kT vs θ – “Lund Plane”



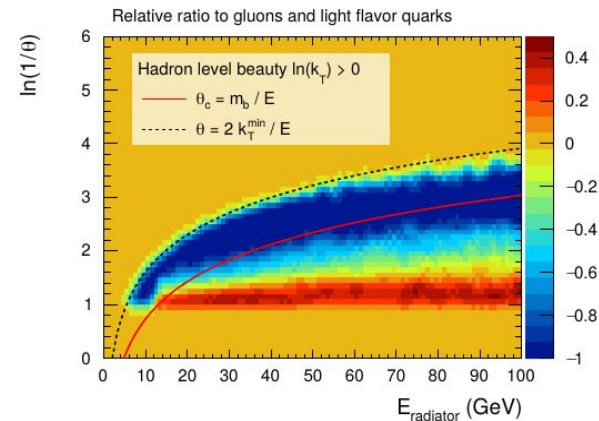
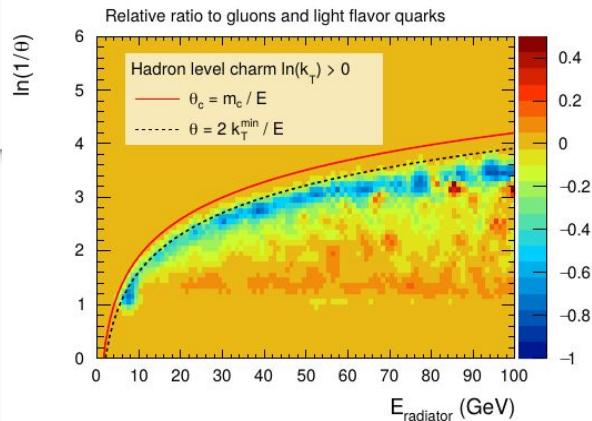
θ vs E_{rad}



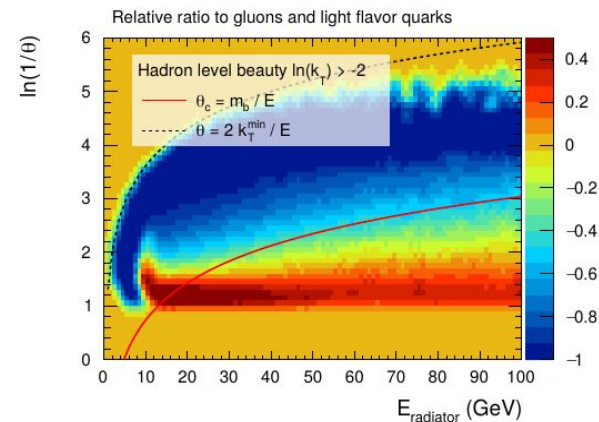
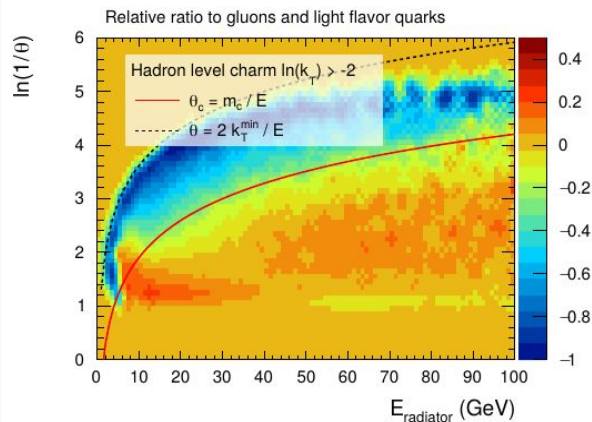
- Smaller E_{rad} does not imply stronger effect

- $1 < \ln(1/\theta) < 3$ is not optimal

- k_T cuts:
 $(\frac{1}{2}, 1, 2) * \Lambda_{\text{QCD}}$ ($=200$ MeV)
 which corresponds to $\ln(k_T/\text{GeV}) = (-2.3, -1.6, -0.9)$ [D0-tagged jets](#)
 or
 $\ln(k_T/\text{GeV}) = (-2, 0)$
 $\frac{2}{3}, 5 * \Lambda_{\text{QCD}}$ [dead-cone w/ declustering](#)



b) Hadron level c-jets (left) and b-jets (right).

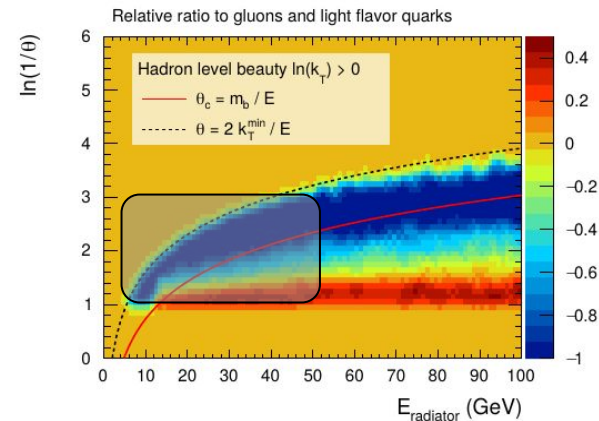
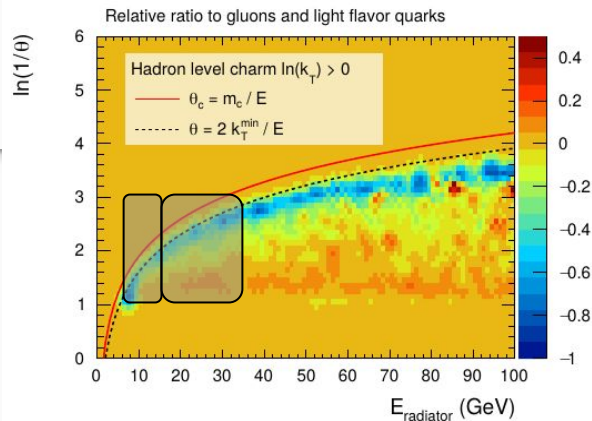


c) Hadron level with a relaxed cut on k_T - demonstration of the impact of non-perturbative effects

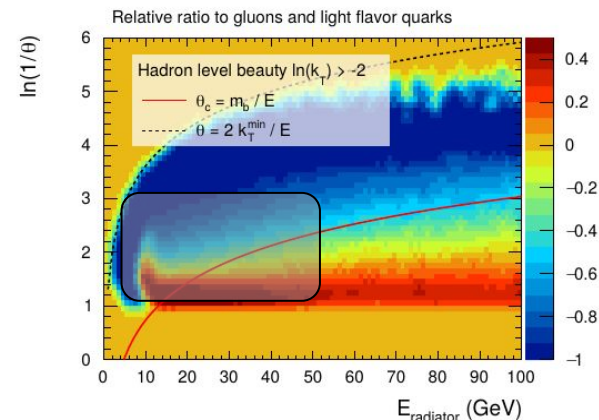
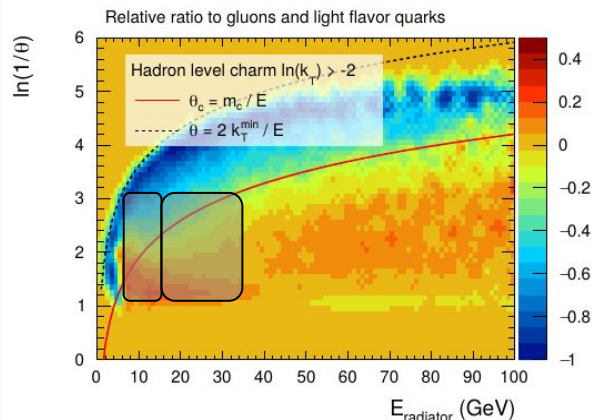
- **Smaller E_{rad} does not imply stronger effect**

- $1 < \ln(1/\theta) < 3$ is not optimal

- **kT cuts:**
 $(\frac{1}{2}, 1, 2) * \Lambda_{\text{QCD}} (=200 \text{ MeV})$
 which corresponds to $\ln(k_T/\text{GeV}) = (-2.3, -1.6, -0.9)$ [D0-tagged jets](#)
 or
 $\ln(k_T/\text{GeV}) = (-2, 0)$
 $\frac{2}{3}, 5 * \Lambda_{\text{QCD}}$ [dead-cone w/ declustering](#)



b) Hadron level c-jets (left) and b-jets (right).



c) Hadron level with a relaxed cut on k_T - demonstration of the impact of non-perturbative effects

Detector efficiency correction



How to select particles findable in the final state from TreeK in the Kinematics.root?

```
df.head(10)
```

executed in 781ms, finished 09:47:22 2020-09-08

entry	fUniqueID	fBits	fLineColor	fLineStyle	fLineWidth	fPdgCode	fStatusCode	fMother[2][0]	fMother[2][1]	fDaughter[2][0]	...	fPy	fPz	fE	fVx	fVy	fVz	fVt	fPolarTheta
0	5	33570823	1	1	1	-11	0	413	-1	422	...	-0.006435	-0.008449	0.014375	-126.314026	-76.794815	-99.857407	5.903354e-09	-99.0
1	5	33570823	1	1	1	11	0	413	-1	416	...	-0.007330	-0.010033	0.017904	-126.314026	-76.794815	-99.857407	5.903354e-09	-99.0
2	9	33570823	1	1	1	11	0	415	-1	419	...	0.000426	-0.000074	0.000673	-119.343674	-94.417297	-162.076736	9.452287e-09	-99.0

```
df.query('fStatusCode == 1 and fPdgCode != 22').query('fPt > 0.15')
```

yields too much (~50-100 particles per event in pp)

fUniqueID, fBits, fLineColor, fLineStyle, fLineWidth, fPdgCode, fStatusCode, fMother[2][0], fMother[2][1], fDaughter[2][0], fDaughter[2][1], fWeight, fCalcMass, fPx, fPy, fPz, fE, fVx, fVy, fVz, fVt, fPolarTheta, fPolarPhi, fPt