Bao Tai Le

Masterthesis update

SoSe 2024
16.4.2024

Bao Tai, Le (26/M)

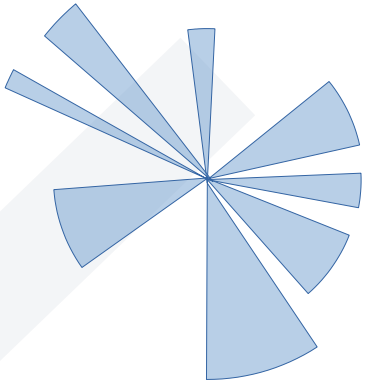
- doing my one year master project in Particle Physics in the Data Analytics research group under Dr. Biebel

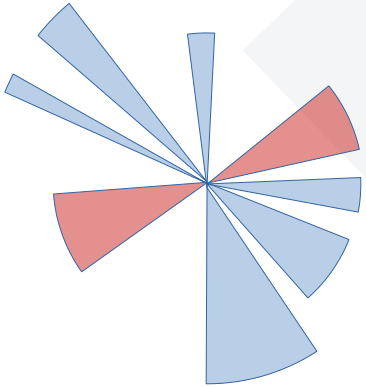
- like watching movies and TV shows

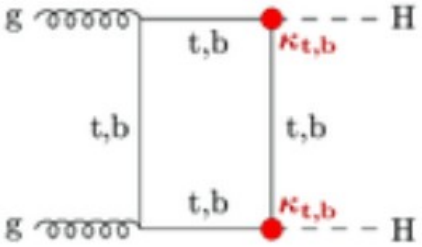
- wants to show you what I am currently working at

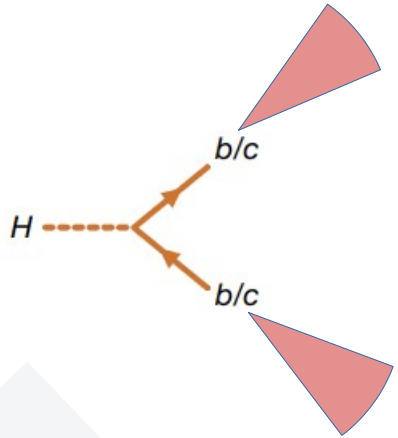
The Higgs-sector as a point of research to find new physics

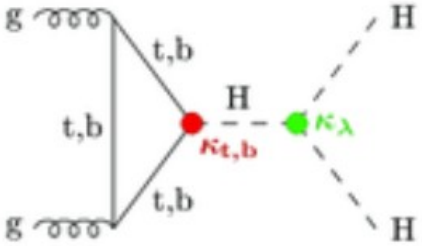
All b-jets → Matched b-jets → Investigation of the 2H->4b → New Physics?







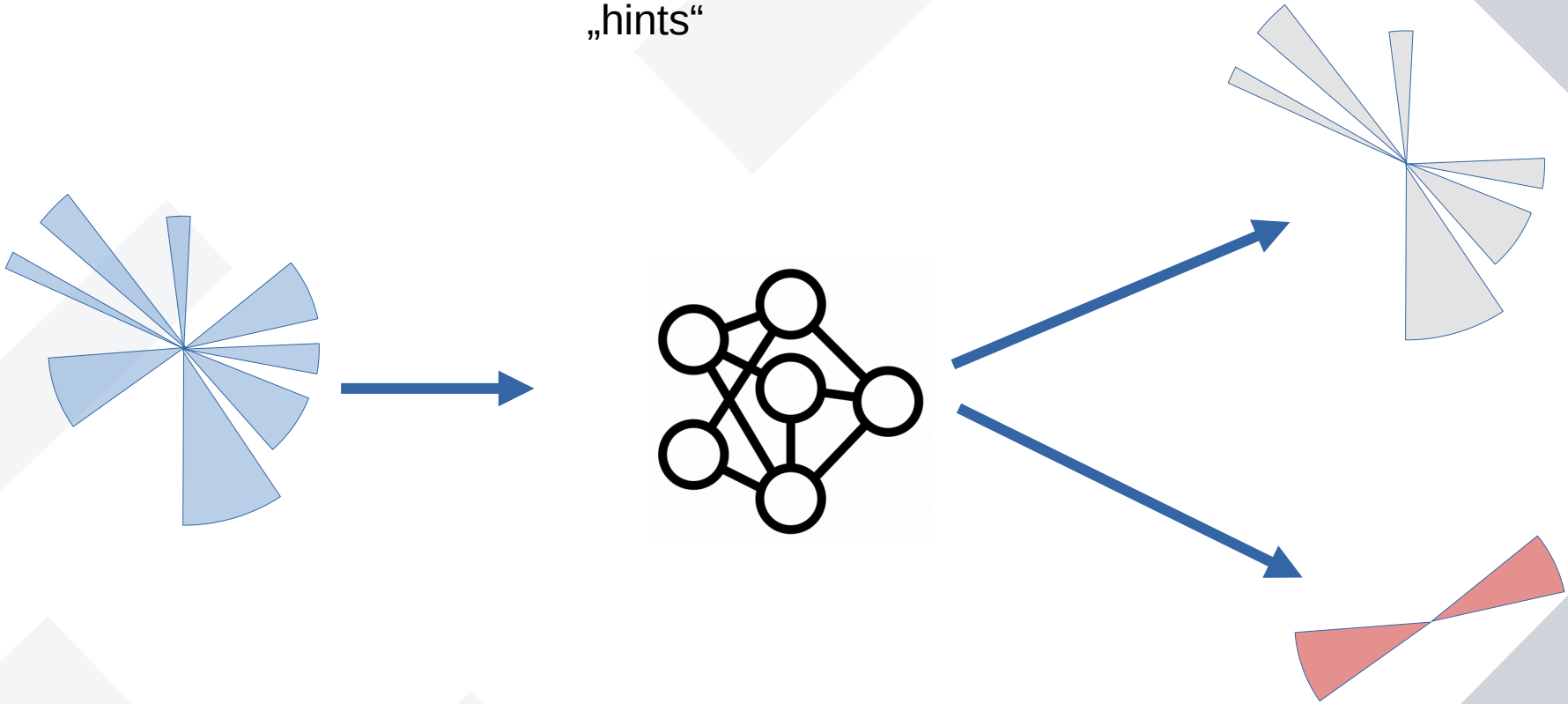




All b-jets

- We need a lot of data
- We need to give it „hints“

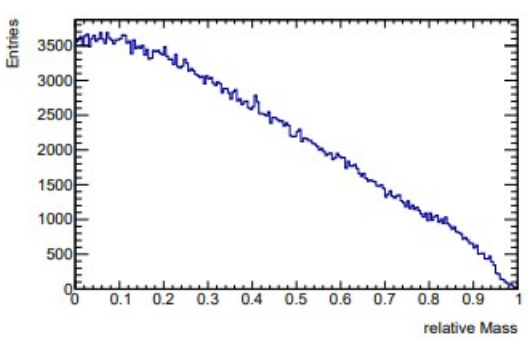
Matched b-jets

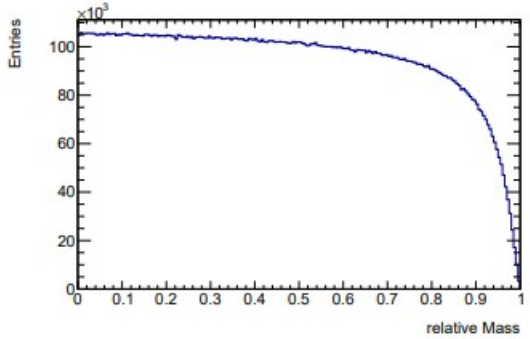


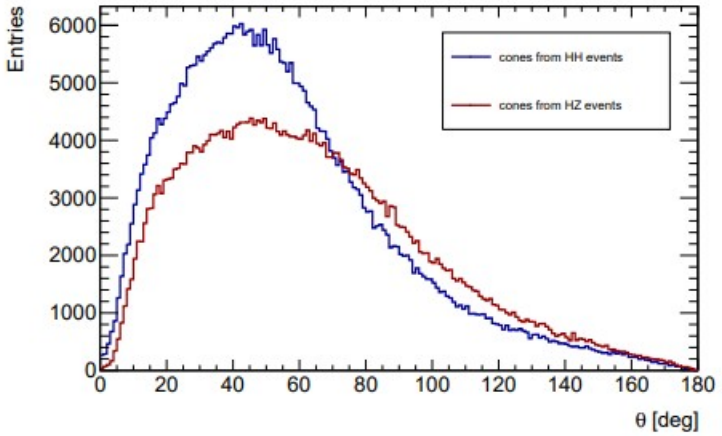
What are hints?

Matched b-pairs

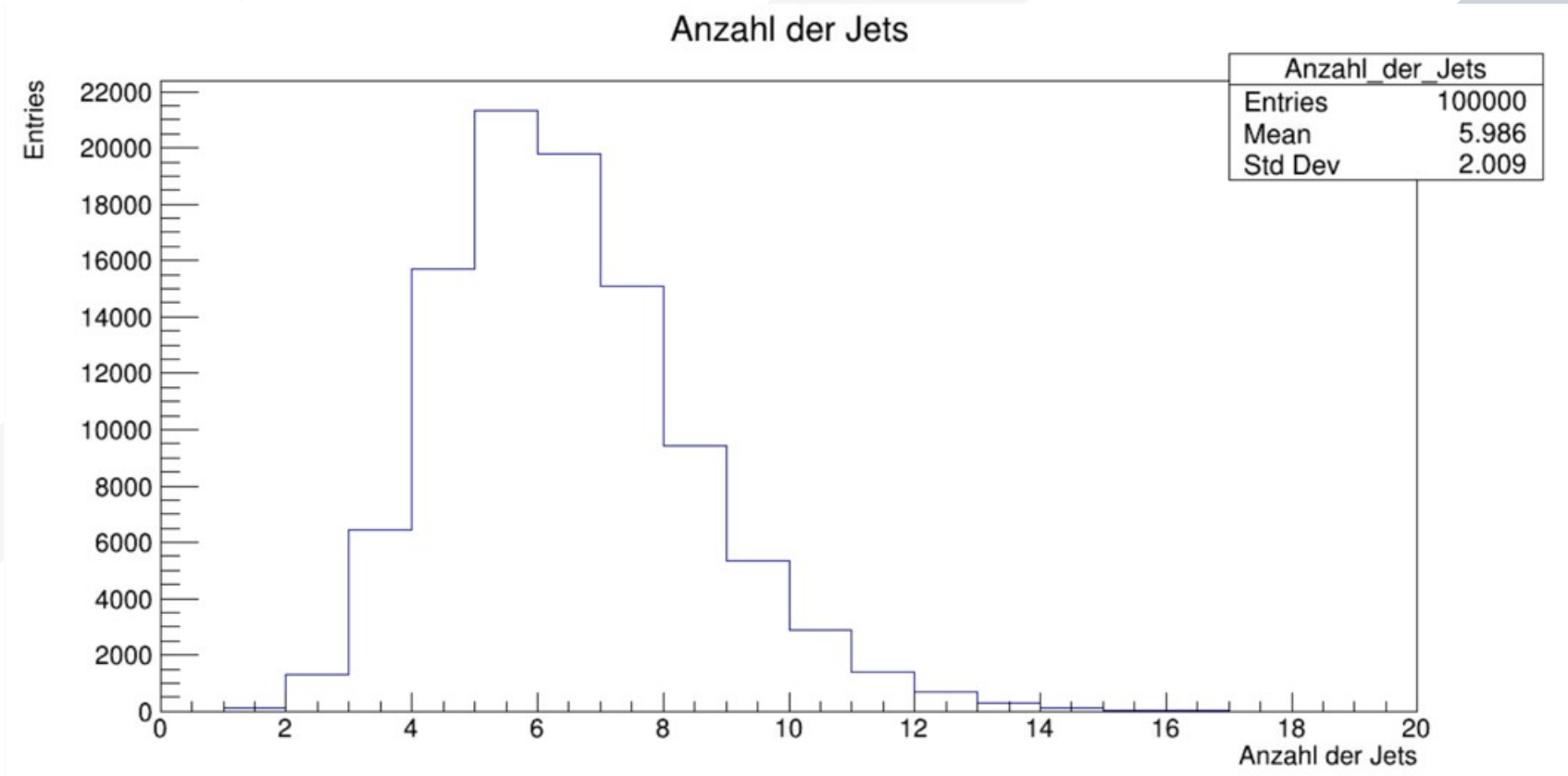
Combinatoric background



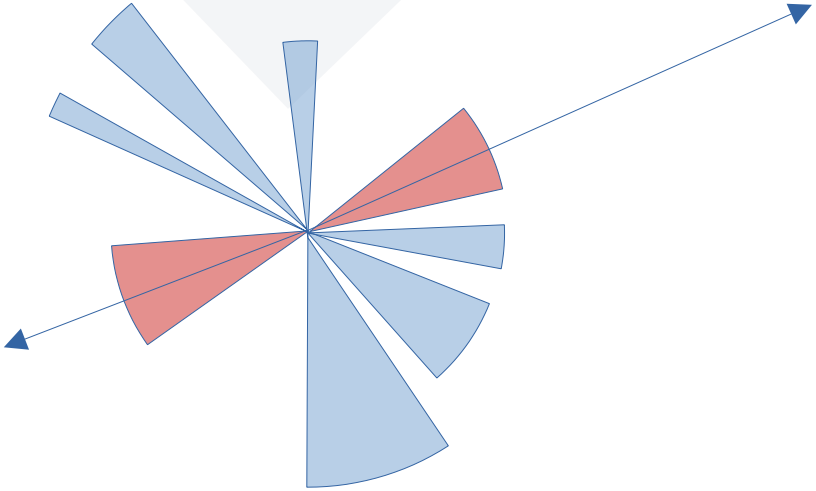




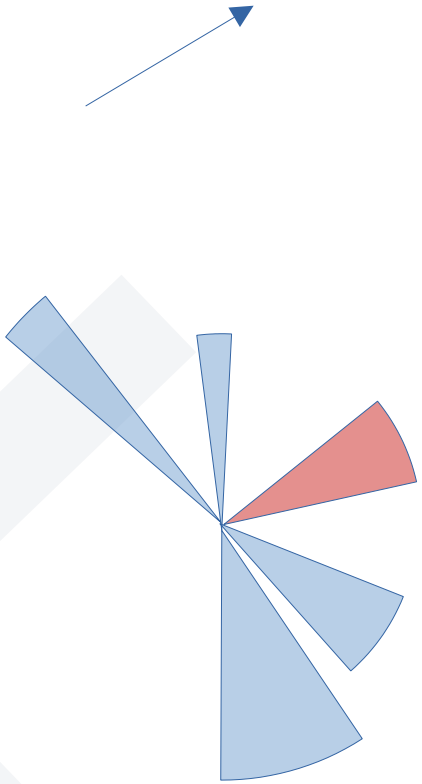
So how did my last week look like?

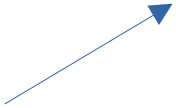

Anzahl der Jets
Anzahl_der_Jets
Entries 100000
Mean 5.986
Std Dev 2.009
Entries
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
2
4
6
8
10
12
14
16
18
20
Anzahl der Jets

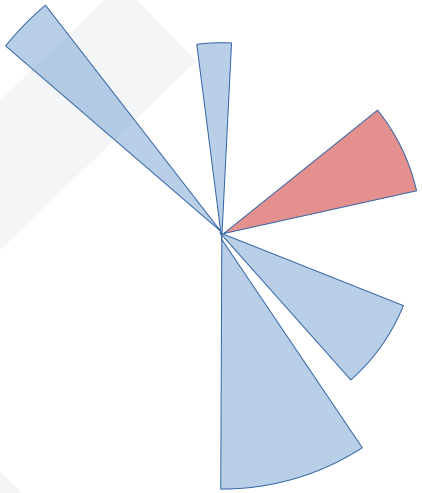
What was the problem? -My assumption



way to find the correct b-quarks-jet-pairs → minimal angular distance





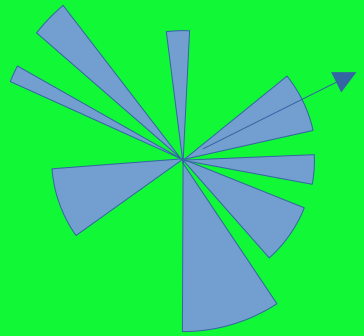


```
 B-quark at line 153 B-quark pseudorapidity: 1.57307 and B-quark phi_p: 0.0125523
Current particle jet number 0 !
                                Phi of the Jet : -0.553548
                          PseudoRapidity of Jet : 0.690425
                                  DeltaR_check : 1.04859
Current particle jet number 1 !
                                Phi of the Jet : 2.77553
                          PseudoRapidity of Jet : 0.835311
                                  DeltaR_check : 2.85978
Current particle jet number 2 !
                                Phi of the Jet : -0.0326976
                          PseudoRapidity of Jet : 1.5552
                                  DeltaR_check : 0.0486531
The new deltaR is : 0.0486531 with the jet number 2
```

```
//Loop over the n-jets to find the smalles deltaR
    for (int n = 0; n < n_jets; n++) {
cout << "Current particle jet number " << n << " !"<< std::endl;
TLorentzVector jet_lvector = TLorentzVector(exclusive_jets[n].px(), exclusive_jets[n].py(), exclusive_jets[n].pz(), exclusive_jets[n].e());

double_t pseudorap_jet= jet_lvector.PseudoRapidity();
double_t phi_jet=jet_lvector.Phi();
double_t deltaR_check = sqrt(pow(pseudorap_p- pseudorap_jet,2)+pow(phi_jet-phi_p,2));

//Output Formating
cout.setf(ios::right, ios::adjustfield);
cout.width(50);
cout <<"Phi of the Jet : "<< phi_jet<<std::endl;
cout.setf(ios::right, ios::adjustfield);
cout.width(50);
cout<<" PseudoRapidity of Jet : "<< pseudorap_jet <<std::endl;
cout.setf(ios::right, ios::adjustfield);
cout.width(50);
cout<<"DeltaR_check : "<< deltaR_check <<std::endl;

    if (deltaR_check < deltaR_init)
    {
        deltaR_init =deltaR_check;
        dummy_n = n;

        cout<<"The new deltaR is : "<< deltaR_init<< " with the jet number " << dummy_n << std::endl;
        }
```

Loop over all Events

Loop over all b-quarks in my particle list In said event



Construct and match all jets in said event to the b quark

event_matches_id	
particle-list index (pp)	jet-index in exclusive jet-array (qq)

Code

```
        if (deltaR_check < deltaR_init)
        {
            deltaR_init =deltaR_check;
            dummy_n = n;

            cout<<"The new deltaR is : "<< deltaR_init<< " with the jet number " << dummy_n << std::endl;
            }

        }
event_matches_id.insert(std::pair<double_t, double_t>(pp,dummy_n)); }
   }
```

Command-Output

```
226 0
228 0
233 0
289 0
```

```
153 2
157 2
158 2
166 2
188 2
```

```
37 5
49 5
109 5
131 0
135 0
138 0
234 5
```

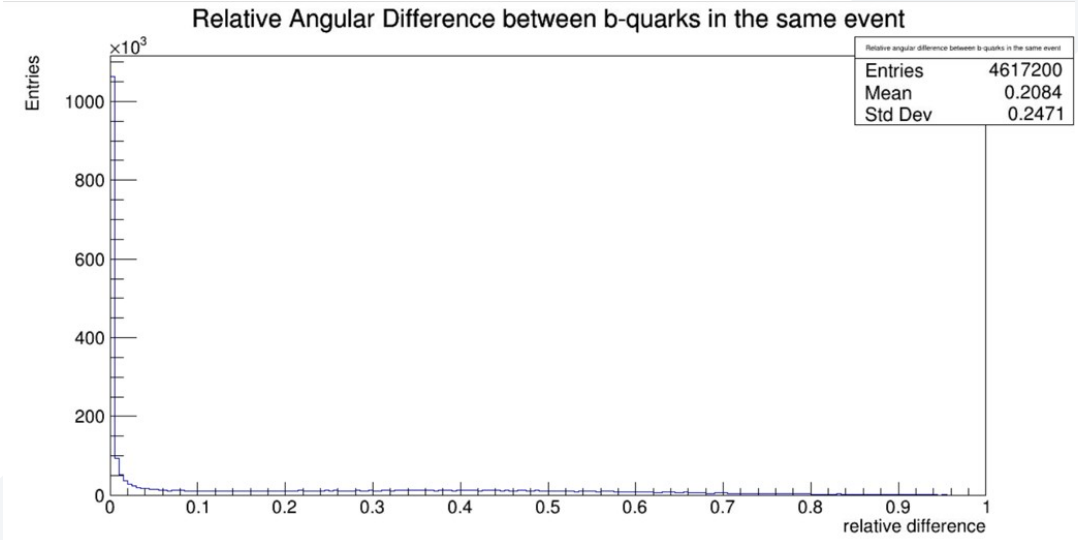
Problem(?)

226 0	153 2	37 5
228 0	157 2	49 5
233 0	158 2	109 5
289 0	166 2	131 0
	188 2	135 0
		138 0
		234 5

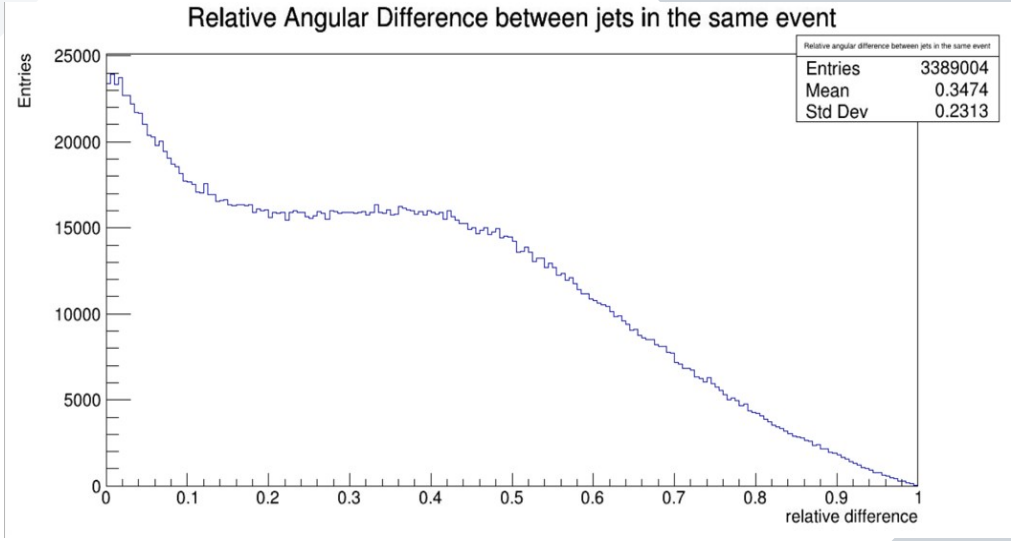
Many b-quarks in the same event match to the same jet
???

Variables-Check(per event)

b-quark-relative-angular-difference



jet relative-angular-difference

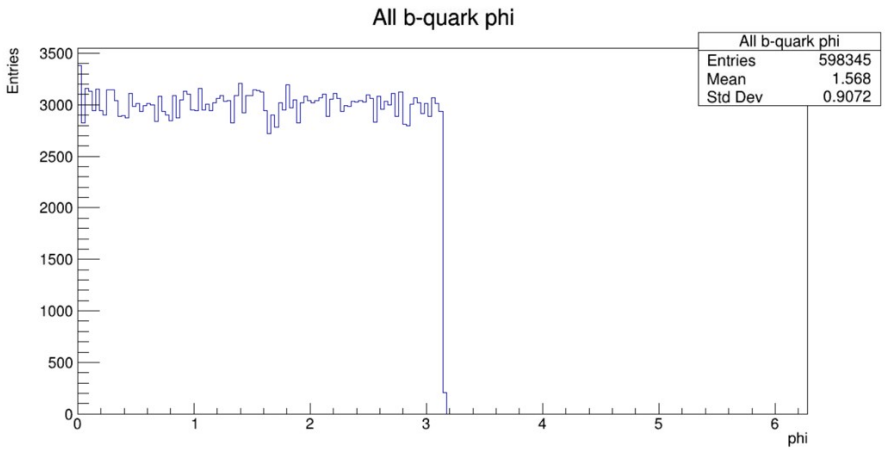


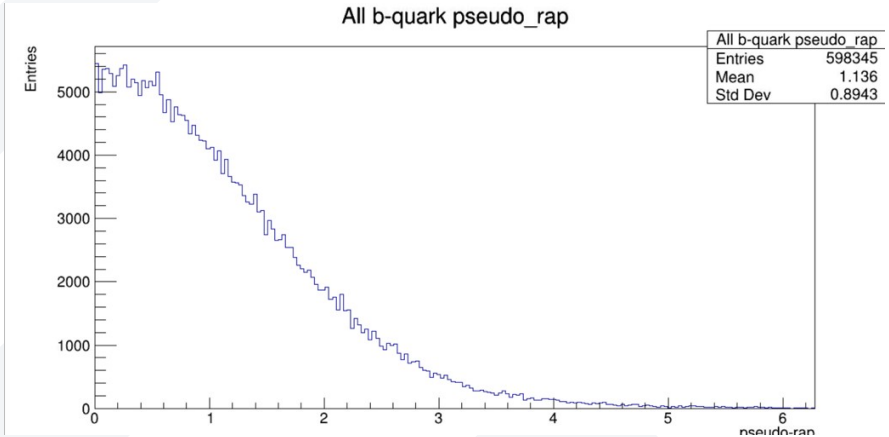
Relative angular difference:

$$\frac{|\theta_1-\theta_2|+|\phi_1-\phi_2|}{|\theta_1|+|\theta_2|+|\phi_1|+|\phi_2|}$$

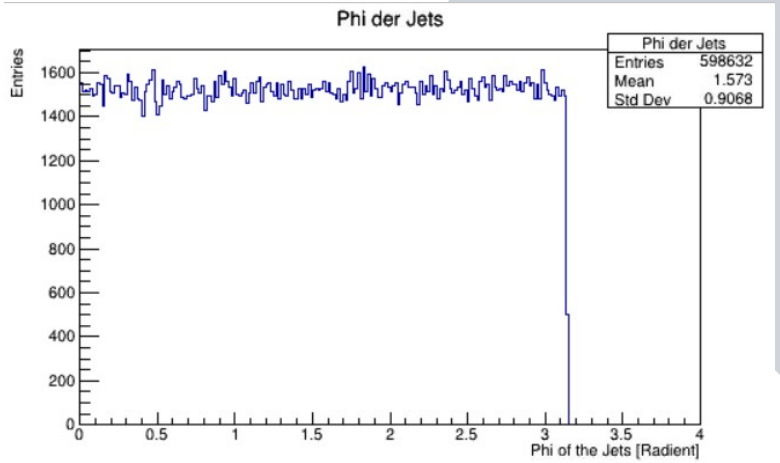
Sanity Check

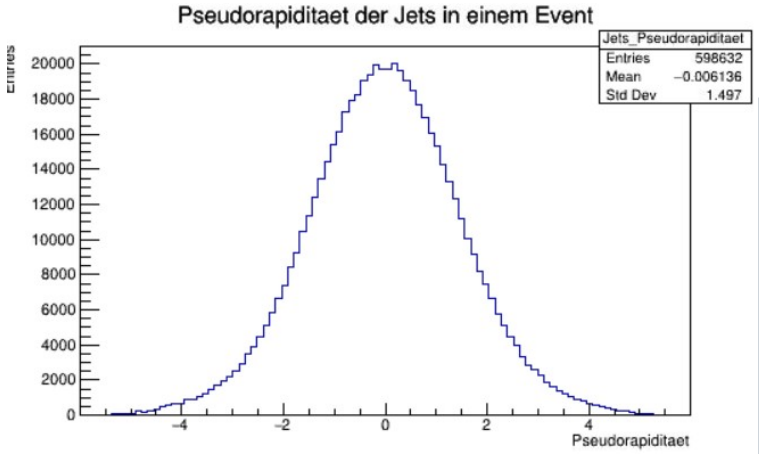
b-quarks-angles





jet-angles





Open Questions

- Is it normal that all my b-quarks are so (angularly) close together

- Work around(?)
- ideas for other variables that can be investigated

- Please let me know!

Resources

- https://www.curious-cravings.com/images/post/standard-model.png
https://en.wikipedia.org/wiki/Gargamelle#/media/File:Neutral_current,_leptonic_event,_muon_neutrino.png
https://arxiv.org/ftp/arxiv/papers/2310/2310.03073.pdf
-Discrimination of HH and HZ Final States Using Neural Networks
-https://cdn3.iconfinder.com/data/icons/data-science-11/64/neural-network-machine-learning-algorithm-1024.png
-https://www.researchgate.net/figure/Feynman-diagrams-for-the-leading-Higgs-boson-interactions-Higgs-boson-production-in-a_fig1_361733458