Introdução à Análise de dados em FAE **(DATA)**

Introdução a estatística para análise de dados em HEP

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EXERCICIO 1

TEXTO

RESPOSTA:

```
    import numpy as np
import uproot
import awkward as ak
import matplotlib.pyplot as plt
import vector
import coffea

path = '/opendata/eos/opendata/cms/mc/RunIISummer20UL16NanoAODv9/ZZ_TuneCP5_13TeV-pythia8/NANOAODSIM/106X_mcRun2_asymptotic_v17-v1/130000/AA03EB34-E055-F44D-873B-1E114A0B09AA.root'


file = uproot.open(path)

print('arquivo:', file.keys())
tree = file['Events;1']
tree.keys()


muon_pt = tree['Muon_pt'].array()
muon_phi = tree['Muon_phi'].array()
muon_eta = tree['Muon_eta'].array()
muon_mass = tree['Muon_mass'].array()
nMuon = tree['nMuon'].array()

muon_pt_val = ak.num(muon_pt)>=4

mask_muon = (muon_pt[muon_pt_val][:, 0] > 20) & (np.abs(muon_eta[muon_pt_val][:, 0] < 2.5))
mask_muon2 = (muon_pt[muon_pt_val][:, 1] > 20) & (np.abs(muon_eta[muon_pt_val][:, 1] < 2.5))
mask_muon3 =  (muon_pt[muon_pt_val][:, 0] * muon_pt[muon_pt_val][:, 1]) < 0
mask_muon_comb = mask_muon & mask_muon2

muon_pt_sel = muon_pt[muon_pt_val][mask_muon_comb]
muon_eta_sel = muon_eta[muon_pt_val][mask_muon_comb]
muon_phi_sel = muon_phi[muon_pt_val][mask_muon_comb]
muon_mass_sel = muon_mass[muon_pt_val][mask_muon_comb]


muon_pt_clean = muon_pt_sel[ak.num(muon_pt_sel) > 0]
muon_eta_clean = muon_eta_sel[ak.num(muon_eta_sel) > 0]
muon_phi_clean = muon_phi_sel[ak.num(muon_phi_sel) > 0]
```

```
muon_mass_clean = muon_mass_sel[ak.num(muon_mass_sel) > 0]


muon_pt_flat = ak.flatten(muon_pt_clean)
muon_eta_flat = ak.flatten(muon_eta_clean)
muon_phi_flat = ak.flatten(muon_phi_clean)
muon_mass_flat = ak.flatten(muon_mass_clean)


muon_pt_before_cut = tree['Muon_pt'].array()
muon_pt_before_cut_clean = muon_pt_before_cut[ak.num(muon_pt_before_cut) > 0]
muon_pt_before = ak.flatten(muon_pt_before_cut_clean)

muon_phi_before_cut = tree['Muon_phi'].array()
muon_phi_before_cut_clean = muon_phi_before_cut[ak.num(muon_phi_before_cut) > 0]
muon_phi_before = ak.flatten(muon_phi_before_cut_clean)

muon_eta_before_cut = tree['Muon_eta'].array()
muon_eta_before_cut_clean = muon_eta_before_cut[ak.num(muon_eta_before_cut) > 0]
muon_eta_before = ak.flatten(muon_eta_before_cut_clean)

muon_mass_before_cut = tree['Muon_mass'].array()
muon_mass_before_cut_clean = muon_mass_before_cut[ak.num(muon_mass_before_cut) > 0]
muon_mass_before = ak.flatten(muon_mass_before_cut_clean)


muon1_4vecs = vector.zip({
 "pt": muon_pt_clean[:, 0],
 "eta": muon_eta_clean[:, 0],
 "phi": muon_phi_clean[:, 0],
 "mass": muon_mass_clean[:, 0]
 })

muon2_4vecs = vector.zip({
 "pt": muon_pt_clean[:, 1],
 "eta": muon_eta_clean[:, 1],
 "phi": muon_phi_clean[:, 1],
 "mass": muon_mass_clean[:, 1]
 })

dimuon = muon1_4vecs + muon2_4vecs
mass_dimuon = dimuon.mass

plt.figure(figsize=(10, 5))


plt.subplot(1, 2, 1)
plt.subplot(1, 2, 1)
plt.hist(muon_pt_before, bins=50, color='#7a21dd',  range=(0, 300))

plt.title(r'Distribui  o de $p_T$ antes do corte do Muon')
plt.xlabel(r"$p_{T}$")
plt.ylabel("Events")

plt.subplot(1, 2, 2)
plt.hist(muon_pt_flat, bins=50, color='#7a21dd',  range=(0, 500))

plt.title(r'Distribui  o de $p_T$ depois do corte do Muon')#, loc = 'left')
plt.xlabel(r"$p_{T}$")
plt.ylabel("Events")

plt.tight_layout()
plt.show()
```

```
103
104
105
106 plt.figure(figsize=(10, 5))
107
108 plt.subplot(1, 2, 1)
109 plt.hist(muon_eta_before, bins=50, color='royalblue' , range=(-2, 2))
110 plt.title("Distribui  o de $eta$ antes do corte do M uon")
111 plt.xlabel(r"$\eta$")
112 plt.ylabel("Events")
113
114 plt.subplot(1, 2, 2)
115 plt.hist(muon_eta_flat, bins=50, color='royalblue', range=(-2, 2))
116 plt.title("Distribui  o de $eta$ depois do corte do M on")
117 plt.xlabel(r"$\eta$" )
118 plt.ylabel("Events")
119
120 plt.tight_layout()
121 plt.show()
122
123 #plot phi
124
125
126 plt.figure(figsize=(10, 5))
127
128 plt.subplot(1, 2, 1)
129 plt.hist(muon_phi_before, bins=50, color='red' , range=(-2, 2))
130 plt.title("Distribui  o de $\phi$ antes do corte do M on")
131 plt.xlabel(r"$\phi$")
132 plt.ylabel("Events")
133
134 plt.subplot(1, 2, 2)
135 plt.hist(muon_phi_flat, bins=50, color='red', range=(-2, 2))
136 plt.title("Distribui  o de $\phi$ depois do corte do M on")
137 plt.xlabel(r"$\phi$")
138 plt.ylabel("Events")
139
140 plt.tight_layout()
141 plt.show()
142
143
144
145 plt.figure(figsize=(10, 5))
146
147
148 plt.hist(mass_dimuon, bins=50, color='#3f90da', alpha=0.7, label='Dimuon', histtype='
        step', range = (0,400))
149
150
151 plt.title("Distribui  es da massa do Muon")
152 plt.xlabel(r"Massa (GeV/c$^2$)", loc='right')
153 plt.ylabel("Events", loc='top')
154 plt.legend(loc='best')
155 plt.grid(alpha=0.3)
156 plt.show()
```

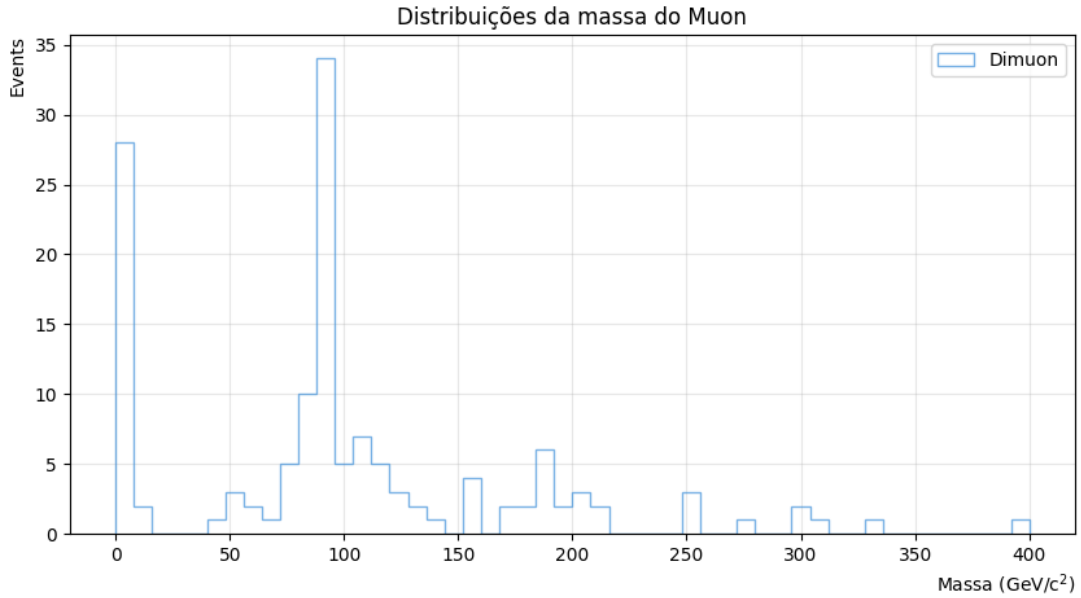

Figura 1: Massa do Múon

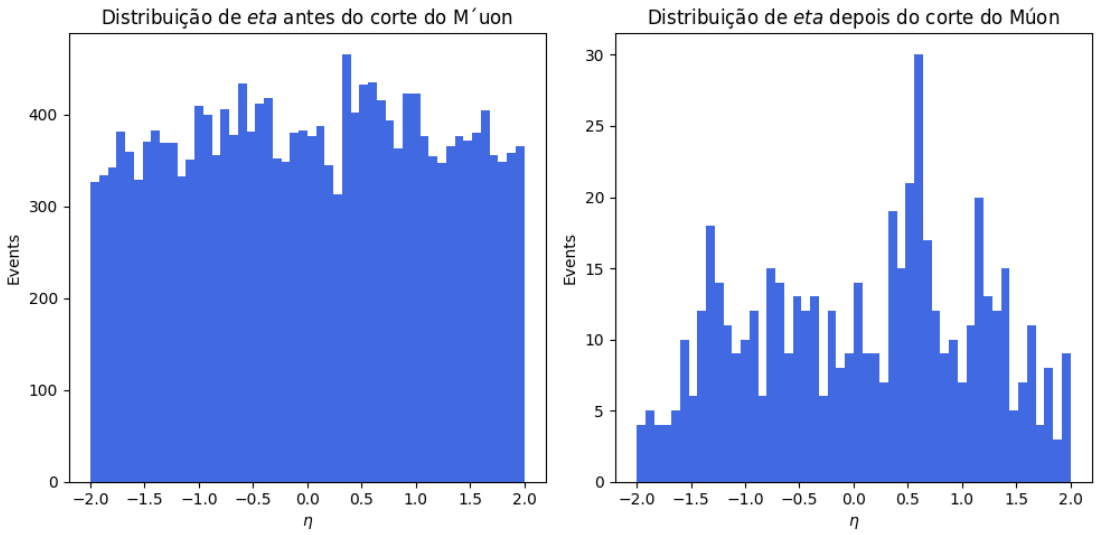

Figura 2: η do Múon

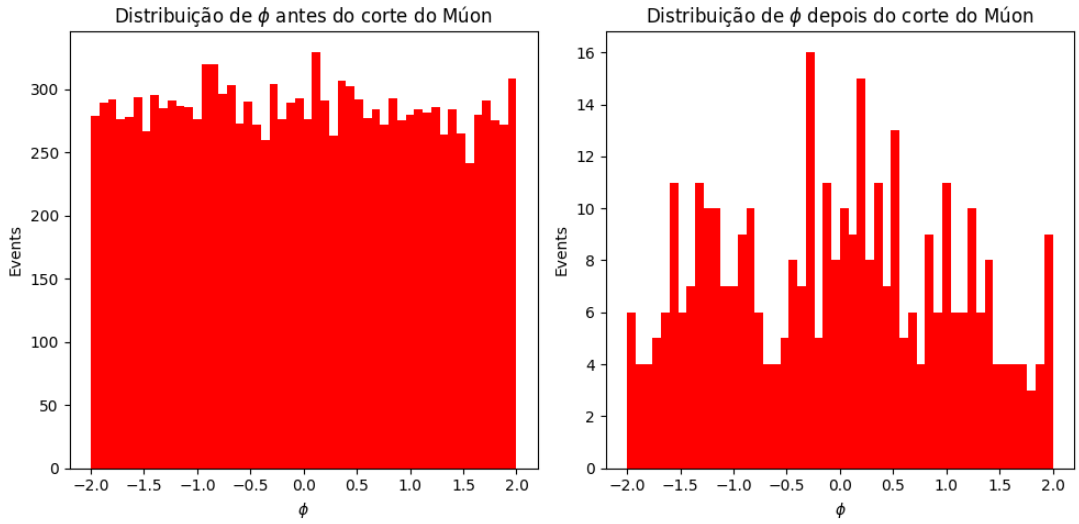

Figura 3: ϕ do Múon

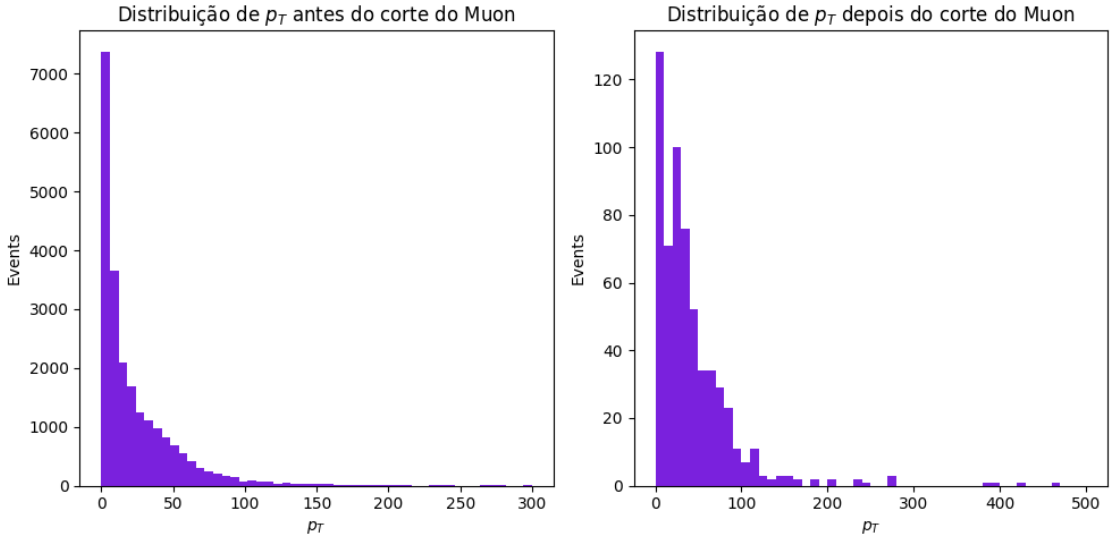

Figura 4: p_T do Múon