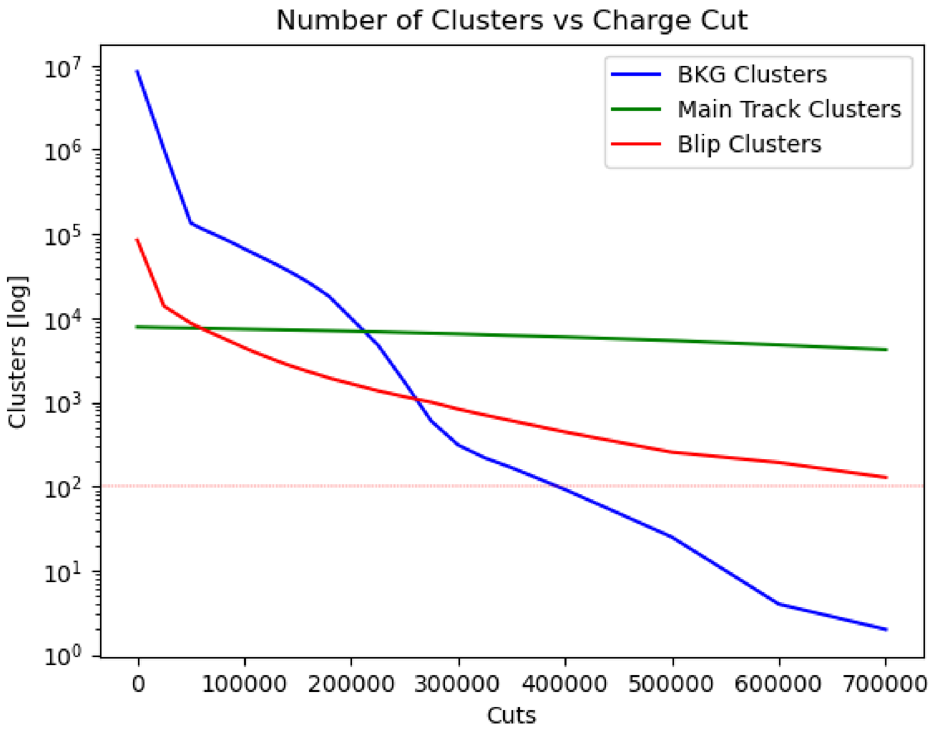
Supernova Pointing

Background Study Update

Harry Akins 13/06/2024

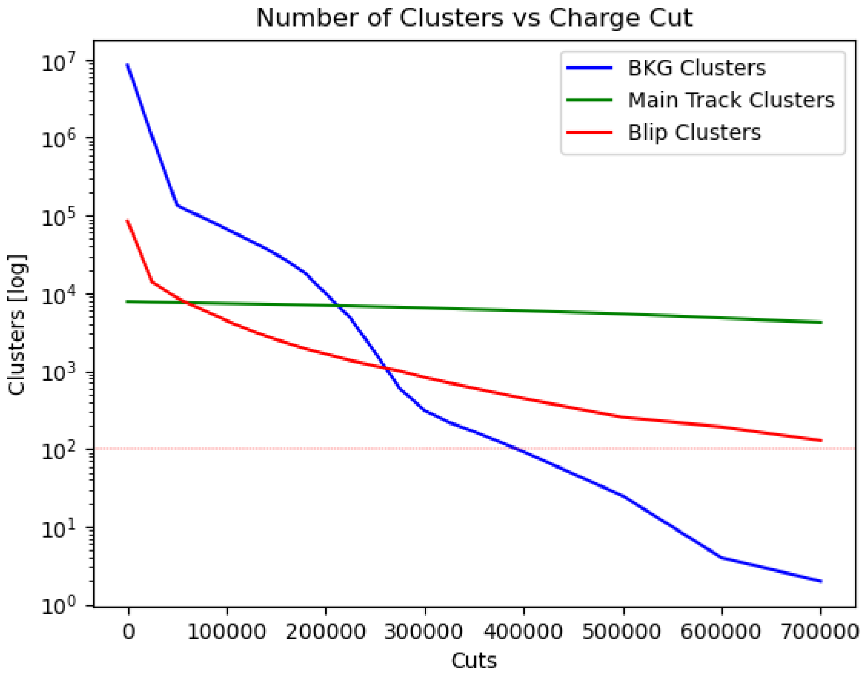
Main Track identifier with Cuts

- Many cuts were not going through
- Condor not submitting some arguments
- Submit many times, eventually everything went through
- 600,000 and 700,000 did not work, < 10 bkg clusters

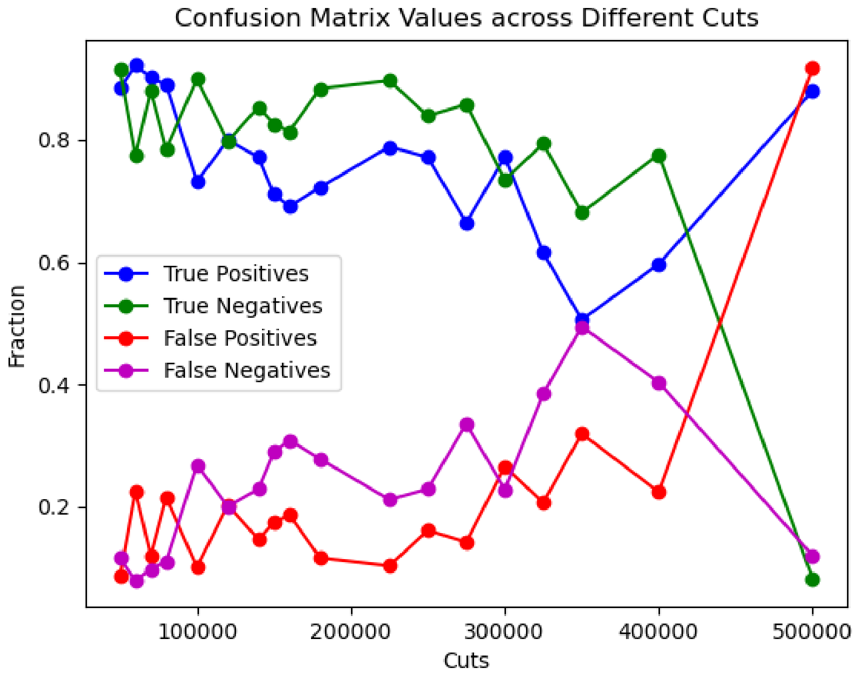


Data used for MT training

Main Track identifier with Cuts

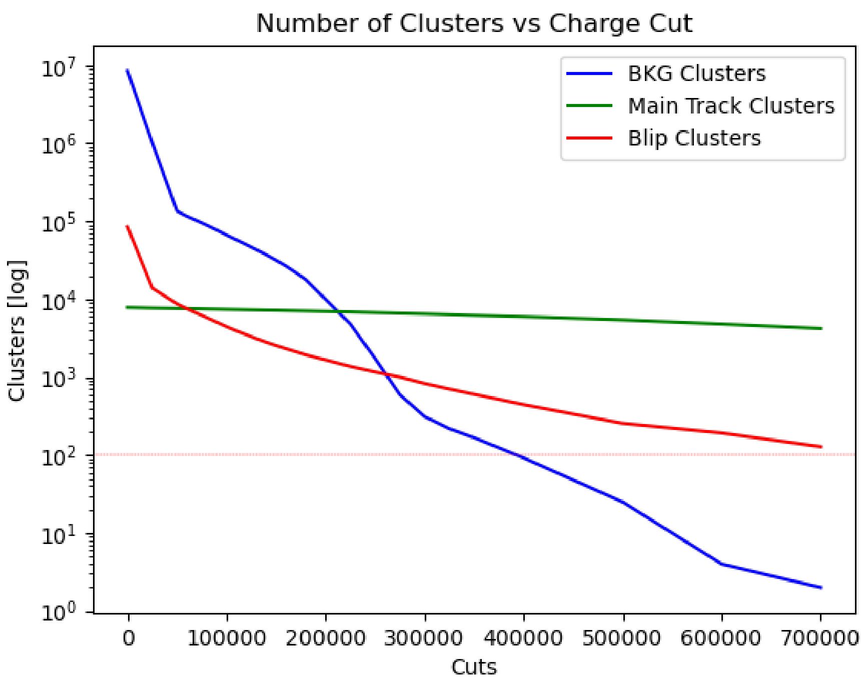


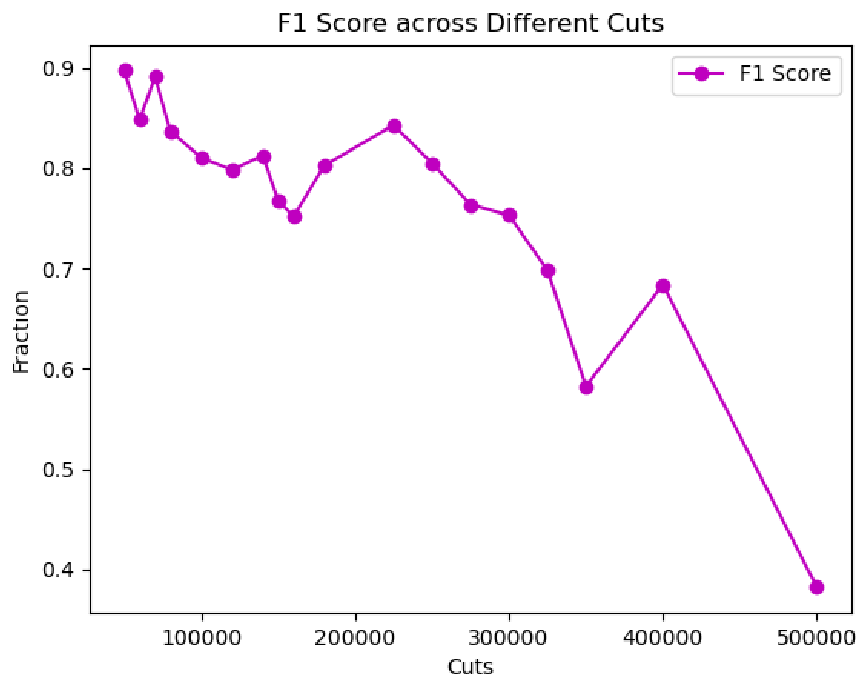
Data used for MT training



Optimizing hyperparameters and training a model using data with different cuts, from 50000 to 700000

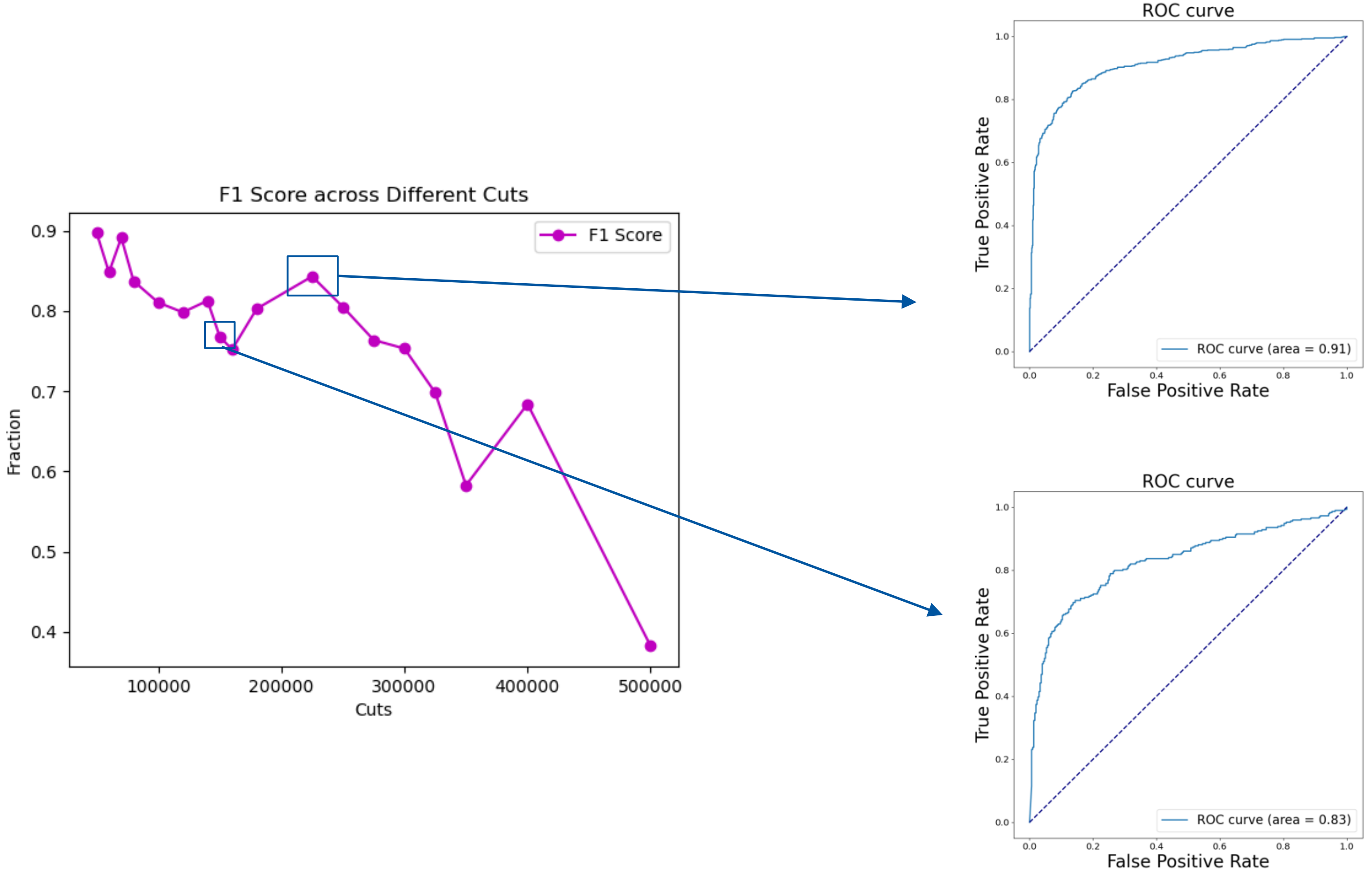
Main Track identifier with Cuts





Data used for MT training

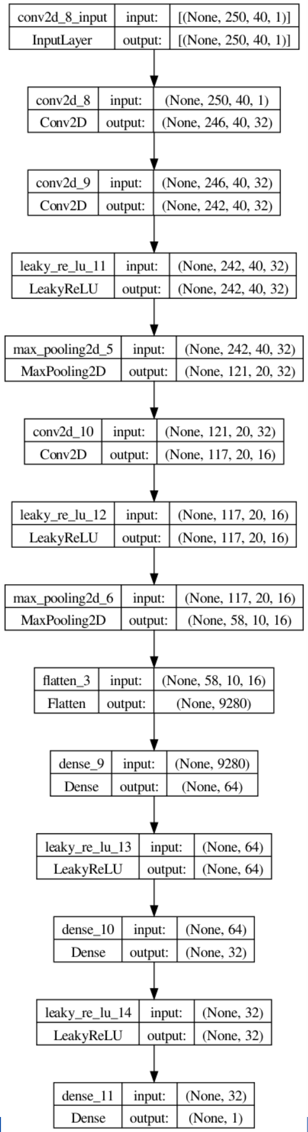
Main Track identifier with Cuts



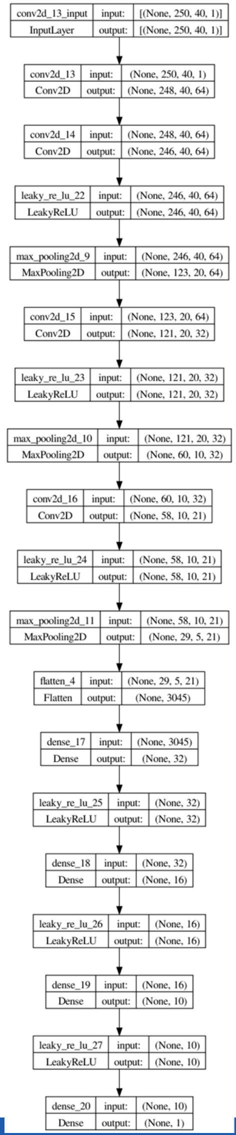
225000 cut

150000 cut

150000



225000

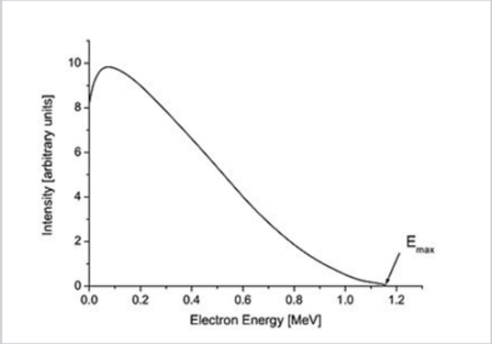


Beta emission spectrum [edit]

Beta decay can be considered as a perturbation as described in quantum mechanics, and thus Fermi's Golden Rule can be applied. This leads to an expression for the kinetic energy spectrum $N(T)$ of emitted betas as follows:[29]

$$N(T) = C_L(T)F(Z,T)pE(Q-T)^2$$

where T is the kinetic energy, C_L is a shape function that depends on the forbiddenness of the decay (it is constant for allowed decays), $F(Z, T)$ is the Fermi Function (see below) with Z the charge of the final-state nucleus, $E = T + mc^2$ is the total energy, $p = \sqrt{(E/c)^2 - (mc)^2}$ is the momentum, and Q is the Q value of the decay. The kinetic energy of the emitted neutrino is given approximately by Q minus the kinetic energy of the beta.



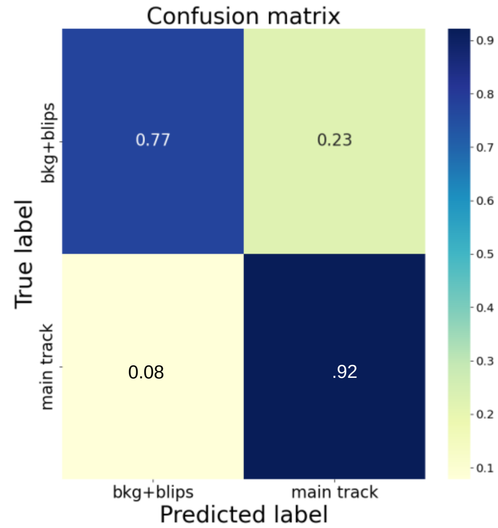
Beta spectrum of ^{210}Bi. $E_{max} = Q = 1.16$ MeV is the maximum energy

As an example, the beta decay spectrum of ^{210}Bi (originally called RaE) is shown to the right.

Fermi function [edit]

The Fermi function that appears in the beta spectrum formula accounts for the Coulomb attraction / repulsion between the emitted beta and the final state nucleus. Approximating the associated wavefunctions to be spherically symmetric, the Fermi function can be analytically calculated to be:[30]

$$F(Z,T) = \frac{2(1+S)}{\Gamma(1+2S)^2}(2p\rho)^{2S-2}e^{\pi\eta}|\Gamma(S+i\eta)|^2,$$


Confusion matrix
True label
bkg+blips
main track
0.77
0.23
0.08
.92
bkg+blips
main track
Predicted label
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1