NR and ER discrimination using Deep Learning Models

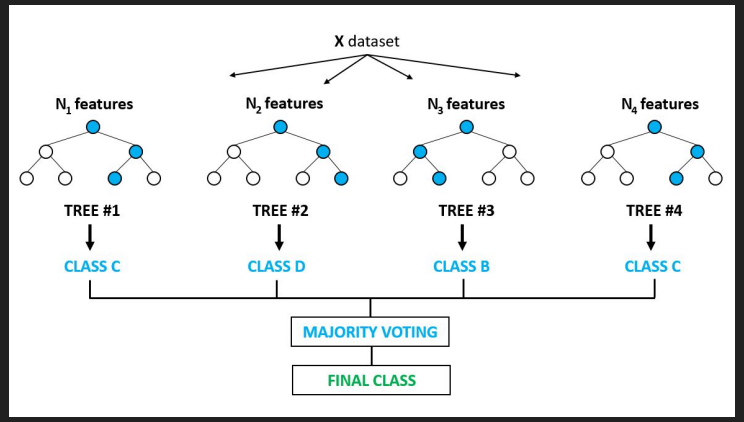
CYGNO-Reconstruction Meeting

Atul Prajapati

09/12/21

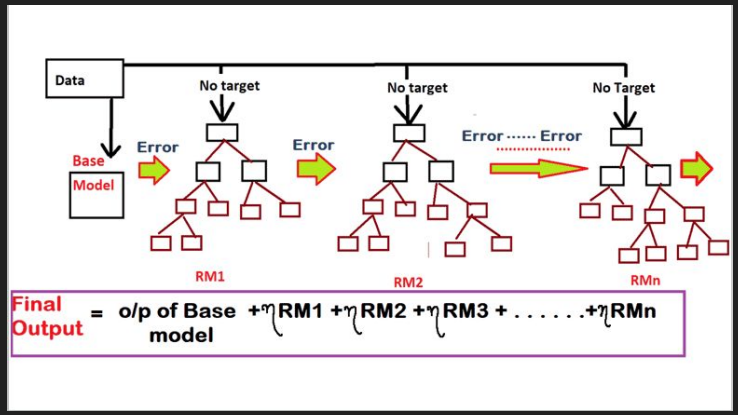
Random Forest and Gradient Boosted Classifiers

RFC



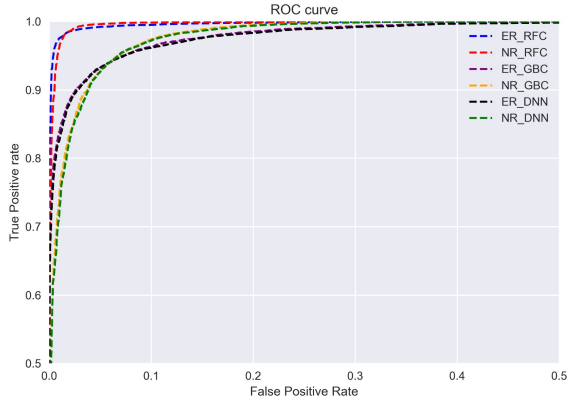
- It can build each tree independently.
- Results are combined at the end of the process.

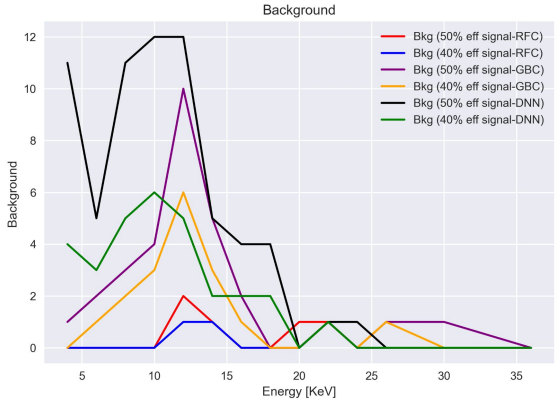
GBC

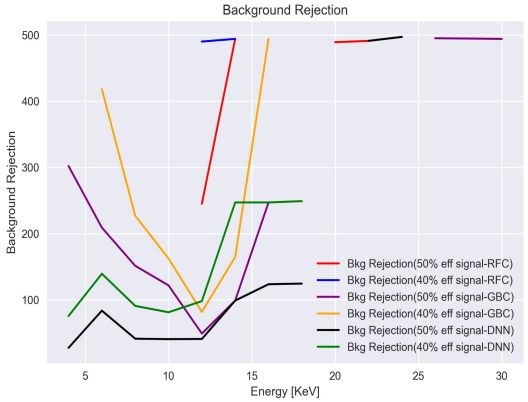


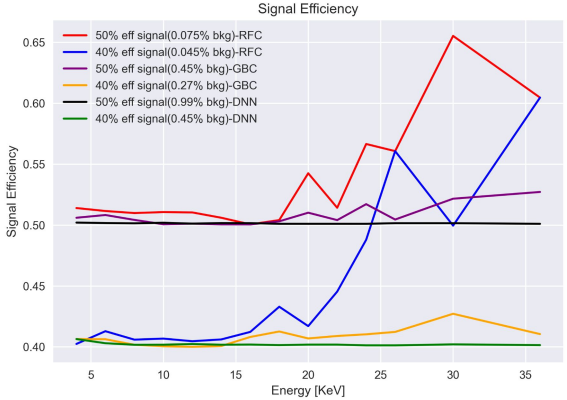
- It builds one tree at a time.
- It combines results along the way.

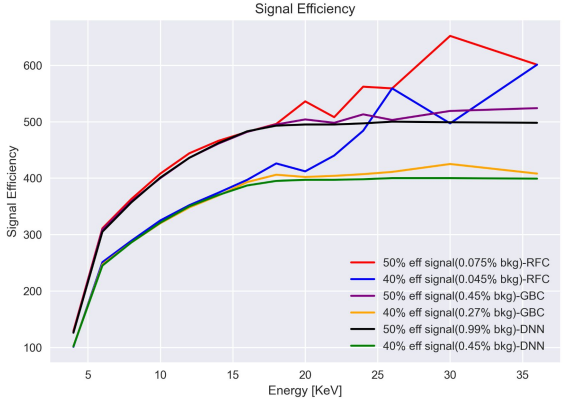
Old Results with smaller samples









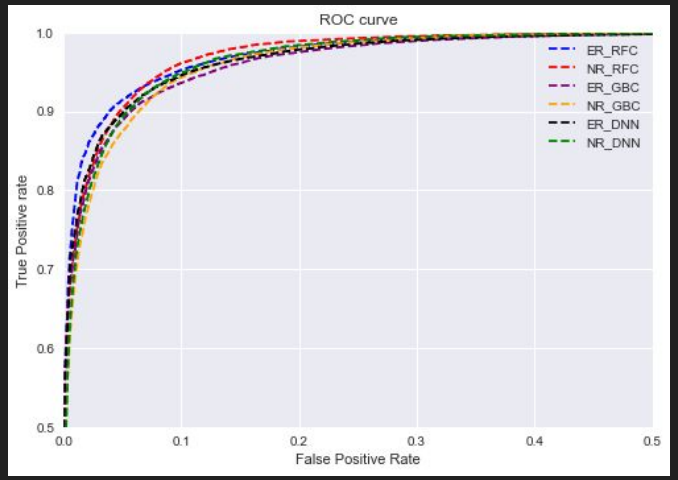


- Rejection = Total No. of ER/ No. of ER left
- Rejection and signal efficiency is computed in each energy bin.

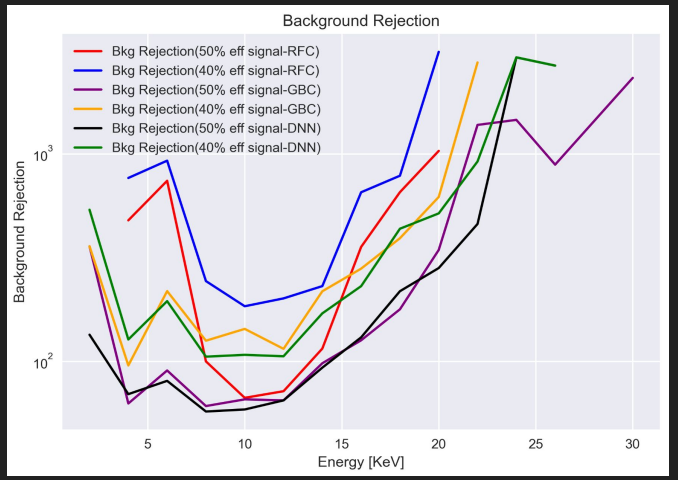
Training with larger samples of Electron Recoils

1. Trained 3 models
   a. Random Forest Classifier (RFC)
   b. Gradient Boosted Classifier (GBC)
   c. Deep Neural Network (DNN)
2. Data Division:
   a. Training : 80%
   b. Testing : 20%
3. Total samples size: 60846 samples (NR+ER)

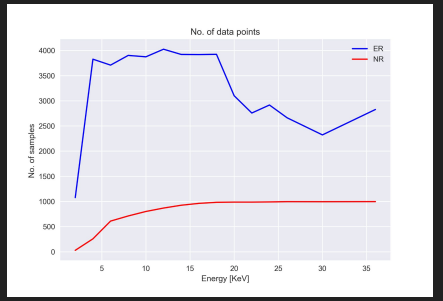
Results



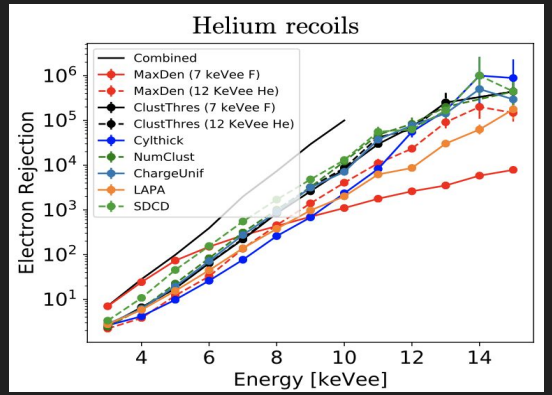
A. ROC Curve



B. Background Rejection



D. No. of Samples

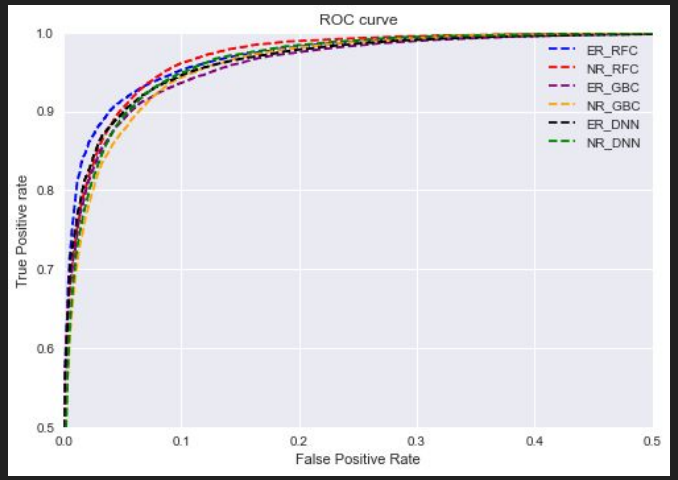


Gas Mixture	Pressure [Torr]	Density $[g/cm^3]$	Drift field [V/cm]	σ_T $[\mu m/\sqrt{cm}]$	$1/(\rho \cdot \sigma_T)$ $\left[\frac{cm^{7/2}}{g \cdot \mu m}\right]$
80% He + 10% CF_4 + 10% CHF_3 [this work]	60	6.69×10^{-5}	40.6	398	37.6
97.4% He + 2.6%SF_6 [15]	760	3.35×10^{-4}	–	78.6	38.0
CF_4 [20]	100	5.17×10^{-4}	400	184	10.5
70% CF_4+28% CHF_3+ 2% C_4H_10 [21]	37.5	1.81×10^{-4}	180	253	21.8
60% He + 40% CF_4 [22]	760	1.68×10^{-3}	500	150	3.97

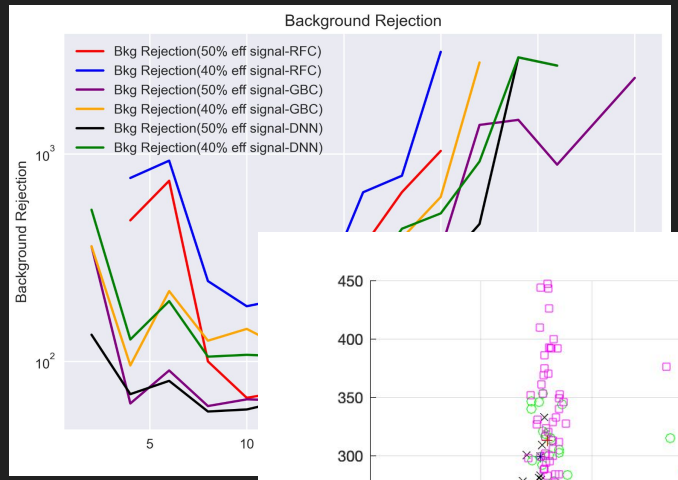
1/(ρ · σT) value strongly impacts electron rejection capabilities.

Observables for recoil identification in gas TPCs (arXiv:2012.13649v1)

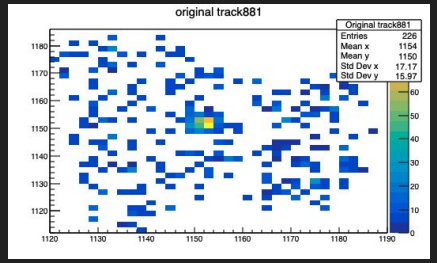
Results

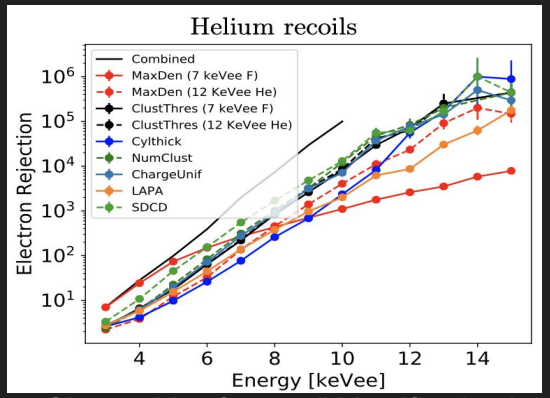


A. ROC Curve

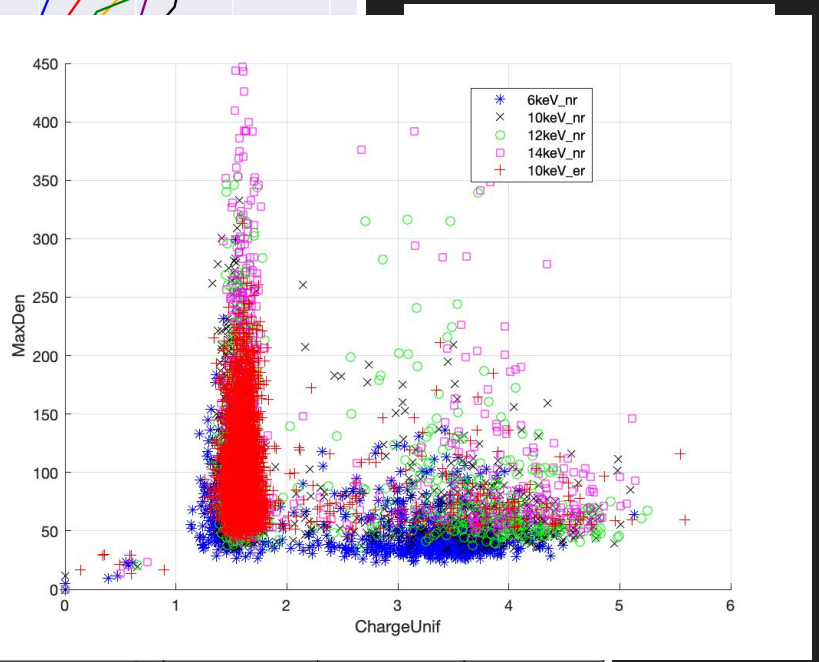


B. Backgro

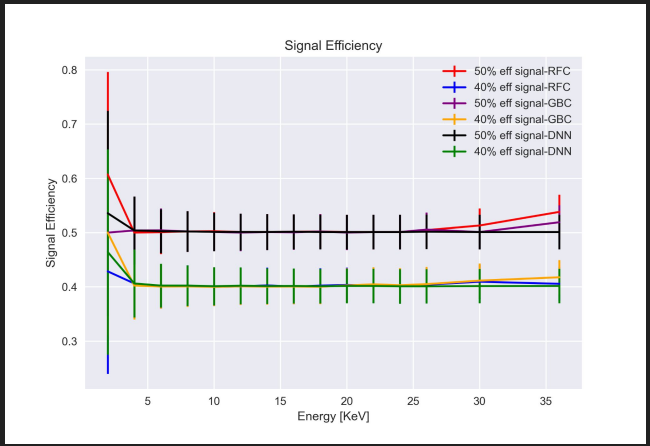




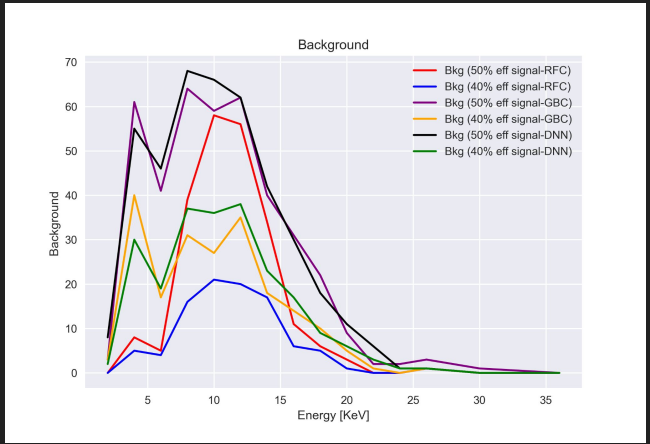
Gas Mixture	Pressu [Torr]				
80% He + 10% CF_4 + 10% CHF_3 [this work]	60				
97.4% He + 2.6%SF_6 [15]	760				
CF_4 [20]	100				
70% CF_4+28% CHF_3+ 2% C_4H_10 [21]	37.5				
60% He + 40% CF_4 [22]	760	1.68×10^{-3}	500	150	3.97



Observables for recoil identification in gas TPCs (arXiv:2012.13649v1)



A. Signal Efficiency



B. Background

Models	Signal Eff.	Bkg. Eff.
RFC	0.40	0.0019
	0.50	0.0045
GBC	0.40	0.0041
	0.50	0.0082
DNN	0.40	0.0045
	0.50	0.0085
Selection on Delta	0.40	0.008
	0.50	0.035

Table 1: Results from all the models with 40 and 50% efficiency on signal in each energy bin and the background is from all then energy bin. Whereas 40 and 50% efficiency with selection on delta is for the whole energy range.