

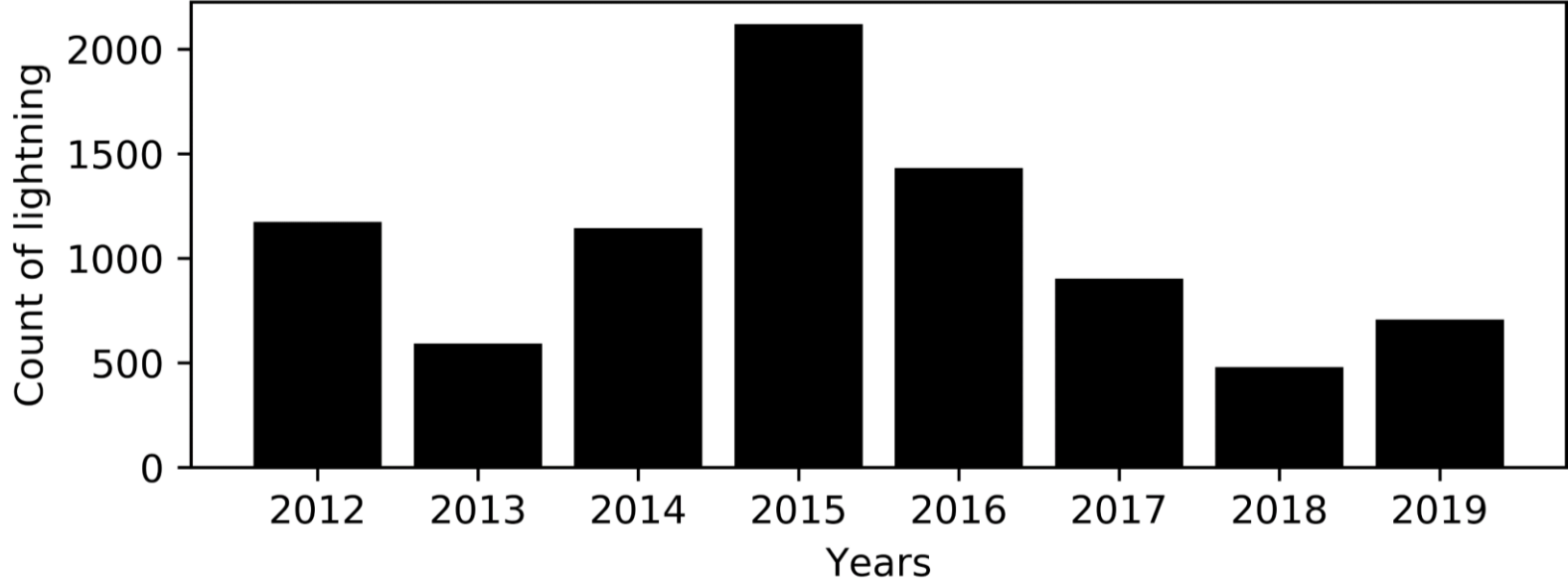
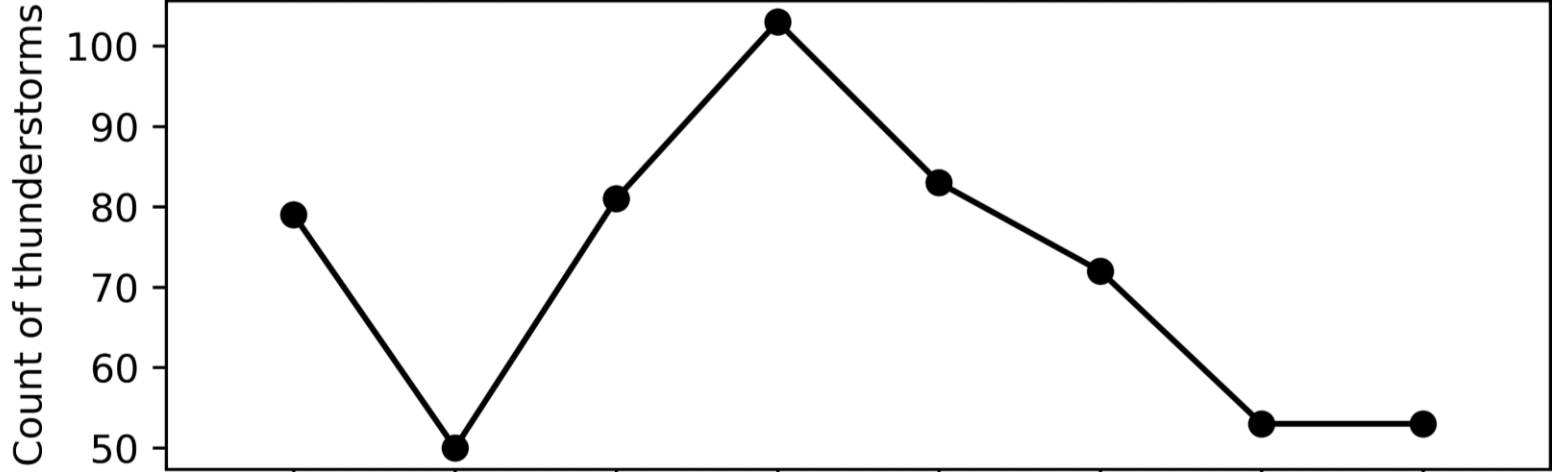
# **Atmospheric Discharge classification with machine learning algorithm**

G. Karapetyan, A. Chilingaryan

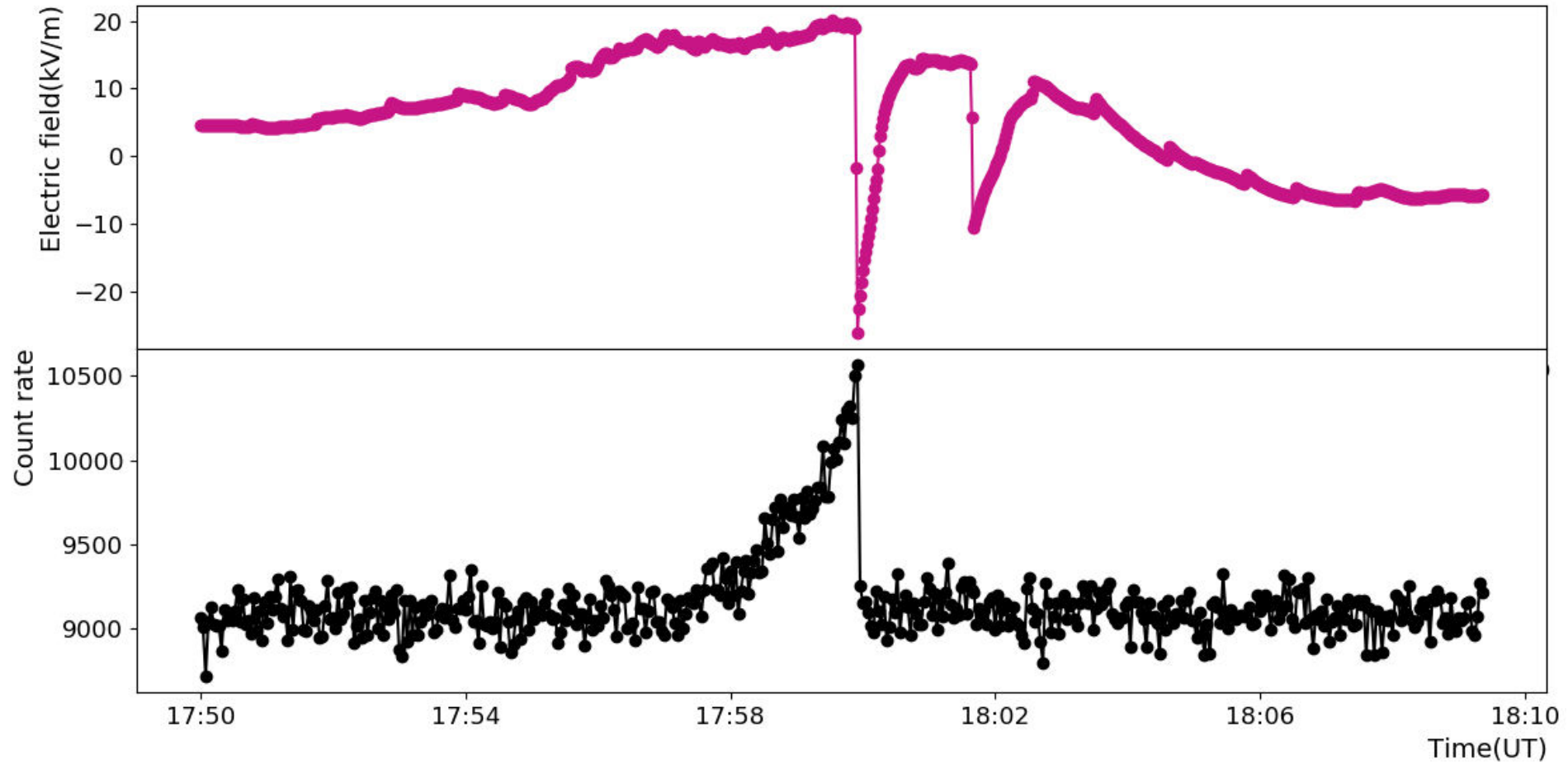
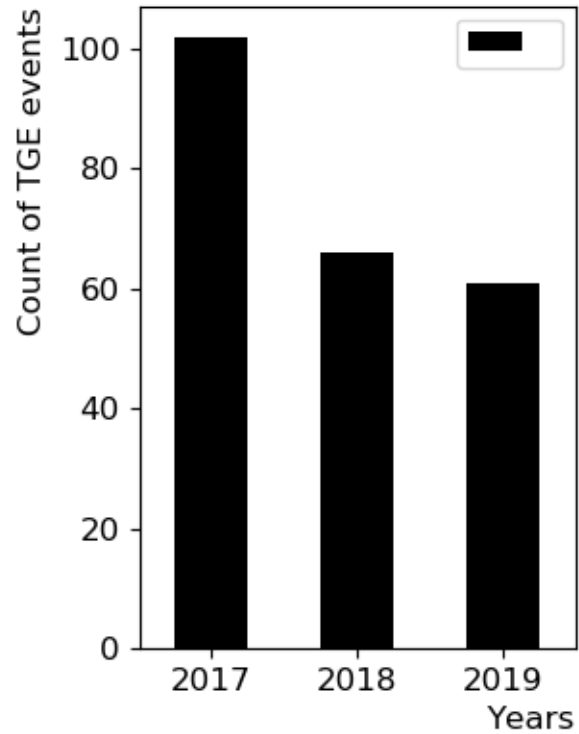
# Overview

- Thunderstorm activity in Aragats
- TGE termination by lightning
- Types of lightning
- Classification based on electric field
- Instrumentation
- Table of already classified lightning discharges
- Data
- Ani source
- Neural network
- Results
- Summary

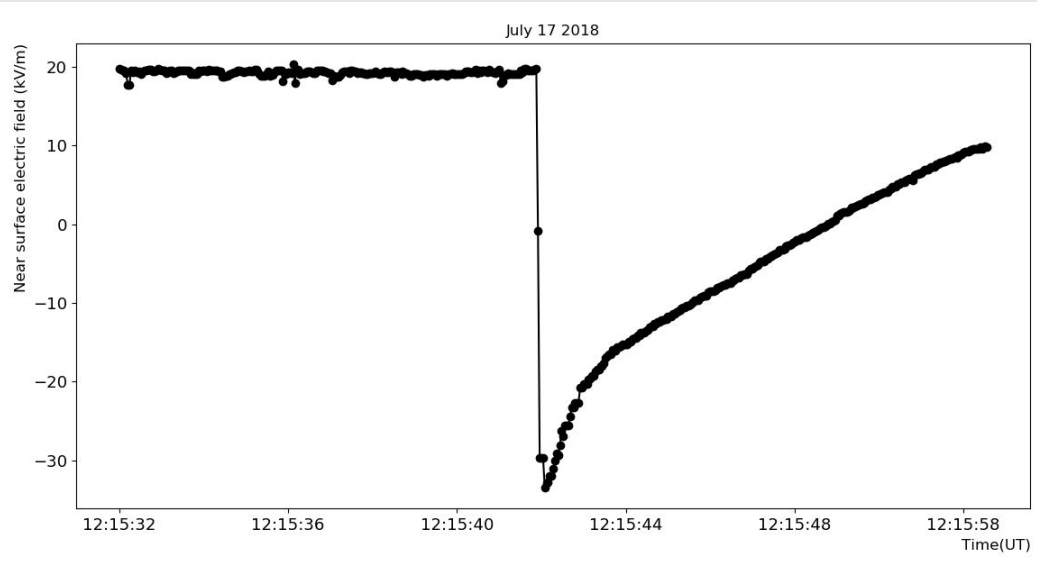
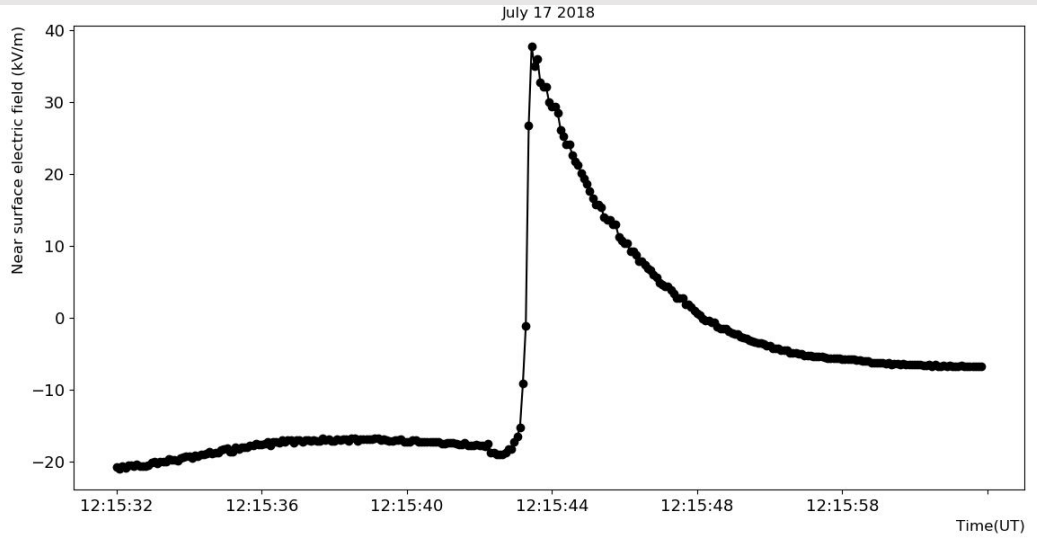
# Thunderstorm activity in Aragats



# TGE activity and termination by lightning

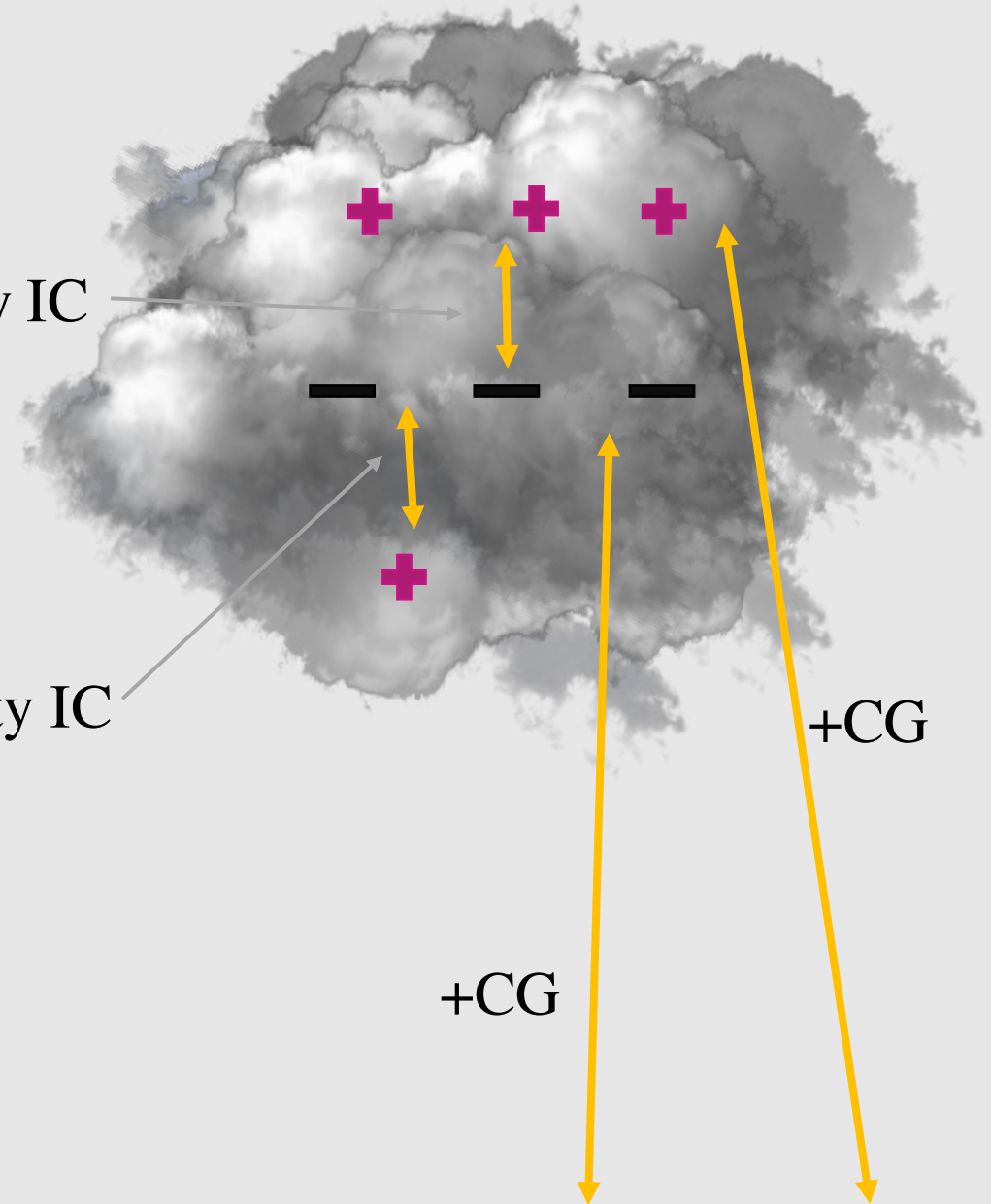


# Types of lightning discharges



Normal polarity IC

Inverted polarity IC



Student test

correlation matrix

Kolmogorov -  
Smirnov test

ANI

Bayesian test

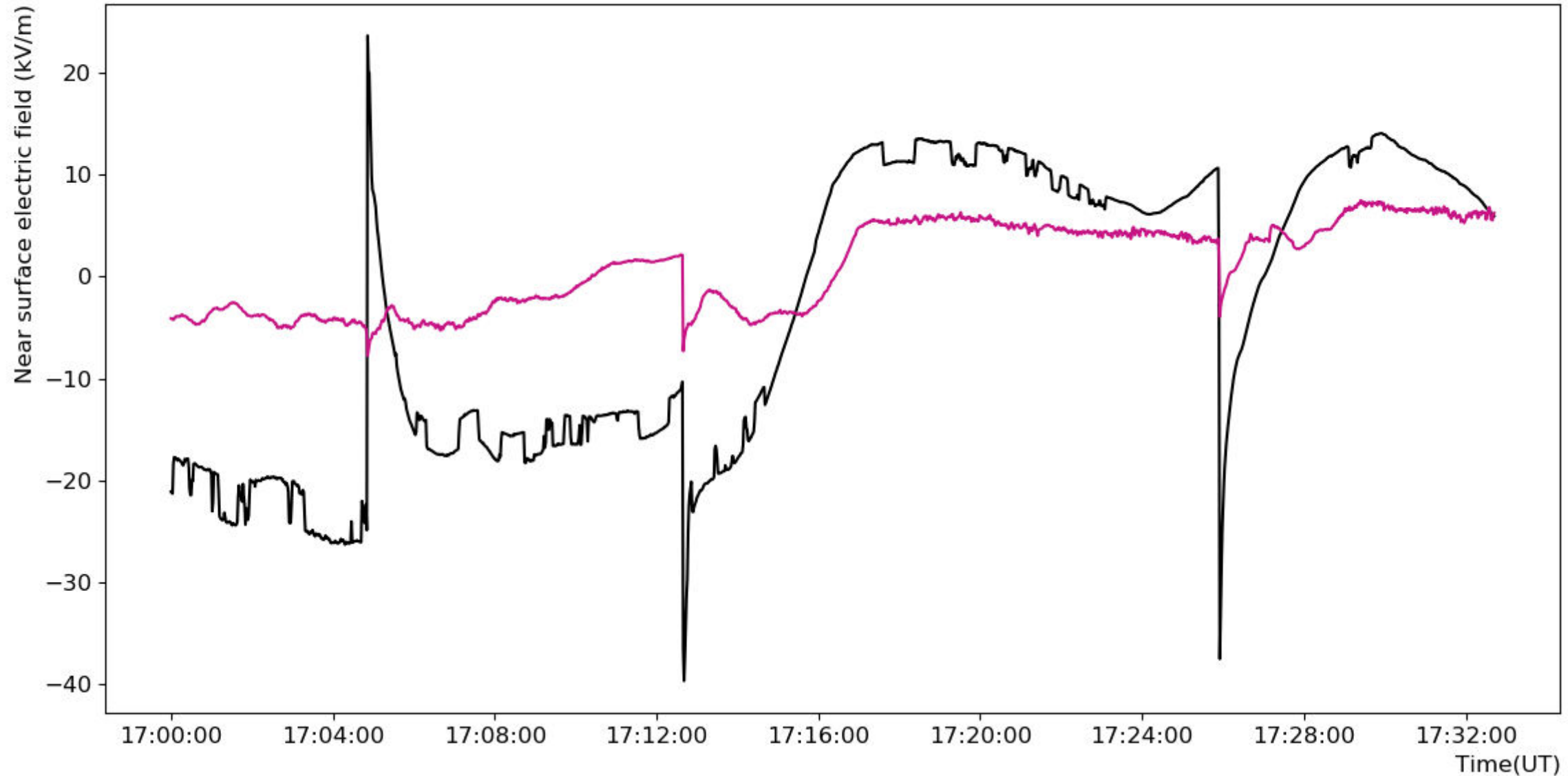
Mahn -  
Uhithny test.

Fisher matrix

Neuronal network

# Classification of type of lightning based on electric field measurements

May 23 2015



# Table of already classified lightning discharges

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## Negative CG (15 events)

03.05.2017 13:54:21  
03.05.2017 13:57:06  
06.05.2017 12:42:23  
06.05.2017 12:47:36  
12.05.2019 20:50:32  
13.06.2019 19:49:20  
18.06.2019 22:13:53  
29.06.2019 13:58:19  
08.07.2019 14:14:10

## Inverted polarity IC (12 events)

08.06.2019 11:02:03  
14.06.2019 17:58:17  
18.06.2019 22:07:17  
07.07.2019 12:00:17  
07.07.2019 12:04:32  
08.07.2019 15:04:45  
08.07.2019 15:05:47  
08.07.2019 15:07:20  
08.07.2019 15:08:58

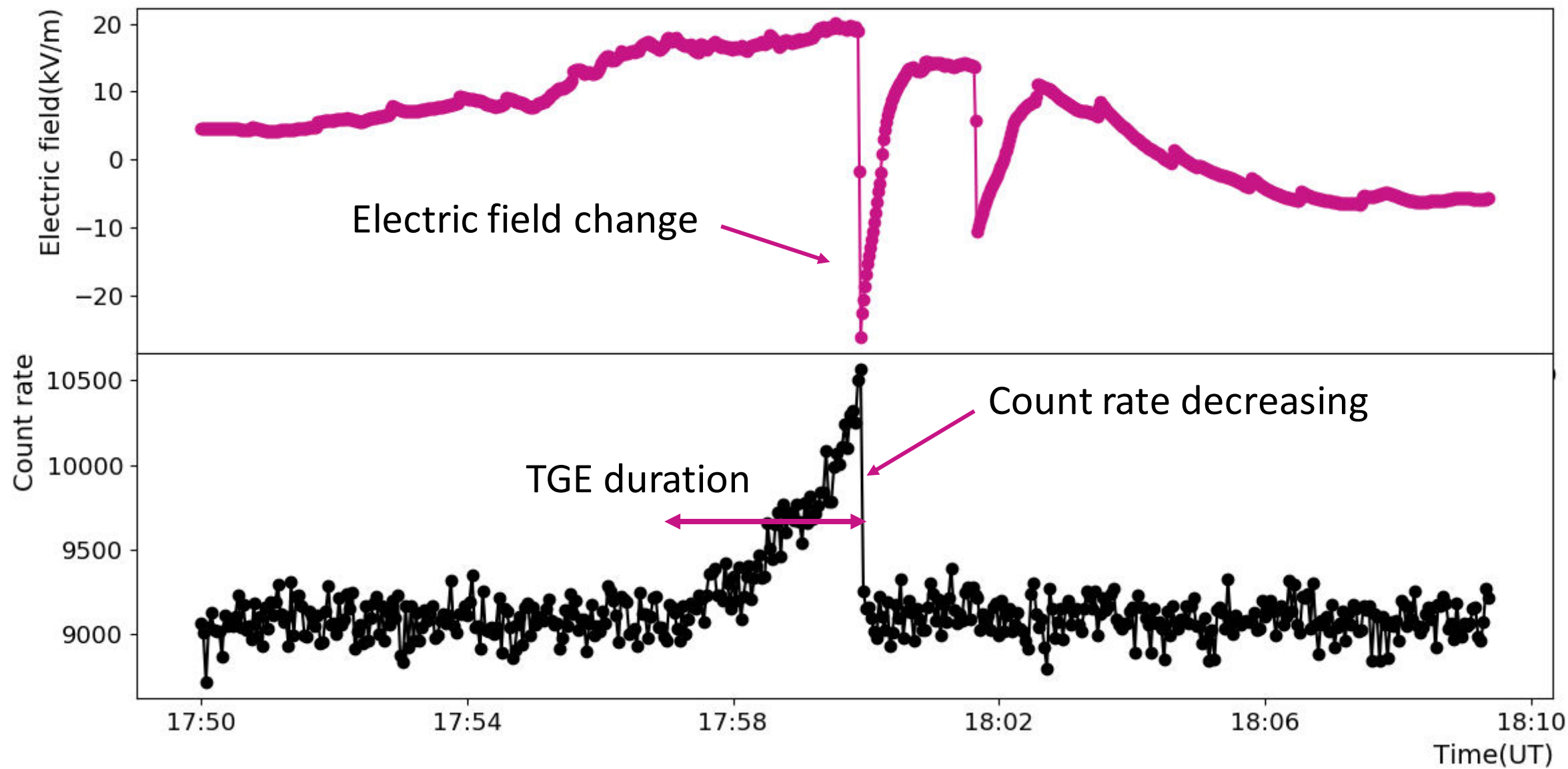
## Normal polarity IC (19 events)

10.08.2018 13:07:09  
11.09.2018 13:52:25  
12.05.2019 20:40:10  
18.05.2019 16:51:24  
20.05.2019 4:22:49  
20.05.2019 4:25:00  
24.05.2019 15:40:51  
13.06.2019 19:51:53  
08.07.2019 14:15:55

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# Used data

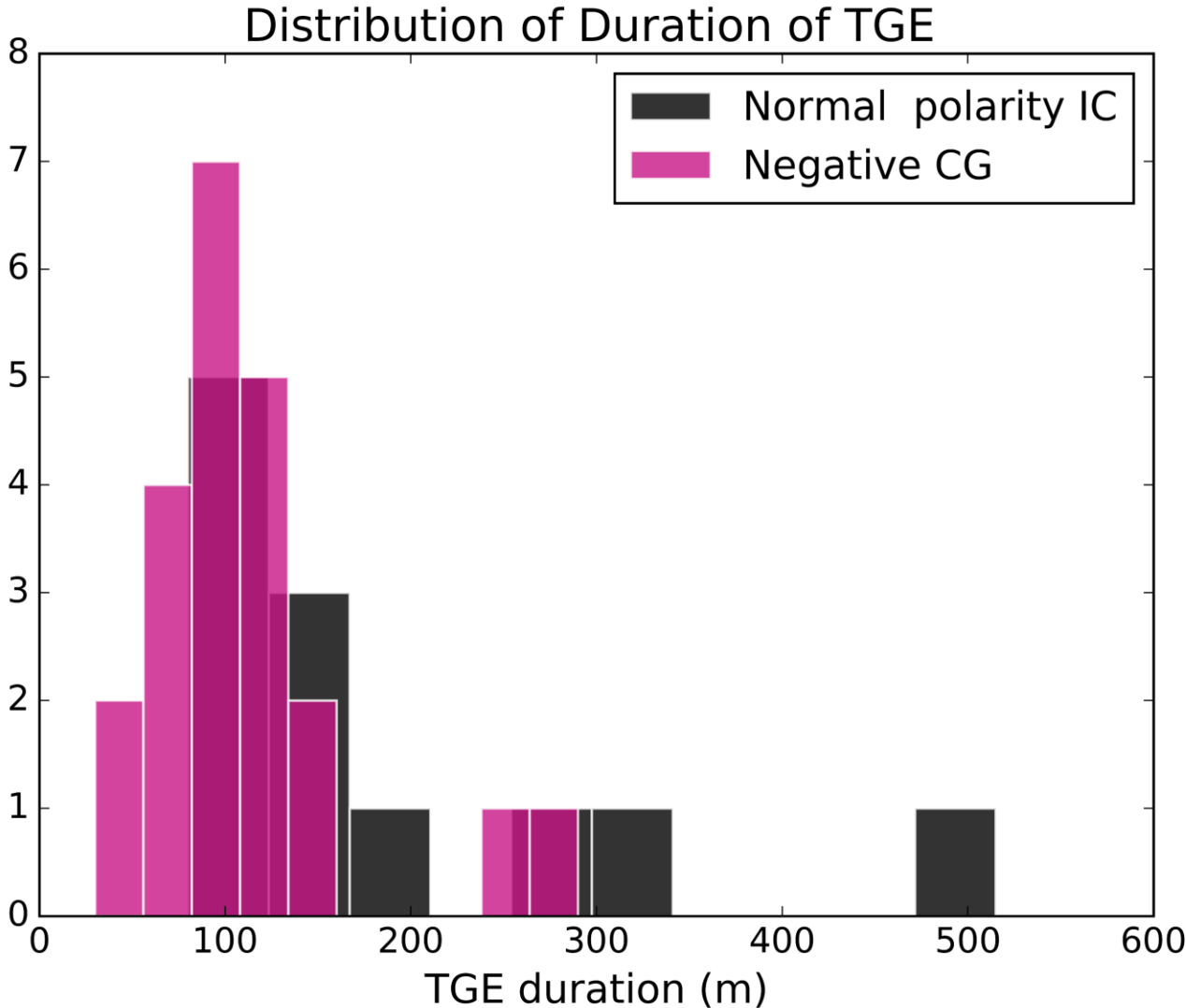


# Student or T test

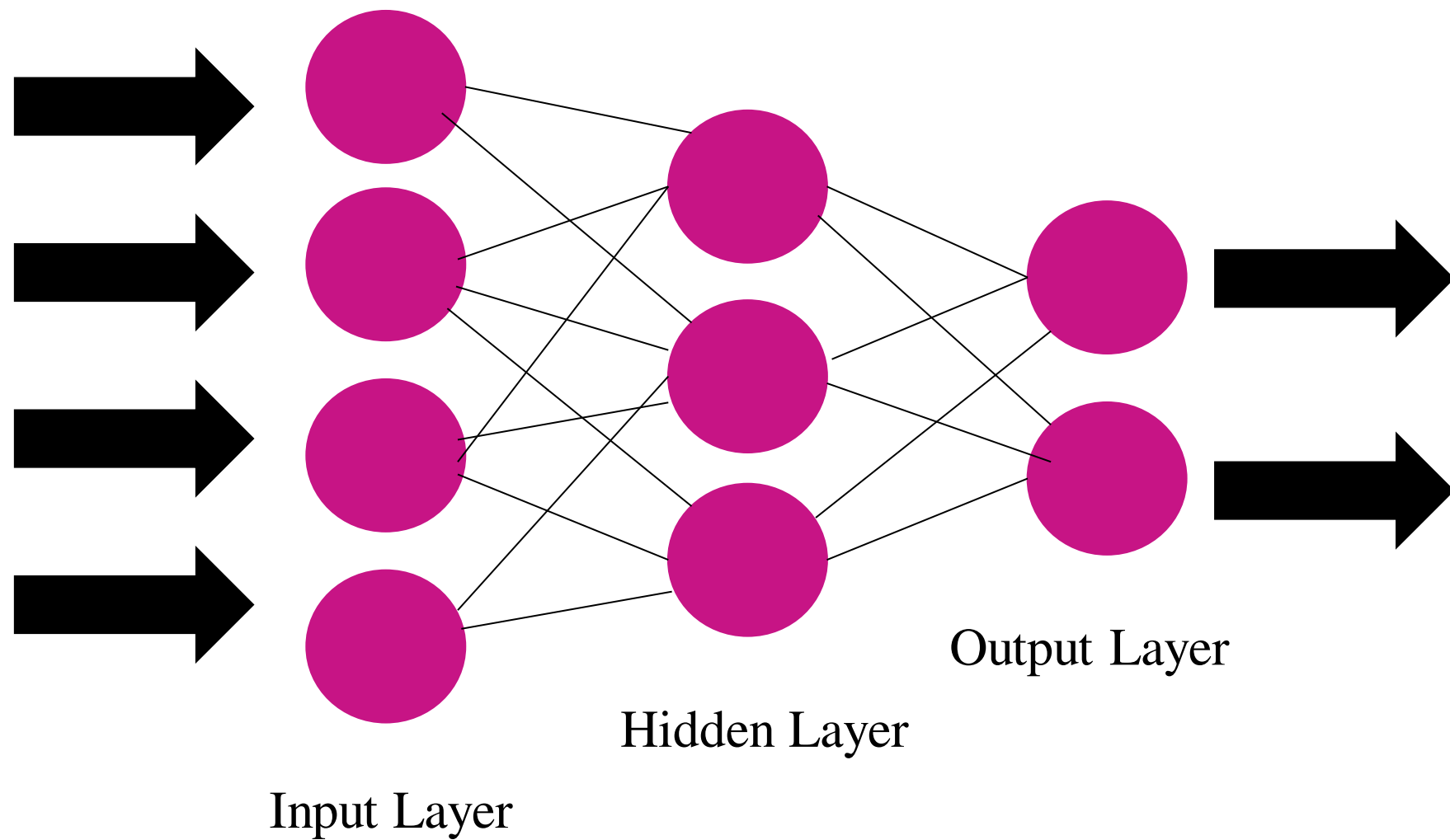
- A large t-score tells that the groups are different.

$$t = \frac{\frac{(\sum D)/N}{\sqrt{\frac{\sum D^2 - \frac{(\sum D)^2}{N}}{(N-1)(N)}}}$$

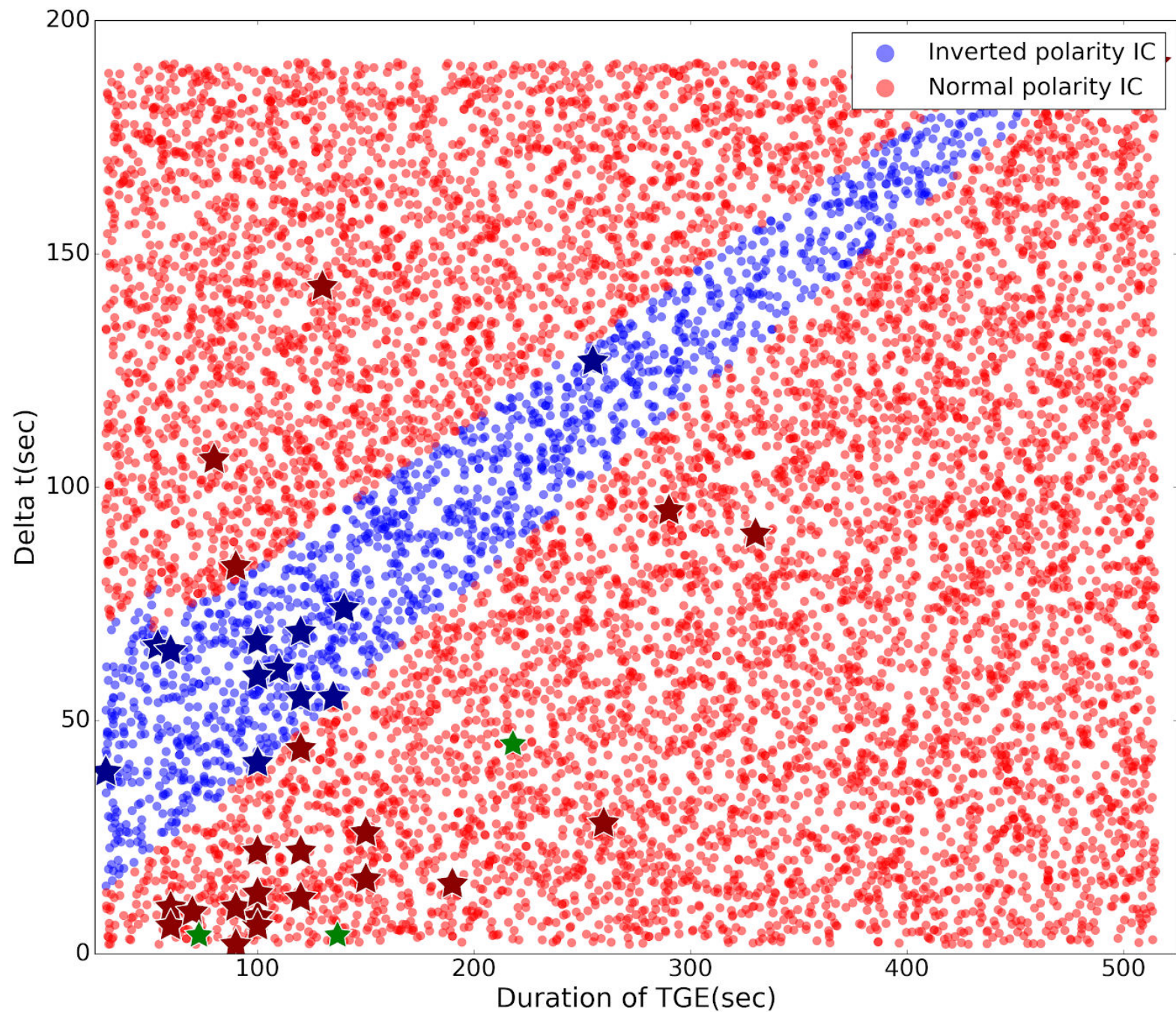
Inverted vs normal polarity IC	
	T value
TGE duration	2.2
CR Decreasing	2.1



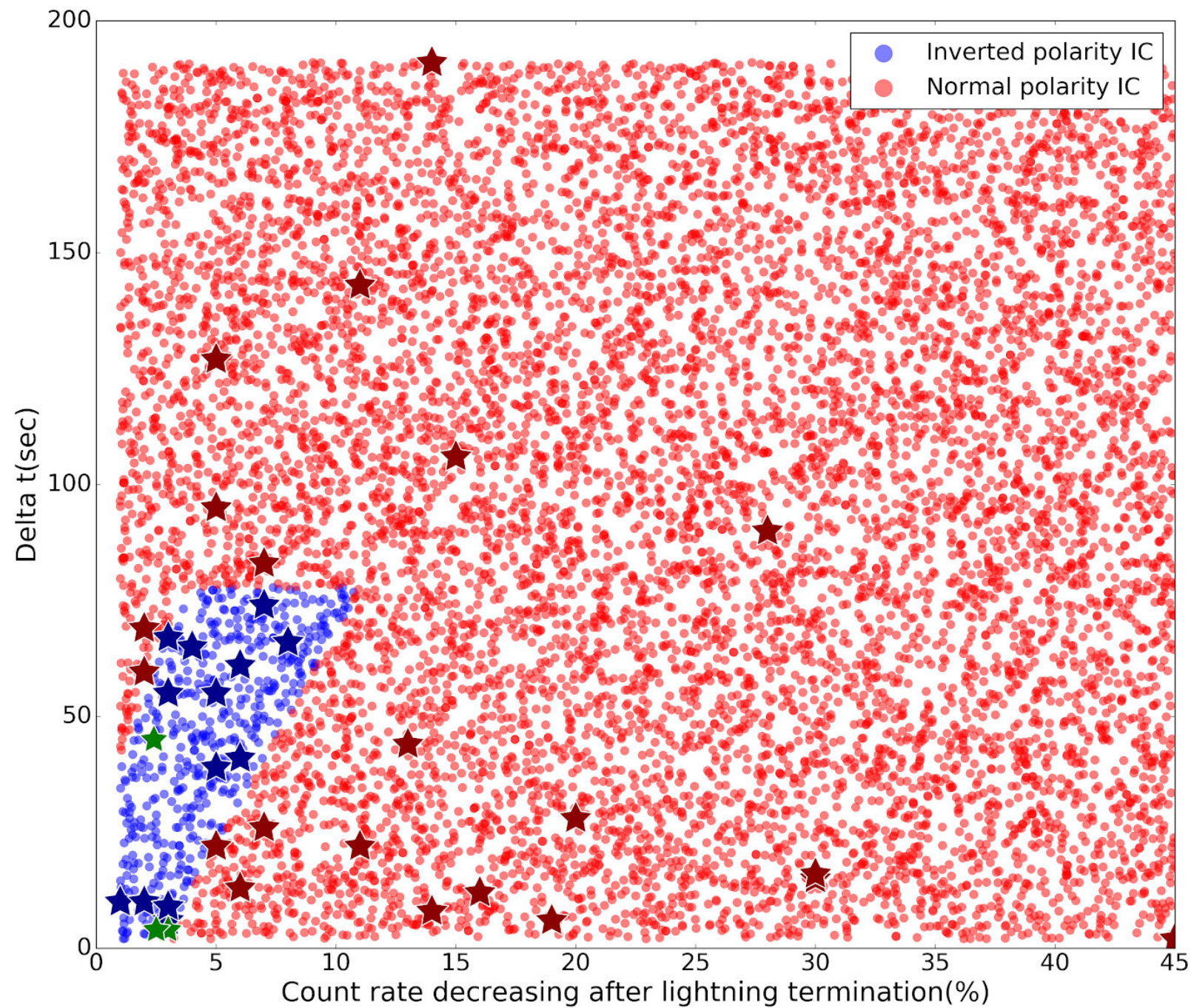
# Neural network



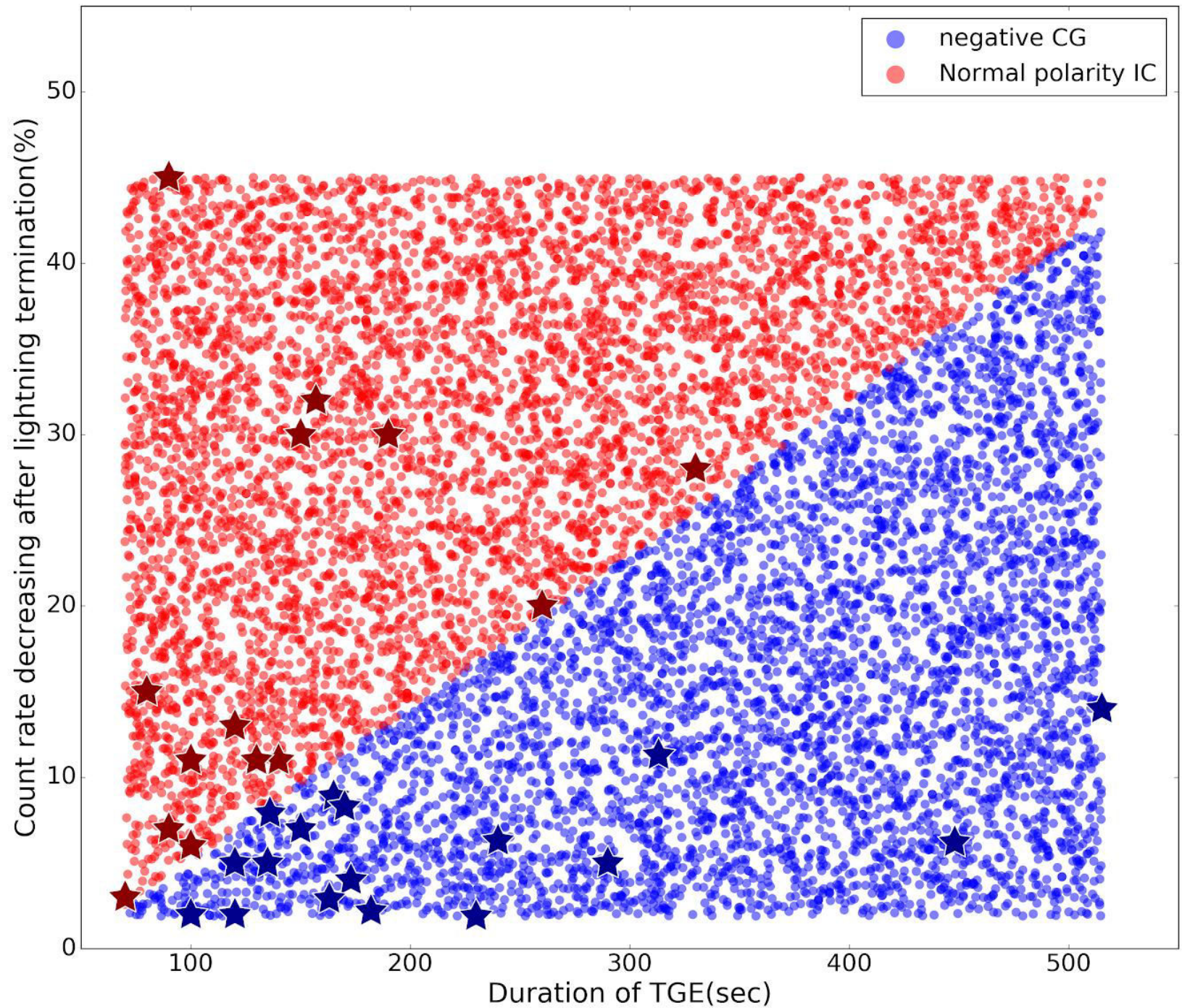
# Inverted and Normal polarity IC



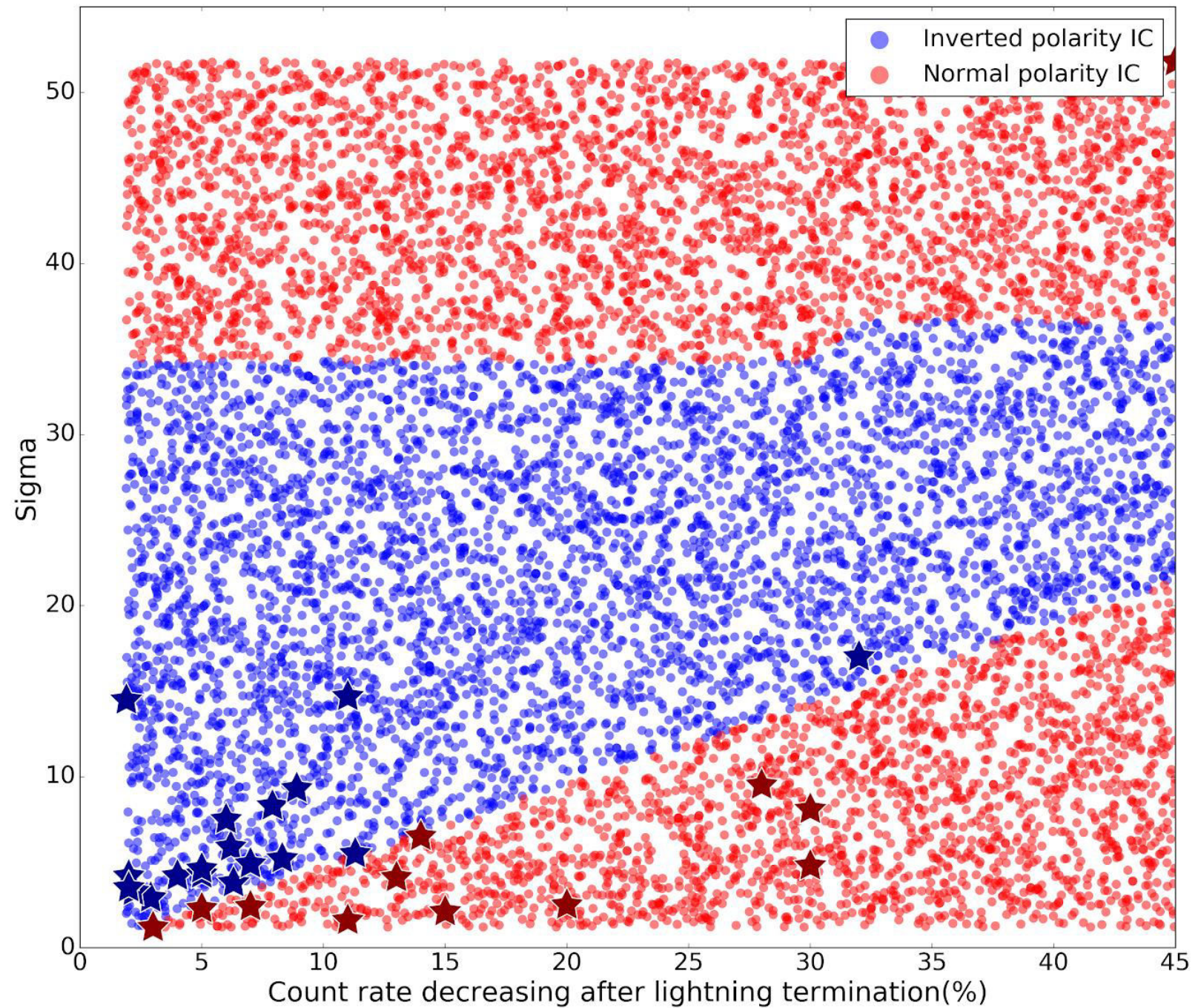
# Inverted and Normal polarity IC



# Negative CG and Normal polarity IC



# Negative CG and Normal polarity IC



# Summary

- We can classify lightning types using only data from particle detectors.
- The ML algorithm worked 93% correctly to separate the CG and IC discharges
- TGE duration shows many correlations with all particle parameters and electric field.



Questions ?