

# About some questions in modern models of thunderstorm runway breakdown

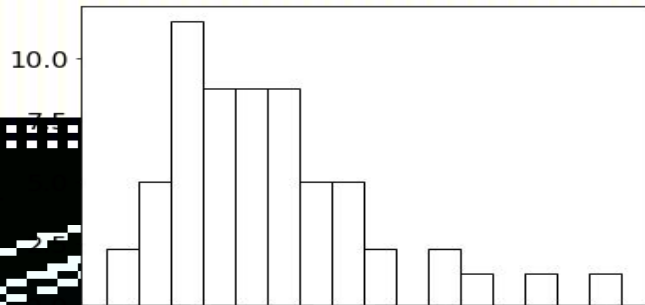
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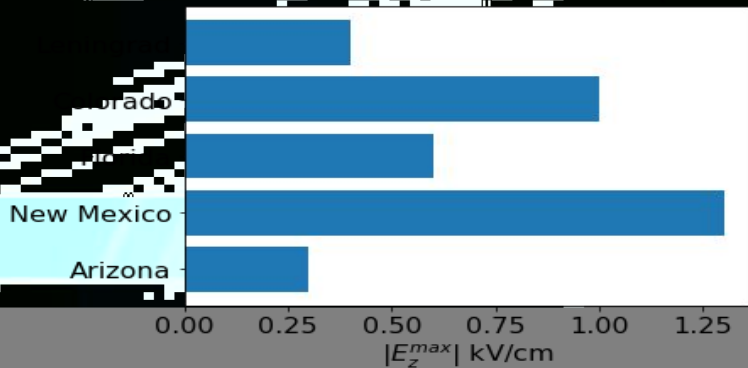
# Thunderstorm breakdown problem

Breakdown electric field ( $E_{th}$ ):

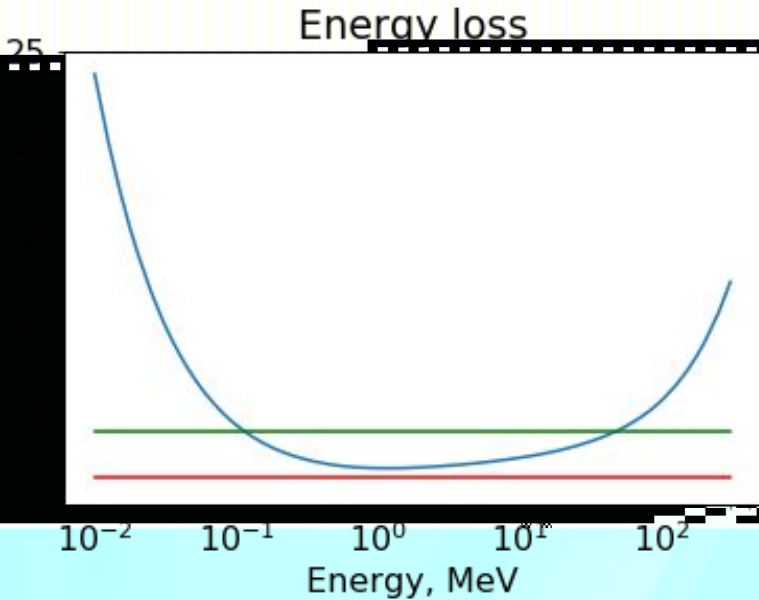
Distribution of horizontal electric field



But real field in cloud is  
an order of magnitude less



# Runway breakdown



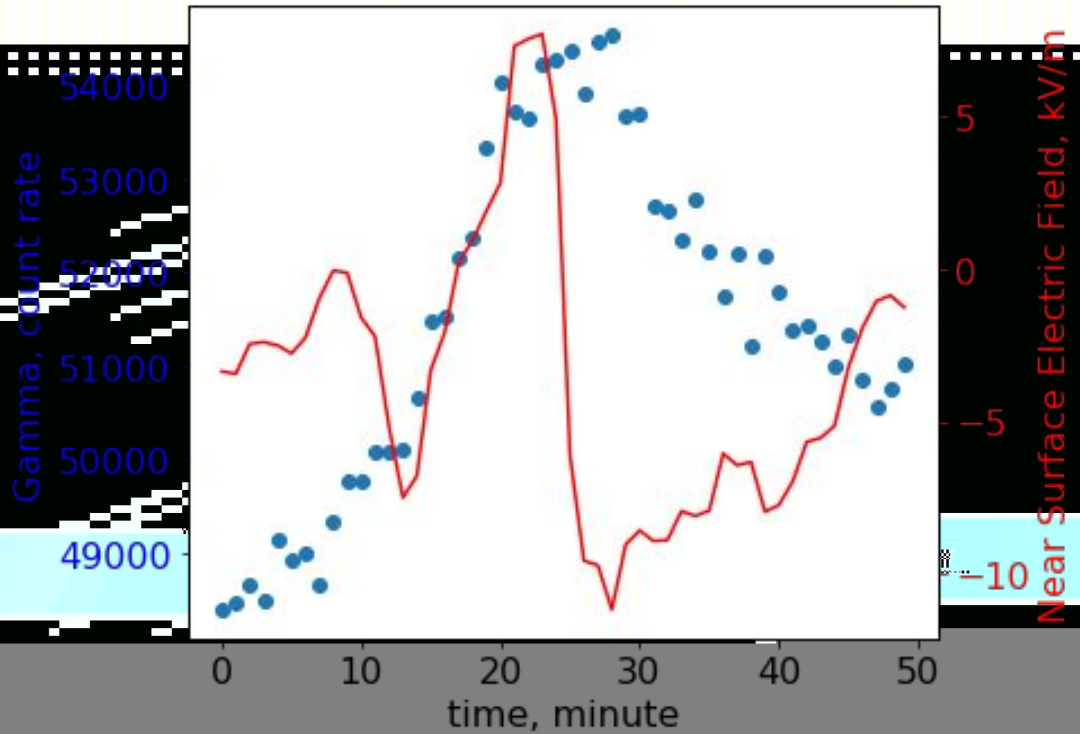
## Gurevich model:

primary ion  
relative to  
breakdown  
condition ~2 keV/sm

# Gamma-ray emissions

- Runway relativistic

Observation TGE on Aragats mount



(TGF and TGE)

# Dwyer model

# Runway breakdown

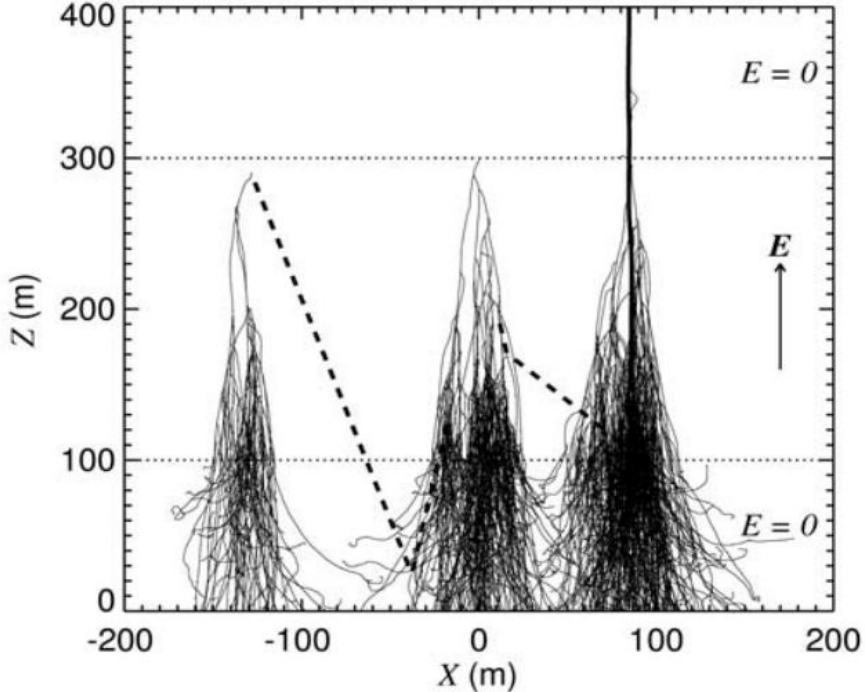
Cloud is an area with length much greater than width and electric field is uniform by width. Improved Gurevich model



gamma to back and ionizes cloud creating new

- Gamma create new primary electron in top area of cloud
- primary electron

# Simulation

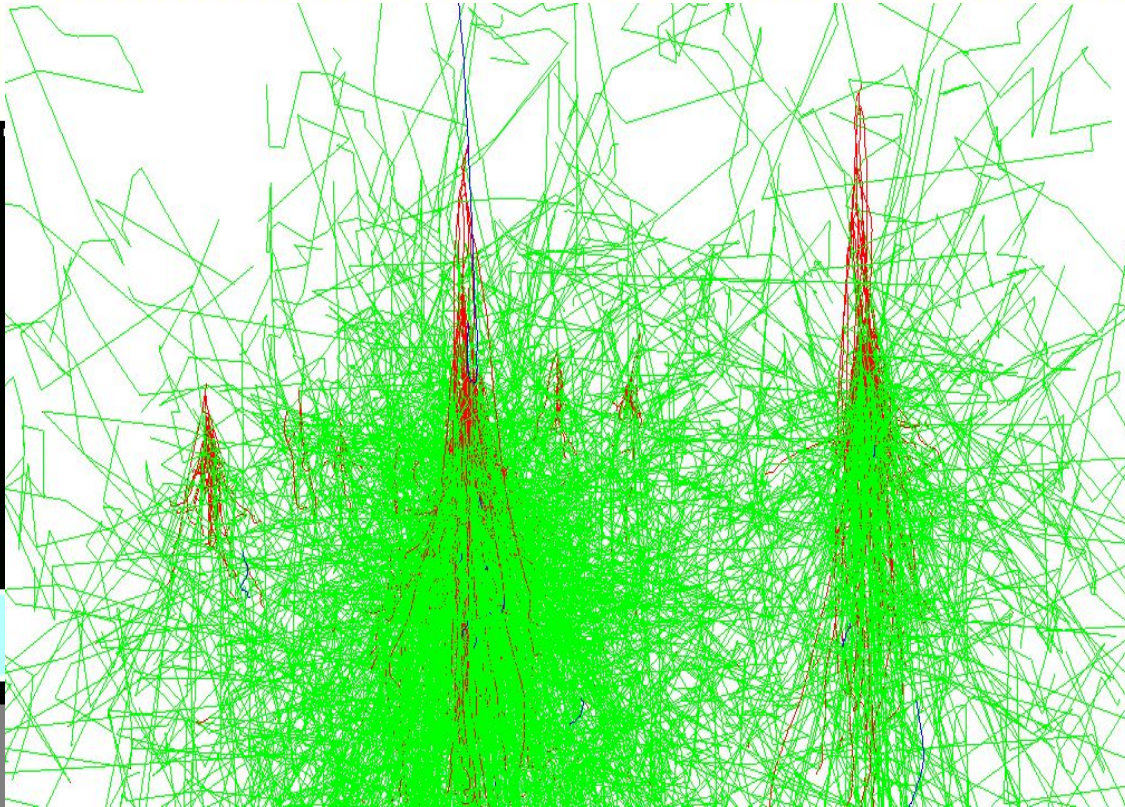


## Conditions:

- normal pressure
- electric field  $10 \text{ kV/cm}$
- primary electron energy  $1 \text{ MeV}$
- $U = 0$
- On graph:
  - light black tracks - electrons
  - bold black track - positron
  - dashed line - gamma-rays

J. R. Dwyer A fundamental limit on electric field in air, Geophysical research letters vol. 30 N. 20, 2003 year.

# GEANT4 simulation: repeating Dwyer



- Normal pressure
- Electric field **10 kV/cm**

Red tracks

Blue tracks

Green tracks



# Realistic simulation

# Methodology

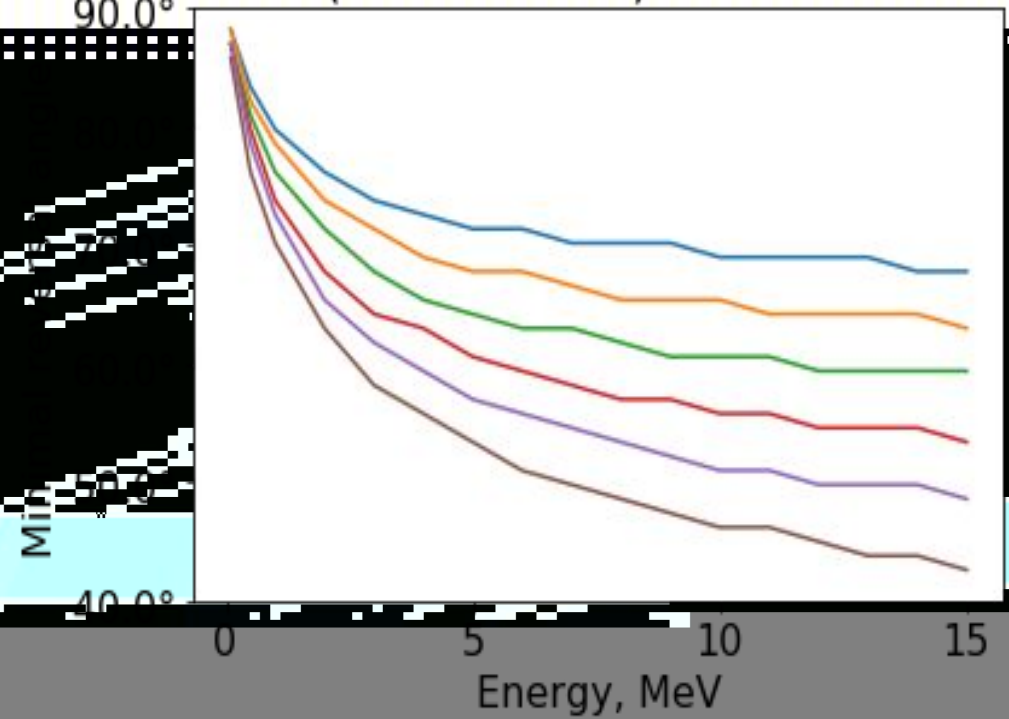
In order to estimate coefficient of reproduction, we

4. compute number of new avalanches, therefore providing coefficient of reproduction (gain).

# Conditions

1. Positron energy and angle should allow it to be

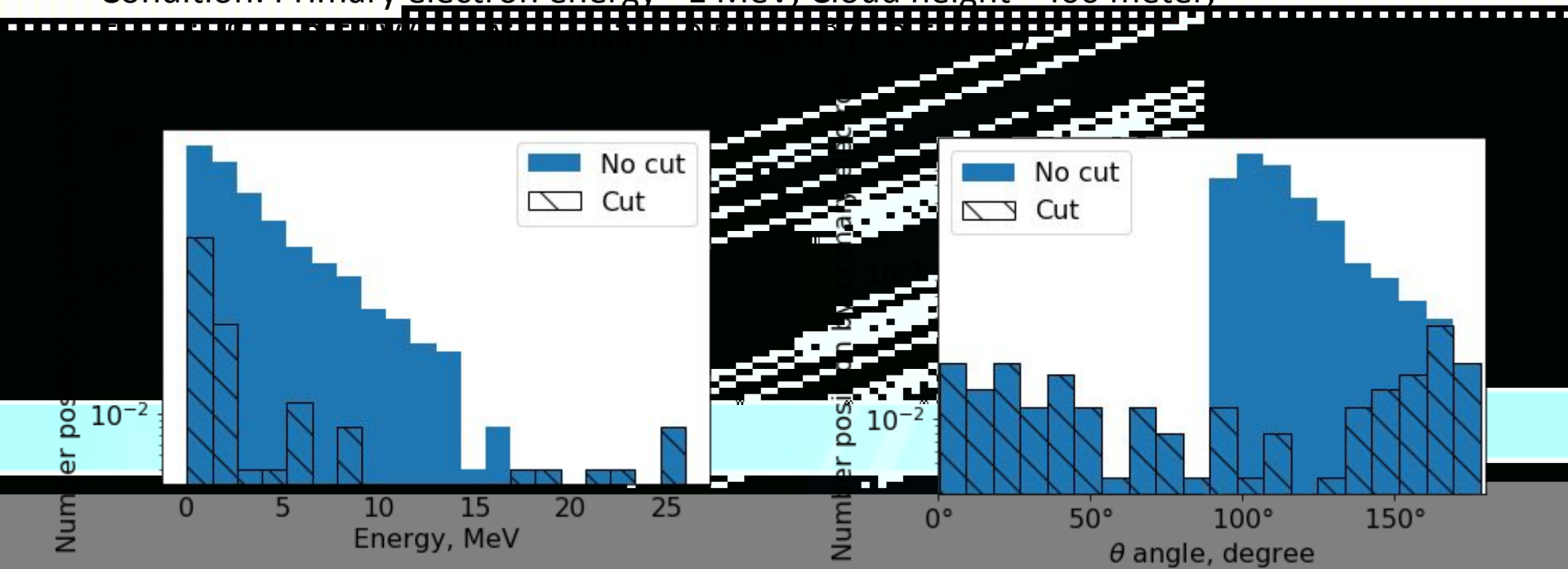
Electron (and Positron) reversal condition



# Positron spectra

Example of 1 and 2 point of methodology

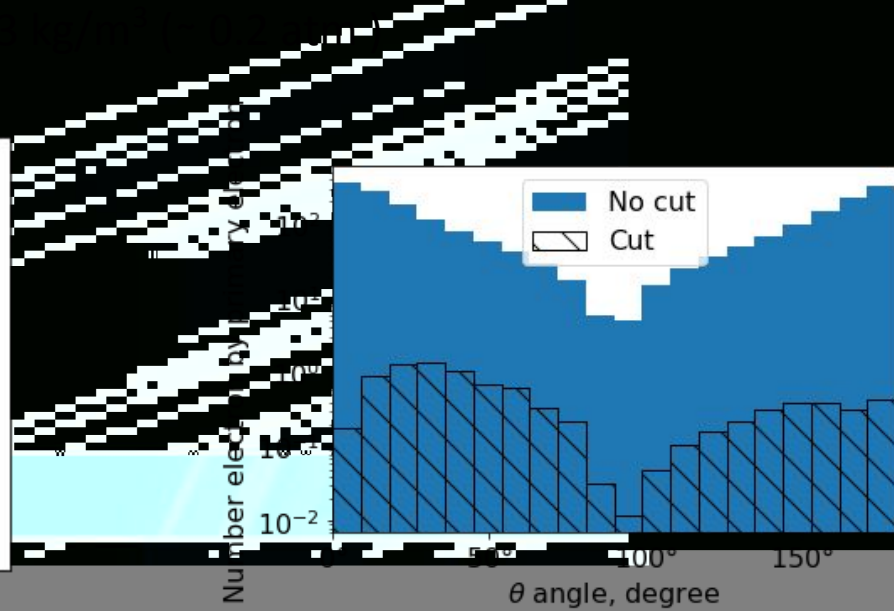
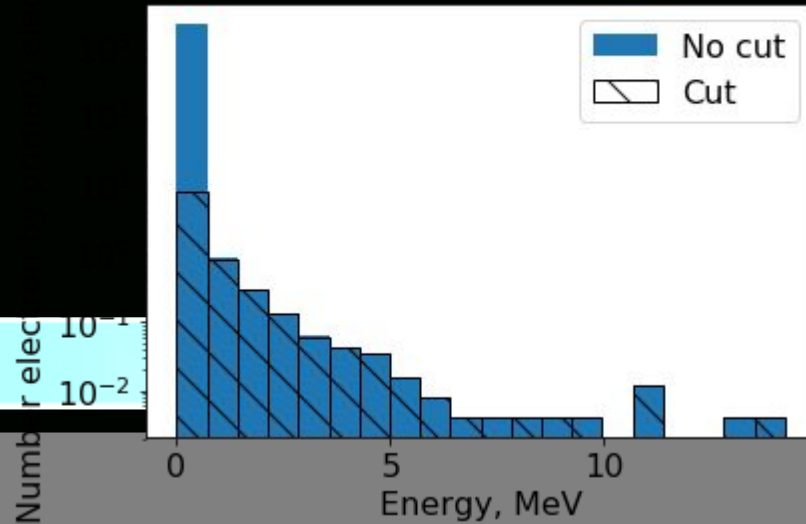
Condition: Primary electron energy - 1 MeV, Cloud height - 400 meter,



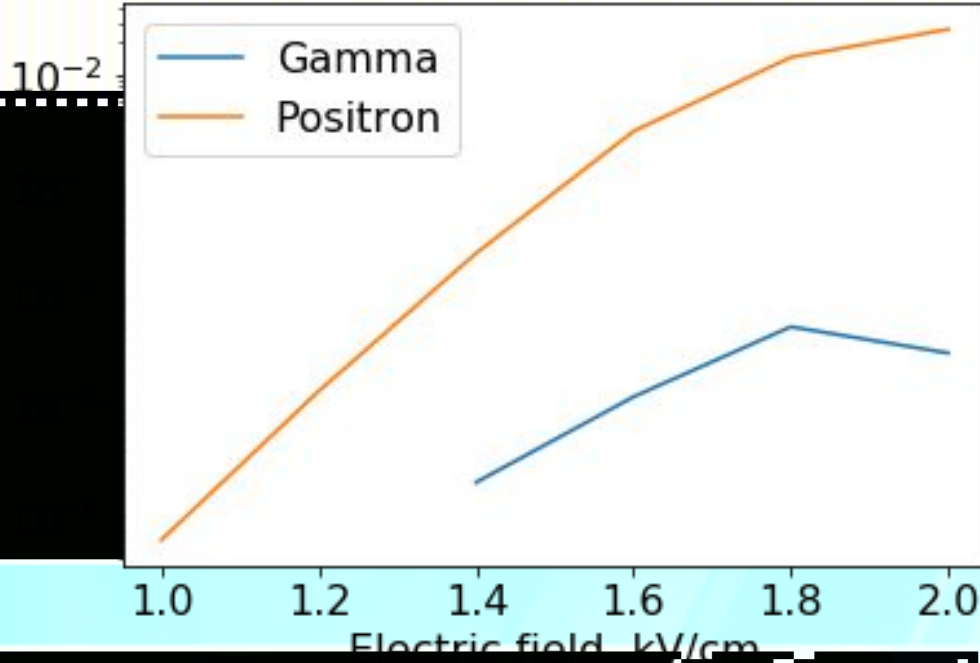
# Positron electron spectra

Example of 3 and 4 point of methodology

Condition: Primary electron energy = 1 MeV, Cloud height = 400 meters



# Gain coefficient



- Primary electron energy

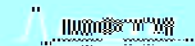
3 MeV

Electric field

1.8 kV/cm

Air density

0.5 atm



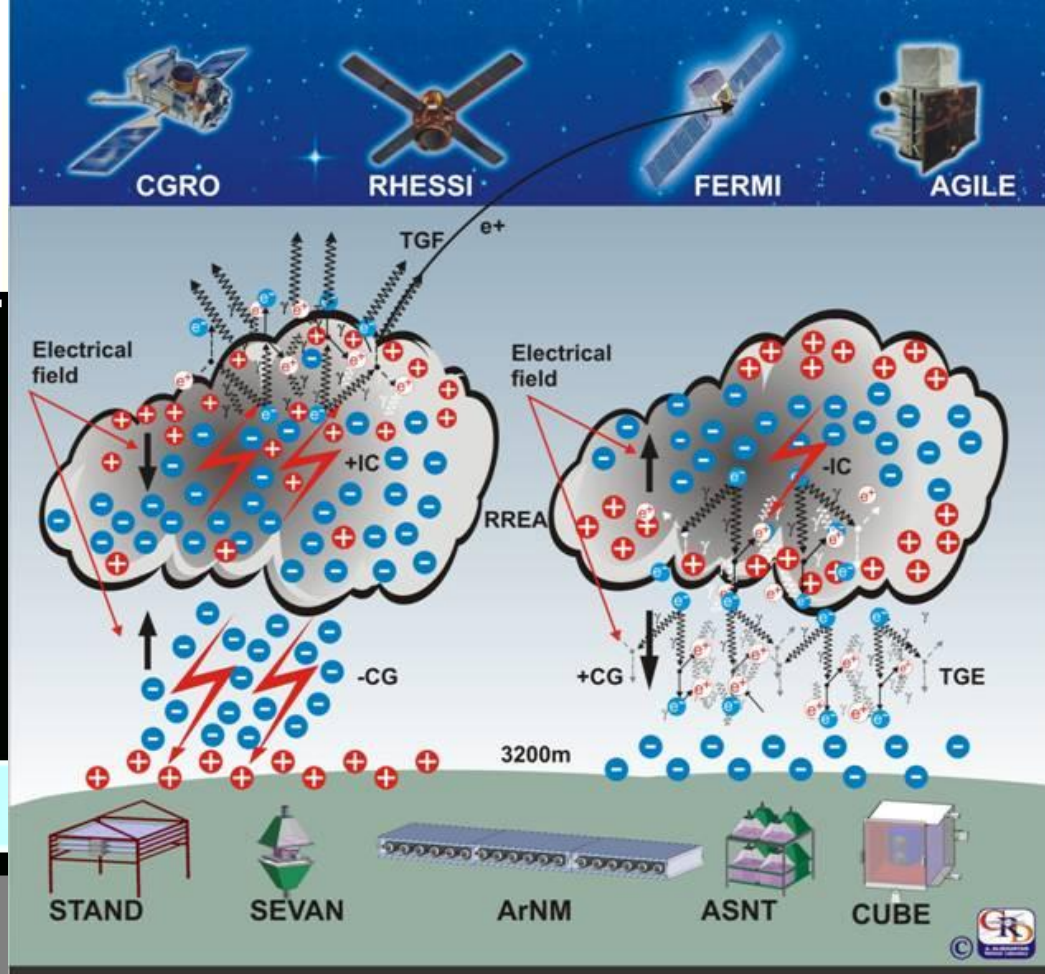
# Conclusions

• Power of electric field  
for  $\mu \approx 10^{-3}$   $\epsilon \approx 0.7$  res

# Thank you for your attention

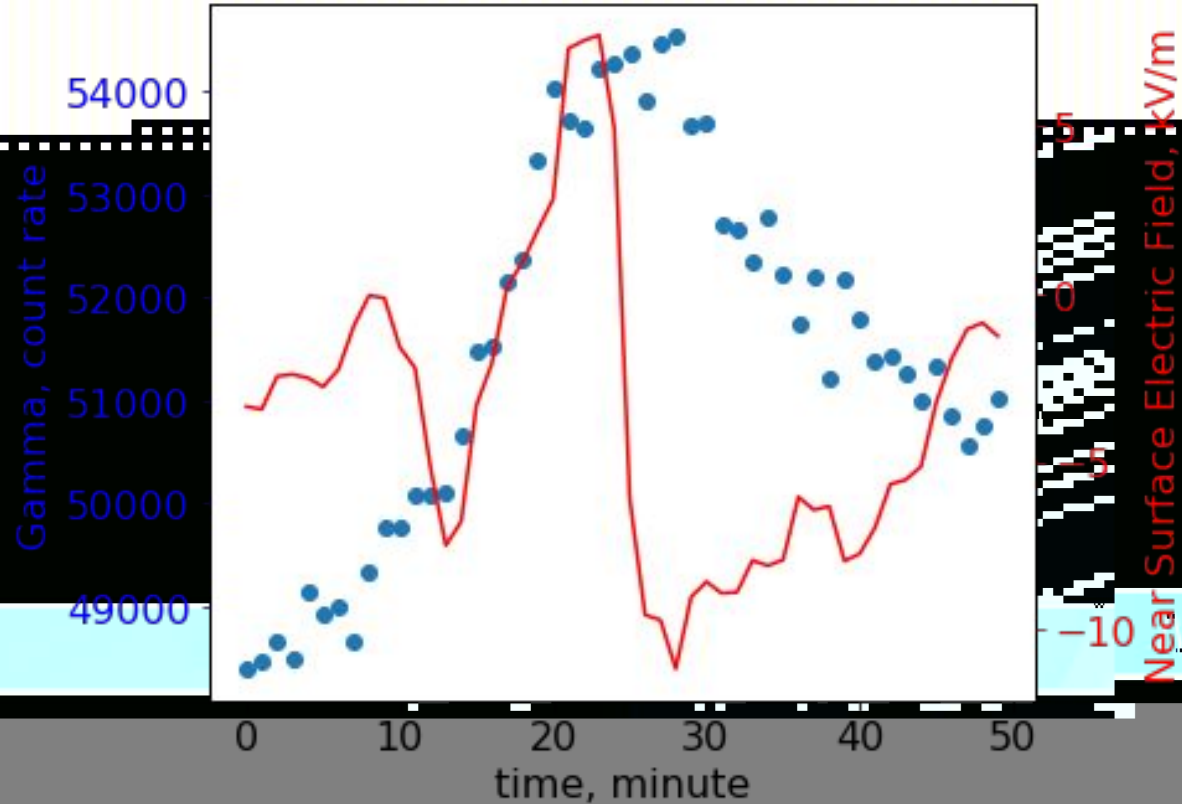






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# Observation TGE on Aragats mount



# New Mexico ballooning measurement



## Positron Gain Coefficient Comparison

