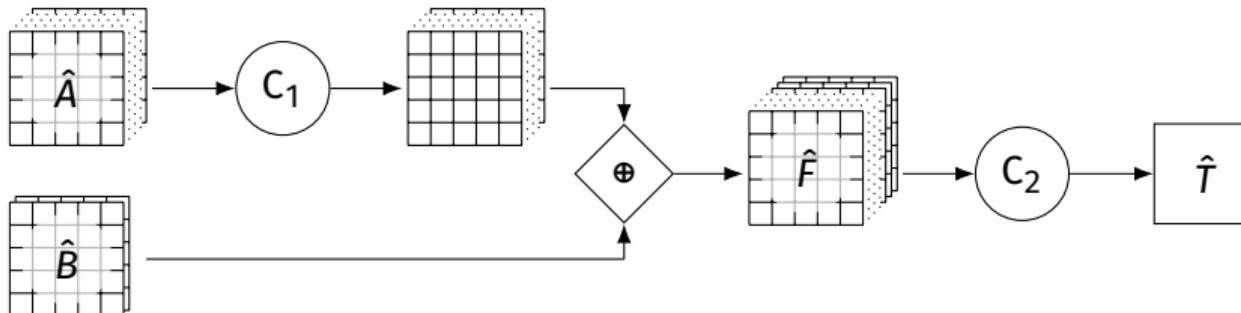


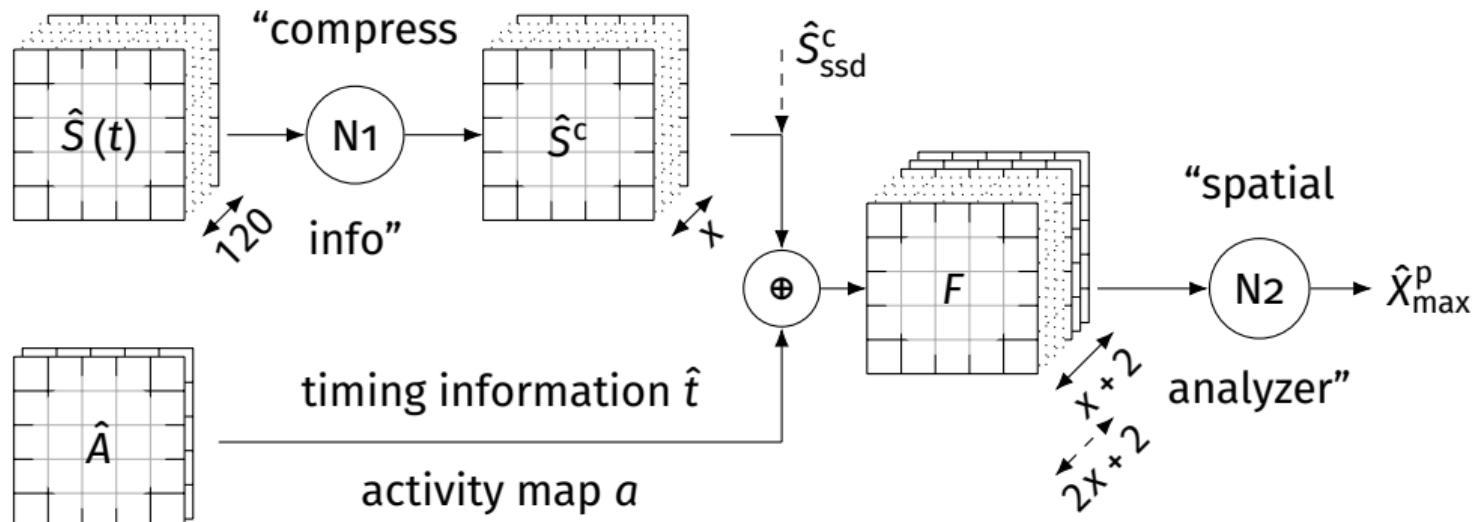
# Prediction of shower depth using neural networks

D. Veberič, D. Schmidt, M. Roth, **S. Hahn** | Supvs.: R. Engel, B. Wundheiler | 26.11.2020

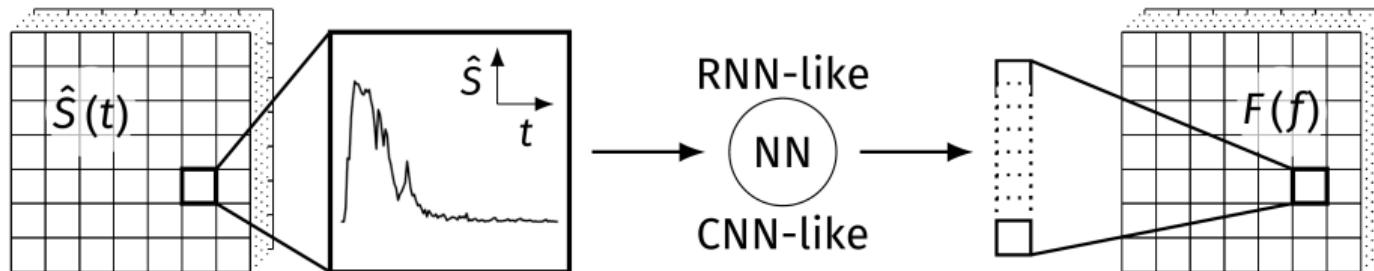
KIT - IAP



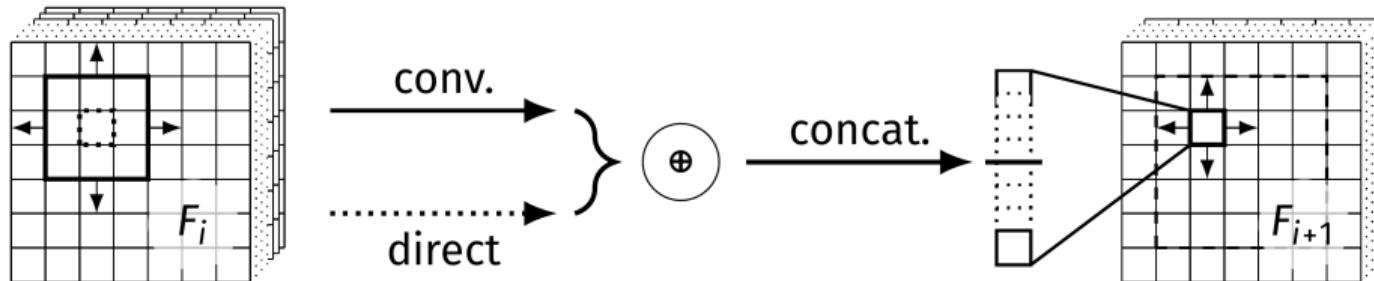
# Neural networks - architecture I



# Neural networks - architecture II



# Neural networks - architecture III



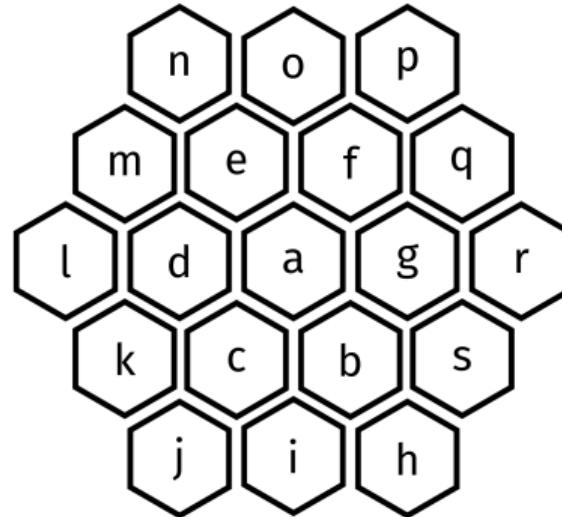
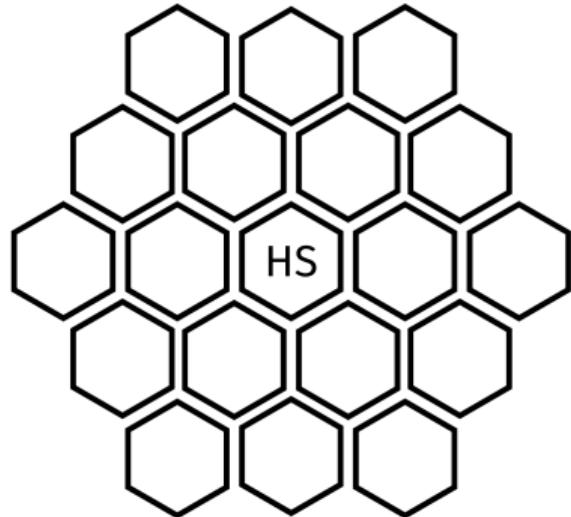
## Problems

- data pipeline
- spatial extend
- trace length

## ToDo

- data augmentation (black tanks,...)
- using all PMT/SSD information
- finding a suitable, final architecture

# Standardization - basics



Neural networks  
○○○○

Standardization procedure  
●○○○○○○

D. Veberič, D. Schmidt, M. Roth, S. Hahn | Supvs.: R. Engel, B. Wundheiler – Event learning

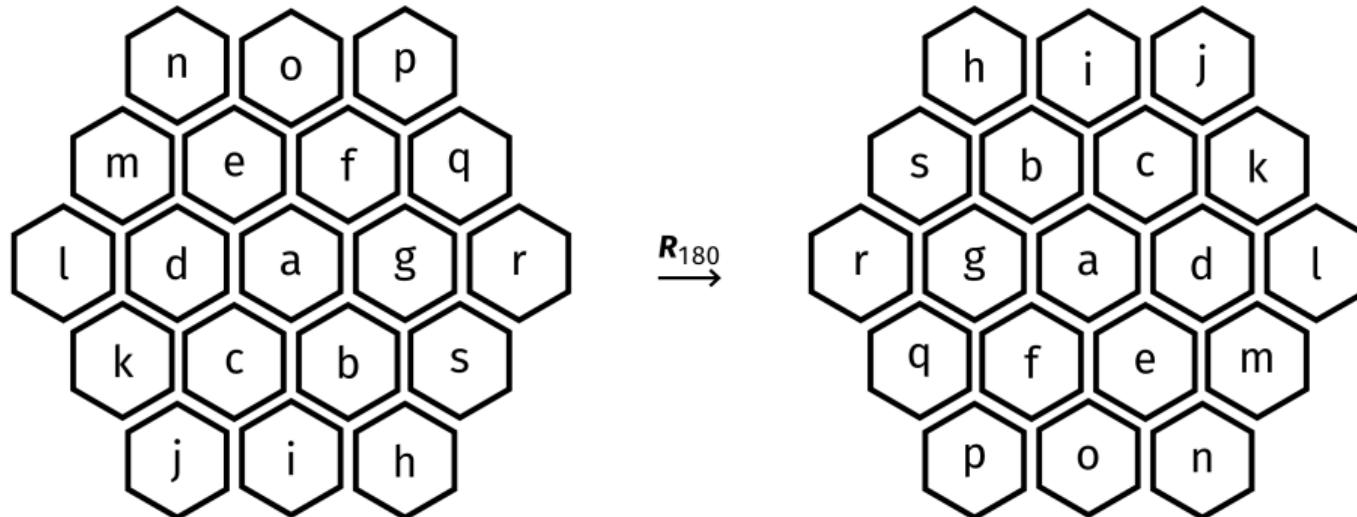
Application on MC  
○○○○

Application on data  
○○○○

November 26, 2020

6/20 (6)

# Standardization - symmetry I



Neural networks  
○○○○○

Standardization procedure  
○●○○○○○

D. Veberič, D. Schmidt, M. Roth, S. Hahn | Supvs.: R. Engel, B. Wundheiler – Event learning

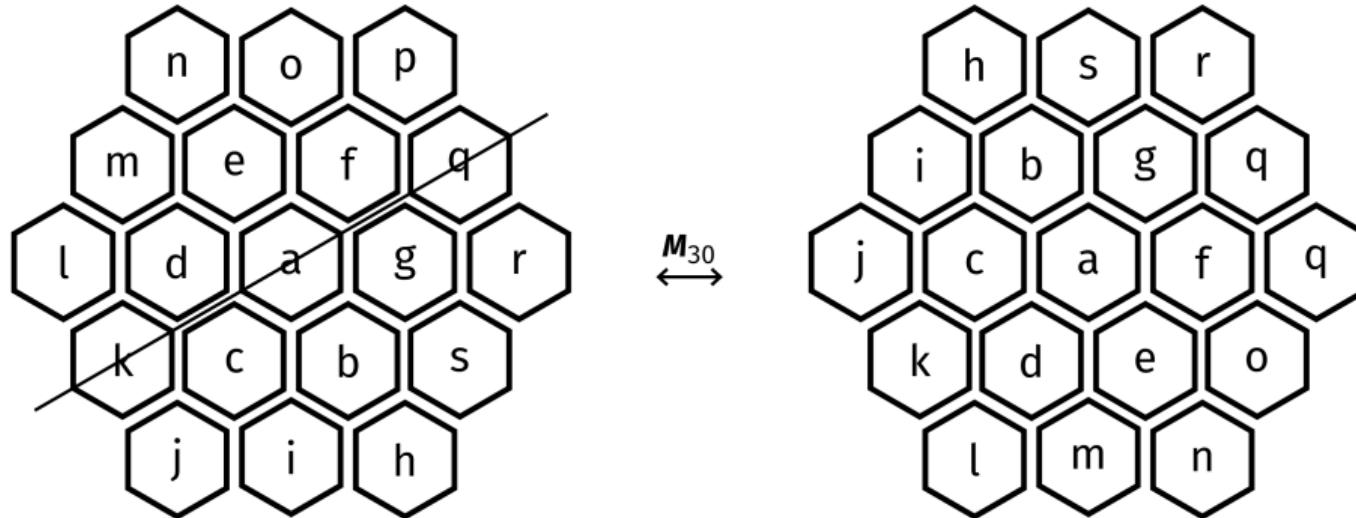
Application on MC  
○○○○○

Application on data  
○○○○○

November 26, 2020

7/20 (7)

# Standardization - symmetry II



Neural networks  
○○○○

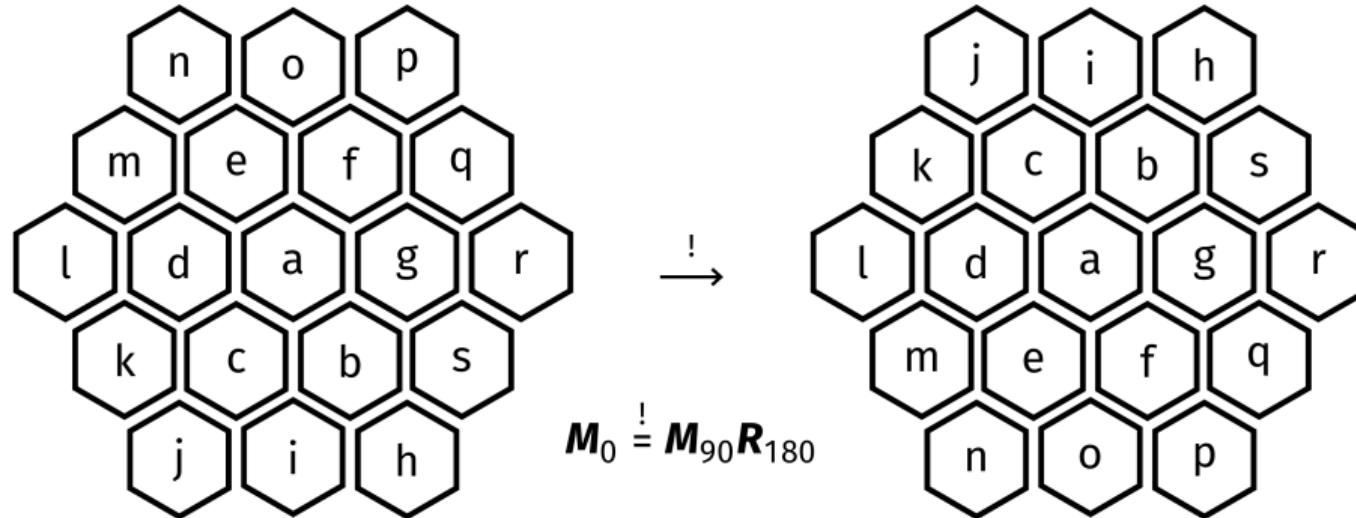
Standardization procedure  
○○●○○○

D. Veberič, D. Schmidt, M. Roth, S. Hahn | Supvs.: R. Engel, B. Wundheiler – Event learning

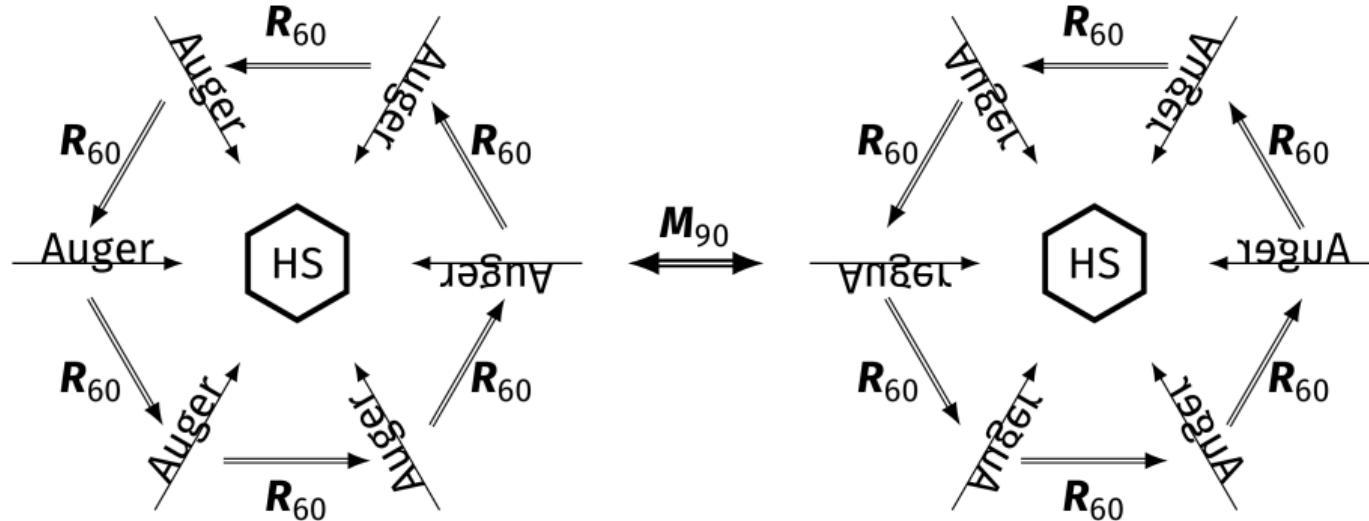
Application on MC  
○○○○

Application on data  
○○○○

# Standardization - degeneracy



# Standardization - transformations



Neural networks  
○○○○

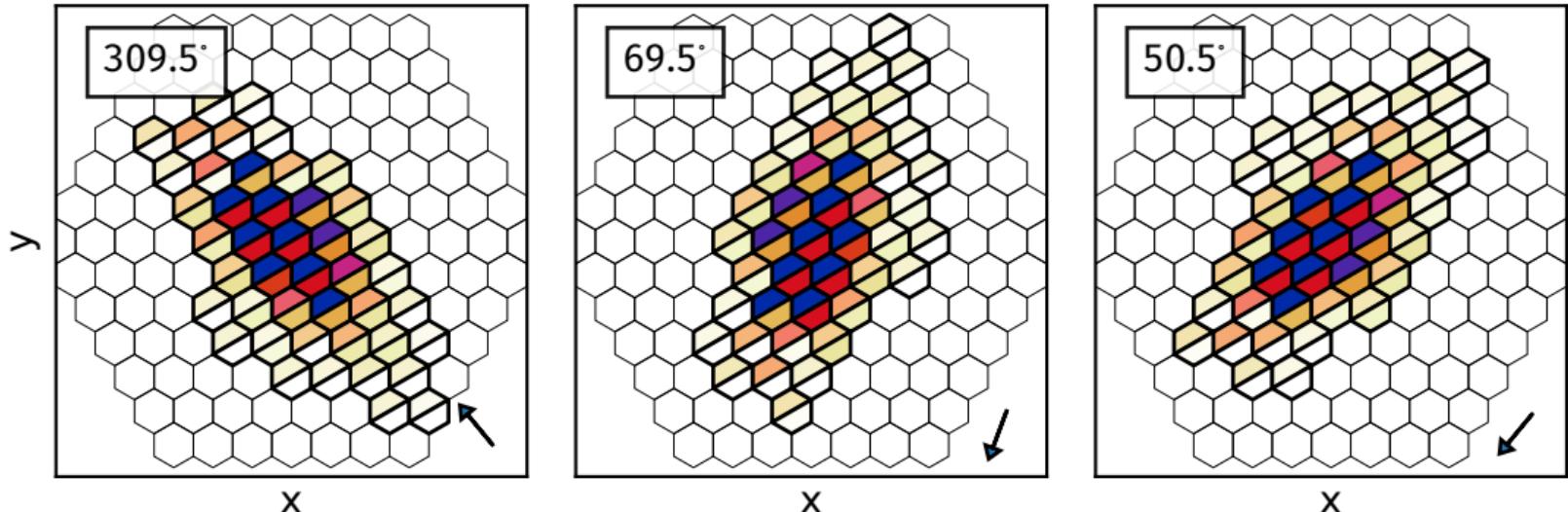
Standardization procedure  
○○○●○○

D. Veberič, D. Schmidt, M. Roth, S. Hahn | Supvs.: R. Engel, B. Wundheiler – Event learning

Application on MC  
○○○○

Application on data  
○○○○

# Standardization - application



# Standardization - Outlook

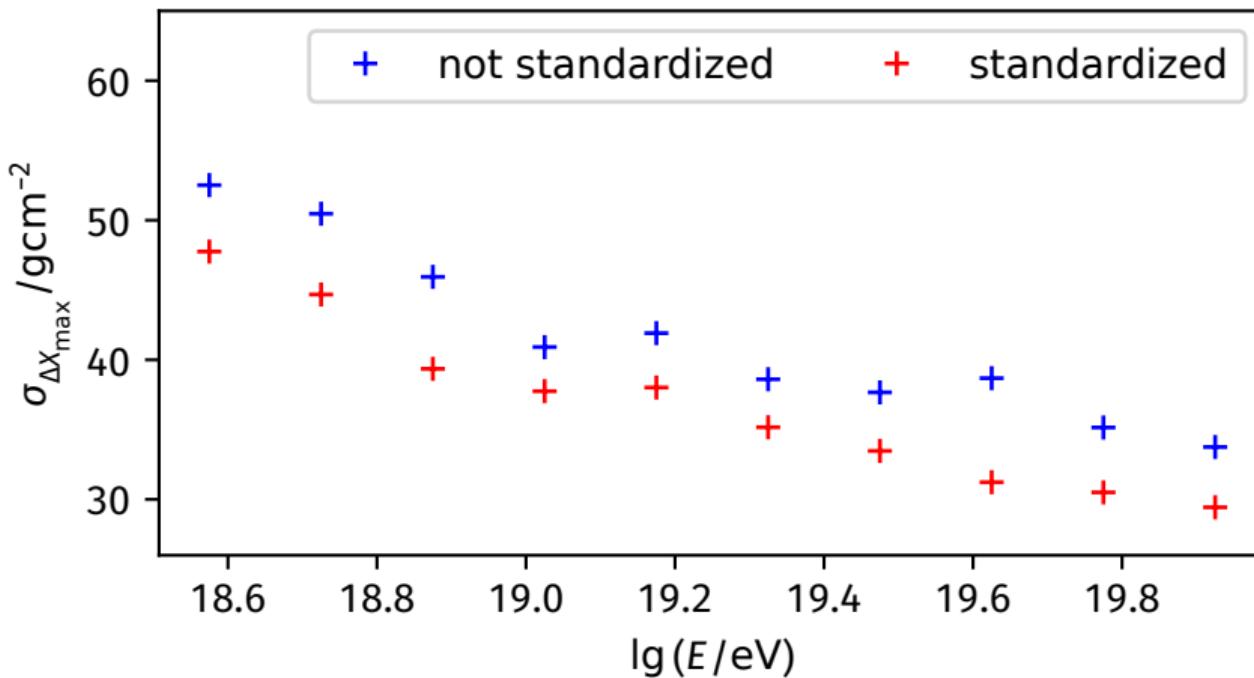
## Problems

- how to standardize input values?

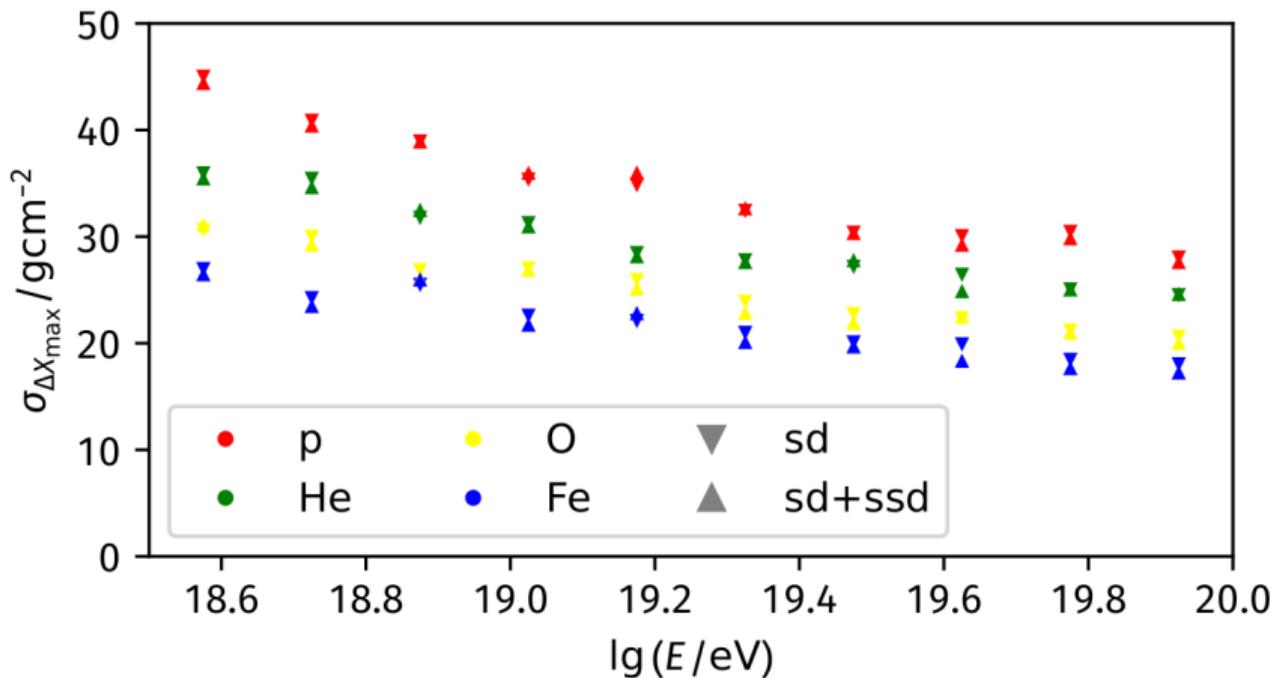
## ToDo

- memory efficiency
- next-order effects (magnetic field, ...)

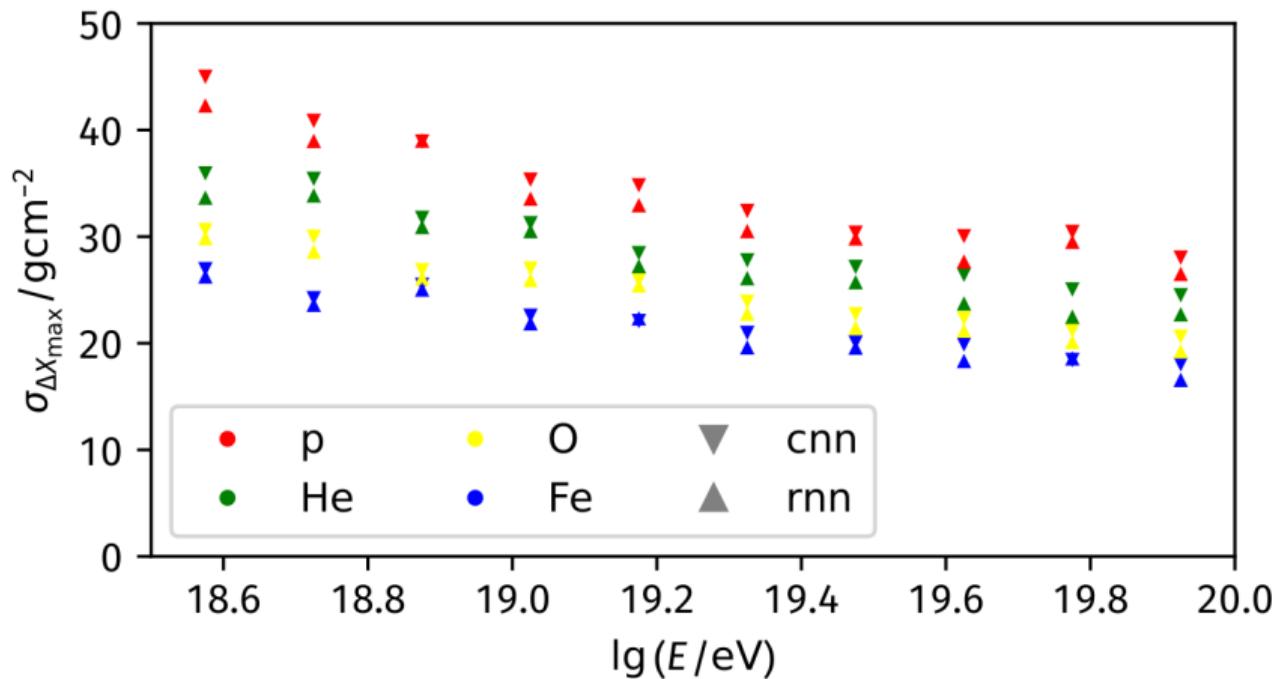
# Application on MC - check standardization



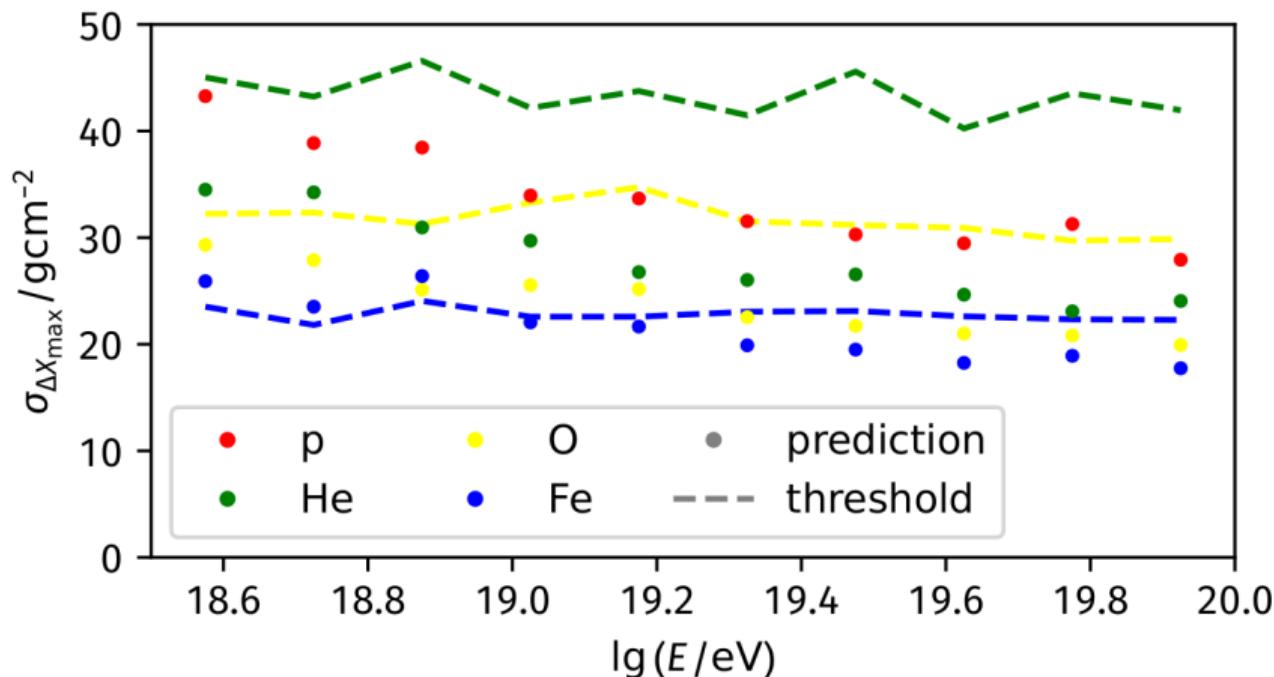
## Application on MC - other tests



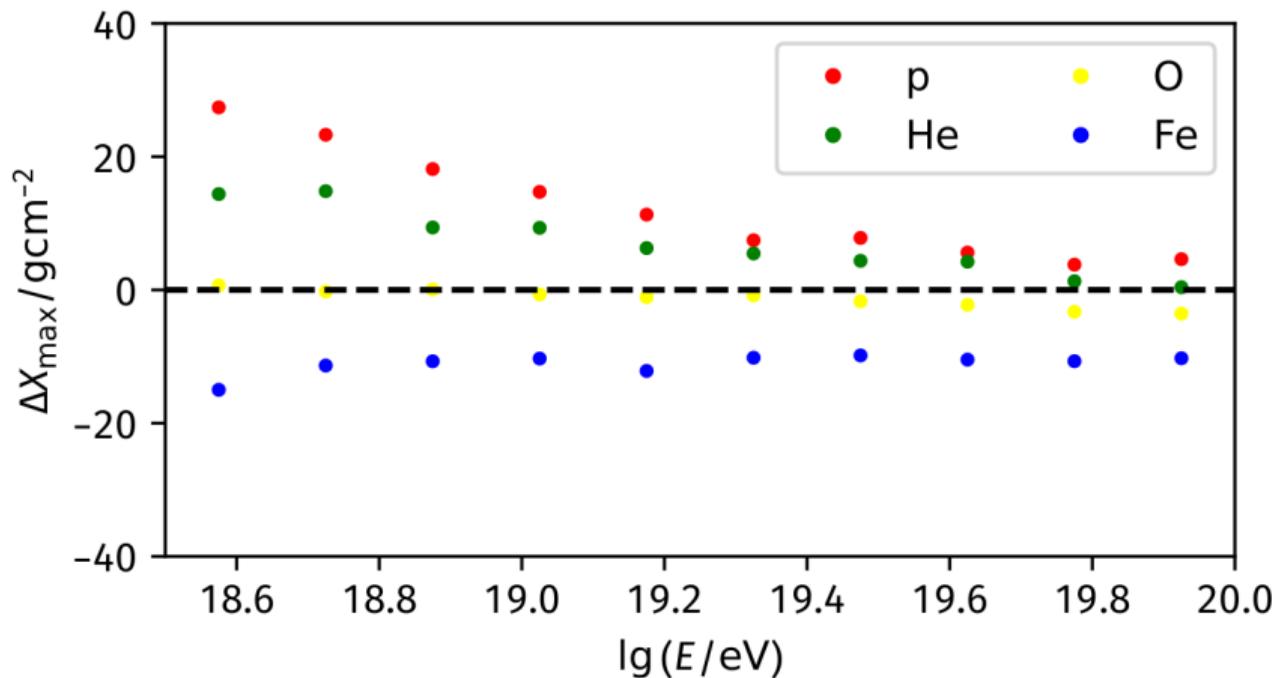
# Application on MC - other tests



# Application on MC - preliminary results



# Application on MC - preliminary results



# Application on MC - Outlook

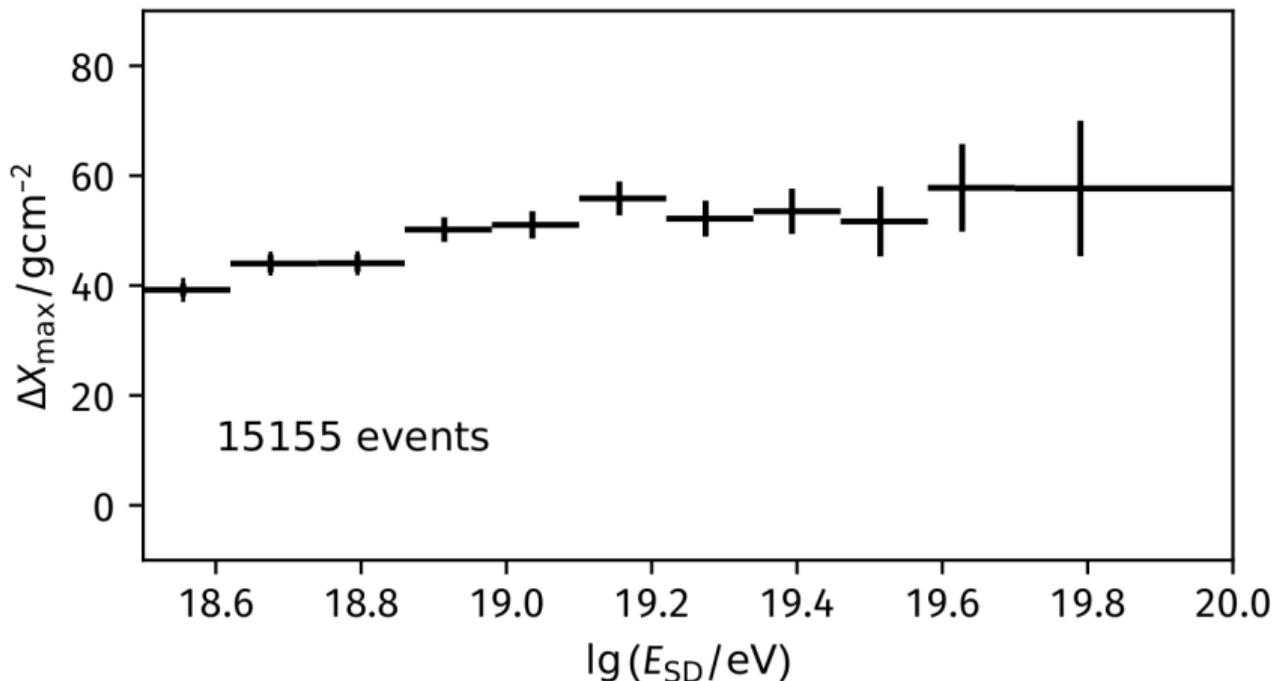
## Problems

- high-energy bias problems
- $X_{\max}$  from interpolated or GH

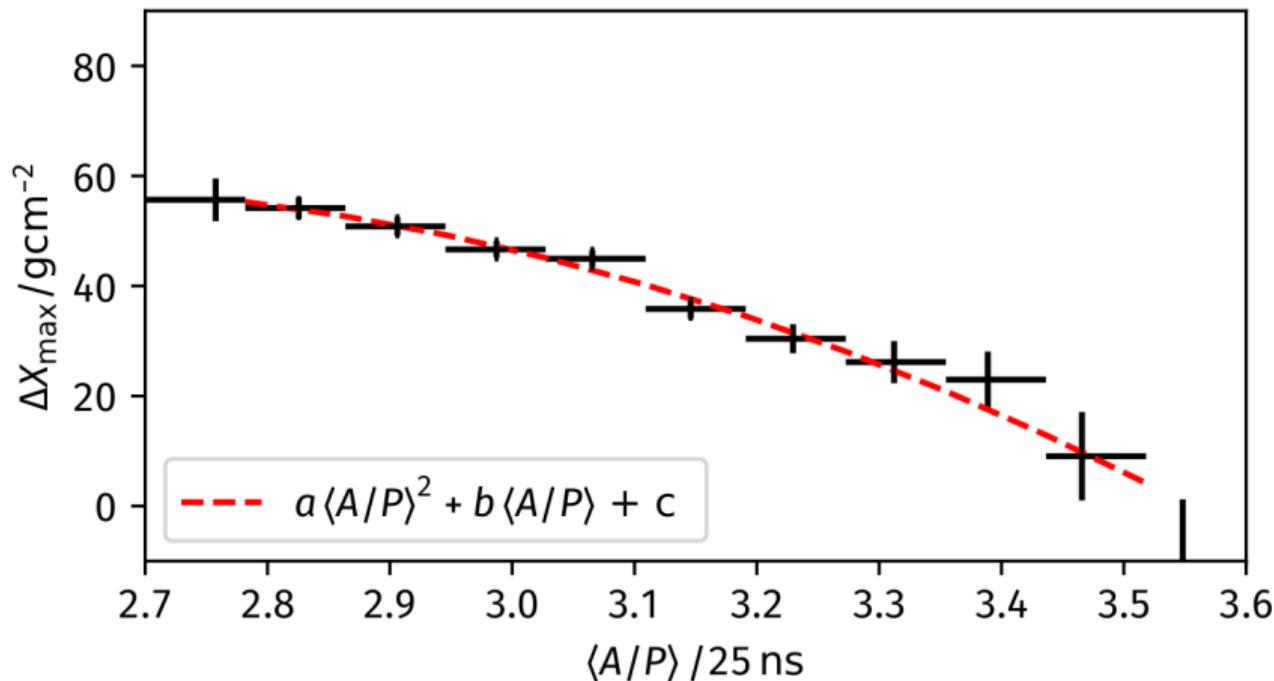
## ToDo

- MC model crosschecks
- introducing energies beyond  $10^{20}$  eV
- testing different evaluation losses

# Application on data - Golden/ICRC 2019 cuts



# Application on data - Golden/ICRC 2019 cuts



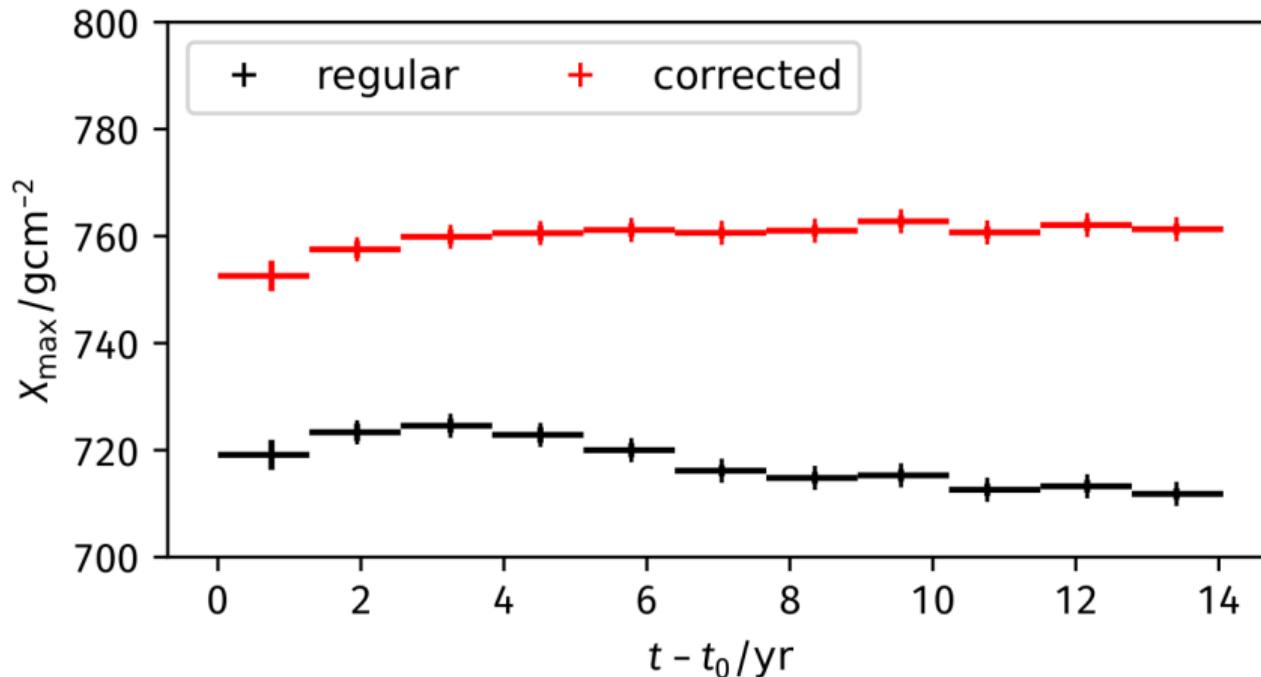
Neural networks  
○○○○

Standardization procedure  
○○○○○○○

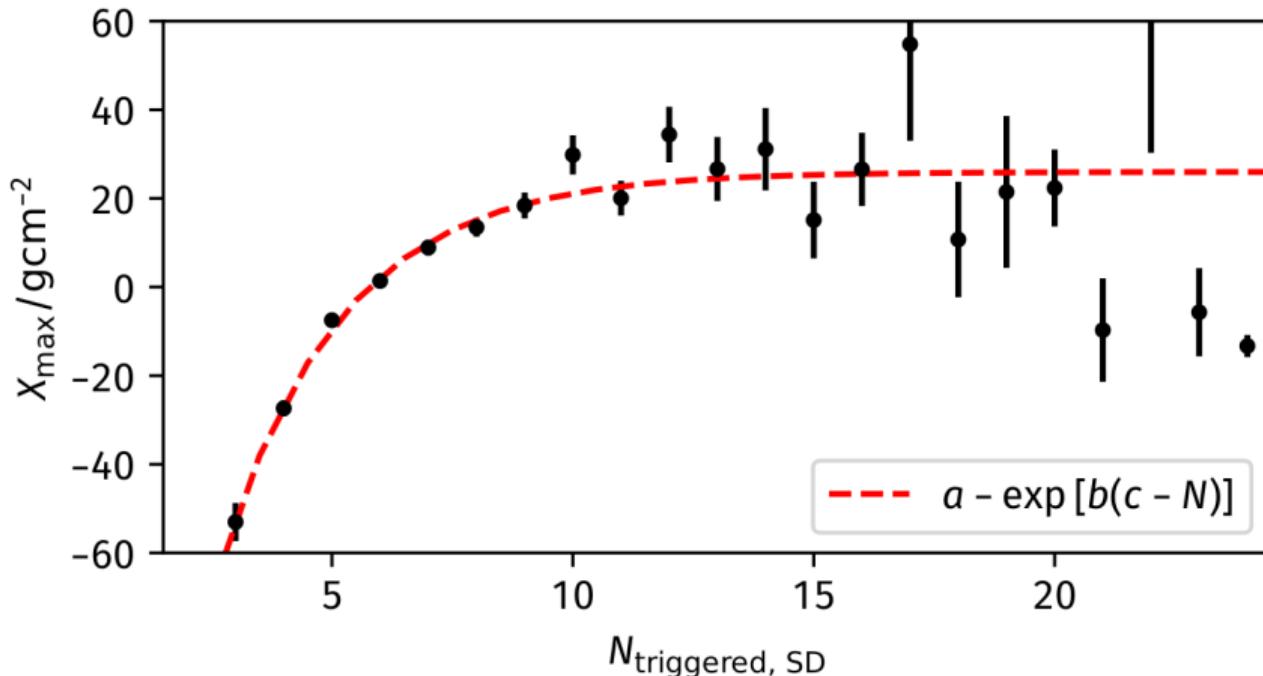
Application on MC  
○○○○

Application on data  
●○○○

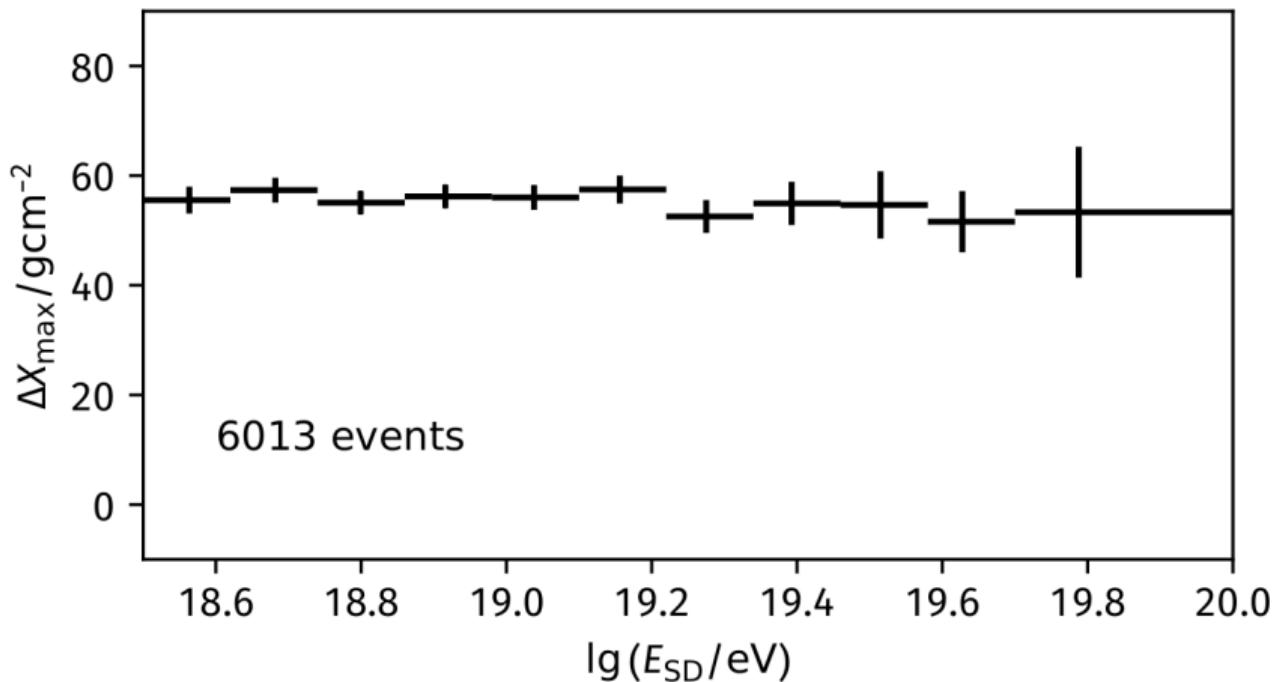
# Application on data - Golden/ICRC 2019 cuts



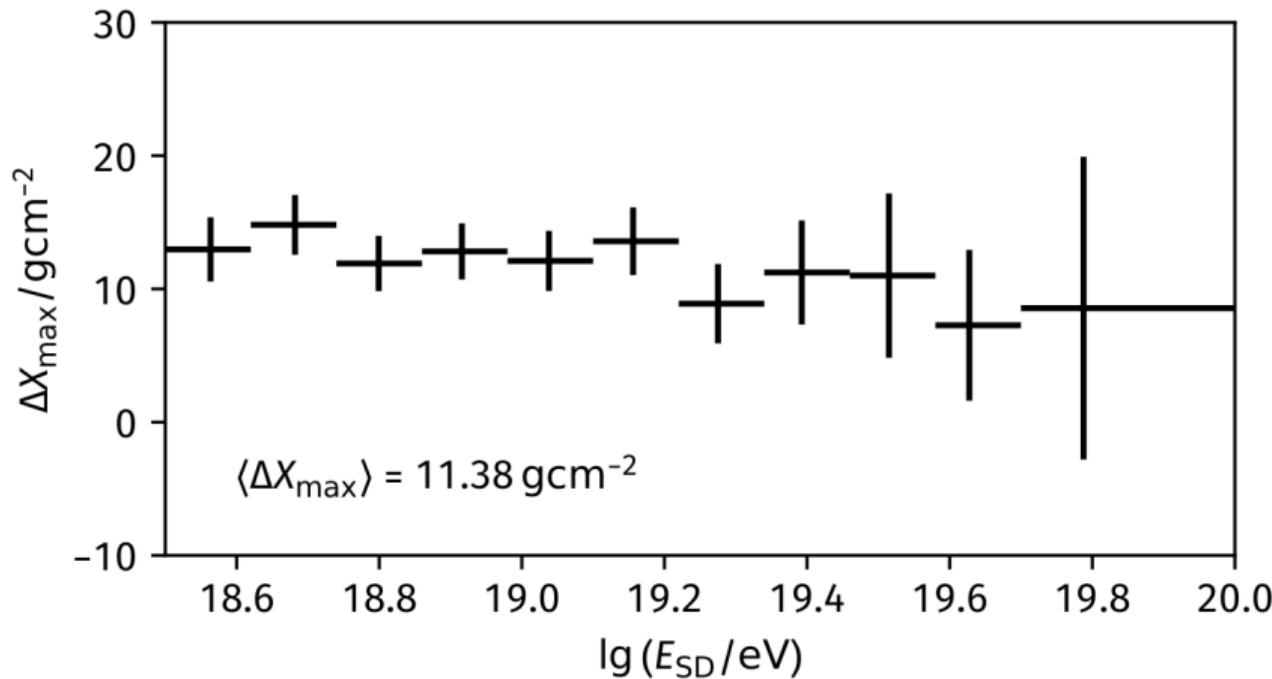
# Application on data - Golden/ICRC 2019 cuts



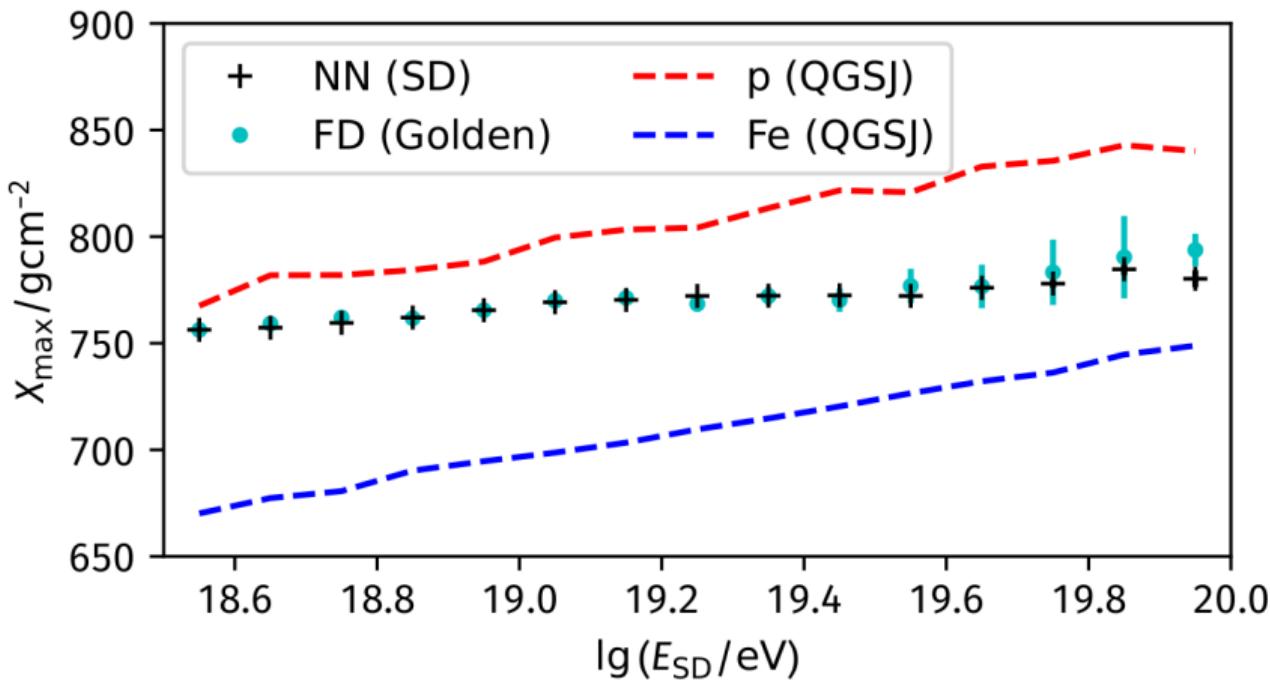
# Application on data - Golden/quality cuts



# Application on data - Golden/quality cuts



# Application on data - SD/ICRC 2019 cuts



# Application on data - Outlook

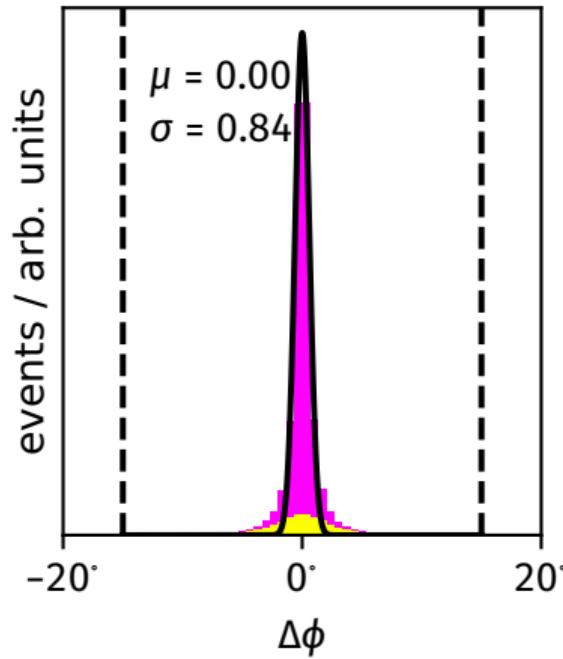
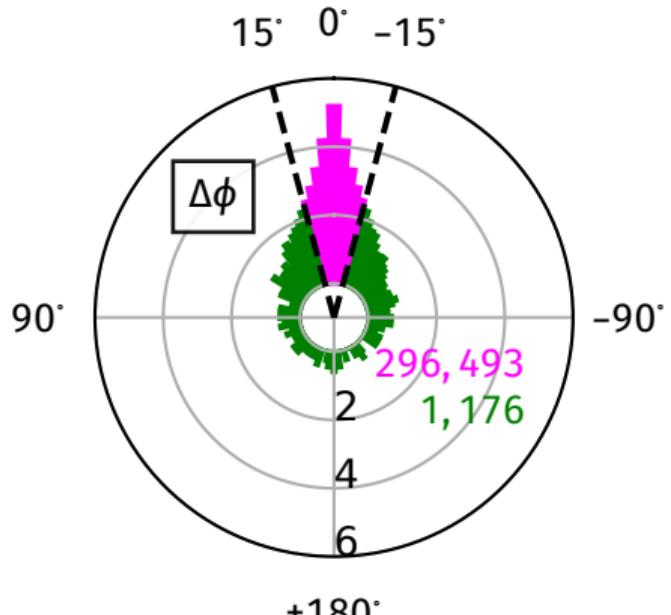
## Problems

- only ICRC 2019 cuts
- Offline mismatch: simulation/real data
- many crosschecks missing

## ToDo

- estimate moments to verify network results
- testing on targets
- finding valid cuts

# Backup - Standardization



# Backup - Standardization

