T2K Notebook

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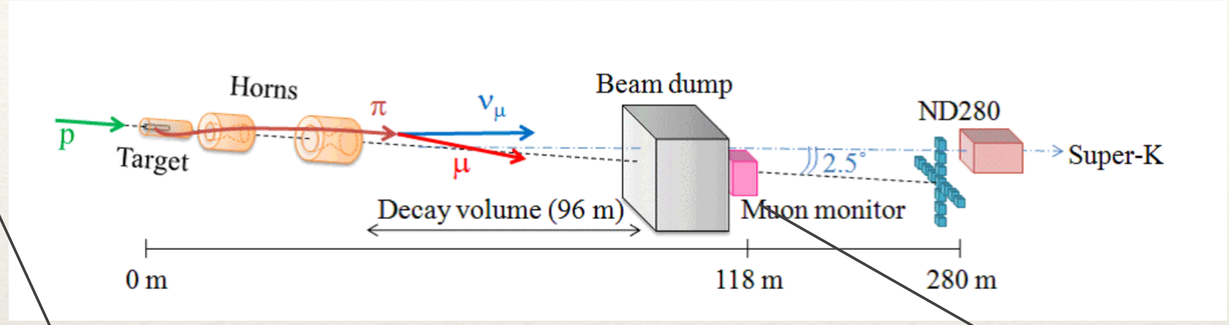
Nov 5th 2024

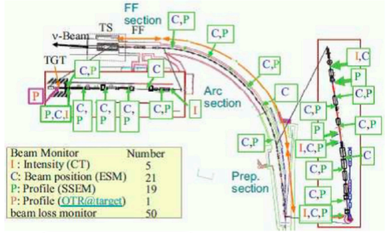
T2K Primary Beam & Muon Monitors

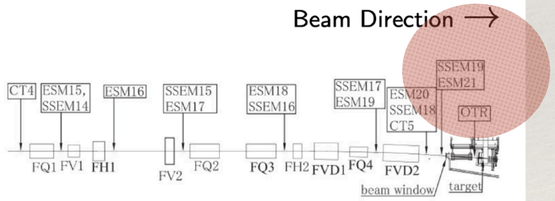


T2K Primary Beam Monitors

Primary Beamline Monitors

Final Focusing Section
(these are used for flux simulation inputs)





- 19 SSEMs (Segmented Secondary Emission Monitors) – monitor beam profile
- 21 ESMs (Electrostatic Monitors) – monitor beam position
- 50 BLMs (Beam Loss Monitors) – monitor beam loss
- 5 CTs (Current Transformers) – monitor beam current
- 1 OTR (Optical Transition Radiation) Monitor – monitors beam profile at target
- MUMON (Muon Monitor) – monitors muon flux/profile after target

Muon Monitors

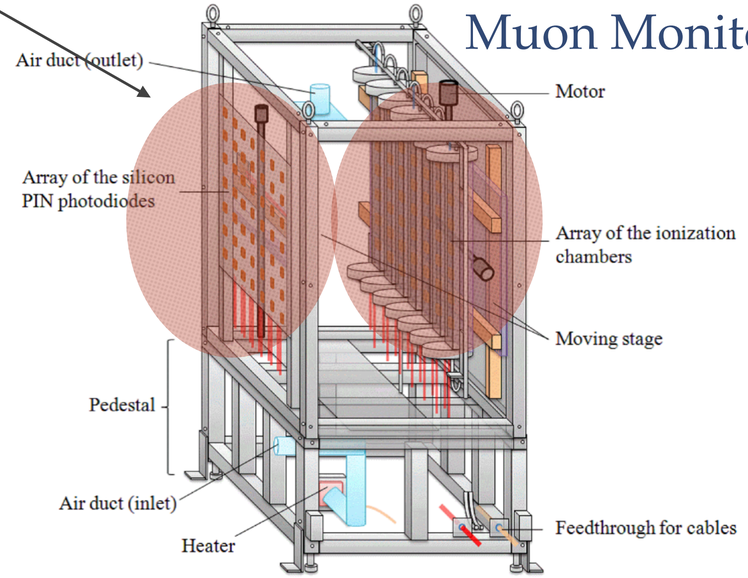


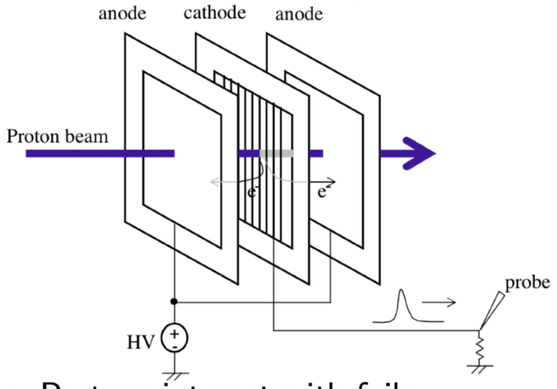
Fig. 3. Schematic view of the muon monitor. The beam enters from the left side. On the upstream side, 49 silicon PIN photodiodes are placed on the support enclosure. On the downstream side, the large moving stage holds seven ionization chambers, each of which contains seven sensors. The whole structure is covered with aluminum insulation panels, which are not drawn in the figure.

Beam Monitors

- BEAM **PROFILE** MONITORS
  - SSEM (Segmented Secondary Emission Monitors)

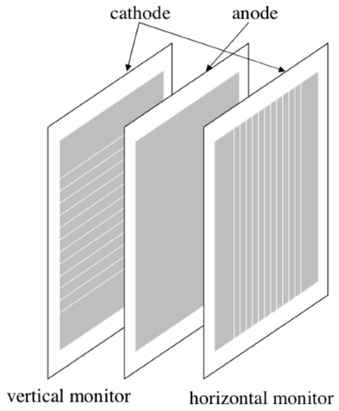
J-PARC NU SSEM Principle and Design

SSEM Principle



- Protons interact with foils
- Secondary electrons are emitted from segmented cathode plane and collected on anode planes
- Compensating charge in each cathode strip is read out as positive polarity signal

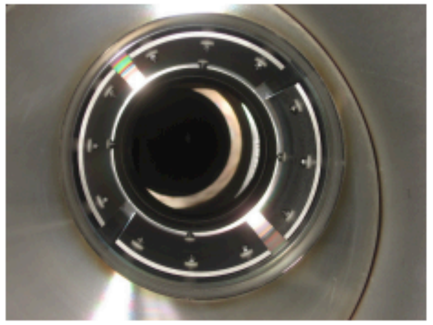
J-PARC NU SSEM



- Single anode plane between two stripped cathode planes
- 5 μm thick Ti foils

- BEAM **POSITION** MONITORS
  - ESM (Electrostatic Monitors)

ESMs



21 ESMs (Electrostatic Monitor)

- Four segmented cylindrical electrodes surrounding the proton beam orbit (80°coverage)

- Non-destructively, continuously monitor the proton beam position using a top-bottom and left-right asymmetry of the beam-induced current on each electrode
  - 4 ESMs were rotated by 45° last year
- Precision on the beam position is better than 450 μm
- However, ESMs are used for monitoring stability of beam position, rather than for calculating absolute beam position
  - ESM19, 20, 21 monitor the beam position nearest the target and are used in determining the proton beam parameters for the flux prediction (when SSEMs are OUT)

What I could dig out from the data

- two different beam intensities
  - muana_run0910178_00.root is at 600kW beam power,
  - muana_run0910086_00.root is at 400 kW beam power

Muon Monitors Data Structure

- musi (silicon sensors)/muic (ionization chamber sensors):
- sum[9]: adc sum
- Q[7][7][9]: integrated charge for each sensor
- fit[5][9]: gaus fit parameters ([0]: const, [1]: x center, [2]: x sigma, [3]: y center, [4]: y sigma)
- wmeanx/y[9]: im not sure
- ped[7][7]: pedestal values for each sensor
- pedrms[7][7]: pedestal rms values
- fitF[9]: fit fitness? not sure

Beam Monitors Data Structure

#SSEM (beam profile monitor), only SSEM19 (array value [18] is available during continuous operation)

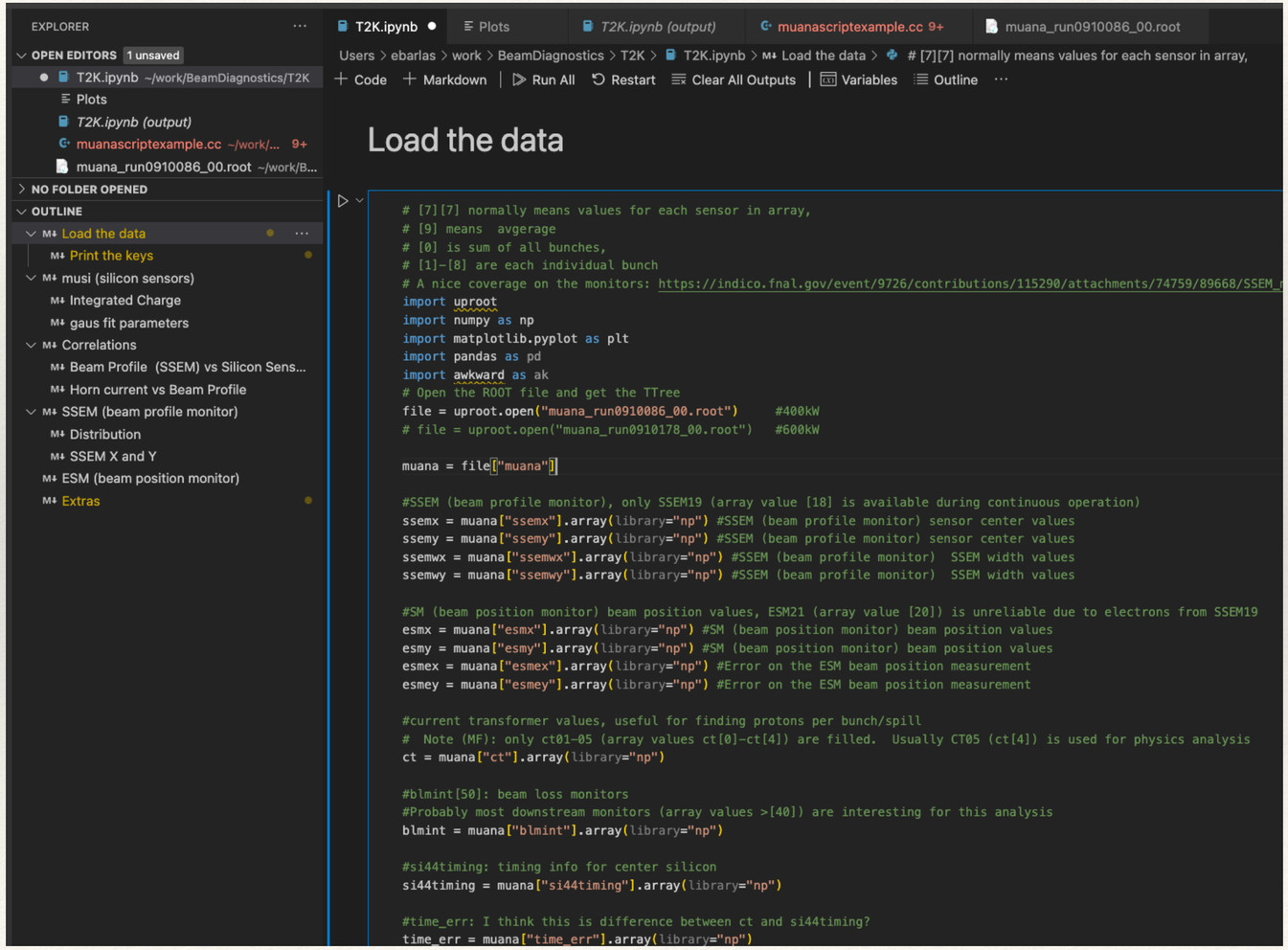
- #SSEM (beam profile monitor) sensor x center values
- #SSEM (beam profile monitor) sensor y center values
- #SSEM (beam profile monitor) SSEM x width values
- #SSEM (beam profile monitor) SSEM ywidth values

#SM (beam position monitor) beam position values, ESM21 (array value [20]) is unreliable due to electrons from SSEM19

- #SM (beam position monitor) beam position values
- #SM (beam position monitor) beam position values
- #Error on the ESM beam position measurement
- #Error on the ESM beam position measurement

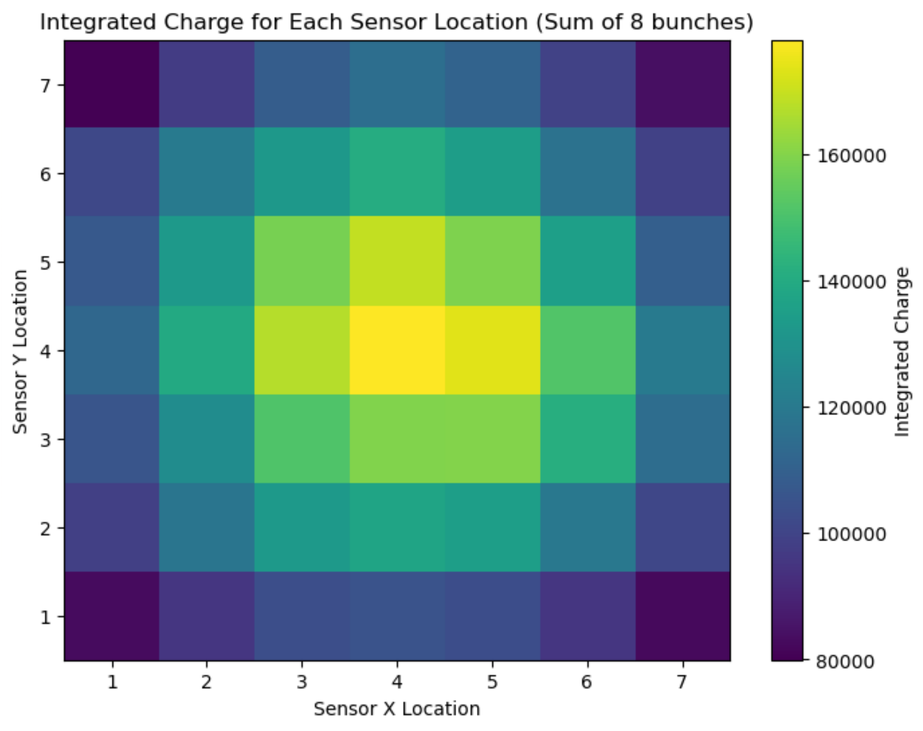
What I could dig out from the data

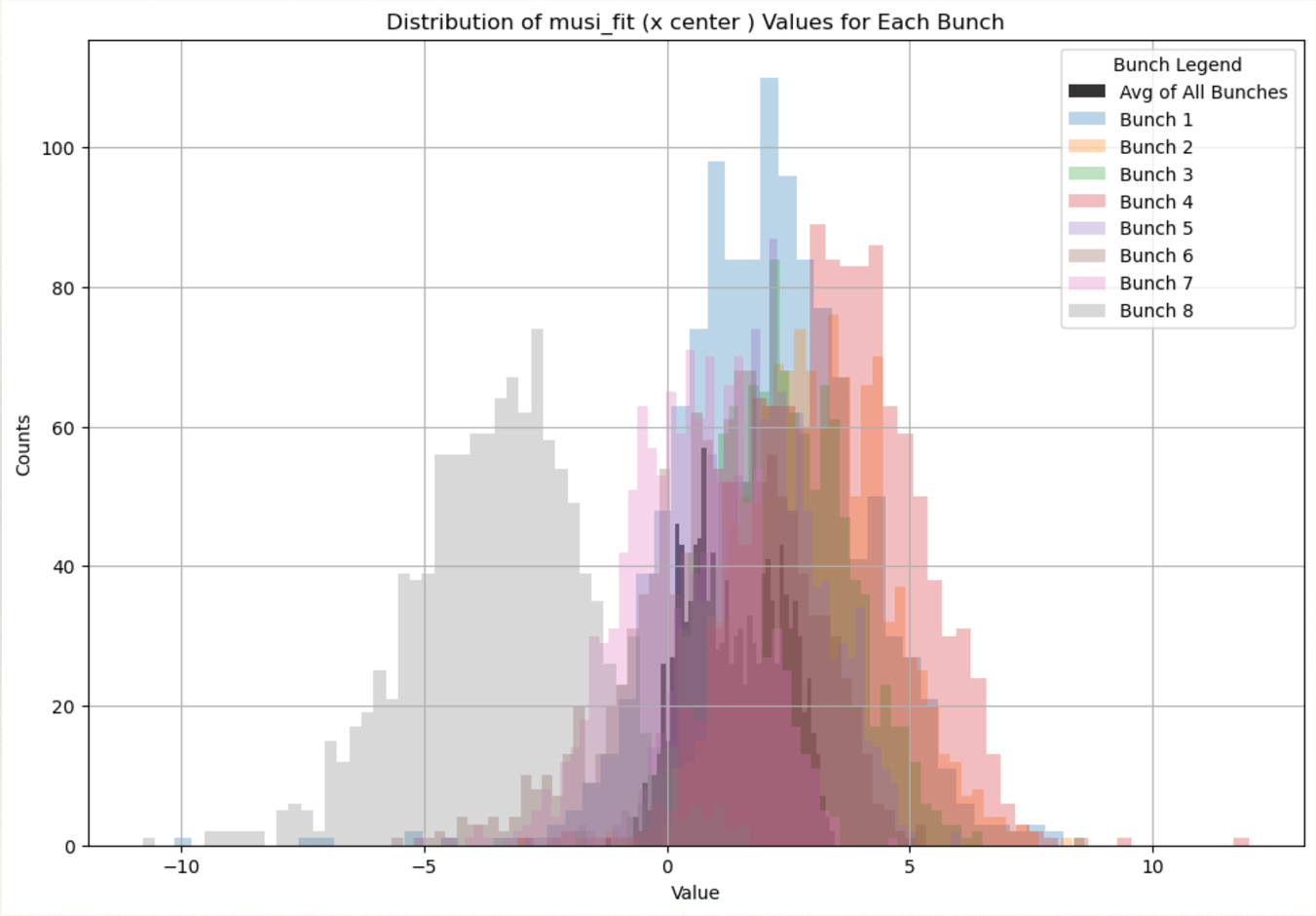
- Implemented the data structure into a Jupyter notebook
- Loaded all the necessary parts which is relevant to us. It's very straightforward to check these parts and their correlation now



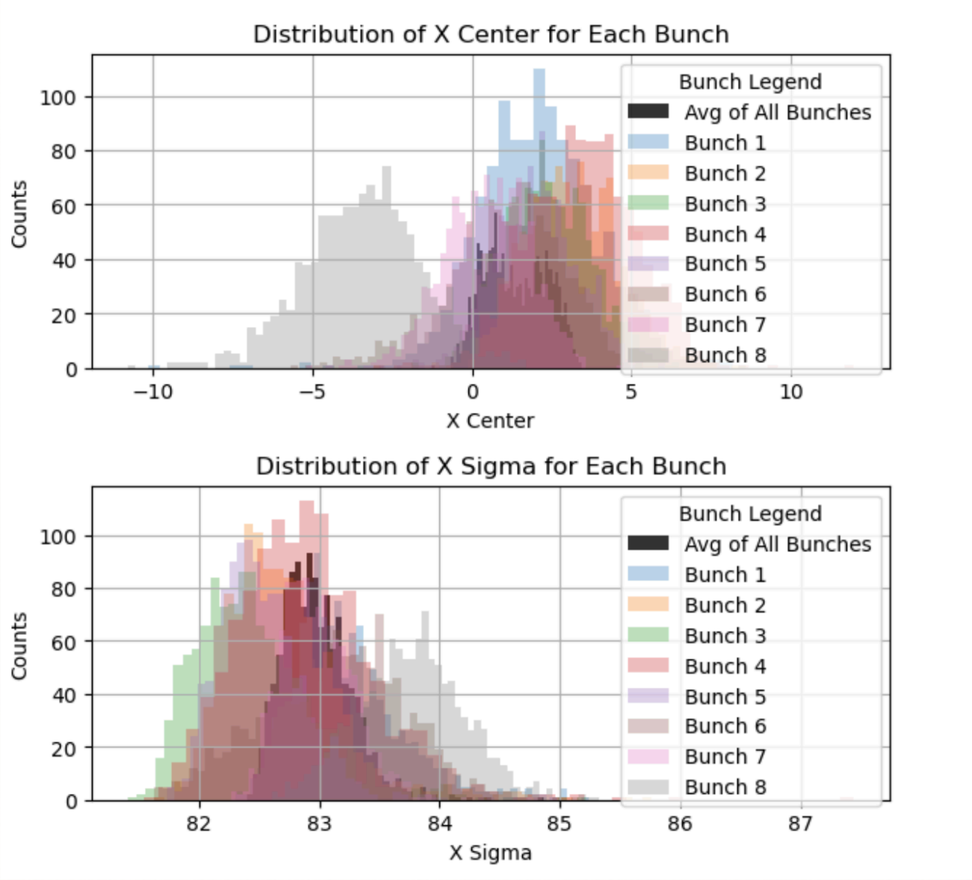
What I could dig out from the data (Musi-Silicon Sensors)

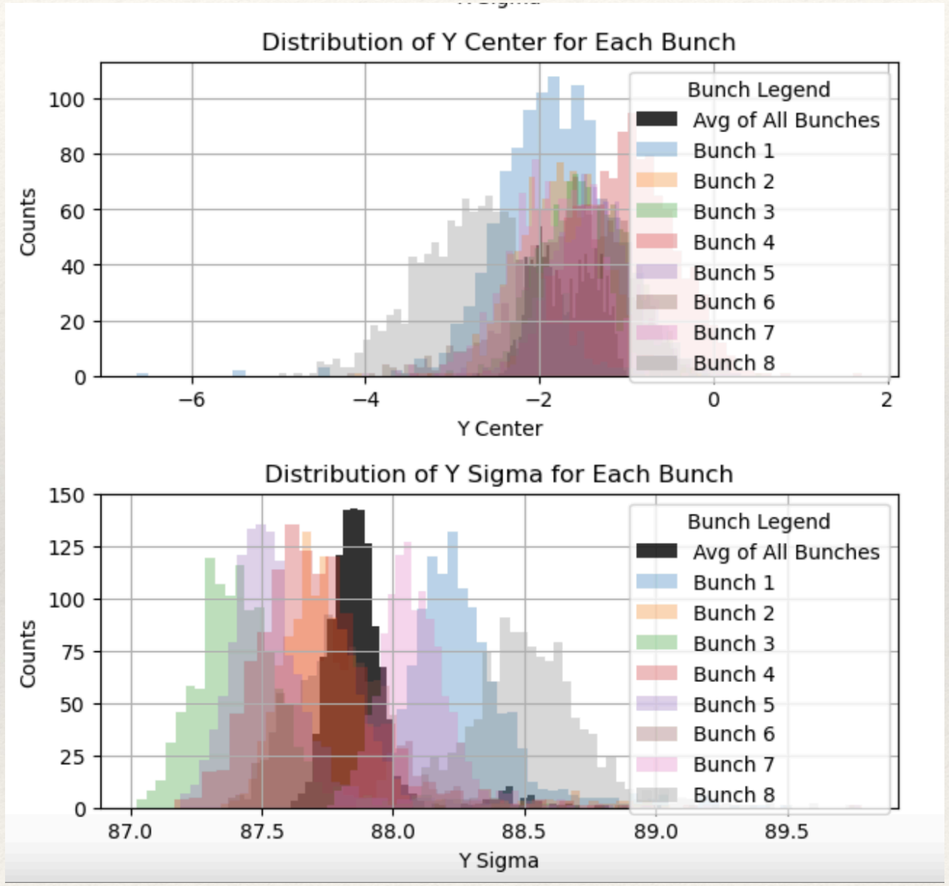
Integrated Charge





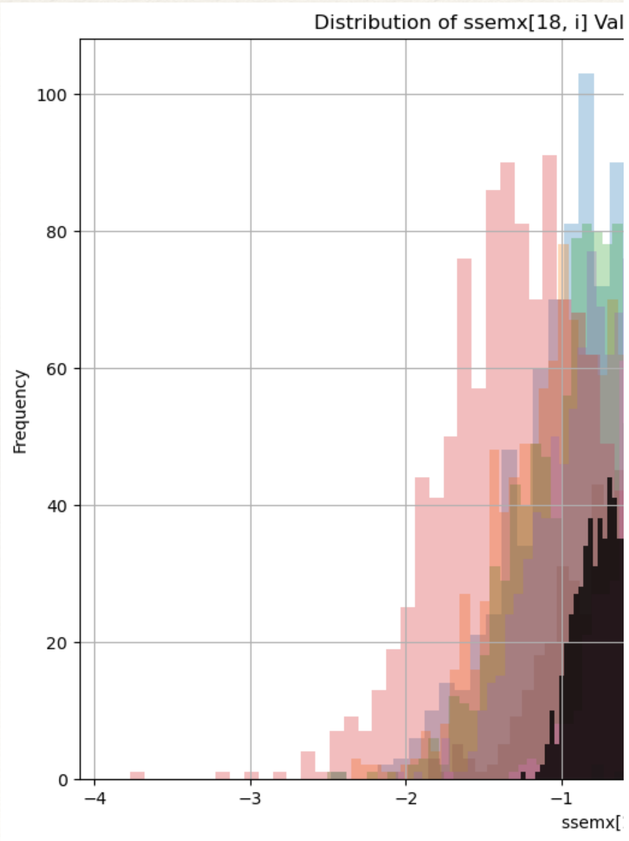
What I could dig out from the data (Musi-Silicon Sensors)

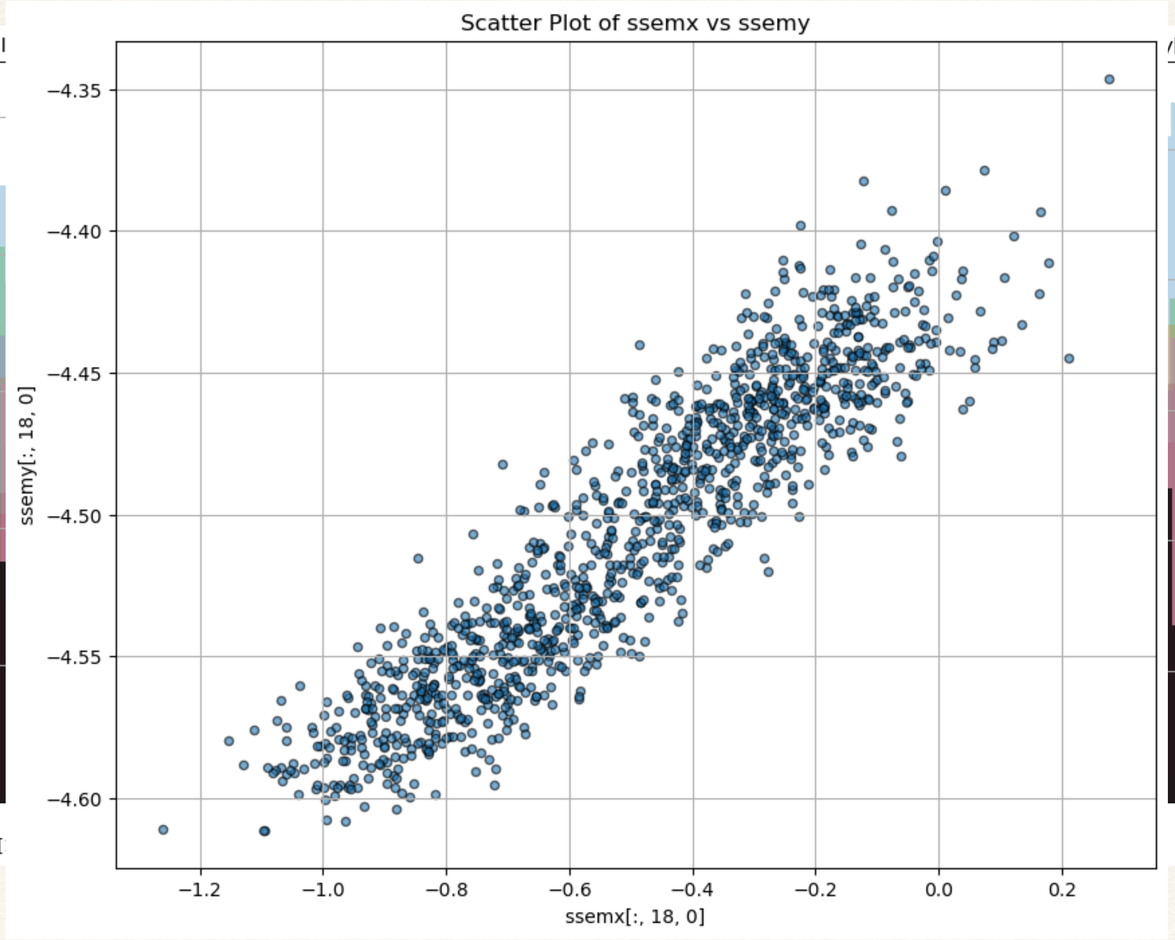


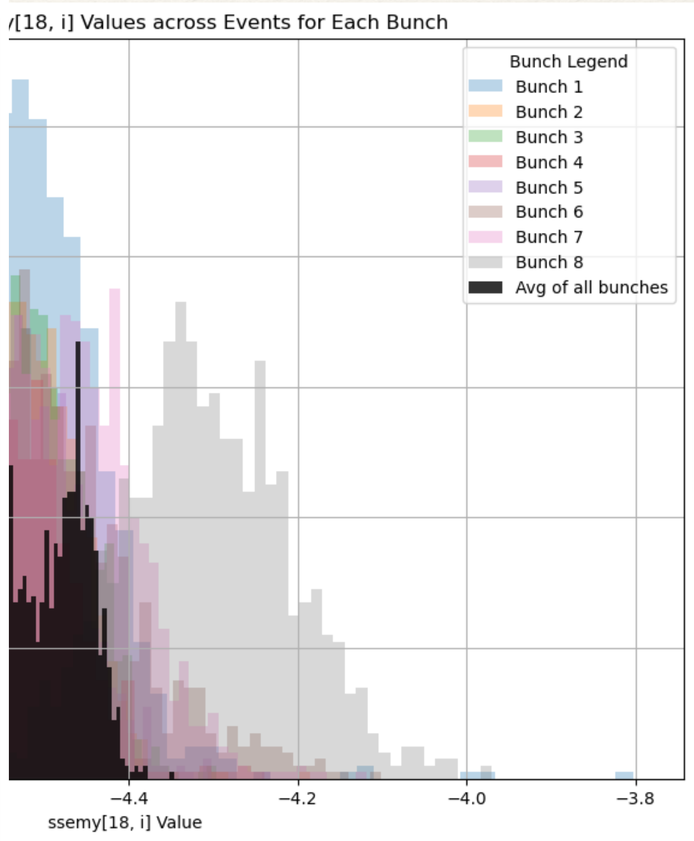


What I could dig out from the data (SSEM Beam Profile)

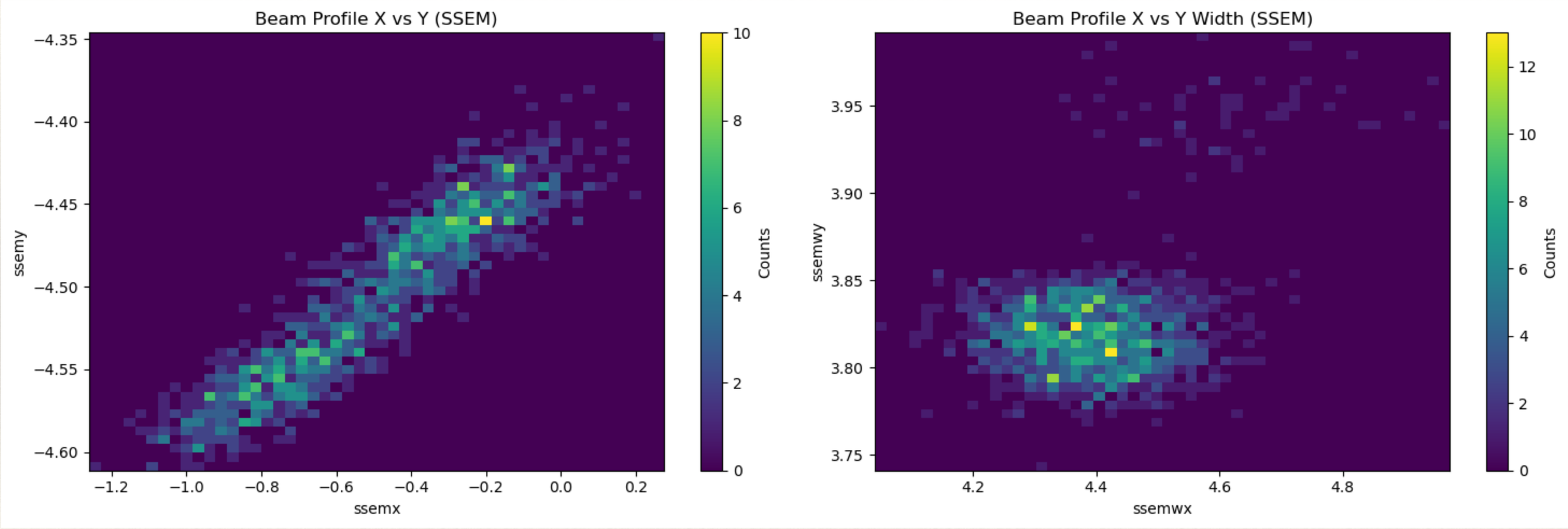
Distributions of SSEM (beam profile monitor) sensor center values for Different Bunches



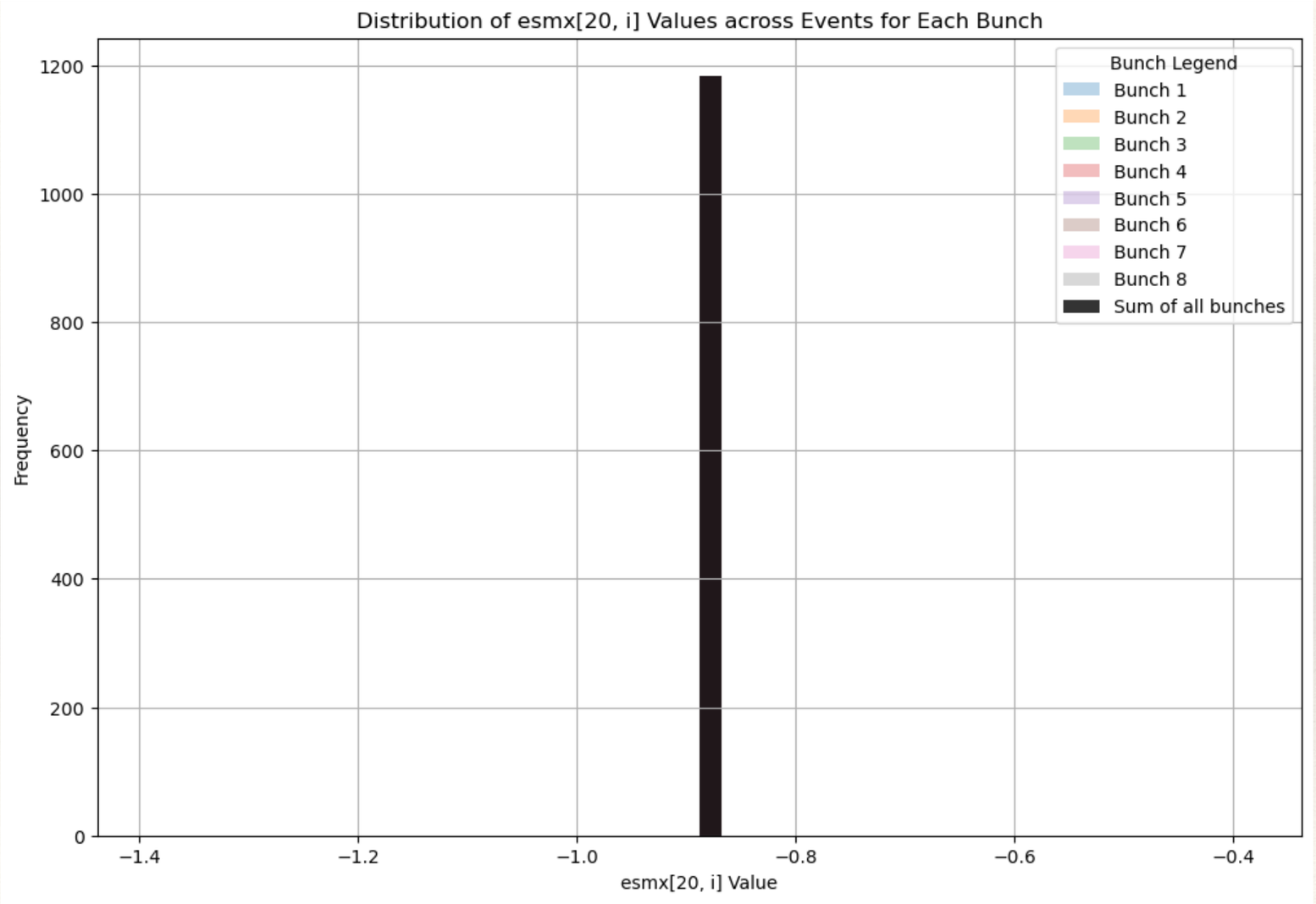




What I could dig out from the data (SSEM Beam Profile)

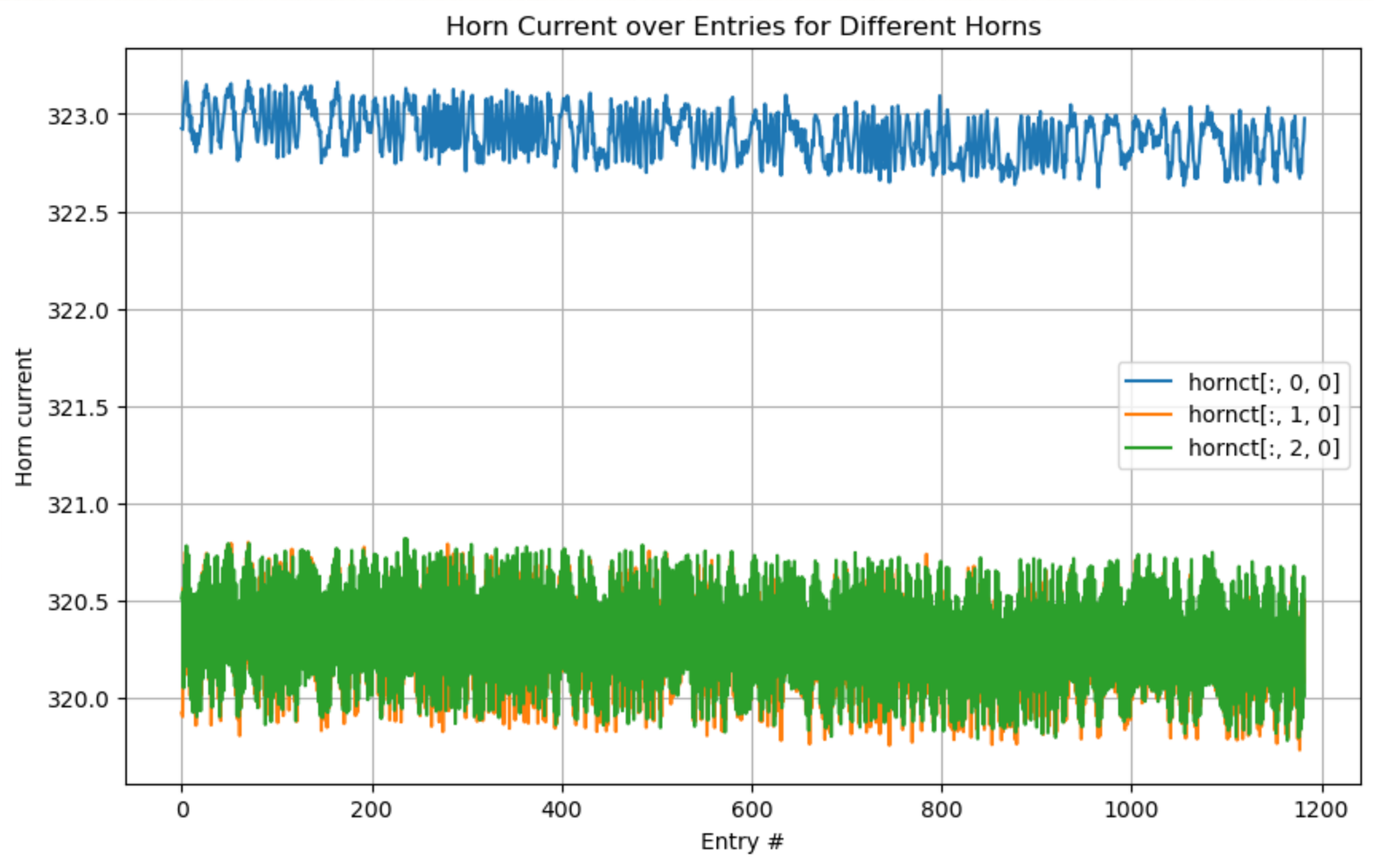


What I could dig out from the data (ESM Beam Position)



ESM data is empty

What I could dig out from the data (Horn Current)

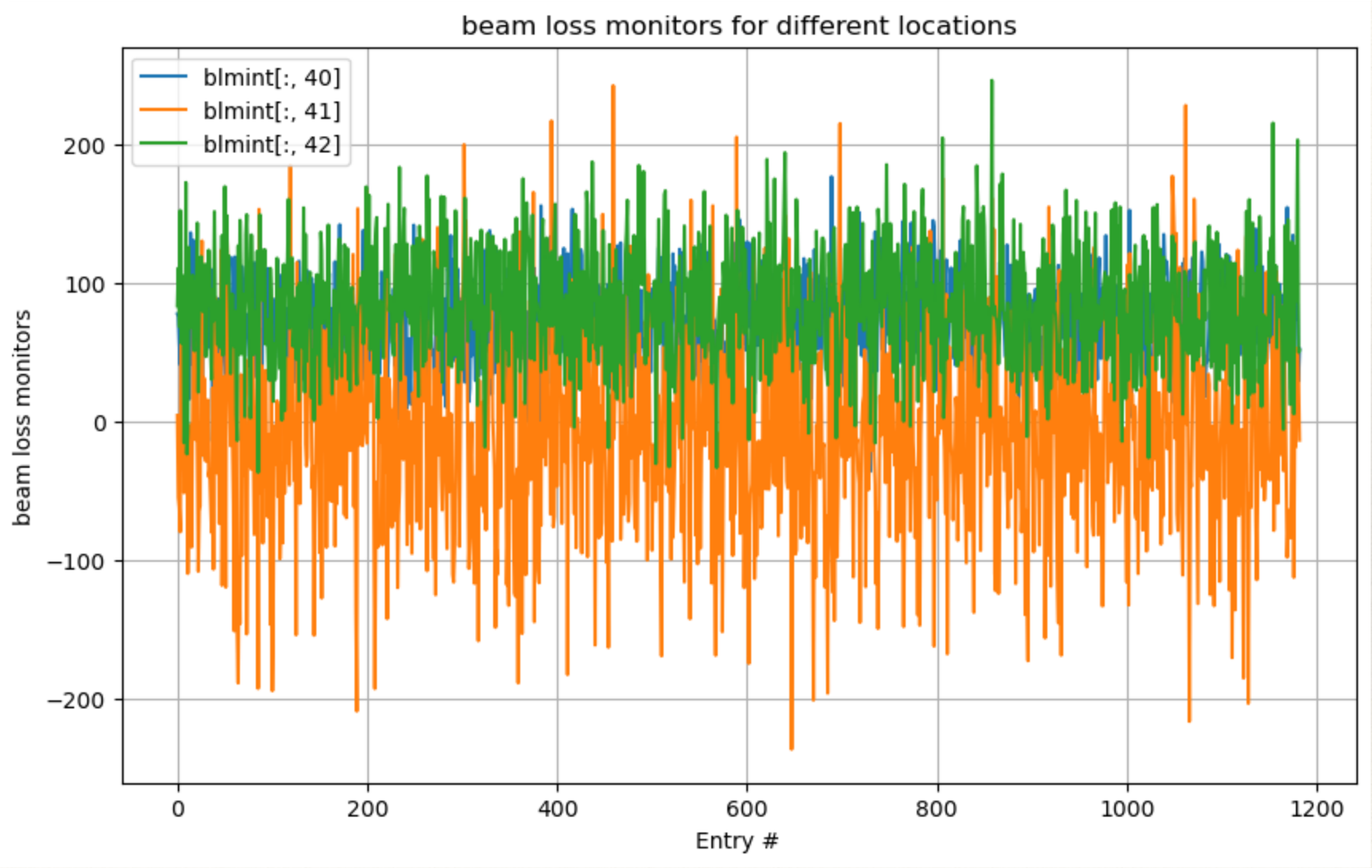


We have 3 entries.

I think they correspond to

3 different horns?

What I could dig out from the data (Beam Loss Monitors)

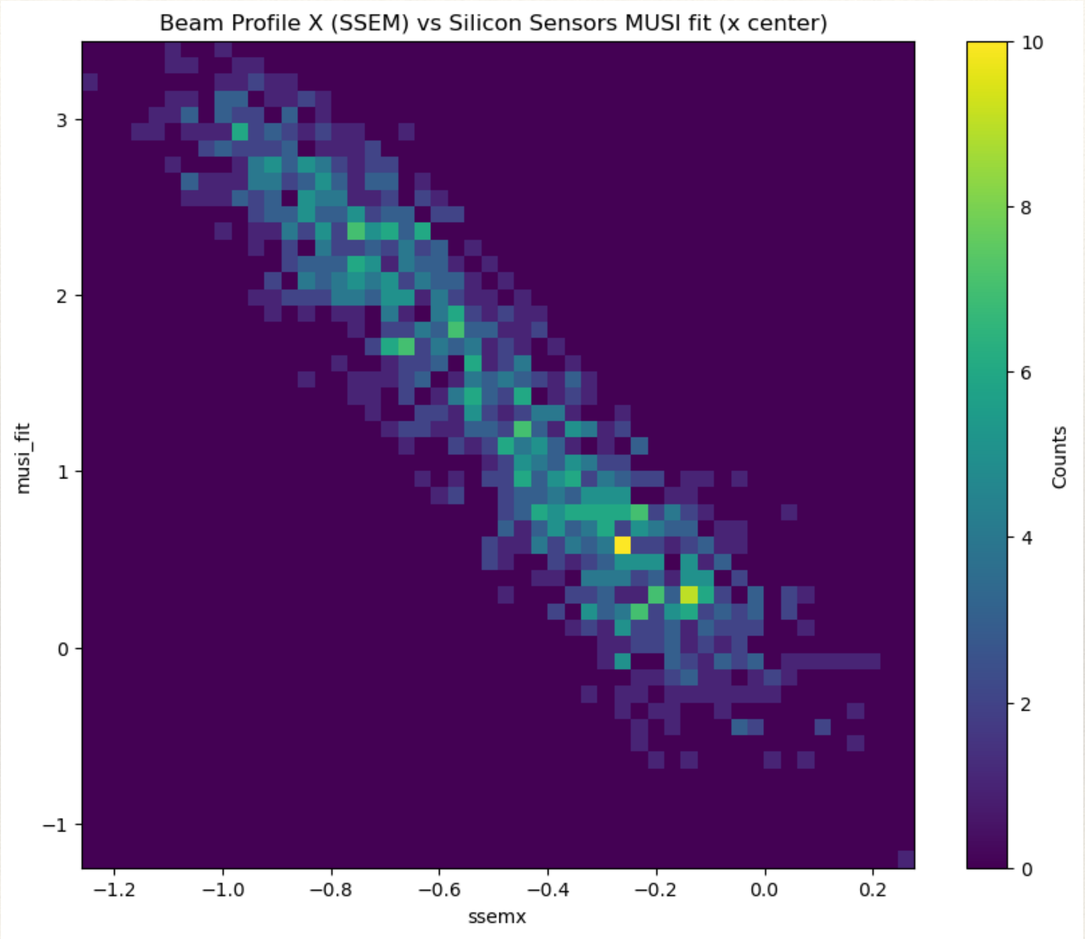


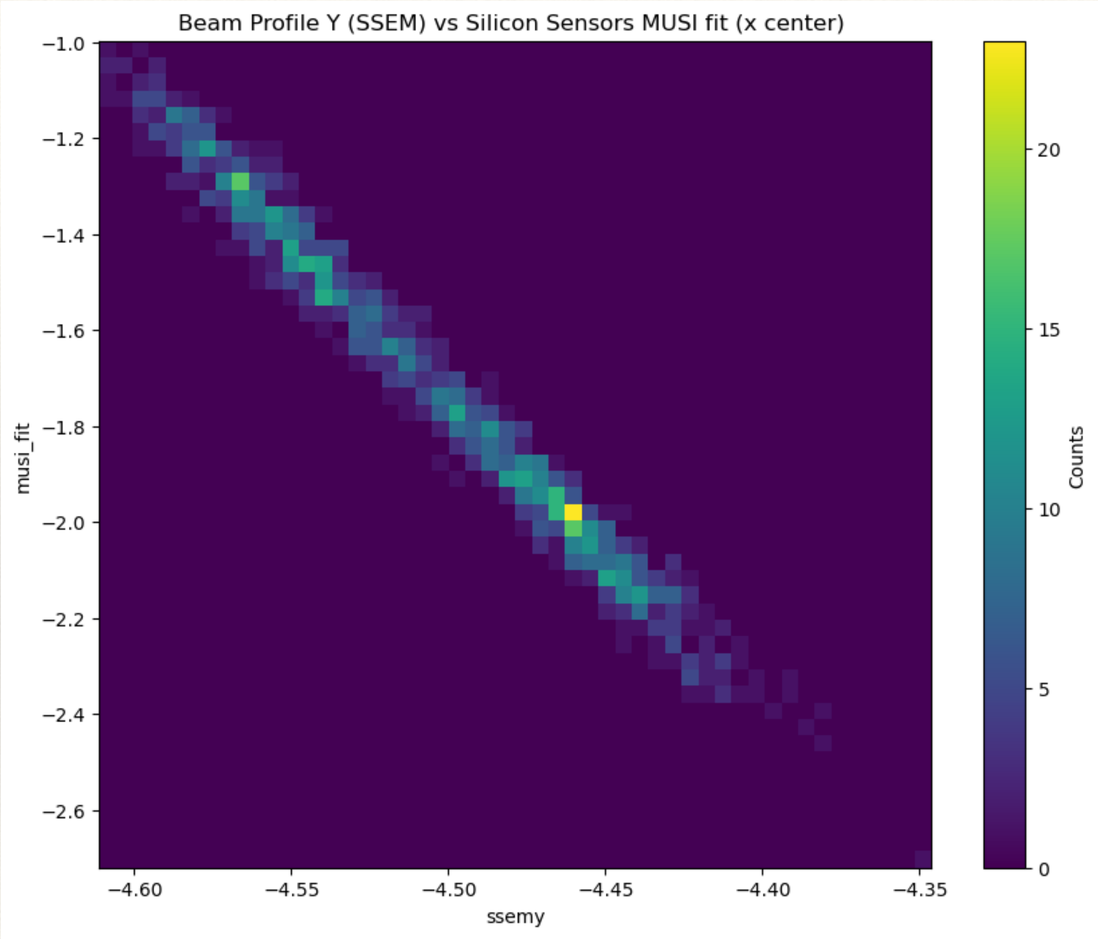
50 monitors.

>40 is related?

What I could dig out from the data (Correlations)

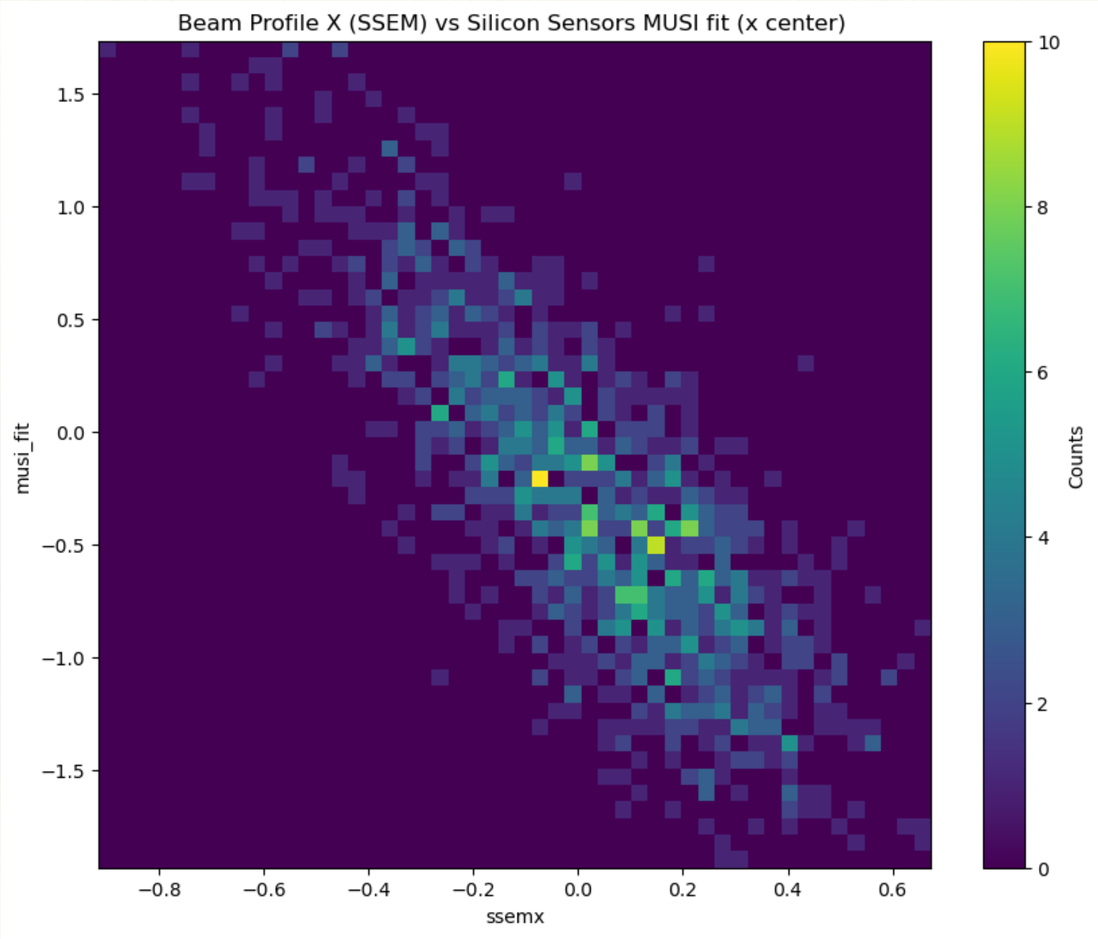
400kW

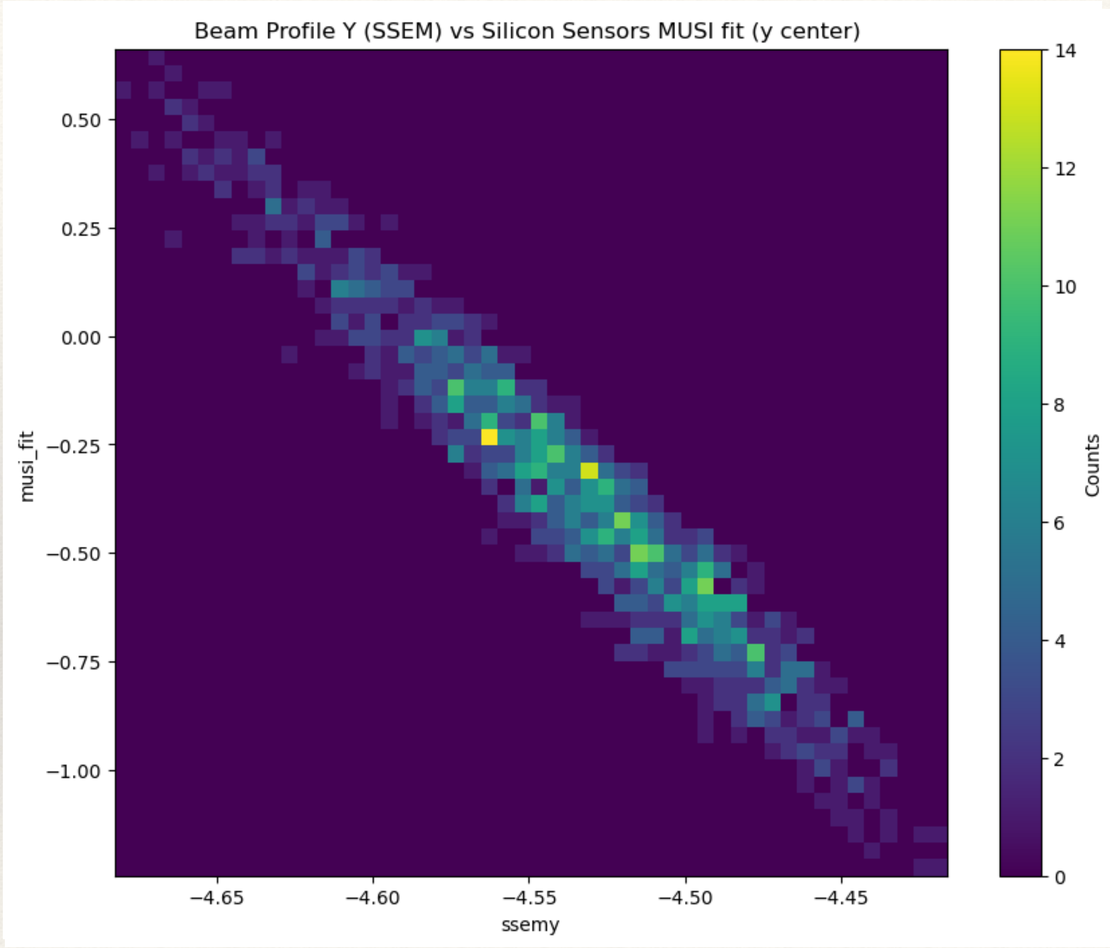




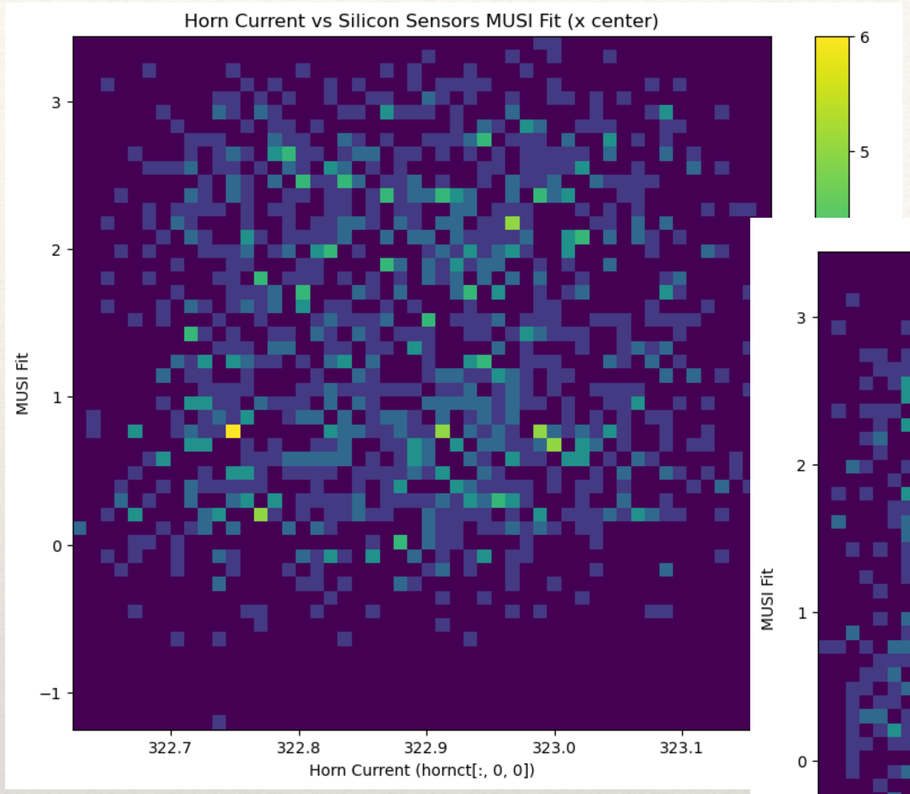
What I could dig out from the data (Correlations)

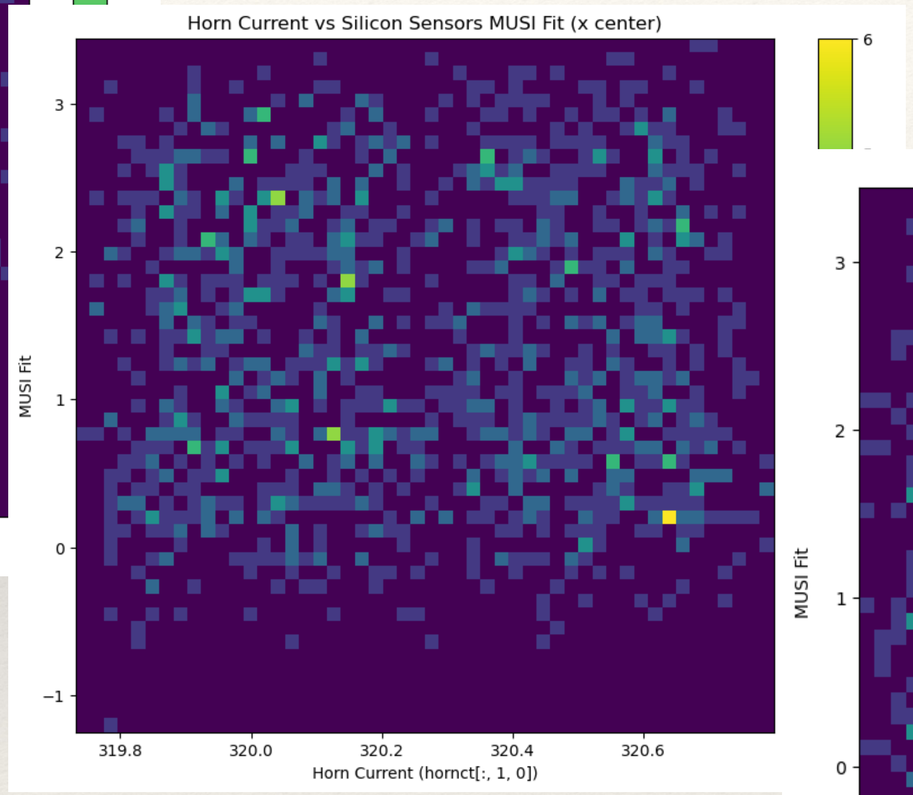
600kW

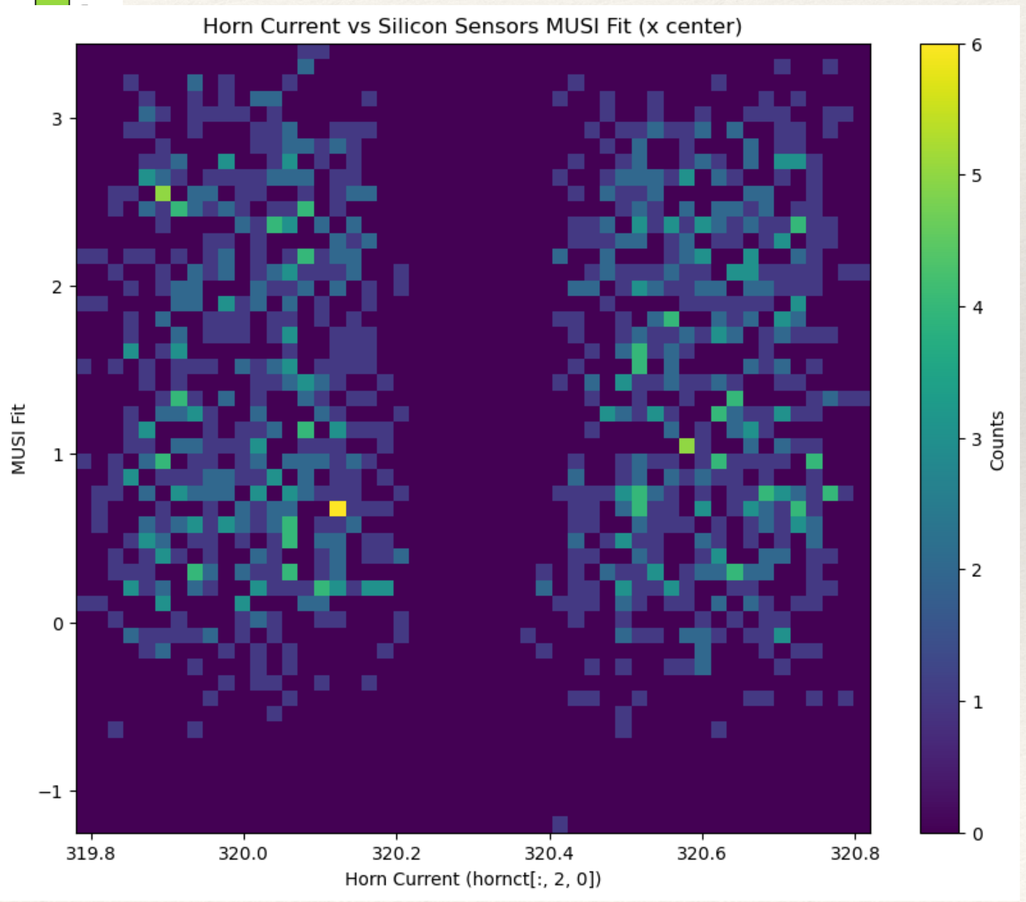




What I could dig out from the data (Correlations)



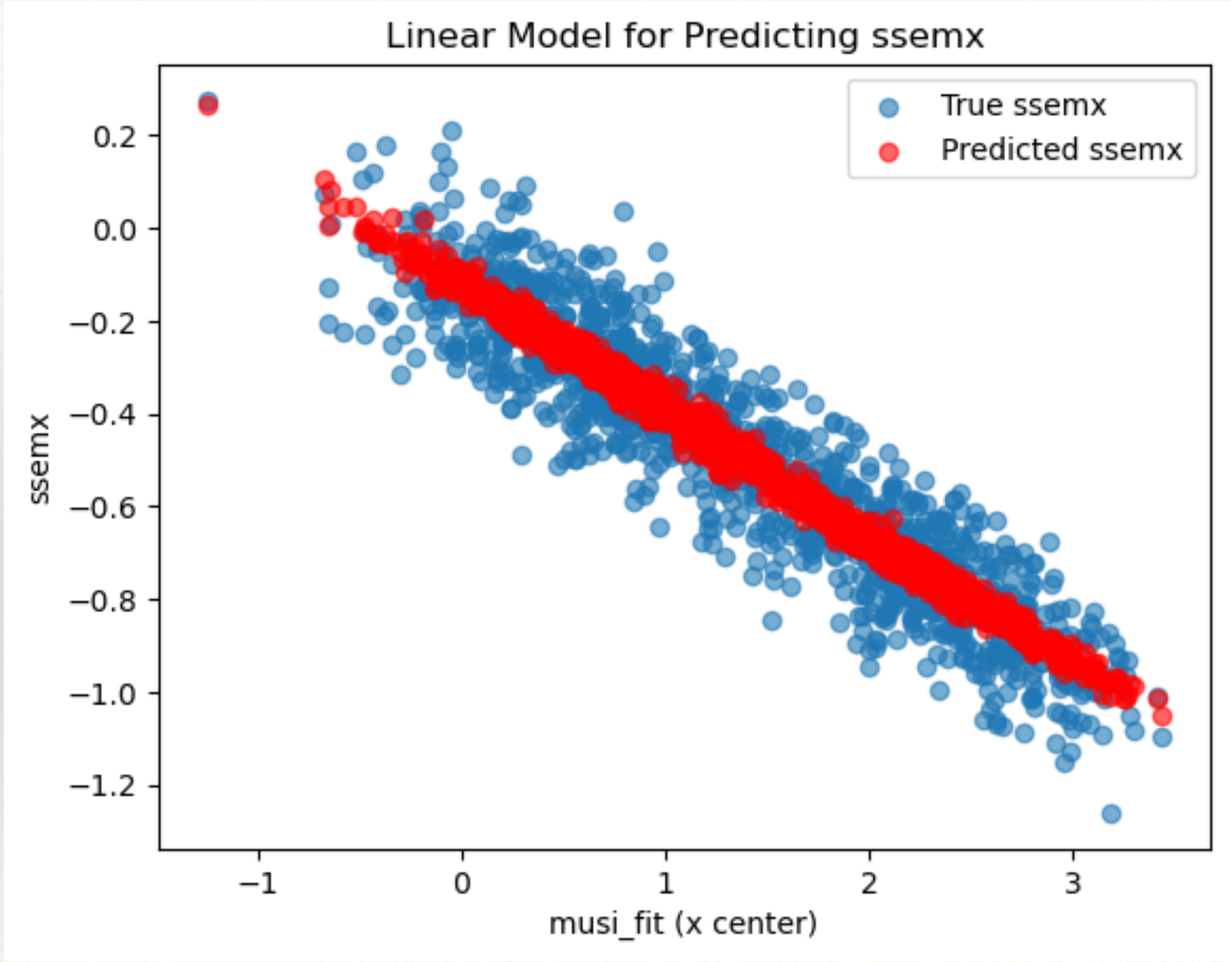




- Correlation between horn current and silicon sensor values

Linear Regression

- A simple example of how linear regression can estimate beam profile from muon monitors



Questions

- Beam positions:
  - SSEM (beam profile monitor): we have this data
  - ESM (beam position monitor) beam position values: we don’t have this data, is unreliable due to electrons from SSEM19.
  - pbeamx/y[5] shows fit beam position but not been being filled?