

Hall C Winter Collaboration Meeting 2023

AI4HallC Project: Global Singles Rates Parameterization

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Outline

Problem introduction

- Non-physics cross-section at low angles (scattering in the dipole)
- DAQ rate limited inclusive measurements
- Wide spectrometer acceptance & small bend angle

Data sources

- Epics, Scaler, Triggers, experimental parameters, models
- Start out simple! Use only one source
- Maybe my project wasn't so simple after all (want ONLY non-physics)

Overview of work done to-date

- Data extraction and cleaning
 - angle, momentum, thickness, rate, current, scaler rates, etc.
- Fail, and try again

Future work

- Start with a simpler project, and get the right answer.
- Build up software tools we can all use

Parameterization of Singles Rates

Separated into two parts:

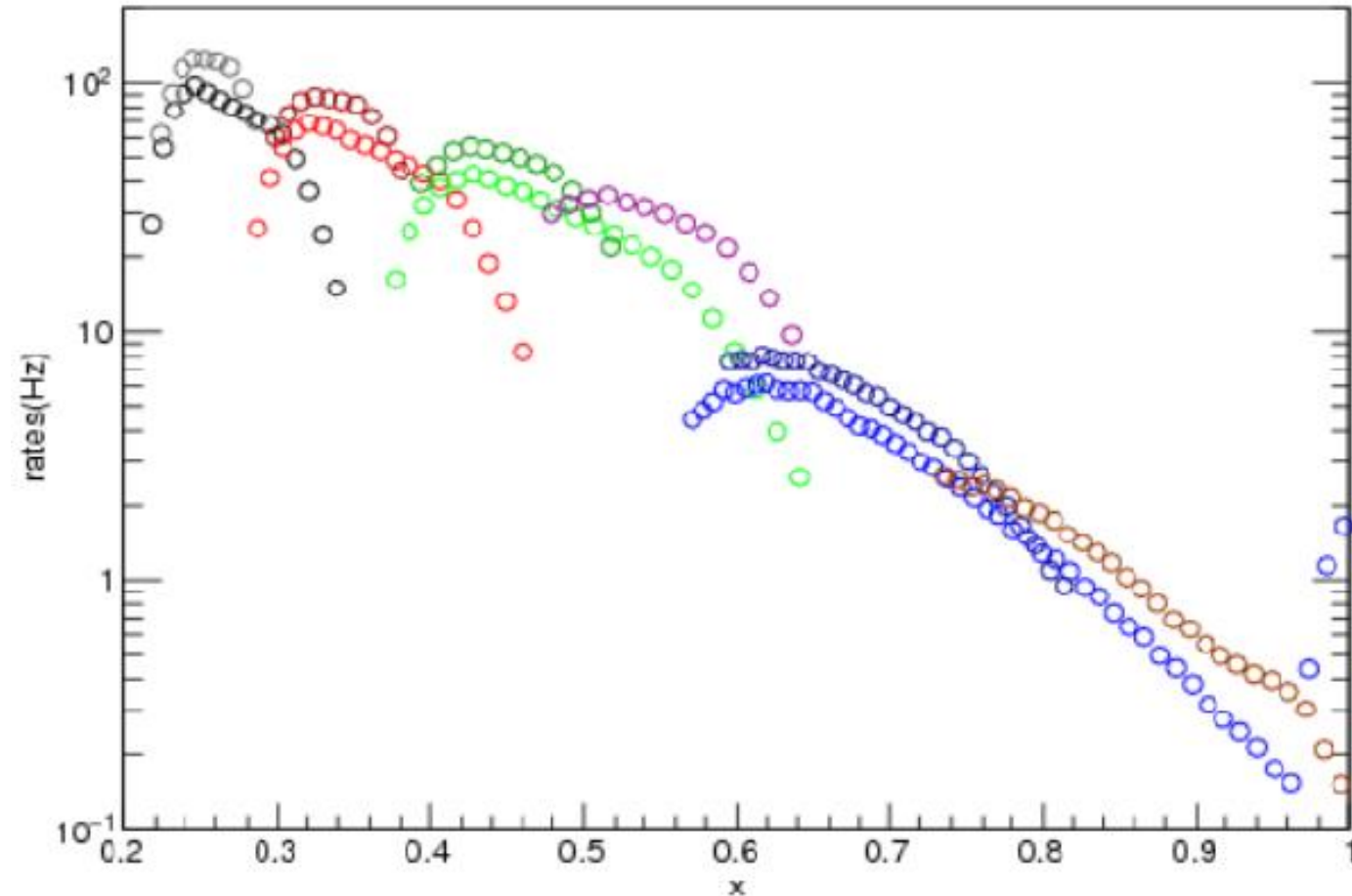
Physics:

- Knowledge of acceptance (monte-carlo) and access to good models (F1F221, etc.) results in anticipated rates.
- In practice we use a monte-carlo and a cross-section model coupled with beam energy, angle, and momentum. We also account for radiative effects and dummy subtraction.

Non-Physics:

- Still physics, but not simulated in either the monte-carlo or cross-section model.
 - High accidental rates
 - User error (failure to simulate physics)
 - Incorrect detector acceptance
 - Bad models
 - Hardware failures / limitations

SHMS rates(light) and HMS rate (dark)



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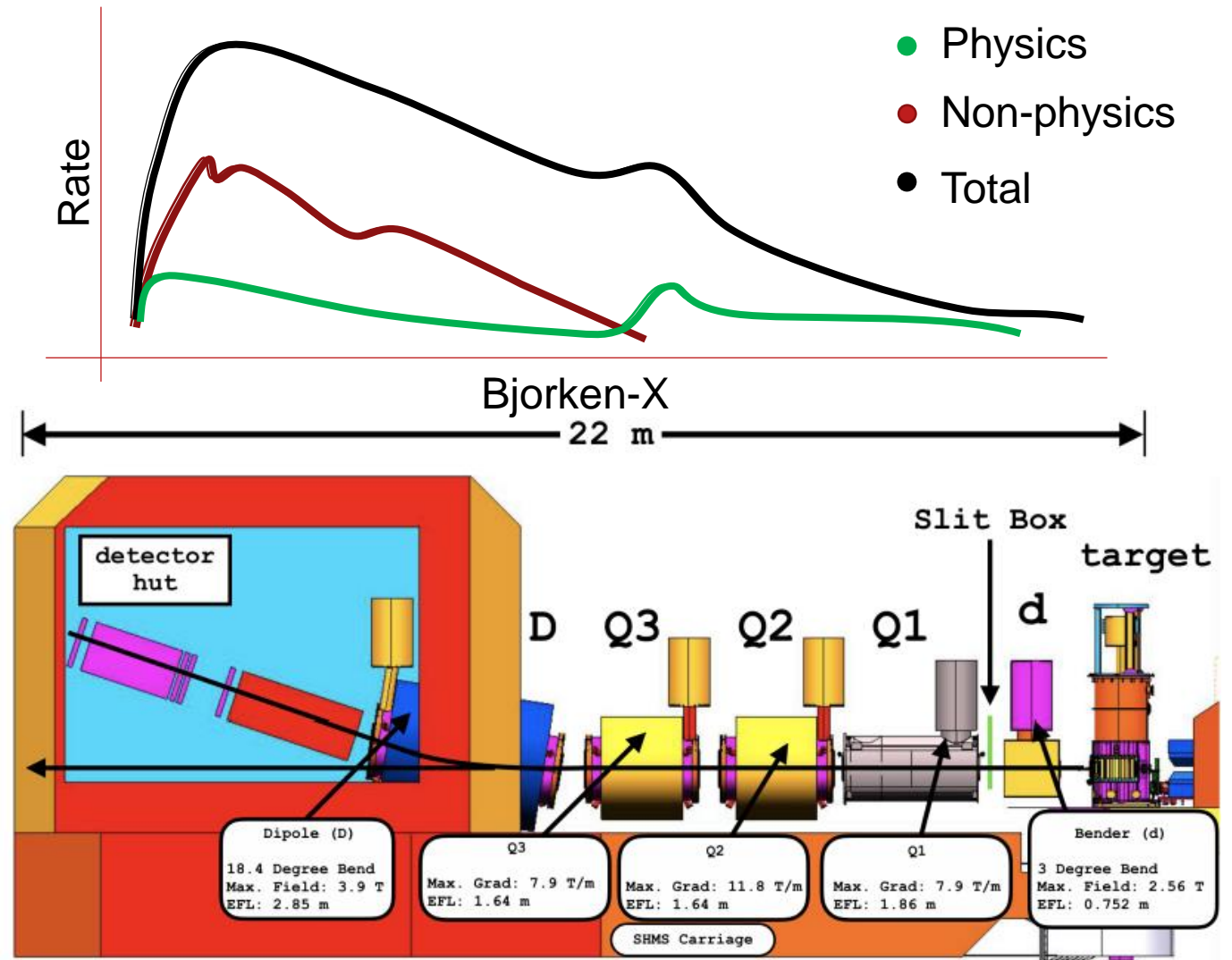


Figure 3.21: Super High Momentum Spectrometer (SHMS) side view.

Parameterization of Singles Rates

Characteristics under consideration

- Trigger that doesn't bias physics results
 - Excludes background processes that are not desirable
 - Exclude physics that isn't useful!
- Why? DAQ rate is limited to ~4kHz

Ways forward

- Full detector response simulation (geant4)
- Corrections applied in the monte-carlo for low-angle events (scattering in the dipole)
- Data driven model of non-physics events
 - Maybe an AI could do this for us?

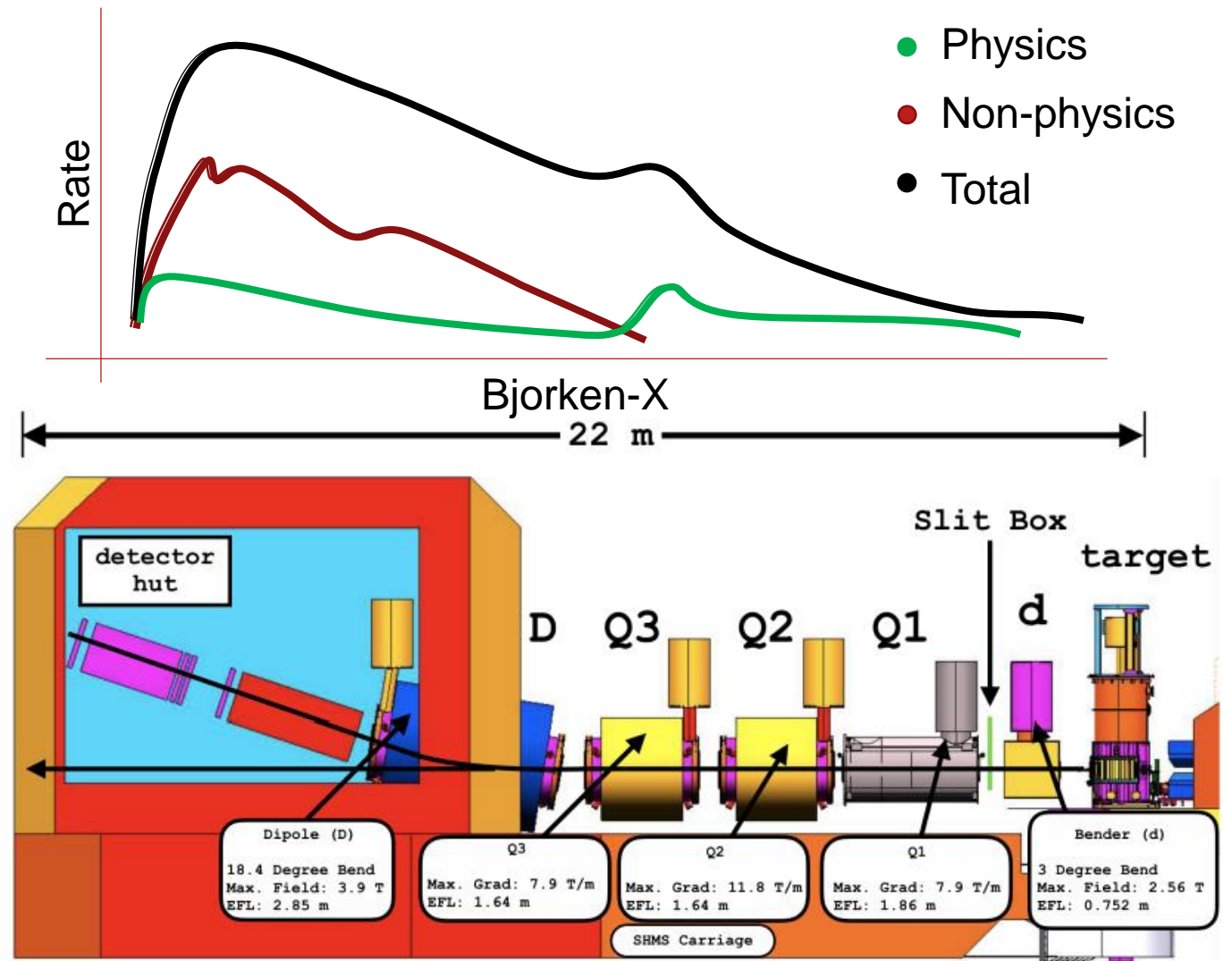
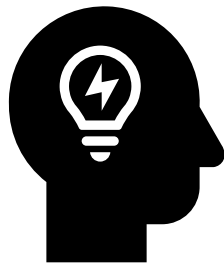


Figure 3.21: Super High Momentum Spectrometer (SHMS) side view.

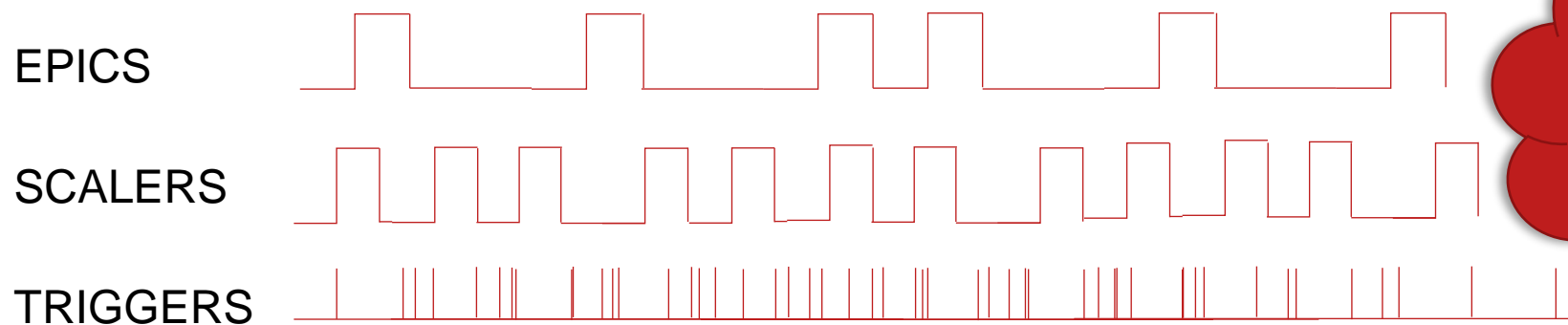
Data Sources

Data stream in hall C

- EPICS – Read out ‘all’ every thirty seconds and some every two seconds (Not everything is recorded)
- SCALERS – After two seconds or a certain number of L1ACCP
- TRIGGERS – full readout of detector stack (poission distributed events in time)

Using cross-domain data sources presents a problem (I am no expert on this)

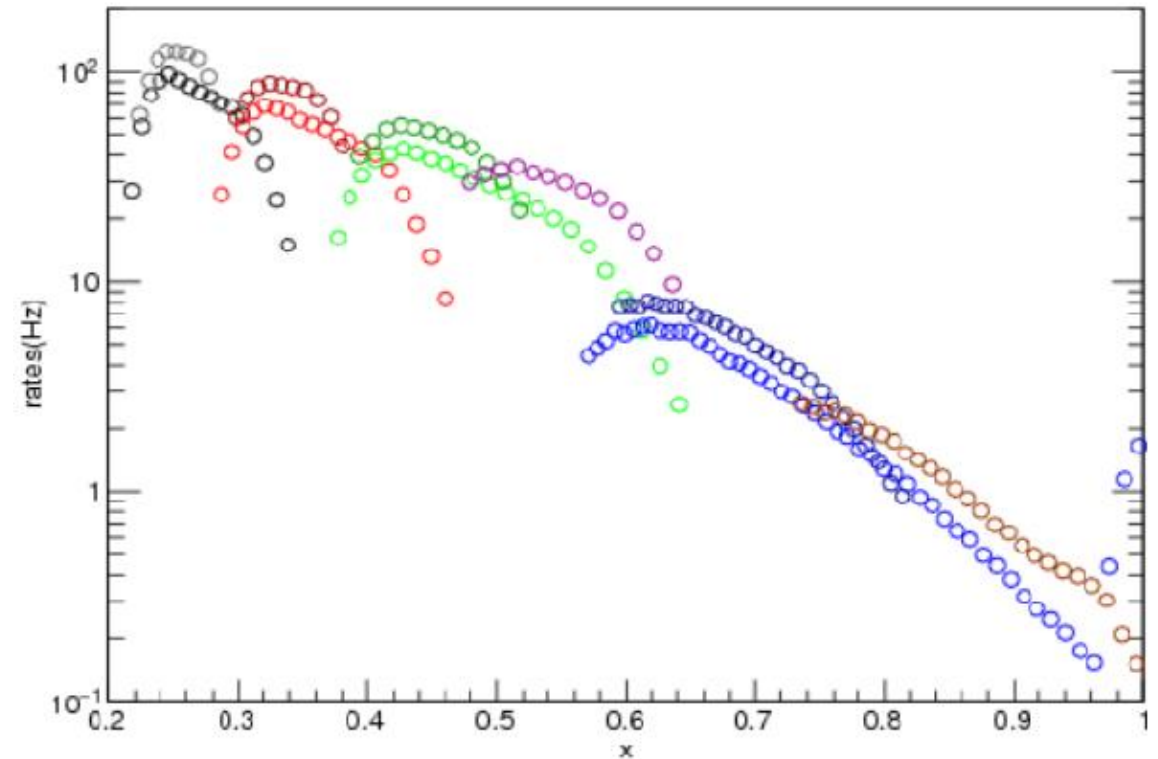
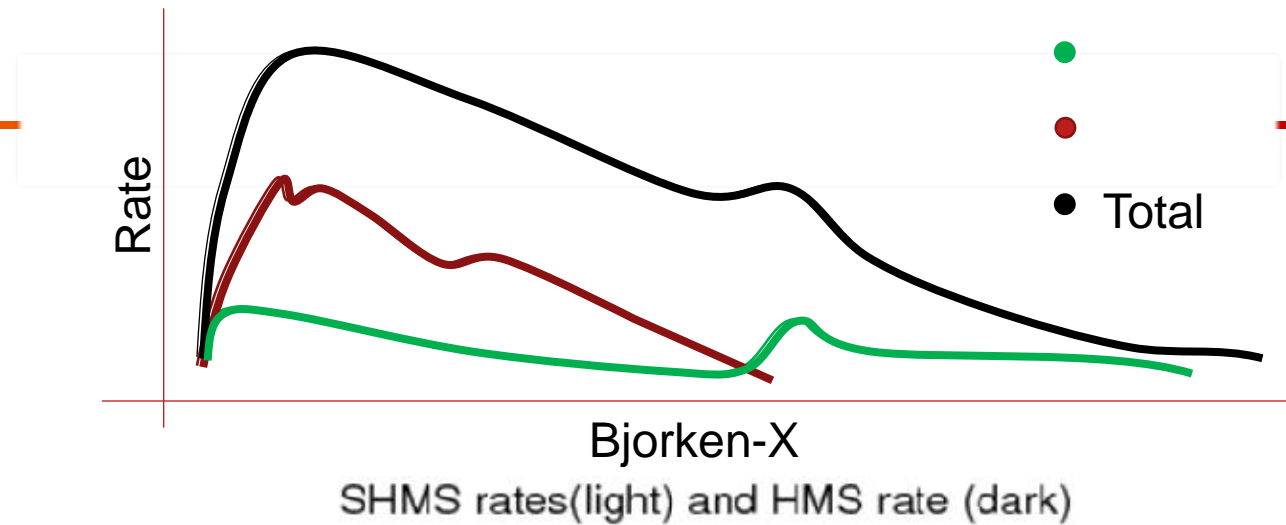
- Resolution will be limited to slower data sources
- Patterns may be learned which are just related to data frequency
- Easier to just use one data source if possible



OTHER SOURCES
angle, target
properties, Earth's
magnetic field, etc.
Rundata object

Data Sources

- THE PHYSICS MODEL!
 - Currently needs iterated in the case of XEM2 (largest singles dataset)
- How to quantify discrepancies in model to not bias result?
- Physics cross-section models could also be produced by neural networks.



Work Done Thus Far

- Extract samples of scalers for at different rates
 - Different targets, angles, hodoscope planes on / off

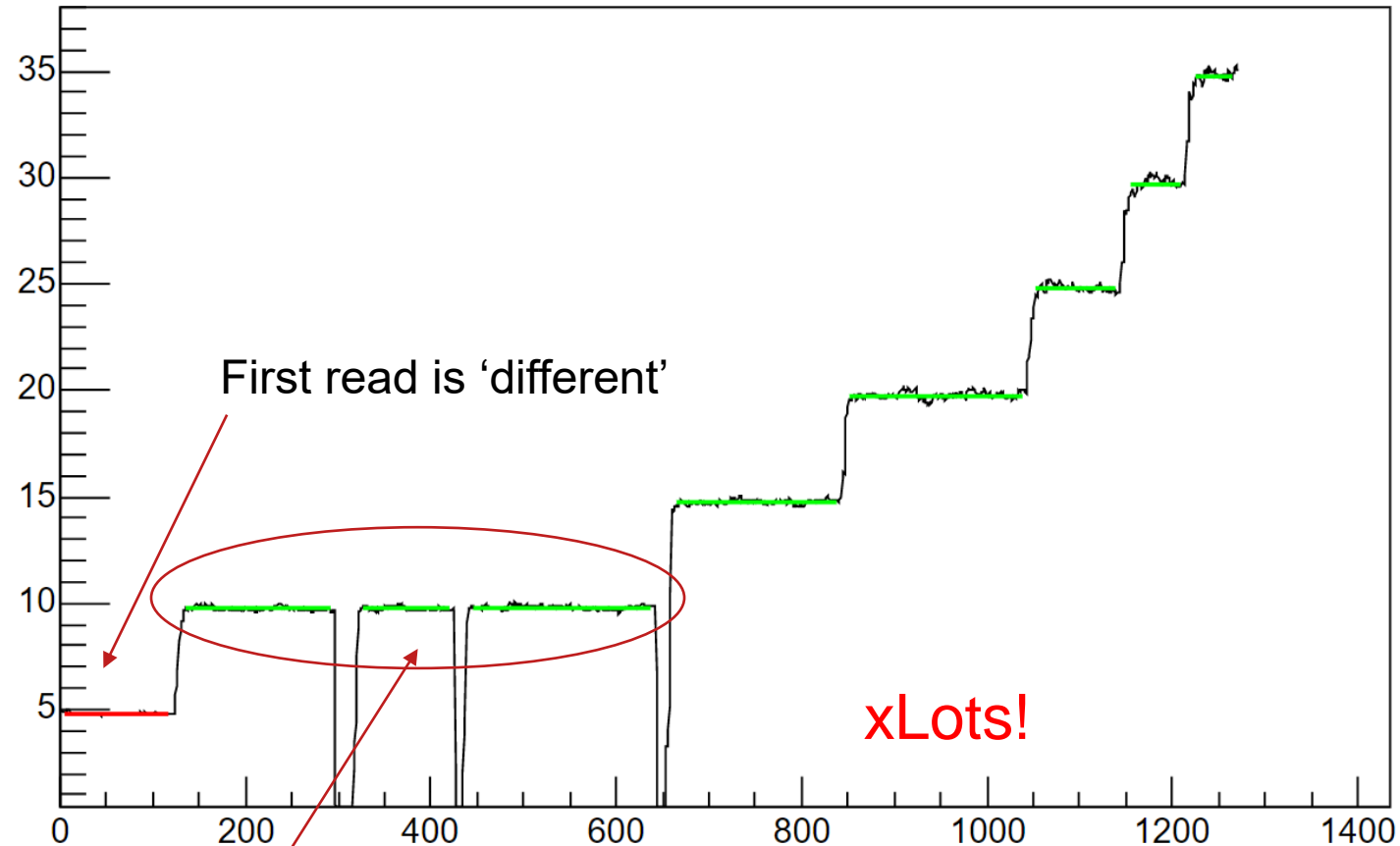
- SCALERS

L1ACCP, active trigger(s), current, edtm, trigger legs

- Could add all the hodoscope paddle rates as well!

- OTHER

Model rate (from mc-single-arm and f1f221), angle, spectrometer, momentum, live times



Should probably remove same current regions?

Moving Forward

Currently I get a low confidence score

- Try out different hidden layers or activation functions
- Have a better model

Try a new project

- We need to do simple things to give us confidence
- Cluster funding, track selection (involves adding code to hcanal, ICK!)

Make a framework we can all use

- The coda data stream is always the same format.