ACNET APPLICATION PROGRAM TO MEASURE THE ENERGY SPREAD IN THE BOOSTER AT INJECTION

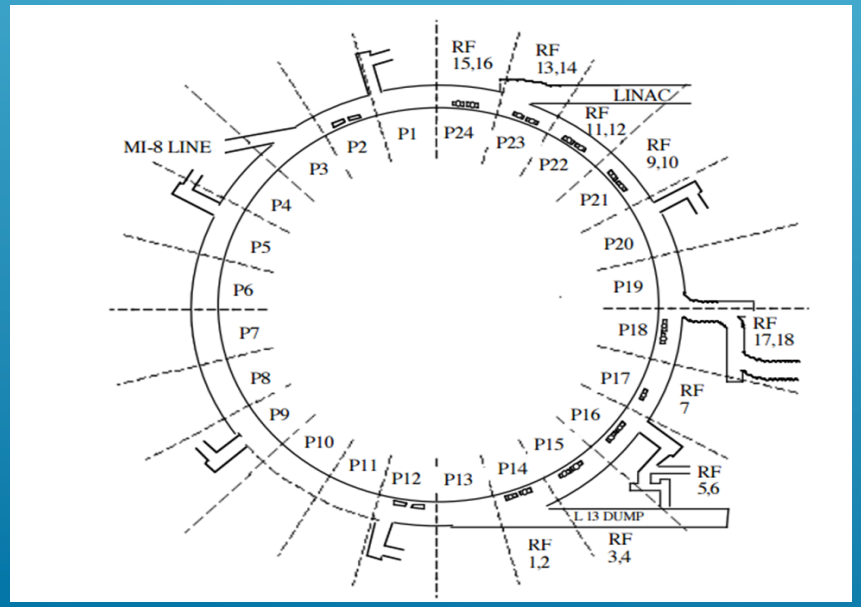
Jovan Nelson

Brown University

Supervisors: Chandra Bhat, Brian Hendricks, Ming Jen Yang

Acknowledgements: Kent Triplett and SIST Program

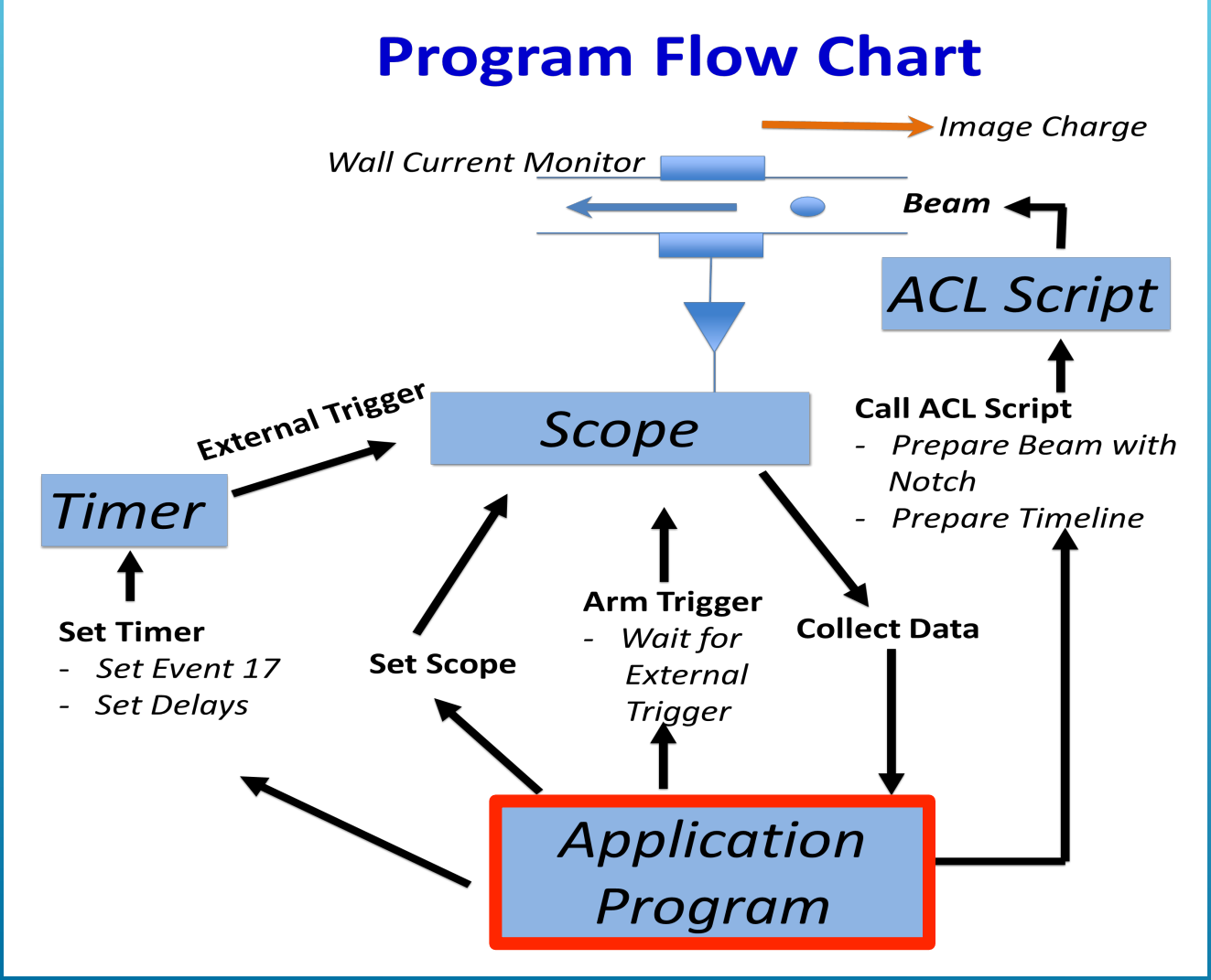
THE BOOSTER



The Booster was first commissioned in October 1970

- Booster has an injection beam energy of 400 MeV from the LINAC and an extraction beam energy of 8 GeV
- About 150 meters in diameter
- Has 19 RF cavities
- 96 combined function dipole magnets

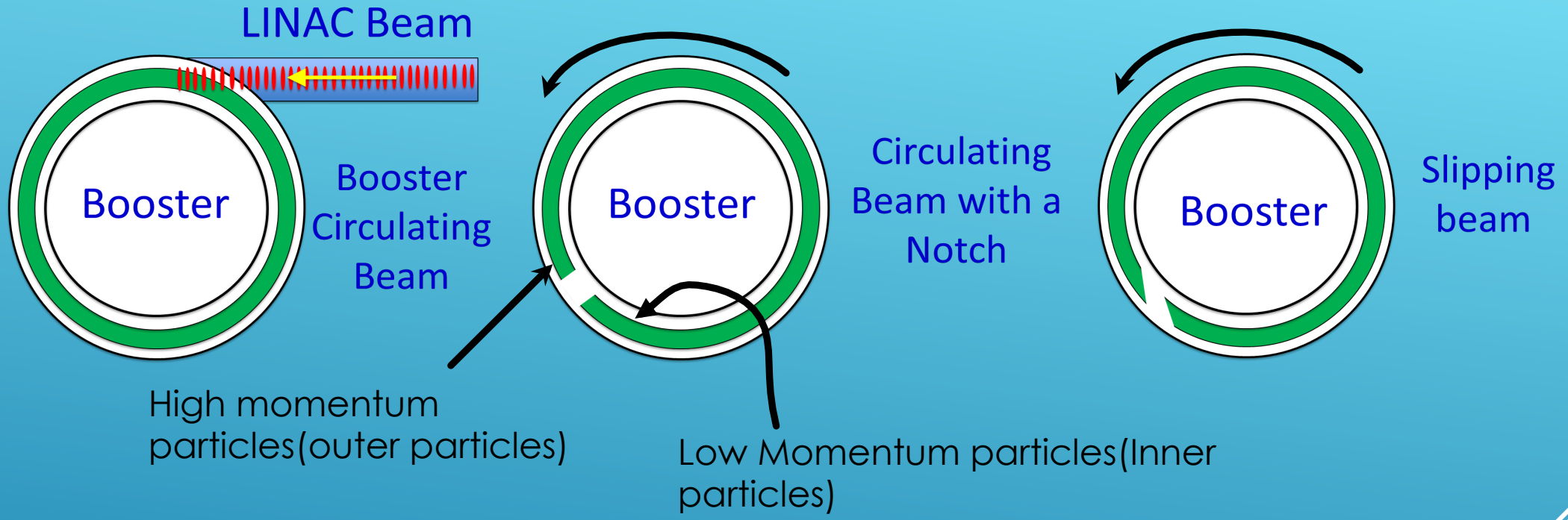
PROGRAM SETUP



In order to measure this energy spread in the Booster an application program was developed

- Built in ACNET environment
- Incorporates various hardware and software
- First application program that can measure the energy spread of multiple Booster turns at injection
- Important for optimizing the beam

DRIFTING PARTICLES

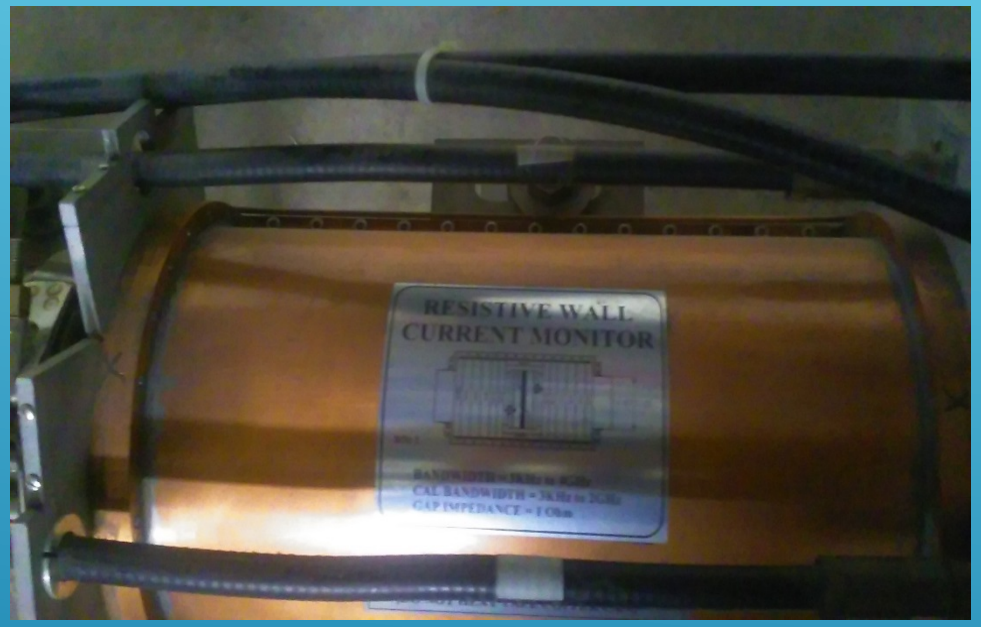


By looking at the drifting of the particles before they are accelerated, we can find the energy spread of the beam by using this equation:

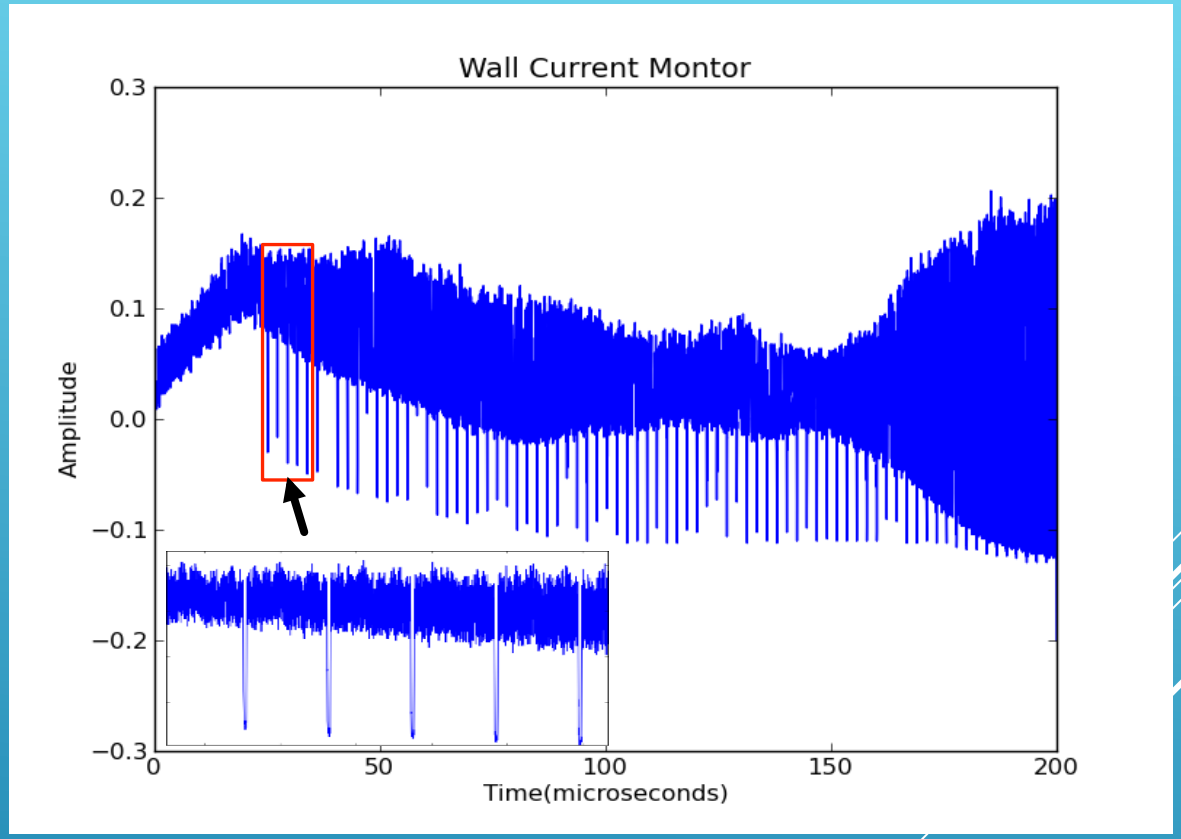
$$\Delta E = \beta^2 \, Es/|\eta| \; Wnotch/Tgraze$$

β - is the relativistic speed
η - is the slip factor
Es- synchronous energy
Wnotch- is the width of the notch
Tgraze- is the revolution time of the "grazing touch"

RAW DATA



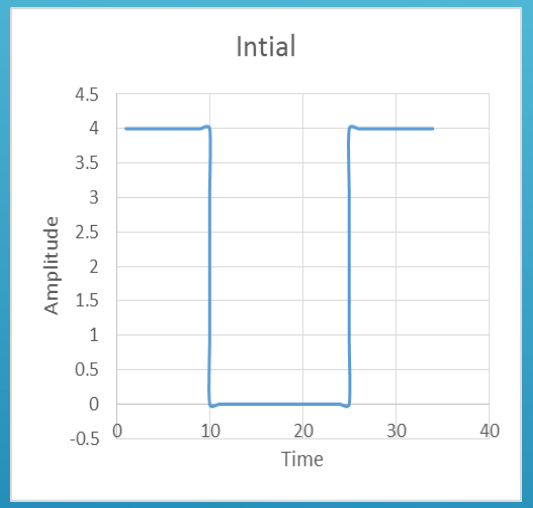
Wall Current Monitor "sees" the notch for every 2.2 microseconds



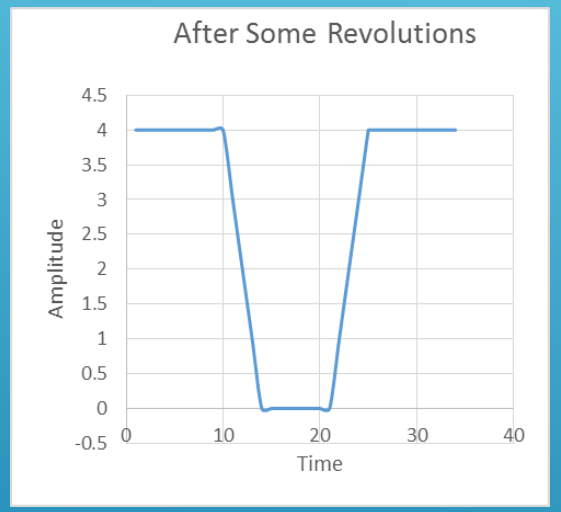
This raw data of the early notch injection scheme, the icicles are the same notch appearing for every revolution.

EVOLUTION OF THE NOTCH

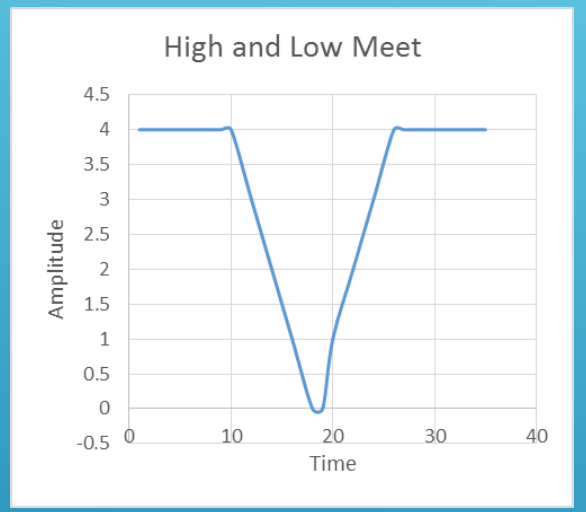
If it were possible to have a square notch and no jittering(in other words an ideal system) this is how the wall current monitor would show how the notch evolves



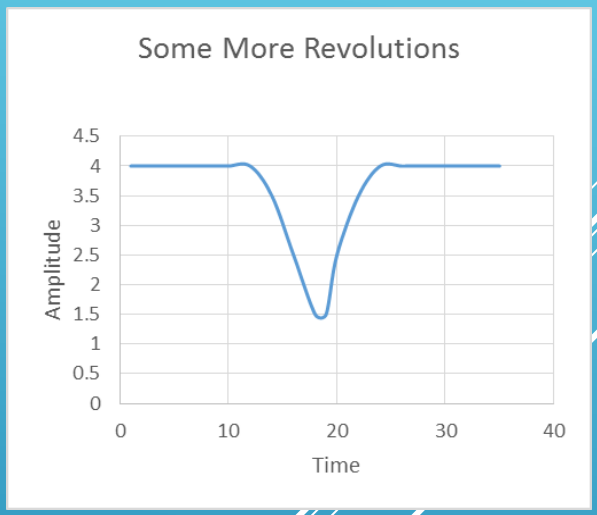
Notch is made



After some revolutions it begins to fill up



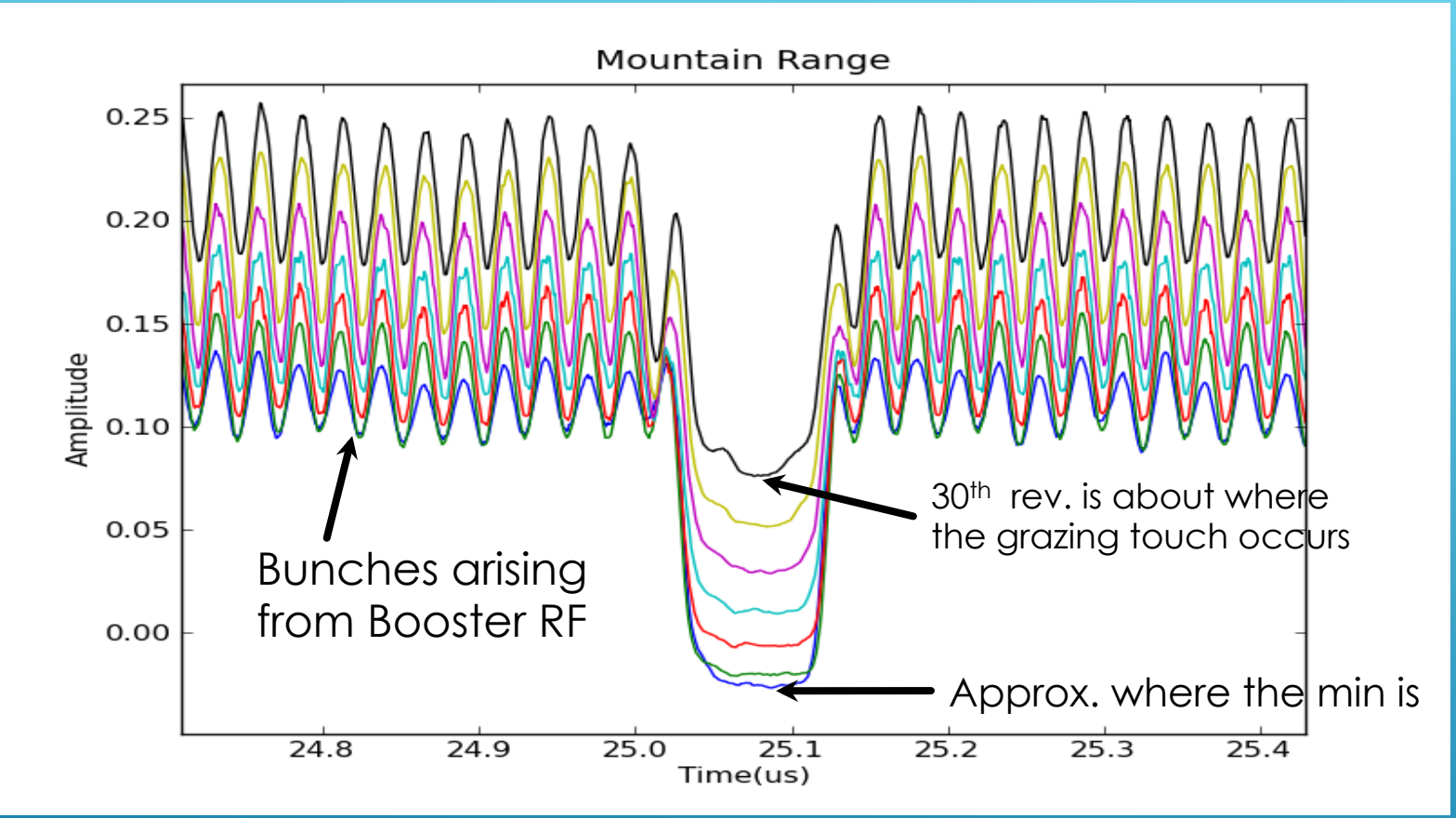
High momentum and low momentum particles have a "grazing touch"



Notch moves up

EVOLUTION OF THE NOTCH

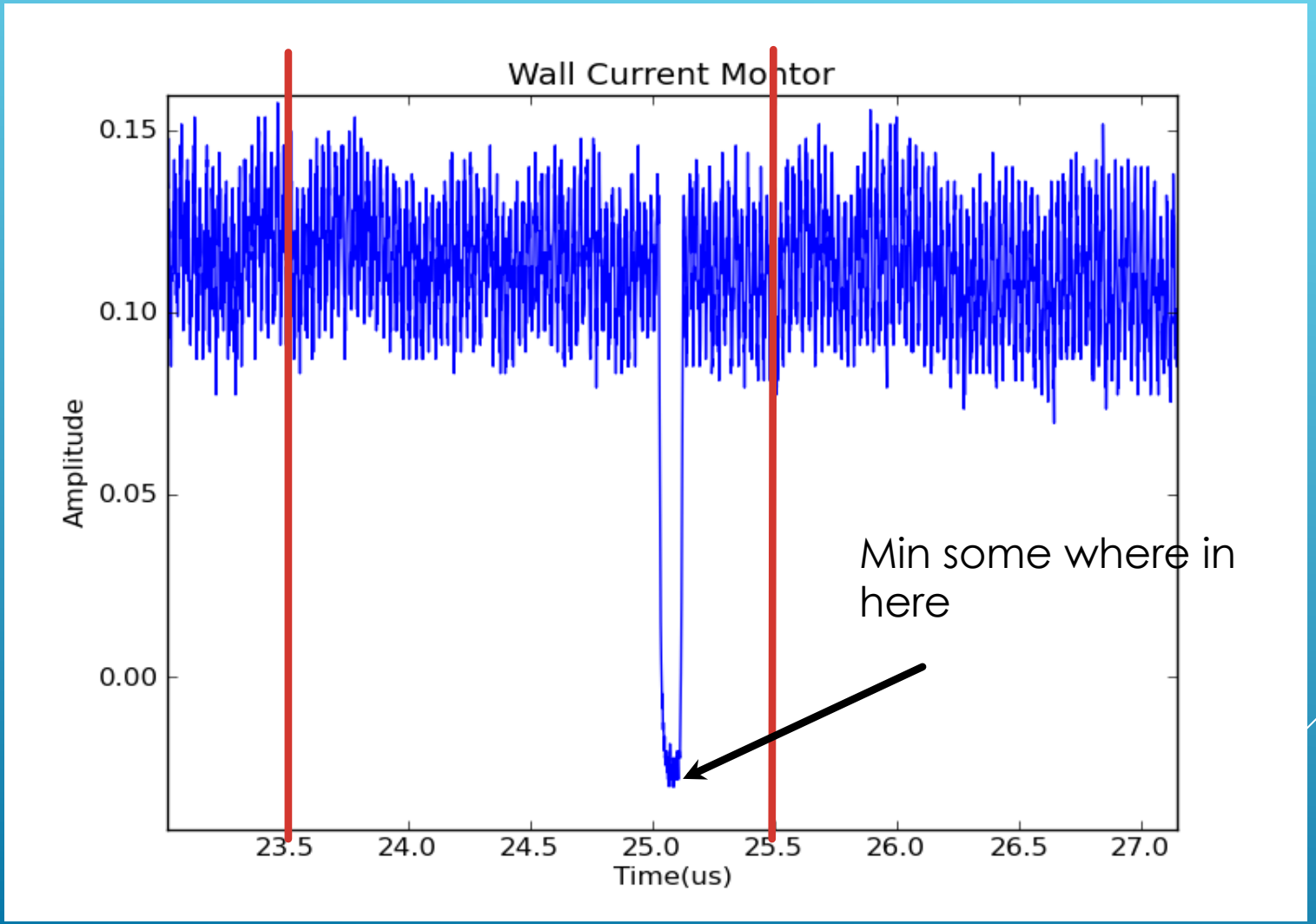
But in reality it looks more like this(and this is with smoothing)



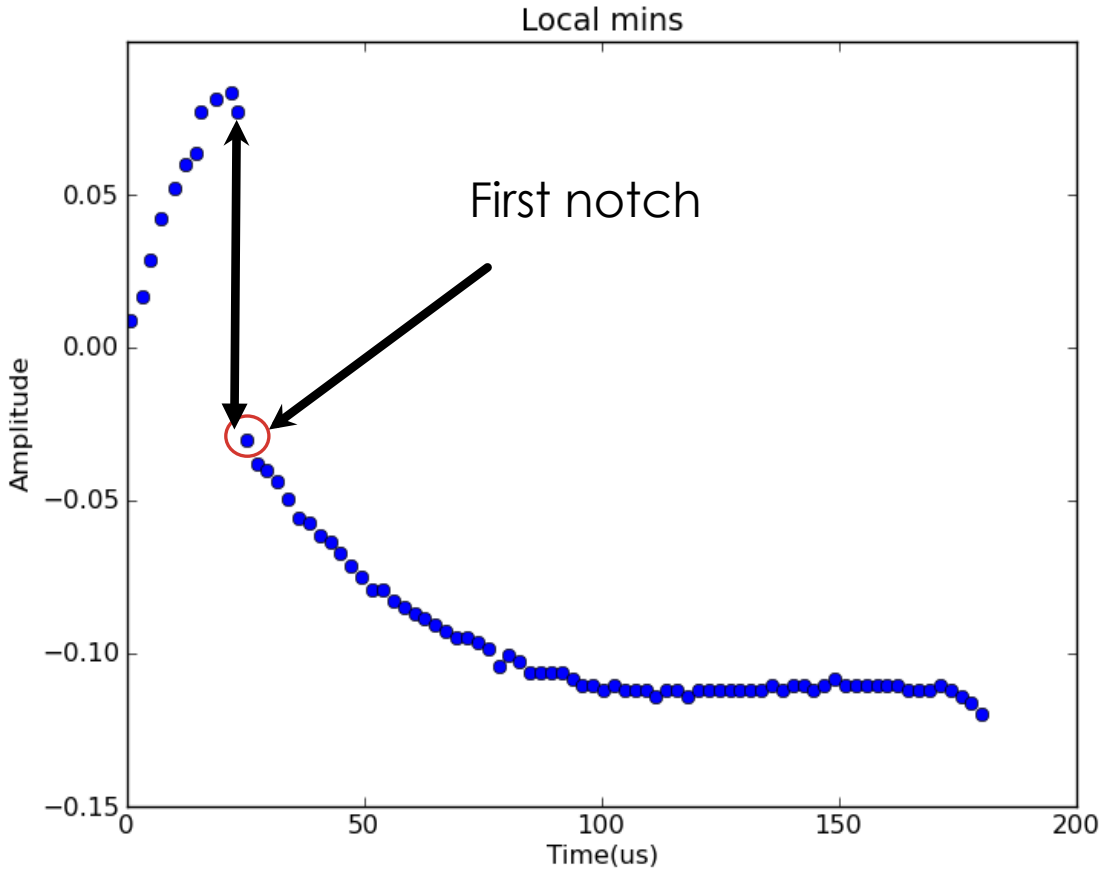
Blue is the first notch, green is 5 revolutions later, red is 10…etc.

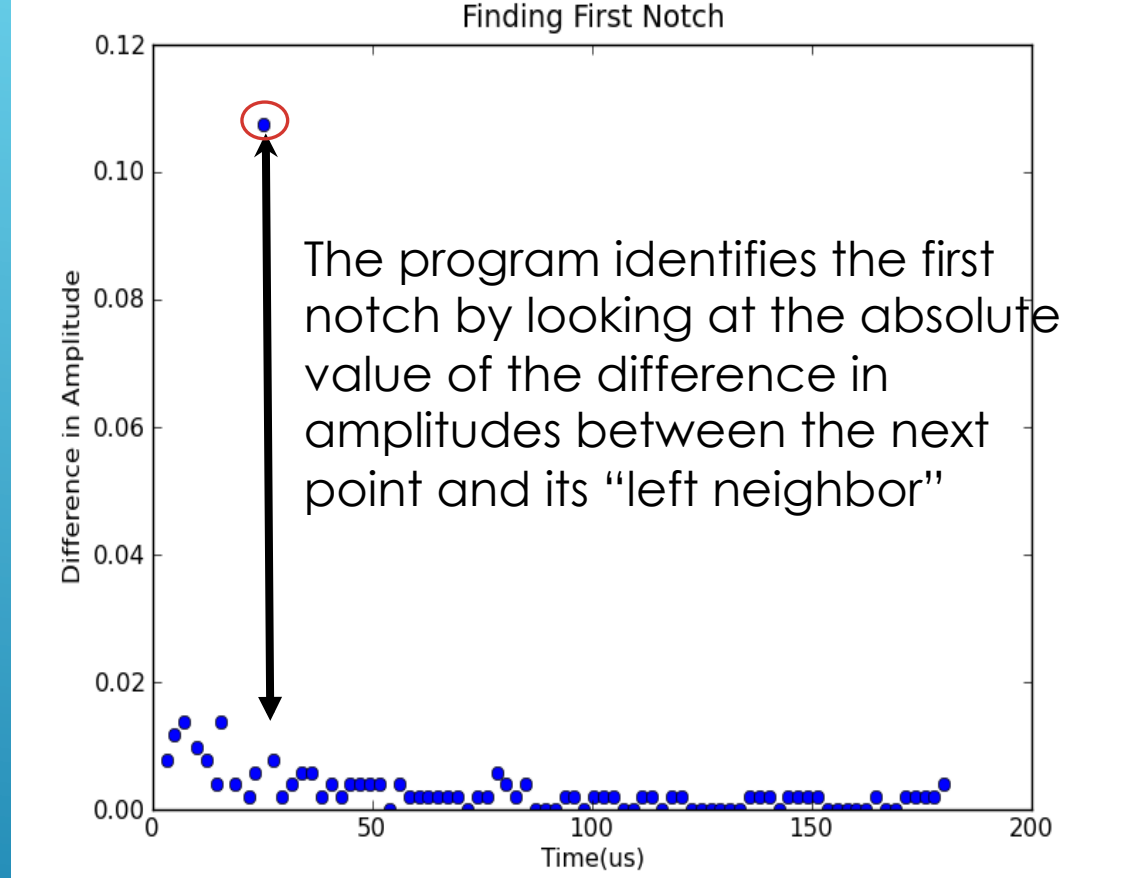
FIND THE MINIMA

To analyze this data we first look for the minimum of the notches in "rough cuts" which are about 2.212 microseconds long(a guessed value)

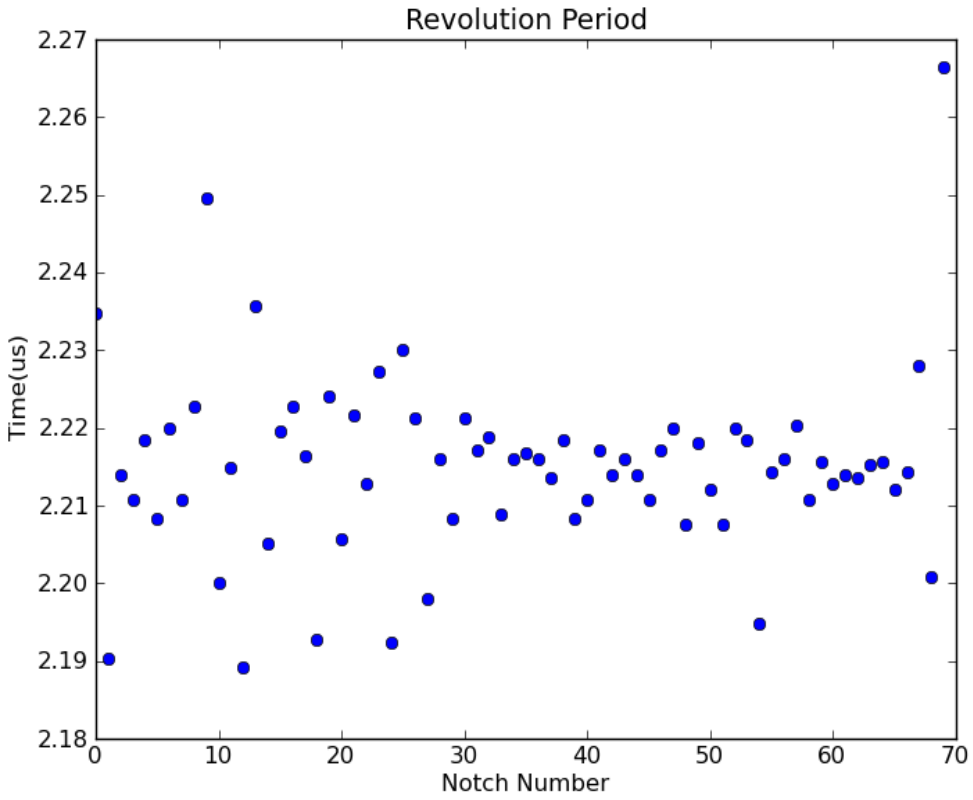


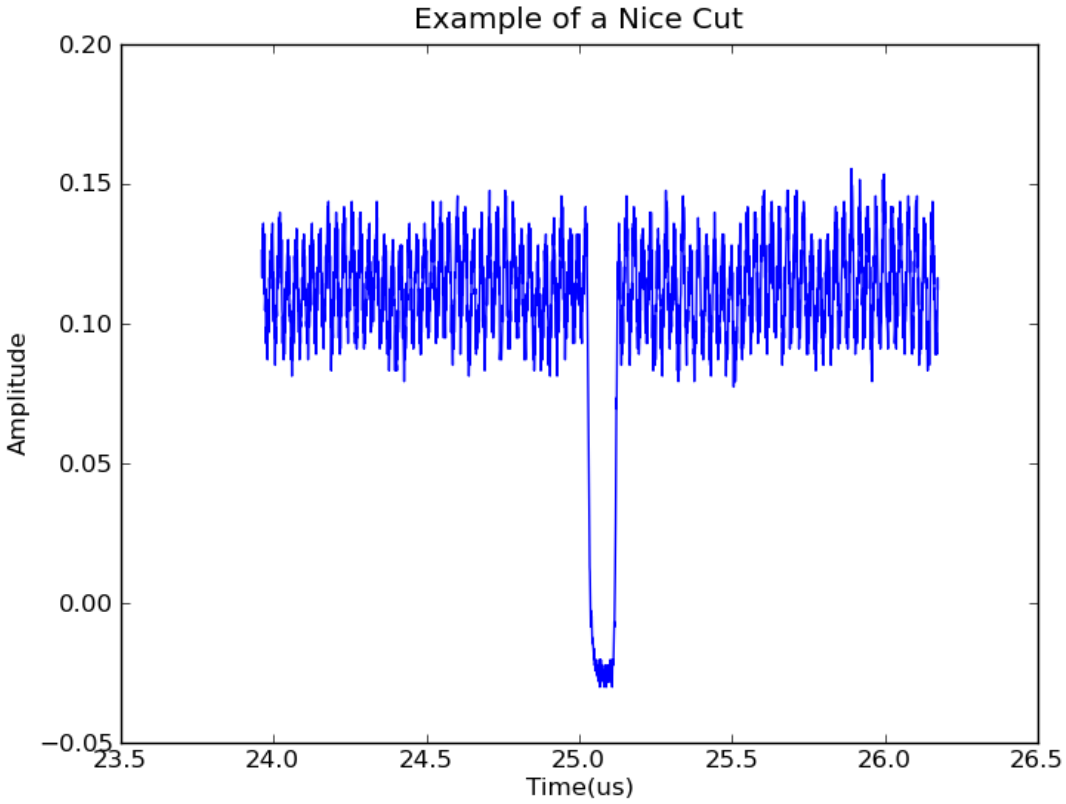
FINDING THE FIRST NOTCH





FINDING THE REVOLUTION PERIOD

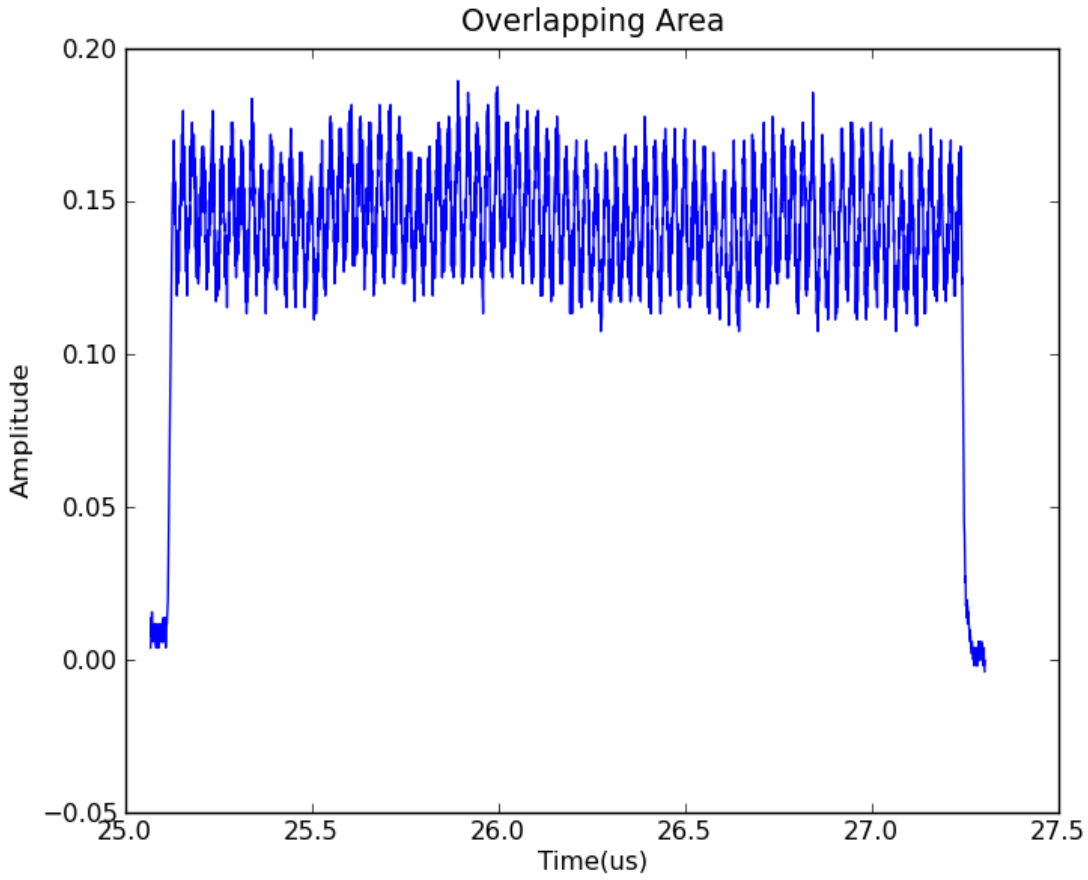




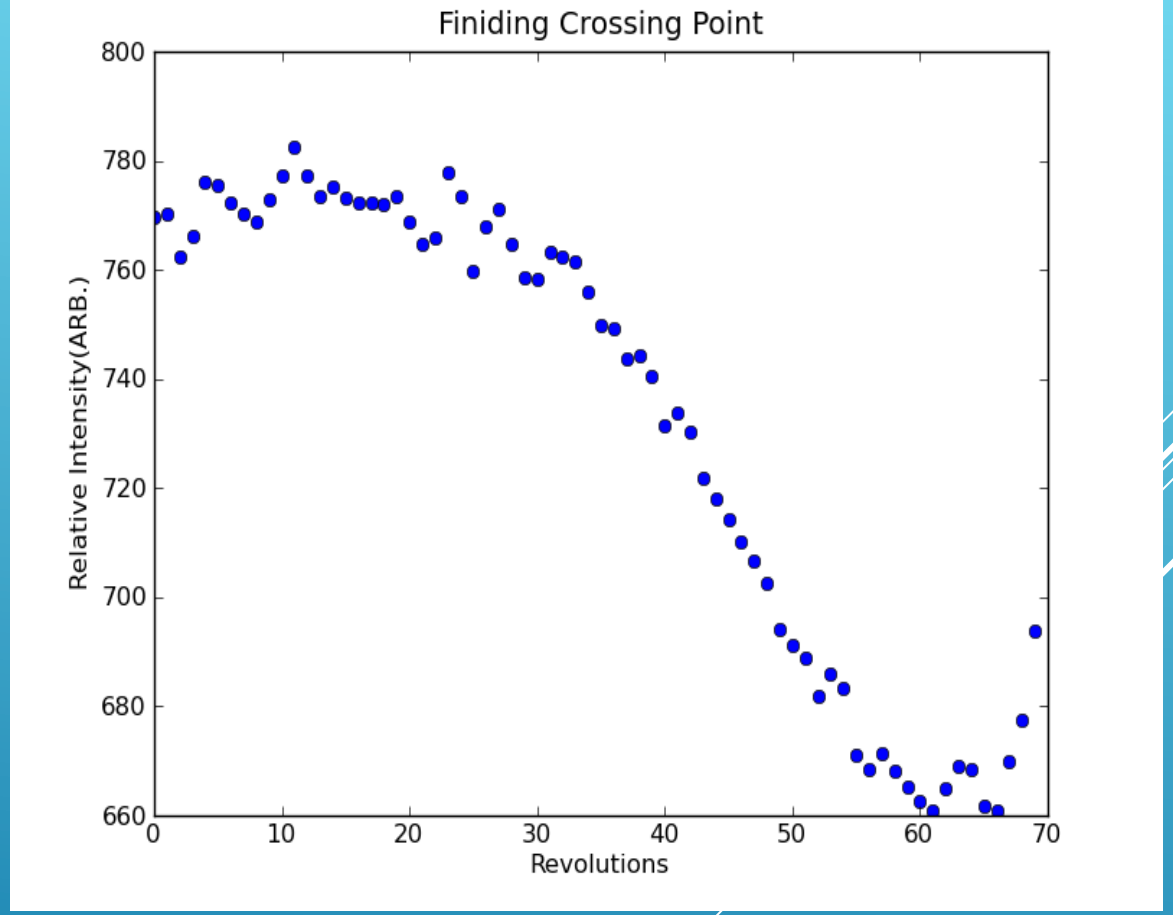
Finding the revolution period of the notches. In the program only the first couple notches are used to make better cuts.

Nicer cuts are good because it makes it easier to move on to the next step of calculating the apparent intensity

CALCULATING THE RELATIVE INTENSITY

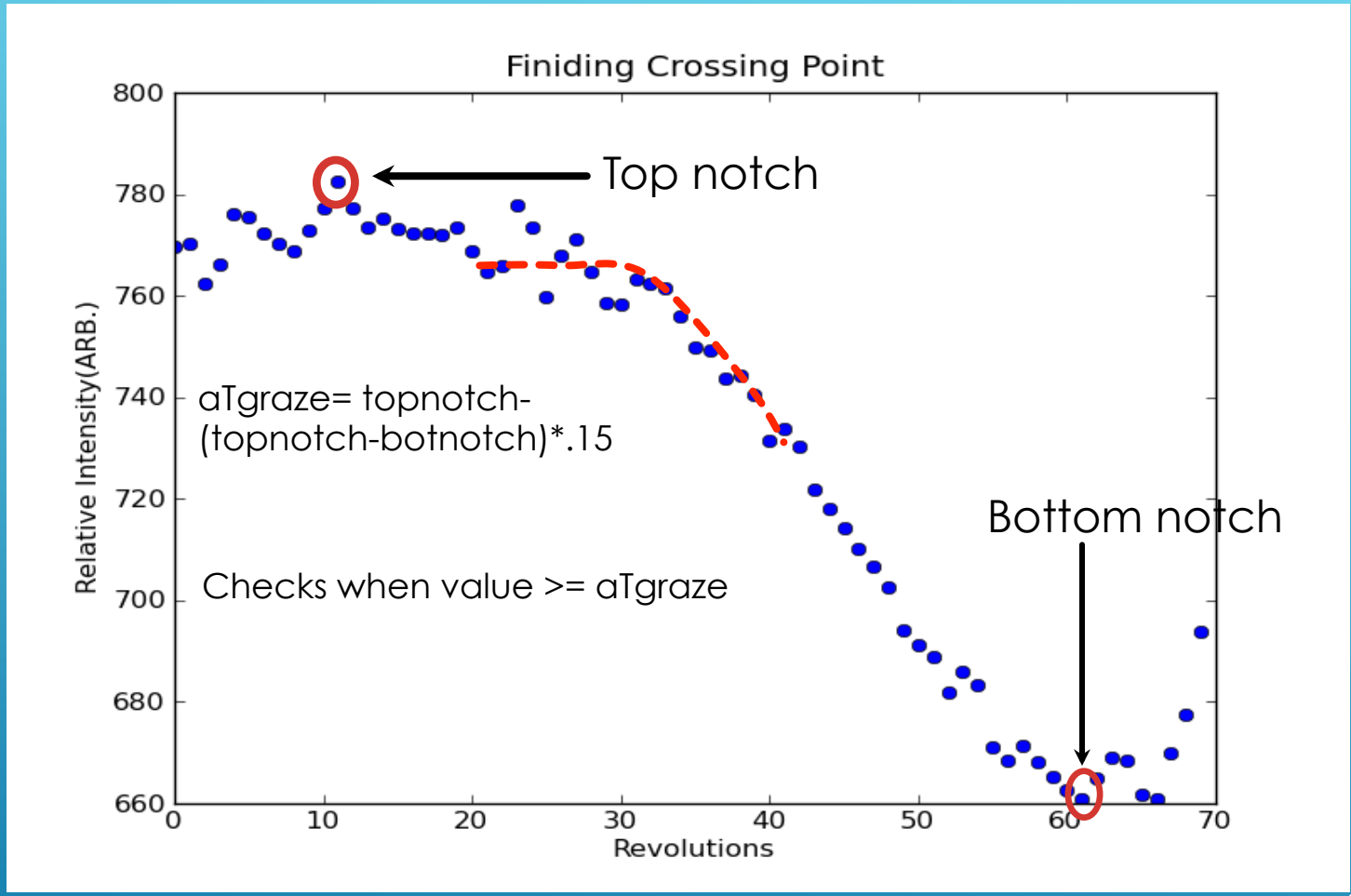


Take an average of the mins and find the area(relative intensity) we do this in between several notches



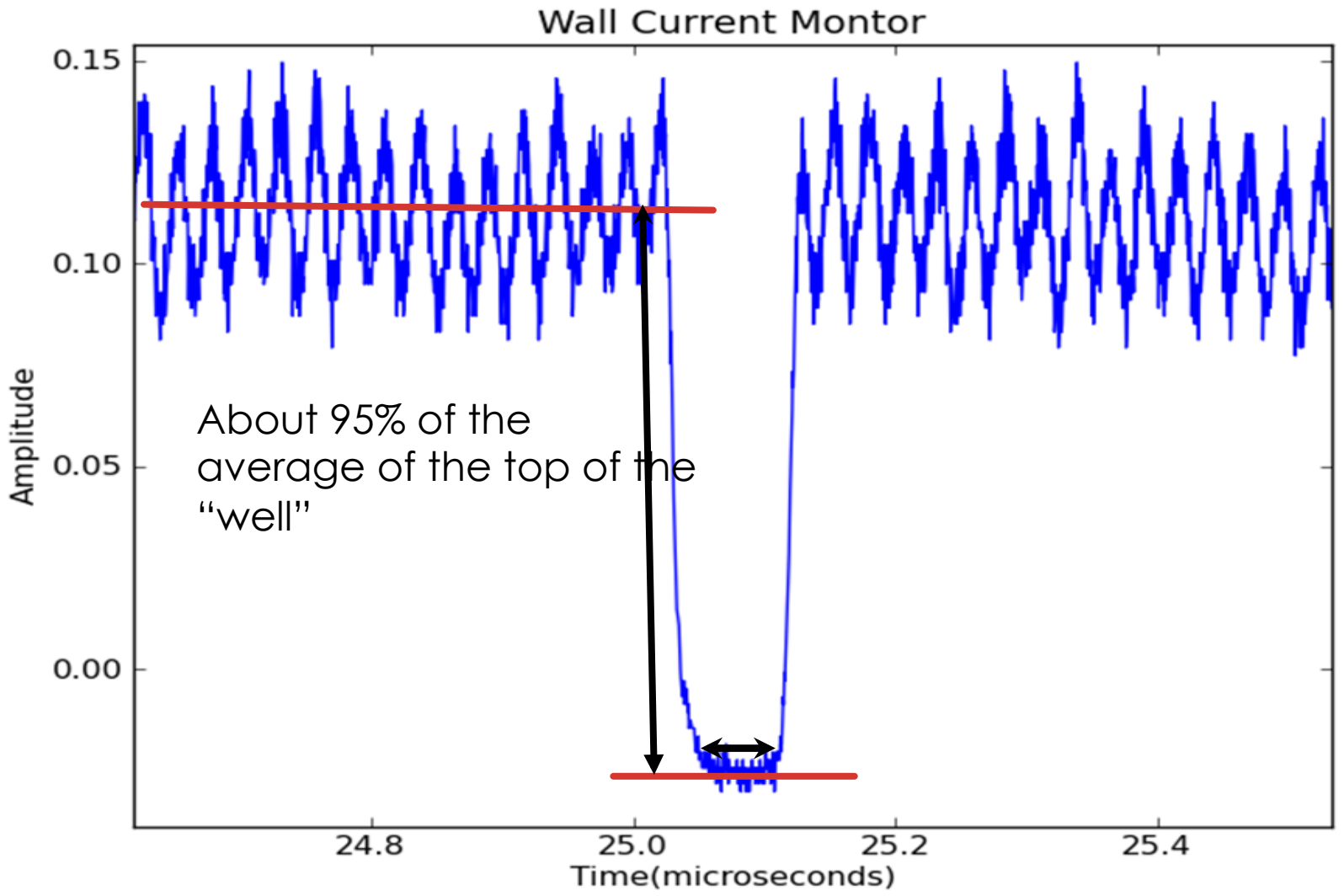
This curve is then generated after finding the area and plotted against revolution. We can see the changing of the notch from this.

FINDING THE GRAZING TOUCH

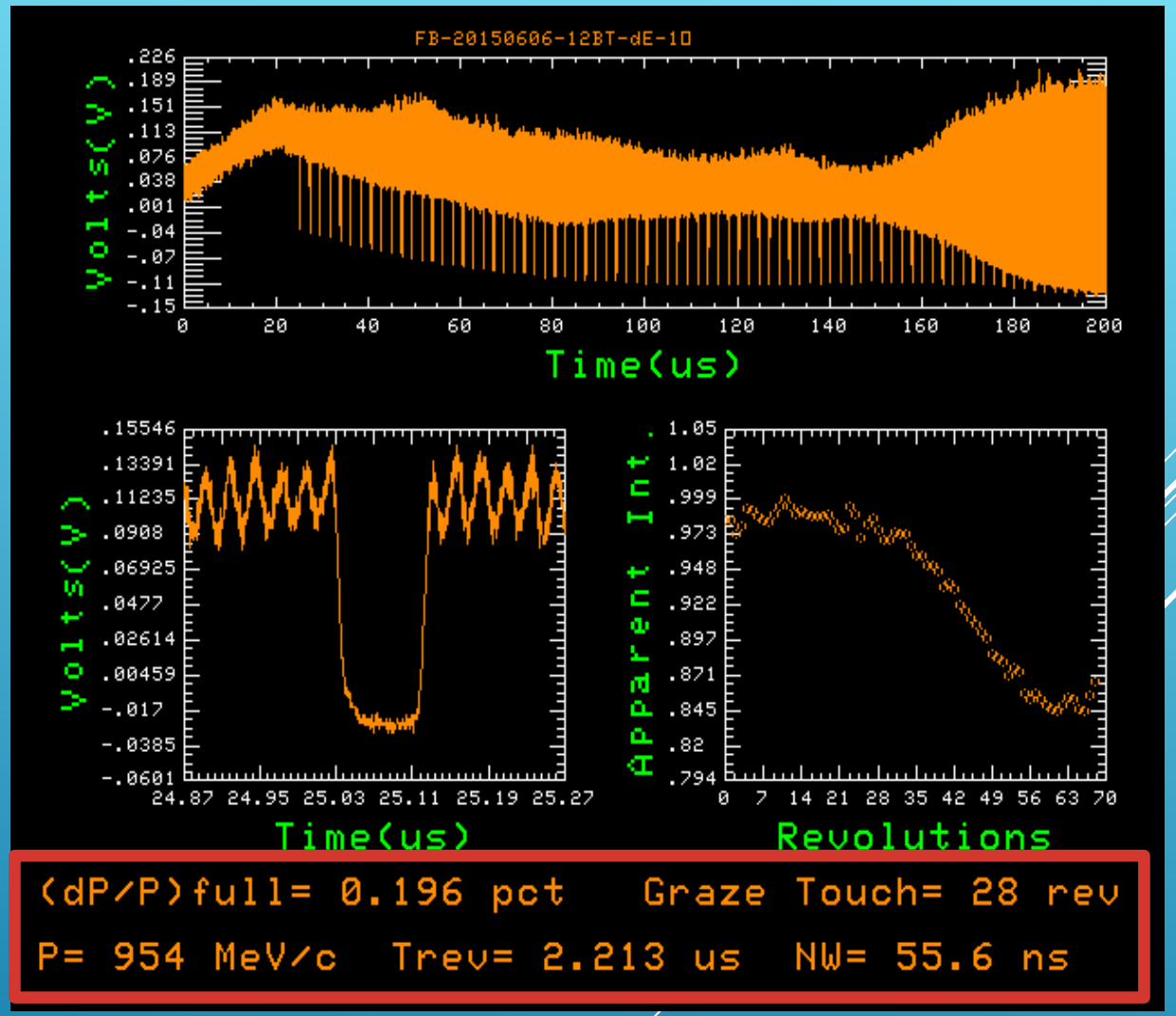


To find the gazing touch the algorithm starts from the bottom notch and compares until it sees an area greater than aTgraze. Confidence level in these values is about 1-2%

FINDING THE NOTCH WIDTH

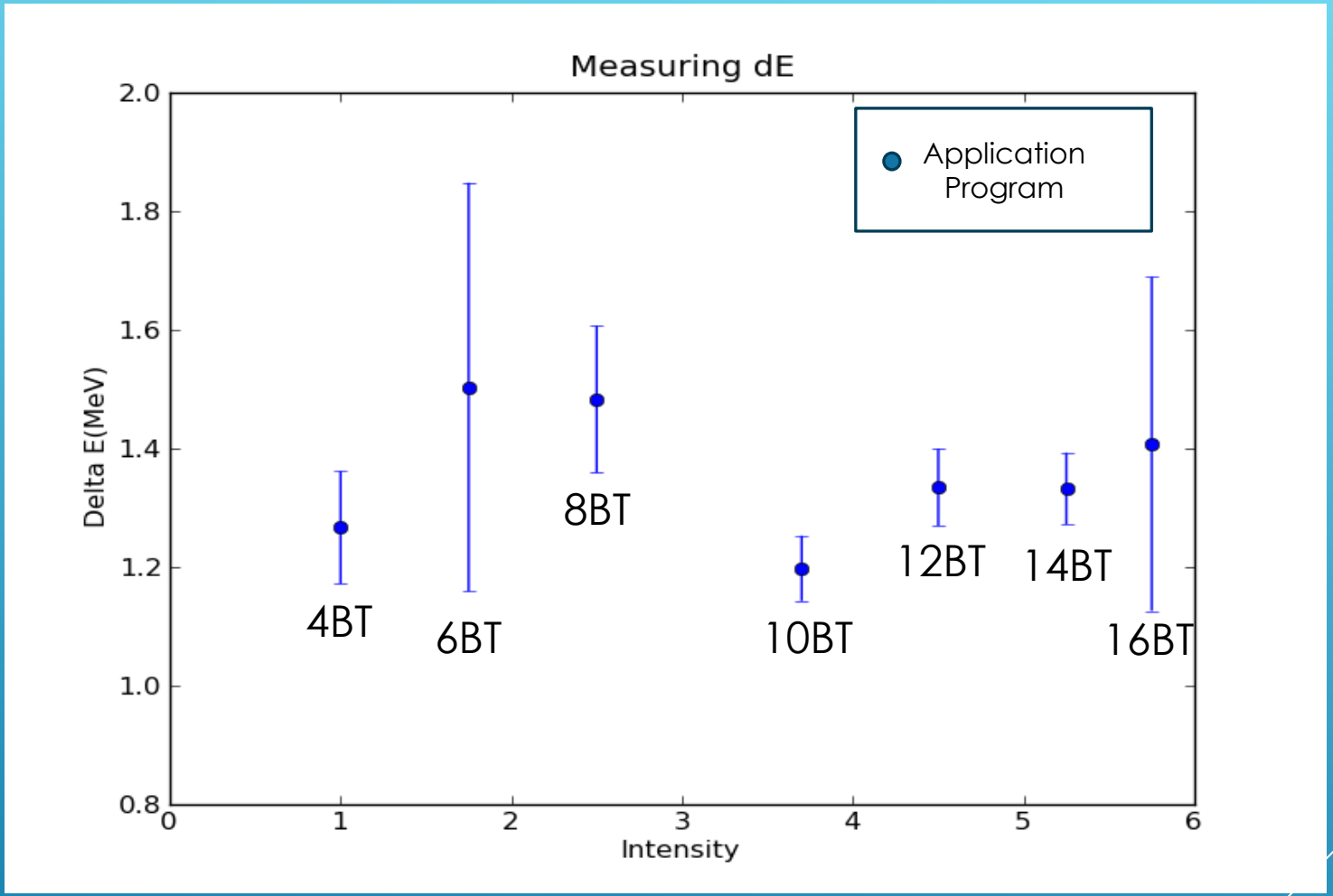


THE APPLICATION PROGRAM



This is what the application program looks like right now and what it gives(most of the graphs before are not in here because they were just used to give a visual of how the analysis works).

LOOKING AT THE ENERGY SPREAD SO FAR



There nothing here that is conclusive about the energy spread but….

It looks like its working….we will know for sure when the beam turns back on and more data is collected.