EasyTracker II

ATLAS Forward Proton - SFT

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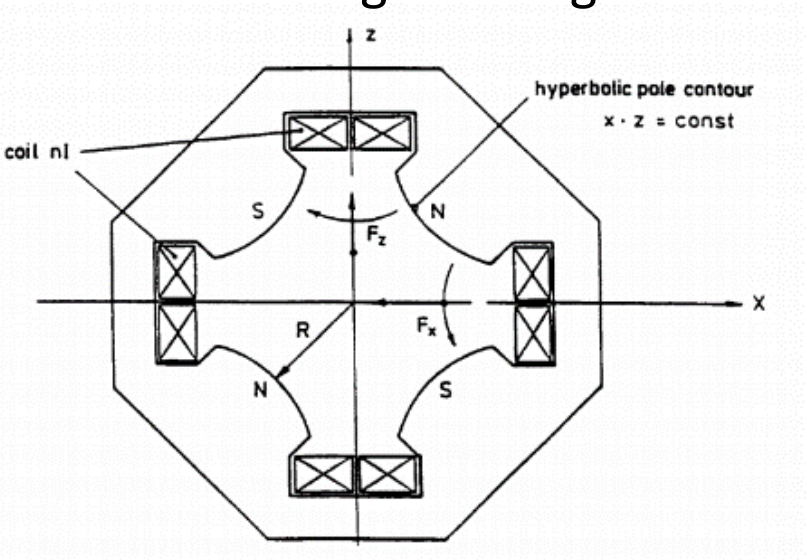
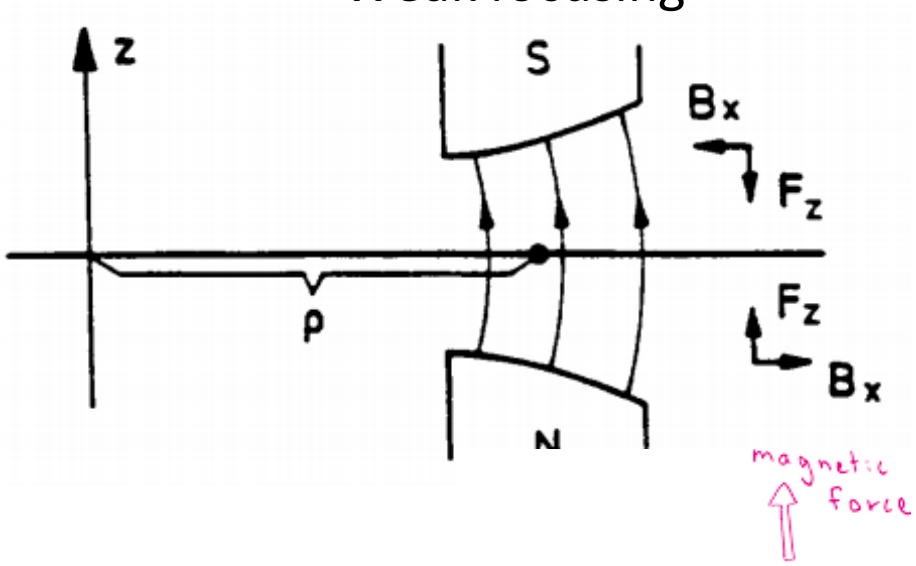
Accelerator optics

Quadrupole Magnet
"Strong focusing"



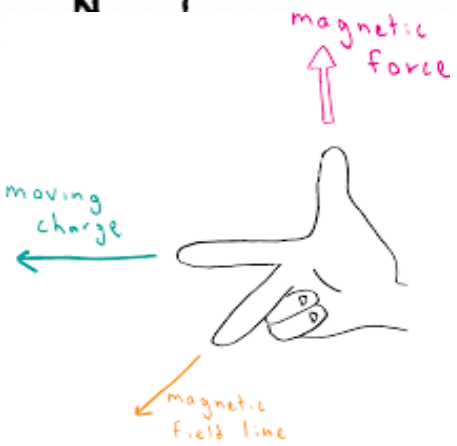
Dipole Magnet
"Weak focusing"



Lorentz Force equation

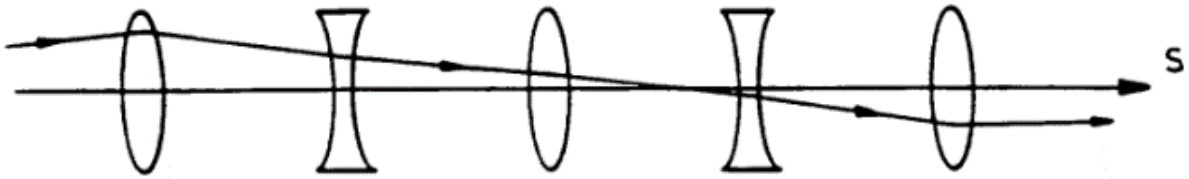
$$F = q\left[E + \left(v \times B\right)\right]$$

Right hand rule



Accelerator optics

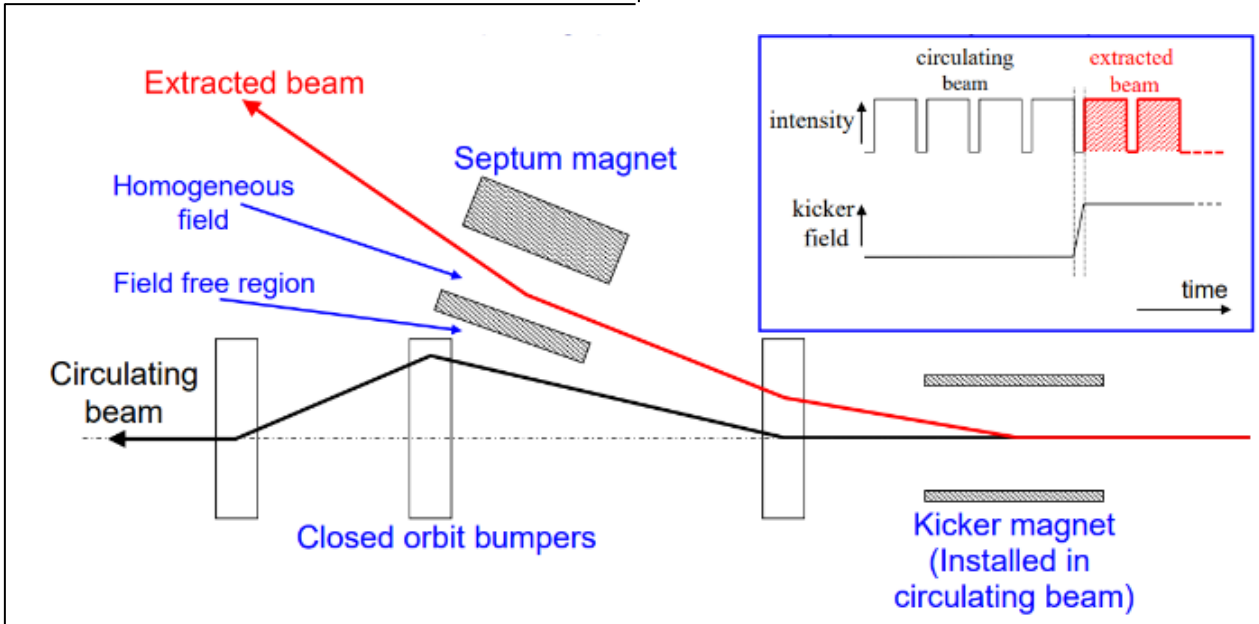
Focusing-defusing lenses



- Nominal particle along the central axis experiences no force.
- Other deviations are kept within the beam envelope.
- Travels in two directions around the ring.

Kicker Magnet

For injection and extraction of the beam.



What is EasyTracker?

Software designed for real time visualisation of simulated beam optics and detector acceptance.

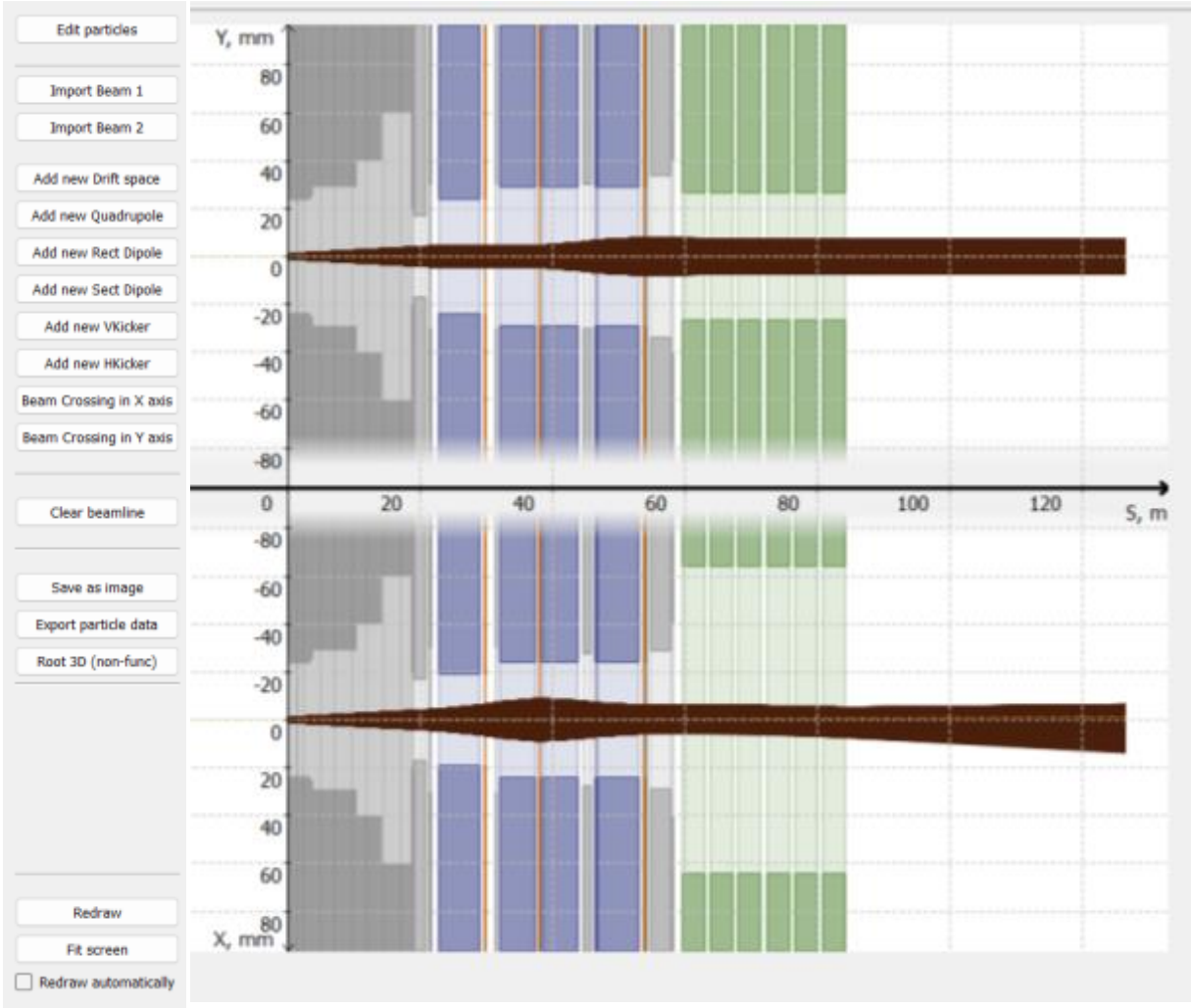


Figure (right): The graphical user interface (GUI) that users can see, interact with and edit in real time. The accelerator setup can be imported from input accelerator optics (TWISS) files.

What is EasyTracker?

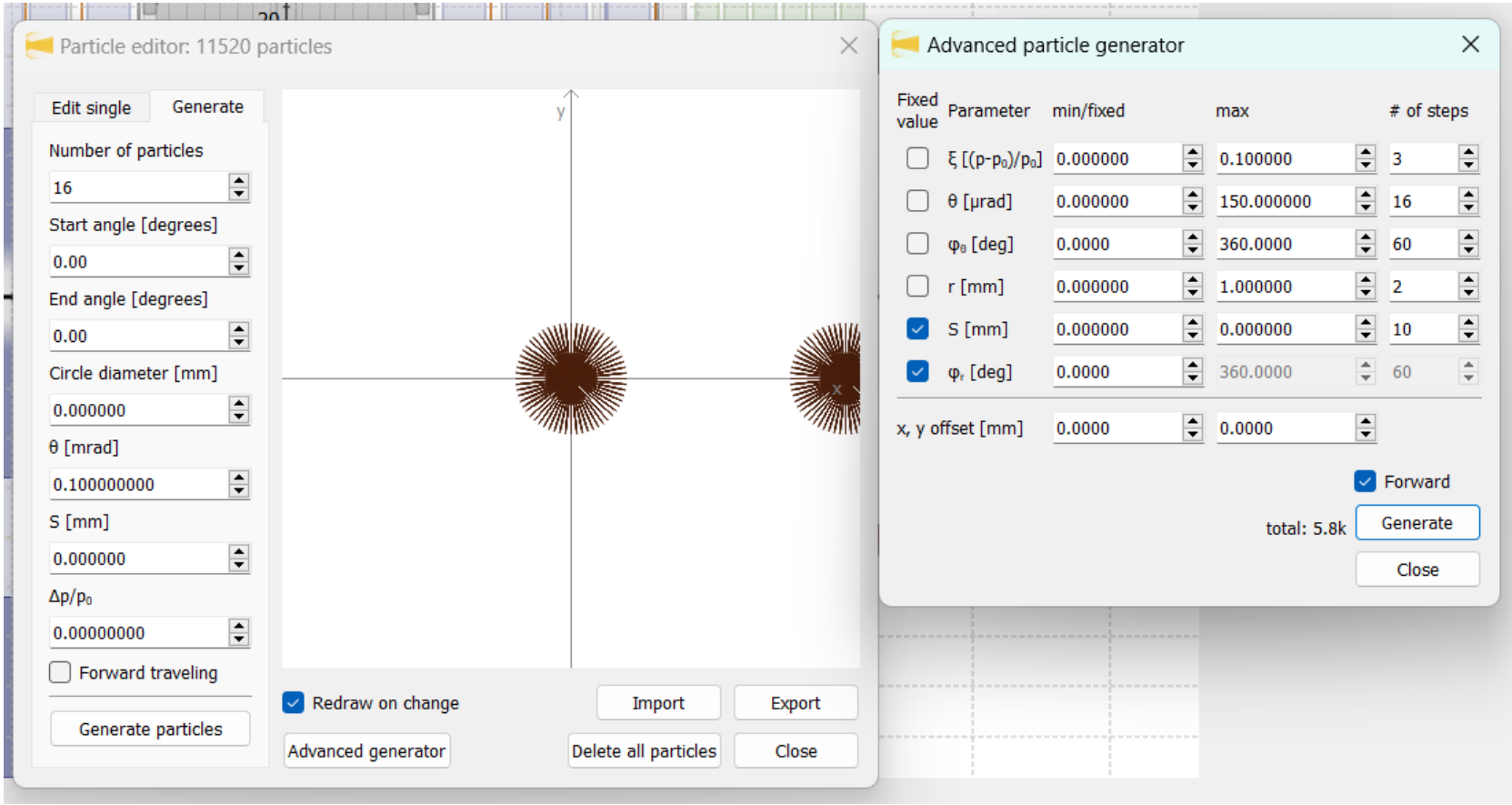


Figure: Controls to generate kinematics of the input particles (protons).

EasyTracker outputs

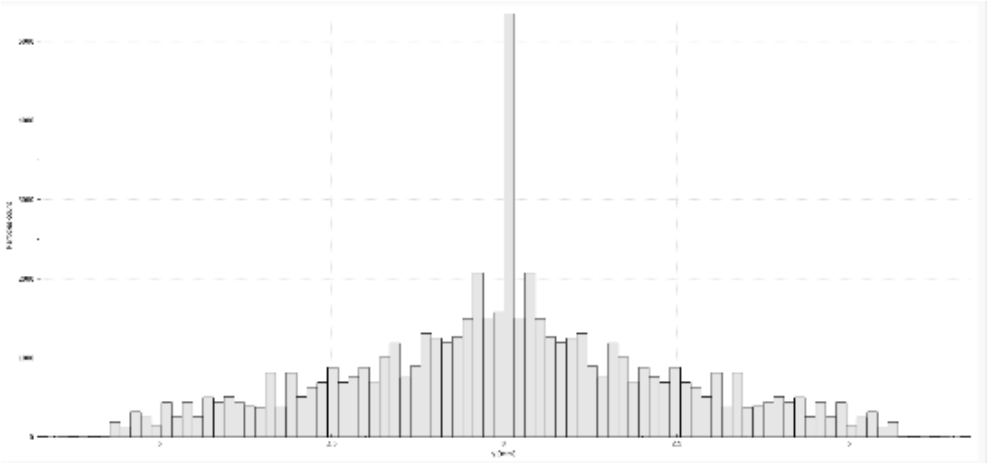
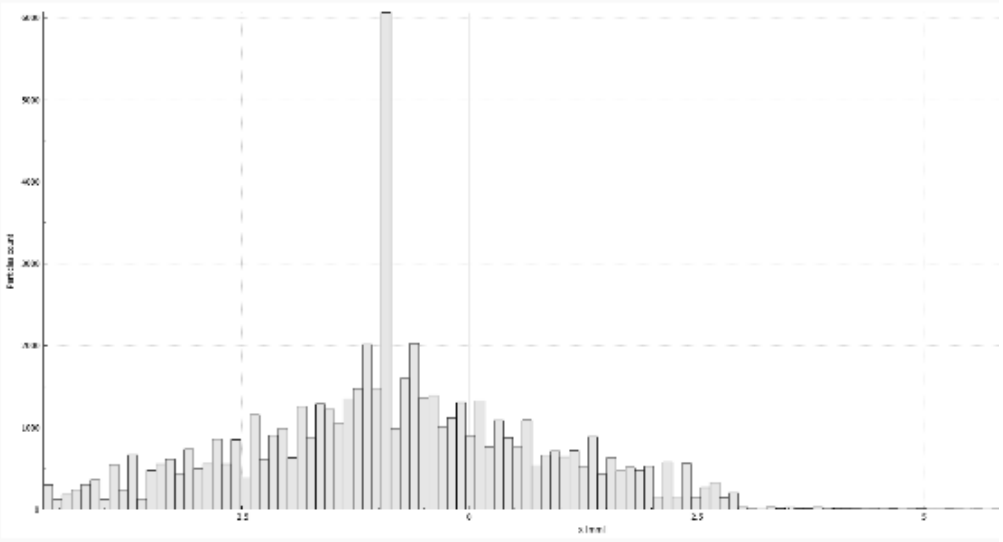


Figure (above): Histogram of x with respect to frequency.



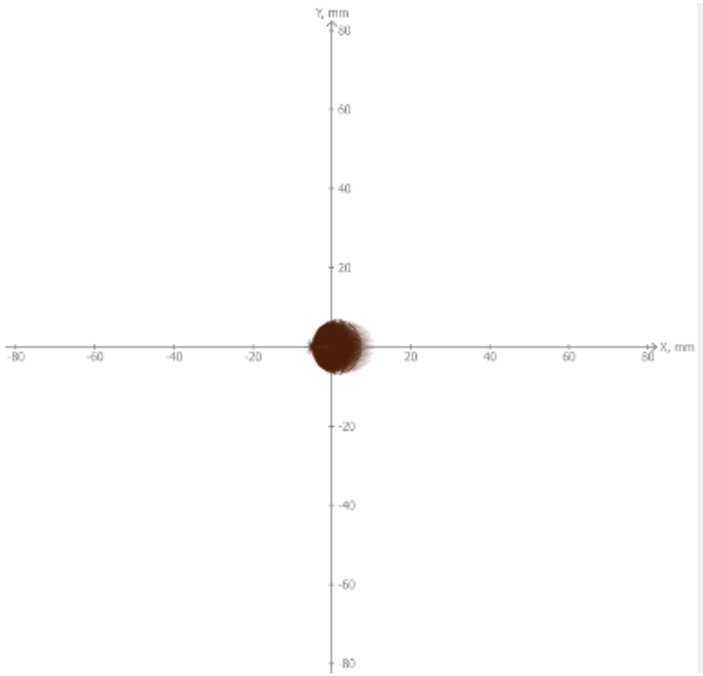


Figure (above): X and Y projection of simulated particles at this data plane.

Figure (left): Histogram of y with respect to frequency.

EasyTracker outputs

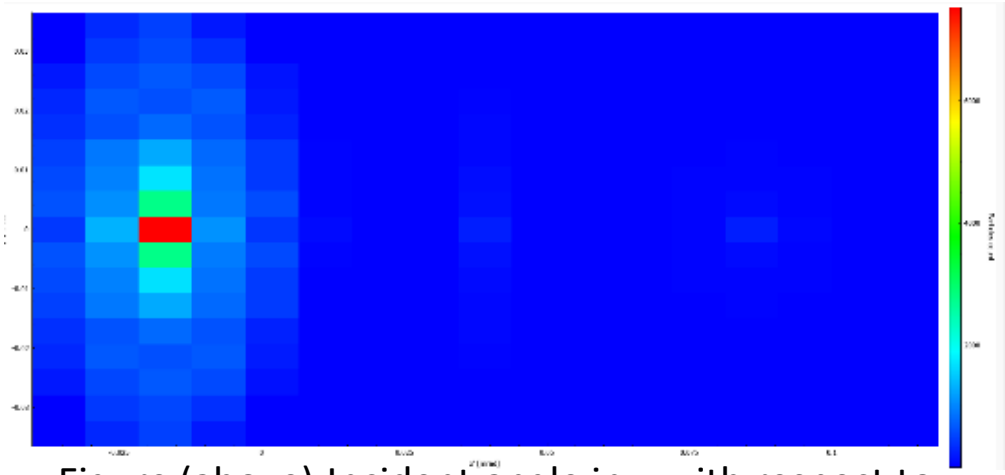


Figure (above):Incident angle in x with respect to incident angle in y.

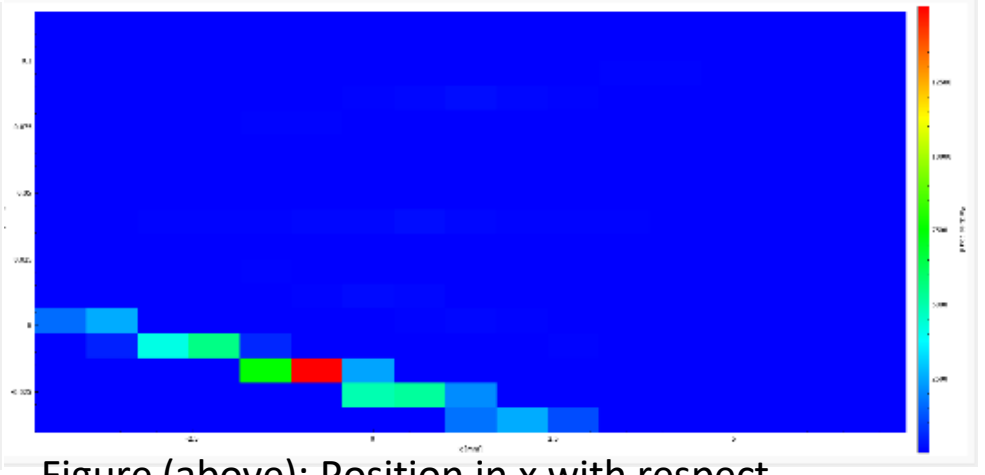


Figure (above): Position in x with respect to incident angle in x.

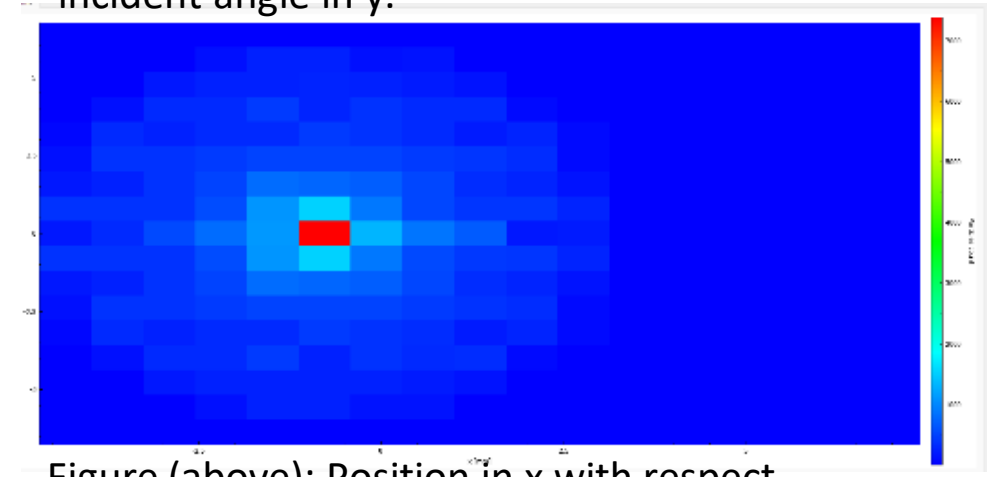


Figure (above): Position in x with respect to position in y.

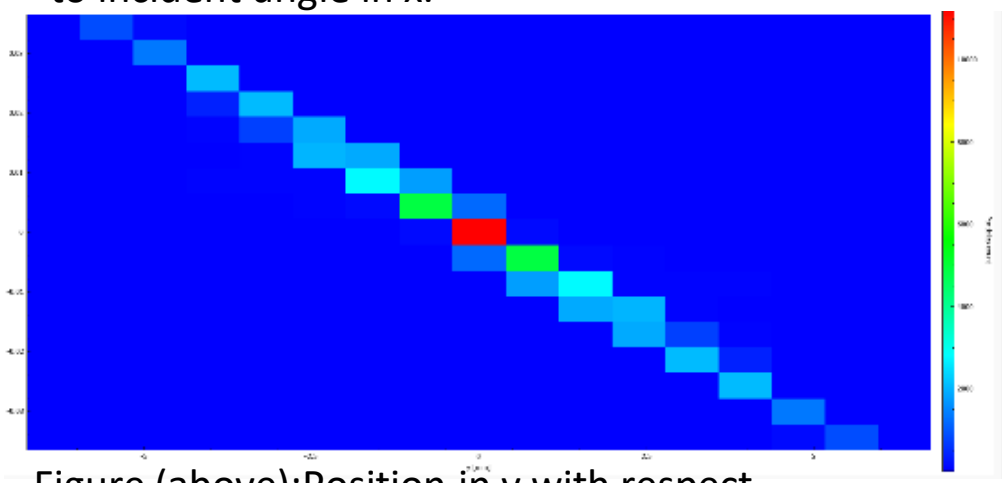


Figure (above):Position in y with respect to incident angle in y.

“But there are already other accelerator optics programs available!”

Why is it needed?

The current industry standard is *MAD-X*, it does:

“basic layout, design, and optimization of optics and for doing basic particle tracking and sensitivity analyses of beam lines, synchrotrons, storage rings, etc,”- US Particle Accelerator School

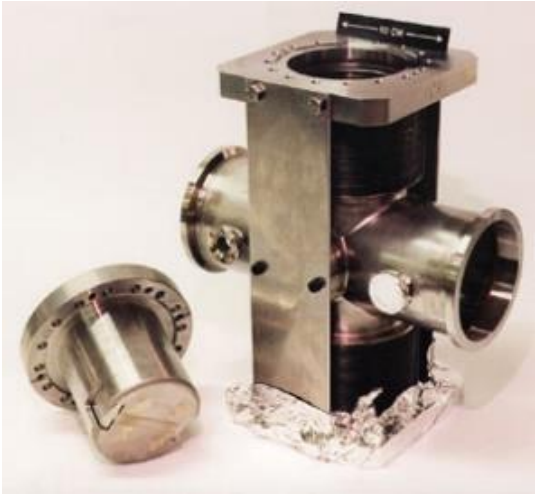
- 300 pages of introductory documentation.
- No interactive user interface (as far as I know).

Standing on the shoulders of honestly pretty normal people

- Version one was part of a 2013 Bachelor's Thesis by *Tomas Komarek* at Palacky University in Olomouc.
- Version two was created by *Vitaly Shinkarenko* in 2020 at Charles University in Prague .
- Last year a CERN summer student *Andrej Sarnatskiy* made great progress and created v2.2.1.

Physics aims

- EasyTracker will be useful to find optimal locations for detectors to achieve their best acceptances/performances.
- ATLAS forward proton (AFP) uses Roman Pot detectors to identify particles very close to the beam that have only been slightly deflected, they are currently on the hunt for instantons.

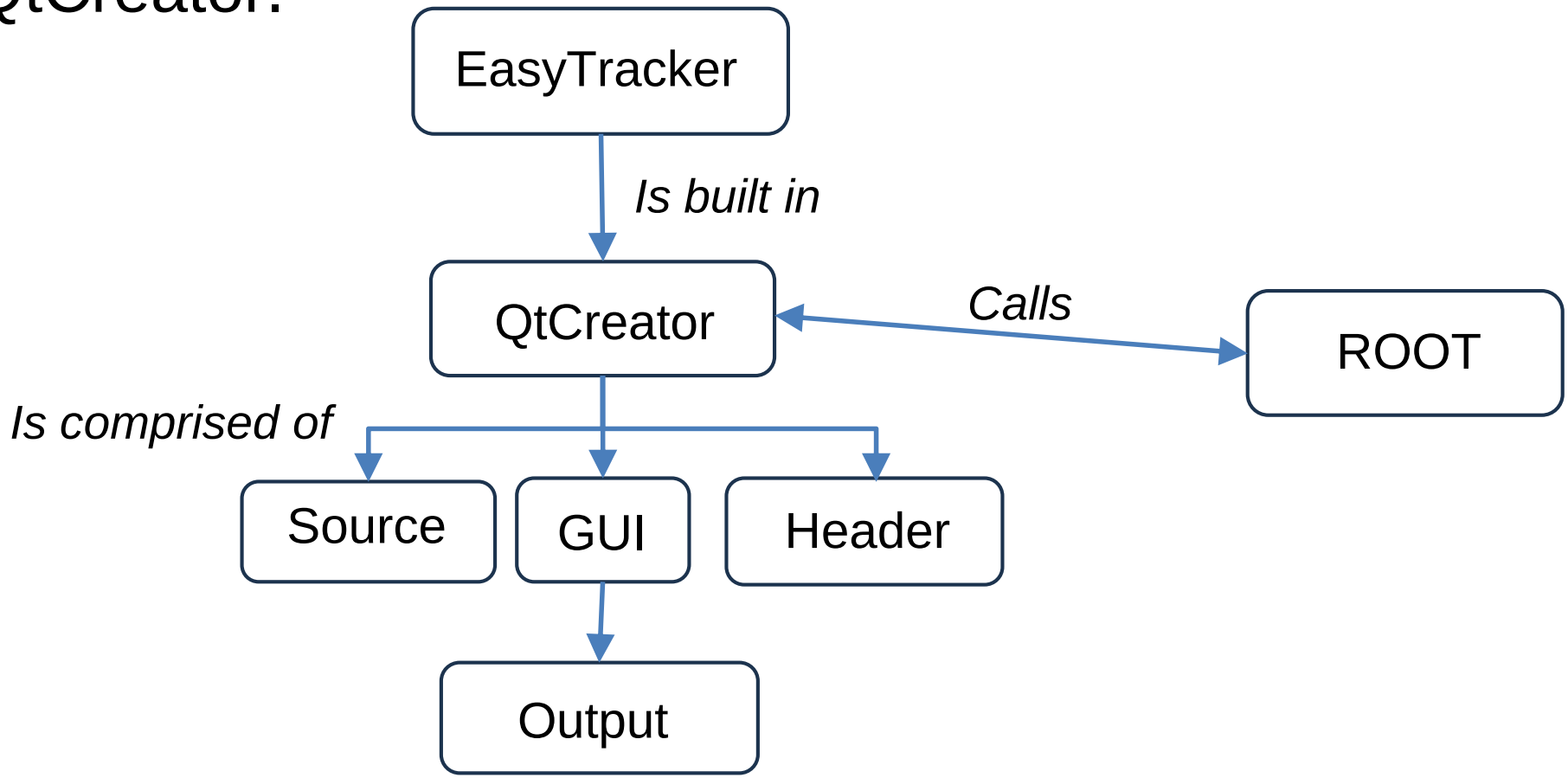


Roman Pots

Wrong Roman Pots

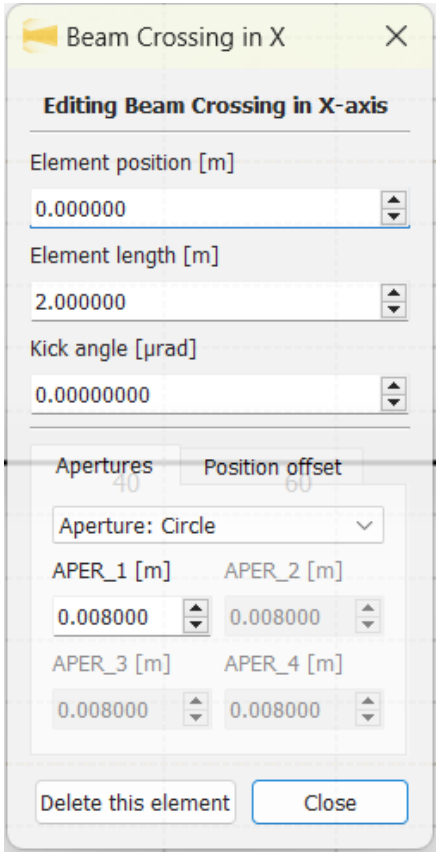
How has it been built?

Written in the C++ language and build within QtCreator.



My contributions (so far)

1. Introduced Beam Crossing in x and y axis.



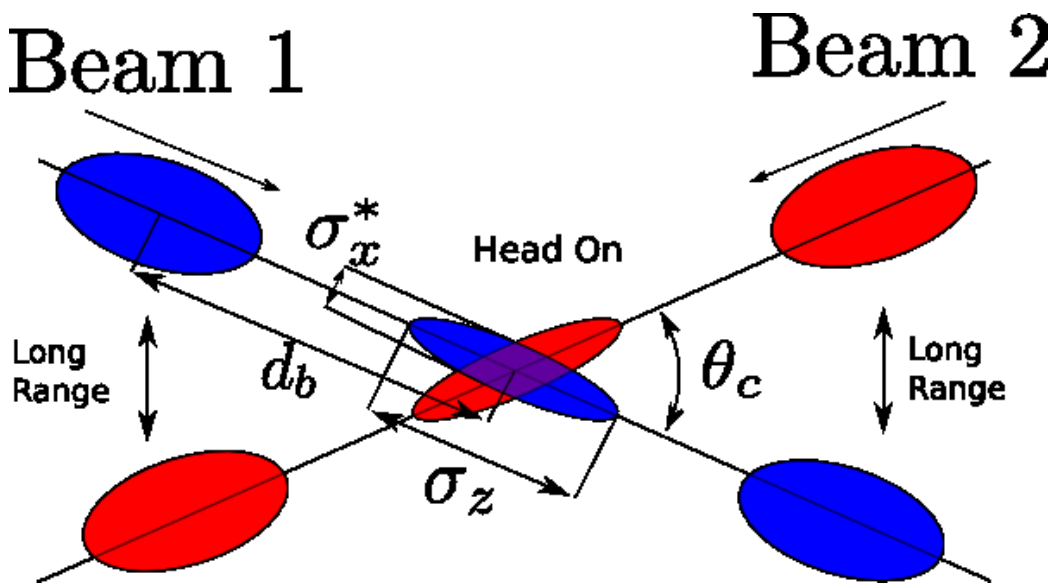


Figure (left): Window for editing element parameters.

The angle must not be dependent on the energy, as it is for the kicker.

My contributions (so far)

2. ROOT Macros for data handling

- Takes output .csv data file from EasyTracker and converts it into a ROOT file.
- Creates appropriate interactive ROOT histograms and graphs.
- Saves them all as PDFs for easy viewing and use.

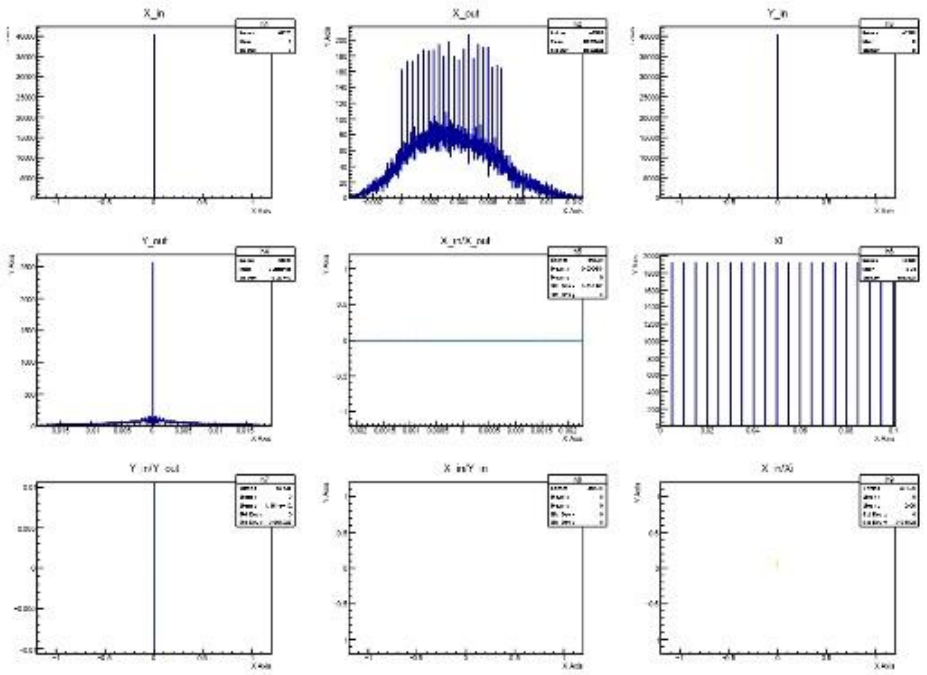


Figure: The output ROOT interface displaying required histograms.

My contributions (so far)

3. Ongoing attempts to integrate macros with Qt and debugging.

With the help of Serguei Kolos.

Future improvements

- Integrate existing ROOT macros into QtCreator.
- Automatically rebin the data properly so it looks presentable and is a more accurate depiction statistical of trends.
- Remove the auto-redraw problem and other bugs affecting EasyTracker.
- Finalise the beam going in the reverse direction.

Questions?

home.cern

Acknowledgements

- My patient and hardworking supervisors Tomas Sykora and Andrea Dell'Acqua.
- Serguei Kolos for support with ROOT/Qt integration.
- Tomas Komarek, Vitaly Shinkarenko and Andrej Sarnatskiy.
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- The CERN & Society foundation for funding my place here at CERN.
- My family and friends both back in the UK and here at CERN, including my Mum & Dad, Molly, Lauryn, Willow and dozens of others.