ABS AT CRYRING

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1. Introduction to CRYRING

CRYRING is a facility mainly for atomic physics. The main parts are a synchrotron and storage ring with 52 m circumference and 0.06¡Br¡1.44 Tm, an electron cooler, and two ion sources. The first one is an electron impact ion source, which mostly produce singly charged ions of atoms and molecules. Examples are ND_3O^+, O_2^+, N_2^+, and Ca^+. The second source is an EBIS source for highly charged ions, e.g. Pb_54^+. The beam currents in CRYRING are quite low, and often we have currents in the range of 100 nA. An experiment takes usually a week.

Typical is that we have new settings every week, and in addition we often have to change ion during an experimental week, so we cannot rely on old settings when we start the machine.

2. Feedback to the Electron Impact Ion Source

In the ion source electrons from a filament wire ionises the neutral gas surrounding it. During operation the filament becomes thinner and thinner and it has to be replaced after a period from six hours to two weeks, depending on how aggressive the ions are.

When the filament becomes thinner one needs to lower the filament current. We often use a feedback program which reads the anode voltage and keep this constant by varying the filament current.

Stability is gained in two ways; firstly the ion energy is kept constant since it is the sum of the platform voltage and a part of the anode voltage. Secondly, some experiments are made with metastable ions produced in the source, and the ratio of metastable ions depends on the anode voltage. In these experiments it is essential to keep this fraction of metastable ions constant.

3. Beam Centring in the Quadrupoles

For several years we have aligned the beam in the injection beamline by centring the beams in the quadrupoles. We insert a screen and view it with a camera. Next the field in a quadrupole is varied and we observe if the beam spot on the screen moves. If it does we adjust the steering element before the quadrupole. At present we have a Pascal application program INJLINE that varies the quadrupoles and asks the operator how much the beam spot has moved on the monitor and then calculates and sends a new value to the steering element. This operation is repeated on three screens for three focusing and three defocusing quadrupoles.

We are working to make this fully automatic and then also substantially faster. We use IMAQ Vision for LabVIEW to analyse the video signal and find the changes. So finally we will have a LabVIEW program that varies quadrupoles, finds the changes, and adjusts the steering elements, but right now the IMAQ-LabVIEW program only finds the position changes and the operator has to transfer the number between the programs.

There is also another Pascal program, which does the same thing in another beamline. This program reads the position of the beam spot from a strip detector. Due to a breakdown of the ion source this program still has to show it usefulness, especially since we have not used this method previously in this beamline.

4. Intensity Optimisation

The low current makes it impossible to use many beam control methods and we usually look only at the intensity during beam transport optimisation. For example we cannot get position information from the pick-ups.

The intensity can be optimised automatically by the Pascal application program OPTI which we call ”the virtual operator”. The program reads a list of parameters from a file, which contains names, suitable steps, and scaling information. The beam signal could be read from a strip detector, a Faraday cup, or from a spectrum analyser. Next the virtual operator systematically varies the parameters up and down, and changes that increase the are kept. A selection of parameters can also be optimised in pairs, i.e. quadrupole doublets and steering elements.

This program is more stupid than a human operator is, but nevertheless it in many cases works better. For example, if the operator is bored or having lunch, or when the cycle time is either less than a few tenths of a second or a second and longer. In the first case OPTI is faster and in the second case it has much better patience. A final example, and maybe the best one, is when you want to optimise parameters where experience doesn’t help, such as the twelve correction dipoles in the ring.