Experiment at KURNS - March 2019

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March 12, 2019

1 Introduction

An experiment is planned at KURNS in March 2019. It is scheduled for 3 weeks (14 working days). The plan of the experiment is detailed here.

2 Schedule

A daily video meeting is planned to summarize the results of the day and organize the experiment of the day after. The first meeting will be Tuesday 19 March at 9:00 in the UK and 18:00 in Japan. Zoom connection will be set up.

- 18th, 19th, 20th March: Linac and the beam transport line between the linac and the main ring (HMBT) beam characterisation.
- 22nd, 25th, 26th March: RF study
- 27th, 28th, 29th March: buffer in case something goes wrong and experiment is delayed.
- 1st to 5th April: H^- stripping efficiency study (C. Brown).

3 Linac and HMBT beam characterisation

3.1 Energy measurement

The energy of the incoming H^- beam is measured with Time Of Flight (TOF) measurement.

- Resolution expected ∼0.2 MeV to 0.3 MeV out of 11 MeV.
- No electron beam available for calibration purpose.
- Measure ToF at 5 points on the linac RF timing from right after the filling to the end of the RF using a shift pulse of 300 ns.

3.2 Momentum spread measurement

The measurement is placed in JBBT line (at the end of the straight line of HMBT). A fluorescent screen is used in the JBBT line with BM2 magnet turned off, and after BM2 in HMBT line with BM2 turned on, to measure the size of the beam. We measure the momentum spread with the dispersion value after BM2 in HMBT (dispersion is null in JBBT). Momentum measurement should be done with 5 different pulse widths: from 300 ns (shortest) to 100 micros? (longest). We may see that the longer pulse causes beam loading and leads to larger momentum spread.

3.3 Position and size of the beam at injection

Beam size and position measured with fluorescent screen just before MR in HMBT. Fluorescent screen measurement needs reasonable charge. The pulse length should be reasonably long, a few 10 μs?

3.4 Physical foil boundary and H^- stripping rate measurement

Goal: Identify the position of the foil and COD at the foil and find the injection orbit with which the beam goes on the COD.

1. Fix injection orbit: position and angle with nominal value.
2. Measure with BPM of the incoming H- beam in MR. A BPM is located before the foil so that signal of opposite sign should be detected.
3. Move the foil position with 2 mm step (not 5 mm step) to reconstruct beam size. Detect proton beam intensity downstream.
4. Plot of position vs proton beam intensity shows the horizontal beam size at the foil position.
5. Adjust injection line orbit such that the beam is injected on the COD at the foil. To make it happen, measure horizontal and vertical beam position turn by turn.
6. Fix the injection orbit with which the beam goes on the COD.
7. Move the foil to find the relative position with respect to the beam. E.g. edge of the beam when the foils is positioned left or right edge of the beam. When the foil is completely out of the injection beam, there is no proton downwards.

4 RF study

4.1 Study of differences between Variable k and Constant k RF patterns

Data taken several times (to study the differences with the same conditions) with TOSCA k RF patterns and with constant k RF patterns in the nominal parameters condition.

4.2 Experimentally verify Uesugi-san's simulation

Goal: See the simulation by Uesugi-san models the reality

1. Fix phis and accelerator some period (0.1 ms to 1 ms with 0.1 ms step) before adiabatically shift phis to zero ($\sim$ 1 ms or less).
2. When the whole beam at the final energy at the flat top is outside the foil, the beam loss should not occur.

We may have to consider the effects of COD as a function of energy although it seems not large.

4.3 RF voltage and synchrotron tune

Goal: Confirm the synchrotron tune and RF voltage are consistent. Observe detuning due to large amplitude oscillation in longitudinal phase space.

1. Start with a constant voltage (4 kV) and a constant phis ($\sim$ 20 deg). Accelerate the beams to the energy where the orbit is outside the foil (15 MeV).
2. Adiabatically change the phis to zero ($\sim$1 ms) to reach the final energy.
3. Suddenly shift of bucket in phase with +/- 10 (or +/- 20) degree steps, to +/- 180 deg
4. Repeat 1-2, then suddenly reduce voltage down to 3 kV at the same time to suddenly change phis.
5. Repeat 1-2, then suddenly reduce voltage down to 2 kV at the same time to suddenly change phis.
6. In each case, record rf voltage monitor (1/1000 of amplifier output) and bunch signal. David requests at least 2 bunch monitor signal simultaneously recorded. Sampling rate should be 4 ns for tomography reconstruction.

5 H^- stripping efficiency study

(see Craig's presentation/report)