Improvement of the Current Stability from the TRIUMF Cyclotron

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TRIUMF cyclotron

LAYOUT OF TRIUMF CYCLOTRON SHOWING EXTRACTED BEAMS

BL4 North
450–500 MeV
(< 100 μA)

ISAC

BL4
180–520 MeV
(< 10 μA)

BL2A
480–500 MeV
(< 100 μA)

ISAC

BL2C
70–110 MeV
(< 80 μA)

AAC

BL1A
180–500 MeV
(< 170 μA)

PT

50 μA isotopes

50 μA

NORTH
Outline

- $\nu_r = 3/2$ resonance source of instability
- Correction of the resonance.
- Split ratio stabilization feed-back loop.
$\nu_r = 3/2$ resonance source of instability
\( \nu = n/2 \) resonance in the presence of \( n^{th} \) field harmonic

Fig. 1: From R. Baartman et al., “Amplitude growth from the rapid traversal of a half-integer resonance”, CYCLOTRON 1984
$\nu_{r}=3/2$ resonance source of instability

Fig. 2: From Y.-N. Rao et al., “Studies of the $\nu_{r} = 3/2$ Resonance in the TRIUMF Cyclotron”, PAC’09.
$\nu = 3/2$ resonance source of instability

**Fig. 3:** Radial variation of the current density measured with HE2 probe.
$\nu_r = 3/2$ resonance source of instability

Fig. 4: Radial variation of the current density measured with HE2 probe.
Correction of the resonance

Fig. 5: Trim and harmonic coils.
Correction of the resonance

Fig. 6: Field correction from one harmonic coil wired in 3rd harmonic.
Correction of the resonance

Fig. 7: Correction with the wrong phase.
Correction of the resonance

Required correction

HC#13

HC#12
Correction of the resonance

Required correction

Full correction!

HC#13

HC#12
Correction of the resonance

Fig. 8: Simulation results.
Correction of the resonance

**Fig. 9:** Actual measurements.
Current stability in high-energy beam lines

![Graph showing extracted current over time for BL1A and BL2A currents from August 18 to 22, 2011, and June 19 to 23, 2012.]

**Fig. 10:** Red dots: BL1A current. Blue crosses: BL2A current. Each plot corresponds to five consecutive days of beam delivery.
Correction of the resonance

Fig. 11: Trim and harmonic coils.
Current stability in high-energy beam lines

**Fig. 12:** Measured split ratio between high-energy beam lines when scanning the phase of HC#13 first harmonic Bz field correction. Three sets of measurements taken with different current flowing into HC#13 are shown here.
Current stability in high-energy beam lines

Fig. 13: Gradual improvement of current stability in the high-energy beam lines since 2011. Red dots: BL1A current. Blue crosses: BL2A current. Each plot corresponds to five consecutive days of beam delivery.
Thank you for your attention!