Improvement of the Current Stability from the TRIUMF Cyclotron

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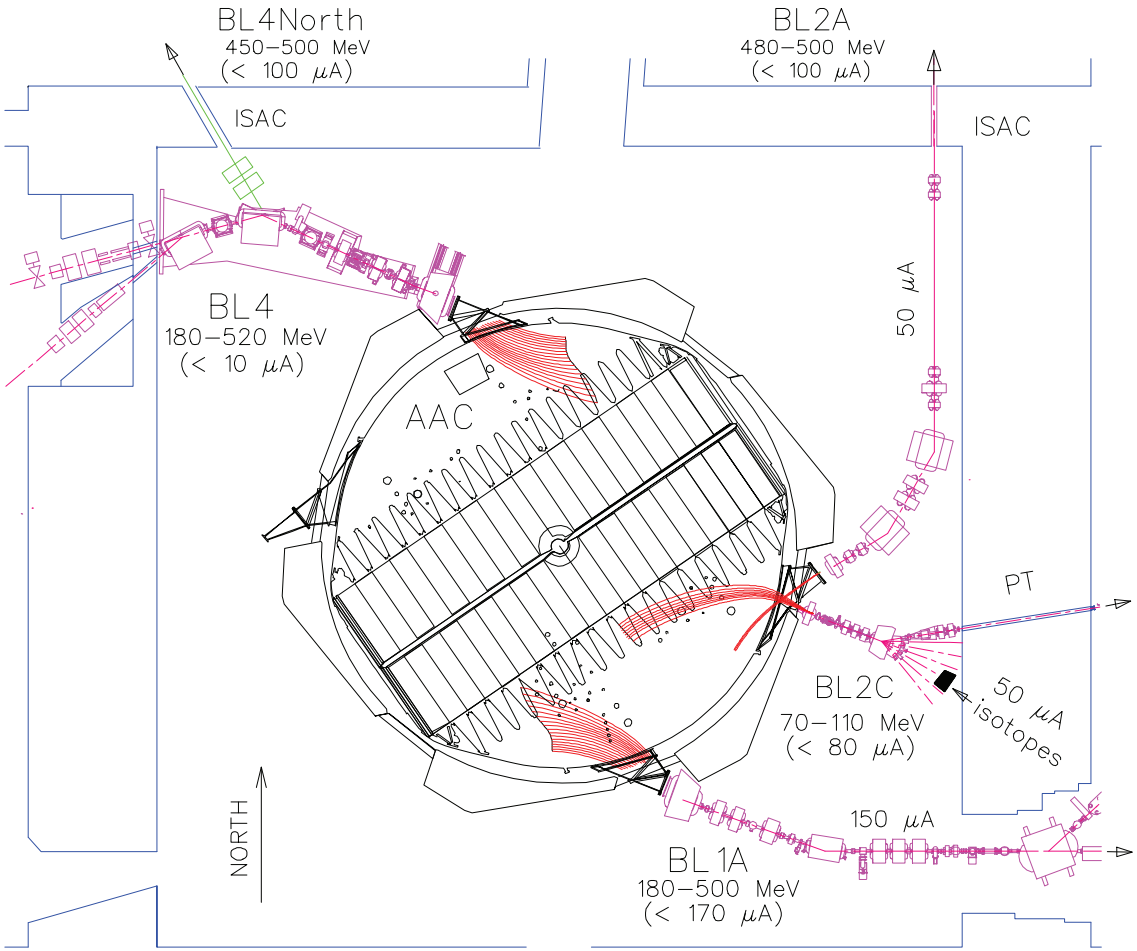
TRIUMF cyclotron

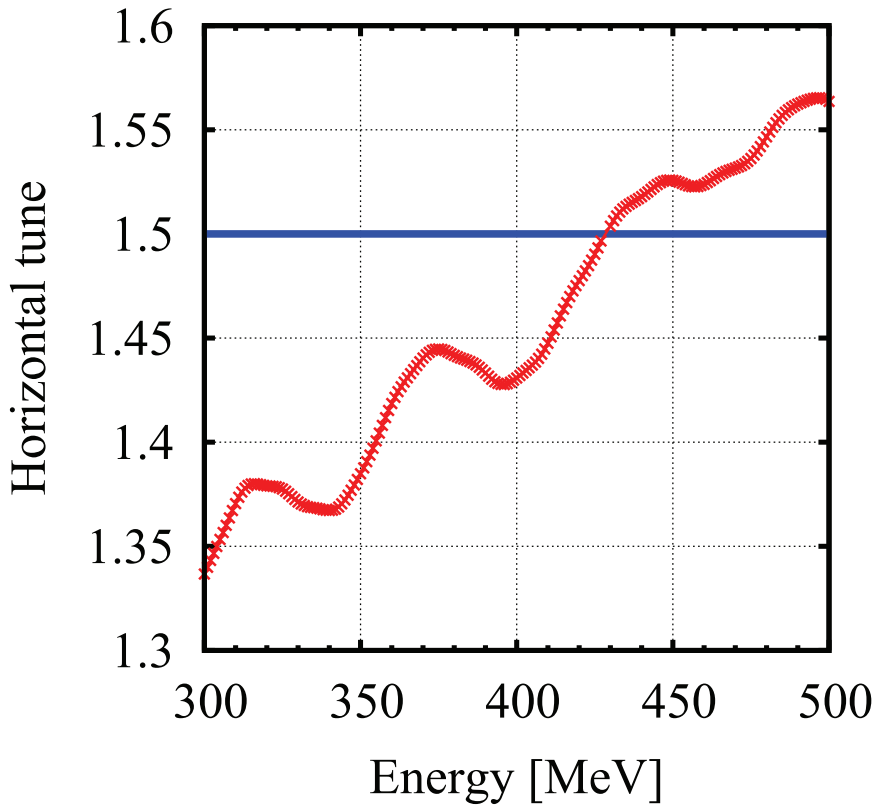


LAYOUT OF TRIUMF CYCLOTRON SHOWING EXTRACTED BEAMS

Outline

- ν_{r}=3/2 resonance source of instability
- Correction of the resonance.
- Split ratio stabilization feed-back loop.

ν_r=3/2 resonance source of instability



ν=n/2 resonance in the presence of n$^{\text{th}}$ field harmonic

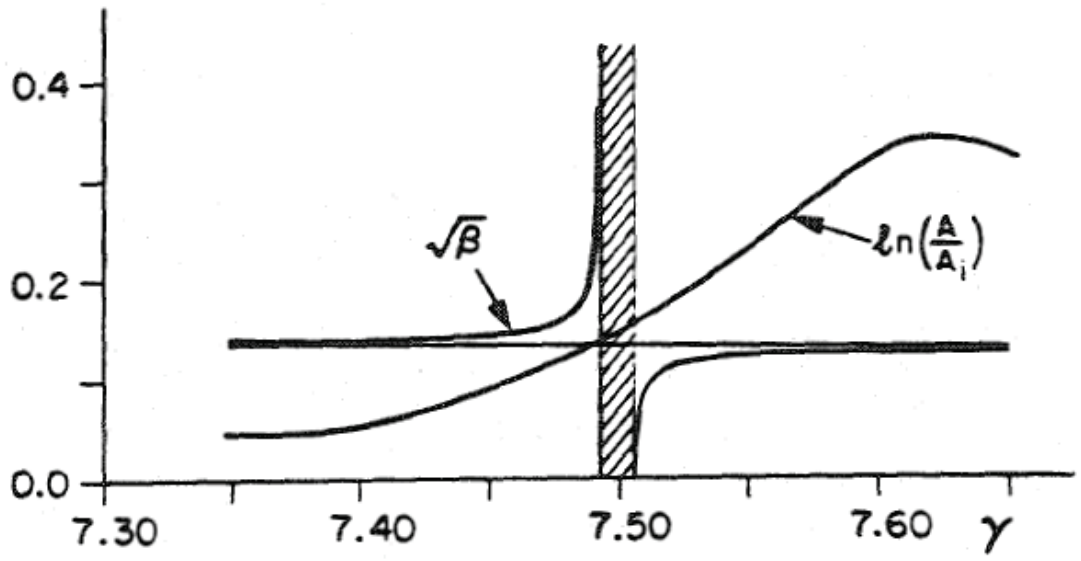


Fig. 1. Calculated β-function and amplitude gain through the ν_r = 15/2 resonance with an energy gain of 45 MeV/turn. The shaded area is the stop band.

Fig. 1: From R. Baartman *et al.*, "Amplitude growth from the rapid traversal of a half-integer resonance", CYCLOTRON 1984

ν_r=3/2 resonance source of instability

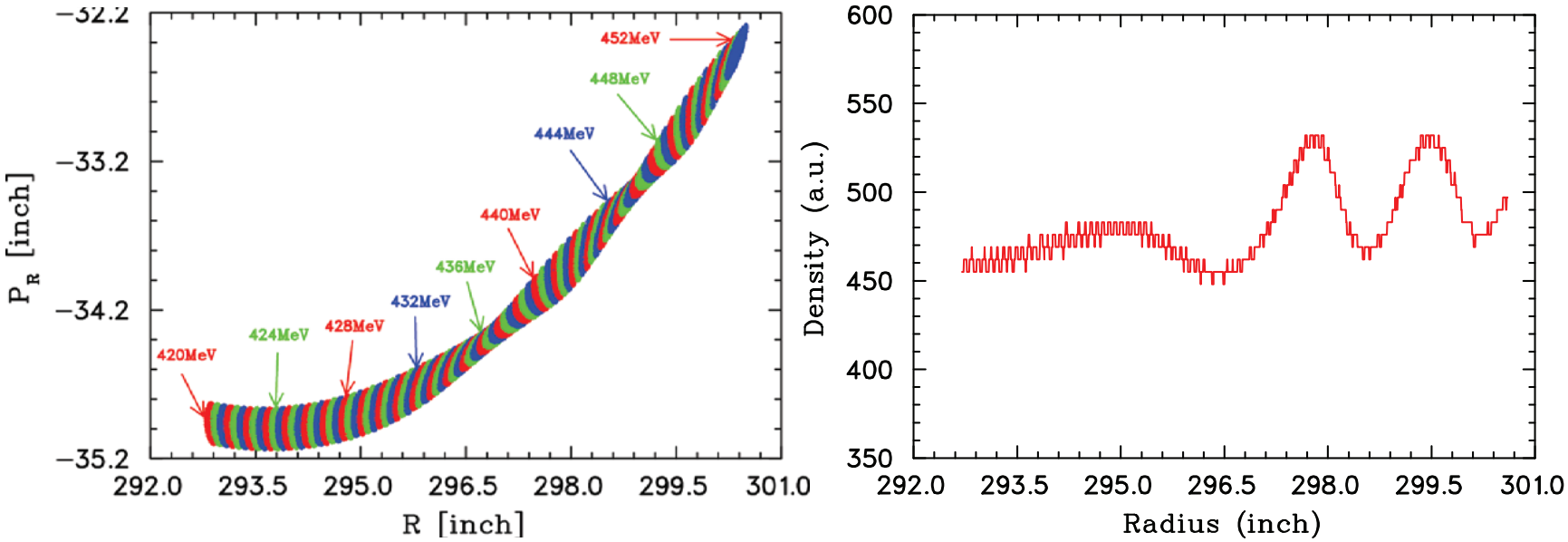


Fig. 2: From Y.-N. Rao *et al.*, "Studies of the $\nu_r = 3/2$ Resonance in the TRIUMF Cyclotron", PAC'09.

ν_r=3/2 resonance source of instability

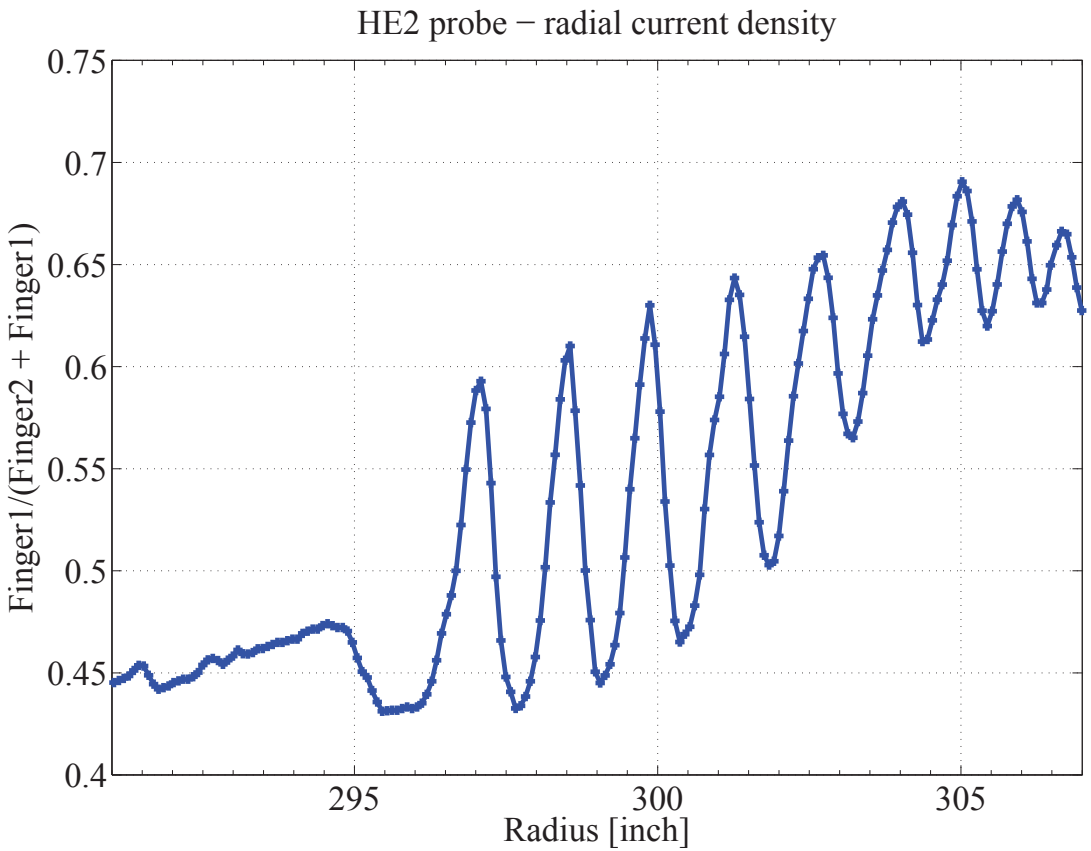


Fig. 3: Radial variation of the current density measured with HE2 probe.

ν_r=3/2 resonance source of instability

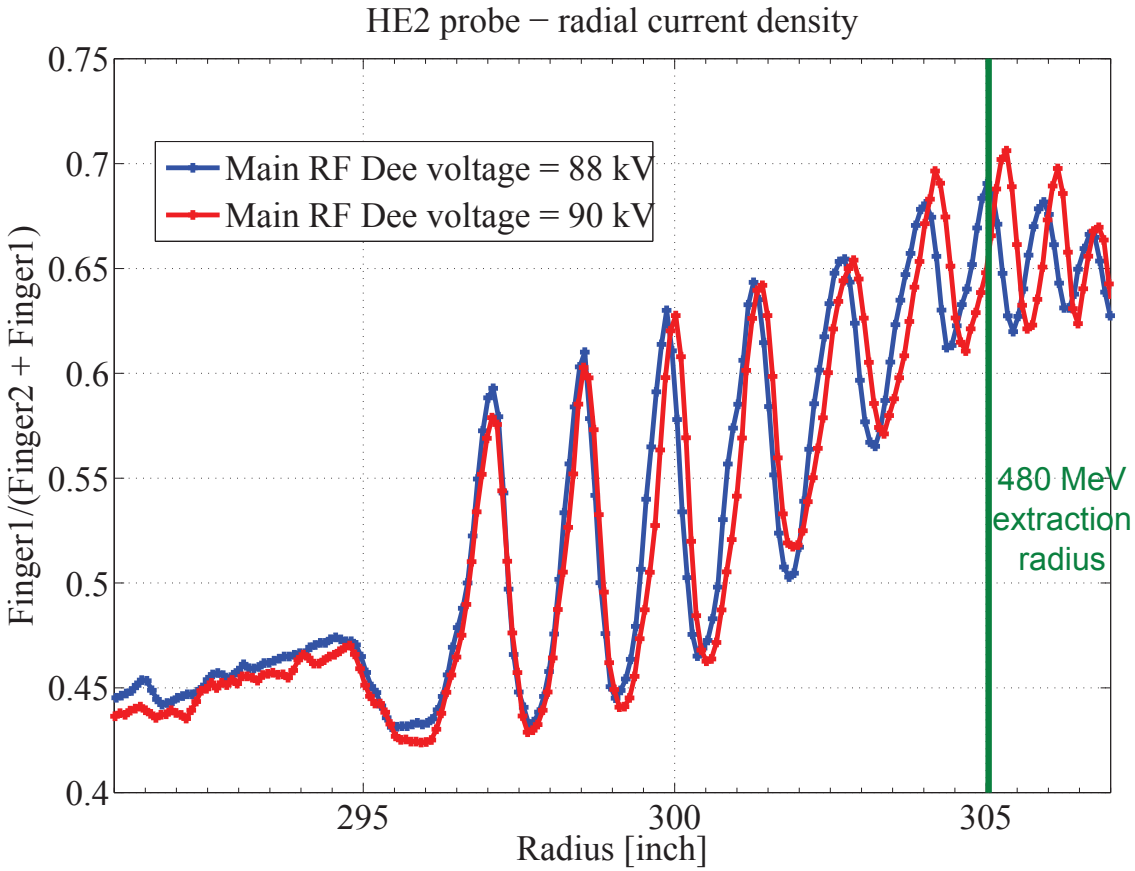


Fig. 4: Radial variation of the current density measured with HE2 probe.

Correction of the resonance

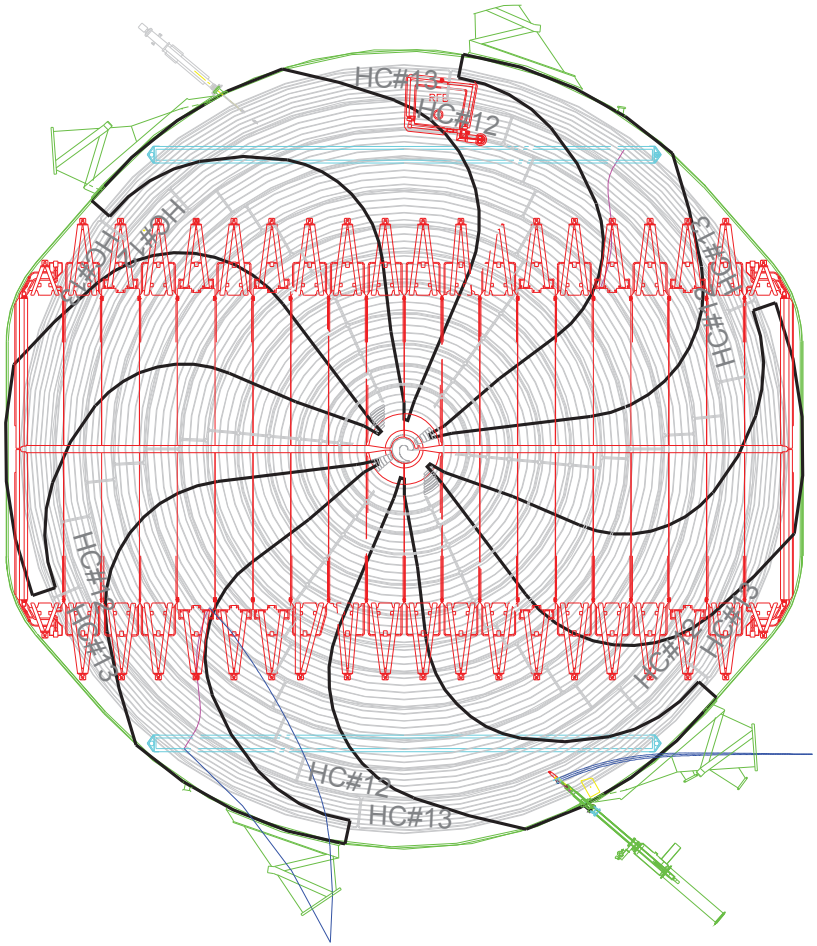


Fig. 5: Trim and harmonic coils.

Correction of the resonance

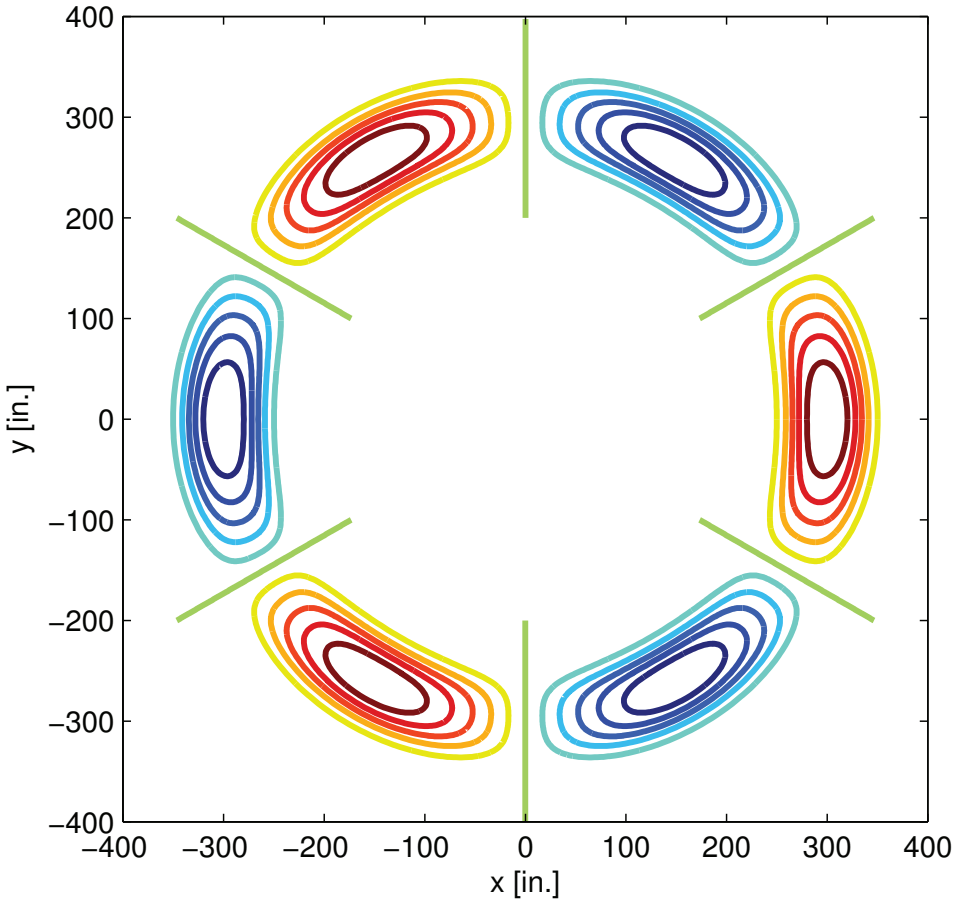


Fig. 6: Field correction from one harmonic coil wired in 3^{rd} harmonic.

Correction of the resonance

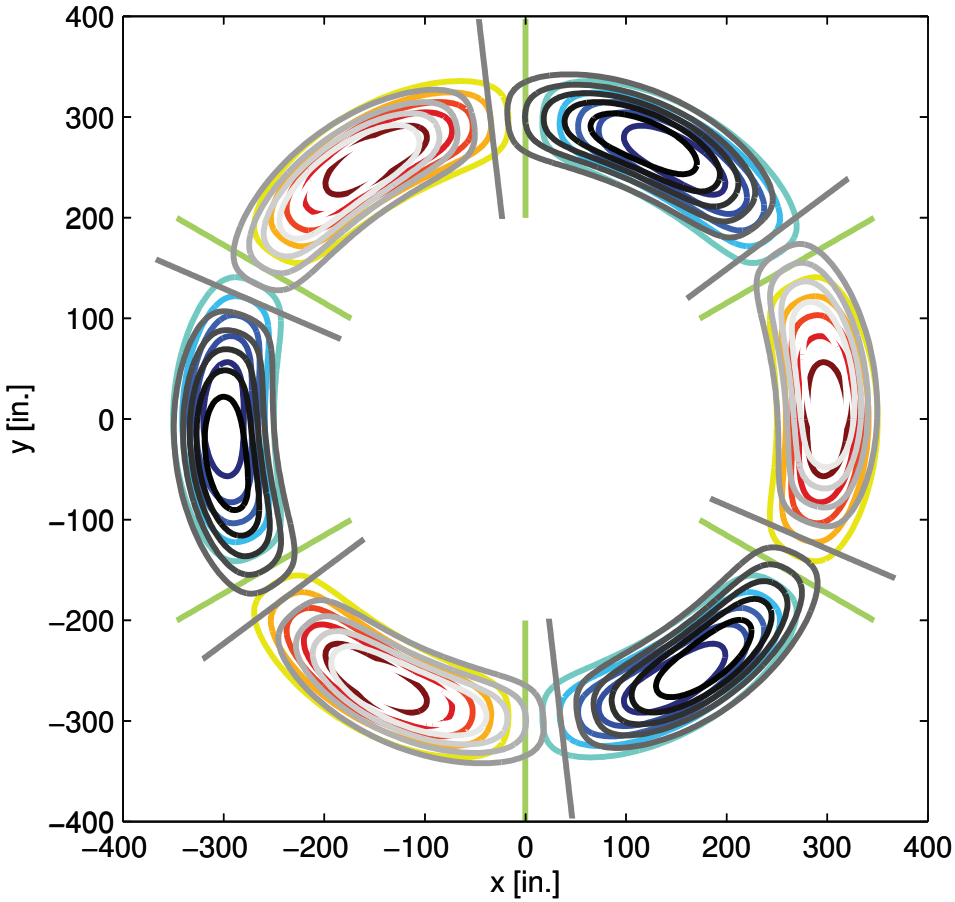
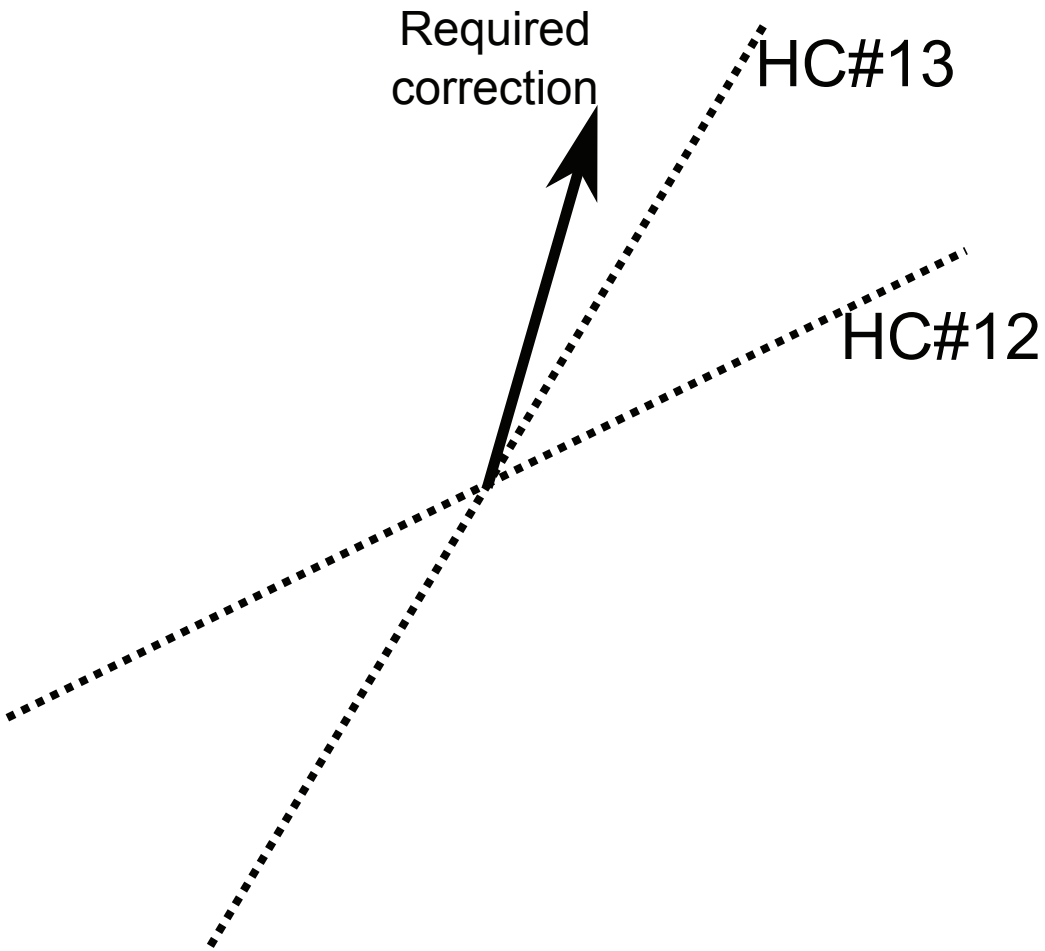
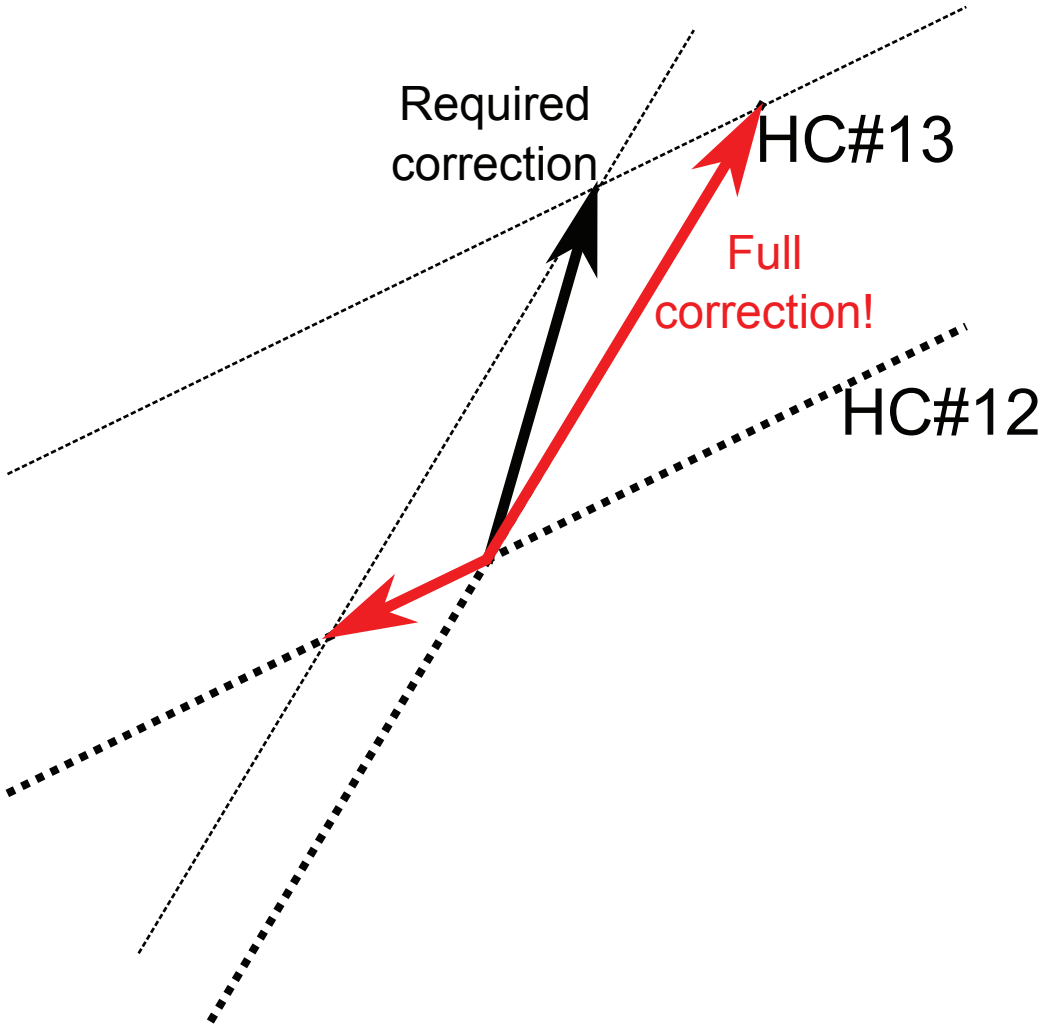


Fig. 7: Correction with the wrong phase.

Correction of the resonance



Correction of the resonance



Correction of the resonance

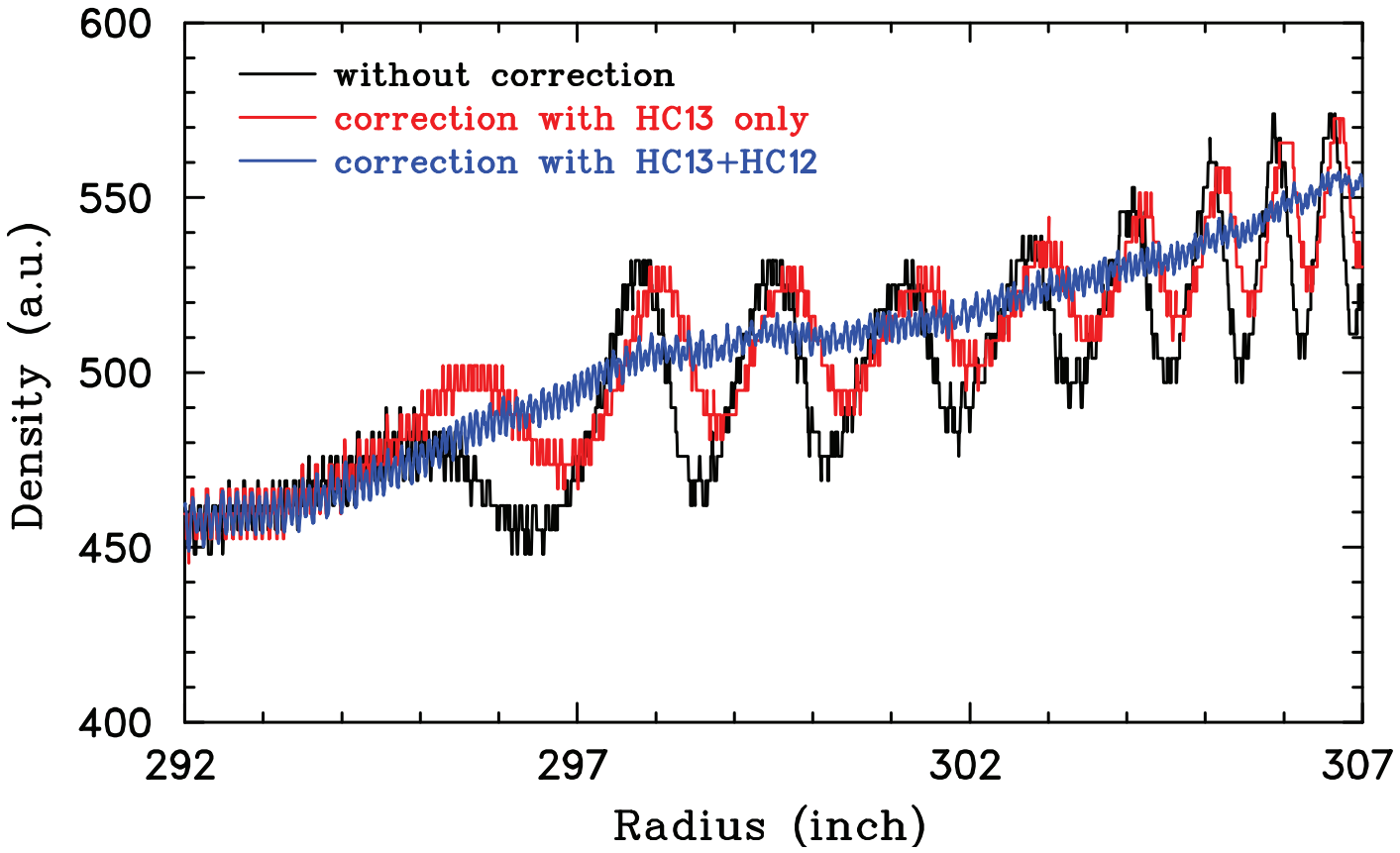


Fig. 8: Simulation results.

Correction of the resonance

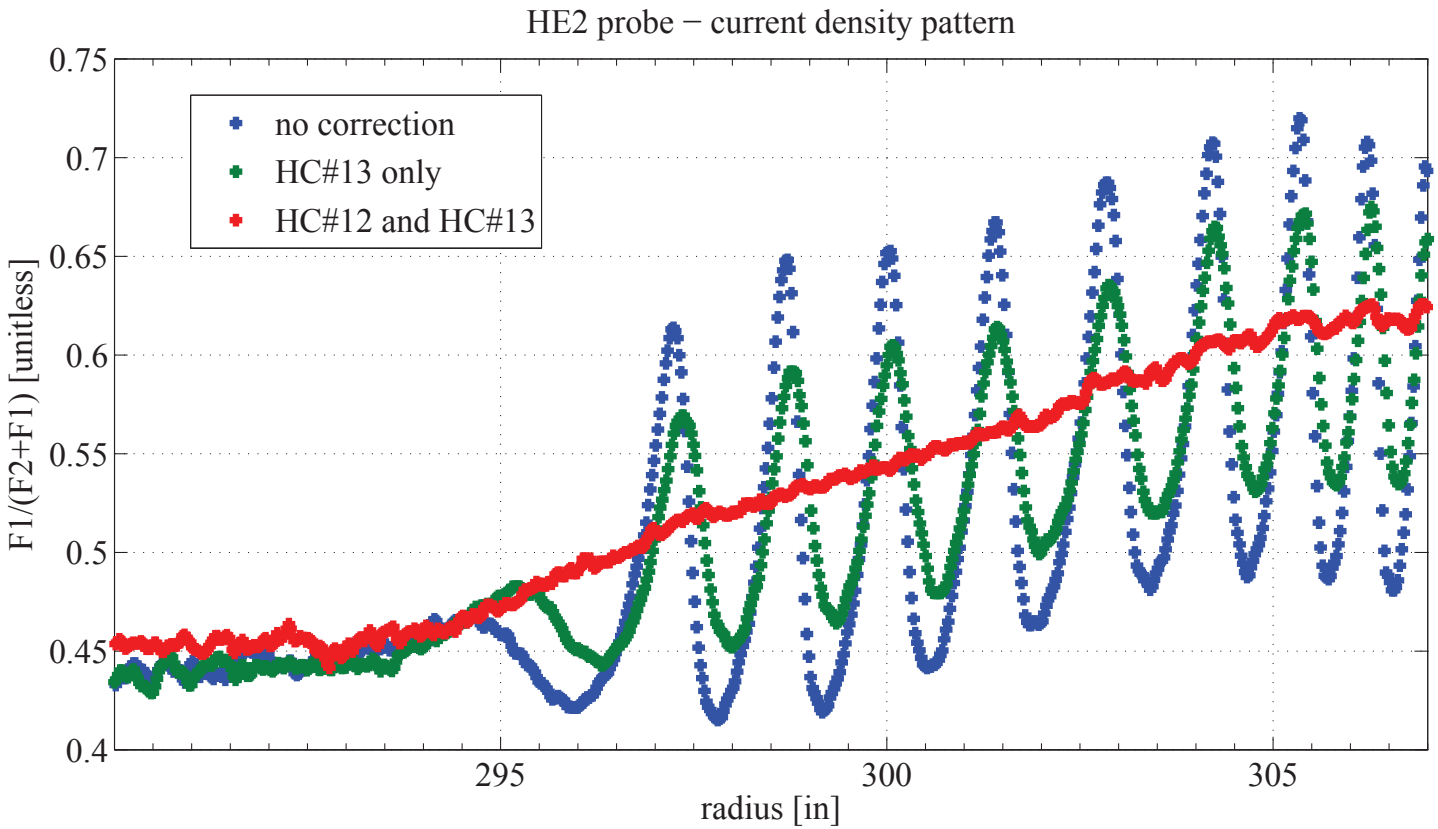


Fig. 9: Actual measurements.

Current stability in high-energy beam lines

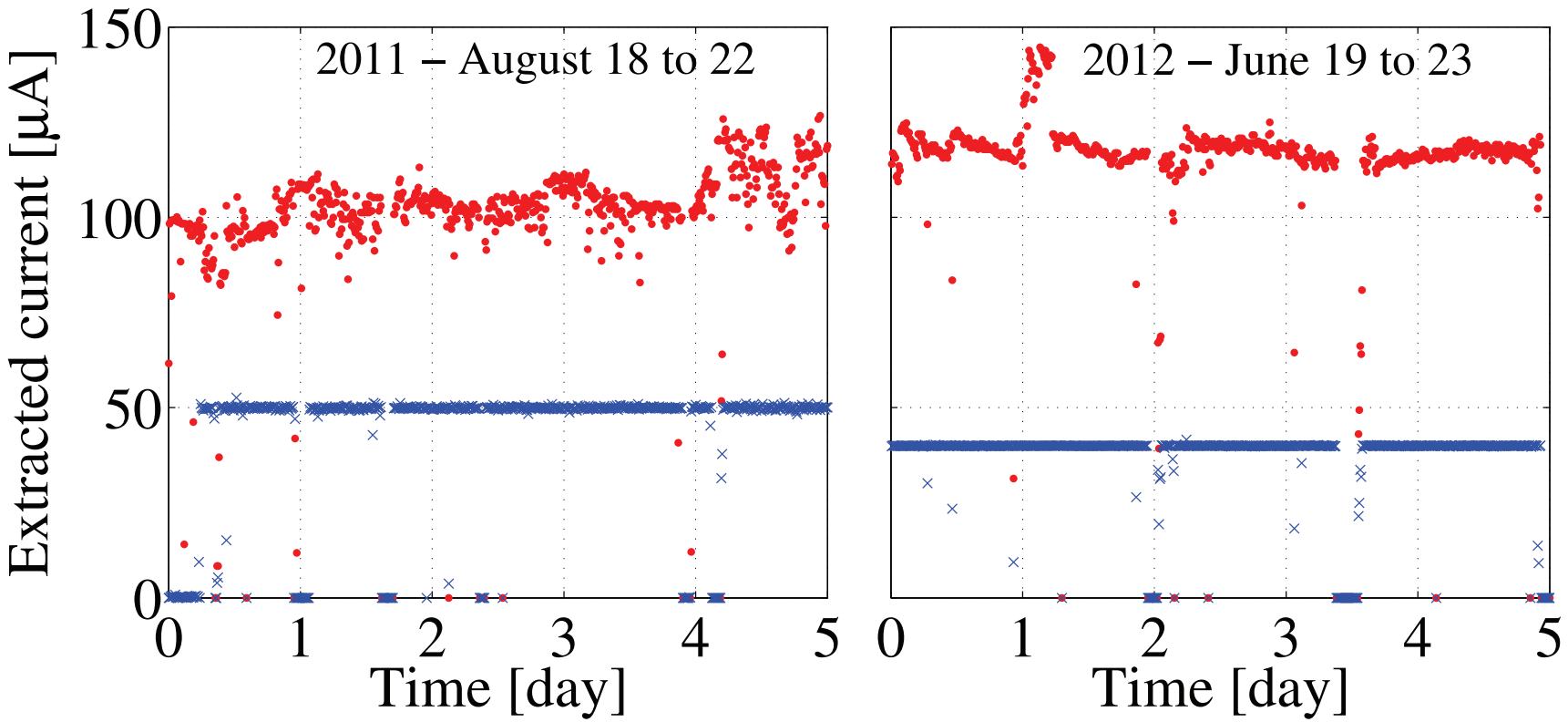


Fig. 10: Red dots: BL1A current. Blue crosses: BL2A current. Each plot corresponds to five consecutive days of beam delivery.

Correction of the resonance

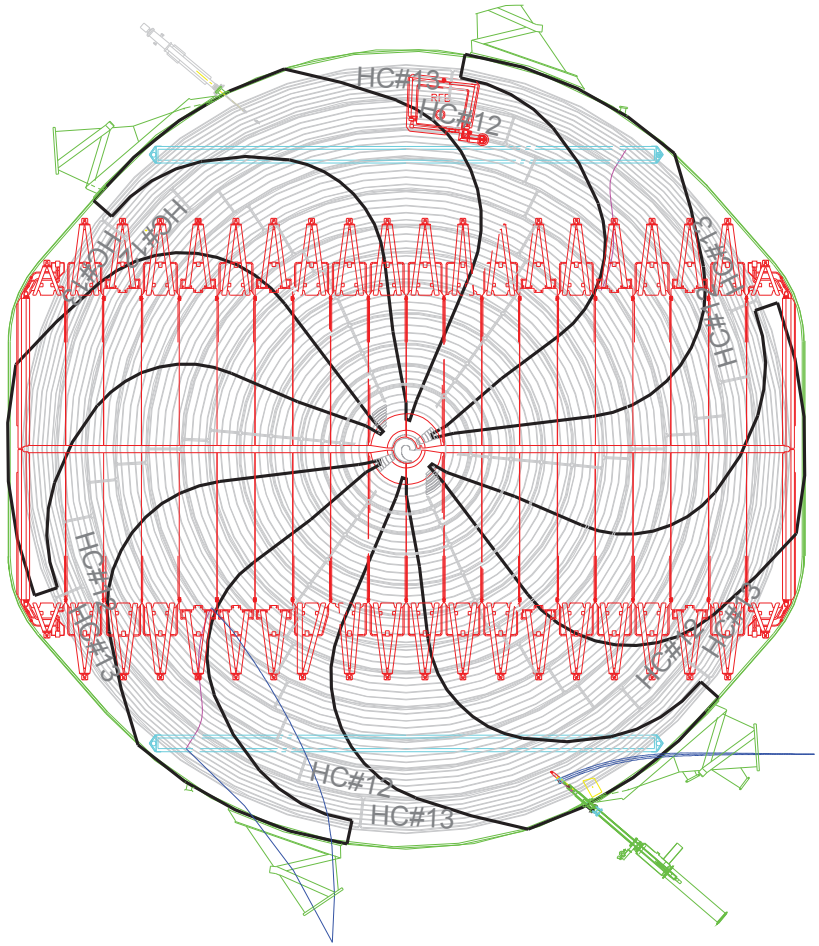


Fig. 11: Trim and harmonic coils.

Current stability in high-energy beam lines

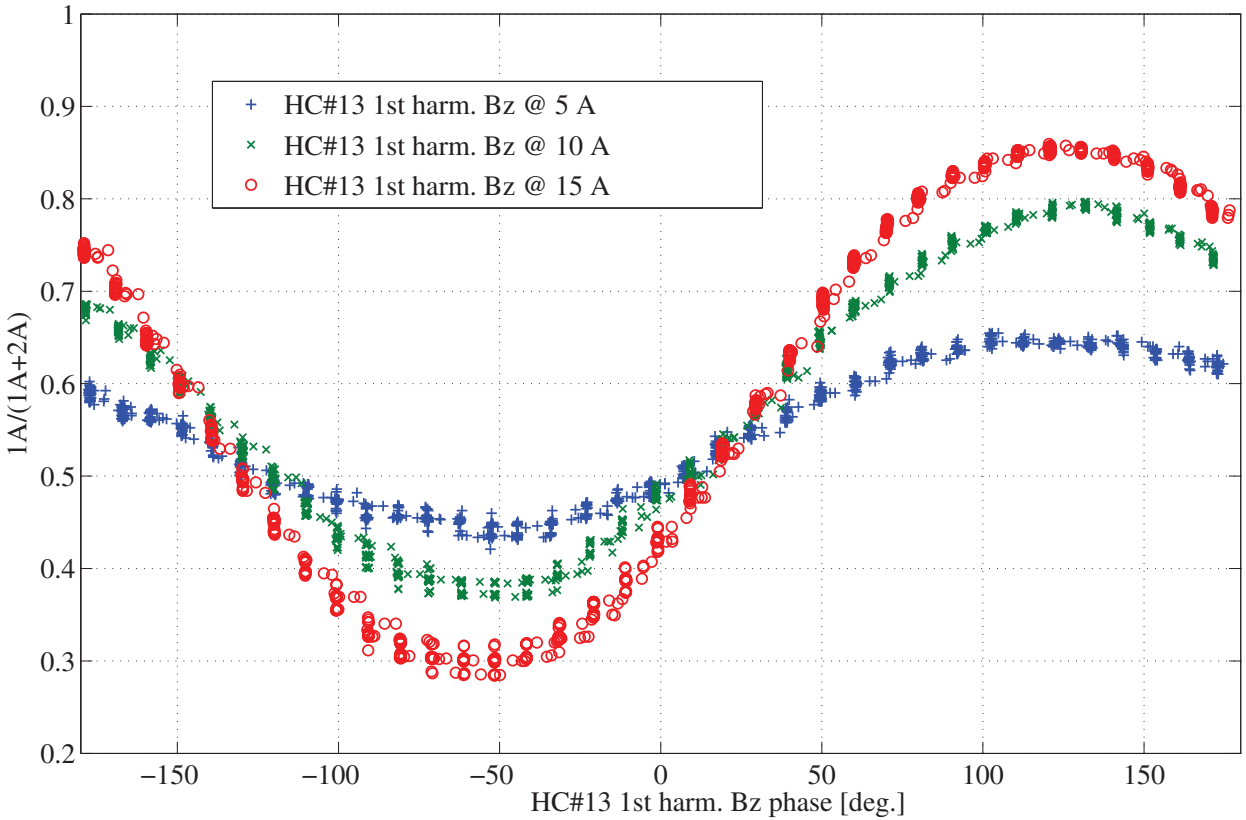


Fig. 12: Measured split ratio between high-energy beam lines when scanning the phase of HC#13 first harmonic Bz field correction. Three sets of measurements taken with different current flowing into HC#13 are shown here.

Current stability in high-energy beam lines

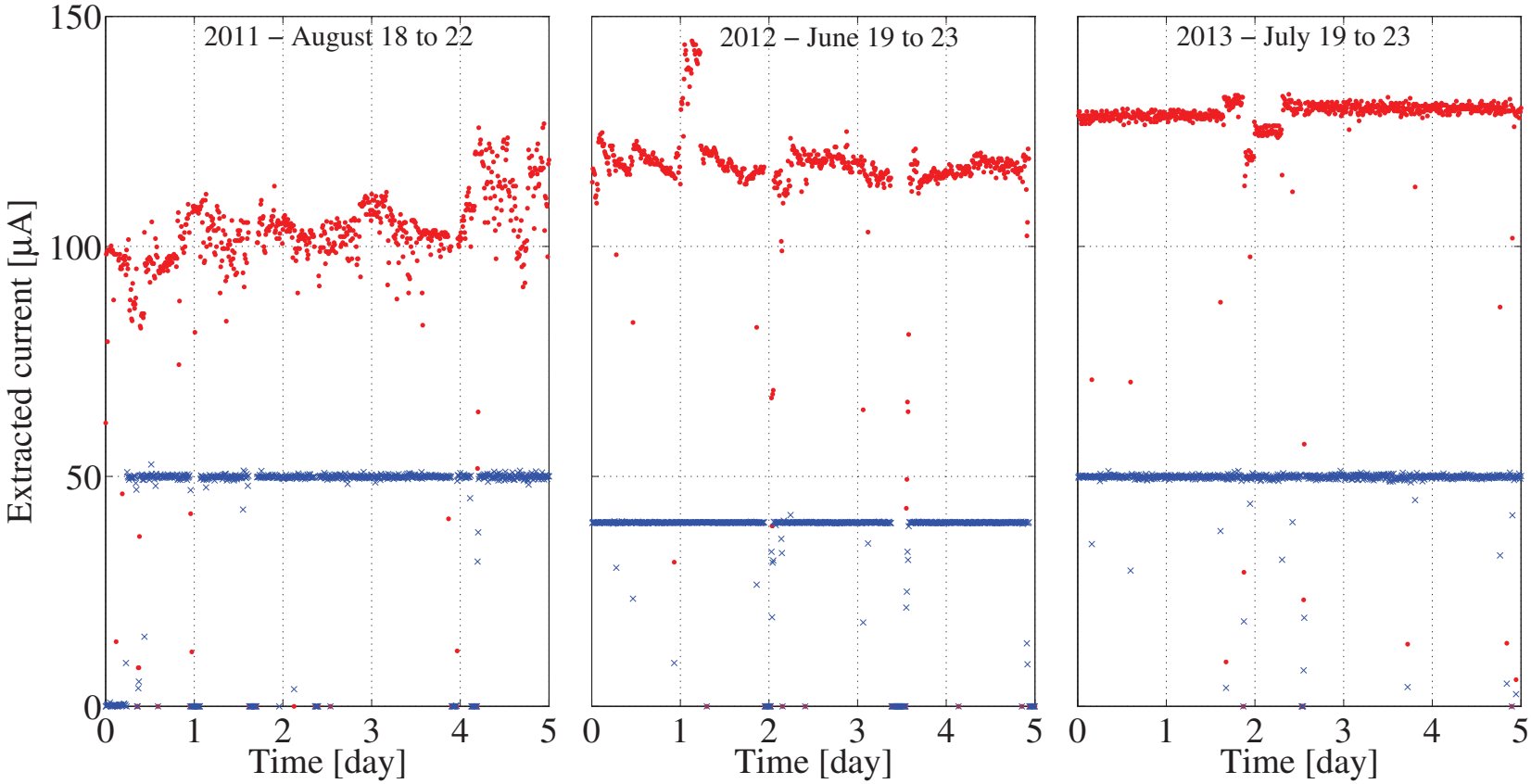


Fig. 13: Gradual improvement of current stability in the high-energy beam lines since 2011. Red dots: BL1A current. Blue crosses: BL2A current. Each plot corresponds to five consecutive days of beam delivery.

Thanks!

Thank you for your attention!