# Sextupole Feed-down effect due to counter-waves in Main Injector and Recycler

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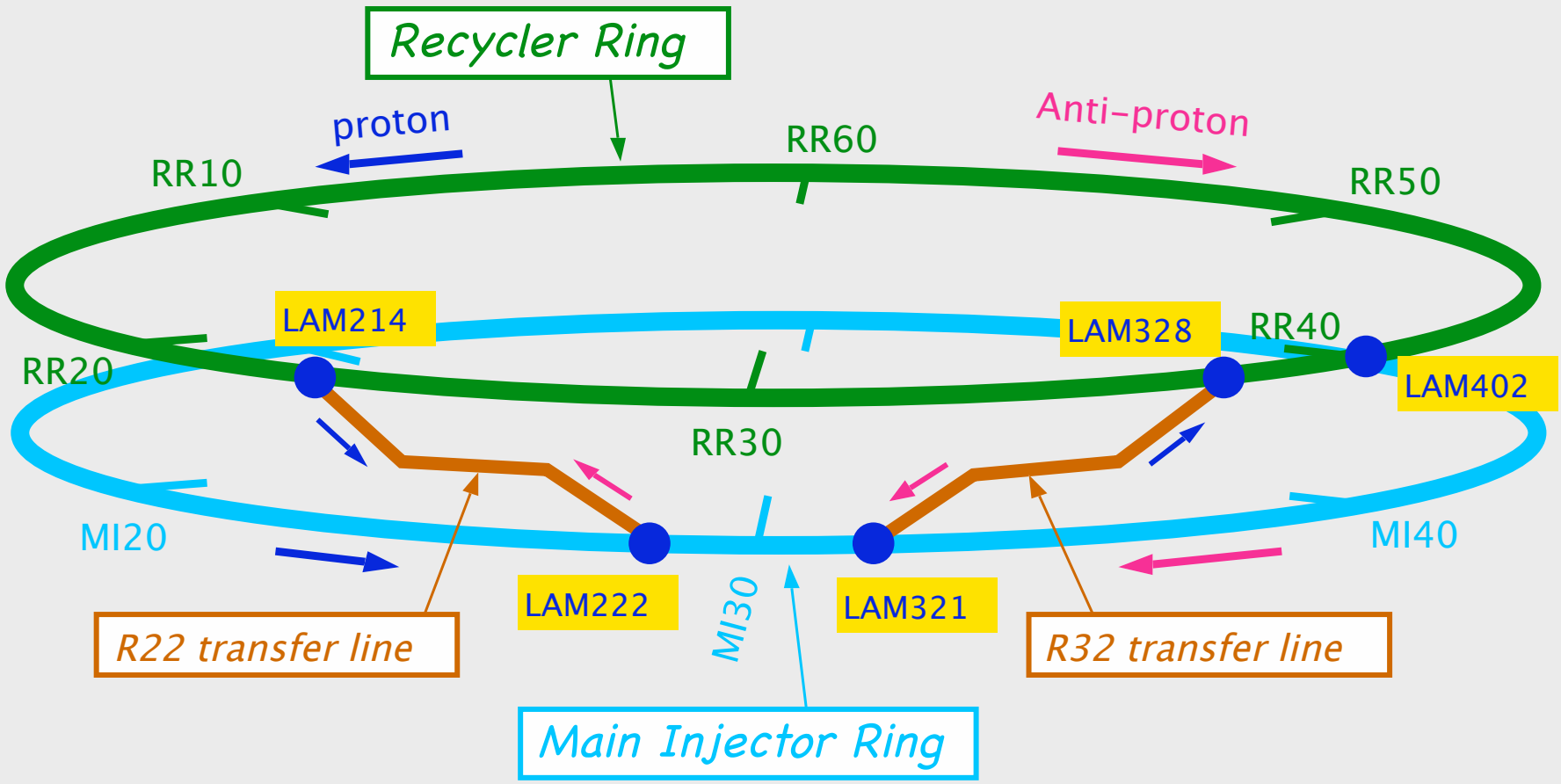
# Beam transfers between MI and RR



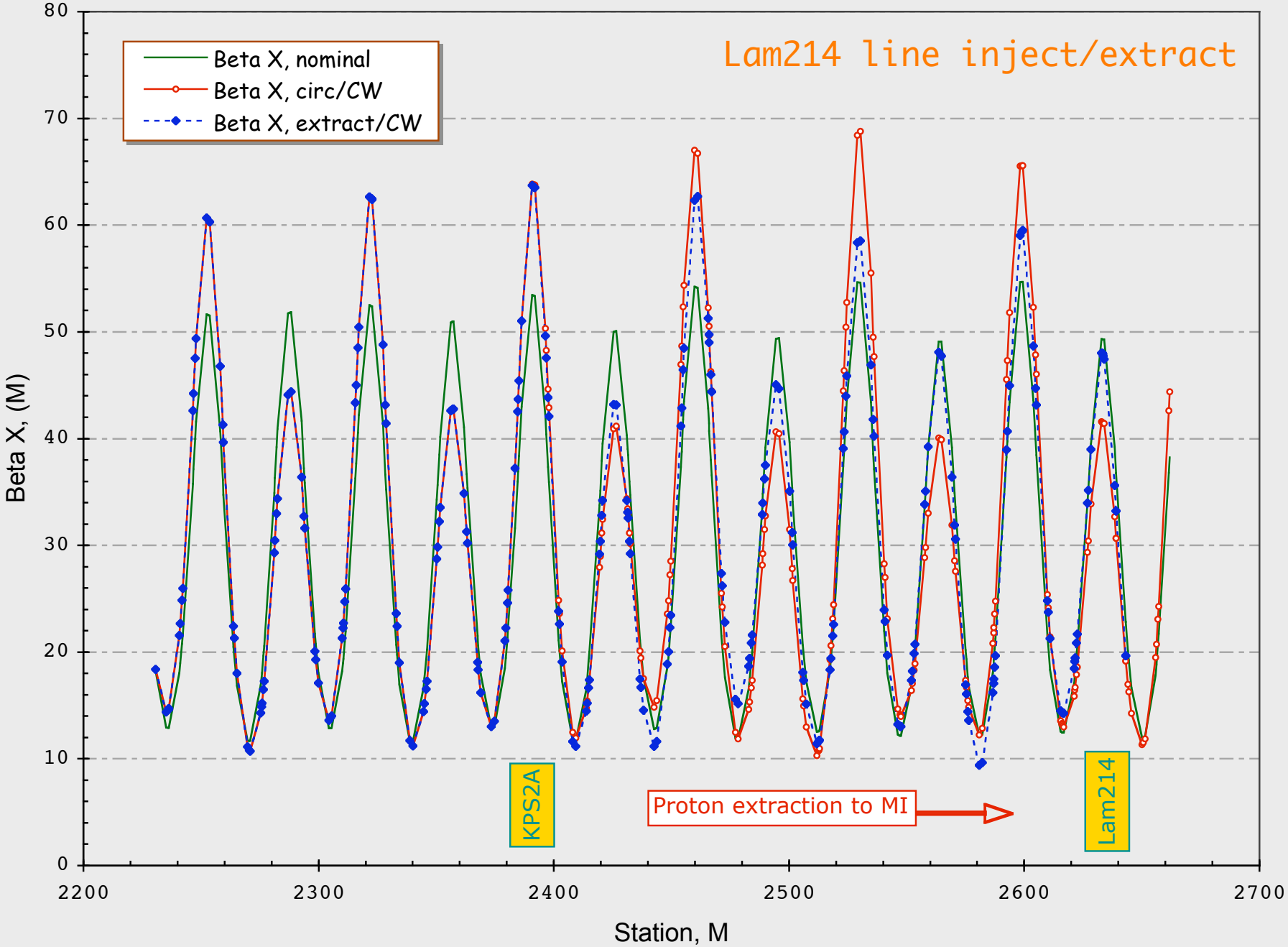
# Four counter-wave segments

- Proton to RR / Pbar from RR to MI
  - MI 304 to 320.
  - RR 330 to 400.
- Pbar to RR / proton from RR to MI
  - MI 224 to 304.
  - RR 130 to 212.

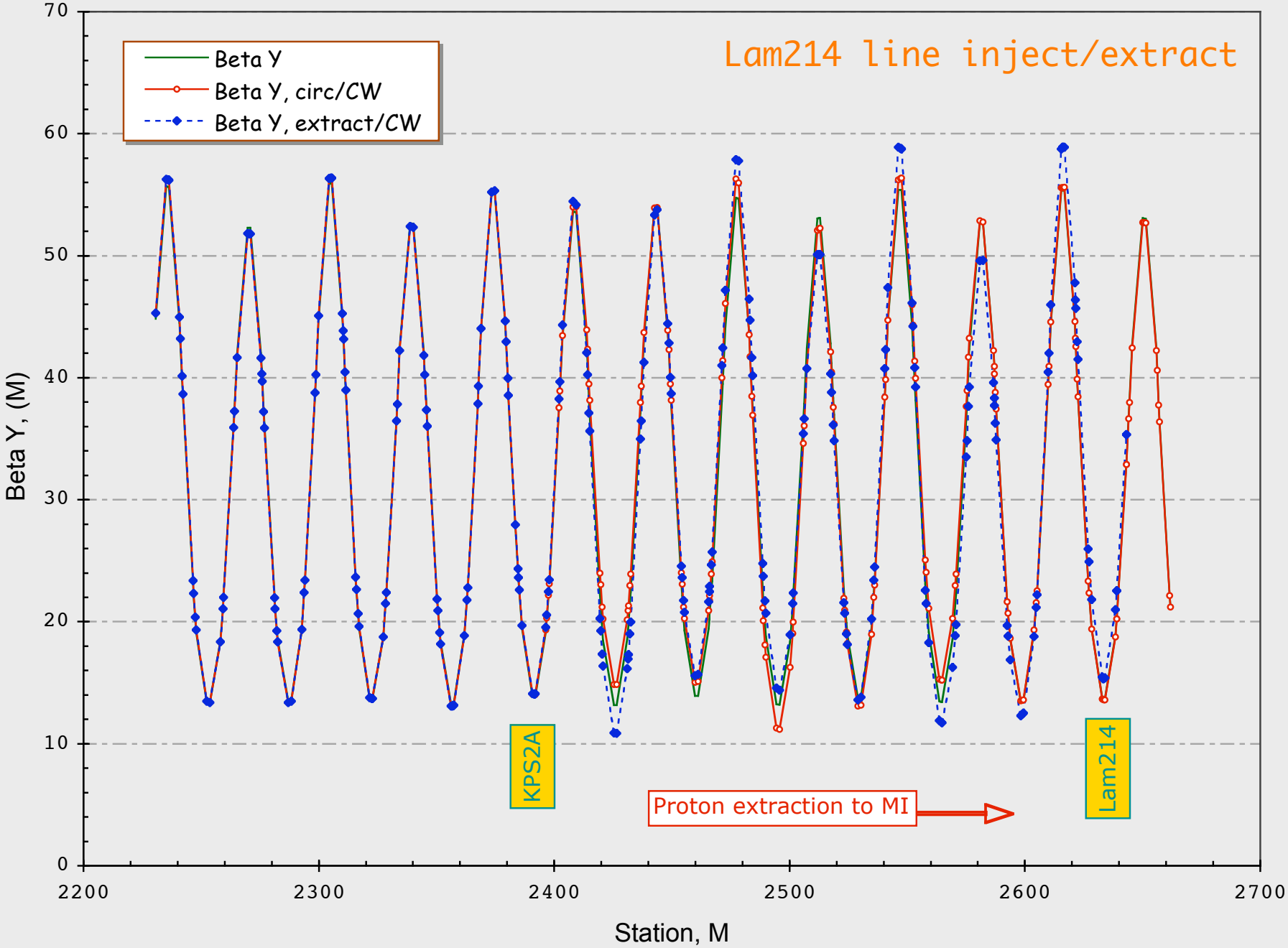
# Feed-down effect from Sextuples

- Circulating orbit displacement
  - Of the order of 25 mm.
  - Feed-downs from sextupoles
    - about 6% of nominal quadrupole field.
- Injected beam orbit
  - 25 mm from central orbit, on the opposite side.
    - About 50 mm from circulating beam.
  - Effect of feed-downs is of opposite sign.
- Not all counter-waves are created equal
  - Differing overall effect.

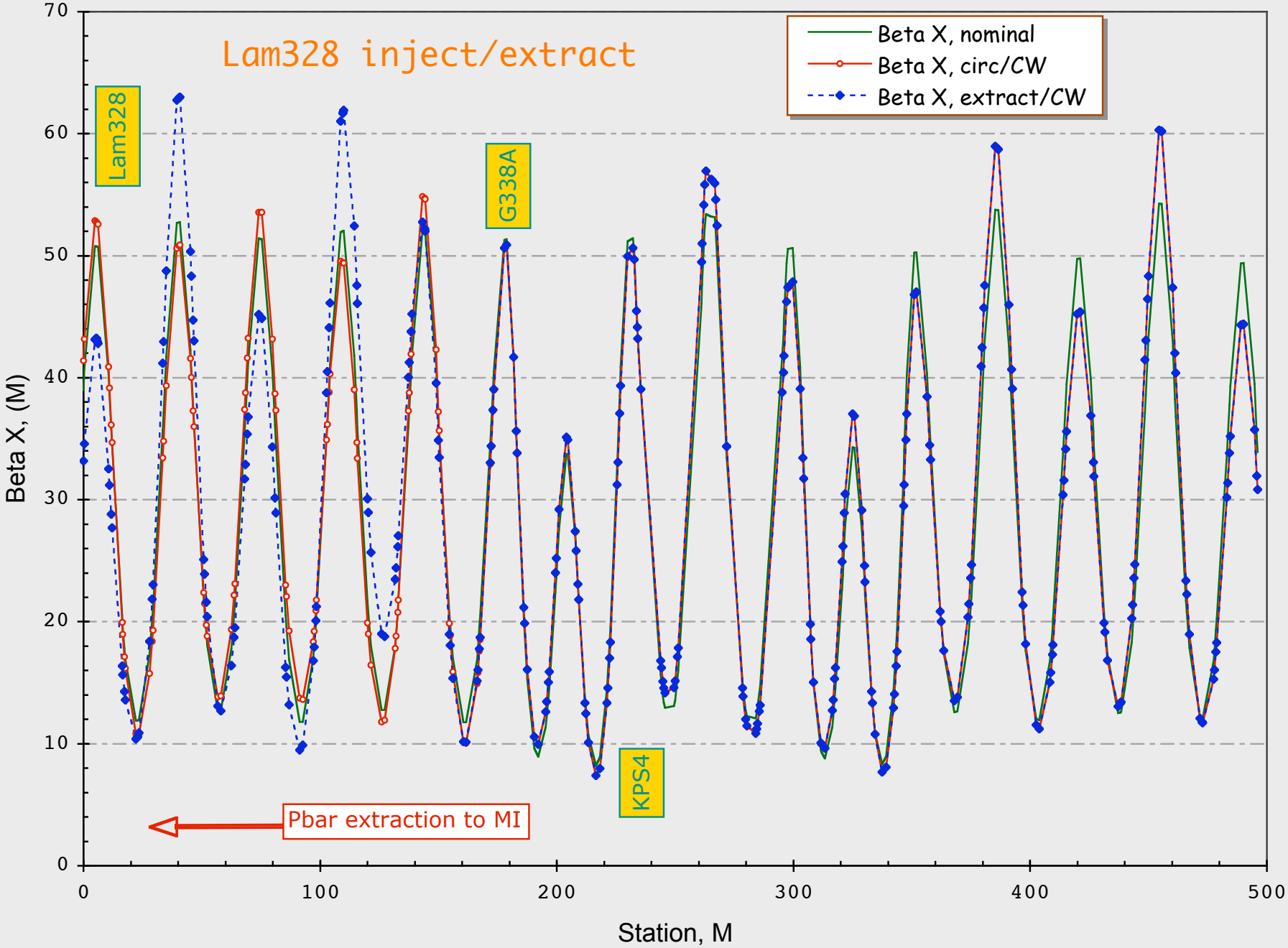
# RR lattice at Lam214, horizontal plane



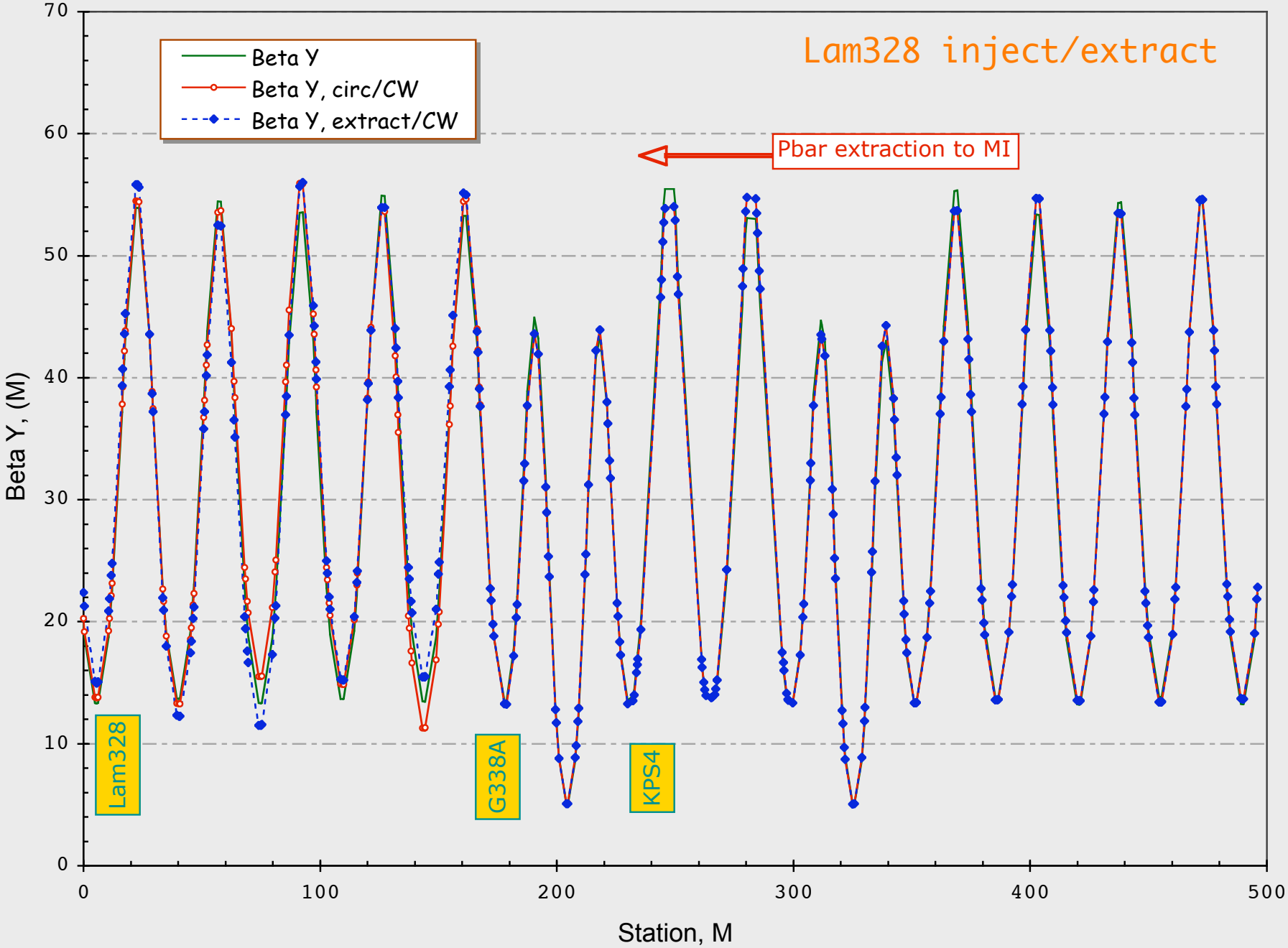
# RR lattice at Lam214, vertical plane



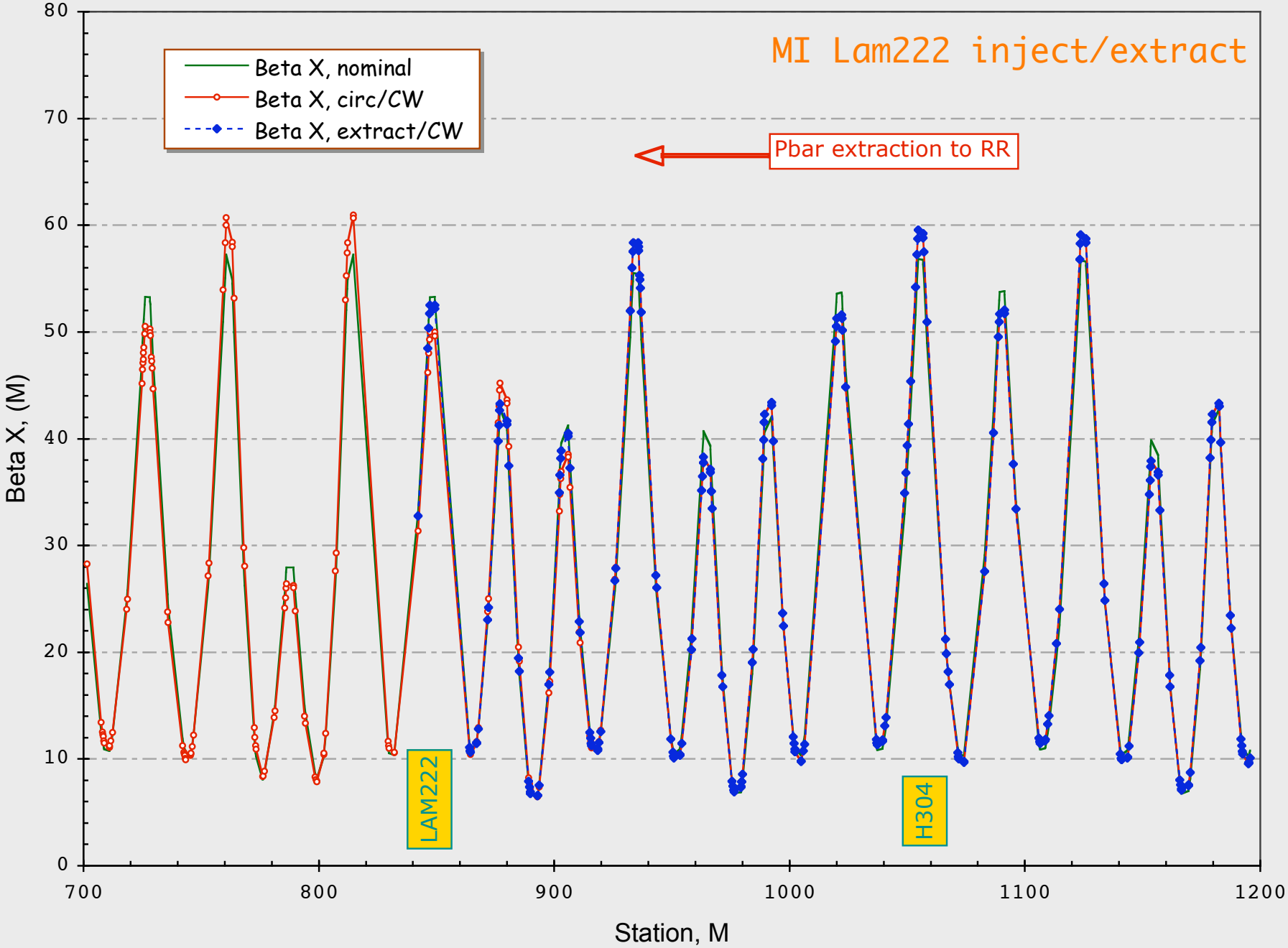
# RR lattice at Lam328, horizontal plane



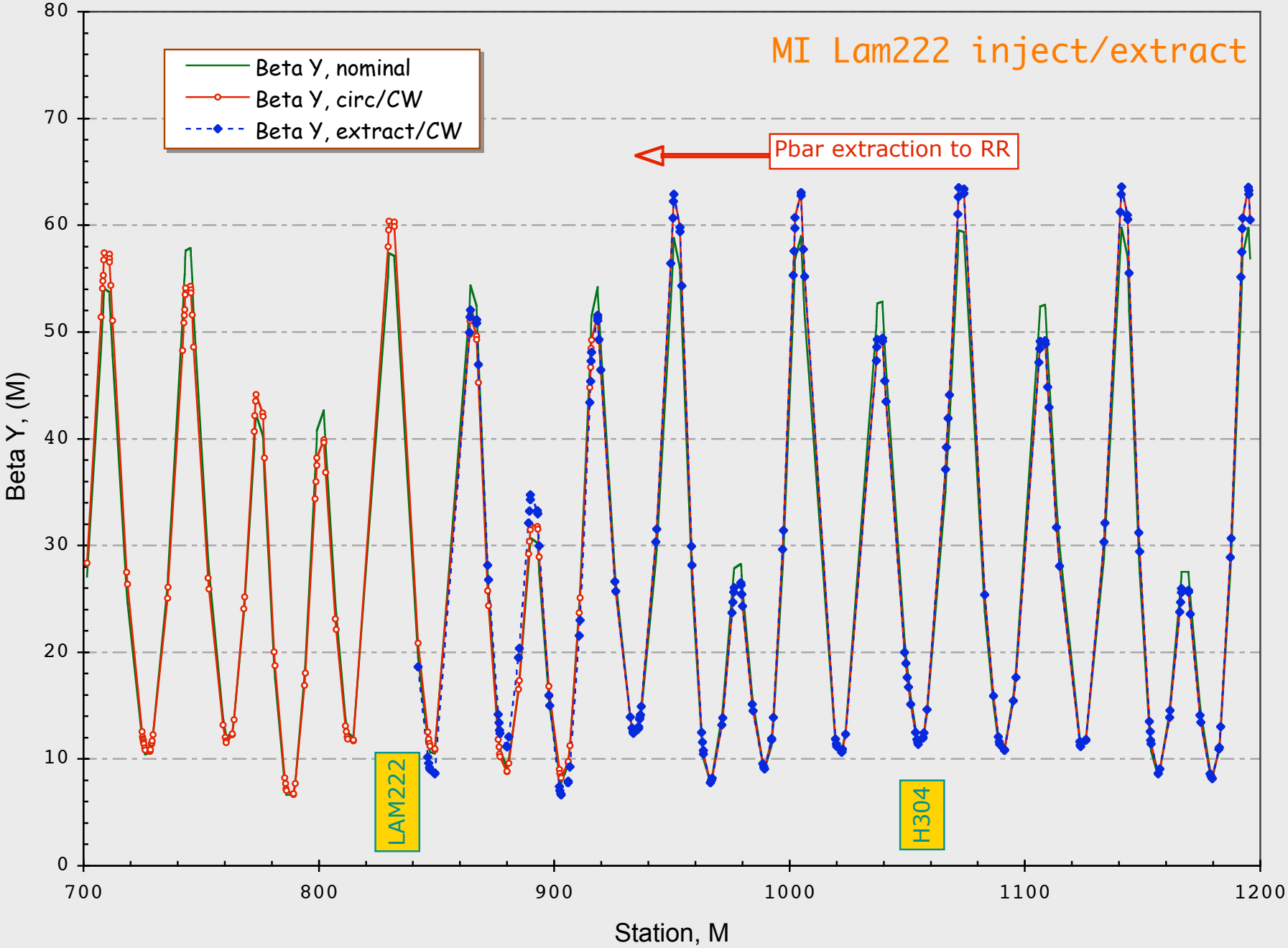
# RR Lattice at Lam328, vertical plane



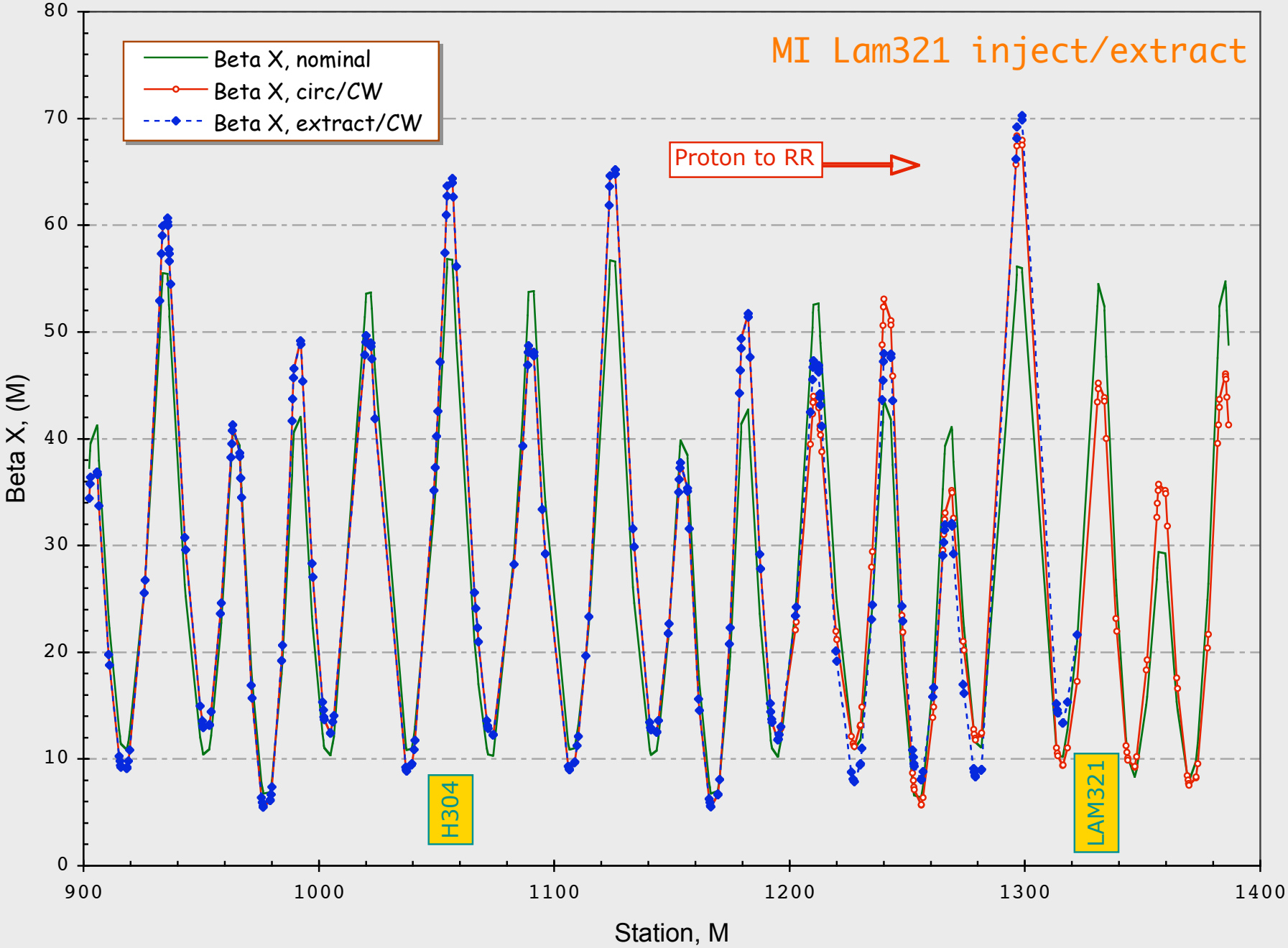
# MI lattice at Lam222, horizontal plane



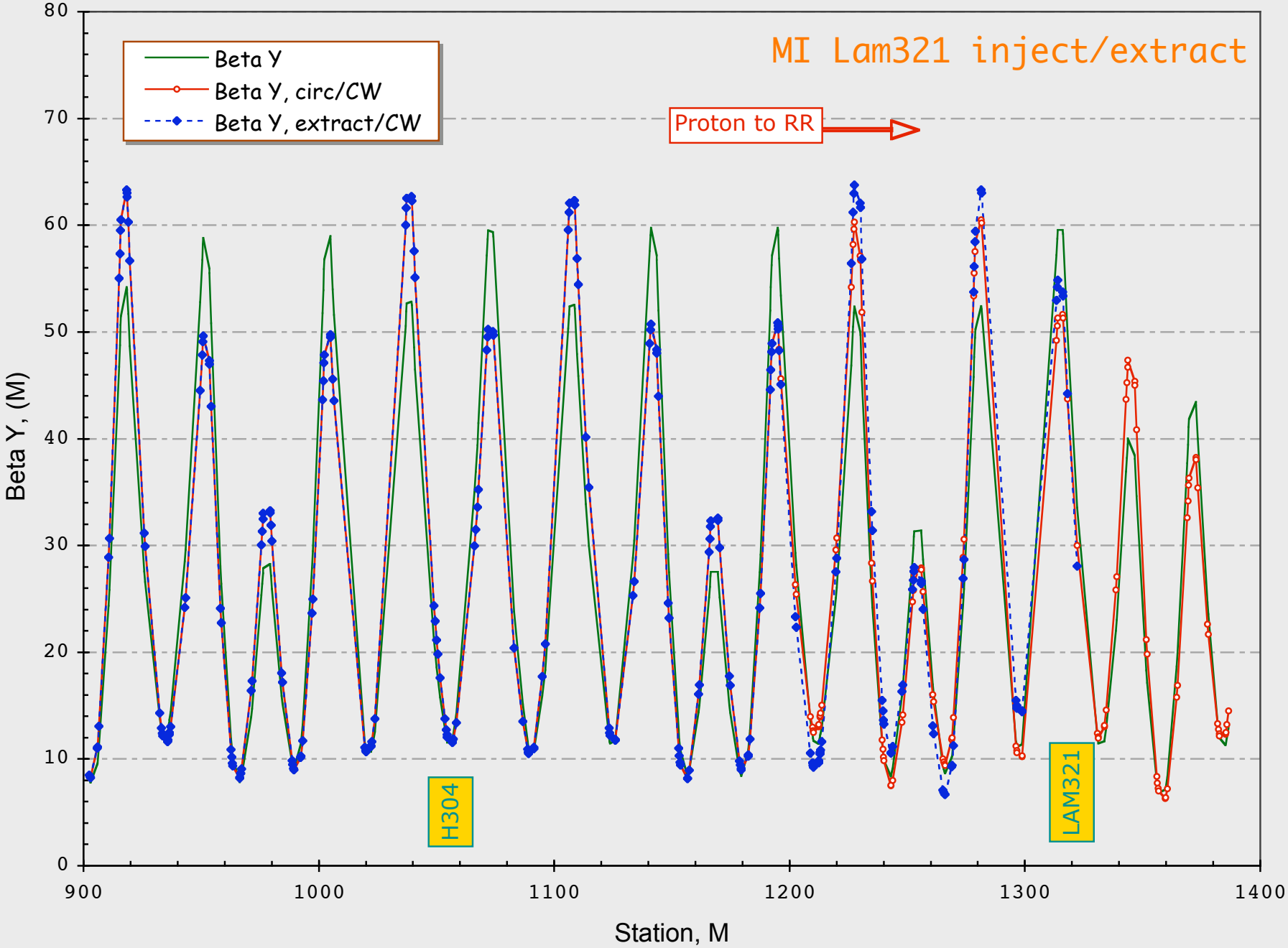
# MI lattice at Lam222, vertical plane



# MI lattice at Lam321, horizontal plane



# MI lattice at Lam321, vertical plane



# Feed-down due to R22 line counter-waves

- Lam321 at Main Injector
  - Horizontal
    - Circulating beam orbit
      - ~10 meters
    - Injection orbit
      - Similar effect as circulating beam.
  - Vertical
    - Beta errors ~10 meters
      - Same pattern for circulating and injection orbit.
- Lam328 at Recycler
  - Horizontal
    - Circulating orbit
      - Small beta errors.
    - Injection orbit
      - Beta error is > 10 meters.
  - Vertical
    - Effect minimal.

# Feed-down due to R32 line counter-waves

- Lam214 in Recycler
  - Horizontal
    - Circulating beam orbit
      - Error > 10 Meters.
    - Injection beam orbit
      - ~5 meters average.
  - Vertical
    - Maximum beta error or 4 meters, at 52 meter nominal.
- Lam222 in Main Injector
  - Horizontal
    - Small perturbation, < 2 meters.
  - Vertical
    - < 2 meters.