Closed Orbit Correction at KARA Storage Ring

Igor Križnar

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Orbit Correction Modifications

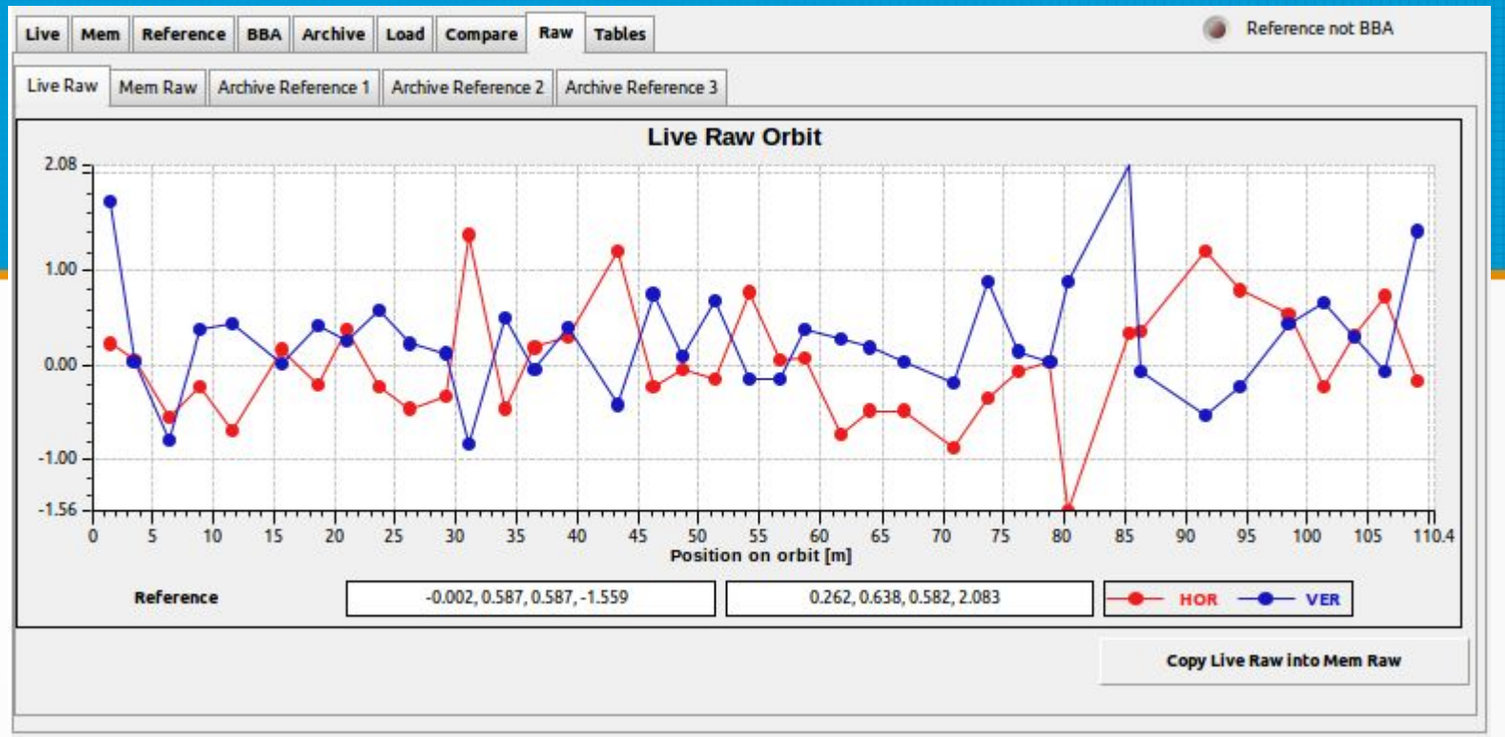
- Basic equation: $x_{(M\ BPMs)} = \underline{R}_{(N \times M\ response\ matrix)} \times a_{(N\ correctors)}$ $(N \neq M)$
- Added frequency to the RM equation
  $a_f = \underline{R}^{-1} \times x + D \times \delta f/f = \underline{R}^{-1} \times x_f$
- Corrector reduction
  $x_{calc} = \underline{R}_{full} \times a_{used}$ -> $a_{reduced} = \underline{R}^{-1}_{reduced} \times x_{calc}$
  - good for reducing over-usage of correctors or if they are close to their limits
- BPM-fix for defined BPMs (e.g. A and B)
  $a_{AB} = \underline{R}^{-1} \times (x_{AB} - x_{AB\text{-}ref})$
- Combining solutions
  $a = c_f \times a_f + c_r \times a_{reduced} + c_{AB} \times a_{AB}$ $(c_f + c_r + c_{AB} = 1)$
  - $c_f : c_{AB}$ is 50% : 50%
  - Above treshold RMS 0.150 mm only a_f is used

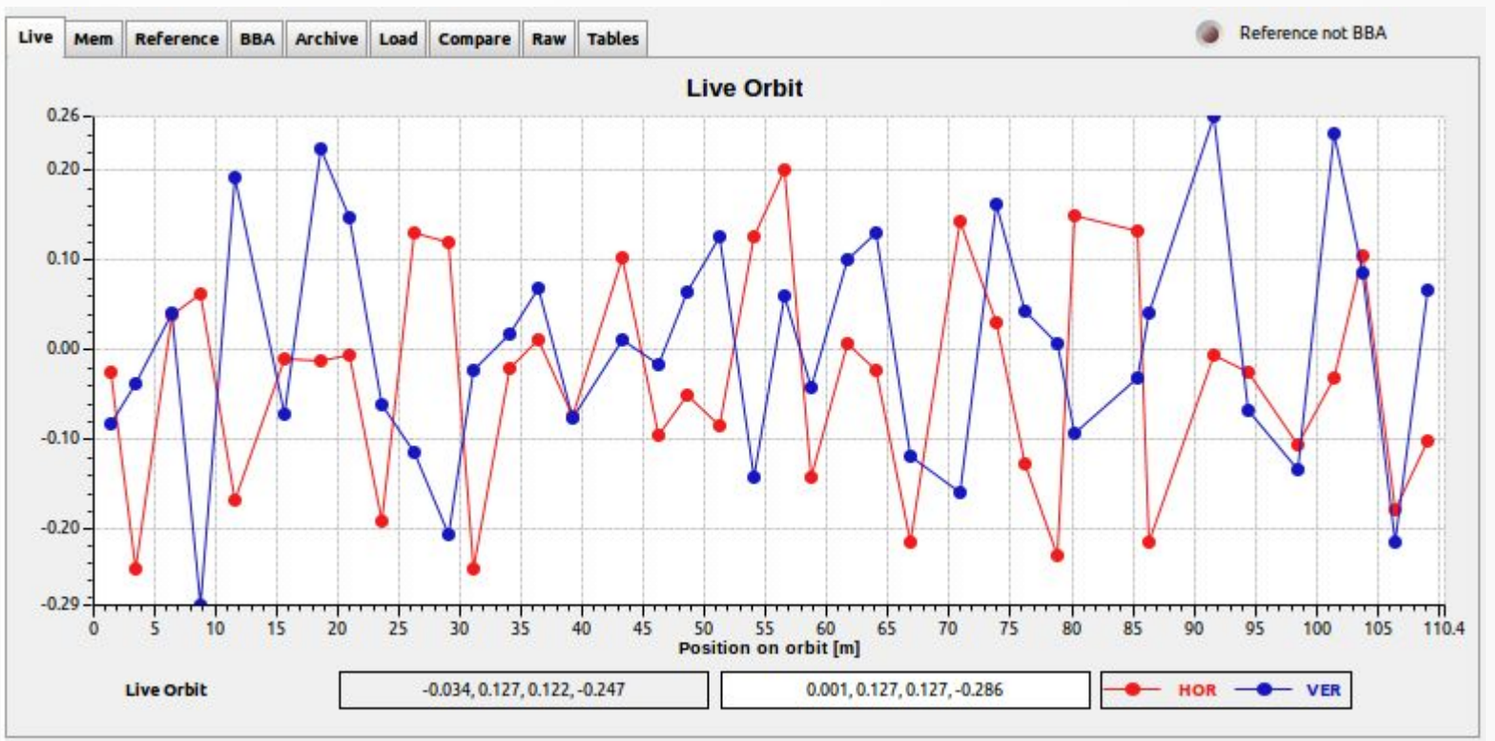
Orbit Correction Implementation

- Reducing solution
  $a_{applied} = a_{current} + c_{scale} \times a_{calculated}$
  - c_{scale} is around 30%
- Application is steps
  $n_{steps} = a_{max\ calculated} / a_{max\ allowed}$
  for i to n_{steps} do $a_{applied} = a_{initial} + i \times c_{scale} \times a_{calculated} / n_{steps}$
- Fast mode
  - using correctors is time costly, avoid doing that
  - if $a_{max\ calculated} < a_{treshold}$ then skip correction
  - do one step $a_{applied} = a_{current} + c_{scale} \times a_{calculated} / n_{steps}$ then recalculate
  - while $x_{RMS\ change} < x_{RMS\ treshold}$ wait

Live Orbit

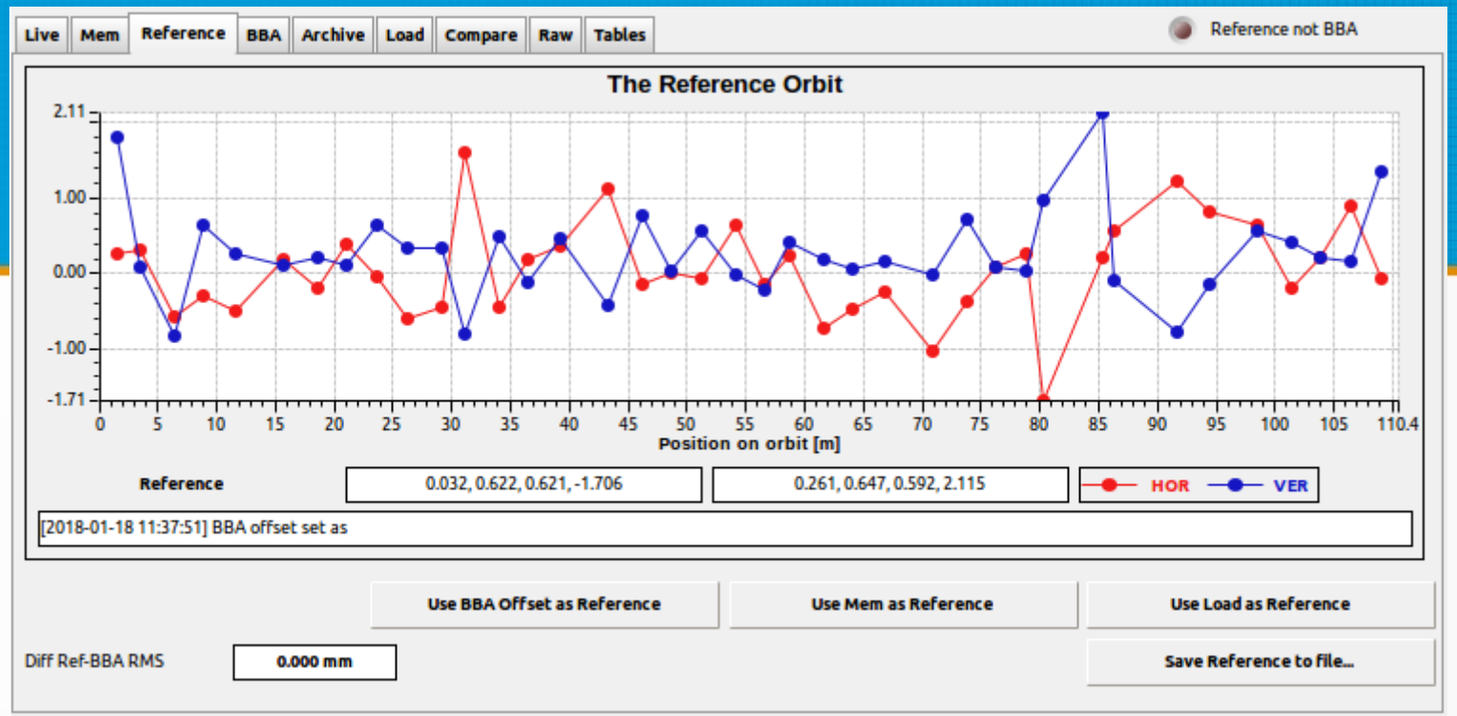
- Raw: direct BPM readings
- “default”: in context of reference

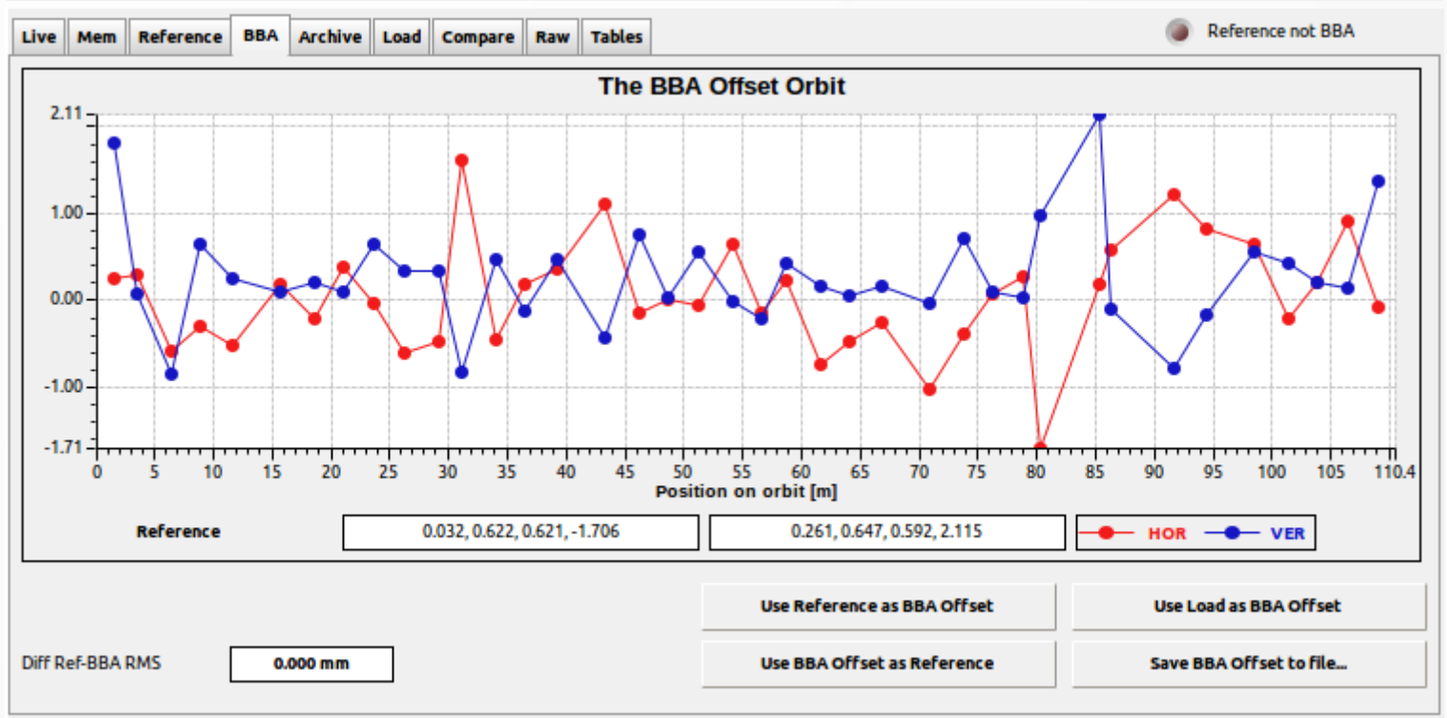




Reference Orbit

- Reference can be in principle any good orbit
- There are good reasons that BBA offset orbit (design or nominal orbit) is a good reference orbit.
- They could be swapped for different purposes during operation.
- SVD optimizes RMS around reference (around 0.120 mm), not individual BPMs.
  - Achieving better RMS reduces drifts and jumps.





Expert view

- Comparison of live (current) orbit to stored orbit.