Vertical Emittance Feedback

at Diamond Light Source

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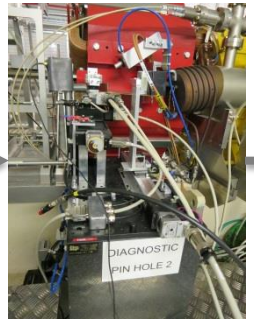
Diamond Light Source

DEELS 2017

Vertical Emittance Feedback (VEFB)

Skew Quad
x98

Pinhole Camera



η, β

σ

Emittance Calculation

ε

$K_{skew}(n)$

(1)Filtering
(weighted average)
$\varepsilon_{filt}(n) = a\,\varepsilon(n) + (1-a)\varepsilon(n-1)$

ε_{filt}

(2)Correction
$\Delta_\varepsilon(n) = \varepsilon_{filt}(n) - \varepsilon_{target}$
$\delta(n) = \delta(n-1) - f\,R^{-1}\Delta_\varepsilon(n)$
$K_{skew}(n) = K_{skew}(n-1) + \delta(n)$

(3)Error Checking
- Away from target
- No effect

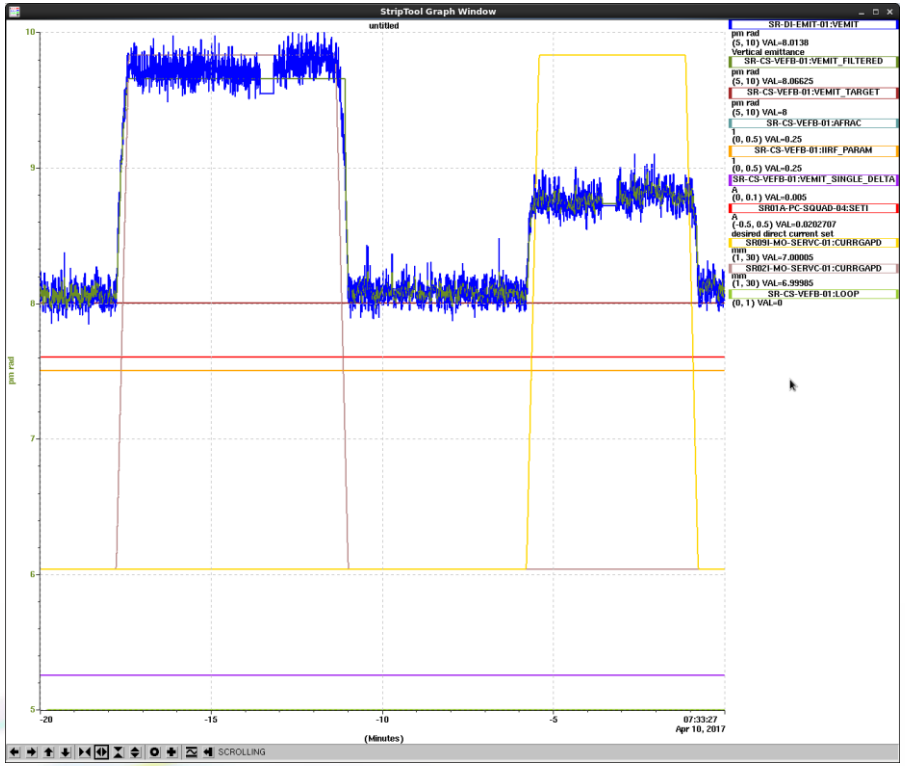
VEFB System
Correction rate @5Hz

ε_{target}

Performance of VEFB

VEFB OFF:

- 2 ID gaps changed 5mm to 29mm
- Step changes in vertical emittance observed

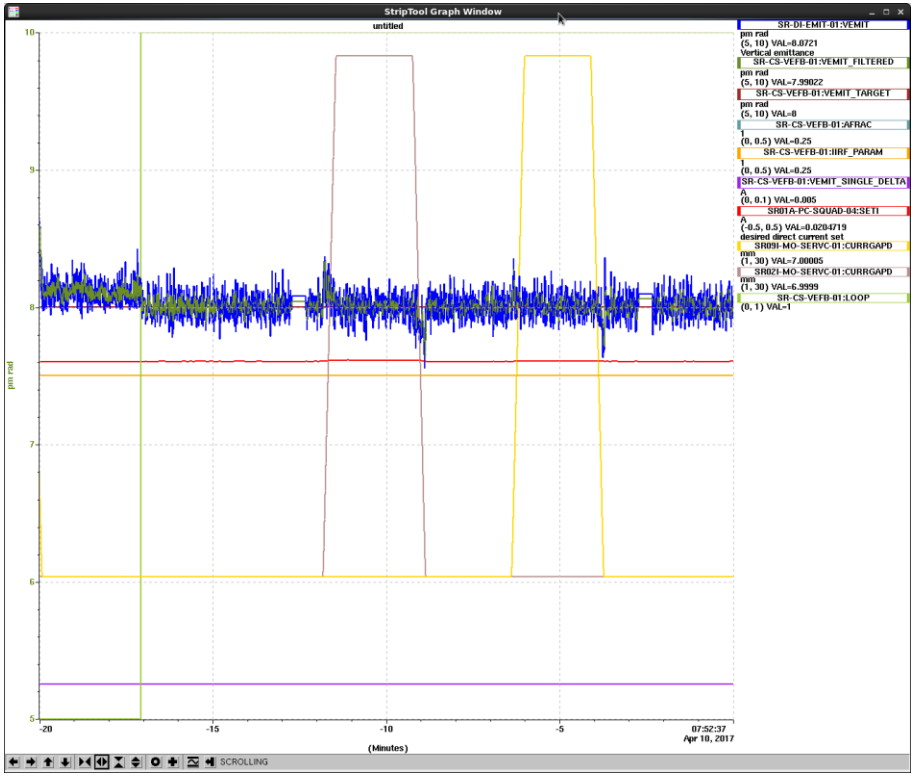


VEFB performance:

- Control @ steady state:
  - 8 pm.rad ± 0.2 pm.rad (± 2.5% of target)
- Control @ ID motions (Full gap movement (over 30s))
  - 8 pm.rad ± 0.45 pm.rad (± 5.6% of target)

VEFB ON:

- 2 ID gaps changed 5mm to 29mm
- Step changes in vertical emittance suppressed
- 2 tuning parameters: filter weight and controller gain
- **Achieve set point tracking and disturbance rejection**



Factors affecting performance

1) Emittance measurement
   a) Resolution
   b) Signal to noise ratio
   c) Measurement method preferences: imaging with pinhole camera (DLS etc), x-ray projection monitors (ESRF) etc.

2) Number of sensors and location
   a) Optimal number of sensors
   b) Optimal sensor distribution around the ring

3) Control algorithm
   a) P only / PI?
   b) Initial conditions checks
   c) No effect checks (anti-windup)

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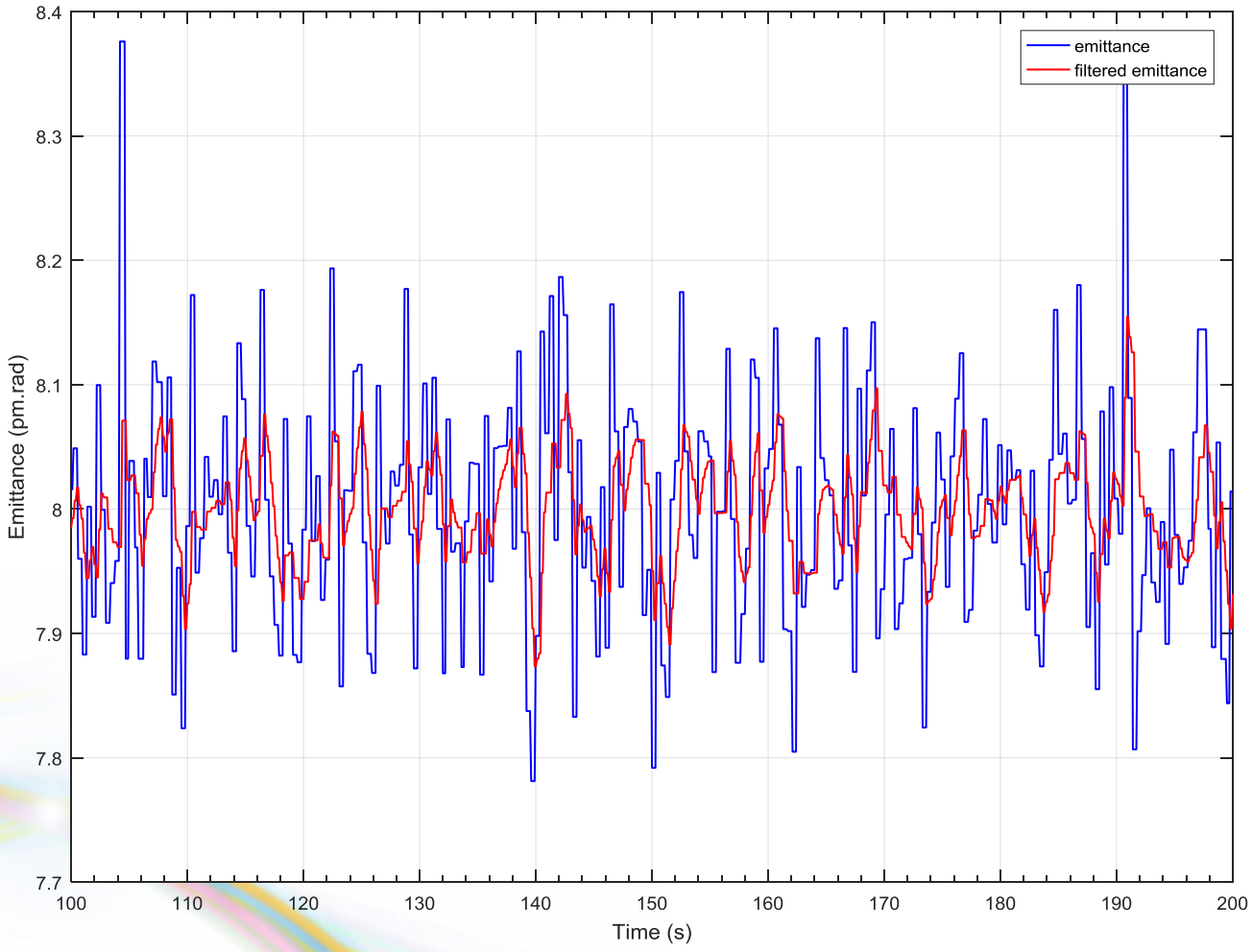
Thanks for listening!

Effect of Filtering

- Filter weight, a affects level of filtering ($a = 1 \rightarrow$ no filtering and $a = 0 \rightarrow$ maximum filtering)
- Figure shows filtering with $a = 0.25$



Effect of Filtering

- Response of emittance to skew quad step change tested
- Time constant = 0.6s and delay = 0.4s (in frequency response, first order with roll-off at 0.36Hz)