FAST ORBIT FEEDBACK CONTROL IN MODE SPACE

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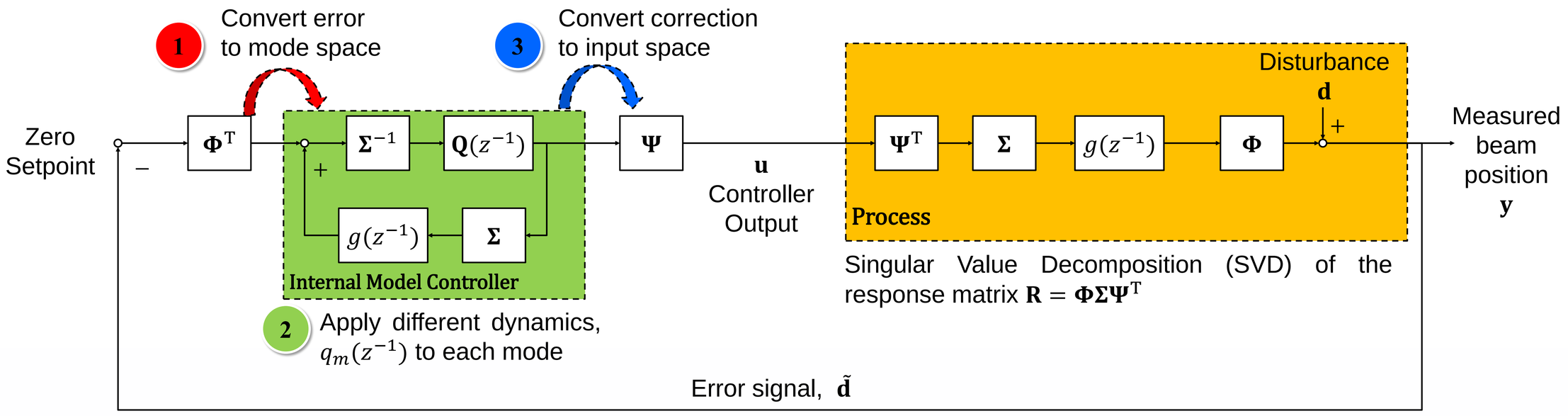
INTRODUCTION

- By Singular Value Decomposition (SVD) of the response matrix each singular value is associated with a spatial mode that can be controlled independently
- Most orbit feedback systems apply the same controller to each mode but adjust the controller bandwidth by applying a different gain resulting from the pseudo-inverse of the response matrix
- Mode space control refers to the method by which not only different gains but different dynamics are applied to individual modes
- This work proposes using a two-dimensional loop shaping technique to select the dynamics for individual modes
- The mode space controller was implemented on the Booster, at Diamond Light Source, operated in stored beam mode

MODE SPACE INTERNAL MODEL CONTROLLER

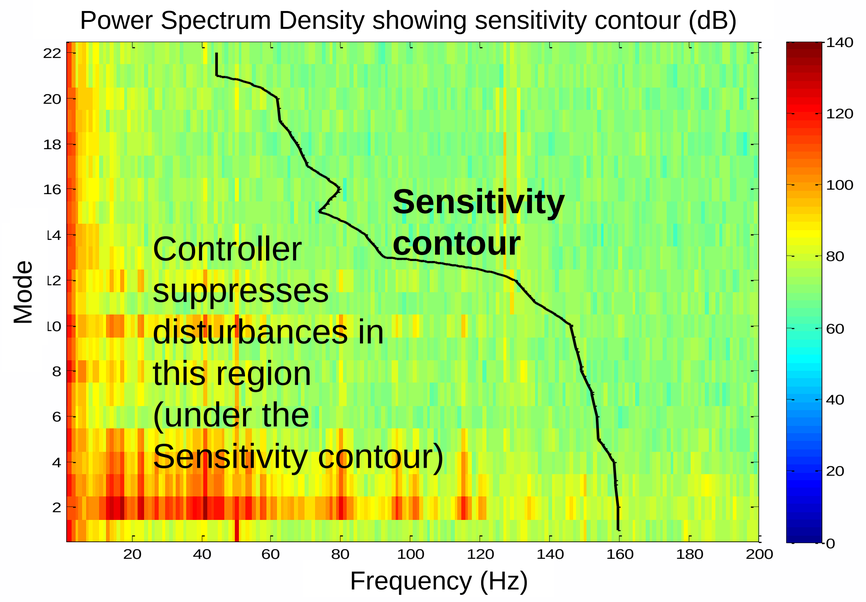


SELECTING CONTROLLER DYNAMICS

- Relationship between the disturbance and the measured beam (sensitivity, $\mathbf{S}(z^{-1})$) used to select dynamics,

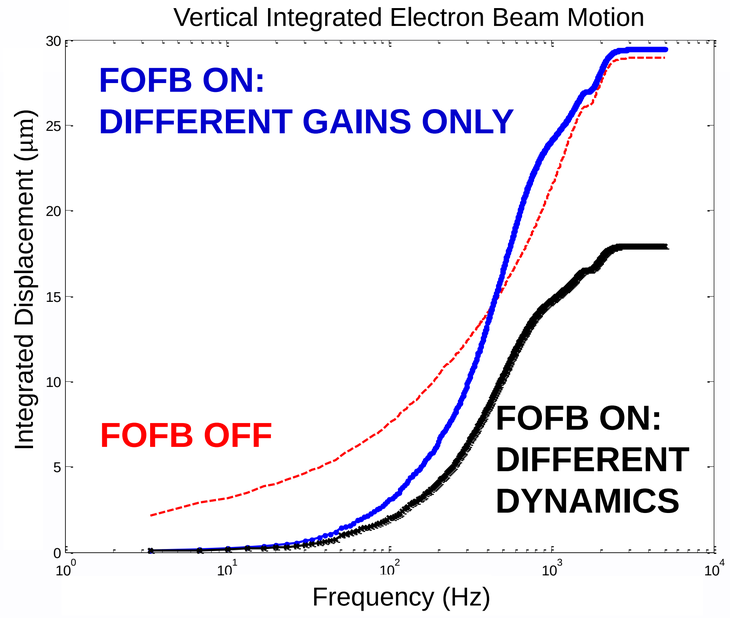
$$\mathbf{y} = \mathbf{S}(z^{-1})\mathbf{d}$$

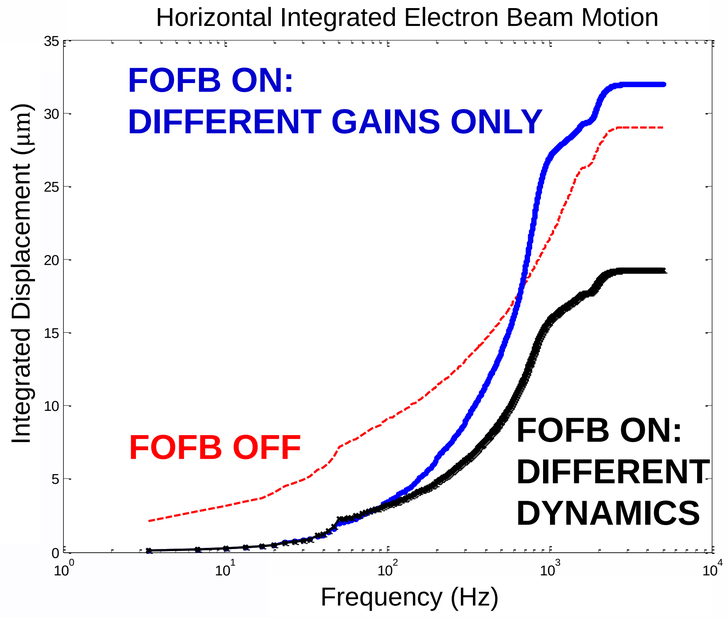
- Sensitivity is shaped to match the disturbance content at each mode
- Sensitivity shape is determined by choice of $q_m(z^{-1})$
- There are 2 tuning parameters for $q_m(z^{-1})$:
  1. Controller gain
     - determines how many modes to use to correct a disturbance at each frequency
  2. Controller bandwidth
     - determines frequencies at which to correct disturbances for each mode



CONTROLLER PERFORMANCE

- Mode space Fast Orbit Feedback control was implemented on the Booster operated in stored beam mode
- The control system takes the beam position from 22 beam position monitors for each plane, and calculates offsets to 44 corrector power supplies at a sample rate of 10 kHz
- Performance was compared to traditional approach of different gains only on each mode
- Enhanced disturbance rejection is achieved by selecting individual dynamics for each mode
- Improved integrated beam motion is achieved over all frequencies in each plane





For more information please visit www.diamond.ac.uk

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