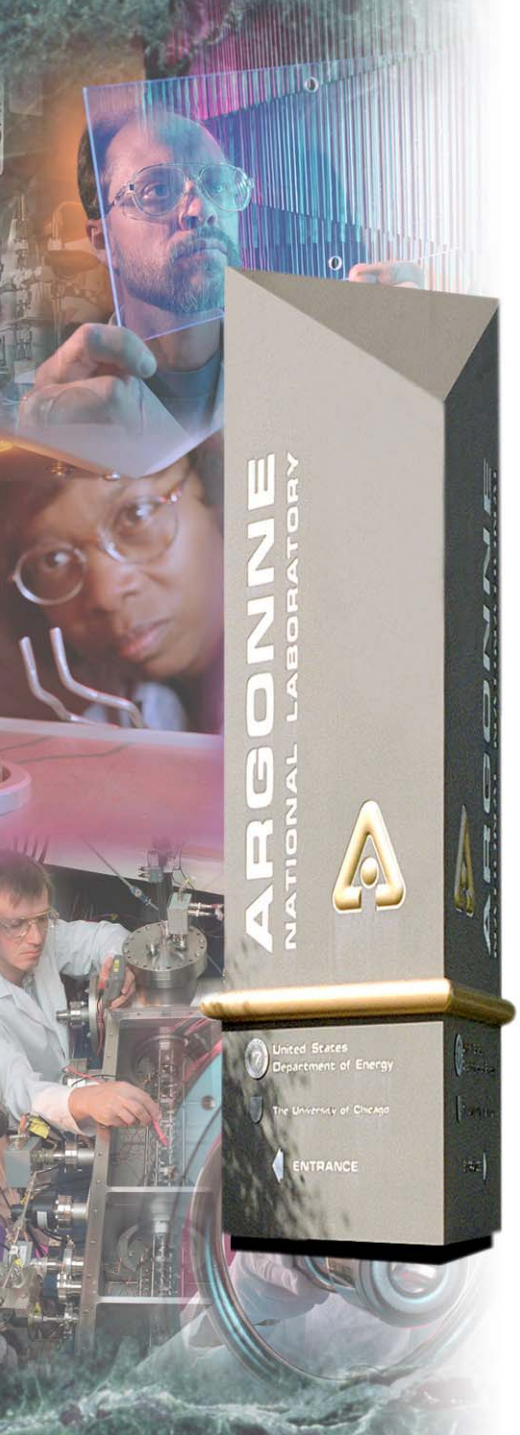


Real Time Feedback Meeting 04/28/2004

Om Singh
Diagnostics Group
APS Operations Division

Argonne National Laboratory

Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

Agenda

- **Purpose of the meeting - singh**
- **RTFB present status/ configuration - singh**
- **Data presentation**

  Step responses – singh, (emery,hahn,erwin,xiang)
  Corrector, Regulator, Bpms frequency responses – singh, (xiang)

- **Corrector ps punch down experiment – decker,(singh,emery)**
- **This presentation is at http://www.aps.anl.gov/asd/diagnostics/rtfb.ppt**

Purpose of RTFB meeting

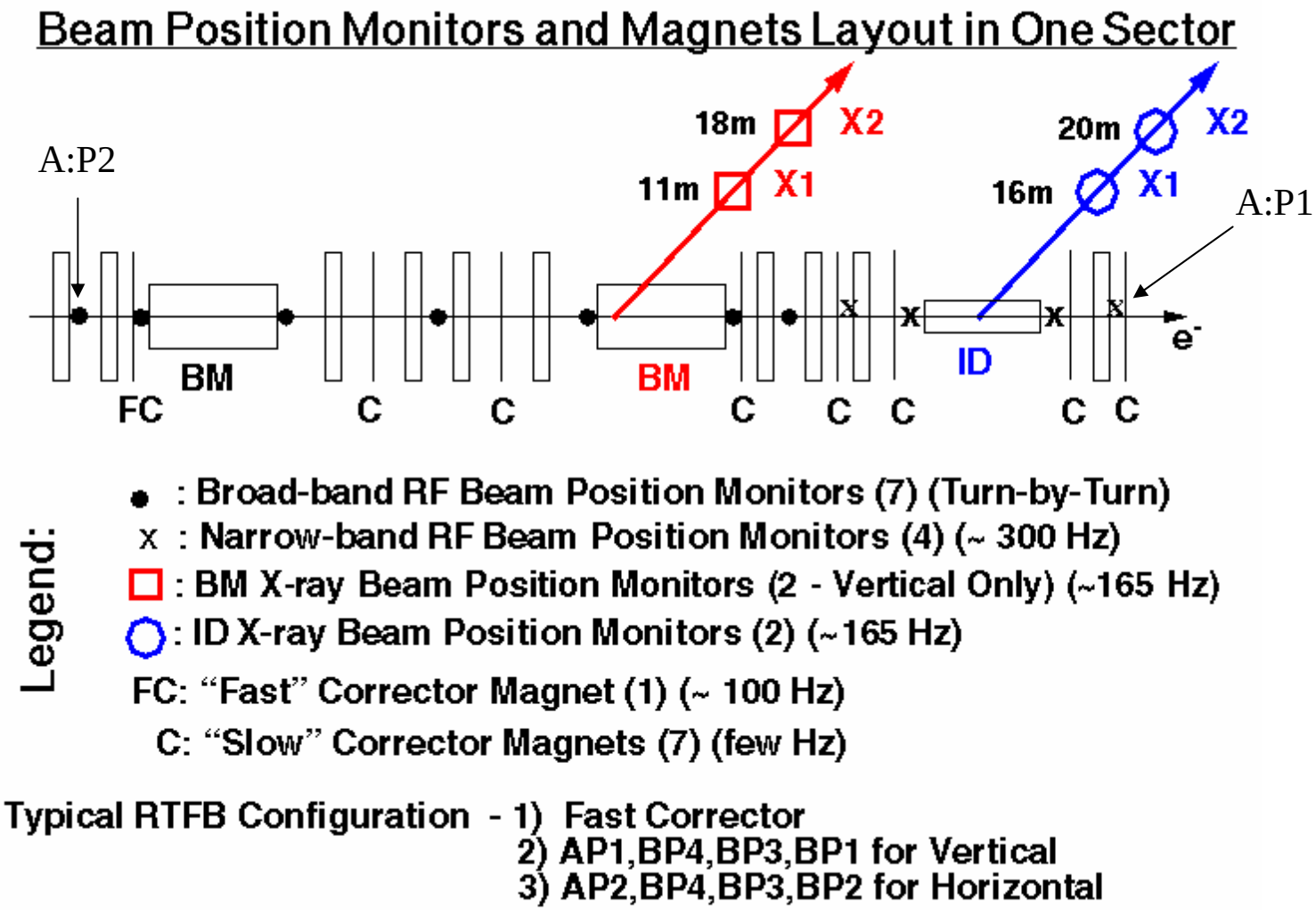
1. NbBpm/Xbpms –
- Should these bpms be included in RTFB?
- What are the benefits?

2. Regulator -
- Should it be re-optimized?

3. Beam dump history for P1s (dbpld) -
- How to deal with no beam history for horizontal P1 Bpms?
- Should go for faster beam history – 1.6 KHz to 16 KHz?

4. Corrector Range –
- Should the range be reduced for more resolution?
- What are impacts on the machine?

Real-Time Feedback Corrector/Bpms Layout



Typical RTFB Configuration - 1) Fast Corrector
2) AP1,BP4,BP3,BP1 for Vertical
3) AP2,BP4,BP3,BP2 for Horizontal

RTFB System Status

Vertical orbit configuration -

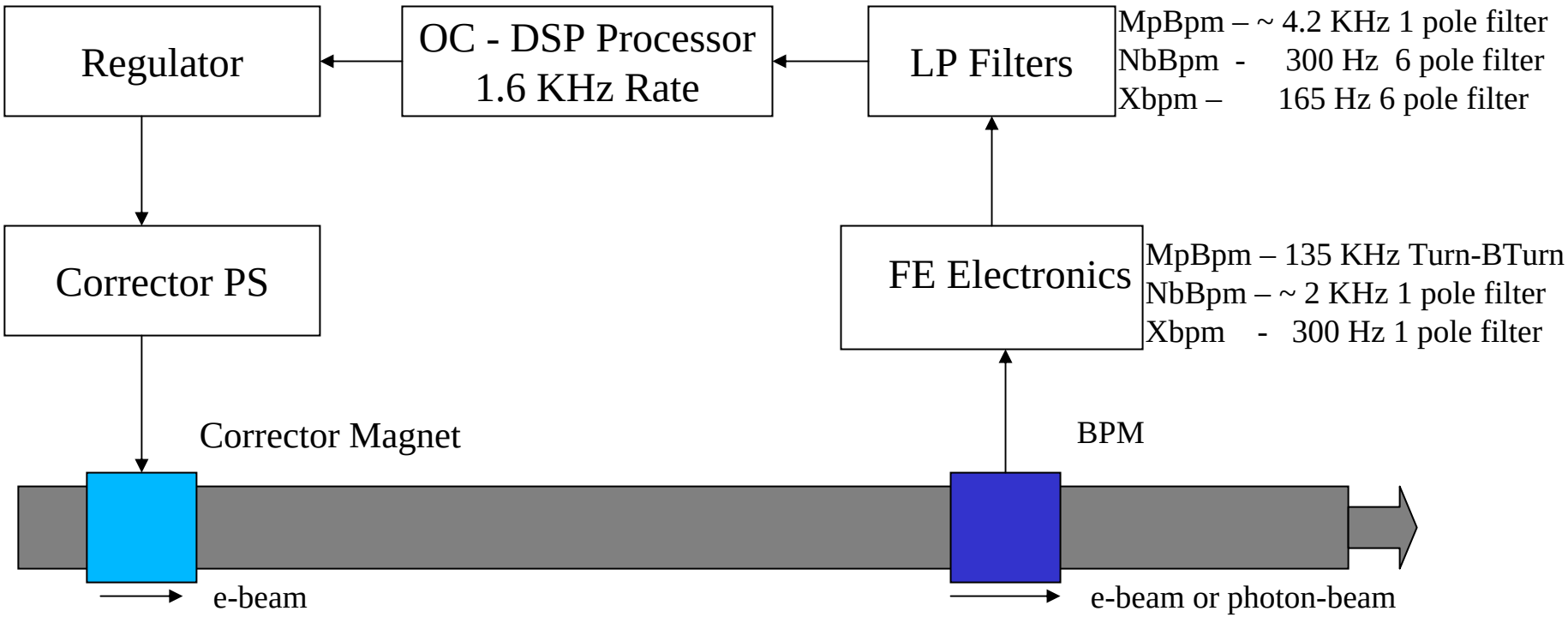
- **Uses AP1,BP4,BP3,BP1 Bpms**
- *** Regulator design - Kp=4; HPF cut-off=0.07 Hz; LPF =25 Hz**
- **Provide beam dump history for DBPLD bpms (P1s)**

Horizontal Orbit configuration -

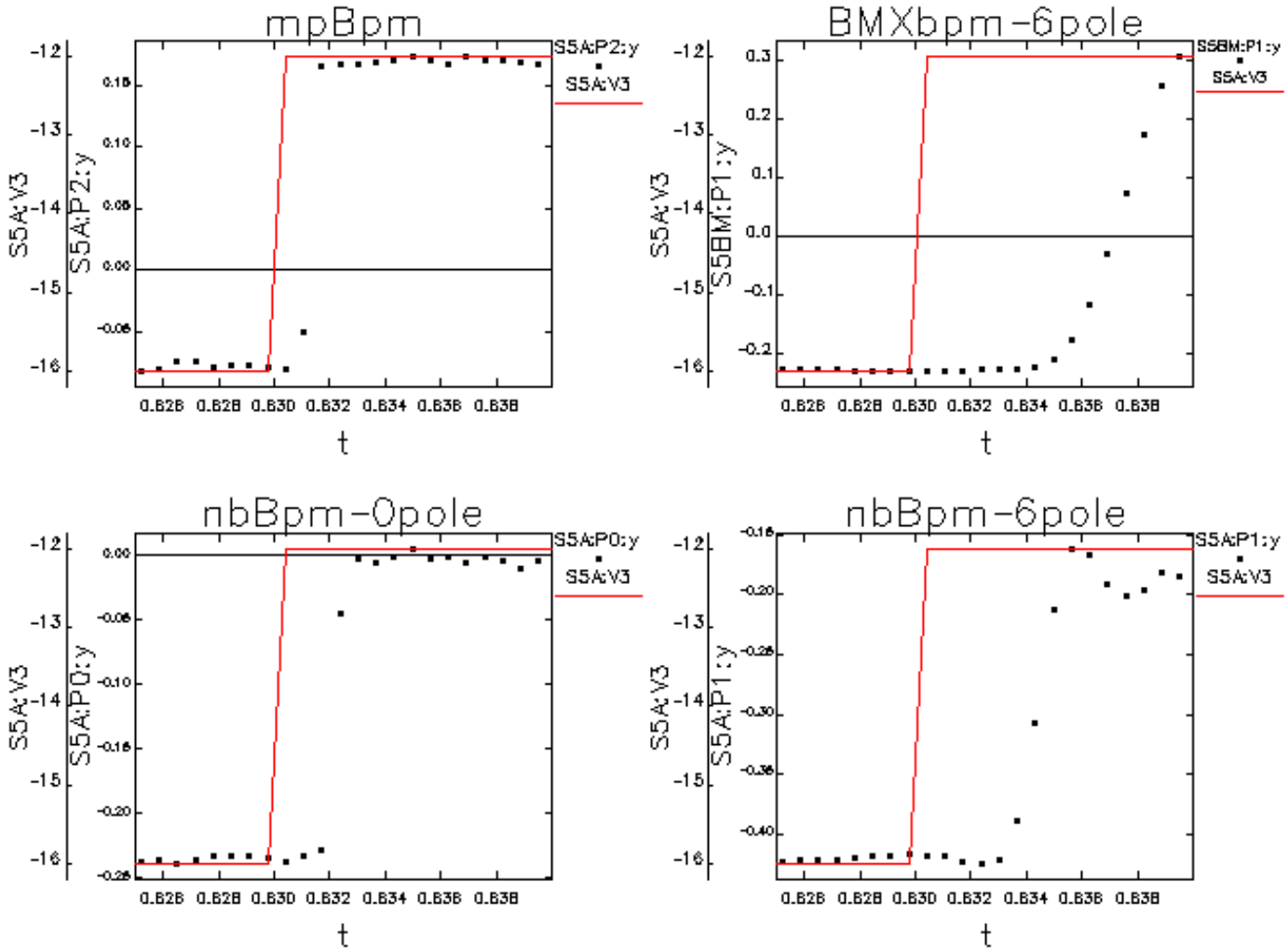
- **Uses AP2,BP4,BP3,BP2 Bpms**
- *** Regulator design - Kp=25; HPF cut-off=0.5 Hz; LPF =2.6 Hz**
- **No beam dump history available for DBPLDs bpms (P1s)**

(* Carwardine/Lenkszus optimization - ~ 1998)

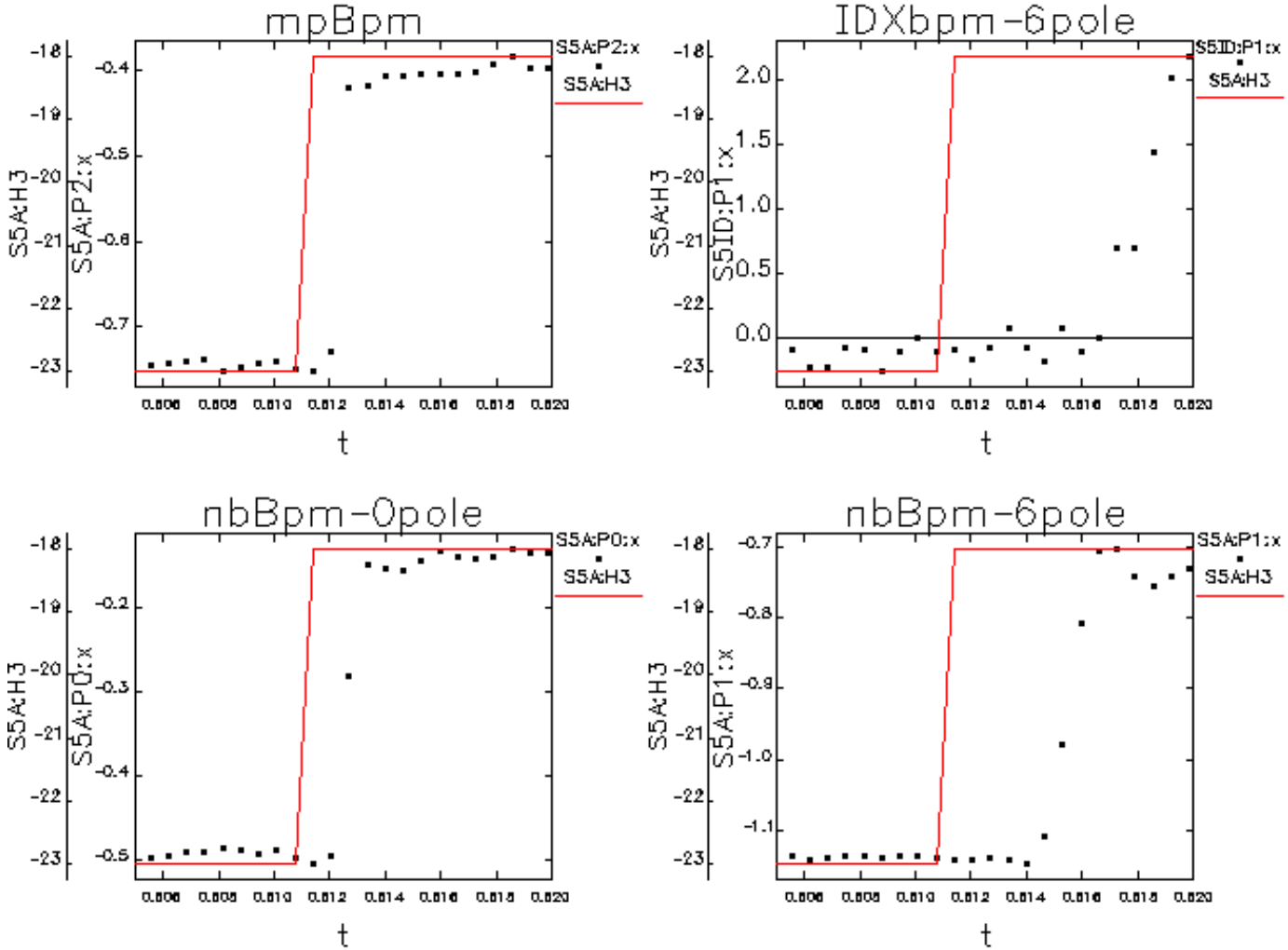
Feedback System Block Diagram - Cartoon



Corrector to Bpm Step Response (Vert) - Emery,Singh,Erwin,Hahn (/home/helios/SR/daily/0403/24/1/RTFB)

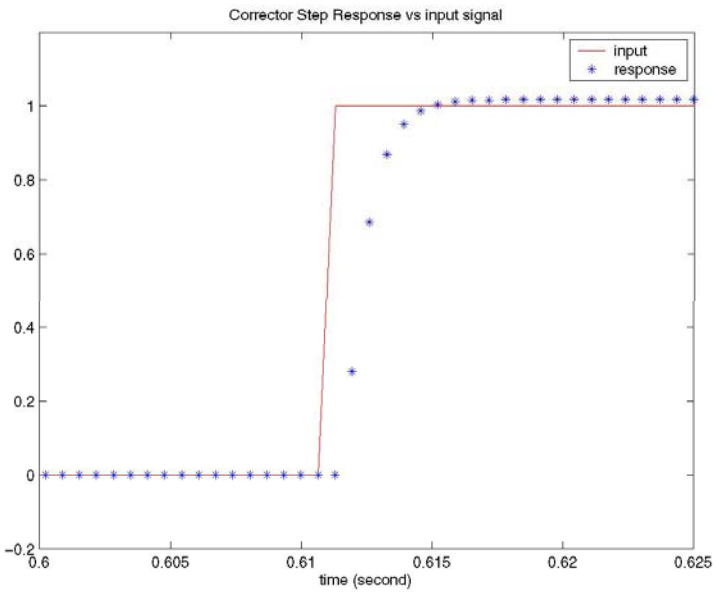


Corrector to Bpm Step Response (Hor) - Emery,Singh,Erwin,Hahn (/home/helios/SR/daily/0403/24/1/RTFB

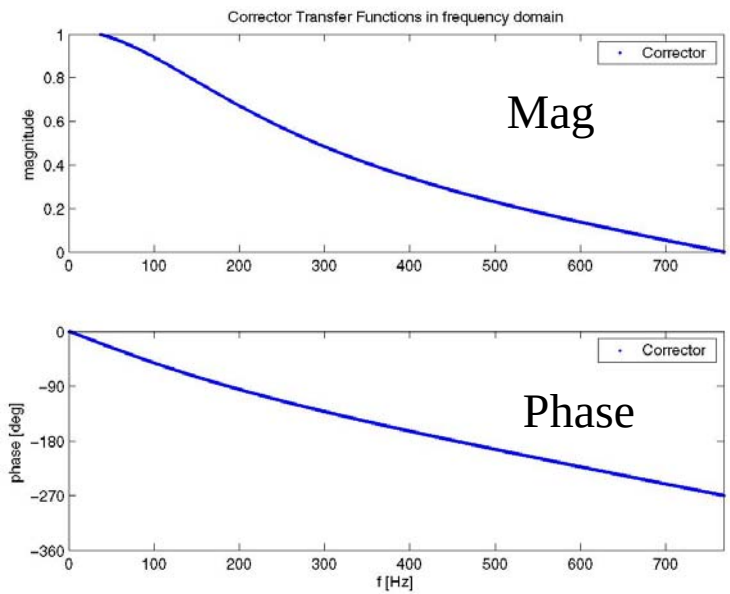


Corrector TF – step and frequency responses - xiang

Step ResponseEach tick = 0.65 ms



Frequency Response – 0 to 750 Hz

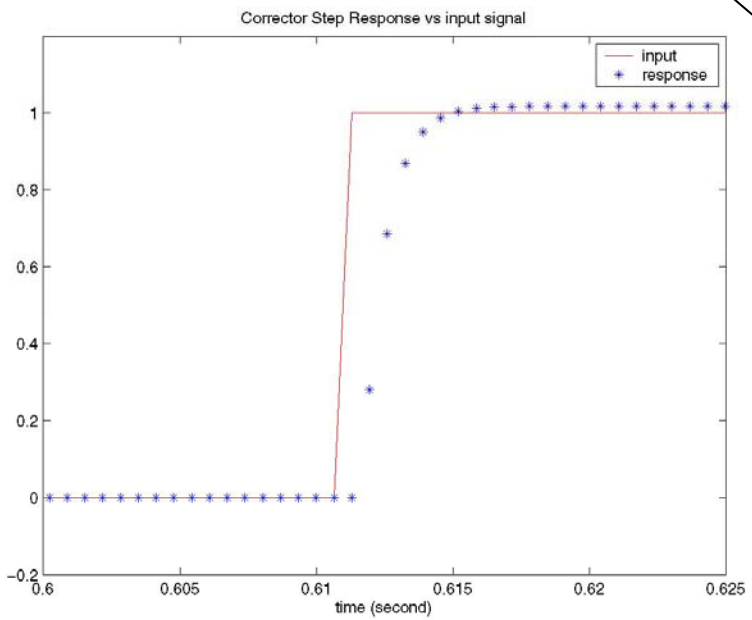


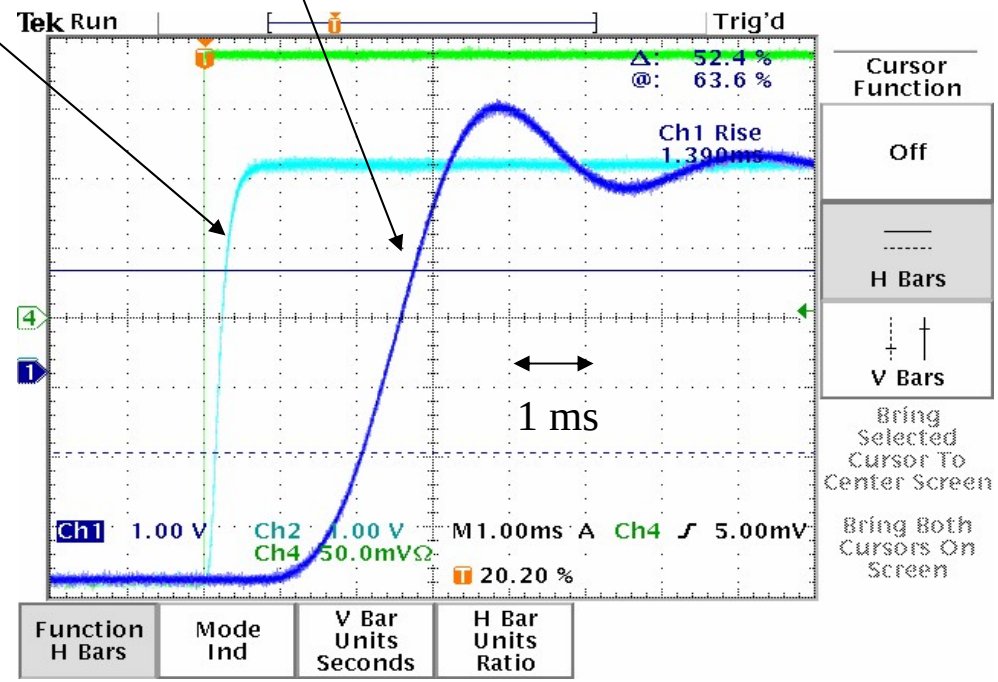
Corr TF = (1/1.54) . (0.43z+0.43)/(z.z-0.45.z)
Translates to minimum of 1 pole at ~100 Hz with ~ 0.7 ms delay

Step responses- xiang

Simulated -
Corrector input to e-beam
Each tick mark = 0.65 ms

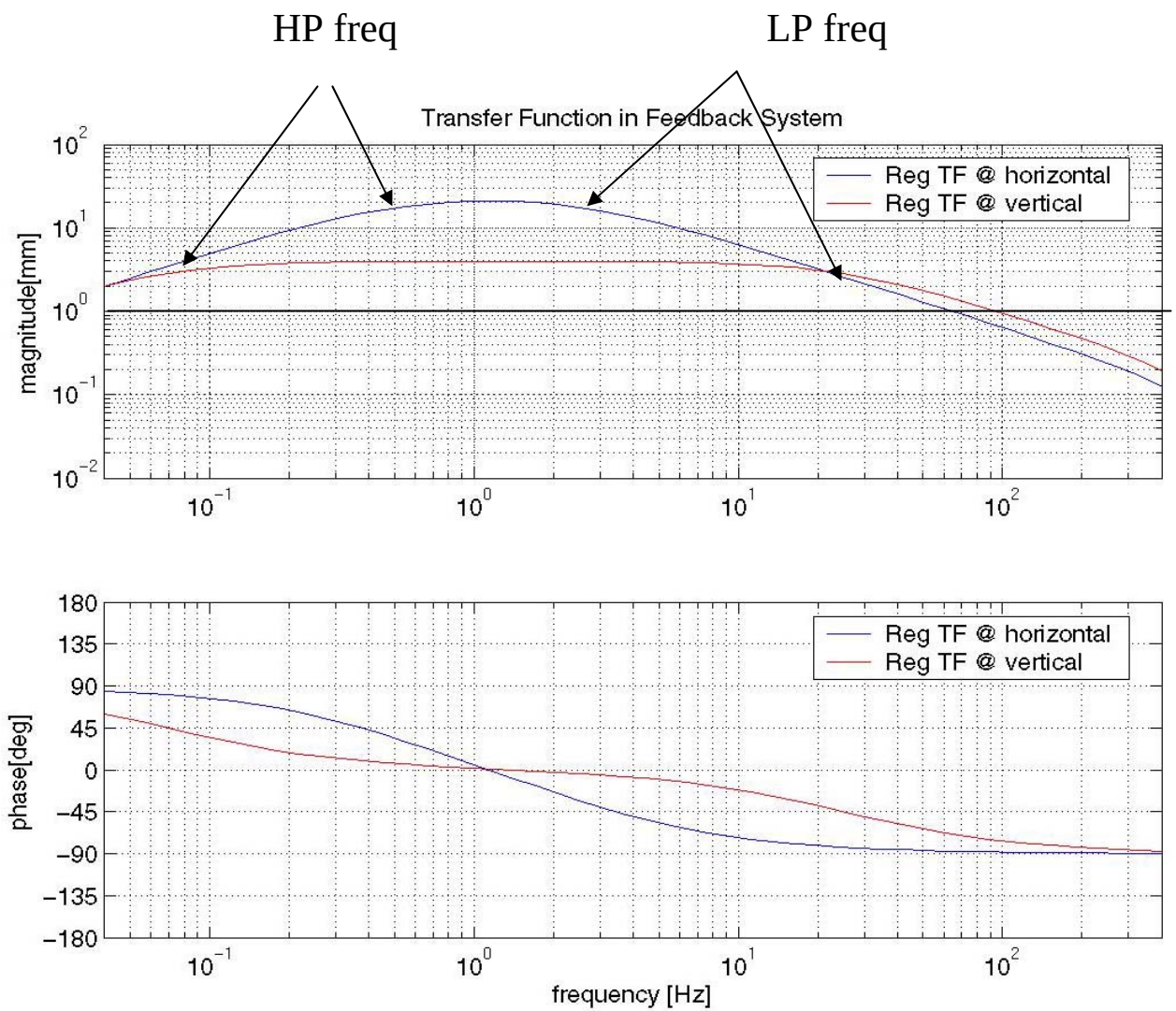
Measured in lab -
e-beam to nbBpm (cyan)– delay < 0.1 ms; 0.3 ms risetime
e-beam to 6 pole filter (blue) – delay > 1 ms; rise time = 1.4 ms





Corr TF = (1/1.54) . (0.43z+0.43)/(z.z-0.45.z)
Translates to 1 pole at ~100 Hz with ~ 0.7 ms delay

Regulator frequency response



Horizontal
Kp=25;HP=0.5Hz; LP=2.6 Hz
Vertical
Kp=4; HP=.07Hz; LP=25Hz

← unity gain line

Critical phase space – ~30 Hz to ~ 100 Hz

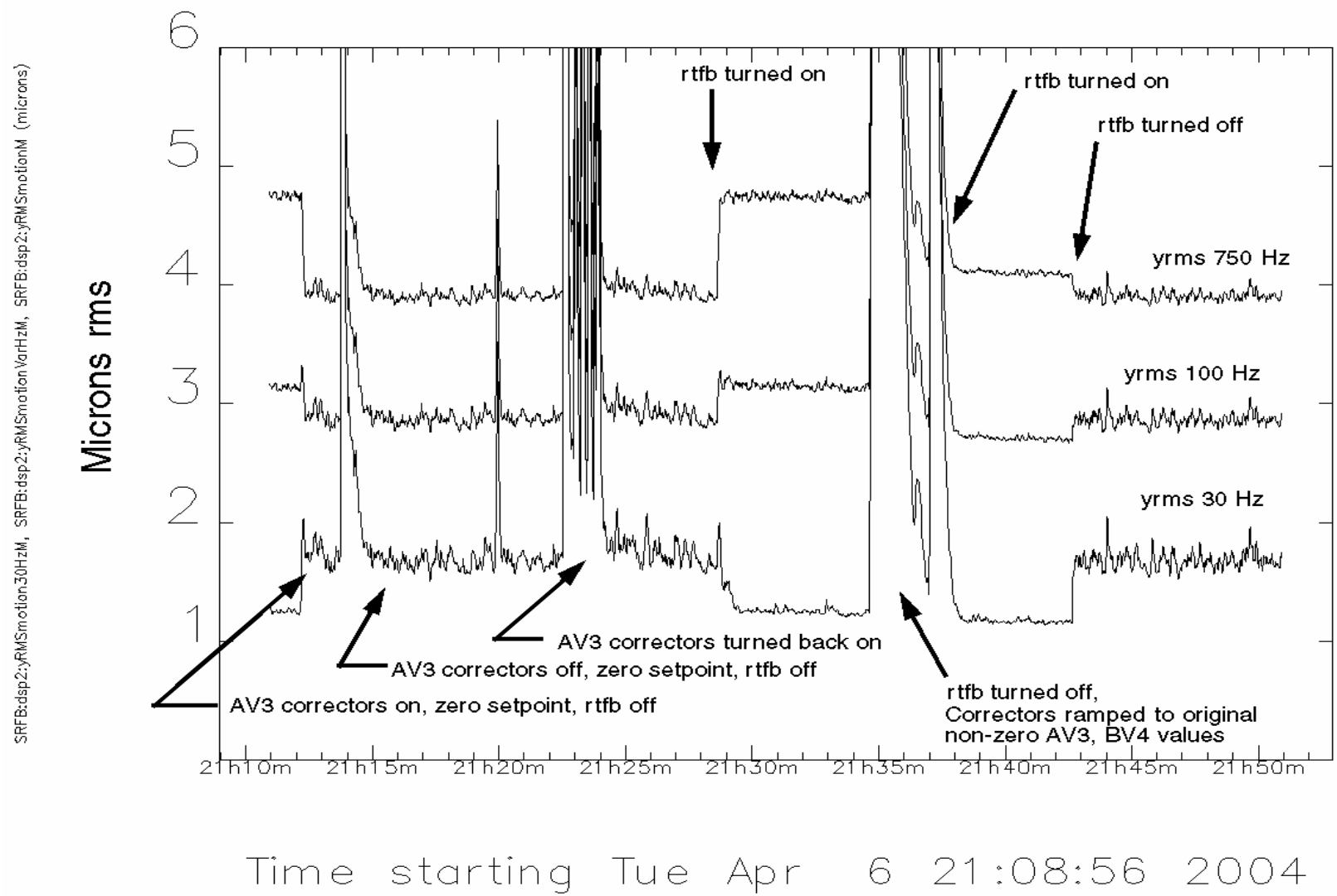
More positive phase is Better for stability in Criticall phase space

Phase budget table

Phase Budget @ 60 Hz – unity gain line (phase margin=135 deg)

system	mpBpm hor	mpBpm Vert	nbBpm hor	nbBpm Vert	
Corrector – 1 pole @ 100 Hz Delay of 0.75 ms	 11 16	 11 16	 11 16	 11 16	
FE electronics Present regulator	~0 85	~0 65	2 85	2 65	
Total without filter	112	92	114	94	
Per pole @ 300 Hz	na	na	11	11	
Total with 6 poles @ 300 Hz			180	160	

A:V3 power supply punch down experiment – Decker/Emery
(/home/helios/SR/daily/0404/06/2/orbitRestore/rmsNoise.png)

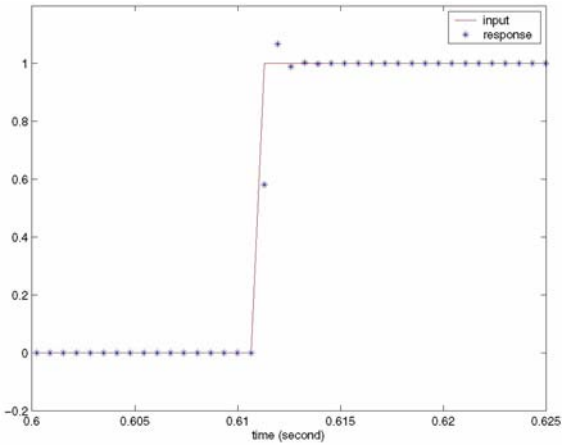


Step and Frequency Responses - Xiang

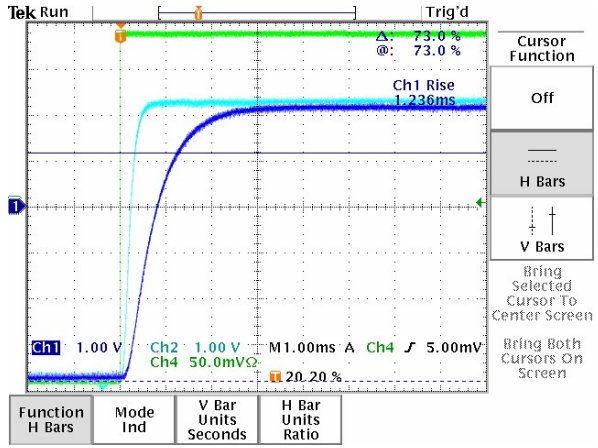
- **Following viewgraphs show step and frequency responses for various filter conditions.**

Step Responses

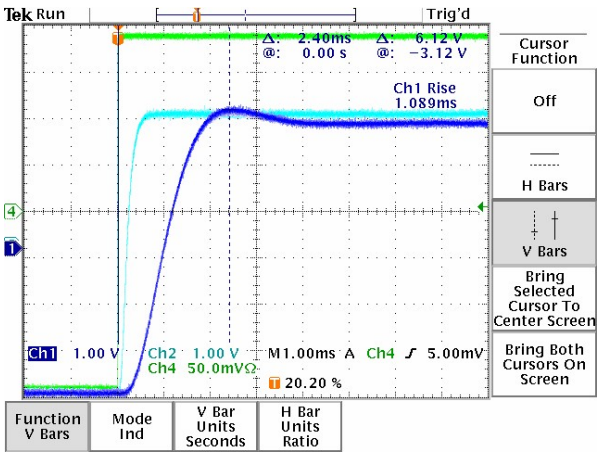
Simulated 1-pole chebyshev filter
1 tick=0.65 ms



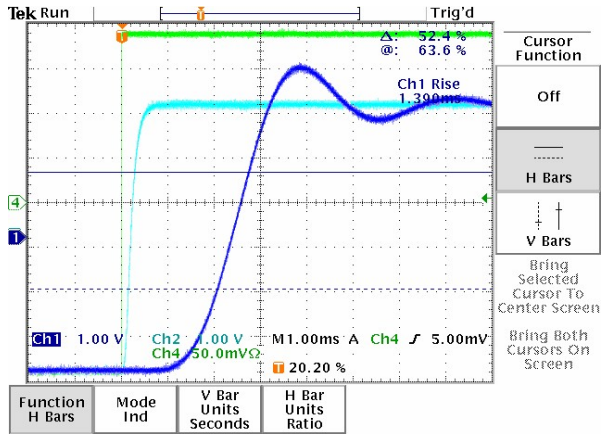
Nbbpm measured – 0/1 pole F
1 box = 1 ms



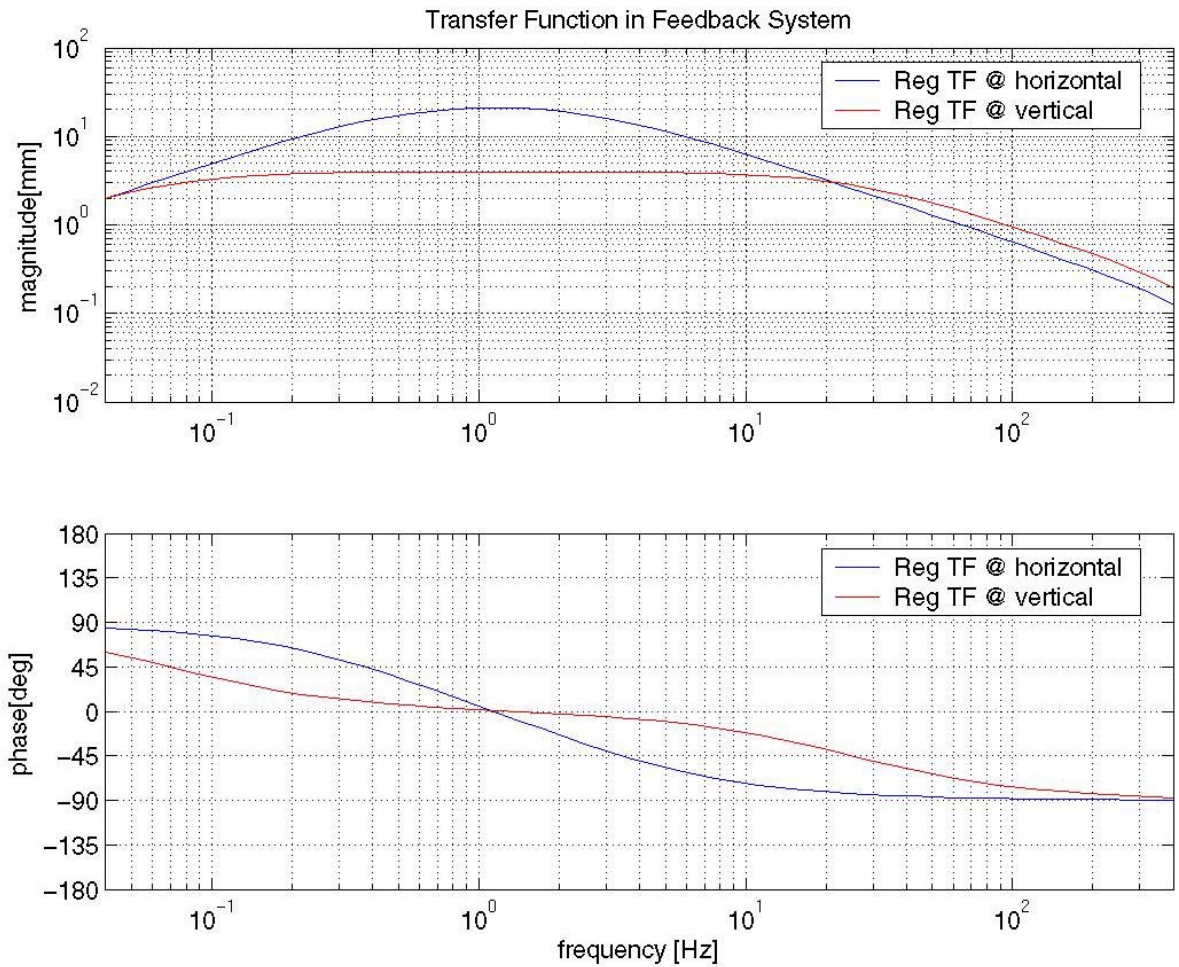
Nbbpm measured – 0/2 pole F



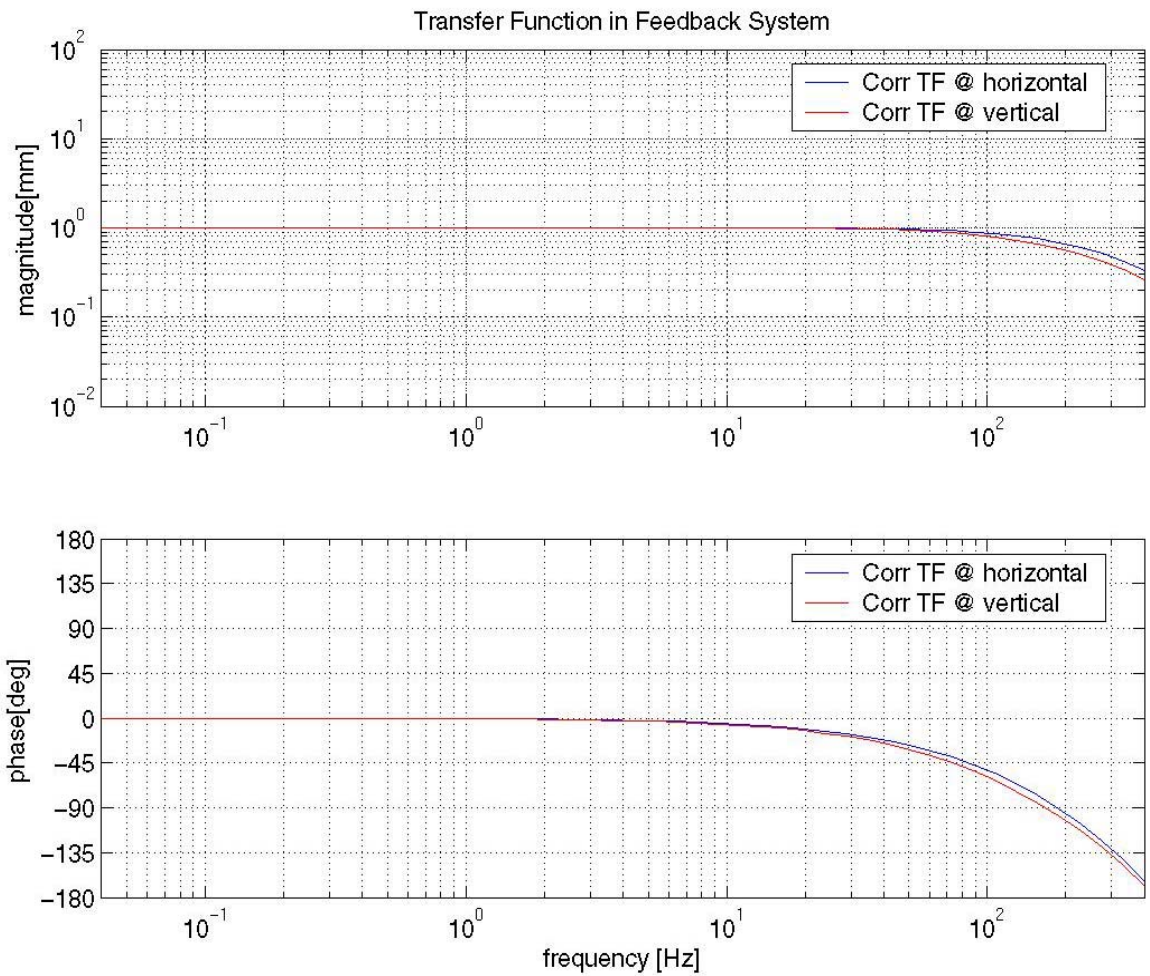
Nbbpm measured – 0/6 pole F



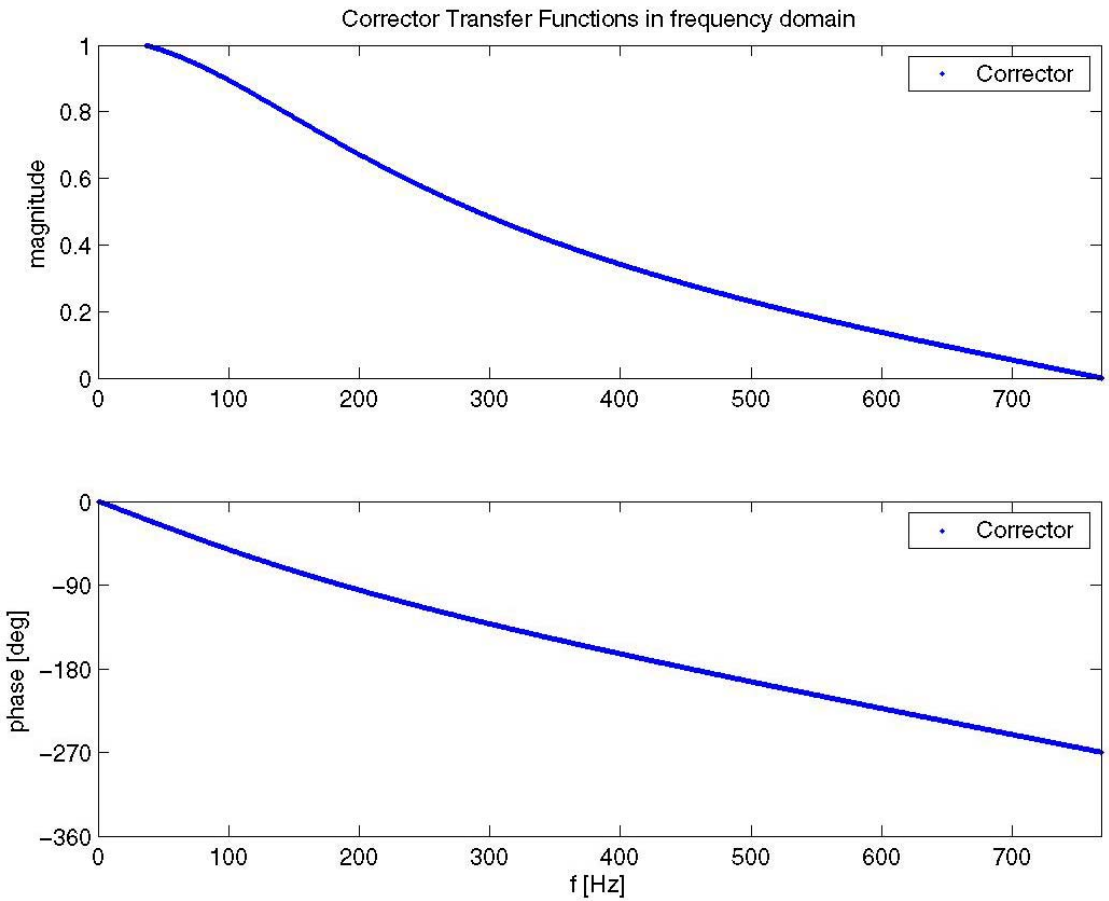
Regulator Response



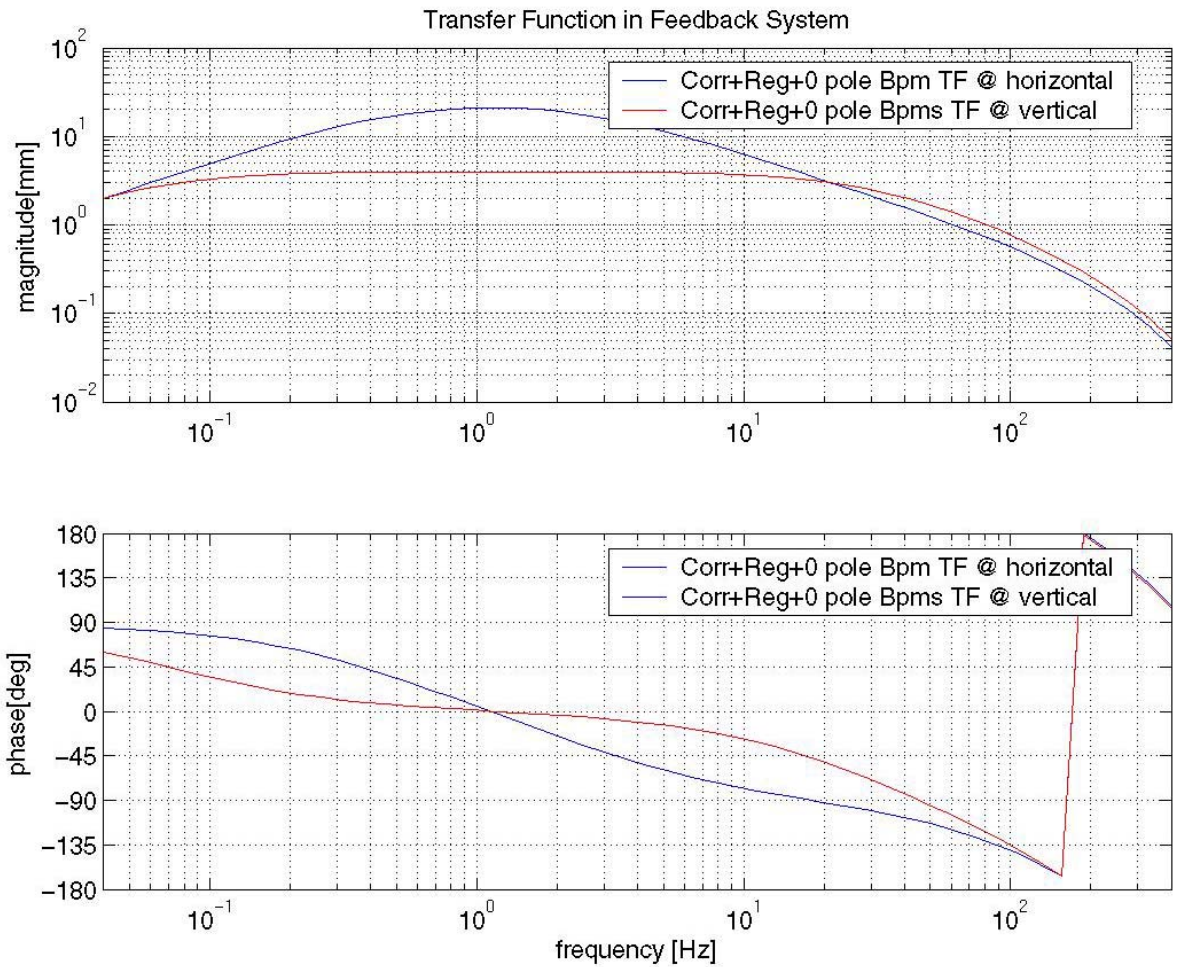
Corrector Response



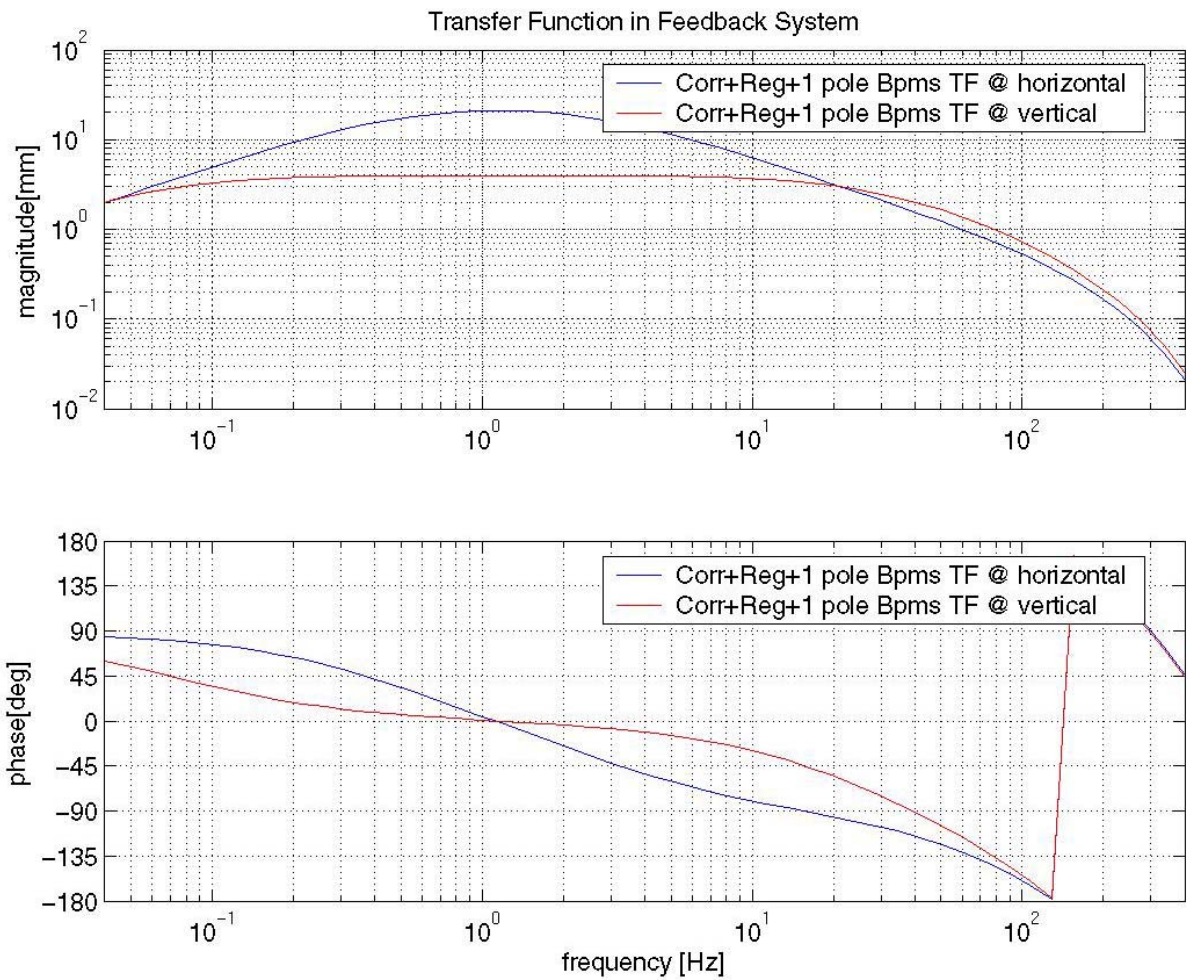
Corrector Response - linear



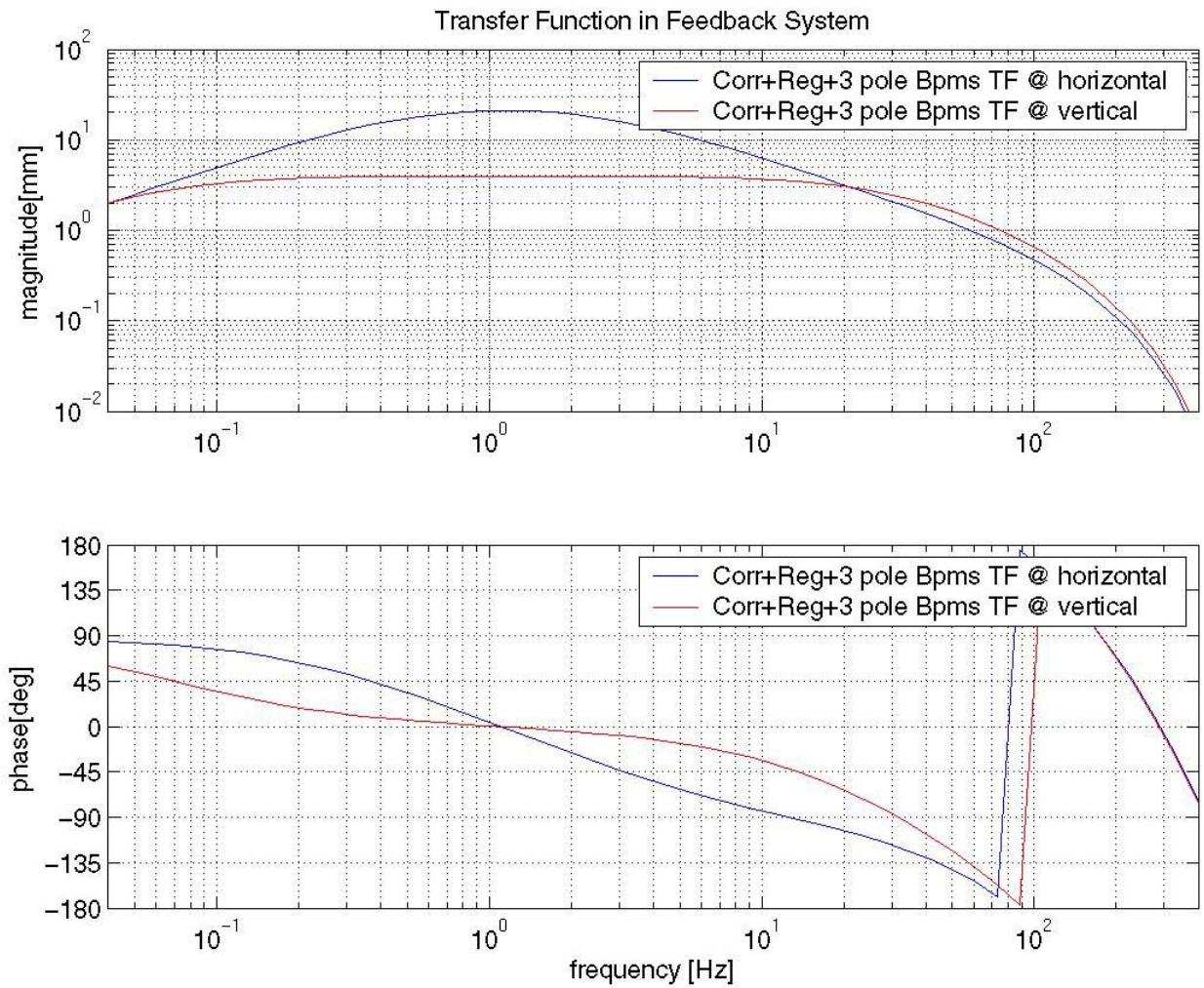
Overall Open Loop Response – 0 pole filter



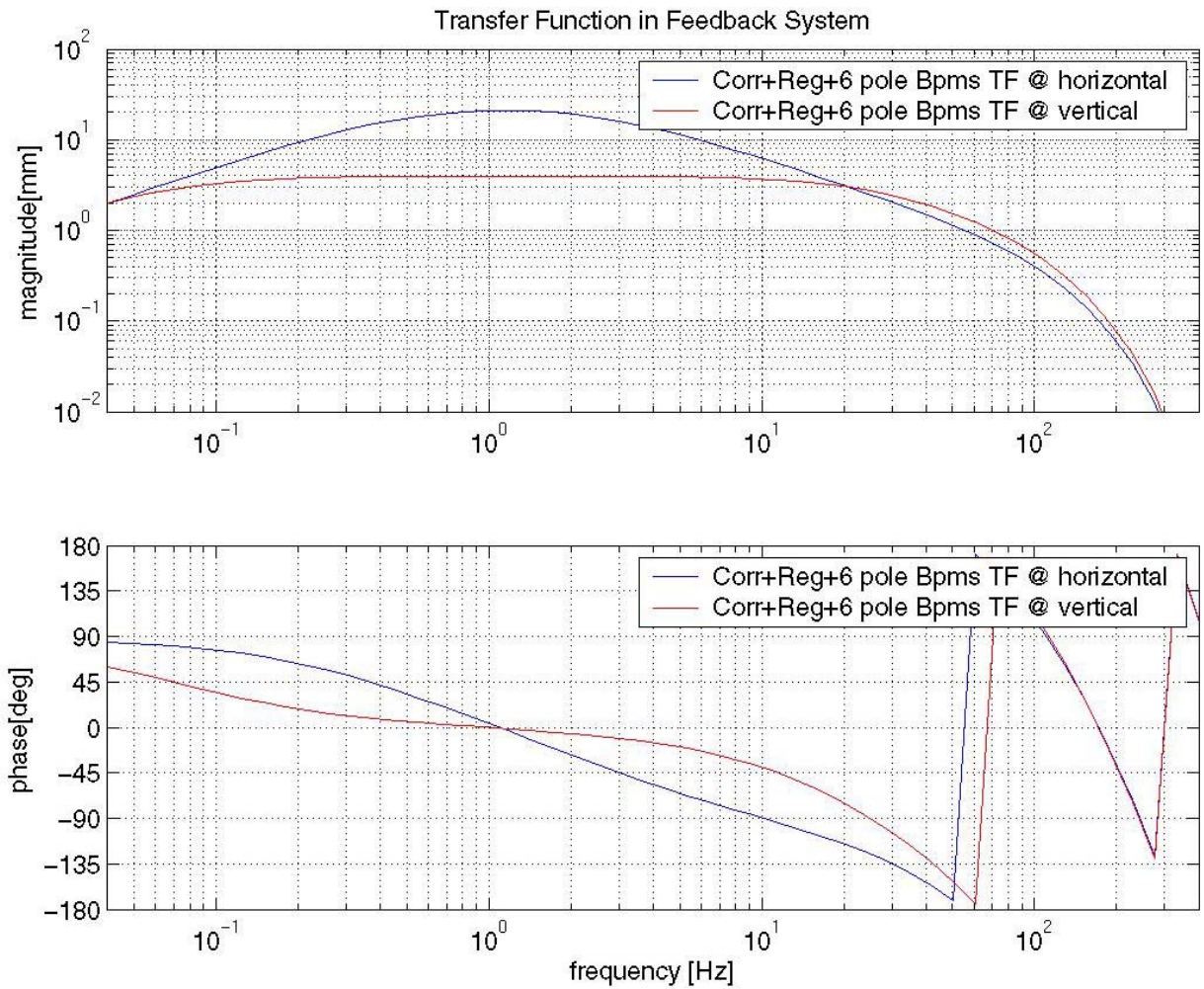
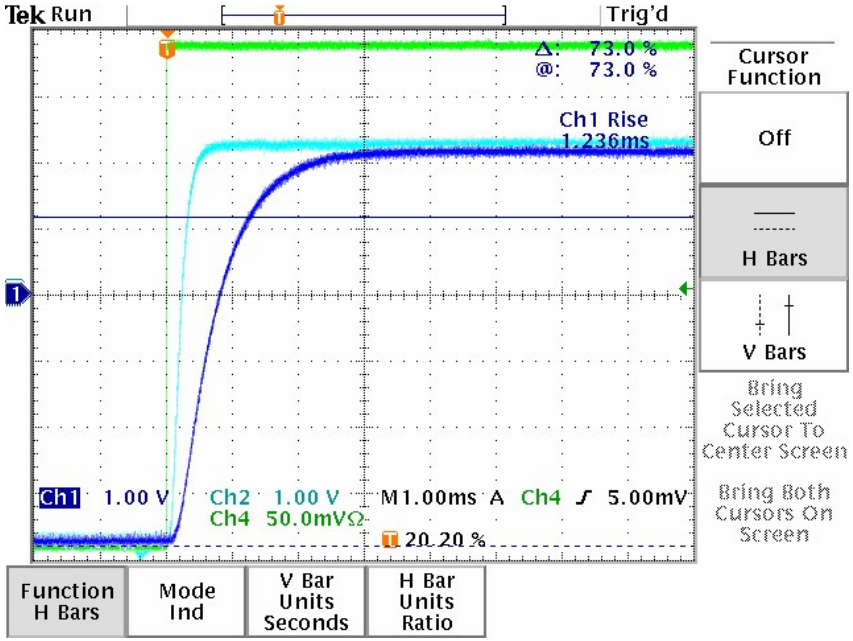
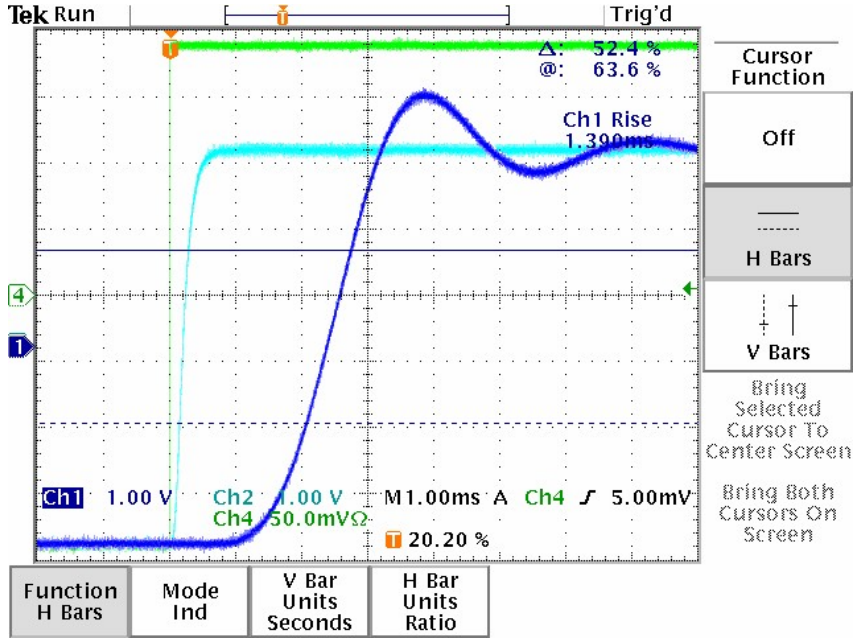
Overall Open Loop Response - 1 pole filter



Overall Open Loop Response – 3 pole filter



Overall Open Loop Response – 6 pole filter



Step Response – 0,1,6 pole