Optimal Filtering

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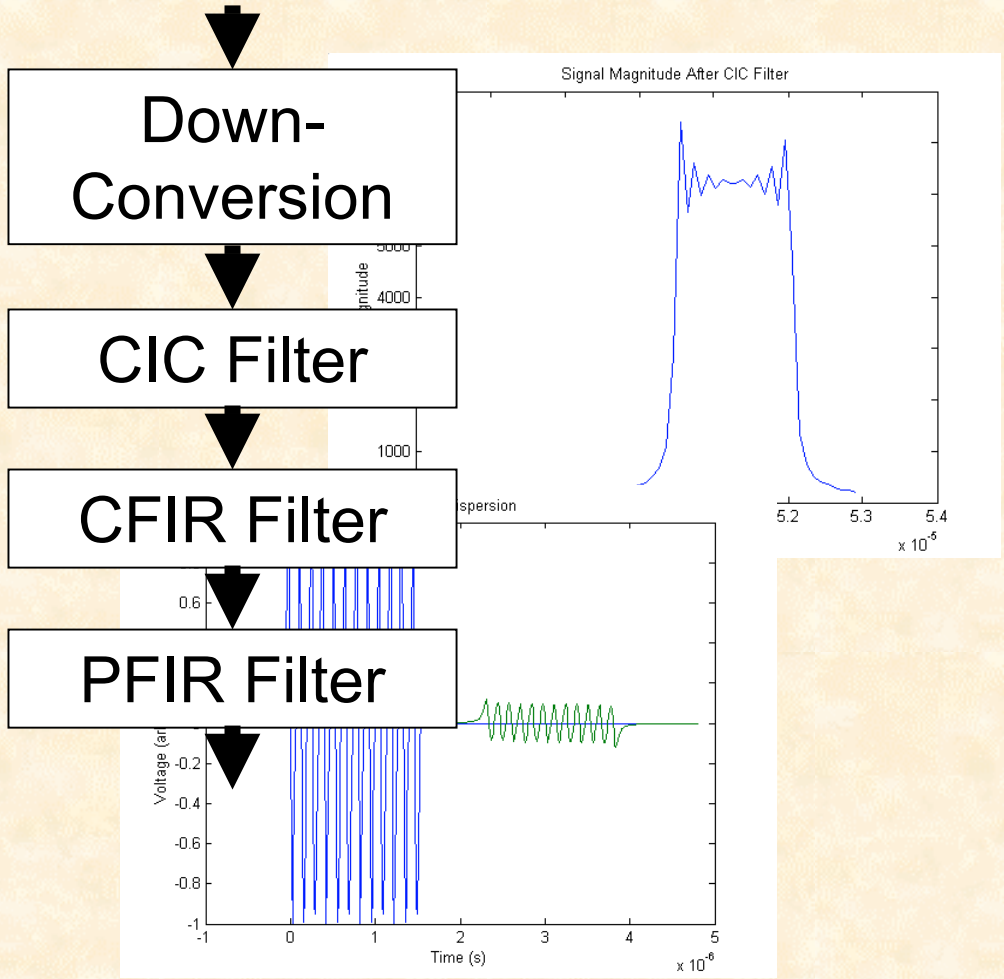
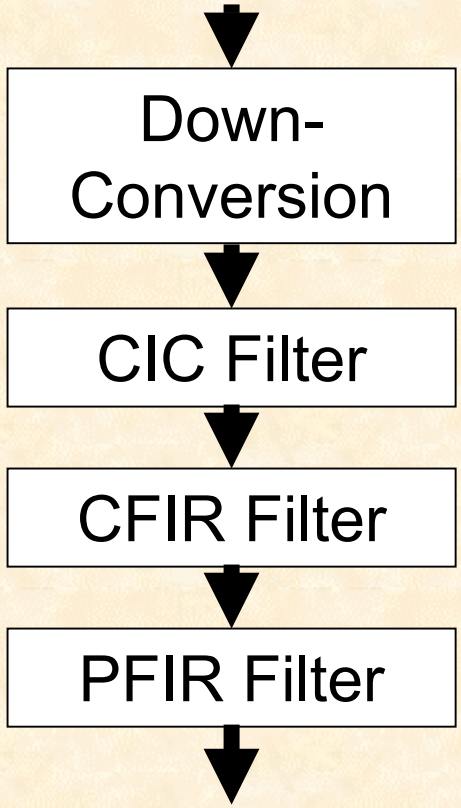
- Extract optimal information about beam position from left and right signals



Graychip Signal Processing

Fermilab

- Graychip down-converter shifts 2.5 MHz (7.5Mhz) to DC
- Acts as envelope detector
- Followed by three stage digital filter



Simulation

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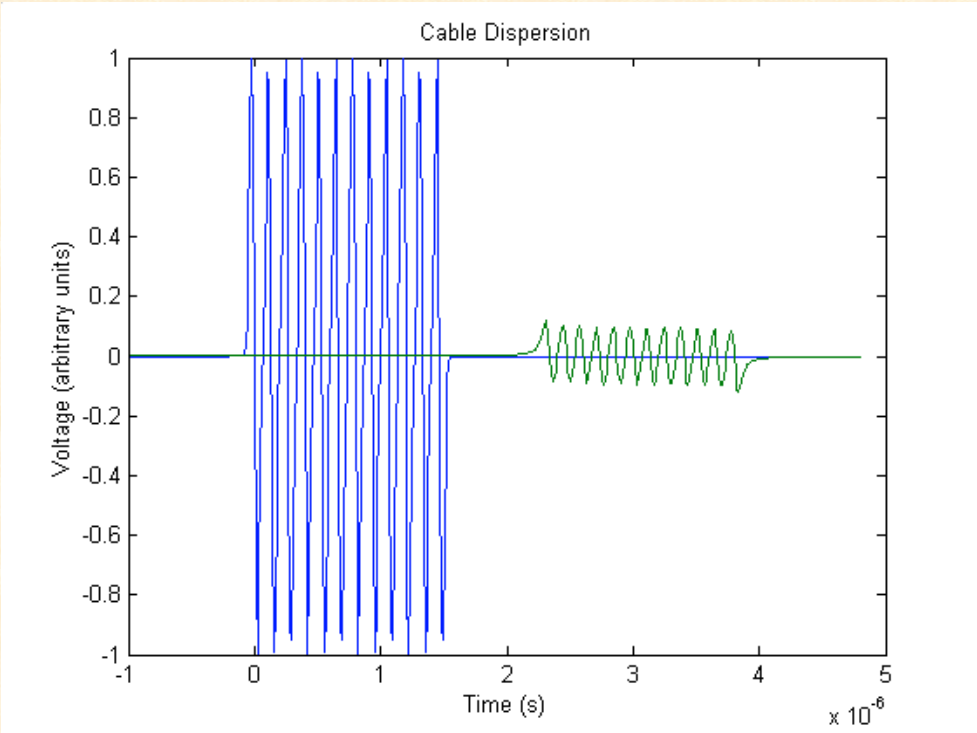
- Matlab simulation
  - Beam Induced signal
  - Cable Dispersion
  - Digitization
  - Graychip Signal processing



Optimal Filter

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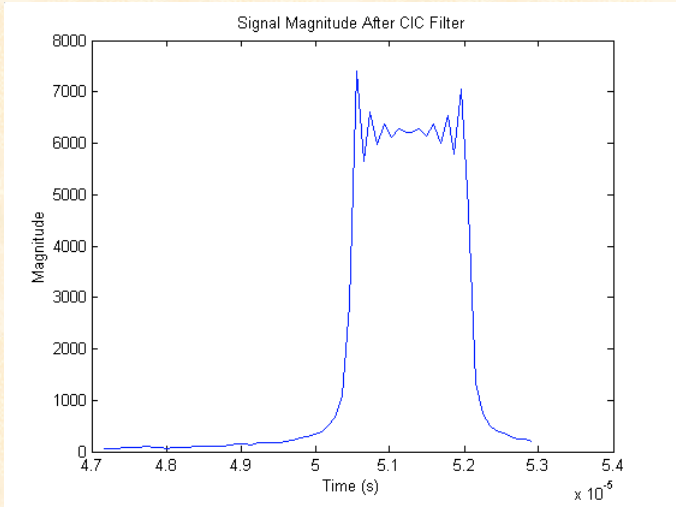
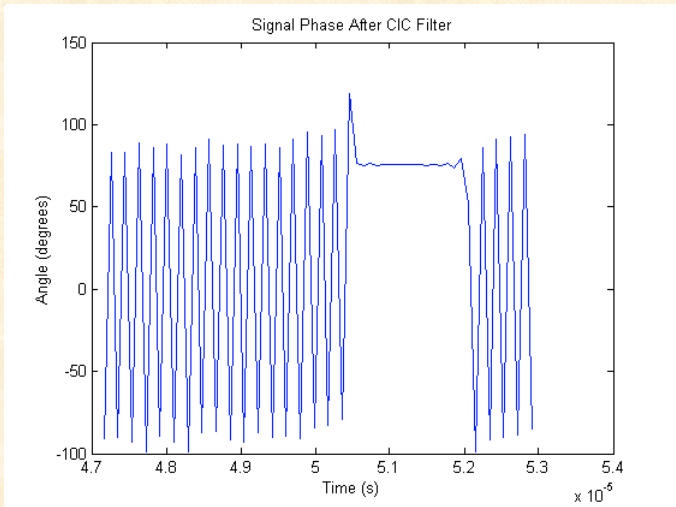
- Optimal Linear Filter – "Matched Filter"
  - Optimal detection of known signal in presence of noise
  - Maximizes signal to noise ratio
  - Equivalent to correlating input signal with known signal
- Output of envelope detection – square pulse
  - Correlate with square pulse of same duration





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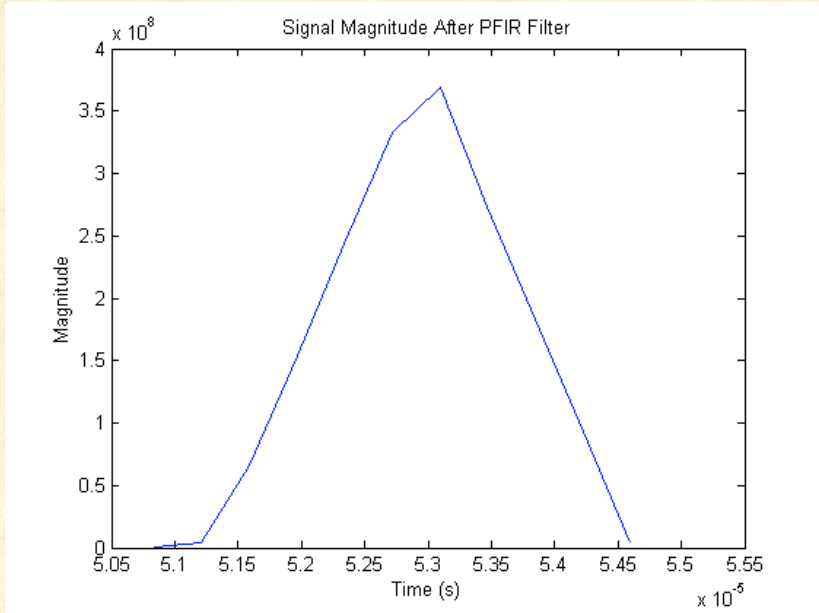
Optimal Filter

- Correlator can be implemented in the PFIR filter of Graychip
- Requires only one of the four available Graychip channels



Optimal Calibration

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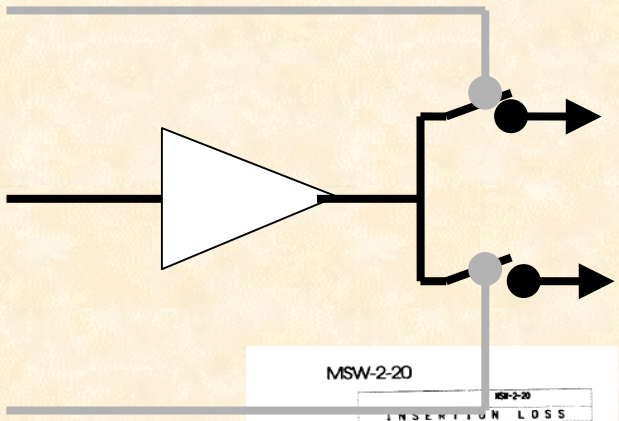
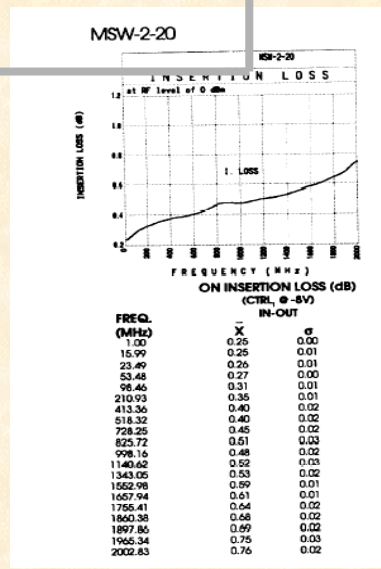
- Determine gain and offset for each channel
- Calibrate using a signal as close as possible to beam induced signal
- Match left and right channels as closely as possible





Existing Preamp

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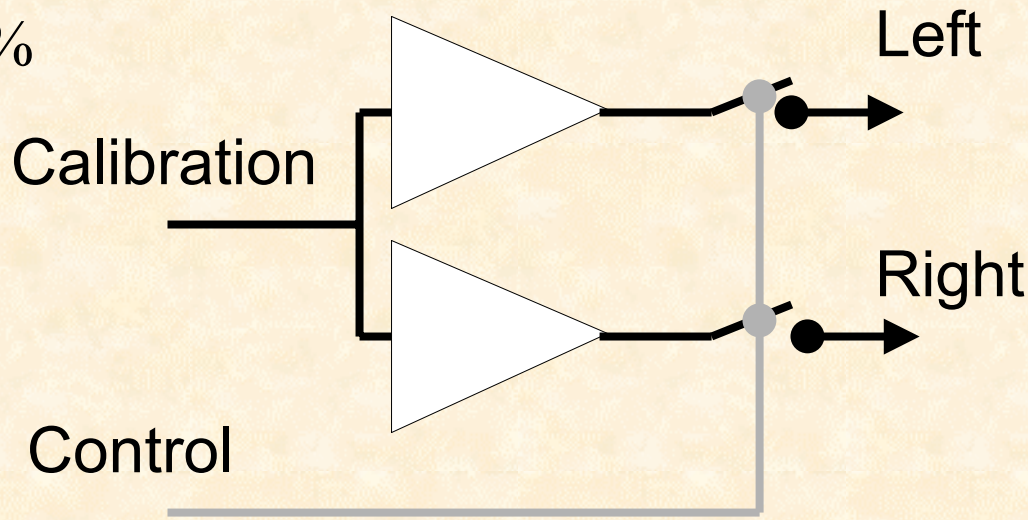
- Calibration fed to two channels separately
- Accuracy limited by 1% tolerance components



Improved Calibration

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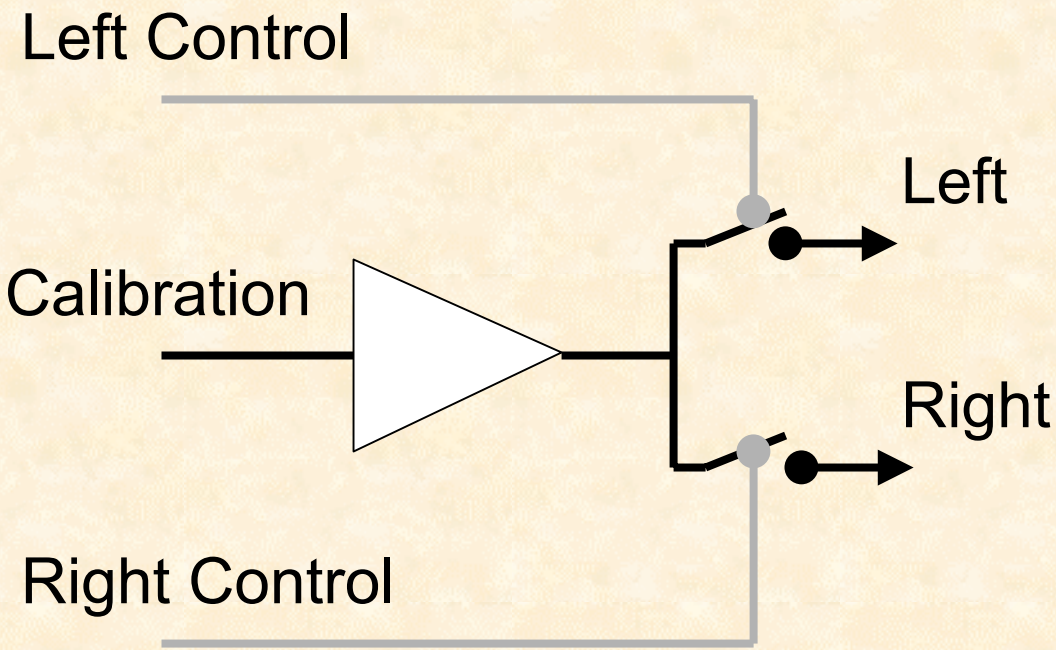
- Switch one signal between left and right channels
- Accuracy limited by the matching of insertion losses between the two switches



Switch Insertion Loss

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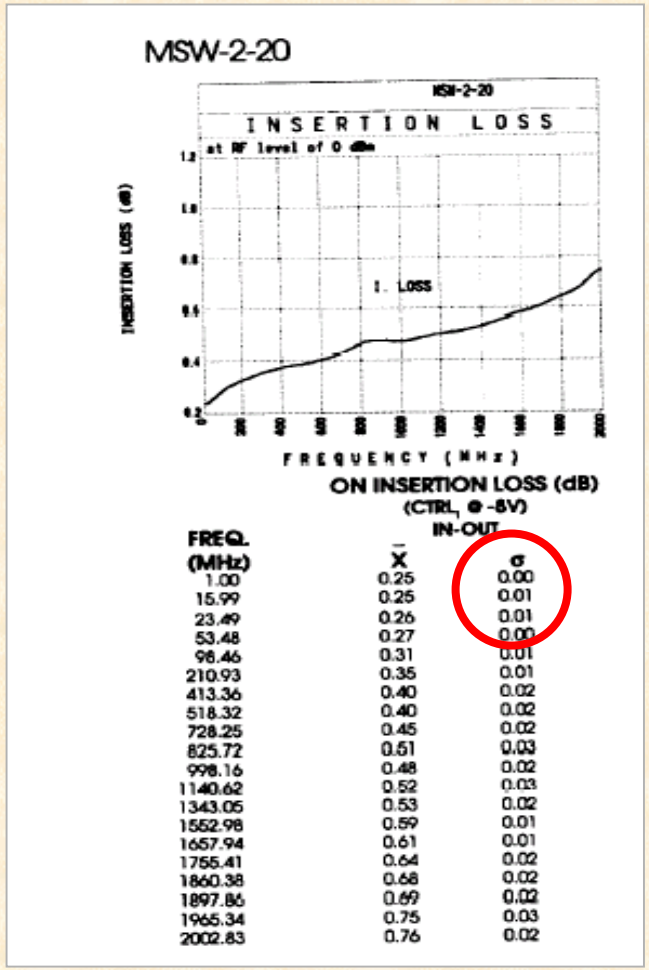
- Minicircuits MSW-2-20
  - Insertion Loss matched to 0.01 db or better between 1 and 15 MHz



FREQ. (MHz)	X̄	σ
1.00	0.25	0.00
15.99	0.25	0.01
23.49	0.26	0.01
53.48	0.27	0.00
98.46	0.31	0.01
210.93	0.35	0.01
413.36	0.40	0.02
518.32	0.40	0.02
728.25	0.45	0.02
825.72	0.51	0.03
998.16	0.48	0.02
1140.62	0.52	0.03
1343.05	0.53	0.02
1552.98	0.59	0.01
1657.94	0.61	0.01
1755.41	0.64	0.02
1860.38	0.68	0.02
1897.86	0.69	0.02
1965.34	0.75	0.03
2002.83	0.76	0.02

Waveform Generation

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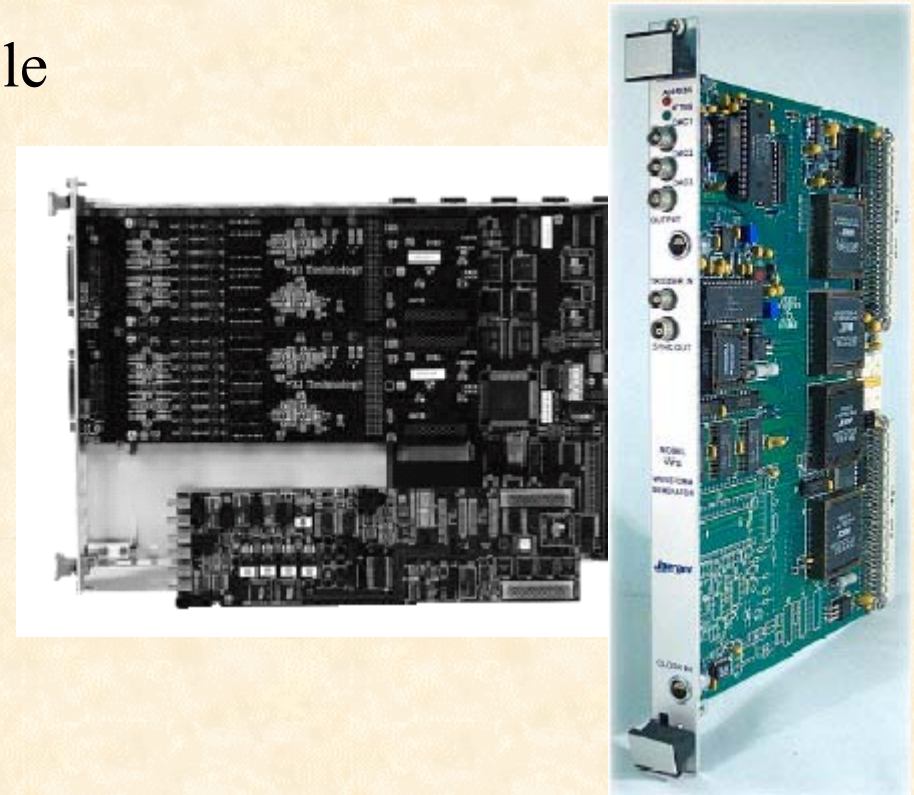
- Several VME arbitrary waveform generators available
  - Joerger VWG
    - 100 MHz 12-bit
  - VXI Technology VM3640
    - 50 MHz 12-bit



Timing

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- FIFO in Graychip can hold 16k samples
- Time to beam by searching FIFO for peak