Rastered Beam Position Reconstruction

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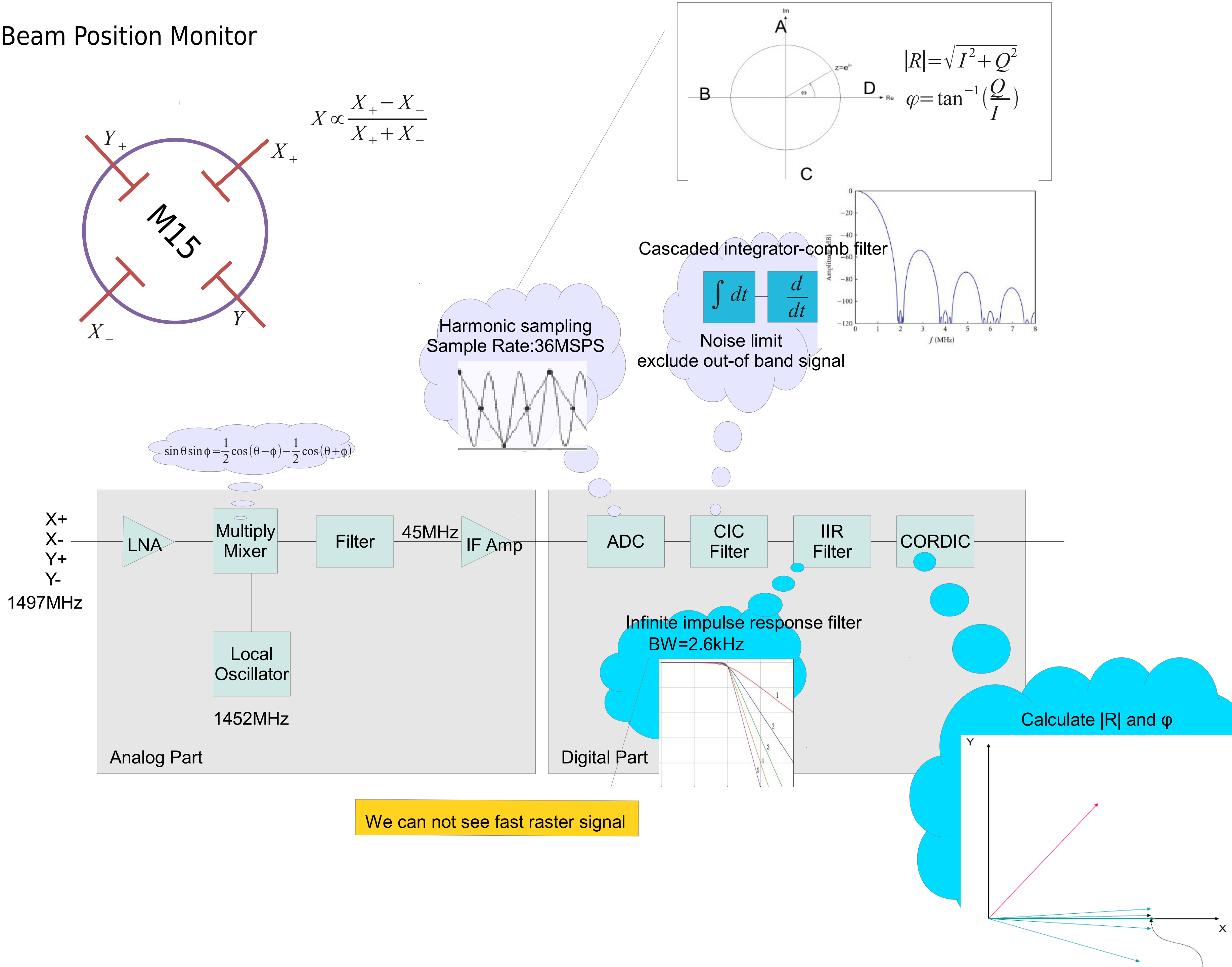
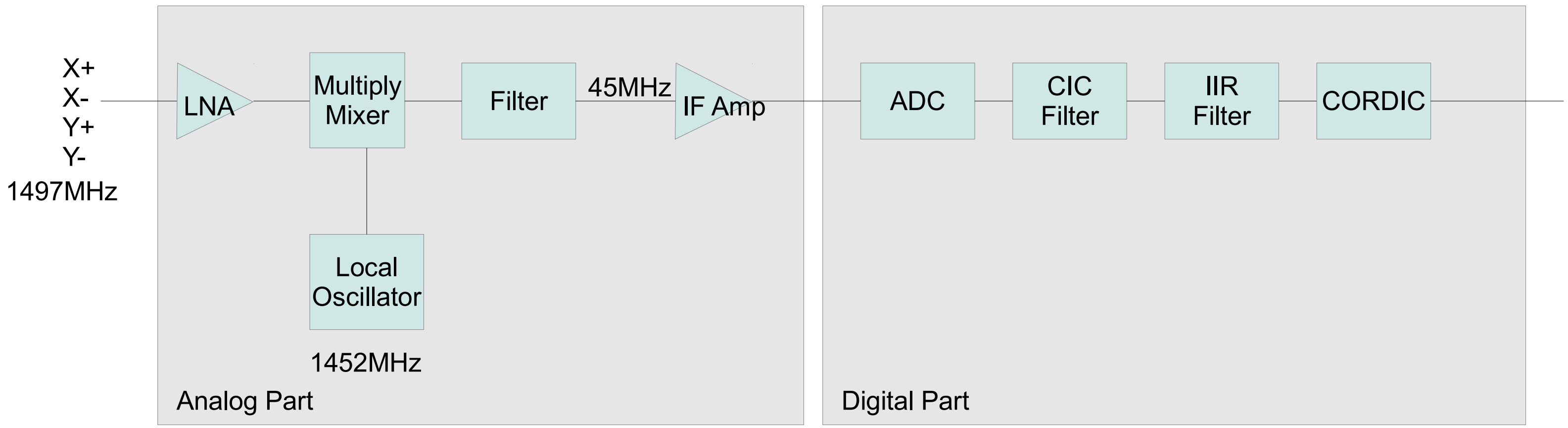
Beam Position Monitor



Signal Delay from BPM Receiver



Analog Delay < 1μs

$$Digital\ Delay(s) = \frac{1}{36\times10^{6}} + \frac{1}{1\times10^{6}} + \frac{1}{2.6\times10^{3}} + \frac{24}{36\times10^{6}} + \frac{1}{1\times10^{6}}$$

From ADC
Depends on Sample Rate

From Filter's Feedback

From Filter
Depends on Bandwidth

From Cordic

From Cordic's Feedback

This Delay time is fixed

To get this delay, there have 2 methods:

1. ask John Musson to give us this number
2. reconstruct the phase

Nonlinearity and x,y couple

Some nonlinearity need to be checked in event-by-event position reconstruction:

1. from raster magnet itself
2. from quadruple magnet

Beam Position Reconstruction

$$X=\langle X\rangle+X(I_{sr})+X(I_{fr})$$

<X> is average beam position in 1000~2000 events gotten from BPM
$X(I_{Sr}), X(I_{fr})$ is the position offset calculated by 2 rasters' current
If ignore linearity, $X(I_{sr})=m_{sr}\cdot(I_{sr}-\langle I_{sr}\rangle),\ X(I_{fr})=m_{fr}\cdot(I_{fr}-\langle I_{fr}\rangle)$

To get $X(I_{Sr})$ and $X(I_{fr})$, we need to do raster calibration

Slow Raster Calibration Procedure:

1. Change X shape to sin(ωt), close Y
2. Take data, Get relationship between BPM readout and slow raster current readout,BPM information need to take phase reconstruction
3. do the same thing as Y

Phase Reconstruction:

$$\begin{aligned}
&\textit{Raster Current}: && R_{im}=R_a\cdot\cos(\omega t_i)\\
&\textit{BPM value}: && B_{im}=B_a\cdot\cos(\omega t_i-\phi)+B_{off}\\
&\textit{True Position}: && B_{itrue}=B_a\cdot\cos(\omega t_i)+B_{off}
\end{aligned}$$

$$|\phi|=2\arctan\sqrt{\frac{\sum_{i=1}^{N}\left[\frac{R_{im}}{R_a}-\frac{B_{im}-B_{off}}{B_a}\right]}{\sum_{i=1}^{N}\left[\frac{R_{im}}{R_a}+\frac{B_{im}-B_{off}}{B_a}\right]}}$$

$$\omega t_i=\arccos\left(\frac{R_{im}}{R_a}\right)$$

Phase Reconstruction at BPM