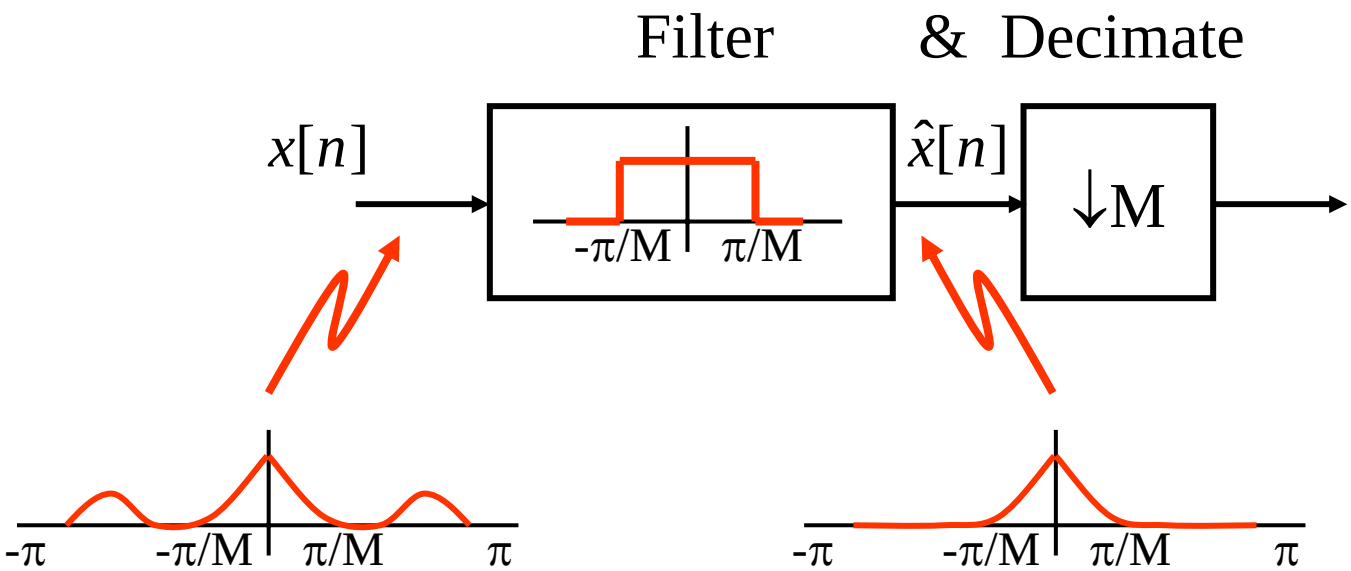
Linear Filtering
and Decimation & Expansion

Need for Filtering – Decimation

Recall: M-Fold Decimation has no aliasing if original signal is an "Mth Band signal"

➔Usually need to ensure this before decimating

➔Pre-filter w/ M-Band D-T LPF (i.e. a D-T anti-alias filter)

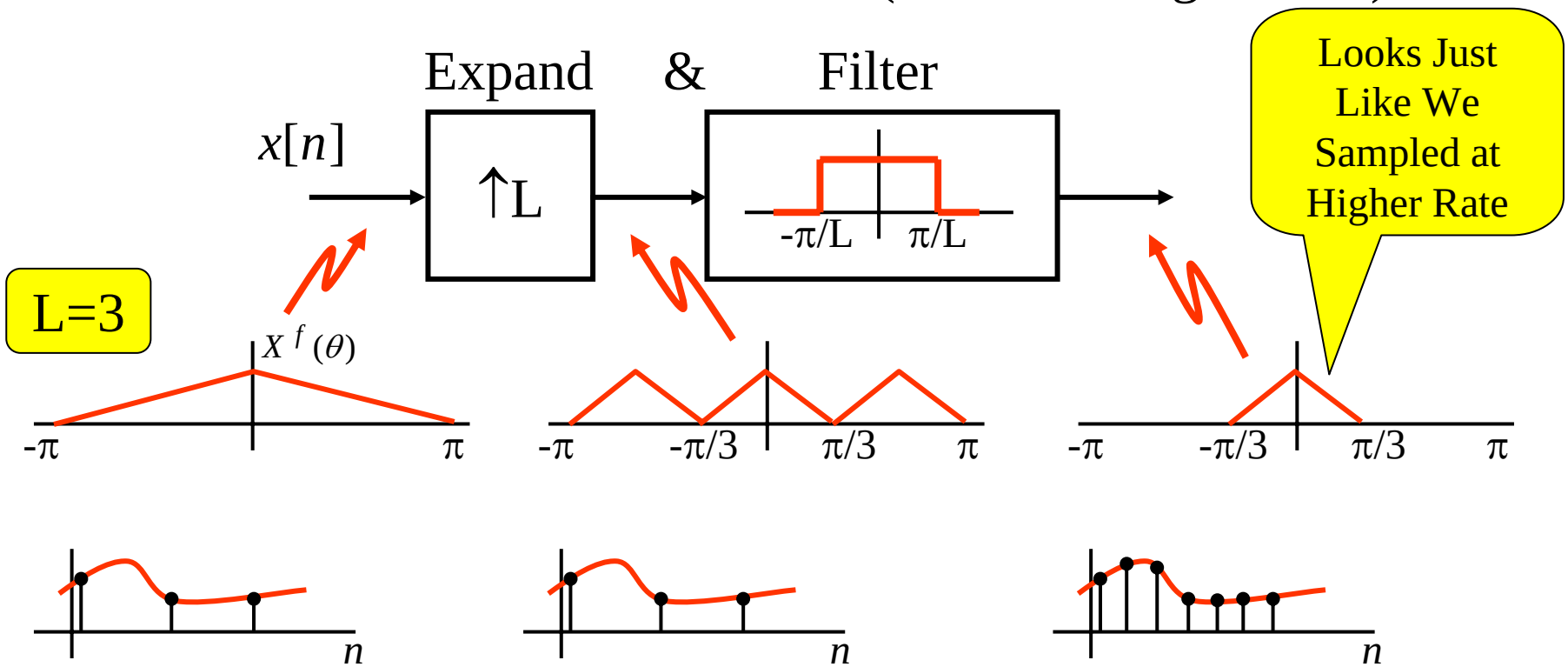


Need for Filtering – Expansion

Recall: Expansion leaves high frequency images that shouldn't be there

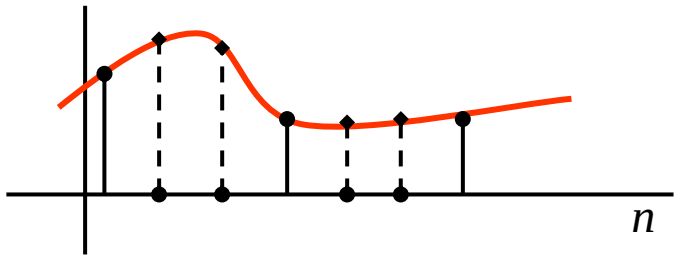
➔Need to remove these after expanding

➔Post-filter w/ L-Band D-T LPF (an "anti-image" filter)



Need for Filtering – Expansion (cont.)

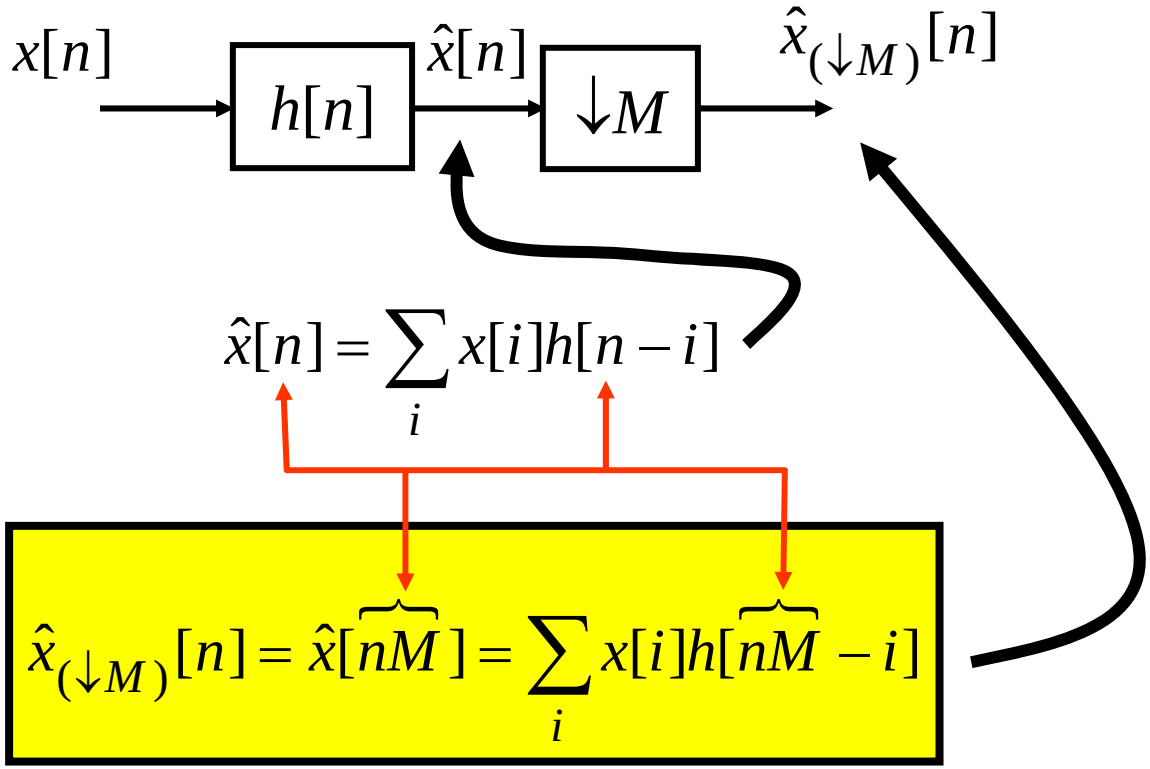
So… the ideal post-filter converts the inserted zeros into interpolated samples:



➔ Expansion-Filtering is called “Interpolation”

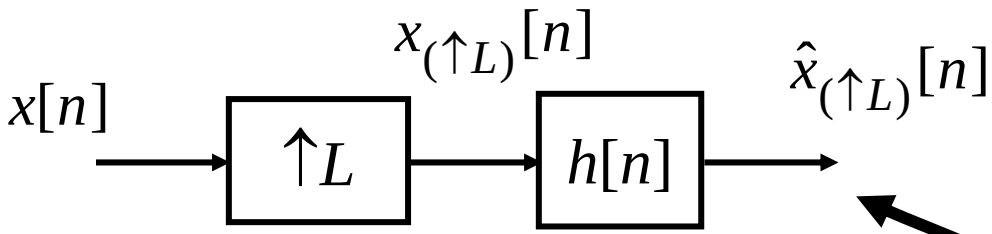
Time-Domain Description – Filter/Decimate

To get a time-domain description of filter/decimate:



Time-Domain Description – Expand/Filter

To get a time-domain description of expand/filter:



$$\hat{x}_{(\uparrow L)}[n] = \sum_i x[i]h[n - Li]$$

We'll see later were this comes from

Staggered Input Index

Staggered Output Index

Compare to filter/decimate:

$$\hat{x}_{(\downarrow M)}[n] = \sum_i x[i]h[nM - i]$$