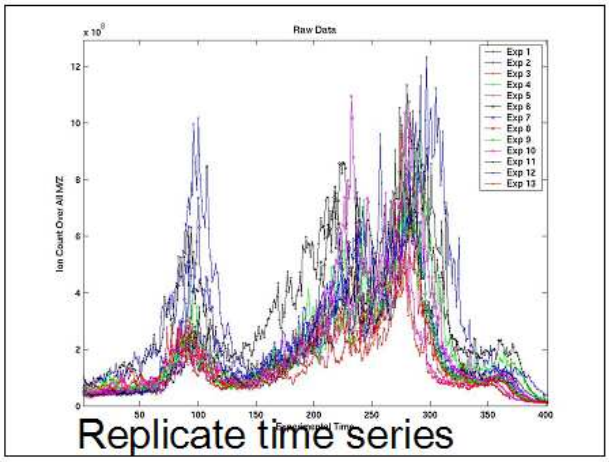
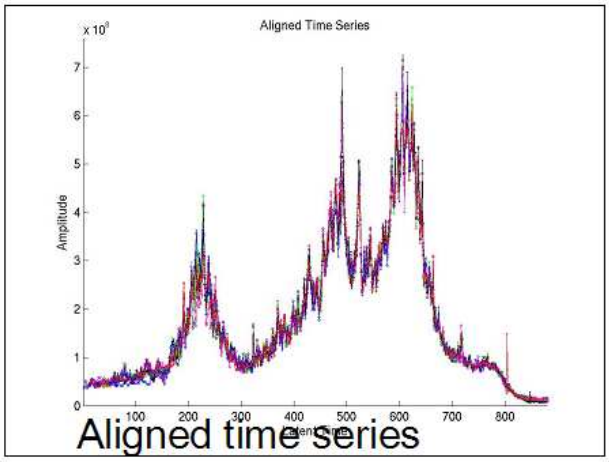
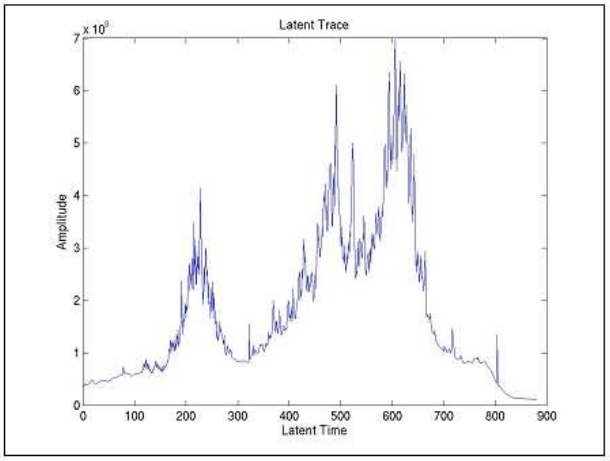
Problem Set-Up



Replicate time series



Aligned time series

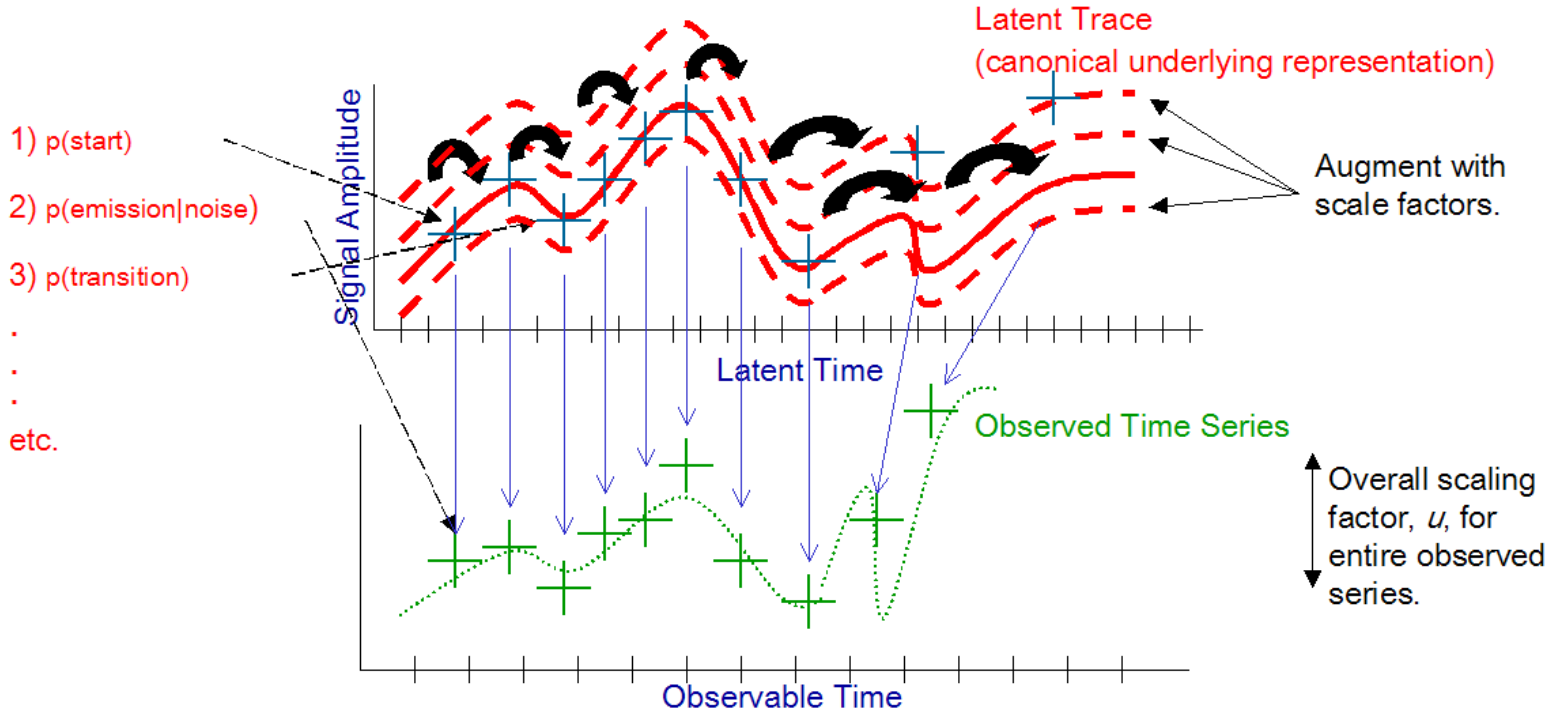


Data fusion:
canonical representation

Continuous Profile Model (CPM)

A generative model for replicate time series data:

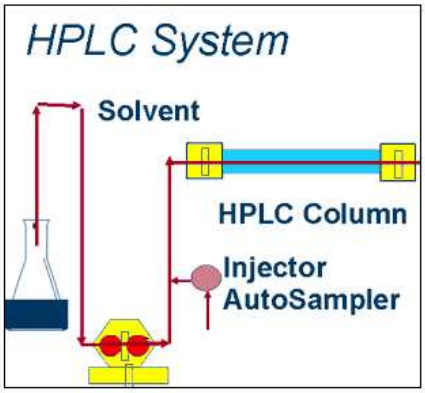
- Each observed time series is a non-uniformly sub-sampled version of a single latent trace.
- Local re-scaling and additive noise are applied to samples.

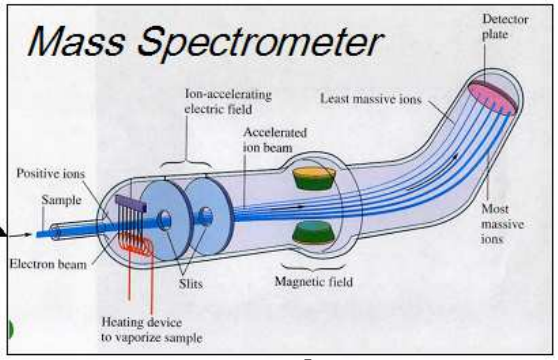


HPLC-MS Experiments

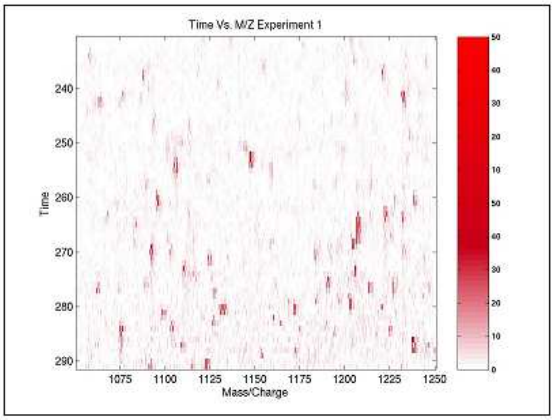
(High Pressure Liquid Chromatography – Mass Spectrometry)

e.g., Blood Sample

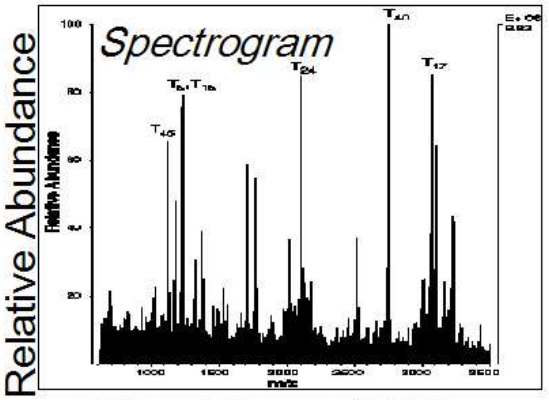




At each time point



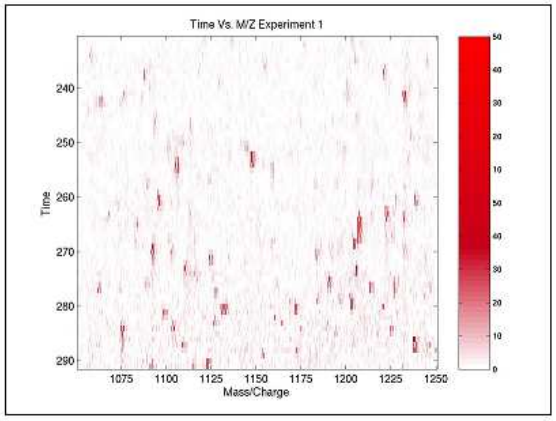
Time off HPLC



Over all time points (e.g., an hour)

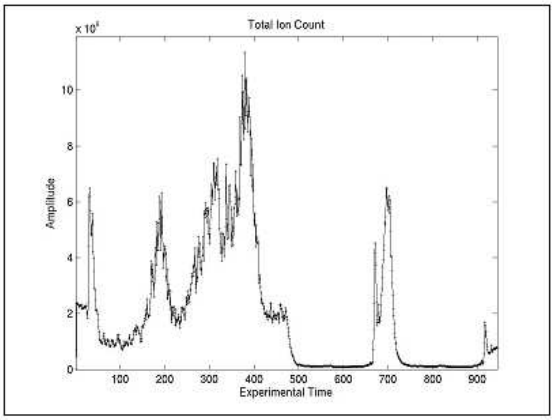
HPLC-MS Total Ion Count

- Collapse 2D time series data to 1D by summing out over all M/Z, at each time point
- Called the *Total Ion Count* (TIC).
- This was done for use with CPM.

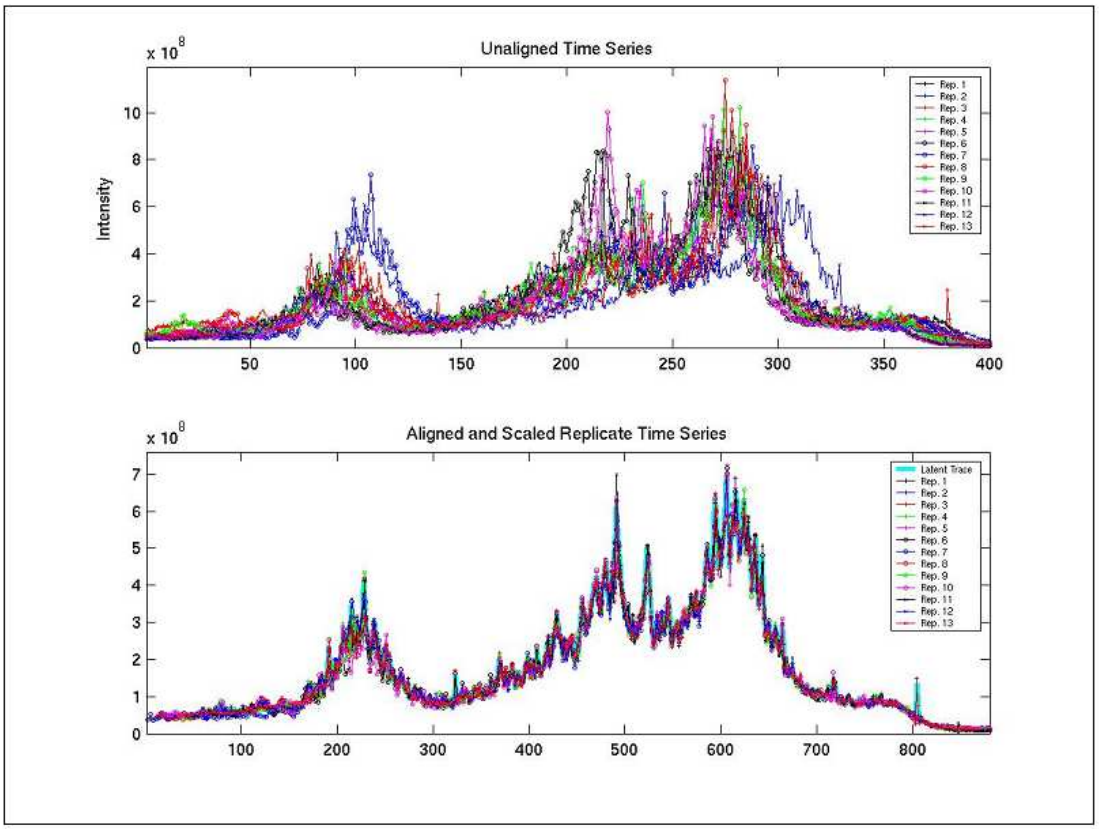


sum out all M/Z

at each time point

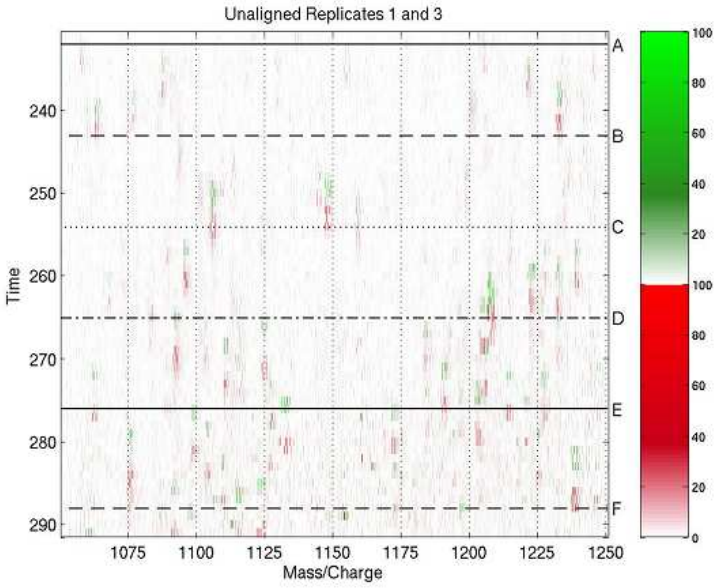


HPLC-MS Total Ion Count Alignments

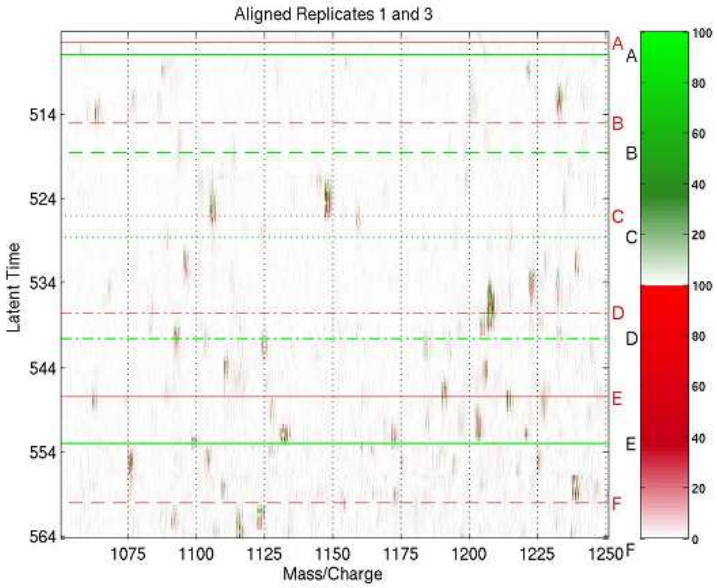


- Trained CPM using 13 replicates.
- Initialized latent trace with one experimental time series, plus noise.
- After training the model, aligned each time series to latent trace using Viterbi (most likely path).

Two-Dimensional HPLC-MS Alignments

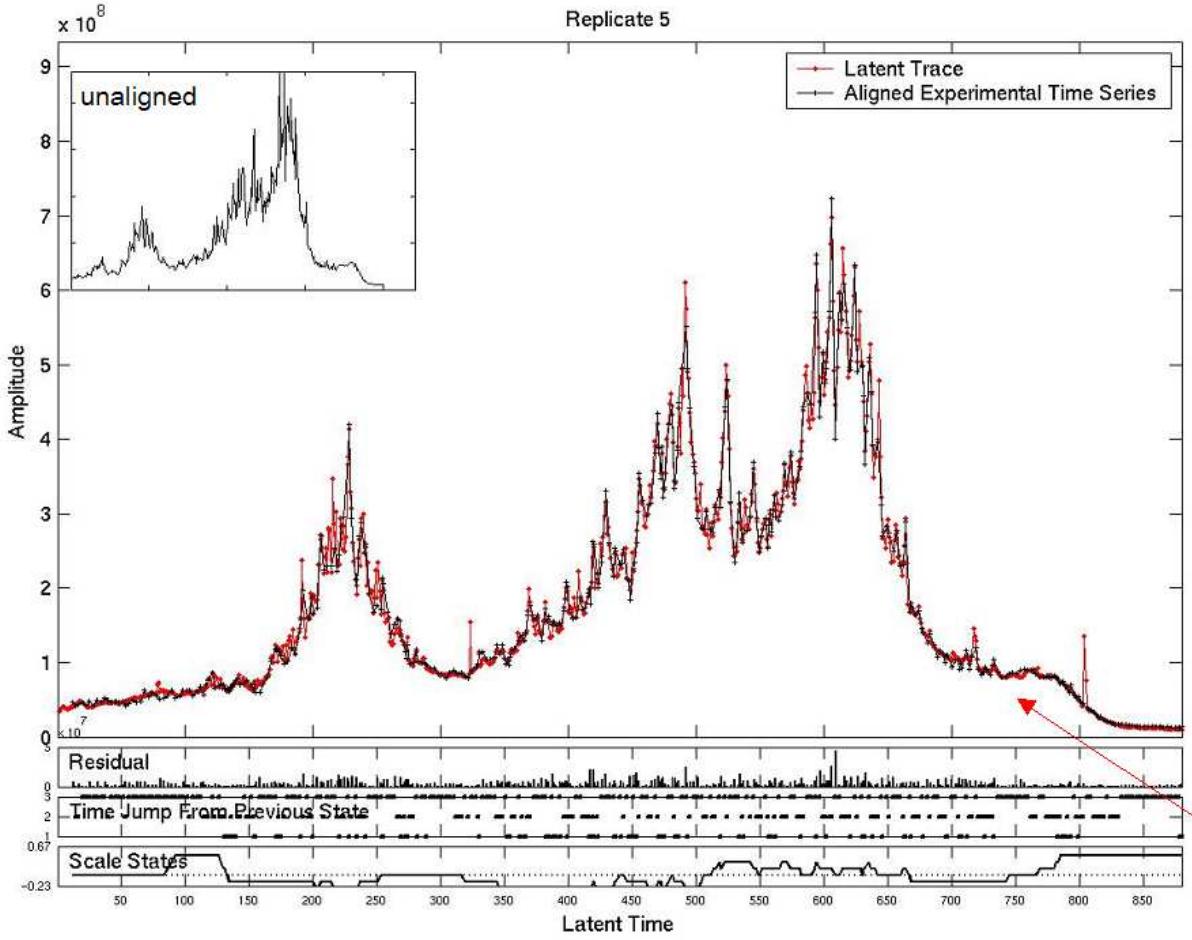


Unaligned



Aligned

HPLC-MS Individual Viterbi Alignment



Model parameters after training:

Time state transitions:

$p^k(\tau_i = a|\tau_{i-1} = b) =$
[.2992, .3386, .3622]

Scale state transitions:

$p(\phi_i = a|\phi_{i-1} = b) =$
[0.72, 0.28]

Scale-centering param:

μ^k=1.1640

Noise Level:

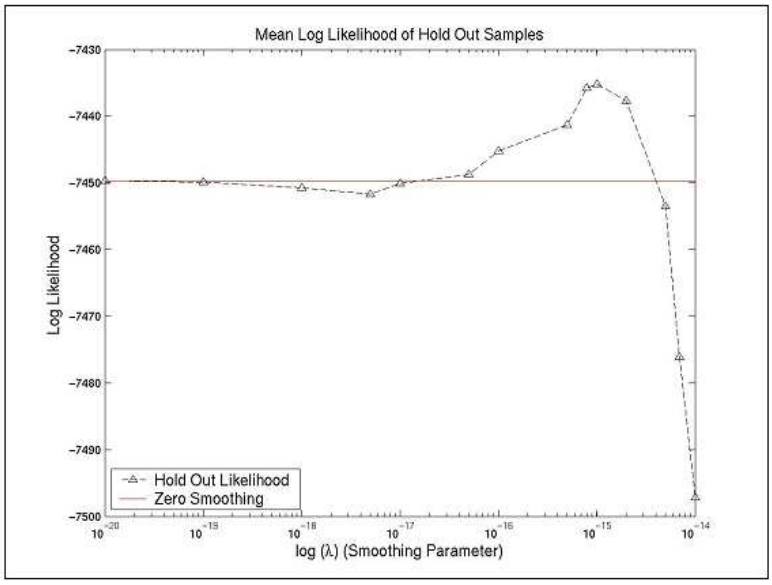
σ=2.1e+02

Latent Trace:

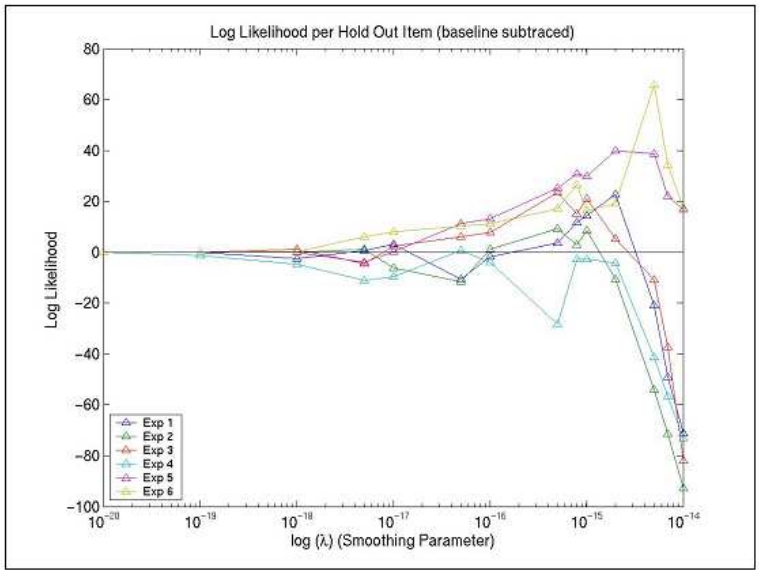
see figure

Cross-Validation Over Smoothing Parameter

Leave-one-out CV for six TICs:



Mean hold out likelihood



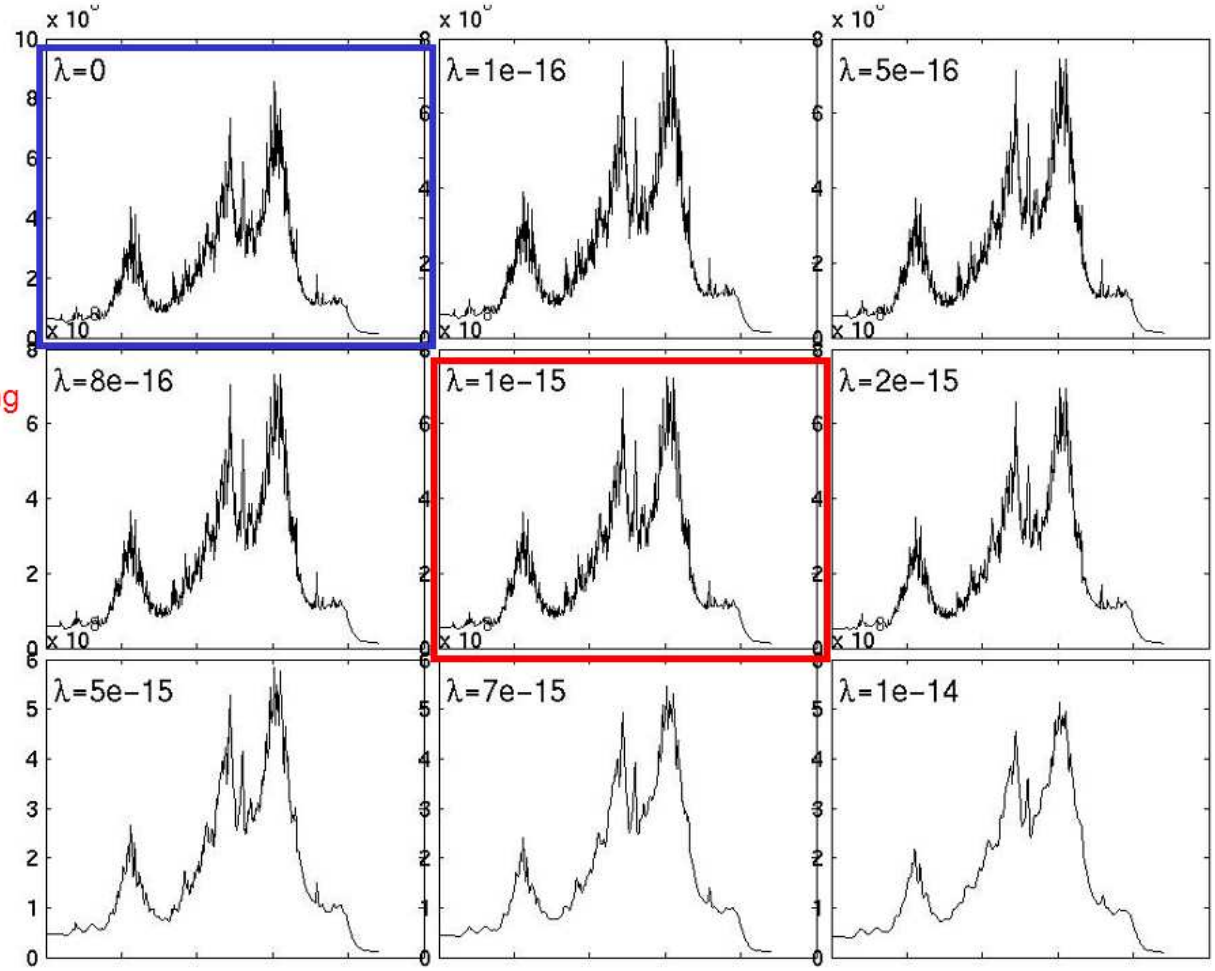
Individual hold out (with no smoothing at zero).

Cross-Validation Over Smoothing Parameter

No smoothing

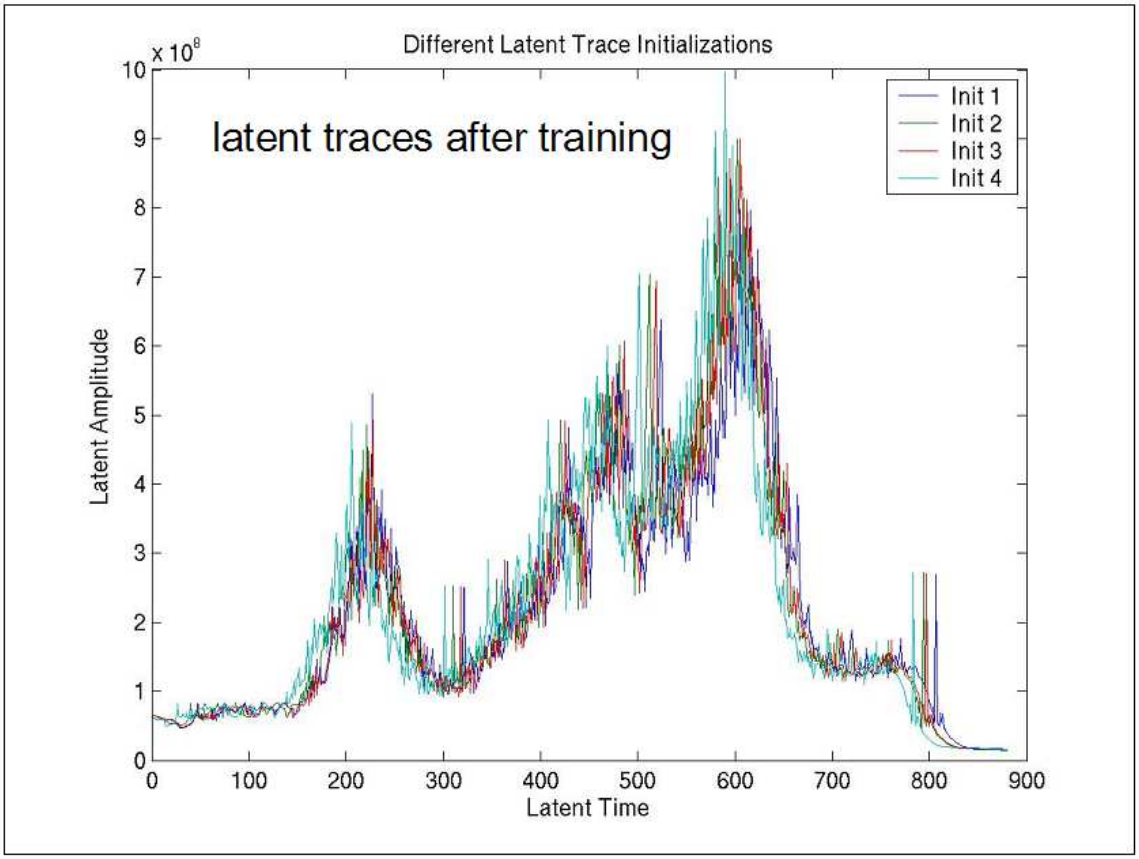
Optimal smoothing

Too much smoothing



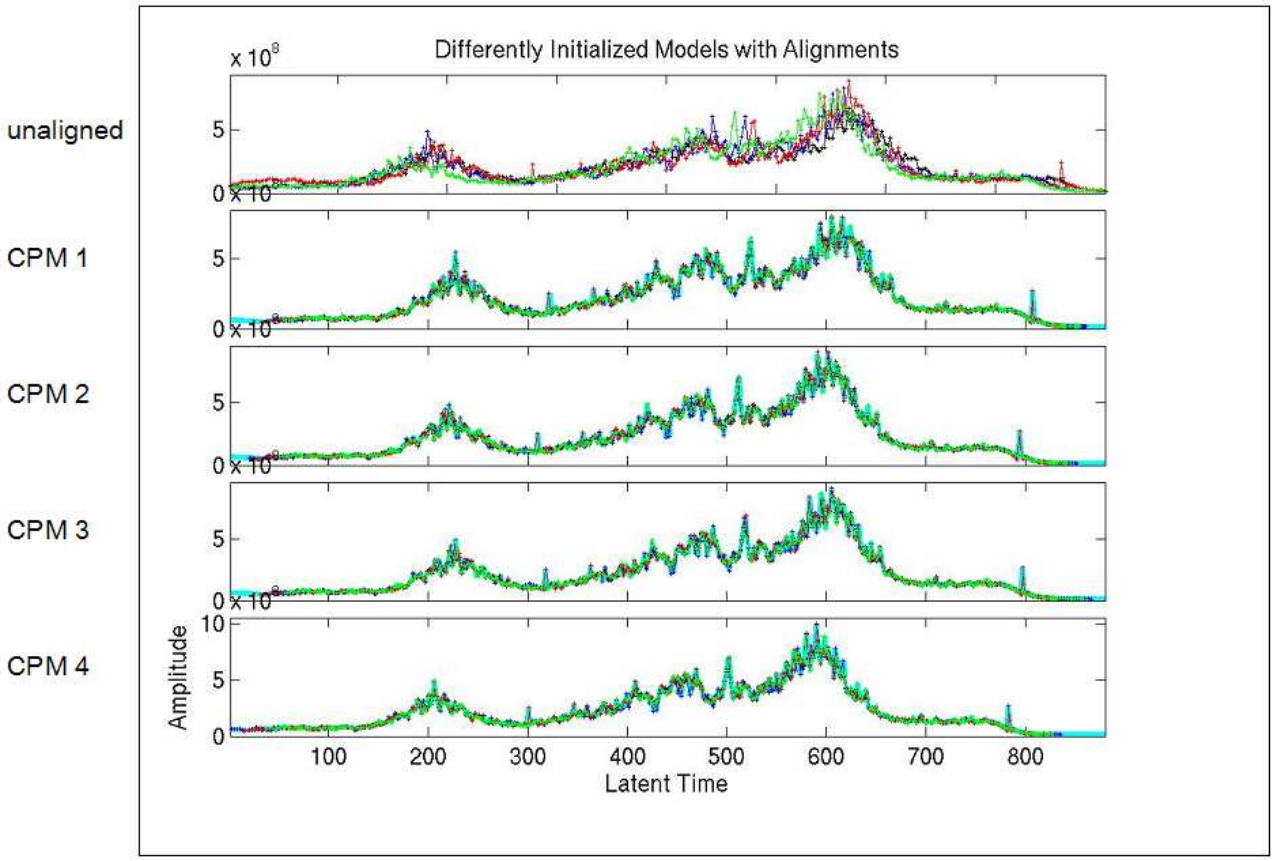
Sensitivity to Initial Latent Trace

Each of 4 samples (plus noise) used to initialize latent trace:

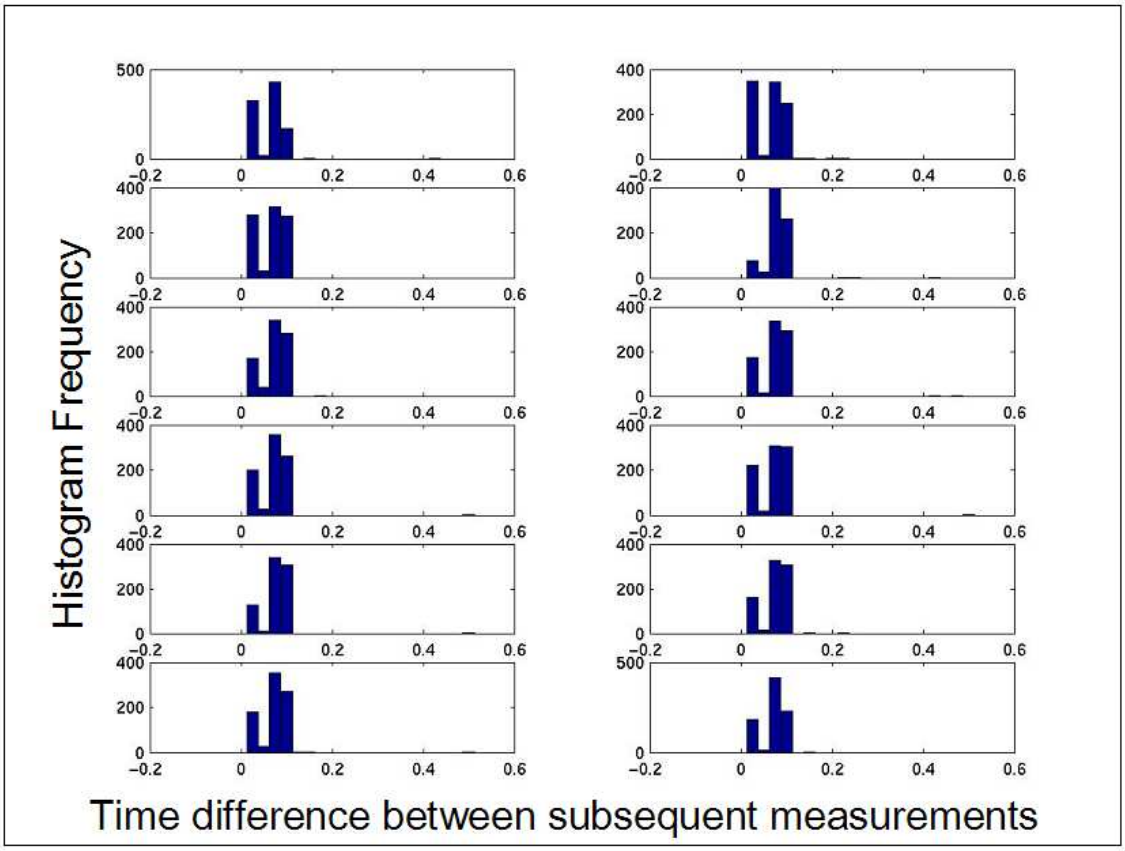


Sensitivity to Initial Latent Trace

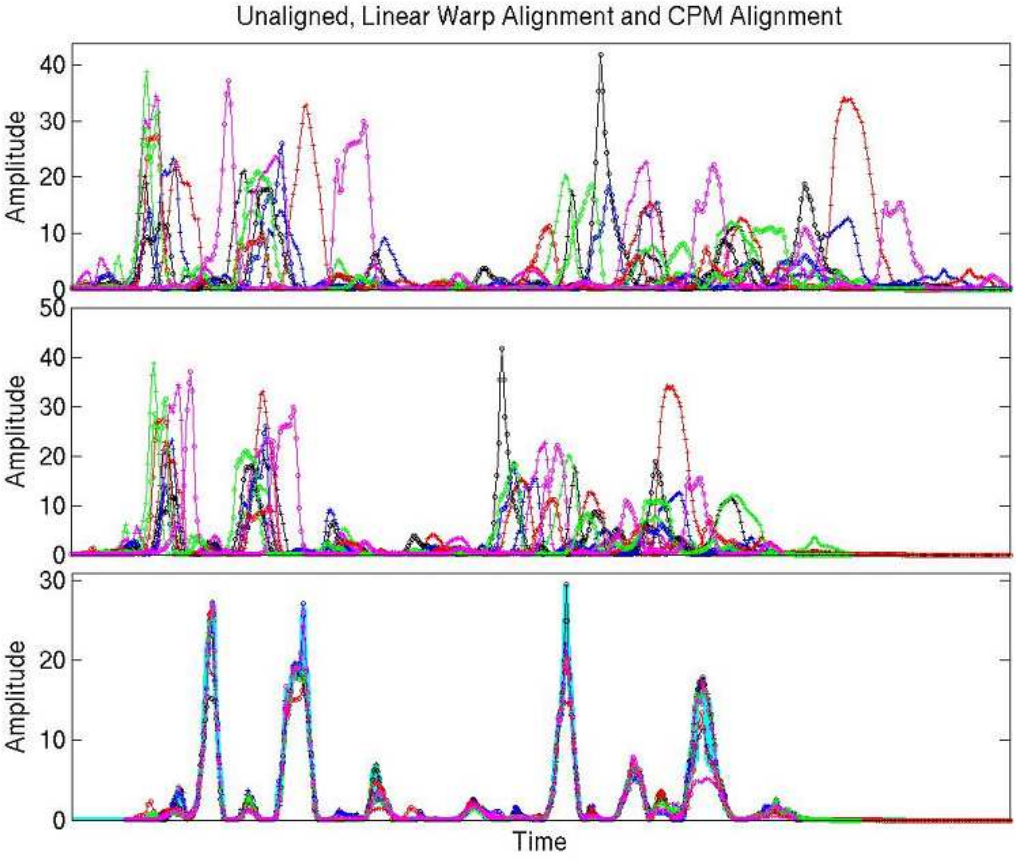
Viterbi alignments using 4 resulting models:

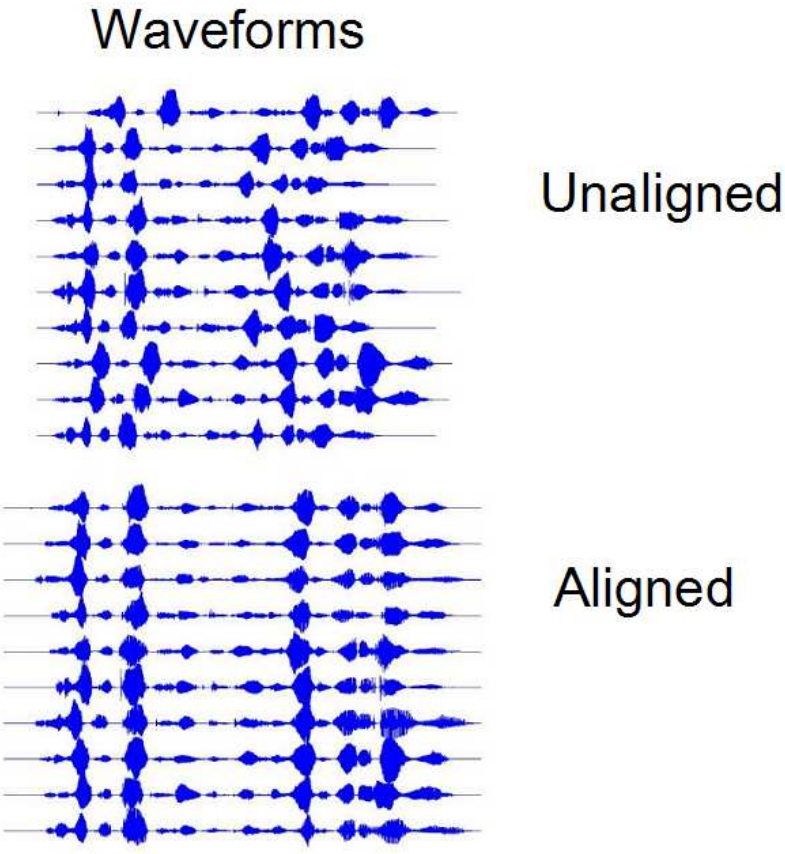


Time Sampling in 12 Replicate HPLC-MS Experiments



Multiple-Speaker Speech Alignments



- Unaligned data from 10 speakers saying same sentence.
- Linear warp with offset.
- Alignment with CPM.

Multiple-Speaker Speech Alignments