Paper data assimilation with 2D DFT based Kalman filter

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Contents

- Details of the dataset we are assimilating
- Idea of 2D discrete Fourier transform
- 2D DFT based Kalman filter on data assimilation

Basis weight sample dataset

- 2,5m * 200m paper web
- Measured by special ATPA machine with very tight traversing path
- Each scan equals 14cm in MD and 1cm in CD
- Size of the datamatrix is thus 250*1454 units

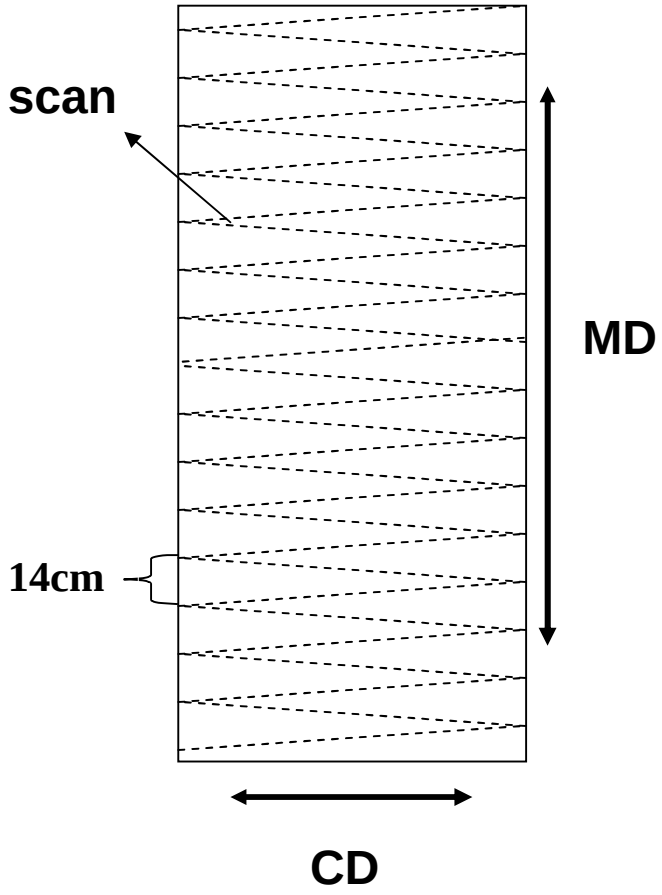
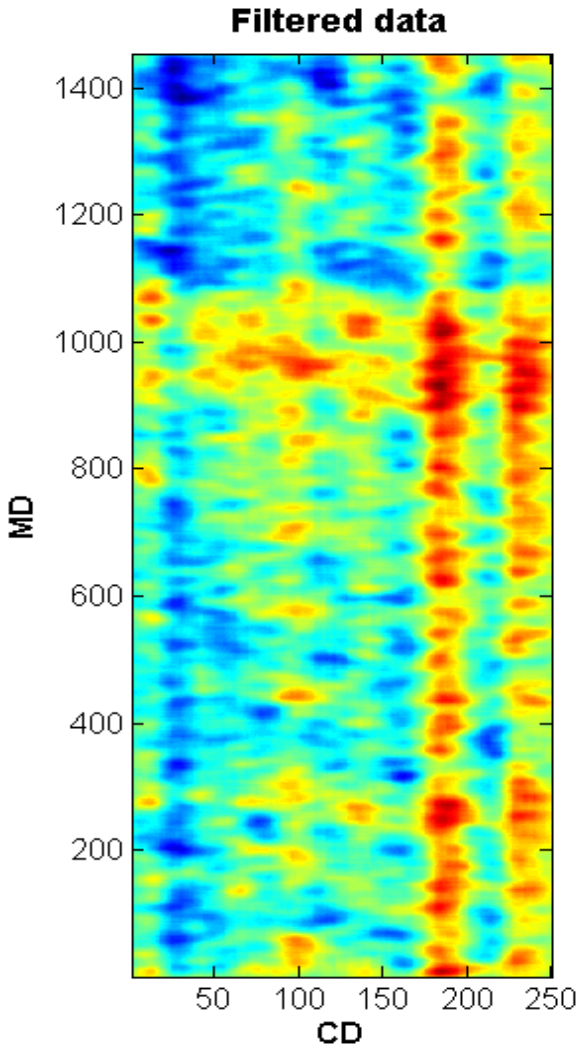
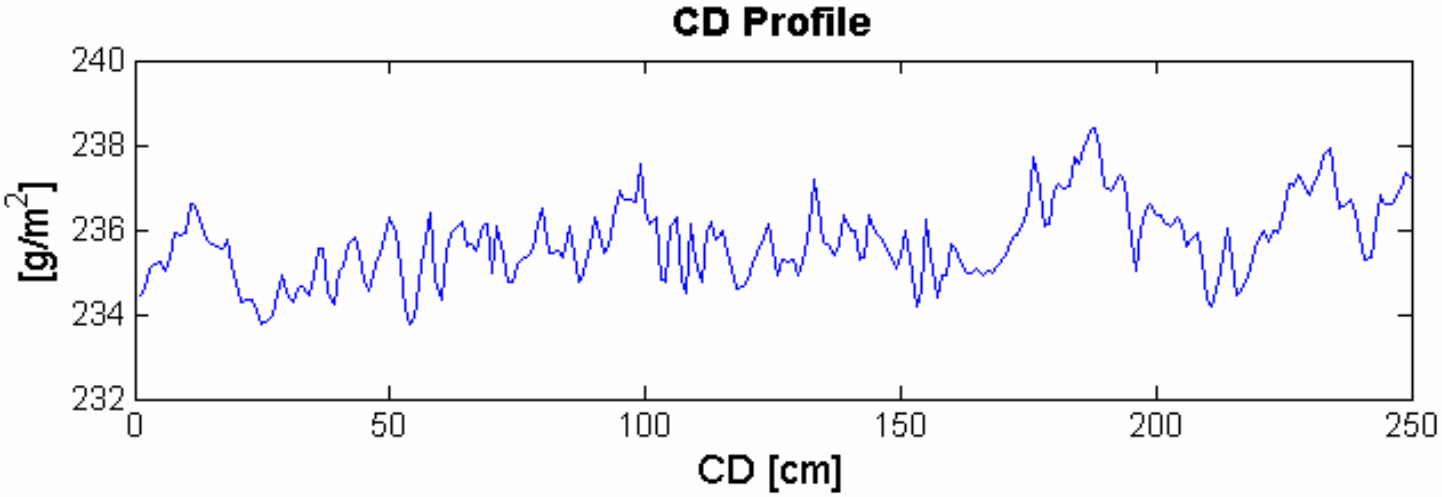


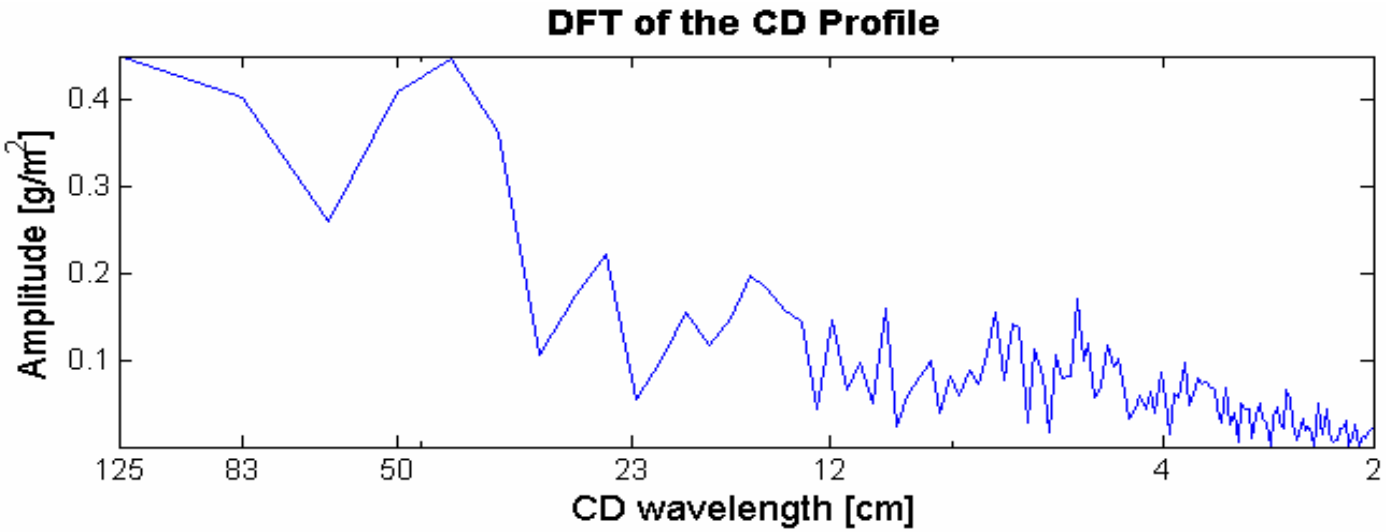
Figure of filtered dataset

- Half of the real width of a paper roll
- Strong variation can be seen in CD
- Also some MD variation visible

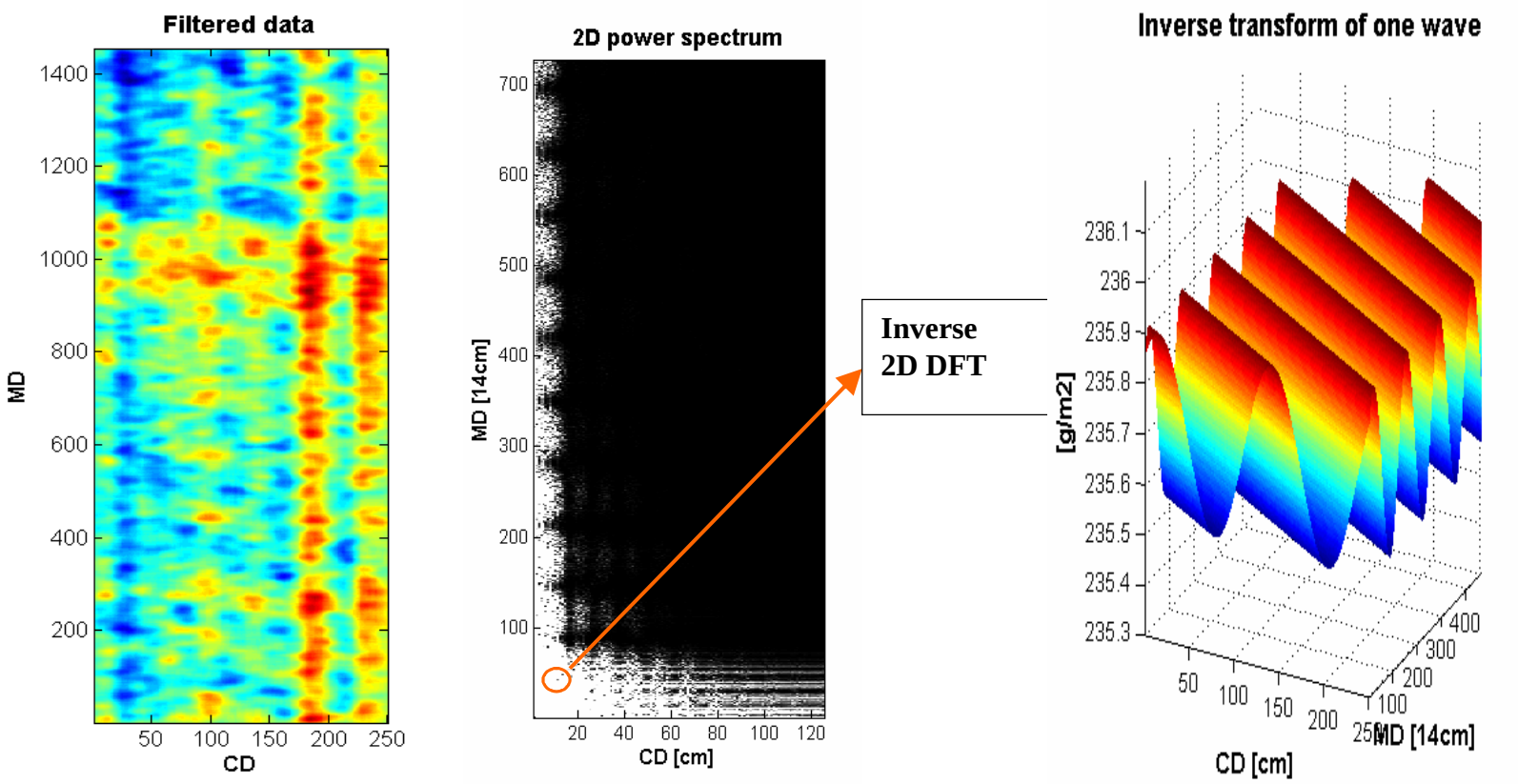


DFT (Discrete Fourier Transform)



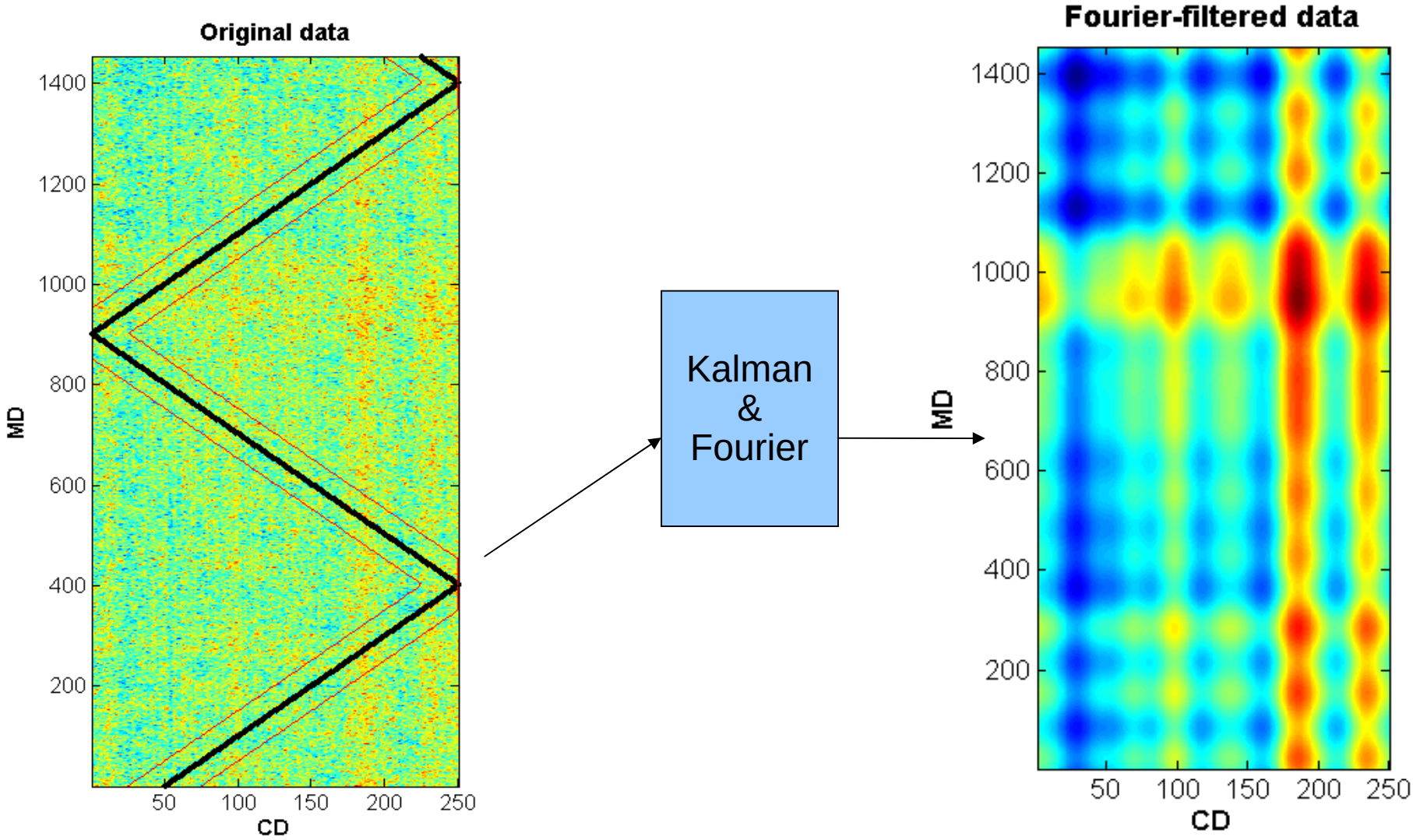


2D DFT



- **With 2D DFT, also diagonal waves can be taken into account, (in addition to CD and MD waves)**

Basic idea of data assimilation



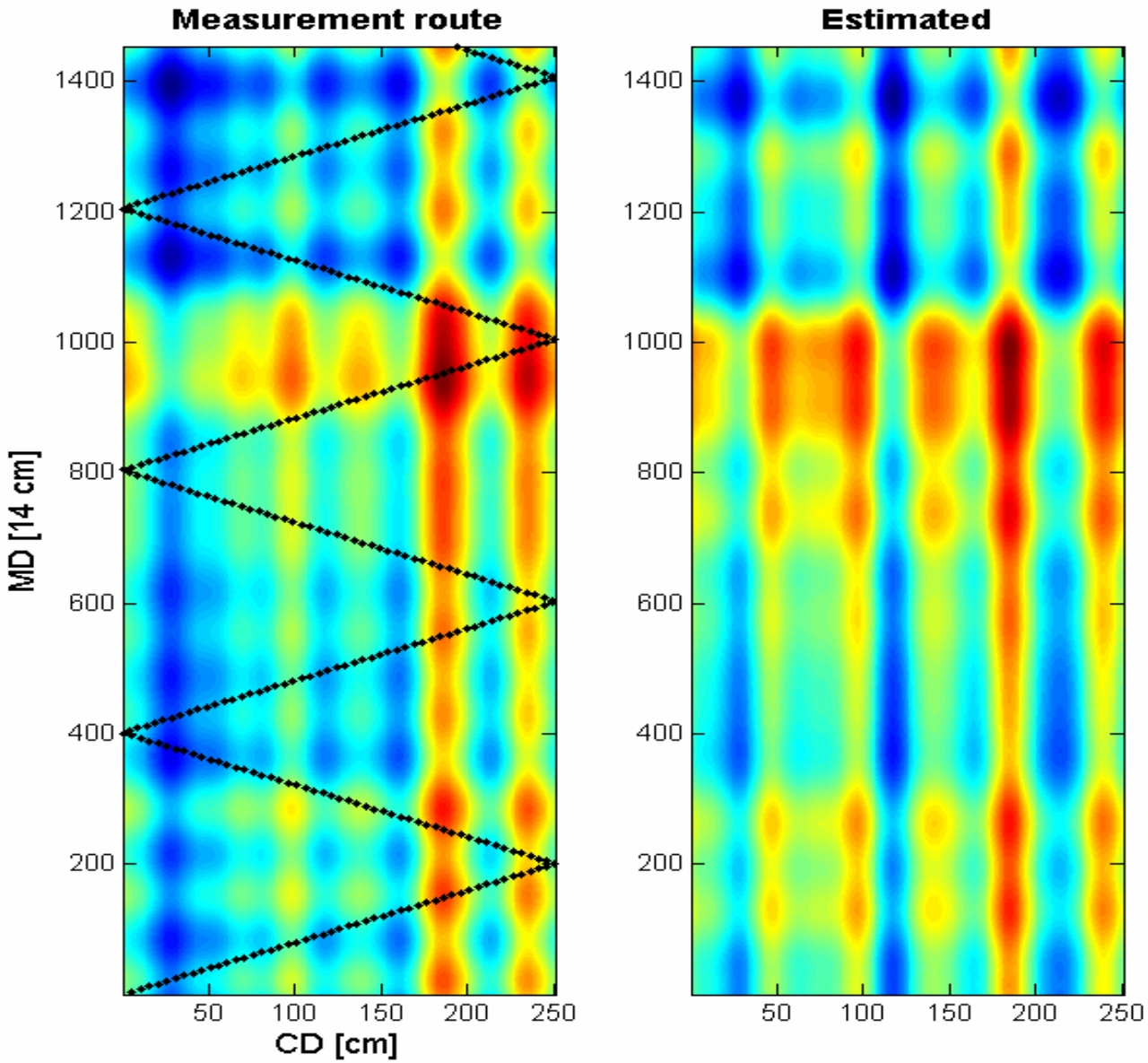
Measurement data --> math stuff ---> Voilà!

The Kalman filter

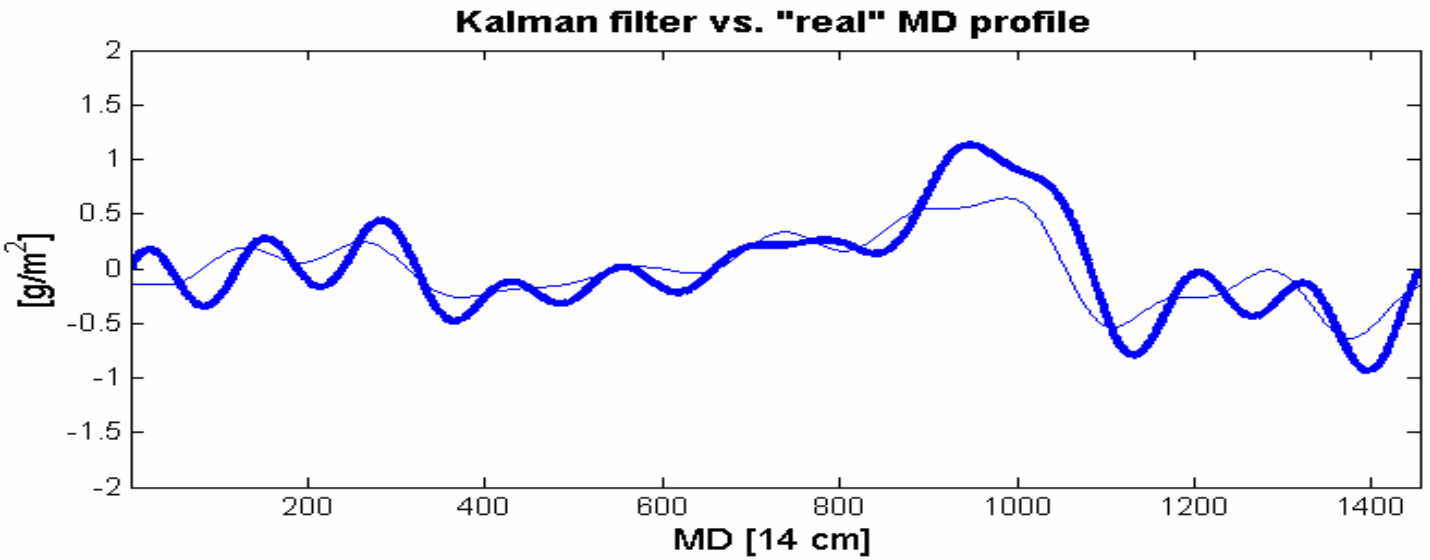
- State vector x = [C_{cd1}, C_{cd2},…, C_{md1},…]
  - Strongest Fourier components corresponding to CD and MD

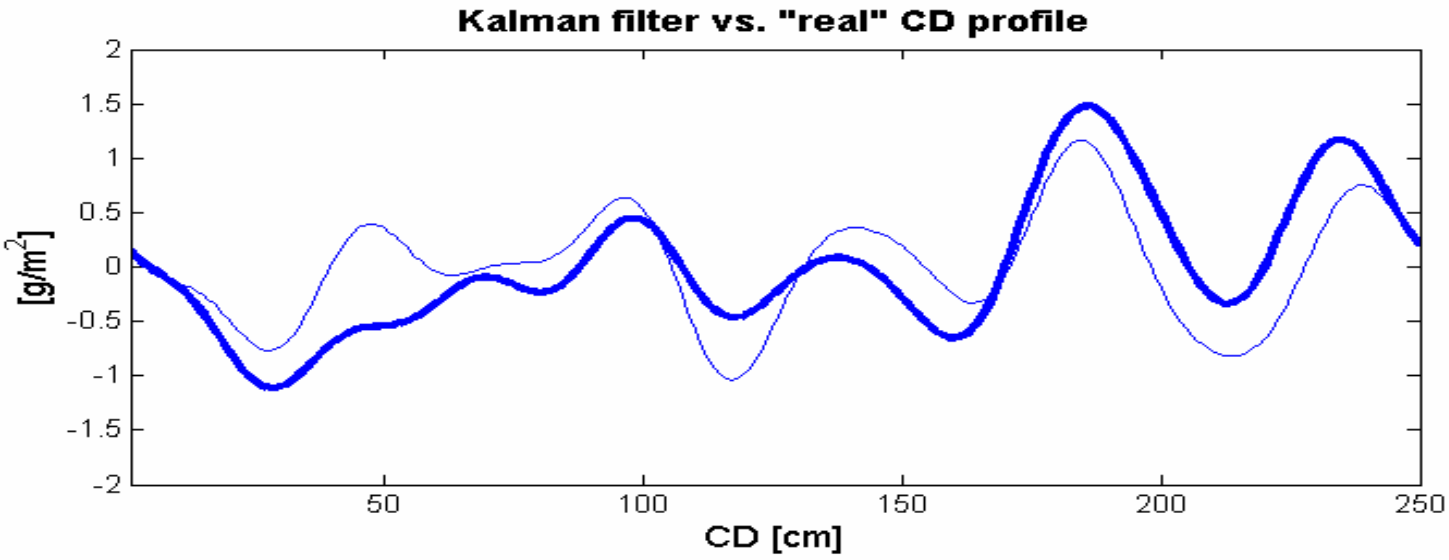
- State vector update: $x_{k+1} = x_k + K\left[y_i - Hx_k\right]$
  - y = measurement data
  - K = Kalman gain vector
  - H = Inverse DFT operator
  - $y_i - Hx$ = difference between the model and a measurement

Results 1


Measurement route
Estimated
MD [14 cm]
CD [cm]
1400
1200
1000
800
600
400
200
50
100
150
200
250

Results 2


Kalman filter vs. "real" MD profile
[g/m2]
MD [14 cm]


Kalman filter vs. "real" CD profile
[g/m2]
CD [cm]