Cell Voltage Noise Removal and Cell Voltage (or Resistance) Slope Calculation

Marc Dupuis

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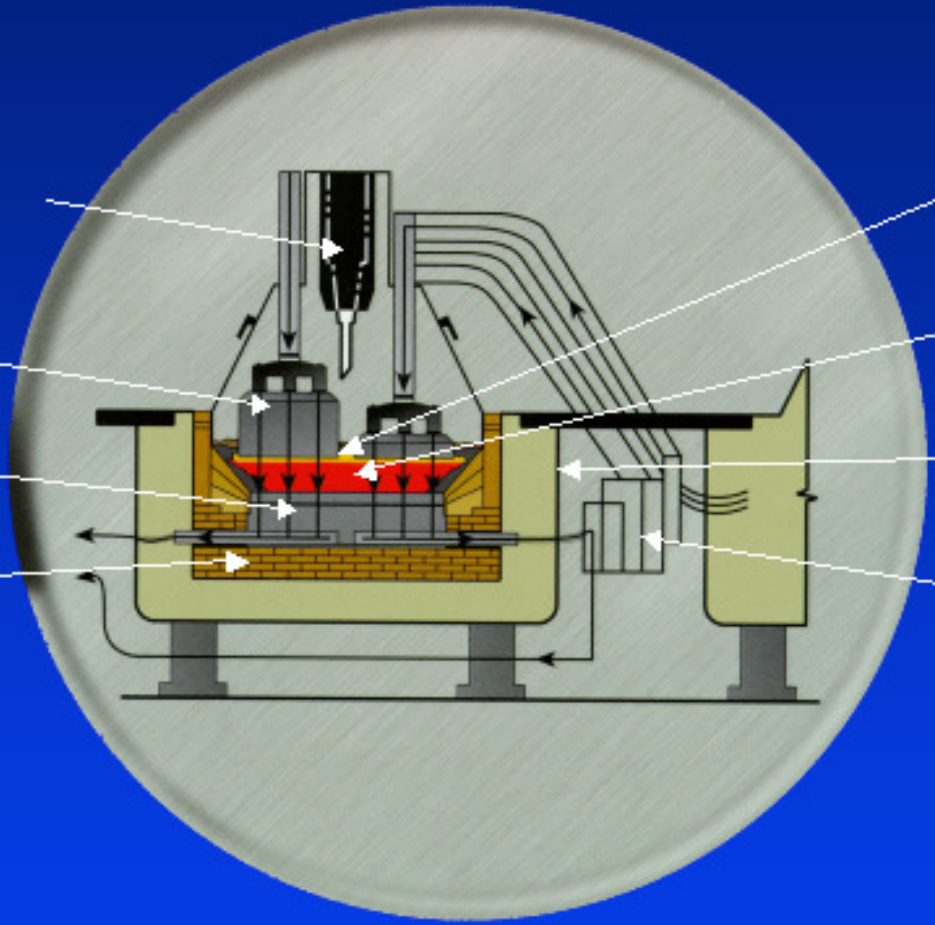
Plan of the Presentation

- Introduction
- Noise Filtration and Slope Calculation
  - linear fit
  - parabolic fit
- Conclusions

Introduction

- Superstructure
- Anode
- Cathode
- Lining Bricks

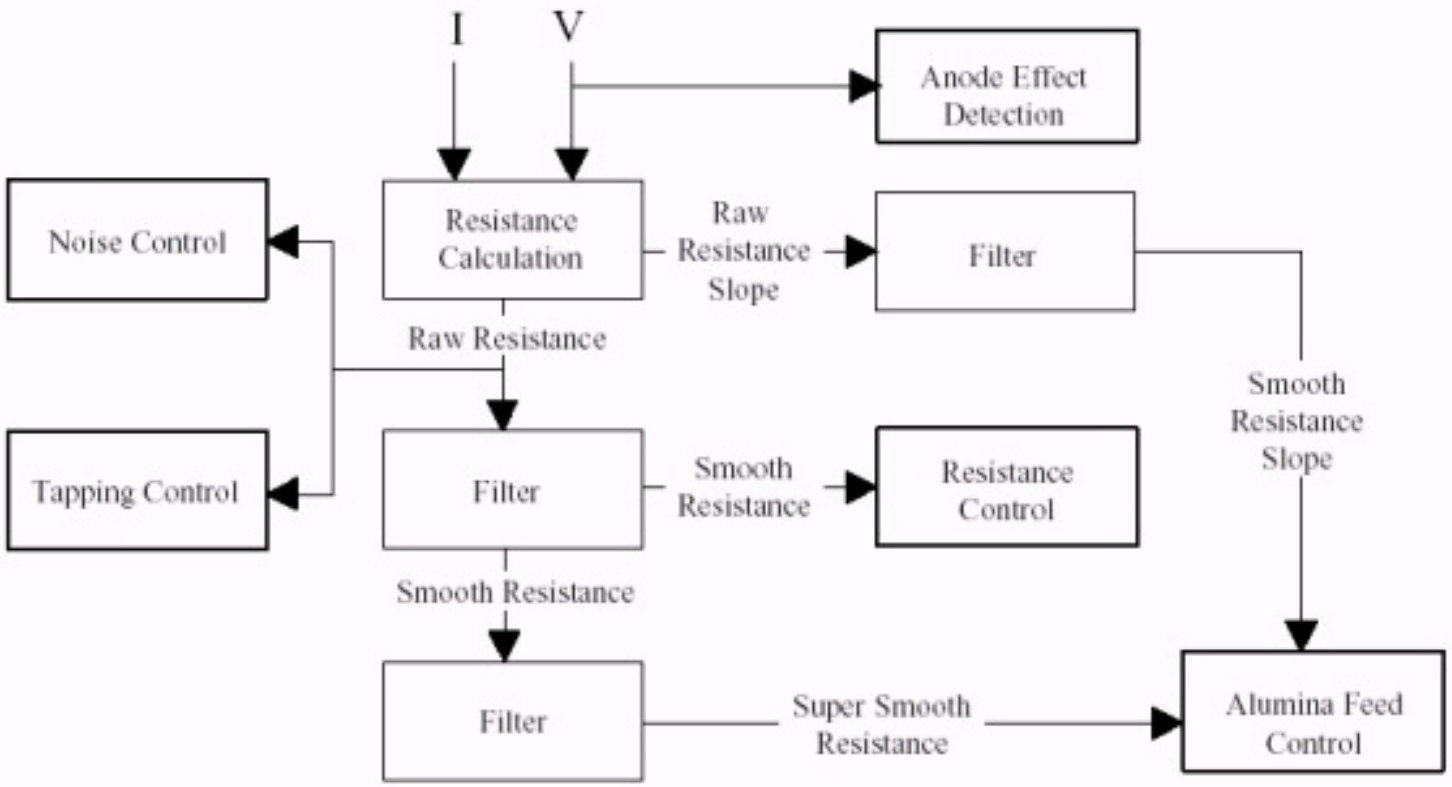


- Electrolyte
- Liquid Metal
- Steel Shell
- Busbar

The Hall-Héroult Cell

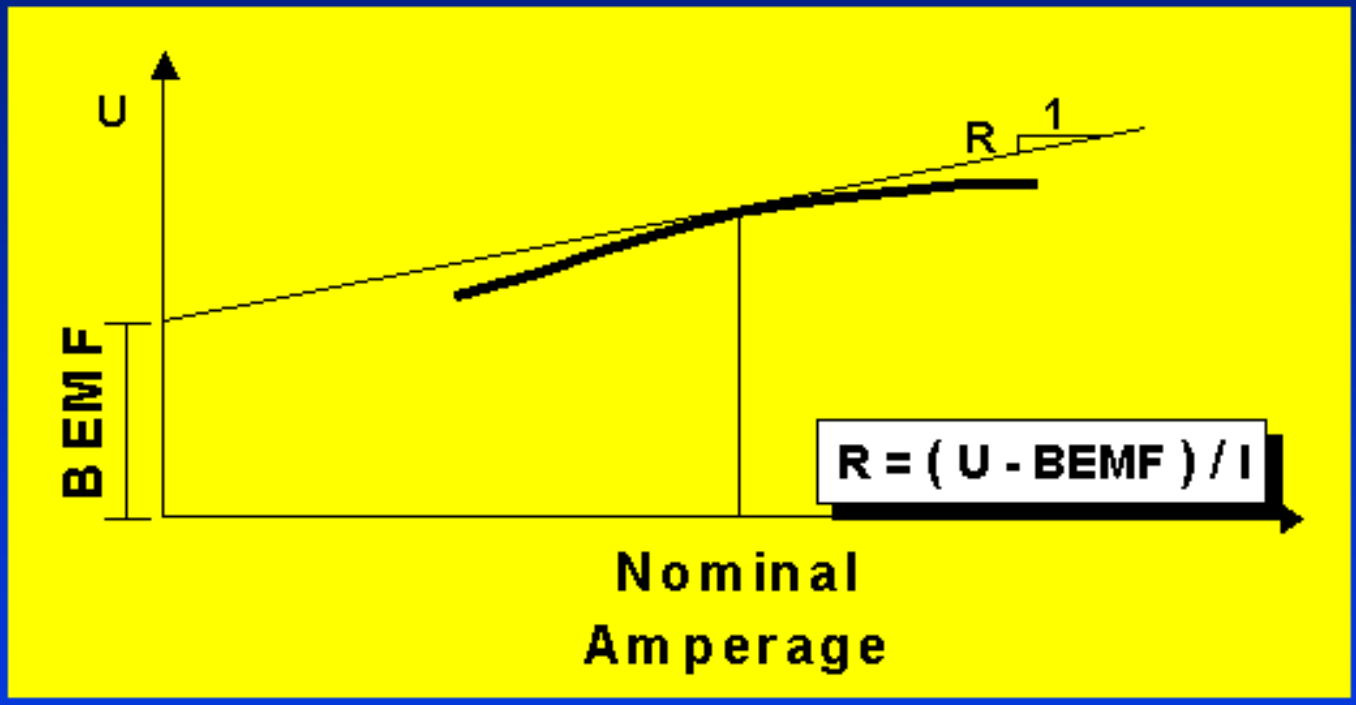
Introduction

Geoff Bearne



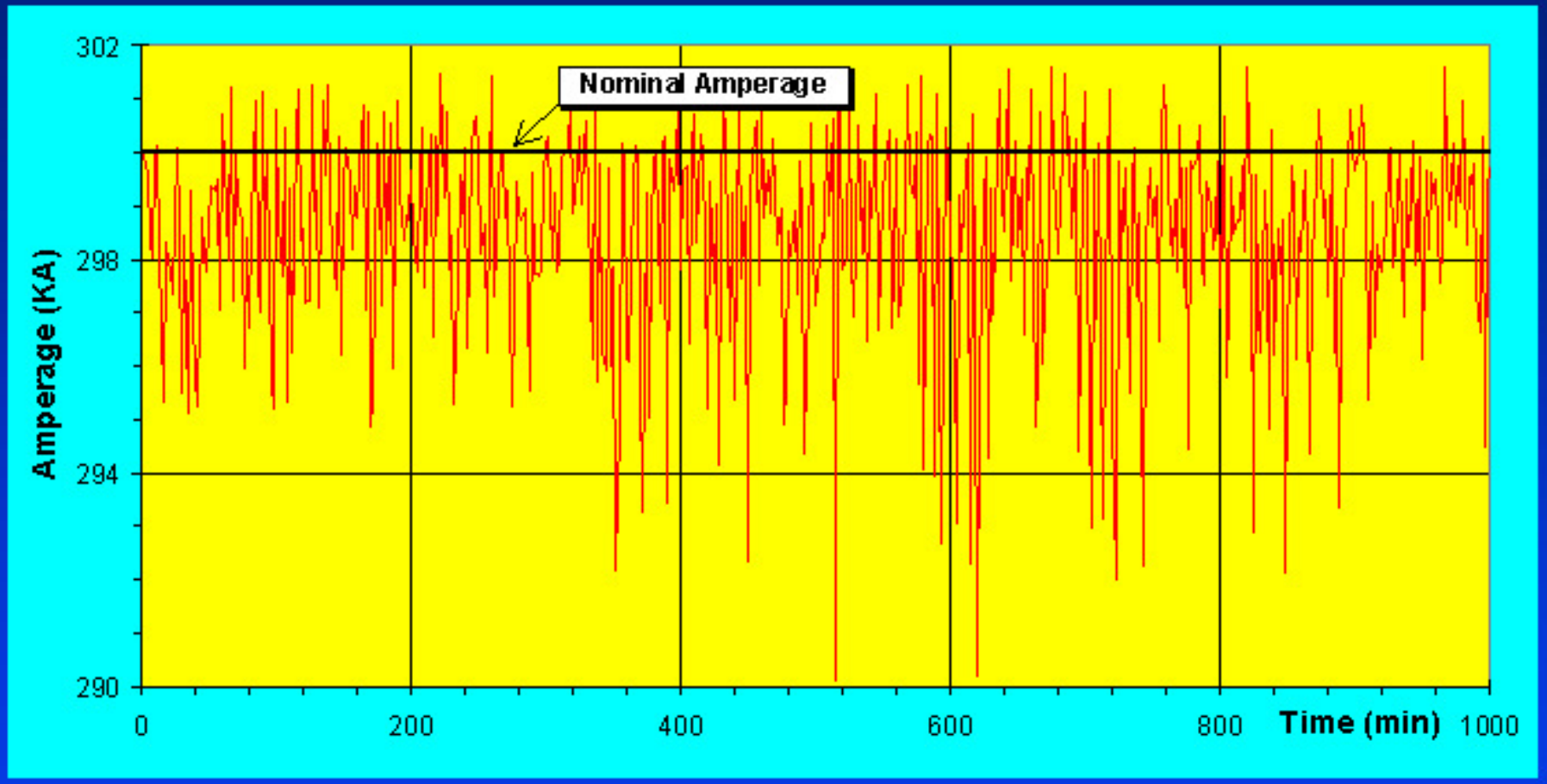
Typical applications of pseudo-resistance for cell control.

Introduction



Calculation of the cell pseudo-resistance (R)

Introduction



Cell Amperage vs. Time

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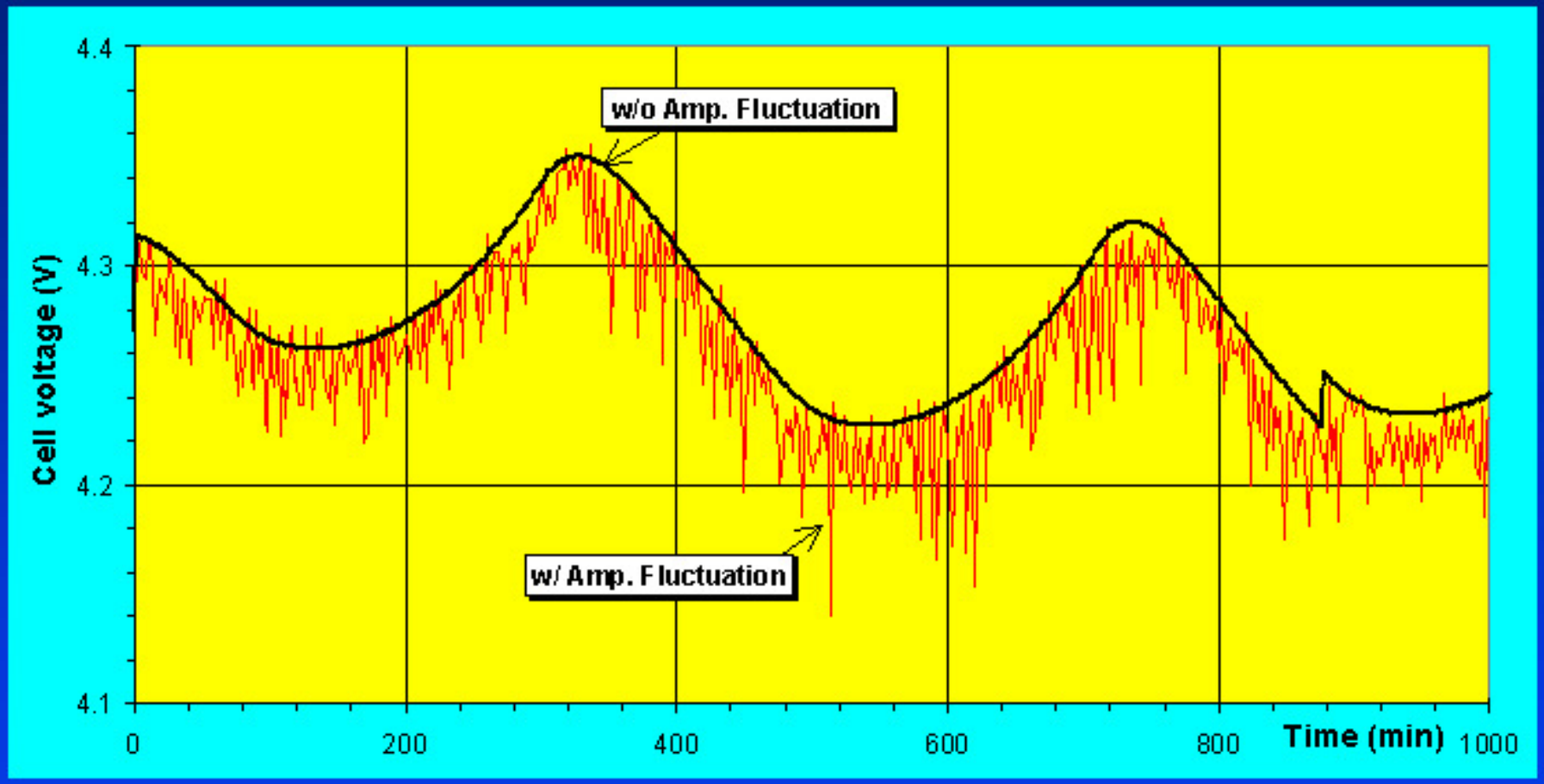
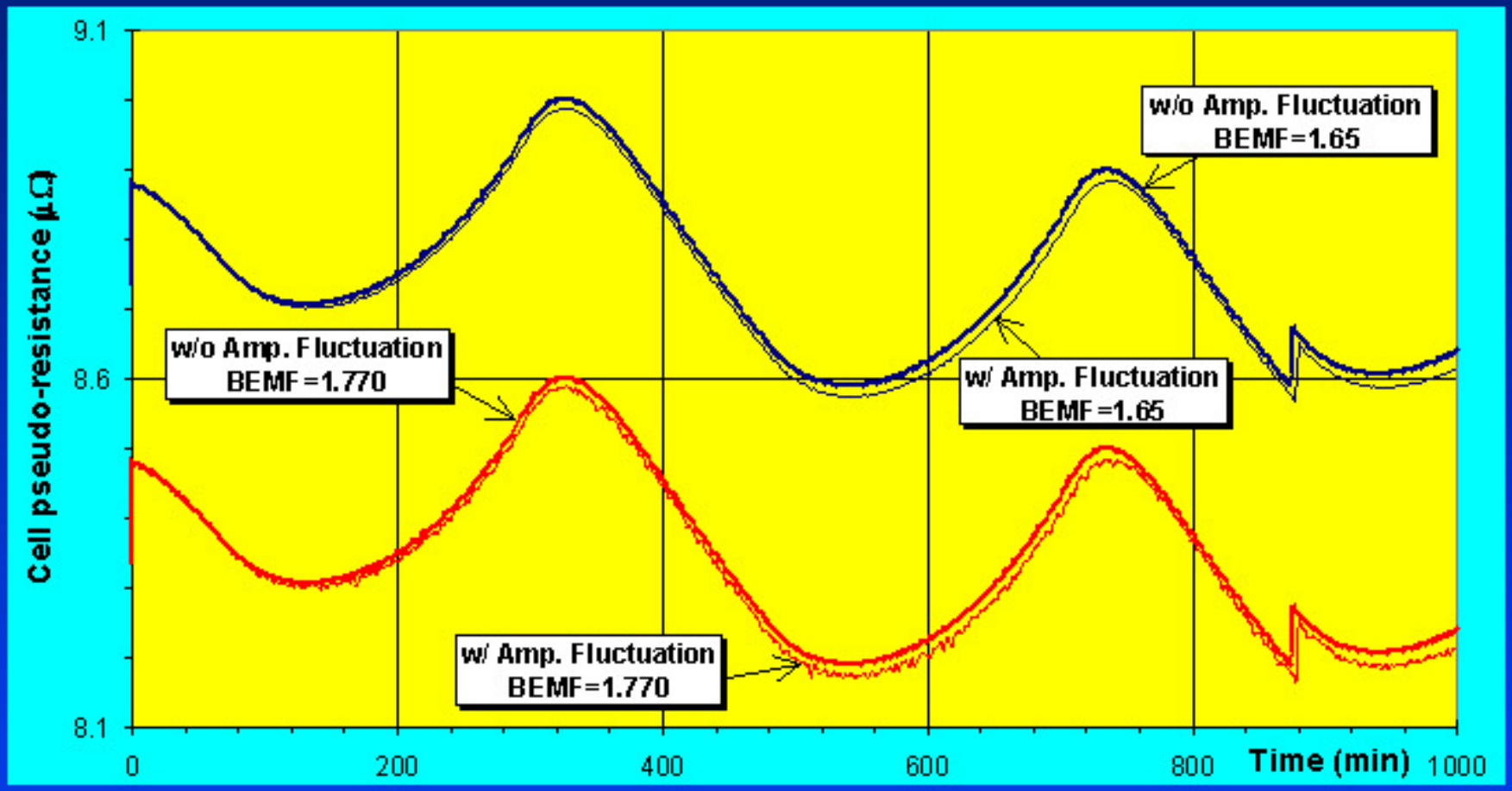
Introduction



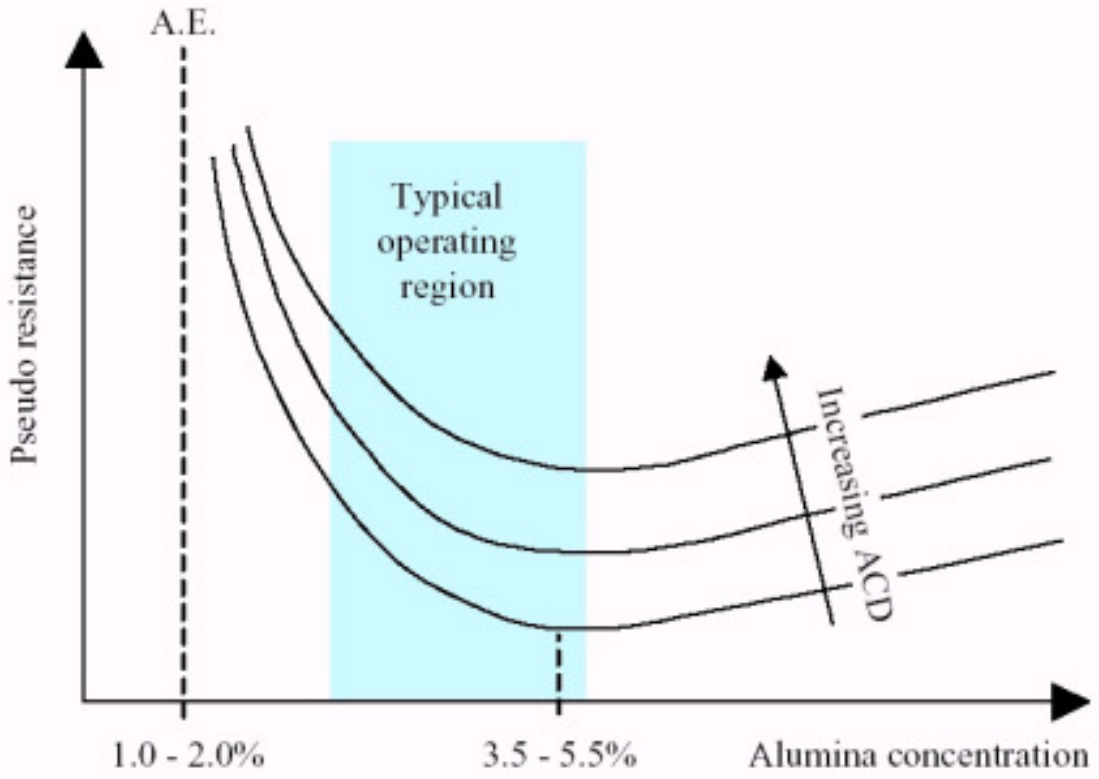
Cell Voltage vs. Time

Introduction



Cell Pseudo-Resistance vs. Time

Introduction

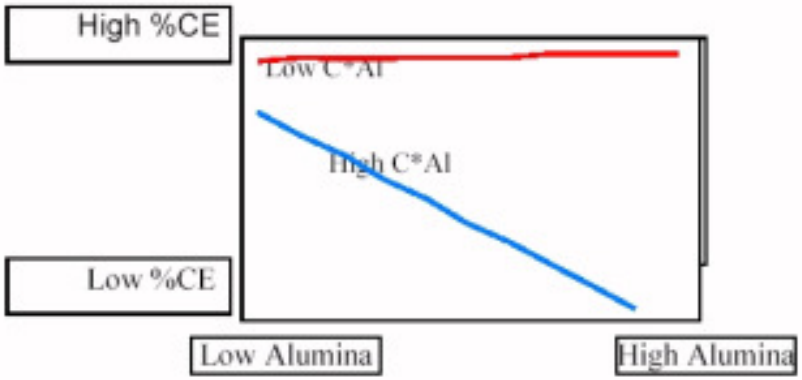


Typical pseudo-resistance versus alumina concentration relationship at constant anode cathode distance.

Introduction

Pareto Plot of Transformed Estimates

Absolute effect sizes from high to low, and how they add up.



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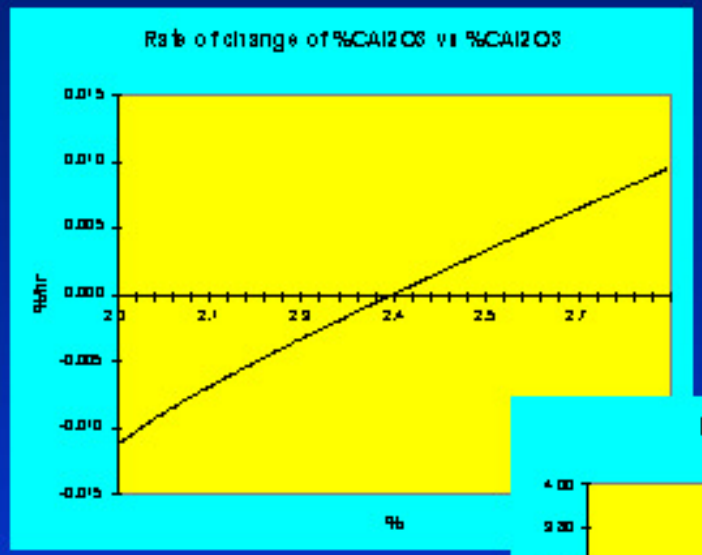
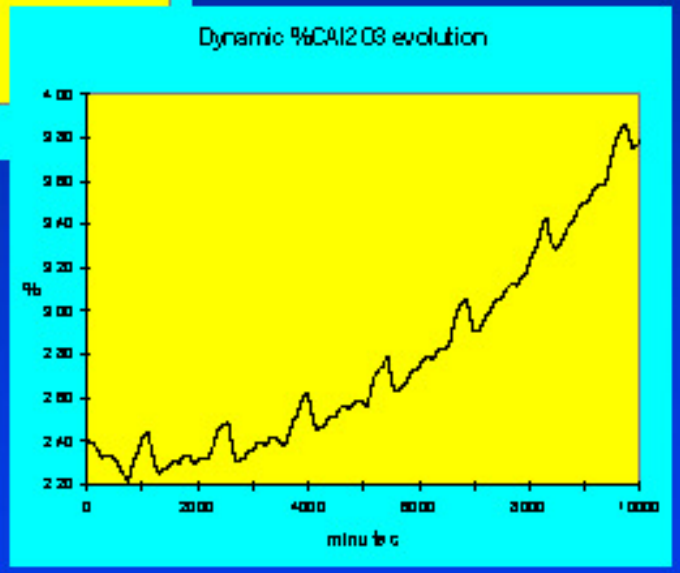
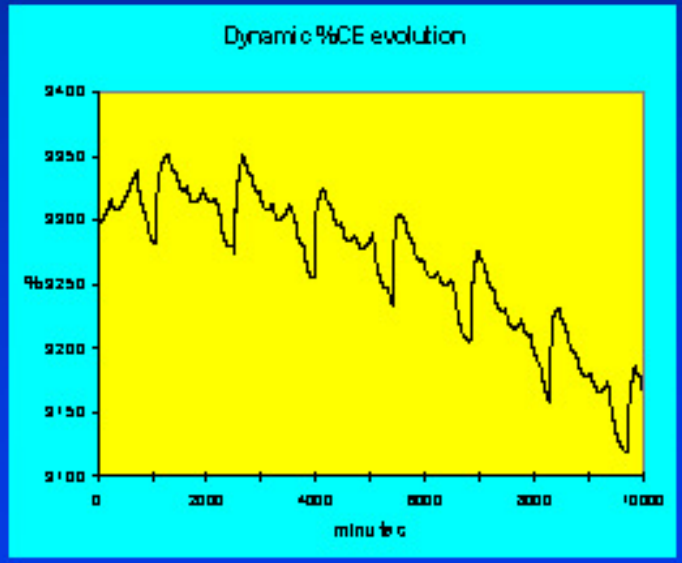


Small initial overfeeding with no alumina control





Negative CE vs. $\%Al_2O_3$ Slope means unstable system

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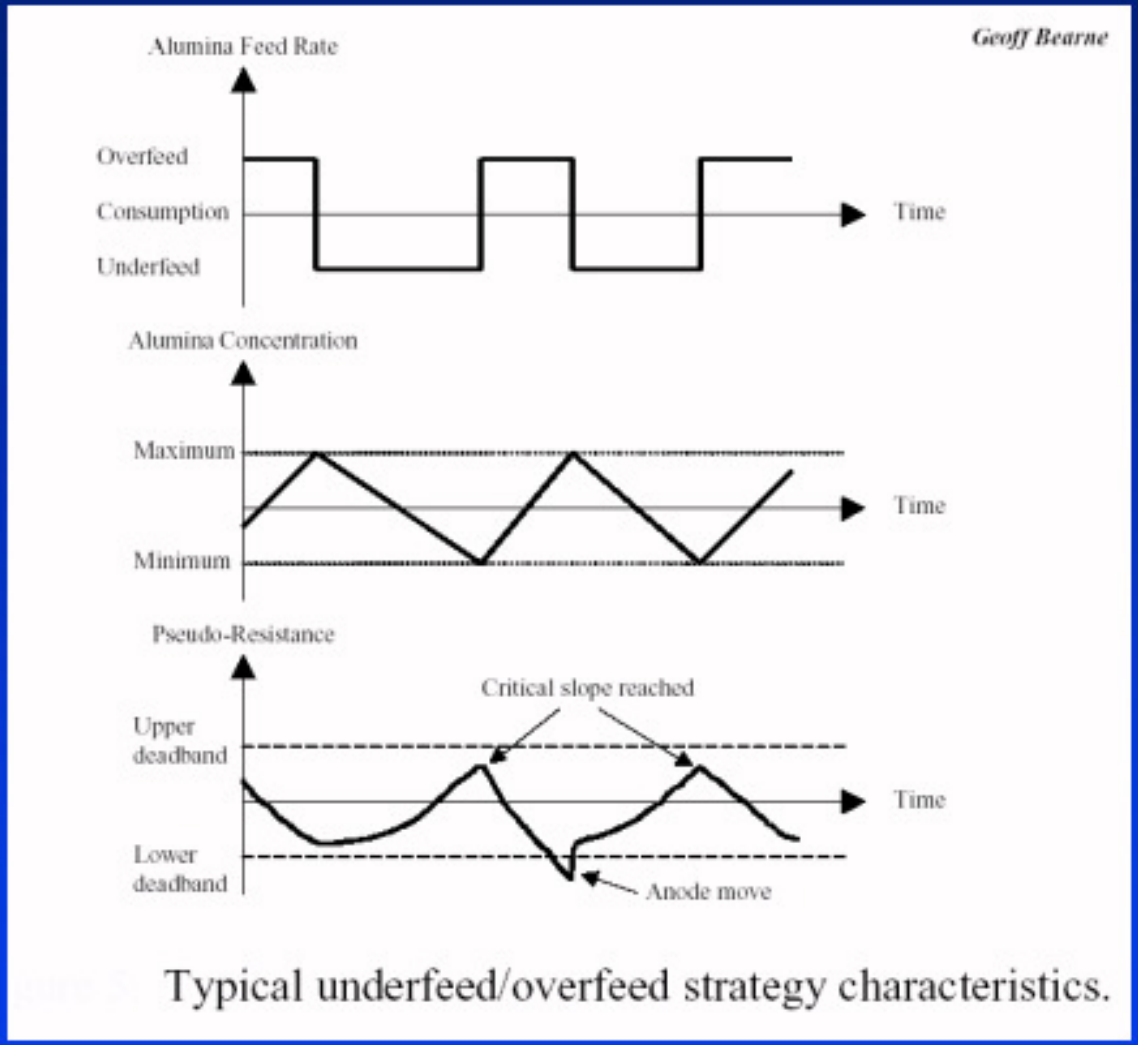
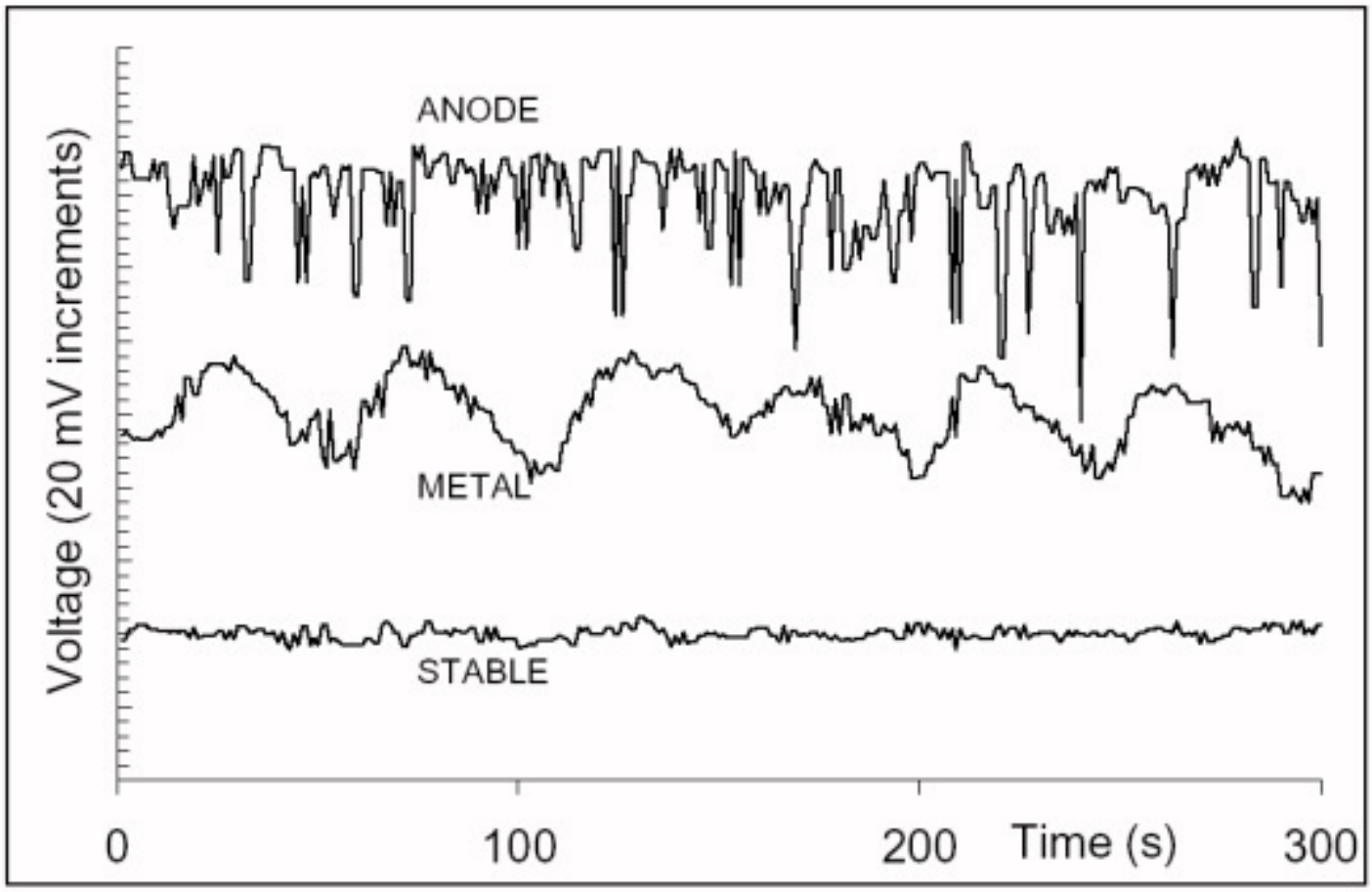
Introduction



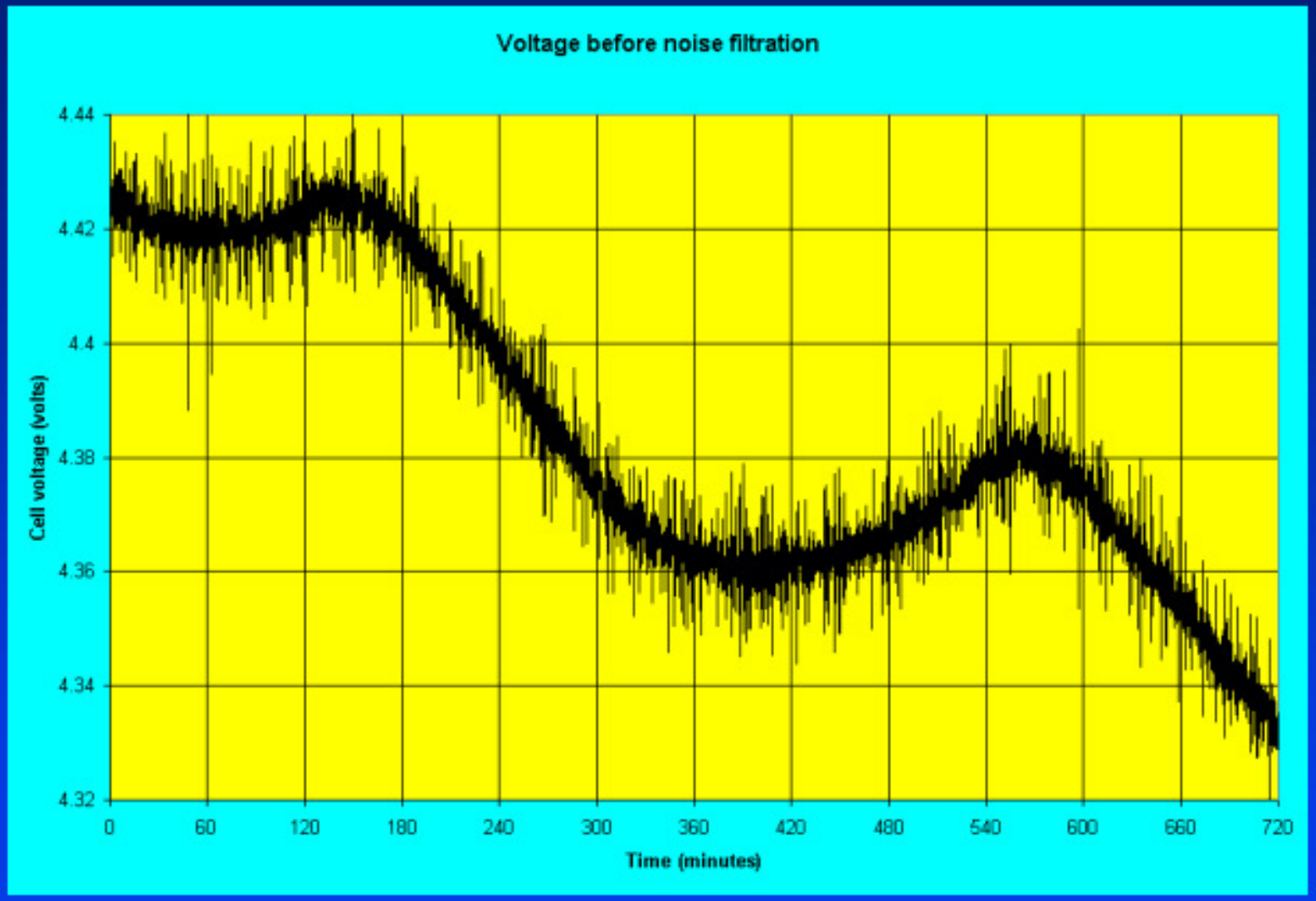
Typical underfeed/overfeed strategy characteristics.

Introduction



Typical noise signals from stable and unstable cells

Noise Filtration and Slope Calculation



Noise Filtration and Slope Calculation

First algorithm tested, linear fit:

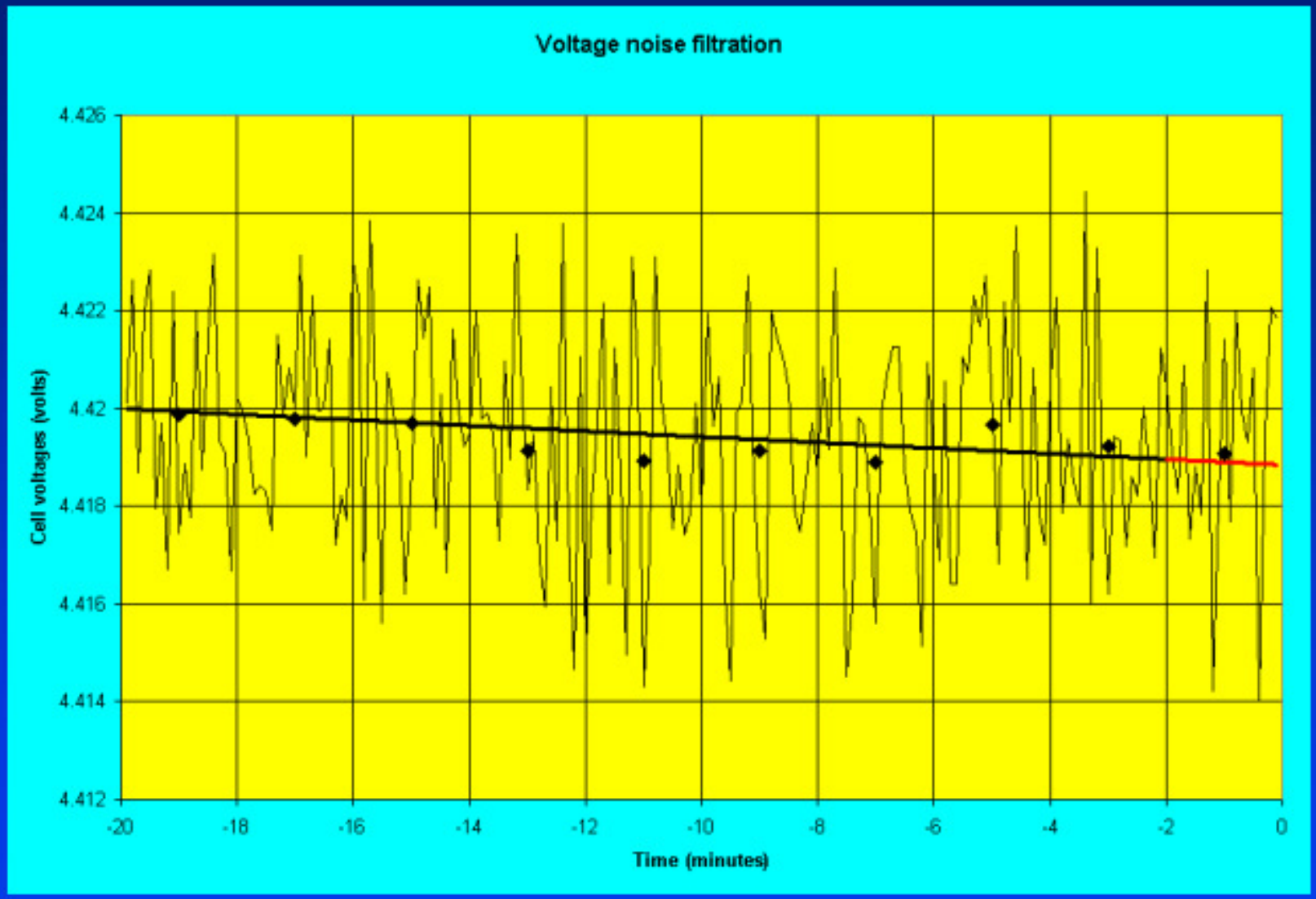
-A cell voltage free of any amperage fluctuation noise is recomputed from the cell "pseudo-resistance" using the nominal amperage.

-The cell voltage computed this way every 6 seconds is then averaged every 2 minutes.

-The best straight line fitting the last 10 "2 minutes averaged cell voltage" is computed.

-Finally, the slope of that straight line is use as estimate of the cell voltage slope at that time.

Noise Filtration and Slope Calculation



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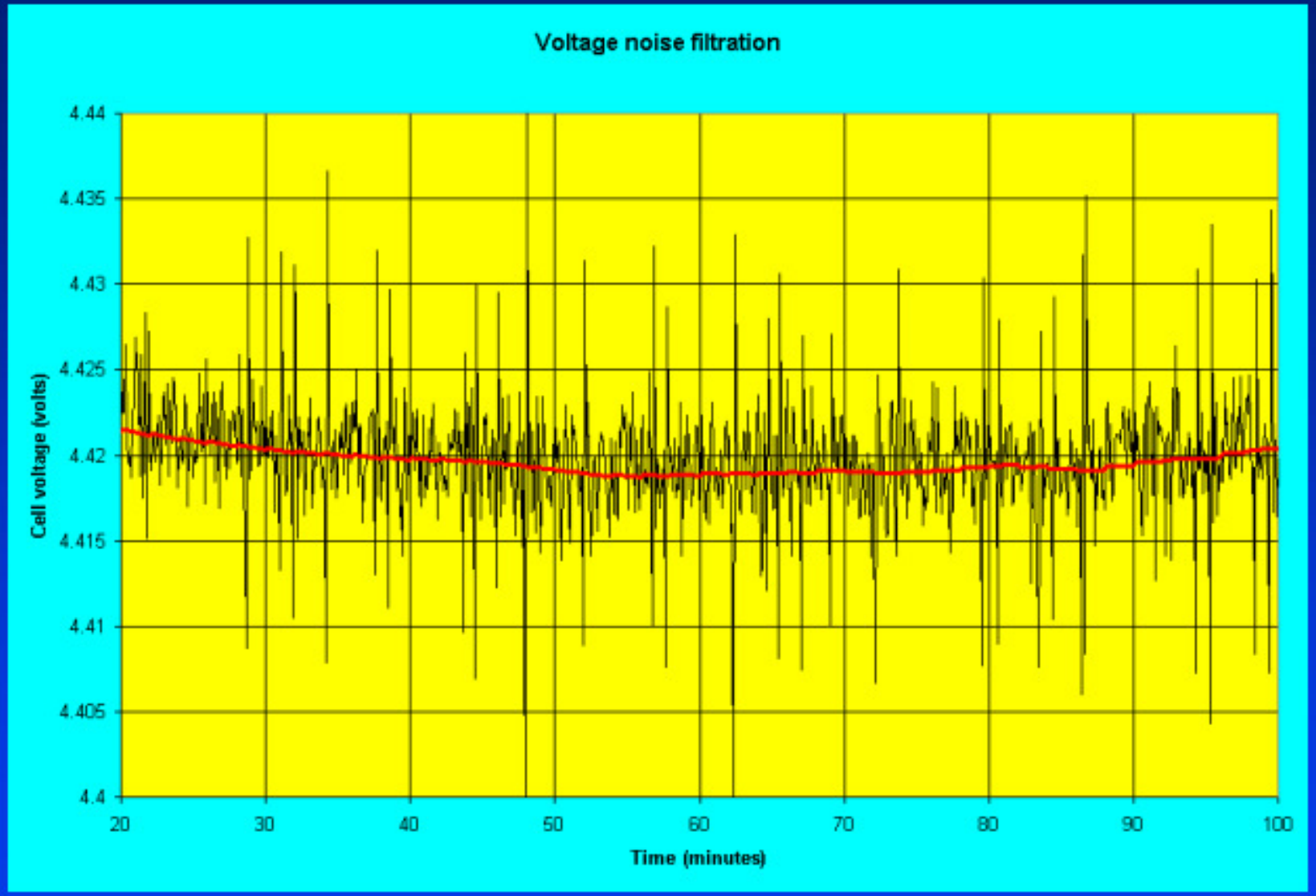

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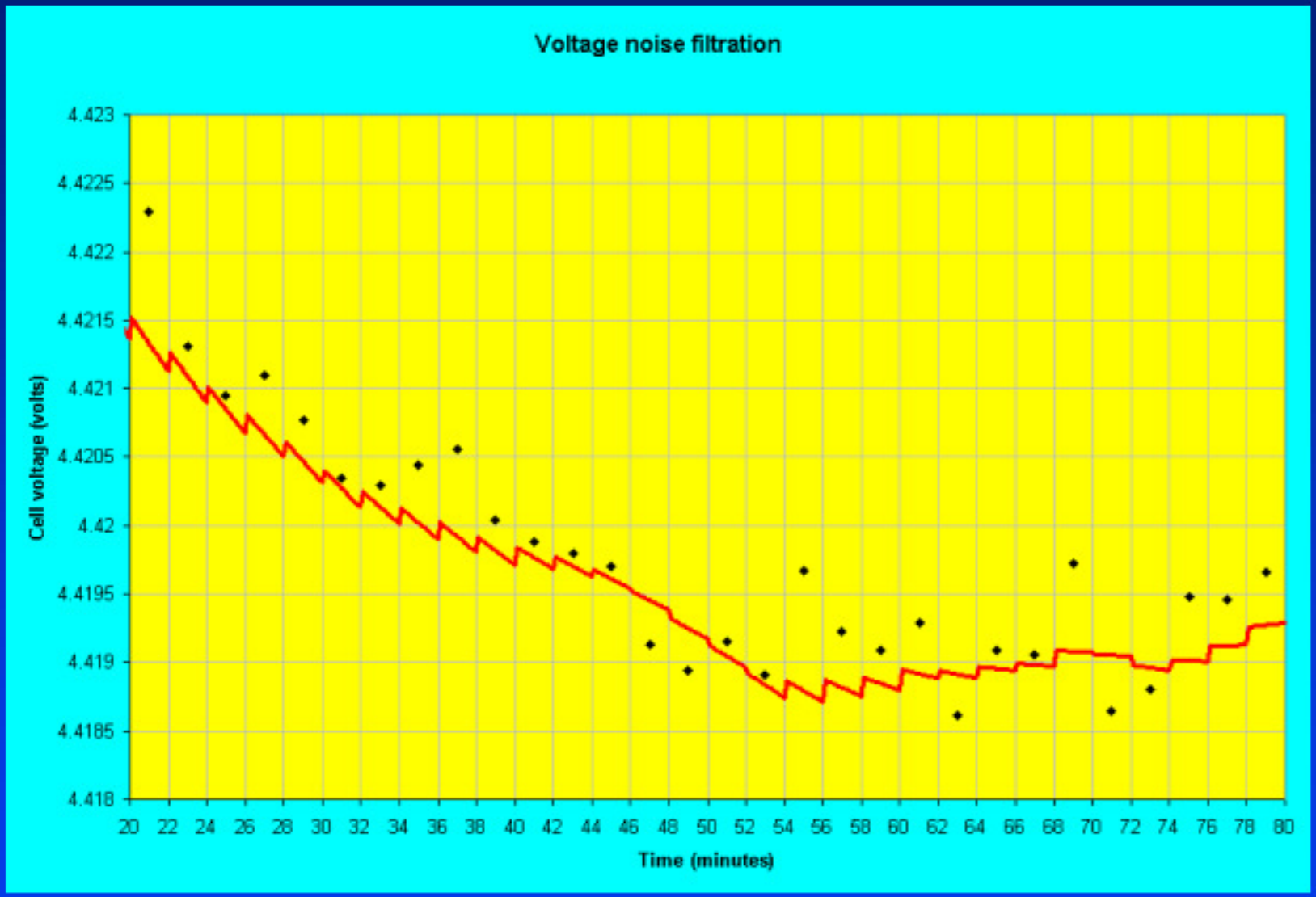
Noise Filtration and Slope Calculation



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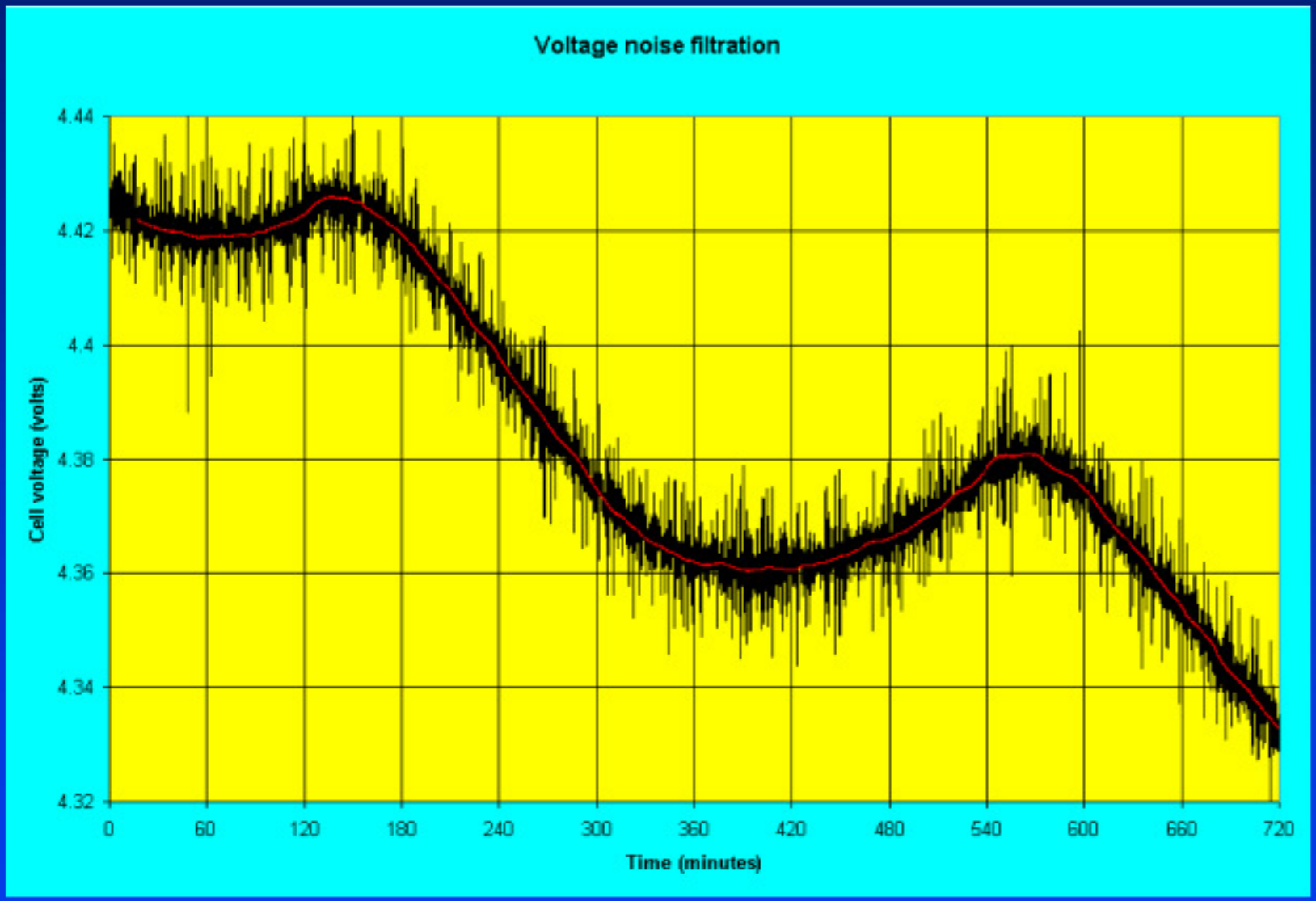
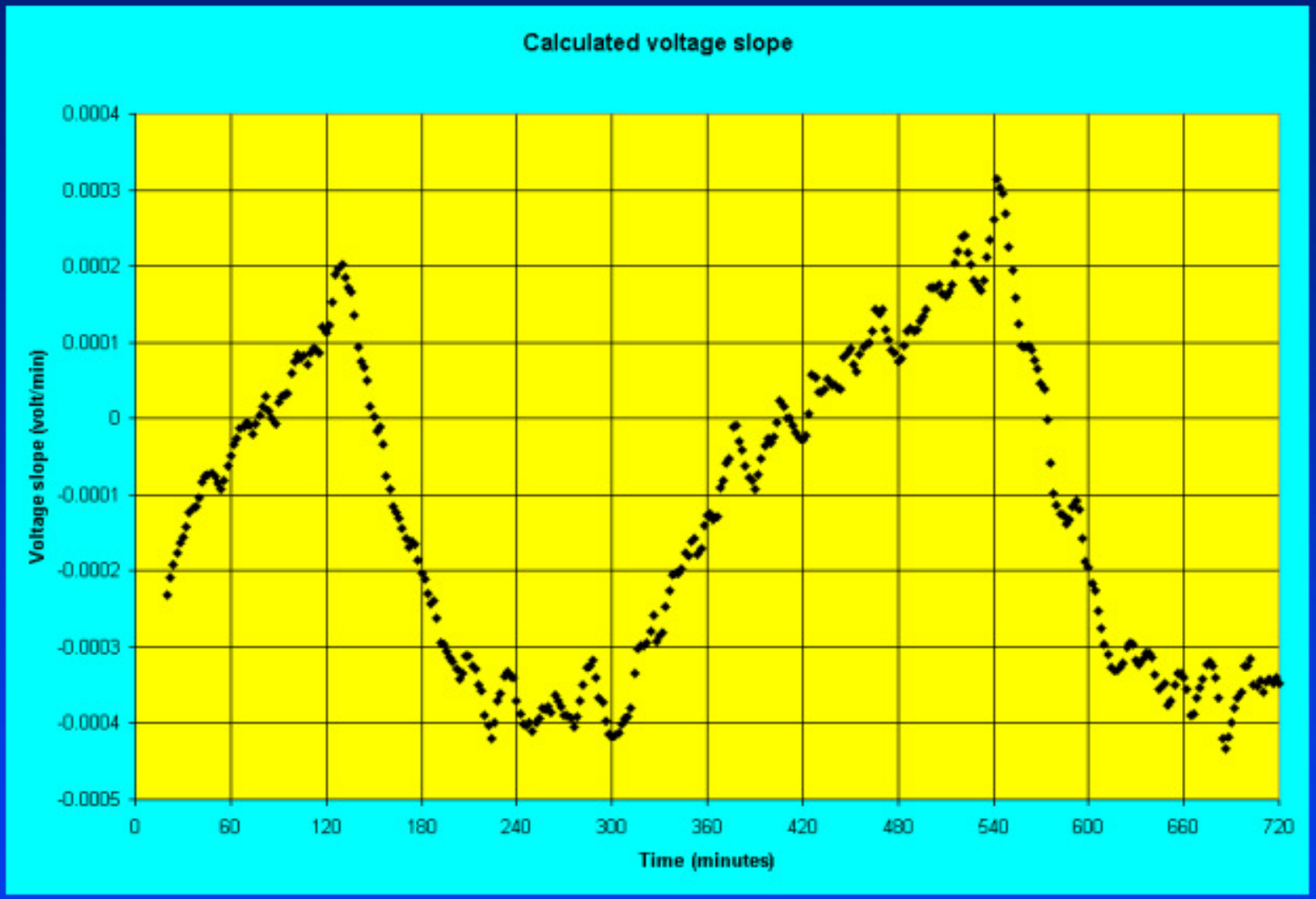
Noise Filtration and Slope Calculation



Noise Filtration and Slope Calculation



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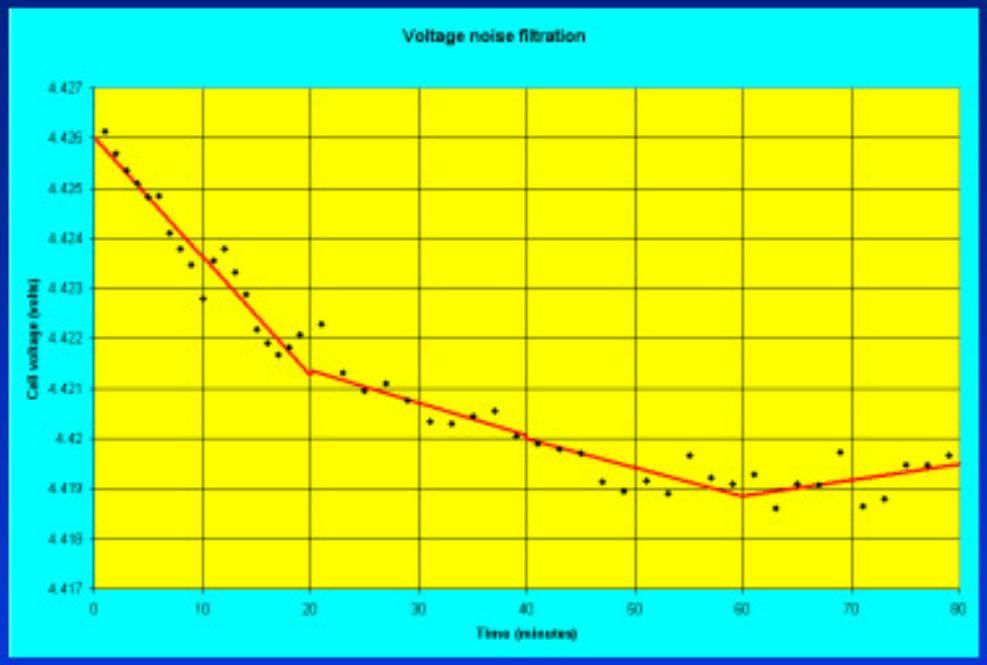
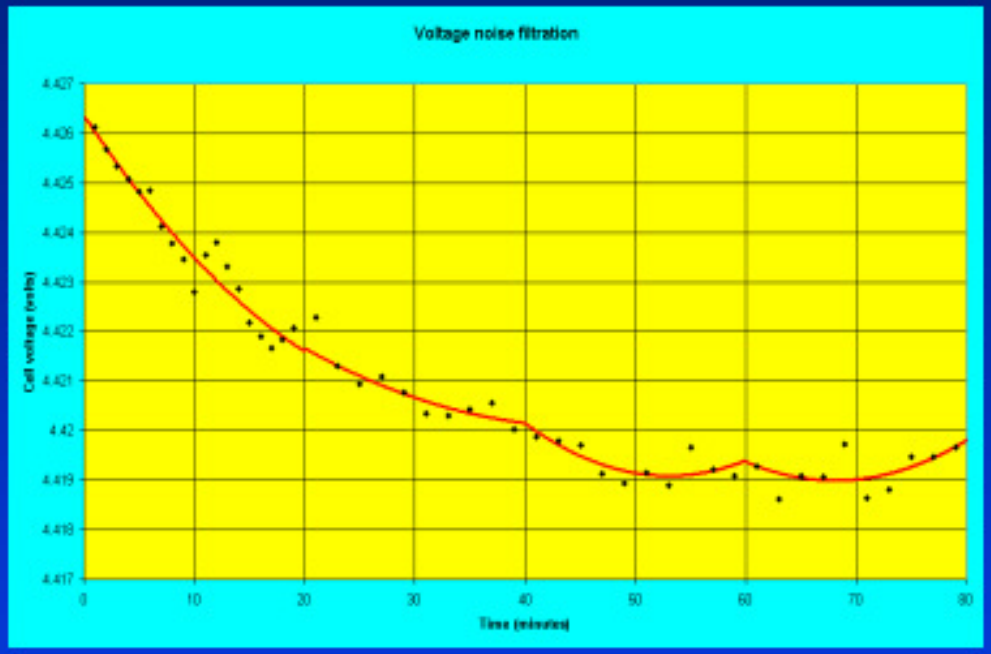
Noise Filtration and Slope Calculation





Linear curve fitting vs. quadratic curve fitting, which gives the most accurate slope calculation?

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Noise Filtration and Slope Calculation

First algorithm tested, quatratic fit:

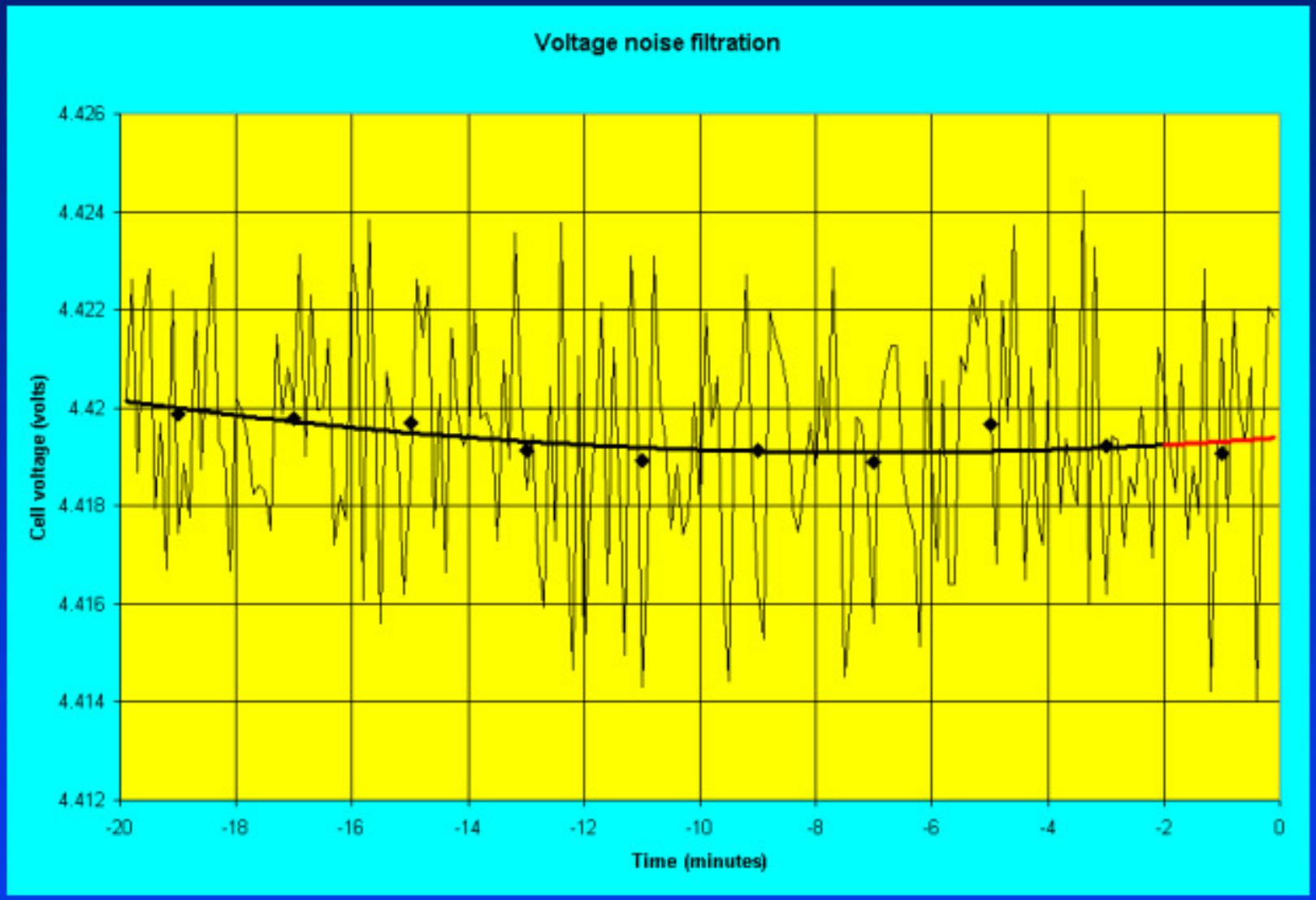
-A cell voltage free of any amperage fluctuation noise is recomputed from the cell "pseudo-resistance" using the nominal amperage.

-The cell voltage computed this way every 6 seconds is then averaged every 2 minutes.

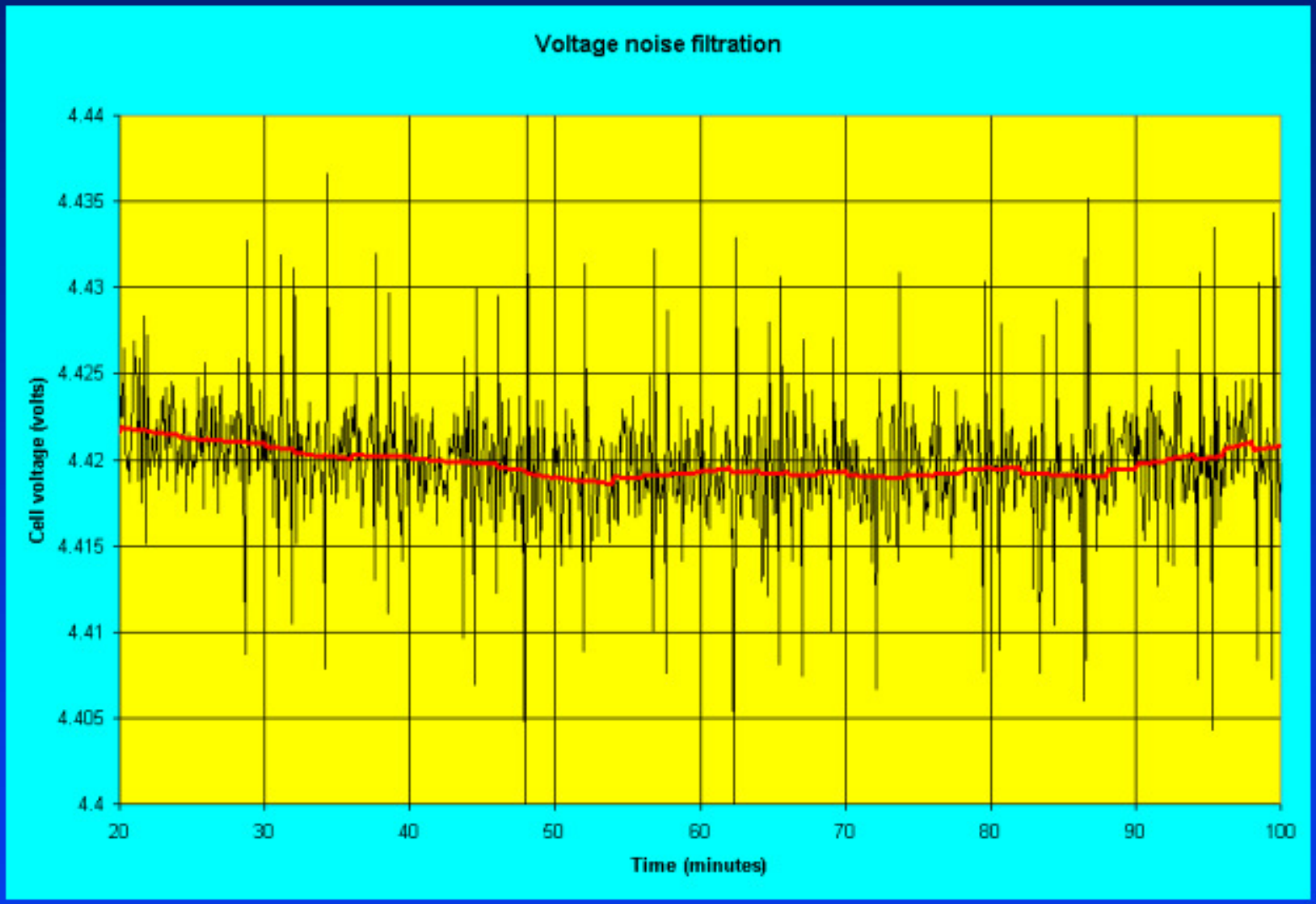
-The best parabolic curve fitting the last 10 "2 minutes averaged cell voltage" is computed.

-Finally, the slope of that parabolic curve at time 0 (linear term coefficient) is use as estimate of the cell voltage.

Noise Filtration and Slope Calculation



Noise Filtration and Slope Calculation



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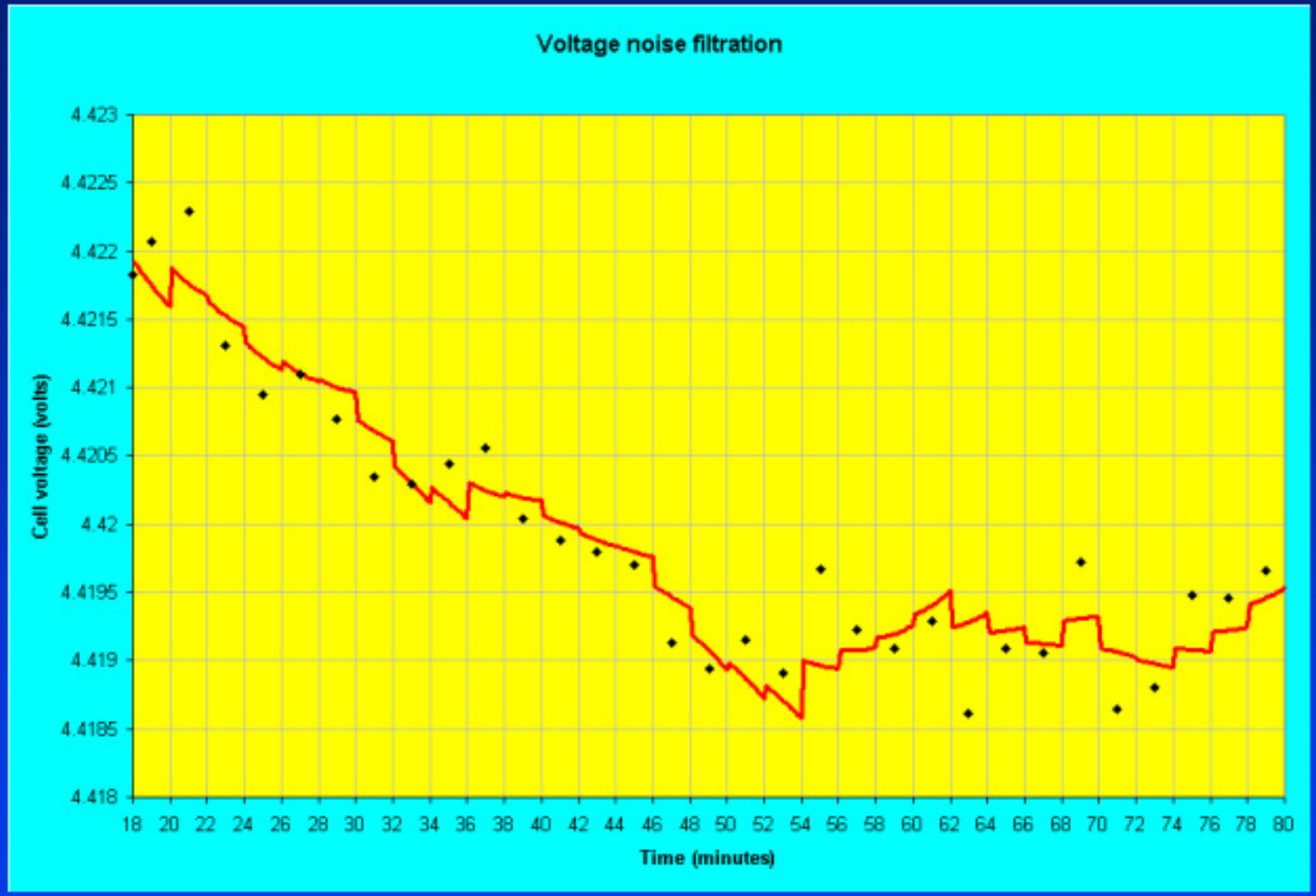

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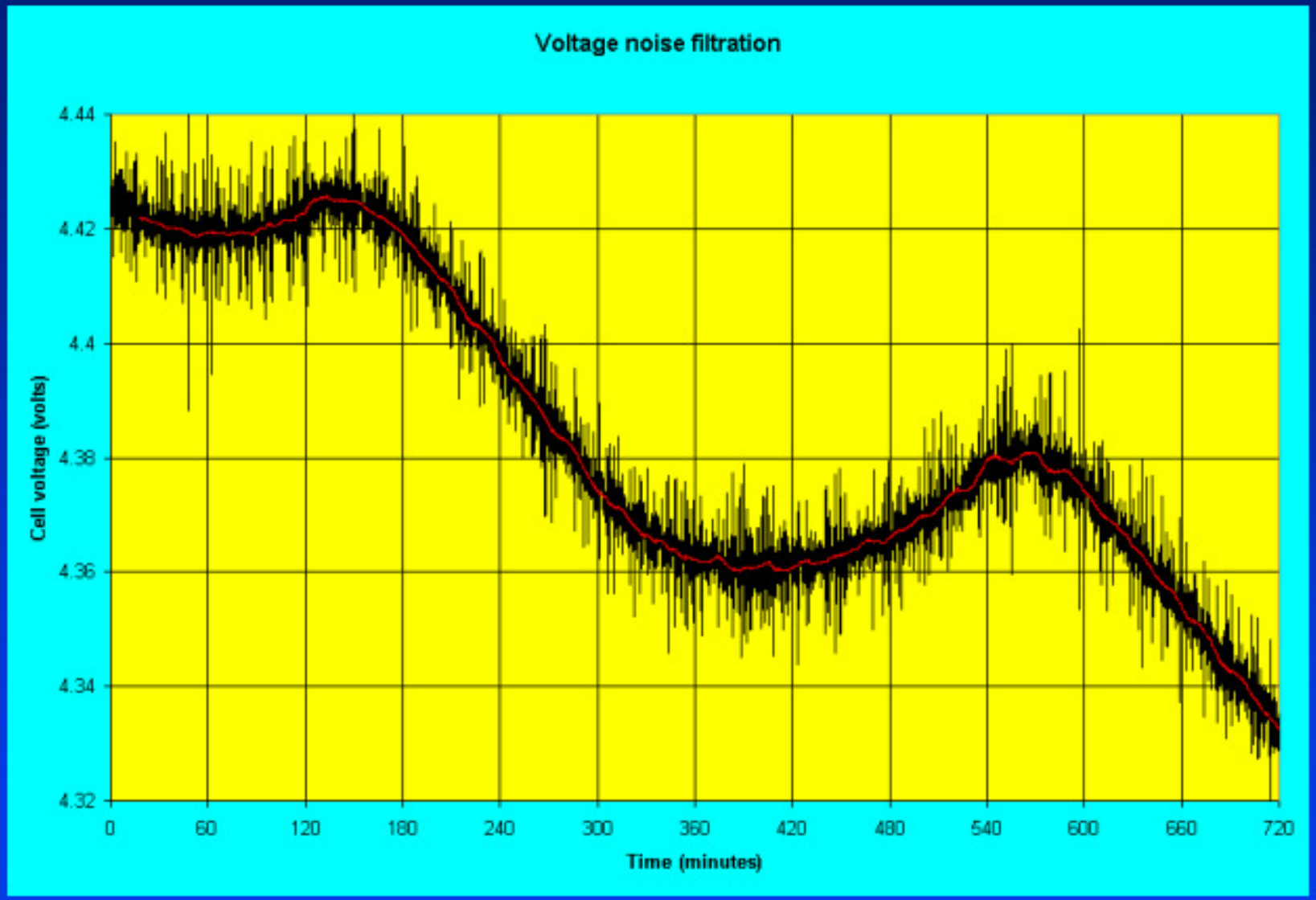
Noise Filtration and Slope Calculation



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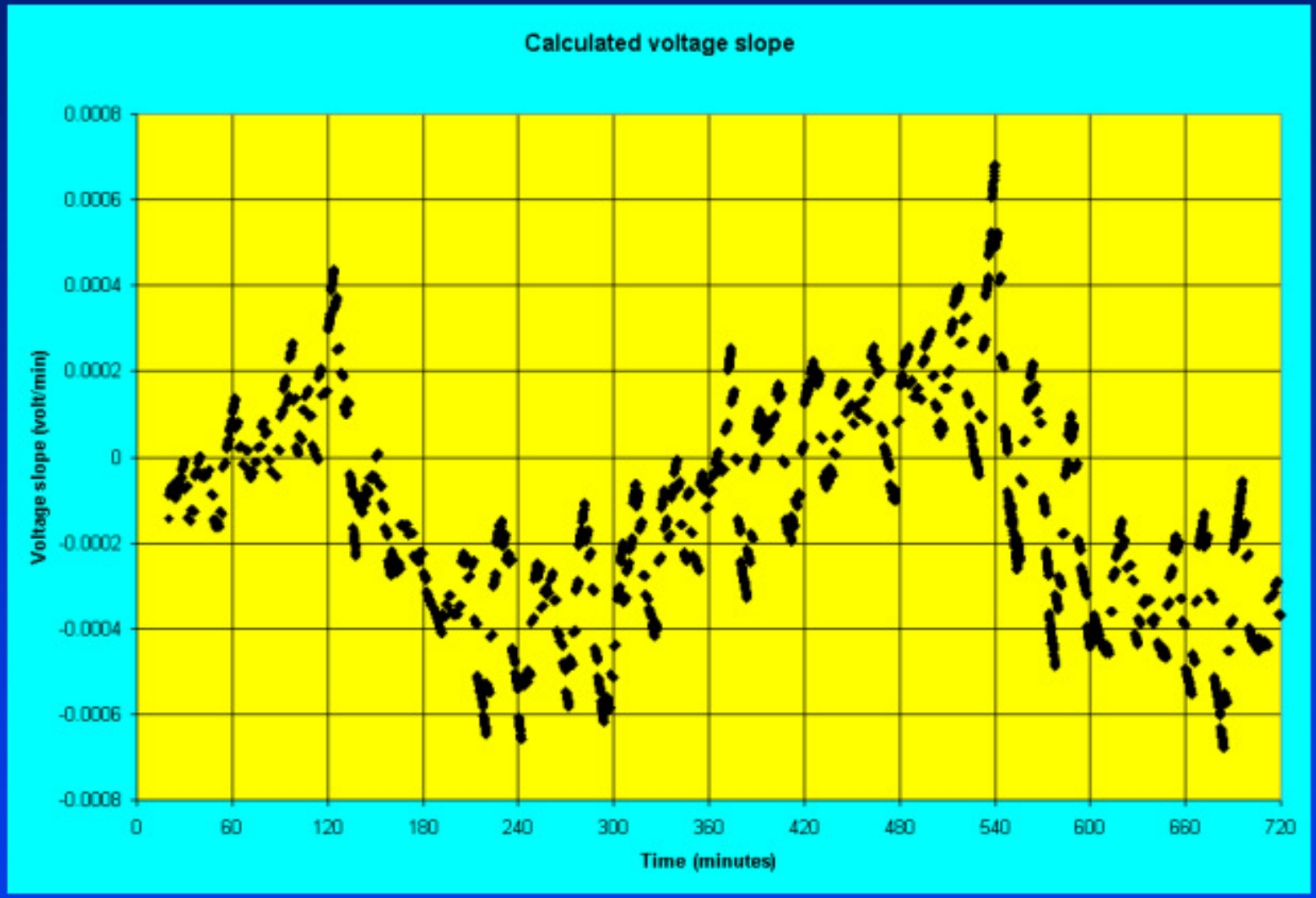
Noise Filtration and Slope Calculation



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Conclusions

- Numerical algorithms that perform cell voltage noise removal and cell voltage (or resistance) slope calculation have been compared.
- High frequency voltage noise can be successfully removed using quite simple averaging and curve fitting techniques.
- A more complex and more CPU demanding parabolic curve fitting scheme produced a noisier and less accurate cell voltage slope estimation than a simpler straight line fitting scheme.
- Next step would be to test the cell voltage noise removal algorithm "on-line" as part of a continuous tracking alumina feeding control algorithm in a dynamic cell simulator.